PSL Field Campaigns




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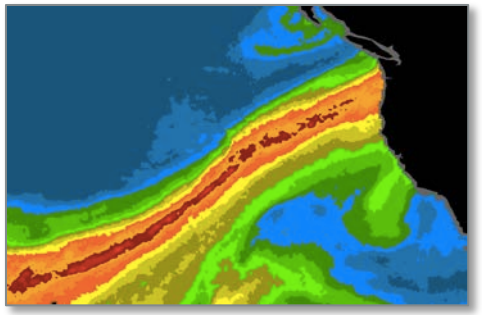
Subject Matter Experts: Leslie Hartten, Matthew Shupe, Elizabeth Thompson, James Wilczak

NOAA Physical Sciences Laboratory Review
November 16-20, 2020

Fields Campaigns Targeted, intensive observation periods that provide measurements to improve our understanding of the physics for Wx & Climate Modeling & Forecasts ***…across all 3 themes***

- **Coupled observations to reveal interdependencies/interactions**

- **Observations to compare with models, assess data assimilation impacts, validation/verification & parameterization assessment**

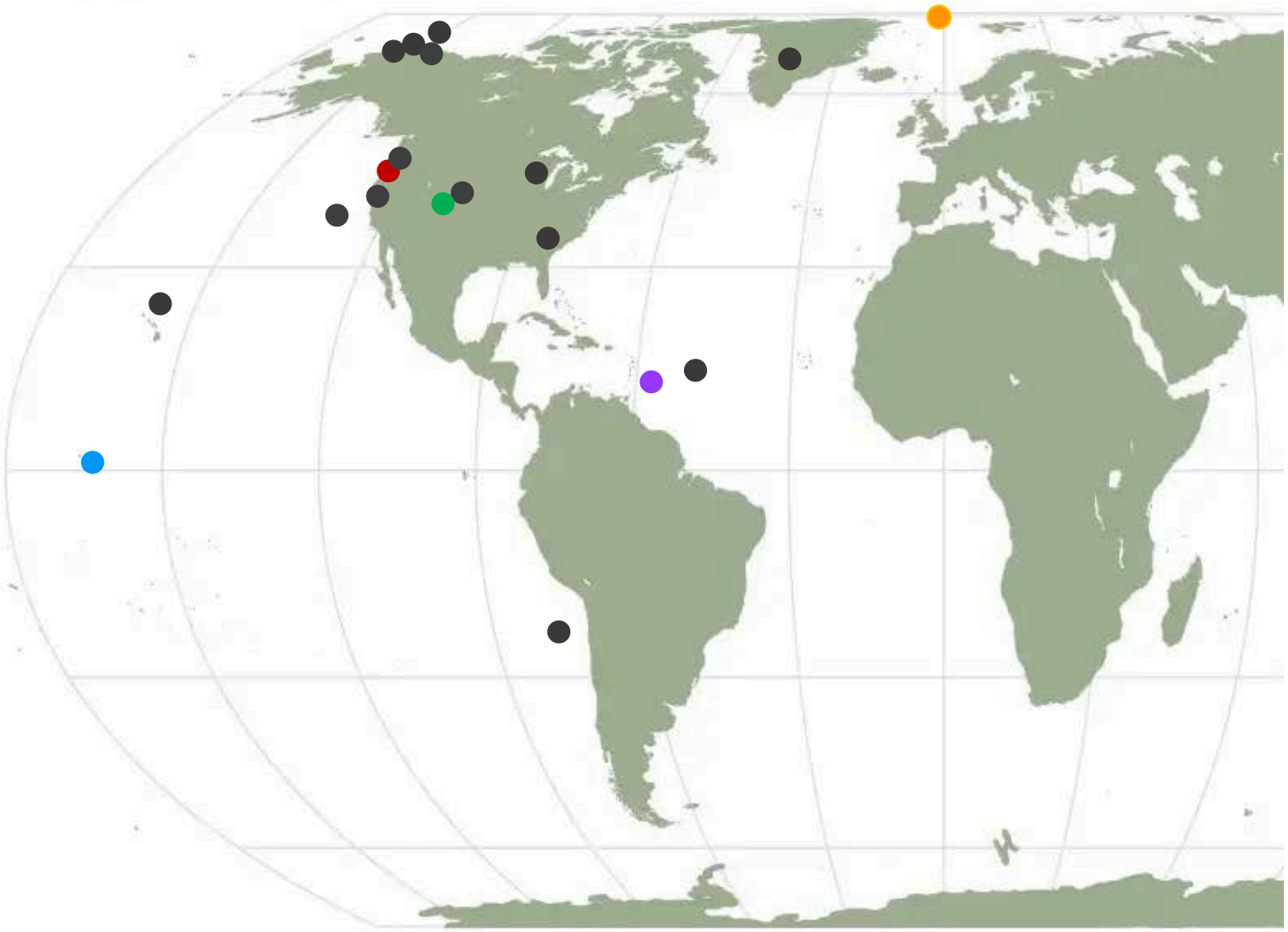


- **Focused observations for understanding specific processes &/or regional forecast needs**

PSL Expertise spans across the campaign enterprise

- Work w/our partners & employ lab-wide expertise to address a science need
- Leaders in developing the science Q's; campaign strategy; deployment design
- Campaign implementation to field & platform leads
- Leaders in Observations-Model synergies
  - ***NRT forecasting for campaign support & model skill assessment***
  - ***NRT model validation/verification, data assimilation***

Where in the world?



