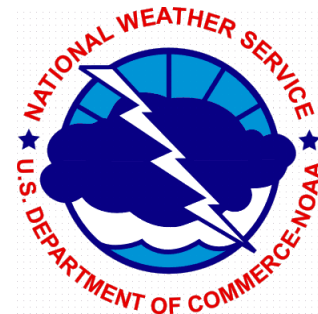




Western States Water Council and California Department of Water Resources

Improving Forecasting Weather to Climate Time Scales
May 27, 2012

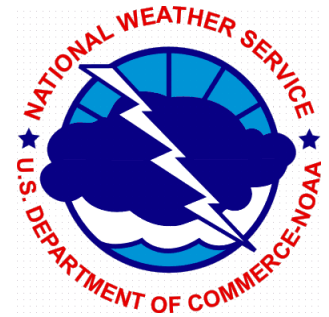
Roger V. Pierce
Meteorologist -in- Charge
National Weather Service Forecast Office
San Diego CA

Who Are We?



A government agency

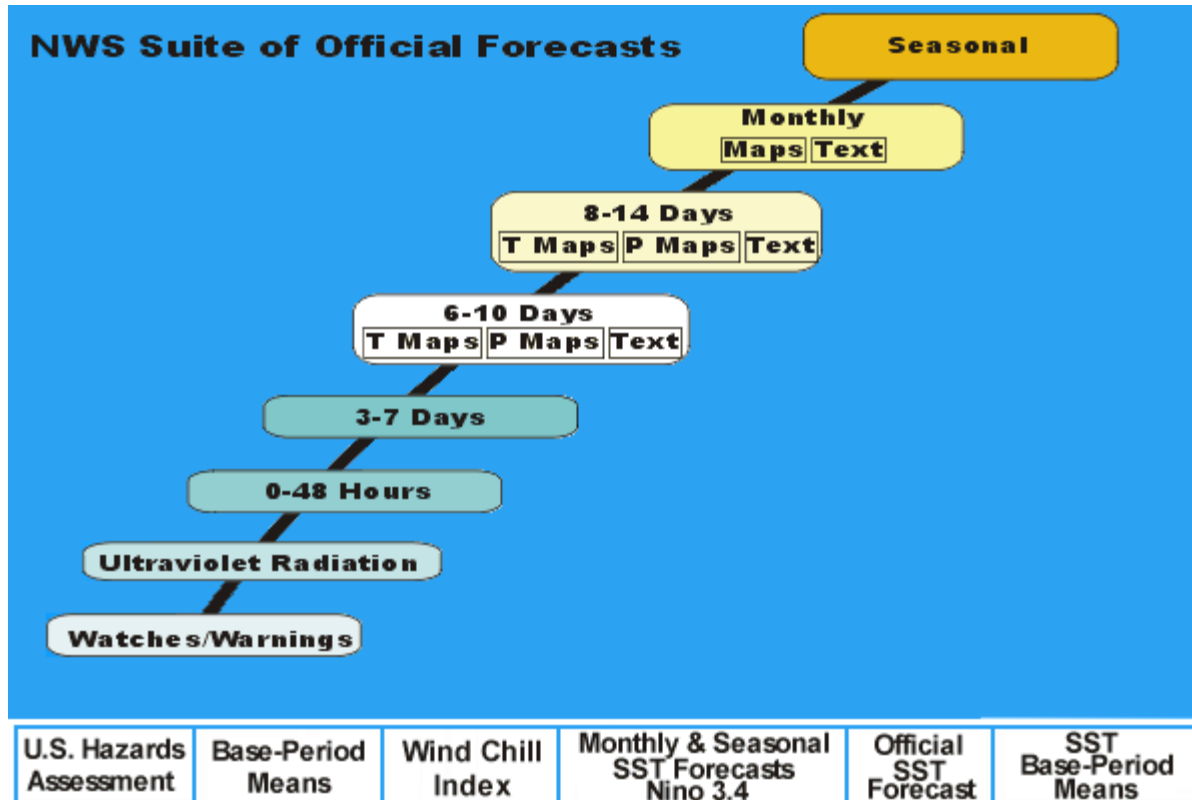




Mission- to provide forecasts and warnings:

- The protection of life and property
- The enhancement of the national economy
- The NWS is the official voice for issuing forecasts and warnings during life-threatening weather.
- Zero to 7 days in advance (10 in discussion)

NOAA – National Weather Service

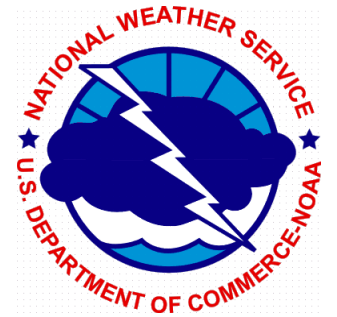


San Diego Forecast and Warning Area





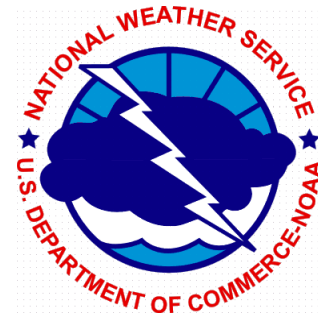
Meteorological Forecasting



- Focus not just on San Diego – but California and the west
- Great opportunity to work with DWR and WSWC
- 0 – 10 days / NWS Climate Prediction Center
10 days and beyond



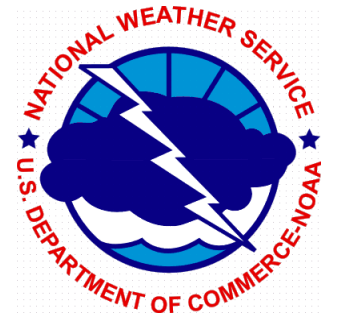
Images for Extreme Weather



Confluence of Mississippi and Missouri Rivers, August 1993. Extensive floods in the Mississippi River basin during the spring and summer of 1993 caused \$20 billion in damages. (Photograph, Sranco Photography, St. Louis, Mo.)

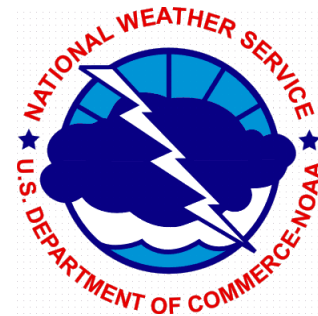


Extremes in the West



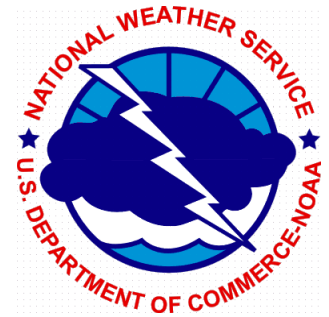


Extremes Forecasts





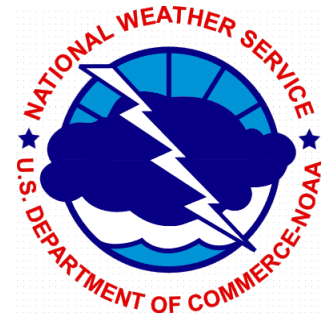
How Do We Improve Forecasts?



- People...People...People
 - Science...Communications...Training
- Data...Data...Data
 - Instruments...Sensors...Satellites
- Computers...Computers...Computers
 - Time...Comms...Programming



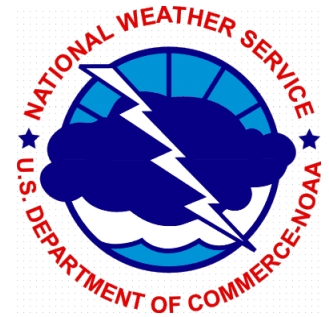
Scale / Forecast Funnel



- Global picture – large scale global storms and how they will impact your individual area
- Continental Picture / United States and adjacent waters
- Western US and Eastern Pacific area
- SoCal - coastal waters / AZ / NV
- Mesoscale – mountains/passes/coastal zones

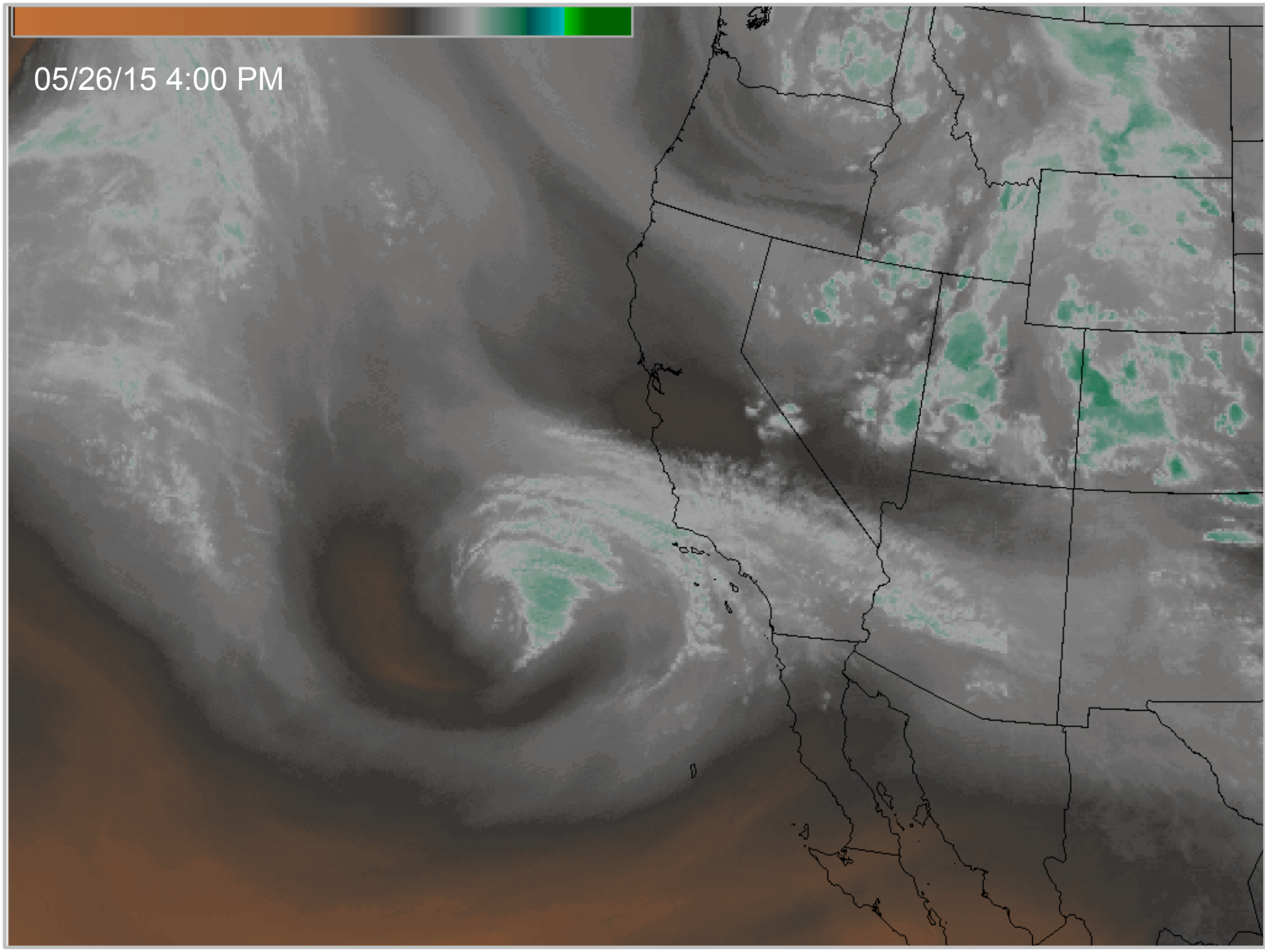


Scale / Forecast Funnel



- Start with a global picture.... Satellites
- Yes there is more than just satellite data:
 - Balloons – sounding data
 - Aircraft data –
 - Profilers
 - Surface based observations – airports / ship reports
 - Buoys -
 - Mesonet data for great localized surface data

