

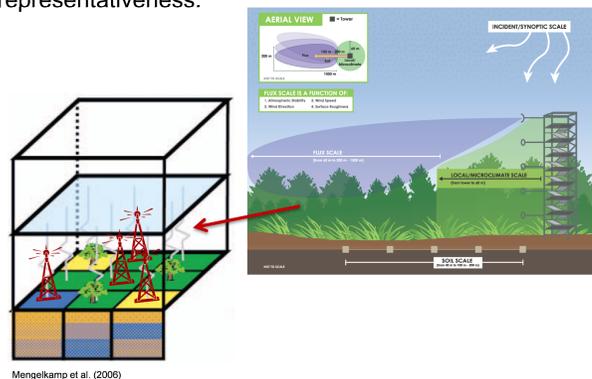


Expanding the representativeness of eddy-covariance fluxes: Seeing the landscape for the footprint

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Background

Estimating the landscape-scale exchange of ecologically relevant trace gas and energy fluxes from tower eddy-covariance measurements is often complicated by surface heterogeneity: A tower eddy-covariance measurement may represent less than 1% of a grid cell resolved by earth system models (order 100–1000 km²). For confronting these models with carbon cycle observations, it is hence critical to address spatial representativeness.



Scale-dependence of spatial representativeness

Location bias

- Spatial average of flux η typically not available
- Surrogated with land cover information, and unknown relationship between land cover information and η
- Fails to quantify representativeness for spatial variation

The Workshop on the Representativeness of Meteorological Observations, June 1981, Boulder, Colo.

C. J. Nappo,¹ J. Y. Caneill, R. W. Furman, F. A. Gifford, J. C. Kaimal, M. L. Kramer, T. J. Lockhart, M. M. Pendergast, R. A. Pielke, D. Randerson, J. H. Shreffler, and J. C. Wyngaard

Spatial representativeness and the location bias of flux footprints over inhomogeneous areas

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$$\Delta = \frac{(\eta - \bar{\eta})^2}{\bar{\eta}^2}$$

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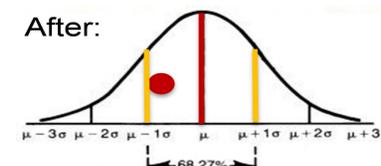
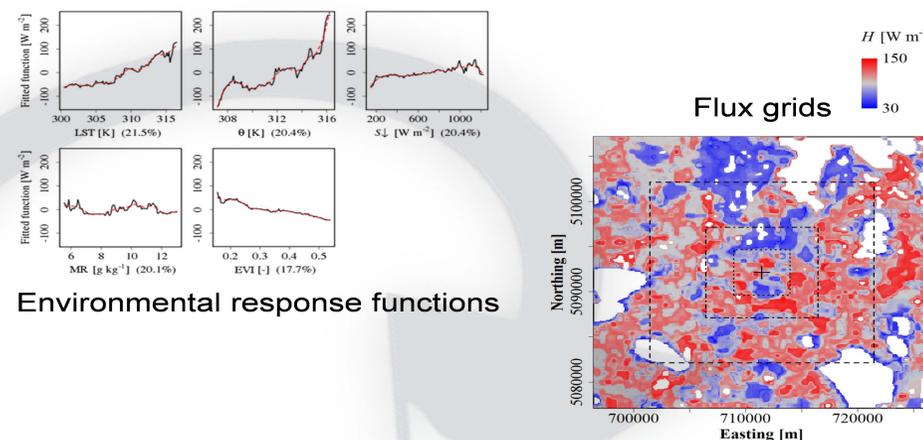
What does the tower flux measurement “see”?

Uncovering the flux field around eddy-covariance measurements

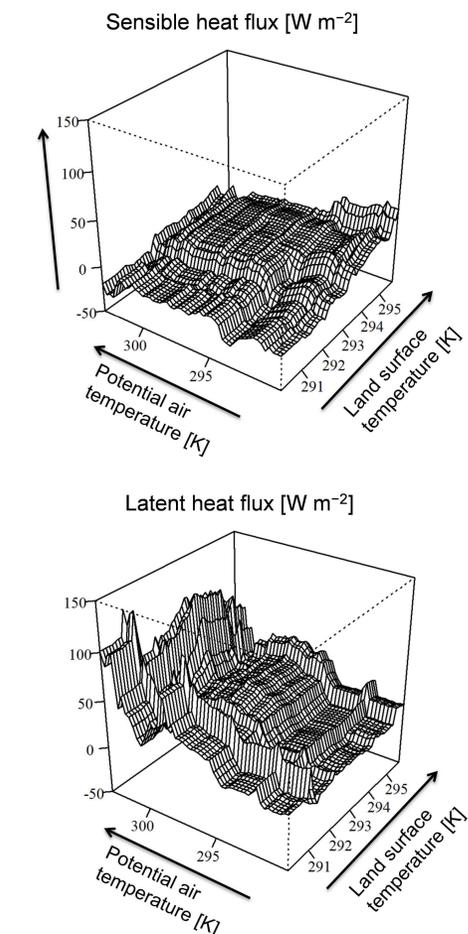


Ameriflux Park Falls 'very tall tower' (447 m): Eddy flux at 122 m.

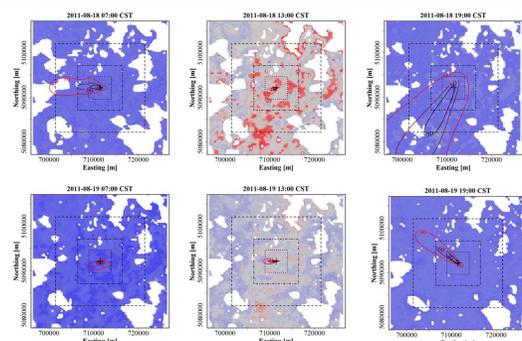
Credit: Matt Rydzik (U Wisconsin)



Multivariate responses

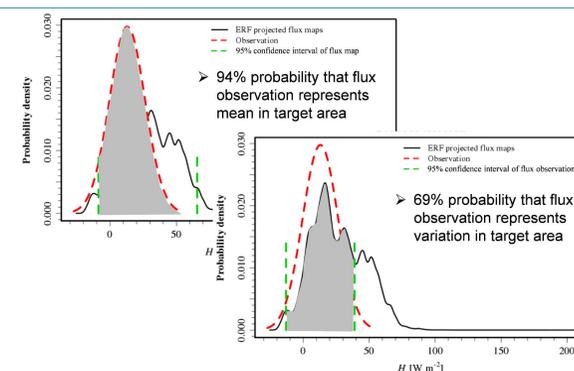


Target area versus varying patch



- Tower never “sees” the same surface combination twice → “location drift”

Representativeness for mean and variation



- Flux grids allow quantifying probability of spatial representativeness at given significance level

Conclusions and outlook

- Observations not cheap, optimize data use efficiency (1% → 70–100%)
- “Calibration to the landscape”
- Unveiling the non-uniform fields of surface-atmosphere exchange
- Rigorous link to larger-scale mechanistic models
 - Model building
 - Data assimilation
- Technical advances
- Other transport modes...

