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Some advance on the comprehension of SR analysis for estimating the flux of a scalar

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In agronomy, the eddy covariance, EC, method likely is the preferred for measuring surface scalar fluxes. For latent heat flux, however, weighing lysimeters maybe preferred in agriculture, but they are rarely affordable and not portable. The dissipation method, DM, is considered the most reliable technique for measuring scalar fluxes over open water because instrument motion contaminates the EC measurements. The main advantage of DM over EC is that it is less sensitive to low frequency instrument platform motions (such as ship and buoys), sensor alignment, precise orientation and stringent steadiness in the mean meteorological conditions (Fairall and Larsen, 1986; Kader, 1992; Edson and Fairall, 1998). Over land, keeping in mind that the EC and DM methods require the same measurements for scalar flux measurement, the DM has several disadvantages versus the EC. Direct measurement of the scalar variance dissipation rate, VDR, requires to capture eddies in the Kolmogorov's microscale (thus scalar time series measured at frequencies in the order of kHz are needed). Therefore, it is not practical. Indirect methods to estimate VDR (such as spectral analysis and second or third order structure functions) requires implementing iterative methods involving similarity relationships that are not well established (Hsieh and Katul, 1997; Castellvi and Snyder, 2008). Currently, there is ample evidence that the DM as explained in traditional micrometeorological books (such as, Panofsky and Dutton, 1984; Brutsaert, 1988; Kaimal and Finnigan; 1994) is, in general, not correct. Accordingly, it likely explains why DM is typically omitted in revisits of micrometeorological methods for estimating scalar fluxes in agronomy. Within the last decade, over some agricultural surfaces, evidence has been shown on the advantages over other micrometeorological methods and the reliability (i.e., close performance to the EC method) of Surface Renewal, SR, theory in conjunction with the Analysis of the scalar time trace to estimate scalar surface fluxes (Paw U et al., 1995). The analysis consists on determination of the mean ramp-pattern dimensions observed in the trace measured at one height. SR analysis is a simple transilient theory that is Lagrangian in nature and based on the scalar conservation equation.
Here, it is shown (indirectly) that for a steady, incompressible and horizontally homogeneous flow, the production term in the budget equation of the mean turbulent variance of a scalar can be expressed in terms of the mean ramp dimensions observed in the trace. Therefore, the budget equation provides a link between the contrasting DM and SR analysis methods for estimating scalar surface fluxes. The dissipation method is based on the finest turbulence scales, whereas the SR analysis is based on canopy-scale coherent structures. By normalizing the budget equation, and invoking similarity, it is shown that DM and SR analysis are closely related (details were given in Castellvi and Snyder, 2008). However, SR analysis avoids the disadvantages of DM and it also overcomes potential problems related with the EC method (such as perfect alignment, rotation of the wind field, sensor separation, shadowing, etc.) because the velocity field (i.e., the sonic anemometer) is not required in SR analysis. The relation between SR analysis and DM allows to better interpret a crucial parameter (originally, denoted as [U+F061]) involved in SR analysis. The parameter [U+F061] was implemented to account for three assumptions made to solve the scalar flux conservation equation coupled with the Lagrangian scalar mass conservation equation. Considering an air parcel that suddenly moves down to the surface which volume covers all the vertical extend of the surface sources (sinks), the assumptions made are the following; (1) The air parcel remains in contact with the sources (sinks) for a period during which it has been enriched (depleted) of scalar, (2) During the enrichment phase there is not loss of scalar (heat for temperature) through the air parcel top, and (3) Molecular diffusion within the air parcel can be neglected.
According to the new [U+F061] parameter expression derived, it is shown that the half-hourly [U+F061][U+F020]value is related to the capability of turbulence to mix the scalar within the air par-

cel during the enrichment (depletion) phase. The expression depends on the variance of the scalar associated to isotropic turbulence over the total (organized and isotropic). The [U+F061] expression suggests that half-hourly [U+F061][U+F020]values are in the range, 0 < [U+F061] $\leq$ 1, at least when measurements are taken in the inertial sub-layer over vegetated surfaces.

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