Welcome to the 2012 OzFlux Workshop

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Australia’s Terrestrial Ecosystem Research Network (TERN)

Helen Cleugh and Eva van Gorsel
CSIRO Marine and Atmospheric Research
Information and knowledge needed for the sustainable management of ecosystems, and the services they provide, in the context of significant environmental change.
Key Ecosystem Research Questions

How are ecosystems changing – including the spatial distribution of plant and animal species – over time?

How do land management and climate drivers affect ecosystems and ecosystem processes?
   – Terrestrial carbon, water and nutrient cycles
   – Greenhouse gas emissions
   – Biodiversity
   – Soil and water quality

What is the impact of natural disturbance regimes and how are they changing?
TERN – a virtual network enabling integration and sharing of data, information and knowledge

• Data collection, validation, curation, discovery and sharing
  • Standardised methods and calibrations

• Research infrastructure
  • Establishing new, and maintaining existing, research facilities
  • Digital infrastructure for storing and publishing data

• Integrating data across scales and domains; into knowledge and management

• Overarching goal of establishing a framework that promotes scientific interaction and planning for a long-term, ecosystem observation network
  • Bringing ecosystem and climate science communities together
TERN Central (U. Qld)
- TERN Director
- Coordination
- Communications
- TERN data portal

Research Facilities
- Data collection
- Integration & synthesis
OzFlux: A continental network of flux stations delivering nationally consistent observations of energy, carbon and water fluxes.

Green - core observations made to standard measurement protocols
Gray - ‘constellation’ measurements specific to each site
OzFlux: A continental network of flux stations delivering nationally consistent observations of energy, carbon and water fluxes

• Inform and test ecosystem and land surface models for Australian ecosystems

• Quantify and understand ecosystem responses to climate change – water use and carbon sequestration under existing and future climates

• Advance climate and Earth system science especially CABLE – the land surface scheme in Australia’s global climate model (ACCESS)
Purpose is to measure ecosystem fluxes

- CO$_2$ and water vapour using eddy covariance method
  - Water ($\lambda E$, ET) and CO$_2$ (NEE)
- Energy
  - Radiation (Q) and heat (H, G)
- Above canopy; spatially-averaged
- Continuous: hourly to multi-annual

OzFlux: a continental network of flux stations
OzFlux: a continental network of flux stations

Purpose is to measure ecosystem fluxes and ...

Drivers:
• Above-canopy meteorology
• Soil temperature and moisture

Data for analysis & interpretation:
• Within-canopy temperature, CO₂, humidity and wind profiles
Knowledge of ecosystem exchange of carbon, water & energy.

OzFlux
Flux tower network
- Surface fluxes
- Radiation
- Meteorology
- Soil properties

AusPlots, Supersites
Intensive field campaigns
- Site characteristics
- Biomass
- Soil carbon & nutrients
- Leaf-level photosynthesis

AusCover
Remote sensing
- Vegetation type
- Leaf area index
- Gross primary product
- Soil moisture
- Hyperspectral

eMAST
Land surface models
- Ecosystem dynamics
- Spatial and temporal dynamics
- Continental & global budgets

From Peter Isaac 2012 TERN Symposium
Resources and status

2009 - 2011: $20m from National Collaborative Research Infrastructure Strategy

2011 - 2014: $25.63m from Education Investment Fund for a second phase TERN-EIF
TERN OzFlux Status and Science
1. Quality of OzFlux Data: energy balance closure

Energy balance closure: **Fluxnet** (948 site years) & **OzFlux** (60 site years)

2. OzFlux Science: Space-time information on ecosystem processes

[Diagram showing a map of Australia with various sites marked and graphs for each site showing ET (mm d^-1) over different months (JASONDJFMAMJ).]
3. Evaluating land surface and ecosystem models

Focus is CABLE - the land surface model in ACCESS

*from M. Williams et al., www.biogeosciences.net/6/1341/2009/*
Using multiple observation types to reduce uncertainty in Australia’s terrestrial carbon and water cycles (Haverd et al, 2012)

CABLE = Community Atmosphere-Biosphere-Land Exchange model
Water, energy, carbon fluxes
Wang et al. (2011)

SLI = Soil-Litter-Iso
Soil hydrology, soil evaporation
Haverd et al. (2011)

CASAcnp = Biogeochemical model
Soil and plant C, N, P dynamics
Wang et al. (2007)

AWAP = Australian Water Availability Project
Met and soil data
Continental processing framework
Model-Data Fusion
Raupach et al. (2009)

BIOS2 = CABLE-SLI-CASAcnp in AWAP operational framework

Multiple observation types reduce uncertainty in Australia’s terrestrial carbon and water cycles.

**DATA (for forcing)**
- Precip, radiation, temp
- Soil, vegetation (RS FPAR)
- All at 0.05° (~ 5km) resolution

**DATA (for assimilation)**
- Eddy fluxes (ET, NEE)
- Streamflow
- Litterfall (leaf NPP)
- Carbon pools

**MODEL**
- BIOS2 = CABLE + SLI + CASAcnp

**PRIOR INFORMATION**
- Parameter estimates (literature)

**MODEL-DATA FUSION**
- Cost function
- Search strategy (down-gradient search)
- Refine target variables

**PRODUCTS**
- Water and carbon fluxes and stores (with uncertainties)
- Maps, monthly time series

**TESTING**
- Independent data

**updated parameter PDF**

**Prior PDF**

**Posterior PDF**
Using BIOS2 to simulate Australian ecosystems

OzFlux data used to improve and evaluate:

• Process representation
• Model parameters
• Model performance

at all time scales (hours to decades)
Using BIOS2 to simulate Australian ecosystems

Multiple observation types reduce uncertainty in Australia’s terrestrial carbon and water cycles. | Vanessa Haverd
Including OzFlux data to constrain BIOS2 simulations of NPP (Net Primary Production) for Australian continent

\[
\text{NPP} = \text{Net Primary Production} = 2.1 \text{ GT C} / \text{y}
\]

error bars = uncertainty from propagated parameter uncertainties (1σ)

Multiple observation types reduce uncertainty in Australia’s terrestrial carbon and water cycles. | Vanessa Haverd
Australia’s water and carbon balance from BIOS2

- Energy, carbon, water budgets
- 1990 – 2009 (monthly)
- 5 km resolution
- Using BIOS2 (CABLE + SLI + CASAcpn)

Multiple observation types reduce uncertainty in Australia’s terrestrial carbon and water cycles. | Vanessa Haverd
4. OzFlux Data Path: High Level

From Peter Isaac 2012 TERN Symposium
OzFlux is a network of micrometeorological flux stations located at various sites within Australia and New Zealand.

OzFlux is part of a global network (see LINKS) of over 500 sites (March 1, 2010) where exchanges of carbon dioxide, water vapour, and energy between terrestrial ecosystem and atmosphere are measured continuously over long periods.

Note: map shows more sites than listed, they will be added soon.

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<th>Landcover</th>
<th>Annual Rainfall</th>
<th>Temp Range °C</th>
<th>Locations</th>
<th>Group</th>
<th>Status</th>
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**Extract the Metadata**

![Import button](image)

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Thank You

Acknowledgements

TERN HQ

OzFlux
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• Vanessa Haverd
• FluxNet