



Center for Western Weather
and Water Extremes

SCRIPPS INSTITUTION OF OCEANOGRAPHY
AT UC SAN DIEGO

Evolution of the Center for Western Weather and Water Extreme's Land-based Observing Efforts and Coordination with Atmospheric River Reconnaissance

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June 29, 2026
AR Recon Workshop

UC San Diego



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Today's Focus: Offshore-to-Onshore Observing Networks

1
Offshore Sampling
AR Recon aircraft +
buoys + etc.



2
Landfall Sampling
CW3E radiosondes



3
Watershed Response
CW3E hydromet
observing networks
across the U.S. West

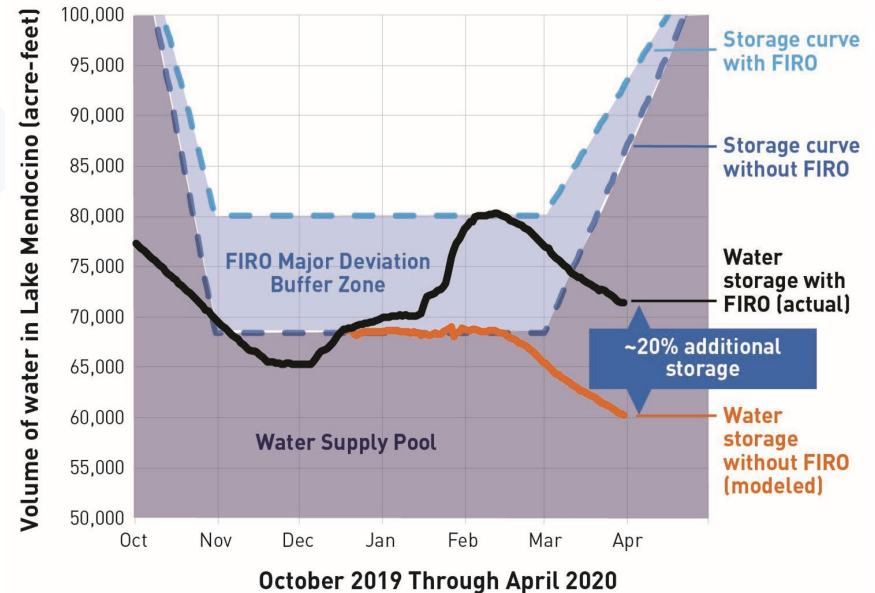


4
Forecast Feedback
verification, model
eval., and operational
decisions

- Operational motivation for the land-based observations
- Evolution of CW3E's land-based observing network
- Coordination with Atmospheric River Reconnaissance (AR Recon) Program
- Integration of land-based observations to improve forecast evaluation and operational confidence

Motivation for CW3E Land-Based Observations

- **Support Forecast Informed Reservoir Operations (FIRO)**
 - Uses forecast information to optimize reservoir operations while balancing flood risk and water supply
 - Reduce unc. In forecasts and watershed response
 - Lake Mendocino FIRO operations showing 20% increase storage space
- **Provide real-time observations** to improve situation awareness, forecast verification, and model evaluation.
- **Observe forecast-sensitive processes**
- **Complement AR Recon** observations by extending monitoring from landfall to watershed response



Observations to Target Forecast Sensitive Processes

Improve forecast confidence by:

- Verify weather and hydrologic models
- Identify systematic errors
- Guide improvements that boost confidence in forecasts

