PSL Annual Operating Plan
(2015-2020)

PSL Strategic Plan (2016-2020)

PSL developed a strategic plan in 2016 that synthesized higher level guidance into the following two overarching science goals and three priority research goals:

Overarching Science Goals

1. Develop new knowledge and capabilities to explain observed weather and climate extremes, variations, trends, and their impacts to inform risk management and adaptation decisions.
2. Identify new sources of predictive skill and improve predictions of weather, water, and climate through observations, understanding and modeling of physical processes and phenomena of the coupled Earth system.

Priority Research Goals

1. Rigorously characterize and predict weather, water, and climate extremes and their uncertainties to inform decision-making.
2. Develop new process understanding, observing, and modeling capabilities to predict conditions associated with too much or too little water for early warning, preparedness, resource management, and adaptation.
3. Increase process understanding of the coupled Arctic system and Arctic-lower latitude interactions to improve NOAA weather, climate, and sea ice forecasts.

PSD Implementation Plan

PSL's strategic goals were implemented through 5-year strategic objectives initially aligned with the three former PSL branches (FY15):

- Climate Analysis Branch
- Water Cycle Branch
- Weather and Climate Physics Branch

later realigned with PSL's eight research teams (FY16):

- Atmosphere-Ocean Processes
- Attribution and Predictability Assessments
- Boundary Layer Observations and Processes
- Dynamics and Multiscale Interactions
- Forecast and Modeling Development
- Hydrometeorology Modeling and Applications
- Hydrometeorolgy Observations and Processes
- Polar Observations and Processes

and finally realigned with predefined performance measures (FY17-FY20):

- Research Publications - Annual number of NOAA peer reviewed publications related to environmental understanding and prediction (20/qtr)
- Research Transitions - Number of weather, water and climate research advances transitioned into applications, operations, and services to inform regional decision making (6/yr)
- Weather/Climate Assessments - Number of assessment reports providing an improved understanding and explanation of recent weather and climate extremes (4/yr)
- Targeted Observations - Number of field studies that advance the understanding and prediction of extreme weather, water and climate events (Target 8/yr)
- NGGPS/UFS Improvements - Number of studies to improve experimental local-to-global forecasting and advance NOAA's Next-Generation Global Prediction System/Unified Forecast System capabilities (6/yr)
- Integrated Earth System Studies - Number of integrated earth system research studies document and clarify the response and sensitivities of living marine resources to climate extremes, variations and change (4/yr)
- Improved Process Understanding - Number of studies that advance the understanding of key environmental processes leading to weather, water and climate extremes, variations and change (8/yr)
- Professional Development - Number staff participating in professional development and communications training (15/yr)
- Organizational Excellence - Number of PSD staff participating in activities that foster an inclusive workplace and strengthen organizational performance (25/yr)

PSL Annual Operating Plan: Milestones and Research to Operations, Applications, and Commercialization (R2X)

Progress toward meeting PSL's strategic objectives were monitored through an annual operating plan (AOP) defined by a set of annual milestones and R2X advances. The Performance Metric Manager of the NOAA Office of Atmospheric and Oceanic Research (OAR) initiated the OAR-wide annual call for milestones and R2X activities every August/September, with milestone and R2X updates requested quarterly. The tables at the end of this document summarize 2015-2020 milestone and R2X targets.

PSL Strategic Plan (2021-2025)

PSL science priorities continue to evolve. PSL has developed a new strategic plan that spans 2021-2025. The plan identifies three primary science objectives:

- Physical Science for Predicting S2S Extremes: Characterize and advance prediction of extreme weather and climate to improve forecasting with an immediate emphasis on sub-seasonal to seasonal timescales

- Physical Science for Water Resource Management: Enhance targeted observations, observation-based understanding, and modeling capabilities to forecast hydrologic extremes (too much or too little water) critical to manage water resources
- Physical Science for Marine Resource Management: Increase targeted observations, process understanding and prediction of environmental conditions impacting the marine resources.

Performance Measure or Milestone				Targets												
Cumulative Measure		Quarterly Cumulative	Yearly Cumulative	15 Q1	15 Q2	15 Q3	15 Q4	16	17	18	19	20	21	R20/R2A Link	Point of Contact	Status/Comments/Documentation
Number of ESRL-PSD peer-reviewed publications		x		41	69	101	138	80	80	80	80	80	80		R. Lataitis	Q1: 41/31 (PSD/NOAA-Library) Q2: 69/46 Q3: 101/70 Q4: 138/96
Develop one science and technology product per quarter related to PSD hydrometeorlogical, boundary layer, or ocean process understanding		x		1	2	3	4	4	4	4	4	4	4		A. White C. Fairall R. Cifelli J. Whitaker	Q1: Added operational numerical weather prediction output (HRRR and RAP models) to the award-winning PSD flux tool that is available on the PSD web site: (http://www.esrl.noaa.gov/psd/data/obs/datadisplay/ViewDataType.php?DataTypeID=67&SiteID=bby). Q2: Demonstated a new disdrometer display tool that incorporates and allows evaluation of operational QPE products such as MRMS and PRISM. Q3: Modified wind profiler signal processing algorithms to be more flexible in their application to remove contaminating signals (clutter) from the raw data. This will help optimize the quality of the final wind profile data product produced in real time. Q4: Devloped a new display that copares wind profiler observations with simulated (analysis field) wind profiles in the operational HRRR model.
Cumulative assessments of climate extreme events, anomalies and trends		x		1	0	0	2	2	2	2	2	2	2		M. Hoerling	Q1: Perlwitz, J., M. Hoerling, and R. Dole, 2014: Arctic Tropospheric Warming: Causes and Linkages to Lower Latitudes. J. Climate. doi:10.1175/JCLI-D-14-00095.1, in press. Q4:Q2: Seager, R, M. Hoerling, S.Schubert, H.Wang, B.Lyon, A.Kumar, J.Nakamura, and N. Henderson, 2014: Causes and Predictability of the 2011 to 2014 California drought, Report of the NOAA Drought Task Force. http://cpo.noaa.gov/MAPP/californiadroughtreport
Cumulative site-years of data collection, cruises, or flight projects for cryospheric, boundary layer mean and turbulent properties, hydrometeorological, and oceanic process studies			x	0	0	0	100	110	120	130	140	150	160		C. Fairall A. White	Data archives can be found at: Cryospheric: http://www.esrl.noaa.gov/psd/arctic/data/index.html Boundary Layer: http://www.esrl.noaa.gov/psd/technology/bao/ Hyrdrometeorological: http://www.esrl.noaa.gov/psd/psd2/index.html Oceanic Processes: http://www.esrl.noaa.gov/psd/psd3/cruises/
Milestone																
PSD-1															**Hoerling**	
Advance Predictive Understanding of the Climate System																
Predictability Sources	Produce two or more predictability assessments of subseasonal to decadal regional climate trends and extremes			x	x									NWS & NIDIS	Zhang, Perlwitz, Kiladis	QI: Perlwitz, J., M. Hoerling, and R. Dole, 2014: Arctic Tropospheric Warming: Causes and Linkages to Lower Latitudes. J. Climate. doi:10.1175/JCLI-D-14-00095.1, in press. Q2: Seager, R, M. Hoerling, S.Schubert, H.Wang, B.Lyon, A.Kumar, J.Nakamura, and N. Henderson, 2014: Causes and Predictability of the 2011 to 2014 California drought, Report of the NOAA Drought Task Force. http://cpo.noaa.gov/MAPP/californiadroughtreport
Models	Transfer experimental guidance for subseasonal-to-seasonal predictions to CPC				x									NWS CPC	Newman	PSD-developed tropical LIM tool - delayed until Q! of FY16 per Matt Newman due to CPC projection
Applications	Enhance the Climate Change web portal to display measures of extremes and potential tipping points in terrestrial and marine ecosystems to support fisheries science experts vulnerability assessments of U.S. marine fish stocks						x							NMFS & USBR	Alexander	The Climate Change Web Portal: a system to access and display climate and earth system model output from the CMIP5 archive. Author List: James D Scott; Michael Adam Alexander; Donald R Murray; Dustin Swales; Jon Eischeid
Foundational Science on Extreme Events																
Observations	Complete a next-generation Historic Climate Reanalysis based on more land and marine observations back to the mid 19th century, with improved Arctic representation						x							DOE	Compo	Q4: Dataset released spanning 1851 to 2011, http://www.esrl.noaa.gov/psd/data/gridded/data.20thC_ReanV2c.html
Attribution of Evolving Climate and Extremes																

Observations	Produce two or more attribution assessments of climate extremes and changes in extreme events			x			x								Hoerling, Eischeid, Quan	QI: Hoerling, M., and Coauthors, 2014: Northeast Colorado extreme rains interpreted in a climate change context [in "Explaining Extremes of 2013 from a Climate Perspective"]. Bull. Amer. Meteor. Soc., 95 (9), S15-S18. Herring, S. C., M. P. Hoerling, T. C. Peterson, and P. A. Stott, Eds., 2014: Explaining Extreme Events of 2013 from a Climate Perspective. Bull. Amer. Meteor. Soc., 95 (9), S1-S96. Q4: Cheng, L., M. Hoerling, A. AghaKouchak, B. Livneh, X. Quan, and J. Eischeid, 2015: How Has Human-induced Climate Change Affected California Drought Risk? J. Climate. doi:10.1175/JCLI-D-15-0260.1, in press. http://journals.ametsoc.org/doi/abs/10.1175/JCLI-D-15-0260.1
Models	Increase the number of climate models, and increase the total number of simulations, used to assess extreme weather and climate events					x									Allured, Xu, Zhang, Quan	Three new models were added (GFDL-AM3, NCAR-CAM5 and (NCAR-CESM1)
PSD-2															**White**	
Observations of High-Impact Weather and Water Processes																
Observations	Increase the number of hydromet observations available to better monitor and increase the predictive understanding of droughts and floods				x									Sandy Supplemental coastal AROs - local NWS WFO access to data and training	King, Johnston, White, Spackman	Milestone completed Q1: Installed, operated and maintained four surface meteorology and soil moisture sites in CA for HMT Legacy project with CA Dept. of Water Resources Q1: Installed, operated and maintained a snow-level radar in Plymouth, NH as part of an outreach project with Plymouth State University. Q1: Installed, operated and maintained an S-band precipitaiton profiler and surface meteorology station in Middletown, CA as part of a orographic precipitation project with the Sonoma County Water Agency. Q2: Conducted CalWater 2015 field study in Eastern Pacific with four research aircraft (NOAA P-3, NOAA G-IV, DOE G-I, and NASA ER2) and NOAA R/V Ron Brown focused on studying the structure of atmospheric rivers and the impact of aerosols on precipitation. Study included 444 dropsonde profiles that were made available on NOAA GTS for assimilation into numerical weather prediction models. Q4: Installed a new atmospheric river observatory for wind energy and hydromet. applications in Forks, WA. Q1-Q4: Operated and maintained three coastal Atmos. River Observatories in the Southeast U.S. as part of a Sandy Supplemental project.
Data	Develop two value-added data displays that take advantage of PSD and/or operational observing networks to support end user decision-making				x										Gottas	Milestone completed Q1: Incorporated operational numerical weather prediction output (HRRR and RAP) into the water vapor flux tool. Q2: Demonstated a new disdrometer display tool that incorporates and allows evaluation of operational QPE products such as MRMS and PRISM. Q4: Devloped a new display that copares wind profiler observations with simulated (analysis field) wind profiles in the operational HRRR model.
Data	Develop in-house AWIPS II capability to increase use of PSD observations and data products in NWS forecast operations.						x								Coleman, Gottas	Milestone completed Q2: Computer equipment ordered Q3: Attended AWIPS-II training in Huntsville, Alabama Q4: Configured baseline AWIPS-II system
Improved Understanding of High-Impact Weather and Water Processes																

Process Studies	Produce two physical process studies that provide an improved understanding of recent extreme weather and/or hydrologic events					x	x								White	Milestone completed Q1: Creamean, J. M., J. R. Spackman, S. M. Davis, and A. B. White, 2014 (Nov.): Climatology of long-range transported Asian dust along the West Coast of the United States, J. Geophys. Res. Atmos., 119, 12,171-12,185. Q1: Neiman, P. J., D. J. Gottas, A. B. White, L. J. Schick, and F. M. Ralph, 2014 (Dec.): The use of snow-level observations derived from vertically profiling radars to assess hydrometeorological characteristics and forecasts over Washington's Green River Basin. J. Hydrometeor., 15, 2522-2541. Q2: Creamean, J. M., A. P. Ault, A. B. White, P. J. Neiman, F. M. Ralph, P. Minnis, and K. A. Prather, 2015 (Jan.): Impact of interannual variations in aerosol particle sources on orographic precipitation over California's Central Sierra Nevada. Atmos. Chem. Phys. Discuss., 15, 931-964. Q2: Hsu, C., L. E. Johnson, R. J. Zamora, T. Schneider, and R. Cifelli, 2015 (Jan.): Downscaling Advanced Microwave Scanning Radiometer (AMSR-E) soil moisture retrievals using a multiple time-scale exponential rainfall adjustment technique. J Geophys. Remote Sensing, 4, 15pp. Q3: Mahoney, K., F. M. Ralph, K. Wolter, N. Doesken, M. Dettinger, D. Gottas, T. Coleman, and A. White, 2015 (Apr.): Climatology of extreme daily precipitation in Colorado and its diverse spatial and seasonal variability. J. Hydrometeor., 16, 781-792. Q3: White, A. B., P. J. Neiman, J. M. Creamean, T. Coleman, F. M. Ralph, and K. A. Prather, 2015 (Jun.): The impact of California's San Francisco Bay Area gap on precipitation observed in the Sierra Nevada during HMT and CalWater. J. Hydrometeor., 16, 1048-1069. Q4: Matrosov, S. Y., 2015 (Jul.): The use of CloudSat data to evaluate retrievals of total ice content in precipitating cloud systems from ground-based operational radar measurements. J. Appl. Meteor. Climatol., 54, 1663-1674.
Improved Prediction of High-Impact Weather and Water Processes																
Models	Produce an evaluation of a distributed hydrologic model and assess it's skill for predicting short-term high-impact hydrologic events in an operational environment.					X								Monterey WFO NWS Western Region	Johnson	Complete. Drafting Tech memo and manuscript for publication
Models	Develop an experimental capability to couple a tributary and coastal storm model to simulate coastal storm surge and flooding						x							California DWR	Cifelli	Complete
Applicatons	Literature Review and Scientific Synthesis on the Efficacy of Winter Orographic Cloud Seeding				x									USBR	Cifelli	http://www.usbr.gov/main/qoi/docs/Literature_Review_and_Scientific_Synthesis_of_the_Efficacy_of_Winter_Orographic_Cloud_Seeding_Peer_Review.pdf
PSD-3															**Fairall**	
Observations of Critical Regional Weather and Climate Processes																
Observations/Data	Collect and archive 1 year of Arctic observations to advance understanding of the surface heat balance and maintain a baseline to assess climate variability.						x								Uttal, Shupe, Crepinsek, Konopleva, Cox, Miller	at NOAA Arctic SEARCH Observatories (Tiksi, Atert, and Eureka). Miller, N. B., M. D. Shupe, C. J. Cox, V. P. Walden, D. D. Turner, and K. Steffen, 2015: Cloud radiative forcing at Summit, Greenland. J. Climate, 28, 6267-6280, doi:10.1175/JCLI-D-15-0076.1.
Observations/Data	Collect and archive data from a major field program to improve model realizations of precipitation on the U.S. West Coast.				x		x								Fairall	1 ship and 2 aircraft platforms from the CALWATER-2 field program
Observations	Design and deploy wind profiler field sites for the WFIP2 project to improve short term wind forecasts for renewable energy applications.						x								Wilczak	Completed - Instrumentation instaaledd and operations begin in FY16
Technology Development	Develop prototype fast pressure and turbulence measurement system for an Arctic-hardened ship-based flux measurement system						x								Pezoa	For the ONR Sea-State FY15 Arctic cruise
Technology Development	Develop and test UAS platforms to improve NOAA's lower polar atmospheric and surface observing capabilities						x								DeBoer	Completed - Publication in review: de Boer, G., S.E. Palo, B. Argrow, G. LoDolce, J. Mack, R.-S. Gao, H. Telg, C. Trussel, J. Fromm, C.N. Long, G. Bland, J. Maslanik, B. Schmid, and T. Hock, 2015: The Pilatus Unmanned Aircraft System for Lower Atmospheric Research, Atmos. Meas. Tech., in review. - CIRES IRP Poster: de Boer, G., C. Fairly, D. Lawrence, and D. Wolfe: Development and Evaluation of Low Cost, Unmanned Aircraft-Based Turbulent Flux Measurement Techniques - Datasets: COALA DataHawk Measurements (available at DOE ARM Archive); ERASMUS Pilatus and DataHawk measurements (to be available at ARM Archive); MetMAP (available through CU ftp site)
Improved Understanding of Critical Regional Weather and Climate Processes																

Observations - Process Studies	Evaluate impacts of spatial and temporal variability of surface-atmosphere exchanges on Arctic boundary layer climatology						x								Uttal	Completed...at IASOA sites (http://www.esrl.noaa.gov/psd/iasoa/home2)
Improved Prediction of Critical Regional Weather and Climate Processes																
Models	Release version 12 of the PSD air-sea flux parameterization that better represents the physics of very high winds (hurricanes) in global data assimilation models						x							NASA GEOS 5	Fairall	Version 12 now available. ftp://ftp1.esrl.noaa.gov/users/cfairall/onr_droplet/parameterization/version12/
Models	Run and archive an ensemble of large-eddy model simulations to evaluate ice formation mechanisms in Arctic mixed-phase clouds.						x								Shupe, Solomon	Completed: Solomon, A., G. Feingold, and M. Shupe, 2015: The role of ice nuclei recycling in the maintenance of cloud ice in Arctic mixed-phase stratocumulus. Atmos. Chem. Phys., 15, 10631-10643, doi:10.5194/acp-15-10631-2015.

Identifier (Name of Parent Project)	Brief Description	Statement of intended purpose	Lifecycle Phase Moving from: Research	Lifecycle Phase Moving from: Development	Lifecycle Phase Moving from: Demonstration	Lifecycle Phase Moving from: Operations or Applications	Lifecycle Phase Moving to: Research	Lifecycle Phase Moving to: Development	Lifecycle Phase Moving to: Demonstration	Lifecycle Phase Moving to: Operations or Applications	Target 15 Q1	Target 15 Q2	Target 15 Q3	Target 15 Q4	Date Completed Fiscal year and quarter the project will transition to operations / applications	OAR Point of Contact	OAR Responsible SES	OAR Contributing Partners	Customer	A clear statement of what condition must be met for the product advancement to have been made. This should be sufficient to allow a	Type of R2A (Choose all applicable): Operations	Type of R2A: Commercial	Type of R2A: Other	Cost of R2A Transition Funding amount to move the project into operations/ applications (Only the profile shift and NOT the total funding amount.)
Reforecasts	Transition of global medium-range reforecast capacity	Dramatically improved weather and weather-climate forecast guidance supported by reforecast data sets													Expect funding for transition in 2015-2017 timeframe	Hamill	Webb		NCEP/EMC		x			
Sea Surface Temperature Diurnal Warming Amplitude Estimates	Modeled global estimates of instantaneous SST diurnal amplitude based on NWP analyses for incorporation in operational Gobal SST analysis	Improved SST product accuracy enabled by correction for diurnal warming influences on individual satellite retrievals													NESDIS Algorithm Readiness Review scheduled for April 2015; product operationalization to follow	Wick	Webb		NESDIS		x			
Ensemble Kalman Filter Data Assimilation System	An ensemble-based data assimilation technique that incorporates flow-dependent estimates for forecast uncertainty. Became operational at NCEP in 2012.	Improved accuracy of forecast initial conditions, which improves forecast skill													Implemented in NCEP operations May 2012, further improvements in subsequent upgrades.	Whitaker	Webb		NCEP/EMC		x			
Stochastic Parameterizations of Model Uncertainty	Improves the representation of model uncertainty in ensemble forecast, improving forecast reliability and analysis accuracy. Became operational in the EnKF DA system at NCEP in 2014.	Improved reliability of forecast ensembles, improved analysis accuracy.													Implemented in NCEP operations in 2015 for the EnKF analysis cycle, preparing for implementation in the medium range global ensemble system in 2016.	Whitaker	Webb		NCEP/EMC		x			
Hydrometeorology Testbed observations	Research observations collected throughout U.S., but most notably in CA	Provides real-time access to NWS offices, including RFC's with SHEF-encoding													2013-2015	Gottas	Webb		NWS Western Region		x			
Streamflow forecasts	Distributed hydrologic model applied to Russian River basin, CA	Provides streamflow everywhere in the basin - not just forecast points													2014-2015	Johnson	Webb		NWS Western Region, CNRFC, and MTR WFO		x			

Automated Digital Frost Forecast System	Gridded Frost and heat forecasts for Russian River basin, CA	Forecasts allow water agency to plan for reservoir releases to accommodate crop spraying to mitiage for frost/heat. Growers can augment storage ponds prior to event to mitgate drawn-downs in tributaries and mainstem Russian on frost days. Goal is to elimi													2014-2015	Reynolds	Webb		NWS Western Region, Sonoma County Water Agency, Sonoma-Mendocino County grape growers, Western Wx Group and Fox Weather - Commerical wx forecast vendors for		x	x	x	
C-LIM tropical forecasts	Empirical model yielding forecasts (and a priori forecasts of forecast skill) for pentads (5-day running means) of tropical SSTs, OLR, and 200/850 mb winds, for forecast leads of 5-270 days.	CLIM will provide a nice complement and alternative for the forecast of anomalous tropical convection to that produced from purely physical models (i.e. CFS, etc.). CPC is already using the C-LIM to aid the NWS operational Global Tropics Hazards and Benef													End of FY15Q4	Newman	Webb		NOAA/NWS/CPC		x			
Air quality PM2.5 post-processing algorithms. DjalalovaIrina	A set of codes to improve the skill of the NOAA/NCEP CMAQ air quality model for ozone and particulate matter forecasts through application of analog and Kalman filter post-processing schemes	Post-processing of PM2.5 forecasts greatly improves model forecast skill, and an automated analog post-processing scheme reduces the need for state and local air quality forecasters to apply their own subjective corrections to the model forecasts													2014-2015	Djalalova	Webb		NWS/National Center for Environmental Prediction, EPA, state and local air management disctricts		x		x	

Performance Measure or Milestone			Quarterly Cumulative	Yearly Cumulative	Targets										Point(s) of Contact	Reporting Level			Tracked R2X	Funding Source or Sponsor	Status/Comments/Documentation
	Cumulative Measure				FY16 Q1	FY16 Q2	FY16 Q3	FY16 Q4	FY17	FY18	FY19	FY20	FY21	FY22		Director	Team Lead	Team Member			
Reporting Performance Measures (required)	Number of ESRL-PSD peer-reviewed publications		x		32	50	60	80	80	80	80	80	80	80	Lataitis	x					Q1: 20 Q2: 40 Q3: 60 Q4: 80
	Develop one science and technology product per quarter related to PSD hydrometeorlogical, boundary layer, or ocean process understanding		x		1	2	3	4	4	4	4	4	4	4	All	x					Q1:Created informational document for stakeholder on the Evaporative Demand Drought Index (EDDI), R2X: transitioned to Drougth.gov (http://www.drought.gov/media/EDDI_2-pager.pdf) Q2: The Grell-Freitas cumulus covective scheme has been ported to the GFS and is being tested with both high-resolution weather forecasts and lower resolution climate simulations. Q3:An AWIPS-2 plugin to display wind profiler data, e.g., from the West Coast network of 449-MHz wind profilers has been developed and tested. In order for it to get to forecast offices, WMO IDs need to be assigned to the sites that will be displayed in AWIPS-2. The NWS is responsible for assigning WMO IDs. Q4:
	Cumulative assessments of climate extreme events, anomalies and trends		x		1	1	1	2	2	2	2	2	2	2	Perlwitz	x					Q1:Published: Stephanie C. Herring, Martin P. Hoerling, James P. Kossin, Thomas C. Peterson, and Peter A. Stott, 2015: Introduction to Explaining Extreme Events of 2014 from a Climate Perspective. Bull. Amer. Meteor. Soc., 96, S1–S4. Q3:Published: Klaus Wolter, Jon K. Eischeid, Xiao-Wei Quan, Thomas N. Chase, Martin Hoerling, Randall M. Dole, Geert Jan Van Oldenborgh, and John E. Walsh, 2015: How Unusual was the Cold Winter of 2013/14 in the Upper Midwest?. Bull. Amer. Meteor. Soc., 96, S10–S14.
	Cumulative site-years of data collection, cruises, or flight projects for cryospheric, boundary layer mean and turbulent properties, hydrometeorological, and oceanic process studies			x	0	0	0	110	120	130	140	150	160	170	Fairall White Uttal	x					Cryospheric: http://www.esrl.noaa.gov/psd/arctic/data/index.html Boundary Layer: http://www.esrl.noaa.gov/psd/technology/bao/ Hyrdromet: http://www.esrl.noaa.gov/psd/psd2/index.html Oceanic Processes: http://www.esrl.noaa.gov/psd/psd3/cruises/ Arctic Atmosphere http://www.esrl.noaa.gov/psd/iasoa/dataataglance
		Milestone																			
	Atmosphere-Ocean Processes - AOP														**Alexander Dias**						
Reporting Milestones (required)		Develop empirical models of S2S (subseasonal-seasonal) and interannual-to-decadal climate dynamics, to benchmark forecast skill and to diagnose how predictability is driven by the coupled interaction of atmospheric, oceanic, and land surface processes						x							Newman		x	x			
		Establish metrics that relate the transport of moisture from the tropics to higher latitudes and its impact on moisture transport and precipitation over North America.					x								Kiladis Alexander Newman		x	x			Completed. Paper published: Swales D., M. Alexander, and M. Hughes, 2016: Examining moisture pathways and extreme precipitation in the U.S. Intermountain West using self-organizing maps, Geophys. Res. Lett., 43, 1727-1735. doi:10.1002/2015GL067478.
		Develop improved understanding of processes driving key modes of tropical variability on a range of spatial and temporal scales				x									Kiladis Dias		x	x			Completed. Two papers have been accepted an are in press in the Journal of Atmospheric Sciences: Kiladis, G. N., J. Dias, and M. Gehne, 2016: The relationship between equatorial mixed Rossby-gravity and eastward inertio-gravity waves: Part I, and Dias, J., and G. N. Kiladis, 2016: The relationship between equatorial mixed Rossby-gravity and eastward inertio-gravity waves: Part II
		Provide model fields and guidance on their use to NOAA fisheries and the marine ecosystem scientists for the assessment of the impact of climate change on living marine resources.			x										Alexander		x	x			Completed. A vulnerability assessment for the impact of climate change on fish in the northwest Atlantic was completed. A techinical report describing the method and a journal article describing the results were published: Morrison, W.E., M. W. Nelson, J. F. Howard, E. J. Teeters, J. A. Hare, R. B. Griffis, J.D. Scott, and M.A. Alexander. 2015. Methodology for Assessing the Vulnerability of Marine Fish and Shellfish Species to a Changing Climate. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OSF-3, 48 p. Hare, J., W. E. Morrison, M. W. Nelson, M. M. Stachura, E.J. Teeters, R. B. Griffis , M. A. Alexander, J. D. Scott, and coauthors, 2016: A vulnerability assessment of fish and invertebrates to climate change on the Northeast U.S. Continental Shelf. published on-line in PLOS ONE
Tracking Milestones (optional)		Understand the processes that contribute to the Pacific Decadal Oscillation				x									Alexander Newman			x			Completed. Newman, M., M. A. Alexander, T. R. Ault, K. M. Cobb, C. Deser, E. Di Lorenzo, N. J. Mantua, A. J. Miller, S. Minobe, H. Nakamura, N. Schneider, D. J. Vimont, A. S. Phillips, J. D. Scott, and C. A. Smith, 2016: The Pacific Decadal Oscillation, Revisited. J. Climate, in press, doi: 10.1175/JCLI-D-15-0508.1.
		Document the impact of sea ice changes and model resolution in the stratosphere on the climate system - publish findings in journal articles.					x								Sun Alexander			x			Completed two papers: Sun, Lantao, Judith Perlwitz and Martin Hoerling, 2016: What caused the recent "Warm Arctic, Cold Continents" trend pattern in winter temperatures? Geophys. Res. Lett., doi: http://dx.doi.org/10.1002/2016GL069024. Polvani, Lorenzo, Lantao Sun, Amy H. Butler, Jadwiga H. Richter and Clara Deser, 2016: Stratospheric sudden warmings overwhelm ENSO as drivers of wintertime climate variability over the North Atlantic and Eurasia. J. Climate, Submitted
		Conduct research on the impact of climate change on high latitude seas and on ocean extremes; communicate the results to NOAA fisheries and submit manuscripts to appropriate journals						x							Alexander			x			
		Quantify the convective makeup of the Madden-Julian Oscillation (MJO) in observations, using space-time spectral and wavelet analysis techniques of satellite cloudiness and reanalysis data.				x									Kiladis Dias			x			Two manuscripts are nearing completion for submission, one by Dias and Kiladis "Influences of the MJO on space-time tropical convection organization" and one by Kikuchi, Kiladis Dias and Nasuno entitled "Convectively coupled equatorial waves within the MJO during CINDY/DYNAMO". Results were presented in two talks, one by Kiladis and the other by Kikuchi at the AMS Tropical Meteorology conference in April, 2016.
		Establish metrics that relate the phenomenon of Rossby wave breaking within the extratropics to the transport of moisture from the tropics to higher latitudes.						x							Kiladis Dias			x			In progress. Working with John Albers of AOP, we are examining the statistics of Rossby wave breaking in two reanalysis datasets, ERA-Interim and MERRA, and we are comparing the implications of the differences between them for the transport of moisture and the global budget of moisture as it relates to precipitation variabilitly on intraseasonal time scales.
		Diagnosis of tropical dynamics using LIM, exploring what changes in ENSO variability/diversity/predictability on decadal time scales are due to predictable dynamics vs. due to unpredictable noise, under both natural and anthropogenic scenarios in CMIP5 models and the various CESM1 experiments.			x										Newman			x			Completed. Developed a regionally-based Linear Inverse Model (LIM) which was applied to observations and to fields from a number of the CMIP5 climate models.
		Test the suitability of coupling a LIM to physically-based numerical models for use in seasonal-decadal predictability analyses and diagnoses of CGCM errors in coupled variability						x							Newman			x			

		Explore the seasonality of the soil moisture autocorrelation statistics in models and "data" and its impact on seasonal-decadal variability and predictability					x								Newman			X			Analysis of observationally-based NLDAS datasets and ICN/SNOTEL station datasets is complete; paper entitled "Potential reemergence of seasonal soil moisture anomalies in North America" is in preparation to be submitted to Journal of Climate.
		Continue to develop web-based tools for presenting information on climate varaibility, such as the MJO, and climate change			x										Alexander Kiladis			X	X		Completed. Developed computer code that computes frequency cross-spectra at each longitude given two data sets and the latitude that the user wants to analyze.
	Attribution and Predictability Assessments - APA														**Perlwitz Rangwala**						
Reporting Milestones (required)		Produce two or more predictabilty assessments for subseasonal to decadal time scales in order to quantify the prospects and gaps for skillful predictions				x		x							Zhang	X	X			CPO/CDEP	Completed (4 papers): Zhang, T., M. P. Hoerling, J. Perlwitz, and T. Xu, 2016: Forced Atmospheric Teleconnections During 1979-2004. J. Climate, 29, 2313-2332. Hoell, A., M. Hoerling, J. Eischeid, K. Wolter, R. Dole, J. Perlwitz, T. Xu and L. Cheng, 2015: Does El Niño Intensity Matter for California Precipitation?, Geophysical Research Letters, doi: 10.1002/2015GL067102 L. Sun, J. Perlwitz, and M. Hoerling, 2016: "What caused the recent "Warm Arctic-Cold Continents" trend pattern in winter temperatures? Geophys. Res. Lett., DOI: 10.1002/2016GL069024. Hoell, A., C. Funk, J. Zinke, L. Harrison, 2016: Modulation of the Southern Africa precipitation response to the El Niño Southern Oscillation by the subtropical Indian Ocean Dipole, Clim. Dyn.. doi:10.1007/s00382-016-3220-6
		Advance the predictive understanding of the physics of drought to improve monitoring and forecasting of drought conditions						x							Hoerling	X	X			USGCRP-Drought	Completed (Two papers): Siegfried D. Schubert, Ronald E. Stewart, Hailan Wang, Mathew Barlow, Ernesto H. Berbery, Wenju Cai, Martin P. Hoerling, Krishna K. Kanikicharla, Randal D. Koster, Bradfield Lyon, Annarita Mariotti, Carlos R. Mechoso, Omar V. Müller, Belen Rodriguez-Fonseca, Richard Seager, Sonia I. Seneviratne, Lixia Zhang, and Tianjun Zhou, 2016: Global Meteorological Drought: A Synthesis of Current Understanding with a Focus on SST Drivers of Precipitation Deficits. J. Climate, 29, 3989–4019, doi: 10.1175/JCLI-D-15-0452.1. Ben Livneh and Martin P. Hoerling, 2016: The Physics of Drought in the U.S. Central Great Plains. J. Climate, 29, 6783–6804, doi: 10.1175/JCLI-D-15-0697.1.
		Produce two or more attribtution assessments of causes of high-impact weather and climate events			x			x							Hoerling Wolter	X	X			USGCRP-Extremes	Completed (3 papers): Stephanie C. Herring, Martin P. Hoerling, James P. Kossin, Thomas C. Peterson, and Peter A. Stott, 2015: Introduction to Explaining Extreme Events of 2014 from a Climate Perspective. Bull. Amer. Meteor. Soc., 96, S1–S4. Klaus Wolter, Jon K. Eischeid, Xiao-Wei Quan, Thomas N. Chase, Martin Hoerling, Randall M. Dole, Geert Jan Van Oldenborgh, and John E. Walsh, 2015: How Unusual was the Cold Winter of 2013/14 in the Upper Midwest?. Bull. Amer. Meteor. Soc., 96, S10–S14. Martin Hoerling, Jon Eischeid, Judith Perlwitz, Xiao-Wei Quan, Klaus Wolter, and Linyin Cheng, 2016: Characterizing Recent Trends in U.S. Heavy Precipitation. J. Climate, 29, 2313–2332, doi: 10.1175/JCLI-D-15-0441.1.
Tracking Milestones (optional)		Finalize study on the impact of El Nino on California Precipitation			x													X			
		Conduct research on the physics of Great Plains Drought					x								Joe and Candida			X			Manuscript in final stages co-authored, Dewes et al.) titled " Uncertainties in drought risk assessment under climate change because of differences in methodological choices for the estimation of evaporative demand"
		Carry out an extreme event study for a 2014 event			x													X			Completed: Klaus Wolter, Jon K. Eischeid, Xiao-Wei Quan, Thomas N. Chase, Martin Hoerling, Randall M. Dole, Geert Jan Van Oldenborgh, and John E. Walsh, 2015: How Unusual was the Cold Winter of 2013/14 in the Upper Midwest?. Bull. Amer. Meteor. Soc., 96, S10–S14.
		Carry out a study on the predictability due to forced atmospheric teleconnections				x												X			Completed: Zhang, T., M. P. Hoerling, J. Perlwitz, and T. Xu, 2016: Forced Atmospheric Teleconnections During 1979-2004. J. Climate, in press.
		Carry out a study of the causes of the 2015 Texas flooding						x										X			
		Carry out research on the drivers of evapotranspiration in Northern Great Plain						x										X		DOI-NCCSC	
		Carry out a study examining Arctic impacts on extreme weather						x										X			
		Participate in knowledge transfer activities including briefings of stakeholders and resource managers.			x	x	x	x										X	see comments		Q1: Created informational document for stakeholder on the Evaporative Demand Drought Index (EDDI), R2X: transitioned to Drougth.gov (http://www.drought.gov/media/EDDI_2-pager.pdf) Q1: Briefing for Water Utility Climate Alliance (WUCA) on Attribution Science addressing General Managers from the largest Water Utilities in the US Q2: Wrote memo for Water Utility Climate Alliance on state of climate science to support their strategic planning. (Joe) Q2:Participated in and wrote recommendations for Great Lakes Integrated Sciences and Assessment (GLISA) Ensemble Advisory committee to develop and evaluate climate projections. (Joe) Q2:Published Meeting Report "High-Resolution Climate Modeling for Regional Adaptation" in EOS, AGU. (Joe, Imtiaz, Candida) Q2: Product: Developed software to calculate and display EDDI (Evaporative Demand Drought Index), which is used by the Wind River Indian Reservation, on the Western Water Assesment Climate Dashboard and Rocky Mountain/High Plains Dashboard, and will be used by other stakeholders for their regional products [Candida, incollaboration with HMA team Mike Hobbins] Q2: Briefing to Steve Torbit (Assistant Regional Director for Science Applications, U.S. Fish and Wildlife Service), climate considerations for the FWS evaluation of the Canadian Lynx for developing a recovery plan under the Endangered Species Act (Andrea) Q2: Briefing on regional climate science to public and tribal lands managers in southwest South Dakota, as part of a National Park Service scenario planning workshop, held January 20-21, 2016 in Rapid City; and participated in ongoing discussions with the NPS scenario planning teamabout to provide relevant climate information for this project. (Andrea) Q2: Six stakeholder briefings on seasonal outlook for climate and water for the following: State of Colorado Water Availability Task Force (2 briefings), Colorado Water Congress, California Dept. of Water Resources (2 briefings), Nevada Water Resources Association. Other agencies briefed during these events include NOAA River Forecast Centers, Colorado River Conservation District, Reclamation [Wolter] Q2: Media briefings for KUNC, Weather Underground, Grand Junction Sentinel, Boulder Daily Camera. [Wolter]
	Boundary Layer Observations and Processes - BLO														**Fairall Bianco**						
Reporting Milestones (required)		Collect and archive data from three major ship field programs to improve model realizations of air-sea fluxes.			x	x		x							Fairall Bianco		X			CPO/COD, ONR	Completed the ONR Sea State cruise on Nov. 11, 2015. Data is archived at : ftp://ftp1.esrl.noaa.gov/psd3/cruises/SeaState_2015/ . Cruise abord Australian ship R/V Investigator Mar. 15-Apr. 20.
		Collect and archive one year's worth of data from Pacific northwest field sites in support of the WFIP2 project to improve short term wind forecasts for renewable energy applications.						X							Fairall Bianco		X			DOE	

