Flux Measurements in a Complex Landscape: IIow Reliable and Consistent Are Fluxes from Single Eddy Covariance Tower?

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Long-term flux monitoring in Asia now receives much attention worldwide with the establishment of measurement networks such as AAN and AsiaFlux. Particular interest lies in monitoring fluxes (using eddy covariance) above forested landscapes that represent bulk of the Asian land covers. In comparison with relatively flat and homogeneous flux sites in Ameriflux or Euroflux, landscapes of Asian flux sites are characterized by patchiness, heterogeneity, and rapid changes in land use. In reality, some errors are inevitable with any eddy covariance systems deployed in FLUXNET. A variety of methods, however, can be used either to correct the measured fluxes or minimize flux losses a priori through careful experimental design.

Recent recognitions of the common failure of surface energy budget closure have resulted in rigorous investigations such as revisiting budget equation, PBL coupling, and refinement of field measurements including calibration and intercomparison. In particular, recent results of the following four independent field experiments have come to our attention: (1) intercomparison among the three major types of eddy covariance systems mounted on a single tower at the Tomakomai forest in Hokkaido, Japan during July of 2000 (Fig. 1), (2) similar comparison to (1) but over a field covered with short grasses with limited fetch in Tsukuba, Japan during May of 2000, (3) intercomparison among seven flux towers equipped with different eddy covariance systems over a uniform pine forest in North Carolina, U.S.A. during October of 1997, and (4) similar to (3) but over a grassland in Oklahoma, U.S.A. during June-July of 1997. Some of these results have just appeared in various scientific journals whereas others are still in the processes of detailed analyses and the preliminary reports are underway.

Up to this time of preparation, tentative conclusions drawn from these four investigations are quite intriguing. For example, the differences in fluxes and turbulent statistics among different sensors mounted on a single tower (Table 1) were as large as those obtained from several individual towers that were spatially distributed within a footprint domain (not shown). In this presentation, major results from these four investigations are highlighted and their implications are discussed in the context of what and where the gaps are.

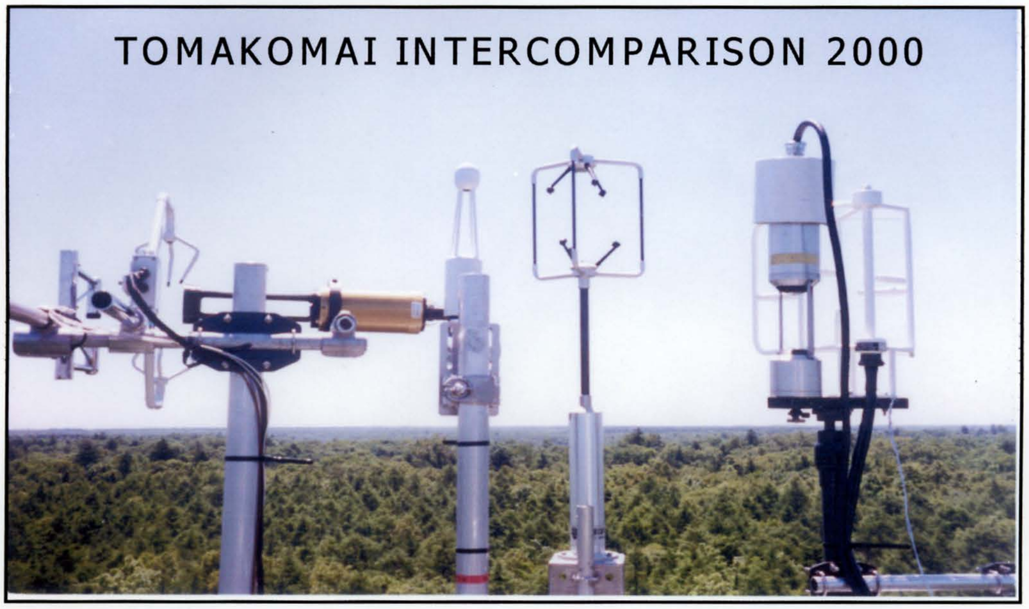

Figure 1. Intercomparison of three eddy covariance systems on a single tower (Tomakomai forest in Hokkaido, Japan during July of 2000)

Table 1. Comparison of turbulence statistics among the three major eddy covariance systems: (1) KD3-E009B, (2) Solent-LI-7500, and (3) CSAT3-OP2. Three values are given without parenthesis, with parenthesis, and with bracket from regressions: $Y_{Solent-LI7500} = a + b \cdot X_{KD3-E009B}$, $Y_{CSAT3-OP2} = a + b \cdot X_{KD3-E009B}$, and $Y_{CSAT3-OP2} = a + b \cdot X_{Solent-LI7500}$, respectively for each column.

Variables	Slope (b)	Intercept (a)	r^2	Range
$\overline{U}$ (ms^{-1})	1.17 (1.06) [0.87]	0.03 (0.24) [0.27]	.92 (.93) [.95]	1 – 4
$\overline{T}$ (° C)	1.03 (0.97) [0.97]	0.33 (2.01) [2.01]	1.0 (1.0) [1.0]	15 – 26
σ_u (ms^{-1})	1.14 (1.00) [0.91]	0.01 (0.09) [0.05]	.94 (.93) [.97]	0.3 – 1.5
σ_v (ms^{-1})	0.95 (1.07) [1.05]	0.04 (0.01) [0.01]	.93 (.92) [.98]	< 1.5
σ_w (ms^{-1})	0.99 (0.98) [0.98]	-0.03 (0.01) [0.03]	.99 (.99) [.99]	< 1
σ_T (°C)	1.02 (0.99) [0.94]	0.01 (0.01) [0.00]	.97 (.98) [.97]	< 0.8
σ_{CO2} (mgm^{-3})	0.56 (0.47) [0.81]	0.00 (0.00) [0.00]	.67 (.68) [.98]	< 20
σ_{H2O} (gm^{-3})	0.78 (0.62) [0.79]	0.00 (0.01) [0.01]	.63 (.64) [.99]	< 0.5
τ ($kgm^{-1}s^{-2}$)	1.22 (1.04) [0.85]	0.00 (-0.02) [-0.01]	.98 (.94) [.96]	-0.6 <
H (Wm^{-2})	1.08 (0.97) [0.89]	0.00 (0.00) [0.00]	.99 (.99) [.99]	< 500
λE (Wm^{-2})	1.07 (0.83) [0.78]	0.00 (0.00) [0.00]	.92 (.92) [.98]	< 300
F_c ($mgm^{-2}s^{-1}$)	0.91 (0.73) [0.80]	0.00 (0.00) [0.00]	.96 (.98) [.98]	-2 ~ 1