FUSION: a GSFC Prototype for Field Spectroscopy Cal/Val

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FUSION Goals

FUSION (not an acronym) goals:

To provide optical measurements of vegetation

- Describe diurnal and seasonal dynamics
- Describe bidirectional reflectance/emission
- Sense hyperspectral reflectance and fluorescence
- Provide measurements that could scale to satellite observations
- Make measurements with spatial and temporal resolution that can be linked to carbon/water fluxes measured by flux towers

FUSION Instrumentation

An automated sensor system collecting simultaneous observations of incoming and reflected radiance

- A pan-tilt unit points fiber optics of the downward-viewing sensors
- Cosine corrected hemispheric viewing for the upward-viewing sensors

Instruments are housed in an insulated box with thermoelectric temperature control for instrument stability

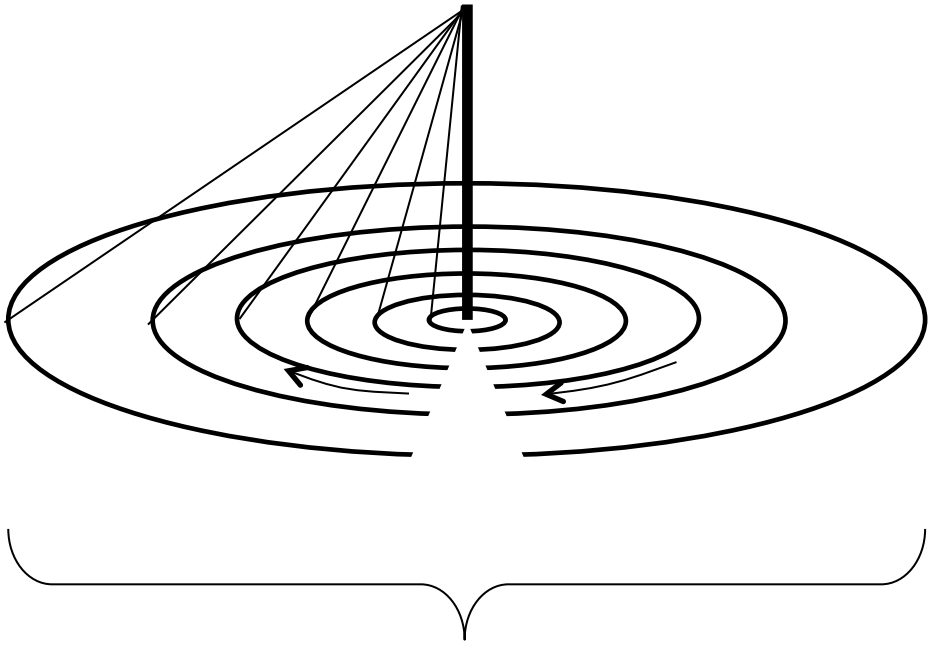
Instruments:

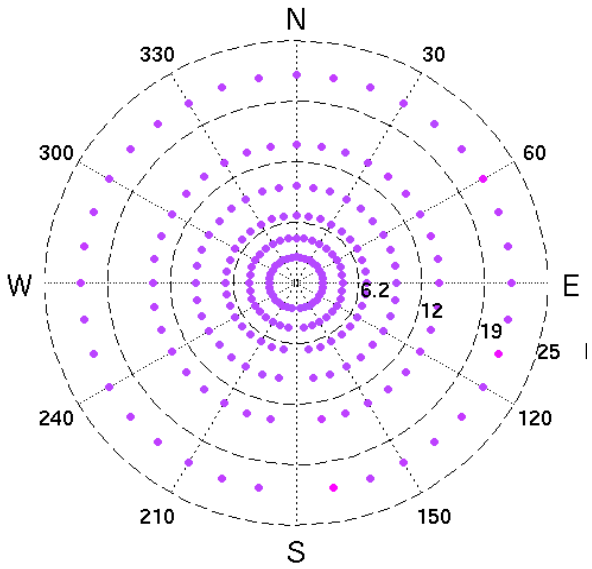
1) upward and downward viewing Ocean Optics USB 4000 Spectrometers (345-1040 nm with resolution of 1.5 nm FWHM);
2) upward and downward viewing Ocean Optics HR 4000 Spectrometers (650- 840 nm at a resolution < 0.13 nm FWHM sampled at 0.06 nm);
3) CFmicro SF15 infrared sensor (8 to 14 μm).

