2013 fluxes from the Great Western Woodlands

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LAND AND WATER FLAGSHIP
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Australian SupersiteNetwork

Department of Environment and Conservation
Our environment, our future

TERN
Terrestrial Ecosystem Research Network

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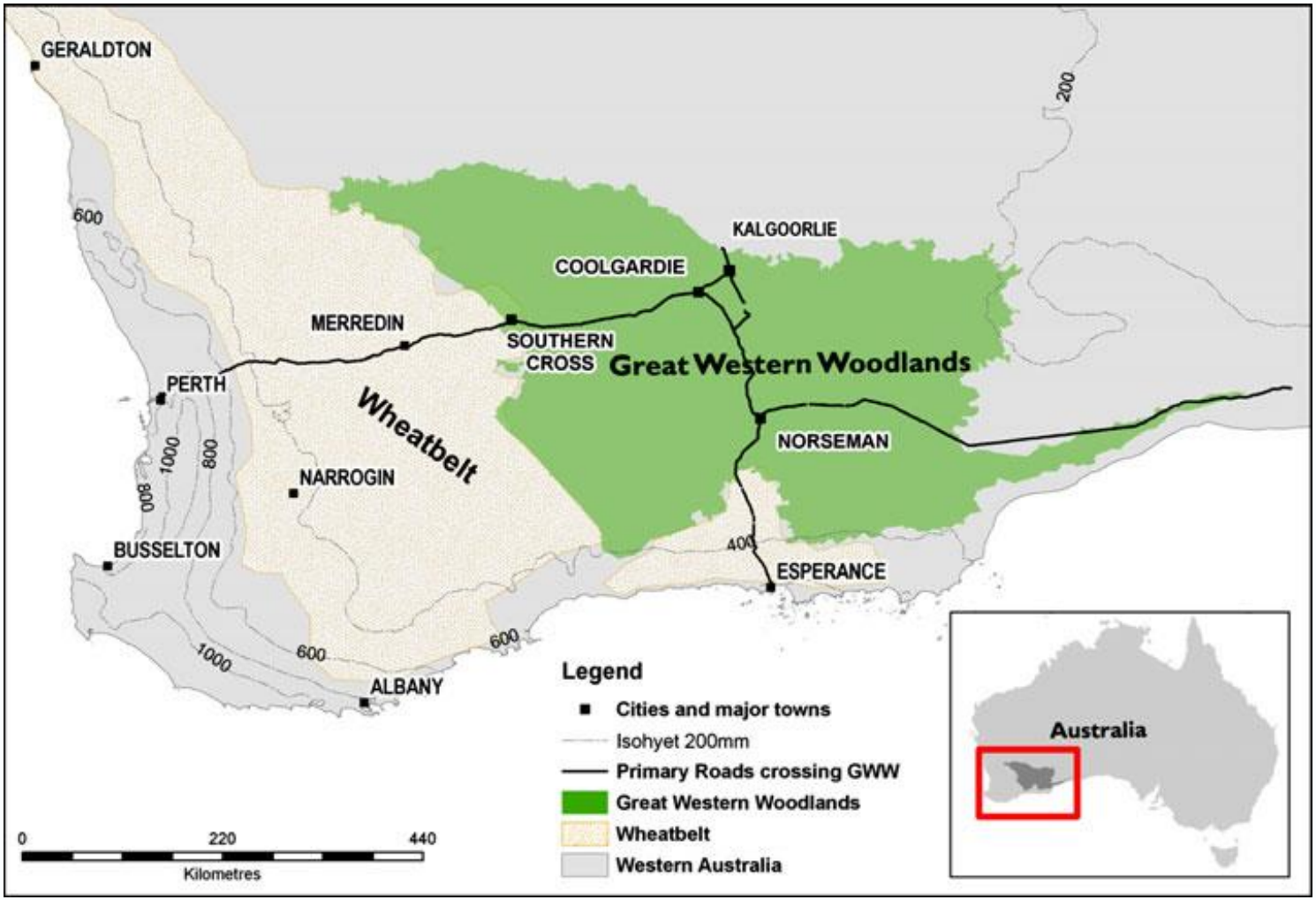
Outline

- Overview of GWW, Credo Station and the flux tower site.
- Climate of Kalgoorlie compared to Alice Springs.
- The first year's flux data (2013).
- Respiration partitioning.



Approximately 56% of the 160,000 km^2 region supports temperate eucalypt woodland, in mosaic with shrubland, mallee and other vegetation. The adjacent WA wheatbelt is comparable but 93% has been cleared (Prober et al. (2012)).

Great Western Woodlands

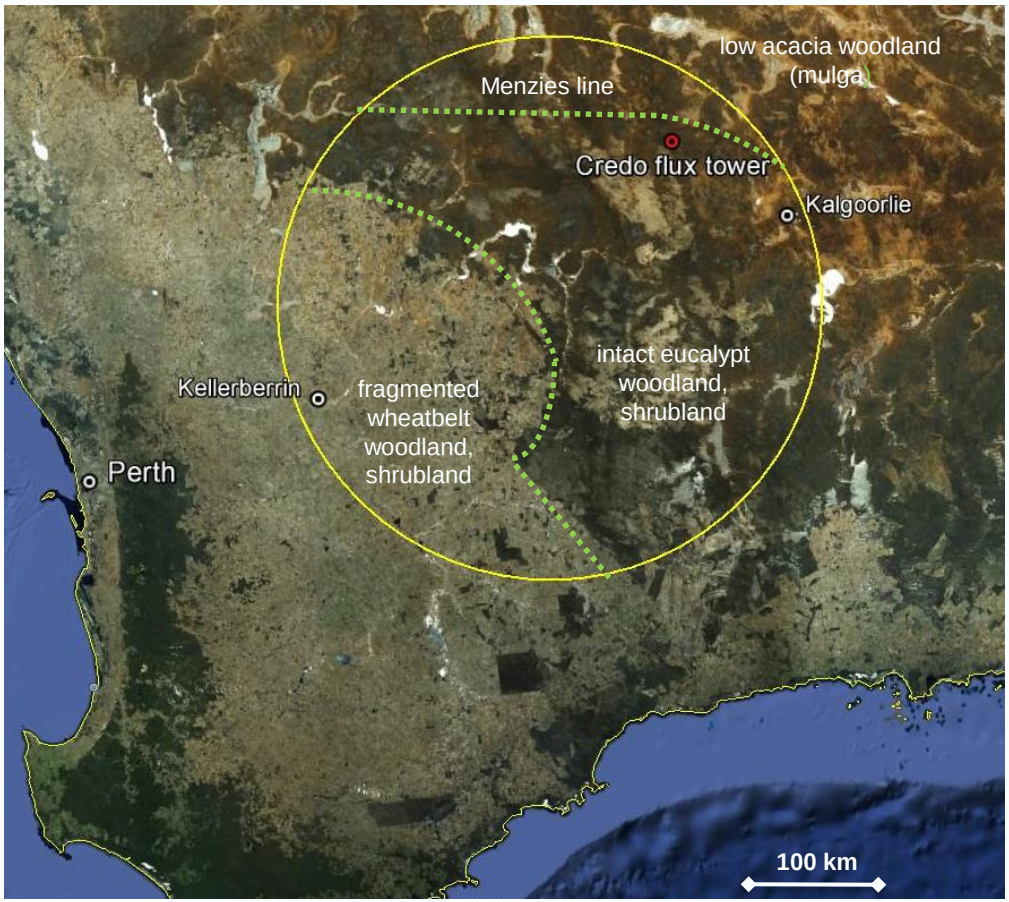
- World's largest intact temperate woodland.
  - 16M hectares or three times the size of Tasmania.
- World's most arid woodland.
  - 20m tall trees persisting with <300mm annual rainfall.
- Mega-diverse. Contains:
  - 20% of Australia's plant species.
  - 30% of Australia's eucalypt species.

Regional-scale goals

- Inform management and climate adaptation in GWW

- Inform management and climate adaptation in the adjacent wheatbelt

The Great Western Woodlands TERN supersite



Credo station

- 120 km NW Kalgoorlie / 630km from Perth.
- Ex sheep station managed for conservation by Department of Parks and Wildlife (DPaW) WA.
- New field studies centre jointly funded by DPaW, TERN and Goldfields Environmental Management Group.
- 260mm mean annual rainfall; uniform-summer dominant.
- At the northern extent of GWW where climate change will impact woodlands soonest.
- Less than 100kms south of ‘Menzies line’ that separates eucalypt woodland from mulga woodland.
- Flux tower and 1 ha plots in old growth woodlands 35km from Credo facilities.

GWW Flux tower site

- 36 m tall tower; 18 m tall vegetation.
- 'homogeneously heterogeneous' ***vegetation*** for at least 4km radius.
- old-growth woodland – uncut during goldrush.
- operational since December 2012.
- deep (4-8m) transported red clays overlying in-situ weathered regolith (to at least 50m depth).
- calcareous hardpans at various depths.
- saline groundwater at 35-45m depth.
- NOT a fire-prone ecosystem.

