MULTIYEAR AEROSOL STUDY BASED ON AEROSOL RADIATIVE PROPERTIES AT EL ARENOSILLO OBSERVATORY: EMPHASIS ON AN EXTREME SAHARAN DESERT DUST EPISODE IN FEBRUARY 2016

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1 - MOTIVATION

Aerosols are emitted into the troposphere and their optical, chemical and microphysical properties influence their direct radiative forcing through scattering and absorbing solar radiation. In order to characterize the means, variability and trends of the absorbing and scattering aerosol processes, the collaboration between INTA and NOAA established a long-term monitoring site for aerosol optical properties at El Arenosillo Observatory (ARN) (southwestern Spain). This work shows the climatological values of several aerosol optical properties. It is also explored the radiative and atmospheric impacts of a February 2016 desert dust (DD) episode on the Iberia Peninsula. It had its origin in North Africa and occurred on the 20th–23rd of February 2016. The dust transport phenomenon was exceptional because of its unusual intensity during the coldest season. A historical dataset (2006–2015) of February scenarios using ECMWF meteorological fields, meteorological parameters, aerosol optical properties, surface O₃ and AOD retrieved from MODIS at ARN were analysed and compared with the levels during the DD event to highlight its exceptionally. Associated with a low-pressure system in western North Africa, flows transported air from the Sahel to Algeria and consequently increased temperatures from the surface to 700 hPa by up to 7–9 °C relative to the last decade. These conditions favoured the formation of a Saharan air layer. The arrival of the DD event at ARN did not affect the surface weather conditions or O₃, but did impact the aerosol radiative forcing at the top of atmosphere (RF_{TOP}). Some aerosol radiative properties did change relative to historical; the particle size and the amount of the aerosol were significantly higher. The DD event caused an increase (in absolute terms) of the mean aerosol RF_{TOP} to a value of ~ 8.1 W m⁻² (long-term climatological value ~ 1.5 W m⁻²).

2 – SAMPLING AREA and LABORATORY FOR AIR QUALITY AND CLIMATE CHANGE (ISLA)

Figure 1 – NOAA/ESRL, affiliate and future permanent aerosol sampling stations around world (as of December 2015). El Arenosillo is identified as ARN site.

Figure 2 – El Arenosillo - Atmospheric Sounding Station is located in the province of Huelva (37°11', 6.71W, 40 m a.s.l) on the coast of the Atlantic Ocean, and close to the Mediterranean Sea and the North African coast. This observatory contributes data to the World Data Centers of the WMO Global Atmosphere Watch.

3 – METHODS

4 – RESULTS

Figure 5 – Annual cycle (2006–2015 daily means) for scattering (ν_s), absorption (ν_a), scattering Ångström exponent (ν_s), single scattering albedo (SSA) and radiative forcing efficiency (RFE). The line across each box represents the median climatological value while the edges of the boxes and the ends of the whiskers represent the 25th and 75th percentiles and the 5th and 95th percentiles, respectively. The mean is represented by the black square. The number of data is represented on the top of each figure.

Figure 8 (Comment 1) – Statistical analysis showing the February climatology of aerosol optical properties and surface O₃. In this figure, the edges of the boxes and the end of the whiskers represent the 5th and 95th percentiles and the minimum and maximum values, respectively.

5 – MAIN CONCLUSIONS

1 – Annual cycle (2006–2015 daily means) of ν_s and ν_a shows two peaks during late summer (September) and winter. It may be related to the long-range transport of DD events during summer and the regional emission of winter domestic fires.

2 – Annual cycle (2006–2015 daily means) of ν_s shows lower values during autum–winter–time, which may be related to rainy days. Ångström cycle shows lower value during warm months.

3 – DD transport from the Sahara to ARN was observed. A low-pressure area located in the Mediterranean region during the 19th of February 2016 caused a warm air flow from the Sahel to the Sahara. The arrival of the warm air masses induced and exceptional warming of the Earth’s surface for this time of year, increasing the temperature at the surface and at 850 hPa between 7°C and 9°C.

4 – The formation and transport of the Saharan aerosol were corroborated by AOD from the MODIS and back-trajectories for the period from the 20th to 22nd of February.

5 – The higher loading caused an increase (in absolute terms) of the mean aerosol radiative forcing at the top of the atmosphere during the DD event to ~8.1 W m⁻².

6 – REFERENCES


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