Numerical Simulation of JSM-SiBUC initialized and externally forced by GAME Reanalysis Data

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1 Introduction

Land-Atmosphere interaction and its role in the formation of meso-scale precipitation systems are one of the most important research targets of GAME-HUBEX Projects. This kind of research becomes possible due to the existence of high accuracy datasets. Regional 4DDA should be executed carefully, making the best use of the data obtained during HUBEX-IOP. In this study, we tested the JSM-SiBUC model using GAME reanalysis data as initial and boundary conditions.

2 Model Description

Japan Spectral Model (JSM) was developed for mesoscale numerical prediction by the Japan Meteorological Agency (JMA). Model variables are represented at 129 $\times$ 129 horizontal grid points and 23 vertical σ levels.

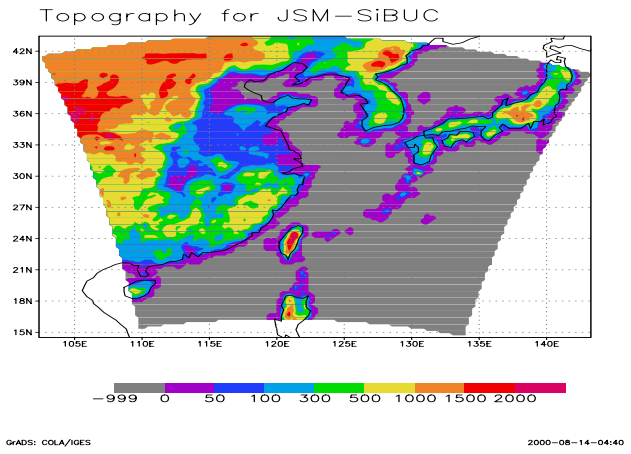

Figure 1: Topography for JSM-SiBUC

In the original JSM model, land-surface process was described very simply, and the surface condition was categorized into only 2 types - land or sea. To deal with land-atmosphere interaction properly, a new land surface scheme (SiBUC), which can treat mixed landuse/landcover conditions, has been developed and coupled into JSM. Not only energy budget, but also water budget at the surface can be calculated using SiBUC.

Model grid formation system (**sp1**) allows us to change the model domain easily. The target area for GAME-HUBEX spreads from 110E to 122E, and from 28N to 40N. The simulation domain should cover this area. And also we have much validation data in Japan area. Furthermore water vapour flux from South China Sea is regarded to have much influence on the formation of Baiu front. Taking these into account, we set the simulation domain as in figure 1. Map projection parameters are also shown in this figure.

3 Surface Parameters for SiBUC

3.1 Landuse and vegetation

In the SiBUC model, the surface of each grid area is divided into three landuse categories and six components:

1. Green Area (vegetation canopy(c), ground(g))
2. Urban Area (building roof(br), building wall(bw), urban ground(ug))
3. Water Body (wb)

The fractional areas of these landuses (V_{ga}, V_{ua}, V_{wb}) and canopy fraction within each landuse (V_c, V_{uc}) are assigned to each grid.
In this study, we used two datasets to construct fractional areas of above landuse within JSM grid. For Japan area, we can use KS-202 data, which has about a 100m resolution and 15 landuse categories. For other parts of the simulation domain, the NOAA-AVHRR global landuse/landcover dataset (from USGS) is used, which has about 1km resolution and 14 categories. In this way, we made up landuse fraction dataset, which has 8 categories (paddy, farmland, grassland, deciduous forest, evergreen forest, bare soil, urban area, and water).

3.2 Soil type

As for soil type, a global digital soil map (from FAO) was used, which has about a 10km resolution and more than 1000 categories. According to the detailed soil texture information for each kind of soil, we re-categorized this dataset into 11 categories (sand, loamy sand, etc.).

