

**What other observations are needed in addition to  $F_s$  for a robust GPP estimate?**

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Unpublished material removed. Pls write [luis.guanter@wew.fu-berlin.de](mailto:luis.guanter@wew.fu-berlin.de) to have it

## ■ EO Fs product (GOSAT-FTS & SCIA)

**755/865nm, ~monthly, ~100 km<sup>2</sup>, clear-sky, fixed overpass time...**

- Do the relationships between Fs and GPP at the leaf-level hold at the synoptic/monthly scale?
- What vegetation & meteorological parameters drive the Fs signal and its link to GPP at the spatial and temporal scales of the space-based Fs?

## ■ This talk:

- Potential issues for the exploitation of space-based Fs for GPP estimation
- Key parameters needed for either Fs analysis or Fs→GPP modeling

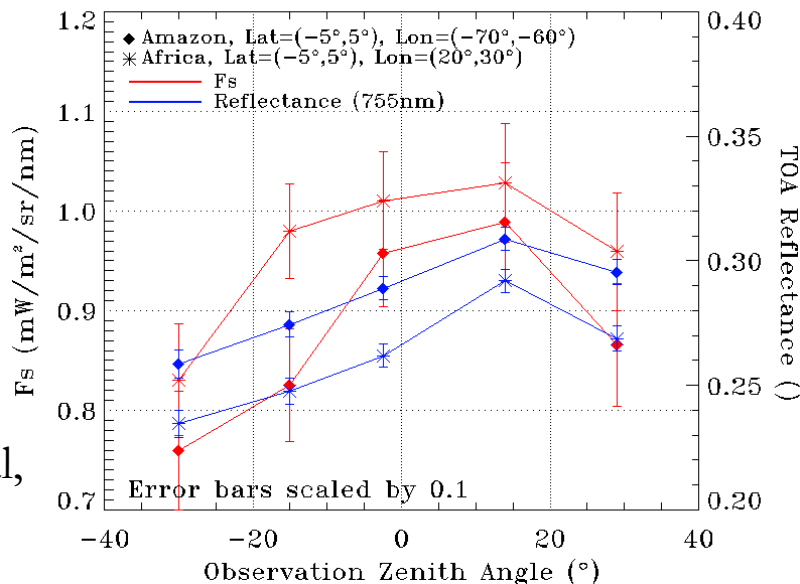
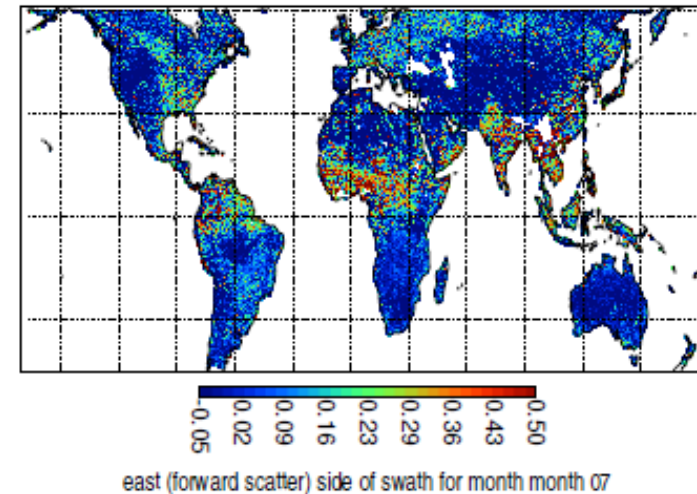
# Estimating GPP from Fs observations

## I. Understanding the space-based Fs signal

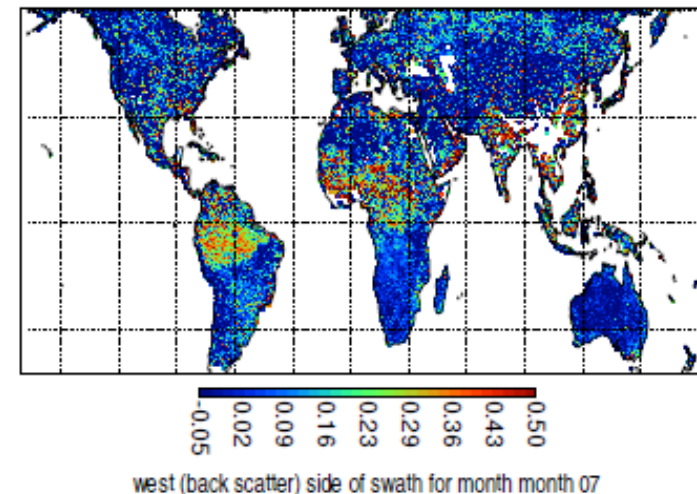
# GPP vs Fluorescence – I. Structural effects, from top-of-canopy to leaf level

## ■ Structure matters: directional effects observed in space-based Fs

- Do we need to model them to avoid noise in the Fs composites?
- If the top-of-canopy dominates the Fs signal, could this lead to a sampling error (illuminated leaves vs entire canopy)?



