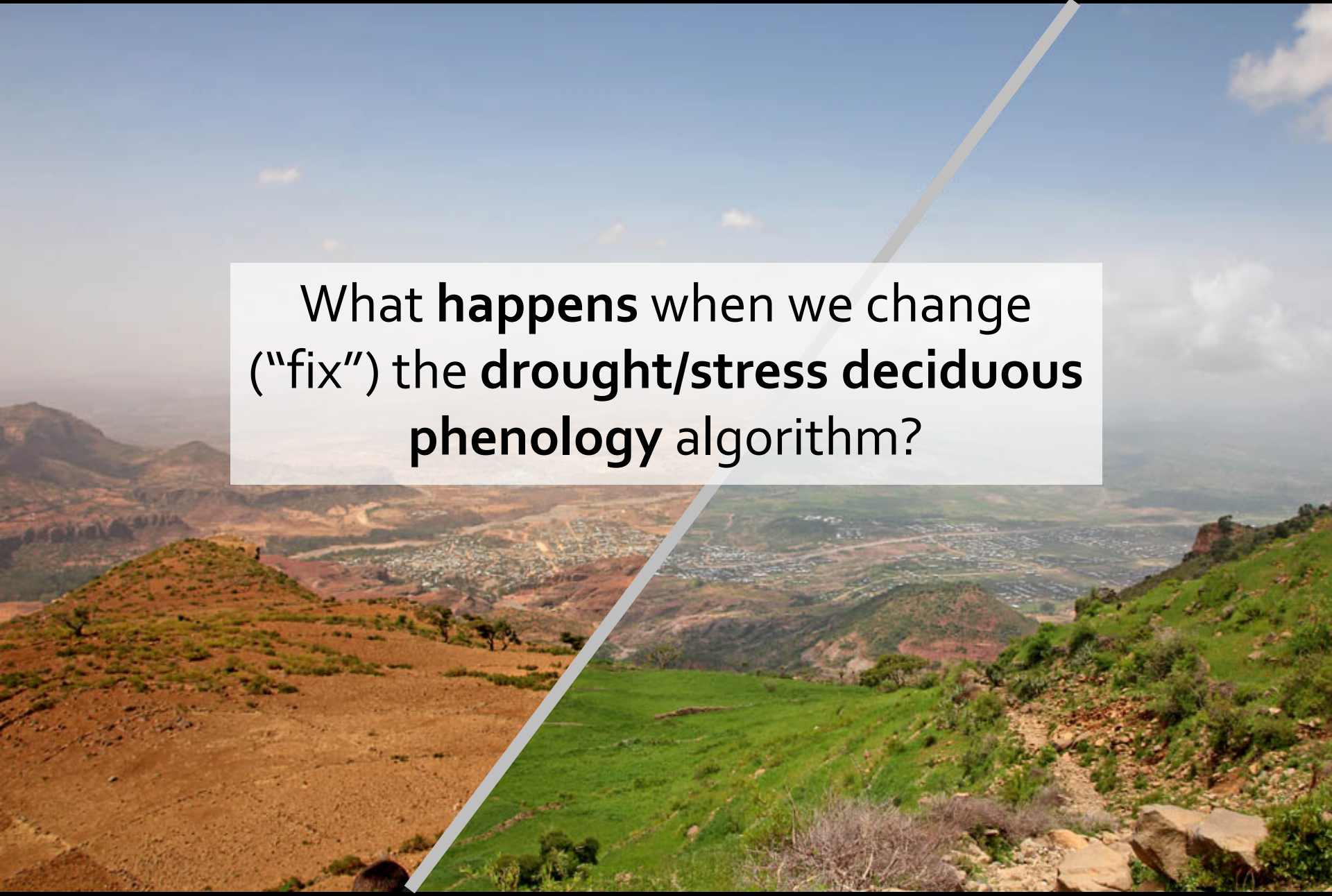
Ecological consequences of altering the drought deciduous phenology algorithm

Kyla Dahlin
with Rosie Fisher & Peter Lawrence
March 2, 2015

image credit: Forrest Copeland
talesfromthebigcountry.wordpress.com



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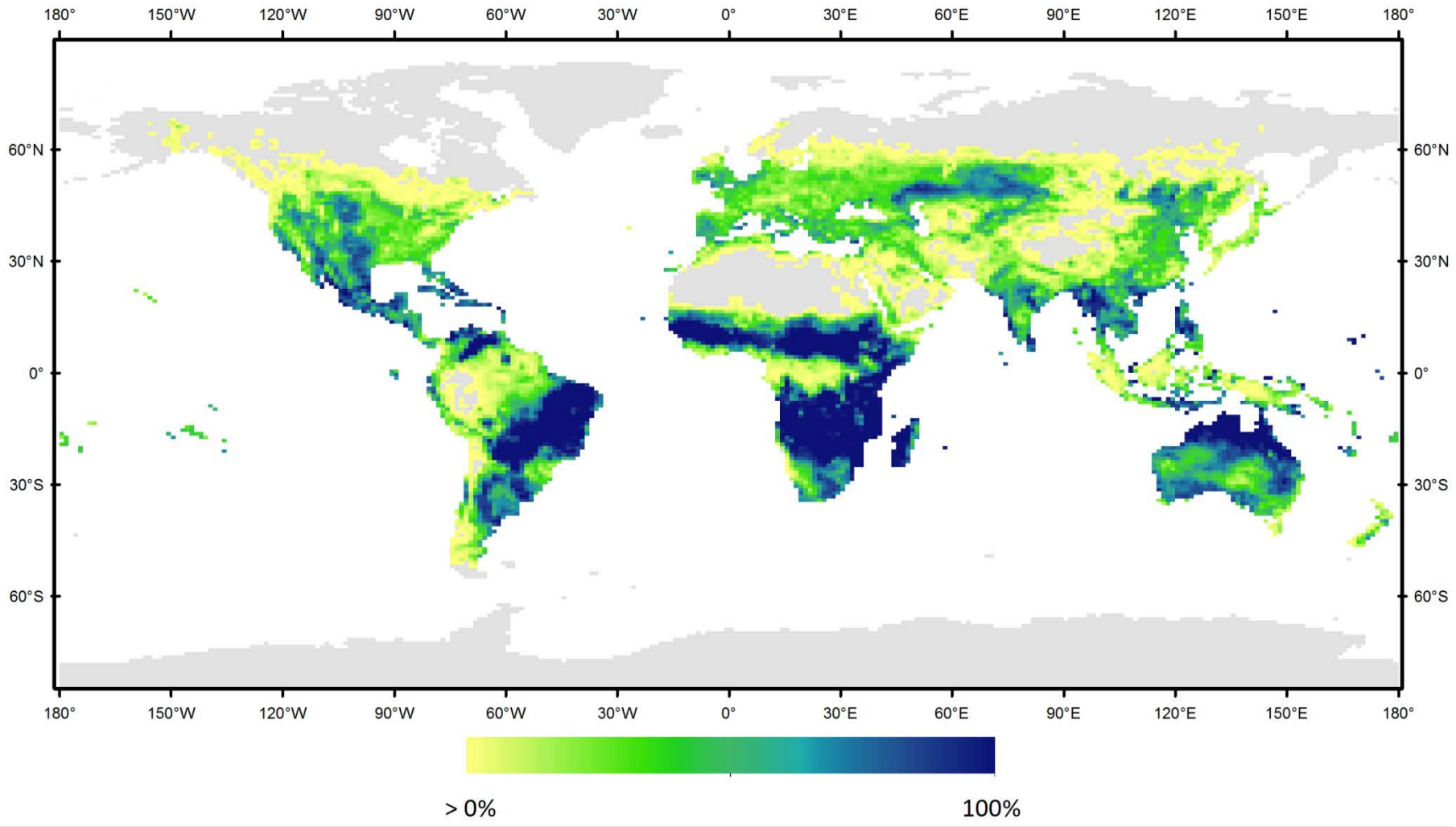
Where is CLM Stress Deciduous?



Questions

- How well does the stress deciduous phenology algorithm work in CLM? **[Leaf Area Index]**

  (compared to AVHRR-derived LAI3g for 1982-2010; Zhu et al 2013)

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- Did we make it work better? (with relatively simple changes)

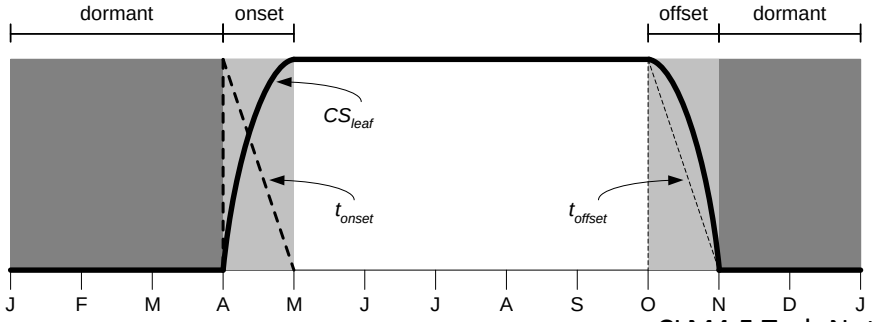
Questions

- How well does the stress deciduous phenology algorithm work in CLM? **[Leaf Area Index]**
  (compared to AVHRR-derived LAI3g for 1982-2010; Zhu et al 2013)
- Did we make it work better? (with relatively simple changes)
- What are the ecological consequences of this change?

How does stress/drought decidousness work in CLM?

(in warm, long-day regions*)

CLM4.5 Tech Note
from White et al 1997



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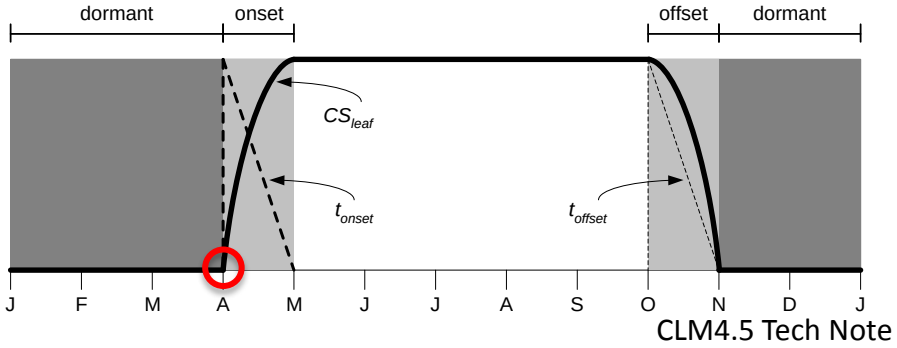

CLM4.5 Tech Note

- Start growing leaves if…
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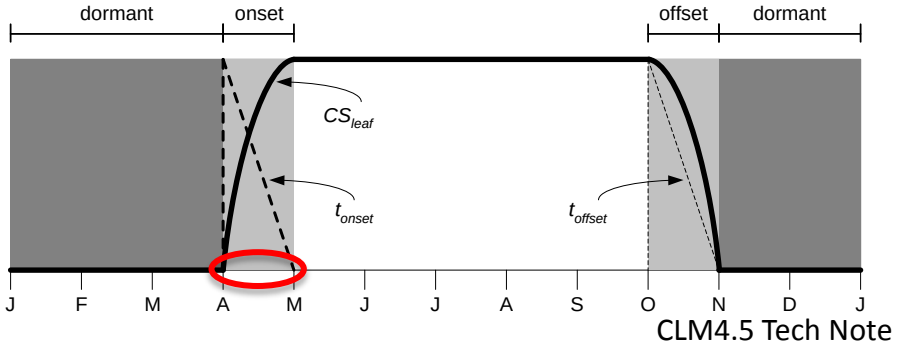

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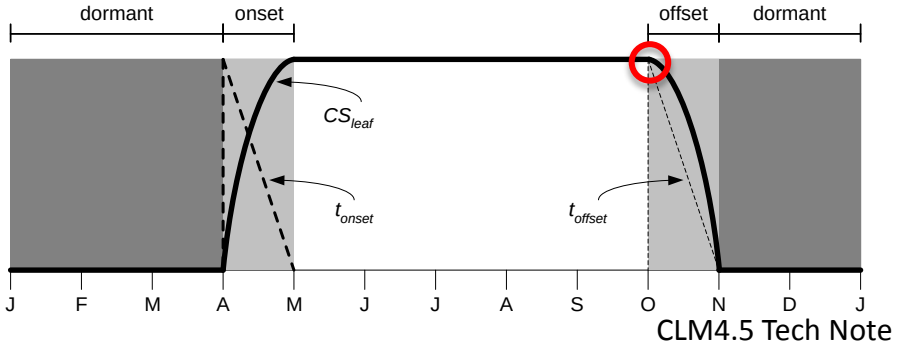

