EGU General Assembly 2009
Vienna, Austria, 19 – 24 April 2009

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The study on free convection events at Nam Co site of the Tibetan Plateau

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Site description

Nam Co site (30.77281 N, 90.96302 E) at 4745 m a.s.l. lies in the northern of the Tibetan Plateau. It is located in 1 km distance SE of Nam Co Lake and in 15 km distance NNW of a ENE-WSW oriented mountain range peaking 5700 m a.s.l. There is another small inner lake located 150 m NW of the site (see Figure 1).

Quality control of flux measurements

The eddy-covariance (EC) raw data (CSAT3, LI-7500, sampling rate: 10 Hz) were processed with the software package TK2, which comprises all state of the art flux corrections and post-field quality control including tests for stationarity and integral turbulence characteristics. Together with a footprint model, the spatial and temporal structure in the data quality of the EC measurements was detected. The resulting high-quality turbulent flux data set was used for the investigation of free convection events (FCEs) at Nam Co site.

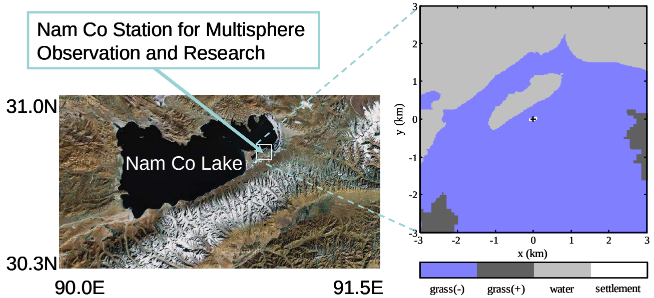

Figure 1: Position and land use map of Nam Co site at the Tibetan Plateau. The dominating land use class at the measurement site, which is located within rather flat terrain, is short grass, referred to as grass(-), with a canopy height not exceeding 5 cm.

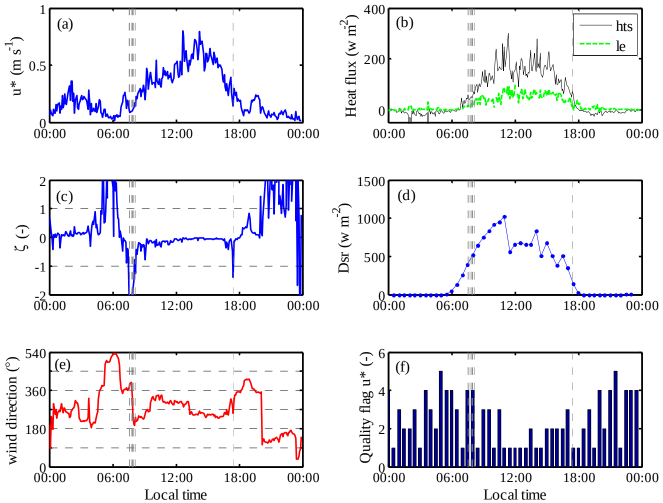

Figure 2: Diurnal variations of the friction velocity (a), sensible and latent heat flux (b), stability parameter ζ (c), downward solar radiation (d), wind direction (e) and the quality flag of the friction velocity (f) on 2 April 2007. The FCE times are indicated by the black dotted lines in each graph for ζ < -1. On that day, FCEs were triggered by a change of the diurnal circulation system in the morning hours.

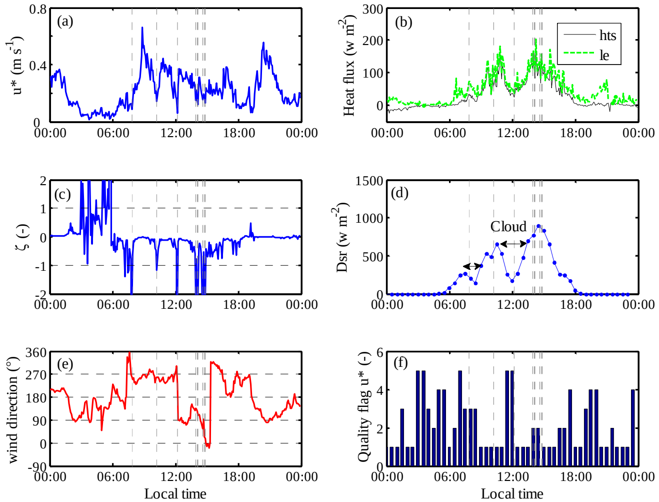

Figure 3: Same as Figure 2 for 23 August 2007. The FCE times are again indicated by the black dotted lines in each graph. On that day, FCEs were mostly triggered by the quick variation of heating difference between different types of land use when clouds covered the surface or clouds moved away (see the downward solar radiation in d).

Free convection events (FCEs)

FCEs occur in the atmospheric surface layer if buoyant forces dominate over shear forces within turbulence production and manifest themselves as plume-like coherent motions. FCEs can be detected by the EC flux measurements if the stability parameter ζ drops below -1:

$$\zeta = \frac{z}{L} = -\frac{z \cdot \kappa \cdot g \cdot \left(\overline{w'\theta_v'}\right)_0}{\theta_v \cdot u_*^3}$$

The generation of FCEs not only can be detected in the morning hours, at times the diurnal circulation system changes its previously prevailed wind direction (Figure 2), but can also be triggered by the quick variation of heating difference between different types of land use during the daytime when clouds cover the surface or clouds move away (Figure 3).

FCEs in relation to monsoon

Before monsoon, FCEs mostly occur in the morning hours. During the monsoon, the generations during the daytime have two summits; one in the morning and another in the afternoon. The FCEs in afternoon have a close relationship with cloud-cover frequency (Figure 4).

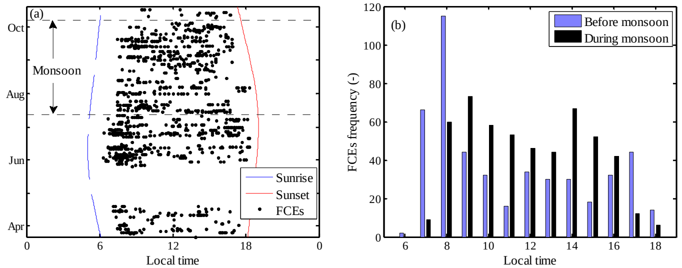

Figure 4: Distribution (a) and frequency statistics (b) of FCE times at Nam Co site.

Conclusions

FCEs lead to the effective convective release of near-ground air masses into the atmospheric boundary layer (ABL) and may strongly influence its local moisture and temperature profiles and its structure.

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References: Göckede, M., Markkanen, T., Hasager, C. B., and Foken, T.: Update of a footprint-based approach for the characterisation of complex measurement sites, Bound.-Lay. Meteorol., 118, 635–655, 2006.
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