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Updated PSC climatology based on CALIOP measurements from 2006-2022

Michael Pitts and Lamont Poole
NASA Langley Research Center, Science Directorate, Hampton, United States of America (michael.c.pitts@nasa.gov)

After more than three decades of research, the roles of polar stratospheric clouds (PSCs) in stratospheric ozone depletion is well established. Heterogeneous reactions on PSCs convert the stable chlorine reservoirs HCl and $ClONO_2$ to chlorine radicals that destroy ozone catalytically. PSCs also prolong ozone depletion by delaying chlorine deactivation through the removal of gas-phase HNO_3 and H_2O by sedimentation of large nitric acid trihydrate (NAT) and ice particles. A substantial recovery of the ozone layer is expected by the middle of this century with reduced global production of ozone depleting substances in accordance with the Montreal Protocol and subsequent amendments. But as climate changes, leading to a colder and perhaps wetter stratosphere and upper troposphere, reliable model predictions of recovery of the Antarctic ozone hole and of potentially more severe ozone depletion in the Arctic are challenging. This is due both to a lack of detailed understanding of the underlying physics and the fact that many global models use simple parameterizations that do not accurately represent PSC processes.

A more complete picture of PSC processes on vortex-wide scales has emerged from the CALIOP (Cloud-Aerosol Lidar with Orthogonal Polarization) instrument on the CALIPSO satellite that has been observing PSCs at latitudes up to 82 degrees in both hemispheres since June 2006. The CALIOP Version 2.0 (v2) PSC algorithm was recently developed to address known deficiencies in previous algorithms and includes additional refinements to increase the robustness of the inferred PSC composition. In this paper, we present an updated PSC reference data record and comprehensive climatology constructed by applying the v2 algorithm to the more than 16-year CALIOP spaceborne lidar dataset. In addition to showing 4-D (latitude, longitude, altitude, and time) information on the occurrence, composition, and variability of PSCs in both hemispheres, we also compare the post-Pinatubo CALIOP PSC data record with the 1979-1989 SAM II (Stratospheric Aerosol Measurement II) solar occultation PSC record to investigate possible long-term variability in PSC occurrence.