CW3E Science Contributions to Lake Mendocino FIRO FVA

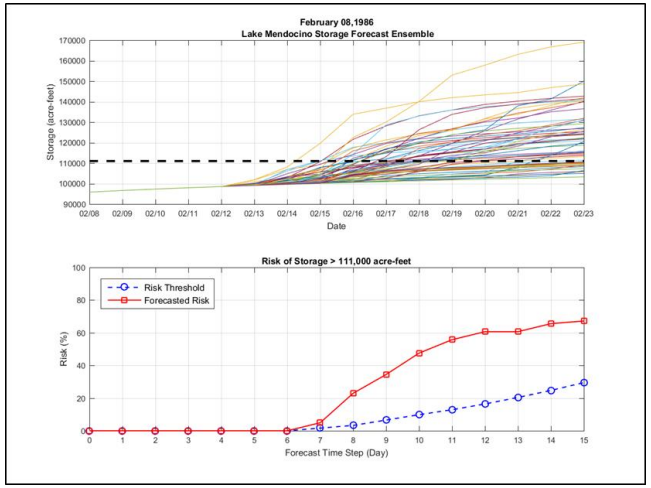
Marty Ralph and Rob Hartman

FIRO Workshop

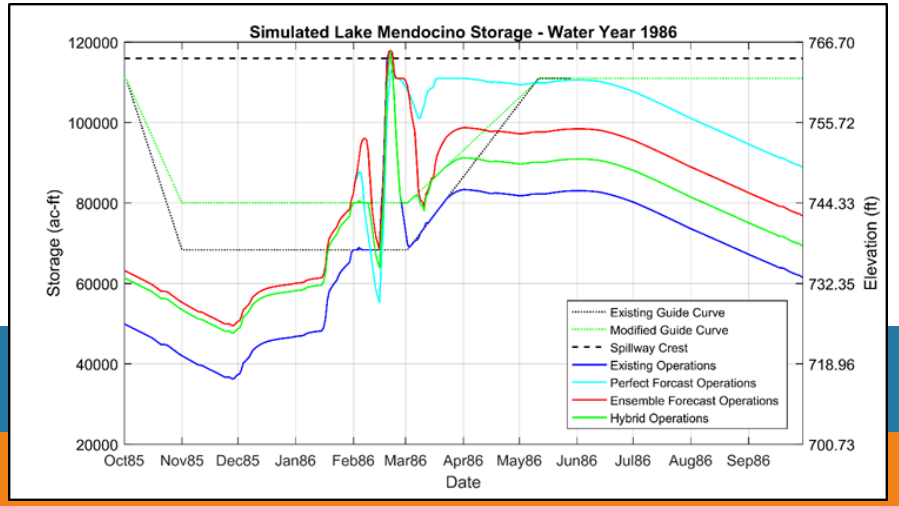
July 31 – August 2, 2018

Reservoir Management Tools

Explore changes to operating rules to permit pre-releases of major ARs to enhance flood risk mitigation



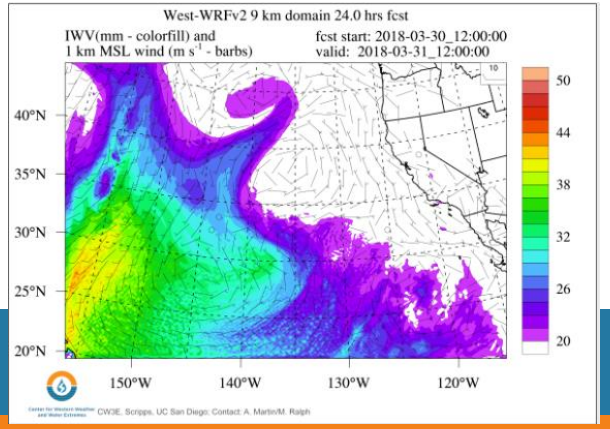
- Improve model for real-time application
- Use scaling to generate more “extreme” events
- Extend model simulations downstream to Guerneville to assess flood issues
- “Optimize” the SWCA EFO model (e.g. modified risk curve) to meet FIRO multi-purpose objectives
- Evaluate deterministic vs. ensemble inflows for days 1-5



Day 1-5 Forecast Enhancements

Determine forecasting enhancements to implement FIRO. Improve skill for extreme events at short lead times.

