The Tibetan Plateau (TP) is the world's most elevated highland which was built over the past 50 million years. With its extent, the TP did not only influence the climate in Asia, but also caused global changes. Today, the TP represents a climate change hot spot and is, as the source region of many large rivers in Asia, crucial for the water supply of billions of people. Considering this background, it is important to obtain a better understanding of the processes that control the climate in the region and to estimate the climate variability on different time scales.

The basic goal of this study is to provide spatial highly resolved quantitative information about the changes in the climatic conditions in Asia during the uplift of the TP and during periods with warmer and colder boundary conditions and thus to put these different timescales in relation. Therefore, the modern climate and the paleoclimate of the region are being simulated with climate models. The global climate model ECHAM5 is dynamically downscaled with the regional climate model REMO, because previous studies have shown, that the results of models with higher resolution are more consistent with paleoclimate reconstructions than the results of models with lower resolution.

The uplift of the TP is approximated by a series of five simulations (topography experiments) in which the elevation of the TP is varied in steps of 25% from 0% to 100% of its present day height. The late Quaternary climate variations are represented by two simulations with boundary conditions for the Mid-Holocene and the Last-Glacial-Maximum (Quaternary experiments). For the Quaternary experiments, the greenhouse gas concentration, orbital parameters, land cover and some vegetation parameters have been adopted for the particular time slice. The evaluation of the simulations' results focusses on annual and seasonal changes of the near surface temperature and precipitation. Variations in the strength of the Indian monsoon are analyzed by means of different monsoon indices. In order to identify and characterize the regional climate types there, a cluster analysis is conducted for the TP and adjacent regions.

The topography experiments show that the annual mean 2m-temperature

drops by up to 30°C in the region of the TP when the height of the plateau is reduced while it becomes colder nearly everywhere else in the model domain. The annual precipitation amount is reduced in the west and north of the TP when its height is reduced. The immense precipitation increase to the north of the TP can be explained by the formation of a trough instead of a ridge in the mid-troposphere of this region. The general spatial pattern of the changes already persists when the height of the TP is reduced to 75% of the present day value and it does not change fundamentally when the height is reduced further. This pertains for the 2m-temperature, the precipitation and for the annual as well as the seasonal means. The analysis of the intensity of the Indian Summer Monsoon shows that the strongest intensification appears between 25% to 75% of the TP's present day elevation. Half of the current elevation is necessary to get a monsoon intensity comparable to the one of today.

In the Mid-Holocene, it is on average colder and more humid in most parts of the model domain compared to present day. But the differences are mostly small and not significant. Concerning the temperature, the model data coincides only sporadically with reconstructed values. However, the reconstructions show great spatial variability, which reflects the uncertainties that are present in this data set. Regarding precipitation, the simulated data matches the reconstructions better. Both the simulated and the reconstructed data point towards wetter conditions.

Compared to present day values, the simulation of the Last-Glacial-Maximum shows up to 8°C lower annual and seasonal mean temperatures everywhere in the model domain compared to present day values. The results are in good conformity with reconstructed temperature values for this time slice. A significant reduction of the annual precipitation amount appears in the west and north of the TP, in India, Southeast Asia and along the east coast of China. Where precipitation reconstructions are available, the model results show good accordance with these values. A significant increase in precipitation appears only between the northern coast of the Bay of Bengal and the Himalayas, but this potentially represents a model artifact. There are big differences between the indices in terms of the monsoon intensity. The Extended Indian Monsoon Rainfall Index shows a strong reduction of the Indian Summer Monsoon,whereas the value of the Webster and Yang Monsoon Index remains nearly unchanged compared to the present day value. A comparison of the monsoon intensity in the topography and the quaternary experiments reveals that the change in boundary conditions between warm and cold intervals affects the Indian monsoon at least as much as the uplift of the TP.



Abb. 1: Vergleich 30-jähriger Mittelwerte der 2m-Temperatur in den Topographieexperimenten: 2m-Temperatur in T100 a) Jahresmittel, b) Winter c) Sommer. Differenz T075-T100 für d) Jahr, e) Winter und f) Sommer. Weitere Teilabbil- dungen analog zu d-f für T050 (g-i), T025 (j-l) und T000 (m-o).



Abb. 2: Vergleich des Niederschlags in den Topographieexperimenten: Nieder- schlag in T100 a) Jahressumme, b) Summe Winter c) Summe Sommer. Prozen- tuale Veränderung T075-T100 für d) Jahr, e) Winter und f) Sommer. Weitere Teilabbildungen analog zu d-f für T050 (g-i), T025 (j-l) und T000 (m-o)



Abb. 3: Differenz 10-jähriger Mitteln der 2m-Temperatur MH-PD für a) Jahr, b) Winter, c) Frühling, d) Sommer und e) Herbst.



Abb. 4: Prozentuale Veränderung 10-jähriger Mittel der Niederschlagssumme MH-PD für a) Jahr, b) Winter, c) Frühling, d) Sommer und e) Herbst.



Abb. 5: Differenz 10-jähriger Mittel der 2m-Temperatur LGM-PD für a) Jahr, b) Winter, c) Frühling, d) Sommer und e) Herbst.



Abb. 6: Prozentuale Veränderung 10-jähriger Mittel der Niederschlagssumme LGM-PD für a) Jahr, b) Winter, c) Frühling, d) Sommer und e) Herbst.