Center for Western Weather and Water Extremes

SCRIPPS INSTITUTION OF OCEANOGRAPHY AT UC SAN DIEGO

Verification of West-WRF During AR Conditions at Lake Mendocino

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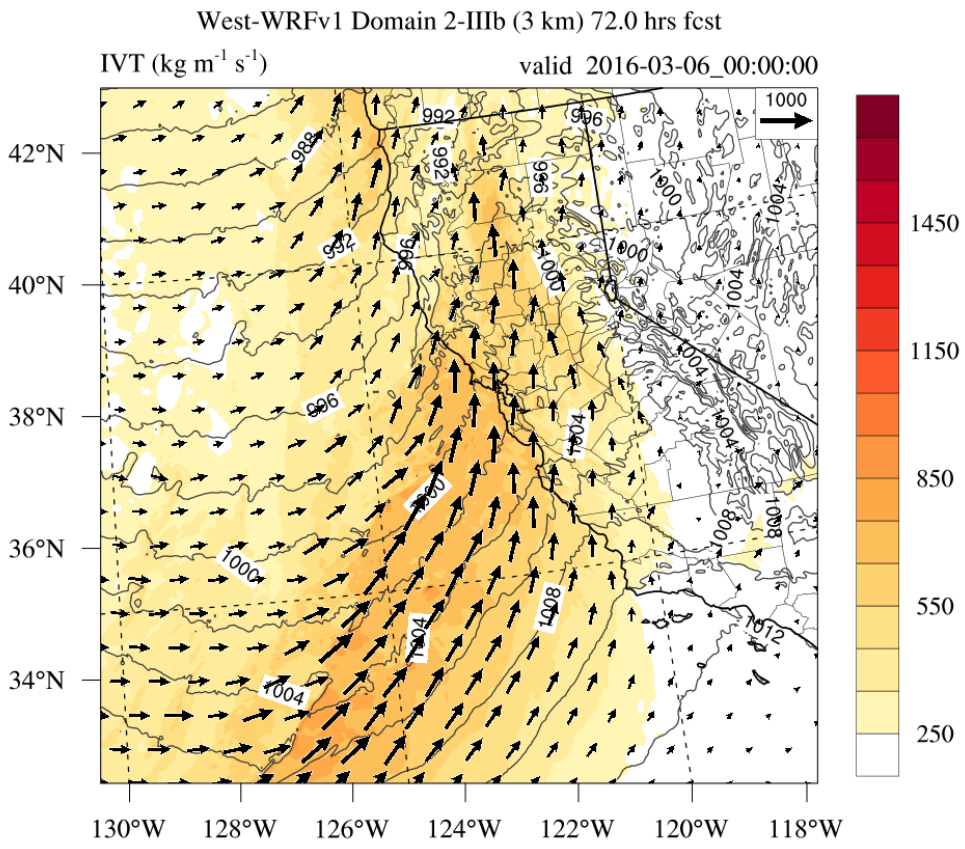
This work supports Workplan 7.2.5: Hydrometeorological Observing and Forecast system

Outline

- What is West-WRF and How Can it Benefit FIRO at Lake Mendocino?
- Results from Year One Quantitative Precipitation Forecasts
- How does West-WRF Design Lead to a Good Performance?
- West-WRF as a Learning Tool
- Plans for the Future

What is West-WRF?



- West-WRF is a regional numerical weather prediction model based on the open source WRF-ARW v3.5.1 optimized at CW3E for AR in Northern CA

- Personnel:
  - Andrew Martin (co-lead developer)
  - John Helly (co-lead developer)
  - Marty Ralph
  - Reuben Demirdjian, Laurel DeHaan, Xin Zhang (programmers and analysts)