FUSION Operations

FUSION is mounted atop a 10 m tall tower in a cornfield

- Makes 350° azimuth angle scans
- At six zenith angles (15°,25°,35°,45°,55°,65°)
- Takes about 25 minutes for a full set

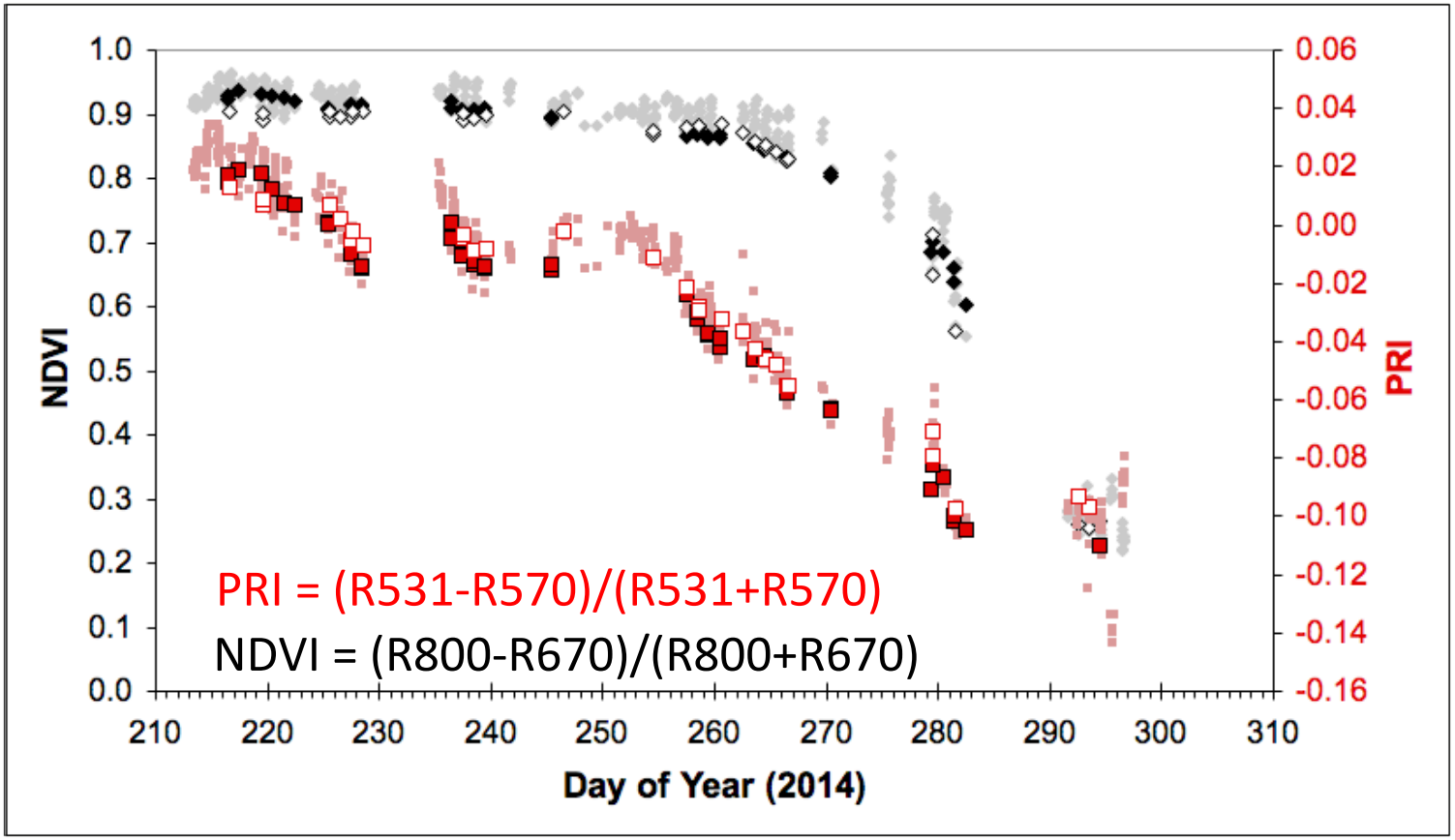




Locations of FOV center points

Seasonal/Diurnal Observations

Solid points - clear sky observations near AM overpass
Open points - clear sky observations near PM overpass