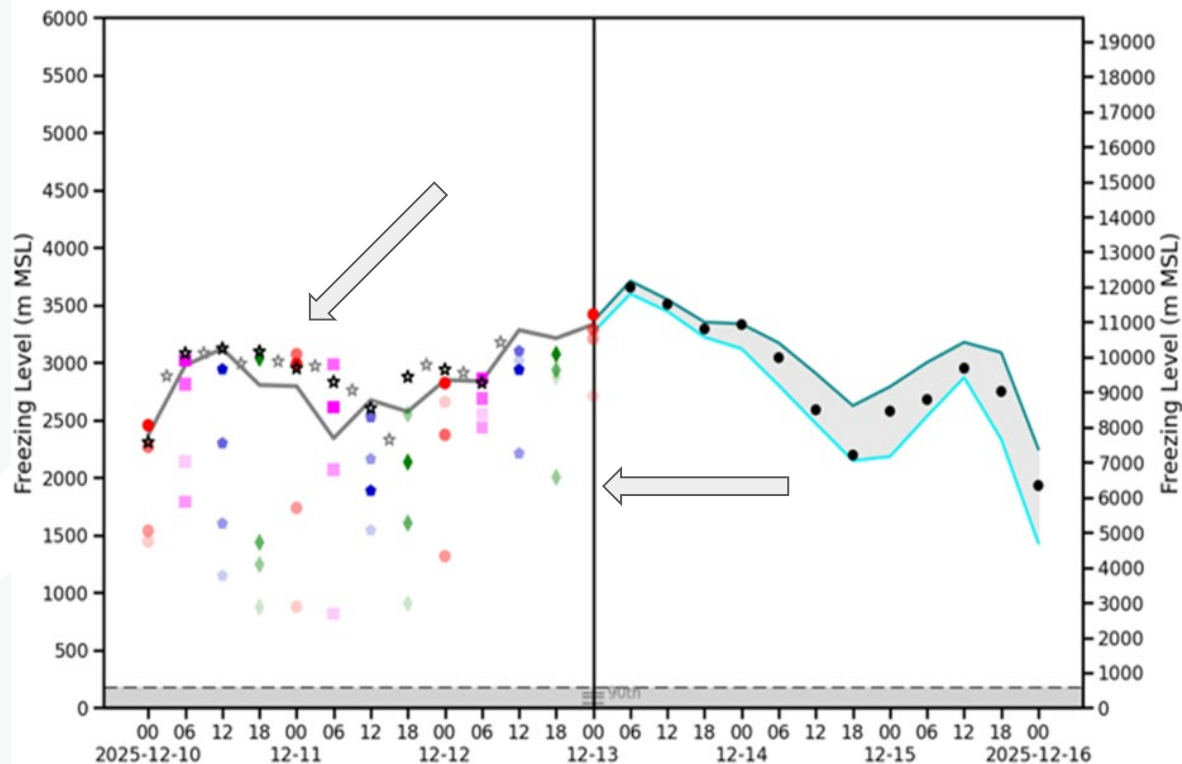
WRF Forecast Freezing Level (Det)

Freezing Level Verification Lead Times

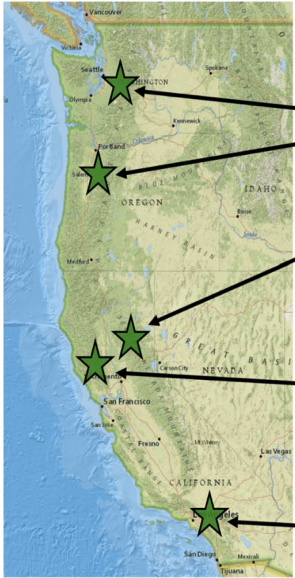
	●	■	◆	◆
Darker	24-h	30-h	36-h	42-h
	48-h	54-h	60-h	66-h
	72-h	78-h	84-h	90-h
Lighter	96-h	102-h	108-h	114-h

