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Downward propagation of anomalies from the stratosphere to the troposphere in high top/low top versions of three climate models

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In winter mid-latitudes zonal mean wind anomalies propagate downward from the upper stratosphere to the surface on a time-scale of a week to a few months. Although the mechanism of the downward propagation is still disputed and several mechanisms have been suggested its potential for extended range forecasts has drawn substantial interest. It has been demonstrated (Christiansen 2005) that simple statistical forecasts based on stratospheric information perform as well as a state-of-the-art dynamical seasonal forecast model when forecasting the surface zonal mean zonal wind at 60 N and the temperature in northern Europe. The stratosphere-troposphere coupling might therefore offer an important contribution for improving dynamical forecasts when it is properly implemented in the forecast system.

While at least some climate models include a good representation of the downward propagation it is not obvious what the requirements for a good representation are. In this paper we investigate the differences in the downward propagation in historical CMIP5 simulations with low and high top versions of three different climate models, EC-Earth, HadGEM2, and CMCC. We have the compared historical model experiments with the ERA reanalysis. Efforts have been made to qualify results with estimates of their statistical significance.

We find that while all the models show a downward propagation from the stratosphere to the troposphere there are differences in both stratospheric and tropospheric time-scales. In general the high top versions have improved over the low top versions when compared to the reanalysis. The smallest changes are found for the model, EC-Earth, which low top version already included a well resolved stratosphere. We relate the changes of the downward propagation to changes in the stratospheric variability and to changes in the wave forcing (EP-flux) from the troposphere.

Reference:

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