HMT
Hydrometeorology Testbed

HMT-West Transition Project Report

Transitioning Research to Operations

Progress & Future Plans

Nov 1, 2012

Hydrometeorology Testbed
NOAA Earth System Research Laboratory

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R2O

- Improved forecaster knowledge base
- Improved/enhanced data flow to operations
- Decision Support Tools
- Web-based information
- Emergency Response

Outline

- Review R2O for FY 12 and earlier
- Outline priority tasks for FY13 and beyond
  - These were vetted through NWS WR HQ and CNRFC
- Discussion

HMT Forecaster Training

Date	Presenter	Format	Title	Audience
10/29/2010 11/2/2010	Dave Reynolds	GoToMeeting VISIT	Understanding and Forecasting Atmospheric Rivers	12 NWS WFOs NCEP HPC NOAA NESDIS Naval Res Lab CSU CIRA NASA SPORT NCAR COMET
11/18/2010	Marty Ralph	COMET Intense QPF Course	Atmospheric River Scientific Findings	23 NWS WFOs NCEP HPC OCWWS ESRL-PSD Met Svc Canada NWS Warning Decision Training Branch NWS Forecast Development and Training Branch
11/8/2011	Marty Ralph/Allen White	NWS WR WEBINAR	HMT Field Operations/Legacy HMT network/Recent Developments in AR studies	24 NWS WFOs and 3 RFCs
03/7/2012	Brian Garcia, Wallace Clark, Tara Jensen	NWS WR WEBINAR	Objective Analysis of ARs	WR SOOs
03/13/2012	Dave Reynolds/Marty Ralph	GoToMeeting	Expected AR impacts on West Coast and new tools for defining ARs and moisture flux in model guidance	WR SOOs

Summary of HMT Transition Projects

Transistion Activity/ Purpose	GoToMeetings	Workshops/ Meetings/Special Secessions/Teams	Real-time Support to Operations	Web Based Information	R2O / O2R
Improved Knowledge Base On AR's - QPF- Orographic effects –Observing systems -Physical processes	VISIT (Virtual Institute for Satellite Integration Training] – WR SSD SOO Calls – COMET HydroMet Workshops	Annual HMT-W HMT-SE workshops AGU Special Session ARs CalWater Debris Flow Workshops HMT HPC Winter Weather Experiments IRWSS Workshop Russian River National Hydrologic Warning Council HMT-W R2O Workshop		Atmospheric River Information Web Page	As of May 2012 – 63 Formal Publications in 14 independent journals.
Decision Support	WR SSD SOO call – Flux Tools HMT Support SCEP/CSTAR on use of anomaly charts for extreme events	D Reynolds joins NWS WR Uncertainty/Confidence Forecast Team as OAR member ARkStorm Multi-Hazard Demonstration Project CalEma Catastrophic Flood Plan to utilize ARkStorm Scenario	.	ARO Flux Tool S-Prof auto-update pages SSMI –GFS Flux Tool GEFS – AR location-duration at landfall	Tim Schneider – HMT Director to NWS - R2O Dave Reynolds – NWS MIC to NOAA OAR – O2R
Improved /Enhanced Data Flow to operations			HMT Legacy (EFREP) -Surface Met, soil moisture, and Freezing level data encoded and provided hourly to WFOs and CNRFC . AROs installed (to be) coast and Sierra foothills. ALPS workstations deployed – WRF Ensembles	NWS Pacific Region deploy GPS receivers in Pacific Basin CA-DWR HMT Legacy Project Google Maps based soil moisture, GPS TPW, Freezing level,Precip	
Emergency Response Support		Special Seattle WFO training session on ARO system and operational use of Flux Tool	Mobile AROs for Debris flows So Cal, Big Sur Basin Howard Hanson Dam		BAMS article on Howard Hanson Dam support

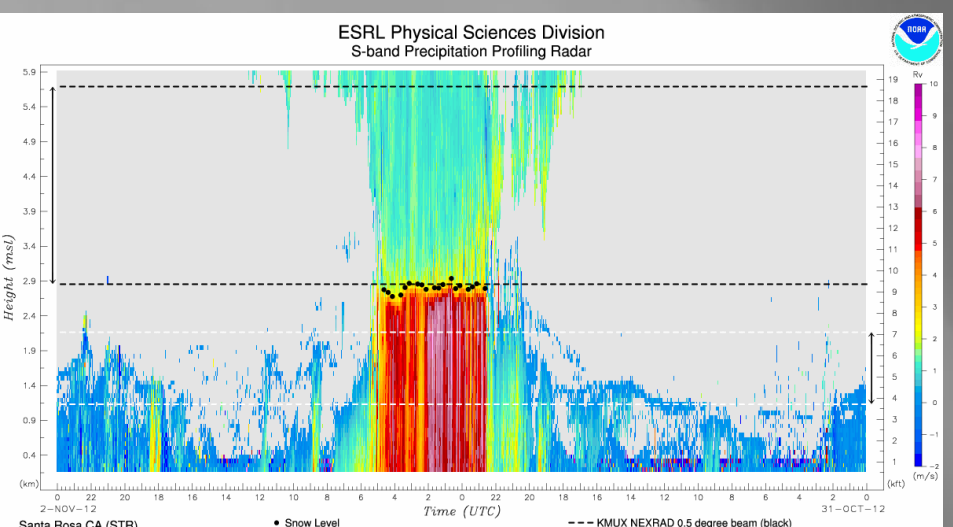
SHEF File sent to CNRFC and WFO MTR with HMT surface obs

```
SRUS55 KSLC 301710
HMTSLC
.B DEN 120430 DH17/DQZ/PPH/XR/US/TA/UD/TD
: HOURLY SURFACE MET MESSAGE FROM
NOAA/ESRL/PSD BOULDER, CO
: FOR SITE METADATA
http://www.esrl.noaa.gov/psd/data/obs/sites/

:    Precip /  Temp  /Wind Spd/  RH    /Wind Dir/ Dew Pt

ANDCA   0.00 /  63.80 /       /  58.32 /       /  46.11
LHMCA -9999  / -9999  / -9999  / -9999  / -9999  / -9999
SMTCA       / -9999  / -9999  / -9999  / -9999  / -9999
SERCA       / -9999  / -9999  / -9999  / -9999  / -9999
LSNCA   0.00 /  44.93 /       /  66.47 /       /  44.44
LSOCA       / -9999  / -9999  / -9999  / -9999  / -9999
MBGSD   0.00 /  45.68 /       /  61.68 /       /  40.52
RODCA   0.00 /  57.23 /       /  70.87 /       /  54.98
CFCCA   0.00 /  46.57 /   1.14 /  71.67 / 249.66 /  50.12
FMSAZ   0.00 /       /       /  74.46 /       /
LDSND   0.00 /  50.71 /  17.49 /  58.22 / 260.03 /  40.03
FBKAZ       /       /       /  78.32 /       /
FFMCA       / -9999  / -9999  / -9999  / -9999  / -9999
ANWNE -9999  /       /       /       /       /
CFXCA   0.00 /  45.29 /       /  69.40 /       /  47.31
ONSCA   0.00 /  46.94 /       /  72.93 /       /  51.48
BRGCA       / -9999  / -9999  / -9999  / -9999  / -9999
CZCCA   0.00 /  47.58 /   4.66 /  65.97 / 337.05 /  45.49
HLDCA   0.00 /  39.13 /       /  70.71 /       /  44.63
PRVCA       / -9999  / -9999  / -9999  / -9999  / -9999
HCPCA   0.00 /  65.67 /       /  61.44 /       /  49.84
LOGCA       / -9999  / -9999  / -9999  / -9999  / -9999
WLSCA -9999  /  72.94 /       / -9999  /       / -9999
BLUCA   0.00 /  46.40 /   8.65 /  59.63 / 203.22 /  39.05
DSTSD   0.00 /  53.57 /   6.02 /  59.55 / 249.11 /  42.69
BBDCA   0.00 /  37.42 /   3.41 /  59.95 / 204.19 /  33.89
SMSCA       / -9999  / -9999  / -9999  / -9999  / -9999
ELGAZ       /       /       /  72.96 /       /
BFLSD   0.00 /  27.23 /  19.61 /  64.79 / 214.34 /  30.24
WCCCA       / -9999  / -9999  / -9999  / -9999  / -9999
LQTCA       / -9999  / -9999  / -9999  / -9999  / -9999
OVLCA       /  51.05 /       /  74.21 /       /  54.94
BBYCA   0.00 /  88.81 /  14.51 /  53.09 / 318.62 /  49.87
CNACA       / -9999  / -9999  / -9999  / -9999  / -9999
CNLAZ -9999  /       /       / -9999  /       /
OCRCA   0.00 /  44.49 /       /  57.00 /       /  35.58
CNHCA       /  36.35 /       /  51.12 /       /  25.31
MTACA       / -9999  / -9999  / -9999  / -9999  / -9999
MCKCA       / -9999  / -9999  / -9999  / -9999  / -9999
PFDCA   0.00 /  48.36 /       /  72.45 /       /  51.85
EHLCA   0.00 /  46.52 /   2.77 /  65.97 / 179.19 /  44.89
```

SHEF encoded freezing level file for CNRFC



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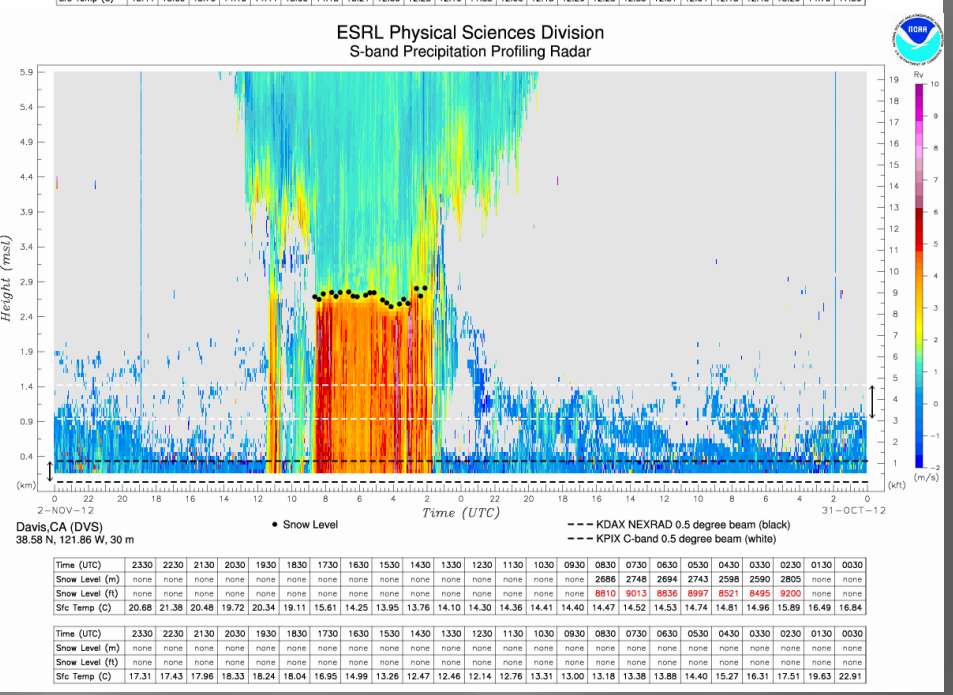
Snow Level (m)	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	2736	2807	2845	2803	2832
Snow Level (ft)	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	8974	9206	9331	9193	9288
Sfc Temp (C)	18.67	19.29	19.22	18.74	17.09	15.94	15.34	13.70	13.06	13.05	13.40	13.45	13.47	13.46	13.37	13.24	13.13	13.13	13.20	13.21	13.21	13.16	13.25	13.34

Time (UTC)	2330	2230	2130	2030	1930	1830	1730	1630	1530	1430	1330	1230	1130	1030	0930	0830	0730	0630	0530	0430	0330	0230	0130	0030
Snow Level (m)	2816	2793	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none
Snow Level (ft)	9236	9161	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none
Sfc Temp (C)	13.44	13.60	13.70	14.13	14.44	15.00	14.18	13.21	12.50	12.28	12.19	11.85	12.06	12.13	12.26	12.23	12.53	12.51	12.04	12.18	12.43	13.26	14.73	17.56



