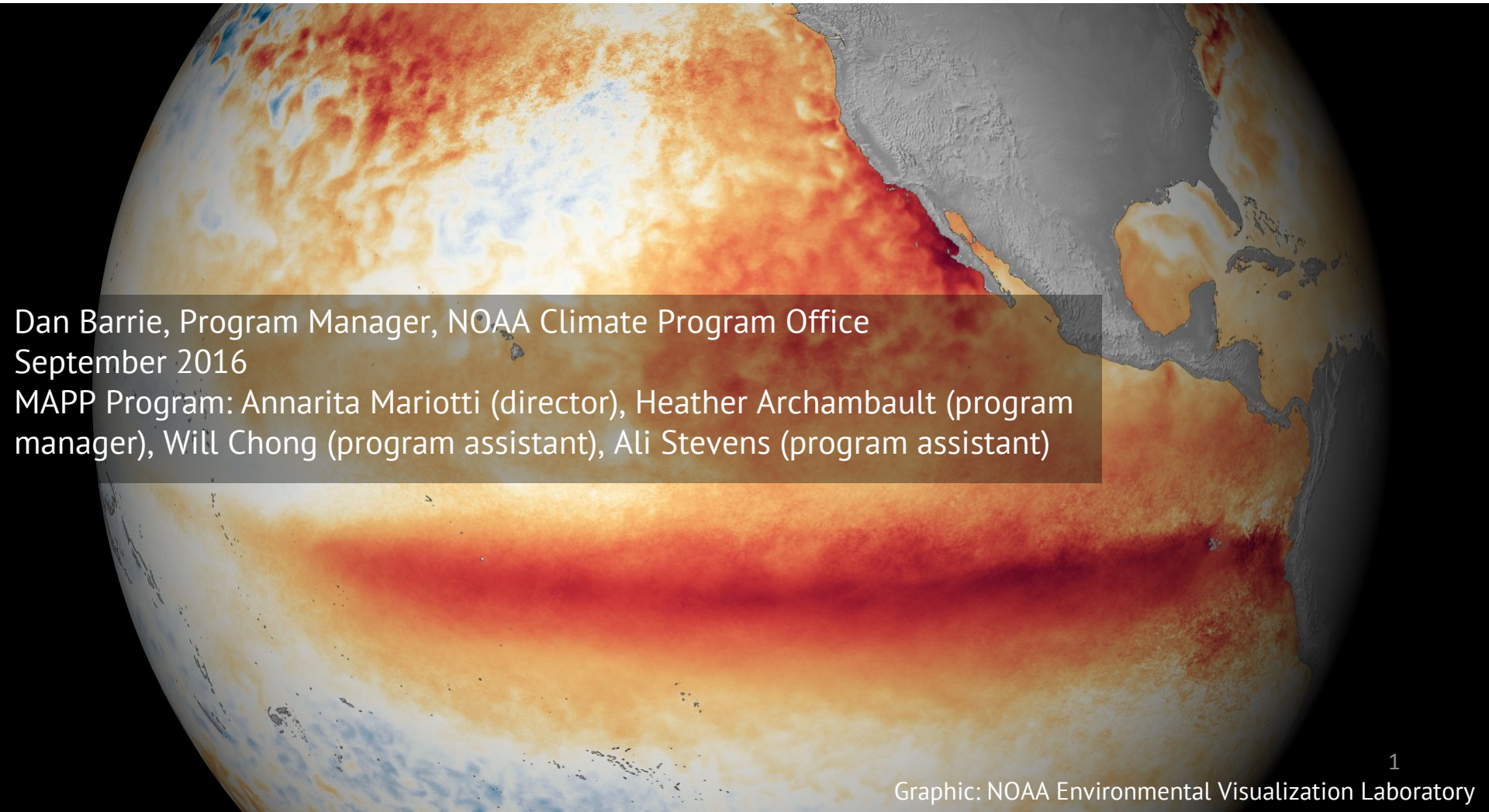
Climate Program Office

MAPP
Modeling, Analysis, Predictions, and Projections

S2S Research Activities at NOAA's Climate Program Office (CPO)

