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Surface Biology and Geology (SBG) Observing Terrestrial Thermal Emission Radiometer (OTTER)

Level 3 Surface Mineralogy (SM)
Product Specification Document (PSD)

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SBG-TIR Level 3 SM Product Specification Document

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TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 Identification

This is the Product Specification Document (PSD) for Level 3 (L3) Surface Mineralogy (SM) data product of NASA's Surface Biology and Geology – Thermal Infrared (SBG-TIR) mission. The SBG-TIR L3 SM product provides surface minerology maps generated from data acquired by the SBG-TIR radiometer instrument according to the SM algorithm described in the SBG-TIR L3 SM Algorithm Theoretical Basis Document (ATBD) (D- 1000788).

1.2 Purpose and Scope

This PSD describes the standard Level 3 SM product generated using the SM algorithm. These include the detailed descriptions of the format and contents of the product and ancillary files that will be delivered to the Land Process Distributed Active Archive Center (LP-DAAC).

1.3 Mission Overview

NASA's SBG mission was a Designated Observable (DO) identified in the National Academies of Sciences, Engineering and Medicine (NASEM) 2017 Decadal Survey. The Decadal Survey document presented a clear vision for the combined roles of visible to shortwave infrared imaging spectroscopy and multispectral or hyperspectral thermal infrared image data in addressing terrestrial and aquatic ecosystems and other elements of biodiversity, geology, natural hazards, the water cycle, and applied sciences topics relevant to many areas with societal benefits.

The SBG-TIR portion of the mission develops the IR multispectral instrument. The SBG-TIR instrument measures the emitted radiance of the Earth surface and uses that information to better understand the dynamics of Earth's changing surface geology and biology, ground/water temperature, snow reflectivity, active geologic processes, vegetation traits, and algal biomass.

SBG-TIR mission addresses the following most important and very important priorities as highlighted by the Decadal Survey:

Most Important
Ecosystems
E1a: Quantify the distribution of the functional traits, functional types, and composition of vegetation and marine biomass, spatially and over time.
E1c: Quantify the physiological dynamics of terrestrial and aquatic primary producers.
E2a: Quantify the fluxes of CO_2 and CH_4 globally at spatial scales of 100 to 500 km and monthly temporal resolution with uncertainty <25% between land ecosystems and atmosphere and between ocean ecosystems and atmosphere.

Hydrology
H1c: Quantify rates of snow accumulation, snowmelt, ice melt, and sublimation from snow and ice worldwide at scales driven by topographic variability.

Solid Earth
S1a: Measure the pre-, syn-, and post eruption surface deformation and products of Earth's entire active land volcano inventory at a time scale of days to weeks.

Very Important
Ecosystems
E1a: Quantify the distribution of the functional traits, functional types, and composition of vegetation and marine biomass, spatially and over time.

Hydrology
H2a: Quantify how changes in land use, water use, and water storage affect evapotranspiration rates, and how these in turn affect local and regional precipitation systems, groundwater recharge, temperature extremes, and carbon cycling.
H4a: Monitor and understand hazard response in rugged terrain and land margins to heavy rainfall, temperature and evaporation extremes, and strong winds at multiple temporal and spatial scales. This socioeconomic priority depends on success of addressing H1b and H1c, H2a, and H2c.

Solid Earth
S1c: Forecast and monitor landslides, especially those near population centers.
S2b: Assess surface deformation (<10 mm), extent of surface change (<100 m spatial resolution) and atmospheric contamination, and the composition and temperature of volcanic products following a volcanic eruption (hourly to daily temporal sampling).

Climate
C3a: Quantify CO_2 fluxes at spatial scales of 100-500 km and monthly temporal resolution with uncertainty <25% to enable regional-scale process attribution explaining year-to-year variability by net uptake of carbon by terrestrial ecosystems (i.e., determine how much carbon uptake results from processes such as CO_2 and nitrogen fertilization, forest regrowth, and changing ecosystem demography.)

