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Climate Model Subgroup

Report of Climate Sub Group 2003

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Objectives

Regional climate information was only addressed to a limited degree in the third IPCC-2001 report. Coarse resolved GCMs simulate general circulation features well in general. At the regional scale, however, the models display area-average biases which are highly variable from region to region and among models.

We are going 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 can not expected to be very high, we are going to make an effort to have the best result in the world.

Interaction between land use and the regional climate is also studied by the regional climate models and data obtained by this project.

Methodology (during the entire five years)

We provide two GCMs and two regional climate models in order to estimate the scenarios. For GCMs, JMA-MRI and CCSR-NIES will be applied. TERC-RAMS and MM5 will be adopted for regional climate models. In early stage of the studies, we focus on the combination of GCM by JMA-MRI and TERC-RAMS, in order to clear away many difficulties expected in the process of the nesting.

To estimate the reliability of the model system, sensitivity tests of the major weather/climate system around Mediterranean Region will be carried out, as well as the sensitivity tests on the land-use. Relation between local climate and major variability of global scale climate system (ENSO, NAO...) must be also studied

Current Results

(1) MRI-CGCM ensemble runs

We conducted the simulations under the SRES A2 and B2 scenarios up to 2100 with the MRI coupled ocean-atmosphere GCM (MRI-CGCM2, Yukimoto et al. 2001). The atmospheric part of the model has a horizontal resolution of T42 (about 280km) and 30 vertical levels. The oceanic part adopted variable resolution 0.5°-2.0° for latitudinal direction with finer grid in the tropics and fixed 2.5° for longitudinal direction. Three ensemble runs were performed for each scenario from different initial conditions. Daily precipitation output was analyzed. We compare 3 ensemble averages of the mid-21st century 20 yr (2041-2060) simulations (denoted as F) under the SRES-A2 scenario with 3 ensemble averages of the present (1981-2000) simulations (P).

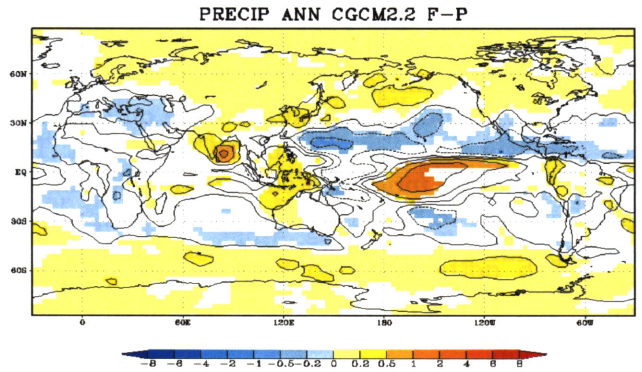

Figure 1: Annual mean total precipitation difference (F - P).

Figure 1 shows the annual mean changes (F-P) in total precipitation at mid-21st century. In the tropics, an eastward displacement of major precipitation center was noted associated with El Nino-like background mean SST changes. The Asian summer monsoon rainfall increased while the African monsoon rainfall decreased. In higher latitudes, total precipitation increased, while there is a decrease in precipitation over the subtropical oceans and the Mediterranean.

Both the frequency and intensity increased in about 40% of the globe, while both the frequency and intensity decreased in about 20% of the globe. In between, which occupies around one third of the globe, the precipitation frequency decreased but its intensity increased, suggesting a shift toward more intense events by global warming. The Mediterranean and the Middle East is such a region where both total precipitation and number of rainy days decreased but precipitation intensity itself increased.

A decrease in precipitation around the Mediterranean region is significant. Changes in precipitation characteristics are also analyzed. It is found that both total precipitation and number of rainy days decreased but precipitation intensity itself increased in the Mediterranean region. Over Turkey, a decrease in rainy events resulted in a decrease in total precipitation. A positive phase of North Atlantic Oscillation-like pattern dominates in the mean response of sea level pressure anomaly, which suppresses cyclone activity. However, due to increase in atmospheric humidity by global warming, precipitation intensity could increase more.

(2) RCM nested run with the analysis data

Figure 2 shows precipitation and horizontal moisture transport obtained by a monthly integration during April,2000 by the regional climate model with the grid interval of 25km and 100km. The initial and lateral boundary conditions of 100km grid system are obtained by the analysis data provided by NCEP/NCAR. The figure indicates inner nested region in which the grid interval is 25km. Simulated precipitation corresponding well with the topography, and is enhanced along the slopes near the coastline. This figure indicates some similarity with observation.

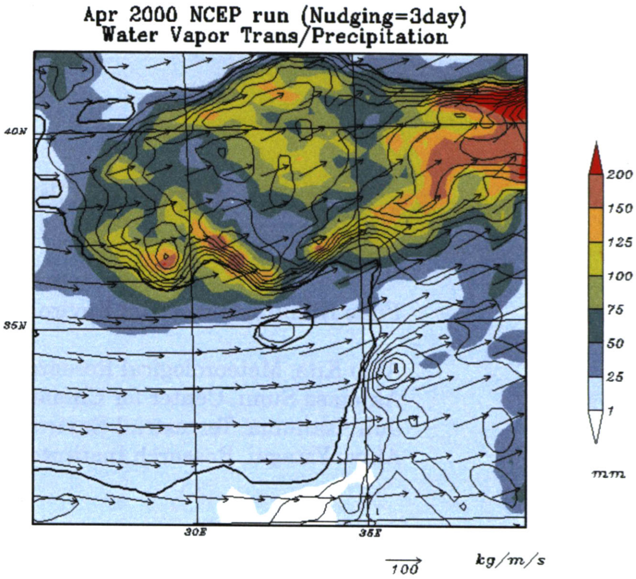

Figure 2: Precipitation and horizontal moisture transport obtained by monthly integration during April,2000 by the regional climate model. Grid interval is 25km.

