The Cloud-Radiative Forcing of the Atmospheric Rivers on the US continents: an observational climatology study

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The "Atmospheric Rivers (ARs)" are narrow channels in the atmosphere that transport an enormous amount of moisture from the tropics to the higher latitudes. Streaks of highly reflective clouds are observed along with the ARs in satellite imagery. These clouds can modify the energy budget on the Earth's surface through pathways such as "cloud-radiative forcing (CRF)", which has recently been preliminary documented in weather-case studies (Luo and Tung 2015). Their climatological impacts are not understood, yet the related cloud microphysics and radiation processes are coarsely represented in contemporary climate models.

We attempted to identify key processes for temporally prolonged and expansive CRF over the continental US using satellite and ERA-interim reanalysis. Through constructing and contrasting the spatial-temporal characteristics for 60 ARs that reached the California coast (the southwest ARs) to 60 ARs that reached Pacific northwest (the northwest ARs) during Nov--Mar, 2000--2008 (Dettinger et al., 2011), it was found that the southwest ARs transported less moisture yet induced more ice clouds thus stronger CRF in the western US than the northwest ARs. Even more, the former was followed more frequently by strong moisture surge from the Gulf of Mexico (the gulf-coast ARs) within 3 days of landfalls (Fig. 1). These secondary ARs penetrated deeply into the central-eastern US, producing abundant mixed-phase clouds, and net CRF cooling in the eastern US. In short, the synergy between the west-coast ARs and the gulf-coast ARs is likely the key for extensive cloud coverage over the continental US.

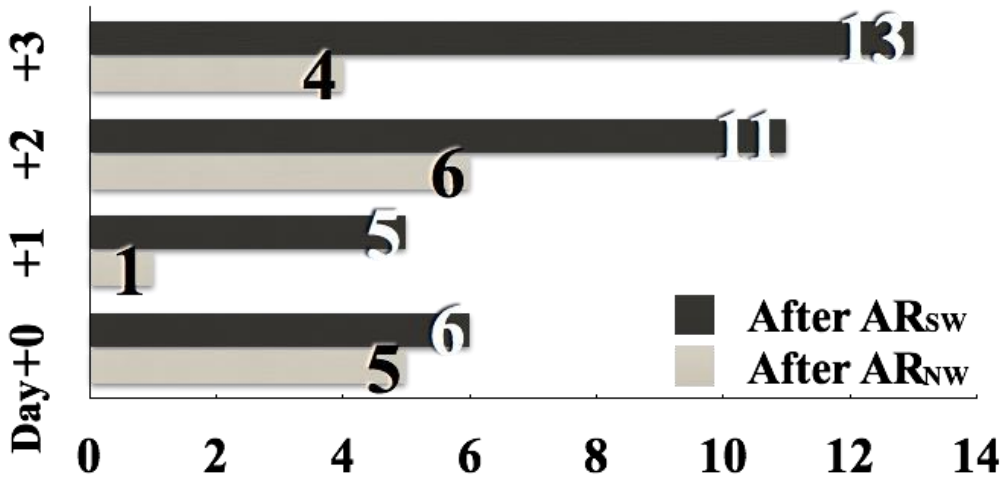

Figure 1. Distribution of gulf-coast AR 0–3 days after the west-coast ARs.

References:

Dettinger, M.D., et al., 2011: Atmospheric rivers, floods, and the water resources of California. Water, 3, doi:10.3390/w3020445.

Luo, Q., and W.-w. Tung, 2015: Case study of moisture and heat budgets within atmospheric rivers, Mon. Wea. Rev., doi: 10.1175/MWR-D-15-0006.1