



Goddard  
SPACE FLIGHT CENTER

# EO-1 Hyperion spectral time series for assessment of ecosystem function

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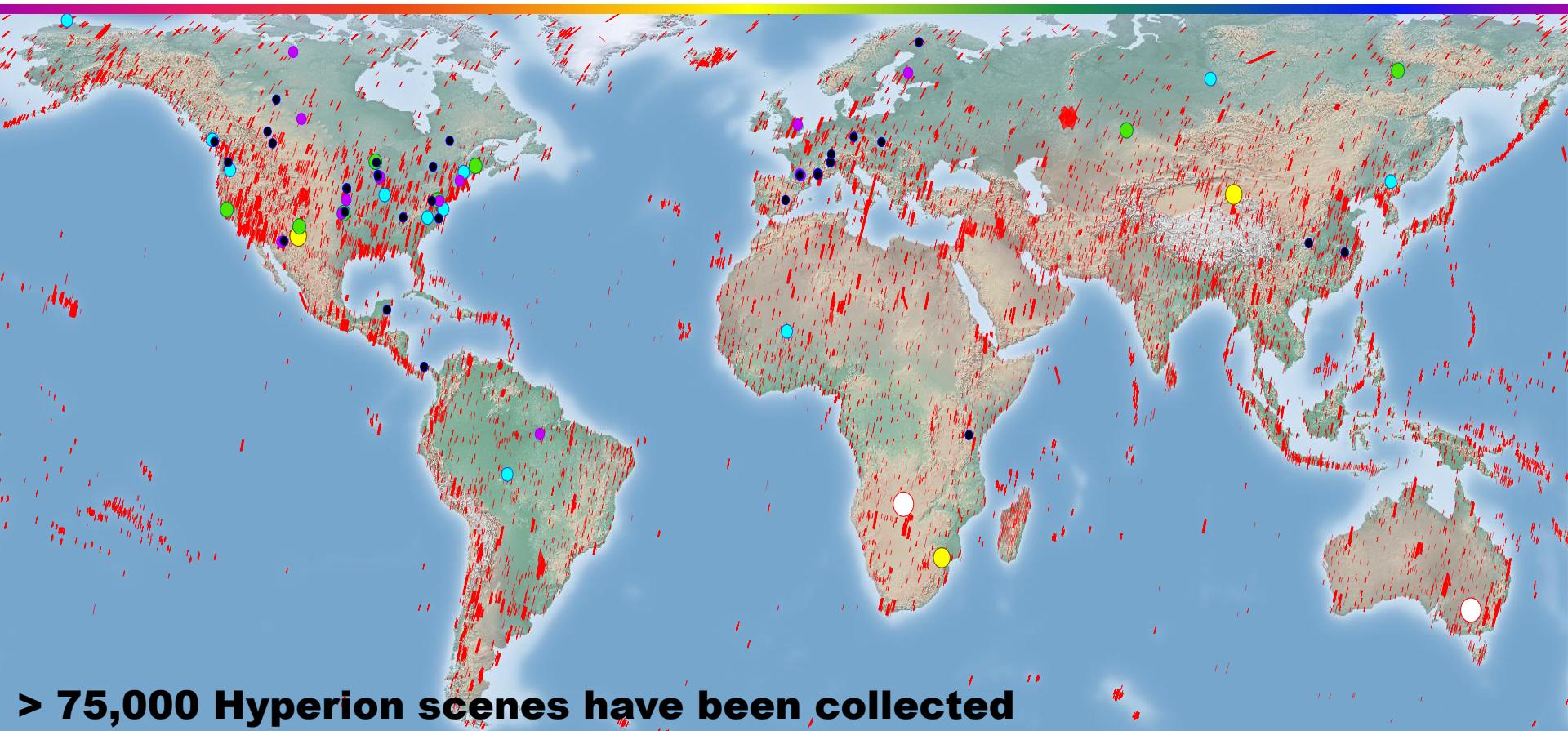
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<sup>2</sup> University of Maryland Baltimore County

