



Understanding and Forecasting Atmospheric Rivers

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- Wes Junker – Former Lead Forecaster
HPC





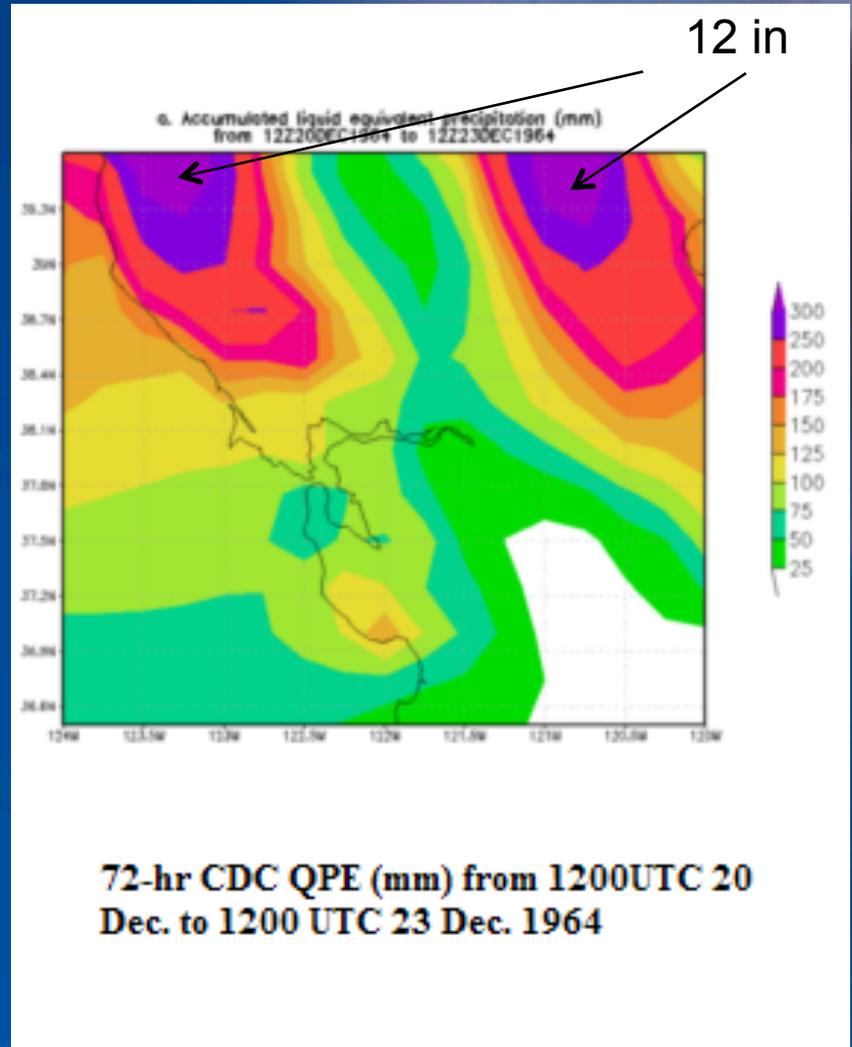
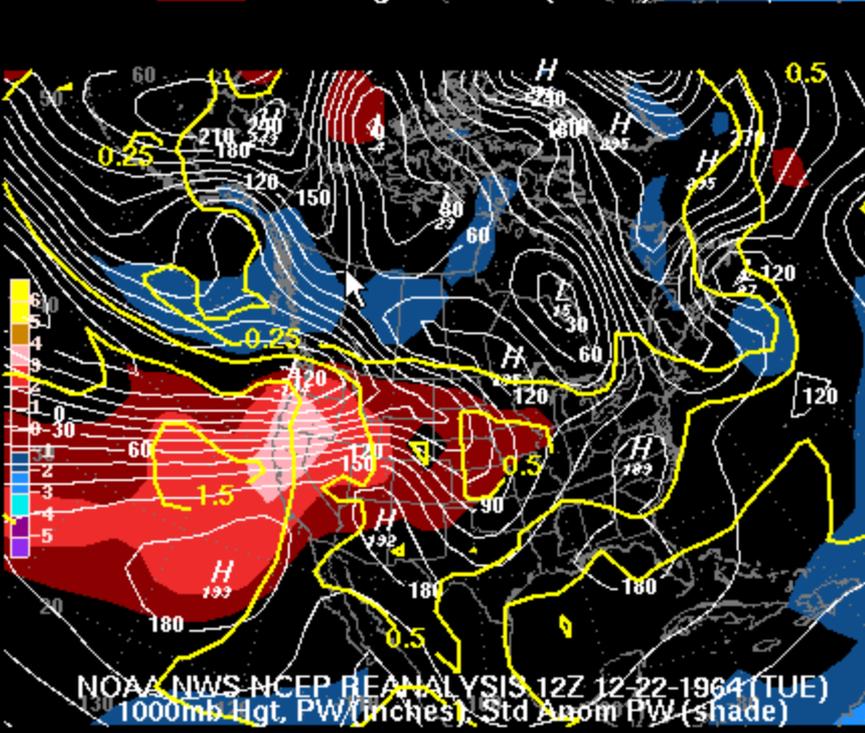
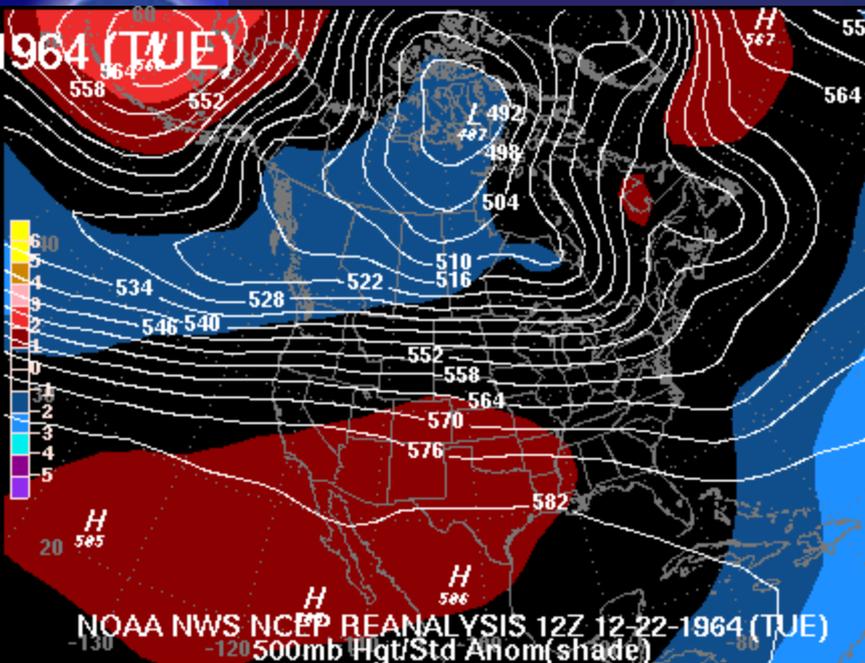
Outline

- Conceptual model of major flood patterns
- Observing an atmospheric river
- Forecast tools and methods
- Importance of lead time
- AR Scaling Factor?
- ARkStorm Forecast Scenario



Dec 1964 synoptic pattern

Ranked #1





Recent AR Event

- Columbus Day Storm October 13-14, 2009
- Very well forecast a week ahead as a significant high impact event – remnants of ex-typhoon involved
- Analogies made to Columbus Day 1962
- Rather poor rainfall forecasts even with 5 to 10 in forecast in 24 hrs (these are very unusual and large values). Underestimated by almost 10 in for wettest locations. 1500 - 2000% of normal rainy day in October!!

