



Center for Western Weather
and Water Extremes

SCRIPPS INSTITUTION OF OCEANOGRAPHY
AT UC SAN DIEGO

Center for Western Weather and Water Extremes (CW3E): A Decade of Partnership with Sonoma County Water

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Director, CW3E

UC San Diego/Scripps Oceanography

UC San Diego



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OCEANOGRAPHY

Center for Western Weather and Water Extremes (CW3E) Annual Meeting June 2025

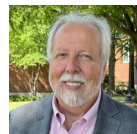
Scripps Seaside Forum at UC San Diego/Scripps Institution of Oceanography, La Jolla, CA



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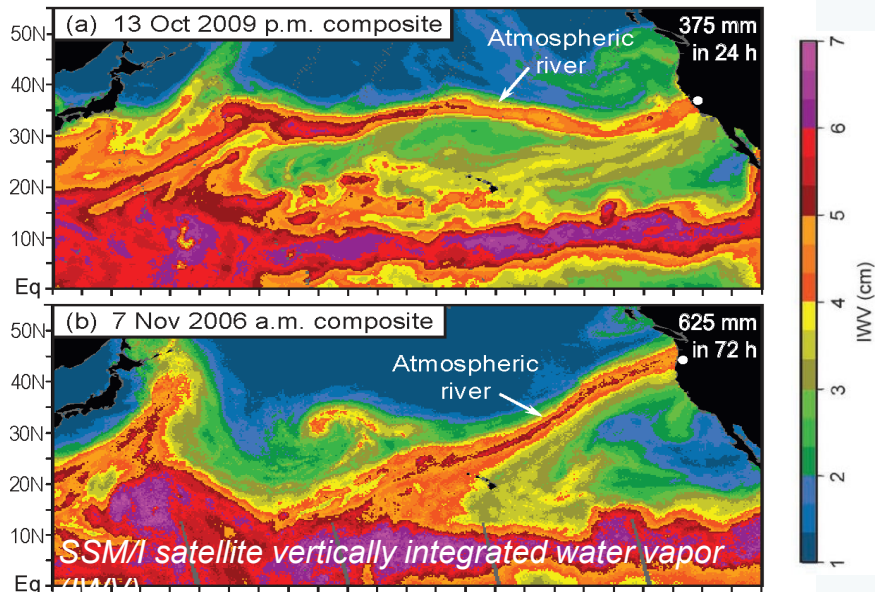
*Director
(Founding)*



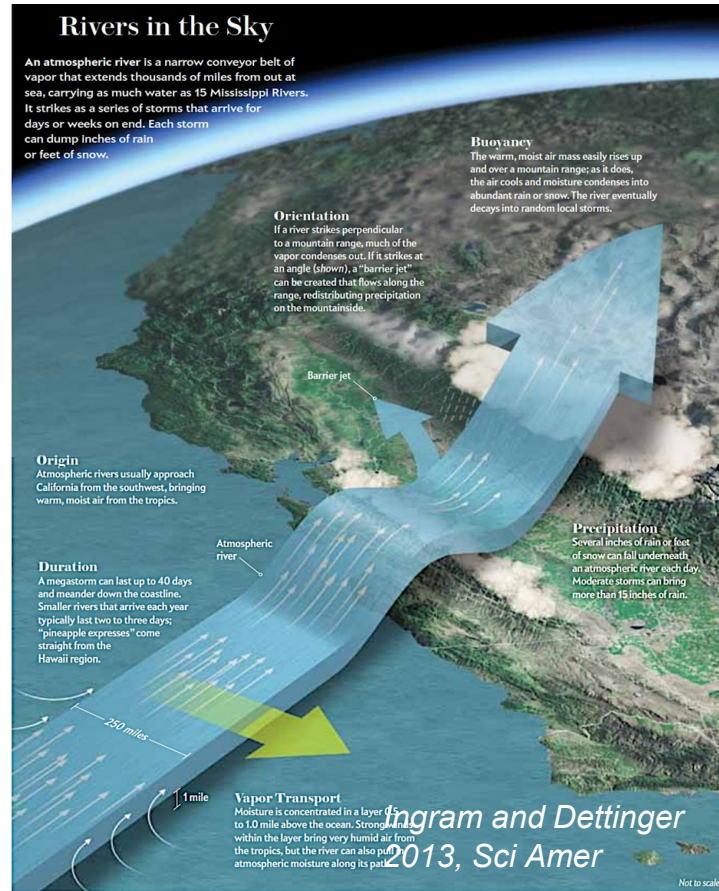
Atmospheric Rivers are Vital to Western U.S. Water Supply and Flooding

