EGU23-941, updated on 26 Apr 2024
https://doi.org/10.5194/egusphere-egu23-941
EGU General Assembly 2023
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Can we predict the expected evolution of polar stratospheric clouds on climatic time scales ?

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During hemispheric winter a vortex forms on poles resulting in a very sharp drop in stratospheric temperatures. When the temperature drops below a particular threshold TNAT that allows nitric acid nucleation, polar stratospheric clouds (PSCs) can start to form. PSCs are responsible for the thinning of the ozone layer. According to climate models, the ozone layer is expected to return to 1960 levels around 2060. However this progress could be slowed down by enhanced PSC formation due to the cooler and wetter stratosphere that could be caused by climate change.

The spaceborne lidar from CALIPSO (Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation) has helped us understand better the spatial and temporal occurrence of PSCs. The CALIPSO PSC product, derived from CALIPSO level 1B measurements, describes the spatial distribution, optical properties, and composition of PSCs along CALIPSO orbits. The product also includes reanalysis temperatures from MERRA2 and complementary information from the Microwave Limb Sounder (MLS), such as HNO3/H2O mixing ratios which are essential to PSCs formation and to TNAT calculation.

In this study we will present a statistical model based on the analysis of the CALIPSO PSC product from 2006 to 2020. It establishes a relationship between the PSC density observed by CALIOP and the density of stratospheric temperatures colder than TNAT. This model allows the prediction of PSC density by pressure level derived from stratospheric temperature. We will show that this model allows us to tell if there is a PSC or not in (2°x4°) boxes over monthly periods, even in places where the satellite CALIPSO doesn't overpass. We will discuss its application on temperatures predicted by Shared Socio-economic Pathways (SSP) scenarios to know the evolution of PSCs over this century. One of our eventual goals would be to investigate if observed PSC densities can constrain stratospheric temperatures predicted by GCMs.