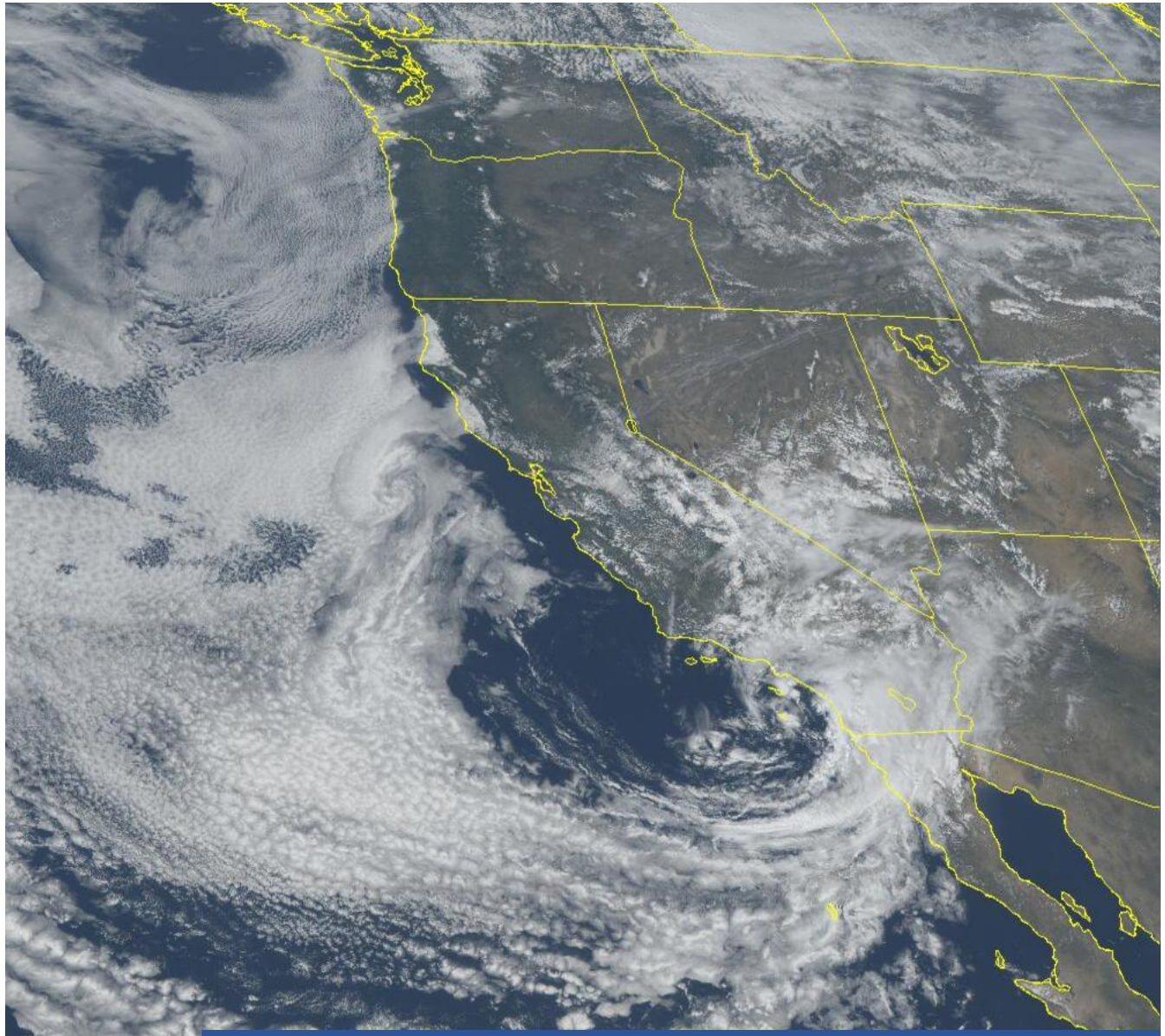


Cutoff low that produced extreme precipitation resulting in landslides in Encinitas, CA on April 10 2020

Extreme Precipitation and Landslide/Debris Flow Research Efforts

Nina Oakley, Ph.D.