4 Initial/Boundary conditions

Originally, JMA global objective analysis data (GANAL), which has a 1.25deg resolution and 12-hour interval, were used as initial and boundary conditions for JSM. JMA carried out special reanalysis to utilize intensified observation data during GAME-IOP. Especially, upper air soundings were enhanced to 4times/day at 21 stations in GAME-HUBEX region. Therefore, the GAME Reanalysis data is expected to have greater accuracy than the original GANAL data.

GAME Reanalysis data (ver.1.0) has a 0.5625deg resolution and 6-hour interval from June 1st to July 31st in 1998. The domain of this dataset is from 36E to 180E, and from 36S to 90N. It has 17 pressure levels up to 10hPa. The 4-dimensional assimilation system is almost the same as JMA's operational system (Model T213L30).

The Baiu frontal zone moved northward from the north of Yangtze River to Huaihe River Basin from 27th June, and then settled. The sustainable rainstorm and heavy rain storm appeared in the north of Jiangsu province, east of Henan province, and north of Yangtze River in Anhui province. So, we selected the simulation period from 0300JST, 26 June to 0300JST, 1 July. Four sets of numerical simulations, initialized at 0300JST (1800UTC) everyday, were carried out.

As for the initialization of surface variables, it was treated simply. Initial sea and land-surface temperature were calculated from climatological values. Since the simulation period was rainy season, initial soil moistures were set to appropriately wet enough values. Now a soil moisture data assimilation system is being developed which involves the Kalman filter and GMS data.

5 Results and discussion

Figure 2 shows simulated rainfall rate at four different times (0900JST, 1200JST, 1500JST, 1800JST) from 27 to 30 June 1998. In general, precipitation field and its movement correspond to cloud image from GMS-5.

Figure 3 shows the simulated cloud coverage by the model and GMS-IR1 image for HUBEX area. According to the image from GMS (right side), the location of cloud is changing day by day. It can be said that JSM-SiBUC can predict the formation of clouds very well for all four cases.

Surface meteorological data collected at meteorological and hydrological stations during HUBEX-IOP were processed and stored as gridded values in hourly intervals.

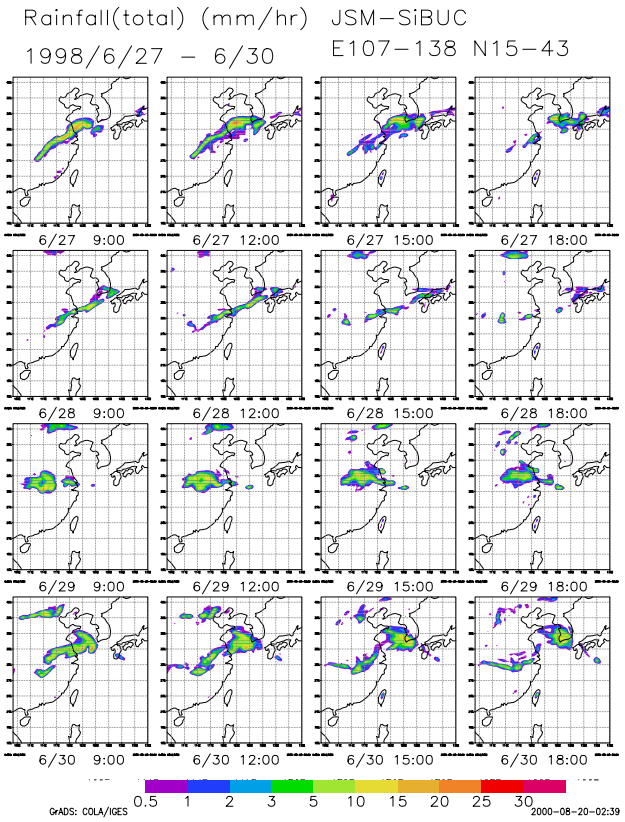

Figure 2: Simulated precipitation from 27th to 30th June 1998

1. Huaihe Basin:
   E111-E122, N31-N36, 10km resolution

2. Shi-Guan Basin:
   E115-E116.2, N31.2-N32.4, 1km resolution

Since the rainfall data from 142 meteorological stations were 12-hourly values, an hourly dataset was produced by considering GMS5 data (IR1 and VIS). If the **IR1** value is less than 0degC, or the **VIS** value is greater than 0.40, then that pixel is regarded as a cloud-covered pixel. Else, that pixel is cloud-free.

