FLUXNET 2017 Workshop
Berkeley, June 2017

FLUXCOM –
from FLUXNET to a global flux picture

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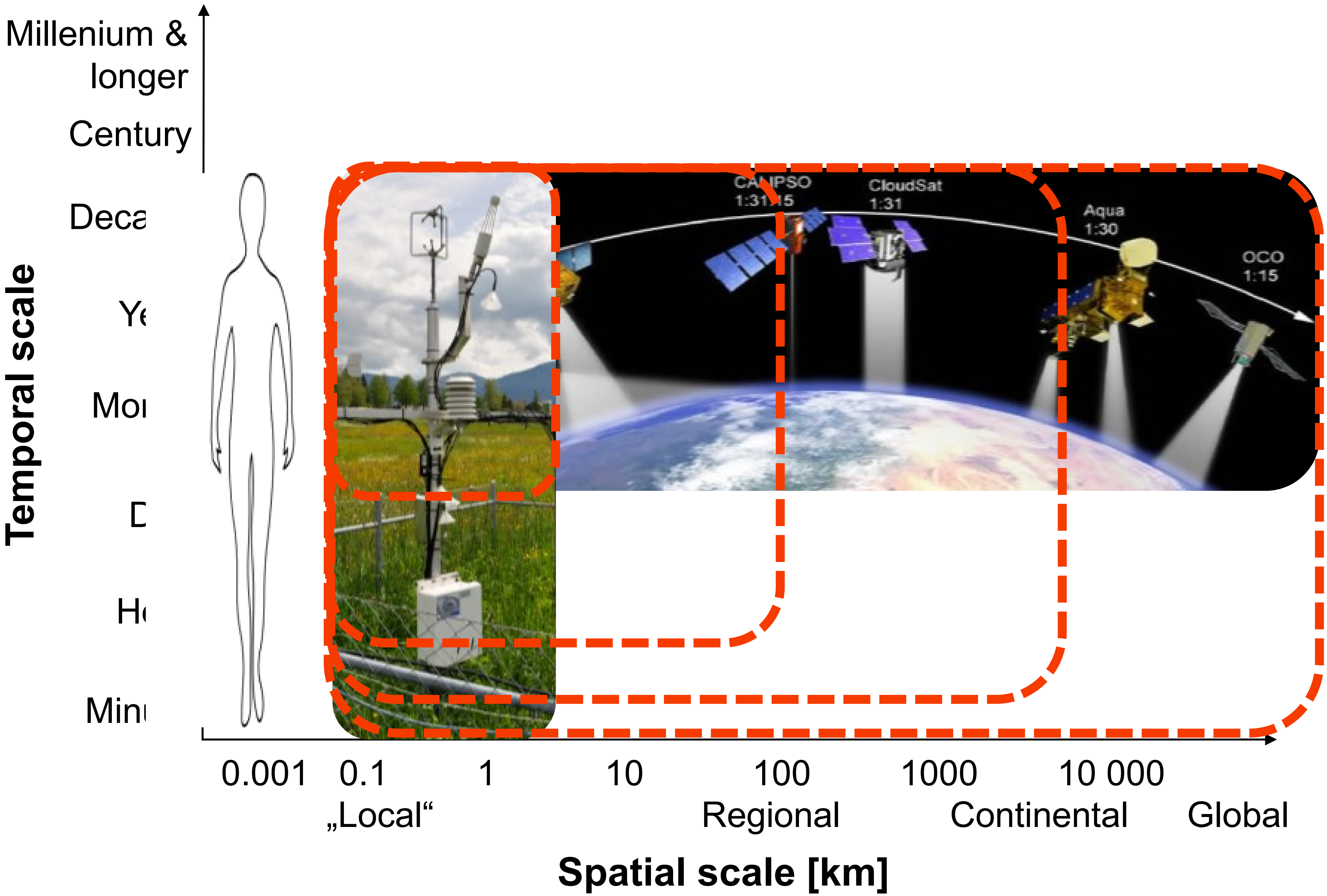
FLUXCOM team

FluxCom

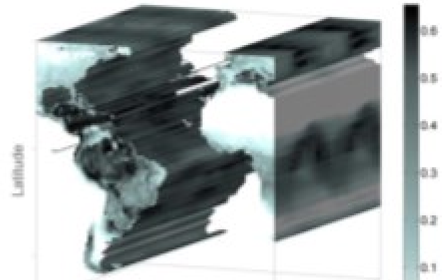
MPI-BGC
Jena


FLUXNET
A Global Network

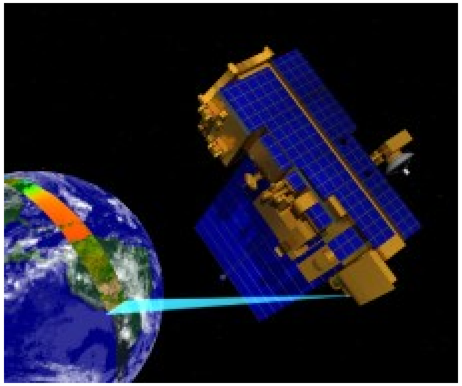
Scaling from flux-towers to globe



Empirical upscaling methodology

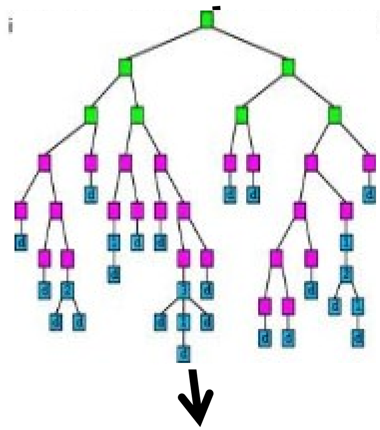


The same gridded explanatory variables



Site-level explanatory variables
- Meteorology
- Vegetation type
- Remote sensing indices

