

## **FLUXNET and Remote Sensing Open-Workshop: Towards Upscaling Flux Information from Towers to the Globe**

V5. June 6, 2011

**Conveners:** Dennis Baldocchi, Laurie Koteen, John Gamon, Markus Reichstein, Dario Papale,

**Organizations:** FLUXNET and SPECNET

**When:** June 7-9, 2011

**Where:** The David Brower Center, Berkeley, CA, <http://www.browercenter.org/>

**Theme:** Next-Generation Carbon-Water Flux Measurement System

### **Mission:**

To provide an intellectual forum for merging and regularizing FLUXNET and SPECNET activities across a spectrum of measurements and data synthesis scales, and to integrate these efforts with satellite remote sensing databases. The goal is to produce an integrated and validated system of measurements that allows us to quantify carbon, water and energy fluxes 'Everywhere, and All of the Time'.

### **General Topics of Discussion:**

1. How to merge eddy covariance flux measurements, field sensors and sensor networks, and hyperspectral remote sensing platforms (towers, airplanes, satellites) to upscale carbon dioxide and water vapor fluxes from a) canopies to landscapes and b) landscape to continents and the globe; and
2. To develop plans for the continuation and intellectual expansion of flux measurement and upscaling activities.

**Who:** The workshop is open to the FLUXNET and SPECNET research communities; scientists, postdocs and graduate students. Registration will be capped at 150 participants. Interested parties include: 1) those measuring and modeling carbon, water and energy fluxes between vegetation and the atmosphere; 2) those conducting ongoing optical sampling linked to fluxes, 3) those making hyperspectral reflectance measurements over landscapes on regular bases and 4) those who are linking land/vegetation flux and remote sensing data and modeling products to produce the next generation of carbon dioxide and water vapor fluxes at the scale of landscapes, continental and global domains.

**Sponsors:** National Science Foundation Research Coordinated Network (RCN) grant, Microsoft, European Cooperation in Science and Technology (COST), NASA, ILEAPS.

## **Products and Goals:**

- 1.** Combine hyperspectral remote sensing and flux time series measurements at co-located sites into a common database. This information is needed to parameterize and validate a hierarchy of models that range from simple light use efficiency (LUE) models that need information on  $f_{par}$ ,  $a_{par}$  and PRI to machine learning to data assimilation models and mechanistic biophysical models.
- 2.** Increase the capacity of the FLUXNET community to measure canopy structure and phenology with remote sensing methods. Examples include the use of digital cameras, broad band sensors based on LEDs or photodiode sensor and or hyperspectral reflectance on a regular basis with manual or automated systems.
- 3.** Discuss protocols and pitfalls in measuring and interpreting flux and remote sensing measurements.
- 4.** Discuss how to use data from the flux, optical sampling and remote sensing networks and remote sensing products to better upscale carbon and water fluxes in time and space.
- 5.** Produce new generation of gridded fluxes and flux drivers for future synthesis activities at local, regional, and continental to global scales. Plan and refine the new FLUXCOM project, which will compare outputs from gridded flux products.
- 6.** Address how good is good enough in upscaling fluxes with remote sensing and flux networks?
- 7.** Discussion and plan future evolution and possible integration of FLUXNET and SpecNet

More generally, we hope to stimulate interesting dialogue that will address disagreements in products and approaches and seek innovative and common solutions to the current lack of convergence.

