EMS7/ECAM8 Abstracts,
Vol. 4, EMS2007-A-00620, 2007
7th EMS Annual Meeting / 8th ECAM

Comparing ENSEMBLES models with different resolution of the stratosphere in climate simulations

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We analyse the vertical structure of temperature and wind and its relation to sea level pressure patterns for present-day and future climate with special emphasis on the SRES A1b scenario for seven European AO-GCMs participating in the EU-project ENSEMBLES (ECHAM5/MPI-OM (MPI-M, Germany), CNRM-CM3 (CNRM, France), IPSL-CM4 (IPSL, France), HadGEM1 (METEO-HC, GB), HadCM3 (METEO-HC, GB), EGMAM (FUB, Germany), and BCM2 (NERSC, Norway)) Four of these models have the top level at 10hPa, HadGEM extends up to 3.1 hPa, while the other two have additional layers to represent the stratosphere: the CNRM-CM3 extends up to 0.05 hPa and the FUB-EGMAM extends up to 0.01h Pa. Vertical resolution ranges from 19 layers (HadCM3, IPSL-CM4) to 45 layers (CNRM-CM3).

Comparison of present-day simulations with ERA40 data for the time period from 1980 to 1999 shows that all models capture the main structure of the zonal mean zonal wind and zonal mean temperature for NH winter season (DJF) and reveal an adequate representation of the tropospheric jet streams.

For the climate change scenarios the ensemble mean atmospheric temperature signal for NH winter reveals the GHG induced tropospheric warming and stratospheric cooling. All models show maximum warming in the lower polar troposphere and in the upper tropical troposphere. However, not all models display a cooling of the lower polar stratosphere. The changes in the zonal mean zonal wind are closely related to changes in the MSLP fields for all models.

The model with the highest top level, EGMAM, is able to produce polar stratospheric

warmings during northern winter, which is an improvement when compared with other models. The tropospheric warming trend in EGMAM leads to an increased number of stratospheric warmings in the future and a more disturbed stratospheric polar vortex. These changes are shown to effect the circulation in the troposphere leading to a weaker change in the zonal wind and MSLP field. In contrast to EGMAM the CNRM-CM3 model simulates a strengthening of the stratospheric polar vortex and a stronger increase of tropospheric westerlies in mid-latitudes. Both results confirm the concept that changes in the tropospheric circulation are related to changes in the stratospheric circulation.