05/26/15 4:00 PM



05/26/15 11:00 AM

OXNARD

+
DOWNTOWN
LOS
ANGELES

+
RIVERSIDE

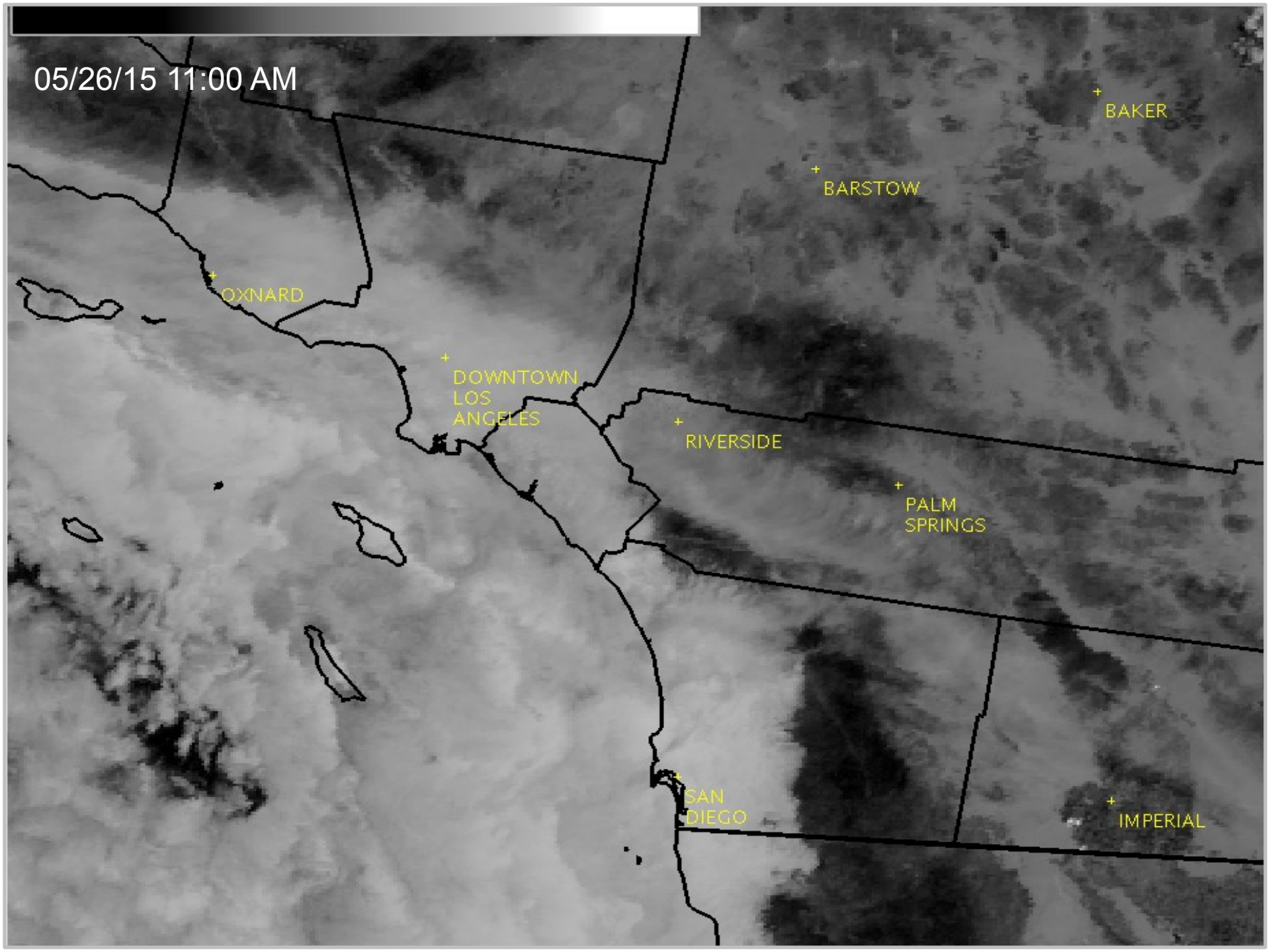
+
PALM
SPRINGS

+
SAN
DIEGO

+
IMPERIAL

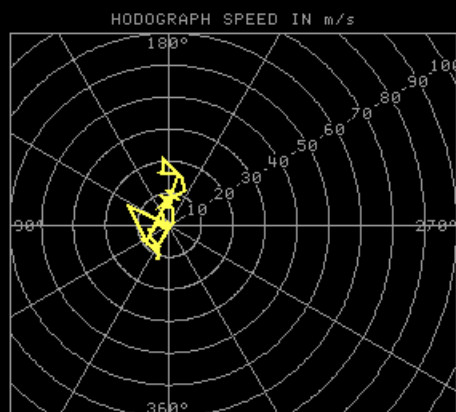
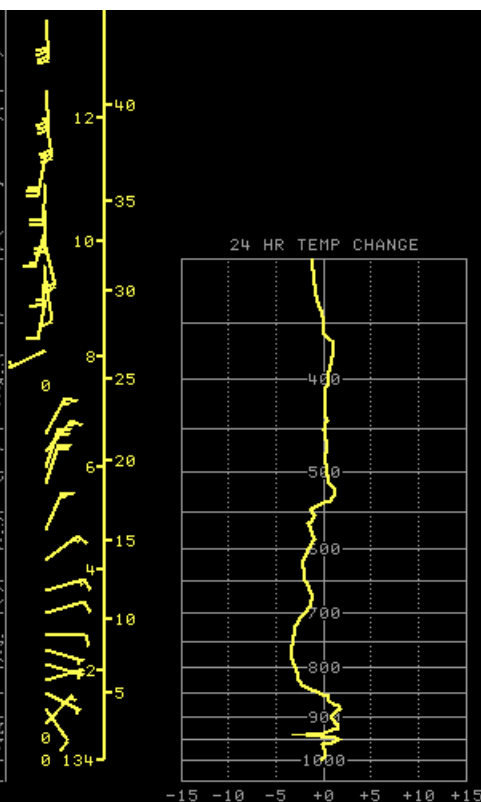
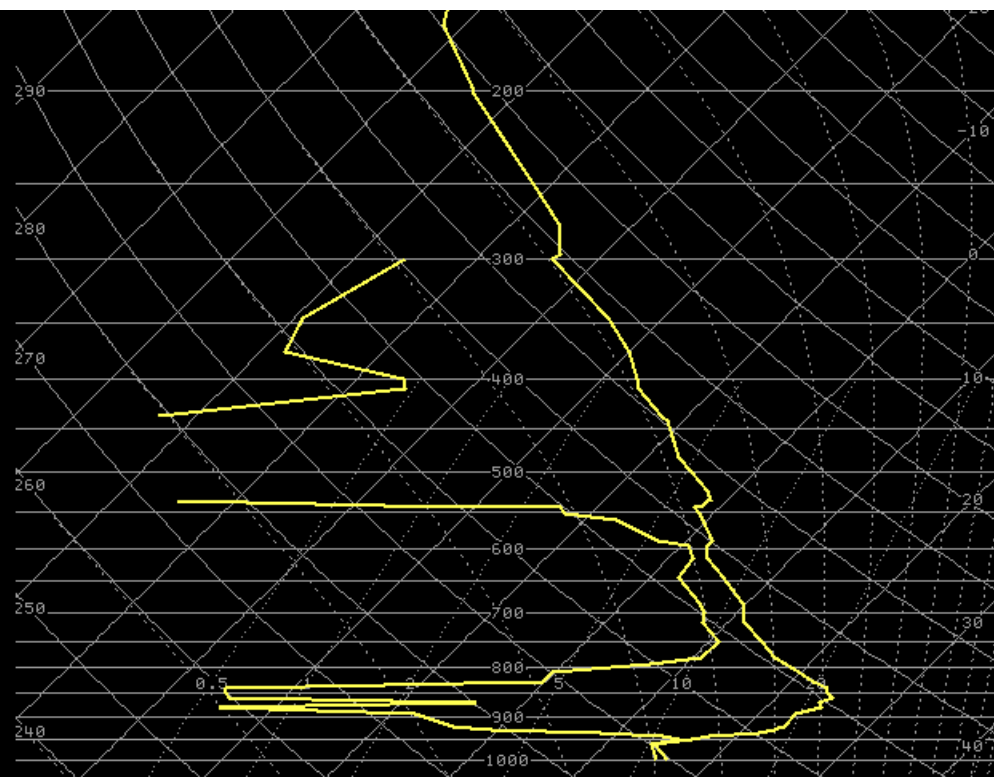
+
BARSTOW

