

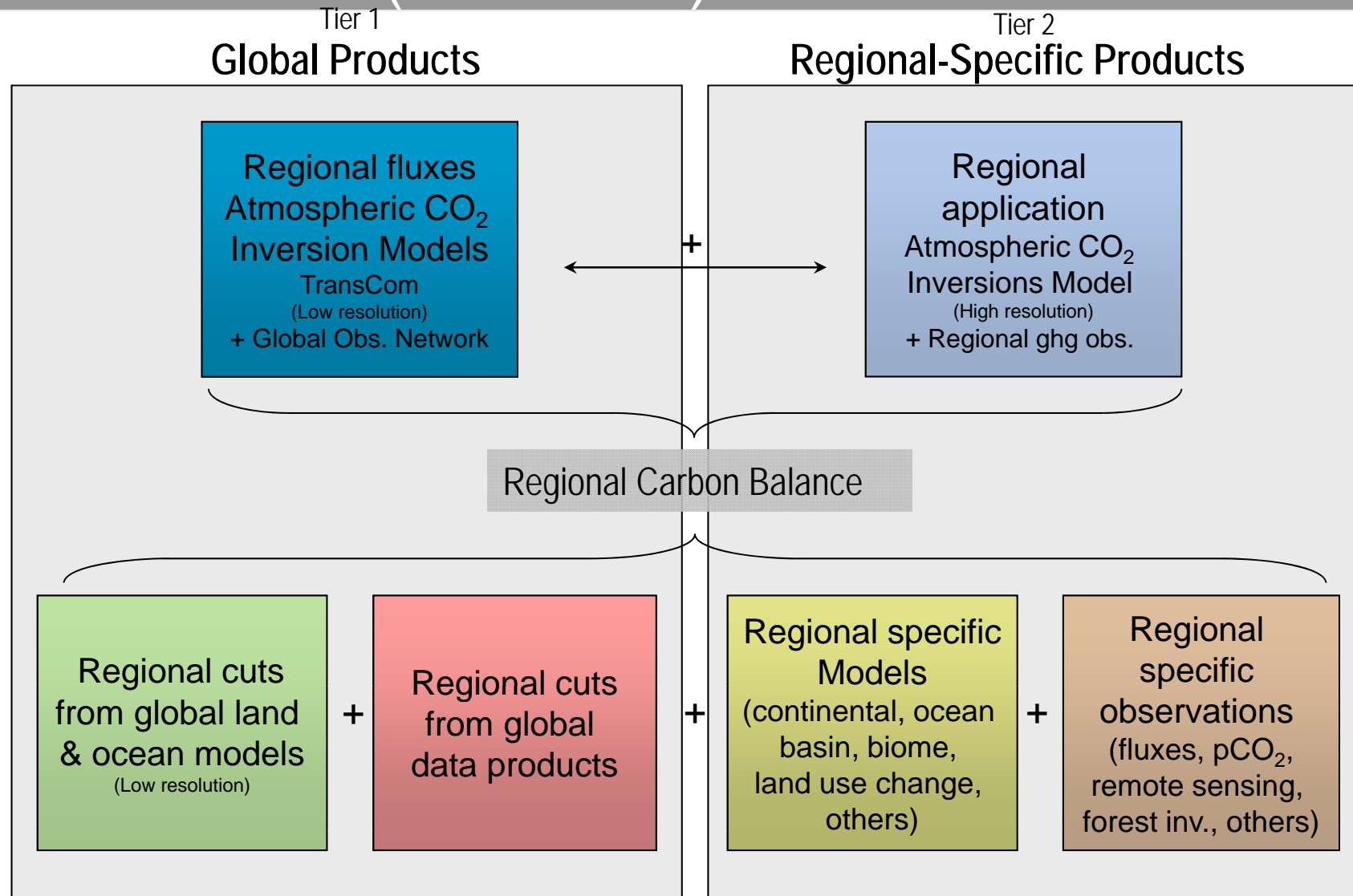
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The Australian Terrestrial Carbon Balance: 1990-2009

**Vanessa Haverd, Christopher Pickett-Heaps, Pep Canadell, Michael Raupach,
Rachel Law, Glen Peters, Raphael Viscarra Rossel, Peter Briggs**



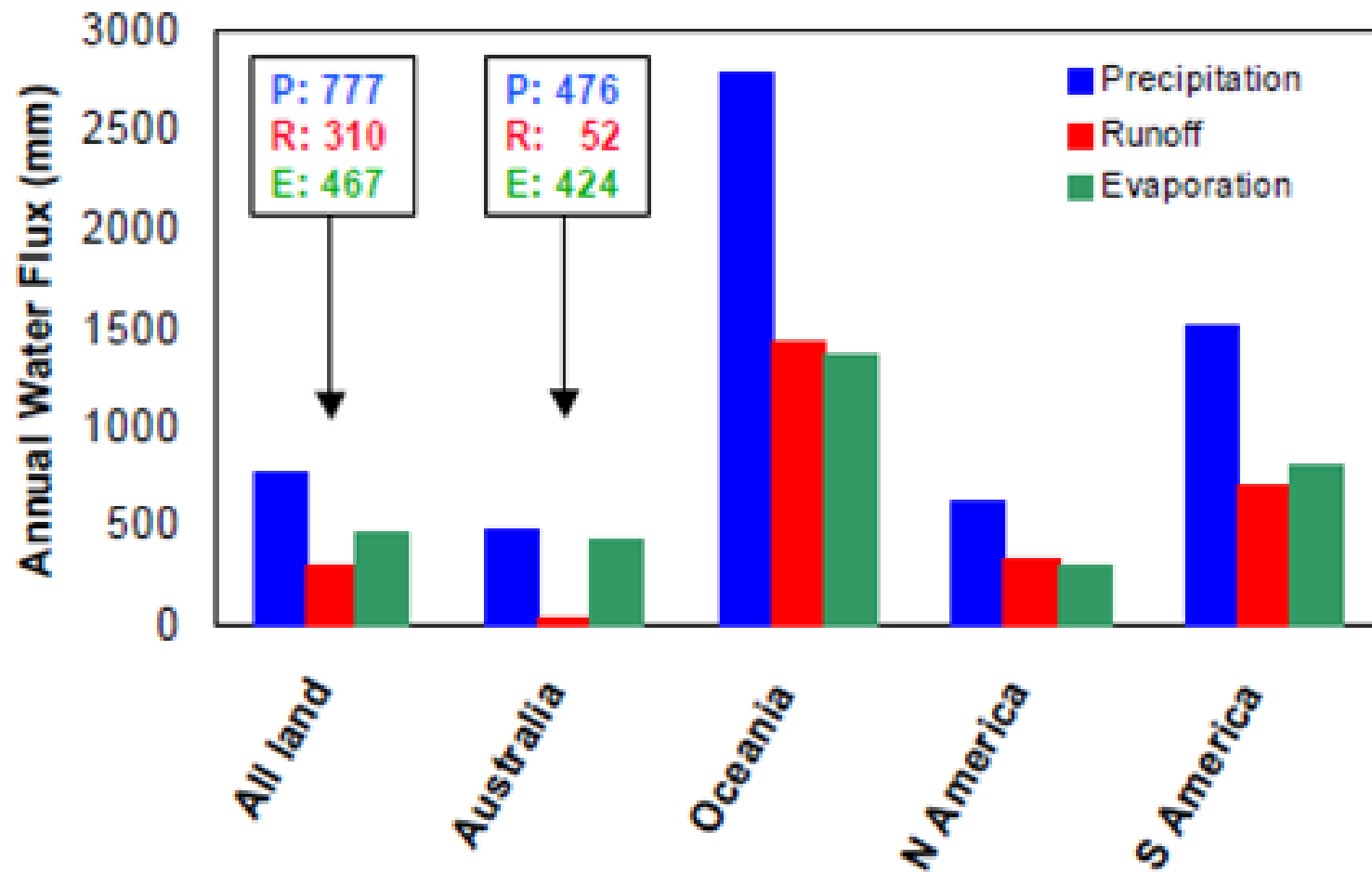
REgional Carbon Cycle Assessment and Processes (RECCAP)



