Geophysical Research Abstracts
Vol. 20, EGU2018-18392, 2018
EGU General Assembly 2018

At which spatiotemporal scales, and in which climate states, can the linear temperature response hypothesis be rejected by data?

Hege-Beate Fredriksen, Martin Rypdal, and Kristoffer Rypdal
UiT the Arctic University of Norway, Mathematics and Statistics, Tromsø, Norway (hege-beate.fredriksen@uit.no)

On global scale, the global mean surface temperature is forced by imbalances in the vertical radiation budget. In general, temperatures respond nonlinearly to the forcing, but averaged over space and time the nonlinear processes can often be represented as linear transport processes characterized by anomalous (turbulent) transport coefficients. For instance, heat exchange between different part of the climate system can be described as heat fluxes proportional to temperature differences and thus lay the foundation for the construction of linear multi-box energy balance models that have proven effective in reproducing the response functions of Earth System Models (ESMs). On the other hand, even in the global temperature, there are fluctuations (internal variability) that are not forced. These are the result of nonlinear, turbulent processes over a vast range of scales, but a testable hypothesis is to assume that these fluctuations can be represented as a stochastic process that can be added linearly to a deterministic, linear forced response. In this work we use instrumental temperature data and ESM runs to test the validity of this hypothesis. While it is clear that the hypothesis is not rejected by the data for the global temperature in a climate system close to radiative equilibrium, the interesting part is to explore its validity on spatiotemporal scales for which multidecadal and shorter variability is resolved, or for climate states that depart strongly from equilibrium. For sufficiently small scales the internal variability dominates the temperature signal, and the linearity of the deterministic response is impossible to test. However, for small spatial scales there is available much more data, and there is a vast literature of nonlinear time series analysis designed to detect nonlinear modes of the climate system. We focus on higher-order spectral analysis which potentially can detect nonlinear energy transfer across scales through resonant mode coupling. Our investigations cast doubt on the validity of the conclusions of Huybers and Curry (2006)1; who suggest that that the scaling behavior of the variability on interannual to centennial scales is a result of a nonlinear cascade of three-mode resonant interactions driven by seasonal forcing.

1 P. Huybers and W. Curry, Nature, 441, 329-332 (2006)