+
BAKER



Radiosonde Launch



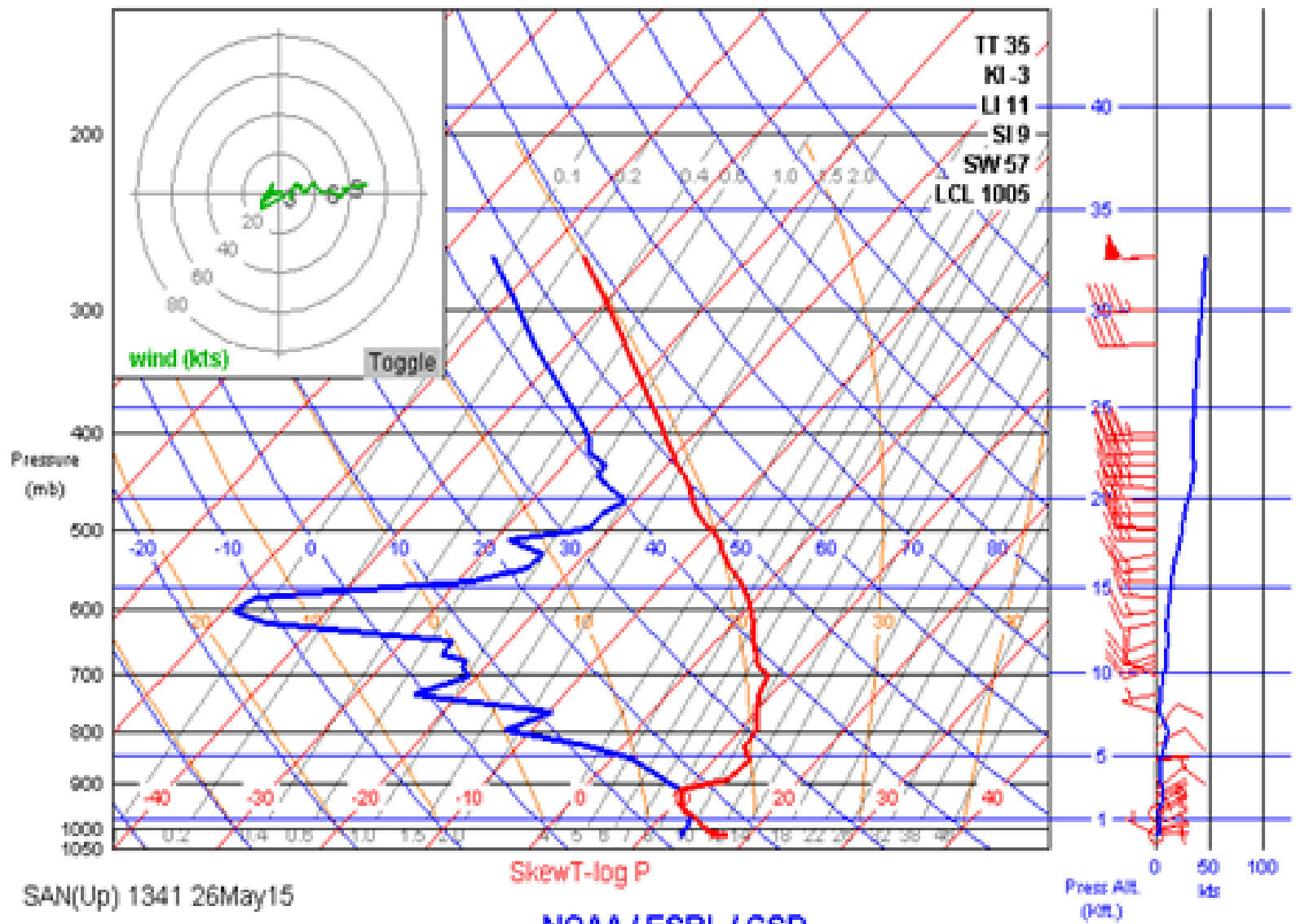


PRECIP WATER= 1.23 in
 K-INDEX= 1
 TOTALS INDEX= 9
 SWEAT INDEX= 28
 DRY MICROBURST POT=1: GST < 30 kts
 FREEZING LEVEL= 16112 ft ASL
 WET-BULB ZERO HGT= 15049 ft ASL
 0-6 KM AVG WIND= 56°/7 kts
 0-6 KM STM MTN (30R75)= 86°/5 kts
 0-3 KM STM REL HELICITY= -3 m²/s²
 FORECAST MAX TEMP= 99° F
 TRIGGER TEMP= 32° C/89° F
 SOARING INDEX= 98 ft/min
 MDPI/WINDEX = 0.01/0

* -PARCEL- T=FCST MAX;Td=50 mb MEAN
 * MOD PARCEL P= 997 mb
 * MOD PARCEL T/Td= 98/59° F/36/15° C
 * CONVECTIVE TEMP= 62° F
 * LIFTED INDEX= 0.4
 * CCL= 1230 ft ASL/ 970 mb
 * LCL= 9329 ft ASL/ 727 mb
 * LFCs= 13369 ft ASL/ 626 mb,
 15829 ft ASL/ 571 mb
 * MAX HAILSIZE= 1.6 cm/0.6 in
 * MAX VERTICAL VELOCITY= 18 m/s
 * EQUIL LEVEL= 33382 ft ASL/280 mb
 * APPROX CLOUD TP= 44619 ft ASL
 * POSITIVE ENERGY ABV LFC= 178 J/KG
 * NEGATIVE ENERGY BLW LFC= -128 J/KG
 * BULK RICHARDSON NUMBER= 21.5

KNKX Skewt Mon 12:00Z 30-Jul-12

Ascent (AC# 11113), valid 26-May-2015 13:41:00 (-9999.0nmv0° from SAN)



Commercial Aircraft Observation



Standard - Aviation Surface Observation System





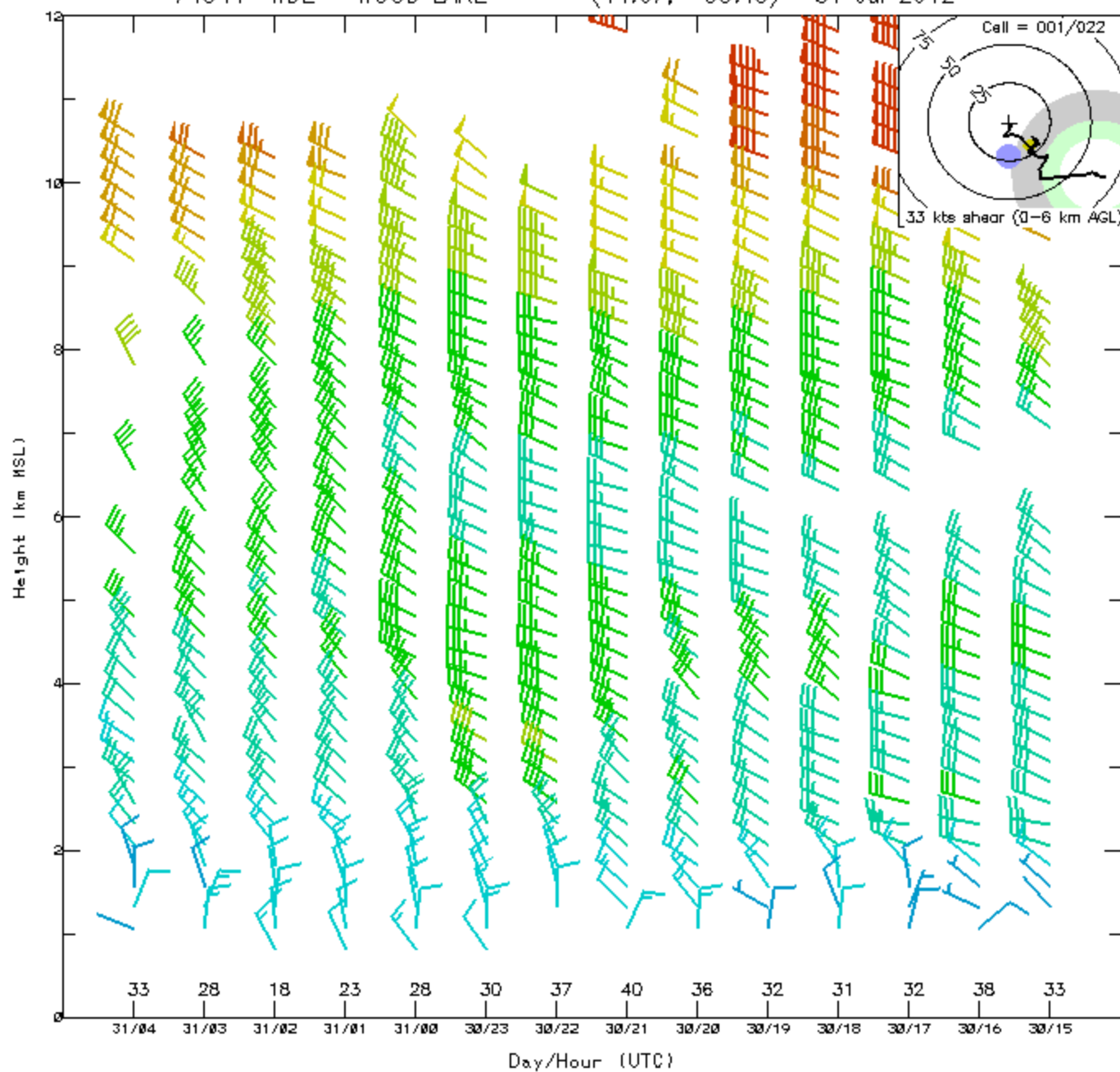
Profiler site at Central, AR

NOAA OAR

74341 WDL - WOOD LAKE

(44.67, -95.43)