<sup>3</sup> USGS



# *EO-1 Time Series at FLUX Sites*

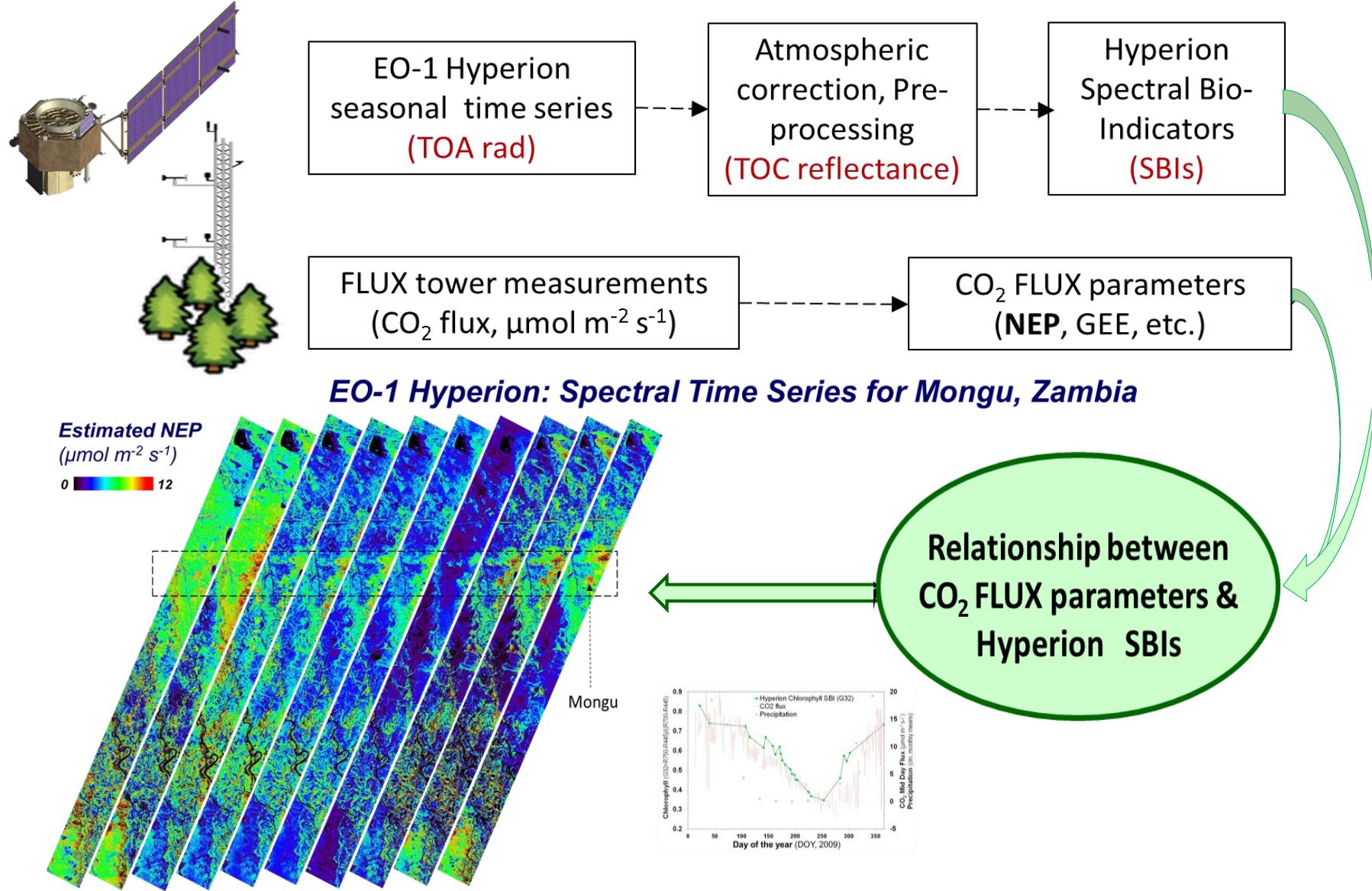


**> 75,000 Hyperion scenes have been collected**

**FLUX site locations and number  
of Hyperion cloud free images**

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

# Processing Workflow



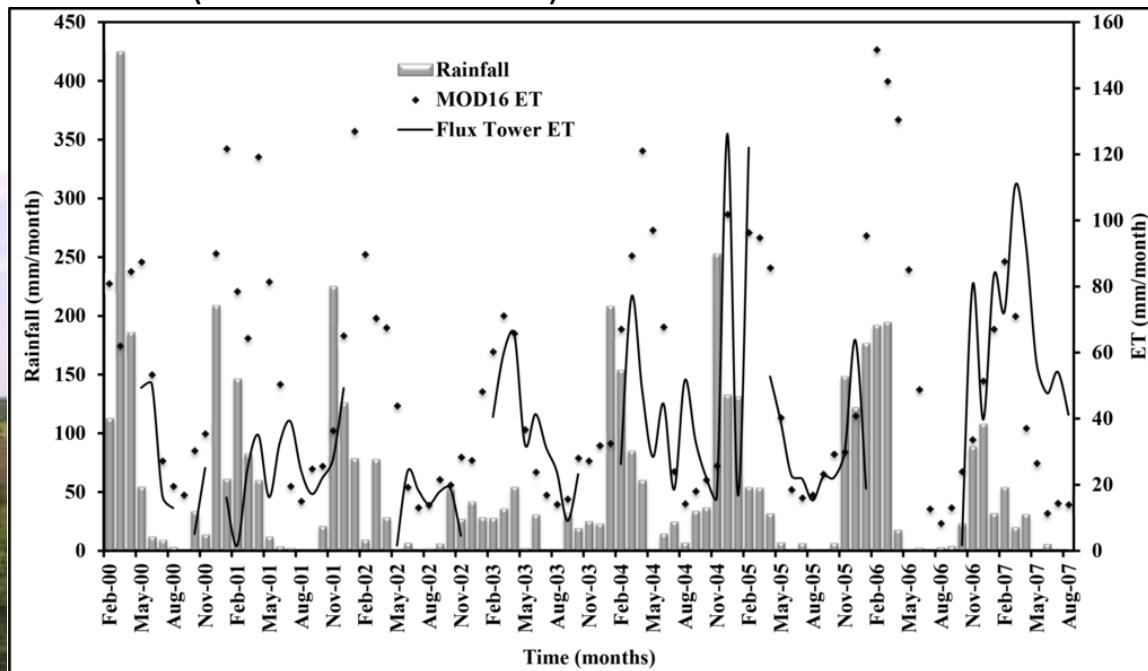
# Skukuza(ZaKru) - Study Site and Data



Year	Feb	Mar	Apr	May	Jun			Jul			Aug			Sep			Oct			Dec
2008											228	241	246	254	259	277	282	287		
2009								198	208		234	239			260	278		350		
2010	44			145	155	173	176	194	199	212	222	235				284	292		336	
2011		100	131	144		175	188				232	245	253			279	318			
2012	70	96	122	135	138	143	151	164	182	216	232	237	253	271	274	321	355			
2013	10	68	123							205	242	263	276	279	284	305				
2014			110					198			257									

## EO-1 Hyperion data by Year and DOY

Monthly time series comparison of MOD16 and Skukuza flux tower ET (Ramoelo et al. 2014)



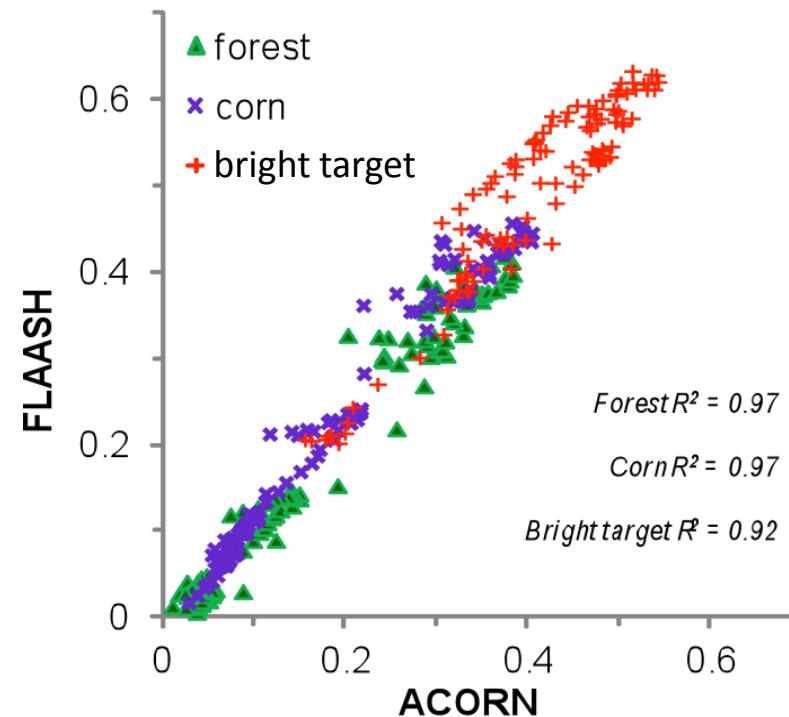
# $\text{CO}_2$ Flux Data Processing

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- Net Ecosystem Production (NEP,  $\mu\text{mol m}^{-2} \text{s}^{-1}$ ) is the  $\text{CO}_2$  absorbed by the vegetation, measured by the flux tower.
- Ecosystem Respiration (Re) was calculated from relationships developed between nighttime Net Ecosystem Exchange (NEE) and air temperature.
  - For Mongu, soil moisture was also used to determine Re
- Gross Ecosystem Production (GEP) is calculated from the observed NEE and Re.

