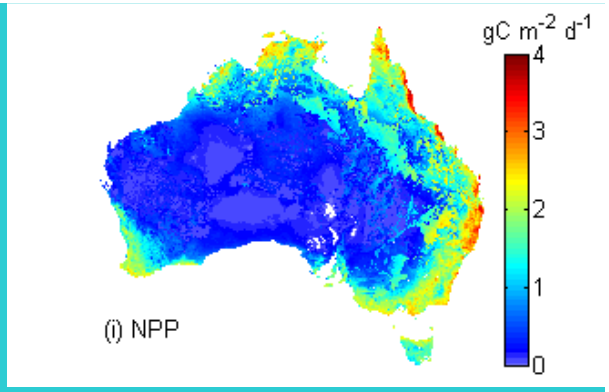

Multiple observation types reduce uncertainty in Australia's terrestrial carbon and water cycles.

Vanessa Haverd | Research Scientist

26 June 2012

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M.R. Raupach, P.R. Briggs, J.G. Canadell, P. Isaac, C. Pickett-Heaps, S.H. Roxburgh, E. van Gorsel, R. Viscarra Rossel, Z. Wang

BIOS2

- BIOS2 = CABLE-SLI-CASAcnp in AWAP operational framework

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

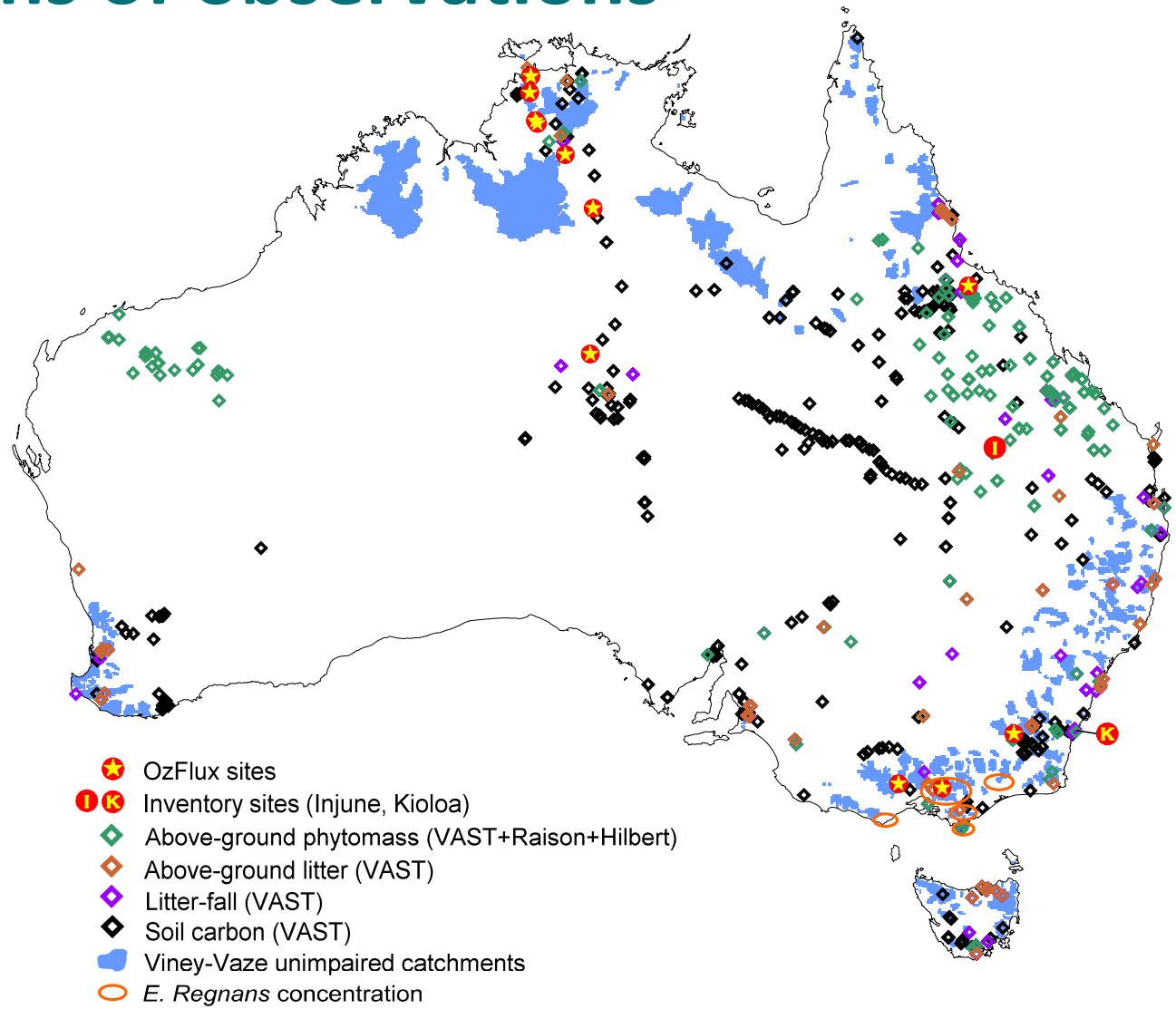
Continental processing framework

Model-Data Fusion

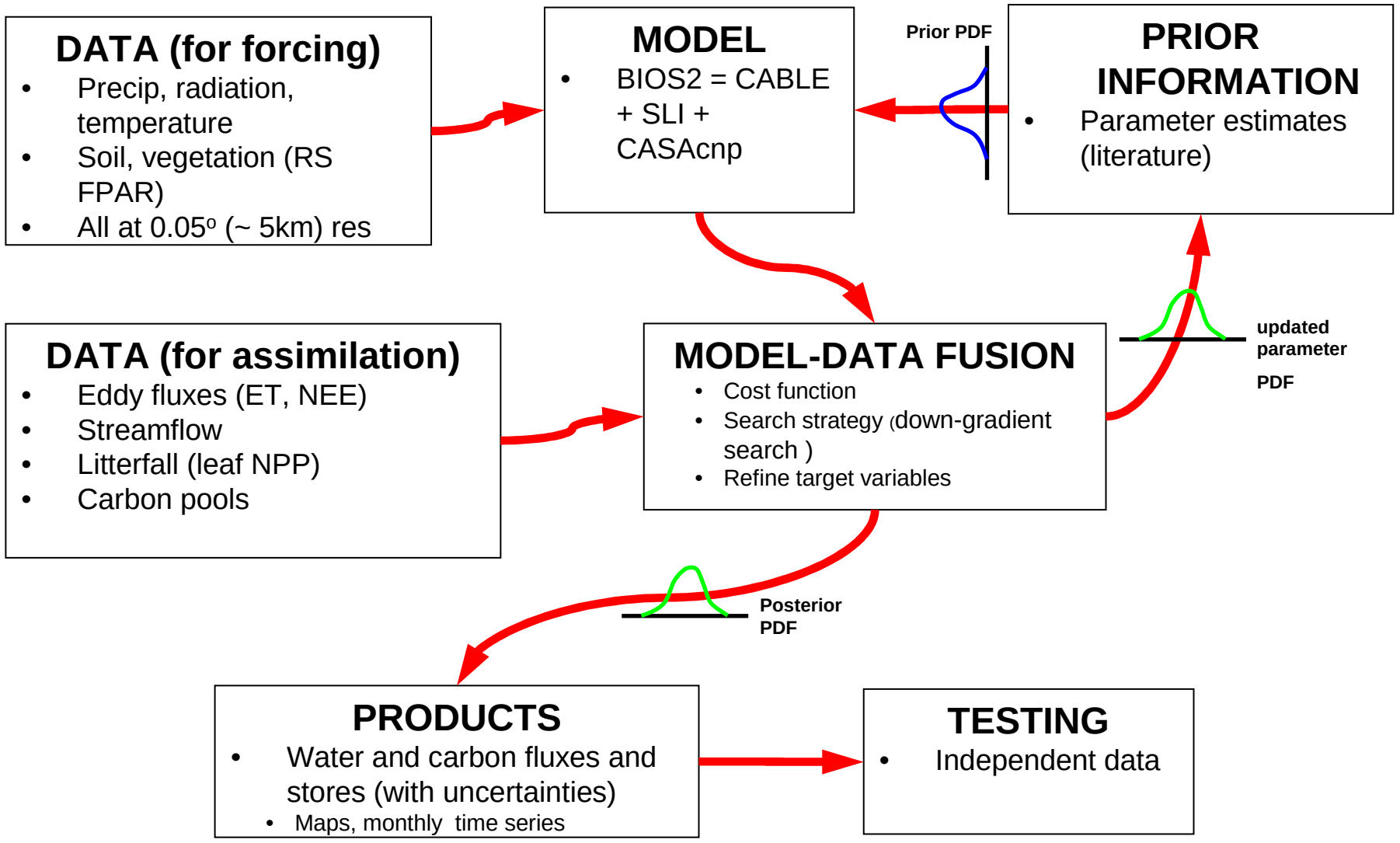
Raupach et al. (2009)

- Paper at submission stage
  - **Haverd, V., Raupach, M.R., Briggs, P.R., Canadell, J.G., Isaac, P., Pickett-Heaps, C., Roxburgh, S.H., van Gorsel, E., Viscarra-Rossel, R. and Wang Z. (2012) Multiple observation types reduce uncertainty in Australia's terrestrial carbon and water cycles. Biogeosciences (In preparation)**

