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# Wombat Flux Supersite

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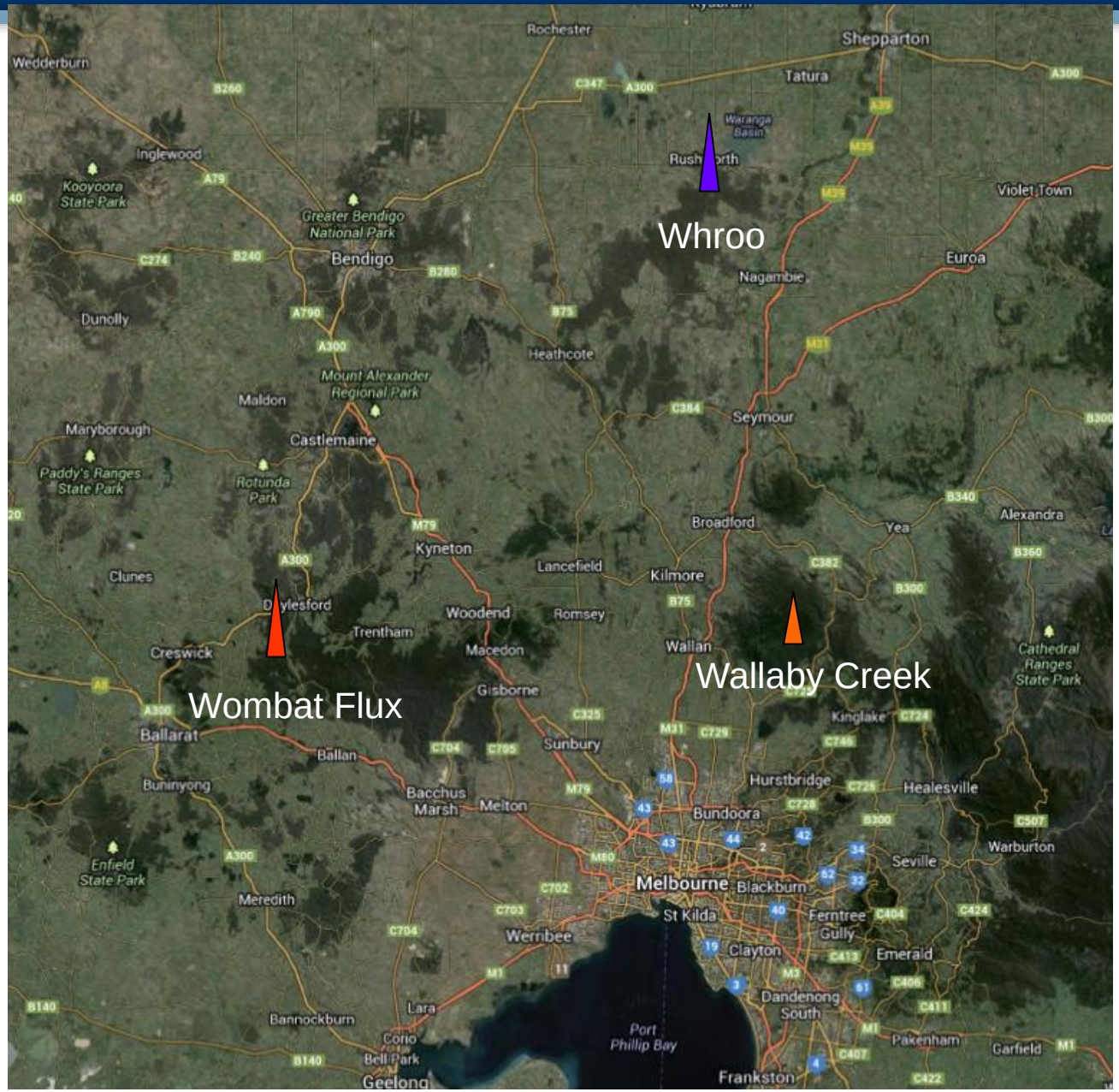
# Whroo & Wombat – two nodes of the Victorian Dry Eucalypt Supersite



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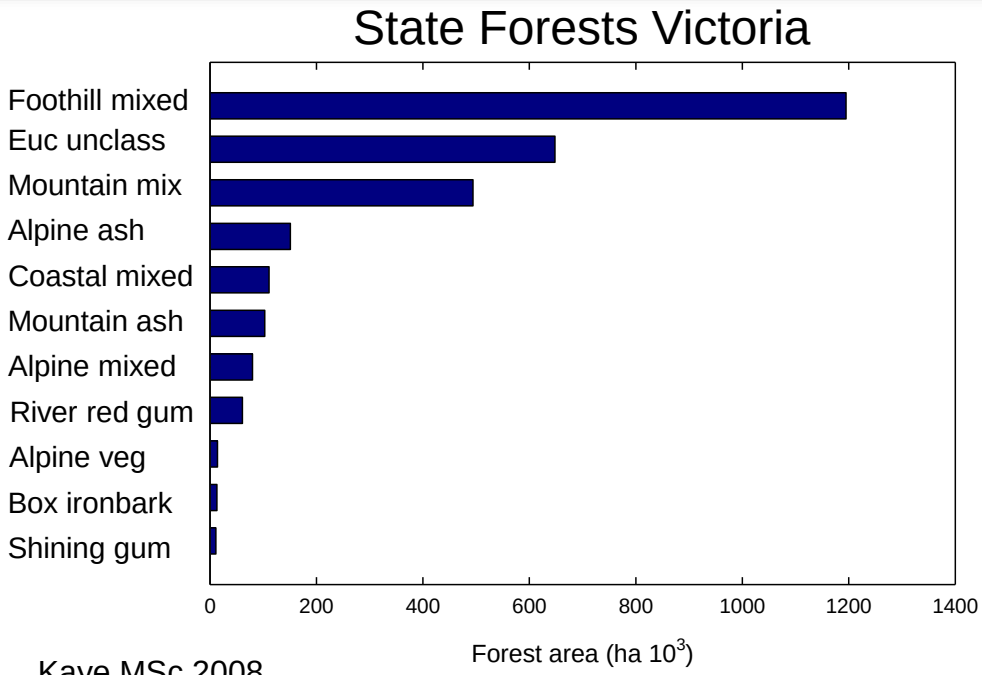


Kaye MSc 2008

- cool temperate dry sclerophyll forest
- *E. obliqua* (messmate stringybark), *E. radiata* (narrow-leafed peppermint), *E. rubida* (candlebark gum)
- Climate: cool temperate to Mediterranean (warm & dry summers, cold & wet winters)
- yellow podzolic soil, silty clays overlying clays (from Ordovician marine sediments)

