AQPI: RAP/HRRR Model Forecasts of Atmospheric River Events over the San Francisco Bay Area

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1. Introduction

- Atmospheric Rivers (ARs) transport moisture from the tropics and bring heavy rain to higher latitudes
- ARs are responsible for roughly 40% of California's annual precipitation
- Better forecasts of rain timing/intensity, streamflow, reservoirs, and storm surge can minimize human, ecosystem, & economic impacts

2. The AQPI Project

- Goal of AQPI (Advanced Quantitative Precip. Info): improve California early warning through research transition, monitoring, and prediction of precipitation, streamflow, and storm surge
- Deploy & assimilate AQPI radar & srfc met instruments; evaluate model predictions of precipitation, streamflow, and storm surge
- 4-year grant awarded by the DWR to multiple partners: NOAA, CSU, USGS, DWR, and NWS

3. NOAA GSD Research Plan

NOAA GSD Role: Evaluate/improve QPF from RAP/HRRR model over AQPI region

Science Question: How well do different versions of the RAP/HRRR model forecast various AR events over California?

Approach:
- Select 6-8 AR events that have occurred
- Download operational & real-time X RAP/HRRR output, & run retrospective simulations with the latest RAP/HRRR model version
- Compare model forecasts of precip and other metrics to available observations

Metrics:
- Precip (Model QPF vs Observed QPE): Stage IV; Mesonet contingency tables; San Jose X-band domain
- Winds, T, water vapor: PSD ARO Profilers (Bodega Bay, Pt Sur)

4. RAP/HRRR Model Versions

RAP/HRRR is a high-resolution mesoscale model for short-term weather forecasts (0-36h)
NOAA/ESRL/GSD develops improved versions of RAP/HRRR and release radar files in NCEP-operations every ~2 years
Currently RAPv4/HRRRv4 is operational; RAPv5/HRRRv4 is under development

5. Case Study: 22-Mar-2018

A. QPF/QPE Comparisons (Stage IV & Mesonet)

RAPv5/HRRRv4

B. QPE/QPF Comparisons in the San Jose Area

HRRRv2 versus HRRRv3
HRRRv4

6. Case Study: 14-Feb-2019

A. Stage-IV Comparisons (6h accum prec)

- Both HRRRv2 and HRRRv3 overestimate rainfall in the first event (21-Mar); underestimate the "main event" (22-Mar)
- Area average accumulation varies widely between various QPE (Quantitative Precipitation Estimation) sources, highlighting the challenges with trying to understand precip
- QPE from the Sand Jose X-band radar is in the middle of the pack of QPE estimates

7. Additional Cases (in progress)

- For 2-Feb, QPF for both HRRR versions compare favorably to Stage-IV; HRRRv4 better
- For 26-Feb, QPF for both HRRR versions compare well in the north but a wet bias in the south
- As with previous cases, HRRR generally has a wet bias at high altitudes and dry bias at low altitudes (with some exceptions)

8. Summary

- QPF evaluated for four AR events for multiple models (HRRRv2, HRRRv3, HRRRv4) against multiple precip measurements (X-band & MRMS radars, Mesonet & SWCA gauges)
- All versions of the HRRR generally predict rainfall spatial distribution and accumulation well, but tend to overpredict high altitude regions and underpredict low altitude regions
- HRRRv4 outperforms HRRRv3 in some but not all cases
- QPE measures vary widely, highlighting challenges with evaluating models

9. Next Steps

- Further explore causes of model biases; compare to additional observations (More ARO sites; Oakland soundings; satellite precipitable water)
- Conduct HRRR retros with and without local X-band radar in the data assimilation to understand its value for improving HRRR forecasts
- Evaluate additional 2-4 cases to understand statistics