Main vegetation types


Eucalyptus salmonophloia
Salmon gum woodland


Eucalyptus salubris Gimlet woodland


Maireana sedifolia Chenopod shrubalnd

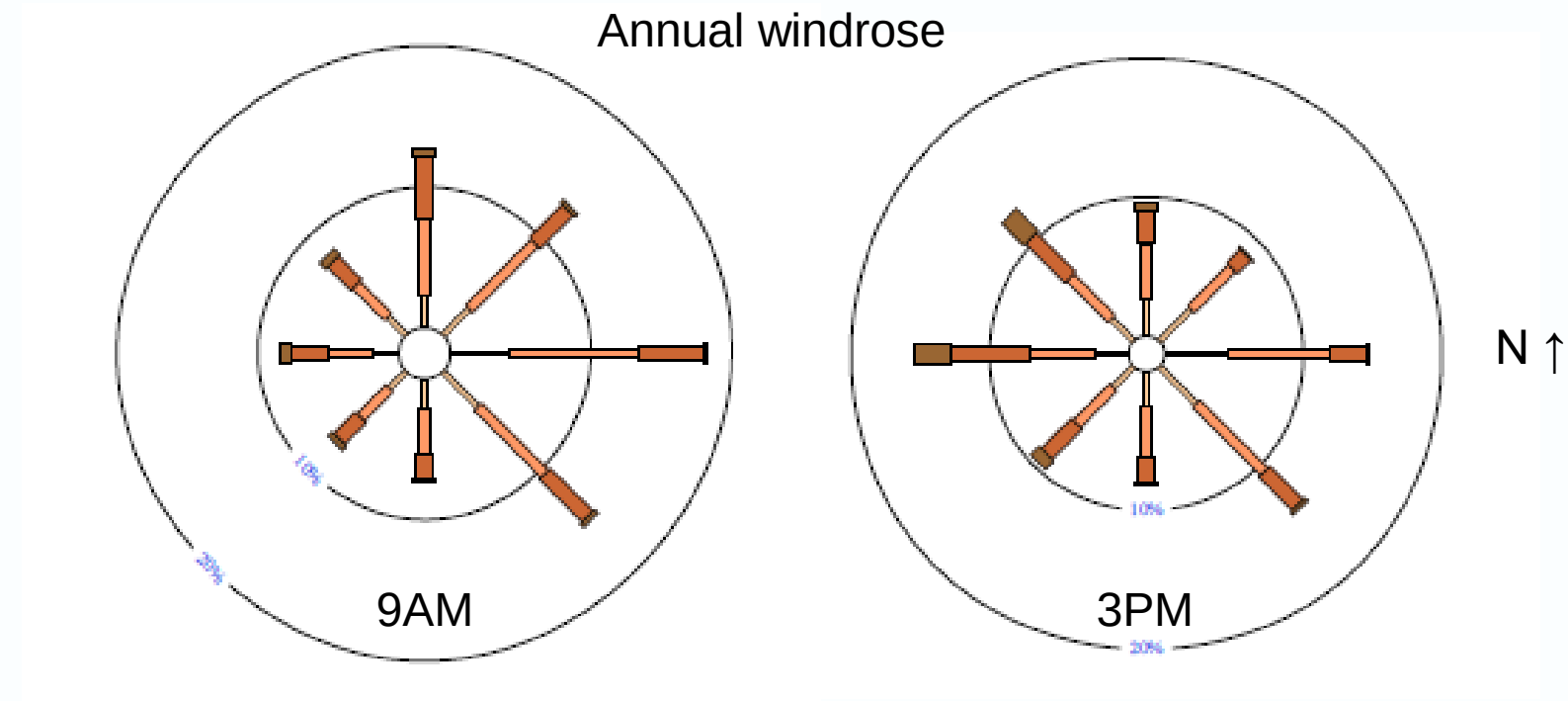

Eucalyptus transcontinentalis
Redwood woodland


Eucalyptus clelandii Blackbutt woodland

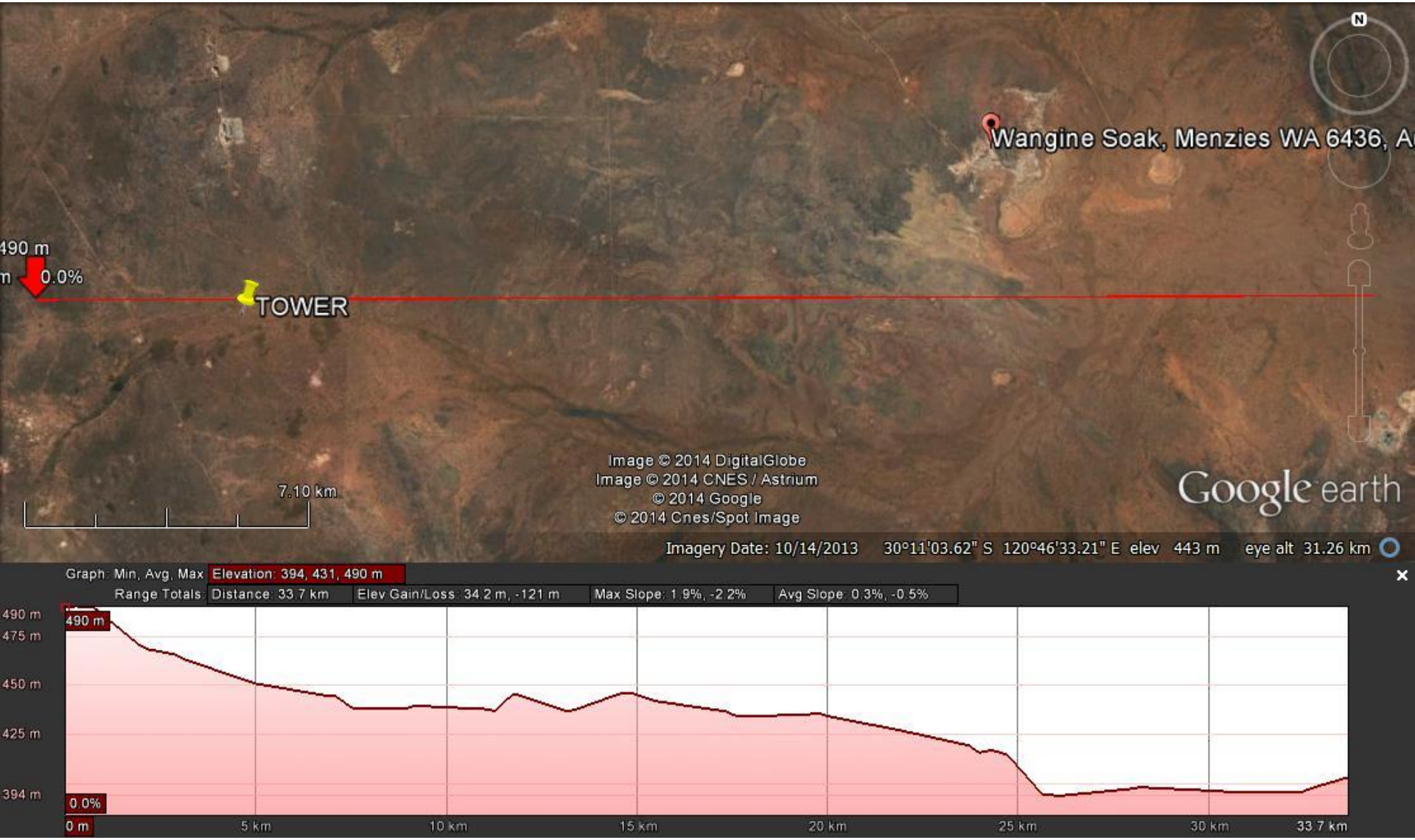

Acacia aneura Mulga woodland

Where does the wind come from?

- CSAT3 points directly south.
- LI-7500A positioned north-east of sonic transducers.
- Obstruction of northerly and north-easterly winds.



Is it flat?


N
Wangine Soak, Menzies WA 6436, A
490 m
m
0.0%
TOWER
7.10 km
Image © 2014 DigitalGlobe
Image © 2014 CNES / Astrium
© 2014 Google
© 2014 Cnes/Spot Image
Google earth
