The AQPI Project

(Advanced Quantitative Precipitation Information)
Building a State-of-the-Art Observation and Forecast System for the San Francisco Bay Area

Jon Rutz (CW3E)
March 2024
Bay Planning Coalition Energy & Water Committee Meeting

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SCRIPPS INSTITUTION OF OCEANOGRAPHY AT UC SAN DIEGO
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CIRA Connecting Models and Observations
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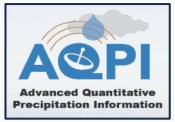
AQPI Advanced Quantitative Precipitation Information

SF Bay Area AQPI Project Team Partners and Supporters



AQPI Background, Current Status, and Future Expectations

- California Department of Water Resources (DWR) Integrated Regional Water Management Program (IRWM) funded the SF Bay Advanced Quantitative Precipitation Information (AQPI) System in 2016 with a $19.84 M grant. Sonoma Water is the administering agency for the program.

- When completed later this year, the AQPI system will provide more detailed radar information across the Bay Area (see slide 6) increasing the accuracy of forecasting and response systems.

- Current annual funding consists of 1 M from DWR and 900k from NOAA (FY23)
  - House has recently concurred with Senate on level funding (900k) for FY24
  - FY25 request will be made (March 2024) for 4.8 M

- DWR grant requires radar installations complete by the end of the 2024 (extension request being submitted this month). Following this, AQPI administration passes from Sonoma Water to CW3E based on the LPAC decision, and development continues following the Concept of Operations document (final April 2024). CIRA/CSU and NOAA will continue as key partners.

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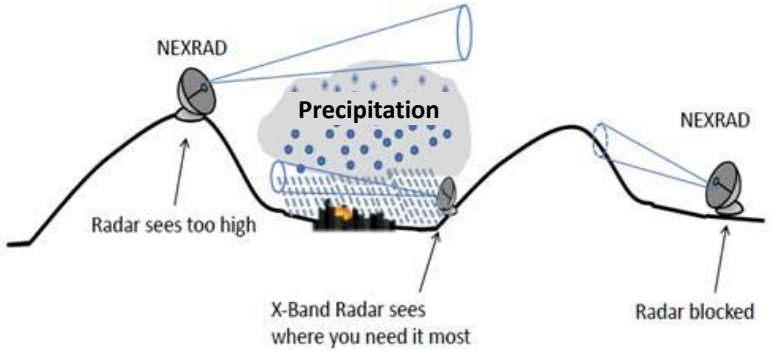
Why is AQPI Needed?

AQPI is needed for a number of reasons:

- Existing Radar Weaknesses:
  - Existing radar can be blocked by terrain, overshoot areas of precipitation, or see precipitation that is not reaching the surface
  - Existing spatial and temporal frequency are not sufficient for stakeholder operations in a high-density, high-value urban environment
- Weather Forecasting: operational staffing, logistics planning, wastewater and water resource management
- Coastal Concerns: flooding and inundation
- Climate change is making precipitation extremes more frequent ***and*** more extreme in northern CA

Who Needs AQPI?

- Water Agencies
- Municipal Utility Districts
- Wastewater Management
- Emergency Response
- Flood Management
- Public Works Departments



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What is the AQPI System?

AQPI has several components

- Observations: Additional radars to overcome beam blockage and overshoot, and meet user needs for for spatial and temporal frequency; additional rain/stream gauges for “ground truth”
- Radar-Derived Products: quantitative precipitation estimate (QPE), Nowcast,
  - QPE can be used in H&H models
- Weather Forecasts: short- and medium-range forecasts of precipitation and other relevant elements
- Coastal Modeling: tides, waves, storm surge, coastal flooding and inundation

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Radar Installation Status

AQPI radar coverage (at right) and installation status (below):