☆ Sounding Freezing Level

— — Station Elevation



Overall FIRO and Observations Timeline



Howard Hanson Dam
Willamette Valley



New Bullards Bar Dam
Oroville Dam



Lake Mendocino
Lake Sonoma



Prado Dam



Seven Oaks Dam

2016



FIRO pilot project
begins Lake
Mendocino

Northern CA:
USBOD and
USUKI

2018



Expansion into
other watershed,
e.g., Yuba-Feather

Southern CA:
USSIO

Northern CA: USYUB
Southern CA:
USCAT

2020



2021



Upper CO
River Basin
Yampa Basin

2023



National Expansion
Pathfinder

Southern
CA:
USTAC

PNW - WA:
USTAC

2024



2025



2026

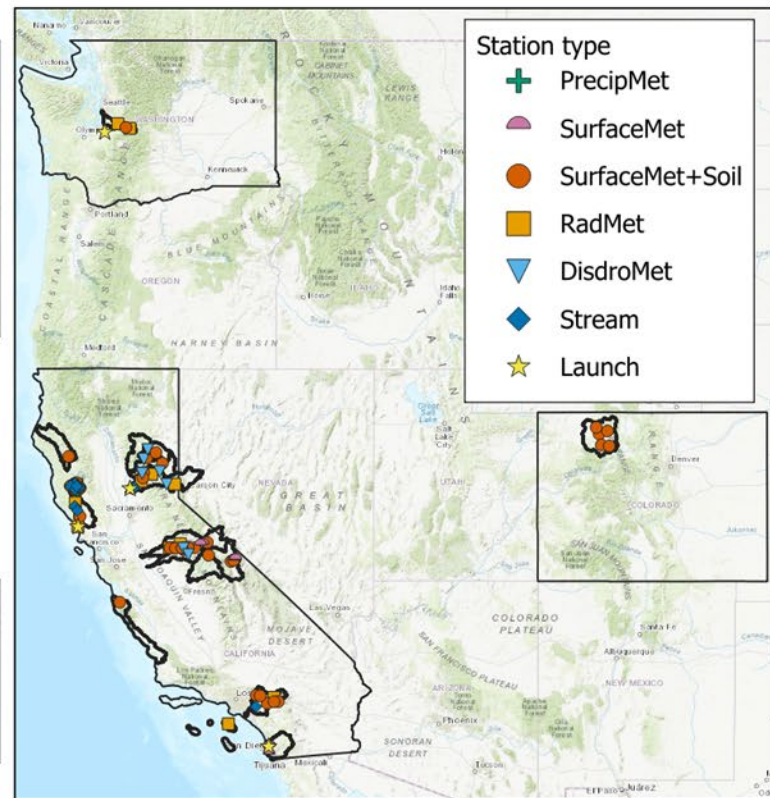


Currently, > 100
stations + launch
sites across
three states

PNW - WA :
USGHC



Station Types

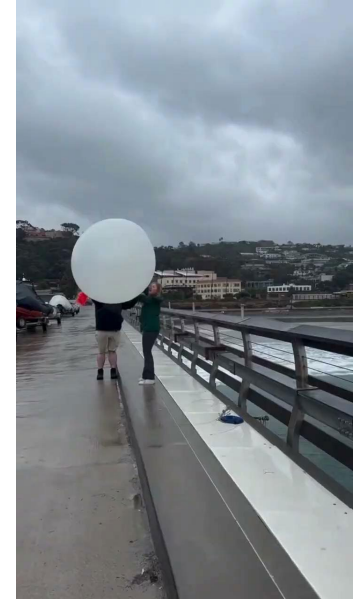


Radiosondes: Primary AR Targeted Observations

- Provides high-resolution profiles of temperature, humidity, winds
- Data provided in near real-time to global operational weather prediction models for data assimilation via the Global Telecommunications System
- Observations used in process-based studies and verification

AR Recon Coordination

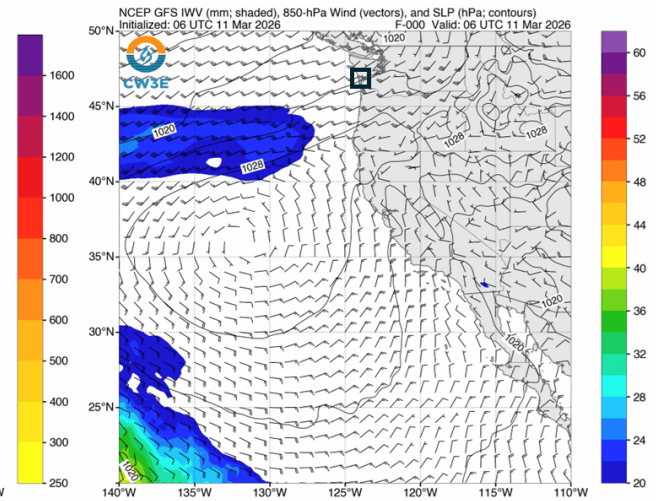
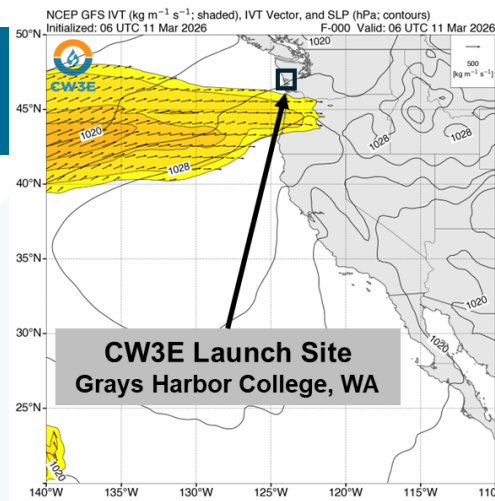
- CW3E Radiosondes - Begins Nov. 1
- Seven operational launch sites along West Coast
 - Paired with coastal and inland site
- Coordination with AR Recon team
- Launches every 3 hrs AR event



