Variable Resolution GCMs

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Variable resolution GCMs using a global stretched grid (SG) with enhanced regional resolution represent a viable new approach to regional and sub-regional climate and climate change studies and applications. The SG-approach is an ideal tool for representing consistent interactions of global/large- and regional/meso- scales. It is an alternative to the widely used nested grid approach introduced over a decade ago as a pioneering step in regional climate modeling.

Several existing SG-GCMs are described. The major results on regional climate simulation obtained with some of the models are presented in terms of optimal SG-designs, and efficiency of regional downscaling. The major discussion is based on the GEOS (Goddard Earth Observing System) SG-GCM regional climate simulations.

Seasonal simulations produced with the SG-GCM for the anomalous U.S. summer events, the drought of 1988, and the flood of 1993, are analyzed in detail. The experiments are aimed at assessing the impact of enhanced regional resolution for model dynamics, physics, and surface boundary forcing, on regional downscaling to mesoscales. The 1993 simulation results have been submitted to the PIRCS (Project to Intercompare Regional Climate Simulations). Also, the North American Monsoon System (NAMS) and its link to the Midwestern U.S. precipitation are studied.

The 1-year SG-GCM simulation using the new SG-design with multiple (four) areas of interest for the period of November 1997 to December 1998, the initial stage of the 1997-1999 ENSO cycle, is presented. The four areas include the major global monsoonal circulations over North America, South America, India-China, and Australia.

The preliminary results of a 10-year (1988-1998) SG-GCM simulation in terms of regional downscaling are analyzed. The 1-year and 10-year experiments show the potential of the SG-approach for long-term regional climate simulations.

The GEOS SG-DAS incorporating the GEOS SG-GCM has been developed. It used for producing enhanced resolution regional analyses and diagnostics for the SG-GCM validation along with other independent high resolution observational data (like gauge precipitation, surface temperature, and surface sea winds).

Brief information on the two new SG-GCMs that are being developed is provided. The first (in collaboration with K.Yeh) is the SG-version of the new NASA/NCAR

FV-GCM (with the finite-volume (FV) Lin-Rood (1996,1997) dynamics), and the second (in collaboration with F.Baer, A.Fournier, J.Tribbia, and M.Taylor) is the SG-version of the GCM with spectral-element dynamics. Both GCMs will use the NCAR CCM4/CAM physics. Using these advanced numerical techniques will provide increased computational efficiency for the new SG-GCMs, and will allow us to employ more flexible stretching strategies beneficial for the efficient regional downscaling.