RMIP simulations with the conformal−cubic model

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1. INTRODUCTION

Two CSIRO models were used for the Regional Model Intercomparison Project (RMIP): the Division of Atmospheric Research Limited−Area Model (DARLAM), and the Conformal−Cubic Atmospheric Model (CCAM). Both models were run at a resolution of about 60 km over the Asian region from March 1997 to August 1998 with forcing supplied by National Center for Environmental Prediction (NCEP) reanalyses. DARLAM uses fairly conventional one−way nesting at its lateral boundaries, as described by McGregor et al. (1993). In contrast, CCAM is a stretched global model including far−field nudging of winds, temperatures and surface pressure. Several CCAM simulations were performed for RMIP.

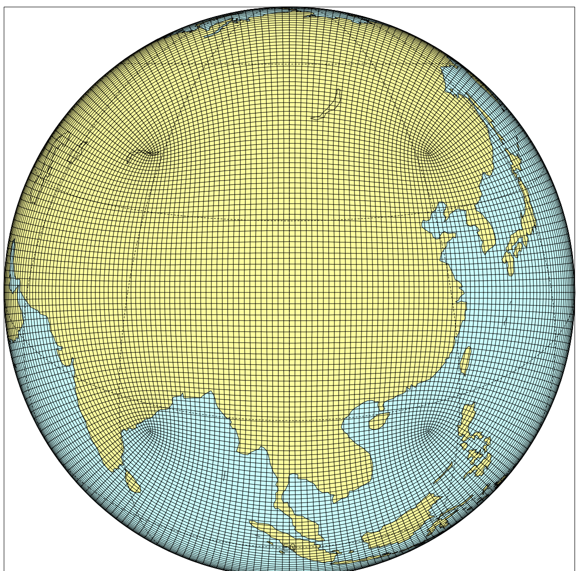

Figure 1. C63 grid used for the RMIP simulations.

2. BRIEF DESCRIPTION OF CCAM

The conformal−cubic global atmospheric model has been developed at CSIRO to augment the regional climate modelling capability provided by the earlier−developed limited−area model (DARLAM). In addition to having a quasi−uniform grid, derived by projecting the panels of a cube on to the surface of the Earth, the conformal−cubic model can be run in stretched−grid mode to provide high resolution over any selected region. Compared to the more traditional nested limited−area modelling approach, it provides greater flexibility for dynamic downscaling from any global model, essentially requiring only sea−surface temperatures (SSTs) and selected far−field variables from the host model (McGregor and Dix, 2001). It also avoids other problems that may occur with limited−area models, such as reflections at lateral boundaries. For the CCAM simulation submitted for RMIP, far−field winds, temperatures and surface pressures were nudged from the NCEP reanalyses for 1997 and 1998. Two experiments are presented here, which include variations on the imposed nudging.

For the RMIP simulations, the grid shown in Fig. 1 was used, with the following model setup:

- C63 global model (6x63x63 grid points) with 18 vertical levels
- Schmidt stretching factor = 0.37, giving about 60−km resolution over Asia
- nudged by 12−hourly NCEP reanalyses
    - − nudged only on furthest panels with e−folding time of at least 24 h.

3. RESULTS OF THE SIMULATIONS

Two CCAM simulations are presented here, both using SSTs from the NCEP reanalyses. The simulations use a new mass−flux cumulus convection scheme, which incorporates downdrafts. The simulations are compared here with the observed June−July−August (JJA) precipitation patterns for 1998. Fig. 2 shows the observations, as collated by Xie and Arkin (1997) on a 2.5° latitude/longitude grid.

The first "standard" simulation used far−field nudging of winds, temperatures and surface pressures, as described above. Fig. 3 shows the JJA precipitation pattern, after some 15 months of simulation. There is generally good agreement between the model and the observed fields, although the precipitation seems deficient over northern India, a little deficient over China, and probably excessive over the ocean in the southeast part of the domain. Also, it is a little too dry over southern India, and maybe a little too wet over the Arabian Sea.

The lowest−level model winds may be compared with the 10−m winds from the NCEP reanalyses. The trade winds are generally well captured. The main discrepancies are around Japan and Korea, where the winds have too strong a southeasterly component.

The second simulation used no nudging at all. This simulation also provides a good representation of the JJA precipitation (Fig. 4). Compared to the first simulation, its precipitation is inferior around Korea and the Japan Sea. This simulation is surprisingly good, considering that it did not use any nudging. Shorter simulations centred over Austrlalia (not shown here) exhibited greater sensitivity for the Australian monsoonal rainfall.

A third simulation was also performed, nudging only winds in the far−field. This is the same arrangement used presently at CSIRO for long regional climate runs over Australia, with forcing from the CSIRO coupled GCMs. This simulation produced results (not shown here) fairly similar to those presented above.

