Using FLUXNET data to constrain SVAT model parameterization

**Project leader:** Ray Leuning (CSIRO)

**Participants:** Reto Stockli (Colorado State University), Forrest Hoffman (ORNL), David Hollinger (USDA Forest Service), Paul Stoy (Edinburgh), Bill Munger (Harvard), Ebba Dellwik (Risoe), Andrew Richardson (UNH), Jens Kattge (MPI Jena), Markus Reichstein (MPI Jena), Mathew Williams (U of Edinburgh)

Most land surface schemes in Global Climate Models (GCMs) use lookup tables to assign parameter values for various plant functional types (PFTs), with the implicit null hypothesis that there is little variation in parameter values within PFTs. We will test this hypothesis by using the FLUXNET dataset, in conjunction with non-linear parameter optimization techniques, to estimate key parameters for each plant functional type in several SVAT models used in current GCMs.

Specific objectives will include:
1. Evaluation of parameter distributions for each PFT to determine parameter ranges, means and variances/covariances.
2. Comparison of parameter values from model inversions with default values used in current GCM look-up tables.
3. Run models in forward direction using optimized parameter values (in a Monte Carlo type setting) to examine consequences of parameter uncertainties on predicted fluxes of CO$_2$, water vapor and sensible heat. Results will be compared with models run using default parameter values. The initial forward model runs will be done off-line, followed by a small number of runs with fully coupled with the GCMs. The latter is a very big task and will require collaboration with major modeling groups.

We will focus on the following land surface models: SiB2.5/3 (CSU), CLM 3/3.5 (NCAR), JULES (UK Met Office) and CABLE (CSIRO and Bureau of Meteorology, Australia), and emphasize the following parameters: $V_{\text{cmax}}$ response curves to diffuse and direct light; aerodynamic canopy turbulence parameters; atmospheric stability parameters; seasonal courses in LAI; soil respiration parameters (Q10, soil moisture); soil water potential for $\frac{1}{2}$ and full stomatal closure; temperature-, VPD-, and light-response curves for net assimilation.

We will use data from a range of different ecosystem types (tropics to tundra), and will focus on sites with a minimum of 5 years of data.

We will invite all PIs who provide data to make an intellectual contribution to the project. Data providers who make such a contribution will be included as coauthors on resulting manuscript. Other data providers will be acknowledged as “group authors”, e.g. “the FLUXNET parameter estimation group” and will be identified by name in the manuscript acknowledgements.
CMAR Overseas Travel Request
(Land and Atmosphere)

Applicant: Ray Leuning  
Date: 24 April 2007

Destination(s): France, USA


Type of Visit:  
☐ Essential (contractual obligations & major commitments)
☒ Optional (conferences, lectures, visiting institutions)

Justification (include the benefits to the project, client, Division or CSIRO):
See below

Leuning’s Mobile:

Request for study leave for 23 August 2007 until 11 Jan 2008
(see the proposed timetable in the attached Excel file).

The central theme of the proposed study leave is to improve my understanding of terrestrial ecosystem function and to use this new understanding to improve CABLE, the land-surface scheme in ACCESS. Twenty percent of my time is currently mapped to the ACCESS under the ACCSP proposal for 2007-08, and I expect this time allocation to increase in future. My role in ACCESS will be to develop novel approaches for modelling vegetation dynamics in CABLE in response to climate change and variability, and to improve model representation of the biogeochemical cycles of carbon, nitrogen and phosphorus.

Key outputs of the proposed study leave will be tests of the hypothesis that the current definitions of plant functional types based on plant phenology and taxonomy are an appropriate way to represent the ecological processes in vegetation dynamics for CABLE, plus a review paper on vegetation-climate interaction.

The following provides a list of proposed activities and their justification.


The three main themes for the conference are:

1. Biosphere-atmosphere coupling: process analyses;
2. Advances in understanding and modelling the interactions and overlap among local, regional and global scales; and
3. Rural and land-use planning and integrated systems.

I will contribute to the land-atmosphere component and will present a paper entitled ‘A simple surface conductance model for estimating regional evaporation from flux tower and MODIS satellite data’. My airfare to and from the conference will be paid by the organizers (see attachment 1).
2) I wish to take recreational leave from 29 Aug until 18 September 2007 (21 days) following the above conference.

3) I then plan to visit Professor Monique Leclerc, Laboratory for Environmental Physics, University of Georgia, Georgia, USA, to discuss the intensive field experiments on advection and dispersion of trace gases in forests that she and her group have performed. I will visit her Flux Super Site at the Savannah River National Laboratory in South Carolina to view her experimental setup and to compare with the Tumbarumba flux station instrumentation. I will also present a seminar entitled “Estimating nocturnal fluxes using an alternative to the \(u\)-threshold filtering technique”. This work will enhance the utility of our Tumbarumba field laboratory as an Australian super site under the proposed NCRIS Terrestrial Ecosystem Research Network (TERN).

4) After Georgia, I plan to spend a total of 27 days at Oregon State University (OSU) where I will work with Professor Beverly Law and emeritus Professor Dick Waring. Professor Law has offered me US$4000 to help with the costs of my visit and Prof Waring has offered cost-free accommodation at his house during my stay (see attachment 2).

