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# Evaluation of carbon fluxes, river runoff and crop yield simulations

S Piao, X Wang, S Peng, H Yang, C Zhao, J Tan,  
L Li, P Ciais et al.

# Content

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- Evaluation of carbon fluxes
- Evaluation of river run-off
- Evaluation of crop yield

# Trendy Models

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Model Name	Abbreviation	Runoff	Reference
Community Land Model 4C	CLM4C	N	Oleson et al., 2010; Lawrence et al., 2010
Community Land Model 4CN	CLM4CN	Y	Oleson et al., 2010; Lawrence et al., 2010
Hyland	Hyland	N	Friend et al., 1997; Levy et al., 2004
Lund-Postdam-Jena	LPJ	Y	Stich et al., 2003
LPJ_GUESS	LPJ-GUESS	Y	Smith et al., 2001
ORCHIDEE-CN	OCN	Y	Zaehle& Friend, 2010; Zaehle et al., 2010
ORCHIDEE	ORCHIDEE	Y	Krinner et al., 2005
Sheffield-DGVM	SDGVM	Y	Woodward et al., 1995
TRIFFID	TRIFFID	Y	Cox, 2001
VEGAS	VEGAS	N	Zeng et al., 2005

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Simulation S1: CO<sub>2</sub> only (time-invariant land use mask, fixed pre-industrial climate)

Simulation S2: CO<sub>2</sub> and climate (time-invariant present-day land use mask)

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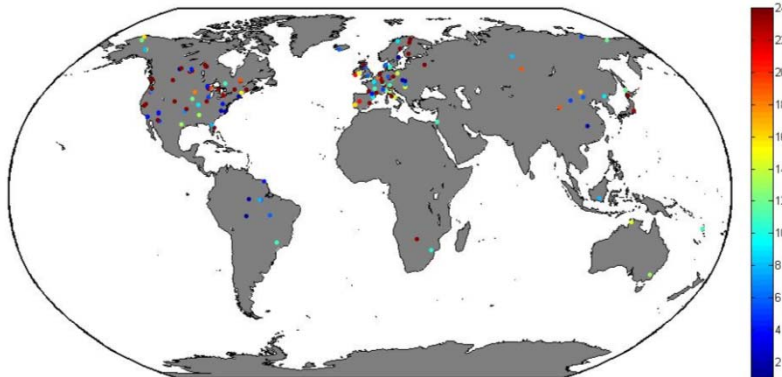
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- Evaluation of carbon fluxes
  - **Global & Regional average**
  - Seasonal cycle
  - Response to interannual climate variability
- Evaluation of river run-off
- Evaluation of crop yield

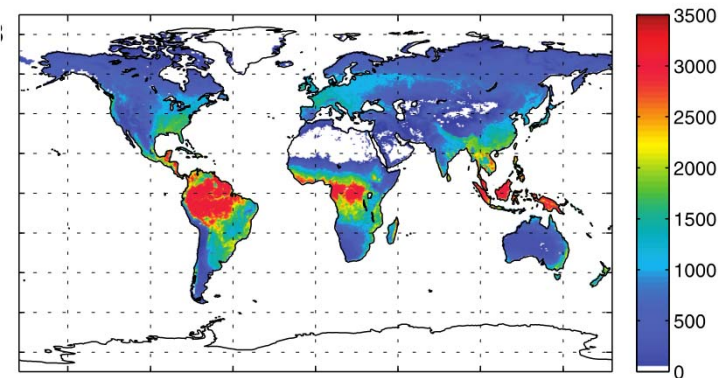
# GPP/NEE Evaluation – “Observation”

- Evaluation against data-oriented global estimation of GPP using MTE (Multiple Tree Ensemble ) approach (Jung et al., 2011, Beer et al., 2010)
- A set of regression trees were trained with GPP estimated from eddy flux measurements of NEE, and 21 candidate predictor variables, including vegetation types, tem, pre, satellite NDVI data...

