Automatic processing of Raman lidar measurements for aerosol classification

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Improving atmospheric aerosol identification is a necessary step for a better forecasting of particulate pollution events. Detailed knowledge of the vertical distribution of aerosol optical properties can provide a strong constraint to data assimilation systems (Wang *et al*, 2013), and the link with surface operational measurements needs to be strengthened. Lidar measurement has emerged as a powerful technique for this integrated approach coupling measurements and modeling. The signal recorded by the atmospheric lidar system is related to the chemical and size distributions of particles, as well as their internal and external structures. A ground-based lidar measurement is thus an efficient way for identifying the aerosol nature over a site and/or a network over time.

We developed a mobile N_2-H_2O vibrational Raman lidar system, called WALI (Water vapor and Aerosol Lidar, Chazette *et al*, 2015), partly for such aerosol studies. The WALI system performed measurements during the international campaigns of ChArMEx (Chemistry-Aerosol Mediterranean Experiment) and HyMeX (Hydrological Cycle in the Mediterranean Experiment). It allowed to classify the aerosol types present over the study site thanks to cross-polarization and N_2-Raman scattering channels (Chazette *et al*, 2016).

Figure 1 gives the temporal evolution of aerosol classification after defining a specific colour map as a function of BER (Backscatter-to-extinction ratio, inverse of the lidar ratio) and PDR (particle depolarization ratio). The colour map is only associated with the PDR during daytime, because N_2-Raman signal-to-noise ratio is limited when the sun is up. Whereas during nighttime, an automatic algorithm using several regularization methods allows to estimate directly and simultaneously the BER and the aerosol extinction coefficient (AEC) against the altitude, from the N_2-Raman signal. BER is proportional to the single scattering albedo. Thus the couple of variables BER and PDR can be used for aerosol classification in colour, whereas AEC is shown by the intensity of the aerosol signal.

A Monte Carlo algorithm has been used in parallel to assess the uncertainties on derived optical parameters, and to evaluate different regularization methods.

We will present these algorithms and their sensitivity studies. It will be illustrated by concrete examples obtained during the mentioned campaigns. The different lidar profile regularization approaches will be discussed in terms of advantages and disadvantages toward an operational process.

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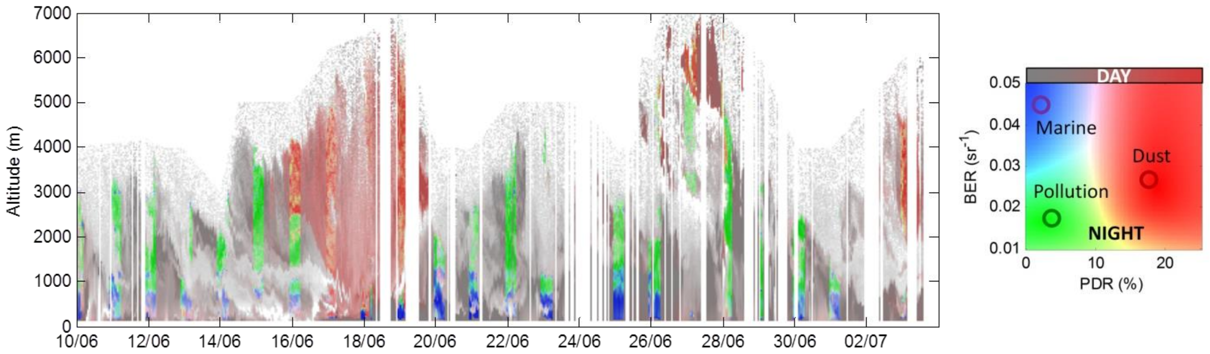

Figure 1. Results of aerosol classification as given by lidar-derived extinction, PDR and BER, with backscatter coefficient coded as saturation (no saturation, white = 0, full saturation = 5 10^{-6} m^{-1} sr^{-1}). Key for the colours is given on the right. Nighttime: dust-, pollution- and marine-like aerosols coded as red, green and blue respectively. Daytime: PDR coded as the saturation of red (top of the colour key). Intermediate colours and grey thus designate undetermined layers where aerosol mixing may occur.