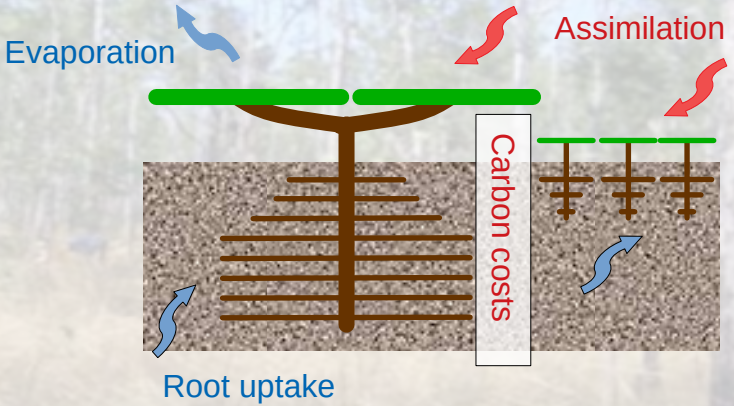
Prediction of leaf area dynamics by maximizing the **Net Carbon Profit**

R.C. Nijzink[1], S. Schymanski[1]



[1] *Luxembourg Institute of Science and Technology, Belvaux, Luxembourg*

remko.nijzink@list.lu

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VEGETATION OPTIMALITY MODEL

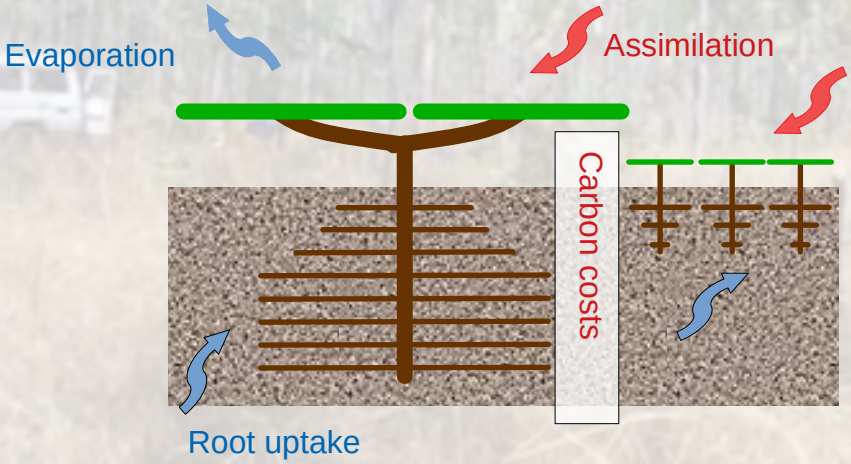
Net Carbon Profit

Total difference of carbon uptake by photosynthesis and carbon costs of the system

+ photosynthesis

- carbon costs
-
-

---------- +
Net carbon profit



VEGETATION OPTIMALITY MODEL

- Motivation
- Methods
- Results
- Conclusions

Net Carbon Profit

Total difference of carbon uptake by photosynthesis and carbon costs of the system

Vegetation Optimality Model

Optimizes vegetation properties to maximize NCP

+ photosynthesis

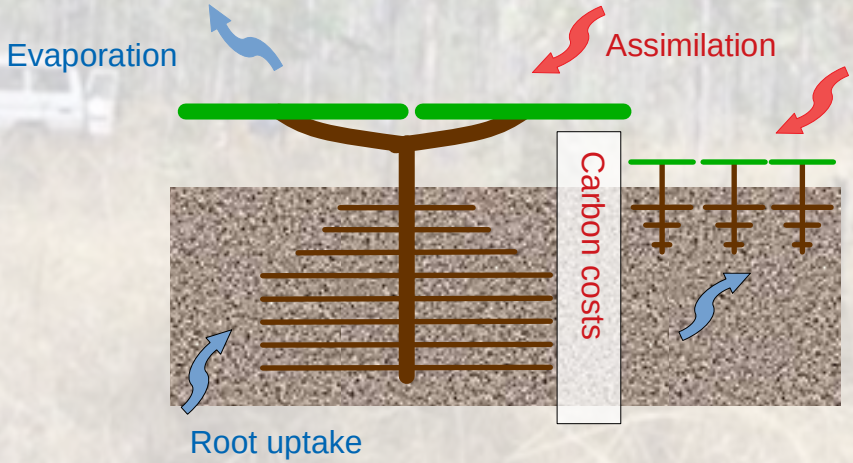
- carbon costs

-

-

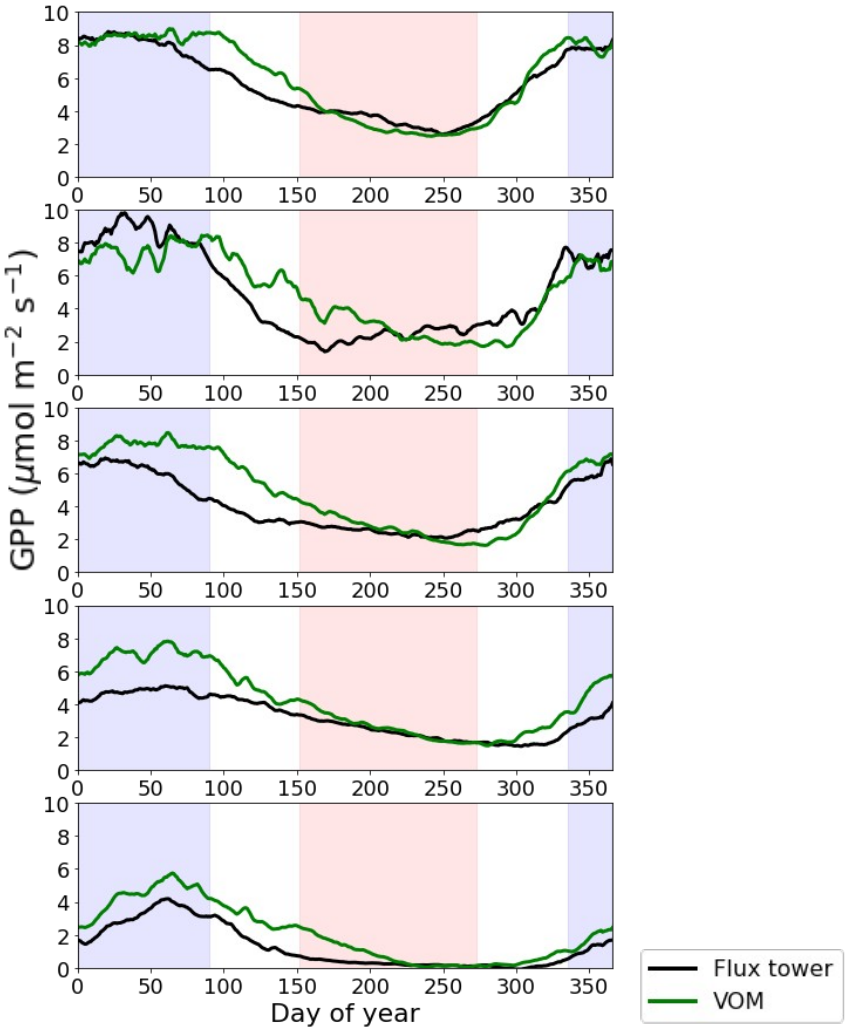
---------- +

Net carbon profit



CURRENT MODEL RESULTS

- Motivation
- Methods
- Results
- Conclusions



Nijzink, et al., Hydrol. Earth Syst. Sci., 26, 525–550, , 2022.

CURRENT MODEL RESULTS

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- Methods
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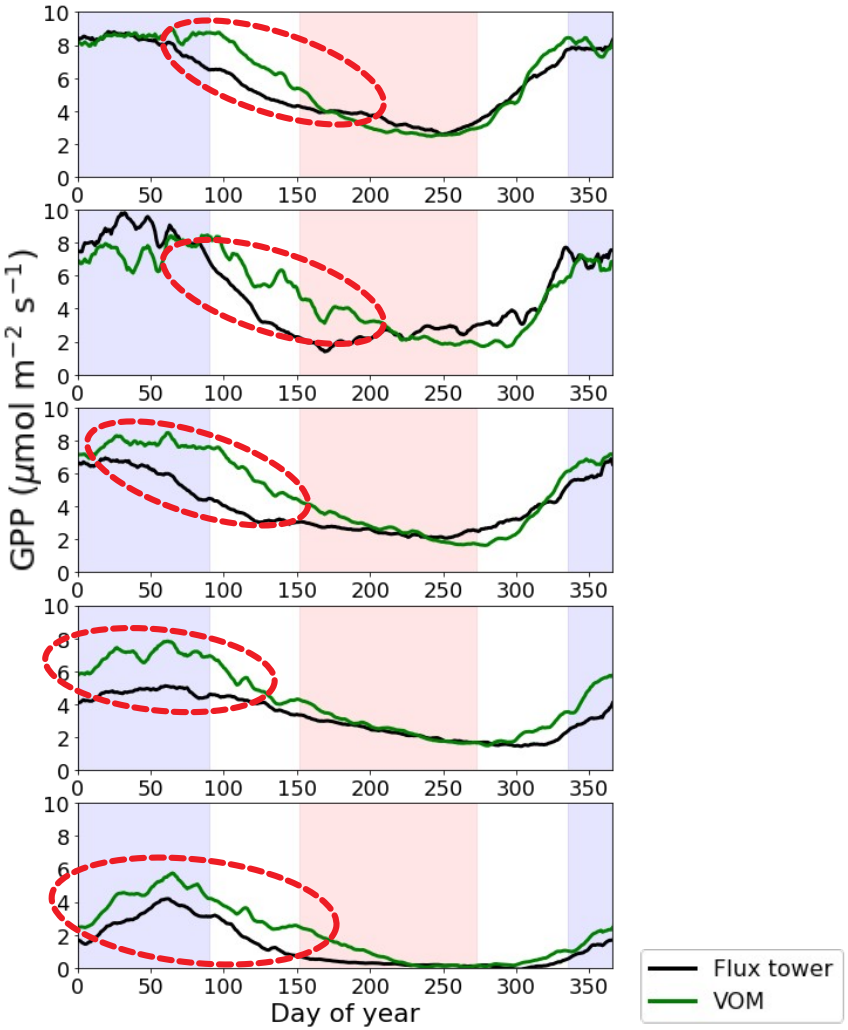
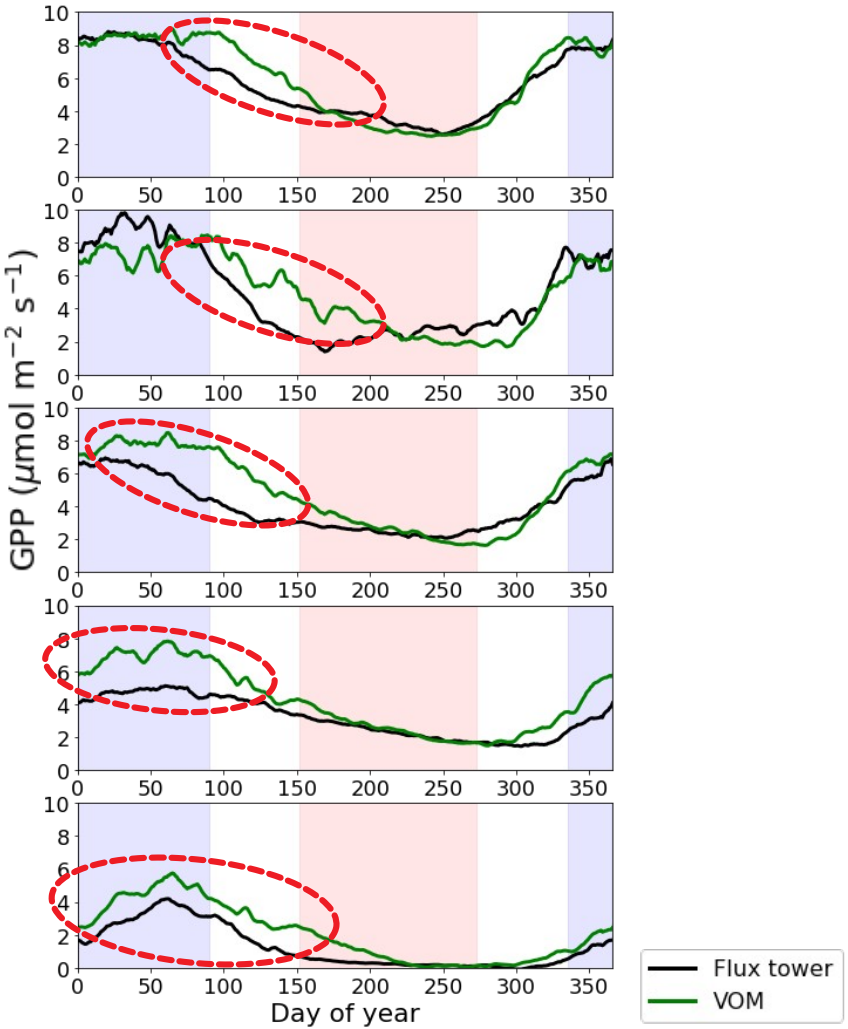


Overestimations of GPP

Nijzink, et al., Hydrol. Earth Syst. Sci., 26, 525–550, , 2022.

