Numerical simulation on vegetation change in Asia associated with uplift of the Tibetan Plateau

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Vegetation distribution over land depends on climate such as temperature and precipitation. Thus, climate change related to growth of the Tibetan Plateau should accompany those in vegetation distribution. Changes of Asian monsoon system and arid climate associated with uplift of the Tibetan Plateau have been investigated by using paleobotanical records such as pollen and leaf fossils (e.g. Sun and Wang, 2005). Therefore, it is important to understand relationships between the vegetation change and climate change by uplift of the Tibetan Plateau.

We have investigated relationships between the altitude of the Tibetan Plateau and monsoonal climate over Asia, with numerical experiments using the coupled ocean-atmosphere general circulation model (GCM) of Meteorological Research Institute (MRI) (MRI CGCM-2.3.2). In our experiments, five model runs were conducted, named TP00, TP25, TP50, TP75, and TP100, in which the altitude of the Tibetan Plateau was 0%, 25%, 50%, 75% and 100% of the present height, respectively. The model includes land surface processes including processes of plants. However, in all runs, spatial distribution of vegetation based on the present observation was fixed. Then, to assess vegetation changes related to the Tibetan uplift, we simulated distribution of vegetation types in the five cases with different altitude of the Tibetan Plateau, using BIOME4 model (Kaplan et al. 2003), which diagnoses a distribution of major vegetation types (biome) as a function of the seasonal cycle of temperature, precipitation, sunshine, and soil moisture condition. Climatology in the GCM experiments was used as input data for BIOME4 model. In this presentation, we show the simulated vegetation change in Asia associated with the Tibetan uplift.

Vegetation in TP100, which is control case, could be simulated realistically. Temperate plants are found in East Asia, and also tropical plants in Southeast Asia. In northwest of India, temperate semi-arid region appears. Also, shrubland and grassland are located northwest and north of the Tibetan Plateau, realistically.

From results in all cases, one can find changes of vegetations associated with climate change due to gradual increase of altitude of the Tibetan Plateau. In TP00, desert and arid-plant region appears widely in mid-latitude region where the Tibetan Plateau exists. As height of the Tibetan plateau increases, the arid region changes gradually to warm mixed forest region in East Asia. Further, the tropical deciduous forest extends obviously in Southeast Asia in TP50. On the other hand, as woodland region to the west of the Tibetan Plateau in TP00 changes to shrubland or grassland in TP100, arid region is formed west of the Tibetan Plateau, with growth of the Tibetan Plateau.