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- Start growing leaves if…
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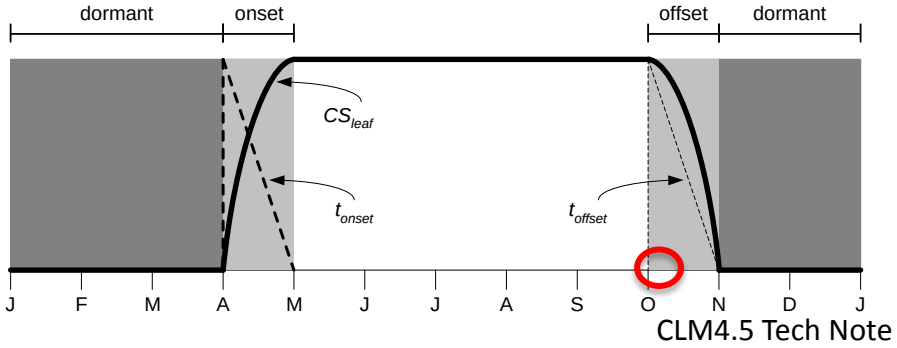

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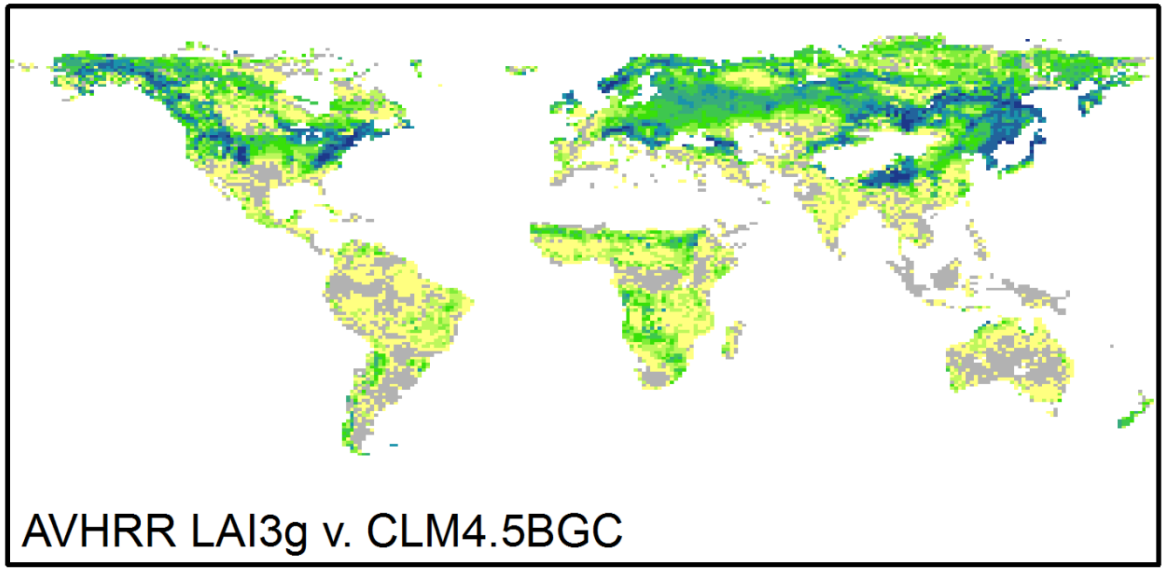
- Leaf drop period fixed at 15 days

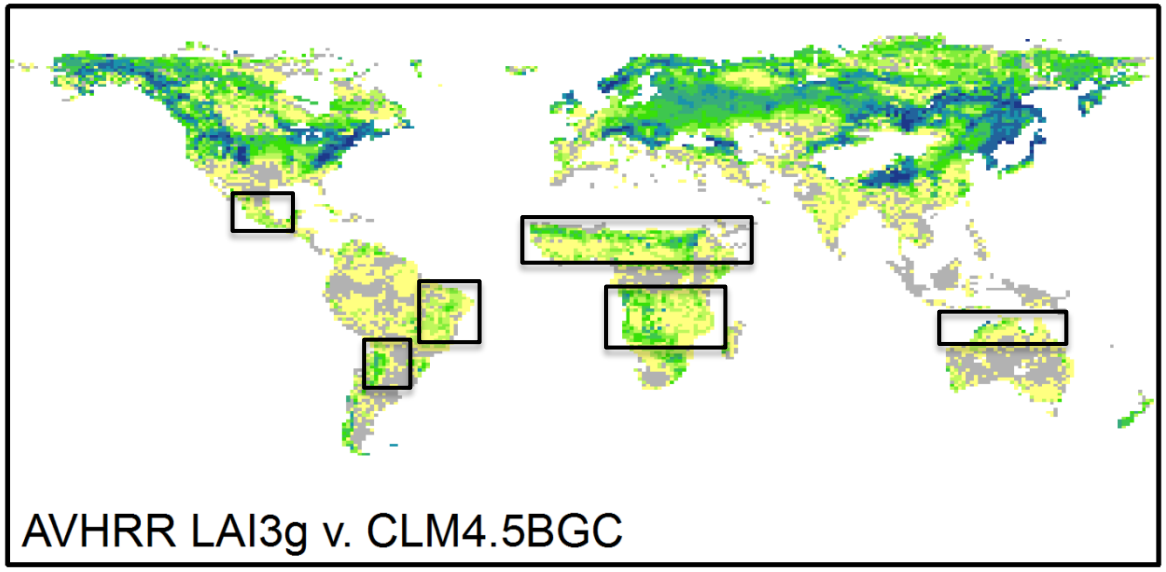
Correlations



R^2

- 0 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.4
- 0.4 - 0.5
- 0.5 - 0.6
- 0.6 - 0.7
- 0.7 - 0.8
- 0.8 - 0.9
- 0.9 - 1
- Not Significant

Correlations



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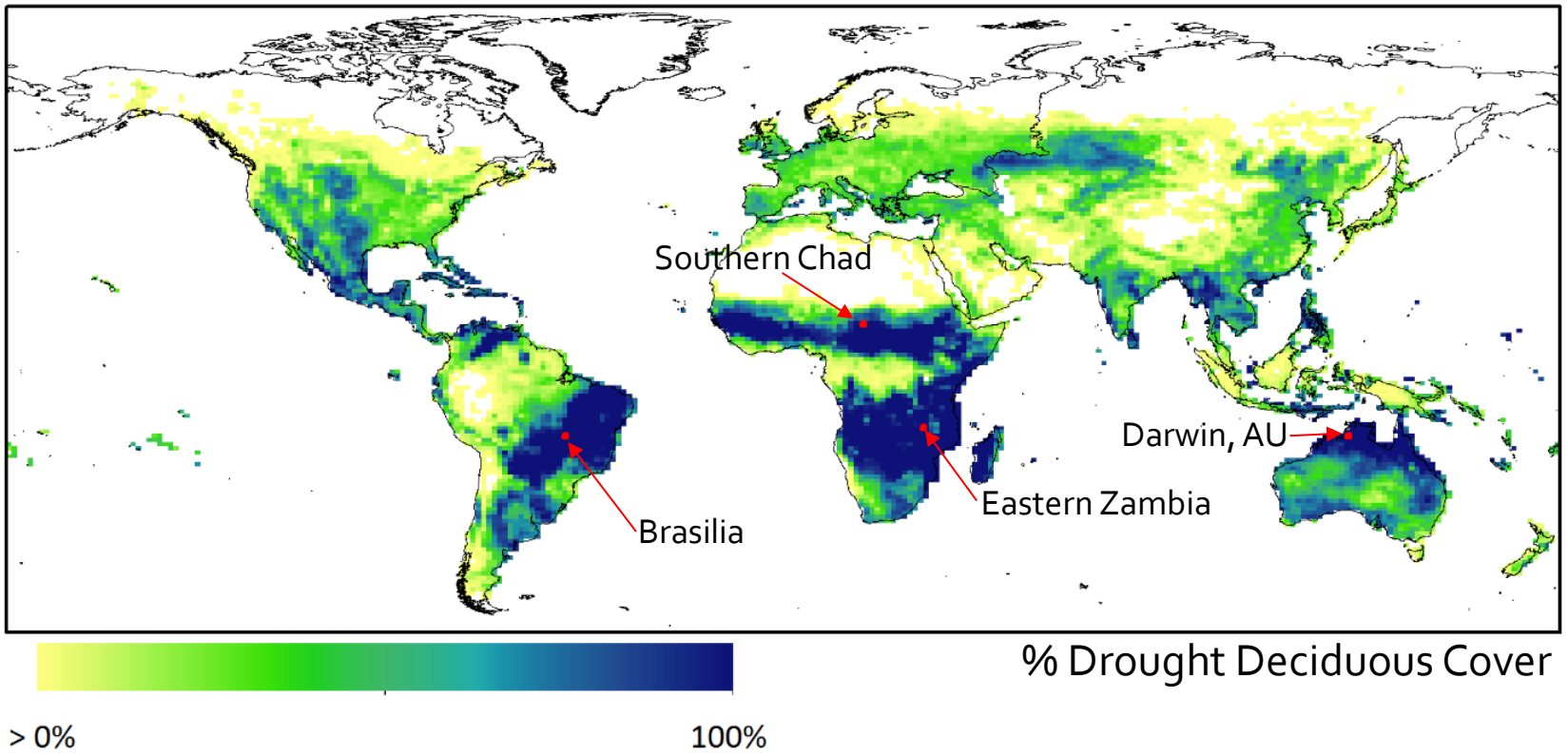
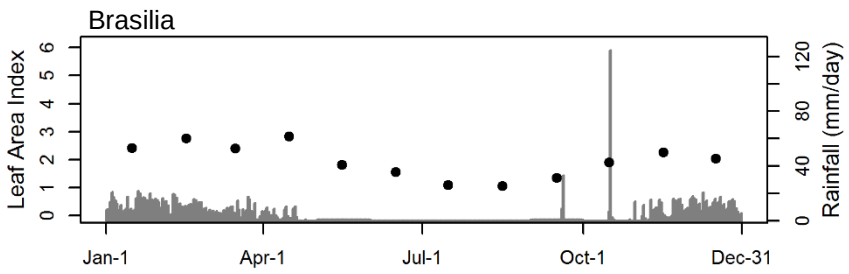
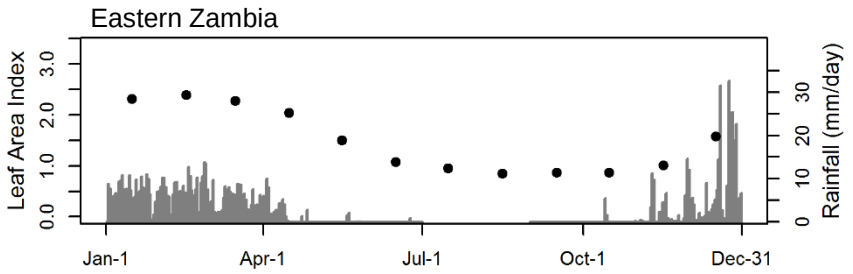
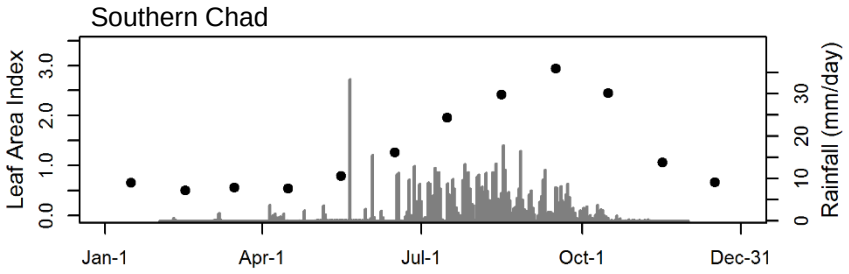
What about at single points?

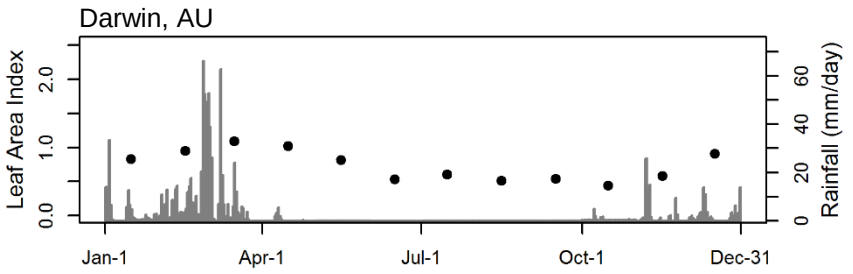


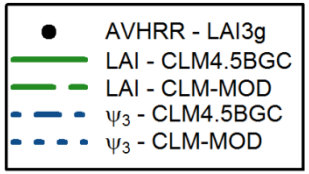
What's going on?











