

What's Needed to Make Full Use of Sentinel-2 Data?



(1) User access to S2 L1C Data (USGS/Dwyer)

(2) MSI Characterization & cross-calibration with Landsat-8 (this presentation)

(3) Applications and Higher-level Products

- Prototype merged Landsat + S2 reflectance product (Vermote/LcPSO)
- “Augmentation” awards to NASA investigators (next slide)
- Recent NASA LCLUC solicitation for multisource land imaging science
 - Coordinated with ESA SEOM (Scientific Exploitation of Operational Mission) program
 - Multi-year investment in new products from fusion of international systems, including Sentinel

NASA FY14 Augmentation Teams



Team	Investigation
Helder	Improved use of PICS sites including BRDF modeling & characterization; Improved use of vegetated calibration sites; Relative gain estimation via lifetime averaging
Czapla-Myers	BRDF measurements of US PICS/calibration sites; Analysis of Sentinel-2 prelaunch calibration data
Markham	Support for analysis of MSI performance data; coordination of Cal Team
Schott	DIRSIG simulations of Sentinel-2 + Landsat time series, including BRDF variability; testing BRDF corrections
Vermote/Claverie	Atmospheric correction approach for MSI (accelerates effort, initial funding currently from LcPSO)
Justice/Claverie	Prioritization of higher-level products for NASA Land Science
Schaaf	BRDF corrections for MSI
Woodcock	Assessment of Copernicus Higher-Level Products strategy; MSI cloud cover algorithm
Roy	Regridding/Projection approach for MSI & merged products; compositing approaches
Ganguly/Dungan	Biophysical algorithm approaches for MSI; NEX programming & systems support

Period of performance: ~April 2014 - April 2015

Sentinel-2 MSI Comparison to Landsat-8 OLI: Data Characteristics and Radiometric Calibration



- Exchanged mission and data quality information between USGS/NASA calibration team and ESA Sentinel-2 team members in meeting in November (in conjunction with PECORA conference)
- Working with CNES (Lacherade, Meygret) to enter Landsat-8 OLI data into SADE and perform cross calibrations with MODIS and MERIS (Barsi)
 - Also CNES working cross calibrations with Pleiades – 1B via moon (Ong)
- Evaluated near-simultaneous acquisition opportunities between MSI and OLI based on ESA provided planned orbit and USGS Landsat-8 Flight Dynamics Group calculations (Barsi)
- Completed measurements of MSI diffuser witness samples (in Code 618 Diffuser Lab; Butler, Georgiev); coordinating comparison of GSFC, University of Arizona (Biggar), and ESA reflectance measurement comparisons (Ong)

ESA-NASA-USGS Sentinel-2 and Landsat Bilateral Meeting: ESA Presentations



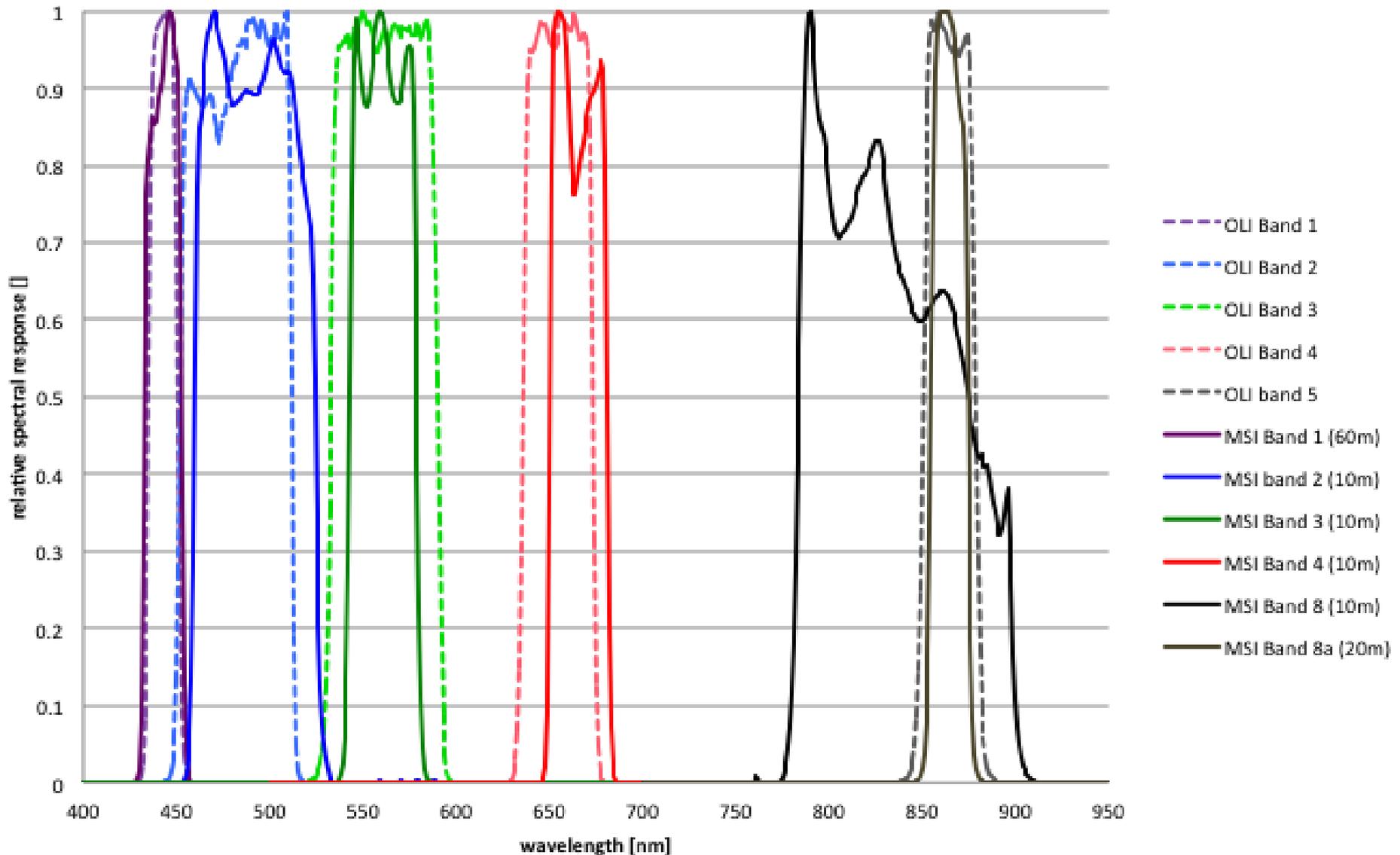
- **Sentinel-2: heading towards launch [mission overview and status], *Francois Spoto (S2 Project Manager) & Bianca Hoersch (S2 Mission Manager)***
- **Sentinel-2 MSI Pre-launch performance characterization and calibration, *Valérie Fernandez (S2 MSI System Engineer)***
 - *SNR, RSR, MTF data provided*
- **Sentinel-2 Calibration/Validation during In-Orbit Commissioning and Operational Phases, *Philippe Martimort (S2 Mission Engineering & Payload Manager), Ferran Gascon (S2 Data Quality Manager)***

Sentinel-2 MSI; Landsat-8 OLI Comparison



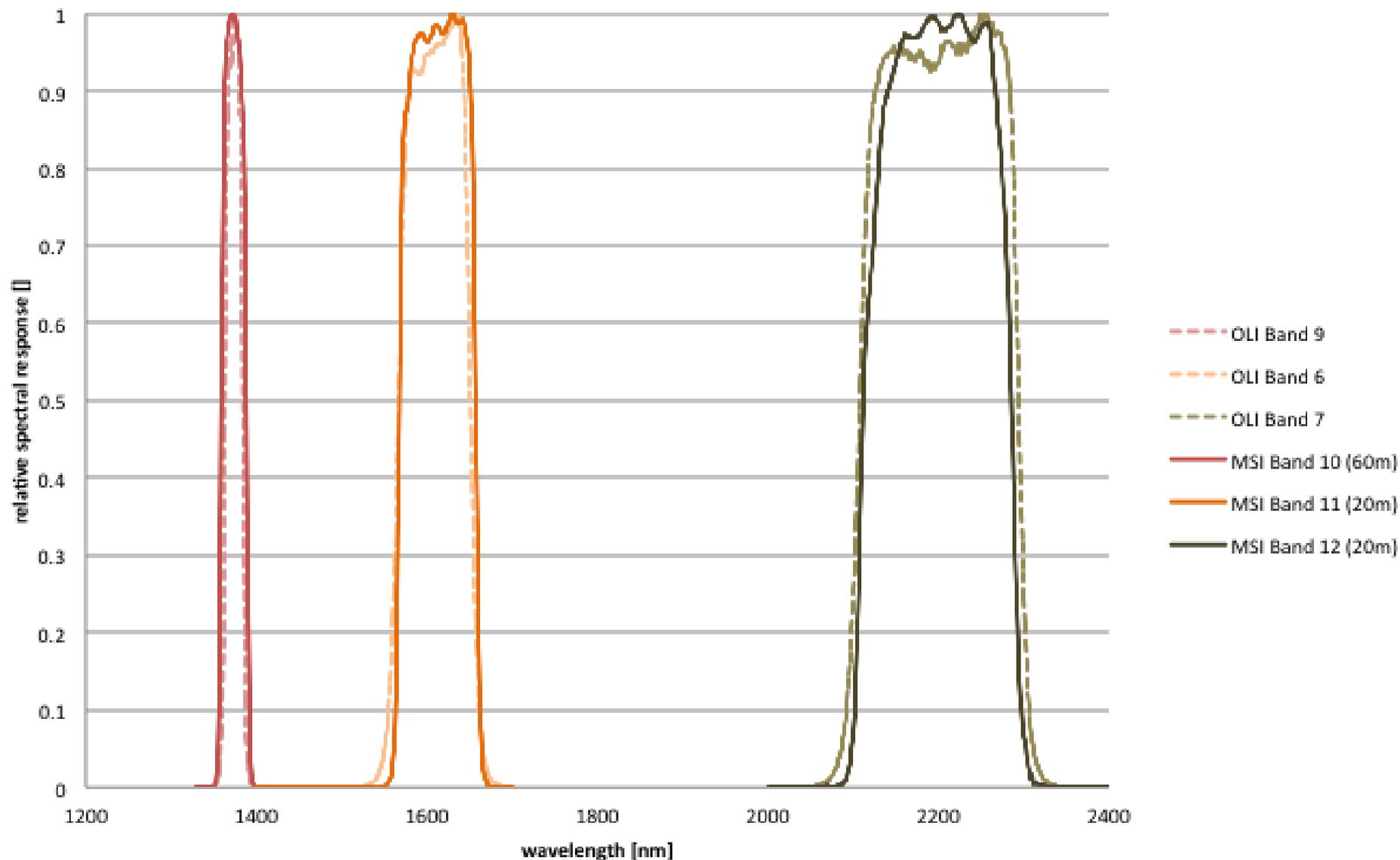
Parameter	MSI	OLI
Swath	290	185
Repeat Cycle	10 (5)	16 (8)
Field of View	20.6°	15°
Equatorial Crossing	10:30 AM	10:13 AM
Spectral Coverage	440-2300 nm	440-2300 nm
Spectral Bands	13	9
IFOV	4 VNIR Bands @ 10 m 6 Bands @ 20 m 3 Atmospheric Bands @ 60 m	8 Bands @ 30 m 1 Pan Band @ 15 m
Data Quantization	12 bits	12 bits
Saturation Radiances	~100% diffuse solar	~100% diffuse solar

OLI/MSI Relative Spectral Response - Similar VNIR Bands



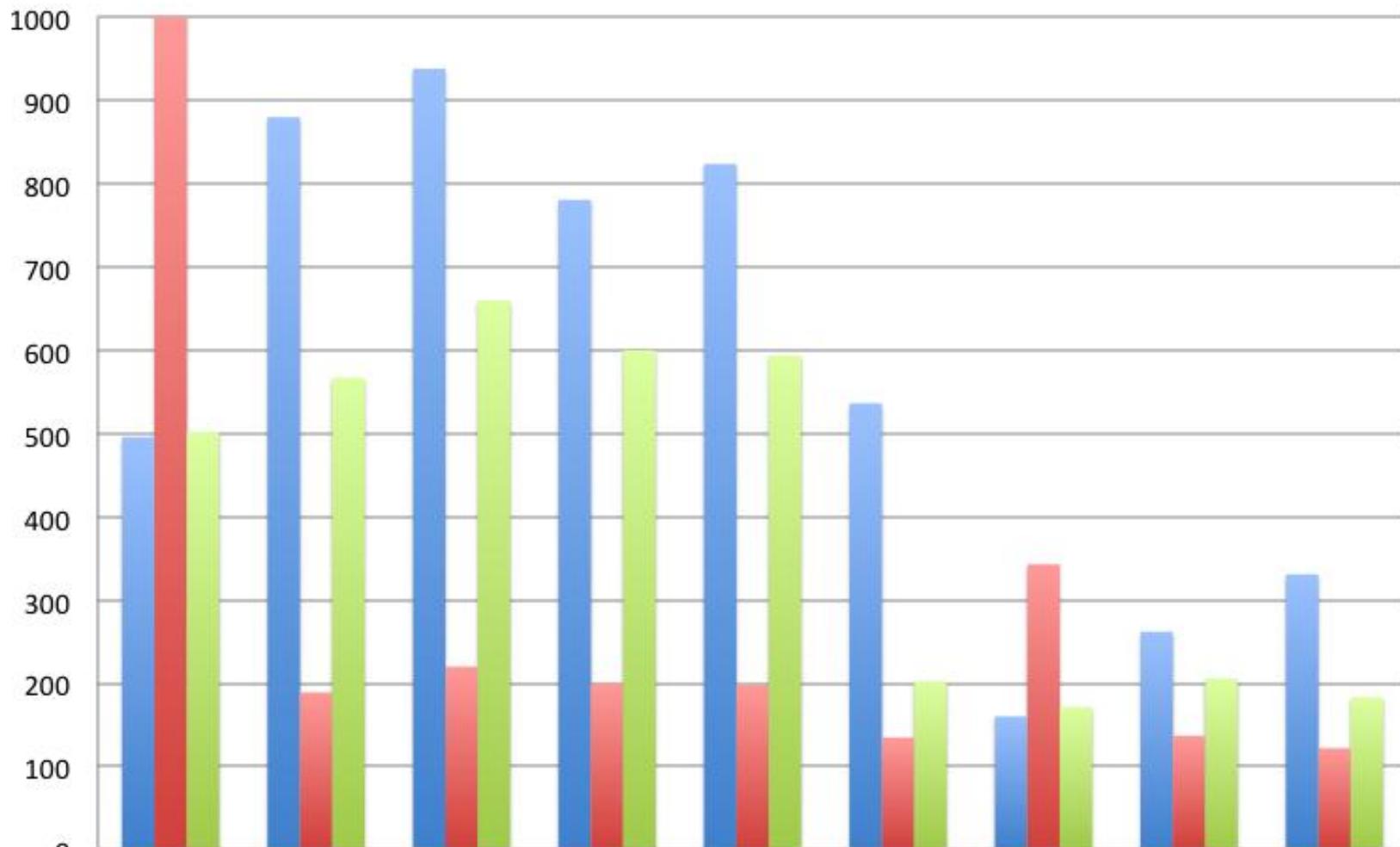
OLI data – instrument level data (as published); MSI – FPA level data (as published) – to be updated

OLI/MSI SWIR Relative Spectral Response - Similar Bands



OLI data – instrument level data (as published); MSI – FPA level data (as published) – to be updated

OLI and MSI SNR @MSI Lref (median for OLI; mean for MSI)



SNR

	1 (443) 1 (443)	2 (482) 2 (490)	3 (561) 3 (560)	4 (655) 4 (665)	5 (865) 8 (842)	5 (865) 8a (865)	9 (1374) 10 (1375)	6 (1608) 11 (1610)	7 (2201) 12 (2190)
OLI	496	880	938	781	824	536	160	262	331
MSI - Native Resolution	1004	189	220	200	198	135	343	137	122
MSI - Adjusted to 30m	502	567	660	600	594	203	172	206	183

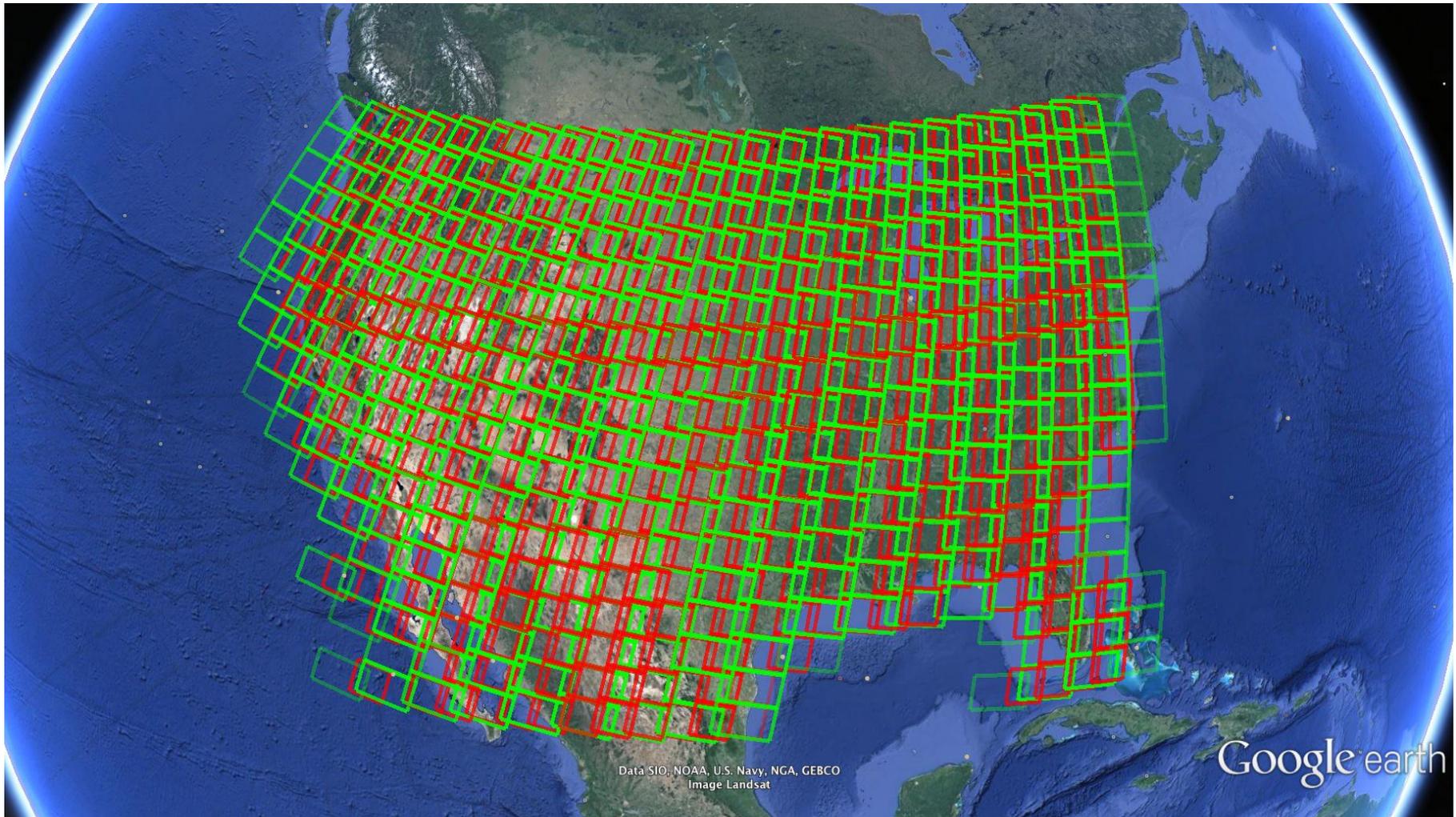
OLI On-Orbit performance; MSI performance predicted from FPA measurements (Chorvalli et al, 2013) – to be updated

Cross-Calibration Opportunities: Orbit Analysis



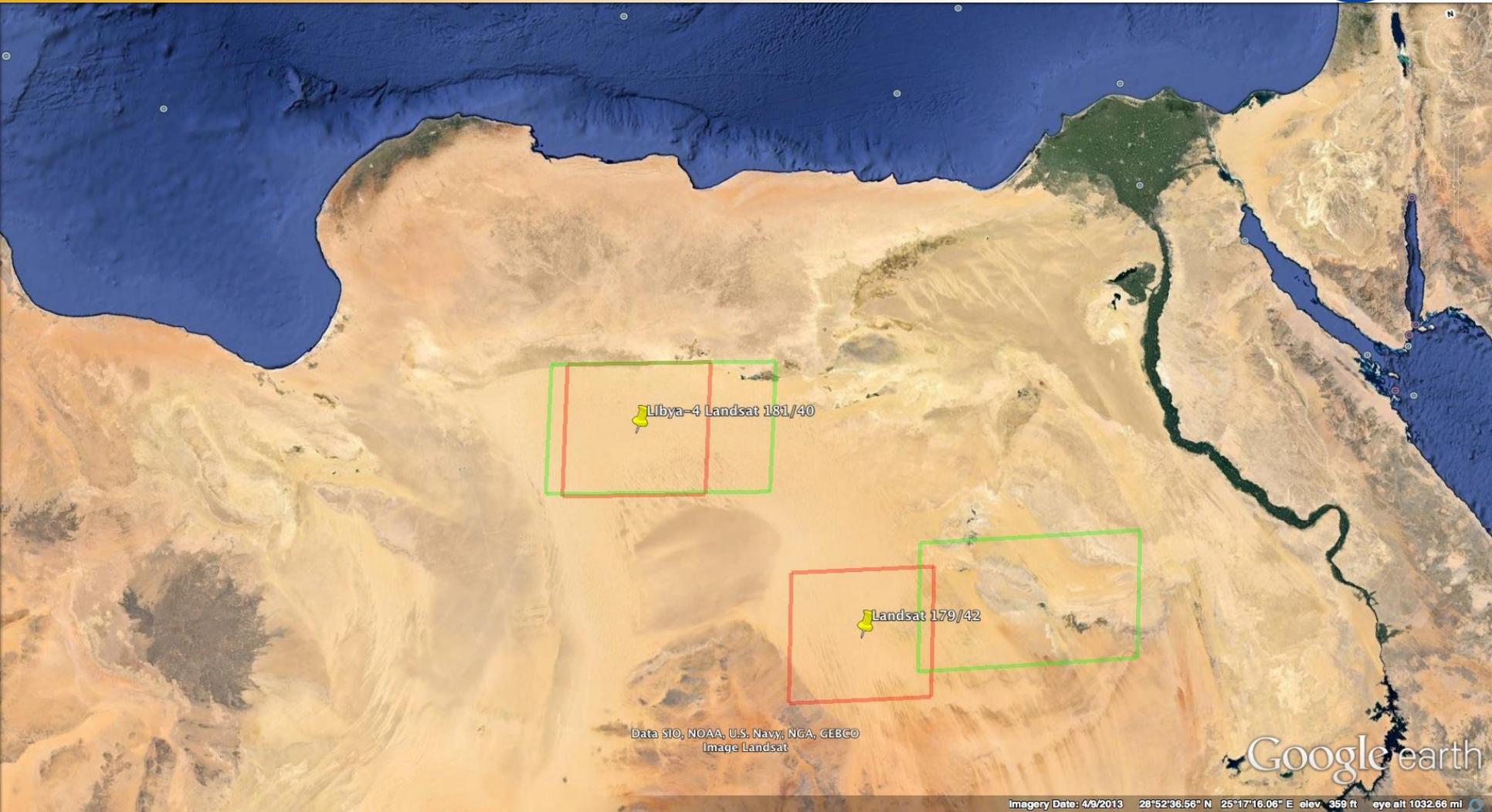
- 10 day repeat of Sentinel-2 and 16 day repeat of Landsat-8 provide 80 day joint repeat cycle
- Some paths provide near simultaneous (~20 minutes) with similar view angles; other path similar view angle passes may be a day apart; pattern repeats longitudinally (location of good paths may change with final orbit, but pattern should be the same)

Continental USA Sentinel-2 Paths (green) and Landsat WRS-2 Paths (red)



Based on predicted orbit from 11/14 data from ESA; Sentinel-2 Ground Track moves 3 paths to East each day on the descending side.

Example Predicted Near-Simultaneous S2a/L8 Passes over Libya-4 (181/40)



June 25, 2015; DOY: 176; Δt : 17 minutes; $\Delta\theta_v$: 2° ; every 80 days. (subject to final orbit changes)
Some good paths for near simultaneous data, e.g., Path 181; some bad, e.g., Path 179, though
good overlap one day apart (Path 179 data shown for July 29, 2015)

Comparative measurements of MSI solar diffuser witness sample



- Objective is to support the synergistic use of Landsat and Sentinel-2 data and to facilitate calibration compatibility between the OLI and the MSI.
- MSI radiometric calibration based on solar diffuser as is OLI's reflectance calibration
- Measurements were conducted on a witness samples and an ESA reference diffuser at US and ESA calibration facilities:
 - Measurements were performed at pre-defined geometries provided by ESA.
 - US measurements are traceable to NIST.
- US facilities
 - GSFC Code 618 Diffuser calibration facility for the VNIR wavelengths from December 2013 to March 2014.
 - University of Arizona Optics Laboratory which focused primarily in the SWIR spectral ranges from March to July 2014.
 - U of A Lab measured OLI flight diffusers (basis for OLI reflectance calibration)
- ESA facilities
 - Physikalisch Technische Bundesanstalt, Germany
 - Centre Spatial de Liège at the University of Liège, Belgium
- Data Analysis and comparative studies are continuing with quasi-regularly scheduled teleconferences.