Center for Western Weather and Water Extremes

SCRIPPS INSTITUTION OF OCEANOGRAPHY AT UC SAN DIEGO

CIRES

University of Colorado Boulder

NOAA

So it's a Land-falling Atmospheric River, Can That Help the Forecaster Make a Better QPF?

David W. Reynolds

Cooperative Institute for Research in Environmental Sciences

Boulder, CO

Brian Kawzenuk

Center for Western Weather and Water Extremes

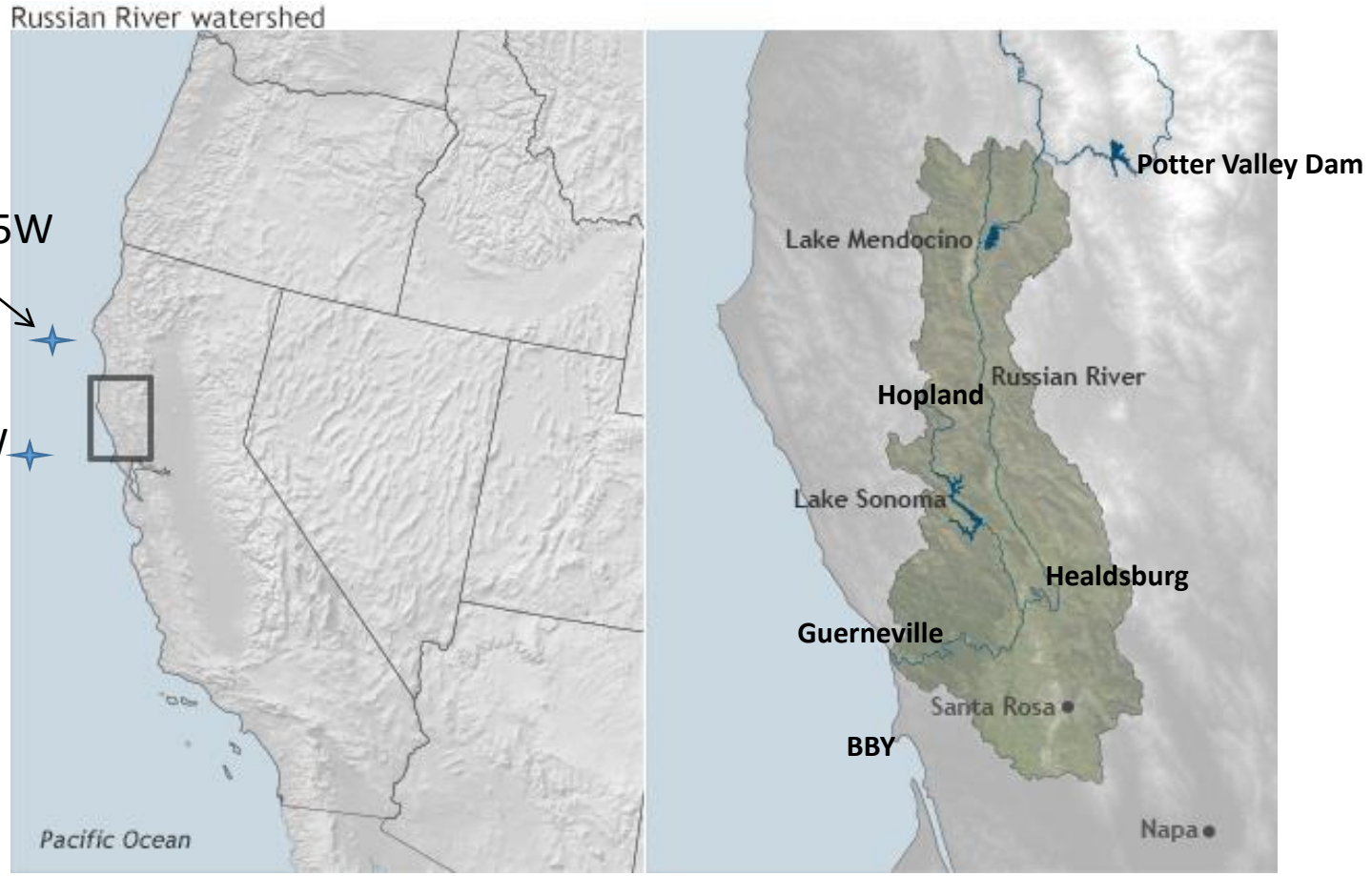
August 8, 2016

International Workshop on Atmospheric Rivers

Outline

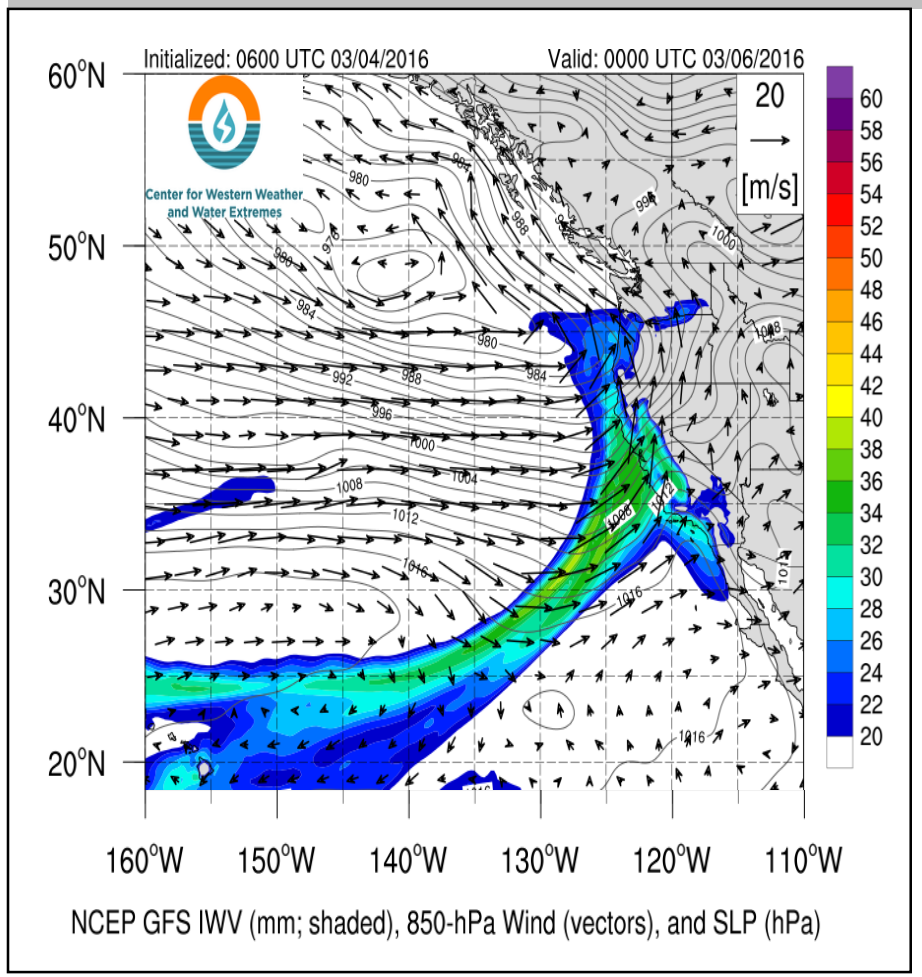
- Review historical CNRFC (California Nevada River Forecast Center) derived 24-hr Mean Areal Precipitation (MAP) and IVT correlations for Lake Mendocino Watershed– **Is IVT a good proxy for 24-hr rainfall?**
- Review CNRFC and GEFS forecast to observed MAPs– **Are model and model derived QPFs better related to observed rainfall than IVT**?
- Review a land-falling AR case from 2016
  - Looked at some 10 cases but will only show early March 2016
- Summary and Recommendations

Russian River Watershed

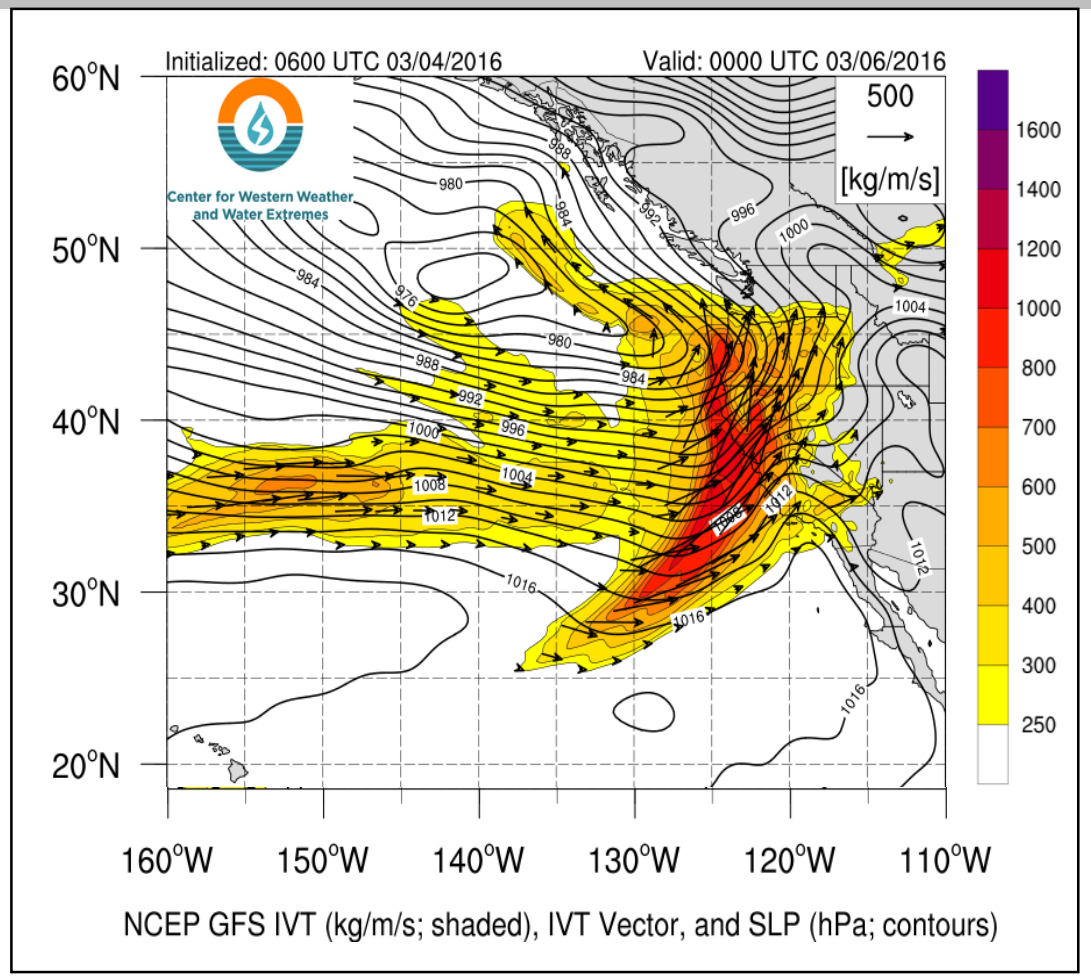


CW3E

Landfalling AR depicted by IWV and IVT 00Z 6 March 2016



NCEP GFS IWV (mm; shaded), 850-hPa Wind (vectors), and SLP (hPa)



NCEP GFS IVT (kg/m/s; shaded), IVT Vector, and SLP (hPa; contours)

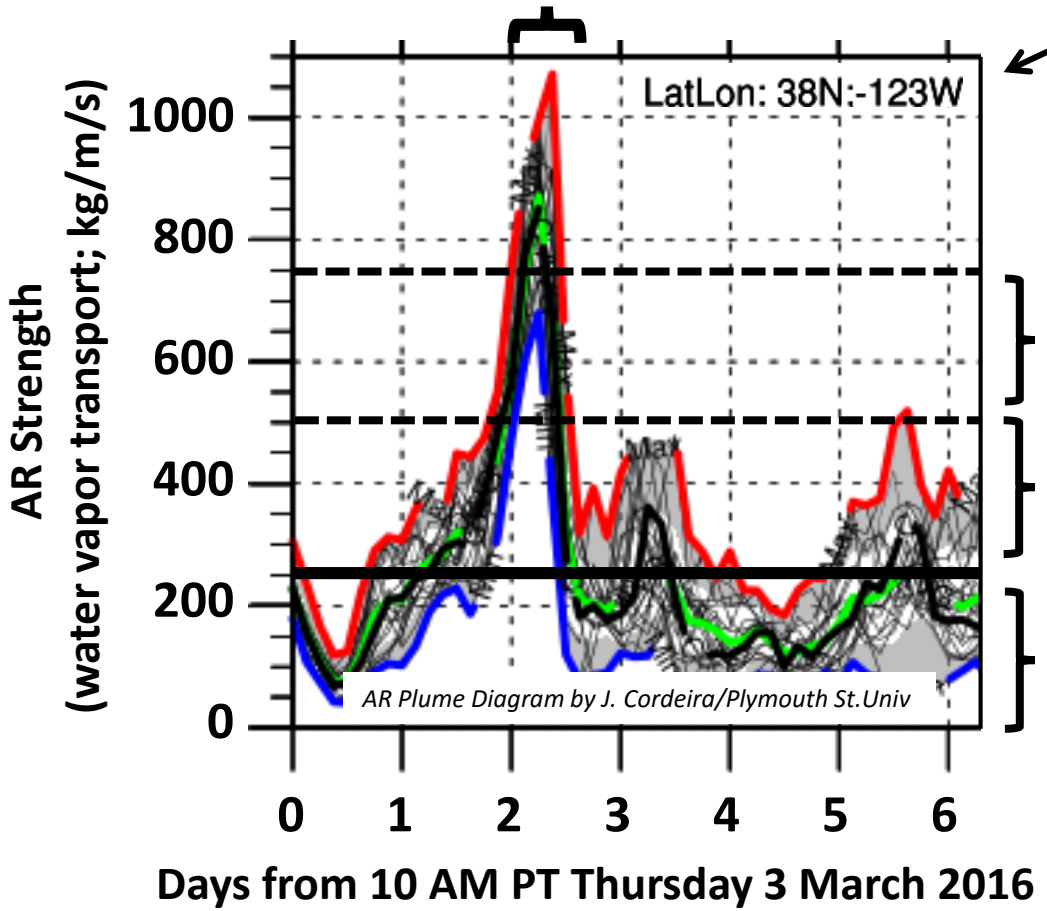
AR summary for Pt Reyes, CA area, including Russian River

Center for Western Weather and Water Extremes
SCRIPPS INSTITUTION OF OCEANOGRAPHY AT UC SAN DIEGO

Normal-duration AR landfall (12-24 hours)

What is a more reliable predictor of AR impacts?

