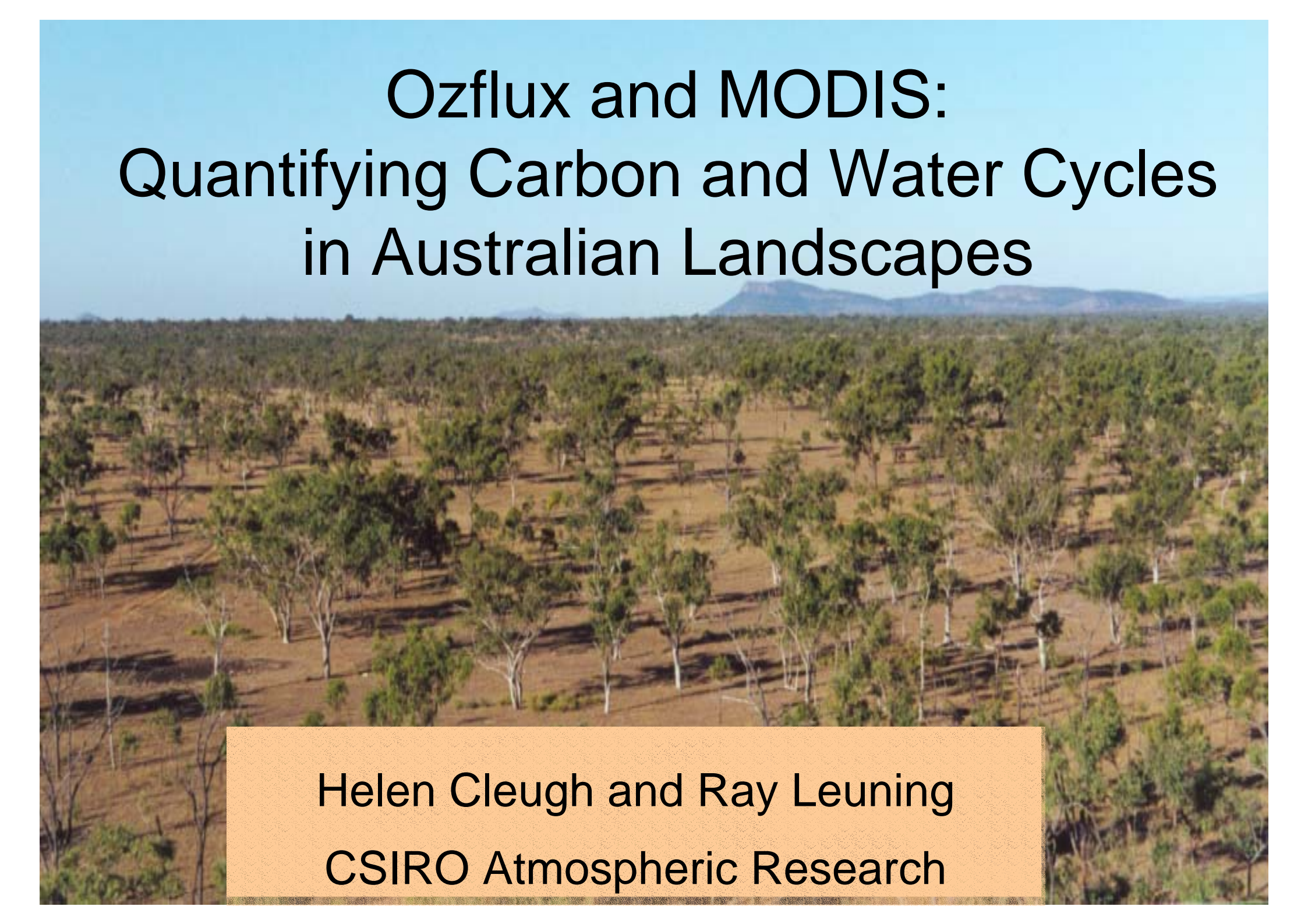


# Ozflux and MODIS: Quantifying Carbon and Water Cycles in Australian Landscapes



Helen Cleugh and Ray Leuning  
CSIRO Atmospheric Research

# 1. Carbon and water cycles at multiple scales in Australian landscapes

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Quantify the interactions between the climate system and the biosphere, especially the coupled cycles of carbon and water, to provide:

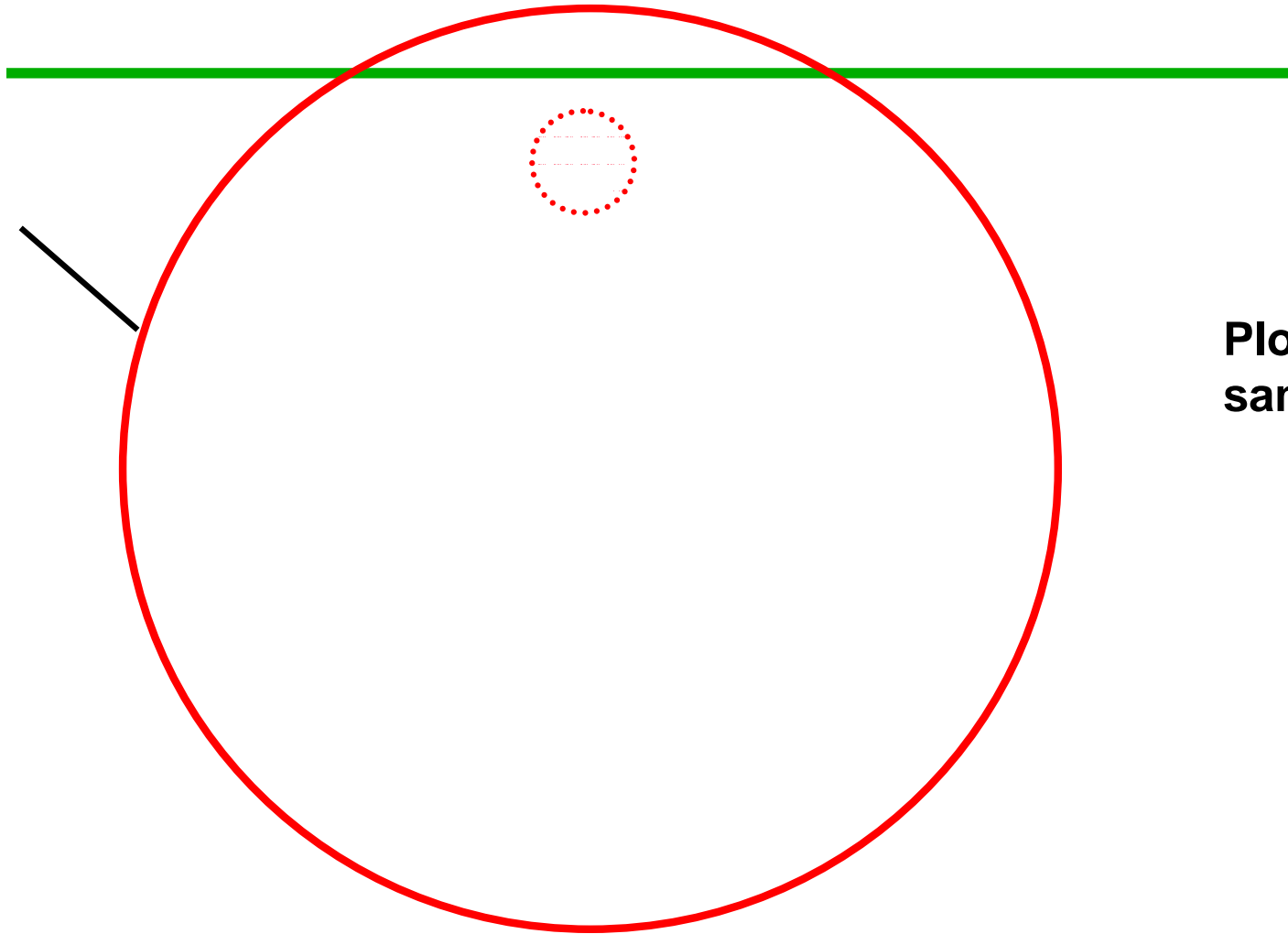
- High quality **data** for developing and testing **terrestrial biosphere-climate system models**
- Improved **understanding** of carbon and water cycling in Australian landscapes
- Better and constrained **budget estimates at multiple time and space scales** by combining measurements and models

## 2. An Integrated Earth Observing System

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- ◆ Atmospheric and terrestrial measurements:
  - **Atmospheric concentrations** – network of CO<sub>2</sub> analysers
  - **Water and carbon** – net land-air fluxes; terrestrial pools & fluxes
  - **Remote sensing** – broad band (e.g. MODIS, AVHRR); hyperspectral
- ◆ Biosphere-climate model, e.g. CABLE – CSIRO's land-air flux (CBM) and terrestrial BGC model (BIOS)
- ◆ Model-data fusion:
  - Parameter estimation, data assimilation, multiple constraints

**Concentration &  
Flux Footprints  
(1 and 100 km<sup>2</sup>)**



**Plot-scale  
sampling**

**From S. Running  
U. of Montana**

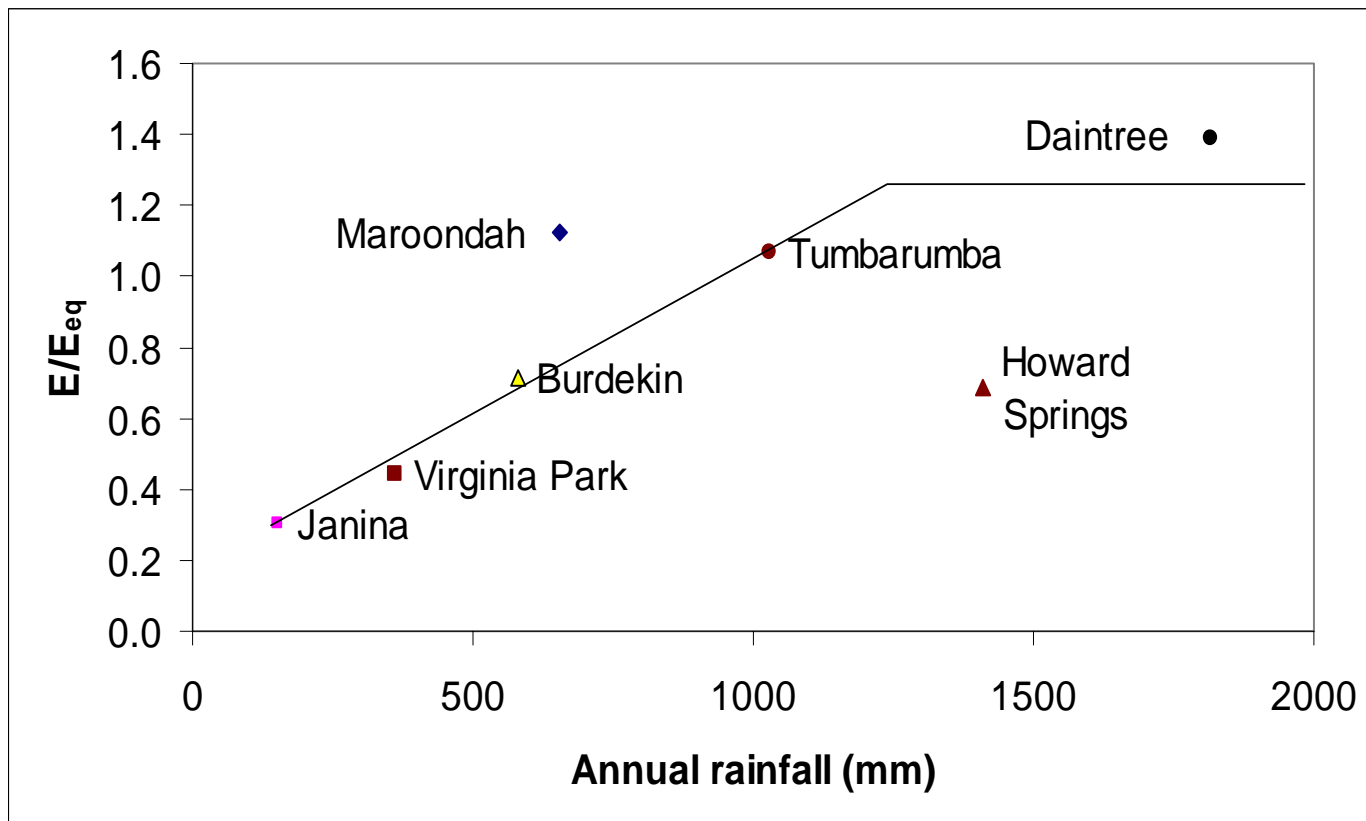
# FLUXNET - Integrating Worldwide CO<sub>2</sub> Flux Measurements

