FLUXNET and Remote Sensing: Open workshop
Berkeley, June 2011

FLUXNET – scope, progress and challenges
Part II: global up-scaling

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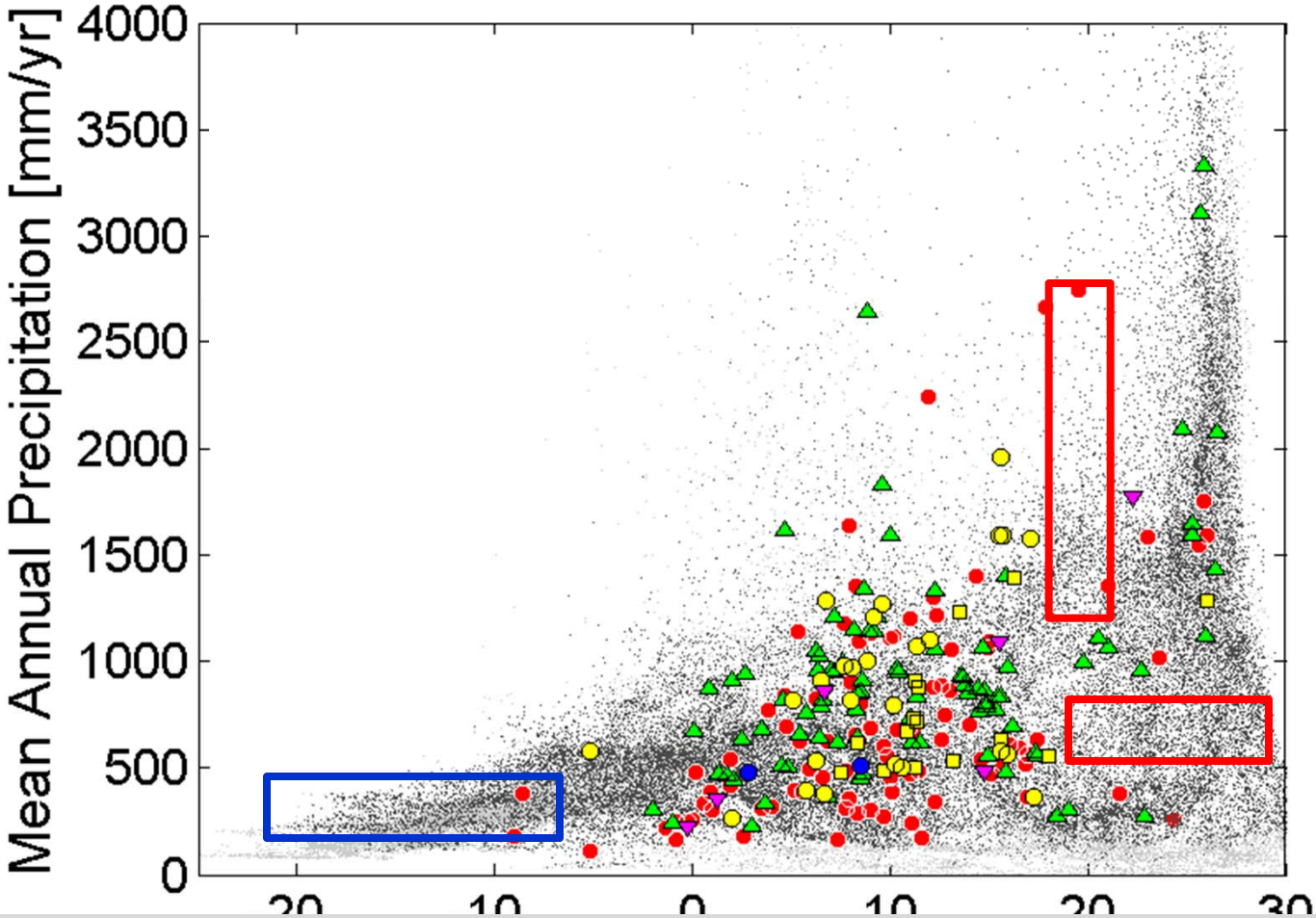
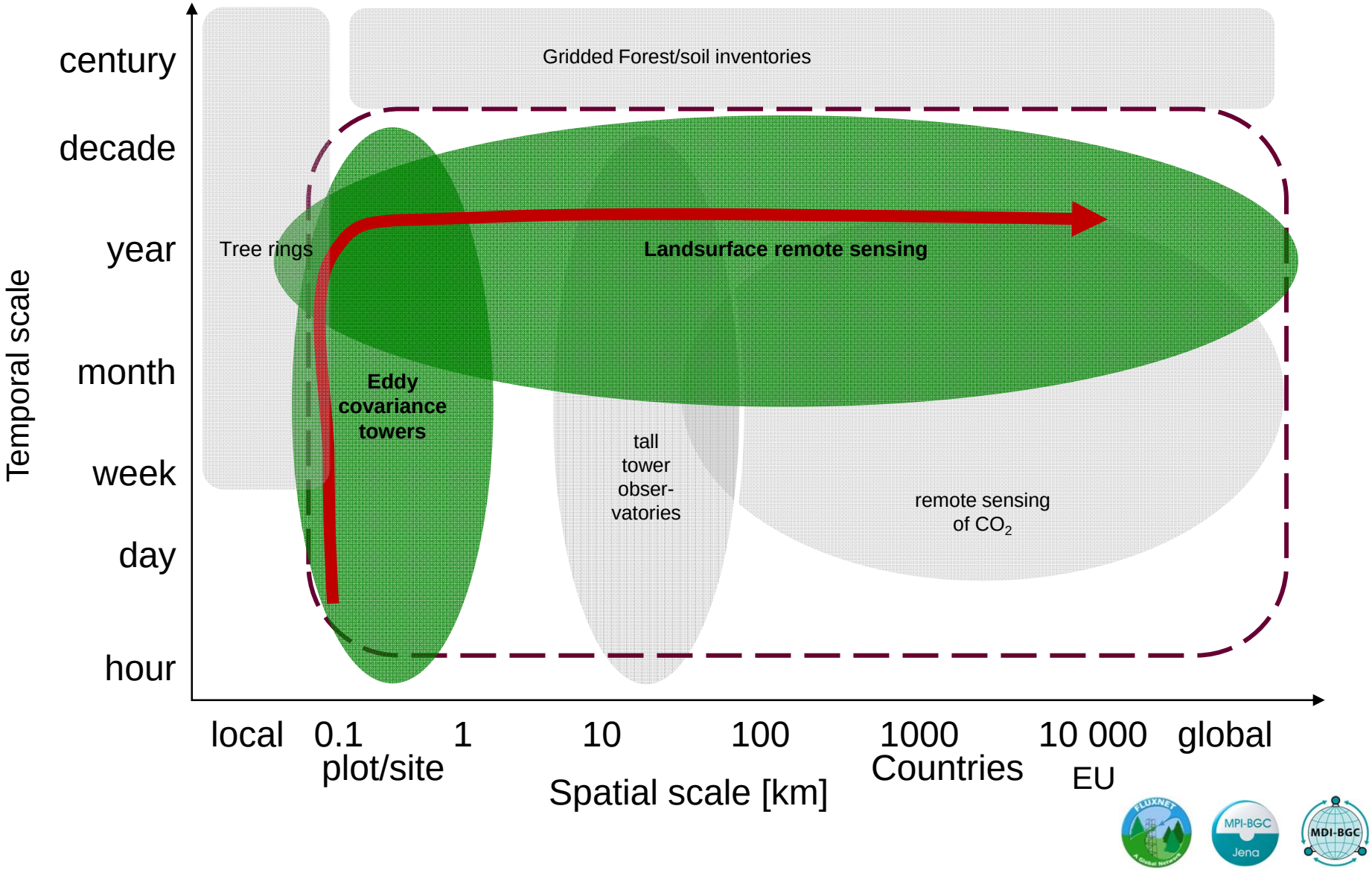
FLUXNET global network of sites: reprentativeness in different dimensions