Site level actual data

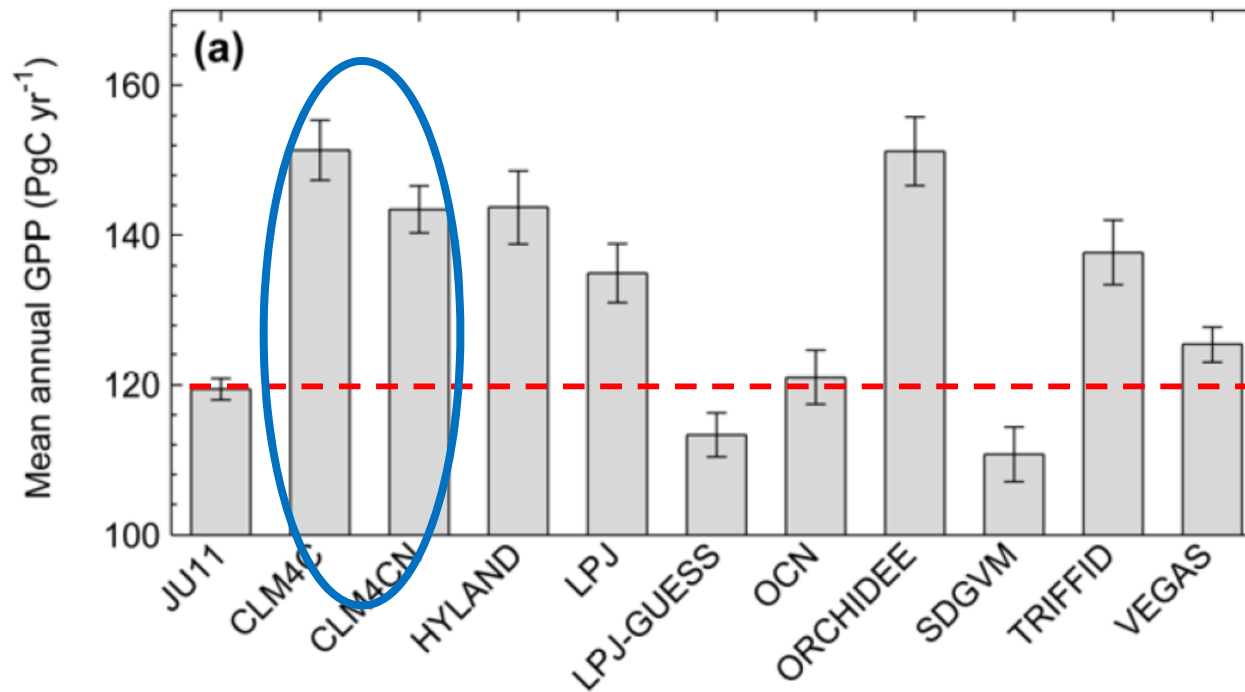


Upscaled gridded dataset product



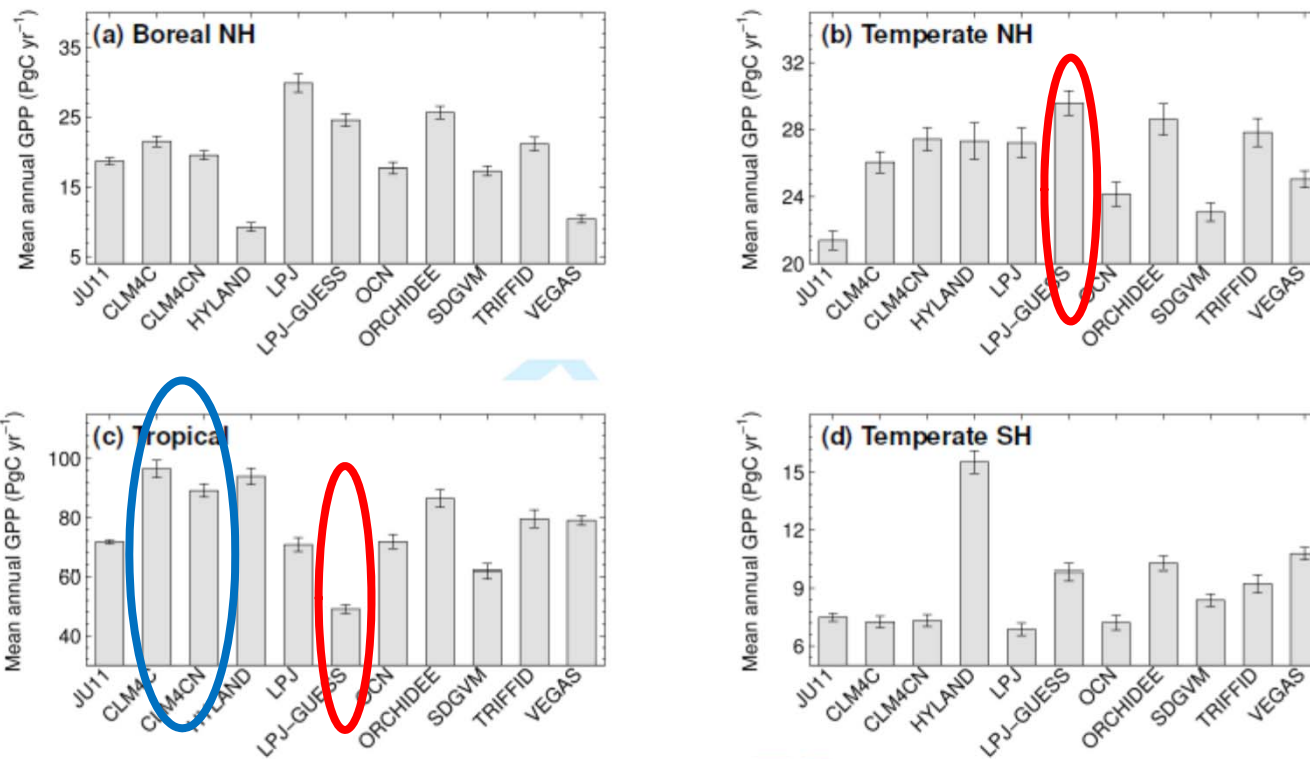
Beer *et al.*, 2010

# GPP - global average



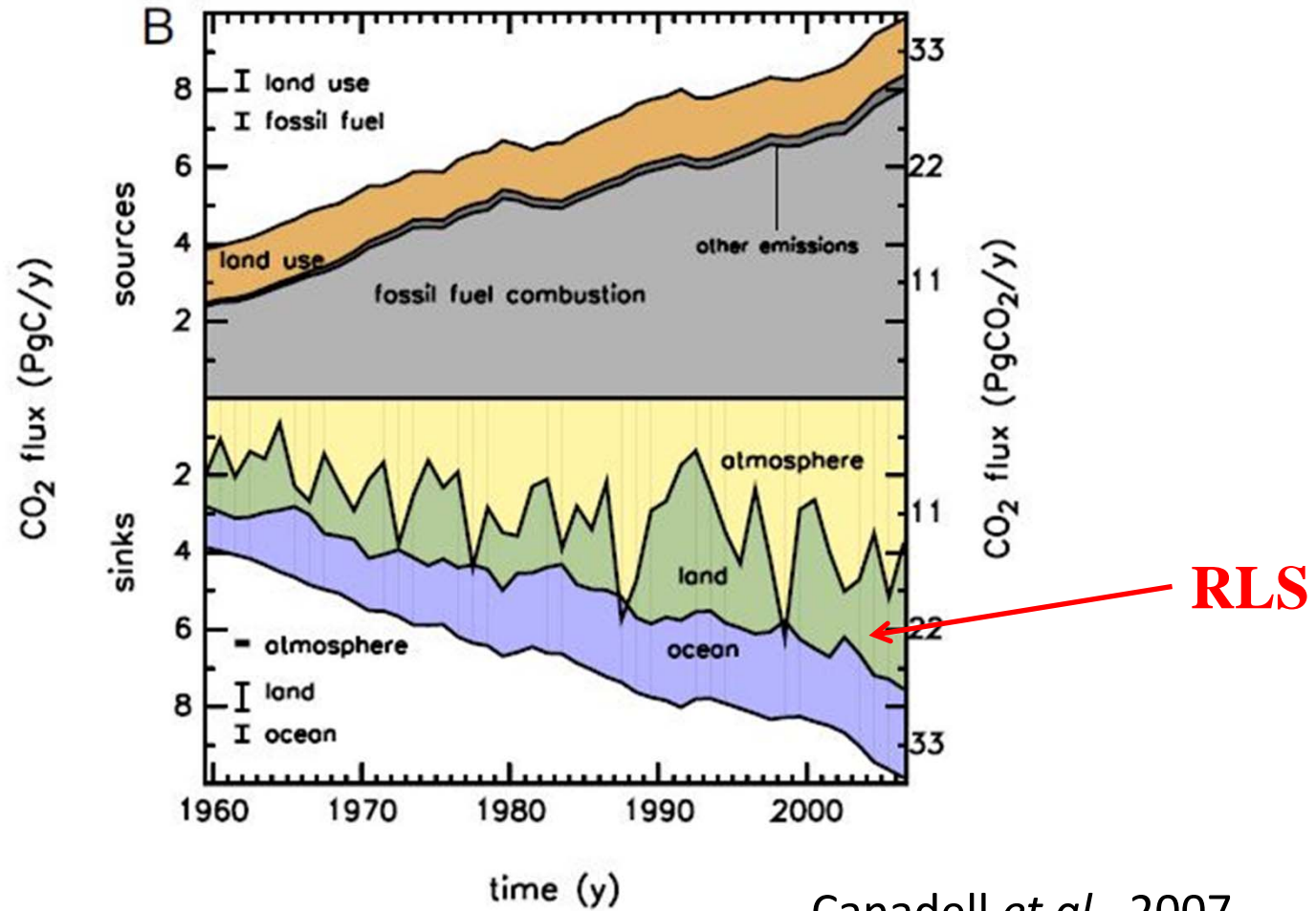
Piao *et al.*, 2013

# GPP - regional average



Piao *et al.*, 2013

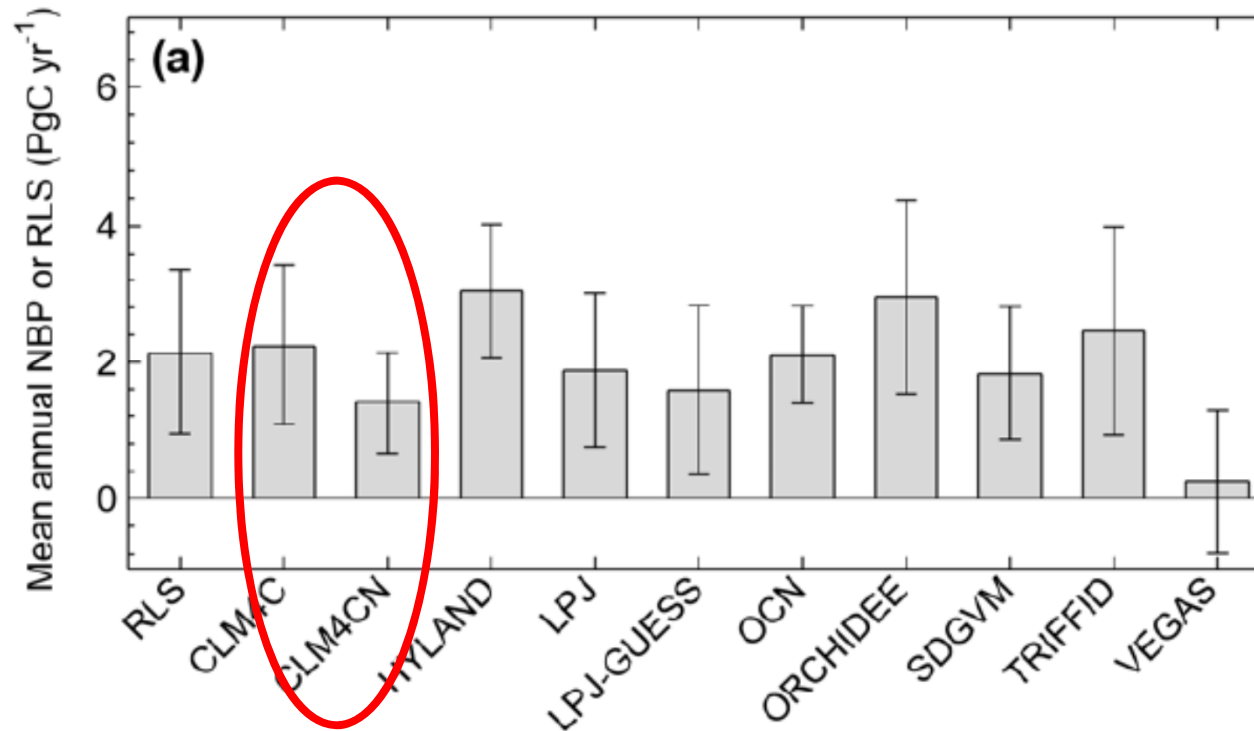
# NBP Evaluation – Residual Land Sink



Canadell *et al.*, 2007



