Case studies of the relation between upper-tropospheric wave propagation and the Red Sea trough

Zakieh Alizadeh¹, Alireza Mohebalhojeh¹, Farhang Ahmadi-Givi¹, Mohammad Mirzaei¹, and Sakineh Khansalari²

¹University of Tehran, Institute of Geophysics, Department of Space physics, Iran, Islamic Republic of (zaki_alizadeh@ut.ac.ir)
²Atmospheric Science and Meteorological Research Center, Tehran, Iran

In recent history, the eastern Mediterranean and Saudi Arabia have experienced extreme precipitation events involving significant financial and human losses. An important subset of these events is associated with the activation of the Red Sea trough (RST). In this study, the effect and role of Rossby wave propagation during three cases (Dec 1993, Jan 2011 and May 1982) of the active RST is investigated. Meanwhile, the synoptic and dynamic factors related to the tropical-extratropical interaction and the lower and upper levels of troposphere are discussed for each event. The data used were extracted from the Era-Interim subsection of the ECMWF database with a time step of 6 hours and a spatial step of 80 km in both latitude and longitude directions.

Despite differences in humidity sources and the amount of hot and humid air ascent in each event, a general pattern can be deduced in all three events. The results show that in all events from a few days before the maximum rainfall, fluxes of heat and humidity are directed to Saudi Arabia and the eastern Mediterranean and the RST is strengthened and extended to the east of the Mediterranean Sea. At the same time, a trough with varying intensity at the level of 500 hPa in the eastern Mediterranean exerts a southward influence, which is caused by the anticyclonic Rossby wave breaking. At the upper levels, associated with the wave activity flux divergence and convergence areas of the Mediterranean storm track, higher amounts of Rossby wave activity enter the northeast region of Africa. Also the meridional convergence of the wave activity flux strengthens the meridional circulation in the north of the Red Sea. Increased horizontal wave activity flux to the northeast Africa and the Red Sea is led to increased head and humidity flux to the region. On the other hand, the weakening of the extension of the Azores high pressure over Africa facilitates the tropical and extratropical interactions over the region. Also in the north or northeast of the Red Sea, a surface low pressure is formed. Having a different source in each case, the mid-level troughs exhibit a northwest-southeast title with respect to the surface lows which lead to baroclinic development and intensification of precipitation events in the eastern Mediterranean and Saudi Arabia.

Keywords: Extreme precipitation, Rossby wave activity flux, Mediterranean storm track, upper level trough, meridional circulation, baroclinic development