CURRENT MODEL RESULTS



Overestimations of GPP

Current VOM-version:

- Vegetation cover optimized
- No specific LAI optimization
- No shaded/sunlit leaves

Nijzink, et al., Hydrol. Earth Syst. Sci., 26, 525–550, , 2022.

CURRENT MODEL RESULTS

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- Methods
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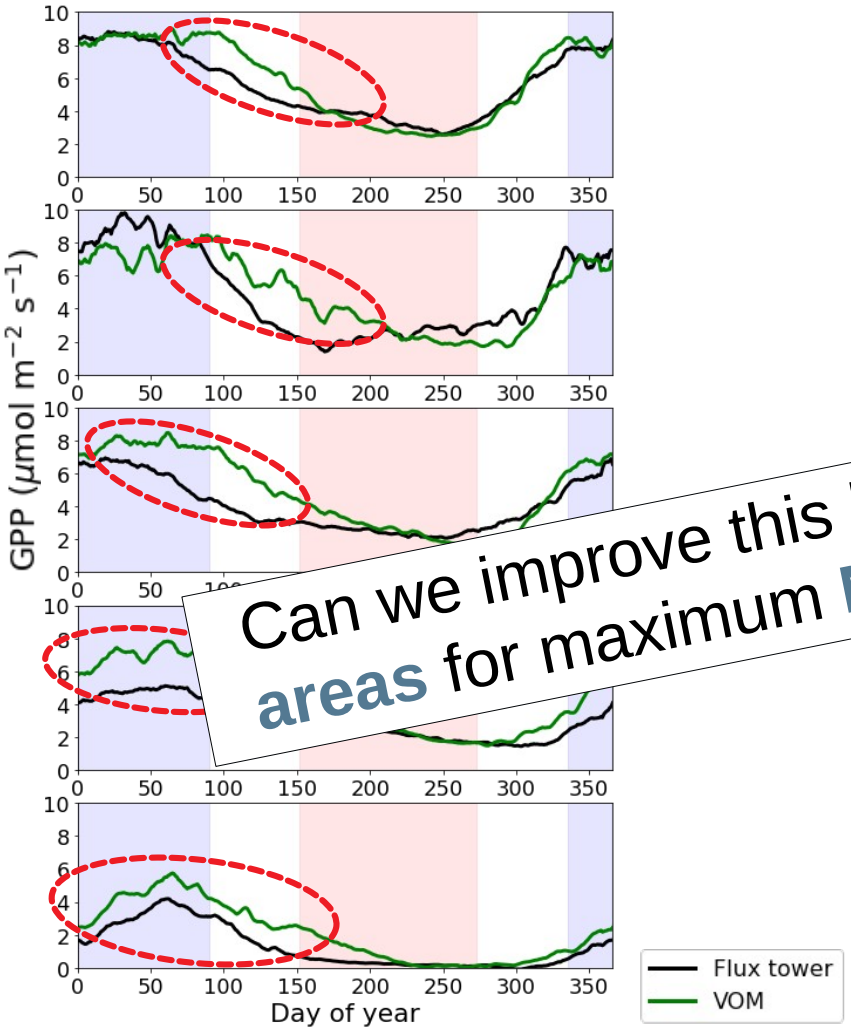
- Conclusions



Overestimations of GPP

Current VOM-version:

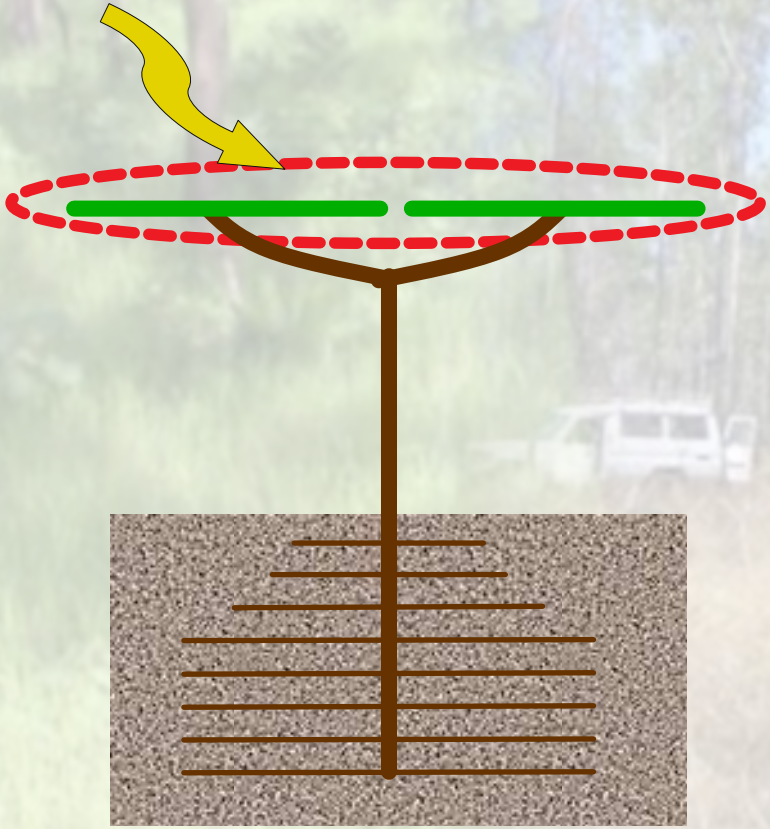
- Vegetation co… …ed
- …on
- …tives

Can we improve this by optimizing **leaf areas** for maximum **NCP?**

Nijzink, et al., Hydrol. Earth Syst. Sci., 26, 525–550, , 2022.

NET CARBON PROFIT

1. daily optimization LAI



Foliage benefits:
Higher assimilation

Foliage costs:
Leaf area index
Cost factor leaf construction/turnover

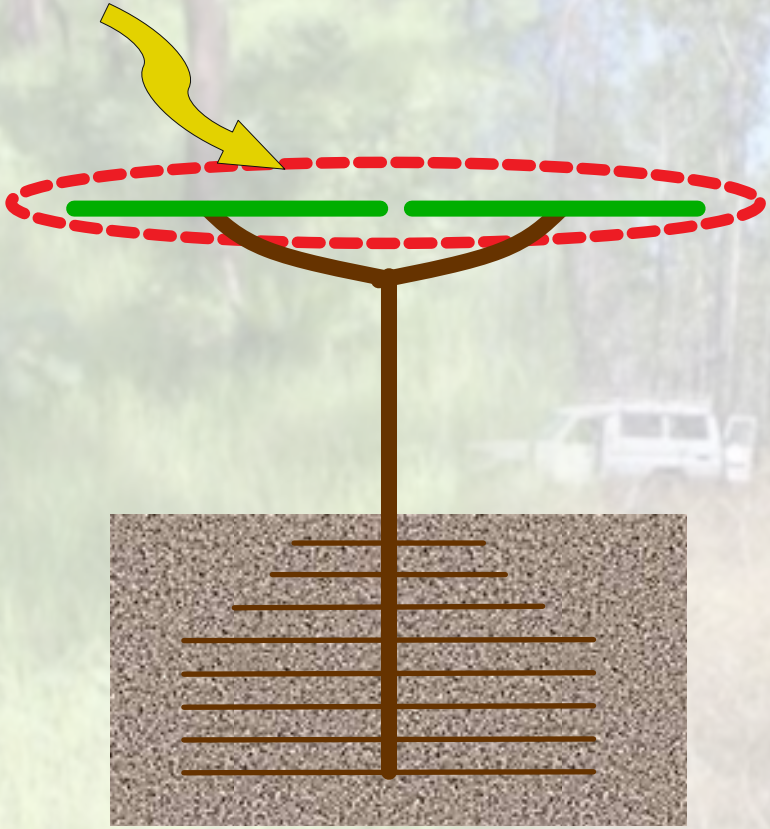
+ photosynthesis

- foliage costs
-
-

---------- +
Net carbon profit

NET CARBON PROFIT

1. daily optimization LAI
2. daily optimization Jmax



Electron transport benefits:
Higher assimilation

Electron transport costs:
Leaf respiration
Fixed percentage of electron transport capacity

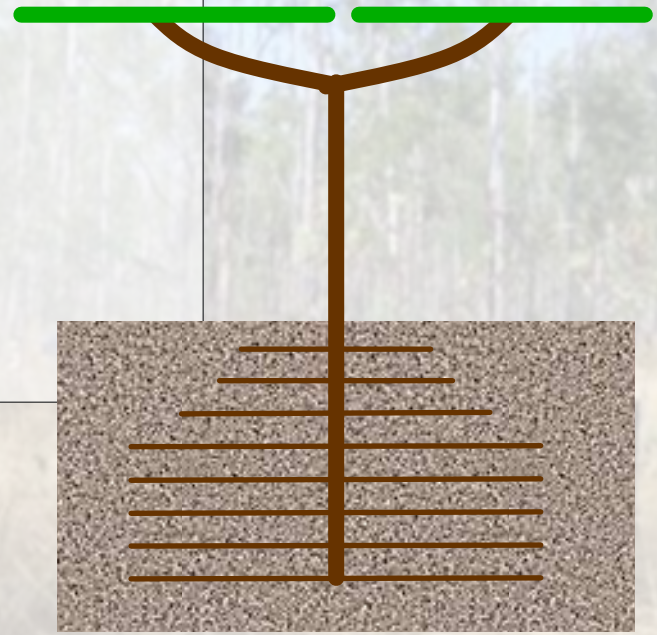
+ photosynthesis

- foliage costs
- leaf respiration
-

---------- +
Net carbon profit

TOWARDS DYNAMIC LAI

0. **No LAI (i.e. reference)**



- Motivation
- Methods
- Results
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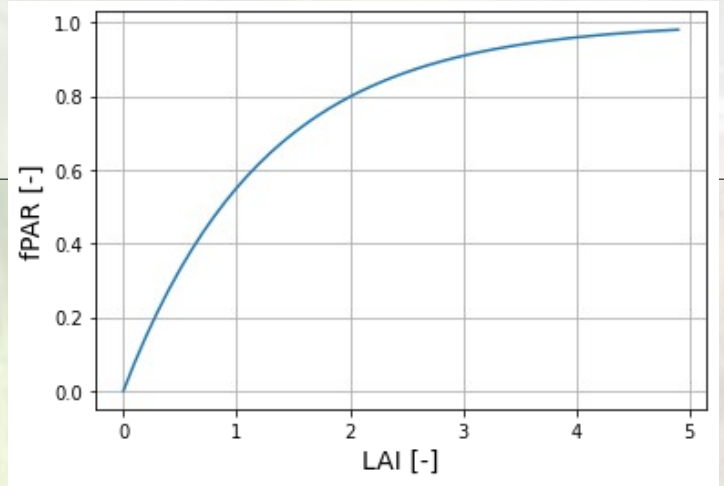
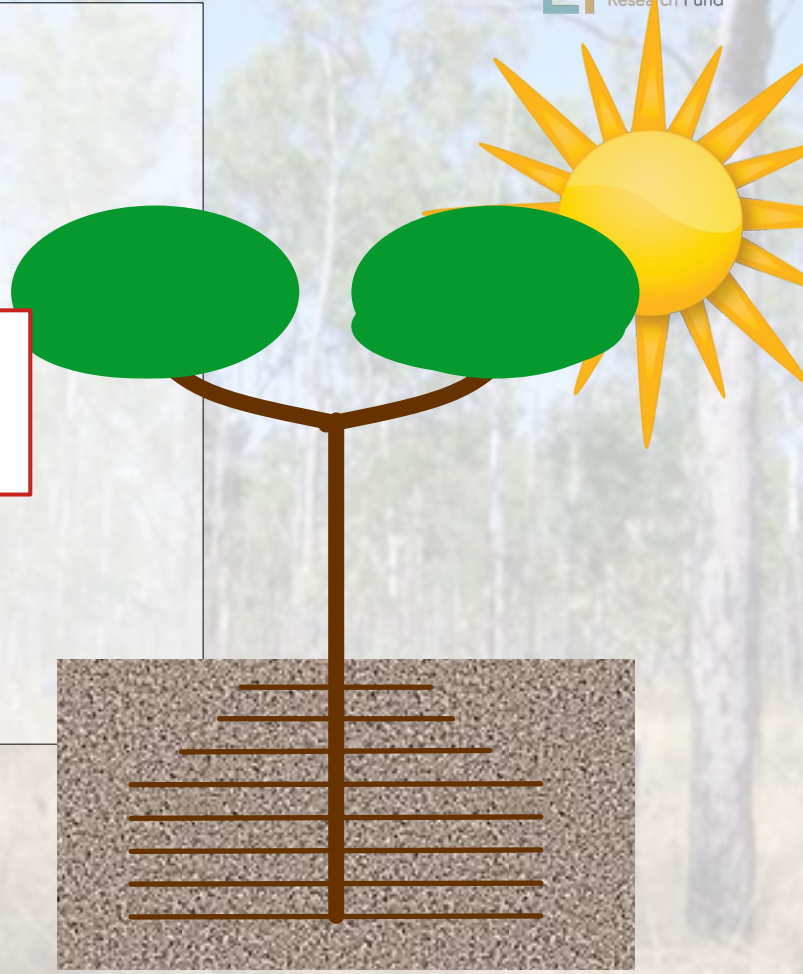
TOWARDS DYNAMIC LAI

