

**FLUXDIS: A Global Flux Data and Information System  
to Support EOS Product Validation**

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## Overview

The FLUXNET project involves two closely related projects within the NASA EOS Validation Program: (1) FLUXNET: Unifying a global array of tower flux networks for validating EOS terrestrial carbon, water and energy budgets and (2) FLUXDIS: A Global Flux Data and Information System to Support EOS Product Validation. The overarching objective of FLUXNET is to provide an infrastructure for the synthesis and analysis of long-term carbon, water and energy flux data that are being acquired world-wide by various regional flux networks. FLUXNET is a network of regional networks. Information compiled by the FLUXNET project will be used by the EOS validation community to validate remote sensing algorithms associated with the MODIS instrument on the Terra satellite. Products to be generated by the MODLAND group and validated by FLUXNET measurements include leaf area index, fraction of photosynthetically active radiation, evaporation and net primary productivity (MODIS 12, 15, 16 and 17 activities). The overall FLUXNET strategy is summarized in the FLUXNET Overview provided on the Web page.

This report highlights efforts of the data component. (All past progress reports are available on the FLUXNET Web page). Team members from both the science and data components have periodic telecons and meetings to address synthesis and organization issues of the FLUXNET database.

## Highlights

- FLUXNET (<http://daac.ornl.gov/FLUXNET/>) has had significant growth over the past 18 months as indicated by the following summary:

| Statistic   | Number<br>June 00 | Number<br>Dec. 01 |
|---|-------------------|-------------------|
| Regional Networks: AmeriFlux, CARBOEUROPE, AsiaFlux, OzNet        | 4                 | 4                 |
| Towers registered   | 148               | 157               |
| Active towers (that have submitted data or defined start year)    | 62                | 80                |
| Years of observations for active towers                           | 306               | 370               |
| Site-years of data submitted to FLUXNET or regional networks      | 103               | 150               |
| Maximum years of record at a tower (Harvard)                      | 10                | 11                |
| Sites with gap-filled, aggregated data available from FLUXNET     | 12                | 36                |
| Site-years of gap-filled, aggregated data available from FLUXNET  | 21                | 97                |
| Site ancillary data records (climate, vegetation, LAI, NPP, etc.) | >3700             | >3600             |
| Number of parameters in data dictionary                           | 261               | 261               |
| Flux related bibliographic citations                              | >3000             | >3500             |
| Flux scientists on FLUXNET email server                           | >300              | 432               |

- The FLUXNET Web pages were completely redesigned and expanded.
- The Web pages provide dynamic access to the site database of ancillary characteristics information that is stored in a relational database management system.
- FLUXNET Meeting was held December 7, 2001 in connection with the Fall AGU meeting.
- Status of FLUXNET summarized in two reports:

- EOS Observer - <http://earthobservatory.nasa.gov/Study/Fluxnet> "International scientists with diverse backgrounds work together to better understand movement of carbon between the Earth's forests and atmosphere"
- GEWEX - [http://public.ornl.gov/fluxnet/Other/FLUXNET\\_Gewex\\_article.htm](http://public.ornl.gov/fluxnet/Other/FLUXNET_Gewex_article.htm) "FLUXNET Advances Integrated Studies of Terrestrial Biosphere – Atmosphere Exchanges of Carbon Dioxide, Water and Energy"
- The MODIS Real-time Validation Exercise is underway.
- Gap-filling algorithms were developed and compared. Dr. Eva Falge travel was supported by the FLUXNET project to spend September 7-13, 2001 at ORNL to discuss modifications to the gap-filling program.
- Collection of papers is about to appear in a special issue of Ag and Forest Meteorology based on the FLUXNET 2000 Synthesis Workshop, held in June 2000.
- FLUXNET PIs participated in international meetings on global carbon dynamics.
- The NASA funding for both the science (Baldocchi et al.) and data (Olson et al.) components of the FLUXNET project was extended for 3 years through the Terrestrial Ecosystems Program Carbon Cycle Science NRA.
- The number of networks and sites is expanding. Presentations at the AmeriFlux meeting (Oct 31, 2001) and the AGU Flux Session (Dec 13, 2001) indicate that the OzFlux (Australia) is operating, towers in New Zealand are operating, KoFlux (Korea) is being planned, CanadaFluxnet may become formally established in 2002, the set of LBA flux towers are organizing their network, and other existing networks also continue to add towers.