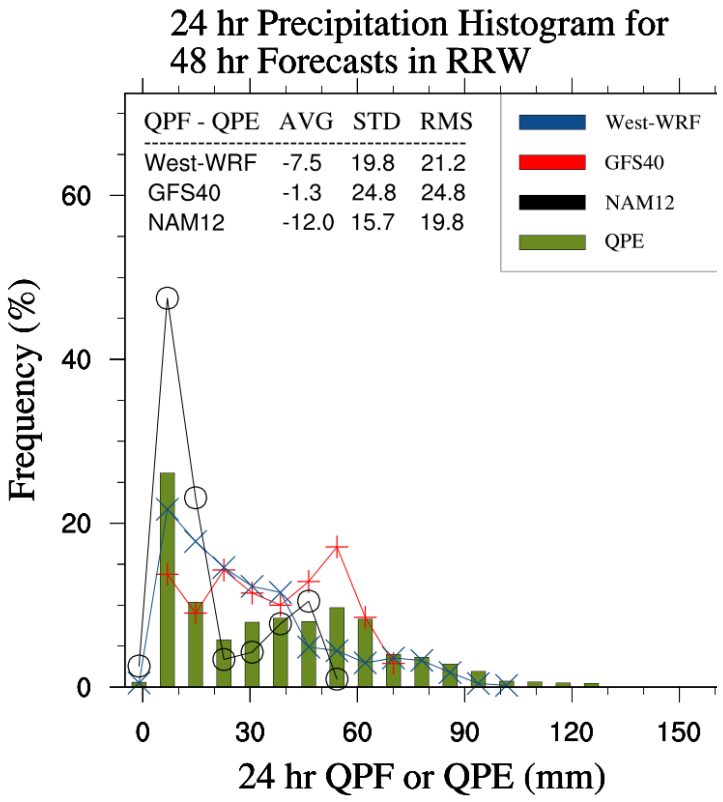
- Why did CW3E Develop West-WRF?
  - To create best possible forecasts of extreme Western precipitation events.
  - To learn the reasons NWP systems might fail to do so.

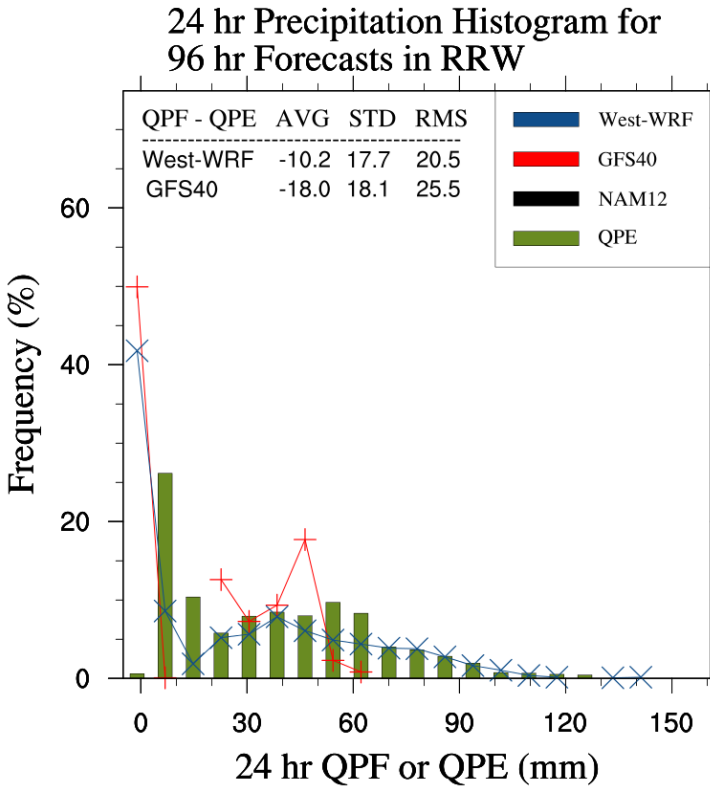
*Visualization is from March 5-7, 2016 Russian River AR