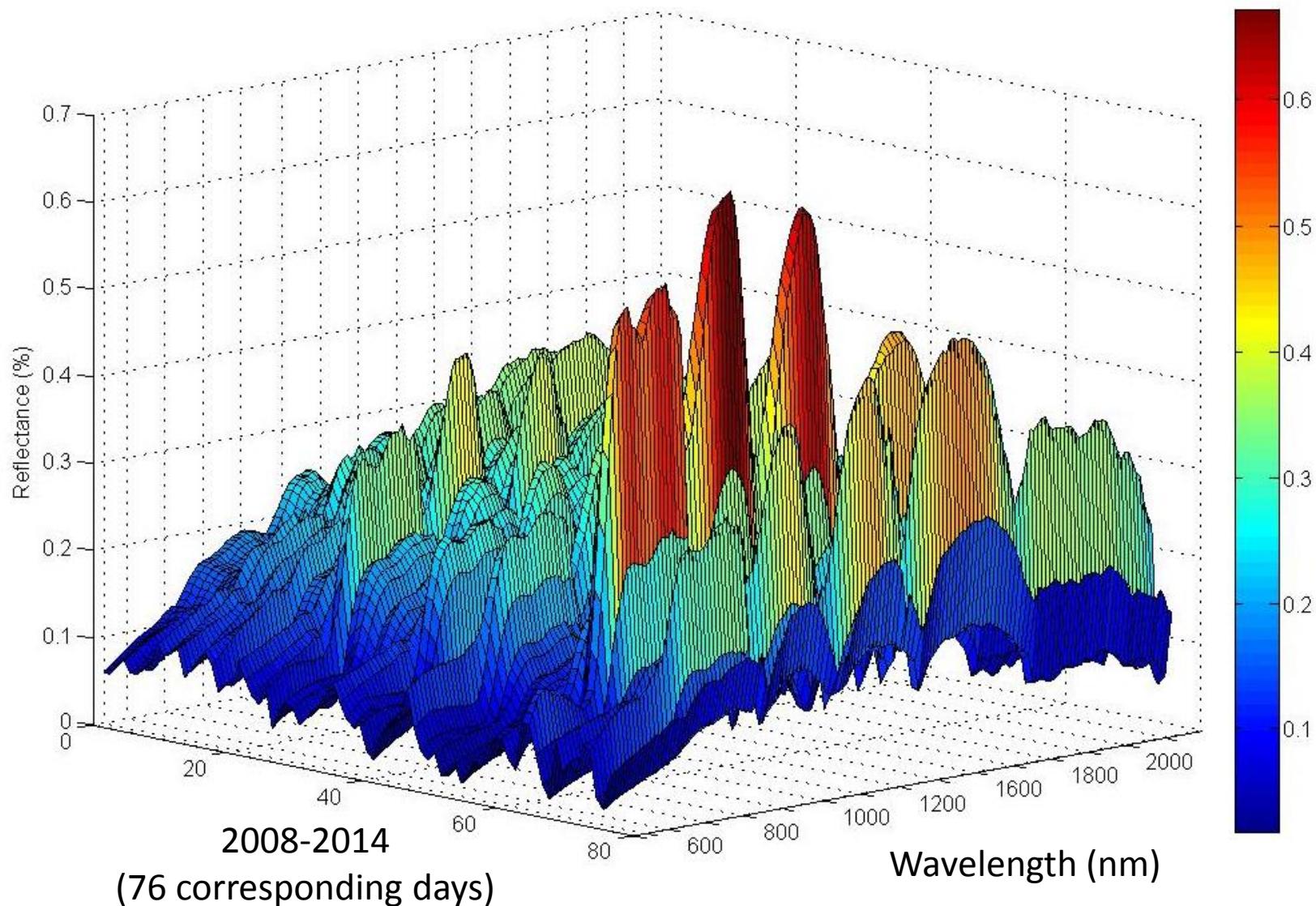
# Correction for Atmospheric Effects

*Hyperion radiance images  
are corrected for  
atmospheric effects to  
surface reflectance using  
the Atmosphere CORrection  
Now, ACORN software.*

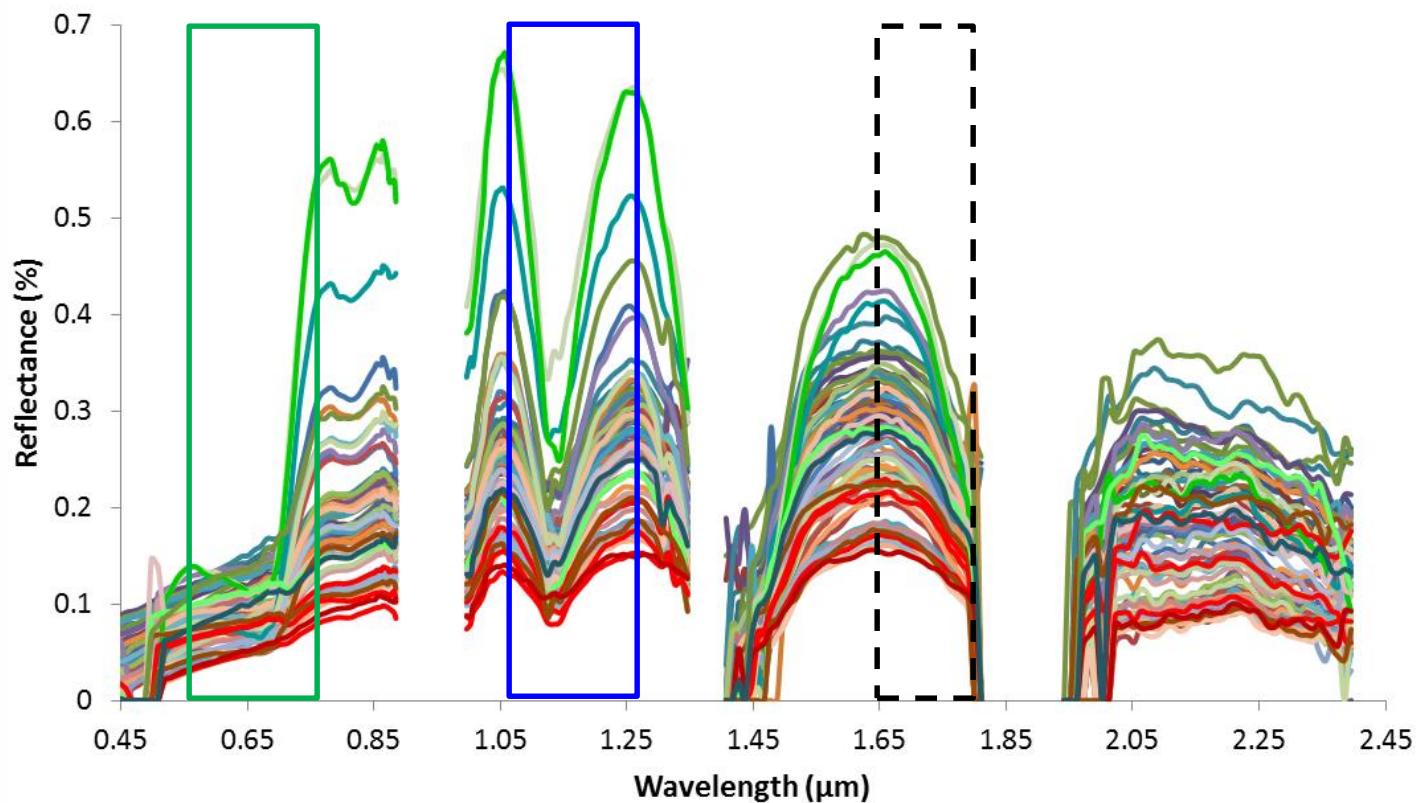


A comparison of images corrected with ACORN and FLAASH (available at <http://eo1.geobliki.com>) reveals relatively similar results ( $r^2 \sim 0.92\text{--}0.99$ ) for different geographical areas and covers. The axes indicate the reflectance value (0-1).