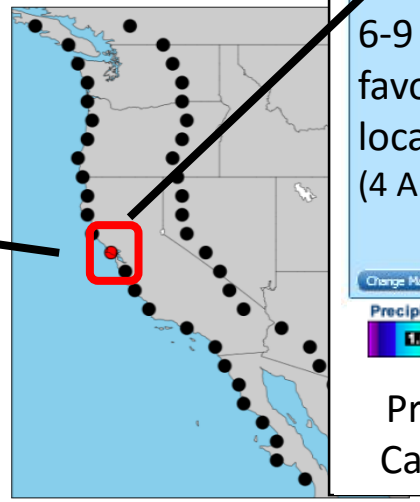
IVT strength or QPF derived from models?

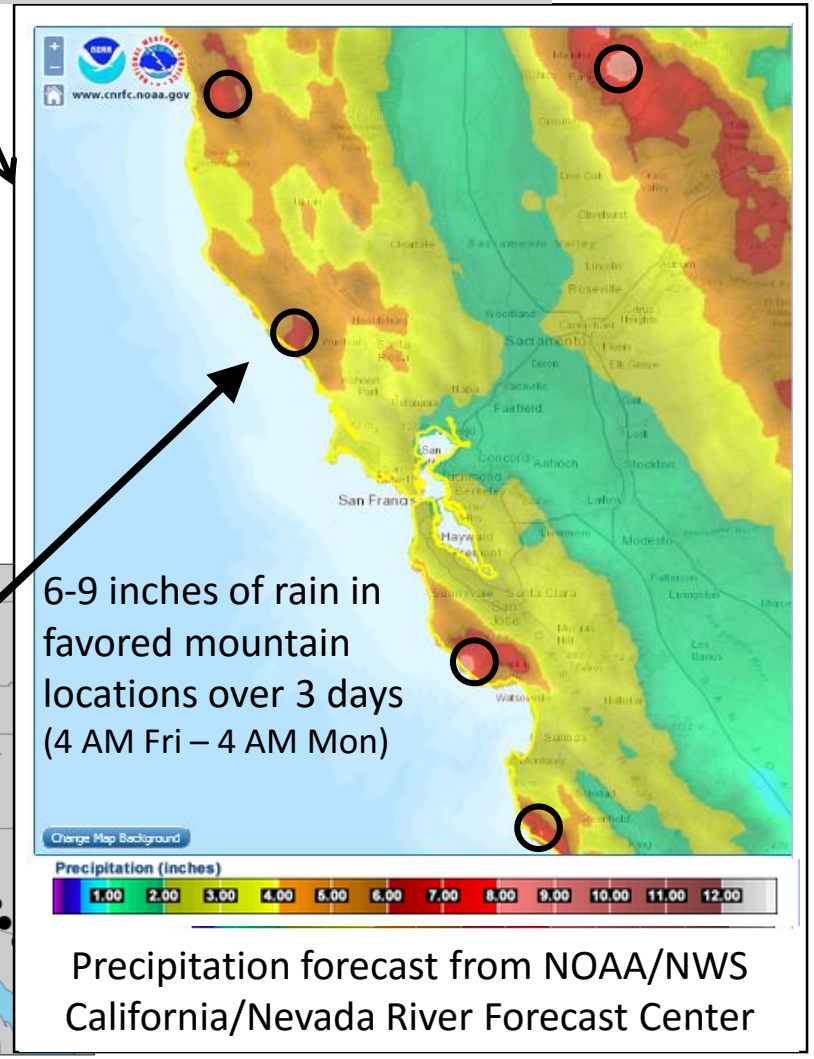


Moderate strength AR

Minimal strength AR

Not an AR





6-9 inches of rain in favored mountain locations over 3 days (4 AM Fri – 4 AM Mon)

Precipitation forecast from NOAA/NWS California/Nevada River Forecast Center

Summary by F.M. Ralph 8 AM PT Fri 4 March 2016

IVT QPF Methodology

- Utilize Rutz NCEP/NCAR* AR catalog from1949-2015 and NASA MERRA data** from 1980-2012.
  - Use 1000-200 mb IVT – show max 6-hr IVT 12z-12z as this showed best results
- Correlate to 24-hr Mean Areal Precipitation (MAP) available from 1949-2015
  - Recalculate using upslope wind direction, precipitation threshold of >=.1 "/day and for matching sample years using Rutz catalog.
  - Lavers et al. (2016) – **showed IVT more predictable than rainfall but is IVT well correlated with subsequent rainfall**?
- Correlate 16-yrs of CNRFC 24-hr forecast MAPs issued daily at 12z to observed MAPs
- Compare 1985-2012 11 member GEFS (V9.1) Ensemble Mean MAPs utilized by CNRFC for probabilistic inflows to Lake Mendocino
  - Rutz and Alcott, 2014 did a similar study using 20 yr GEFS data and CPC QPE for CONUS

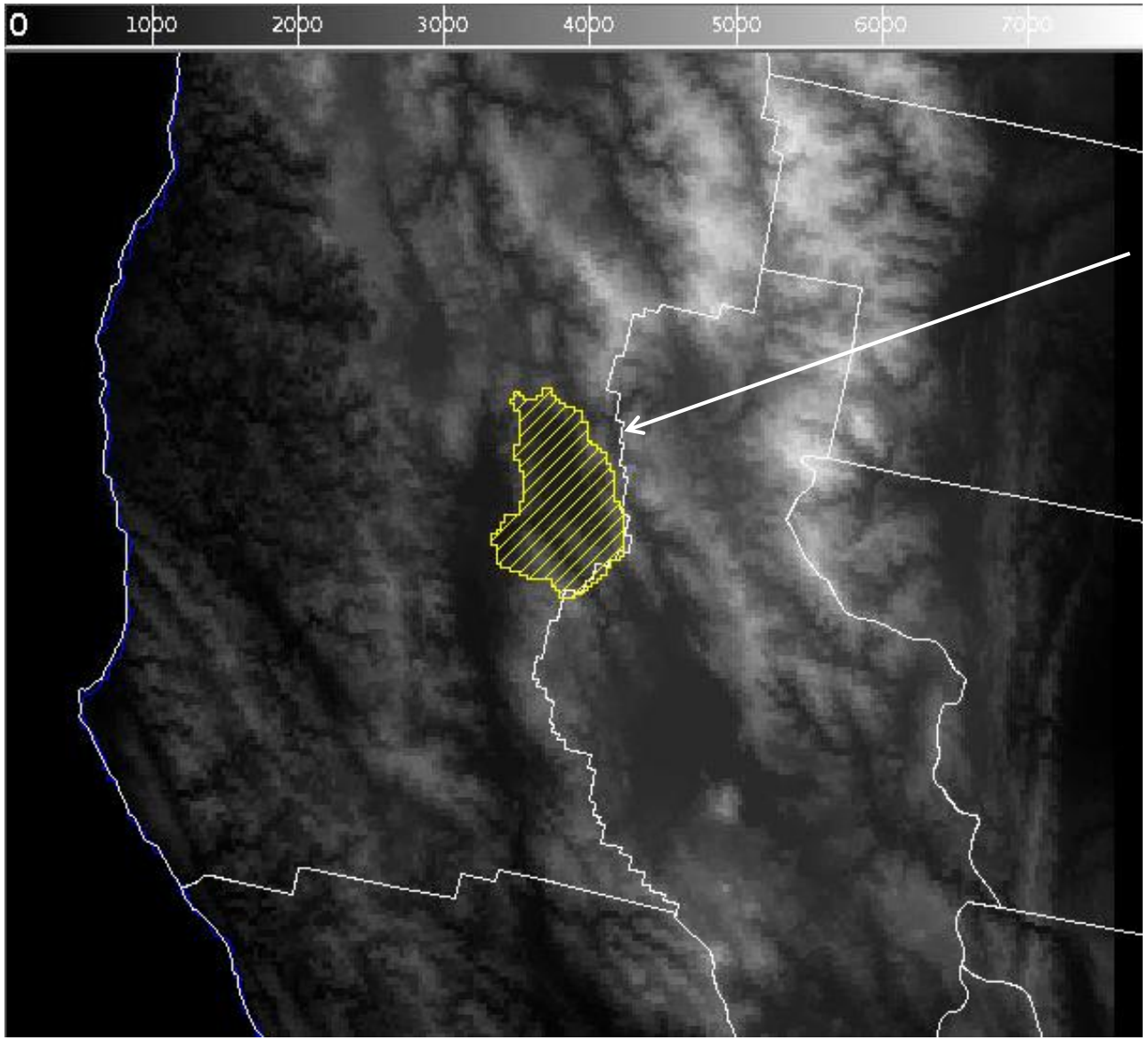
* http://rda.ucar.edu/datasets/ds090.0/ ** http://disc.sci.gsfc.nasa.gov/mdisc/data-holdings

CW3E

Case-study Approach

- Focus on Lake Mendocino Watershed
  - Use MAP
- Utilize 12z model runs to coordinate with CNRFC 5-Day 6-hr QPFs
- Utilize NWS GFE software
  - Calculate MAPs for each model available
- Using GFS40 analysis compute layer average vapor transport for each case at 40N 125W at 6-hr intervals
  - 550-700, 700-850, 850-1000, 200-1000 MB

