Geophysical Research Abstracts
Vol. 20, EGU2018-12561, 2018
EGU General Assembly 2018

Effect of variable fetch on surface renewal estimates of sensible and latent heat fluxes in cotton

Nitai Haymann, Victor Lukyanov, Shabtai Cohen, and Josef Tanny

Agricultural Research Organization, Institute of Soil, Water and Environmental Sciences, Rishon LeZion, Israel
(tanai@volcani.agri.gov.il)

Knowledge of crop evapotranspiration (ET) is important for efficient irrigation management. The eddy covariance (EC) technique is useful in measuring whole canopy sensible and latent heat fluxes from field crops. However, it requires expensive equipment and complex data analysis; hence it is for research only. Aiming at developing a low-cost and simple method that will be available for day-to-day use by growers, we investigated here the surface-renewal (SR) method. The method is based on high frequency measurements of air temperature near the canopy top by a miniature thermocouple. Air temperature signal is analyzed by structure functions to determine mean half-hourly ramp amplitude and period, from which sensible heat flux is estimated up to a weighing factor α. Additional measurements of net radiation and soil heat flux allow extraction of ET from energy balance closure analysis. Since miniature thermocouple measurements of air temperature can be performed near the canopy top, we hypothesize that fetch requirements can be relaxed relative to those for EC, and a relatively small fetch is sufficient for reliable flux measurements by SR.

In the present study the SR technique was examined in a cotton field in southern Israel. Nine miniature thermocouples were installed at various distances from field edges and at different heights above the ground, providing variable fetch from 40 to 225 m, depending on field geometry and wind direction. An EC system was installed within the field at 3.65 m height at a position that provided sufficient fetch (400 m) for reliable reference values of sensible and latent heat fluxes. Net radiation and soil heat flux were measured to facilitate energy balance closure analysis. To evaluate the SR performance, half-hourly sensible and latent heat flux data from SR were regressed against reference EC values.

Excellent energy balance closure of 0.99 (R^2 = 0.92) was obtained for non-continuous 21 days of measurements. SR data for each sensor were classified by either available fetch or by 90% flux footprint. Only cases where footprint was smaller than the available fetch were included in the analysis. Two footprint models were examined, Kljun et al. (2004) and Hsieh et al. (2000).

Results of fetch classification showed that the SR weighing factor α varied between 0.86 and 1.14 and was independent of fetch. Footprint classification provided weighing factors between 0.6 and 1.1 for the Kljun model and between 0.87 and 1.34 for the Hsieh model. ET extracted from SR sensible heat flux and energy balance closure was regressed against ET reference values measured by the eddy covariance. Results showed deviations of up to 15% and 30% between SR and EC, for the Kljun and Hsieh model data, respectively. We conclude that in the cotton field under study the SR technique was reliable in estimating sensible and latent heat fluxes and the weighing factor was essentially independent of the geometrical fetch and the flux footprint of the sensors.