# NBP Evaluation – decadal average



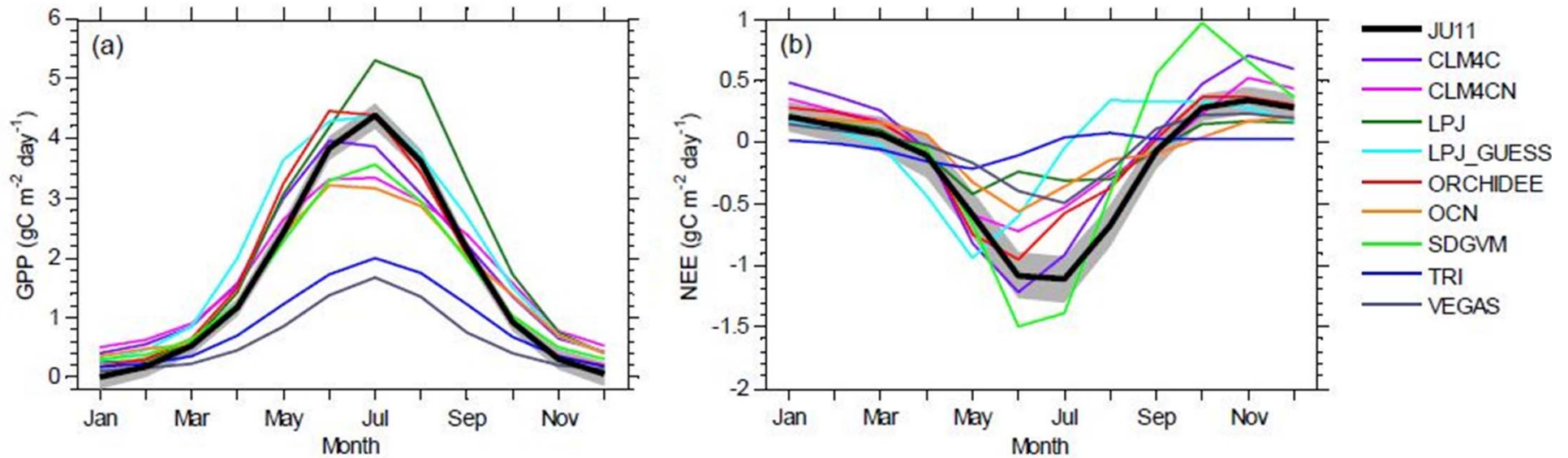
Piao *et al.*, 2013

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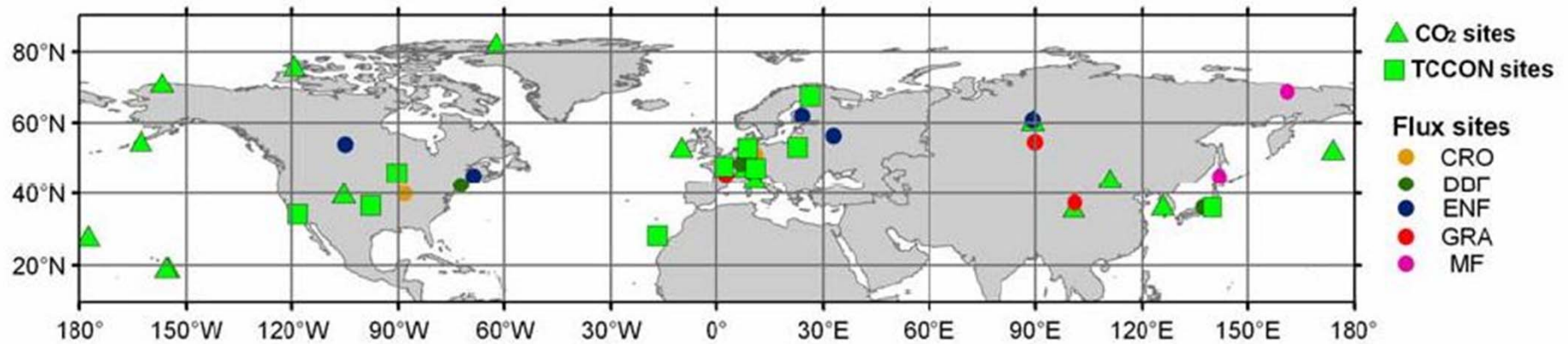
- Evaluation of carbon fluxes
  - Global average
  - **Seasonal cycle**
  - Response to interannual climate variability
- Evaluation of river run-off
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# Seasonal Cycle - North of 25°N