# EO-1 Hyperion Reflectance at Skukuza (ZaKru FLUX Site)

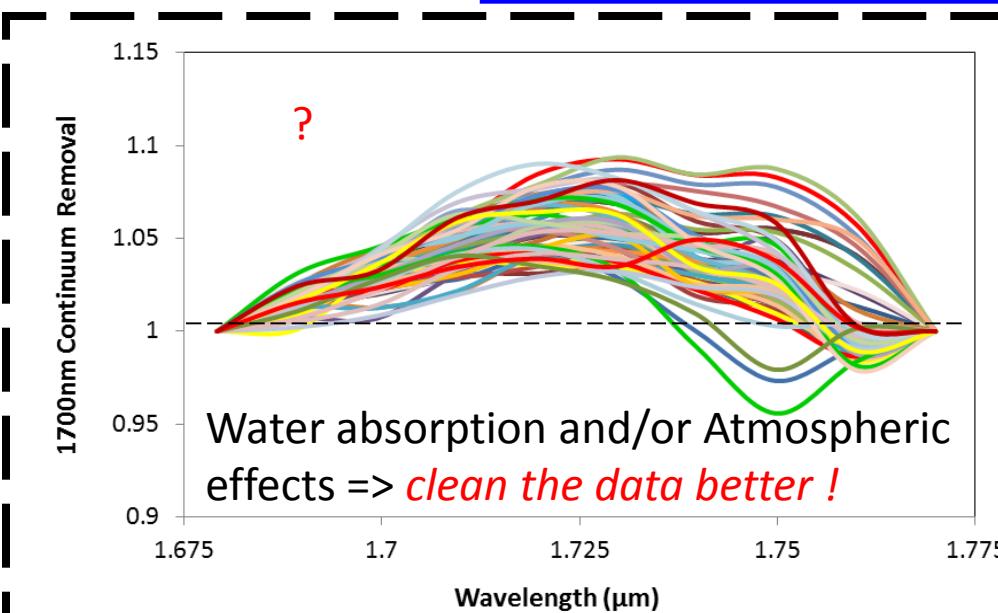
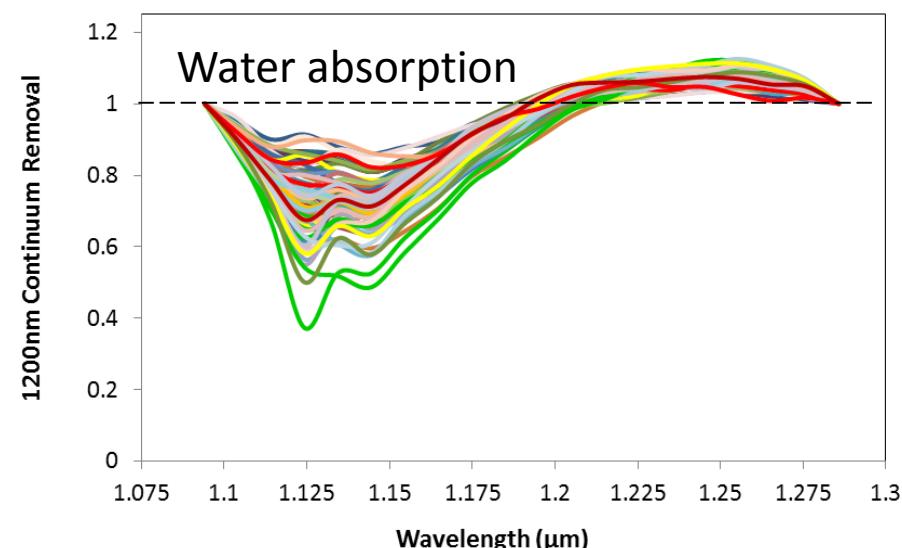
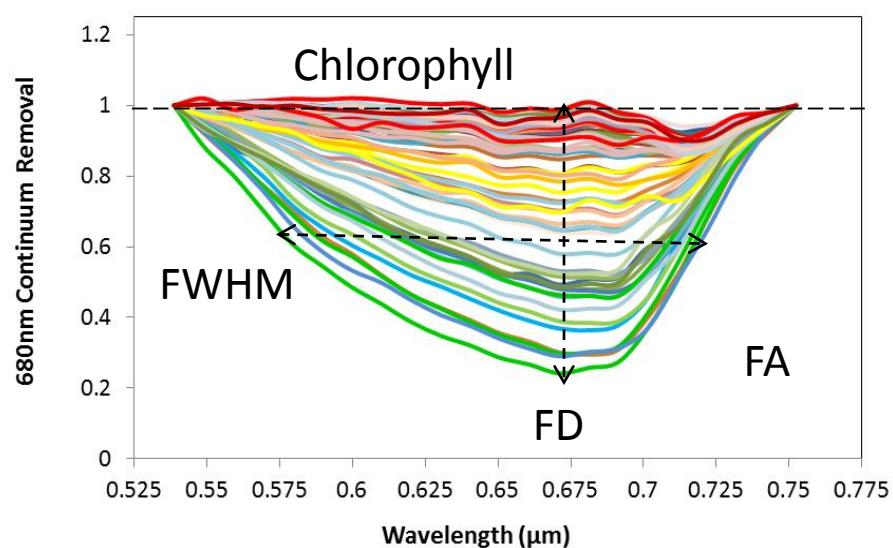


# Changes in EO-1 Hyperion (%)



- 2008\_159
- 2008\_167
- 2008\_177
- 2008\_185
- 2008\_190
- 2008\_208
- 2008\_218
- 2008\_228
- 2008\_241
- 2008\_246
- 2008\_259
- 2008\_277
- 2008\_282
- 2008\_287
- 2009\_203
- 2009\_239
- 2009\_278
- 2010\_44
- 2010\_155
- 2010\_176
- 2010\_199
- 2010\_222
- 2010\_235
- 2010\_284
- 2010\_336
- 2011\_144
- 2011\_188
- 2011\_245
- 2011\_279
- 2012\_70
- 2012\_122
- 2012\_138
- 2012\_151
- 2012\_182
- 2012\_232
- 2012\_253
- 2012\_274
- 2012\_355
- 2013\_68
- 2013\_10
- 2013\_123
- 2013\_236
- 2013\_242
- 2013\_279
- 2013\_305
- 2014\_110
- 2014\_198