31 Jul 2012



Tools for Water in a Changing Climate



Tools for Water in a Changing Climate





WSR-88D

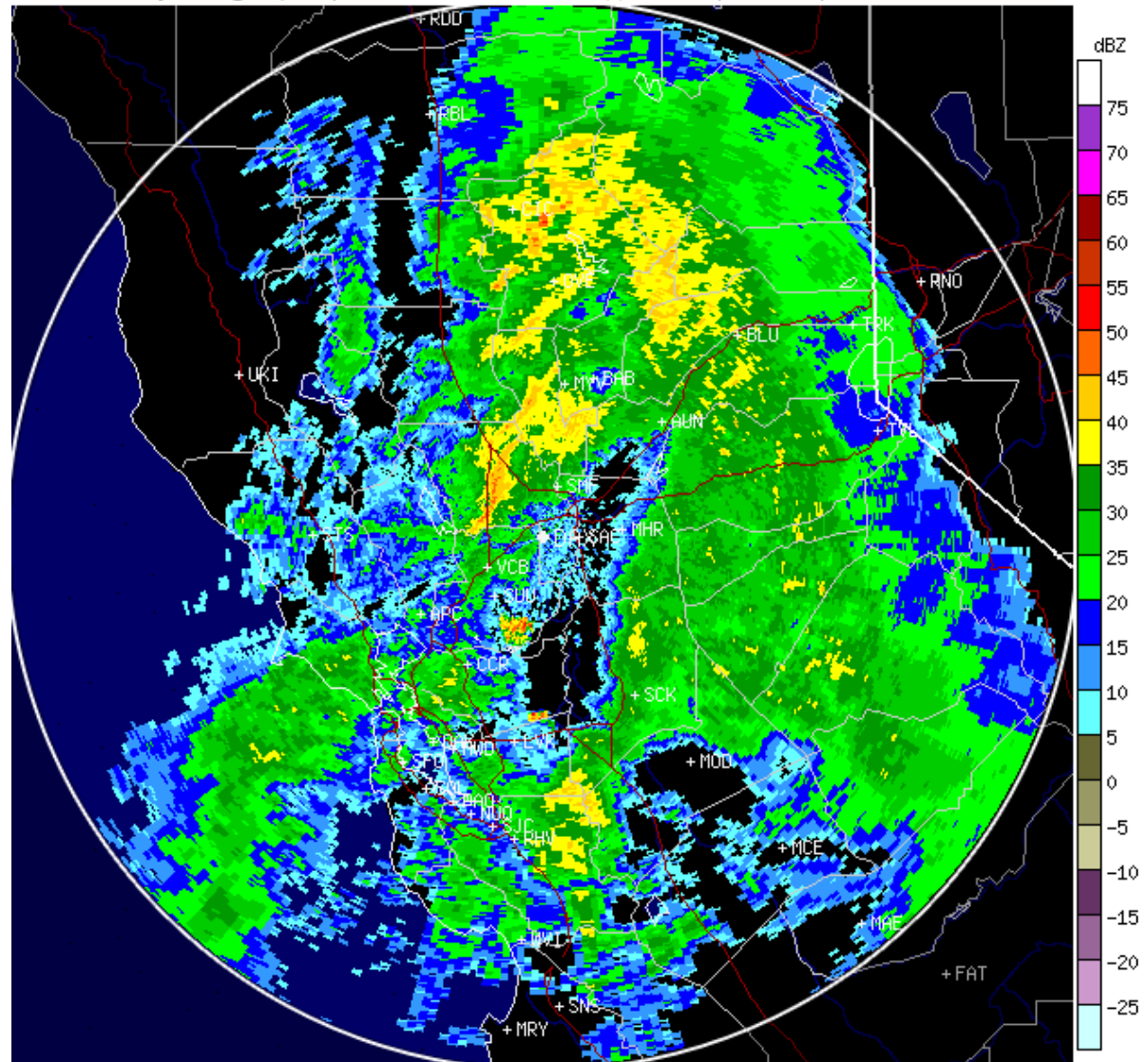
Sacramento Radar on
Friday at about 10 am.

Red's and bright yellows
indicating heavy rainfall.

KDAX -- Sacramento, CA
Base Reflectivity: 0.5 degrees, Precip Mode

11:59:25 UTC Fri 30 November 2012

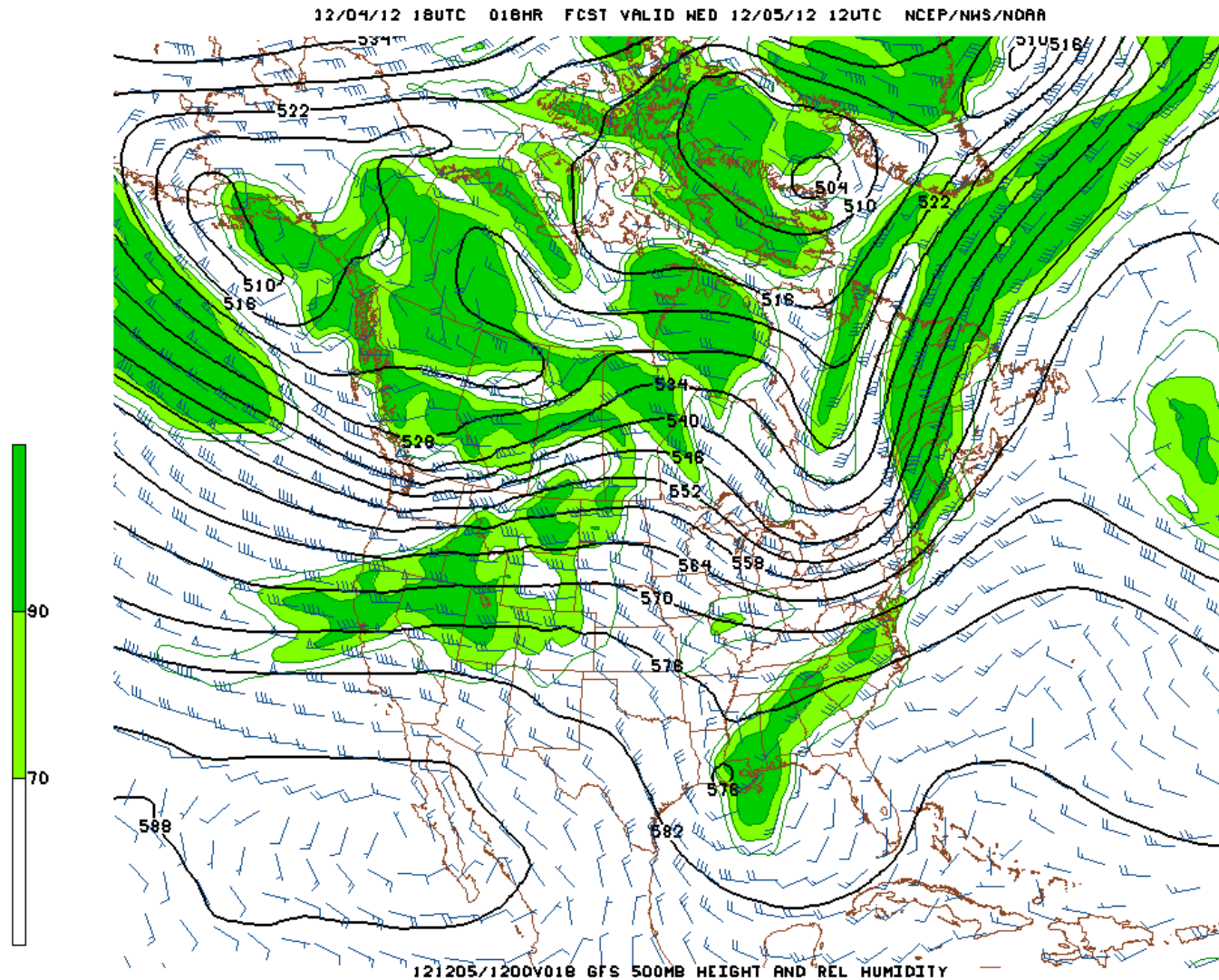
(c) UCAR <http://www.rap.ucar.edu/weather/radar/>

