Physical Sciences Laboratory (PSL) Overview (2015-2020)

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Director

NOAA Physical Sciences Laboratory Review
November 16-20, 2020

Outline

- **Vision, Mission & Goals**

- **What is PSL**

- **Organization**

- **Staffing Demographics**

- **Funding Portfolio**

- **Research Themes**

- **Structure of the Review**

PSL research advances NOAA and OAR Missions

- **PSL conducts research in support of the NOAA mission *to understand and predict changes in climate, weather, oceans, and coasts, to share that knowledge and information with others, and to conserve and manage coastal and marine ecosystems and resources.***

- **PSL science supports the OAR mission *to conduct research to understand and predict the Earth system; develop technology to improve NOAA science, service, and stewardship; and transition the results so they are useful to society.***

PSL Legislative Drivers

- Title II, Section 201(h)(1) of United States Congress enacted PL115-25, with the short title, "**WEATHER RESEARCH AND FORECASTING INNOVATION ACT OF 2017**, "To improve the National Oceanic and Atmospheric Administration's weather research through a focused program of investment on affordable and attainable advances in observational, computing, and modeling capabilities to support substantial improvement in weather forecasting and prediction of high impact weather events, to expand commercial opportunities for the provision of weather data, and for other purposes."

- **NATIONAL INTEGRATED DROUGHT INFORMATION SYSTEM ACT OF 2006 and REAUTHORIZATION ACTS of 2014 and 2019** establish and maintain a National Integrated Drought Information System within NOAA to improve drought monitoring, forecasting, and early warning capabilities and to determine the contribution of weather events to reducing the severity or ending drought conditions.

- **THE SECURE WATER ACT (SUBTITLE F OF PUBLIC LAW 111–11** identified NOAA as a source for the credible science required by other agencies, state, and local decision makers, and the private sector, and to provide "the best available scientific information with respect to presently observed and projected future impacts of global climate change on water resources."

- **MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT Public Law 94-265, as amended through October 11, 1996** "to assure that the national fishery conservation and management program utilizes, and is based upon, the best scientific information available" (101-627, 104- 297) Conservation and management measures shall be based upon the best scientific information available."

- **MARINE MAMMAL PROTECTION ACT, sec. 1371** "The Secretary, on the basis of the best scientific evidence available and in consultation with the Marine Mammal Commission, is authorized and directed from time to time, having due regard to the distribution, abundance, breeding habits, and times and lines of migratory movements of such marine mammals."

- **MARINE RESOURCES AND ENGINEERING DEVELOPMENT ACT of 1966 (Pub. L. 89-454)** to "develop, encourage, and maintain a coordinated, comprehensive, and long-range national program in marine science for the benefit of mankind, to assist in protection of health and property, enhancement of commerce, transportation, and national security, rehabilitation of our commercial fisheries, and increased utilization of these and other resources."

PSL Vision and Mission

Vision: *An informed society that uses science-based environmental intelligence to effectively anticipate and respond to threats and opportunities related to weather, water and climate extremes.*

Mission: *To conduct scientific research to observe, understand, model, predict and forecast weather, water and climate extremes and their impacts.*

PSL Research Goals

- **Rigorously characterize and predict weather, water, and climate extremes and their uncertainties to inform decision making.**

- **Understand, observe, model and predict conditions associated with too much or too little water for early warning, preparedness and adaptation.**

- **Improve monitoring and prediction of weather, climate, and water conditions impacting marine resources in support of NOAA stewardship responsibilities.**

PSL: Why we pursue our research

- **To position NOAA to provide the early warning and inform preparedness** needed to mitigate disruptive impacts.

- **To position NOAA to reduce future vulnerabilities and increase resiliency** by predicting the nation's path through a varying and changing climate.

- **To identify new sources of predictability** as a foundational scientific underpinning for the delivery of NOAA services.

- **To pursue a use-inspired research strategy** that balances responsiveness to existing needs with innovation in anticipation of future needs.

PSL: How we do our research

- **Deploy existing observing technologies, and develop new technologies**, to advance observation-based process understanding of extremes.

- **Apply observations to evaluate model forecast systems** and identify systematic errors.

- **Analyze data and information to provide diagnostic explanations** that advance predictive understanding of weather, water and climate extremes

- **Develop and apply models to transform predictive understanding into capabilities to forecast and predict** weather, water and climate extremes.

- **Transform science-based knowledge into actionable science** that is readily available to support operations, applications and decision making.

PSL-generated resources supporting our research

- **Research datasets and web-based browser, analysis and visualization tools**

- **20th Century Reanalysis**

- **FACTS: A Community Resource <u>Fa</u>cility for Weather and <u>C</u>limate Assessmen<u>ts</u>**

- **Global Ensemble Forecast System (GEFS) Version 12 reanalysis and reforecasts**

- **Experimental products and services which inform operations and decision making**
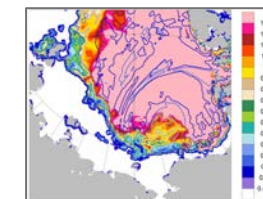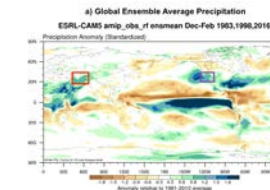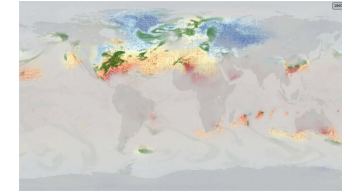
PSL Organizational Structure
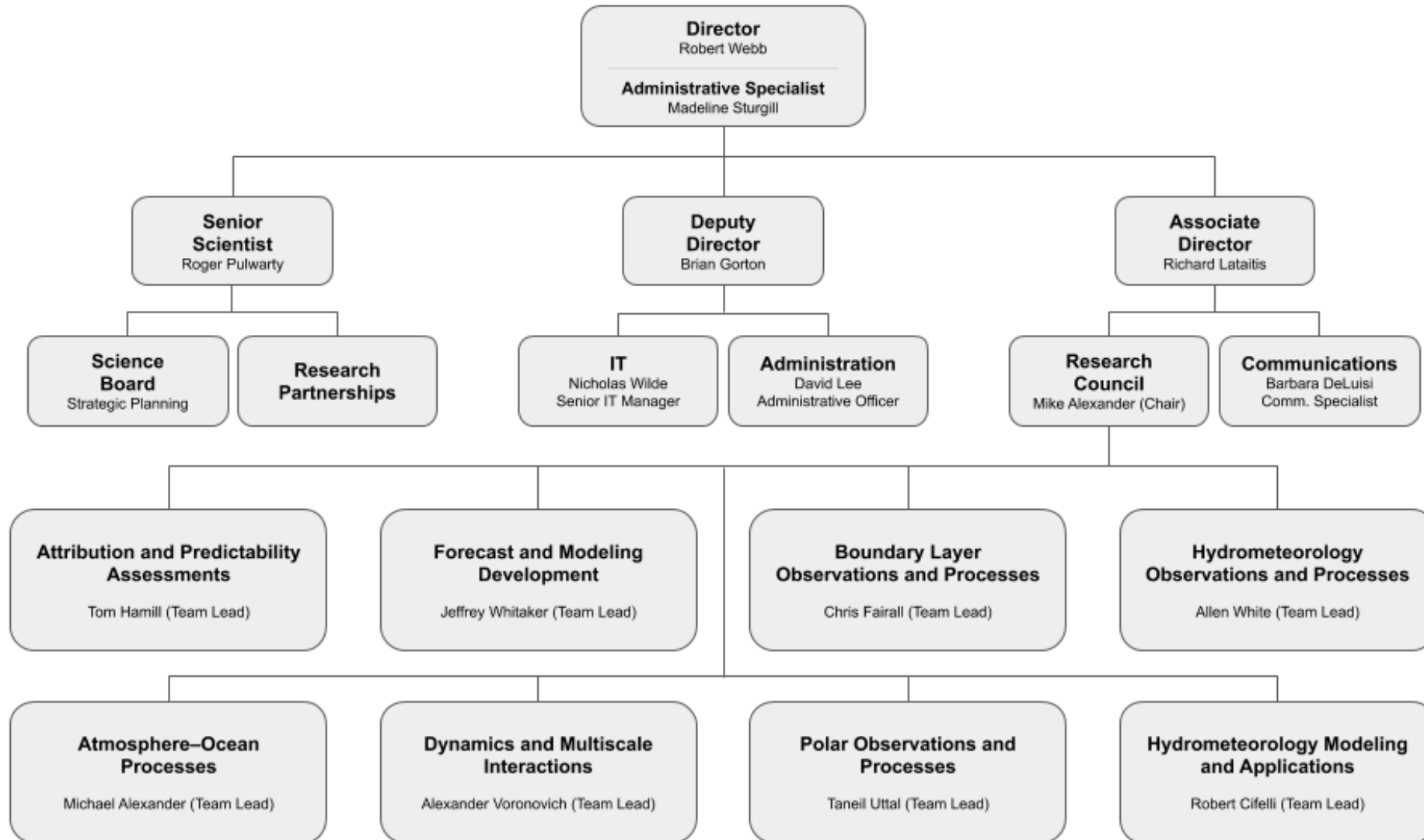
PSL Research Teams

Atmosphere-Ocean Processes
Investigating the roles of ocean processes, air-sea interaction, and tropical-extratropical exchanges on climate variability.