# Workshop Agenda

## Day One

<b>08:00 - 09:00</b>	Registration and Breakfast	
<b>09:00 - 10:30</b>	<b>Session 1. Introduction/Overview</b>	<i>Goldman Auditorium</i>
<i>09:00-09:15</i>	1. Welcome, Conference Charge and Scope, Dennis Baldocchi, University of California, Berkeley.	
<i>09:15-09:55</i>	2. Overview of FLUXNET, Scope and Progress, Markus Reichstein, Max Planck Institute, and Dario Papale, University of Tuscia	
<i>09:55-10:35</i>	3. Overview of SpecNet, Scope and Progress, John Gamon, University of Alberta	
<i>10:35-11:00</i>	Coffee	<i>Gallery and Terrace</i>
<b>11:00 - 12:00</b>	<b>Session 2. Progress on Upscaling Carbon Dioxide and Water Vapor Fluxes from Canopies to Landscapes</b>	
		<i>Goldman Auditorium</i>
<i>11:00-11:20</i>	1. On Making and Interpreting Regular Hyperspectral Reflectance measurements on Towers, Thomas Hilker, University of British Columbia	
<i>11:20-12:00</i>	2. On Detecting Phenology and Canopy Structure with Digital Cameras, Hyperspectral Remote Sensing and Eddy Covariance Measurements <i>European Perspective</i> , Lisa Wingate, Cambridge, (1120-1140) <i>North American Perspective</i> , Andrew Richardson, Harvard, (1140-1200)	
<b>12:00 - 13:30</b>	Lunch	<i>Gallery and Terrace</i>
<b>13:30 - 13:55</b>	<b>Session 3. Upscaling from Canopies to Landscapes, continued</b>	
		<i>Goldman Auditorium</i>
<i>13:30-13:55</i>	1. Coupling 3D Radiative Transfer Models with Soil Vegetation Transfer Models for Sparse Vegetation and Validating with Hyperspectral Remote Sensing and Eddy Covariance Flux Data, Hideki Kobayashi, Japan Agency for Marine-Earth Science and Technology	
<b>13:55 - 15:35</b>	<b>Session 4. Upscaling from Landscapes to Continents and the Globe</b>	
		<i>Goldman Auditorium</i>

13:55-14:20	1. Space Based Measurements of CO2 from GOSAT and OCO-2, David Crisp, NASA Jet Propulsion Laboratory	
14:20-14:45	2. Success and Failures with Implementing Biophysical Modeling to Upscale Carbon and Water Fluxes to the Global Scale, Youngryel Ryu, Harvard/ Seoul National University	
14:45-15:10	3. Success and Failure of Implementing Data Driven Upscaling of Spatial Fluxes using Flux Networks and Remote Sensing, Jingfeng Xiao, University of New Hampshire	
15:10-15:35	4. New NASA Earth Exchange, NEX, Database, Ramakrishna Nemani, NASA Ames	
15:35-16:00	Coffee	
<b>16:00 – 17:00</b>	<b>Session 5. General Discussion and Feedback from the Audience, Panel of Speakers</b>	
<b><i>Adjourn</i></b>		
<b>18:00 – 19:30</b>	Reception and no host bar	<i>Gallery and Terrace</i>
<b><u>Day 2</u></b>		
<b>08:00 – 09:00</b>	Breakfast	
<b>09:00 – 09:15</b>	<b>Plenary</b>	<i>Goldman Auditorium</i>
<b>09:15 – 12:00</b>	<b>Breakout Discussion/Panel Sessions</b>	
09:15-10:30	Topic 1. Flux and Hyperspectral Remote sensing: Emerging vegetation indices and data products	<i>Kinzie Room</i>
	<b><i>Discussion Leaders and Rapporteurs:</i></b> Fred Huemmerich, Carolyn Nichol, Elizabeth Pattey, Josep Penuelas.	
	<b><i>Suggested Topics:</i></b> Measuring PRI from towers: are there biochemical, physiological, structural and functional factors that converge towards a common function between PRI and LUE? Are unique PRI-LUE functions needed for different plant functional types or LAI classes?	
	Roles of clumping, leaf and sun angles, view angles, canopy structure, and background illumination on extracting PRI information.	

What other spectral difference indices can be used to deduce information on plant water status, eg water band indices. Should these new methods/indices replace  $LUE=f(vpd)$ ?

New Technology, Dos and Don'ts of Measurements. Developing new sensors for continuous measurements of spectral reflectance, light transmission and phenology, e.g. LED or photodiodes, digital cameras, spectrometers, on a regular basis.

Remaining issues: utility of cheap vs expensive spectrometers (eg Ocean Optics at \$3000 works well between 400 and 1000 nm), camera quality, resolution.

09:15-10:30

Topic 2. Fluxes, Hyperspectral Remote Sensing and Models:

*Goldman Auditorium*

**Discussion Leaders and Rapporteurs:** Kazuhito Ichii, Josh Fisher, Chris Williams, Mark Friedl

**Suggested Topics :**

What conceptual framework(s) (models) should we use and why?; Pros and Cons of Light Use Efficiency vs Regression Tree methods vs Bottom Up biophysical modeling? What different information is needed to compute water fluxes vs carbon fluxes? How do we deal with ecosystem respiration or methane fluxes?