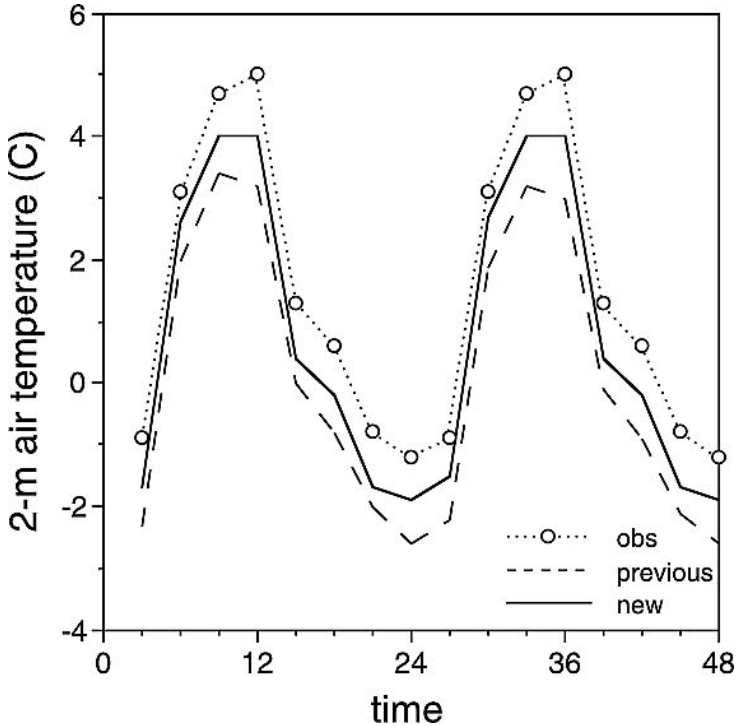


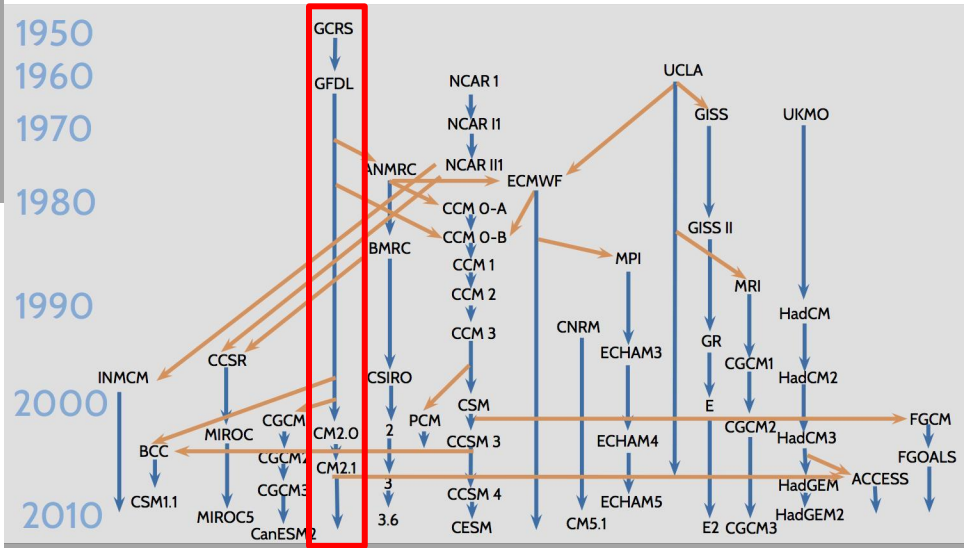
Dan Barrie, Program Manager, NOAA Climate Program Office
September 2016
MAPP Program: Annarita Mariotti (director), Heather Archambault (program manager), Will Chong (program assistant), Ali Stevens (program assistant)

Graphic: NOAA Environmental Visualization Laboratory

OAR Leadership in Subseasonal to Seasonal Prediction Research

Climate Program Office (CPO) and predecessor Office of Global Programs (OGP) initiatives have targeted prediction system improvements for 20 years. The figure below from Ek et al. (2003) shows improvements in T2m resulting from an upgraded land model





GFDL's predecessor, the Weather Bureau's General Circulation Research Section (GCRS), consolidated model development activities into a focused effort in the 1950s.

Model genealogy figure from Ben Sanderson (NCAR)

OAR Leadership Today

NGGPS Phase 1 Testing
Project Summary Assessment

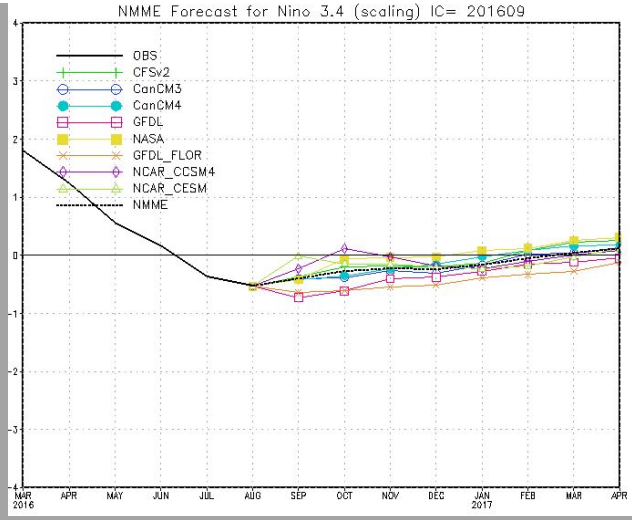
	Idealized Tests	3-km, 3-day forecasts	Performance	Scalability	Nesting or Mesh Refinement	Software Maturity
FV3						
MPAS						
NIM						
NMM-UJ						
NEPTUNE						

Meets or exceeds readiness for needed capability
Some capability but effort required for readiness
Capability in planning only or otherwise insufficiently ready

Recommendation (strongly endorsed by NWS) is to perform phase 2 testing with only MPAS and FV3

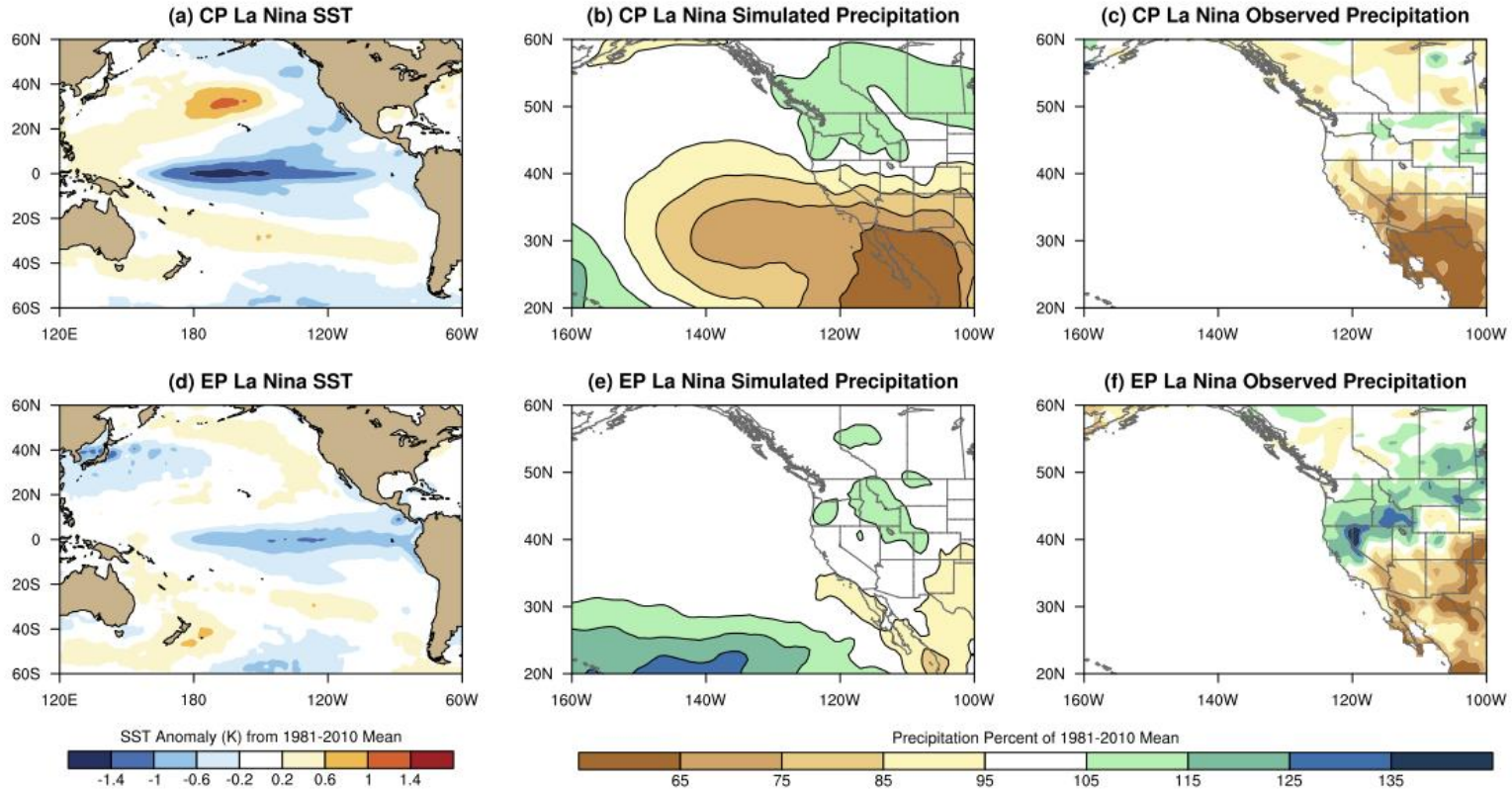
GFDL's modeling leadership continues – the GFDL dynamical core was selected through an intense competitive process to serve as the core of the next-generation NWS prediction system.