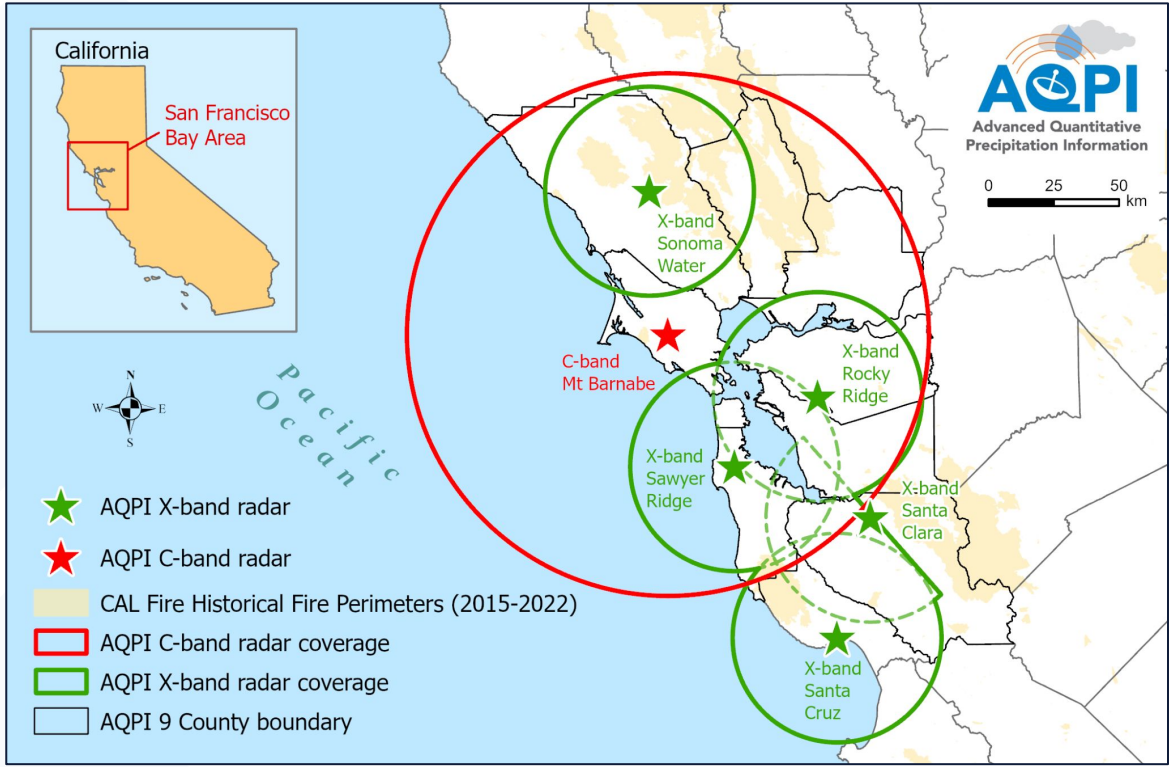
X-Band Radars:

- Sonoma Water (2018)
- Santa Clara (2019)
- Santa Cruz* (2022)
- Rocky Ridge (2023)
- Sawyer Ridge (2024)

C-Band Radars:

- Mt Barnabe (2024)

