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NAM-SCA: A New Approach for High-Resolution Cloud Modelling

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Advent of global cloud-resolving model (CRM) achieved by Japanese Earth Simulator often leads to an extremely misleading argument that all the parameterization problems will be replaced by explicit high-resolution modelling. However, this type of arguments totally forget the fact that CRM itself is built up on various subgrid-scale parameterizations. Thus we need to move beyond this type of "brutal" high resolution modelling approaches by seeking methodologies (not necessarily parameterization) for correctly and more efficiently representing complex atmospheric processes of smaller and smaller scales.

In order to advance towards this goal, we propose the approach of NAM-SCA: Nonhydrostatic Anelastic Model under Segmentally-Constant Approximation. The idea for this model is inspired from various different sources. First of all, a branch of mathematics called the multiresolution analysis provides a philosophical basis for pursuing this possibility: in the same sense as wavelet can extensively compress an image, the multiresolution analysis provides extensive possibilities for compressing numerical models. Application of this principle into practice leads to a very flexible time-dependent mesh refinement or nesting, far more extensively than conventional approaches can provide. A "deconstruction" analysis of the mass flux convective analysis, on the other hand, reveals that the mass flux decomposition itself can be used for this purpose: NAM is simply decomposed into an ensemble of mass flux modes, purely as a geometrical representation, under a spirit of multiresolution analysis, but without any further approximations. We call this representation as SCA due to its geometrical constraint.

NAM-SCA can run much efficiently than conventional CRM by adopting high resolutions only where they are required, and potentially it can achieve a much higher resolution than the current CRM can achieve. A two-dimensional version is already operational available. Possibility of three-dimensional version will also be discussed, as well as implications for the downscaling problem.

References:

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