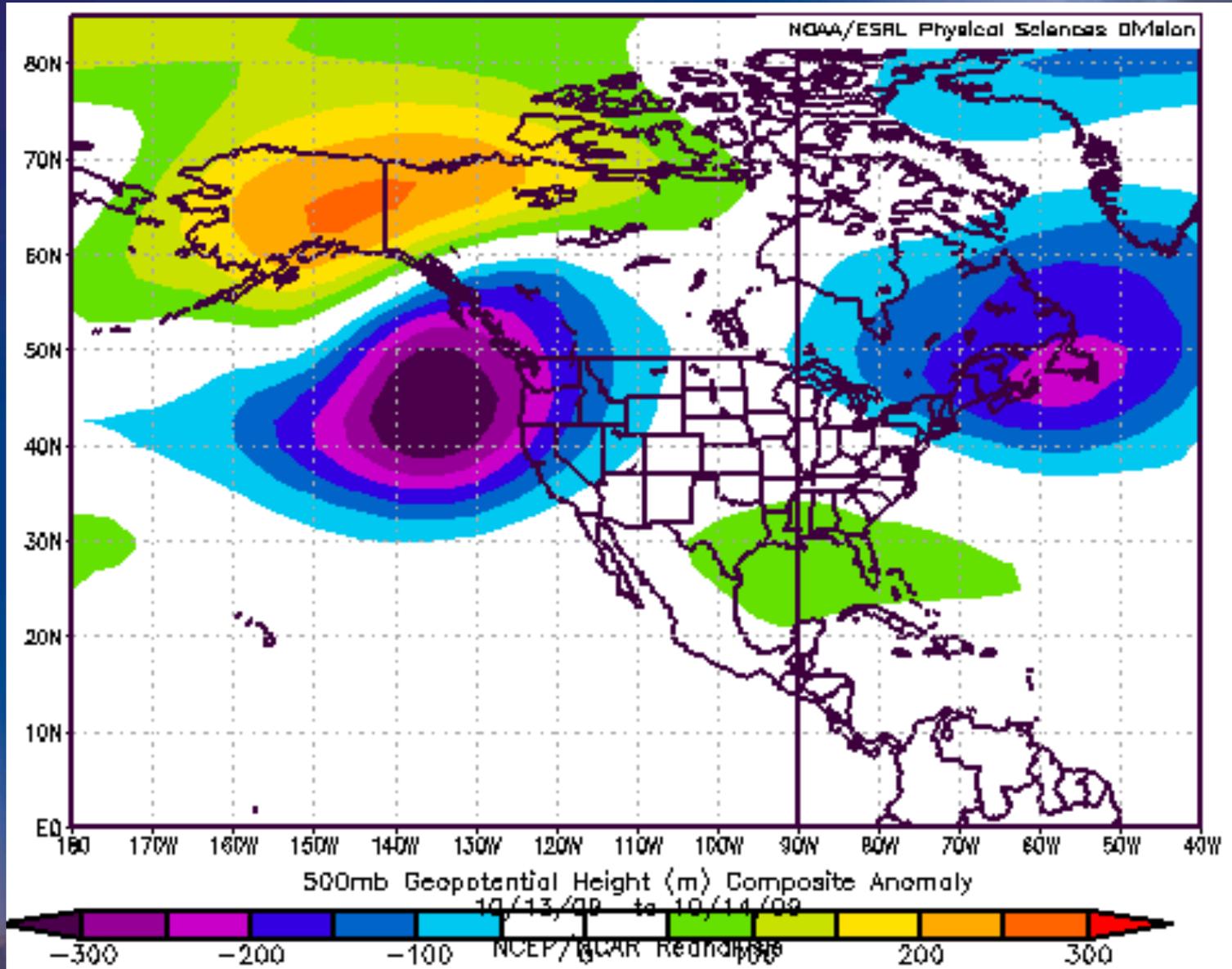


Acronyms

- LLJ- Low Level Jet – speed max lowest 3k ft
- IWV- Integrated Water Vapor – sfc to top of atmosphere. Larger value more rainfall potential.
- $IWV * LLJ =$ potential rainfall rates – $IWV > .8in$ and $LLJ > 25$ kts – Atmospheric River