It is interesting to display the differences between JJA precipitation in 1998 (when flooding occurred in China) and 1997, for the "standard" simulation. It can be seen from Fig. 5 that there is generally good agreement between the observed and simulated fields. In particular, the increased rainfall over most of China and Korea is well captured, as is the decrease over Indochina. However, the changes over Japan are not well captured, nor those over India or western China

4. CONCLUDING COMMENTS

The CCAM simulations for RMIP have produced generally good representations of the monsoonal rainfall for 1997 and 1998. The runs use a weaker form of forcing from the analyses than traditional one−way nesting. Perhaps surpisingly, the simulation with zero nudging also produces good monsoonal rainfall; this implies that the monsoonal rainfall over this Asian region is strongly controlled by the SST distribution.

REFERENCES

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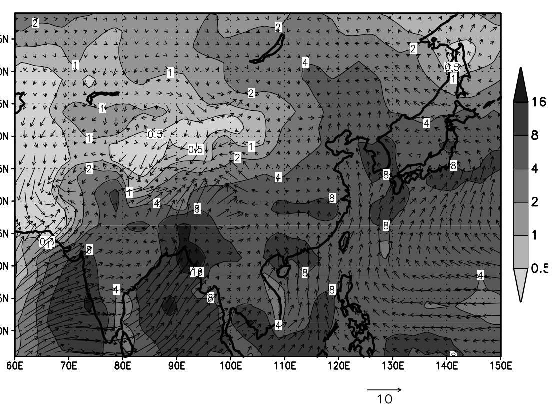

Figure 2. Observed precipitation (mm/day) for JJA 1998 from the analyses of Xie and Arkin, and 10−m winds from the NCEP reanalyses.

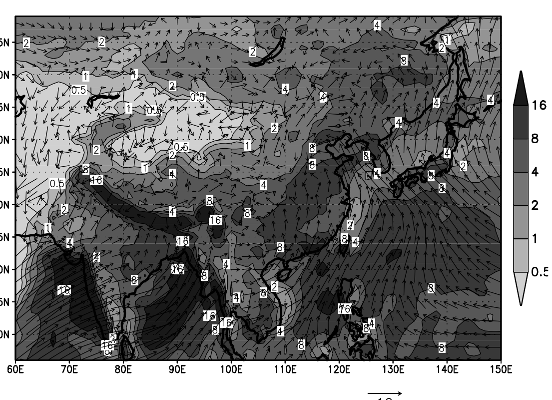

Figure 3. Precipitation (mm/day) and 40−m wind vectors for JJA 1998 from the CCAM simulation with far−field nudging.

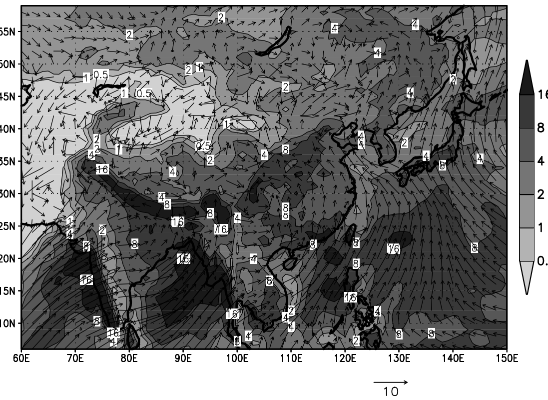

Figure 4. As for Fig. 3, but for the CCAM simulation without any nudging.

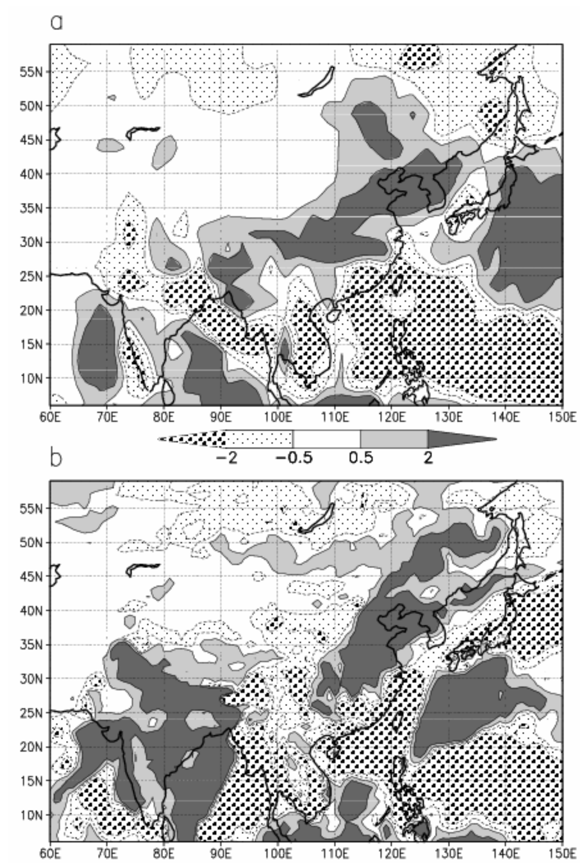

Figure 5. Differences between JJA precipitation (mm/day) over the RMIP region in 1998 from that in 1997 for a) observations, b) the "standard" CCAM simulation.