Interactions between the atmosphere and snow cover in the non-monsoon season over the Tibetan Plateau

Nozomu Hirose[1]; Kenichi Ueno[2]

[1] JST; [2] Life and Environmental Sci., Univ. Tsukuba

Winter snow over the Tibetan Plateau (TP) has an important role in the subsequent summer rainfall over east China though modulation of atmospheric circulation at the periphery of the Plateau region (Wu and Qian,2003, Zhan et al., 2004).

Ueno et al. (2007) observed the shallow snow and bare soil area were heterogeneously distributed in a 10-100m spatial scale by the field experiment in winter 2004 over the TP, and pointed out that the prominent snow redistribution provide the both possible physical mechanisms for the long-tem shallow snow existence and atmospheric heating in early spring.

In this study, we focus on the land surface-atmospheric interaction at the central part of TP and Naqu basin, and investigate the characteristics of weather condition and snow spatial distribution based on the in-situ and reanalysis data. We implement the numerical simulation of the regional climate model, and diagnose the effect of snow during the specific atmospheric and snow condition.

In-situ data were observed by CEOP/ Tibet Project (Koike et al., 2005) near Naqu city (31.48N, 92.06E, 4508 m) from January to April in 2004. NCEP/NCAR reanalysis data and satellite data are also used.

In the central TP, strong sub-tropical jet stream prevailed at 200 hPa. On the other hand, surface wind speed is weakened by near surface boundary layer effect. Surface wind speed at 10m height is dramatically increased around noon and became clam at night. Its peak is up to 10m/s abound early evening. Rainfall events correspond to the weakening of sub-tropical jet stream. Especially, the frequency of rainfall events in April became increasing with the weakening sub-tropical jet stream. On the other hand, snow at the basin scale became increasing continuously from January to February, and then disappears in the lower altitude and flat area after the end of February. Although rainfall events occur after March, long term snow cover can not exist.

We carry out the snow sensitivity analysis using WRF model. Noah land surface scheme including WRF can introduce the effect of snow heterogeneity to simulate more accurate surface variables. To investigate the snow effect, WRF model simulation is carried out during four periods, which have different of snow and atmospheric condition.

Test run case is applied to the observed shallow snow condition. Its results represent the diurnal change of surface wind speed, which is caused by mixing layer development. Moreover, the experiment, which uses the larger surface albedo, shows the diurnal change of surface wind speed is strongly decreasing. That is, under present circumstance, the observed shallow and heterogeneous snow cover has a small contribution to depress surface sensible heat flux. That causes the shallow mixing layer and the diurnal change of surface wind speed. Especially, mixing layer is developed in noon, and then atmospheric heating is obviously dominant when upper subtropical jet stream is weakened. Much snow run case is designed by adding large snow to test run case. Its results show the decreasing atmospheric heating in April when mixing layer is strongly developed in test run case. That is, when snow cover in early spring is large, we can speculate that the atmospheric heating, which is caused by surface sensible heat flux, is dramatically decreasing.

Moreover, Q1 and Q2 (Yanai et al, 1973) are calculated to quantify the seasonal progress of atmospheric heating. The diurnal change of Q1 in midwinter reaches lower than 500hPa. Interseasonal variability of Q1, which is mainly caused by upper horizontal advection, is analyzed corresponding to synoptic-scale variability. On the other hand, the diurnal change of Q1 in early spring is up to 400hPa. The contribution of the time-varying term to Q1 is large. Because of small Q2 from midwinter to early spring, we can consider that the sensible atmospheric heating is small. The result of much snow experiment showed that Q1 in early spring is depressed.