Figure 4 shows simulated and observed rainfall (gridded value) for the Huaihe River Basin. This model can predict the rainfall area rather well, but the predicted rainfall amount is larger (especially on 27 June) than the observed one.

6 Conclusion

In this study, we applied the JSM-SiBUC model to the GAME-HUBEX region, and tested GAME reanalysis data(ver.1.0) as initial and boundary conditions. Four numerical simulations were carried out for the period from 27 June to 30 June in 1998. Surface meteorological data and GMS data were used to validate the model.

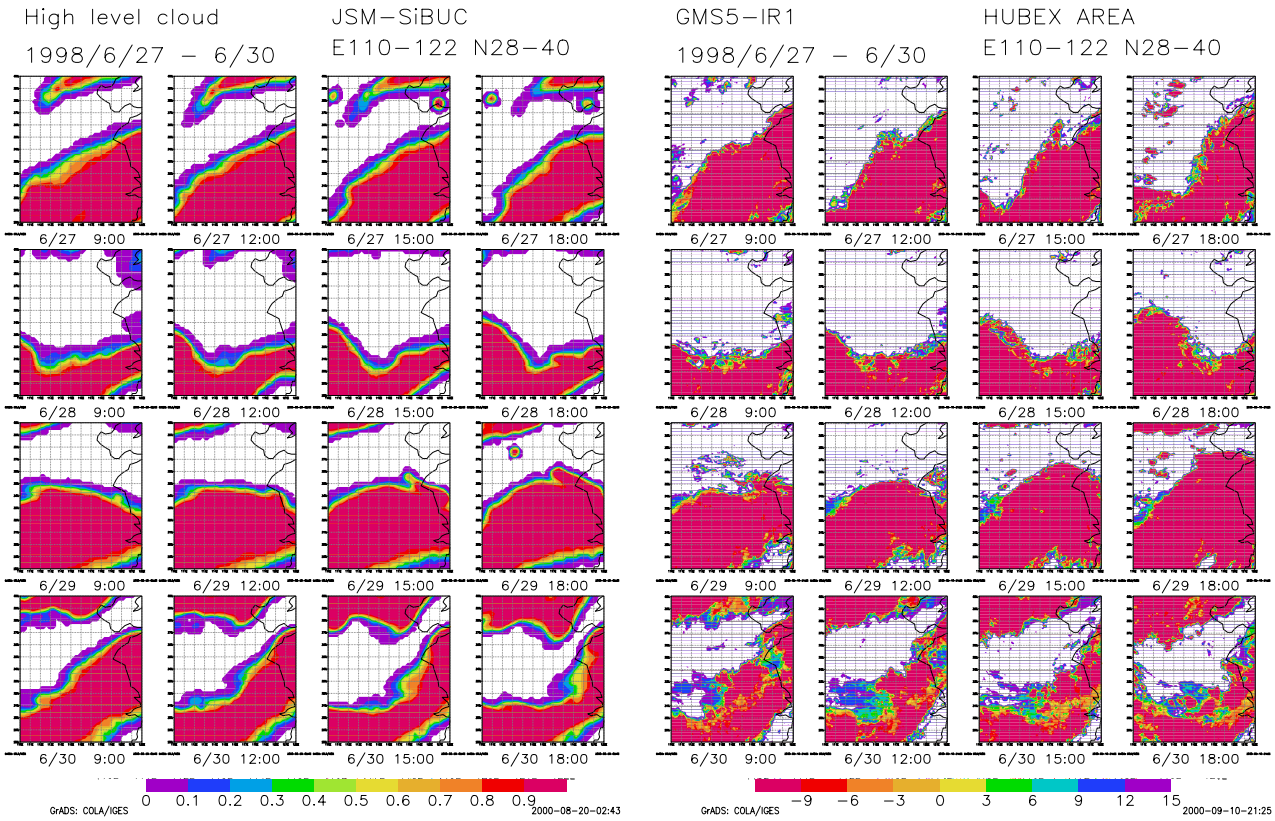

Figure 3: Simulated and observed (GMS-IR1) cloud cover in HUBEX area (12deg × 12deg)