Locations of observations



Model-data fusion

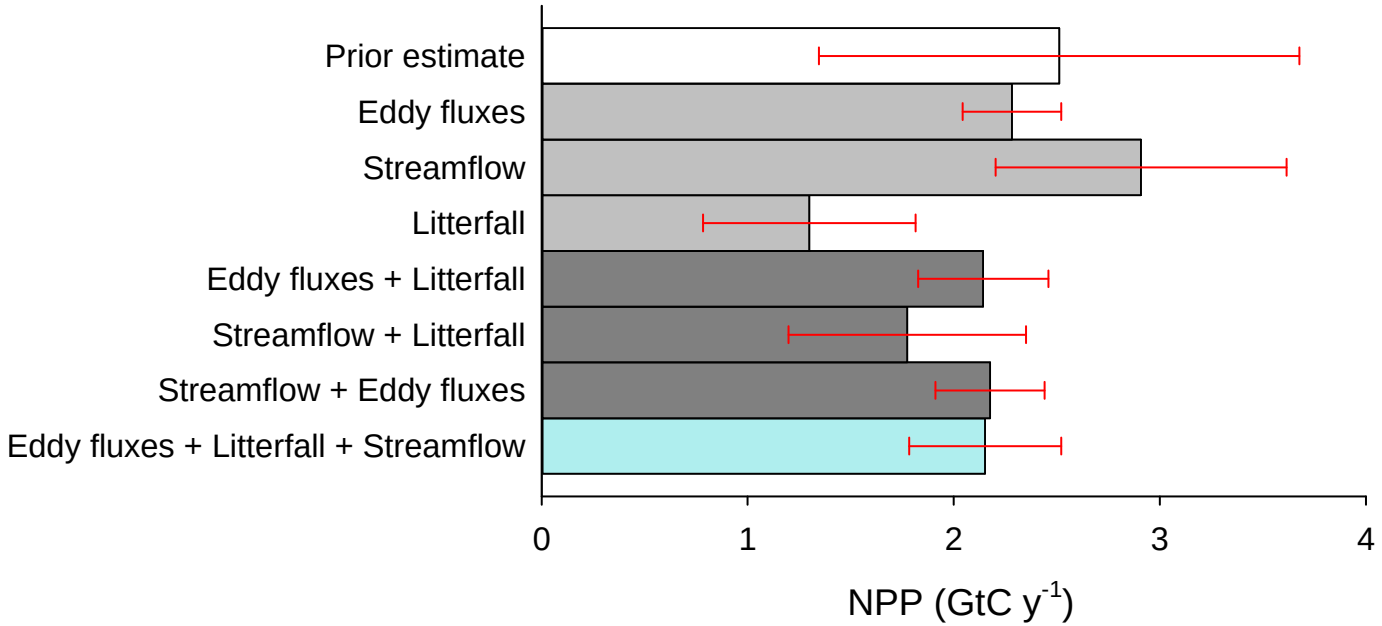


Mini-Australia

- Random stratified sample of 1000 grid cells out of 277,000 for Australia

Multiple constraints on Australian terrestrial Net Primary Production : Eddy flux data provide the tightest constraint

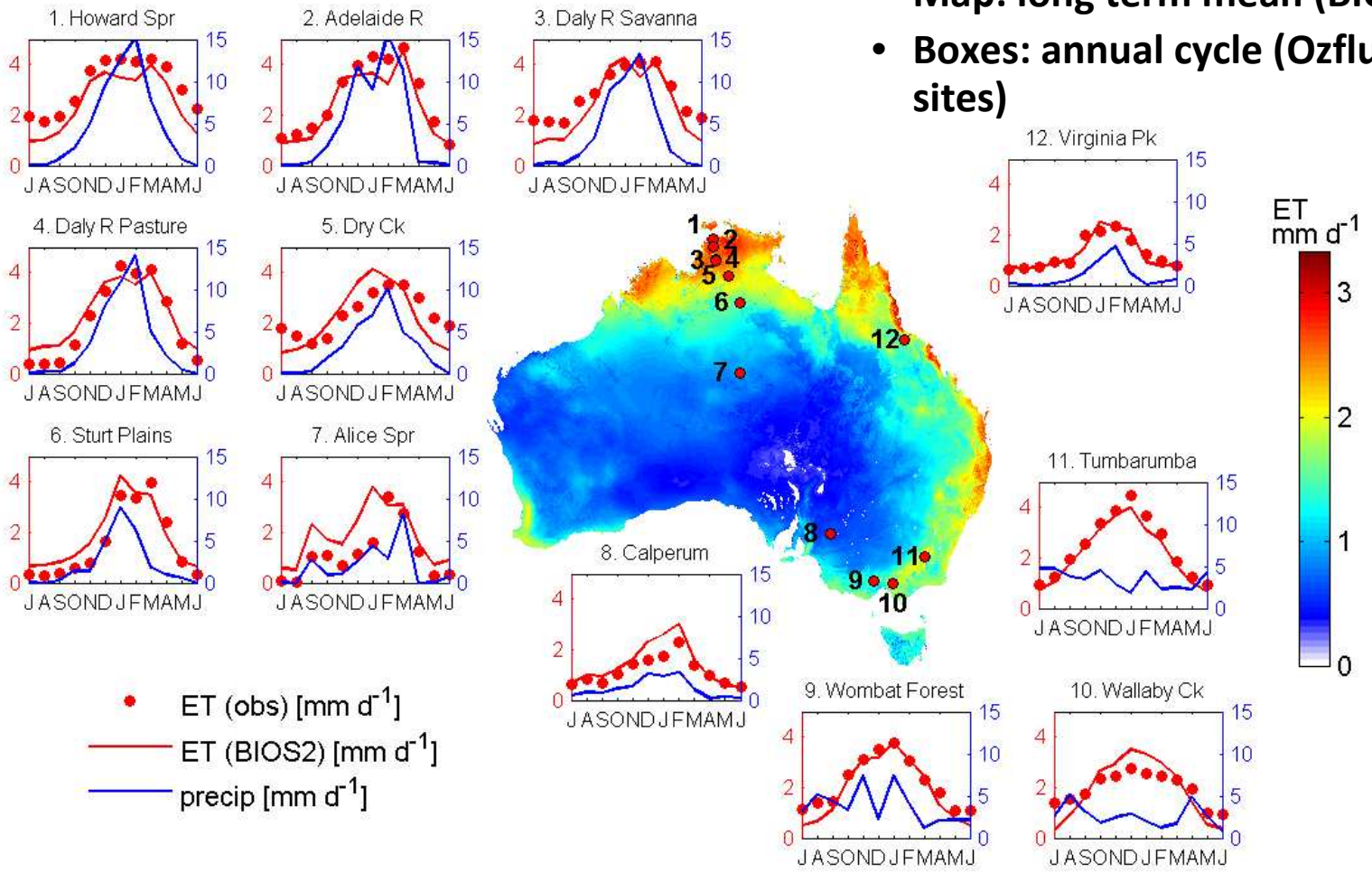
error bars = uncertainty from propagated parameter uncertatinties (1σ)



Haverd, V., Raupach, M.R., Briggs, P.R., Canadell, J.G., Isaac, P., Pickett-Heaps, C., Roxburgh, S.H., van Gorsel, E., Viscarra-Rossel, R. and Wang Z. (2012) Multiple observation types reduce uncertainty in Australia's terrestrial carbon and water cycles. Biogeosciences (In preparation)

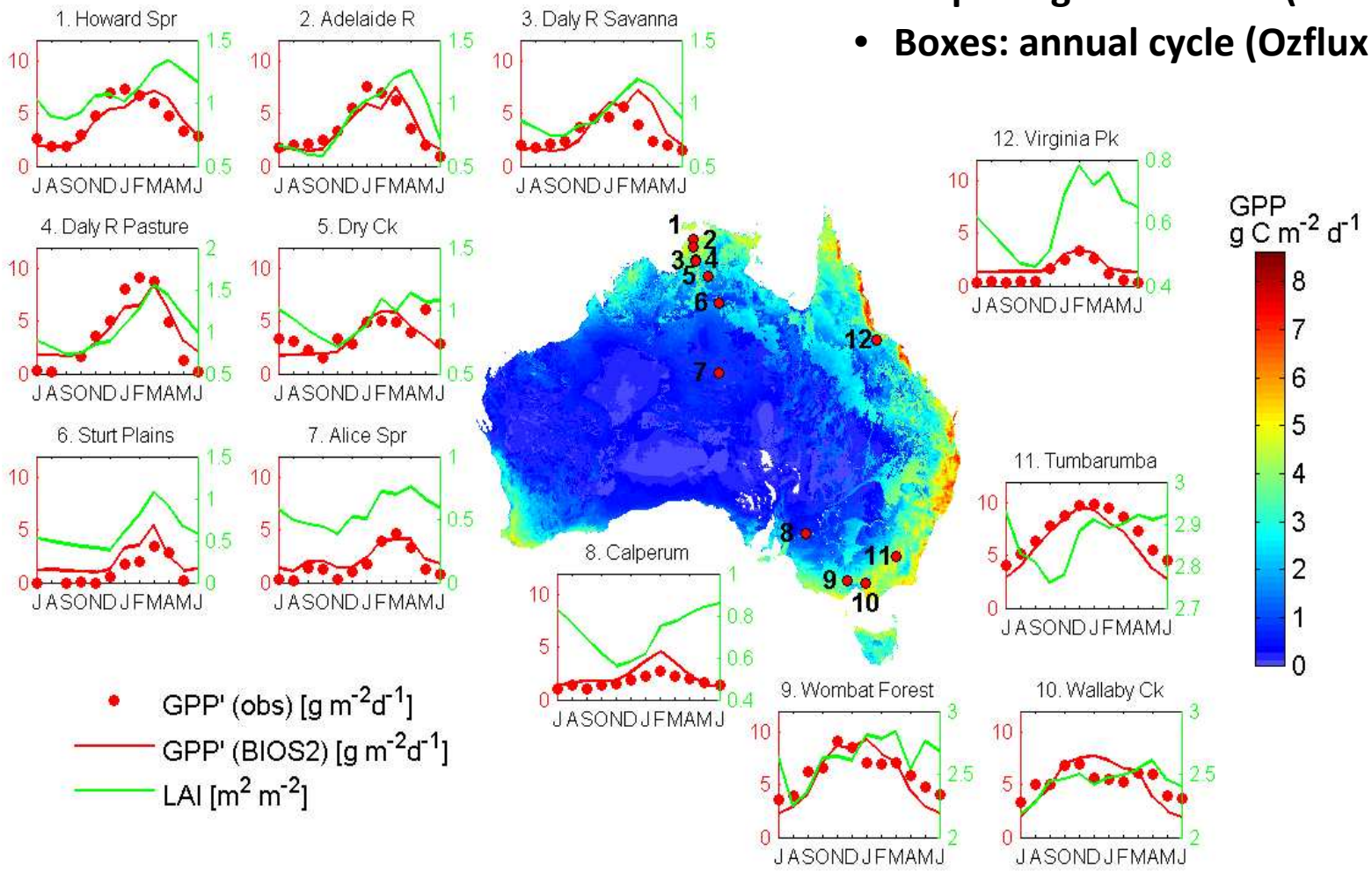
BIOS2 evaluation: **Evapotranspiration**

