Geophysical Research Abstracts
Vol. 21, EGU2019-3214, 2019
EGU General Assembly 2019

Influence of GPS RO and Radiance Data Assimilation on the Forecast Performance of an Atmospheric River Case Affecting California

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This study uses the 3-Dimensional Variational (3DVAR) Data Assimilation (DA) method of the Weather Research and Forecasting (WRF) Model to evaluate the influence of Global Positioning System (GPS) Radio Occultation (RO) and radiance DA on the forecast of an atmospheric river case. The GPS RO refractivity from Constellation Observing System for Meteorology, Ionosphere, and Climate (COSMIC) and microwave radiance from Advanced Microwave Sounding Unit (AMSU) and Microwave Humidity Sounder (MHS) are used in the DA experiments. To assess the impact of GPS RO and radiance data, an atmospheric river case with lower predictability in the Global Ensemble Forecast System (GEFS) is selected, which made landfall on northern California on 9th February 2007 and produced more than 170 mm of rainfall in 48 hours. The landfall location and associated rainfall of most atmospheric river cases during 2006-2008 were qualitatively predicted in the GEFS 10-day forecasts. However, the landfall of this case and the associated rainfall signal over California were not captured in the 6-10 day forecasts of GEFS. In this study, we perform the cycling assimilation of different observation data over a 3-day period to assess the contribution of each data to the improvement of the weekly forecast of this atmospheric river case.

To define the area of the atmospheric river, the vertically integrated water vapor transport (IVT) from 1000 hPa to 200 hPa is calculated and the area with values exceeding 250 kg/m/s is considered as the atmospheric river. Results show that the high IVT area moves closer to the coast of California in the 7-day forecast with the assimilation of GPS RO data than the control run, which did not assimilate the GPS RO data. Although the atmospheric river still does not make the landfall in the 7-day forecast, the assimilation of GPS RO provides some improvements in the forecast of the moisture feature (e.g. value and location of high water vapor area) at lower levels. On the other hand, the 7-day forecast with the assimilation of radiance data substantially improves the forecast of the landfall and rainfall pattern of this atmospheric river case. Because the pressure gradient around the atmospheric river at the low and middle levels is stronger for the forecast with the assimilation of radiance data than the control run, the wind speed and baroclinic structure of synoptic environment are stronger when the atmospheric river approaches the land, allowing the high IVT area to reach California and produce the expected rainfall.