



The Eastward Shift of the Walker Circulation in response to Global Warming and its relationship to ENSO variability

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This study investigates the global warming response of the Walker Circulation and the other zonal circulation cells (represented by the zonal stream function) in a CMIP5 multi-model ensemble (MMEns) under the RCP4.5 scenario. The changes in the mean state are presented as well as the changes in the modes of variability.

The mean zonal circulation weakens nearly everywhere along the equator. Over the Pacific the Walker cell also shows a significant eastward shift. These changes in the mean circulation are very similar to the leading mode of interannual variability in the tropical zonal circulation cells, which is dominated by ENSO variability. During an El Niño event the circulation weakens and the rising branch over the Maritime Continent shifts to the east in comparison to neutral conditions (vice versa for a La Niña event). Two thirds of the global warming forced trend of the Walker cell can be explained by a long-term trend in this interannual variability pattern, i.e. a shift towards more El Niño-like conditions in the multi-model mean under global warming.

In interannual variability the zonal circulation exhibits an asymmetry between El Niño and La Niña events. El Niño anomalies are located more to the east compared to La Niña anomalies. Consistent with this asymmetry we find a shift to the east of the dominant mode of variability of zonal stream function under global warming. All these results vary among the individual models, but the MMEns of CMIP3 and CMIP5 show in nearly all aspects very similar results, which underline the robustness of these results.

The observed data (ERA Interim reanalysis) from 1979 to 2012 shows a westward shift and strengthening of the Walker Circulation. This is opposite to what the results in the CMIP models reveal. However, 75% of the trend of the Walker Cell can again be explained by a shift of the dominant mode of variability, but here towards more La Niña-like conditions. Thus long-term trends of the Walker cell seem to follow to a large part the pre-existing dominant mode of internal variability.