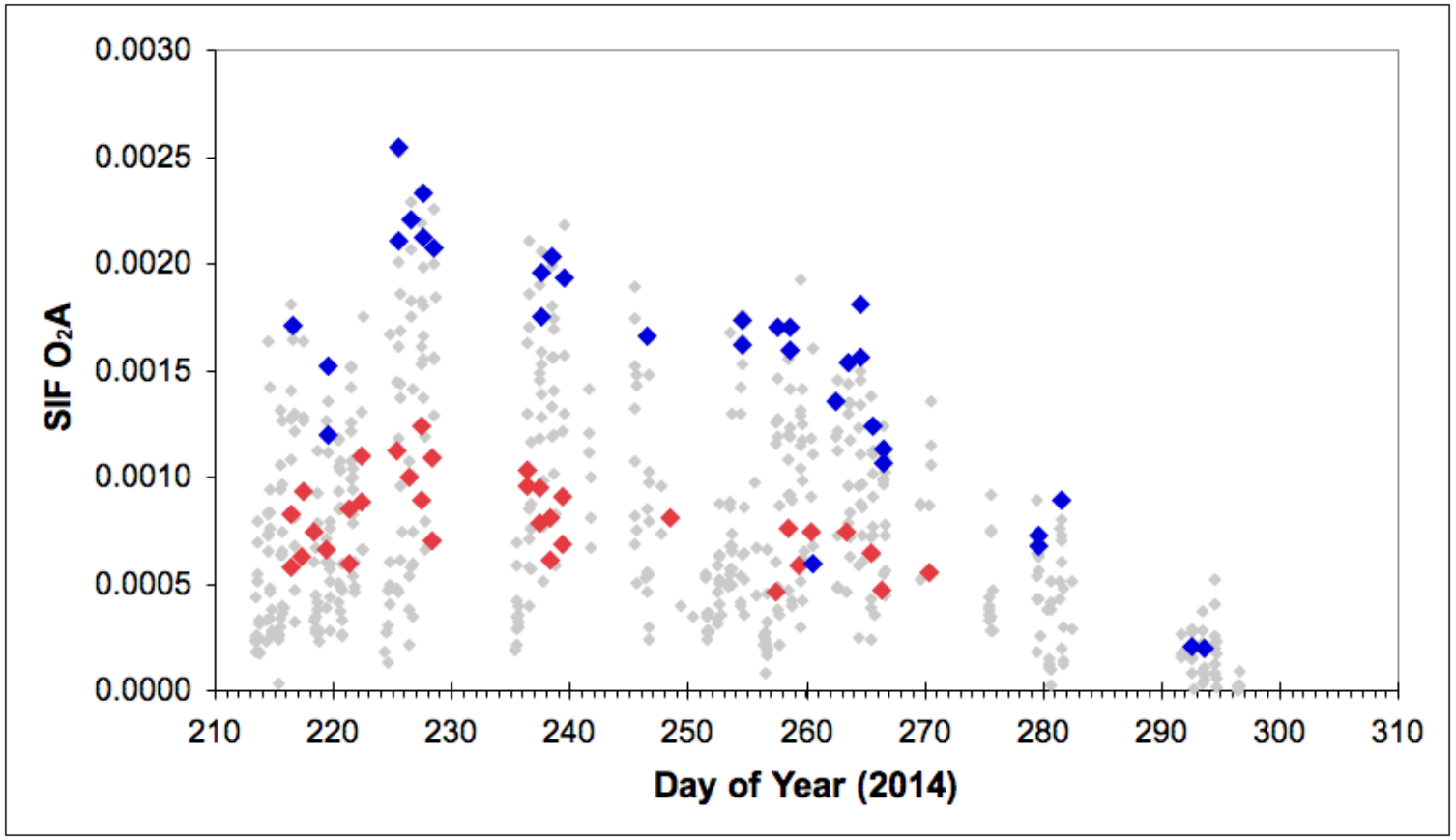


Single view angle: 25° VZA, 330° VAZ

Seasonal/Diurnal Observations

Solar Induced Fluorescence at O_2A (760 nm)