Guanter et al,  
RSE, 2012

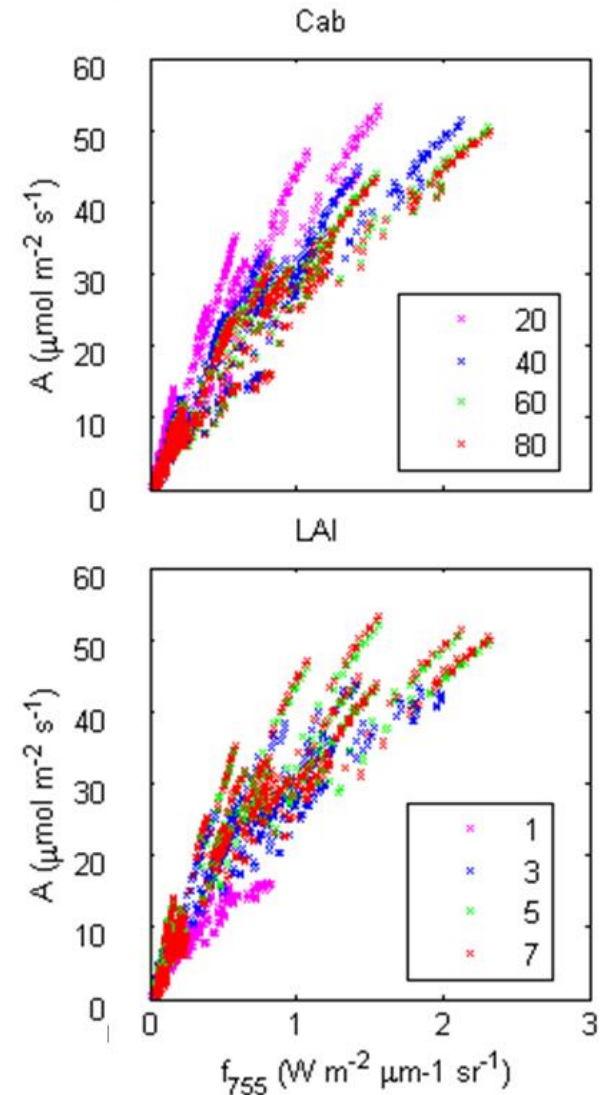


Joiner et al, AMT, 2012

## Structure matters:

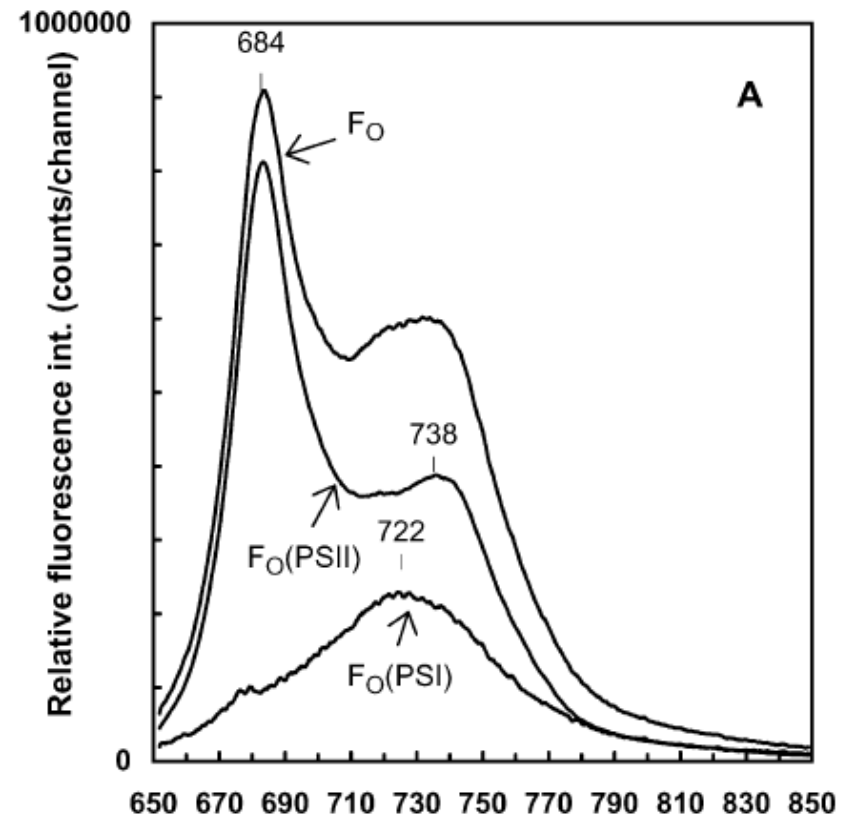
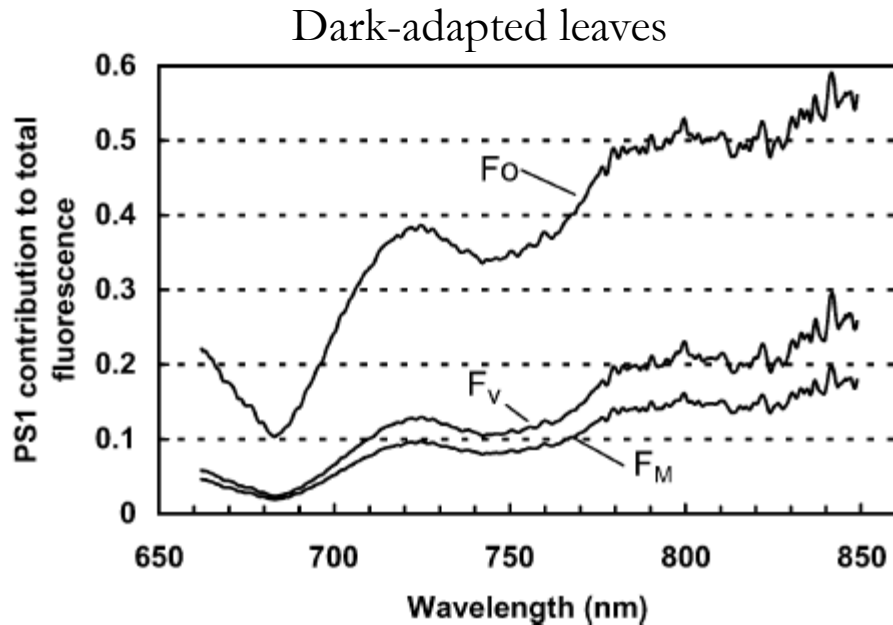
Emission, scattering and absorption processes coupled within the canopy

- Signal affected by reabsorption within the canopy.
- How to go from the top-of-canopy to the leaf level in complex canopies?
- Do we have a proxy to Cab on a global scale? Greenness indices?



Van der Tol et al.

- Fs from PS I: ~APAR (green), canopy chlorophyll content
  - Fs from PS II: ~LUE, sensitive to down-regulation
- ➔ From which photosystem comes our **GOSAT-FTS** Fs in 760 nm?



