

CalWater-2015 Update

26 January 2015

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(CalWater-2 Mission Scientists, Platform Scientists and Working Group leads, and Steering Committee members – see summary slide describing CalWater leadership; thanks to the dozens of other scientists, engineers and support staff not listed here)

CalWater-2015

NOAA G-IV

NOAA P-3

DOE G-1

Research Aircraft at McClellan Airfield, Sacramento, CA
25 January 2015

Photo by Marty Ralph (UCSD/Scripps/CW3E)

DOE G-1 aircraft: measuring cloud, rain and snow particles, as well as aerosols such as dust and smoke from sources near and far

NOAA G-IV aircraft: measuring atmospheric river strength and structure offshore using dropsondes and precipitation radar

NOAA P-3 aircraft: measuring ocean and atmosphere with radars for precipitation, cloud & ocean waves, and air & ocean sondes

NOAA Ron Brown Ship: measuring aerosols, clouds, atmospheric rivers, ocean surface and subsurface conditions

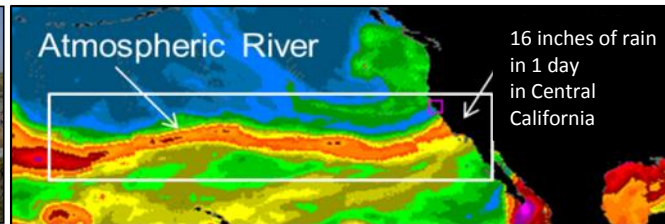
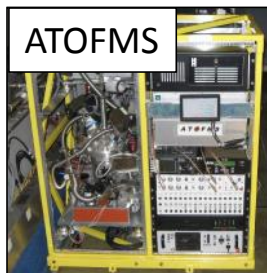
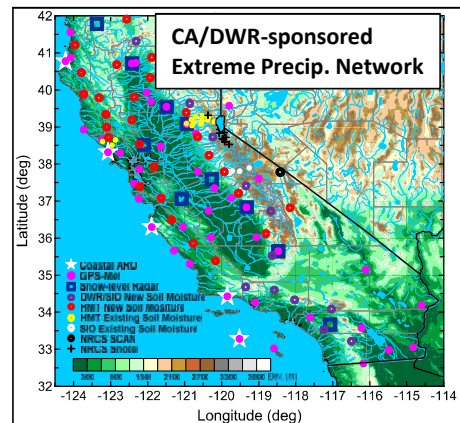
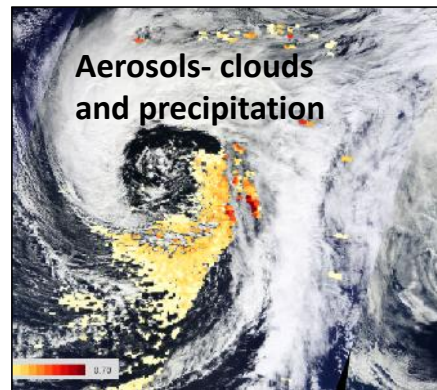
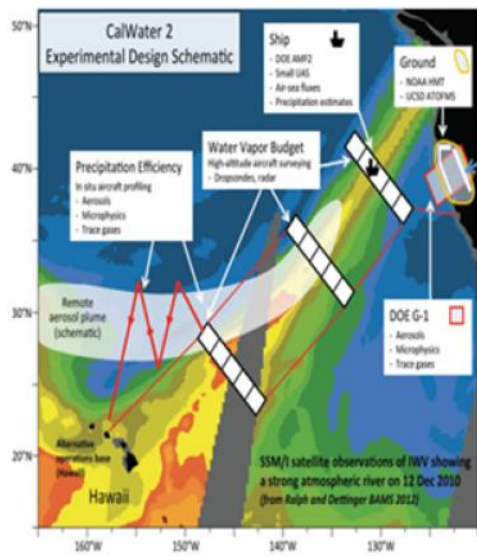
DOE AMF2: many sensors mounted on the NOAA ship; measuring aerosols, precipitation, clouds & winds aloft and at the surface

CA Dept. of Water Resources extreme precipitation network: measuring atmospheric rivers, snow level and soil across California

NSF - sponsored aerosol and rain measurements at the coast

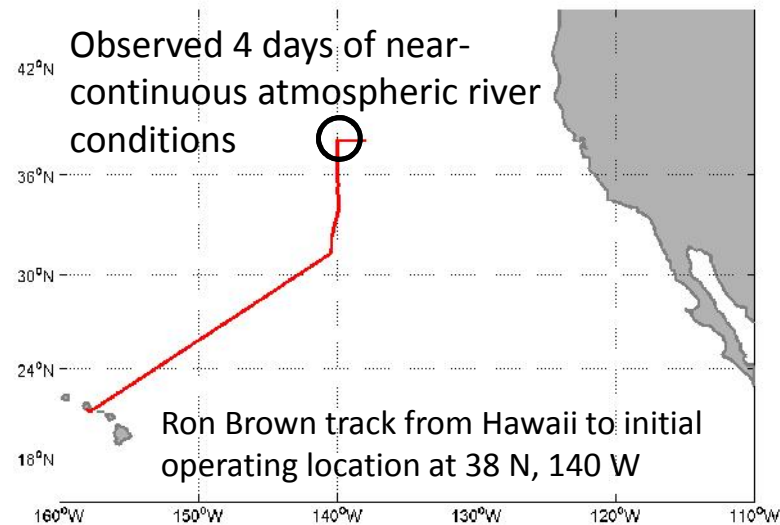
NASA ER-2 aircraft: measuring aerosols, clouds and water vapor with radar, lidar and radiometer

CalWater - 2015



CALWATER2: Ship-based Sensors

- DOE AMF2 - PNNL (Leung) (Aerosols, radars, lidars, wind profiler, ...)
- Fluxes and Near-Surface Meteorology-ESRL/PSD (Fairall)
- Balloon soundings - NOAA/NESDIS (Nalli)
- Wave dissipation (SWIFT buoys) –UW/APL (Thompson)
- GPS water vapor - U Hawaii (Almanza , Businger)