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Ozflux

# Ozflux - a continental network of fluxes and concentrations and a part of the global Fluxnet

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**Padthaway**



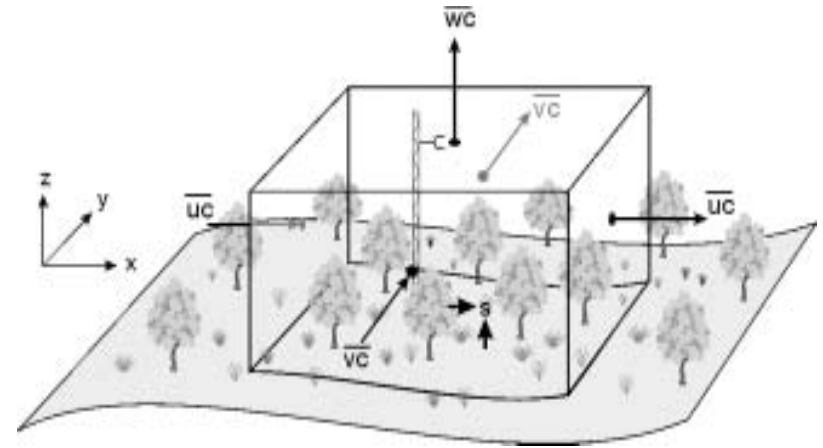
# Ozflux - continuous monitoring of carbon and water fluxes at local scales

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- ◆ Evaporation and net carbon fluxes in contrasting ecosystems:
  - Grazed, subtropical savanna (Virginia Park) from July 2001
  - Cool, upland, Eucalypt forest (Tumbarumba) from March 2000
- ◆ Constrained estimates of net ecosystem exchange (NEE):
  - Spatial and temporal variation in carbon pools and fluxes
  - Compare net land-air fluxes with aggregated carbon fluxes
- ◆ Develop, parameterise and test models:
  - MODIS algorithms
  - CABLE – CSIRO's Biosphere-Climate Model

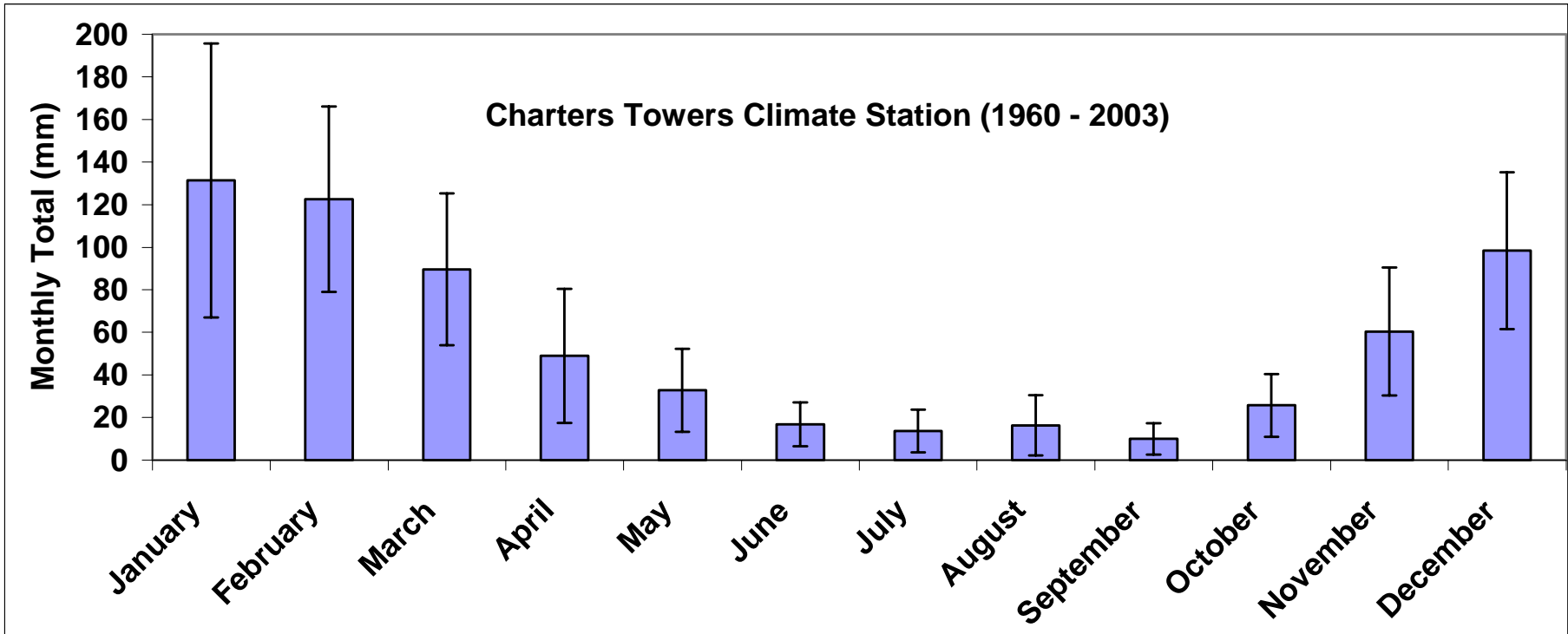
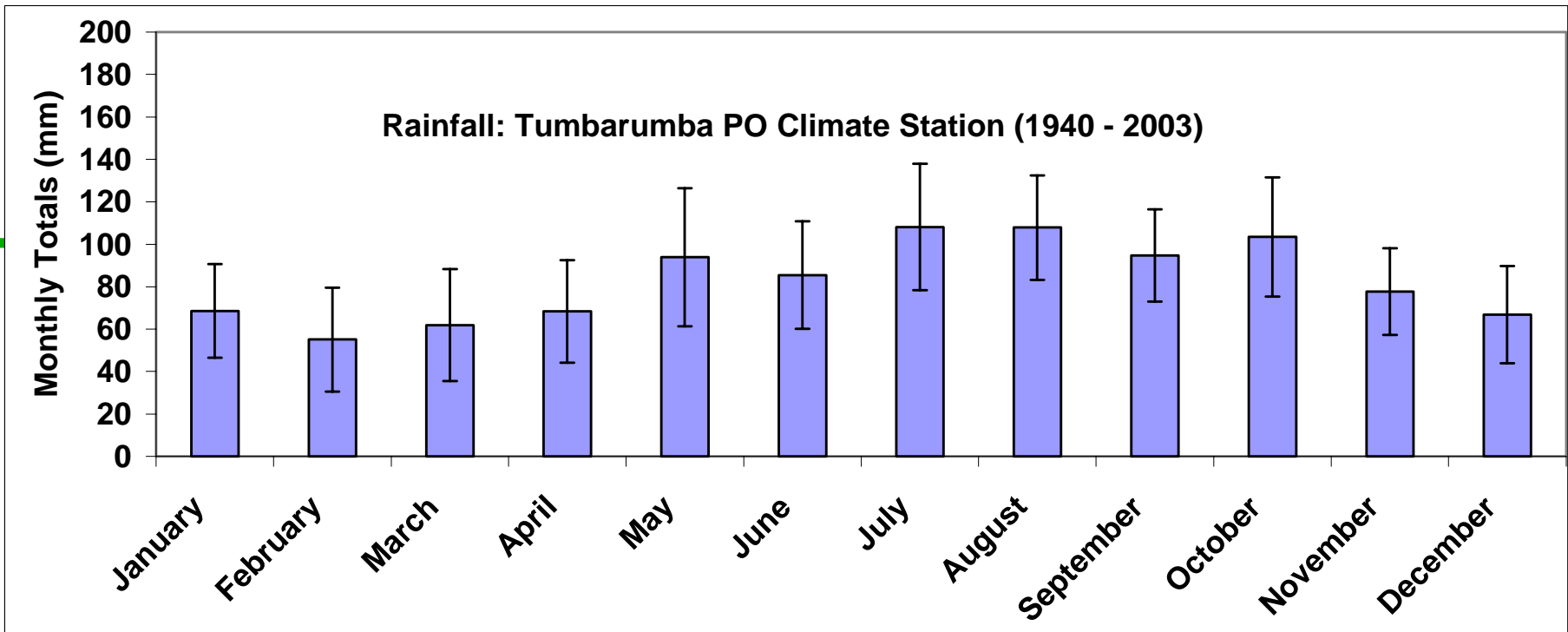
# Flux Stations

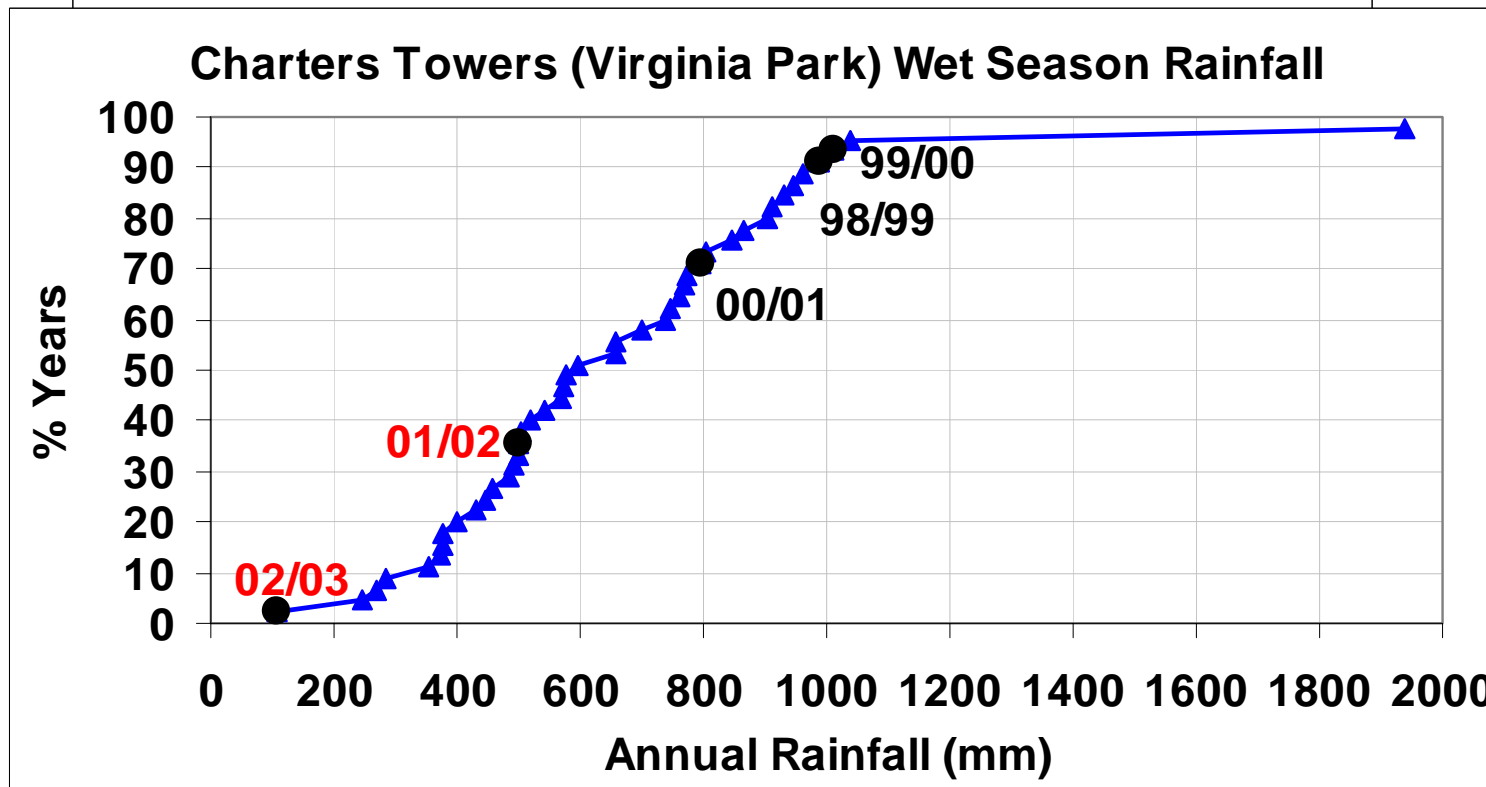
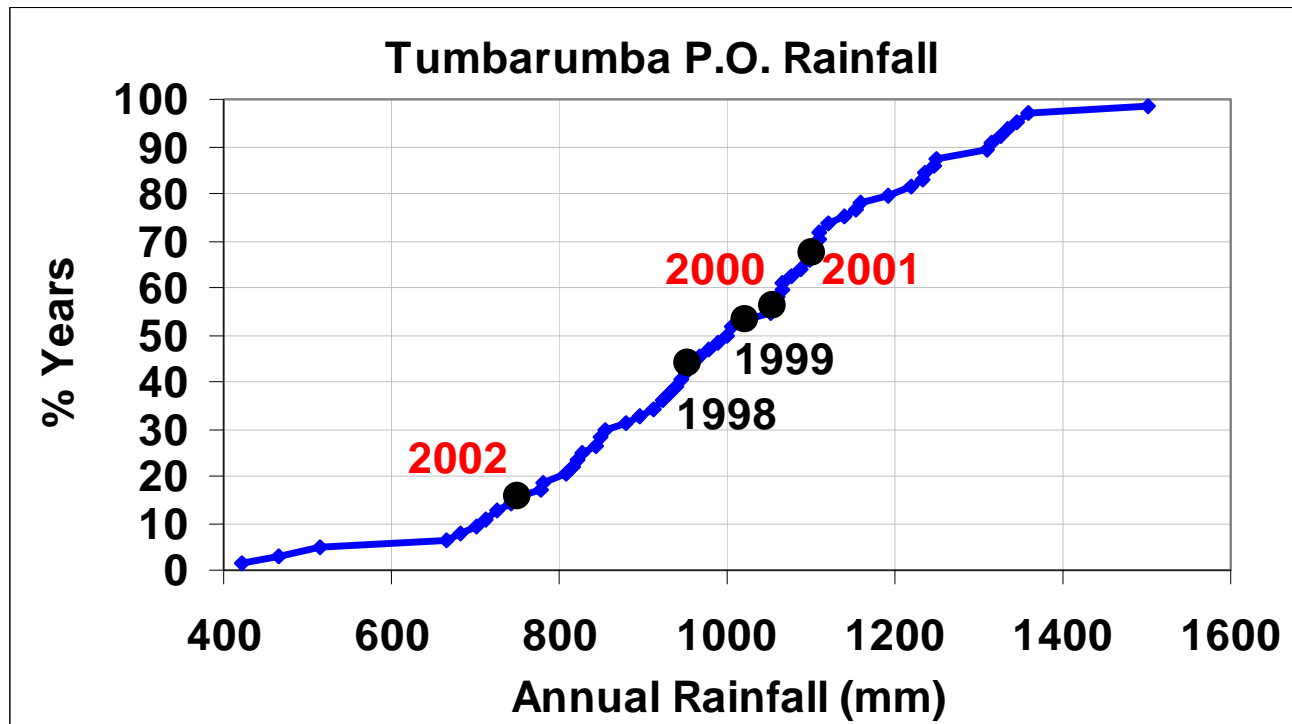
- ◆ Hourly, long term measurements:
  - Water, CO<sub>2</sub>, heat, momentum fluxes
  - Hyperspectral reflectances
  - Driving meteorology
  - Soil and canopy stores
- ◆ Features:
  - Autonomous
  - Purpose-built database for data archiving and quality control
  - On-line processing and automated, daily data transfer into database