Frank et al., Biochim. Biophys. Acta (2002)

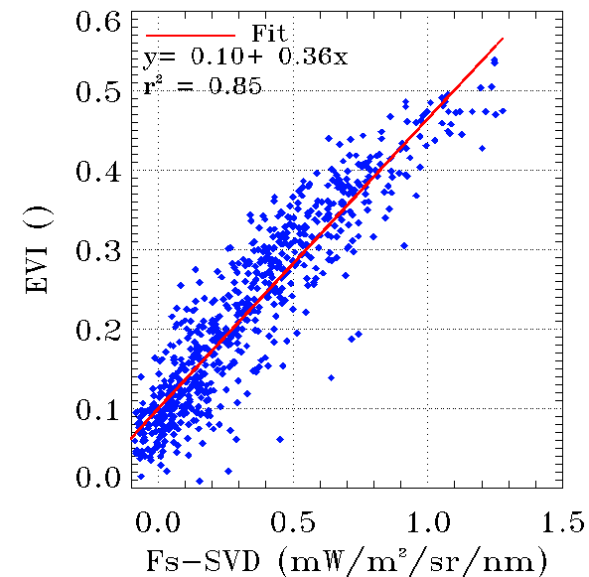
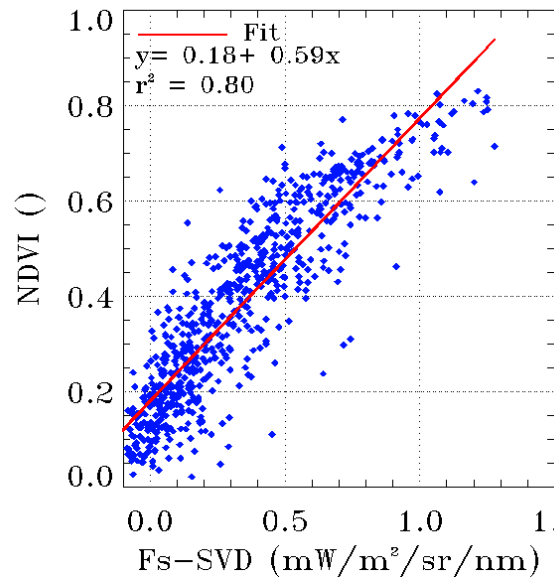
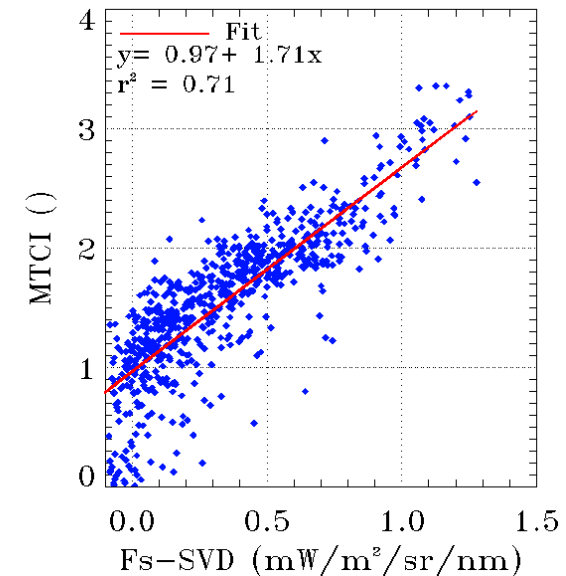
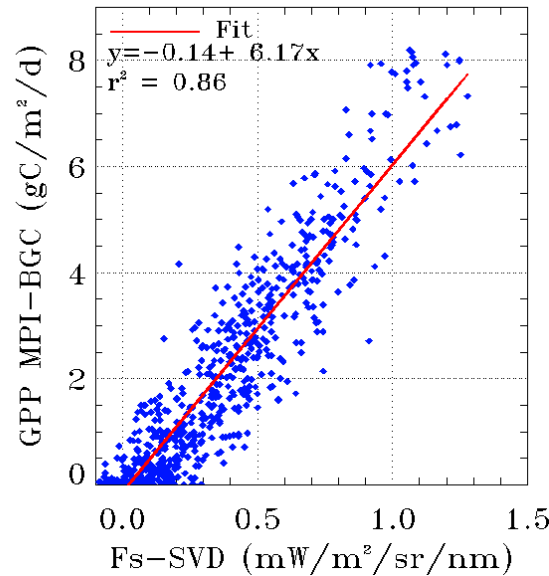
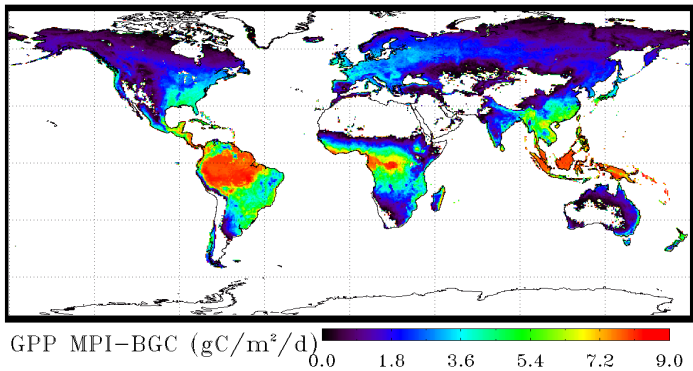
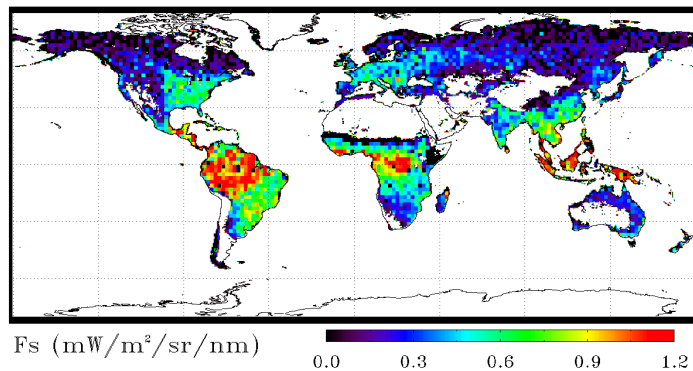
### Temporal sampling:

- Temporal sampling from GOSAT and SCIA:
  - One observation every x-days sampling several kms
  - At ~13:30 (GOSAT-FTS) or ~10:30 (SCIA)
  - Only for clear-skies
- Temporal sampling of Fs-based GPP products? Annual? Monthly?
- How to extrapolate these observations to a monthly GPP estimate?