Time (UTC)	2330	2230	2130	2030	1930	1830	1730	1630	1530	1430	1330	1230	1130	1030	0930	0830	0730	0630	0530	0430	0330	0230	0130	0030
Snow Level (m)	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	2686	2748	2694	2743	2598	2590	2805	none	none
Snow Level (ft)	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	8810	9013	8836	8997	8521	8495	9200	none	none
Sfc Temp (C)	20.68	21.38	20.48	19.72	20.34	19.11	15.61	14.25	13.95	13.76	14.10	14.30	14.36	14.41	14.40	14.47	14.52	14.53	14.74	14.81	14.96	15.89	16.49	16.84

Time (UTC)	2330	2230	2130	2030	1930	1830	1730	1630	1530	1430	1330	1230	1130	1030	0930	0830	0730	0630	0530	0430	0330	0230	0130	0030
Snow Level (m)	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none
Snow Level (ft)	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none
Sfc Temp (C)	17.31	17.43	17.96	18.33	18.24	18.04	16.95	14.99	13.26	12.47	12.46	12.14	12.76	13.31	13.00	13.18	13.38	13.88	14.40	15.27	16.31	17.51	19.63	22.91

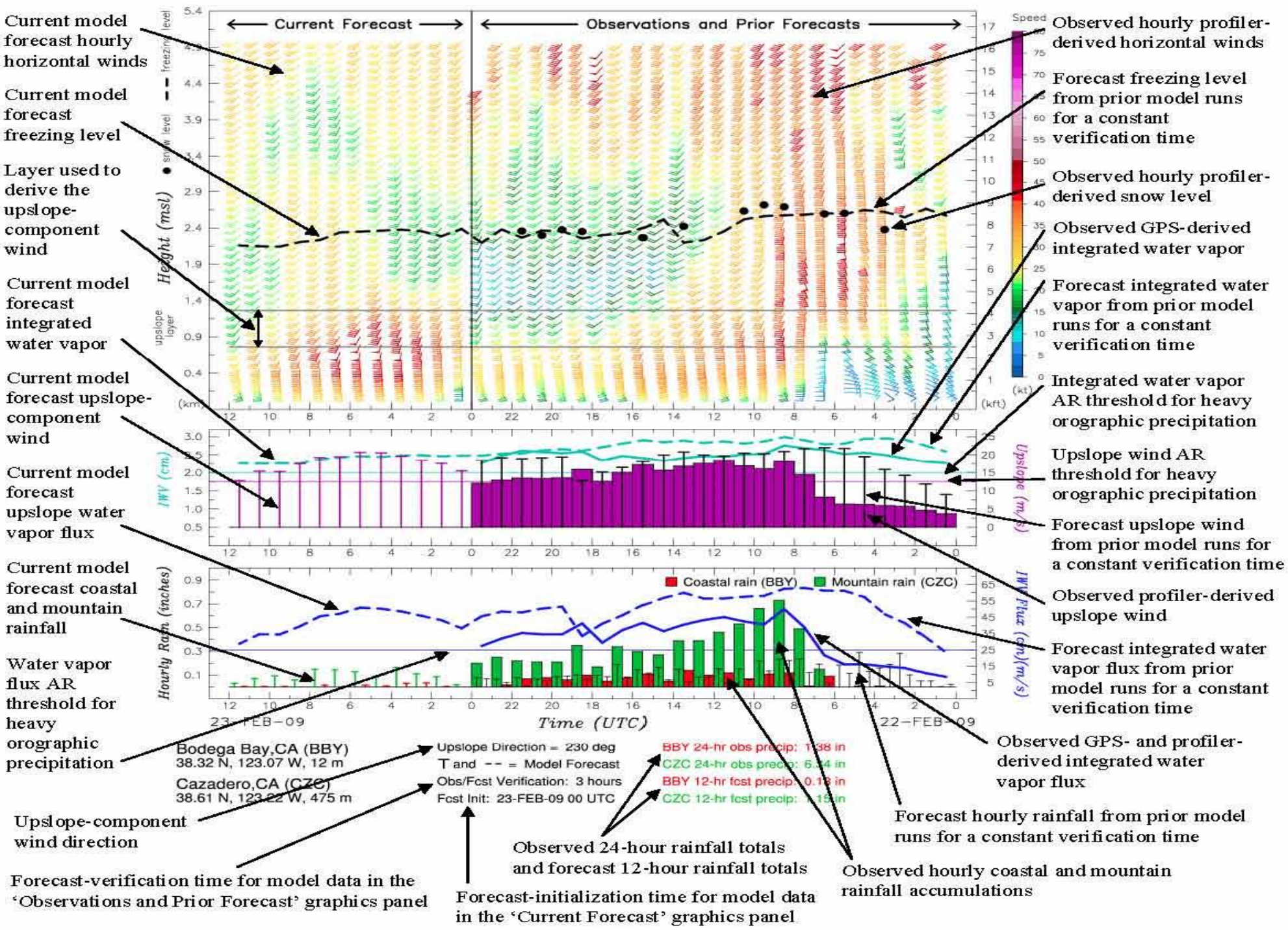
- .B DEN 121101 DH03/DQZ/HZH
  : VERTICALLY POINTED RADAR-DERIVED FREEZING LEVEL...
  : 765 FOOT CONSTANT OFFSET FROM MEASURED SNOW LEVEL.
  : MESSGAGE FROM NOAA/ESRL/PSD BOULDER, CO
  : FOR SITE METADATA http://www.esrl.noaa.gov/psd/data/obs/sites/

STDCA -9999
HCPCA -9999
WPTWA -9999
PFDCA -9999
STRCA 9.988
CFFCA -9999
CFCCA -9999
SEAWA -9999
SACCA -9999
CCOCA 8.873
SNSCA -9999
BBYCA 9.450
KNVCA -9999
NERCA -9999
OVLCA 9.255
WPCWA -9999
.END
.BR DEN 121101 DH02/DQZ/HZH
: VERTICALLY POINTED RADAR-DERIVED FREEZING LEVEL...
: 765 FOOT CONSTANT OFFSET FROM MEASURED SNOW LEVEL.
: MESSAGE FROM NOAA/ESRL/PSD BOULDER, CO

WPTWA 6.554
.END

Coastal Atmospheric River (AR) Monitoring and Early Warning System

Profiler and precipitation observations provided by the NOAA/ESRL Physical Sciences Division
GPS observations and model forecast provided by the NOAA/ESRL Global Systems Division



References

Jankov, Isidora, J. Bao, P.J. Neiman, P.J. Schultz, H. Yuan, A.B. White, 2009: Evaluation and comparison of microphysical algorithms in WRF-ARW model simulations of atmospheric river events affecting the California coast. *J. of Hydrometeor.*, **10**, 847-870.

Neiman, P.J., A.B. White, F.M. Ralph, D.J. Gottas, and S.I. Gutman, 2009: A water vapor flux tool for precipitation forecasting. *Water Management*, **162**, WM2, doi: 10.1680/wama.2009.162.2.83.

Neiman, P.J., F.M. Ralph, A.B. White, D.E. Kingsmill, and P.O.G. Persson, 2002: The statistical relationship between upslope flow and rainfall in California's coastal mountains: Observations during CALJET. *Mon. Wea. Re*

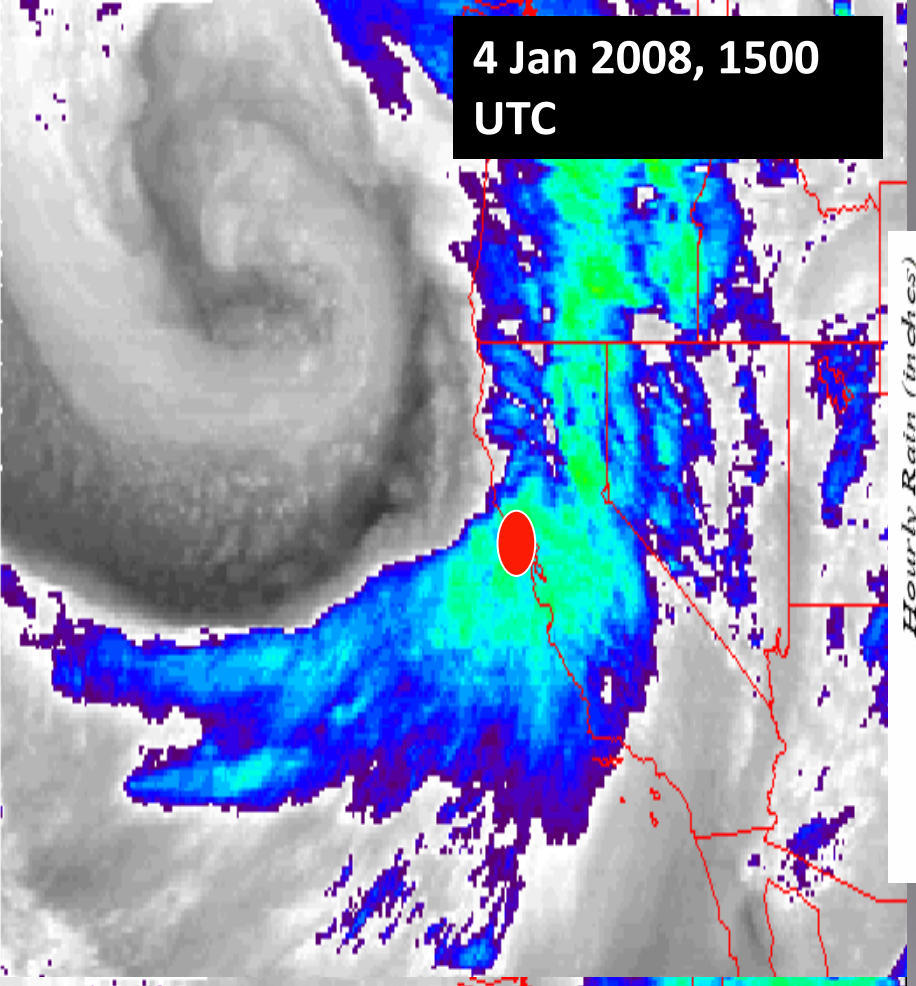
Ralph, F. M., P. J. Neiman, G. A. Wick, S. I. Gutman, M. D. Dettinger, D. R. Cayan, River: Role of atmospheric rivers. *Geophys. Res. Lett.*, **33**, L13801, doi:10.102

White, Allen B., Daniel J. Gottas, Eric T. Strem, F. Martin Ralph, Paul J. Neiman, 200 use with Doppler radar spectral moments. *J. Atmos. Oceanic Technol.*, **19**, 687