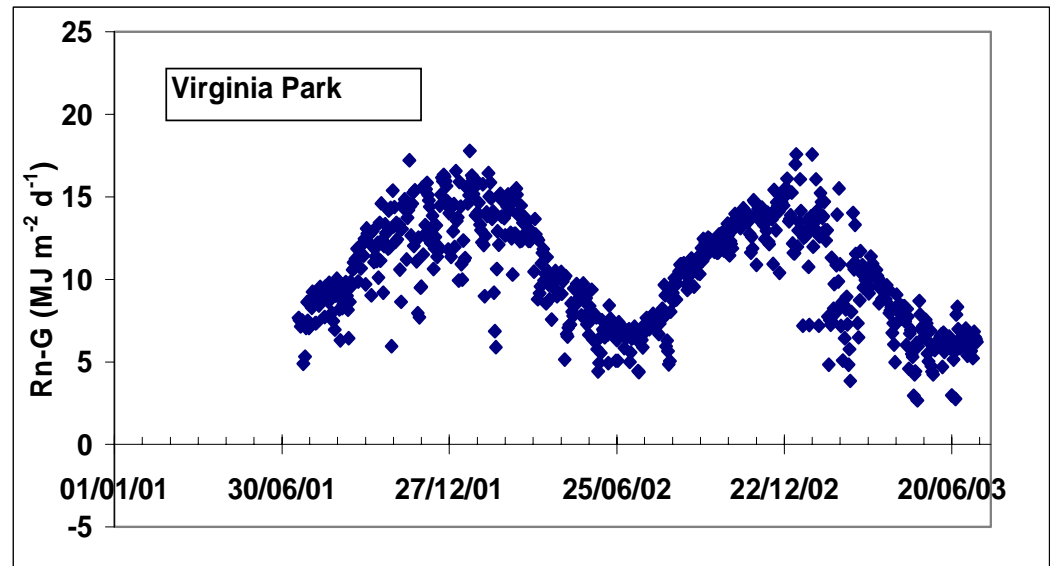
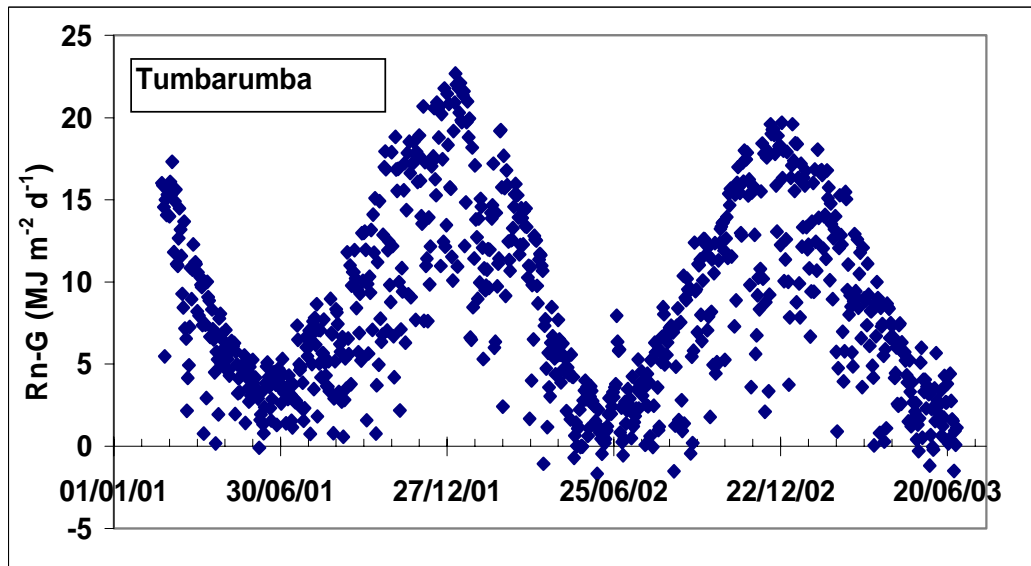
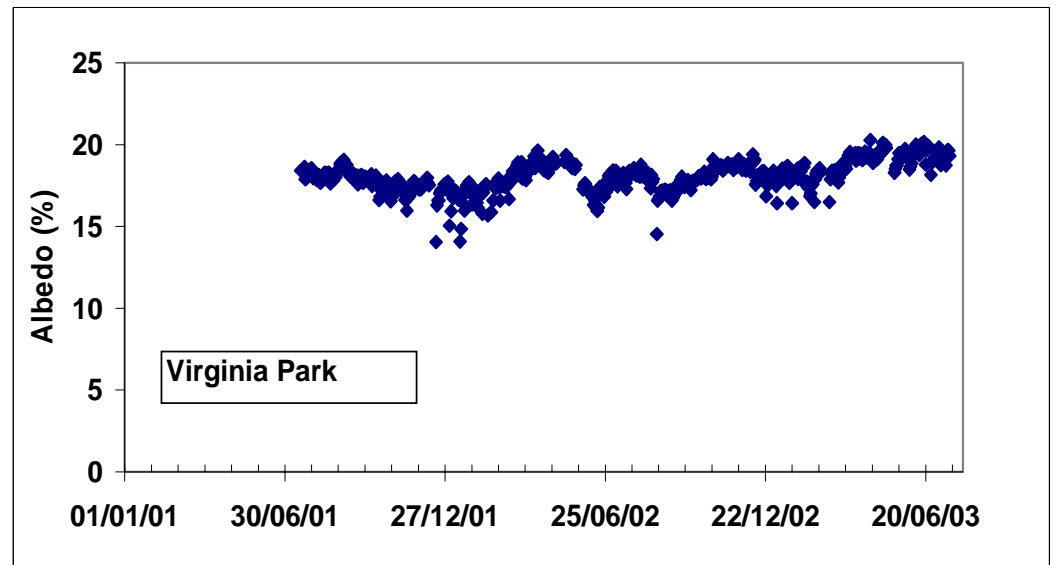
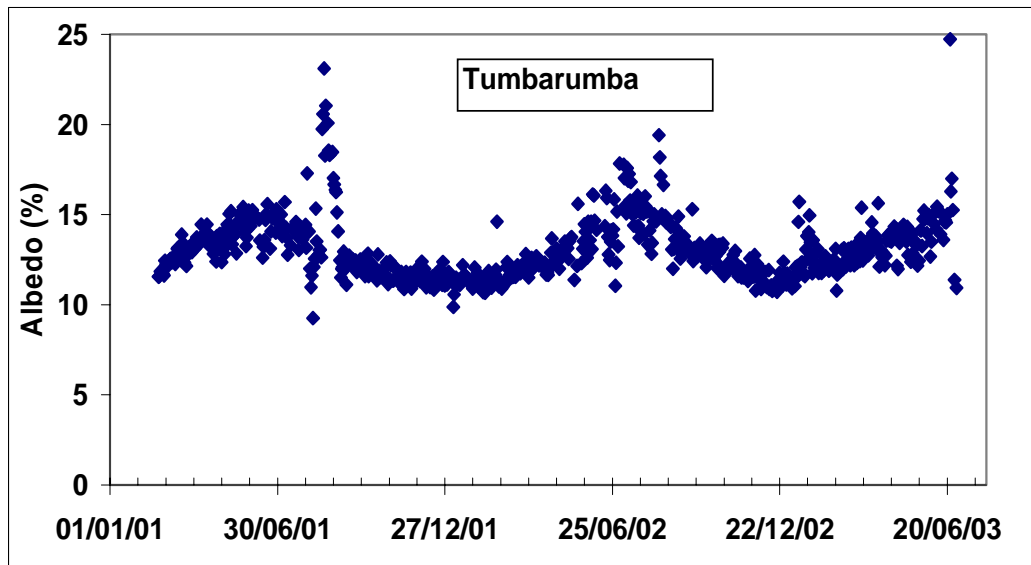
$$\int_0^h \left\langle \frac{\partial \bar{c}}{\partial t} \right\rangle dz + \int_0^h \left\langle \frac{\partial \bar{u}c}{\partial x} + \frac{\partial \bar{v}c}{\partial y} \right\rangle dz + \langle \bar{w}c \rangle = \langle \bar{S} \rangle$$