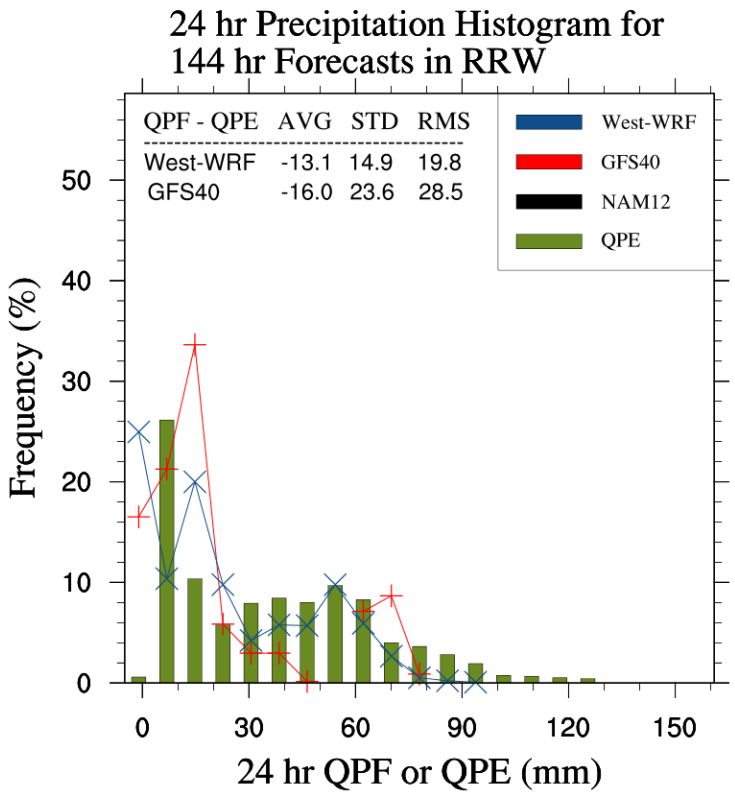
How Might West-WRF Benefit FIRO?

- Sufficient resolution to investigate small watersheds, e.g. Lake Mendocino catchment.
  - Addresses gap in available Global NWP
- Sufficient forecast lead time to identify events on release planning horizon (> 5 days).
  - Addresses gap in available Regional NWP
- End-to-end control over all sources of forecast error.
  - Addresses gap in all extramural models
- Ability to re-forecast for purposes of investigating physical processes, e.g. sea surface forcing, aerosols, mesoscale frontal waves.
- Future ability to assimilate special observations, and package into a probabilistic forecasting system.
- Future ability to couple with hydrologic models.

West-WRF Precipitation Skill



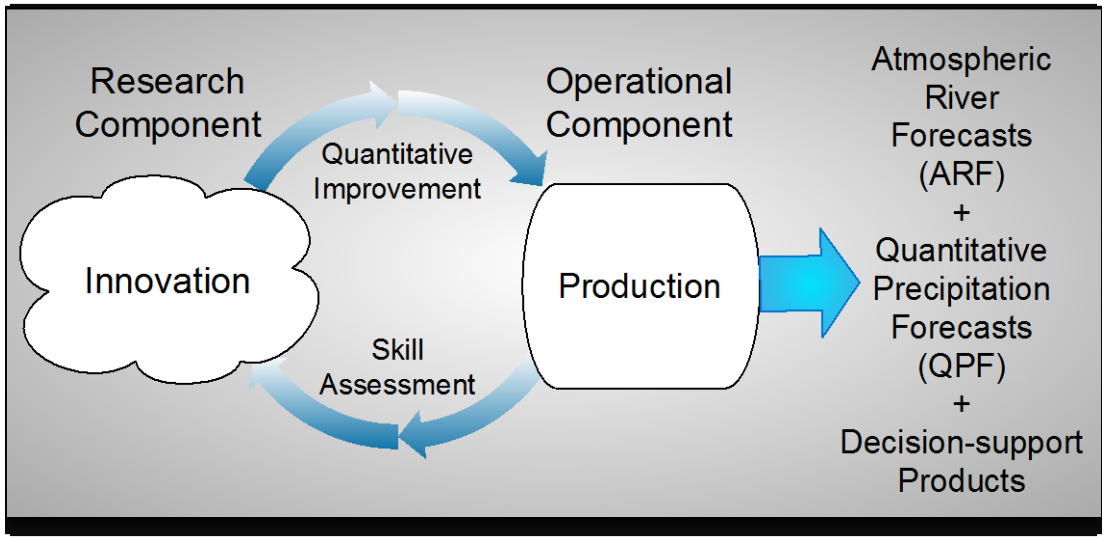




Investigating in another way: Does West-WRF capture the precipitation distribution - esp. the large amounts?

**Results are preliminary – about 50% of planned reforecasts have been run.

How is West-WRF Executed?

