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Climatological features of stratospheric streamers in the FUB-CMAM with increased horizontal resolution

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Abstract. The purpose of this study is to investigate horizontal transport processes in the winter stratosphere using data with a resolution relevant for chemistry and climate modeling. For this reason the Freie Universität Berlin Climate Middle Atmosphere Model (FUB-CMAM) with its model top at 83 km altitude, increased horizontal resolution T42 and the semi-Lagrangian transport scheme for advecting passive tracers is used.
A new approach of this paper is the classification of specific transport phenomena within the stratosphere into tropical-subtropical streamers (e.g. Offermann et al., 1999) and polar vortex extrusions hereafter called polar vortex streamers. To investigate the role played by these large-scale structures on the inter-annual and seasonal variability of transport processes in northern mid-latitudes, the global occurrence of such streamers was calculated based on a 10-year model climatology, concentrating on the existence of the Arctic polar vortex. For the identification and counting of streamers, the new method of zonal anomaly was chosen. The analysis of the months October-May yielded a maximum occurrence of tropical-subtropical streamers during Arctic winter and spring in the middle and upper stratosphere. Synoptic maps revealed highest intensities in the subtropics over East Asia with a secondary maximum over the Atlantic in the northern hemisphere. Furthermore, tropical-subtropical streamers exhibited a higher occurrence than polar vortex streamers, indicating that the subtropical barrier is more permeable than the polar vortex barrier (edge) in the model, which is in good correspondence with observations (e.g. Plumb, 2002; Neu et al., 2003). Interesting for the total ozone decrease in mid-latitudes is the consideration of the lower stratosphere for tropical-subtropical streamers and the stratosphere above ~20 km altitude for polar vortex streamers, where strongest ozone depletion is observed at polar latitudes (WMO, 2003). In the lower stratosphere the FUB-CMAM simulated a climatological maximum of 10% occurrence of tropical-subtropical streamers over East-Asia/West Pacific and the Atlantic during early- and mid-winter.

The results of this paper demonstrate that stratospheric streamers e.g. large-scale, tongue-like structures transporting tropical-subtropical and polar vortex air masses into mid-latitudes occur frequently during Arctic winter. They can therefore play a significant role on the strength and variability of the observed total ozone decrease at mid-latitudes and should not be neglected in future climate change studies.

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