Impact of Amazon fire on plant productivity

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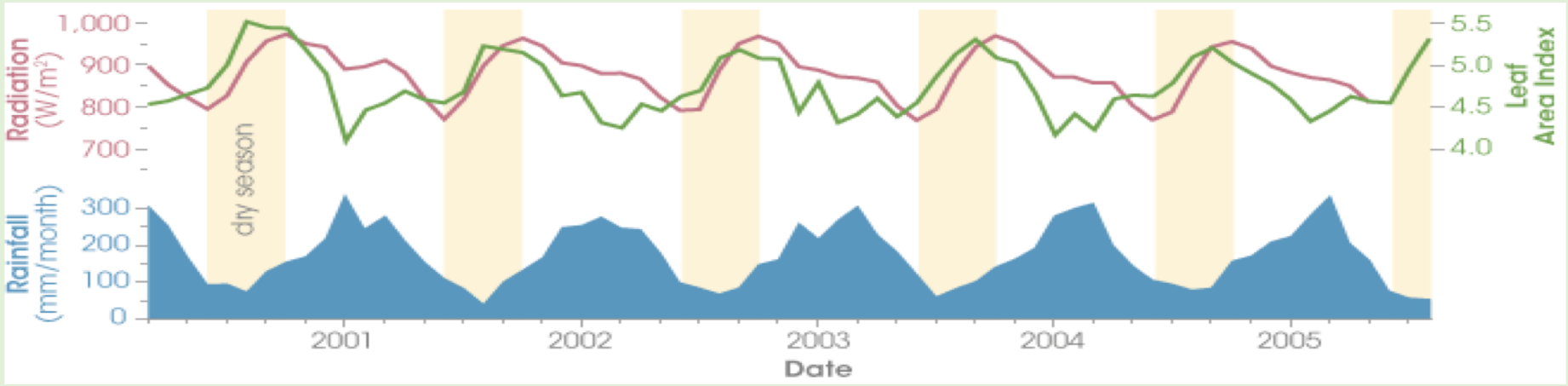
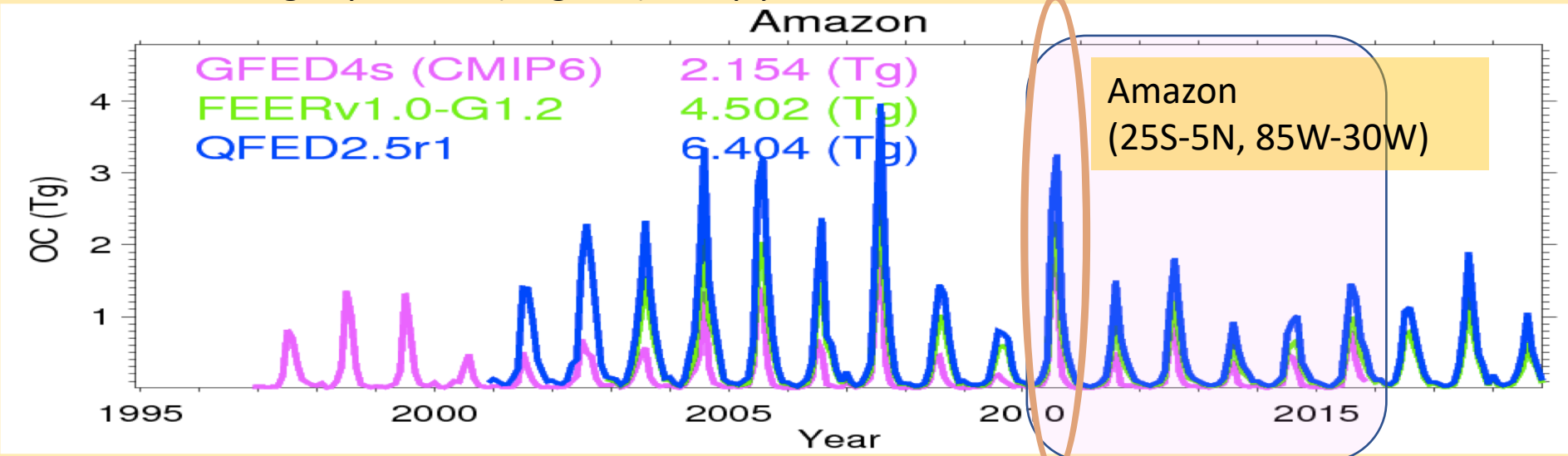
Why do we care?