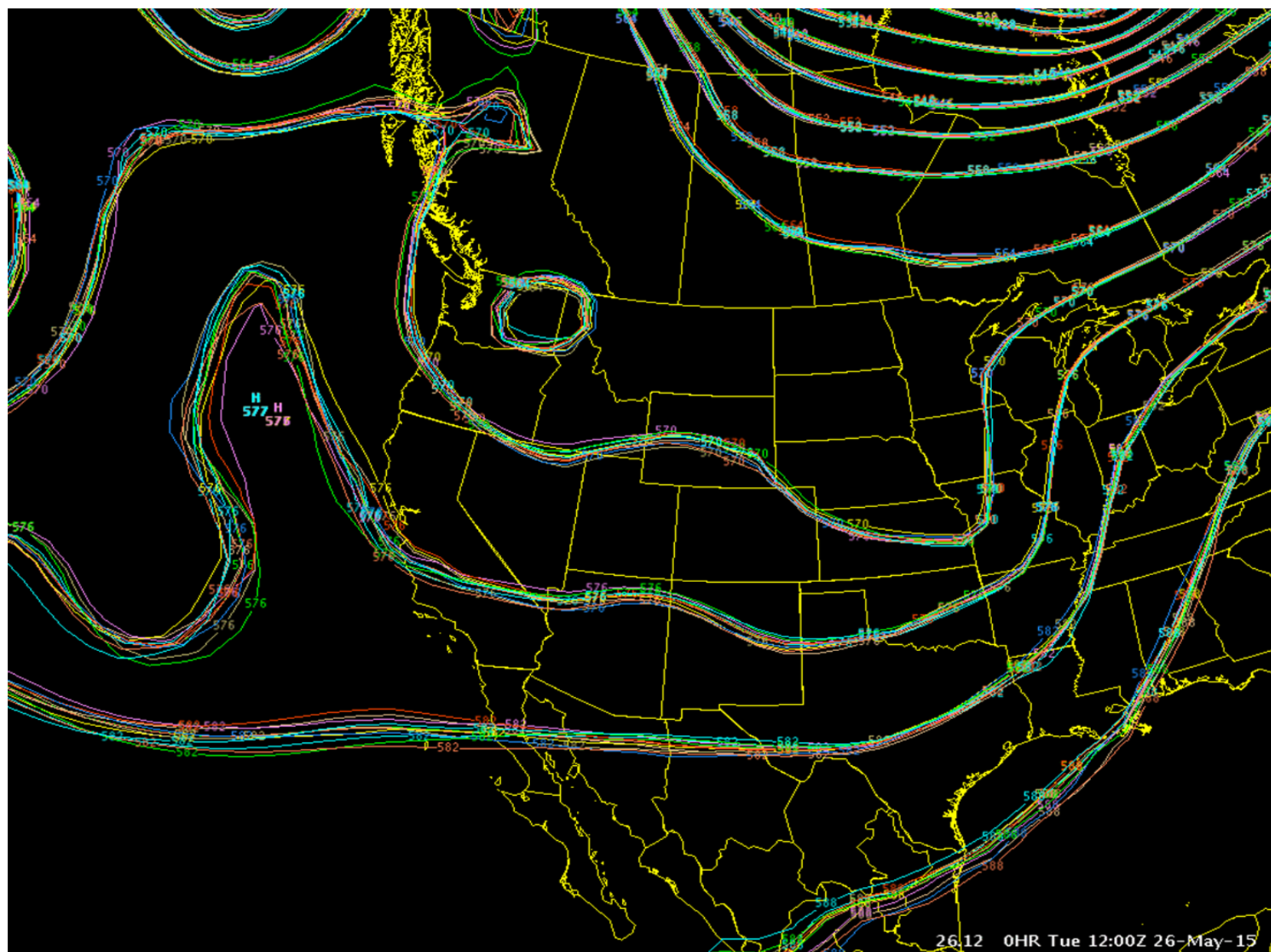


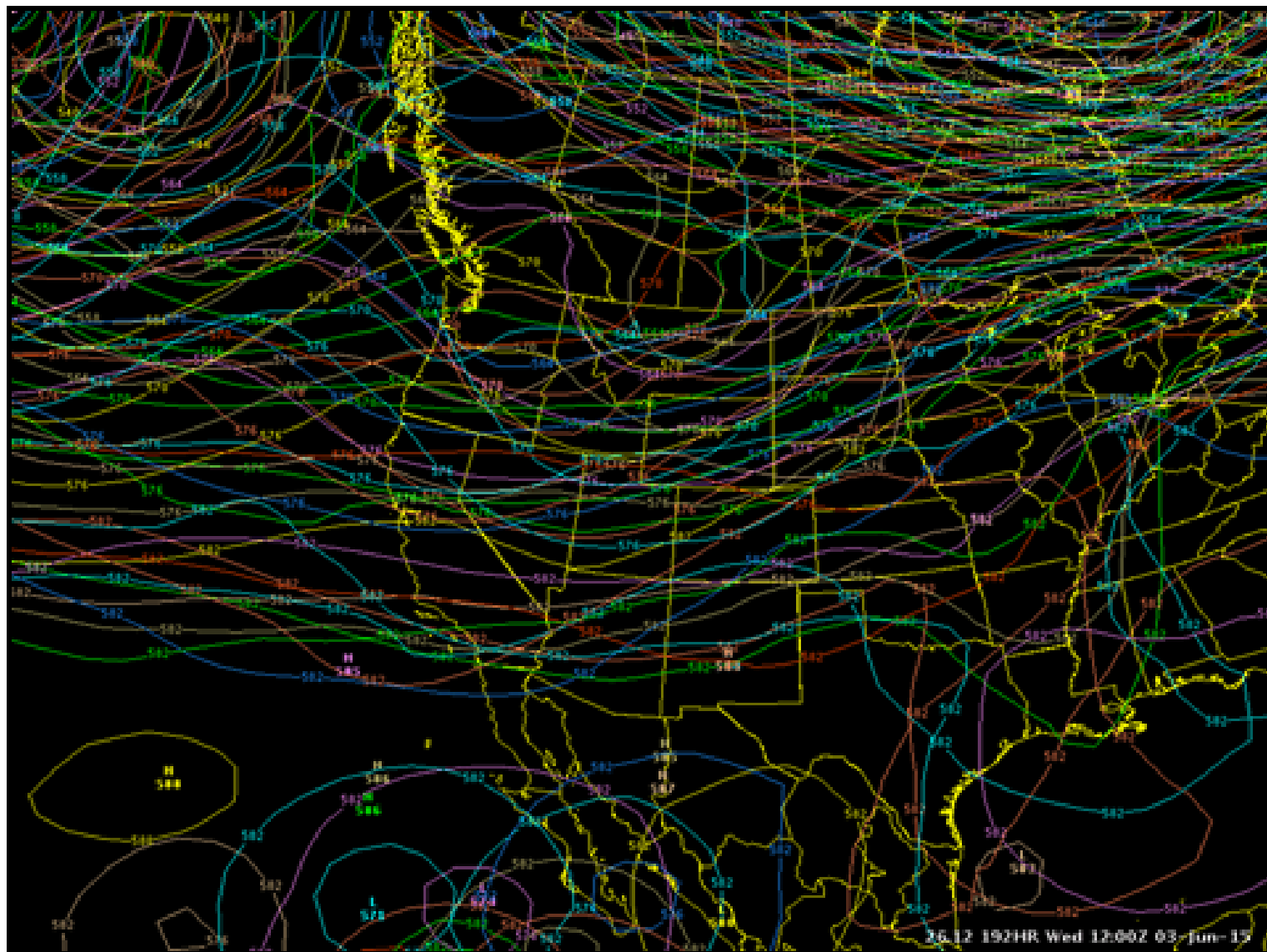
Other Data

- MesoWest – University of Utah – citizen weather observers to corporate weather observing companies with surface data – user beware.
- GPS – Water Vapor
- Unmanned Aerial Systems
- Hurricane Hunter Aircraft
- COOP Data

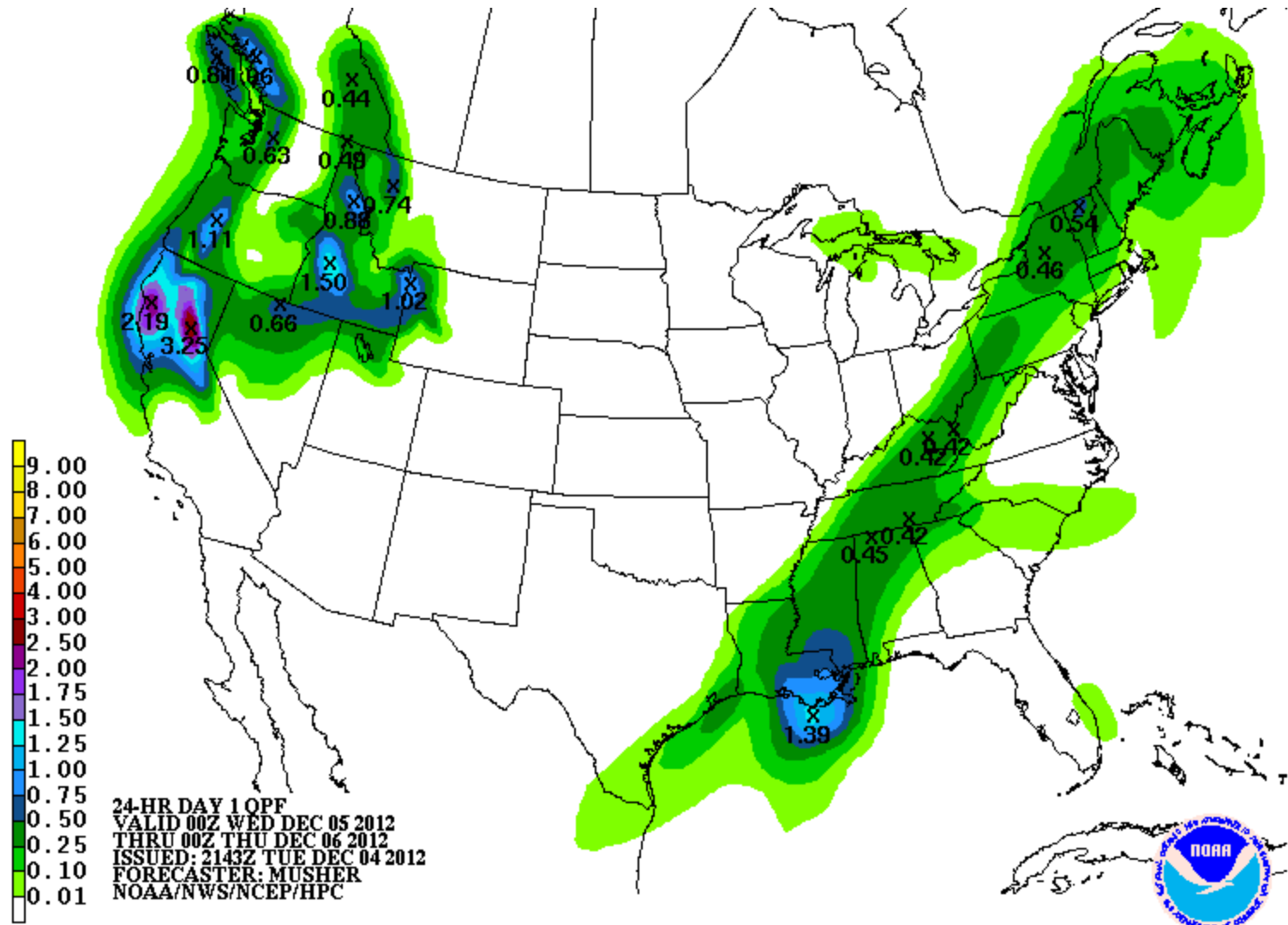
Numerical Weather Models

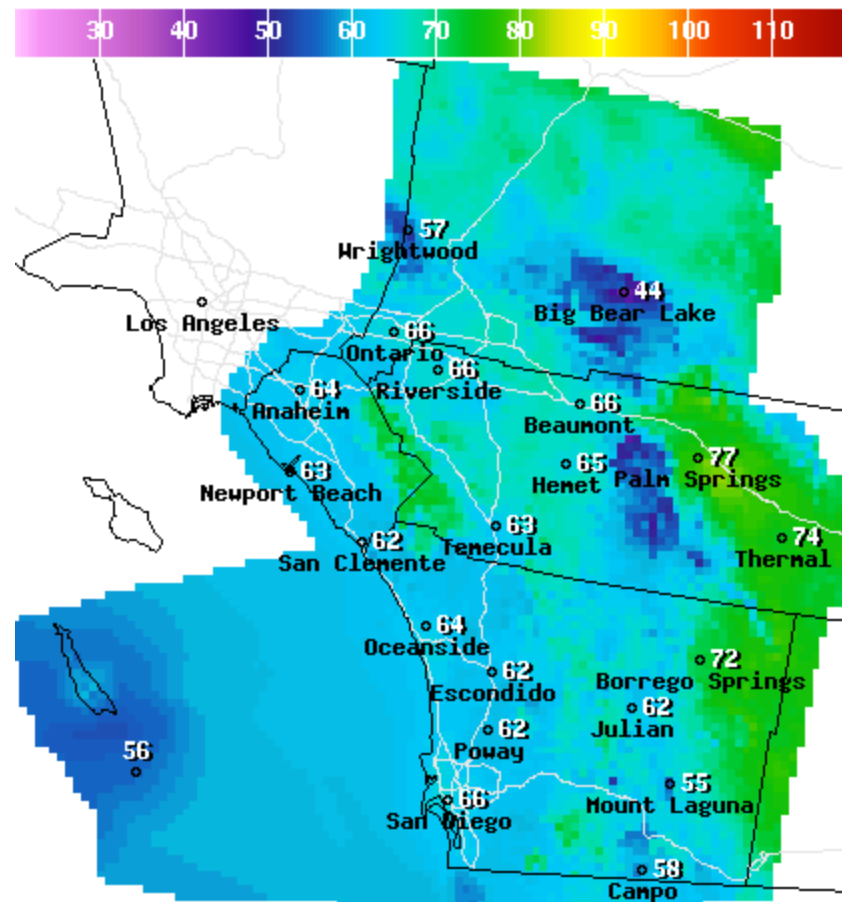






24 hour Quantitative Precipitation Forecast





Low Temperature(F) Ending Tue Jul 31 2012 11AM PDT
(Tue Jul 31 2012 18Z)