Center for Western Weather and Water Extremes

Scripps Institution of Oceanography, University of California, San Diego

CW3E

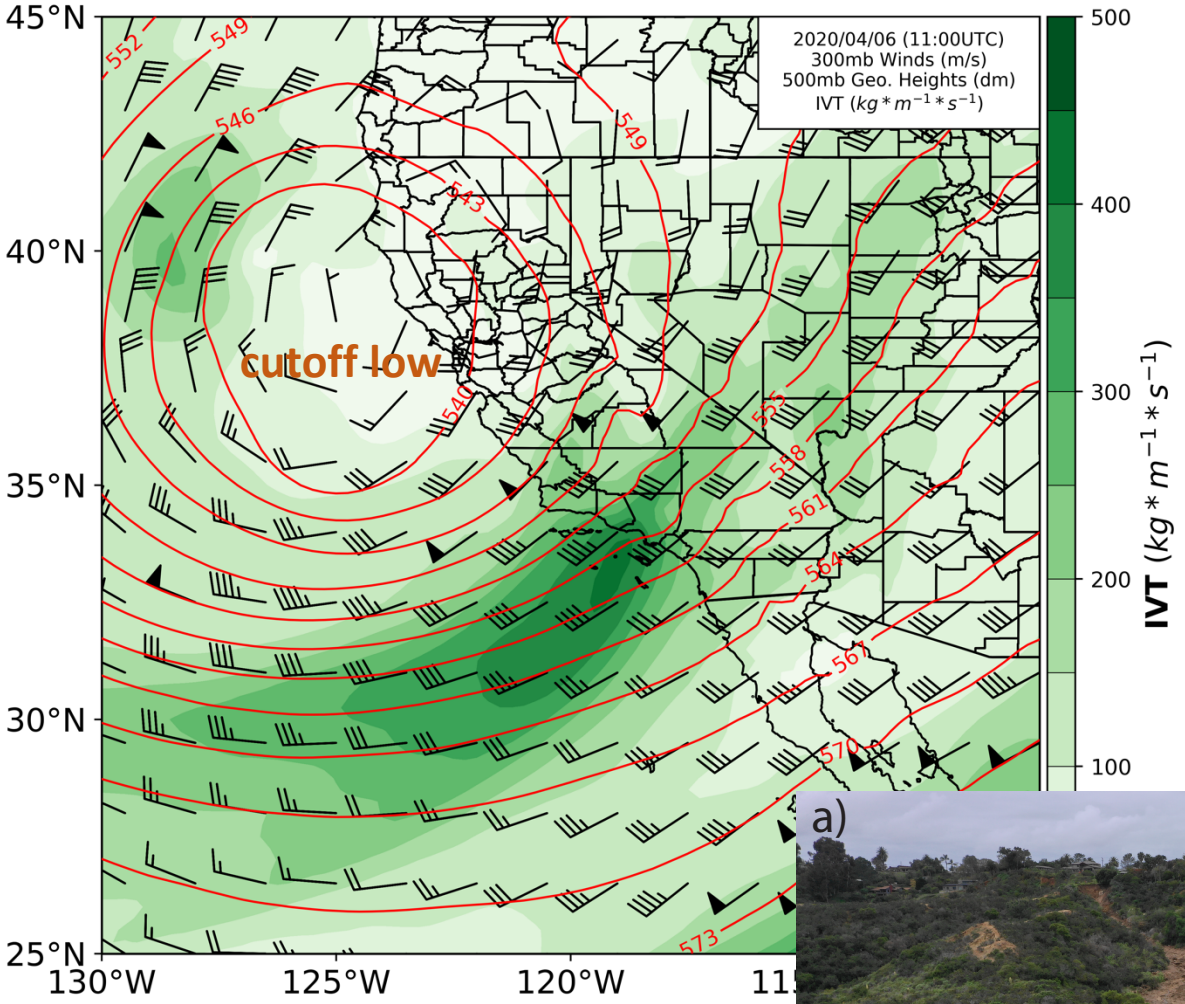
Post-Fire Debris Flow versus Shallow Landslide

Post-fire debris flow: Antecedent rainfall not a factor. Driven by short duration, high intensity rainfall (e.g., 15 min duration)
Need mesoscale information; AR characteristics like IVT, IWV magnitudes have limited benefit.

Shallow landslide (can mobilize into a debris flow):
Antecedent rainfall matters. Potential for achieving conditions within-storm. In some cases, burst of high intensity precipitation appears to be critical factor.

