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Planetary and synoptic scale adjustment of the Northern Hemisphere atmosphere to stratospheric ozone changes

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Unforced complex climate model simulations with prescribed and with interactive stratospheric ozone chemistry are analysed by computing the barotropic and baroclinic Eliassen-Palm (EP) fluxes in tropo- and stratosphere. It is shown that naturally occurring changes between high and low Arctic Oscillation (AO) phases exert a strong influence on the Northern Hemisphere storm tracks. Two time slices with positive and negative AO phases have been analyzed with respect to the feedbacks between the time-mean flow, the quasi-stationary planetary and the baroclinic waves. Owing to the interactive chemistry the long planetary wave fluxes from the troposphere into the stratosphere are increased. This enhances the wave drag and weakens the stratospheric polar vortex winds. The inadequate treatment of stratospheric dynamics in the IPCC AR4 models is characterized by an unrealistically intense polar vortex which prevents penetration of planetary waves and makes the winter vortex too stable. The reduction of the polar vortex strength due to interactive ozone chemistry therefore improves the feedback description between tropo and stratosphere with more realistic EP fluxes. During the positive AO phases the strong stratospheric vortex is accompanied by enhanced transient EP fluxes in the troposphere. During negative AO phases connected with a weak stratospheric vortex the stationary EP fluxes in the lower stratosphere are increased.