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Regional Climate Simulations with RIEMS2.0 (Regional Integrated Environment Modeling System) in China

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RIEMS1.0 (Regional Integrated Environmental Modeling System version 1.0) was developed by researchers from the START (Global change System for Analysis, Research, and Training) Regional Center for Temperate East Asia, IAP/CAS in 1998. The model was built on the thermodynamic frame of PSU/NCAR MM5V2, into which a land surface scheme (BATS1e) and radiative transfer scheme (the revised CCM3) are integrated. The model has been widely used in regional climate studies in the East Asia monsoon system and expresses excellent performance from RMIP (Regional Climate Model Inter-comparison Project). RIEMS2.0 is now being developed starting from RIEMS1.0 by the Key Laboratory of Regional Climate Environment Research for Temperate East Asia, IAP/CAS, and Nanjing University. The new version is built on the thermodynamic framework of nonhydrostatic approximation from MM5V3 with the same land surface model and radiation scheme as RIEMS1.0. To make it an integrated modeling system, the Princeton ocean mode (POM), Atmosphere-Vegetation interaction model (AVIM) and a chemical model are now being integrated.

In order to test RIEMS2.0's ability to simulate short-term climate, we perform ensemble simulations with different physics process schemes. The model will be used to perform ensemble simulations on two continuous extreme climate events, which is serve drought with high temperature in north China in the summer (June, July and August) of 1997 and serve flood in the Yangtze River valley in the summer of 1998. The results show that RIEMS2.0 can reproduce the spatial distribution of the precipitation and SAT from two continuous extreme climate events in the summer of 1997/1998, and disclose sub-regional characteristics. Though difference can be found among ensemble members, ensembles can decrease the model's uncertainty and improve the simulation decision in a certain degree. The model's performance on the precipitation and surface air temperature simulation can be improved with suitable physics process schemes.

In order to test RIEMS2.0's ability to simulate long-term climate and climate change, we compare simulated precipitation and surface air temperature (SAT) from 1980 to 2007 under different cumulus parameterization schemes with the observed data. The results show that RIEMS2.0 can reproduce the spatial distribution of precipitation and SAT, but that the model overestimates precipitation with the rainfall center moving northwestward and underestimates SAT for annual simulations. Annual, interannual variations and the anomalies in precipitation and SAT for different climate subregions are well captured by the model. Although similar distribution can be found between observed data and simulated results under different cumulus parameterization schemes, these show differences in intensity and location. Therefore, RIEMS2.0 shows good stability and does well in simulating the long-term climate and climate changes in China.

Further analysis on RIEMS2.0's performance in East Asia shows that the model can reproduce the characteristics of the East Asia Monsoon system, as well the rain belt movement. Simulated results and observed data for the monthly mean precipitation and SAT correlate well. There is nice consistency for the anomalies between the simulation and observation. RIEMS2.0 can disclose regional climate characteristics in East Asia in a certain degree.

Key words RIEMS2.0, Climate and climate change, Extreme climate event, Ensemble simulation, Simulation ability