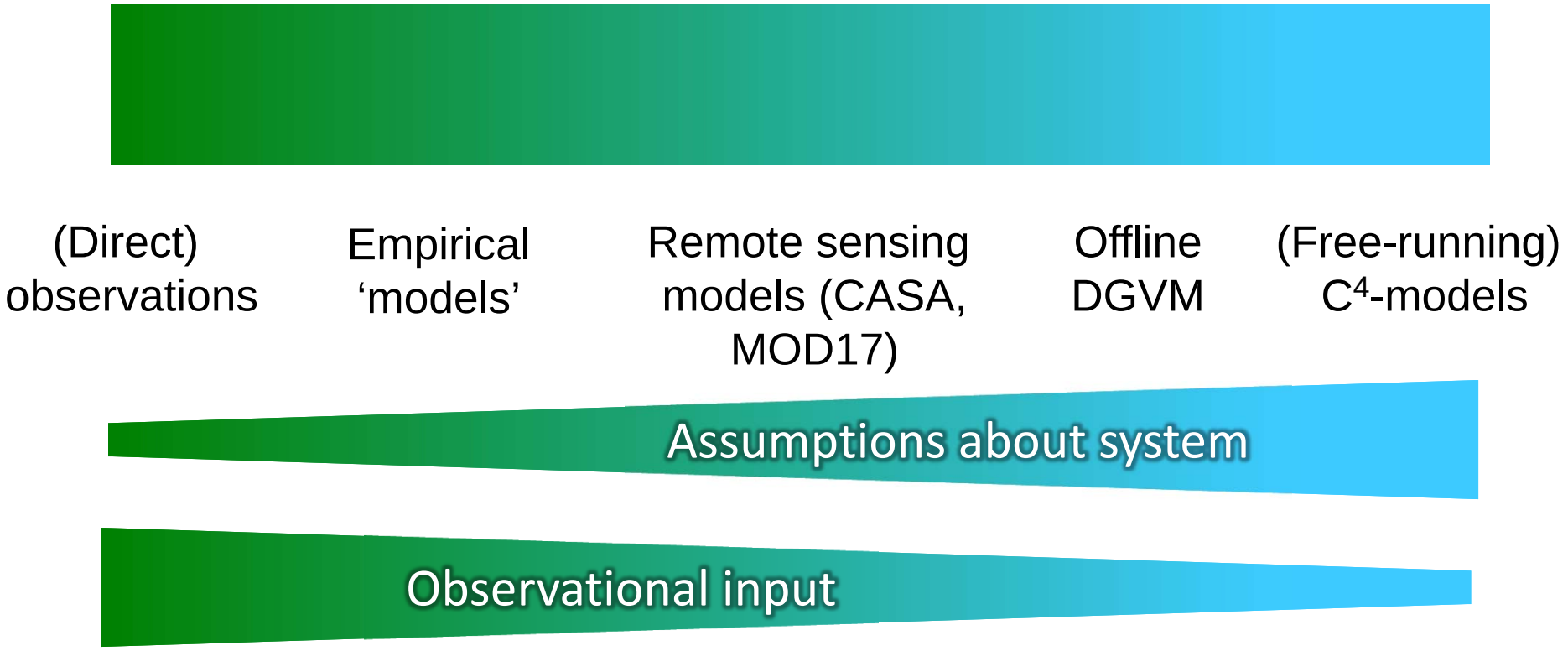


Can we learn general relationships between fluxes, properties and drivers for „filling the gaps“?

From point to globe via integration with remote sensing

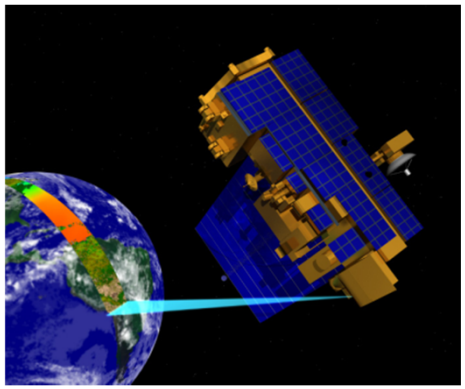


FLUXNET gridded products rationale:



… be as much as possible on observational side!

Empirical upscaling methodology



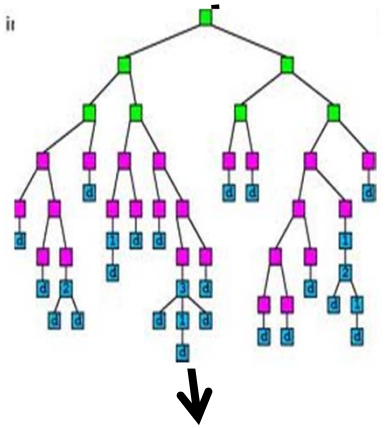
Temperature: CRU-PIK
Precipitation: GPCP
FPAR: harmonized AVHRR, SeaWIFS, MERIS product
Vegetation map: SYNMAP

The same gridded explanatory variables

Site-level explanatory variables

- Meteorology
- Vegetation type
- Remote sensing indices

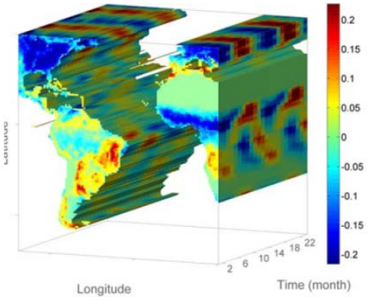
Training



Training

Target variable ecosystem-atmosphere flux

Gridded target variable



(Partly) overcomes site-pecularities, point-to-grid scale mismatch and representativeness

➔  with models....

Details:

Biogeosciences, 6, 2001–2013, 2009
www.biogeosciences.net/6/2001/2009/

Biogeosciences

Towards global empirical upscaling of FLUXNET eddy covariance observations: validation of a model tree ensemble approach using a biosphere model

M. Jung[1], M. Reichstein[1], and A. Bondeau[2]

doi:10.1038/nature09396

Recent decline in the global land evapotranspiration trend due to limited moisture supply

Martin Jung[1], Markus Reichstein[1],
Alessandro Cescatti[7], Jiquan Chen[8]
Nadine Gobron[13], Jens Heinke[11], J
Keith Oleson[6], Dario Papale[18], An
Ulrich Weber[1], Christopher Willia

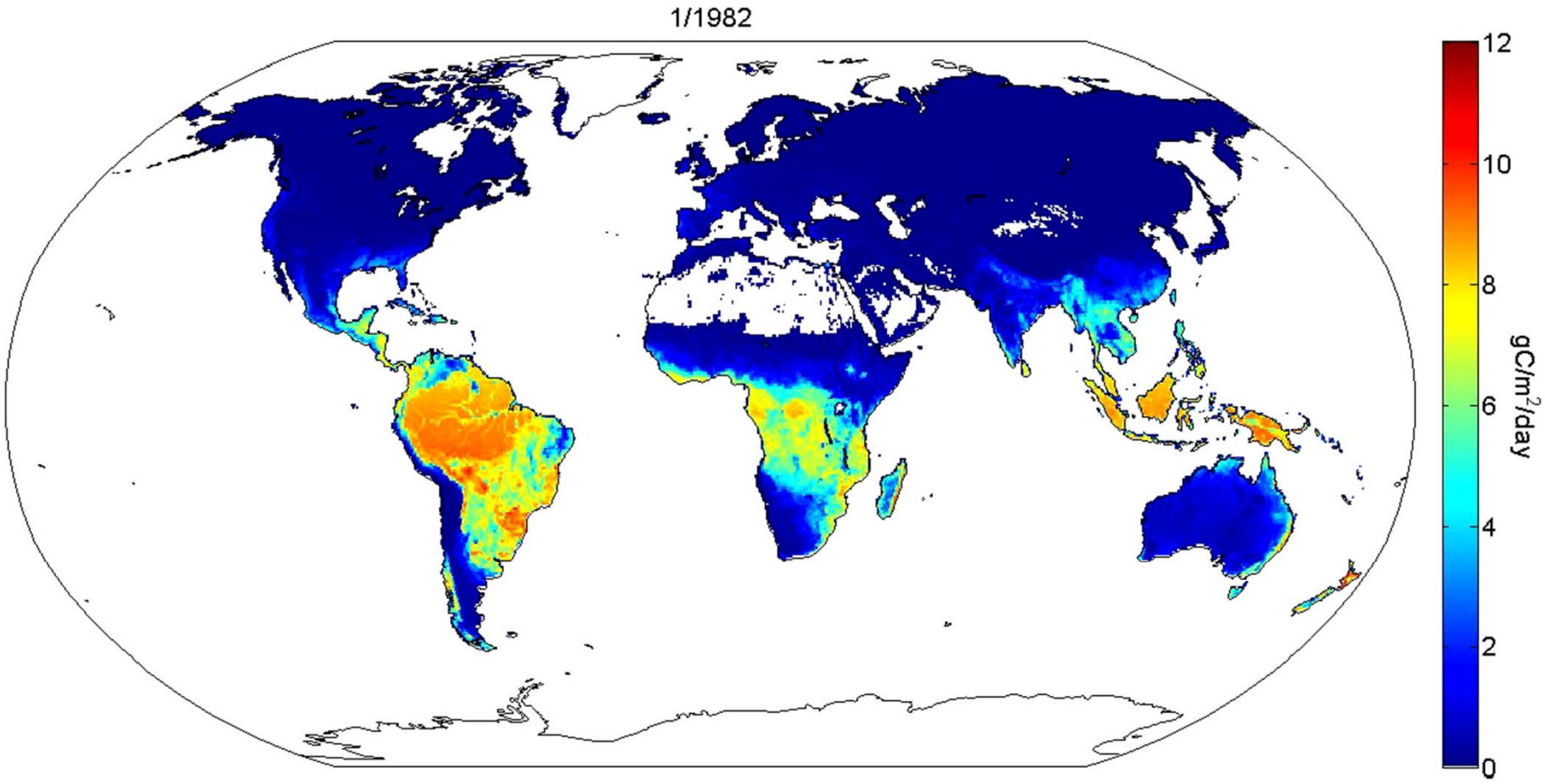
Terrestrial Gross Carbon Dioxide Uptake: Global Distribution and Covariation with Climate

Christian Beer,[1*] Markus Reichstein,[1] Enrico Tomelleri,[1] Philippe Ciais,[2] Martin Jung,[1] Nuno Carvalhais,[1,3] Christian Rödenbeck,[4] M. Altaf Arain,[5] Dennis Baldocchi,[6] Gordon B. Bonan,[7] Alberte Bondeau,[8] Alessandro Cescatti,[9] Gitta Lasslop,[1] Anders Lindroth,[10] Mark Lomas,[11] Sebastiaan Luyssaert,[12] Hank Margolis,[13] Keith W. Oleson,[7] Olivier Roupsard,[14,15] Elmar Veenendaal,[16] Nicolas Viovy,[2] Christopher Williams,[17] F. Ian Woodward,[11] Dario Papale[18]

... and coffee (beer!) break...

27 years of monthly global biosphere-atmopshere exchange @ 0.5°

Here: Gross primary productivity



Robust patterns...