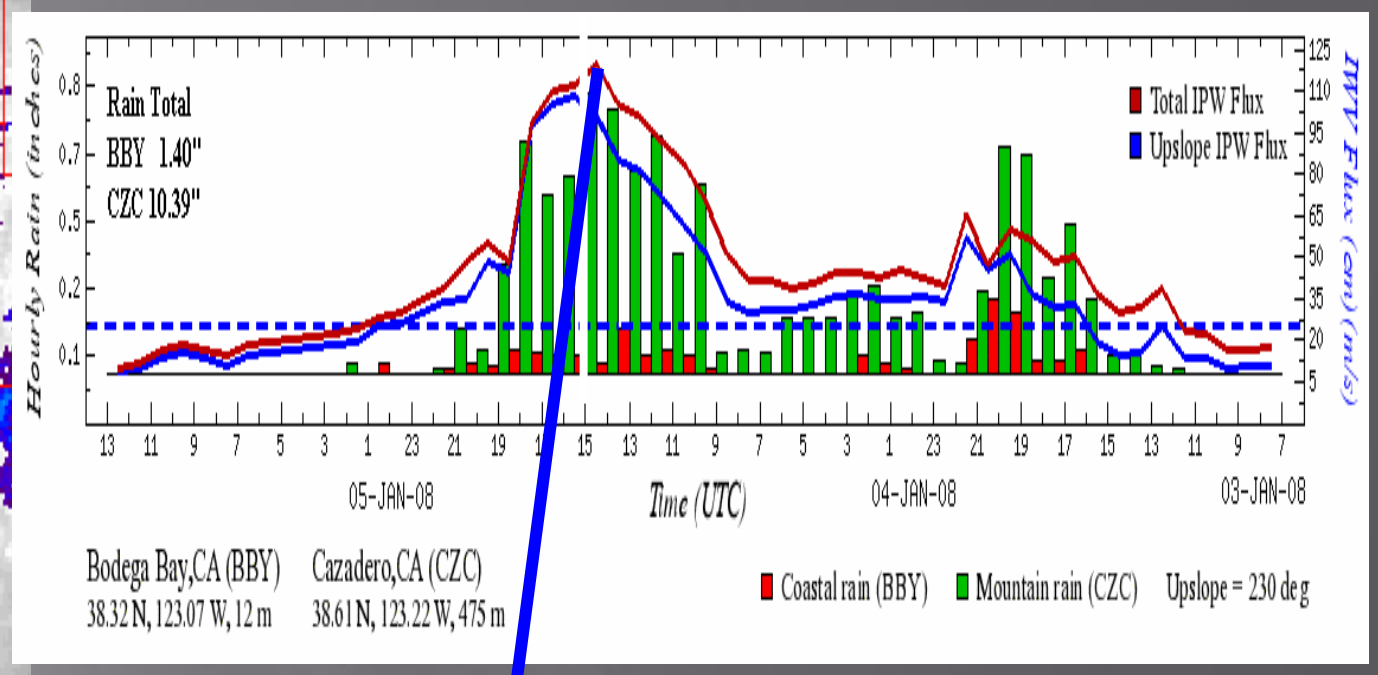
Yuan, Huiling, J.A. McGinley, P.J. Schultz, C.J. Anderson, and C. Lu, 2008: Short-ra ensembles during the HMT-West-2006 Campaign. *J. of Hydrometeor.*, **9**, 447-

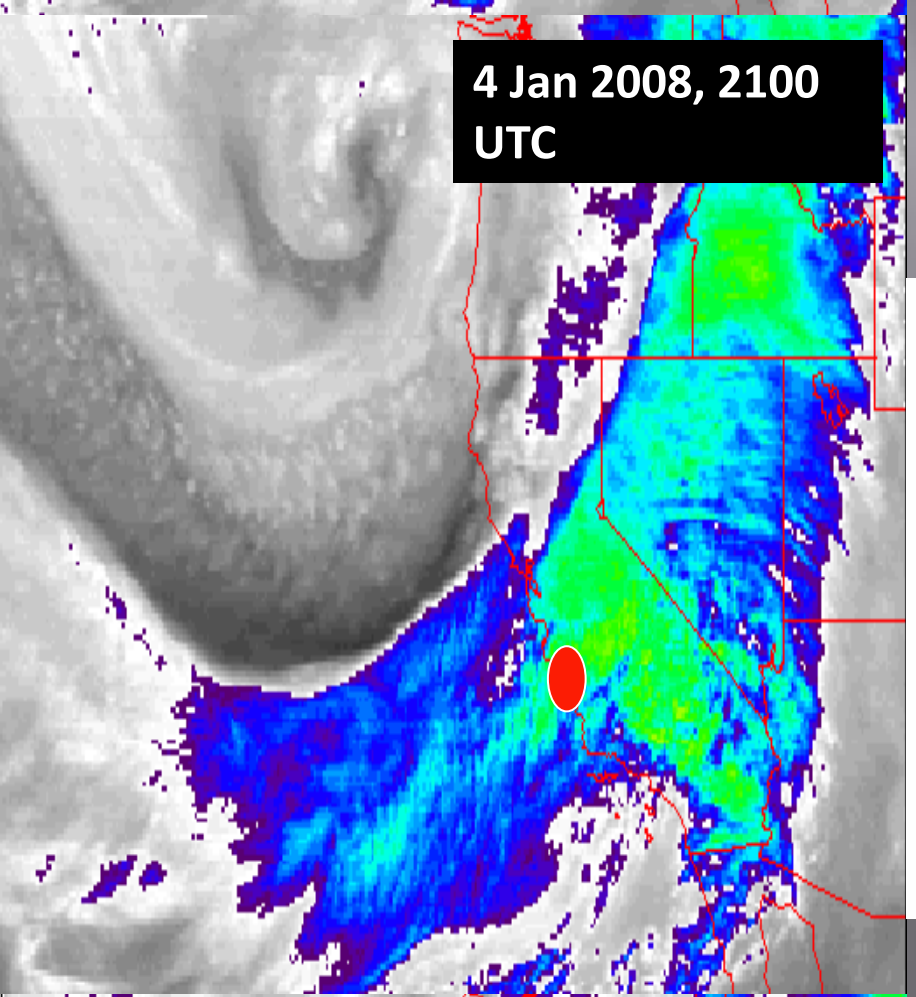
Product Access: http://www.etl.noaa.gov/et7/data/ **Contacts**

