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Changes in aerosol optical properties over the Mediterranean basin based on 6-year (2000-2006) MODIS data

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Atmospheric aerosols, both natural and anthropogenic, can cause climate change through their direct, indirect and semi-direct effects on the radiative energy budget of the Earth-atmosphere system. However, the quantification of the aerosol effects is very difficult because aerosol physical, chemical and optical properties are highly variable in space and time, due to their short atmospheric lifetime. Therefore, continuous monitoring of aerosol properties is essential, especially for climatically sensitive regions such as the Mediterranean basin, parts of which are threatened by desertification processes. This region is of special importance because it is a crossroad where aerosols from different sources are superimposed and mixtures of different kinds of particles converge. Moreover, there is a strong climatic effect of aerosols in the Mediterranean Basin, especially in summer, is due to cloud-free conditions and high solar radiation intensity. Lately, sophisticated satellite-based instruments have improved drastically the observation ability of aerosols, providing accurate data with complete spatial coverage for the study region.

In this study, we investigate the temporal variability of aerosol optical properties, with emphasis on aerosol optical depth (AOD), over the broader area of the Mediterranean basin. Emphasis is given to possible changes of aerosol loads and properties occurring in the study region, which can have severe effects on the region's climate. The study

is performed using daily mean data measured by the MODerate resolution Imaging Spectroradiometer (MODIS) instrument onboard the Terra and Aqua satellites, that cover the 6-year period from 2000 to 2006. More specifically, we use AOD data at 550nm, but also at 6 other wavelengths extending from 470 to 2130 nm, over land and ocean, taken from the MODIS-Terra Level-3 daily gridded atmospheric data product. The data cover the period from 1 March 2000 to 28 February 2006. The daily mean AOD data have a spatial resolution of 1º x 1º latitude-longitude, and cover the area extending between 29.5ºN and 46.5ºN in latitude and 10.5ºW and 38.5ºE in longitude.

The results of our study reveal an important inter-annual variability of aerosol optical depth having taken place in the study region. More specifically, a decreasing trend has occurred over the period 2000-2006, which was computed to be equal to -18% in relative percentage terms. This trend has been evaluated as being statistically significant according to the applied Man-Kendall test. Our investigation shows that the overall decreasing trend of aerosol optical depth is mainly attributed to decreasing loads of fine aerosol particles of anthropogenic origin. Moreover, the decreasing AOD trend is not uniform over the whole basin, but it appears mainly in western parts of the Iberian, Italian and Balkan peninsulas (and adjacent sea surfaces), as well as in the southern Anatolian peninsula. The atmospheric circulation over these areas is strongly affected from the North Atlantic Oscillation patterns, which leads to the conclusion that the decreasing AOD trend is possibly related to the increasing precipitation, associated with decreasing NAO index during the study period. The MODIS-indicated decreasing trend of AOD is also suggested by corresponding aerosol data from AERobot RObotic NETwork (AERONET) stations in the study region. The agreement between MODIS and AERONET, further supports the validity of our conclusions on decreasing aerosol load in specific Mediterranean basin's areas, which is of great importance for the energy budget, and hence climate, of these regions.