- Establish forecast evaluation methodology for West-WRF
- Identify key physical processes that need to be resolved in model forecasts
- Assess uncertainty of large events using West-WRF ensembles
- Assess QPF and streamflow/inflow skill for Lake Mendocino
- Compare data assimilation methods to evaluate impacts on extreme event forecasts
- Implement an operational data assimilation system for NRT (near real time) West-WRF

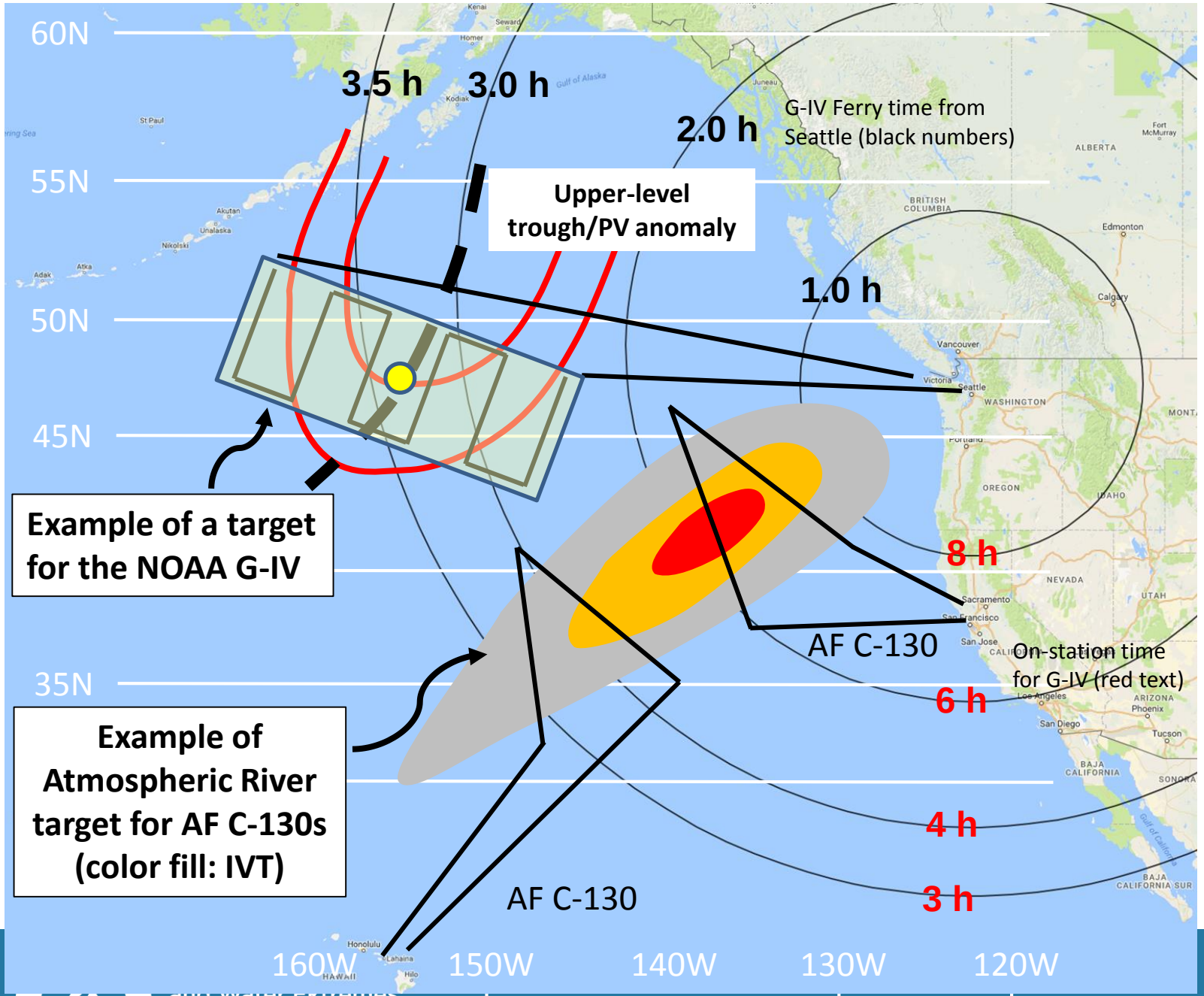


Forecast Informed Reservoir Operations Steering Committee. (2017). Preliminary viability assessment of Lake Mendocino. Available from: http://escholarship.org/uc/item/66m803p2