*E. obliqua*

*E. radiata*

*E. rubida*

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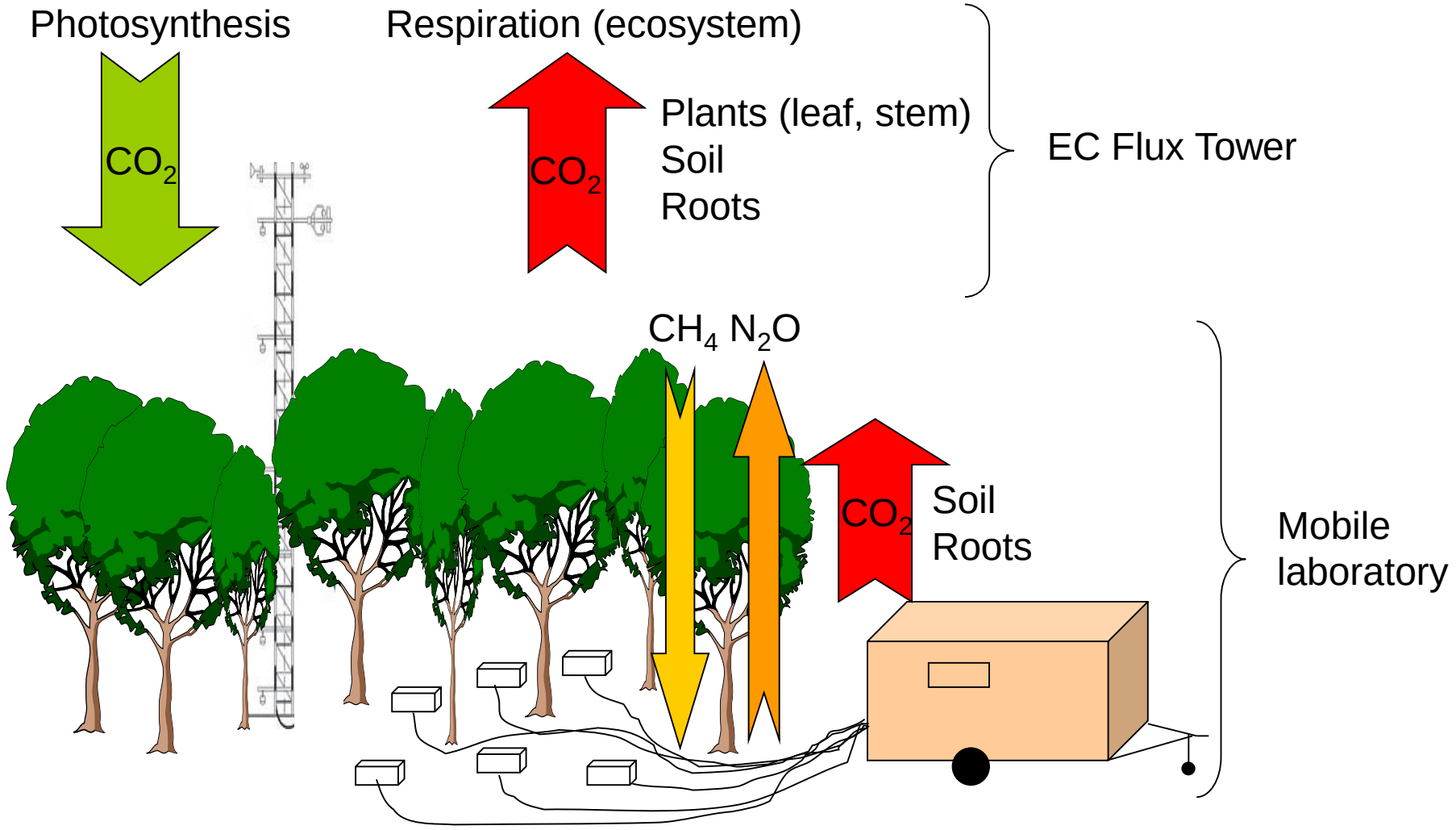
# Wombat Flux Supersite set-up




Flux tower 35m
Mean canopy 25m

Drought treatments (-40% of rainfall)

Satellite
Sites (2010-12)

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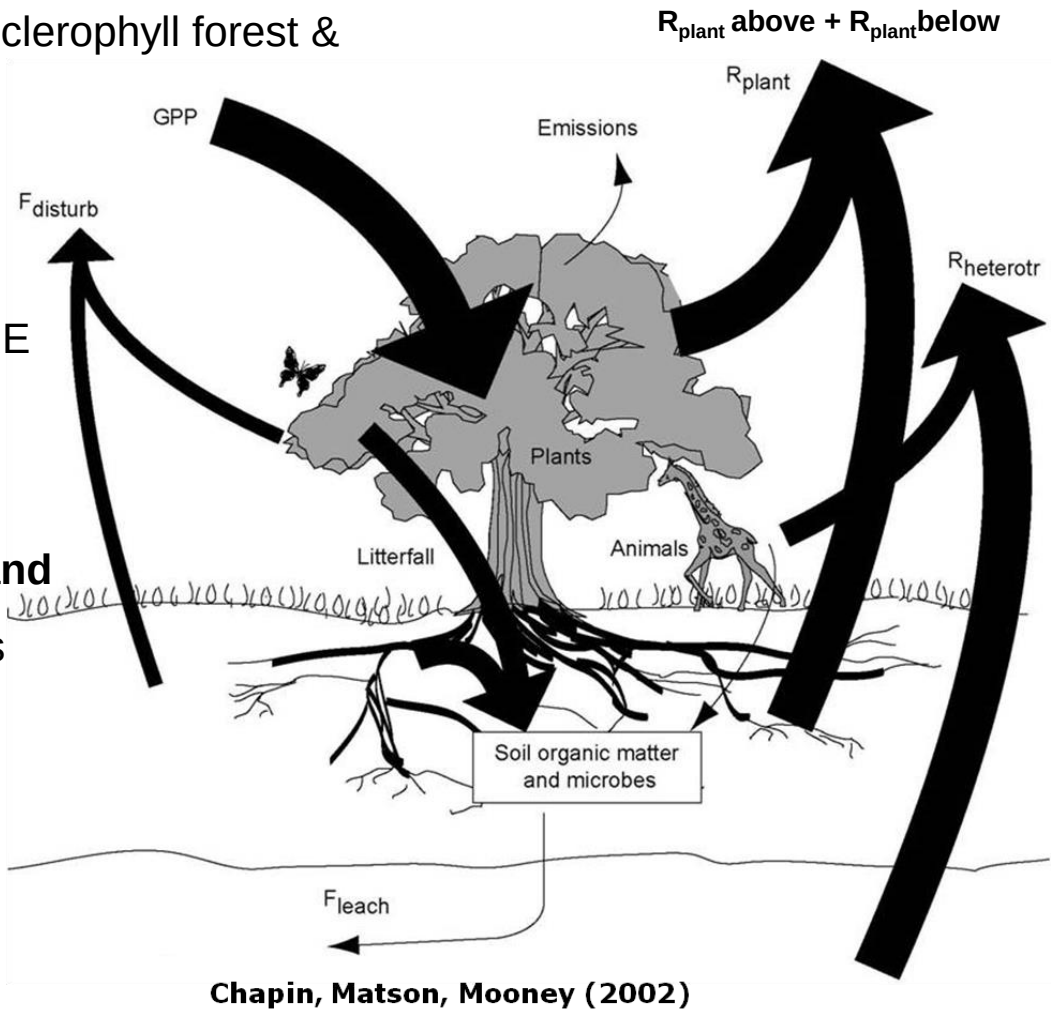
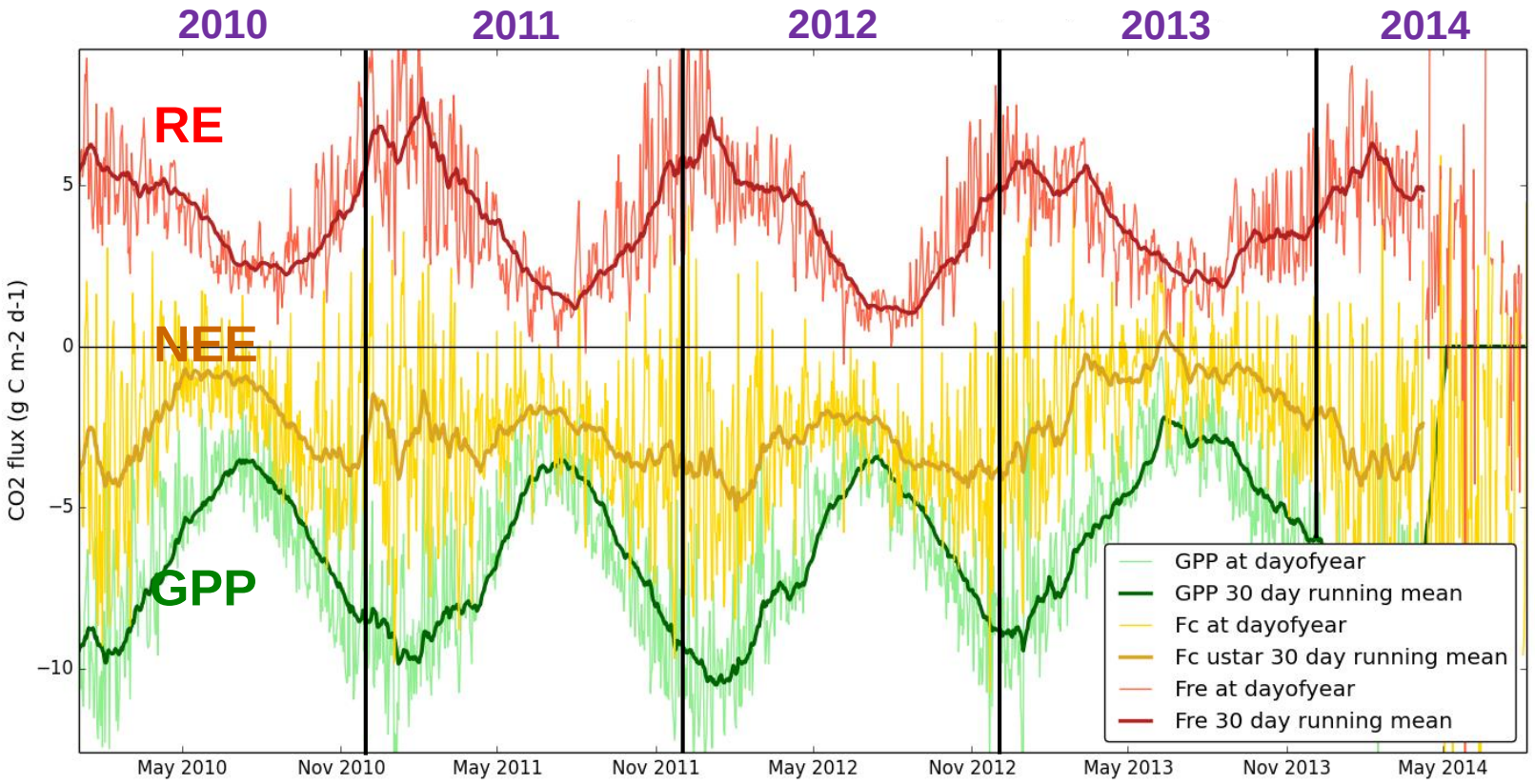
# Wombat Forest Flux