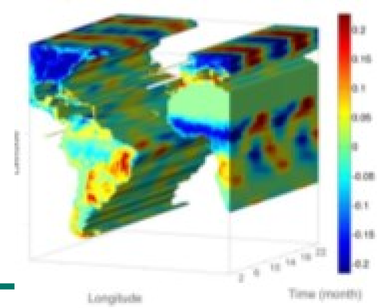
Training



Training

Target variable
ecosystem-atmosphere flux

Gridded target variable

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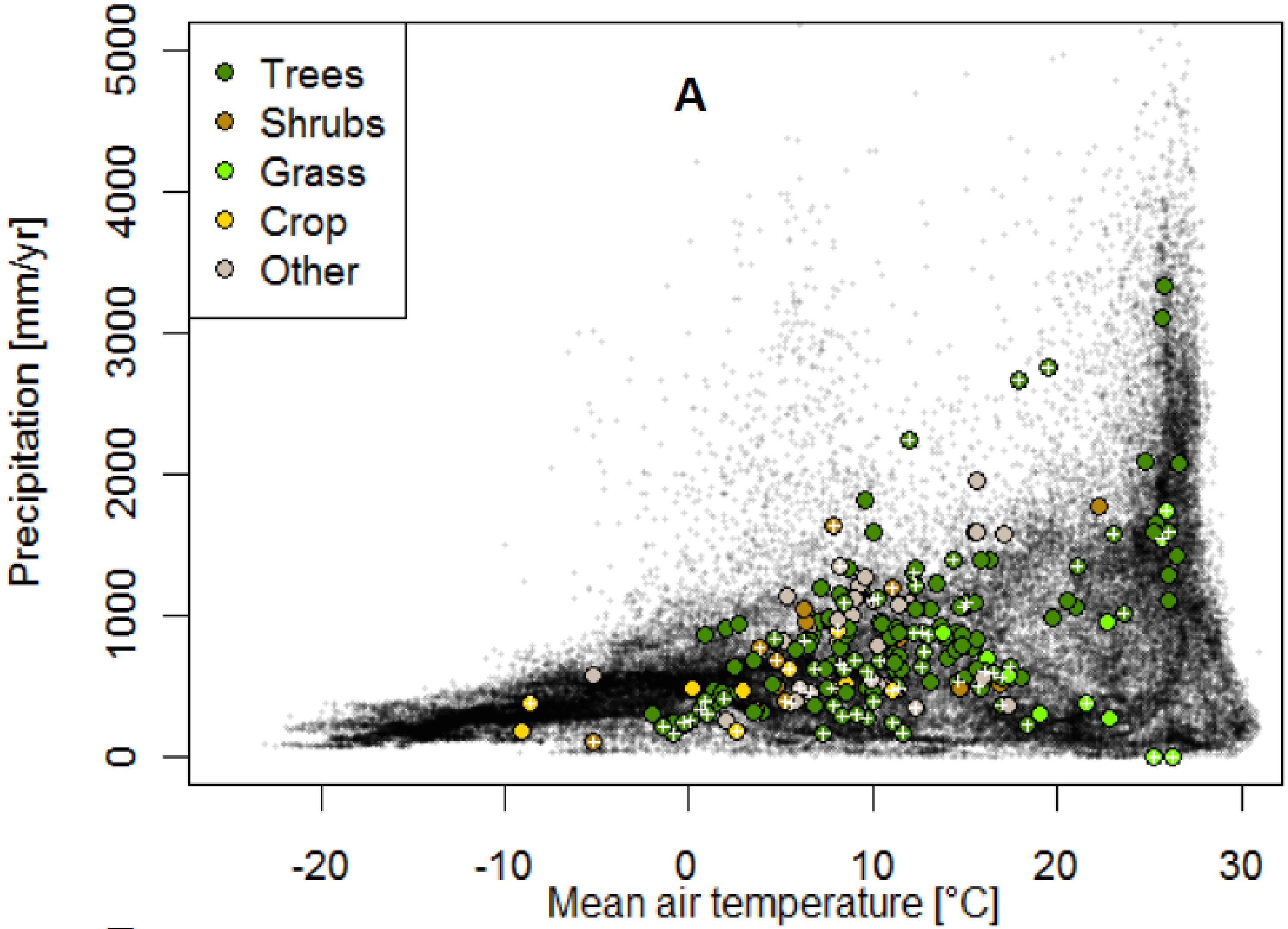
Representativeness in climate space



Reichstein et al. (2014), PNAS

After 1st promising results: global effort

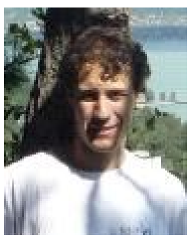
D. Papale

M. Reichstein

M. Jung

K. Ichii

G. Camps-Valls



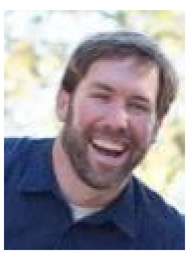
G. Tramontana

ML

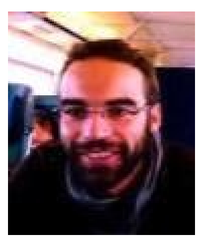
FluxCom

C. Schwalm

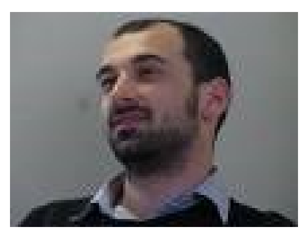
MDF



T. Hilton



N. Carvalhais



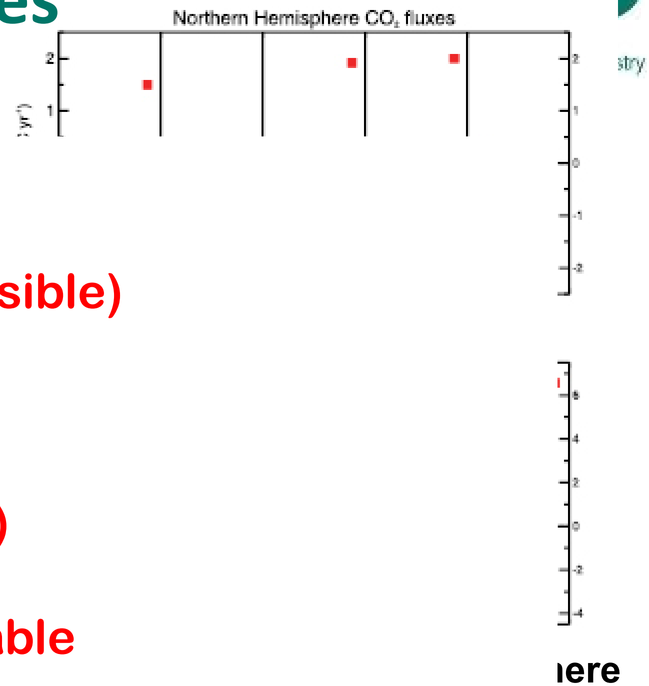
A. Bloom

T. Keenan

1st idea: RECCAP ws, Tuscia

Consolidation: Berkeley 2012 ws

Inferring fluxes: complementary strategies



<u>Key assets and challenges of bottom-up:</u>

+ Flux predicted from flux (➔ crossvalidation possible)

+ Spatially explicit at potentially high resolution

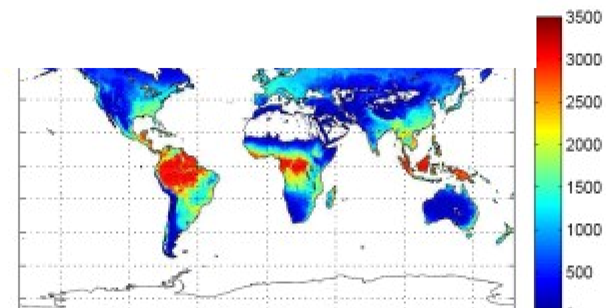
+ High-temporal resolution possible (incl. diurnal)