ARs can produce extreme precipitation and flooding (Ralph et al. 2005, 2006)

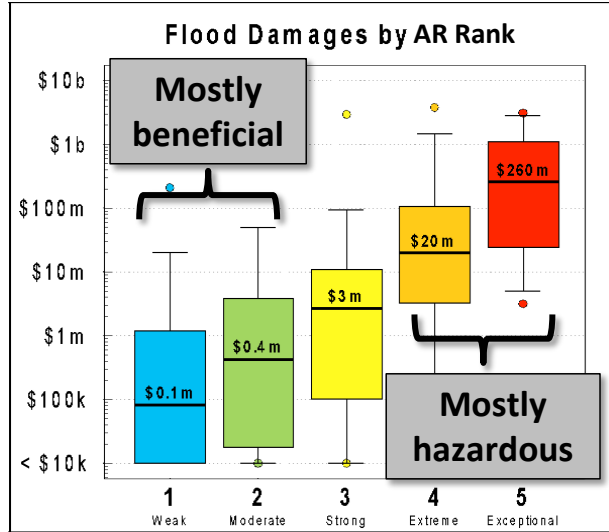
However, ARs also provide up to half of annual precip and Sierra snow – ARs are key to water supply. (Dettinger et al. 2011)



Ralph et al. 2013 BAMS

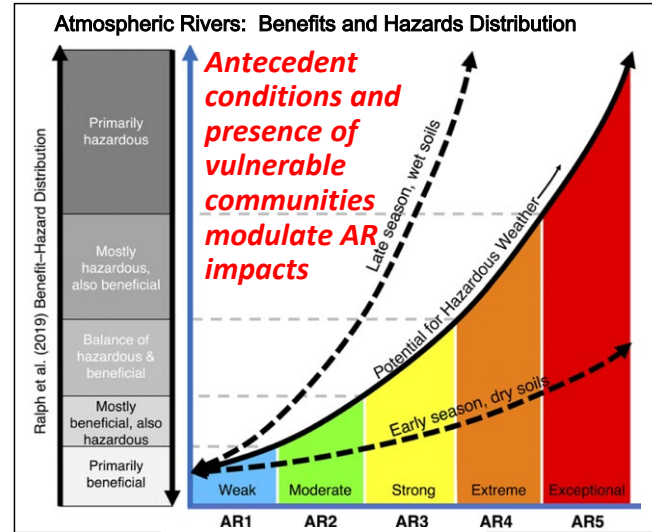


ARs drive flood damages in California and the West



Corringham et al. 2019
Science Advances

84% of All Flood Damages over 40 years in the West are from ARs



Bartlett and Cordeira 2021
Weather and Forecasting

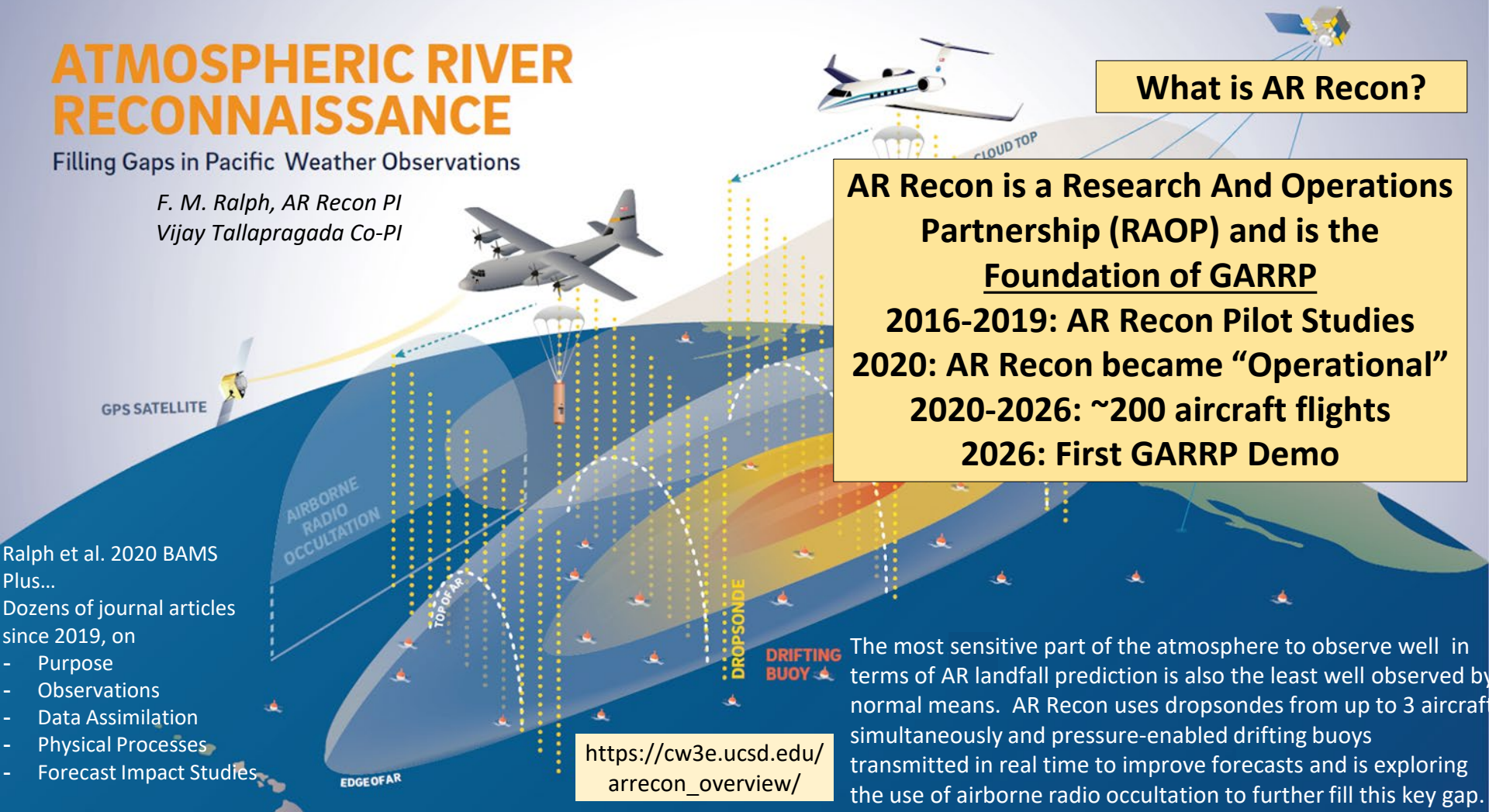
Flood damages increase exponentially with AR Ranking

ATMOSPHERIC RIVER RECONNAISSANCE

Filling Gaps in Pacific Weather Observations

F. M. Ralph, AR Recon PI

Vijay Tallapragada Co-PI



What is AR Recon?

AR Recon is a Research And Operations Partnership (RAOP) and is the Foundation of GARRP

2016-2019: AR Recon Pilot Studies

2020: AR Recon became “Operational”

2020-2026: ~200 aircraft flights

2026: First GARRP Demo

Ralph et al. 2020 BAMS

Plus...

Dozens of journal articles

since 2019, on

- Purpose
- Observations
- Data Assimilation
- Physical Processes
- Forecast Impact Studies

