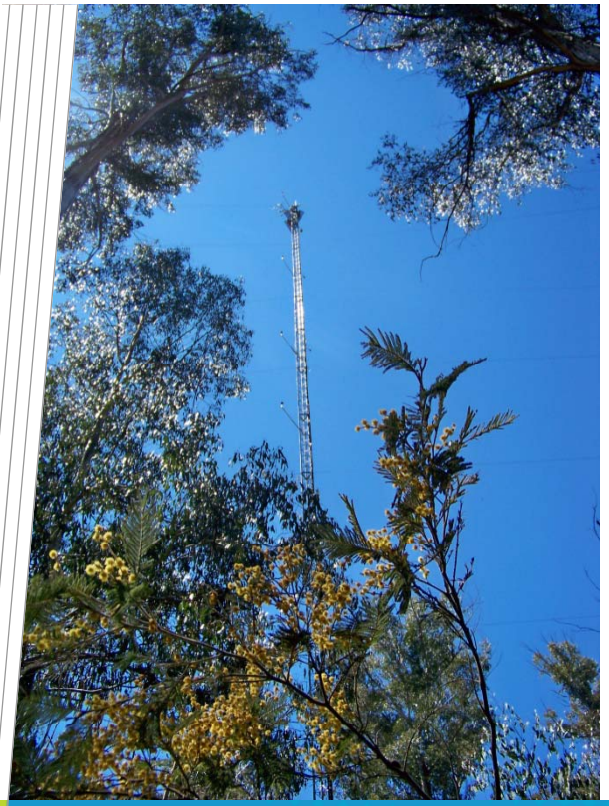

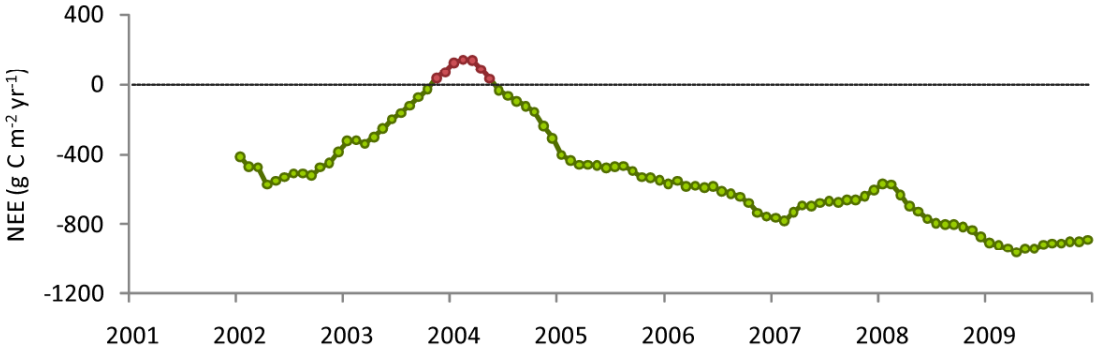

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What drives carbon exchange between a temperate sclerophyll forest and the atmosphere on time scales from hours to multiple years?

Eva van Gorsel (1), Heather Keith (2), Helen Cleugh (1), Vanessa Haverd (1), Ray Leuning (1)
(1) CSIRO Marine and Atmospheric Research, Canberra, Australia
(2) The Fenner School of Environment and Society, ANU, Canberra, Australia

April 4-8 2011

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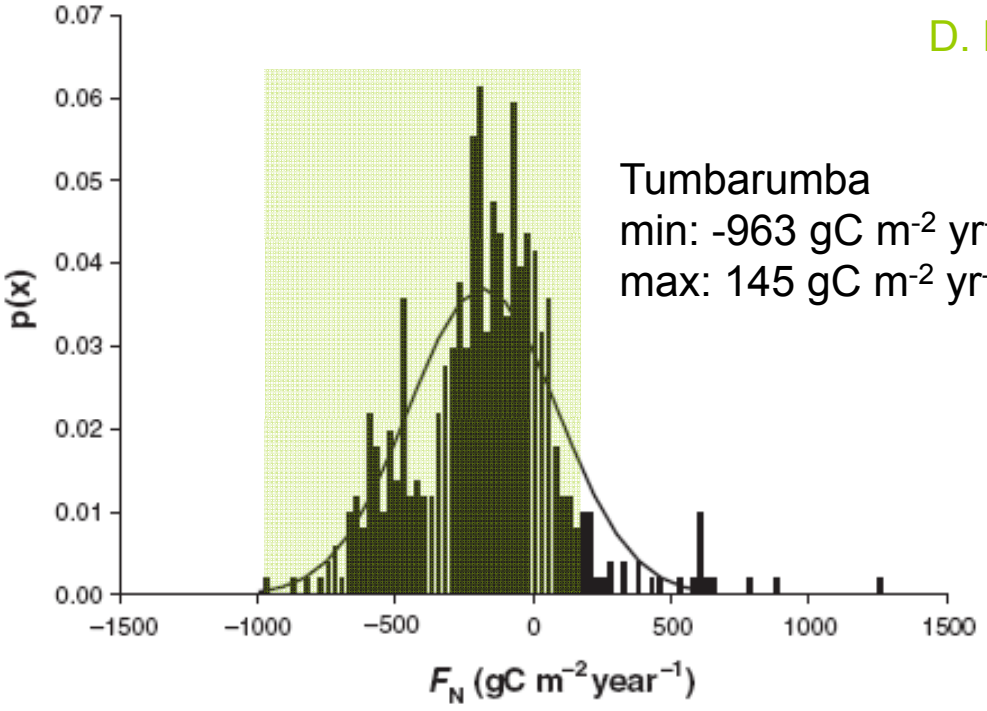
Variability of NEE, FLUXNET

D. Baldocchi, 2008, *Aust. J. of Botany*



Tumbarumba
min: -963 gC m^{-2} yr^{-1}
max: 145 gC m^{-2} yr^{-1}

Site and Topography

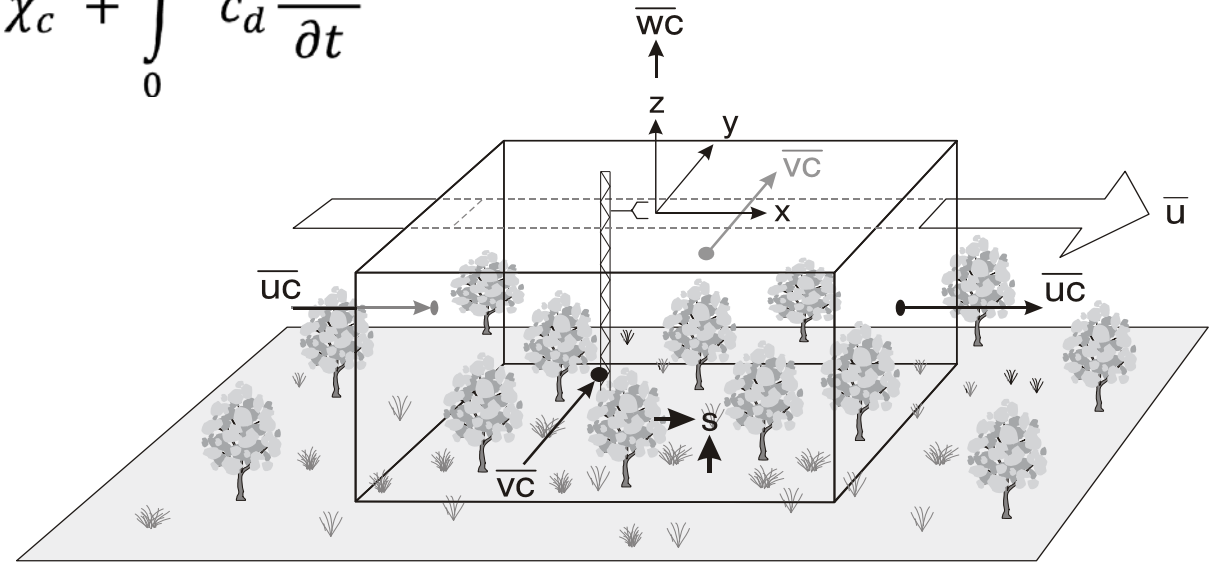
Site and Topography

- 40 m tall Eucalypt forest (evergreen, wet sclerophyll)
- L_{ai}~2.4
- Forest cover and species homogenous within radius > 5 km
- Shallow basin sloping towards N

Photographs : Dale Hughes

Mass conservation in CV around flux tower

$$NEE = \overline{c_d}\overline{w'\chi_c{}'} + \int_0^{z_{ref}} \overline{c_d}\frac{\overline{\partial \chi_c}}{\partial t}$$



To get to this (commonly used) equation we have:

- Transformed the co-ordinate system
- Assumed horizontal homogeneity of the site
- Neglected horizontal eddy flux divergence
- Employed the ergodic hypothesis
- Assumed steady state

