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.

Location bias

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

Uncovering the flux field around eddy-covariance measurements

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

Credit: Matt Rydzik (U Wisconsin)

Environmental response functions

Flux grids

Sensible heat flux [W m⁻²]

Latent heat flux [W m⁻²]

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…

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