Bronze Medal

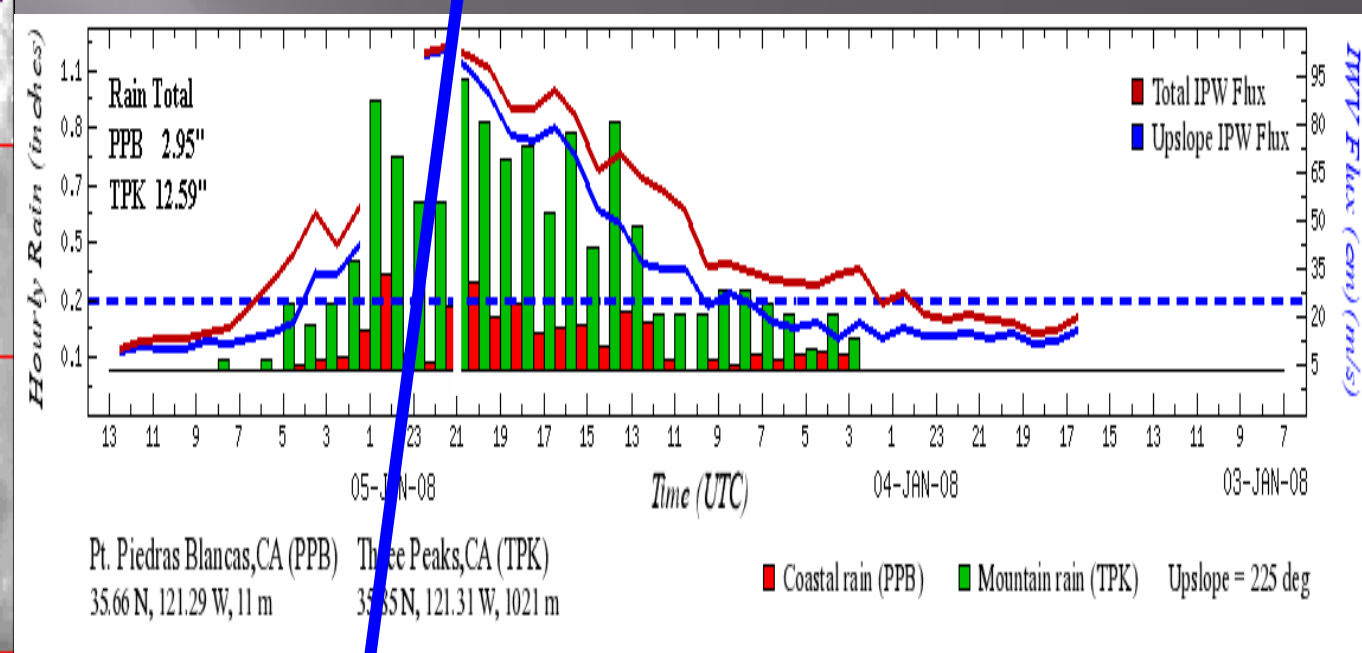


Time of max AR bulk flux at BBY: 1500 UTC 4 Jan

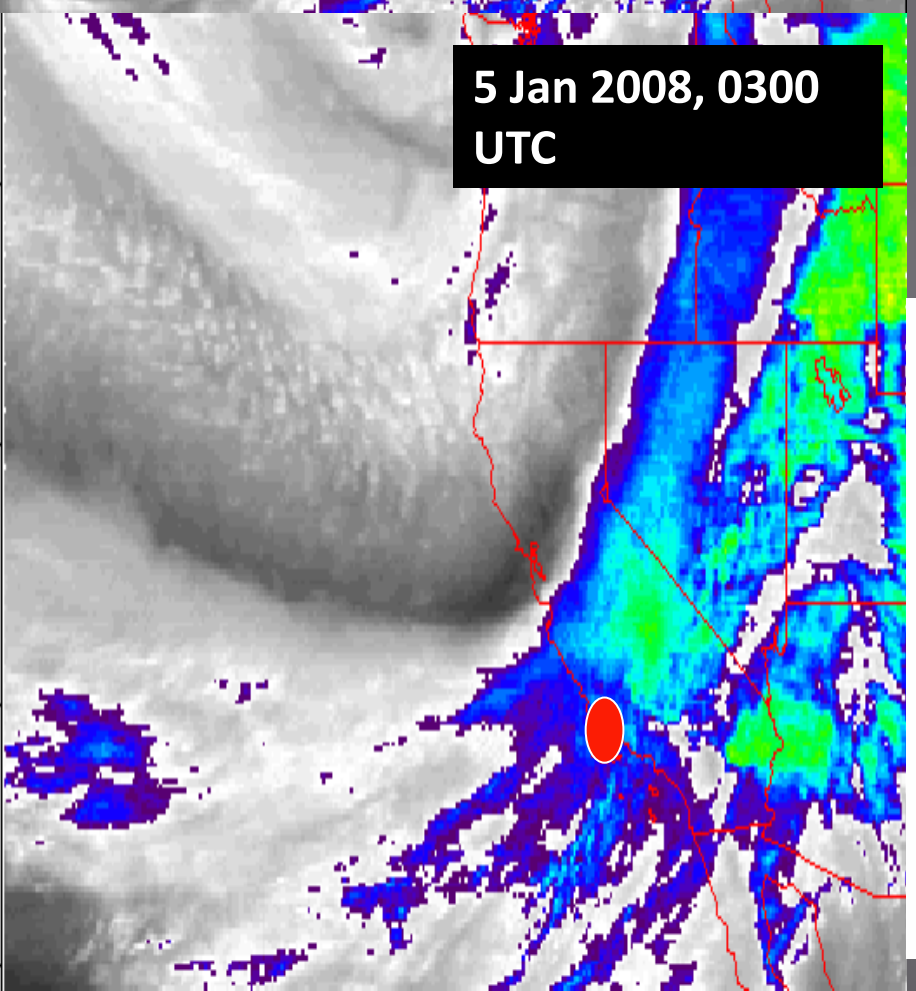




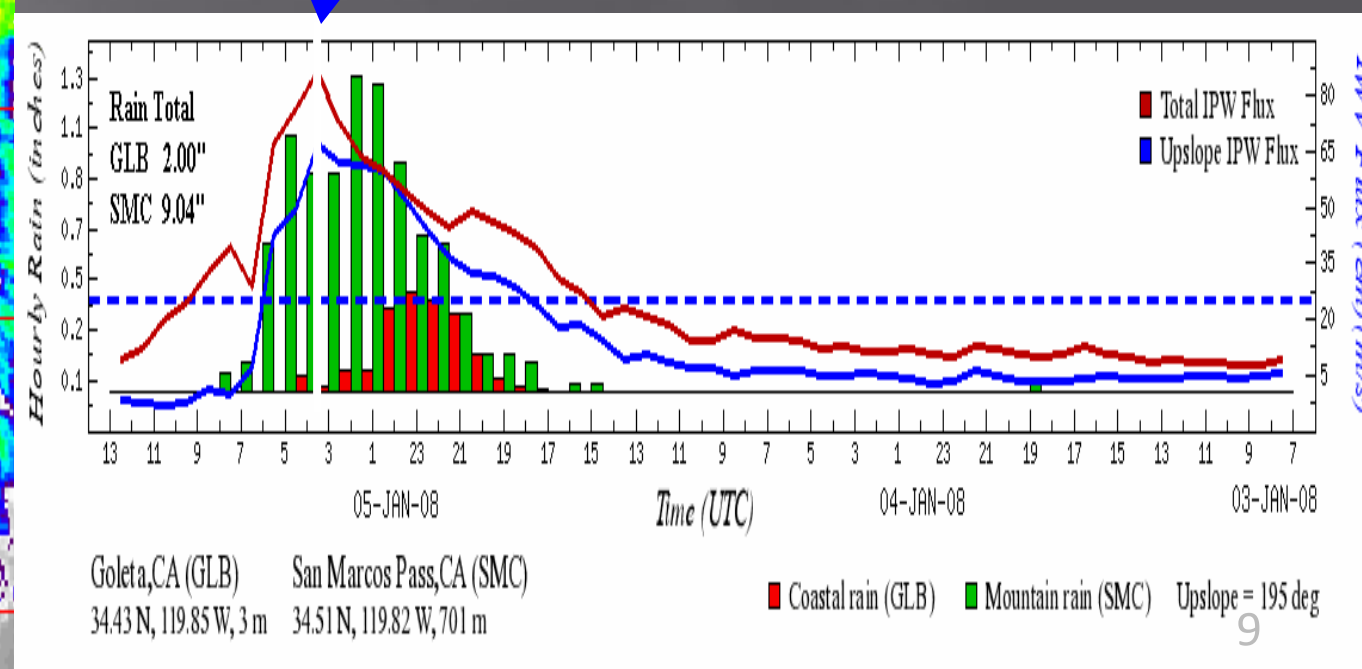
Time of max AR bulk flux at PPB: 2100 UTC 4 Jan



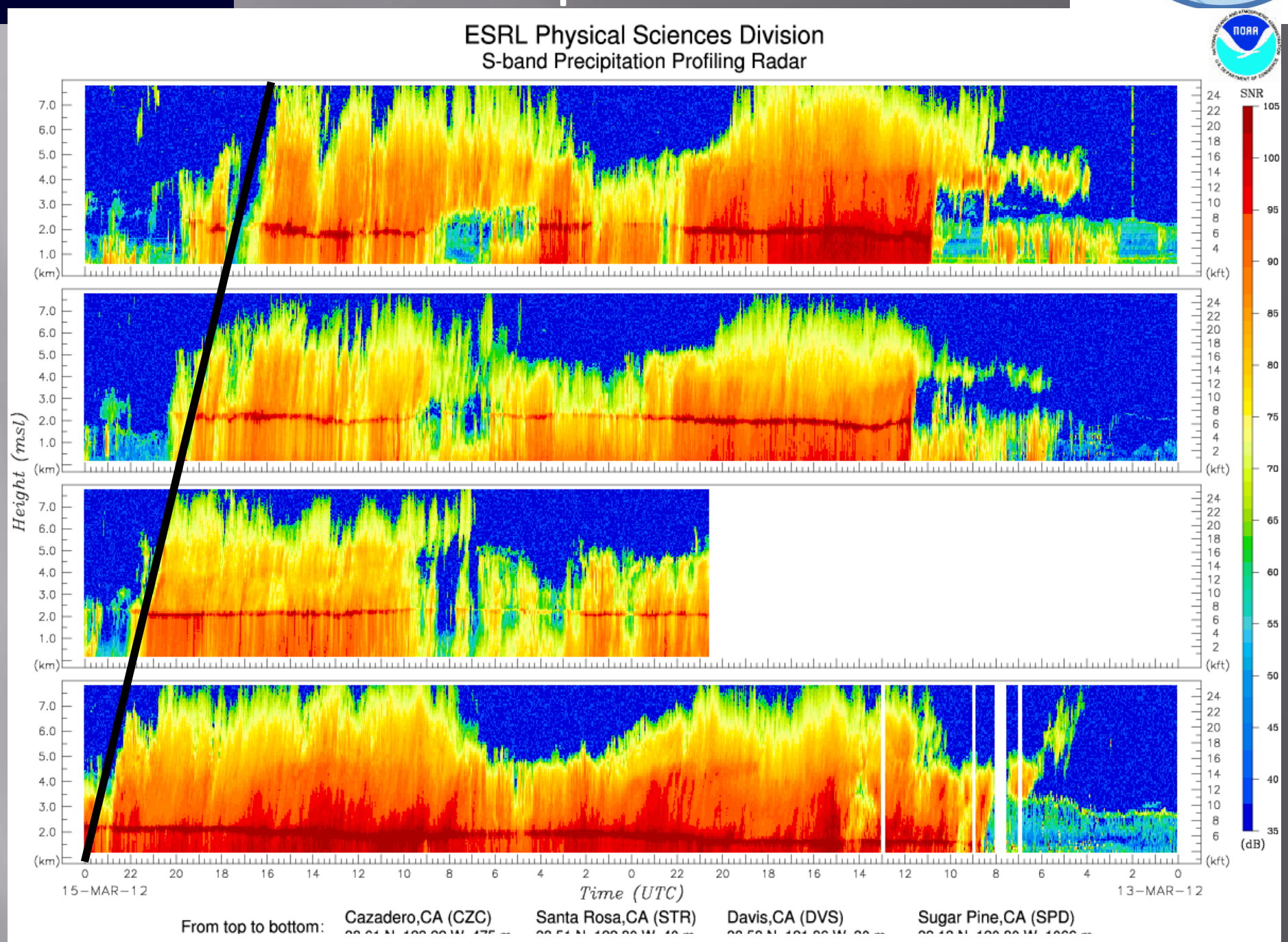
AR Propagation: ~12 m s^{-1}.
½-day lead time for SoCal



Time of max AR bulk flux at GLA: 0300 UTC 5 Jan



Auto-update S-Prof



New observations

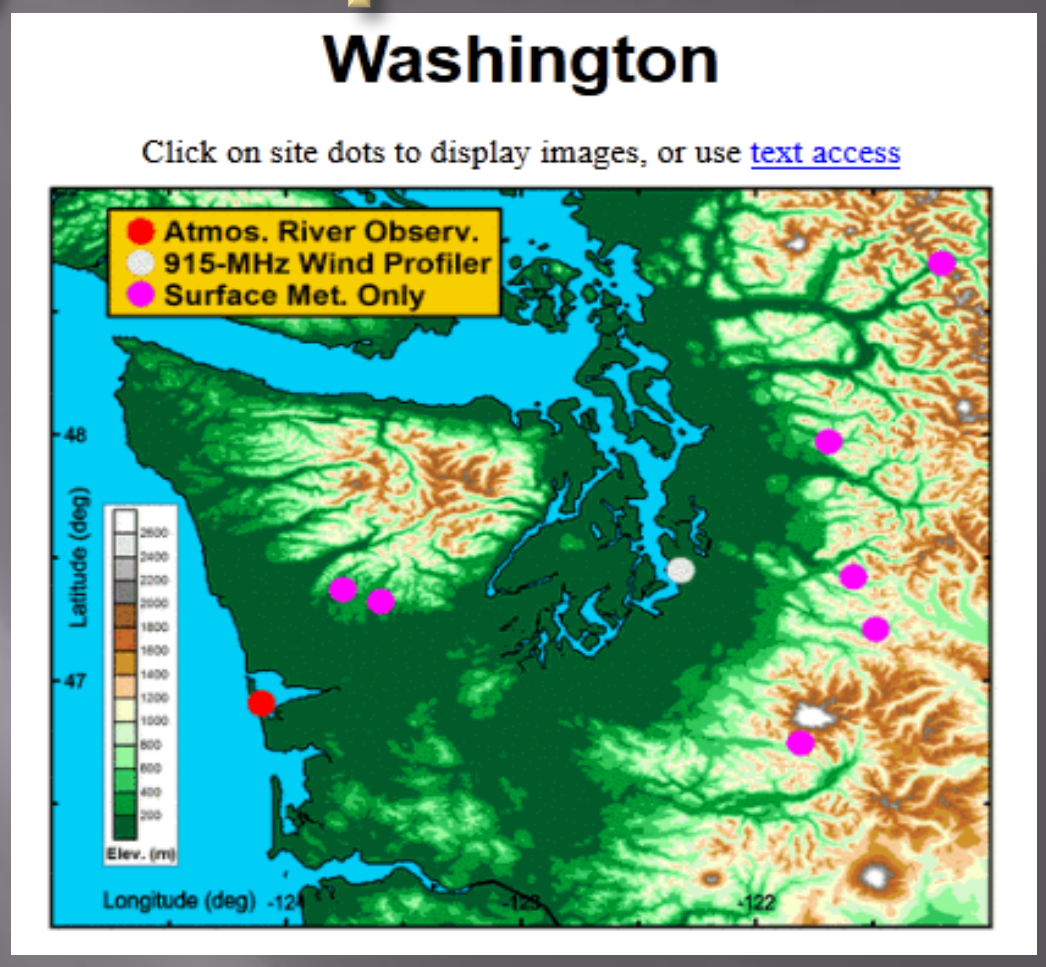
Vertically integrated water vapor (cm)

Snow level observing network showing the "snow level" in 1000's of feet above sea level. The snow level is the altitude above which precipitation is occurring as snow at that place and time.

EmergencyResponse

Howard Hansen Dam

Bronze Medal



Basin Complex Fire
Big Sur Coast

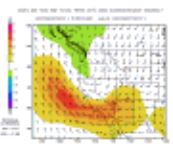
WR Toolkit -Build Confidence (reduce uncertainty) in High Impact Decision Support

Toolkit Items

Methodology: Developing confidence in an event occurring can start with seeing deterministic model consistency, with the following products intended to help build confidence through effective use of ensemble and probabilistic information. Start by looking at the large scale anomalies and spreads to help keep situational awareness of potential high impact events, and then drill down by using plumes and probabilistic info to build confidence in the details of an event. Each item below is accompanied by a quick list of how it can help you build confidence in the forecast and also key limitations. More in depth training and documentation are provided in the Toolkit Training page (left-hand menu).

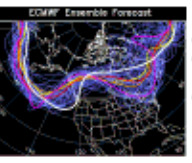
Please share how these tools helped/hurt your assessment of confidence with your SOO!

Big Picture/Situational Awareness



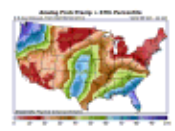
GEFS Anomalies [situational awareness table] [maps with archives] [backup]

- Look At: MSLP, Precip Water, 500 height, 700 wind, 700 temperature
- Confidence: low spread + high anomalies = confidence in a significant event
- Limitations: underdispersiveness of gefs, anomalies look weak when spread is high



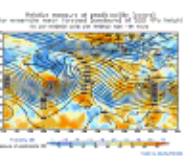
ECMWF Ensemble [hpc link] [NEW: normalized spread maps]

- Look At: spaghetti plots, focus on bottom two images showing ecmwf/gefs ensemble members
- Confidence: due to underdispersiveness of gefs...when ecmwf ensemble is tightly clustered = increased confidence; lower than 1.0 normalized spread indicates lower than normal spread and, in theory, higher confidence.
- Limitations: only a few 500 height contours available, ecmwf has more members so it can look noisier



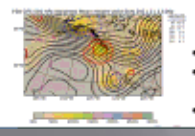
Reforecast Analogs [esrl page]

- Look At: upper and lower tercile probs for days 4-6, 6-10, 8-14
- Confidence: high (above 40%) probs in either category suggest increased confidence for above/below normal precip
- Limitations: only looks at precip over a long forecast period,



NCEP Relative Measure of Predictability [new page]

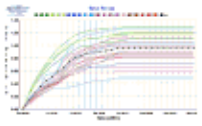
- Look At: values of RMOP relative to significant trof/ridge features
- Confidence: high values indicate that GEFS mean is more likely to verify, low values indicate less probability
- Limitations: only looking at GEFS mean, which will wash out smaller scale features when there is timing/spatial uncertainty.