QPF verification using NWS GFE Software



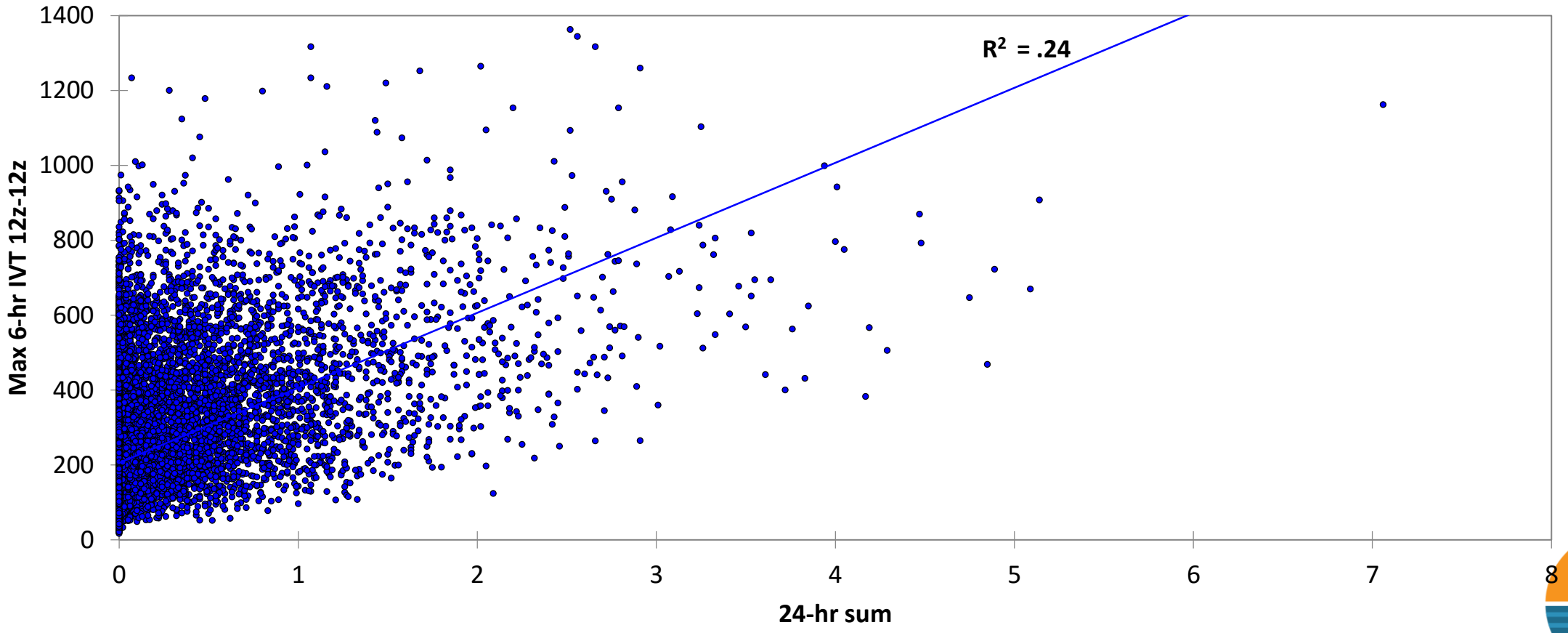
Lake Mendocino Watershed

Derive the Mean Areal Precipitation (MAP)for each model available

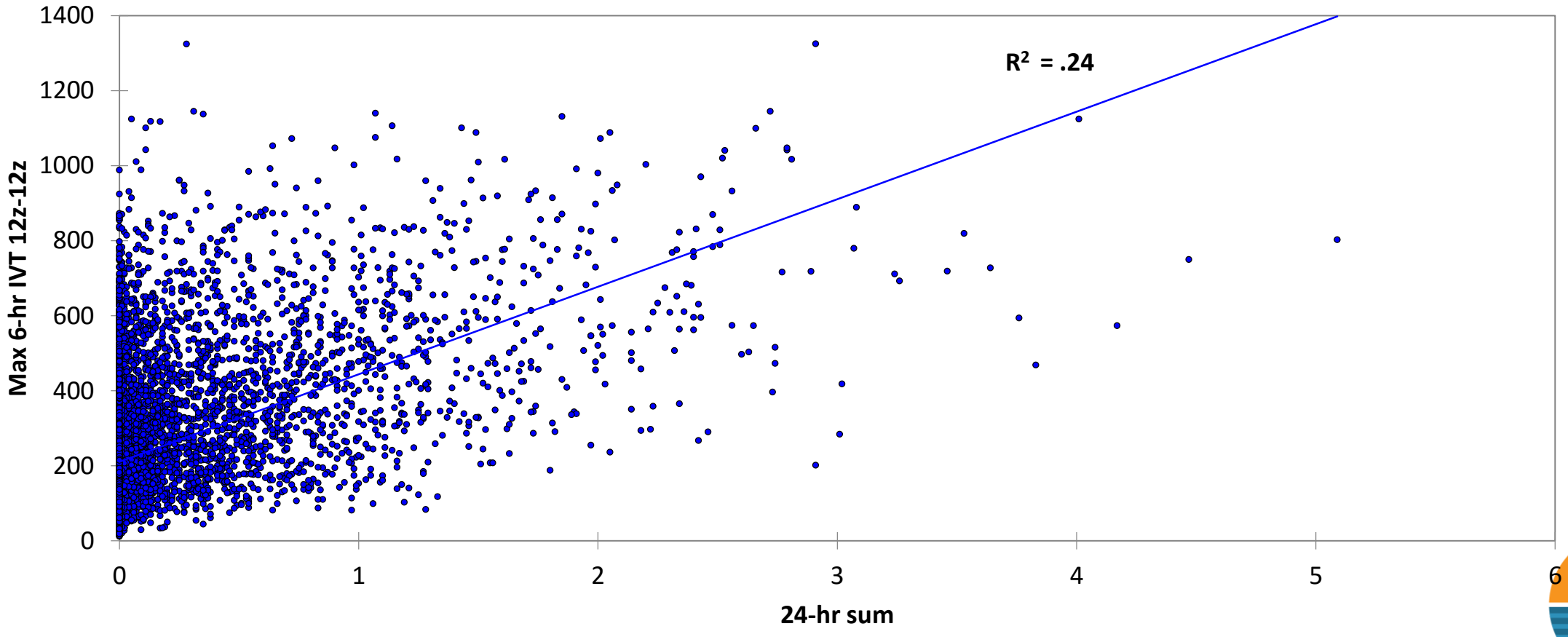
Compare to MAP provided by CNRFC

Compare to IVT at landfall

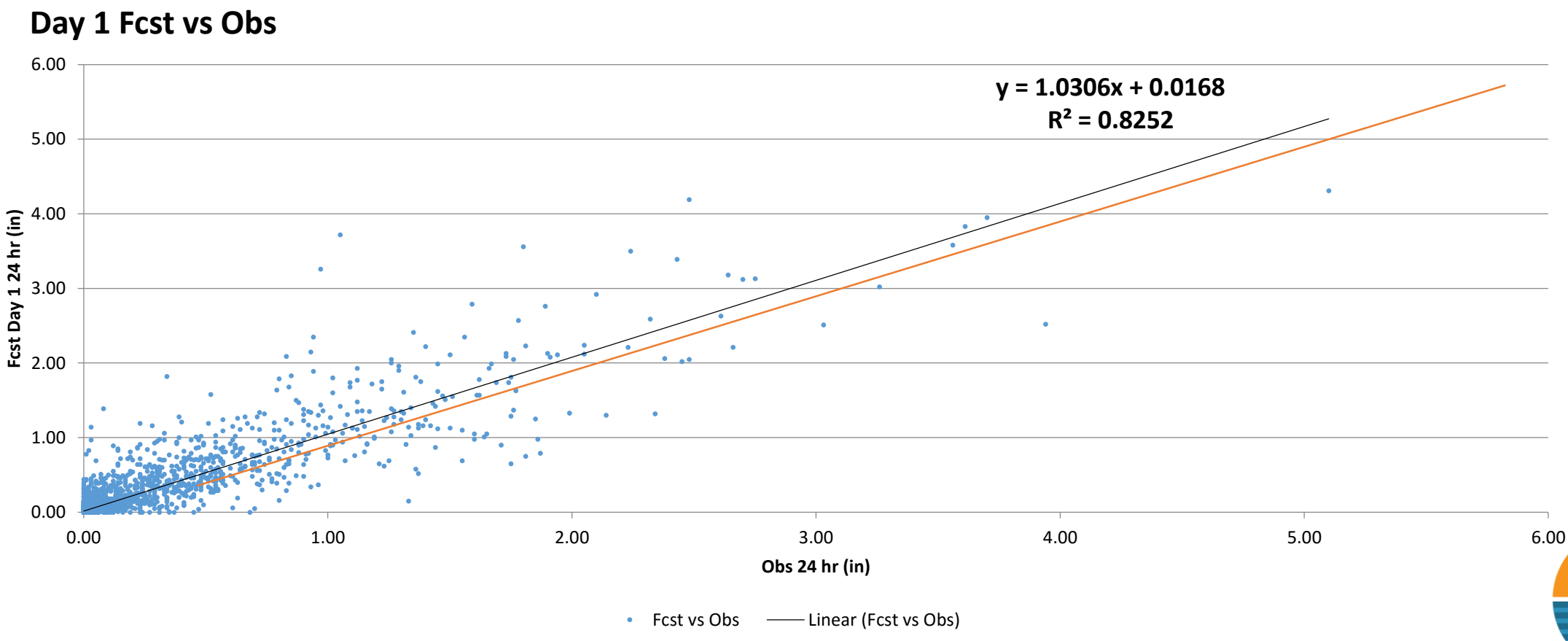
Max 6-hr IVT NCEP/NCAR from 12z-12z at 40n 125W and 12-12z 24-hr QPE Lake Mendocino 1949-2015



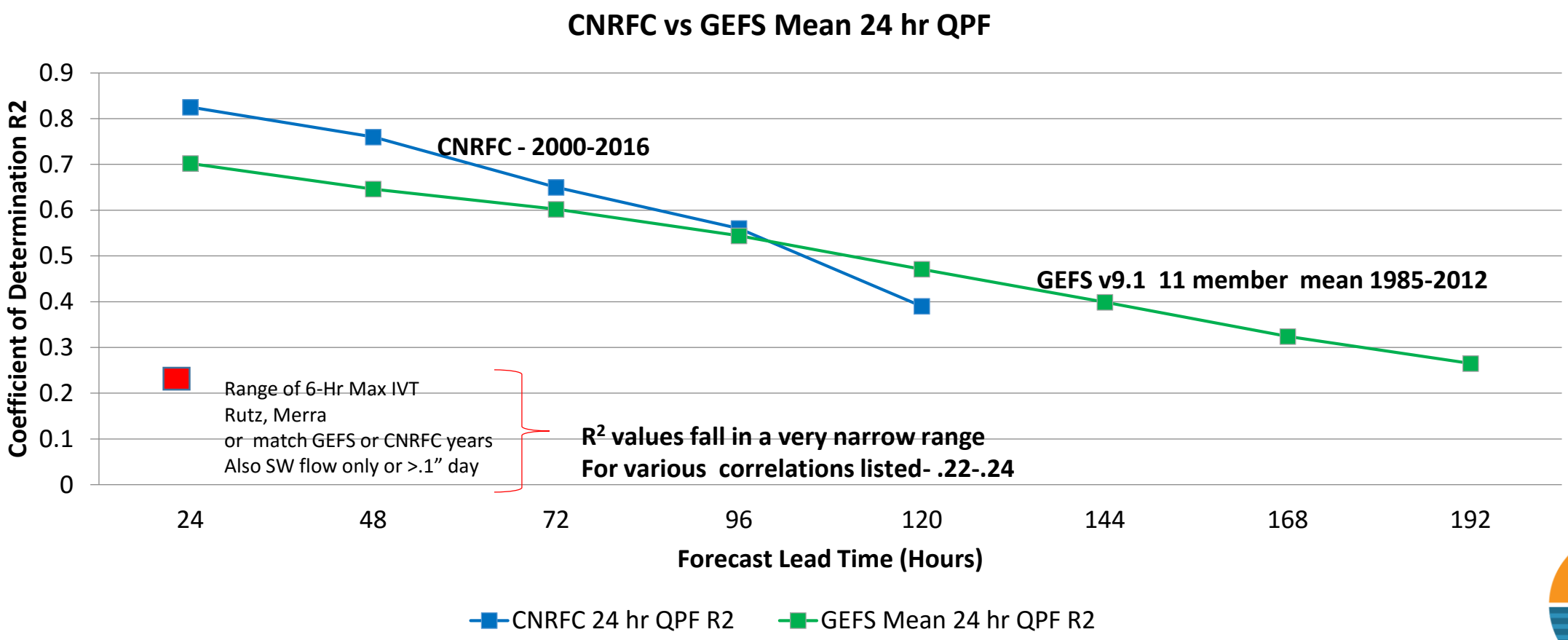
Max 6-hr IVT MERRA 12z-12z at 40n 125W and 12-12z 24-hr QPE Lake Mendocino 1980-2012



CNRFC Day 1 24 hr QPF Correlation to Observed Lake Mendocino Watershed (2000-2016)

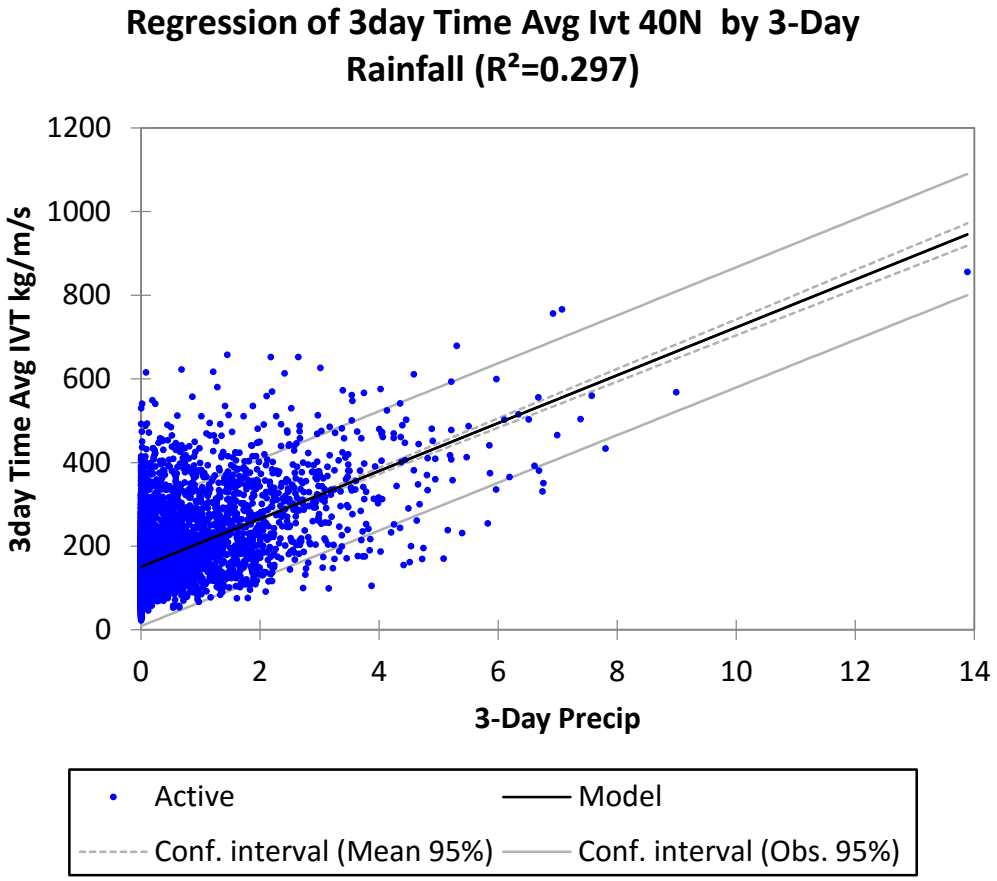


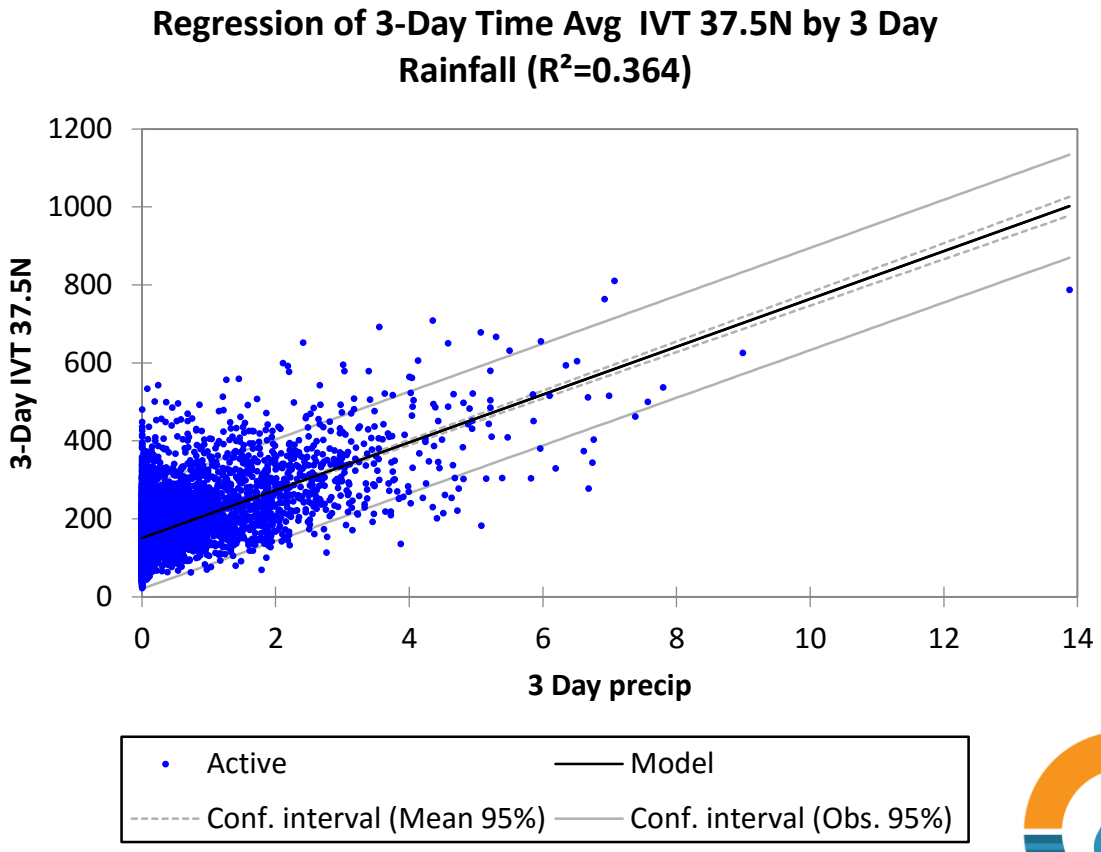
R^2 Values for CNRFC-GEFS Mean and IVT to 24 hr MAP Lake Mendocino