https://cw3e.ucsd.edu/arrecon_overview/

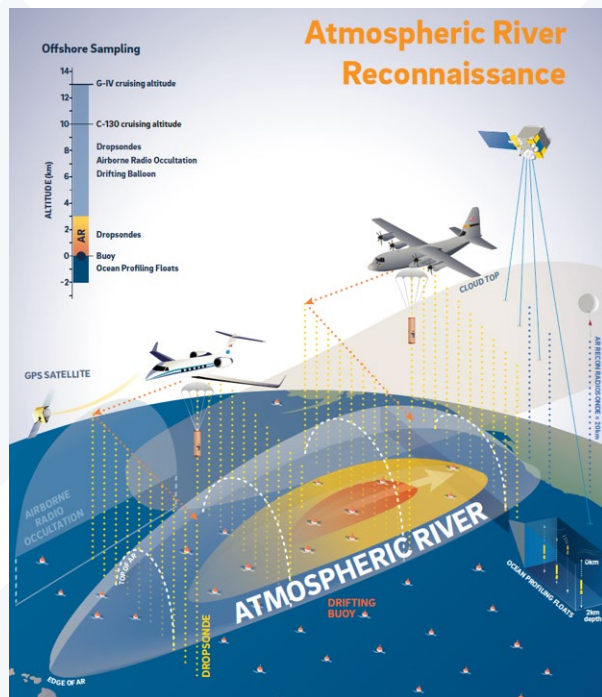
The most sensitive part of the atmosphere to observe well in terms of AR landfall prediction is also the least well observed by normal means. AR Recon uses dropsondes from up to 3 aircraft simultaneously and pressure-enabled drifting buoys transmitted in real time to improve forecasts and is exploring the use of airborne radio occultation to further fill this key gap.

WHAT IS ATMOSPHERIC RIVER RECONNAISSANCE



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Ralph et al. 2020 BAMS

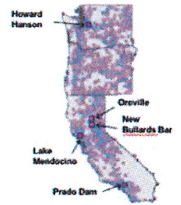
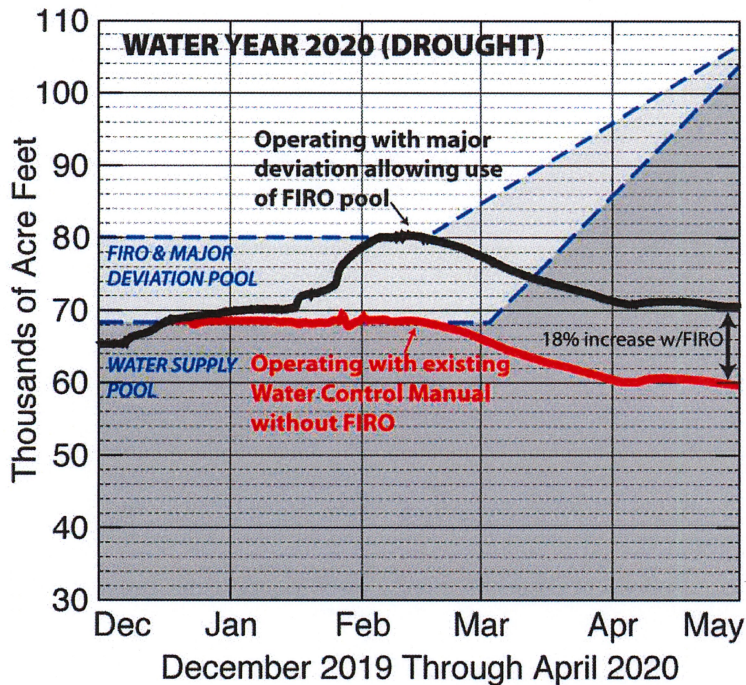


- Atmospheric River Reconnaissance is a **Research and Operations Partnership** to collect data to improve forecasts of atmospheric rivers.
- “Hurricane Hunters” from the U.S. Air Force Reserve Command 53rd Weather Reconnaissance Squadron and NOAA Office of Marine and Aviation Operations fly missions above atmospheric rivers over the Pacific.
- Flights are planned by a team of meteorologists and flight directors.
- Flight data is complemented by data from drifting buoys, and weather stations and balloon launches on land.
- Data collected is assimilated into global forecast systems.

