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CALIPSO PSC Observations During the 2009-2010 Arctic Winter: Implications for PSC Nucleation Mechanisms

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An intensive field campaign focused on measurements related to polar stratospheric clouds (PSCs) and ozone chemistry was conducted in the Arctic during January-March 2010 as part of the European Union project RECONCILE (reconciliation of essential process parameters for an enhanced predictability of Arctic stratospheric ozone loss and its climate interactions). To complement the more focused measurements from the RECONCILE field campaign, we have used spaceborne lidar measurements from CALIPSO (Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations) to provide a vortex-wide perspective of the 2009-2010 PSC season. The 2009-2010 Arctic winter was unusually cold at stratospheric levels from mid-December through the end of January and one of only a few winters over the past half-century with synoptic-scale temperatures below the frost point. It was also the most intense PSC season of the CALIPSO four-year Arctic data record with more PSCs observed than in the three previous Arctic seasons combined. In this paper, we present a general overview of the 2009-2010 winter, examine in detail the evolution of PSC composition during the season, and explore the unique aspects of this season in attempt to understand the underlying physical mechanisms. Of particular interest is the early phase of the season (15-30 December 2009) that was dominated by patchy, tenuous nitric acid trihydrate (NAT) clouds. Mountain wave ice PSCs were not observed by CALIPSO during this period, suggesting that ice nuclei are not a prerequisite for NAT formation. We will look more closely at the onset of PSCs during the 2009-2010 winter and also prior years to access the significance of a non-ice nucleation mechanism for NAT PSCs.