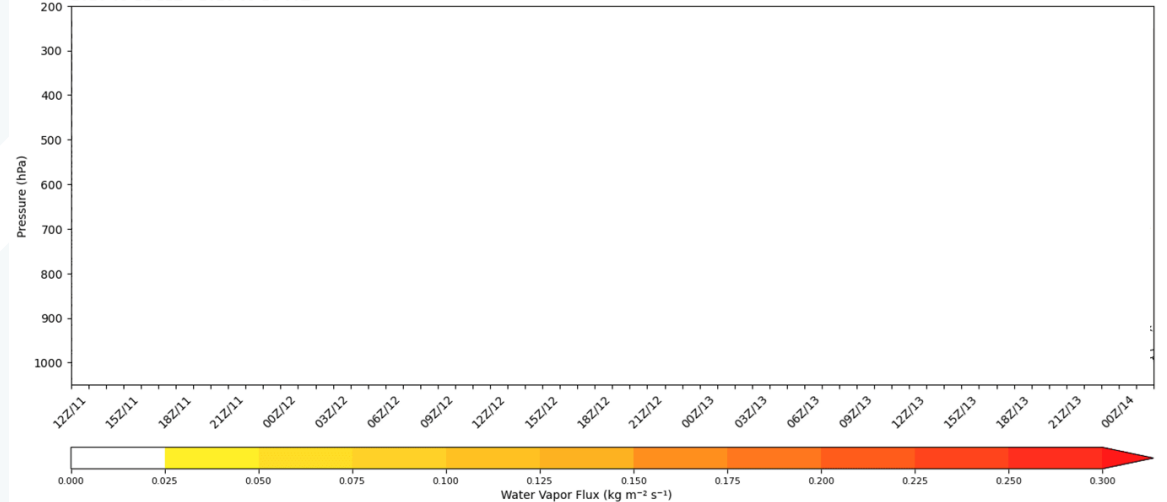
Radiosondes

Characterize key physical processes that control inflow responses:

- AR duration
- AR strength
- AR orientation
- Freezing level evolution
- Vertical distribution of moisture