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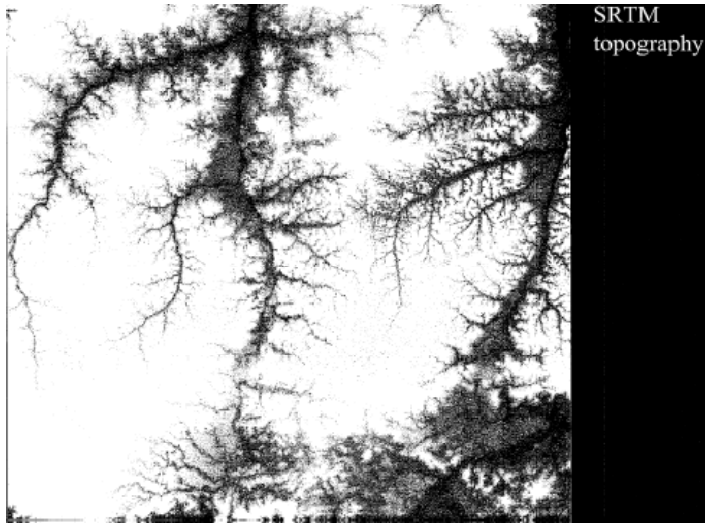
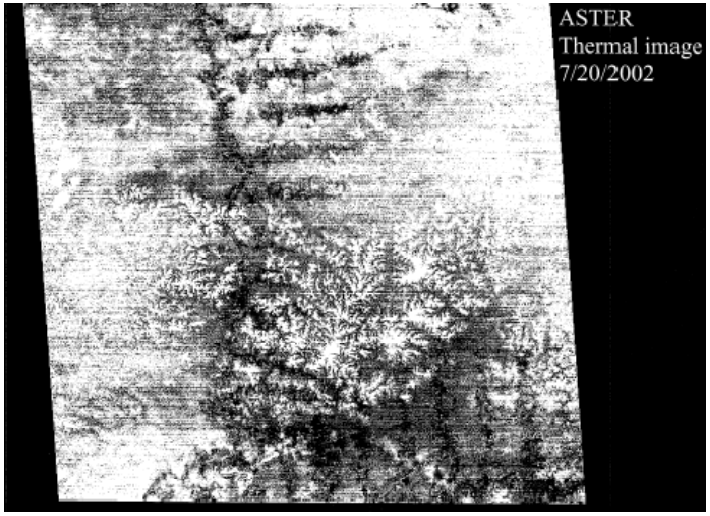
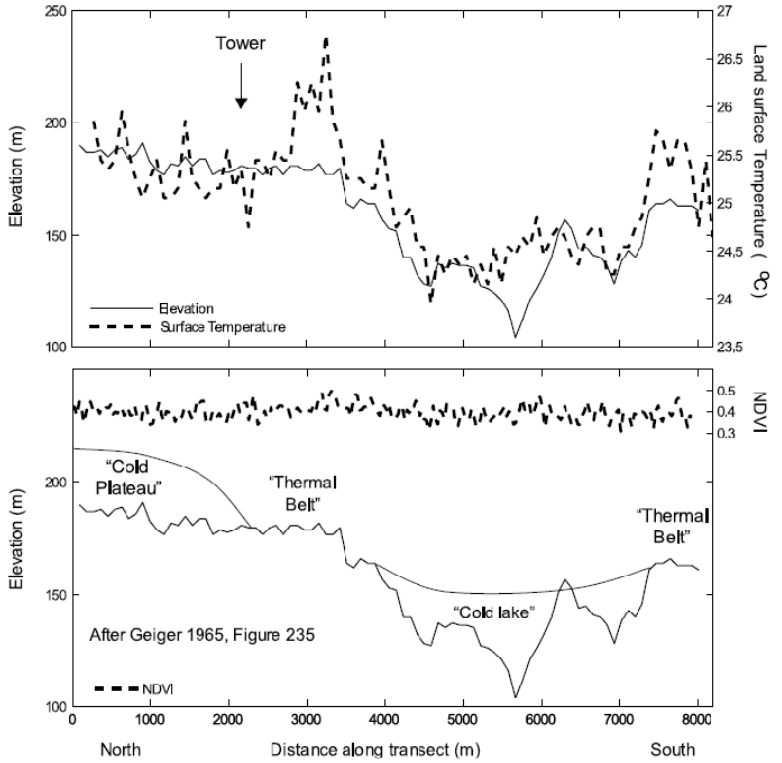
Nocturnal Flow Cold air drainage





M. Goulden et al., 2006



Santarem LBA site. Valleys in topographic map coincide with cold areas in ASTER thermal image suggesting cold air drainage. Similar corroborating evidence exists from many sites – including Tumbarumba (van Gorsel, 2006, 2007 and 2008).

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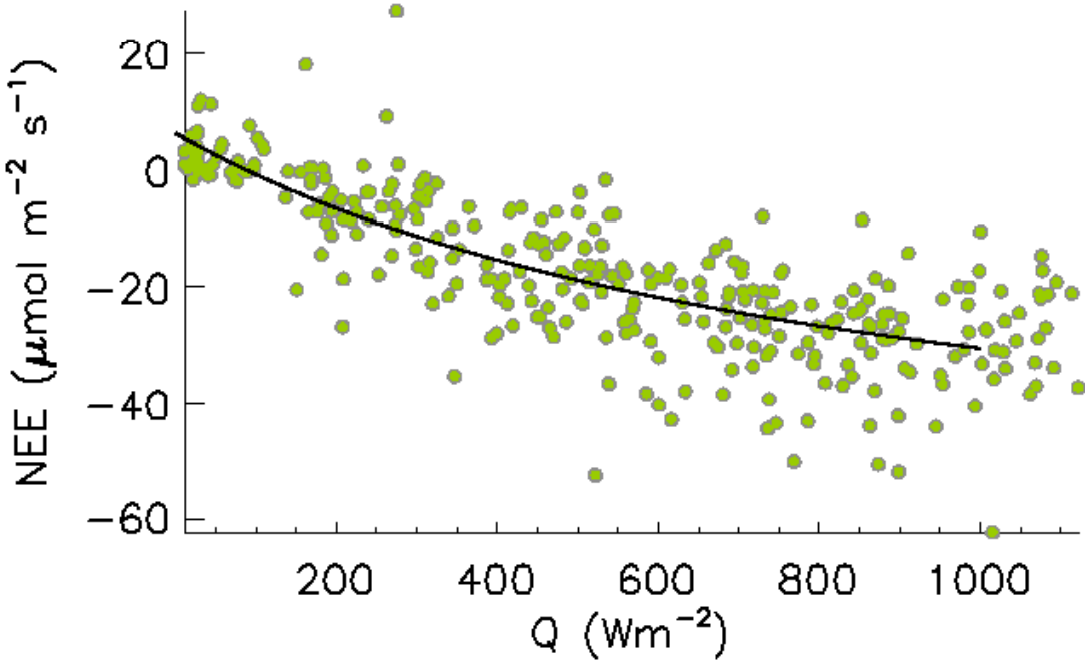
Modelling NEE

hyperbolic light-response curve (Michaelis-Menten)

$$NEE = \frac{\alpha\beta Q}{\alpha Q + \beta} + \gamma$$



α canopy light utilization efficiency (umol C J^{-1})

β maximum CO2 uptake rate of canopy at light saturation (umol C m^{-2} s^{-1})

γ terrestrial ecosystem respiration (umol C m^{-2} s^{-1})

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Modelling NEE

include temperature dependence of respiration

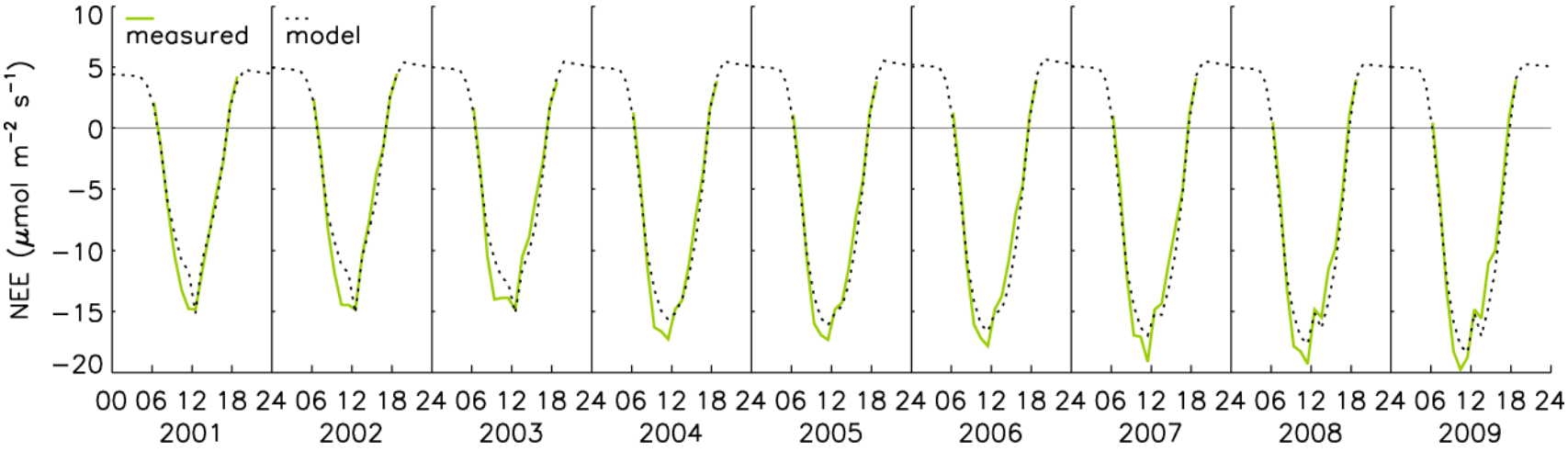
$$NEE = \frac{\alpha\beta Q}{\alpha Q + \beta} + \delta \exp\left(\varepsilon T_s\right)$$

include dependence on vapour pressure deficit (VPD)

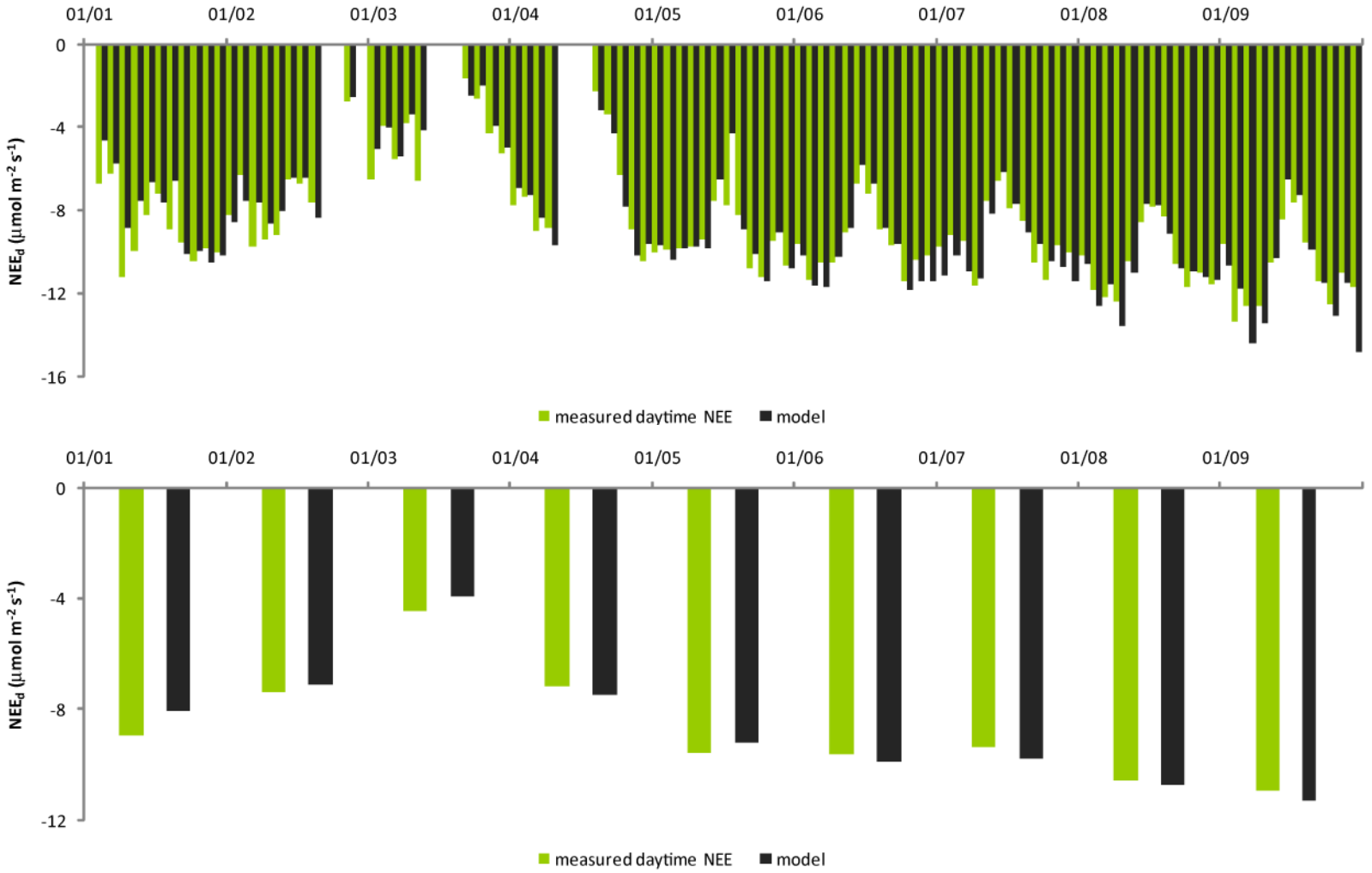
$$\beta = \begin{cases} \beta_0 \exp\left(-k(VPD - VPD_0)\right) & ; \quad VPD > 10\ hPa \\ \beta_0 & ; \quad VPD < 10\ hPa \end{cases}$$