Imagery Date: 10/14/2013 30°11'03.62" S 120°46'33.21" E elev 443 m eye alt 31.26 km

Graph: Min, Avg, Max Elevation: 394, 431, 490 m
Range Totals: Distance: 33.7 km Elev Gain/Loss: 34.2 m, -121 m Max Slope: 1.9%, -2.2% Avg Slope: 0.3%, -0.5%
490 m
475 m
450 m
425 m
394 m
490 m
0.0%
0 m
5 km
10 km
15 km
20 km
25 km
30 km
33.7 km

Is it flat?


Wangine Soak, Menzies WA 6436, A
438 m
13.3 km
0.4%
TOWER
7.11 km
Image © 2014 DigitalGlobe
Image © 2014 CNES / Astrium
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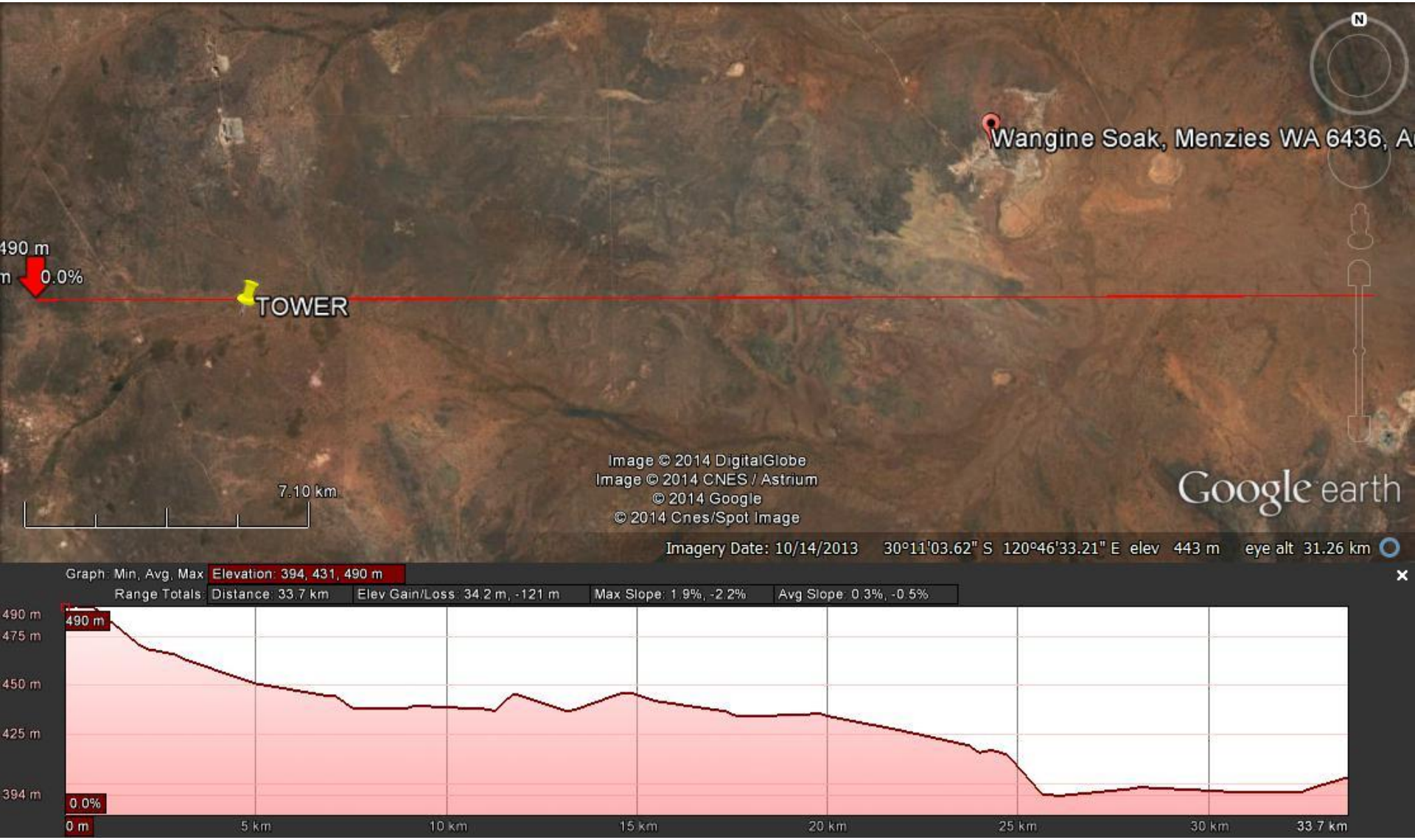
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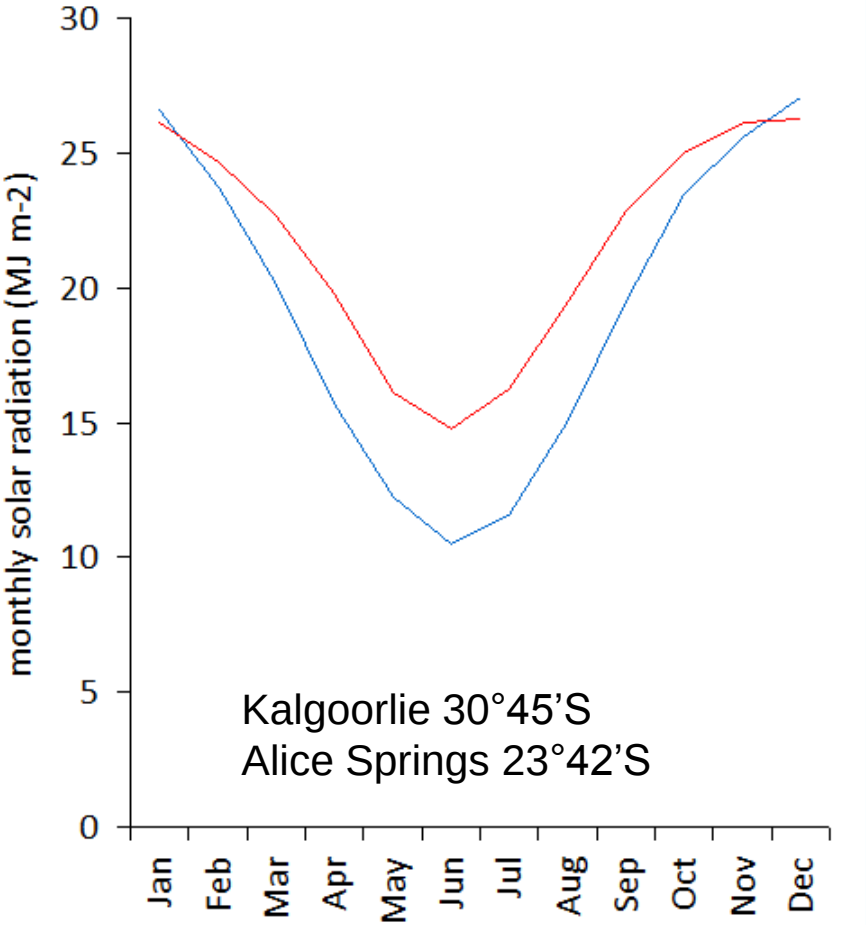
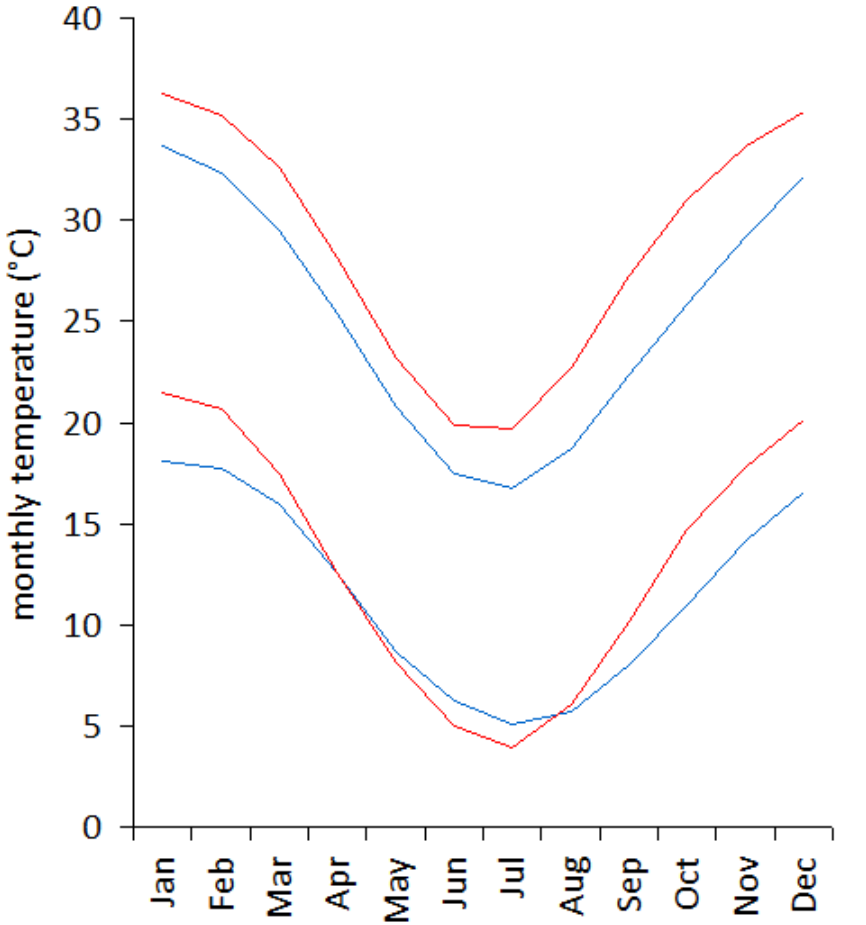
33.7 km