CW3E

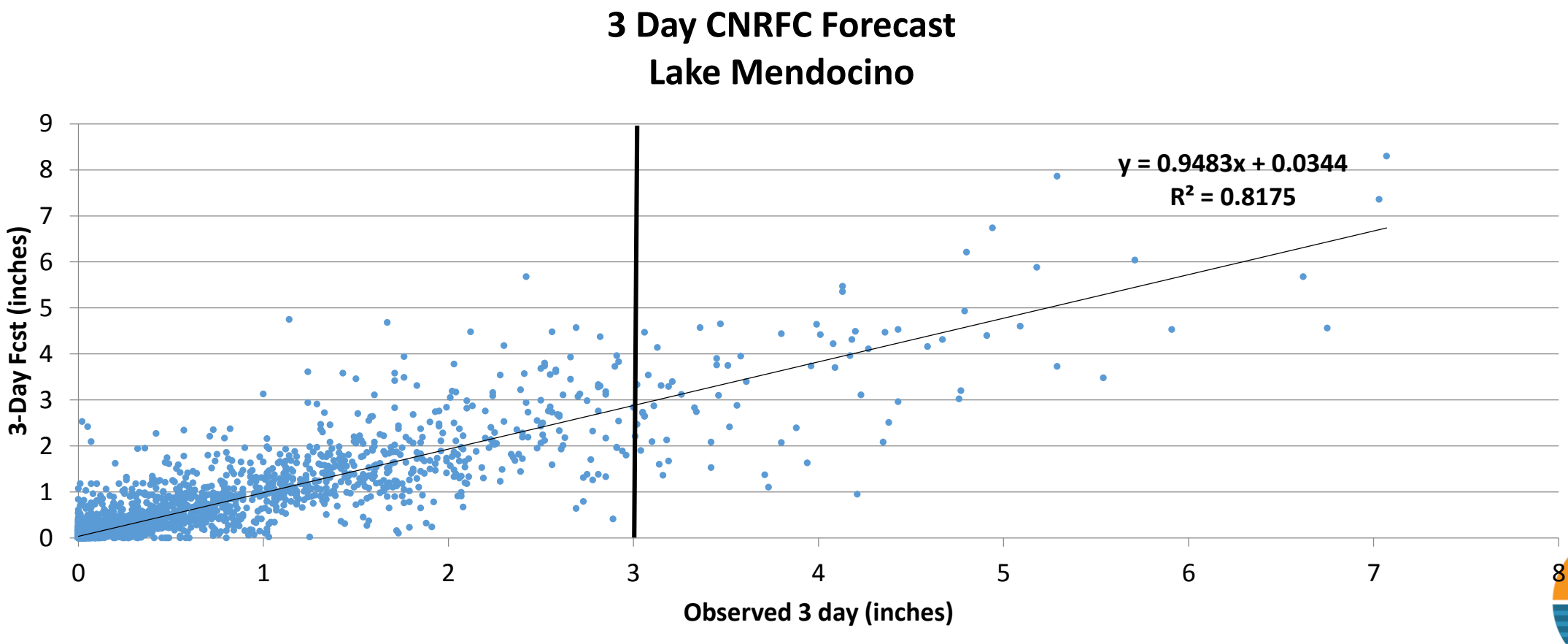
NCEP/NCAR 3-Day Time-Average 6-hr IVT vs 3-day MAP Lake Mendocino 40N and 37.5N





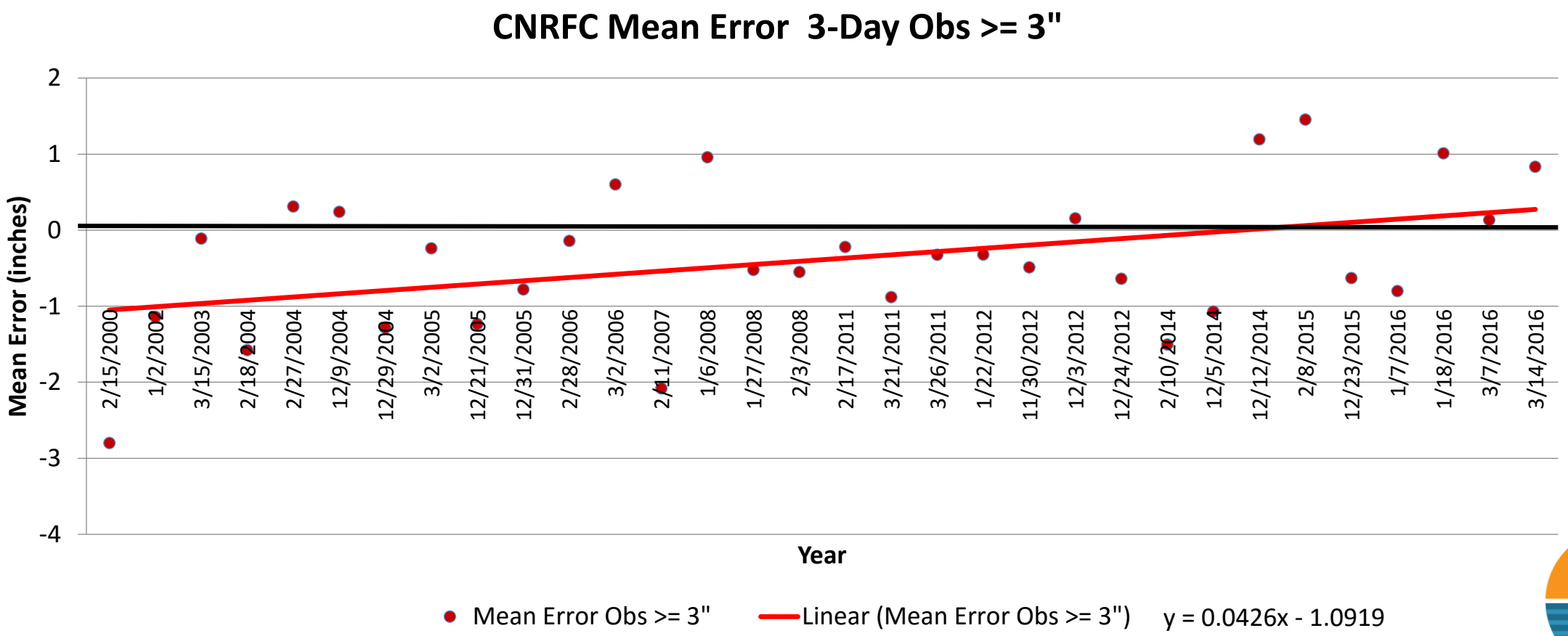
CW3E

3 Day CNRFC Total QPF vs Observations 2000-2016



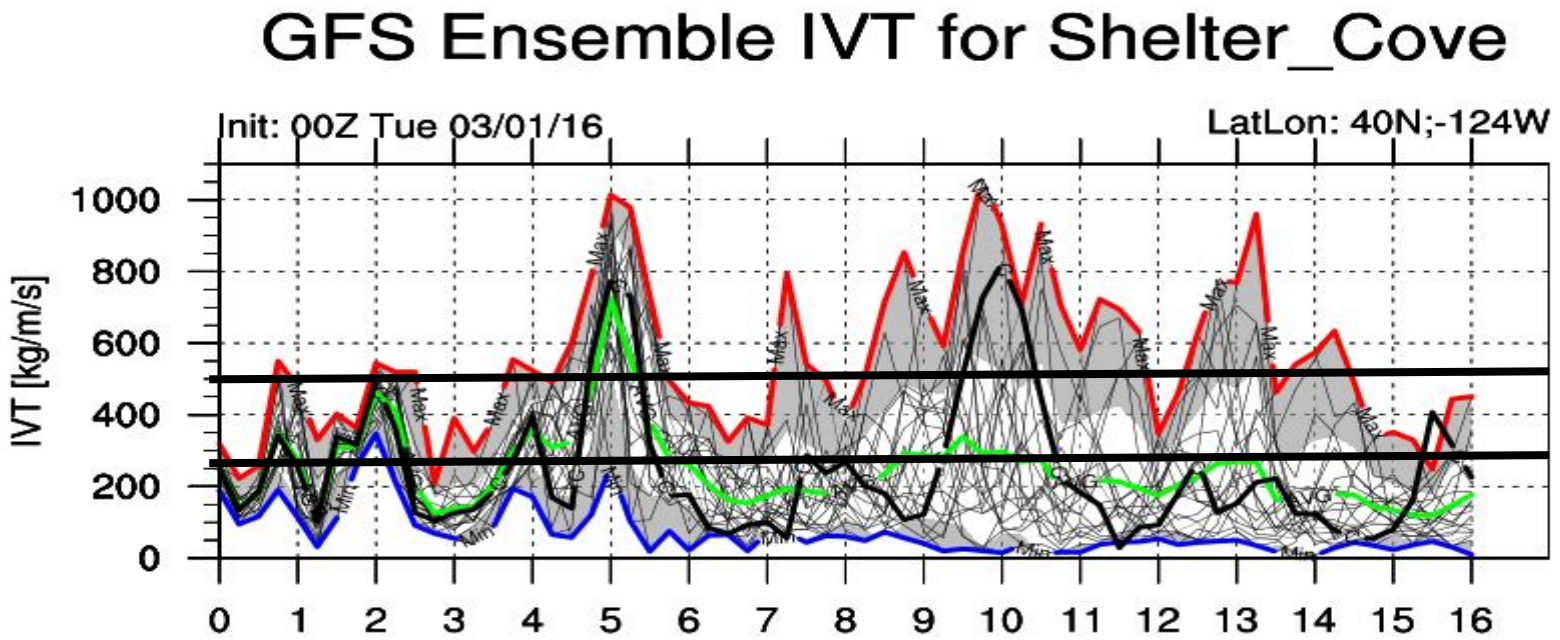
CW3E

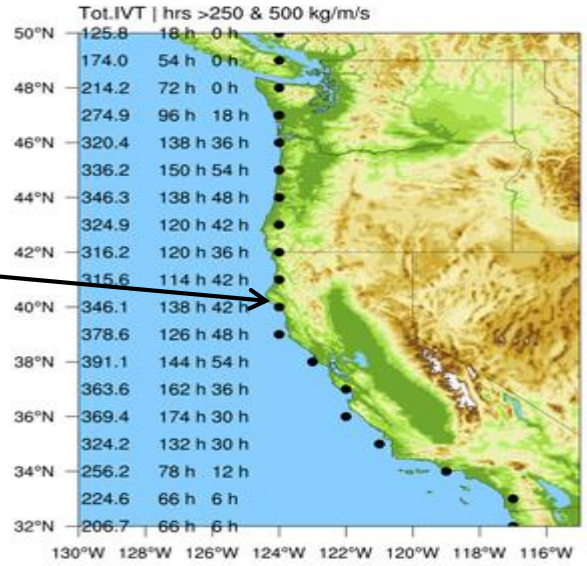
Trends in 3-Day Forecast Mean Error (Bias)



CW3E

IVT Plume Diagrams GEFS





138 hrs > 250 kg/m/s
42 hrs > 500 kg/m/s

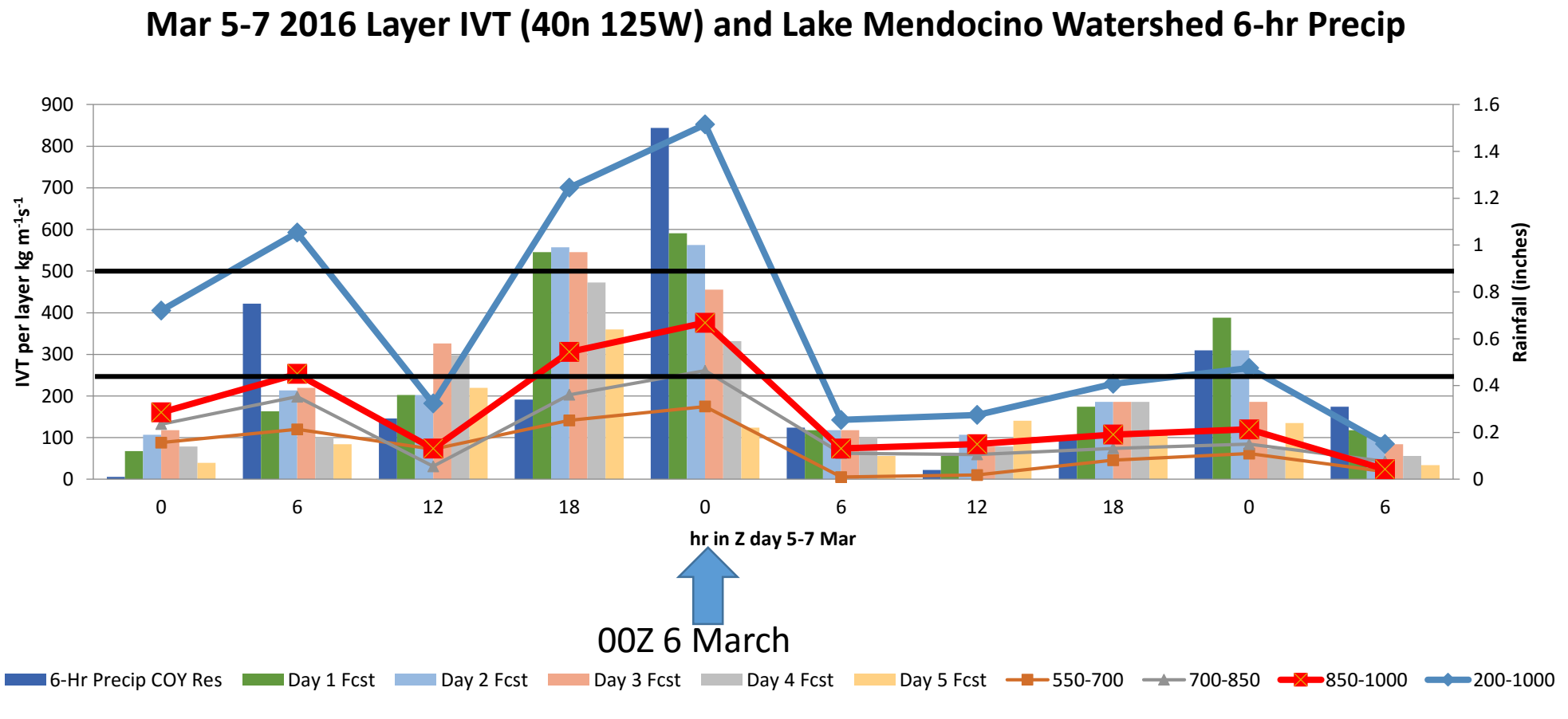
00Z 6 March

00Z 11 March

GFS control forecast (black line), the ensemble-mean (green line), and the maximum (red line) and minimum (blue line) ensemble value at each forecast time. White shading represents +/- 1 standard deviation forecast from the ensemble mean