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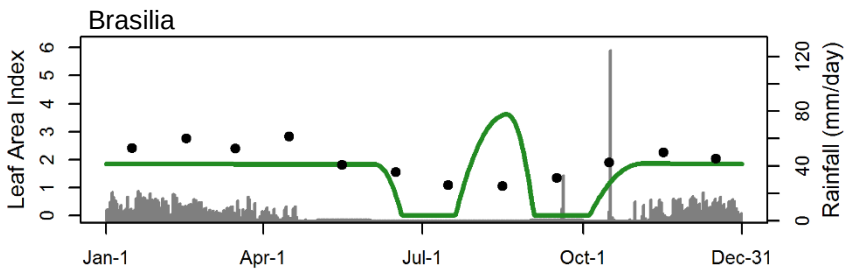

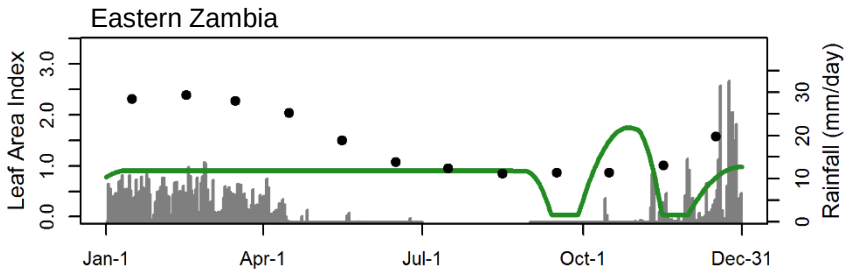

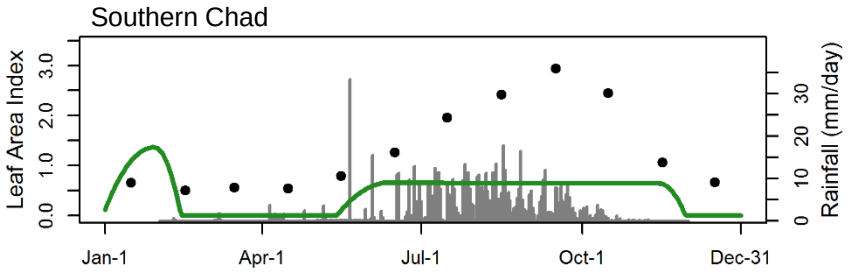

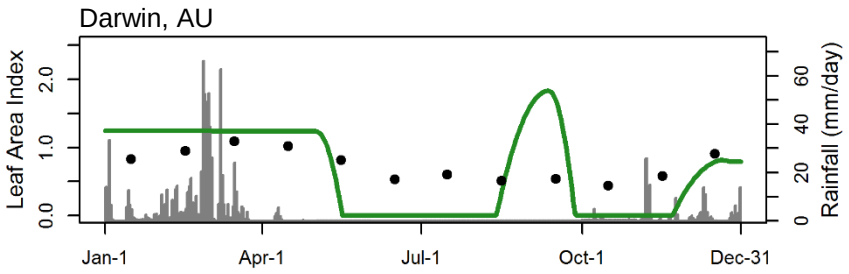

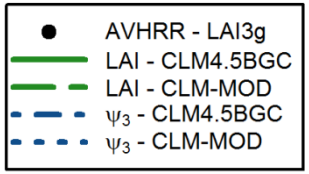

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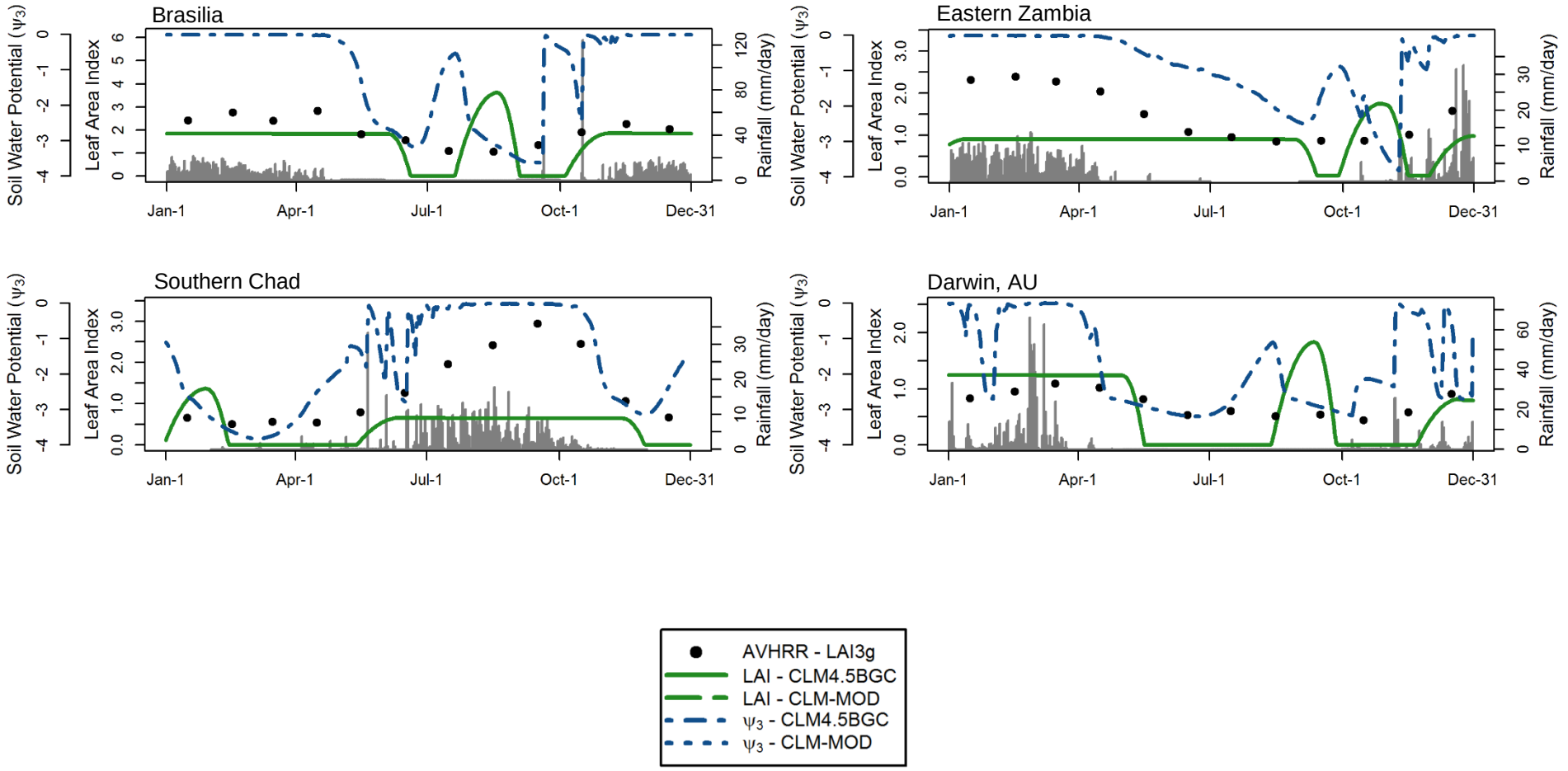
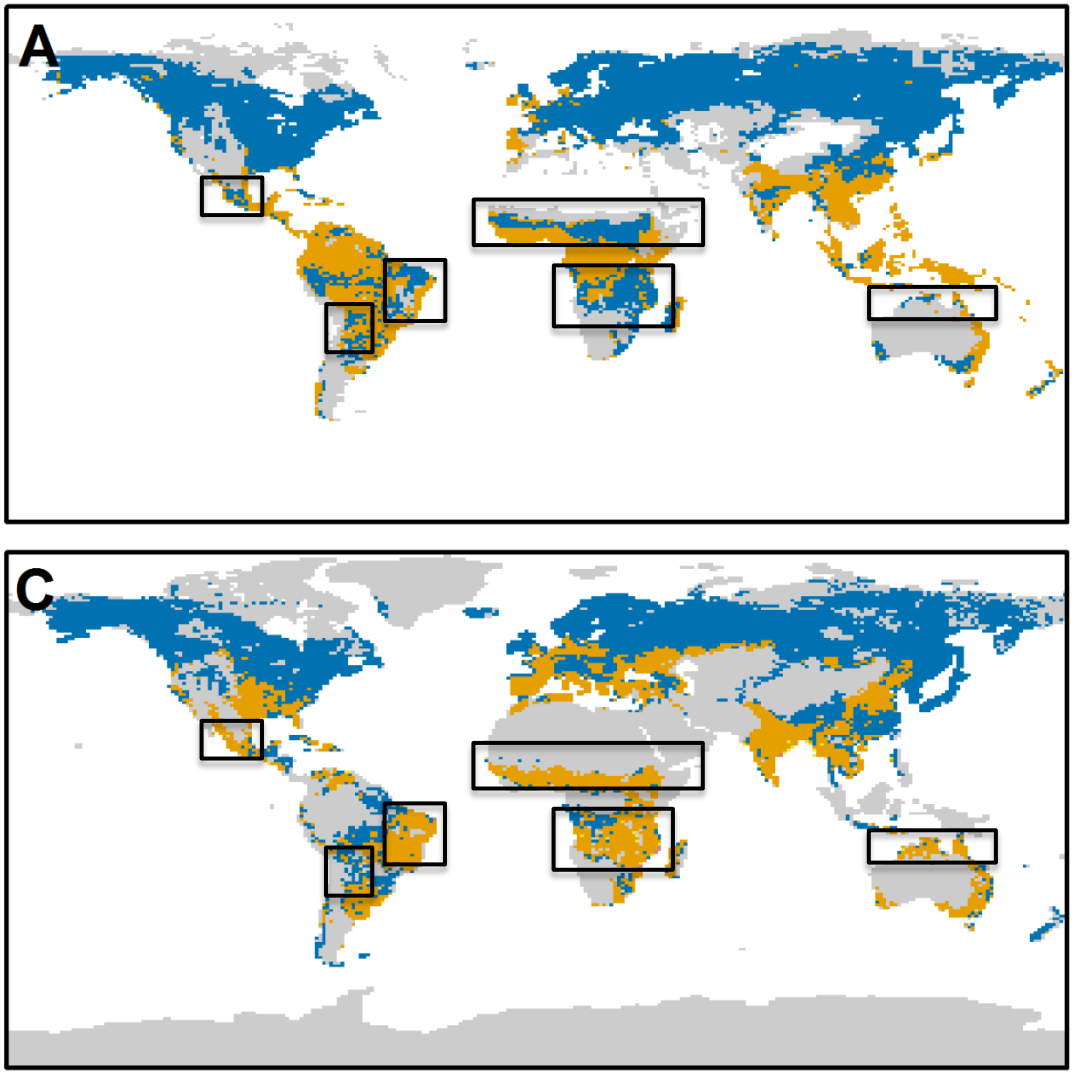


Counting Peaks

AVHRR LAI3g

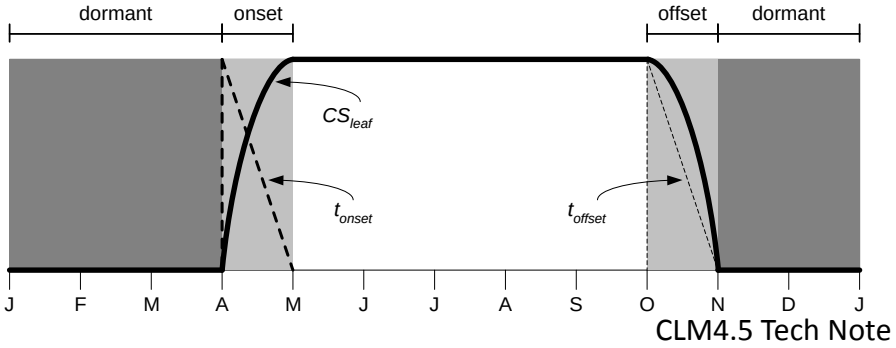
CLM4.5BGC



How does stress decidousness currently work in CLM?

(in warm, long-day regions)

