EO-1 Hyperion Spectral Time Series
for assessment of ecosystem function

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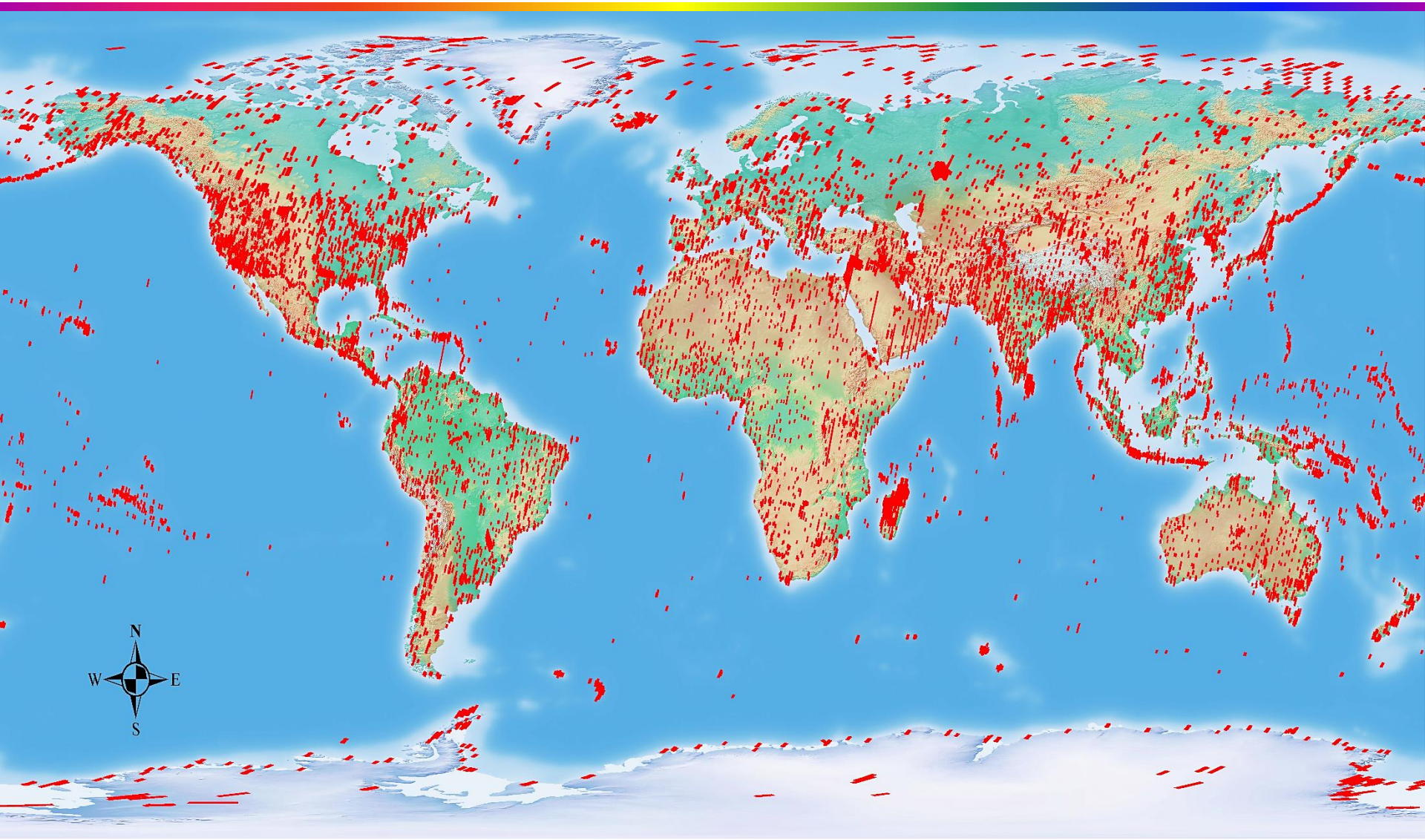
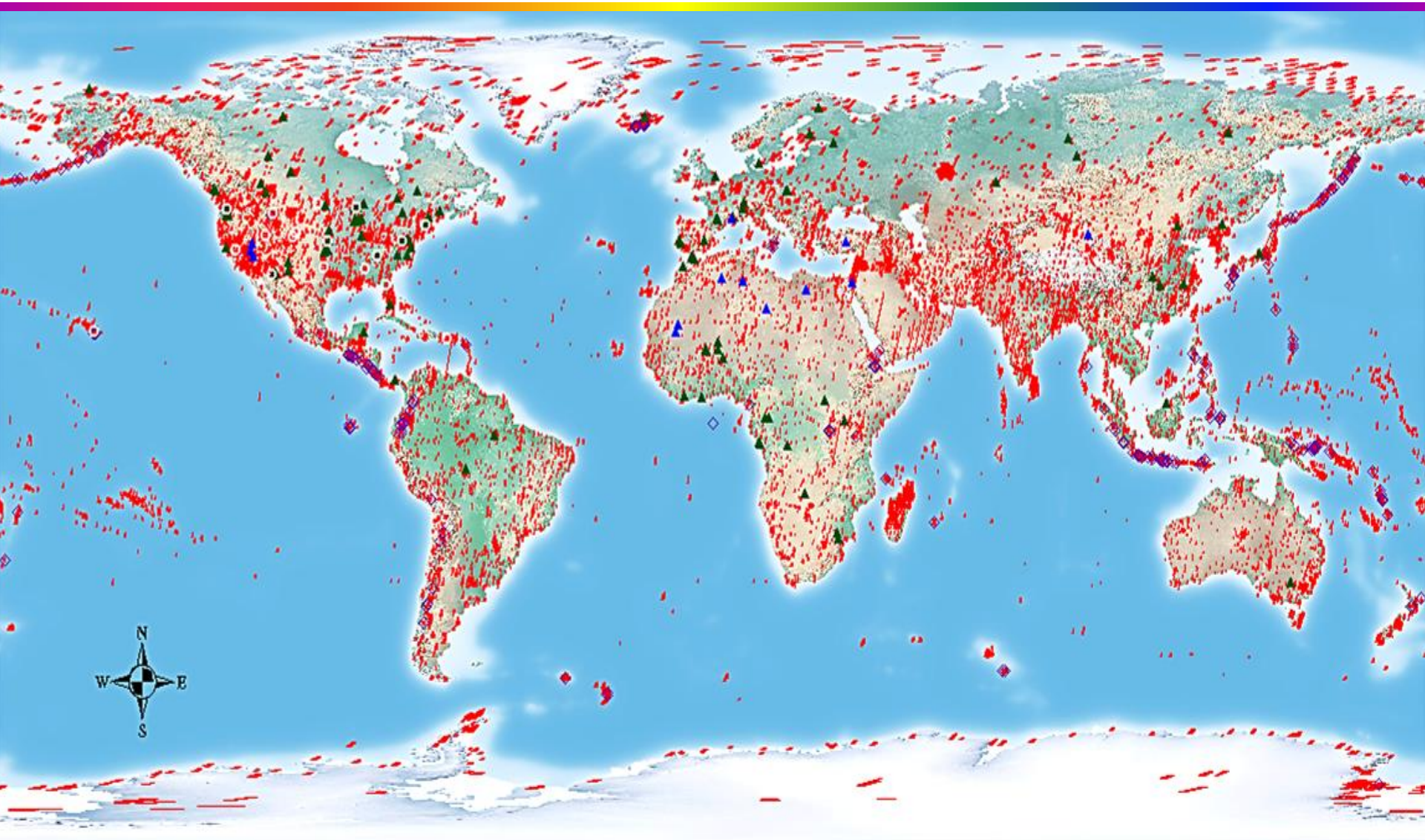
Hotspots of bio-diversity
http://www.plants2020.net/about-the-gspc

