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The effect of the Asian Monsoon to the atmospheric boundary layer over the Tibetan Plateau

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Abstract
Modulation of the diurnal variations in the convective activities associated with day-by-day changes of surface flux and soil moisture was observed in the beginning of the monsoon season on the central Tibetan plateau (Sugimoto et al., 2008) which indicates the importance of land-atmosphere interactions in determining convective activities over the Tibetan plateau. Detailed interaction processes need to be studied by experiments designed to evaluate a set of hypotheses on mechanisms and linkages of these interactions. A possible function of vegetation to increase precipitation in cases of Tibetan High type was suggested by Yamada and Uyeda (2006). Use of satellite derived plateau scale soil moisture (Wen et al., 2003) enables the verification of these hypotheses (e.g. Trier et al. 2004). To evaluate these feedbacks, the mesoscale WRF model will be used because several numerical experiments are being conducted to improve the soil physical parameterization in the Noah land surface scheme in WRF so that the extreme conditions on the Tibetan plateau could be adequately represented (Van der Velde et al., 2009) such that the impacts on the structure of the atmospheric boundary layer can be assessed and improved.
The Tibetan Observational Research Platform (TORP) operated by the Institute of Tibetan Plateau (Ma et al., 2008) will be fully utilized to study the characteristics of the plateau climate and different aspects of the WRF model will be evaluated using this extensive observation platform (e.g. Su et al., 2012). Recently, advanced studies on energy budget have been done by combining field and satellite measurements over the Tibetan Plateau (e.g. Ma et al., 2005). Such studies, however, were based on a single satellite observation and for a few days over an annual cycle, which are insufficient to reveal the relation between the land surface energy budget and the Asian monsoon over the Tibetan plateau. Time series analysis of satellite observations will provide the needed temporal and spatial coupling and means for validation of mesoscale model simulations (Zhong et al., 2009, 2011). When these time series are integrated into energy balance analyses methods (Su, 2002, 2005) with reanalysis data, plateau scale diurnal radiative and turbulence fluxes can be generated (Oku et al., 2005; Su et al., 2010) for the study of the boundary layer atmospheric structures at plateau scale. As such regional land-atmosphere feedbacks and atmospheric boundary layer structures can be studied.
The quantification of the multi-scale atmospheric boundary layer and land surface processes over the heterogeneous underlying surface of the Tibetan Plateau is a challenging problem that remains unsettled despite many years of efforts. Using field observation, truth investigation, land surface process parameterization and meso-scale simulation, the dynamical and thermal uniform function of the atmospheric boundary layer and its effect to the atmospheric boundary layer will be analyzed in this research.

Results
The different characteristics of the Boundary layer with Asia monsoon season exchange over TP

The height of atmospheric boundary layer was higher before monsoon season than it in summer. It was around 3-4 km above the ground in spring, while it was 1-2 km during monsoon season. It due to sensible heat flux was stronger in spring than it in summer. Using wavelet analysis method, we decomposed the wind include horizontal and vertical velocity from radiosounding observational data. The reason of high boundary layer height was disclosed.
Compared to the observation, the output of model was underestimation during spring, while it was reasonable in summer monsoon.

The effect of the Asian Monsoon to the precipitation on the TP

Numerical simulation of climate on the TP was implemented for the whole year of 2008 using WRF-Noah model. The output of the WRF model is compared to TRMM data set for precipitation and ERA-interim land product for soil moisture. Modeled precipitation was greater than TRMM observes except for southwest of the TP. The modeled results are good agreement with TRMM data. The mean bias is around 22 mm/month and the standard deviation is around 30. More detailed statistics analysis will be done in the near future.

The precipitation of convective increased from Jan. to June and arrives to the maximum of 36 percent in July, then decreases. It was obviously that the convective activity was strong during monsoon season. The monthly total precipitation extents from southeast to northwest with summer monsoon arrived at TP and it is largest in July. Figure 10 shows that there is positive absolute verticity at 500 mb, but it is response on that it exist a negative potential verticity at 300 mb on the TP.

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