Phoenix ModTrend Tool [data]

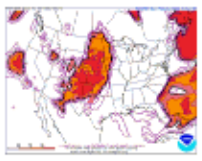
- Look At: Patterns of spread and trends together from recent GFS solutions
- Confidence: spread + consistent trend may increase confidence in a particular solution occuring; spread + no trend indicates more scattered, inconsistent GFS solutions and decrease confidence
- Limitations: available only for GFS; past research has shown that trends in model solutions should not be extrapolated to determine the final

Details/Probabilities/Extremes



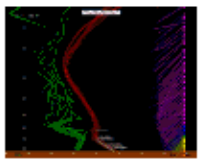
Plumes [interactive sref plumes] [gefs plumes]

- Look At: 10m winds, precip/snow accumulations
- Confidence: low spread between plumes = increased confidence, clusters can indicate other possible solutions/worst case scenarios
- Limitations: need to evaluate many points keeping SREF resolution in mind, mean (black line) may be of limited use



SREF Probabilities [spc page] [aviation]

- Look At: calibrated tstm prob (post-processed guidance), wind/rh joint probs (fire weather), cape/shrear joint probs (severe weather), various precip probs; note dProg/dT functionality by clicking on forecast hour
- Confidence: higher probs, especially multi-ingredient joint probs, indicate higher confidence
- Limitations: sref resolution is marginal for terrain effects, changes coming to replace Eta and RSM members

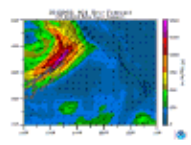


BUFKIT SREF [program download] [sref data]

- Look At: ensemble soundings (messy but has similar utility to that of spaghetti plot), plumes of wind gust, precip, snowfall under the OverView section (where you can also step through each member)
- Confidence: low spread between plumes = increased confidence, clusters can indicate other possible solutions/worst case scenarios
- Limitations: need to evaluate many points, keep SREF resolution in mind (won't resolve terrain flows, and model smoothing of terrain may impact sounding elevation).

CIPS Cold Season Analog Guidance [cips page warm season]

- Look At: Western US domain, which moves based on the pattern; Impact Guidance graphics for probability of various thresholds (e.g. precip, wind, snowfall); List of analog dates are sorted by how they match forecast pattern overall.
- Confidence: Helps build confidence in the impacts, assuming the GFS forecast is the preferred model in a given situation.
- Limitations: Focuses on GFS output only; graphics will appear smoothed (e.g. no PRISM)



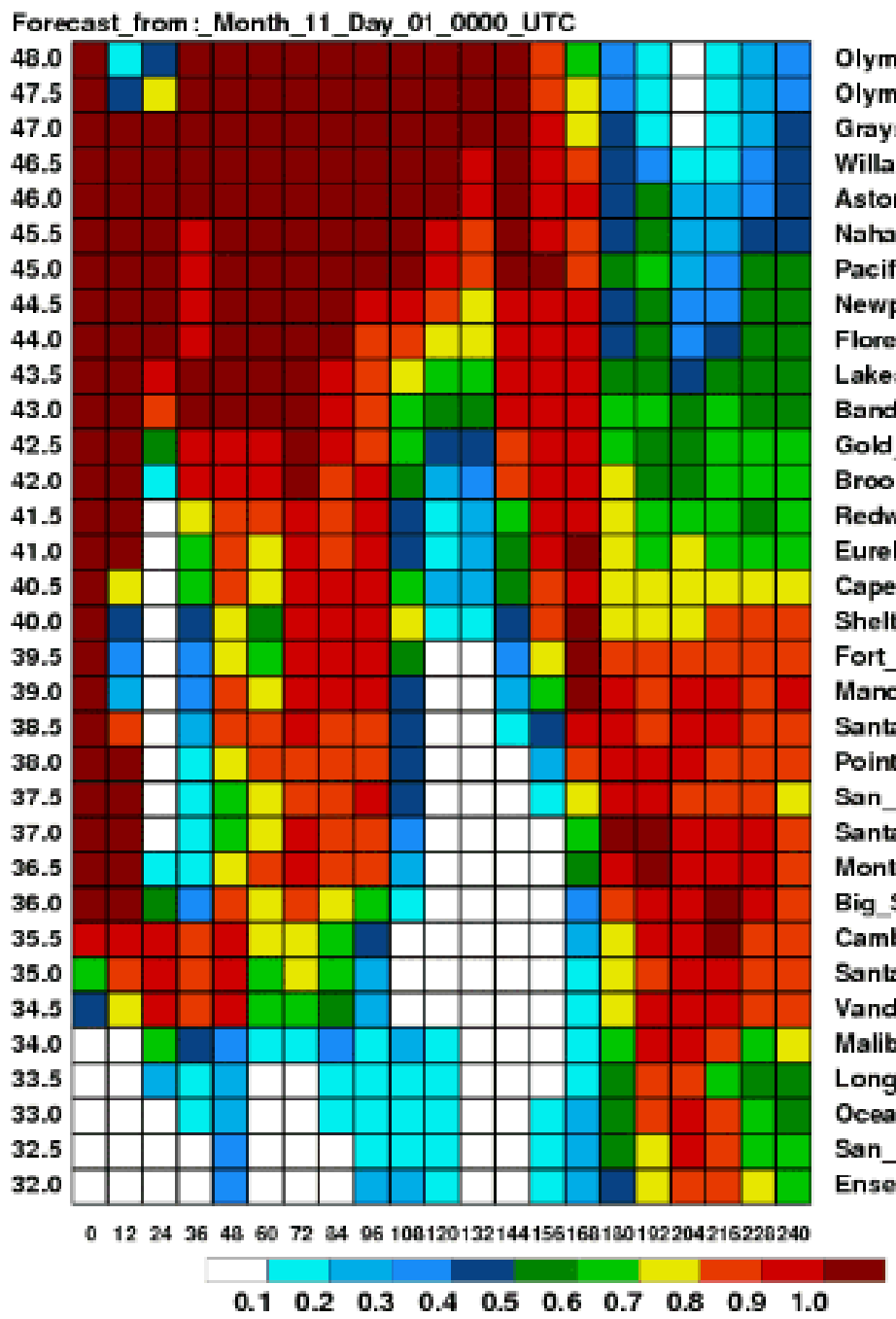
ESRL Automated Atmospheric River Tool [data]

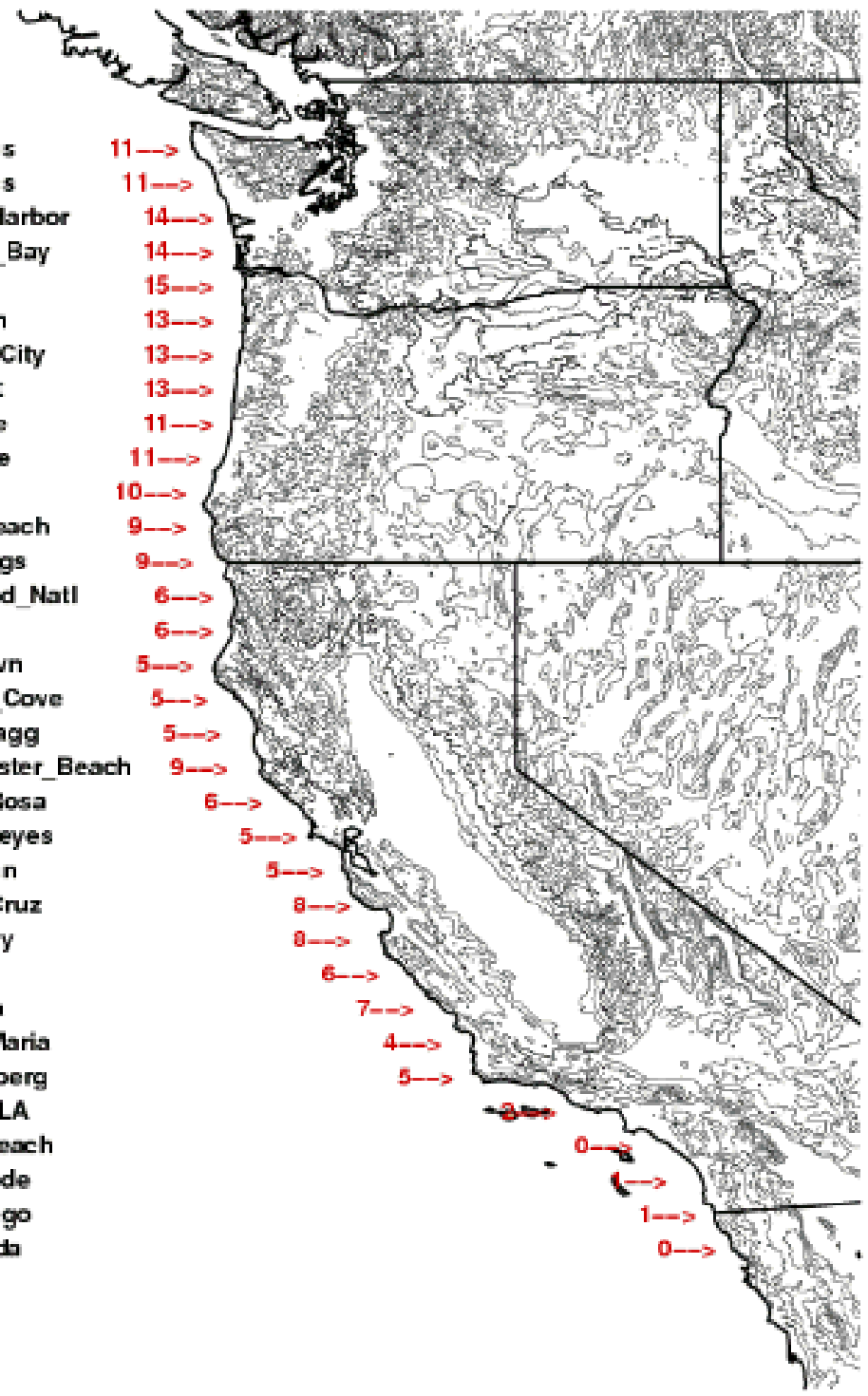
- Uses integrated water vapor transport to detect AR's in the deterministic GFS solution. Check out the SOO.DOH call from 3/12/12 for more info and background.
- Confidence: Readily identify major AR's the help build confidence in significant precip.
- Limitations: Based only on the deterministic GFS solution.