- Not all predictors needed for NEE readily available

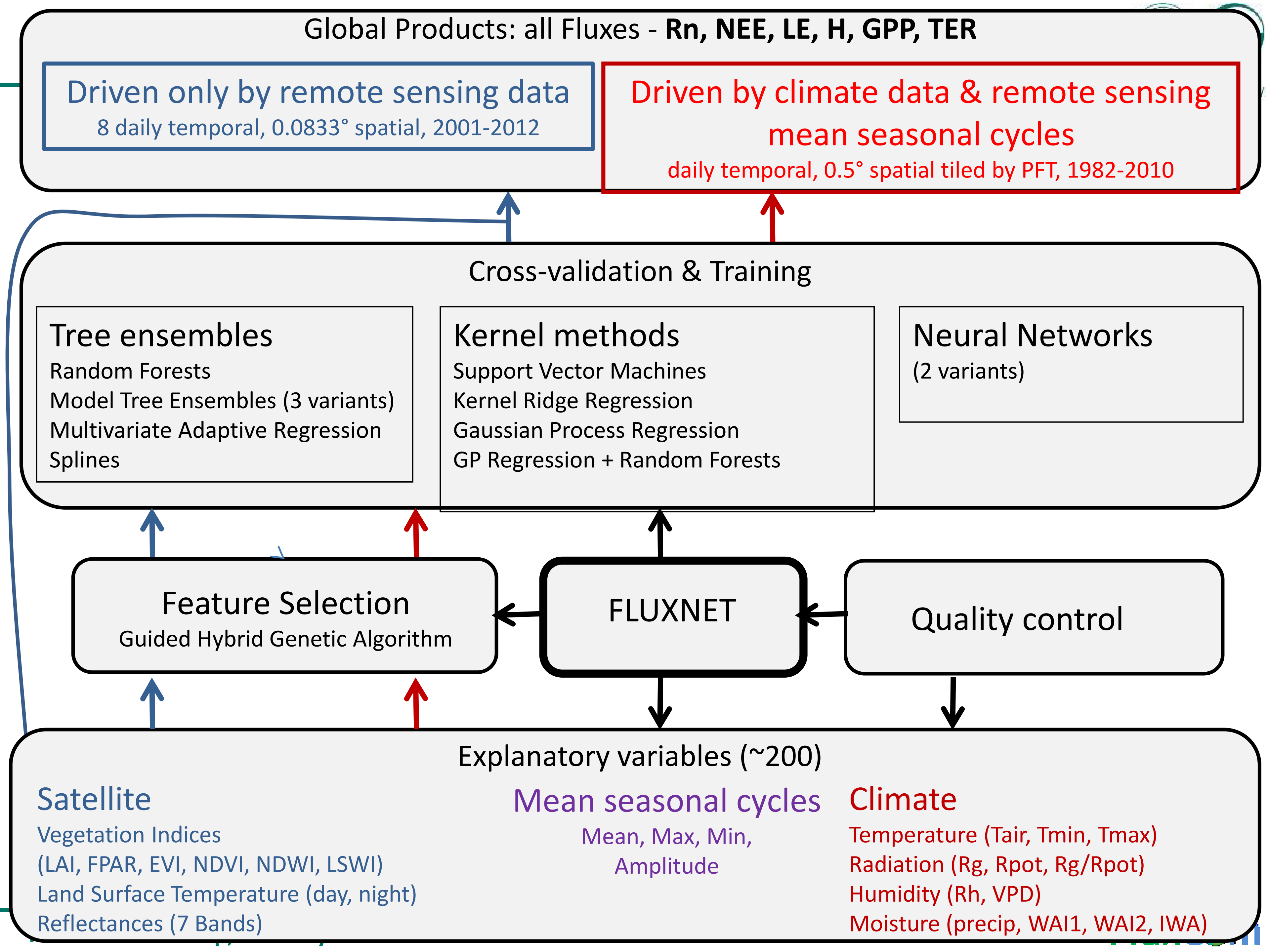
- No global constraint (➔ can be globally “off”)

Bio-Atm flux network

Remote sensing and meteo fields, „Biosphere“ modelling



Spatially explicit flux estimates



Global Products: all Fluxes - **Rn, NEE, LE, H, GPP, TER**
Driven only by remote sensing data
8 daily temporal, 0.0833° spatial, 2001-2012
Driven by climate data & remote sensing mean seasonal cycles
daily temporal, 0.5° spatial tiled by PFT, 1982-2010
Cross-validation & Training
Tree ensembles
Random Forests
Model Tree Ensembles (3 variants)
Multivariate Adaptive Regression Splines
Kernel methods
Support Vector Machines
Kernel Ridge Regression
Gaussian Process Regression
GP Regression + Random Forests
Neural Networks
(2 variants)
Feature Selection
Guided Hybrid Genetic Algorithm
FLUXNET
Quality control
Explanatory variables (~200)
Satellite
Vegetation Indices
(LAI, FPAR, EVI, NDVI, NDWI, LSWI)
Land Surface Temperature (day, night)
Reflectances (7 Bands)
Mean seasonal cycles
Mean, Max, Min, Amplitude
Climate
Temperature (Tair, Tmin, Tmax)
Radiation (Rg, Rpot, Rg/Rpot)
Humidity (Rh, VPD)
Moisture (precip, WAI1, WAI2, IWA)

Cross-validation (leave-one-site-out)

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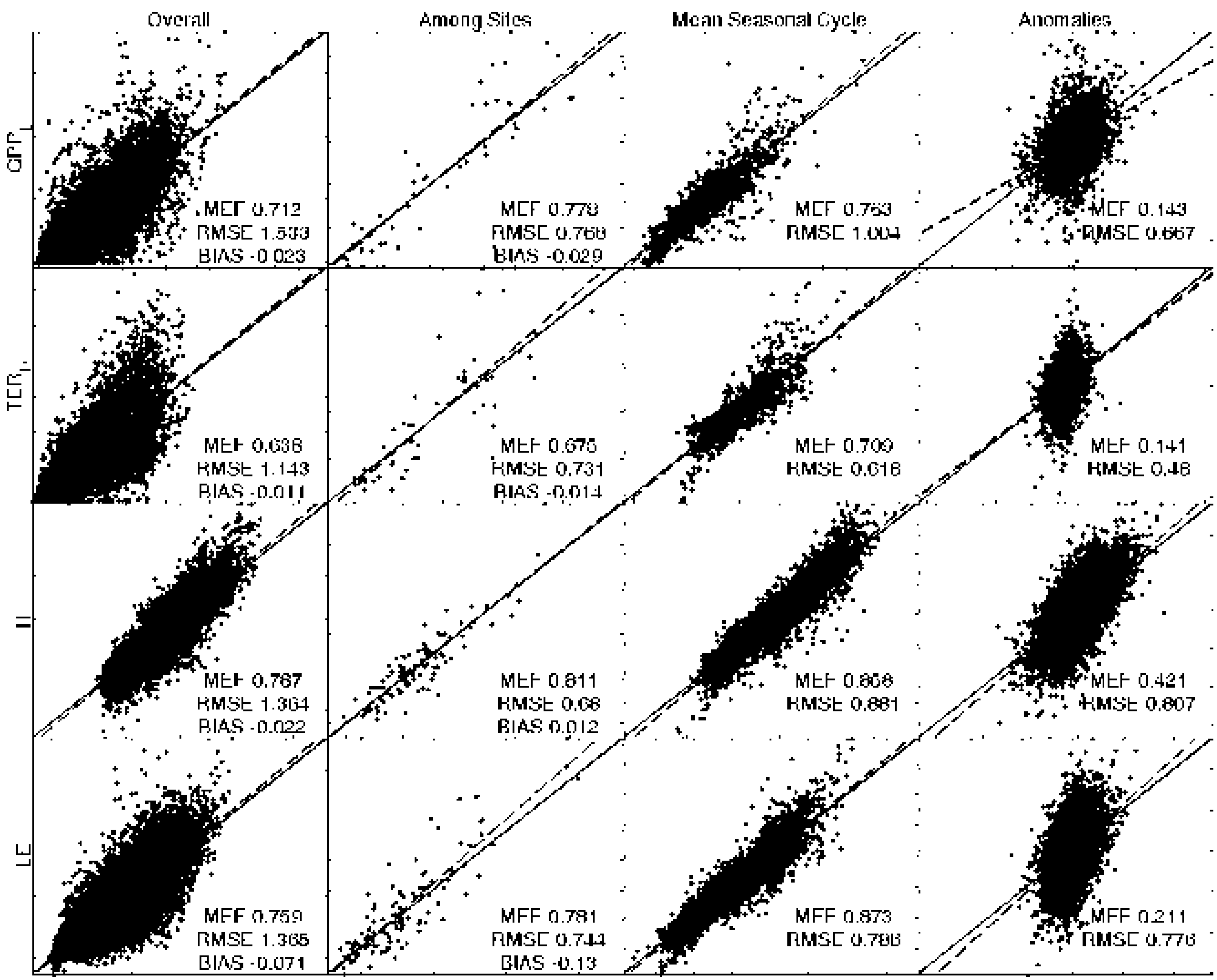
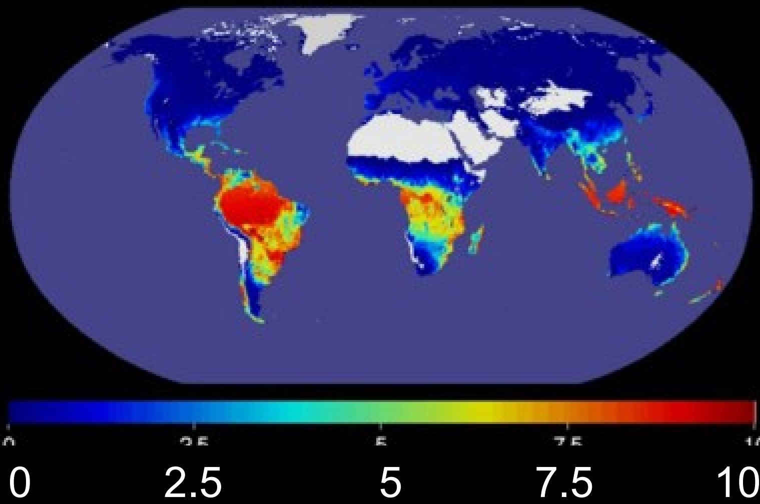