30 day moving window

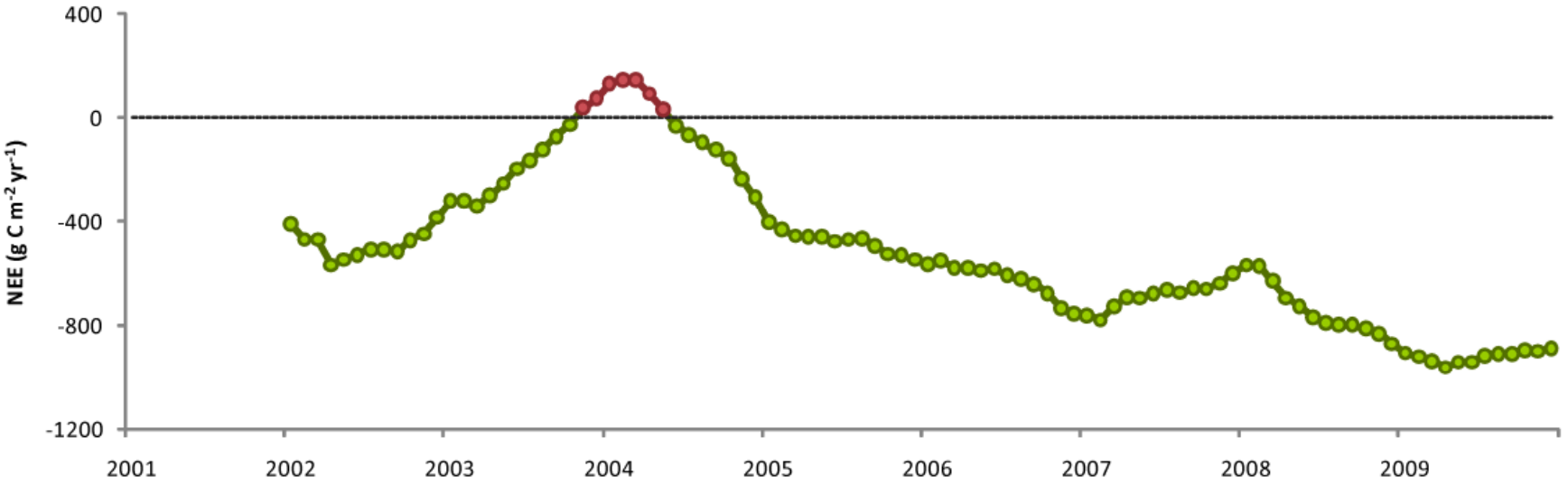
Model Results



Model Results



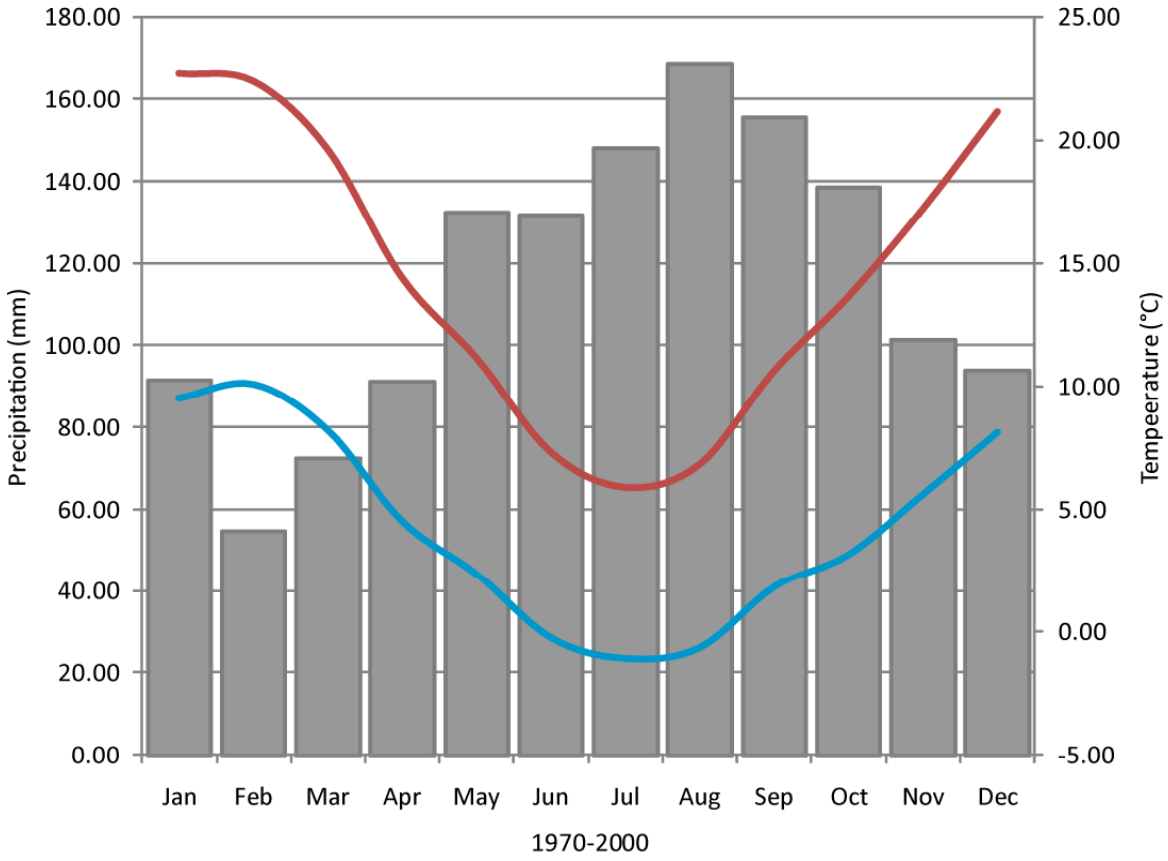
NEE at Bago State Forest (Tumbarumba)



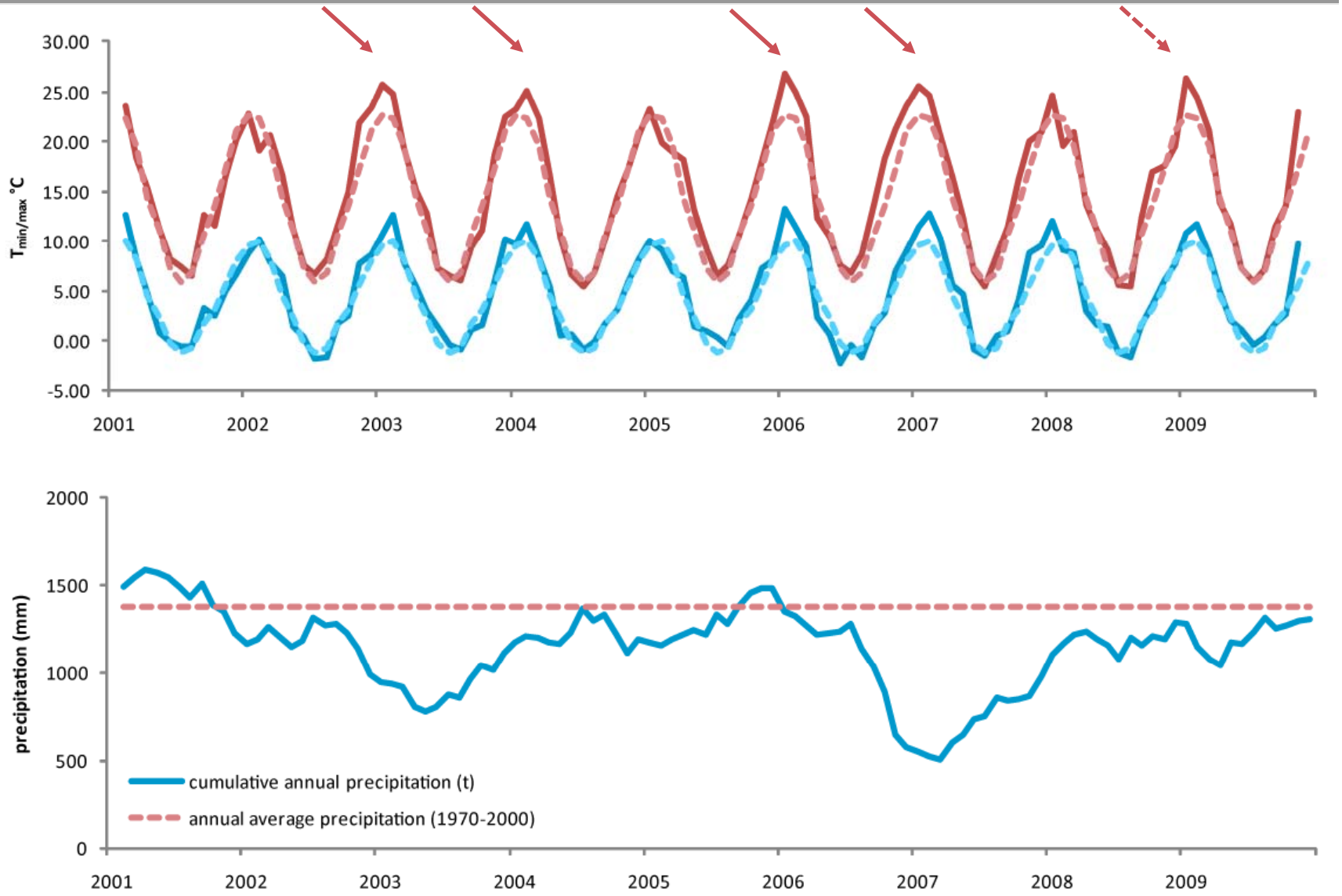
Climate at Bago State Forest (AWAP data)