# Changes in Vegetation Features in EO-1 Hyperion Spectra

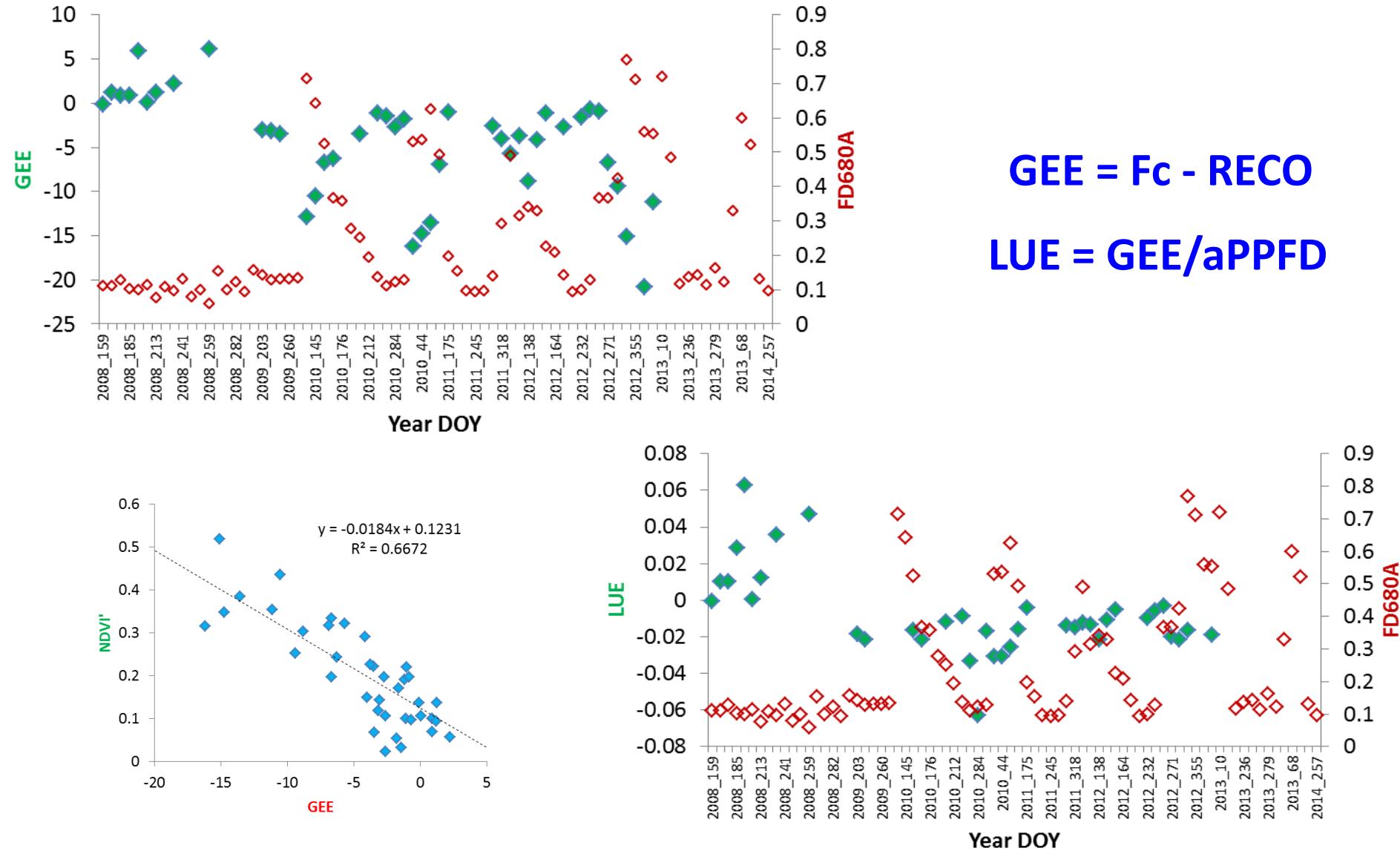


# EO-1 Hyperion Spectral Parameters

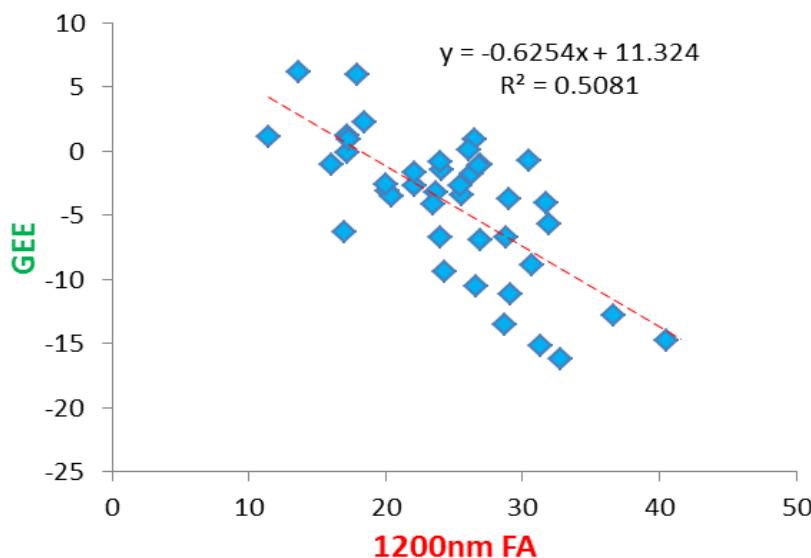
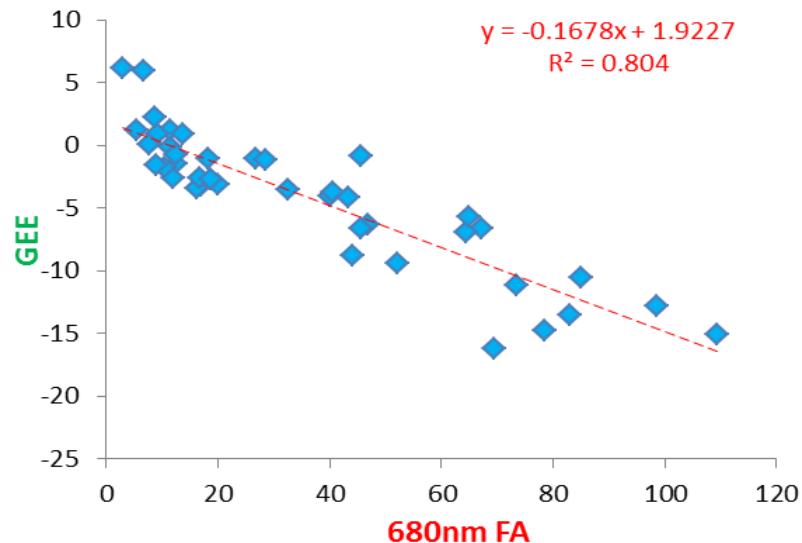
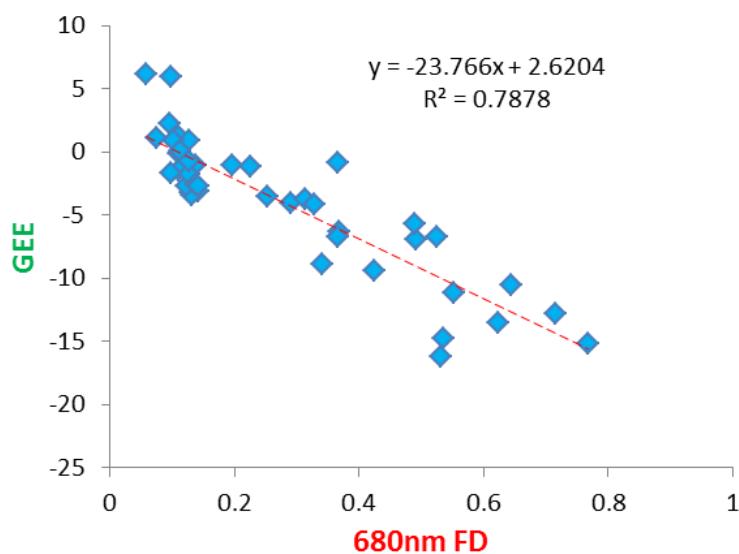
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Spectral parameters	Description / Formula
680 FD	Depth of the CR feature
680 FA and 1200 FA	Area of the CR feature
Chl PII	R671, R690, R803
G33	R750:803/R691:742
Dmax	Max D in the 650-750 nm
WBI	$D_{max}/(D_{max} + 12)$
Dmax_Dfr	$(D_{max}-D_{fr})/(D_{max}+D_{fr})$

