SIT-33-14	NOAA and CSIRO	Develop a proposal with appropriate CEOS entities for a GEO-LEO application case study using CARD4L and multiple datasets.	SIT TW 2018
	Rationale: SIT Chair has challenged CEOS to identify productive avenues of collaboration to build on the GEO-LEO initiative started in 2016 by CSIRO and JAXA.		

Session 5: GEO-LEO		
16:30	Review Application Case Study using CARD4L from Multiple GEO and LEO Satellites	K. Gallo
16:45	Discussion on: - Any concerns or additional recommendations related to the proposed GEO-LEO example. - Agree on the incorporation of any additional recommendations and the GEO-LEO example plans for presentation at SIT TW.	Moderator: S. Labahn
17:30 – Adjourn		

Review of Application Case Study using CARD4L from Multiple GEO and LEO Satellites

Kevin Gallo, NOAA/NESDIS

LSI-VC-6

Ispra, Italy

5 September 2018

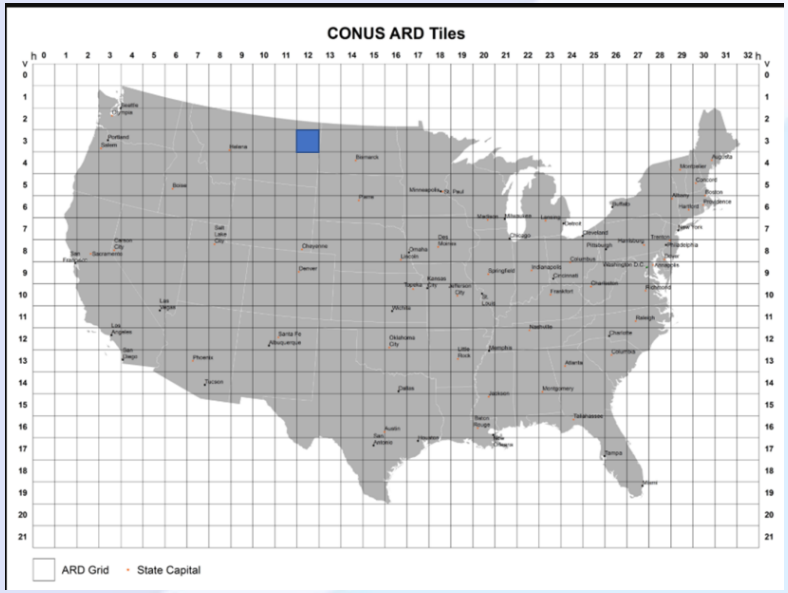
SIT-33-14 (NOAA and CSIRO): Develop a proposal with appropriate CEOS entities for a GEO-LEO application case study using CARD4L and multiple datasets.

A proof of concept example is proposed that will assist in development of a proposal in response to SIT-33-14. This conceptual example will include GEO and LEO products acquired over a brief (20-day interval) for an Analysis Ready Data grid cell located within the Conterminous USA.

The primary emphasis of this GEO/LEO effort will be to provide technical guidance for development of a formal proposal in response to SIT-33 Action item 14. A land application case study, ***Multi-Sensor Monitoring of Vegetation Condition,*** was selected for this example as this effort is being initiated within the CARD4L effort of the Land Surface Imaging-Virtual Constellation.

	Objective / Deliverable	Description / Context	Linkages	CEOS Work Plan Ref.	Target Date
ARD	CARD4L Framework Development	LSI-VC will develop the first CARD4L Product Family Specifications, with at least two documents presented for endorsement at CEOS-31. Draft versions of these specifications will be used to inform LSI-VC contributions to FDA-4. A CARD4L Assessment Framework will also follow.	FDA-AHT WGCV	FDA-7	Q4 2017
ARD	Develop a Roadmap for the Routine Production of Intercomparable CARD4L	Building on agreed specifications of CARD4L products, LSI-VC will develop a roadmap for how interested CEOS Agency missions and programs can start processing land surface imaging data to geometrically and radiometrically intercomparable surface reflectance, surface temperature, and analogous radar products.	WGCV	VC-27	Q4 2018
ARD	Trial CARD4L Supply to FDA Pilots	Through the production/provision of CARD4L datasets in support of the FDA pilots, LSI-VC will gather evidence on the associated technical challenges. Where possible, WGCapD capacity development capabilities will be leveraged.	FDA-AHT SEO WGCapD	FDA-4	Q4 2017

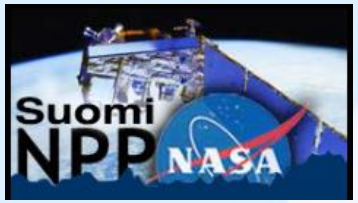
The location of this initial example within the CONUS will permit inclusion of several data sets that are presently available in a near-ARD format within this region.



