Saharan dust transport to northern South America: a case of study

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Motivation

~On June 27, 2014, large concentrations of atmospheric particulate matter (PM) were detected over central Colombia, being there first event of Saharan mineral dust deposition to be reported in Colombia.

~Mineral dust incursion into the Atlantic ocean and the Caribbean is one of the major climatological features of the distribution of aerosols in this region (Jones et al., 2003).

~Dust transport and deposition to the Amazon basin is higher during boreal winter and is predominated by easterly trade winds, while during the boreal summer season, the majority of the mineral dust is transported to the Caribbean sea and North America (Yu et al., 2015).

~Burpee (1972) pointed out that mineral dust incursion into the Caribbean sea and North America during this season is modulated by the activity of African Easterly Waves (AEW).

~The role of AEW into the mineral dust entrainment into the atmosphere has been discussed for years (Zuluaga et al., 2003).

~Between 10% and 20% of the desert dust that is transported across the Atlantic ocean during boreal summer is related to AEW activity (Jones et al., 2003).

Figure 1. A. Large concentration of PM over Medellin on June 27 2014. Image source: minuto30.com B. Dust transport over Atlantic ocean from June 24. Image source: Nasa Earth Observatory.

Datasets

MODIS AOD: 10km x 10km, daily, 2014 (Nowottnick et al., 2011).

ERA Interim Reanalysis: 1.5°x1.5°, daily, 2014 (Uppala et al., 2005).

NOAA Optimum Interpolation SST: 1.0°x1.0°, monthly, 1971-2010 (Reynolds et al., 2002).

NCEP/NCAR Reanalysis: 2.5°X2.5°, monthly, 1981-2010 (Kalnay et al., 1996).

TRMM rainfall data 3b42 V7: 0.25°x0.25°, daily, June 2014 (Huffman et al., 2007).

Methods

Tracking AEW method: Relative vorticity is calculated from ERA Interim U and V components of wind and then vertically averaged between the 850hPa and 600hPa levels. Finally it is smoothed to a T42 resolution through bilinear interpolation (Serra et al., 2010).

Evidence the occurrence of the dust transport event: Relative vorticity is overlaid to MODIS aerosol optical depth and TRMM daily rainfall in composite images between June 22 and June 27 2014.

El niño like conditions during the occurrence of the event: Sea surface temperature anomalies and sea level pressure standardised anomalies are calculated for June 2014 related to the 1971-2000 NOAA OI SST climatology and the NCEP-NCAR reanalysis sea level pressure related to the 1981-2010 climatology respectively.

Results

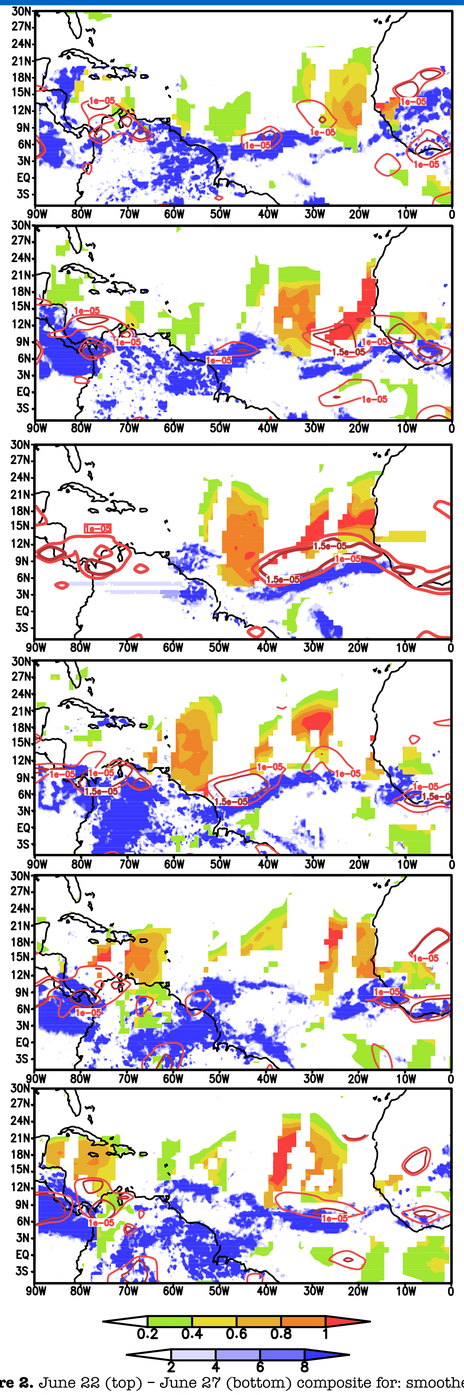

Figure 2. June 22 (top) – June 27 (bottom) composite for: smoothed ERA Interim relative vorticity, TRMM daily total precipitation and MODIS aerosol optical depth.