0. No LAI (i.e. reference)

1. **LAI optimization**

- Optimized for daily NCP
- Uses Lambert-Beer
- Leaves absorb same PAR



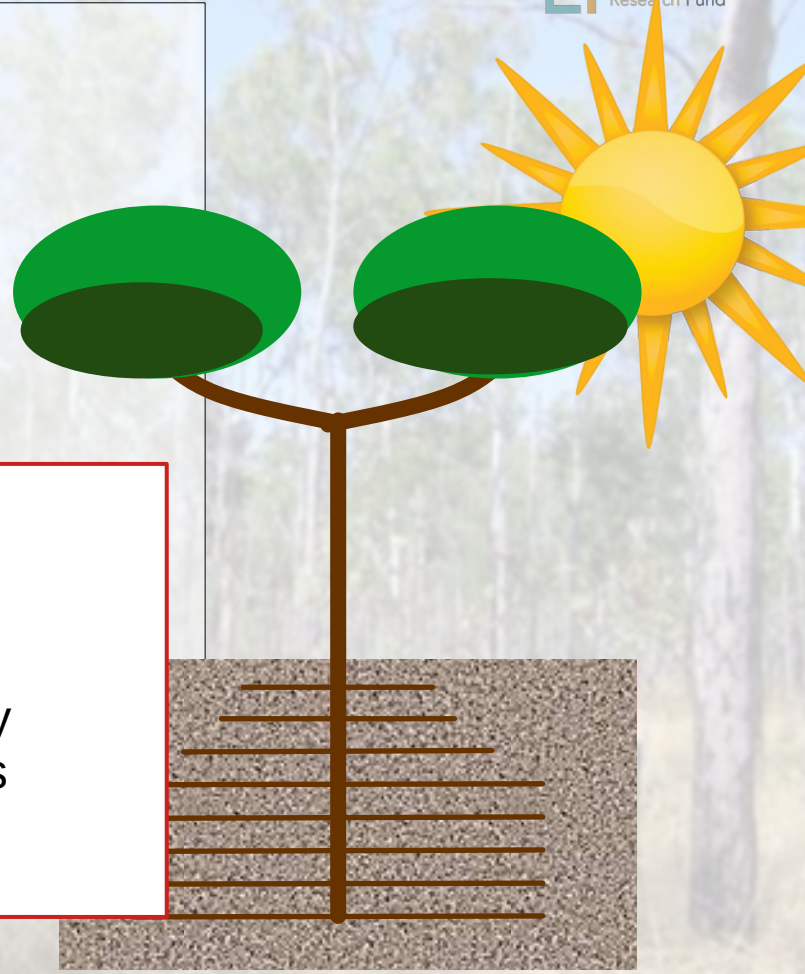


TOWARDS DYNAMIC LAI

0. No LAI (i.e. reference)
1. LAI optimization
2. LAI optimization + **shade/sunlit fractions**

- Sunlit: PARdir + PARdiff
- Shade: PARdiff

Still one “big leaf”:
- Same electron transport capacity
- Sum of shaded + sunlit electrons transport rates used in big leave

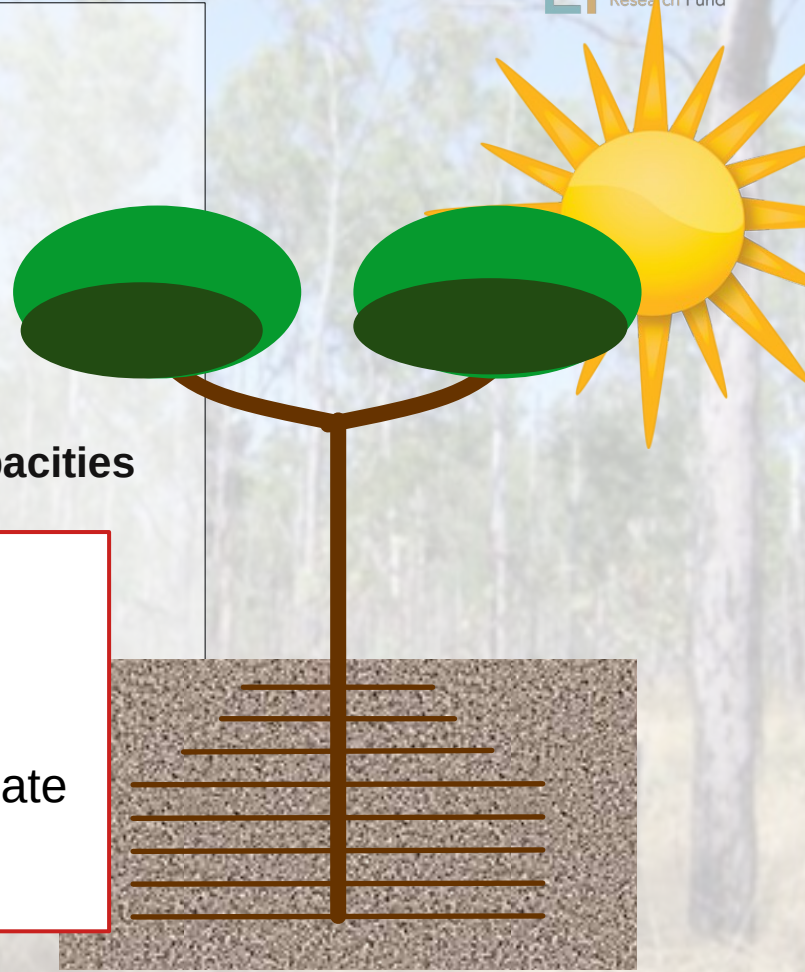


TOWARDS DYNAMIC LAI

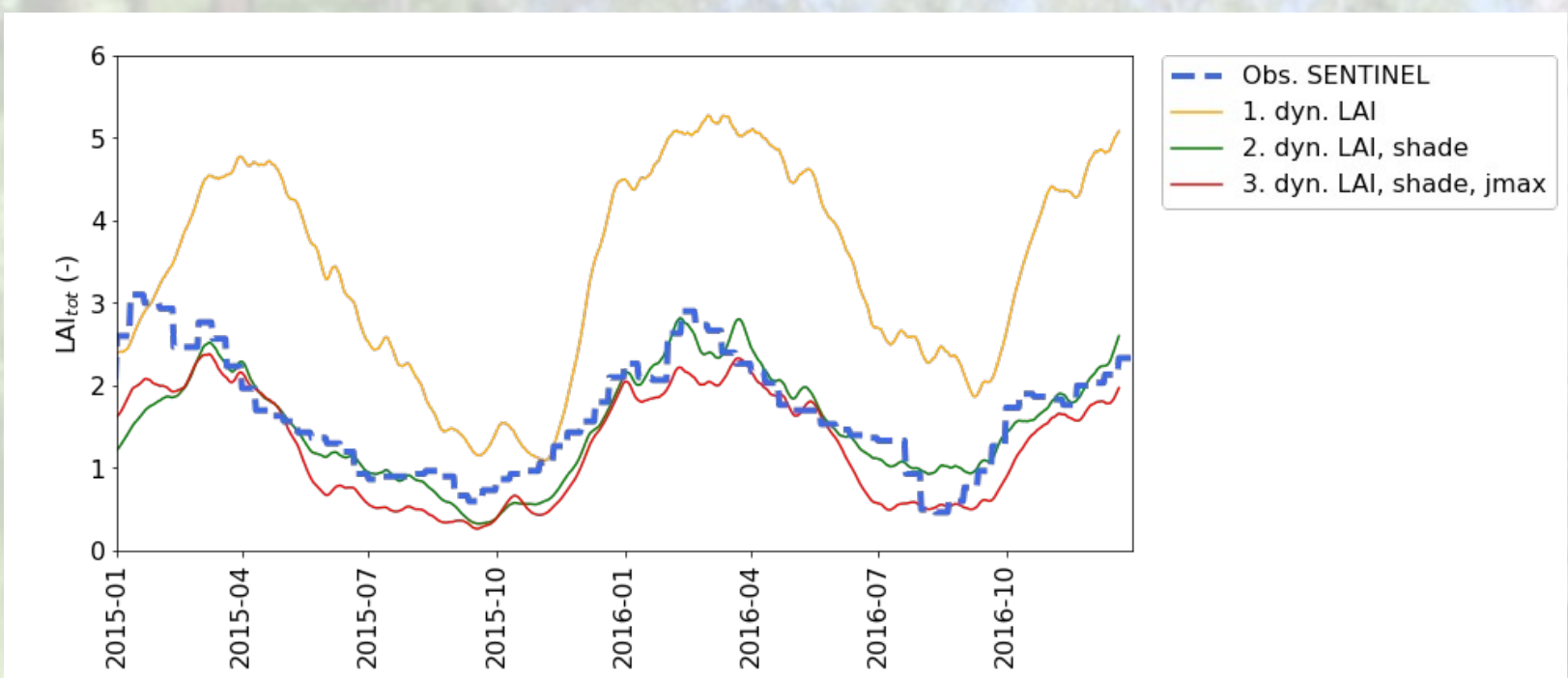
0. No LAI (i.e. reference)
1. LAI optimization
2. LAI optimization + shade/sunlit fractions
3. LAI optimization + shade/sunlit fractions + **shade/sunlit electron transport capacities**

- Sunlit: PARdir + PARdiff
- Shade: PARdiff

Two “big leaves” with **separate**:
- Electron transport capacity and rate
- Stomatal conductance
- Photosynthesis