# Some examples of global GPP-Fs comparisons

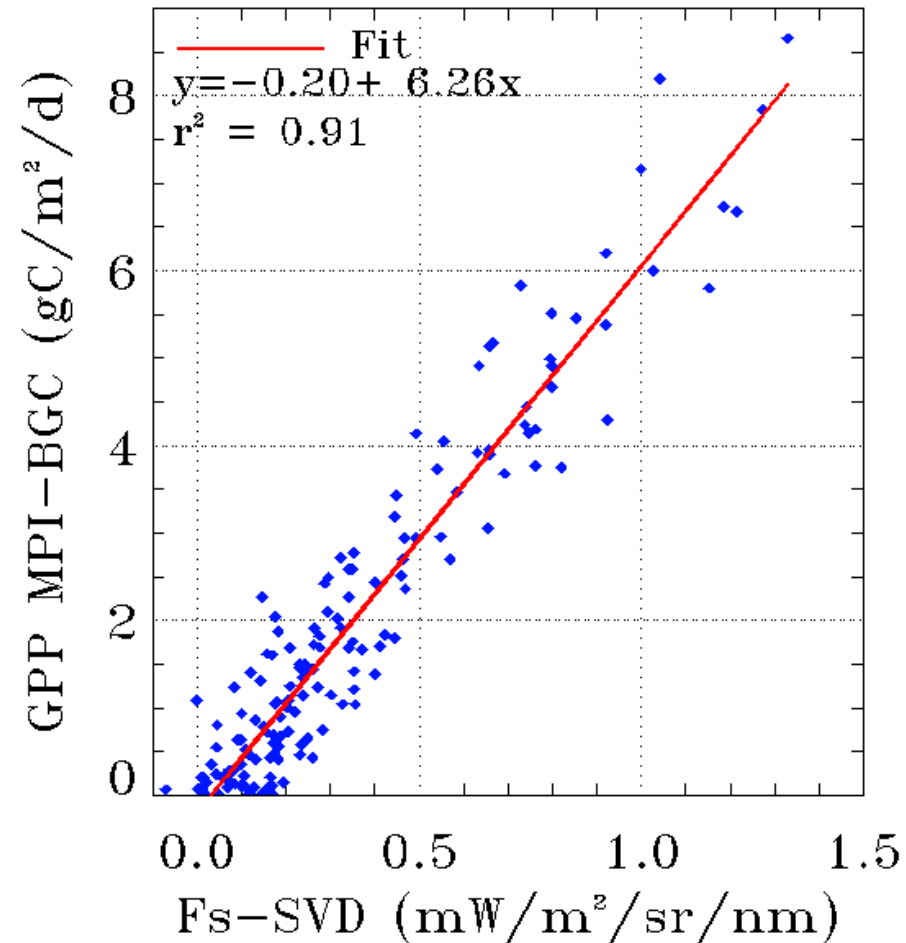
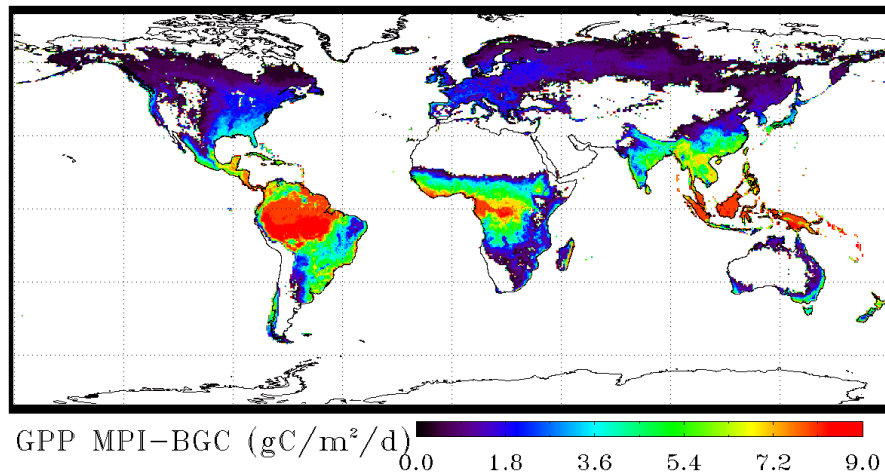
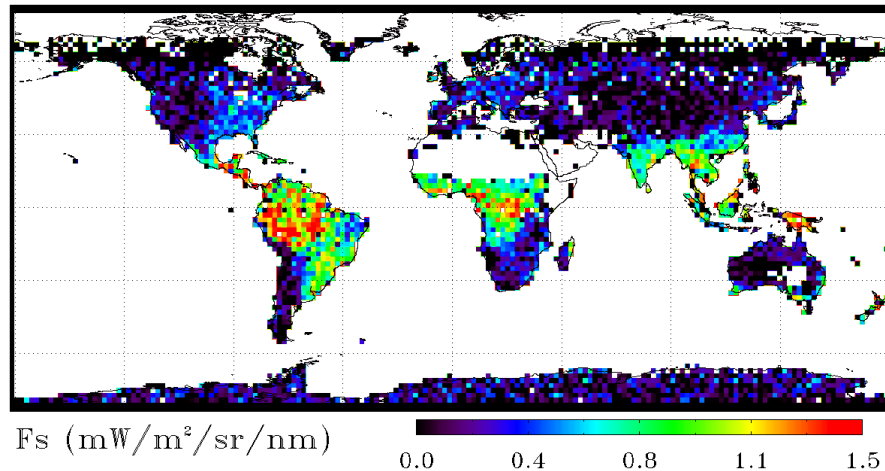
Annual Average  
Jun09-May10