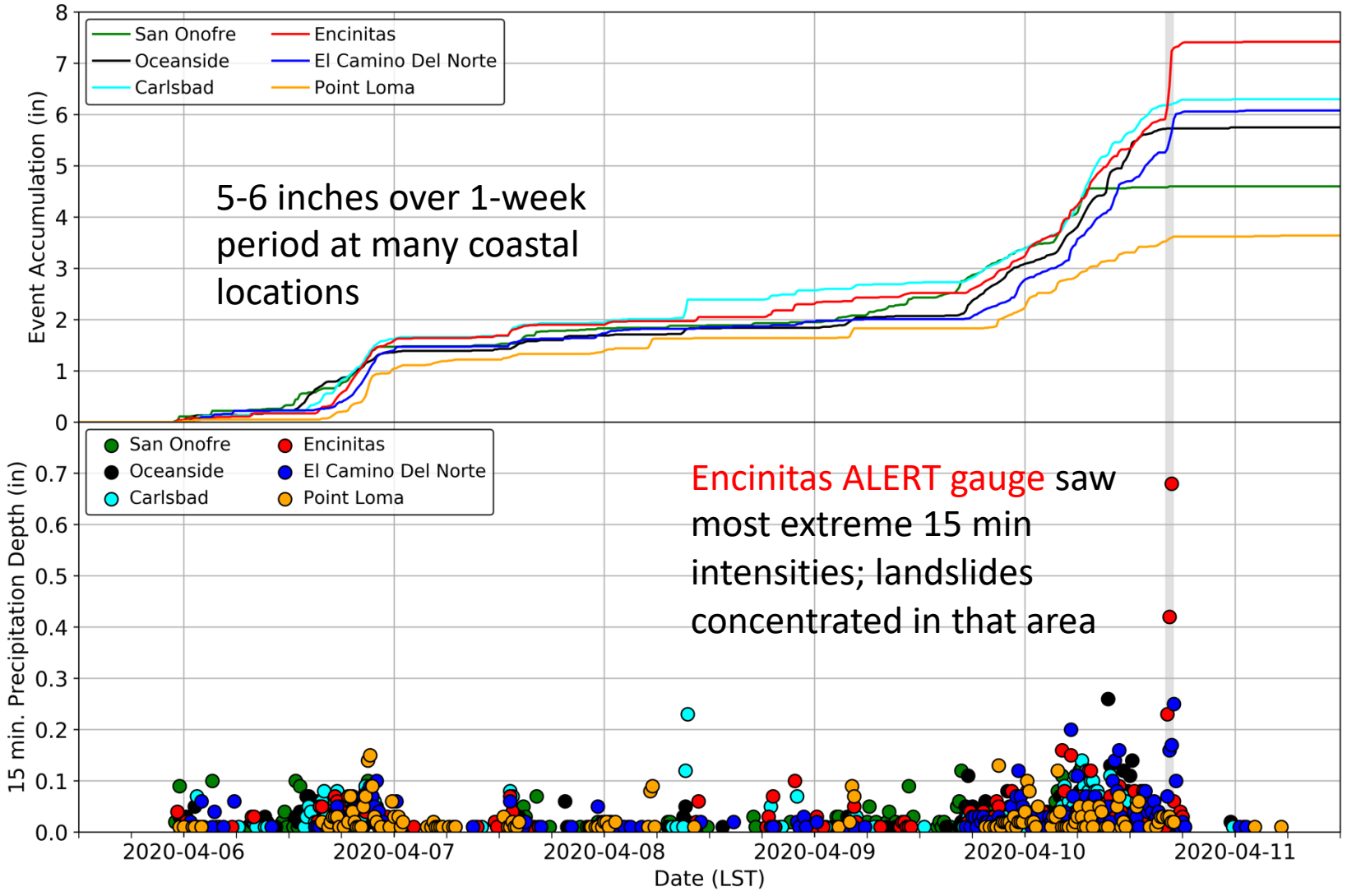

Many shallow landslides in Tuolumne R. Cyn.
Photo: B. Collins, USGS

Landslides in Encinitas, CA April 10 2020

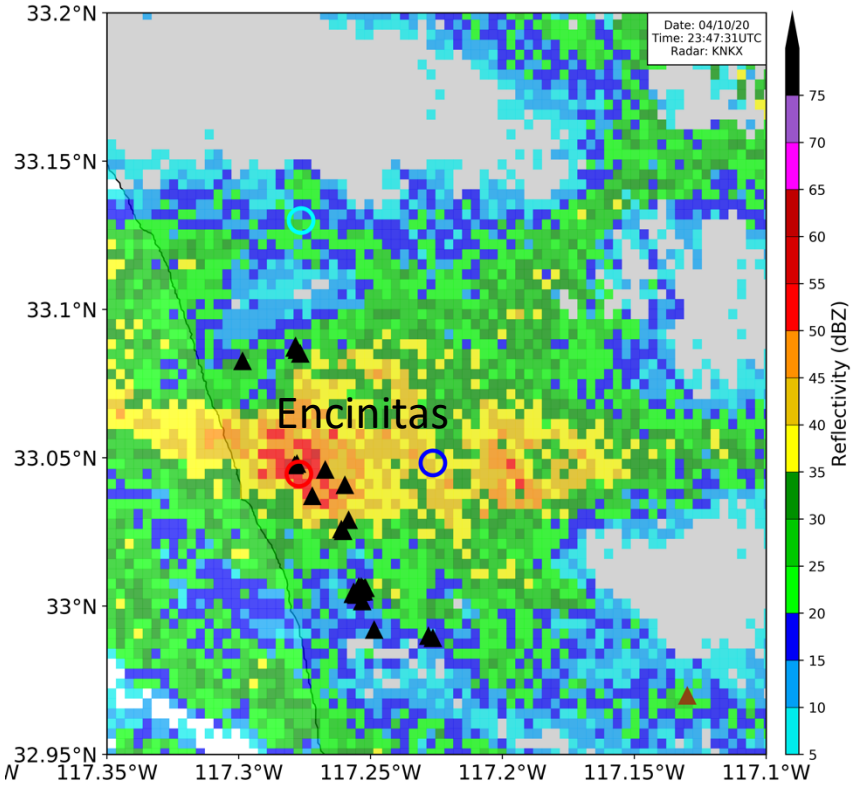


- Cutoff low with weak atmospheric river impacted southern CA
- Closed circulation re-circulated moisture into area, persistent precipitation
- See the **CW3E News Item** dated June 3 for full discussion of storm's impacts across CA