Attribution & Predictability Assessments
Identifying the causes of extremes in weather and climate, the conditions under which they are predictable, and improving their prediction.

Boundary Layer Observations & Processes
Advancing the understanding of atmospheric boundary-layer processes.

Dynamics and Multiscale Interactions
Understanding and predicting variations and trends in weather, water, and climate, with an emphasis on extremes.
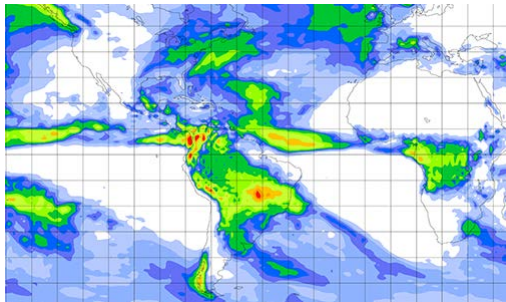
Forecast and Modeling Development
Research and development to improve NOAA operational forecast products.

Hydrometeorology Modeling & Applications
Advancing hydrometeorology methods, models and applications to address weather, climate, and water extremes.

Hydrometeorology Observations & Processes
Improving precipitation & streamflow predictions through improved observations and understanding of hydrometeorological phenomena.

Polar Observations & Processes
Improving Polar climate prediction and sea ice/weather forecasting in Earth's Polar regions.
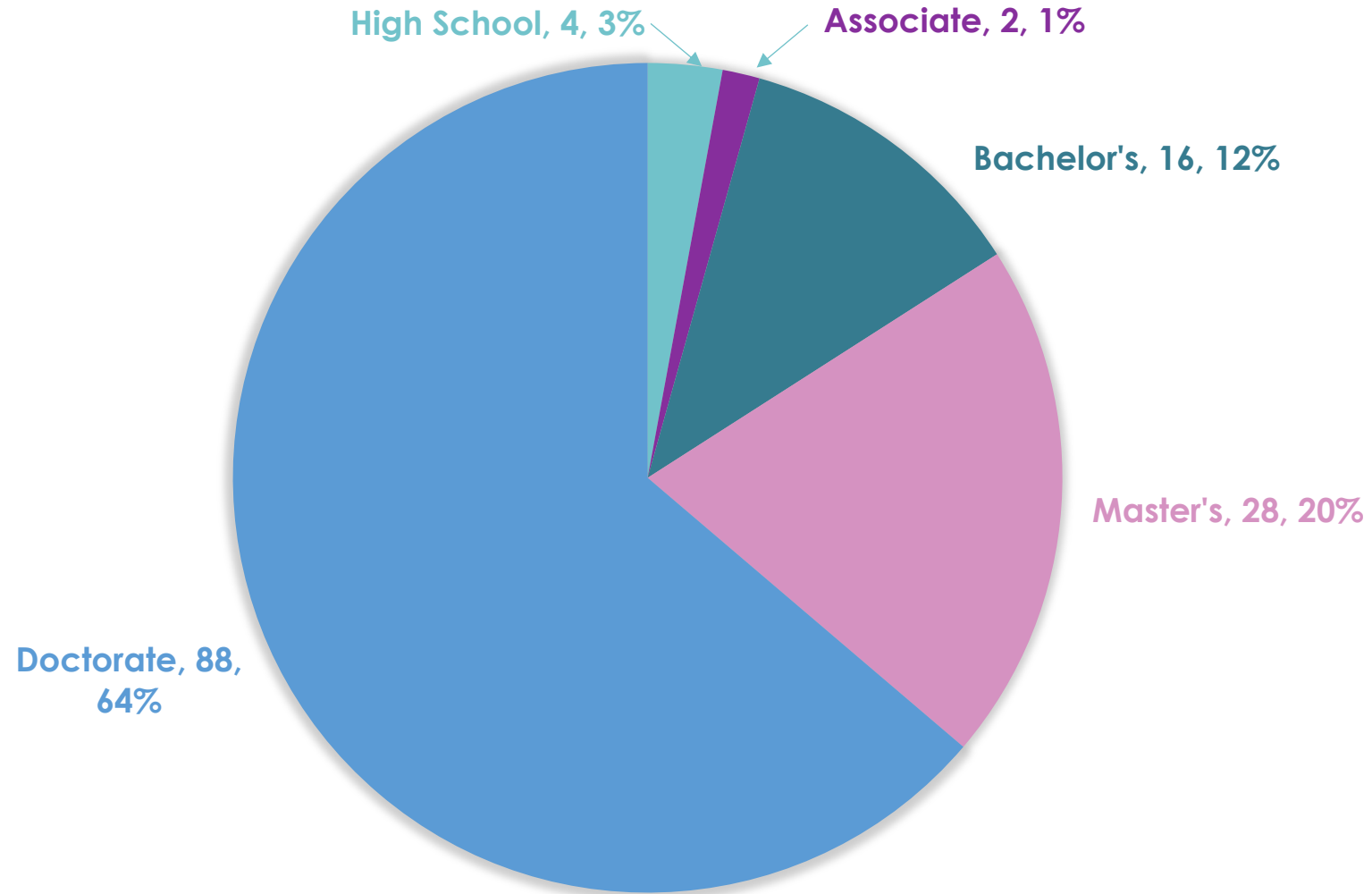
PSL Staffing by Fiscal Year
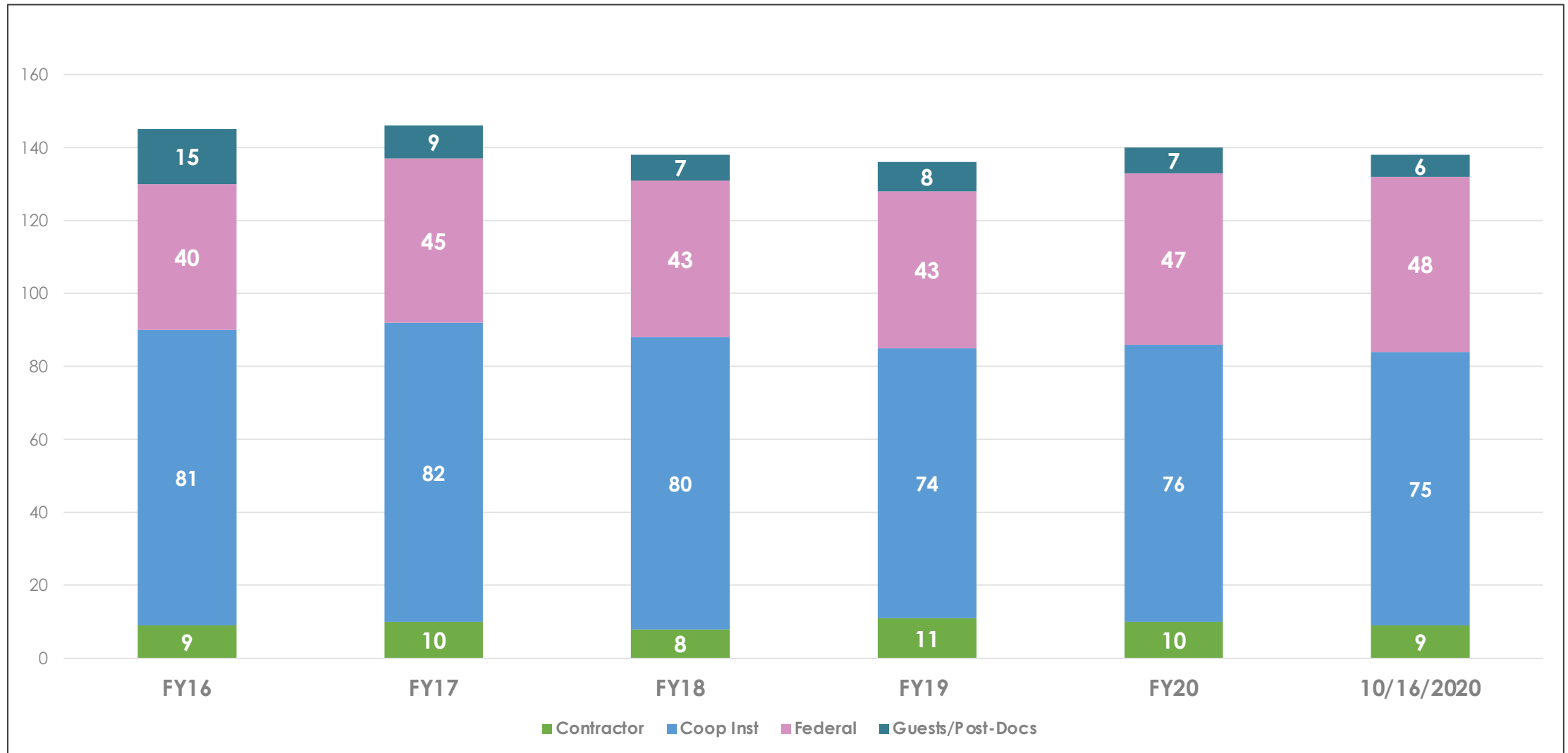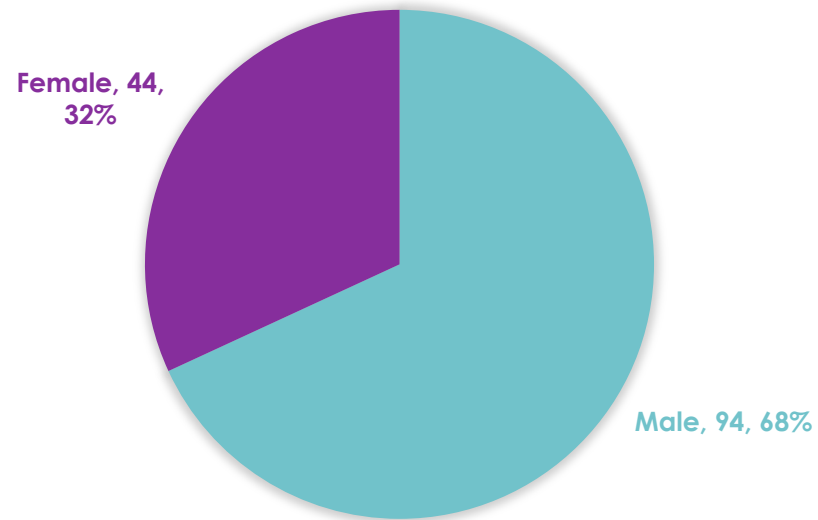
PSL Staff Distribution