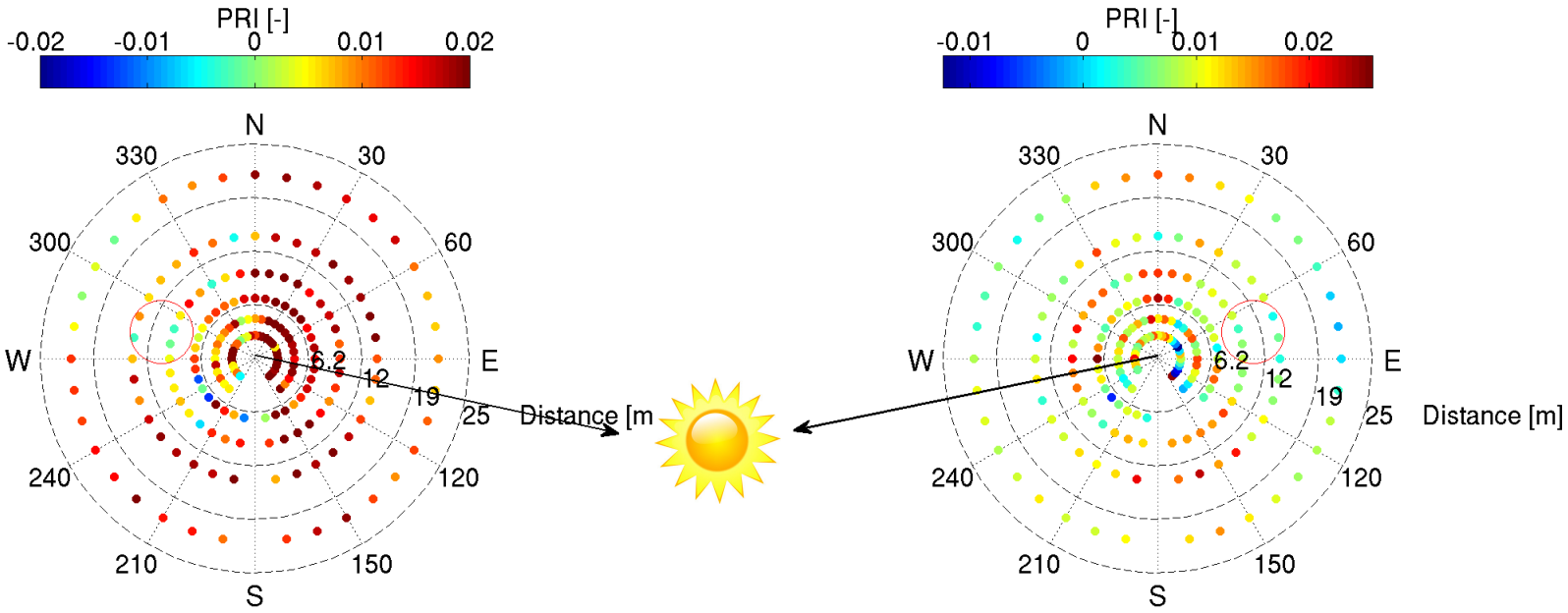
Red points - clear sky observations near GOME-2 overpass
Blue points - clear sky observations near OCO-2 overpass



Single view angle: 25° VZA, 330° VAZ

Bidirectional Observations - PRI

Morning and afternoon bidirectional patterns of Photochemical Reflectance Index (PRI = (R531-R570)/(R531+R570))
August 14, 2014, SZA ~ 50° at both times



