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Investigation of PSC Processes During the 2010-2011 Arctic Winter

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Extensive measurements and modeling activity over the past two decades have shown that polar stratospheric clouds (PSCs) and aerosols play important roles in the springtime chemical depletion of ozone at high latitudes. Heterogeneous reactions on the surfaces of stratospheric particles at cold temperatures convert chlorine reservoir species HCl and $ClONO_2$ into ozone-destructive forms. Also, if PSC particles grow sufficiently large to sediment, they can irreversibly redistribute odd nitrogen (a process commonly known as denitrification), thereby slowing the reformation of the chlorine reservoirs and prolonging the ozone depletion process. A more complete picture of PSC occurrence and composition is emerging from spaceborne measurements being provided by the CALIOP (Cloud-Aerosol LIdar with Orthogonal Polarization) lidar system onboard the CALIPSO (Cloud-Aerosol-Lidar and Infrared Pathfinder Satellite Observations) spacecraft and the limb-sounding MIPAS (Michelson Interferometer for Passive Atmospheric Sounding) infrared spectrometer on Envisat. CALIOP, which has been operating nearly continuously since mid-June 2006, provides high spatial resolution observations of aerosols/PSCs. MIPAS, which has been in operation since 2002, provides information on PSCs and key gas species, including NO_y. In this paper, we examine the CALIOP and MIPAS observations from the 2010-2011 Arctic winter, which was marked by unprecedented severe ozone loss. The seasonal evolution of PSCs during this unusual Arctic winter is investigated, including their spatial extent and composition. MIPAS NO_y measurements are utilized to examine the progression and magnitude of denitrification during the winter/spring. The correlation between nitric acid trihydrate (NAT) PSC cloud occurrence and denitrification is also examined. Finally, we compare the stratospheric particle measurements with ClO and $ClONO_2$ observations to explore their role in chlorine activation.