PSL Staff Function

Data, 4, 3%

Technical Support, 7, 5%

Admin Support, 12, 9%

Management, 5, 4%

Engineering, 6, 4%

Science, 104, 75%
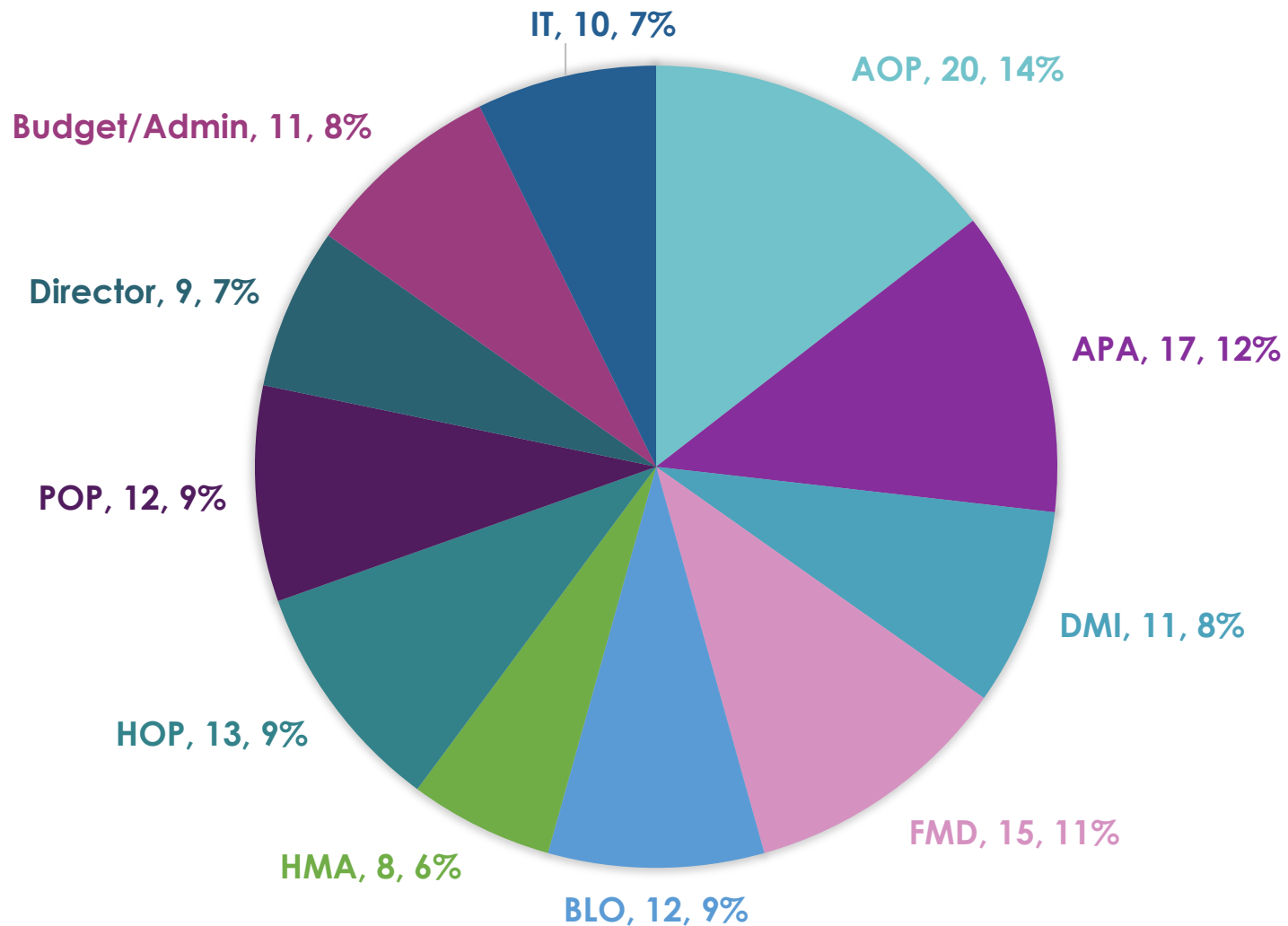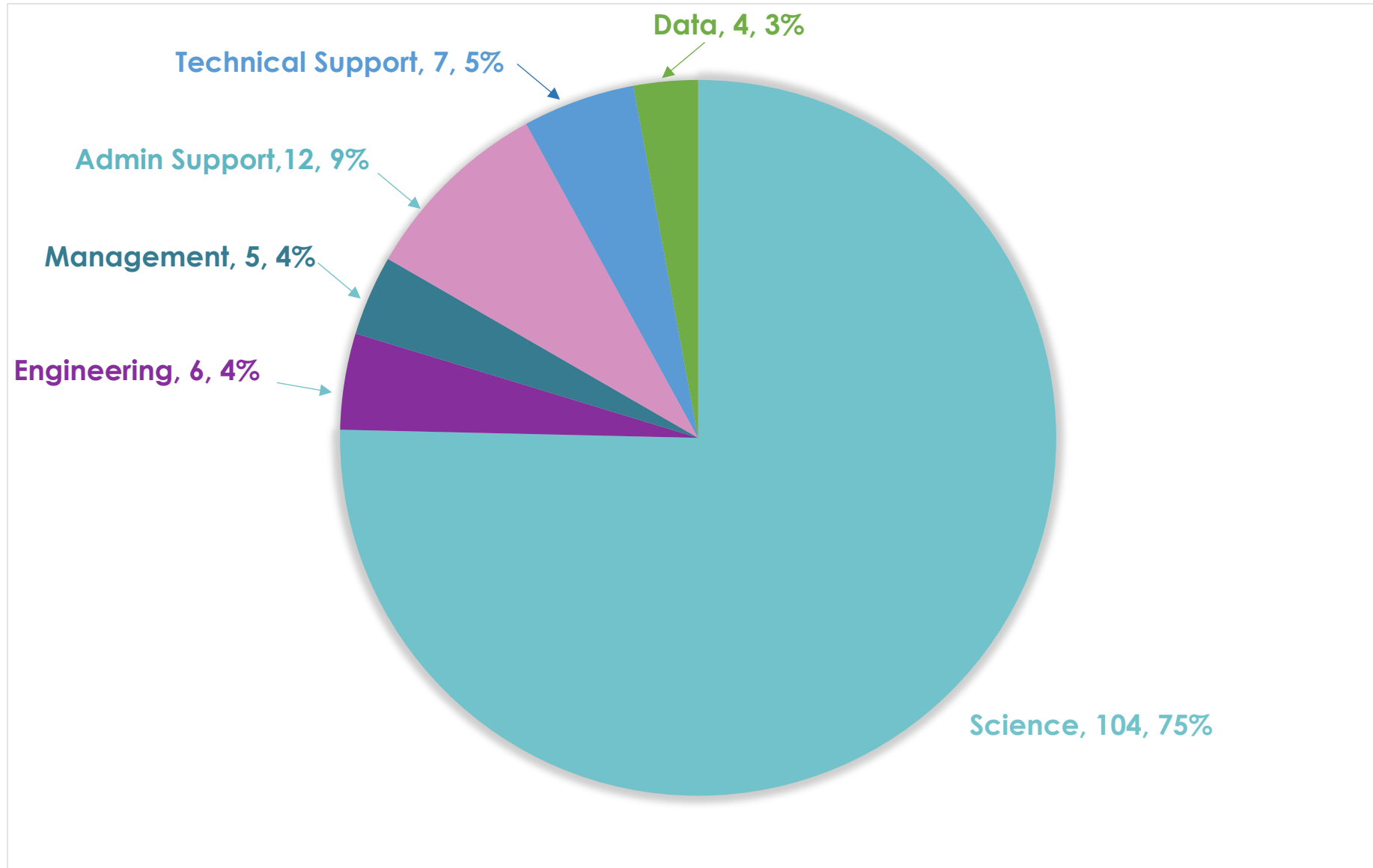
PSL Staff Degree Distribution