# Wombat Flux – research focus

- **Carbon balance** of a dry temperate sclerophyll forest & its strength as carbon sink/source
- Quantification of **NEE, RE, GPP**
- Quantification and contribution of **soil $CO_2$ emissions** (RS) to overall RE
- Quantification of **soil non-$CO_2$ GHG** exchange processes ($CH_4$ and $N_2O$)
- Identification **of seasonal variation and drivers** of these fluxes, i.e. processes
- **database** for carbon- and land surface models



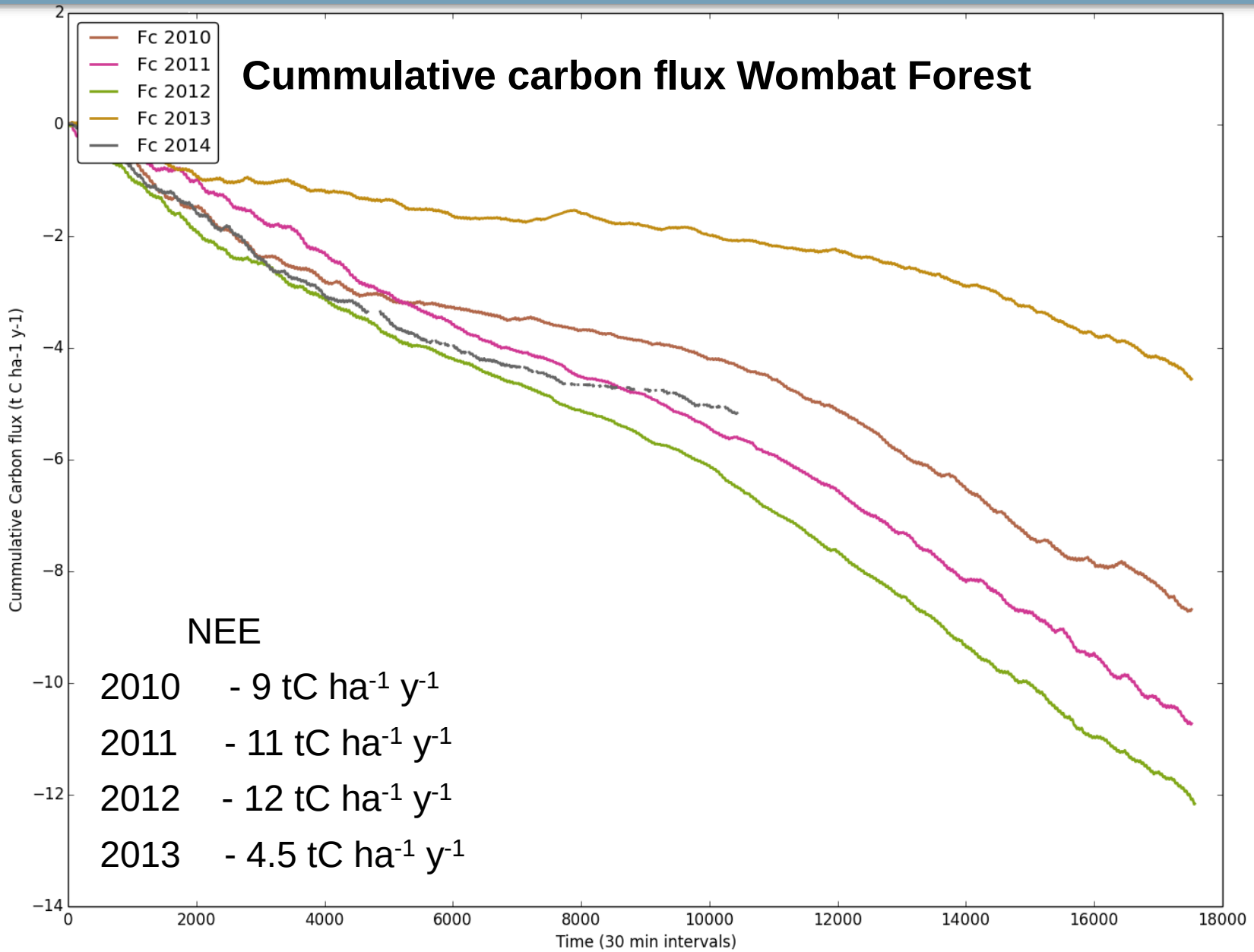
# Net Ecosystem $CO_2$ Exchange (NEE)




Wombat forest is a strong and continuous carbon sink at all times

→ Large seasonal variation of NEE
→ Stronger C sink in summer than in winter
→ Partitioning very difficult, ecosystem respiration very high, hence artificially high GPP

# Cumulative $CO_2$ for 2010-2014




NEE

2010 - 9 tC $ha^{-1}$ $y^{-1}$

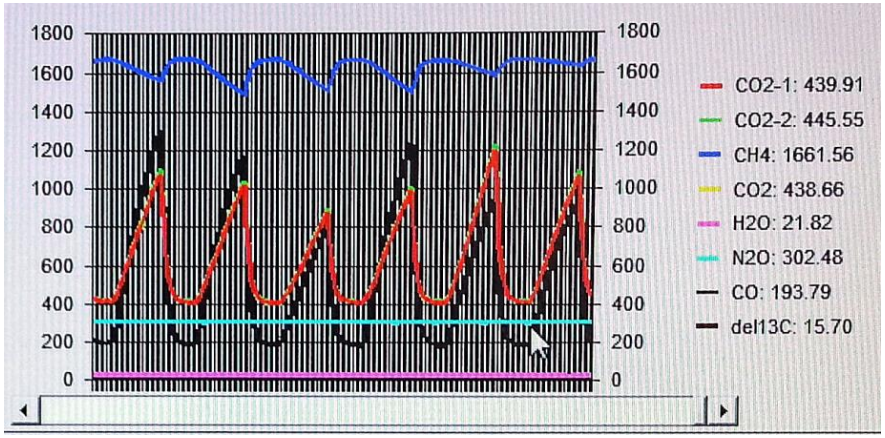
2011 - 11 tC $ha^{-1}$ $y^{-1}$

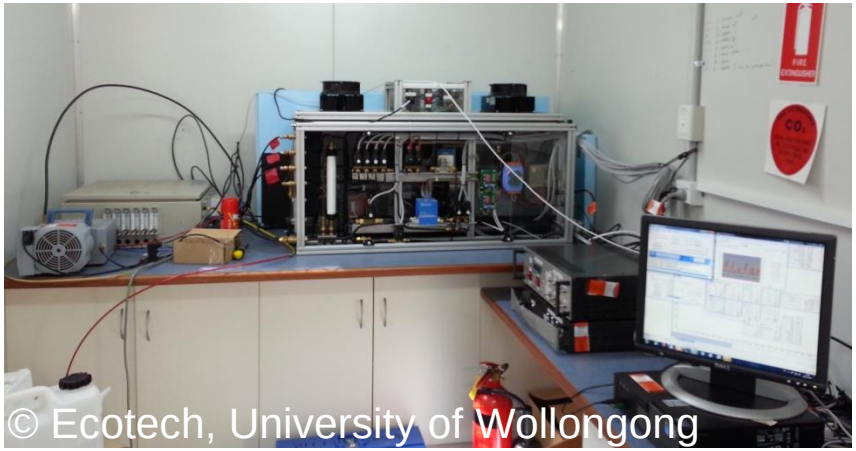
2012 - 12 tC $ha^{-1}$ $y^{-1}$

2013 - 4.5 tC $ha^{-1}$ $y^{-1}$

# Soil GHG measurements

- 6 automated soil GHG chambers
- FTIR (*Fourier Transform Infra Red*) trace gas analyser
- Remote power supply system
- internet access
- simultaneous & continuous (1min) measurements of $CO_2$, $CH_4$, $N_2O$, CO and $\delta^{13}C$