Weather
W3a: Determine how spatial variability in surface characteristics modifies regional cycles of energy, water and momentum (stress) to an accuracy of 10 W/m^2 in the enthalpy flux, and 0.1 N/m^2 in stress, and observe total precipitation to an average accuracy of 15% over oceans and/or 25% over land and ice surfaces averaged over a 100 × 100 km region and 2- to 3-day time period.

The SBG-TIR mission answers these questions by accurately measuring the emitted radiance of Earth's surface in the mid-infrared (MIR) and TIR spectral regions using a multispectral radiometer. The instrument measures radiance data in 8 spectral bands from 3.95 to 12.05 μm with approximately 60 meter spatial resolution at nadir and a nominal revisit time of 3 days at the equator.

1.4 Applicable and Reference Documents

"Applicable" documents levy requirements on the areas addressed in this document. "Reference" documents are identified in the text of this document only to provide additional information to readers. Unless stated otherwise, the document revision level is Initial Release. Document dates are not listed, as they are redundant with the revision level.

1.4.1 Applicable Documents

SBG-TIR Science Data Management Plan (TBD)

SBG-TIR Level 1 Algorithm Theoretical Basis Documents (TBD)

SBG-TIR Level 1 Algorithm Specification Document (TBD)

SBG-TIR Level 2 Algorithm Theoretical Basis Documents (TBD)

SBG-TIR Level 2 Algorithm Specification Document (TBD)

SBG-TIR Project Level 3 Science Data System Requirements (TBD).

SBG-TIR Level 3 SM Algorithm Theoretical Basis Document (TBD)

1.4.2 Reference Documents

2017-2027 Decadal Survey for Earth Science and Applications from Space (ESAS 2017)

SBG Science and Applications Traceability Matrix (SATM)

1.5 SBG-TIR Data Products

SBG-TIR Level 0 data include spacecraft packets that have been pre-processed by the Ground Data System (GDS). Level 1 products include spacecraft engineering data, the time-tagged raw sensor pixels appended with their radiometric calibration coefficients, the blackbody pixels used to generate the calibration coefficients, geolocated and radiometrically calibrated at-sensor radiances of each image pixel, the geolocation tags of each pixel, and the corrected spacecraft attitude data. Level 2 products include the visible near infrared top of atmosphere (VNIR TOA) reflectance, VNIR bottom of atmosphere (BOA) reflectance, the normalized difference vegetation index (NDVI), the surface temperature and emissivity of each spectral band retrieved from the at-sensor radiance data, and a cloud mask. Level 3 products include evapotranspiration, elevated temperature features, and surface minerology data derived from Level 2 data. Level 4 products contain evaporative stress index, water use efficiency, and volcanic activity derived from Level 2 and 3 data.

The four levels of data products are listed in Table 1-1. This document will discuss only the Level 3 SM product.

Table 1-1: SBG-TIR Product Groups

Area	Product	Short Name
Fundamental (Level 1)	Radiance at Sensor	RAS
Fundamental	Surface Temperature and Emissivity	LSTE (incl WT, ST and SGC)
Fundamental	Cloud mask	CM
Plant Functional Traits Suite	Evapotranspiration (ET),	ET
	Water Use Efficiency (WUE),	WUE
	Evaporative Stress Index (ESI)	ESI
Geology Suite		
	Surface Mineralogy (TIR only)	SM
	Elevated Temperature Features	ETF
	Volcanic Activity	VA
Snow Physics Suite		
	Snow temperature (use Fundamental LST&E)	ST
Aquatics Biology / Biogeochemistry Suite	Water temperature (use Fundamental LST&E)	WT

2.0 DATA PRODUCT ORGANIZATION

2.1 Product File Format

All SBG-TIR standard products are stored in the Geographic Tagged Image File Format (GeoTIFF). GeoTIFF is a general purpose file format and programming library for storing scientific data. The GeoTIFF format was originally created by Dr. Niles Ritter with the Open Geospatial Consortium publishing the OGC GeoTIFF standard, which defines the GeoTIFF by specifying requirements and encoding rules for using the Tagged Image File Format (TIFF) for the exchange of georeferenced or geocoded image data. The following sections provide some key elements of GeoTIFF that will be employed in SBG-TIR data products. Complete documentation of the GeoTIFF structure and application software can be found at https://www.ogc.org/standard/geotiff/.

