

Estimating area-averaged surface fluxes over contrasted agricultural patchwork in a semi-arid region

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ABSTRACT: Population growth has resulted in intense demands on the quantity and quality of water resources worldwide. The sustainability of water resources in the 21st Century will depend on our ability to correctly manage water resources systems under a more variable future climate. Semi-arid regions are in particular jeopardy, experiencing rates of population development that exceed those of other climatic regions and are highly sensitive to increasing anthropogenic pressures, variations in climate, and the disruptions associated with long-term climate change. In arid and semi-arid regions, irrigated agriculture consumes about 80 to 90% of total available water. Therefore, a sound and efficient irrigation practice is an important step for achieving sustainable management of water resources in these regions. In this regard, a better understanding of the water balance is essential for exploring water-saving techniques. One of the most important components of water balance in semi-arid areas is the evapotranspiration (ET). Measuring ET over large and heterogeneous surfaces is possible through the deployment of a network point sampling devices such as Eddy Correlation systems which are expensive and require a well trained staff to operate and maintain them. Alternatively, one can use scintillometer to derive area-averaged sensible heat flux and then obtain latent heat or ET as the residual terms of the energy balance equation since available energy can be easily estimated through a combination of ground and remotely sensed data. In this study, an experimental setup has been designed to investigate the effectiveness of the large aperture scintillometer (LAS) to obtain area-averaged sensible and latent heat flux along a transect of about 1.8 km made up of three contrasting agricultural fields: cotton, wheat and chickpeas. The comparison against reference area-averaged fluxes measured by eddy correlation systems (EC) shows that the LAS based fluxes are overestimated by about 15%. In an attempt to explain such behavior, several reasons are proposed: a) The LAS measurement was made below the blending height which may violate the requirement for the applicability of Monin-Obukhov Similarity Theory (MOST); b) The fact the sensitivity of the LAS along the optical path is not uniform but follows a bell-shaped curve; c) The division and the contrast between the fields may provide a source of additional turbulence, the LAS does not distinguish between upward and downward eddies, both contribute to the recorded signal; d) The eddy correlation underestimates sensible and latent heat fluxes since their sum is smaller than the observed available energy (the no closure of the energy balance). This later explanation is supported by the fact that the correspondence between measured and simulated heat flux improved when the fluxes were adjusted to force closure of the