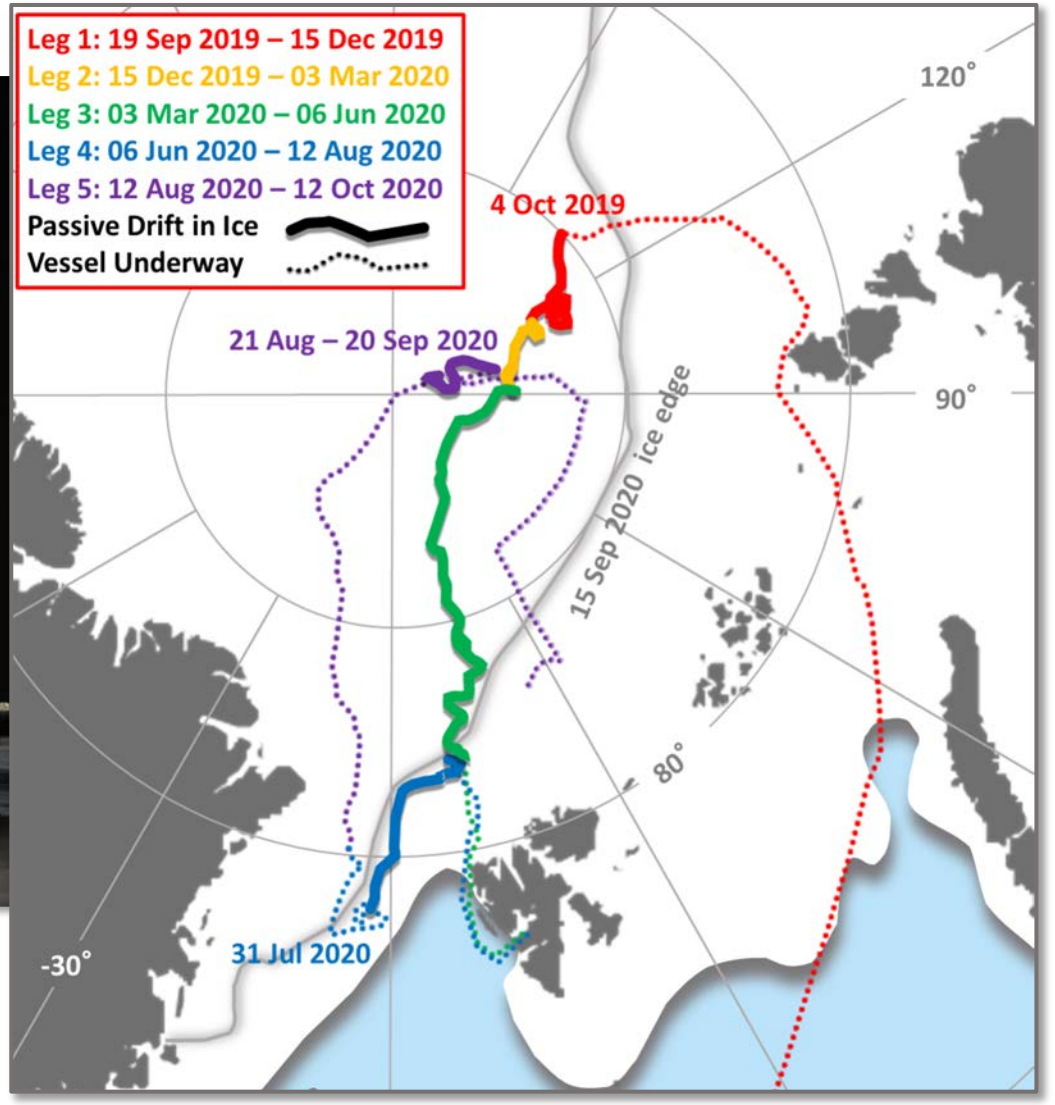
The Arctic System
MOSAiC

Hydrometeorology
ENRR

Winds & BL
WFIP2
LAPSE-RATE

Air-Sea Interaction
ATOMIC

MOSAiC Multidisciplinary drifting Observatory for the Study of Arctic Climate

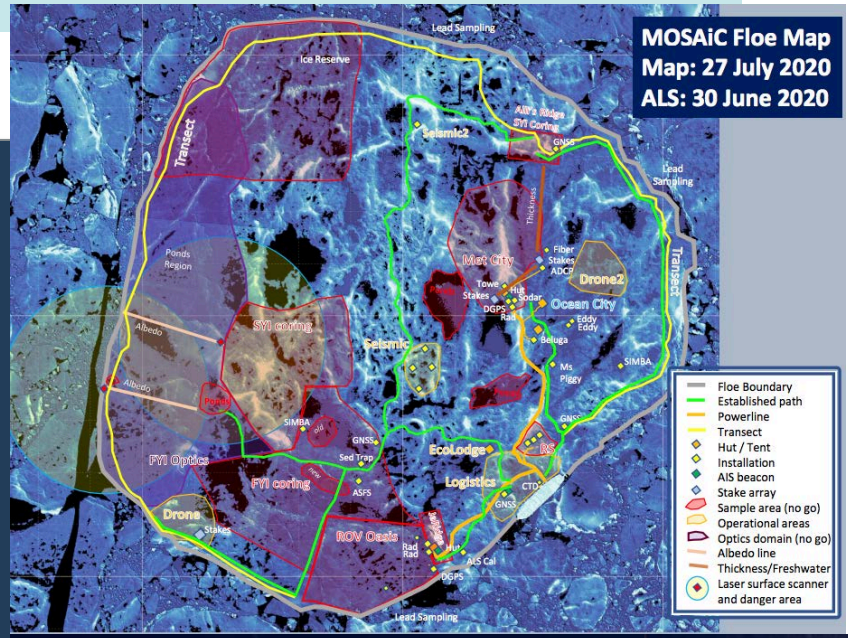


19 Sept 2019 – 12 Oct 2020
20 Nations >60 Institutions >400 field participants

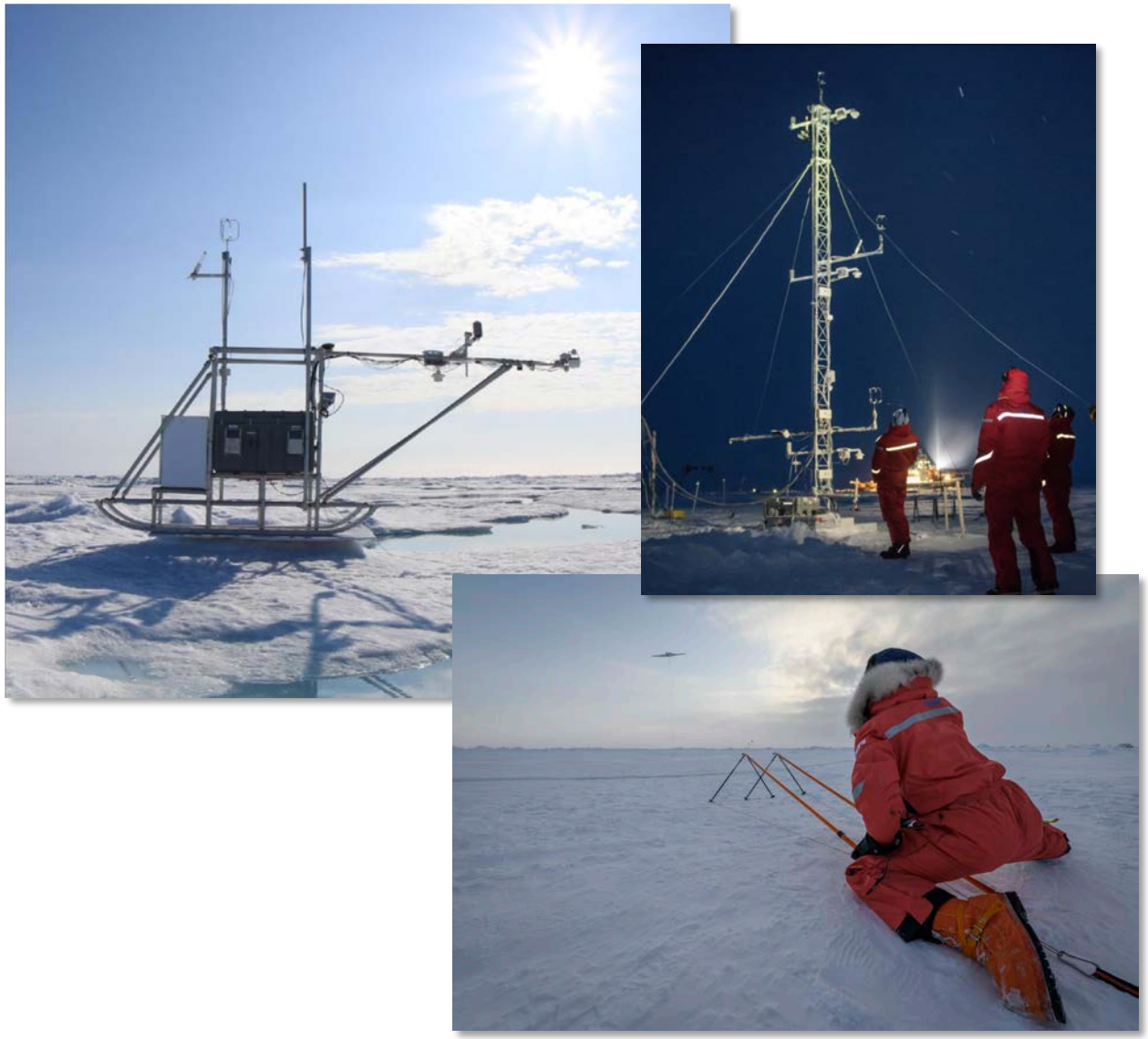
MOSAiC Science Goal

What are the Causes and Consequences of an Evolving and Diminished Arctic Sea-Ice Cover?

Advance the understanding of coupled climate processes in the Central Arctic to more accurately integrate them into regional & global climate models.



MOSAiC PSL Roles



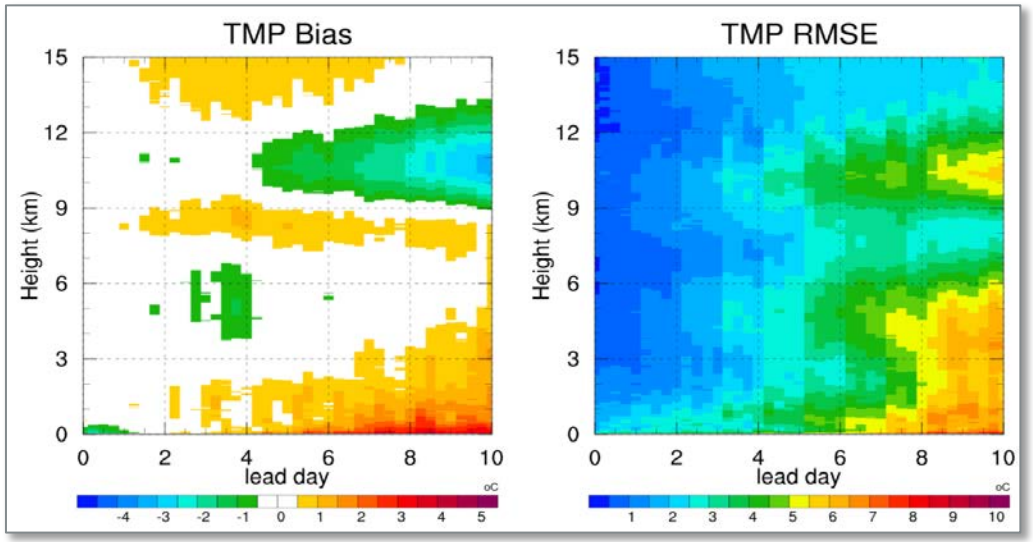
- **Campaign Leadership** Co-Lead w/AWI
- **Field Leadership** Expedition Co-Lead, Atmosphere Team Leads
- **Projects** (NSF & DOE)
  - Thermodynamic & Dynamic Drivers of Sea Ice
  - Surface-Atmosphere Gas Exchange & Ozone
  - UAS Observations of the Atmosphere & Surface
  - Atmospheric Drivers of the Arctic Energy Budget
- **Technologies:** ASFS, UAS, Gas Flux Chambers, etc.
- **Modeling**
  - Forecasts for camp & supply vessels
  - Assessment of Operational Models via WMO Polar Prediction Project
  - NRT Model Verification and Model Intercomparisons
- **On-Ice & Logistics Support** Sept'19-Oct '20
- **US Outreach & Communications** w/CIRES

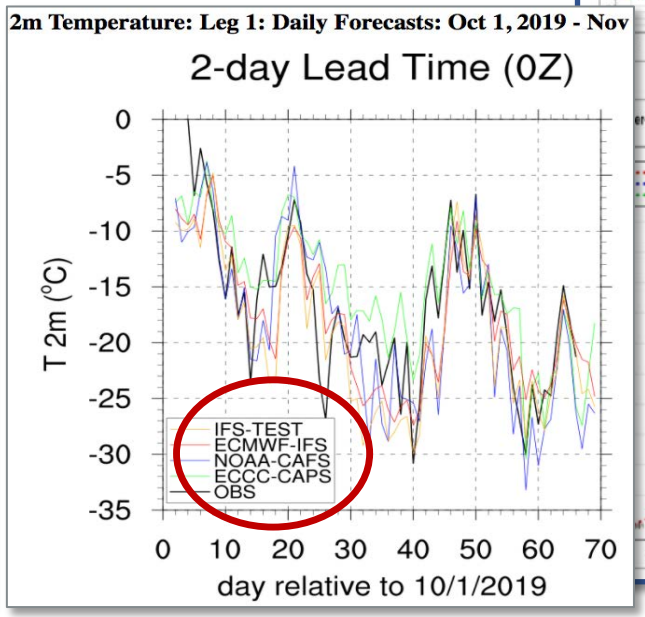
MOSAiC Science

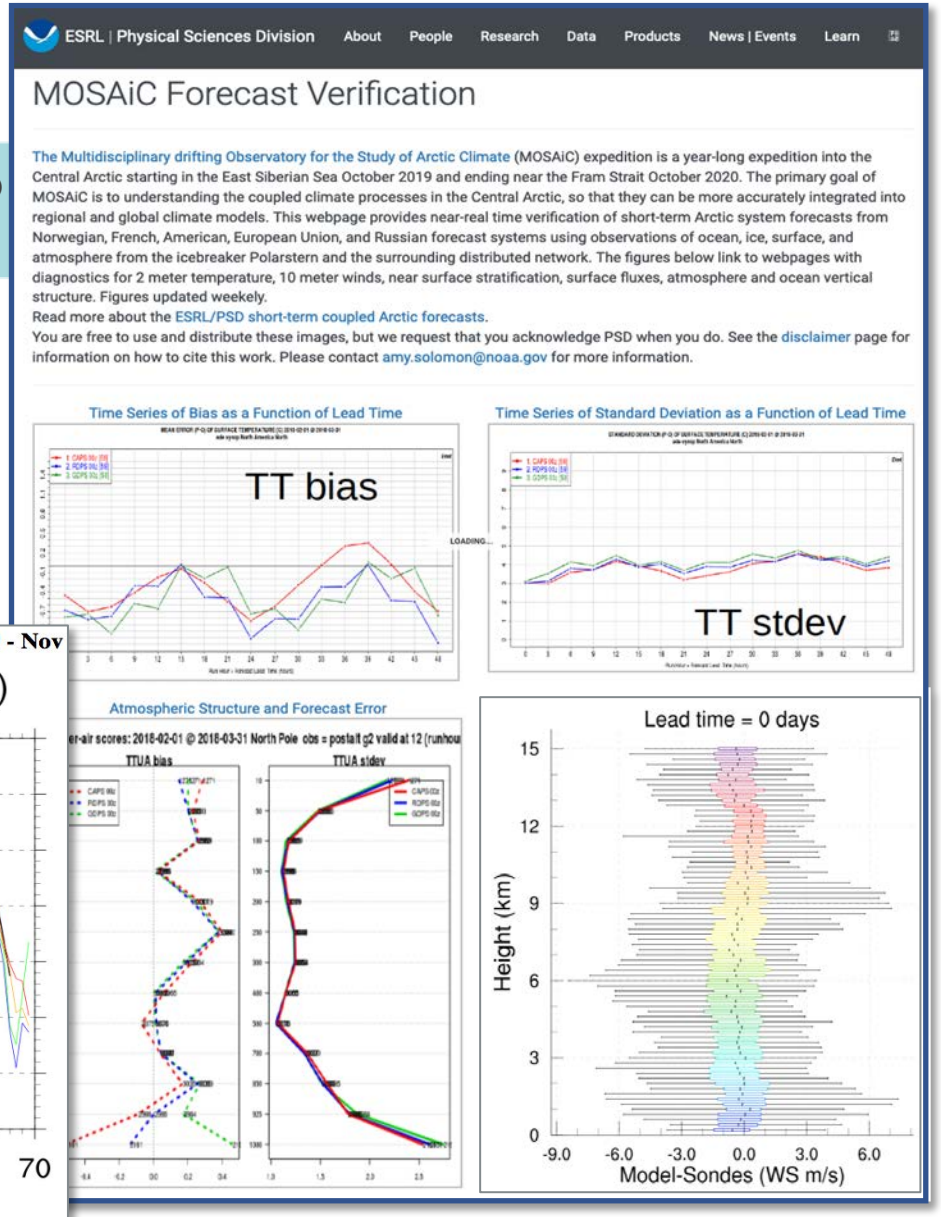
MOSAiC Near Real-Time Verification Project - Using observations to improve the simulation of coupled processes unique to the Arctic