Jason Cordeira GFS AR Intensity/Duration Tool

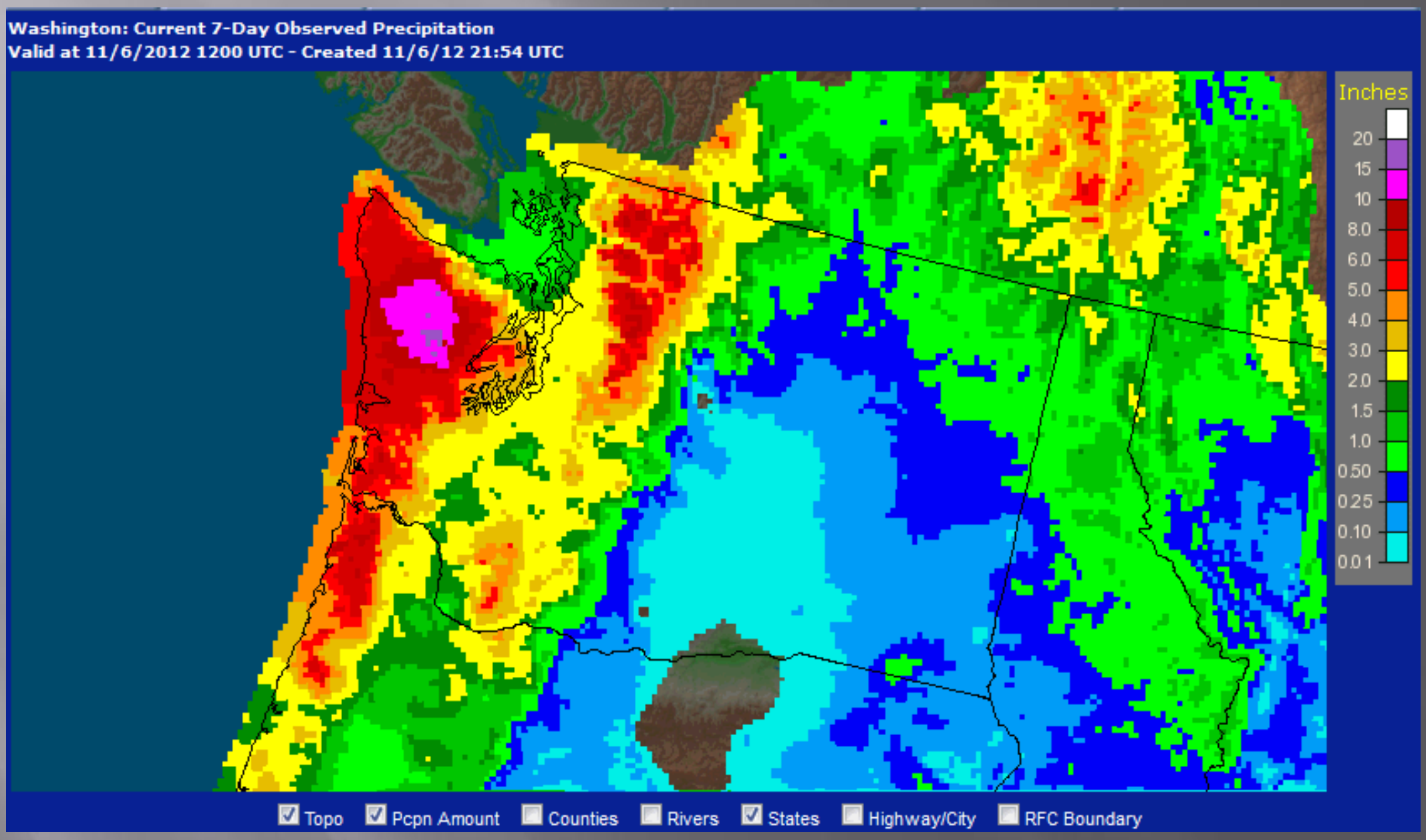
Western U.S. contours: Terrain at 250,500,1000, and every 500 m thereafter.

