First Lorenz workshop workshop abstract

Weather Regimes and a Stochastic/Deterministic Strategy for Ultra-High Resolution Simulation of Earth's Water Cycle.

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Abstract:

The water cycle is intimately coupled to the circulation patterns of Earth's climate. We won't have confidence in our ability to simulate changes in the former if we don't have confidence in simulating changes in the latter. Of particular relevance are weather regimes: idealized numerical experiments with Lorenz's '63 system suggest that these regimes can respond dynamically to external forcing in a highly nonlinear way. Hence, if the real climate system has regimes, it is crucial that our climate models can simulate regime structures accurately if we are to estimate regional changes in the water cycle with confidence.

In the first part of the talk, evidence will be presented for the existence of regime structures (and their linkage to the water cycle) from reanalysis data. Then, simulations of weather regime from output of the ECMWF model at various resolutions (from T159 to T1279) and using stochastic and deterministic parametrisations, will be discussed. Results show that high-wavenumber variability (>T511) appears important in being able to simulate non-gaussianity in general, and observed regime structures (and hence the precipitation patterns associated with these structures) in particular. However, it may not be necessary to simulate this high frequency variability deterministically.

The results suggest a new strategy for the development of the dynamical cores of high-resolution cloud resolved spectral climate models. In particular it is proposed that the degree of numerical precision of floating point real numbers, and of the extent to which computations are fully bit reproducible (both of which put significant demands on scarce energy and computational resources) are treated as scale-dependent. The concept is explored with the Lorenz '96 system where the "small scale" variables are treated with reduced precision and run on emulators of ultra-fast energy-efficient stochastic processing hardware. Some corresponding but preliminary results from the ECMWF dynamical core will also be shown.