Geophysical Research Abstracts
Vol. 21, EGU2019-10338, 2019
EGU General Assembly 2019

Causes of surface energy imbalances of eddy covariance measurements in mountainous terrain

Norbert Pirk (1), Eirik Ramtvedt (1), Sven Decker (1), Massimo Cassiani (2), John F. Burkhart (1), Frode Stordal (1), and Lena M. Tallaksen (1)

(1) University of Oslo, Department of Geosciences, Oslo, Norway, (2) NILU - Norwegian Institute for Air Research, Kjeller, Norway

The surface energy balance is a key constraint for ecological processes and represents the lower boundary condition for the atmosphere. Field measurements of surface energy fluxes are therefore crucial for the understanding of the Earth system and feedbacks therein. Direct measurements with the eddy covariance technique often show an imbalance of the surface energy fluxes, especially at sites with complex terrain and heterogeneous surface cover.

At the Finse field site in Alpine Norway, we found an energy balance closure of only 38-58%, mostly depending on measurement height (footprint size) and wind direction, but relatively constant at different measurement locations in the area. Different hypothesised causes for the large lack of closure were investigated using (1) spatially distributed measurements of net radiation, (2) riverine discharge and temperature measurements to estimate lateral energy fluxes in the eddy footprint, and (3) airborne measurements of the temperature profile in the lowest 120 m of the atmospheric boundary layer.

Accounting for spatial variations in net radiation within the footprint improved the energy balance closure by only 4%. The quantification of lateral energy transport in the river is subject to large uncertainties caused by the confluence of cool glacial and warm non-glacial streams within the footprint (spatial temperature differences can exceed 10 degree C in summertime). Possible biases in the eddy fluxes are supported by measured vertical temperature profiles in the lower atmospheric boundary layer that show warm layers (0.5 K warmer than ground level) at 20-30 m a.g.l. persisting even during 5 m/s average horizontal wind speed. Unconventional eddy flux calculations using the ogive optimisation method, however, did not significantly improve the energy balance closure. Further investigations combining our in-situ measurements with large eddy simulation conducted in PALM will quantify the role of coherent structures on eddy flux estimations in complex mountainous terrain.