High School, 4, 3%

Associate, 2, 1%

Bachelor's, 16, 12%

Master's, 28, 20%

Doctorate, 88, 64%

PSL Staff Gender Diversity

PSL STAFF (ALL) DIVERSITY - GENDER

Female, 44, 32%

Male, 94, 68%

PSL STAFF (FEDS) DIVERSITY - GENDER

Female, 18, 38%

Male, 30, 62%
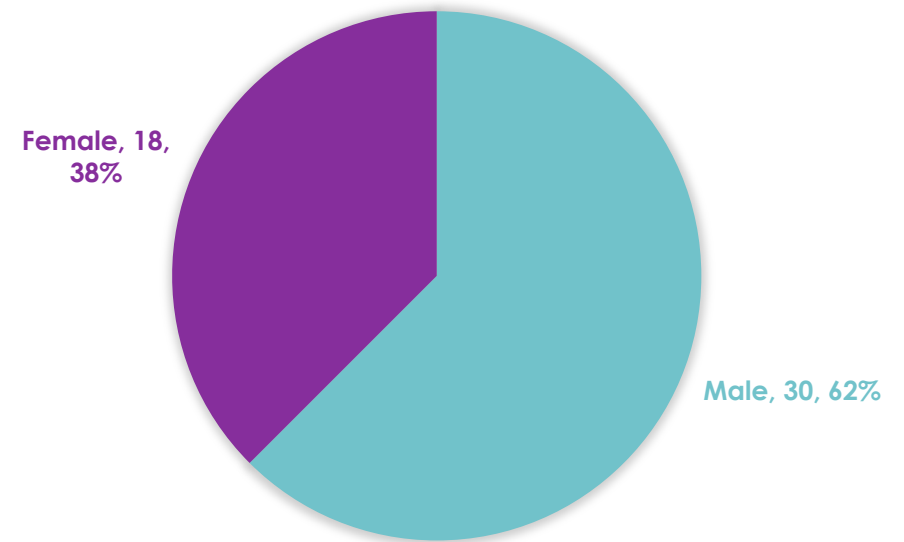
PSL Staff Racial Diversity

PSL STAFF (ALL) DIVERSITY - RACE

Asian/Pacific Islander, 13, 9%

Hispanic, 6, 4%

Black, 1, 1%

White, 118, 86%

PSL STAFF (FEDS) DIVERSITY - RACE

Asian/Pacific Islander, 3, 6%

Hispanic, 6, 13%

White, 39, 81%
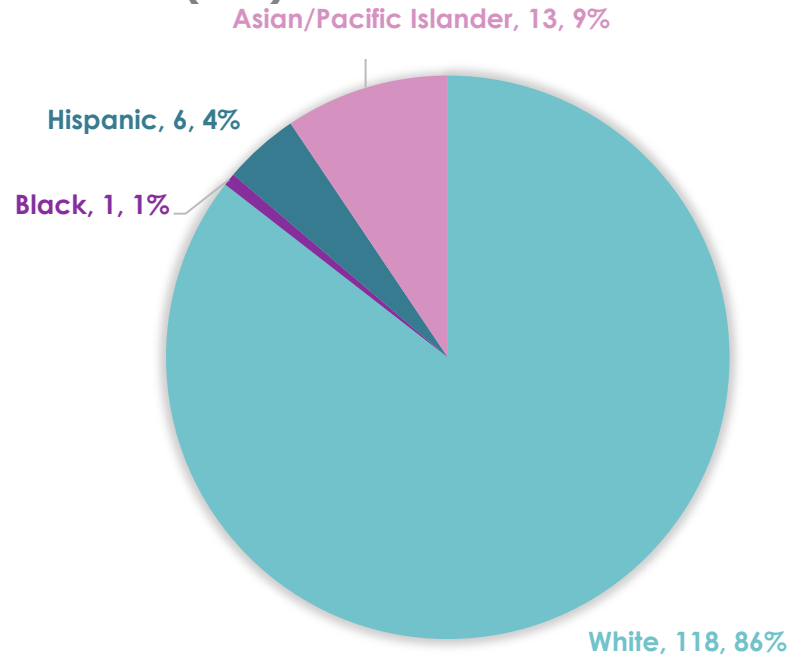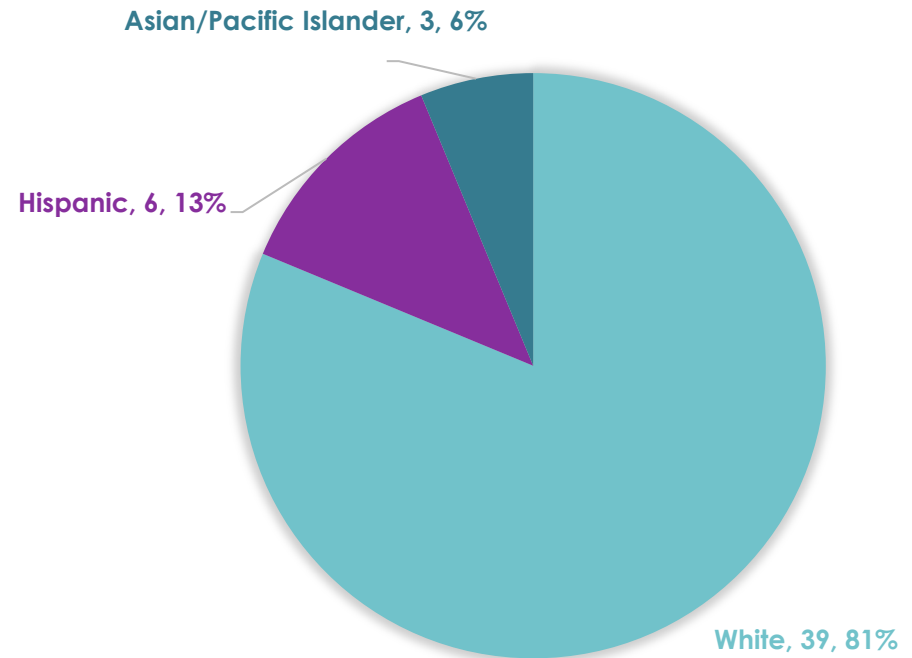
PSL Income by Fiscal Year
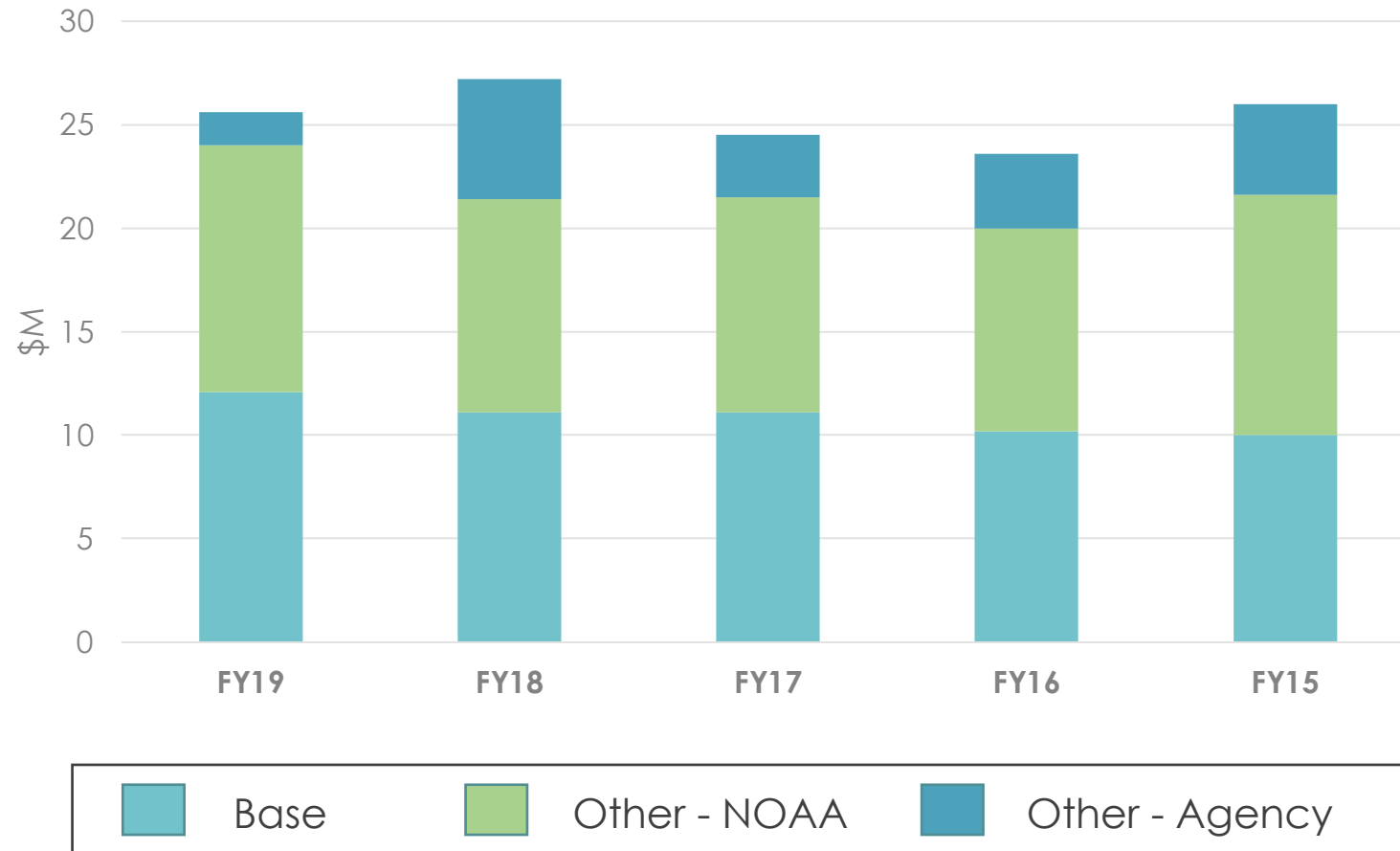
Physical Sciences Laboratory FY 2019 Funding Portfolio