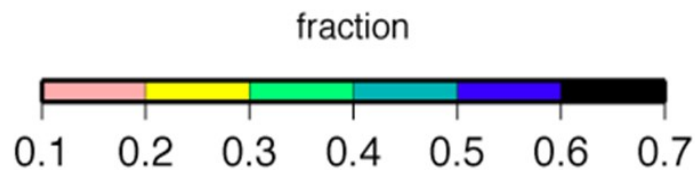
NWS San Diego, CA

Graphic Created Jul 30 8:49PM PDT



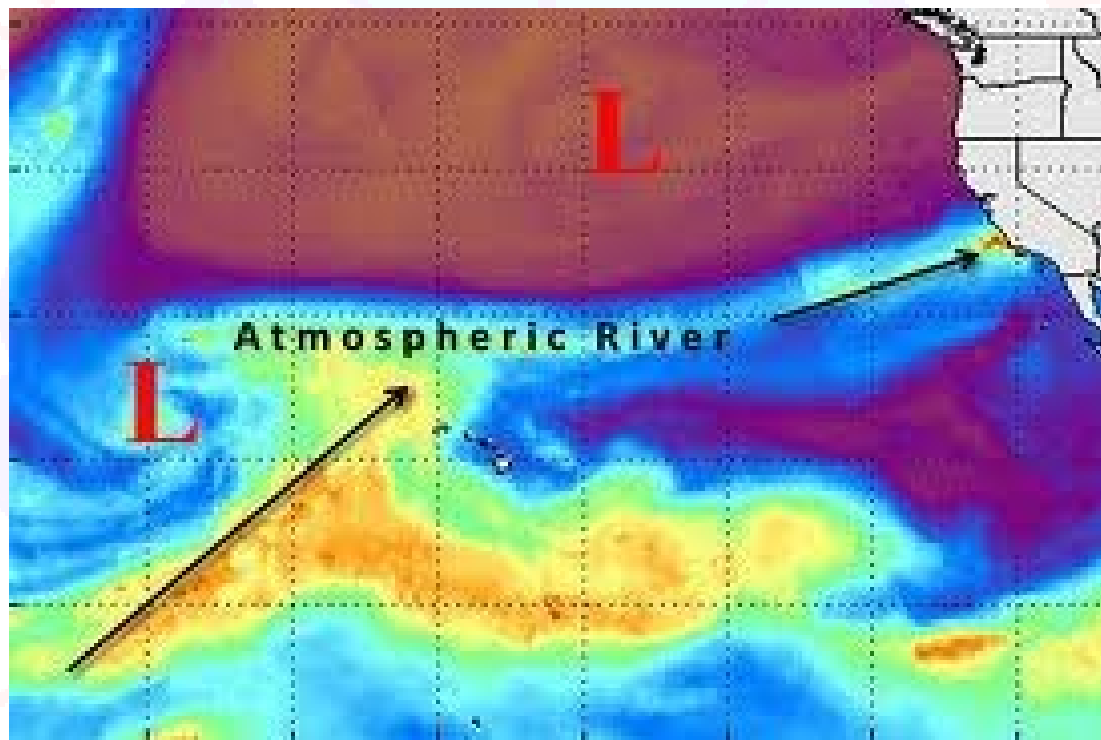
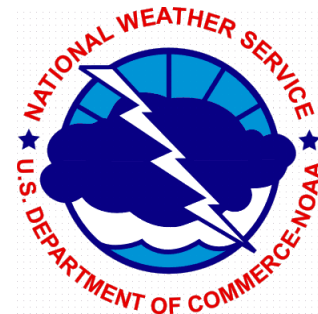
a) COEFFICIENTS OF VARIATION OF
TOTAL PRECIPITATION, WY 1951-2008

**SOUTHWEST U.S.
PRECIPITATION IS
UNIQUELY
VARIABLE**



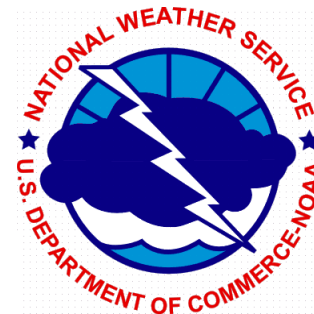


Pattern Recognition

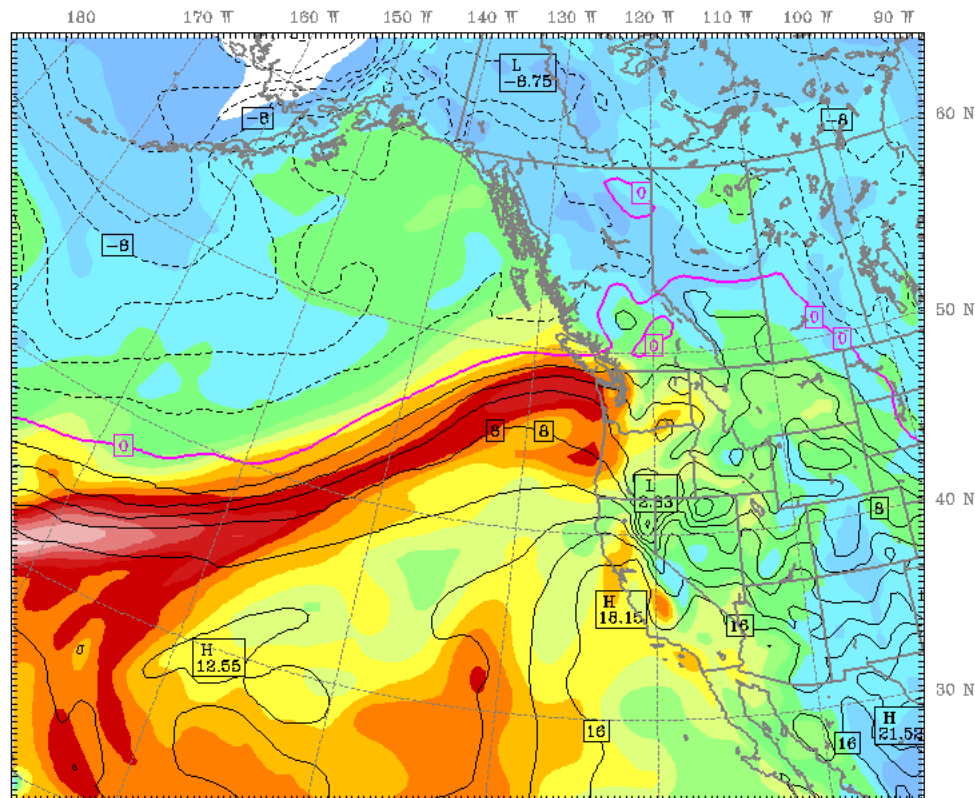




Pattern Recognition

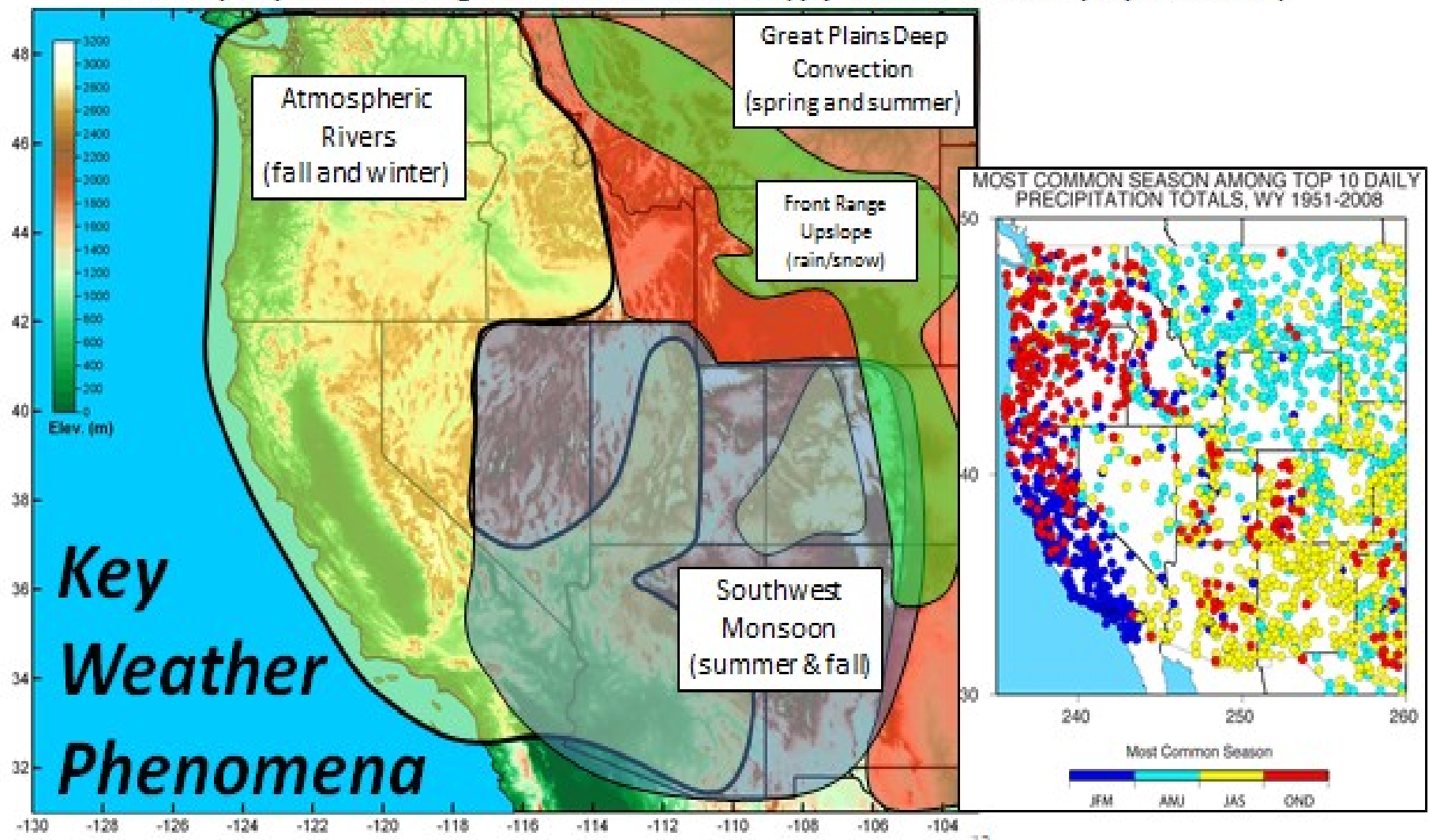


UW WRF-GFS 36km Domain Init: 12 UTC Tue 29 Mar 11
 Fcst: 39 h Valid: 03 UTC Thu 31 Mar 11 (20 PDT Wed 30 Mar 11)
 Column-integrated water vapor (mm)
 850 mb Temperature (C)



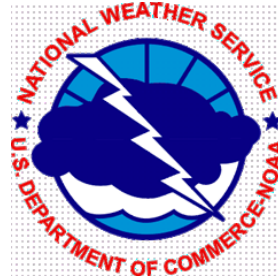
CONTOURS: UNITS=C LOW= -16.000 HIGH= 20.000 INTERVAL= 2.0000
 0 7.5 15 22.5 30 37.5 45 52.5 60 67.5 75 82.5 90 mm
 Model Info: V3.1.1 KF YSU PBL Thompson Ther-Diff 36 km, 37 levels, 216 sec
 LW: RRTM SW: Dudhia DIFF: simple KM: 2D Smagor