The sensor data/products proposed for this conceptual example will include those available from GOES-16 (Advanced Baseline Imager), Aqua and Terra (MODIS), S-NPP (VIIRS), Sentinel-2 (MSI), and Landsat 8 (OLI) platforms.

sentinel-2

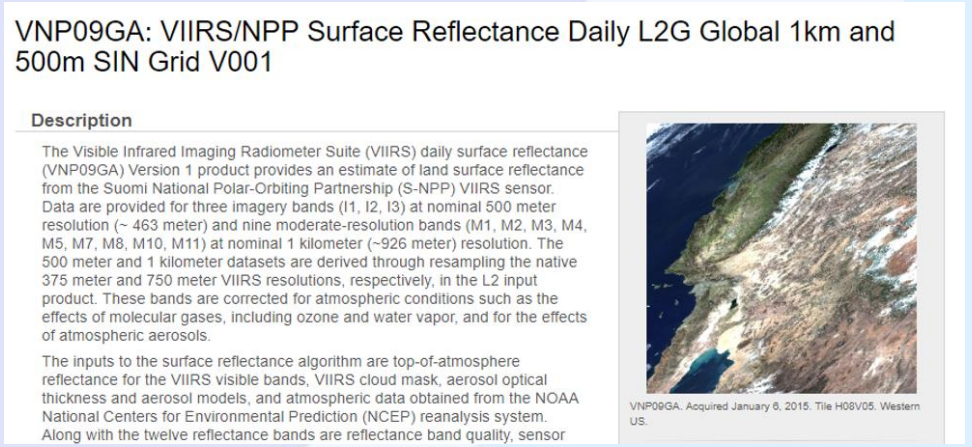
GEOSTATIONARY OPERATIONAL ENVIRONMENTAL SATELLITE-R SERIES
GOES R
NOAA ~ NASA



MODIS
MODERATE RESOLUTION IMAGING SPECTRORADIOMETER

Based on the CARD4L product specifications and interests expressed by CSIRO the conceptual example will include *Visible and Near-IR Reflectance, Normalized Difference Vegetation Index, and Land Surface Temperature products.*

A *20-day interval* is proposed for the duration for the initial product suite. This interval would permit observation of green vegetation with at least one revisit cycle by the Landsat 8 OLI sensor for the selected ARD grid cell.



VNP09GA: VIIRS/NPP Surface Reflectance Daily L2G Global 1km and 500m SIN Grid V001

Description

The Visible Infrared Imaging Radiometer Suite (VIIRS) daily surface reflectance (VNP09GA) Version 1 product provides an estimate of land surface reflectance from the Suomi National Polar-Orbiting Partnership (S-NPP) VIIRS sensor. Data are provided for three imagery bands (I1, I2, I3) at nominal 500 meter resolution (~ 463 meter) and nine moderate-resolution bands (M1, M2, M3, M4, M5, M7, M8, M10, M11) at nominal 1 kilometer (~926 meter) resolution. The 500 meter and 1 kilometer datasets are derived through resampling the native 375 meter and 750 meter VIIRS resolutions, respectively, in the L2 input product. These bands are corrected for atmospheric conditions such as the effects of molecular gases, including ozone and water vapor, and for the effects of atmospheric aerosols.

The inputs to the surface reflectance algorithm are top-of-atmosphere reflectance for the VIIRS visible bands, VIIRS cloud mask, aerosol optical thickness and aerosol models, and atmospheric data obtained from the NOAA National Centers for Environmental Prediction (NCEP) reanalysis system. Along with the twelve reflectance bands are reflectance band quality, sensor

VNP09GA. Acquired January 6, 2015. Tile H08V05. Western US.

MOD11A1: MODIS/Terra Land Surface Temperature/Emissivity Daily L3 Global 1 km SIN Grid V006

Description

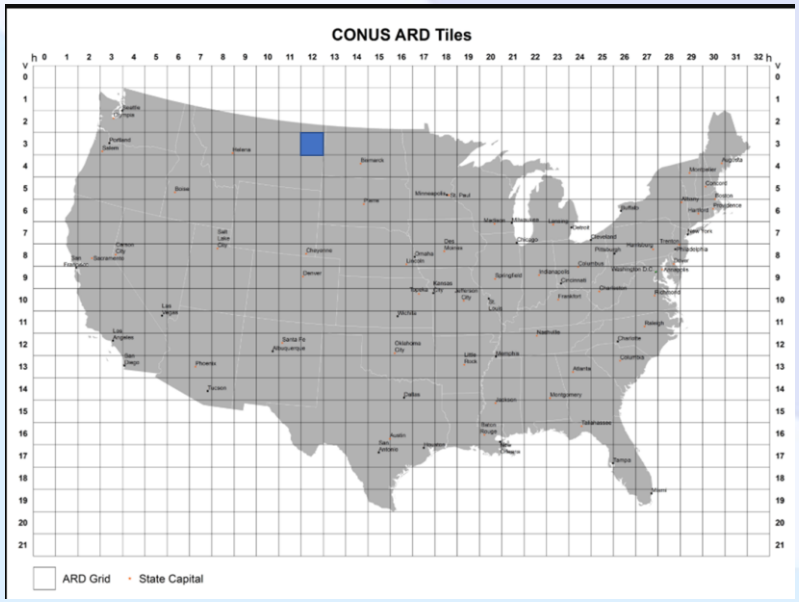
The MOD11A1 version 6 product provides daily, per-pixel land surface temperature (LST) in a 1200 x 1200 kilometer grid. The pixel temperature value is derived from the MOD11_L2 swath product. Above 30 degrees latitude, some pixels may have multiple observations where the criteria for clear-sky are met. When this occurs, the pixel value is a result of the average of all qualifying observations. Provided along with both the day-time and night-time surface temperature bands and their quality indicator layers, are MODIS bands 31 and 32 and six observation layers. Validation at stage 2 has been achieved for all MODIS LST/Emissivity products.

Improvements/Changes from Previous Versions

- Removed cloud-contaminated LSTs not only from level 3 LST products but also from level 2 LST products, which includes MOD11_L2.
- Updated the coefficient look-up table (LUT) for the split-window algorithm with comprehensive regression analysis of MODIS simulation data in

MOD11A1. Acquired June 21, 2003. Tile H17V05. Strait of Gibraltar.

