Classification of atmospheric river events on the U.S. West Coast using a trajectory model

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We investigate transport pathways of water vapor associated with landfalling atmospheric river (AR) events that result in precipitation along the West Coast of the U.S. for winters of 1997–2010. The majority of AR events (86%) over the West Coast of the U.S. are grouped into three trajectory types, and two of them are closely associated with the AR events. We designate the first type as Ascending near landfall and of Tropical Origin (AT), the second type as Ascending near landfall and of Extratropical Origin (AE), and the third type as Descending or parallel near landfall and of Extratropical Origin (DE), which is accompanied but not directly associated with the AR events. The main findings obtained by computing back trajectories with a trajectory model using the Modern Era Retrospective analysis for Research and Applications reanalysis data set and clustering analysis are summarized below:

- The majority of AR events (86%) in the western U.S. are related to one of the three trajectory types.
- The magnitude and the spatial distribution of precipitation of a given AR event are found to be strongly determined by the type of trajectories. For example,
  - i) AR events composed of both AT and AE trajectories (AT+AE) have more frequent precipitation over a broad region of the western U.S.
  - ii) AR events composed of both AT and DE trajectories (AT+DE) have intense precipitation over the southwestern U.S. due to AT trajectories.
  - Iii) AR events of AT-only trajectories (AT-only) have intense precipitation, especially over the northwestern U.S., but are less frequent compared to those of AT + AE trajectories.
- Trajectory types are closely linked to diabatic heating and upper-level PV anomalies.
- About 70% of AR events are associated with anticyclonic Rossby wave breaking events.

This study highlights the value of characterizing various types of AR events into a small set of sensible groups, and obtaining common characteristics and differences of their regional impacts in terms of their water vapor origins and pathways. Potentially, this study will provide support for rain and flood prediction over west coast of the U.S.