Atmospheric Chemistry and Physics
An Interactive Open Access Journal of the European Geosciences Union

Atmos. Chem. Phys., 6, 863-881, 2006
www.atmos-chem-phys.net/6/863/2006/

Large-scale atmospheric circulation biases and changes in global climate model simulations and their importance for climate change in Central Europe

A. P. van Ulden and G. J. van Oldenborgh
KNMI, P.O. Box 201, 3730 AE De Bilt, The Netherlands

Abstract. The quality of global sea level pressure patterns has been assessed for simulations by 23 coupled climate models. Most models showed high pattern correlations. With respect to the explained spatial variance, many models showed serious large-scale deficiencies, especially at mid-latitudes. Five models performed well at all latitudes and for each month of the year. Three models had a reasonable skill.
We selected the five models with the best pressure patterns for a more detailed assessment of their simulations of the climate in Central Europe. We analysed observations and simulations of monthly mean geostrophic flow indices and of monthly mean temperature and precipitation. We used three geostrophic flow indices: the west component and south component of the geostrophic wind at the surface and the geostrophic vorticity. We found that circulation biases were important, and affected precipitation in particular. Apart from these circulation biases, the models showed other biases in temperature and precipitation, which were for some models larger than the circulation induced biases.

For the 21st century the five models simulated quite different changes in circulation, precipitation and temperature. Precipitation changes appear to be primarily caused by circulation changes. Since the models show widely different circulation changes, especially in late summer, precipitation changes vary widely between the models as well. Some models simulate severe drying in late summer, while one model simulates significant precipitation increases in late summer. With respect to the mean temperature the circulation changes were important, but not dominant. However, changes in the distribution of monthly mean temperatures, do show large indirect influences of circulation changes. Especially in late summer, two models simulate very strong warming of warm months, which can be attributed to severe summer drying in the simulations by these models. The models differ also significantly in the simulated warming of cold winter months. Finally, the models simulate rather different changes in North Atlantic sea surface temperature, which is likely to impact on changes in temperature and precipitation. These results imply that several important aspects of climate change in Central Europe are highly uncertain. Other aspects of the simulated climate change appear to be more robust. All models simulate significant warming all year round and an increase in precipitation in the winter half-year.

Final Revised Paper (PDF, 1739 KB) Discussion Paper (ACPD)

Citation: van Ulden, A. P. and van Oldenborgh, G. J.: Large-scale atmospheric circulation biases and changes in global climate model simulations and their importance for climate change in Central Europe, Atmos. Chem. Phys., 6, 863-881, 2006. Bibtex EndNote Reference Manager