Guanter et al, RSE, 2012

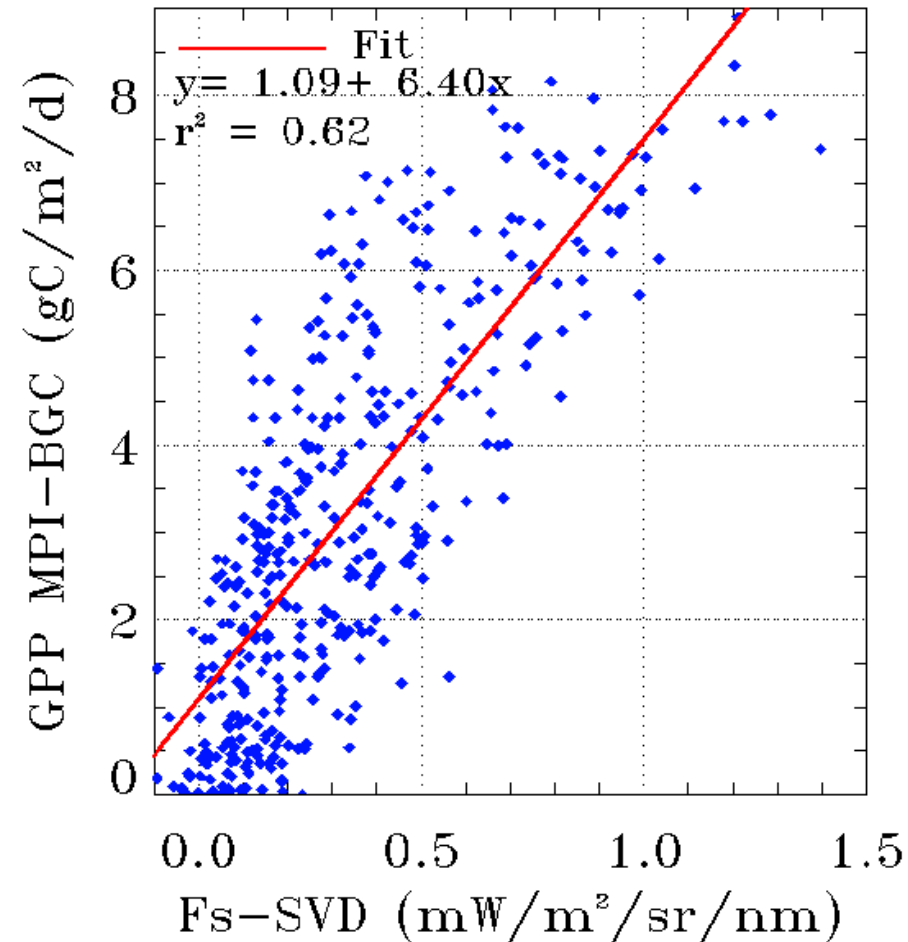
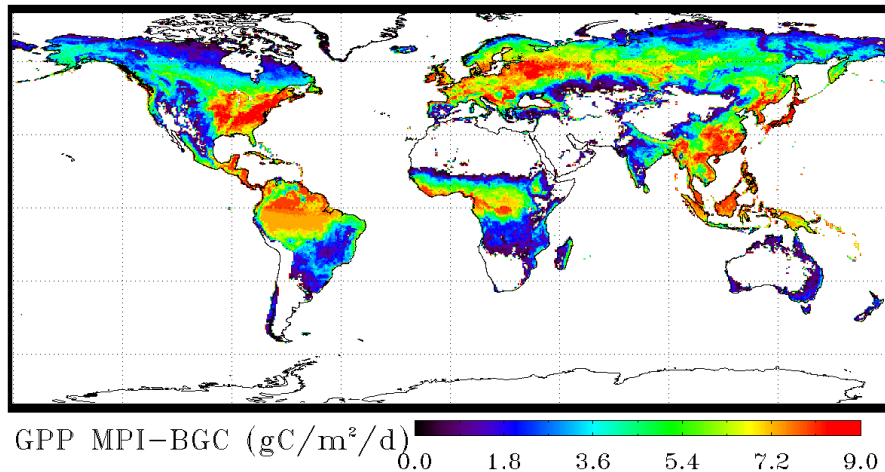
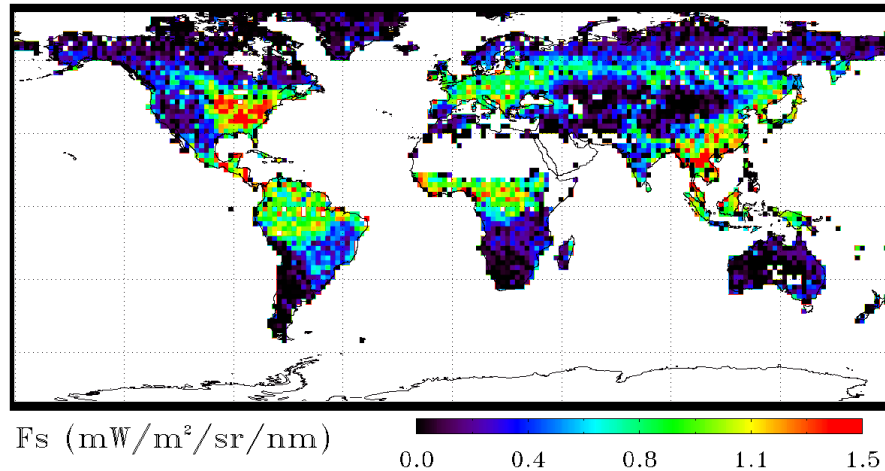