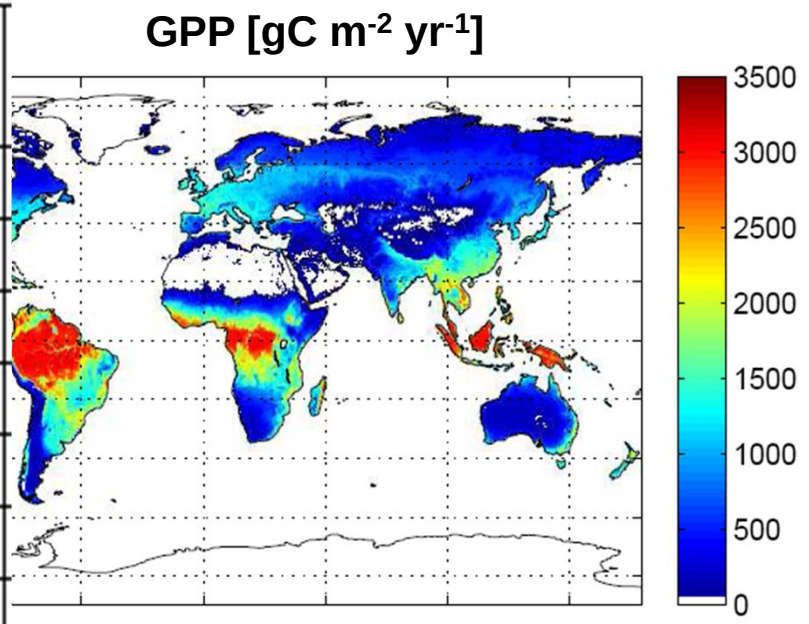
Across space and time scales

Global estimation of terrestrial gross primary productivity (GPP)

Global total: 123 +-8 Pg/yr

Ensemble median map

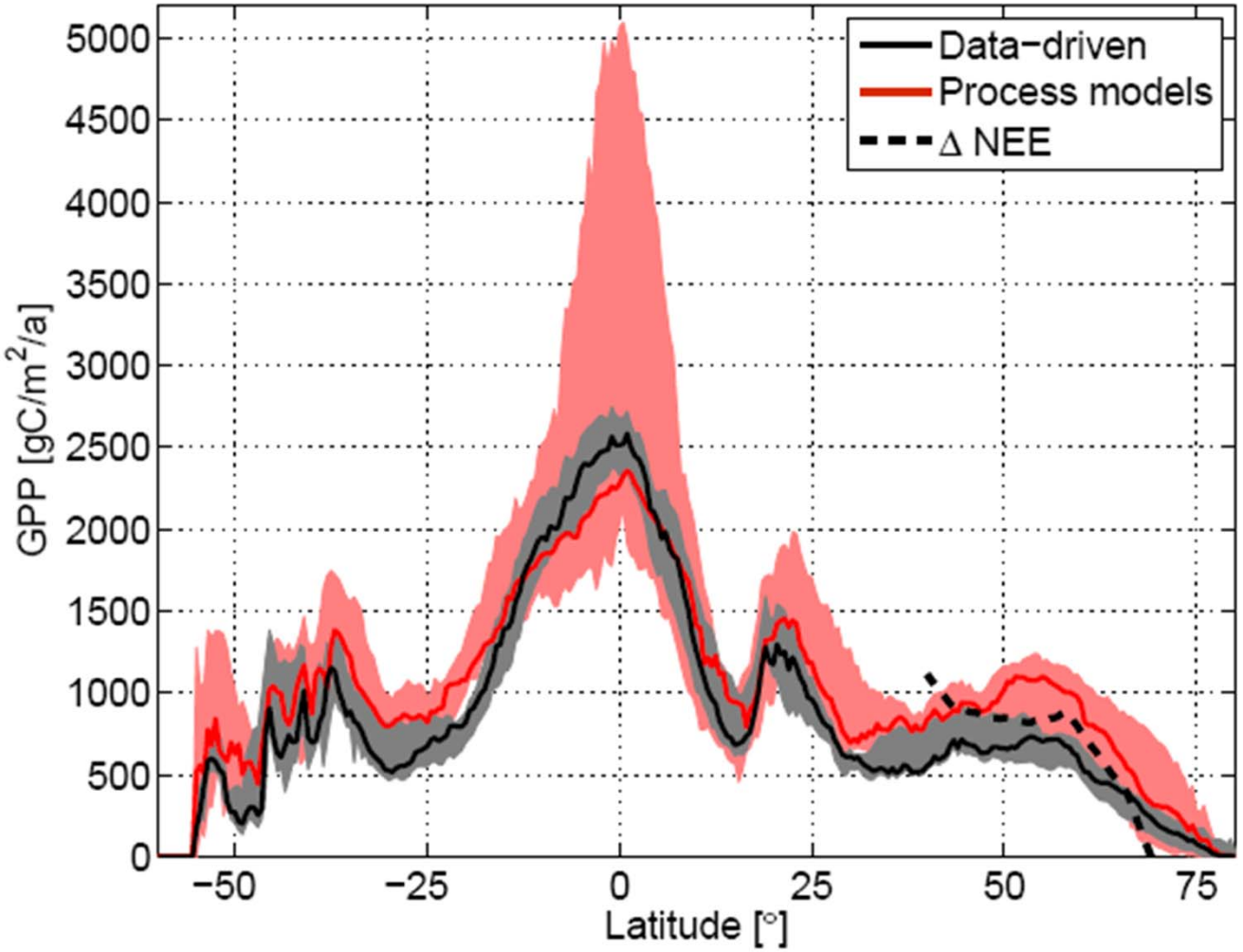
Biome	GPP [Pg C a^{-1}]
Tropical forests	40.8
Temperate forests	9.9
Boreal forests	8.3
Tropical savannahs & grasslands	31.3
Temperate grasslands & shrublands	8.5
Deserts	6.4
Tundra	1.6
Croplands	14.8
Total	121.7



Beer et al. (2010), Science

Light-use eff. ignores C4 veg (> 20 Pg)

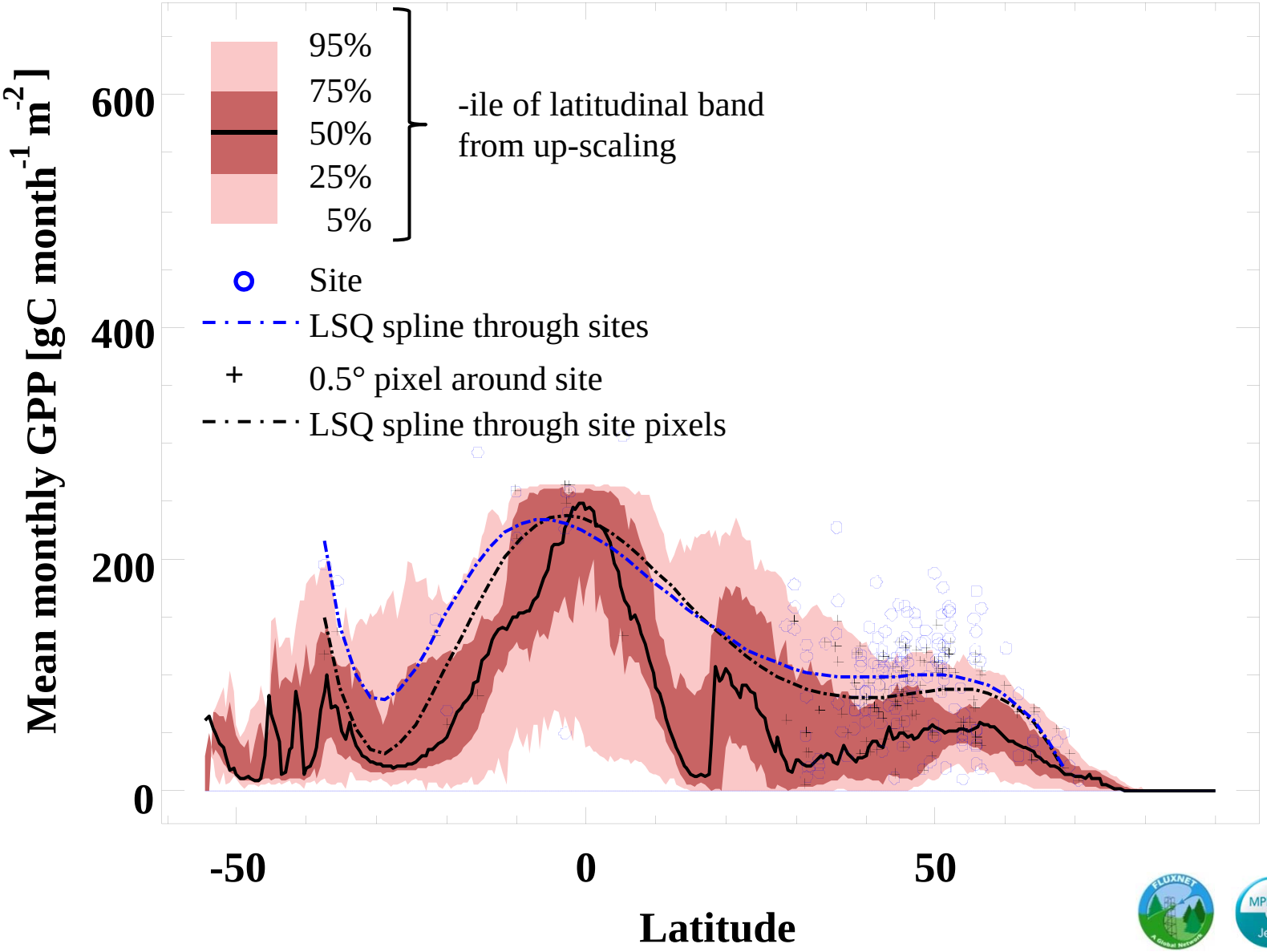
Latitudinal patterns of GPP as model constraint