2.2 GeoTIFF Notation

The key concepts of the GeoTIFF Abstract Data Model are Files, Groups, Datasets, Datatypes, Attributes and Property Lists. The following sections provide a brief description of each of these key GeoTIFF concepts.

2.2.1 GeoTIFF File

A File is the abstract representation of a physical data file. Files are containers for GeoTIFF Objects. These Objects include Groups, Datasets, and Datatypes.

2.2.2 GeoTIFF Group

Groups are containers for other Objects, including Datasets, named Datatypes and other Groups. In that sense, groups are analogous to directories that are used to categorize and classify files in standard operating systems.

The notation for files is identical to the notation used for Unix directories. The root Group is “/”. Like Unix directories, Objects appear in Groups through “links”. Thus, the same Object can simultaneously be in multiple Groups.

2.2.3 GeoTIFF Dataset

The Dataset is the GeoTIFF component that stores user data. Each Dataset associates with a Dataspace that describes the data dimensions, as well as a Datatype that describes the basic unit of storage element. A Dataset can also have Attributes.

2.2.4 GeoTIFF Datatype

A Datatype describes a unit of data storage for Datasets and Attributes. Datatypes are subdivided into Atomic and Composite Types.

Atomic Datatypes are analogous to simple basic types in most programming languages. GeoTIFF Atomic Datatypes include Time, Bitfield, String, Reference, Opaque, Integer, and Float. Each atomic type has a specific set of properties. Examples of the properties associated with Atomic Datatypes are:

- Integers are assigned size, precision, offset, pad byte order, and are designated as signed or unsigned.

- Strings can be fixed or variable length and may or may not be null terminated.
- References are constructs within GeoTIFF Files that point to other GeoTIFF Objects in the same file.

GeoTIFF provides a large set of predefined Atomic Datatypes. Table 2-1 lists the Atomic Datatypes that are used in SBG-TIR data products.

Table 2-1: GeoTIFF Atomic Datatypes

GeoTIFF Atomic Datatypes	Description
BYTE	unsigned, 8-bit, little-endian integer
SHORT	unsigned, 16-bit, little-endian integer
LONG	unsigned, 32-bit, little-endian integer
RATIONAL	2 unsigned, 32-bit, little-endian integer
SBYTE	signed, 8-bit, little-endian integer
SSHOR	signed, 16-bit, little-endian integer
SLONG	signed, 32-bit, little-endian integer
SRATIONAL	2 signed, 32-bit, little-endian integer
FLOAT	32-bit, little-endian, IEEE floating point
DOUBLE	64-bit, little-endian, IEEE floating point
ASCII	NULL terminated string
UNDEFINED	8-bit byte

Composite Datatypes incorporate sets of Atomic datatypes. Composite Datatypes include Array, Enumeration, Variable Length and Compound.

The Array Datatype defines a multi-dimensional array that can be accessed atomically.

Variable Length presents a 1-D array element of variable length. Variable Length Datatypes are useful as building blocks of ragged arrays.

Named Datatypes are explicitly stored as Objects within an GeoTIFF File. Named Datatypes provide a means to share Datatypes among Objects. Datatypes that are not explicitly stored as Named Datatypes are stored implicitly. They are stored separately for each Dataset or Attribute they describe.

None of the SBG-TIR data products employ Enumeration or Compound data types.

2.2.5 GeoTIFF Dataspace

A Dataspace describes the rank and dimension of a Dataset or Attribute. For example, a “Scalar” Dataspace has a rank of 1 and a dimension of 1. Thus, all subsequent references to “Scalar” Dataspace in this document imply a single dimensional array with a single element.

Dataspaces provide considerable flexibility to GeoTIFF products. They incorporate the means to subset associated Datasets along any or all of their dimensions. When associated with specific properties, Dataspaces also provide the means for Datasets to expand as the application requires.