Schematic illustration of regional variations in the primary weather phenomena that lead to extreme precipitation, flooding and contribute to water supply in the Western U.S. (Ralph et al. 2014)





Longer Period Forecasts



- Oceanography – sea surface temperatures
- Global circulation patterns
- Modern era measurements – ie. outgoing longwave radiation
- Pattern recognition on a monthly to decadal scale
- Trend analysis
- Generalizations in forecasting and skill

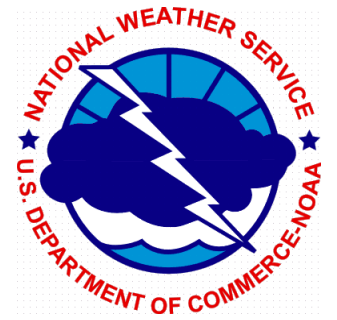


Key Science Gaps

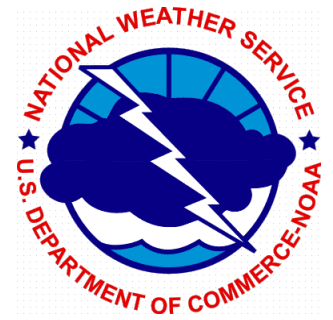


Major goal: Measure influx of moisture to California from landfalling atmospheric rivers and study the influence of transported (cross Pacific) or local (Central Valley) aerosols on precipitation from the coast to Sierra

- **Evolution and structure of ARs**, including quantifying terms in the water vapor transport budget (air-sea flux, rainout, frontal convergence, entrainment from tropics)
- **Prediction of aerosols and properties** during intercontinental transport to the U.S. West Coast, including dust, biological and ice nuclei
- **Effects of climate variability and change** on these phenomena



- **What does your customer want? –**
Match the desires of the customer to the science
- **Improve the science -**
- **Infuse new technology -**
- **Improve products –**
- **Private – Public Partnerships**



www.weather.gov – U.S. point and click weather

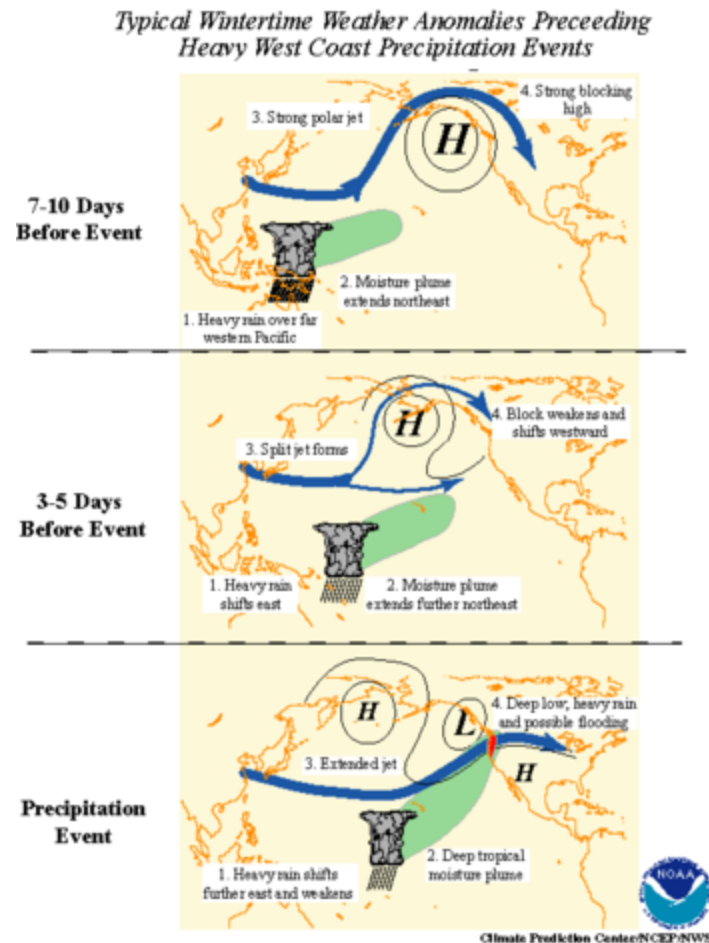
www.weather.gov/sgx - San Diego point and click

www.ncep.noaa.gov – NWS National Centers for
Environmental Prediction

-longer range forecasts – Climate Prediction Center

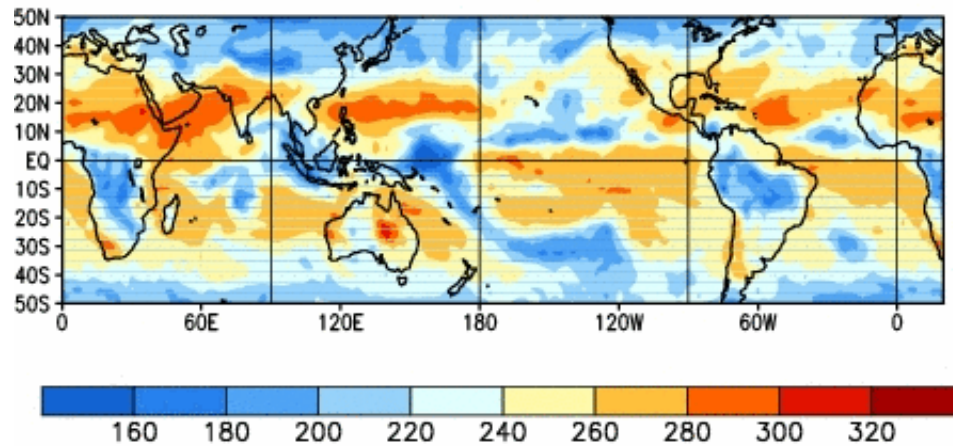
-shorter range forecasts – Weather Prediction Center

Madden-Julian Oscillation

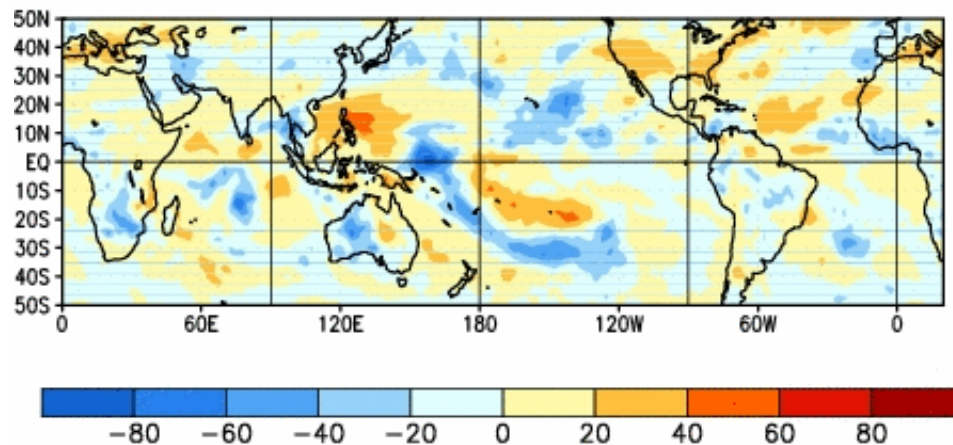


Outgoing Longwave Radiation

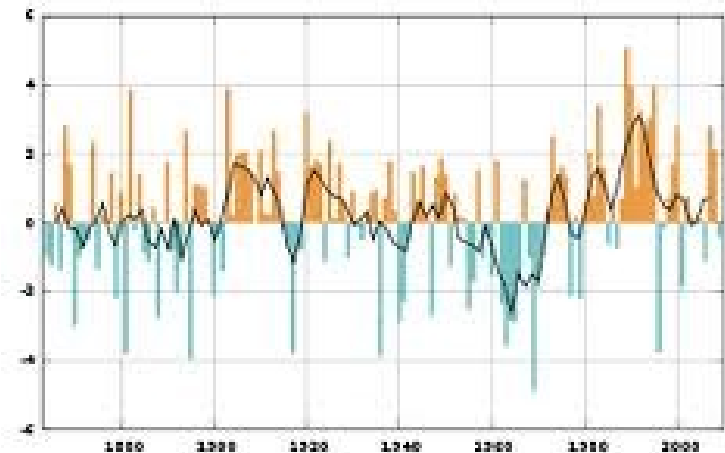
OLR Pentad Centered on 24 NOV 2012



OLR ANOMS Pentad Centered on 24 NOV 2012



North Atlantic Oscillation

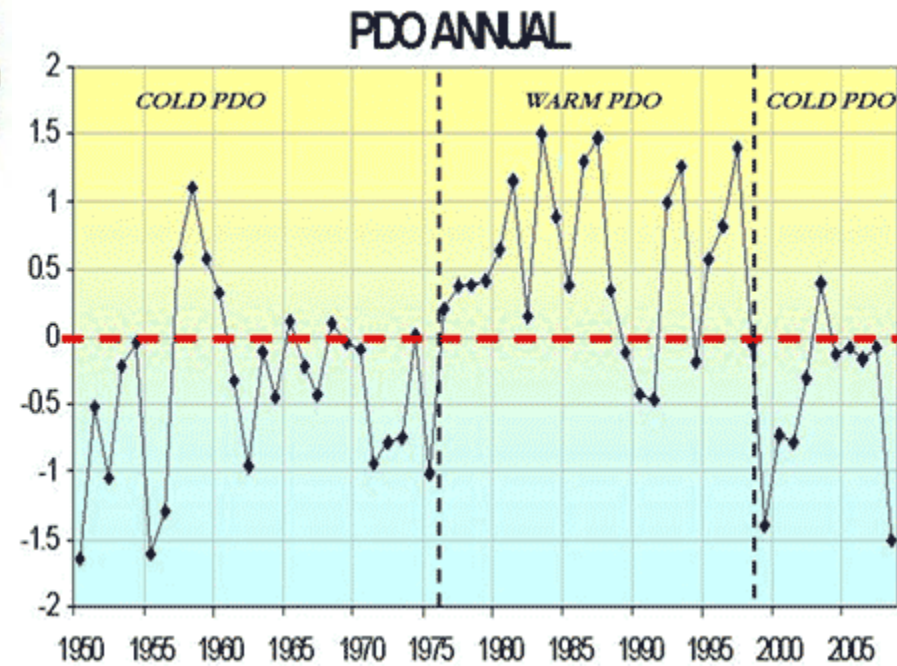
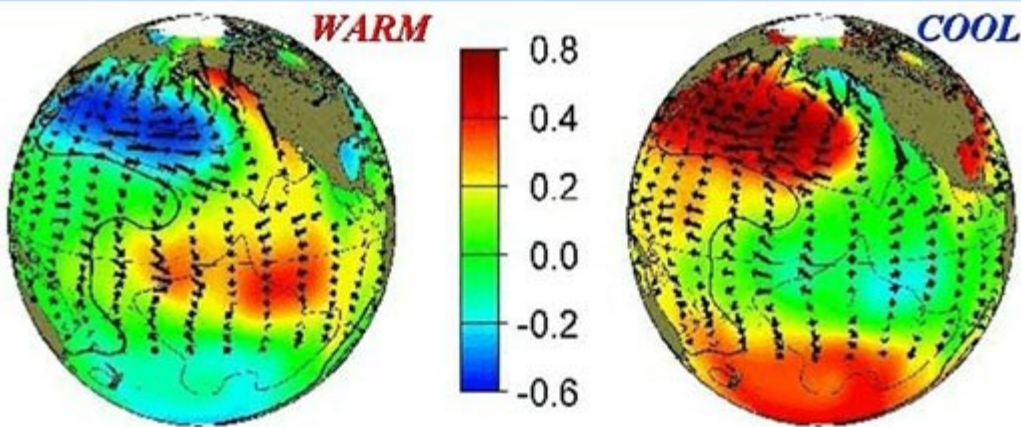


