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Downscaling, parameterization, decomposition, compression: a perspective from the multiresolution analysis

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Abstract. Geophysical models in general, and atmospheric models more specifically, are always limited in spatial resolutions. Due to this limitation, we face with two different needs. The first is a need for knowing (or "downscaling") more spatial details (e.g., precipitation distribution) than having model simulations for practical applications, such as hydrological modelling. The second is a need for "parameterizing" the subgrid-scale physical processes in order to represent the feedbacks of these processes on to the resolved scales (e.g., the convective heating rate).

The present article begins by remarking that it is essential to consider the downscaling and parametrization as an "inverse" of each other: downscaling seeks a detail of the subgrid-scale processes, then the parameterization seeks an integrated effect of the former into the resolved scales. A consideration on why those two closely-related operations are traditionally treated separately, gives insights of the fundamental limitations of the current downscalings and parameterizations.

The multiresolution analysis (such as those based on wavelet) provides an important conceptual framework for developing a unified formulation for the downscaling and parameterization. In the vocabulary of multiresolution analysis, these two operations may be considered as types of decompression and compression. A new type of a subgrid-scale representation scheme, NAM-SCA (nonhydrostatic anelastic model with segmentally-constant approximation), is introduced under this framework.

Full Article in PDF (PDF, 925 KB)

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