## Details

**Flux Data:** Flux data are flowing from AmeriFlux and EUROFLUX regional networks to FLUXNET. There are now 4 regional networks including AmeriFlux, CARBOEUROPE (combined EUROFLUX, MedeFlu, and other towers), AsiaFlux (expanded Japannet), and OzNet. We have 157 towers registered in FLUXNET and have processed and are providing access to data from 36 sites with 97 site-years of data. Data have been submitted to regional networks from 36 towers representing 150 site-years of data (see attached table). About half of the data are on the EUROFLUX CD-ROM (3 years of data for each of 16 sites) that was released in June 2000.

The data processing strategy is that the 1/2-hour or hourly flux and micrometeorology data are being compiled, reviewed, and maintained by the regional networks. FLUXNET will maintain copies of the data for long-term archive and process the data to produce a more standardized gap-filled, aggregated flux data for a set 13-15 flux parameters that were selected by the flux community.

**Web Page:** The FLUXNET Web page(<http://daac.ornl.gov/FLUXNET/>) has been updated, including maps, background information, data access, and project description. Flux data are distributed through the Web page and will be archived at the ORNL DAAC. The completed 3-yr EUROFLUX project will be the first set of flux data to be archived.

**Real-time Validation:** The Real-time Validation Exercise

(<http://daac.ornl.gov/FLUXNET/invitation.html> and

<http://cdiac.esd.ornl.gov/programs/ameriflux/modelval.htm>) is coordinated by Steve Running and his MODLAND team to bring together flux tower data, model results, and the MODIS product. We are supporting the exercise by compiling the required model driver data and the flux data. The micrometeorology data are flowing to the AmeriFlux Network Office from about 20 AmeriFlux sites on a weekly schedule. Five model groups are ready to run their models. The MODIS and model results are to be posted on AmeriFlux and FLUXNET Web pages. Also, half of the 24 EOS Land Validation Core Test Sites are flux tower sites and four of these are included in the NASA BIGFOOT project. MODAPS is extracting MODIS products for 11x35 cutouts for core and flux sites and sending data to the ORNL DAAC for processing. They are sending the following 8-day composites products in hdf format, integerized sinusoidal projection:

- Surface Reflectance (MOD09A1),
- Surface Temperature (MOD11A 1&2),
- LC/LCC (MOD12Q1),
- VI (MOD13A2),
- fPAR/LAI (MOD15A2),
- PSN (MOD17A2),
- BRDF (MOD43B4)

ORNL is posting these cutouts re-projected to UTM (7x7 km) in a single expanding ASCII table for each site-product with rows representing dates and columns values for the pixels surrounding flux towers.

**Gap-Filling:** Gap filling algorithms were programmed in PV-Wave and described in a paper that has published in Agriculture and Forest Meteorology. The FLUXGAP program is being used to process flux data. Dr. Eva Falge travel was supported by the FLUXNET project to spend September 7-13, 2001 at ORNL to discuss modifications to the gap-filling program.

**Site Database:** The site characteristics database for flux tower sites has been updated. We have designed and implemented a data management foundation for the continued updating and expansion of the site database. This is based on a relational database management system (RDBMS). The RDBMS has component tables to organize information on investigators, projects, flux towers and associated measurement sites, measurement methods, supporting literature, and data. The aggregated monthly and annual flux data and ancillary or ecological data will be stored in the RDBMS so that each value can be thoroughly documented as to its source and methods used. Currently there are over 3600 records in the RDBMS.

**Workshop:** A special issue of Ag and Forest Meteorology will contain a series of synthesis papers based on the FLUXNET 2000 Synthesis Workshop, held at the Marconi Conference Center, Marshall, California, June 11-14, 2000. The Workshop brought together an international group of 28 scientists to review progress in collecting and analyzing CO<sub>2</sub>, water, and energy fluxes.

**International:** FLUXNET participated in several international activities that are concerned with global carbon dynamics. These include the International Geosphere-Biosphere Program (developing a Terrestrial Carbon Plan for global carbon studies), Global Terrestrial Observing System (developing a global carbon-observing network), and the International Satellite Land Surface Climatology Project (adding ground-based carbon data s to its collection of gridded climate and land cover data).

**Parameters:** Significant effort has been devoted to defining flux parameters to achieve consistency within the database. The parameter list was compiled from lists developed by regional networks. The initial list of approximately 100 parameter associated with measuring the fluxes

and characterizing the surrounding area. Parameter names, definitions, units of measure, typical methods and instruments, and ranges are defined. Lists have been distributed at the annual AmeriFlux and the EUROFLUX meeting for review and confirmation of site-specific parameters.