2018
Atmospheric River Reconnaissance Flight Strategies

Center time: 0000 UTC
Dropsonde deployment window:
2100 – 0300 UTC

Each aircraft has a range of about 3500 nm



and Water Extremes
SCRIPPS INSTITUTION OF OCEANOGRAPHY
AT UC SAN DIEGO

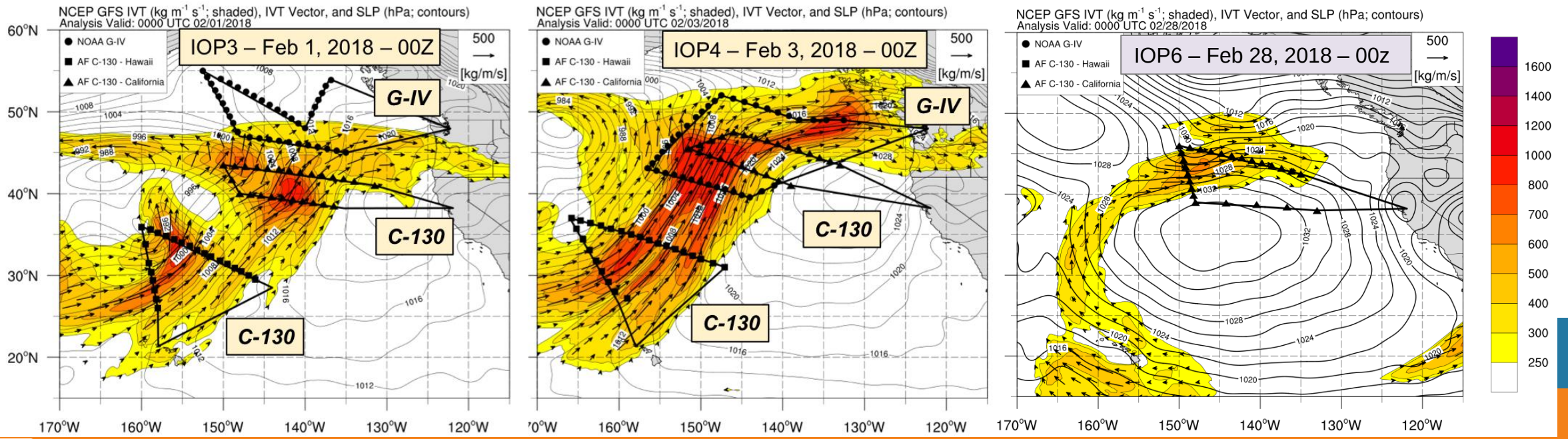
F.M. Ralph (AR Recon PI) and AR Recon Team

AR Recon Modeling and Data Assimilation Steering Committee

Formation of an “AR DA Steering Committee” and “AR DA Technical Work Plan”

Steering Committee

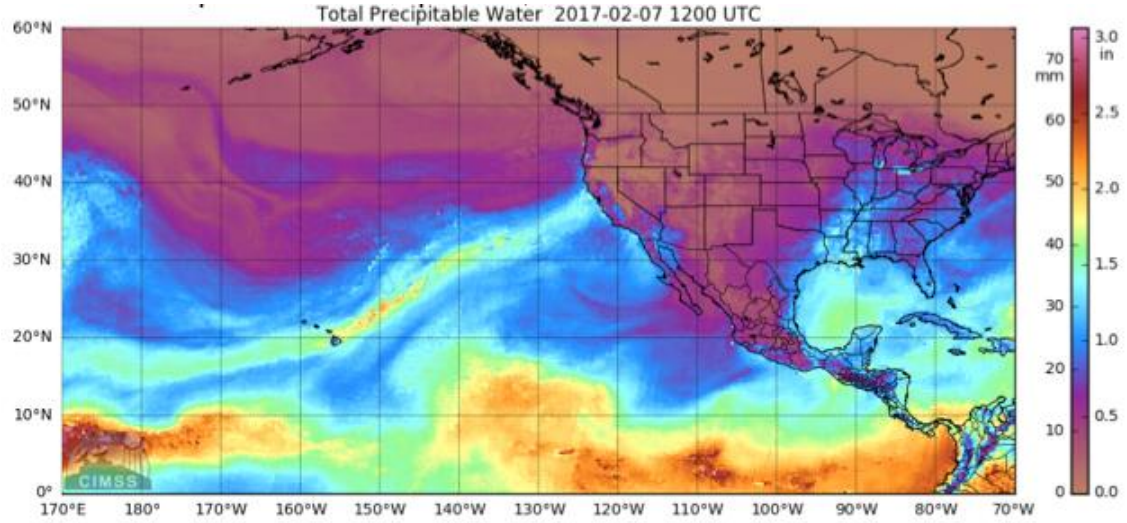
- F. Martin Ralph – (UCSD/Scripps/CW3E) - AR Recon PI and AR DA SC Co-Chair
- Vijay Tallapragada (NOAA/NWS/NCEP) – AR Recon Co-PI and AR DA SC Co-Chair
- Jim Doyle (NRL)
- Aneesh Subramanian (UCSD/Scripps/CW3E)
- Chris Davis (NCAR/MMM)
- Florian Pappenberger (ECMWF)



Day 6-10 Forecast Enhancements

Pursue the reliable and skillful outlooks at 6 to 14 days of the low risk for extreme precipitation events

- Develop, test, and implement probabilistic AR real time outlooks for week 2
- Identify synoptic scale precursor patterns that are related to periods of low AR activity (e.g. blocking, teleconnections)



