**Requirements and potential uses of GOES-16 ABI surface reflectance within the Focus Themes and initiatives of the CEOS Land Surface Imaging-Virtual Constellation (LSI-VC).**

***Introduction***

This document was prepared to address the potential non-meteorological uses for Geostationary (GEO) satellite data as described in the CEOS report on this topic titled “*Non-meteorological Applications for Next Generation Geostationary Satellites Study*” as applicable within the LSI-VC.

There are currently three **Focus Themes** within the LSI-VC which include [1]:

1. Promoting **analysis-ready data** and minimizing the need for end users to understand satellite overpass differences, and sensor-specific processing,
2. Compilation of **land user community requirements** related to (i) better optimization of land surface imaging programs (ii) identification of current data gaps, and
3. Development of a **Moderate Resolution Interoperability** (MRI) framework for complementarity and compatibility among Earth observing systems.

The GOES-16 Advanced Baseline Imager (ABI) surface reflectance data are relevant to all three LSI-VC Focus Themes due to the complimentary nature of the ABI GEO data (medium spatial, 0.5 km visible and 1.0 km near-IR)/high temporal, 15 min data acquisition frequency for full disk) compared to the low Earth orbit (LEO) data (high spatial/medium temporal) available from Landsat or Sentinel-2. The potential uses and requirements related to the potential uses and applications of GOES-R ABI surface reflectance data within the LSI-VC are discussed below for each focus theme.

***Theme 1: Analysis Ready Data***

A primary and foundational initiative within the LSI-VC is an effort to produce CEOS **Analysis Ready Data** (ARD) for Land (CARD4L) products (**Focus Theme 1**). The goal of this effort is production of products that have been sufficiently pre-processed to permit their use for intra-product analysis.

Potential uses and requirements of GOES-16 ABI surface reflectance within **Focus Theme 1**:

The format and contents of the ABI data [2] lends itself to the possibility of compatibility with the formats and requirements proposed for ARD of the LEO data from sensors onboard Landsat and Sentinel. Although the ABI spatial resolution is coarser than the Landsat or Sentinel sensors, the frequency of ABI observations and large coverage area facilitate the coincident observations of land surfaces that are helpful for sensor intercomparison.

***Theme 2: Land Community Requirements***

**Focus theme 2** (**land user community requirements)** supports documentation of current land product gaps and proposals for better optimization of existing programs. This theme includes integration of “validated requirements for forestry, carbon, climate, and agriculture; and identify potential continuity issues for land surface observations from space via CEOS Agency assets” [1].

Potential uses and requirements of GOES-16 ABI surface reflectance within **Focus Theme 2**:

The land user community requirements for non-meteorological uses of GEO data have been compiled [2] and include numerous examples of products that could benefit from multi-sensor (GEO and LEO) algorithms.

Non-meteorological uses of the ABI data, as mentioned in [2] include:

1. Fire/(Hot-Spot): *Detection and fire radiative power,*
2. Land Surface Temperature: *Temperature measurements*
3. Snow: *Cover and Depth (over Plains)*
4. Floods and standing water: *detection, mapping and monitoring*
5. Vegetation: *vegetation indices and green fraction*
6. Drought/Evapotranspiration: *Detection and Vegetation Health Index*
7. Albedo: *Reflectance value*
8. Incident Solar Radiation: *downward shortwave radiation.*

***Theme 3: Moderate Resolution Sensor Interoperability***

A framework for ***Moderate Resolution Sensor Interoperability*** (MRI) is under development within the CEOS LSI-VC (**Focus Theme 3**) in response to a CEOS objective to encourage complementarity and compatibility among Earth observing systems. While the initial focus of the framework is land surface optical reflectance products in the 10-100 m spatial resolution range, the developed framework is designed for expansion to sensors that include other spatial and spectral resolutions [3].

The goal of interoperability is “to enable the use of disparate sensors to achieve a coherent single data stream to enable characterization of actual changes on the Earth’s surface through time” [3]. The two common pathways to interoperability include:

i) Changes to operational products or post processing methodologies to create interoperable products (e.g., acceptance of standard cross-calibration references, geographic reference grids, and atmospheric models).

ii) Accommodation to inherent differences between products (e.g., degradation of products to a comparable merged product).

There are four overarching components of the data products that will be included in the MRI and CARD4L efforts. The components and examples of their details [3] are:

1. General Metadata: provided at the product or scene level, includes *Coordinate Reference System, Reference grid accuracy, Geometric accuracy, and Spectral Bands.*
2. Per Pixel Metadata: includes *Cloud cover assessments, Cloud Shadow, Land/water mask, Snow and ice mask, and Digital Elevation Model.*
3. Data Measurements: *includes sensor measured variables* (*“Minimum requirement is at-sensor reflectance calibrated and validated to a known absolute source”* [3]), *Measurement Normalization, Aerosol, water vapor and Ozone corrections, and Spectral Band Adjustment Factor corrections.*
4. Geolocation: *includes Geometric Correction and Resampling.*

Potential uses and requirements of GOES-16 ABI surface reflectance within **Focus Theme 3**:

The new near-IR band on the ABI lends to greater compatibility of the ABI GEO data with the LEO data from sensors onboard Landsat and Sentinel. The availability of ABI surface reflectance data for land surfaces would lend itself to potential development of multi-sensor (GEO and LEO) products as suggested in [2]. Additionally, development of multi-sensor products that include GOES-16 ABI data should be readily applicable to similar GEO data that may be available (e.g., Himawari AHI data).

***Summary***

The availability of ABI surface reflectance data in a similar ARD format as proposed for Landsat and Sentinel sensor data (Theme 1) will encourage:

* Sensor interoperability proposed in Theme 3 expanded to LEO and GEO interoperability,
* Synergistic use of GEO and LEO data for enhanced non-meteorological applications of GEO satellites [2] for products of interest by land community (Theme 2),
* Use of ABI as a data gap-filler for the LEO data and products when LEO data are unavailable (Theme 3),
* Intercomparison and characterization of products in support of land product validation (e.g, as within the NOAA-USGS Land Product Characterization System [4]).

While the ABI top of atmosphere reflectance (TOA) data are currently available at spatial resolutions of 0.5 km for visible (band 2) and 1.0 km for near-IR (band 3), the current plans for surface reflectance products (and a TOA normalized difference vegetation index product) are for these products to be produced at a spatial resolution of 2.0 km [5,6]. The availability of the surface reflectance data at the same resolutions as the currently available TOA data would be preferred and more applicable to the land science community.

***References***

1. The Land Surface Imaging Virtual Constellation Implementation Plan. CEOS, 2017.

2. Non-meteorological Applications for Next Generation Geostationary Satellites Study. CEOS, 2016.

3. Moderate Resolution Sensor Interoperability Framework Initiative, CEOS, Version 0.8; 19 June 2017

4. The NOAA-USGS Land Product Characterization System (https://landsat.usgs.gov/lpcs)

5. GOES-R Advanced Baseline Imager (ABI) Algorithm Theoretical Basis Document for Surface Albedo (http://www.goes-r.gov/products/ATBDs/option2/Land\_Albedo\_v1.0\_no\_color.pdf)

6. GOES-R Advanced Baseline Imager (ABI) Algorithm Theoretical Basis Document for Vegetation Index (http://www.goes-r.gov/products/ATBDs/option2/Land\_NDVI\_v2.0\_no\_color.pdf)