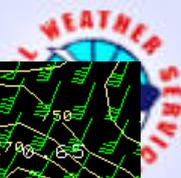


500 mb anomaly chart for Oct 13-14 2009



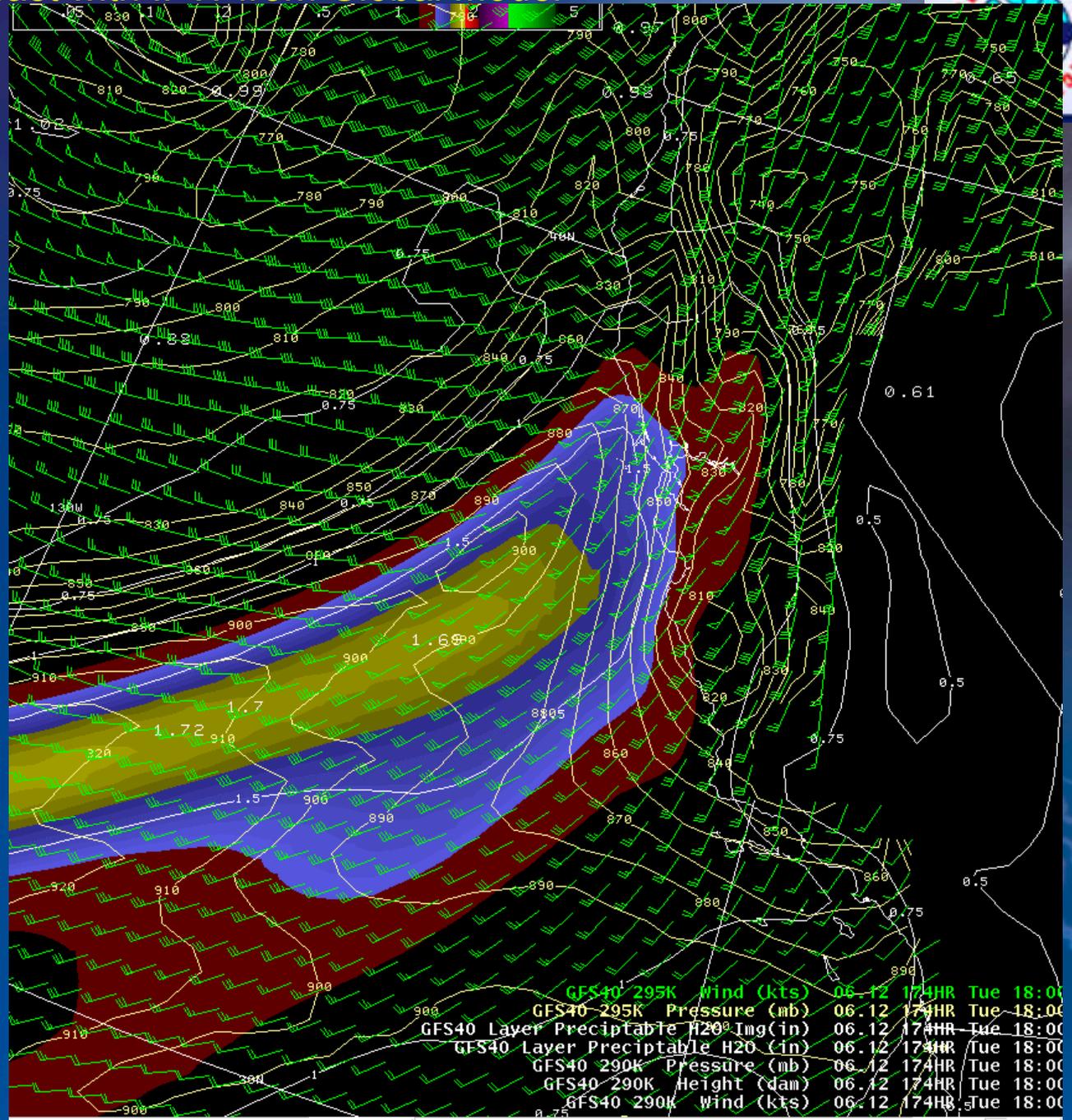


7 day Forecast with IPW from Global Model



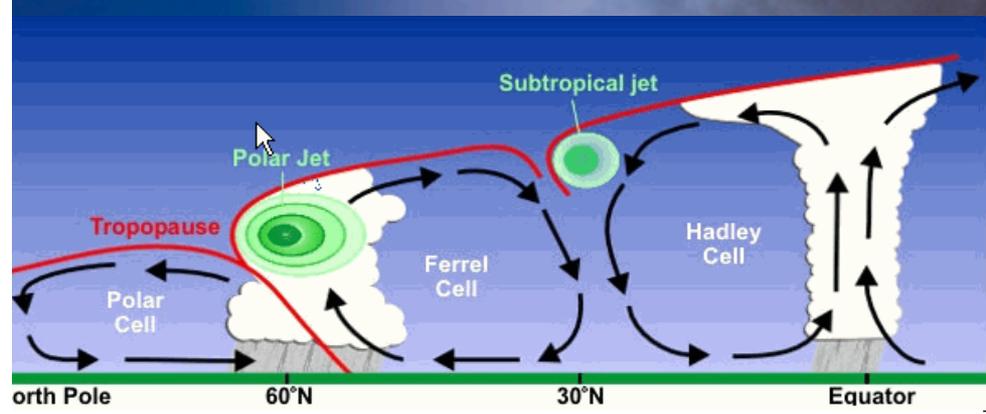
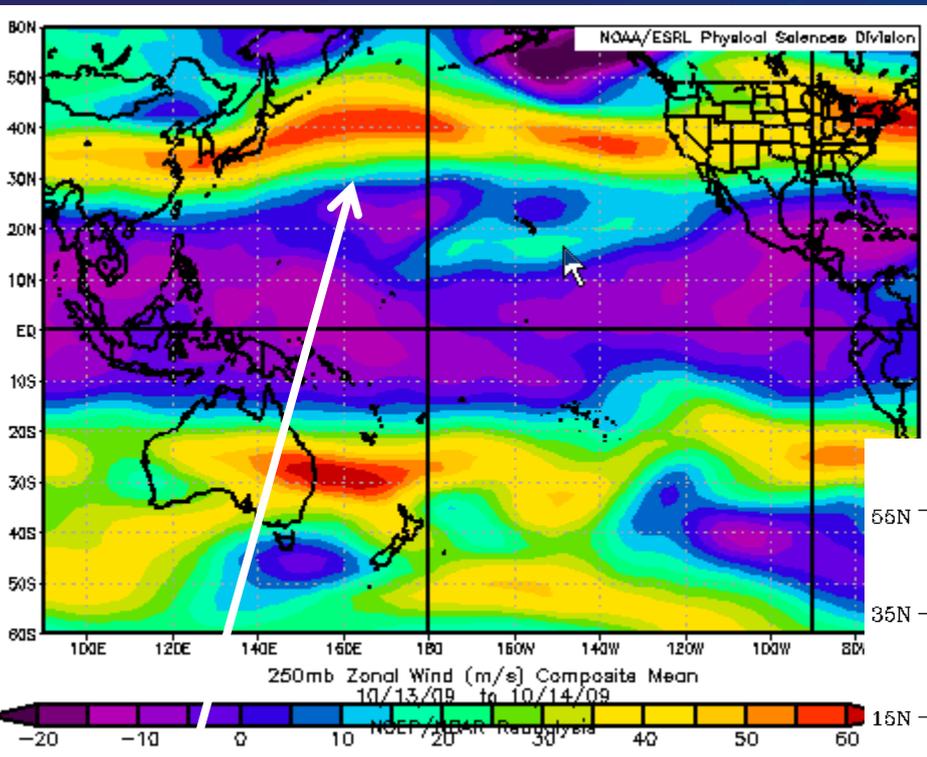
ARs and LLJ occur in warm sector of extratropical cyclones