## September-October-November



# Some examples of global GPP-Fs comparisons

## June-July-August



# Some examples of global GPP-Fs comparisons

Fs-GPP per PFT

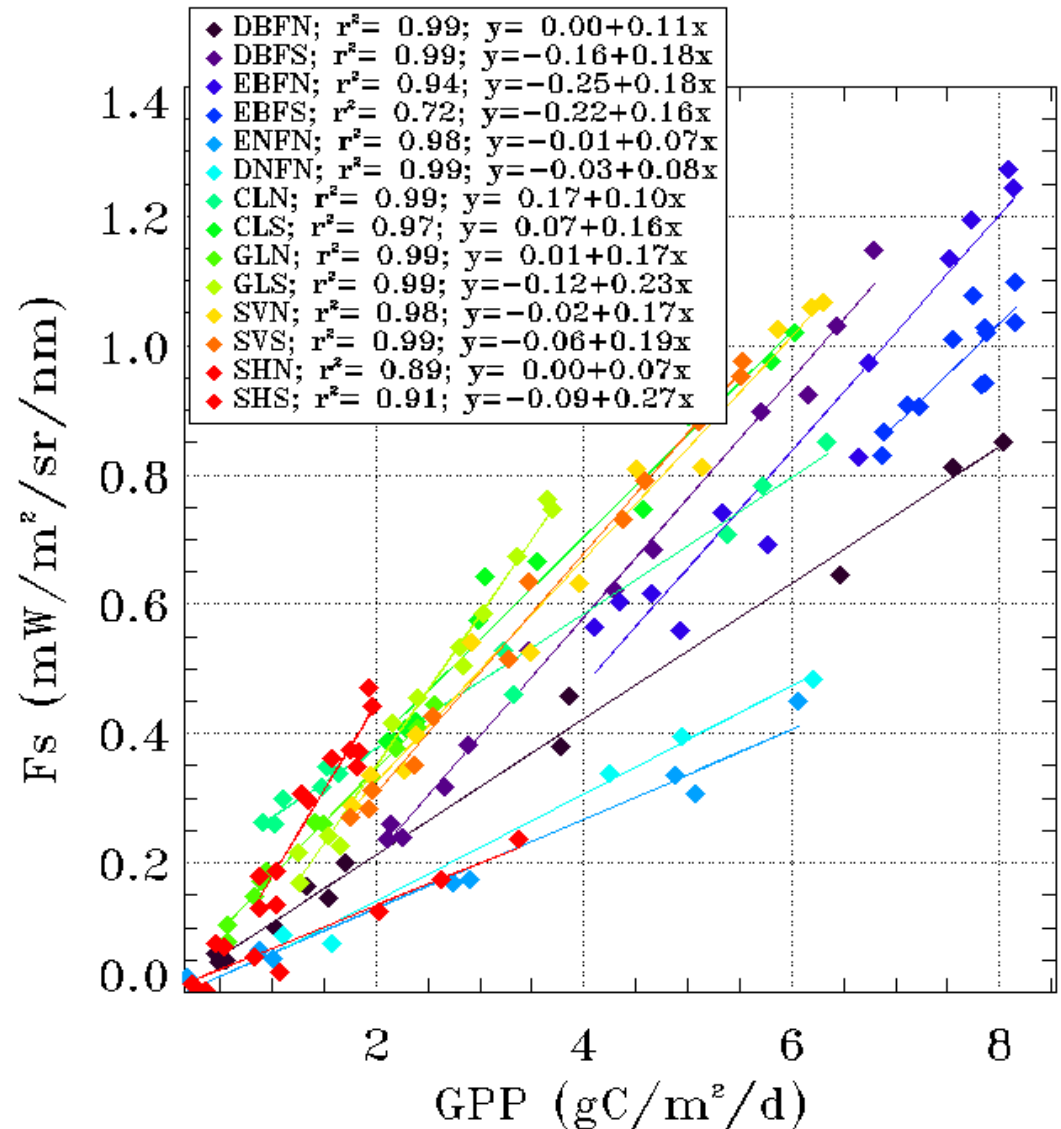
Each point is a monthly average

High linear relationship, but a different slopes in the GPP-Fs relationship for different biomes

Structure?