Landslides in Encinitas, CA April 10 2020

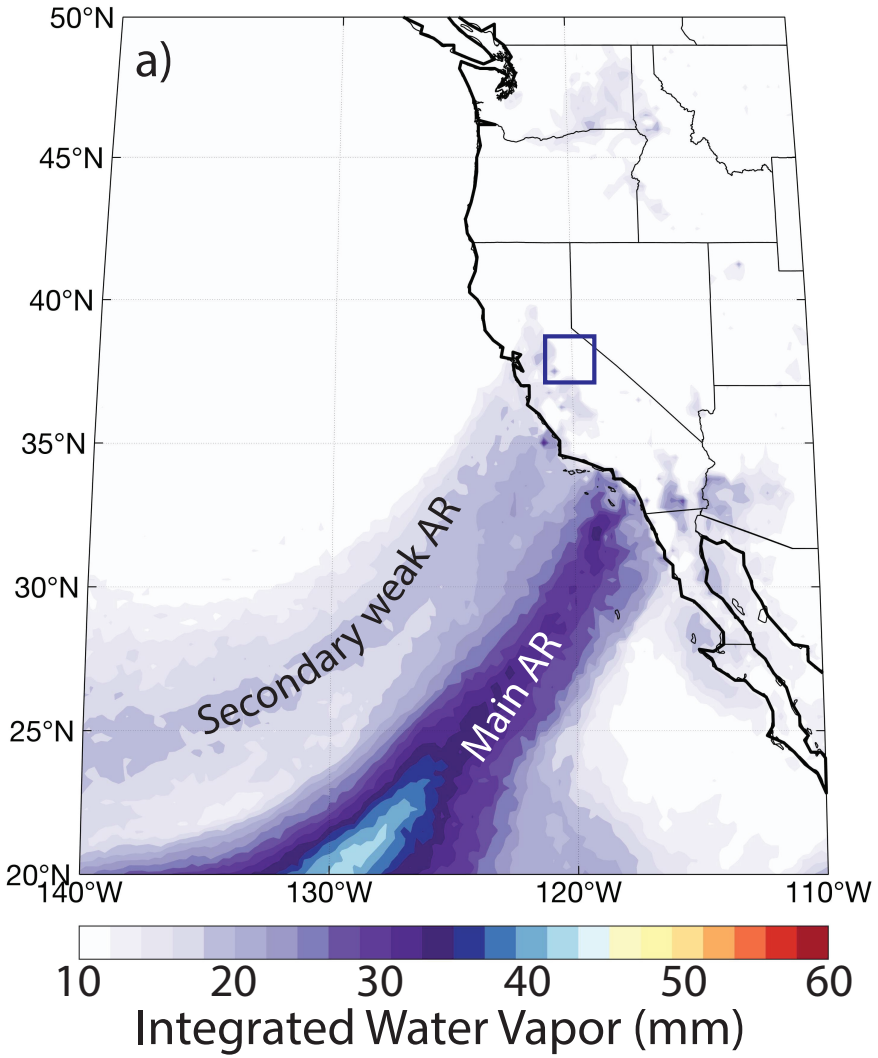


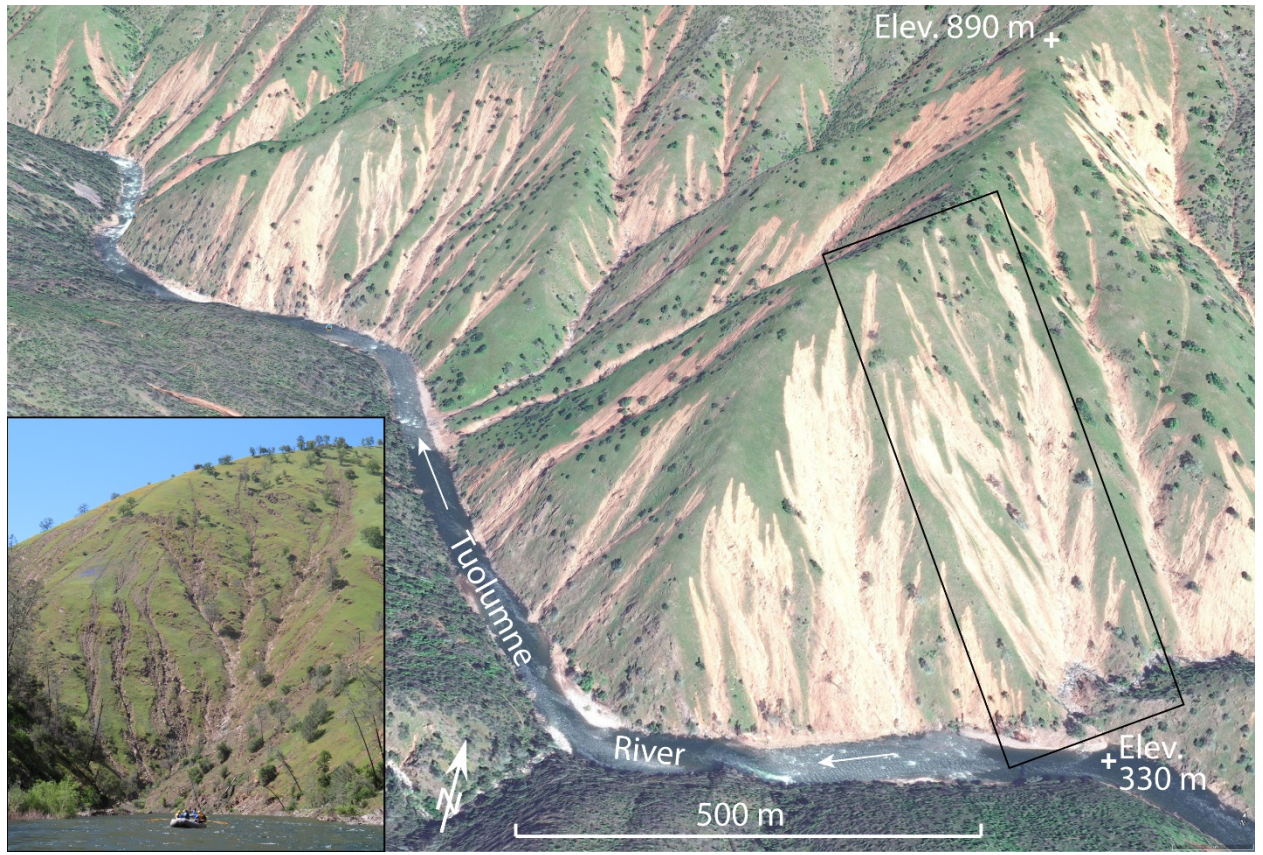
Thunderstorm on afternoon of Apr 10 produced high intensity rainfall coincident with landslide observations



