Geophysical Research Abstracts
Vol. 16, EGU2014-3729, 2014
EGU General Assembly 2014

Emergent constraints on regional climate change projections

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While relying on output from multiple models for climate projections is standard practice, there is no consensus on how best to combine simulations from a multimodel ensemble as of yet. Here we apply the recently proposed "Second-order Exchangeability Analysis for Multimodel Ensembles" by Rougier et al. to study the effect of recent observed regional change as a constraint on future expected change. In this approach to combine multimodel ensembles, the climate model outputs in the ensemble are assumed to be exchangeable whereas the ensemble mean differs from the true climate system. Observations of the climate system are then used to estimate this "ensemble discrepancy" and the updated projections.

We analyse the relationship between recent trends and future projections in near-surface temperature, rainfall and sea level pressure using simulations of the CMIP5 ensemble. Preliminary results indicate that up to 40% of the variability in projected changes is related to recent trends. At present, observed regional climate change therefore provides only weak constraints for future projections. The greenhouse gas (GHG) component of recent change, however, provides much stronger constraints. This highlights the differences in the regional response to non-GHG forcing across different models and the need to better understand the causes of observed regional change to find more relevant constraints for regional projections. We validate the approach in a perfect model framework using alternative models from the CMIP5 archive as pseudo-observations. Finally, we compare projected regional changes with and without observational constraints. In most regions we find little difference between the constrained and unconstrained projections due to the weak relationship between recent and future change and/or the consistency of observed recent change with simulated recent changes.