Model representation of AR

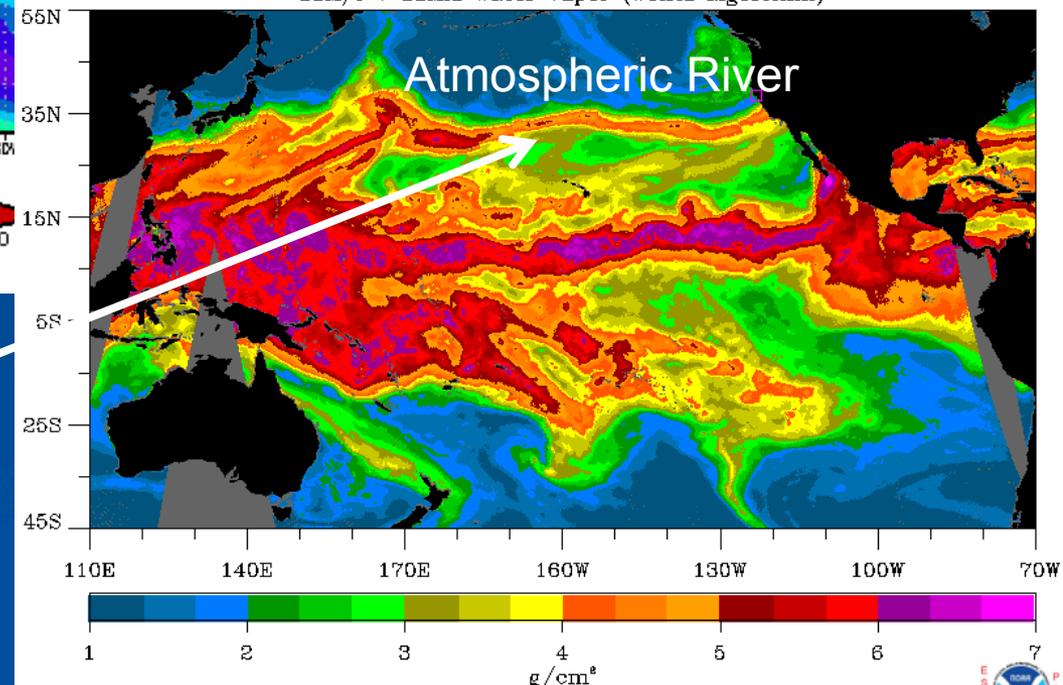




SSM/I shows AR stretching across Pacific to Central California



October 14, 2009 1000 UTC Preceding 12 Hours
SSM/I + SSMIS Water Vapor (Wentz algorithm)