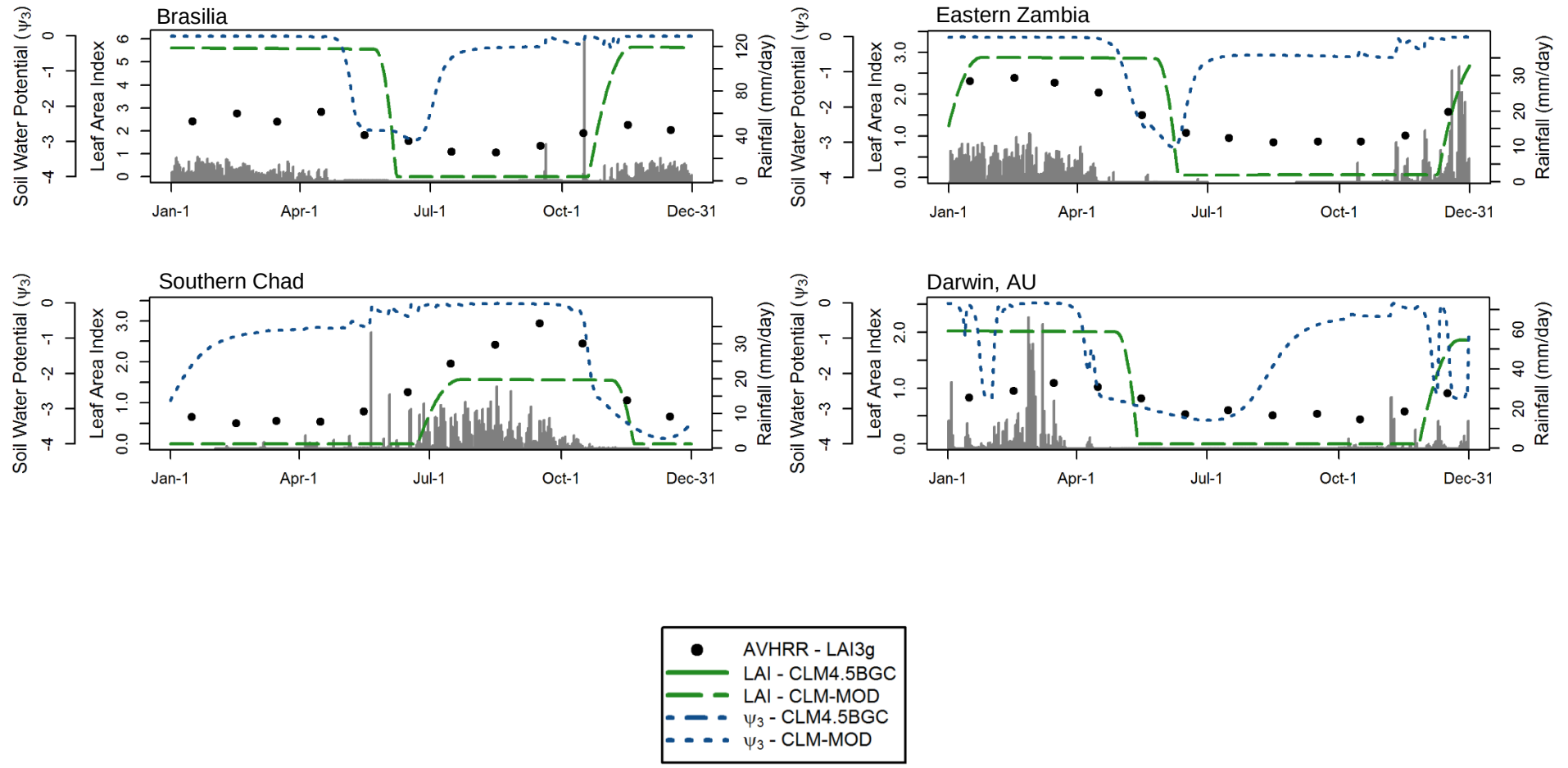
CLM4.5 Tech Note
from White et al 1997



CLM4.5 Tech Note

- Start growing leaves if…
  - 3rd soil layer is wet (soil water potential > -2 MPa) for 15 days
  - **It RAINS! (20 mm in the past 10 days)**
- Onset period fixed at 30 days
- Start dropping leaves if…
  - Onset period is complete
  - 3rd soil layer is dry (soil water potential < -2 MPa) for 15 days
- Leaf drop period fixed at 15 days

What's going on?



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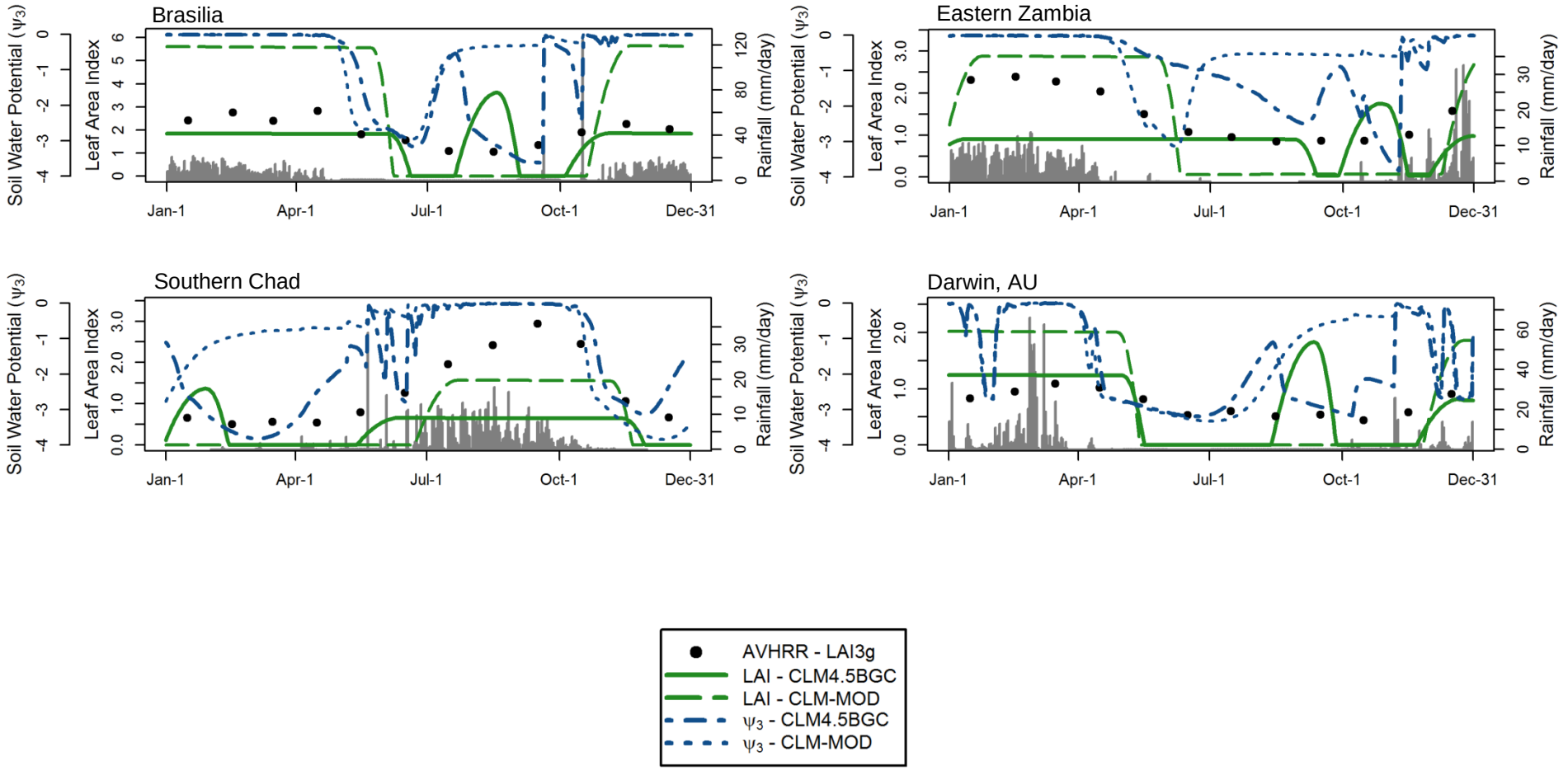
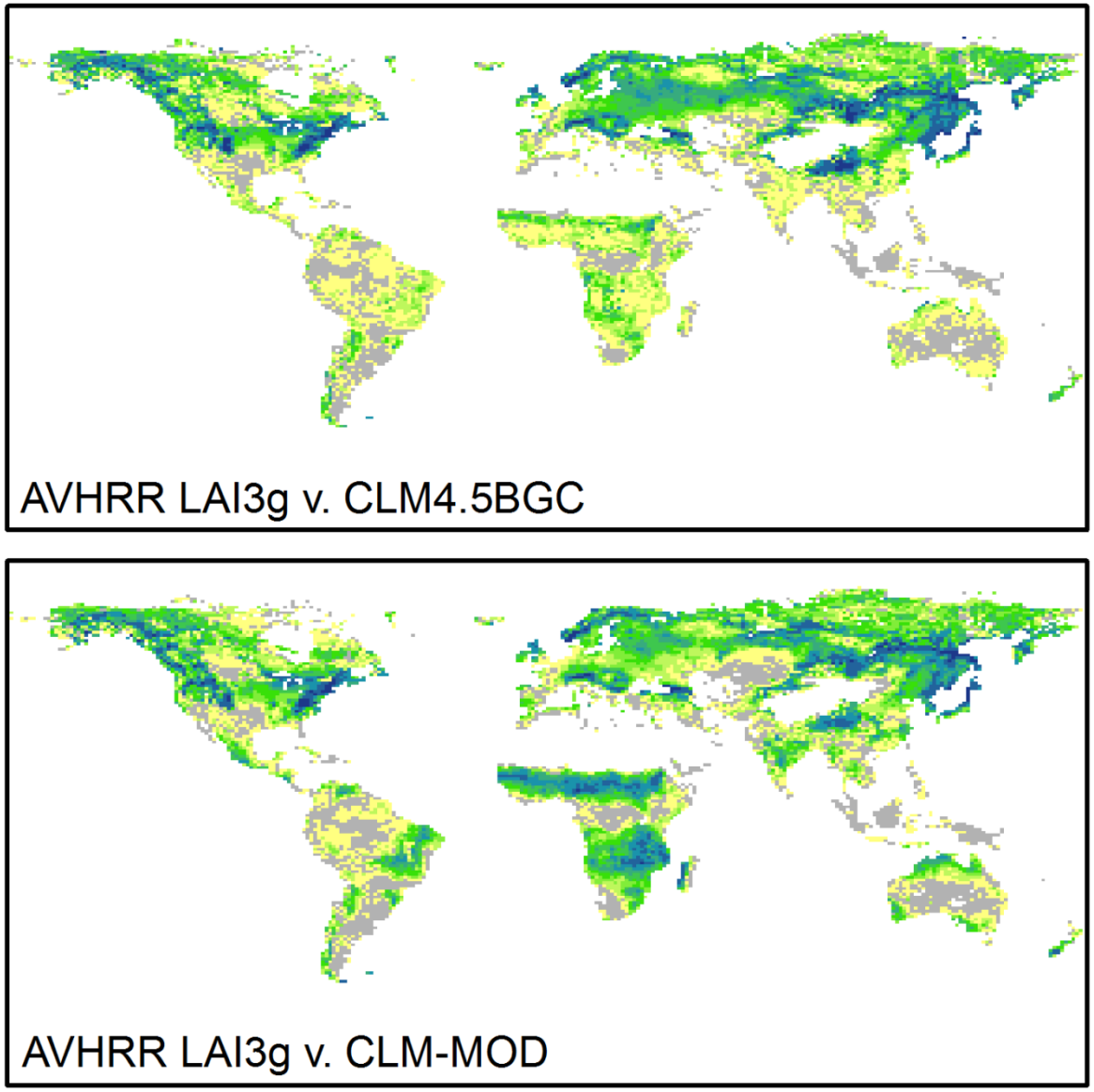


Correlations



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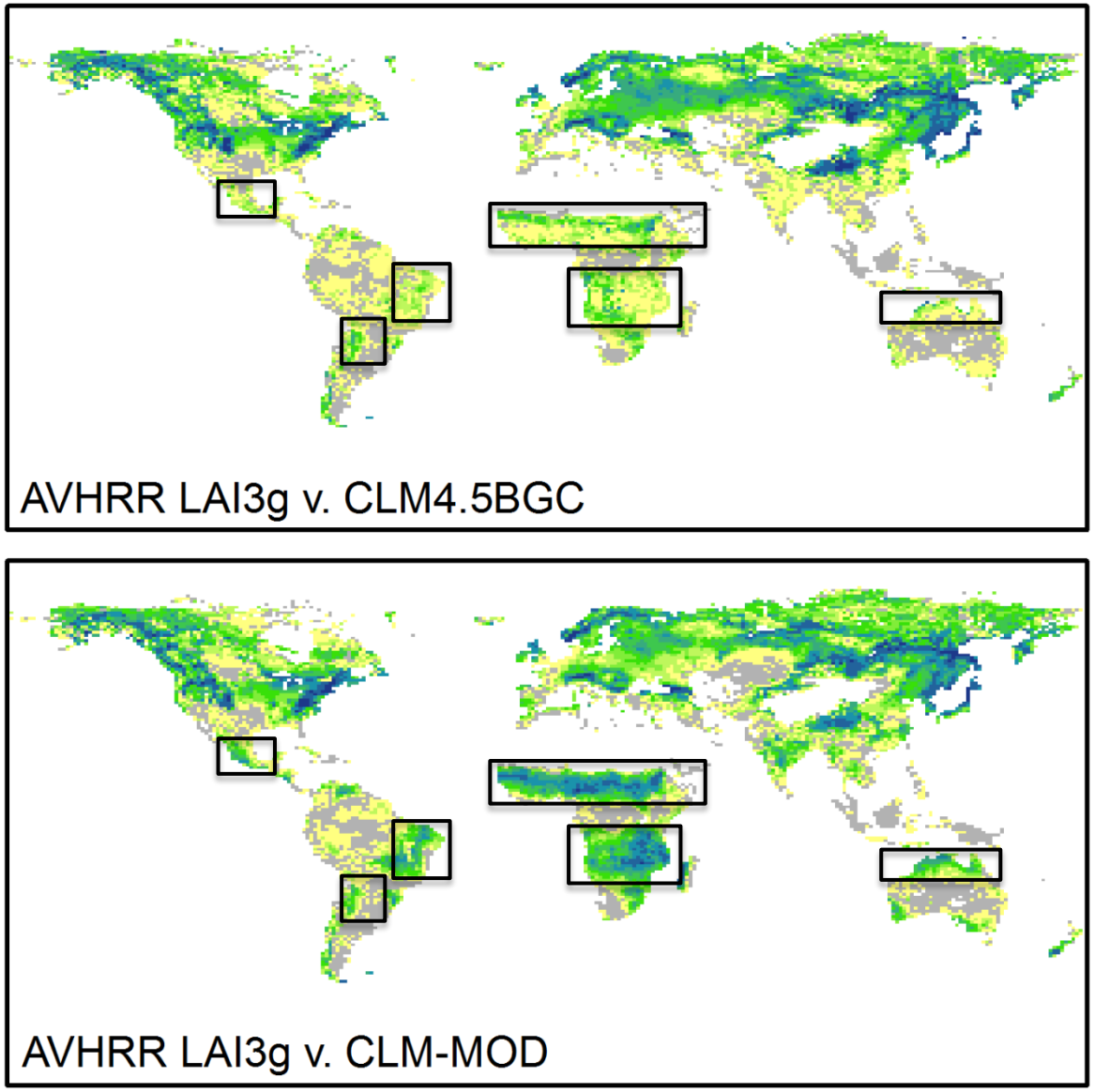

What about fire?