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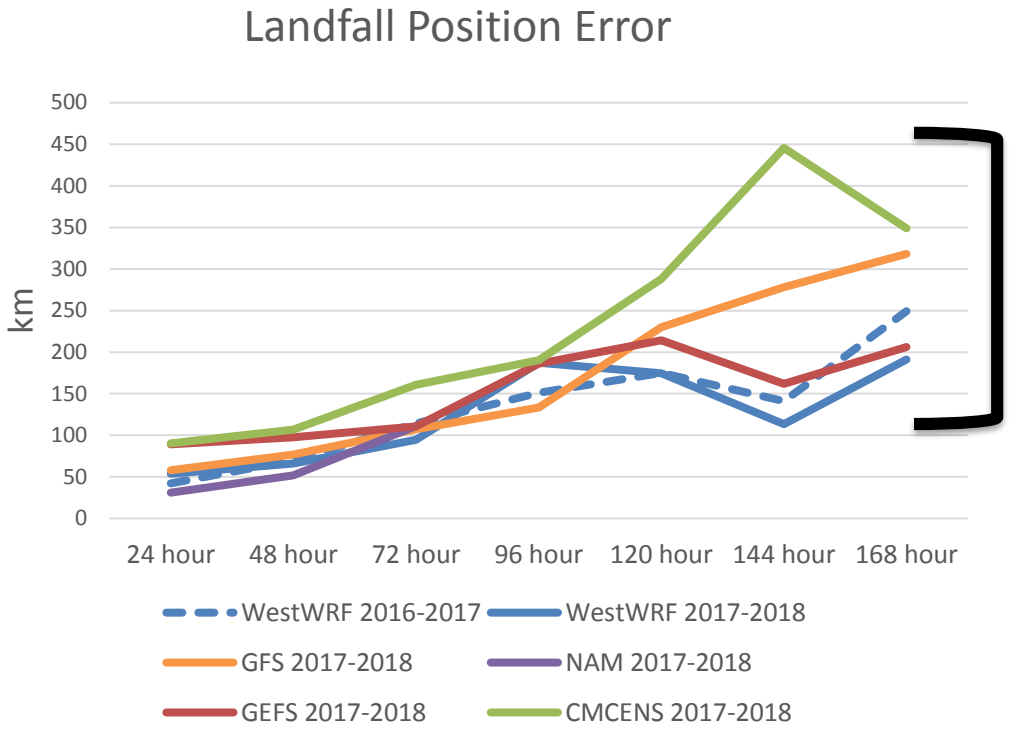
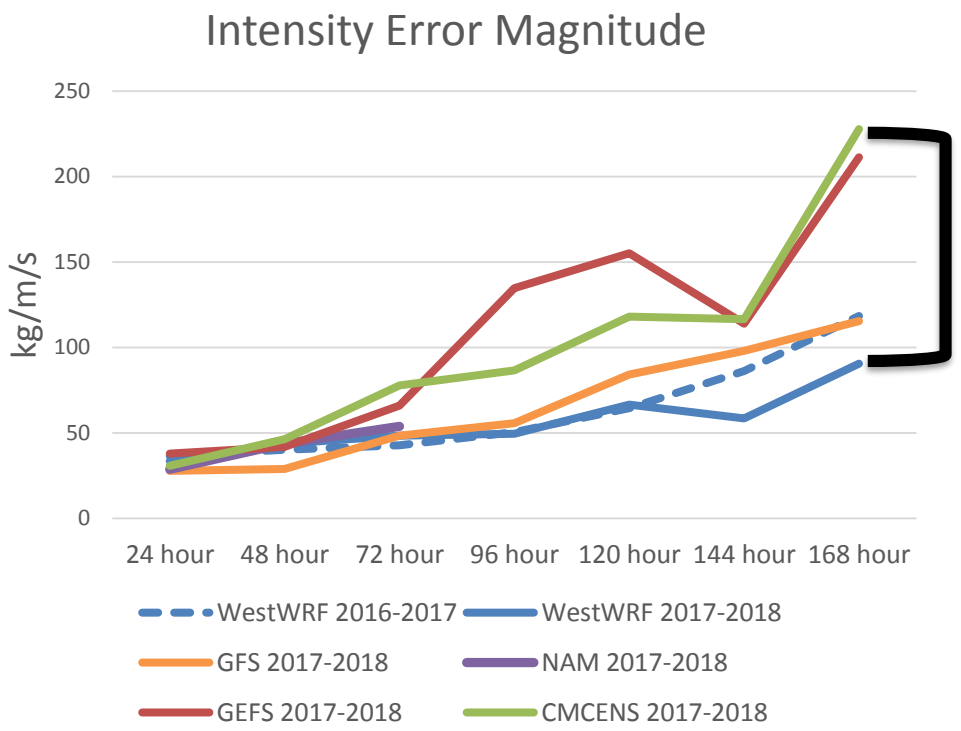
West-WRF Performance in AR Landfalls

By error in landfall position and intensity at landfall, West-WRF outperforms the other models shown up to 7 days lead time.





- MODE object-based AR Landfall Verification has been used to measure forecast skill in a suite of models during WY 2018.
- The MODE methodology can separately evaluate the propagation and intensity of features like an AR.
- These results, though preliminary, suggest that object-based verification may alleviate the phase error penalty imposed on high res. models by traditional point or grid-to-grid verification.