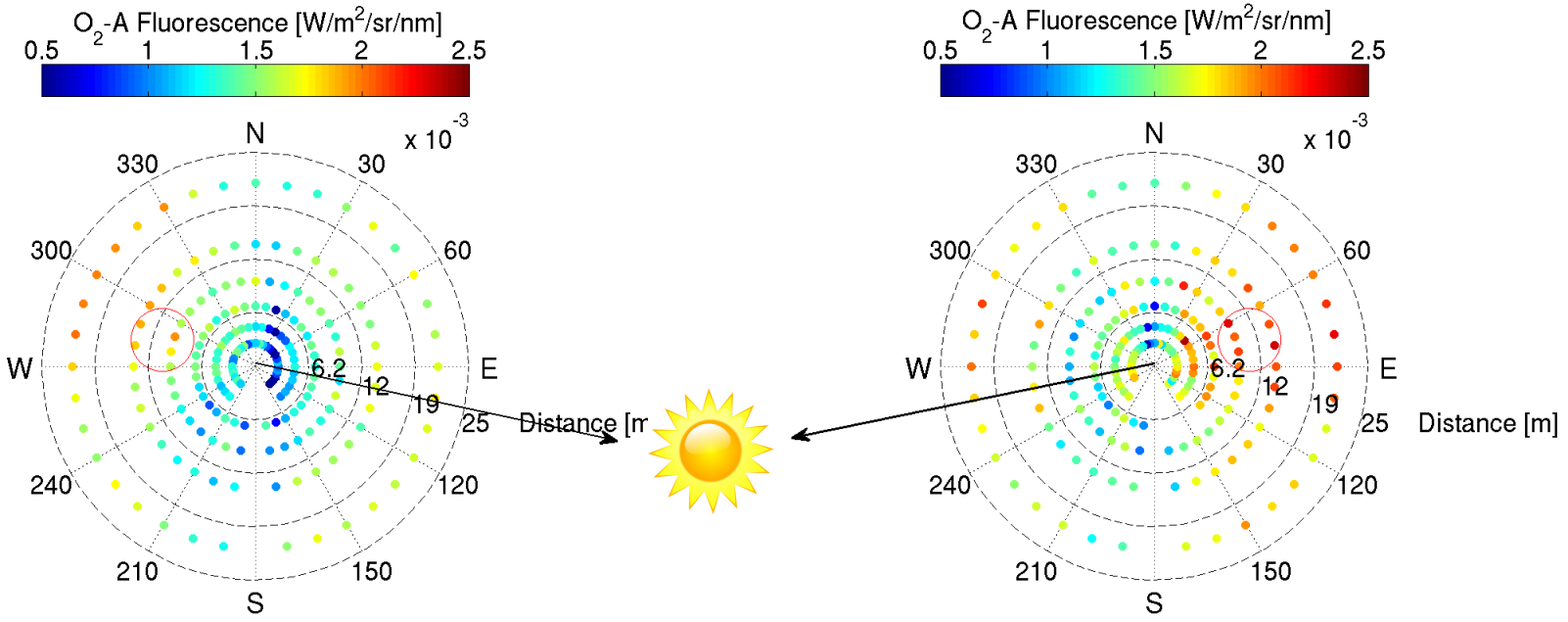
Morning
10:00 AM

Afternoon
4:30 PM

From Neus Sabater Medina

Bidirectional Observations - SIF

Morning and afternoon bidirectional patterns of Far-red Solar Induced Fluorescence (SIF) in the O_2A absorption band (760 nm)
August 14, 2014, SZA ~ 50° at both times