- **Map: long term mean (BIOS2)**
- **Boxes: annual cycle (Ozflux sites)**

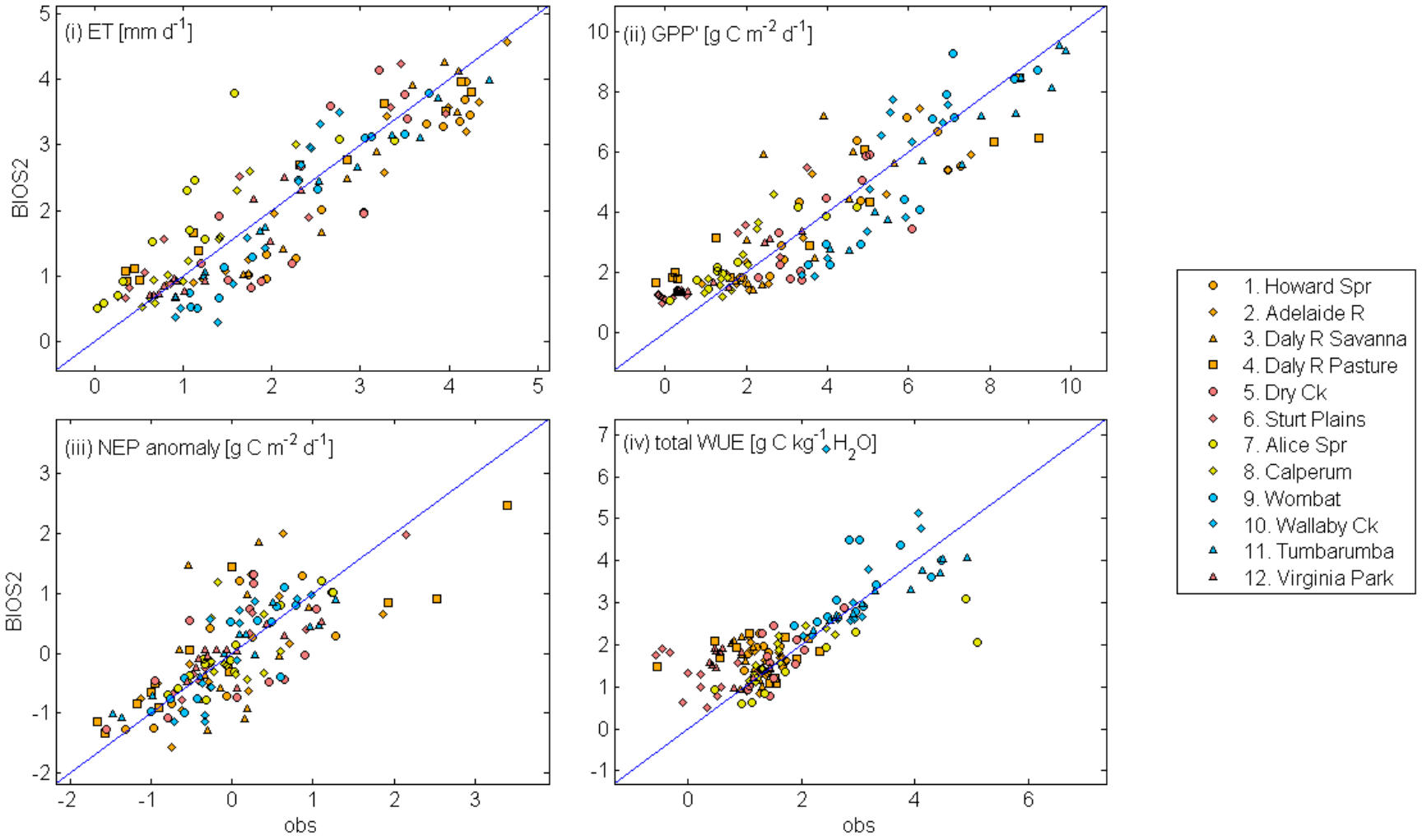


BIOS2 evaluation: **Gross Primary Production**

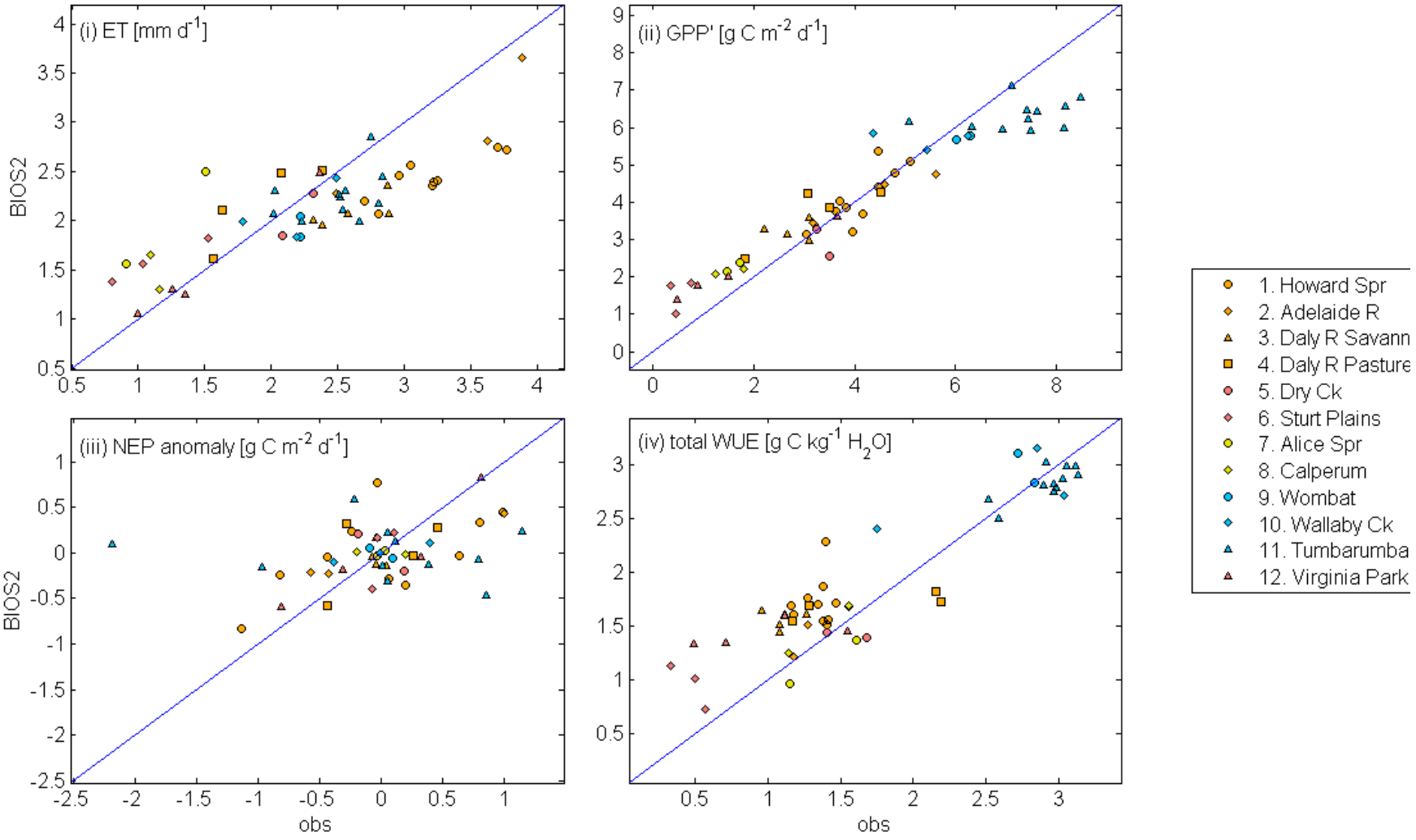
- **Map: long term mean (BIOS2)**
- **Boxes: annual cycle (Ozflux sites)**