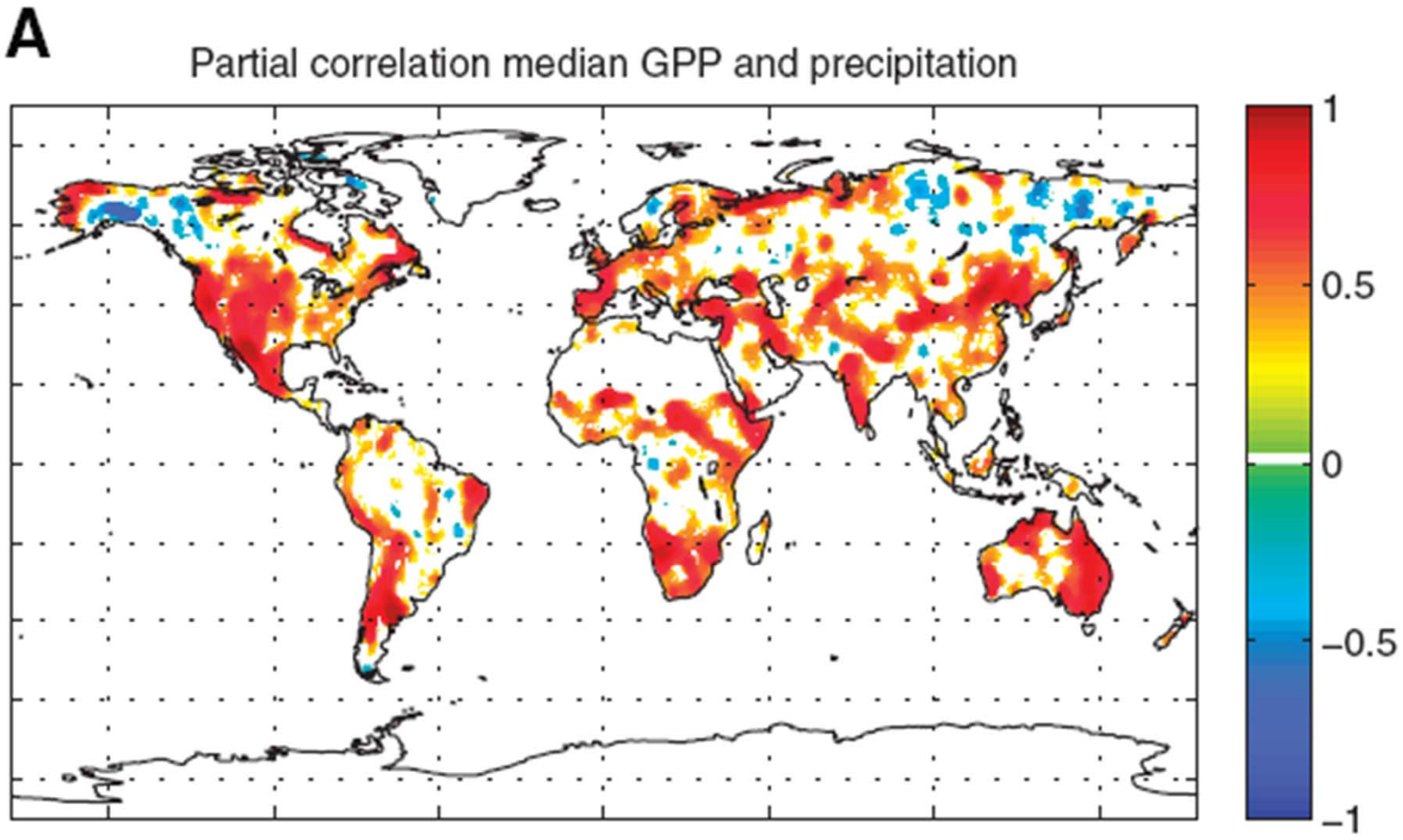
Process models:
CLM-CN
LPJ-DGVM
LPJmL
SDGVM
ORCHIDEE

All 1° resolution or higher

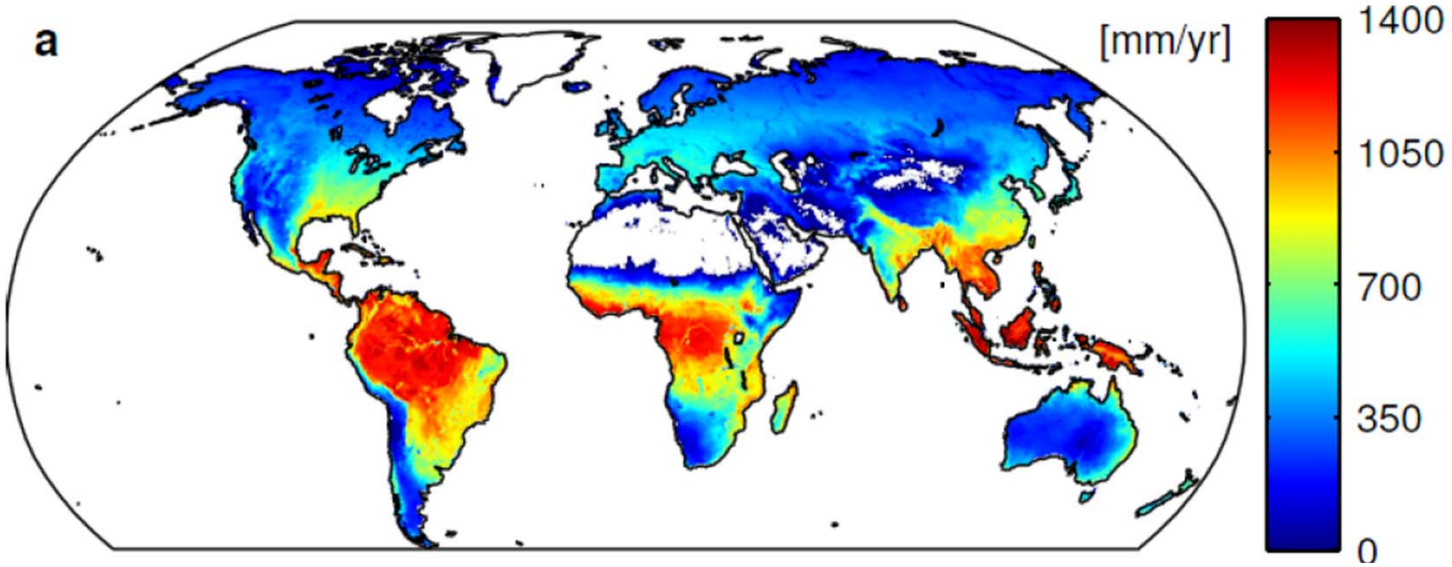
Within-pixel and zonal representativeness: sites are at higher end!



Precipitation control of productivity



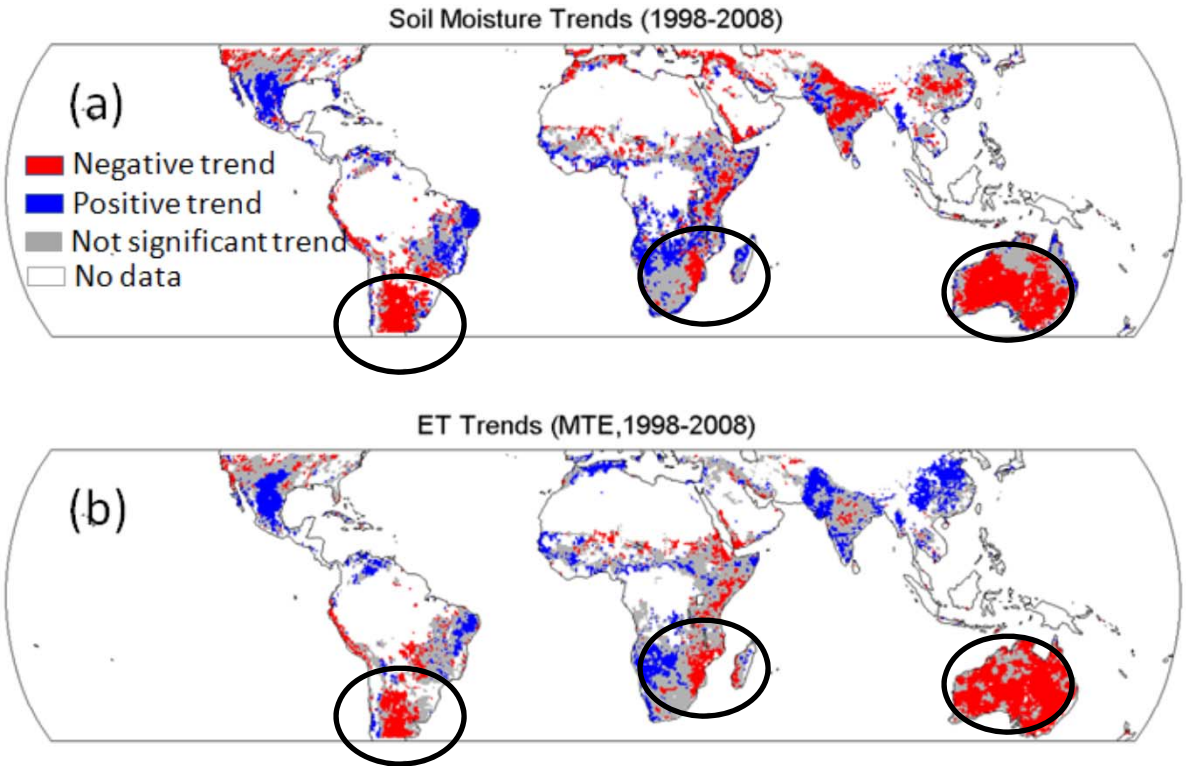
Global evapotranspiration (ET): ca. 65 Eg yr^{-1}