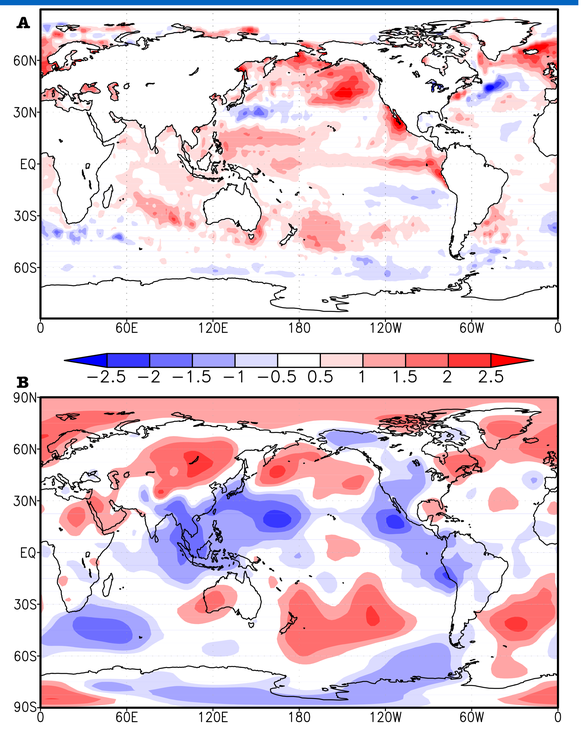

Figure 3. 3A. NOAA OI SST anomalies for June 2014. 3B. NCEP-NCAR Sea level pressure standardised anomalies for June 2014.

~Figure 2 shows an AEW reaching the central region of Colombia on June 27, the same day in which the large concentrations of particulate matter were reported.

~This singular AEW is tracked backwards until the northwestern African continent on June 22; taking 6 days to travel across the Atlantic ocean.

~It can be seen that the higher value of AOD overlays with the relative vorticity maxima, while both variables propagate westward.

~Although there was precipitation across the Atlantic ocean during the dates of the mineral dust transport event, that precipitation occurred to the south of the dust transport.

~The non-occurrence of precipitation stimulated the maintenance of the transport across the Atlantic ocean.

~Figure 3 shows that during June of 2014 there were anomalies of about 2°C in the SST over the equatorial eastern Pacific ocean.

~Standardised anomalies of sea level pressure below -2 suggests an important reduction on the sea level pressure for the equatorial eastern Pacific ocean.

~Salas et al. (2012) proposed a possible influence of El Niño years over the trajectory of the African Easterly Waves.

~Figure 3 evidences that El Niño like conditions were present during the dust transport event, and suggests and important positive gradient towards the equatorial eastern Pacific ocean that can deviate AEW's from their typical trajectory.

Conclusions

~The results presented in this work lead to prove the occurrence of the mineral dust transport on June 2014.

~Satellite observations of aerosol optical depth, display the westward propagation of the dust plume until its deposition in the central region of Colombia.

~The present work provides an evidence of the influence of the African Easterly Waves activity over the Saharan dust transport into the Americas.

~The non-occurrence of precipitation stimulated the maintenance of the transport across the Atlantic ocean.

~The mineral aerosol was not deposited along the trajectory, thus favouring the dust transport for reaching the northern Andean region.

~The sea level pressure and sea surface temperature gradients towards the equatorial eastern Pacific ocean imposed by the development of El Niño during the particular event suggest an evidence of the influence of El Niño events over the trajectory AEW.

~El Niño like conditions might operate as an attractor for AEW's that deviates them southern of their common trajectory, towards the northern South America continent.

~Although it is suggested that El Niño like conditions might influence the trajectory of the AEW and its possible associated dust transport, different studies most be done in order to verify the possible influence of El Niño years over the trajectories of the AEW.

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