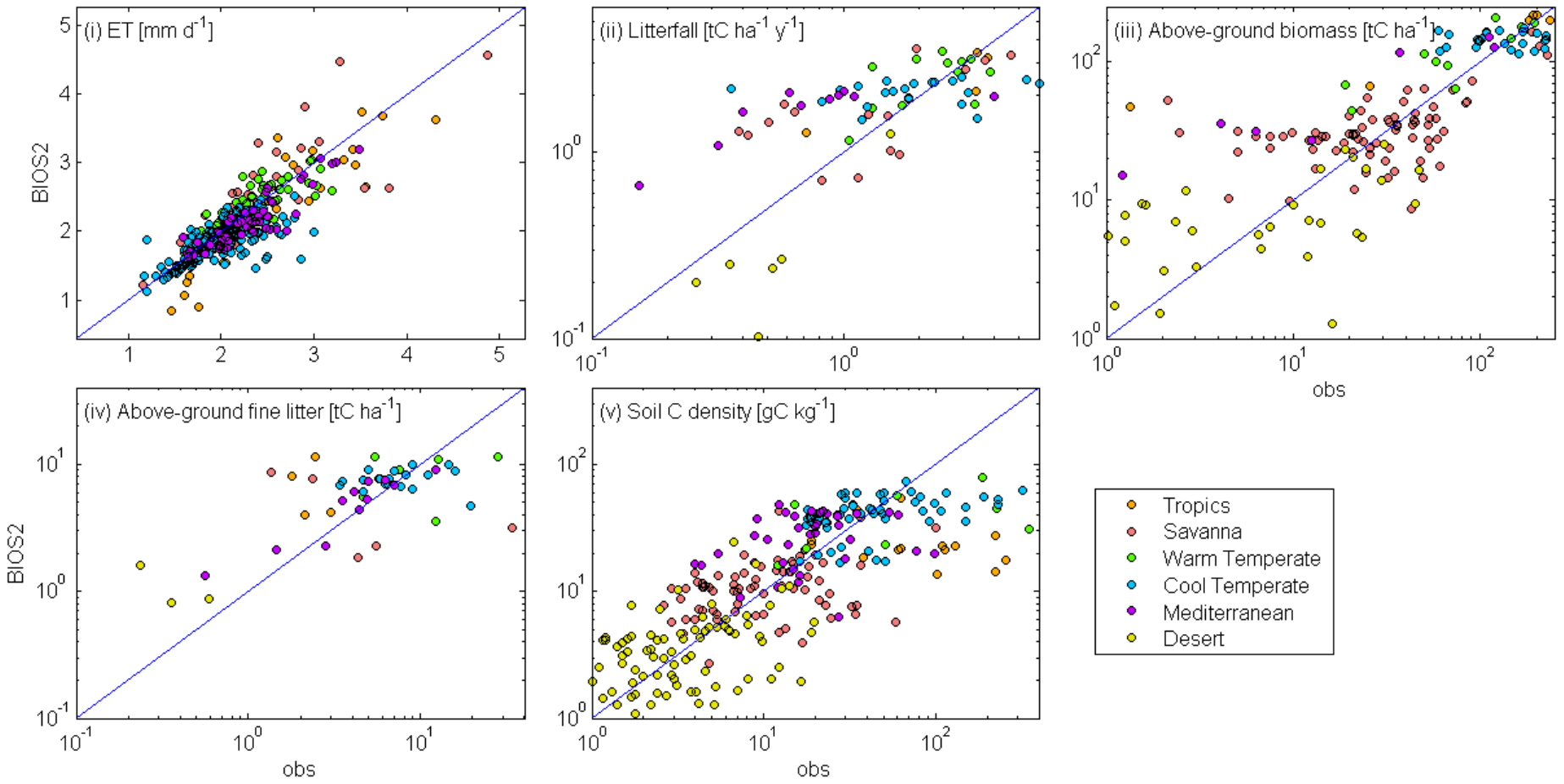
BIOS2 evaluation: **monthly mean carbon and water fluxes (OzFlux)**



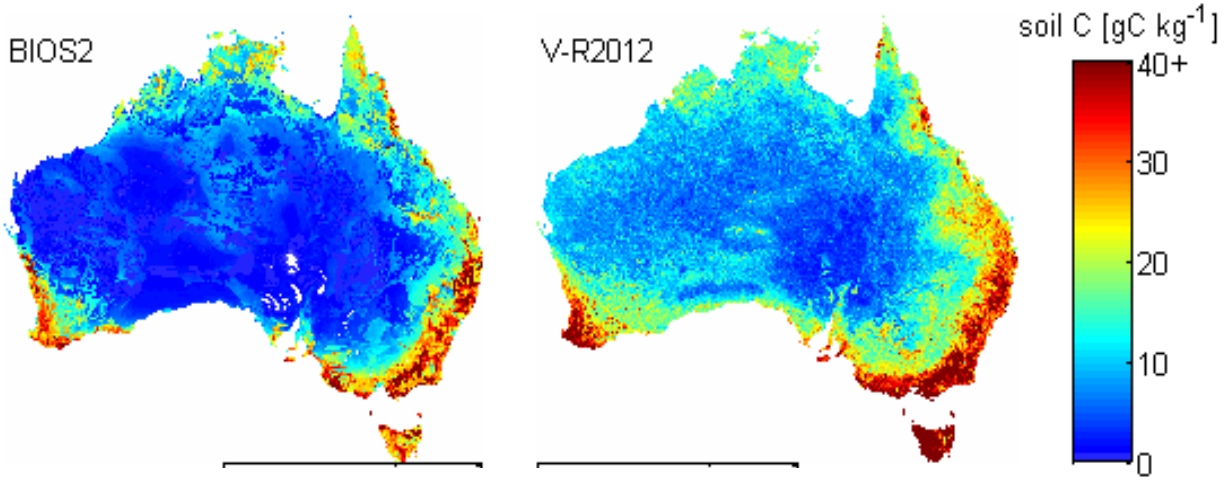
BIOS2 evaluation: **annual mean carbon and water fluxes (OzFlux)**

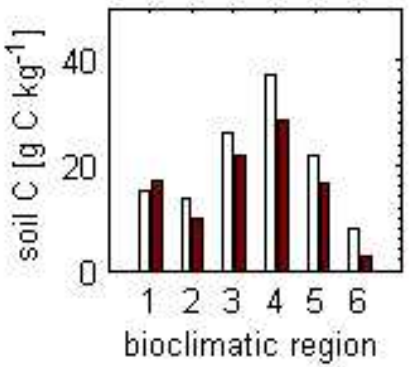


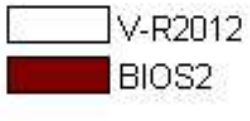
BIOS2 evaluation: long term ET from streamflow and carbon pool data

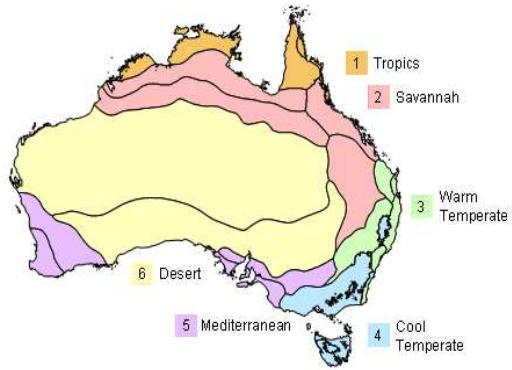


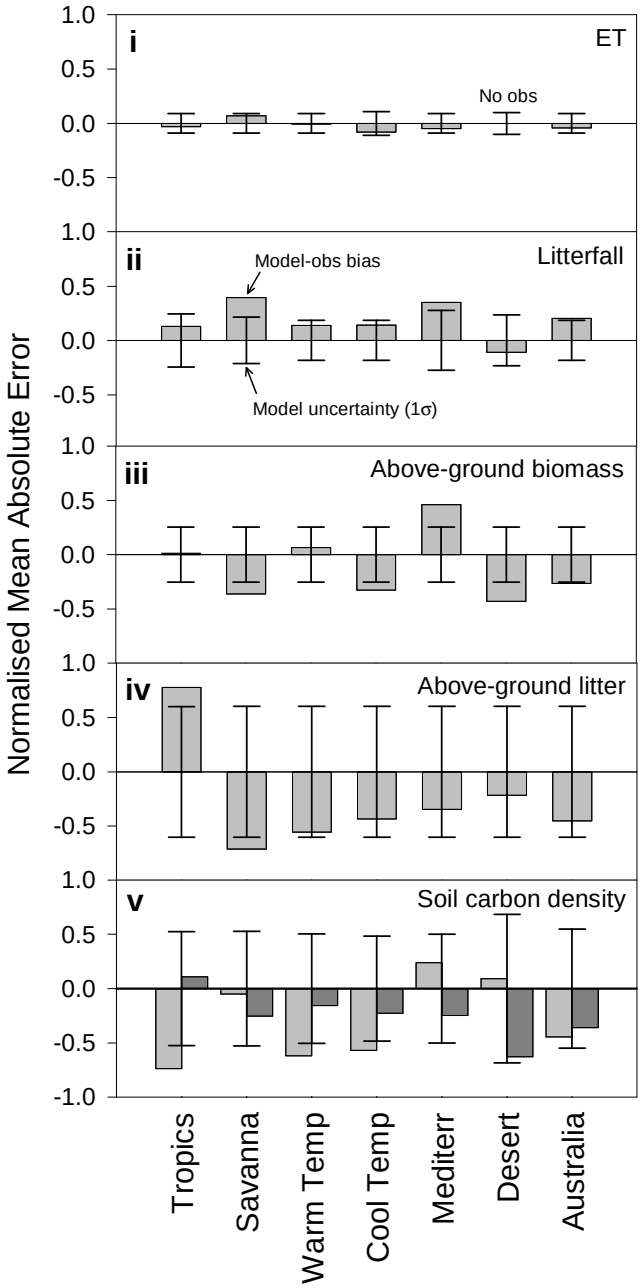
BIOS2 evaluation: soil carbon density (Viscarra Rossel 2012)





