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Data quality control using the fractional uncertainty of the eddy covariance measurements

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The eddy covariance technique (EC) is available to monitor heat, water, and carbon dioxide (CO_2) fluxes over various land covers. The uncertainty information as important as the flux data is necessitated in the studies on sites comparison, model estimation, and model-data synthesis to understand the interactions between the biosphere and the atmosphere, and the biogeochemical cycle in terrestrial ecosystem. While the uncertainty is served by calculating the variance of covariance with the time series of EC measurement (Finkelstein and Sims, 2001), those knowledge has been insufficient to understand the characteristics (Kim *et al.*, 2008; Kim *et al.*, 2009). Therefore, the fractional uncertainty (ϕ: $= \frac{\delta}{|F|}$; δ: square root of variance; F: flux) by EC measurements is investigated with those frequency distribution, spatiotemporal variations, and variations according to the averaging window size of the time series.

The ϕ is calculated as

$$\phi = \frac{\delta}{|F|} = \frac{\sigma}{\overline{x'y'}}$$

where, the σ is estimated by the variance of Finkelstein and Sims (2001) and the $\overline{x'y'}$ is covariance between the time series of vertical wind velocity and target scalar. The analyzed vegetation types are cassava, sugar cane, paddy field, and deciduous forest with various measurement heights (2, 3, 6, 7, 15, 30 and 100 m) in Thailand and Korea.

As the results, we could find that: First, the modes of ϕ_H, ϕ_{lE}, and ϕ_{CO_2} as the location based on descriptive statistics over the tropical paddy field for 24-30 May 2007 are 0.11±0.05, 0.09±0.03, and 0.14±0.05, respectively, and then the differences of ϕ among the fluxes are not acknowledged. Second, the ϕ is also unchangeable against the growing stage, though minimum F_{CO_2} values are different ($F_{CO_2} \approx -0.1$ or ≈ -0.5 mg m^{-2} s^{-1}) according to the discrepancy of leaf area indexes (LAI: ≈0.5 and ≈2.0, respectively) by main wind directions. Finally, the temporal variation of the ϕ over tropical deciduous forest during 3 years is not recognized, while the spatial variation of the ϕ, which is due to flux measurement height, is captured in the analysis using the data estimated various vegetation types and measurement heights.

Using the constancy of ϕ, it should be possible to develop a method for the quality control of flux data and the error analysis about flux uncertainty, though more estimation and validation studies are required to use this method as a general application.