ESRL led an El Niño rapid response experiment to collect an unprecedented high-resolution data set of observations of tropical conditions and the extratropical response. This data set will be critical to better understanding El Niño and to improving models and forecasts, amongst other outcomes.



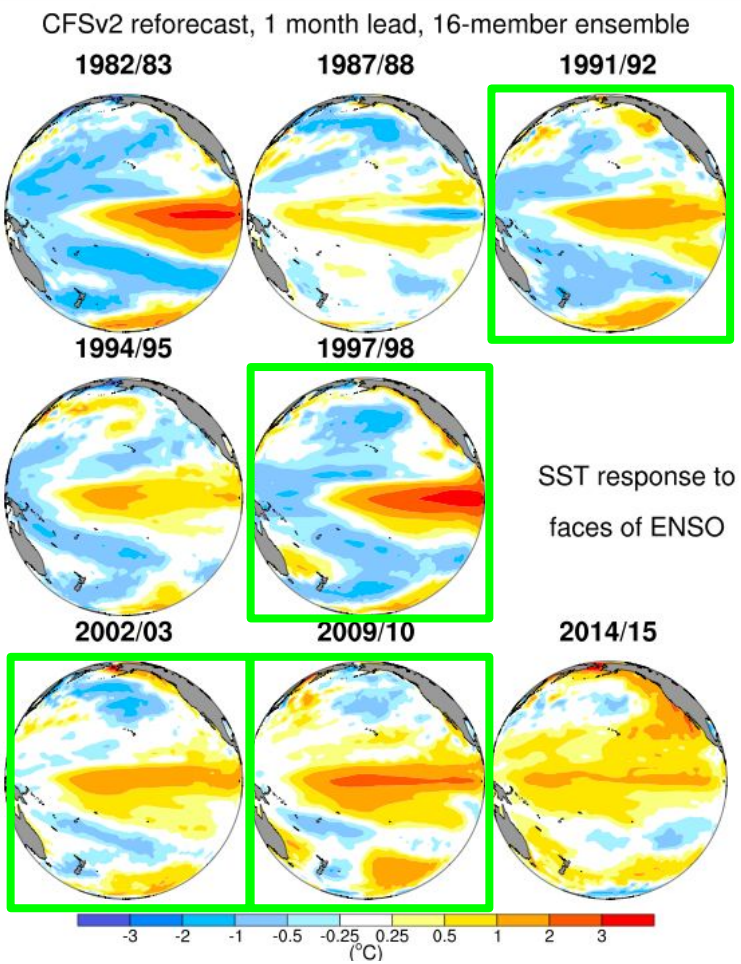
CPO, through the OAR-NWS Climate Test Bed, led the development of the North American Multi Model System, a major interagency effort, which includes input from seven research and operational climate models.

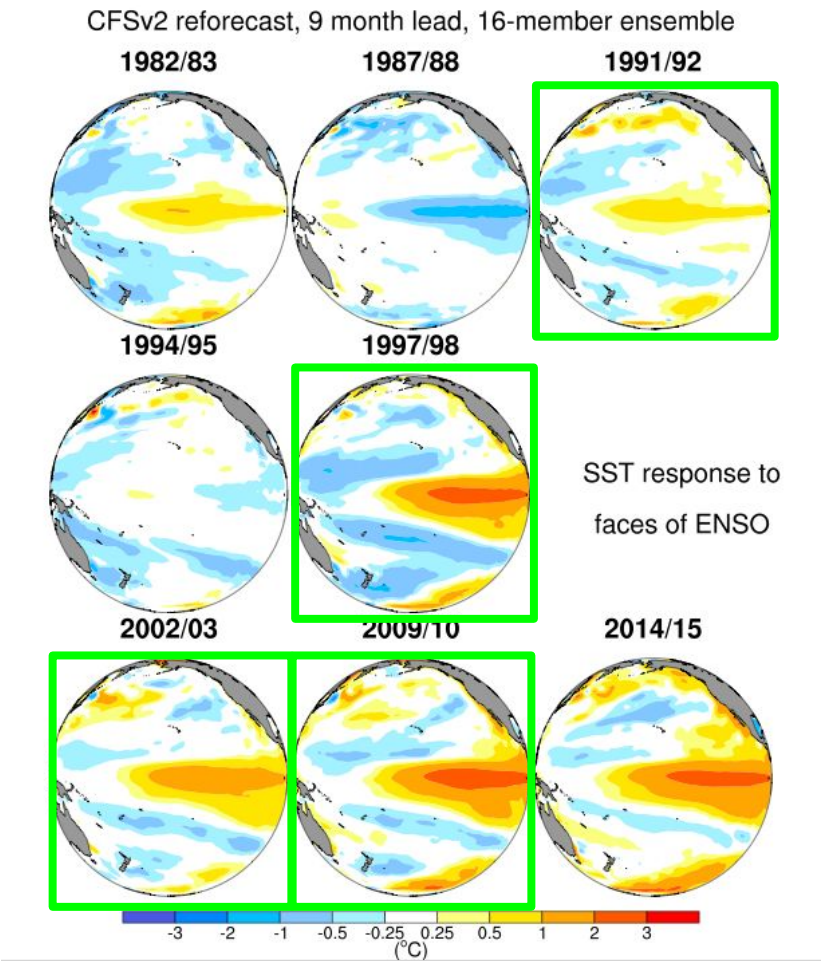
ESRL Research



- ESRL looking at precipitation impacts in La Nina conditions
- Models agree with Observations for Central Pacific-oriented La Ninas -- dry in west.
  - EP model-obs. disagreement: only four events in obs. record (nine for CP)
  - Assuming models are correct, small precip. impact for EP La Nina
- Both moderate and strong La Ninas impact precipitation in the West