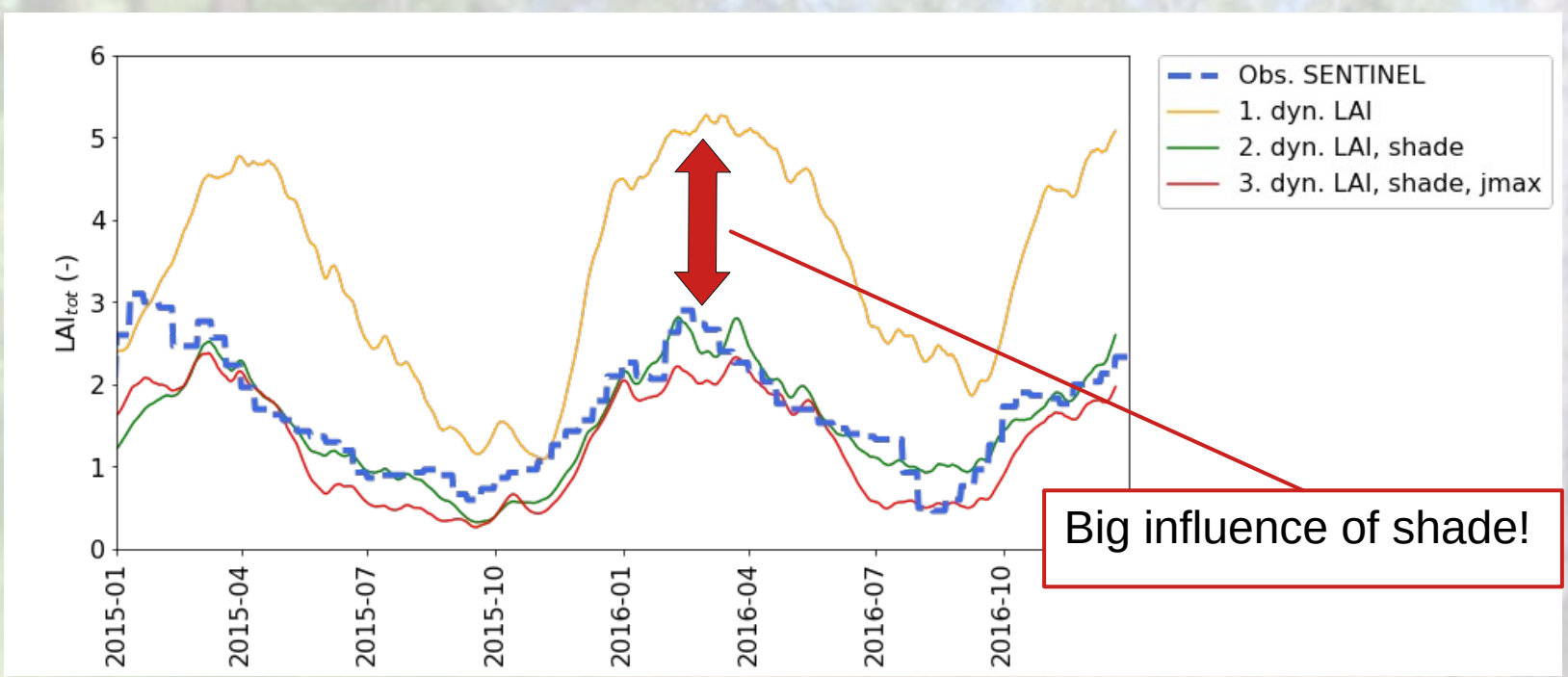


MODELLED AND OBSERVED LAI

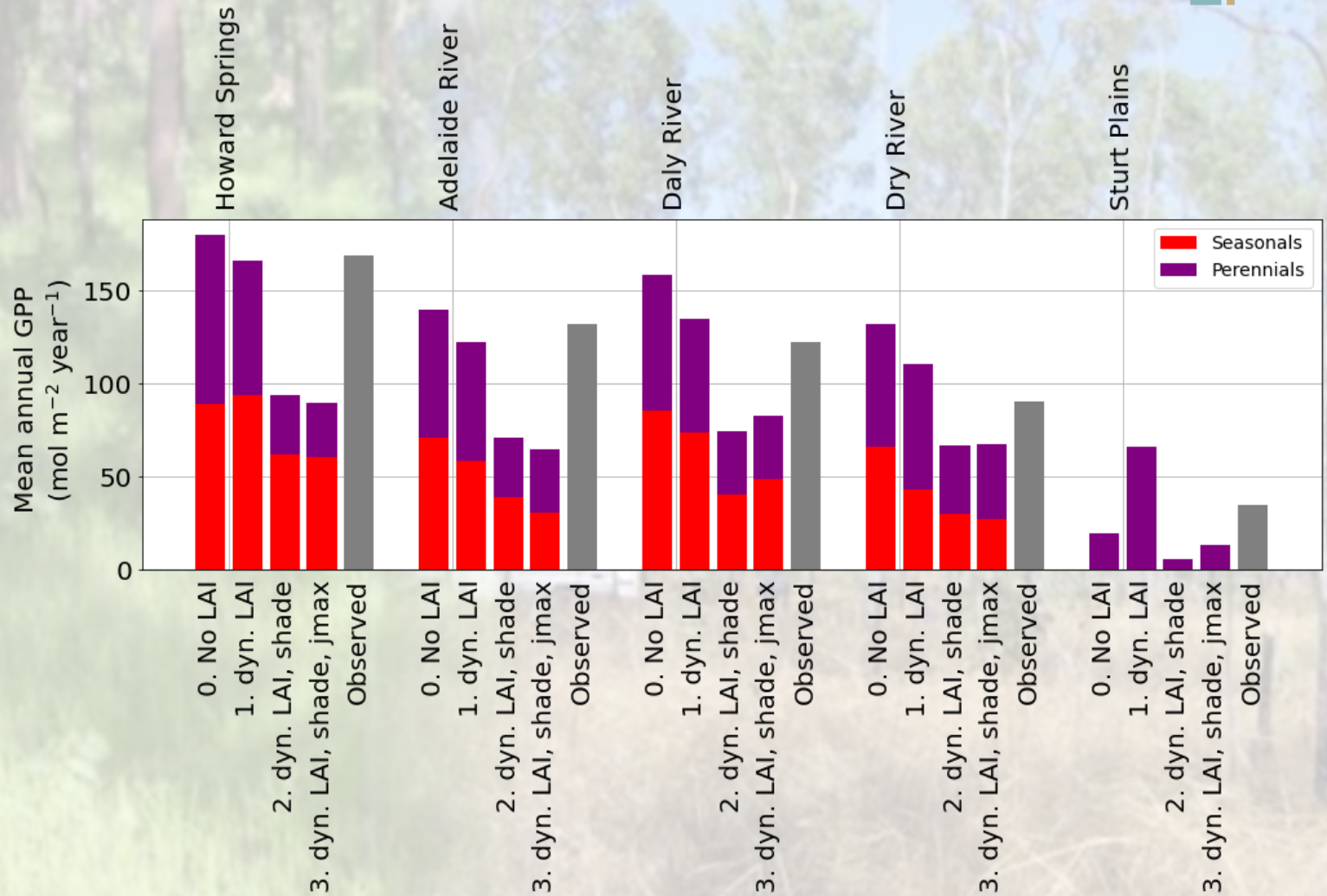


MODELLED AND OBSERVED LAI

- Motivation
- Methods
- Results
- Conclusions

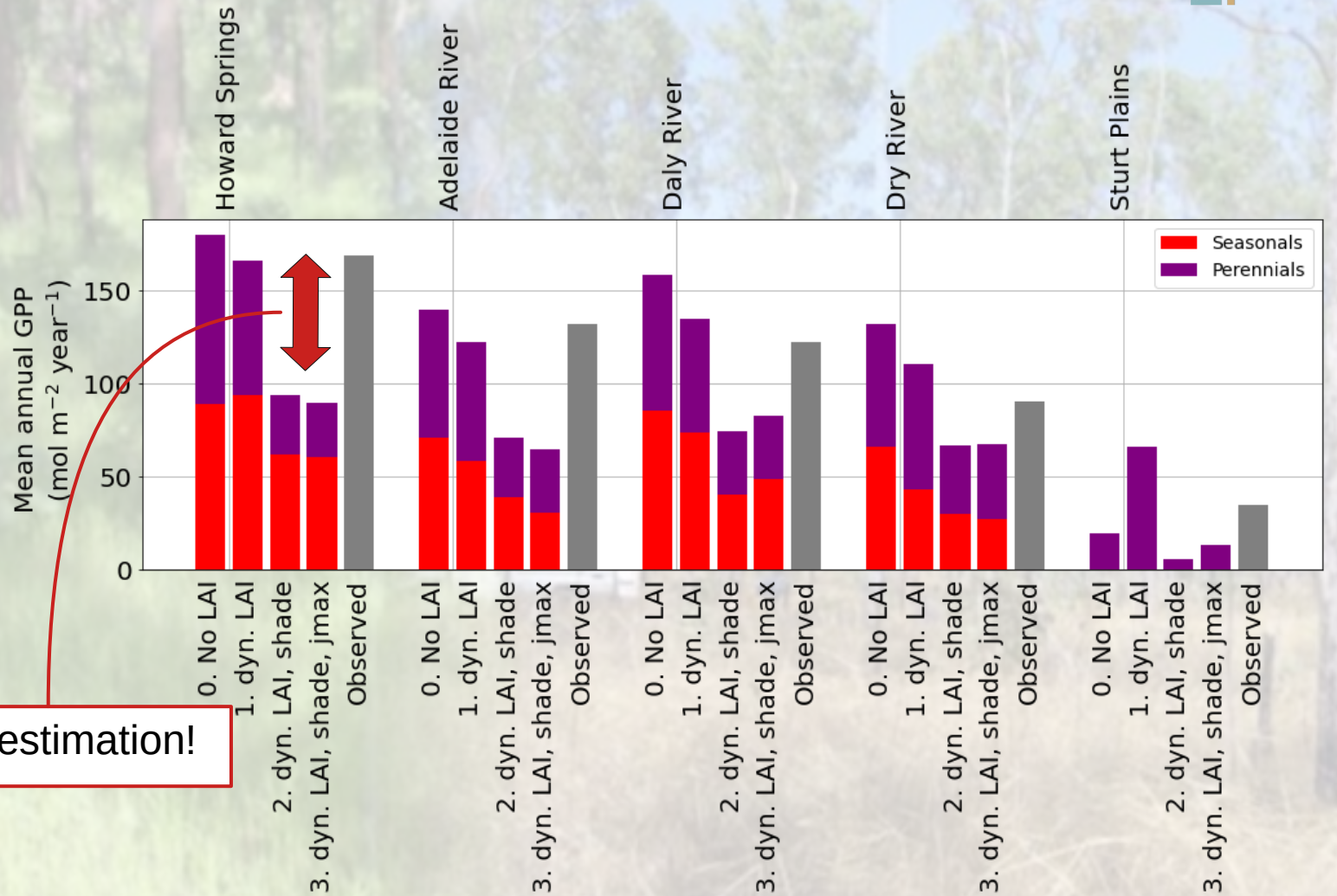


WHAT HAPPENS WITH THE FLUXES?



WHAT HAPPENS WITH THE FLUXES?

