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Sensible heat fluxes by scintillometry and eddy covariance in an irrigated vineyard

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Evapotranspiration (ET) measurements over inhomogeneous and extensive surfaces - typical conditions at the catchment scale - are still challenging due to spatial variability of vegetation, soil conditions and land topography. Traditional micrometeorological techniques, e.g. eddy covariance (EC), cannot be applied under these conditions, requiring homogenous surface and being characterized by limited footprint. In this context, a suitable technique to measure turbulent fluxes is scintillometry, which can give measurements of sensible heat flux at larger scale, providing averages over heterogeneous surfaces. ET can then be estimated as residual of the energy budget.

In this study, we present results from a one-week campaign held during summer 2016 in Southern Italy. We deployed a Large Aperture Scintillometer (LAS) in an extensive vineyard of 140 ha on a path length of 760 m. The site was characterized by gently slope terrain with uniform crop. However, spatial and temporal variability of soil water content was expected due to irrigation shift rotation among different plots. In order to have reference measurements of local sensible heat flux, we deployed three sonic anemometers along the scintillometer path, representative of different irrigation schedules. In addition, the EC station close to the middle of the path was equipped with an open-path infrared gas analyzer, net radiometer and soil heat flux plates to solve the energy budget. The aim of the study was to test the ability of scintillometry to provide a spatially averaged flux, representative of the possibly diverse conditions in an extended footprint upwind to the measurement path.

The heat flux measured by LAS (H_{LAS}) showed to be extremely sensitive to the value of beam effective height (z_{eff}) used in data processing (z_{eff} = 6.4 m, above a canopy height of 1.8 m). The relationship between sensible heat flux measured by EC (H_{EC}) and H_{LAS} showed to be very good (H_{LAS} = 1.06 H_{EC} + 1.73, r^2 = 0.97) for the EC station in the middle of the path. On the contrary, H_{LAS} was higher compared to H_{EC} for the EC stations close to the path ends, resulting in an overestimation of the average EC flux of around 20%. Scintillometer measurements showed to be highly influenced by the central area of the path, whereas off-center fluxes were not adequately represented.