▲ landslide

Widespread Landsliding in Tuolumne River Canyon, March 22 2018

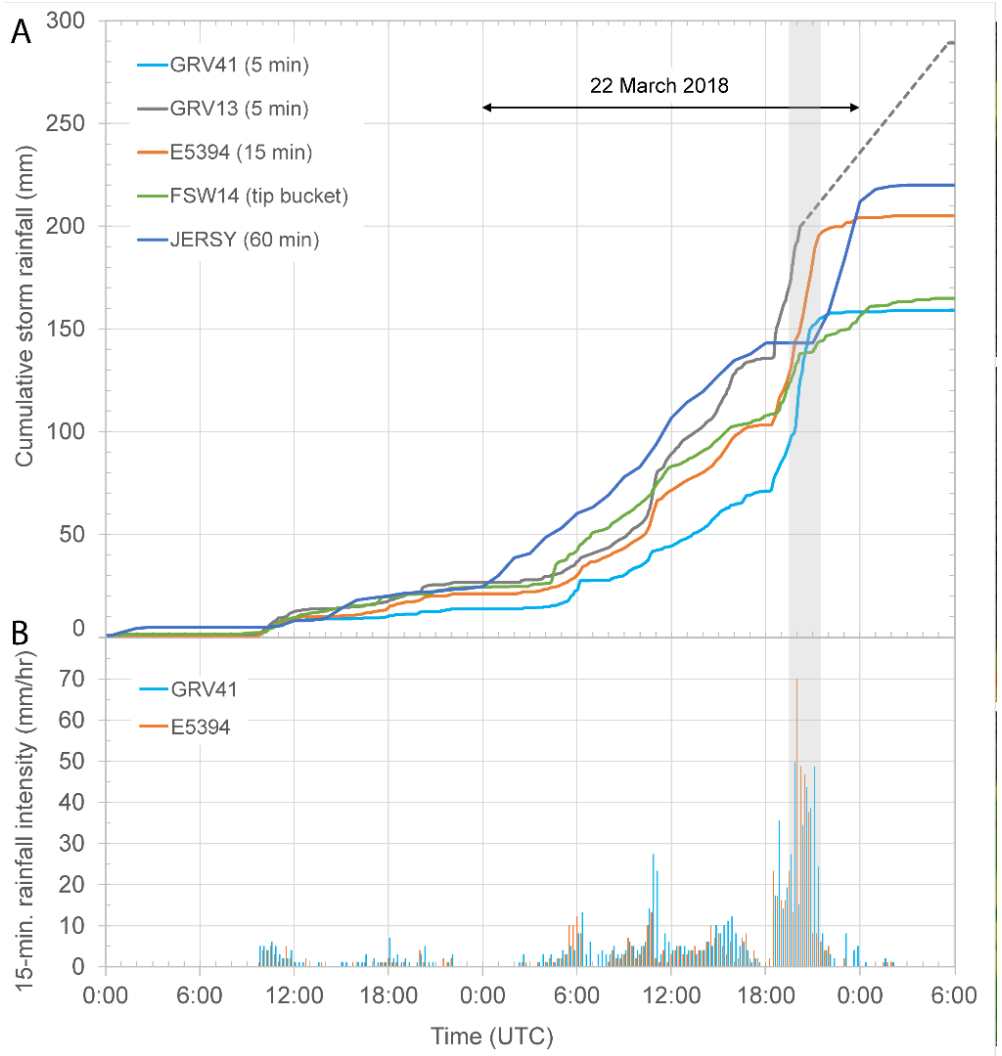


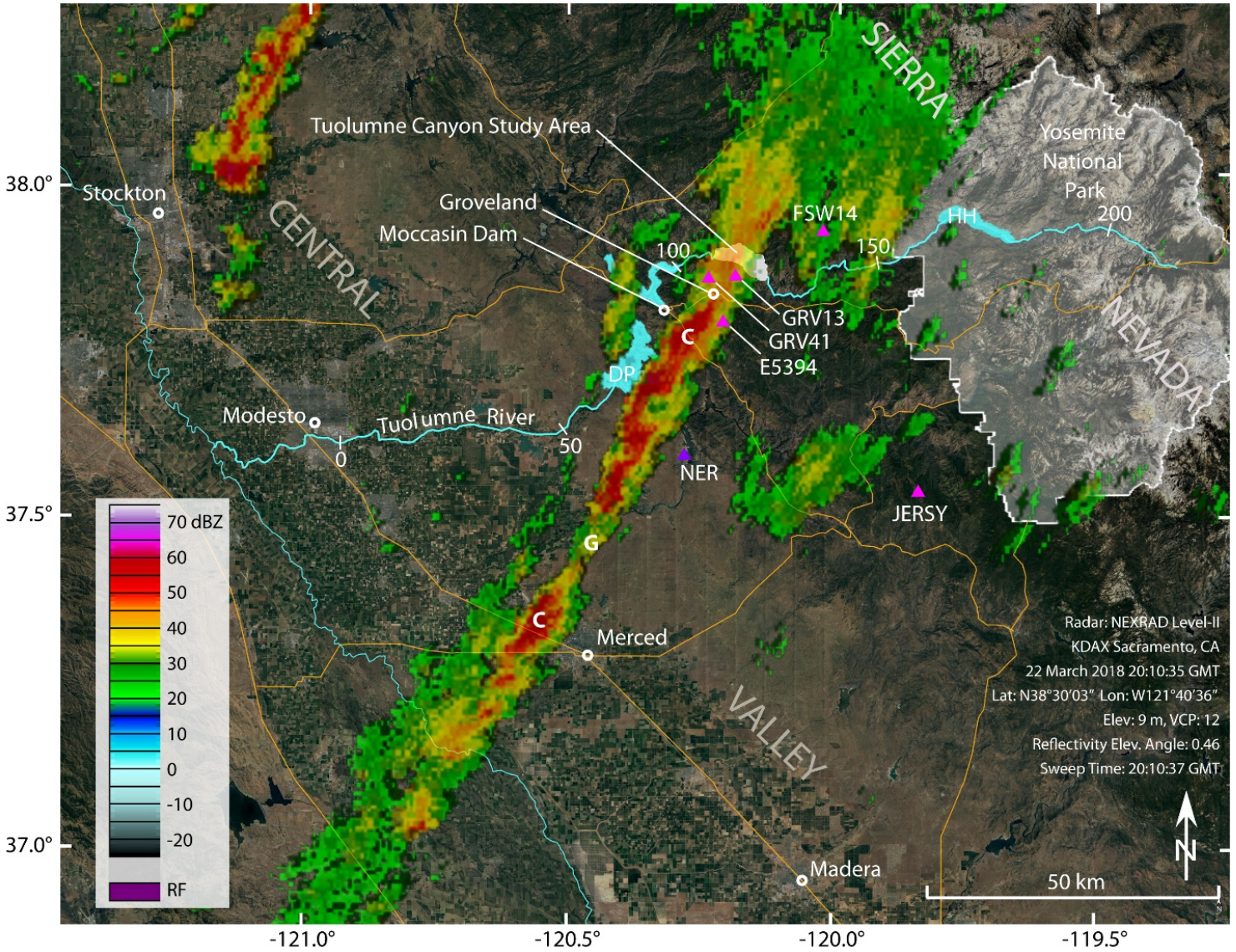


Impacts: As much as 16x local annual sediment yield into Tuolumne River in this landslide event. Seepage at Moccasin Dam and evacuation. Estimated damage to infrastructure in the area $74M. Remote area so threats to life/property minimal.

