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Influence of mountain waves and NAT nucleation mechanisms on polar stratospheric cloud formation at local and synoptic scales during the 1999-2000 Arctic winter

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Abstract. A scheme for introducing mountain wave-induced temperature pertubations in a microphysical PSC model has been developed. A data set of temperature fluctuations attributable to mountain waves as computed by the Mountain Wave Forecast Model (MWFM-2) has been used for the study. The PSC model has variable microphysics, enabling different nucleation mechanisms for nitric acid trihydrate, NAT, to be employed. In particular, the difference between the formation of NAT and ice particles in a scenario where NAT formation is not dependent on preexisting ice particles, allowing NAT to form at temperatures above the ice frost point, T_{ice}, and a scenario, where NAT nucleation is dependent on preexisting ice particles, is examined. The performance of the microphysical model in the different microphysical scenarios and a number of temperature scenarios with and without the influence of mountain waves is tested through comparisons with lidar measurements of PSCs made from the NASA DC-8 on 23 and 25 January during the SOLVE/THESEO 2000 campaign in the 1999-2000 winter and the effect of mountain waves on local PSC production is evaluated in the different microphysical scenarios. Mountain waves are seen to have a pronounced effect on the amount of ice particles formed in the simulations. Quantitative comparisons of the amount of solids seen in the observations and the amount of solids produced in the simulations show the best correspondence when NAT formation is allowed to take place at temperatures above T_{ice}. Mountain wave-induced temperature fluctuations are introduced in vortex-covering model runs, extending the full 1999-2000 winter season, and the effect of mountain waves on large-scale PSC production is estimated in the different microphysical scenarios. It is seen that regardless of the choice of microphysics ice particles only form as a consequence of mountain waves whereas NAT particles form readily as a consequence of the synoptic conditions alone if NAT nucleation above T_{ice} is included in the simulations. Regardless of the choice of microphysics, the inclusion of mountain waves increases the amount of NAT particles by as much as 10%. For a given temperature scenario the choice of NAT nucleation mechanism may alter the amount of NAT substantially; three-fold increases are easily found when switching from the scenario which requires pre-existing ice particles in order for NAT to form to the scenario where NAT forms independently of

ice.

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