EO-1 Acquisitions Since Launch



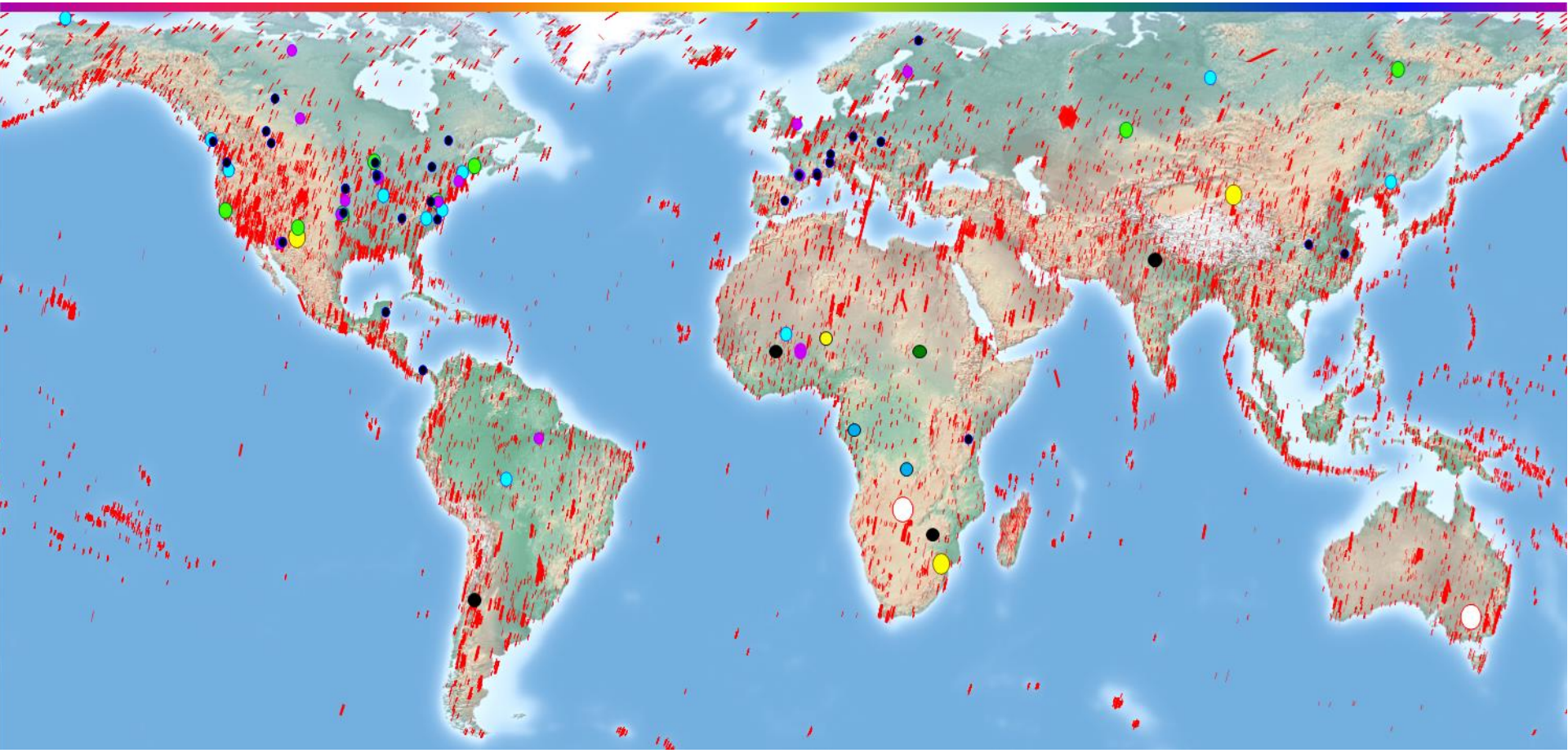
>85,000 (2000 through May 2016)

EO-1 Hyperion Spectral Time Series



Repeated Collections at: CEOS calibration sites (blue triangles), FLUX sites (green triangles), NEON (white circles) and Volcanoes (purple diamonds)

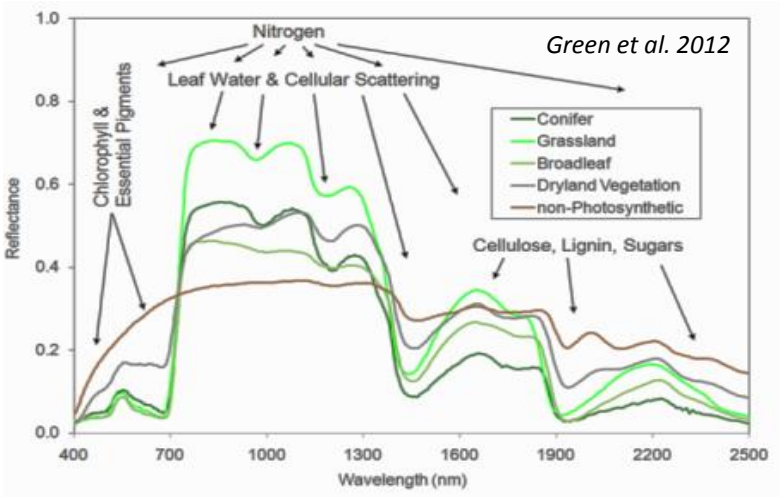
EO-1 Spectral Time Series at FLUX Sites



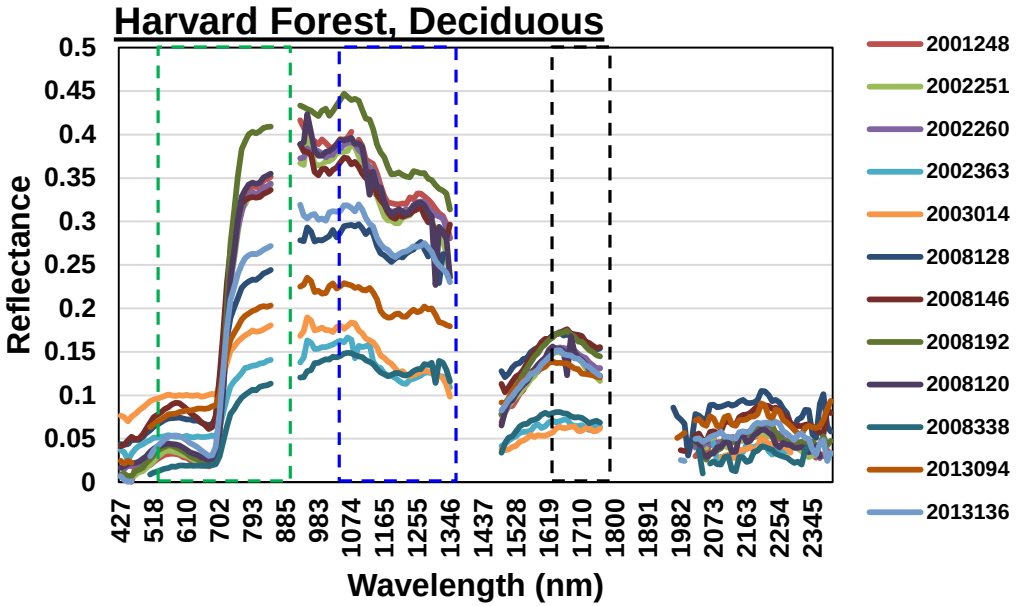
FLUX site locations and number of Hyperion cloud free images

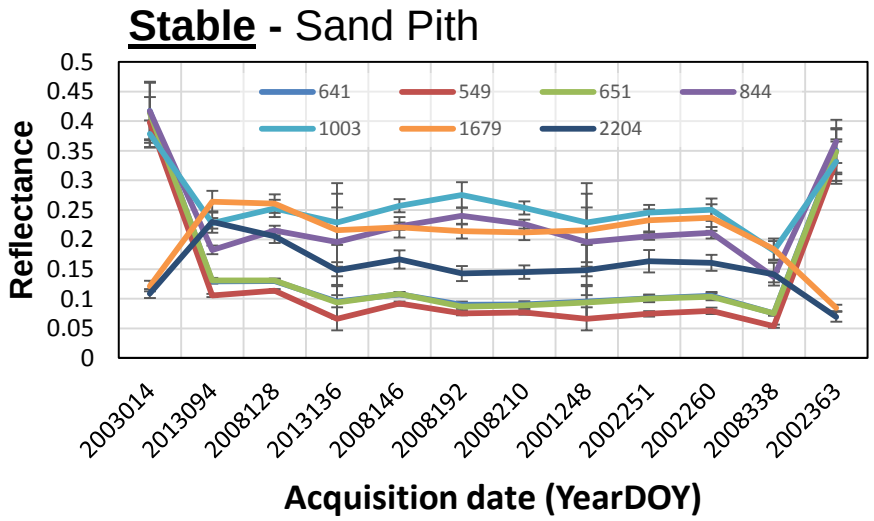
1 - 7
8 - 20
20 - 40
40 - 60
60 - 90
90 - 135

Seasonal Spectral Changes

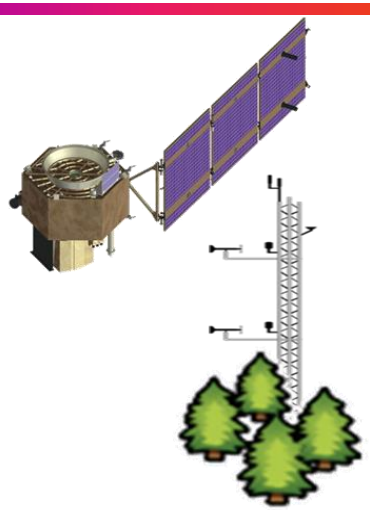


Changes in the chemical and physical configuration of vegetation canopies are expressed as changes in the contiguous spectral signatures.