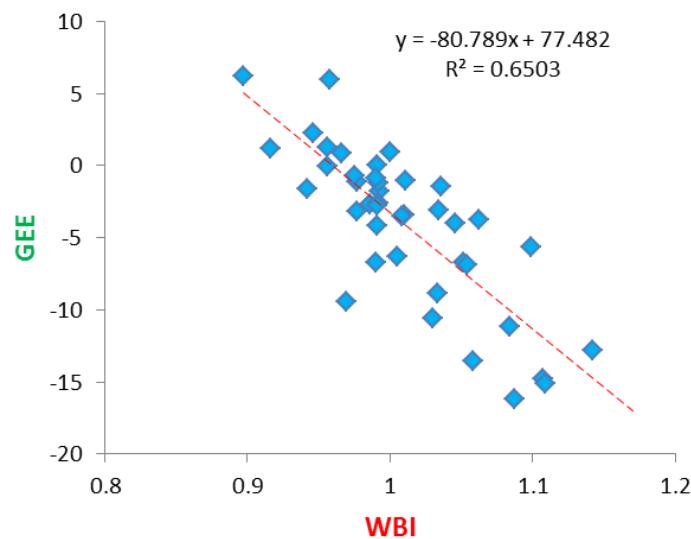
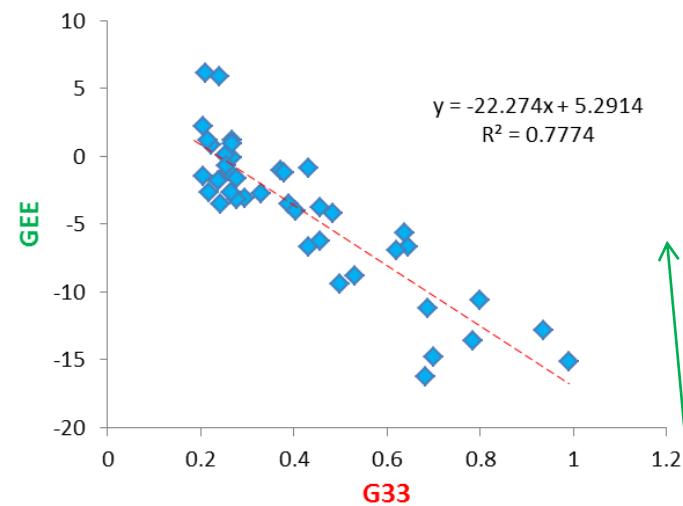
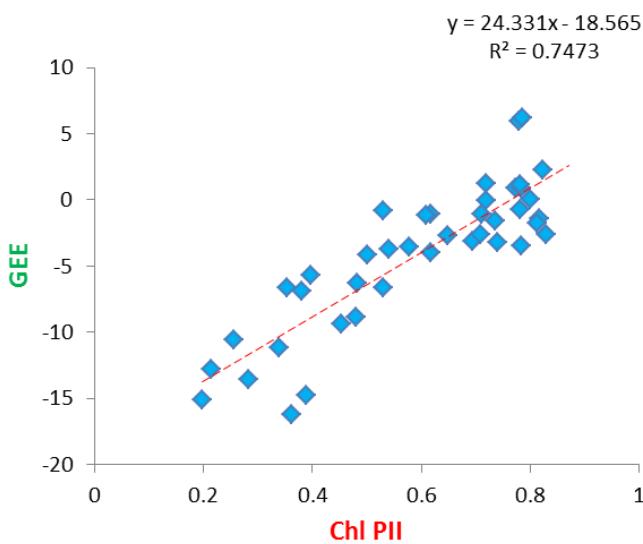
# Spectral Time Series at Skukuza