AMF2 Instruments

- ▶ Aerosol Observing System (AOS)
- ▶ Radar Wind Profiler (RWP)
- ▶ Vertically pointing W-band cloud radar (WACR)
- ▶ Microwave radiometer (MWR)
- ▶ Ceilometer, micropulse lidar (MPL), and high spectral resolution lidar (HSRL)
- ▶ 3-channel microwave radiometer (MWR3C)
- ▶ Portable Radiation Measurement Package (PRP2) and sun pyranometer (SPN)
- ▶ Atmospheric Sounder by Infrared Spectral Technology (ASSIST) [newer version of the atmospheric emitted radiance interferometer (AERI)]
- ▶ Meteorological instruments (MET) and atmospheric profiling (SONDE)
- ▶ Added CSU ice nuclei samples (IS)

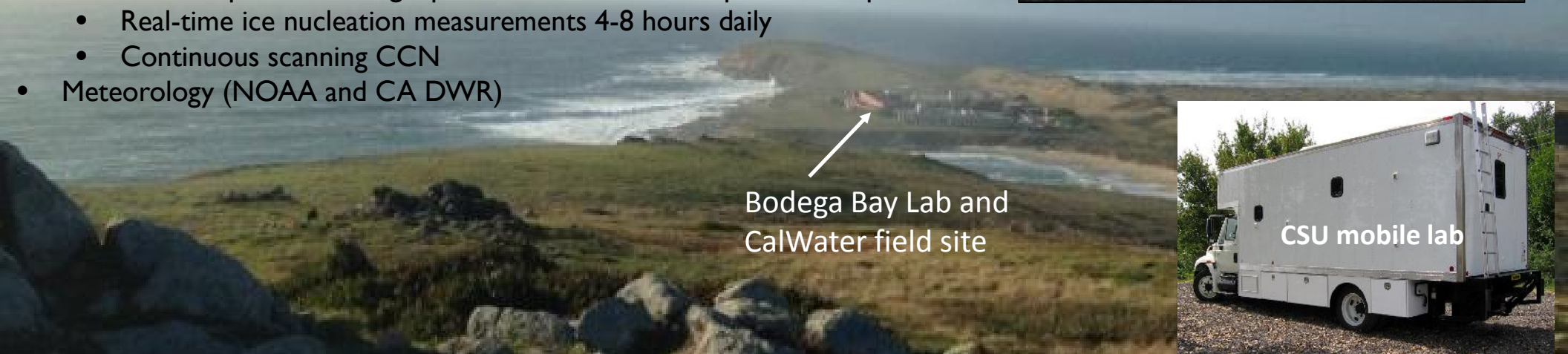


NSF-supported aerosol and precipitation measurements at **Bodega Bay**: UCSD, Colorado State University, North Carolina State University



PIs: Kim Prather (UCSD/Scripps), Sonia Kreidenweiss (CSU), Marcus Petters (NCSU)
Also Paul Demott (CSU) and Andrew Martin (UCSD/Scripps)

- Precipitation collections for residue chemical, biological and ice nucleation
- Aerosols
 - Single particle aerosol mass spectrometry
 - IMPROVE chemically-specified PM_{2.5} and PM₁₀
 - WIBS-4A bioaerosols and fluorescence microscopy collections
 - Continuous aerosol size distribution
- Cloud-active aerosols
 - Ice nucleation filter samples (integrated periods for offline analysis)
 - Selected periods of single particle ice nuclei mass spectral composition
 - Real-time ice nucleation measurements 4-8 hours daily
 - Continuous scanning CCN
- Meteorology (NOAA and CA DWR)



Bodega Bay Lab and
CalWater field site



CalWater-2015 is Underway – 27 January Status

The CalWater-2015 interagency and multi-disciplinary field campaign is now fully underway

- Planning began in 2011 after CalWater-1, which collected data from 2009-2011 over land
- CalWater-2 “Early Start” campaign in 2014 provided spin-up for this major campaign in 2015
- Follow-on efforts are proposed for 2016 and 2017

Major facilities and staff from partners form interagency steering committee co-led by Scientists from UCSD/Scripps

1. National Oceanographic and Atmospheric Administration (NOAA)
2. Department of Energy (DOE)
3. California Department of Water Resources (DWR)
4. National Science Foundation (NSF)
5. National Atmospheric and Space Administration (NASA)
6. University of California, San Diego (UCSD) & Scripps Institution of Oceanography (SIO)
7. Colorado State University (CSU)
8. Hebrew University of Jerusalem
9. Plymouth State University (PSU)
10. North Carolina State University (NCSU)
11. Naval Research Laboratory (NRL)

CalWater-2015 is Underway – 27 January Status

CalWater-2015 field program has now sampled

- moderate-to-strong AR conditions offshore, aerosols and clouds over northern California and offshore
- developed tailored forecasting tools and capabilities to support the daily field operations planning and execution
- Running West-WRF in prototype operational forecast mode for mission support

CalWater-2015 is providing valuable calibration/validation opportunities for two new NASA remote sensing instruments recently placed on the International Space Station:

- “RapidScat” scatterometer for measuring ocean surface winds, and
- “CATS” lidar for measuring aerosol profiles and thin cloud properties