2.2.6 GeoTIFF Attribute

An Attribute is a small aggregate of data that describes Groups or Datasets. Like Datasets, Attributes are also associated with a particular Dataspace and Datatype. Attributes cannot be subsetted or extended. Attributes themselves cannot have Attributes.

2.3 SBG-TIR File Organization

2.3.1 Structure

SBG-TIR data products follow a common convention for all GeoTIFF Files. Use of this convention provides uniformity of data access and interpretation.

The SBG-TIR Project uses GeoTIFF Groups to provide an additional level of data organization. All metadata that pertain to the complete data granule are members of the "/Metadata" Group. All other data are organized within Groups that are designed specifically to handle the structure and content of each particular data product.

2.3.2 Data

All data in GeoTIFF files are stored in individual Datasets. All related Datasets in an SBG-TIR product are assigned to an GeoTIFF Group. A standard field name is associated with each Dataset. The field name is a unique string identifier. The field name corresponds to the name of the data element the Dataset stores. This document lists these names with the description of each data element that they identify.

Each Dataset is associated with an GeoTIFF Dataspace and an GeoTIFF Datatype. They provide a minimally sufficient set of parameters for reading the data using standard GeoTIFF tools.

2.3.3 Element Types

SBG-TIR GeoTIFF employs the Data Attribute "Type" to classify every data field as a specific data type. The "Type" is an embellishment upon the standard GeoTIFF Datatypes that is designed specifically to configure SBG-TIR data products.

Table 2-2 lists all of the "Type" strings that appear in the SBG-TIR data products. The table maps each SBG-TIR "Type" to a specific GeoTIFF Datatype in both the GeoTIFF file and in the data buffer. The table also specifies the common conceptual data type that corresponds to the "Type" in SBG-TIR executable code.

Table 2-2: Element Type Definitions

Type	GeoTIFF Datatype (File)	GeoTIFF Datatype (Buffer)	Conceptual Type
Unsigned8	BYTE		unsigned integer
NULL-terminated8	ASCII		unsigned integer
Unsigned16	SHORT	H5T__USHORT	unsigned integer
Unsigned32	LONG		unsigned integer
2 Unsigned32	RATIONAL		unsigned integer
Signed8	SBYTE		signed integer
8-bit	UNDEFINE		signed integer
Signed16	SSHORT		signed integer
Signed32	SLONG		signed integer
2 Signed32	SRATIONAL		signed integer
Float32	FLOAT		floating point
Float64	DOUBLE		floating point

Type	GeoTIFF Datatype (File)	GeoTIFF Datatype (Buffer)	Conceptual Type

2.3.4 File Level Metadata

All metadata that describe the full content of each granule of the SBG-TIR data product are stored within the explicitly named "/Metadata" Group. Metadata are handled using exactly the same procedures as those that are used to handle data. The contents of each Attribute that stores metadata conform to one of the SBG-TIR Types. Most metadata elements are stored as scalars. A few metadata elements are stored as arrays. The metadata appear in a set of GeoTIFF Groups under the "/Metadata" Group. These GeoTIFF Groups contain a set of GeoTIFF Attributes.

2.3.5 Local Metadata

SBG-TIR standards incorporate additional metadata that describe each GeoTIFF Dataset within the GeoTIFF file. Each of these metadata elements appear in an GeoTIFF Attribute that is directly associated with the GeoTIFF Dataset. Wherever possible, these GeoTIFF Attributes employ names that conform to the Climate and Forecast (CF) conventions. Table 2-3 lists the CF names for the GeoTIFF Attributes that SBG-TIR products typically employ.

