Plinius Conference Abstracts,
Vol. 11, Plinius11-101, 2009
11th Plinius Conference on Mediterranean Storms


# A novel method to quantify aerosol and cloud synergy effects on the atmosphere - A storm case study

I. Carmona and P. Alpert

Department of Geophysics and Planetary Sciences, Tel Aviv University, Tel Aviv, Israel (isaaccar@post.tau.ac.il / 972-3-6409282)

Aerosols have various effects on the atmosphere that are generally not incorporated in numerical weather predictions and are not fully understood. Most of the operational models do not take realistic aerosol distributions into account in their radiation transfer, leading to model errors in temperature, cloudiness, precipitation, winds and other atmospheric variables. In this study we employ a large data-base of model errors to infer the real total atmospheric response to aerosols. This is a novel method that reveals in an indirect method the real aerosols and cloud interaction on tropospheric temperatures.

Two main results are reported here. First, the correlation between the UK Metrological Office (UKMO) model temperature error ($\Delta$T) at level 850hPa for Tel Aviv (Israel) during the year 2002 and the Moderate Resolution Imaging Spectroradiometer (MODIS) Aerosol Optical Thickness (AOT) $\geq$0.5, was found to be -0.54. Second, the sign of the correlation between the European Center Medium range Weather Forecasting (ECMWF) monthly averaged model surface temperature errors for Italy and the MODIS AOT depends on the aerosol type as reflected by the specific area. The correlation between air surface ECMWF $\Delta$T and AOT was found to be +0.70 in southern Italy.

We also investigate the impact of aerosols, clouds and their interaction on weather. Using a multi-linear regression model to separate between predictor variables, we compare measurements of MODIS/TERRA AOT and several Tel Aviv University Mesoscale Model (MM5) prediction errors including temperature, absolute humidity, horizontal wind vertical temperature gradient, over central Israel. For temperature, we found that aerosols increase air temperature in the low altitudes (1000-850hPa; for the years 2001-2005), whereas the interaction between aerosols and clouds cools the air. At 950 hPa, the temperature increases by 1.193$\pm$ 0.274K for one unit of AOT (=1) and decreases by -1.285$\pm$ 0.337K for each unit of aerosol-cloud interaction of AOT*(cloud cover) =1. For wind, we found that at the 900 hPa level aerosols increase the wind velocity by 1.564$\pm$ 0.360m/s for each AOT=1 and the aerosol-cloud interaction reduces the wind velocity by -1.148$\pm$0.442m/s.

Mineral dust particles constitute a major part of the aerosols in Israel. They heat the lower troposphere due to extensive absorption of thermal ground infrared radiation, but reduce the solar radiation which reaches the ground due to increased cloudiness caused by aerosol-cloud interactions, consequently cooling the lower troposphere altitudes. It is assumed that the reduction/increase in the lower atmospheric temperatures causes a decline/intensification in the mixing layer kinetic energy and therefore reduction/intensification in wind velocity.

Investigation of the temperature model errors in a day of extreme dust storm in Israel reveals the change induced in the dynamics due to aerosols.

D_ABSTRACT@