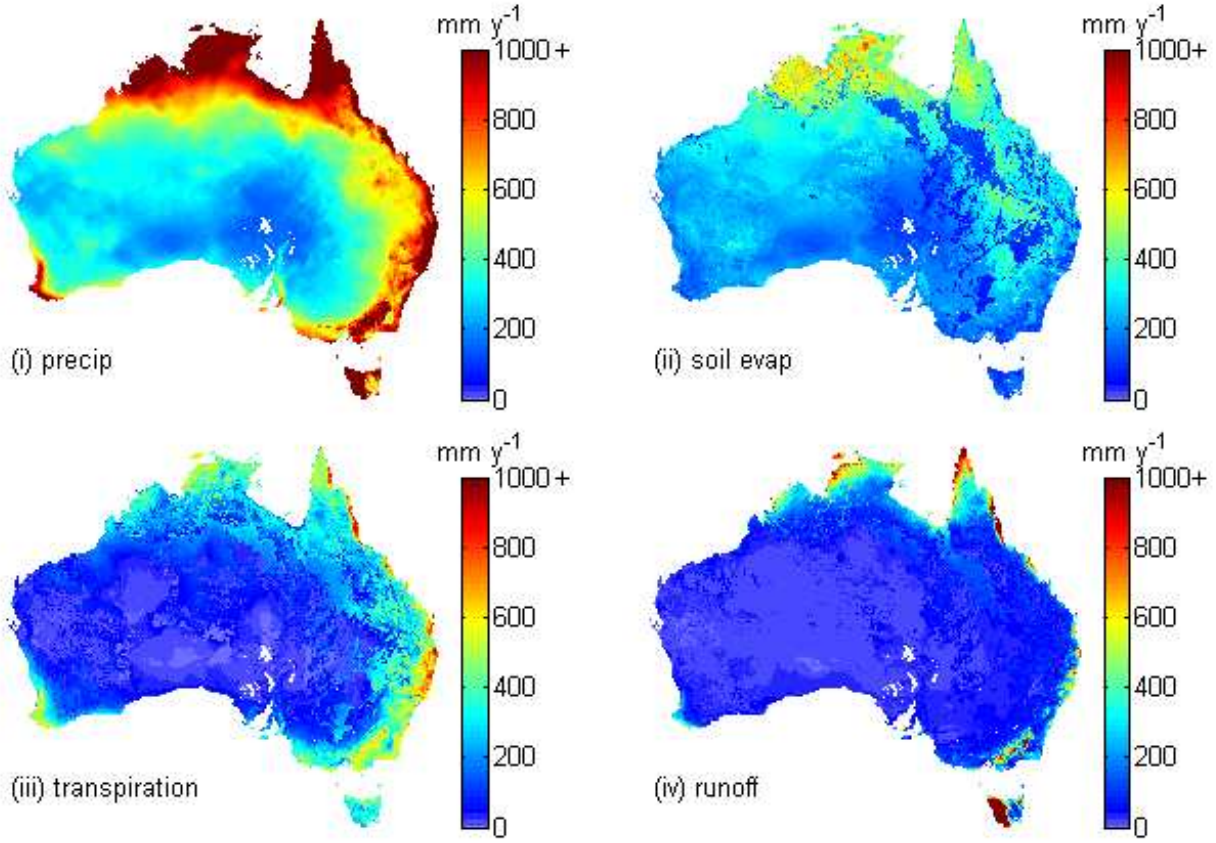




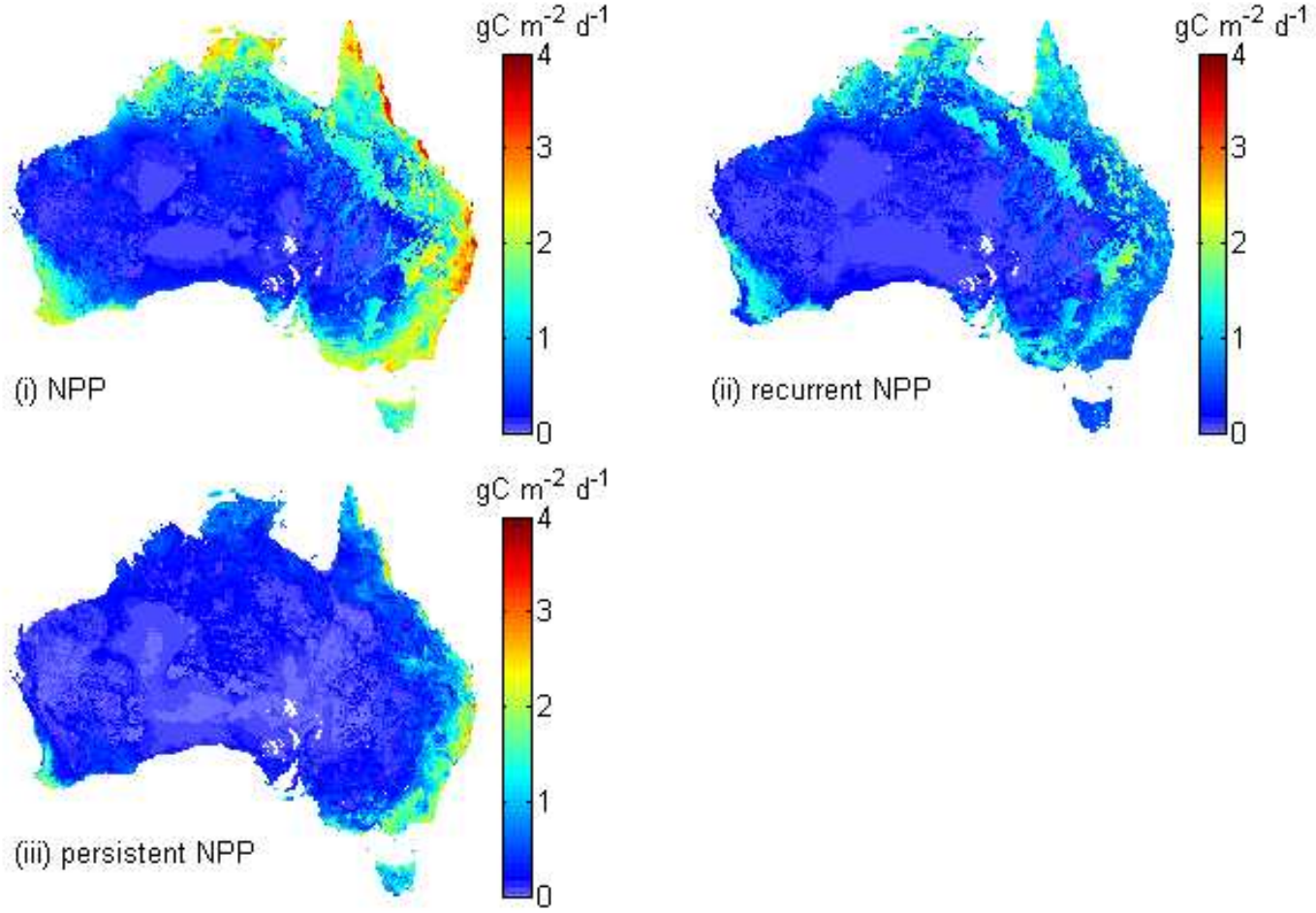

Normalised Mean Absolute Error
i
ET
No obs
ii
Litterfall
Model-obs bias
Model uncertainty (1σ)
iii
Above-ground biomass
iv
Above-ground litter
v
Soil carbon density
1.0
0.5
0.0
-0.5
-1.0
Tropics
Savanna
Warm Temp
Cool Temp
Mediterr
Desert
Australia

BIOS2 results: **Mean water balance: Australia**

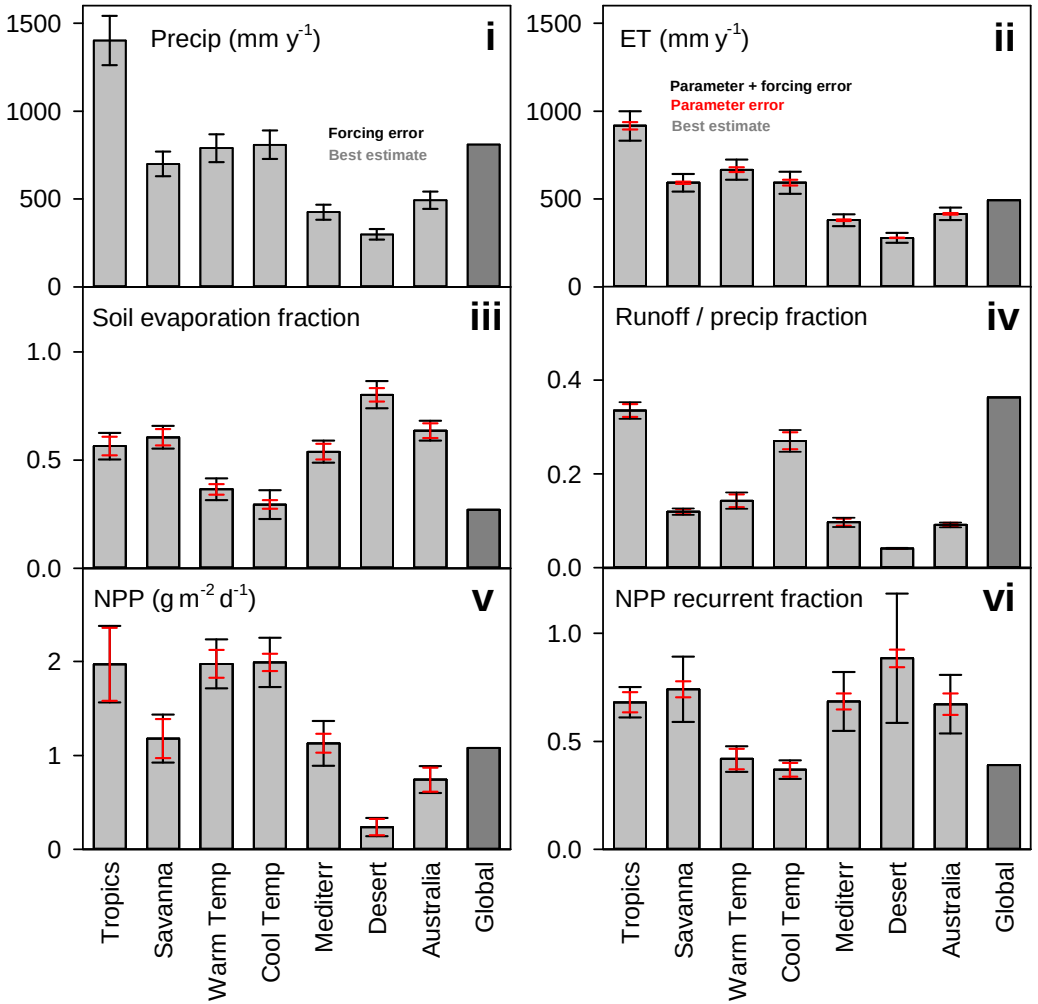
$$\underbrace{\frac{\Delta W}{\Delta t}}_{\text{Change in soil water store}} = \underbrace{P}_{\text{Precipitation}} - \underbrace{E_T}_{\text{Transpiration}} - \underbrace{E_S}_{\text{Soil Evaporation}} - \underbrace{Q}_{\text{Outflow (surface + deep)}}$$