- Motivation
- Methods
- Results
- Conclusions



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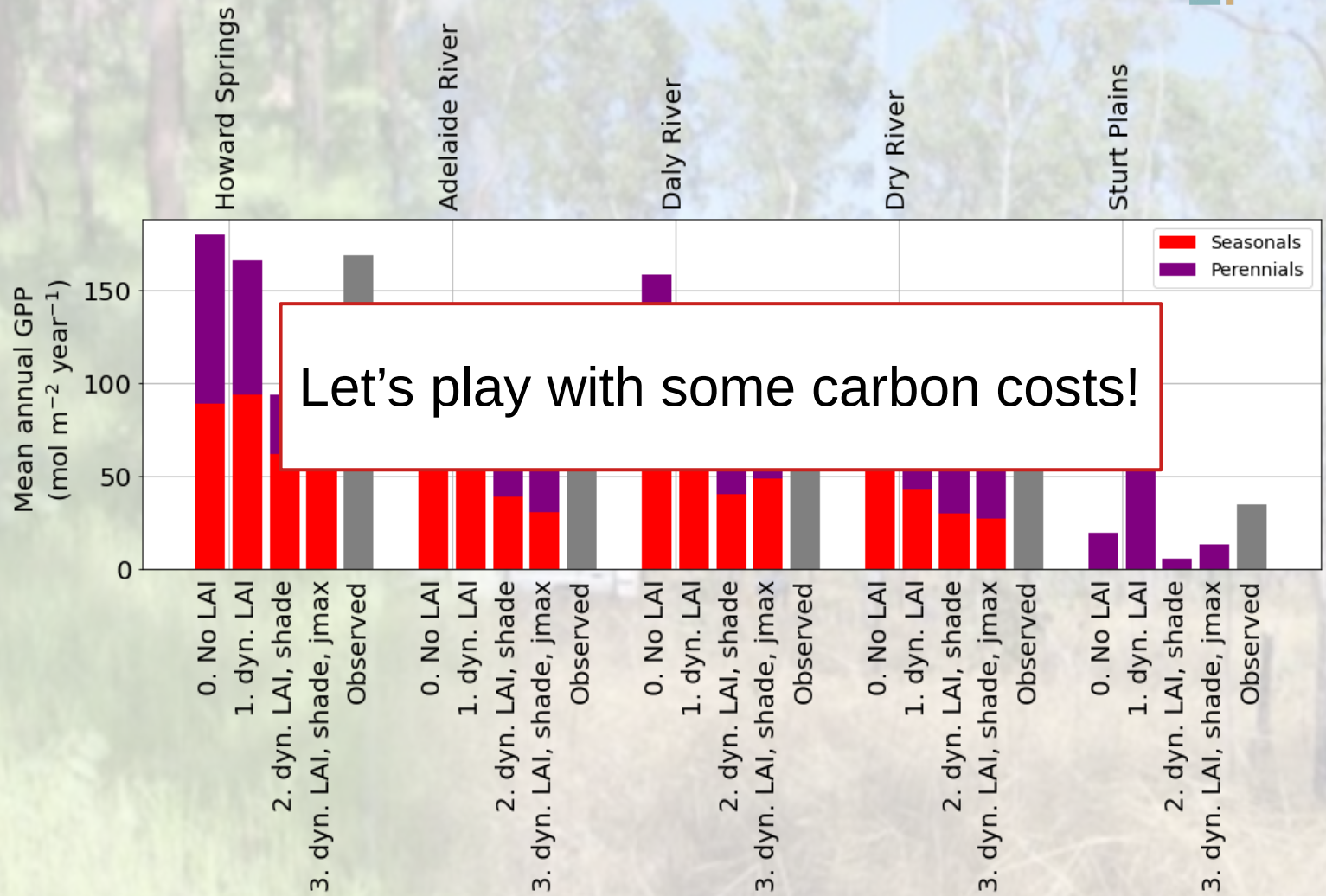
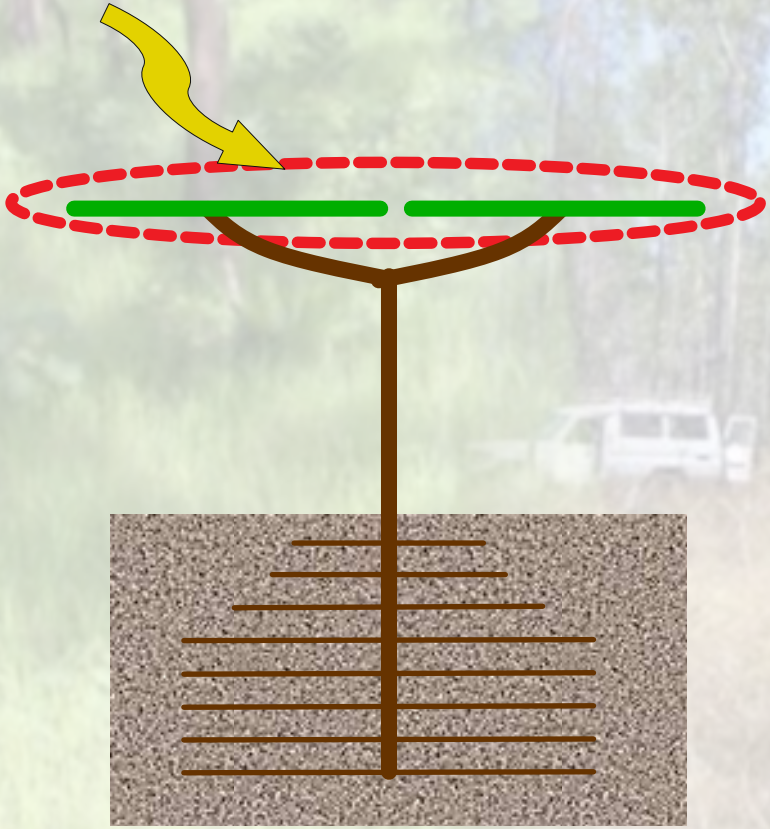


LET'S PLAY WITH SOME CARBON COSTS!

Daily optimization Jmax



Electron transport benefits:
Higher assimilation

Electron transport costs:
Leaf respiration
Fixed percentage of electron transport capacity

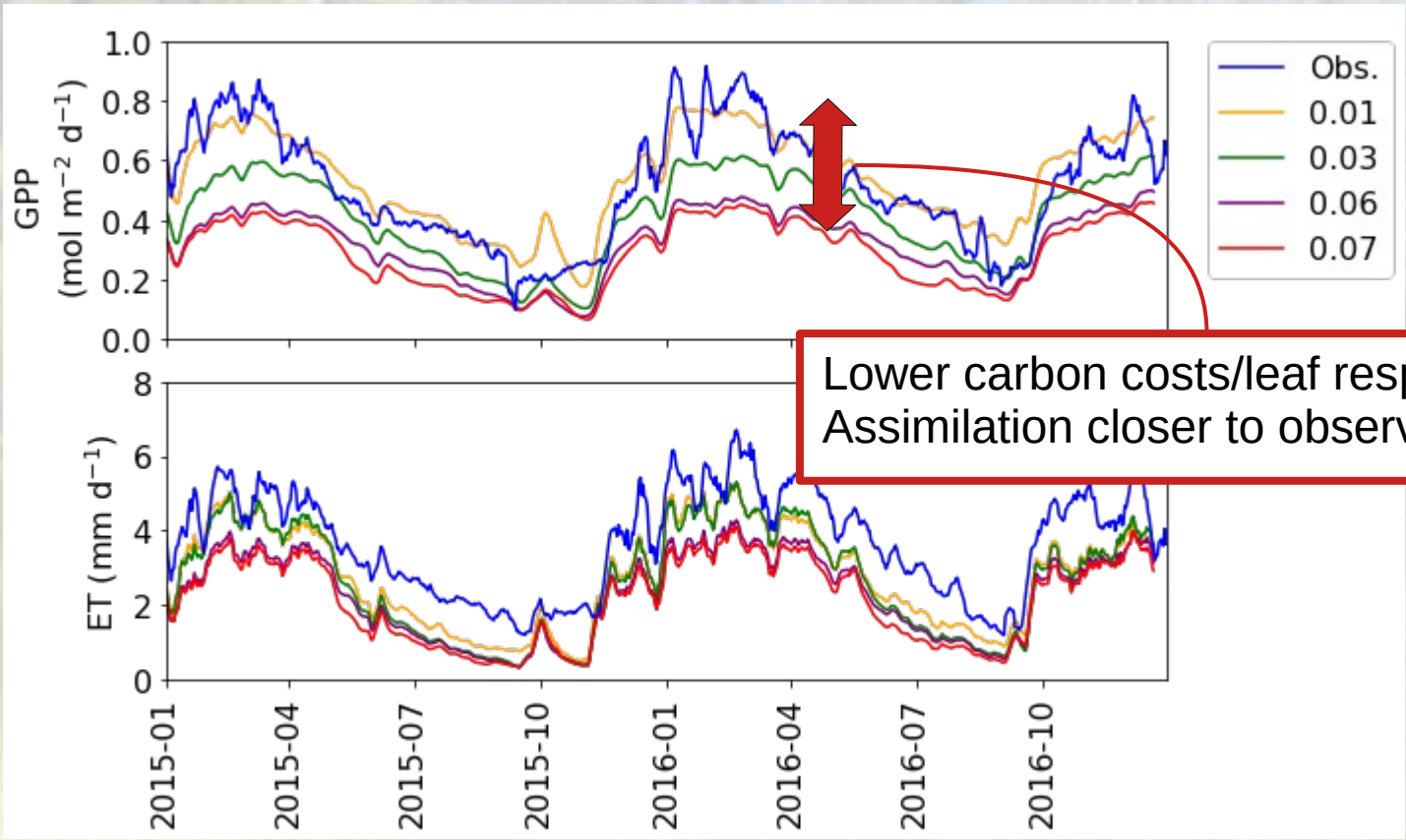
+ photosynthesis

- foliage costs
- leaf respiration
-

---------- +
Net carbon profit

LET'S PLAY WITH SOME CARBON COSTS!

- Motivation
- Methods
- Results
- Conclusions



Lower carbon costs/leaf respiration:
Assimilation closer to observations

LET'S PLAY WITH SOME CARBON COSTS!

- Motivation
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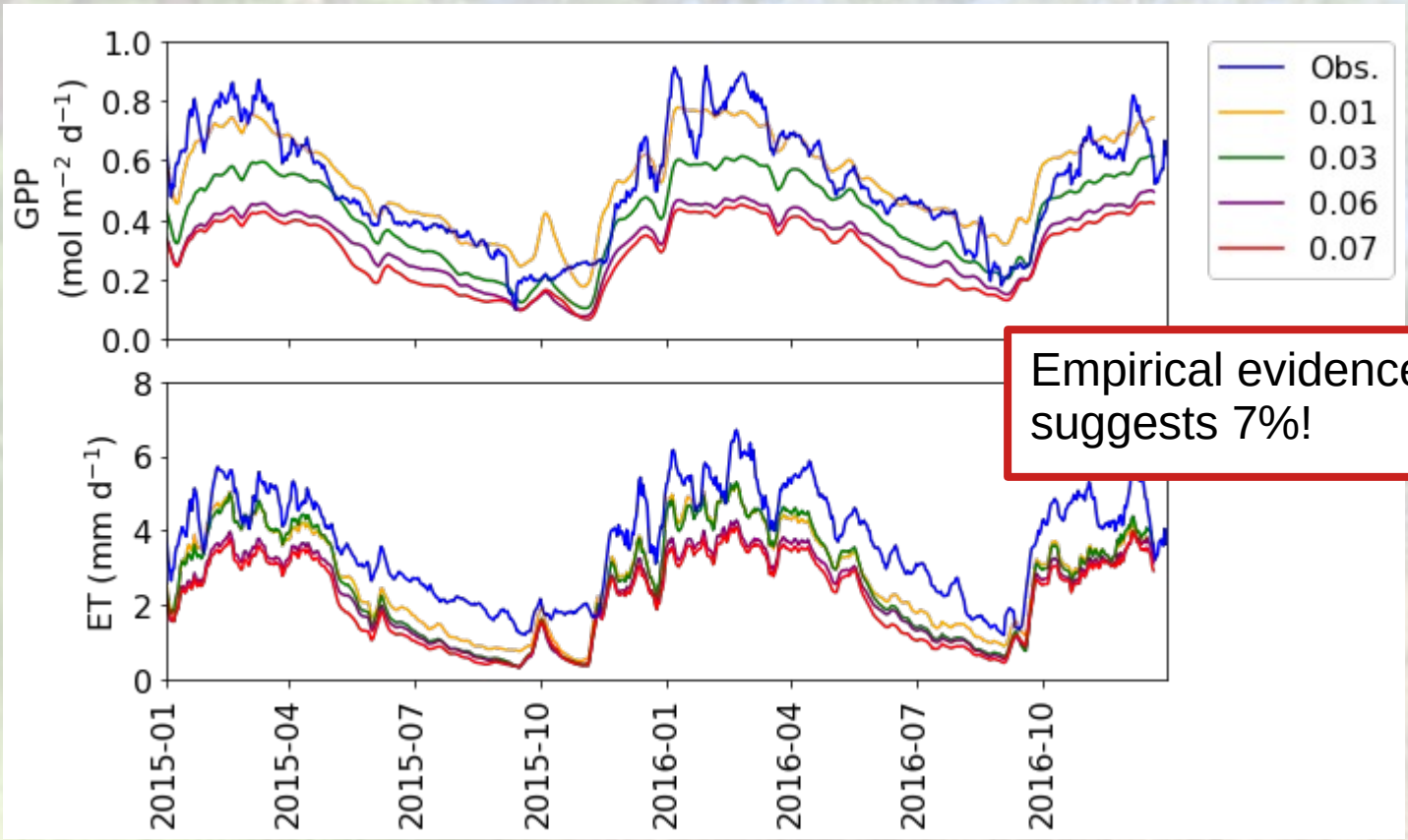

Empirical evidence suggests 7%!

LET'S PLAY WITH SOME CARBON COSTS!