Amazon forest thrive during dry season

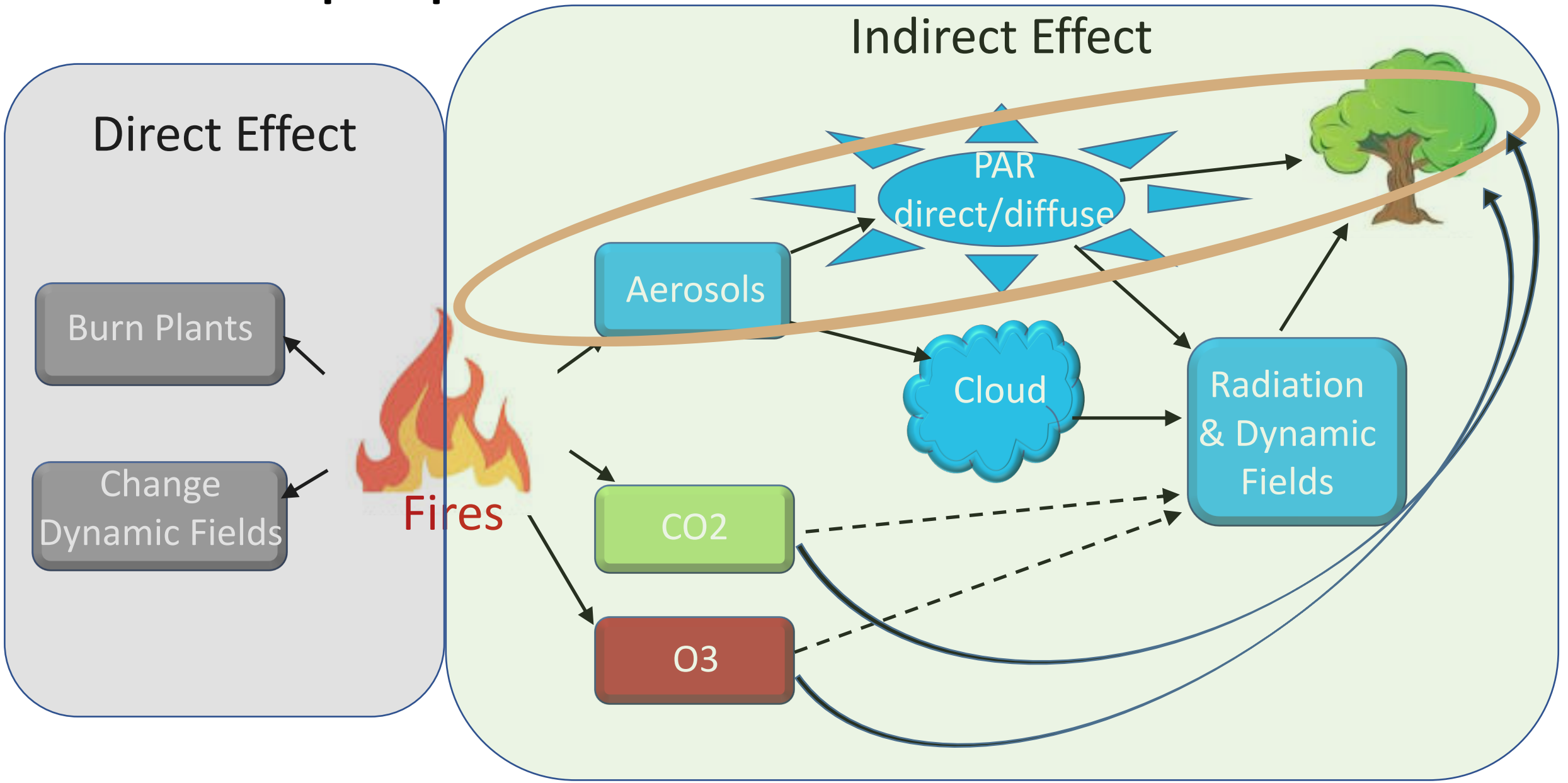


Radiation, Leaf Area Index, and Rainfall over Amazon during 2000-2005 (*Myneni et al. 2007*)

Amazon experience fires during dry season (Aug-Oct) every year

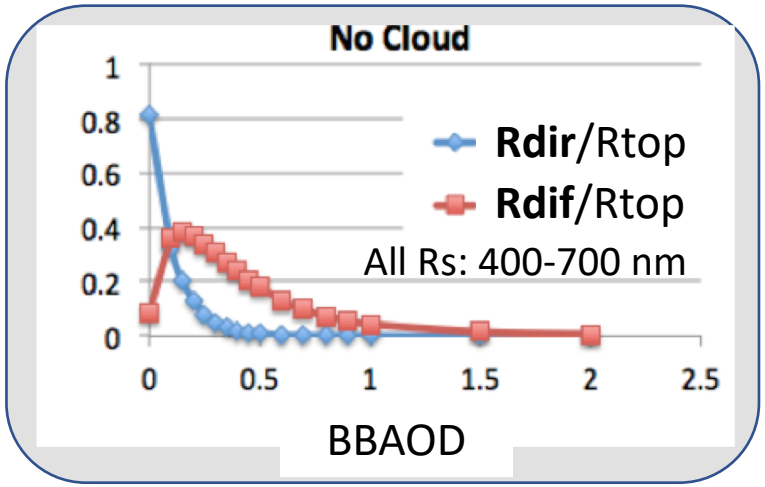


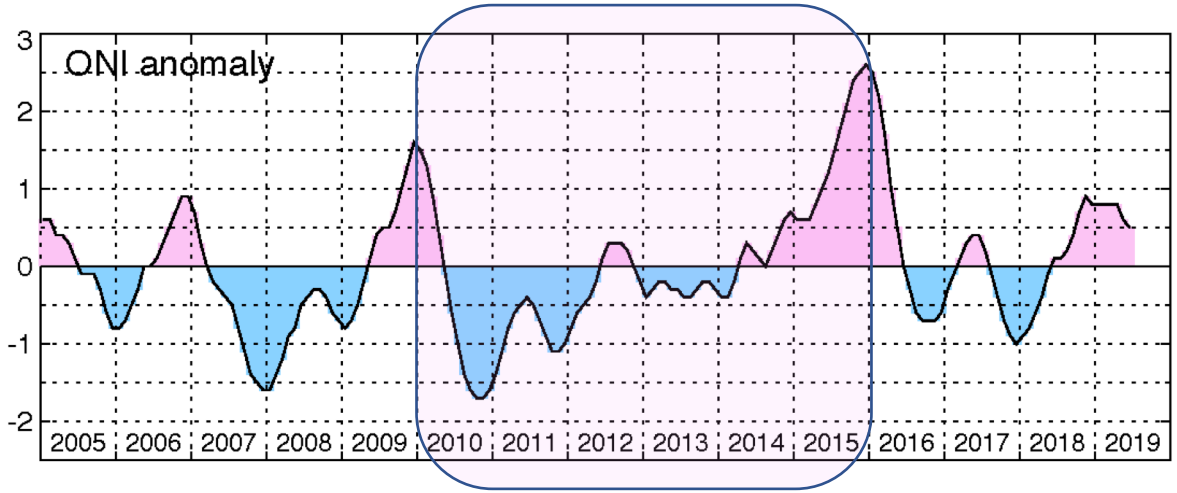
How fires impact plants



Objectives

1. How biomass burning aerosols impact Amazon productivity via radiation only





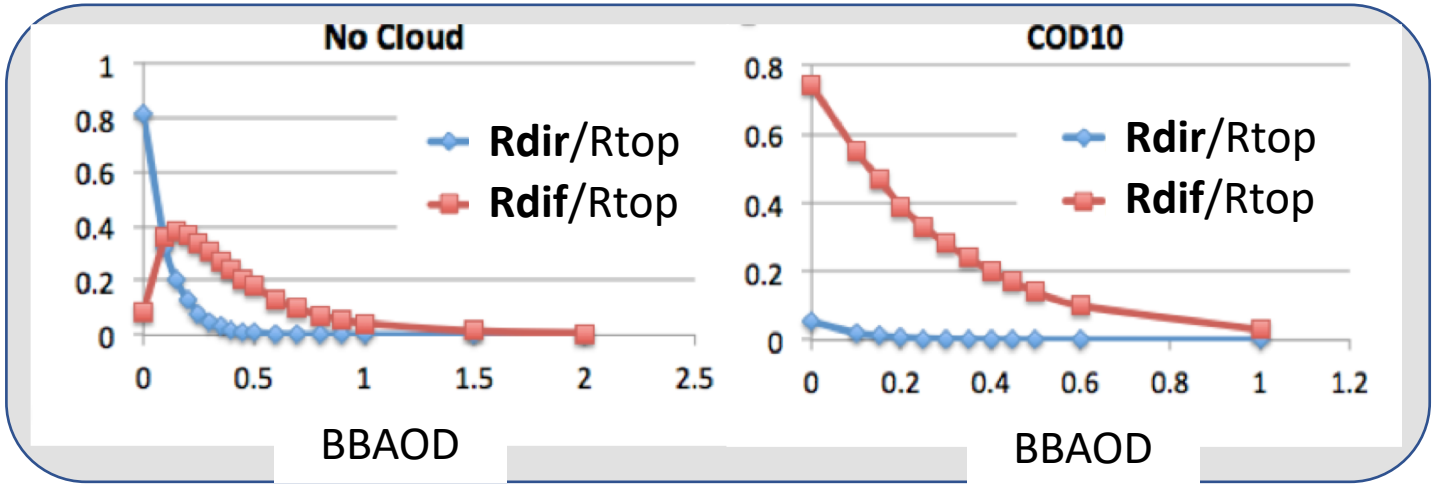
Two experiments	allaer	nobbaer
Atmos dynamic fields	realtime BBaer over 2010-2015	realtime BBaer over 2010-2015
rad fields into land	realtime BBaer over 2010-2015	No BBaer