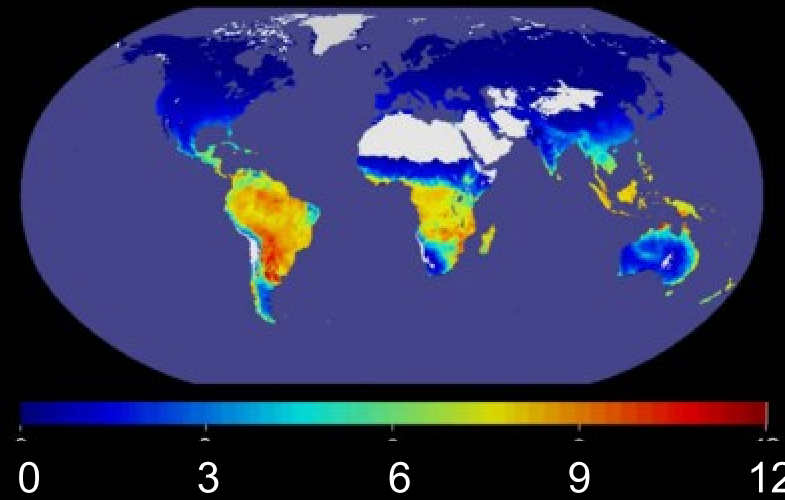
Tramontana et al. (2016), BG

Data-driven view on dynamic Biosphere-Atmosphere Exchange

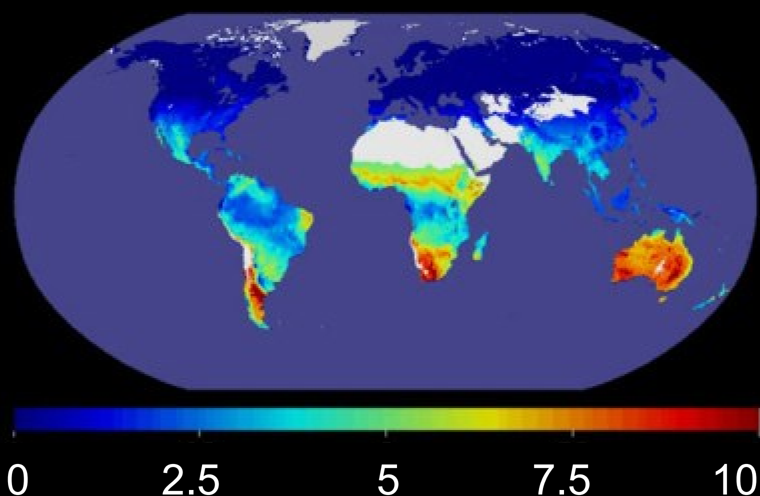
Primary production (GPP) [g m^{-2} day^{-1}]



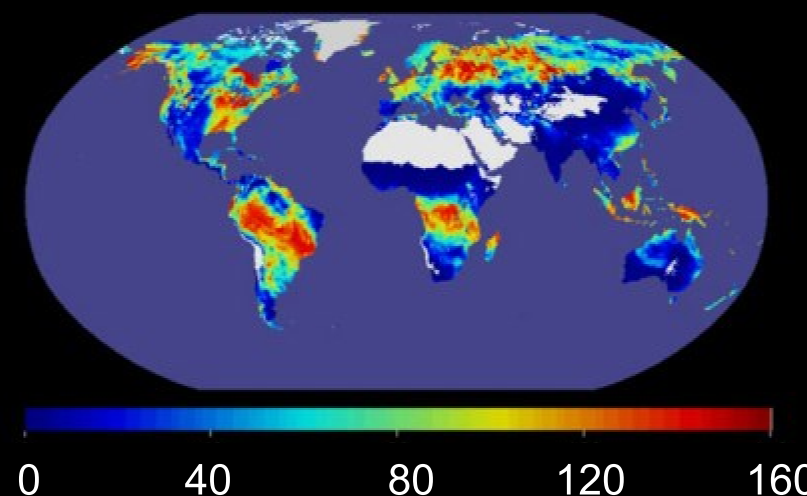
Evapotranspiration [MJ m^{-2} day^{-1}]



Sensible heat flux [MJ m^{-2} day^{-1}]



Soil water availability [index]



Data: Jung et al. (2011). Animations: F. Gans, MPI-BGC

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for Biogeochemistry

How to evaluate?
How to analyse?

