How do we make Ameriflux useful for ecosystem models?

And upscaling, and model-data fusion, and synthesis, and ...

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A rant

http://kenlevine.blogspot.de/
We’ve become good at gap-filling and flux partitioning

We even know how uncertain they are, not that we tend to tell anyone
Moffat et al., 2007, AgForMet

Desai et al., 2008, AgForMet
We’ve become good at gap-filling and flux partitioning

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But it’s led to massive abuse in the model evaluation and model-data fusion community (i.e., “observed GPP”, gap-filled “data” for assimilation)

What could we do better to make Ameriflux useful for models?
Perform rigorous QA/QC

• Automate some of data quality reports (e.g., helpful reports from Bai Yang and Dario Papale)

• Automate flagging of suspect observations (NEON approach, Mauder TK3 method)

• We have a few hundred million observations in Ameriflux – we can choose to be picky!
N does not equal N

**QA/QC strategy for long-term EC measurements (TK3)**
(Mauder et al., AgForMet, 2013)

**Tests on high-frequency data**
- Instrument diagnostic flags (e.g. CSAT3 0-63, LI7500 240-251)
- Instrumental/plausibility limits (site-specific)
- Spike-detection with MAD-test, $z = 7$

**Tests on statistics, flux calculation + corrections**
- Maximum number of missing values: $\leq 10\%$: flags = 0, $>10\%$: flags = 2
- Stationarity test covariances (FW96,MF04, $<30\%$: flag = 0, $<75\%$: flag = 1)
- Test on well-developed turbulence (ITC test: FW96,MF04, $<30\%$: flag = 0, $<100\%$: flag = 1)
- [w] after planar fit $> 0.10 \text{ m s}^{-1}$: former flags +1, $>0.15 \text{ ms}^{-1}$: flags = 2
- Interdependence of flags due to corrections/conversions:
  - if $\text{flag}_E=2$ then former $\text{flag}_H+1$
  - else if $\text{flag}_H=2$ then former $\text{flag}_E+1$
  - else if $\text{flag}_E=2$ or $\text{flag}_H=2$ then former $\text{flag}_{NEE}+1$

**Quantification of errors/uncertainty estimates**
- Instrumental noise error after Lenschow et al. (2000)
- Systematic error: flux underestimation and lack of energy balance closure, only applicable for daytime: $EBR = \text{sum (LE+H)}/\text{Sum}(R_n-G-J)$ for one day
- Footprint: Kormann&Meixner(2001); calculate percentage of flux contribution from several targets of interest
Signal from noise?
Address uncertainty

- **Random flux uncertainty**
  - Empirical approaches (Lenschow, Richardson/Hollinger)
  - Direct approaches (Billesbach, Finkelstein, Salesky)

- **Systematic uncertainty**
  - Primarily $u^*$ sensitivity (Barr, Papale)
  - Also footprint bias (Wang, Desai, Metzger)

- **Meteorological and energy balance uncertainty** might be a bigger deal for models
  - Models want gap-filled met as driver, usually assume energy balance or closed water budget
  - Ameriflux roving standard (Hanson/Biraud/Law)
Random error is important!

\[ \sigma = 0.13 + 0.20 \text{ INEE CH}_4 \]

(a) Hourly \[ r^2 = 0.14 \]

\[ \sigma = 0.42 + 0.12 \text{ INEE CH}_4 \]

(b) Daily \[ r^2 = 0.10 \]

Desai, 2014, submitted
Footprint bias is important!

Desai et al., 2008b, AgForMet
Ameriflux Park Falls ‘very tall tower’ (447 m): Eddy flux at 122 m.

Credit: Matt Rydzik (U Wisconsin)

Based on: Metzger et al., 2013, Biogeosci.
Use model informatics to identify observational needs

PEcAn

http://pecanproject.org/

Dietze et al., JGR-G, 2014
Recommendations

• Make all data available freely, in automated fashion!
• Gap-filling met (Ricciuto/Yang/Papale style) and ET > gap-filling NEE
• Systematic uncertainty > random uncertainty
• Uncertainty in energy balance, met components as important as NEE
• Stop calling GPP, RE observations
  – provide community tool to output range of GPP and RE based on methods and uncertainty
• Automate flagging and random/systematic flux uncertainty (TK3), report roving comparison met uncertainty or bias in tower metadata
  – May require archive and access to high-freq (10-20 Hz)
• Run footprint models for all sites, all hours
  – use methods like ERF to identify representative observations
• Make BADM files machine-readable (XML, NetCDF, CSV) to allow easy model ingest
  – using standard units, naming conventions – use model experiments to identify what key BADM obs every site should collect and at what frequency
Also: Engage future tower monkeys
Reading suggestions