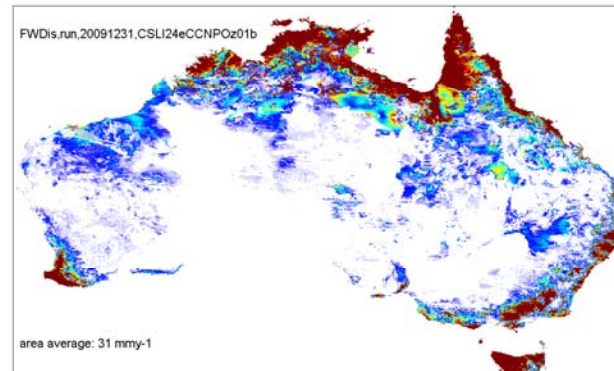
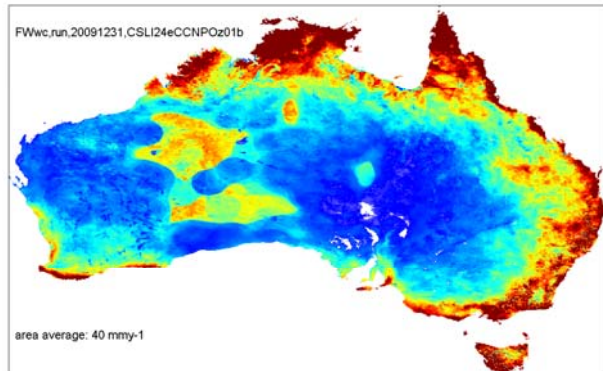
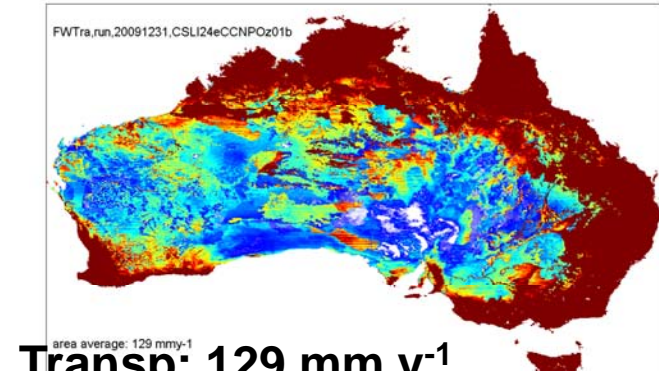
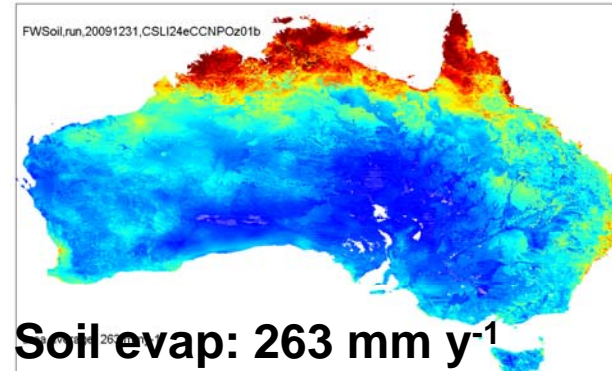
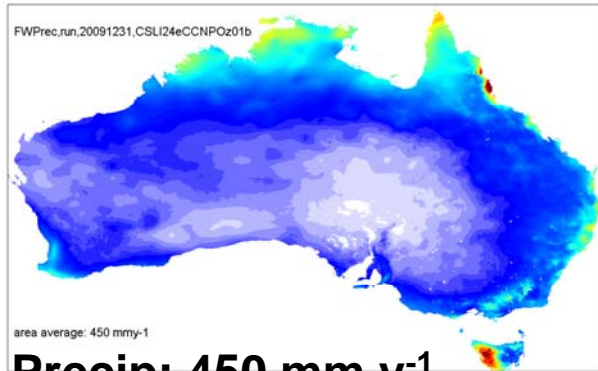
Methods

- **CABLE-SLI-CASCACNP**
 - High resolution (0.05 °) land surface model simulations of coupled carbon and water budgets at hourly resolution.
 - Forced by gridded met and LAI (woody and grassy) from remotely-sensed FPAR
 - Constrained by eddy flux data; soil moisture; streamflow; litterfall; biomass; soil carbon measurements.
- **DGVMs, resampled to 0.05° resolution for comparison with CABLE-SLI-CASCACNP**
- **Independent continental LUC, fire emissions, export by trade**

