Geophysical Research Abstracts
Vol. 15, EGU2013-9098, 2013
EGU General Assembly 2013

On the factors influencing surface-layer energy closure and their seasonal variability over the semi-arid Loess Plateau of Northwest China

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The energy observed in the surface layer, when using eddy-covariance techniques to measure turbulent fluxes, is not balanced. Important progress has been made in recent years in identifying potential reasons for this lack of closure in the energy balance, but the problem is not yet resolved. In this paper, long-term data that include output of tower, radiation, surface turbulence flux and soil measurement collected from September 2006 to August 2010 in the Semi-Arid Climate Change and Environment Observatory, Lanzhou University, in the semi-arid Loess Plateau of Northwest China, were analysed, focusing on the seasonal characteristics of the surface energy and the factors that have impact on the energy balance closure (EBC). The analysis shows that (1) the longterm observations are successful; the interaction between the land and the atmosphere in semi-arid climates can be represented by the turbulent transport of energy. In addition, even though the residual is obvious, this suggests that the factors that impact the EBC are stable, and their seasonal variations are identical. The analysis also shows that (2) four factors have obvious impact on the EBC: the diverse schemes for surface soil heat flux, the flux contribution from the target source area, the low-frequency part of the turbulence spectra, and the strength of atmospheric turbulence motion. The impact of these four factors on the EBC are similar in all seasons. Lastly, the results indicate that (3) atmospheric turbulence intensity is a very important factor in terms of its impact on the EBC. The relative turbulence intensity, RIw, characterises the strength of atmospheric turbulence motion, and is found to exert a noticeable impact on the EBC; in all seasons, the EBC is increased when the relative turbulence intensity is enlarged.