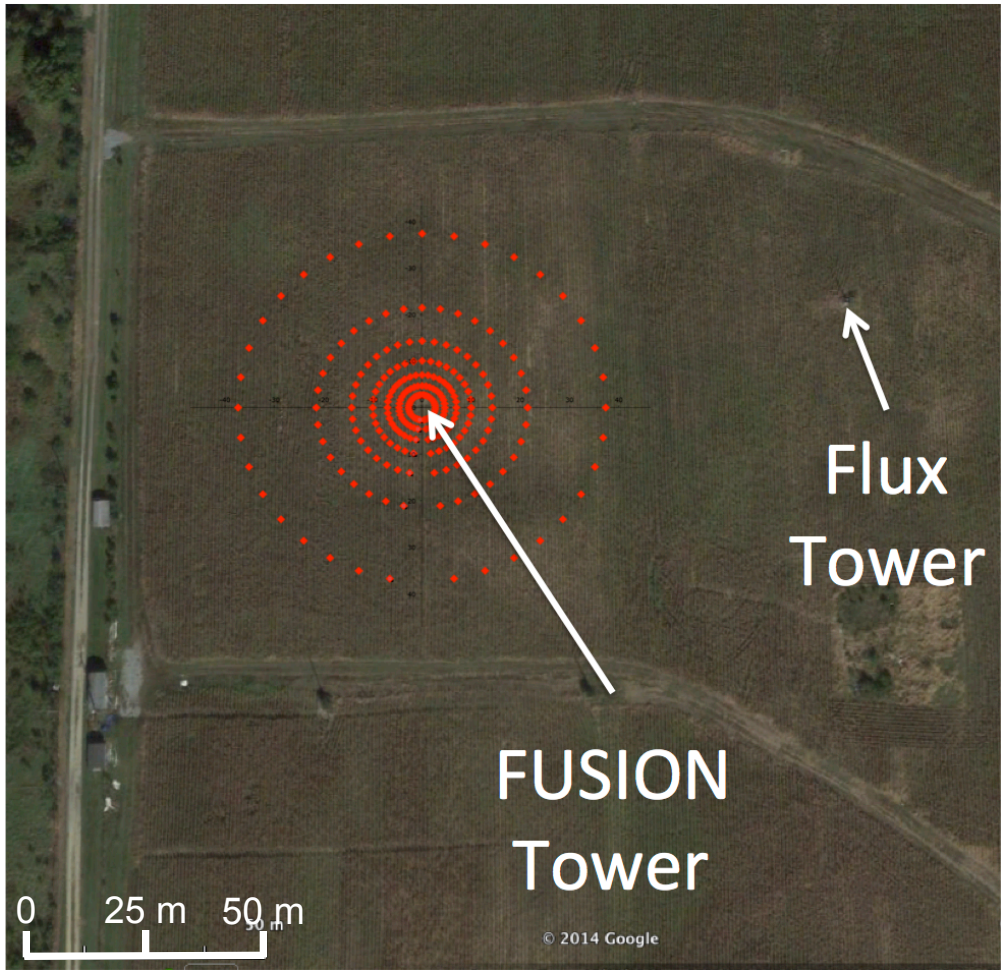


Morning
10:00 AM

Afternoon
4:30 PM

From Neus Sabater Medina

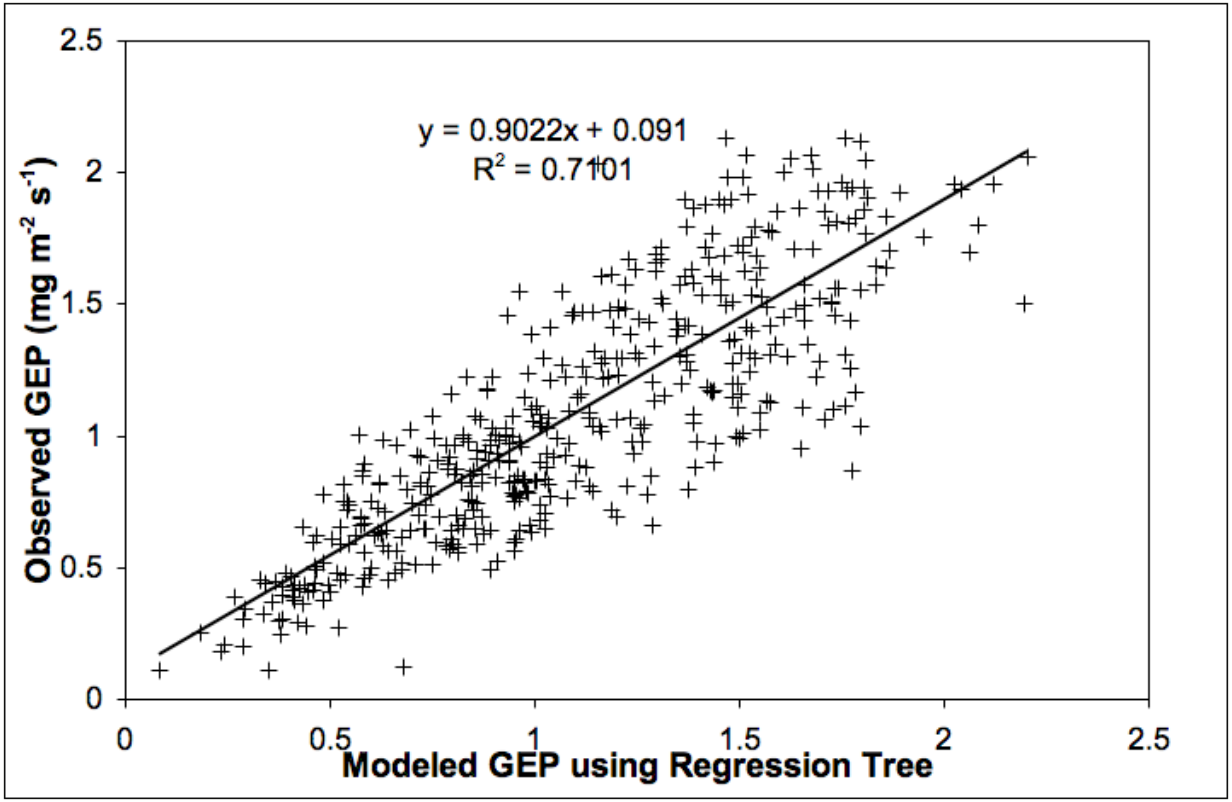
Combining Optical and Flux Data



Flux tower ~105 m from FUSION tower

Estimating GEP from FUSION Optical Signals

Light Use Efficiency model using NDVI and PAR with a variable LUE based on a regression tree model using PRI and SIF at O_2A and O_2B