Long term water balance



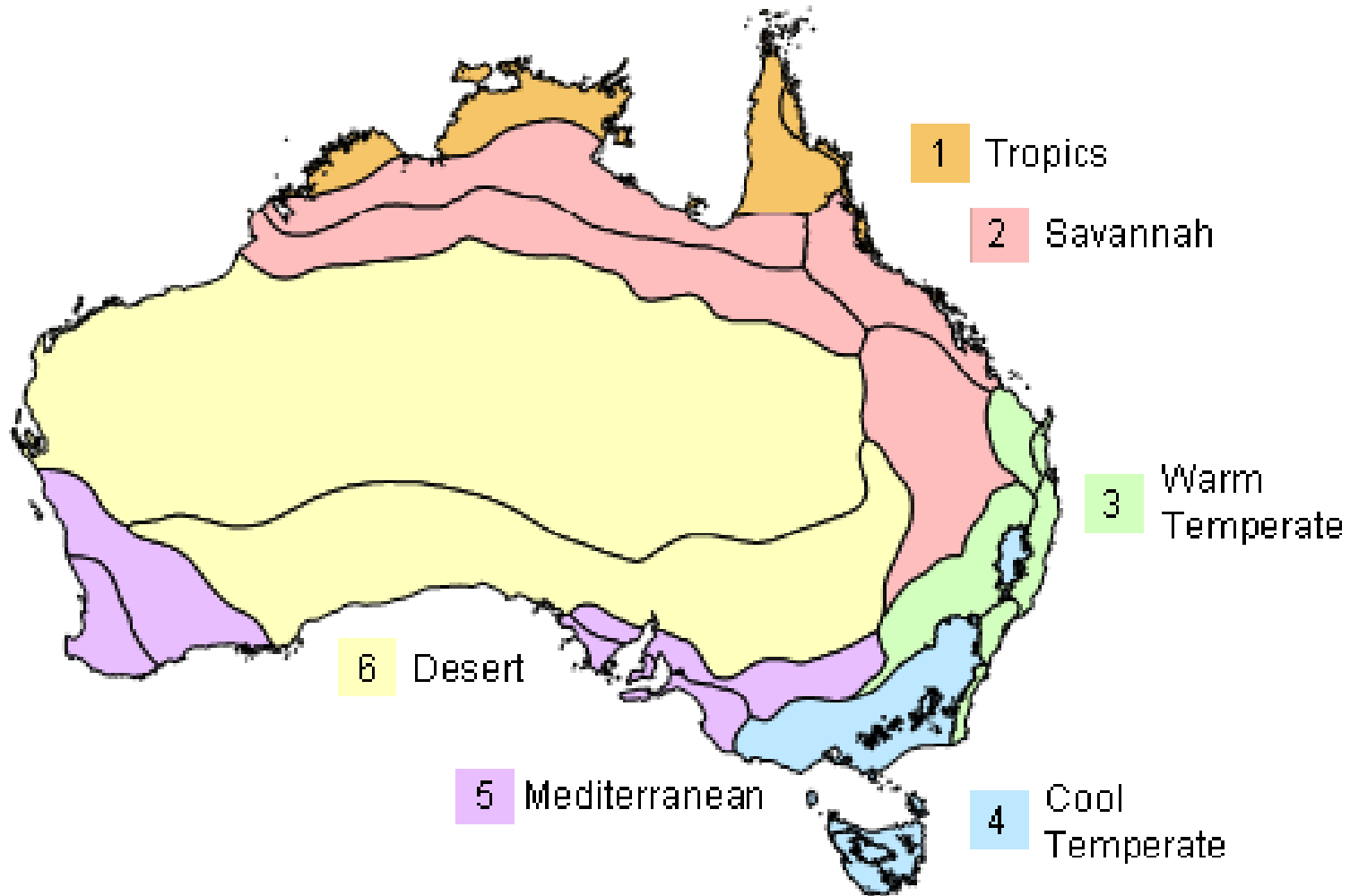
Continental water balance: 2000:2009



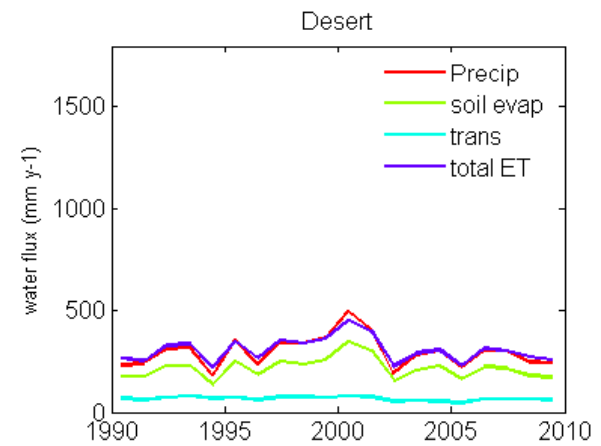
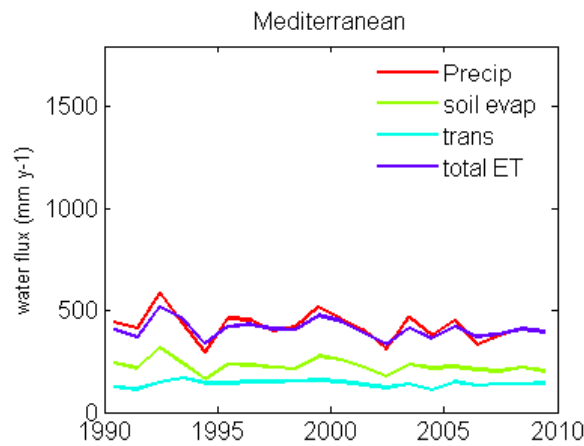
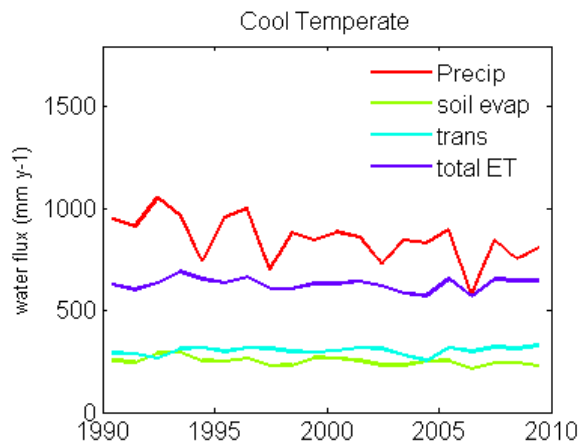
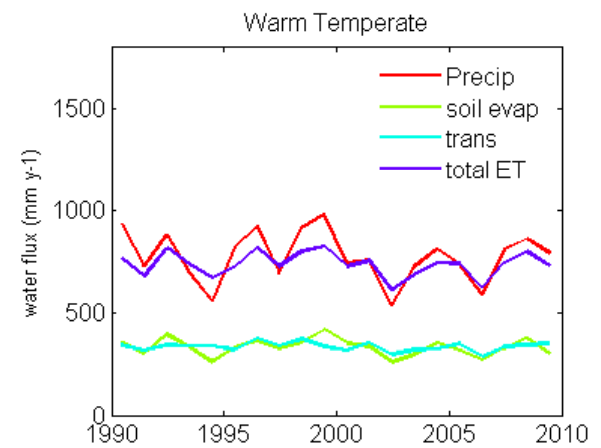
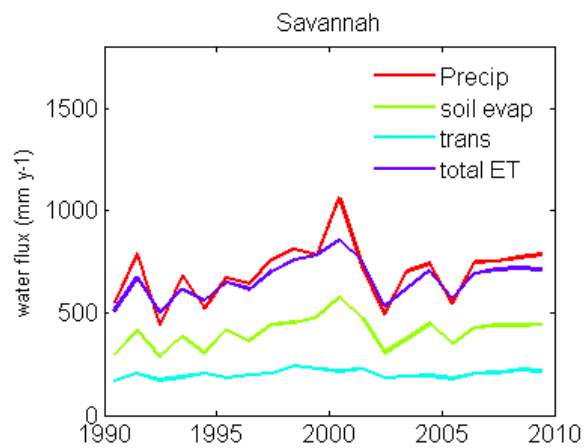
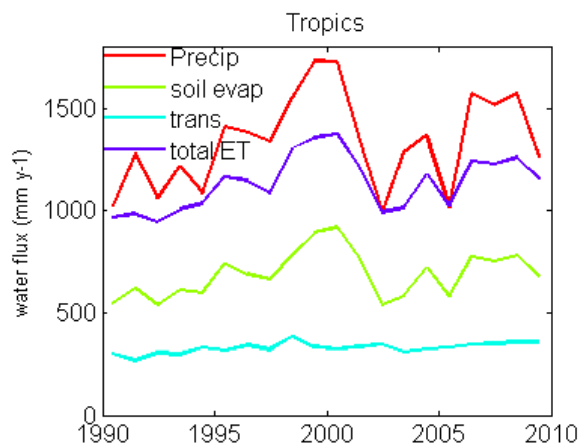
Wet canopy evap: 40 mm y⁻¹

Discharge: 31 mm y⁻¹

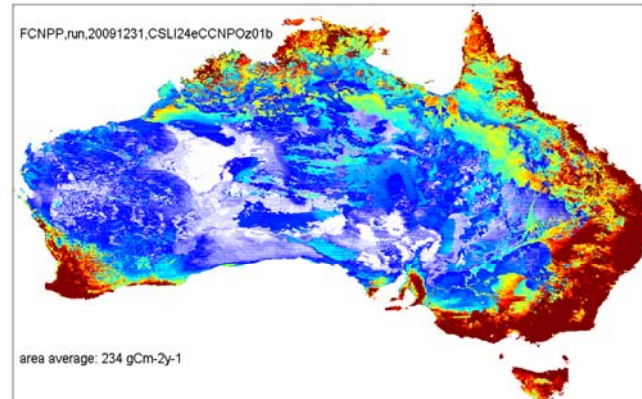
Aggregation of Hutchinson Agro-Climatic Classification