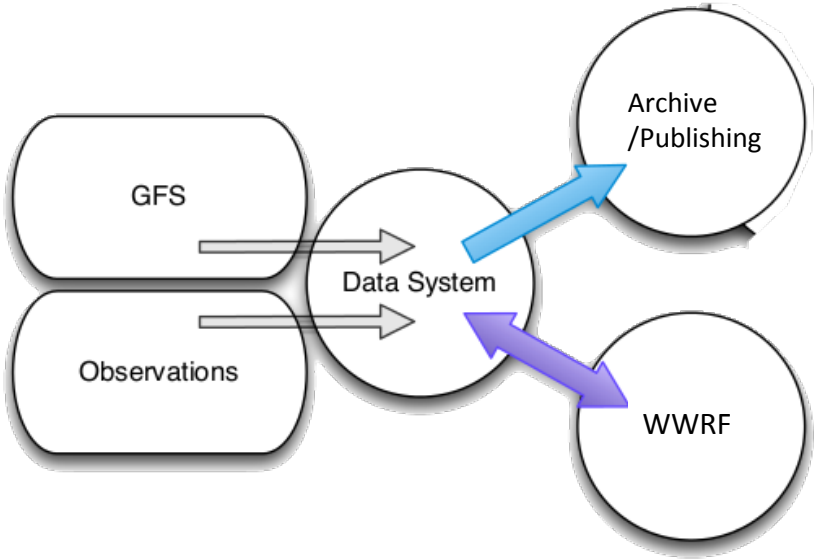


Operational Forecasts:

- Over 500 twice-daily forecasts issued
- Finest spatial resolution: 3 km
- Simulated radar and GPS occultation observations at key locations (BBY, CZC, Others on-demand)
- Forecast products published real-time to cw3e.ucsd.edu
- ftp accessible archive on cw3e-003.sdsc.edu

Automated Data Ingest, Archiving and Preprocessing System Developed at SDSC with Funding from DWR

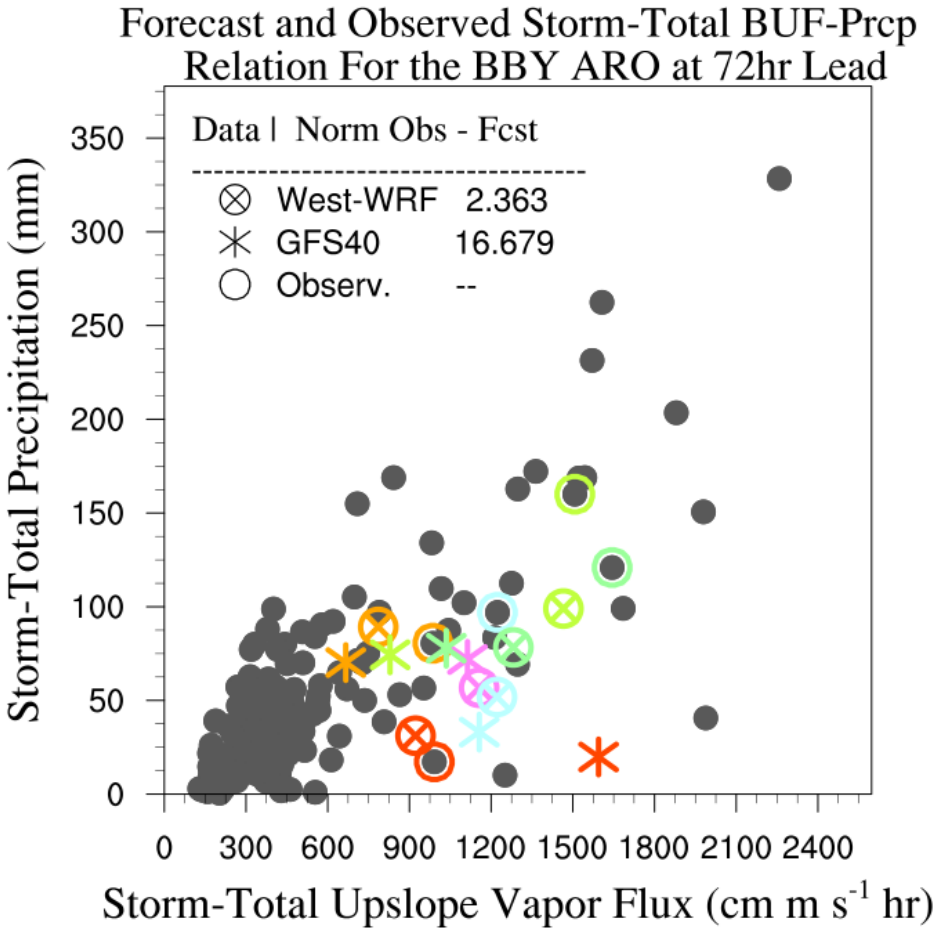
- GFS is fetched from NCEP
- Observations (validation only for now) are fetched from NOAA-ESRL, State AR Observing Network
- Preprocessing for WWRF is performed on dedicated machines and pushed to massively parallel computing platform.



