Dust events over Kuwait inferred from micropulse lidar soundings

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The Arabian Peninsula is one of the dustiest places in the world. The main sources of dust are the alluvial plains of Iraq, the plateau of eastern Jordan, the Jazirah (Jezireh) of eastern Syria, and the interior plains of Dhofar and adjacent interior eastern Yemen. According to Notaro et al. (2015) the recent increase of the dust emission activity in the Arabian Peninsula is due to the prolonged drought episodes in the Fertile Crescent. Kuwait is of great interest due to highest recorded dust density in the Arabian Peninsula (Sabbah, 2010).

We present in this paper new lidar measurements obtained in the Kuwait with the objective of assessing the vertical distribution of dust haze in this region and characterizing the main transport pathways of dust.

A polarized Micropulse Lidar (P-MPL) has been recently installed in the Kuwait station (29.3º N, 47.9º E, 40 m a.s.l.) by the College of Health Sciences, the Public authority for Education and Training of Kuwait. Routine measurements are performed from November 2013 to date for dust research. The lidar uses a Nd:YVO_4 laser emitting 6-8 μJ at 532 nm with a frequency of 2500Hz. A Matsukov-Cassegrain telescope with two polarization channels composes the receiving system. Routine measurements are 30-m vertical resolution and 30-second integrating time.

Several dust events are observed all year long in Kuwait with a maximum intensity in summer (June-July). Dusty days are classified by the Met. Services based on surface wind speed and visibility into 4 categories: "dust storm", "rising dust", "suspended dust" and "haze". We present here a selected event corresponding to the case "rising dust" with mean daily wind speed between 4 and 11 m/s and visibility better than 1 km. The analysed period ranges between 18 and 28 June 2014

The aerosol extinction profiles are computed following a standard Klett's method and constant lidar ratio of 35 Sr . The lidar ratio is within the lower range of acceptable lidar ratio for dust particles. The aerosol extinction coefficient is vertically integrated to give the aerosol optical thickness (AOD). Figure 1 shows the comparison between 5-min time step and the AOD retrieved from the MODIS DeepBlue operational algorithm. The time series have been filtered of unrealistic values and the range of observations in AOD is limited up to 2.0. We observe a steady increase in the AOD from June 18 to 22. A burst in the AOD is observed on June 23 corresponding to the strong signal observed in the lidar raw signal in the planetary boundary layer. The retrieved MODIS AOD when available is in a good agreement with the lidar ones.

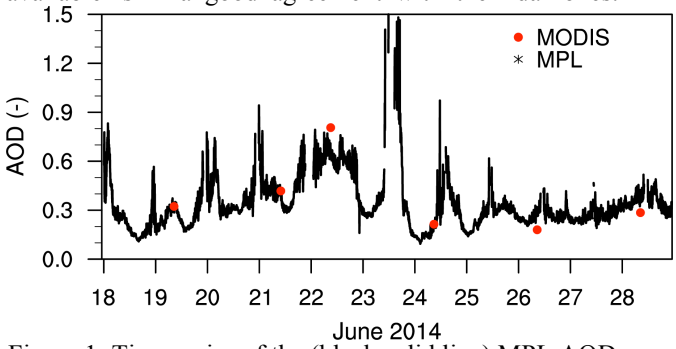

Figure 1: Time series of the (black solid line) MPL AOD and (red dots) AQUA DeepBlue AOD at 550 nm.

The analysis of the vertical extinction coefficient profiles on June 22 reveals a first maximum observed in the boundary layer below 500 m (nighttime profiles), a second maximum is observed at 2 km and the third one in a layer between 4 and 6 km.

The backtrajectories obtained using the HYSPLIT model indicates that the air masses arriving on 22 June in the morning over Kuwait have different origins. In the upper layer, the air mass travels over Syria and Iraq under Shamal wind regime before being advected over the gulf. The air mass is then uplifted over the high mountains range in Iran and turned back toward Kuwait. The air mass arriving at 500 m is subsiding from higher altitude and should not carry large amount of dust as confirmed by the rather weak aerosol extinction coefficient of 0.15 km^{-1}. The large increase in the extinction coefficient at 2 km could be due to the advection of dust from Saudi Arabia as reveals by the UV aerosol Index derived from OMI observations during the event. However a possible contribution from the sources areas straddling the border between Iran and Pakistan could also be expected

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