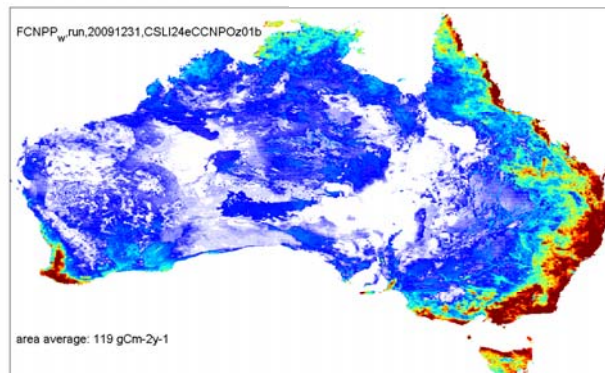
Water balance: annual time series



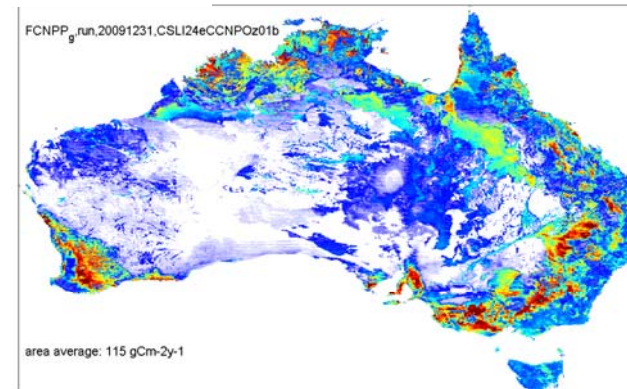
CABLE-SLI Continental NPP: equal contributions from woody and grassy vegetation.