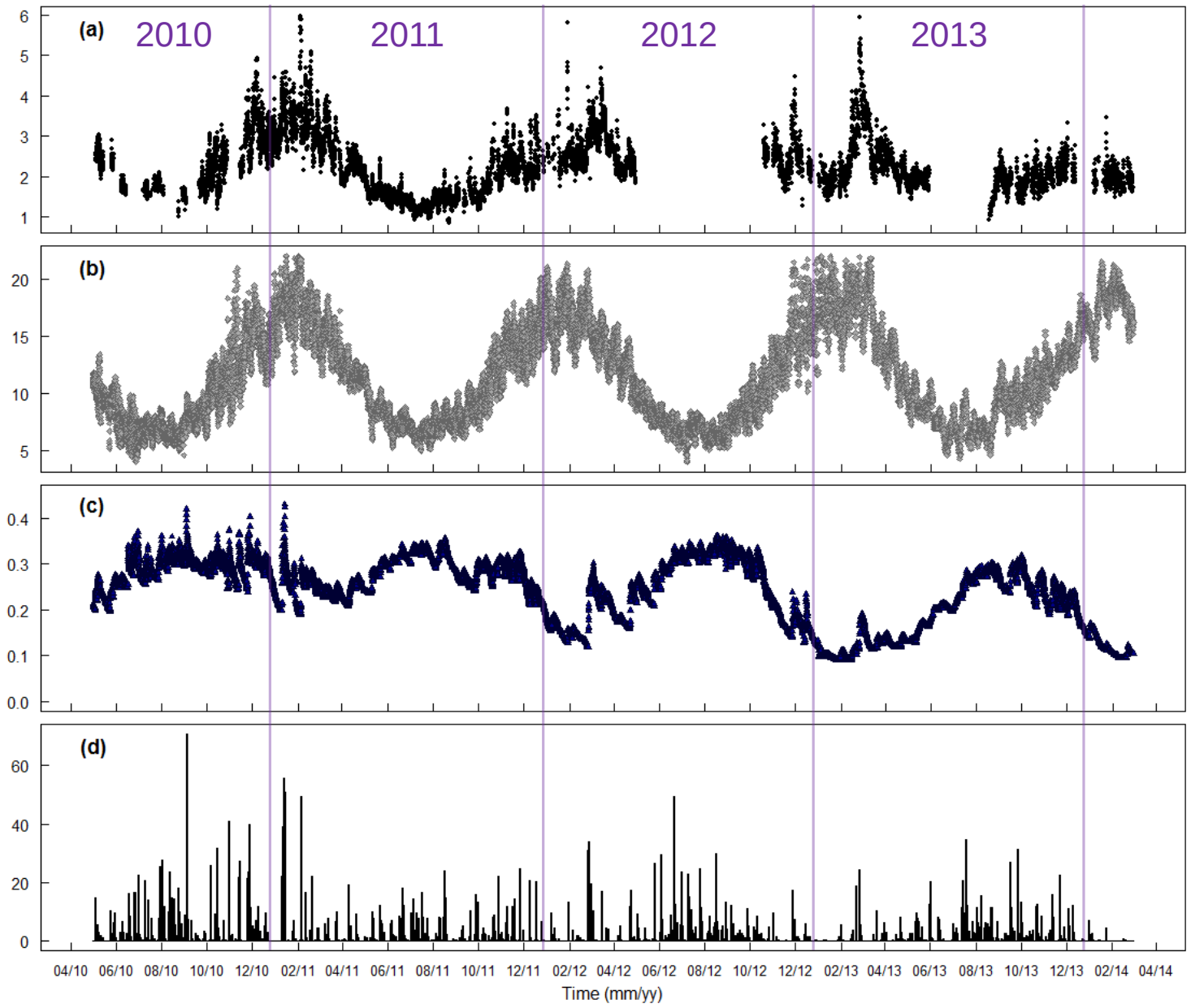

# Soil respiration (RS) Wombat Forest

RS
($\mu$mol $m^{-2}$ $s^{-1}$)

Soil temperature
($^{o}$C)

Soil moisture
($cm^{-3}$ $cm^{-3}$)

Precipitation
(mm $d^{-1}$)



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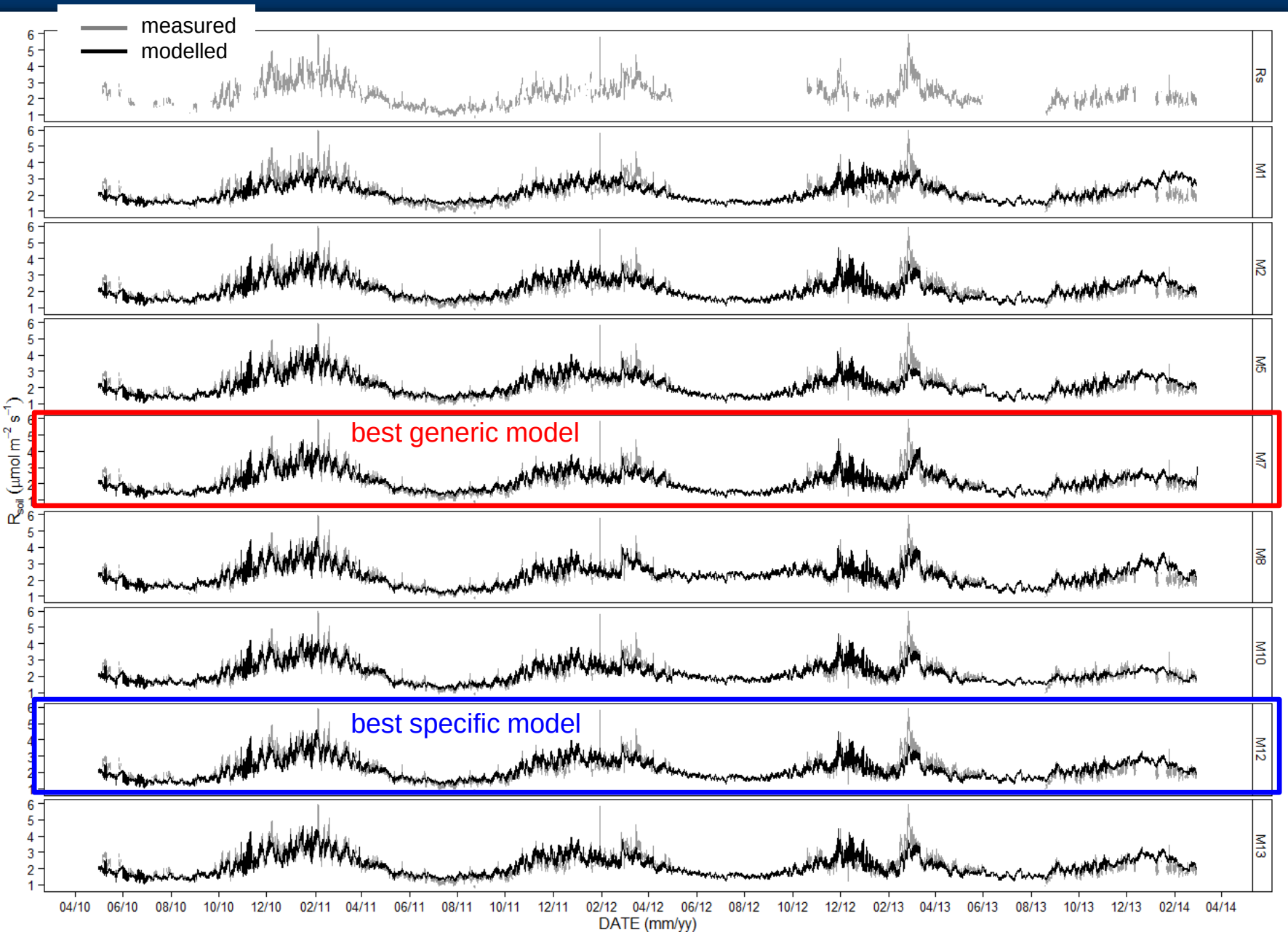
# Predicting soil respiration