* Separate funding source



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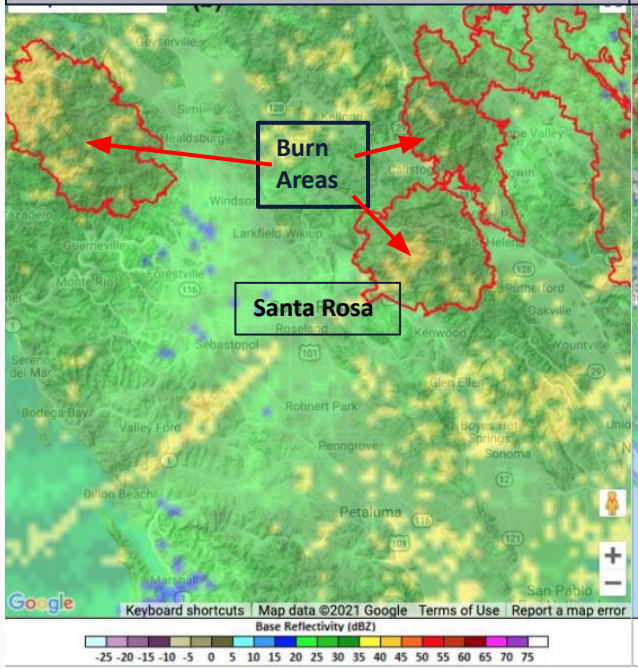
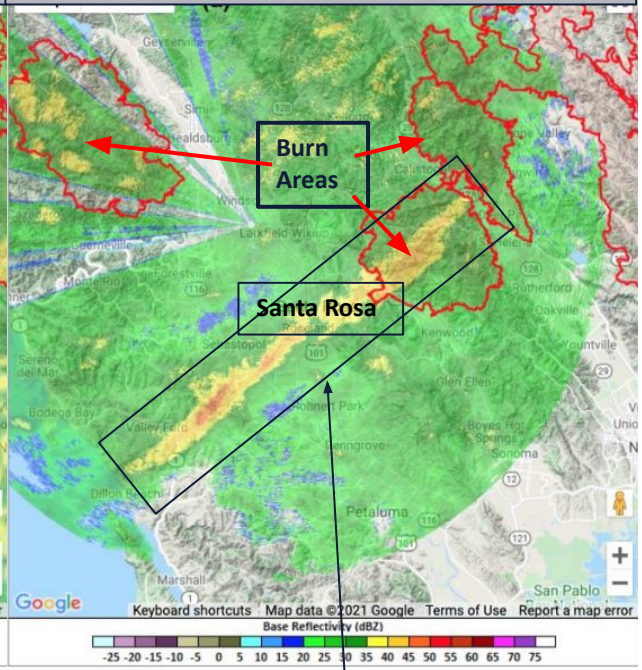
Santa Rosa, CA - 24 Oct 2021 ~1845 UTC

NEXRAD (s-band) from Monterey

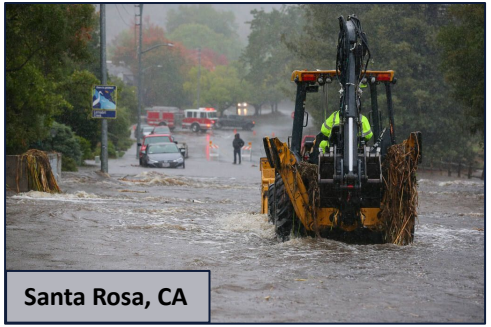


AQPI (x-band) from Santa Rosa