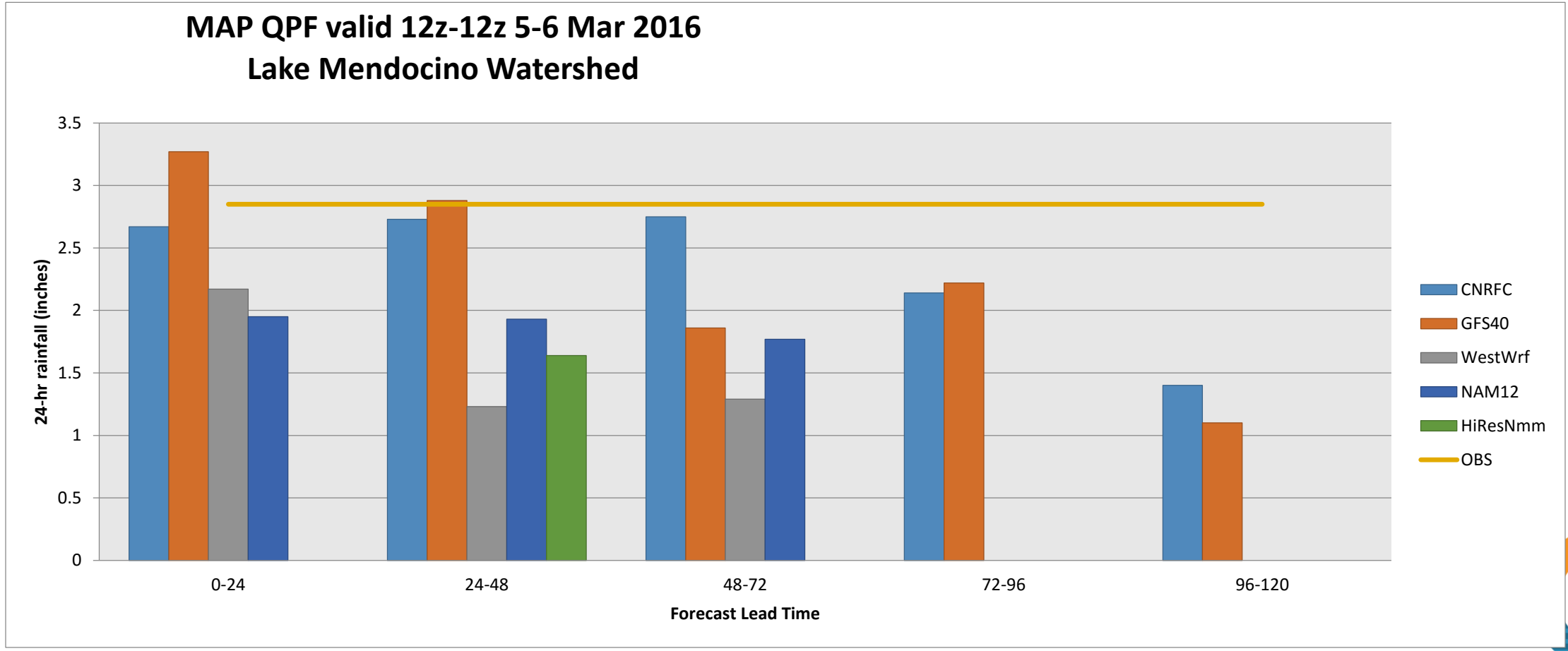
CW3E

5-7 Mar 2016 Layer IVT and CNRFC 6-hr Fcst and Obs MAPs

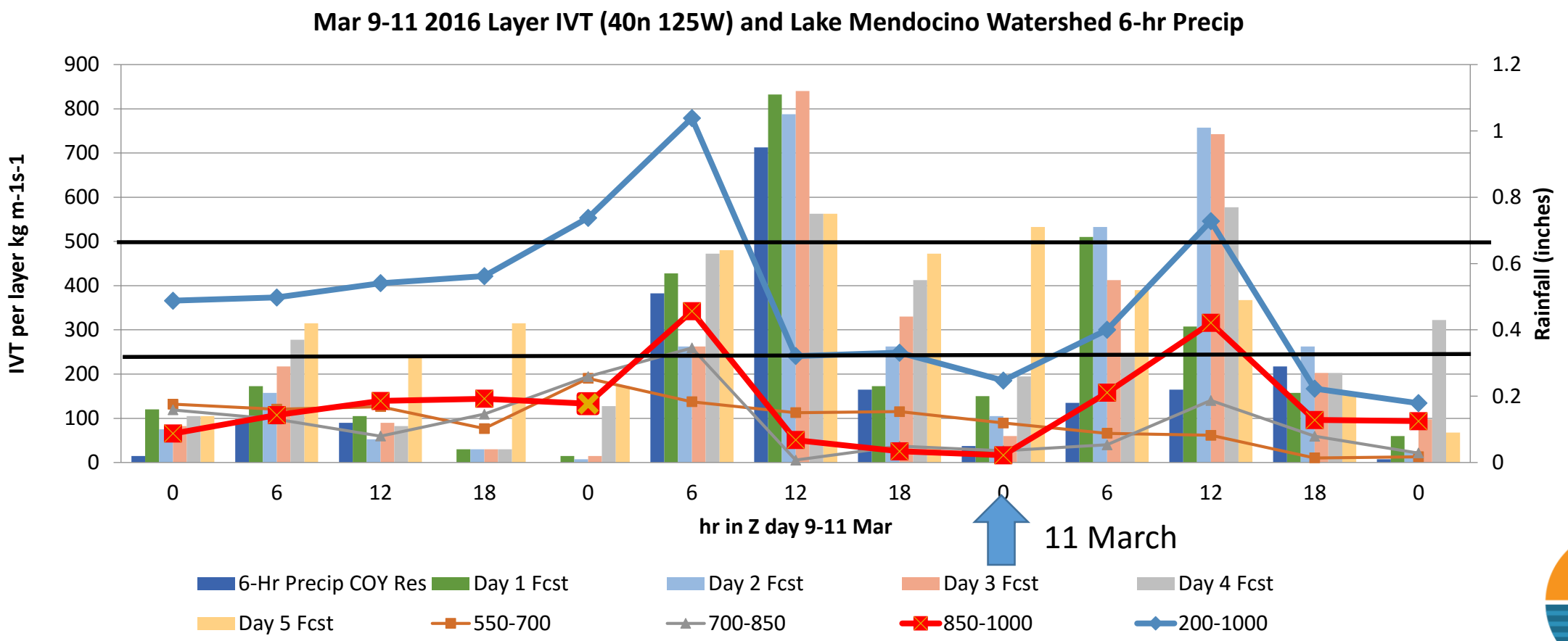


CW3E

Mar 5-6, 2016 MAP QPF Verification

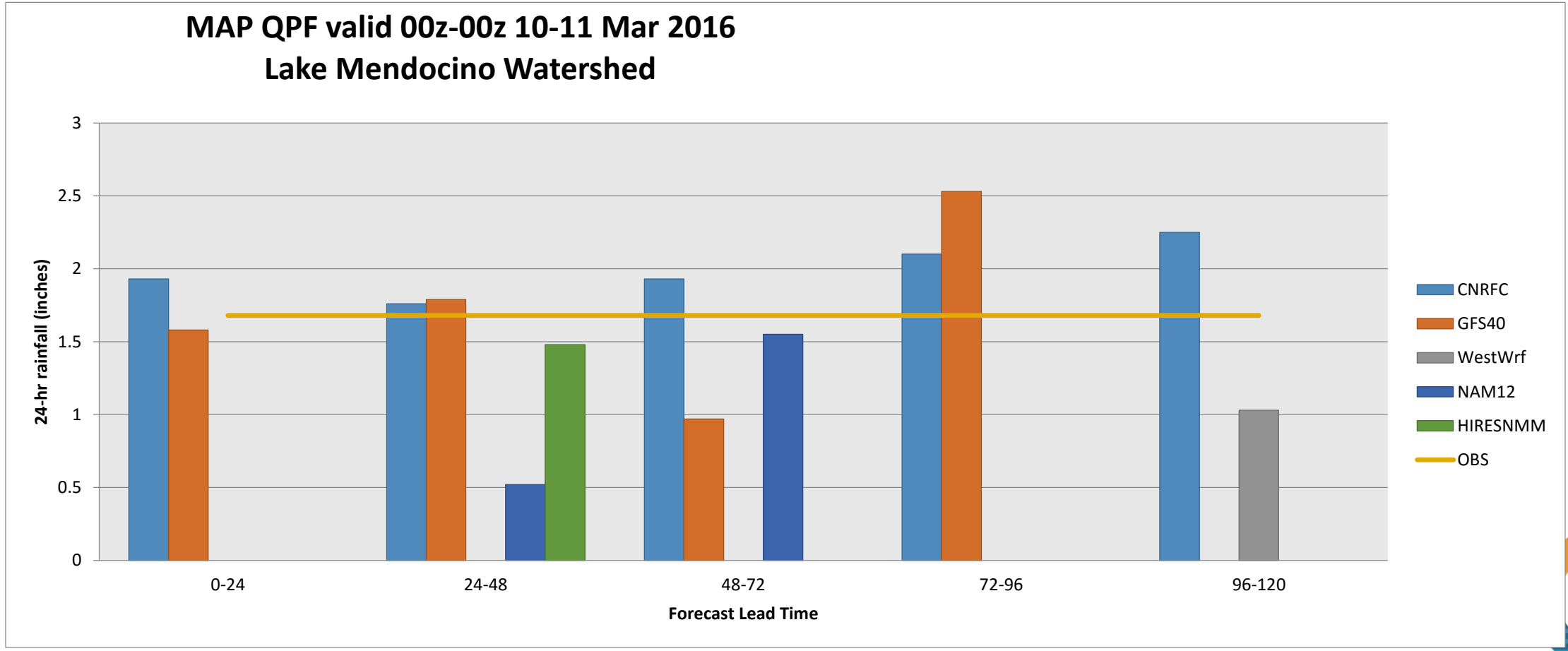


9-11 Mar 2016 Layer IVT and CNRFC 6-hr Fcst and Obs MAPs



CW3E

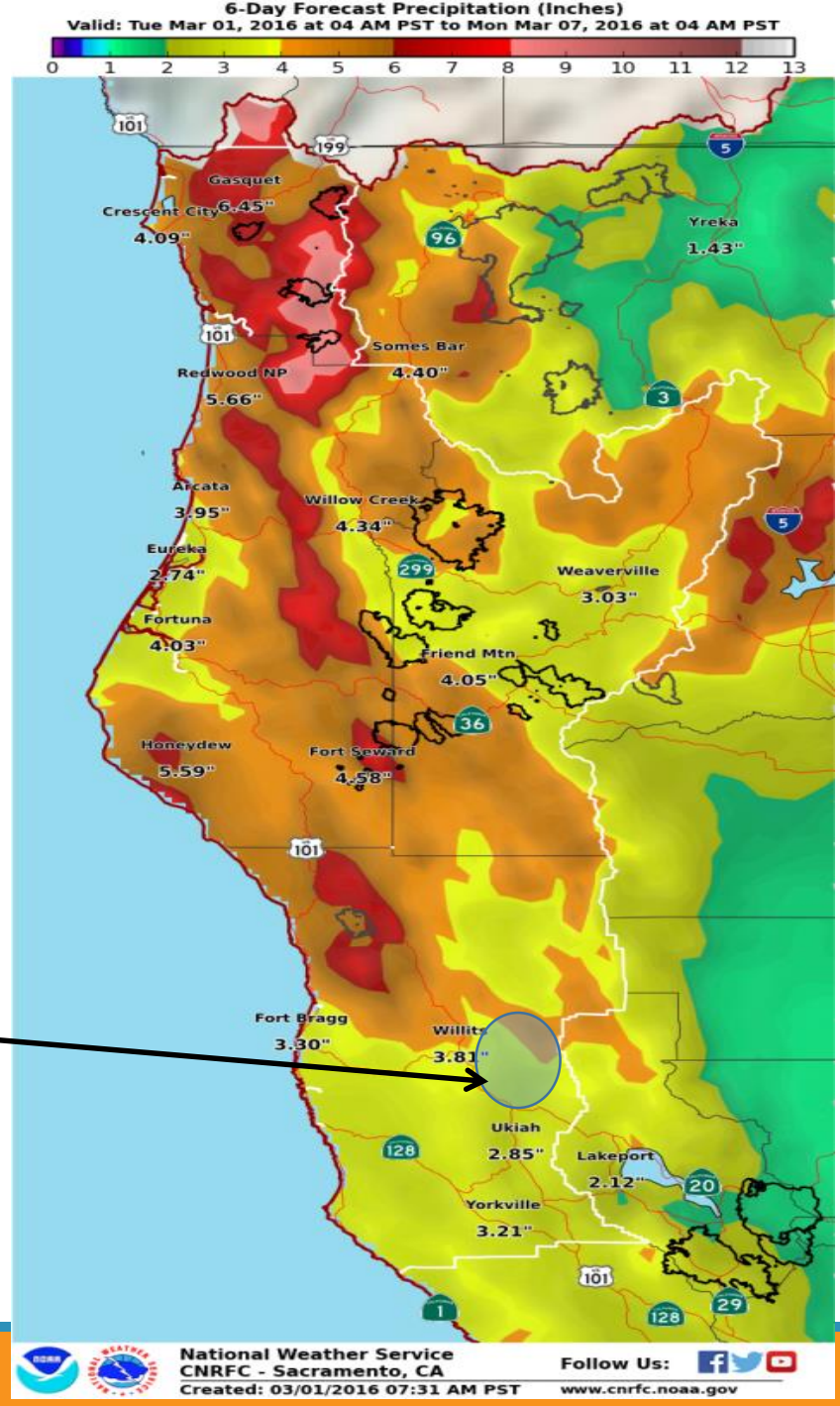
Mar 10-11, 2016 MAP QPF Verification



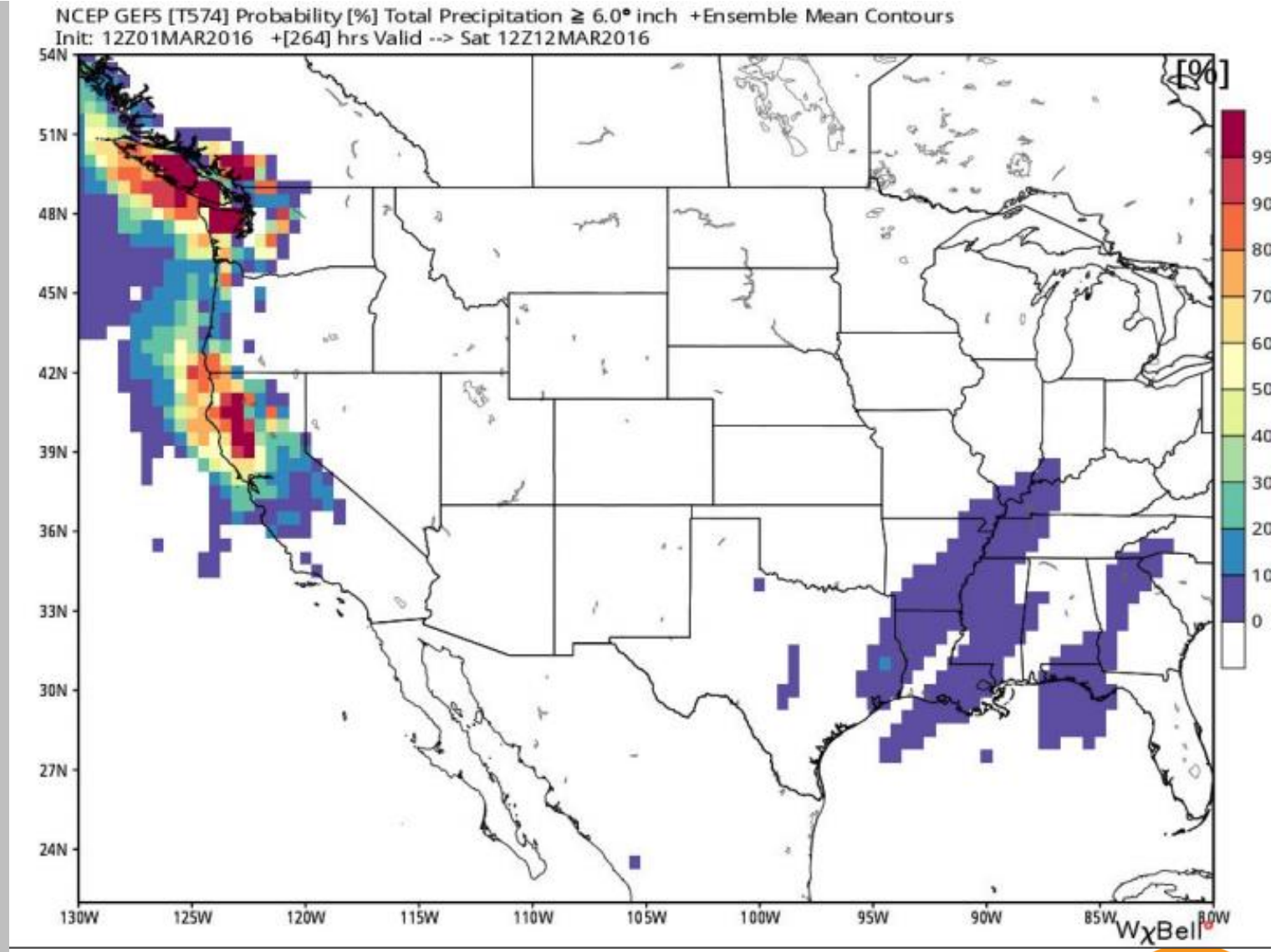
Based on Correlations QPF better Predictor of Impacts than IVT

CNRFC 6 Day QPF from 1 Mar 2016

Lake Mendocino

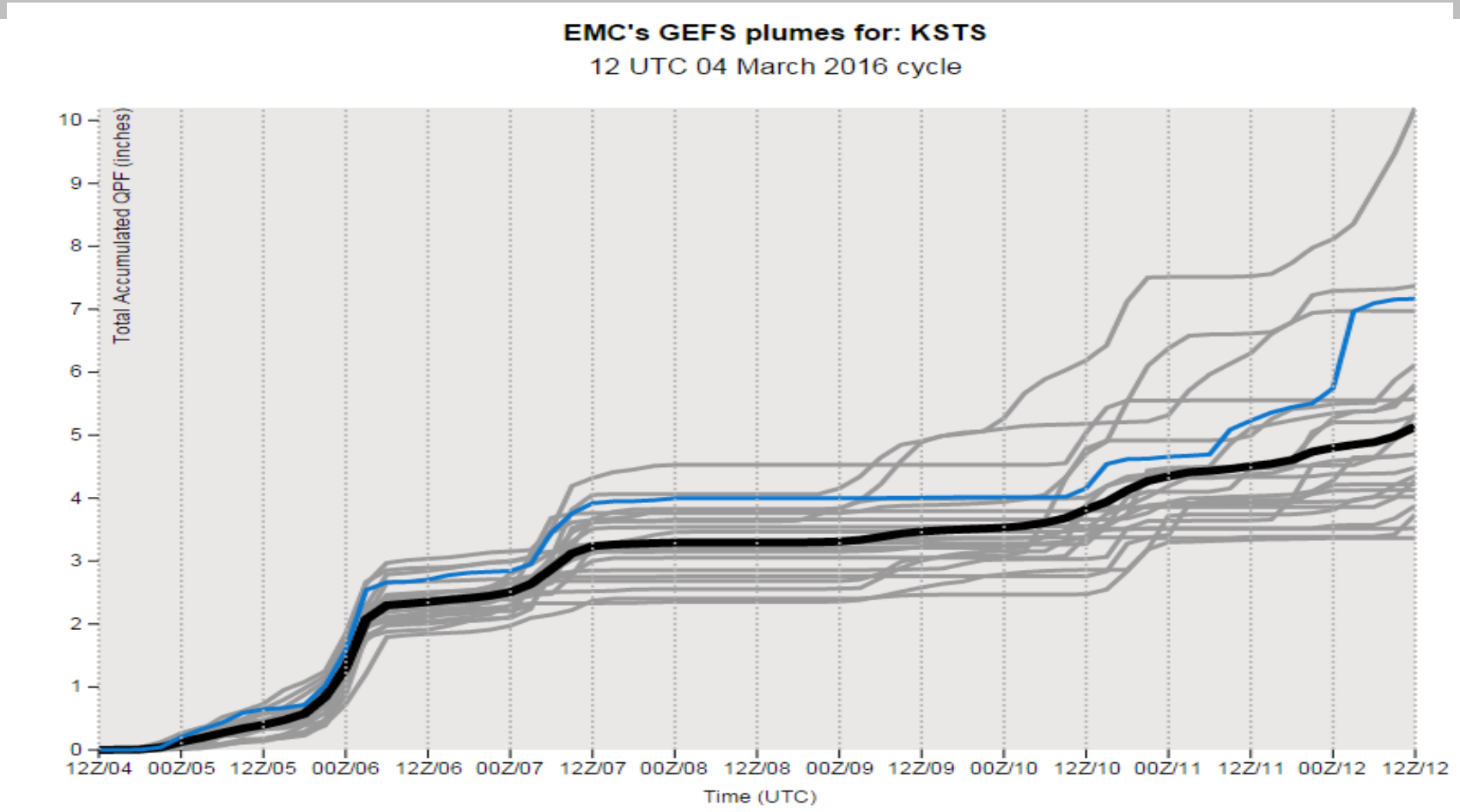


GEFS Model Probability of >= 6” March 1-March 12, 2016



CW3E

Plume Diagrams from GEFS



CW3E

Conclusions and Recommendations

- IVT (200-1000mb) not as good an indicator of potential rainfall impacts of land-falling ARs as is model or manual QPFs
  - Supports Rutz-Alcott 2014 study for CONUS
  - IVT may be more predictable (Lavers) but IVT not well correlated to subsequent rainfall for this study area over long term
- Utilize model QPFs (3 day totals) to define strength of land-falling ARs?
  - R-Cats to define AR strength

  as defined by Ralph and Dettinger, 2012-BAMS

	Rainfall Category 1	Rainfall Category 2	Rainfall Category 3	Rainfall Category 4
Defining 3-day precipitation thresholds (mm)	200 ≤ P < 300	300 ≤ P < 400	400 ≤ P < 500	500 ≥ P
Number of stations reaching these 3-day totals per year	173	23	4	2
Number/year of 3-day episodes with station(s) reaching this level	48	9	2	1
Average stations > 200 mm/episode	2	7	13	15

- Forecaster situational awareness better served by focusing on model QPF- especially looking at 3-5-7 day totals given timing and exact locations can be off utilizing 6-12-24 hr model QPFs