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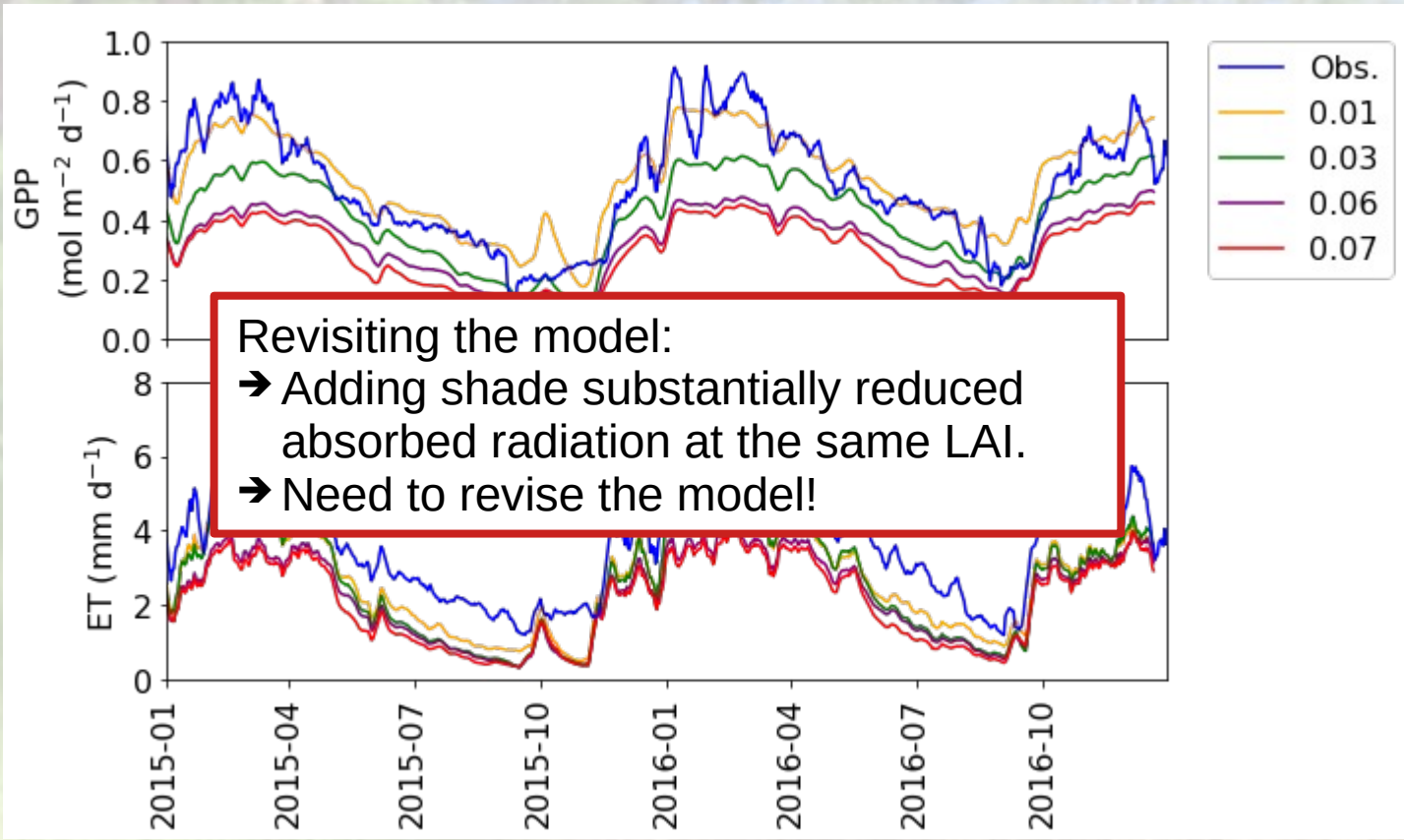

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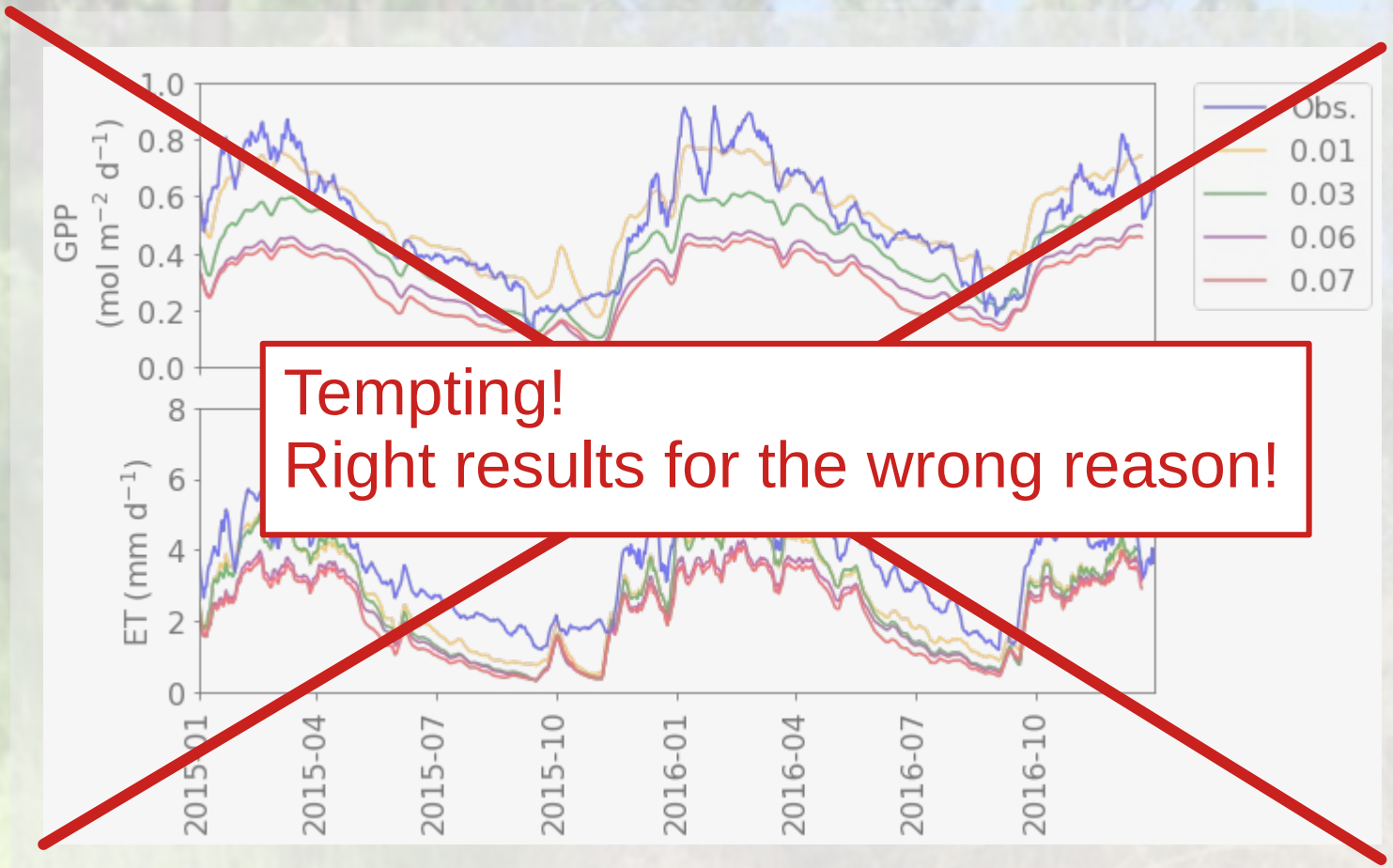

CONCLUSION

Optimizing for **Net Carbon Profit** allows for a systematic evaluation of results, but…

… need to resist all temptations!

R.C. Nijzink, S. Schymanski
remko.nijzink@list.lu

Prediction of leaf area dynamics by maximizing the **Net Carbon Profit**

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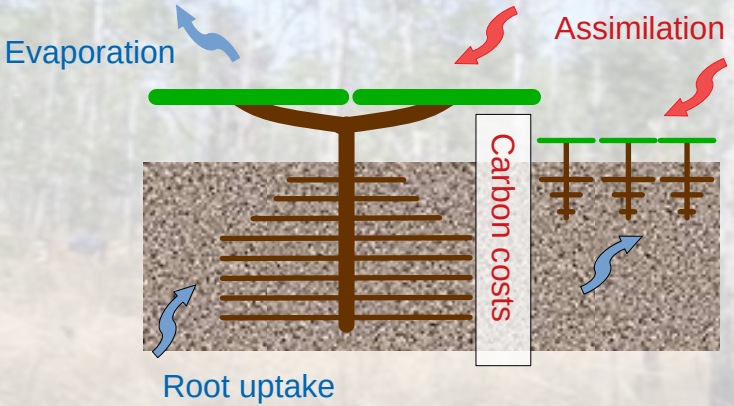
Appendix



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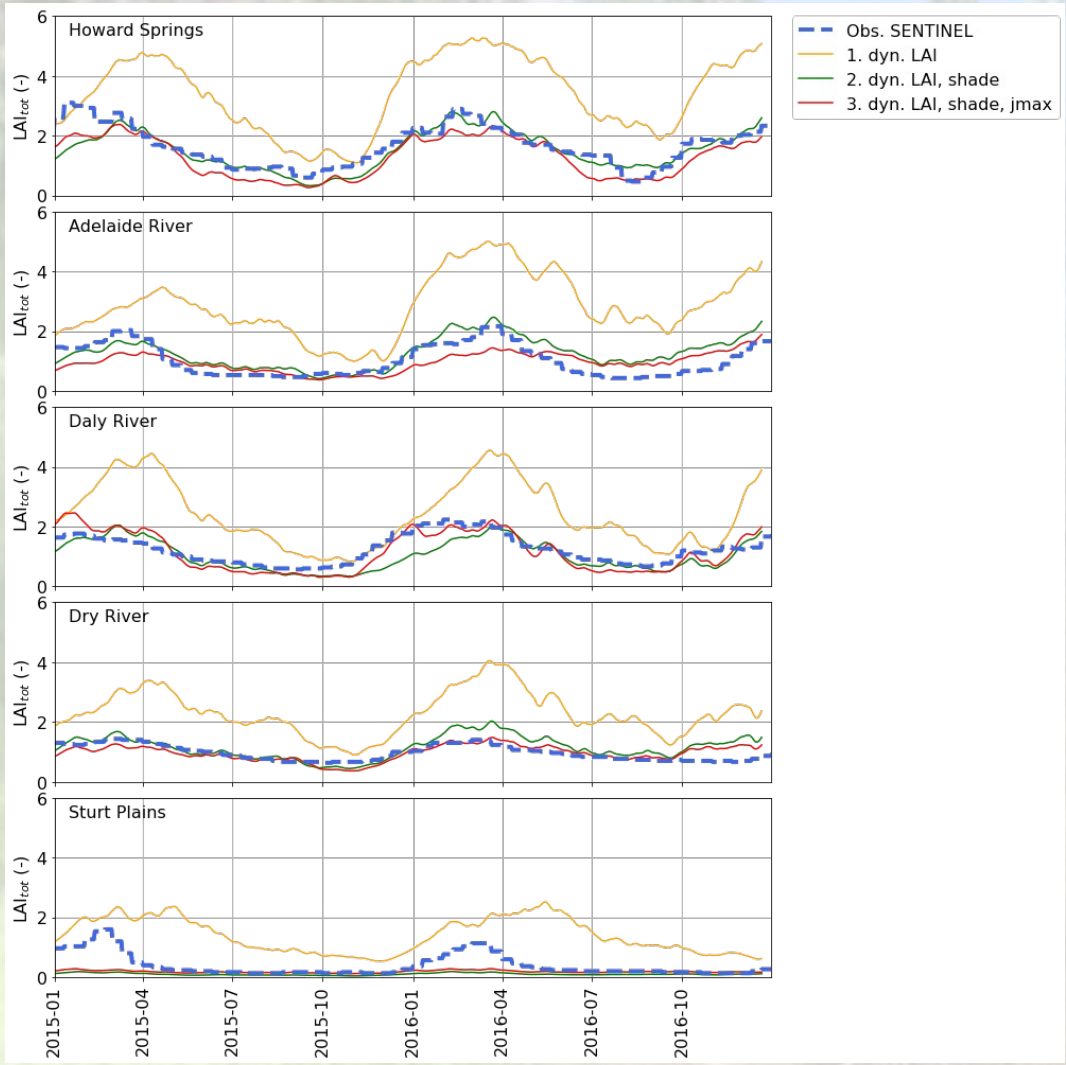
MODELLED AND OBSERVED LAI