1380 mm

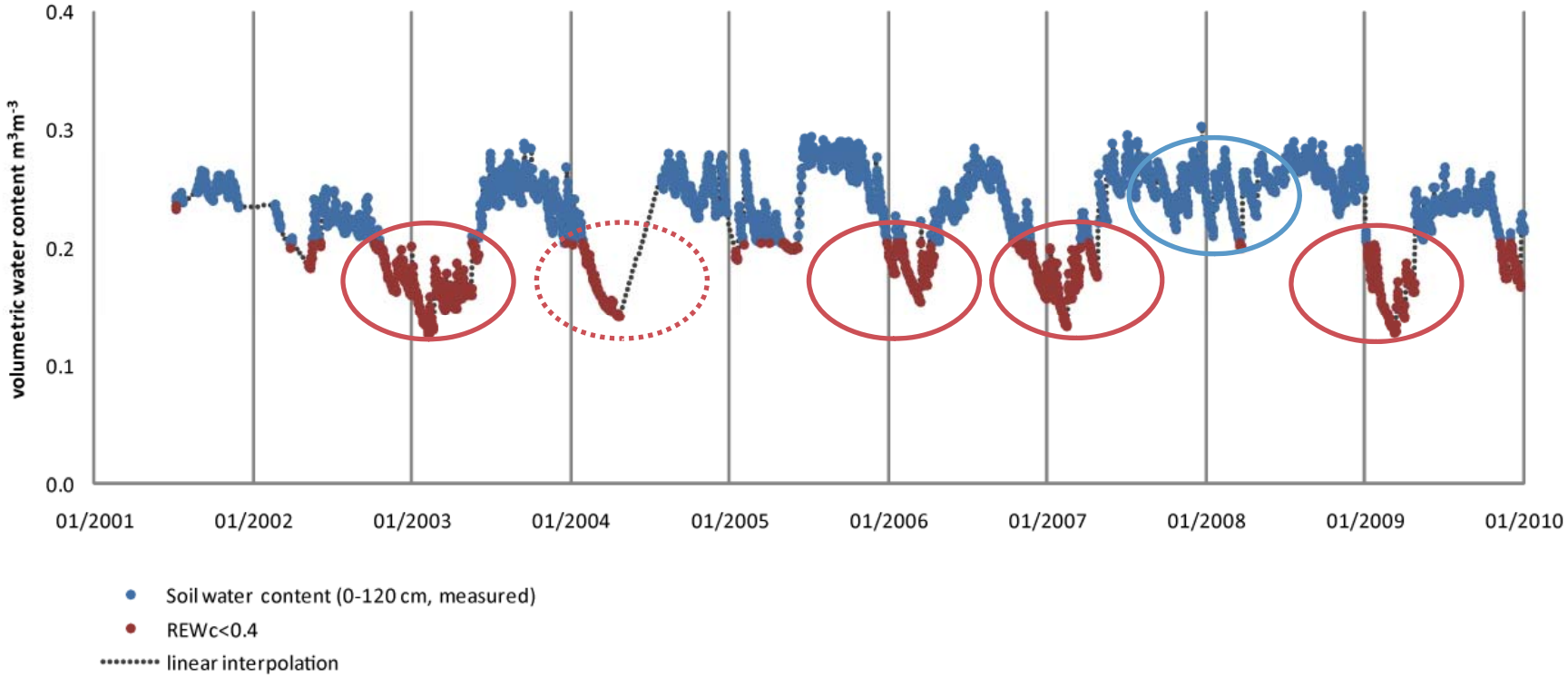
22.7 °C
-1.09 °C



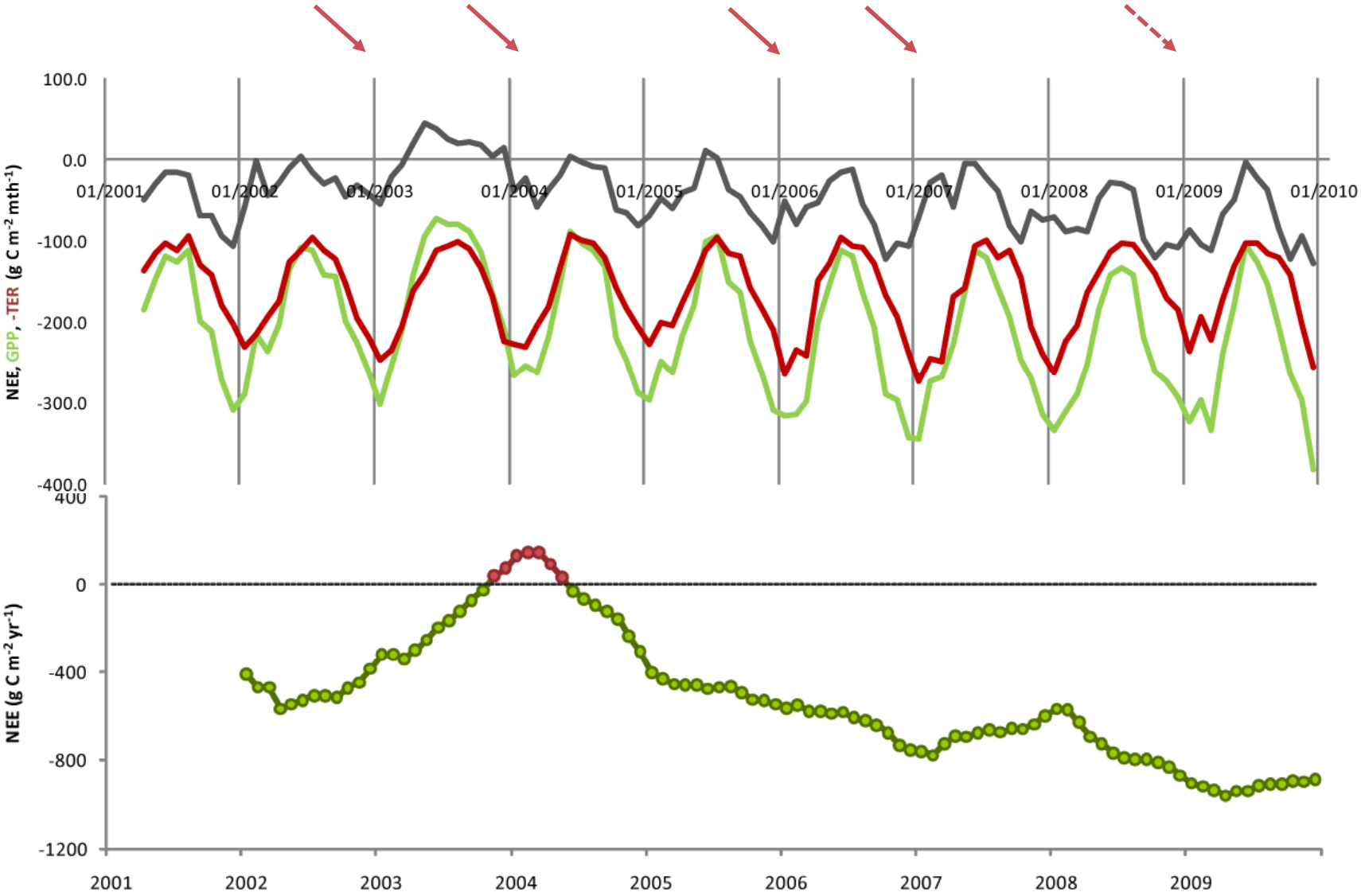
temperature / precipitation



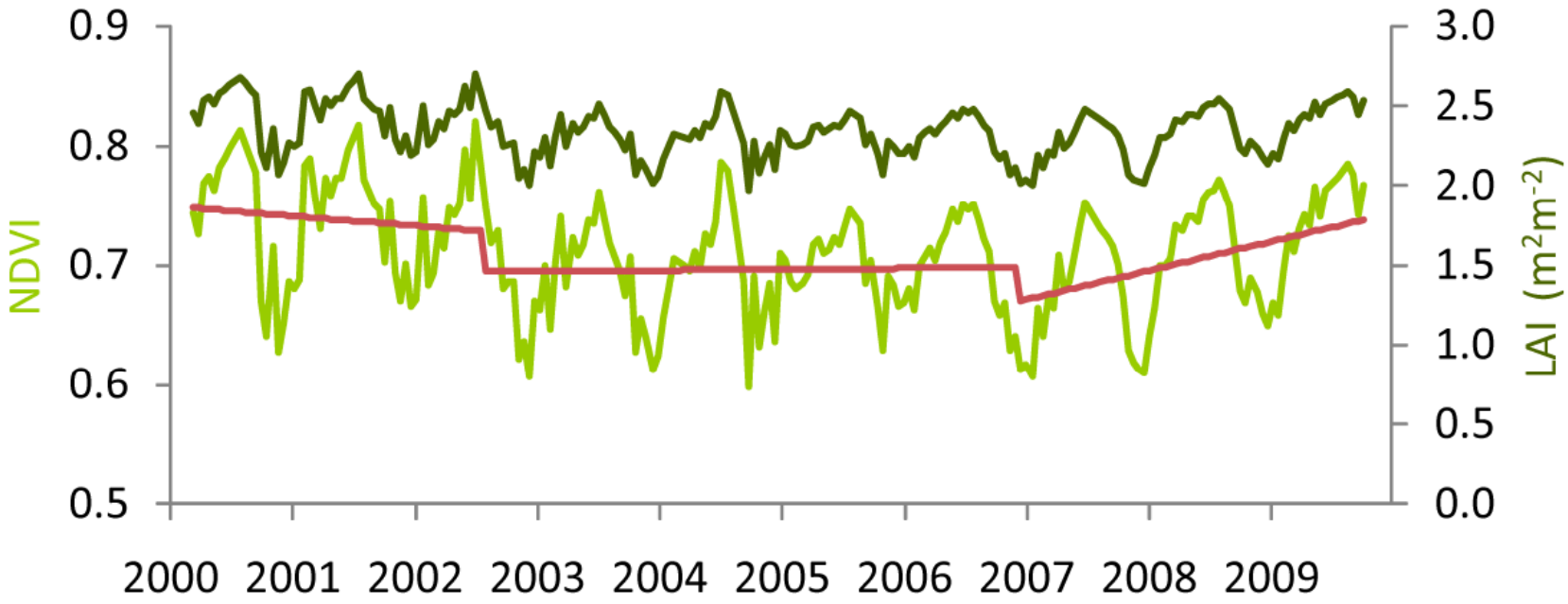
Soil water content and Relative Extractable Water