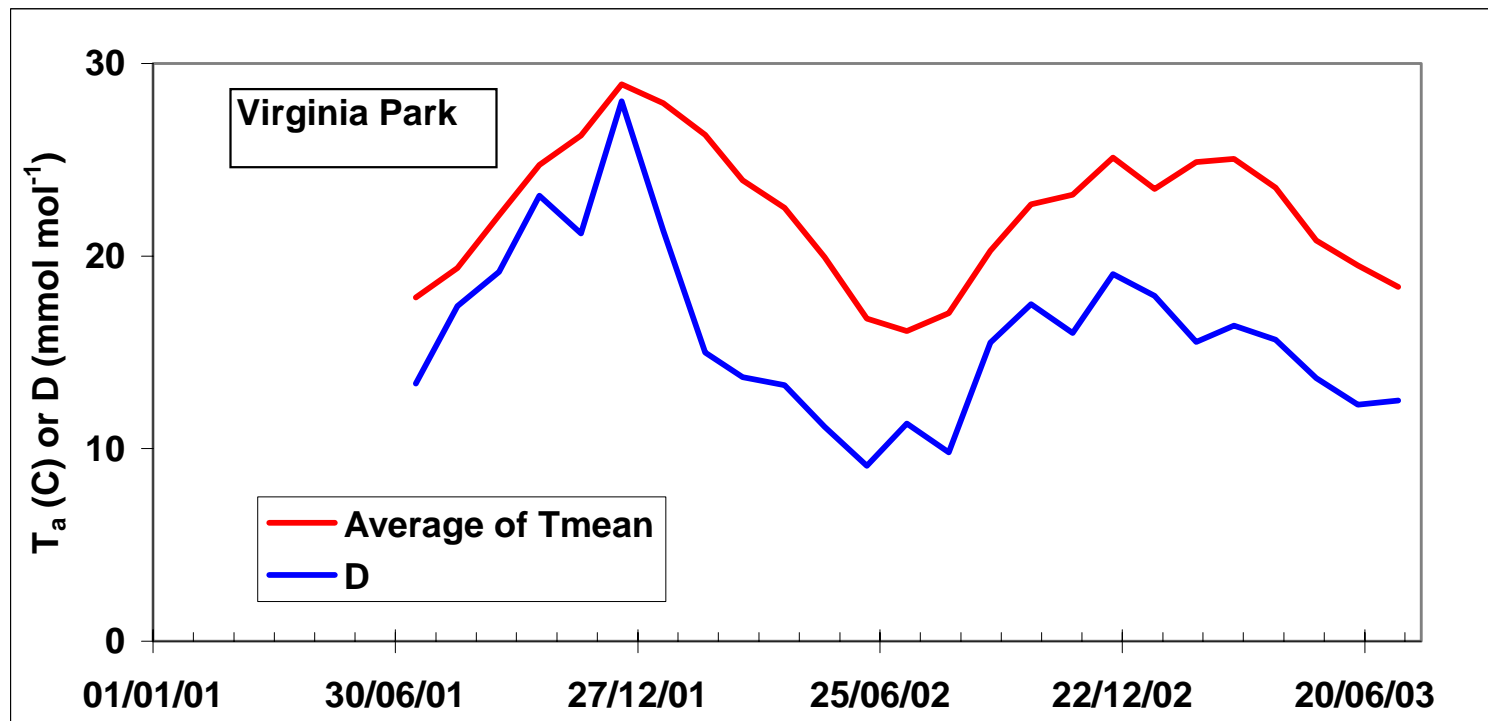
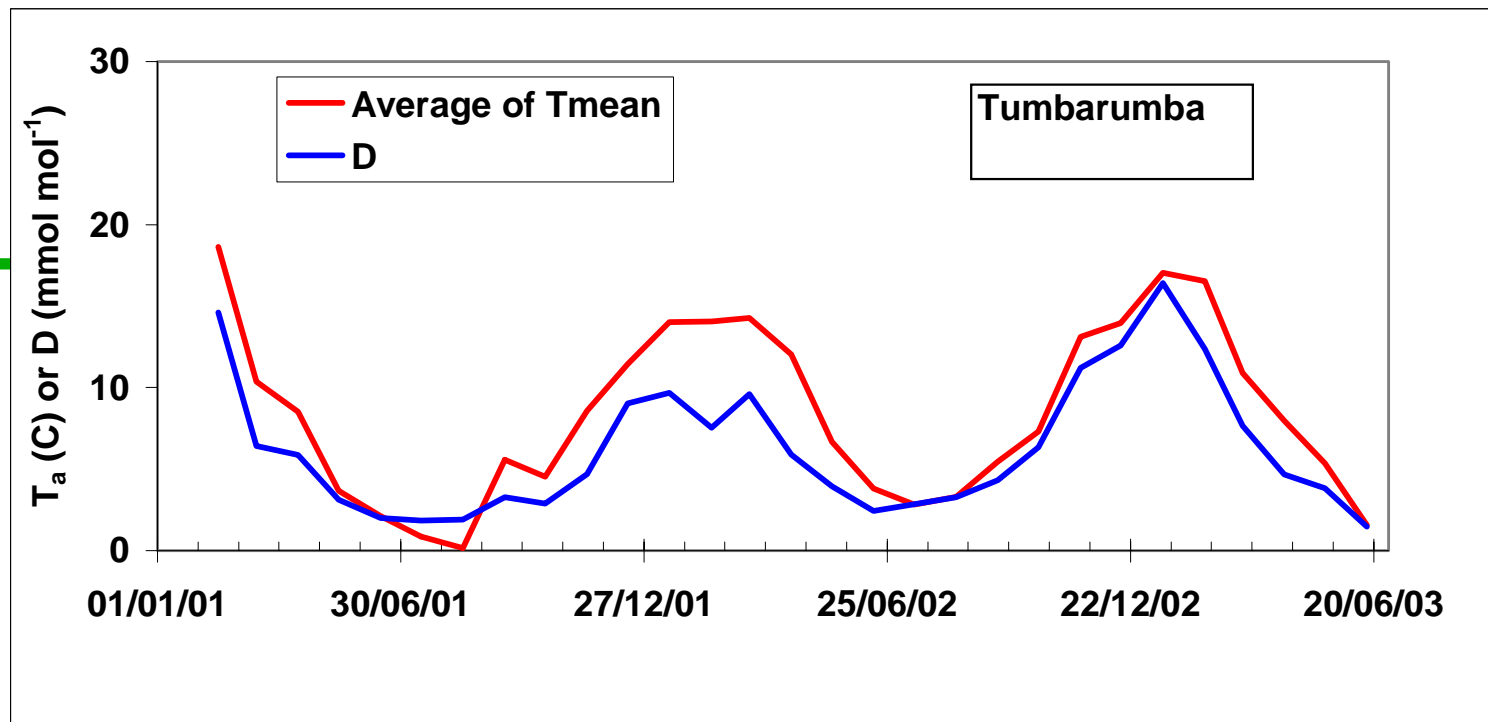




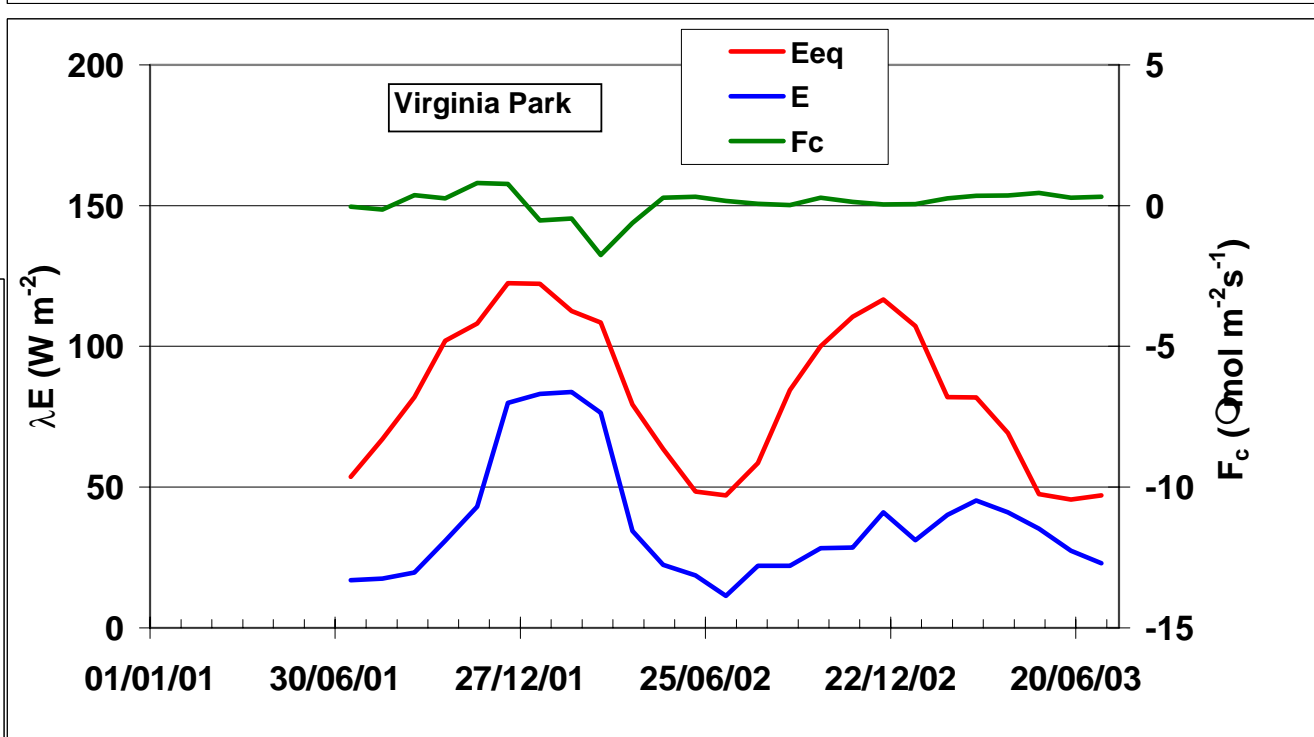
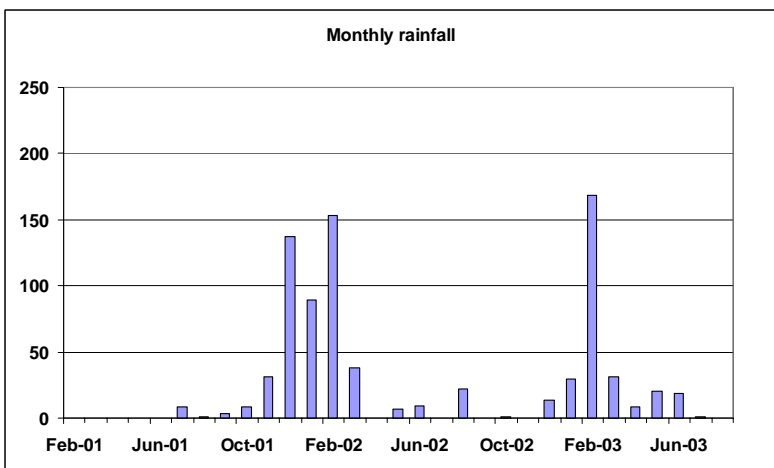
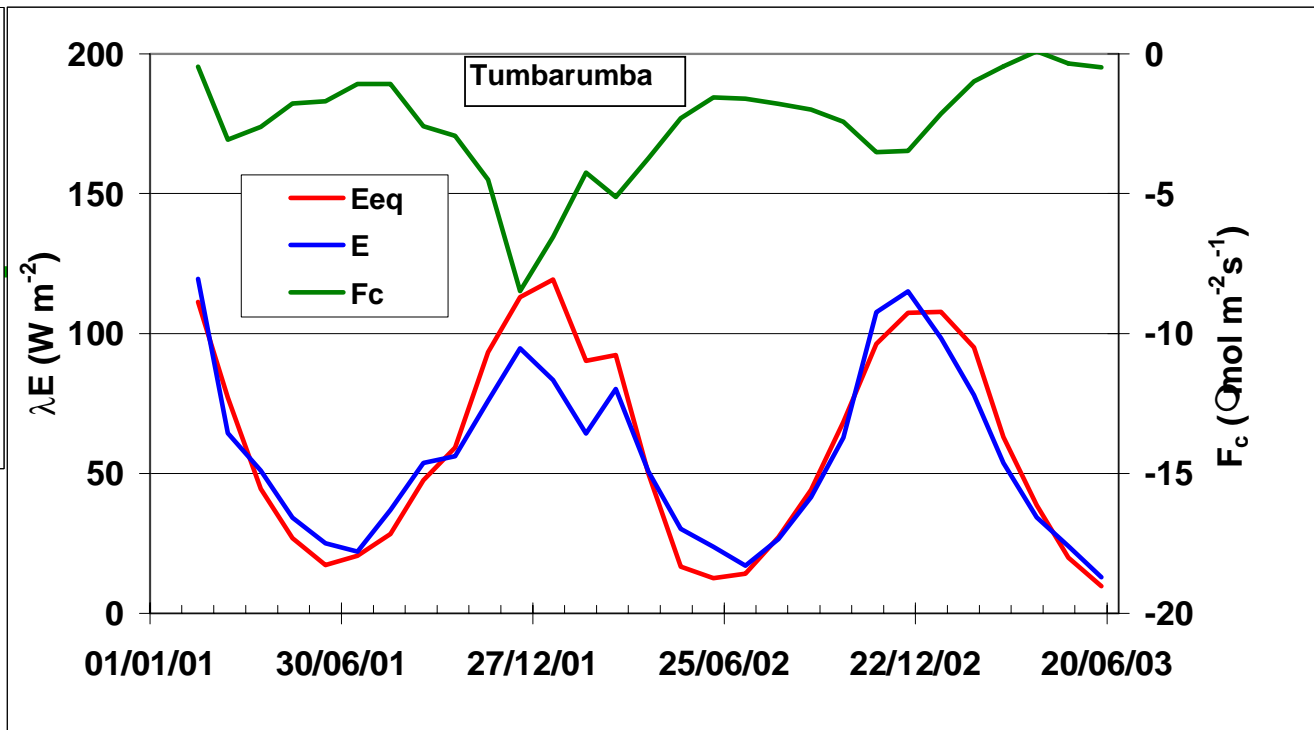
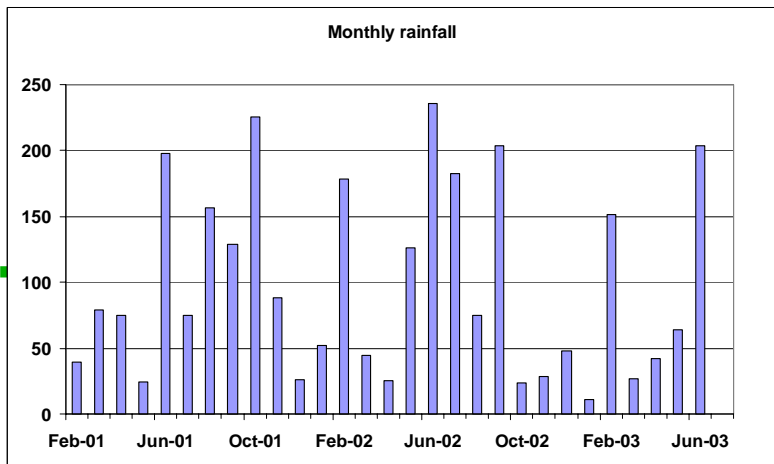
# Ozflux: Radiation



