Regional Climate Modeling around Mediterranean

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1. Introduction

In order to provide scenarios of the likely climate change in precipitation, temperature and insolation around the Mediterranean region after the global warming, modeling studies are carried out using GCMs and regional climate models. Although the accuracy is not expected to be very high in the regional scale, we are going to make an effort to obtain the reliable scenarios. We provide two GCMs and two regional climate models in order to estimate the scenarios. JMA-MRI and CCSR-NIES will be applied for the GCMs. TERC-RAMS and MM5 will be adopted for regional climate models (RCMs). In early stage of the studies, we focus on the combination of GCM: JMA-MRI and RCM: TERC-RAMS, in order to clear away many difficulties expected in the process of the nesting.

2. Nested run with the analysis data

Before the nested run using the products of the GCM, regional climate model should be tested its accuracy and reliability and the parameters assumed in the model should be adjusted for the nested run. Figure 1A shows precipitation and horizontal moisture transport obtained by a monthly integration during April,2000 by the regional climate model with the grid interval of 100km. The initial and lateral boundary conditions are obtained by the analysis data provided by NCEP/NCAR. The rectangle in the figure indicates the nested region, in which grid interval is assumed to be 25km. The nested monthly precipitation is shown in Figure 1B.

These results were obtained assuming the internal grid point nudging. Predicting variables except for specific humidity are restored to the given values in the coarse grid system with the e-folding time constant of 3 days. Since specific humidity is not restored, the conservation law for water vapor is still kept.

Simulated precipitation corresponding well with the topography, and is enhanced along the slopes near the coastline.

Monthly precipitation observed by rain gauges is shown in Fig.2. Amount of precipitation is shown by the same color categories in Fig.1. Precipitation was large at Adana and the northeastern part of Turkey. Precipitation simulated by the model (Fig.1B) indicates some similarity with observation.

Figure 3 shows monthly precipitation of April during 7 years (1994-2000, except for 1999 because of lack of rain gauge data). Right blue bars indicate the simulated precipitation, blue bars indicate mean values observed at 36 stations. Simulated precipitation is also mean values at 36 grid points near each observation stations. The model accuracy is quite poor for the year to year variation, although 7 years mean value is roughly agree with the observed one. Standard deviations of year to year variation, which are indicated by error bars at the mean values, are also overestimated.

3. Nested run with GCM

Figure 4A shows monthly precipitation of April by the model nested with the GCM output during ten years of 1991 to 2000. Year to year variation of the climate simulated by GCM is independent

from the variation of the actual climate, so that the comparison of the year to year variation with observation has no meaning. However, ten years mean precipitation is overestimated, i.e., roughly 1.7 times larger than seven years mean of the observation. Similar nested run with GCM out put during 2071 to 2080 are shown in the Fig.4B. Monthly precipitation reduces by about 10%. Standard deviation of year to year variability are also shown in these figure by error bars on the ten year mean precipitation. The standard deviation increases from 16.3 to 23.7. This means the frequency of drought and flood may be increased.

Figure 5 shows distribution of change in precipitation during the 80 years. Model predicts that precipitation will decrease in the most part of the Mediterranean region. This is a simple reflect of the result of GCM. The regional climate model, however, shows that precipitation will increase in some areas in Turkey. These predictions have only poor reliability, because the regional model still cannot simulate the year to year variation in monthly precipitation.

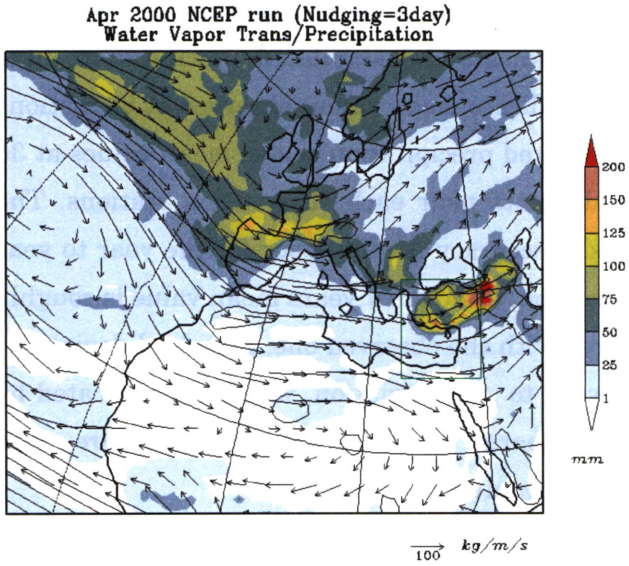

Figure 1A: Precipitation and horizontal moisture transport obtained by monthly integration during April,2000 by the regional climate model. Grid interval is 100km.