Different answers for carbon fluxes
and energy fluxes

Seasonal cycle of NEE against inversion and model

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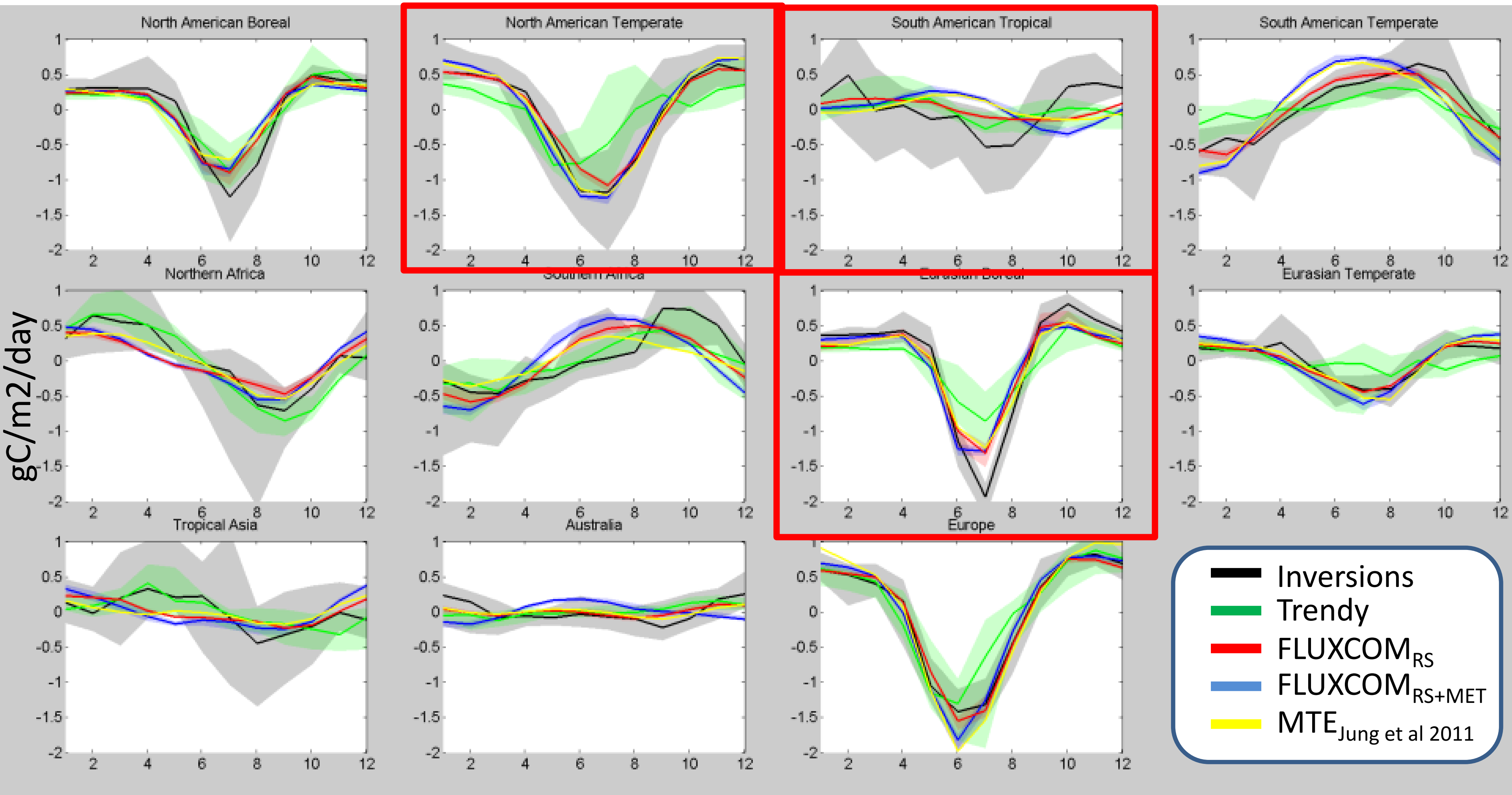
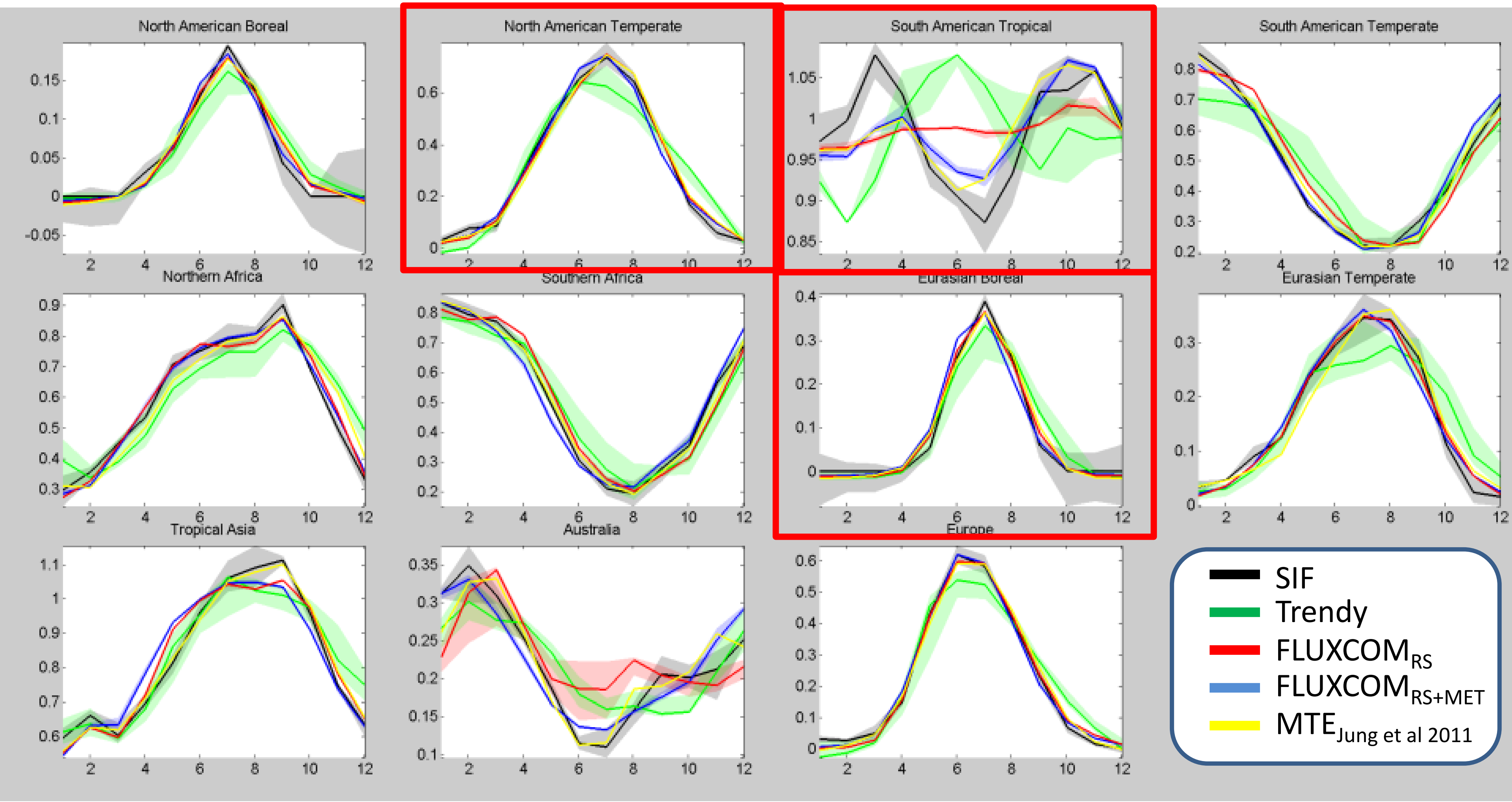
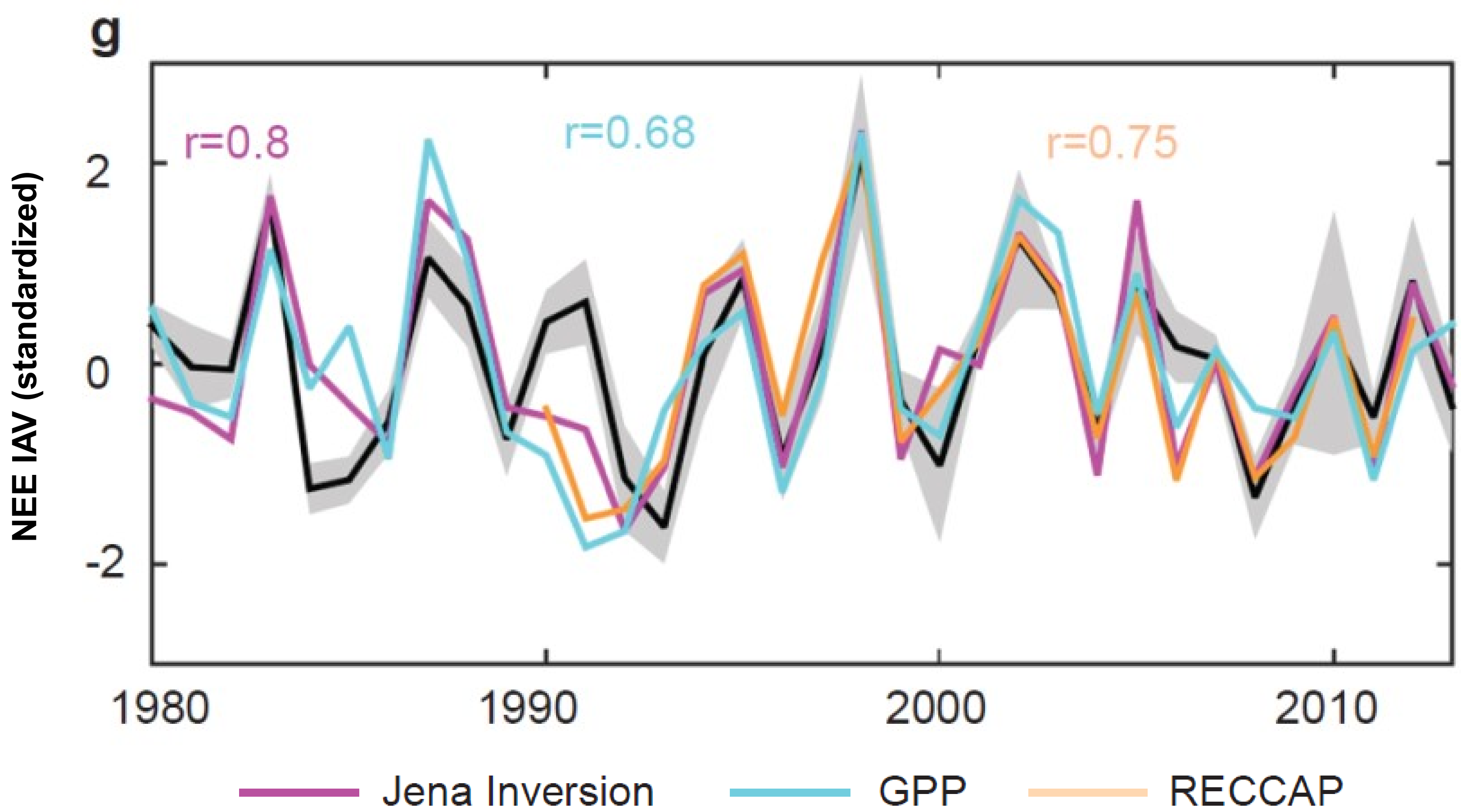
“NEE” (fire subtracted)