Probability of IVT > X units: 100 200 300 400 500



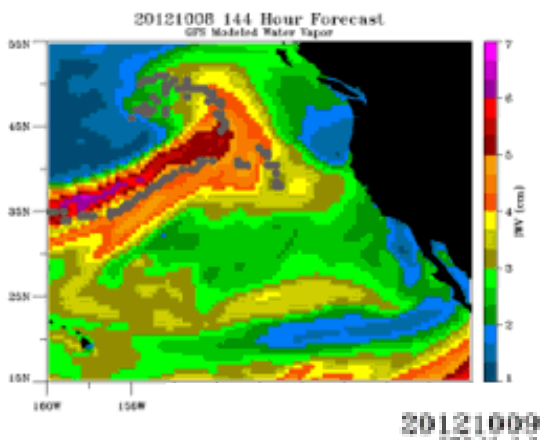


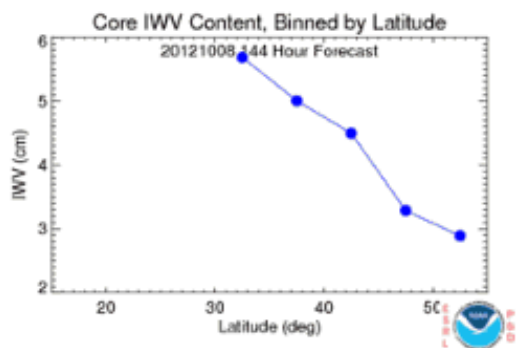
7 Day QPE Oct 31-Nov 6 2012

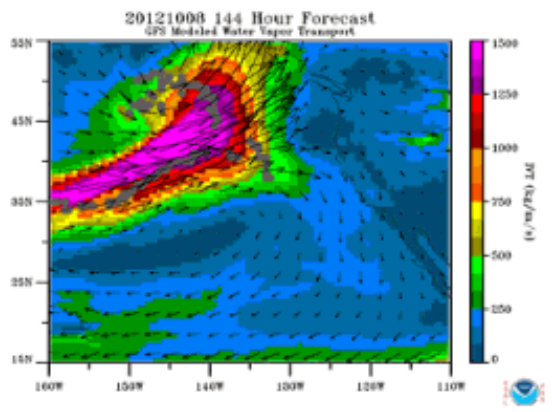


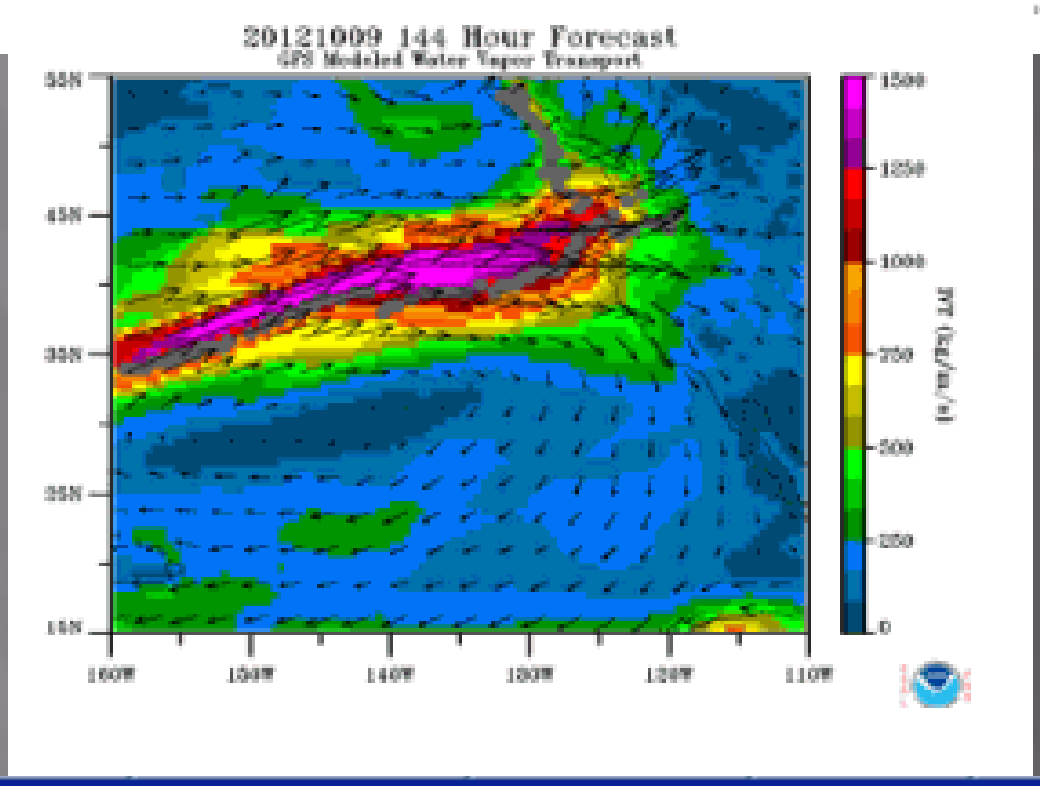
Wick AR Detection and Flux Tool

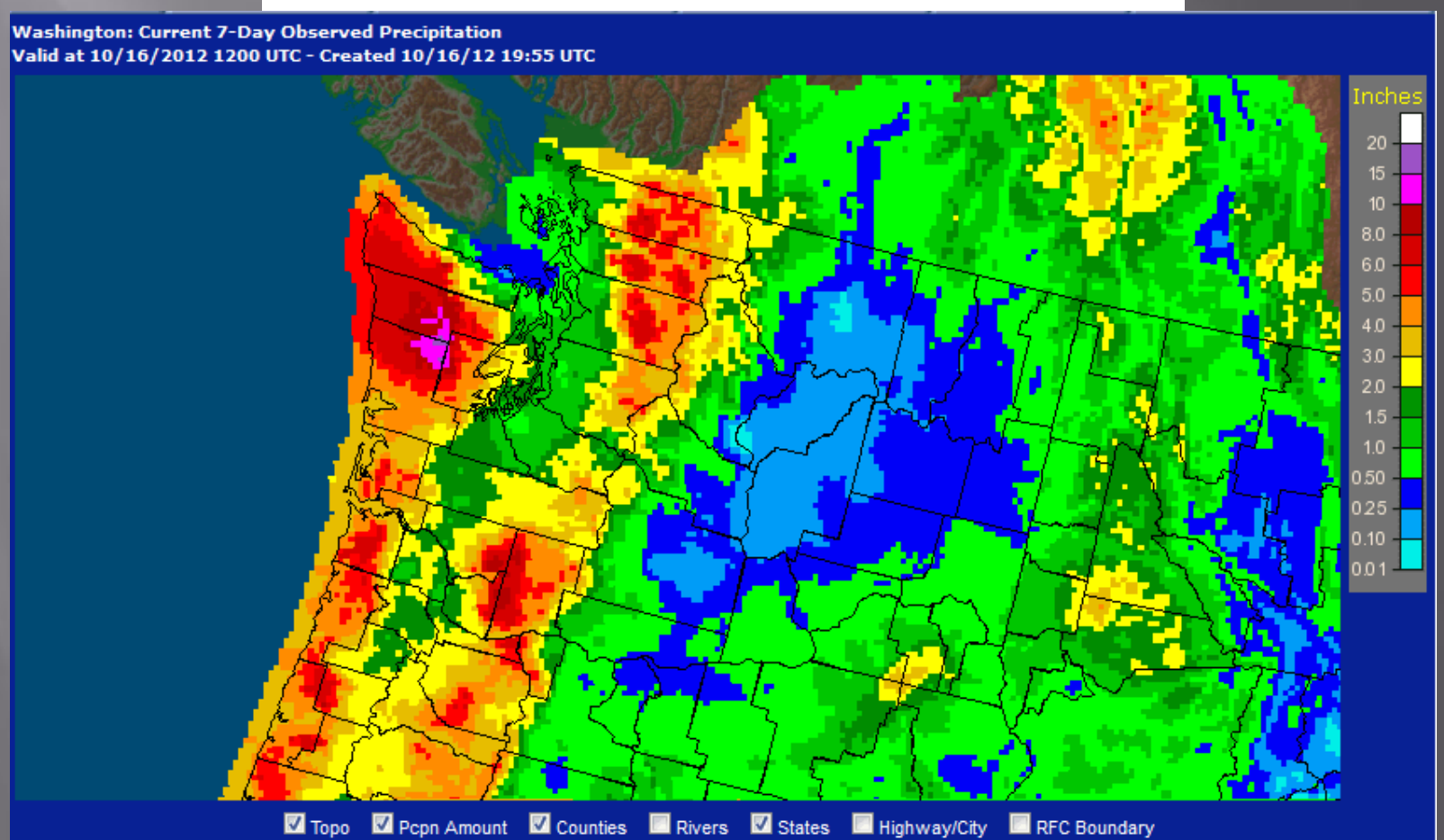
6-Day Forecast Valid 12 Z on 20121014







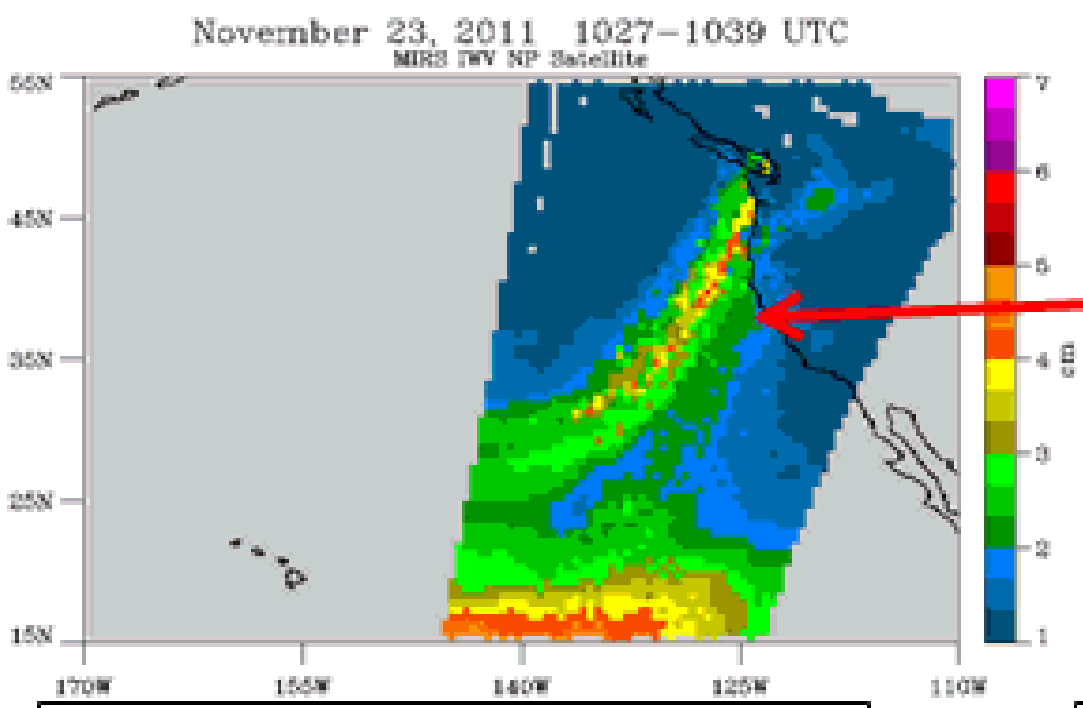




HMT Proposed Transition Projects

Project – Listed in order of priority	Purpose	Resources Required	Personnel and man months	Expected start Expected Completion	User Base	Focal Point For NWS
AR Analog Tool	Pattern match forecast land-falling AR to historical events and corresponding observed rainfall to be used as analog	AR detection tool and historical SSMI AR climatology extracted from tool Stage 4 6-hr QPE	Paul Neiman – 2 Gary Wick – 2 Ellen Sukovich – 2 Dave Reynolds – 1 Tim Coleman – 1 Dan Gottas - 1	October 2012 – September 2013	West Coast WFOs CNRFC NWRFC Army Corps	Jonathan Rutz/Mike Staudenmaier/WRSSD
Develop offshore AR Intensity Category and Land-falling Rainfall Threat	Provide forecasters and decision makers a method to assess threat of offshore ARs	Numerical forecast guidance combined with AR tool above to allow automation. Provide in terms of anomalies as well.	Ben Moore – 3 Gary Wick – 1 Dave Reynolds -1	April 2013-December 2013	West Coast WFOs CNRFC NWRFC US Army Corps	Jonathan Rutz/Mike Staudenmaier/WRSSD
Deliver HMT Ensemble means of various sfc parameters to AWIPS II	Provide forecasters with means to view 3-km WRF ensemble mean sfc fields in AWIPS II and GFE	3-km WRF Ensemble mean field in GRIB2 via LDM through WRH to CA field offices.	SPORT-HMT project GSD- Brian Etherton and Linda Wharton	May 2012-March 2013	West Coast WFOs CNRFC NWRF CNRFC	Trevor Alcott/Chad Kahler/WRSSD Bill Rasch/STO
Enhanced Flux Tool QPF Calibrated Probability of Exceedance	Improve short term-1-12 hr QPF by converting to PQPF	3-km WRF ensembles updated hourly with post-processing to remove bias	GSD – 3 Dan Gottas -1	April 2013-December 2013	West Coast WFOs CNRFC NWRFC US Army Corps SFPUC	Jonathan Rutz/Mike Staudenmaier
EFREP data incorporated into NWS hydro operations	Educate forecasters/hydrologist in operational utility of EFREP data and provide in form directly usable by existing NWS software. Identify NWS champion for this effort	Real-time EFREP data including Freezing level, soil moisture, IWV, and low-level moisture flux coded into format ingested by NWS software	Allen White – 1 Dan Gottas – 2 Tim Coleman – 1 Dave Reynolds -1 NWS - 2	January 2012 September 2015	West Coast WFOs CNRFC NWRFC	Art Henkel, Dan Kozlowski/CNRFC Chad Kahler/ WRSSD Joint NWS/OAR SCEP at STO

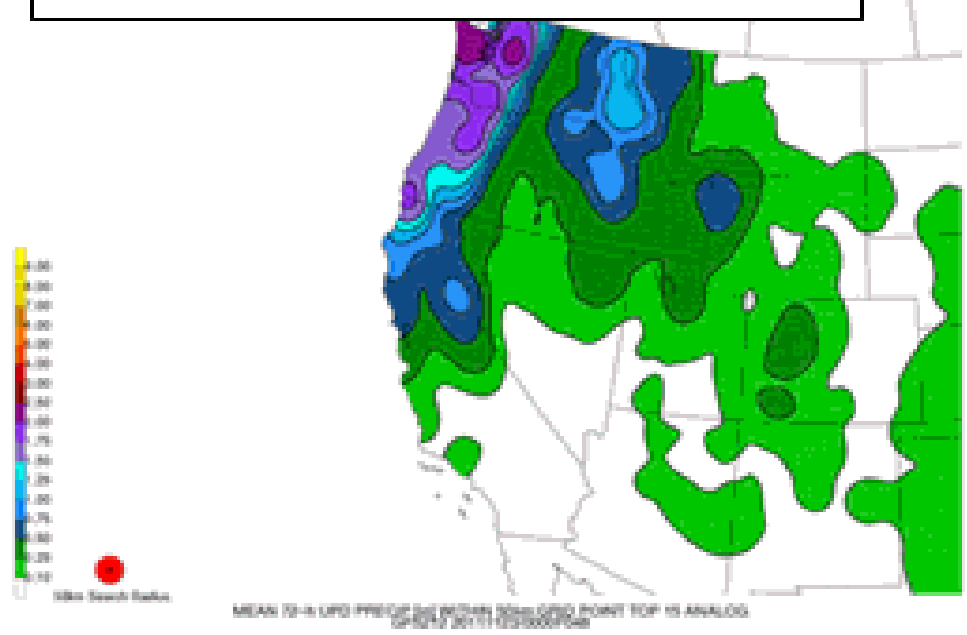
AR Analog and QPF Best Estimate - Modeled after St Louis Univ CIPS (Cooperative Institute for Precipitation Systems) Analog System



Find best matches to this shape, size, intensity, location from historical SSMI imagery

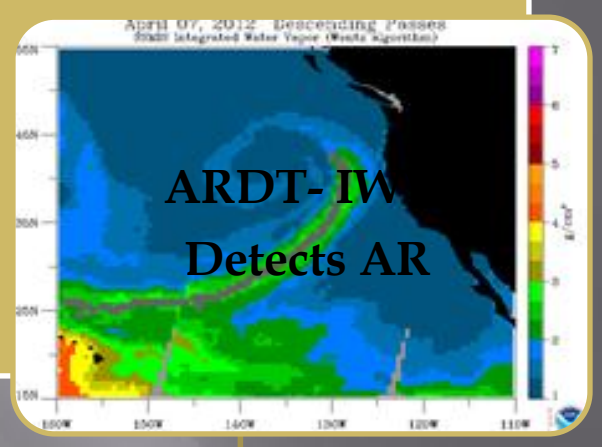
Generate mean from 10 best analogs

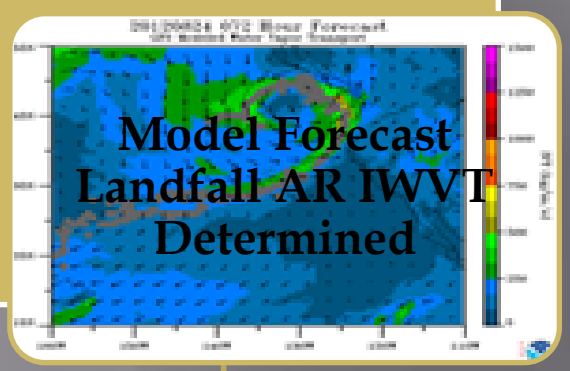
Generate probability of > 3in using 10 best analogs

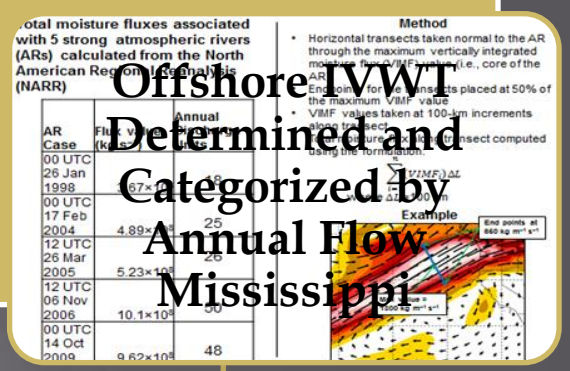


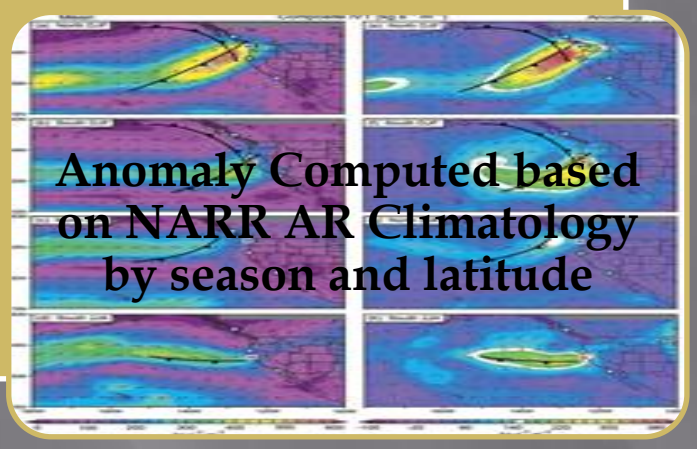
Reforecast with lead time?

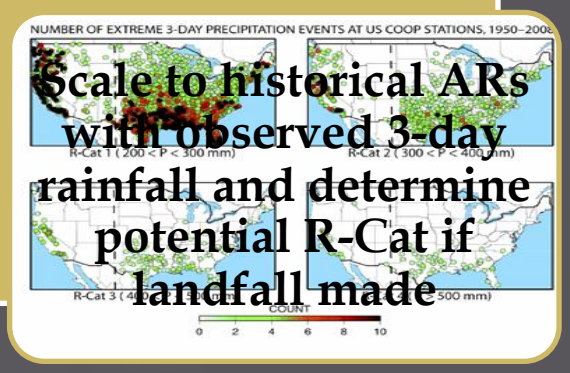
AR Flux Intensity/Anomaly and Rainfall Potential