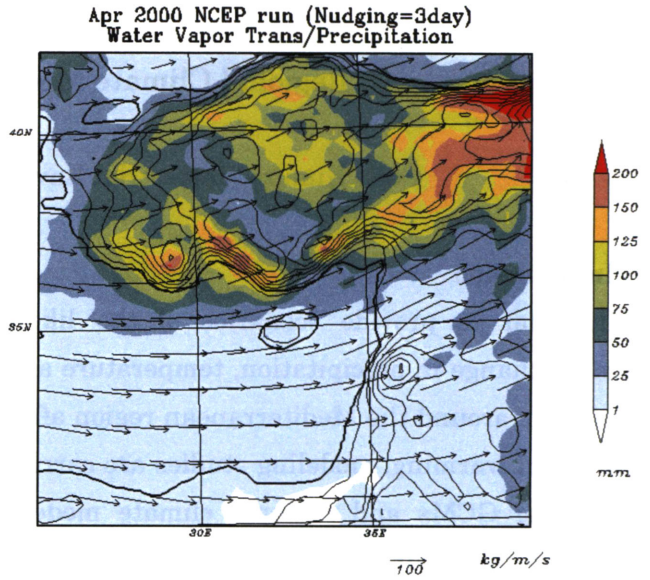

Figure 1B: Same as Fig.1A, but for the nested domain in the rectangle shown in the Fig.1A. Grid interval is 25 km.

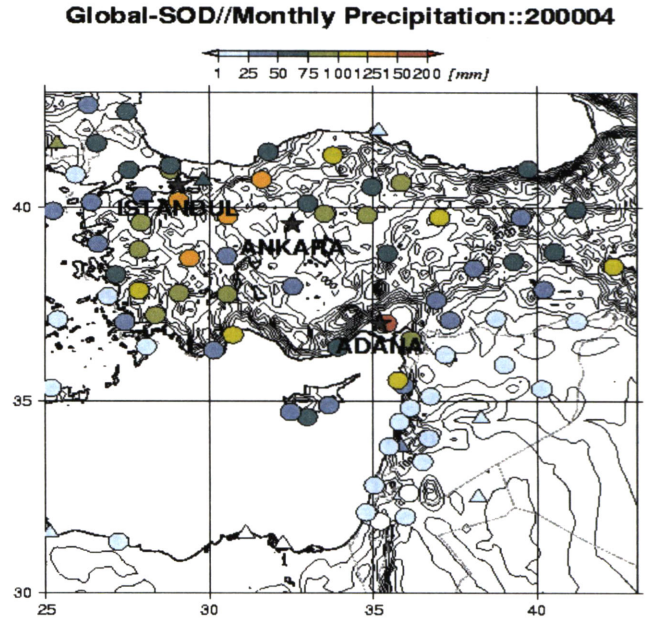

Figure 2: Monthly precipitation observed by rain gauges. Amount of precipitation is shown by the same color categories in Fig.1.

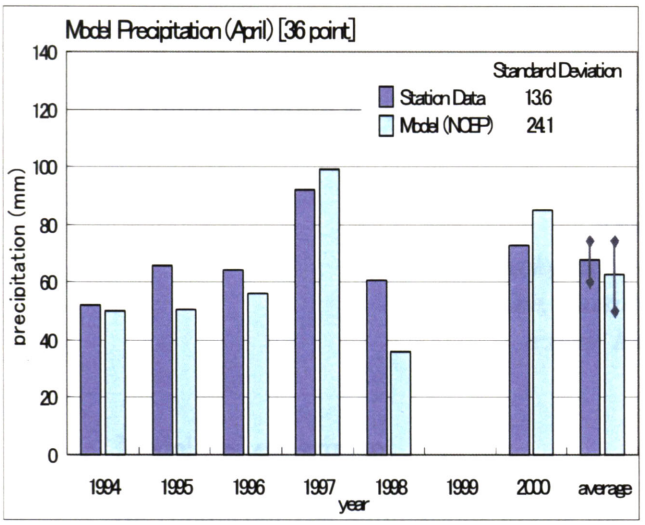

Figure 3: Monthly precipitation of April during 7 years 1994-2000, except for 1999. Right blue bars: simulated precipitation. Blue bars: mean values at 36 station data in the entire Turkey.