NCFR!


Guerneville, CA


Santa Rosa, CA

Source: https://www.pressdemocrat.com/article/news/atmospheric-river-lashes-the-north-bay-bringing-flooding-power-outages/

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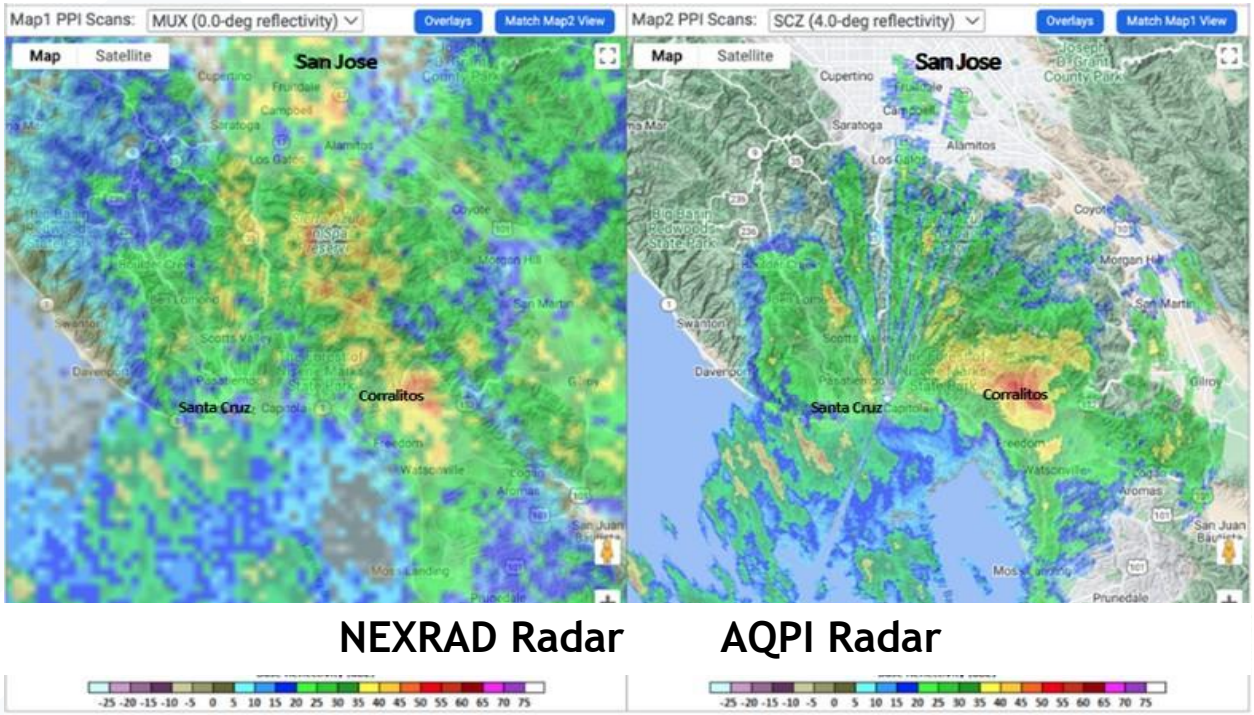
AQPI Radar Imagery - Santa Cruz Region March 10, 2023