Key Partners: CW3E/UC San Diego, NCEP/NWS, NOAA Aircraft Operations Center, US Air Force, ECMWF, Naval Research Laboratory, National Center for Atmospheric Research, Universities

AR Recon Drivers:

Forecast-Informed Reservoir Operations Viability Depends Upon Skillful AR Forecasts to support Water Supply Reliability and Flood Risk Management



Key FIRO Finding

Better forecasts of extreme precipitation and streamflow, starting from the storms that produce them, can enable greater flexibility in operating many reservoirs, creating greater water supply reliability and reducing flood risk

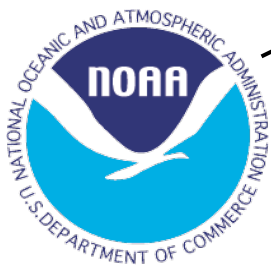
AQPI Program: Big Picture



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Local Sponsors
(largest three shown)



AQPI
Advanced Quantitative
Precipitation Information



UC San Diego

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Key Outcomes

- Radar Mosaic QPE & Nowcast
- Customized QPF Forecasts
- Data Display and Delivery
- Data Integration Services
- Mobile Radar Program

AQPI delivers the **most accurate** rainfall data available to Bay Area partners and pilots enhanced radar-observational capacity across California

Information: <https://cw3e.ucsd.edu/aqpi/>

User Dashboard: <https://cw3e.ucsd.edu/Projects/AQPI/main.html>

AQPI Radars

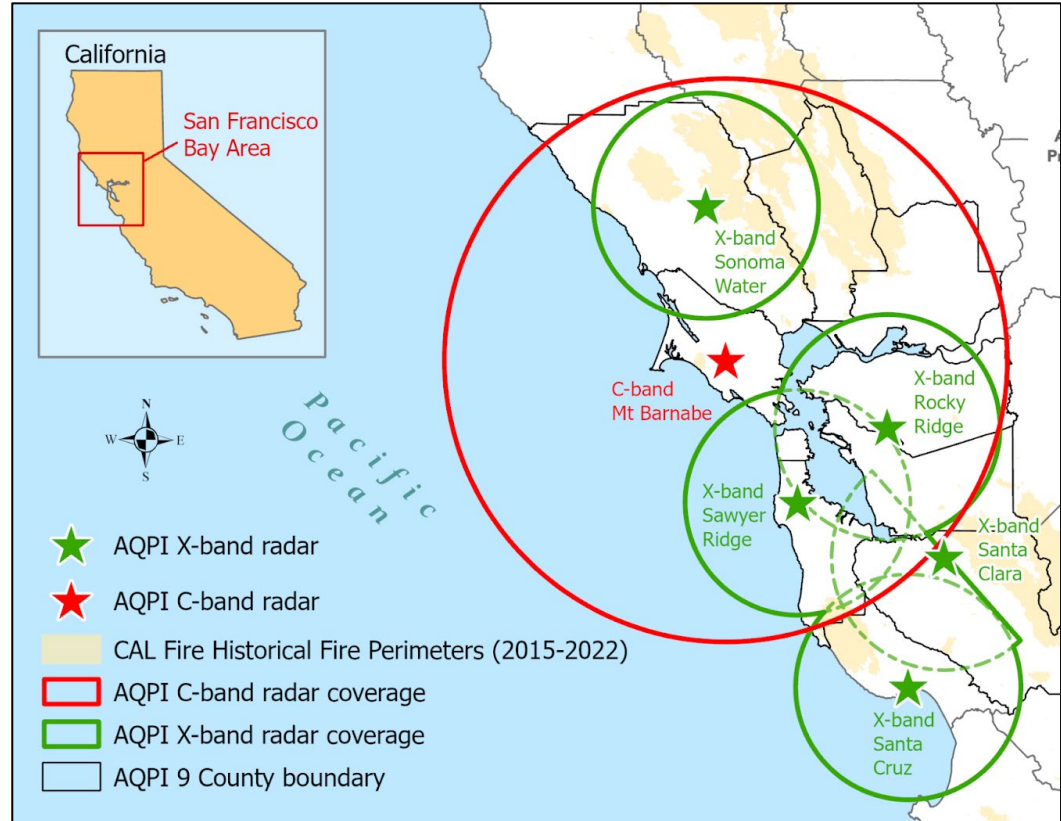


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The AQPI radar network is designed to complement the existing NWS radar network by filling existing gaps in coverage and providing greater detail in densely-populated areas

- The X-band radars (green) provide localized detail
- The C-band radar provides offshore coverage and greater lead time, fills gaps in X-band coverage, and provides redundancy

AQPI and NWS radar data can be combined, producing a radar “mosaic” and “nowcast” across the Bay Area