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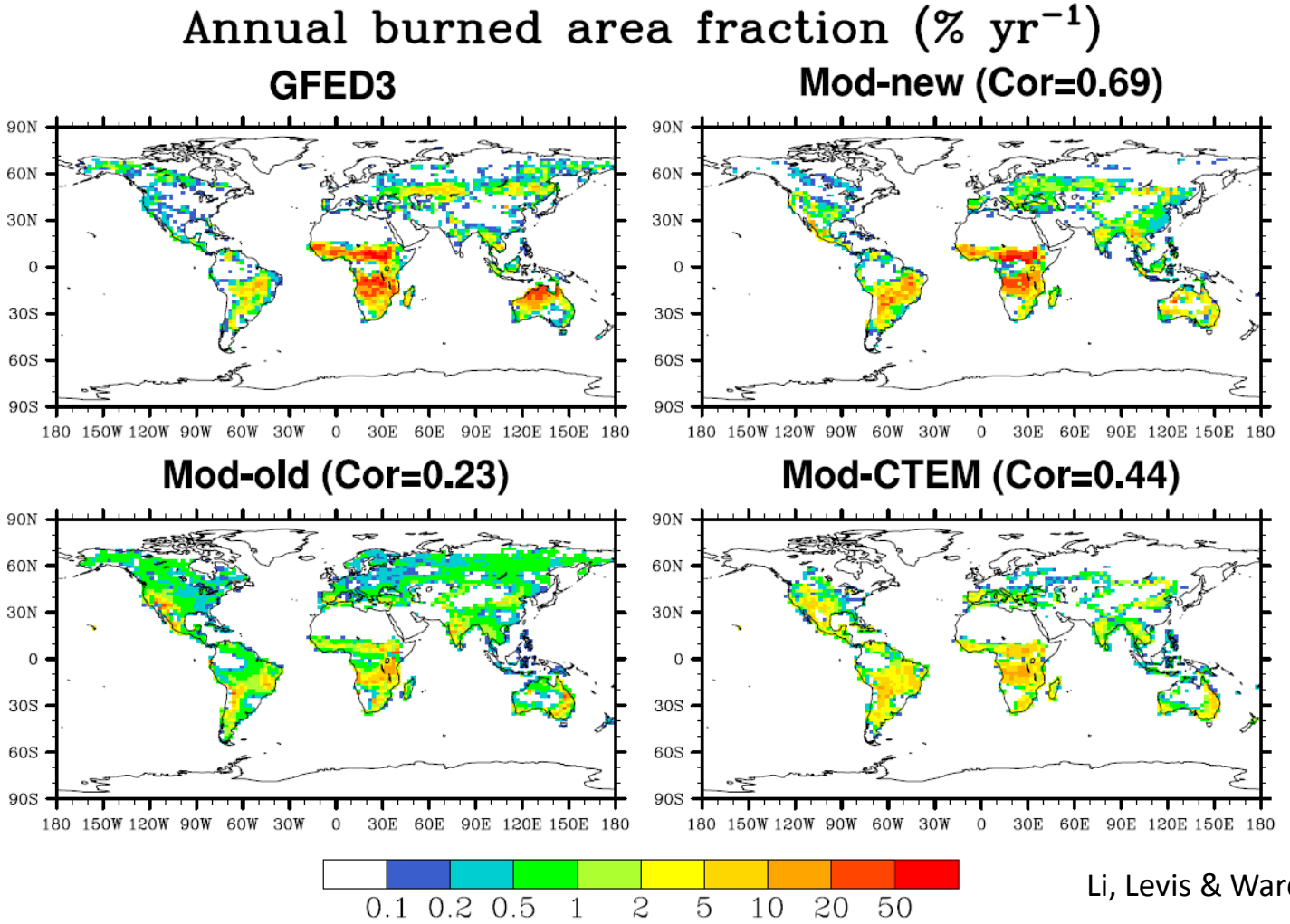

Li, Levis & Ward 2013

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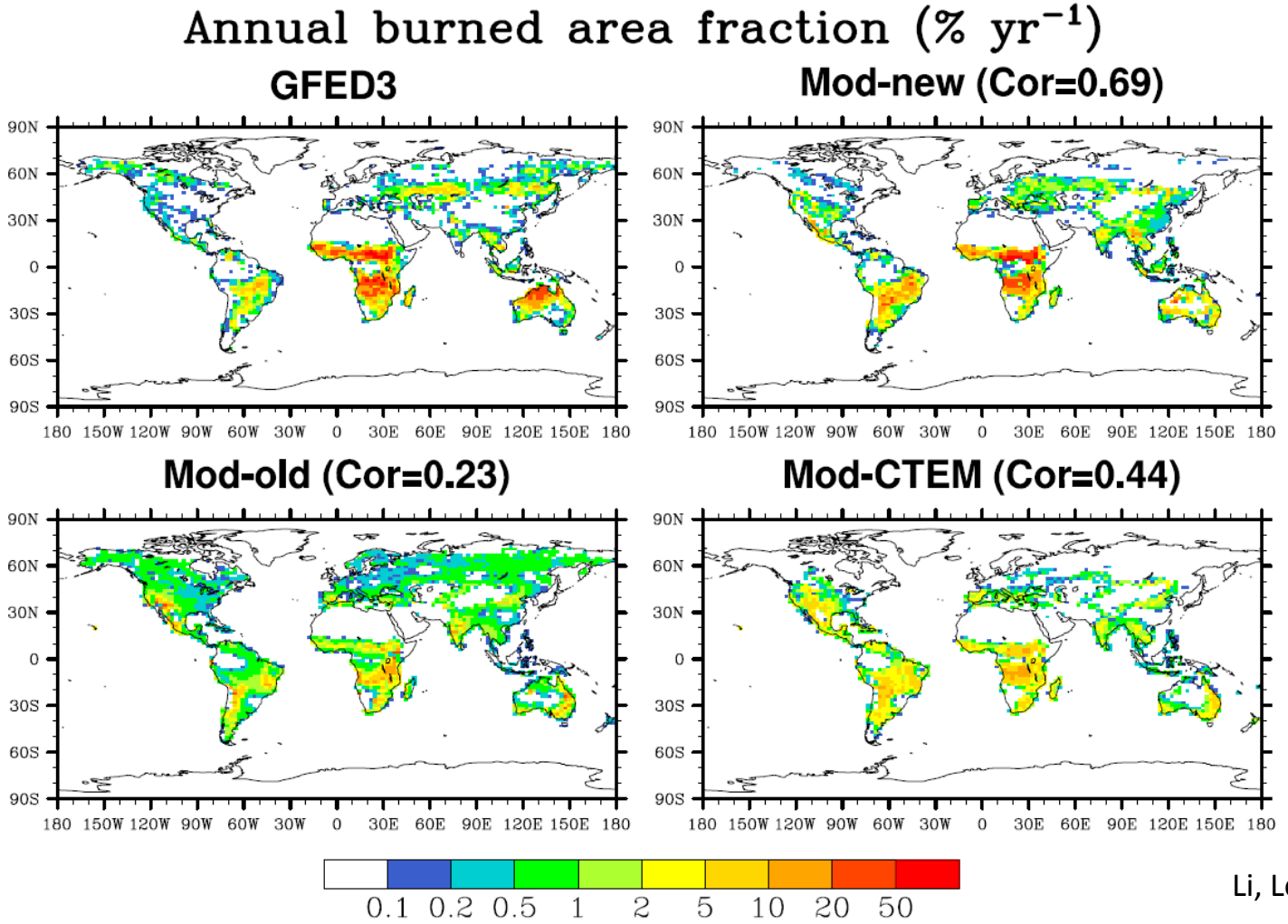
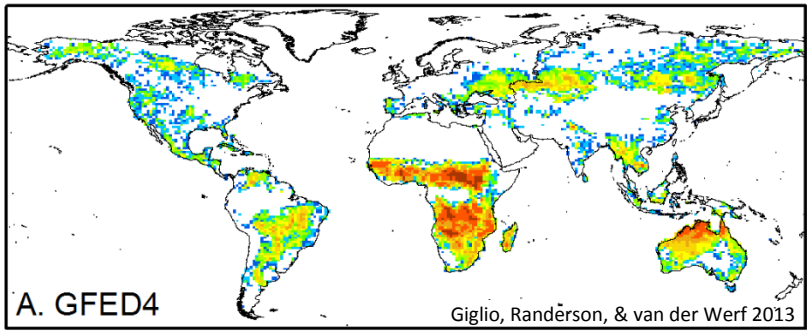


GFED3
CLM4CN
~2° resolution*
Qian forcing
1997-2004

Li, Levis & Ward 2013

New

Annual burned area fraction (% yr^{-1})

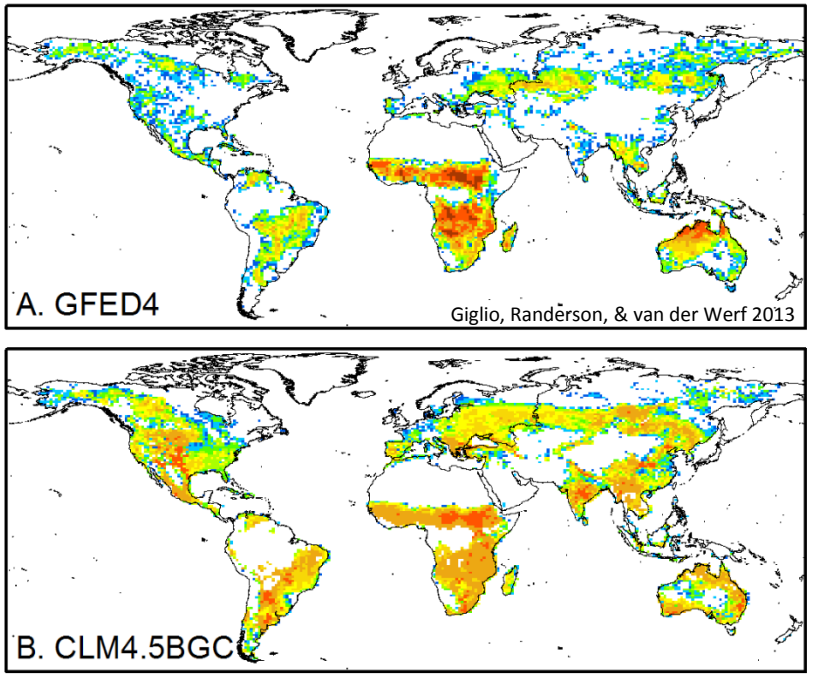


GFED4
CLM4.5BGC
~1° resolution
CRU-NCEP forcing
1996-2010

- > 50%
- 20 - 50
- 10 - 20
- 5 - 10
- 2 - 5
- 1 - 2
- 0.5 - 1
- 0.2 - 0.5
- 0.1 - 0.2
- 0 - 0.1%

New

Annual burned area fraction (% yr^{-1})



R = 0.44
(drought deciduous only R = 0.35)

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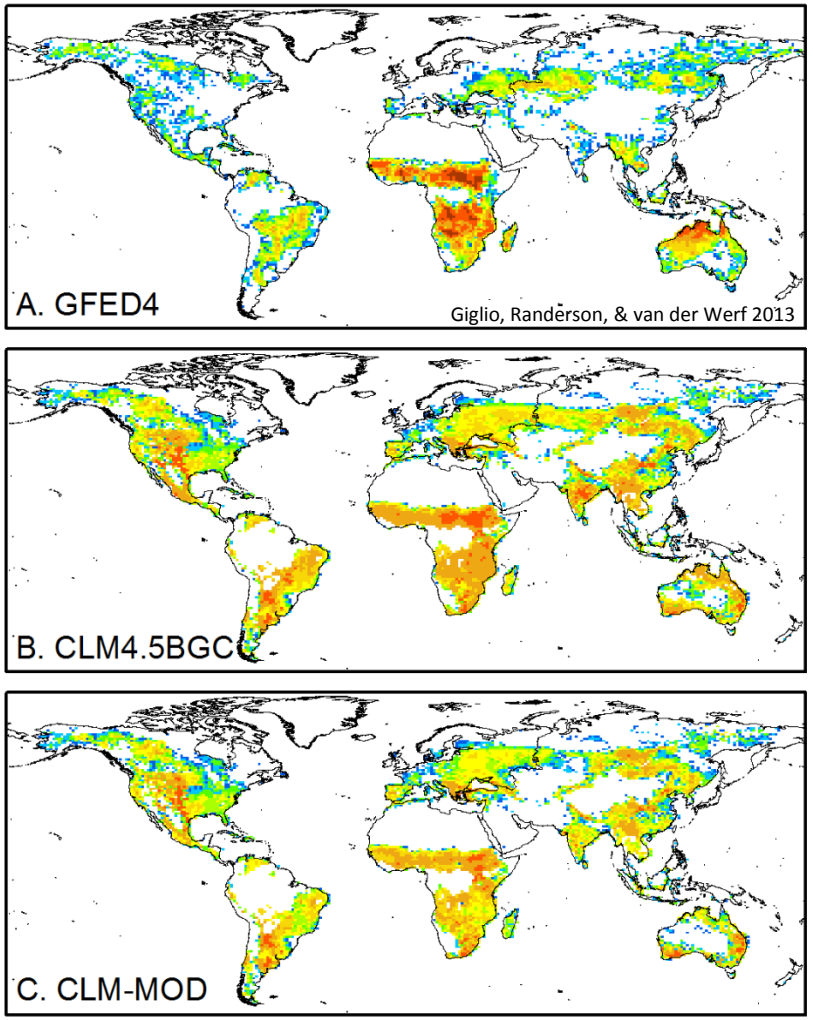
Annual burned area fraction (% yr^{-1})