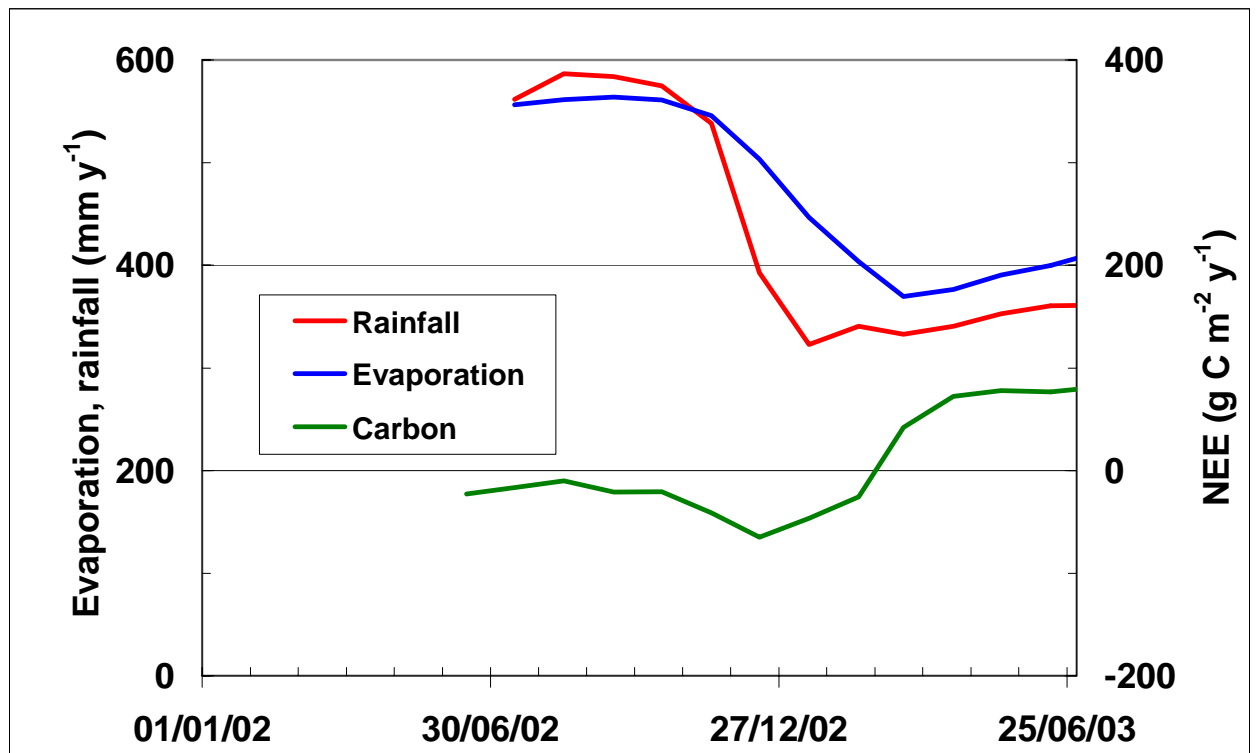
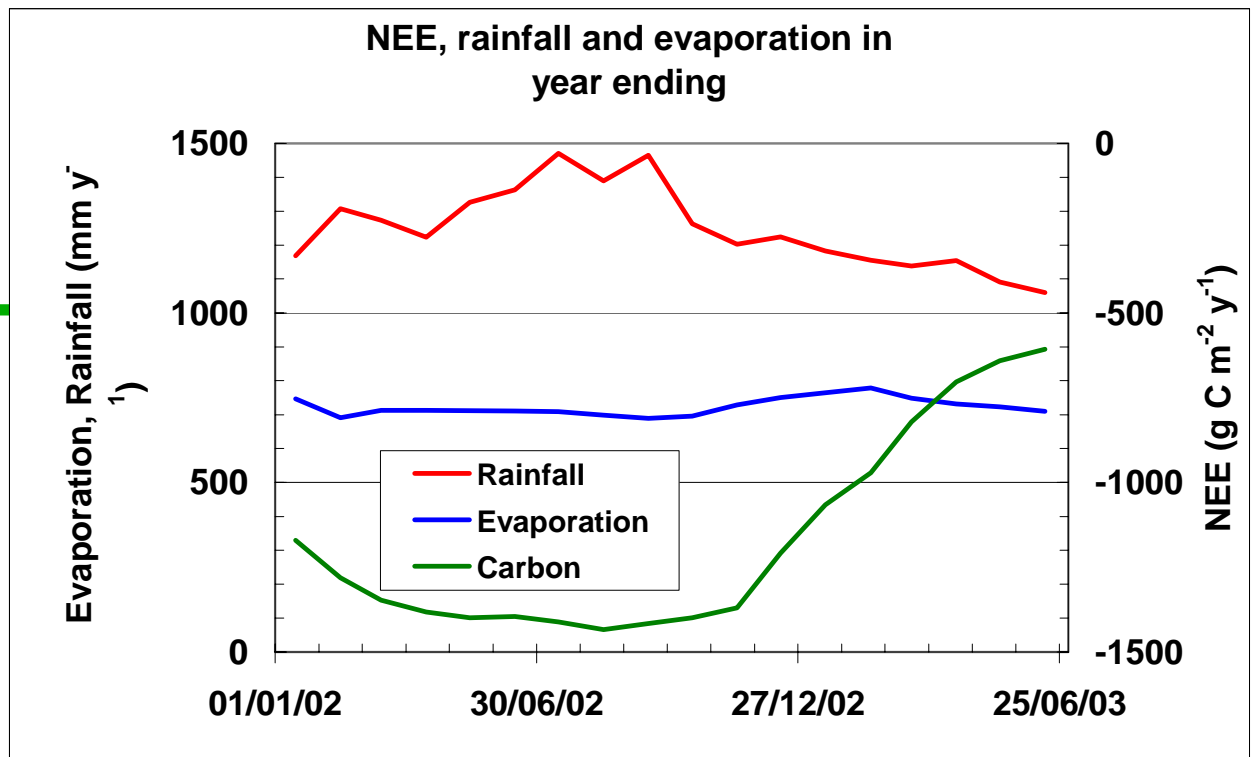
Ozflux:  
Temperature  
& humidity