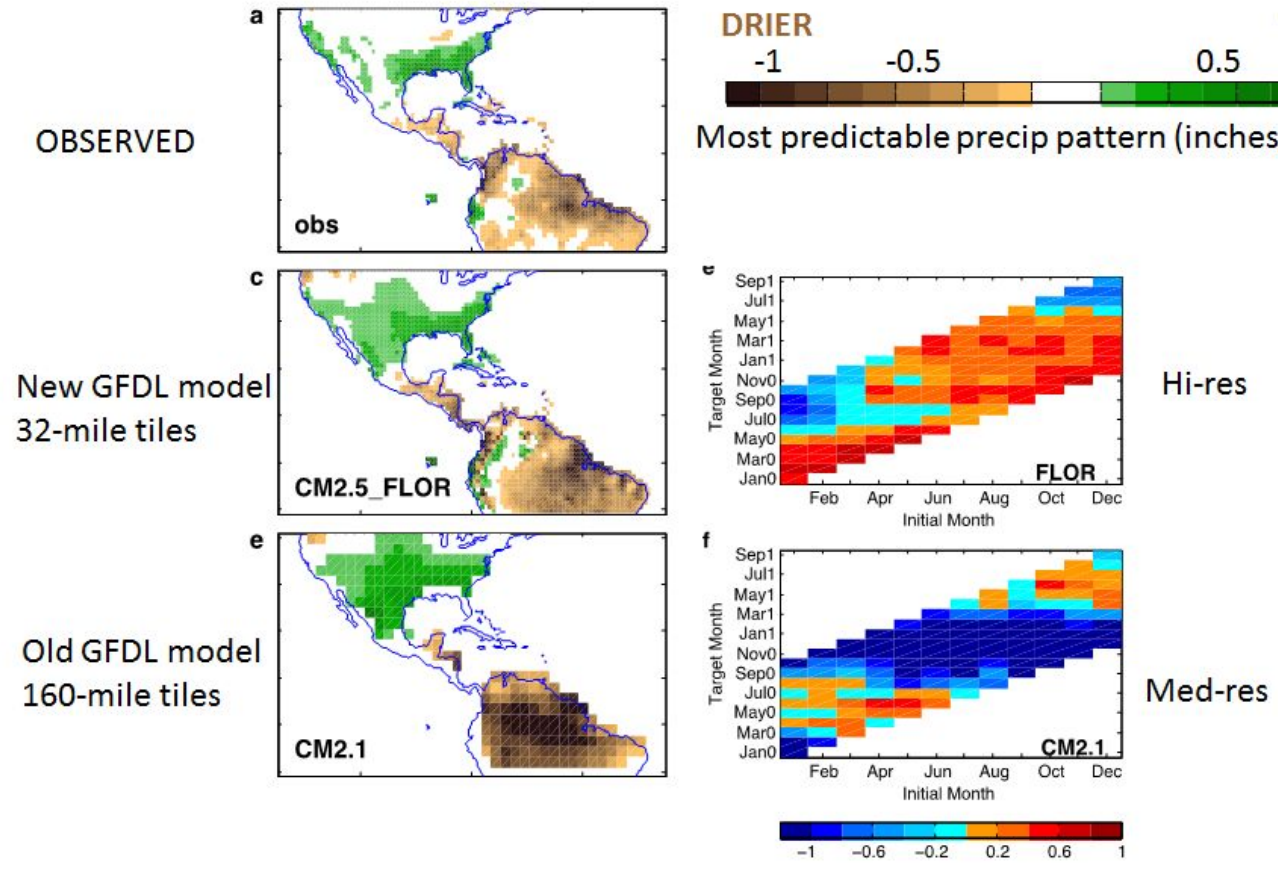
ESRL Research





- Examining skill loss from 1-month lead (left) to 9-month lead (right)
  - Why do some verify while others don't?
  - What about the atmospheric response?