Table 2-3: SBG-TIR Specific Local Attributes

CF Compliant Attribute Name	Description	Required?
Units	Units of measure. Appendix A lists applicable units for various data elements in this product.	Yes
valid_max	The largest valid value for any element in the Dataset. The data type in valid_max matches the type of the associated Dataset. Thus, if the associated Dataset stores float32 values, the corresponding valid_max will also be float32.	No
valid_min	The smallest valid value for any element in the Dataset. The data type in valid_min matches the type of the associated Dataset. Thus, if the associated Dataset stores float32 values, the corresponding valid_min will also be float32.	No
_FillValue	Specification of the value that will appear in the Dataset when an element is missing or undefined. The data type of _FillValue matches the type of the associated Dataset. Thus, if the associated Dataset stores float32 values, the corresponding _FillValue will also be float32.	Yes, for all numeric data types
long_name	A descriptive name that clearly describes the content of the associated Dataset.	Yes

2.4 Data Definition Standards

The following sections of this document specify the characteristics and definitions of every data element stored in the SBG-TIR data products. Table 2-4 defines each of the specific characteristics

that are listed in those sections. Some of these characteristics correspond with the SBG-TIR GeoTIFF Attributes that are associated with each Dataset. Data element characteristics that correspond to SBG-TIR GeoTIFF Attributes bear the same name. The remaining characteristics are descriptive data that help users better understand the data product content.

In some situations, a standard characteristic may not apply to a data element. In those cases, the field contains the character string 'n/a'. Hexadecimal representation sometimes indicates data content more clearly. Numbers represented in hexadecimal begin with the character string '0x'.

Table 2-4: Data Element Characteristic Definitions

Characteristic	Definition
Type	The data representation of the element within the storage medium. The storage class specification must conform to a valid SBG-TIR type.
Units	Units of measure. Typical values include "deg", "degC", "Kelvin", "meters/second", "meters", "m**2", "seconds" and "counts". Appendix A includes references to important data measurement unit symbols.

2.4.1 Double Precision Time Variables

SBG-TIR double precision time variables contain measurements relative to the J2000 epoch. Thus, these variables represent a real number of Standard International (SI) compatible seconds since 11:58:55.816 on January 1, 2000 UTC.

2.4.2 Array Representation

This document employs array notation to demonstrate and clarify the correspondence among data elements in different product data elements. The array notation adopted in this document is similar to the standards of the Fortran programming language. Indices are one based. Thus, the first index in each dimension is one. This convention is unlike C or C++, where the initial index in each dimension is zero. In multidimensional arrays, the leftmost subscript index changes most rapidly. Thus, in this document, array elements ARRAY(15,1,5) and ARRAY(16,1,5) are stored contiguously.

GeoTIFF is designed to read data seamlessly regardless of the computer language used to write an application. Thus, elements that are contiguous using the dimension notation in this document will appear in contiguous locations in arrays for reading applications in any language with an GeoTIFF interface.

This document differentiates among array indices based on relative contiguity of storage of elements referenced with consecutive numbers in that index position. A faster or fastest moving index implies that the elements with consecutive numbers in that index position are stored in relative proximity in memory. A slower or slowest moving index implies that the elements referenced with consecutive indices are stored more remotely in memory. For instance, given array element ARRAY(15,1,5) in Fortran, the first index is the fastest moving index, and the third index is the slowest moving index. On the other hand, given array element array[4][0][14] in C, the first index is the slowest moving index, and the third index is the fastest moving index.

3.0 SBG-TIR PRODUCT FILES

The SBG-TIR product file will contain at least 3 groups of data: A standard metadata group that specifies the same type of contents for all products, a product specific metadata group that specifies those metadata elements that are useful for defining attributes of the product data, and the group(s) containing the product data. (Note: A product metadata is not to be confused with a GeoTIFF object metadata.)

All product file names will have the form:

```
SBG-TIR_<PROD_TYPE>_<OOOOO>_<SSS>_<YYYYMMDDThhmmss>_<BBbb>_<VV>.<TYPE>
```

Where:

PROD_TYPE: Product type =
L1B_GEO, Geolocation parameters and at-sensor calibrated radiances
L1C_RAD, Gridded radiance at sensor
L1C_VNIR, Gridded radiance at sensor (VNIR)
L2_LSTE, Land Surface temperature and emissivity
L2_CLOUD, Cloud mask
L2_VNIR_TOA, VNIR TOA reflectance
L2_VNIR_BOA, VNIR BOA reflectance
L2_NDVI, NDVI
L3_ET, Evapotranspiration retrieved
L3_ETF, Elevated Temperature Features
L3_SM, Surface Minerology
L4_ESI, Evaporative Stress Index
L4_WUE, Water Use Efficiency
L4_VA, Volcanic Activity
OOOOO: Orbit number; starting at start of mission, ascending equatorial crossing
SSS: Scene ID; starting at first scene of each orbit
YYYYMMDDThhmmss: Starting time of scene
BBbb: Build ID of software that generated product, Major+Minor (2+2 digits)
VV: Product version number (2 digits)
TYPE: File type extension=
.tif, for the data file
.tif.xml, for the metadata file

3.1 Standard Metadata

This is the minimal set of metadata that must be included with each product file. The standard metadata consists of the following:

Table 3-1: Standard Product Metadata

Name	Type	Size	Example
Group	**Standard Metadata**		
AncillaryInputPointer	String	variable	Group name of ancillary file list
AutomaticQualityFlag	String	variable	PASS/FAIL (of product data)
BuildID	String	variable	
CampaignShortName	String	variable	Primary
CollectionLabel	String	variable	
DataFormatType	String	variable	GeoTIFF

DayNightFlag	String	variable	
EastBoundingCoordinate	LongFloat	8	
HDFVersionID	String	variable	
ImageLines	Int32	4	
ImageLineSpacing	Float32	4	60
ImagePixels	Int32	4	
ImagePixelSpacing	Float32	4	60
InputPointer	String	variable	
InstrumentShortName	String	variable	SBG-TIR
LocalGranuleID	String	variable	
LongName	String	variable	SBG-TIR
NorthBoundingCoordinate	LongFloat	8	
PGEName	String	variable	L3_SM
PGEVersion	String	variable	
PlatformLongName	String	variable	
PlatformShortName	String	variable	
PlatformType	String	variable	Spacecraft
ProcessingLevelID	String	variable	3
ProcessingLevelDescription	String	variable	Level 3 Surface Mineralogy
ProducerAgency	String	variable	
ProducerInstitution	String	variable	
ProductionDateTime	String	variable	
ProductionLocation	String	variable	
RangeBeginningDate	String	variable	
RangeBeginningTime	String	variable	
RangeEndingDate	String	variable	
RangeEndingTime	String	variable	
SceneID	String	variable	
ShortName	String	variable	L3_SM
SISName	String	variable	
SISVersion	String	variable	Final
SouthBoundingCoordinate	LongFloat	8	
StartOrbitNumber	String	variable	
StopOrbitNumber	String	variable	
WestBoundingCoordinate	LongFloat	8	

3.2 Product-Specific Metadata

Any additional metadata necessary for describing the product will be recorded in this group.

Table 3-2: Product Specific Metadata

Name	**Type**	**Size**	**Example**
Group	**L3_SM_Metadata**		
QualityBitFlag	Int	255	01011011011
AvgETUncertainty	Float	8	
AncillaryFiles	Int	4	100
AncillaryFileAirTemperature	String	255	CFSR_FILENAME_DATE
AncillaryFileSMid	String	255	EDAY_V7NC_CFSRINSOL_2018200.dat
AncillaryFileBadMask	String	255	

AncillaryFileInsolation	String	255	CFSR_FILENAME_DATE
AncillaryFileLandcover	String	255	NLCD_FILENAME
AncillaryFileLST	String	255	LSTE_FILENAME
AncillaryFileMixingRatio	String	255	CFSR_FILENAME_DATE
AncillaryFilePressure	String	255	CFSR_FILENAME_DATE
AncillaryFileSurfaceReflectance	String	255	LANDSAT_TARFILE_NAME
AncillaryFileSurfReflectanceFill	String	255	
AncillaryFileWindSpeed	String	255	CFSR_FILENAME_DATE
BandSpecification	Float32	8	
Projection	String	255	(SBG-TIR or UTM)
Geotransform	String	255	
OGC Well Known Text	String	variable	Blank if Projection=SBG-TIR If Projection=UTM, EG: {PROJCS["UTM_Zone_11N",GEOGCS["GCS_WGS_1984",DATUM["D_WGS_1984",SPHEROID["WGS_1984",6378137.0,298.257223563]],PRIMEM["Greenwich",0.0],UNIT["Degree",0.0174532925199433]],PROJECTION["Transverse_Mercator"],PARAMETER["False_Easting",500000.0],PARAMETER["False_Northing",0.0],PARAMETER["Central_Meridian",-117.0],PARAMETER["Scale_Factor",0.9996],PARAMETER["Latitude_Of_Origin",0.0],UNIT["Meter",1.0]]}