Soil water content and Relative Extractable Water

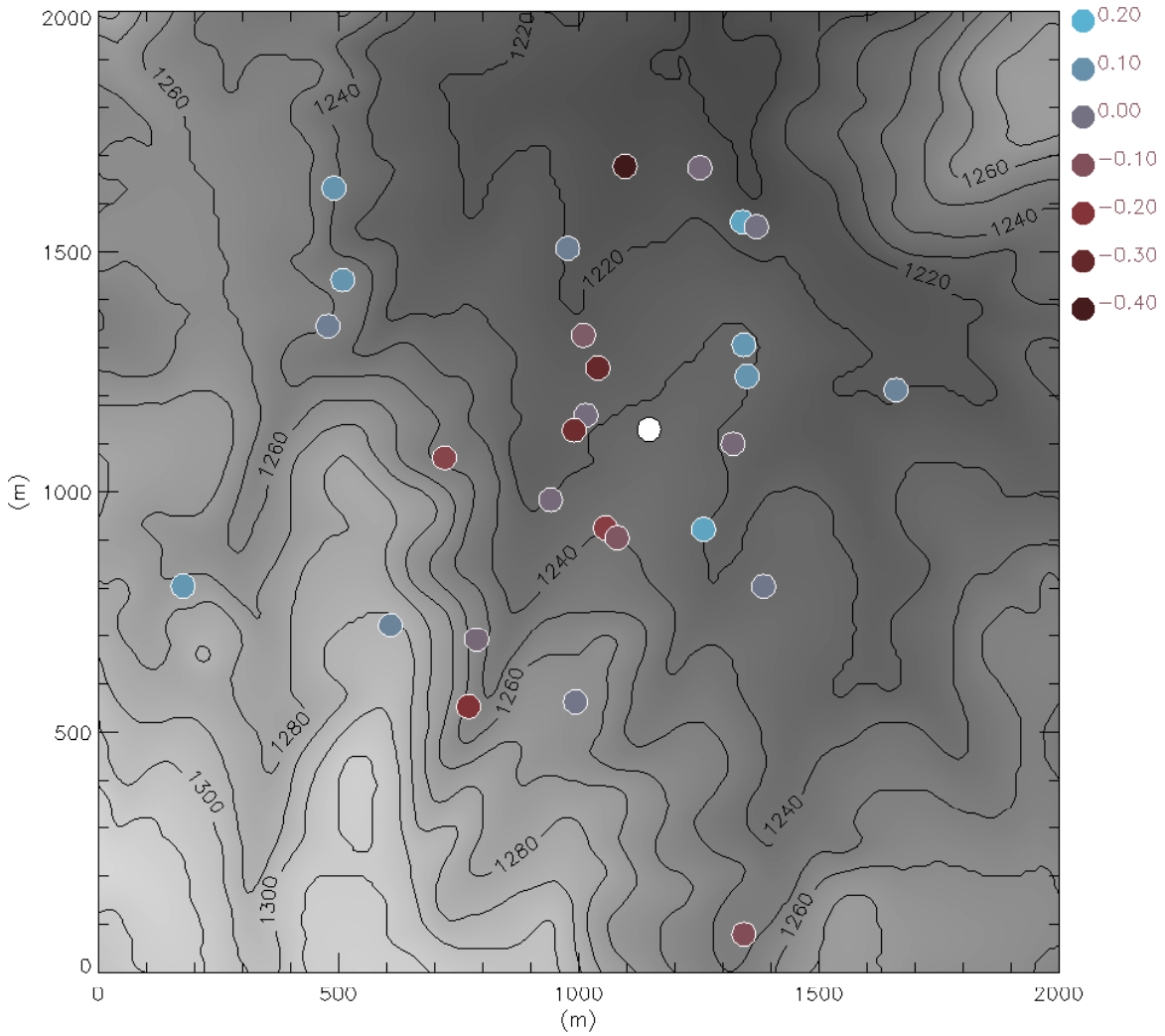


NDVI // LAI

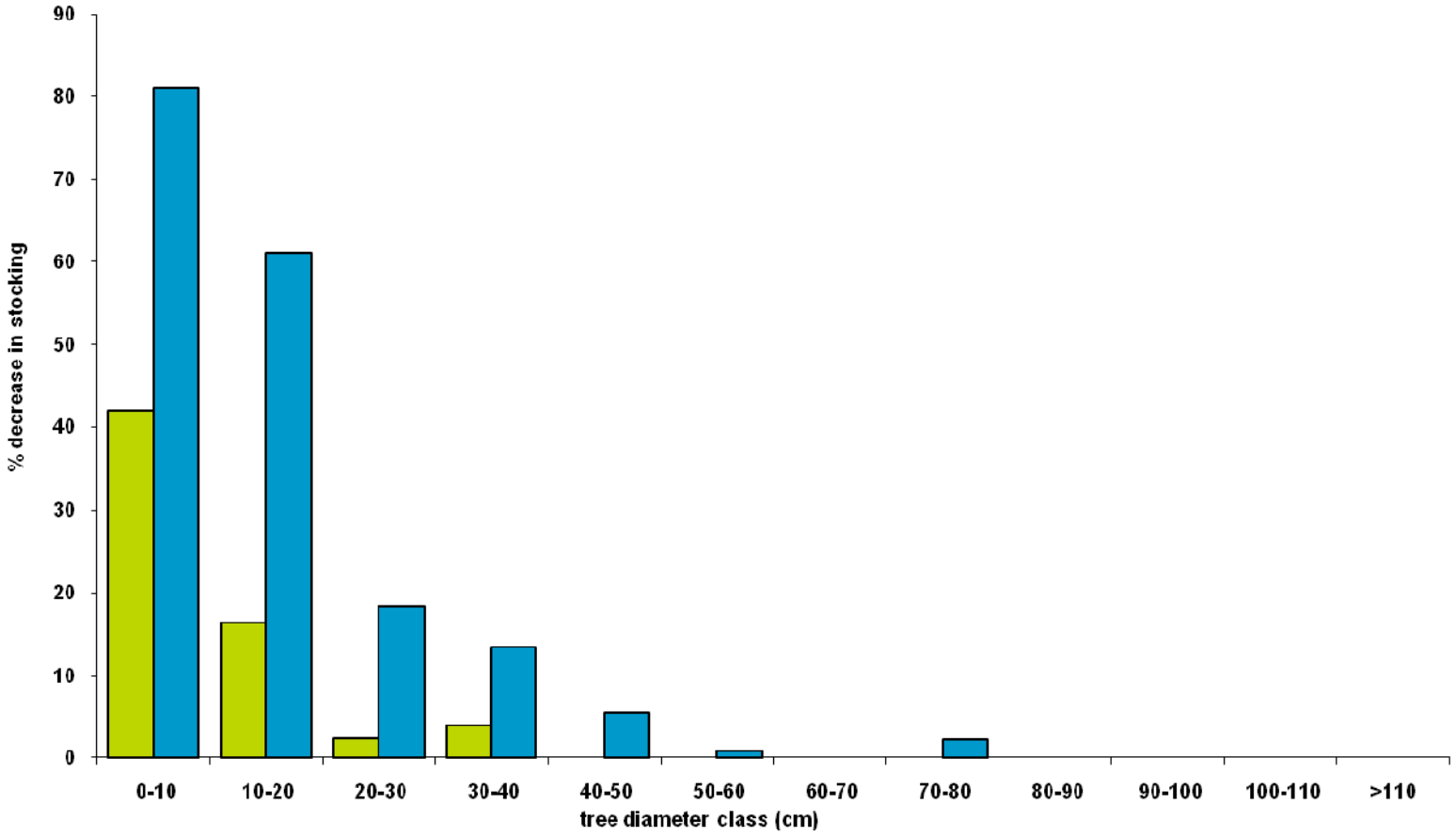


J. Verbesselt et al., 2010, *Forest Ecol. Manag.*

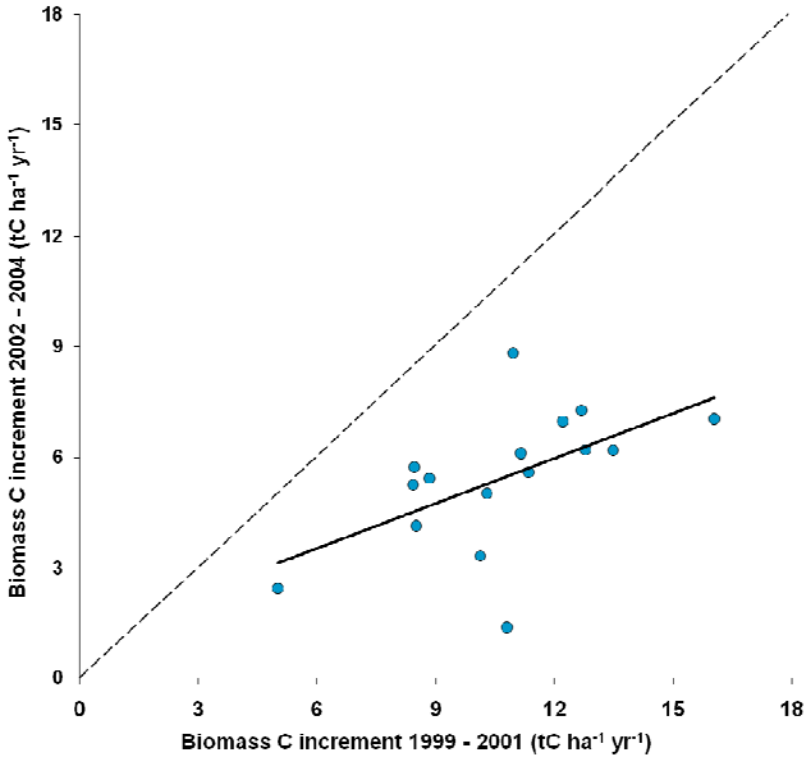
Changes in LAI 2002 to 2006



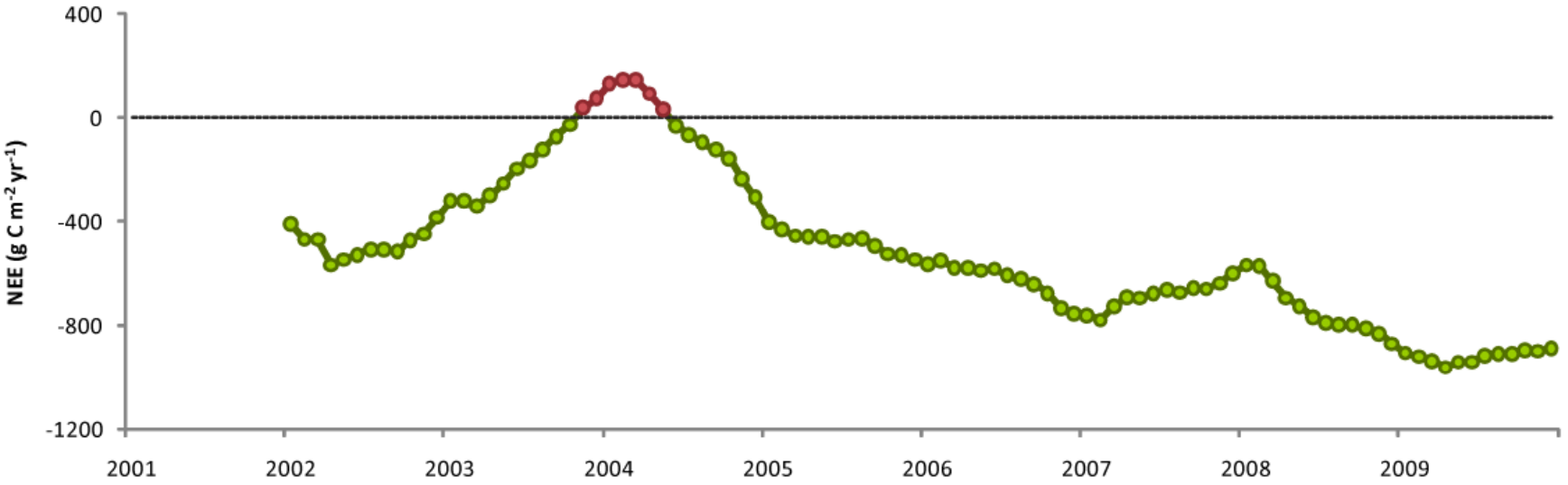
Mortality (1998 – 2001) and (2002-2005)