March 10, 2023 - Radar imagery from the Monterey NEXRAD (MUX; left) and Santa Cruz AQPI X-band (SCZ; right) around 2:00 am PT. The high intensity storm cell near Corralitos was more clearly identified by the AQPI radar, and produced heavy rainfall, flash flooding, road washouts, and evacuations near Soquel, CA.



NEXRAD Radar **AQPI Radar**

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AQPI Case Study Santa Cruz County AR Storms – Bates Creek Flooding

CLICK TO PLAY VIDEO

Bates Creek flooded in the early morning hours of March 10, 2023. The creek is a minor tributary of Soquel Creek, which is a local river that drains to the sea through Capitola Village. Previously, Bates Creek passed through a large culvert, which was overwhelmed by an unexpected and significant amount of rainfall, taking out the Main Street in Soquel and stranding residents of 450 homes. Main Street was their only way out. The County undertook emergency repairs to restore access. AQPI radar data informed Emergency Managers on the scope and magnitude of remaining precipitation in the area to help clarify when to safely lift evacuation orders.

View video here: https://bayplanningcoalition.org/wp-content/uploads/2023/06/Bates-Creek-Flooding-03.10.23.mp4

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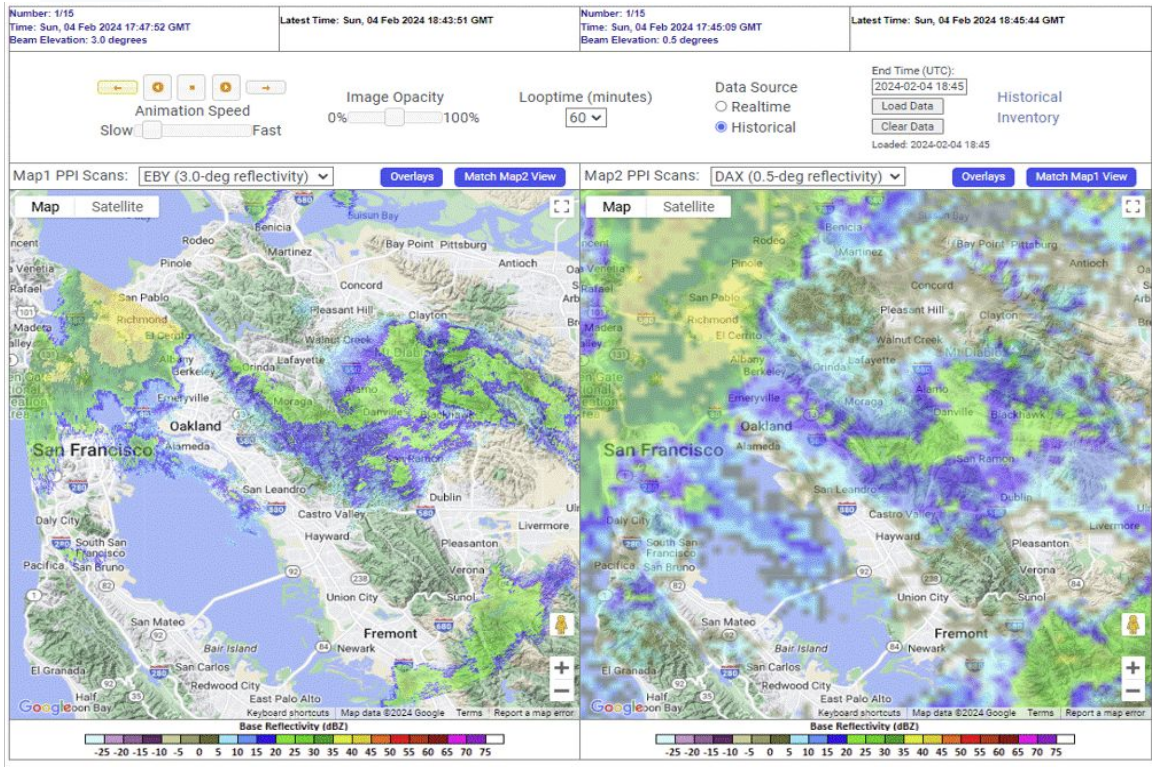
AQPI Radar Imagery – East Bay Rocky Ridge | February 4, 2024

February 4, 2024 - Radar imagery from the East Bay Rock Ridge AQPI x-band (left) and NEXRAD (right). The image shows a band of heavy precipitation moving through Alameda and Contra Costa Counties.



AQPI Radar **NEXRAD Radar**

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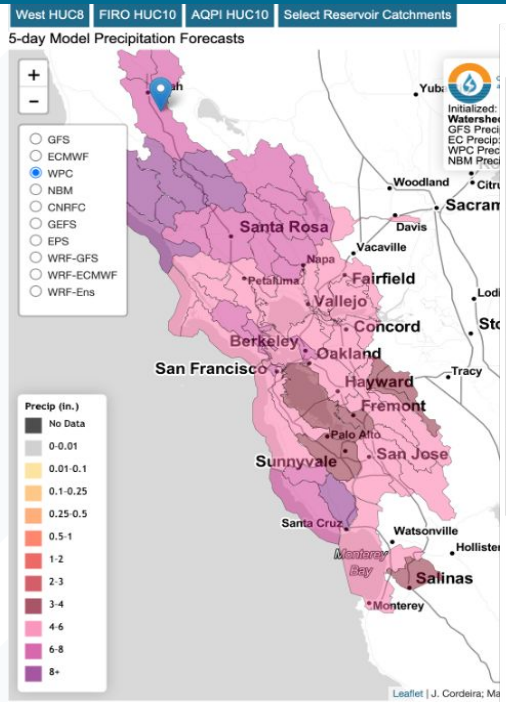
Weather Forecasts that Support AQPI – Watershed Forecast Tool



Toggle: 1 Map vs 3 Maps Zoom to: AQPI Region

Refresh Entire Page

Multi-Model Forecast QPF Grid: Upper Russian River
Forecast initialized: 00Z 01/06 | Through F120