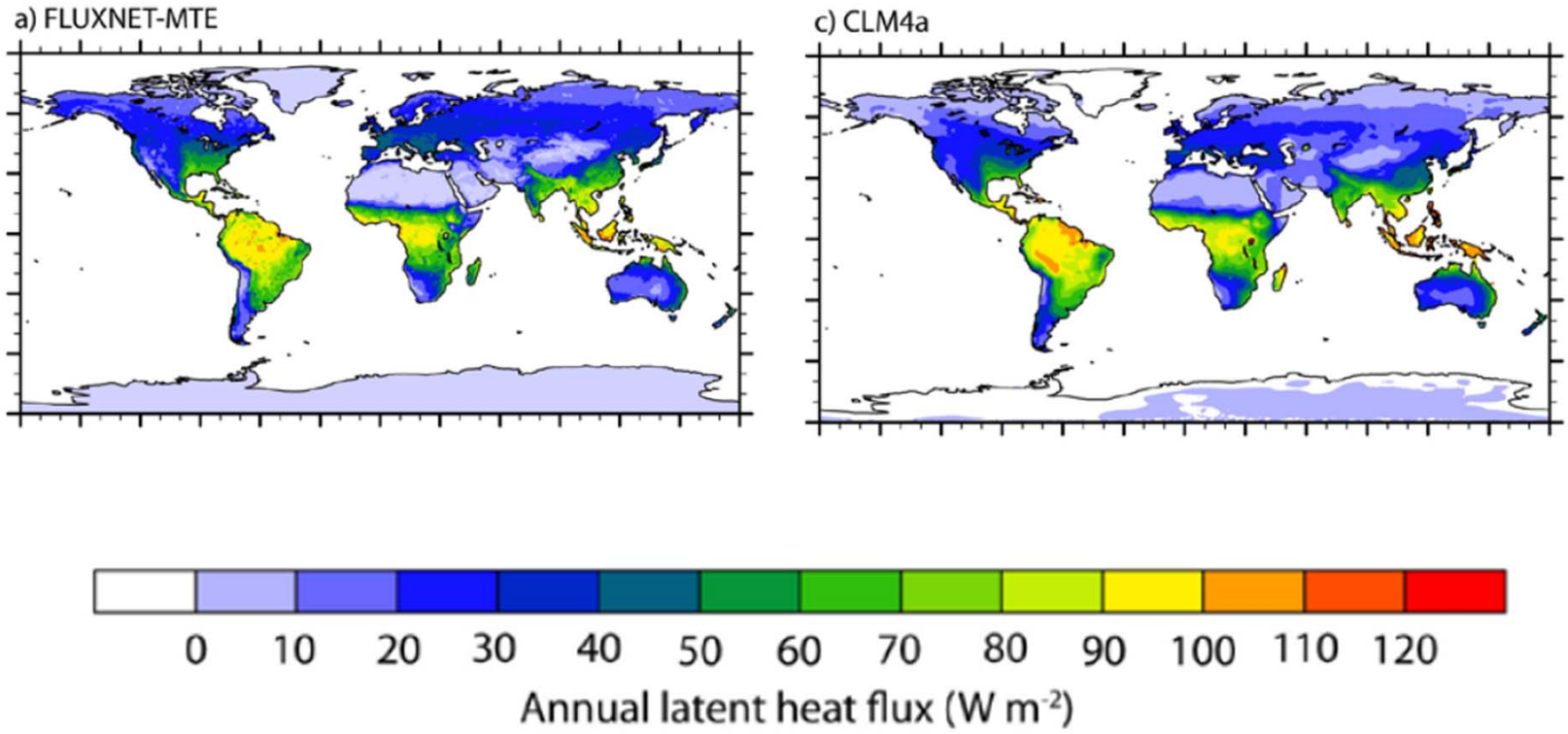
Jung et al. (2010), Nature

Plausible ET decadal variability

1998-2008 ET and soil moisture ‚trends' (from TRMM)



Improving models: CLM

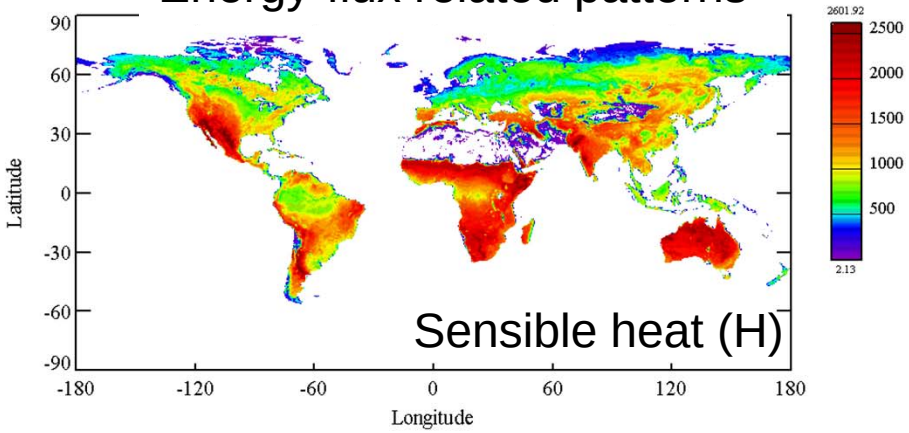


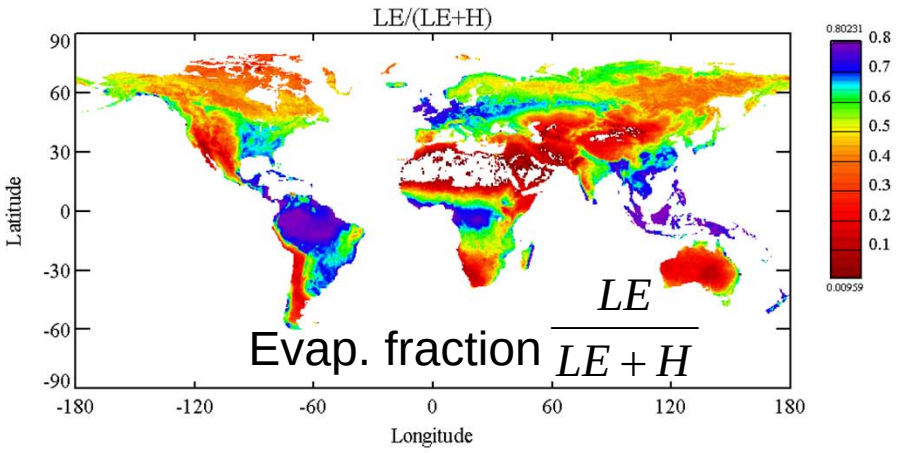
Bonan et al. (2011)