GFED4
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CRU-NCEP forcing
1996-2010

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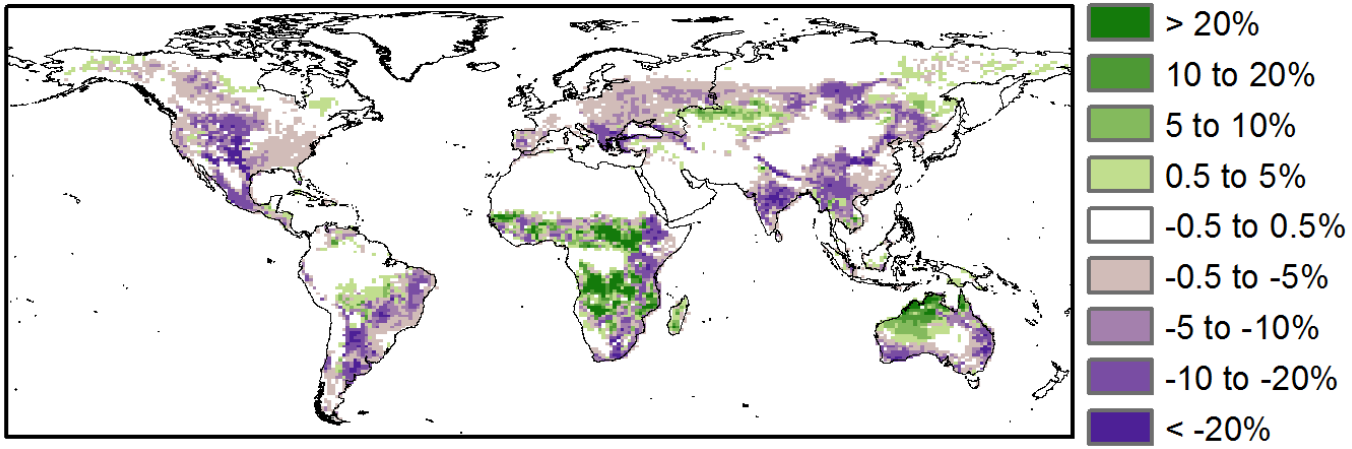
(drought deciduous only R = 0.35)

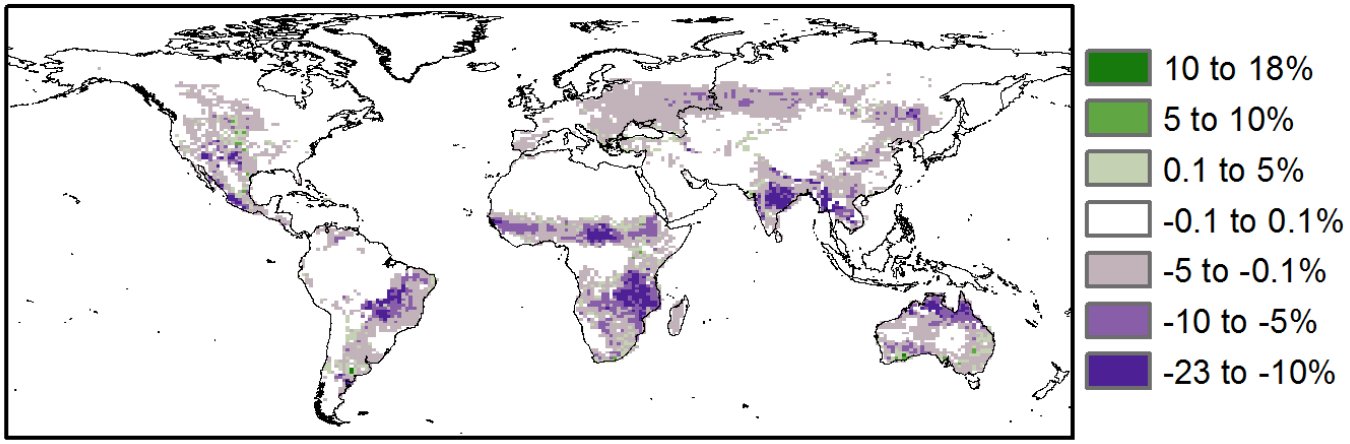
R = 0.33
(drought deciduous only R = 0.23)

Difference Maps

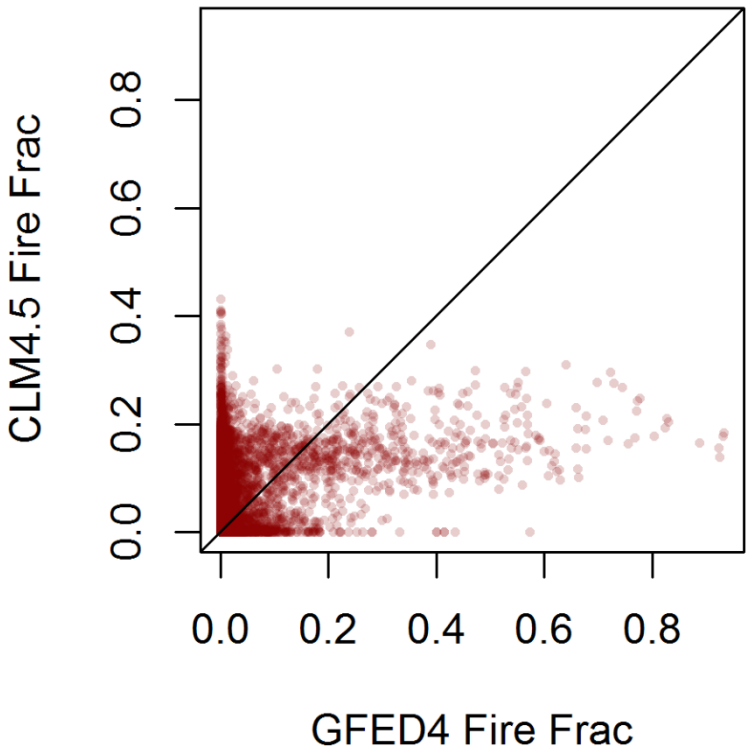
GFED4 - CLM4.5



CLM-MOD - CLM4.5



Scatterplots



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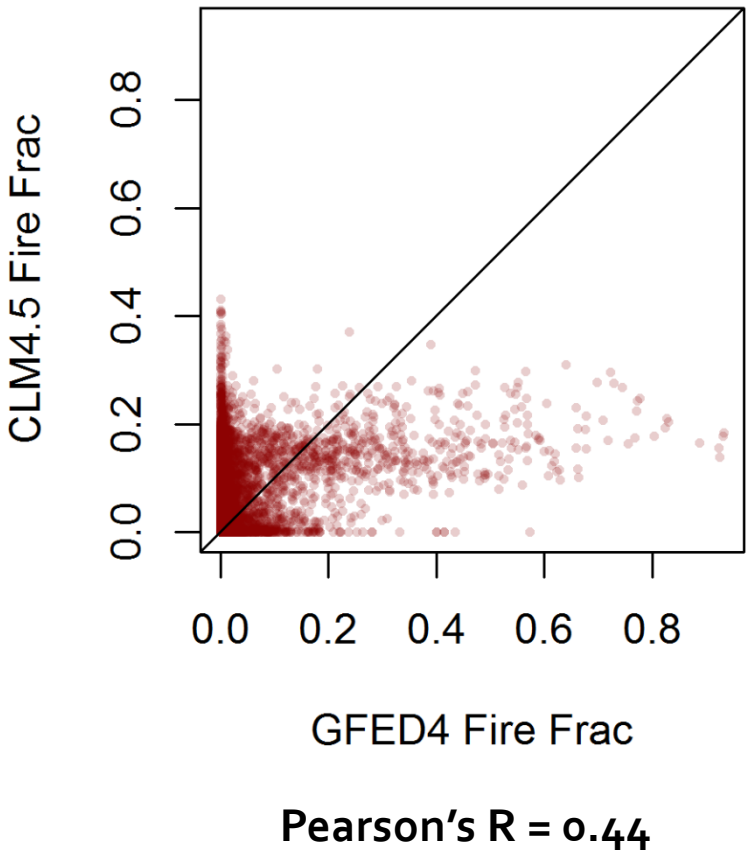
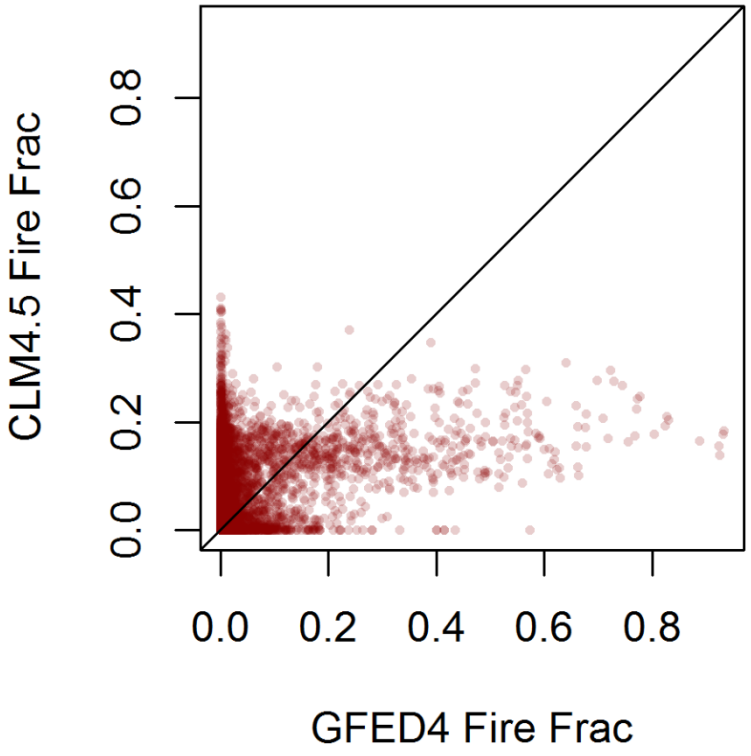


