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Can gravity waves significantly impact PSC occurrence in the Antarctic?

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Abstract. A combination of POAM III aerosol extinction and CHAMP RO temperature measurements are used to examine the role of atmospheric gravity waves in the formation of Antarctic Polar Stratospheric Clouds (PSCs). POAM III aerosol extinction observations and quality flag information are used to identify Polar Stratospheric Clouds using an unsupervised clustering algorithm.

A PSC proxy, derived by thresholding Met Office temperature analyses with the PSC Type Ia formation temperature (T_{NAT}), shows general agreement with the results of the POAM III analysis. However, in June the POAM III observations of PSC are more abundant than expected from temperature threshold crossings in five out of the eight years examined. In addition, September and October PSC identified using temperature thresholding is often significantly higher than that derived from POAM III; this observation probably being due to dehydration and denitrification. Comparison of the Met Office temperature analyses with corresponding CHAMP observations also suggests a small warm bias in the Met Office data in June. However, this bias cannot fully explain the differences observed.

Analysis of CHAMP data indicates that temperature perturbations associated with gravity waves may partially explain the enhanced PSC incidence observed in June (relative to the Met Office analyses). For this month, approximately 40% of the temperature threshold crossings observed using CHAMP RO data are associated with small-scale perturbations. Examination of the distribution of temperatures relative to T_{NAT} shows a large proportion of June data to be close to this threshold, potentially enhancing the importance of gravity wave induced temperature perturbations. Inspection of the longitudinal structure of PSC occurrence in June 2005 also shows that regions of enhancement are geographically associated with the Antarctic Peninsula; a known mountain wave "hotspot". The latitudinal variation of POAM III observations means that we only observe this region in June–July, and thus the true pattern of enhanced PSC production may continue operating into later months.

The analysis has shown that early in the Antarctic winter stratospheric background temperatures are close to the T_{NAT} threshold (and PSC formation), and are thus sensitive to temperature perturbations associated with mountain wave activity near the Antarctic peninsula (40% of PSC formation). Later in the season, and at latitudes away from the peninsula,

temperature perturbations associated with gravity waves contribute to about 15% of the observed PSC (a value which corresponds well to several previous studies). This lower value is likely to be due to colder background temperatures already achieving the T_{NAT} threshold unaided. Additionally, there is a reduction in the magnitude of gravity waves perturbations observed as POAM III samples poleward of the peninsula.

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