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Anthropogenic changes in the planetary wave structure over the North Atlantic and Western Europe during winter

R. Haarsma and F. Selten
KNMI, Research, De Bilt, Netherlands (haarsma@knmi.nl)

The dynamical mechanisms that cause the anthropogenic change in the planetary wave structure over the North Atlantic and Western Europe during winter in CMIP3 and CMIP5 models have been analyzed.

The change in the zonal velocity is, due to the thermal wind relationship, tied to relative changes in the meridional temperature profile. The dominant relative changes in the meridional temperature profile over the North Atlantic are a subtropical heating and a mid-latitude cooling. The first is related to the downward advection of upper tropospheric tropical heating, whereas the latter is related to changes in ocean dynamics and mixing. The induced changes in meridional temperature gradient are key for understanding the simulated changes in the zonal wind profile by the CMIP3 and CMIP5 models.

The change in the meridional velocity is related to the anthropogenic weakening of the Walker circulation. The induced changes in the tropical upper tropospheric divergence modify the propagation of Rossby waves from the tropics to the extra-tropics. The response has a wave number five pattern and can be simulated with a barotropic vorticiy model forced with a Rossby wave source that is computed from the change in the tropical upper tropospheric divergence. For the Western Europe the most prominent source region resides in the subtropical Atlantic.