The effect of orographic waves on Antarctic Polar Stratospheric Cloud (PSC) occurrence and composition

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Background

The Antarctic Peninsula is a well-known orographic-gravity wave hotspot. Case studies have shown that some of these waves are responsible for the formation of PSCs (e.g., Hopfner et al., 2006, Eckermann et al., 2009, Noel et al., 2009). We investigate orographic-gravity wave activity and PSC occurrence during the entire 2007 PSC season at 60-70S.

We use CALIOP lidar backscatter data and the algorithm of Pitts et al. (2009) to separate the PSCs observed into four composition classes: super-cooled ternary solution (STS), ice and two liquid/NAT mixed classes called Mix 1 and Mix 2. The Mix 1 (Mix 2) class has lower (higher) number density per volume of NAT. We calculate the PSC volume on isentropic surfaces between 400K – 700K. COSMIC GPS-RO temperature profiles are used to extract gravity wave temperature variances, similar to Alexander et al. (2009). For both datasets, we bin the data into 10 degree latitude width, 20 degree longitude width and 7 days in time to ensure sufficient data coverage.

Using the upwind region of the Peninsula as a background level (to minimize planetary wave and synoptic influences), around 50% of both H2O ice PSCs and a high NAT number density liquid/NAT mixture class (Mix 2) are advected above and downstream of the Peninsula. We also study the 70-80S results (not shown here), although due to the colder synoptic conditions, a lower proportion of PSCs are directly attributable to orographic gravity wave activity.

Conclusions

These results support the mountain-wave seeding hypothesis at various intervals throughout the entire Antarctic winter and illustrate the important role of mesoscale orographic-gravity wave forcing in determining PSC occurrence and composition near the edge of the Antarctic vertex. We clearly observe the relation between enhanced orographic wave activity and H2O ice PSC formation and downstream increases in NAT at 60-70S. We attribute around 50% of H2O ice PSCs in this latitude band as being due to orographic gravity wave activity alone the Peninsula.

The results presented here are discussed in more detail by Alexander et al. (2011).

References:
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