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Polar Stratospheric Clouds from ground-based lidar and CALIPSO observations and Chemistry Climate Models evaluation

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We evaluate the Antarctic PSC observational databases of CALIPSO and the ground-based lidars of NDACC (Network for Detection of Atmospheric Composition Changes) located in McMurdo and Dumont D'Urville stations and provide a process-oriented evaluation of PSC in a subset of CCMVAL-2 chemistry-climate models.
Lidar observatories have a decadal coverage, albeit with discontinuities, spanning from 1992 to today hence offering a unique database. A clear issue is the representativeness of ground-based long-term data series of the Antarctic stratosphere conditions that may limit their value in climatological studies and model evaluation. The comparison with the CALIPSO observations with a global coverage is, hence, a key issue.
In turn, models can have a biased representation of the stratospheric conditions and of the PSC microphysics leading to large discrepancies in PSC occurrence and composition.
CALIPSO observations indicate a large longitudinal variability in PSC formation in the polar atmosphere and ground-based observations are hence representative of different cloud conditions.
Point-to-point comparison is difficult due to sparseness of the database (or PSC appearance at the edge of the vortex) and to intrinsic differences in spatial distribution between models and observations. So the use of simple diagnostics that are independent from instrumental coverage is fundamental. Comparison between ground-based and satellite borne-lidar is overall satisfactory and differences may be attributed to differences in coverage.
As expected, McMurdo site is dominated by a NAT-type regime that is a clear feature of the eastern part of polar vortex while Dumont D'Urville is largely influenced by the transition at the edge the polar vortex resulting, on average, in a much reduced PSC coverage with a partition between NAT and STS cloud types.
Data from the 5 CCMs having provided PSC surface areas on daily basis have been evaluated using the same diagnostic type that may be derived CALIPSO (i.e. frequency of PSC occurrence function of lon-lat, height and temperature) showing large differences that may be explained by the interplay of model temperatures that may show a large bias (negative for 3 models over 5) and the microphysical scheme itself. Two models in fact show an excess of NAT formation relative to ice clouds while two others have an unrealistic dominance of ice. Most of them show a somewhat too efficient PSC production with temperature decrease below NAT formation temperature.
Evaluation CCMs with ground-based instruments databases should be done with great care due to the large spatial differences inside the polar vortex that are not fully reproduced by the models. In turn, longer series as provided by NDACC should be used to evaluate interannual variability and trends that is difficult to identify in the shorter CALIPSO database.