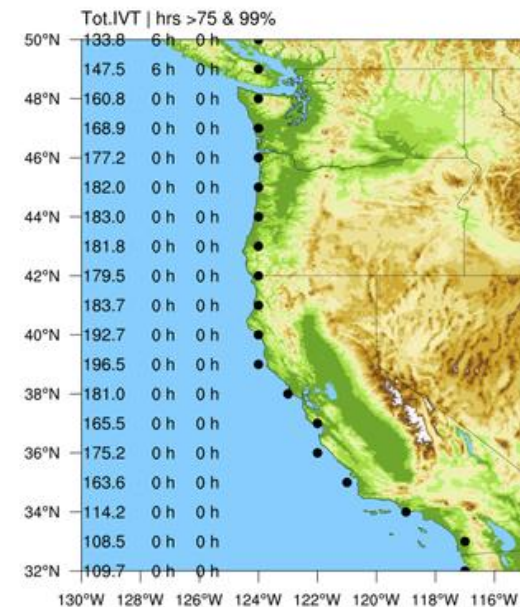
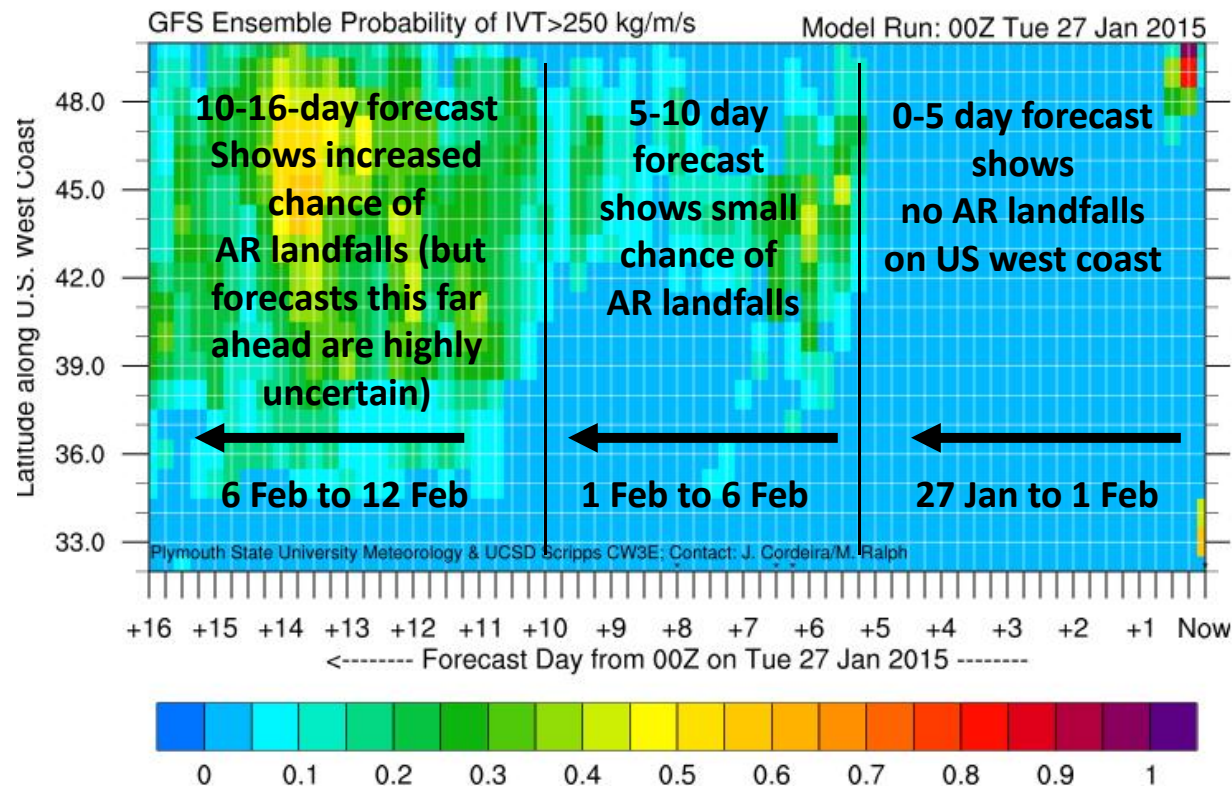
CalWater-2015 will run at full strength through mid February

- some major facilities continuing to late February and even into early March
- aerosol and cloud sampling has been very successful
- offshore area has been very active in terms of atmospheric river conditions
- forecasts and climatology indicate the likelihood of significant precipitation in northern California during the remainder of the campaign

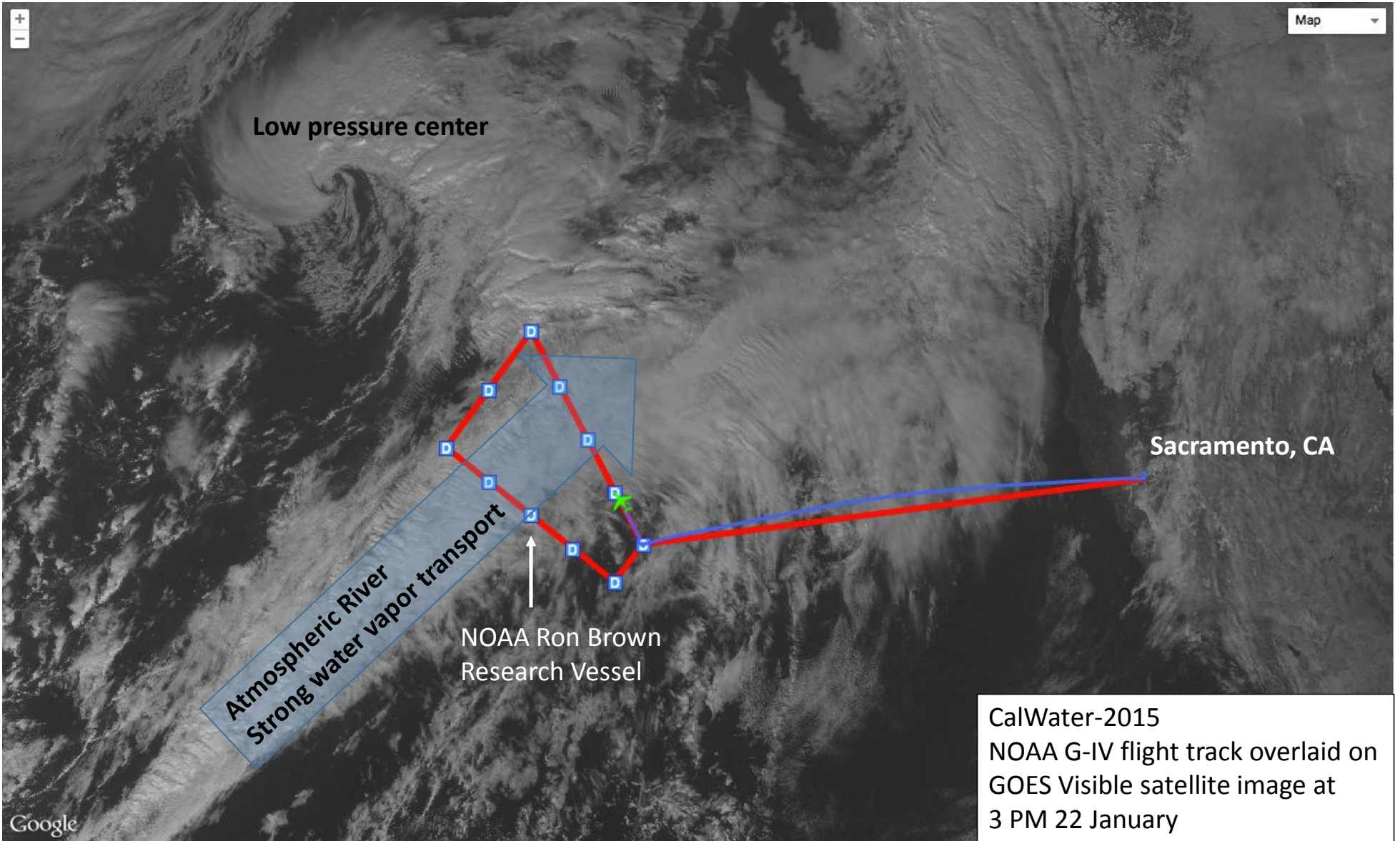
CalWater-2015 is Underway – 27 January Status