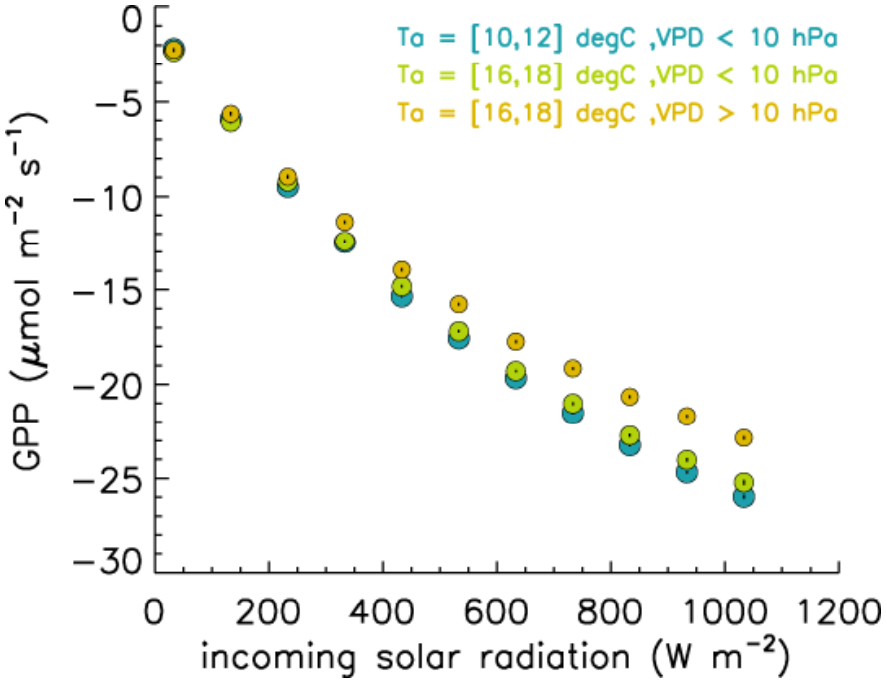
Biomass increment



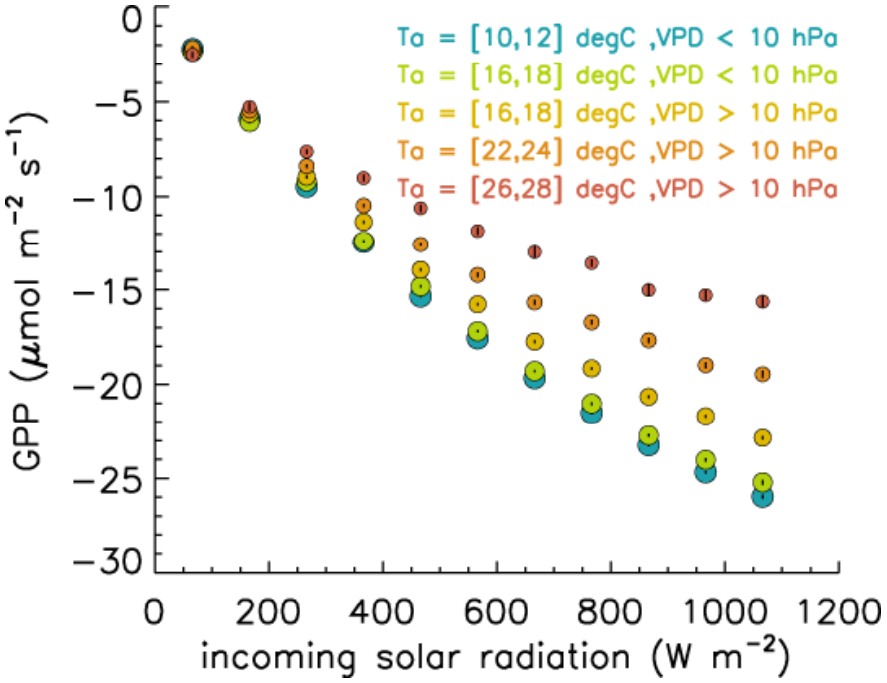
NEE at Bago State Forest (Tumbarumba)