Using short-term forecasts to identify potential errors in the representation of "fast" processes that cause biases in climate model projections of Arctic climate change

Intercomparing modeling center forecasts





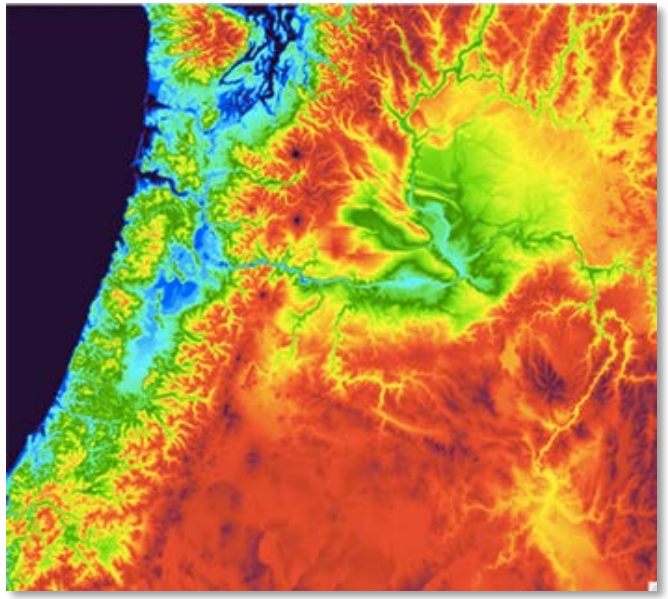


WFIP2 Second Wind Forecast Improvement Project

A joint DOE, NOAA, Vaisala, & University partnership
18-month field deployment focusing on the Columbia River Gorge & Columbia Basin in eastern OR & WA (2015-2017)

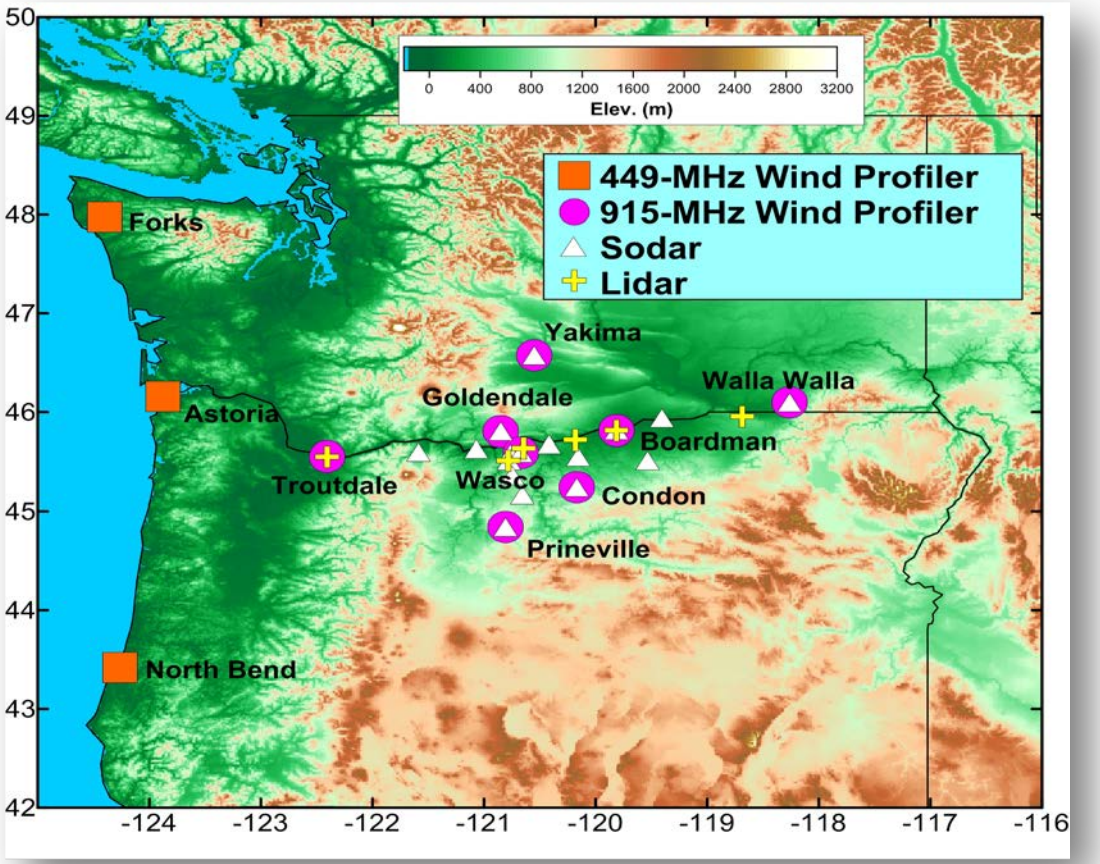
PSL Science Goal

Reduce the cost of integrating wind energy onto the electric grid by improving short-term wind forecast skill for turbine-height winds in regions with complex terrain.



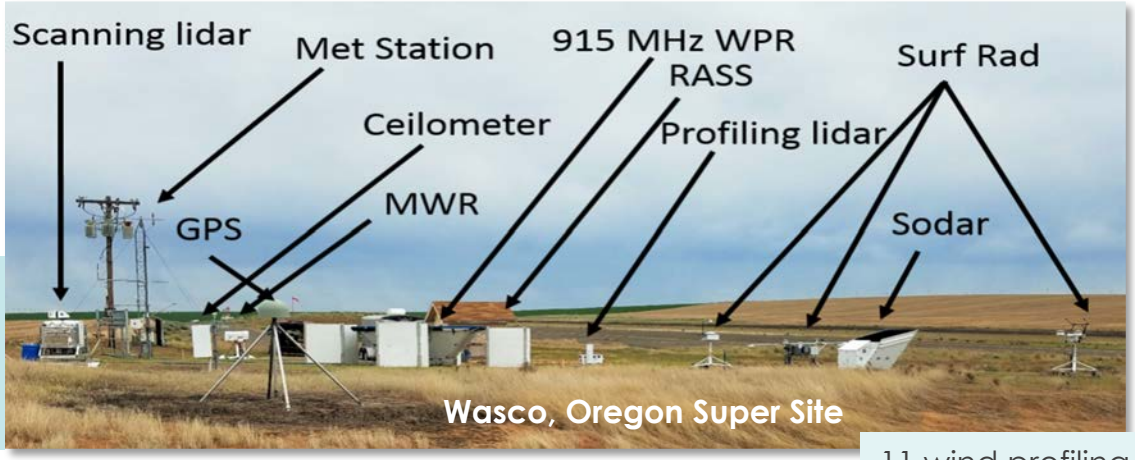
WFIP2 PSL Lead Roles

- Development of observational field campaign strategy
- Deployment & monitoring of instrumentation
- Measuring the impact of additional measurements on NWP skill
- Evaluation of HRRR & RAP models through development of the RT model evaluation tool

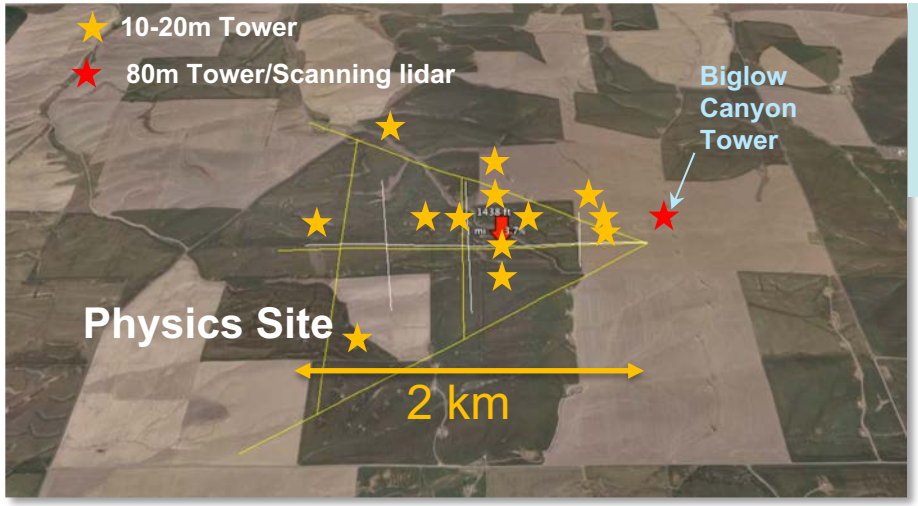


WFIP2 PSL Multi-Scale Observations

Instruments deployed to understand the meteorological dynamics across a variety of scales that impact wind energy productions



Super-site observations to help unravel the complex meteorological dynamics on the larger mesoscale