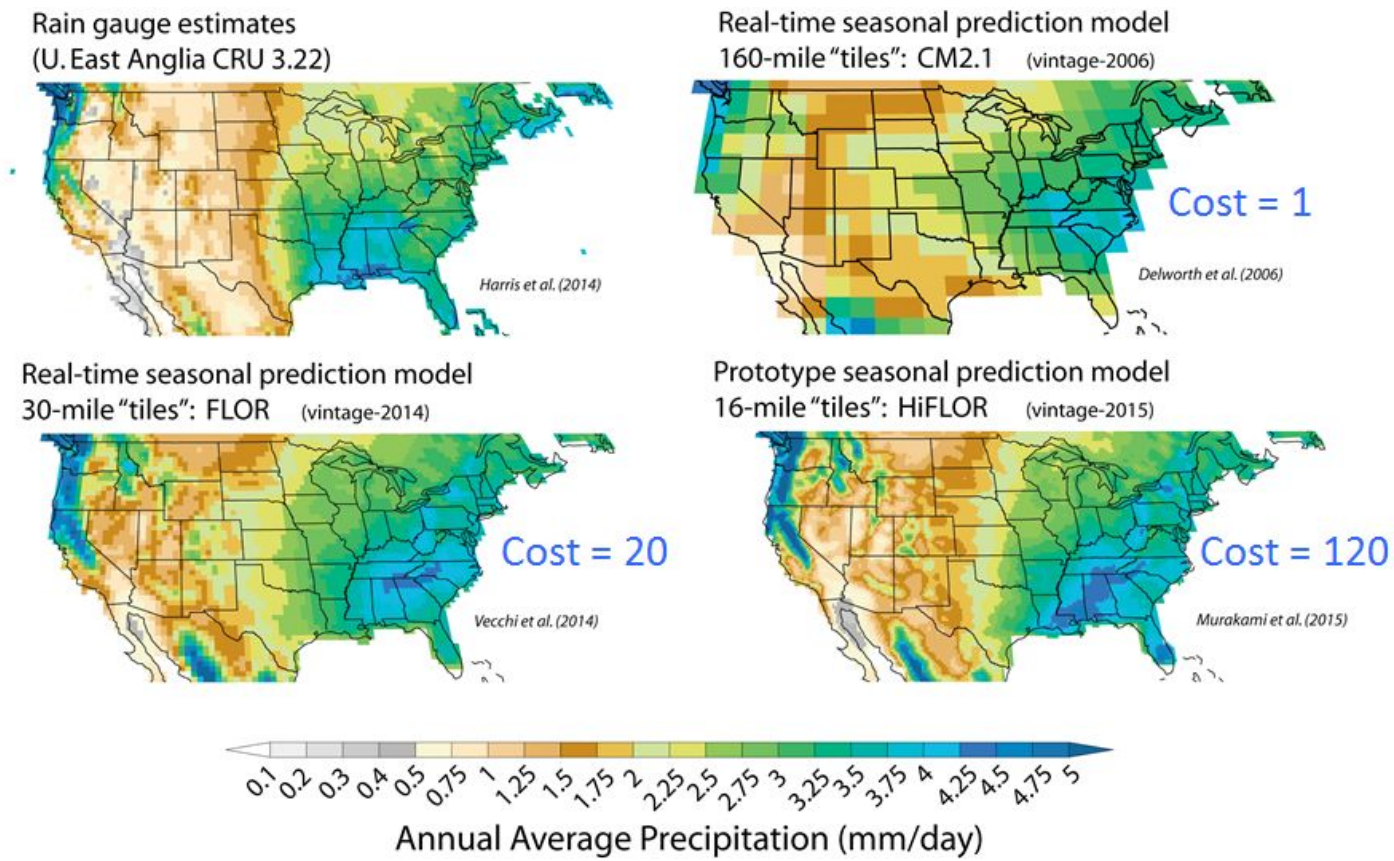
GFDL Research



(Adapted from Jia et al. 2015, J. Clim.)

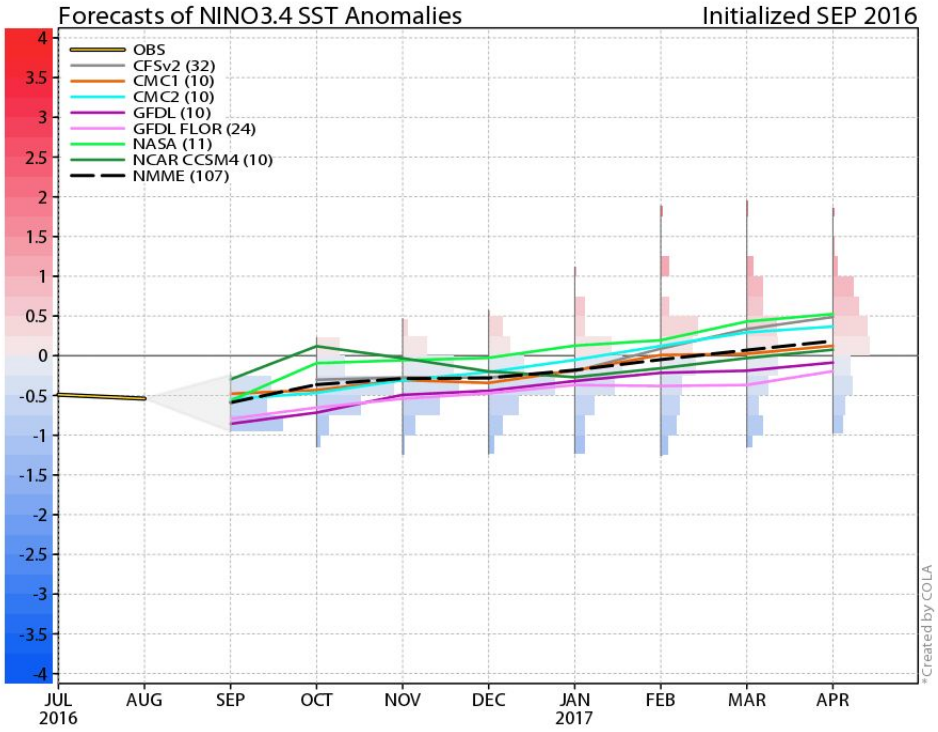
- GFDL FLOR system shows significant improvements for ENSO prediction
- Data is available -- 33 years, 12 start months, 12 ensemble members
- CM2.5 and FLOR models are publically available.

GFDL Research



- Smaller grid spacing improves simulation and allows phenomena (e.g., mountain snow) to be better represented
- Lots of data for HiFLOR

CPO prediction research



The MAPP and Climate Variability and Predictability programs are the current flag bearers for 20 years of CPO/OGP support for seasonal prediction research.

Focal areas:

- advancing statistical and dynamical modeling, including multi-model ensemble prediction systems
- understanding model biases, and improving model processes and physics
- developing novel climate reanalysis techniques
- improving data assimilation and monitoring systems

CPO involved in:

- Supporting past GEWEX efforts and establishment of new GEWEX-US office.
- Coordination with international, interagency, laboratory, and operational center partners.

MAPP efforts to improve predictions

MAPP Notables:

- Development and support for NMME (research and real-time).
- Development of the Climate Forecast System, version 2.
- Drought Task Force - NIDIS link
- Climate Prediction Task Force
- Subseasonal to Seasonal Prediction Task Force
- Reanalysis research
- Data assimilation
- Predictability and prediction research at the Center for Ocean-Land-Atmospheres (George Mason University)
- $3M+ in new subseasonal to seasonal research investments in FY16, including transition to operations work. With co-support from NWS, NESDIS, NASA, and Navy.
- Targeted improvements to model atmospheric physics.