Pearson's R = 0.44

Scatterplots



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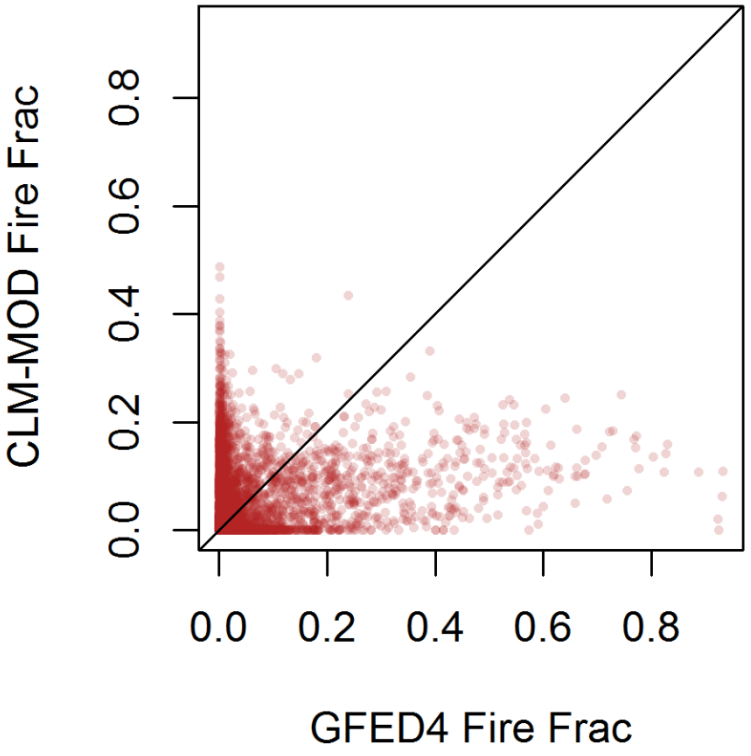
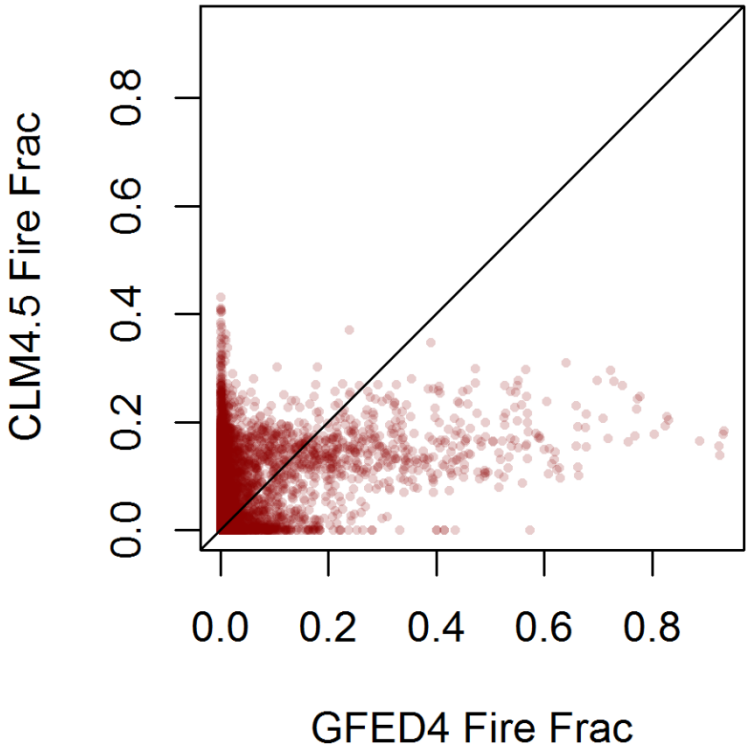
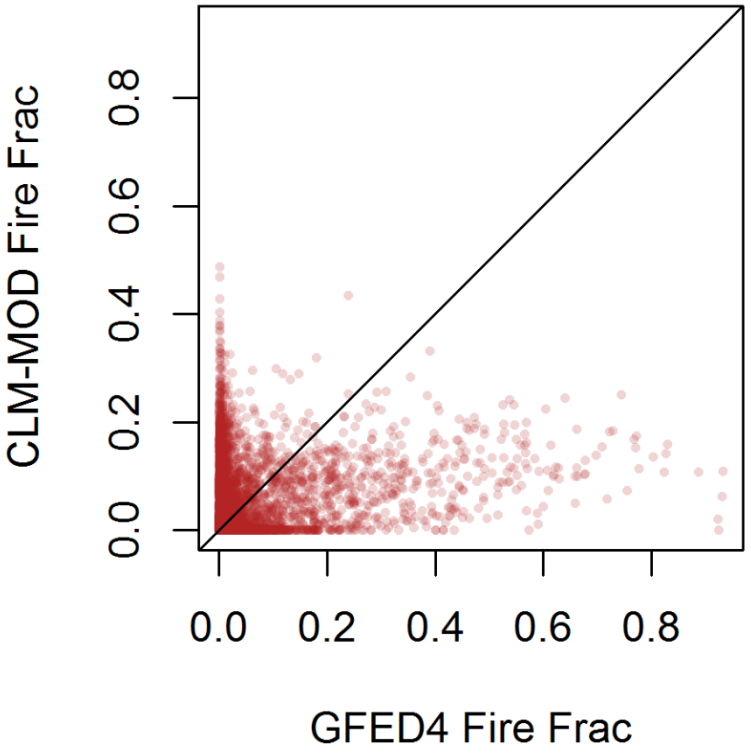


Pearson's R = 0.33

Scatterplots

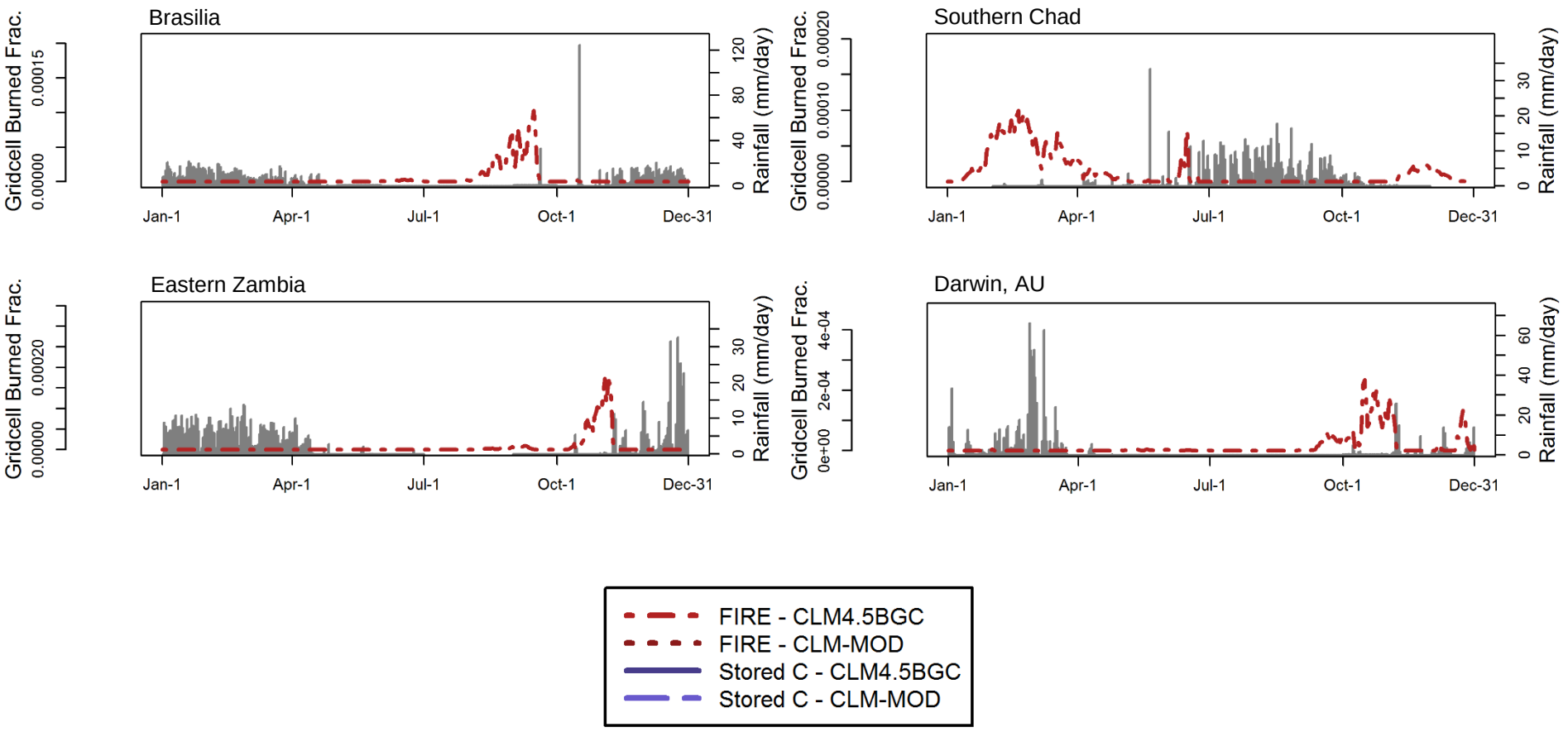


Pearson's R = 0.44
Spearman's ρ = 0.66



Pearson's R = 0.33
Spearman's ρ = 0.63

1 year of Fire & Veg Carbon



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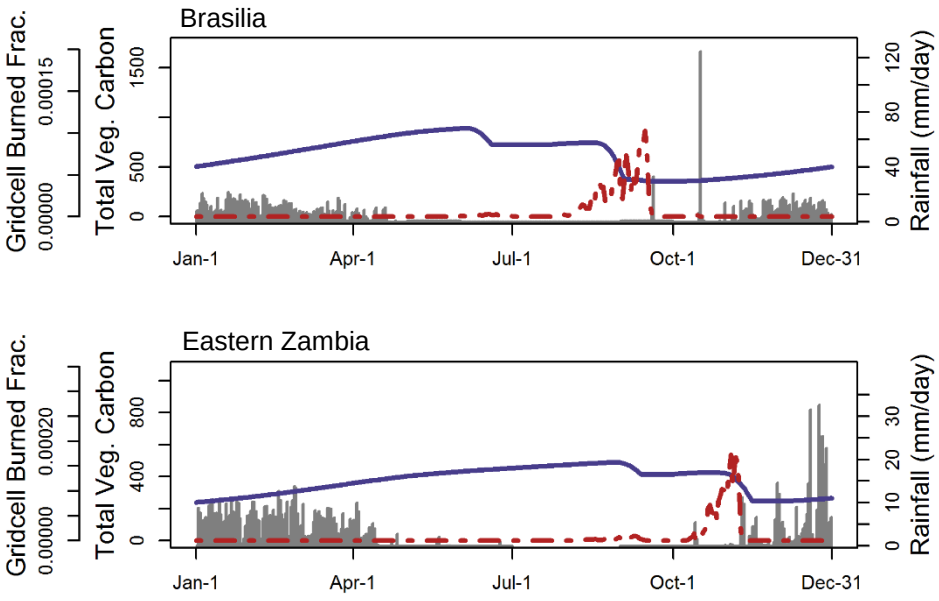
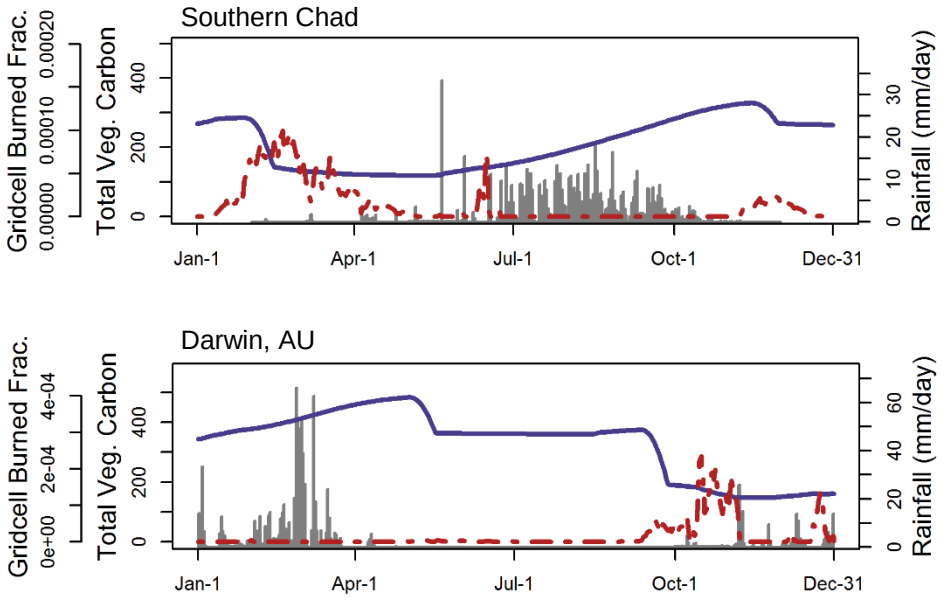
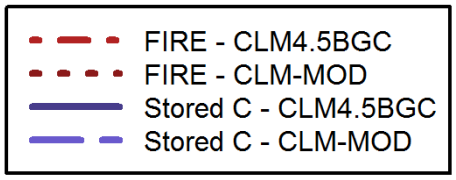
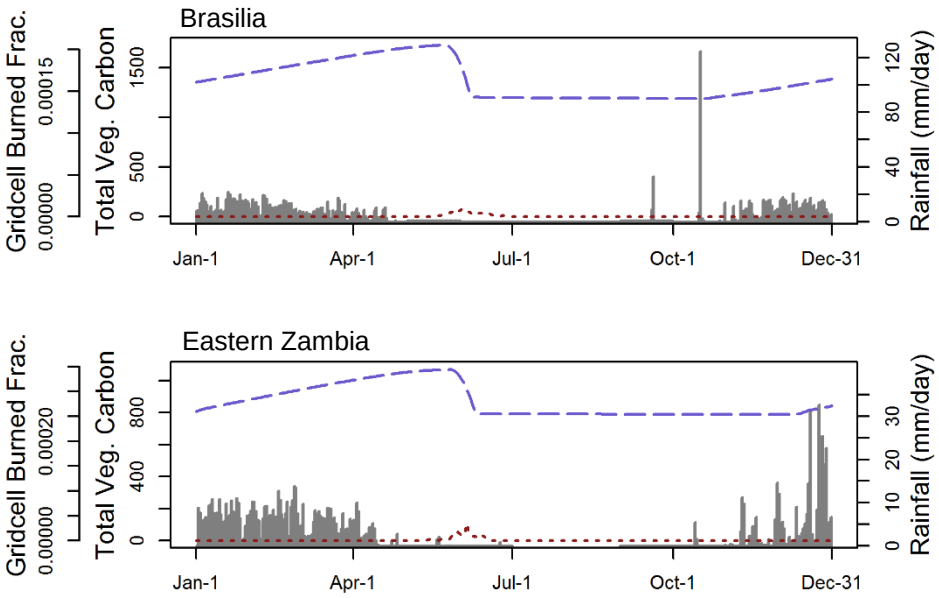
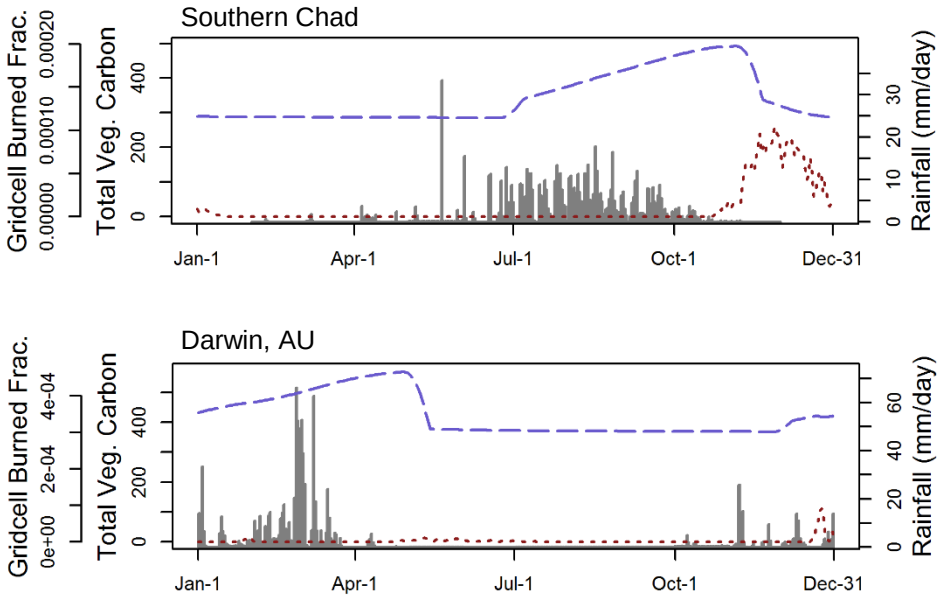