Comparison with sun induced fluorescence seasonal cycle (2009-2010)



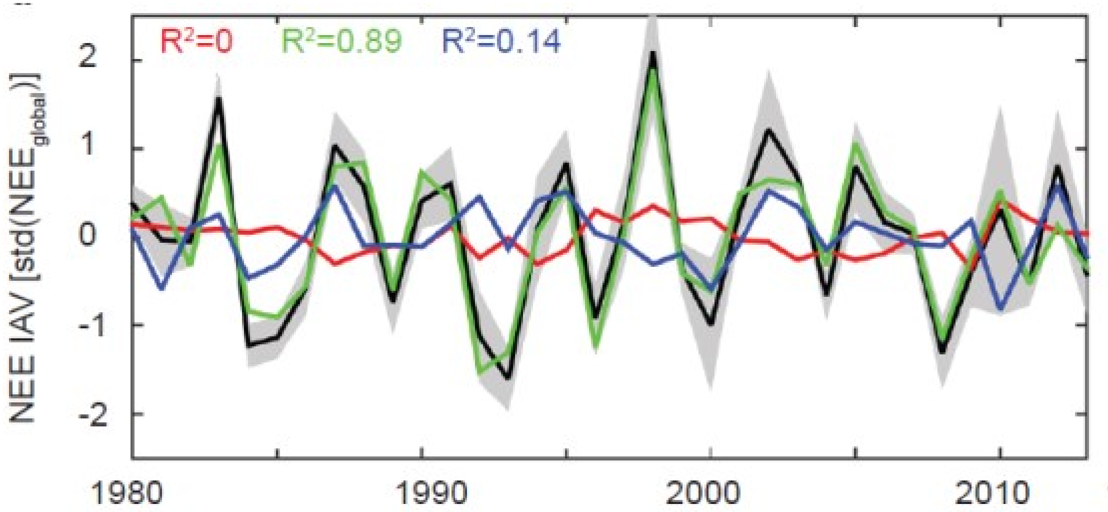
FLUXCOM and atmospheric inversion-based NEE variability correlate well



…as good as state-of-the-art ensemble of vegetation models ("Trendy")
[but magnitude does not match well!]