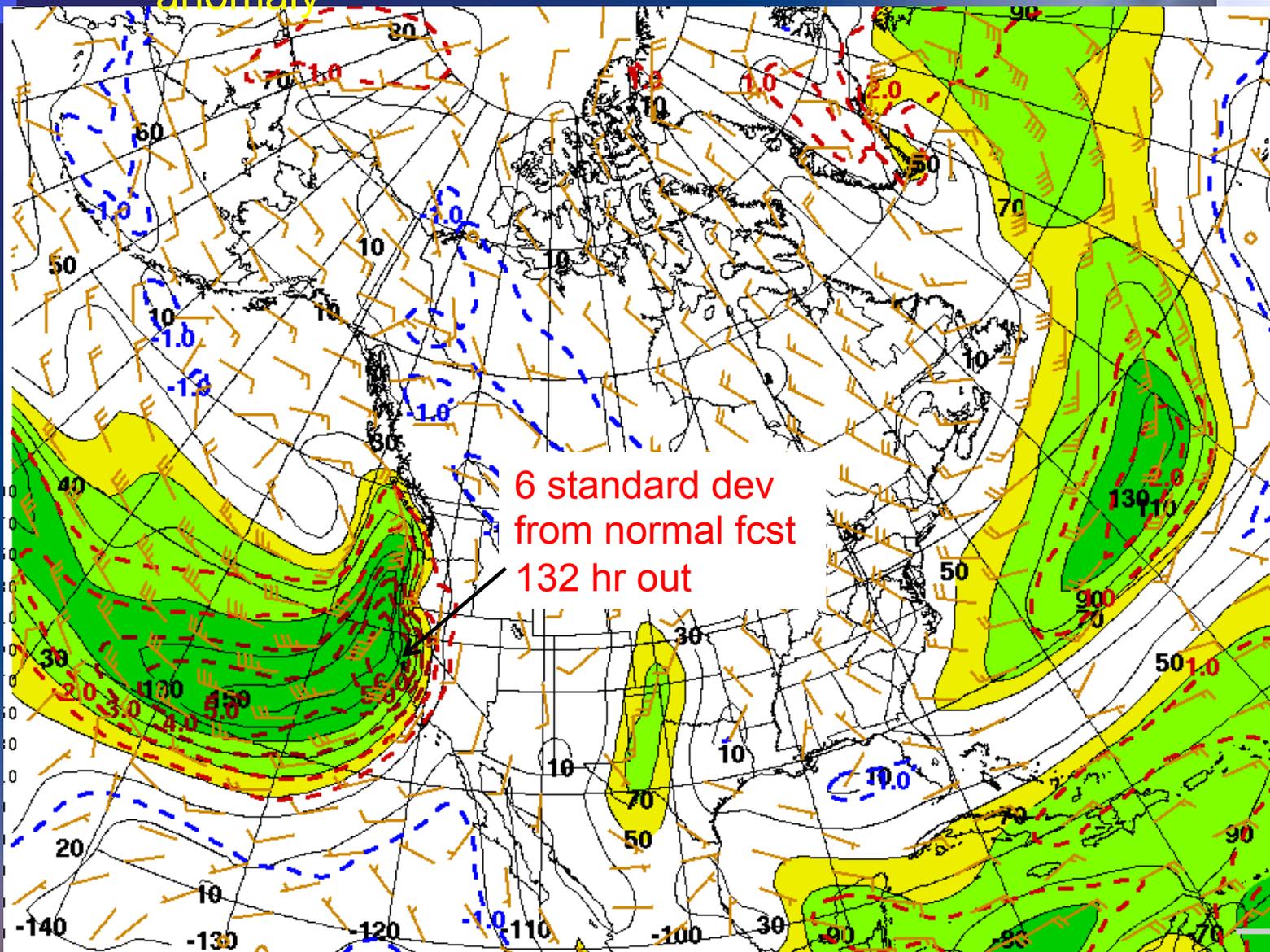
Extended East-Asian Jet





NCEP Global Ensemble Forecast System

132 hr forecast of 850 mb moisture flux and anomaly

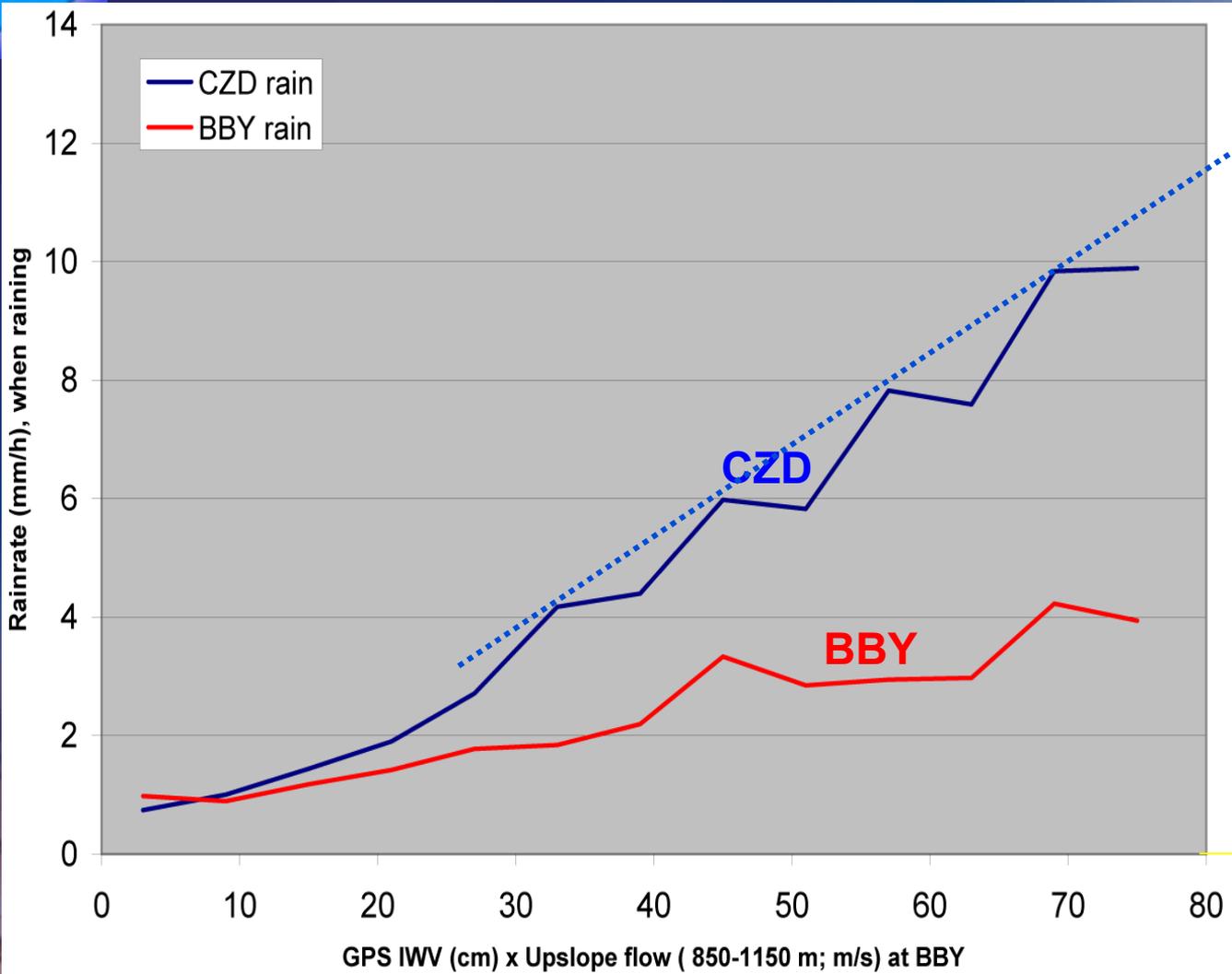


091008 00Z GEFS 132HR 850 hPa MOISTURE FLUX(10*[G/KG M/SEC])STANDARDIZED ANOMALIES(10*)
VALID TIME 091013 12



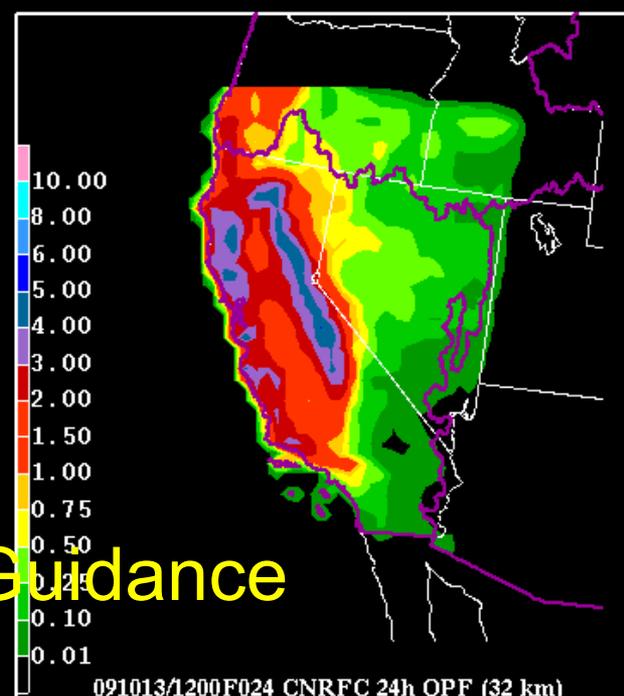
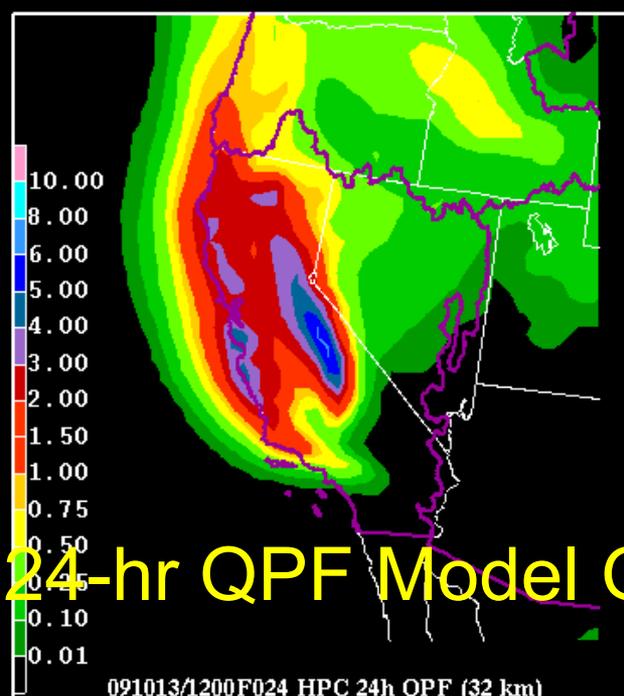
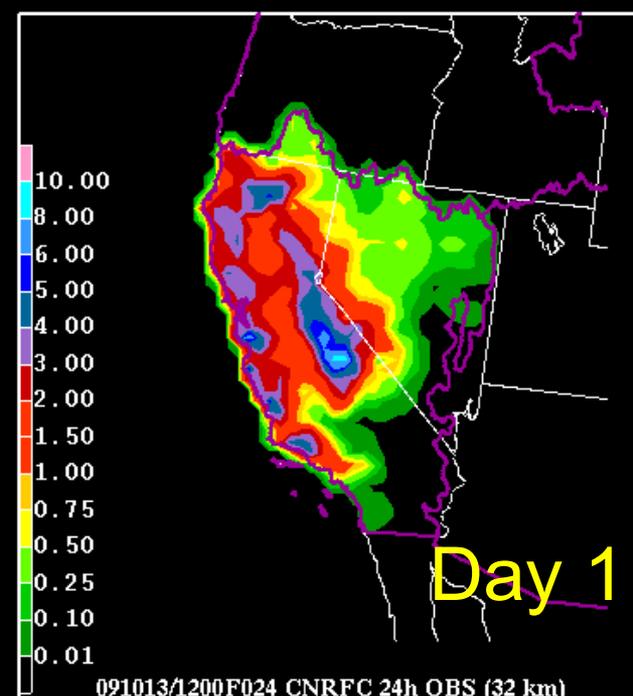
Bulk Upslope IWV Flux vs. Rainrate