GFS-Op 2023010600	0.02	0.01	0.01	0.00	0.04	0.33	0.42	0.04	0.79	0.50	0.15	0.05	0.01	0.06	0.72	0.72	0.09	0.26
EC-Op 2023010600	0.04	0.02	0.02	0.05	0.05	0.16	1.12	0.96	0.71	0.99	0.31	0.17	0.10	0.42	0.48	0.12	0.01	0.04
WPC 2023010600	0.02	0.03	0.07	0.29	0.29	0.28	0.78	0.40	0.79	0.88	0.29	0.22	0.16	0.37	0.68	0.87	0.58	0.31
NBM 2023010600	0.02	0.09	0.08	0.31	0.46	0.47	0.60	0.49	0.70	0.58	0.25	0.17	0.13	0.50	1.02	0.75	0.53	0.33
CNRFC 2023010600	0.02	0.05	0.06	0.24	0.39	0.47	0.74	0.55	0.73	0.93	0.28	0.19	0.11	0.29	0.63	0.72	0.68	0.55
GEFS Mean 2023010600	0.01	0.02	0.01	0.03	0.13	0.35	0.49	0.28	0.71	0.69	0.17	0.11	0.06	0.38	0.86	0.53	0.27	0.43
EPS Mean 2023010600	0.06	0.03	0.06	0.12	0.12	0.23	0.83	0.69	0.74	0.79	0.28	0.16	0.17	0.62	0.67	0.33	0.28	0.33
WRF GFS 2023010600	0.00	0.03	0.05	0.07	0.18	0.44	0.42	0.26	1.12	0.79	0.46	0.02	0.11	0.36	0.11	0.15	0.01	0.53
WRF EC 2023010600	0.01	0.09	0.03	0.10	0.05	0.23	0.62	0.28	0.60	0.59	0.34	0.07	0.15	0.73	1.09	0.09	0.04	0.07
WRFE Mean 2023010600	0.01	0.04	0.02	0.09	0.15	0.42	0.55	0.38	0.74	0.70	0.22	0.12	0.15	0.62	0.73	0.32	0.24	0.34
	12 AM	6	12 PM	6	12 AM	6	12 PM	6	12 AM	6	12 PM	6	12 AM	6	12 PM	6	12 AM	6

6-h Precip: <0.01" | 0.01-0.05" | 0.05-0.10" | 0.10-0.15" | 0.15-0.20" | 0.20-0.25" | 0.25-0.30" | 0.30-0.35" | 0.35-0.40" | 0.40-0.45" | >0.45"

West WRF ECMWF	0.23	1.18	1.60	2.05	0.32	X	X
West WRF Ensemble	0.17	1.50	1.78	1.82	1.04	X	X

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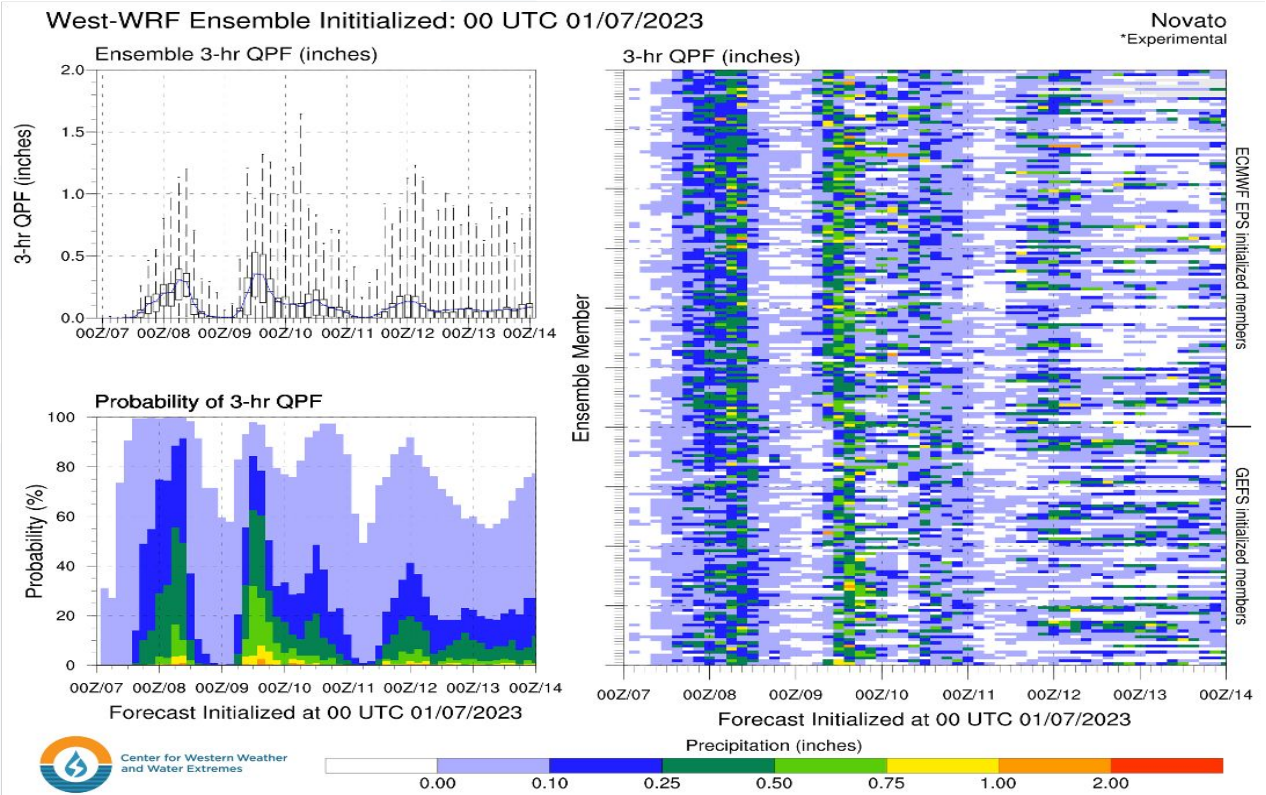
Weather Forecasts that Support AQPI – West-WRF