Jung et al. (2017), Nature

Global signal related to temperature, local signal to water



„global“

Temperature driven
Water driven
Radiation driven
Total signal

Global C-Cycle-temperature relation demystified

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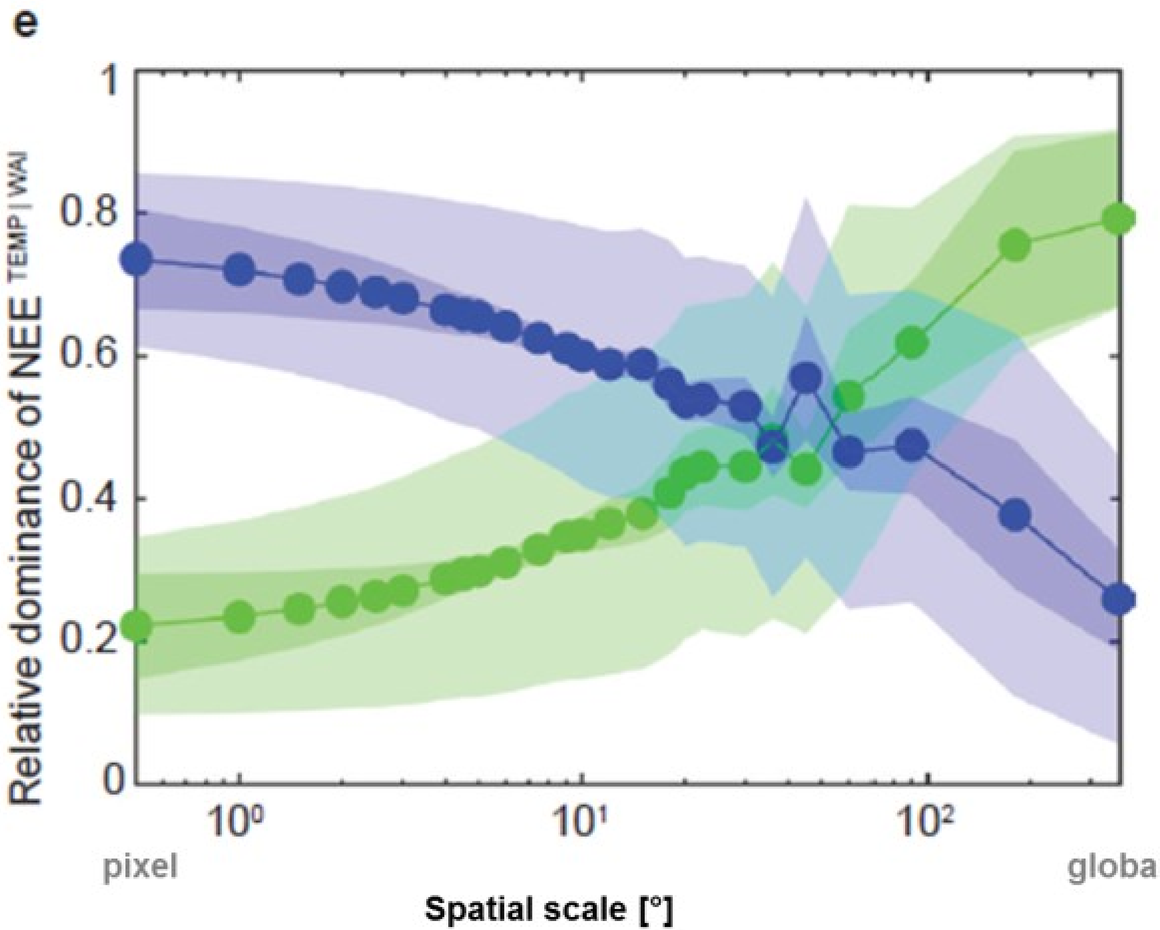