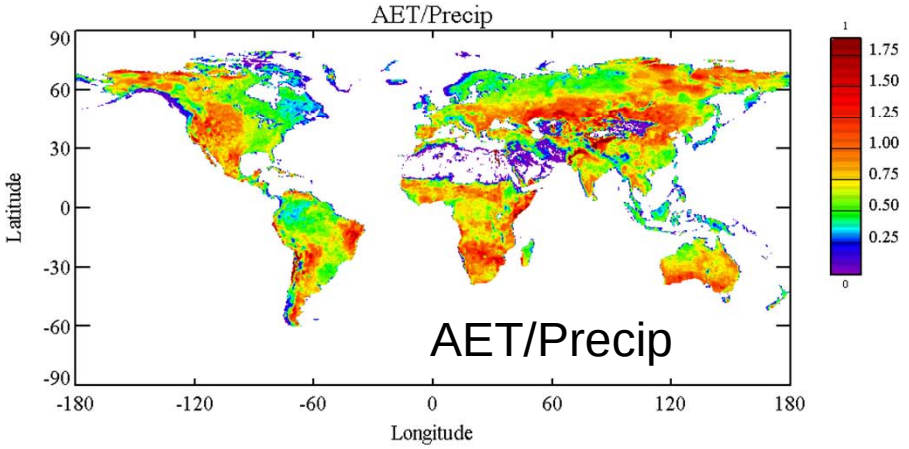
Biosphere ‚properties‘

multivariate, synoptic view

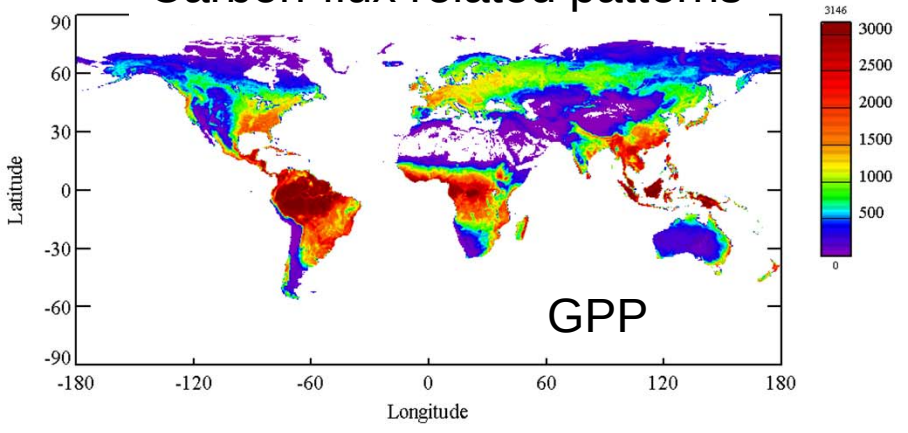
Energy-flux related patterns

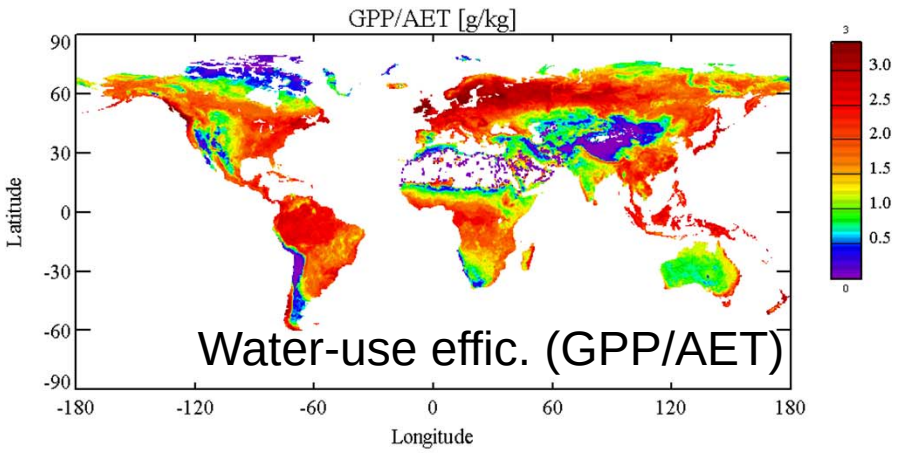


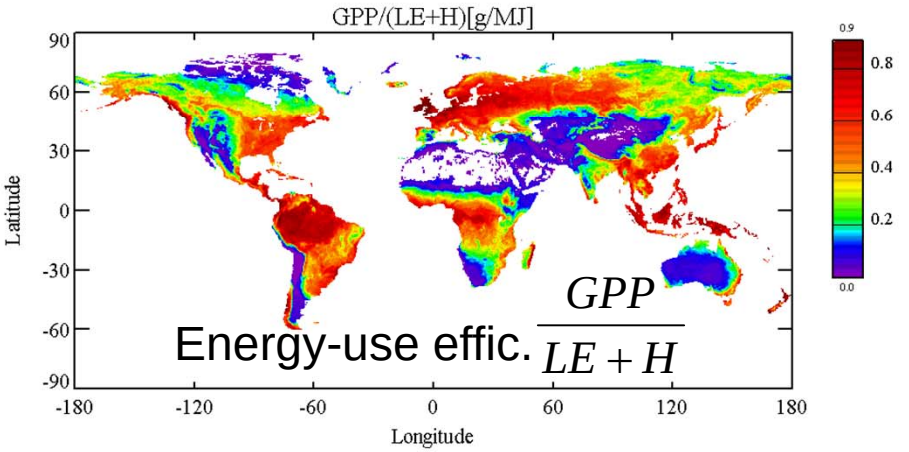




Carbon-flux related patterns

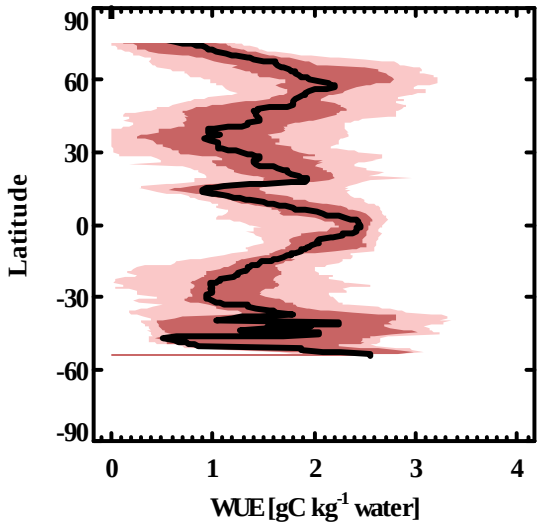




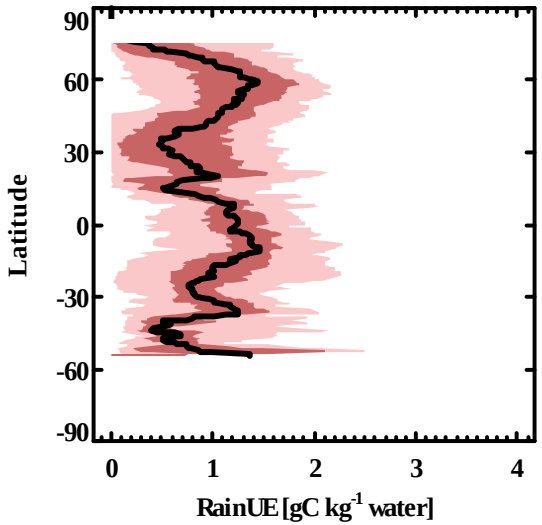


Latitudinal functional biosphere patterns

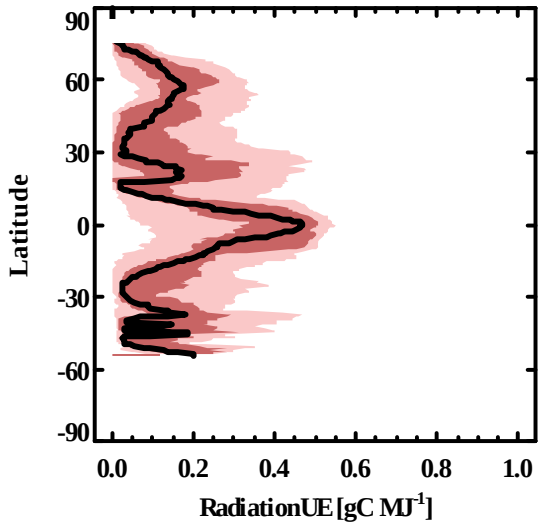
Water-use efficiency

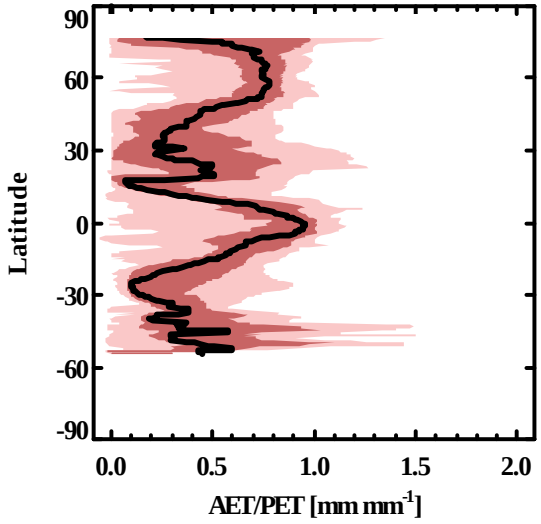


Rain-use efficiency

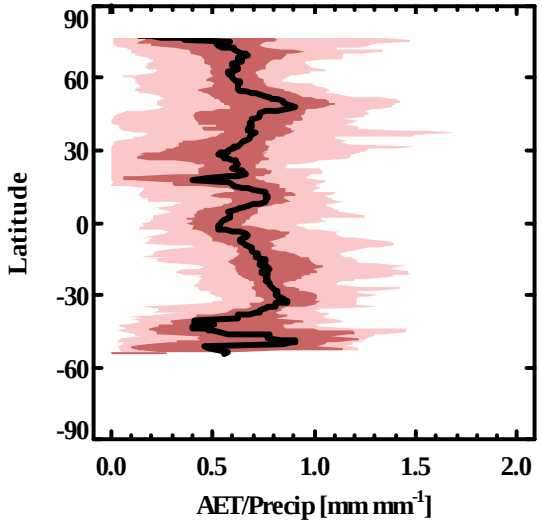


Radiation-use efficiency

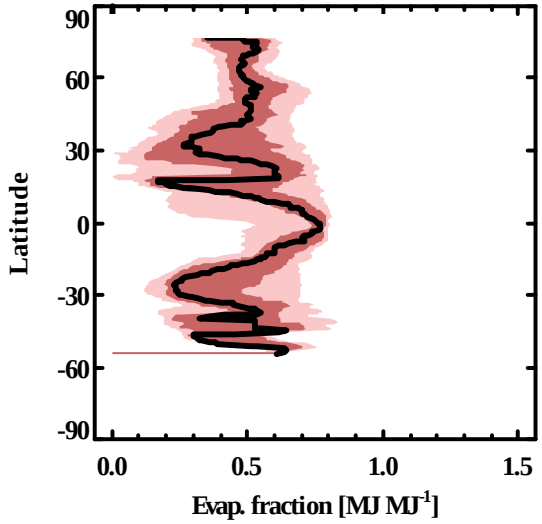




AET/PET



AET/Precip

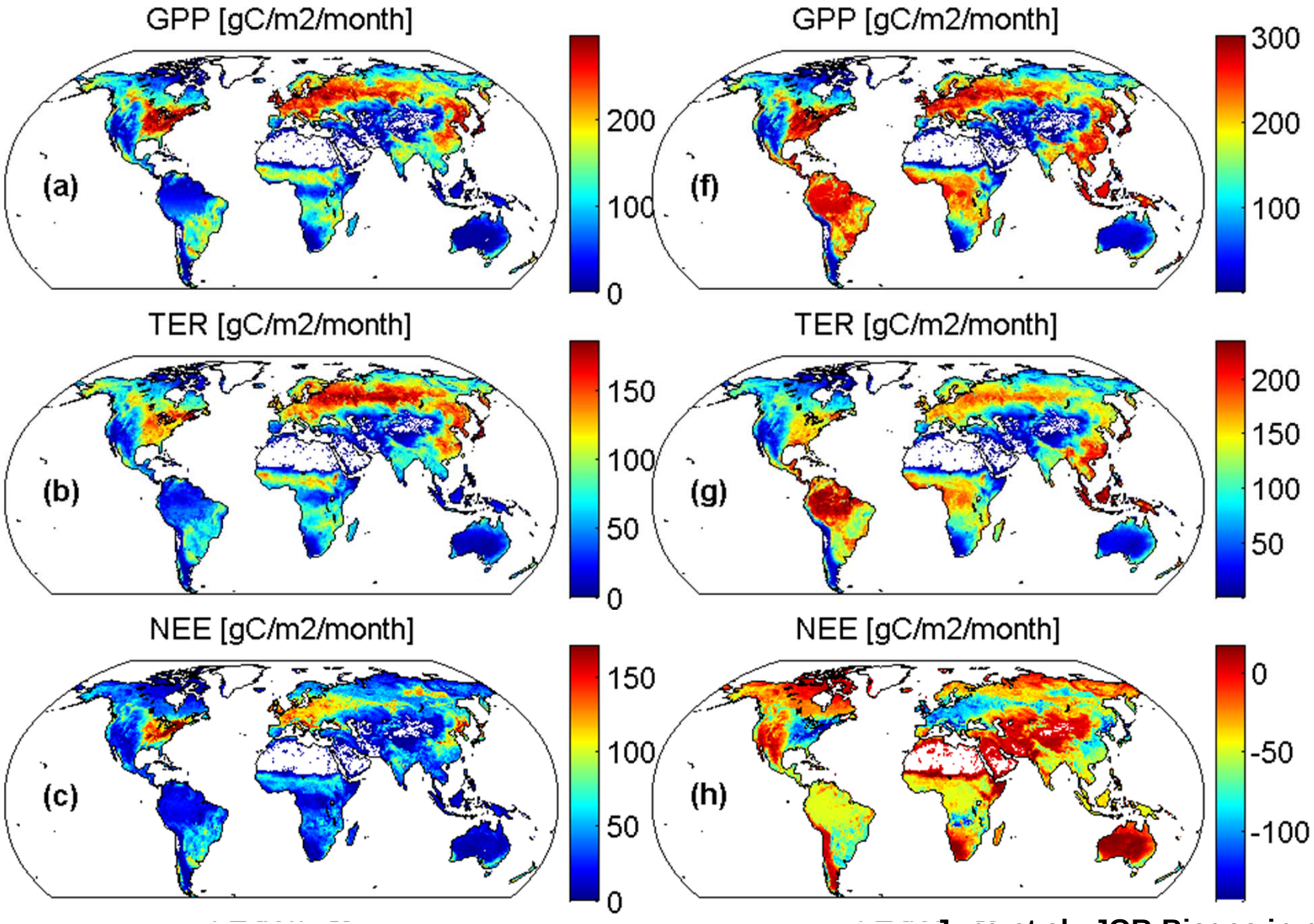


Evaporative fraction