		Investigate extension of surface-layer turbulent scaling theory to lowest few hundred meters of the marine boundary layer to ipmrove air-sea flux paramterizations in global climate models.						x							Fairall		X			NOAA	Dropsonde data from pre-CALWATER, CALWATER2, DYNAMO, and ENRR have been analyzed. In the tropics there are issues in the lowest 50 m. Still investigating.
Tracking Milestones (optional)		Collect PSD air-sea flux data into a single easy-to-use file						x							Fairall			X		CPO/COD	Version 1 has been created with 59,000 1-hr air-sea flux estimates. Currently analyzing to correct problems. Plan to extend by adding 1 or 2 more recent cruises. Contacted Prof. J. Edson (U. Conn) to add his observations.
																		X			
	Dynamics and Multiscale Interactions - DMI														**Voronovich Compo**						
Reporting Milestones (required)		Produce two or more studies that illustrate the potential of using using satellite- and airborne-based electromagnetic soundings to retrieve soil moisture, and winds and wave spectra over the ocean.				x		x							Voronovich Zavorotny		X				Two papers: A. Voronovich, V. Zavorotny, "Determination of surface reflectivity using radio signals of opportunity" and A. Voronovich, V. Zavorotny, "Measurement of ocean wave directional spectra using airborne HF/VHF synthetic aperture radar: an evaluation" were submitted to Waves in Random and Complex Media and IEEE Trans. on Geosci. and Remote Sensing, correspongly.
		Provide analysis fields and guidance on the use of the 20th Century Reanalysis for improved understanding of historical extreme events and climate variability and change					x								Compo		X				Completed at go.usa.gov/XTd, including links to publications.
		Develop physically based probability models relevant for the detection and attribution of changes in extreme anomaly statistics in a changing mean climate.						x							Penland Compo Sardeshmukh		X				Completed work for two papers: 1. Sardeshmukh, Compo, McColl, Penland: Unexpected impacts of global warming on regional temperature extremes, and 2. Sardeshmukh, Wang: Dynamic versus Thermodynamic control of regional precipitation variations and extremes.
Tracking Milestones (optional)																		X			
																		X			
	Foecast and Modeling Development - FMD														**Whitaker Pincus/Pegion**						
Reporting Milestones (required)		Develop and test two potential improvements to the NCEP operational data assimilation system.				x		x							Whitaker		X	X		NGGPS	1- testing very large ensembles for the data assimilation, which will elimate the need for localization in the EnKF
		Develop and test two potential improvements to the physical parameterizations used in the NCEP operational prediction suite.				x		x							Pegion		X	X		NGGPS	1-The Grell-Freitas cumulus covective scheme has been ported to the GFS and is being tested with both high-resolution weather forecasts and lower resolution climate simulations. 2-testing with the new boundary layer and shallow convective scheme (SHOC) has begun, and will lead to informing new stochastic physics shcemes for the GFS.
Tracking Milestones (optional)		Test a new method of producing calibrated forecast products using reforecast datasets.						x										X			
		With collaborators, develop a new radiation package for atmospheric models that increases efficiency, accuracy, and flexibility.						x							Pincus			X			
	Hydrometeorology Modeling and Applications - HMA														**Zamora (Acting) Hughes**						
Reporting Milestones (required)		Produce at least one physical process study that provides improved understanding of recent extreme weather and/or water events and can be used to inform prediction models						x							Kingsmill		X	X			Point of contact for this effort has left PSD. An initial extreme weather study was completed and power point presentation developed and shared with other members of HMA. This study is not currrently advanced sufficiently for publication purposes. Currently waiting for approval from Front Office to moce forward with the study in FY17.
		Prototype coupling of tributary and coastal storm models to simulate hydrologic runoff and coastal storm surge					x								Johnson		X	X			Completed initial prototype demonstrating data exchange between watershed distributed and coastal hydrodynamic models in the Napa river basin. Work is on-going to produce more sophisticated coupling using a variety of surface flood inflows and soil moisture conditions to interface with the coastal storm surge model.
		Develop a regional assessment capability for selected extreme precipitation and hydrologic runoff events using a coupled atmosphere-terrestrial modeling framework				x									Mahoney		X	X			Completed. Presented at AMS 30th Conference on Hydrology. Title: Examining terrain elevation assumptions used in current extreme precipitation estimation practices: A modeling study of the 2013 Colorado Front Range floods. Authors: K. Mahoney, J. Lucas, and B. McCormick
Tracking Milestones (optional)		Conduct preliminary testing of soil moisture data assimilation for a distributed hydrologic model				x									Zamora			X			Completed. Poster presentation AMS 30th Conference on Hydrology. Title: Testing a successive correction based data assimilation methodology in the NWS Hydrology Laboratory Research Distributed Hydrological Model. Authors: Robert Zamora, Andrea Thorstensen, and Rob Cifelli
	Hydrometeorlogy Observations and Processes - HOP														**White Jackson**						
Reporting Milestones (required)		Produce two physical process studies that provide an improved understanding of recent extreme weather and/or hydrologic events					x	x									X			NOAA	Completed. Q1: Coplen, T. C., P. J. Neiman, A. B. White, and F. M. Ralph, 2015: Categorisation of northern California rainfall for periods with and without a radar brightband using stable isotopes and a novel automated precipitation collector. *Tellus B* , **67**, 28574. Q2: Neiman, P. J., B. J. Moore, A. B. White, G. A. Wick, J. Aikins, D. L. Jackson, J. R. Spackman, and F. M. Ralph: An Airborne and Ground-Based Study of a Long-Lived and Intense Atmospheric River with Mesoscale Frontal Waves Impacting California during CalWater-2014. Mon. Wea. Rev., **144**, 1115-1144. Q3: Mahoney, K., D. L. Jackson, P. Neiman, M. Hughes, L. Darby, G. Wick, A. White, E. Sukovich, and R. Cifelli: Understanding the role of atmospheric rivers in heavy precipitation in the Southeast US, Mon. Wea. Rev., **144**, 1617-1632.
		Produce two observing system science studies that describe new instruments, new instrument algorithms, or instrumented field campaigns			x			x									X			NOAA	Completed. Q1: White, A. B., K. M. Mahoney, R. Cifelli, and C. W. King, 2015: Wind profilers to aid with monitoring and forecasting of high-impact weather in the Southeastern and Western United States. *Bull. Amer. Meteor. Soc* ., **96**, 2039–2043. Q2: Behrangi A., B. Guan, P. J. Neiman, M. Schreier, and B. Lambrigtsen, 2016: On the quantification of Atmospheric Rivers precipitation from space: Composite assessments and case studies over the Eastern North Pacific Ocean and the Western United States. *J. Hydrometeo* r., **17**, 369–382.
		Increase the number of hydromet observations available to better monitor and increase the predictive understanding of droughts and floods			x	x											X			U.S. DOE, Callifronia Dept. of Water Resources, Sonoma County Water Agency	Completed. Q1: Installed three 1/4-scale 449-MHz wind profilers with RASS and surface met. stations in Oregon and Washington for a contract with the Pacific Northwest National Laboratory and in support of the second Wind Forecast Improvement Project (WFIP2). Q1: Installed four 915-MHz Boundary-layer wind profilers with RASS and surface met. stations in and near the Columbia River Basin for a contract with U.S. DOE and in support of WFIP2.

		Develop and implement a capability to dispaly a PSD data product in AWIPS2 environment to better infuse experimental reserach products into an operational setting					x										X		X	NOAA/USWRP	In Progress. An AWIPS-2 plugin to display wind profiler data, e.g., from the West Coast network of 449-MHz wind profilers has been developed and tested. In order for it to get to forecast offices, WMO IDs need to be assigned to the sites that will be displayed in AWIPS-2. The NWS is responsible for assigning WMO IDs.
Tracking Milestones (optional)																		X			
																		X			
	Polar Observations and Processes - POP														**Uttal Shupe**						
Reporting Milestones (required)		Lead the International Arctic Systems to Observe the Atmosphere (www.iasoa.org) to provide access to pan-Arctic atmospheric continuous station data and coordinate international research teams that will advance understanding the role of the Arctic atmosphere in the Arctic system with observation-based and reanalysis-based research						x							Uttal		X	x		NOAA/CPO/ARP NOAA/ESRL/PSD	Q4: COMPLETED:. 5 science working groups have met on a regular schedule (every 6 weeks) on the topics of radiation, surface-atmosphere exchanges, regional processes and transports, surface ozone, and GHG. Each working group has had signficant outcomes with peer-reviewed publications, white papers, new processing technqiues, and new instruments installations. http://www.esrl.noaa.gov/psd/iasoa/science. Publication: International Arctic Systems for Observing the Atmosphere (IASOA): An International Polar Year Legacy Consortium, 2016: Uttal, T + 52 co-authors, Bull Amer. Met. Soc, 97, 1033-1056.
		Conduct field programs and intensive campaigns in and around the Arctic Ocean to result in comprehensive data sets and conduct process studies to understand the detailed physics of Arctic cloud-atmosphere-aerosol-surface flux interactions that will improve model performance						x							Shupe deBoer Persson Fairall		x	x		NSF/DOE/ONR/NOAA	Q4: COMPLETED: PSD scientists participated in the Sea State project in the Beaufort Sea, making measurements of atmospheric parameters and surface fluxes. PSD scientists flew unmanned aircraft to measure atmosphere and surface properties at Oliktok Point, Alaska. PSD scientists lead year round observations of clouds, atmospheric structure, and radiation at Summit, Greenland. All three of these activities have lead to the production of data sets that are being used to study physical processes in the Arctic system. Some of the measurements are specifically being used to evaluate PSD modeling tools.
		Develop a RASM-ESRL model to produce regional 5-day ice forecasts and hindcasts for the Alaska and Arctic region to understand physical proccesses impacting sea-ice forecast skill and interface with the NWS NCEP and the Alaska Testbed to compare against operational sea-ice forecasting models						x							Intrieri Solomon Persson			x		NOAA/OAR/ESPC	Q3: COMPLETED: http://www.esrl.noaa.gov/psd/forecasts/seaice/
Tracking Milestones (optional		Publish an article describing the IASOA consortium that includes preliminary science results and directrions of working groups			x										Uttal		x	x		CPO/ARP	Q3: COMPLETED: International Arctic Systems for Observing the Atmosphere (IASOA): An International Polar Year Legacy Consortium, 2016: Uttal, T + 52 co-authors, Bull Amer. Met. Soc, 97, 1033-1056. Cyberinfrastructure and Collaboratory Support for the Integration of Arctic Atmospheric, 2016: Starkweather S. and T. Uttal, Bull. Amer. Met. Soc., 97, 917-922.
		Test statistical model of seasonal sea-ice forecasting based on station radiation anomolies and publish results					x								Cox Uttal		x	x		CPO/ARP	Q4: COMPLETED: The Role of Springtime Arctic Clouds in Determining Autumn Sea Ice Extent, 2016: Cox C.J., T. Uttal, C.N. Long, M.D. Shupe, R.S. Stone and S. Starkweather, J. Climate, 29, 6581-6596.
		Collect and archive continous data from NOAA supported instrumentation at Alert and Eureka Canada and Tiksi, Russia						x							Uttal		x			CPO/ARP	Q4: COMPLETED AND ONGOING: Site Visit to Eureka site with significant upgrades and maintenance of instrumentation. Collctionand archiving of 1 year of data (Arctic Atmosphere) for Eureka, Alert and Tiksi stations.
		Collect PSD air-land Arctic flux data into a single easy-to-use file and publish					x								Uttal Grachev Crepinsek Konopleva		x	x		CPO/ARP	Q4: ON-GOING: Data is processed and publication to ftp site: ftp://ftp1.esrl.noaa.gov/psd3/arctic/tiksi/FLUX_Product/Science journal publication and DOI publication in process.
		Expand and automate the Arctic atmosphere data portal to include addtional atmopshere and cryosphere data sets						x							Uttal			x		CPO/ARP	Q4:COMPLETED AND ONGOING - Added data for new observatory (Oliktok Point). Updated data for 9 observatories. http://www.esrl.noaa.gov/psd/iasoa/dataataglance.
		Participate in sea ice forecasting testbed exercise with the NWS Anchorage Sea Ice Desk to evaluate RASM-ESRL model performance in an operational setting				x									Intrieri Solomon			x		NOAA/OAR/ESPC	Q1: COMPLETED
		Collect and archive data from Summit, Greenland						x							Shupe		x			NSF	Q4: COMPLETED and ONGOING: Summit, Greenland data has been routinely collected over FY2016 and archived redundantly at NOAA-ESRL (http://www.esrl.noaa.gov/psd/arctic/observatories/summit/) and DOE ARM (www.archive.arm.gov) archives.
		Conduct and report on UAS campaigns from Oliktok Point, Alaska						x							deBoer			x		DOE	
		Describe the impacts of clouds on Greenland surface energy budgets and melt					x								Shupe		x			NSF	Q4: COMPLETED and ONGOING: Measurements from Summit, Greenland were used to characterize the impacts of clouds on the surface energy budgets in three papers. 1) Miller, N. B., M. D. Shupe, C. J. Cox, V. P. Walden, D. D. Turner, and K. Steffen, 2015: Cloud radiative forcing at Summit, Greenland. J. Climate, 28, 6267-6280, doi:10.1175/JCLI-D-15-0076.1. 2) Solomon, A., M. D. Shupe, and N. B. Miller, 2016: Cloud-atmospheric boundary layer-surface interactions on the Greenland Ice Sheet during the July 2012 extreme melt event. J. Climate, submitted. 3) Miller, N. B., M. D. Shupe, C. J. Cox, D. Noone, and K. Steffen, 2016: The surface energy budget at Summit, Greenland. The Cryosphere, submitted, doi:10.5194/tc-2016-206.

Transiton Project Name	Description	Purpose	Lifecycle Phase (defined below)								FY16 Target				Out-Year Target					Expected Transiton Completion Date (FY/Q)	OAR Point of Contact (@noaa.gov)	OAR Responsible SES	OAR Contributing Partners	Customer(s)	A clear statement of what condition(s) must be met for the transition to be considered completed.	Type of R2X			Estimated Cost of R2X Transition ($K)	Comments
			Moving From				Moving To																							
			Research	Developme	Demonstra	Applicati	Research	Developme	Demonstra	Applicati	Q1	Q2	Q3	Q4	FY17	FY18	FY19	FY20	FY21							Operations	Commerical	Other		
Atmosphere-Ocean Processes - Alexander/Dias																														
Annual Updates to Climate Change Web Portal	The Climate Change Portal is web-based system (http://www.esrl.noaa.gov/psd/ipcc/) for visualizing model output used to simulate historical and future projections of the climate system. The portal was deployed in FY13 but is updated with enhancements annually.	The web portal provides scientists, resource managers, and stakeholders a framework to evaluate and interpret the models by comparing them to observations (land/rivers portion) during the historic record and view how they project climate change in the future. To this end, Federal water and fisheries managers have already used this tool in decision making processes.			x					x				x	x	x	x	x	x	FY16/Q4	Michael.Alexander	Webb		Federal water and fisheries managers (e.g. NMFS)		x		x		Need entry here - what update is being transitioned?
Attribution and Predictability Assessments - Perlwitz/Barsugli (in progress)																														
ENSO Situational Awareness	ENSO monitoring and impact assessment	To provide knowledge of the state of ENSO, give context to ENSO forecasts, and provde assesment of risks			x					x	x	x	x	x						FY16/Q4		Webb		CPC; NIDIS and their EWS; WWA; RCSDs; FEWSNET;				X		Ongoing knowledge transfer to a wide range of stakeholders and resource managers.
Boundary Layer Observations and Processes - Fairall/Bianco																														
Direct covariance fluxes from NOAA NDBC Tropical Buoy Array	Develop, test, and deploy a low-power direct covariance flux system for buoy operation.	Improve accuracy of flux estimates from NOAA buoys for climate reference, NWP comparions, and satellite CAL/VAL		x					x								X			FY19/Q4	Chris.Fairall	Webb	M. Cronin PMEL, J. Keene NDBC	CPO/COD, NDBC	Certification by NDBC	X				Proposal submitted to CPO/COD TPOS202. Item can removed if proposal is not funded.
[PSD Air-Sea Flux System]()	Transfer to a commercial entity the PSD air-sea flux system	To provide broader access of a mature technology to the public, private and academic sectors			X					X					X					?	Chris.Fairall	Webb		Various operational and other public, private and academic entities (e.g., Universities)	Documented transfer of technology to a commercial entity		X			PSD is currently working with the NOAA Technology Partnerships Office (TPO) to explore the market potential of this technology. TPO wil advise on necessary steps. Item can be removed if TPO determines transfer is not feasible.
Dynamics and Multiscale Interactions - Voronovich/Compo																														
Direct-TV SIgnals of Opportuntiy	The amplitude/strength of Direct-TV signals is influenced by path-integrated liquid water (ILW), which, in principle, provides a means of measuring this important atmospheric variable with either commercial or relatively inexpensive reproductions of Direct-TV receiving antennas. This project involves the development of a Direct-TV type of receiver and a demonstration of its potential for measuring ILW.	This technology can potentially provide regional/national network-scale ILW water measurements to complement current GPS integrated water vapor measurements.	x					x						x						FY20/Q4	alexander.voronovich	Webb			The technology is transitioned to an operational or commercial entity that provides regional/national network-scale ILW measuremtents.		x			PSD has initiated a collaboration (pending finalization of contract) with The Ohio State University to have two Masters-level students construct two Direct-TV-type Ku band receivers that will enable PSD scientists to test the proposed concept.
Forecast and Modeling Development - Whitaker/Pegion																														
Reforecasts and Reanalyses	Transition of a capacity for generating global medium-range reanalyses and reforecasts	Dramatically improved weather and weather-climate forecast guidance supported by reforecast data sets and their use in statistical post-processing.			x					x					x					FY17/Q2	Tom.Hamill	Webb		NCEP/EMC		X				There is not yet complete funding for the production of a next-generation reanalysis, only for the preliminary steps of setting up an observation database, performing experiments on the configuration, and testing methods for dealing with observation system changes over time. We anticipate matching funds in the future from the subseasonal prediction project that will allow us to actually perform the next-generation reanalysis/reforecast (in conjunction with NWS partners).
Ensemble Kalman Filter Data Assimilation System	Annual updates to an ensemble-based data assimilation technique that incorporates flow-dependent estimates for forecast uncertainty. Became operational at NCEP in 2012.	Improved accuracy of forecast initial conditions, which improves forecast skill			x					x				x	x	x	x	x	x	initial implementation in Q3FY12, with annual upgrades.	Jeffrey.S.Whitaker	Webb		NCEP/EMC		X				Implemented in NCEP operations May 2012, further improvements in subsequent upgrades.
Stochastic Parameterizations of Model Uncertainty	Improves the representation of model uncertainty in ensemble forecast, improving forecast reliability and analysis accuracy. Became operational in the EnKF DA system at NCEP in 2014. Implement in the GEFS.	Improved reliability of forecast ensembles, improved analysis accuracy.			x					x					x					FY14/Q4 (implement in the DA cycle) FY17/Q4 (implement in the GEFS)	Jeffrey.S.Whitaker	Webb		NCEP/EMC		X				Implemented in NCEP operations in 2014 for the EnKF analysis cycle, preparing for implementation in the medium range global ensemble system in 2017.
4D Incremental Analysis Update for global data assimilation	Improve the retention of analysis increments in the forecast system by smoothly introducing them into the forecast model during the assimilation window.	Improved use of observations in the analysis system, improved forecasts.			x					x					x					FY17/Q1	Jeffrey.S.Whitaker	Webb		NCEP/EMC		x				
4D Ensemble-Variational Data assimilation	WIth NCEP collaborations, test and implement a 4D upgrade to the operational 3D Ensemble-Variation DA system	Improved use of observations in the analysis system, improved forecasts.			x					x			x							FY16/Q3	Jeffrey.Whitaker	Webb		NCEP/EMC		X				
Post-Processed Precipitation Guidance	Under the NWS National Blend of Models, will transfer improved methods for post-processing of precipitation variables to NWS	Improved deterministic and probabilistic forecasts of precipitation-related variables			x					x					x					Ongoing, with next transition ~ Q2 FY2017	Tom.Hamill	Webb		NCEP/MDL		x				
Hydrometeorology and Modeling Applicaitons - Cifelli/Hughes																														
Streamflow Forecasts	Distributed hydrologic model applied to Russian River basin, CA	Provides streamflow everywhere in the basin - not just forecast points			x					x						x				FY18/Q2	Lynn.Johnson	Webb		NWS Western Region, CNRFC, and MTR WFO	The distributed forecast model must be running in the CHPS/FEWS operational environment at either the CNRFC or the Monterey, CA WFO	X			$200k	Using USWRP funding, the model performance is currently being evaluated by stakeholders (WFO, CNRFC, CA Dept of Water Resources) and a concept of operations to run the model in parallel with the RFC's "lumped" model is being developed. Visualization tools are also being developed to help forecasters interpret the streamflow forecasts, especially for uncertainty estimation.

Automated Digital Frost Forecast System	Gridded frost and heat forecasts for Russian River basin, CA	Forecasts allow water agency to plan for reservoir releases to accommodate crop spraying to mitiage for frost/heat. Growers can augment storage ponds prior to event to mitgate drawn-downs in tributaries and mainstem Russian on frost days. Goal is to eliminate any fish strandings to restore endangered salmon species in Russian.			x					x				x						FY16/Q4	David.Reynolds	Webb		NWS Western Region, Sonoma County Water Agency, Sonoma-Mendocino County grape growers, Western Wx Group and Fox Weather - Commerical wx forecast vendors for Counties.	Frost/Heat forecast system runnning in AWIPS II environment within the NWS Weather Forecast Office in Monterey, CA or Western Region.	X	X	X	$100k	Funding required to move this beyond the demonstration phase. The transition to NWS will require endorsement from NWS HQ.
Evaporative Demand Drought Index (EDDI)	Index for drought monitoring and early warning as well as fire risk	Improved early warning for drought and "flash drought" as well as quantitative assessment for fire risk			x					x							x			FY19/Q3	Mike Hobbins	Webb		NWS/National Water Center	EDDI running fully autmoated at NWC producing forecasts	X			$900k	Funding required to move this beyond demonstration phase. Funding may come through RTAP, if proposal awarded (submitted Dec. 2015)
Hydrometeorology Observations and Processes - White/Jackson																														
Sea Surface Temperature Diurnal Warming Amplitude Estimates	Modeled global estimates of instantaneous SST diurnal amplitude based on NWP analyses for incorporation in operational Gobal SST analysis	Improved SST product accuracy enabled by correction for diurnal warming influences on individual satellite retrievals			x					x				x						FY16/Q4	Gary.Wick	Webb		NESDIS		X				NESDIS Algorithm Readiness Review scheduled for late in FY 2015; product operationalization to follow
Improved Wind Profiler Signal Processing	Improved wind profiler singal processing is needed to remove increasingly evident contaminating signals caused by radio frequency interference, ground clutter, and migrating birds	To provide the highest quality real-time wind profile data to end users		x					x					x						FY16/Q4	Daniel.Gottas	Webb		NWS, DOE, other	Improved signal processing algorithm is deployed on wind profiilers	X	X	X		
Wind profiler display in AWIPS-2	In transition from AWIPS-1 to AWIPS-2, the capability to display wind profiler data was lost. PSD is developing a standalone version of AWIPS-2 to enhance the R2X process and will deomonstrate the capability to display wind profiler data on this modernized NWS platform.	To provide NWS forecasters with easy access to wind profiler data, including data collected by the West Coast picket fence of 1/4-scale 449-MHz wind profilers		x					x					x						FY16/Q4	Daniel.Gottas	Webb	GSD	NWS	Wind profiler data display capabiltiy is implemented on PSD standalone AWIPS-II platform	X				
Polar Observations and Process - Uttal/Shupe																														
Sea Ice Forecasting	The RASM-ESRL model produces regional 5-day ice forecasts and hindcasts for the Alaska and Arctic region to understand physical proccesses impacting sea-ice forecast. Validation, skill metrics, and comparisons with other NOAA and Navy forecast models will be completed in 2016.	Improve understanding and model representation of coupled ice-ocean-atmosphere processes to better predict sea ice on the 0-10 day time scale			x					x				x						FY16/Q4	Janet.Intrieri	Webb		NWS Alaska Region		X				
An Arctic Data Porrtal	The IASOA data portal uses a metadata harvesting technique to link users to over 900 data sets from 10 observatories related to properties of the Arctic Atmosphere. The data set will be expanded to include additional international data and a faceted search tool will be implemented.	Access to pan-Arctic data sets allows for both observation-based Arctic research and initialization/assimulation/validation of models that further process understanding of the Arctic environment and linkages to mid-latitudes		x					x					x						FY16/Q4	Taneii.Uttal Sandy.Starkweather	Webb	GMD	International Research	An Arctic Data portal that will provide comprehensive metadata and access to atmospheric data sets collected at a pan-Arctic system of observatories.			X		New Report Describes Progress and Promise of Interagency Approach to Arctic Research (https://www.whitehouse.gov/blog/2015/12/14/new-report-describes-progress-and-promise-interagency-approach-arctic-research) Cyberinfrastructure and Collaboratory Support for the Integration of Arctic Atmospheric Research (http://dx.doi.org/10.1175/BAMS-D-14-00144.1)

Mission Function	NOAA Readiness Level (RL)	Readiness Levels Defined
Research	**1**	Basic research and/or development principles observed and reported
	2	Formulation of concept for operations, application, commercialization or other uses for societal benefits
Development	**3**	Proof-of-concept (viability established)
	4	Validation of system, process, product, service, or tool in laboratory or other experimental environment
	5	Validation of system, process, product, service, or tool in relevant environment
Demonstration	**6**	Validation of system, process, product, service, or tool in relevant environment (potential demonstrated)
	7	Prototype demonstrated in an operational or other relevant environment (functionality demonstrated in pseudo real world environment)
	8	System, process, product, service, or tool completed and "mission qualified" through test and demonstration in operational or other relevant end-to-end environment (functionality demonstrated)
Application	**9**	System, process, product, service, or tool approved for deploymen/application and use in decision making (transition complete)

Performance Requirement (PR) (End state in meeting organizational goals and objectives)	Performance Measure (The monitoring of ongoing progress toward pre-established goals.)	PM Identifier	Performance Milestone (A distinct activity planned for completion on a scheduled date extracted from individual PSD staff annual performance plans)	Quarterly Cumulative	Yearly Cumulative	Prior Year Actuals							FY17 Targets				FY18 Targets				Out-Year Targets					PSD Point-of-Contact/ Research Team	Tracked R2X? (Y/N)	Completed? (Y/N)	Description//Comments/Documentation
						FY10	FY11	FY12	FY13	FY14	FY15	FY16	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	FY19	FY20	FY21	FY22	FY23				
		A																											
Experimental weather, water and climate products or services transitioned to a new stage (e.g., development, demonstration, application, operations)	Cumulative number of weather and climate research advances transitioned into applications, operations and services to inform regional decision making	A.1	Develop and implement a capability to display PSD, HMT or JTTI information product in AWIPS2 environment to better infuse experimental reserach products into an operational setting										X	X												A. White (HOP)		Y	An AWIPS-2 plugin to display wind profiler data has been developed (Q1) and is being tested (Q2). During testing of the wind-profiler ingest and display, a system instability was identified as being the cause of intermittent data outages on the WFO-prototype AWIPS-2 server within PSD. A new WFO-version of AWIPS-2 was recently installed to address the problem, and a new round of testing will commence in Q4. Plugin and documentation was passed to NWS/WRH to implement capability across WFOs in Q4. Progress on this milestone was delayed by the unexpected loss of key staff in Feb. 2017.
		A.2	Develop web-based tools for dissemination of Evaporative Demand Drought Index for research and monitoring										x		x											Perlwitz (APA)		Y	https://www.esrl.noaa.gov/psd/eddi/ The webtool is developed and will have a widespread public release by early-to-mid September of 2017. This tool provides information related to EDDI current conditions, and historical timeseries and data, in addition to many other resources to interpret and use this drought index --- including an EDDI manual.
		A.3	Produce two or more reports documenting user needs for drought and water-related climate monitoring and outlooks												x	x										Perlwitz (APA)		Y	1) Project annual report on NIDIS Water Resources Monitor and Outlook project with NWS (WRMO) submitted to NIDIS 2) Ray, A.J., M. Stokes, A. Nielson, R. Hartman, J. A. Intermill III, M. C. Kruk, D. Miskus, and R. Vose. (2017). National Water Resources Monitoring and Outlook: a new national scale product for timely water intelligence, AMS extended abstract https://ams.confex.com/ams/97Annual/webprogram/Paper314921.html 3) White, CJ, Henrik Carlsen, Andrew W. Robertson, Richard Klein, Jeffrey K. Lazo, Arun Kumar, Frederic Vitart, Erin Coughlan de Perez, Andrea J. Ray, Virginia Murray, Sukaina Bharwani, Dave MacLeod, Rachel James, Lora Fleming, Andrew P. Morse, Bernd Eggen, Richard Graham, Erik Kjellström, Emily Becker, Kathleen V. Pegion, Neil J. Holbrook, Darryn McEvoy, Michael Depledge, Sarah Perkins-Kirkpatrick, Timothy J. Brown, Roger Street, Lindsey Jones, Tomas A. Remenyi, Indi Hodgson-Johnston, Carlo Buontempo, Rob Lamb, Holger Meinke, Berit Arheimer and Stephen E. Zebiak. 2017. Applications of subseasonal-to-seasonal (S2S) predictions. Meteorological Applications, doi:10.1002/met.1654. 4) Dilling, L., M. Daly, D.Kenney, R. Klein, K. Miller, A. Ray, W. R. Travis, O. Wilhelmi. Urban water systems, 2017: Drought response lessons for climate change adaptation. submitted to Water Resources Research
		A.4	Development of online portal for Near-Realtime Assessment of US Heavy Rainfall Events, using routinely updated on-line portal tool developed in PSD										x													Perlwitz (APA)		Y	A propotype for July-August 2016 20yr Precipitaiton Extremes is developed. https://www.esrl.noaa.gov/psd/repository/WeatherClimateExtremes -Seasonal highlight's updates are provided for September-October 2016 20yr Precipitation Extremes and March-April 2017 20yr Precipitation Extremes -Capability enhancement to select data by region and time period
		A.5	Development of PSD portal for LIM forecasts on pentad to yearly time scales													x													
		A.6	Implement National Water Model v 1.1 hydrological model in PSD													x										Zamora (HMA)		Y	NWS NCEP NWM version 1.1.3 code has been installed and compiled on PSD HP-Apollo computing cluser. Tests are ongoing using NLDAS retrospective forcing data sets. Floating point results and water balance checks will be made with model runs completed using NWS WCOSS computers.
		A.7	Transition to NCEP a Kalman-Filter Analog (KFAN) bias correction method for PM.25 forecasts from the operational CMAQ air quality model.												x											Wilczak		Y	A Kalman-Filter Analog bias correction scheme for particulate matter air quality forecasts has been developed and tested, and is now being implemented at NCEP for inclusion in their 2017 update to the operational CMAQ model.
		A.8	Develop, produce, and release a new version of the 20th Century reanalysis (version 3) to better represent extreme events and characterize their uncertainty back to 1850										x	x	x	x	x	x	x	x						Jeff Whitaker (FMD)		Y	
		A.9	Develop, produce, and release a new modern-era high-resolution atmospheric global reanalysis and reforecast to facilitate the generation of high-quality operational post-processed model guidance by the National Weather Service																		x					Tom Hamill (FMD) and Jeff Whitaker (FMD)		Y	See google drive document at https://docs.google.com/document/d/1IQ4S7yFg4ykXIQbT-Qoc8FEiqITFArOEaJPdm0jmn2c/edit
		A.Total	Cumulative number of advances in weather and climate research transitioned into applications, operations and services to inform regional decision making		10								4	1	4	4										Lataitis			
		B																											
Assessments of current and future states of the climate system that identify potential impacts and inform science, service, and stewardship decisions.	Cumulative number of assessment reports providing an improved understanding and explanation of recent weather and climate extremes	B.1	Cumulative number of attibution assessments of climate extreme events, anomalies and trends		3									x		x										Perlwitz		Y	-Hoell, A., M. Hoerling, J. Eischeid, X. Quan, and B. Liebmann, 2017: Reconciling Theories for Human and Natural Attribution of Recent East Africa Drying. J. Climate, 30,1939–1957, doi: 10.1175/JCLI-D-16-0558.1. -Funk, C., L. Harrison, S. Shukla, D. Korecha, T. Magadzire, G. Husak, G. Galu, and A. Hoell, 2016: Assessing the Contributions of Local and East Pacific Warming to the 2015 Droughts in Ethiopia and Southern Africa. Bull. Amer. Meteor. Soc., 97, S75–S80, https://doi.org/10.1175/BAMS-D-16-0167.1 -Eden, J.M., K. Wolter, F.E.L. Otto, and G.J. van Oldenborgh, 2016: Multi-method attribution analysis of extreme precipitation in Boulder, Colorado. Environmental Research Letters, 11, 124009. doi:10.1088/1748-9326/11/12/124009 . -Quan, XW, M. Hoerling, L. Smith, J. Perlwitz, T. Zhang, A. Hoell, K. Wolter, J. Eischeid: Extreme California Rains During Winter 2015-16: A Change in El Niño Teleconnection?, submitted the BAMS Special Issue on Explaining Extreme Events of 2016 from a Climate Perspective. -Wolter, K. M. Hoerling, J. Eischeid, D. Allured: Was the Record-Breaking Eastern US Snowstorm "Jonas" a Reminder of the Past, or A Sign of Things to Come? submitted the BAMS Special Issue on Explaining Extreme Events of 2016 from a Climate Perspective
		B.2	Produce two or more predictabilty assessments for subseasonal to decadal time scales in order to quantify the prospects and gaps for skillful predictions		4								x	x												Perlwitz		Y	-Hoell, A., M. Barlow and F. Cannon (2017), Oceanic Origins of Historical Southwest Asia Precipitation During the Boreal Cold Season, Journal of Climate, doi: 10.1175/JCLI-D-16-0519 -Wolter, K., M. Hoerling, J.K. Eischeid, and L. Cheng, 2016: What History Tells us about 2015 US Daily Rainfall Extremes [in "Explaining Extremes of 2015 from a Climate Perspective"]. Bull. Amer. Meteor. Soc., 97, S9-13. doi:10.1175/BAMS-D-16-0166 -Liebmann, B., I. Bladé, C. Funk, D. Allured, X. Quan, M. Hoerling, A. Hoell, P. Peterson, and W. Thiaw, (2017): Climatology and Interannual Variability of Boreal Spring Wet Season Precipitation in the Eastern Horn of Africa and Implications for its Recent Decline. J. Climate, doi: 10.1175/JCLI-D-16-0452.1. -Hoell, A., C. Funk, J. Zinke, and L. Harrison (2016), Modulation of the Southern Africa precipitation response to the El Niño Southern Oscillation by the subtropical Indian Ocean Dipole, Clim Dyn, 1-12, doi:10.1007/s00382-016- 3220-6.
		B.3	Establish the origin of tropospheric ozone and the effect of ozone on U.S. air quality during summer													x										Kiladis (AOP) and J. Perlwitz (APA)		Y	Albers, J., J. Perlwitz, G. N. Kiladis, et al. 2017: Mechanisms Governing Interannual Stratosphere to Troposphere Ozone Transport. J. Geophys. Res. (submitted).
		B.4	Evaluation of potential for improved seasonal to decadal SST forecast skill, both in the Tropics and globally												x	x										Voronovich (DMI)		Y	Newman M., and P. D. Sardeshmukh, 2017: Are we near the predictability limit of tropical Indo-Pacific sea surface temperatures? Geophys. Res. Lett., 44, doi:10.1002/2017GL074088
		B.5	Assessing the 2015/16 El Nino event from an oceanographic perspective, and whether it is consistent with past natural variability												x											Alexander (AOP) Perlwitz(APA)		Y	Newman, M., A. Wittenberg, L. Chang, G. P. Compo, and C. A. Smith, 2017: The extreme 2015/16 El Niño, in the context of historical climate variability and change. Submitted to Bull. Amer. Meteor. Soc.
		B.6	Assess the 2014/-2016 warming in the California Current System, and whether it is consistent with past natural variability												x											Alexander (AOP)		Y	Jacox, M.G., M. A. Alexander, N. J. Mantua, J.D. Scott, G. Hervieux, R. S. Webb, F. E. Werner, 2017: Multiyear Extreme Ocean Temperatures with Impacts on Living Marine Resources off the US West Coast during 2016. Submitted to the Bull. Amer. Met. Soc.