External Reimbursable (7 projects) $1.6M
National Weather Service (8 projects) $2M
Weather Program Office (14 projects) $5.7M
Weather & Air Quality Base Allocation $6.4M
Climate Base Allocation $5.7M
Climate Program Office (7 projects) $3.5M
Other NOAA (8 projects) $.7M

$25.6M
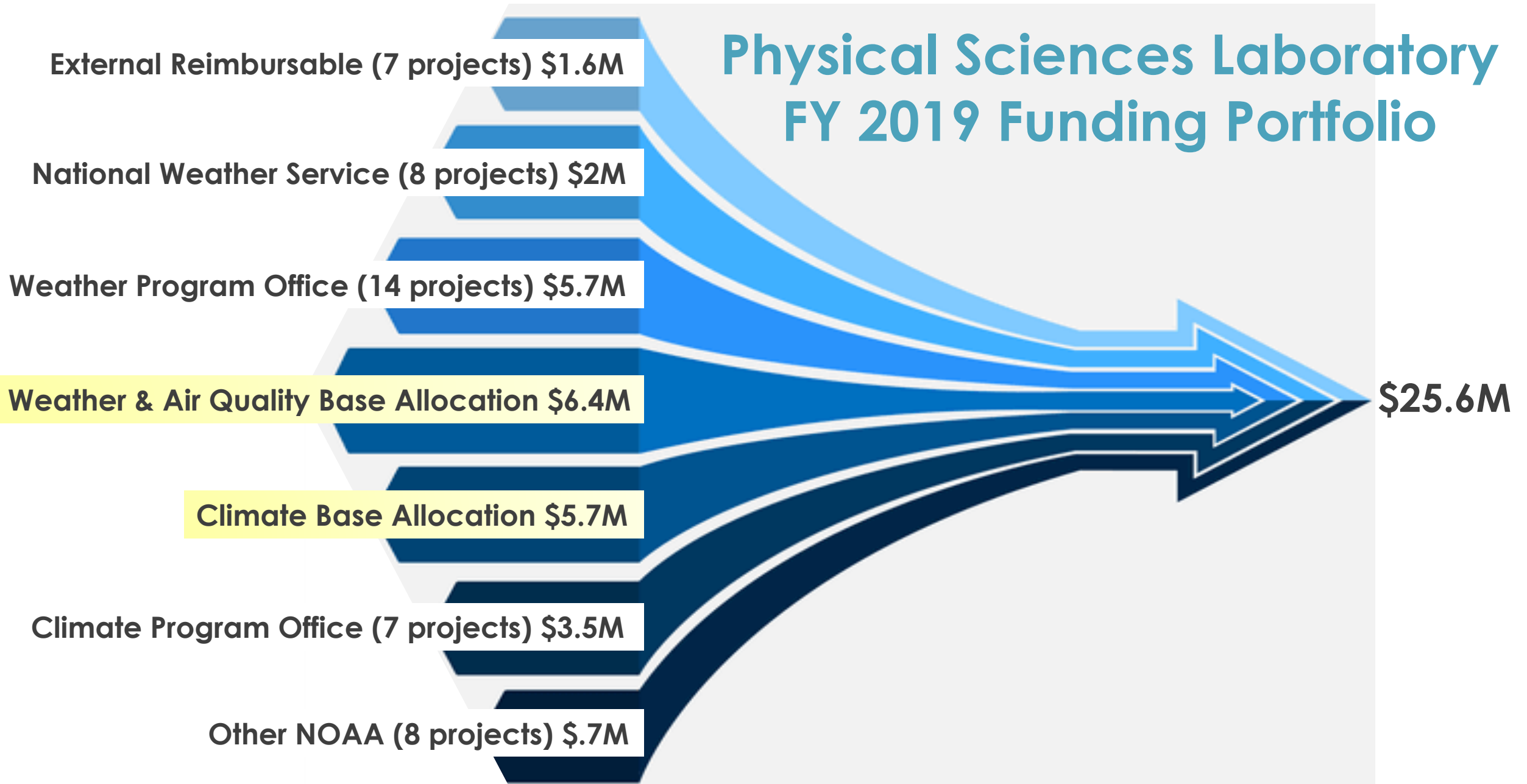
PSL FY19 Expenditures by Function (millions)

Boulder Assessments; $1.4; 5%

PSL IT; $1.3; 5%

PSL Administration; $3.0; 12%

Weather & Air Quality; $8.2; 32%

Climate Research; $11.7; 46%
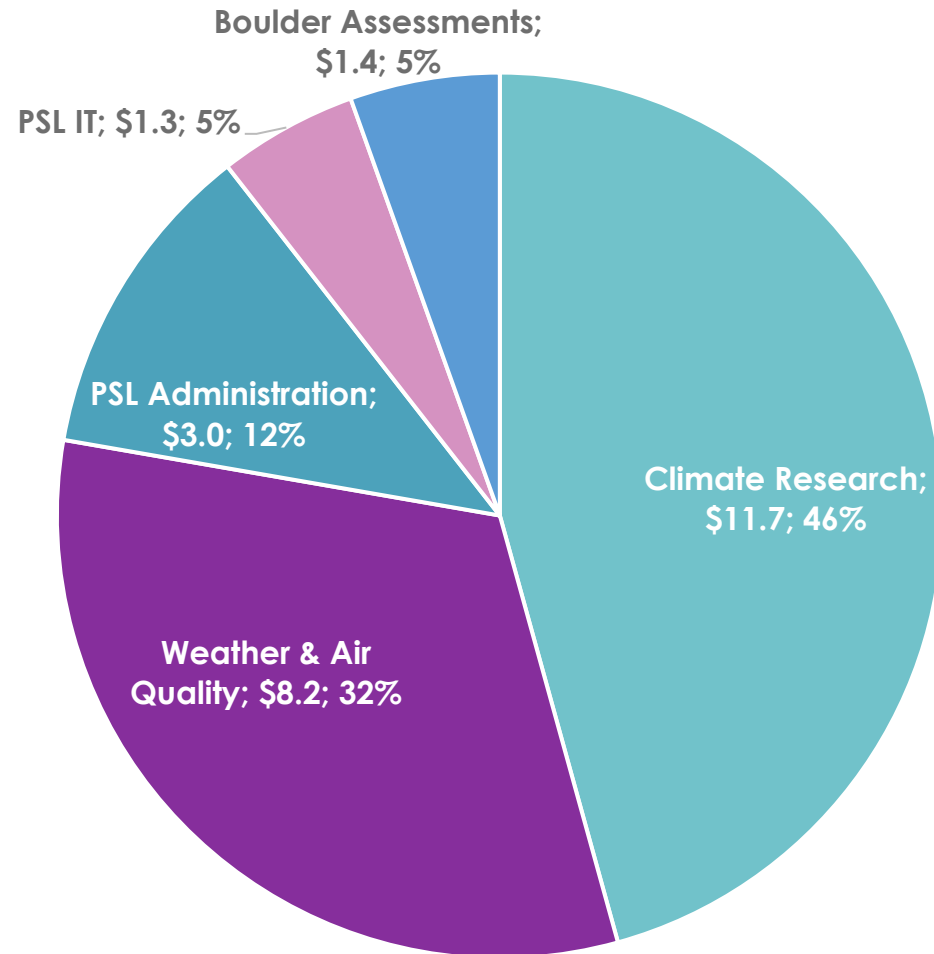
PSL FY19 Expenditures by Category (millions)

