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Numerical simulation of the sensitivity of the mean meridional circulation in the middle atmosphere to the mountain waves during stratospheric warmings

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Dynamical interactions between tropospheric and stratospheric layers have recently received increasing attention. These interactions intensify during stratospheric warming (SW) events. In this study, numerical simulations have been performed to estimate the transformation of the mean meridional circulation in altitude range 0 – 100 km at different phases of simulated SW events in January-February including and excluding impact of mesoscale orographic gravity waves (OGWs). To achieve statistical significance an ensemble of 12 pairs of model runs with and without a parameterization of OGW effects has been performed using the numerical middle and upper atmosphere model (MUAM). Nowadays, MUAM is one of a few mechanistic GCM in the world able to reproduce major stratospheric warmings. Obtained results demonstrate weakening of the zonal mean meridional circulation at altitudes up to 100 km during and after simulated SWs compared to the time intervals before SWs. At altitudes below 50 km, southward mean meridional winds decrease (up to 15%) before and after simulated SWs. OGW effects may increase the mean northward wind at altitudes above 60 km up to 10 – 15 %. The most significant changes of the meridional circulation in the middle atmosphere are detected at the middle and high latitudes of the Northern Hemisphere: the southward meridional circulation increases at altitudes above 40 km and decreases below 40 km. Thus, the global-scale mean meridional circulation in the middle atmosphere may significantly depend on different phases of SW events during the northern winter season. It is also quite sensitive to the dynamical and thermal OGW impacts.