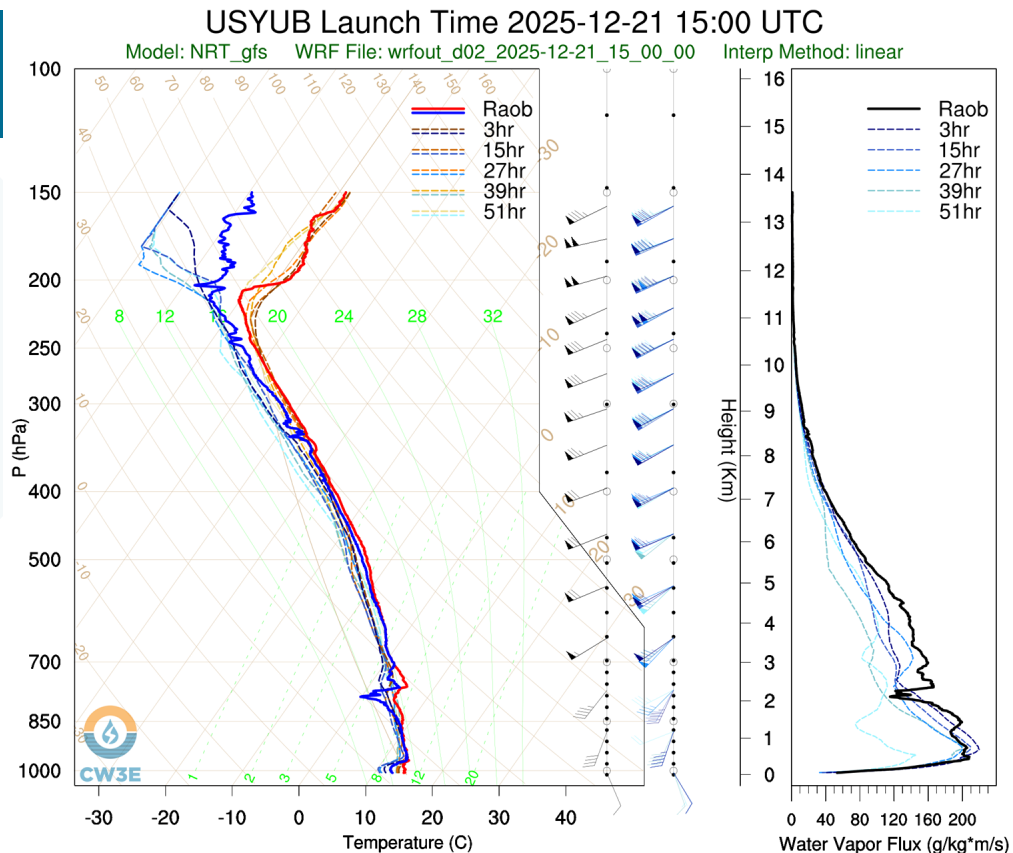
CW3E USGHC Radiosonde Observed Vapor Flux ($\text{kg m}^{-2} \text{s}^{-1}$), Winds (knots)
2026-03-11 12Z - 2026-03-14 00Z