# Predicting soil respiration

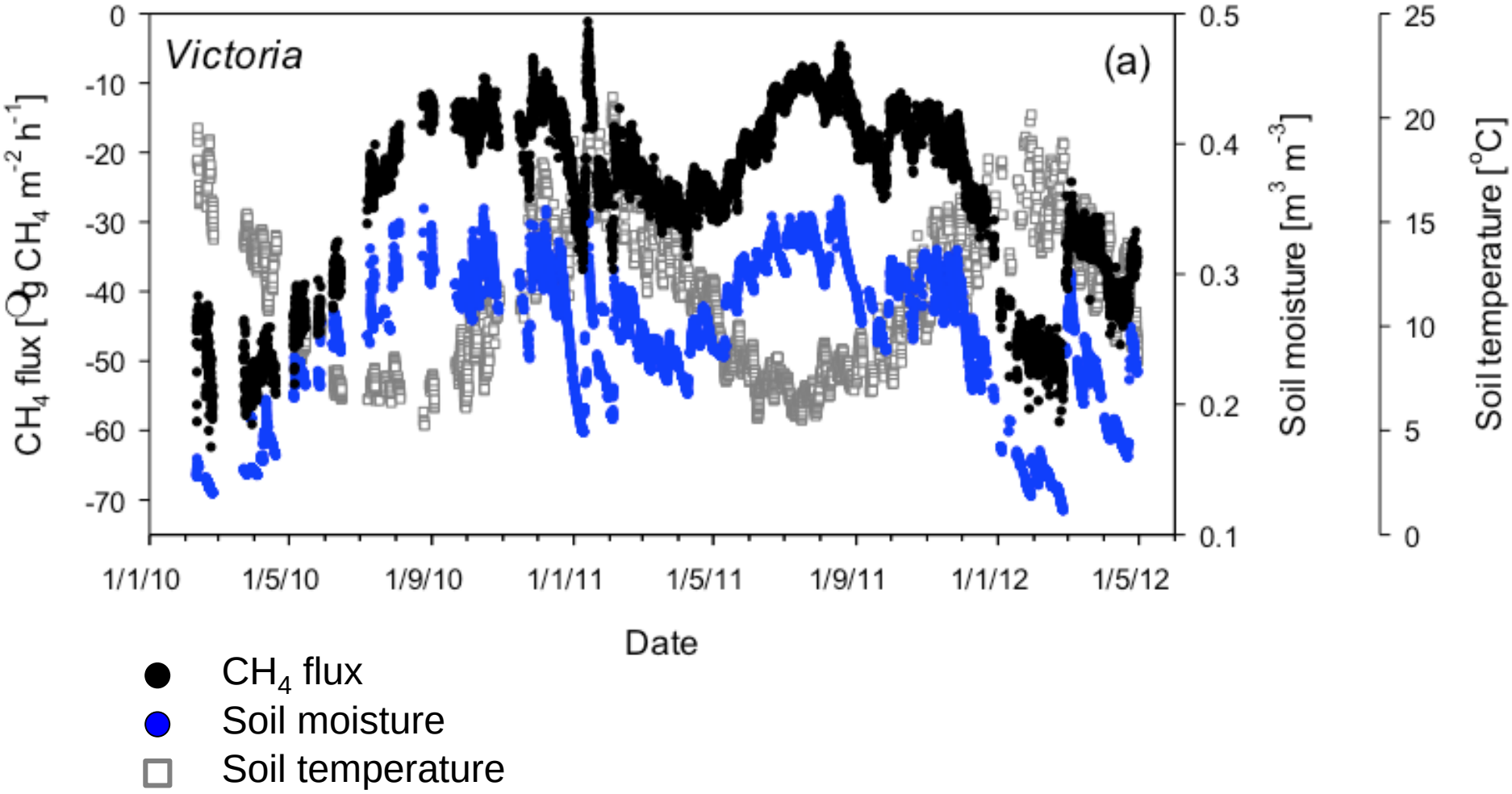
| model | adj. $R^2$ | p-value | e | e (%) | MAE | MAE (%) | RMSE | RSME (%) | Δ (%) | ME |
|---|---|---|---|---|---|---|---|---|---|---|
| M1 | 0.53 | 0.000 | -0.003 | -0.13 | 0.356 | 15.74 | 0.490 | 21.65 | 5.92 | 0.53 |
| M2 | 0.72 | 0.000 | 0.000 | -0.01 | 0.293 | 12.96 | 0.382 | 16.86 | 3.90 | 0.72 |
| M3 | 0.69 | 0.000 | -0.001 | -0.03 | 0.312 | 13.78 | 0.400 | 17.67 | 3.89 | 0.69 |
| M4 | 0.73 | 0.000 | -0.001 | -0.04 | 0.282 | 12.45 | 0.376 | 16.62 | 4.17 | 0.73 |
| M5 | 0.73 | 0.000 | -0.001 | -0.04 | 0.279 | 12.34 | 0.375 | 16.58 | 4.24 | 0.73 |
| M6 | 0.73 | 0.000 | -0.002 | -0.08 | 0.273 | 12.07 | 0.371 | 16.37 | 4.30 | 0.73 |
| M7 | 0.73 | 0.000 | -0.001 | -0.06 | 0.274 | 12.08 | 0.371 | 16.37 | 4.29 | 0.73 |
| M8 | 0.78 | 0.000 | -0.018 | -0.78 | 0.236 | 10.44 | 0.336 | 14.86 | 4.43 | 0.78 |
| M9 | 0.75 | 0.000 | -0.020 | -0.90 | 0.256 | 11.32 | 0.361 | 15.95 | 4.62 | 0.75 |
| M10 | 0.77 | 0.000 | -0.001 | -0.03 | 0.249 | 10.98 | 0.344 | 15.21 | 4.23 | 0.77 |
| M11 | 0.75 | 0.000 | -0.001 | -0.05 | 0.264 | 11.68 | 0.356 | 15.73 | 4.06 | 0.75 |
| M12 | 0.72 | 0.000 | 0.000 | 0.00 | 0.287 | 12.68 | 0.377 | 16.68 | 3.99 | 0.72 |
| M13 | 0.73 | 0.000 | -0.001 | -0.03 | 0.281 | 12.42 | 0.372 | 16.43 | 4.02 | 0.73 |

The generic model uses a Lloyd & Taylor temperature function and a Gompertz soil moisture function. This model can explain 73% of data with little bias.
**This model can be applied in global or continental models!**

The specific model uses the same functions but they are annually optimised (i.e. retrospectively calibrated). This model can explain 72% of data with little bias and lower errors.