		B.7	Detecting and attributing changes in ENSO over the last 50 years.											x	x										Voronovich (DMI)		Y	Capotondi and Sardeshmukh, 2017: Is El Nino really changing ? Geophys. Res. Lett., 44, doi:10.1002/2017GL074515
		B.8																										
		B.9																										
		B.Total	Cumulative number of assessment reports providing an improved understanding and explanation of recent weather and climate extremes		7								1	2	4	4									Webb			
		C																										
Advances in the observation, understanding, and prediction of high-impact, extreme events accelerated from the design and execution of field campaigns to investigate the coupled behavior of the atmosphere interacting with land, ocean and cryosphere.	Implementation of field and observation-based research studies to advance the best available science for monitoring, understanding and predicting extreme events.	C.1	Lead the International Arctic Systems to Observe the Atmosphere (www.iasoa.org) to provide access to pan-Arctic atmospheric continuous station data and coordinate international research teams that will advance understanding the role of the Arctic atmosphere in the Arctic system with observation-based and reanalysis-based research																						Taneil Uttal		Y	(1) Backman, J., Schmeisser, L., Virkkula, A., Ogren, J. A., Asmi, E., Starkweather, S., Sharma, S., Eleftheriadis, K., Uttal, T., Jefferson, A., Bergin, M., and Makshtas, A.: On Aethalometer measurement uncertainties and multiple scattering enhancement in the Arctic, Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2016-294, in review, 2016. (2) Solomon, A., M.D. Shupe, and N.B. Miller, 2017: Cloud-Atmospheric Boundary Layer-Surface Interactions on the Greenland Ice Sheet during the July 2012 Extreme Melt Event. Journal of Climate. doi:10.1175/JCLI-D-16-0071.1. (3) Grachev A.A., Uttal T., Persson P.O.G., Akish E.A., Morris S.M., Cox C.J., Fairall C.W., Stone R.S., Lesins G., Makshtas A.P., Repina I.A. (2017) Seasonal and latitudinal variations of surface fluxes at Arctic terrestrial sites. Climate Dynamics submitted. (4) Miller, N.B., M.D. Shupe, J.T.M. Lenaerts, J.E. Kay, G. de Boer and R. Bennartz: Process-based evaluation of ERA-Interim, Climate Forecast System version 2, and Community Earth System Model 2 in central Greenland, J. Geophys. Res. , submitted (5) J. Creamean, M. Maahn, G. de Boer, A. McComiskey, A.J. Sedlacek, Y. Feng: The influence of local petroleum exploration, regional wildfires, and long range transport on summer 2015 aerosol over the North Slope of Alaska, Atmos. Chem. Phys. Discuss. , submitted (6) Maahn, M., G. de Boer, J.M. Creamean, G. Feingold, G.M. McFarquhar, W. Wu and F. Mei: The observed influence of local anthropogenic pollution on northern Alaskan cloud properties, Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2017-302 www.iasoa.org
		C.2	Quantification of Santa Clara radar impact for QPE for selected ENRR events											X											R. Cifelli (HMA)		Y	Cifelli, R., V. Chandrasekar, H. Chen, and L.E. Johnson, 2016: High Resolution Radar Quantitative Precipitation Estimation in the San Francisco Bay Area: Rainfall Monitoring for the Urban Environment. J. Meteor. Soc. Japan, in review.
		C.3	Climate model representation of ARs and distribution and frequency of precipitation	?																								
		C.4	Synoptic/mesoscale analysis of CalWater2 observations of 2015 AR events										X												A. White (HOP)		Y	Neiman, P. J., N. Gaggini, C. W. Fairall, J. Aikins, J. R. Spackman, L. R. Leung, J. Fan, J. Harding, N R. Nalli, and A. B. White, 2017 (Sep): An analysis of coordinated observations from NOAA's Ronald Brown ship and G-IV aircraft in a landfalling atmospheric river over the North Pacific during CalWater-2015. *Mon. Wea. Rev.* , **145**, 3647-3669.
		C.5	Conduct study utilizing airborne observations of high-impact weather events to evaluate satellite-based representation of the atmospheric state												X										A. White (HOP)		Y	Dropsonde profiles from the Global Hawk matched to satellite retrievals of 10 m specific humidity (Qa) retrievals using SSMIS imager observations revealed that the structure of the water vapor profiles can impart Qa retrieval bias. Relatively dry (wet) middle tropospheric soundings were found to be associated with satellite Qa dry (wet) bias. Coincident SSMIS sounder observations were used to identify water vapor profiles with relatively dry or wet middle tropospheric water vapor; therefore, satellite sounder observations can help reduce the conditional biases in the satellite-retrieved Qa data products. These results were presented at the CIRES Rendezvous. This work also complemented completion of the Surface Hazards using Operational Unmanned Technology (SHOUT) project final data impact study which is available at: ftp://ftp1.esrl.noaa.gov/et6/sat/shout/data_impact/shout_final_impact_20170630_share.pdf Formal implementation of PSD's sea surface diurnal warming estimates into the operational NESDIS sea surface temperature analyses has been delayed at NESDIS due to a shortfall in funding required to implement the operational code. Supplemental funding is being pursued to help support the operational group in NESDIS. In the meantime, however, the collaboration gained PSD's co-authorship on a published paper submitted from NESDIS: Maturi, E., A. Harris, J. Mittaz, J. Sapper, **G. Wick**, X. Zhu, P. Dash, and P. Koner, 2017: A new high resolution sea surface temperature blended analysis, *Bull. Amer. Meteor. Soc.* , **98**, 1015-1026.
		C.6	Develop physically-based parameterizations for subgrid scale variation in numerical forecast models based on observations and high resolution model simulations										x	x	x	x									Penland (DMI) Whitaker(FMD), Bao (FMD), Hamill (FMD)		Y	Three first-generation physically based methods of stochastic parameterization are in the process of being transferred to NCEP/EMC for use in the Global Ensemble Forecast System (GEFS). Second-generation methods are being developed from data collected at Darwin and from ship observations in the eastern Pacific. Two journal articles are in development.
		C.7	Assess the impacts of the scale interactions between synoptic and mesoscale systems on the Madden-Julian Oscillation										x	x											G. Kiladis (AOP)		Y	Sakaeda, N., G. Kiladis, and J. Dias, 2017: The Diurnal Cycle of Tropical Cloudiness and Rainfall Associated with the Madden-Julian Oscillation. J. Climate. doi:10.1175/JCLI-D-16-0788.1, in press. Dias, J., N. Sakaeda, G. N. Kiladis, and K. Kikuchi, 2017, Influences of the MJO on the space-time organization of tropical convection J. Geophys. Res. (accepted with revisions)
		C.8	Produce an assesement of National Water Model performance during the January 2017 Russian river flood events using the HMT suite of hydrometeorological observations												x										R. Zamora (HMA)		Y	Results presented at the 2017 American Meteorological Society Annual Meeting. Title of talk: Evaluating Full Physics and Conceptual Hydrological Model Soil Moisture Simulations with Observations. Authors: R.J. Zamora, A.R. Thorstensen, and R. Cifelli
		C.9	Investigate the thermodynamic versus dynamic controls on mean and extreme precipitation in observations and models												x				x						Penland (DMI)		Y	Sardeshmukh, P.D. and J.W Wang: Dynamic versus thermodynamic control of changes in mean and extreme precipitation over 1979-2012. To be submitted. This study, which has been presented at recent AGU and AMS meetings, shows that the observed precipitation changes are consistent with similar changes in the statistics mid-tropospheric vertical velocity, and are therefore largely under dynamic not thermodynamic control.Climate models are muting this dynamic control of the precipitation changes and overemphasizing the thermodynamic control.
		C.Total	Cumulative number of field and observation-based research studies to advance the best available science for monitoring, understanding and predicting extreme events.		6								2	3	1	4									Lataitis			
		D																										

Increased predictive understanding of tropical-extratropical coupling, moisture transport and heavy precipitation from investigations of tropical - extratropical linkages and synoptic-scale or mesoscale meteorological features.	Diagnostic and modeling research advances the predictive understanding of tropical-extratropical coupling, moisture transport and heavy precipitation	D.1	Develop one science and technology product per quarter related to PSD hydrometeorlogical, boundary layer, or ocean process understanding												x	X										A. White (HOP)		Y	Devised a new method of precise measurements of the sea wave directional spectra by low-frequency Synthetic Aperature Radar on aircraft (Q2. see milestone H3 for publication). Prototyped (Q4) an automated gap-flow detection tool based on observations from a strategically deployed wind profiler in the Columbia River gorge. Detection algorithm was further tested and tuned during Q3; graphics tool development was delayed until Q4, and has been completed. Progress on this milestone was delayed by the unexpected loss of key staff in Feb. 2017. Roll out of the tool to the Portland WFO will occur in FY18. Prototyped (Q4) a snow-level forecast model verification tool. Tool allows forecasters to see how well the HRRR model is predicting the snow level for the current event and past events using PSD's network of snow-level sensing radars as verification. Progress on this milestone was delayed by the unexpected loss of key staff in Feb. 2017. Roll out of the tool to WFOs in West Coast states will occur in FY18.
		D.2	Produce two physical process studies that provide an improved understanding of recent extreme weather and/or hydrologic events										x		x											A. White (HOP)		Y	Kingsmill, D. E., P. J. Neiman, and A. B. White, 2016 (Nov): Microphysics regime impacts on the relationship between orographic rain and orographic forcing in the coastal mountains of Northern California. *J. Hydrometeor.* , **17**, 2905-2922. Kalina, E. A., S. Y. Matrosov, J. J. Cione, F. D. Marks, J. Vivekanandan, R. A. Black, J. C. Hubbert, M. M. Bell, D. E. Kingsmill, and A. B. White, 2017 (May): The ice water paths of small and large ice species in hurricanes Arthur (2014) and Irene (2011), *J. Appl. Meteor. Climatol.* , **56**, 1383-1404.
		D.3	Produce two observing system science studies that describe new instruments, new instrument algorithms, or instrumented field campaigns											x	x											A. White (HOP) R. Cifelli (HMA)		Y	Johnston, P. E., J. R. Jordan, A. B. White, D. A. Carter, D. M. Costa, and T. E. Ayers, 2017 (Feb): The NOAA FM-CW snow level radar. *J. Atmos. Oceanic Technol.* , **34**, 249-267. Matrosov, S. Y., R. Cifelli, A. White, and T. Coleman, 2017 (Apr): Snow-level estimates using operational polarimetric weather radar measurements. *J. Hydrometeor.* , **18**, 1009-1019.
		D.4	Increase the number of hydromet observations available to better monitor and increase the predictive understanding of droughts and floods												x	X										A. White (HOP)		Y	Installed one of PSD's 1/4-scale 449-MHz wind profilers, radio acoustic sounding system, GPS receiver and surface met towers at Platteville, Colorado, to test new singal processing algorithms that will improve the quality and reliability of real-time wind and temperature profile data. A side benefit of this project is provide similar data to forecasters in the Denver/Boulder Weather Forecast Office that they received previously from the National Profiler Network profiler that is no longer operating at this location.
		D.5	Assessment of GFS forecast skill during ENRR and extend this analysis to dynamical fields													x										G. Kiladis (AOP)		Y	Prepare two manuscripts to be submitted before October 2017, the first being the precipitation assessment and the second on the dynamical fields. Co-authors will be J. Dias, M. Gehne, G. Kiladis, and N. Sakaeda
		D.6	Diagose the role of ENSO and it's varaibility on ARs, moisture transport and precipitation over the western US											x												Alexander(AOP)		Y	Kim, H. M., Y. Zhou, and M. A. Alexander, 2017: Changes in atmospheric rivers and moisture transport over the Northeast Pacific and western North America in response to ENSO diversity, Climate Dynamics, DOI: 10.1007/s00382-017-3598-9 (published on line March 2017)
		D.7	Diagnose the robustes of the relationship of tropical QBO and extratropical circulation													x										APA (Perlwitz)		Y	Perlwitz, J, L. Sun, J. H. Richter, J. Albers and J. Bacmeister, 2017: What determines the strength of the QBO-Stratospheric Polar Vortex Connection on mut-decadal time scale? (submitted to GRL)
		D.8																											
		D.9																											
		D.Total	Cumulative number of diagnostic and modeling studies and products developed to advance the predictive understanding of tropical-extratropical coupling, moisture transport and heavy precipitation		6								1	2	4	3										Webb			
		E																											
Research advances contributing to the development of the NOAA next-generation global prediction system capable of dramatically improved global numerical weather predictions on time scales of 1-30 days	Model development, sensitivity and evaluation research to improve NOAA's next-generation global prediction system capabitilites	E.1	Release Version 13 of the PSD Hurricane sea spray flux parameterization	X												X										Chris Fairall		Y	Version 13 is currently undergoing testing and will go public on Sep 30, 2017. ftp://ftp1.esrl.noaa.gov/BLO/Air-Sea/onr_droplet/parameterization/version13/
		E.2	Develop and test two potential improvements to the operational NCEP data assimilation system.	x												x										Jeffrey Whitaker (FMD)		Y	
		E.3	Develop and test two potential improvements to the physical parameterizations used in the NCEP operational prediction suite.	x												x										Jeffrey Whitaker (FMD)		Y	
		E.4	Finish development and begin testing a new radiation package for the NGGPS that increases efficiency, accuracy, and flexibility.	x												x										Robert Pincus (FMD)		Y	
		E.5	Jointly with C.6: Develop physically-based parameterizations for subgrid scale variation in numerical forecast models based on observations and high resolution model simulations										x	x	x	x	x	x	x	x						Penland (DMI), Whitaker(FMD), Bao(FMD), Hamill(FMD),		Y	Three first-generation physically based methods of stochastic parameterization are in the process of being transferred to NCEP/EMC for use in the Global Ensemble Forecast System (GEFS). Second-generation methods are being developed from data collected at Darwin and from ship observations in the eastern Pacific. Two journal articles are in development. in FY2017 we have shown that an experimental stochastical parameterization is able to increase the spread of forecasts without degrading the skill.
		E.6	Collaborate with GSD/ESRL scientists to assess the skill of "scale aware" convective parameterizations on tropical and extratropical forecast performance within the NCEP forecast system	x											x											George Kiladis (AOP)			
		E.7	Reanalysis / reforecast development (see A.9 above)																		x					Tom Hamill and Jeff Whitaker (FMD)			article published on issues we've encountered during development phase, at: Hamill, T. M., 2017: Changes in the systematic errors of global reforecasts due to an evolving data assimilation system. Mon. Wea. Rev., 145, 2479-2485.
		E.8	Develop and transfer to operations at NCEP/EMC an approach for generating more spread in near-surface properties in global ensembles																		x					Tom Hamill (FMD)			Pending EMC agreement, this code will be part of the GEFS v 12, operational ~ 2019.
		E.9																											
		E.Total	Cumulative number of model development, sensitivity and evaluation studies to improve NOAA's next-generation global prediction system capabitilites		5								1	1	1	5										Whitaker, Hamill, Fairall, Kiladis			
		F																											
		F.1	Evaluate changes in the mean, varaibility and extreme sea surface temperatures over the 21st century in large marine ecosystems											x												Alexander (AOP)	N	Y	Alexander, MA, JD Scott, KD Friedland, KE Mills, JA Nye, AJ Pershing, AC Thomas, 2017. Projected sea surface temperatures over the 21st century: changes in the mean, variability and extremes. Elementa (submitted).
		F.2	Document observed changes in the seasonal cycle of SST along the US east coast. (Important for the seasonal life cycles (phenology) of marine organisms											x												Alexander (AOP)	N	Y	Thomas, AC, AJ Pershing, KD Freidland, JA Nye, K Mills., MA Alexander, NR Record, R Weatherbee, and ME Henderson, 2017: Seasonal trends and phenology shifts in sea surface temperature on the North American northeast shelf. Elementa (accepted).
		F.3	Produce an analysis of the persistence of snow refugia as habitat for the North American Wolverine, to meet US Fish and WIldlife service regulatory needs												x											Perlwitz (APA)		Y	Ray, AJ, Barsugli, JJ, Livneh, B, Rangwala, I, and Dewes, C. 2017. Wolverine Climate Change Snow Refugia Study. A report to the U.S. Fish and Wildlife Service by the NOAA/ESRL Physical Sciences Division. 7 September 2017, 94 pp.

Research accelerating the development and application of coupled earth system analysis and modeling to understand where, when, and how ecosystems and ecosystem services may encounter critical environmental tipping points	Integrated earth system research studies document and clarify the response and sensitivies of living marine resources to climate extremes, variations and change	F.4	Advance understanding of terrestrial and aquatic ecological tipping points by collaborating with ecologists on least two reports.											x		x										Perlwitz (APA)		Y	Sofaer HR, Barsugli JJ, Jarnevich CS, Abatzoglou JT, Talbert MK, Miller BW, Morisette JT., 2017: Designing ecological climate change impact assessments to reflect key climatic drivers. Glob Chang Biol. , doi: 10.1111/gcb.13653. -Steen, V, Noon, B, Sofaer, H, Skagen, S, Ray, A. "Projecting Species' Vulnerability to Climate Change: Which Uncertainty Sources Matter Most and Extrapolate Best?" Ecology and Evolution, DOI: 10.1002/ece3.3403 -Enquist, C.A.F. , S. T. Jackson, G. Garfin, F. W. Davis, L. R. Gerber, J. Littell, J. L. Tank, A. Terando, T. Wall, B. Halpern, J. K.Hiers, T. L. Morelli, E. McNie, N. L. Stephenson, M. A. Williamson, C. A. Woodhouse, L. Yung, M. Brunson, K. Hall, L. M. Hallett, D. M. Lawson, M. Moritz, K. Nydick, A. Pairis, A. J. Ray, C. Regan, H. D. Safford, M. W. Schwartz, M. R. Shaw. 2017. Special Issue on Foundations of Translational Ecology. Frontiers in Ecology and the Environment, in press.
		F.5	Characterize regime shifts in the Pacific ocean on decadal timescales													x										Alexander (AOP)			
		F.6	Advancing understanding of changes in snow processes in the Intermountain West and their impacts on water availability and ecosystem												x											Perlwitz (APA)		Y	McNeeley S.M., C. Dewes, C. J. Stiles, T. Beeton, I. Rangwala, M. Hobbins, C. Knutson, 2017:. Anatomy of an interrupted irrigation season: Micro-drought at the Wind River Indian Reservation. submitted to Climate Risk Management.
		F.7																											
		F.8																											
		F.9																											
		F. Total	Cumulative number of integrated earth system research studies document and clarify the response and sensitivies of living marine resources to climate extremes, variations and change		4									3	1	2										Alexander, Perlwitz			
		G																											
Develop, prototype and demonstrate experimental local, regional and global forecasting capabilities	Cumulative number of observational, process, and numerical analysis research findings that improve experimental local to global forecasting of weather, water and climate extremes, variations and change	G.1	Advancing capabilities for forecasting sea ice on short to medium timescales thorough evaluation of the RASM-ESRL model performance and for advancing model parameterizations.																							Janet Intrieri	N		1) Deliver coupled model forecast guidance; 2) Participate in Alaska Testbed Exercise; 3) Publications: Ongoing https://www.esrl.noaa.gov/psd/forecasts/seaice/
		G.2	Implement an experimental version of National Water model in a research setting for targeted watersheds and conduct evaluation of soil moisture and streamflow to guide model development																										
		G.3	Evaluate the ice thicknesses produced by RASM-ESRL using estimates based on a new thermodynamic technique																										
		G.4	Evaluate surface fluxes and soil moisture reprensentations in HRR model using Columbia Gorge observations.																										
		G.5	Update the Linear Inverse Model forecasts of El Niño to include sea surface height in real time.												x											Penland(DMI)		Y	Newman M., and P. D. Sardeshmukh, 2017: Are we near the predictability limit of tropical Indo-Pacific sea surface temperatures? Geophys. Res. Lett., 44, doi:10.1002/2017GL074088. This recently published study shows the utility of including SSH in the LIM's state vector.
		G.6	Develop a model-based analog method for predicting conditions in the Indian and Pacific Oceans including El Niño.													x										Michael Alexander (AOP)		Y	Ding, H., M. Newman, M. A. Alexander, and A. Wittenberg, 2017: Skillful climate forecasts of the tropical Indo-Pacific using model-analogs . Manuscript in preparation; will be submitted to J. CLimate by the end of Q4 in FY17.
		G.7	Updated version of tropical CLIM (CLIM v4.0) for use at CPC.													x													
		G.8	Improve forecast skill of boundary layer winds and temperatures through evaluation of the High Resolution Rapid Refresh (HRRR) model using observations collected during the second Wind Forecast Improvement Project (WFIP2).													X										Wilczak		Y	Using a suite of observing systems deployed during WFIP2, including radar wind profilers, microwave radiometers, lidars and sodars, evaluations will be made of the fidelity of boundary layer physical processes affecting wind and temperature forecasts in complex terrain.
		G.9	Characterize observed and modeled long-term changes in extreme near-surface temperatures over the globe.													x				x						Penland (DMI)		Y	Sardeshmukh, Compo, McColl, and Penland: Unexpected changes in extreme temperatures associated with 20th century climate change. Programs to generate the relevant probability distributions have been developed. Results are to be submitted.
		G.10	Development and transition to operations of improved methods for postprocessing of precipitation related variables using multi-model ensembles under the National Blend of Models project.											X				X								Tom Hamill (FMD)		Y	Hamill, T.M., E. Engle, D. Myrick, M. Peroutka, C. Finan, and M. Scheuerer, 2017: The U.S. National Blend of Models for Statistical Postprocessing of Probability of Precipitation and Deterministic Precipitation Amount. Mon. Wea. Rev., 145, 3441–3463, https://doi.org/10.1175/MWR-D-16-0331.1 . Work on improved methodology ongoing.
		G. Total	Cumulative number of observational, process, and numerical analysis research findings that improve experimental local to global forecasting of weather, water and climate extremes, variations and change		5									1	1	4	1									Jim Wilczak (BLO), Janet Intrieri (POP)			
		H																											(79) Scheuerer, M., S. Gregory, T. M. Hamill, and P. E. Shafer, 2016: Probabilistic precipitation type forecasting based on GEFS ensemble forecasts of vertical temperature profiles. Mon. Wea. Rev., 145, 1401-1412.
Improved basis for confidence in understanding key oceanic, atmospheric, hydrologic, biogeochemical, and socioeconomic components of the	Advances in observational, process, numerical and predictability research increase the scientific understanding of key	H.1	Number of ESRL-PSD peer-reviewed publications													x				x									
		H.2	Cumulative site-years of data collection, cruises, or flight projects for cryospheric, boundary layer mean and turbulent properties, hydrometeorological, and oceanic process studies		X											X					X					Chris Fairall, Allen White,Taneil Uttal		Y	4 Air-sea flux cruises (3 ocean, 1 Great Lakes). 9 Months surface flux and soil moisture data at Wasco site Columbia Gorge. 9 Months of wind profiler/S-band radar obs at eight sights for WFIP-II 12 Months of continued O&M for California's 21-st Century Observing Network including over 100 sites with GPS-Met, soil mositure and surface obs, snow-level radars, or coastal wind profilers (2017 NOAA Tech Transfer Award and 2017 Federal Laboratory Consortium's Mid-Continent Notable Technology Development Award). 12 Months Atmospheric and Surface Data (Tiksi) 12 Months Atmospheric and Surface Data (Eureka) 12 Months Atmospheric and Surface Data (Alert)
		H.3	Produce two or more studies that illustrate the potential of using using satellite- and airborne-based electromagnetic soundings to retrieve soil moisture, and winds and wave spectra over the ocean.	X									X	X												A. Voronovich/DMI	N	Y	Two papers published: (1) A. Voronovich, V. Zavorotny, "Determination of surface reflectivity usin radio signals of opportunity", Waves in Random and Complex Media, Nov. 2016, DOI: 10.1080/17455030.2016.1253902, and (2) A.Voronovich, V. Zavorotny, "Measurement of Ocean Wave Directional Spectra Using Airborne HF/VHF Synthetic Aperture Radar: A Theoretical Evaluation," IEEE Trans. Geoscience Remote Sensing, v. 55 (6), DOI: 10.1109/TGRS.2017.2663378. An experiment providing initial proof of the concept of a possibility of measuring soil moisture by transmitting/receiving signals by a pair of octocopters was conducted.
		H.4	Release verson COAREG35 of the NOAA COARE air-sea gas transfer flux algorithm													X										Chris Fairall		Y	Version 3.6 is currently undergoing testing and will go public on Sep 30, 2017. ftp://ftp1.esrl.noaa.gov/BLO/Air-Sea/bulkalg/cor3_6/
		H.4	Estimate the skill of SST forecasts in large marine ecosystems in US waters from the North American Multimodel Ensemble (NMME)											X												Michael Alexander (AOP)		Y	Jacox, MG, MA Alexander, CA Stock, and G Hervieux, 2017. On the skill of seasonal sea surface temperature forecasts in the California Current System and its connection to ENSO variability. Submitted to Climate Dynamics, DOI 10.1007/s00382-017-3652-7. Hervieux, G, MA Alexander, CA Stock, MG Jacox, K Pegion, E Becker, F Castruccio, and D Tommasi, 2017: More reliable coastal SST forecasts from the North American Multimodel Ensemble. Climate Dynamics, DOI 10.1007/s00382-017-3608-y.

climate system and impacts	environmental processes	H.6	Develop methods for using seasonal to decadal predictions to better manage living marine resources.												x											Michael Alexander (AOP)		Y	Tommasi, D, et al., 2017: Managing living marine resources in a dynamic environment: The role of seasonal to decadal climate forecasts. Prog. Oceanogr., 152, 15-49. Tommasi, D., C A. Stock., K. Pegion, G. A. Vecchi, R. D. Methot, M. A. Alexander, . M Checkley, 2017. Improved management of small pelagic fisheries through seasonal climate prediction. Ecological Applications, 27, 378-388. 10.1002/eap.1458. Tommasi, D. C. A. Stock, M. A. Alexander, X. Yang, A. Rosati, G. A. Vecchi, 2017: Multi-annual climate predictions for fisheries: an assessment of skill of sea surface temperature forecasts for large marine ecosystems. Frontiers in Marine Science, 4, https://doi.org/10.3389/fmars.2017.00201.
		H.7	Produce at least two studies to advance the predictive understanding of the physics of drought to improve monitoring and forecasting of drought conditions	2									x													Perlwitz		Y	Hoell, A., A. Gaughan, S. Shukla, T. Magadzire (2017): The Hydrologic Effects of Synchronous El Nino Southern Oscillation and Subtropical Indian Ocean Dipole Events Over Southern Africa, Journal of Hydrometeorology Dewes CF, Rangwala I, Barsugli JJ, Hobbins MT, Kumar S (2017) Drought risk assessment under climate change is sensitive to methodological choices for the estimation of evaporative demand. PLoS ONE 12(3): e0174045. doi:10.1371/journal.pone.0174045
		H.8	Produce an anlysis of land and wildlife managers' use of climate information in the North Central U.S.													X													
		H.9																											
		H.Target	Number of observational, process, numerical and predictability research studies that increase the scientific understanding of key environmental processes		5								1	3	1	3										Fairall, Voronovich			
		I																											
Increase in personal skills of staff applicable to duties in support of the PSD and OAR mission through education and training	Increased participation by PSD staff in appropriate professional development and communications training opportunities	I.1	Leadership and communication skills training												2											Hoell			A. Hoell attended 5-day federal mediation training (April, 2017) R.Lataitis attended 9-day OPM LEAD training in Denver, CO (September, 2017)
		I.2	Facilitation skills and working with Congressional traning												2											Gorton			
		I.3	Supervisory Policy Training											1												Lee			
		I.4	OAR New Employee Orientation											1												Lee			
		I.4	6 months OWP/NWC Assignment													1										Cifelli			
		I.6																											
		I.7																											
		I.8																											
		I.9																											
		I. Total	Cumulative number PSD staff participating in appropriate professional development and communications training		15									2	4											Gorton			
		J																											
Promotion of a more inclusive workplace environment where diversity and individual differences are valued and leveraged to achieve the vision and mission of the organization.	Increased number of employees participating in activities that foster innovative policies and procedures and strengthen organizational performance.	J.1	Mentor interns from Hollings, Pathways, EPP, SOARS and other undergraduate and graduate internship programs including students from under-represented groups {NOTE: PSD almost always has a number of these interns, but who hosts and the demographics of the students varies]	various	12								1	2	10	10										All federal PSD Research Team Leads			
		J.2	Creating an inclusive work environment from a top-down management perspective through monthly senior PSD leadership sessions focused on improving organizational health by maximizing clarity and minimizing politics, so staff feel empowered to be themselves and can fully contribute in a workplace environment that promotes creativity and vitality	3	9									3	3	3										Webb			
		J.3	Reconstitute the Workplace Advisor Committee (WAC) to promote and address diversity and inclusion in PSD to ensure that PSD staff do not have to be "an edited version of herself/himself " in order to fit in.												X											Andrew Hoell (WAC)			WAC hosted two social events to bring together PSD staff from different background both professional and personal. These events promote opportunities for PSD staff to feel comfortable with their colleagues and PSD's work environment.
		J.4	Represent OAR and ESRL at the American Indian Science and Engineering Society (AISES) National Conference													X										Webb			
		J.4																											
		J.6																											
		J.7																											
		J.8																											
		J.9																											
		J.Total	Cumulative number PSD staff participating in activities that foster innovative policies and procedures and strengthen organizational performance		25								1	5	14	14										Webb			