Seasonal patterns

Amplitude of mean seasonal cycle

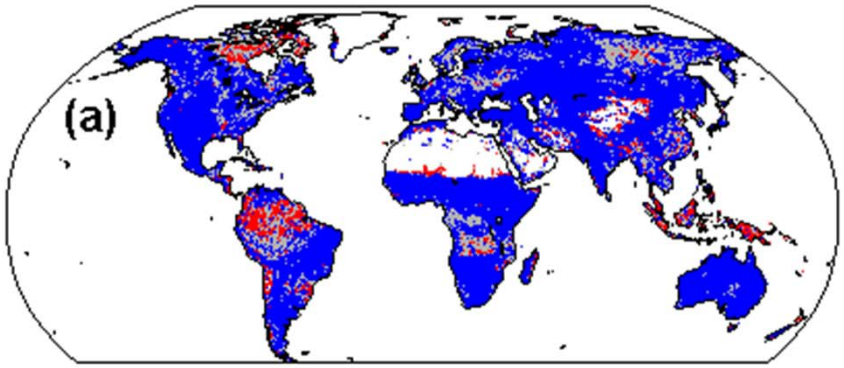
Max of mean seasonal cycle



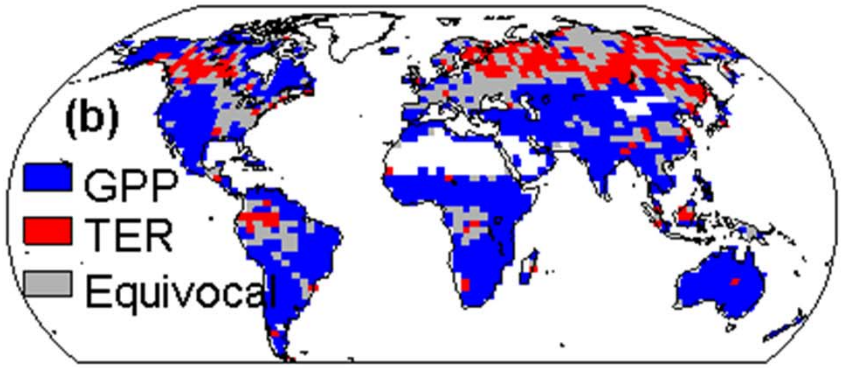
Jung et al., JGR-Biogeo in press

NEE interannual variability driven by GPP or TER? Correlative patterns

MTE



DGVM from Sitch et al. (2008)



Jung et al., JGR-Biogeo in review

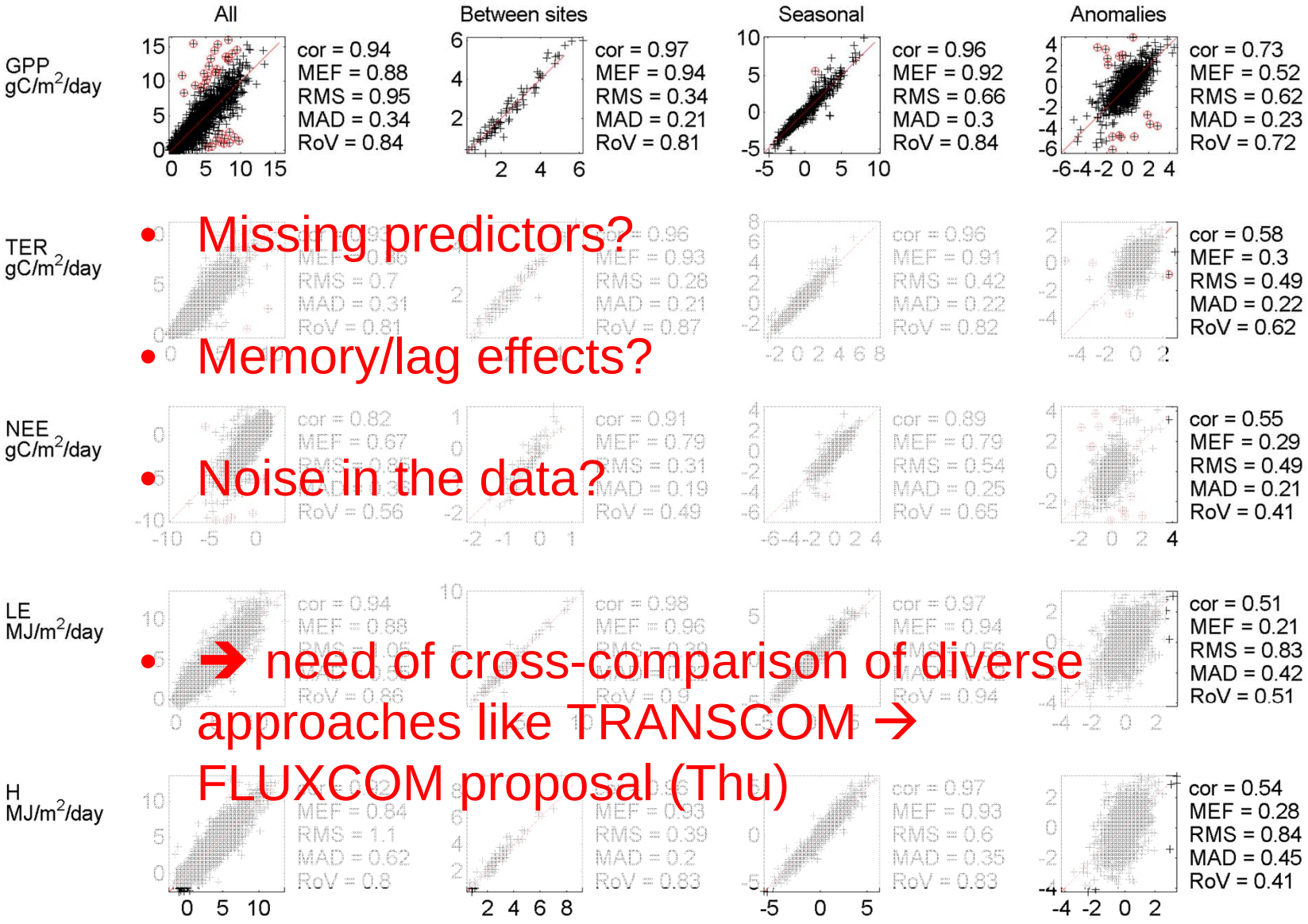
Now the ChOPs*…

* ChOP = Challenge and opportunity

ChOP* I: Interannual variability and lag effects

* ChOP = Challenge and opportunity

Cross-validation across time-scales shows: room for improvement



- Missing predictors?
- Memory/lag effects?
- Noise in the data?
- → need of cross-comparison of diverse approaches like TRANSCOM → FLUXCOM proposal (Thu)

