Surface renewal method for estimating sensible heat flux

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Abstract

For short canopies, latent energy flux may be estimated using a shortened surface energy balance from measurements of sensible and soil heat flux and the net irradiance at the surface. The surface renewal (SR) method for estimating sensible heat, latent energy, and other scalar fluxes has the advantage over other micrometeorological methods since the method requires only measurement of the scalar of interest at a point and the method may be applied close to the canopy surface, thereby reducing fetch requirements. The SR analysis for estimating sensible heat flux from canopies involves high-frequency air-temperature measurements (typically 2 to 10 Hz) using unshielded and naturally-ventilated 25- to 75-μm diameter fine-wire thermocouples. The SR method is based on the premise that a parcel of air connected to the surface, after it has been enriched or depleted, is renewed by an air parcel from above. There are 2 SR analysis approaches: the ideal SR analysis approach which presumes a constant α factor; and a set of SR approaches that avoid the use of the α calibration factor. The weighting factor α depends on measurement height, canopy structure and stability conditions since it depends on the capability of the highest frequency eddies to mix the scalar within the air parcels renewed by coherent structures. A combination approach using SR and either similarity theory, that requires friction velocity or wind-speed measurements, or dissipation theory, has also been used to estimate *H*. The combination SR and dissipation method only requires high-frequency air-temperature data and may be considered not to require calibration. The ideal SR and combination SR/dissipation approaches are the least expensive micrometeorological methods for estimating sensible heat flux and also latent energy flux if one forces closure of the surface energy balance. However, application of SR analysis using slow data-loggers require some expertise since high-frequency air temperature data are not usually stored with the slower data-loggers. Some structure functions can be stored for post-processing and determination of ramp amplitude and ramp period, but the appropriate time lags have to be chosen *a priori*. Fortunately, modern data-loggers avoid this problem and complex SR analysis approaches can now be applied. However, for routine purposes, applications using the ideal SR analysis approach with slow data-loggers may be of interest since it is a very affordable method.

Keywords: surface energy balance, sensible heat flux, latent energy flux, evaporation