- Rents & Utilities, $1.4, 5%
- Travel, $0.3, 1%
- Equipment, Supplies & Other, $0.9, 4%
- Contract Labor, $1.3, 5%
- Federal Labor, $9.7, 38%
- CI Labor, $12.0, 47%
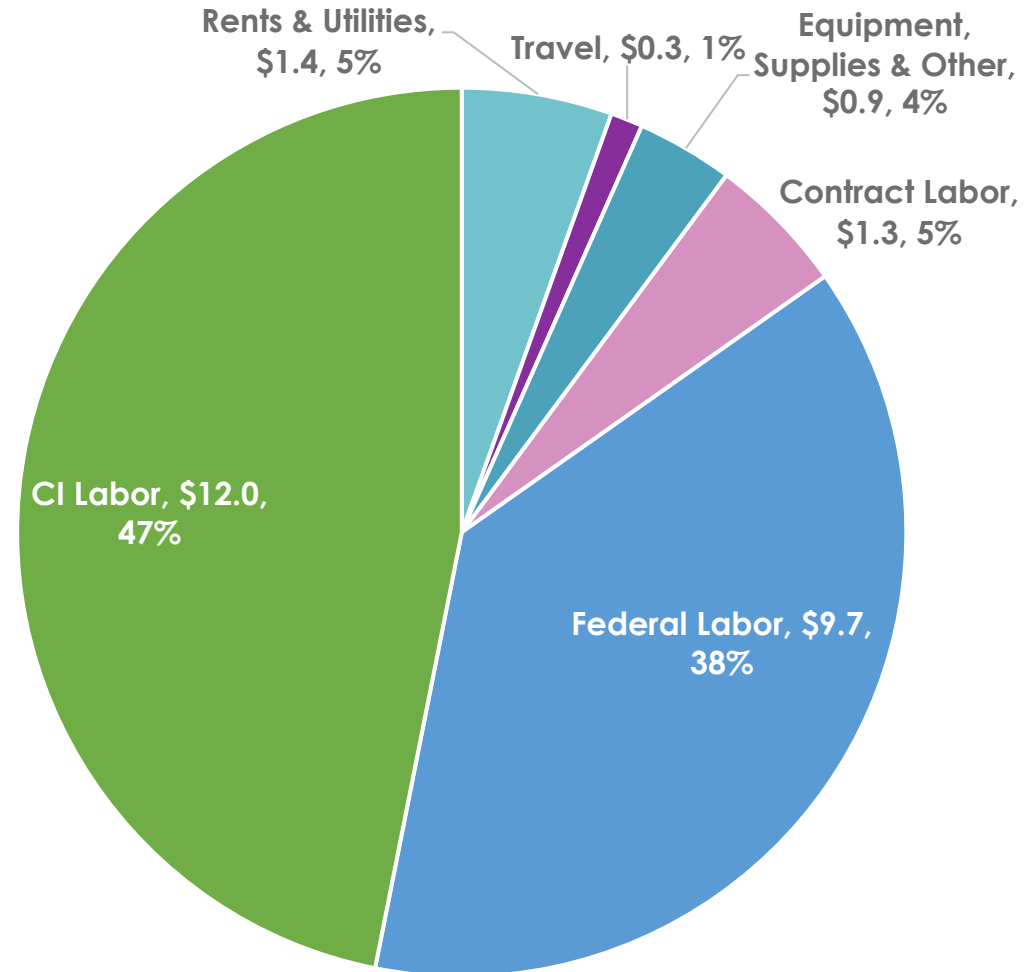
PSL Measures of Excellence

<u>Professional Organization Fellowships</u>

    American Meteorological Society

    American Indian Science and Engineering Society

    Acoustical Society of America

    Cooperative Institute for Research in Environmental Sciences

    Cooperative Institute for Research in the Atmosphere

<u>Awards and Recognition</u>

    DOC/NOAA/OAR

    CIRES

    Federal and State Agencies

    Professional Societies

    Reviewer/Editor

    Journal and Publications

    Invited Presentations and Posters

    Outreach, Education, EEO and Diversity Efforts

PSL Indicators of Quality

Scientific Leadership
      International Organizations
      NOAA
      Other Federal Agencies
      National Academy of Sciences Committees
      State, Tribal and Local Agencies
      Research Programs
      Field Campaigns
      National and International Workshops and Conferences

Postdoctoral Research Fellowships
      National Academy of Sciences / National Research Council
      University Corporation for Atmospheric Research, Postdocs
      Cooperative Institute for Research in Environmental Sciences

PSL 2015-2019 Publications

Number of PSL Publications Per Year CY 2015-2019

> **5-year average: 120 papers**
> **Publication per scientist: 1.1 papers**
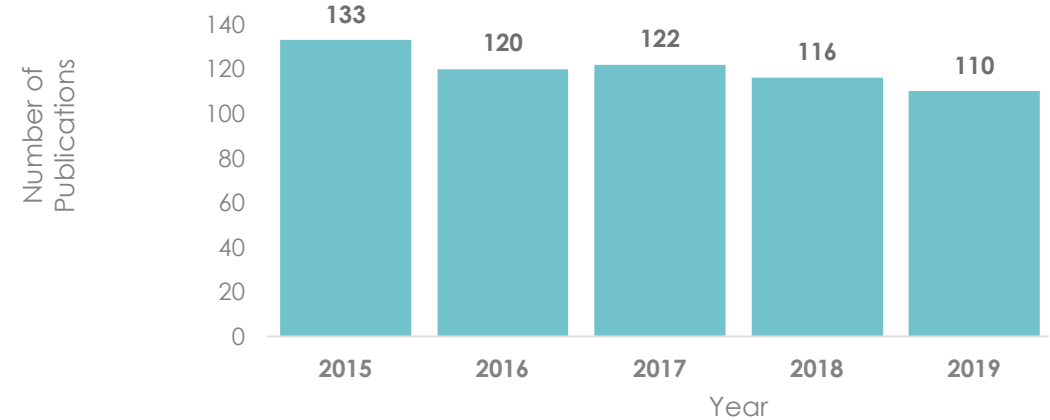
Snapshot of PSL Fiscal Year 2020 Publications

(October 1, 2019 – September 30, 2020)
119 peer-reviewed journal papers
4 book chapters
2 science reports
9 research-quality datasets

PSL-Wide 2015-2019 Bibliometrics

13305
Total times cited

609
Total publications, 2015-2019

21.8
Average cites per publication

50
Five Year H-Index

PSL Number of Publications per Journal

Journal	Count
Bulletin of the American Meteorological Society	65
Journal of Climate	55
Monthly Weather Review	42
Geophysical Research Letters	32
Atmospheric Chemistry and Physics	28
Climate Dynamics	28
Journal of Geophysical Research Atmospheres	24
Journal of Atmospheric and Oceanic Technology	20
Journal of Hydrometeorology	20
Atmospheric Measurement Techniques	19
Journal of Applied Meteorology and Climatology	16
Journal of the Atmospheric Sciences	12
Journal of Advances in Modeling Earth Systems	11
Journal of Geophysical Research Oceans	11
Remote Sensing	10
Qtly Journal of Royal Meteorological Soc	8
Weather and Forecasting	7
Atmospheric Research	6
Frontiers in Marine Science	6
Nature Climate Change	6

Journals in which PSL has published more than 5 times over the five year period.

