Center for Western Weather and Water Extremes
SCRIPPS INSTITUTION OF OCEANOGRAPHY AT UC SAN DIEGO

ATMOSPHERIC RIVER FORECASTING DECISION SUPPORT TOOLS

CHALLENGE

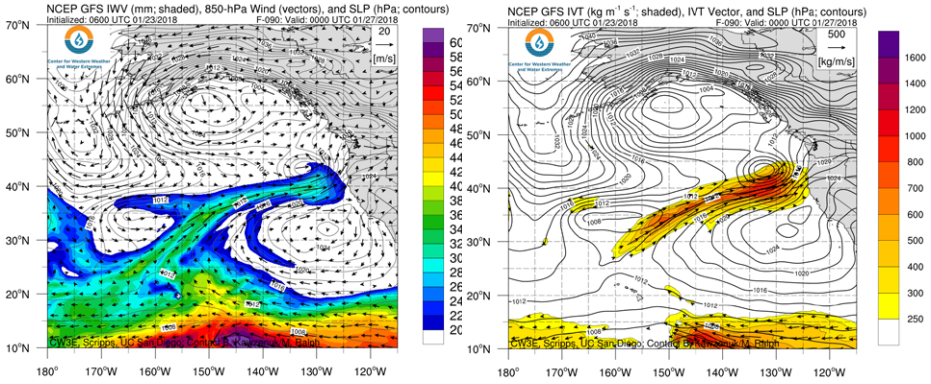
Atmospheric river (AR) forecasts are key to accurately predicting precipitation and flooding in California. However, standard meteorological monitoring and prediction methods and tools have not been tailored to ARs.

ACCOMPLISHMENTS

CW3E developed and maintains a website (http://cw3e.ucsd.edu) containing unique observations, analyses, and a comprehensive collection of tools specific to AR forecasting to help fill this gap. Many of the tools incorporate a new way of measuring and categorizing the strength and potential impacts of landfalling ARs.[1] The products developed by CW3E and partners have created new awareness of predicted AR strength, position and duration in support of water resources management, hazard mitigation, and forecasting applications for a range of users and decision makers.

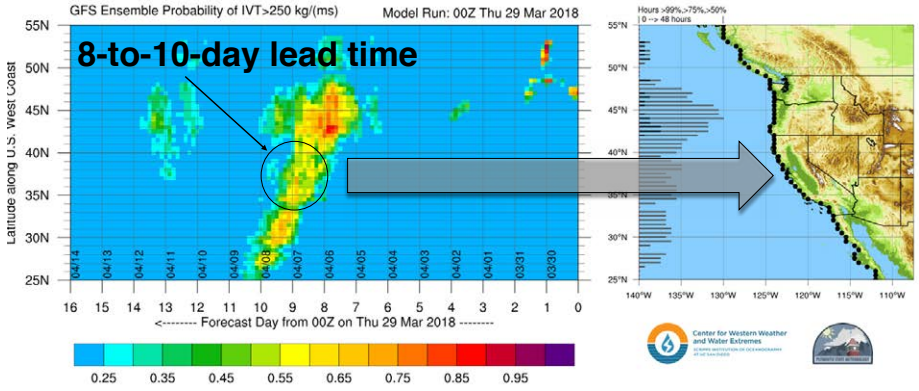
KEY ANALYSIS & FORECAST TOOLS

- **Forecast Maps** are derived from NOAA numerical weather prediction model data to predict large-scale and small-scale aspects of landfalling ARs up to 10 days in advance. These maps are a foundational component to CW3E experimental forecast outlooks.



Example of CW3E forecast maps of integrated atmospheric water vapor (IWV) (left) and integrated vapor transport (IVT) (right) on 27 January 2018 prior to the landfalling of a particularly intense AR.

- The **AR Landfall Tool** developed by Dr. Jay Cordeira (Plymouth State University) and Dr. Marty Ralph (CW3E) provides longer-range ensemble forecast guidance of the intensity, duration and timing of landfalling ARs up to 16 days in advance. Recent upgrades include adding AR orientation, which is a necessary parameter for diagnosing watersheds that will receive the most precipitation.