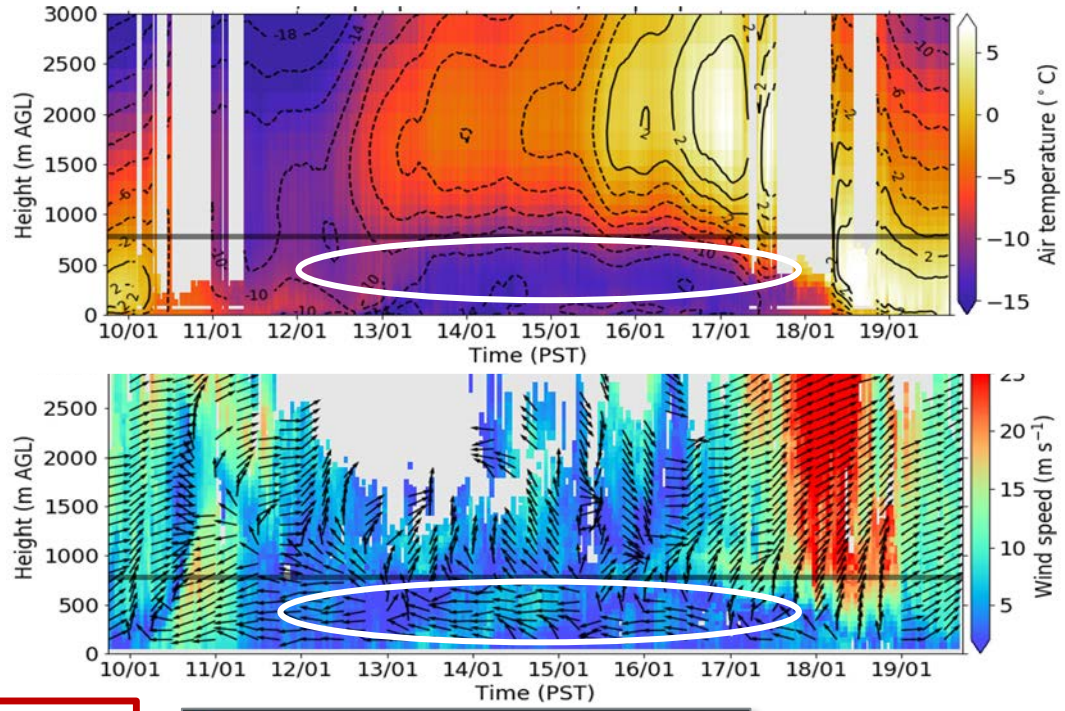
"Physics Site" obs to get down to a single model grid cell scale

11 wind profiling radars w/RASS
17 sodars
5 wind profiling lidars
5 scanning lidars
4 mw radiometers
10 microbarographs
1 Ceilometer
28 sonic anemometers
5 radiative flux systems
4 soil moisture sites
~200 radiosonde
Wind plant data from 14 wind plants (1,569 turbines)

WFIP2 Forecast Solutions

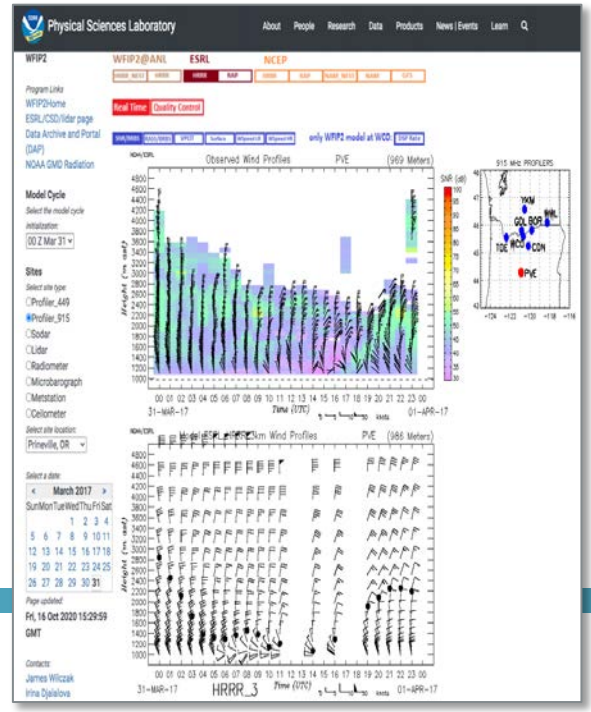
Obs revealed 3 meteorological events most affecting wind energy

- *Gap flows*
- *Mountain waves & wakes*
- *Cold pools*



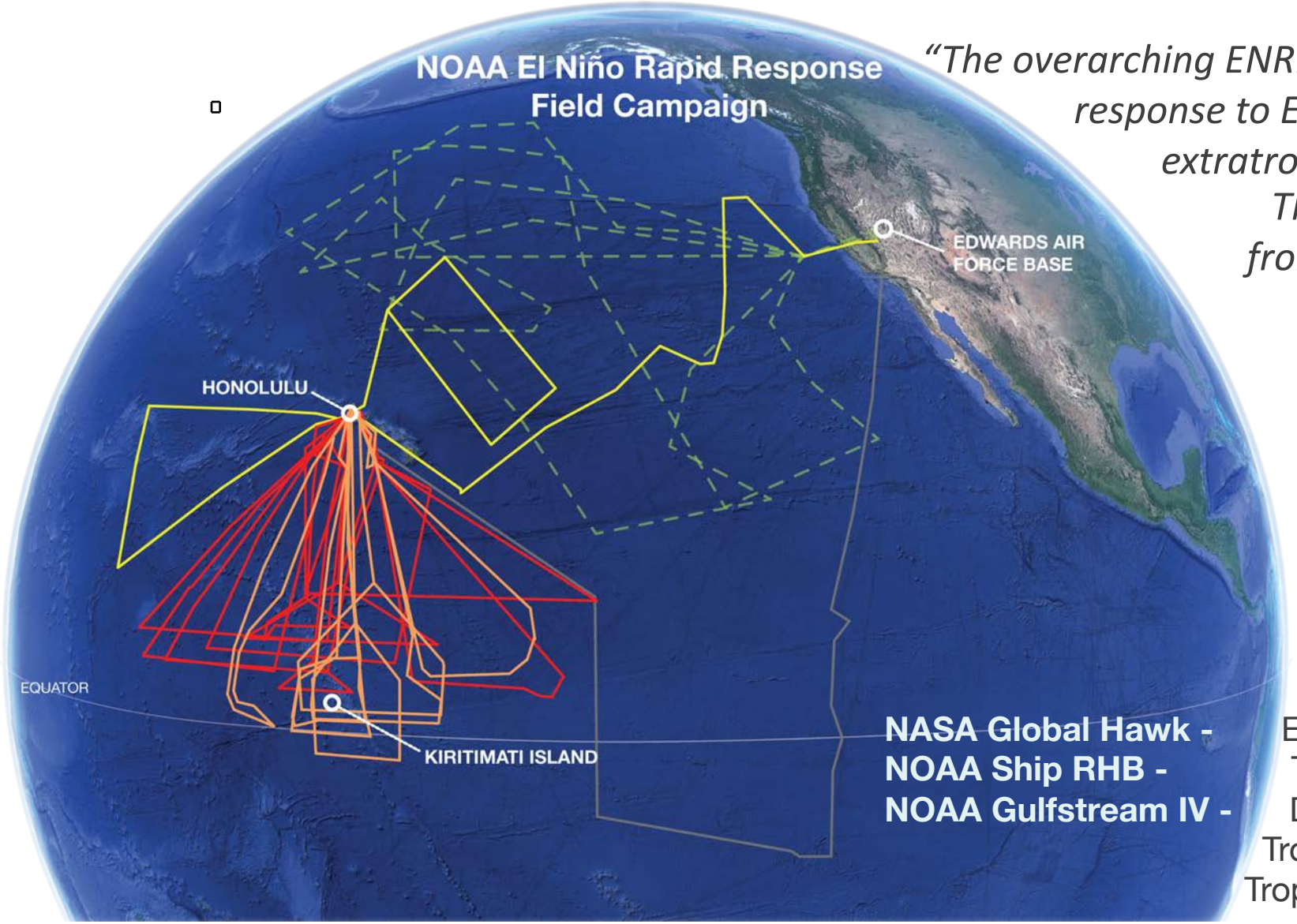
PSL's observation-based model verification web page revealed biases in the HRRR

Based on this information, GSL made a correction to the HRRR PBL scheme to better match the obs, then tested the revised parameterization nationally to confirm the improvement for the WFIP2 domain would not degrade performance elsewhere.



Images: Joe Olson

ENRR El Niño Rapid Response 21 January - 28 March 2016



"The overarching ENRR goal was to determine the atmospheric response to El Niño and the implications for predicting extratropical storms and U.S. West Coast rainfall. The field campaign observations extended from the central tropical Pacific to the West Coast, with a primary focus on the initial tropical atmospheric response that links El Niño to its global impacts."

Dole et al. 2018

ENRR Approach

Rapid Response Deploy to observe the biggest climate-weather system player in RT rather than watching it develop with the moored array

Targeted high-resolution observations using the planes & ships to obtain targeted measurements at smaller scales needed to understand the development & intensity of a growing El Nino.

- tropical convective heating, divergent flow
- effects on subtropical jet & extratropical storm activity

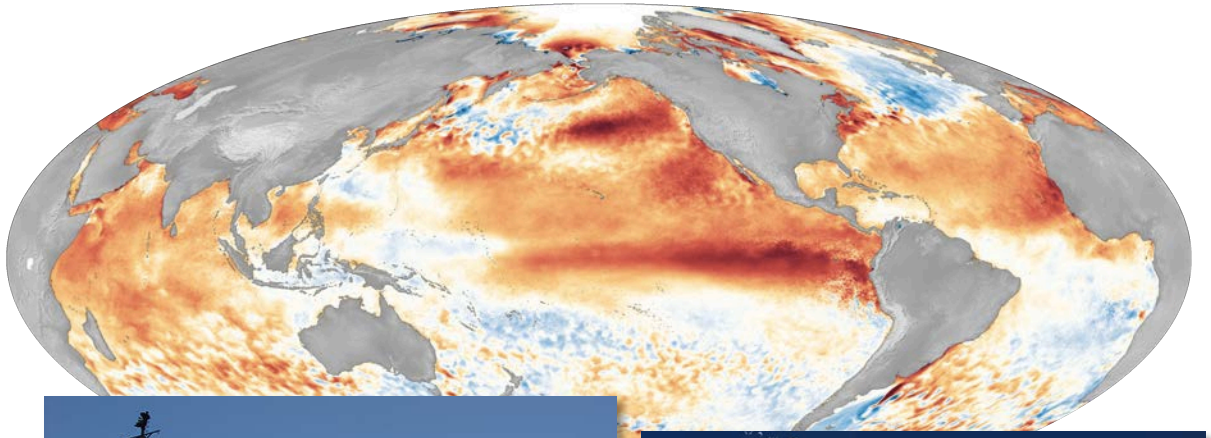
RT availability of obs for global forecast models