Forecast for 18Z 13-Oct-2009 near CZD, based on GFS fcst initialized on 18Z 6-Oct-2009

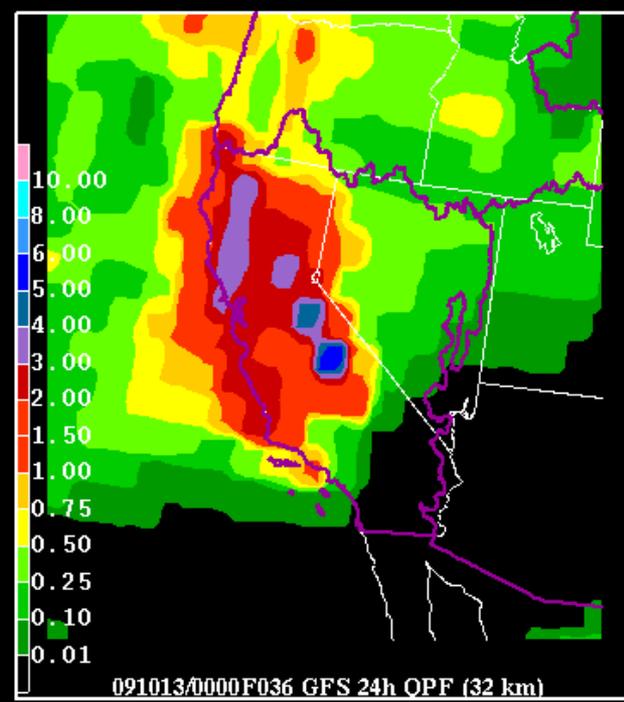
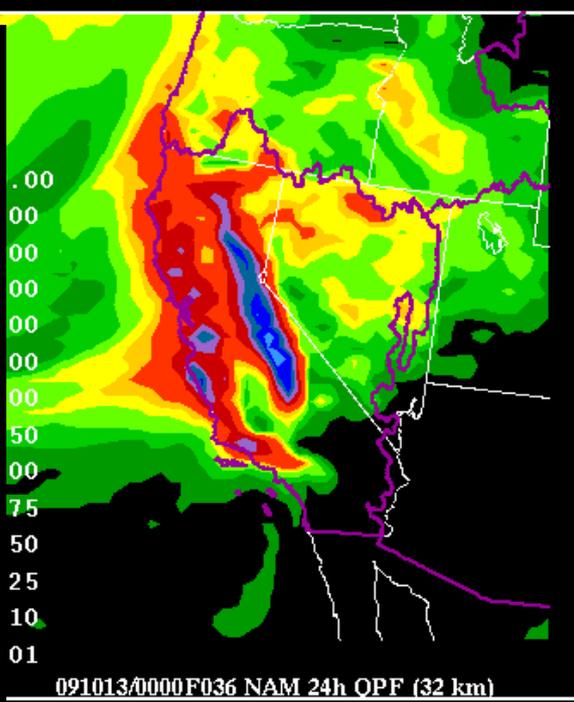
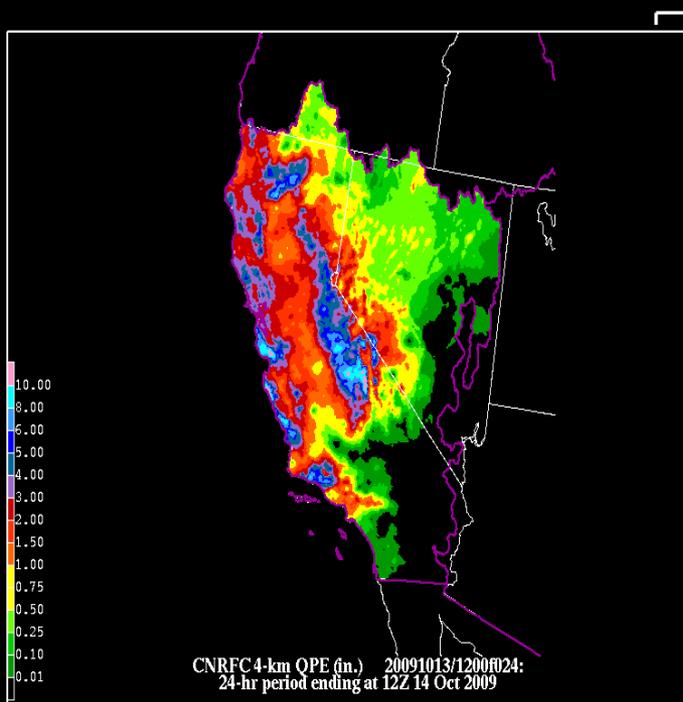