# Relationship between Spectral Features and GEE

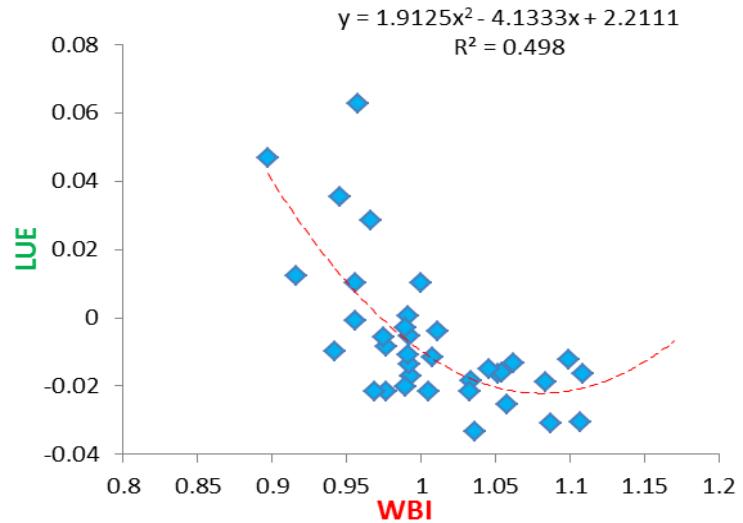
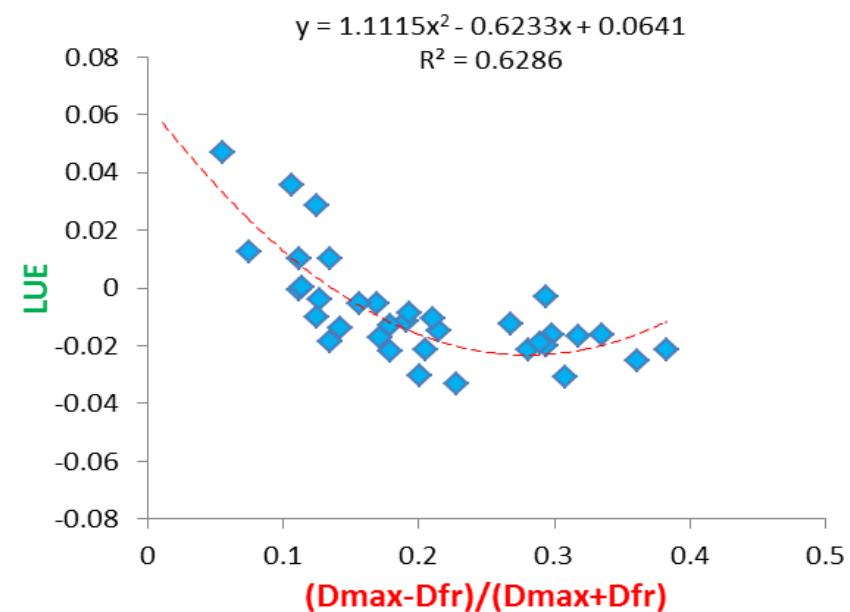
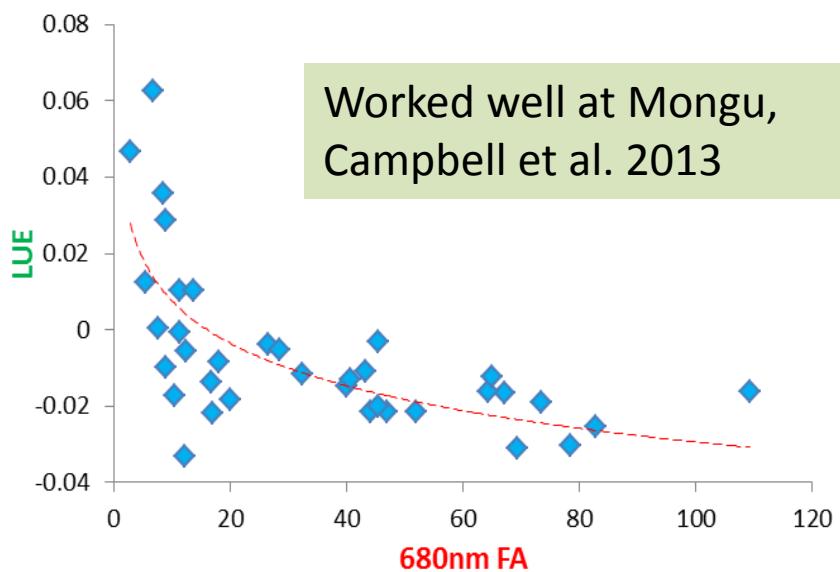


# Relationship between Spectral Indices and GEE



Worked well at Mongu,  
Campbell et al. 2013

# Relationship between Spectral Parameters and LUE



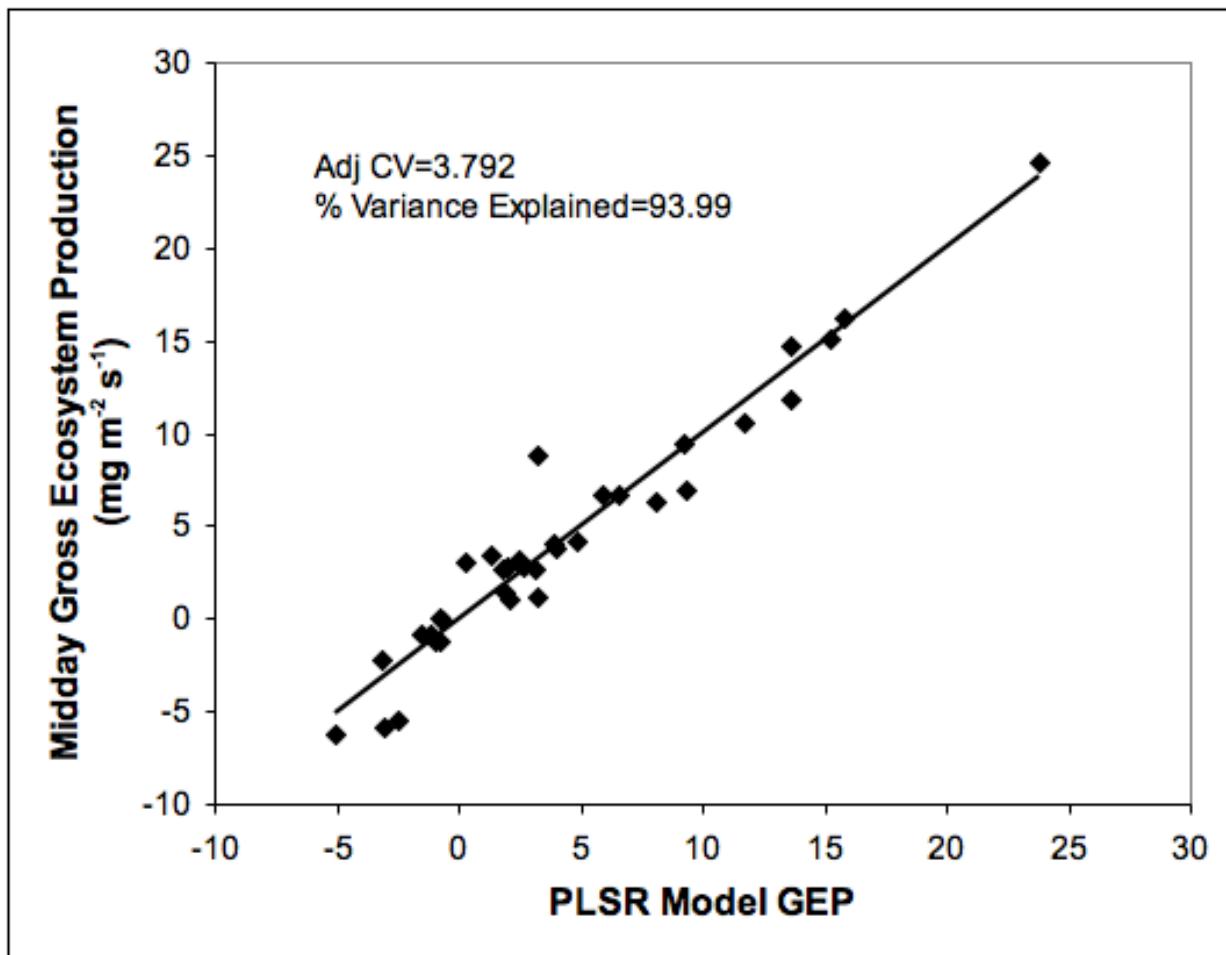
# Regression Coefficients for the Top Performing Spectral Parameters ( $R^2$ values)