Assessed forecast system sensitivities

- uncertainties in model physics
- data assimilation impacts

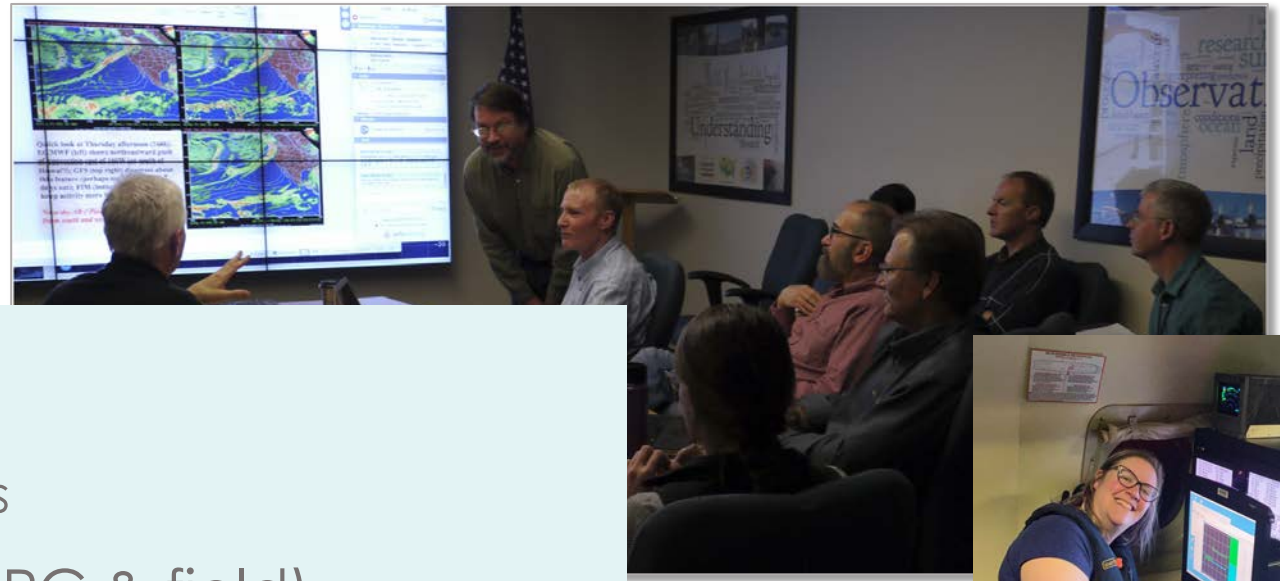
Evaluate satellite retrievals

Increase NOAA's situational awareness & early warning capabilities

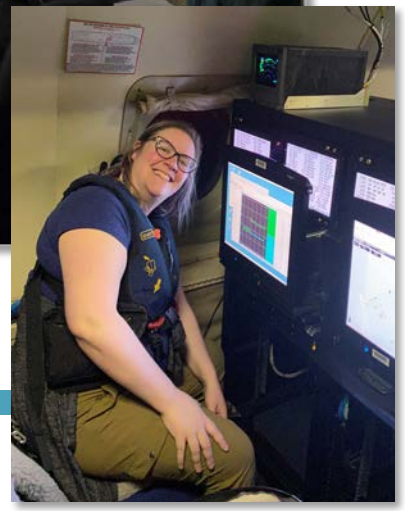


ENRR PSL Roles

- Proposed, planned, & led the campaign
- Provided surface-based instrumentation & most field staff
- Hosted & staffed DWBs for flight planning
- Transferred observations to GTS
- QC'd & published multiple data sets



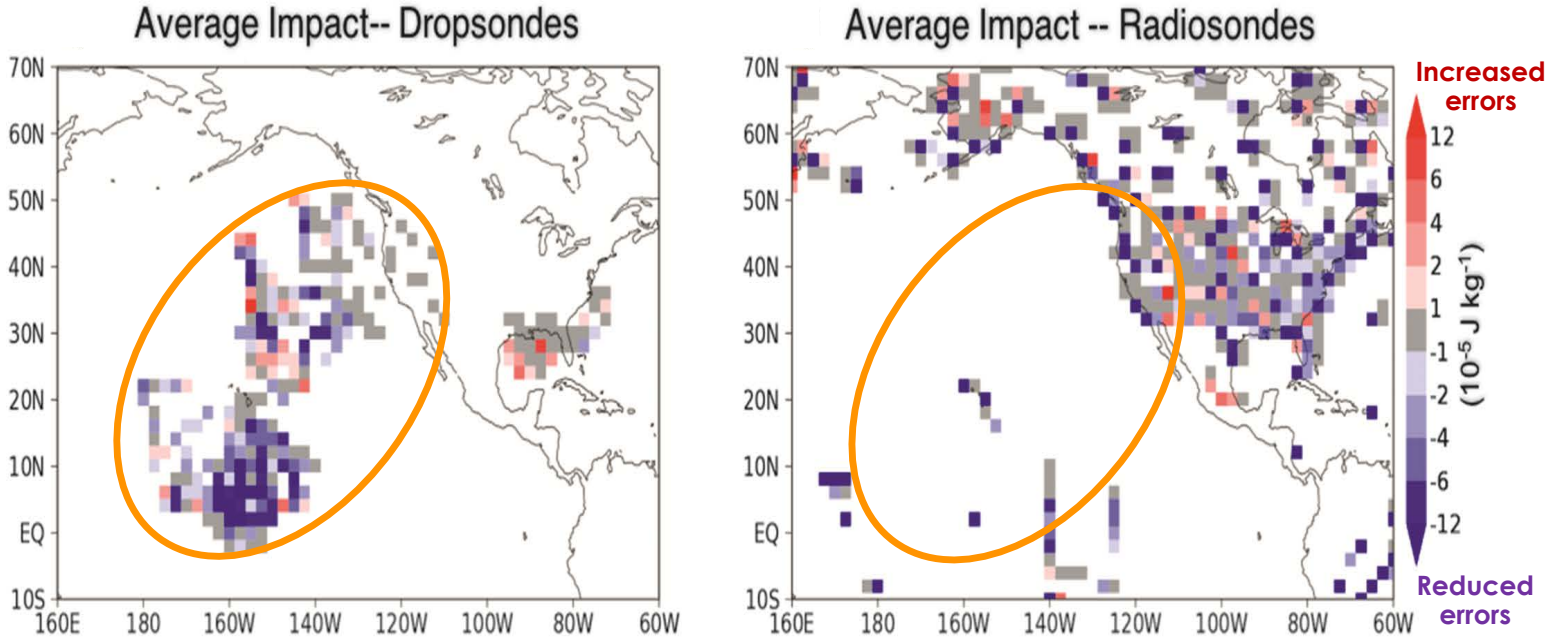
- Incorporated education & outreach
  - Blog posts from both DSRC & the field
  - Kiritimati Island residents, visiting scientists
- Achieved PSL-wide participation (DSRC & field)
  - Admin staff; Engineers; IT specialists; Modelers & Observers



ENRR Improved analyses locally

"assimilating ENRR observations led to stronger outflow associated with 200-hPa divergence from the deep tropics region of the Pacific Ocean, particularly when flights entered that area."

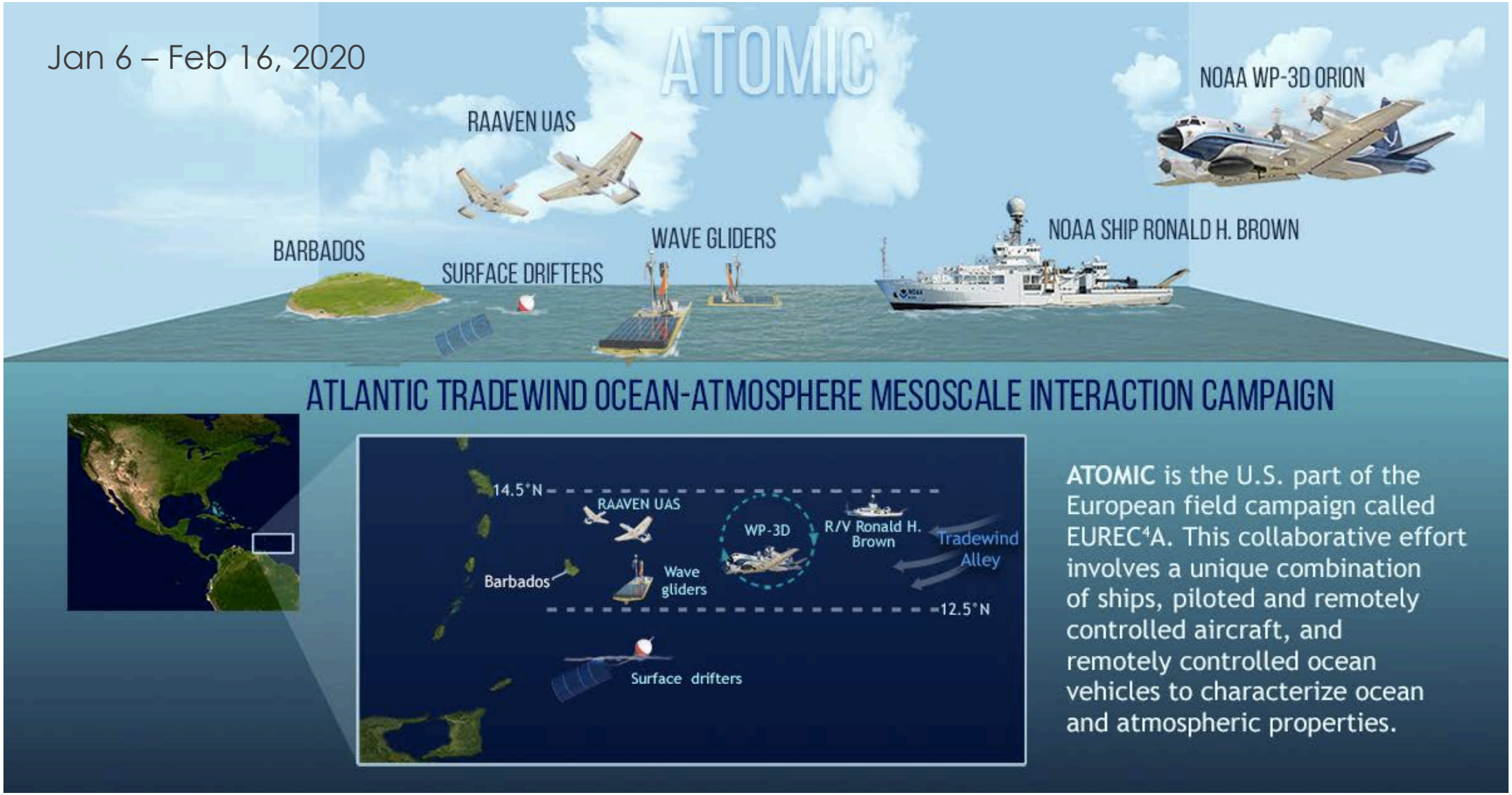
"assimilating ENRR observations pulled the analysis fields closer to the observations…. suggest[ing] that these observations were not redundant within the existing observation network, despite the dense satellite & aircraft cover-age of some variables throughout many levels of the troposphere"