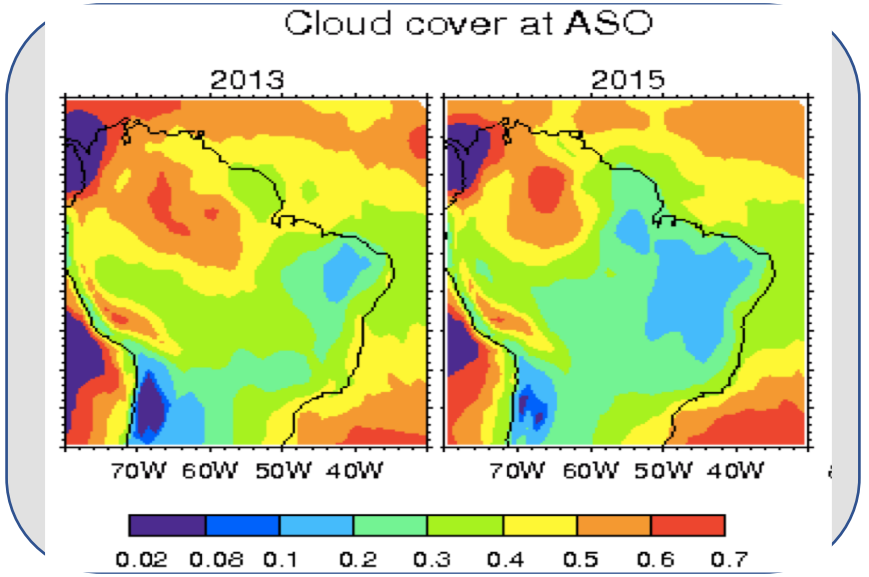
The **allaer** and **nobbaer** : The only difference in their GPP simulations is the different radiation fields in GEOScatchCN with and without impact of BB aerosols.

"replay" mode : We run GEOS in replay mode. Every 6h, the model dynamical state (winds, pressure, temperature, and humidity) is set to the balanced state provided by MERRA2 meteorological analyses.

Objectives

2. How sensitive is the impact of BBaer-radiation-plants on environment clouds?



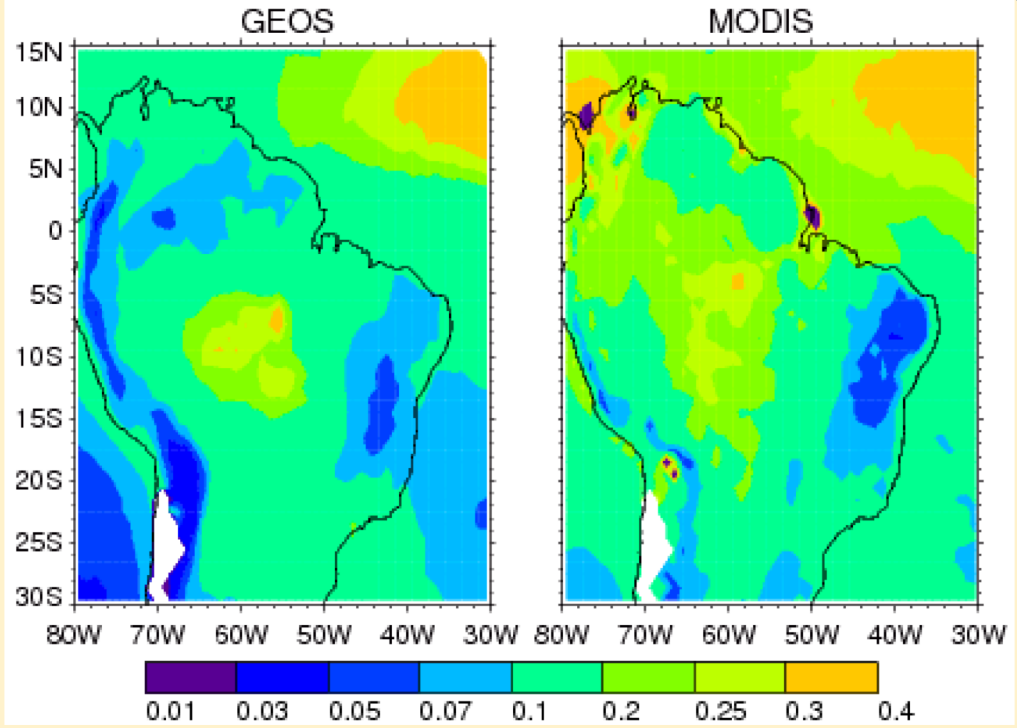


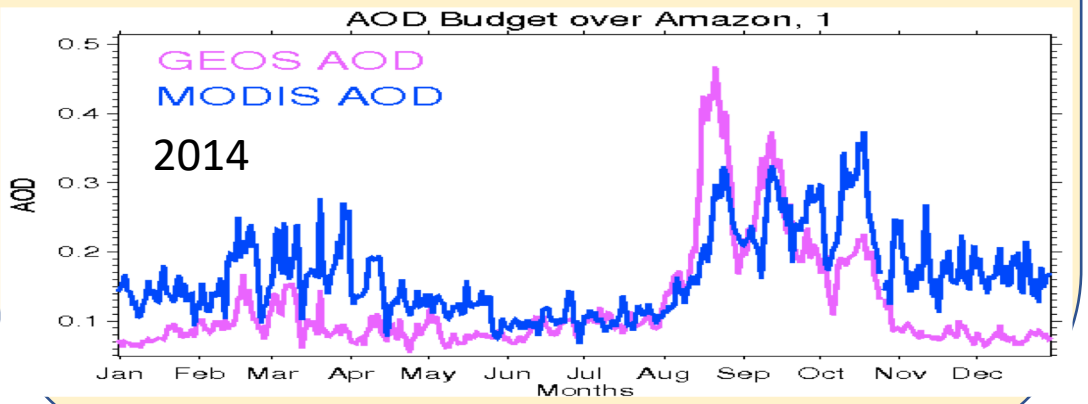
Two experiments	callaer	cnobbaer
Atmos dynamic fields	Same BBaer over 2010-2016	Same BBaer over 2010-2016
rad fields into land	Same BBaer over 2010-2016	No BBaer

We will analyze the cloud, GPP and PAR-to-GEOScatchCN of **callaer** and **cnobbaer** for 7 Aug-Oct (ASO) seasons. We will investigate how interannual cloud variation adjusts the impact of BBaer-radiation-plants.