- **CalWater Command Center operating at McClellan Airfield (Sacramento)**
 - Began 12 January
 - Daily weather briefings from 8-9 AM PT, including atmospheric river, aerosol, and cloud forecasts
- **All four research aircraft are now on station prepared for science flights**
 - DOE's G-1 aircraft at McClellan since 13 January: 6 science flights completed, including a coordinated flight with the NASA ER-2
 - NOAA's G-IV aircraft at McClellan since 14 January: 4 science flights completed (89 sondes deployed)
 - NASA's ER-2 aircraft at Palmdale ready as of 19 January: 1 science flight completed
 - NOAA's P-3 aircraft at McClellan as of 25 January: First science flight scheduled for 27 January
- **The NOAA Ron Brown research ship and sensors are sampling offshore**
 - Departed Hawaii on 14 January
 - On station at 38 N, 140 W from 20-25 January: 4+ days of continuous AR conditions
 - Two G-IV overflights during AR conditions
 - Ocean sampling coordinated mission with P-3 planned for 27 January
 - Port call in San Francisco on 29-30 January (24 hours)
- **DOE's AMF-2 sensing facility is operating on the NOAA Ron Brown**
 - Sensing of cloud and aerosol over the ocean provides linkages with measurements aloft by G-1 and at the ground near Bodega Bay CA
- **NSF-supported ground-based chemistry and meteorology site at Bodega Bay is operating**
- **100-station extreme precipitation/AR mesonet network in CA is operating**

Forecast chances of landfall of at least weak Atmospheric River conditions on the U.S. West Coast from 27 Jan to 12 Feb - updates available on the "AR Portal" at cw3e.ucsd.edu

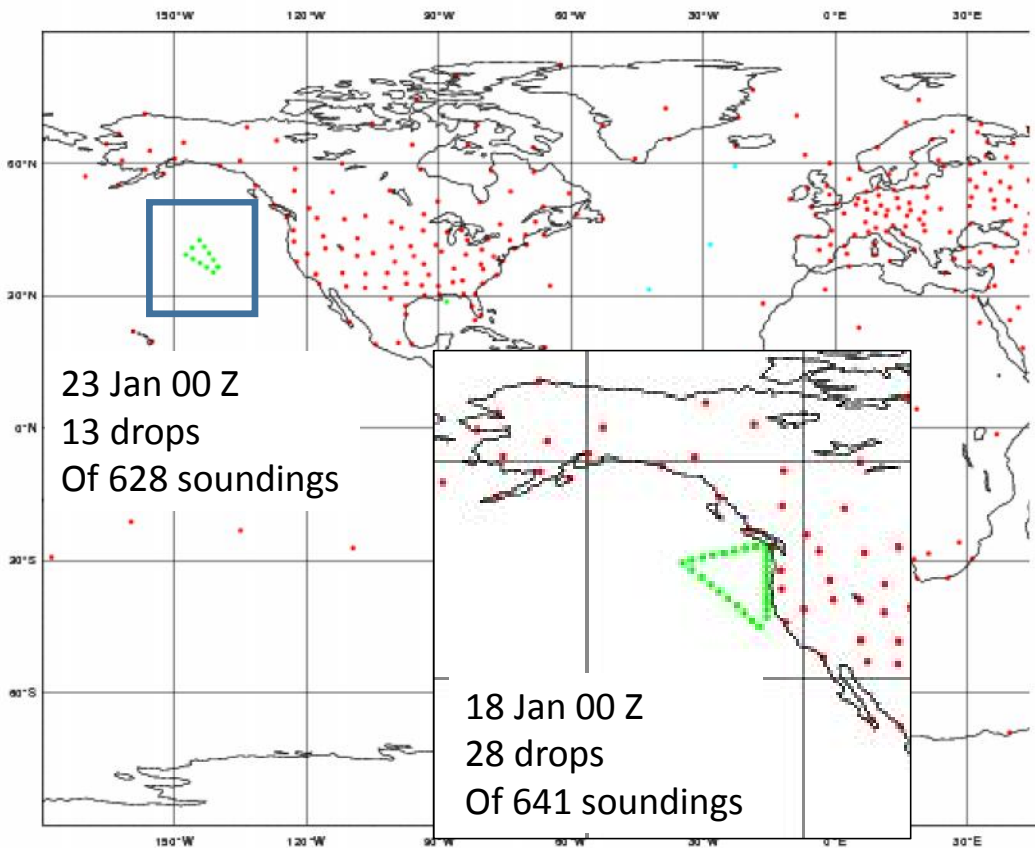


What does this diagram show? The main diagram (left display) is read from *right* to *left* at a given latitude in order to indicate how many days from today AR conditions are likely at the coast. By plotting the display from *right* to *left*, the display shows you "what is in the pipeline" as storm systems generally move from west to east. This diagram shows the chances (i.e., probability) of having at least weak "atmospheric river" conditions (i.e., strong horizontal water vapor transport, called "IVT" exceeding 250 kg/m/s) at different latitudes along the U.S. West Coast from "today" through the next 16 days at 6-hour increments. It uses a threshold of IVT > 250 kg/m/s as the threshold for AR conditions based on years of study. The landfall locations are the black dots in the right-most panel. The probability is based on 21 different forecasts run simultaneously with slightly different starting conditions (which simulates the "butterfly effect"). The forecasts are from the NOAA/NWS' "GFS" global weather forecast model. The probability is shaded on a scale from 0% (blue) to 100% (purple). The landfall locations are the black dots in the right-most panel. The right map-panel shows the total 16-day time-integrated IVT (Tot.IVT) for that location in millions of kg/m (left column of numbers). The diagram also shows the number of hours a location along the coast may expect to see AR conditions along with uncertainty. These hours are drawn in the region next to the U.S. West Coast in the right-most panel. These numbers represent the number of hours (over the next 16 days) a location has a 75% chance of AR conditions (middle column of numbers) or a 99% chance of AR conditions (right column of numbers). The higher this number, the longer AR conditions are likely and the more precipitation may be expected!

