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CMIP3 Surface and Upper Air Parameters over Europe: Their Quality, Climate Trends, and Suitability as Driving Data for Regional Climate Simulations

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The quality of Regional Climate Model (RCM) simulations is strongly dependent on the quality of their lateral boundary conditions delivered by Global Circulation Models (GCMs). Therefore, a detailed analysis of GCM driving data is an important, but often neglected precondition for regional climate modelling studies.

In this study, 24 GCMs from the Climate Model Intercomparison Project (CMIP3) are analysed with respect to performance in historic periods and trends in future scenario simulations. Multiple surface and upper air parameters are analysed. The model performance is evaluated against E-OBS and ERA-40 reference data for the period 1961 to 2000. Further, the climate change signals (CCSs) of two scenario periods 2021 to 2050 and 2071 to 2100 (reference period 1971 to 2000) are quantified and checked for significance. Finally, correlation between model performance and CCS is evaluated in order to reveal insights in the relation between model performance and climate sensitivity.

The results show that there is no perfect GCM but that a handful of models have an excellent performance in all seasons. Regarding climate trends, air temperature, specific humidity and geopotential height are increasing significantly in the scenario period. For other parameters like precipitation, the ensemble shows a mix of non significant signals and changes in both directions. Well performing GCMs show no significantly different CCSs than worse performing GCMs and they feature same CCS uncertainty (spread) compared to the entire ensemble.

The results of this study give a comprehensive overview on the performance and climate trends in the CMIP3 simulations over Europe and serve, amongst others, as basic information for the selection of driving data of European regional climate modelling studies.