*Other West-WRF Partners: DWR, SDSC

What gives West-WRF an Advantage?

A Focus on the Russian River Watershed

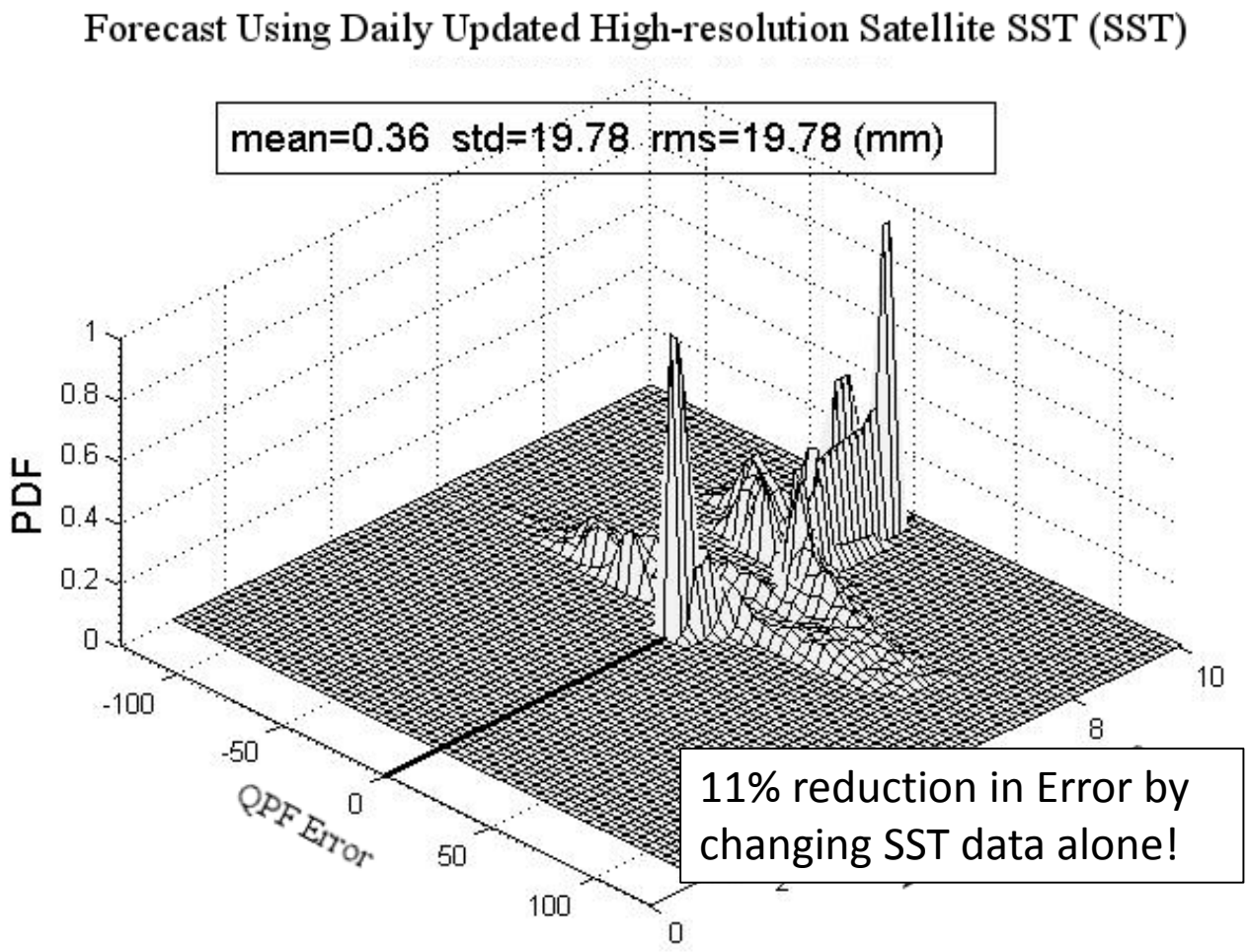


Normalized 2-dim. Error: ARO - Model

Lead Time	West-WRF	GFS
48	0.81	22.36
72	2.36	16.68
120	12.35	34.20
168	28.66	26.88