Data and Processing



EO-1 Hyperion seasonal time series (TOA rad)

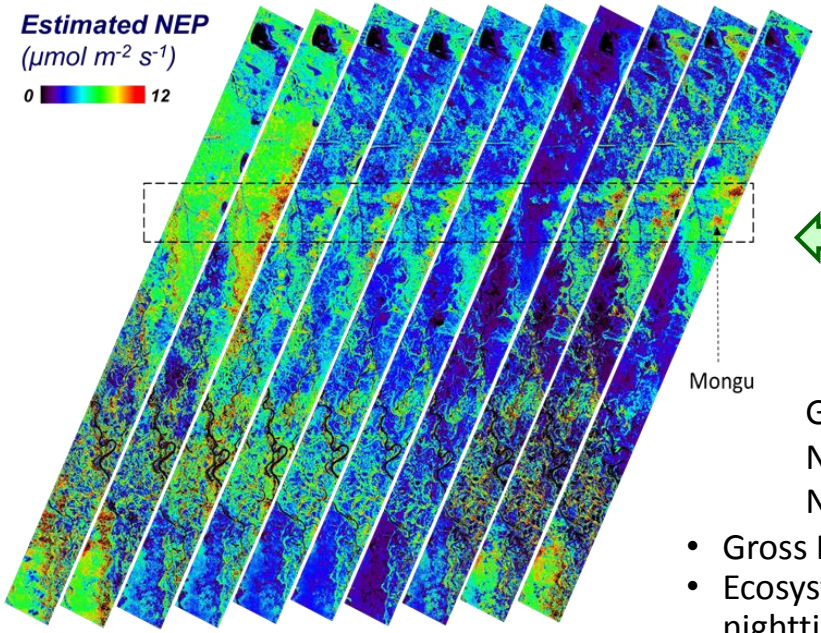
Atmospheric correction, Pre-processing (TOC reflectance)

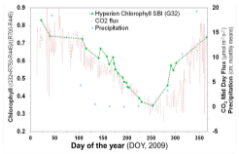
Hyperion Spectral Bio-Indicators (SBIs)

FLUX tower measurements (CO_2 flux, µmol m^{-2} s^{-1})

CO_2 FLUX parameters (**NEP**, GEE, etc.)

EO-1 Hyperion: Spectral Time Series for Mongu, Zambia





Relationship between CO_2 FLUX parameters & Hyperion SBIs

GEE = gross ecosystems exchange

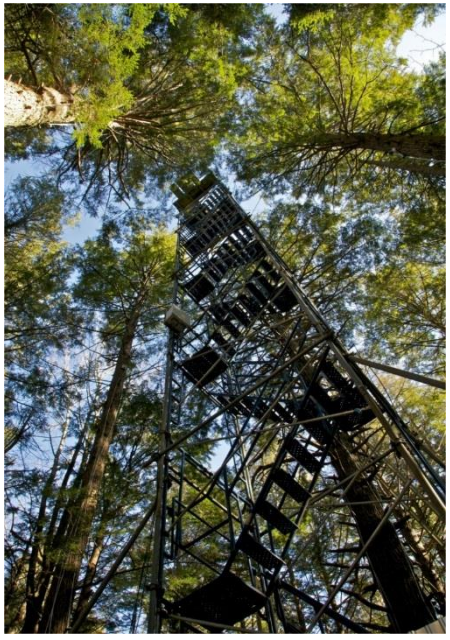
NEP = GEE – Re

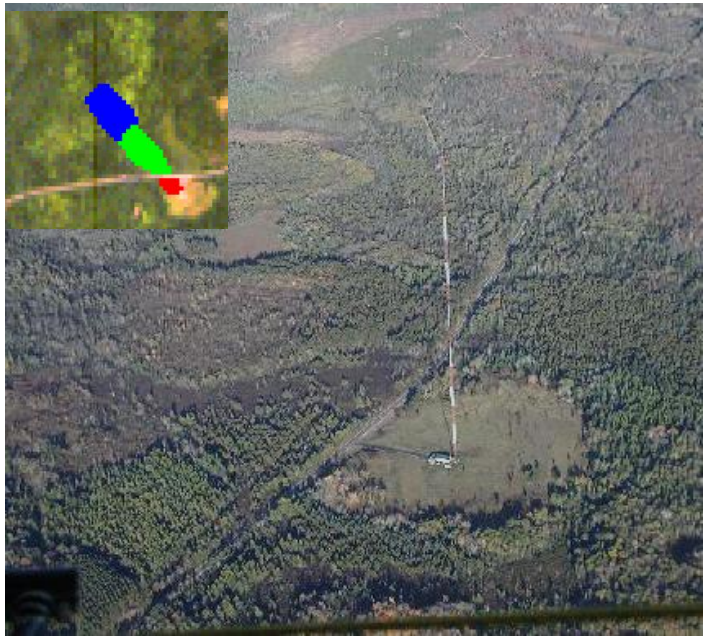
NEE = -NEP

- Gross Primary Production (GPP = GEP, µmol m^{-2} s^{-1})
- Ecosystem Respiration (Re) -calculated from relationships between nighttime Net Ecosystem Exchange (NEE) and air temperature
- Net Ecosystem Production -> from the observed GEE and Re