Model Verification

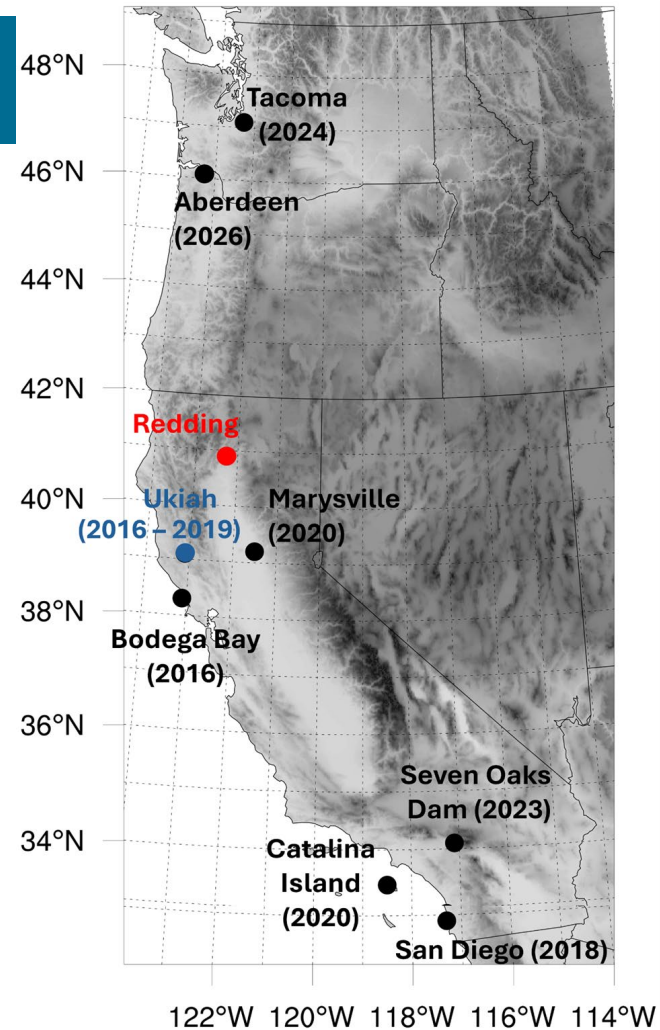
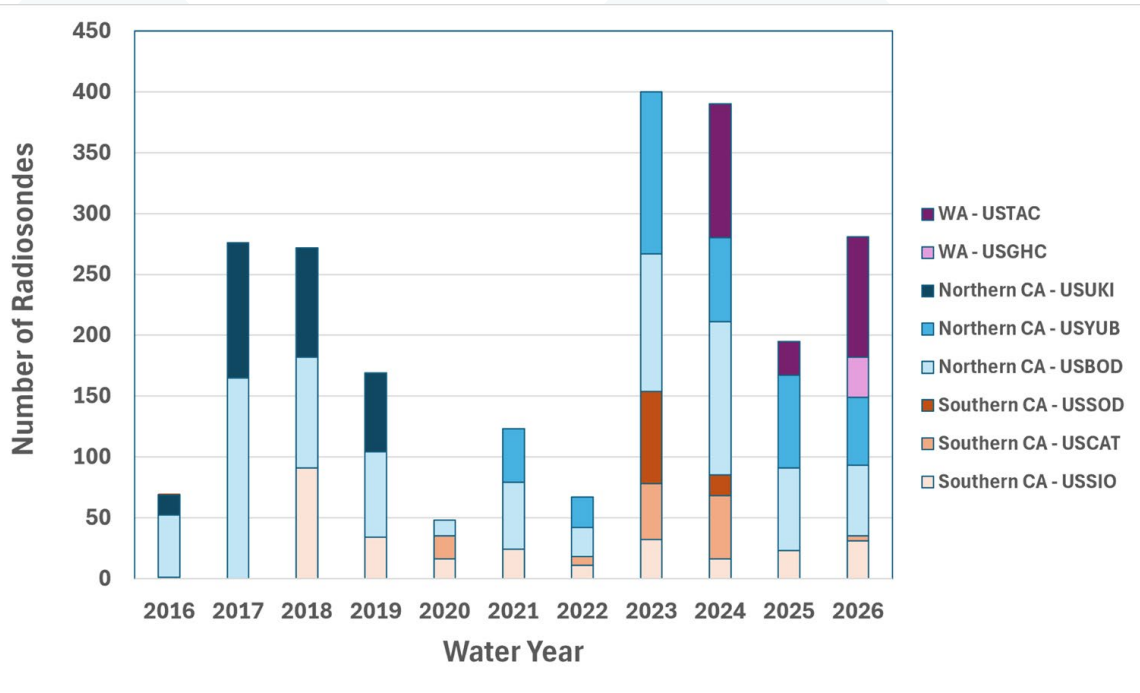
Verify weather and hydrologic models, identifying systematic errors and guiding improvements that boost confidence in forecasts

- Compare radiosonde observational data to near real-time WRF model output at varying model lead times
- Use historic radiosonde data to archive for process studies focused on addressing systematic errors



