

Anthropogenic changes in the Walker circulation and the impact on extra-tropical planetary wave structure

Rein Haarsma[†]; Frank Selten; Wilco Hazeleger

[†]Royal Netherlands Meteorological Institute (KNMI), Netherlands

Leading author: haarsma@knmi.nl

A robust change in the tropical circulation induced by anthropogenic warming is a weakening of the Walker circulation. This weakening is approximately uniform. It affects the upper tropospheric divergence thereby modifying the propagation of Rossby waves from the tropics into the extra-tropics. This can be modeled by the barotropic vorticity equation forced with a Rossby wave source that is computed from the upper tropospheric divergence. Using the barotropic vorticity equation as a diagnostic tool it is demonstrated for the AR4 IPCC models that the weakening of the Walker circulation has a significant impact on the extra-tropical planetary wave structure and to a large extent explains the observed changes in the AR4 IPCC models. The dominant response is a circumglobal wavenumber five pattern in the meridional wind similar to the circumglobal waveguide pattern (CWP). This analysis implies that a correct simulation of the Walker circulation and its response to anthropogenic changes are crucial for a correct simulation of the anthropogenic change in the extra-tropical planetary wave structure. Structure and intensity of the Walker circulation of the AR4 IPCC models show significant deviations from the Walker circulation as diagnosed from the ERA Interim and NCEP/NCAR reanalysis. Improving the simulation of the Walker circulation will thus narrow the uncertainty in the anthropogenic change of the extra-tropical planetary wave structure.