PSL Approach to Research

Observe
Develop, acquire and tailor instruments to observe, monitor and deploy for targeted field campaigns, remote sensing, integrated observing systems

Understand
Observation-based process understanding, how predictable, limits of predictability, characterize uncertainty, diagnostic studies, explain, visualize

Partnerships
Public service, use-inspired, NOAA line offices, public and private sectors, academic community, mutual benefit, sharing, leveraging, synergizing, advances NOAA mission

Share that Information with others
Communicate what is known and not known, experimental information products and services, knowledge assessments, transitioning research to applications and operations

Predict
Model, forecast, evaluate, outlooks, projections, systematic errors, parameterizations, assimilate, ensembles, reanalysis, reforecast, post-processing

PSL Strategic Plans

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Earth System Research Laboratory

Physical Sciences Division
Strategic Plan 2016–2020
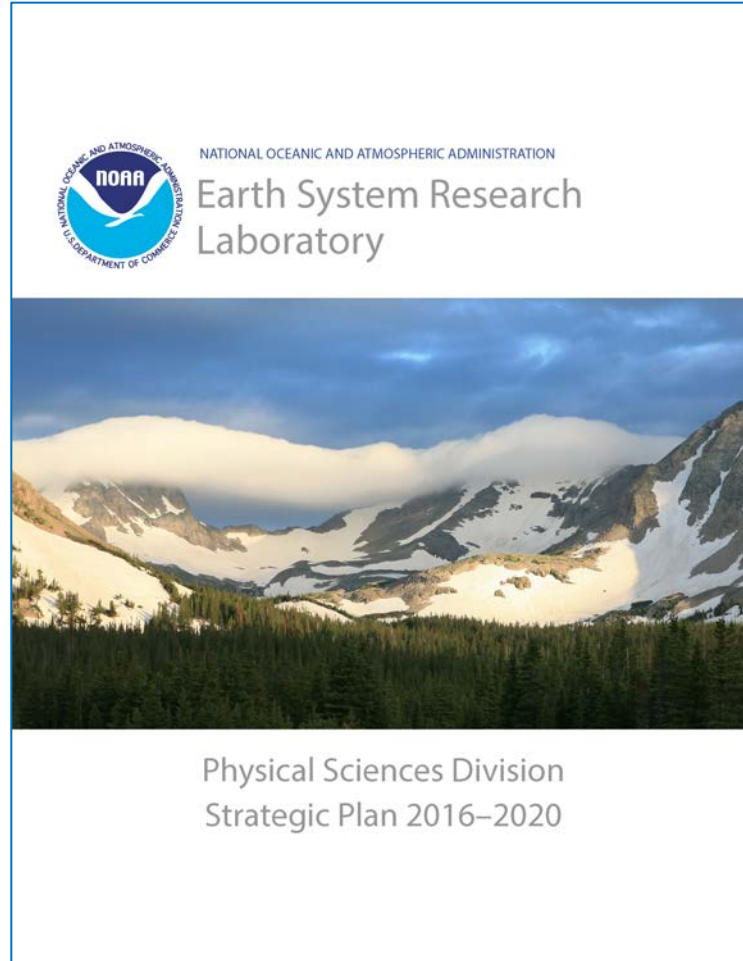
Draft 2021-2025 Plan to advance NOAA's Mission into the future will be informed by five-year laboratory review.

https://psl.noaa.gov/about/pdf/PSL_Strategic_Plan_2016-2020.pdf

PSL Structure of the Review

❖ **A Lead-off Presentation and Discussion Session with OAR leadership, Portfolio Stewards**

❖ **Discussion of the Prerecorded PSL Overview Presentation**

❖ **Discussions of the Prerecorded Presentations with PSL subject matter experts for the three PSL Research Themes**
- 🌡️ **Physical Science for Predicting Extremes**
- 💧 **Physical Science for Water Resource Management**
- 🐟 **Physical Science for Marine Resource Management**

❖ **Discussions of the Prerecorded Presentations with PSL subject matter experts for the five PSL Focus Areas**
- **Observing Capabilities**
- **Field Campaigns**
- **Modeling and Forecasting**
- **Research Partnerships**
- **R2X Transitions**

❖ **Discussion Sessions**
- **Stakeholders**
- **Cooperative Institute Directors**
- **Earlier Career Staff**
- **NOAA Line Office Representatives**

PSL Use-Inspired Research Themes
(Evaluate in terms of Quality, Relevance, Performance)

- **<u>Physical Science for Predicting Extremes</u>**: characterize and advance prediction of extreme weather and climate to improve forecasting.

- **<u>Physical Science for Water Resource Management</u>**: increase targeted observations, process understanding, and modeling capabilities to forecast hydrologic extremes (too much or too little water).

- **<u>Physical Science for Marine Resource Management</u>** increase targeted observations, process understanding and prediction of environmental conditions impacting marine resources.

PSL Phraseology Throughout the Review

Thank you for agreeing to serve as a member of the PSL five-year lab review panel.

We look forward to answering questions and clarifying our science during the sessions associated with each of the pre-recorded presentations.

Welcome to the rest of the PSL review.

Back up slides

PSL Experimental Web Pages &Tools

Tools for creating maps, time-series, correlations, Hovmollers, and other custom plots and analysis products for use in investigating weather, and climate

https://psl.noaa.gov/cgi-bin/data/getpage.pl
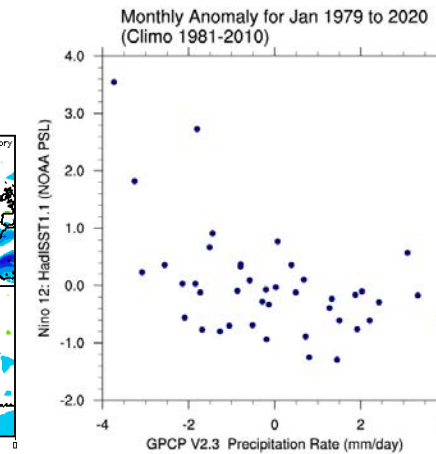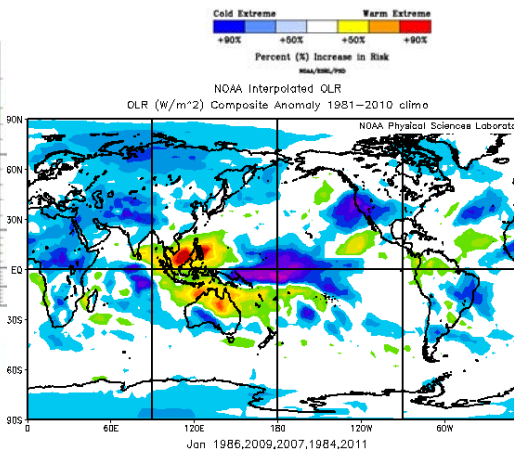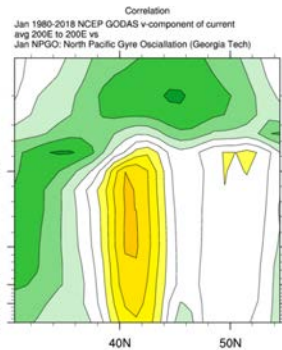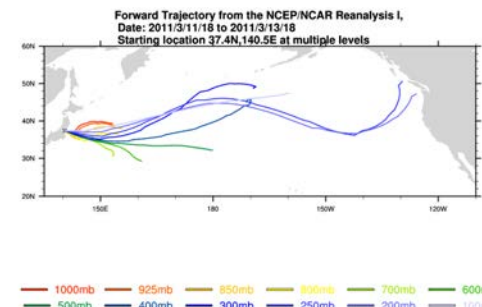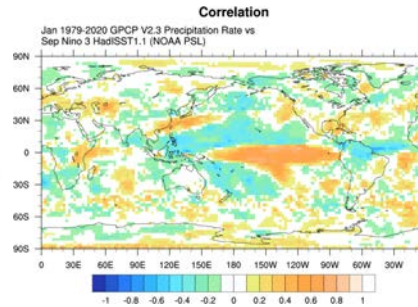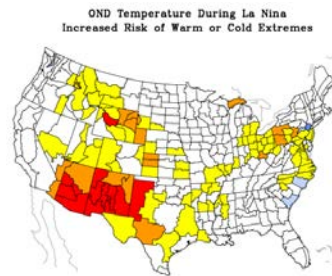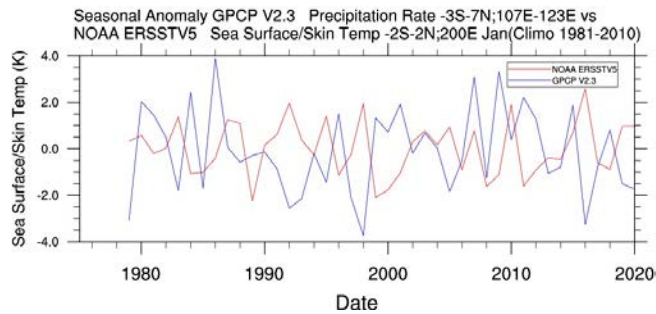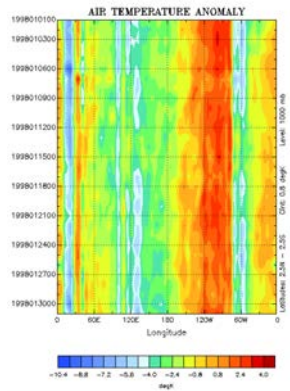
- **Since 1995**
- **30+ Tools**
- **Current, historic, and forecasts**
- **Timescales: Hourly to Centuries**
- **50+ Datasets**
- **50+ Time-series (PNA…)**
- **Regions: Arctic, Globe, US, Tropics**
- **Special Features: User uploads of dates and time-series, lead/lags, comparisons, distributions, composite events, tools specific to research projects**
- **5M custom plots a year**
- **10M pregenerated (for example maproom)**

The 20th Century Reanalysis (20CR) provides a global, 200-year history of sub-daily weather

by assimilating surface pressure observations into a modern NOAA weather model

20CRv3 weather, obs, and "fog of ignorance" (selected dates 1860—1952)