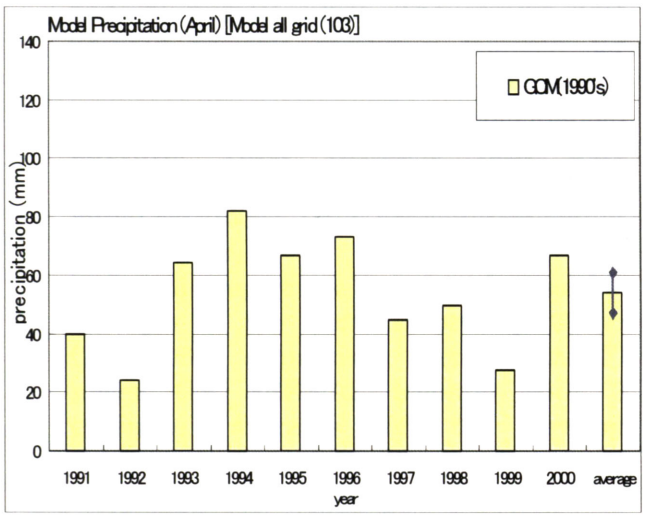

Figure 4A: Monthly precipitation in April by the RCM nested with the GCM output during ten years of 1991 to 2000.

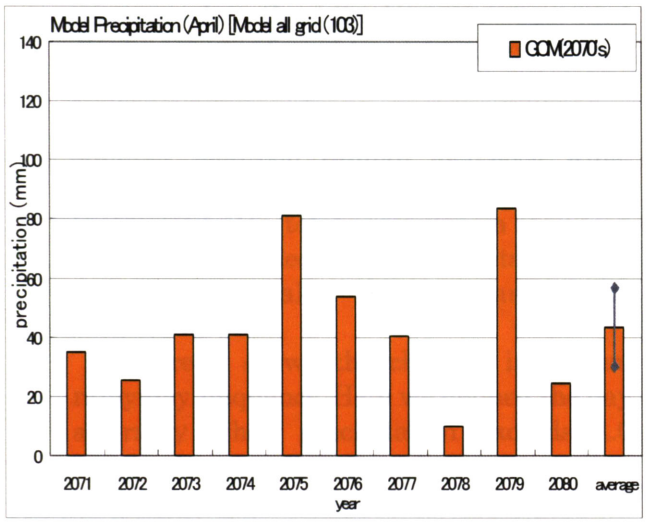

Figure 4B: Same as 4A, but for 2071 to 2080.

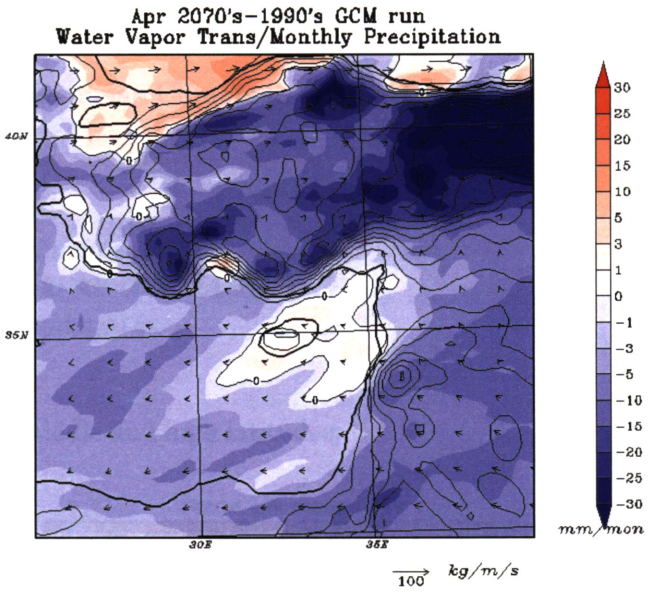

Figure 5: Distribution of change in precipitation during the 80 years.