Example of ***single-day visible band*** GEO-LEO data for a single US ARD tile.



CONUS ARS tile h12 v03.

This tile includes several in situ networks (SURFRAD and USCRN) that measure surface reflectance, land surface temperature, soil moisture, and additional variables.

The tile is located in a region with vegetation, and low frequency of cloudy days during summer months.

Surface Radiation Budget Network (SURFRAD) station

Sensor data evaluated for the single-day (30 May 2017) GEO-LEO example.

Landsat OLI

Landsat 8 OLI/TIRS Level-2 Data Products - Surface Reflectance

The U.S. Geological Survey (USGS) offers on-demand production of Landsat 8 Operational Land Imager/Thermal Infrared Sensor (OLI/TIRS) Surface Reflectance data through EarthExplorer. Surface Reflectance products provide an estimate of the surface spectral reflectance as it would be measured at ground level in the absence of atmospheric scattering or absorption. The Surface Reflectance products are generated at the Earth Resources Observation and Science (EROS) Center at a 30-meter spatial resolution. The EROS Science Processing Architecture (ESPA) on-demand interface corrects satellite images for atmospheric effects to create Level-2 data products. Landsat 8 Surface Reflectance data are generated from the Landsat Surface Reflectance Code (LaSRC). LaSRC makes use of the coastal aerosol band to perform aerosol inversion tests, uses auxiliary climate data from MODIS and uses a unique radiative transfer model. Additionally, LaSRC hardcodes the view zenith angle to "0", and the solar zenith and view zenith angles are used for calculations as part of the atmospheric correction. Details about LaSRC and Landsat 8 Surface Reflectance data products can be found in the Landsat 8 Surface Reflectance Product Guide.

The following date ranges apply to the availability of the Landsat archive for Surface Reflectance processing:

- Landsat 8 OLI/TIRS: April 2013 to Present

Most Landsat 8 Collection 1 Level-1 scenes in the USGS archive can be processed to Surface Reflectance. Please note the following caveats:

- Surface Reflectance is not run for a scene with a solar zenith angle greater than 76°.
- Users are cautioned against processing data acquired over high latitudes (> 65º) to Surface Reflectance.
- Efficacy of Surface Reflectance correction will be likely reduced in areas where atmospheric correction is affected by adverse conditions:
  - Hyper-arid or snow-covered regions
  - Low sun angle conditions
  - Coastal regions where land area is small relative to adjacent water
  - Areas with extensive cloud contamination

Landsat 8 OLI/TIRS Surface Reflectance acquired April 5, 2017 (Path 34, Row 41)

S-NPP VIIRS

VNP09GA: VIIRS/NPP Surface Reflectance Daily L2G Global 1km and 500m SIN Grid V001

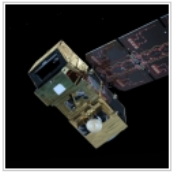
Description

The Visible Infrared Imaging Radiometer Suite (VIIRS) daily surface reflectance (VNP09GA) Version 1 product provides an estimate of land surface reflectance from the Suomi National Polar-Orbiting Partnership (S-NPP) VIIRS sensor. Data are provided for three imagery bands (I1, I2, I3) at nominal 500 meter resolution (~ 463 meter) and nine moderate-resolution bands (M1, M2, M3, M4, M5, M7, M8, M10, M11) at nominal 1 kilometer (~926 meter) resolution. The 500 meter and 1 kilometer datasets are derived through resampling the native 375 meter and 750 meter VIIRS resolutions, respectively, in the L2 input product. These bands are corrected for atmospheric conditions such as the effects of molecular gases, including ozone and water vapor, and for the effects of atmospheric aerosols.

The inputs to the surface reflectance algorithm are top-of-atmosphere reflectance for the VIIRS visible bands, VIIRS cloud mask, aerosol optical thickness and aerosol models, and atmospheric data obtained from the NOAA National Centers for Environmental Prediction (NCEP) reanalysis system. Along with the twelve reflectance bands are reflectance band quality, sensor

VNP09GA. Acquired January 6, 2015. Tile H08V05. Western US.

Sentinel-2 MSI



The Sentinel-2 mission comprises a constellation of two polar-orbiting satellites placed in the same orbit, phased at 180° to each other. It aims at monitoring variability in land surface conditions, and its wide swath width and high revisit time (10 days at the equator with one satellite, and 5 days with 2 satellites under cloud-free conditions which results in 2-3 days at mid-latitudes) will support monitoring of changes to vegetation within the growing season. The coverage limits are from between latitudes 56° south and 84° north.

For mission planning information, see the Copernicus Mission pages.

This Sentinel-2 Mission Guide provides a high-level description of the mission objectives, satellite description and ground segment. It also addresses the related heritage missions, thematic areas and Copernicus services, orbit characteristics and coverage, instrument payload, and data products.

Terra (and Aqua) MODIS

MOD09GA: MODIS/Terra Surface Reflectance Daily L2G Global 1 km and 500 m SIN Grid V006

Description

The MOD09GA Version 6 product provides an estimate of the surface spectral reflectance of Terra MODIS Bands 1 through 7 corrected for atmospheric conditions such as gasses, aerosols, and Rayleigh scattering. Provided along with the 500 m reflectance and four observation bands are a set of nine 1 km observation bands. The reflectance layers from the MOD09GA are used as the source data for many of the MODIS land products. Validation at stage 3 has been achieved for all MODIS Surface Reflectance products.