CW3E

International AR Workshop

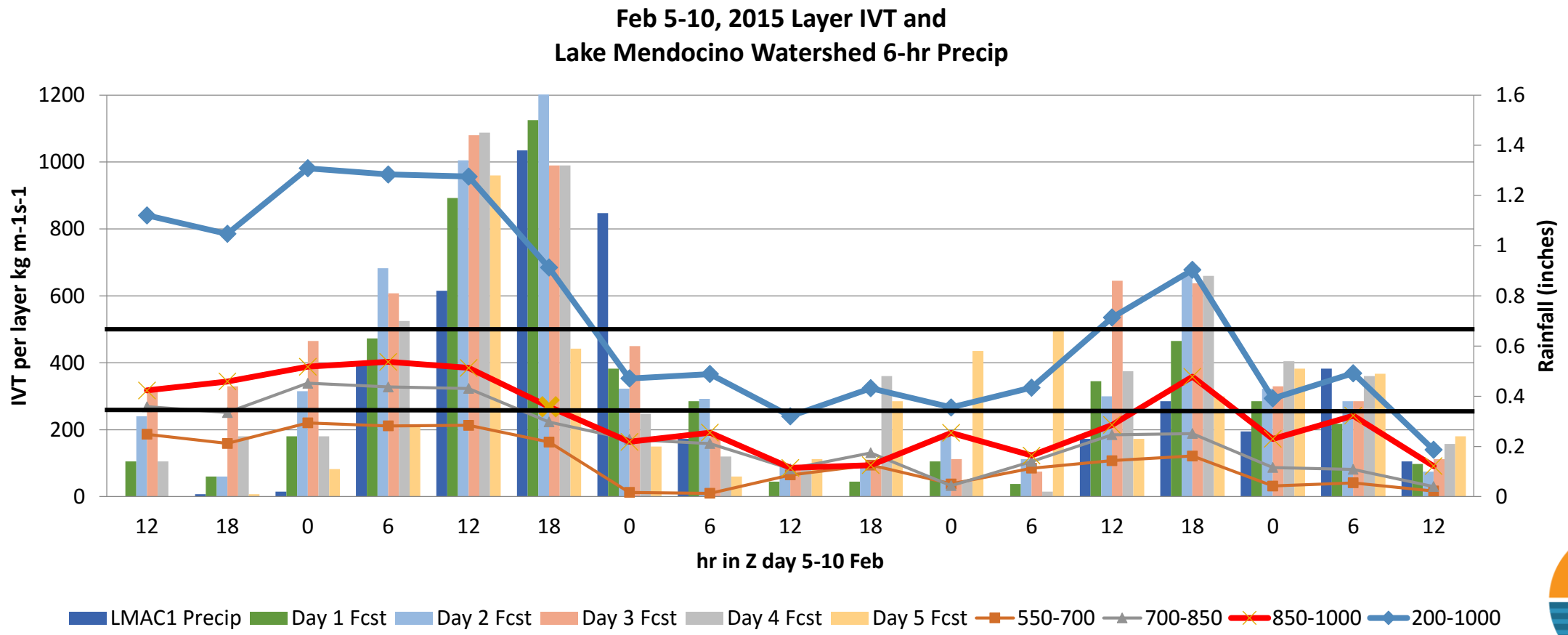
Thank You

david.reynolds@noaa.gov

CW3E

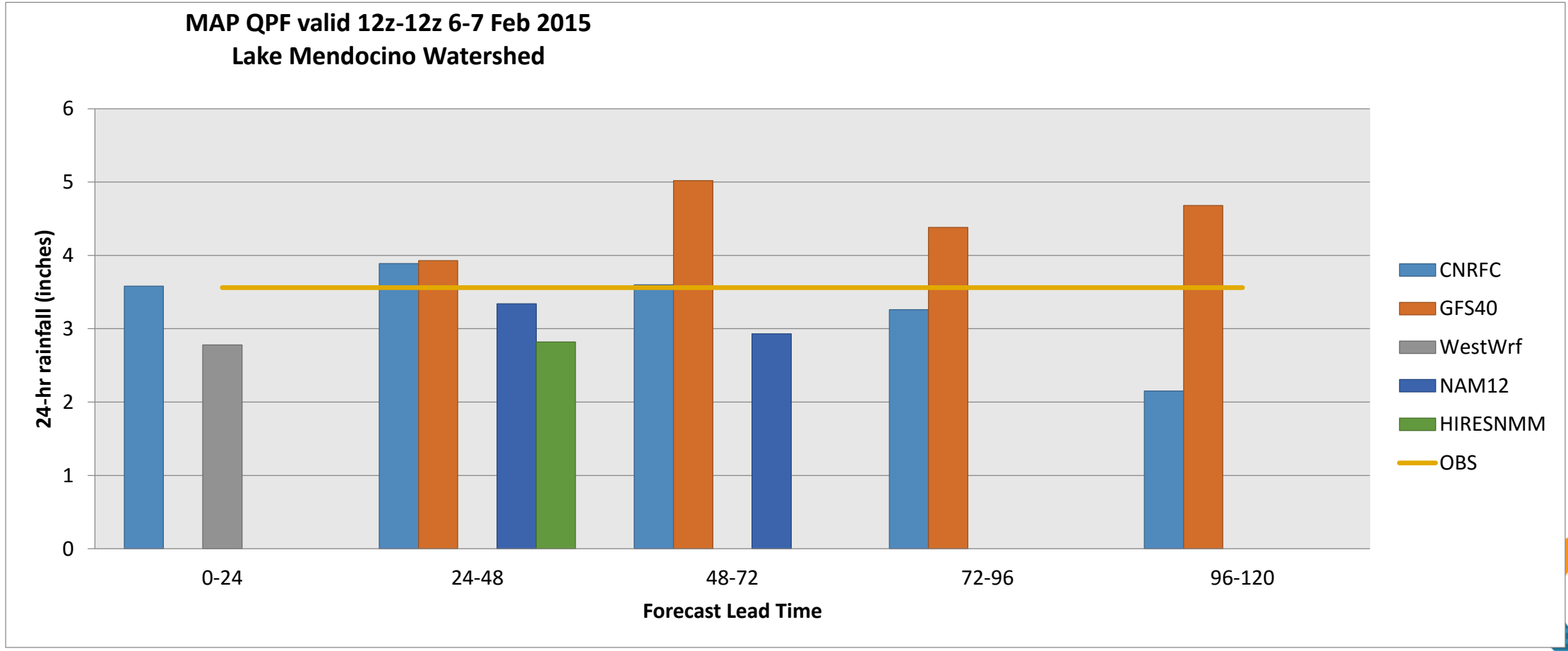
EXTRAS

Feb 5-10, 2015 Layer IVT and CNRFC 6-hr Fcst and Obs MAPs



CW3E

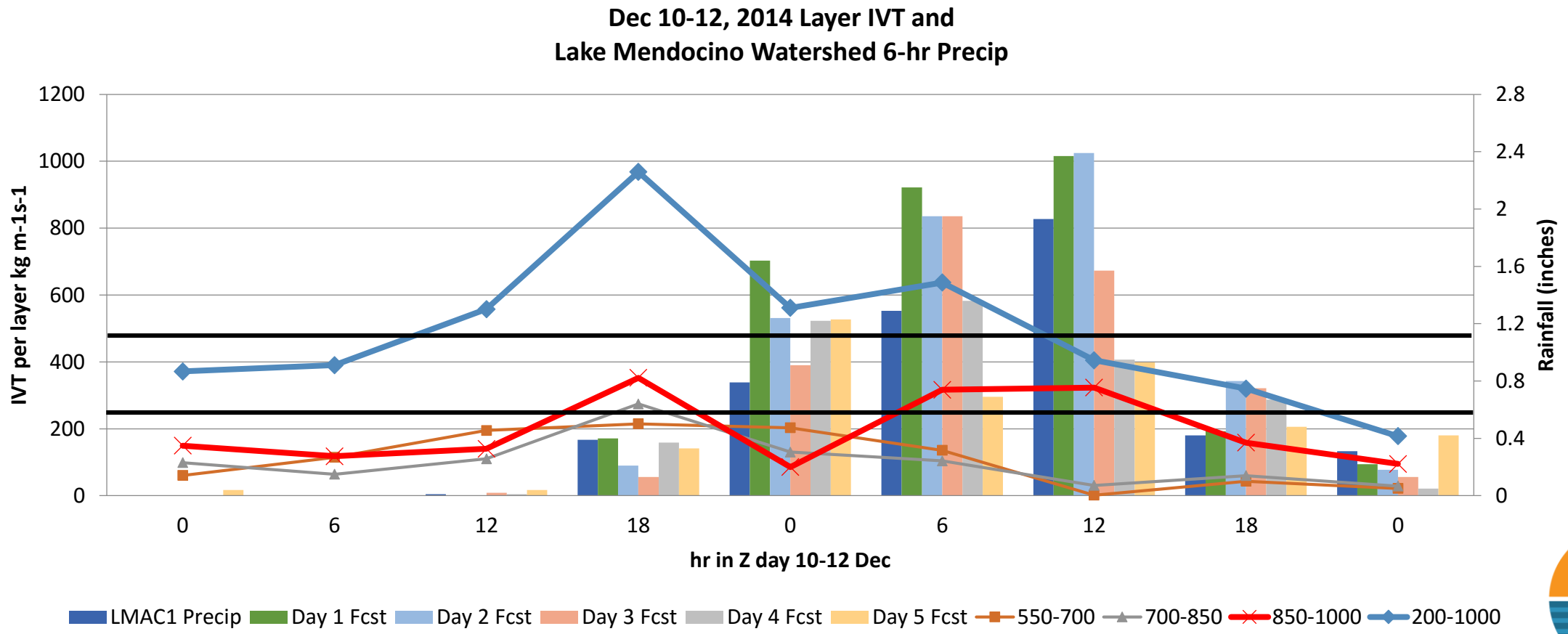
Feb 6-7, 2015 24-hr MAP QPF Verification



CW3E

Dec 10-12, 2014 IVT vs CNRFC MAP 6-hr QPE

250* and 500** kg m^{-1} s^{-1} IVT annotated with respect to 200-1000 mb IVT

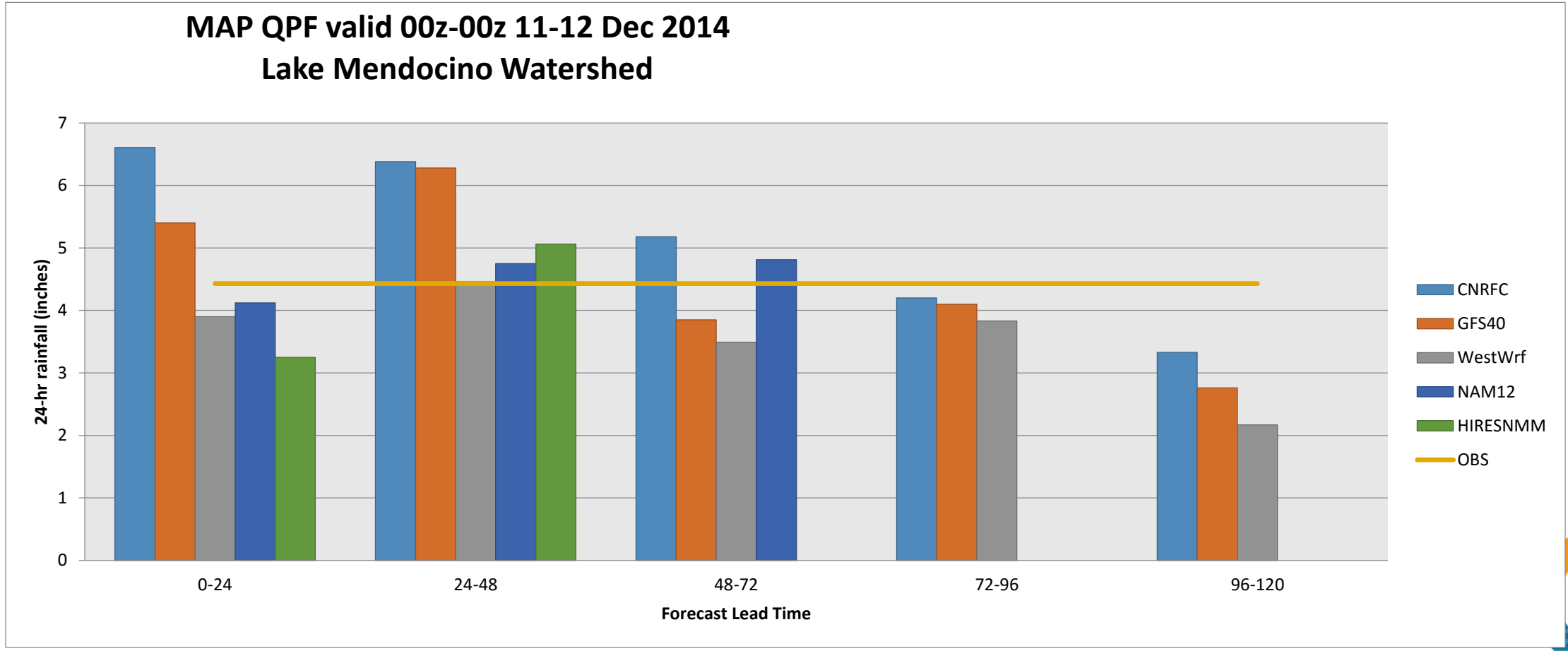


* After Rutz et al, 2014 Mon. Wea. Rev.

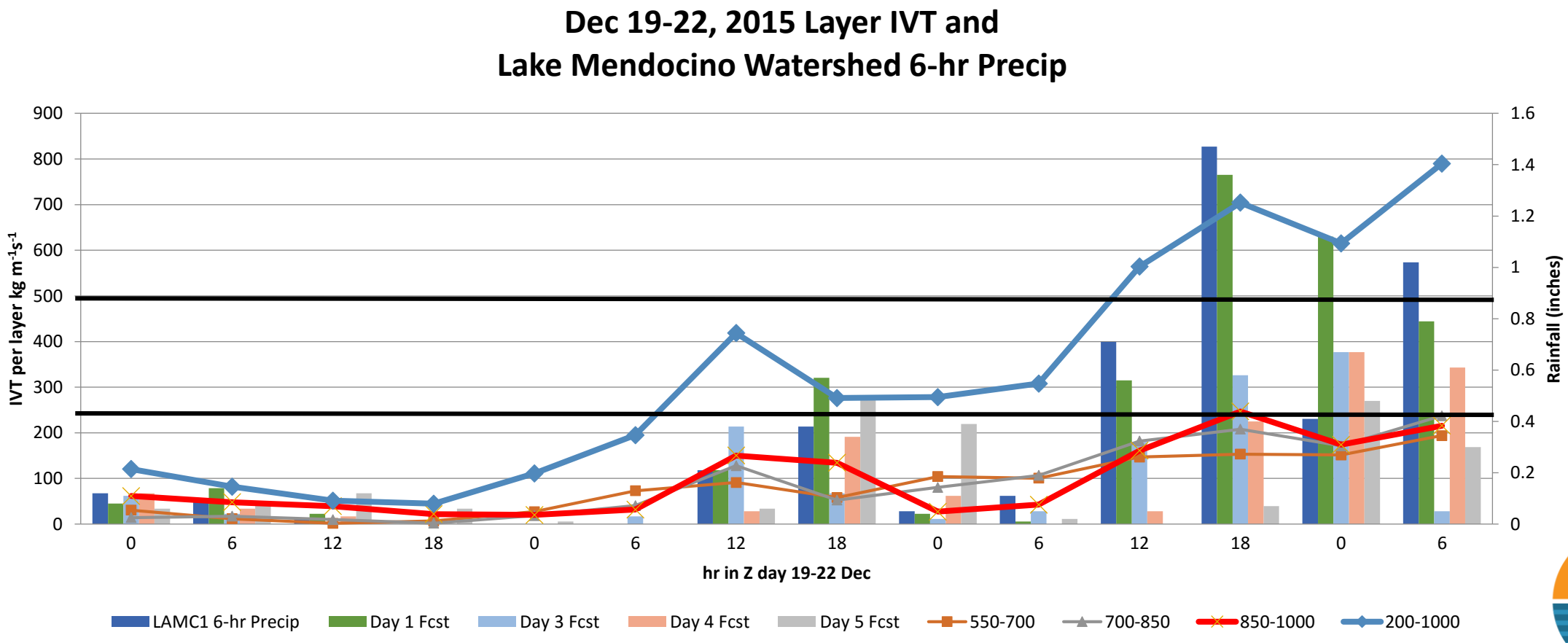
**Cordeira - http://cw3e.ucsd.edu/?page_id=491#LFT

CW3E

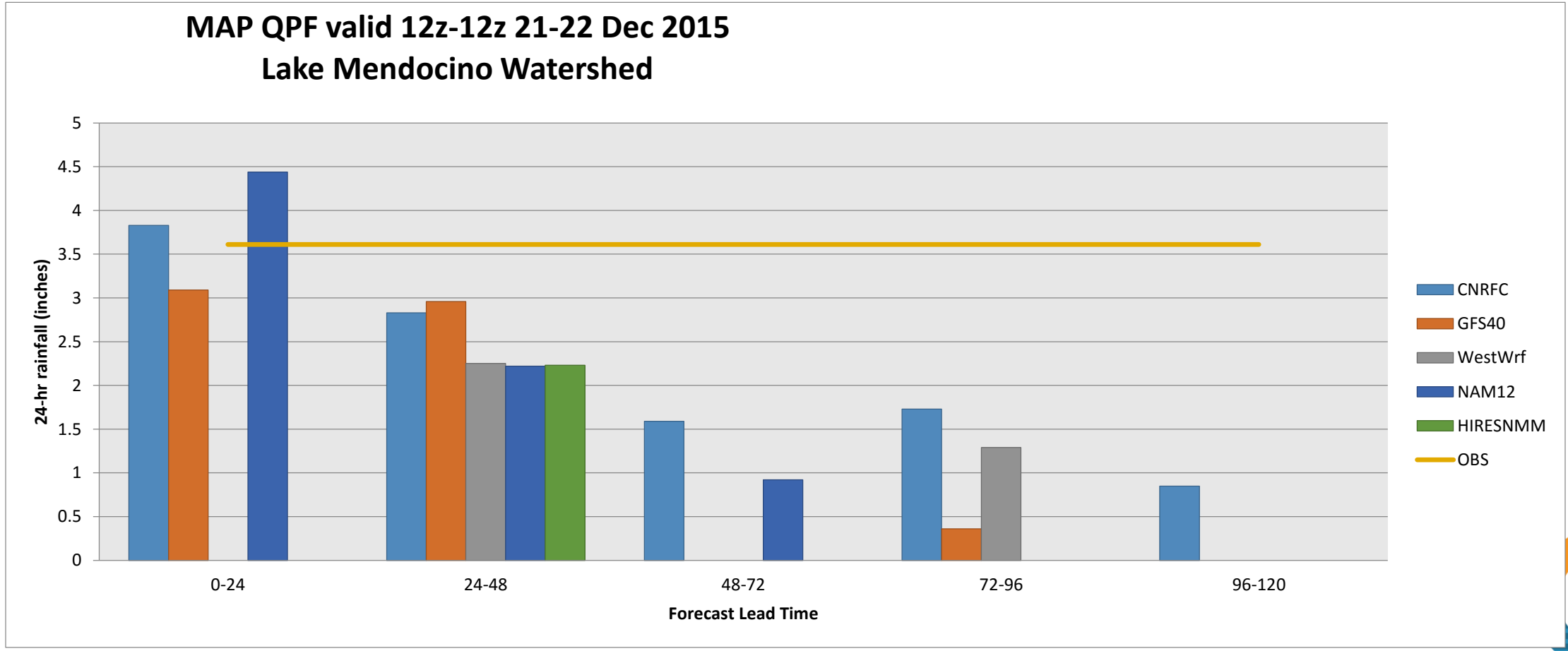
Comparison of MAPs CNRFC and NWP Lake Mendocino Watershed 24 hr Amounts



