



A Scale to Characterize the Strength and Impacts of Atmospheric Rivers

CHALLENGE

Scales for meteorological phenomena, such as hurricanes and tornadoes, have proven very useful in raising public awareness of potentially hazardous conditions, forecasting, and conducting research. Atmospheric rivers (ARs) are the most impactful type of storm that occurs in California and along the U.S. West Coast and are a major source of extreme precipitation. Despite the widely recognized importance of ARs, until creation of this scale, no concise method had existed for conveying the possible spectrum of benefits and hazards that communities face during a particular AR event.

ACCOMPLISHMENT

The Center for Western Weather and Water Extremes (CW3E) and a number of collaborators developed a scale for characterizing the strength and impacts of ARs (Figure 1). The work on this scale has occurred over several years, led by F.M. Ralph, Director of CW3E at UC San Diego's Scripps Institution of Oceanography, with input from many experts, especially from the National Weather Service (J. Rutz, C. Smallcomb), Plymouth State University (J. Cordeira), U.S. Geological Survey (M. Dettinger), California's Department of Water Resources (M. Anderson), University of Colorado (D. Reynolds) and the U.S. Army Corps of Engineers (L. Schick, retired). It was recently formalized through acceptance of the peer-reviewed paper by Ralph et al. (2018) in the leading meteorological journal *Bulletin of the American Meteorological Society*.¹

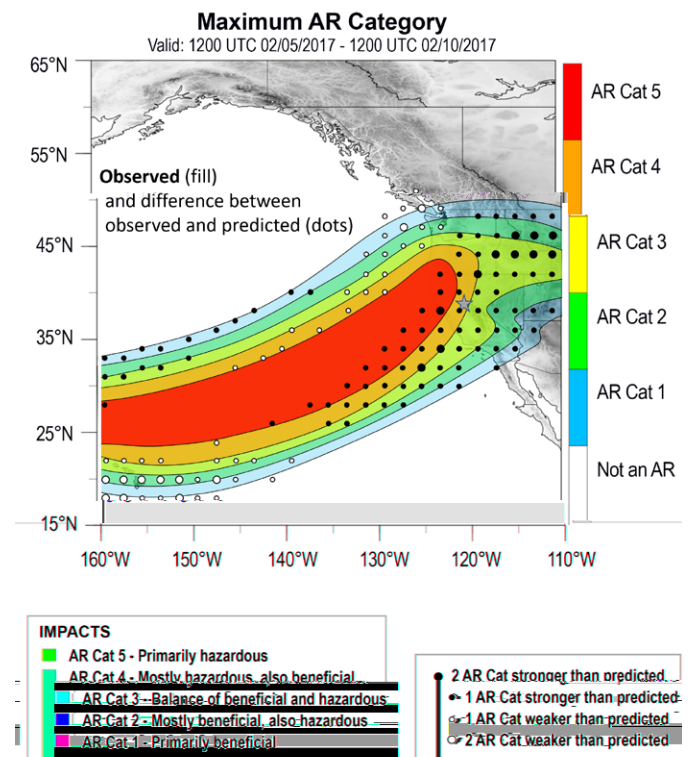


Figure 1. Top, AR CAT conditions associated with the storm that caused problems at northern California's Oroville Dam in February 2017, including evacuation of 200,000 people. Bottom, AR CAT scale and typical associated impacts.

APPLICATIONS OF AN AR SCALE

The AR category (AR CAT) of an AR event is based on its maximum INTENSITY and DURATION (Figure 2). Intensity measures the integrated water vapor transport (IVT), or the amount of water vapor that an AR transports. Given an increased focus on AR-related science and impacts, it is likely that this AR CAT scale will be widely used to communicate the benefits and hazards associated with ARs in the western United States, where they contribute

strongly to hydrological impacts. This is especially true of the hazards associated with extreme and exceptional ARs. The AR CAT scale is intended to serve the western United States, as other meteorological scales have served other parts of the nation.

DETERMINING THE AR CAT FOR AN AR EVENT²

Step 1: Pick a location (Figure 2, top).