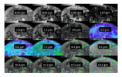
Improvements/Changes from Previous Versions

- Improvement to the aerosol retrieval and correction algorithm and use of new aerosol retrieval look-up tables.
- Refinements to the internal snow, cloud, and cloud shadow detection algorithms. Uses BRDF database to better constraint the different threshold used.
- Processes ocean bands to create a new Surface Reflectance Ocean product and provide QA data sets for these bands.
- Improved discrimination of salt pans from cloud and snow and flag salt pan in QA band.

GOES-16 ABI

NOAA GOES-R Series Advanced Baseline Imager (ABI) Level 2 Cloud and Moisture Imagery Products (CMIP)

ABI-L2-CMIP



Example of ABI imagery for each of the 16 bands.

The Cloud and Moisture Imagery product contains one or more Earth-view images with pixel values identifying brightness values that are scaled to support visual analysis. The product includes data quality information that provides an assessment of the cloud and moisture imagery data values for on-earth pixels. Cloud and Moisture Imagery product files are generated for each of the sixteen Advanced Baseline Imager (ABI) reflective bands (channels 1 - 6 with approximate central wavelengths 0.47, 0.64, 0.865, 1.378, 1.61, 2.25 microns respectively) and emissive bands (channels 7 - 16 with approximate central wavelengths 3.9, 6.185, 6.95, 7.34, 8.5, 9.61, 10.35, 11.2, 12.3, 13.3 microns respectively). In addition, there is a multiband product file where the imagery at all bands is included. The imagery value for the

Show more...

Dataset Citation

Dataset Identifiers

ISO 19115-2 Metadata

GEO and LEO visible band comparison

Visible band wavebands

GEO		LEO			
Sensor/ Waveband	GOES (ABI)	MODIS	Landsat 8 (OLI)	VIIRS	Sentinel-2 (MSI)
(µm)	0.59 -0.69	0.62 – 0.67	0.64 – 0.67	0.60 – 0.68	0.64 – 0.68

Visible band native spatial resolution

GEO		LEO			
Sensor/ Resolution	GOES (ABI)	MODIS	Landsat 8 (OLI)	VIIRS	Sentinel-2 (MSI)
(m)	500	250	30	375	10

In this single-day example, all data were mapped to the Landsat 30 m spatial resolution.

GEO and LEO visible band comparison

Nominal data volumes of *native products*

GEO		LEO			
Sensor/ Channels	**GOES[1] (ABI)**	**MODIS[2]**	**Landsat 8 (OLI)[3]**	**VIIRS[2]**	**Sentinel-2 (MSI)**
(µm)	80 MB	7.4 MB	40 MB	100 MB	na*

1. GOES single CONUS scene, visible band (NetCDF)
2. MODIS (HDF4) and VIIRS (HDF5) single sinusoidal tile, includes additional bands and data
3. OLI single ARD tile, single visible band (GeoTIFF)

Sentinel-2 MSI data were not available for this single-day example.

GEO and LEO visible band comparison

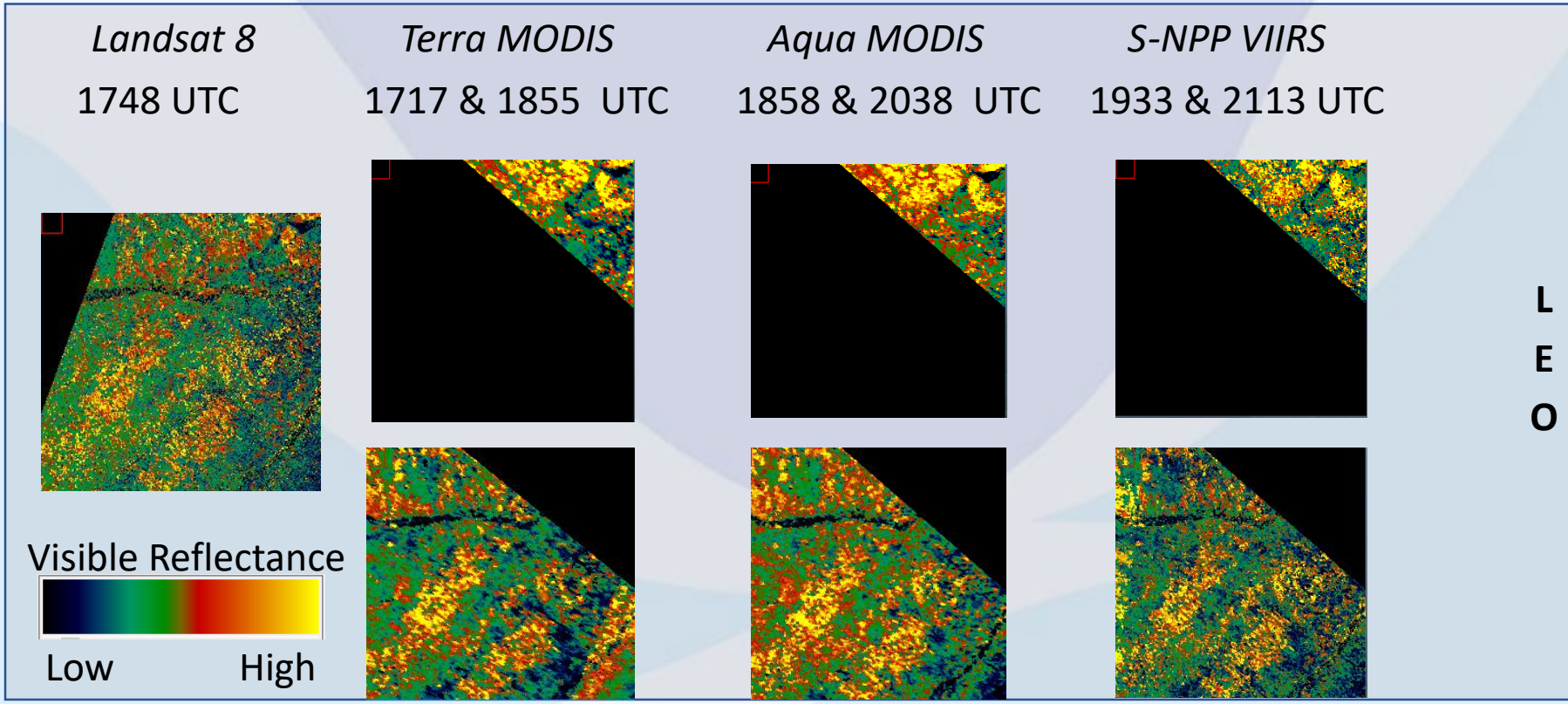
Nominal data volumes of products *mapped to Landsat 30 m CONUS ARD tile*

GEO		LEO			
Sensor/ Channels	**GOES[1] (ABI)**	**MODIS[2]**	**Landsat 8 (OLI)[3]**	**VIIRS[2]**	**Sentinel-2 (MSI)**
(µm)	98 MB	98 MB	40 MB	98 MB	na*

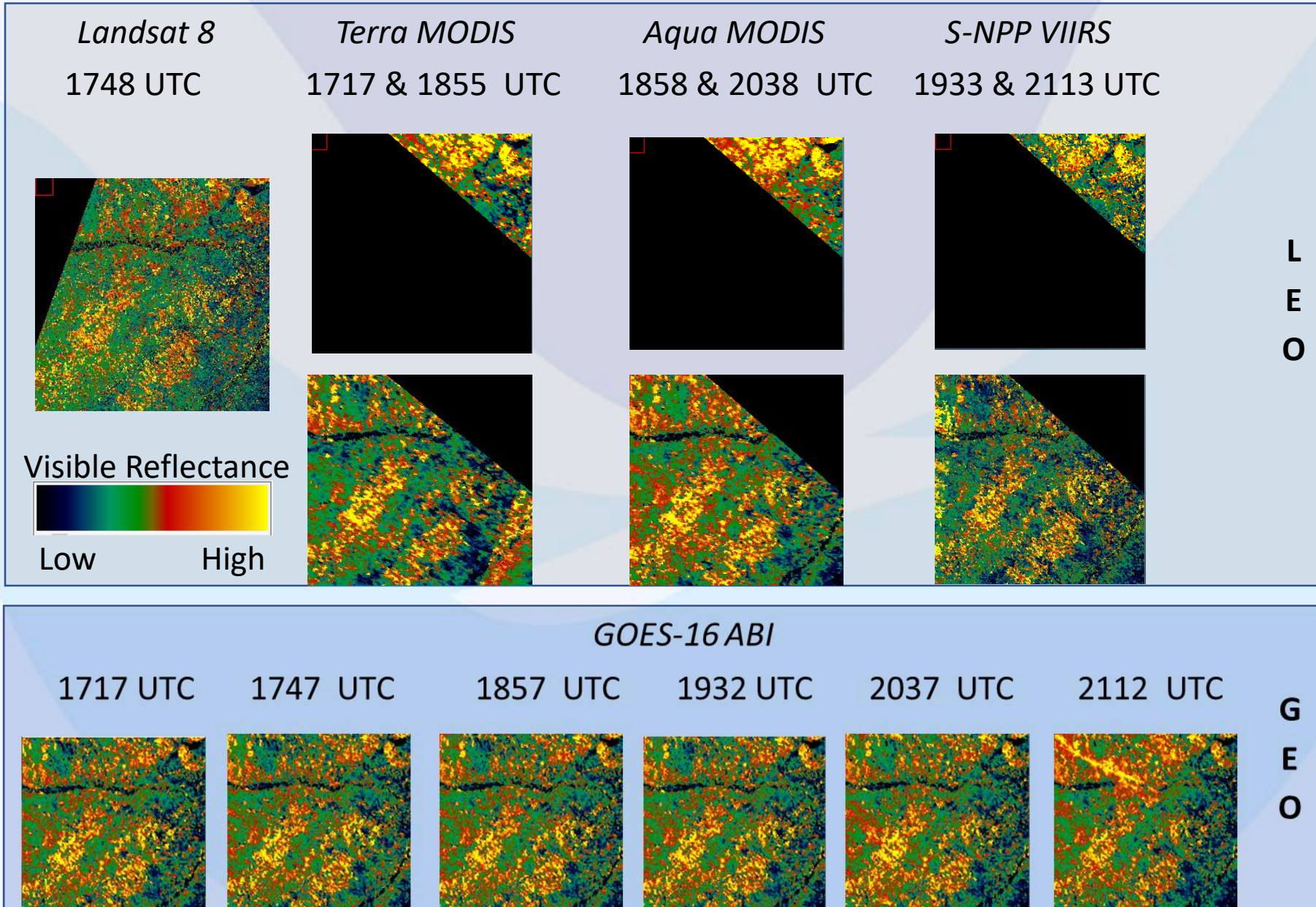
1. GOES single visible band (GeoTIFF)
2. MODIS and VIIRS visible band (GeoTIFF)
3. OLI single ARD tile, single visible band (GeoTIFF)

Sentinel-2 MSI data were not available for this single-day example.

30 May (day 150) 2017: Visible Channel Reflectance for CONUS ARD tile h12 v03.



30 May (day 150) 2017: Visible Channel Reflectance for CONUS ARD tile h12 v03.

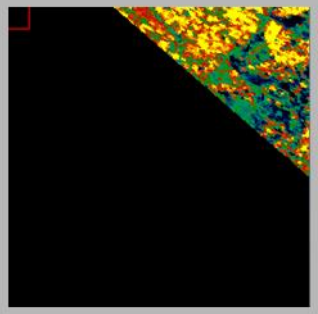


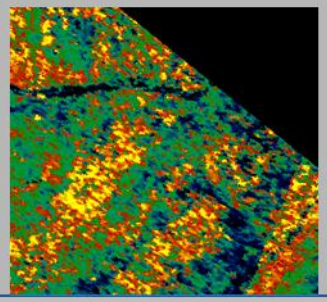
Issues/Concerns with GEO-LEO effort

- MODIS and VIIRS products may require processing to mosaic several sinusoidal tiles of data into a seamless product for direct comparison with other data mapped within the ARD tile system.

Terra MODIS

h11v04 and h10v04

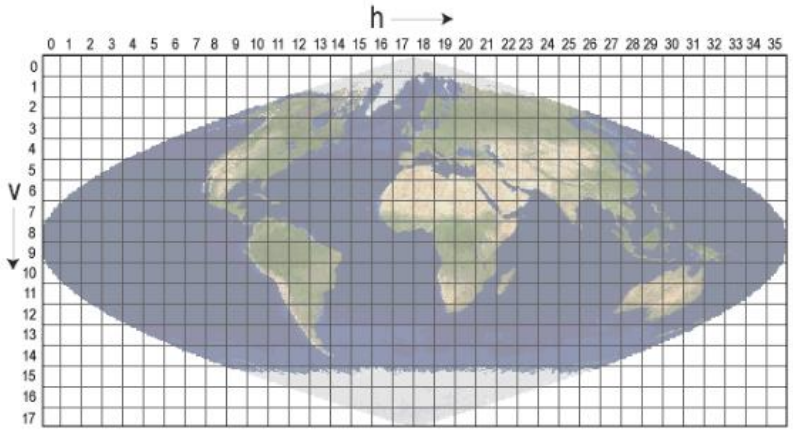




Sinusoidal Tile Grid

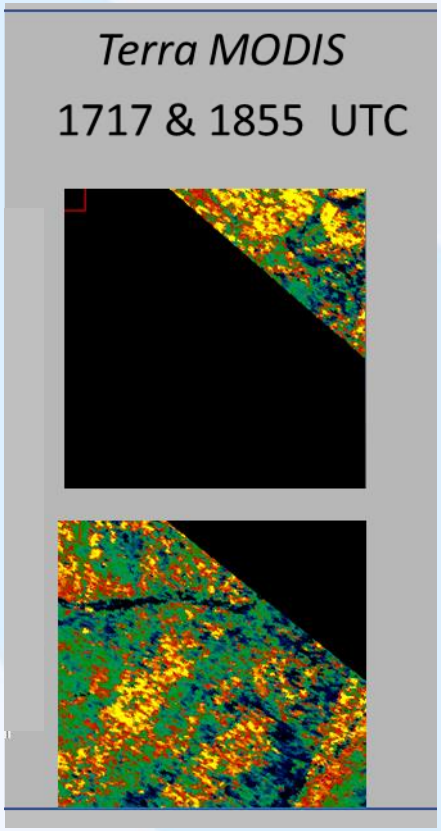
There are 460 non-fill tiles, tiles are 10 degrees by 10 degrees at the equator.
The tile coordinate system starts at (0,0) (horizontal tile number, vertical tile number) in the upper left corner and proceeds right (horizontal) and downward (vertical).
The tile in the bottom right corner is (35,17).

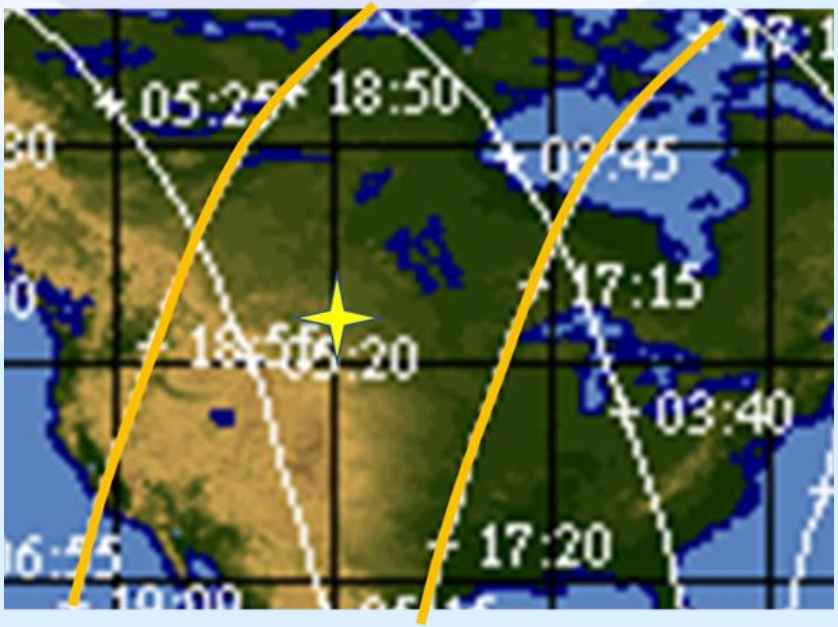
- Table of Tile Bounding Coordinates (10 deg tiles).
- Table of Tile G-ring Coordinates (10 deg tiles).
- General Cartographic Transformation Package (GCTP) projection parameters and other tile infomation.