GWW Flux tower site description

Site	basal area m2/ha	sapwood area m2/ha	foliage cover	LAI	LA:SA m2/cm2
Salmongum	5.0	0.47	0.08	0.31	0.65
Gimlet	5.1	0.51	0.11	0.41	0.80
Redwood	4.9	0.53	0.09	0.26	0.48
Blackbutt	6.6	1.59	0.17	0.47	0.30

Climate of Kalgoorlie and Alice Springs





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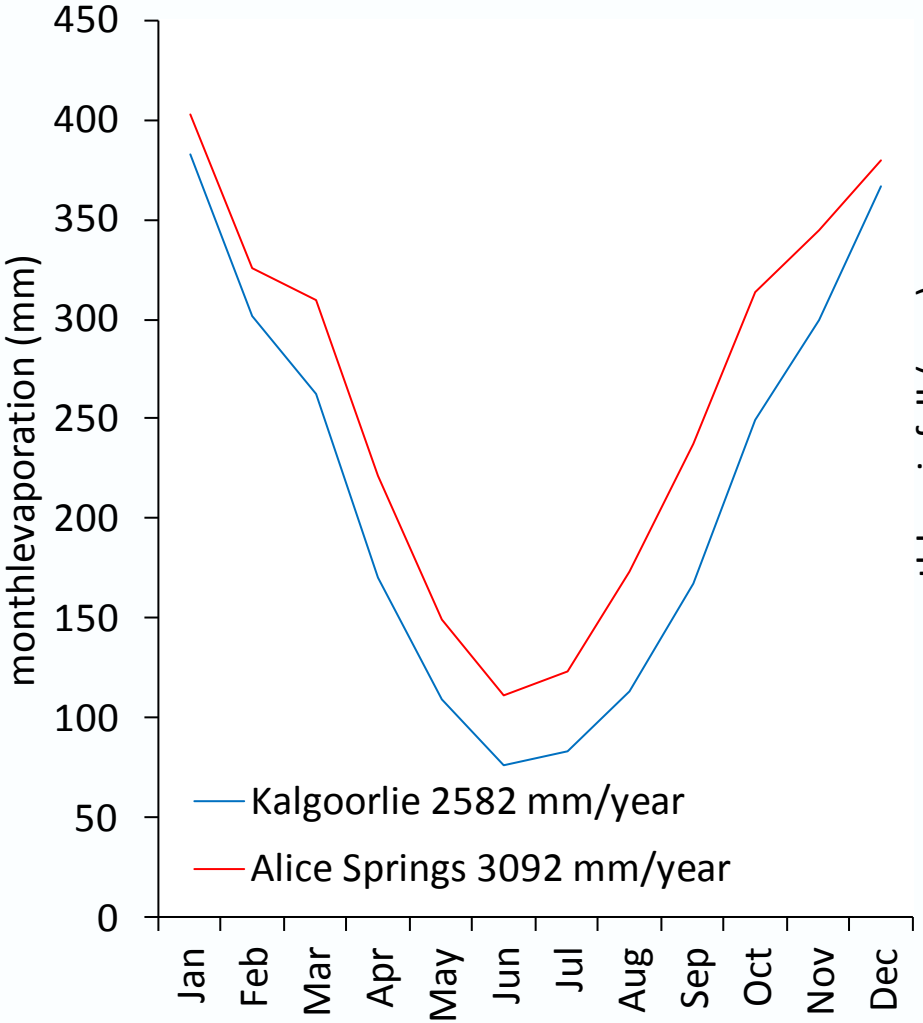
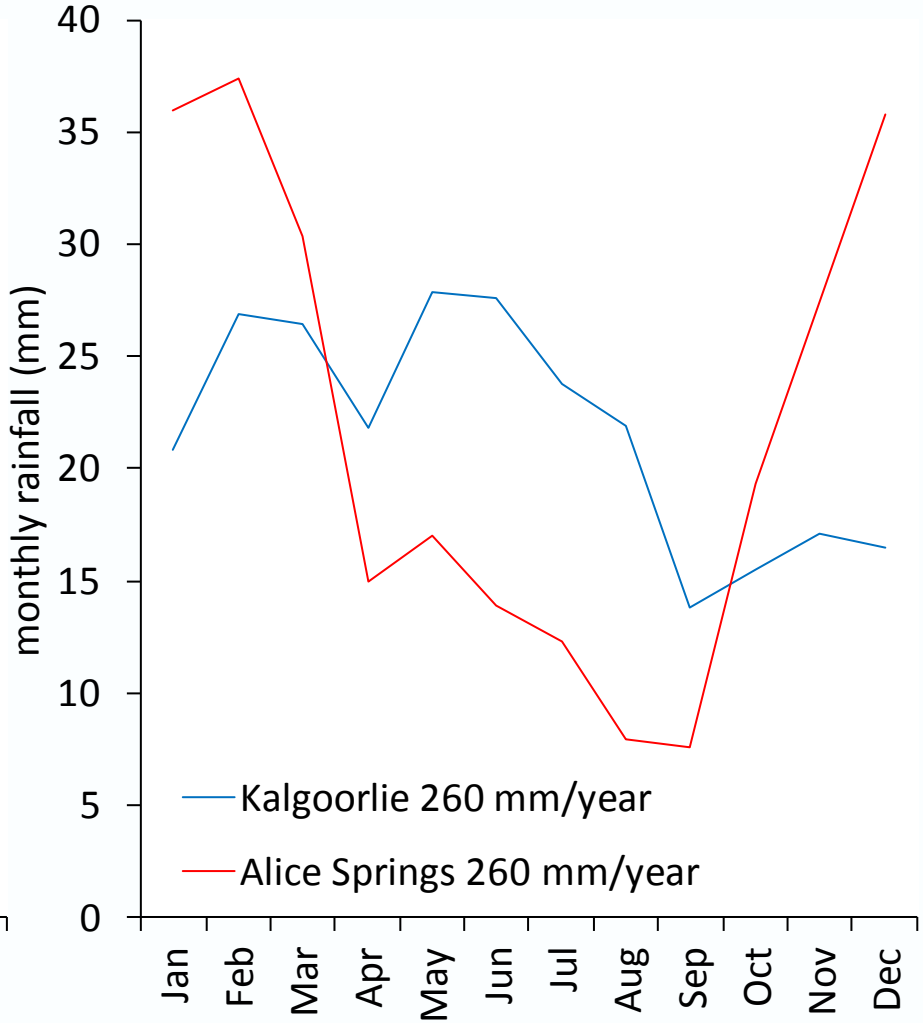
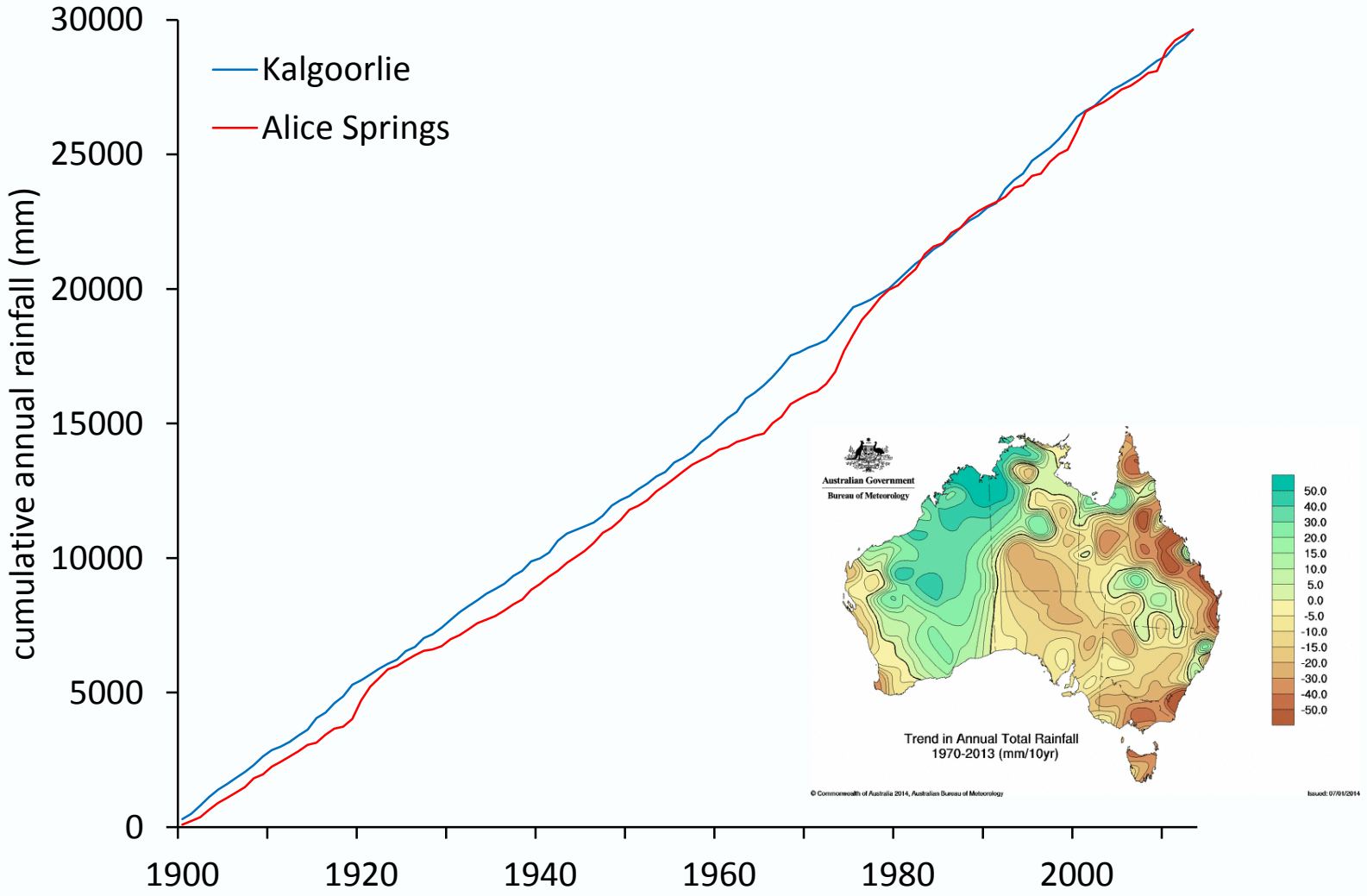
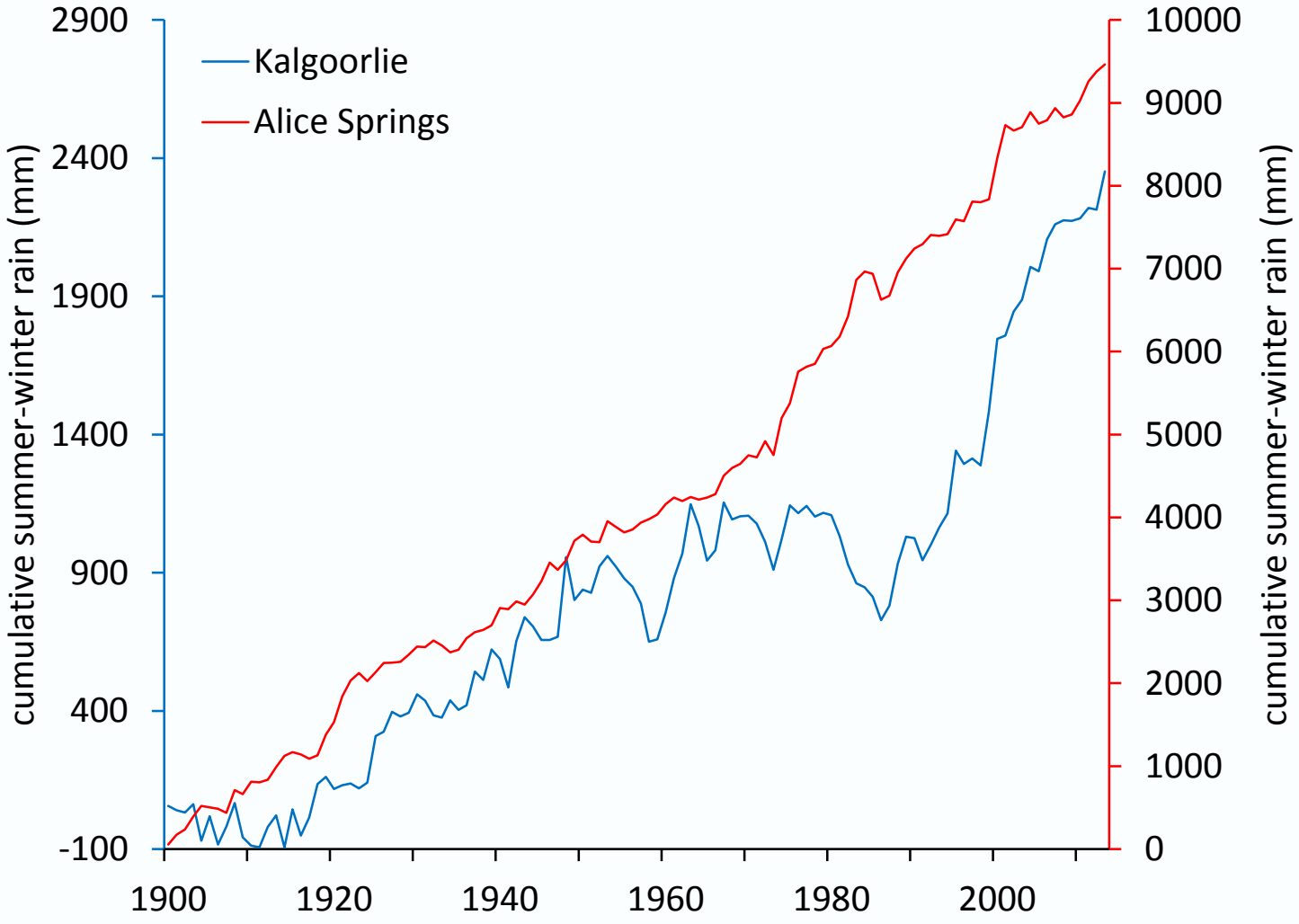




