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Turbulent Heat Fluxes Across the Lake-Air Interface in Case of Very Young Waves

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Abstract Text:

Turbulent momentum and heat fluxes are major driving forces of lake hydro- and thermodynamics. Large, but still highly fetch limited lakes differ significantly from marine environments due to the developing wave field that is characterized by very young waves with typical wave age of 0.5-10 in our case. A few studies, including our recently published analysis, already showed that new wave related parameterizations are necessary to improve the estimation of momentum fluxes. We have recently launched an observational campaign in Lake Balaton to measure momentum, heat and water vapor fluxes using the eddy-covariance (EC) technique. Lake Balaton is the largest freshwater lake (596 km², mean depth of 3.2 m) in Central Europe with a typical fetch of 2-10 km. Our hydrometeorological observatory was deployed offshore in the westernmost basin with an average fetch of 3 km. Beside the EC set-up, upwelling and downwelling short- and longwave radiations were measured by a net radiometer, the heat content of the water column by a thermistor chain, and the sediment heat flux by heat flux plates in order to close the energy budget. In our analysis, we determine heat and water vapor transfer coefficients and roughness lengths and their dependence on wave state for fetch limited conditions, since waves were simultaneously recorded with an upward looking, bottom mounted ultrasonic surface tracker. On the one hand, the reliability of observed heat fluxes are quantified by the analysis of the energy balance. On the other hand, the observed evaporation are evaluated against water mass budget estimates on a monthly scale. The variability of heat fluxes and their environmental drivers are also analyzed at different timescales (hourly, diurnal, monthly) during the period that lasted from late spring to early fall (May to October 2019).

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