Issues/Concerns with GEO-LEO effort

- MODIS and VIIRS products are often comprised of several orbital paths (different times of data acquisition) which will influence temporal match-up with other data.

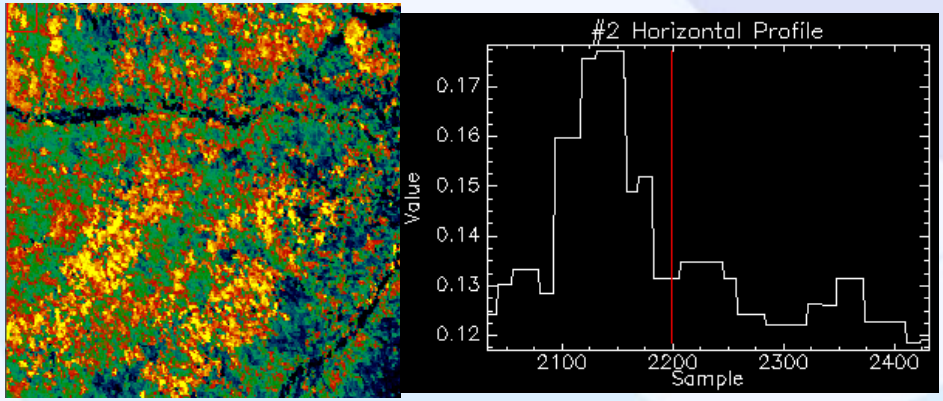




Issues/Concerns with GEO-LEO effort

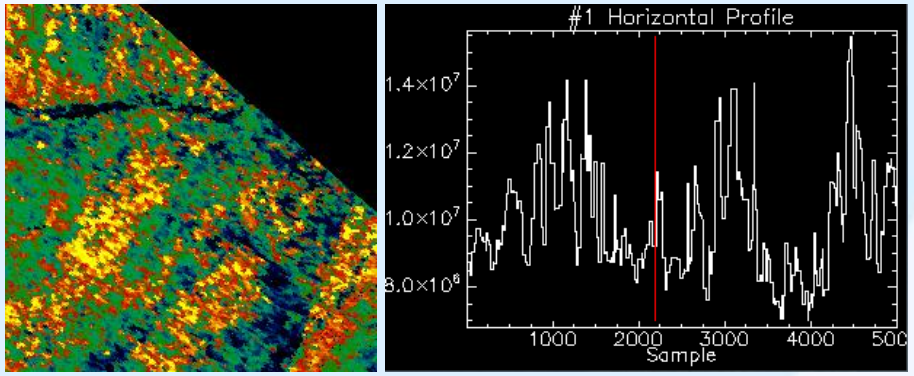
- Scaling of reflectance (and temperature) vary with sensors.

GOES-16 ABI
1857 UTC



Basic Stats	Min	Max	Mean	Stdev
Band 1	0.075946	0.272283	0.135525	0.017306

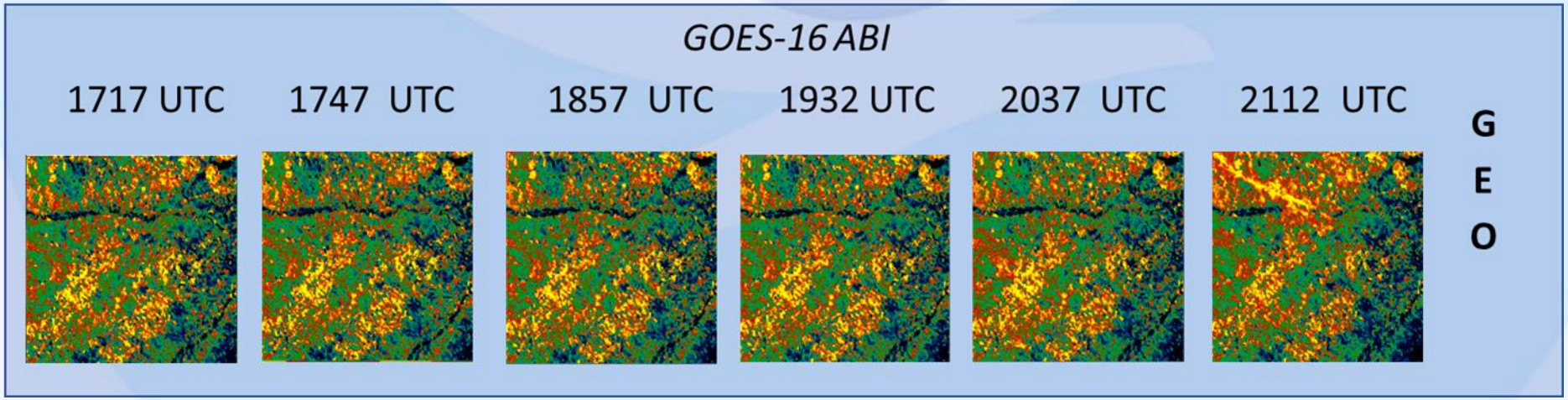
Terra MODIS



Basic Stats	Min	Max	Mean	Stdev
Band 1	0.000000	21300000.000000	7807606.527600	3988101.265761