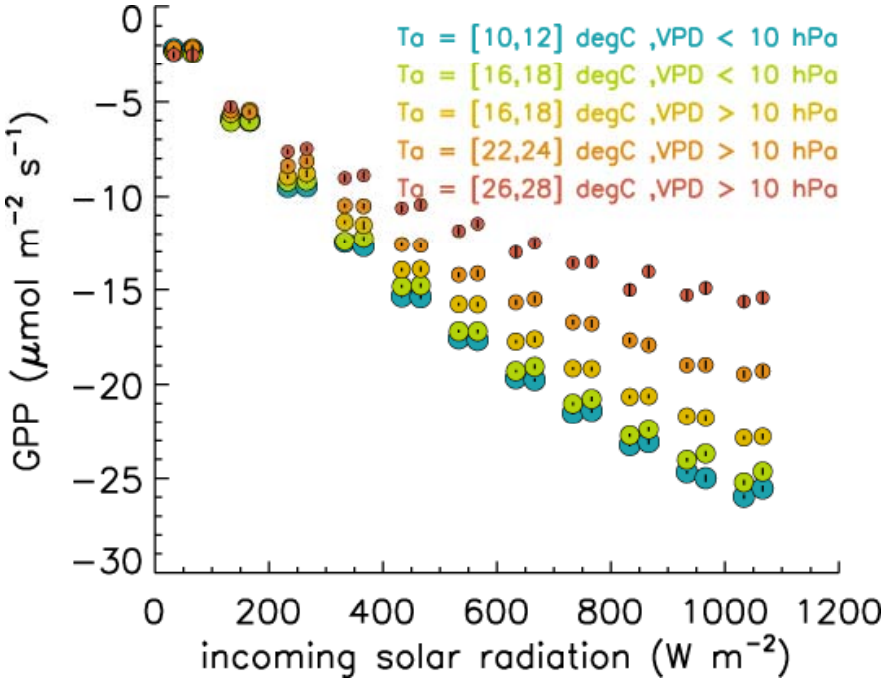
Ecosystem Assimilation 2001-2009



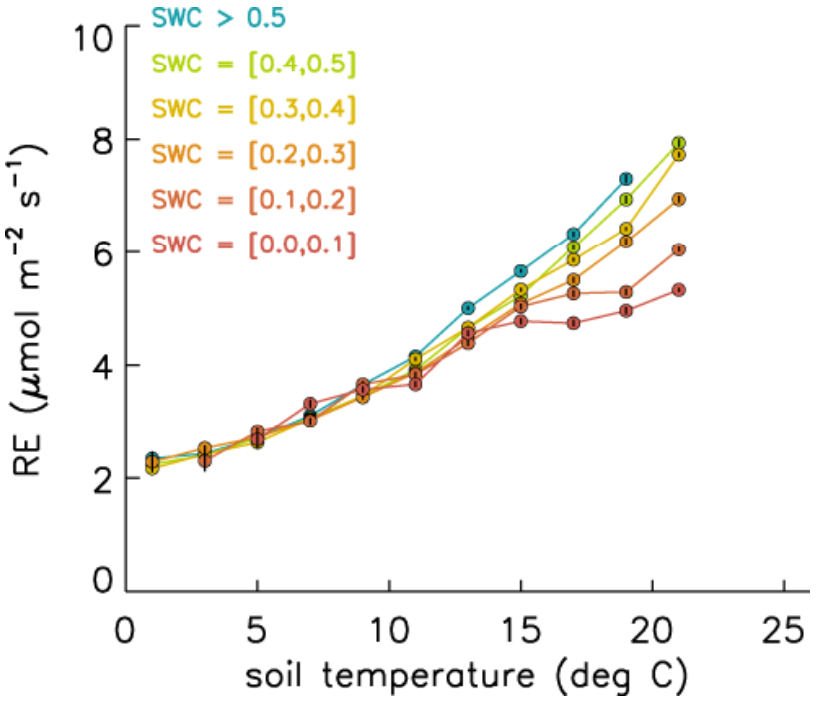
Ecosystem Assimilation 2001-2009



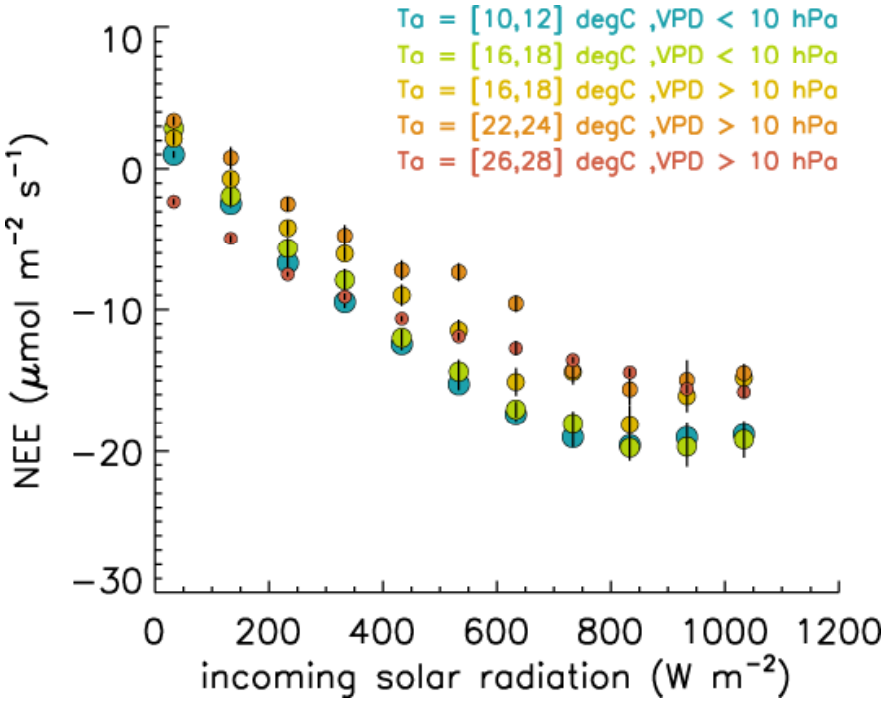
Ecosystem Assimilation 2001-2009



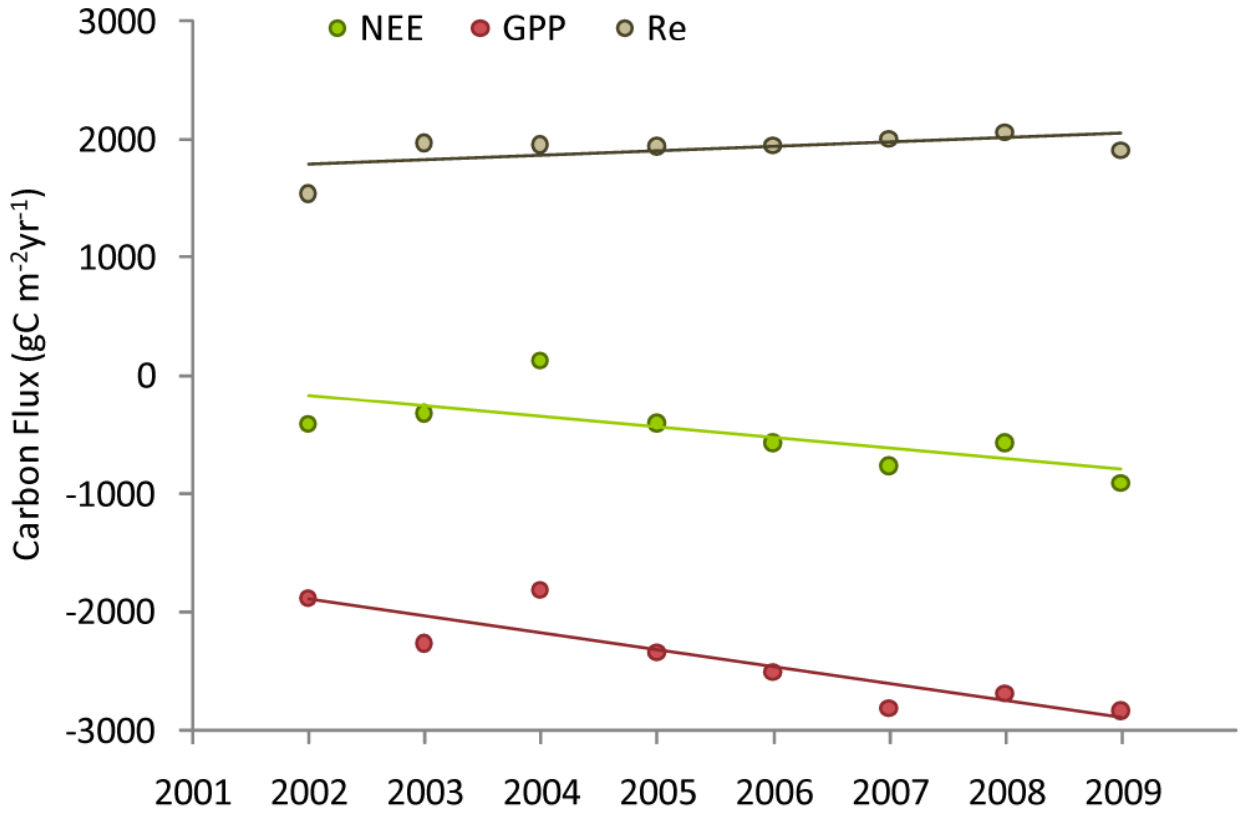
Ecosystem Respiration 2001-2009



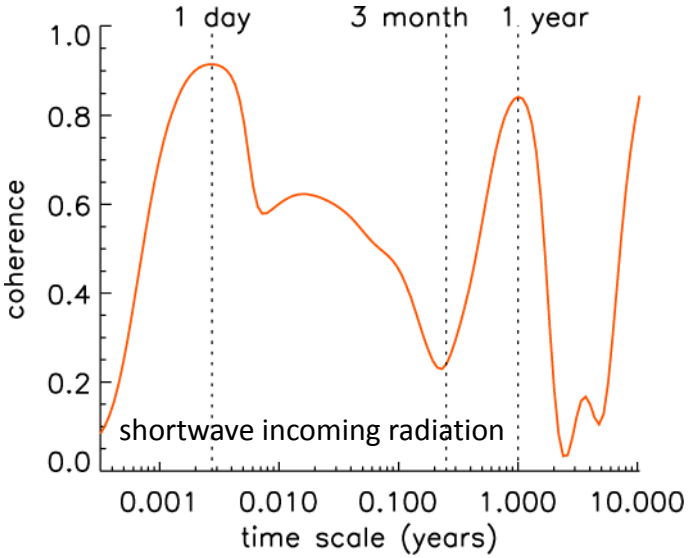
Daytime Net Ecosystem Exchange (measured) 2001-2009