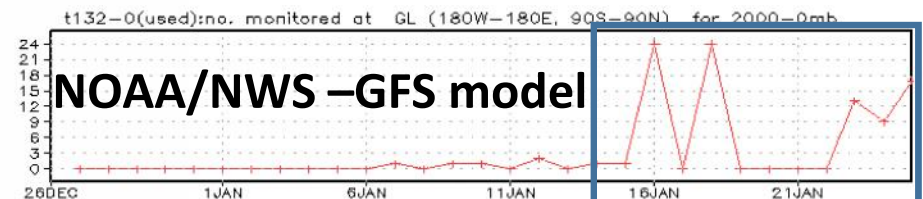
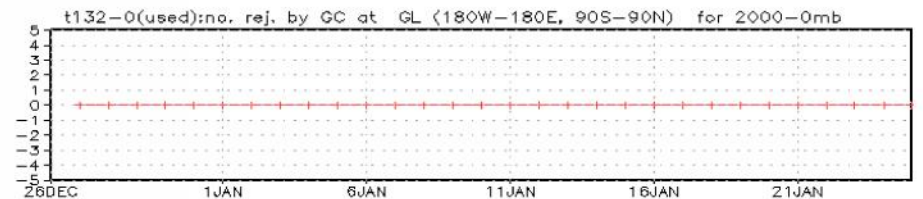
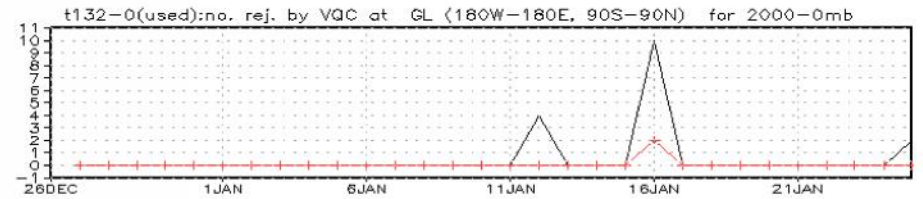
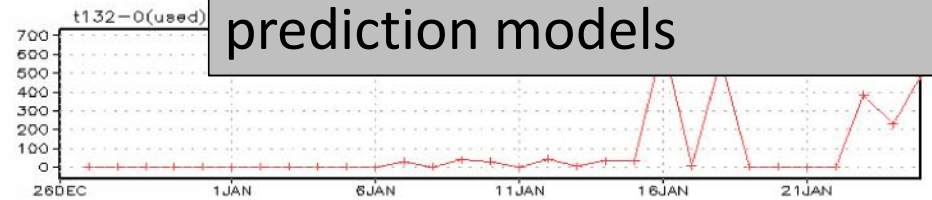


ECMWF Data Coverage (All obs DA) - Temp
 23/Jan/2015; 00 UTC
 Total number of obs = 628

- 3 SHIP
- 612 LAND
- 0 MOBILE
- 13 DROPSONDE



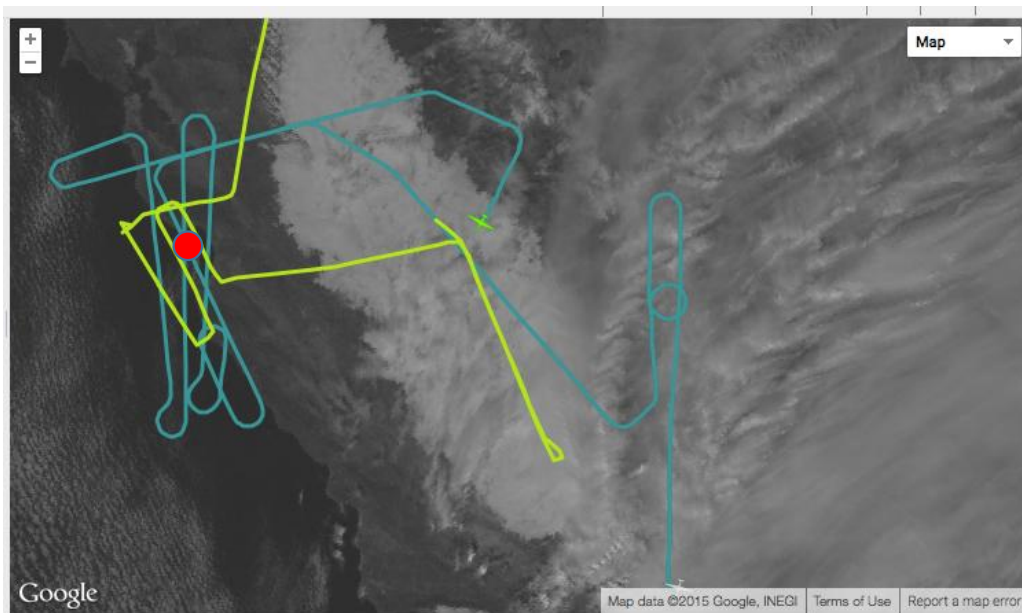
CalWater dropsondes being assimilated into weather prediction models