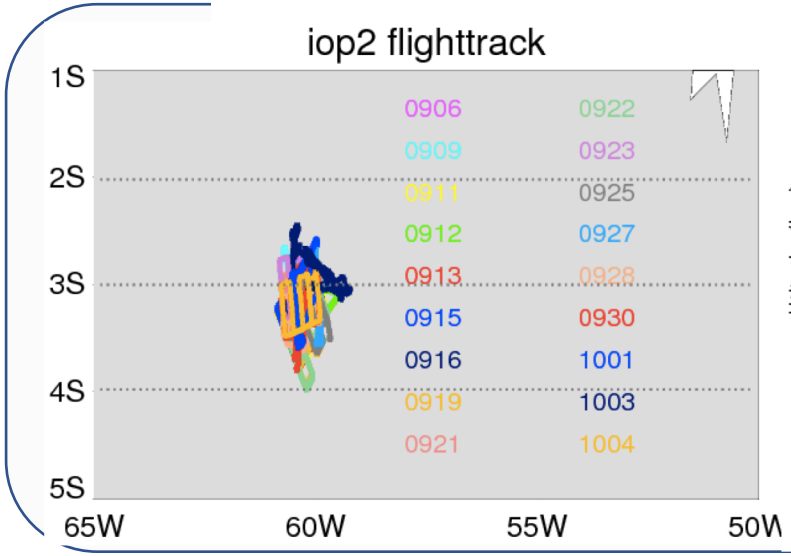
Sanity check for GEOS performance

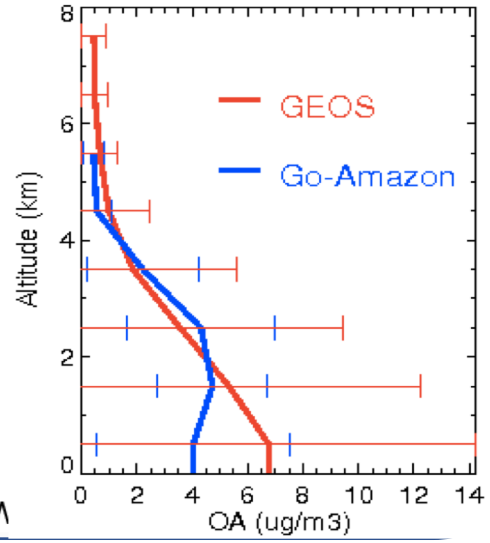
Compare AOD with MODIS





GoAmazon 2014 Sept-Oct

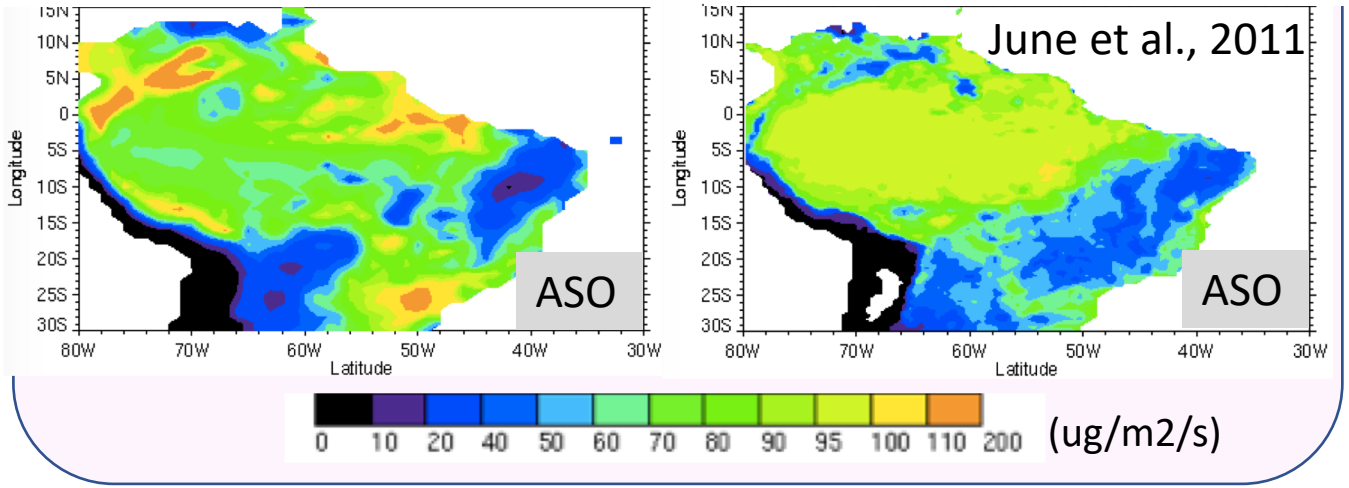




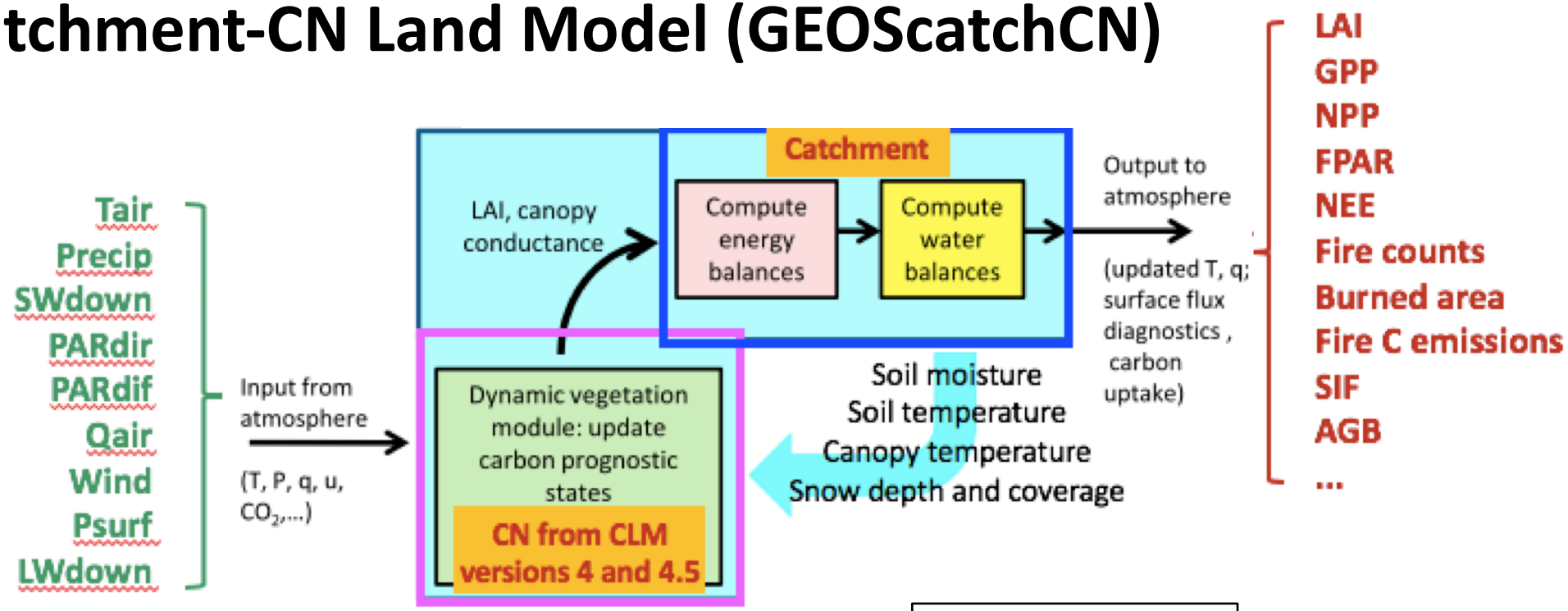
GPP

GEOS 2010-2016

Ensemble 1983-2011



GEOS Catchment-CN Land Model (GEOScatchCN)