Net impact of ENRR G-IV dropsonde observations (20 Jan–16 Mar 2016, 20°N – 20°S) on NASA GEOS model 24-h 00 UTC forecasts of global moist energy

(Slivinski et al. 2019)

ATOMIC Atlantic Tradewind Ocean-Atmosphere Mesoscale Interaction Campaign



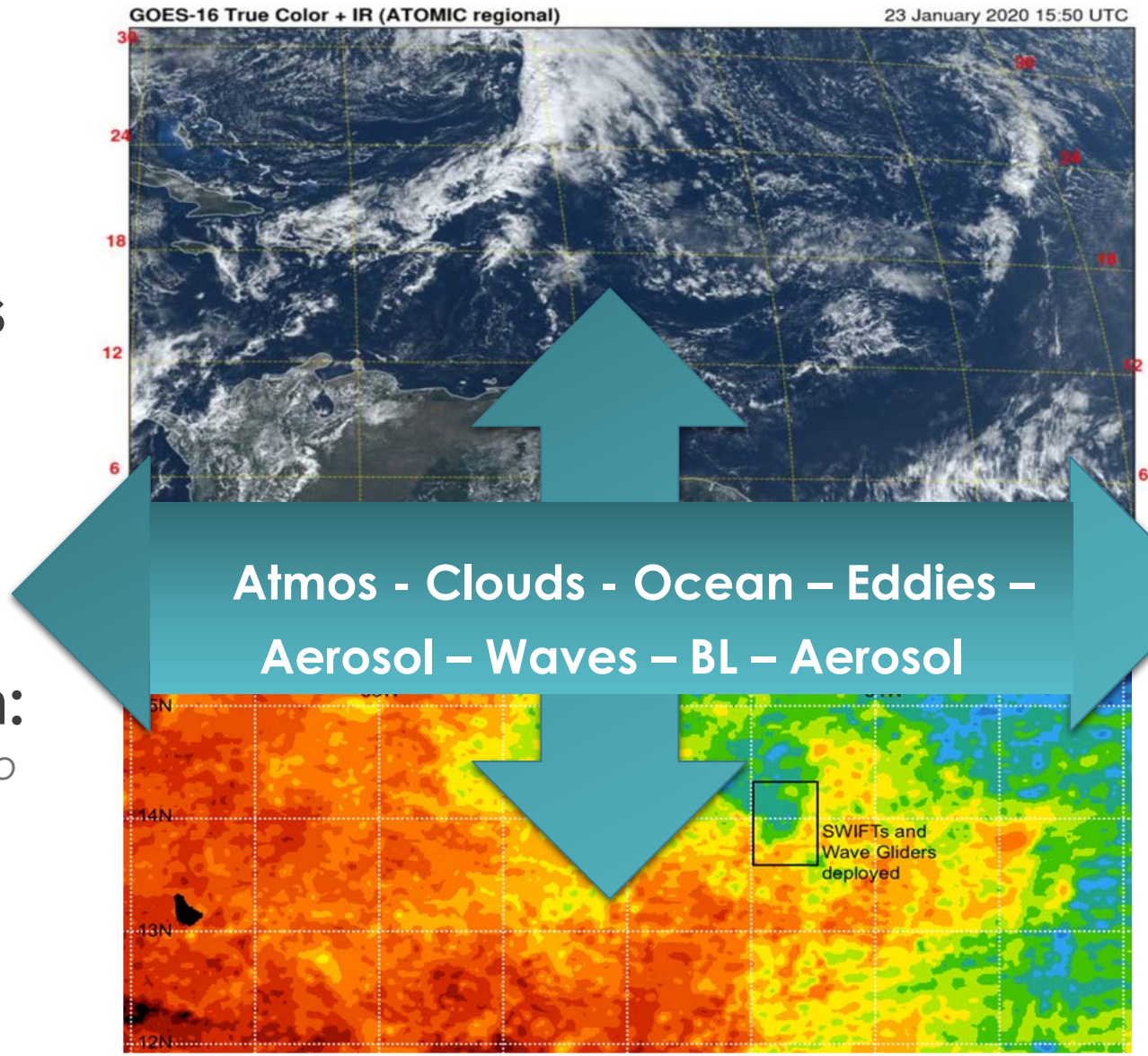
ATOMIC Science Goals

Measure properties of atmosphere, ocean, & air-sea interface across ocean eddies as they evolve in this unique region

Understand physical mechanisms responsible for feedbacks between:

… on scales ranging from turbulence to regional to sub-seasonal

… throughout time & across space



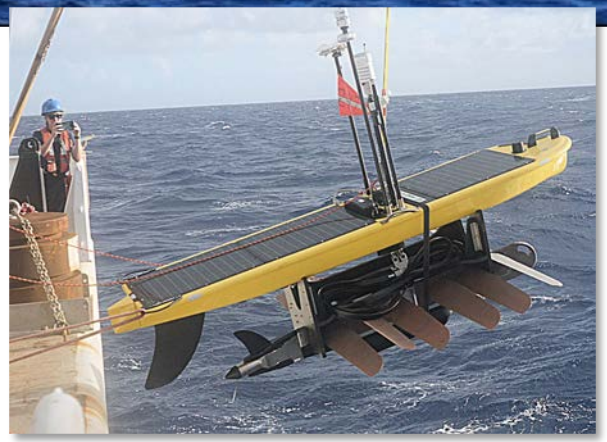
ATOMIC PSL's Roles

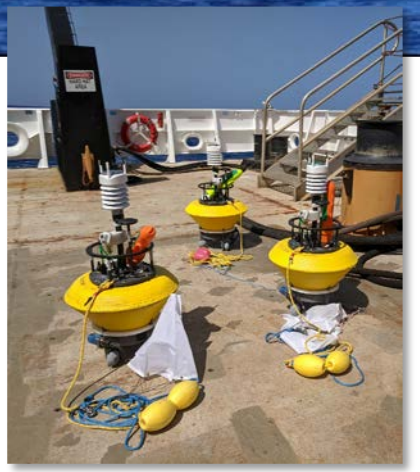
NOAA R/V Ronald H. Brown - 35-day cruise
- Air-sea fluxes, radar, 6x daily balloons
- 6 SWIFTs drifters: 21 days each
- 2 Wavegliders: 30 & 34 days each

NOAA P3 - 11 mission flights:
- 320 Dropsondes / 185 AXBTs
- Radars, cloud probes, etc.