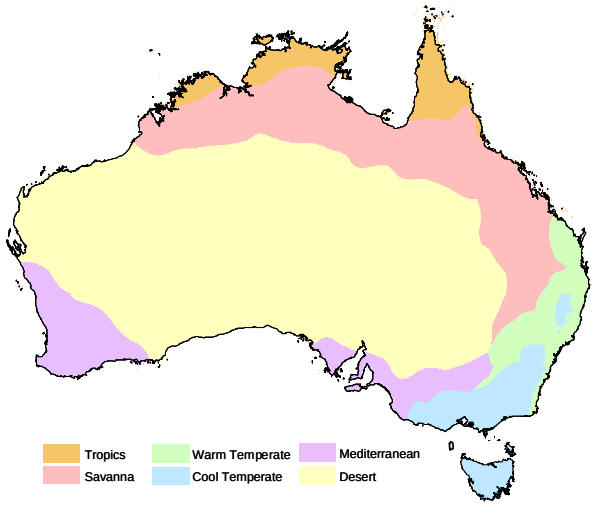


BIOS2 results: **Net Primary Production**



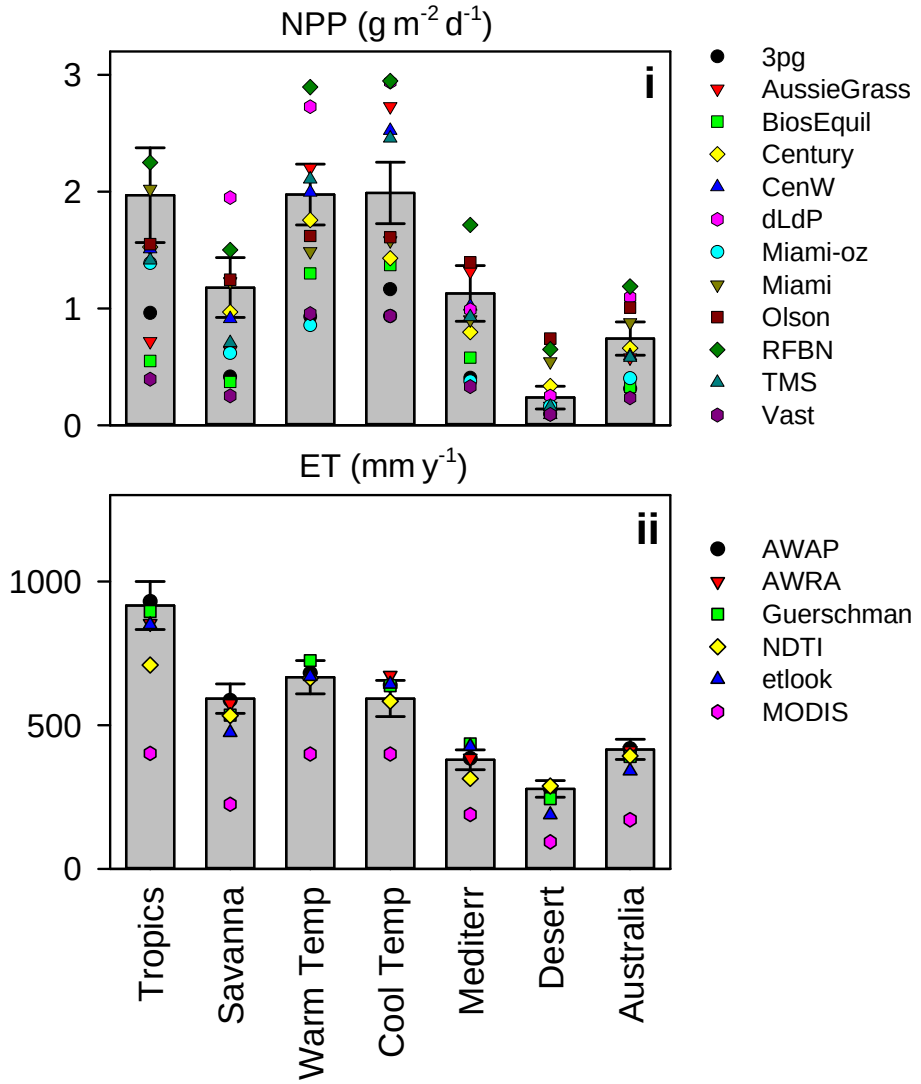
BIOS2 results: water balance and net primary production



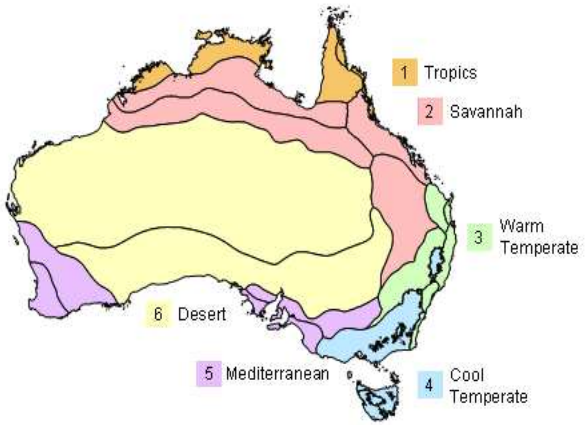


NPP and ET: comparing with other estimates

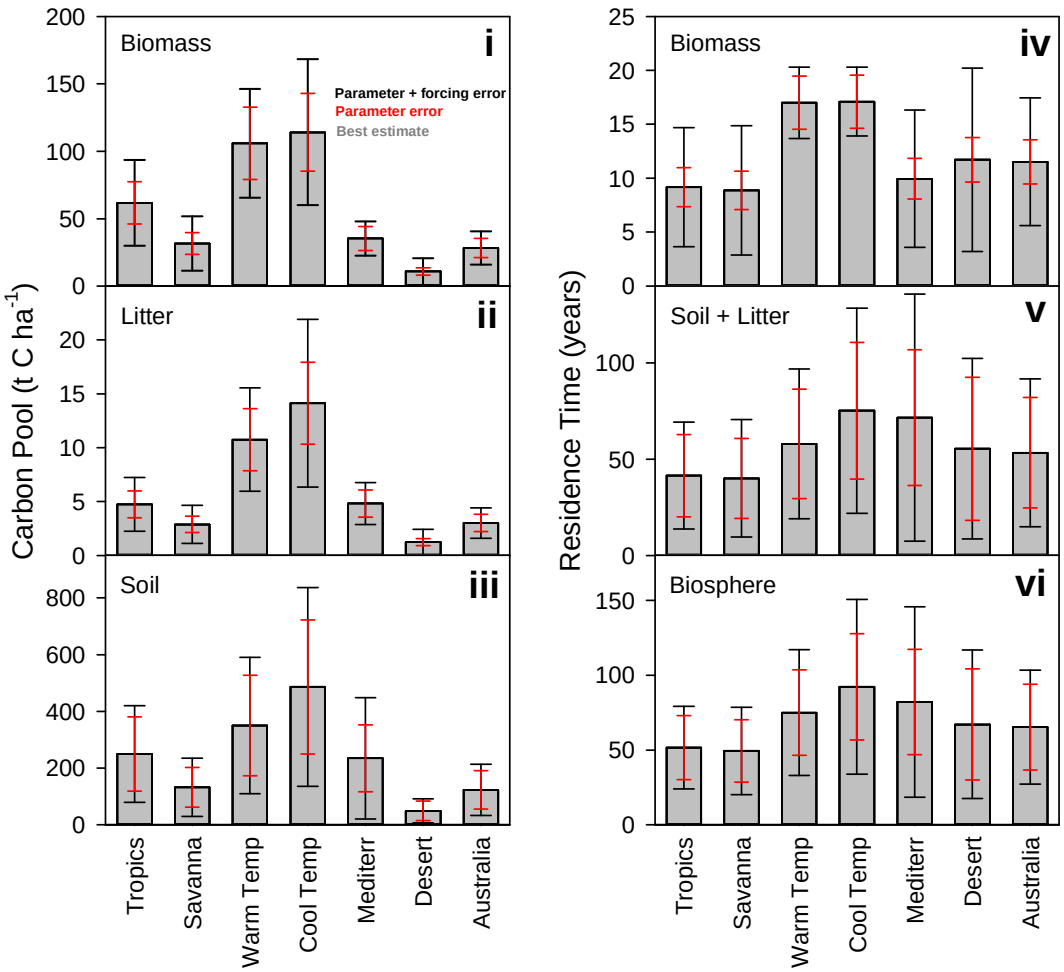
12 mean NPP estimates for Australia from (Roxburgh et al 2004)

