A VARIABLE-RESOLUTION STRETCHED-GRID GENERAL CIRCULATION MODEL AND DATA ASSIMILATION SYSTEM WITH MULTIPLE AREAS OF INTEREST: STUDYING THE ANOMALOUS REGIONAL CLIMATE EVENTS OF 1998

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The GEOS (Goddard Earth Observing System) stretched-grid (SG) GCM and the GEOS SG-DAS have been developed and thoroughly tested over the last few years (Fox-Rabinovitz et al. 1997, 2000, 2001, 2002, Fox-Rabinovitz 2000). The model and system are used for regional climate experiments for seasonal, annual, and multiyear time scales. The following major results have been recently obtained.

Introduction of the new design of the stretched grid with multiple areas of interest allowed us to study simultaneously the variety of anomalous regional climate events of 1998 at mesoscale resolution. Both the SG-GCM simulation and SG-DAS assimilation products obtained with enhanced regional resolution are used in the study.

The new stretched-grid design with multiple (four) areas of interest, one at each global quadrant, is implemented into both a stretched-grid GCM and a stretched-grid data assimilation system (DAS). The four areas of interest include: the U.S./Northern Mexico, the El-Nino area/Central South America, India/China, and the Eastern Indian Ocean/Australia. Both the stretched-grid GCM and DAS annual (November 1997 through December 1998) integrations are performed with 50 km regional resolution while the maximum grid interval is about 3 degrees. The moderate stretching is used. The efficient downscaling to mesoscales is obtained for both the SG-GCM and SG-DAS for each of the four areas of interest while the consistent interactions between regional and global scales and the quality of global circulation is preserved. This is the advantage of the stretched-grid approach.

Also, the hurricanes, typhoons, and severe storms for the areas of interest and their vicinities are produced with the GEOS SG-DAS.

The areas of interest with enhanced regional resolution are located within each global quadrant that makes the grid-point global distribution more homogeneous than that of the original stretched grid design with one area of interest. Such homogeneity of a grid-point distribution affects positively the overall quality of global simulated and assimilated products.

The global fields and diagnostics are well reproduced by the SG-GCM simulation and SG-DAS assimilation. Their spectra are very close for all spectral ranges: the long-, medium-, and short-wave ones. The spectra are also close to that of the reference1x1 degree ECMWF reanalyses except for the shortest waves or mesoscales for which the stretched-grid spectra show larger energy due to higher resolution used for the large regions of interest.

The global zonal mean vertical distributions of prognostic variables are close to those of the reference 1x1 degree ECMWF reanalyses. The same is true for horizontal distributions of the prognostic and diagnostic fields. All that confirms that the high quality global characteristics are obtained for simulated and assimilated fields.

The simulated and assimilated anomalous regional climate events of 1998 include: the spring (April-June) flooding in the Midwest and Northeast and the drought in southeastern U.S.; the December-1997 - May-1998 Mexican drought; the Indian summer (June-September) monsoon; the severe summer (June-September) flooding in China; anomalous precipitation over Australia; anomalous March-May precipitation over South America; and precipitation over the African Sahel region. The above event simulation and data assimilation captured the major anomalies at medium and mesoscale resolution.

For all of the events the simulated and assimilated precipitation and/or precipitation anomaly patterns appeared to be close to each other and also close in many details to gauge precipitation data. Simulated precipitation is sometimes overestimated compared to that of assimilated or gauge data precipitation especially outside the areas of interest. Assimilated precipitation compares generally well with gauge data. The mesoscale features are adequately produced for both simulated and assimilated precipitation.

Other diagnostic and prognostic variables at different levels compare well with verifying data. All that shows the success of stretched-grid simulation and assimilation in terms of the efficient downscaling to realistic mesoscales.

The overall conclusion is that the SG-GCM simulation and SG-DAS assimilation produced realistic global and especially regional products that adequately represent the various anomalous regional climate events occurred in1998. Evidently, the quality of assimilated products is higher than that of simulated ones.

The obtained results show that both the SG-GCM and SG-DAS with multiple areas of interest are viable practical tools for simultaneous high-resolution simulations and data assimilations of regional climate events in all four global quadrants.

References

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