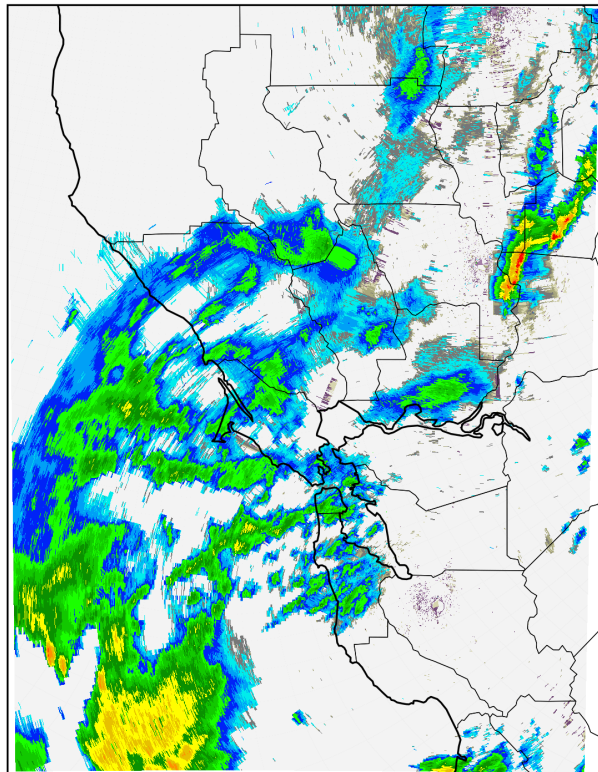


AQPI Radar: Dec 24 –25, 2025

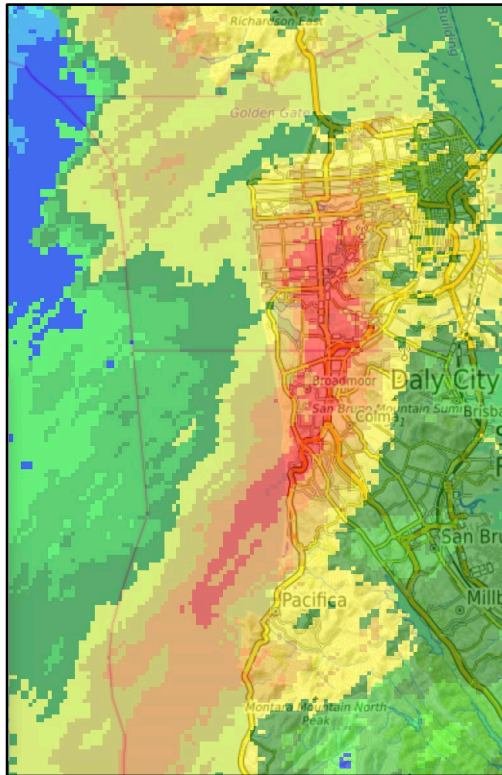
Entire AQPI Domain

Zoomed View at 2:20am PST Dec 25, 2025

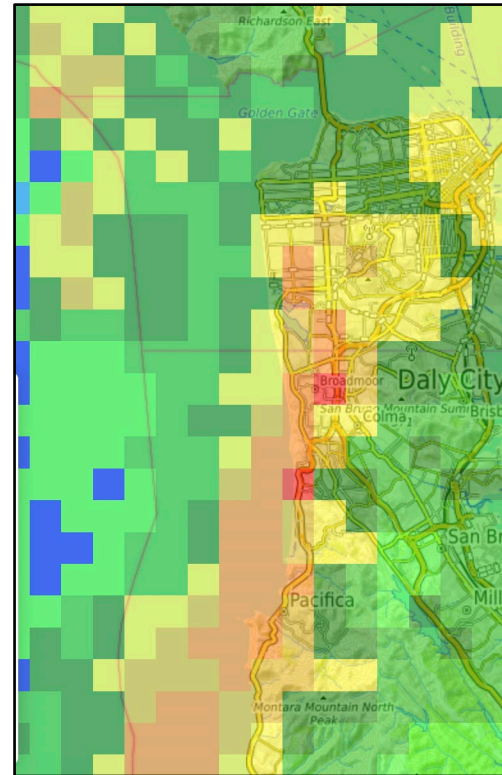
AQPI Mosaic 4:00PM PST Dec 24, 2025



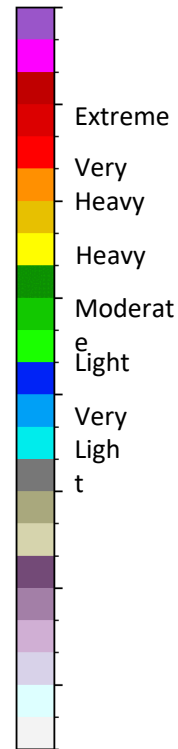