Total NPP: 234 gCm⁻²

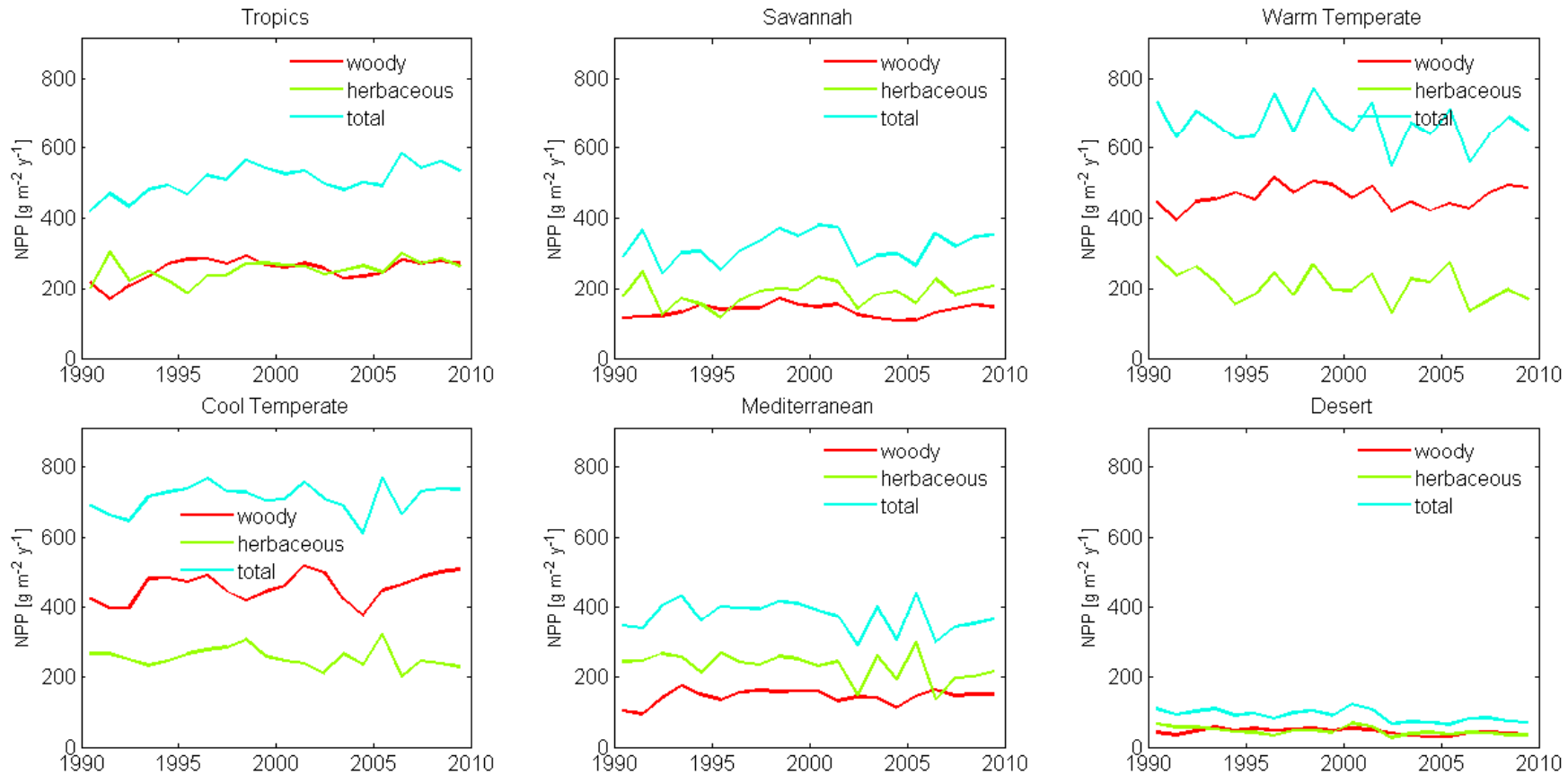


woody NPP: 119 gCm⁻²

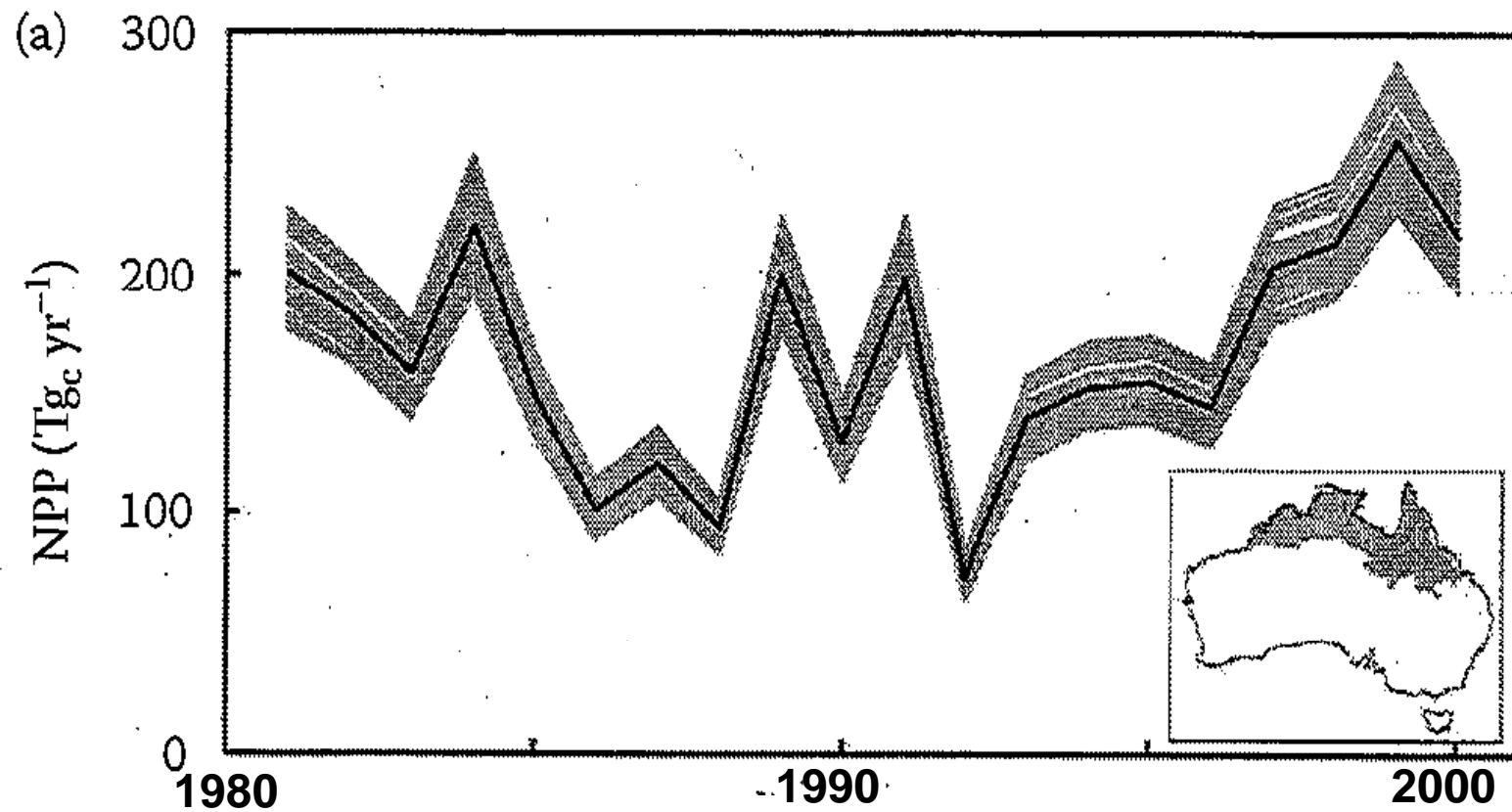


grassy NPP: 115 gCm⁻²

Annual NPP: woody and herbaceous components

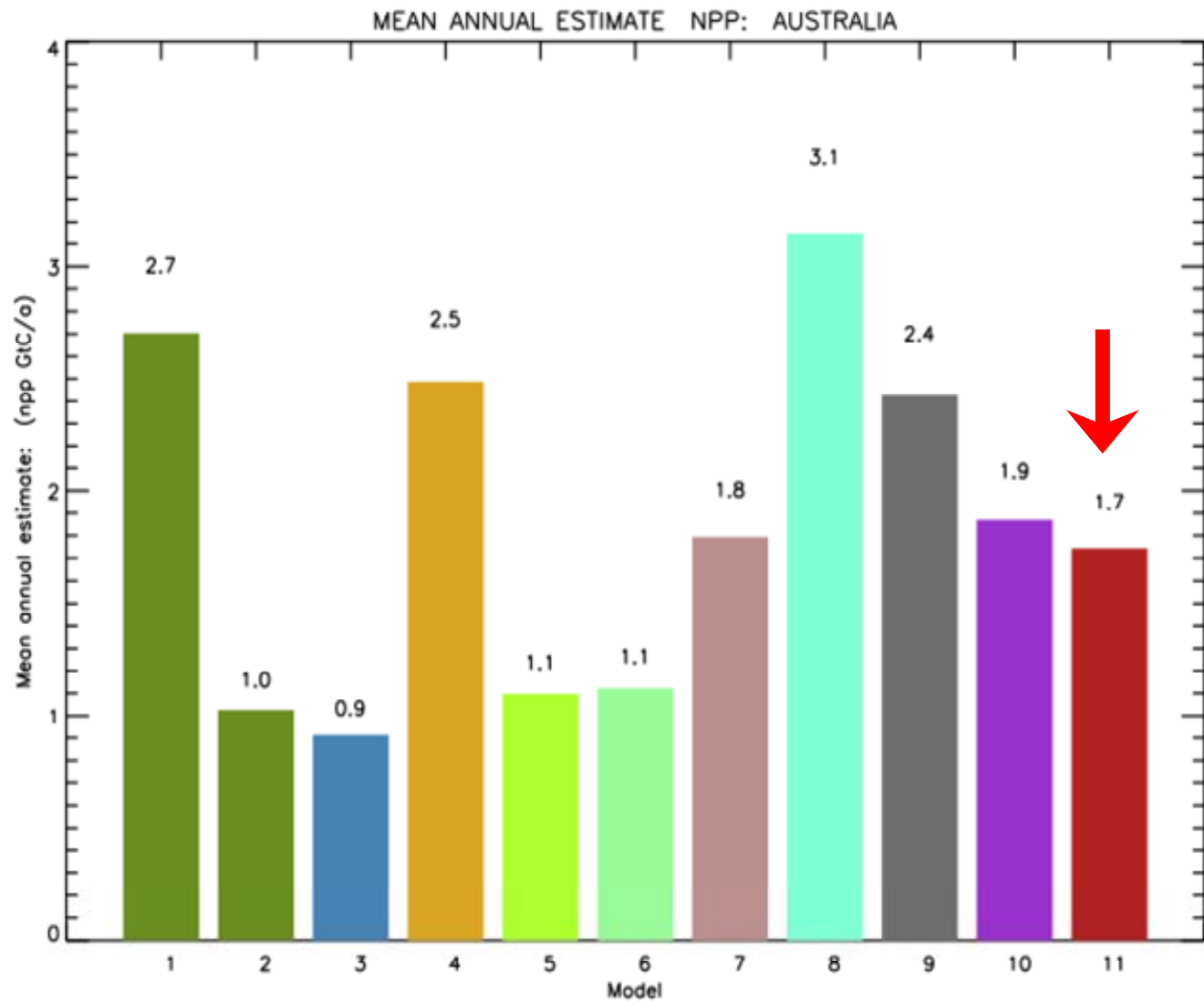


NPP interannual variability?