Figure 3 shows monthly precipitation of April during 7 years (1994-2000, except for 1999 because of lack of rain gauge data). Light blue bars indicate the simulated precipitation, while 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 good for the year to year variation, and 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 slightly overestimated.

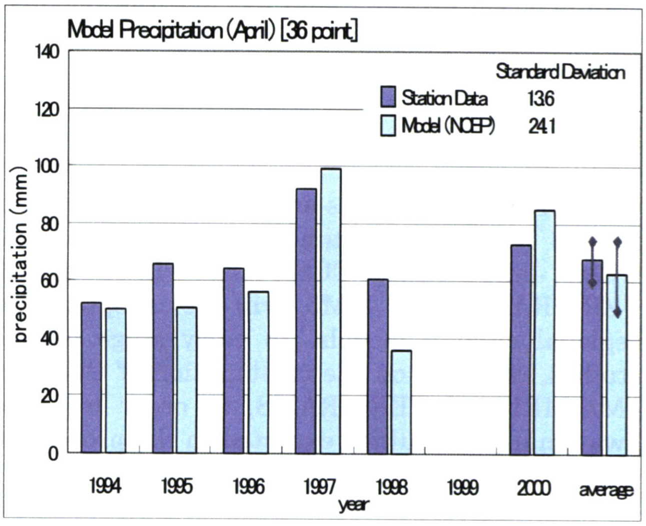

Figure 3: Monthly precipitation of April during 7 years 1994-2000, except for 1999. Light blue bars: simulated precipitation. Blue bars: mean values at 36 station data in the entire Turkey.

(3) RCM nested run with GCM

Although turning of the regional climate model is still not enough to obtain the interpretation of GCM products, we are testing the nested scheme of the regional climate model with GCMs.

Figure 4 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 reflection of the result of GCM. The regional climate model, however, shows that precipitation will further decrease in the mountainous regions in Turkey.

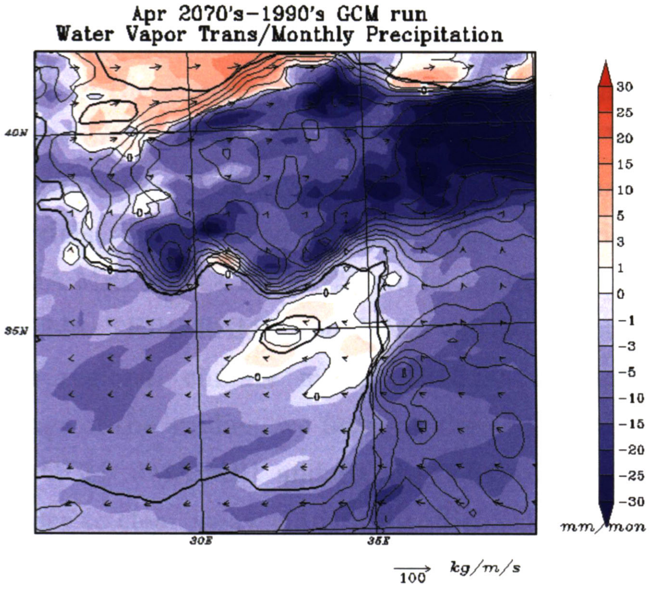

Figure 4: Distribution of change in precipitation during the 80 years

(4) Preliminary report of recent precipitation change over the East Mediterranean

Using station data provided by Global Telecommunication System (GTS) network, recent trend of precipitation over the East Mediterranean is investigated. We used data from 1977 to 2000 by combining three dataset of global daily precipitation. 1) The archived data by NOAA from 1977 to 1991 are summarized in a Global Daily Summary CD-ROM. 2) Recent (after 1994) surface meteorological data archived by NOAA is opened by NCDC 3) Precipitation data from 1992 to 1993 have been provided by Dr. Xie (NOAA/CPC). There are 769 stations in the region (20-50E/20-50N), but stations which report more than 12 years during the 24 years (1977-2000) are only 325 stations.

Only stations with more than 12 years record are analyzed. Roughly speaking, over East Mediterranean, rainfall season is winter and dry season is summer. It is obvious that precipitation has decreasing trend in January. In April and July, most part of Turkey except for Black Sea region shows increasing trend. While in October mid and north part of Turkey shows increasing trend.

Turkes (1996) investigated precipitation trend over Turkey from 1930 to 1993, and pointed out 1) Area-averaged annual rainfall series have decreased slightly over all of Turkey and apparently over the Black Sea and Mediterranean rainfall regions, although none of the trends in the area-averaged rainfall series were statistically significant.

Since we used shorter and later time series and our station data contains many missing field, it is very difficult to compare the above results with Turkes (1996). However, at least we may point out in January (rainy season) precipitation shows decreasing trend and it affects decreasing trend of annual precipitation trend.

(5) Cloud likely to be formed by large-scale irrigation around Adana

Images obtained by the sensor MODIS boarded on satellites Terra and Aqua are analyzed in order to detect low-level clouds in Turkey. Images are obtained at about 10:00 to 12:00 local time by Terra and 12:00 to 14:30 by Aqua in the interval of about three days each.

Low-level clouds were frequently observed around Adana during summer. The clouds were found 75 images in total 140 images in this season. Over 60% of the low-level clouds seems to be generated over the plain and to be related with land-surface. During other season, low-level clouds appear less than 30%.

On the region of Antalya, having similar topography with Adana, the frequency of low-level clouds is less than 30% even in summer.

From the shape of the clouds, the distribution correlated with topography, and seasonal variation of frequency, the low-level clouds seem to be enhanced by the irrigation around Adana. In order to clarify the relation between the clouds and irrigation, more study is necessary with satellite images, surface observation data and numerical modeling.