Spatial scale separation of limited area models in the context of spectral nudging and isotropic discrete filtering

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The concept of spatial scale separation is analyzed in terms of model evaluation and dynamical downscaling techniques.
The main objective in downscaling is to obtain regional weather phenomena that are influenced by the local topography or other small scale features. The continental scale atmospheric state is assumed to be well resolved in global reanalyses data and thus it is to be retained by a regional model.
For some meteorological conditions, like blocking weather situations, a regional model may simulate large scale features which do no agree with the large scale state of the global forcing data. The application of a spectral nudging technique forces the regional model to approximate the large scales to the reanalysis data for the whole integration area while the small scales are computed exclusively by the regional model.
Large-scale control of regional climate modeling overcomes the fundamental problem of dealing with an ill-posed boundary value problem, but its usefulness depends on the specific application. The method of spectral nudging in regional climate modeling is discussed, and its utility in forcing the known large-scale state without suppressing regional and local variability is demonstrated.

Also, spatial scale separation can be used for limited area model evaluation purposes. A two-dimensional discrete filter was developed which serves as a tool to classify meteorological fields according to their spatial dimensions by filtering certain wave number ranges. Thereby it performs an isotropic spatial scale separation of the limited area model fields.
The filter algorithm is presented and examples demonstrate the scale separation of atmospheric fields on limited area grids which can be used for model evaluation, comparisons or process studies.

References :

Von Storch, H., H. Langenberg, and F. Feser, 2000:
A Spectral Nudging Technique for Dynamical Downscaling Purposes
Monthly Weather Review Vol. 128, Nr. 10, pp 3664-3673

Weisse, R. and F. Feser, 2003:
Evaluation of a method to reduce uncertainty in wind hindcasts performed with regional atmosphere models
Coastal Engineering, Volume 48(4), 211-225.