WAVETRISK dynamically adaptive climate model coupled to dry physics and orography

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Abstract

Adaptive global circulation models (GCMs) could significantly improve the computational efficiency and accuracy of climate simulations by dynamically adjusting the local grid resolution to ensure a specified numerical tolerance or to track features of interest. However, it is unclear how well dynamically adaptive dynamical cores perform when coupled to various physics sub-models. It is also an open question whether, or to what extent, these physics sub-models must be made scale aware to cope with time-dependent horizontal grid resolution. Apart from the long-term goal of building dynamically adaptive earth system models (ESM), understanding how physics models respond to changing grid resolutions also helps better understand the sensitivities of non-adaptive climate models.
This talk reports on significant progress towards the goal of developing an adaptive climate model: coupling of the WAVETRISK-ATMOSPHERE hydrostatic adaptive dynamical core with Hourdin's (1992) "simple dry physics", and with a consistent multiscale representation of the NCAR global topography model. Our results suggest that no scale-aware modifications of the dry physics are needed to deal with the dynamically changing local horizontal resolution. We find it is possible to include orography in an adaptive dynamical core using a relatively simple multiscale representation of the underlying topography. In addition to developing a multiscale topography representation, we have implemented a standard subgrid scale orography (SSO) parameterization for unresolved orography, which models mountain drag and blocking effects (Lott & Miller 1997, Japanese Meteorological Agency 2019).

These results characterize the climatology of the simple dry physics model, which positions it as an intermediate idealized physics between the Held and Suarez (1995) model and moist physics models. We propose that Hourdin's simple dry physics could be a useful foundation for more realistic test cases.
This is joint work with Gabrielle Ching-Johnson (Meteorology Department, Reading University, UK), Thomas Dubos (LMD, École Polytechnique, France) and Peter Lauritzen (NCAR, Boulder, USA).

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