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AR Detection and Situational Awareness

Develop AR-specific forecast skill metrics. Evaluate opportunities for improving forecast skill for extreme precipitation events

- AR categories that relate to FIRO impacts
- AR-specific landfall skill metrics
- AR landfall GEFS tool
- Link appropriate AR forecast tools to CDEC DSS
- On-line, real-time object-based AR forecast skill assessment tool

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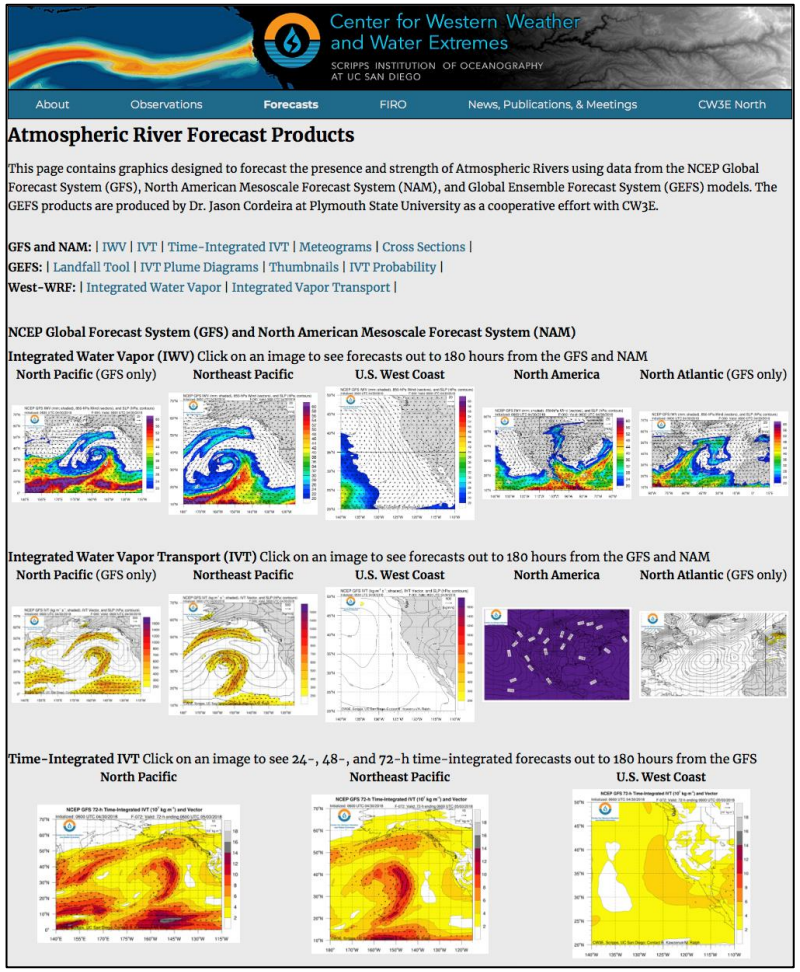
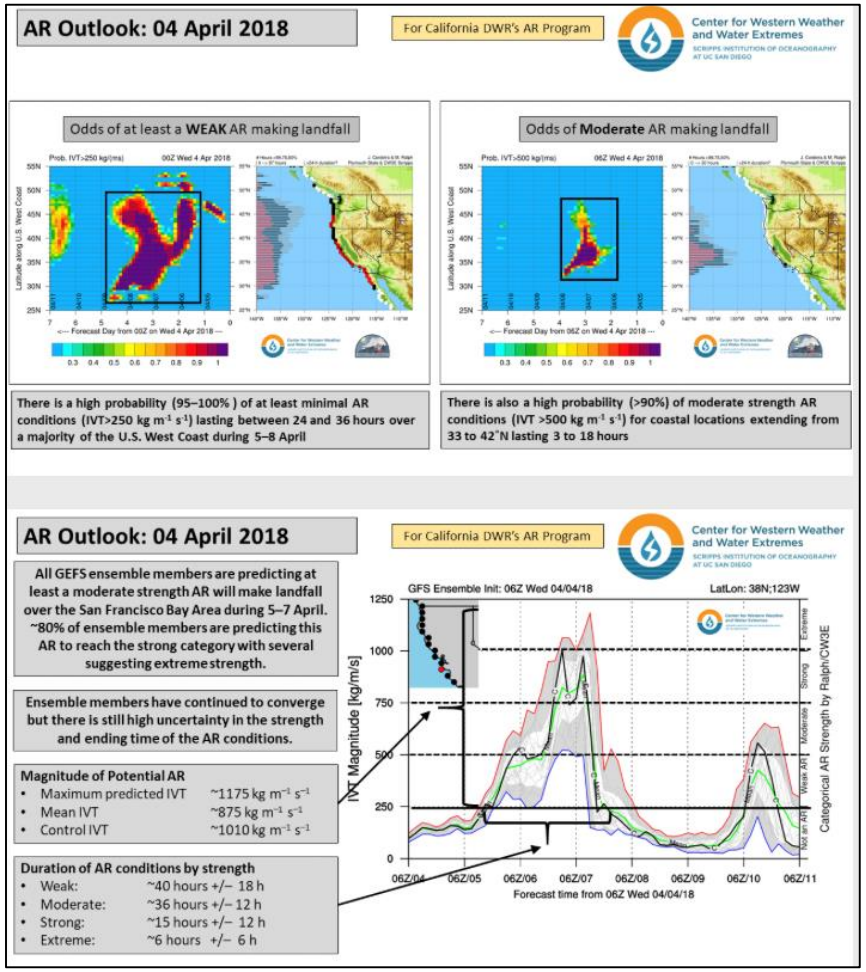
AR Monitoring and Prediction Tools (cw3e.ucsd.edu)