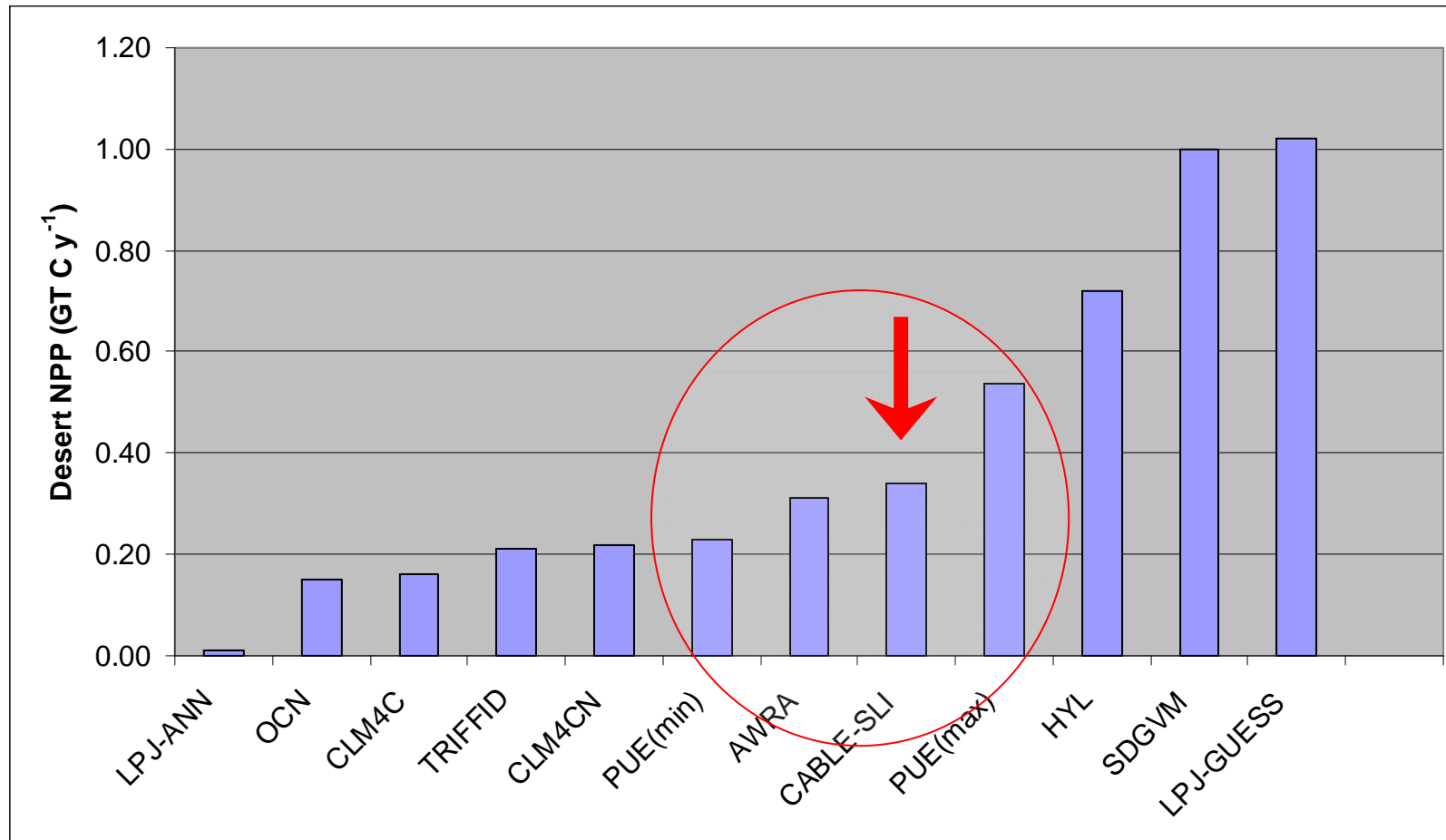
VAST 1.2 NPP, Barrett 2011

Continental NPP: multiple model estimates

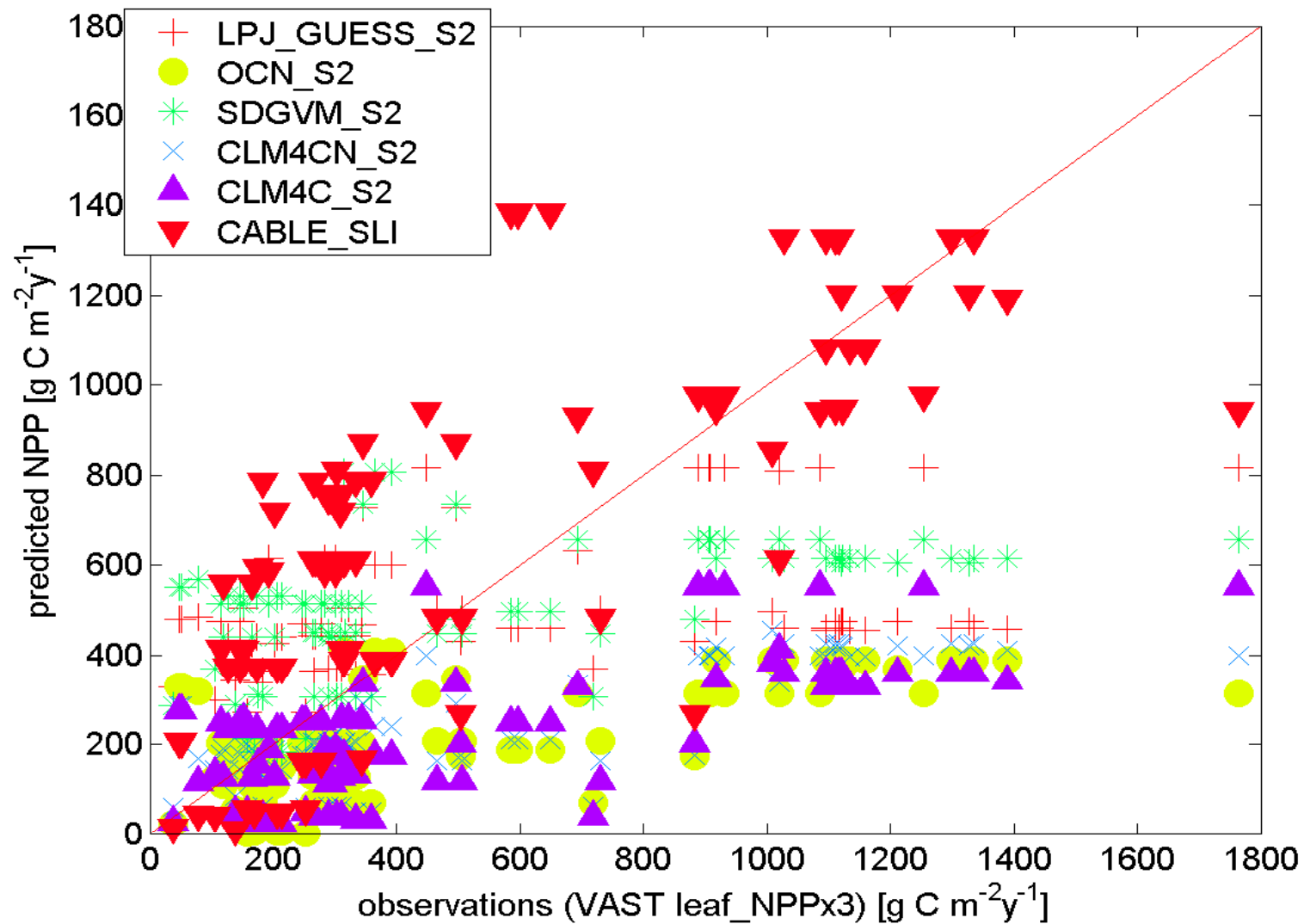


LPJ_GUESS_S2
LPJ_ANN_S2
OCN_S2
SDGVM_S2
CLM4C_S2
CLM4CN_S2
TRIFFID_S2
HYL_S2
AWRA
CABLE-SLI

Desert NPP: multiple model estimates

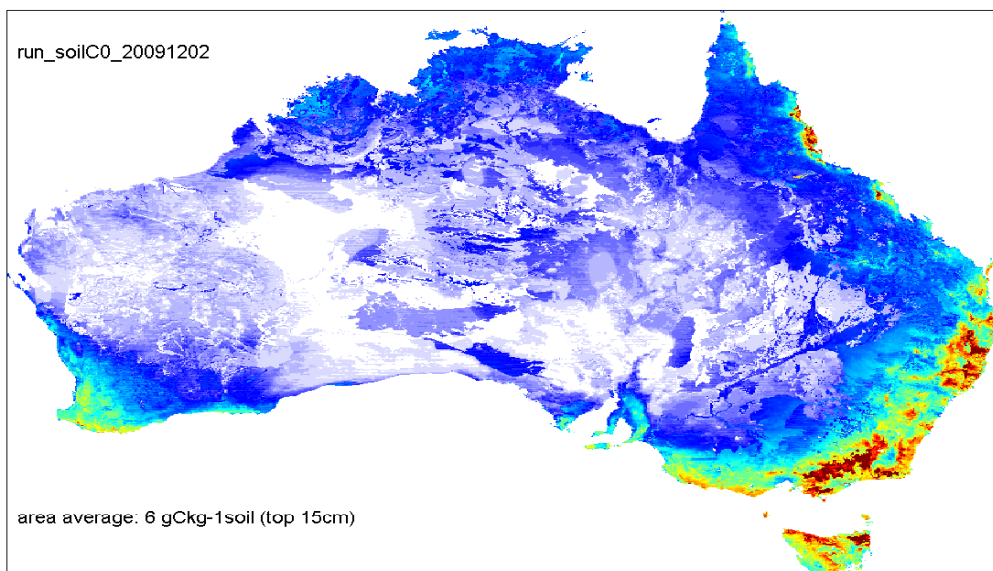


Model output (1990-2009 NPP) vs observations from VAST dataset

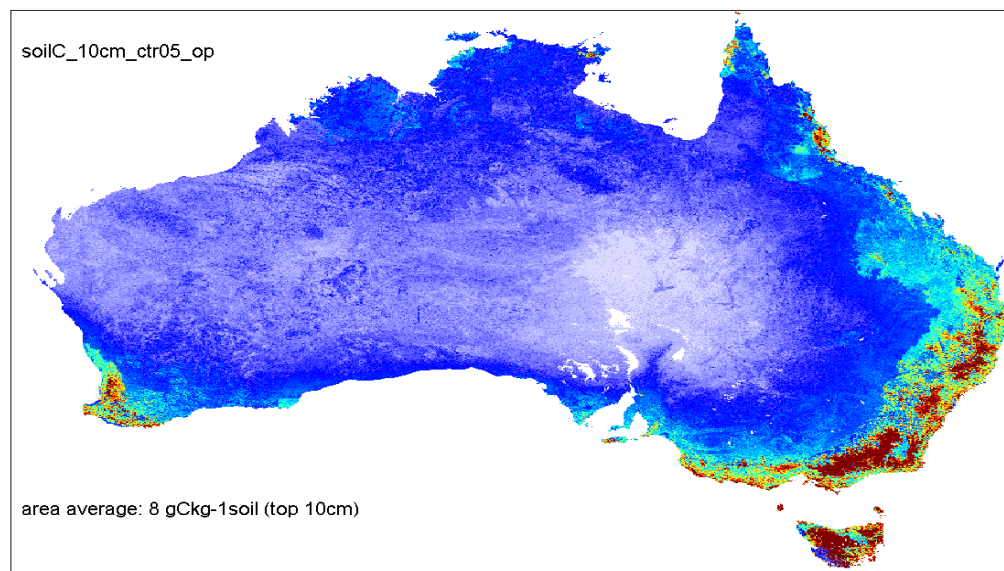


Soil carbon density

CABLE-SLI-CASACNP



Viscarra Rossel (meas-based with spatial modelling)



Soil Carbon density (gC/kg-1: top 10 cm)						