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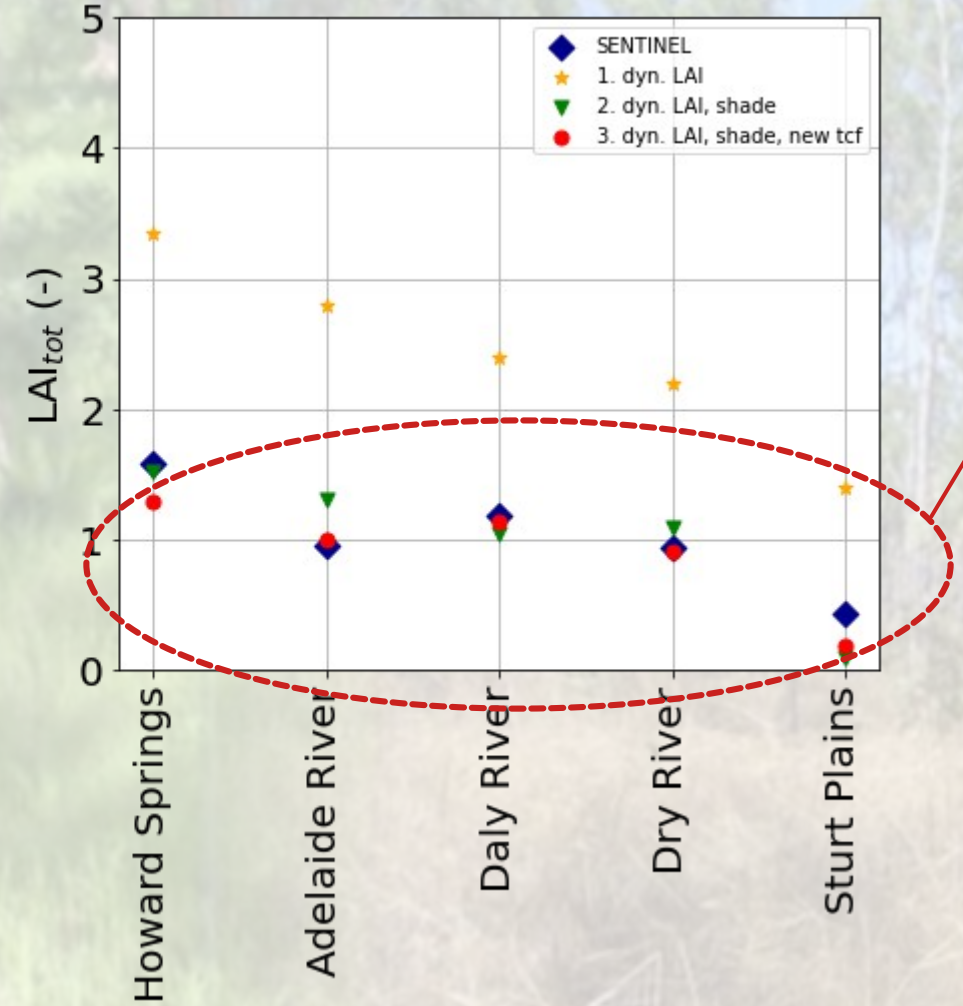
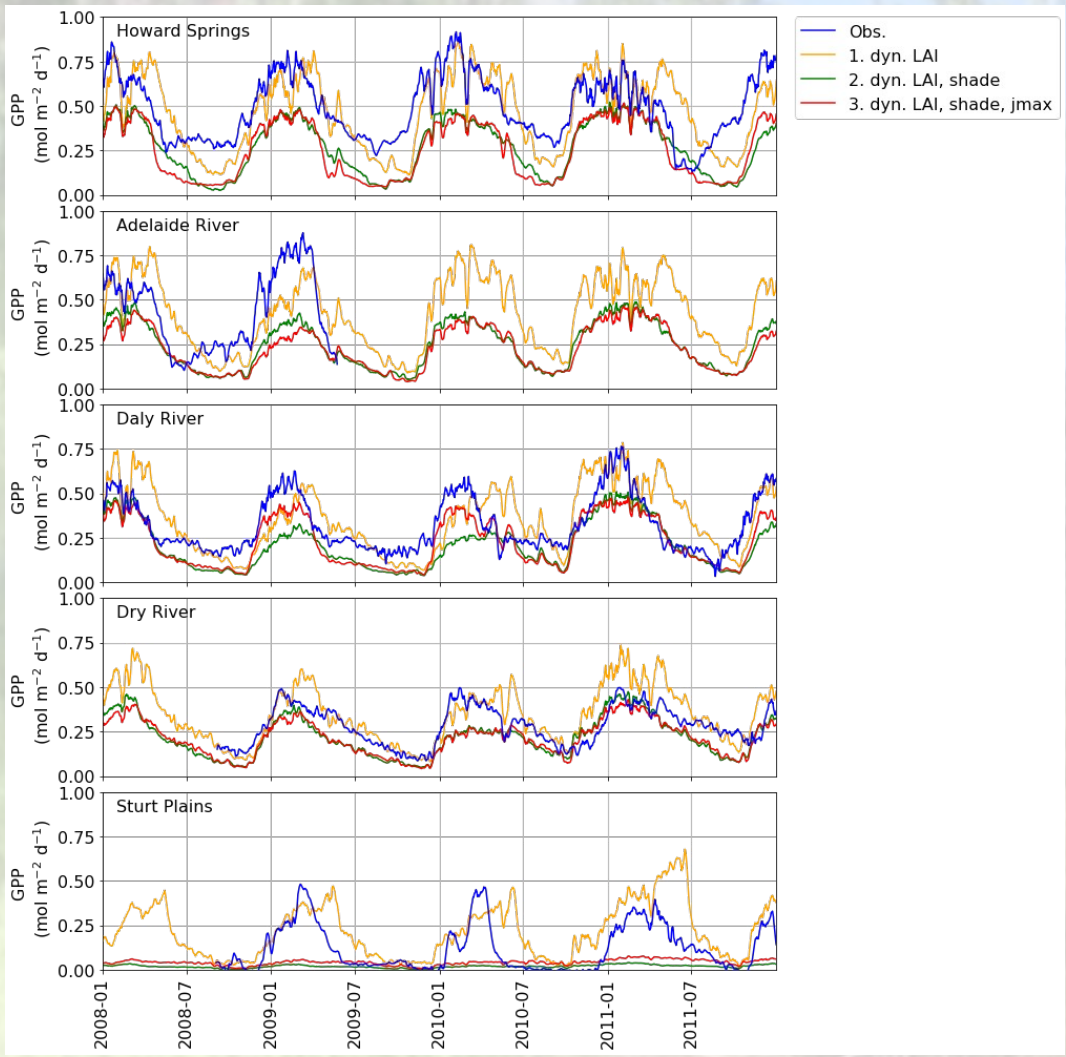


LAI not bad compared to SENTINEL!

MODELLED AND OBSERVED GPP



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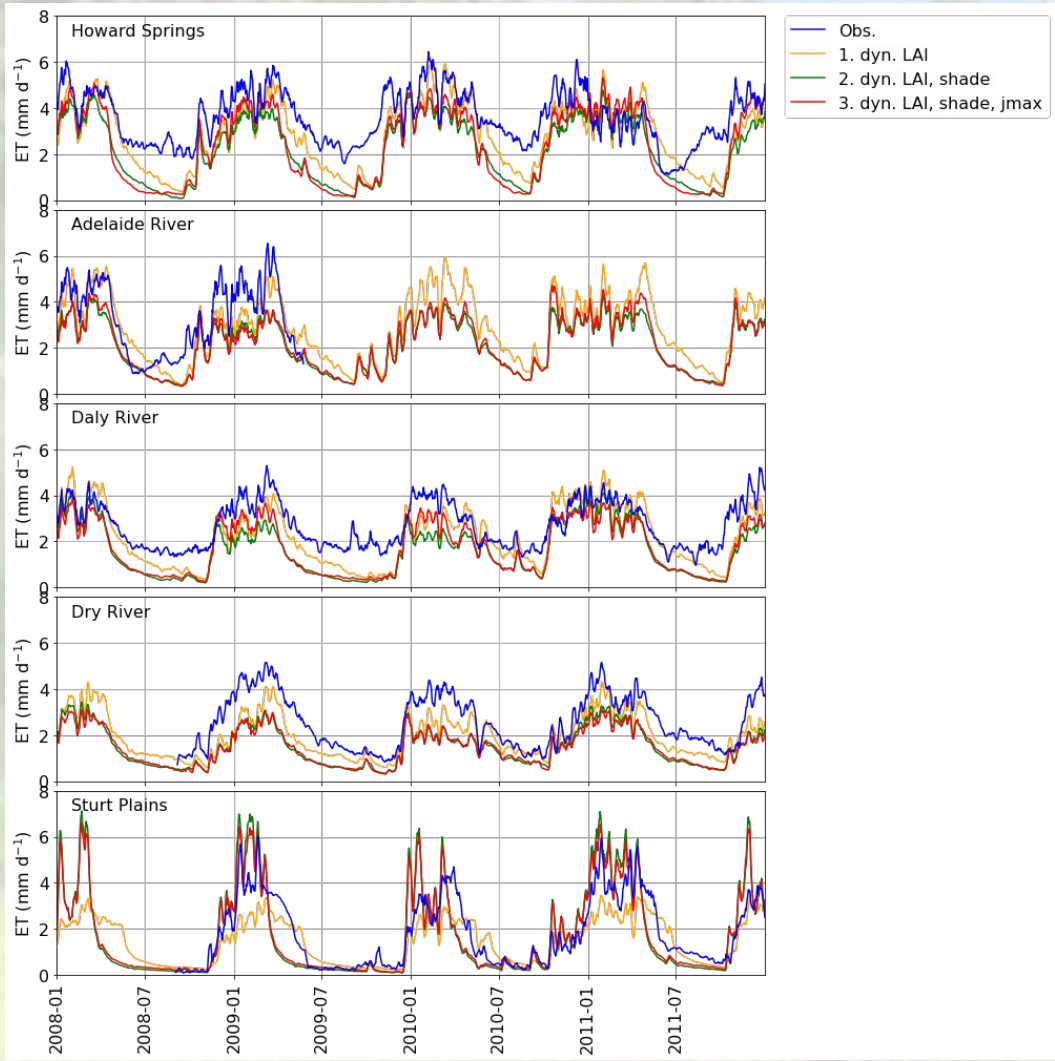
MODELLED AND OBSERVED ET



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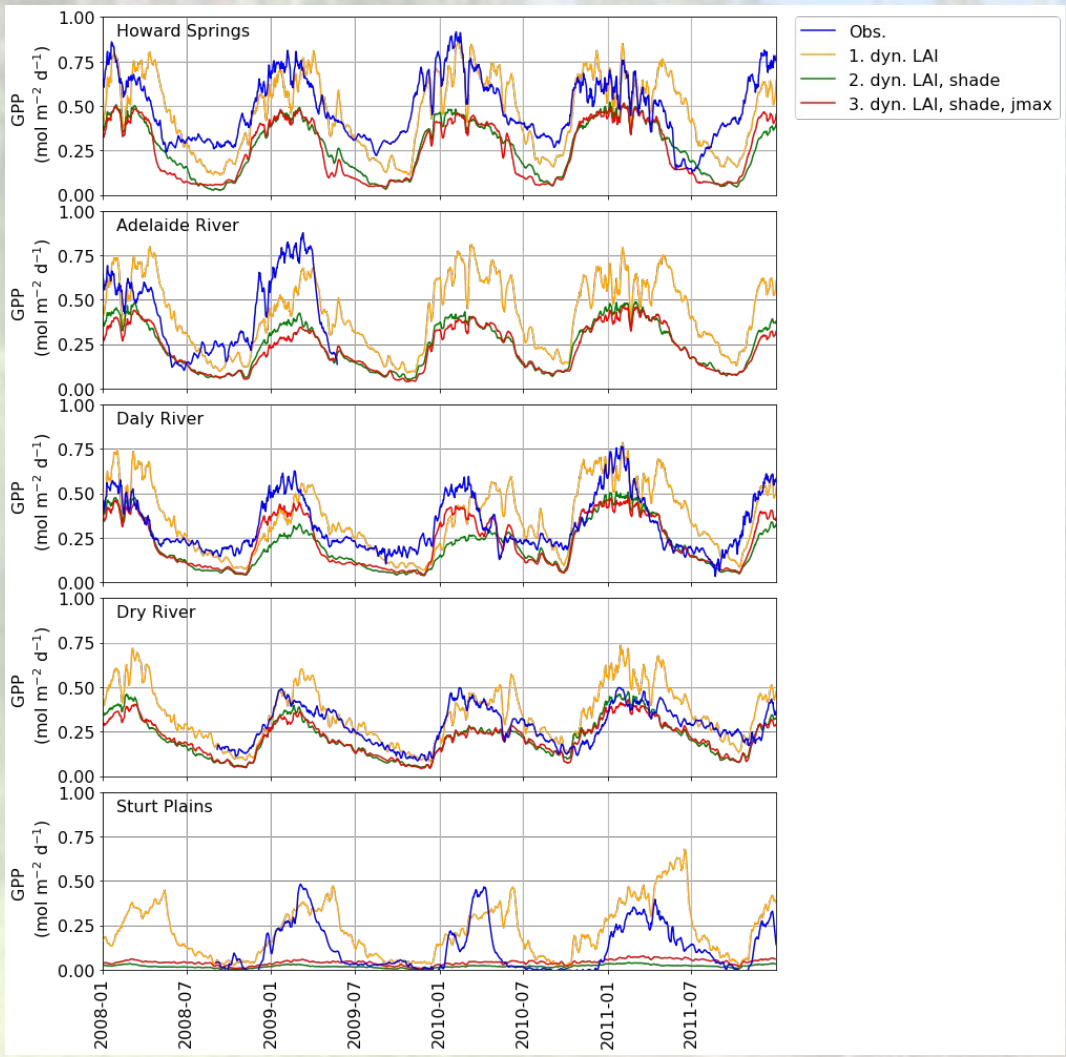