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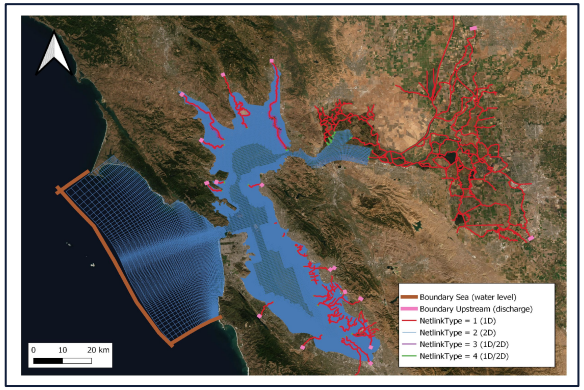
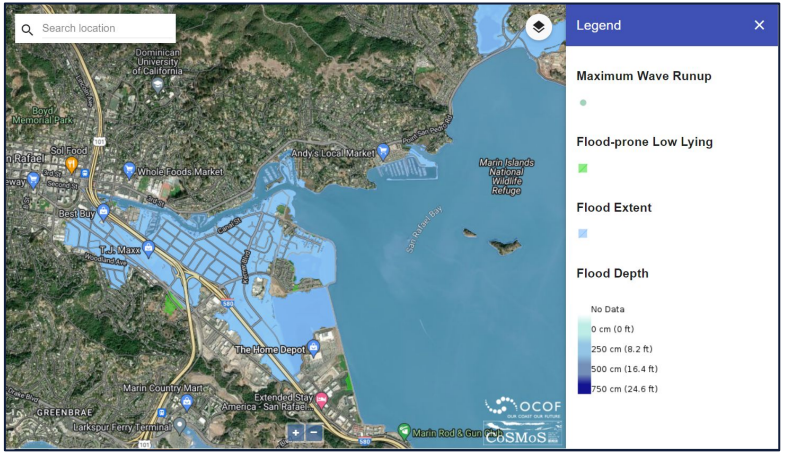
CoSMoS: Coastal Storm Modeling System

CoSMoS is a coastal inundation model

- Takes into account fluvial inputs, NWM coupled, tide forecast, wind, pressure, HYCOM - off-shore oceanic forecast system for sea level anomalies (waves not included yet) wind and air pressure from HRRR data, *precipitation is a future goal*
- Produced hourly with HRRR, 18-h lead time (36 h every 6 h), covers elevations < 10 m
- Outputs water level (relative to ocean surface) and water depth (relative to land surface)





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Additional Major Efforts

One major goal of AQPI is assimilation of the new X-band and C-band radar data into weather forecast models… This allows the model to use radar information to improve the short-term (0-6 hour) forecast.