Identifier (Name of Parent Project)	Brief Description	Statement of intended purpose	Moving from				Moving to				Target	Actual	Target	Actual	Target	Actual	Target	Actual	Why was the target missed? When will the target be completed? What is the risk of missing the target?	Targets					Date Completed Fiscal year and quarter the project will pplications	OAR Point of Contact	OAR Responsible SES	OAR Contributing Partners	Customer	condition must be met for the product advancement to have been made. This should be sufficient to allow a knowledgeable observer to evaluate whether the	Type of R2A (Choose all applicable)			Cost of R2A Transition	Comments
			Research	Development	Demonstration	Operations or Applications	Research	Development	Demonstration	Operations or Applications	17 Q1	17 Q1	17 Q2	17 Q2	17 Q3	17 Q3	17 Q4	17 Q4		18	19	20	21	22							Operations	Commercial	Other	Funding amount to move the project into operations/ applications (Only the profile shift and NOT the total funding amount.)	
Atmosphere-Ocean Processes - Alexander/Dias																																			
Annual Updates to Climate Change Web Portal	The Climate Change Portal is web-based system (http://www.esrl.noaa.gov/psd/ipcc/) for visualizing model output used to simulate historical and future projections of the climate system. The portal was deployed in FY13 but is updated with enhancements annually.	The web portal provides scientists, resource managers, and stakeholders a framework to evaluate and interpret the models by comparing them to observations (land/rivers portion) during the historic record and view how they project climate change in the future. To this end, Federal water and fisheries managers have already used this tool in decision making processes.			x					x							x			x	x	x	x	x	FY16/Q4	Michael. Alexander	Webb		Federal water and fisheries managers (e.g. NMFS)		x		x		
Attribution and Predictability Assessments - Perlwitz/Barsugli (in progress)																																			
ENSO Situational Awareness	ENSO monitoring and impact assessment	To provide knowledge of the state of ENSO, give context to ENSO forecasts, and provde assesment of risks			x					x	x		x		x		x								FY16/Q4		Webb		CPC; NIDIS and their EWS; WWA; RCSDs; FEWSNET;				X		Ongoing knowledge transfer to a wide range of stakeholders and resource managers.
Boundary Layer Observations and Processes - Fairall/Bianco																																			
Direct covariance fluxes from NOAA NDBC Tropical Buoy Array	Develop, test, and deploy a low-power direct covariance flux system for buoy operation.	Improve accuracy of flux estimates from NOAA buoys for climate reference, NWP comparions, and satellite CAL/VAL		x					x													X			FY19/Q4	Chris.Fairall	Webb	M. Cronin PMEL, J. Keene NDBC	CPO/COD, NDBC	Certification by NDBC	X				Proposal submitted to CPO/COD TPOS202. Item can removed if proposal is not funded.
PSD Air-Sea Flux System	Transfer to a commercial entity the PSD air-sea flux system	To provide broader access of a mature technology to the public, private and academic sectors			X					X										X					?	Chris.Fairall	Webb		Various operational and other public, private and academic entities (e.g., Universities)	Documented transfer of technology to a commercial entity		X			PSD is currently working with the NOAA Technology Partnerships Office (TPO) to explore the market potential of this technology. TPO wil advise on necessary steps. Item can be removed if TPO determines transfer is not feasible.
Dynamics and Multiscale Interactions - Voronovich/Compo																																			
Direct-TV SIgnals of Opportuntiy	The amplitude/strength of Direct-TV signals is influenced by path-integrated liquid water (ILW), which, in principle, provides a means of measuring this important atmospheric variable with either commercial or relatively inexpensive reproductions of Direct-TV receiving antennas. This project involves the development of a Direct-TV type of receiver and a demonstration of its potential for measuring ILW.	This technology can potentially provide regional/national network-scale ILW water measurements to complement current GPS integrated water vapor measurements.	x					x									x								FY20/Q4	Alexander. Voronovich	Webb			The technology is transitioned to an operational or commercial entity that provides regional/national network-scale ILW measurements.		x			
Forecast and Modeling Development - Whitaker/Pegion																																			
Reforecasts and Reanalyses	Transition of a capacity for generating global medium-range reanalyses and reforecasts	Dramatically improved weather and weather-climate forecast guidance supported by reforecast data sets and their use in statistical post-processing.			x					x										x					FY17/Q2	Tom.Hamill	Webb		NCEP/EMC		X				There is not yet complete funding for the production of a next-generation reanalysis, only for the preliminary steps of setting up an observation database, performing experiments on the configuration, and testing methods for dealing with observation system changes over time. We anticipate matching funds in the future from the subseasonal prediction project that will allow us to actually perform the next-generation reanalysis/reforecast (in conjunction with NWS partners).
Ensemble Kalman Filter Data Assimilation System	Annual updates to an ensemble-based data assimilation technique that incorporates flow-dependent estimates for forecast uncertainty. Became operational at NCEP in 2012.	Improved accuracy of forecast initial conditions, which improves forecast skill			x					x							x			x	x	x	x	x	initial implementation in Q3FY12, with annual upgrades.	Jeffrey.S. Whitaker	Webb		NCEP/EMC		X				Implemented in NCEP operations May 2012, further improvements in subsequent upgrades.
Stochastic Parameterizations of Model Uncertainty	Improves the representation of model uncertainty in ensemble forecast, improving forecast reliability and analysis accuracy. Became operational in the EnKF DA system at NCEP in 2014. Implement in the GEFS.	Improved reliability of forecast ensembles, improved analysis accuracy.																		x					FY14/Q4 (implement in the DA cycle) FY17/Q4 (implement in the GEFS)	Jeffrey.S. Whitaker	Webb		NCEP/EMC		X				Implemented in NCEP operations in 2014 for the EnKF analysis cycle, preparing for implementation in the medium range global ensemble system in 2017.
4D Incremental Analysis Update for global data assimilation	Improve the retention of analysis increments in the forecast system by smoothly introducing them into the forecast model during the assimilation window.	Improved use of observations in the analysis system, improved forecasts.			x					x										x					FY17/Q1	Jeffrey.S. Whitaker	Webb		NCEP/EMC		x				
4D Ensemble-Variational Data assimilation	WIth NCEP collaborations, test and implement a 4D upgrade to the operational 3D Ensemble-Variation DA system	Improved use of observations in the analysis system, improved forecasts.			x					x					x										FY16/Q3	Jeffrey. Whitaker	Webb		NCEP/EMC		X				

Post-Processed Precipitation Guidance	Under the NWS National Blend of Models, will transfer improved methods for post-processing of precipitation variables to NWS	Improved deterministic and probabilistic forecasts of precipitation-related variables			x					x										x					Ongoing, with next transition ~ Q2 FY2017	Tom.Hamill	Webb		NCEP/MDL		x				
Hydrometeorology and Modeling Applicaitons - Cifelli/Hughes																																			
Streamflow Forecasts	Distributed hydrologic model applied to Russian River basin, CA	Provides streamflow everywhere in the basin - not just forecast points			x					x											x				FY18/Q2	Lynn. Johnson	Webb		NWS Western Region, CNRFC, and MTR WFO	The distributed forecast model must be running in the CHPS/FEWS operational environment at either the CNRFC or the Monterey, CA WFO	X			$200k	Using USWRP funding, the model performance is currently being evaluated by stakeholders (WFO, CNRFC, CA Dept of Water Resources) and a concept of operations to run the model in parallel with the RFC's "lumped" model is being developed. Visualization tools are also being developed to help forecasters interpret the streamflow forecasts, especially for uncertainty estimation.
Automated Digital Frost Forecast System	Gridded frost and heat forecasts for Russian River basin, CA	Forecasts allow water agency to plan for reservoir releases to accommodate crop spraying to mitiage for frost/heat. Growers can augment storage ponds prior to event to mitgate drawn-downs in tributaries and mainstem Russian on frost days. Goal is to eliminate any fish strandings to restore endangered salmon species in Russian.			x					x							x								FY16/Q4	David. Reynolds	Webb		NWS Western Region, Sonoma County Water Agency, Sonoma-Mendocino County grape growers, Western Wx Group and Fox Weather - Commerical wx forecast vendors for Counties.	Frost/Heat forecast system runnning in AWIPS II environment within the NWS Weather Forecast Office in Monterey, CA or Western Region.	X	X	X	$100k	Funding required to move this beyond the demonstration phase. The transition to NWS will require endorsement from NWS HQ.
Evaporative Demand Drought Index (EDDI)	Index for drought monitoring and early warning as well as fire risk	Improved early warning for drought and "flash drought" as well as quantitative assessment for fire risk			x					x												x			FY19/Q3	Mike Hobbins	Webb		NWS/National Water Center	EDDI running fully autmoated at NWC producing forecasts	X			$900k	Funding required to move this beyond demonstration phase. Funding may come through RTAP, if proposal awarded (submitted Dec. 2015)
Hydrometeorology Observations and Processes - White/Jackson																																			
Sea Surface Temperature Diurnal Warming Amplitude Estimates	Modeled global estimates of instantaneous SST diurnal amplitude based on NWP analyses for incorporation in operational Gobal SST analysis	Improved SST product accuracy enabled by correction for diurnal warming influences on individual satellite retrievals			x					x							x								FY16/Q4	Gary.Wick	Webb		NESDIS		X				NESDIS Algorithm Readiness Review scheduled for late in FY 2015; product operationalization to follow
Improved wind profiler signal processing	Improved wind profiler singal	To provide the highest quality real-time wind profile data to end users		x					x								x								FY16/Q4	Daniel. Gottas	Webb		NWS, DOE, other	Improved signal processing algorithm is deployed on wind profiilers	X	X	X		
Wind profiler display in AWIPS-2	In transition from AWIPS-1 to AWIPS-2, the capability to display wind profiler data was lost. PSD is developing a standalone version of AWIPS-2 to enhance the R2X process and will deomonstrate the capability to display wind profiler data on this modernized NWS platform.	To provide NWS forecasters with easy access to wind profiler data, including data collected by the West Coast picket fence of 1/4-scale 449-MHz wind profilers		x					x								x								FY16/Q4	Daniel. Gottas	Webb	GSD	NWS	Wind profiler data display capabiltiy is implemented on PSD standalone AWIPS-II platform	X				
Polar Observations and Process - Uttal/Shupe																																			
Sea Ice Forecasting	The RASM-ESRL model produces regional 5-day ice forecasts and hindcasts for the Alaska and Arctic region to understand physical proccesses impacting sea-ice forecast. Validation, skill metrics, and comparisons with other NOAA and Navy forecast models will be completed in 2016.	Improve understanding and model representation of coupled ice-ocean-atmosphere processes to better predict sea ice on the 0-10 day time scale			x					x							x								FY16/Q4	Janet.Intrieri	Webb		NWS Alaska Region		X				
An Arctic Data Porrtal	The IASOA data portal uses a metadata harvesting technique to link users to over 900 data sets from 10 observatories related to properties of the Arctic Atmosphere. The data set will be expanded to include additional international data and a faceted search tool will be implemented.	Access to pan-Arctic data sets allows for both observation-based Arctic research and initialization/assimulation/validation of models that further process understanding of the Arctic environment and linkages to mid-latitudes		x					x								x								FY17/Q4	Taneii.Uttal Sandy. Starkweather	Webb	GMD	International Research	An Arctic Data portal that will provide comprehensive metadata and access to atmospheric data sets collected at a pan-Arctic system of observatories.			X		New Report Describes Progress and Promise of Interagency Approach to Arctic Research (https://www.whitehouse.gov/blog/2015/12/14/new-report-describes-progress-and-promise-interagency-approach-arctic-research) Cyberinfrastructure and Collaboratory Support for the Integration of Arctic Atmospheric Research (http://dx.doi.org/10.1175/BAMS-D-14-00144.1)

Performance Requirement (PR) (End state in meeting organizational goals and objectives)	Performance Measure (The monitoring of ongoing progress toward pre-established goals.)	PM Identifier	Performance Milestone (A distinct activity planned for completion on a scheduled date extracted from individual PSD staff annual performance plans)	Quarterly Cumulative	Yearly Cumulative	Prior Year Actuals							FY18 Targets				FY19 Targets				Out-Year Targets					PSD Point-of-Contact/Research Team	More Detailed Description	Completed? (Y/N)	Evidence of Accomplishment: Comments/Documentation/Reports/Papers/Website/Datasets
						FY11	FY12	FY13	FY13	FY15	FY16	FY17	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	FY20	FY21	FY22	FY23	FY24				
		A																											
Experimental weather, water and climate products or services transitioned to a new stage (e.g., development, demonstration, application, operations)	Number of weather, water and climate research advances transitioned into applications, operations and services to inform regional decision making	A.1	Finalize a CRADA with Radiometrics, Inc., to commercialize PSD's snow-level radar technology												X											White/HOP		N	CRADA partner Radiometrics, Inc. has delayed signing CRADA until a sound business case can be made.
		A.2	Develop experimental HRRR data to use to inform Probable Maximum Precipitation estimation in CO-NM Dam Safety Study													X										Mahoney/HMA		Y	Final report prepared as part of CO-NM Dam Safety project. Draft report is here: https://drive.google.com/file/d/1PdtJ4ViHRkwB6DzvhYyzMUpSVWaKWXnd/view
		A.3	Provide quarterly services to better inform regional decision makers on evolving climate conditions and extreme events										x	x	x	x										Hoell/APA	Respond to decision makers regarding their requests of information on extreme events and evoling climate conditions including droughts, extreme rains,river and urban flooding, snowstorms. Provide monthly expert advise on the NOAA ENSO Alert system and to FEWSNET stakeholders	Y	FEWS NET seasonal forecast review https://earlywarning.usgs.gov/fews/download/index.php Example: https://earlywarning.usgs.gov/fews/download/SeasonalForecasts/06_2018/jun2018_fct_review.pdf FEWS NET special reports http://www.fews.net/search?keywords=special%20report Two-page documents in support of NIDIS interaction with stakeholders on drought development and outlooks: https://www.drought.gov/drought/sites/drought.gov.drought/files/NorthernPlains_2017Drought_Assessment%2BAttributionStudy.pdf https://www.drought.gov/drought/sites/drought.gov.drought/files/NorthernPlains_HistoricalCharacter.pdf https://www.drought.gov/drought/sites/drought.gov.drought/files/NorthernPlains_2017DroughtEvolution.pdf https://www.drought.gov/drought/sites/drought.gov.drought/files/NorthernPlains_2017AttributionDroughtOutlook_Droughtgov.pdf https://www.drought.gov/drought/documents/us-northern-great-plains-drought-predictability
		A.4	Transition to NCEP an updated Kalman-Filter Analog (KFAN) bias correction method for ozone and PM.25 forecasts from the operational CMAQ air quality model.													X										Wilczak/BLO			An updated version of the air-quality Kalman-Filer Analog post-processing code that provides improved skill at forecasting extreme events for both ozone and PM2.5 was developed, tested, and evaluated against the NCEP CMAQ forecasts through May, 2018, and delivered to NCEP. Based on this testing, NCEP has approved the new ozone post-processing scheme, as well as updates to the PM2.5 scheme, for its next operational model implementation upgrade, currently scheduled for autumn 2018.
		A.5	Demonstrate and provide forecast guidance products (daily during fall freezeup period - Q1,Q4) of sea ice, atmosphere, ocean conditions for the Arctic Basin on 0-10 day scales.										?			X										Intrieri and Uttal/POP	Initiated a NOAA Arctic Testbed activity to conduct experiments on ensemble forecast techniques for Arctic short-term forecasts. These experimental forecasts use a subset of the NOAA Global Ensemble Forecast System members as lateral forcing for the high-resolution coupled system. Observations (such as IABP buoy measurements) are being used as metrics that quantify skill statistics. NOAA/ESRL is working closely with the NWS to identify critical products to inform weather and sea ice forecasting as well as to assess and analyze ensemble member products and utility. Uploaded real-time drift forecasts from the fully-coupled model forecasts for buoys in the Beaufort, Barents, and Chukchi Seas to the YOPP Sea Ice Drift Forecast Experiment (SIDFEx). Provided real-time forecasts of sea ice properties (strain rate, lead opening rate, etc.) to the Navy in support of the ICEX campaign in the Beaufort Sea as model guidance for potential danger due to ice movement and lead openings. Real-time forecasts of atmosphere, sea ice, and ocean conditions in support of PSD UAV activities as part of the ONR SODA campaign.	Y	https://www.esrl.noaa.gov/psd/forecasts/seaice
		A.6	Develop, produce, and release a new version of the 20th Century reanalysis (version 3) to better represent extreme events and characterize their uncertainty back to 1850.													x				x						Compo/DMI	In Q4FY19, we will complete production and release of a new, higher-resolution dataset from 1850-present using newly digitized observations and improved assimilation algorithms.	Y	In Q4FY18, we completed development of a new, higher-resolution dataset from 1850-present using newly digitized observations and improved assimilation algorithms.
		A.7	Develop, produce, and release a new modern-era high-resolution atmospheric global reanalysis and reforecast to facilitate the generation of high-quality operational post-processed model guidance by the National Weather Service												x					x						Whitaker/FMD	Development to be completed by Q3FY18, production by Q4FY19. See google drive document at https://docs.google.com/document/d/1IQ4S7yFg4ykXlQbT-Qoc8FEiqlTFArOEaJPdm0jmn2c/edit		
		A.8	Develop a new version of the Climate Change Web Portal											x												Alexander/AOP	https://www.esrl.noaa.gov/psd/ipcc/	y	https://www.esrl.noaa.gov/psd/ipcc/
		A.Total	Number of advances in weather, water and climate research advances transitioned into applications, operations and services to inform regional decision making		X							New				8										Lataitis/DIR			
		B																											

Performance Requirement (PR) (End state in meeting organizational goals and objectives)	Performance Measure (The monitoring of ongoing progress toward pre-established goals.)	PM Identifier	Performance Milestone (A distinct activity planned for completion on a scheduled date extracted from individual PSD staff annual performance plans)	Quarterly Cumulative	Yearly Cumulative	Prior Year Actuals							FY18 Targets				FY19 Targets				Out-Year Targets					PSD Point-of-Contact/Research Team	More Detailed Description	Completed? (Y/N)	Evidence of Accomplishment: Comments/Documentation/Reports/Papers/Website/Datasets
						FY11	FY12	FY13	FY13	FY15	FY16	FY17	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	FY20	FY21	FY22	FY23	FY24				
Assessments of current and future states of the climate system that identify potential impacts and inform science, service, and stewardship decisions.	Number of assessment reports providing an improved understanding and explanation of recent weather and climate extremes	B.1	Produce two or more attribution assessments of climate extreme events, anomalies and trends												x	x										Perlwitz/APA	Produce assessments on recent extreme events including Northern Plains drought of summer 2017, Extreme precipitation events of summer 2017, and Arctic Warmth of 2016	Y	Sun, L., Allured, D., Hoerling, M., Smith, L., Perlwitz, J., Murray, D. (2018), Drivers of 2016 Record Arctic Warmth Assessed Using Climate Simulations Subjected to Factual and Counterfactual Forcing. Weather and Climate Extremes, 19 1-9, doi: 10.1016/j.wace.2017.11.001 Knutson, T., J.P. Kossin, C. Mears, J. Perlwitz, and M.F. Wehner, 2017: Detection and attribution of climate change. In: Climate Science Special Report: Fourth National Climate Assessment, Volume I [Wuebbles, D.J., D.W. Fahey, K.A. Hibbard, D.J. Dokken, B.C. Stewart, and T.K. Maycock (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 114-132, doi: 10.7930/J01834ND. Perlwitz, J., T. Knutson, J.P. Kossin, and A.N. LeGrande, 2017: Large-scale circulation and climate variability. In: Climate Science Special Report: Fourth National Climate Assessment, Volume I [Wuebbles, D.J., D.W. Fahey, K.A. Hibbard, D.J. Dokken, B.C. Stewart, and T.K. Maycock (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 161-184, doi: 10.7930/J0RV0KVQ. Taylor, P.C., W. Maslowski, J. Perlwitz, and D.J. Wuebbles, 2017: Arctic changes and their effects on Alaska and the rest of the United States. In: Climate Science Special Report: Fourth National Climate Assessment, Volume I[Wuebbles, D.J., D.W. Fahey, K.A. Hibbard, D.J. Dokken, B.C. Stewart, and T.K. Maycock (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 303-332, doi: 10.7930/J00863GK.
		B.2	Produce one or more predictability assessments for subseasonal to decadal time scales in order to quantify the prospects and gaps for skillful predictions													X										Perlwitz/APA	Assess how the tropics shift the probability of daily to seasonal precipitation extremes over the Middle East and Afghanistan, Assess predictability of the failed SCAL rains in winter 2016, Initiate factorial analysis of seasonal forecast skill		Zhang, T., M. P. Hoerling, K. Wolter, J. Eischeid, L. Cheng, A. Hoell, J. Perlwitz, X. Quan, and J. Barsugli, 2018: Predictability and Prediction of Southern California Rains during Strong El Nino Events: A Focus on the Failed 2016 Winter Rains. J. Climate, 31, 555-574, doi:10.1175/JCLI-D-17-0396.1. Quan, X., M. Hoerling, J. Perlwitz, and H. Diaz, 2018: On the Time of Emergence of Tropical Width Change. J. Climate. doi:10.1175/JCLI-D-18-0068.1, in press. Hoell, A., M. Barlow, T. Xu, and T. Zhang, 2018: Cold Season Southwest Asia Precipitation Sensitivity to El Niño–Southern Oscillation Events. J. Climate, 31, 4463–4482, https://doi.org/10.1175/JCLI-D-17-0456.1
		B.3	Produce an assessment report on the inclusion of climate change in extreme preciptation estimation for dam safety													X										Mahoney/HMA		Yes	Part of final report to CO-NM Dam Safety https://docs.google.com/document/d/1dCo7YP2MTDvsls_f-cDzaEMr6Ds4L4xwGKJtoat8vGE/edit
		B.4	Document and understand relationship of changes in 5-day average hot and cold extreme events to changes in mean, variance, skewness, and kurtosis.											~~X~~		~~X~~			x							Penland/DMI	Diagnose changes in hot and cold extremes around the world in terms of the changes in the moments of the temperature distribution.	No	Sardeshmukh/Compo/McColl/Penland - "Unexpected changes of extreme warm spells associated with global warming" - paper in preparation. Additional calculations were needed. Now expected Q3 FY19
		B.Total	Number of assessment reports providing an improved understanding and explanation of recent weather and climate extremes		X							New				5										Webb/DIR			
		C																											
		C.1	Provide observing equipment, field site/data communications infrastructure, and IT hardware/software maintenance and upgrades annually as required to succesfully operate and maintain California's 21-st century observing network and to make data and value-added products available to NWS Weather/River Forecasters and other end users													X				X						White/HOP	Funding for installation, operation and maintenance of this CA observing network is provided by the California Department of Water Resrouces	Y	Real-time data and images are available here: https://www.esrl.noaa.gov/psd/data/obs/datadisplay/.
		C.2	Acquire (property transfer to NOAA) three 449-MHz Doppler wind profilers with RASS that were built for DOE in support of WFIP2												X											White/HOP	PSD will initially operate and maintain the wind profilers at their current locations in OR and WA as part of the West Coast wind profiler picket fence, but could move them in the future to support other reserach field campaings	Y	PSD began taking over leases and site costs in March 2018. Operation and maintenance of the profilers is ongoing. SF-122 form authorizing equipment transfer was signed in Nov. 2017.
		C.3	Roll out and evaluate, collaborating with staff at the Portland WFO, a new gap flow detection tool based on PSD's wind profiler and surface observations collected at Troutdale, OR										X		X											Gottas/HOP	Tool will give forecasters the ability to detect and monitor gap flow conditions that lead to winter weather hazards in the Portland metropolitan area and that are not captured accurately in numerical weather prediciton.	Y	Real-time tool made available to forecasters prior to 12/15/2017 here: https://www.esrl.noaa.gov/psd/data/obs/datadisplay/ViewDataType.php?DataTypeID=86&SiteID=tde. A manuscript documenting the tool has been completed with Portland WFO staff and accepted for publication: Neiman, P.J., D.J. Gottas, A.B. White, W.R. Schneider, and D.R. Bright, 2018: A real-time online data product that automatically detects easterly gap flow events and precipitation type in the Columbia River Gorge. *J. Atmos. Oceanic Technol.*, in press, doi.org/10.1175/JTECH-D-18-0088.1.
		C.4	Develop soil moisture anomaly climatology for selected NIDIS pilot basins													X										Zamora/HMA		Y	Annual report and monthly team meeting notes.
		C.5	Generate reference evapotransporation reanalyses for the evaporative demand drought index, to support FEWSNET, and for reference ET foreacsting													X										Cifelli/HMA		Yes	Data set available here: ftp://ftp.cdc.noaa.gov/Projects/RefET/global/
		C.6	Roll out and evaluate, collaborating with CNRFC and CA/NV Weather Forecast Offices, a new snow level forecast verification tool that takes advantage of the snow-level sensing radars in CA for verificaiton										X		X											White/HOP	Tool will allow forecasters to evaluate how well the High Resolution Rapid Refresh weather forecast model is forecasting the altitude where snow changes into rain (a.k.a. snow level) using PSD's array of vertically pointing radars deployed in CA, CO, OR, and WA for verification.	Y	Tool was presented at the AMS Mountain Meteorology Conference in Jun. 2018 Tool was rolled out to NWS Weather Forecast Office SOOs, WCMs, and MICs in Aug. 2018. Several staff responded with positive feedback. Tool is available to forecasters and the general public online at https://www.esrl.noaa.gov/psd/data/obs/datadisplay/ViewDataType.php?DataTypeID=87&SiteID=ovl
		C.7	Develop physically-based parameterizations for subgrid-scale variations in numerical forecast models based on observations and high-resolution model simulations.													x				x						Penland(DMI)/Bao(FMD)/Whitaker(FMD)/Hamill(FMD)	PSD will employ observations gathered by PSD scientists, theory developed by PSD scientists, and output from large-eddy simulations to diagnose the relevant probability distribution functions necessary for the implementation of stochastic parameterizations in FV3.	Y	An article led by Lisa Bengtsson is under revision.
Advances in the observation, understanding	Number of field and observation-	C.8	Investigate the thermodynamic versus dynamic controls on mean and extreme precipitation in observations and models.													X				x						Penland/DMI		Y	Article in preparation (Lead author either P. Sardeshmukh or A. Wang)

Performance Requirement (PR) (End state in meeting organizational goals and objectives)	Performance Measure (The monitoring of ongoing progress toward pre-established goals.)	PM Identifier	Performance Milestone (A distinct activity planned for completion on a scheduled date extracted from individual PSD staff annual performance plans)	Quarterly Cumulative	Yearly Cumulative	Prior Year Actuals							FY18 Targets				FY19 Targets				Out-Year Targets					PSD Point-of-Contact/Research Team	More Detailed Description	Completed? (Y/N)	Evidence of Accomplishment: Comments/Documentation/Reports/Papers/Website/Datasets
						FY11	FY12	FY13	FY13	FY15	FY16	FY17	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	FY20	FY21	FY22	FY23	FY24				
Advances in the observation, understanding, and prediction of high-impact, extreme events accelerated from the design and execution of field campaigns to investigate the coupled behavior of the atmosphere interacting with land, ocean and cryosphere.	based research studies to advance the best available science for monitoring, understanding and predicting extreme events.	C.9	Develop standardized PSD protocols for observing and processing to create standardized, interoperable surface flux data products for land and ocean surfaces													x										Uttal (POP)/ Fairall POP/White (HOP)	PSD will develop autonomous SEB flux stations for the MOSAiC projectas prototype for future standardized systems whiehc will produce a standardized product	Y	Engineering design is completed and one prototype data set has been processed. This is a multi-year effort
		C.10	Improve understanding of processes that influence moisture fluxes and precipitation in and through Oregon's Columbia River Gorge													x										Alexander/cross-team		Y	Mahoney, K., D. Swales, M.J. Mueller, M. Alexander, M. Hughes, and K. Malloy, 2018: An Examination of an Inland-Penetrating Atmospheric River Flood Event under Potential Future Thermodynamic Conditions. J. Climate, 31, 6281-6297, https://doi.org/10.1175/JCLI-D-18-0118.1 A new polarimetric radar approach to distinguish between stratiform bright-band (BB) rain and warm non-bright band (NBB) rain in the Columbia River gorge was applied to WSR-88D KRTX (i.e., Portland NEXRAD) measurements during 2015 -2017 significant rain events. The have implications for QPE improvements since microphysical properties (and hence corresponding rain rate estimators) of BB and NBB rain are significantly different.
		C.Total	Number of field and observation-based research studies to advance the best available science for monitoring, understanding and predicting extreme events		X							New				10										Lataitis/DIR		Y	The surface fluxes from the Physics Site in the Gorge were analyzed and bulk-flux parameterizations were developed and tuned to the observations. Mahoney, K., D. Swales, M.J. Mueller, M. Alexander, M. Hughes, and K. Malloy, 2018: An Examination of an Inland-Penetrating Atmospheric River Flood Event under Potential Future Thermodynamic Conditions. J. Climate, 31, 6281-6297, https://doi.org/10.1175/JCLI-D-18-0118.1
		D																											
Increased predictive understanding of tropical-extratropical coupling, moisture transport and heavy precipitation from investigations of tropical - extratropical linkages and synoptic-scale or mesoscale meteorological features.	Number of diagnostic and modeling studies and products developed to advance the predictive understanding of tropical-extratropical coupling, moisture transport and heavy precipitation	D.1	Evaluate GFS model resolution and new model core (FV3) on performance for forecasting atmospheric rivers and their impacts during CalWater													X										White/HOP		Y	Comparisons of GFS forecasts at two different resolutions (27km and 13 km grid spacing) were made with Stage IV precipitation observations using the Meteorological Evaluation Tool (MET). The analysis focused on the coastal regions of N. California, Oregon, and Washington on 6 Feb 2015, a landfalling AR day. Various MET options were used: grid stat (forecast comparisons averaged across a grid), series stat (comparisons at each grid point in a grid), and MODE (an object-oriented analysis tool). All three methods of analysis did not show a significant difference in the precipitation forecasts for this case.
		D.2	Assess QPF skill and implications for National Water Model performance													X										Mahoney/HMA		Y	Brief to Office of Water Prediction leadership; manuscript in development documenting performance: https://drive.google.com/open?id=1cZQfysGXrgN7M4Mng5L5bQquoKrjPwJWvksN49tvaol
		D.3	Develop novel metric to evaluate the coupling between atmosphere and ocean in the tropical Pacific in seasonal forecast models to advance ENSO predictions													x										Perlwitz/APA		Y	Science is done; paper in preparation (lead author is Klaus Wolter)
		D.4	Develop novel methods of diagnosing the impact of stochastic parameterization on the Madden-Julian Oscillation in models.													X										Bao(FMD)/Penland(DMI)	We shall deliver preliminary results involving the particular dynamical nature of the Madden-Julian Oscillation as observed and as simulated by FV3.	Y	Science is done; paper in preparation (lead author is Leslie Hartten)
		D.5	Evaluate the NCEP GFS and ECMWF IFS 10 day forecast skill for precipitation and associated dynamical fields												x											Kiladis	results published and presented at multiple scientific conferences (AMS annual, AMS Hurr. & Trop. Metereology, AMS Weather Analysis and Forecasting, U. Illinois, SUNY Albany, U. Nebraska)	Y	Dias, J., M. Gehne, G. N. Kiladis, N. Sakaeda, P. Bechtold, and T. Haiden, 2018: Equatorial waves and the skill of NCEP and ECMWF numerical weather prediction systems. Mon. Wea. Rev., 146, 1763-1784.
		D.Total	Number of diagnostic and modeling studies and products developed to advance the predictive understanding of tropical-extratropical coupling, moisture transport and heavy precipitation		X							New				5										Webb/DIR			
		E																											
Research advances contributing to the development of the NOAA next-generation global prediction system capable of dramatically improved global numerical weather predictions on time scales of 1-30 days	Number of model development, sensitivity and evaluation studies to improve NOAA's next-generation global prediction system capabilities	E.1	Develop and test two potential improvements to the operational NCEP data assimilation system.													X				x						Whitaker/FMD	The operational GSI/EnKF code was updated to improve the efficiency and accuracy of the analysis. Updates included: 1) improved efficiency in forward operator calculations, 2) support for the FV3 GFS, 3) a four-dimensional incremental analysis update capability.	Y	
		E.2	Develop and test two potential improvements to the physical parameterizations used in the NCEP operational prediction suite.													X				x						Whitaker/FMD	A parameterization of sub-grid scale variations using cellular automata was developed for the deep convection scheme in the FV3GFS model.	Y	
		E.3	Expand testing of a new radiation package for NGGPS with emphasis on accuracy and efficiency													X										Whitaker/FMD	Code developed, hosted on github. Testing with HRRR/RAP model ongoing	Y	
		E.4	Develop and implement tropical relaxation experiments to assess how improved tropical forecasts could enhance prediction skill over North America													x										Kiladis/AOP	The code for tropical relaxation is developed and currently being tested	N	
		E.5	Develop new diagnostics to evaluate NGGPS tropical model performance and transfer them to NCEP													x										KIladis/AOP	New diagnostics have been developed and are being tested using model output from FV3GFS. Transfer to NCEP will be done thought MET and it is in progress.	N	
		E.Total	Number of model development, sensitivity and evaluation studies to improve NOAA's next-generation global prediction system capabitilities		X							New				5										Webb/DIR			
		F																											

Performance Requirement (PR) (End state in meeting organizational goals and objectives)	Performance Measure (The monitoring of ongoing progress toward pre-established goals.)	PM Identifier	Performance Milestone (A distinct activity planned for completion on a scheduled date extracted from individual PSD staff annual performance plans)	Quarterly Cumulative	Yearly Cumulative	Prior Year Actuals							FY18 Targets				FY19 Targets				Out-Year Targets					PSD Point-of-Contact/Research Team	More Detailed Description	Completed? (Y/N)	Evidence of Accomplishment: Comments/Documentation/Reports/Papers/Website/Datasets
						FY11	FY12	FY13	FY13	FY15	FY16	FY17	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	FY20	FY21	FY22	FY23	FY24				
Research accelerating the development and application of coupled earth system analysis and modeling to understand where, when, and how ecosystems and ecosystem services may encounter critical environmental tipping points	Number of integrated earth system research studies document and clarify the response and sensitivities of living marine resources to climate extremes, variations and change	F.1	Produce climate risk assessments for NOAA Fisheries and the U.S. Fish and Wildlife Service for use in decisionmaking												X											Ray/APA	Complete the last of three climate risk assessments and study requests for NOAA Fisheries; finalize analysis of snow persistence done to support the USFWS Species Status Assessment of the wolverine	Y	Reports complete: 1) Lagron, C.M., Ray, A.J., and Barsugli, J.J. 2018. Saco River and Northeast Climate Brief, submitted to the U.S. Fish and Wildlife Service, report submitted to the NOAA National Marine Fisheries Service. 2) Ray, A.J., Barsugli, J. J., Livneh, B., Dewes, C, Rangwala, I, Heldmyer, A. 2017. Future snow persistence in Rocky Mountain and Glacier National Parks: An analysis to inform the USFWS Wolverine Species Status Assessment, submitted to the USFWS Region 6.
		F.2	Develop forecast systems for large marine ecosystem regions													X										Alexander/AOP		Y	Muhling B.A., D. Tommasi, S. Ohshimo, M.A. Alexander, and G. DiNardo, 2018: Regional-scale surface temperature variability allows prediction of Pacific bluefin tuna recruitment ICES Journal of Marine Science, doi:10.1093/icesjms/fsy017. Turi, G., Alexander, M., Lovenduski, N. S., Capotondi, A., Scott, J., Stock, C., Dunne, J., John, J., and Jacox, M., 2018: Response of O2 and pH to ENSO in the California Current System in a high-resolution global climate model. Ocean Sci., 14, 69-86, https://doi.org/10.5194/os-14-69-2018. Test physical/ecosystem forecast systems have been developed for the US west coast and Bering Sea.
		F.3	Examine the response of marine ecosystems to climate varaibility and change											X												Alexander/AOP		y	Alexander MA, JD Scott, KD Friedland, KE Mills, JA Nye, AJ Pershing, AC Thomas, 2018: Projected sea surface temperatures over the 21st century: Changes in the mean, variability and extremes for large marine ecosystem regions of Northern Oceans. Elementa: Science of the Anthropocene, 6 (1):9, DOI: http://doi.org/10.1525/elementa.191 Jacox, M. G., M. A. Alexander, N. J. Mantua, J. D. Scott, G. Hervieux, R. S. Webb, and F. E. Werner, 2017: Forcing of multiyear extreme ocean temperatures that impacted California Current living marine resources in 2016 [in "Explaining extreme events of 2016 from a climate perspective"], Bulletin of the American Meteorological Society, 98, S27-S33, doi: 10.1175 /BAMS-D-17-0119.1. Le Bris, A., K. E. Mills, R. A. Wahle, Y. Chen, M. A. Alexanderc, A. J. Allyna, J. G. Schuetz, J. D. Scott, and A. J. Pershing, 2018: Climate vulnerability and resilience in the most valuable North American fishery. PNAS, published on-line, https://doi.org/10.1073/pnas.1711122115.
		F.4	Develop and perform experiments with a high resolution ocean model along the eastern seaboard												X											Alexander/AOP		y	Model experiments with ROMS, a high resolution ocean model, have been completed resulting in two manuscripts: Shin, S-I., M. Alexander, C. Stock, E. Curchitser, Dynamical Downscaling of future hydrographic changes over the northwest Atlantic Ocean. Alexander, M. A., Shin S-I., J. D. Scott, E. Curchitser, C Stock, The response of the Northwest Atlantic to climate change in a regional model forced by three global climate models.
		F. Total	Number of integrated earth system research studies document and clarify the response and sensitivities of living marine resources to climate extremes, variations and change		X							New				4										Webb/DIR			
		G																											
Develop, prototype and demonstrate experimental local, regional and global forecasting capabilities	Number of observational, process, and numerical analysis research findings that improve experimental local to global forecasting of weather, water and climate extremes, variations and change	G.1	Improve forecast skill of boundary layer winds and temperatures through evaluation of the High Resolution Rapid Refresh (HRRR) model using observations collected during the second Wind Forecast Improvement Project (WFIP2)													X										Wilczak/BLO			
		G.2	Develop a "model-based" analog forecast system for predicting ENSO (SSTs and sea surface height in the tropics)										X													Alexander/AOP		y	Ding, H., M. Newman, M. A. Alexander, A T. Wittenberg, 2017: Skillful climate forecasts of the tropical Indo-Pacific Ocean using model-analogs. Journal of Climate, 31, 5437-5459, https://doi. org/10.1175/JCLI-D-17-0661.1.
		G.3	Develop and transition to operations of improved methods for postprocessing of precipitation related variables using multi-model ensembles under the National Blend of Models project.											X												Hamill/FMD			
		G. Total	Number of observational, process, and numerical analysis research findings that improve experimental local to global forecasting of weather, water and climate extremes, variations and change		X							New				3										Webb/DIR			
		H																											
		H.1	Number of ESRL-PSD peer-reviewed publications	X		114	123	122	122	135	143	120	20	40	60	80	20	40	60	80	80	80	80	80	80	Lataitis/DIR			
		H.2	Participate in 7 air-sea flux cruises (6 ocean, 1 Great Lakes)													X										Fairall/BLO	9 Months of cloud observations of stratocumulus and precipitation from California coast	N	One cruise executed in April (Stratus); 2 months fall and 4 months summer in Great Lakes; 2 cruise legs MISOBOB, 2 cruise legs PISTON. WHOTS cancelled.
		H.3	Release version COAREG36 of the NOAA COARE flux algorithm for fresh water/ice (Great Lakes).													X										Fairall/BLO	COARE refers to a suite of algorithms to compute air-sea fluxes from bulk meteorological variables. Fluxes include stress, sensible heat, latent heat, and 6 trace gases.	Y	The algorithms have been updated and documented. Codes available at ftp://ftp1.esrl.noaa.gov/BLO/Air-Sea/bulkalg/cor3_6/
		H.4	Develop method for retrieving soil moisture by using reflections of electromagnetic signal													X				x						Voronovich/DMI	Processing experimental data obtained by in-house developed airborne system (J.Lynch,HOP) and correspomdomg modeling	N	The measurement system is not ready yet due to lack of engineering workforce.
		H.5	Assess impact of variable forcings on soil moisture climatology in the National Water Model for selected NIDIS basins													X										Zamora/HMA		Y	National Water Model has been run using NLDAS and Stage IV precipitation forcing for the Russian and Babocomair NIDIS test basins. Open Literature paper describing the results has been submitted to OAR/PSD internal review 10/2018
		H.6	Demonstrate prototype coupling of National Water Model and coastal flood model in San Francisco Bay													X										Cifelli/HMA		Y	Poster. Bay-Delta Science conference and followup testing as part of project milestone.
		H.7	Demonstrrate prototype blended QPE product using NEXRAD and X-band radar in San Francisco Bay area													X										Cifelli/HMA		Y	Figures generated and shared with internal AQPI team
		H.8	Use hi-res modeling to examine extreme precipitation events toward increased understanding of key environmental processes on weather and climate timescales													X										Mahoney/HMA		Y	Final report as part of CO-NM dam safety project