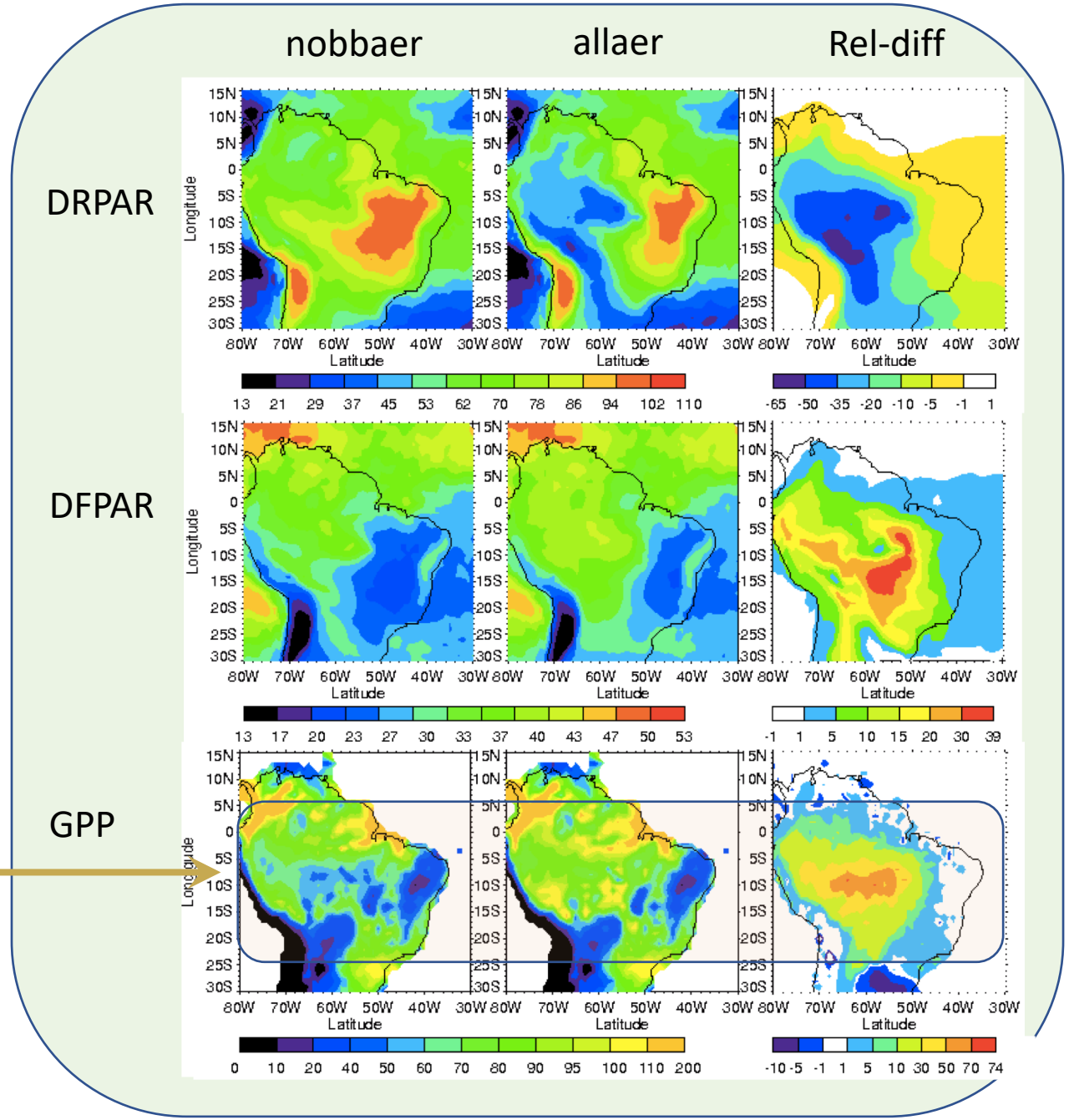
Koster et al. (2014

- Photosynthesis and transpiration depend non-linearly on solar radiation, via the light response of stomata
- The canopy is treated as two leaves (sunlit and shaded) in CLM4
- The DRPAR and DFPAR absorbed by the vegetation is apportioned to the sunlit and shaded leaves as described by Thornton and Zimmermann (2007).