**Bibliography:** We are compiling references and key papers to document the source of ancillary site information. Often information such as LAI, NPP, soil properties, etc. are published in papers by ecologists at the site; therefore, it is important to have references to these papers.

**Funding:** The NASA funding was extended through the end of 2001 for both the science (Baldocchi et al.) and data (Olson et al.) components of the FLUXNET project. The ORNL data component receives its funding through the ESDIS project office that includes both core DAAC funds and supplemental funds coordinated by the EOS Validation program. We continue to have periodic telecons with D. Baldocchi, University of California, Berkley and Steve Running, University of Montana, to keep the two components in close communications.

**Continued Funding:** The NASA funding for both the science (Baldocchi et al.) and data (Olson et al.) components of the FLUXNET project was extended for 3 years through the Terrestrial Ecosystems Program Carbon Cycle Science NRA. The ORNL component will leverage supporting the flux community by sharing some of the tasks with the ORNL DAAC. The division of tasks is:

- **Carbon Science Tasks** (with FLUXNET Science Component)
  - Support synthesis activities (enhanced data products)–Support flux community (email server, announcements, bibliography)
  - Provide gap-filling algorithm in PV\_Wave (with flux community input)
  - Write papers: “Documenting the FLUXNET Database”, “Characterizing the Flux Network”, “Comparing Flux Gap-filling Algorithms”
- **DAAC Tasks** (traditional data sharing and archiving tasks)
  - Compile new data and metadata from regional networks (QA, gap filling, Ustar corrections, temporal aggregation)–Compile additional site characteristics information from literature and PIs
  - Present site information in relational database system with on-line access
  - Post cutouts of of selected MODIS products for selected towers
  - Develop summary table to indicate site data availability status
  - Archive EUROFLUX data and other final flux data

### **Papers and presentations:**

See the FLUXNET Science component final report (Baldocchi 2001) and the FLUXNET Web page for lists of recent presentations, publications and reports.

Presentations by the FLUXNET Data Component during the past 18 months:

Olson, R. J., R. B. Cook, L. A. Hook. 2001. Data Support for EOS Validation. Presentation at NASA EOS Validation Program. Washington, D.C. January 2001.

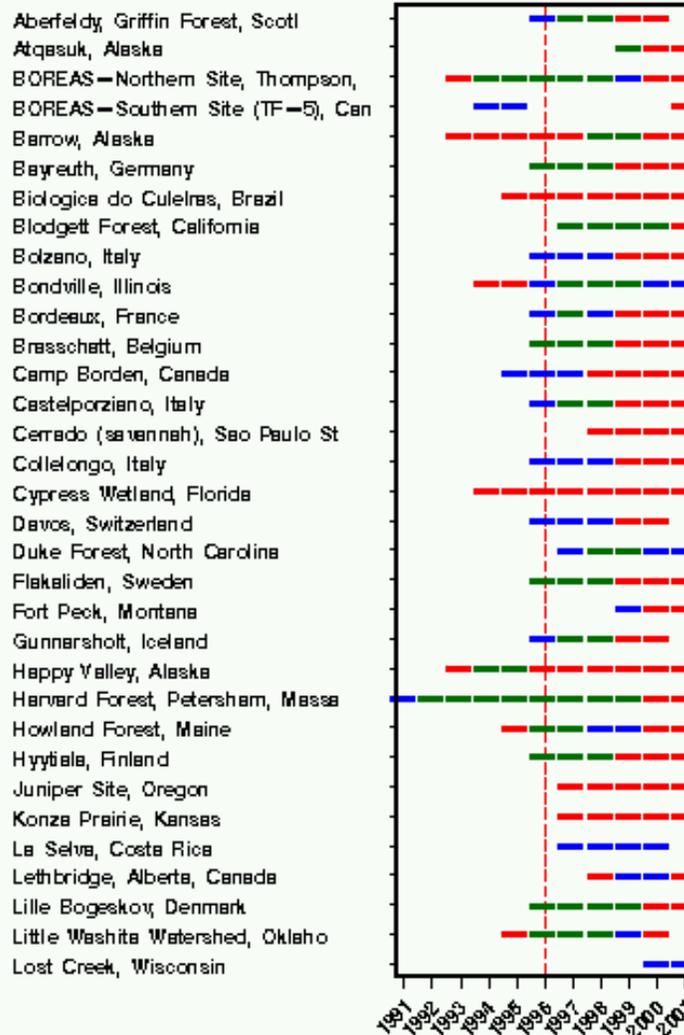
Olson, R. J., Falge, E., Baldocchi, D., Gu, L., Holladay, S., Cook, R. B. 2001. A Global Network of Eddy-Covariance Flux Towers to Study Ecosystem Dynamics, Enhance Models, and Validate Remote Sensing Products. Presented at the American Geophysical Union Spring Meeting, Boston, Massachusetts, May 31, 2001.