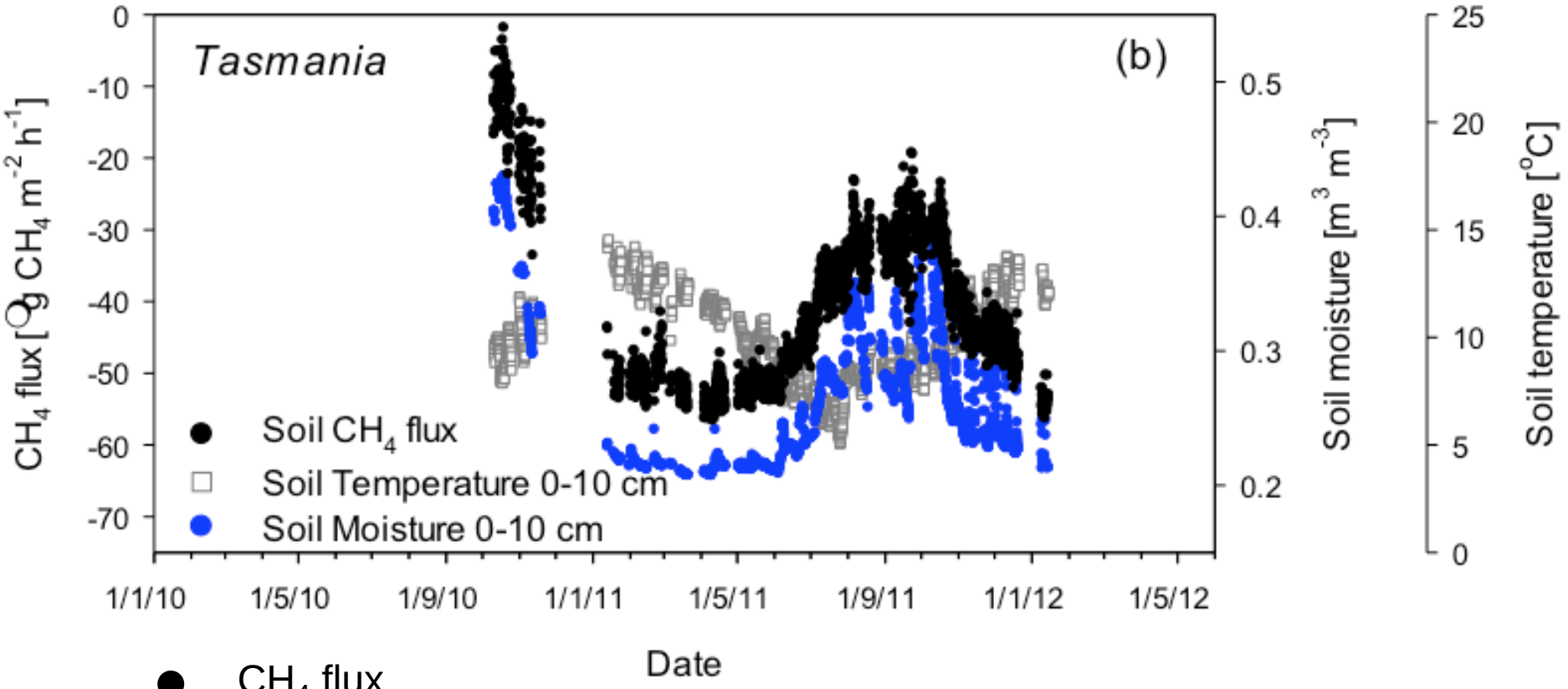
Differences between models were very small, so does not matter which is used.
BUT: very moist conditions during these years, so this might change during a dry year.
→ Recommend M7 since temperature alone explains 53% of flux

# Methane flux – Wombat forest




Methane flux closely linked to soil moisture variations at Wombat site

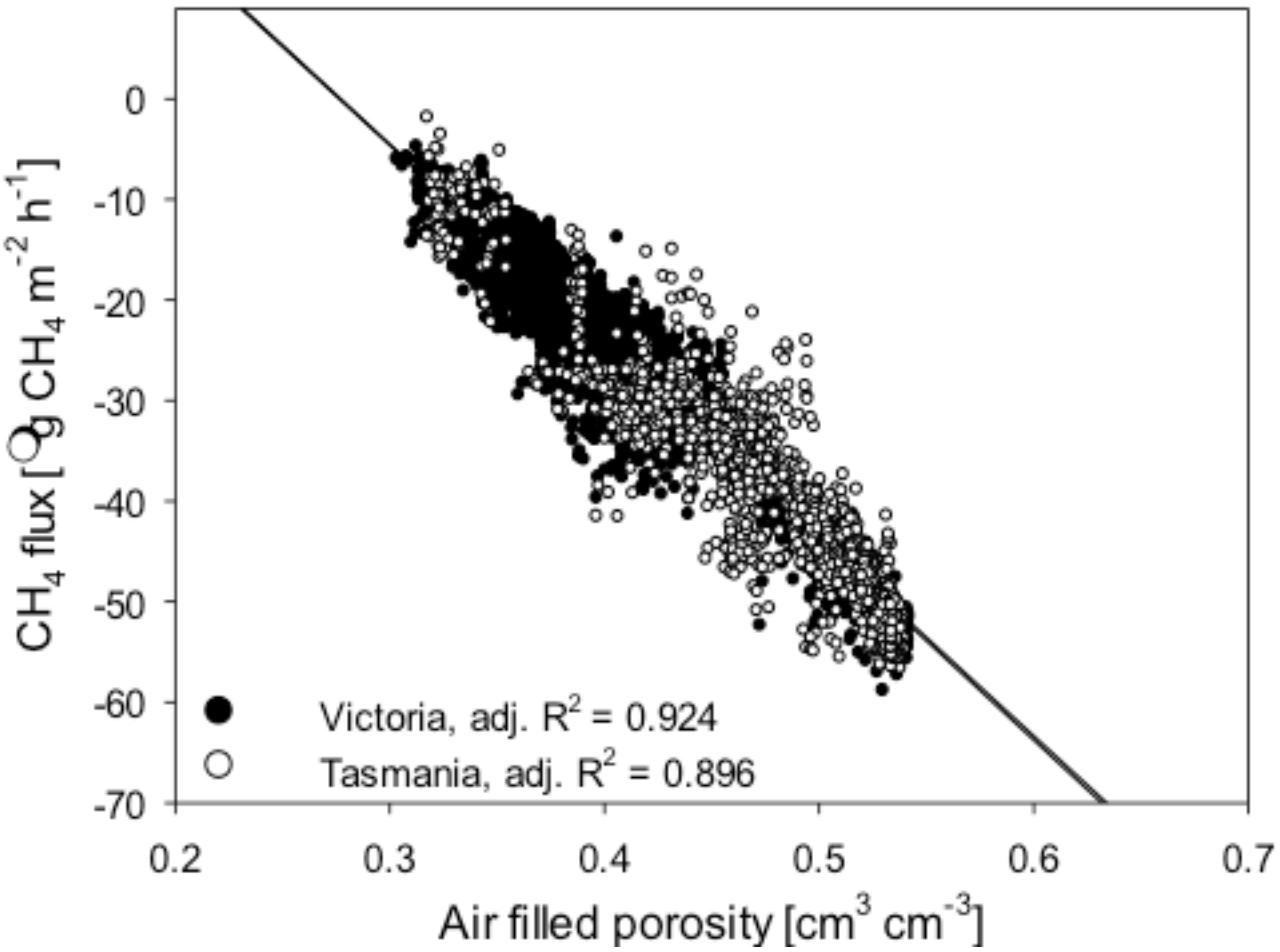
# Methane flux – Warra Supersite




- $CH_4$ flux
- Soil moisture
- Soil temperature

Methane flux closely linked to soil moisture variations at Warra site

# Methane flux and soil moisture




Methane flux is strongly controlled by soil moisture and soil diffusivity

→ AFP (or volumetric water content) explains ~90% of flux variation!