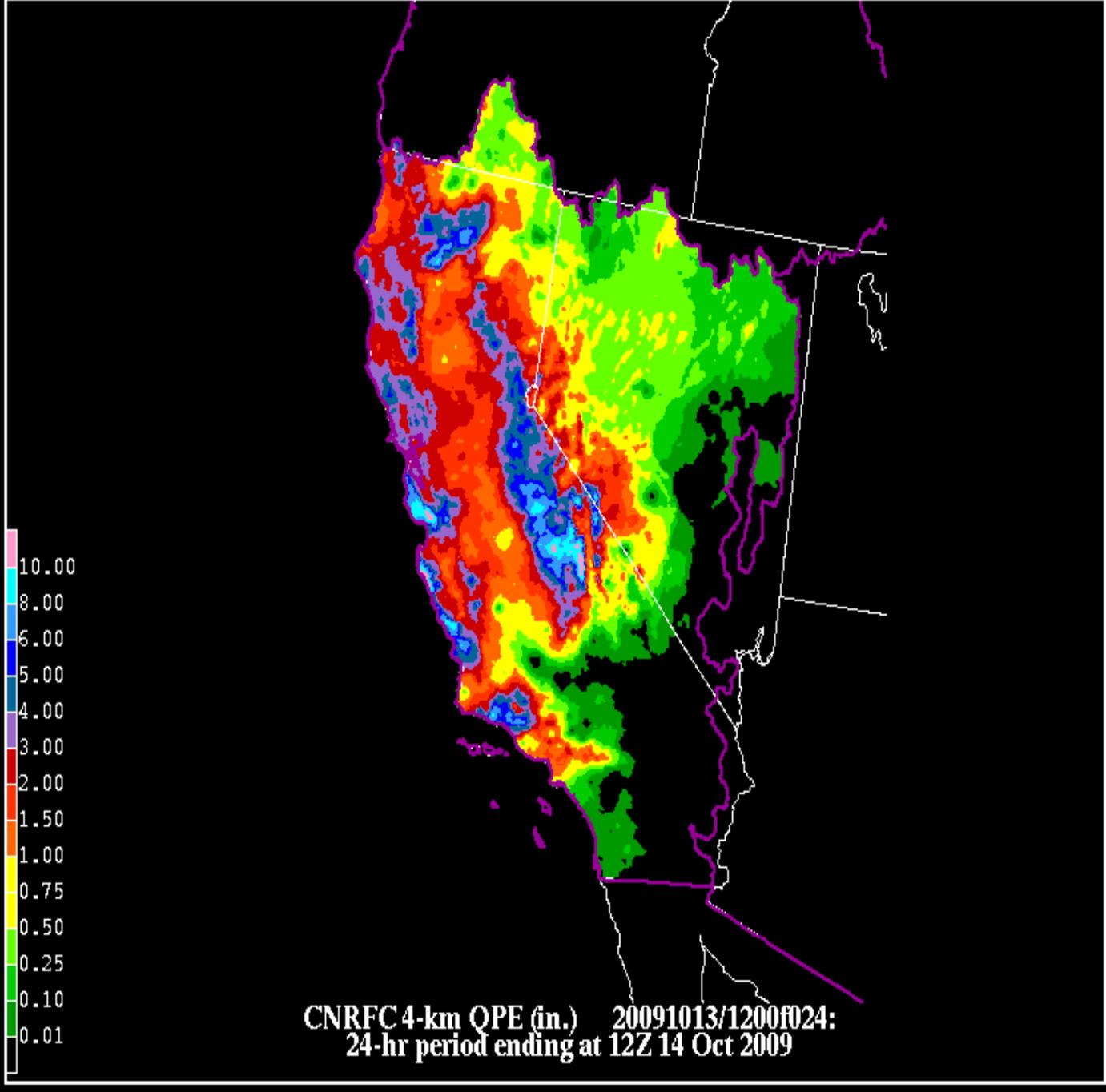
Rainrate and orographic rain enhancement at CZD increases with increasing bulk upslope IWV flux,

i.e., with strengthening AR conditions



Day 1 24-hr QPF Model Guidance





10.00
8.00
6.00
5.00
4.00
3.00
2.00
1.50
1.00
0.75
0.50
0.25
0.10
0.01

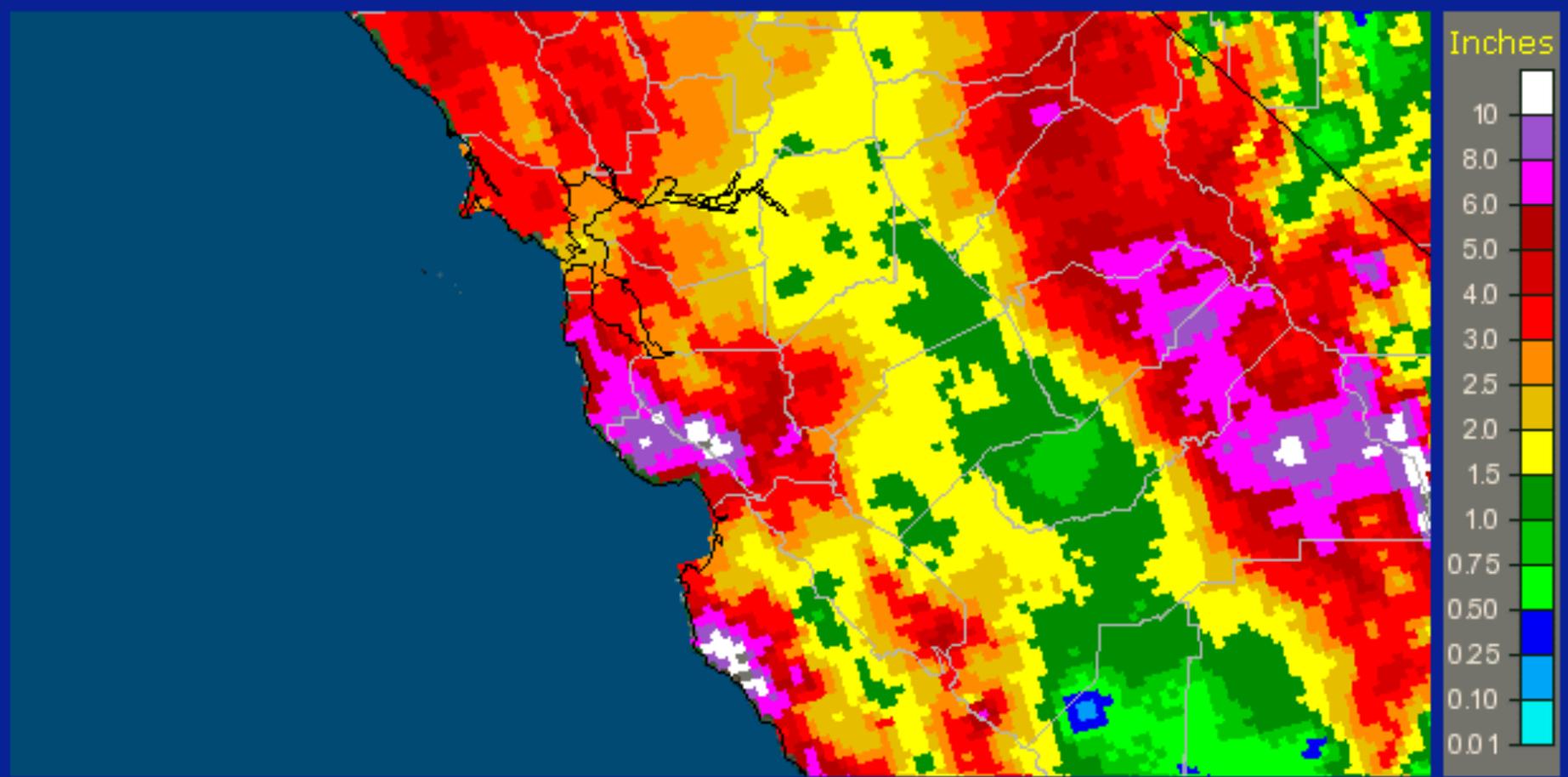
CNRFC 4-km QPE (in.) 20091013/1200f024:
24-hr period ending at 12Z 14 Oct 2009