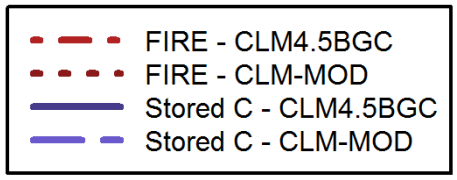




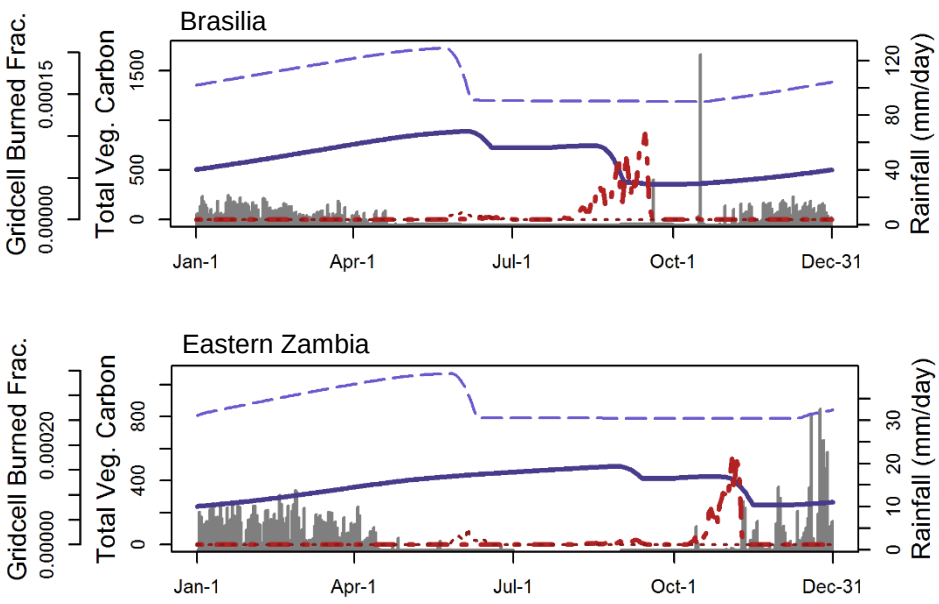
1 year of Fire & Veg Carbon

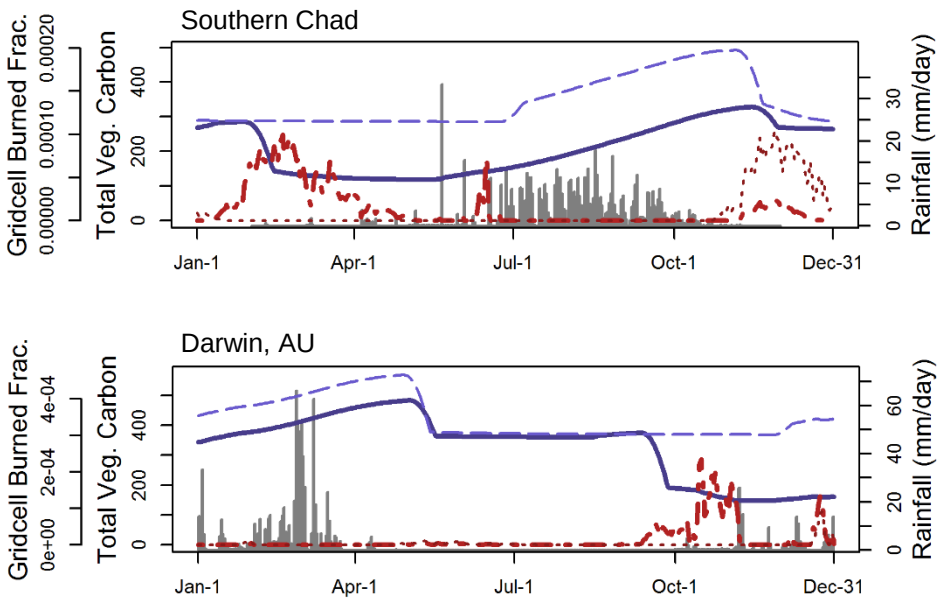


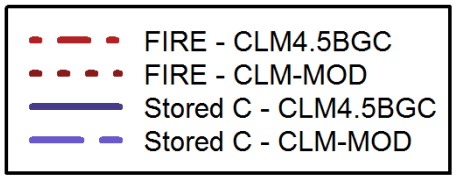




1 year of Fire & Veg Carbon







Conclusions

- Delaying budburst until some **rain has fallen gives better agreement with the satellite-derived LAI data**, both for magnitude and seasonal cycle in savanna regions.

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- But this change degrades our ability to predict **fire patterns**.

Conclusions

- Delaying budburst until some **rain has fallen gives better agreement with the satellite-derived LAI data**, both for magnitude and seasonal cycle in savanna regions.
- But this change degrades our ability to predict **fire patterns**. But not by much.

Conclusions

- Delaying budburst until some **rain has fallen gives better agreement with the satellite-derived LAI data**, both for magnitude and seasonal cycle in savanna regions.
- But this change degrades our ability to predict **fire patterns**. But not by much.
- More implications? Soil C, climate feedbacks, etc.

Thanks!

Questions?

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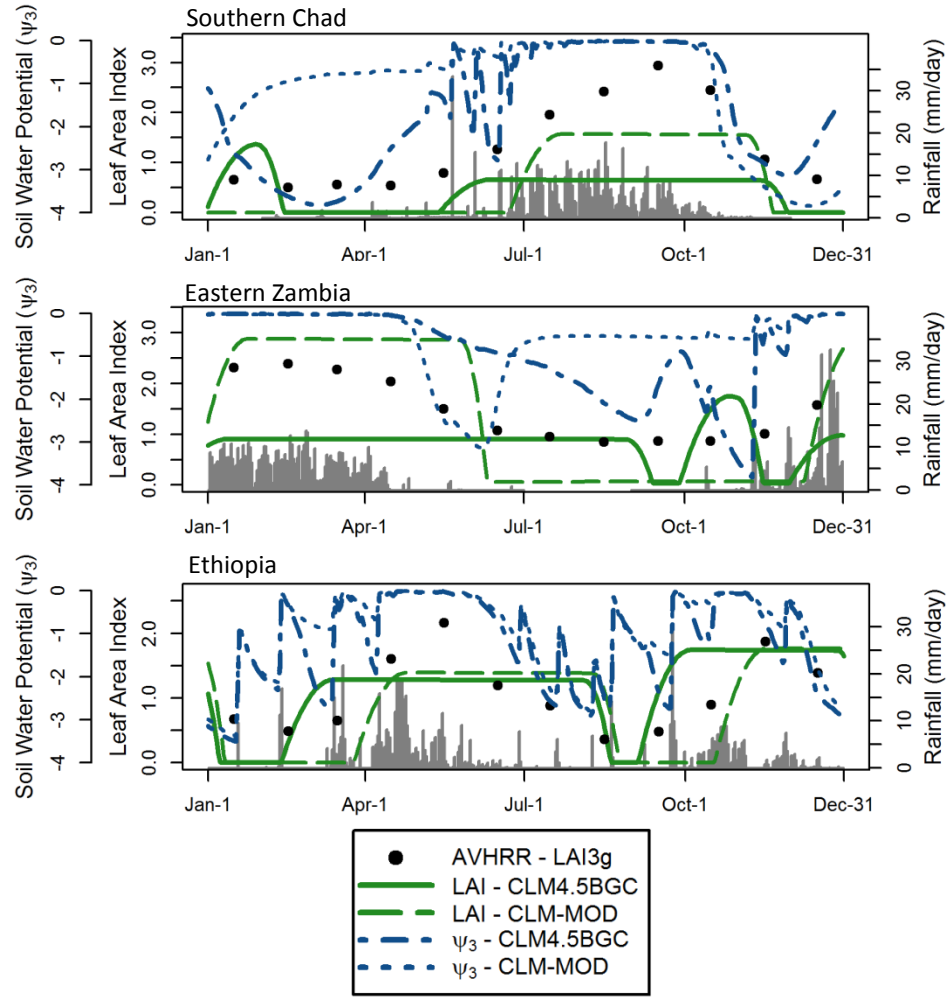
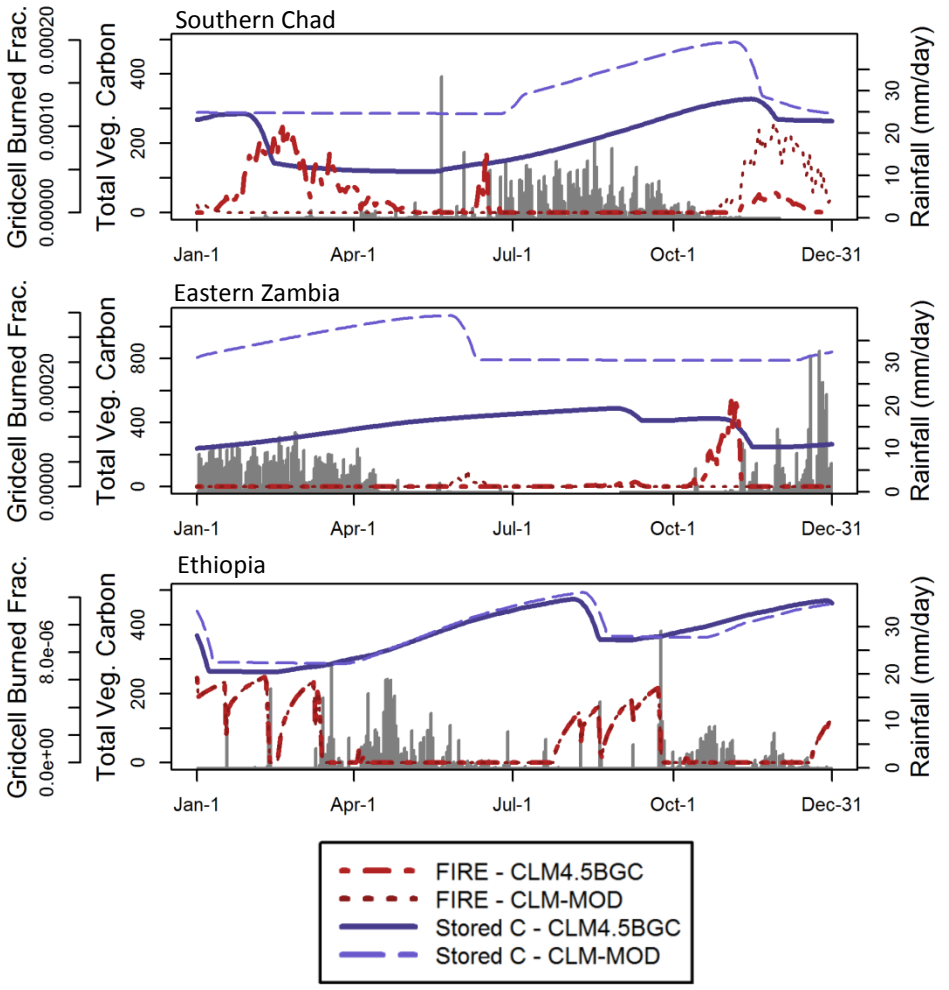

Southern Chad
Eastern Zambia
Ethiopia
Soil Water Potential (ψ3)
Leaf Area Index
Rainfall (mm/day)
Jan-1
Apr-1
Jul-1
Oct-1
Dec-31
AVHRR - LAI3g
LAI - CLM4.5BGC
LAI - CLM-MOD
ψ3 - CLM4.5BGC
ψ3 - CLM-MOD


Southern Chad
Eastern Zambia
Ethiopia
Gridcell Burned Frac.
Total Veg. Carbon
Rainfall (mm/day)
Jan-1
Apr-1
Jul-1
Oct-1
Dec-31
FIRE - CLM4.5BGC
FIRE - CLM-MOD
Stored C - CLM4.5BGC
Stored C - CLM-MOD