*Ralph et al., *J. Hydromet.* (2013); Martin et al., In Prep.

West-WRF is also a Powerful Learning Tool



11% reduction in Error by changing SST data alone!

With it, we are investigating:

- The limits of deterministic predictability under AR conditions.
- The impact of physical processes:
  - Ocean energy fluxes
  - Aerosols and cloud microphysics

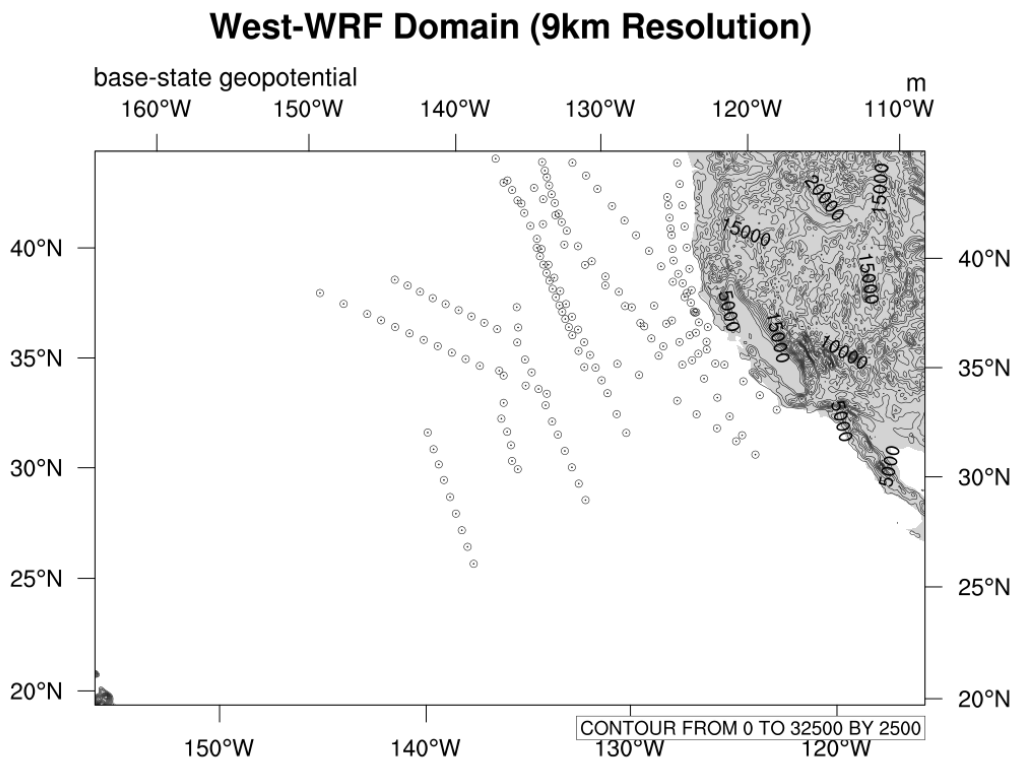
  on forecast skill during AR

Data Source	24 hr QPF – QPE RMSE
GFS	22.16 mm
SKTM	21.23 mm
cSST	20.61 mm
SST	19.78 mm

Future Development with West-WRF

- Optimization of Parameterized Physics. We have begun the tools to execute this in year one.
- Develop Ensembles for the purpose of Probabilistic Forecasts
- Data Assimilation. Twofold benefit:
  - Better forecast skill
  - Measure and characterize model error
- Integrate West-WRF with a coupled hydrologic model