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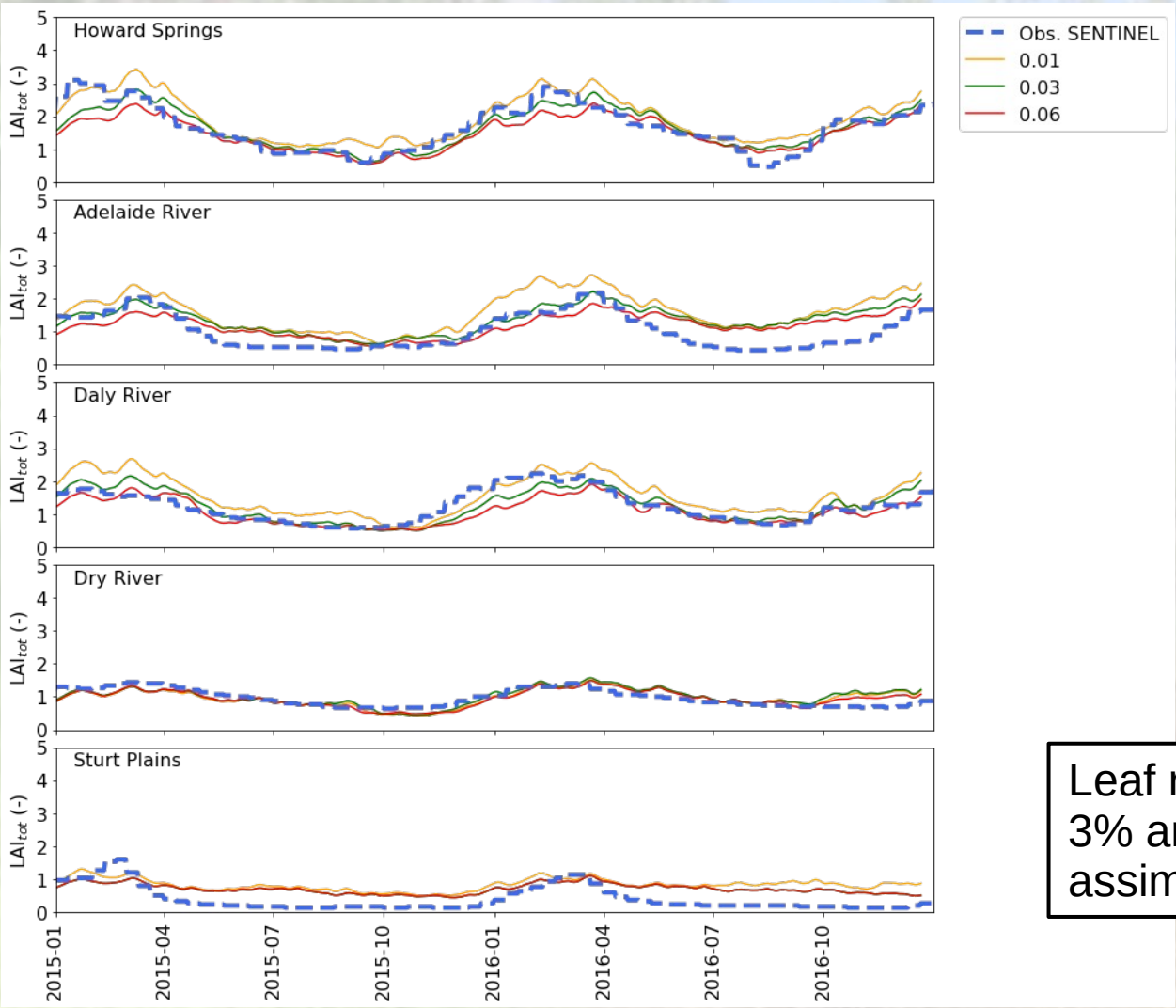
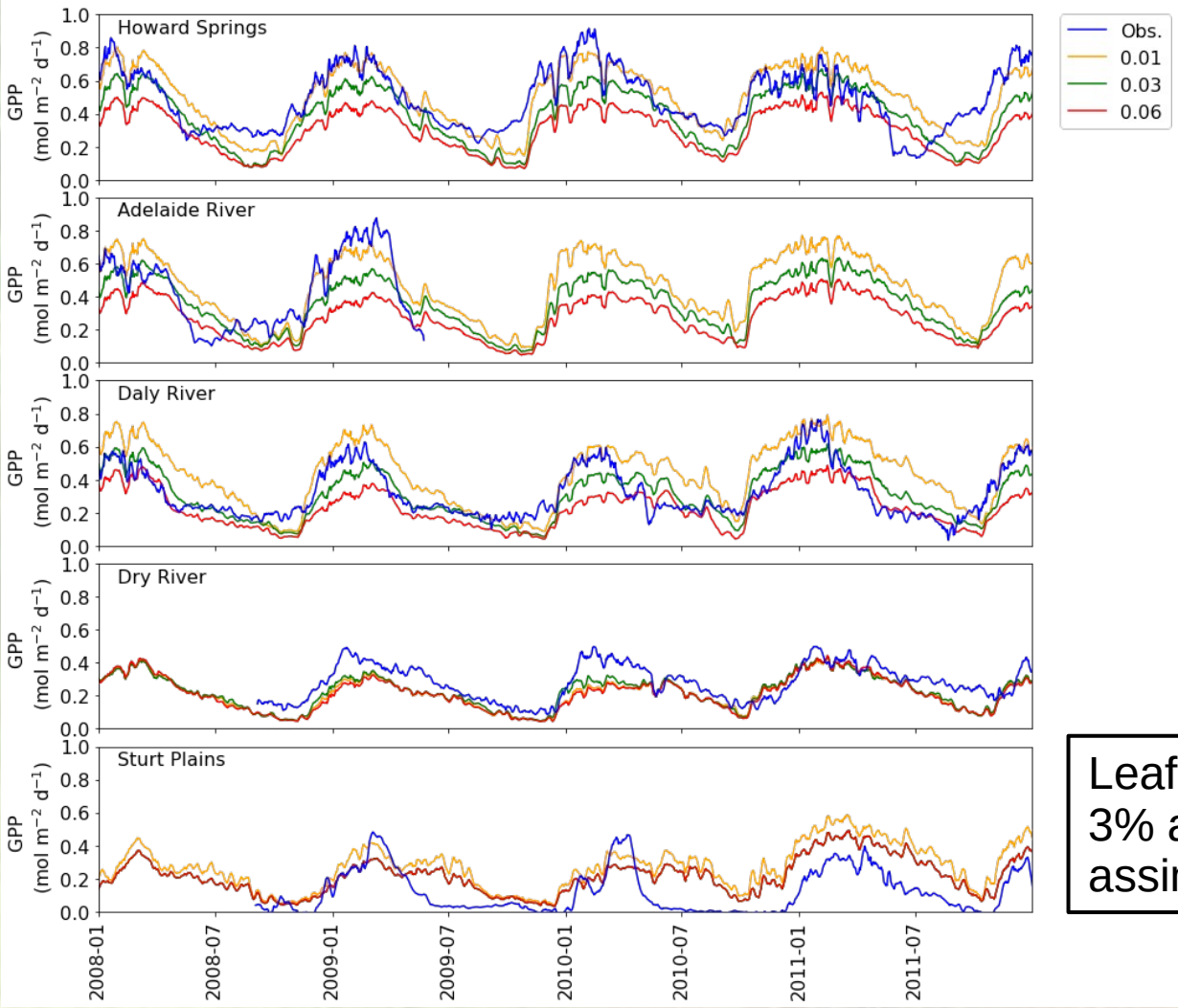


Leaf respiration for 1%, 3% and 6% of assimilation.

- Motivation
- Methods
- Results
- Conclusions

MODELLED AND OBSERVED GPP



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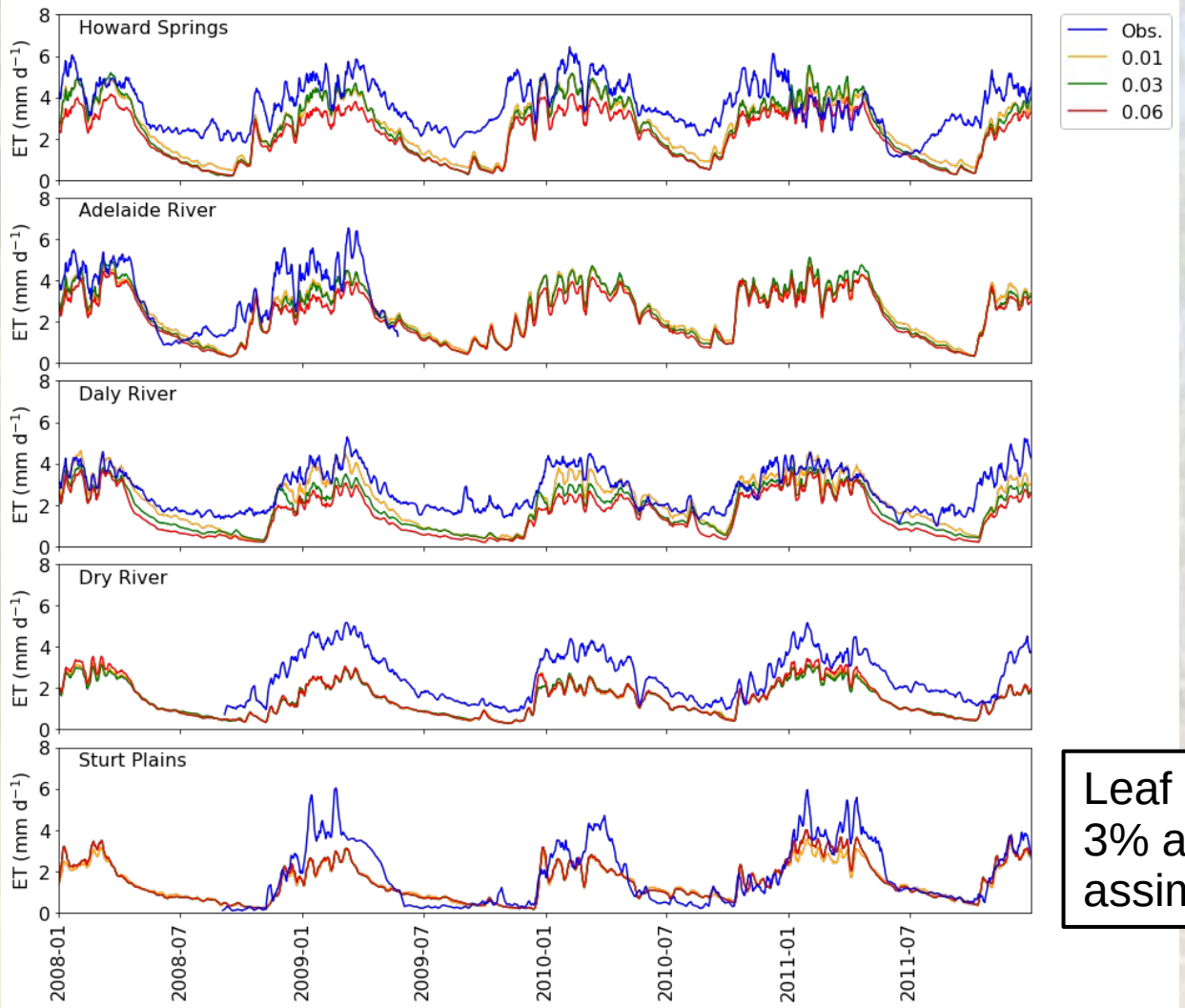

Leaf respiration for 1%, 3% and 6% of assimilation.

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REPOSITORIES

See also our repositories for more information:

- VOM model runs for the different steps:

  https://renkulab.io/projects/remko.nijzink/vom-lai

- VOM sensitivities for leaf respiration:

  https://renkulab.io/projects/remko.nijzink/vom-lai-analyses

- VOM analyses for LAI:

  https://renkulab.io/projects/remko.nijzink/vom-lai-analyses