	Tropics	Savannah	Warm Temperate	Cool Temperate	Mediterranean	Desert
CABLE-SLI-CASACNP	10.3	6.4	20.4	29.4	11.4	2.0
Viscarra Rossel	8.9	7.9	22.8	41.0	12.6	3.5

Briefly...the methodology involved:

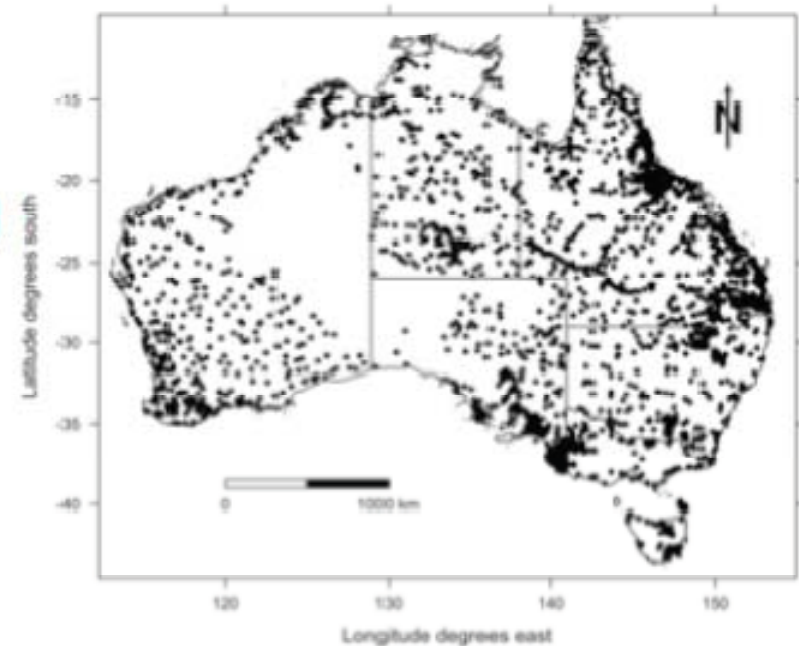
4606 soil samples soil (0-20cm)
samples from across Australia

Organic carbon measurements were made with both laboratory measurements and soil visible-infrared spectra

Spatial modelling using a wide range of environmental covariates including climatic, vegetation, land use and soil layers – Models are interpretable!