Rainfall trend



Cumulative summer-winter rainfall



Climate comparison summary

- Annual rainfall at Kalgoorlie similar to Alice Springs but more uniformly distributed.
- Less radiation and potential evaporation at Kalgoorlie.
- Recent increase of summer rainfall at Kalgoorlie.
- Credo predicted to have increasing rainfall and increasing summer rainfall.

Questions

- Is old-growth salmongum a carbon source or a carbon sink?
- How will increasing (summer) rainfall impact on carbon fluxes and stores in old-growth salmongum?
- Does climate change have implications for carbon, weed and fire management of the Great Western Woodlands?

Tower measurements

At 36m: Radiation, carbon, water, heat and momentum fluxes. Wind speed/direction, temp/RH.

- At 2m: temp/RH.
- At 8cm depth: 3*heatflux plates.
- Soil moisture at depths: 5, 10, 20, 30, 50, 70, 90, 110-140 cms.
- Soil temp at depths: 5, 10, 20, 30, 50 cm.

- Recently installed 2nd EC system at 3m.
- About to purchase: NR lite, CS650s, ???

Other site measurements

At four 1ha plots:

•Annual: DBH (4 sites) and LAI/cover (2), floristics/ground-cover (2), soil/and diversity (1).

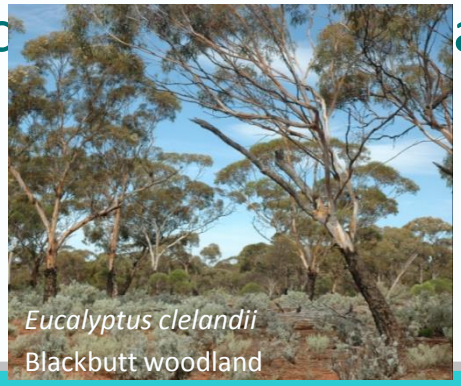
•Quarterly: litterfall (4), soil respiration and soil evaporation (2), groundwater depth (2).

•Continuous: band dendrometers (4), overstorey sapflow (2-4), bird monitoring (2).

•Two ecofiz campaigns led by Keith Bloomfield.


Eucalyptus salmonophloia
Salmon gum woodland


Eucalyptus salubris
Gimlet woodland

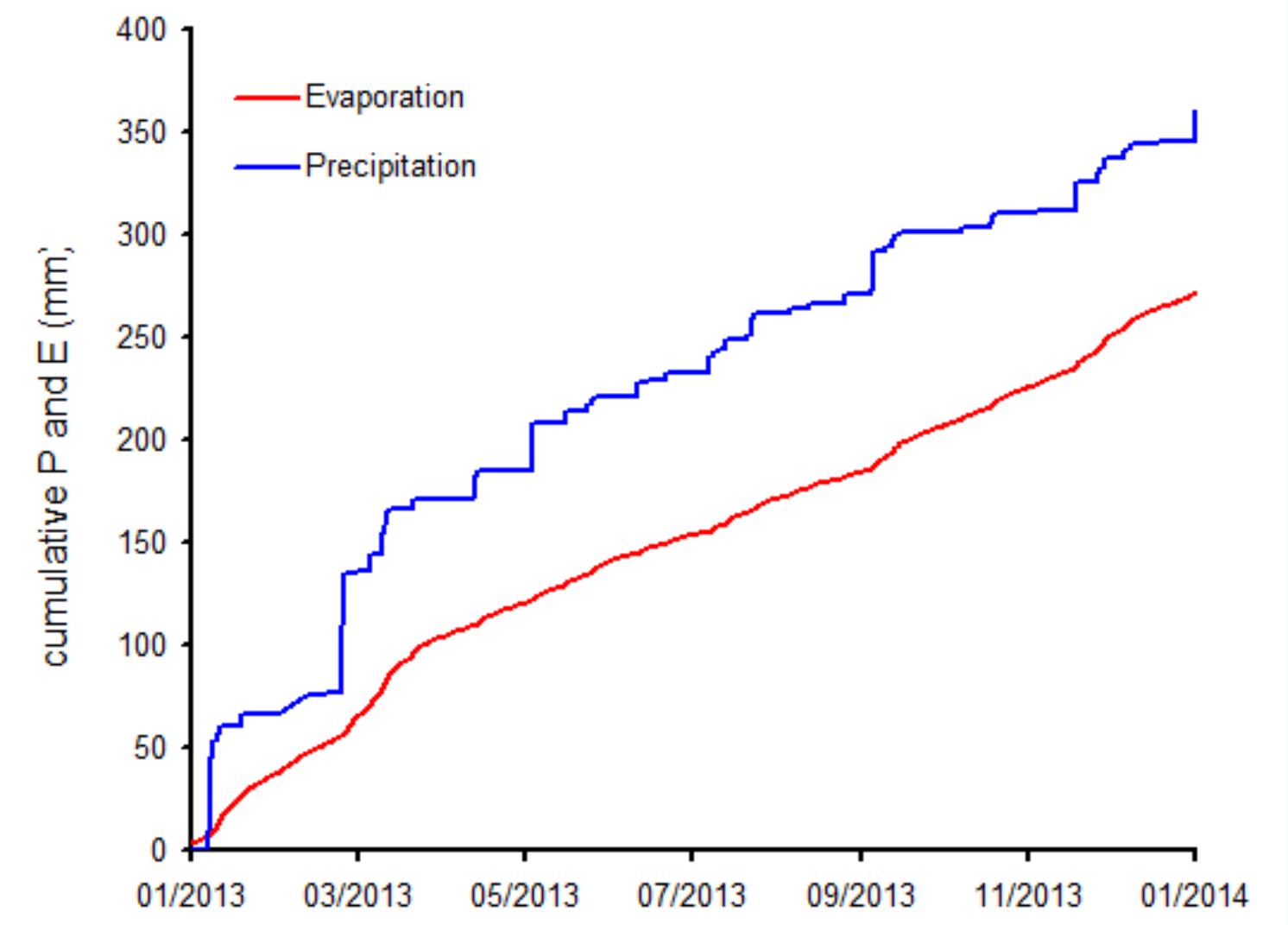

Eucalyptus clelandii
Blackbutt woodland


Eucalyptus transcontinentalis
Redwood woodland

Energy, water and carbon balance

	W/m2
mean annual available energy	113.7
mean annual latent heat flux	21.1
mean annual sensible heat flux	61.6
(Fe + Fh) / Fa	0.73
	mm
annual precipitation	360
annual evaporation	272
E/P	0.76
	ton C / ha
annual net ecosystem exchange	-0.5
annual gross ecosystem productivity	-3.7
annual gross ecosystem respiration	3.2

Where does the water go?