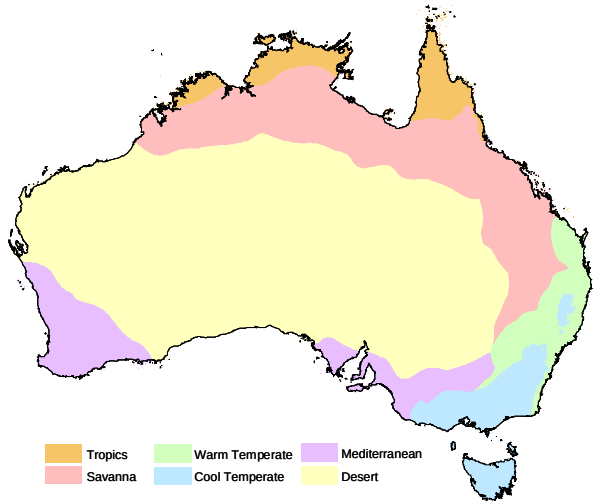


7 mean ET estimates for Australia (King et al 2012)

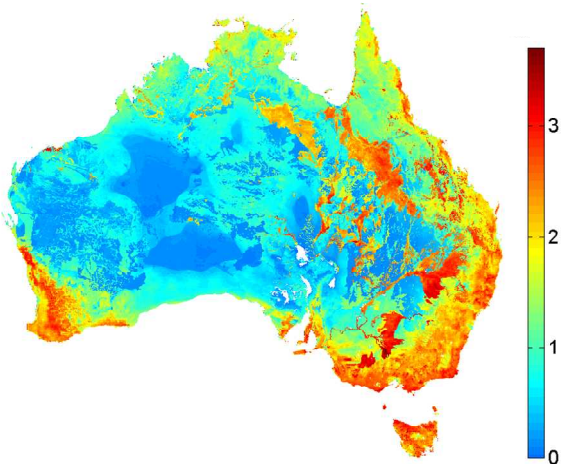


BIOS2 results: carbon pools and residence times

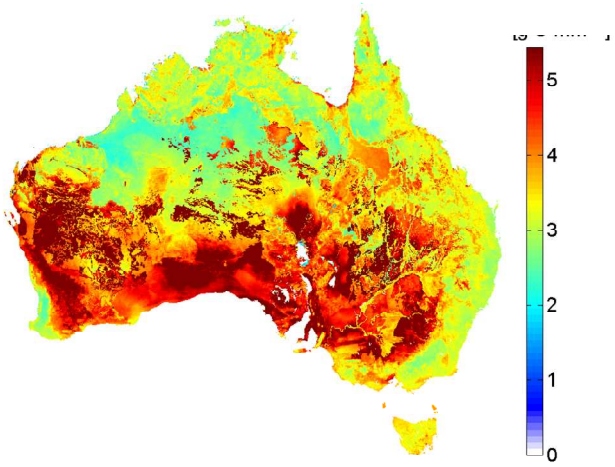




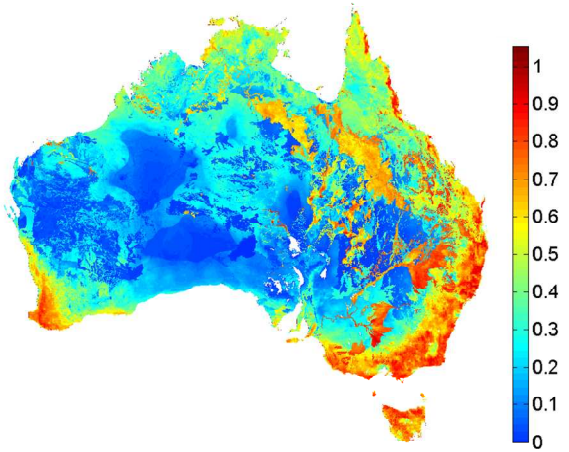
Total water use efficiency (GPP/ET)



(i) Water use efficiency [g C kg^{-1} H_2O]

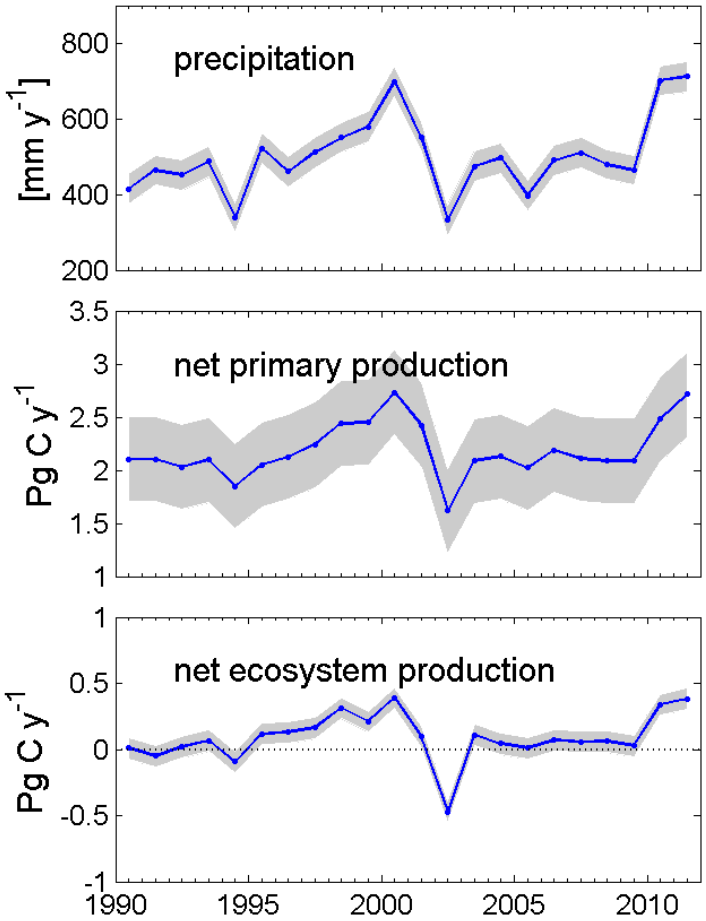


(ii) Transpiration use efficiency [g C kg^{-1} H_2O]

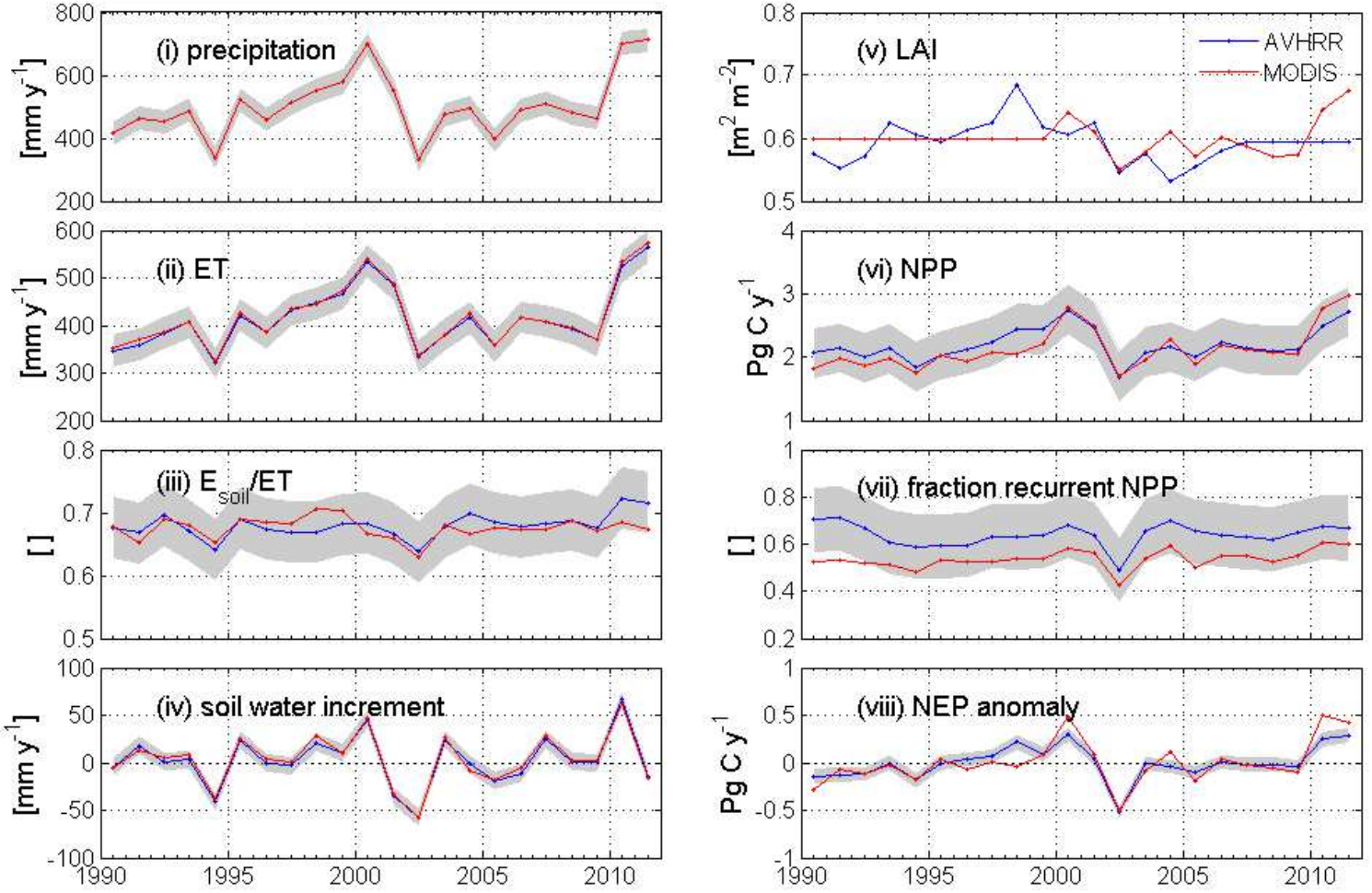


(iii) Transpiration fraction (E_{trans}/ET)

