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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Do tropospheric clouds influence Polar Stratospheric cloud occurrence in the Arctic?" *by* P. Achtert et al.

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We thank referee 1 for the review. Below we respond to the questions/comments raised by the referee.

Referee: This manuscript presents an interesting issue about the link between PSC and tropospheric clouds. Some previous studies reported by the authors have already suggested such potential links, and in this context the present studies exhibit a more global study using satellite data from Calipso. This new investigation confirms a potential simultaneous occurrence of both clouds. This study is interesting however it does not bring much new understanding of the link between occurrences of both cloud types.

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Response: Recent Antarctic studies from Wang et al. 2008 and Adhikari et al. 2010 suggested that the link between tropospheric and stratospheric clouds is due to a dynamic effect or a radiative effect. The results of our study show that radiative effects do not contribute significantly to the reported linkage between tropospheric and stratospheric clouds. Thus, we contributed to an improved understanding of the link between these two cloud types.

Referee: No new results are provided to make progress about the causality between both events. Authors suggest that PSC occur when tropospheric clouds are present, but from this study the reverse could also be true: tropospheric cloud may occur when PSC are present. Similarly no direct link may exist but their simultaneous occurrence can result from a similar dynamical process. So I suggest to modify slightly the title in something like "Do tropospheric clouds and Polar Stratospheric Clouds occurrence linked" which corresponds better to the results presented here.

Response: Thanks for the comment. We agree and changed the title to: "On the linkage between tropospheric and Polar Stratospheric clouds in the Arctic as observed by space–borne lidar."

Referee: The discussion can also extend the possible links on the reverse directions or any other common causes. Also it is suggested that tropospheric clouds could change the microphysical properties of the PSC. This point is not clear to me and I think if this discussion is based on factual information, it should be developed and better explained. It is not reasonable to group all the tropospheric clouds in a single category to study the potential link with PSC while all the tropospheric clouds occur through very different processes. At least cirrus and liquid clouds could be separate to test the robustness of the correlations. It seems interesting to investigate why these simultaneous occurrences failed sometime. Probably temperature (and temperature history) may help in this context.

Response: Figure 5 shows the occurrence of PSCs with respect to the top temperature

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of the underlying cloud system. Since colder and warmer cloud tops correspond to higher and lower clouds, respectively, this figure gives an impression of the relationship between PSC occurrence and the kind of an underlying cloud system. It is the top of the cloud system that determines the radiative effect and not the phase. Note that deep-tropospheric clouds are usually mixed-phase clouds. These clouds seem to have the strongest relation to PSC occurrence in comparison to liquid clouds and cirrus.

We changed the discussion of Figure 4 to explain the impact of tropospheric clouds on the microphysical properties of PSCs: "Cooling associated with the presence of tropospheric clouds has an impact on the microphysical properties of PSCs as is discussed by Adhikari et al. (2010). Their finding show that high and deep-tropospheric cloud systems have an significant effect on the relative occurrence of different PSC types, especially on ice PSCs. PSCs of the type ice and mix associated with cirrus and deep tropospheric clouds showed larger backscatter ratios compared to PSCs associated with no cirrus and deep tropospheric clouds. (Adhikari et al., 2010) concluded that this is due to an increase of the nucleation efficiency, providing higher particle number concentrations. Our observations are in agreement with the findings by Adhikari et al. (2010). Figure 4d, e, f (associated with deep tropospheric clouds) shows larger number of observations with higher backscatter ratios compared to Figure 4c which is associated with PSCs observation without underlying tropospheric clouds. In contrast to Adhikari et al. (2010) our study revealed no increased backscatter ratio within PSCs observed above cirrus clouds."

We changed the discussion part of the paper with respect to the comments of both reviewers. We added and discussed also some more references:

Fromm, M., Alfred J, Pitts M., A unified, long-term, high-latitude stratospheric aerosol and cloud database using SAM II, SAGE II, and POAM II/III data: Algorithm description, database definition, and climatology J. Geophys. Res., 108, doi:10.1029/2002JD002772, 2003.

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Simmonds, I., and Keay K.: Mean Southern Hemisphere extratropical cyclone behavior in the 40-year NCEP-NCAR reanalysis, J. Clim.,13, 873-885, doi:10.1175/1520-04422000013, 2000.

Carrasco, K. F., Bromwich D. H., and Monaghan A. J.: Distribution and characteristics of mesoscale cyclones in the Antarctic: Ross Sea east-ward to the Weddell Sea, Mon. Weather Rev., 131, 289-301, doi:10.1175/1520-04932003131, 2003.

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 32065, 2011.

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