- Beverly E. Law is Professor of Global Change Forest Science in the College of Forestry, and she has an adjunct appointment with the College of Oceanic and Atmospheric Sciences at Oregon State University. Professor Law is the Science Chair of the AmeriFlux network of over 100 research sites in the Americas. She is the author or coauthor of over 80 scientific papers and book chapters.

- Emeritus Professor Richard H. Waring is a forest ecologist and professor in the Department of Forest Science. He has spent his career investigating the physiological ecology of trees by characterizing and quantifying the relationships among physiological, insect and disease attack, assessing the underlying causes of stress, and applying remote-sensing technology to assess forest productivity across regions.

The reason for visiting OSU is that Professors Law and Waring have a deep understanding of forest ecology and I will be able to learn much from them during my visit. Prof. Law runs several flux stations in a transect across Oregon where she is examining the effects of climate variability on forest productivity and data from these studies are of great relevance to the development and testing of CABLE. The work will also assist in framing some of the key science questions for the program in terrestrial carbon cycle science that is being developed by the sub-committee of the Australian Academy of Science (Earth System Science Sub-committee), and which we anticipate will proceed as a funded program post 2008.

While at OSU I will commence analyzing data from Tumbarumba and several other international Fluxnet data sets. The objective of the analysis will be to examine the following:

- Statement: Most Global Climate Models (GCMs) use lookup tables to assign parameter values for various plant functional types (PFTs).

- Null hypothesis: There is little variation in parameter values within PFTs used in GCMs.

- Test of hypothesis: use the Fluxnet dataset to estimate parameters of several SVAT models used in GCMs using non-linear parameter optimization techniques for representative flux tower data for each plant functional type.

- I will look at the distribution of parameter values for each PFT to determine ranges and means and compare values from model inversion with default values used in current GCM’s. I will then run the models in the forward direction to examine consequence of mean and standard deviations of model parameters on calculated fluxes of CO2, water vapour and heat.
This project grew out of my attendance at the Fluxnet Workshop in Italy during February 2007 and will involve collaboration with several other international groups running other land-surface schemes. The project will be of major benefit in testing the underlying assumptions used in the land-surface schemes of all GCMs, including ACCESS.

Part-way through my visit to OSU I will travel to Utah to meet Bert Tanner, Vice-President of Marketing for Campbell Scientific. This company is a major supplier of instrumentation to the international flux measuring community and we will discuss instrumentation and other scientific requirements of this community. This will be of great benefit and relevance to the proposed Australian TERN being developed through NCRIS. I will then travel to Boulder, Colorado, to attend the annual Ameriflux meeting where I will present a paper entitled ‘Terrestrial Carbon and Water Fluxes using Flux Towers and MODIS Remote Sensing’ that is based on the work we have done in Australia.

5) Finally, I plan to spend 69 days visiting the Prof. Walt Oechel, Director of the Global Change Research Group at San Diego State University (SDSU) in California. Prof. Oechel has offered me a sum of US$5300 to help cover some of the costs of my visit to SDSU (see attachment 3).

Professor Walt Oechel has an outstanding scientific reputation in plant ecology and he been named to the Institute for Scientific Information's "Highly Cited Researchers" list. This list, which comprises less than 0.5% of all publishing researchers, is based on the important scientific developments made by individuals in the last two decades. Prof. Oechel is also one of eight scientists selected to receive National Science Foundation Director's Award for Distinguished Teaching Scholars. Further personal information on Prof Oechel may be found at http://www.sci.sdsu.edu/GCRG/personnel/oechel/oechel.html.

Prof Oechel runs many flux stations ranging from the Arctic to desert ecosystems and I can learn a great deal from his profound understanding of terrestrial ecology. I plan use the knowledge I will gain at both OSU and SDSU to continue the analysis of global data sets started at OSU as outlined above. I also want to use the time away to improve my understanding of the literature on the interaction of climate and vegetation with the aim of writing a sound review of the subject for publication. This science review will benefit development not just of ACCESS, but also strategic science in the carbon–climate interactions domain.

The proposed study program is deliberately ambitious but I strongly believe that the work will be of lasting benefit to CSIRO, and to the Joint Research Operation by improving the modelling of terrestrial ecosystems within ACCESS.

My application has the strong support of Dr Ying Ping Wang (leader of CABLE) and Dr Helen Cleugh (Stream Leader, Land and Atmosphere).
### Financial Requirements

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|                        |              | Kt13a   | 5000   |

| Is this travel to be invoiced to external agency upon return? | NO |
| If "NO", have sufficient funds been budgeted for this trip? | Yes |

*PNO KT61a and Kt13a are 2006 - 07 PNOs, and will be replaced by the appropriate PNO when the 2007 - 08 project is approved.*

### External funding

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| Personal contribution | 885 |
'In principle' consent (Program Leader to Complete):

I rate this overseas visit as: Essential ☑ Optional

I have assessed this request against the Overseas Travel Criteria and support it.

Signed: (Program Leader with PNO responsibility)
Date:

Supported: (Stream Leader)
Date:

Supported: (Theme Leader)
Date: