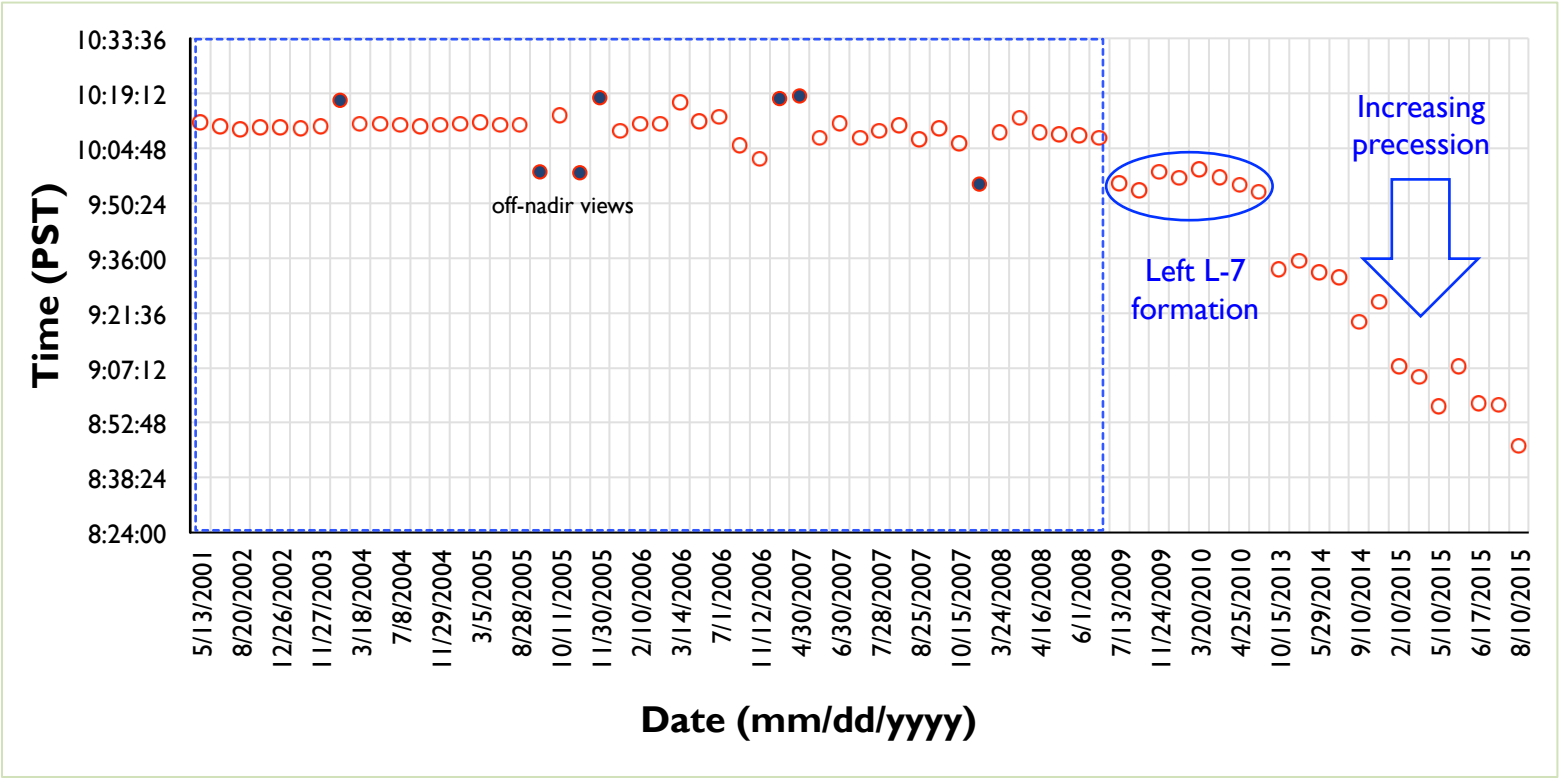
EO-1 END OF MISSION IMPACTS OF CHANGING ILLUMINATION ANGLES ON HYPERION & ALI COLLECTIONS

SHANNON FRANKS, CHRISTOPHER NEIGH, PETYA CAMPBELL, GUOQING SUN, QINGYUAN ZHANG, TIAN YAO AND KARL HUEMMRICH

June 1st, 2016

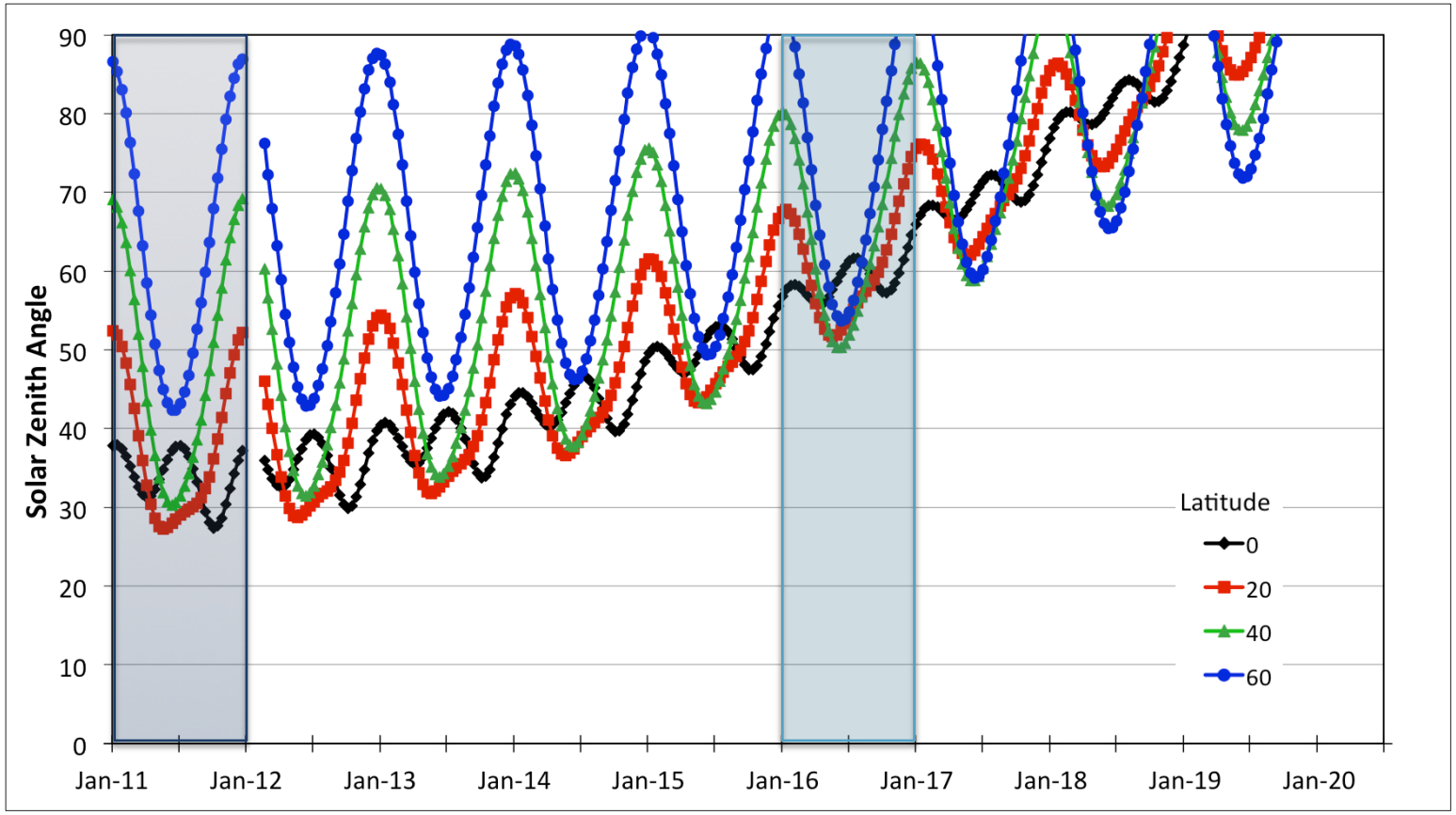
ROLL OF ORBITAL PRECESSION ON LOCAL CROSSING TIMES



- Left A-train formation in 2008
- Completely ran out of fuel in 2011 and precession increased
- Our results are current up to crossing times around 8:40am
- Will reach 8am equatorial crossing times in October, 2016
- Satellite will be decommissioned in early 2017

Solar Zenith Angle at EO-1 Overpass

SZA depends on overpass time, latitude, and date. Changes in overpass times results in SZA already experienced by EO-1 for different latitudes and dates.



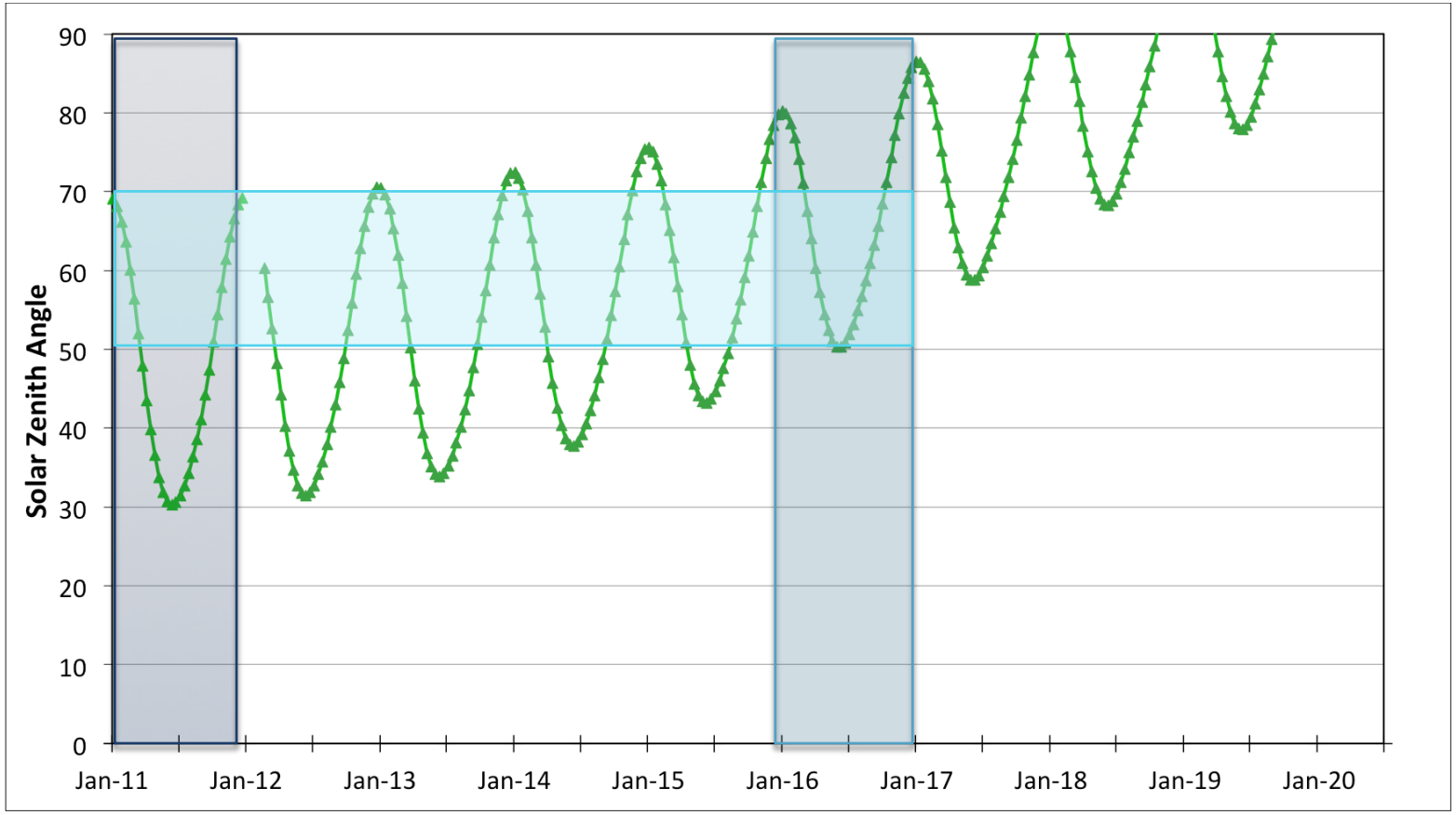
Nominal 10:00 AM Overpass

2016

Lines represent SZA at overpass for different latitude bands

Solar Zenith Angle at EO-1 Overpass 40°N

For 40°N approximately 60% of the time in 2016 the SZA at EO-1 overpass time are within previously experienced range of SZA for that latitude.



Nominal 10:00 AM Overpass

2016

RESEARCH STUDY HIGHLIGHTS

- ALI vs. Landsat 7/8: ALI variability is small and consistent when compared to Landsat NDVI.
- 1st derivative analysis: Although the reflectance varies due to seasonality and other factors, the spectral features are stable.
- Hyperion NDVI (forests): When compared to MODIS, variability is small, less than 10% difference.
- Hyperion reflectance since precession (cal/val site): Hyperion's reflectance is within 0.05 to 0.09 (VNIR and SWIR, respectively) of its mean before precession started. (not going to cover)
- Hyperion via differing correction models: Hyperion reflectance is stable in most bands, independent of 3 atmospheric correction models: <0.05 VNIR and < 0.10 SWIR. (not going to cover)

EO-1 Advanced Land Imager (ALI) NDVI over time

The variability is small (i.e. Δ NDVI < 0.05) and does not increase over mission lifetime.

Landsat date	ALI date
8/15/2015	8/13/2015
8/12/2014	8/9/2014
9/26/2013	9/27/2013
8/6/2012	8/5/2012
8/20/2011	8/27/2011
8/17/2010	8/17/2010
9/23/2009	9/21/2009
9/12/2008	9/9/2008
6/30/2007	6/30/2007
8/11/2002	8/11/2002
5/4/2001	5/4/2001

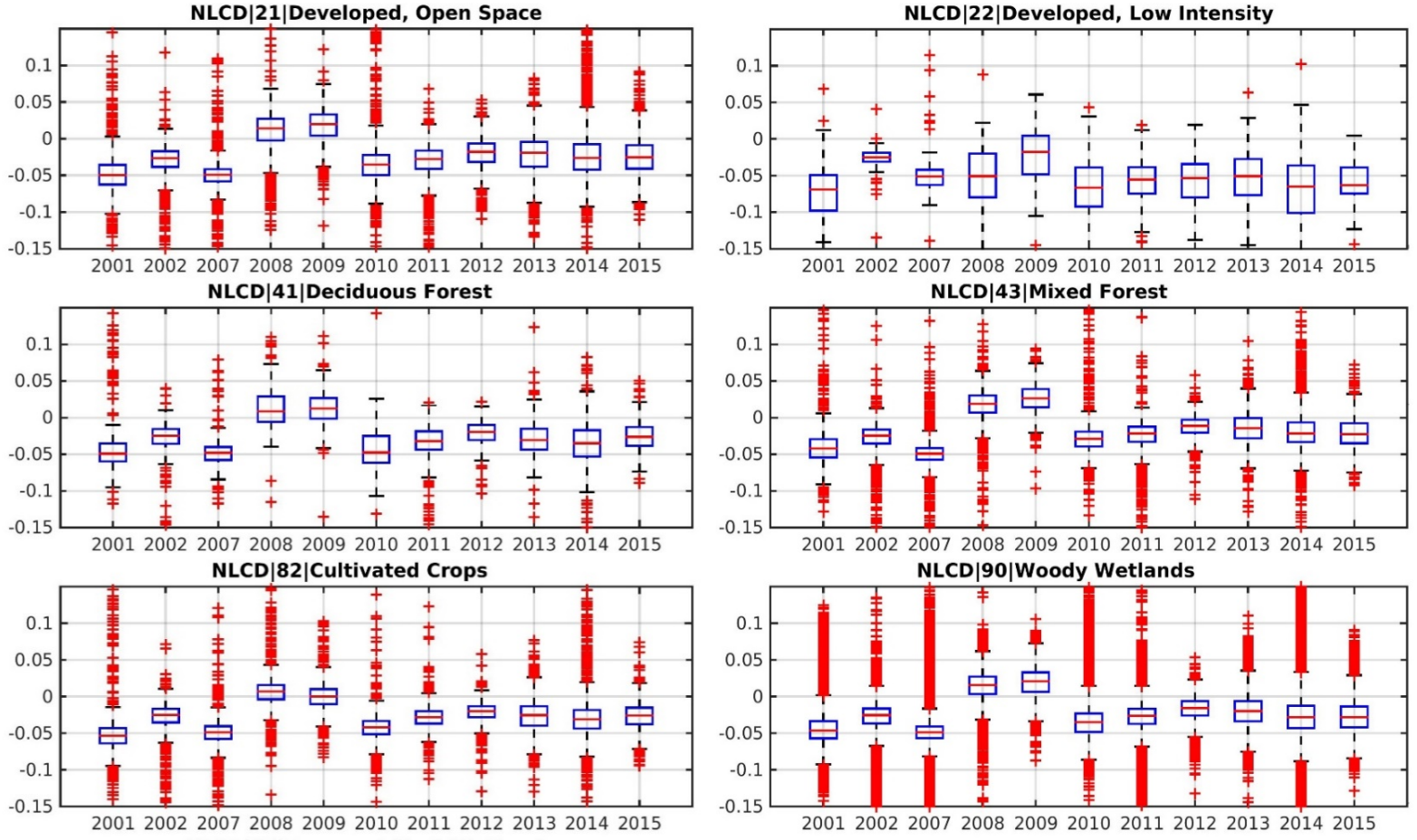
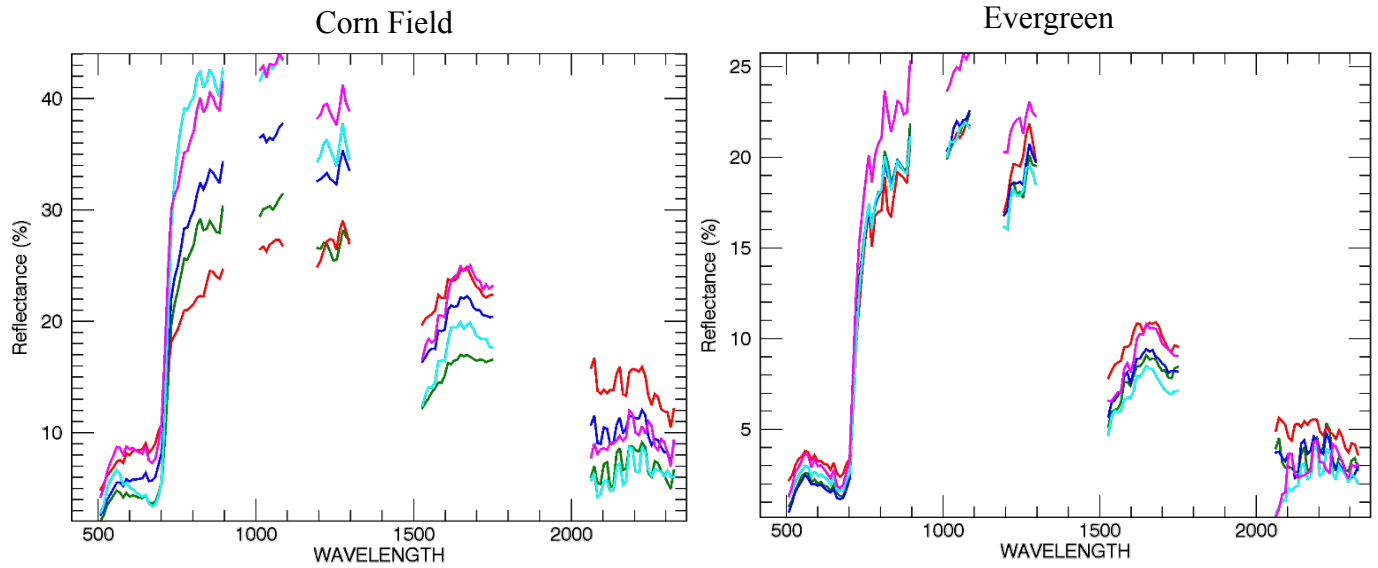
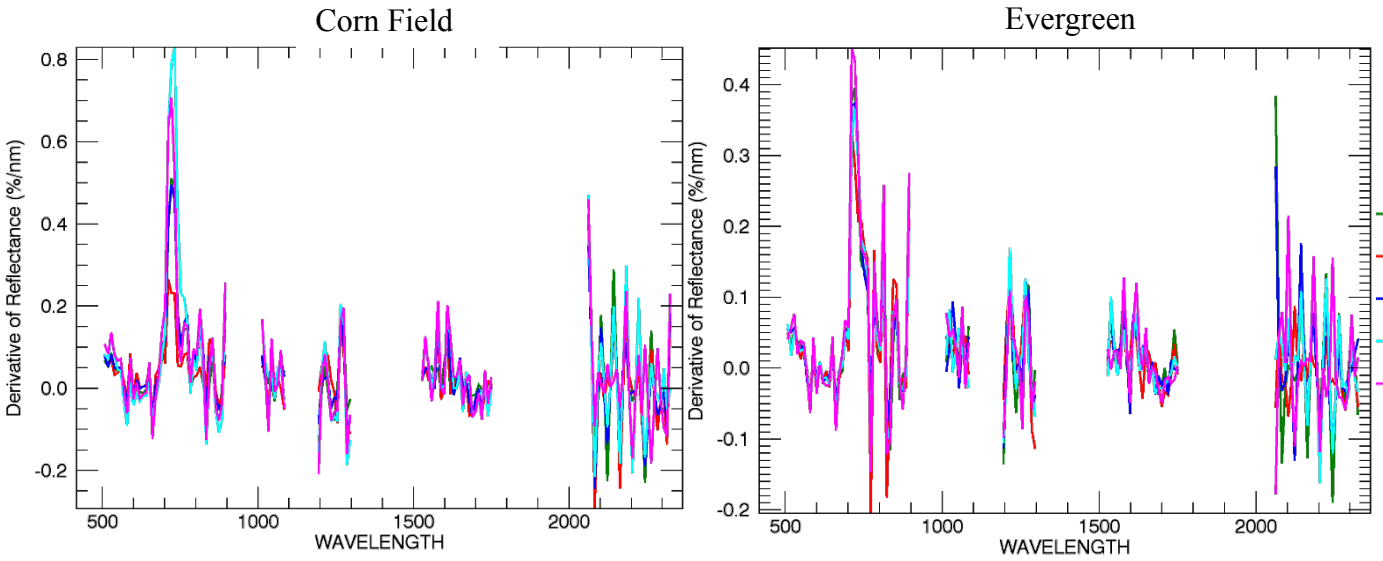