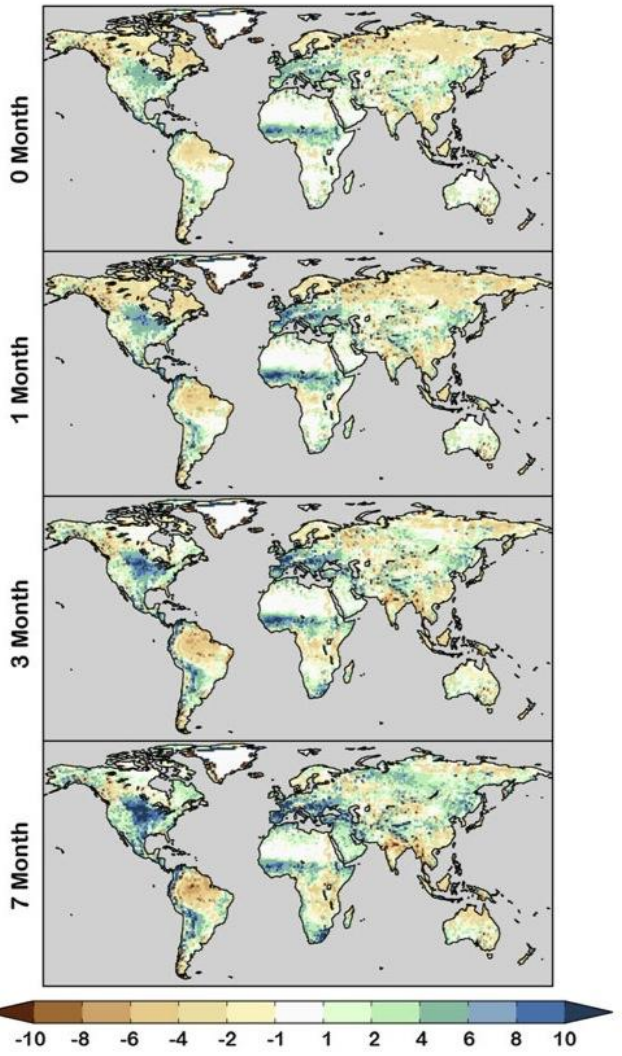
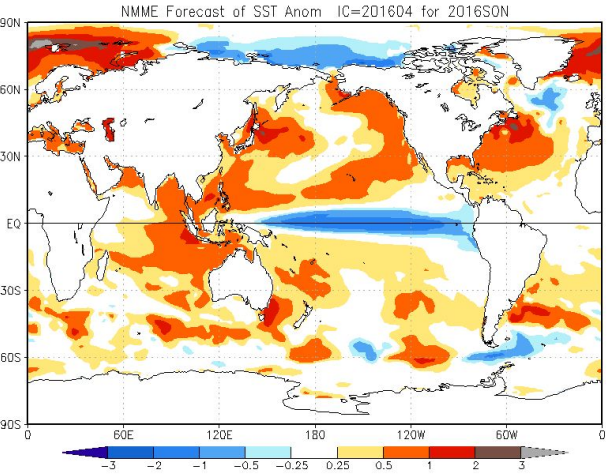


Fig. 3 As in Fig. 2 for JJA volumetric soil moisture (10–40 cm layer) forecast errors relative to CFS reanalysis

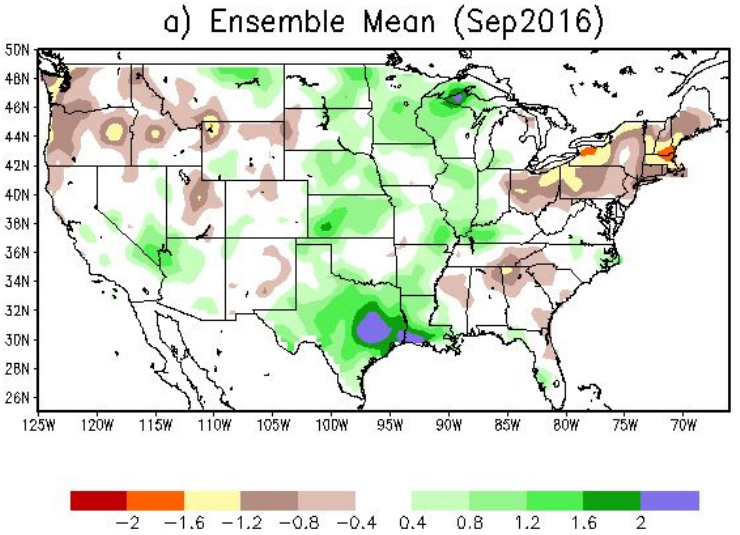
Evaluation of soil moisture biases with lead time in the CFSv2 reforecasts (Dirmeyer, CFSv2 Topical Collection (2013)

Transition to Operations

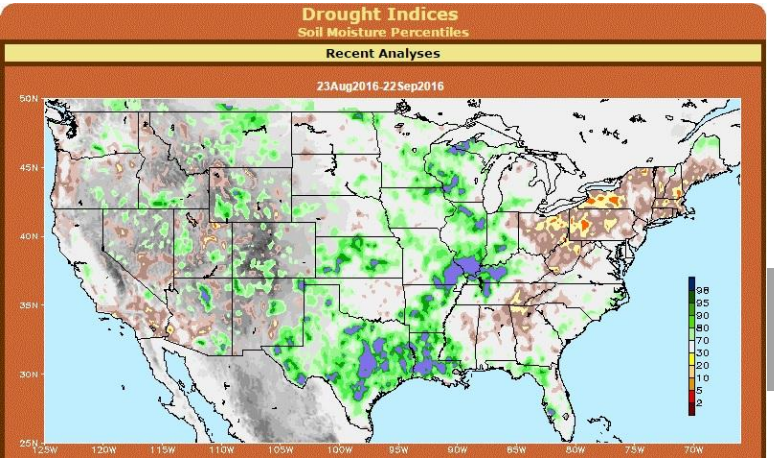
The **Climate Test Bed** is a joint effort of NWS and OAR/CPO, focused on enabling the transition of research into operations