1860-03-01

https://vimeo.com/410322672
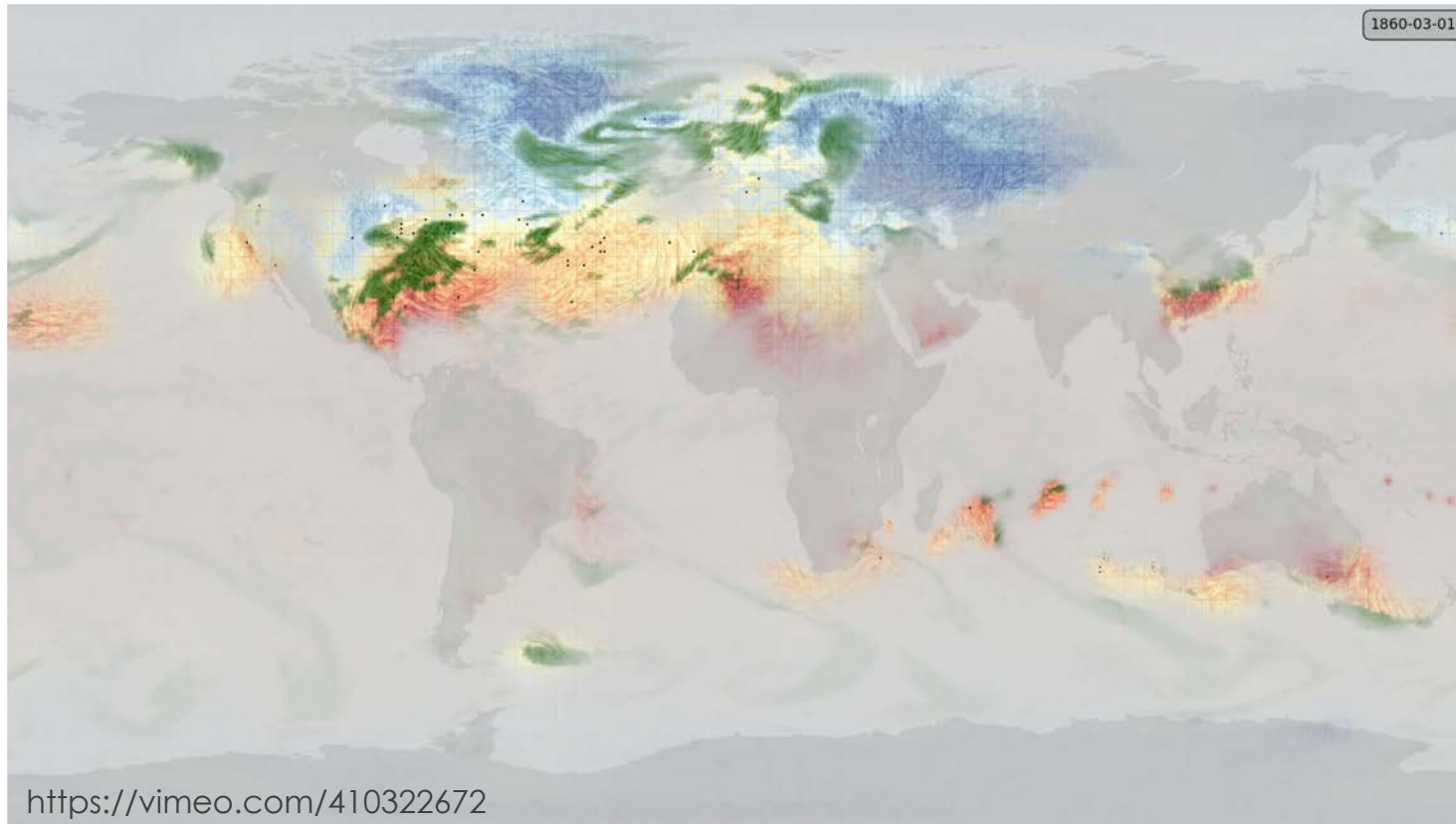
NOAA-CIRES-DOE 20th Century Reanalysis Version 3 facilitated by ACRE
- Global: 75km horizontal, 64 level grid
- 3-hourly resolution
- Spans 1836-2015 [1806-1835 experimental]
- Provides 80 estimates of temperature, wind, precipitation, pressure, humidity, & other variables, from the ground to the top of the atmosphere
- Used to, e.g., validate climate models and understand extreme weather and climate over the last 200 years.

https://go.usa.gov/XTd

Slivinski, Compo, Whitaker, Sardeshmukh, Giese, McColl, Allan, Yin, Vose, Titchner, Kennedy, et al,   QJRMS,   2019
Slivinski, Compo, Sardeshmukh, Whitaker, McColl, Allan, Brohan, Yin, Smith, Spencer, et al, J. Clim., submitted, 2020

FACTS: A Community Resource
_FA_cility for Weather and _C_limate Assessmen_TS_
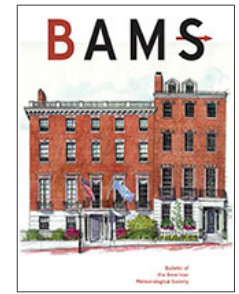
FACTS provides the science community with analysis tools; multimodel, multiforcing climate model ensembles; and observational/reanalysis datasets for addressing a wide class of problems on weather and climate variability and its causes.
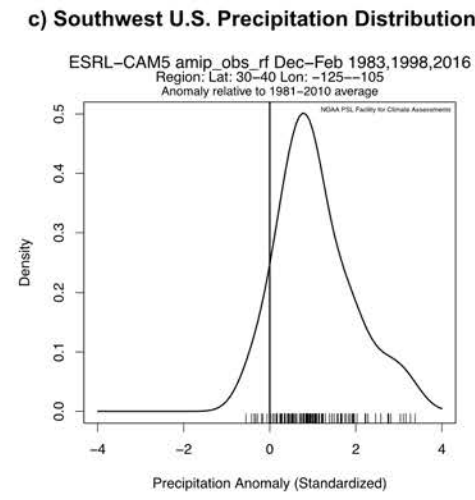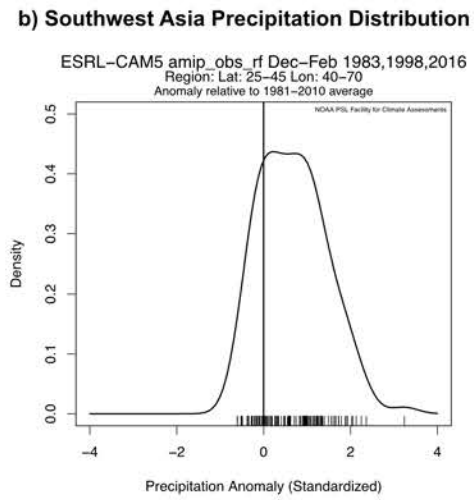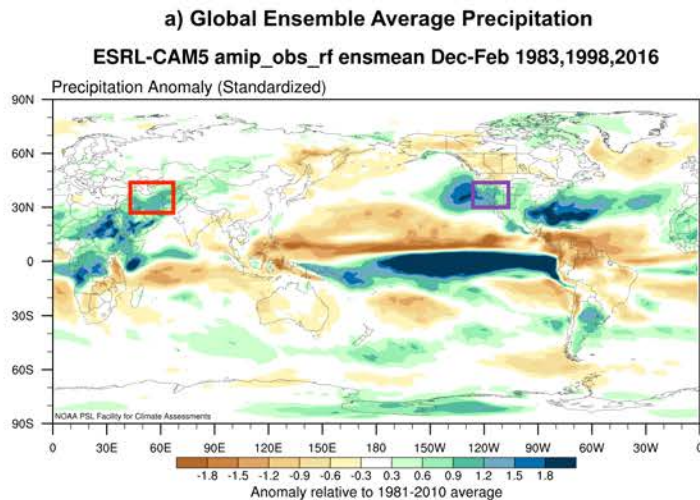
FACTS analysis and visualization of precipitation predictability related to strong El Niño events.

Atmospheric model data in FACTS shows that strong El Niño events are related to widespread precipitation anomalies.

Histograms generated in FACTS of historical model simulations show the statistical likelihood of anomalous rainfall over Southwest Asia and the Southwest U.S. during strong El Niños.

Murray, D., and Coauthors, 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.

GEFS v12 reanalyses and reforecasts

- PSL scientists worked closely with colleagues at the Environmental Modeling Center on many improvements in the recently implemented Global Ensemble Forecast System (GEFS) version 12.

- PSL adapted modern stochastic physics so that the resulting ensemble now has increased spread and somewhat reduced mean error, i.e., the ensemble provides more realistic probabilistic forecasts. /index.html

- PSL produced the 20-year reanalysis and worked with EMC on the associated reforecasts.

  - Reanalysis produced with the hybrid ensemble variational system used in current operations.   It largely replaces the decade-old CFSv2 reanalysis.

  - Reforecasts are computed every day to 16 days lead, once weekly to +35 days lead.   Data are publicly available of NOAA's Big-Data Project at Amazon Web Services, https://noaa-gefs-retrospective.s3.amazonaws.com/index.html

Examples of experimental products & services