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Importance of upper-level troughs in Mediterranean precipitating systems from satellite climatology to case studies

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Heavy precipitating events are rather common in the Mediterranean region, with both local effects and large scale dynamics contributing to their occurrence and severity. Because of the several scale interactions and the inherent non-linearity of the atmospheric dynamics, the predictability of such events is limited at best to a couple of days, and indicating the importance of a precise description of the environment in which they develop.

The importance of upper-level troughs is first shown by contrasting the large-scale environment associated with moderate and extreme precipitating systems in the Mediterranean, using 7 years (2001-2007) data from the Advanced Microwave Sounding Unit (AMSU), on board NOAA satellites (Funatsu et al. MWR 2009 in press). Channel 8 of AMSU-A is used to identify upper-level troughs, while combinations of channels 3 to 5 of AMSU-B are used to detect precipitation following Funatsu et al. (JGR 2007). A climatology of precipitation shows that rain occurrence is widespread over the Mediterranean except in the eastern part of the basin in summer. Convective precipitation presents a seasonal migration being more frequent over land from April to August and over the Mediterranean Sea from September to December. A composite analysis was performed for selected regions where the frequency of intense precipitation is relatively high. Two cases were contrasted: rain without convection and extensive areas of deep convection. The composites show that an upper-level trough is present in both moderate and extreme rainfall, but the trough is narrower and deeper in the extreme precipitation events, in all seasons. At low-levels, sea surface temperature composites from ECMWF analyses show that the Mediterranean is often about 1 K warmer for extreme rainfall, and low-level winds much stronger and coming from the sea, suggesting that surface fluxes are essential in the development and maintenance of such heavy rainfall events.

The role of upper-level troughs is further illustrated on two case studies, a storm that hit Algiers on 10 November 2001 (Argence et al. QJRMS 2009) and a Medicane that occurred on 26 September 2006 over Southern Italy. The short term forecasts of these two cases failed to reproduce the timing and the intensity of the convection associated with these two events. These forecasts are shown to be sensitive to the fine-scale upper-level structures. Initial conditions were modified using potential vorticity (PV) inversion guided by either water vapor imagery or a PV-advection model. In both cases the PV change in the upper-level flow leads to change in the triggering of deep convection that positively impacts the storm forecast and its associated precipitation fields.