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Measuring evapotranspiration: comparison of eddy covariance, scintillometers and enclosed chambers

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Evapotranspiration (ET) is the combination of evaporation from the soil surface and transpiration from plants. It is an important component of the hydrological cycle, particularly in arid and semi-arid areas where most of the precipitation is returned to the atmosphere via ET. It also drives the land-surface energy balance, largely affecting soil temperature and the heat exchange between the land and atmosphere. Therefore, the ability to quantify ET is important for accurate climate and weather predictions, as well as improving the management of water resources.
Various methods for measuring ET are available, including gas chambers, lysimeters, Bowen-ratio energy balance stations, eddy-covariance systems, scintillometers, and space-borne sensors. These methods differ in spatial scales (from leaf to basin scale), time scales (seconds to days), principles (water-balance, mass-transfer, eddy-correlation, energy balance) and have their own strengths and limitations. For instance, point scale measurements, such as those obtained using lysimeters, assume that the sample is representative of a larger area, whereas measurements at a basin scale assume that the spatial average of all the other components in the water or energy balance equations can be measured accurately.
The purpose of this study is to compare different techniques to measure ET across their respective scales and to identify causes of discrepancies between measurements. The final aim is to identify a technique or a combination of techniques to be used for verification of remote sensing evapotranspiration products.
The study area is located in the Yanco Study Area (34.561°S, 35.170°S, 145.826°E, 146.439°E), situated within the western plains of the Murrumbidgee River catchment, in New South Wales, Australia. This area has been extensively monitored and a series of field experiments have been performed in the past to contribute to the pre- and post-launch algorithm development of earth observing satellites such as SMOS, and the NASA SMAP mission. In May 2012, an eddy-covariance system was installed at 16m on top of an 18 m tall tower for the validation of remote sensing products derived by the Japan Aerospace Exploration Agency (JAXA) from data obtained with the Advanced Microwave Scanning Radiometer-2 (AMSR-2) on-board Global Change Observation Mission (GCOM-W1). Using a footprint model, 90% of the fluxes measured by the EC system on the tower are emitted within an approximately 1km footprint upwind of the tower. Two optical (different manufacturers) and two microwave (different frequencies) scintillometers were installed so that their respective footprints were within that of the EC system. Additionally, four automated gas chambers (L:500mm, W:500mm, H:650mm) were deployed in the centre of the ~1km footprint of the EC tower for approximately 8 hours daily, for 3 days a month, from August to December 2013. During the days of the campaigns, further measurements were obtained with a mobile gas chamber (D: 300mm, H: 400mm) within the footprint, at 200m, 400m, 600m and 800m from the tower, along the scintillometer transect. This aims at understanding the spatial variation of evapotranspiration within the ~1km footprint of the EC tower footprint and consequently along the scintillometer path, in order to assess the influence of the individual locations to the overall flux measurements. Results comparing the latent flux measurements derived from the eddy-covariance system, scintillometers, and gas chambers will be presented.