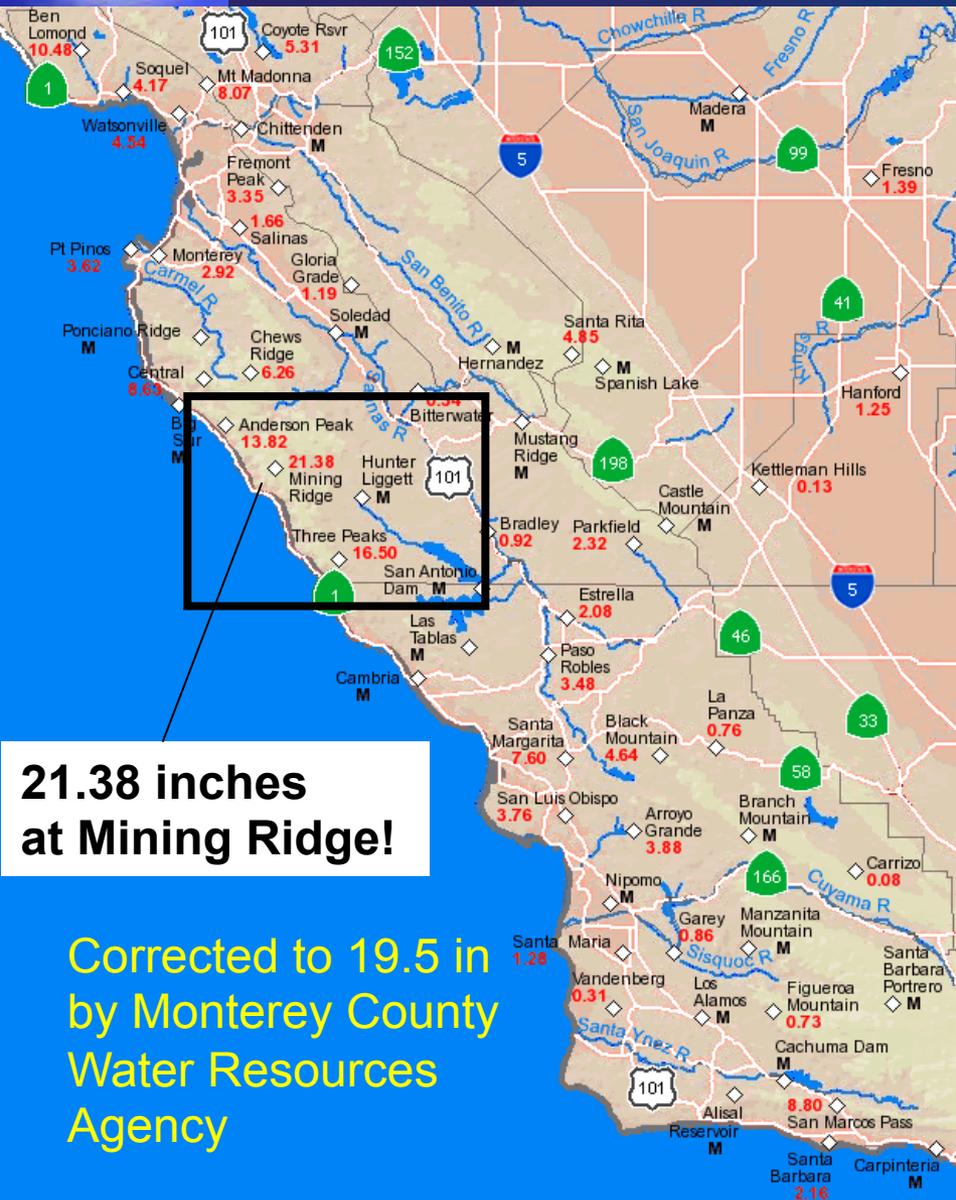




CNRFC 24-hr QPE Ending 12Z 14 Oct 2009

San Francisco Bay Area, CA (MTR): 10/14/2009 1-Day Observed Precipitation
Valid at 10/14/2009 1200 UTC - Created 10/16/09 10:34 UTC





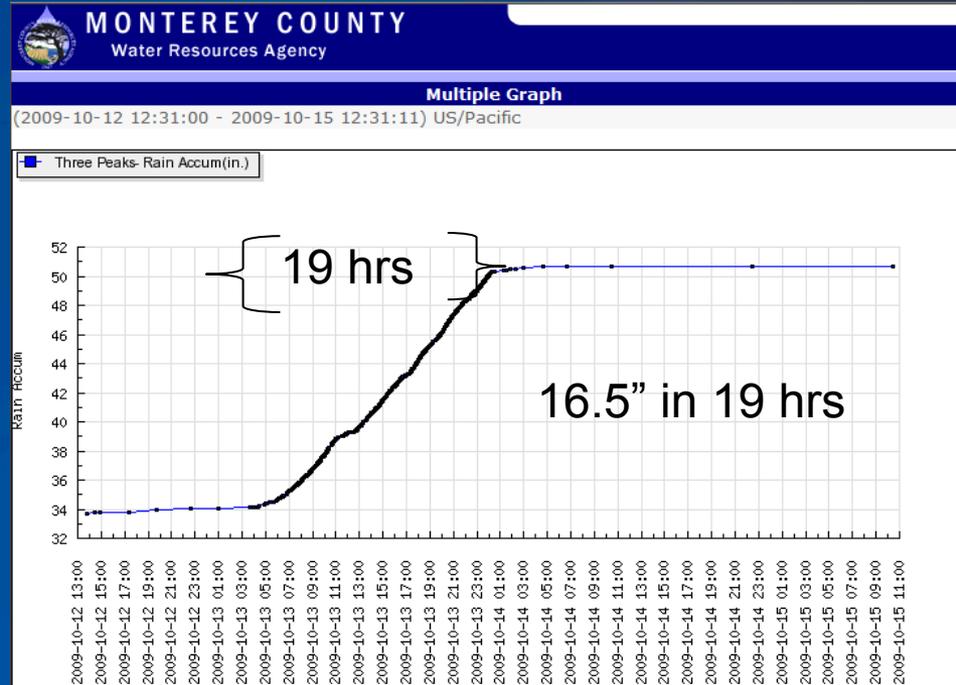
**21.38 inches
at Mining Ridge!**

**Corrected to 19.5 in
by Monterey County
Water Resources
Agency**

24 Hour Precipitation (Inches) Ending Wed Oct 14 2009 at 04 AM PDT
NOAA / NWS / California Nevada River Forecast Center

Max 24-h precip from Alert Raingage network as of 1200 UTC 14 October

- **Three peaks
Alert trace**





Conclusions



- Land-falling Atmospheric Rivers play a major role in producing extreme rainfall events in CA.
- Forecasters should now have a much better understanding of what these phenomena are, how they form, and how to diagnose them in model output.
- Knowledge allows forecasters to provide up to a week lead-time in alerting state and local emergency officials and water resource agencies to the “potential” flood threat. This is critical if forecast based reservoir operations are to be successful.
- It is proposed that a scaling factor (1-5) capturing the potential strength/impacts of land-falling ARs be created much like land-falling tropical cyclones. This could be based on model forecast QPF (Ralph and Dettinger) or projected rain rates using model forecasts of IPW and LLJ magnitudes aka Neiman.
- Consecutive days of stalled AR or multiple ARs over a week could be California’s Katrina. Especially following a Dec-Jan 1969. ARkStorm!