AQPI Mosaic



Without AQPI

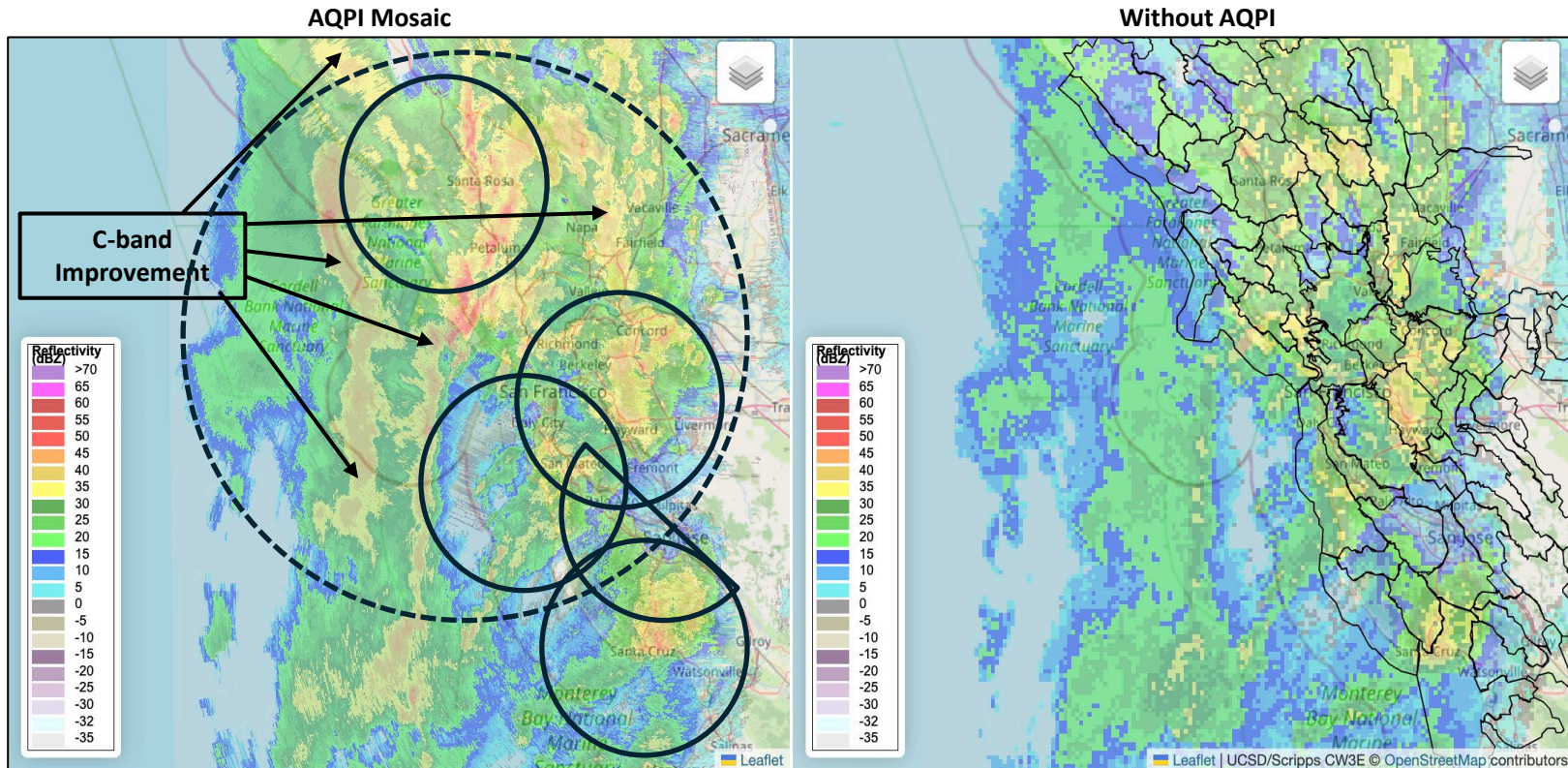


Rainfall
Intensity

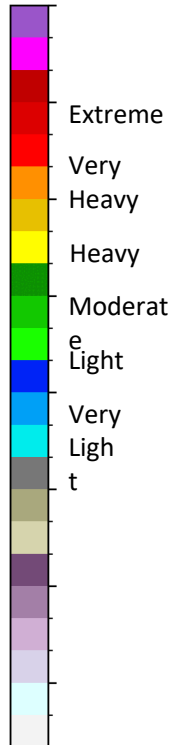


Initial C -Band Data: April 11 -12, 2026

Full AQPI Domain at 4:40pm PDT Apr 11, 2026



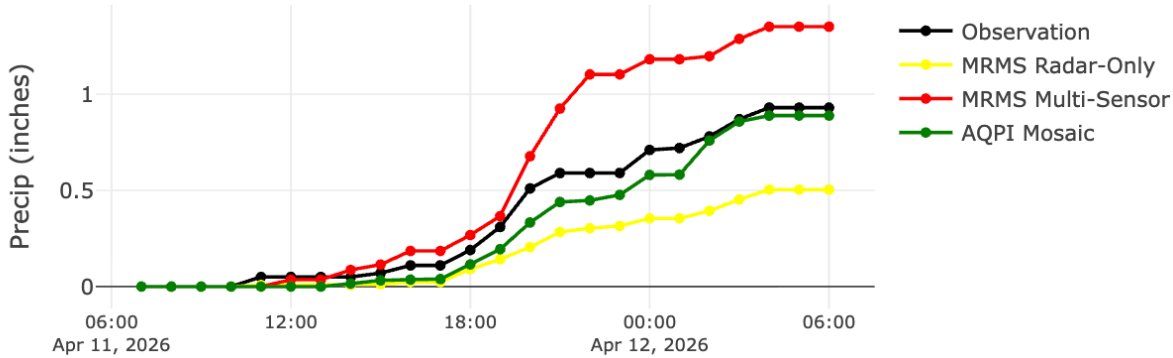
