On the appropriateness of spectral nudging in regional climate models

Regional climate models (RCMs) are increasingly being employed to address issues of major societal importance. Dynamical downscaling data from a coarser driving model may be classified into four types. Numerical weather prediction is considered Type 1, in which sensitivity to initial conditions is retained. Higher order types (2 and above) are considered RCMs, in which the initial conditions of the model are "forgotten" but lateral boundary conditions feed data into the regional model. This encompasses the use of RCMs for both seasonal climate forecasting and climate change projection. It is an a priori expectation that RCMs should retain or enhance variability of synoptic-scale features and add information on the smaller scale because of enhanced resolution and differences in model physics. Experiments with two RCMs show, however, that absent some sort of interior nudging to the model, large-scale variability is systematically lost and this problem worsens with larger domain size and coarser grid spacing. Spectral nudging is the best approach in RCM dynamical downscaling because it yields less reduction in added variability of smaller scales that grid nudging. These lessons have been applied to produce seasonal climate forecasts and climate change projections with the WRF model, dynamically downscaling the NCEP CFS model and HadCM3 model, respectively. Preliminary results are shown that strongly support the application of spectral nudging to best represent the North American warm season, in terms of both climatology and interannual variability related to Pacific SST forcing.