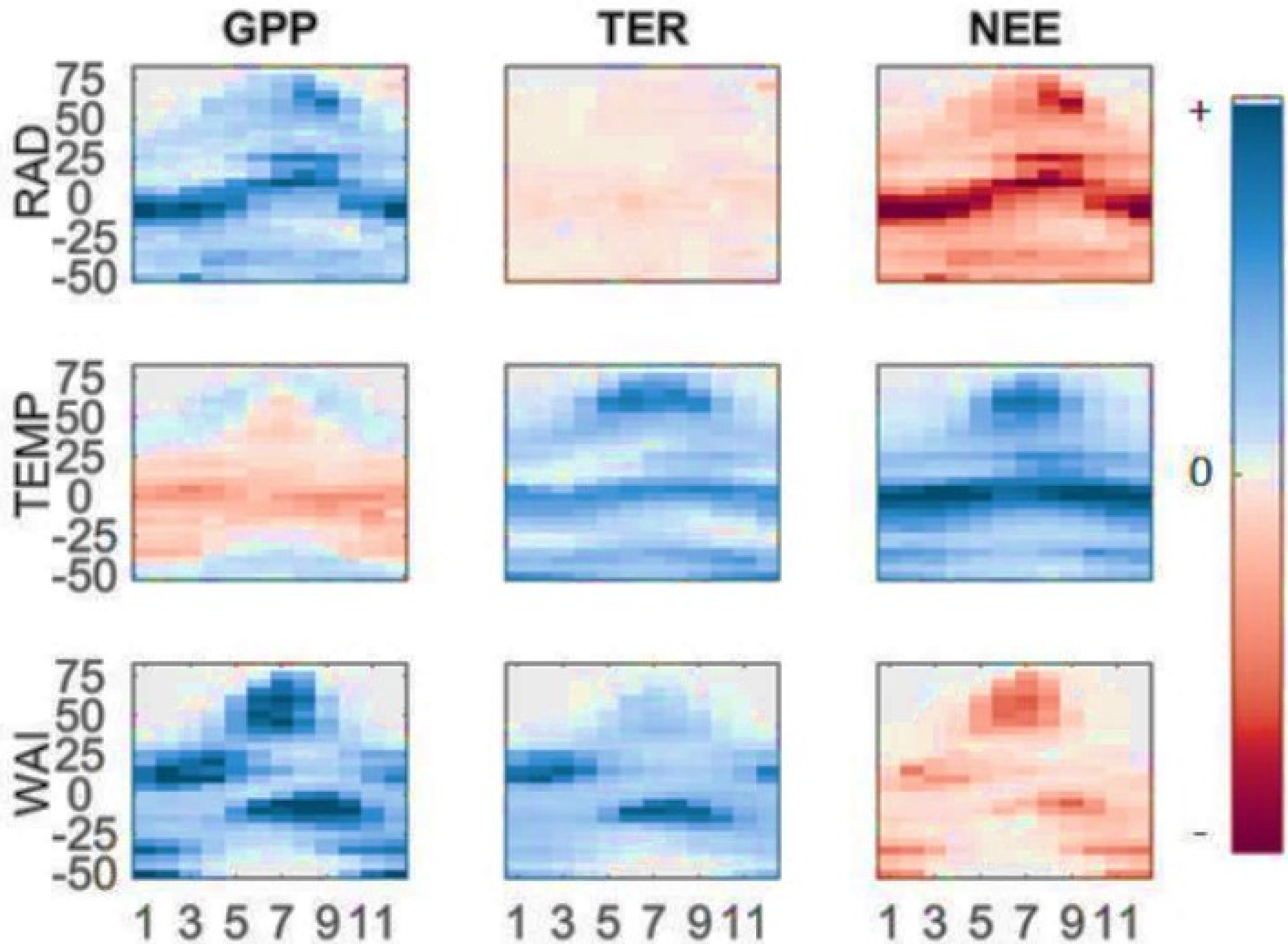
ature
NEE
ient

water
NEE
ient

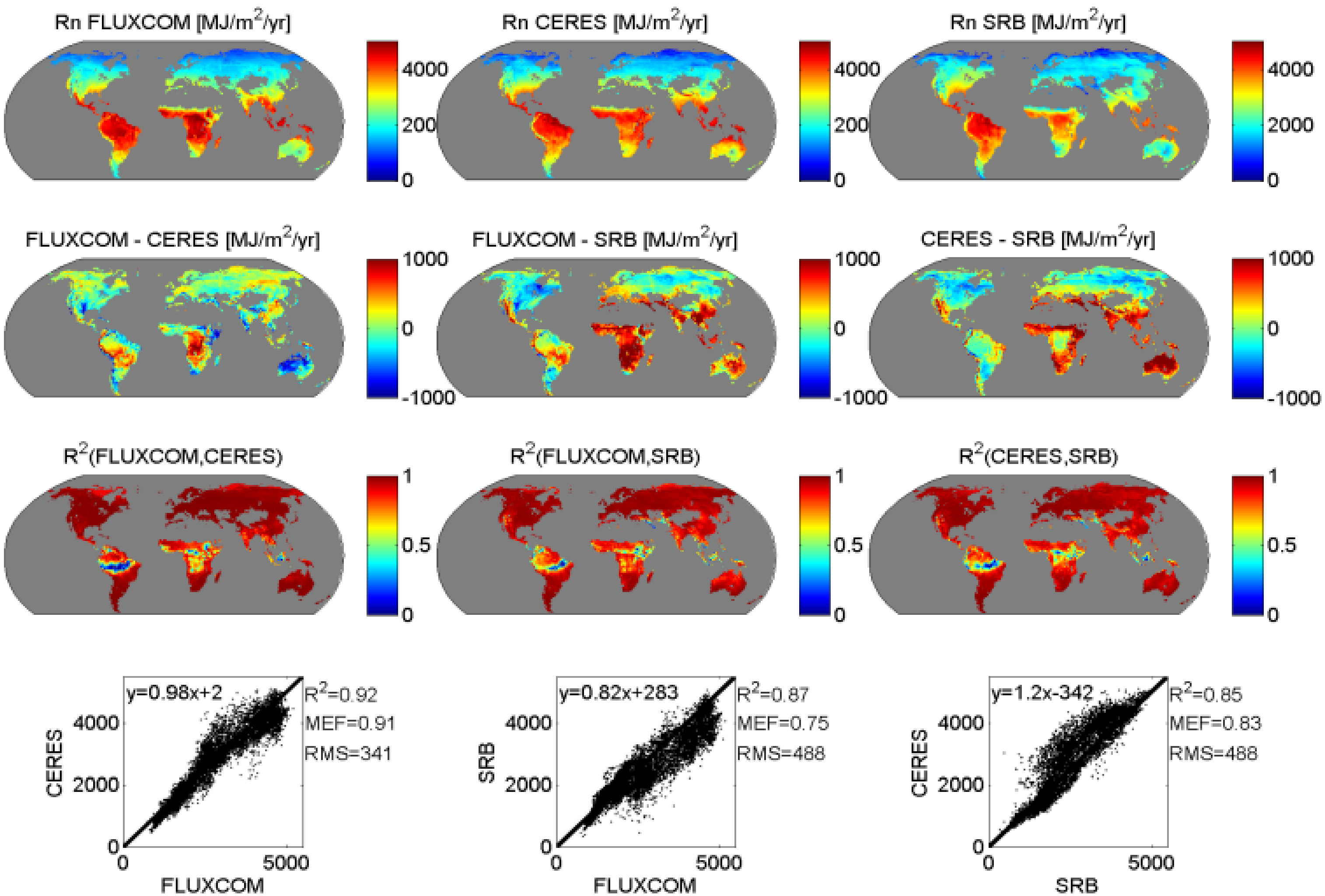
Jung et al. (2017)

Monthly-latitudinal sensitivities: water effects on GPP and TER compensate

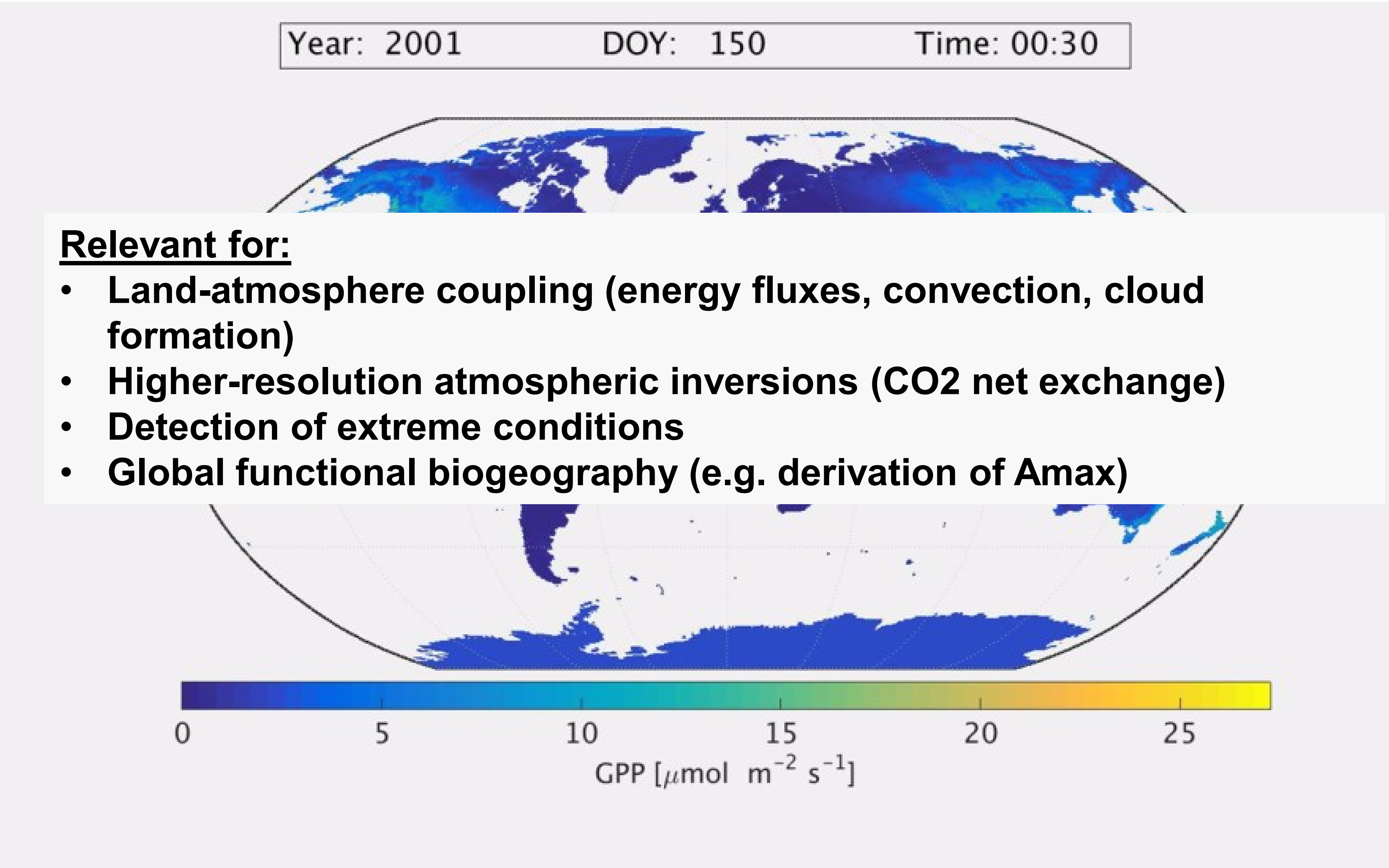
Based on: $\delta Flux = a_{Temp} * \delta Temp + a_{WAI} * \delta WAI + a_{RAD} * \delta Rad$**, for each month**



Evaluation of upscaled Rn



Half-hourly data-driven flux estimates



Relevant for:

- **Land-atmosphere coupling (energy fluxes, convection, cloud formation)**
- **Higher-resolution atmospheric inversions (CO2 net exchange)**
- **Detection of extreme conditions**
- **Global functional biogeography (e.g. derivation of Amax)**

Bodesheim, Jung, Mahecha et al.

Some of the next steps

- Tackling global NEP (Simon Besnard)
- Global partitioning of ET = T + E (Jacob Nelson)
- Incorporate dynamic effects (cf. my AGU talk)
- FLUXCOM-MDF (Nuno Carvalhais, Anthony Bloom)
- Incorporating CO_2 effect
- Updating:
  - using FLUXNET2015
  - Using MODIS Collection 6
- So many more things ….