Step 2: Determine a period of time when $IVT \geq 250$ $\text{kg m}^{-1} \text{s}^{-1}$ (using 3 hourly data) at that location, either in the past or as a forecast. The period when IVT continuously exceeds $250 \text{ kg m}^{-1} \text{s}^{-1}$ determines the AR's start and end times, and thus also the AR duration for the AR event at that location.

Step 3: Determine AR intensity by finding maximum IVT during the AR at that location. This sets the AR intensity and preliminary AR CAT (Figure 2, bottom).

Step 4: Determine the final value of the AR CAT to assign (Figure 3).

- If the AR duration is ≥ 48 hours, then promote the value by one category.
- If the AR duration is < 24 hours, then demote the value by one category

Note: You can find AR intensity and duration forecast information on the CW3E webpage (cw3e.ucsd.edu) under "Forecasts" by selecting "AR, IWV, and IVT Forecasts."

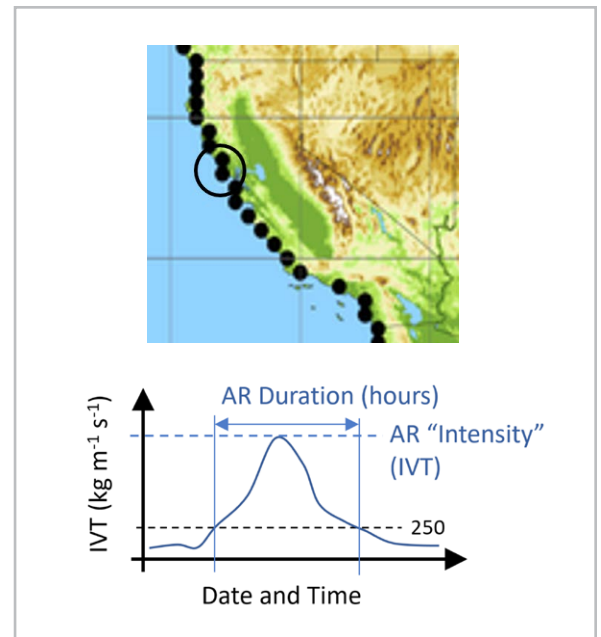


Figure 2. (top) To determine the AR location, pick a location and (bottom) then determine the maximum intensity and duration.

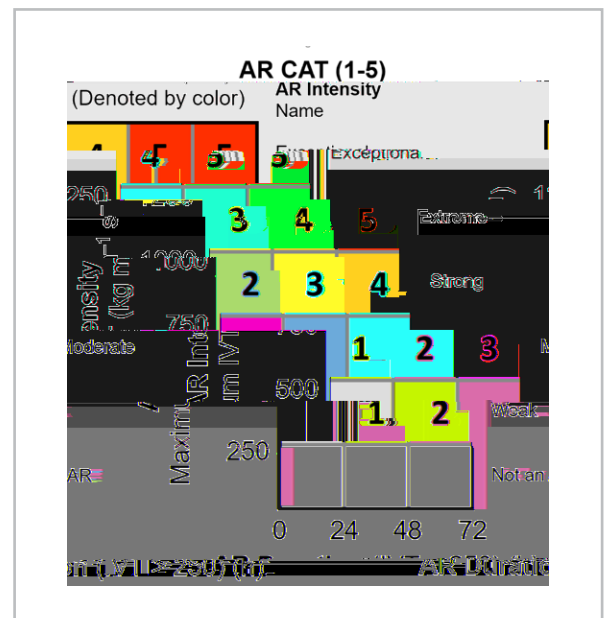


Figure 3. The AR CAT scale categorizes AR events based on the maximum instantaneous IVT associated with a period of AR conditions (i.e., $(IVT \geq 250)(h) \text{ kg m}^{-1} \text{ s}^{-1}$) and the duration of those conditions at a point.

References

- ¹ Ralph, F. Martin, Jonathan J. Rutz, Jason M. Cordeira, Michael Dettinger, Michael Anderson, David Reynolds, Lawrence J. Schick and Chris Smallcomb, 2018: A Scale to Characterize the Strength and Impacts of Atmospheric Rivers. Bull. Amer. Meteorol. Soc., (in press, Sept. 2018).
- ² An "AR event" refers to the existence of AR conditions at a specific location for a specific period of time.