Peng *et al.*, in prep

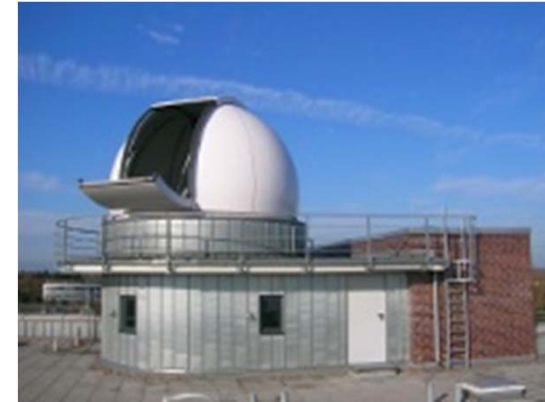
# Seasonal Cycle Observations



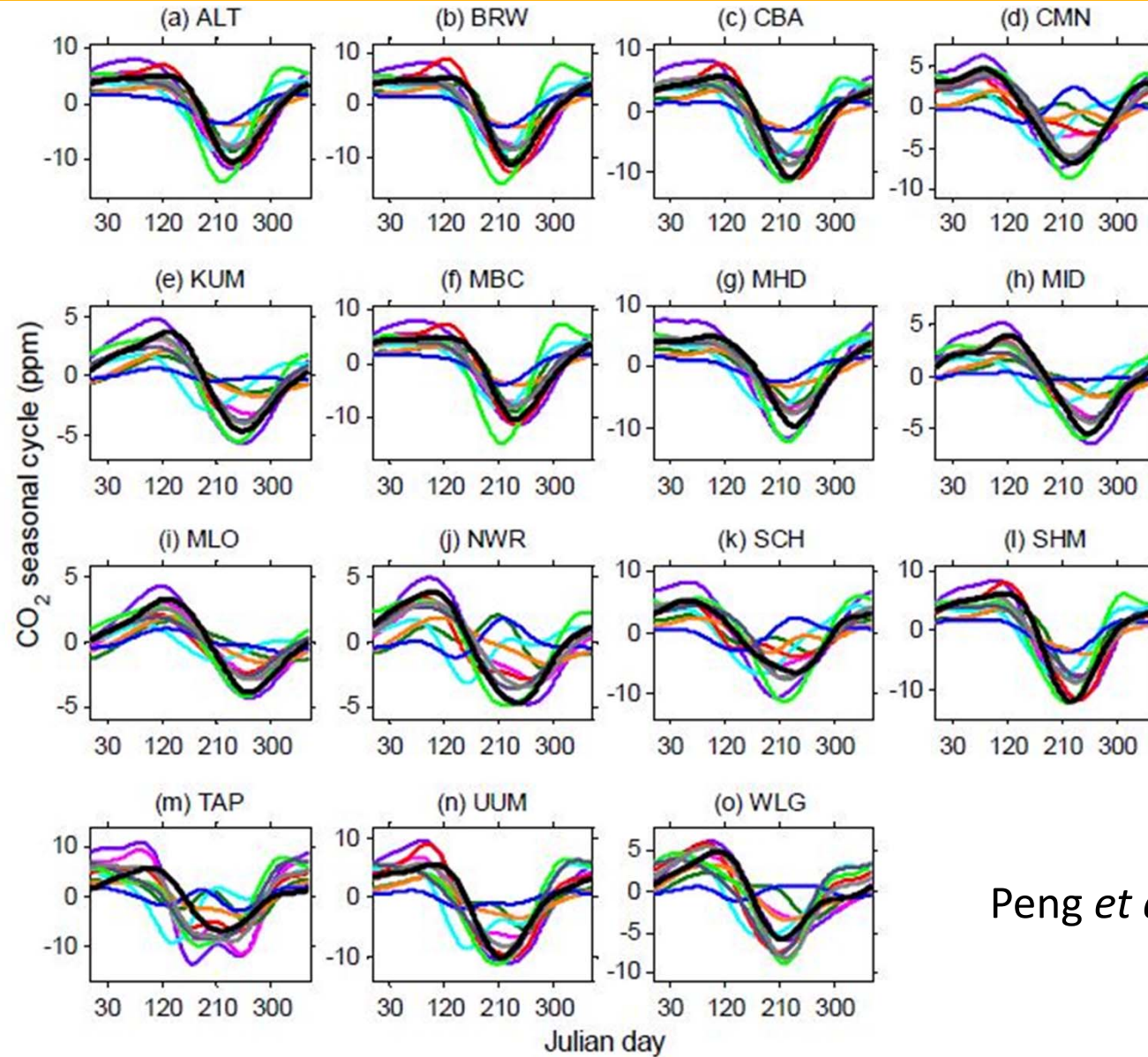
16 Flux sites

15 [CO<sub>2</sub>] sites

10 TCCON sites

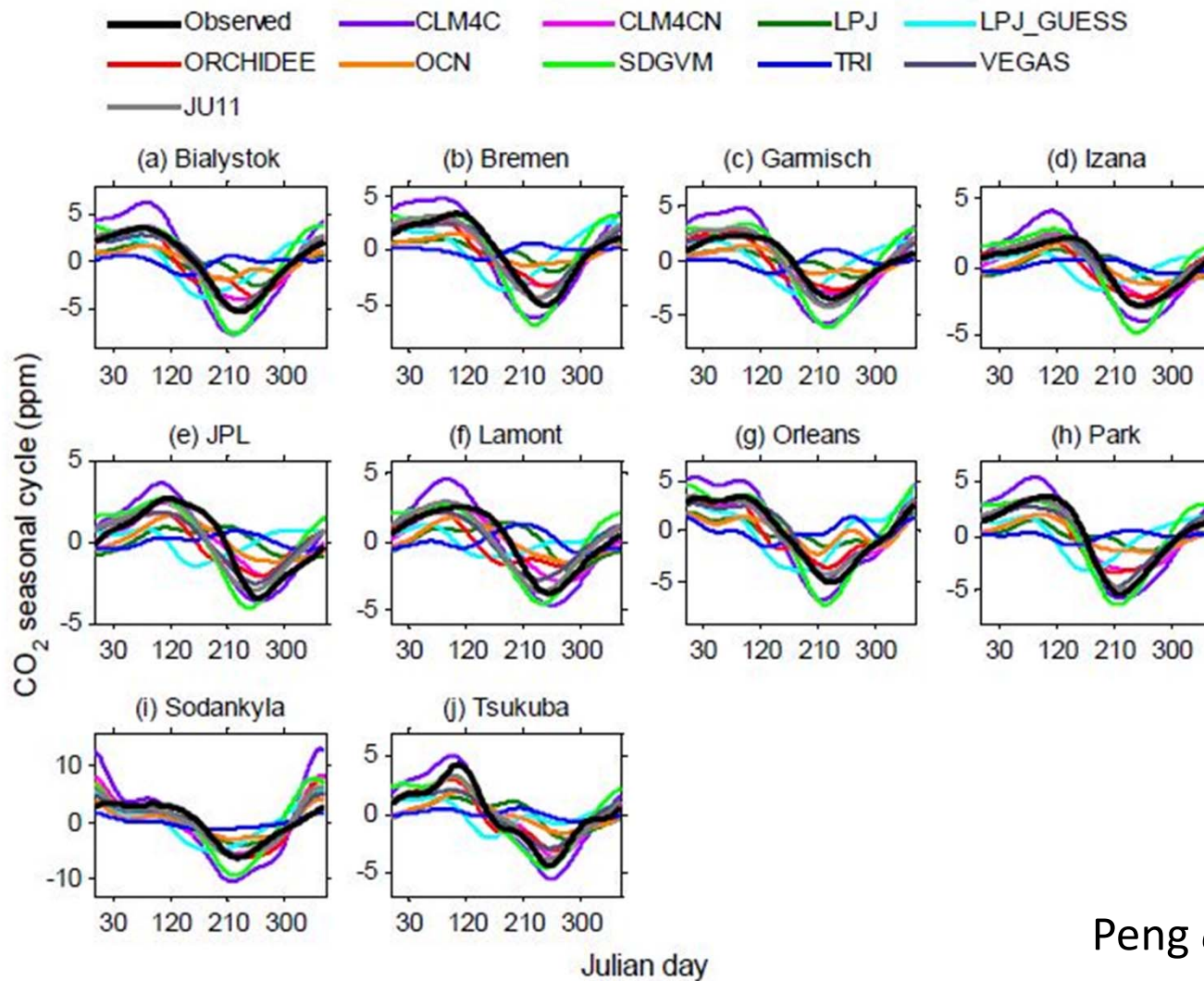


# Seasonal Cycle – [CO<sub>2</sub>]



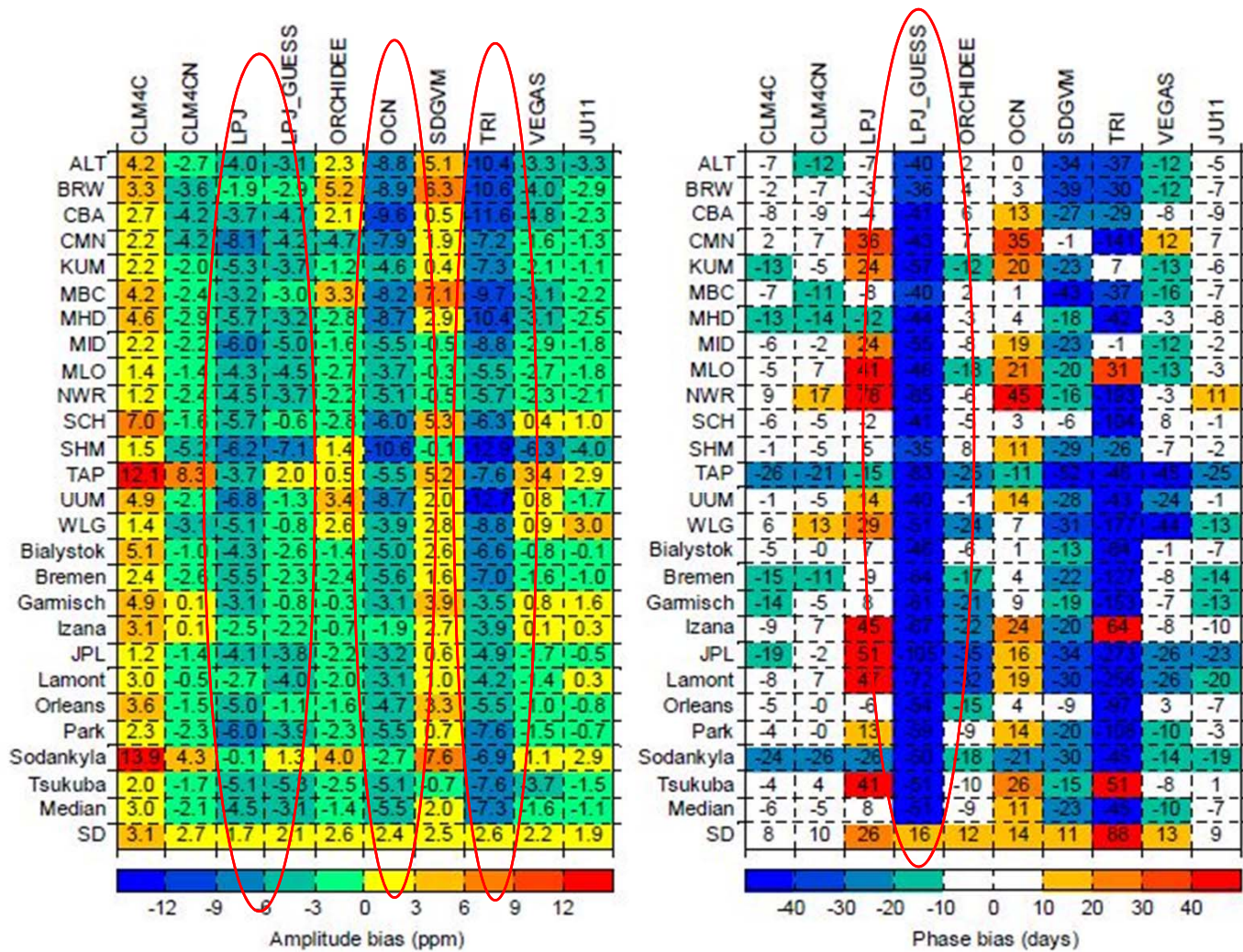