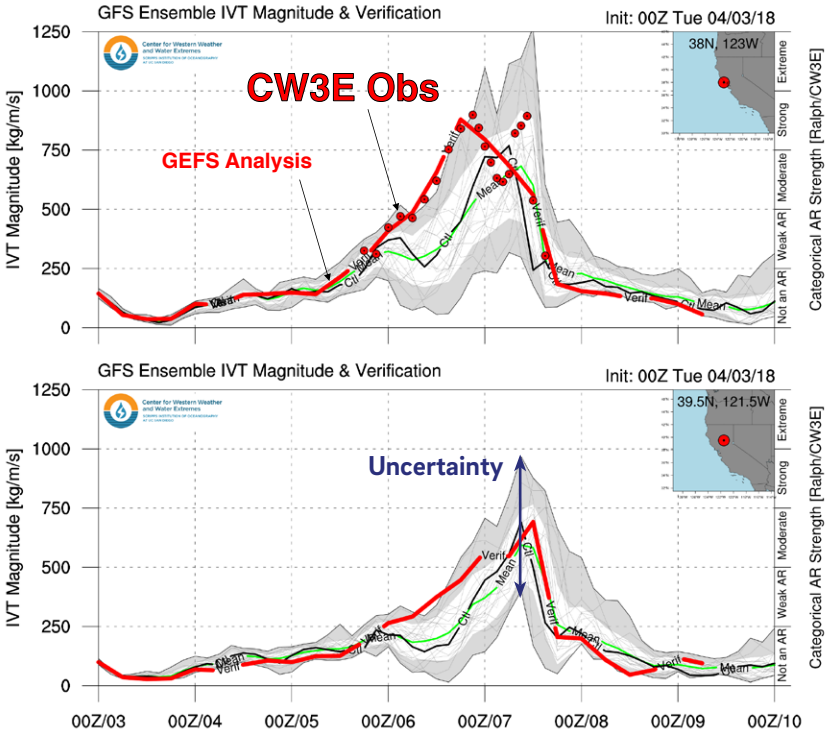


The AR Landfall Tool depicts the likelihood of an AR (shaded in colors) by latitude (y-axis) and forecast time (right to left on the x-axis) from March 29, 2018, providing forecast guidance 8-to-10 days in advance of the AR on April 7.

- **Forecast Plumes** are generated in real time on the CW3E website and are used in outlooks and storm summaries. These "plume diagrams" convey uncertainty information in the timing and intensity of landfalling ARs according to the AR Intensity scale.[2] Two types of verification of AR intensity complement the plume diagrams: (1) the model derived GEFS analysis and (2) observations collected by CW3E. These verifications show how well the AR was forecast 4 days in advance, how the AR was stronger earlier than expected, and how observations provide more accurate representation of AR intensity than the model.
- **Watershed Forecast Tools** provide forecast guidance on watershed-scale impacts of AR precipitation. One such forecast tool uses ensemble forecasts of freezing levels and NOAA/NCEP/WPC precipitation, along with a 1-km elevation model, to downscale rain-snow levels to watershed-scale, providing a forecast of how AR precipitation would be partitioned between rain and snow. The tool provides this information both as an interactive topographic map, and as detailed watershed-scale time series. The tool covers watersheds in CA, OR, WA, NV, ID and northwest MT, where rain-snow partitioning in AR storms is key to water resources operations. It provides a sense of forecast uncertainty in rain-snow levels that is important for assessing AR-driven flood and water supply risks, and is intended for water resource managers across the western United States.

NEXT STEPS

These tools are being continually improved and refined, and new tools will be developed as science advances and in response to growing demands for better forecast tools that are tailored to unique conditions of the western United States.

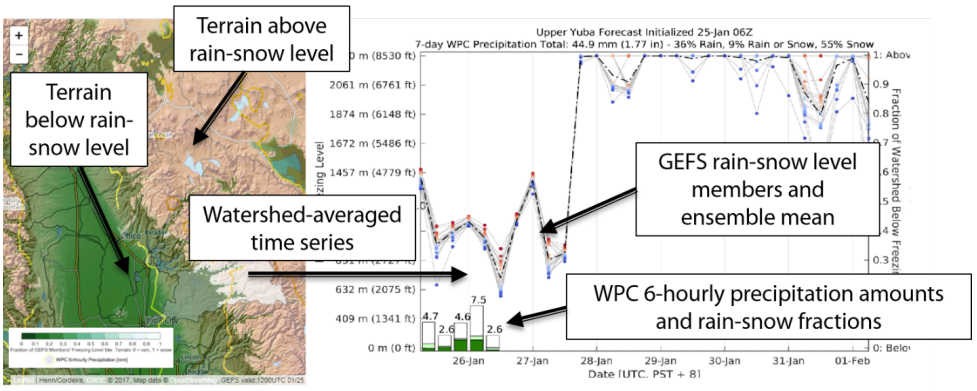


Ensemble-derived forecasts of IVT magnitude with verification (red). Each gray line is a different forecast model, green is the mean, and black is the "control" forecast. This example is for a forecast initialized on April 3, 2018 for Bodega Bay, CA and Oroville/Thermalito.

References

[1] Cordeira et al. 2017 Bull. Amer Meteorol. Soc.

[2] Ralph et al., Bull. Amer. Meteorol. Soc., *in revision.*



Rain-snow forecast tool for a forecast made on Jan 25, 2018. Left panel shows map of areas above rain-snow level (light shading), below rain-snow level (dark shading), and precipitation rates (contours). Right panel shows watershed forecast information, including time series of GFS ensemble rain-snow levels, watershed-mean precipitation rates, and fractions of precipitation falling as rain and snow.