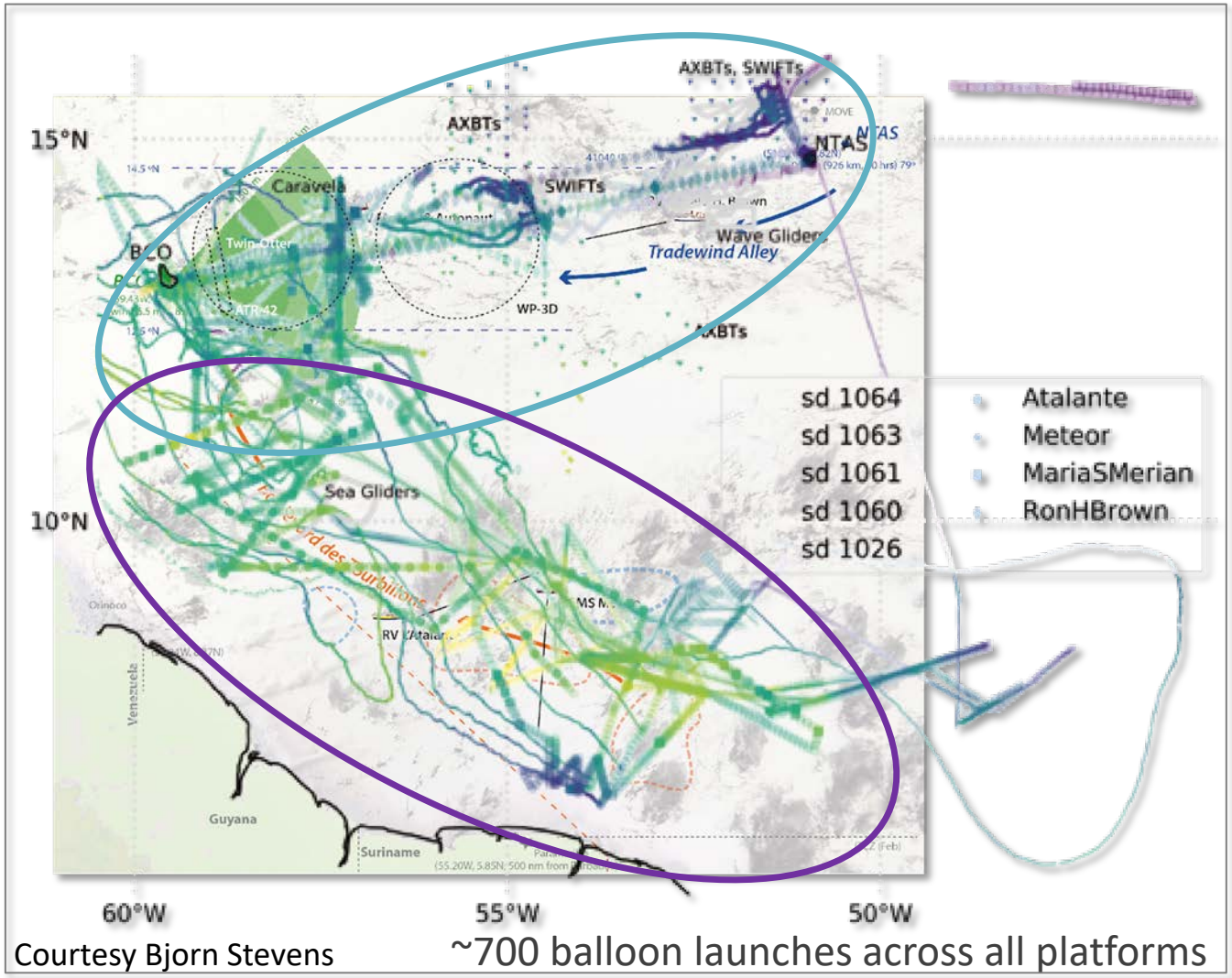
UAS - 39 flights:
- 77+ flight hours

Forecast Support/Model Eval



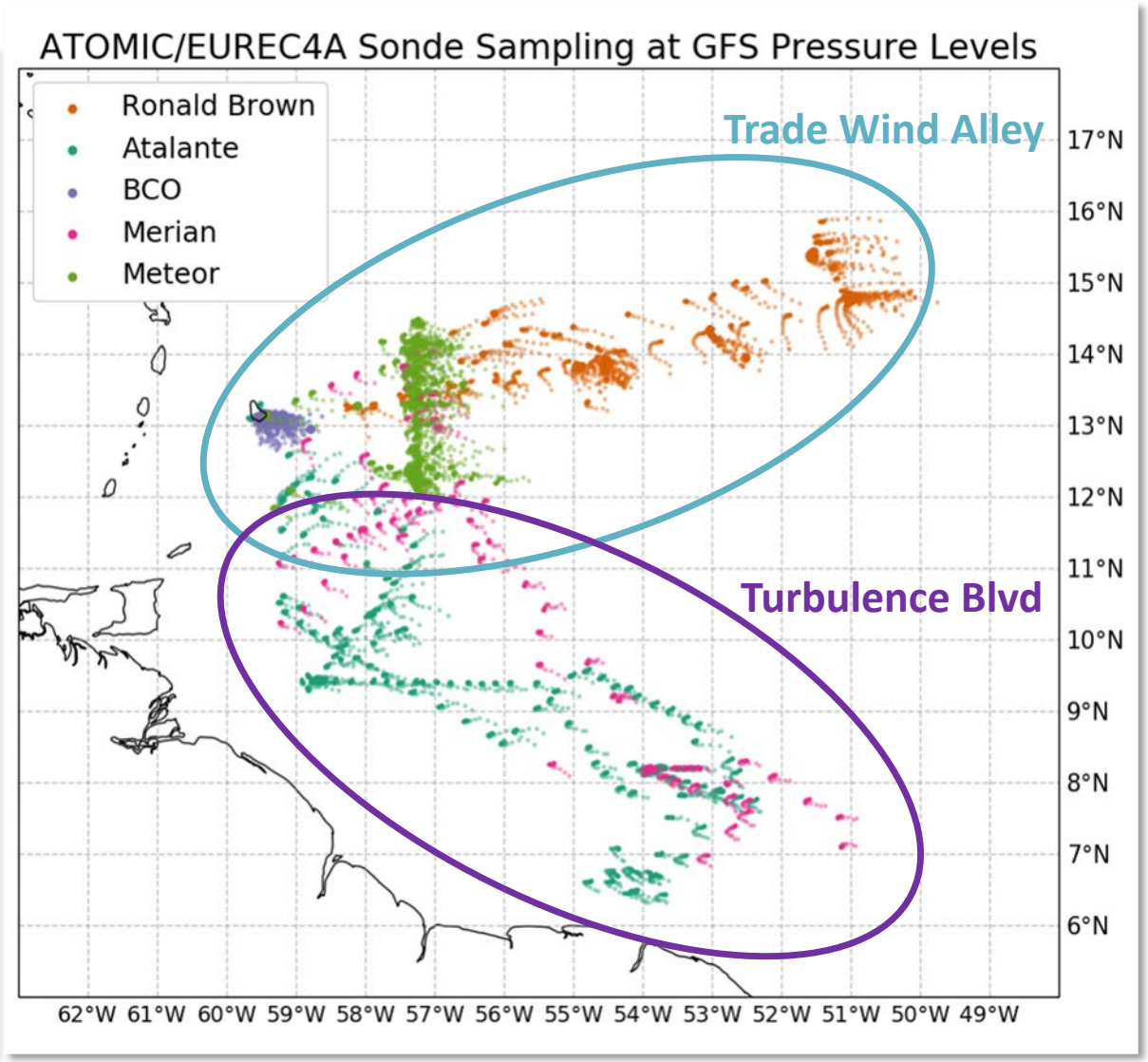


EUREC4A & ATOMIC Strength in numbers

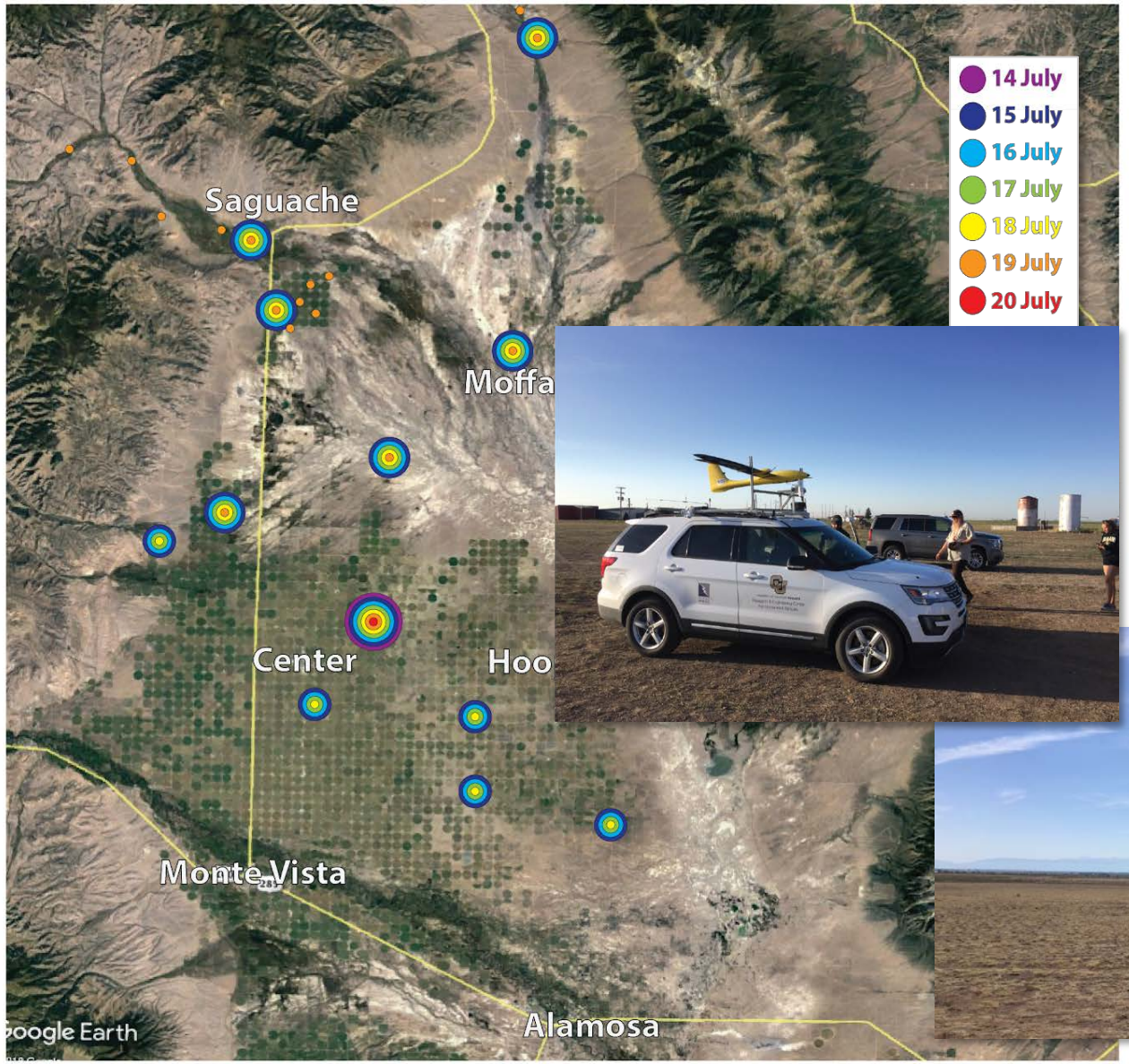


Courtesy Bjorn Stevens

~700 balloon launches across all platforms



LAPSE-RATE Lower Atmospheric Profiling Studies at Elevation – a Remotely-piloted Aircraft Team Exp