Collins et al. in revision, *JGR Earth Surface*

Widespread Landsliding in Tuolumne River Canyon, March 22 2018





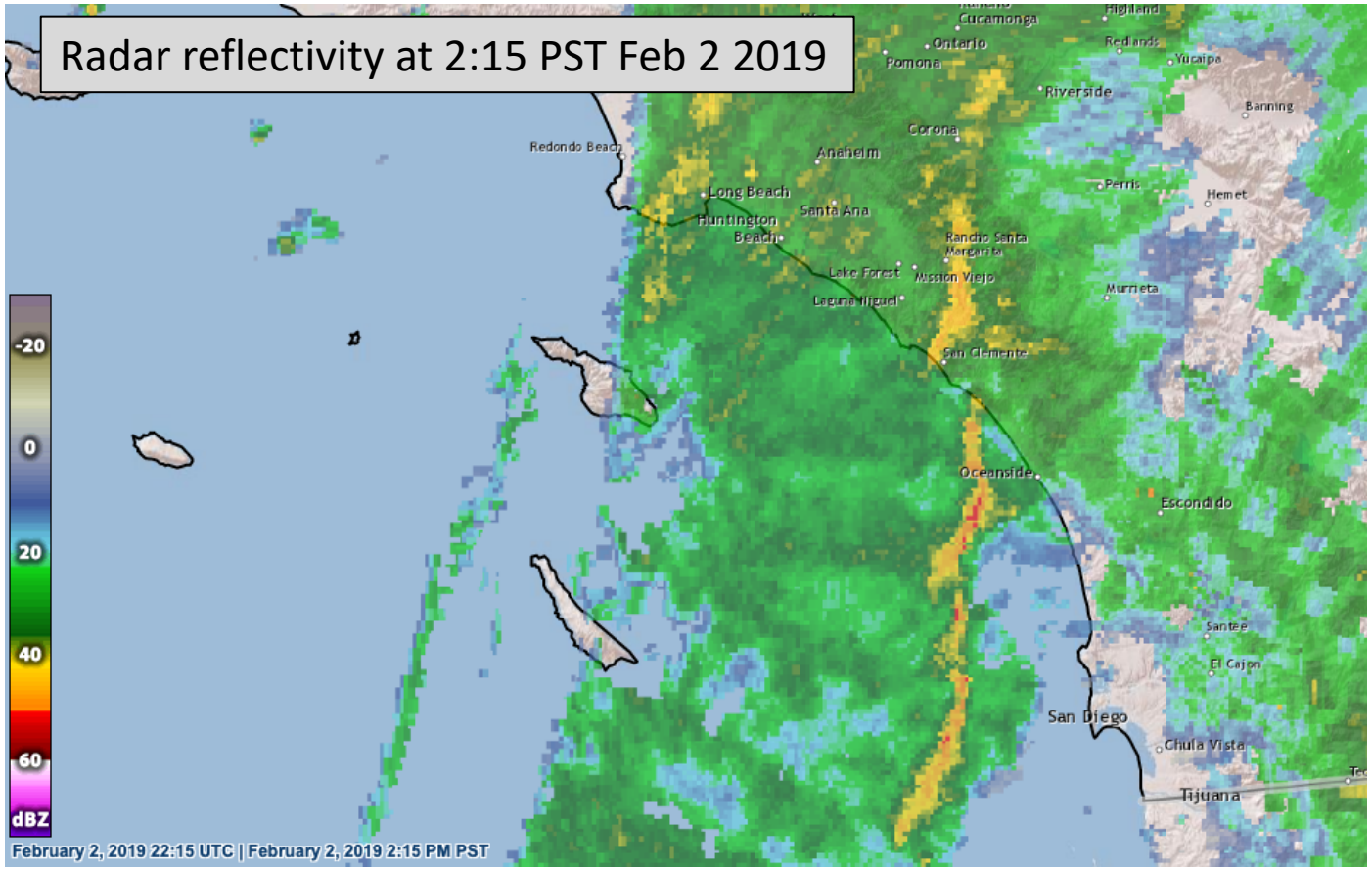
High intensity rainfall along cold front of secondary plume acted as trigger for landslides

Collins et al. in revision, *JGR Earth Surface*

Understanding and forecasting drivers of high intensity rainfall

Feb 2 2019: An atmospheric river with a narrow cold frontal rainband impacted southern CA Bight causing flash flooding, debris flows on Woolsey burn area (LA County)

