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Multiple Linear Polarization Lidar with Improved Polarization Retrievals for Enhanced Atmospheric Observation in the Arctic

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The measurement of orthogonal polarization planes from laser light scattered by clouds and aerosols is a common technique to classify cloud conditions or aerosol types using lidar. Increasingly, polarization measurements are evolving from qualitative assessments of liquid-to-ice phase transitions in clouds to more precise quantitative measurements of mixed phase clouds, cloud particle orientation, and aerosol type classifications. Viewing polarization retrievals in a more quantitative way can enhance the information content related to cloud or aerosol particles but requires a precise understanding of system and scattering effects. Herein, measurements of multiple, non-orthogonal, planes of linear polarization are implemented to advance the use of quantitative assessment of lidar polarization methods for cloud and aerosol studies. Results from the Clouds Aerosols Polarization and Backscatter (CAPABL) Lidar, located at Summit Camp, Greenland (72.35'N, 38.25'W), will be presented to examine the advantages of using multiple planes of linear polarization. The advantages demonstrated are enhanced signal dynamic range, reduced system effects due to signal saturation, ability to independently measure horizontal orientation of ice crystals, and self-calibration of retrievals. Data from the recently upgraded system will be presented to demonstrate these advantages, which allow CAPABL to adjust and increase signal dynamic range by approximately an order of magnitude while simplifying calibration and reducing systematic errors. These enhancements facilitate a more quantitative retrieval to describe mixed phase clouds and horizontally oriented ice crystals, both, of which, have important implications to Greenland's mass and energy budgets by modulating cloud scattering properties.