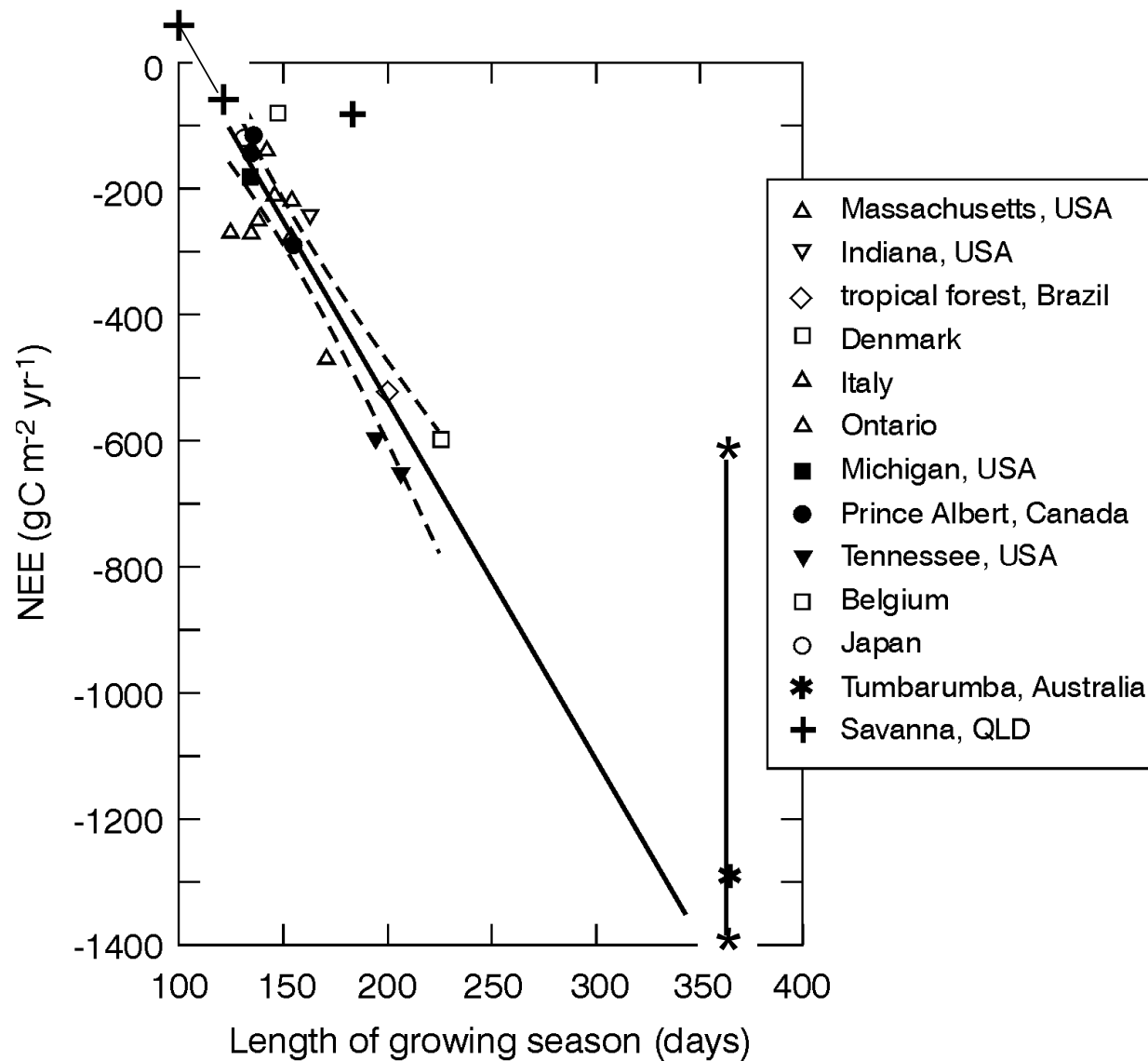
# Ozflux: Net carbon & water fluxes



# Ozflux: Interannual variability in NEE & water use

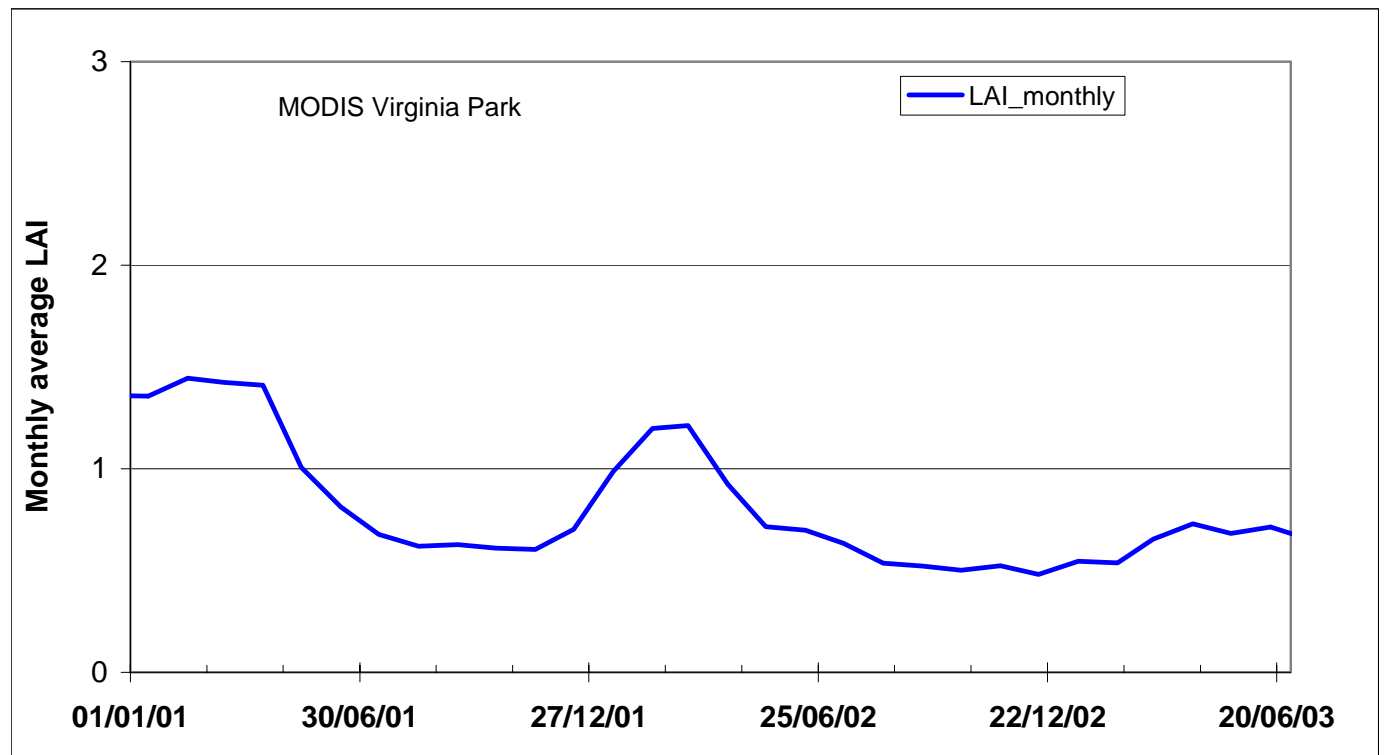
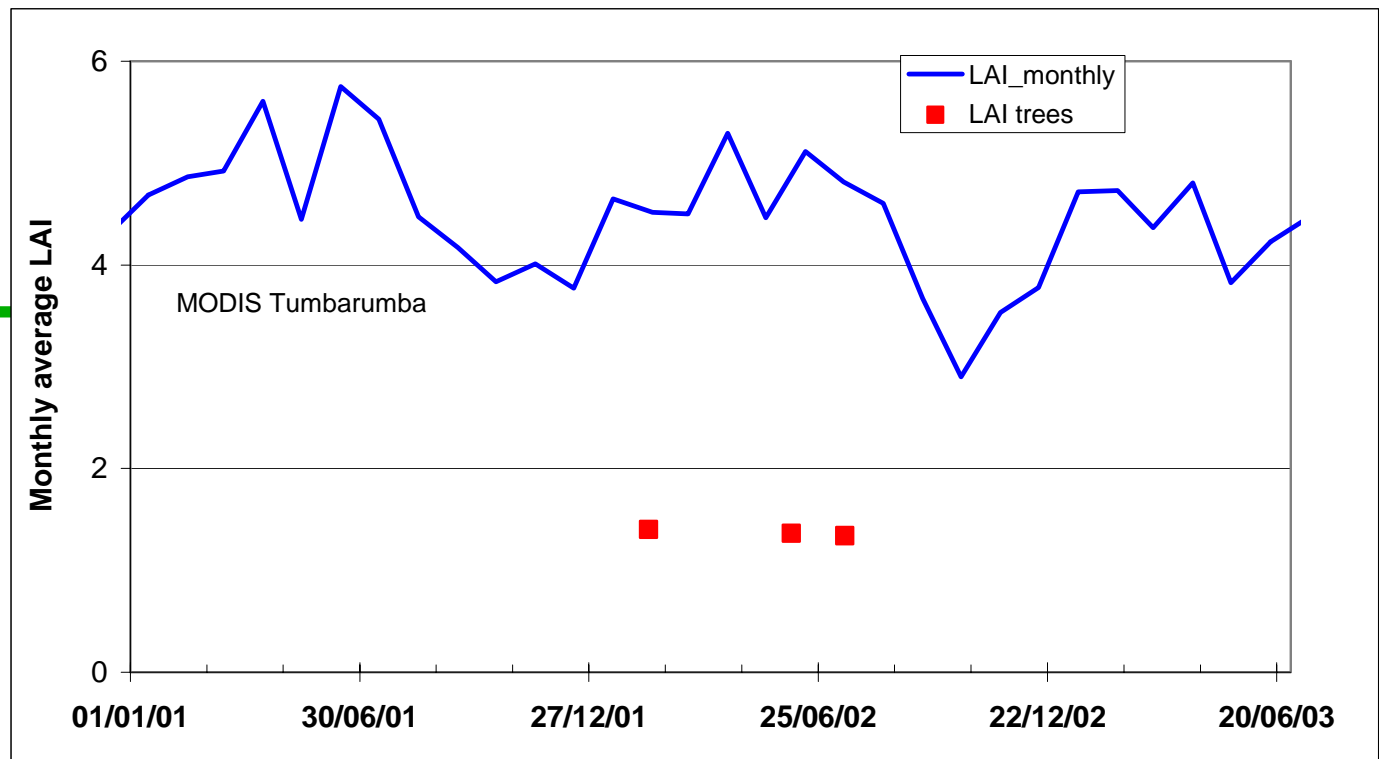


# Annual NEE - Australian and international ecosystems

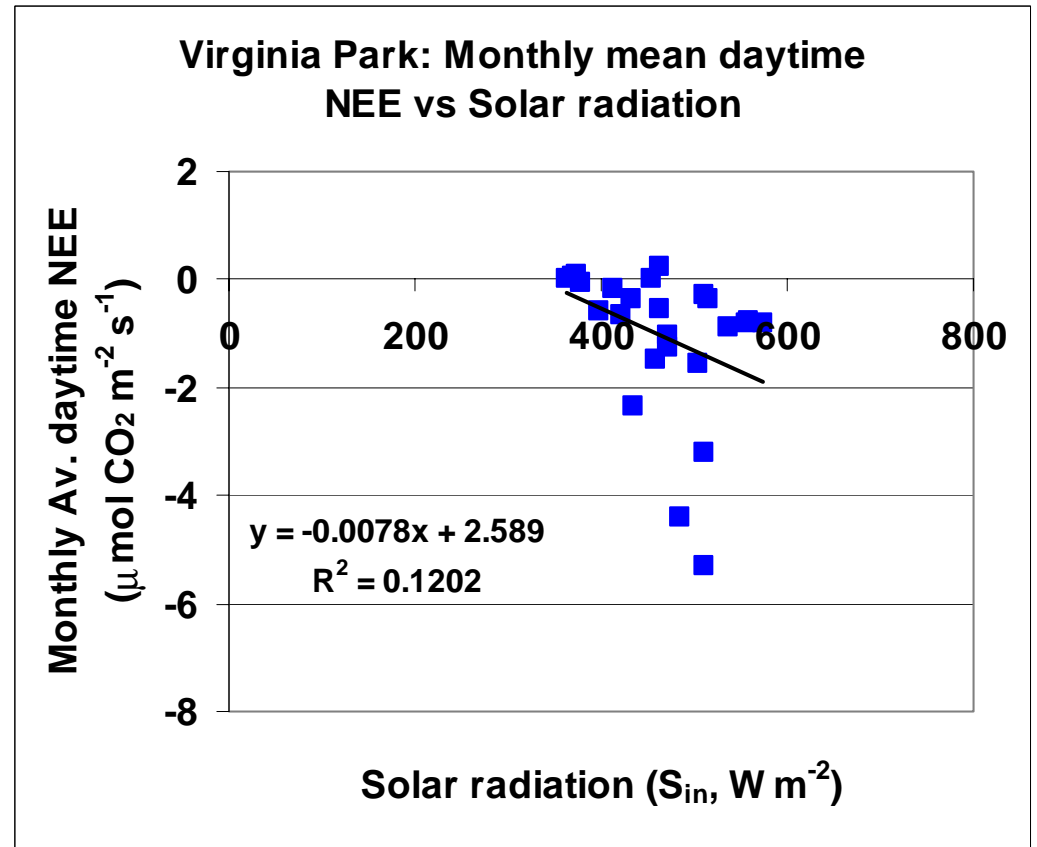
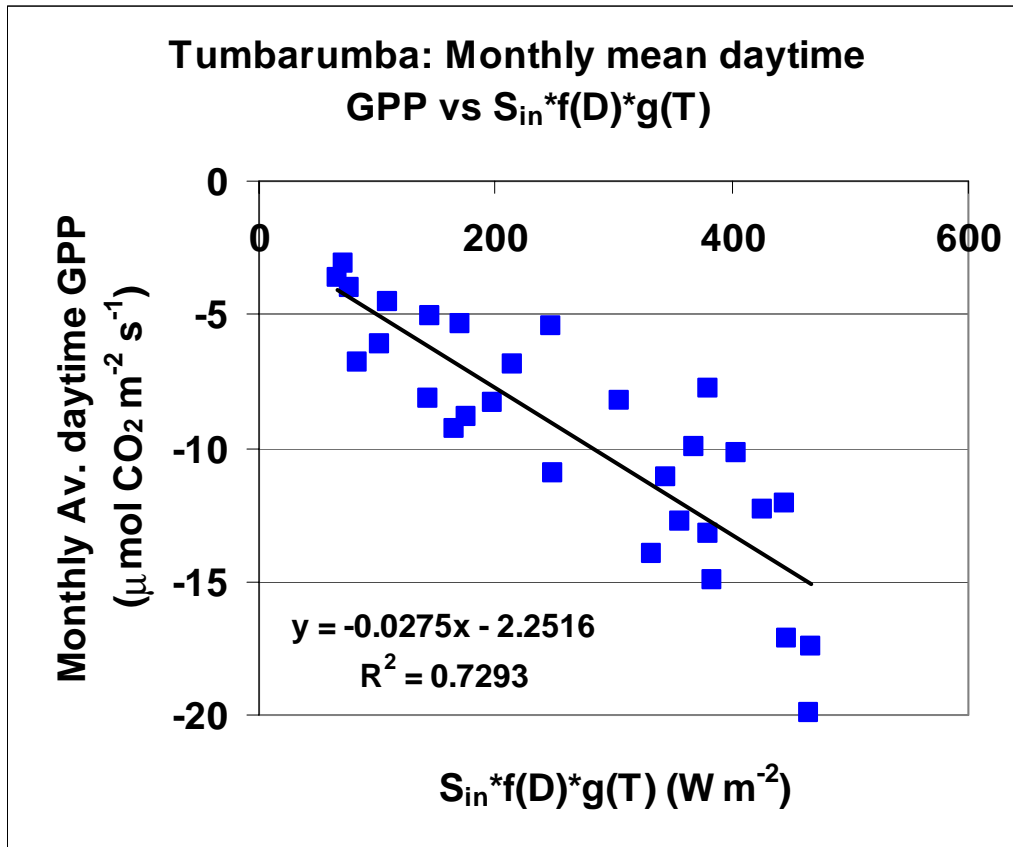