Peng *et al.*, in prep

# Seasonal Cycle – xCO<sub>2</sub>

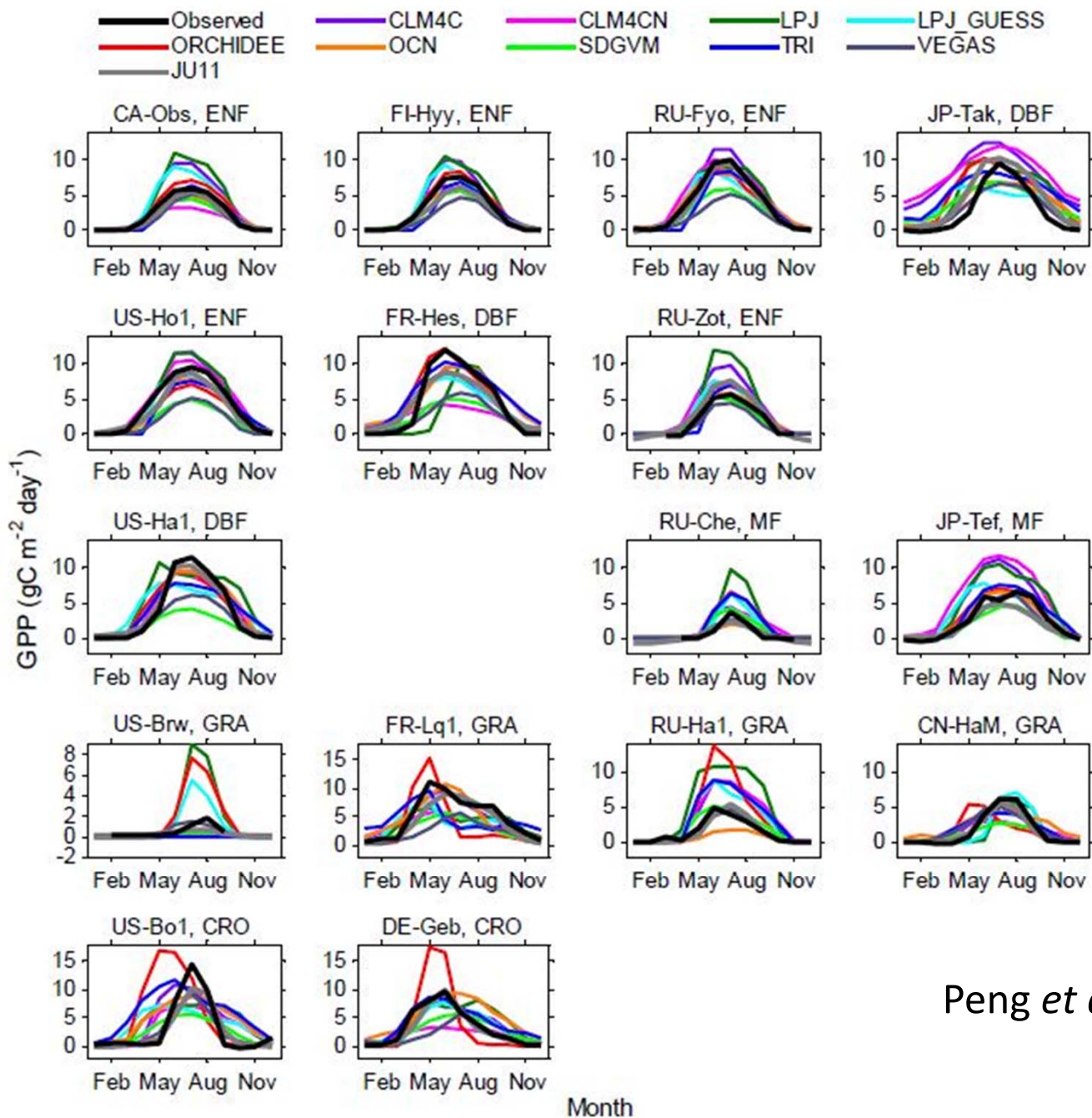


Peng *et al.*, in prep

# Amplitude and Phase bias

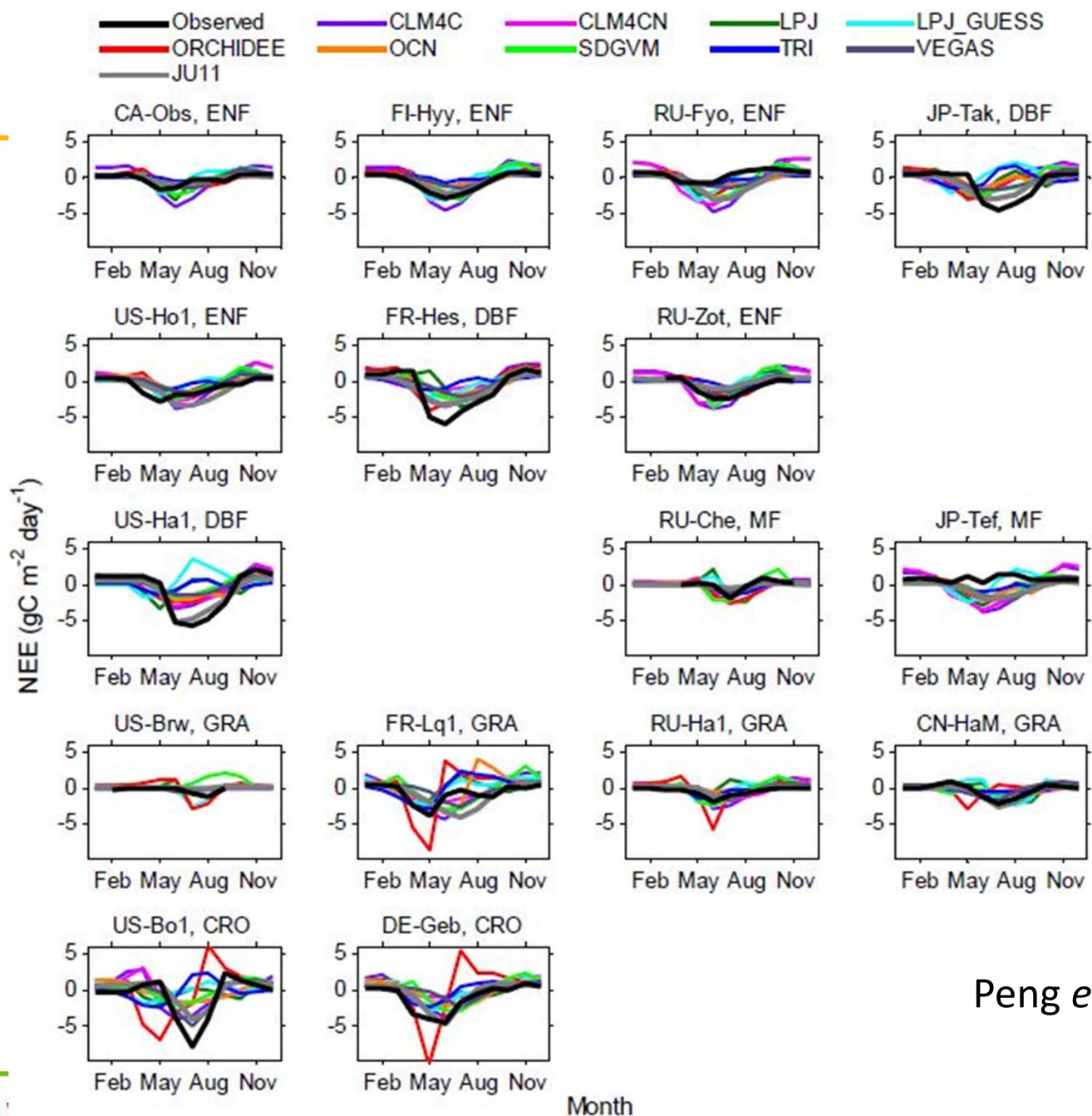


Peng *et al.*, in prep



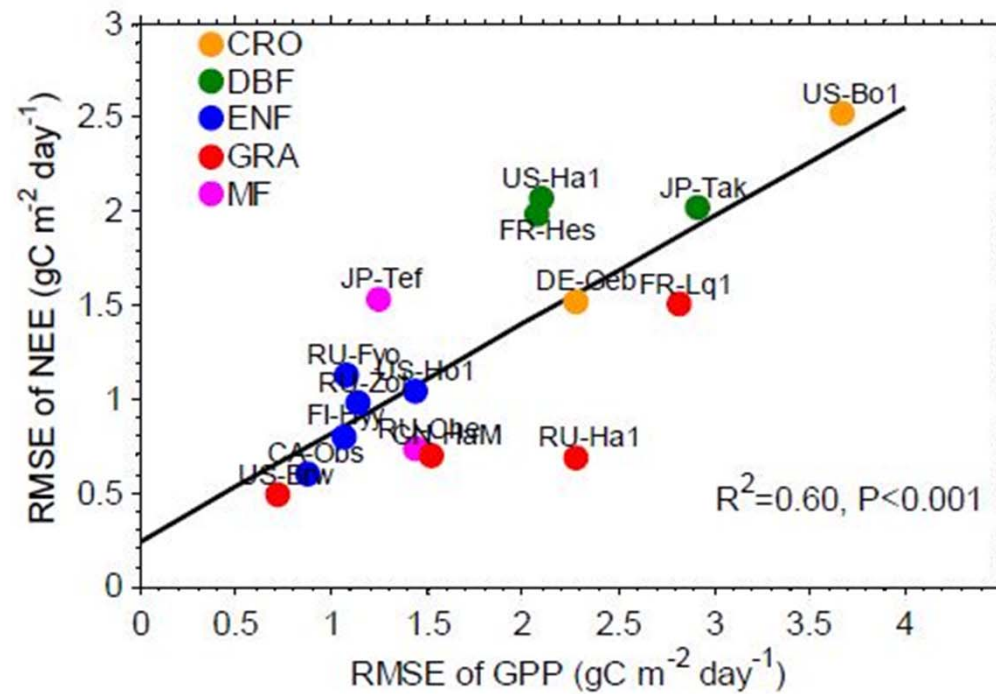