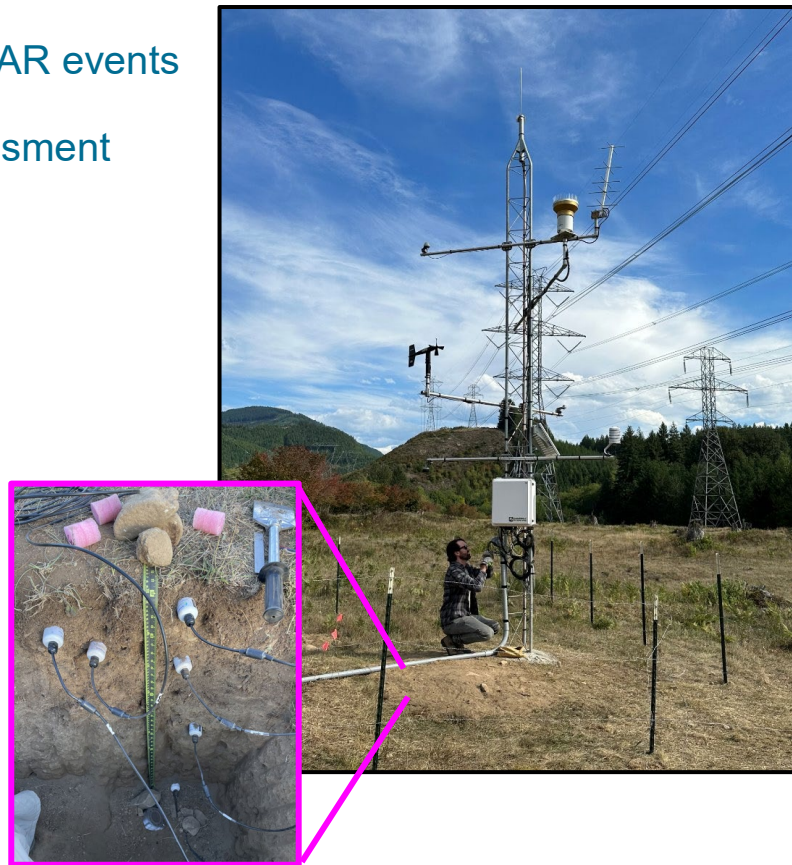
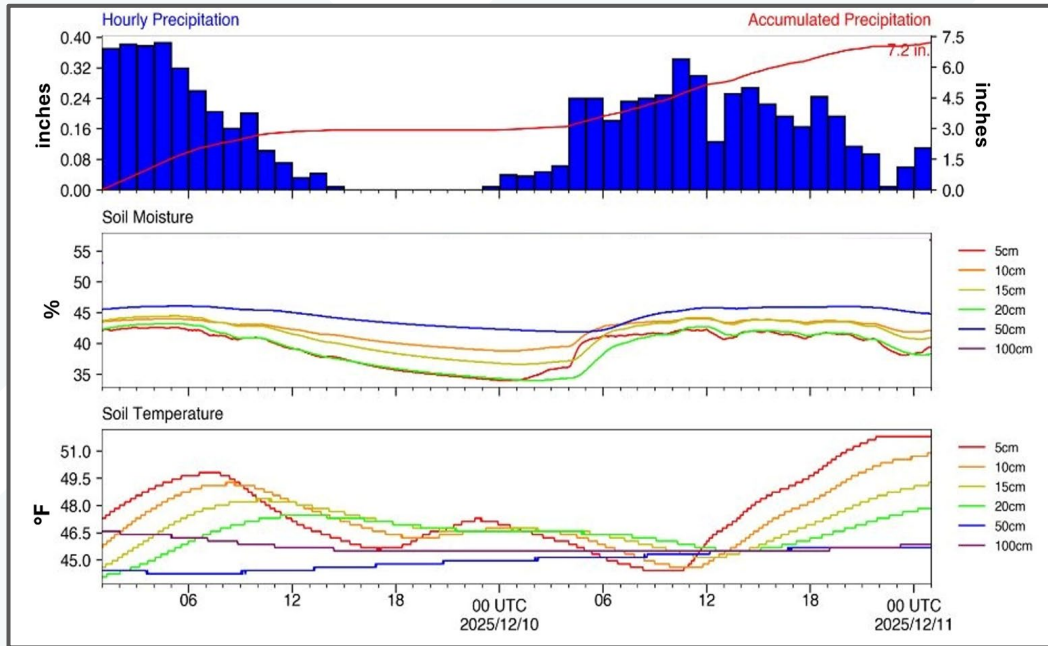
Lead Time	Init Time (UTC)	Cape (J)	IWV (mm)	IVT ($\text{kg m}^{-1} \text{s}^{-1}$)	0°C Height (m)
Raob	---	0	35.35	805.5	3194.42
3hr	2025-12-19 12:00	0	33.85	771.3	3102.39
15hr	2025-12-20 00:00	0	32.68	726.1	3053.24
27hr	2025-12-20 12:00	0	33.74	707.3	3078.41
39hr	2025-12-21 00:00	0	34.08	611.5	3008.79
51hr	2025-12-21 12:00	0	34.01	536.6	2939.03