- CW3E develops and maintains a growing number of AR monitoring & prediction tools
  - *These are used by NWS forecasters and are the basis for key parts of the AR forecast information shown on NOAA/PSD's website*

- Expanding to include more decision support tools, interactive analyses and forecast, watershed-scale tools, pre-event outlooks, and post-event analyses

- Not just ARs





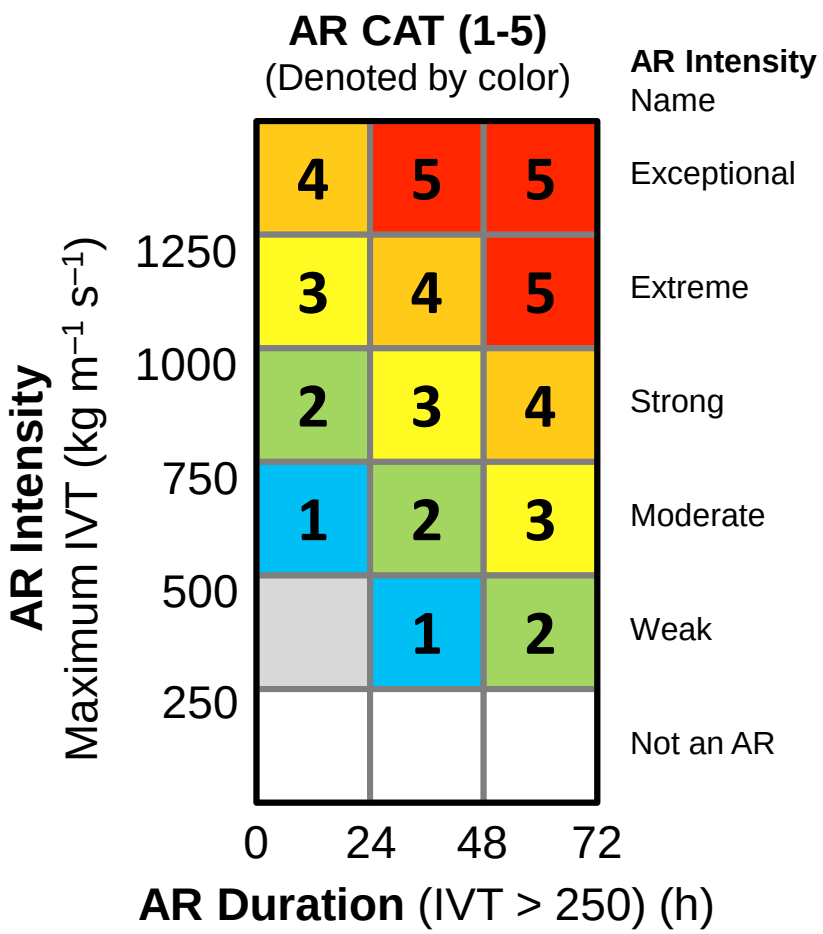
Provided by J. Cordeira, F.M. Ralph and CW3E staff

A Scale to Characterize the Strength and Impacts of Atmospheric Rivers

F. Martin Ralph (SIO/CW3E), J. J. Rutz (NWS), J. M. Cordeira (Plymouth State), M. Dettinger (USGS), M. Anderson (CA DWR), D. Reynolds (CIRES), L. Schick (USACE), C. Smallcomb (NWS); *Bull. Amer. Meteor. Soc. (accepted pending revision;revised June 2018)*

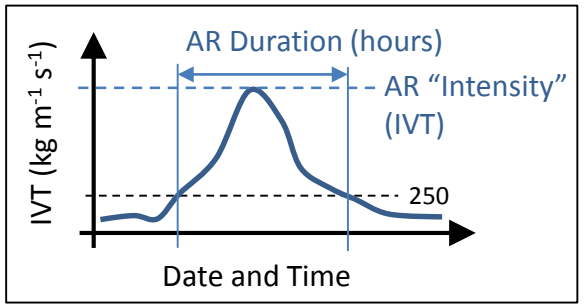
The AR CAT level of an AR Event* is based on its *Duration* and max *Intensity* (IVT)*****