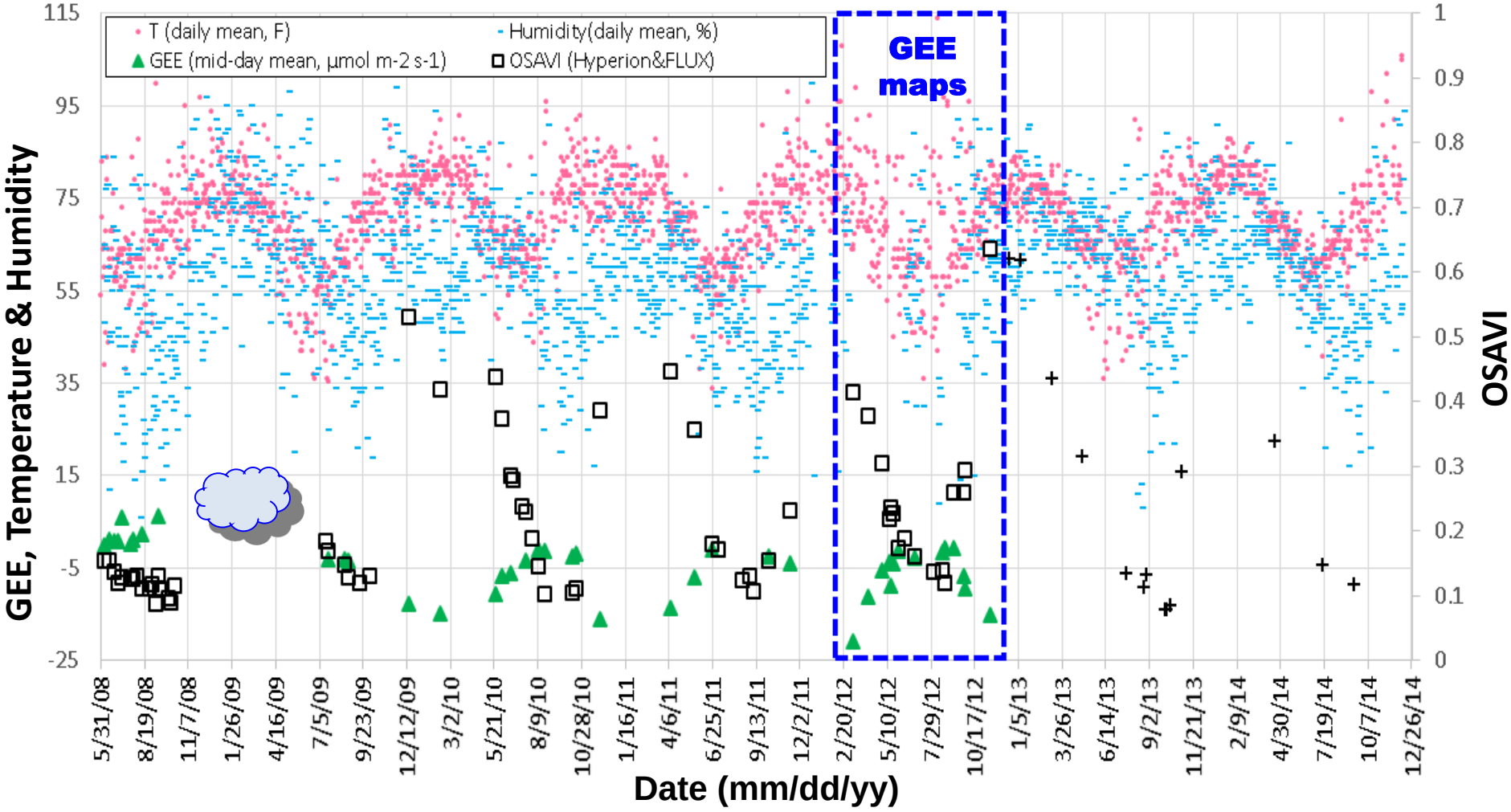
Sites

FLUX Site, Location	Harvard Forest, MA, USA	Park Falls, WI, USA	Skukuza, South Africa
Climate	Temperate	Temperate	Arid, Steppe, Hot
Vegetation type	Northern Hardwoods: EMS Evergreen: Eastern hemlock	Deciduous Broadleaf Mixed	Grassland Savannah
Tower height (m)	US-Ha1 and US-Ha2 30 m	US-Pfa 30 m, 122 m, 396 m	ZA-Kru 30 m
Hyperion images	12 (2001-2013)	47 (2008-2014)	72 (2008-2014)