Radiosondes



Beyond Soundings: Soil Moisture and Surface Meteorology

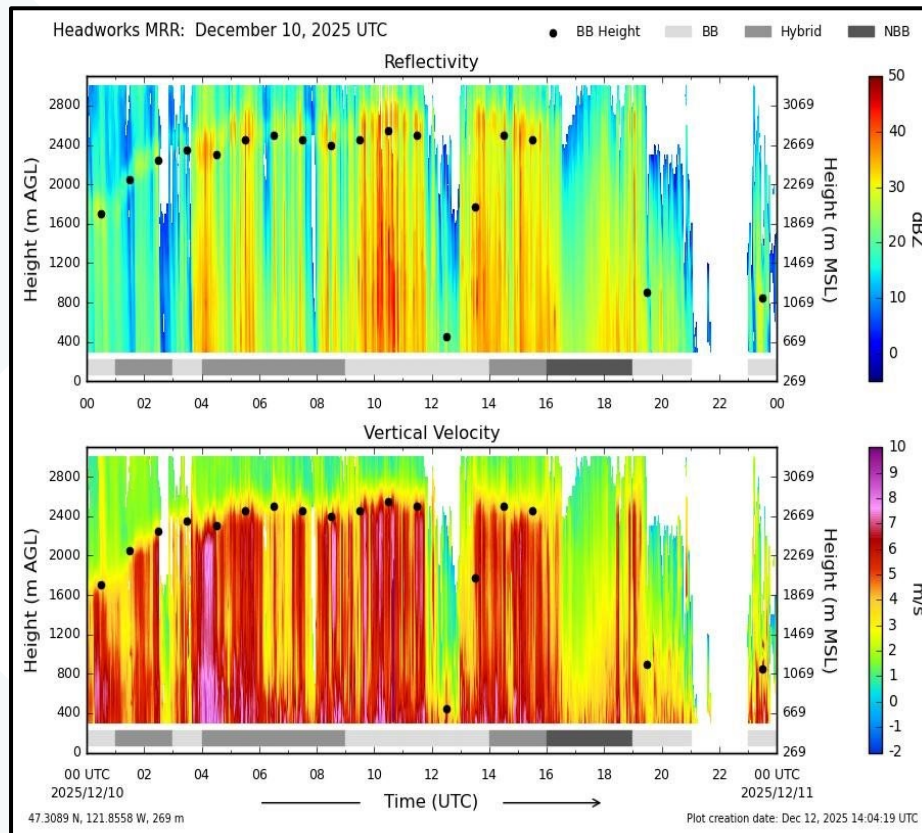
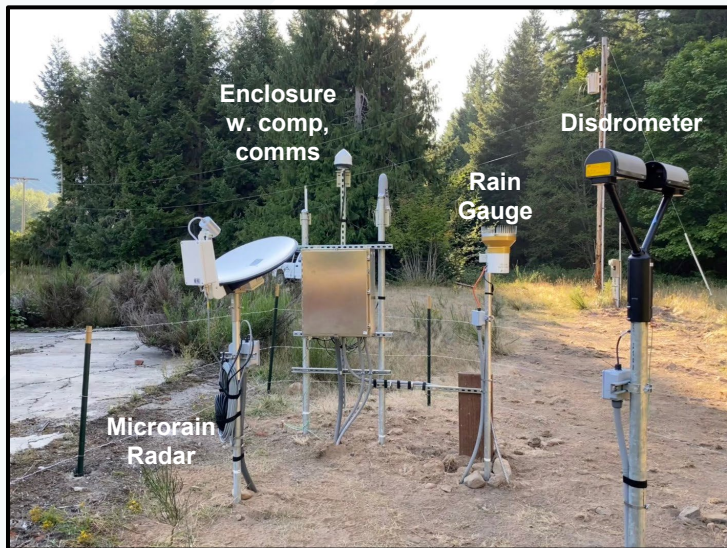
- Antecedent conditions of the watershed prior to the AR events
- Real-time situational awareness for operations
- Risk-informed decision-making and long term assessment
- Documents long-term changes in watershed



Beyond Soundings: Precipitation Characterization

Forecast Sensitive Processes

- Freezing Level: small vertical errors can shift basin response
- Precipitation Phase: rain vs. snow control runoff generation



Takeaways and Future Directions

- CW3E's land-based observing network has expanded into a multi-state operational network supporting atmospheric river science and water/reservoir management
- Coordinated AR Recon and land-based observations provide an end-to-end observing system from the Pacific Ocean to watershed response
- Integrated observations improve forecast evaluation, model development, and operational confidence for high-impact atmospheric river events
- Efforts will continue to focus on expanding observations in forecast-sensitive regions in support for FIRO and AR Program efforts