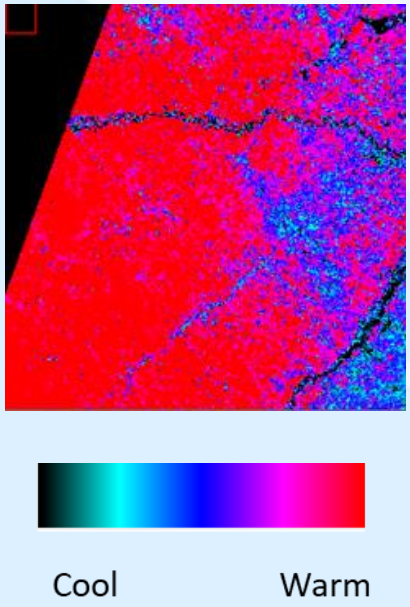
Issues/Concerns with GEO-LEO effort

- Surface Reflectance for GOES ABI currently unavailable (TOA reflectance currently used for 30 May 2017 example).



Issues/Concerns with GEO-LEO effort

- Landsat LST data currently unavailable (under production)
- Currently unable to retrieve map projection info for MODIS LST products.

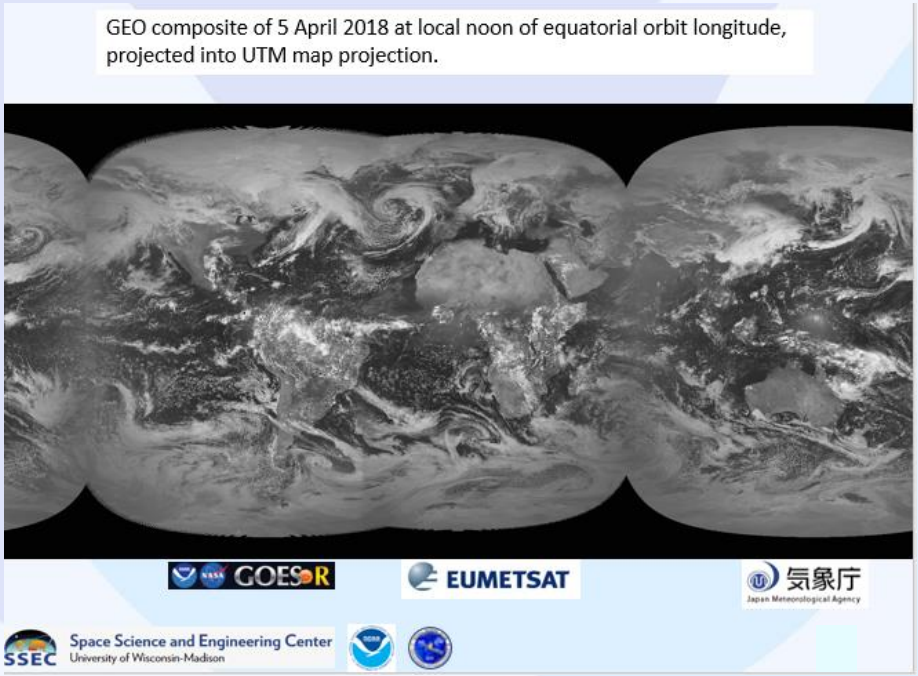


Landsat 8 B10 temperature
1748 UTC

Next Steps

Once the initial 20-day product is prepared its evaluation will be encouraged throughout the relevant CEOS VCs and WGs (e.g., GEOGLAM, WGISS, WCCV).

The VCs and WGs are requested to consider their respective contributions (e.g., additional data/products) for the next step, a formal proposal as requested in response to SIT-33 action 14.



Additional global test sites (perhaps one per continent) and *data products* are solicited, for a combined GEO/LEO product similar to the conceptual example. The global GEO/LEO product will include locations within the coverage regions of GEO satellites that include sensors similar to the GOES ABI. In addition to data from other GEO satellites, the global product would also be expected to include sensors and data from additional LEO satellites.

Contacts: Kevin Gallo (kevin.p.gallo@noaa.gov) and Steve Labahn (labahn@usgs.gov)

Session 5: GEO-LEO		
16:30	Review Application Case Study using CARD4L from Multiple GEO and LEO Satellites	K. Gallo
16:45	Discussion on: - Any concerns or additional recommendations related to the proposed GEO-LEO example. - Agree on the incorporation of any additional recommendations and the GEO-LEO example plans for presentation at SIT TW.	Moderator: S. Labahn
17:30 – Adjourn		

Discussion on Application Case Study using CARD4L from Multiple GEO and LEO Satellites

Steven Labahn, USGS

LSI-VC-6

Ispra, Italy

5 September 2018

Discussion points for recommendations to proceed with GEO-LEO Application Case Study.

- 20 day interval?
- Additional Locations?
- Visible, near-IR, NDVI, and LST as available for OLI/TIRS, MODIS, VIIRS, MSI, and ABI?
- Utilize ABI and MSI TOA reflectance in absence of surface reflectance?
- Map data to Landsat spatial resolutions or keep in native spatial resolution?
- Mosaic MODIS and VIIRS tiles or leave as mapped to CONUS ARD tile?
- Scale all variables (e.g., reflectance) from various sensors to common scale?
- Additional datasets?
- Data accessibility?
- Present this topic at SIT TW?