NOAA/NWS - GFS model

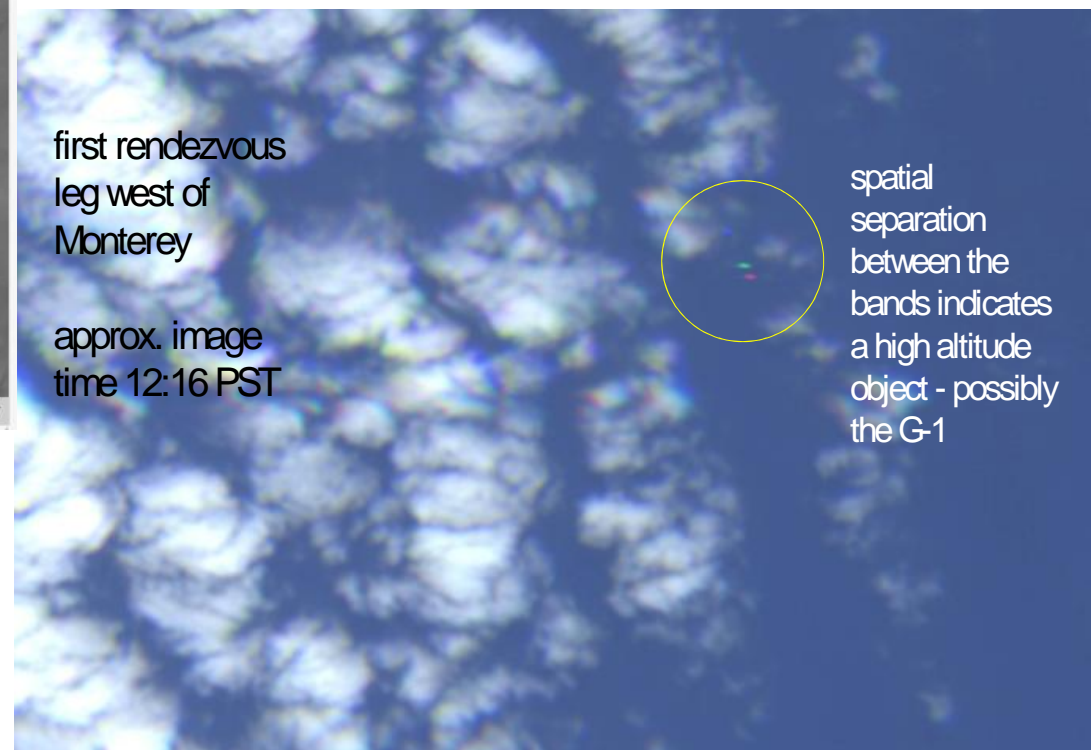
— init. outloop — final outloop

On January 20, G-1 and ER-2 rendezvous near Monterey Bay to target a high altitude layer of dust transported across the Pacific, and later rendezvous over Fresno to characterize high altitude clouds



Visible satellite image over CA, with flight tracks of the two aircraft. Monterey Bay is near the red dot.

Image from the NASA ER-2 aircraft overflying the DOE G-1 aircraft



first rendezvous
leg west of
Monterey

approx. image
time 12:16 PST

spatial
separation
between the
bands indicates
a high altitude
object - possibly
the G-1

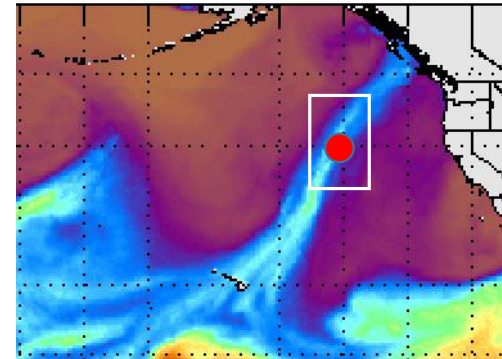
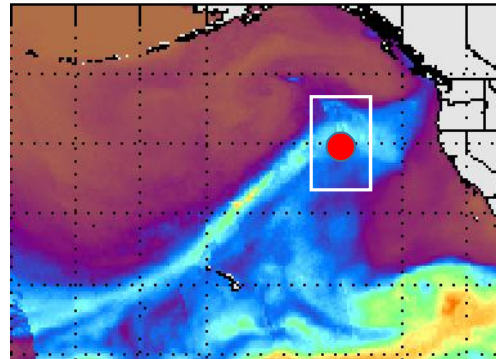
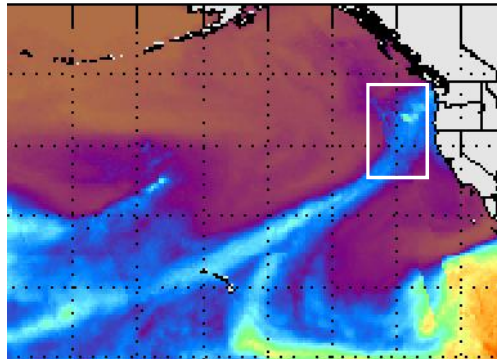
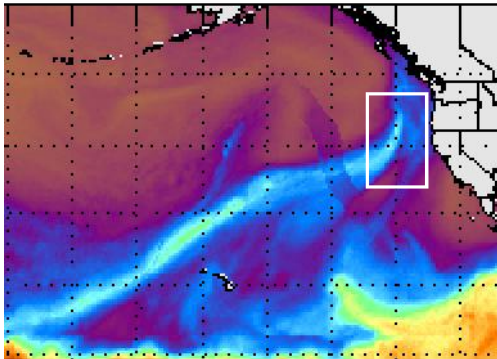
Atmospheric rivers sampled far offshore using the NOAA G-IV aircraft and Ron Brown ship