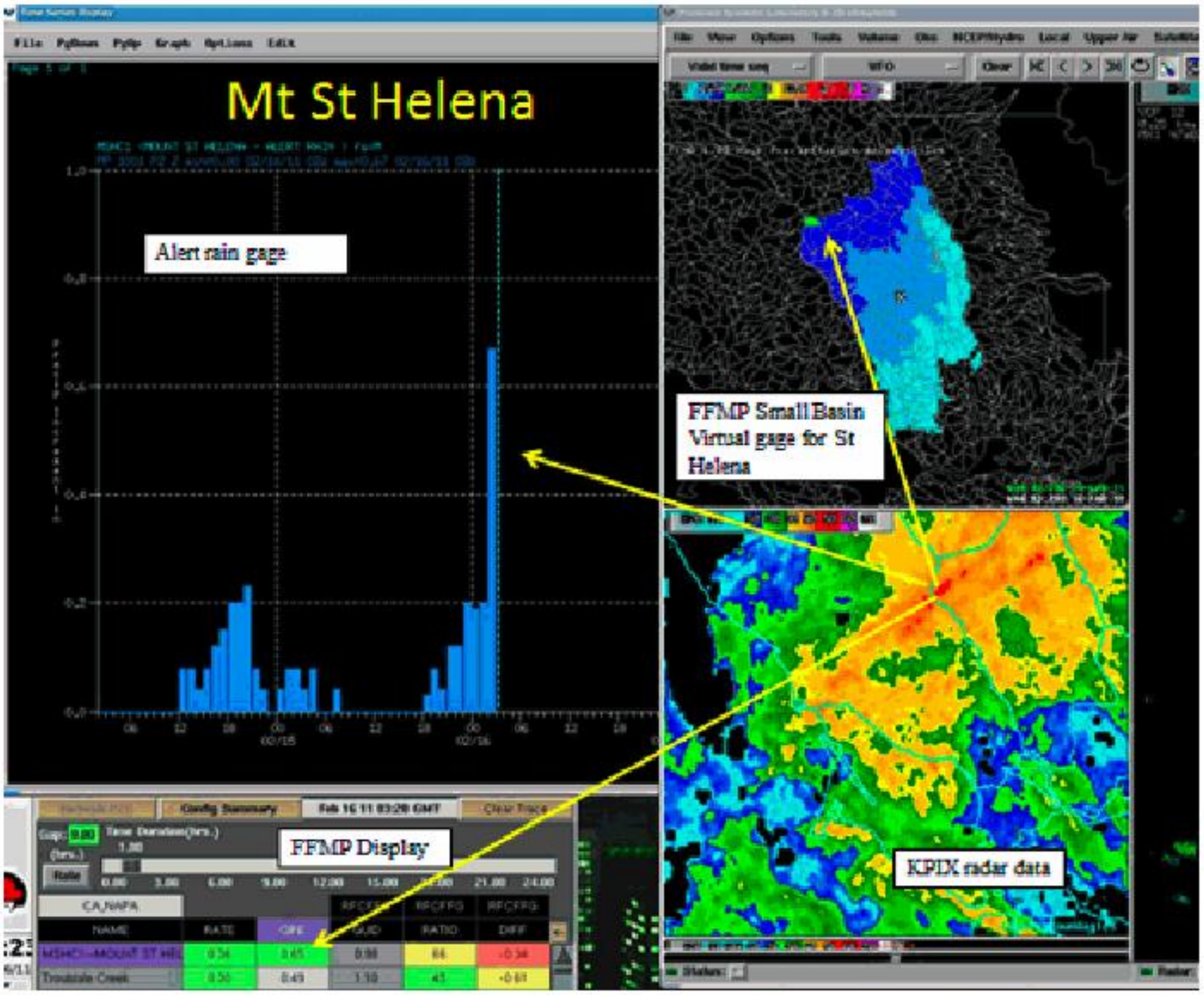


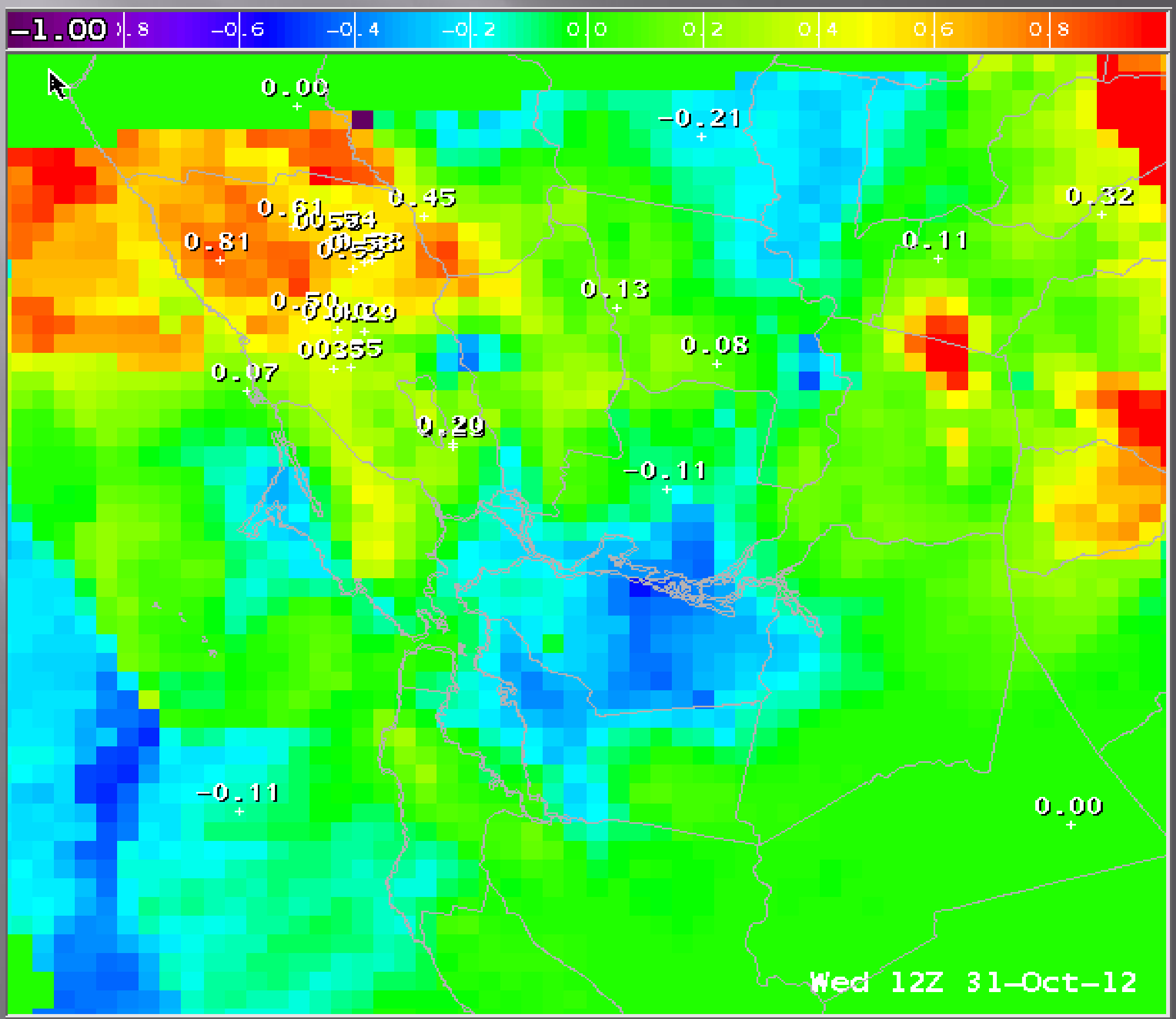
Figure 11. Upper left is the observed hourly rainfall from the Mt. St Helena Alert gage. The upper right panel shows the high resolution basin definition with color shading showing one hour rain rates with warmer colors indicating higher rain rates. The location of the Mt. St. Helena gage is shown. The bottom right is the KPIX .5 degree reflectivity used to obtain the rain rates while the lower left shows the FFMP basin table with the virtual Mt. St. Helena gage showing the estimated QPE for one hour which compares very favorably to the observed.

E. Probabilistic QPF to Enhance Water Vapor Flux Tool

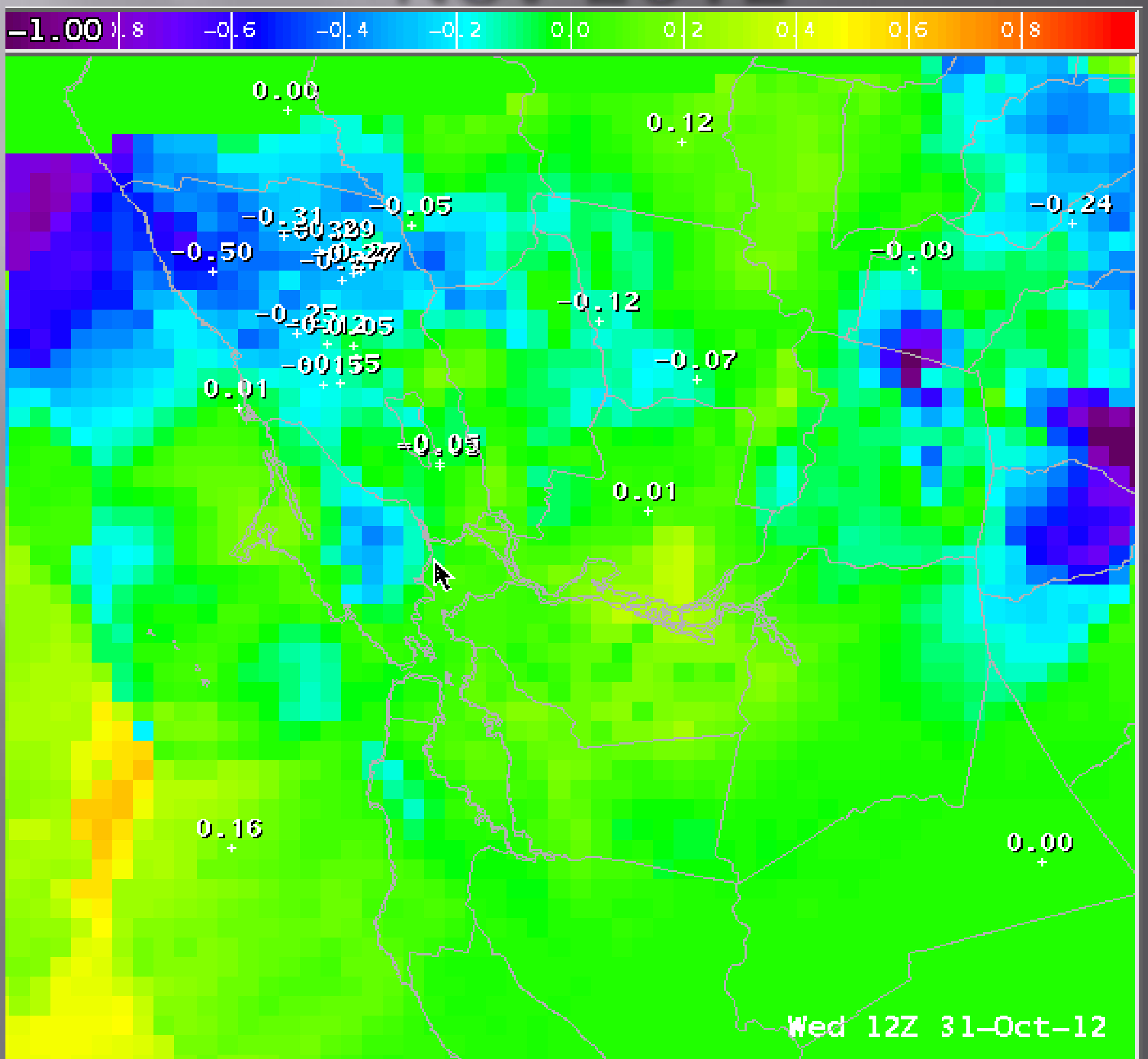
Currently the IWV Flux Tool utilizes a deterministic 9 Km WRF run to forecast the next 12 hours of hourly rainfall for each ARO site. The IWV Flux Tool has proven to be useful in forecasting the kinematic and thermodynamic variables like low-level winds and moisture flux but does a very poor job in predicting hourly rainfall, especially when enhanced by orography. This may be due to model resolution and/or model physics. To provide a more useful tool, it is proposed to utilize the WRF 3 km ensemble mean value along with calibrated ensemble probabilities of exceedance values for various thresholds such as 1 to 3 inch rainfalls over the next 6 and 12 hours. This should provide some measure of confidence to the forecasters in utilizing the flux tool to make better warning decisions.

Table 4 summarizes the proposed projects that will be pursued over the next 2 to 4 years as part of HMT West.

Mmosaic – Rmosaic 24 hrs ending 12z 1 Nov



Mmosaic minus Gmosaic 24 hr QPE ending 12z 1 Nov 2012



Obstacles to Successful Transition

- Resources
  - Financial – i.e. push vs pull by/for NWS
  - Human – do these fit with ongoing efforts in HMT
- Internal priorities
  - Where does R2O fall in relation to ongoing and planned efforts
    - R2O vs Publications??
- Changing Priorities