North American Multi-Model Ensemble

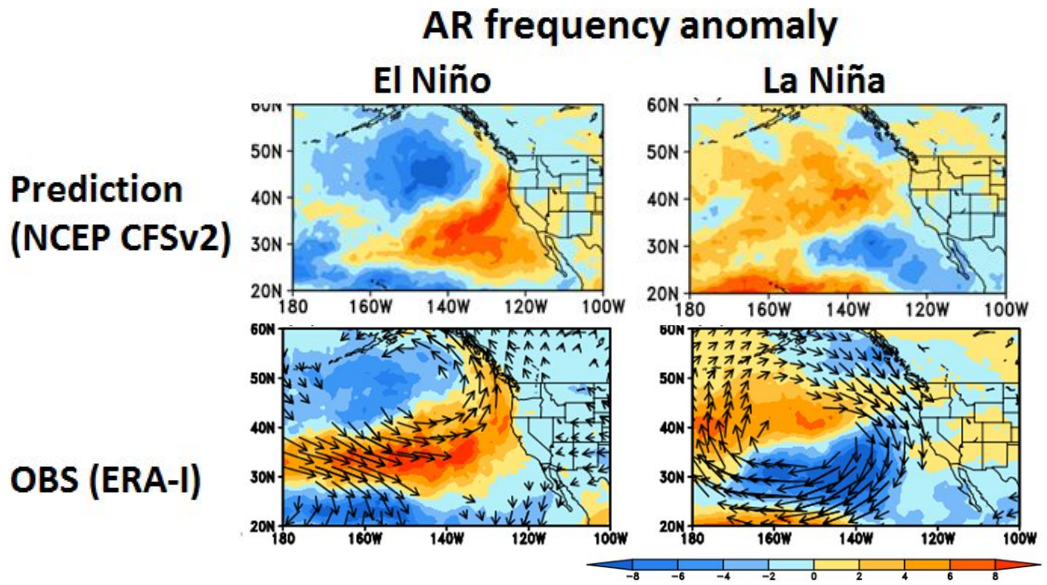


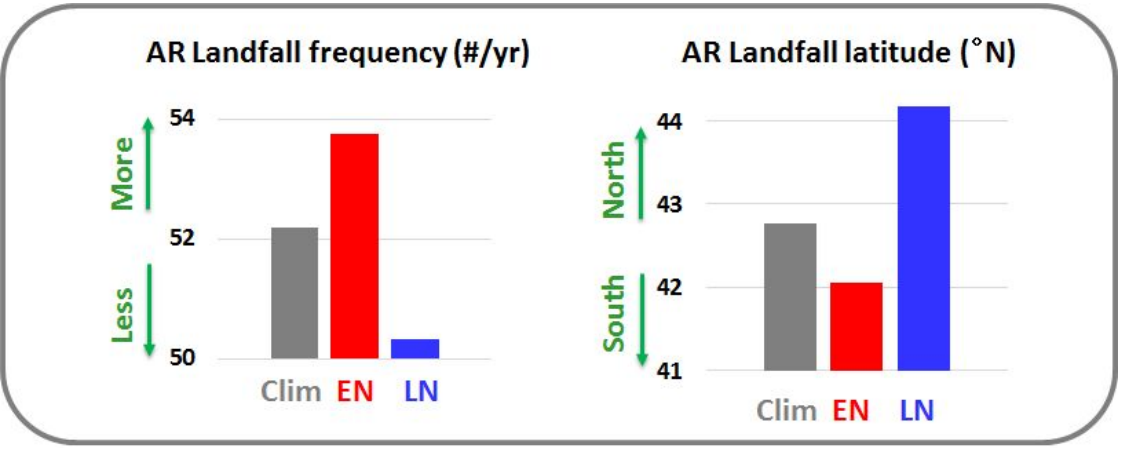
Standardized Precipitation Index forecasts derived from NMME



North American Land Data Assimilation System

Recent Relevant MAPP Research





Hyemi Kim (Stony Brook University)

- Looking at seasonal prediction of AR events
- CFSv2 does a good job simulating ENSO-AR variability in lead-1 DJF forecast (left top and middle)
- ENSO modulates both AR frequency and and average landfall latitude, from:
  - 42 degrees (California/Oregon border; **El Nino**) to
  - 44 degrees (Central Oregon coast; **La Nina**)

Figures courtesy Hyemi Kim

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Drought Task Force California Focus

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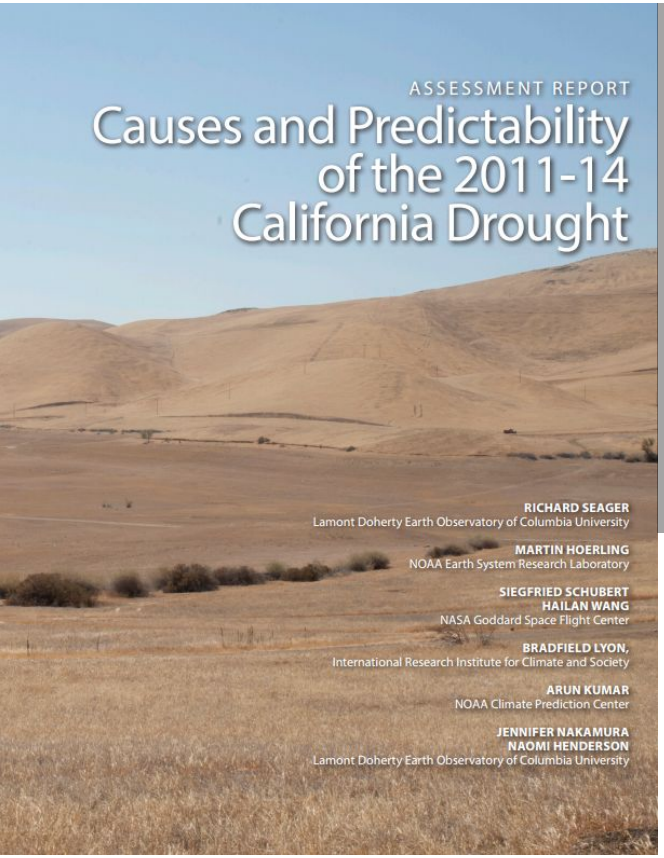
NATIONAL INTEGRATED DROUGHT INFORMATION SYSTEM