composite: 2015-01-15 19:00:00 UT

composite: 2015-01-18 00:30:00 UT

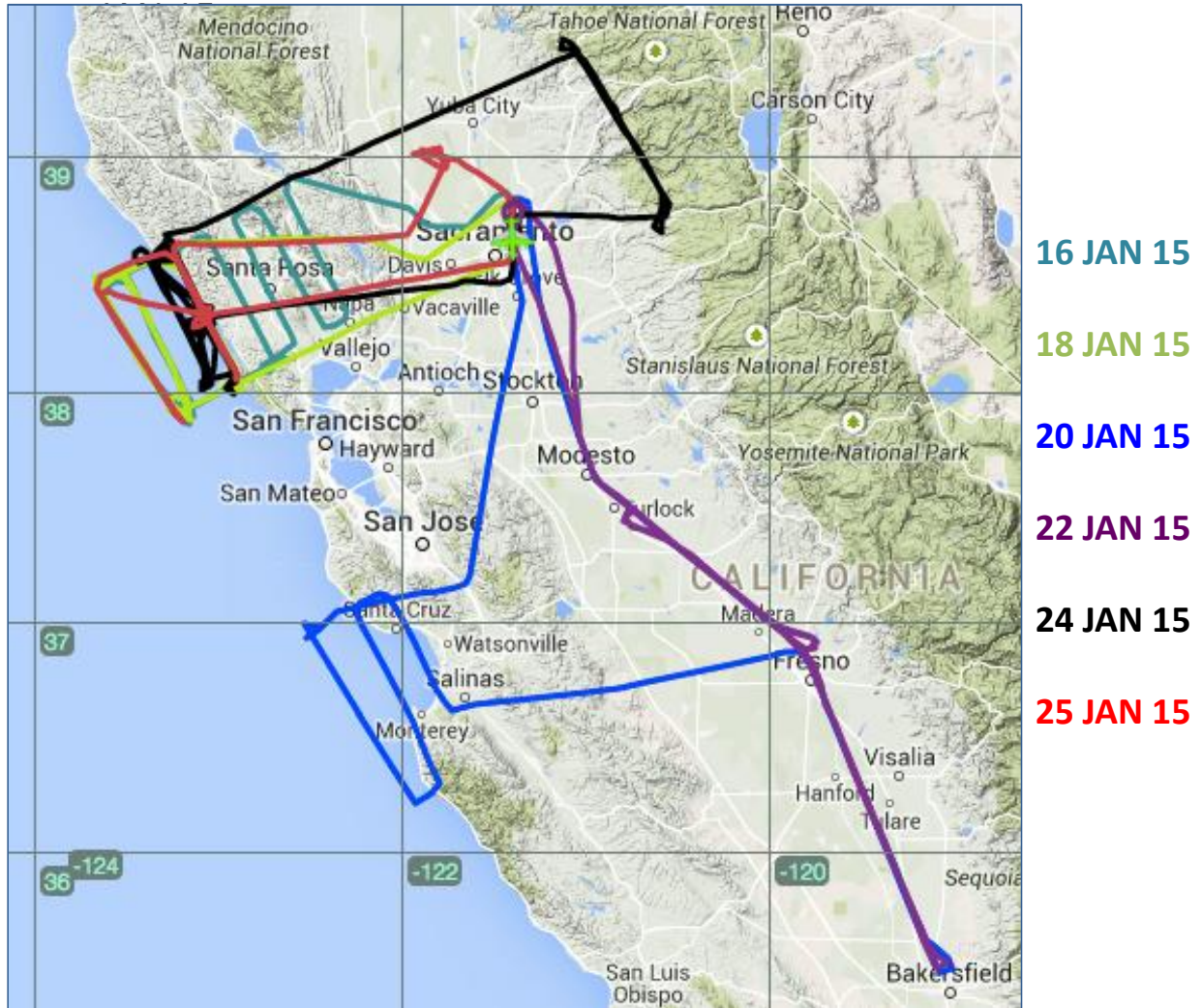
composite: 2015-01-23 00:00:00 UT

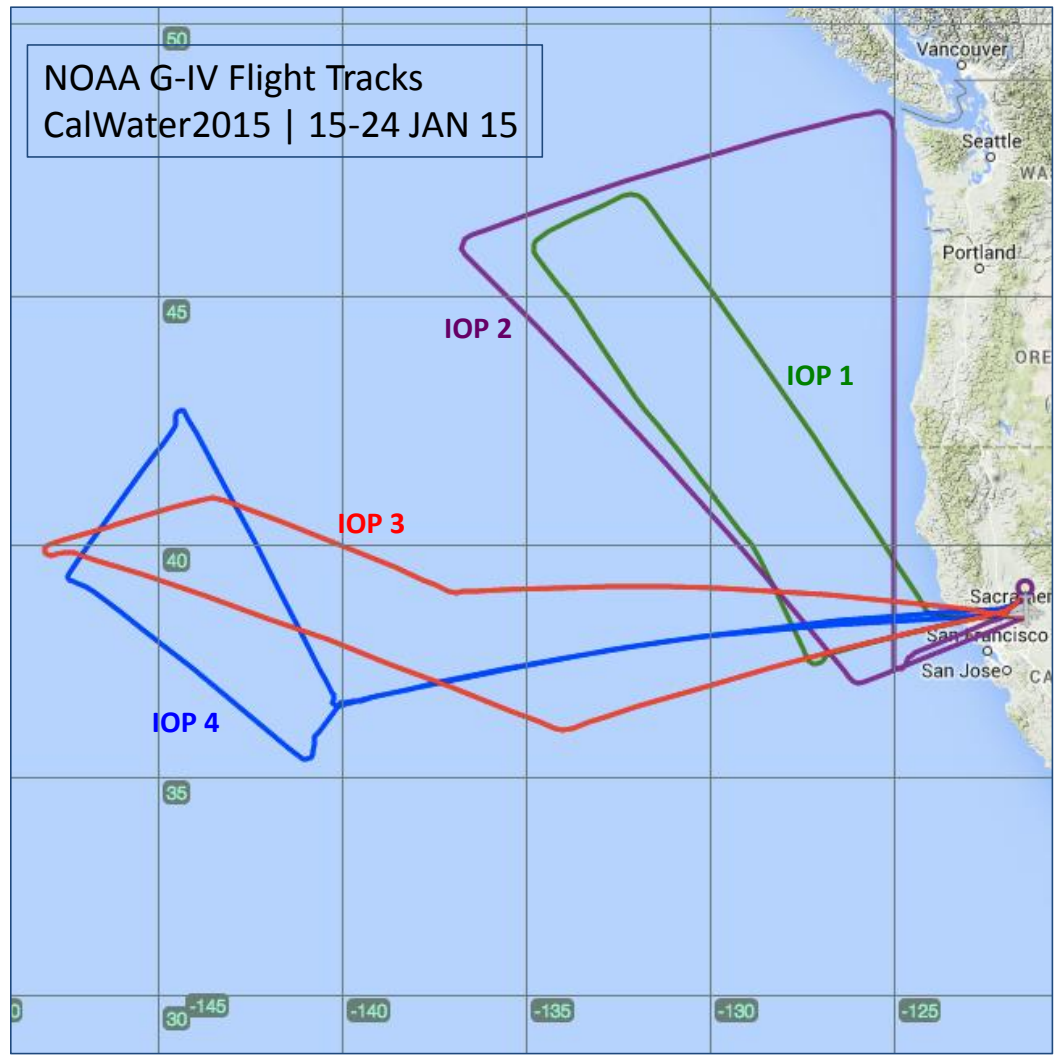
composite: 2015-01-24 21:00:00 UT



SSM/I satellite images of vertically integrated water vapor (IWV) showing four times during which the NOAA G-IV aircraft observed atmospheric river conditions. Two of these also included unique observations from the NOAA Ron Brown ship with DOE sensors onboard observed by CalWater-2015. White boxes are the approximate areas of G-IV aircraft flights, and the red dot marks the location of the Ron Brown ship. The ship continuously observed atmospheric river conditions for roughly 4 days. (SSM/I images are from the CIMMS website)