Olson, R. J. 2001. *In situ* Data for Long-Term Data Programmes. Presentation at Terrestrial Carbon Observation In Situ Meeting, Global Terrestrial Observing System Secretariat. Frascati, Italy, 5-8 June 2001.

- Olson, R. J., R. B. Cook, and D. Baldocchi. 2001. Global Carbon Observing Networks: Point Data. Terrestrial Carbon Observation In Situ Meeting, Global Terrestrial Observing System Secretariat. Frascati, Italy, 5-8 June 2001.
- Olson, Richard J., Eva Falge, Dennis Baldocchi, Lianhong Gu, and Susan Holladay. 2001. A Global Network of Eddy-Covariance Flux Towers to Study Ecosystem Dynamics, Enhance Models, and Validate Remote Sensing Products. Poster presented at the Open Science Conference, Amsterdam, the Netherlands, July 6, 2001.
- Olson, R. J., Falge, E., Baldocchi, D., Gu, L., Holladay, S. 2001. Ecosystem Dynamics based on a Global Network of Eddy-Correlation Flux Towers. Presented at the Ecological Society of America Annual Meeting. Madison, Wisconsin, Aug 8, 2001.
- Olson, R. J., Falge, E., Holladay, S., Olsen, L., Hargrove, W., and Hoffman, F. 2001. FLUXNET: Distribution of a Global Network of Eddy-Covariance Flux Towers and their Role in Validating Models and Remote Sensing Products. Presentation at Fall AGU Meeting, San Francisco, CA. Dec 13, 2001.

# Status of Sites and Data by Year

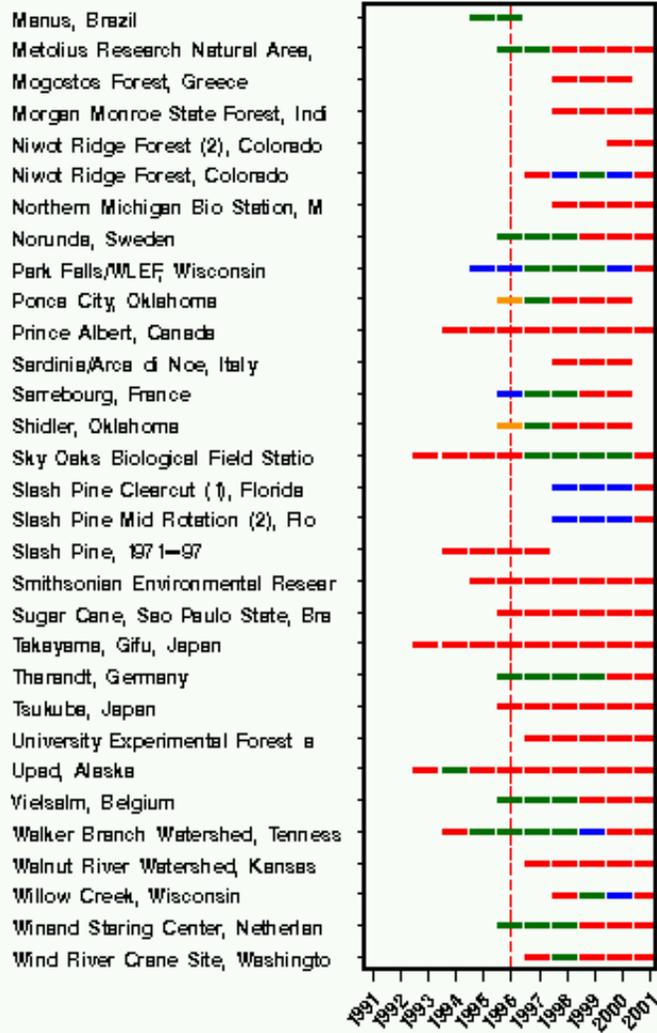
group= 1



Data Status:    - - - 1-Collected    - - - 2-Submitted    - - - 3-GA Review    - - - 4-Processed

# Status of Sites and Data by Year

group=2



Data Status: 1-Collected 2-Submitted 3-QA Review 4-Processed