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# Ozflux: Comparison between MODIS & flux towers

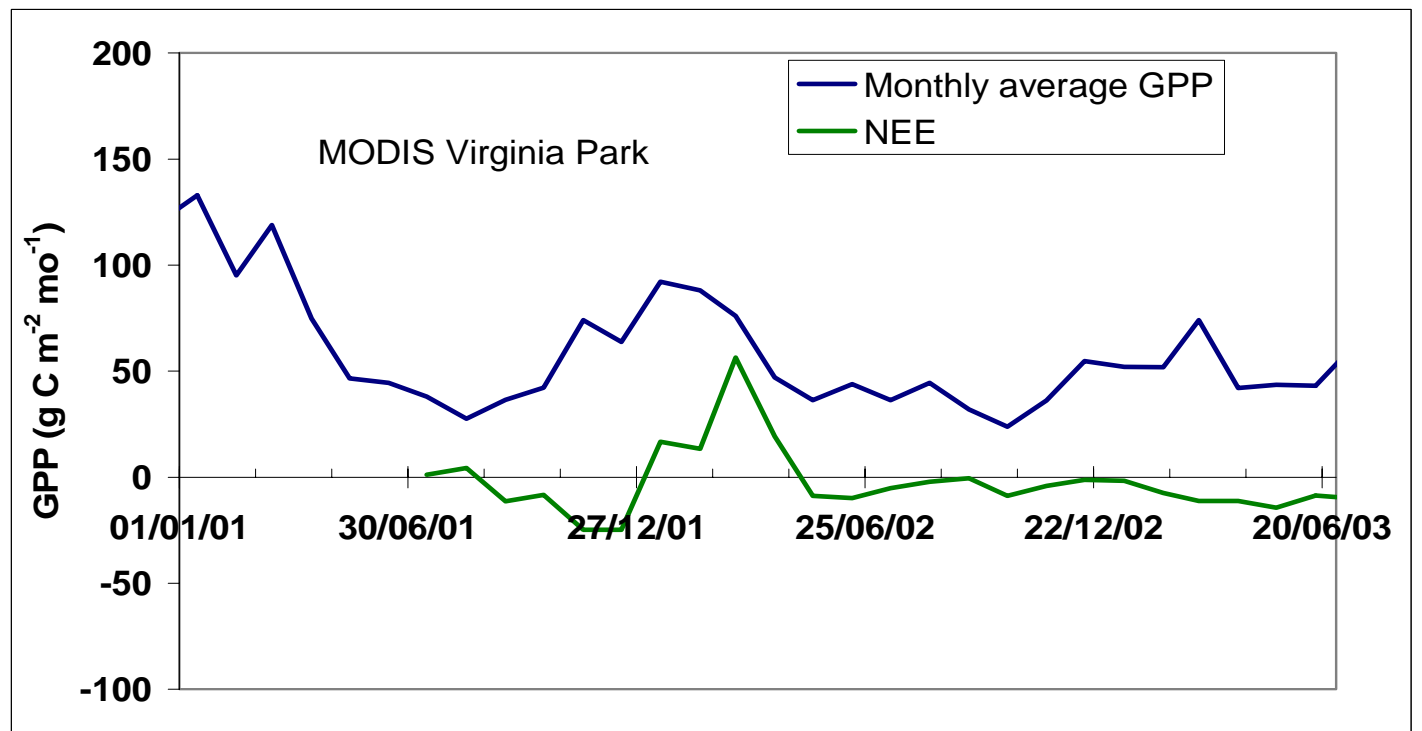
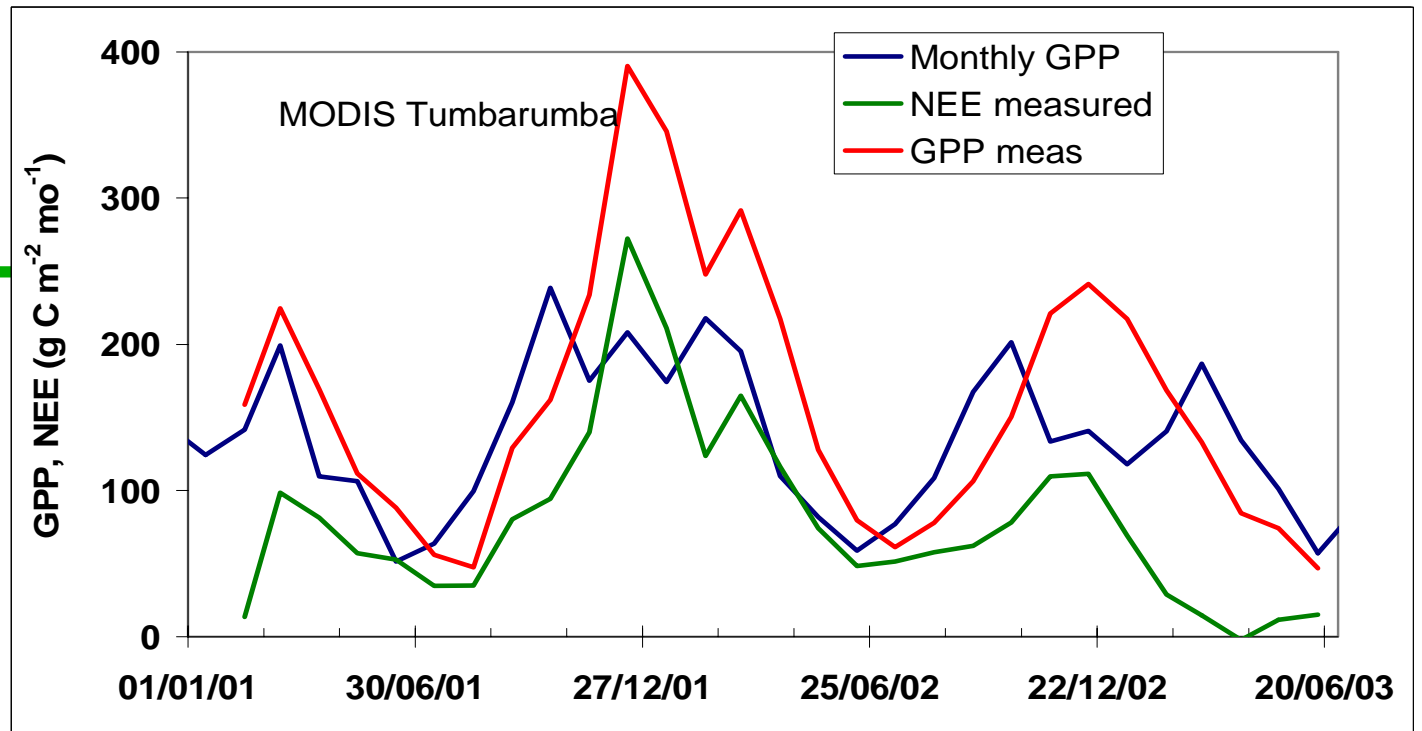


# Linking radiances to fluxes



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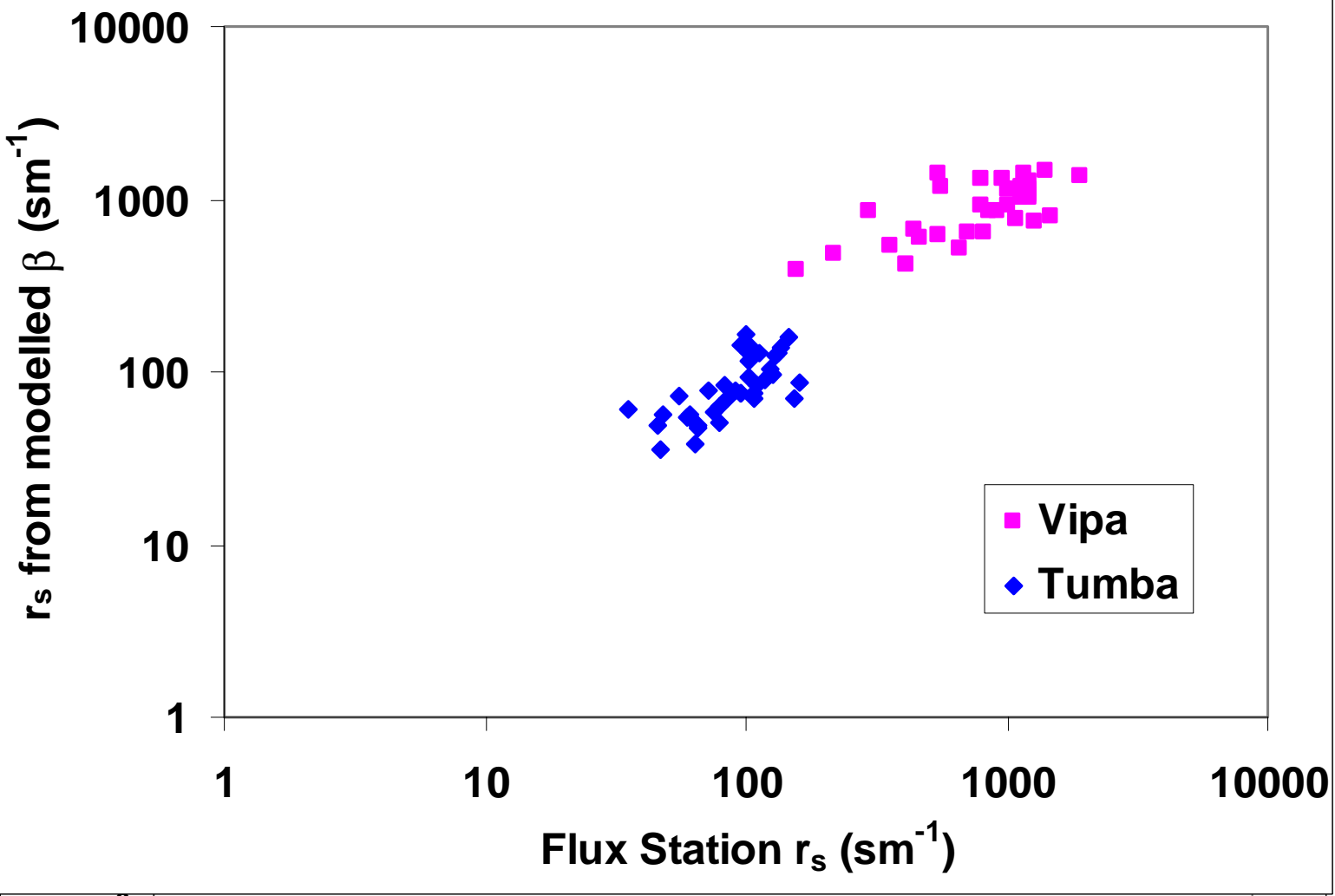
# Ozflux: Comparison between MODIS & flux towers



Virginia Park Flux Site: Predicting LE from MODIS "Bowen ratio"

