RSM transferability studies during CEOP

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1. Introduction

The predominance of either dynamical or physical processes varies in different regions of the globe. Therefore, various regional models have been developed. As the regional simulation of the water- and energy cycle is very sensitive to how physical processes are represented within a regional model, transferability studies are a suitable approach to validate the performance of a regional model under different meteorological conditions.

The aim of this study is to evaluate the Regional Spectral Model (RSM) simulated energy and water budget by transferability studies. This is achieved by transferring the RSM to seven different domains taken from the Continental Scale Experiments (CSE). These domains are distributed all over the globe. The validation of RSM simulated cloudiness over these seven CSE domains showed already the benefit of transferability studies. The results of this study will also contribute to the ICTS (Inter CSE transferability study), where the performance of three regional models is evaluated by transferring them to the seven different CSEs (Rockel et al. 2004).

2. The Regional Spectral Model RSM

The regional spectral model (RSM) was initially developed by Juang and Kanamitsu (1994) (see also Juang et al. 1997 and Kanamitsu et al. 2004) to provide a regional extension to the parent global spectral model (GSM), and in principle provides an almost seamless transition between the RSM and the GSM or the associated NCEP reanalyses (Kalnay et al. 1996; Kanamitsu et al. 2002) and the higher resolution region of interest. Both the GSM and RSM use the same primitive hydrostatic system of virtual temperature, humidity, surface pressure and mass continuity prognostic equations on terrain-following sigma (sigma is defined as the ratio of the ambient pressure to surface pressure) coordinates. Therefore, in the absence of any regional forcing, and intrinsic internal dynamics, any significant physical parameterization differences, and significant spatial resolution the total RSM solution should be identical to the GSM solution. A minor structural difference is that the GSM utilizes vorticity, divergence equations, whereas the RSM utilizes momentum equations in order to have simpler lateral boundary conditions. The GSM and RSM horizontal basis functions are also different. The GSM uses spherical harmonics with a triangular truncation of 62 (T62) whereas the RSM uses cosine or sine waves to represent regional perturbations about the imposed global scale base fields on the regional grids. The double Fourier spectral representations are carefully chosen so that the normal wind perturbations are anti-symmetric about the lateral boundary. Other model scalar variables (i.e. virtual temperature, specific humidity, and surface log pressure) use symmetric perturbations. Several papers have described the RSM regional simulation capability. In short the RSM, like other regional models, provides increased focus for specific regions, can be constrained by realistic large-scale conditions, and can make use of higher resolution regional data sets for model validations.

3. Method

For each CSE domain two RSM runs have been carried out for July 1986 at 50 km horizontal resolution using NCEP reanalyses as initialization and boundary conditions. The only difference between these two model runs is the diagnostic cloud scheme: For one run the cloud scheme of Campana (1994) was used, in the other run the Slingo (1991) cloud scheme was used. These model runs were compared with ISCCP-D2 data. As the differences between model and data might not only be caused by model deficiencies, the ranges of uncertainties have to be estimated, first (Meinke et al. 2004). This has been done for uncertainties caused by the model initialization and boundary conditions provided by the NCEP reanalysis and for the uncertainties caused by the ISCCP cloud detection algorithm. The ranges of uncertainty are estimated using the concept of a confidence band (Meinke et al. 2004). The combined estimated range of these uncertainties is 12 %. Only if the differences between model and data exceed this uncertainty range, they can be identified as model deficiencies.

4. Results

The comparisons of the model runs and the ISCCP-D2 data indicate for all domains that the cloud cover derived by ISCCP is larger than the cloud cover simulated by both RSM runs. In some domains the difference of RSM and ISCCP does not exceed the estimated range of uncertainty of 12 %, in others it does. This clarifies the uncertainty of a validation result based on one certain domain: The cloud parameterization may give good results for one domain. However, it may show deficiencies for another domain with different meteorological conditions. Transferring the model to the 7 different CSE domains gives a better insight on how often the differences between RSM and ISCCP exceed the uncertainty range. There are for both model runs more cases where the difference exceeds the uncertainty range than cases where the difference does not exceed the range of uncertainty. This indicates that both cloud schemes have a deficiency regarding the simulation of cloud cover. Comparisons of the spatial distribution of clouds show that the two diagnostic cloud schemes used for the two different RSM runs have different strengths connected with different dynamical and physical processes.

Sensitivity tests for both cloud schemes with decreased relative humidity thresholds show that best results can be achieved with decreased relative humidity thresholds in the Slingo scheme. After adjustment of the relative humidity threshold most of the differences between RSM and ISCCP do not exceed the range of uncertainty.

5. Summary and Outlook

The validation of the model performance under different meteorological prerequisites in various CSE domains becomes more sophisticated than doing comparisons only over one domain.

In order to validate other components of the energy and water cycle data from the Coordinated Enhanced Observation Period (CEOP) will be compared with the model output. Thus, the model runs for the seven different CSE domains will be carried out during CEOP, from 1 July 2001 until 31 December 2004. As equilibration of the land surface is necessary the runs begin July 1, 1999.

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