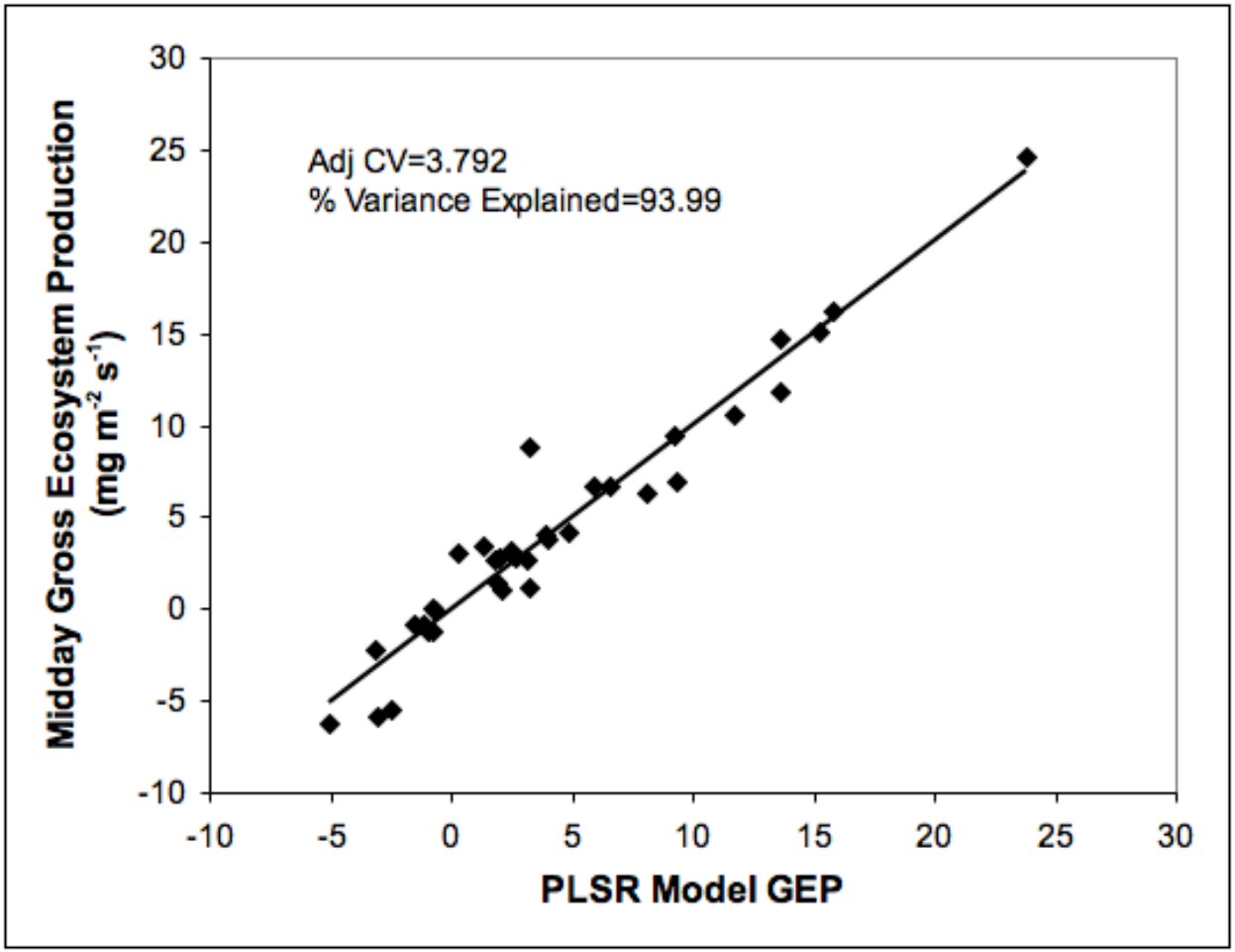




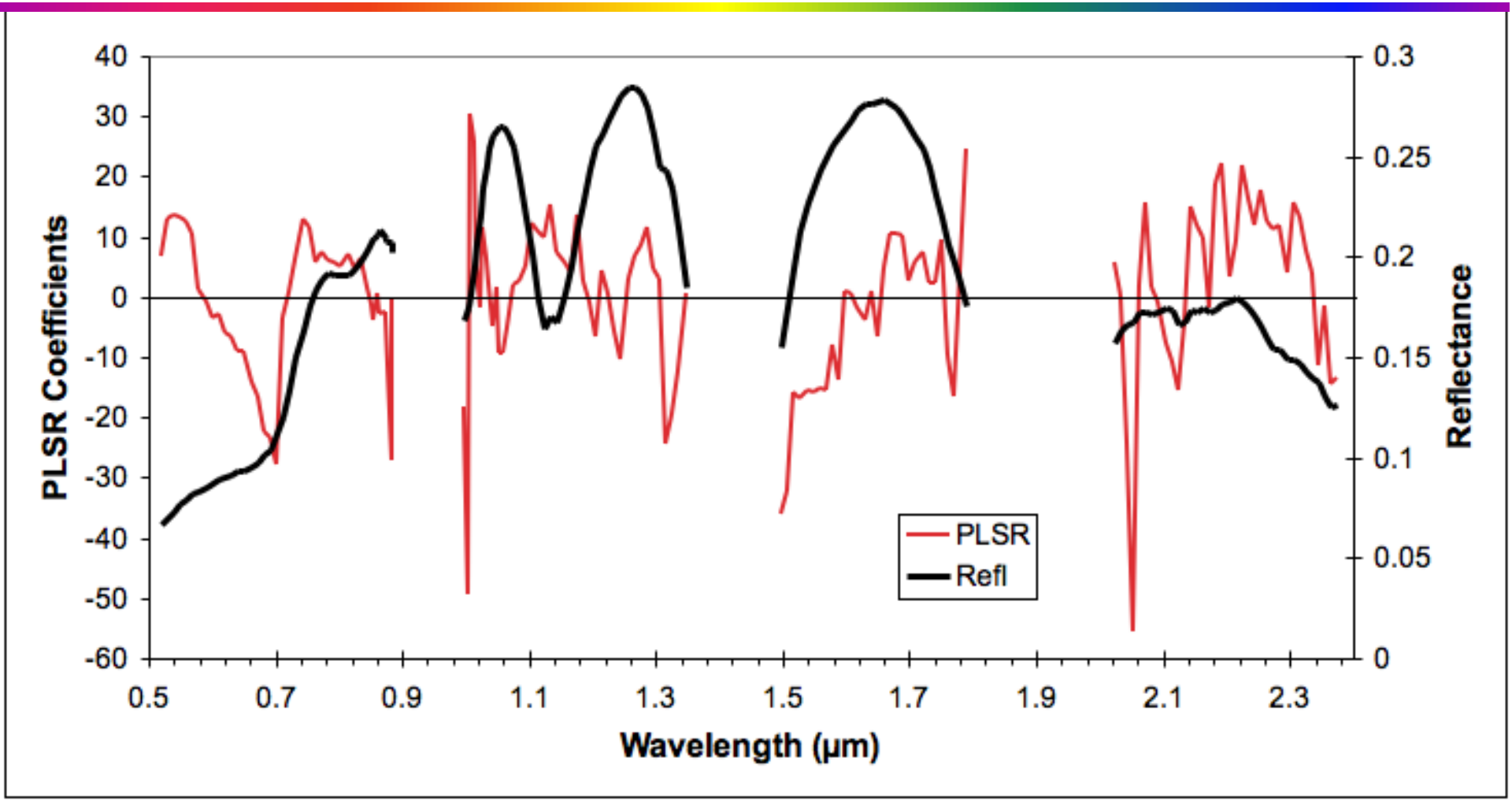
Hyperion Time Series at Skukuza



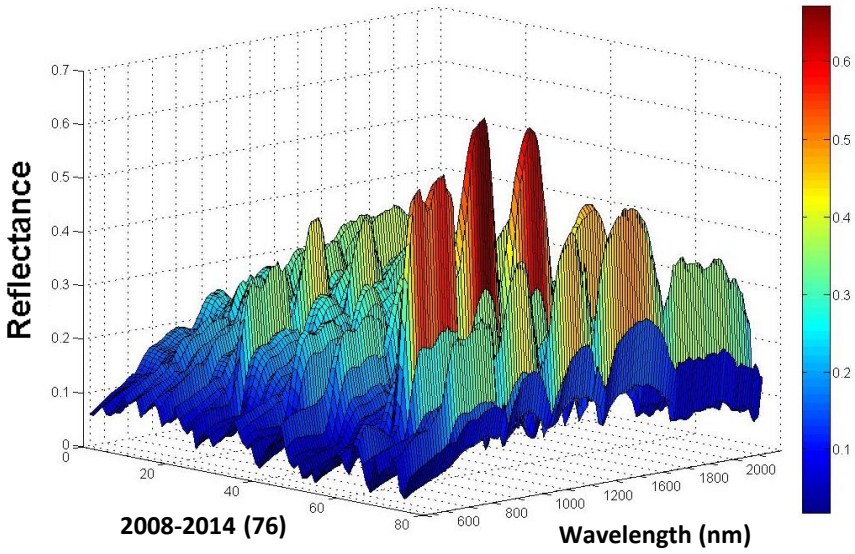
Midday GEP estimated using a partial least squares regression

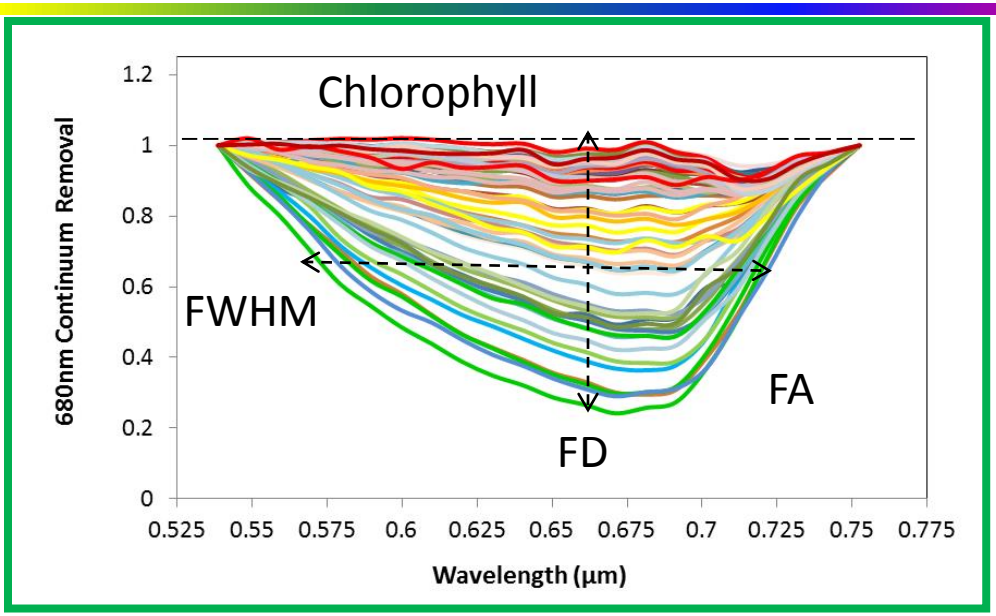


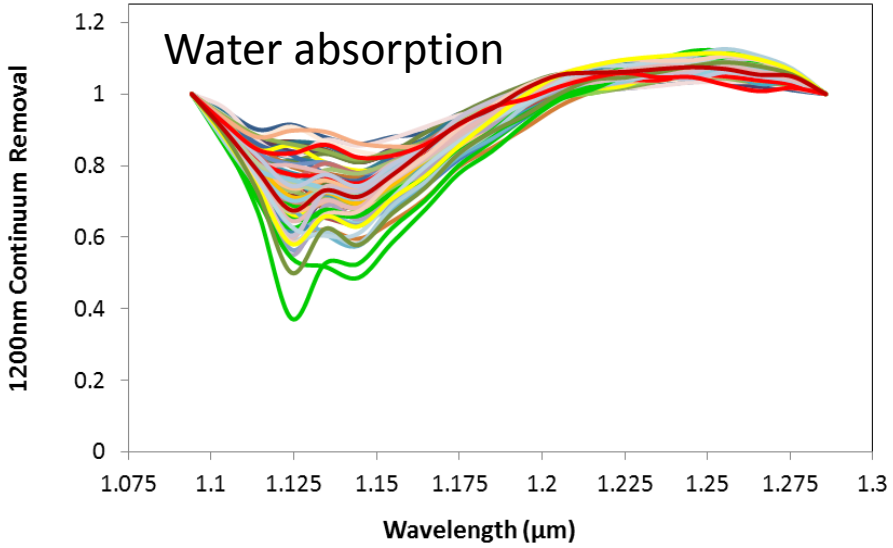
Average Hyperion spectral reflectance for Skukuza (black) and the coefficients derived from PLSR vs. GEP (red)



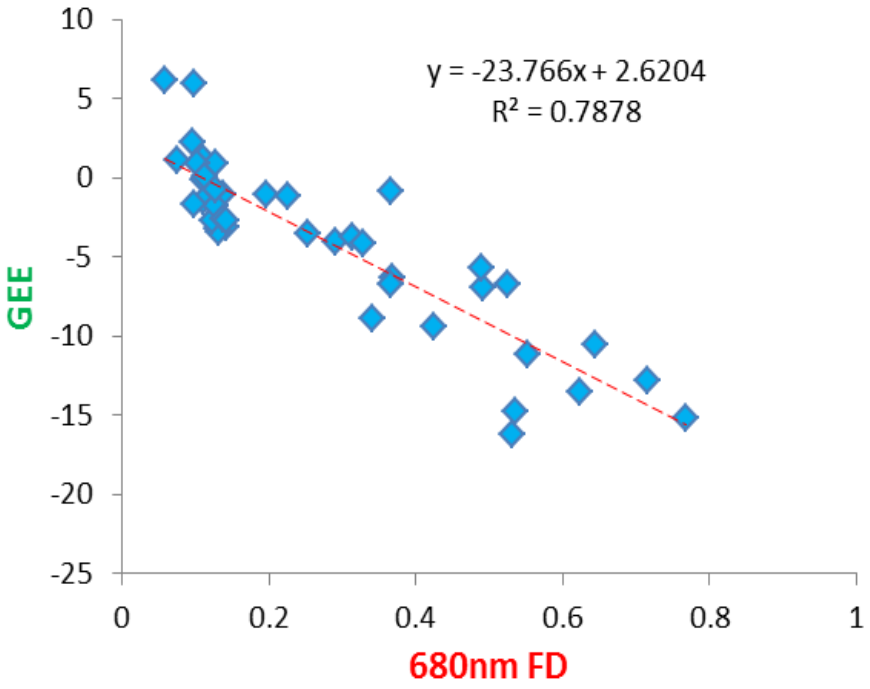
Changes in Vegetation Reflectance and Spectral Features, Skukuza