How Amazon PAR and GPP change due to the impact of BBaer on radiation (Objectiv 1)

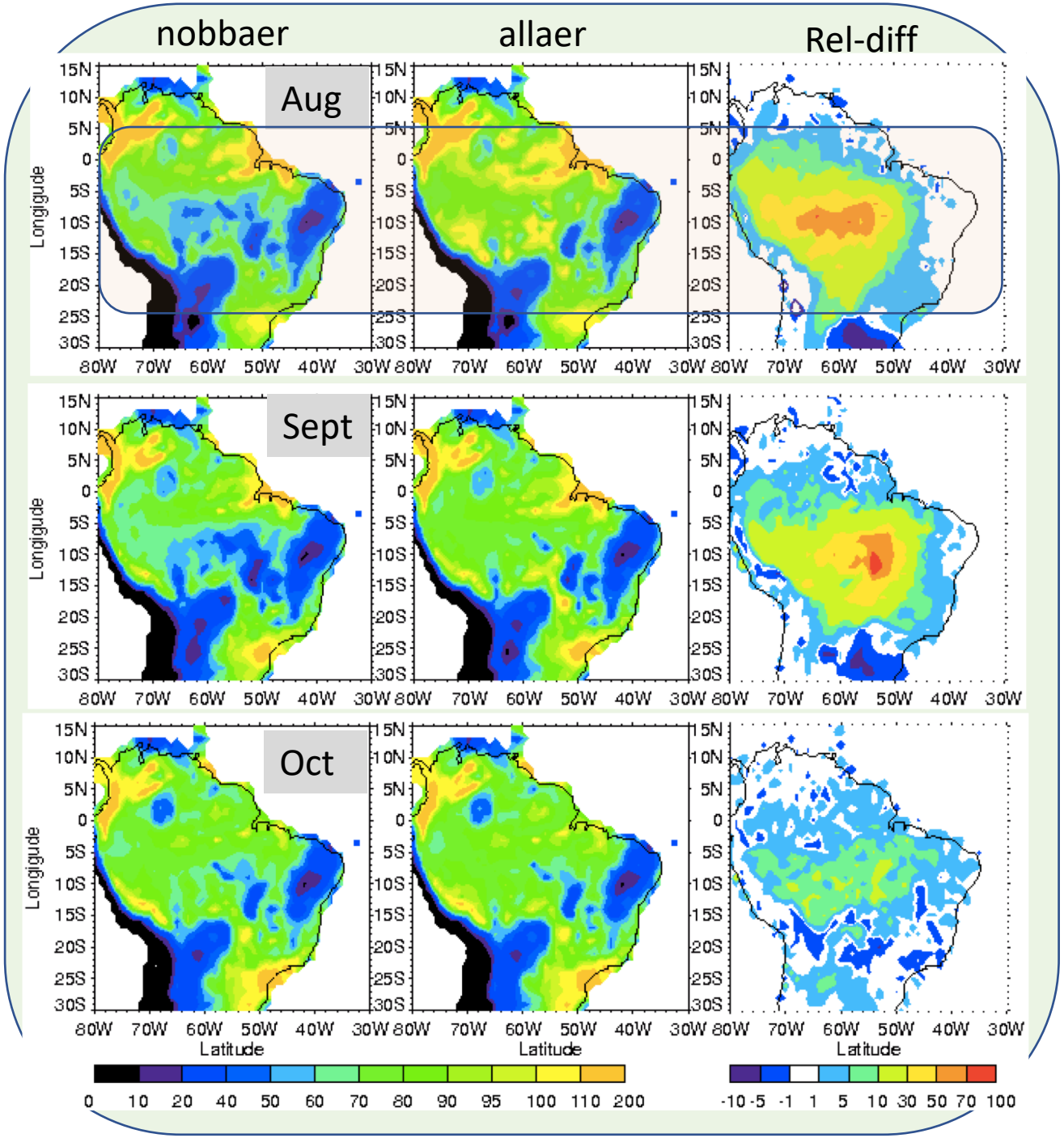
201008	nobbaer	allaer	Rel-diff
	W/m2	W/m2	%
DRPAR	84.3	67,5	-19.9
DFPAR	31.2	34.9	12.1
	GtC	GtC	%
GPP	2.25	2.55	12.9

Amazon: land over 25S-5N, 80W-30W
Red-diff (%) = (allaer – nobbaer) / nobbaer

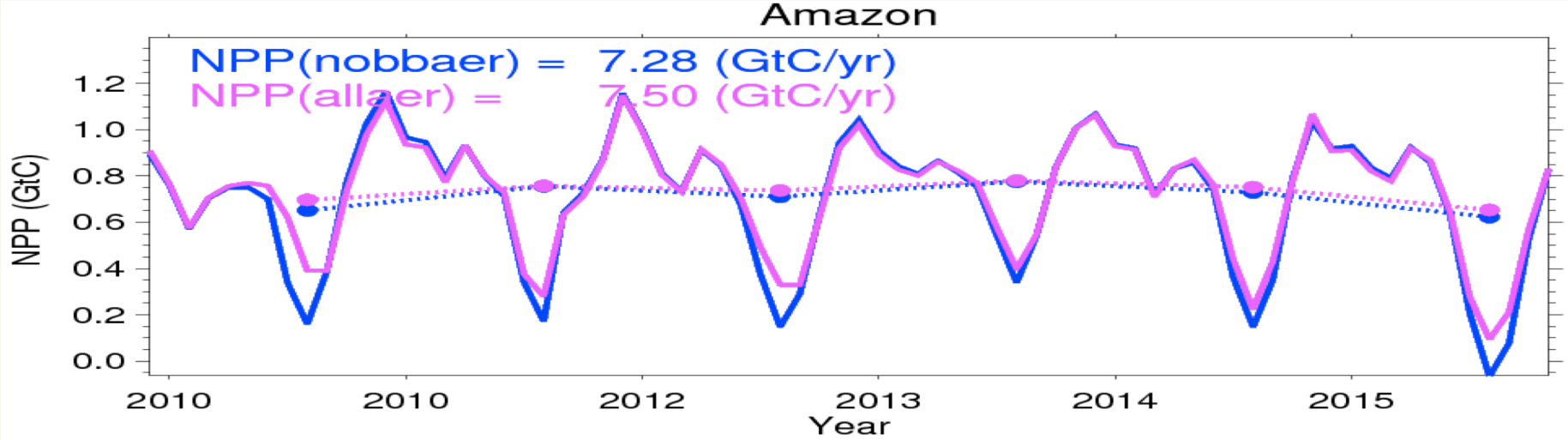


How monthly GPP response to PAR change due to the impact of BBaer on radiation

2010 month	GPP (exp1) (GtC)		Rel-Diff (%)
	nobbaer	allaer	
Aug	2.25	2.55	12.9
Sept	2.06	2.30	11.2
Oct	2.31	2.38	2.8



What is the NPP response?