Performance Requirement (PR) (End state in meeting organizational goals and objectives)	Performance Measure (The monitoring of ongoing progress toward pre-established goals.)	PM Identifier	Performance Milestone (A distinct activity planned for completion on a scheduled date extracted from individual PSD staff annual performance plans)	Quarterly Cumulative	Yearly Cumulative	Prior Year Actuals							FY18 Targets				FY19 Targets				Out-Year Targets					PSD Point-of-Contact/Research Team	More Detailed Description	Completed? (Y/N)	Evidence of Accomplishment: Comments/Documentation/Reports/Papers/Website/Datasets
						FY11	FY12	FY13	FY13	FY15	FY16	FY17	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	FY20	FY21	FY22	FY23	FY24				
Improved basis for confidence in understanding key oceanic, atmospheric, hydrologic, biogeochemical, and socioeconomic components of the climate system and impacts	Number of observational, process, numerical and predictability research studies that increase the scientific understanding of key environmental processes	H.9	Diagnose the role of temperature and precipitation in driving Decadal Extremes in Colorado River Runoff													X										Hoerling/APA		N	° Developed a capability to run a land surface model (VIC) for diagnosing Colorado River Basin runoff sensitivity to imposed T and P forcings ° Conducted an ensemble of high resolution global GCM simulations (CAM5 ~ 50km) for a historical period, and used those experiments to diagnose runoff sensitivity to temperature and precipitation variability in the Upper Colorado River Basin. ° Presented preliminary results on Colorado River runoff response to meteorological forcing and its long-term change in 3 seminars: ---- ESRL/PSD (Boulder, CO) August 2018 ---- Aspen Global Change Institute (Aspen, CO), Sept 2018 ---- MountainCLIM Meeting (Gothic, CO), Sept 2018 ° Convened a science meeting of experts to discuss the current state of understanding on the causes for reduced streamflow in the Colorado River, ESRL/PSD September 2018. ° Paper is in preparation
		H.10	Assess ventilation technologies designed for maintaining stable, research-grade broad-band radiometric measurements that are attenuated by ice contamination and design optimum autonomous and attended systems.													X										Uttal/POP	Experiment conducted in Barrow Alaska with 26 separate sensor systems showing a number of robust deicing systems. Power requirements documented for assistance and design of autonomous systems when required.	Y	Data published at: https://www.esrl.noaa.gov/psd/arctic/d-ice/
		H.Target	Number of observational, process, numerical and predictability research studies that increase the scientific understanding of key environmental processes		X							New				9										Lataitis/DIR			
		I																											
Increase in personal skills of staff applicable to duties in support of the PSD and OAR mission through education and training	Number PSD staff participating in appropriate professional development and communications training	I.1	Leadership and communication skills training													X													
		I.2	Facilitation skills and working with Congressional traning													X													
		I.3	Supervisory Policy Training													X													
		I.4	OAR New Employee Orientation													X													
		I. Total	Number PSD staff participating in appropriate professional development and communications training									New				15										Gorton/DIR			
		J																											
Promotion of a more inclusive workplace environment where diversity and individual differences are valued and leveraged to achieve the vision and mission of the organization.	Number PSD staff participating in activities that foster innovative policies and procedures and strengthen organizational performance	J.1	Mentor interns from Hollings, Pathways, EPP, SOARS and other undergraduate and graduate internship programs including students from under-represented groups {NOTE: PSD almost always has a number of these interns, but who hosts and the demographics of the students varies]													X										Gorton/DIR			
		J.2	Create an inclusive work environment from a top-down management perspective through monthly senior PSD leadership sessions focused on improving organizational health by maximizing clarity and minimizing politics, so staff feel empowered to be themselves and can fully contribute in a workplace environment that promotes creativity and vitality													X										Webb/DIR			
		J.Total	Number PSD staff participating in activities that foster innovative policies and procedures and strengthen organizational performance		X							New				53										Webb/DIR			

Identifier (Name of Parent Project)	Brief Description	Statement of intended purpose	Lifecycle Moving from: Research	Lifecycle Moving from: Development	Lifecycle Moving from: Demonstration	Lifecycle Moving from: Operations or Applications	Lifecycle Moving to: Research	Lifecycle Moving to: Development	Lifecycle Moving to: Demonstration	Lifecycle Moving to: Operations or Applications	Target 18 Q1	Actual 18 Q1	Target 18 Q2	Actual 18 Q2	Target 18 Q3	Actual 18 Q3	Target 18 Q4	Actual 18 Q4	Targets 19	Targets 20	Targets 21	Targets 22	Targets 23	Date Completed Fiscal year and quarter the project will transition to operations	OAR Point of Contact	OAR Responsible SES	Contributing Partners	Customer	A clear statement of what condition must be met for the product advancement to have been made. This should be sufficient to allow a knowledgeable observer to evaluate whether the advancement has been achieved.	Type of R2A (Choose all applicable): Operations	Type of R2A (Choose all applicable): Commercial	Type of R2A (Choose all applicable): Other	Cost of R2A Transition: Funding amount to move the project into operations/ applications (Only the profile shift and NOT the total funding amount.)	Comments	Weather Act
	Finalize a CRADA with Radiometrics, Inc., to commercialize PSD's snow-level radar technology	Transfer of federally developed technology into commercial sector			x					x							x							FY18, Q4	White	Webb	CIRES	Radiometrics	Signed CRADA		x			There is currently some concern about getting the CRADA signed by the end of the fiscal year due to a lack of available labor force to execute manufacture process at commercial partner (80 % probabiltiy of completion)	
	Develop experimental HRRR data to use to inform Probable Maximum Precipitation estimation in CO-NM Dam Safety Study	Develop model-based precipitation products to inform dam safety risk minimization and prototype future improvements to Probable Maximum Precipitation generation methods		x					x						x									FY18, Q3	Mahoney	Webb	ESRL GSD	Colorado, New Mexico Divisions of Dam Safety	High-resolution Rapid Refresh (HRRR) and other dynamical model produced grids of maximum precipitation, precipitation type, and historical extreme events diseeminated to project sponsors and incorporated into user software utilities	x	x			The "Lifecycle Phase Moving to" is likely somewhere between "Development" and "Demonstration." Products do exist and have already been demonstrated. They are a prototype though, and in that sense are an "experimental tool"	
	Transition to NCEP an updated Kalman-Filter Analog (KFAN) bias correction method for ozone and PM.25 forecasts from the operational CMAQ air quality model.	Improve NWS air quality forecasts			x					x							x							FY18, Q4	Wilczak	Webb		NWS, State and local forecasters, public	Bias -corrected gridded ozone fields created for each forecast cycle tested and evalauted by NCEP and incorporated into oeprational NCEP air quality forecasts	x				Forecast grids have already been transitoned to and tested and evaluated by NCEP but still are waiting on higher level sign-off to opertionalize.	
	Transition the Evaporative Demand Drought Index (EDDI) to an operational status at the National Water Center.	Provide a service for drought early warning, and ongoing drought monitoring to stakeholders affected by agricultural, hydrologic, and ecological drought, and at wildfire risk			x					x									x					FY19, Q3	Hobbins	Webb	Desert Research Institute & NOAA-National Water Center	NOAA-National Water Center	EDDI running at National Water Center and providing user-queryable drought monitoring andf ancillary information to stakeholders	x				Target date for complete transition to NWC is May 2019.	
	Develop and transition to operations improved methods for postprocessing of precipitation related variables using multi-model ensembles under the National Blend of Models project.	Develop statistically postprocessed, high-resolution multimodel ensemble guidance to provide National Weather Service forecasters with a calibrated, downscaled starting point for producing digital forecasts.			x					x			x											FY18, Q2	Hamill	Webb		NWS/NCEP	Algorithms tested and delivered for implementation in initial version of NBM QPF product	x					
	The first-generation stochastic physics package from the NOAA Environmental Modeling System/Global Spectral Model (NEMS/GSM) will be ported to new NEMS dynamical core (FV3) to better represent model uncertainty in ensemble forecasts.	Improved representation of model uncertainty in the NOAA Global Ensemble Forecast System (GEFS)			x					x			x											FY18, Q2	Whitaker	Webb		NWS/NCEP	Stochastic physics parameterizations implemented in time for use in beta implementation of FV3GFS data assimilation system and FV3GEFS reforecasts	X					
	ESRL/PSD is a co-developer of the NOAA operational ensemble-variational data assimilation system. This project supports ongoing development and maintenance of the code, and testing of new algorithms, in collaboration with NCEP/EMC.	Improved analyses and forecasts in the operational NCEP Global Forecast System (GFS)			x					x			x											FY18, Q2	Whitaker	Webb		NWS/NCEP	Code developed, tested and integrated into the master repository for the NCEP Global Statistical Interpolation System. Experiments performed and analyzed to quantify the impact of the code changes.	x					
	Demonstrate and provide forecast guidance products (daily during fall freeze up period - Q1,Q4) of sea ice, atmosphere, ocean conditions for the Arctic Basin on 0-10 day scales.	Improve forecasts of sea ice and Arctic conditions during Arctic fall freeze-up period			x					x	x	x					x	x	x					FY19, Q3	Intrieri	Webb	NWS Arctic Testbed	NWS	Adoption by NWS of current experimental sea ice forecasting capability.	x					
	Develop, produce, and release a new modern-era high-resolution atmospheric global reanalysis and reforecast to facilitate the generation of high-quality operational post-processed model guidance by the National Weather Service	Improve NWS operational forecasts			x					x									x					FY19, Q3	Hamill	Webb	NCEP OAR/CPO	NCEP CPC and EMC, as well as NWS forecast offices	Provide datasets needed to post-process operational global ensemble forecasts to provide calibrated probabilities to the public.	x					

Identifier (Name of Parent Project)	Brief Description	Statement of intended purpose	Lifecycle Moving from				Lifecycle Moving to				Target	Actual	Target	Actual	Target	Actual	Target	Actual	Targets					Date Completed Fiscal year and quarter the project will transition to operations	OAR Point of Contact	OAR Responsible SES	Contributing Partners	Customer	A clear statement of what condition must be met for the product advancement to have been made. This should be sufficient to allow a knowledgeable observer to evaluate whether the advancement has been achieved.	Type of R2A (Choose all applicable)			Cost of R2A Transition	Comments	Weather Act
			Research	Development	Demonstration	Operations or Applications	Research	Development	Demonstration	Operations or Applications	18 Q1	18 Q1	18 Q2	18 Q2	18 Q3	18 Q3	18 Q4	18 Q4	19	20	21	22	23							Operations	Commercial	Other	Funding amount to move the project into operations/ applications (Only the profile shift and NOT the total funding amount.)		
	Develop, produce, and release a new version of the 20th Century reanalysis (version 3) to better represent extreme events and characterize their uncertainty back to 1850.	See column B			x					x									x					FY19, Q3	Compo	Webb	CIRES, NCEI, PMEL	climate researchers, federal, private sector and academic	A dataset is made available to climate researchers that includes 3-hourly gridded fields back from 1850-present.			x			
	Provide quarterly services to better inform regional decision makers on evolving climate conditions and extreme events (NIDIS)	See column B	x							x	x	x	x	x	x	x	x	x						Ongoing	Hoell	Webb	NIDIS	NIDIS Federal Partners	Understand characteristics and predictability of Northern Plains Drought and apply to seasonal forecasts used by NIDIS partners			x		This is an FY18-19 project in which we use the case of the 2017 Northern Plains drought to motivate examination of the causes and predictability of all droughts over the region (FY19, Q1 end date)	
	Provide quarterly services to better inform regional decision makers on evolving climate conditions and extreme events (FEWSNET)	See column B	x							x	x	x	x	X	x	X	x	X						Ongoing	Hoell	Webb	USGS NASA USAID	USAID Famine Early Warning System Network	Understand predictability of African and Asian drought and apply to seasonal forecasts used by food security analysts			x		This is an ongoing collaboration in which we examine predictability of drought and use that information to advise food security analysts famine outlooks that are then used by the U.S. government to mobilize aid	
	Develop a new version of the Climate Change Web Portal	Provide accessible climate variability and change information to fisheries and water resource managers											x	X										FY18, Q2	Alexander	Webb		NMFS, fishery and water managers		x	x	x			
	Improve stratospheric ozone in GFS	Upgraded Naval Research Laboratory's CHEM2D-OPP stratospheric ozone parameterization in NCEP GFS system			x					x								x	x					FY19, Q2	Compo	Webb	EMC, NRL, CPC, SUNY-Albany	NCEP/NOAA	The parameterization is currently in parallel testing in the new FV3GFS and will be included in the operational implementation FV3 GFS	x					
	Improve stratospheric water vapor in GFS	Included Naval Research Laboratory's CHEM2D-OPP stratospheric water vapor parameterization in NCEP GFS system			x					x								x	x					FY19, Q2	Compo	Webb	EMC, NRL, CPC, SUNY-Albany	NCEP/NOAA	The parameterization is currently in parallel testing in the new FV3GFS and will be included in the operational implementation FV3 GFS						
	Testing channel loss parameterization in the National Water Model	This is NOAA Joint Technology Tranfer grant funded research that seeks to improve National Water Model performance in arid climate regimes by simulating water losses in river channels.			x					x										x				FY 20 Q2	Zamora	Webb	University of Arizona, OWP	OWP	The parameterization will be included in the 2021 National Water Model Operational NCEP Update after parallel tesing in 2020.						

Performance Requirement (PR) (End state in meeting organizational goals and objectives)	Performance Measure (PM) (The monitoring of ongoing progress toward pre-established goals.)	PM Identifier	Performance Milestone (A distinct activity planned for completion on a scheduled date extracted from individual PSD staff annual performance plans)	Quarterly Cumulative	Yearly Cumulative	Prior Year Actuals (Measures establshed in FY18)									FY19 Targets				FY20 Targets				Out-Year Targets					PSD Point-of-Contact/ Research Team	More Detailed Description	Completed? (Y/N)	Evidence of Accomplishment: Comments/Documentation/Reports/Papers/Website/Datasets
						FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	FY21	FY22	FY23	FY24	FY25				
	Research Publications		**Number of peer-reviewed PSD publications**	**X**		**108**	**114**	**123**	**122**	**125**	**148**	**144**	**131**	**118**	**20**	**40**	**60**	**80**	**20**	**40**	**60**	**80**	**80**	**80**	**80**	**80**	**80**	**Lataitis/DIR**			
		A																													
Experimental weather, water and climate products or services transitioned to a new stage (e.g., development, demonstration, application, operations)	**Research Transitions** Number of weather, water and climate research advances transitioned into applications, operations and services to inform regional decision making (Target 6/yr)	A.1	Produce "hybrid" QPE product for the SF Bay Area to better represent precipitation location, intensity, and duration compard to existing operational QPE products															X										Chen/HMA	QPE will be developed using combination of new X-band and NEXRAD radar data as part of the AQPI project	Y	Will be part of AQPI product suite this fall (west coast wet season)
		A.2	Develop novel methods for predicting ENSO and other ocean states.															X										Alexander/AOP	Test forecast systems based on empirical methods, especially Linear Inverse Models, and model analogs to observatios to predict ENSO, and ocean conidtions in large marine ecosystems	Y	Developed model analog forecasts using both the North American Multi Model Ensemble (NMME) and models in phase 5 of the Climate Model Intercomparison Project version5 (CMIP 5) archive. Ding, H., M. Newman, M. A. Alexander, and A. T. Wittenberg, 2019: Diagnosing secular variations in retrospective ENSO seasonal forecast skill using CMIP5 model-analogs. Geophys. Res. Lett., 46, 1721-1730, doi: 10.1029/2018GRL080598.
		A.3	Officially transition EDDI data to National Water Center														X											Hobbins/HMA	NWC will host EDDI dataa products	Y	Data products are being generated at National Water Center. Value added products still being generated at PSD.
		A.4	Develop probabilistic air quality forecasting tools based on the analog ensemble and test their efficacy in collaboration with NCEP.															X										Wilczak/BLO	Probability of exceedance maps for surface ozone and PM2.5 will be developed based on the analog ensemble, and verified using reliability diagrams. The ensemble spread-skill relationship will be evaluated, and graphics will be created for potential use in the NCEP air quality forecast guidance system.	Y	Developed probabilistic ozone and PM2.5 post-processing tools and demostrated their skill using historical forecasts.
		A.5	Produce and release a new version of the NOAA/CIRES/DOE 20th Century reanalysis (version 3) to better represent extreme events and characterize their uncertainty back to 1850.															x										Compo/DMI	In Q4FY19, we have completed production and release of a new, higher-resolution dataset from 1850-present using newly digitized observations and improved assimilation algorithms.	Y	Paper published: Slivinski, LC, Compo, GP, Whitaker, JS, et al. Towards a more reliable historical reanalysis: Improvements for version 3 of the Twentieth Century Reanalysis system. Q J R Meteorol Soc. 2019; 1– 33.https://doi.org/10.1002/qj.3598. Dataset is complete from 1850-2017, and will be publicly released in by Q2FY20.
		A.6	Produce experimental postprocessed forecast guidance to possibly include fire-weather products for week 2, subseasonal precipitation products, and streamflow products.																	x								Hamill/APA	Three projects are getting started in late FY18 and early FY19, on fire weather, subseasonal precipitation, and streamflow. Optimistically first publications for each would be submitted in early 2020. Experimental products and transitions to operations follow in subsequent years pending successful results	Y	
		A.7	Provide 0-10 day sea-ice forecast products to the National Ice Center														X											Solomon/Intrieri/POP	Provide CAFS output of sea ice information compatible with the National Ice Center analysis platform.	Y	
		A.8																													
		A.9																													
		A.10																													
		A.Total	**Number of weather, water and climate research advances transitioned into applications, operations and services to inform regional decision making (Target 6/yr)**		**X**									**8**				**12**				**18**	**24**	**30**	**36**	**42**	**48**	**Lataitis/DIR**			
		B																													
Assessments of current and future states of the climate system that identify potential impacts and inform science, service, and stewardship decisions.	**Weather/Climate Assessments** Number of assessment reports providing an improved understanding and explanation of recent weather and climate extremes (Target 4/yr)	B.1	Produce two or more attribution assessments of climate extreme events, anomalies and trends															x										Hamill/APA	----- APA staff expect to submit by the end of FY19 at least 3 peer-reviewed publications on this topic, including assessments on Northern Great Plains drought, Wind River snowpack changes, and snowpack changes effects on wolverine populations.	Y	Hoell and Hoerling are editors of the 7th Annual Special BAMS issue on Explaining Extreme Events. Also: Badger A. M., B. Livneh, M. P. Hoerling and J. K. Eischeid (October 2018): Understanding the 2011 Upper Missouri River Basin floods in the context of a changing climate. J. Hydrol., 19, 110-123. doi:10.1016/j.ejrh.2018.08.004. Also: Hoell A., J. Perlwitz, C. Dewes, K. Wolter, I. Rangwala, X.-W. Quan, J. K. Eischeid and (January 2019): Anthropogenic Contributions to the Intensity of the 2017 United States Northern Great Plains Drought. Bull. Amer. Meteor. Soc., 100, S19-S24. doi:10.1175/BAMS-D-18-0127.1 Barsugli J. J., M. P. Hoerling and B. Livneh (March 2019): Is the Recent Drought on the Colorado River the New Normal? EOS, 100, doi:10.1029/2019EO117173
		B.2	Produce two or more predictability assessments for subseasonal to decadal time scales in order to quantify the prospects and gaps for skillful predictions															x										Hamill/APA	APA staff expect to submit at least two peer-reviewed publications on this topic by end of FY2019, likely including Northern Great Plains drought, NAO predictability, and upper-Colorado streamflow changes due to decadal-to-centennial temperature and precipitation changes.	Y	Also: Agel L., M. Barlow, F. Colby, B. Hanin, J. L. Catto, A. Hoell and J. Cohen (February 2019): Dynamical analysis of extreme precipitation in the US northeast based on large-scale meteorological patterns. Clim. Dyn., 52 (3-4), 1739-1760. doi: 10.1007/s00382-018-4223-2 . Also: Hoell A. (November 2018): Middle East and Southwest Asia Daily Precipitation Characteristics Associated with the Madden–Julian Oscillation during Boreal Winter. J. Climate, 31, 8843-8860. doi:10.1175/JCLI-D-18-0059.1 Also: Hoerling, M. P., J. Barsugli, B. Livneh, J. Eischeid, X. Quan, and A. Badger (2019): Causes for the Century-Long Decline in Colorado River Flow, J. Climate, in press.
		B.3	Finish study and submit journal article on the planetary-scale and synoptic-scale atmospheric processes associated with long-duration extreme precipitation events in California during winter 2016–2017												X													Moore/HOP	The study utilizes reanalysis data combined with PSD wind profiler and surface observations to diagnose processes driving extreme precipitation during winter 2016–2017. In addition, the performance of operational models in predicting the extreme precipitation is evaluated using model forecasts from the TIGGE archive.	Y	Paper was submitted to journal in July: Moore, B. J., A. B. White, D. J. Gottas, and P. J. Neiman, 2019: Extreme precipitation events in northern California during winter 2016–2017: Multiscale analysis and climatological perspective. *Mon. Wea. Rev.*, submitted.
		B.4	Document and understand relationship of changes in 5-day average hot and cold extreme events to changes in mean, variance, skewness, and kurtosis.															X										Penland/DMI	Diagnose changes in hot and cold extremes around the world in terms of the changes in the moments of the temperature distribution.	Y	Sardeshmukh/Compo/McColl/Penland - "Unexpected changes of extreme warm spells associated with global warming" - paper in preparation.
		B.5	Finish study and submit journal article on large-scale atmospheric flow regimes linked to long-duration extreme precipitation events in northern California														X											Moore/HOP	A long-term climatology of extreme 7-day precipitation events is constructed for northern California, and distinct large-scale low-frequency flow regimes associated with the events are objectively identified in reanalysis. Characteristics of the flow regimes and processes by which they support extreme precipitation are examined through reanalysis-based composite analysis.	Y	Analysis is complete. Seminar given at PSD and at an international conference. Originally, this research was to be included in the the publication that resulted from milestone B.3. However it was decided to allow that journal paper to proceed on its own. A journal article on the results of this milestone's research will be submitted in FY20.

Performance Requirement (PR) (End state in meeting organizational goals and objectives)	Performance Measure (PM) (The monitoring of ongoing progress toward pre-established goals.)	PM Identifier	Performance Milestone (A distinct activity planned for completion on a scheduled date extracted from individual PSD staff annual performance plans)	Quarterly Cumulative	Yearly Cumulative	Prior Year Actuals (Measures establshed in FY18)									FY19 Targets				FY20 Targets				Out-Year Targets					PSD Point-of-Contact/ Research Team	More Detailed Description	Completed? (Y/N)	Evidence of Accomplishment: Comments/Documentation/Reports/Papers/Website/Datasets
						FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	FY21	FY22	FY23	FY24	FY25				
		B.6	Complete draft manuscript describing QPF and hydrologic foreccast performance of Ellicott City flash flood event														X											Viterbo/HMA		Y	Paper in review - J. Hydromet
		B.7	Document and evaluate performance of new method to bias correct operational radar QPE in SF Bay area															X										Chen/HMA	Utilize a Baysian technique to bias correct NEXRAD radar QPE using gauge data	Y	Paper in review - J. Hydromet
		B.8	Finish study and draft journal article on observed and modeled low level jets in the marginal ice zone															X										Hughes/HMA		Y	Study complete
		B.9	Use of NOAA/CIRES reanalysis data sets and dynamical downscaling to evaluate utility of historical extreme storm reconstruction for Probable Maximum Precipitation															X										Mahoney/HMA		Y	Ongoing; two presentations at Dam Safety conferences (April and September) and a manuscript draft in prepartion
		B.10	Examine Aleutian Low - Beaufort Sea Anticyclone (ALBSA) Index in the context of extremes in Arctic snow cover melt and accumulation dates															X										Uttal/Cox/POP	The index was originally conceived as a metric for studying/monitoring/supporting prediction of the timing of snowmelt in northern Alaska. It has already been expanded regionally, for example to the timing of the onset of sea ice melt over Chukchi/Beafort/Est Siberian Seas. The first objective is to publish the index (currently in review). The next steps include expanding analysis to other seasons. In particular, the index shows promise as a useful tool for understanding ice growth and loss in the Bering/Chukchi Seas in winter, which have seen extremes 2017-2019. We are also looking for new collaborators with NOAA Fisheries, NSIDC and NOAA Distributed Biological Observatory in mind.	Y	(1) Cox, CJ, RS Stone, DC Douglas, RM Stanitski, MR Gallagher, The Aleutian Low - Beaufort Sea Anticyclone: A cliamte index correlated with the timing of springtime melt in the Pacific Arctic cryosphere, GRL, in review. (2) Cox et al. (2018) 43rd Annual NOAA CDPW Digest, doi forthcoming. (3) Dataset hosted/updated by PSD (C Smith/C Cox): https://www.esrl.noaa. gov/psd/data/timeseries/ALBSA/
		B.Total	**Number of assessment reports providing an improved understanding and explanation of recent weather and climate extremes (Target 4/yr)**		**X**									**6**				**8**				**12**	**16**	**20**	**24**	**28**	**32**	**Webb/DIR**			
		C																													
	Targeted Observations Number of field studies that advance the understanding and prediction of extreme weather, water and climate events. (Target 8/yr)	C.1	Finish study and submit journal article on the frequency of occurrence and meteorological forcing of easterly gap flow events through the Columbia River Gorge and their associated weather hazard impacts in the Portland, Oregon metropolitan area.														X											White/HOP	Study takes advanatage of PSD's strategically located reasearch Doppler wind profiler and surface meteorology station at Troutdale, Oregon, an automated online gap-flow detection tool developed in FY18, and regional operational surface observations from the National Weather Service.	Y	Paper was submitted and accepted for publcation in Sep.: Neiman, P. J., D. J. Gottas, and A. B. White, 2019: A two-cool-season wind profiler-based analysis of westward-directed gap flow through the Columbia River Gorge. *Mon. Wea. Rev.*, in press.
		C.2	Provide observing equipment, field site/data communications infrastructure, and IT hardware/software maintenance and upgrades annually as required to succesfully operate and maintain California's 21-st century observing network and to make data and value-added products available to NWS Weather/River Forecasters and other end users.															X										White/HOP	Funding for this task is provided under a contract with State of California through the Department of Water Resources. New five-year MOU currently under DOC/NOAA legal review at the end of FY19. Operation and maintenance of the network has continued through FY19. Data from the network is publically available on a PSD website. Data is sent to MADIS for ingest into NOAA operational weather prediction models. Data is sent to NWS Western Region with SHEF-encoding for direct input into CNRFC and WFO smart tools.	Y	Wind profiler, snow-level radar, GPS integrated water vapor, and surface meteorological data from the network were used to help describe the anomalous hydrometeorolgical conditions leading up to and during the 2017 Oroville Dam flood mitigation crisis: White, A. B., B. J. Moore, D. J. Gottas, and P. J. Neiman, 2019 (Jan.): Winter storm conditoins leading to excessive runff above California's Oroville Dam during January and February 2017. Bull. Amer. Meteor. Soc., 100, 55-70.
		C.3	Facilitate installation of observing equipment (scanning radars) to improve monitoring and forecasting or precipitation in the SF Bay area														X											Cifelli/HMA		Y	2 X-band radars installed and operating in Santa Clara and Santa Rosa
		C.4	Submit journal article summarizing the Sensing Hazards with Operational Unmanned Technology (SHOUT) campaign and associated forecast impacts.													X												Wick/HOP	Proposal to the *Bulletin of the American Meteorological Society* already sent and positive response received in Sept 2018. NOAA Technical Memorandum published in FY18.	Y	Paper was submitted to the journal in July. Wick, G. A., and coauthors, 2019: NOAA's Sensing Hazards with Operational Unmanned Technology (SHOUT) Experiment: Observations and forecast impacts, *Bull. Amer. Meteor. Soc.*, submitted.
		C.5	Finish study on the reliability of sea surface diurnal warming estimates derived from operational geostationary satellite products. Submit journal article time permitting.															X										Wick/HOP		Y	Analysis complete. Reuslts presented at two scientific conferences. Journal paper currently being drafted. Diurnal waming code shared with NESDIS and EUMETSAT for inclusion into their sea-surface temperature algorithms.
		C.6																													
		C.7	Develop physically-based parameterizations for subgrid-scale variations in numerical forecast models based on observations and high-resolution model simulations.																x			x	x	x	x	x	x	Penland(DMI) Bao(FMD) Whitaker(FMD) Hamill(APA)	PSD will employ observations gathered by PSD scientists, theory developed by PSD scientists, and output from large-eddy simulations to diagnose the relevant probability distribution functions necessary for the implementation of stochastic parameterizations in FV3.	Y	The article led by Lisa Bengtsson has appeared in Monthly Weather Review. Additional articles and parameterizations implemented in FV3 in future years.
		C.8	Investigate the thermodynamic versus dynamic controls on mean and extreme precipitation in observations and models.																x									Penland/DMI		Y	The Sardeshmukh and Wang paper: "Dynamic vs. thermodynamic control on changes in mean and extreme precipitation" is in preparation. Results were presented at the Fall 2018 AGU meeting and the Annual 2019 AMS meeting.
		C.9	Create high resolution (1-min) Merged Observatory Data MODFs files for Barrow, Alaska that are interoperable with NWP model time-step data															X										Uttal/POP	The YOPPsiteMIP (YOPP = Year of Polar Prediction, MIP = Model Intercomparison Project) is designed look at the impact of fast (scale of minites) processes on model prediction skill especially for short-lived extreme events. The compilation of observational data sets needed to combine variables from dozens of instruments into formats can support MIPs or model diagnotics tool kit is a complex data-science and management effort	?	
		C.10	Construction of on-ice tower and autonomous surface energy and gas flux stations for deployment at the MOSAiC ice camp															X										Uttal/Shupe/POP Fairall/Bloomquist/BLO	PSD will deploy observations and take a lead on atmospheric and surface flux mesurements at the year-long MOSAiC ice camp. Systems will be deployed in September 2019. These systems include three autonomous stations outfitted for intensive atmsopheric observations, one 40 ft micrometeorology and flux tower at the main camp and one mobile radiometeric intercomparison station.	Y	Developed and deployable assets.
		C.Total	**Number of field studies that advance the understanding and prediction of extreme weather, water and climate events (Target 8/yr)**		**X**									**10**				**16**				**24**	**32**	**40**	**48**	**56**	**64**	**Lataitis/DIR**			
		D																													
		D.1	Develop diagnostics to evaluate the relationship between stratospheric wave variability and tropical precipitation															X										Kiladis/AOP		y	Three papers completed: Kim, Y. -H., G. N. Kiladis, J. R. Albers, J. Dias, M. Fujiwara, J. W. Anstey, I. -S. Song, C. J. Wright, Y. Kawatani, F. Lott, and C. Yoo, 2019: Comparison of equatorial wave activity in the tropical tropopause layer and stratosphere represented in reanalysis. Atm. Chem. Phys., doi: 10.5194/acp-2019-110, Sakaeda, N., J. Dias, and G. N. Kiladis, 2019: Assessment of the relationship between the QBO and organized modes of tropical convection. J. Geophys. Res., (submitted), Holt, L., F. Lott, R. R. Garcia, G. N. Kiladis et al., 2019: An evaluation of tropical waves and wave forcing of the QBO in the QBOi models. Quart. J. Roy. Met. Soc., (accepted with revisions).

