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A Study on the atmospheric heating process over the Tibetan Plateau by using a land data assimilation system

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Introduction The Tibetan Plateau (TP), located in the central part of Eurasian Continent, forms the unique climate in the world because of its very high altitude (4,500m high in average) and especially the atmospheric heating over the TP is noted as a component having strong influence on the formation of large scale atmospheric circulation such as the Asian Summer Monsoon (ASM). Previous studies indicate that the convective activity is important for the heating (e.g. Yanai and Li, 1994, Ueda et al., 2003, Taniguchi and Koike, 2007). Many previous studies, however, didn't take fine spatial and time variation of land condition, which plays a key role in generating the convections, into consideration. Moreover, it is also pointed out that the atmosphere is significantly heated up when the convective activity is not active and in the upper layer where the convection cannot reach (Taniguchi and Koike, 2008). This study investigated the atmospheric heating over the TP in pre- and early monsoon seasons in 2008 at regional scale by using a land data assimilation system coupled with an atmospheric model (LDAS-A) developed in our laboratory (Rasmy et al. 2010), considering also the connection with synoptic scale atmospheric condition, and developed an understanding of the whole picture of the heating over the TP. LDAS-A reproduces the land and the atmospheric state and their spatial and time variability with a high degree of accuracy by assimilating the lower-frequency microwave brightness temperature. Model setup and Methods The target areas of this study are Naqu (the Eastern Tibet, 90.5E~93.5E, 30.5N~33.5N) and Gaize (the Western Tibet, 82.3E~85.5E, 30.5N~33.5N), and the target period is from 21 April to 17 July, which is pre-monsoon and early phase of summer monsoon period in these areas. It is indicated that convective activity and atmospheric heating in this period are closely related with the formation of ASM. The hourly data with the spatial resolution of 0.05^{o}x0.05^{o} in horizontal direction and 90 pressure levels for the vertical layer is used. The time step of calculation is 6 seconds and that of assimilation is 1 day. NCEP FNL (Final) Operational Global Analysis data is used as initial and boundary condition for LDAS-A. The heat budget analysis is conducted and in this heat budget, the heat storage is considered to be generated by five components: horizontal advection, vertical advection and heating by latent heat release, turbulence diffusion and radiation. Results The heating process over the TP consists of three parts which vary depending on the height: the sensible heat transportation below the height of approximately 450hPa, the latent heat transportation in the height from 470hPa to 230hPa, and the horizontal advection above the height of about 250hPa. The sensible heat and the latent heat are directly supplied from the TP, showing the diurnal variation. That is, these are the regional scale processes. In contrast, the horizontal advection has its heat source in the southwest of the TP and influenced by the synoptic scale circulation. The horizontal advection rapidly weakens in the middle of the target period. This attenuation coincides with the formation of the Tibetan high and has relationship with the seasonal change in convective activity.