Geophysical Research Abstracts
Vol. 19, EGU2017-2130, 2017
EGU General Assembly 2017

Relationships between energy balance closure and turbulent transport of energy

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The energy balance residual (EBR), defined as the difference between the available energy (sum of net radiation and ground heat flux) and the turbulent fluxes of latent and sensible heat, is often found to have a large positive value. Several land surface experiments and flux networks report an average energy balance closure of approximately 80%. Although different factors can influence the energy balance closure across measurement campaigns, a significant EBR even when sites are horizontally with short canopies indicates of a systematic bias resulting from the general underestimation of the aerodynamic transport of energy, especially horizontal divergence of the mean advective fluxes and transport by low-frequency motions generally called ‘secondary circulations’. These low frequency local transports can occur from various processes such as coherent large scale organized motions, convective cells and even significant transient changes. Thus, we decided to study the budget of the turbulent kinetic energy (TKE) in conjunction with the energy balance closure and the turbulent fluxes associated with non-local motions, advection and flux divergence. In the current work, this interdependency has been investigated using surface flux (Eddy Covariance) at the TERENO sites Fendt, Graswang and Rottenbuch in Southern Germany (with gentle topography. Statistical methods for dimensional reduction techniques has been used to extract the effects and significance of aforementioned processes towards explaining the observed annual average EBR of about 50 Wm-2. Initial results indicate a high correlation between EBR and the TKE dissipation rate, as well as the skewness of vertical velocity and the turbulent fluxes associated with flux divergence, confirming the role of secondary circulations. Overall, improved understanding of such connections between the fundamental mechanisms of TKE transport and the energy balance likely advances the knowledge towards constraining the modeling uncertainties of biosphere-atmosphere interaction, especially under spatial complexity.