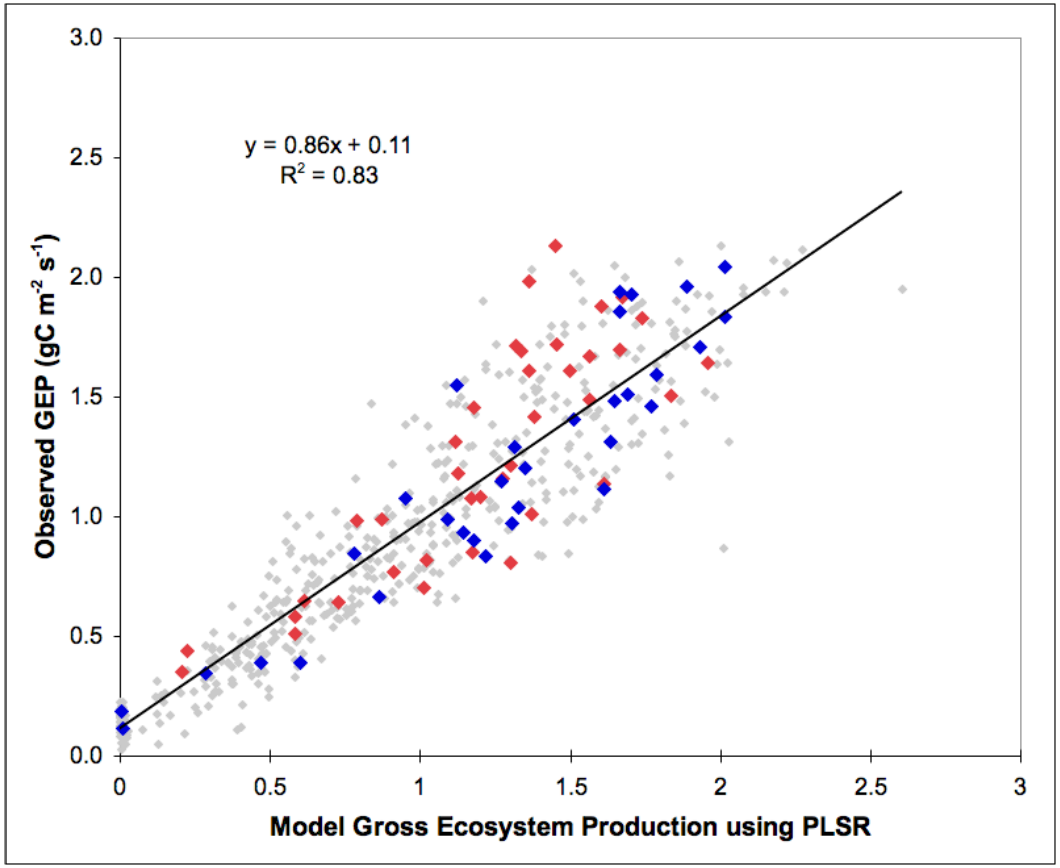


Single view angle: 25° VZA, 330° VAZ
Data covers entire season

Estimating GEP from FUSION Optical Signals

Red points - clear sky observations near AM overpass

Blue points - clear sky observations near PM overpass



Single view angle: 25° VZA, 330° VAZ

Data covers entire season

FUSION and Satellite Cal/Val

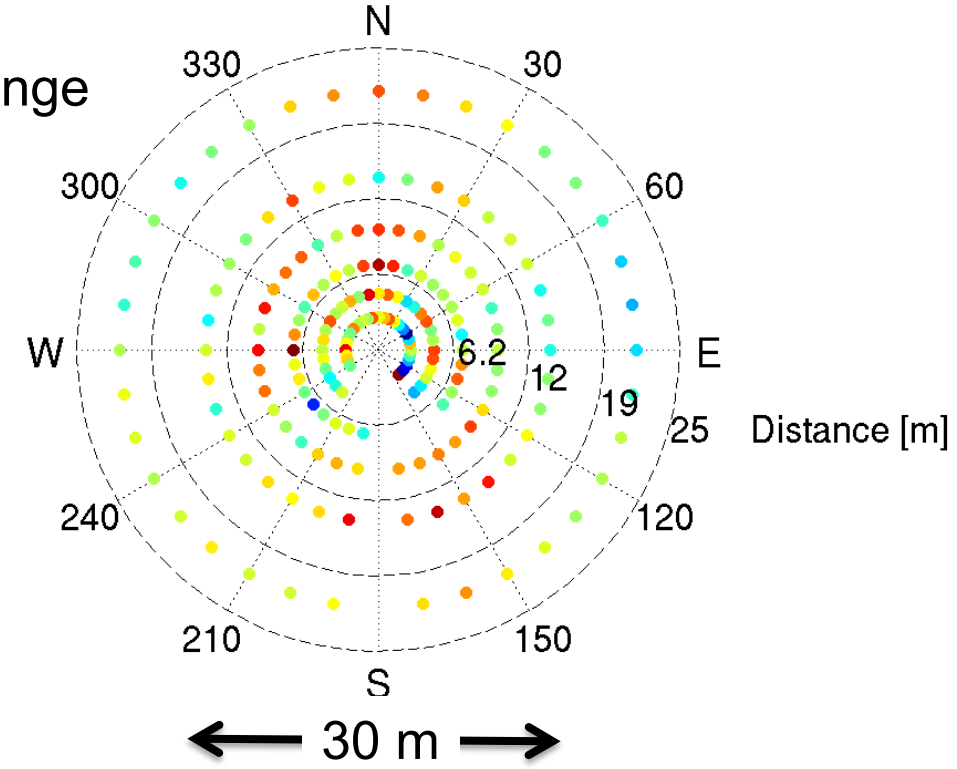
FUSION collects a large number of samples within an area the size of satellite pixels

Provides a description of bidirectional reflectance patterns for information to interpret view angle effects

Spectral data can be convolved to any satellite band

Continuously collect measurements to examine effects of different overpass times

Describes seasonal change



From Neus Sabater Medina

Conclusions

- FUSION provides optical measurements for scientific studies, algorithm development, and satellite/aircraft product cal/val
- In our cornfield studies with FUSION we were able to:
  - Observe significant bidirectional effects in spectral vegetation indices and SIF related to sun and view geometry
  - Observe new aspects of seasonal phenology in different optical indices
  - Develop optically-based algorithms to describe diurnal and seasonal patterns of Gross Ecosystem Production