Rainfall Intensity



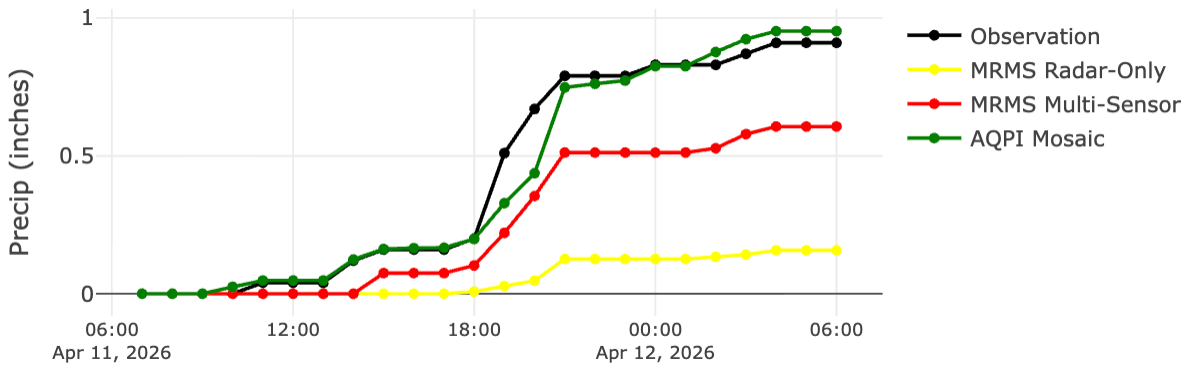
AQPI Radar: April 11 -12, 2026



Storm Total Precipitation (both locations not covered by X-band radar)



**Lake Sonoma
Recreation Area**



Dillon Beach
*(north end of Point Reyes
National Seashore)*