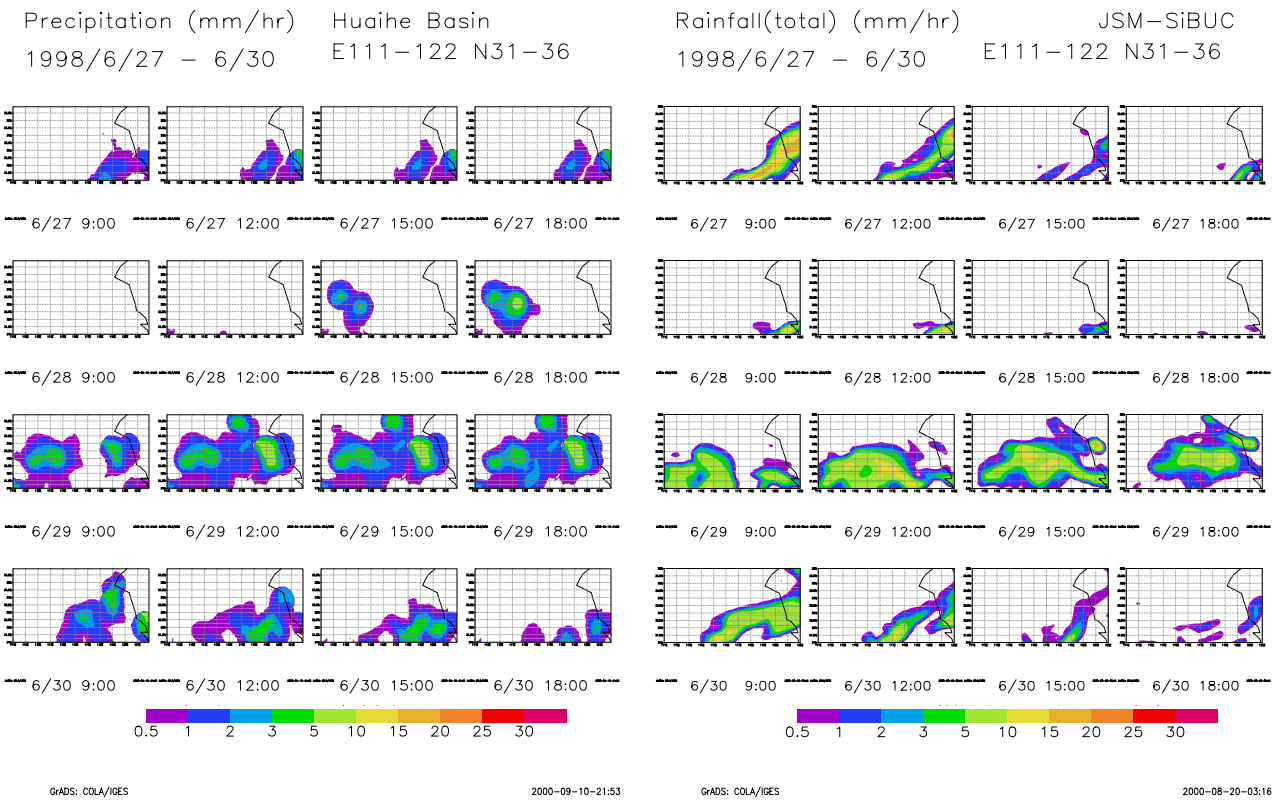

Figure 4: Simulated and observed (surface station's data) precipitation in Huaihe River Basin(11deg × 5deg)