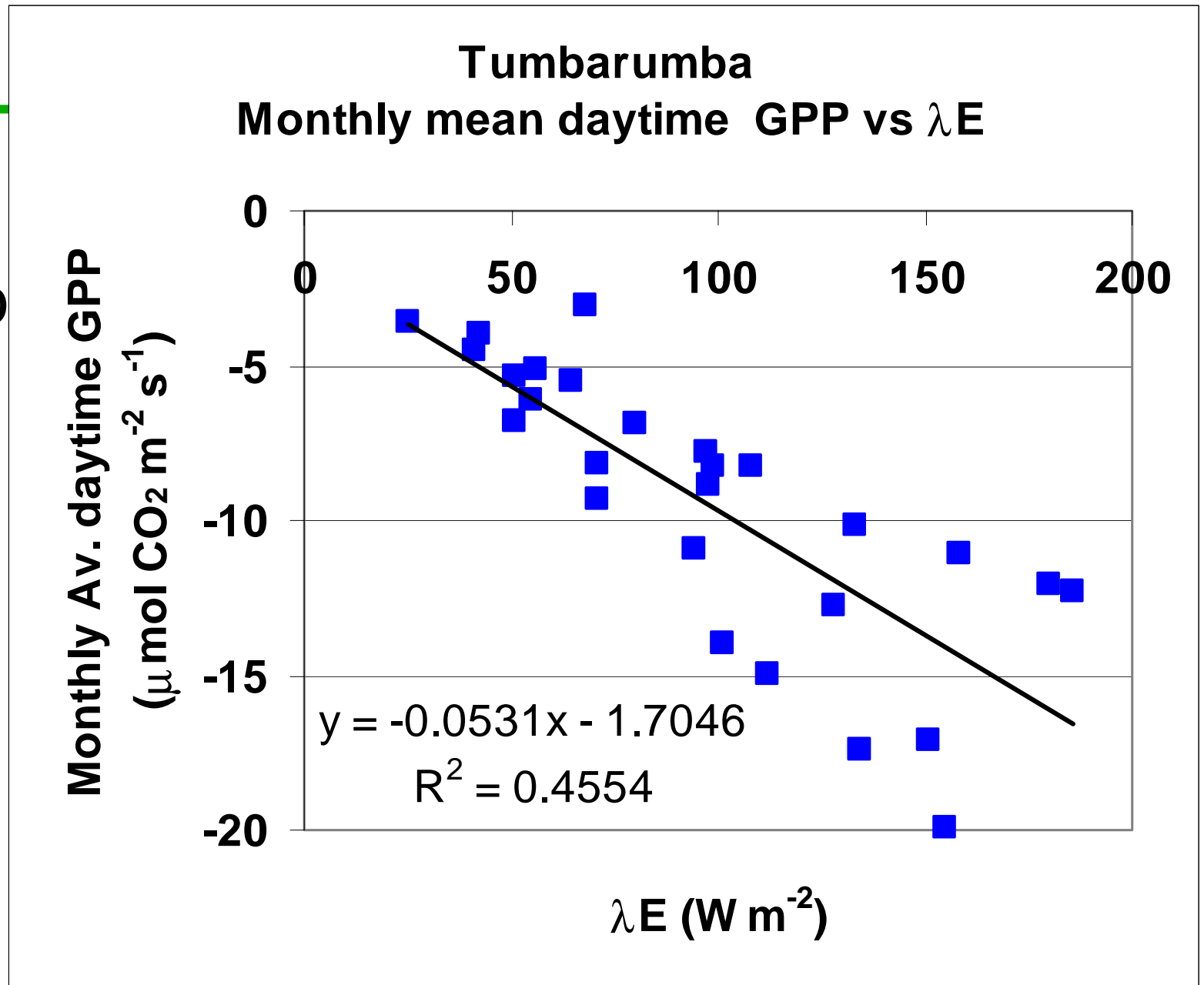


Linking  
radiances to  
fluxes

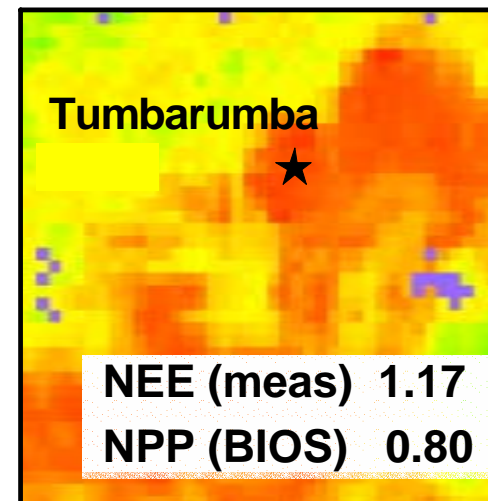
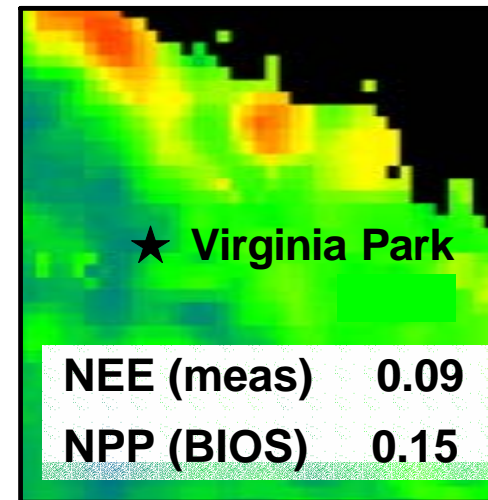
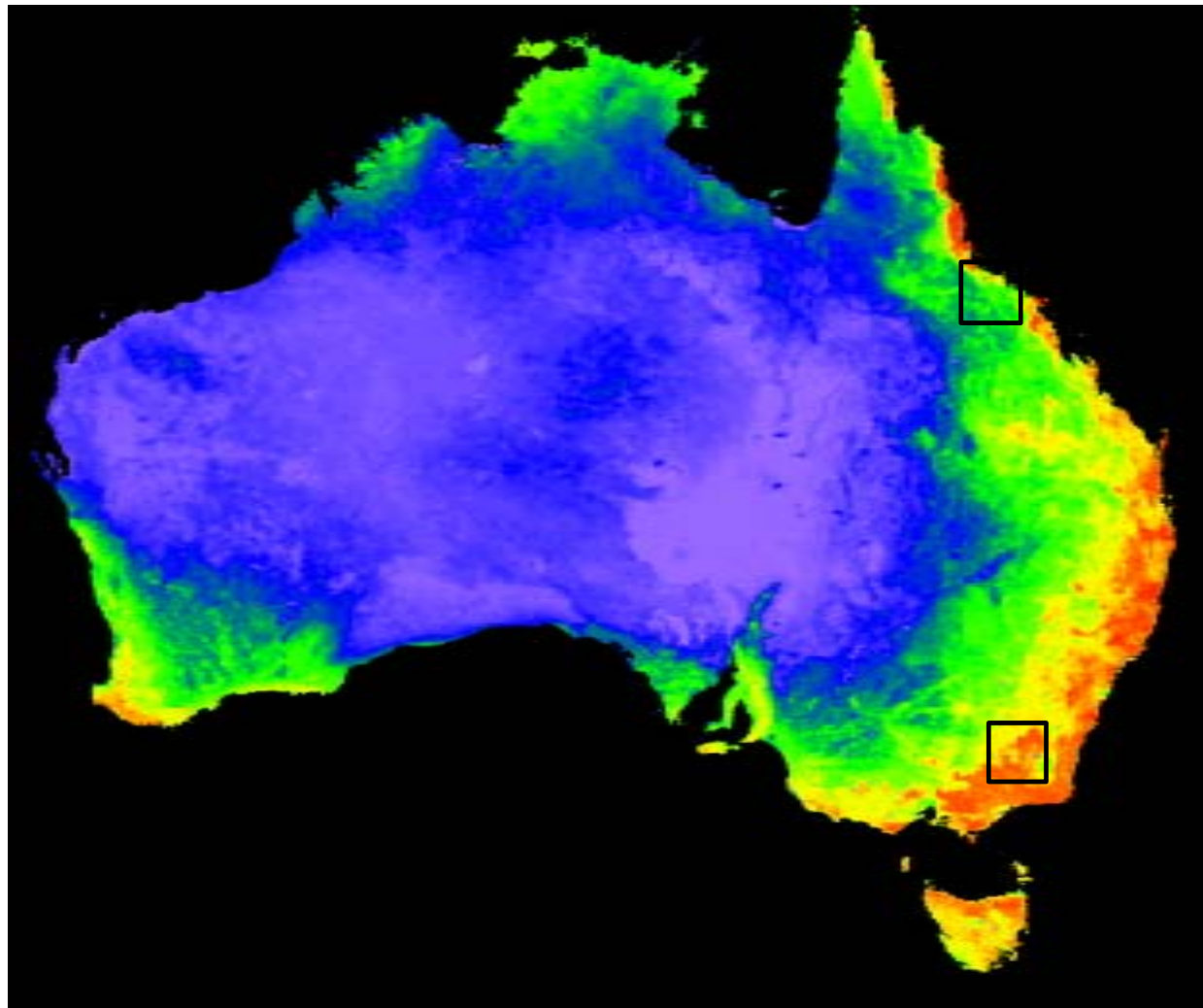


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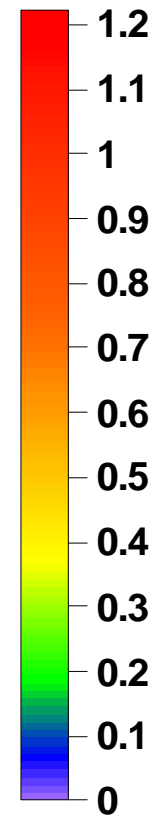
Linking  
radiances to  
fluxes



# Comparing measured NEE with BIOS predictions (equilibrium NPP)



kg C m<sup>-2</sup> y<sup>-1</sup>



**NPP**  
kgCm<sup>-2</sup>y<sup>-1</sup>

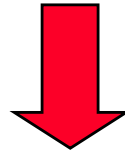
## 4. Concluding comments - directions

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- ◆ **Monitoring** the budgets of carbon and water at regional and continental scales:
  - A network of flux and atmospheric concentrations
  - Remote sensing
  
- ◆ **Dynamic terrestrial biosphere model (CABLE)**
  
- ◆ **Model-data fusion** – an effective and efficient synthesis framework for integrating observations and models to:
  - Quantify the **state** of the system (e.g. carbon stores, fluxes)
  - Provide better **predictions**

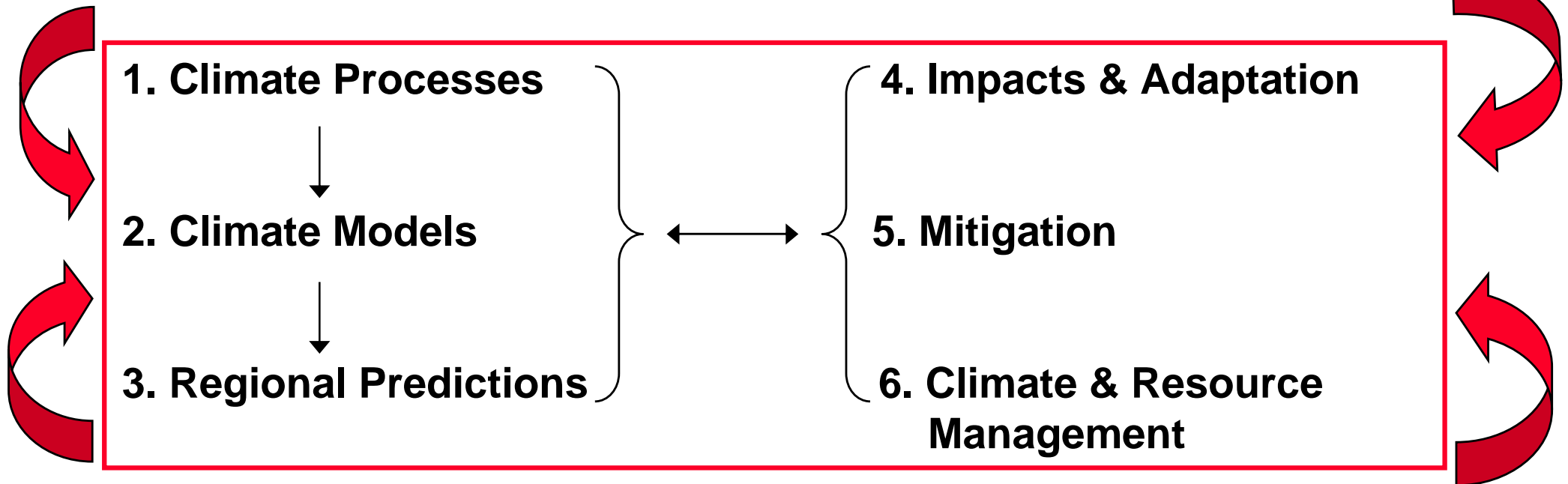
# An Integrated Earth Observing System

- remote sensing
- fluxes and atmospheric concentrations
- biosphere-climate model



Near real-time  
budgets of carbon,  
water, nutrients....

Improved predictions



Improved land surface  
and climate models

Monitoring and  
evaluation