West-WRF Validation Methods 1



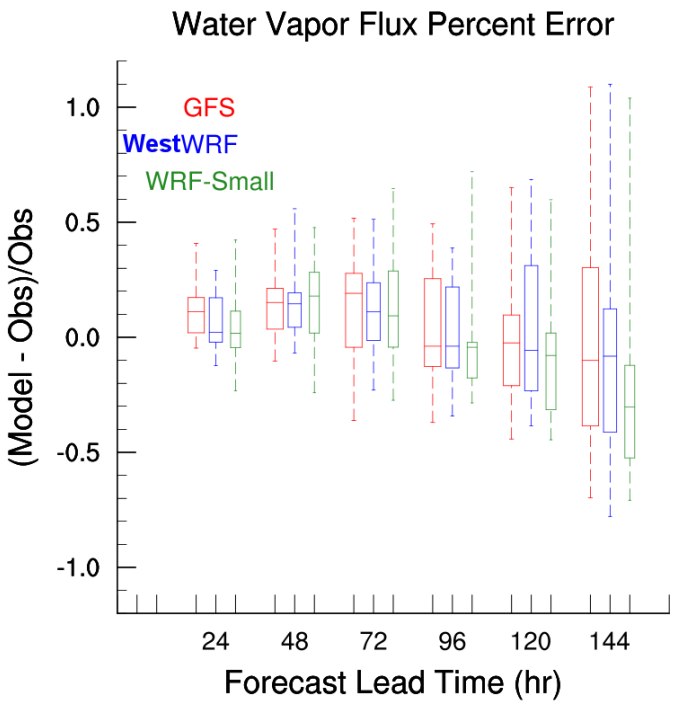
Location of Calwater dropsondes used in study of forecast errors

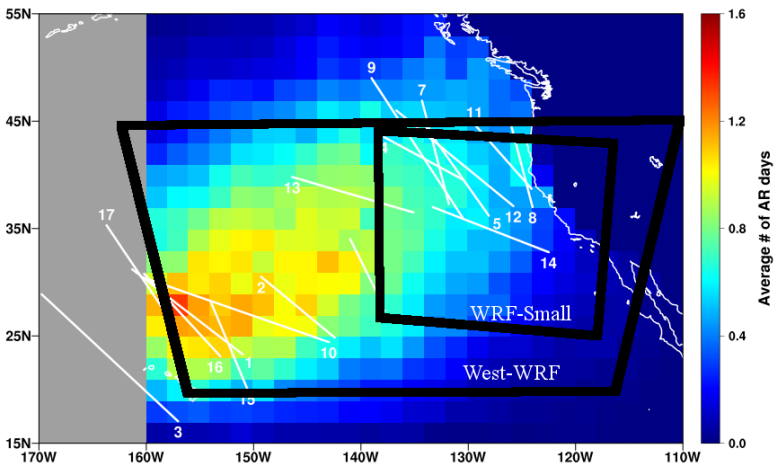
15 Calwater flights completed AR Core transects during Calwater 2. Use these observations to investigate skill at storm scales (dx > 80 km) and compare to skill from GFS.

Focus is on water vapor flux (i.e. delivery of water vapor to RRW) prediction of fronts, LLJ, and low-level static stability.

What gives West-WRF an Advantage?

1. Limited Boundary Condition Error





Error in Along-AR water vapor flux vs. forecast lead time for West-WRF, GFS and common WRF Domains.

- We desire that AR properties are well-forecast over the open Pacific as well.
- Regional NWP suffer in this regard because of their boundary conditions.
- We designed West-WRF so that for most AR geometry, BC error would not sig. affect Oceanic AR.

West-WRF Validation Methods 2

Start Date	Start Time	Duration	Special Obs
12/10/2014	1500	32	
02/06/2015	0400	27	CalWater IOP
02/08/2015	0900	25	CalWater IOP
12/09/2015	1300	26	
12/20/2015	1400	47	
01/17/2016	0400	25	
01/28/2016	1700	32	
03/05/2016	2200	33	FIRO Soundings
03/09/2016	0800	42	FIRO Soundings
03/12/2016	1500	37	

10 AR that made landfall in the Russian River Watershed are used to build a database for precipitation and local scale Wx verification.

QPE is produced at 4 km scale: suitable for investigating local scale precipitation response.

Bodega Bay ARO provided additional wind, moisture and precipitation data for validation.