Time-lagged Effects of Spring Tibetan Plateau Soil Moisture on the Monsoon over China in Early Summer

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It has been shown in numerous studies that a clear relationship exists between the amount of winter or spring snow over the Tibetan Plateau (TP) and the rainfall over the Yangtze River region (YR) in eastern China and the south China region (SC) in the subsequent summer (e.g. Wu and Qian 2003; Qian et al. 2003; Zhang et al. 2004). One common conclusion of all these studies is that in the year with anomaly large snow cover over the TP, the Asian summer monsoon precipitation in the subsequent summer is anomalously high over the YR and is anomalously low over the SC. On the other hand, in the year with anomalously low snow cover over the TP, a reverse pattern can usually be observed.

The increase in soil moisture due to snow-melt could be an important factor for this change in the precipitation pattern since its memory is relatively long. In this study, six numerical experiments with different initial soil moisture of 20 %, 30 %, 40 %, 50 %, 60 % and 70 % at TP were performed using a regional climate model (Chan et al. 2004) running for the period from 1 April to 30 June 1998. The control experiment is the one with the value of 30 %. The results of the experiments show that the initial soil moisture at TP (ISMTP) in the spring period has a relatively long memory for the local as well as regional climate. In particular, as shown in Figs. 1 and 2, the increase in the ISMTP could in general result in an increase in the amount of monsoon precipitation over YR, a decrease in the monsoon precipitation over SC, and a southward shift in the position of the Baiu rainband over Japan. These patterns of precipitation differences due to changes in ISMTP in the sensitivity experiments are consistent with the corresponding patterns due to anomalous snow covers over TP in winter or spring. The changes in the precipitation over SC and the Baiu rainband appear to be related to the meridional shift in the position of the Northwestern Pacific subtropical high in association with the changes in ISMTP. In addition to the changes in precipitation pattern, the local effects of the increase in the ISMTP could decrease the air temperature (Fig. 3), upward vertical velocity, evaporative fluxes, and surface heating over TP. Finally, It has also been shown in this study that the Tibetan High can be weakened for high ISMTP, and so the strength of the Asian summer monsoon

Reference

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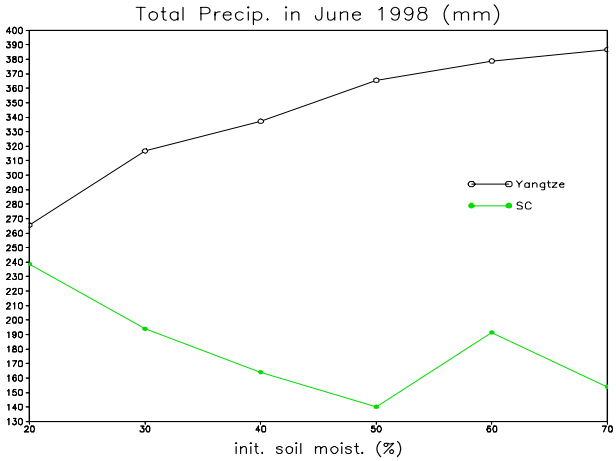

Fig. 1. Variation of total precipitation in June 1998 with different initial soil moisture at Tibetan Plateau over the Yangtze River region (28°-33°N, 115°-120°E) and the south China region (20°-27°N, 105°-120°E).

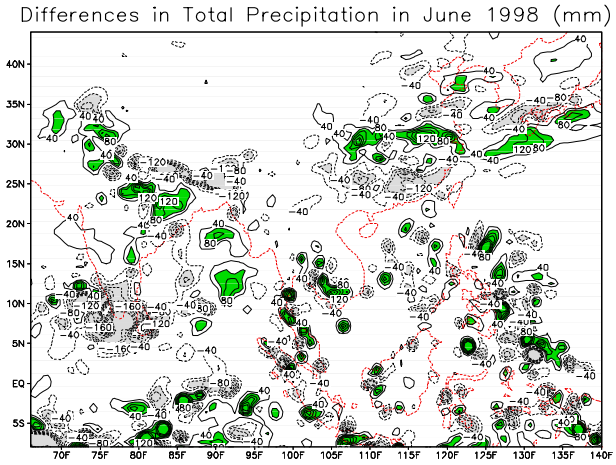

Fig. 2. Differences in total precipitation in June 1998 between the experiment with 70% initial soil moisture at Tibetan Plateau and the control experiment. Contour intervals are 40 mm with lighter shading denotes negative values less than -80 mm and darker shading for positive values greater than 80 mm.

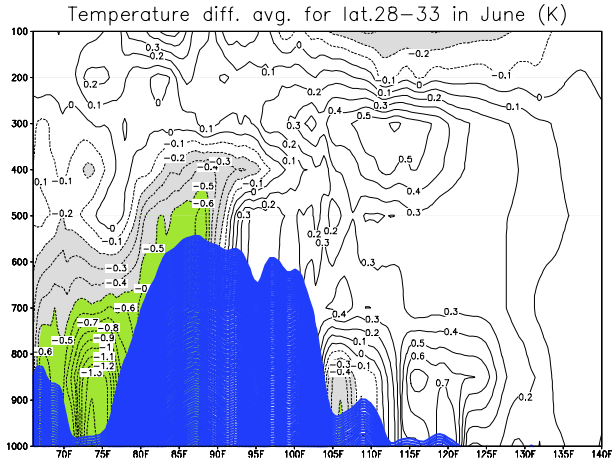

Fig. 3. Vertical profile of differences in temperature (K) averaged from 28° to 33°N. Contour intervals are 0.1 K and lighter shading denotes negative values less than -0.2 K and darker shading for negative values less than -0.6 K.