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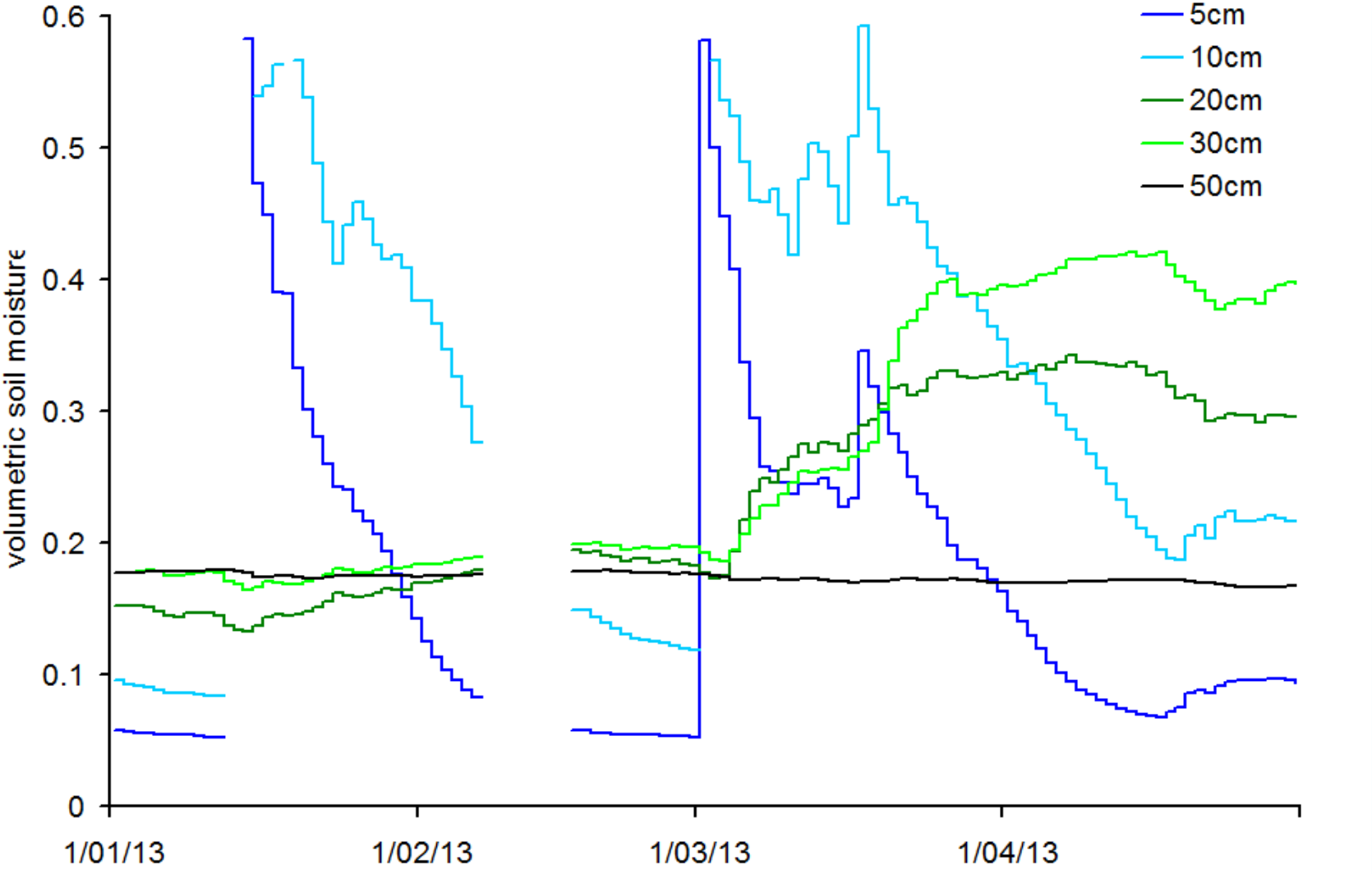

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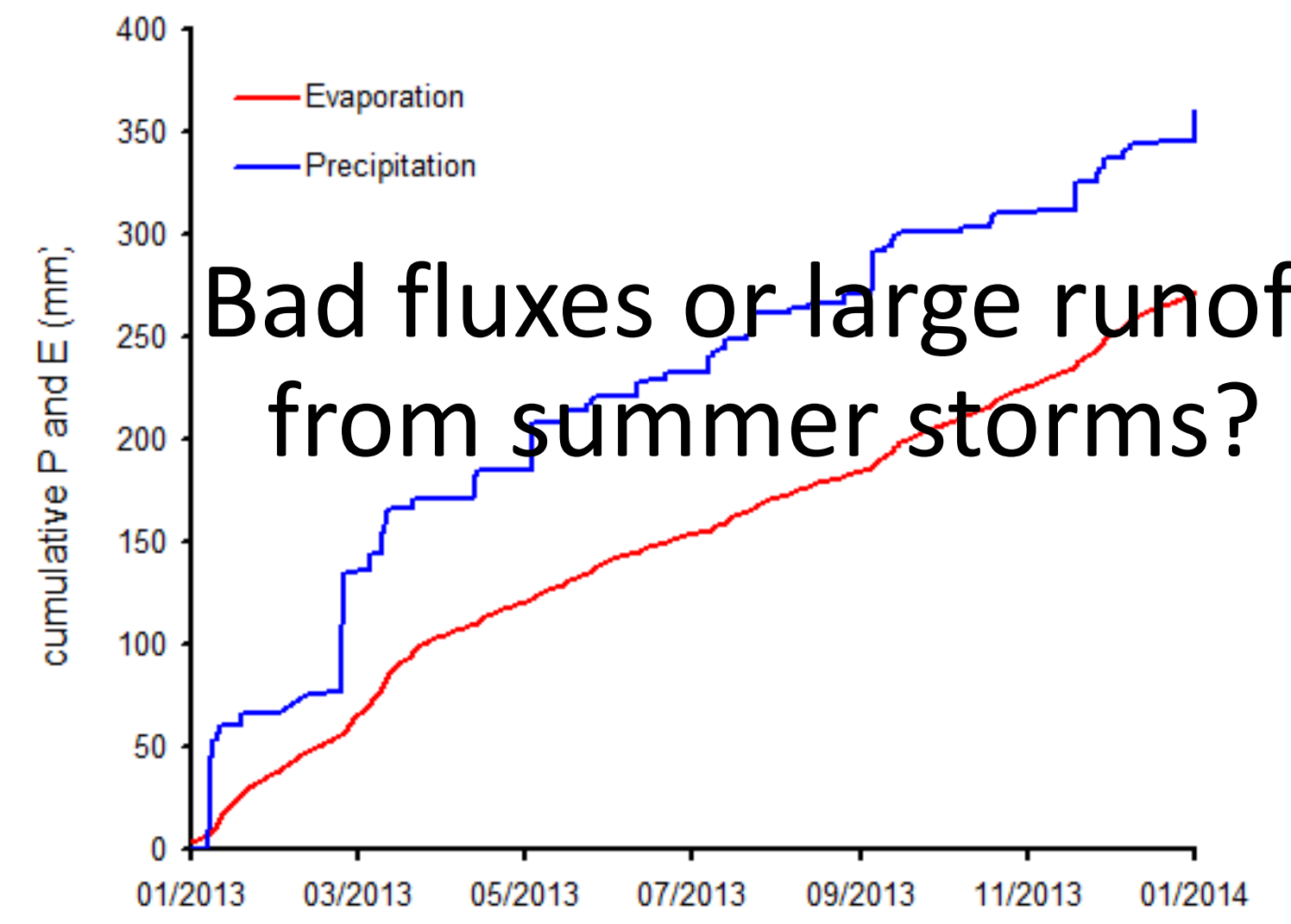
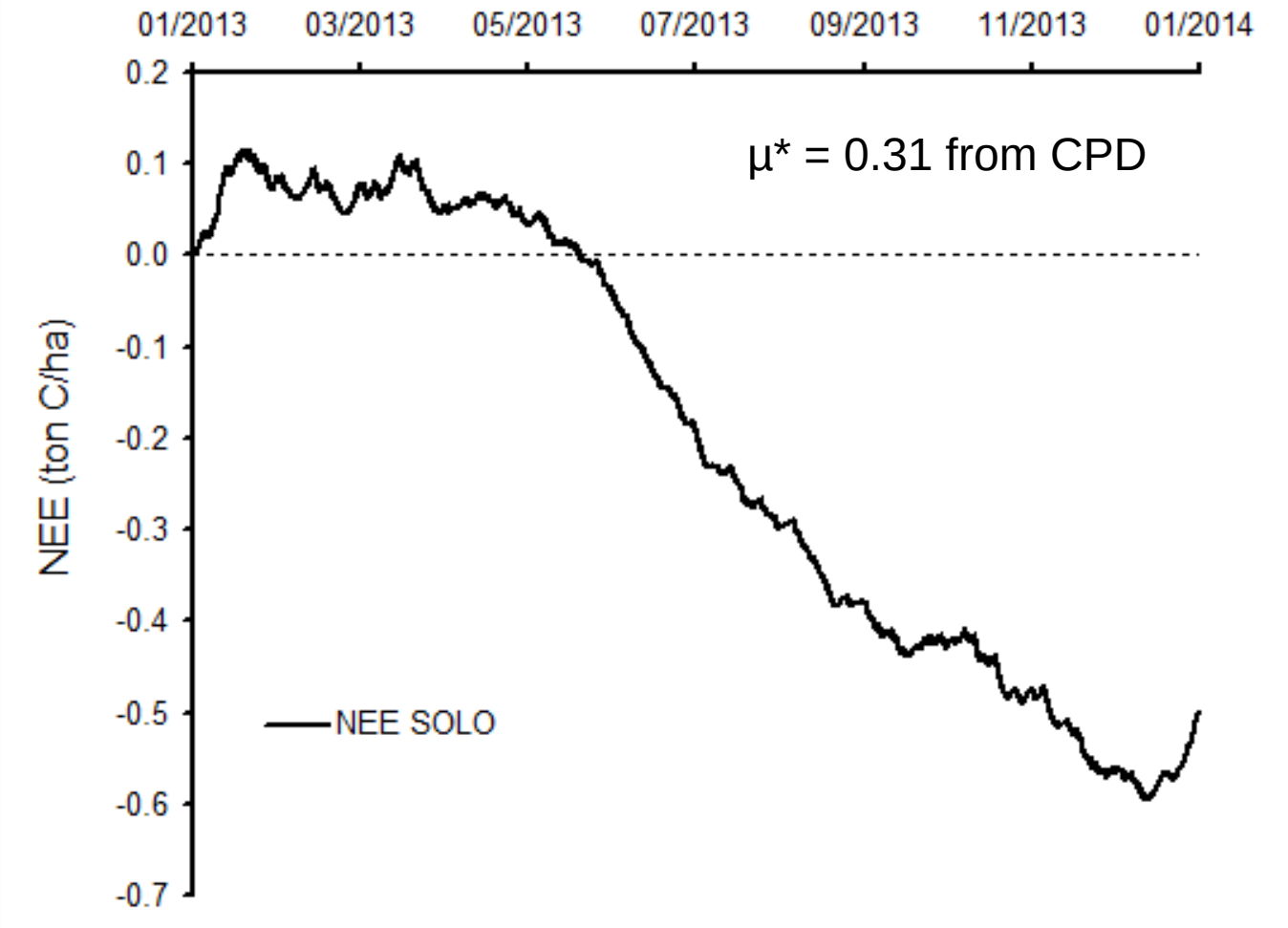
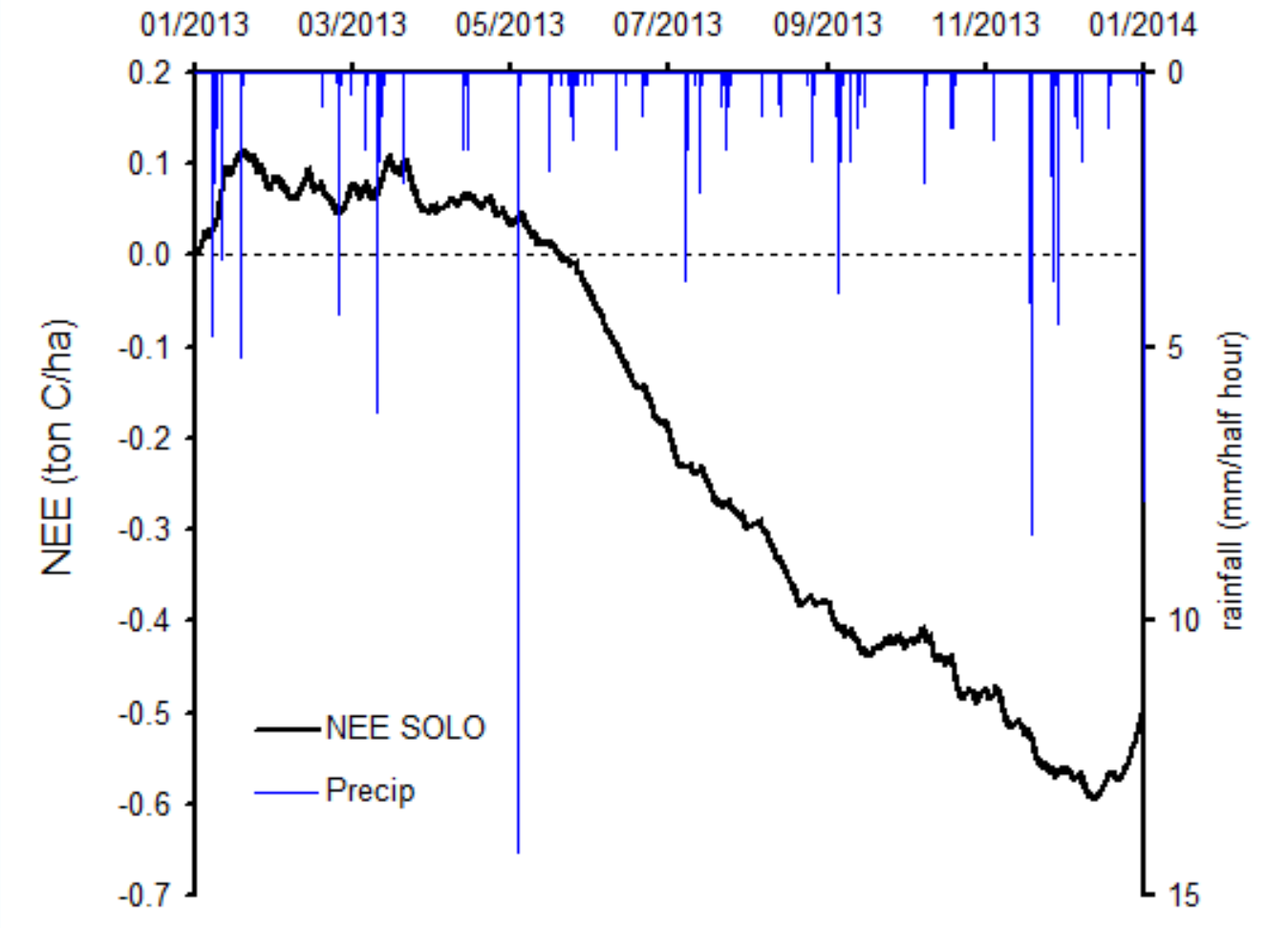