Performance Requirement (PR) (End state in meeting organizational goals and objectives)	**Performance Measure (PM)** (The monitoring of ongoing progress toward pre-established goals.)	**PM Identifier**	**Performance Milestone** (A distinct activity planned for completion on a scheduled date extracted from individual PSD staff annual performance plans)	**Quarterly Cumulative**	**Yearly Cumulative**	**Prior Year Actuals (Measures establshed in FY18)**									**FY19 Targets**				**FY20 Targets**				**Out-Year Targets**					**PSD Point-of-Contact/ Research Team**	**More Detailed Description**	**Completed? (Y/N)**	**Evidence of Accomplishment: Comments/Documentation/Reports/Papers/Website/Datasets**
						FY10	**FY11**	**FY12**	**FY13**	**FY14**	**FY15**	**FY16**	**FY17**	**FY18**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**FY21**	**FY22**	**FY23**	**FY24**	**FY25**				
Increased predictive understanding of tropical-extratropical coupling, moisture transport and heavy precipitation from investigations of tropical - extratropical linkages and synoptic-scale or mesoscale meteorological features.	**Tropical/Extratropical Interactions** Number of diagnostic and modeling studies and products developed to advance the predictive understanding of tropical-extratropical coupling, moisture transport and heavy precipitation (Target 4/yr)	D.2	Develop and implement tropical relaxation experiments to assess how improved tropical forecasts could enhance prediction skill over North America															X										Kiladis/PSD	Development completed and experiments are ongoing. Further testing and implementation is taking place. First manuscript is in progress.	y	Multi-year project is ongoing with excellent progress. One paper published: Dias, J., and G. N. Kiladis, 2019: The influence of tropical forecast errors on higher latitude predictions. Geophys. Res. Lett., 46, 4450-4459, doi.org/10. 1029/2019GL082812. We continue to run and analyze relaxation experiments with weekly or more timely group updates on progress.
		D.3	Develop SP-WRF experiments to study the role of tropical-extratropical interactions in modulating tropical waves.															X										Kiladis/Tulich/Dias AOP	We will use SP-WRF to test the obervational hypotheis that regional variations in eastward moving convective wave demographics are modulated by tropical to extratropical interactions	N	This multi-year project is ongoing, our new NRC postdoc Yuan-Ming Cheng has just arrived for two years and he will be working on this project with Stefan Tulich.
		D.4	Develop novel methods of diagnosing the impact of stochastic parameterization on the Madden-Julian Oscillation in models.															x										Bao(FMD) Penland(DMI)	We shall deliver preliminary results involving the particular dynamical nature of the Madden-Julian Oscillation as observed and as simulated by FV3-GFS.	Y	The paper "MJO Evolution as revealed by multivariate principal oscillation analysis, Part I: an MJO-like dynamical mode" is in preparation (to be submitted to J. Climate). The MJO has been examined in the coupled FV3 and a benchmark for comparing parameterizations with and without stochastic physics is under investigation.
		D.5																													
		D.6																													
		D.7																													
		D.8																													
		D.9																													
		D.10																													
		D.Total	**Number of diagnostic and modeling studies and products developed to advance the predictive understanding of tropical-extratropical coupling, moisture transport and heavy precipitation (Target 4/yr)**		**X**									**5**				**8**				**12**	**16**	**20**	**24**	**28**	**32**	**Webb/DIR**			
		E																													
Research advances contributing to the development of the NOAA next-generation global prediction system capable of dramatically improved global numerical weather predictions on time scales of 1-30 days	**NGGPS Improvements** Number of model development, sensitivity and evaluation studies to improve NOAA's next-generation global prediction system capabilities (Target 6/yr)	E.1	Develop and test two potential improvements to the operational NCEP data assimilation system.															X										Whitaker/FMD	Two improvements were implemented and tested: 1) improvement in the use of radiance observations in the EnKF (through improved vertical localization) 2) implementation of four-dimensional incremental analysis update (IAU) in the NCEP/EMC workflow	Y	Four-dimension incremental analysis update and a new, more efficient EnKF algorithm that assimlates satellite radiances more effectively are running now in pre-implementation parallel testing for the GFS version 16 upgrade (scheduled for FY21).
		E.2	Develop and test two potential improvements to the physical parameterizations used in the NCEP operational prediction suite.															X										Whitaker/FMD	Two improvements to the GFS stochastic physics were implemented and tested: 1) improvements to the random pattern generator that improve efficiency and allow the use of the native model grid, 2) a celluar automata scheme for represented sub-gridscale variability was added to FV3GFS	Y	A new scheme for representing uncertainty in deep convection that uses cellular automata to simulate stochastic processes such as the production and destruction of subgrid convective elements was implemented in FV3GFS and is undergoing testing for potential inclusion in GEFS version 13. An update to the SPPT scheme used in GEFS version 12 has been tested and found to better represent the effect of uncertainty in cloud radiative effects on the ocean and land states. This update is also undergoing further testing for potential inclusion in GEFS version 13.
		E.3	Evaluate NGGPS advanced physics suite candidates and provide scientific assesment.														X					X						Bao/FMD	Two evaluations were performed: 1) As part of an independent assessment/evaluation commitee, a recommendation was delivered to NCEP/EMC on the configuration of the advanced physics package for GFS version 16. 2) Evaluate the minimal complexity required in cloud microphysics parameterizations to satistfy NGGPS QPF performance goals.	Y	PSD scientists participated in the evaluation of candidate physics suites, and contributed to a report that led to the choice of a suite for GFS version 16.
		E.4	Develop new diagnostics to evaluate NGGPS tropical model performance and transfer them to NCEP															X										Kiladis/PSD	Development of this multi-year project is ongoing with support granted by NCEP	y	Work continues on this multi-year project and we are actively developing diagnostics for NGGPS model assessment in conjunction with the NOAA funded Model Diagnostics Task Force (MDTF) and the NSF funded Model Evaluation Tools (MET) at UCAR. We have three papers in conjunction with this project: Wolding, B., J. Dias, G. N. Kiladis, F. Ahmed, and E. Maloney, 2019: Interactions between moisture and tropical convection. Part I: Convective lifecycle and spatiotemporal dependence. J. Atmos. Sci., (submitted). Wolding, B., J. Dias, G. N. Kiladis, F. Ahmed, and E. Maloney, 2019: Interactions between moisture and tropical convection. Part II: The convective coupling of equatorial waves. J. Atmos. Sci., (submitted). Bengtsson, L., et al., 2019: Convectively coupled equatorial wave simulations using the ECMWF IFS and the NOAA GFS cumulus convection schemes in the NOAA GFS model. Mon. Wea. Rev., (in press). A fourth paper: "Tropical Diagnostics for numerical model development" by M. Gehne, J. Dias, G.N. Kiladis, et al. is in preparation.
		E.5	Develop diagnostics to evaluate developments of EMC sea-ice and related system (Arctic ocean/atmosphere) forecast products															X										Intrieri/Solomon/POP	A diagnostics toolkit will be developed to assess how CAFS model output of cloud and boundary layer properties and associated processes compare to UFS benchmark runs in 2015.	Y	
		E.6																													
		E.7																													
		E.8																													
		E.9																													
		E.10																													
		E.Total	**Number of model development, sensitivity and evaluation studies to improve NOAA's next-generation global prediction system capabitilities (Target 6/yr)**		**X**									**7**				**12**				**18**	**24**	**30**	**36**	**42**	**48**	**Webb/DIR**			
		F																													

Performance Requirement (PR) (End state in meeting organizational goals and objectives)	Performance Measure (PM) (The monitoring of ongoing progress toward pre-established goals.)	PM Identifier	Performance Milestone (A distinct activity planned for completion on a scheduled date extracted from individual PSD staff annual performance plans)	Quarterly Cumulative	Yearly Cumulative	Prior Year Actuals (Measures establshed in FY18)									FY19 Targets				FY20 Targets				Out-Year Targets					PSD Point-of-Contact/ Research Team	More Detailed Description	Completed? (Y/N)	Evidence of Accomplishment: Comments/Documentation/Reports/Papers/Website/Datasets
						FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	FY21	FY22	FY23	FY24	FY25				
Research accelerating the development and application of coupled earth system analysis and modeling to understand where, when, and how ecosystems and ecosystem services may encounter critical environmental tipping points	**Integrated Earth System Studies** Number of integrated earth system studies to improve understanding of living marine resource responses to climate extremes, variations and change (Target 4/yr)	F.1	Use regional high-resolution models to understand and assess the effects of climate variability and change on US coastal ocean environments.														X											Alexander/AOP		Y	Alexander, M. A., S. Shin, J. D. Scott, E. Curchitser, C. Stock, 2019: The Response of the Northwest Atlantic Ocean to Climate Change J. Climate , submitted. Shin, S., and M. A. Alexander, 2019: Dynamical Downscaling of Future Hydrographic Changes over the Northwest Atlantic Ocean J. Climate , submitted. We anticipate that these two papers will be accepted shortly.
		F.2	Contribute to the development of seasonal prediction systems for living marine resource applications															X										Alexander/AOP	Funded through the NOAA MAPP program	Y	Jacox, M, M A. Alexander, et al. 2019: Seasonal-to-interannual prediction of U.S. coastal marine ecosystems: Forecast methods, mechanisms of predictability, and priority developments. Progress in Oceanography, submitted. Jacox, M. G., D. Tommasi, M.
		F.3	Diagnose the affects of climate varaibility on CO2 fluxes at the air-sea interface													X												Alexander/AOP		Y	published paper: Brady, R. X., N. S. Lovenduski, M. A. Alexander, M. Jacox, and N. Gruber, 2019: On the role of climate modes in modulating the air-sea CO2 fluxes in eastern boundary upwelling systems, Biogeosciences, 16, 329-346, https://doi.org/10.5194/bg-16-329-2019.
		F.4	Examine the predictability of marine heat waves															X										Alexander/AOP	Use output from global climate forecast systems to document which aspects of the 2014-2016 heat wave off the US west coast were predictable and how forecast skill, or lack thereof, relates to mechanisms driving the heat wave's evolution.	Y	Jacox, M. G., D. Tommasi, M. A. Alexander, G. Hervieux, and C. Stock (2019), Predicting the evolution of the 2014-16 California Current System marine heatwave from an ensemble of coupled global climate forecasts, Frontiers in Marine Science, 6:497, doi:10.3389/fmars.2019.00497.
		F.5	Use multi-decadal observations from northern Alaska, reanalyses and satellite data to examine the atmospheric drivers of interannual and long-term variability in the snow-free season, the relationship between snow cover, sea ice and lake ice; and the responses to such variability within the ecosystem, including wildlife, vegetation and biogeochemistry.															X										Uttal/Cox/POP	Analyzed data and variables include regional atmospheric pressure patterns from reanalyses; historical weather data (e.g., NWS Coop); NOAA and DoE-ARM climate data (radiation/albedo, meteorology, gases); lake thaw dates; satellite-based vegetation pheonology, sea ice and snow albedo; and variables related to the breeding season of North Slope wildlife, in particular the Mandts Black Guillemot. Partners include NOAA-GMD, U.S. Geological Survey, Friends of Cooper Island (US based non-profit) and the North Slope Borough.	Y	2 published papers, 3rd in review: (2) Cox, CJ, RS Stone, DC Douglas, DM Stanitski, GJ Divoky, GS Dutton, C Sweeney, J Craig George, D Longenecker (2017), Drivers and environmental responses to the changing annual snow cycle of northern Alaska, BAMS, 98, 2559-2577, https://doi.org/10.1175/BAMS-D-16-201.1. (1) de Boer, G, CJ Cox, J Creamean (2019) Accelerated springtime melt of northern Alaska river systems resulting from niveo-aeolian deposition events, Arctic, in press. (3) Cox, CJ, RS Stone, DC Douglas, RM Stanitski, MR Gallagher, The Aleutian Low - Beaufort Sea Anticyclone: A cliamte index correlated with the timing of springtime melt in the Pacific Arctic cryosphere, GRL, in review.
		F.6	Working on Entry for snow persistence/wolverine study; its not marine - but living resource																												will be manuscript submitted to journal
		F.7																													
		F.8																													
		F.9																													
		F.10																													
		F. Total	**Number of integrated earth system studies to improve understanding of living marine resource responses to climate extremes, variations and change (Target 4/yr)**		**X**									**4**				**8**				**12**	**16**	**20**	**24**	**28**	**32**	**Webb/DIR**			
		G																													
Develop, prototype and demonstrate experimental local, regional and global forecasting capabilities	**Improved Forecasting of Extremes** Number of observational, process, and numerical analysis research findings that improve experimental local to global forecasting of weather, water and climate extremes, variations and change (Targte 2/yr)	G.1	Prototype use of post-processed GEFS forecasts to improve hydrologic predictions															X										Viterbo/HMA	Use bias corrected GEFS forcings as input to the NWM to improve medium range, probabilistic hydrologic prediction	Y	Completed initial testing to downscale and bias correct GEFS forcings in physically consistent manner for hydrologic prediction
		G.2	Document and assess performance of NOAA operational forecast models covering the Oroville dam crisis and other recent events in CA															X										Bytheway/HMA	Use combination of observations and models to assess QPF/hydrologic performance over a range of forecast lead times. A combination of GFS and the National Water Model will be used. DIscussions with DWR and the CNRFC will be conducted to highlight the biggest forecast challenges. Emphasis will be on understanding physical processess responsible for QPF/hydrologic performance	Y	Assessed performance of HRRR and GFS for Oroville and other events and presented results to NWS (CNRFC) and CA-Dept of Water Resources in May 2019. Follow-on work to assess sensitivity of hydrologic prediction to precipitation forcing will occur in FY20.
		G.3																													
		G.4																													
		G.5																													
		G.6																													
		G.7																													
		G.8																													
		G.9																													
		G.10																													
		G. Total	**Number of observational, process, and numerical analysis research findings that improve experimental local to global forecasting of weather, water and climate extremes, variations and change (Target 2/yr)**		**X**									**3**					**4**			**6**	**8**	**10**	**12**	**14**	**16**	**Webb/DIR**			
		H																													
		H.1	Develop and evaluate an algorithm to estimate rainfall drop-size distribution parameter profiles using PSD's vertically pointing radars operating in the S-band (~3 GHz) frequency band														X											White/HOP	Algorithm will allow observed microphysical profiles to be compared with numerical model respresentation of these profiles with the goal of improving precipitation parameterizations. Algorithm underwent code modifications and further testing in FY19.	Y	Algorithm underwent code modifications and further testing in FY19. Verified complex mathematical relations. Verified derived drop-size distributions against known distributions. Improved iterative procedures.
		H.2	Complete 20th year of rainfall process partitioning analysis using PSD's vertically pointing precipitation radars to further understanding of precipitation processes and inform numerical modeling improvements																									White/HOP	Analysis will complement microphysics tool described above by partitioning different types of precipitation classifications such as stratiform, warm rain, and convection. Code ready to run. Waiting on retrieval of archived data from the field. The complete datasets should be ready for analsyis in early FY20.	N	Results of the first 19 years of rainfall process partitioning were presented in Sep.: White, A. B., D. J. Gottas, R. Cifelli, and H. Chen, 2019: Bulk microphysical properties of orographic rainfall deduced by vertically pointing radars in the Western United States. *39th Intern. Conf. on Radar Meteor.*,16-20 September 2019, Nara, Japan. AMS, Boston.

Performance Requirement (PR) (End state in meeting organizational goals and objectives)	Performance Measure (PM) (The monitoring of ongoing progress toward pre-established goals.)	PM Identifier	Performance Milestone (A distinct activity planned for completion on a scheduled date extracted from individual PSD staff annual performance plans)	Quarterly Cumulative	Yearly Cumulative	Prior Year Actuals (Measures establshed in FY18)									FY19 Targets				FY20 Targets				Out-Year Targets					PSD Point-of-Contact/ Research Team	More Detailed Description	Completed? (Y/N)	Evidence of Accomplishment: Comments/Documentation/Reports/Papers/Website/Datasets
						FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	FY21	FY22	FY23	FY24	FY25				
Improved basis for confidence in understanding key oceanic, atmospheric, hydrologic, biogeochemical, and socioeconomic components of the climate system and impacts	**Improved Process Understanding** Number of observational, process, numerical and predictability research studies that increase the scientific understanding of key environmental processes (Target 8/yr)	H.3	Continue development of a National Water Model (NWM) soil moisture climatology for the CONUS and provide percentile data set to the Office of Water Prediction for them to test with the operational NWM output of soil moisture.														X											Hughes/HMA		Y	PSD completed percentile data set using National Water Model v1.2 retrospective data and provided to OWP for prototype visualization. In FY20, PSD will develop percentile data set using National Water Model 2.0 retrosepctive data and assess differences with percentiles using v1.2.
		H.4	Analyze the impact of skewed National Water Model soil moisture climatologies for Mediterranean climates along the U.S. West Coast for determining drought severity. Present results at AMS Conference on Hydrology (Q2) and draft publication for submission to referreed journal (Q4).													X		X										Hughes/HMA		Y	AMS presentation completed. White paper describing research results drafted with Office of Water Prediction. White paper will be used as publication draft as soon as Office of Water Prediction approves.
		H.5	Develop method for retrieving soil moisture by using reflections of electromagnetic signal															x										Voronovich/DMI	Processing experimental data obtained by in-house developed airborne system (J.Leach,HOP) and corresponding modeling	Y	The measurement system is not ready yet due to lack of engineering workforce. However, the inversion technique and corresponding software were developed and numerical simulation performed. Draft of corresponding paper is prepared.
		H.6	Investigate the moisture transport into the inter mountain west in regional climate simulations															X										Mahoney/HMA	Use CORDEX data sets	Y	Paper draft being prepared: "Current and Future Precipitation Projections for the Western United States in NA-CORDEX models"
		H.7	Release version 3.6 of the NOAA flux COARE algorithm.														X											Fairall/BLO	Algorithm is available on FTP site. Publication in progress.	Y	ftp://ftp1.esrl.noaa.gov/BLO/Air-Sea/bulkalg/cor3_6/
		H.8	Participate in 4 air-sea flux cruises (3 ocean, 1 Great Lakes)														X											Fairall/BLO		Y	OOMD Stratus completed in March 2019. OOMD WHOTS re-scheduled for Oct. OGP PISTON underway Sept 2019. Great Lakes season completed. See ftp://ftp1.esrl.noaa.gov/psd3/cruises/ for data.
		H.9																													
		H.10																													
		H.Target	**Number of observational, process, numerical and predictability research studies that increase the scientific understanding of key environmental processes (Target 8/yr)**		**X**									**9**					**16**			**24**	**32**	**40**	**48**	**56**	**64**	**Lataitis/DIR**			
		I																													
Increase in personal skills of staff applicable to duties in support of the PSD and OAR mission through education and training	**Professional Development** Number PSD staff participating in professional development and communications training (Target 15/yr)	I.1	Leadership and communication skills training																											Y	
		I.2	Facilitation skills and working with Congress training																											Y	
		I.3	Supervisory Policy Training																											Y	
		I.4	OAR New Employee Orientation																											Y	
		I. Total	**Number PSD staff participating in professional development and communications training (Target 15/yr)**		**X**									**15**					**30**			**45**	**60**	**75**	**90**	**105**	**120**	**Gorton/DIR**			
		J																													
Promotion of a more inclusive workplace environment where diversity and individual differences are valued and leveraged to achieve the vision and mission of the organization.	**Organizational Excellence** Number PSD staff participating in activities that foster an inclusive workplace and strengthen organizational performance (Target 25/yr)	J.1	Mentor interns from Hollings, Pathways, EPP, SOARS and other undergraduate and graduate internship programs including students from under-represented groups (NOTE: PSD almost always has a number of these interns, but who hosts and the demographics of the students varies)																									Gorton/DIR		Y	
		J.2	Create an inclusive work environment from a top-down management perspective through monthly senior PSD leadership sessions focused on improving organizational health by maximizing clarity and minimizing politics, so staff feel empowered to be themselves and can fully contribute in a workplace environment that promotes creativity and vitality																									Webb/DIR		Y	
		J.Total	**Number PSD staff participating in activities that foster an inclusive workplace and strengthen organizational performance (Target 25/yr)**		**X**									**25**					**50**			**75**	**100**	**125**	**150**	**175**	**200**	**Webb/DIR**			

Identifier (Name of Parent Project)	Brief Description	Statement of intended purpose	Lifecycle Moving from				Lifecycle Moving to				Target	Actual	Target	Actual	Target	Actual	Target	Actual	Out-Year Targets					Date Completed Fiscal year and quarter the project will transition to operations	PSD Point of Contact	OAR Responsible SES	Contributing Partners	Customer	A clear statement of what condition must be met for the product advancement to have been made. This should be sufficient to allow a knowledgeable observer to evaluate whether the advancement has been achieved.	Type of R2A (Choose all applicable)			Cost of R2A Transition	Comments	Weather Act
			Research	Development	Demonstration	Operations or Applications	Research	Development	Demonstration	Operations or Applications	FY19 Q1	FY19 Q1	FY19 Q2	FY19 Q2	FY19 Q3	FY19 Q3	FY 19 Q4	FY19 Q4	20	21	22	23	24							Operations	Commercial	Other	Funding amount to move the project into operations/ applications (Only the profile shift and NOT the total funding amount.)		
EDDI	Transition the Evaporative Demand Drought Index (EDDI) to an operational status at the National Water Center.	Provide a service for drought early warning, and ongoing drought monitoring to stakeholders affected by agricultural, hydrologic, and ecological drought, and at wildfire risk			x					x								x						FY19, Q4	Hobbins	Webb	Desert Research Institute & NOAA-National Water Center	NOAA-National Water Center	EDDI running at National Water Center and providing user-queryable drought monitoring andf ancillary information to stakeholders	x				Target date for complete transition to NWC is May 2019.	
NGGPS Improvements	ESRL/PSD has developed parameterizations of model uncertainty in the NCEP operational global ensemble forecast system. These parameterizations are crucial for producing accurate representations of forecast uncertainity for both the data assimilation cycle and the ensemble prediction system. This project supports ongoing development aimed at improving these parameterizations, in collaboration with NCEP/EMC.	Improved representation of model uncertainty in the NOAA Global Ensemble Forecast System (GEFS)			x					x							x							FY19, Q4	Whitaker	Webb		NWS/NCEP	Stochastic physics parameterizations implemented in time for use in beta implementation of FV3GFS data assimilation system and FV3GEFS reforecasts	X					
NGGPS Improvements	ESRL/PSD has developed the Ensemble Kalman Filter (EnKF) component for the operational global data assimilation system. The EnKF is used to update an ensemble of forecasts in the data assimliation cycle, and that ensemble is used to estimate background-error covariances needed by the data assimlation update. This project supports ongoing development aimed at improving the use of ensemble information in the data assimilation system, in collaboration with NCEP/EMC.	Improved representation of background errors in the operational data assimilation system, leading to improved use of observations, improved analyses and forecasts.		x					x								x							FY19, Q4	Whitaker	Webb		NWS/NCEP	Improvements to the operational data assimilation system tested and merged in time for the code freeze ahead of the next operational FV3GFS upgrade.						
NGGPS Improvements	Develop, produce, and release a new modern-era high-resolution atmospheric global reanalysis and reforecast to facilitate the generation of high-quality operational post-processed model guidance by the National Weather Service	Improve NWS operational forecasts			x					x									x					FY19, Q3	Hamill	Webb	NCEP OAR/CPO	NCEP CPC and EMC, as well as NWS forecast offices	Provide datasets needed to post-process operational global ensemble forecasts to provide calibrated probabilities to the public.	x				Due to EMC problems with their diurnal sea-surface temperature forecast algorithm, reanalysis and reforecast production is somewhat delayed and final delivery may slip to Q2FY2020.	
Arctic Sea Ice Forecasting	Produce experimental forecast guidance products (daily during fall freeze up period - Q1,Q4) of sea ice, atmosphere, ocean conditions for the Arctic Basin on 0-10 day scales.	Improve forecasts of sea ice and Arctic conditions during Arctic fall freeze-up period		x					x						x									FY19, Q3	Intrieri	Webb	NWS Arctic Testbed	NWS/NCEP	Use by NCEP as a demonstration baseline of potential NGGPS Arctic sea ice forecast performance Adoption by NWS of current experimental sea ice forecasting capability.	x					
NGGPS Improvements	Develop, produce, and release a new modern-era high-resolution atmospheric global reanalysis and reforecast data set to facilitate the generation of high-quality operational post-processed model guidance by the National Weather Service	Improve NWS operational forecasts			x					x					x									FY19, Q3	Hamill	Webb	NWS/NCEP OAR/CPO	NCEP, CPC and EMC, as well as NWS forecast offices	Use of reanalysis and reforecast datasets by customers to post-process operational global ensemble forecasts to provide calibrated probabilities to the public.	x					
Soil Moisture Drought Monitoring	Prototype NOAA's National Water Model soil moisture products for drought monitoring in select NIDIS watersheds	Develop experimental soil moisture drought monitoring capability based on hourly, best available, quality-controlled NWM output.															x							FY19, Q4	Cifelli	Robert Webb	NWS/NWC	NIDIS	A demonstration of possible adoption of watershed-scale NWM-derived soil mositure anamoly maps by NIDIS			x			
20C Reanalysis	Develop, produce, and release a new version of the 20th Century reanalysis (version 3) to better represent extreme events and characterize their uncertainty back to 1850.	See column B			x					x									x					FY19, Q3	Compo	Webb	CIRES, NCEI, PMEL	climate researchers, federal, private sector and academic	A dataset is made available to climate researchers that includes 3-hourly gridded fields back from 1850-present.			x			
NIDIS	Provide quarterly services to better inform regional decision makers on evolving climate conditions and extreme events (NIDIS)	See column B	x							x	x		x		x		x							Ongoing	Hoell	Webb	NIDIS	NIDIS Federal Partners	Understand characteristics and predictability of Northern Plains Drought and apply to seasonal forecasts used by NIDIS partners			x		This is an FY18-19 project in which we use the case of the 2017 Northern Plains drought to motivate examination of the causes and predictability of all droughts over the region (FY19, Q1 end date)	
FEWSNET	Provide quarterly services to better inform regional decision makers on evolving climate conditions and extreme events (FEWSNET)	See column B	x							x	x		x		x		x							Ongoing	Hoell	Webb	USGS NASA USAID	USAID Famine Early Warning System Network	Understand predictability of African and Asian drought and apply to seasonal forecasts used by food security analysts			x		This is an ongoing collaboration in which we examine predictability of drought and use that information to advise food security analysts famine outlooks that are then used by the U.S. government to mobilize aid	
Climate Chnage Web Portal	Continue the development of the Climate Change Web Portal	Provide accessible climate variability and change information to fisheries and water resource managers			x				x				x											Ongoing	Alexander	Webb		NMFS, fishery and water managers	Interactive web-portal for displaying a suite of climate variables	x	x	x			
ENSO	Develop prediction systems for ocean conditions including ENSO	Explore new methods for prediction of important ocean varaibles and indices	x					x									x							FY19,Q4	Alexander	Webb		NWS, NMFS	Skill shown based on retrospective forecasts.	x		x			
Stratospheric Ozone	Improve stratospheric ozone in GFS	Upgraded Naval Research Laboratory's CHEM2D-OPP stratospheric ozone parameterization in NCEP GFS system			x					x			x											FY19,Q2	Compo	Webb	EMC, NRL, CPC, SUNY-Albany	NCEP/NOAA	The parameterization is currently in parallel testing in the new FV3GFS and will be included in the operational implementation FV3 GFS.	x					
Stratospheric Water Vapor	Improve stratospheric water vapor in GFS	Included Naval Research Laboratory's CHEM2D-OPP stratospheric water vapor parameterization in NCEP GFS system			x					x			x											FY19, Q2	Compo	Webb	EMC, NRL, CPC, SUNY-Albany	NCEP/NOAA	The parameterization is currently in parallel testing in the new FV3GFS and will be included in the operational implementation FV3 GFS	x					

Identifier (Name of Parent Project)	Brief Description	Statement of intended purpose	Lifecycle Moving from: Research	Development	Demonstration	Operations or Applications	Lifecycle Moving to: Research	Development	Demonstration	Operations or Applications	Target FY19 Q1	Actual FY19 Q1	Target FY19 Q2	Actual FY19 Q2	Target FY19 Q3	Actual FY19 Q3	Target FY 19 Q4	Actual FY19 Q4	Out-Year Targets 20	21	22	23	24	Date Completed Fiscal year and quarter the project will transition to operations	PSD Point of Contact	OAR Responsible SES	Contributing Partners	Customer	A clear statement of what condition must be met for the product advancement to have been made. This should be sufficient to allow a knowledgeable observer to evaluate whether the advancement has been achieved.	Type of R2A (Choose all applicable): Operations	Commercial	Other	Cost of R2A Transition: Funding amount to move the project into operations/ applications (Only the profile shift and NOT the total funding amount.)	Comments	Weather Act
JTTI	Testing channel loss parameterization in the National Water Model	This is NOAA Joint Technology Tranfer grant funded research that seeks to improve National Water Model performance in arid climate regimes by simulating water losses in river channels.			x					x									x					FY20,Q2	Zamora	Webb	University of Arizona, OWP	OWP	The parameterization may be included in the 2021 National Water Model Operational NCEP Update after parallel tesing in 2020.	x					
D-ICE	Determine best practice ice mitigation strategies for broad-band radiometers	Improve monitoring of broadband radiation which is a critical component of global surface energy budets by (1) assessing current technology duirng icing conditions, (2) quanitfying the impact of icing (3) identifying the attributes of successful ice-mitigation systems.																						FY19, Q4	Uttal	Webb	Industry: Delta-T, Kipp & Zonen, Hukseflux, Eppley, EKO. Insitutes: NOAA-GMD, US. Dept. of Energy-ARM, NCAR, MeteoSwiss (Switzerland), AWI (Germany), PMOD-WRC (global standard, Swtizerland), BSRN	Operators (e. g., BSRN, NOAA-GMD), engineering/ development (federal, private sector, academic), end-users (e. g., climate researchers)	Dissemination of results to end-users (via publication), operations community (via Baseline Surface Radiation Network) and industry (via report to partners), as well as incorporation of results by NOAA-PSD for decision-making in flux systems deployed to high latitude/altitude environments.						
miniFlux	Small UAS sensor package to measure winds, temps, RH, and P to derive atmospheric fluxes	Characterization of atmospheric properties needed for model validation and process studies																						FY20, Q2	Intrieri	Webb	NOAA UAS	NOAA UAS	Completion and sign-off of UASPO Transition Plan						
																										Webb									

Performance Requirement (PR) (End state in meeting organizational goals and objectives)	Performance Measure (PM) (The monitoring of ongoing progress toward pre-established goals.)	PM Identifier	Performance Milestone (A distinct activity planned for completion on a scheduled date extracted from individual PSD staff annual performance plans)	FY20 Targets				PSD Point-of-Contact	PSD Research Team	More Detailed Description (as needed)	Tracked as R2X Transition?	Completed? (Y/N)	Evidence of Accomplishment/Follow-up Actions (If completed provide evidence in the form of comments, documentation, reports, papers,websites, datasets, etc. If not completed state why and identify follow-up actions)
				Q1	Q2	Q3	Q4						
Peer reviewed scientific publications that document research results and communicate research advances to NOAA's operational centers, the broader scientific community, stakeholders, and the general public.	**Research Publications** Annual number of NOAA peer reviewed publications related to environmental understanding and prediction (Target 20/qtr)		**Number of peer-reviewed PSD publications (20/qtr)**	**20**	**40**	**60**	**80**	**Lataitis**	**DIR**			120	
		A											
		A.1	Complete GEFS Reanalysis and Reforecast data set				X	Hamill Whitaker	APA FMD	Completion of GEFS reanalysis and reforecast, with publication of one or more articles describing it, and a disk archive publicly accessible. Partners: NWS (EMC, CPC, MDL, NWC)		Y	Computation of reanalyses and reforecasts complete. Transfer from tape to disk storage underway (storage solution both on NOAA disk and Amazon cloud). Journal article expected to be ready for submission ~ Jun 2020.
		A.2	Operational implementation of improved probabilistic quantitative precipitation forecast in National Blend of Models (NBM)		X			Hamill	APA	Operational implementation of some elements of the improved algorithm as described in: Hamill, T. M., and Scheuerer, M., 2018: Probabilistic precipitation forecast postprocessing using quantile mapping and rank-weighted best-member dressing. Mon. Wea. Rev., 146, 4079-4098. Also: Online appendix 1. Anticipated next PSD deliverable will be code suitable for leveraging GEFS reforecasts to improve NBM precipitation quality via PPGC grant. Partner: NWS MDL		N (ongoing new activities)	Operational implementations depends on MDL's implementation schedule and is out of the control of PSD. They do plan to implement improvements in coming years. Follow-up consists of actions under precipitation grand-challenge grant to leverage GEFS reforecasts in National Blend precipitation. Transition plan developed and being monitored by OAR WPO.
		A.3	Deployment of experimental cool-season temperature and precipitation forecasts based on a combined, lagged sea-surface temperature regression model				X	Hamill	APA	Experimental web graphics page hosted by PSD that is updated periodically, providing cool-season probabilistic forecasts of temperature and precipitation based on method developed internally at PSD as described in: Switanek, M., J. J. Barsugli, M. Scheuerer, and T. M. Hamill, 2019: Present and past sea surface temperatures: a recipe for better seasonal climate forecasts. Weather and Forecasting, submitted. Partners: CPC	Y	N	Journal article published, Switanek, M. B., J. J. Barsugli, M. Scheuerer, and T. M. Hamill, 2020: Present and Past Sea Surface Temperatures: A Recipe for Better Seasonal Climate Forecasts. Wea. Forecasting, 35, 1221–1234, https://doi.org/10.1175/WAF-D-19-0241.1. Tech transition intended of this capability to CPC; we initiated (5/2020) tracking this as a tech transition project, and it is being tracked quarterly in a NWS quad chart now.
		A.4	Deliver daily, 0-10 day forecasts of ice, ocean, atmosphere fields using the PSD Coupled Arctic Forecast (CAFS) model	X	X	X	X	Intrieri	POP	Daily forecasts are posted on a publicly accessible website and used by NWS-Alaska Region forecasters, NIC, and the Alfred Wegner Institute as part of the MOSAiC forecast suite (https://www.esrl.noaa.gov/psd/forecasts/seaice/)	x	Y	Journal article submitted: Intrieri, J.M. et al., 2020. Evaluation of the NOAA, experimental Coupled Arctic Forecast System. Forecasts posted daily to website: https://psl.noaa.gov/forecasts/seaice/
		A.5	Analyze the results of extension of the NOAA-CIRES-DOE 20th Century Reanalysis version 3 data				X	Compo Whitaker	DMI FMD	Extend 20CRv3 dataset to 2018 and back in time. Archive the extension and release it at PSD. Prepare two papers based on the results.		N	Extension back to 1806 is complete. Extension to 2018 is delayed due to issues from UK partners to obtain needed boundary conditions. Data are archived and available from https://www.psl.noaa.gov/data/20thC_Rean/. First of two papers using new dataset to 2015 has been submitted: Slivinski, Compo, Sardeshmukh, Whitaker et al., 2020: An evaluation of the performance of the 20th Century Reanalysis version 3, J. Climate, in review.
		A.6	Construct Merged Observatory Arctic Data Files (ship or campaign) for community research analyses				X	Uttal	POP	Construct Merged Observatory Arctic data files (ship or campaign) with python libraries to decrease latency in the usage of research grade observations that are not submitted to the GTS with an end goal of creating verification data sets for diagnostic toolkits		N	This project is not completed however considerable progress has been made towards completion. The progress is (1) Development of a detailed schema with CF complian format (2) Construction of a python toolkit that will be the basis of construction of the MODF files (3) Assembly of a MODF makers group with representatives from 5 Arctic countries and 2 Arctic Ship Campaigns (4) Programmatic adoption of the activity by the WMO/PPP YOPPsiteMIP program (5) Coordination with the User-Modelers creating companion model files.
		A.7	Develop and demonstrate miniflux and microbuoy observing technologies		X			Intrieri	POP	miniFlux was succesfully deployed during the ATOMIC field campaign in Jan-Feb 2020 using the University of Colorado UAS RAAVEN vehicle.	x	Y	Successfully deployed miniFlux to ATOMIC campaign (Jan-Feb 2020); Planning for test flights on NOAA UAS vehicle in Fall 2020 (delayed due to COVID)
		A.8	Demonstrate "hybrid" quantitative precipitation estimation product using gap-fill and NEXRAD radar data as part of the AQPI project			X		Chen	HMA	We have published a paper about bias correction of NEXRAD radar QPE product, which will be incorporated in the "hybrid" QPE system. But operational implementation of this bias correction module will depend on the availability of real-time gauge data. The real-time (MADIS) gauge data is out of control of PSL. Before having access to real-time gauge data, NEXRAD QPE without bias correction is used in the hybrid product. Chen, H., R. Cifelli, V. Chandrasekar, and Y. Ma, 2019: A Flexible Bayesian Approach to Bias Correction of Radar-Derived Precipitation Estimates over Complex Terrain: Model Design and Initial Verification. J. Hydrometeor., 20, 2367–2382, https://doi.org/10.1175/JHM-D-19-0136.1.		Y	I have designed an interpolation technique to reprocess the 1-km NEXRAD data to match AQPI X-band product resolution (i.e., 250 m). I have also developed a fusion scheme to combine the two products. The processing code was delivered to Greg's team at GSL for operational test. Currently I am working with GSL to improve the robustness of the system in the operational environment. We should have the "hybrid" QPE system running smoothly by the end of Q4. Also, I have already finished preliminary demonstration of the "hybrid" QPE product to show its superior performance to the current NEXRAD radar product. A more comprehensive evaluation paper is planned for FY21, and it is still in progress. In short, we have finished the development and demonstration phases. We are working on real-time implementation and enhancing the operational reliability, which should be accomplished within Q4. Please let me know if you have any concerns.

