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Reconstruction of soil surface temperature via Fourier analysis to quantify surface energy fluxes

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Quantifying the surface energy and water balance is a prerequisite for understanding the complex interplay between the atmospheric and terrestrial part of the earth. Therefore, it is necessary to estimate the partitioning of the incoming solar energy into ground heat flux, latent and sensible heat. The amount of evaporating water can be measured by the expensive and elaborated eddy-covariance method, but in general measurements of surface fluxes are difficult to obtain. This is why they are often determined from more theoretical approaches based on energy budget calculations at the soil surface. To compute, e.g., the latent heat portion, this indirect methods, like Penman-Monteith, make use of various atmospheric quantities, but usually lack information about the temperature right at the soil surface which therefore needs to be approximated.

We investigate synthetic and field measured soil temperature data via Fourier analysis to extract the frequency information of temperature readings in different depths. This allows us to determine the apparent thermal soil diffusivity and to project back all frequency components from within the soil profile towards the surface. This yields a reconstruction of the temperature at the upper soil boundary which can directly be used to calculate the energy balance at the interface to the atmosphere.

We will present the performance of the projection for synthetic data for which the method could be validated very well. Assumptions and approximations made will be discussed. Furthermore, we will demonstrate its application to field-measured data from our test site next to Heidelberg, Germany.