Bad fluxes or large runoff from summer storms?

Net ecosystem exchange

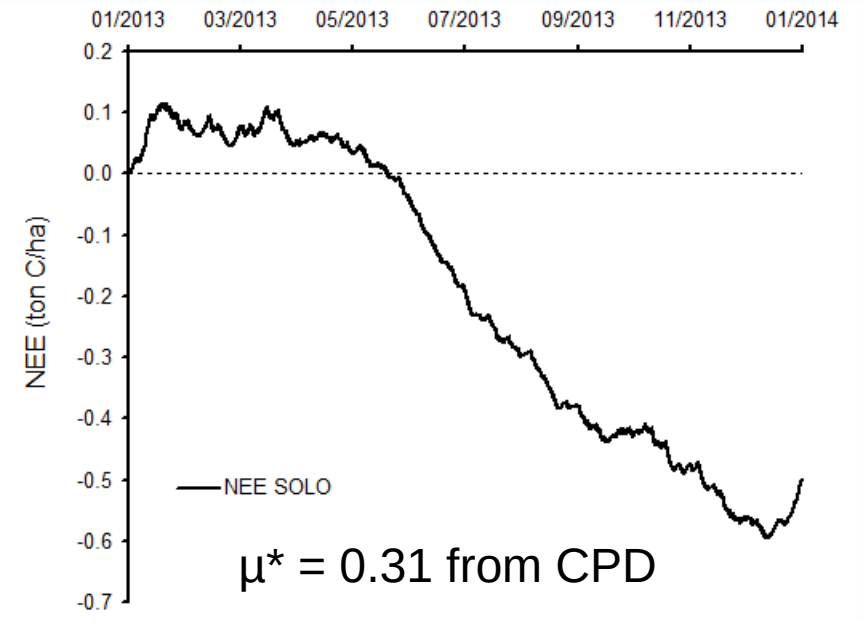


Net ecosystem exchange

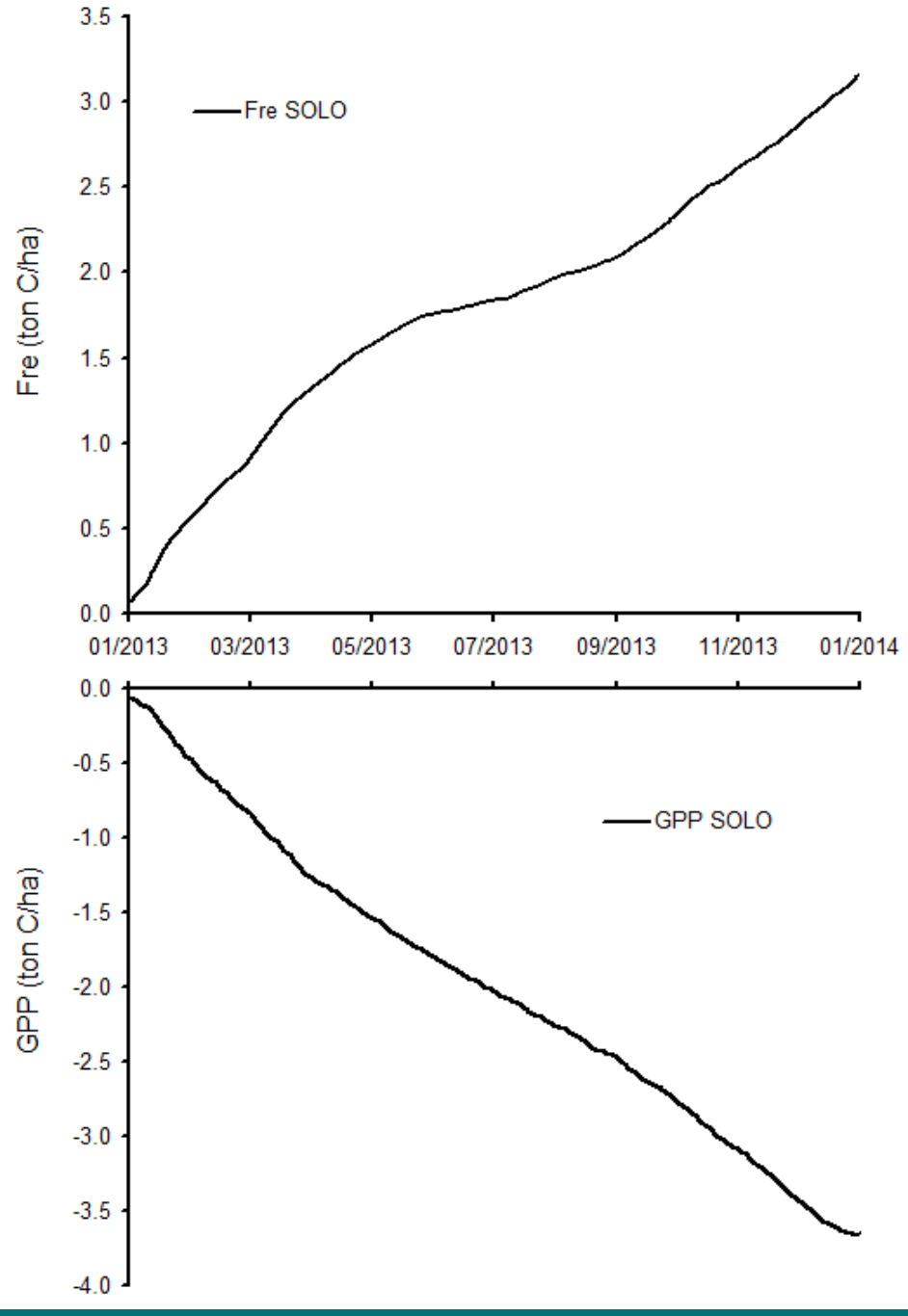


Net ecosystem exchange

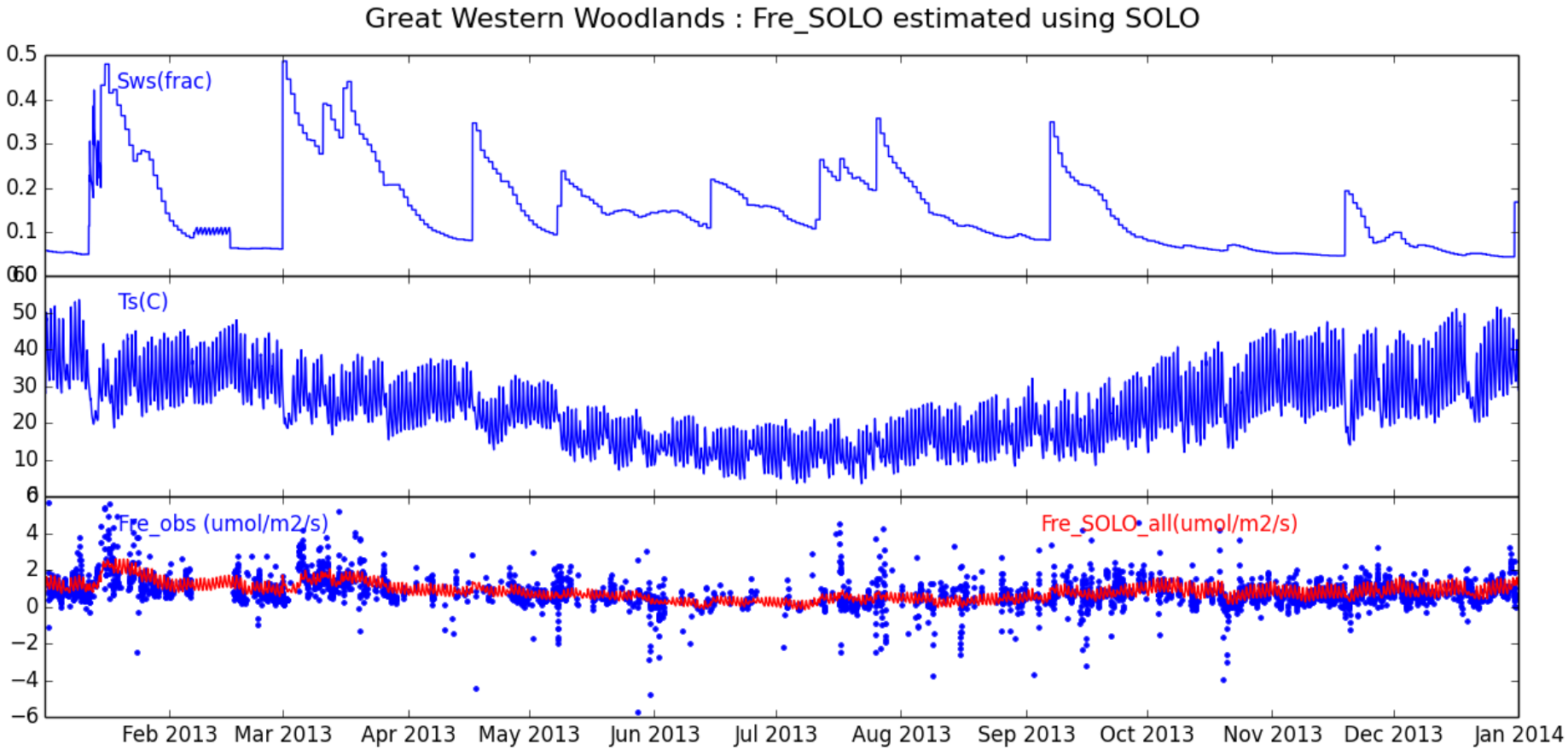
	ton C / ha
annual net ecosystem exchange	-0.5
annual gross ecosystem productivity	-3.7
annual gross ecosystem respiration	3.2

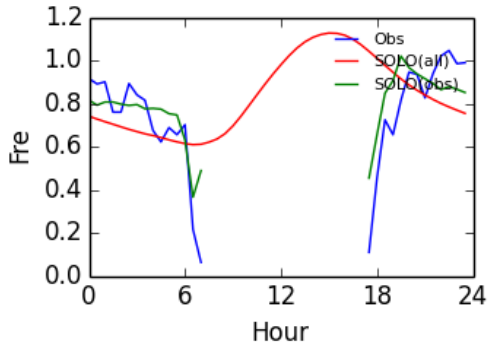


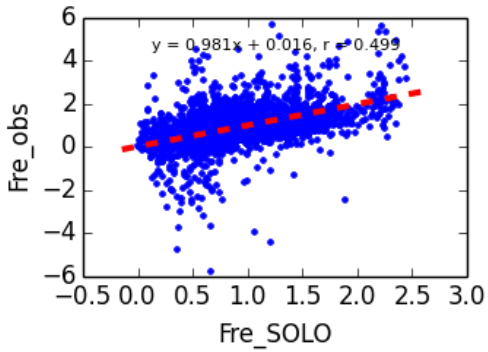
μ* = 0.31 from CPD



Guessing Fre

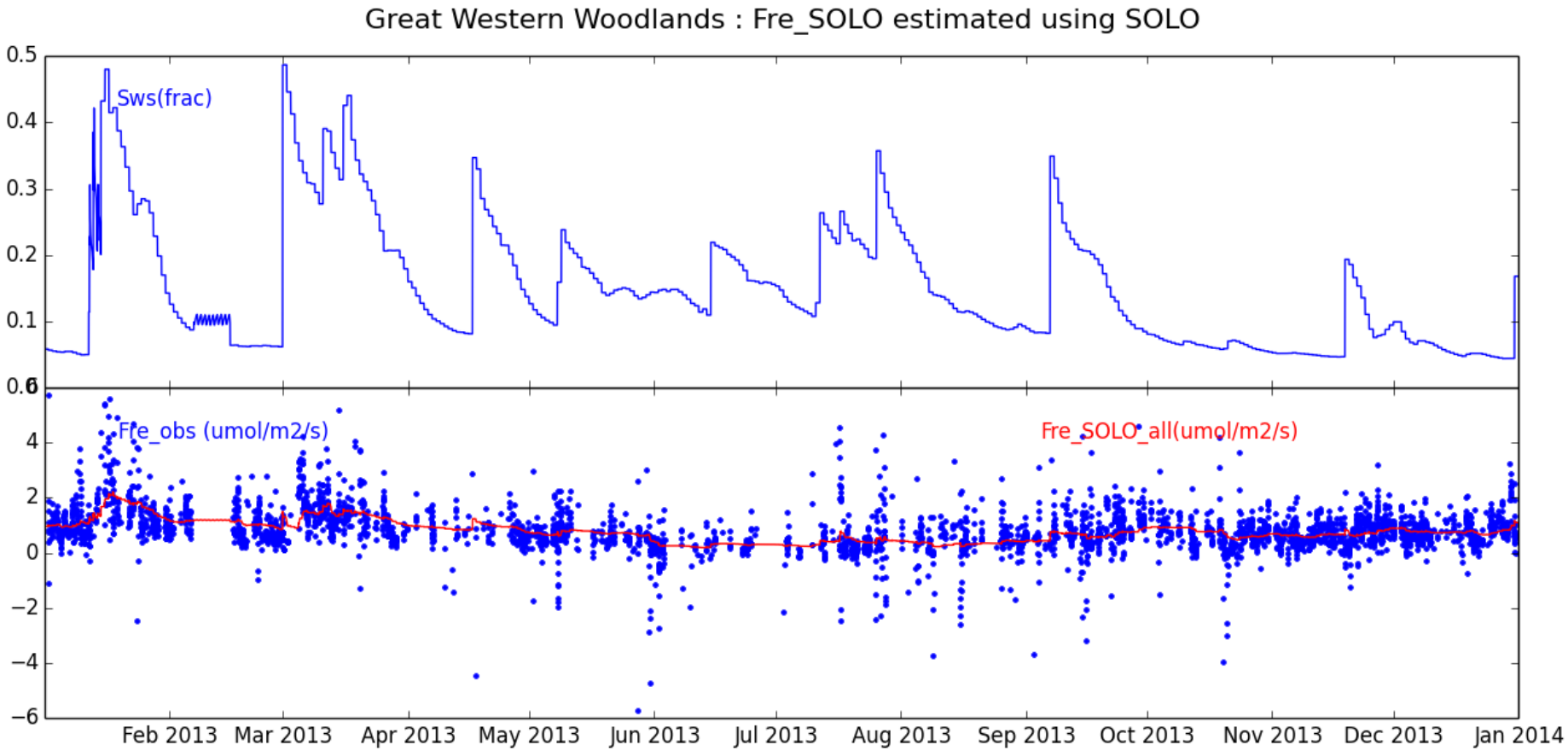


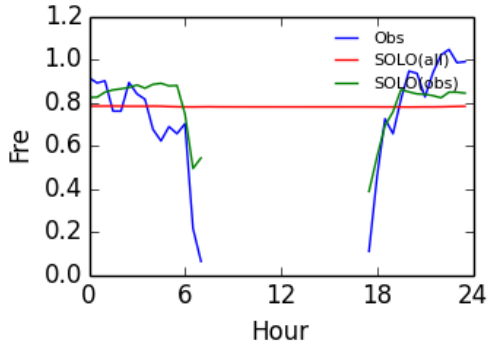


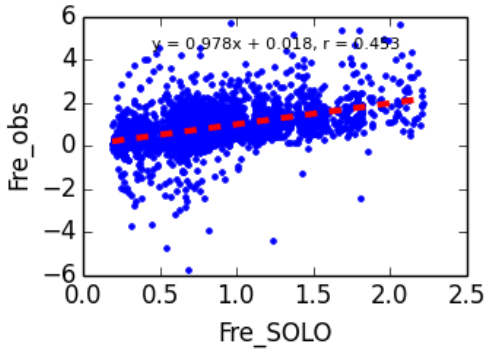


No. points	3541	No. filled	13979
Nodes	1	Slope	0.9805
Training	500	Offset	0.01624
Nda factor	5	r	0.499
Learning rate	0.01	RMSE	0.7128
Iterations	500		