Spectral Parameters	$R^2$ to GEE
680nm FD	0.79 *
680nm FA	0.80 *
1200nm FA	0.51
Chl PII	0.75 *
G33	0.78 *
WBI	0.65
NDVI	0.67

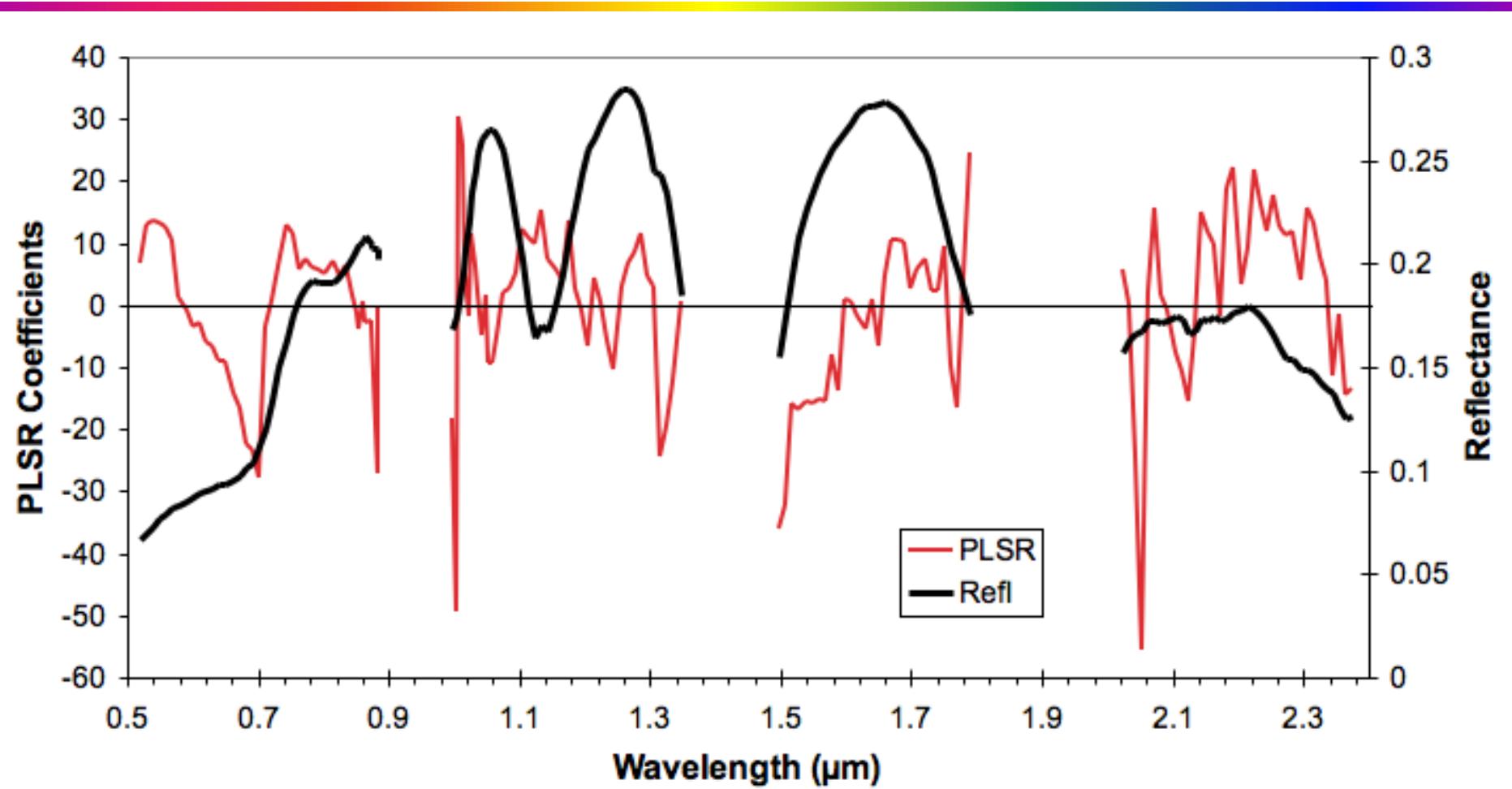
Spectral Parameters	$R^2$ to LUE
680nm FA	0.49
Dmax_Dfr	0.63 *
WBI	0.50

Worked well at Mongu,  
Campbell et al. 2013

# 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)



# Future Work

Site	Images		Site	Images		Site	Images		
	Total	Clear		Total	Clear		Total	Clear	
Tapajos (LBA: Santarem)	267	21	Metolius/Cascades, OR	101	37	Bily Kriz Beskidy (spruce)	22	5	
Skukuza	258	91	Jasper Ridge	98	44	BCI	17	0	
Uardry	238	132	Bartlett	★	91	24	Audubon	12	8
Mongu	227	135	Duke forest, HW	89	34	Milk river, Rangeland	11	5	
Prk Falls, WI LTER	224	55	Hyytiala	★	87	15	Walnut Gulch /Kendall	9	7
★ BC DF49, Campbell River	180	38	Virginia coastal reserve	84	36	Santa Rita Grassland	9	7	
Barrow	176	31	Hackett River	82	18	Dyn_Agra_(Crop_land)	8	2	
Howland forest ★	171	42	Madison WI	★	51	15	Wind River Crane, WAS	8	1
Zotino	166	33	Arlington_BF	49	14	ARM/CART SGP	6	8	
Changbaishan	165	40	French agri, site 3	44	15	NC Loblolly plantation	6	3	
JI-Parana(Jaru-LBA)	163	39	BERMS_SSA	42	13	BC Young, Campbell River	6	2	
Dunhuang	158	78	French savanna, Mali	36	26	Baraboo Hills	6	1	
★ BARC (USDA corn N)	130	48	Konza prairie	36	13	Oil sands	6	1	
ARM/CART Ponca City	123	47	French agri, site 1	36	10	Mead US-Ne1	5	4	
Jornada	115	72	Sian Kaan	36	1	Mead US-Ne2	5	4	
Shortandy, Kazhstan	115	42	SERC	34	9	ARM/CART Shider	5	3	
Barton Bendish	112	17	Sodankyla	30	4	Barrax	5	2	
Bondville	111	32	Thor, IT (Micol1)	28	0	Oak Ridge, Tennessee	5	2	
Sevilleta	103	57	Micol2	28	0	Blackhawk island	5	1	
Yakitsk Larch	101	49	Harvard Forest	★	25	13	Mead US-Ne3	4	3