Fig. 1 Statistics for median NDVI difference between Landsat and ALI sensors, per seven National Land Cover Database (NLCD) classes. Red line is median, blue box is quartiles, and red crosses are outliers. NDVI values were derived from Top of Atmosphere (TOA) reflectance.

Reflectance and Its 1st Derivative of EO-1 Hyperion Data (from 2005 to 2015)





Hyperion data acquired at Baltimore-Washington Area (USDA site near GSFC).
The reflectance varies due to seasonal and other factors, but the 1st derivative is stable showing a consistent signal over time.

Date	Acq. Time (GMT)	Off Nadir	Sun Elev.
10/01/2005	15:30	-7.74	43.65
10/05/2008	15:36	8.05	43.21
09/24/2012	15:21	-0.16	45.24
09/28/2014	14:34	-13.3	37.81
07/26/2015	14:15	-2.81	47.24

EO-1 Hyperion NDVI over time in Howland Forest, Maine

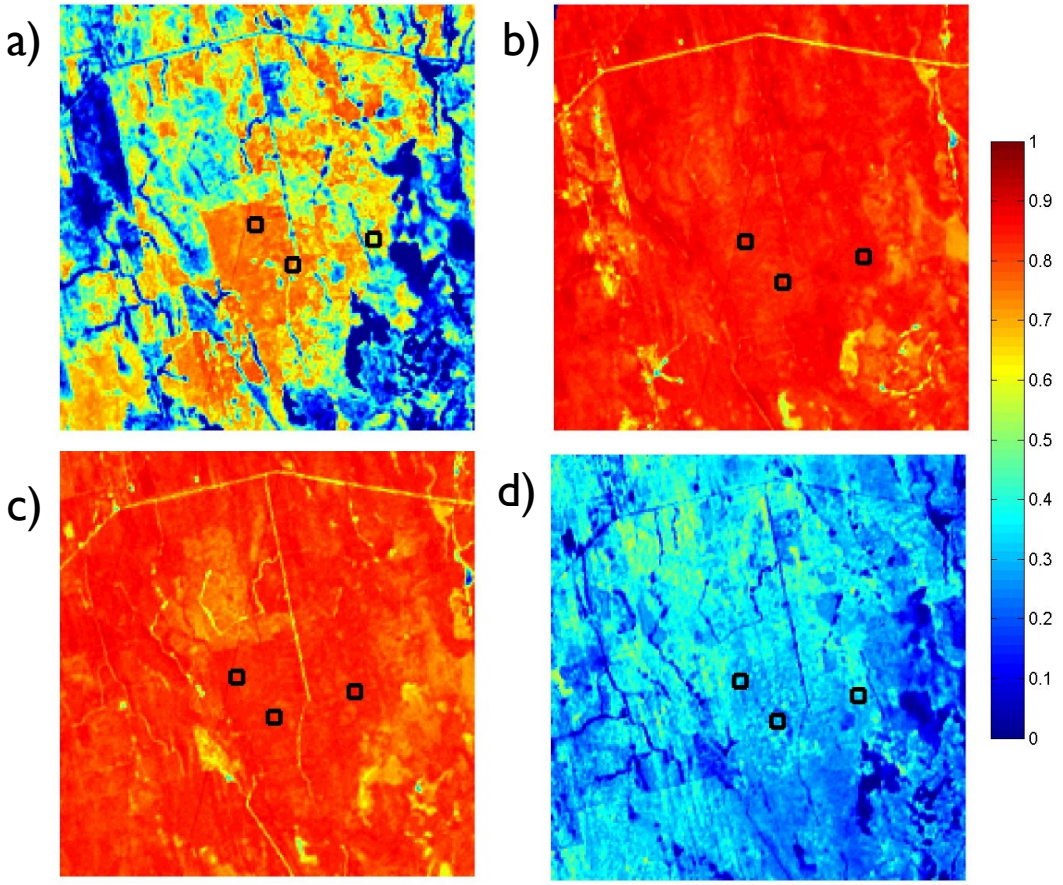


Fig. 1 NDVI maps from EO-1 Hyperion images over the Howland Forest area in Maine across four seasons from: a) Spring (March 5, 2014); b) Summer (Aug. 12, 2014); c) Fall (Sept. 22, 2008); d) Winter (Dec. 9, 2010). Three flux tower sites are indicated with black squares.

EO-1 Hyperion images can provide vegetation phenology in fine spatial scale. The NDVI difference between Hyperion and MODIS is small (i.e. Δ NDVI < 0.10) and does not increase over time.

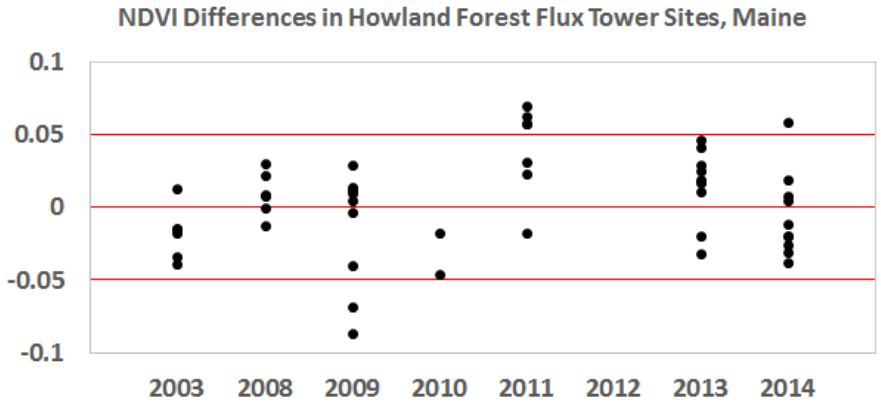


Fig. 2 NDVI difference between Hyperion and MODIS for the three flux tower sites in the Howland forest area of Maine from 2003 to 2014. The selected dates for comparison are July 20, 2003; Sept. 26, 2008; Jan. 10, 2009; May 13, 2009; Dec. 9, 2010; Feb. 22, 2011; Nov. 8, 2011; April 12, 2013; Oct. 29, 2013; March 5, 2014; and Aug. 12, 2014.

SUMMARY

Five independent studies have shown that since EO-1 orbital precession has changed:

- The data quality is not diminishing for either ALI or Hyperion when compared with other highly calibrated and stable sensors.
- The variability is within 5% for the VNIR and within 10% for the SWIR wavelengths.
- This variability is not seriously affected by various atmospheric correction techniques, which is encouraging for time-series analysis.