Guessing Fre



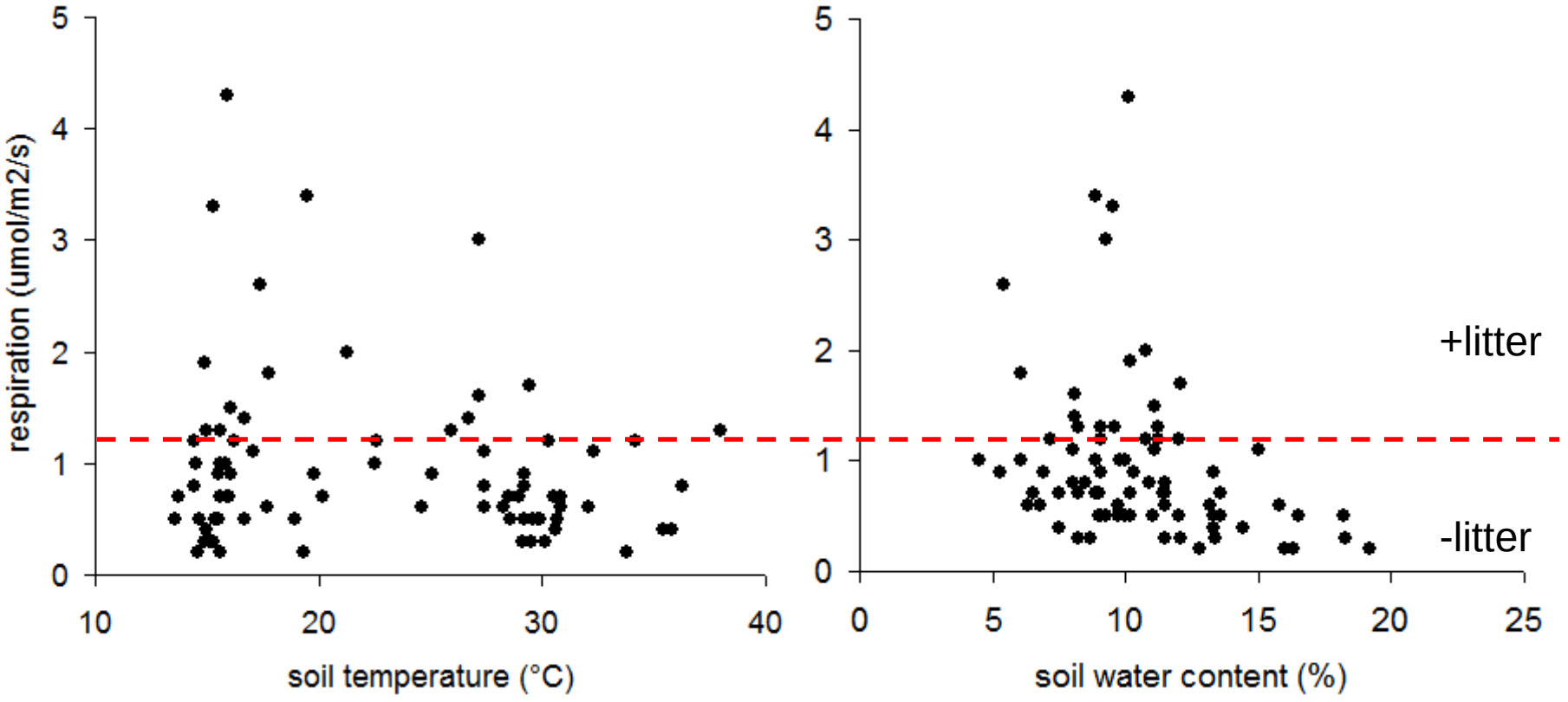




No. points	3541	No. filled	13979
Nodes	1	Slope	0.9781
Training	500	Offset	0.01823
Nda factor	5	r	0.4532
Learning rate	0.01	RMSE	0.7332
Iterations	500		

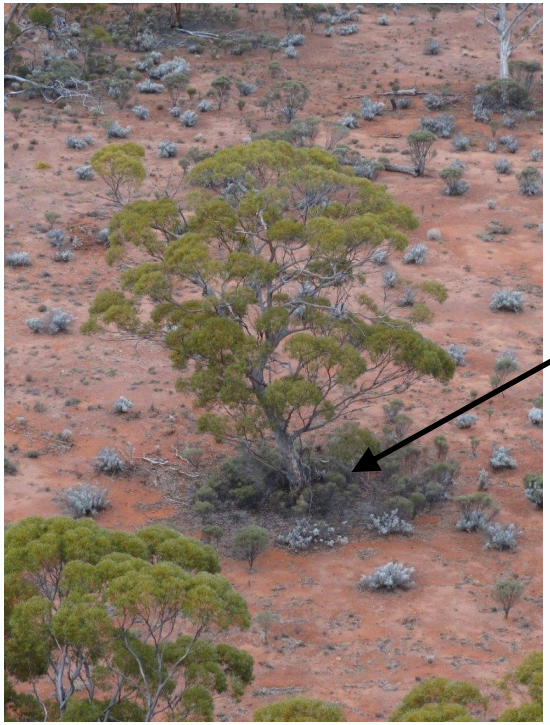
Soil respiration in September 2014

- Mean Rs = 1 µmol/m2/s = 3.8 ton C /ha/year.
- During daytime only.

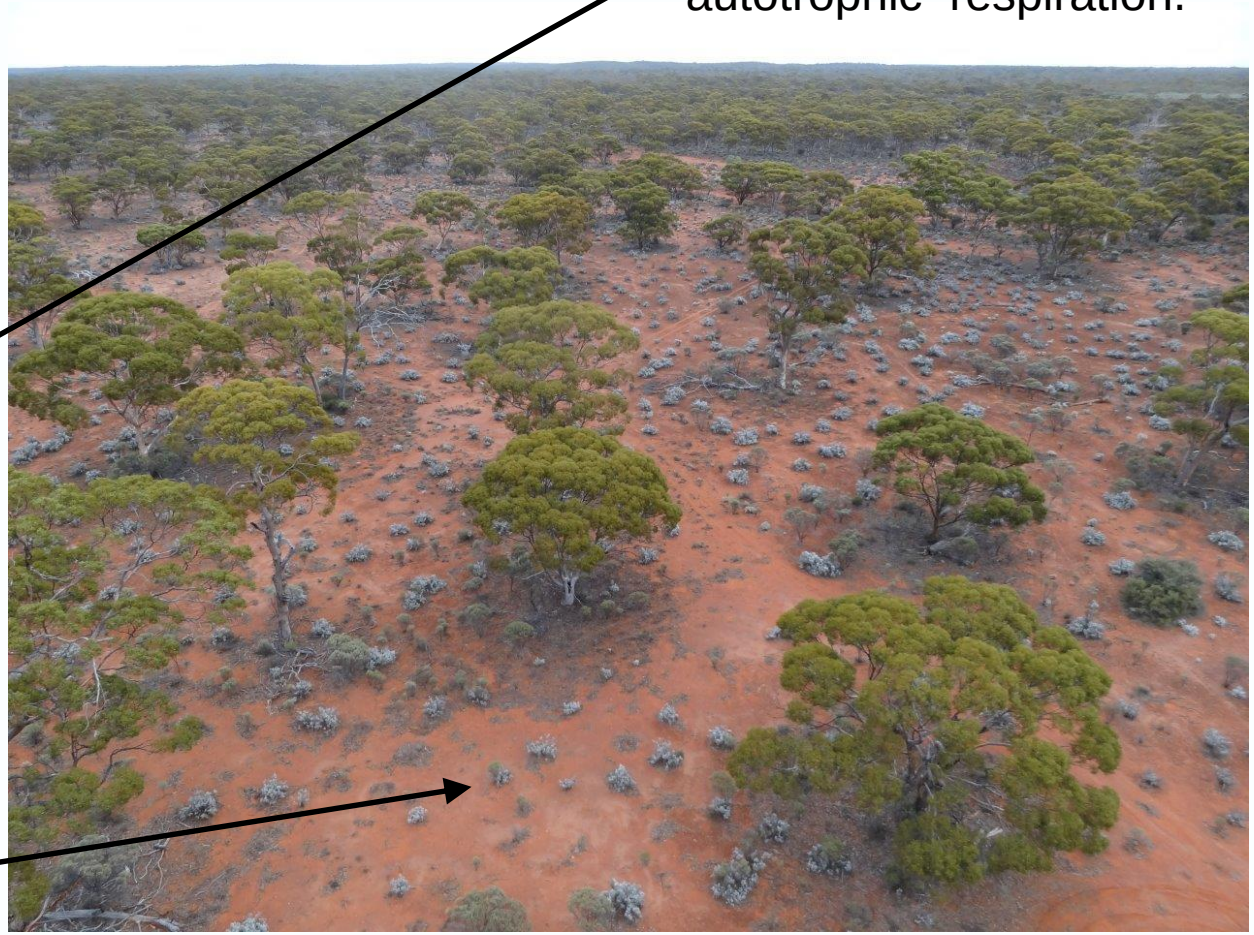


Resource islands

Resource islands



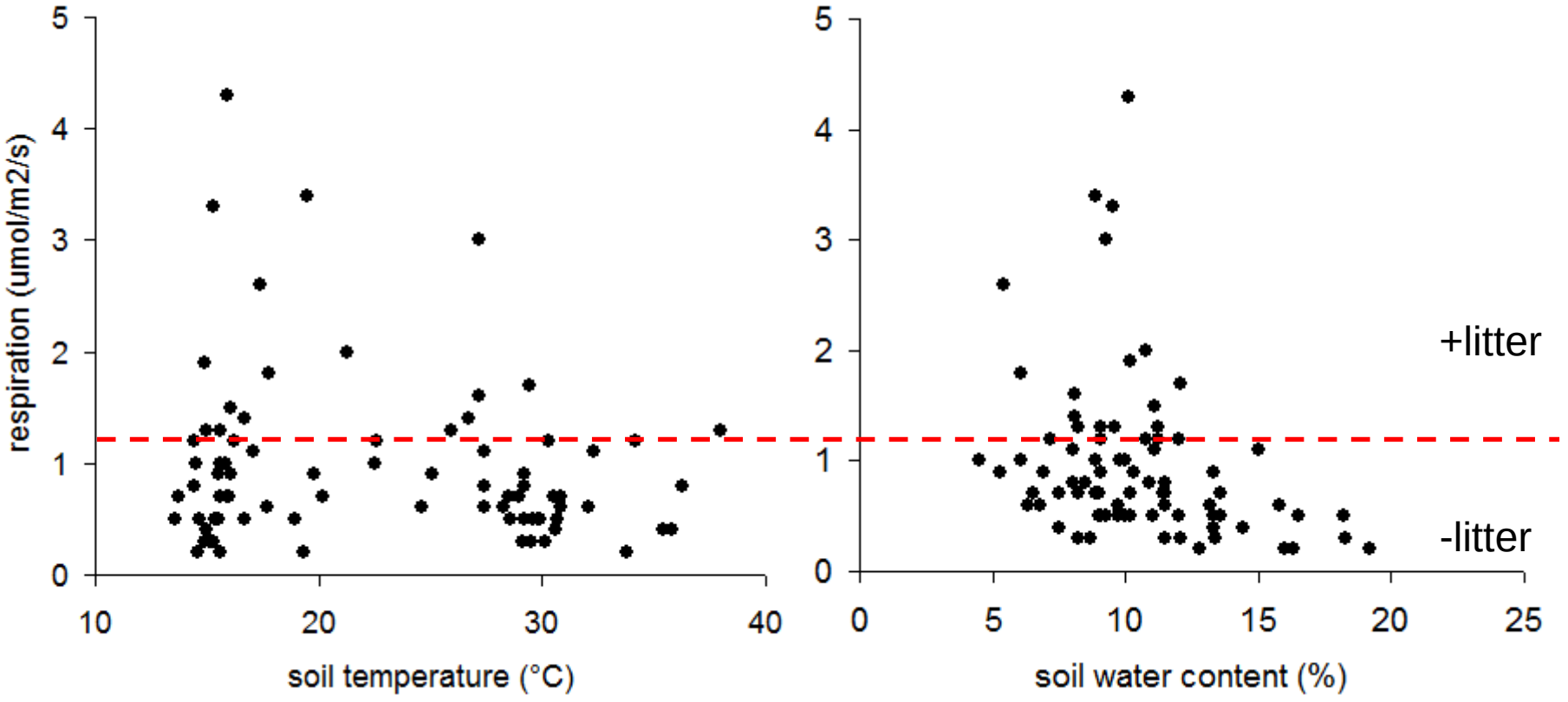
Heterotrophic and autotrophic respiration.



Mainly autotrophic respiration?

Soil respiration in September 2014

- Mean Rs = 1 µmol/m2/s = 3.8 ton C /ha/year.
- Doesn't include stem, canopy, termite, coarse woody debris respiration.



Not trees






Conclusions from 2013

- Low productivity consistent with low annual rainfall.
- Net carbon sink in 2013, but above average rainfall.
- Heavy summer rain fills the top 30-50cm of soil, but does much of the rain run off-site?
- Respiration >= assimilation in summer-autumn; opposite is true in winter-spring.
  - Temperature, tree fall, termites?
- Respiration from EC agrees well with limited field data, but could be underestimating true respiration.
  - Night versus day; soil versus whole landscape.

Final thoughts

- How to deal with obstructed wind directions?.
- Does the site suffer from serious advection?
- Can ‘resource islands’ be used to scale field data?
- Do termites control the C and H_2O balances, and stand dynamics?
  - And did they steal my missing fluxes?