** An "AR Event" refers to the existence of AR conditions at a specific location for a specific period of time.*
*** How long IVT>250 at that location. If duration is <24 h, reduce AR CAT by 1, if longer than 48 h, add 1.*
**** This is the max IVT at the location of interest during the AR.*



- AR Cat 5 – Primarily hazardous
- AR Cat 4 – Mostly hazardous, also beneficial
- AR Cat 3 – Balance of beneficial and hazardous
- AR Cat 2 – Mostly beneficial, also hazardous
- AR Cat 1 – Primarily beneficial

IMPACTS



Determining AR Intensity and AR Category

Step 1: Pick a location

Step 2: Determine a time period when IVT > 250 (using 3 hourly data) at that location, either in the past or as a forecast. The period when IVT continuously exceeds 250 determines the start and end times of the AR, and thus also the **AR Duration** for the AR event at that location.

Step 3: Determine **AR Intensity**
- Determine max IVT during the AR at that location
- This sets the AR Intensity and *preliminary* AR CAT

Step 4: Determine *final* value of **AR CAT** to assign
- If the AR Duration is > 48 h, then promote by 1 Category
- If the AR Duration is < 24 h, then demote by 1 Category

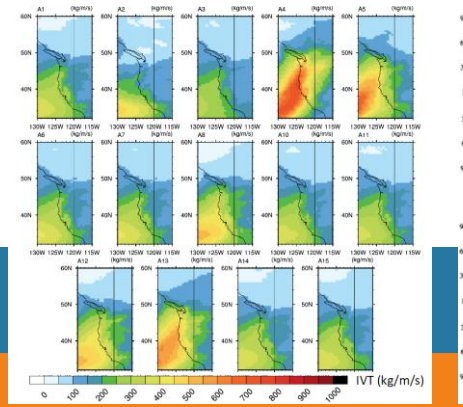
On the Web:
CW3E.UCSD.EDU
On Twitter:
@CW3E_Scripps

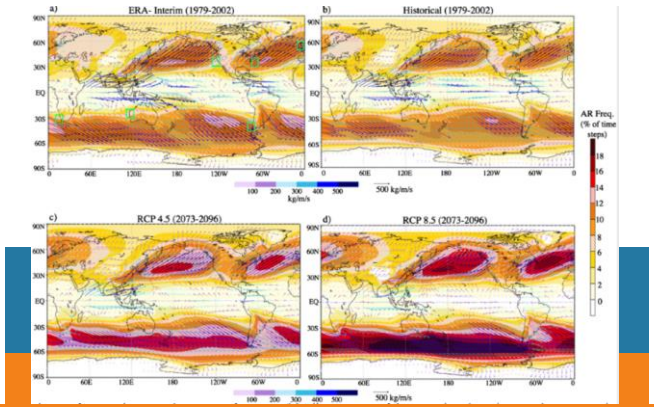
Center for Western Weather and Water Extremes

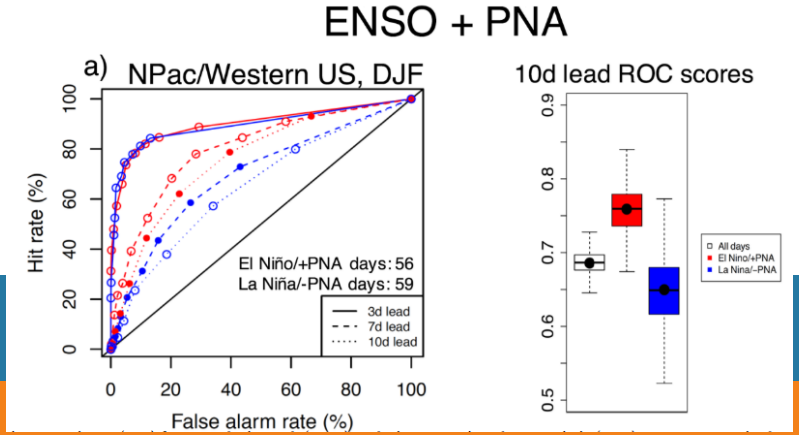
S2S Forecast Enhancements

Enhance seasonal forecasting capabilities.

- Develop, test, and implement probabilistic AR real time outlooks for week 3
- Identify synoptic scale precursor patterns that are related to periods of low AR activity beyond week 2
- Investigate ocean/atmosphere coupling in long-range prediction
- Investigate how interannual and decadal climate variability modulate AR activity and/or drought on the West Coast
- Investigate the how relationship between MJO and QBO can lead to forecasts of opportunity at 3-5 weeks







Mundhenk et al. (2018) introduced an empirical model for predicting anomalous AR activity at S2S leads based on the phase of the MJO and QBO.

Results showed the potential for skillful “forecasts of opportunity” at leads greater 2 weeks, the point beyond which dynamical models provide little additional skill.