Mapping made at 90 x 90 m pixel (i.e. 3 arc seconds) resolution

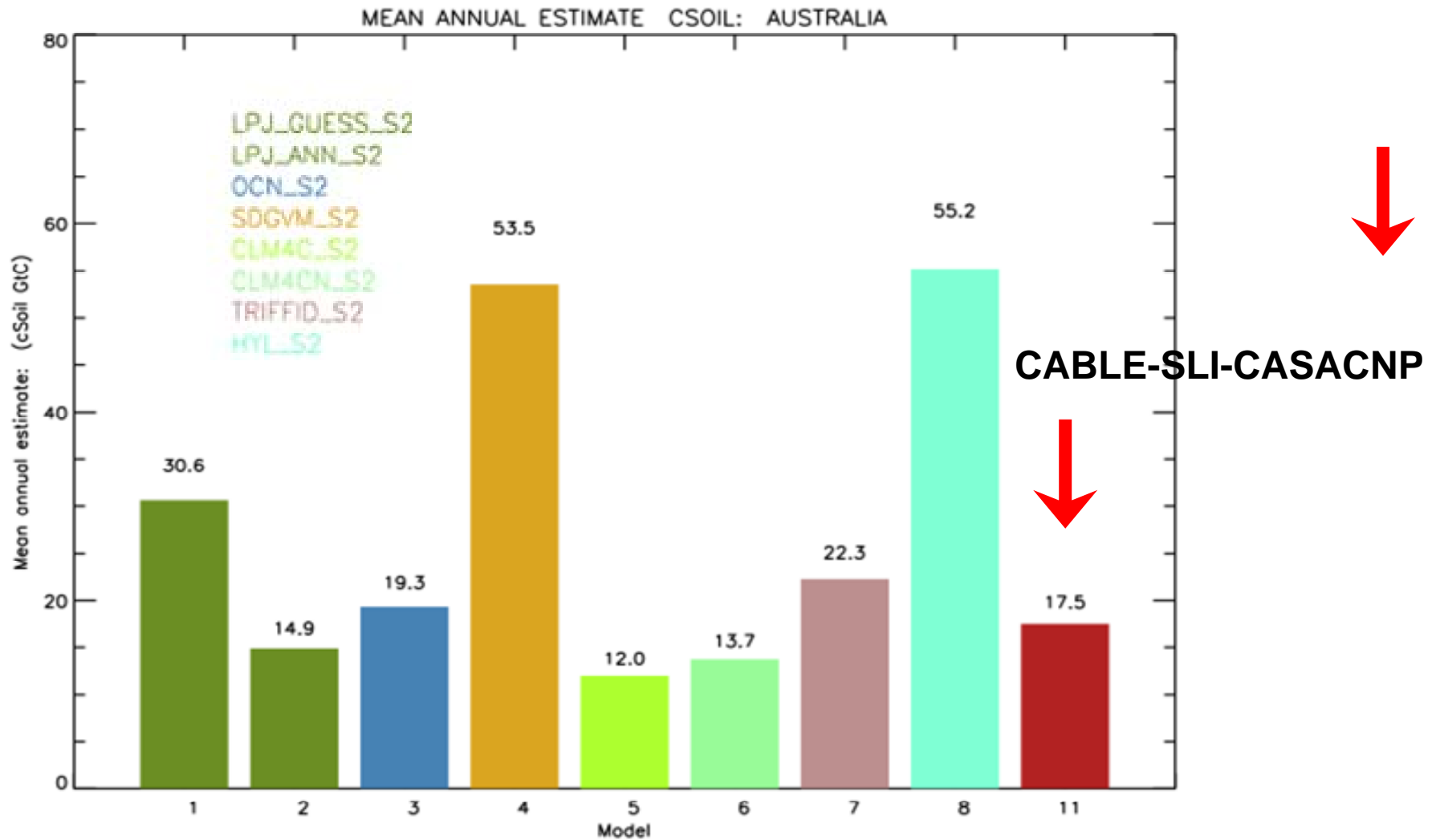
All maps produced together with error maps to assess uncertainty



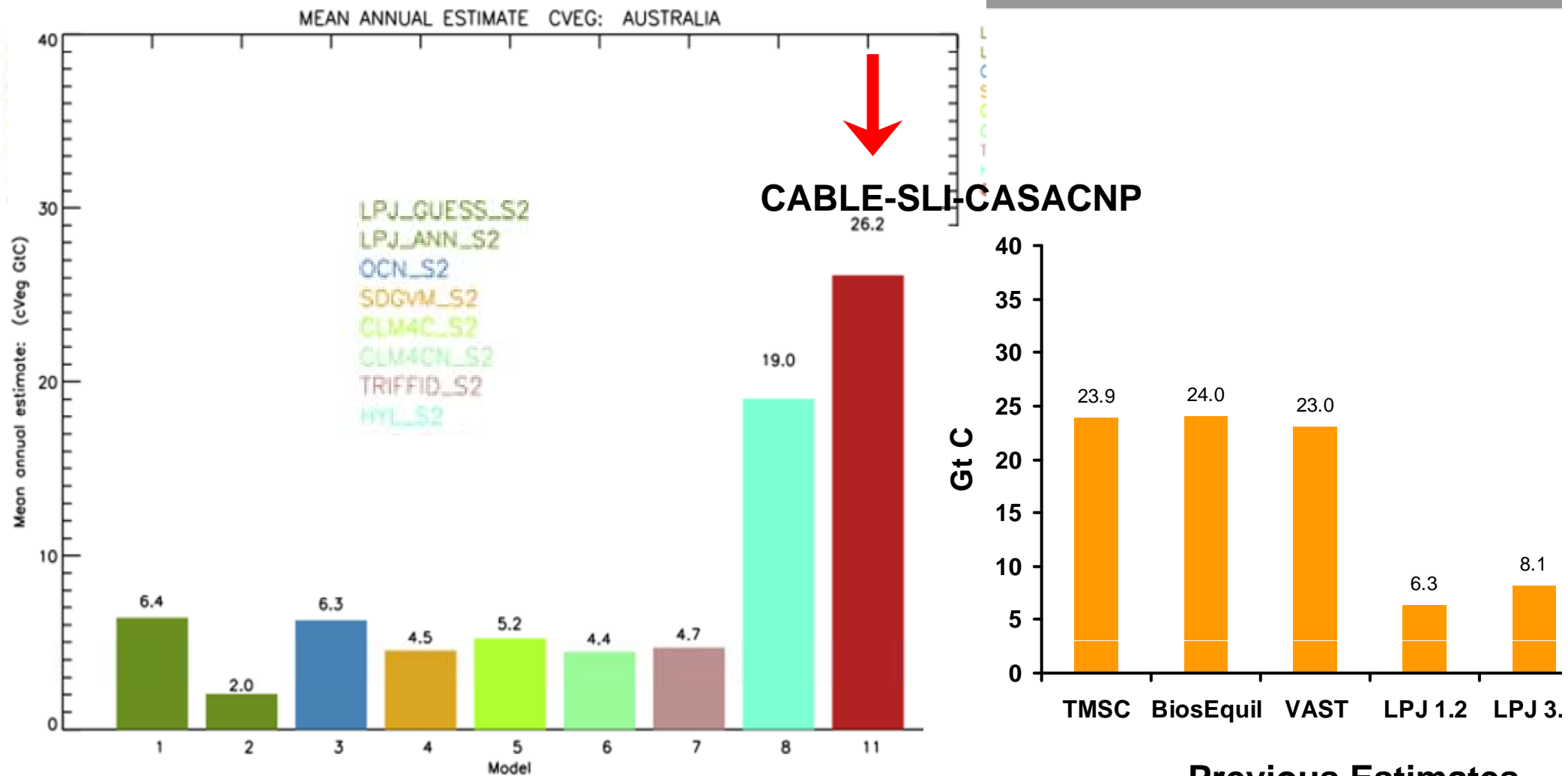
All maps validated using both cross and test set validations

Can model to TOC density to different depths.

Soil carbon pools : multimodel estimates



Continental Biomass



Current DGVMs and CABLE-SLI-CASACNP

Previous Estimates

Summary

		Other	CABLE-SLI	DGVM min	DVGM max
GPP	GtC.y ⁻¹		3.3	2.1	6.3
NPP	GtC.y ⁻¹		1.7	0.9	3.1
RA	GtC.y ⁻¹		1.6	1.4	3.2
RH	GtC.y ⁻¹		1.5	0.9	2.8
NEP	GtC.y ⁻¹		-0.2	-0.3	0.9
Fire	GtC.y ⁻¹	0.1			
Riverine	GtC.y ⁻¹	small			
LUC	GtC.y ⁻¹	0.02			
NBP	GtC.y ⁻¹				
Trade	GtC.y ⁻¹	0.01			
Territorial	GtC.y ⁻¹	0.09			
Consumption	GtC.y ⁻¹	0.08			

Maps more than just pretty pictures?

- CABLE-SLI parameter estimation & evaluation using:
 - Stream-flow
 - Oznet soil moisture
 - Hourly latent heat fluxes (3 sites so far, but can easily extend)
- CASA-CNP parameter estimation & evaluation using:
 - Carbon stores (soil, above-ground biomass, litter)
- Independent evaluation using:
 - Ozflux NEE (monthly)
 - Long-term leaf NPP (VAST data set)
- Diagnosis of model structural problems using multiple data types...more on this tomorrow.