Effect of mountain uplift on warm pool: a study with the new MRI coupled GCM

Akio Kitoh[1], Manabe Abe[2] and Tetsuzo Yasunari[3]

[1] Meteorological Research Institute, Tsukuba, Japan
kitoh@mri-jma.go.jp
[2] Graduate School of Geoscience, University of Tsukuba, Tsukuba, Japan
abe@luft.geo.tsukuba.ac.jp
[3] Institute of Geoscience, University of Tsukuba, Tsukuba, Japan
yasunari@atm.geo.tsukuba.ac.jp

Large-scale mountains such as the Tibetan plateau, Rocky mountains and Andes mountains, play essential roles to form the present climate. Therefore those uplift was a major event in the natural history of the earth. For example, the uplift of the Tibetan plateau has led to the evolution and the variety of monsoon climate system in Asian region (e.g. Kutzbach et al. 1993). A number of geological evidence for climate changes due to the uplift has been found both over land and the ocean. However, as the climate change is forced not only the mountain uplift but also other forcing such as astronomical forcing, variation of CO_2 level and ice sheet extent in the past, it is difficult to separate the effect of the past mountain uplift. Therefore, experimental studies with an atmosphere and ocean coupled general circulation model (GCM) is needed to understand global influence, including the ocean, of the uplift.

In this study, the newly developed MRI coupled GCM (MRI-CGCM2, Yukimoto et al. 2001) is used. We integrated the control run with a realistic land-sea distribution and orography (M-run) and the anomaly run without a flat surface everywhere by keeping the same land-sea distribution (NM-run). Figure 1 shows the difference in annual mean precipitation between M-run and NM-run. The precipitation increases in the region between the eastern Indian Ocean and the western Pacific Ocean and in Asian region by mountain uplift, while precipitation decreases in the western Indian Ocean and the central Pacific Ocean. Particularly, a zonal contrast of precipitation in NM-run is reversed to that in M-run in the tropical Indian Ocean. Figure 2 shows the difference in annual mean sea surface temperature (SST). Over the tropical region in NM-run, the local SST maximum above 28°C is centered around the date line, while SST below 25°C is found in the eastern Indian Ocean, the eastern Pacific Ocean, and the eastern Atlantic Ocean. However, in M-run, SST above 28°C extends in the western Pacific Ocean as observed, which is in contrast with that in NM-run.

Furthermore, in the equatorial Indian Ocean, the SST gradient is reversed between the two runs. Thus, the formation of the western Pacific warm pool is controlled by mountain uplift through changes in monsoon circulation in our experiment. In addition to this study, we continue to investigate the influence of different altitude of mountains on the global climate.

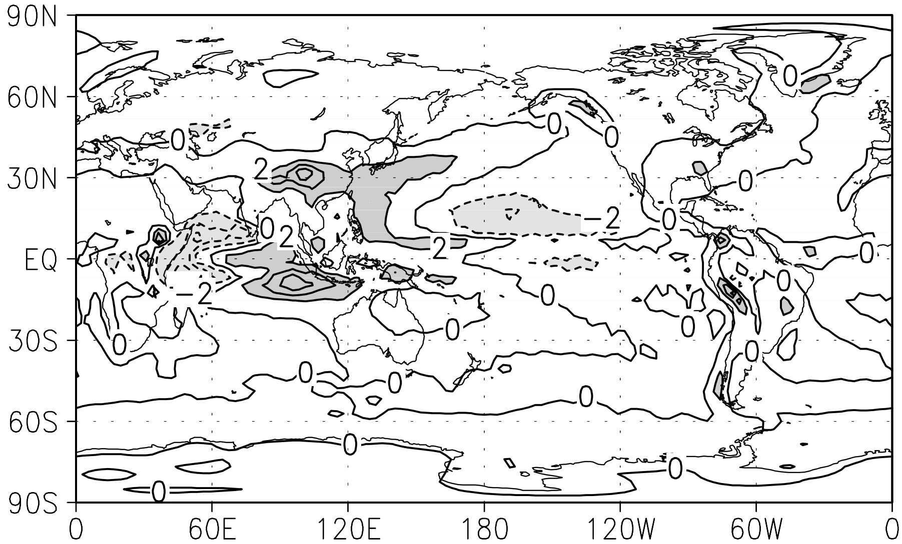

Figure 1: Annual mean precipitation difference between M-run and NM-run. The contour interval is 2 mm/day.

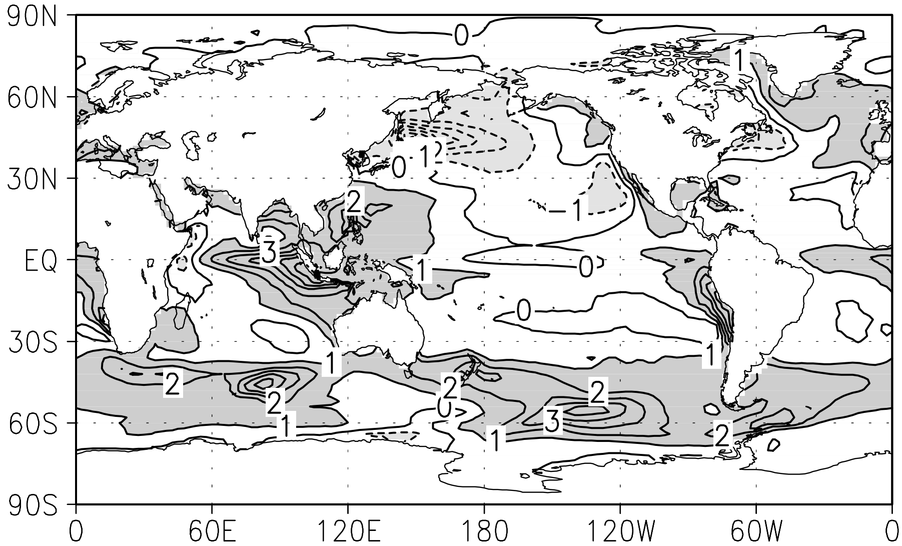

Figure 2: Annual mean SST difference between M-run and NM-run. The contour interval is 1°C.