- Parallel efforts underway using the in-house ***CW3E West-WRF*** and the ***NWS High-Resolution Rapid Refresh (HRRR)***, which is the premier operationally used short-range forecast model.

Another goal is documenting the benefit of AQPI, both through case studies and statistically

- NOAA estimates 60.9 M/yr in avoided costs and benefits to the Greater Bay Area (Johnson et al. 2020). Follow up studies are planned.

March 21, 2023

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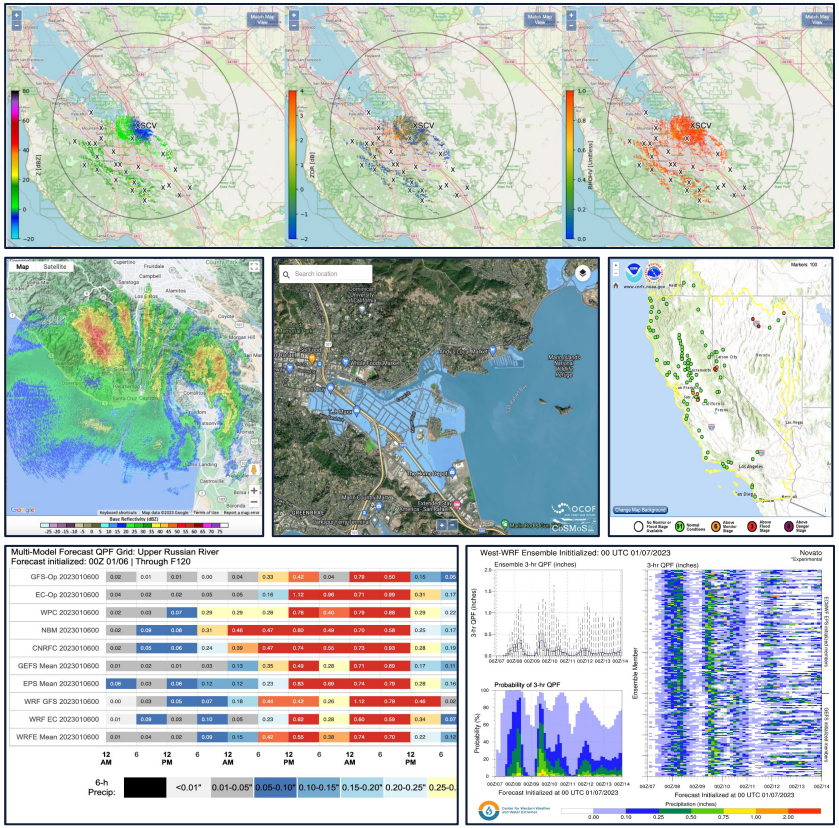
What's Next? Scientific Effort over the Next ~3 Years

- Produce high-quality, multi-radar QPE mosaic inc. bright-band QC and provide this data in formats useful for stakeholder H&H models
- Develop next-generation radar "Nowcast" system
- Engage with national initiatives such as MRMS so that AQPI data flows downstream into HRRR, NWM, etc.
- Develop a consolidated user interface with all AQPI-related observational and forecast data – ensure dynamic functionality, data archival, and user friendliness
- Provide robust training and stakeholder support



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Summary

AQPI usage is growing, and stakeholder feedback is informs development. In the future, AQPI data will flow directly & indirectly into stakeholder operations

- Real-time radar monitoring will play a role in certain situations
- H&H models will be driven by high-quality QPE, ensemble-based (probabilistic) atmospheric forecasts, and a nowcast benefitting from radar data assimilation
- These and other radar-derived products will support a robust suite of decision support tools, including supplementary weather forecast products
- AQPI data will flow downstream into national initiatives such as MRMS, HRRR, and the National Water Model

Contact

Jon Rutz (jrutz@ucsd.edu)
AQPI Program Management & Technical Lead

Information / Data Access

Sonoma Water AQPI Info: Access Here

AQPI User Interface: Access Here

NOAA Radar Archive: Access Here
NEXRAD and AQPI Radar Side-by-Sides

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