Battelle G-I Flight Tracks - CalWater2015 | 15-25



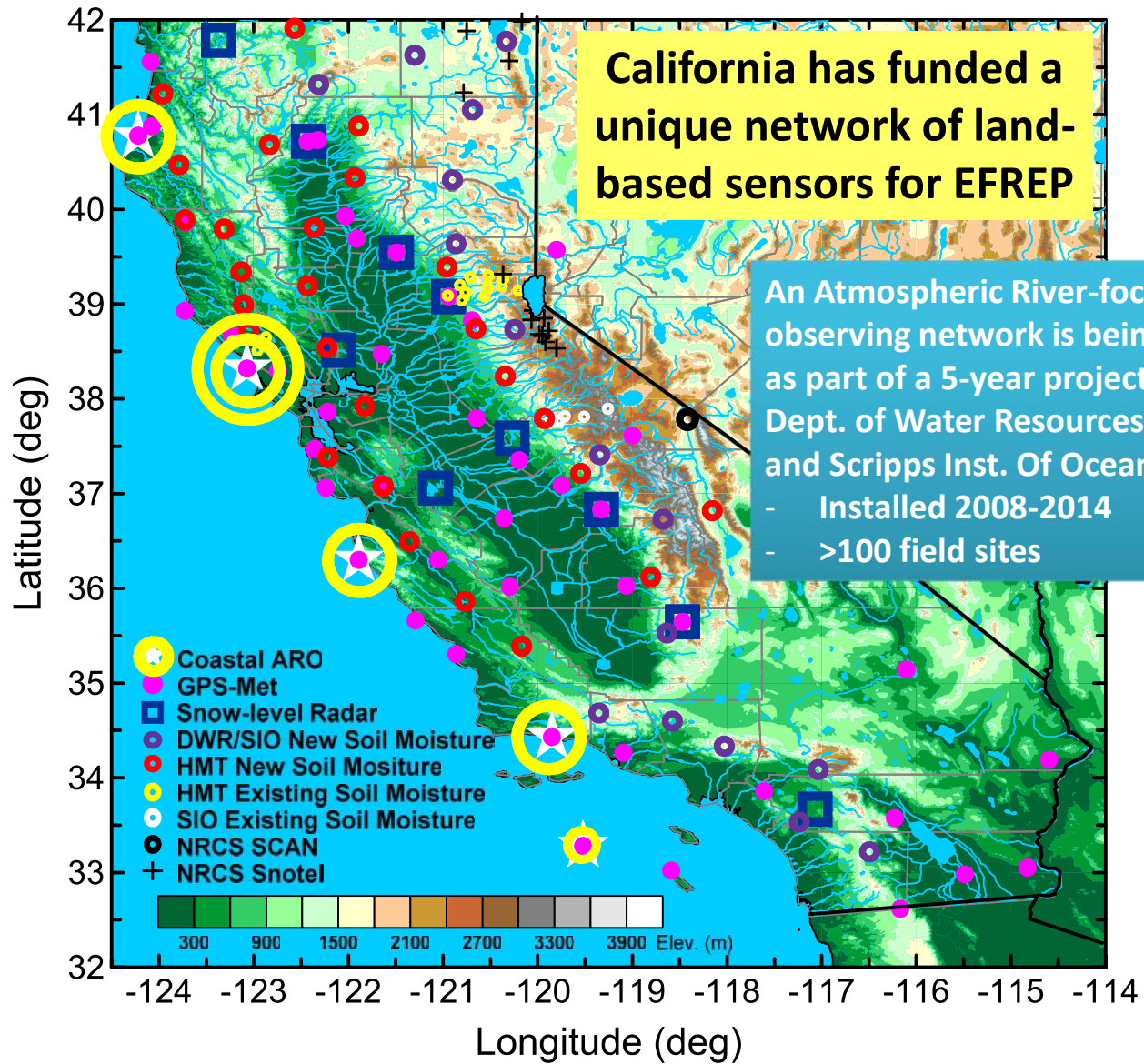


**G-IV IOP-1:
15 JAN 15**

**G-IV IOP-2:
17 JAN 15**

**G-IV IOP-3:
22 JAN 15**

**G-IV IOP-4:
24 JAN 15**



CalWater 2 Core Scientific Steering Group

(formed in 2012)

Investigator	Affiliation
F. M. Ralph (Co-Lead)	Scripps Institution of Oceanography, University of California San Diego
K. A. Prather (Co-Lead)	Scripps Institution of Oceanography, University of California San Diego
D. Cayan (Co-Lead)	Scripps Institution of Oceanography, University of California San Diego US Geological Survey
P. Demott	Colorado State Univ.
M. Dettinger	Scripps Institution of Oceanography, University of California San Diego US Geological Survey
C. Fairall	NOAA Earth System Research Laboratory
L. R. Leung	Pacific Northwest National Laboratory
D. Rosenfeld	The Hebrew University of Jerusalem
S. Rutledge	Colorado State University
J. R. Spackman	NOAA Earth System Research Laboratory Science and Technology Corporation
D. E. Waliser	NASA Jet Propulsion Laboratory
A. B. White	NOAA Earth System Research Laboratory

CalWater 2015 – ACAPEX Leadership Team

Mission Scientists	Affiliation/Emphasis
F. M. Ralph	Scripps/Atmospheric Rivers
K. A. Prather	Scripps/Aerosol-Cloud/Precip.
Ruby Leung	DOE/Aerosol-Cloud/Precip.
Allen White	NOAA/Atmospheric Rivers

Platform Scientists	Facility
Ruby Leung	DOE AMF2 and G-1
Chris Fairall	NOAA Ron Brown
Janet Intrieri	NOAA G-IV
Ryan Spackman	NOAA P-3
Allen White	HMT
Kim Prather	Bodega Bay
David Diner	NASA ER-2

Working Group Leads	Working Group
Ryan Spackman	2015 Operations Implementation
Andrew Martin	Modeling and Analysis
John Helly	Data Management
Jason Cordeira	Forecasting