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Aerosol Lidar Imaging Quality Depending on the Sensing Radiation Wavelength

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Abstract. The elastic lidar return from the atmosphere provides versatile spatially and time-resolved information about the state and dynamics of the molecular and aerosol atmospheric components. This information allows one to determine for instance the vertical profiles of the atmospheric temperature and pressure, the optical depth of the whole atmosphere or specific sub-layers inside, the evolution of the aerosol stratification and different hydrometeors, the structure and shape variations, and the drift of clouds, specific layers of Saharan or volcanic dust, smoke flows from fires, etc. Certainly, the quality of imaging aerosol objects in the atmosphere is conditioned by the lidar return power that depends, e.g., on the sensing laser pulse energy, the scattering cross section and concentration of the aerosol particles, the efficiency of the receiving lidar system and so on. The higher the return power the higher the measurement signal-to-noise ratio (SNR) and the imaging brightness, accuracy and contrast. At equal aforementioned factors of importance, the return signal power may be essentially influenced by the sensing radiation wavelength and the specificity of the imaged objects. Then, the balance between backscattering and attenuation along the lidar line of sight may outline optimal wavelengths (interval) ensuring a maximum return under determinate environmental conditions.

Since the question about such an optimal wavelength has not been purposefully and systematically considered so far, we are developing here a "phenomenological empirical modeling" approach to the problem based on evaluating the measurement SNR profile along the line of sight and simulating the noisy lidar profile itself by using well-known accepted models of the optical properties of different specific aerosol objects and background of interest.

The initial results from the investigation conducted so far show for instance that the relatively shorter sensing wavelength (~ 400 nm) would be advantageous when sensing "clear atmosphere". The longer wavelengths (850 nm, 1064 nm) become more suitable for sensing aerosol-loaded atmosphere. Still longer wavelengths (~ 1064 nm and 2000 nm) would be preferable for instance when detecting clouds through hazy atmosphere.

Thus, depending on the type of the detected (studied) aerosol objects and the aerosol environments, one may choose the optimal lidar wavelength to achieve maximum imaging brightness, contrast, resolution, accuracy, etc.