July 2018 San Luis Valley, CO

>100 people / 50 aircraft / 1 community day

1287 UAS flights … 262.4 flight hours!

25 radiosondes launched
5 mobile mesonets
Met stations
Modeling & forecast teams

LAPSE-RATE Science Goals

Experiment design allowed for UAS intercomparison + science

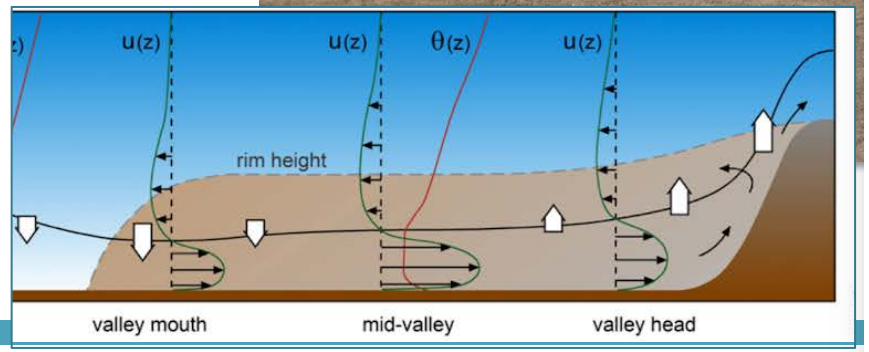
Platform & sensor intercomparison

Valley drainage flows & BL physics

Convective initiation

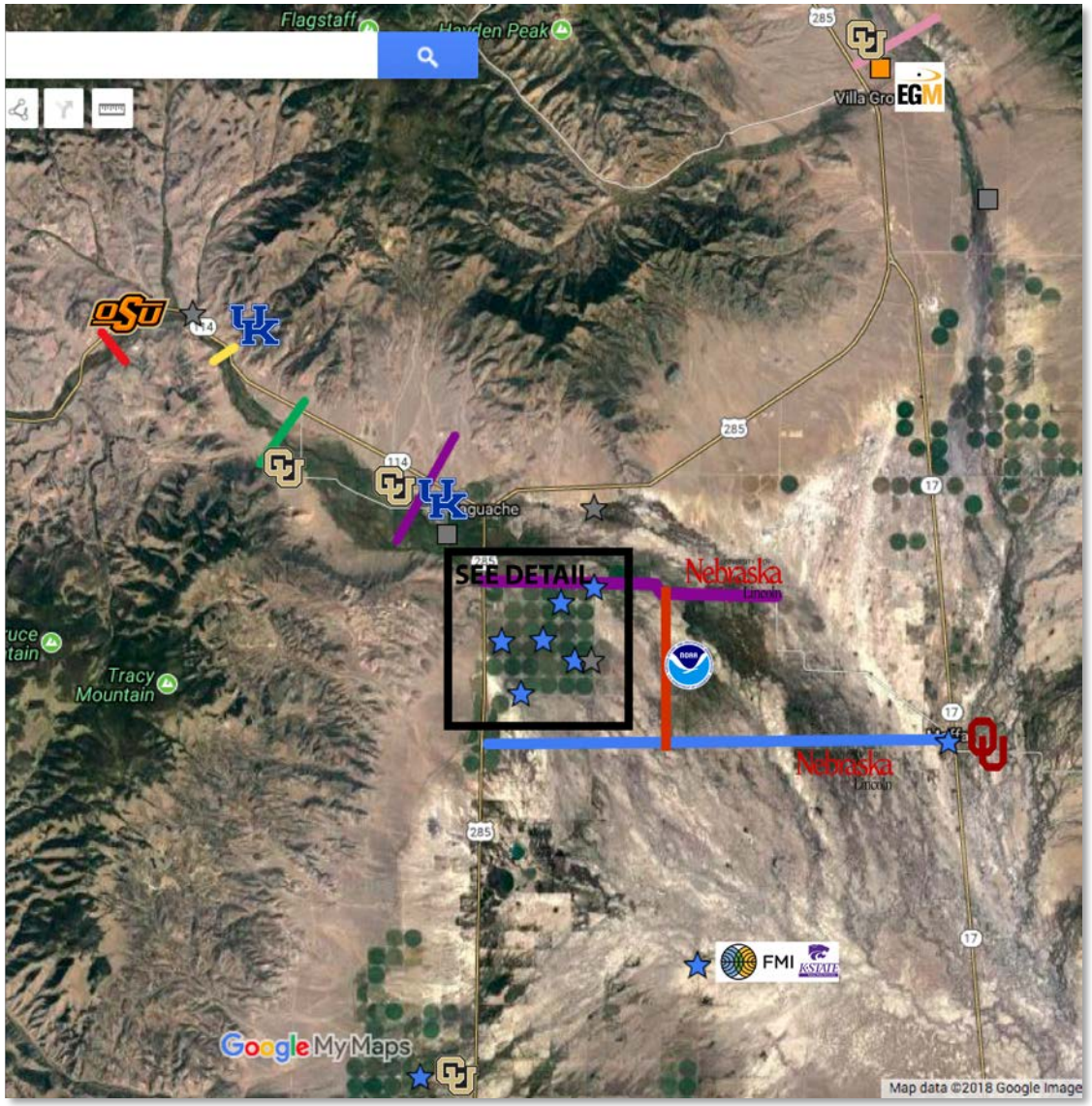
Aerosol processes

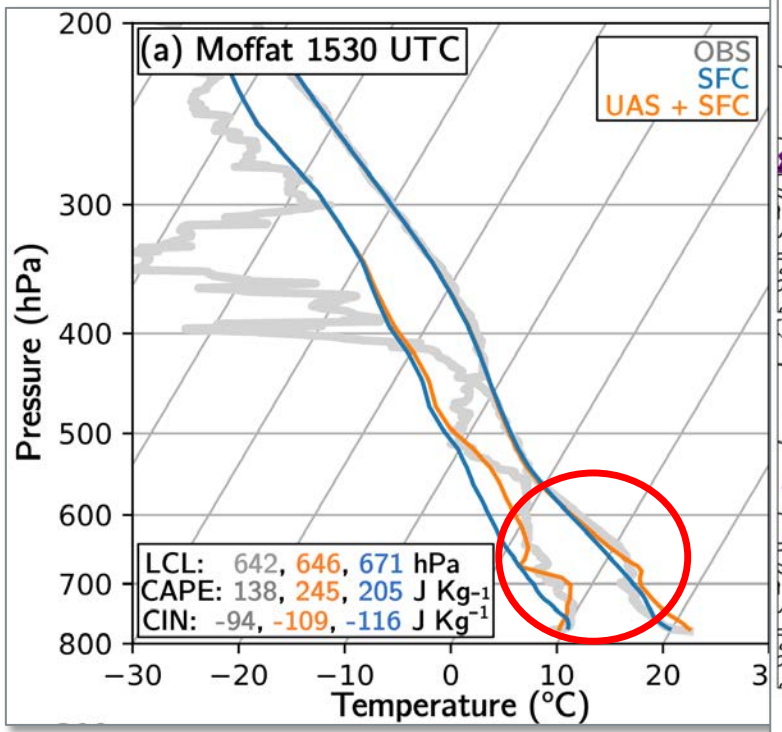
UAS model DA evaluation

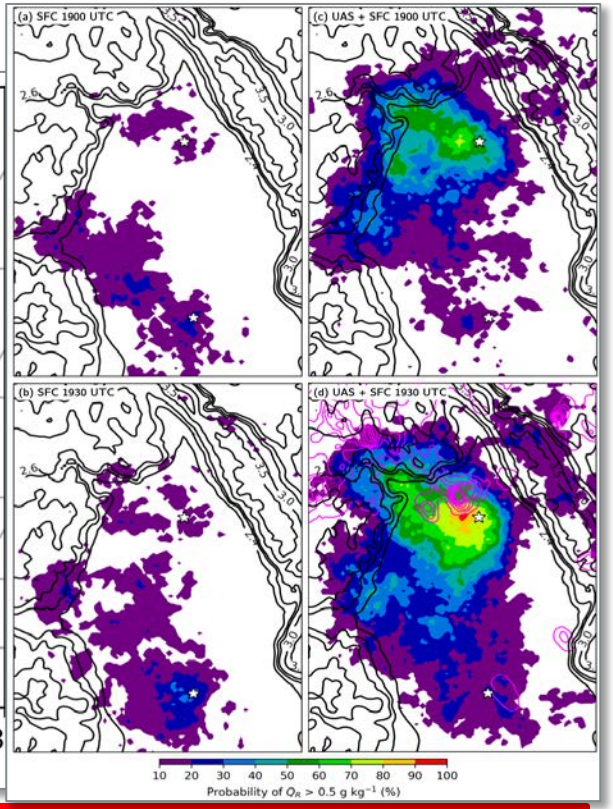


LAPSE-RATE PSL's Roles

LAPSE-RATE Science







UAS obs assimilated into a high-resolution configuration of WRF using enKF improved the representation of the pre-convective moisture profiles. UAS also captured strong outflows that triggered CI in the center of the valley, close to where it was observed. These outflows and subsequent CI were not well-captured in the simulation using only conventional surface observations.

Future Campaigns

Arctic

(AC)3 – Arctic Clouds

Winds

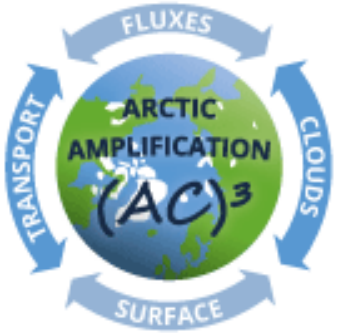
AWAKEN – Wake Experiment
WFIP3 - Off-shore Wind Energy

Air- Sea Interactions

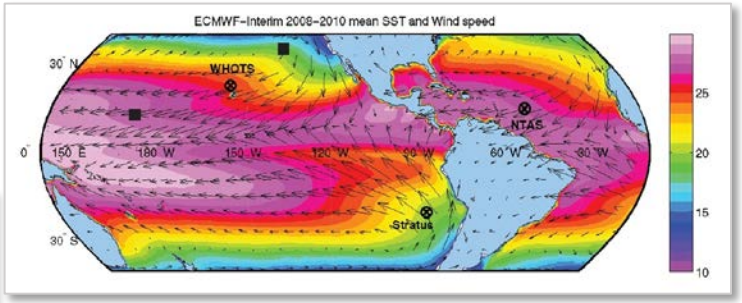
Flux Reference Cruises
CLEAR – FL Remote Sensing
ATOMIC2 – North Atlantic

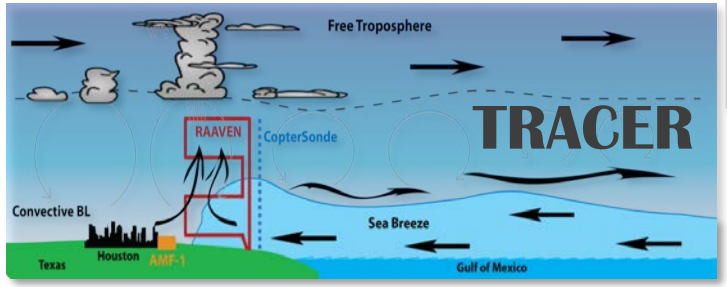
Water Cycle and Precipitation

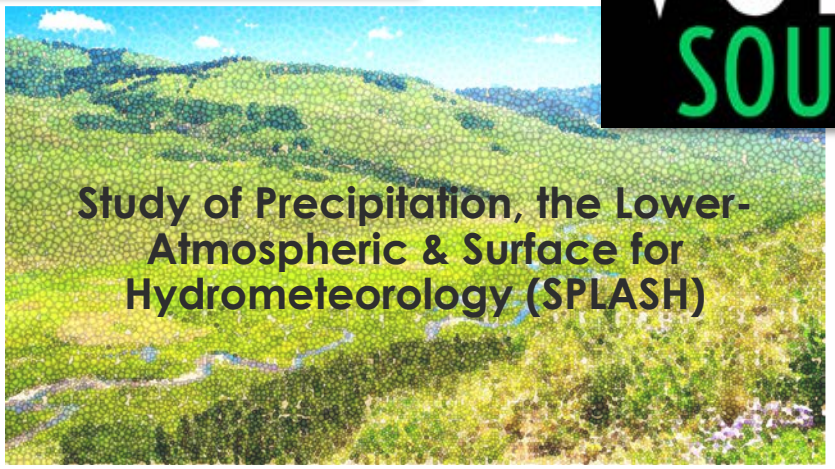
Precipitation Grand Challenge
SAIL/SPLASH – Watershed Hydromet CO
TRACER – Aerosol-Convection Interactions
VORTEX-SE - Severe Wx



American Wake Experiment (AWAKEN)







Campaigns Advancing Science

- PSL works with partners
- PSL draws upon expertise across the lab
- PSL develops the science questions
- PSL designs the campaign strategy
- PSL leads in the execution of the field work
- PSL creates observation-model synergies
- PSL answers the questions

Thank you!

We look forward to additional discussion & questions in our live panel discussion