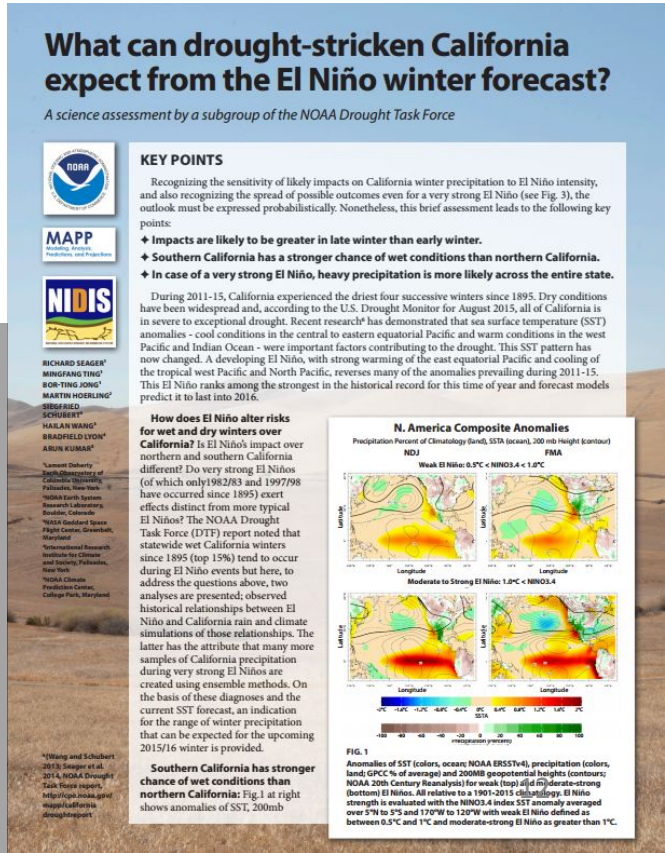
Scientific assessment of the 2011-2014 period of the drought. Causes:

- Weather conditions -- high pressure ridge off West Coast diverted storms
- Response to SST forcing
- La Nina in first year, then continued ocean influence.

- **Continuing questions:**
  - Winter 2015-2016 forecast evaluation
  - Impact of temperature and ET on the drought

Scientific assessment of El Nino impacts on California winter precipitation

- Impacts of El Nino typically greater in late winter
- Southern California higher odds of wet than Northern California



What can drought-stricken California expect from the El Niño winter forecast?

A science assessment by a subgroup of the NOAA Drought Task Force

MAPP
NIDIS

RICHARD SEAGER¹ MINGFANG TING¹ BOR-TING JONG¹ MARTIN HOERLING² SIEGFRIED SCHUBERT³ HAILAN WANG³ BRADFIELD LYON⁴ ARUN KUMAR⁵

¹Lamont Doherty Earth Observatory of Columbia University, Palisades, New York ²NOAA Earth System Research Laboratory, Boulder, Colorado ³NASA Goddard Space Flight Center, Greenbelt, Maryland ⁴International Research Institute for Climate and Society, Palisades, New York ⁵NOAA Climate Prediction Center, College Park, Maryland

KEY POINTS

Recognizing the sensitivity of likely impacts on California winter precipitation to El Niño intensity, and also recognizing the spread of possible outcomes even for a very strong El Niño (see Fig. 3), the outlook must be expressed probabilistically. Nonetheless, this brief assessment leads to the following key points:

- **Impacts are likely to be greater in late winter than early winter.**
- **Southern California has a stronger chance of wet conditions than northern California.**
- **In case of a very strong El Niño, heavy precipitation is more likely across the entire state.**

During 2011-15, California experienced the driest four successive winters since 1895. Dry conditions have been widespread and, according to the U.S. Drought Monitor for August 2015, all of California is in severe to exceptional drought. Recent research* has demonstrated that sea surface temperature (SST) anomalies - cool conditions in the central to eastern equatorial Pacific and warm conditions in the west Pacific and Indian Ocean - were important factors contributing to the drought. This SST pattern has now changed. A developing El Niño, with strong warming of the east equatorial Pacific and cooling of the tropical west Pacific and North Pacific, reverses many of the anomalies prevailing during 2011-15. This El Niño ranks among the strongest in the historical record for this time of year and forecast models predict it to last into 2016.

How does El Niño alter risks for wet and dry winters over California? Is El Niño's impact over northern and southern California different? Do very strong El Niños (of which only1982/83 and 1997/98 have occurred since 1895) exert effects distinct from more typical El Niños? The NOAA Drought Task Force (DTF) report noted that statewide wet California winters since 1895 (top 15%) tend to occur during El Niño events but here, to address the questions above, two analyses are presented; observed historical relationships between El Niño and California rain and climate simulations of those relationships. The latter has the attribute that many more samples of California precipitation during very strong El Niños are created using ensemble methods. On the basis of these diagnoses and the current SST forecast, an indication for the range of winter precipitation that can be expected for the upcoming 2015/16 winter is provided.

Southern California has stronger chance of wet conditions than northern California: Fig.1 at right shows anomalies of SST, 200mb

*(Wang and Schubert 2013; Seager et al. 2014, NOAA Drought Task Force report, http://cpo.noaa.gov/mapp/california droughtreport

N. America Composite Anomalies

Precipitation Percent of Climatology (land), SSTA (ocean), 200 mb Height (contour)

NDJ FMA

Weak El Niño: 0.5°C < NINO3.4 < 1.0°C

Moderate to Strong El Niño: 1.0°C < NINO3.4

FIG. 1

Anomalies of SST (colors, ocean; NOAA ERSSTv4), precipitation (colors, land; GPCC % of average) and 200MB geopotential heights (contours; NOAA 20th Century Reanalysis) for weak (top) and moderate-strong (bottom) El Niños. All relative to a 1901-2015 climatology. El Niño strength is evaluated with the NINO3.4 index SST anomaly averaged over 5°N to 5°S and 170°W to 120°W with weak El Niño defined as between 0.5°C and 1°C and moderate-strong El Niño as greater than 1°C.

Relevant new activities

- **Projects focused on:**
  - Monitoring soil moisture and snow
  - Flash droughts
  - Products on HUCs
  - Climate teleconnections
  - S2S predictability and model performance
    - Atmospheric Rivers
    - Land Surface Feedbacks
    - Troposphere/Stratosphere connections
    - Extratropical storm tracks
    - Tropical controls on U.S. climate and weather

- **The Subseasonal Experiment (SubX)**
  - Multiple models participating in a coordinated experiment to improve predictions and prediction skill at subseasonal timescales
  - Multiple modeling and prediction centers: NOAA, NCAR, Environment Canada, NASA, Navy
  - Building on NMME experience