Peng *et al.*, in prep





Peng *et al.*, in prep

# Seasonal Cycle – GPP vs. NEE



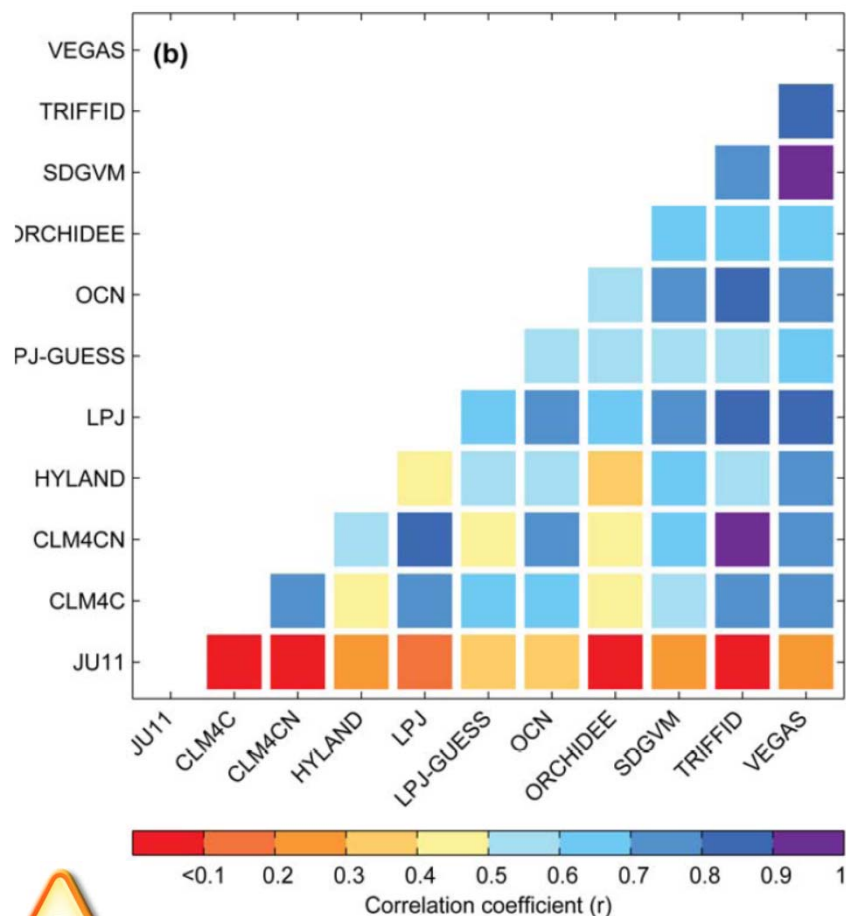
Peng *et al.*, in prep

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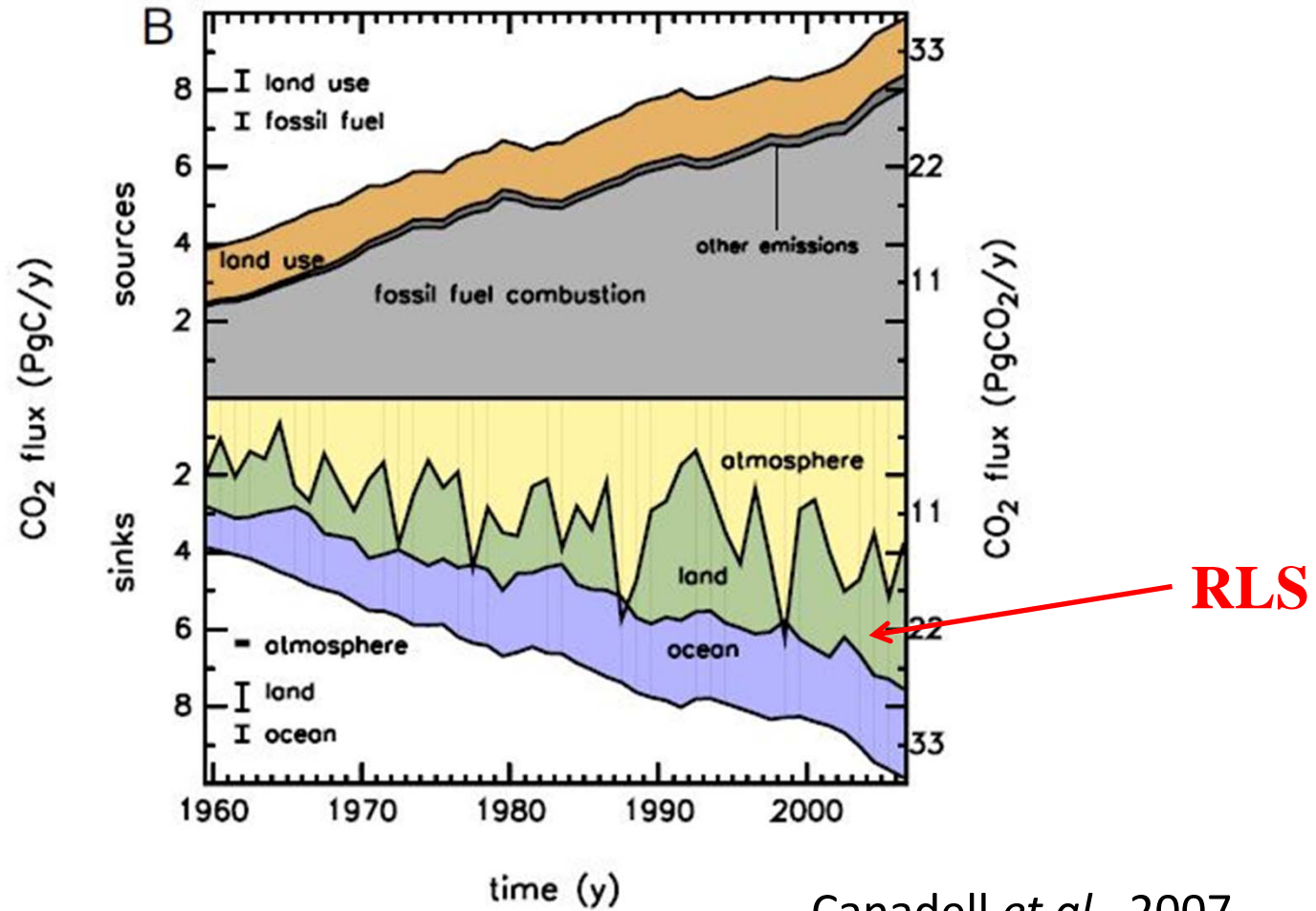
# Interannual Variation in GPP