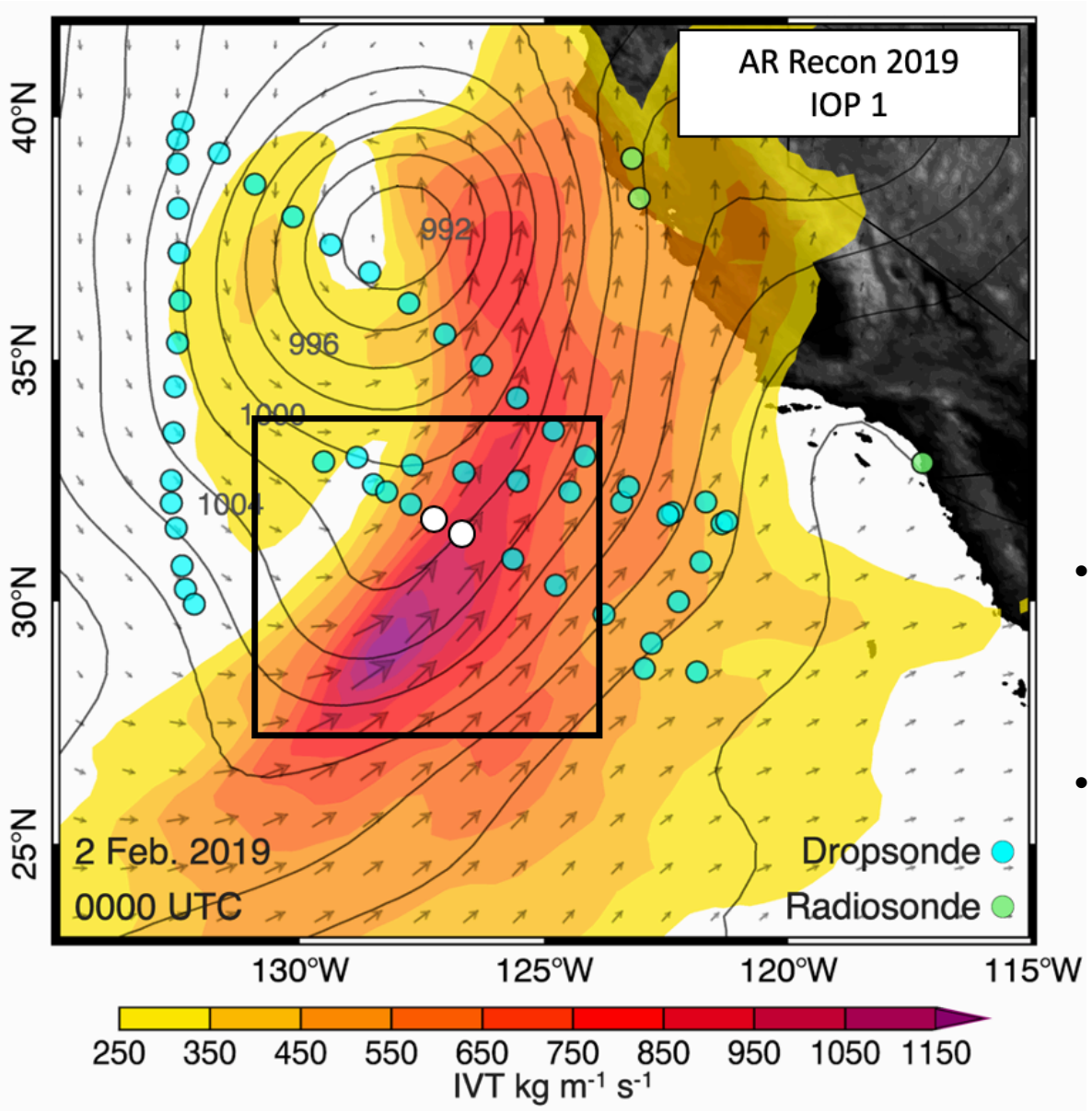
Cannon et al., *Monthly Weather Review*, accepted



Were there large-scale signals indicating this band was likely to develop?

How well did mesoscale models do at identifying various characteristics of this band?

Understanding and forecasting drivers of high intensity rainfall



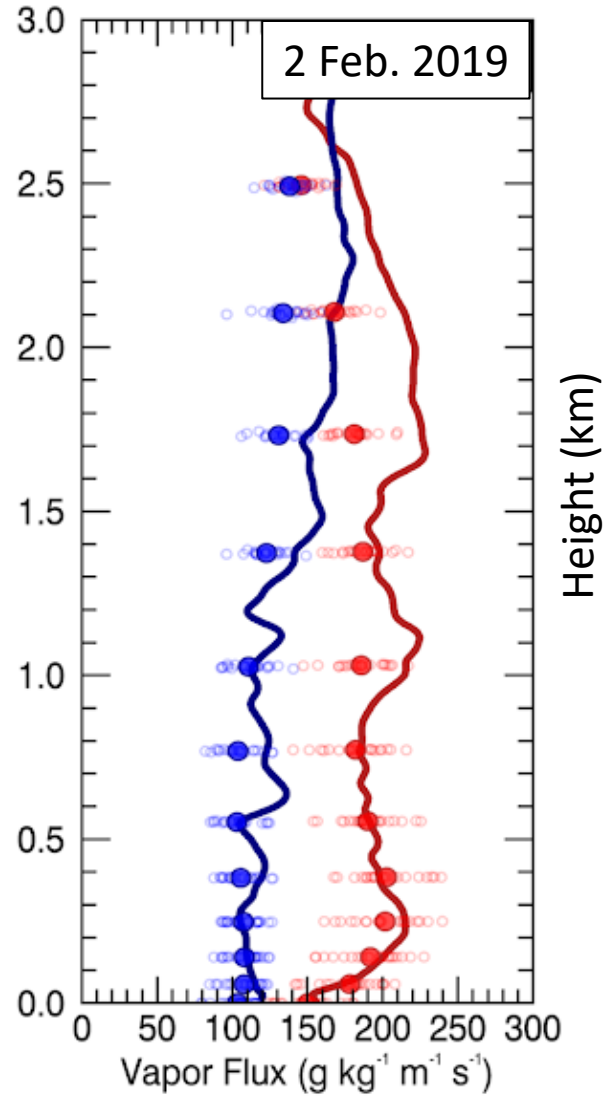
Cannon et al., *Monthly Weather Review*, accepted