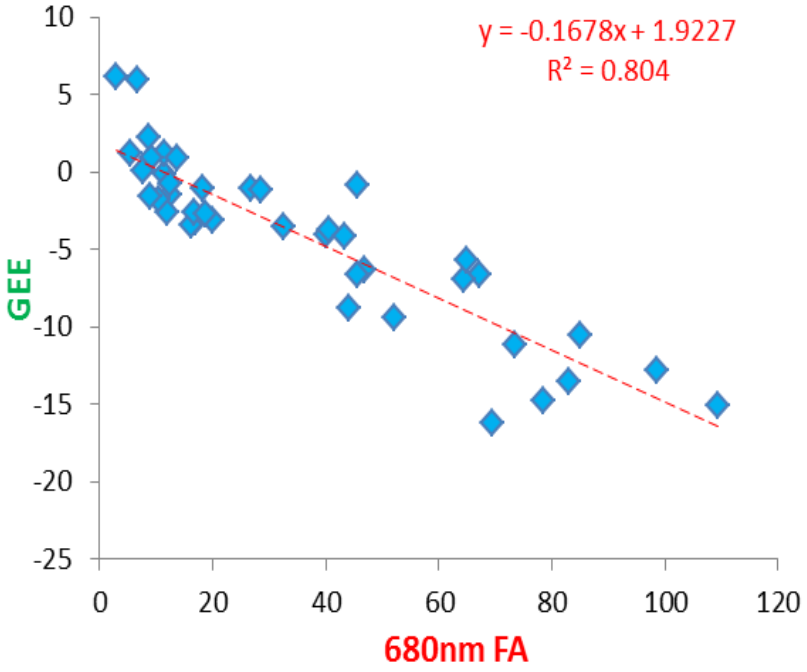




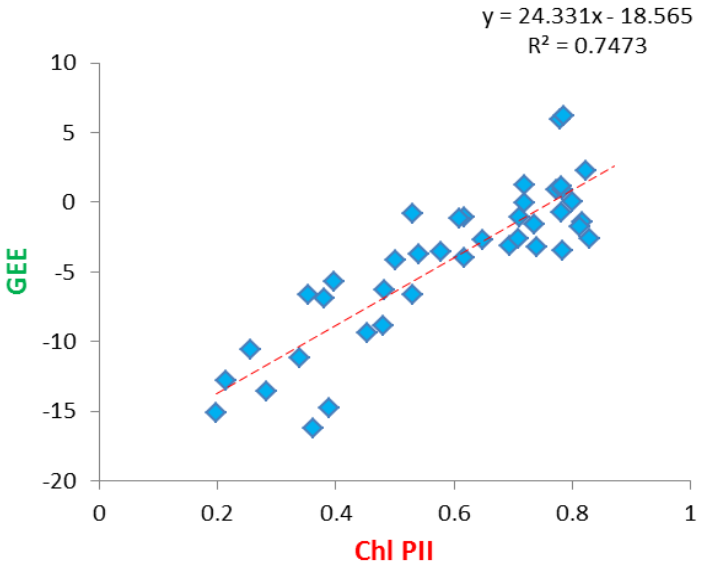


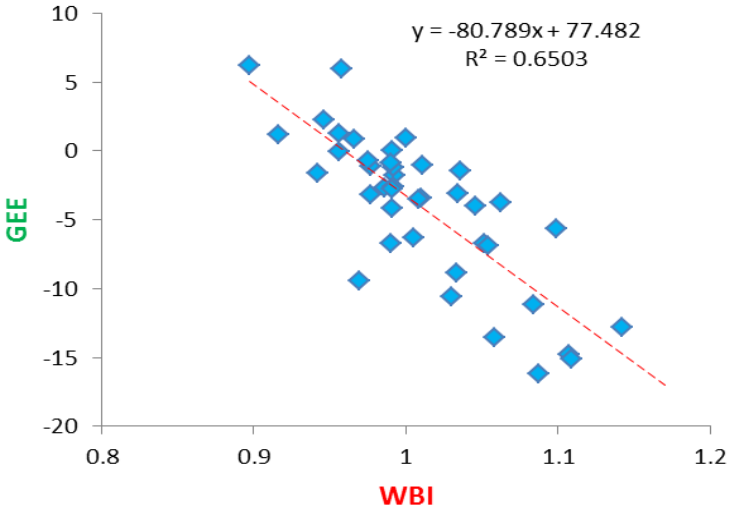
Chlorophyll Feature (PRISM) and GEE

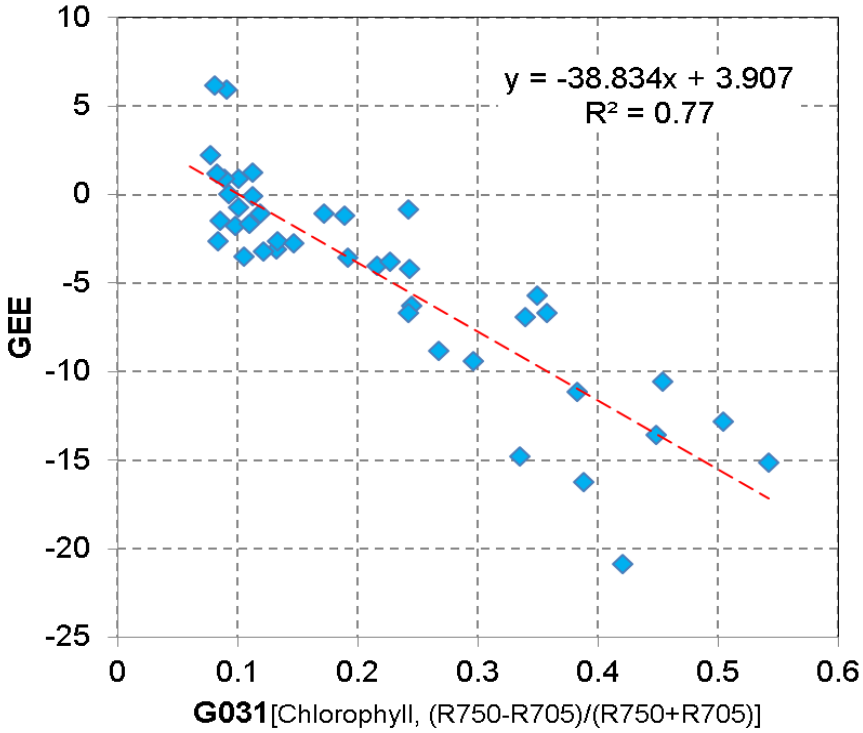




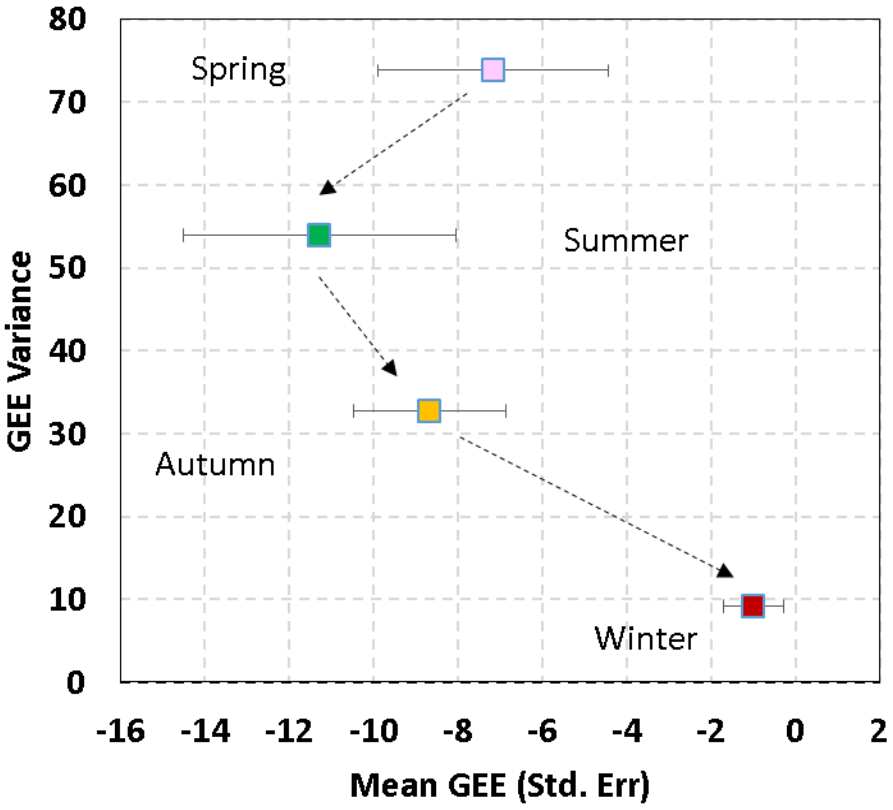
Narrow-band VIs and GEE

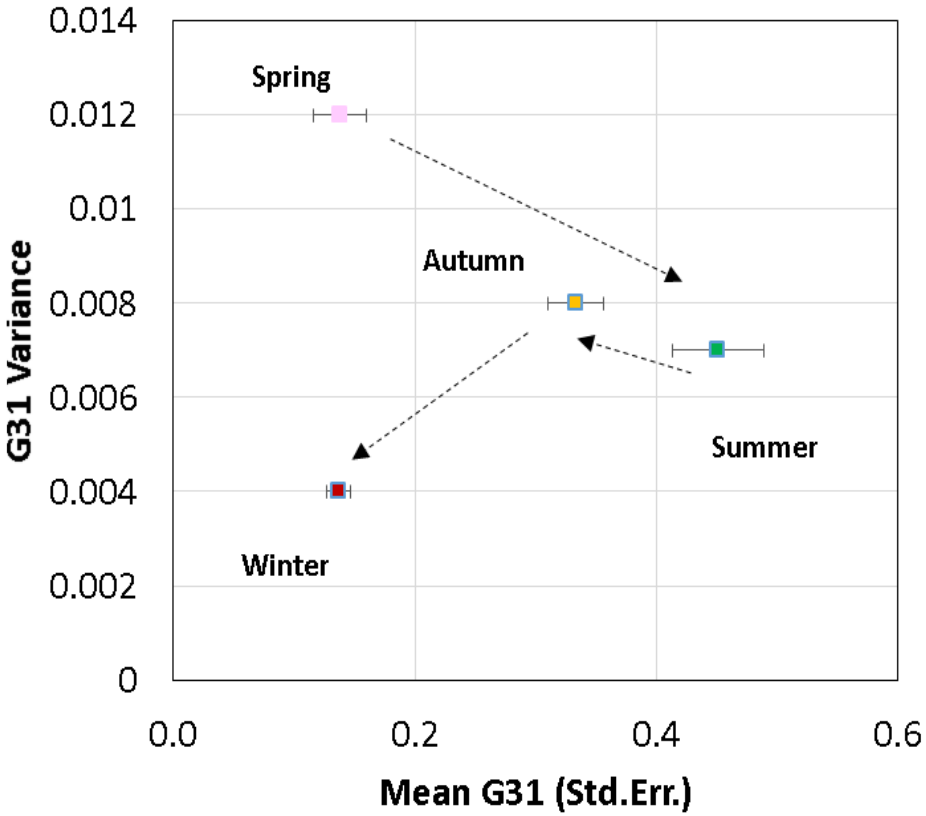




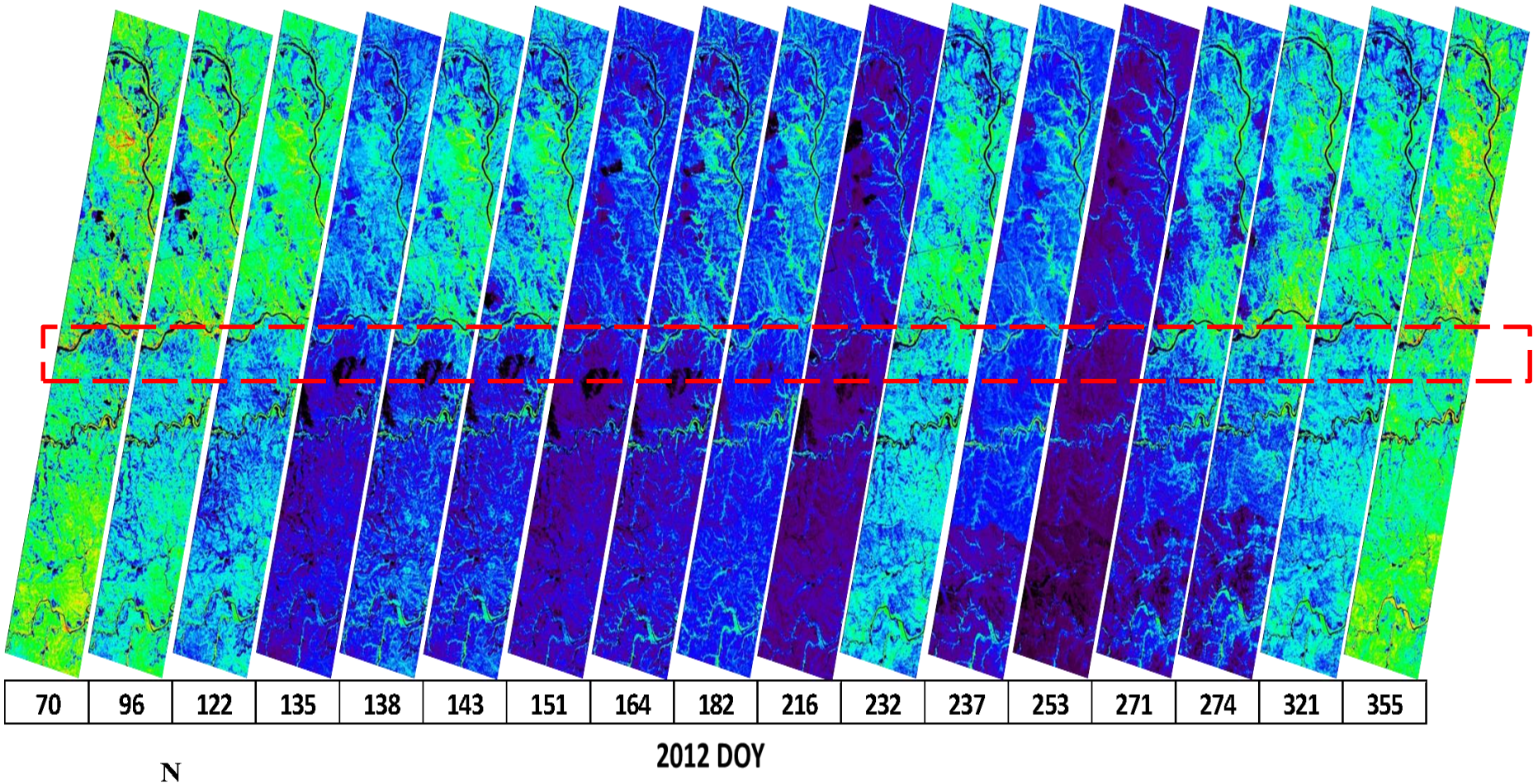


Seasonal Variation in GEE and Spectral VIs (G31), Skukuza





GEE at Skukuza, Based on FD

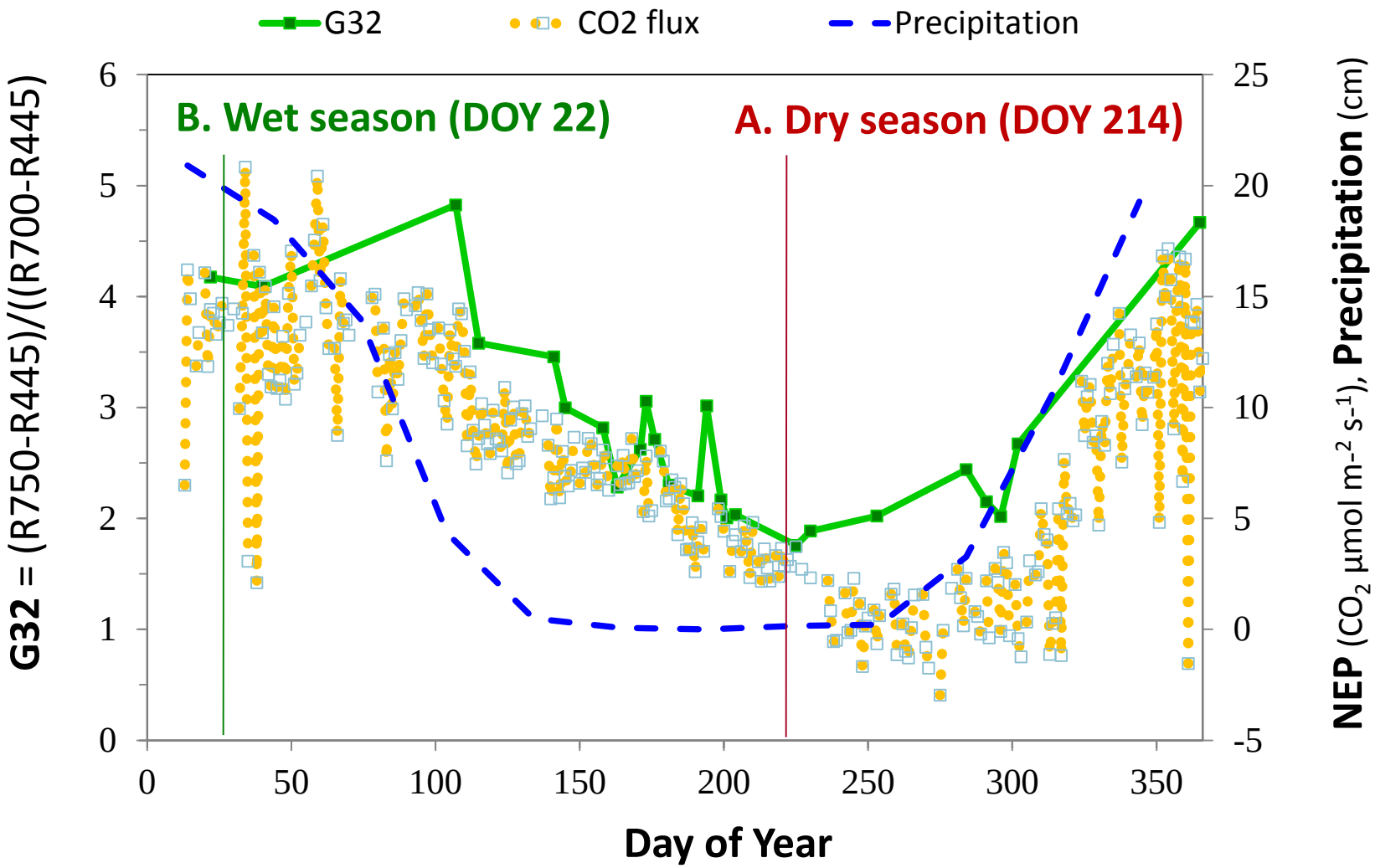


Skukuza, Hyperion VIs, Regression Coefficients (R^2)

Spectral Parameters	Description (bands, nm)	Harvard Forest MA, USA *Ha1: EMS* *Ha2: HL*		Park Falls Wisconsin, USA	Skukuza South Africa
		R^2 [NEP]		R^2 [NEE]	R^2 [GEE]
680nm FD	continuous	0.65	ns	0.56 **	0.68 *
680nm FA	continuous	0.69	ns	0.56 **	0.73 *