To be used with caution

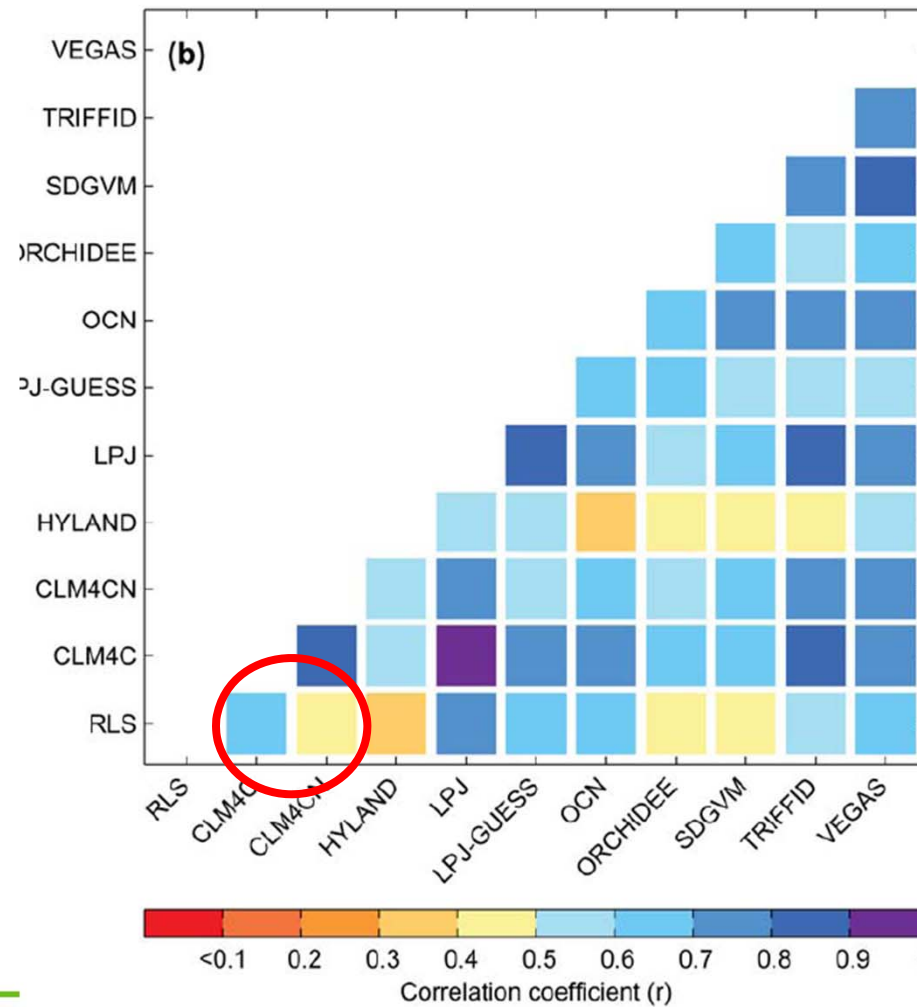
- JU11's GPP variability, however, may be considered as more uncertain than models
- JU11 trained model using spatial gradients among different sites (there are few long series) and then used the derived relationship to extrapolate to temporal interannual gradients;
- This assumes that spatial and interannual sensitivity of GPP to climate are the same, which may be not correct