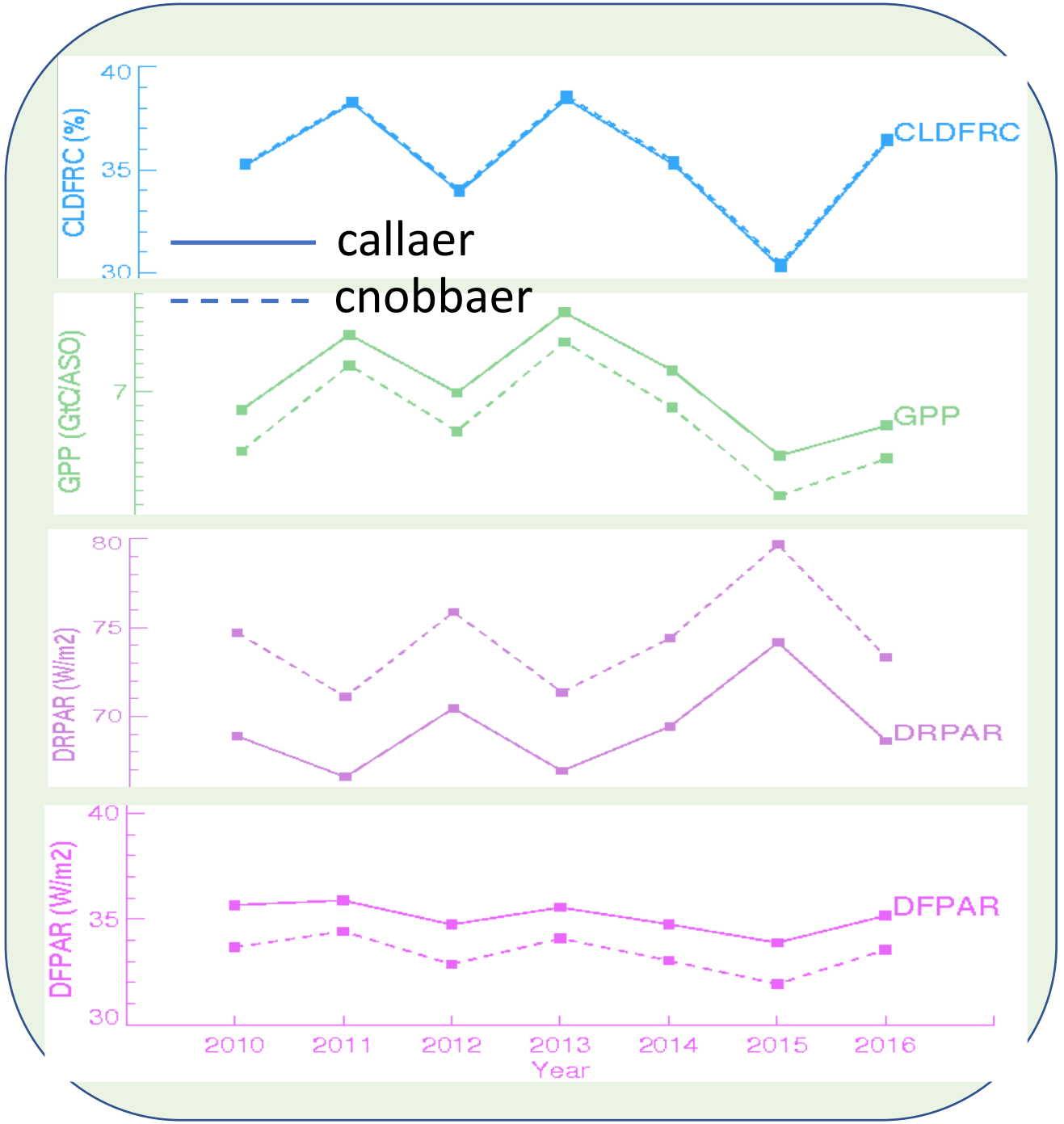
Amazon (25S-5N, 85W-30W) during 2010-2015:

- NPP is increased by 3.0%/yr with the impact of BBaer-radiation-plants
- Average NPP is enhanced by ~220 TgC/yr
- Regional fire emitted ~250 TgC/yr

=>3.0% of NPP enhancement equivalent to ~88% of C loss by fires

Cloud vs aerosol effect (Objective 2)

Every Aug-Oct (ASO) over Amazon



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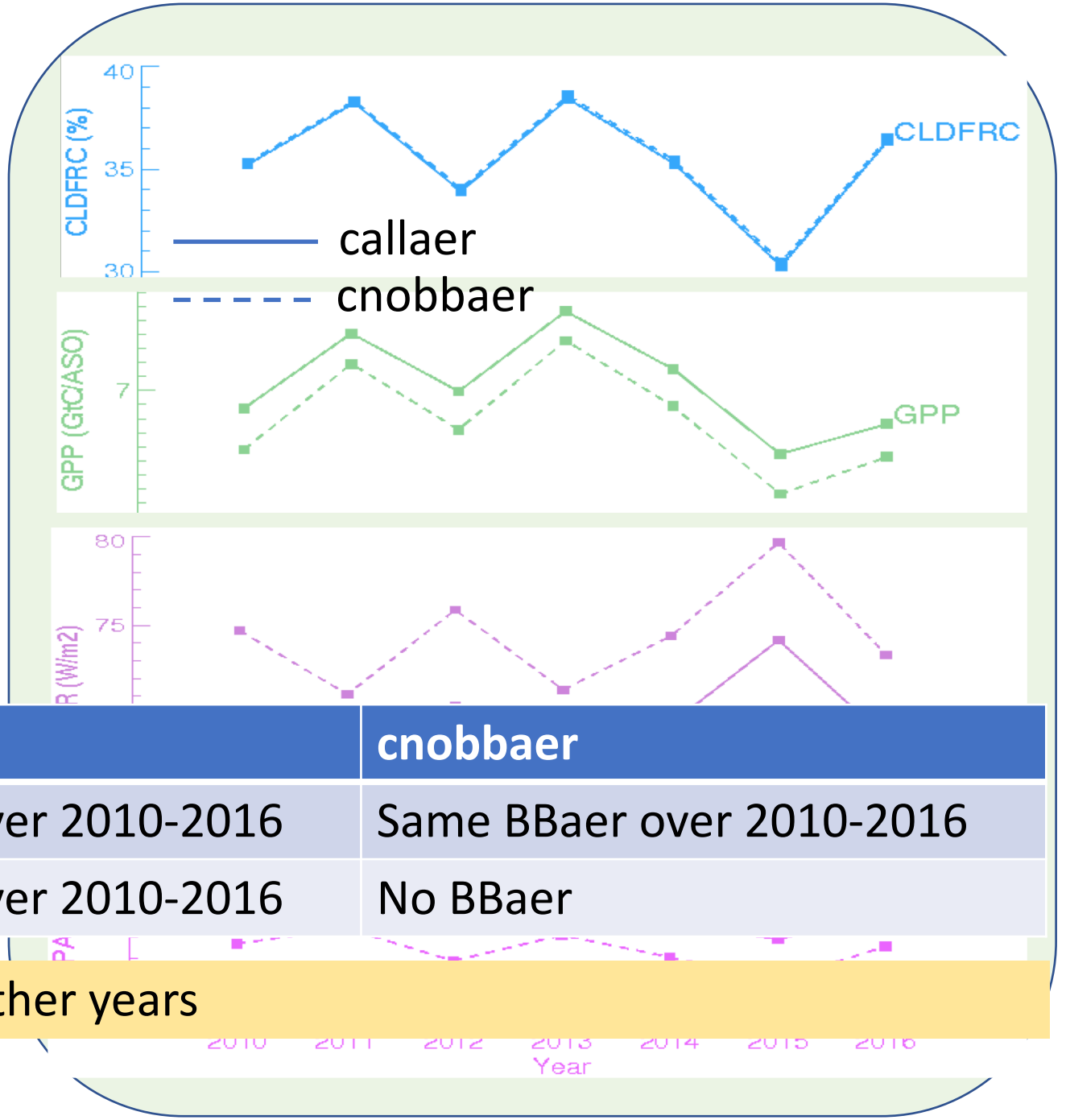

