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Heat flux in the presence of sea surface swell

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In the scientific community is an ongoing process of developing Earth System models to better describe the climate system, presently also wave models are introduced in atmosphere-ocean coupled models. It is, however, not fully understood how to introduce full effects of waves on the atmosphere and ocean. It is well-known that surface gravity waves modulate the air-sea momentum transport and turbulence features in the atmosphere. Less is known about flux of heat and scalars. Measurement have, however, shown that there are surface wave-coherent components also of heat flux. Surface waves can be separated into growing sea and swell waves with very different impact on air-sea interaction processes.

An idealized Large-Eddy Simulation (LES) code with a moving lower wavy surface (Sullivan et al., 2008) is used to study the organization of potential temperature fluctuations and sensible heat fluxes. It shows how flux redistribute near surface waves due to swell wave-induced vertical wind. Correlation of vertical wind fluctuations and temperature fluctuations at the frequency of the wave show an impact of swell waves on heat flux. However, not as significant as for momentum transport. LES results are also linked to a detailed analysis of measurements taken at the marine micro-meteorological field station Östergarnsholm in the Baltic Sea in northern Europe as well as on the FLIP platform outside Hawaii. Results from field measurements, that include more processes and complexities not present in the idealized numerical simulations, are emphasized in the discussion of the obtained results.

This study shows that more realistic coupling of atmosphere-ocean models must include air-sea interaction associated with surface gravity waves because a part of the near-surface fluxes of sensible heat and momentum can be found at frequencies of the dominant wave components of the wave-field. Continued development of Atmosphere-Wave-Ocean coupled model systems is therefore necessary for Earth-System-Models.