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Effect of horizontal resolution on ECHAM6-AMIP performance

Eileen Hertwig (1), Jin-Song von Storch (1), Dörthe Handorf (2), and Klaus Dethloff (2)

(1) Max Planck Institute for Meteorology, Hamburg, Germany, (2) Alfred Wegener Institute for Polar and Marine Research, Potsdam, Germany

The effect of increasing horizontal resolution on the simulated mean climate state and climate variability is analyzed in the atmospheric general circulation model ECHAM6. For that purpose three AMIP-style simulations with the resolutions T63L95, T127L95, and T255L95 are compared to reanalysis data (ERA-Interim).

Besides looking at individual variables and phenomena, we introduce a global metric, a mean normalized error, to determine if the simulation improves overall when the horizontal resolution is increased. Biases in atmospheric fields as well as tropospheric and stratospheric biases individually are analyzed, since to our knowledge, the behavior of the stratospheric bias has so far not been analyzed systematically.

The main result is that, overall, the bias of the simulated climate improves with increasing resolution when considering the mean state and the variance. The improvement for the mean state is greater than for the variance and the largest differences are found in the step from T63 to T127, while the T255 simulation shows smaller improvements compared to T127. The error in the stratosphere is generally stronger but the relative benefit of increasing resolution is greater than in the troposphere.

Some climate variability phenomena and climate modes also show sensitivity toward horizontal resolution. However, for others the model results hardly change with horizontal resolution. This may partly be explained by inadequate tuning for the high resolution version of ECHAM6. Major challenges remain in the simulation of the precipitation and climate features like the MJO, which might require a coupled atmosphere-ocean model.