# Additional measurements of stand dynamics

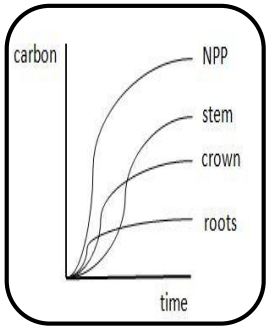
Climate change

Detection of carbon fluxes

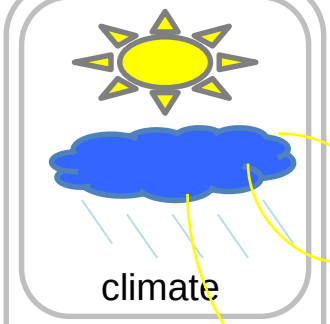
Crown dynamics

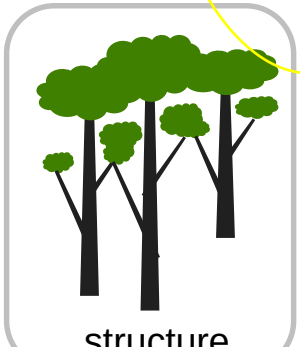
Stem increments

Seasonality of growth

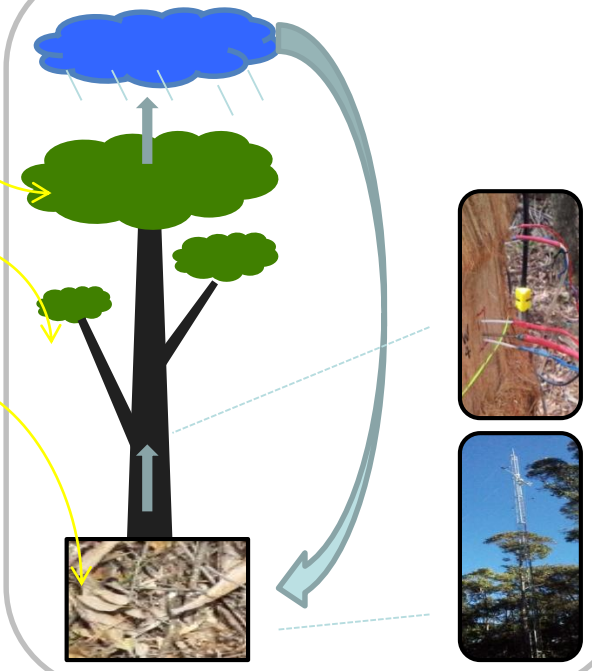



Structural dynamics

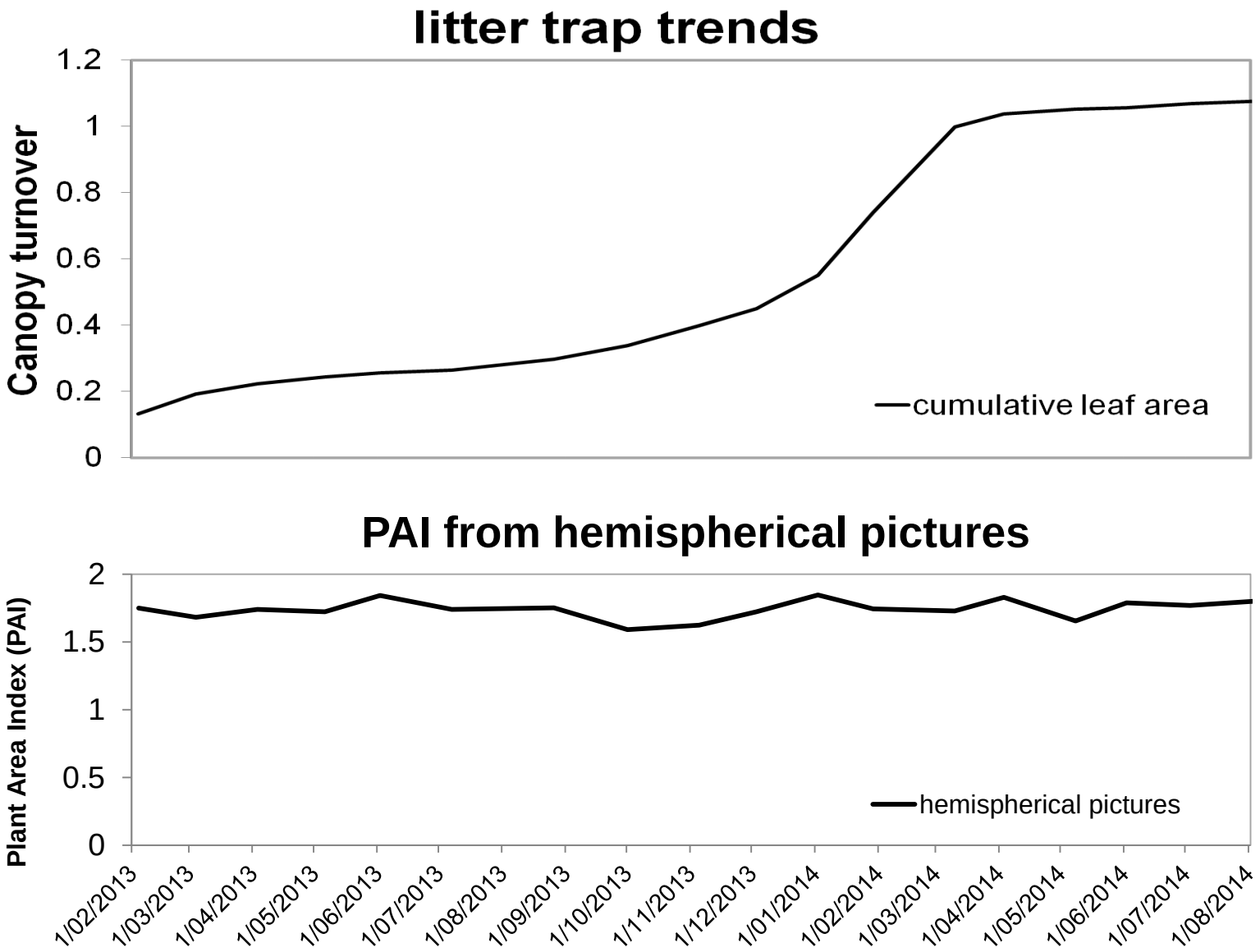


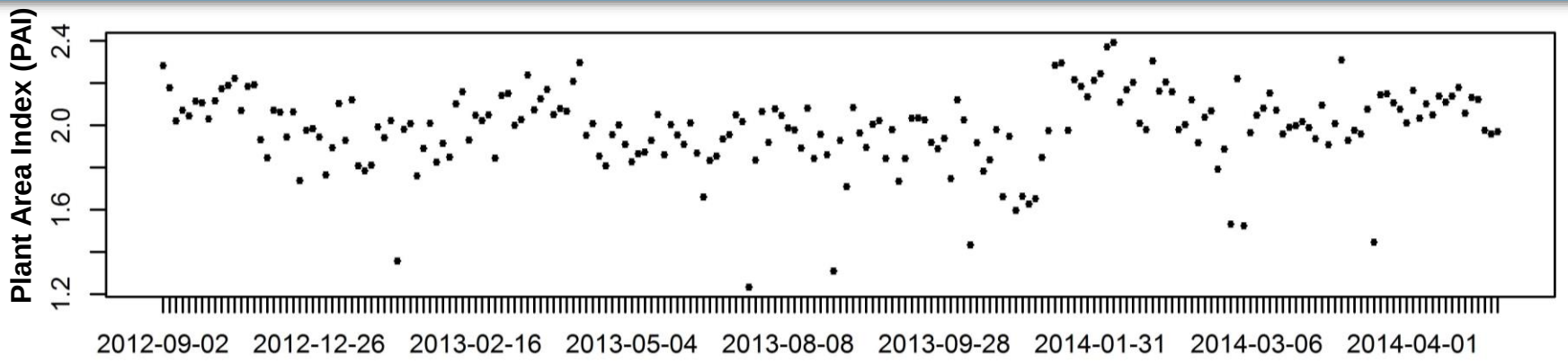

Carbon and water fluxes

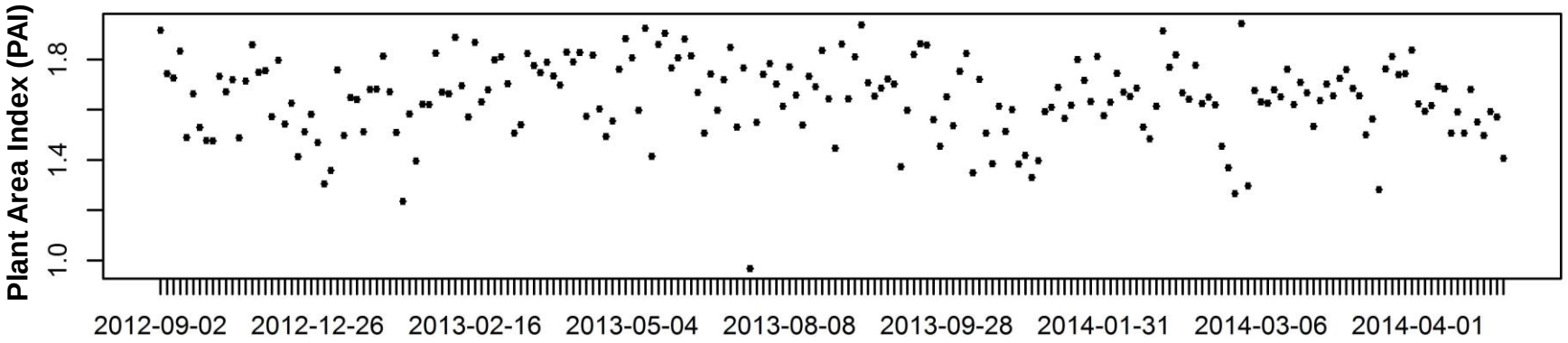


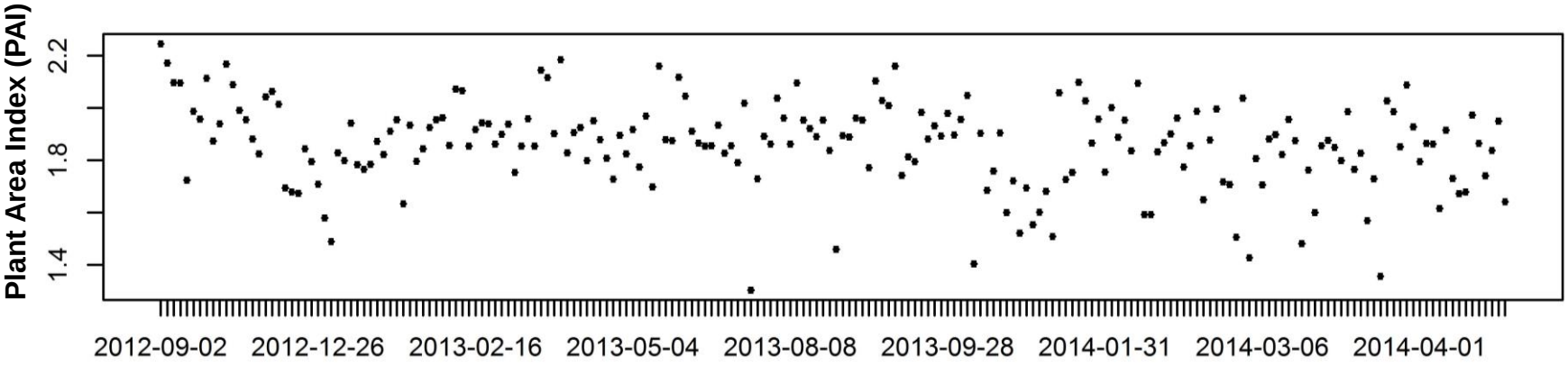
# Crown dynamics – litter traps and DHP



# crown dynamics – VEGNET

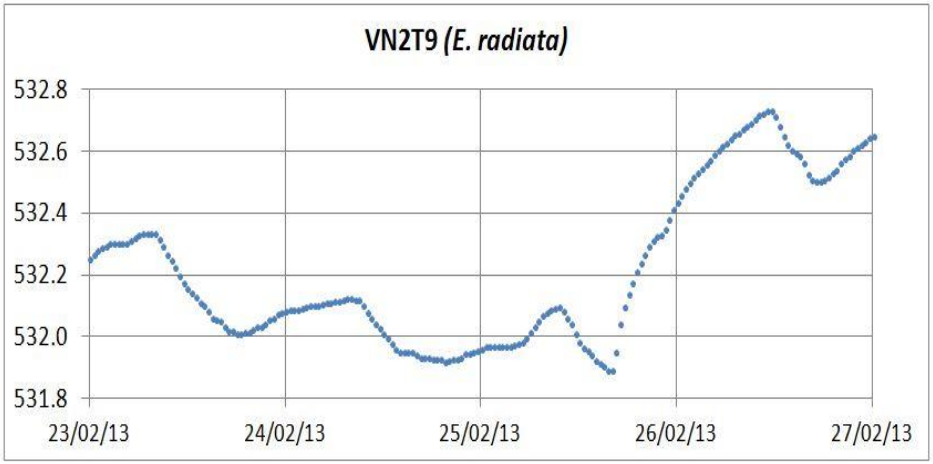


# Stem dynamics – micro and manual band dendrometer

## Stem dynamics



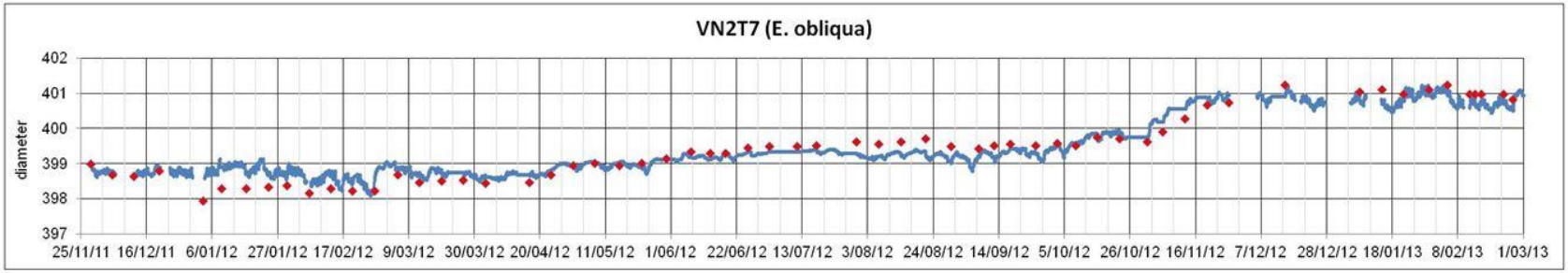