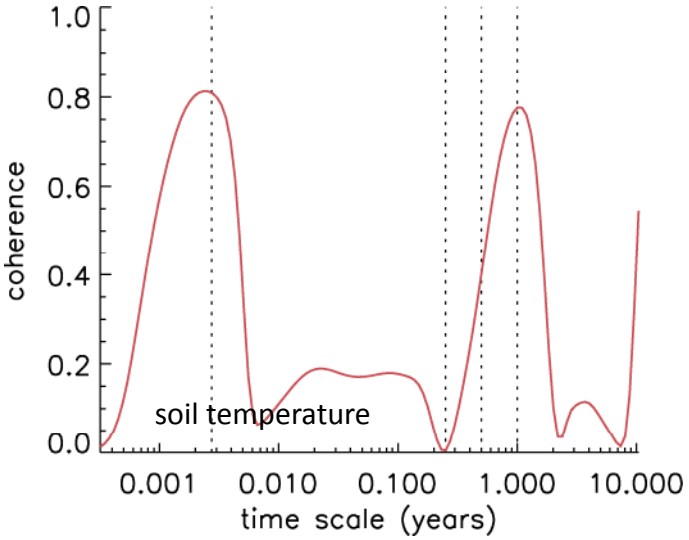


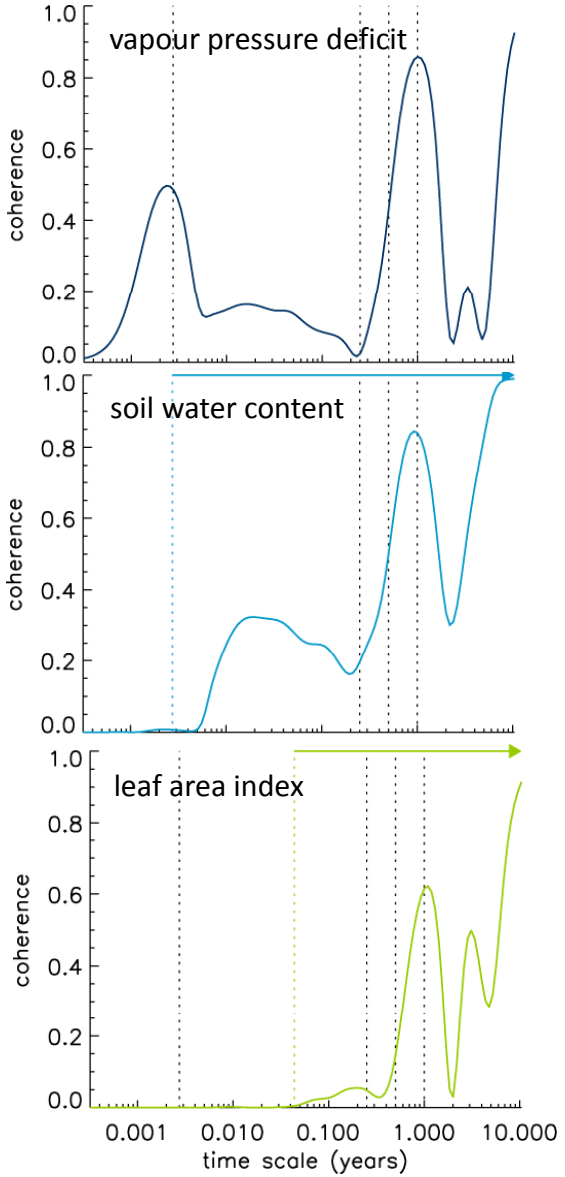
NEE, GPP and Re



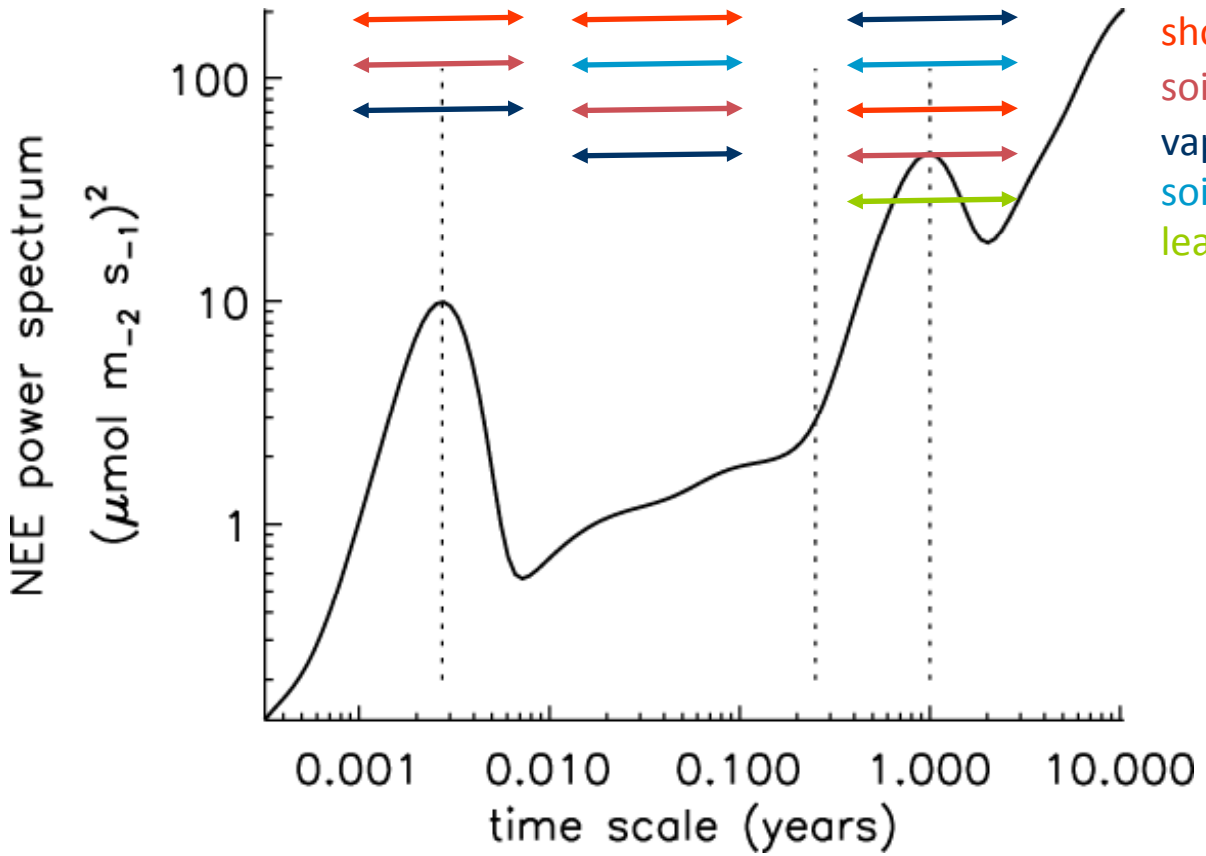
Drivers and Fluxes on time scales from days to years coherence spectra [2002-2009]







Drivers and Fluxes on time scales from days to years coherence spectra



shortwave incoming radiation
soil temperature
vapour pressure deficit
soil water content
leaf area index

Conclusions / Summary

Highly dynamic forest ecosystem

respond mainly to the meteorological drivers

- radiation and soil temperature on an hourly time scale
- radiation and SWC on a seasonal time scale
- VPD, SWC and radiation on an annual time scale
- LAI and SWC on a multi annual time scale

subject to stress caused by meteorological drivers

- drought (low soil moisture on TER / high VPD on GPP)
- Insects (as a result from antecedent weather conditions)

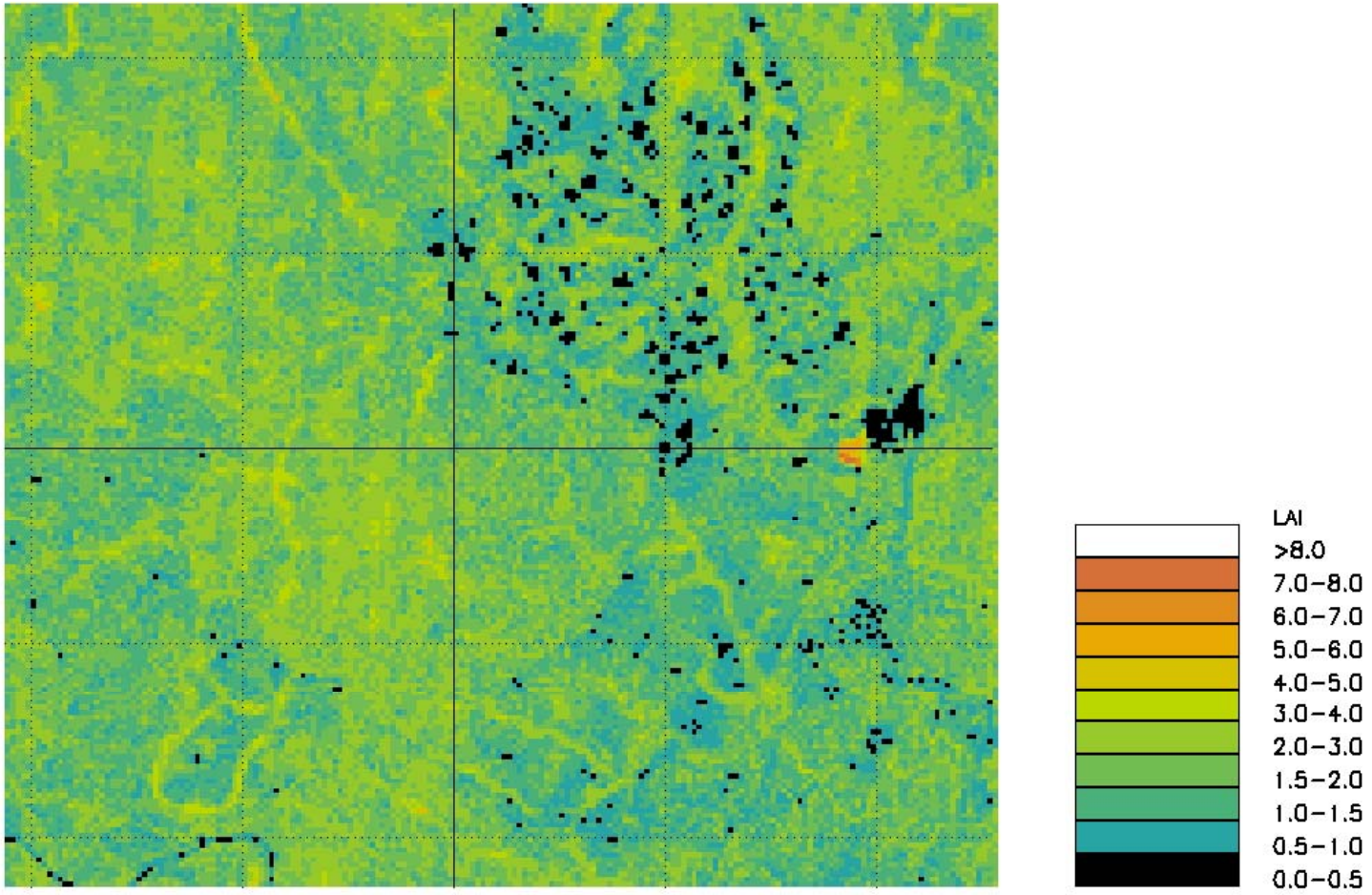
Conclusions / Summary

- the response to these combined stressors resulted in
- reduced leaf area
- reduced stomatal conductance and photosynthetic capacity
- loss of assimilate to insects
- reduced biomass increment
- increased mortality

effect of disturbance due to insects on GPP is greater than on TER
→ the carbon sink turned to a carbon source for several month

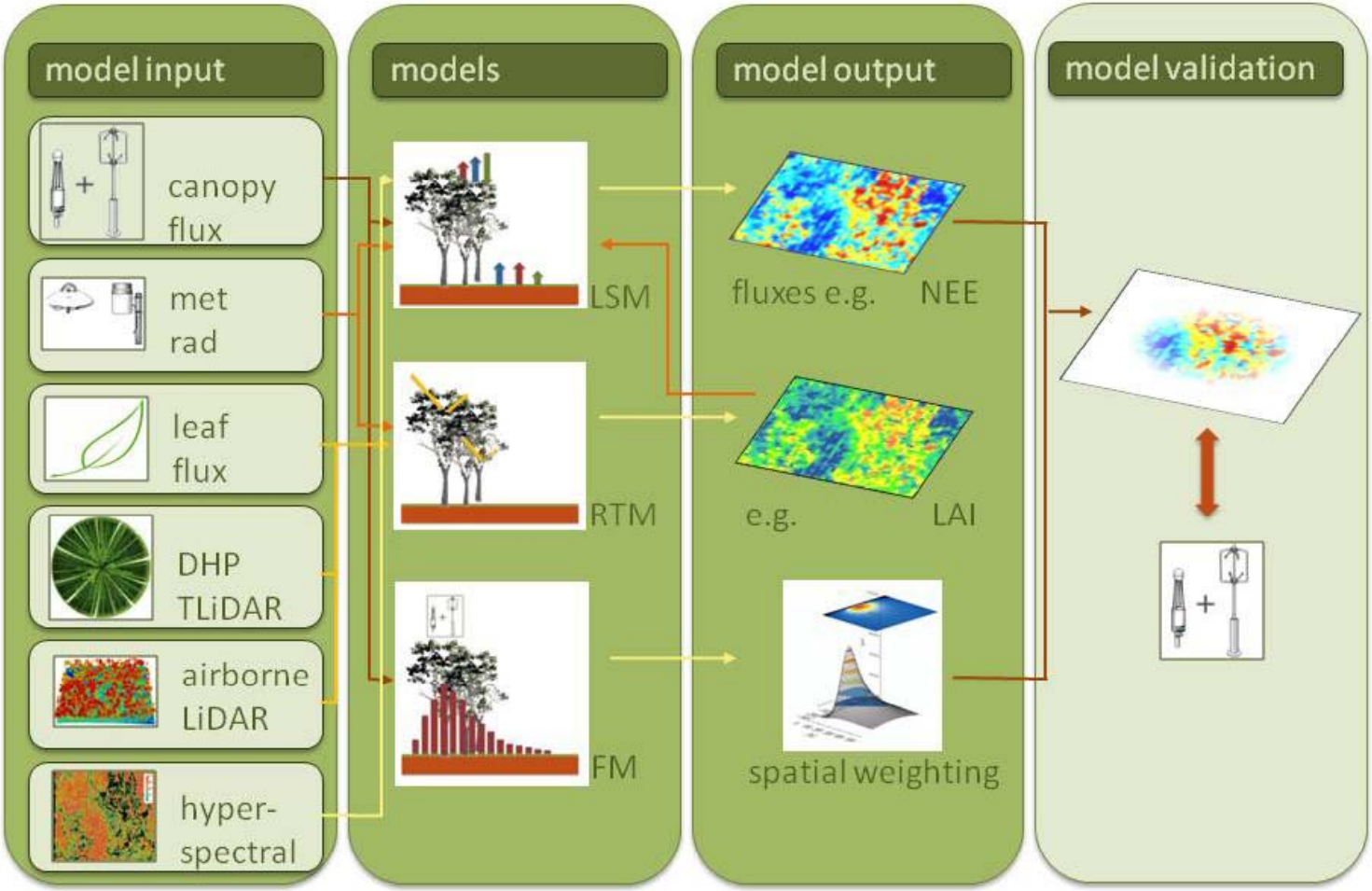
Outlook

effect of partial logging on fluxes?



Outlook

effect of partial logging on fluxes?



CSIRO Marine and Atmospheric Research
Eva van Gorsel

Email: eva.vangorsel@csiro.au
Web: www.cmar.csiro.au

Thank you

Contact Us
Phone: 1300 363 400 **or** +61 3 9545 2176
Email: enquiries@csiro.au **Web:** www.csiro.au