- Lisbon, Portugal and Stykkisholmur/Reykjavik, Iceland
- [Azores high](#) and the [Icelandic low](#)

Pacific Decadal Oscillation

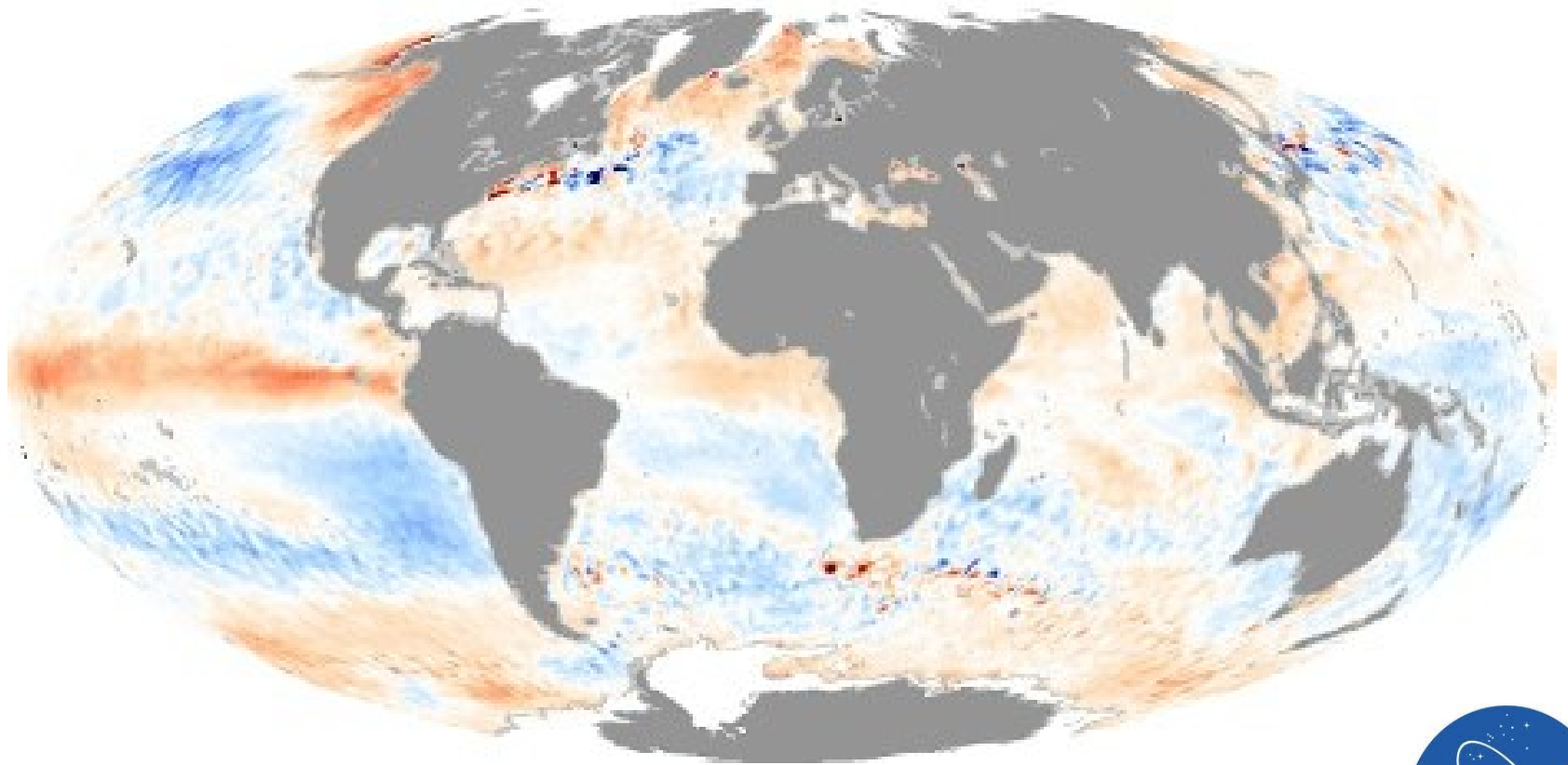
Pacific Decadal Oscillation

University of Washington and JPL scientists (*Mantua, etal*) found a decadal scale oscillation in the Pacific they call the PDO



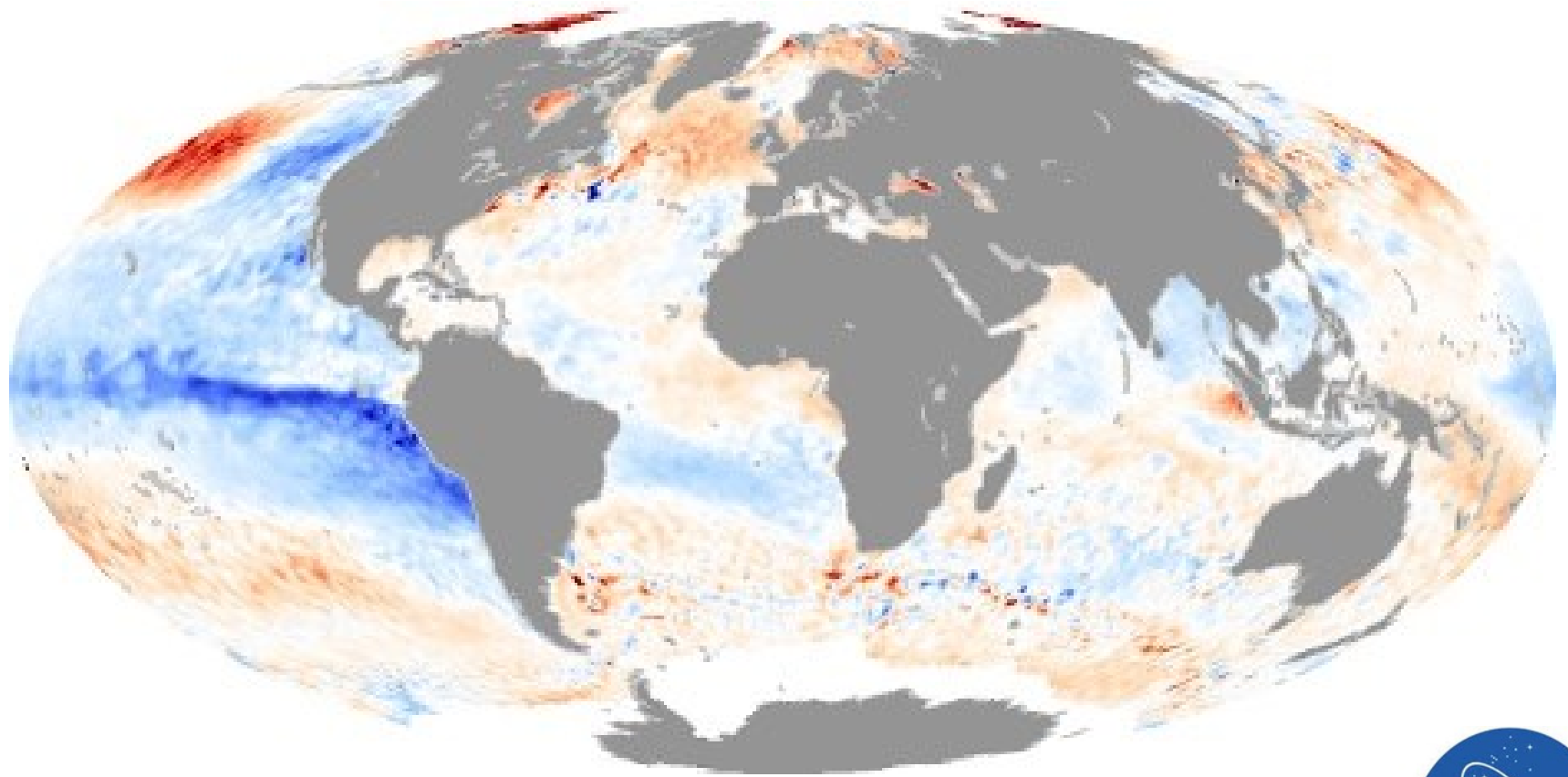
El Nino

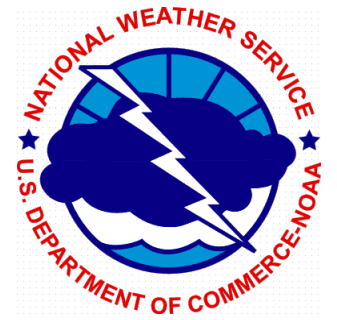
- Nov 2002



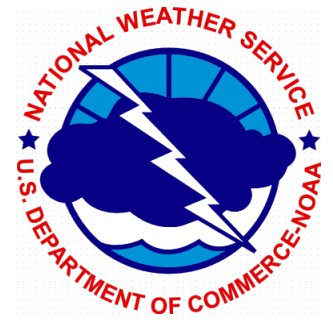
La Nina

- Nov 2007





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- **Infuse new technology -**
- **Improve products –**
- **Private – Public Partnerships**



www.weather.gov – U.S. point and click weather

www.weather.gov/sgx - San Diego point and click

www.ncep.noaa.gov – NWS National Centers for
Environmental Prediction

-longer range forecasts – Climate Prediction Center

-shorter range forecasts – Weather Prediction Center