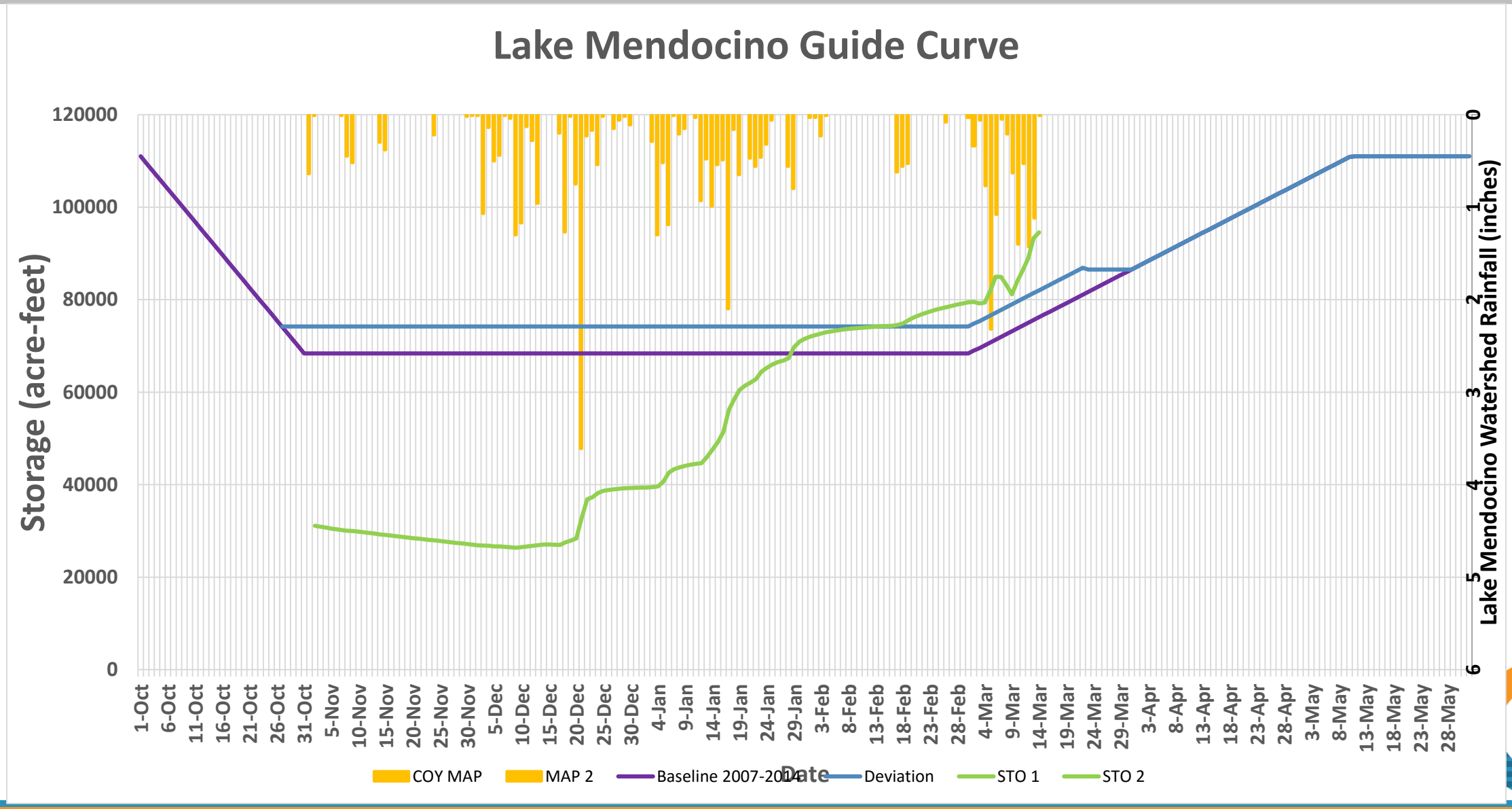
Dec 19-22, 2015 Layer IVT and 6-hr Fcst and Obs CNRFC MAPs



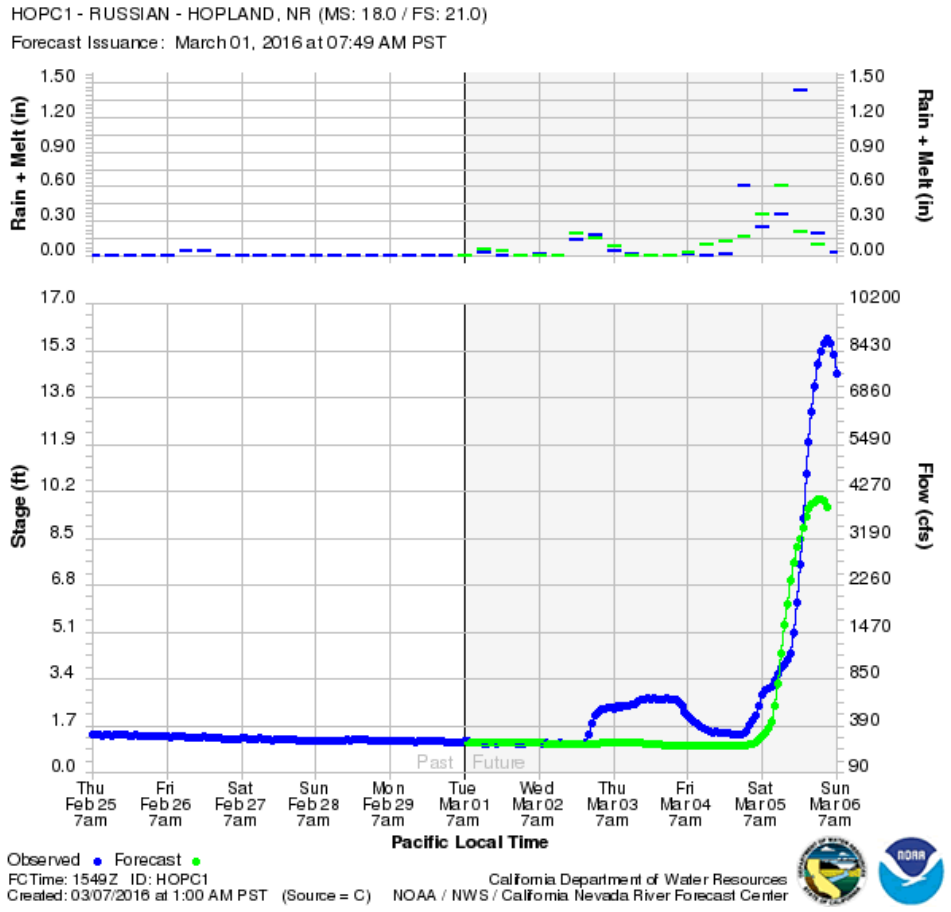
21-22 Dec 2015 MAP QPF Verification



Lake Mendocino Operations 2015-2016

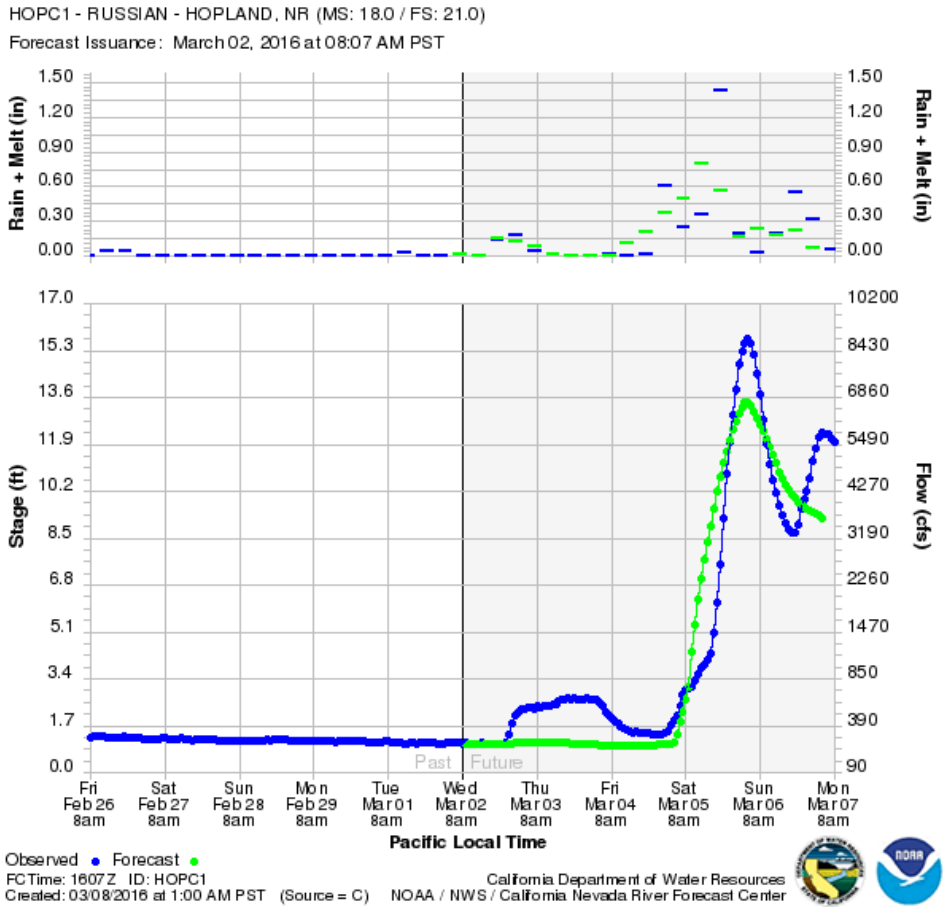


Forecasts Flows and Stage at Hopland
Day 5 Forecast



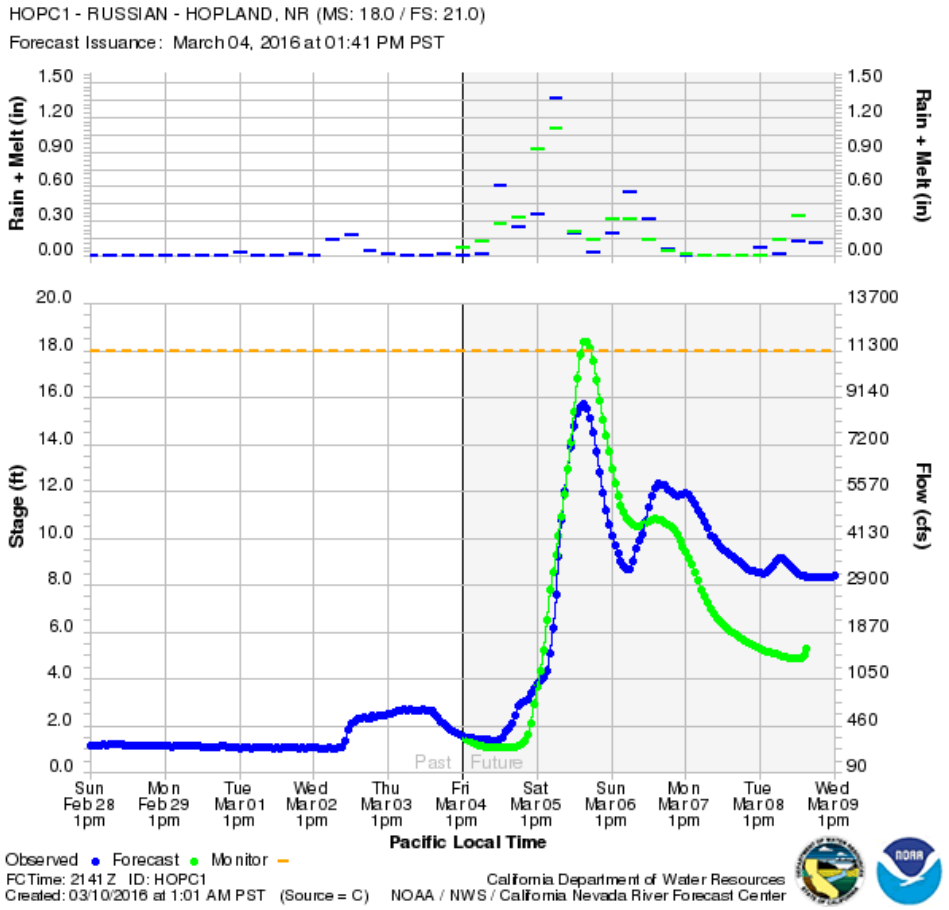
CW3E

Forecasts Flows and Stage at Hopland
Day 4 Forecast



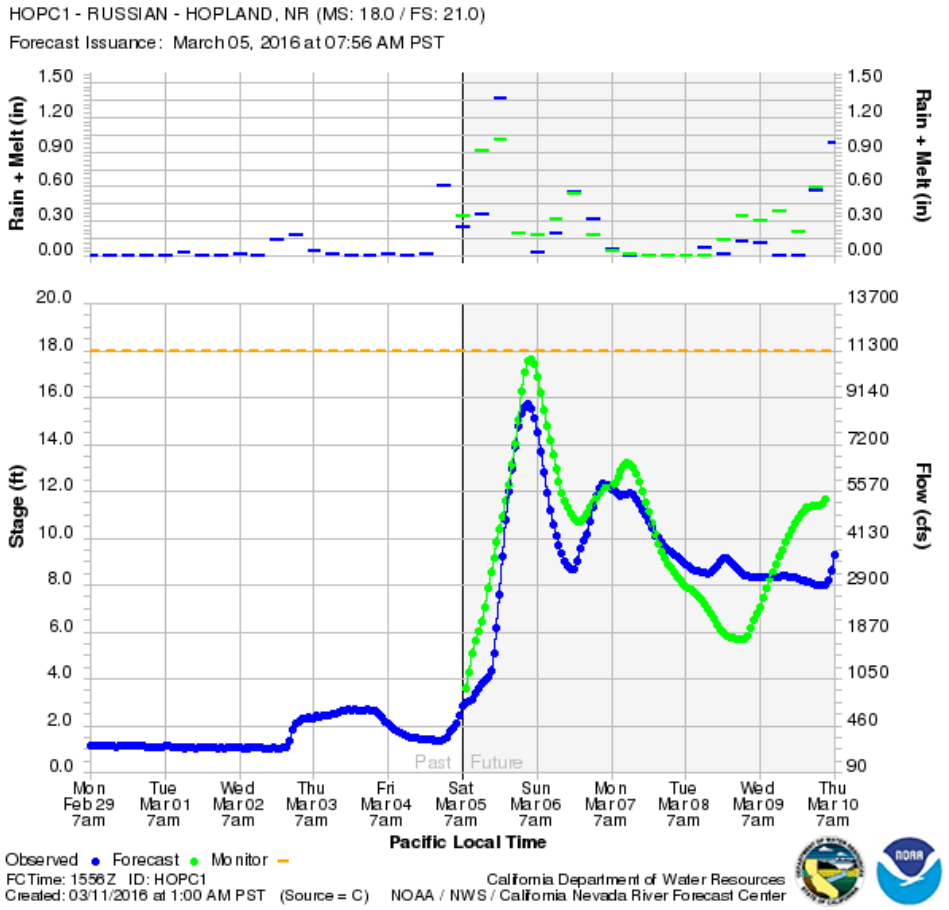
CW3E

Forecasts Flows and Stage at Hopland
Day 2 Forecast



CW3E

Forecasts Flows and Stage at Hopland
Day 1 Forecast



CW3E