# NBP Evaluation – Residual Land Sink



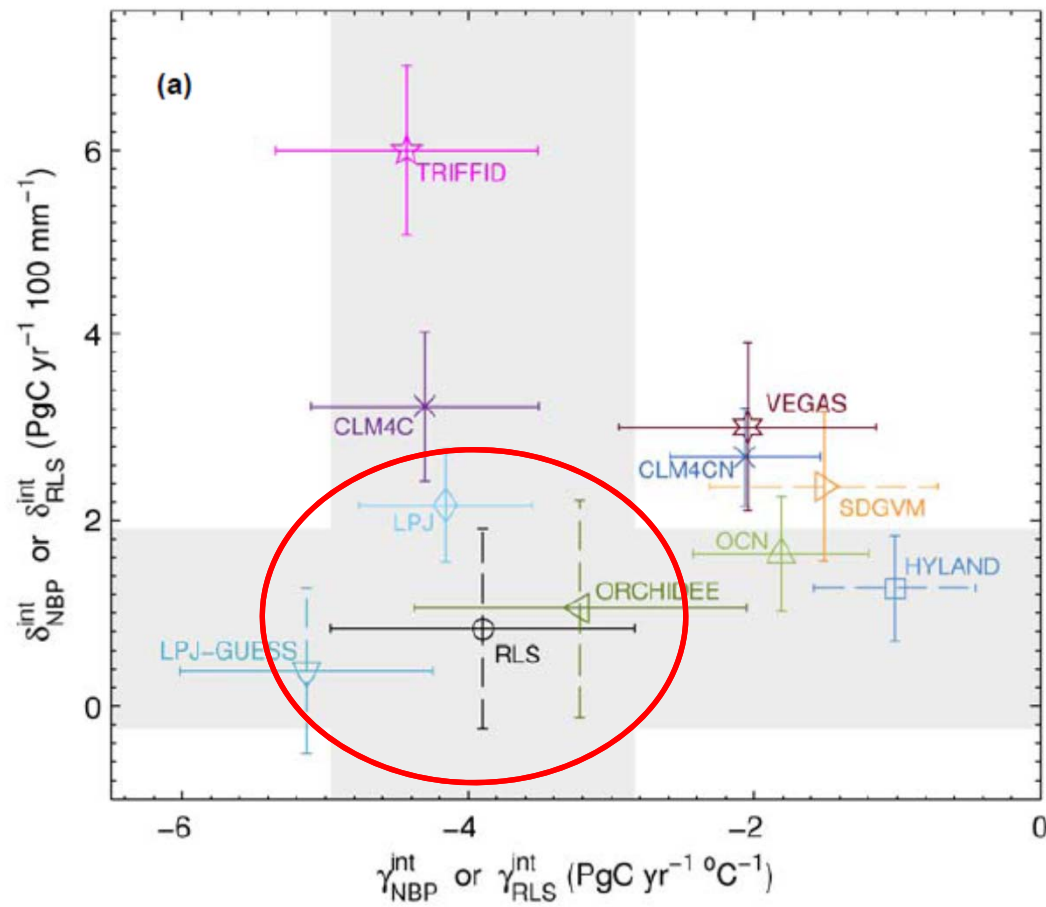
Canadell *et al.*, 2007

# Interannual Variation in NBP



Piao *et al.*, 2013

# NBP Response to Interannual Climate Variations



Piao *et al.*, 2013

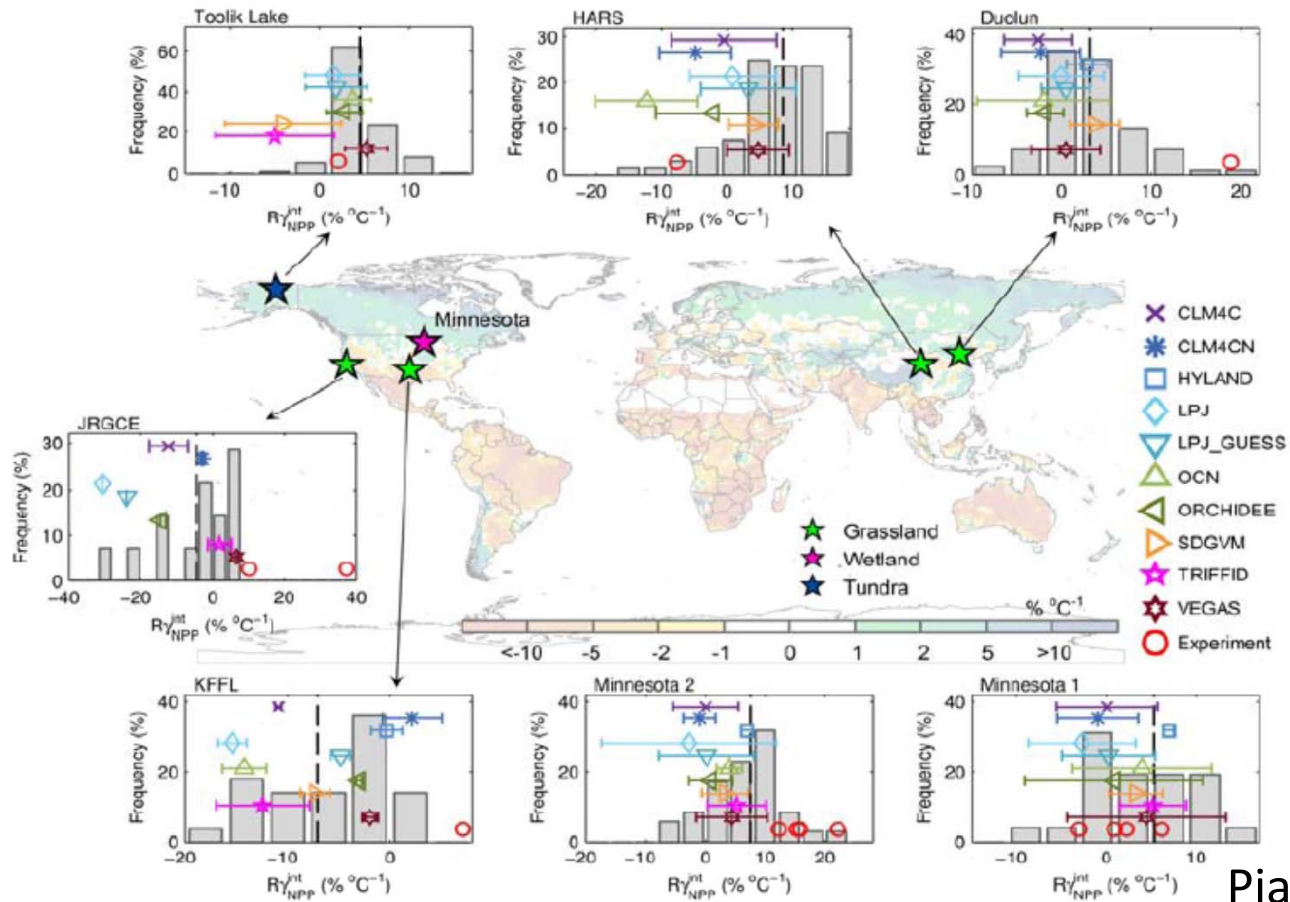
# Warming Experiment

	Haibei Alpine Research Station (HARS)	Jasper Ridge Global Change Experiment (JRGCE)	Duolun	Minnesota 1	Minnesota 2	Kessler's Farm Field Laboratory (KFFL)	Toolik Lake, arctic LTER
Location	Tibetan Plateau, China	California, USA	Inner Mongolia, China	Minnesota, USA	Minnesota, USA	Oklahoma, USA	Alaska, USA
Latitude	37°37'N,	37°24'N,	42°02'N,	47°N,	47°N,	34°59'N,	68°38'N,
Longitude	101°12' E	122°14' W	116°17' E	92°W	92°W	97°31' W	149°34' W
MAT (°C)	-2	13	2	3	4	16	-7
MAP (mm)	600	818	386	497	762	914	320
Vegetation type	Grassland	Grassland	Grassland	Wetland	Wetland	Grassland	Tundra
References	Klein et al., 2007	Shaw et al., 2002; Dukes et al., 2005	Bai et al., 2010	Weltzin et al., 2000; Updegraff et al., 2001	Weltzin et al., 2000; Updegraff et al., 2001	Luo et al., 2009	Chapin et al., 1995





# Temperature Sensitivity of NPP



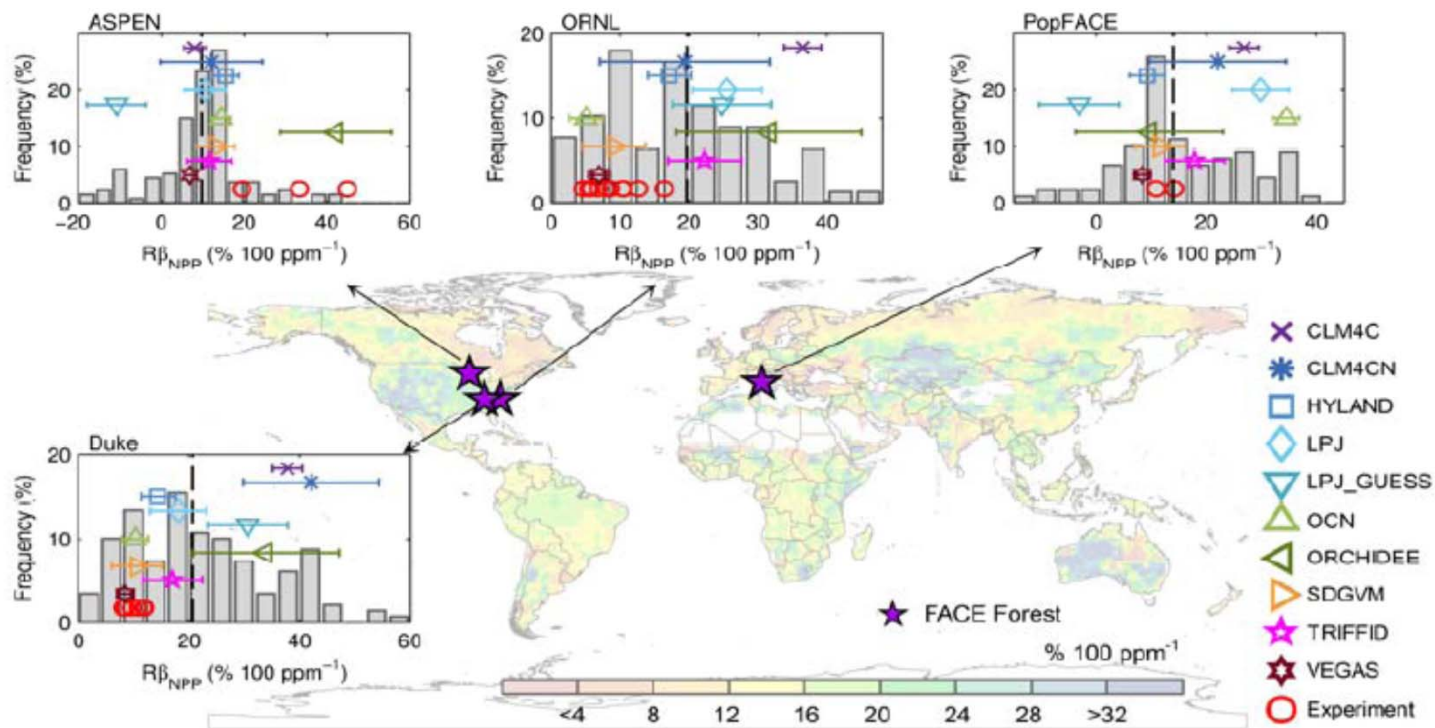
Piao *et al.*, 2013

# FACE Experiments

	ASPEN FACE	Duke FACE	ORNL FACE	PopFACE
Location	Rhinelander, Wisconsin, USA	Durham, North Carolina, USA	Oak Ridge, Tennessee, USA	Toscana (Viterbo), Italy
Latitude Longitude	45°40'N 89°37'W	35°58'N 79°05'W	35°54'N 84°20'W	42°22'N 11°48'E
Mean annual temperature (°C)	4.9	15.5	14.2	14.1
Mean annual Precipitation (mm)	810	1140	1390	818
Available NPP data	2001 - 2003	1997 - 2002	1999 - 2008	2000, 2001
Main species	<i>Populustremuloides</i> Michx., <i>Acer saccharum</i> Marsh., <i>Betula papyrifera</i> Marsh.	<i>Pinustaeda</i> L.	<i>Liquidambar</i> <i>styraciflua</i> L.	<i>Populus alba</i> L., <i>P. nigra</i> L., <i>P. ×euramericana</i> DodeGuinier
Elevated CO <sub>2</sub> concentration (ppm)	580	580		



# CO<sub>2</sub> sensitivity of NPP



Piao *et al.*, 2013

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Thanks for your attention!