Performance Requirement (PR) (End state in meeting organizational goals and objectives)	Performance Measure (PM) (The monitoring of ongoing progress toward pre-established goals.)	PM Identifier	Performance Milestone (A distinct activity planned for completion on a scheduled date extracted from individual PSD staff annual performance plans)	FY20 Targets				PSD Point-of-Contact	PSD Research Team	More Detailed Description (as needed)	Tracked as R2X Transition?	Completed? (Y/N)	Evidence of Accomplishment/Follow-up Actions (If completed provide evidence in the form of comments, documentation, reports, papers,websites, datasets, etc. If not completed state why and identify follow-up actions)
				Q1	Q2	Q3	Q4						
Experimental weather, water and climate products or services transitioned to a new stage (development, demonstration, operations/application)	Research Transitions Number of weather, water and climate research advances transitioned into applications, operations and services to inform regional decision making (Target 6/yr)	A.9	Demonstrate real time forecasts of storm surge in San Francisco Bay area using a USGS coastal model forced by the NOAA High Resolution Rapid Refresh atmospheric model and NOAA National Water Model (hydrologic)				X	Cifelli	HMA			Y	The USGS coastal model is running on a development box in GSL and is producing regular coastal flooding forecasts forced with the HRRR model. The demonstration with National Water Model coupling is shown in this poster: https://psl.noaa.gov/aqpi/science/AGU2020_AQPI_v4.pdf that was presented at AGU 2020
		A.10	Complete transition the Evaporative Demand Drought Index (EDDI) to an operational status at the National Water Center (Demonstration to Operations/Application)	x				Hobbins	HMA	Provide a service for drought early warning, and ongoing drought monitoring to stakeholders affected by agricultural, hydrologic, and ecological drought, and at wildfire risk. Reference ET and EDDI are now being estimated at NWC using PSD-originated software, with their data to be shared with PSD (either pushed or pulled) in a raw format not usable by stakeholders; PSD will add any value for stakeholders and host the EDDI products exactly as we do currently; the NWC and PSD IT groups are finalizing the data transfer details, leaving PSD's remaining tasks to check their EDDI against ours and set up the data transfer at our end, which we anticipate being completed in Q1 of FY20.	x	Y	The EDDI data are now generated at the National Water Center and made available from their server. Completed in Q2.
		A.11	Soil Moisture Drought Monitoring: Prototype NOAA's National Water Model soil moisture products for drought monitoring in select NIDIS watersheds (Development to Demonstration)				x	Cifelli	HMA	Statement of intended purpose: Develop experimental soil moisture drought monitoring capability based on hourly, best available, quality-controlled NWM output. Condition for completion: A demonstration of possible adoption of watershed-scale NWM-derived soil moisture anomaly maps by NIDIS Partners: NWS/NWC Customers: NIDIS		Y	The prototyping of sm products has been completed and results are shown in this white paper that will form the basis of a future mansuscript https://docs.google.com/document/d/1pLdD-099G5j7CfZLj0bEhbmyjRw6SoIu9fpnVpEvyVY/edit. Presentation of results to the Drought Task Force is available here https://docs.google.com/presentation/d/11VgBaDgZt5NLbQRqXN0a68Ub-_iL1KnuMqNvprm2BB4/edit#slide=id.g70e7653252_0_1304
		A.12	20C Reanalysis: Produce and release an extension of the NOAA-CIRES-DOE 20th Century reanalysis (version 3) to better represent extreme events and characterize their uncertainty back to 1812 and out to 2018 (Development to Operations/Applications))				x	Compo	DMI	Condition for completion: A dataset is made available to climate researchers that includes 3-hourly gridded fields from 1812 to 2018. Partners:CIRES, NCEI, PMEL, UK Met Office Customers: climate researchers, federal, private sector and academic		N	Extension back to 1806 is complete. Extension forward to 2018 is delayed due to issues from UK partners to obtain needed boundary conditions. Data are made available via website: https://www.psl.noaa.gov/data/20thC_Rean/
		A.13	NIDIS: Provide quarterly services to better inform regional decision makers on evolving climate conditions and extreme events	x	x	x	x	Hoell	APA	Condition for completion: Understand characteristics and predictability of Midwest Drought and apply to seasonal forecasts used by NIDIS partners Partners:NIDIS Customers: NIDIS Federal Partners		Y	- Presentation to NIDIS coordinators in April to advertise project and recent advances - 'Lessons Learned from the 2017 Flash Drought Across the U.S. Northern Great Plains, and Canadian Prairies' in revision at Bulletin of the American Meteorological Society - Organizing a 'Flash Drought Workshop in December 2020'
		A.14	FEWSNET: Provide monthly, and sometimes weekly, services to better inform future food security scenarios over sub-Saharan Africa, Afghanistan and Central America	x	x	x	x	Hoell	APA	Condition for completion: Research to inform guidance on future weather and climate conditions to produce future food security scenarios Partners: USGS, NASA, NOAA/CPC, U.C. Santa Barbara, University of Maryland Customers: U.S. Agency for International Development, FEWS NET		Y	- Developed El Nino 2-page document https://fews.net/el-ni%C3%B1o-southern-oscillation - Delivered training to food security analysts in April and May - Delivered monthly agroclimatic assumptions used in food security scenario development - "Characteristics, Precursors, and Potential Predictability of Amu Darya Drought" accepte for publication at Climate Dynamics - "The Modulation of Daily Southern Africa Precipitation by the El Nino Southern Oscillation" to be submitted to Journal of Climate
		A.15	Climate Change Web Portal: Continue the development of the Climate Change Web Portal (Demonstration to Operations/Applications)			x		Alexander	AOP	Statement of intended purpose: Provide accessible climate variability and change information to fisheries and water resource managers Condition for completion: Interactive web-portal for displaying a suite of climate variables Customers:NMFS, fishery and water managers		Y	We have added the ability to display output from CMIP 6 models and from regional ocean model simulations along the northeast US coast.
		A.16	ENSO: Develop prediction systems for ocean conditions including ENSO (Development to Demonstration)				x	Alexander	AOP	Statement of intended purpose: Explore new methods for prediction of important ocean variables and indices Customers: NWS/NMFS Condition for completion: Skill shown based on retrospective forecasts.		Y	Ding, H., M. Newman, M. A. Alexander, and A. T. Wittenberg, 2020: Relating CMIP5 model biases to seasonal forecast skill in the tropical Pacific. *Geophys. Res. Lett.*, **47**, doi: 10.1029/2019GL086765. Shin, S., P. D. Sardeshmukh, M. Newman, C. Penland, M.A. Alexander. Impact of Annual Cycle on ENSO Variability and Predictability. J. Climate, submitted.

Performance Requirement (PR) (End state in meeting organizational goals and objectives)	Performance Measure (PM) (The monitoring of ongoing progress toward pre-established goals.)	PM Identifier	Performance Milestone (A distinct activity planned for completion on a scheduled date extracted from individual PSD staff annual performance plans)	FY20 Targets				PSD Point-of-Contact	PSD Research Team	More Detailed Description (as needed)	Tracked as R2X Transition?	Completed? (Y/N)	Evidence of Accomplishment/Follow-up Actions (If completed provide evidence in the form of comments, documentation, reports, papers,websites, datasets, etc. If not completed state why and identify follow-up actions)
				Q1	Q2	Q3	Q4						
		A.17	JTTI: Testing channel loss parameterization in the National Water Model (Demonstration to Operations/Application)		x			Zamora	HMA	Statement of intended purpose:This is NOAA Joint Technology Transfer grant funded research that seeks to improve National Water Model performance in arid climate regimes by simulating water losses in river channels. Condition for completion:The parameterization may be included in the 2021 National Water Model Operational NCEP Update after parallel testing in 2020. Partners: University of Arizona Customers: OQP		Y	The channel loss parameterization is planned to be included in the next release of the NWM - 2.1
		A.18	miniFlux: Complete development of small UAS sensor package to measure winds, temps, RH, and P to derive atmospheric fluxes (Demonstration to Operations)		x			Intrieri	POP	Statement of intended purpose: Characterization of atmospheric properties needed for model validation and process studies Condition for completion: Completion and sign-off of UASPO Transition Plan (Submitted in April 2020 / still waiting for sign-off) Partners/Customers: NOAA UAS	Y	Y	Submitted miniFlux Transition Plan to UASPO and OAR Transition Manager (March 2020). Final flight testing with L3 Harris LAtitude vehicle delayed due to COVID.
		A.19	COARE flux algorithm:PSD has developed a family of parameterizations of air-sea and air-ice fluxes. The fluxes include basic meteorology and trace gases. The parameterizations are used compute fluxes from the surface boundary conditions and the near-surface atmospheric variables.				x	Fairall	BLO	Statement of intended purpose:Improve treatment of surface boundary conditions in numerical models. Customer: NOAA NCEP		N	New versions developed and made available on GITHUB. Contact made with H. Alves NMC. Development at NMC is going slowly.
		A. 20	Develop post processing code for PM2.5 and ozone for a new coupled FV3-CMAQ air quality forecast system.				x	Wilczak	BLO	Statement of intended purpose:PSD will develop post processing code for PM2.5 and ozone for a new coupled FV3-CMAQ air quality forecast system. Condition for completion: Skill shown relative to the raw FV3-CMAQ simulations. Partner/Customer: NOAA NCEP	X	N	Delayed because FV3-CMAQ model simualtions have not yet been provided by NCEP due to problems in implementing the GFS FV3 model. Instead, promising new post-processing algortihms have been developed using the older NAM-CMAQ model, and these will be applied to the FV3-CMAQ simulations when they become available. Delle Monache, L., S. Alessandrini, I. Djalalova, J. Wilczak, J. C. Knievel, 2020: Improving Air Quality Predictions over the United States with an Analog Ensemble. Accepted by Weather and Forecasting.
		A.21	Development of Fire Weather Related 8-14 Day Forecast Products for CPC				X	Hamill	APA	Develop algorithms in PSD for prediction of fire-weather and related elements at lead times of 8-14 days, based on ECMWF and GEFS reforecasts. Pending CPC and NWS fire weather manager agreement that there is useful skill, transfer these to CPC to be used in operational fire-weather forecast products.		Y	As of 7/2020, PSL staff are approximately 95 percent complete with their algorithmic development, but the main effort in tech transition is still to come. An article documenting preliminary research is Worsnop, R.P., M. Scheuerer, and T.M. Hamill, 2020: Extended-Range Probabilistic Fire-Weather Forecasting Based on Ensemble Model Output Statistics and Ensemble Copula Coupling. Mon. Wea. Rev., 148, 499-521, https://doi.org/10.1175/MWR-D-19-0217.1 . Worsnop has briefed CPC on the results and at a mid-June 2020 meeting. A POC for tech transition to CPC has been identified and Worsnop will be in contact and start collaborating on preliminary steps required for tech transition
		A.22	Week 3 - 4 precipitation forecast outlooks				X	Hamill	APA	Develop improved predictions of sub-seasonal precipitation forecasts over the US based on the statistical postprocessing of GEFS and/or ECMWF reforecasts; document them in the form of one or more peer-reviewed articles. Pending demonstration of skill and interest from CPC, work with them to operationally implement them into CPC operations. Funded by the California Dept. of Water Resources. Partner: CPC.		Y	Journal article submitted April 2020 - Using Artificial Neural Networks for Generating Probabilistic Subseasonal Precipitation Forecasts over California" (MWR-D-20-0096) by M. Scheuerer et al.
		A.Total	**Number of weather, water and climate research advances transitioned into applications, operations and services to inform regional decision making (Target 6/yr)**				**6**	**Lataitis**	**DIR**				Partners include:Desert Research Institute & NOAA-National Water Center :
		B											

Performance Requirement (PR) (End state in meeting organizational goals and objectives)	Performance Measure (PM) (The monitoring of ongoing progress toward pre-established goals.)	PM Identifier	Performance Milestone (A distinct activity planned for completion on a scheduled date extracted from individual PSD staff annual performance plans)	FY20 Targets				PSD Point-of-Contact	PSD Research Team	More Detailed Description (as needed)	Tracked as R2X Transition?	Completed? (Y/N)	Evidence of Accomplishment/Follow-up Actions (If completed provide evidence in the form of comments, documentation, reports, papers,websites, datasets, etc. If not completed state why and identify follow-up actions)
				Q1	Q2	Q3	Q4						
Assessments of current and future states of the climate system that identify potential impacts and inform science, service, and stewardship decisions.	**Weather/Climate Assessments** Number of assessment reports providing an improved understanding and explanation of recent weather and climate extremes (Target 4/yr)	B.1	Produce two or more attribution assessments of climate extreme events, anomalies and trends		X		X	Hamill	APA	Possible contributions may include: (1) BAMS paper submitted on FACTS web site maintained by PSD. (2) BAMS Explaining Extremes Events publication (coordination and editing by Hoell, Hoerling) (~Dec 2019) (3) Reattribution / reforecasting of Colorado rain of 2013: Hoerling will present at AGU in special session extreme events. Possible written assessment depending on interest and feedback. (4) Andy Hoell will present at AGU and to CPO on winter/spring 2019 precipitation in the US Great Plains. A journal articl will be submitted in summer 2020. (5) An internal document on PSD attribution / predictability data set evolution, including counter-factual best practices and a plan for FACTS 2.0. (6) Peer-reviewed manuscript submitted on "Confirmation for and Predictability of Distinct Impacts of El Niño Flavors" (Tao Zhang, Hoell, Hoerling, Perlwitz)	x	Y	Zhang, T., M. P. Hoerling, A. Hoell, J. Perlwitz, and J. Eischeid (June 2020): Confirmation for and Predictability of Distinct U.S. Impacts of El Niño Flavors. J. Climate, 33, 5971–5991, https://doi.org/10.1175/JCLI-D-19-0802.1. Hoerling, M. P., L. Smith, X. Quan, J. Eischeid, J. Barsugli, and H. Diaz, 2020: Explaining the Spatial Pattern of U.S. Extreme Daily Precipitation Change. J Climate, submitted. Murray, Donald, Andrew Hoell, Martin Hoerling, Judith Perlwitz, Xiao-Wei Quan, Dave Allured, Tao Zhang, Jon Eischeid, Catherine A. Smith, Joseph Barsugli, Jeff McWhirter, Chris Kreutzer, and Robert S. Webb (August 2020): Facility for Weather and Climate Assessments (FACTS): A Community Resource for Assessing Weather and Climate Variability. Bull. Amer. Meteor. Soc., 101, E1214–E1224, https://doi.org/10.1175/BAMS-D-19-0224.1. Herring, S.C., N. Christidis, A. Hoell, M.P. Hoerling, and P.A. Stott,2020: Explaining Extreme Events of 2018 from a Climate Perspective.Bull. Amer. Meteor. Soc.,101,S1–S134,https://doi.org/10.1175/BAMS-ExplainingExtremeEvents2018.15. Hoell, A., M. Hoerling, J. Eischeid, 2019: Could America's Wettest Winter of 2018-19 Have Been Anticipated? (Invited), AGU Fall Meeting 2019.
		B.2	Produce two or more predictability assessments for subseasonal to decadal time scales in order to quantify the prospects and gaps for skillful predictions, including droughts.			X	X	Hamill	APA	Possible contributions may include: 1. Submit a proposal for an Aspen Global Change Institute on "Colorado River Flow and its Climate Drivers", for the 15 March 2020 AGU call for proposals. 2. Conduct analysis on the topic " The Millenium Drought on the Colorado River."	x	Y	Hoell, A., J. Eischeid, M. Barlow, A. McNally, 2020: Characteristics, precursors, and potential predictability of Amu Darya Drought in an Earth system model large ensemble. In press. https://link.springer.com/article/10.1007/s00382-020-05381-5 Hoell, A., A. Gaughan, L. Harrison, T. Magadazire, 2020: The Modulation of Daily Southern Africa Precipitation by the El Niño Southern Oscillation Across the Summertime Wet Season. Accepted with revision at Journal of Climate. Hoell, A. and 15 coauthors, 2020: Lessons Learned from the 2017 Flash Drought Across the U.S. Northern Great Plains and Canadian Prairies. In press at Bulletin of the American Meteorological Society. Pendergrass, A.G., Meehl, G.A., Pulwarty, R., Hoell, A, others, 2020: Flash droughts present a new challenge for subseasonal-to-seasonal prediction.Nat. Clim. Chang.10,191–199 (2020). https://doi.org/10.1038/s41558-020-0709-04. Hoell, A., Eischeid, J, 2019: On the interpretation of seasonal Southern Africa precipitation prediction skill estimates during Austral summer. Clim Dyn53,6769–6783 (2019). https://doi.org/10.1007/s00382-019-04960-5
		B.3	Investigate a probabilistic description of soil moisture in the western United States, particularly in California				x	Penland	DMI	This effort includes guiding a new postdoctoral fellow and continuing engagement with the NOAA FACETS program.		Y	An article by Fowler and Penland was submitted to Journal of Hydrology. Although it was rejected, the California State hydrologist expressed interest in developing a warning system for extreme soil moisture anomalies. The postdotoral fellow, Dr. Megan Fowler, was offerred and accepted a position at NCAR and no longer works with us.
		B.4	Provide guidance to CO-NM Dam Safety regarding recommended increase in Probable Maximum Precipitation resulting from Climate Change			X		Mahoney	HMA	PSD and Western Water Assessment prepared report to CO-NM Dam Safety organizations summarizing peer reviewed literature information to account for climate change - the conclusions are being considered for incorporation into updated state dam safety regulations.		Y	1. McCormick, Lukas, and Mahoney, 2020: 21st Century Dam Safety Rules for Extreme Precipitation in a Changing Climate, Journal of Dam Safety., June 2020. 2. 2019 Governor's Award for High-Impact Research: https://psl.noaa.gov/news/2019/111319.html
		B.5	Summarize production of hail in future climate assessment and prepare draft manuscript			X		Mahoney	HMA	Likely a contribution to Explaining Extreme Event (BAMS) attribution study		Y	Mahoney, K. M., "2018 Extreme Hail Storms and Climate Change: Foretelling the future in tiny, turbulent crystal balls?", Bull Amer Soc., Explaining Extreme Events Special Issue (invited perspective piece), January 2020, Vol. 101, No. 1.
		B.6	Conduct assessment of post-processed, downscaled forcings in GEFS on hydrologic prediction for selected CA watersheds				X	Viterbo	HMA	Forcings are downscaled in physically consistent manner		Y	Preliminary assessments were conducted and are shown in this slideset presented to the PSL Front Office and NOAA Team Leads in spring 2020 https://docs.google.com/presentation/d/14_Xx49kvy5j-HGvHFtePUnrOGDkvmu1YjgkBOl5voFk/edit#slide=id.g731654a44e_0_0

Performance Requirement (PR) (End state in meeting organizational goals and objectives)	Performance Measure (PM) (The monitoring of ongoing progress toward pre-established goals.)	PM Identifier	Performance Milestone (A distinct activity planned for completion on a scheduled date extracted from individual PSD staff annual performance plans)	FY20 Targets				PSD Point-of-Contact	PSD Research Team	More Detailed Description (as needed)	Tracked as R2X Transition?	Completed? (Y/N)	Evidence of Accomplishment/Follow-up Actions (If completed provide evidence in the form of comments, documentation, reports, papers,websites, datasets, etc. If not completed state why and identify follow-up actions)
				Q1	Q2	Q3	Q4						
		B.7	Assess performance of HRRR model in quantitative precipitation forecasts for selected watersheds in western U.S.			X		Bytheway	HMA			Y	As part of the AQPI project I have worked to identify a suitable reference for QPF evaluation in northern California, where there is large uncertainty in QPE. A summary of QPE uncertainty in this region was published in the Journal of Hydrometeorology earlier this year (https://doi.org/10.1175/JHM-D-19-0160.1), and presented at the 2019 Fall AGU meeting. With an understanding of this large uncertainty, I have been working to develop a methodology to assess HRRR model performance that takes this uncertainty into account, and am currently working on a manuscript of this work. The internally funded project was a collaborative effort with the California Department of Water Resources to evaluate the performance of the experimental HRRR ensemble in three small basins in the Upper Feather River drainage area. The HRRR-E was evaluated for an AR event that took place over Valentines Day 2019, and the results were presented at the 2020 AMS Annual Meeting.
		B.8	Conduct assessment of National Water Model soil moisture anomalies for periods of drought across the U.S.			X		Hughes	HMA			Y	I would say this evaluation is largely complete (i.e., I think OK to say Y since there is no deliverable noted). We are preparing a manuscript on the results. I presented results on a Drought Task Force Call in March, and also have a poster on the results at AMS mountain met happening this week. Briefly, we found that retrospective NWM simulations performed similarly to current operational land surface models in terms of their ability to represent drought-relevant soil moisture anomalies.
		B.9											
		B.10											
		B.Total	**Number of assessment reports providing an improved understanding and explanation of recent weather and climate extremes (Target 4/yr)**				**4**	**Webb**	**DIR**				
		C											
		C.1	Operate multiple observing systems in support of the Wisconsin Chequamegon Heterogeneous Ecosystem Energy-balance Study Enabled by a High-density Extensive Array of Detectors (CHEESEHEAD)	X				White	HOP	Operate two integrated wind profiler observing systems and microwave radiometers in Wisconsin for the Chequamegon Heterogeneous Ecosystem Energy-balance Study Enabled by a High-density Extensive Array of Detectors (CHEESEHEAD) experiment to better understand how varied land use impacts atmospheric circulations.		Y	Datasets from two integrated boundary-layer observing systems deployed in Prentice and Lakeland, WI have been collected, quality controlled, and archived on the NCAR EOL CHEEESHEAD archive: https://data.eol.ucar.edu/dataset/592.026
		C.2	Deploy and operate multiple observing systems in support of the Verification of the Origins of Rotation in Tornadoes EXperiment-Southeast (VORTEX-SE) field campaign	X				White	HOP	Deploy and operate a 915-MHz wind profiler with Radio Acoustic Sounding System (RASS) and a 449-MHz wind profiler with RASS for the VORTEX-SE field intensive to determine which type of wind profiler and RASS combination provides the best dynamic and thermodynamic information for determining the source of rotation associated with severe thunderstorms. More information on VORTEX-SE can be found at https://www.nssl.noaa.gov/projects/vortexse/		Y	449-MHz system was successfully installed and operated. Data collection is ongoing and data are available at https://psl.noaa.gov/data/obs/datadisplay/. Original site for 915-MHz was scrapped because local authorities were non-responsive. A second site for the 915-MHz system is being investigated. However, until the second site is ready, the 915-MHz system will be set up in Courtland, AL alongside the 449-MHz system in order to compare height coverage of RASS measurements. Deployment of the 915-MHz system has been delayed by the COVID-19 pandemic. Installation will occur once travel is permitted again.
		C.3	Deploy and operate a snow-level radar and precipitation disdrometer at PSD's Los Gatos, CA soil moisture site	X				White	HOP	Deploy and operate a snow-level radar and precipitation disdrometer at PSD's Los Gatos, CA soil moisture site to help improve quantitative precipitation estimation with the Santa Clara Valley X-band radar deployed for the Advanced Quantitative Precipitation Information (AQPI) project and the NWS KMUX radar by providing the vertical profile of radar reflectivity in various microphysical regimes associated with West Coast storms. More information on AQPI can be found at https://esrl.noaa.gov/psd/aqpi/		Y	A snow-level radar (SLR) was succesffuly installed in October. Data collection is ongoing and data are available at https://psl.noaa.gov/data/obs/datadisplay/.
Advances in the observation, understanding, and prediction of high-impact, extreme events accelerated from the design and execution of field campaigns to investigate the coupled	**Targeted Observations** Number of field studies that advance the understanding and prediction of extreme weather,	C.4	Support NOAA's HMT-West Legacy Observing Network and make data and value-added products available to NWS Weather/River Forecasters and other end users.	X	X	X	X	White	HOP	Provide observing equipment, field site/data communications infrastructure, and IT hardware/software maintenance and upgrades annually as required to successfully operate and maintain NOAA's HMT-West Legacy Observing Network and to make data and value-added products available to NWS Weather/River Forecasters and other end users. Funding for this task is provided under a contract with the State of California through the Department of Water Resources. A new five-year MOU will begin in FY20. Data from the network is publically available on a PSD website: (https://www.esrl.noaa.gov/psd/data/obs/datadisplay/). Data is sent to MADIS for ingest into NOAA operational weather prediction models. Data is sent to NWS Western Region with SHEF-encoding for direct input into CNRFC and WFO smart tools.		Y	Data collection from 100+ sites is ongoing and data are available at https://psl.noaa.gov/data/obs/datadisplay/. A new five-year MOU with the California Department of Water Resources to support operation and maintenance was signed in December, but funding was not received until August primarily due to complications related to the COVID-19 pandemic. Continued work to operate and maintain the network is also on hold until travel restrictions are lifted.

Performance Requirement (PR) (End state in meeting organizational goals and objectives)	Performance Measure (PM) (The monitoring of ongoing progress toward pre-established goals.)	PM Identifier	Performance Milestone (A distinct activity planned for completion on a scheduled date extracted from individual PSD staff annual performance plans)	FY20 Targets				PSD Point-of-Contact	PSD Research Team	More Detailed Description (as needed)	Tracked as R2X Transition?	Completed? (Y/N)	Evidence of Accomplishment/Follow-up Actions (If completed provide evidence in the form of comments, documentation, reports, papers,websites, datasets, etc. If not completed state why and identify follow-up actions)
				Q1	Q2	Q3	Q4						
investigate the coupled behavior of the atmosphere interacting with land, ocean and cryosphere.	water and climate events. (Target 8/yr)	C.5	Provide operational support (staff and instrumentation) for the year-long Arctic Multidisciplinary drifting Observatory for the Study of Arctic Climate (MOSAiC) expedition	X	X	X	X	White Uttal Fairal	HOP POP BLO	The year-long, central Arctic MOSAiC expedition in combination with the ongoing measurements at the surrounding Arctic land observatories will comprise the most comprehensive snapshot of the Arctic environment and processes in history. Four separate observing projects will be supported by PSD cooperative institute and federal scientists and technical staff. The PSD effort for the MOSAiC deployment includes installation and operation of three remote surface flux stations (sleds) around the German icebreaker Polarstern, a flux tower next to the ship, gas sampling, UAV flights and science oversight of the DOE Mobile Facility More information on the MOSAic project can be found at https: //www.mosaic-expedition.org/ https://webtest.psd.esrl.noaa.gov/psd/mosaic/		Y	Successful deployment of systems for observing the surface energy budget, cloud, aerosol components and composition of the atmosphere over the central Arctic Ocean during the MOSAiC expedition is nearing completion. Despite the challenges presented by the COVID pandemic and unexpected expedition delays with anticipated but unknown environmental and logistic elements, a year long data set on the Central Arctic Ocean environment has resulted. Two Federal staff spent a combined ~11 months and eight CI staff spent a combined ~41 months collecting data at the ice camp; this was combined with several months of logistics and engineering support before and during the expedition. The Automated Surface Flux Systems that were deployed are providing a foundation for developing long-term on-ice observing systems to support the global observing enterprise. Investigations on coupling processes and forecasting assessments have been led by PSL staff.
		C.6	Continue numerical simulations and analysis of soil moisture profile retrieval capabilities using small UAVs.				X	Voronovich	DMI	Further develop a method of retrieval of soil moisture using remote sensing means. Submit a paper for publication.		Y	Numerical simulations of the soil moisture (SM) retrievals were successfully accomplished for realistic profiles of SM and noisy data. The paper was prepared and submitted for publication.
		C.7	Identify site(s)and facilitate the deployment of at least one X-band scanning radar in the San Francisco Bay area as part of Advanced Quantitative Precipitation Information (AQPI) System		X			Cifelli	HMA	CSU CIRA will be deploying the radar(s) as part of the multi-organization AQPI effort.		N	This milestone is delayed due to the ongoing pandemic. NOAA faciliated an agreement among the local water agencies in the east bay (EBMUD, Contra Costa, Alameda County Flood Control, Alamdea Public Works, Zone 7) to deploy and operate an AQPI X-band radar at Las Trumpas State Park (Rocky Ridge). Site preparation is complete and the plan for power and data comms has been established. A draft agreement has been worked out with American Tower, the organization that leases the site. The last step before actual radar deployment is to have the agreement approved by the Sonoma Water Board of Supervisors (the AQPI grant administrator). This is anticpated 1st Qtr FY21.
		C.8											
		C.9											
		C.10											
		C.Total	**Number of field studies that advance the understanding and prediction of extreme weather, water and climate events (Target 8/yr)**				**8**	**Lataitis**	**DIR**				
		D											
		D.1	Participate in a 3 month intensive observing period during the year-long MOSAiC expedition to study Arctic cyclone generation, air mass modification and transports			X		Uttal	POP	The Year of Polar Prediction super-site Model Intercomparison Project (YOPPsiteMIP) is an observation-modeling exercise of the WMO Polar Prediction Project that will assemble interoperable model time-step data from NWP centers and high cadence (1 min) Merged Observation Data Files for investigating and improving process understanding and model bias accumulation. It will test the ability of NWP models to simulate and predict systems and linkages to extreme events in lower latitudes. More information on the Year of Polar Prediction project and the YOPPsiteMIP can be found at: https://www.polarprediction.net/		Y	Successful data collection during the MOSAiC expedition (See: A6 and C. 5) including capturing several Arctic cyclone events. Preliminary analysis has been completed; publication pending until the MOSAiC expedition is completed. Manuscript in progress.
		D.2	Provide a census for the variety of stratospheric equatorial waves in observations, assess their scales, and investigate their connection with tropospheric equatorial wave activity and precipitation.				X	Kiladis	AOP	Activity is ongoing, results have been reproduced using the new reanalysis dataset ERA5 and these mostly agree with previous findings using ERA interim with a few interesting exceptions that we are still investigating.		Y	Two manuscripts are in progress: Kiladis, G.N., J. R. Albers, and J. Dias, The scales and variability of stratospheric Kelvin and mixed Rossby-gravity waves. Albers, J. R., G. N. Kiladis and J. Dias, Impacts of the Quasi-biennial oscillation on the propagation of stratospheric waves. Analysis needed to be redone using the newer ERA5 dataset which is now in progress. Once analysis is completed the manuscripts will be updated with the newer results, anticipated completion by the end of the calendar year.
		D.3	Extend currently running tropical relaxation experiments to specifically examine the impact of the Madden-Julian Oscillation, Kelvin, and other equatorial waves on extratropical precipitation forecasts.			X		Kiladis	AOP	Development completed and experiments are ongoing. Further testing and implementation is taking place, with progress being discussed in weekly teleconferences.		Y	Draft manuscript is currently being reviewed by co-authors while first author Dias is on maternity leave: Dias, J., S. N. Tulich, M. Gehne, G. N. Kiladis, Tropical origins of Weeks 2-4 forecasts errors during Northern Hemisphere cool season. Anticipated completion November 2020 once first author Dias returns from maternity leave. Analysis of newer relaxation experiments with co-PIs Tulich and Gehne is ongoing.
		D.4	Further develop and extend Super Parameterization Weather Research and Forecasting (SP-WRF) model experiments to study the role of tropical-extratropical interactions in modulating tropical waves.				X	Kiladis	AOP	Observational analysis is ongoing for comparison with parallel modeling runs using SP-WRF. Modeling setup has been implemented and initial runs and comparison with observations are being undertaken.		Y	Two manuscripts are in preparation, one devoted to observational results and the other to comparison of model results to observations. Cheng, Y. -M., S. N. Tulich, and G. N. Kiladis, Observational evidence for the forcing of equatorial wave activity by the extratropical circulation. Tulich, S. N., and G. N. Kiladis, The Madden-Julian Oscillation, Convective Coupled Kelvin Waves, and the Basic State Zonal Flow: Insights from idealized simulations with superparameterized physics

Performance Requirement (PR) (End state in meeting organizational goals and objectives)	**Performance Measure (PM)** (The monitoring of ongoing progress toward pre-established goals.)	**PM Identifier**	**Performance Milestone** (A distinct activity planned for completion on a scheduled date extracted from individual PSD staff annual performance plans)	**FY20 Targets**				**PSD Point-of-Contact**	**PSD Research Team**	**More Detailed Description** (as needed)	**Tracked as R2X Transition?**	**Completed?** (Y/N)	**Evidence of Accomplishment/Follow-up Actions** (If completed provide evidence in the form of comments, documentation, reports, papers,websites, datasets, etc. If not completed state why and identify follow-up actions)
				Q1	**Q2**	**Q3**	**Q4**						
Research advances contributing to the development of the NOAA next-generation global prediction system capable of dramatically improved global numerical weather predictions on time scales of 1-30 days	**NGGPS/UFS Improvements** Number of studies to improve experimental local-to-global forecasting and advance NOAA's Next-Generation Global Prediction System capabilities (Target 6/yr)	D.5	Develop new diagnostics to evaluate NGGPS tropical model performance and transfer them to NCEP				X	Kiladis	AOP	Refine diagnostics to evaluate NGGPS tropical model performance developed during FY19, implement these in Python, and transfer them to the MET+ package at NCAR for NCEP model development.		Y	Initial diagnostics packages have been implemented in MET+ and are available to NCEP and the rest of the community for use. Additonal diagnostics have been developed and transferred to MET+ during Q4. Further diagnostic development, along with discussions for implementation with NCEP, is ongoing. Two manuscripts published: Wolding, B., J. Dias, G. N. Kiladis, F. Ahmed, E. Maloney and M. Branson, 2020: Interactions between moisture and tropical convection. Part I: Convective lifecycle and spatiotemporal dependence. J. Atmos. Sci., 77, 1783-1799. Wolding, B., J. Dias, G. N. Kiladis, E. Maloney and M. Branson, 2020: Interactions between moisture and tropical convection. Part II: The convective coupling of equatorial waves. J. Atmos. Sci., 77, 1801-1819.
		D.6	ESRL/PSD has developed parameterizations of model uncertainty in the NCEP operational global ensemble forecast system. These parameterizations are crucial for producing accurate representations of forecast uncertainty for both the data assimilation cycle and the ensemble prediction system. This project supports ongoing development aimed at improving these parameterizations, in collaboration with NCEP/EMC (Demonstration to Operations/Applications).				x	Whitaker	FMD	Statement of intended purpose: Improved representation of model uncertainty in the NOAA Global Ensemble Forecast System (GEFS) Condition for completion: Stochastic physics parameterizations implemented in time for use in beta implementation of FV3GFS data assimilation system and FV3GEFS reforecasts Customer: NCEP	x	Y	Stochastic physics parameterizations updated and re-tuned for new version of GFS (version 16) that has a higher model top (80km vs 50km in version 15). Sponge layer at top of model modified to reduced excessive spread near 80 km.
		D.7	ESRL/PSD has developed the Ensemble Kalman Filter (EnKF) component for the operational global data assimilation system. The EnKF is used to update an ensemble of forecasts in the data assimilation cycle, and that ensemble is used to estimate background-error covariances needed by the data assimilation update. This project supports ongoing development aimed at improving the use of ensemble information in the data assimilation system, in collaboration with NCEP/EMC. (Development to Demonstration)				x	Whitaker	FMD	Statement of intended purpose: Improved representation of background errors in the operational data assimilation system, leading to improved use of observations, improved analyses and forecasts. Condition for completion: Improvements to the operational data assimilation system tested and merged in time for the code freeze ahead of the next operational FV3GFS upgrade. Customer: NCEP	x	Y	Updates to EnKF for GFS version 16 tested, tuned and optimized for computation efficiency. Improved treatment of satellite radiances achieved through improvements to vertical covariance localization. The ability to treat inter-channel vertical error correlations for radiances included. Improvements to the LETKF solver included to allow switch from the serial filter solver used previously in operations. Updates to the forecast model to improve IO efficiency and allow for incremental analysis update (IAU) in GFS v16.
		D.8	Develop, produce, and release a new modern-era high-resolution atmospheric global reanalysis and reforecast to facilitate the generation of high-quality operational post-processed model guidance by the National Weather Service (Demonstration to Operations/Applications)		X			Hamill	APA	Statement of intended purpose: Improve NWS operational forecast Condition for completion: Provide datasets needed to post-process operational global ensemble forecasts to provide calibrated probabilities to the public. Partners: NCEP, OAR/CPO Customer: NCEP CPC and EMC, as well as NWS forecast offices			See A.1 above for more.
		D.9	UFS Arctic Improvements: Deliver Arctic-focused diagnostics toolkit for assessing UFS performance wrt high quality observations and provide SME analysis (Development to Demonstration)				x	Intrieri	POP	Statement of intended purpose: Assess and improve UFS Arctic region forecast skill Condition for completion: Transition toolkit and analysis information to EMC UFS Development Team (POC: Lydia Stefanova). Customer: NCEP/EMC and DTC	x	Y	Transition toolkit and analysis information to EMC UFS Development Team (POC: Avichal Mehra, Lydia Stefanova, Tara Jensen)
		D.10											
		D.Total	**Number of model development, sensitivity and evaluation studies to improve NOAA's next-generation global prediction system capabilities (Target 6/yr)**				**6**	**Webb**	**DIR**				
		F											
		E.1	Examine the MOSAiC year in the context of multidecadal observations from land stations and the SHEBA expedition (1997-98)			X		Uttal	POP	Determine if the Arctic system has reached or is approaching a tipping point		N	A comprehensive bibliography of ~800 papers from the SHEBA program has been compiled and reviewed now. This activity will be continuing into 2021.
		E.2	Examine marine heat waves, including the processes that cause them and their predictability			X		Alexander	AOP	Survey of the processes that cause marine heat waves. Examine the heat wave developing off the US west coast in 2019.	x	Y	Jacox, M. G., M. A. Alexander, S. J. Bograd, and J.D. Scott, 2020: Thermal displacement by marine heatwaves. *Nature*. DOI: 10.1038/s41586-020-2534-z Amaya, D. J., M. A. Alexander, A. Capotondi, C. Deser, K. B. Karnauskas, A.. J. Miller, and N. J. Mantua, 2020: Are long-term changes in mixed layer depth influencing North Pacific marine heatwaves? *Bull. Amer. Met. Soc.*, submitted. Funded proposal by NOAA/Climate Program Office titled "Develop a process based understanding of marine heat waves: present and future" (with Michael Jacox and Clara Deser).