Cold sector

Warm sector

WRF ensemble Member

WRF ensemble mean

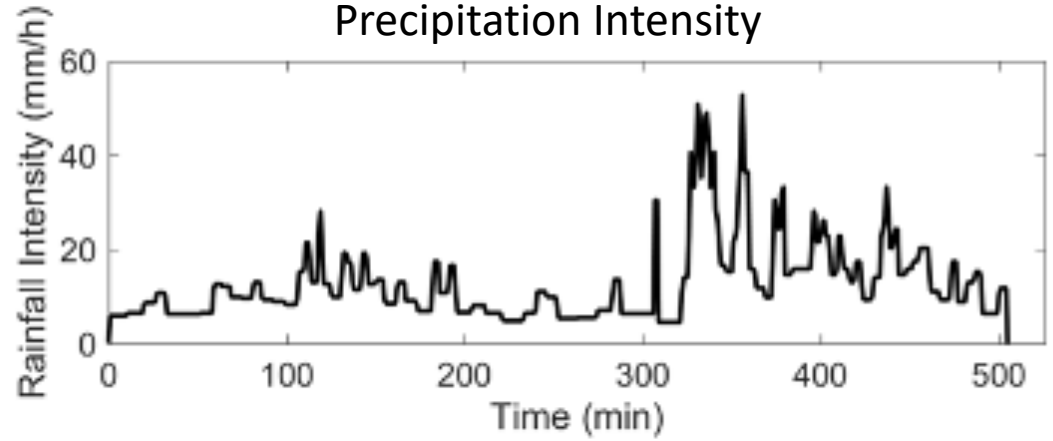


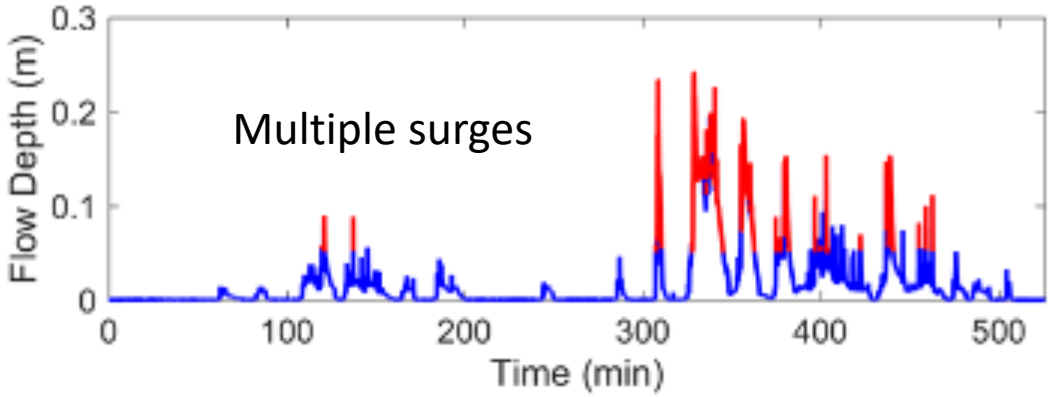
- All 21 WRF ensemble members reasonably simulate NCFR characteristics several days ahead of landfall
- Presence of NCFR associated with rapid drop in sea level pressure and enhancement of temperature gradient along cold front

Precipitation Characteristics and Debris Flow/Flash Flood Response

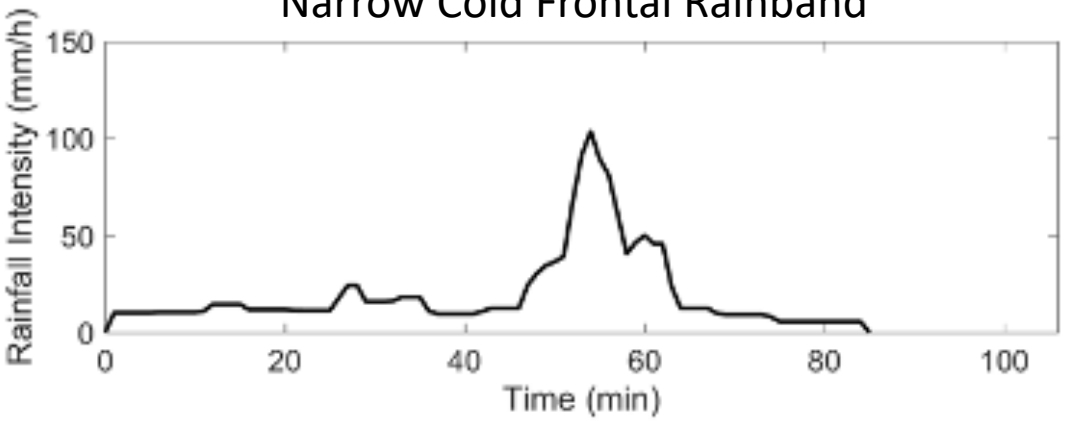
- Hypothesis: Different precipitation timeseries produce distinct debris flow/flash flood responses
- Provides insight to impacts and discerning between nuisance and impactful debris flows

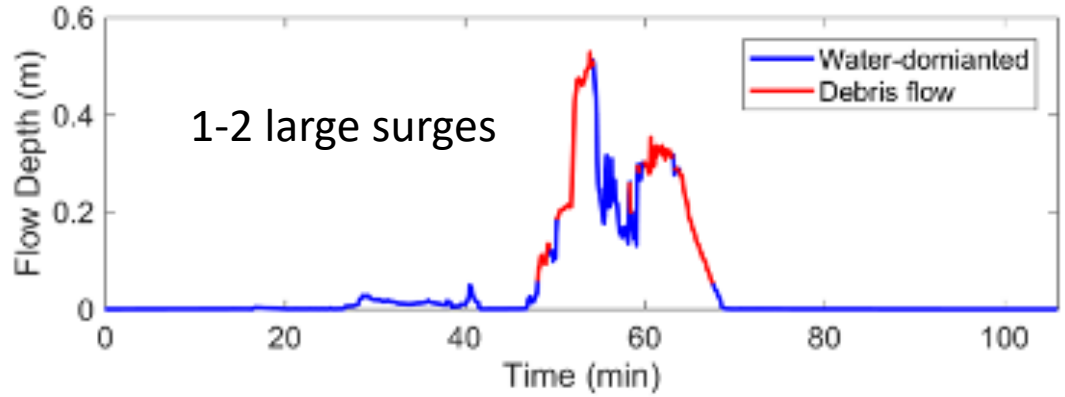
Broad Area of Moderate-to-High Precipitation Intensity





Narrow Cold Frontal Rainband





Images courtesy Luke McGuire, Univ. of Arizona

Next steps:

- Use emerging hourly to sub-hourly products to understand climate change impacts on debris flow/landslide hazards
- Explore use of AQPI for monitoring Bay Area landslide/debris flow hazards

Thank you!

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On the way to Catalina to launch weather balloons, Feb 2020