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CALIPSO polar stratospheric cloud observations: second-generation detection algorithm and composition discrimination

M. C. Pitts[1], L. R. Poole[2], and L. W. Thomason[1]
[1]NASA Langley Research Center, Hampton, Virginia, USA
[2]Science Systems and Applications, Incorporated, Hampton, Virginia, USA

Abstract. This paper focuses on polar stratospheric cloud (PSC) measurements by the CALIOP (Cloud-Aerosol LIdar with Orthogonal Polarization) lidar system onboard the CALIPSO (Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations) spacecraft, which has been operating since June 2006. We describe a second-generation PSC detection algorithm that utilizes both the CALIOP 532-nm scattering ratio (ratio of total-to-molecular backscatter coefficients) and 532-nm perpendicular backscatter coefficient measurements for cloud detection. The inclusion of the perpendicular backscatter measurements enhances the detection of tenuous PSC mixtures containing low number densities of solid (likely nitric acid trihydrate, NAT) particles and leads to about a 15% increase in PSC areal coverage compared with our original algorithm. Although these low number density NAT mixtures would have a minimal impact on chlorine activation due to their relatively small particle surface area, these particles may play a significant role in denitrification and therefore are an important component of our PSC detection. In addition, the new algorithm allows discrimination of PSCs by composition in terms of their ensemble backscatter and depolarization in a manner analogous to that used in previous ground-based and airborne lidar PSC studies. Based on theoretical optical calculations, we define four CALIPSO-based composition classes which we call supercooled ternary solution (STS), ice, and Mix1 and Mix2, denoting mixtures of STS with NAT particles in lower or higher number densities/volumes, respectively. We examine the evolution of PSCs for three Antarctic and two Arctic seasons and illustrate the unique attributes of the CALIPSO PSC database. These analyses show substantial interannual variability in PSC areal coverage and also the well-known contrast between the Antarctic and Arctic. The CALIPSO data also reveal seasonal and altitudinal variations in Antarctic PSC composition, which are related to changes in HNO_3 and H_2O observed by the Microwave Limb Sounder on the Aura satellite.

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