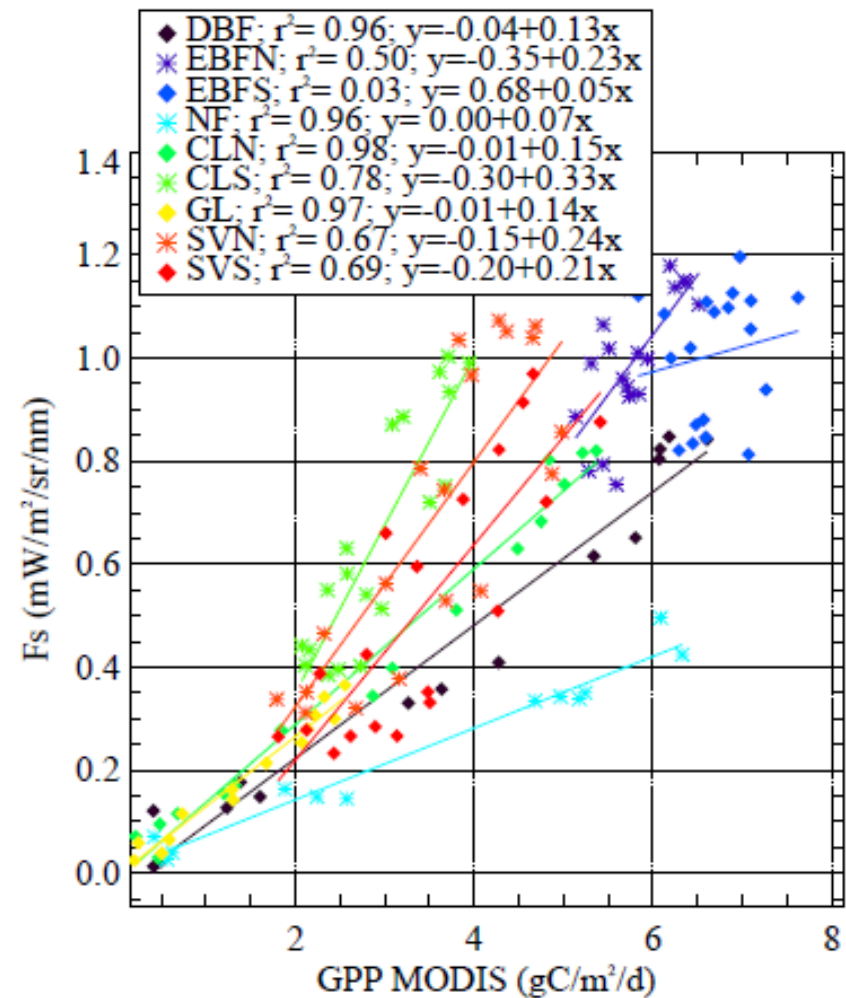
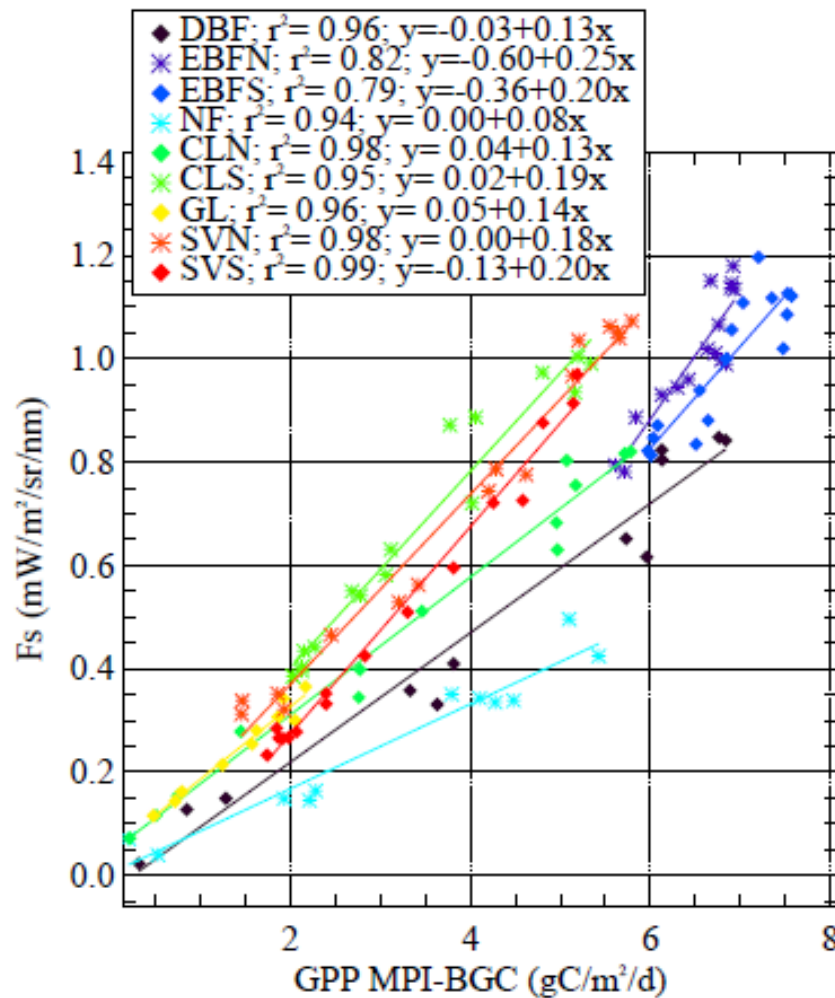
Biochemistry?

GPP from  
M. Jung – MPI-BGC

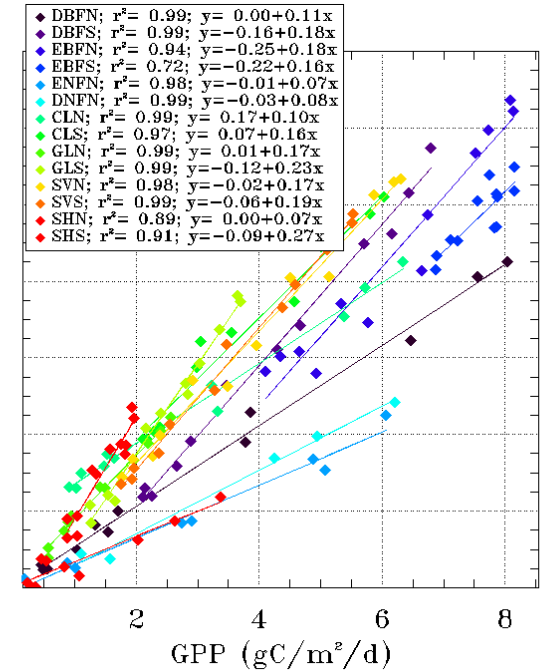
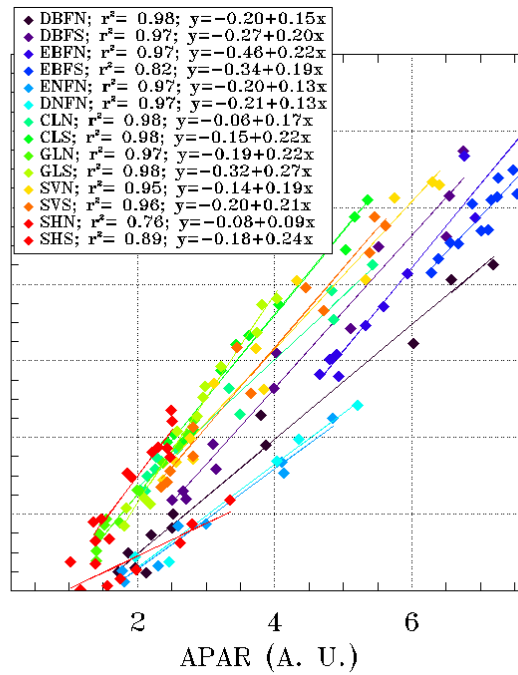
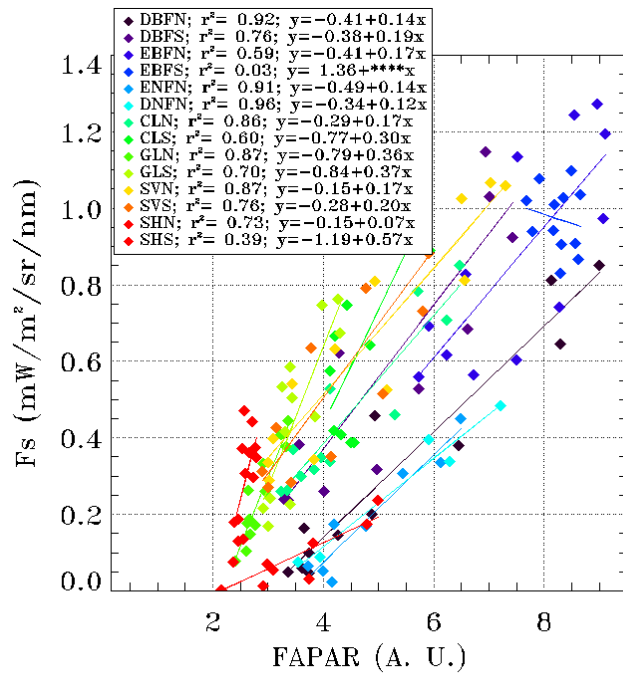


