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Small-scale and mesoscale lake surface water temperature structure: Thermography and in situ measurements from Lake Geneva, Switzerland

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Lake surface water temperature (LSWT), which varies spatially and temporarily, reflects meteorological and climatological forcing more than any other physical lake parameter. There are different data sources for LSWT mapping, including remote sensing and in situ measurements. Depending on cloud cover, satellite data can depict large-scale thermal patterns, but not the meso- or small-scale processes. Meso-scale thermography allows complementing (and hence ground-truth) satellite imagery at the sub-pixel scale.
A Balloon Launched Imaging and Monitoring Platform (BLIMP) was used to measure the LSWT at the meso-scale. The BLIMP consists of a small balloon tethered to a boat and is equipped with thermal and RGB cameras, as well as other instrumentation for geo-location and communication. A feature matching-based algorithm was implemented to create composite thermal images. Simultaneous ground-truthing of the BLIMP data were achieved using an autonomous craft measuring among other in situ surface/near surface temperatures, radiation and meteorological data. Latent and sensible surface heat fluxes were calculated using the bulk parameterization algorithm based on similarity theory.
Results are presented for the day-time stratified low wind speed (up to 3 ms-1) conditions over Lake Geneva for two field campaigns, each of $\sim$6 h on 18 March and 19 July 2016. The meso-scale temperature field ($\sim$1-m pixel resolution) had a range and standard deviation of 2.4°C and 0.3°C, respectively, over a 1-km2 area (typical satellite pixel size). Interestingly, at the sub-pixel scale, various temporal and spatial thermal structures are evident – an obvious example being streaks in the along-wind direction during March, which we hypothesize are caused by the steady $\sim$3 h wind condition. The results also show that the spatial variability of the estimated total heat flux is due to the corresponding variability of the longwave cooling from the water surface and the latent heat flux.