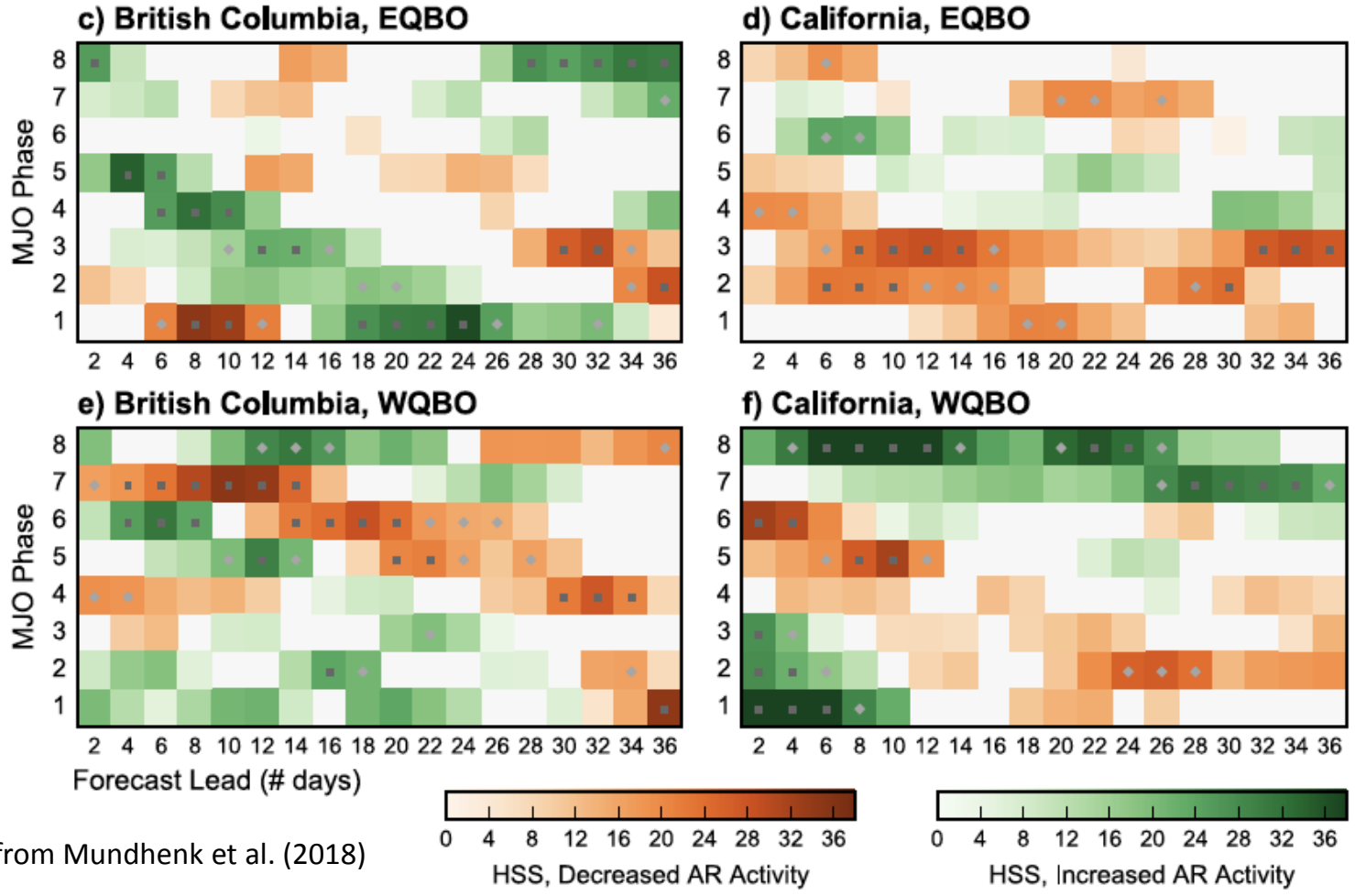


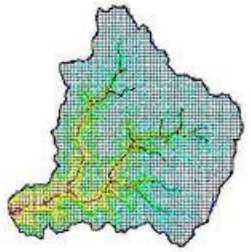
Image from Mundhenk et al. (2018)

Partly supported by FIRO

Hydrologic Model Improvement

Evaluate emerging watershed and runoff forecast systems such as National Water Model and GSSHA

- Assess potential of GSSHA and WRF-Hydro to improve FIRO outcomes compared to CNRFC streamflow forecasts
- Assess sensitivity of streamflow forecast to uncertainty in precipitation using ensemble forecasts from West-WRF/GSSHA
- Publication on GSSHA development and performance
- Assess value of soil moisture observations in WRF-Hydro
- Assess assimilation of soil moisture observations in GSSHA (NCAR task order dependent)



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Observations and Monitoring

Conduct scientific inquiry to ensure that monitoring is adequate

- QPE assessment: compare gridded high-resolution precipitation data sets/observations to CNRFC
- Draft document describing enhanced monitoring in the RR watershed in support of FIRO including how the data sets have improved applicable research (West-WRF, model evaluation/development and ensemble production)

Questions / Discussion