G31	750, 705	0.76	0.46	0.70	**0.77 ***
NDVI	Av. 760-900, 620-690	0.64	0.29	0.68	0.67
Dmax	D max (650...750 nm)	0.78	0.73	0.84 *	0.74
OSAVI	670, 800	0.71	0.63	0.76	0.72
NDII	819, 1649	ns	ns	0.64 **	0.69
MSR705	445, 750	0.82	0.67	0.71	0.72
PRI3	530, 550	0.73	0.85	0.62	0.43
R685_655	685, 655	0.62	ns	0.54	0.61

* Worked well at other sites (e.g. Mongu, Duke forest and Konza prairie; Campbell et al. 2013)
** Mid-April through mid-October only, with outlier removed

Corresponding Spectral and NEP Phenology



Spectral bio-indicator associated with chlorophyll content best captured the CO_2 dynamics related to vegetation phenology. Required multitemporal data set.

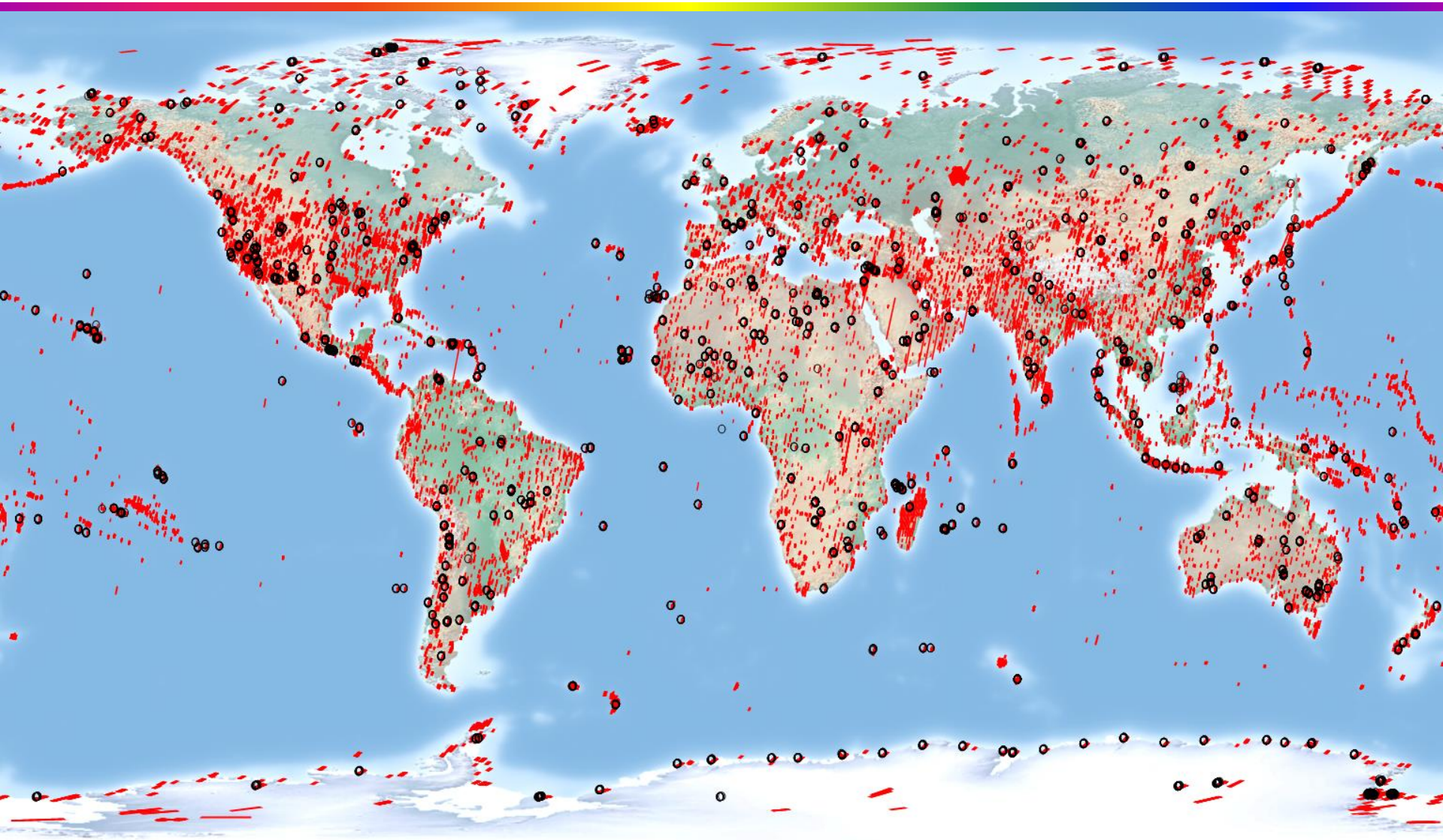
Mongu : Campbell et al. 2013

Conclusions

- The results indicate a strong correlation between CO_2 flux parameters and Hyperion's spectral parameters associated with chlorophyll and photosynthetic function.
- The spectral parameters associated with photosynthetic dynamics across all sites require continuous spectra.
  - In the conifer forests chlorophyll levels do not change as significantly as in the deciduous forest. In the hemlock forest (Ha 2: HL) phenology was traceable with the PRI3 SBI, when in the deciduous canopies (Ha1: EMS, Park Falls and Skukuza) derivative and feature depth SBIs performed better.
- The approach requires a diverse spectral coverage representative of the seasonal dynamics in vegetation function.

This study provides a step toward a common (global) hyperspectral strategy to monitor the vegetation ability to uptake CO_2.

Locations with >10 Hyperion Acquisitions



Spectral Parameters and LUE, Skukuza