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Impact of atmospheric small-scale fluctuations on climate sensitivity

R. Seiffert (1,2), J.-S. von Storch (1)

(1) Max Planck Institute for Meteorology, Hamburg, Germany, (2) International Max Planck Research School on Earth System Modelling, Germany (contact: rita.seiffert@zmaw.de)

The estimation of the climate response to increasing greenhouse gas concentrations is one of the main challenges in complex numerical climate modelling. However, all numerical models have finite spatial and temporal resolutions. The impact of not resolved processes is parameterised without taking the variability induced by subscale processes into account.

Our hypothesis states that the negligence of this small-scale variability can lead to an over-/underestimation of the climate sensitivity. If the assumption is made that the climate response can be estimated by using the fluctuation dissipation theorem as suggested by Leith(1975), the response of a large-scale variable to CO_2 forcing would crucially depend on its statistics in the undisturbed system. Hence, if the statistics of the large-scale variable are altered due to the missing small-scale variability, the lack of small-scale variability could cause an incorrect climate response.

Using a coupled atmosphere-ocean general circulation model (ECHAM5/MPI-OM) experiments with enhanced small-scale variability are done. White noise is added to spectral coefficients with high total wave numbers. The enhanced small-scale variability leads to a reduction in temperature response by 5-15%. The experiments are further used to assess the validity of the fluctuation dissipation theorem.