*Micro dendrometer:*

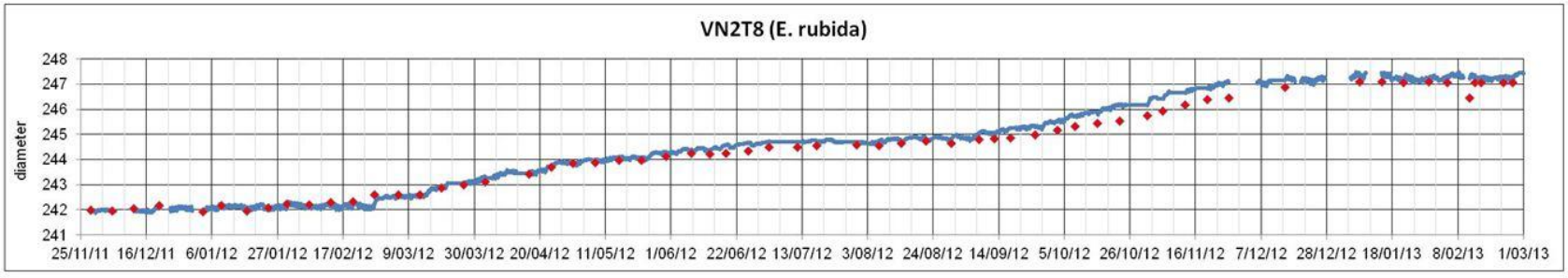
- since November 2011
- 29 trees in total
- continuously monitoring

*Manual band dendrometer:*

- 74 trees in total
- read manually (weekly/biweekly)

Comparison automated (−) vs manual (•) dendrometers

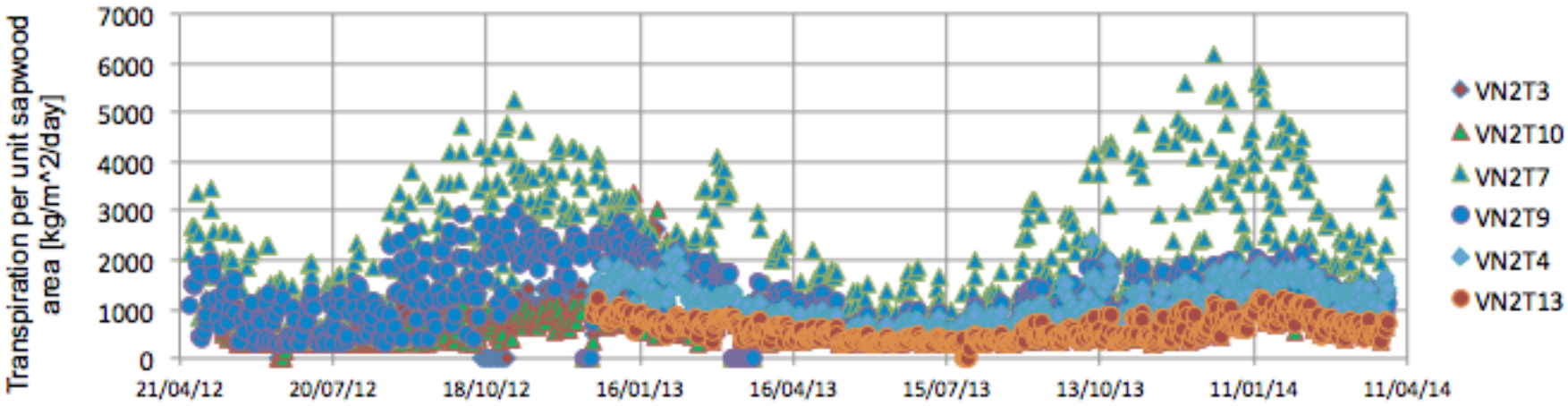


# Tree water use monitoring – sap flux

- since April 2012
- 14 trees in total
- half hourly resolution

## Long-term water-use at one VEGNET plot




blue = E. Obliqua red = E. Rubida green = E. radiata

# Wombat Flux – instrumentation summary

- EC fluxes – Jan 2010
- GHG fluxes – Jan 2010
- Stem dendrometer – Nov 2011
- Tree water-use – Apr 2012
- VEGNET sensor – Sep 2012
- Hemi pix LAI – Feb 2013
- Litter fall – Feb 2013
- PAR fractions – Nov 2013