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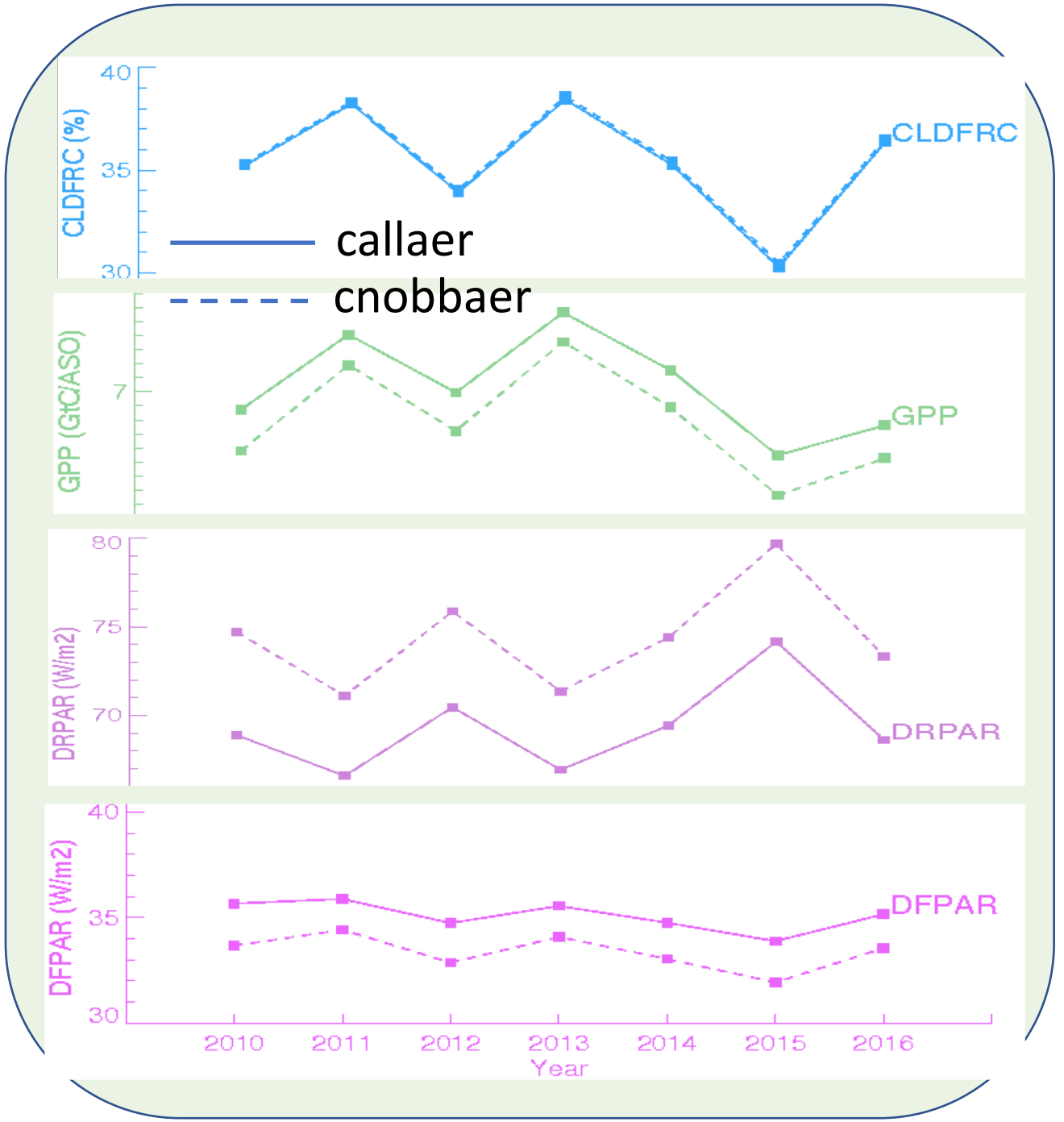
Use BBaer of 2014 and repeat it for all other years

Cloud vs aerosol effect (Objective 2)

Every Aug-Oct (ASO) over Amazon

1. dGPP between the two runs almost unchanged every year => the regional impact of BBaer-rad-plant is insensitive to background clouds under Amazon dry environment
2. A strong positive correlation between CLDFRC and GPP => Cloud (rad, precip, etc) control the overall GPP during Amazon dry season



Summary

1. The impact of BBaer on radiation fields that drive GEOSCatchCN could increase Amazon GPP up to 13%, via increasing DFPAR by 12% and decreasing DRPAR by 20%, on a monthly basis during 2010-2015
2. Consequently, Amazon NPP is increased by 3.0%/yr, which is ~220TgC/yr. This NPP enhancement is equivalent to ~88% of C loss due to Amazon fires. Of course, this compensation occurs only once, while the loss of plants, particularly forest, could persist for decades.
3. The regional impact of BBaer-radiation-plants is insensitive to the background cloud fields under Amazon dry environments during 2010-2016.
4. There is a strong positive relationship between cloud cover and GPP over Amazon dry season during 2010-2016.

How fires impact plants: future study