Performance Requirement (PR) (End state in meeting organizational goals and objectives)	Performance Measure (PM) (The monitoring of ongoing progress toward pre-established goals.)	PM Identifier	Performance Milestone (A distinct activity planned for completion on a scheduled date extracted from individual PSD staff annual performance plans)	FY20 Targets				PSD Point-of-Contact	PSD Research Team	More Detailed Description (as needed)	Tracked as R2X Transition?	Completed? (Y/N)	Evidence of Accomplishment/Follow-up Actions (If completed provide evidence in the form of comments, documentation, reports, papers,websites, datasets, etc. If not completed state why and identify follow-up actions)
				Q1	Q2	Q3	Q4						
Research accelerating the development and application of coupled earth system analysis and modeling to understand where, when, and how ecosystems and ecosystem services may encounter critical environmental tipping points	**Integrated Earth System Studies** Number of integrated earth system research studies that document and clarify the response and sensitivities of living marine resources to climate extremes, variations and change (Target 4/yr)	E.3	Contribute to the development of seasonal prediction systems for living marine resource applications				X	Alexander	AOP			Y	Jacox, M. G., M. A. Alexander, et al. (2020), Seasonal-to-interannual prediction of North American coastal marine ecosystems: Forecast methods, mechanisms of predictability, and priority developments, Progress in Oceanography, doi:10.1016/j.pocean.2020.102307. Capotondi, A., M. Jacox, et al., 2019: Observational Needs Supporting Marine Ecosystems Modeling and Forecasting: From the Global Ocean to Regional and Coastal Systems. Front. Mar. Sci. 6:623. doi: 10.3389 /fmars.2019.00623 PSL bias corrected output from the NMME global climate forecast models to provide boundary conditions for regional ocean models, which were used to make forecasts off the US west coast and in the Bering Sea. Downscaling using the regional model and bias correcting improved the forecasts. The systems are being used to predict conditions for fish & invertebrates that live on or near the bottom including dungeness crabs.
		E.4	Work with fishery scientists in NOAA and at other institutions to investigate how climate change can influence living marine resources.				X	Alexander	AOP			Y	Member of the NOAA climate-fisheries planning and implementation teams. Provided climate data for a vulnerability assessemnt for marine habitats off the US east coast. Presenter and observer for the Marine Sanctuaries CLimate Change Focus group Alexander, PSL staff member of the NOAA Integrated Ecosystem Assessement Scientific Steering Committee Contributes to three papers submitted to a special issue of the journal Elementa on what the physical, biogeochemical and ecological state of the Gulf of Maine may be like in 2050.
		E.5											
		E.6											
		E.7											
		E.8											
		E.9											
		E.10											
		E. Total	**Number of integrated earth system studies to improve understanding of living marine resource responses to climate extremes, variations and change (Target 4/yr)**				**4**	**Webb**	**DIR**				
		G											
		F.1	Develop an algorithm to estimate rainfall drop-size distribution parameter profiles using PSD's vertically pointing radars operating in the S-band (~3 GHz) frequency band. Draft and submit journal article.				X	White	HOP	Being able to observe the precipitation drop-size distribution will allow direct comparison with numerical model simulated drop-size distribution to help diagnose model bias and deficiencies.		Y	The algorithm has been tested and modified. A draft manuscript by Johnston et al. entitled, "Preliminary drop size distributions measured with NOAA Snow Level Radar," has been completed and is in internal review in Q4. Submission to the *Journal of Oceanic and Atmospheric Technology* will occur early in FY21. Collaboration with modelers to diagnose model bias and deficiences in representing the drop-size distribution will also occur in FY21.
		F.2	Draft and submit a journal article describing large-scale atmospheric flow regimes linked to long-duration extreme precipitation events in northern California. Draft and submit journal article.				X	Moore	HOP	Analysis is complete. Seminar given at PSD and at an international conference in FY19.		Y	A draft manuscript by Moore et al. entitled, "Long-duration heavy precipitation events along the U.S. West Coast," has been completed and is in internal review in Q4. Delayed in order to make necessary corrections and refinements regarding the methodology, results, and text. Submission to the journal *Monthly Weather Review* will occur late in FY20 or early in FY21.
		F.3	Draft and submit journal article on the reliability of sea surface diurnal warming estimates derived from operational geostationary satellite products.				X	Wick	HOP	Analysis complete. Results presented at two scientific conferences. Diurnal waming code shared with NESDIS and EUMETSAT in FY19 for inclusion into their sea-surface in temperature algorithms		Y	A draft manuscript by Wick et al. entitled, "Assessment of extreme diurnal warming in operational geosynchronous satellite sea surface temperature products," has been completed and is in internal review in Q4. Submission to the journal *Remote Sensing* will occur late in FY20 or early in FY21.

Performance Requirement (PR) (End state in meeting organizational goals and objectives)	Performance Measure (PM) (The monitoring of ongoing progress toward pre-established goals.)	PM Identifier	Performance Milestone (A distinct activity planned for completion on a scheduled date extracted from individual PSD staff annual performance plans)	FY20 Targets				PSD Point-of-Contact	PSD Research Team	More Detailed Description (as needed)	Tracked as R2X Transition?	Completed? (Y/N)	Evidence of Accomplishment/Follow-up Actions (If completed provide evidence in the form of comments, documentation, reports, papers,websites, datasets, etc. If not completed state why and identify follow-up actions)
				Q1	Q2	Q3	Q4						
Improved basis for confidence in understanding key oceanic, atmospheric, hydrologic, biogeochemical, and socioeconomic components of the climate system and impacts	**Improved Process Understanding** Number of studies that advance the understanding of key environmental processes leading to weather, water and climate extremes, variations and change (Target 8/yr)	F.4	Add the GFS (FV3 core) to PSD's water vapor flux tool				X	Gottas	HOP	PSD's water vapor flux tool is available at sites where PSD operates Doppler wind profilers, and more specifically, the picket fence of semi-permanent atmospheric river observatories deployed along the U.S. West Coast. The tool combines observations and numerical weather prediction output in a unique display that allows forecasters to evaluate model predictions of the incoming flux of water vapor, the snow level, and the precipitation that result from landfalling atmospheric rivers. This effort will allow NWS forecasters to evaluate how well the GFS is predicting atmospheric river conditions several days in advance. This complements the current tool, which does the same for the HRRR and RAP models on shorter time scales.	x	Y	Update to the tool to include the GFS was completed early in Q2. Forecasters can now choose from the HRRR, HRRRX, RAP, and GFS to compare with observations. An example can be viewed at https://www.esrl.noaa.gov/psd/data/obs/datadisplay/ViewDataType.php?DataTypeID=67&SiteID=bby&DataSourceID=1 by choosing one of the model buttons in the upper left of the display.
		F.5	Diagnose multidecadal changes in global climate extremes.				X	Penland	DMI	Complete two studies of changes in temperature and precipitation extremes using newly available reanalysis datasets and model.		y	Articles are in preparation showing that extremes have decreased in approximately 40% of the globe.
		F.6	Explain the physical basis for changes to western U.S. high altitude precipitation in future climate scenarios. Prepare draft journal article.				X	Hughes	HMA	Part of BOR and SERDP funded efforts - collaboration between HMA and AOP		Y	A draft journal article "Changes in extreme IVT on the US west coast in NA-CORDEX, and relationship to mountain and inland extreme precipitation" has been prepared and is being reviewed by co-authors.
		F.7	Describe model differences in precipitation characteristics/moisture transport in western U.S. resulting from climate change. Prepare draft journal article.				X	Mahoney	HMA	Part of BOR and SERDP funded efforts - collaboration between HMA and AOP		Y	Mahoney et al., 2020: Current and Future Precipitation Projections for the Western United States in NA-CORDEX models. Climate Dynamics, *in review*.
		F.8	Conduct evaluation of snow processes in National Water Model for at least one basin in U.S.				X	Viterbo	HMA	Part of BOR and NWS SLA snow data assimilation projects		Y	A preliminary evaluation was conducted in the Tuolumne watershed, CA and the results presented in a poster at AGU 2020
		F.9	Conduct evaluation of National Water Model for various lead times in selected western U.S. basins			X		Kim	HMA	Part of BOR and AQPI projects		Y	- Evaluated the short-range streamflow forecasts (out to 18 hours) of the national water model for June 2019 - December 2019 as a preliminary assessment. - Presented the short-range preliminary assessment results to the project team members (PPT form, if you need it, please let me know) - Keep archiving and evaluating the short-range streamflow forecast for Jan. 2020 - Jun. 2020. - Keep archiving and evaluating the medium-range (out to 10 days) streamflow forecast for Jun. 2019 - Jun. 2020. - Finished writing a draft of a preliminary assessment of the national water model for the short-range in the San Francisco bay area, and received the feedback from co-authors in the NCAR (ready to go the internal review). - Implemented a case study of Pilarcitos Lake for the San Francisco Public Utilities Commission.
		F.10	Examine the processes responsible for the development, evolution, and persistence of the northeast Pacific marine heat wave during 2013-2016.				X	Capotondi	DMI			Y	In collaboration with Matt Newman and colleagues at the Georgia Institute of Technology, we have examined the statistics of northeast Pacific marine heatwaves, and the influence of the tropical Pacific on their intensity and duration using a Linear Inverse Modeling approach: Xu, T., M. Newman, A. Capotondi, and E. Di Lorenzo, 2020: The continuum of northeast Pacific marine heatwaves and their relationship to the tropical Pacific. Geophys. Res. Lett., submitted. Other related accomplishments: Amaya, D. J., M. A. Alexander, A. Capotondi, C. Deser, K. B. Karnauskas, A.. J. Miller, and N. J. Mantua, 2020: Are long-term changes in mixed layer depth influencing North Pacific marine heatwaves? Bull. Amer. Met. Soc., submitted. NOAA-MAPP funded proposal entitled: "Mechanisms of US West Coast Variability and Change in Observations and Models". (with Prashant Sardeshmukh)
		F.11	Develop metrics for how well climate models simulate ENSO			x		Alexander Newman	AOP			Y	Published paper on results in Q3: Ding, H., M. Newman, M. A. Alexander, and A. T. Wittenberg, 2020: Relating CMIP5 model biases to seasonal forecast skill in the tropical Pacific. Geophys. Res. Lett., 47, e2019GL086765, doi: 10.1029/2019GL086765.
		F.12	Organize and host a US CLIVAR workshop on Multiyear prediction.			x		Alexander Newman	AOP			N	Workshop organized but postponed due to coronavirus (rescheduled for June 2021).
		F.13	Participate in 2 air-sea flux cruises (WHOTS and Stratus)				x	Fairall	BLO	Stratus and WHOTS are annual cruises to the NOAA flux reference buoys funded by OOMD. PSD participates to provide quality assurance of meteorological observations.		Y	2 cruises were completed: WHOTS Oct 2019, NTAS Jan 2020, Stratus was aborted because of COVID. Reporting will be part of GOMO annual report.
		F.14	Lead the ATOMIC field program to study shallow cumulus and air-sea interaction in the N Atlantic				x	Fairall	BLO	ATOMC is a the US contribution to an international field program being conducted in Jan-Feb 2020 off Barbados. NOAA is providing a research vessel and a P-3 aircraft. https://www.esrl.noaa.gov/psd/atomic/	x	Y	The project was sucessfully completed in Jan 5-Feb 15, 2020. In processes of creating data archive.
		F.15	Execute a process modeling study in support of "The Atlantic Tradewind Ocean-Atmosphere Mesoscale Interaction Campaign" (ATOMIC, US)				x	Dias Pincus	AOP FMD	Implement LES experiments to interpolate data from ATOMIC. Our primary focus is to examine how mesoscale structures in the lower atmosphere and the upper ocean might interact and regulate air-sea coupling.		N	Postdoc hiring has been delayed because of COVID

Performance Requirement (PR) (End state in meeting organizational goals and objectives)	Performance Measure (PM) (The monitoring of ongoing progress toward pre-established goals.)	PM Identifier	Performance Milestone (A distinct activity planned for completion on a scheduled date extracted from individual PSD staff annual performance plans)	FY20 Targets				PSD Point-of-Contact	PSD Research Team	More Detailed Description (as needed)	Tracked as R2X Transition?	Completed? (Y/N)	Evidence of Accomplishment/Follow-up Actions (If completed provide evidence in the form of comments, documentation, reports, papers,websites, datasets, etc. If not completed state why and identify follow-up actions)
				Q1	Q2	Q3	Q4						
		F.16	Complete analyses of observations and evaluations of HRRR simulations from the Second Wind Forecast Improvement Project (WFIP2)				x	Wilczak	BLO	WFIP2 was a major NOAA and DOE study of flow in complex terrain with applications to wind energy forecasting. https://www.esrl.noaa.gov/psd/renewable_energy/wfip2/		Y	Draxl, C. R. P. Worsnop, G. Xia, Y. Pichugina, D. Chand, J. K. Lundquist, J. Sharp, G. Wedam, J. M. Wilczak, and L. K. Berg, 2020: Mountain waves impact wind power generation. Submitted to Wind Energy Sci. Discussions. Bianco, L. I. V. Djalalova, J. M. Wilczak, J. B. Olson, J. S. Kenyon, A. Choukulkar, L. K. Berg, H. J. S. Fernando, E. P. Grimit, R. Krishnamurthy, J. K. Lundquist, P. Muradyan, M. Pekour, Y. Pichugina, M.T. Stoelinga, D. D. Turner, 2019: Impact of model improvements on 80-m wind speeds during the second Wind Forecast Improvement Project (WFIP2). Geosci. Model Dev., 12, 4803-4821, https://doi.org/10.5194/gmd-12-4803-2019 Olson, J.B., J.S. Kenyon, I. Djalalova, L. Bianco, D.D. Turner, Y. Pichugina, A. Choukulkar, M.D. Toy, J.M. Brown, W.M. Angevine, E. Akish, J.-W. Bao, P. Jimenez, B. Kosovic, K.A. Lundquist, C. Draxl, J. K.Lundquist, J. McCaa, K. McCaffrey, K. Lantz, C. Long, J. Wilczak, R. Banta, M. Marquis, S. Redfern, L.K. Berg, W. Shaw, and J. Cline, Improving Wind Energy Forecasting through Numerical Weather Prediction Model Development, Bulletin of the American Meteorological Society, doi: 10.1175/BAMS-D-18-0040.1, 2019. McCaffrey, K., J.M. Wilczak, L. Bianco, E. Grimit, J. Sharp, R. Banta, K. Friedrich, H.J.S. Fernando, R. Krishnamurthy, L. Leo, and P. Muradyan, 2020: Identification and Characterization of Cold Pool Events in the Columbia River Basin during WFIP2. Journal of Applied Meteorology and Climatology, doi:10.1175/JAMC-D-19-0046.1, 2019. Grachev, A. A., C. W. Fairall, B. W. Blomquist, H. J. S. Fernando, L. S. Leo, S. F. Otárola-Bustos, J. M. Wilczak, K. L. McCaffrey, 2020: On the surface energy balance closure at different time scales. Agricultural and Forest Meteor., https://doi.org/10.1016/j.agrformet.2019.107823
		F.17	Support development of a research plan for the Third Wind Forecast Improvement Project (WFIP3)				x	Wilczak	BLO	In collaboration with DOE, plans for a WFIP3 field program focussed on offshore wind energy will be developed.		Y	PSL collaborated with DOE on the development of science goals for WFIP3, substantially contributed to the development of a DOE Funding Opportunity Announcement (FOA) for WFIP3, and particiapted in the review of proposals submitted for the FOA.
		F. Total	**Number of observational, process, numerical and predictability research studies that increase the scientific understanding of key environmental processes (Target 8/yr)**	**8**			**8**	**Lataitis**	**DIR**				
		I											
Increase in personal skills of staff applicable to duties in support of the PSD and OAR mission through education and training	**Professional Development** Number PSD staff participating in professional development and communications training (Target 15/yr)	G.1	Support leadership and communication skills training				24	Gorton	DIR	2020 NOAA Leadership Seminar (4); Developing Your Essential Skills (1); Basic Travel Training (2); Challenges and Opportunities in the Multi-Generational Workplace (1); Developing Women Leaders (1); Effective Communication and Presentation Skills (1); Natural Resources and Conservation Compliance Regulations (2); NOAA 2020 Hispanic Employment Program Career Development Webinars (6); The 5 Deadly Vowels of Leadership (1); Writing Self- Accomplishments (4); Writing Safety Policies (1)		Y	
		G.2	Support training in facilitation skills and working with Congress training				3	Gorton	DIR	Contributing as a Vital Team Member (1); Establishing Effective Virtual Teams (1); Why is Mentoring Important? (1);		Y	
		G.3	Support supervisory policy training				37	Gorton	DIR	Roadmap to Success: Hiring…People with Diabilities (10); Time & Attendance for Supervisors (5); Managing Teleworkers (3); Effective Performance Management (1); Performance Management Overview (1); Preventing Harassment and Discrimination for Supervisors (12); Reasonable Accommodation (1); Bonus and Incentive Awards Training (1); Federal Budget Process - Planning Through Appropriations (1); Supervisor Development: Fundamentals (1); What Leaders Must Must Understand About Diversity & Leading in the 21st Century (1);		Y	
		G.4	Support OAR New Employee Orientation				7	Gorton	DIR	CY2019 Ethics - New Employee Ethics Training (6); Onboarding in a Virtual Environment (1)		Y	
		G. Total	**Number PSD staff participating in professional development and communications training (Target 15/yr)**				**15**	**Gorton**	**DIR**				
		J											
Promotion of a more inclusive workplace environment where	**Organizational Excellence** Number PSD staff participating in	H.1	Mentor interns from Hollings, Pathways, EPP, SOARS and other undergraduate and graduate internship programs including students from under-represented groups {NOTE: PSD almost always has a number of these interns, but who hosts and the demographics of the students varies]				5	Gorton	DIR	Engela Sthapit (NERTO Intern), mentored by Mimi Hughes; Carolein Mossel (NERTO Intern), mentored by Kelly Mahoney; Matt Watwood (Pathways Intern), mentored by Tom Hamill/Steve Penny; Megan Yannacito (Pathways Intern), menotred by David Lee; Koffi Apegnadjro (NOAA EPP/MSI Program), mentored by Roger Pulwarty/Rob Cifelli		Y	

Performance Requirement (PR) (End state in meeting organizational goals and objectives)	**Performance Measure (PM)** (The monitoring of ongoing progress toward pre-established goals.)	**PM Identifier**	**Performance Milestone** (A distinct activity planned for completion on a scheduled date extracted from individual PSD staff annual performance plans)	**FY20 Targets**				**PSD Point-of-Contact**	**PSD Research Team**	**More Detailed Description** (as needed)	**Tracked as R2X Transition?**	**Completed?** (Y/N)	**Evidence of Accomplishment/Follow-up Actions** (If completed provide evidence in the form of comments, documentation, reports, papers,websites, datasets, etc. If not completed state why and identify follow-up actions)
				Q1	**Q2**	**Q3**	**Q4**						
environment where diversity and individual differences are valued and leveraged to achieve the vision and mission of the organization.	participating in activities that foster an inclusive workplace and strengthen organizational performance (Target 25/yr)	H.2	Create an inclusive work environment from a top-down management perspective through monthly senior PSD leadership sessions focused on improving organizational health by maximizing clarity and minimizing politics, so staff feel empowered to be themselves and can fully contribute in a workplace environment that promotes creativity and vitality				12	Webb	DIR				
		H.Total	**Number PSD staff participating in activities that foster an inclusive workplace and strengthen organizational performance (Target 25/yr)**				**25**	**Webb**	**DIR**				

Identifier (Name of Parent Project)	Brief Description	Statement of intended purpose	Lifecycle Moving from				Lifecycle Moving to				Target	Target	Target	Target	Future Targets					Date Completed	PSD Point of Contact	PSD Research Team	OAR Responsible SES	OAR Contributing Partners	Customer	A clear statement of what condition must be met for the product advancement to have been made.	Type of R2A			Comments
			Research	Development	Demonstration	Operations or Applications	Research	Development	Demonstration	Operations or Applications	FY20 Q1	FY20 Q2	FY20 Q3	FY 20 Q4	21	22	23	24	25								Operations	Commercial	Other	
EDDI	Complete transition the Evaporative Demand Drought Index (EDDI) to an operational status at the National Water Center.	Provide a service for drought early warning, and ongoing drought monitoring to stakeholders affected by agricultural, hydrologic, and ecological drought, and at wildfire risk			X					X	X									FY20, Q2	Hobbins	HMA	Webb	Desert Research Institute & NOAA-National Water Center	NOAA-National Water Center	Reference ET and EDDI implemented at NWC.	x			Reference ET and EDDI are now being estimated at NWC using PSD-originated software, with their data to be shared with PSD (either pushed or pulled) in a raw format not usable by stakeholders; PSD will add any value for stakeholders and host the EDDI products exactly as we do currently; the NWC and PSD IT groups are finalizing the data transfer details, leaving PSD's remaining tasks to check their EDDI against ours and set up the data transfer at our end, which we anticipate being completed in Q1 of FY20.Target date for complete transition to NWC is December 2019. Completed in Q2.
NGGPS/UFS Improvements (GEFS)	ESRL/PSD has developed parameterizations of model uncertainty in the NCEP operational global ensemble forecast system. These parameterizations are crucial for producing accurate representations of forecast uncertainty for both the data assimilation cycle and the ensemble prediction system. This project supports ongoing development aimed at improving these parameterizations, in collaboration with NCEP/EMC.	Improved representation of model uncertainty in the NOAA Global Ensemble Forecast System (GEFS)			X					X				X						FY20, Q4	Whitaker	FMD	Webb		NWS/NCEP	Stochastic physics parameterizations implemented in time for use in beta implementation of FV3GFS data assimilation system and FV3GEFS reforecasts	X			
NGGPS/UFS Improvements (GSI/EnKF)	ESRL/PSD has developed the Gridpoint Statistical Interpolation (GSI) Ensemble Kalman Filter (EnKF) component for the operational global data assimilation system. The EnKF is used to update an ensemble of forecasts in the data assimilation cycle, and that ensemble is used to estimate background-error covariances needed by the data assimilation update. This project supports ongoing development aimed at improving the use of ensemble information in the data assimilation system, in collaboration with NCEP/EMC.	Improved representation of background errors in the operational data assimilation system, leading to improved use of observations, improved analyses and forecasts.		X					X					X						FY20, Q4	Whitaker	FMD	Webb		NWS/NCEP	Improvements to the operational data assimilation system tested and merged in time for the code freeze ahead of the next operational FV3GFS upgrade.	X			
Arctic Sea Ice Forecasting	Produce daily experimental forecast guidance products of sea ice, atmosphere, ocean conditions for the Arctic Basin on 0-10 day scales.	Improve 0-10 day forecasts of sea ice and Arctic conditions			X					X	X	X	X	X						FY20, Ongoing	Intrieri	POP	Webb		NWS/NCEP, NIC, NWS-Alaska Region Forecast Office, Alfred Wegner Institute (MOSAiC)	Daily forecasts are posted online for use by NOAA NWS, outside partners (https://www.esrl.noaa.gov/psd/forecasts/seaice/)	x			Completed
NGGPS/UFS Improvements (Arctic)	Deliver Arctic-focused diagnostics toolkit for assessing UFS performance wrt high quality observations and provide SME analysis	Assess and improve UFS Arctic region forecast skill		X					X		X									FY20, Q1	Intrieri	POP	Webb		NCEP/EMC	Transition toolkit and analysis information to EMC UFS Development Team (POC: Avichal Mehra)	X			Completed

Identifier (Name of Parent Project)	Brief Description	Statement of intended purpose	Lifecycle Moving from: Research	Lifecycle Moving from: Development	Lifecycle Moving from: Demonstration	Lifecycle Moving from: Operations or Applications	Lifecycle Moving to: Research	Lifecycle Moving to: Development	Lifecycle Moving to: Demonstration	Lifecycle Moving to: Operations or Applications	Target FY20 Q1	Target FY20 Q2	Target FY20 Q3	Target FY 20 Q4	Future Targets 21	22	23	24	25	Date Completed	PSD Point of Contact	PSD Research Team	OAR Responsible SES	OAR Contributing Partners	Customer	A clear statement of what condition must be met for the product advancement to have been made.	Type of R2A: Operations	Type of R2A: Commercial	Type of R2A: Other	Comments
CMAQ Improvements	Over the past several years PSD has been working Improve NCEP codes for air quality forecasts via the Community Multiscale Air Quality (CMAQ) Modeling System.	Develop post processing code for PM2.5 and ozone for a new coupled FV3-CMAQ air quality forecast system.	X					X						X							Wilczak	BLO	Webb		NOAA NCEP	Skill shown relative to the raw FV3-CMAQ simulations.	X			Delayed because FV3-CMAQ model simualtions have not yet been provided by NCEP due to problems in implementing the GFS FV3 model. Instead, promising new post-processing algortihms have been developed using the older NAM-CMAQ model, and these will be applied to the FV3-CMAQ simulations when they become available.
Temperature and Precipitation Forecast Improvements	Deployment of experimental cool-season temperature and precipitation forecasts based on a combined, lagged sea-surface temperature regression model	Provide cool-season probabilistic forecasts of temperature and precipitation based on method developed internally at PSD..			X					X				X						FY20, Q4	Hamill	APA	Webb		Weather/climate community	Experimental web graphics page completed and following submitted for publication: Switanek, M. B., J. J. Barsugli, M. Scheuerer, and T. M. Hamill, 2020: Present and Past Sea Surface Temperatures: A Recipe for Better Seasonal Climate Forecasts. Wea. Forecasting, 35, 1221–1234, https://doi.org/10.1175/WAF-D-19-0241.1.			X	
Sensor Improvements	Develop and demonstrate miniflux and microbuoy observing technologies	Advance air-sea-ice observational capability, in particular, as related to the measurement of ocean and atmosphere boundary layer fluxes to help improve our predictive understanding of these processes and their representation in climate models.		X					X			X									Intrieri	POP	Webb			Flight testing of miniFlux onboard the L3 Harris vehicle (in AZ) and from a moving ship platform (The Becker ship in FL).			X	Testing has been postponed due to COVID-19 so the final demonstration for NOAA UASPO is still TBD
Attribution Assessments	Produce two or more attribution assessments of climate extreme events, anomalies and trends	Investigate and communicate our understanding of the causes of climate extreme events, anomalies and trends.	X							X		X		X						FY20 Q2,Q4	Hamill	APA	Webb		Weather/climate community Decision/policy makers	Possible contributions may include: (1) BAMS paper submitted on FACTS web site maintained by PSD. (2) BAMS Explaining Extremes Events publication (coordination and editing by Hoell, Hoerling) (~Dec 2019) (3) Reattribution / reforecasting of Colorado rain of 2013: Hoerling will present at AGU in special session extreme events. Possible written assessment depending on interest and feedback. (4) Andy Hoell will present at the CDPW on understanding record winter/spring 2019 precipitation in the US Great Plains. Possible AMS Annual presentation as well. A journal article is likely too, perhaps in 2020. (5) An internal document on PSD attribution / predictability data set evolution, including counter-factual best practices and a plan for FACTS 2.0. (6) Peer-reviewed manuscript submitted on "Confirmation for and Predictability of Distinct Impacts of El Niño Flavors" (Tao Zhang, Hoell, Hoerling, Perlwitz)			X	

Identifier (Name of Parent Project)	Brief Description	Statement of intended purpose	Lifecycle Moving from				Lifecycle Moving to				Target	Target	Target	Target	Future Targets					Date Completed	PSD Point of Contact	PSD Research Team	OAR Responsible SES	OAR Contributing Partners	Customer	A clear statement of what condition must be met for the product advancement to have been made.	Type of R2A			Comments
			Research	Development	Demonstration	Operations or Applications	Research	Development	Demonstration	Operations or Applications	FY20 Q1	FY20 Q2	FY20 Q3	FY 20 Q4	21	22	23	24	25								Operations	Commercial	Other	
Predictability Assessments	Produce two or more predictability assessments for subseasonal to decadal time scales in order to quantify the prospects and gaps for skillful predictions, including droughts.	Investigate and communicate our understanding of the limits of predictability of subseasonal to decadal weather-climate phenomenon.	X							X			X	X						FY20 Q3,Q4	Hamill	APA	Webb		Weather/climate community Decision/policy makers	Possible contributions may include: 1. Submit a proposal for an AGU Chapman Conference on "Colorado River Flow and its Climate Drivers", for the 15 March 2020 AGU call for proposals. 2. Complete analysis and prepare a manuscript on the topic " The Millenium Drought on the Colorado River." 3. Preliminary results of the diagnoses of GEFS reforecasts for stratospheric and precipitation. 4. Some or all of GLACE protocol data for FV3 GFS system created. Possible associated journal articles.			X	
Marine Heat Waves	Examine marine heat waves, including the processes that cause them and their predictability	Survey of the processes that cause marine heat waves to improve the predictive understanding of these events. Examine the heat wave developing off the US west coast in 2019.											X							FY20, Q3	Alexander	AOP	Webb		Weather/climate community	Draft and submit for publication a journal paper describing the result of this study.			X	
Water Vapor Flux Tool	Add the GFS (FV3 core) to PSD's water vapor flux tool	PSD's water vapor flux tool is available at sites where PSD operates Doppler wind profilers, and more specifically, the picket fence of semi-permanent atmospheric river observatories deployed along the U.S. West Coast. The tool combines observations and numerical weather prediction output in a unique display that allows forecasters to evaluate model predictions of the the incoming flux of water vapor, the snow level, and the precipitation that result from landfalling atmospheric rivers. This effort will allow NWS forecasters to evaluate how well the GFS is predicting atmospheric river conditions several days in advance. This complements the current tool, which does the same for the HRRR and RAP models on shorter time scales.												X						FY20, Q4	Gottas	HOP	Webb		Weather/climate community NWS Western Region	Implementation of of advanced capability on current website	X			Update to the tool to include the GFS was completed early in Q2. Forecasters can now choose from the HRRR, HRRRX, RAP, and GFS to compare with observations. An example can be viewed at https://www.esrl.noaa.gov/psd/data/obs/datadisplay/ViewDataType.php?DataTypeID=67&SiteID=bby&DataSourceID=1 by choosing one of the model buttons in the upper left of the display.
ATOMIC Field Program	Lead the ATOMIC field program to study shallow cumulus and air-sea interaction in the North Atlantic	ATOMC is a the U.S. contribution to an international field program being conducted in Jan-Feb 2020 off Barbados. NOAA is providing a research vessel and a P-3 aircraft. https://www.esrl.noaa.gov/psd/atomic/. The purpose of the field program is to improve our predictive understanding of the phenomena and their representation in climate models.												X						FY20, Q2	Fairall	BLO	Webb	PMEL, AOML	Weather/climate community	Successful completion of field study			X	The project was sucessfully completed in Jan 5-Feb 15, 2020. In processes of creating data archive.

Identifier (Name of Parent Project)	Brief Description	Statement of intended purpose	Lifecycle Moving from				Lifecycle Moving to				Target	Target	Target	Target	Future Targets					Date Completed	PSD Point of Contact	PSD Research Team	OAR Responsible SES	OAR Contributing Partners	Customer	A clear statement of what condition must be met for the product advancement to have been made.	Type of R2A			Comments
			Research	Development	Demonstration	Operations or Applications	Research	Development	Demonstration	Operations or Applications	FY20 Q1	FY20 Q2	FY20 Q3	FY 20 Q4	21	22	23	24	25								Operations	Commercial	Other	
GEFSv12 reforecast usage to improve National Blend of Models Precipitation Forecasts	Adapt code in the National Blend of Models so that it utilizes the longer training data sets available with the GEFSv12 reforecasts, and thereby produces improved precipitation forecasts	Adapt the National Blend of Models (NBM) so its precipitation postprocessing leverages Global Ensemble Forecast System version 12 (GEFSv12) reforecasts, improving precipitation product quality that anchor NWS forecast products. Starting fall 2020, the GEFSv12 will provide reforecasts that are statistically consistent with the real-time forecasts. Currently, the NBM uses only the past 60 days of forecasts for training data; this approach is especially problematic in transition seasons, warm-to-cool and cool-to-warm, when the character of precipitation forecasts shifts from convective to large scale, and back. With modest adjustments, the NBM code can be reconfigured to leverage the GEFSv12 reforecasts.			X					X					X					FY21 Q4 delivered to MDL	Hamill	APA	Webb	None	NWS MDL	Ultimate condition is the operational implementation in the NBM, but the time of this depends on MDL's implementation schedule. The ultimate delivery for PSL will be code and documentation and data suitable to MDL that provides what they need to support the operational implementation.	X			This was funded by OAR WPO under its precipitation grand challenge project