Assessing cloud microphysics from dual-field-of-view polarization lidar: technical aspects and potential applications.

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Aerosol-cloud interactions are complex and have proved to be one of the most elusive aspects when attempting to understand aerosol effects on Earth's atmosphere. To reduce the knowledge gap with regard to the role of aerosol on warm and cold clouds, practical observational techniques to assess both, aerosol and cloud properties, as well as the meteorological conditions have shown to be essential [1].

Lidar instruments are quite robust when it comes to aerosol particles, as they allow the resolution of aerosol optical properties on a vertical basis, from which microphysical information can be derived [2]. However, in cloudy periods, the single scattering approach, typically used to solve the lidar equation, breaks due to multiple scattering of the light when going through clouds, which are optically much denser than aerosol layers. In liquid-water clouds, the multiple scattering is particularly strong. Still, the features of the lidar return in this regime are closely related to the microphysical structure of the cloud and to the geometric setup of the lidar system. To exploit this relationship, lidar-based approaches to derive the microphysical properties of liquid water clouds, such as the droplet effective radius and number concentration, have emerged during the last decades, being the dual-field-of-view Polarization lidar one of the most recent arrays introduced, allowing the observation and characterization of cloud properties around the clock and with high temporal resolution [3, 4].

Several PollyXT-type lidar systems [5] from TROPOS have received an upgrade to achieve depolarization measurements at two fields of view. Those systems have been located at different locations over the globe for long-term campaigns since 2018. The growing dataset is being used to study aerosol effects on clouds under different environmental conditions, looking on a first stage to the so-called instantaneous effect, i.e., how droplet number changes along with the aerosol-particle number. This contribution would like to delve into the technical aspects of the dual-FOV polarization approach, such as the retrieval scheme and setup of the instrument, and also provide an overview of the applicability of this technique for aerosol-cloud-interaction research.

Keywords: polarization lidar, dual field-of-view, aerosol and cloud microphysics, aerosol-cloud interactions.

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