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The influence of different El Nino types on the northern hemisphere stratosphere simulated by the MPI-ESM

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It is known that the El Nino Southern Oscillation (ENSO), although it is mainly a tropospheric phenomenon, has an impact on the polar winter stratosphere [e.g. van Loon and Labitzke, 1987: Camp and Tung, 2007]. This has also been shown in simulations with general circulation models (GCM) [Sassi,et al. 2004, Manzini et al. 2006]. For a couple of years there are discussions about two different "flavors" of the the El Nino, the central Pacific (or Modoki) El Nino and the east Pacific El Nino [e.g. Wang and Weisberg, 2000; Yu and Kao, 2007; Ashok et al. 2007]. An observational study [Graf and Zanchettin, 2012] indicate that the polar vortex is more disturbed during EP El Ninos.

Here we to investigate the influence of the equatorial sea surface temperatures on the stratosphere-troposphere coupling in the northern hemisphere winter season in a fully coupled atmosphere-ocean-land GCM. We use two versions of the Max-Planck-Institute for Meteorology model MPI-ESM, namely MPI-ESM-LR with lower T63 L47 atmosphere and GR15 ocean resolution and the MPI-ESM-MR with the same horizontal resolution in the atmosphere but a higher resolution in the vertical (L95) and in the ocean (TP04). To exclude effects of natural and anthropogenic forcing, we analyze a 1000 year coupled control simulation with pre-industrial greenhouse gas concentration and constant solar forcing (piControl). For comparison with reananlyis data we also analyze uncoupled atmosphere-only simulations with observed sea surface temperatures from 1979 until 2008 (AMIP). We compare three ways of defining El Nino: the central Pacific (CP), the east Pacific (EP) and the canonical Nino3.4 El Nino. We show to what extent the MPI-ESM is able to simulate these different types of El Nino and how they affect the polar stratosphere.

The MPI-ESM model is in both versions capable of producing CP and EP El Ninos. However, the CP El Nino is dominant one in terms of magnitude and the EP El Nino has a relative small impact on global surface temperature and precipitation. In the polar stratosphere however, the warm temperature anomaly is stronger for EP El Ninos which is in agreement with NCEP reanalysis data [Graf and Zanchettin, 2012]. Defining the El Nino according to the Nino3.4 Index, the surface temperature and precipitation pattern reveals a very similar pattern compared to the CP El Ninos. However, significant impact on the stratosphere is only visible in the MPI-ESM-MR resolution. In the lower resolution version the signal is absent. Potential reasons for this behavior could be related to e.g. the different horizontal resolution of the ocean or the interactively calculated Quasi-biennial Oscillation (QBO) which is only simulated in MPI-ESM-MR . These factors as well as the combined QBO and El Nino effect, which is not linear [Calvo et al., 2009], will be further discussed for the different types of El Nino.