# Some examples of global GPP-Fs comparisons

Guanter et al, RSE, 2012



Same trends for two independent GPP models forced with different inputs



## F<sub>s</sub> vs [GPP, APAR, FAPAR]

- Different slopes already at the  $F_s$ -FAPAR level (nothing to do with GPP modeling)
- Generally smaller slopes for the NH
- Possible explanations:
  - Structure (Cab reabs, green vs non-photosynthetically APAR)
  - $F_{s,yield}$  sensitive to meteorology

# **Estimating GPP from Fs observations**

## **II. Data sets and EO missions**

## ■ Vegetation

- EVI/NDVI, FAPAR/LAI (MODIS)
- FAPAR, MTCI (MERIS)
- “Structure”: BRDF parameters (MODIS/MISR)
- “Structure”: Canopy height, JPL (Simard) ICESat/GLAS
- PRI: MODIS? SCIA?
- EO-driven GPP (MODIS, MPI)
- GPP from biosphere models?

## ■ *GPP from flux towers?*

## ■ Meteorology

- Temperature (daytime, nighttime, daily minimum...)
- Relative humidity (vapor pressure deficit)
- Illumination (PAR, Swflux, sunrise/sunset)
- Soil moisture (SMOS?)
- Soil water availability (MPI)

## ■ Atmosphere

- XCO<sub>2</sub>
- Tropospheric O<sub>3</sub>??

## ■ PFTs: IGBP (MODIS), Synmap (MPI)

**Question: how good are these parameters for GPP modeling?**  
**Spatial resolution/co-location issues?**

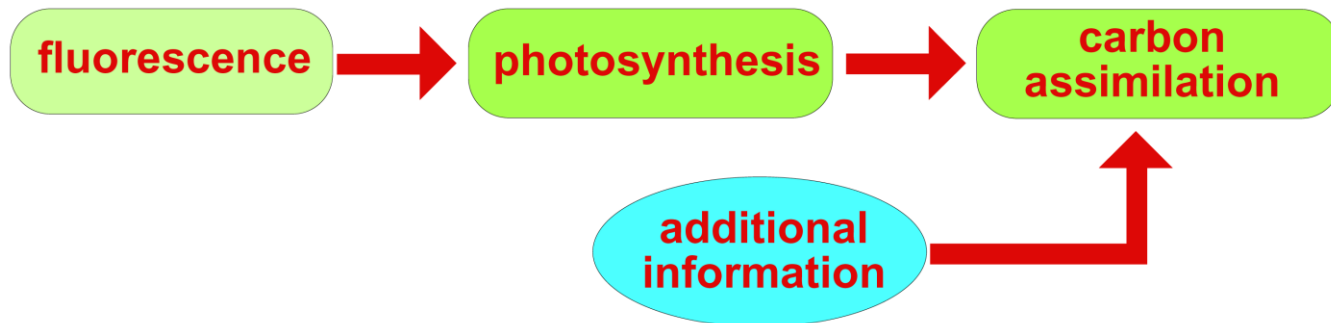


## ■ FLEX's target parameters:

1. **Photosynthesis rates** from chlorophyll fluorescence
2. **Gross primary production (GPP)** from photosynthesis rates and complementary information (data assimilation)

## ■ The FLEX concept $\rightarrow$ consistent observation of chlorophyll fluorescence and other key parameters to model GPP

1. **Photochemistry:** Fluorescence and PRI
2. **Greenness, biomass:** reflectance-based indices (fAPAR, LAI, Cab...)
3. **Meteorological forcing:** PAR, surface temperature and water vapour



# FLEX/FLORIS instrument requirements

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- **Broad Mission configuration:** FLORIS in tandem with S-3
  - ~815 km altitude
  - Local solar time: 10:00 LTDN
  - Temporal co-registration with S-3 < 6s
- **Mission Duration**
  - At least 3 full vegetation cycles
  - Target of 5 years
- **Spectral range** 520 nm to 800 nm
- **Spectral resolution** between 0.1 and 0.3 nm in core spectral range (Oxygen bands and red-edge)
- **Ground resolution** 300 m (500 m to enhance SNR)
- **Swath width** > 120 km – goal 150 km
- High imaging and spectral performance requirements

# Ancillary parameters from GOSAT

- GOSAT FTS & CAI, able to provide useful parameters in addition to Fs to constrain GPP
  - Brightness temperature
  - Total column water vapor → Vapor pressure deficit
  - ~ MODIS' NDWI: canopy water content
  - (CAI) High spatial resolution NDVI → fAPAR
- Under-utilized so far? Is this interesting for a satellite-based GPP estimation? Should we bother to get those too?
- ~VPD, NDWI also for **OCO-2**, A-train could complete the others