BIOS2 results: interannual variability of continental NPP and NEP

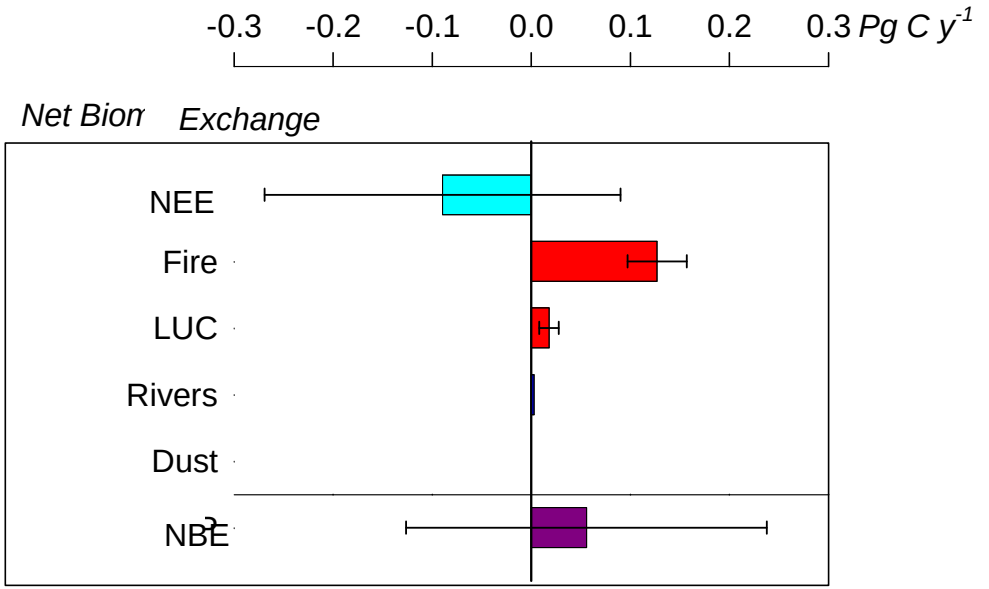


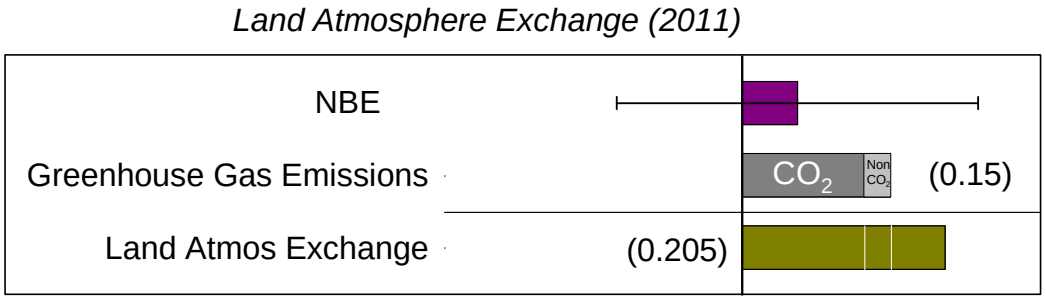
BIOS2 results: interannual variability of continental NPP and NEP



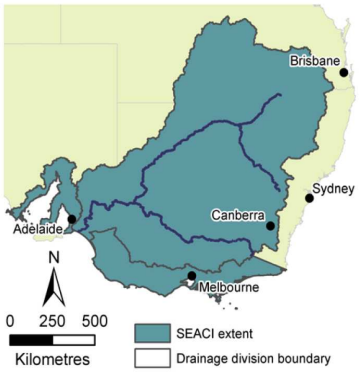
BIOS2 application: the Australian Continental Carbon Budget (1990-2011)

- positive flux = emission
- error bars = interannual variability (1σ)

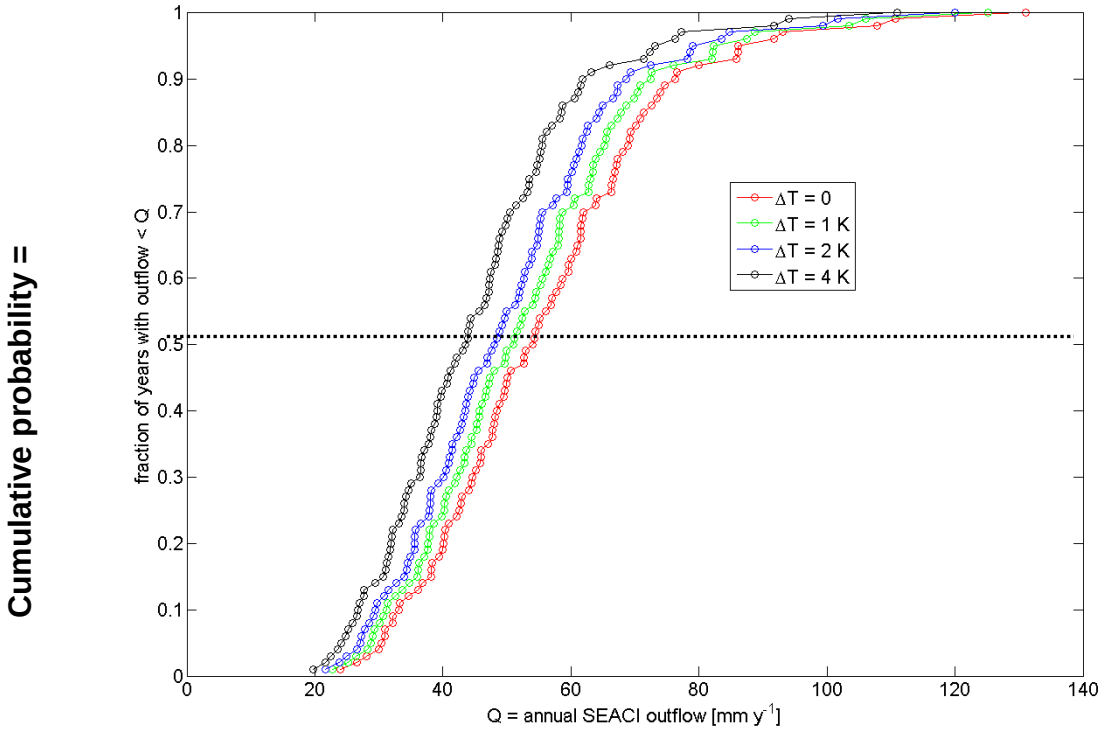




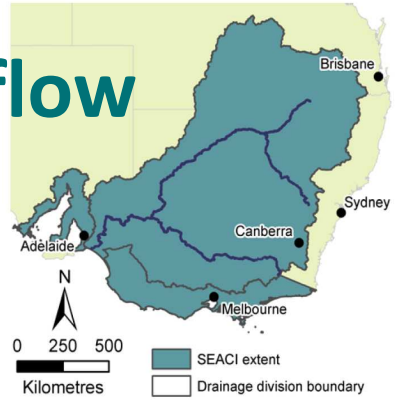
BIOS2 application: Effect of warming on outflow distribution



- Cumulative probability = prob(outflow < Q)
  = fraction of years with outflow < Q
- 4 K warming reduces median outflow by 24%
- Similar fractional reductions at other cumulative probabilities



BIOS2 application: Likely changes in outflow



- Change in Q = ∑(change in driver) x (sensitivity to driver)

$$\frac{\Delta Q}{Q} = \eta(Q,P)\frac{\Delta P}{P} + \eta(Q,T)\Delta T + \eta(Q,S)\frac{\Delta S}{S} + \eta(Q,U)\frac{\Delta U}{U} + \eta(Q,C)\Delta C + \eta(Q,L)\frac{\Delta L}{L}$$

Precipitation | **Temperature** | **Solar** | **Wind** | **CO_2** | **LAI**

Driving variable (X)	η(Q,X) = sensitivity of Q to X	Definition of η(Q,X)	Assumed future perturbation (ΔX)	Resulting fractional change in outflow (ΔQ/Q)
Temperature (T)	−0.1 K^{-1}	∂(ln Q)/∂T	ΔT = +1 K	**−5%**
Precipitation (P)	+2.9	∂(ln Q)/∂(ln P)	ΔP/P = −5%	**−14%**
Solar radiation (S)	−1.3	∂(ln Q)/∂(ln S)	ΔS/S = 0%	–
Wind speed (U)	−0.11	∂(ln Q)/∂(ln U)	ΔU/U = −2%	+0.2%
CO_2 (C)	**+0.0006 ppm^{-1}**	∂(ln Q)/∂C	ΔC = +100 ppm	**+6%**
Leaf Area Index (L)	−0.04	∂(ln Q)/∂(ln L)	ΔL/L = +10%	−0.4%

Thank you

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