How good is good enough at regional vs global scales, daily vs annual scales?

At what time and space scales should we aggregate and integrate data? How well can we integrate fluxes from single snap shots (e.g. remote sensing) to daily integrals?; How should we handle errors?

What data layers are needed to better implement current and future simulations, e.g merging Aqua and Terra data products on land and atmospheric conditions; maps on disturbance and C4/C3 distribution; the concept of "optical types"

09:15-10:30

Topic 3. Fluxes, Hyperspectral Remote Sensing and Upscaling:

*Tamalpais Room*

**Discussion Leaders and Rapporteurs:** Laura Chasmer, Matthias Goekkede, Natasha Kljun

**Suggested Topics** : Matching flux footprints with remotely sensed scenes; Should we gap fill by wind direction? Extracting grid averaged products for drivers, parameters and fluxes to set priors for Bayesian models.; Assessing errors and uncertainties; Validating the sums and averages at regional to global scales with top down models, watershed run off data, other products; How good is good enough? ; Spatial/Temporal Representativeness of the products.

10:30-11:00	Coffee	Gallery and Terrace
<b>11:00-12:00</b>	<b>Breakout Discussion/Panel Sessions Continued</b>	
12:00-13:30	Lunch	Gallery and Terrace
1:00	<b><u>POSTER SETUP in the Tamalpais Room</u></b>	
13:30-15:30	<b>Poster Sessions</b>	Tamalpais Room
15:30-16:00	Coffee	Gallery and Terrace
16:00-17:00	<b>Plenary Reports, General Discussion on Topics for White Papers and Synthesis Papers</b>	Goldman Auditorium

**Day 3**

08:00-09:00	Breakfast	
09:00-10:30	<b>Breakout Discussion/Panel Sessions</b>	
09:30-10:30	Topic 4. COST/SpecNet Session on Optical Sampling	Kinzie Room
	<b>Discussion Leaders and Rapporteurs:</b> John Gamon, Loris Vescovo	
09:30-10:30	Topic 5. Discussion: Regional to Global Questions to be Addressed with Flux Networks	Goldman Auditorium

**Topics to Discuss:** Issues with sustaining the networks; Roles of few Super sites vs many cheaper sites? What New Sites are Needed or Initiated?;

What new variables should we measure (e.g. roots, LIDAR, spectral reflectance, standard deviation of horizontal velocity vectors, light transmission with digital cameras)? Are we measuring the right variables?

Outputting data products to FLUXNET database, giving as well as taking data; data submission and sharing; publishing and co-authorship;

***Discussion Leaders and Rapporteurs:***

*Asia:* Shaoqian Wang, Nobuko Saigusa;

*Europe:* Dario Papale;

*North America:* Larry Flanagan

*Australia:* Eva vanGorsel, Jason Beringer;

*Fluxnet:* Dennis Baldocchi;

*Database:* Catharine van Ingen

**10:30 - 11:00** Coffee *Gallery and Terrace*

**11:00 – 12:00 Breakout Discussion/Panel Sessions**

Topic 6. Flux and Remote sensing, merging data products, Future Directions  
*Goldman Auditorium*

***Discussion Leaders and Rapporteurs:*** Oliver Sonnentag, Nicholas Coops, Alfredo Huete, Jeff Chambers

Topics: New and Emerging Network-scale Science questions? Potential White Papers and Synthesis papers.

**12:00 – 13:30** Lunch *Gallery and Terrace*

**13:30 – 15:00** Topic 7. Flux and Remote sensing, merging data products, Future Directions, continued.

*Goldman Auditorium*

***Discussion Leaders and Rapporteurs:*** Jingfeng Xiao, Markus Reichstein, Dario Papale, Deb Agarwal, Gilberto Zonta-Pastorello

Databases, Computational Resources and New Statistical Tools for Next Generation Products; Extracting Knowledge from the Data or Signal from the Noise and Chaos

Who is willing to do what and where?

Funding and future: Research coordinating networks (RCN II), Data-driven flux integration comparison project (FLUXCOMP), Geocarb, International Carbon Observatory System (ICOS)

**15:00** Adjourn