ChOP* II: Local heterogeneity – matching pixel and footprint

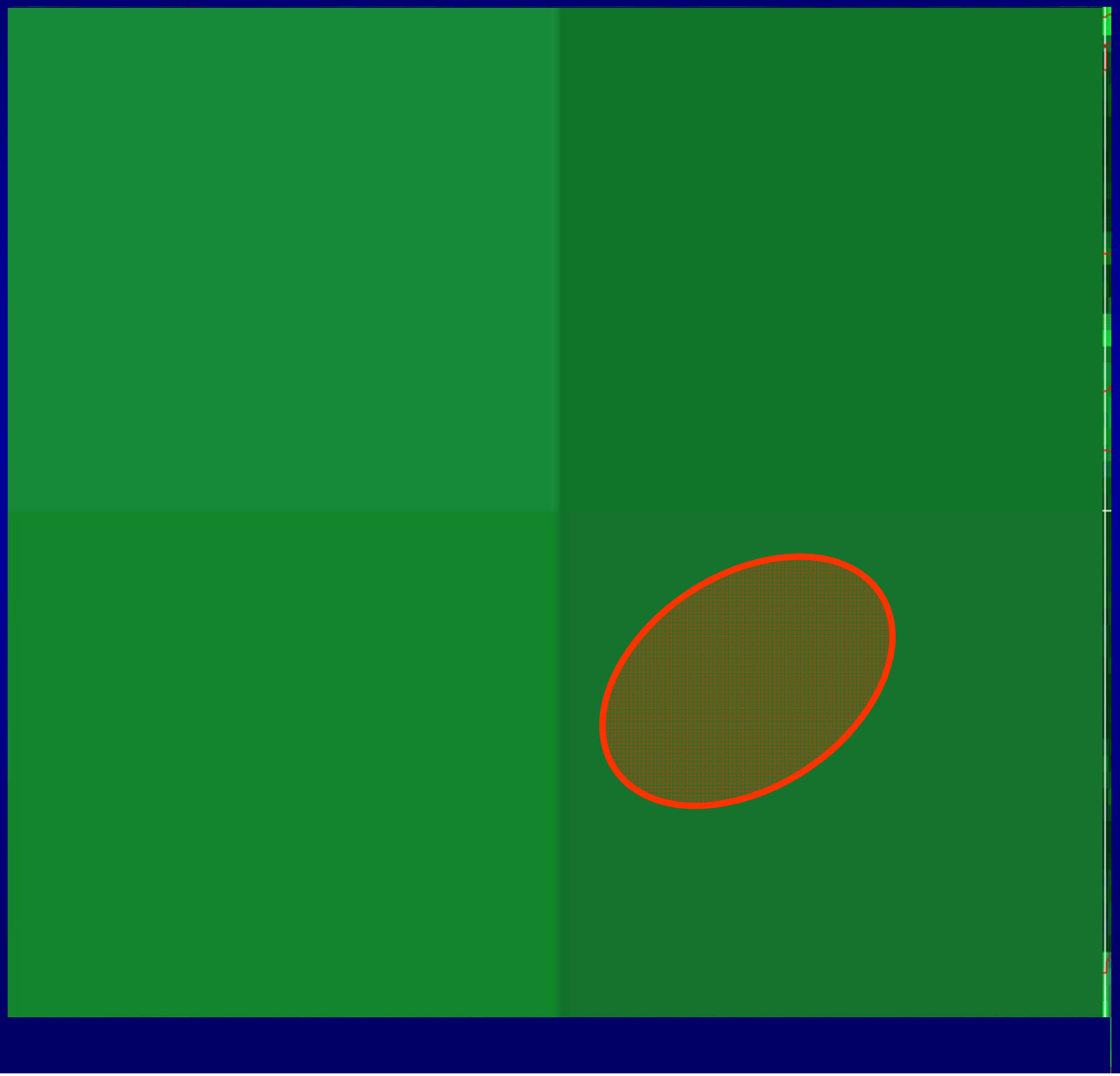
* ChOP = Challenge and opportunity

Spatial heterogeneity...

Aerial photo

Landsat

MODIS



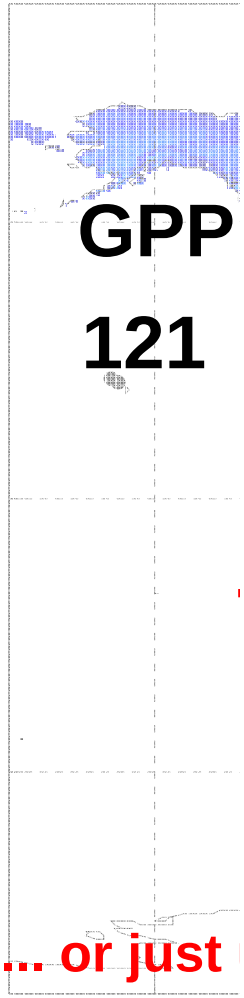
Integration of footprint and high-res remote sensing analysis !

Chen et al. (2010) Ag For Met

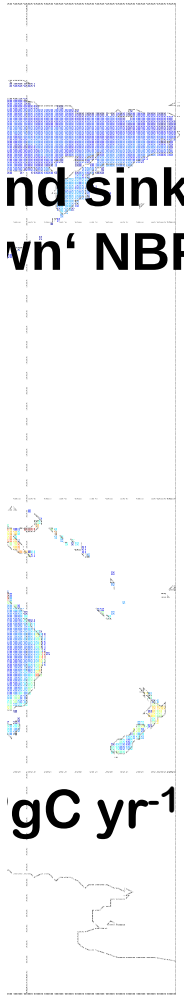
ChOP* III: Closing the global balance

* ChOP = Challenge and opportunity

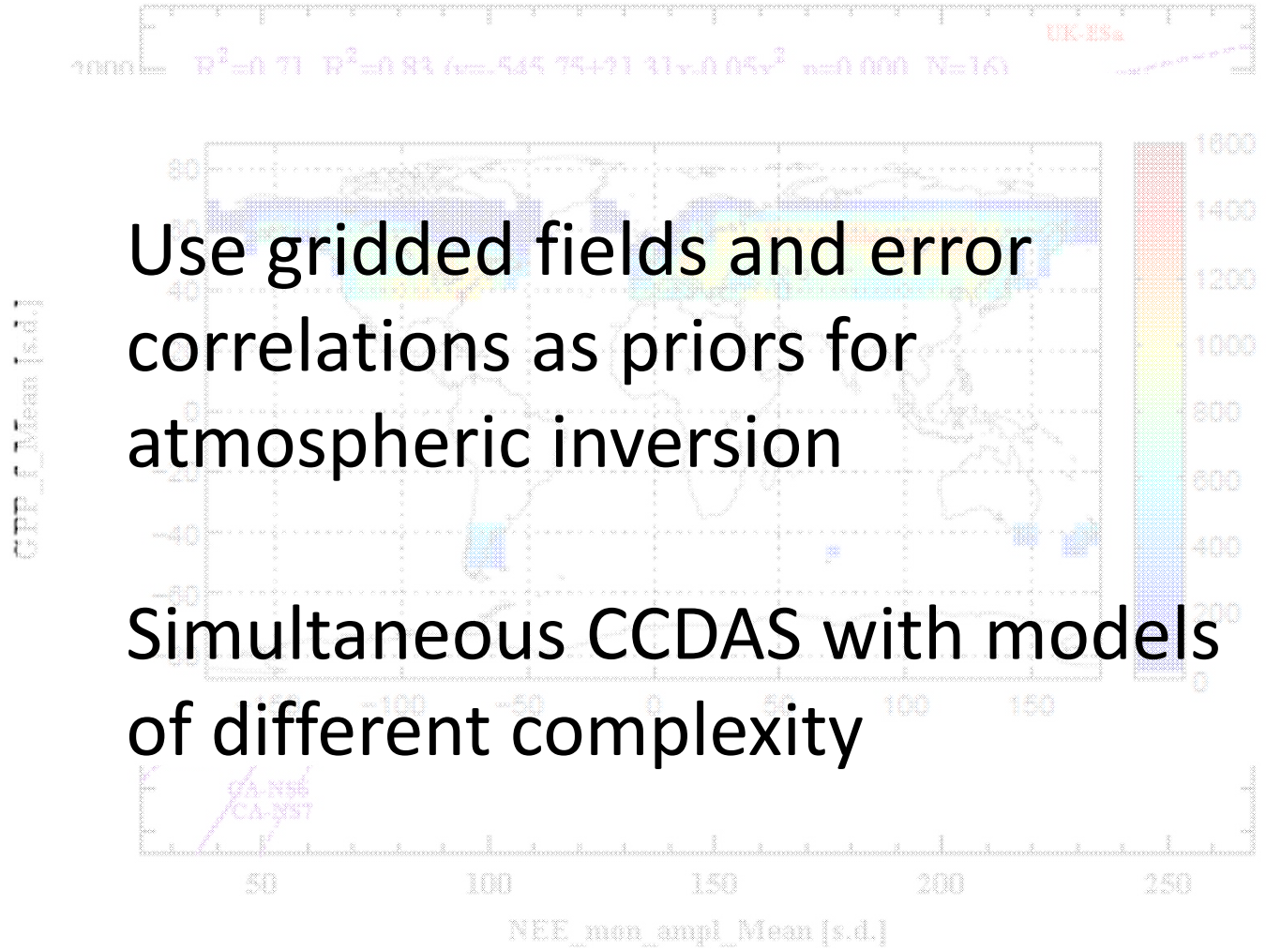
Challenge: closing the global balance



1. What can we do now given the available data?
2. What can we design in the future?



ChOP* IV: Synergy with atmospheric constraints



Use gridded fields and error correlations as priors for atmospheric inversion

Simultaneous CCDAS with models of different complexity

The four ChOPs

1. Tackling **interannual variability and NEE** incl. lag effects ("**right predictors**")
2. Addressing **local heterogeneity** (or even make use of it)
3. Closing the **global balance (NBP incl. disturb)**
4. Integration with **atmospheric observations**

FLUXNET

Thanks for the collaboration !

www.fluxdata.org www.fluxnet.ornl.gov