3.3 Product Data

The product data will be stored in this group. Exact contents and layouts to be defined by each PGE and will conform to the GeoTIFF specifications.

Table 3-3: Product Data Definitions

Field Name	TYPE	UNIT	Field Data
GROUP	**L3_SURFACE_MINEROLOGY**		
Amphibole Percentage	Int8	0-100	
Carbonate Percentage	Int8	0-100	
Mica Percentage	Int8	0-100	
Olivine Percentage	Int8	0-100	
Plagioclase Feldspar Percentage	Int8	0-100	
Potassium Feldspar Percentage	Int8	0-100	
Pyroxene Percentage	Int8	0-100	
Quartz Percentage	Int8	0-100	
Sulfate Percentage	Int8	0-100	
Blackbody Percentage	Int8	0-100	
Band 1 Residual Error	Float16	0-100	
Band 2 Residual Error	Float16	0-100	
Band 3 Residual Error	Float16	0-100	

Band 4 Residual Error	Float16	0-100	
Band 5 Residual Error	Float16	0-100	
Band 6 Residual Error	Float16	0-100	
RMS Error	Float16	0-100	
Wt Perc Silica	Uint8	0-100	
Data Quality	Int8		

3.4 Product Metadata File

The product metadata for each product file will be generated by the PCS from the metadata contents of each product file. The metadata will be converted into extensible markup language (XML). These will be used by the DAAC for cataloging. Exact contents and layout to be defined by PCS.

4.0 APPENDIX A: ABBREVIATIONS AND ACRONYMS

ARS	Agricultural Research Service
ASD	Algorithm Specifications Document
ATBD	Algorithm Theoretical Basis Document
CCB	Change Control Board
CDR	Critical Design Review
CF	Climate and Forecast (metadata convention)
CM	Configuration Management
CONUS	Continental United States
COTS	Commercial Off The Shelf
DAAC	Distributed Active Archive Center
dB	DeciBel
DCN	Document Change Notice
deg	Degrees
deg/sec	Degrees per Second
DEM	Digital Elevation Model
DN	Data Number
EASE	Equal Area Scalable Earth
ECI	Earth Centered Inertial coordinate system
ECR	Earth Centered Rotating coordinate system
ECS	EOSDIS Core System
EOS	Earth Observing System
EOSDIS	EOS Data and Information System
ESDIS	Earth Science Data and Information System
ESDT	Earth Science Data Type
ESI	Evaporative Stress Index
ET	Evapotranspiration
FOV	Field of View
FSW	Flight Software
GB	gigabytes, 10^9 bytes
GDS	Ground Data System
GeoTIFF	Geographic Tagged Image File Format
GHA	Greenwich Hour Angle
GHz	Gigahertz, 10^9 hertz
GMAO	Global Modeling and Assimilation Office
GMT	Greenwich Mean Time
GPP	Gross Primary Production
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
HK	Housekeeping (telemetry)
HRSL	Hydrology and Remote Sensing Laboratory
Hz	Hertz
HSD	Health and Status Data
I&T	Integration and Test
ICD	Interface Control Document
I/O	Input/Output
IOC	In-Orbit Checkout

IPA	Inter-Project Agreement
ITAR	International Traffic in Arms Regulation
JPL	Jet Propulsion Laboratory
K	Kelvin
KHz	Kilohertz
Km	kilometer, 1000 meters
L0 – L4	Level 0 through Level 4
LAN	Local Area Network
LEO	Low Earth Orbit
LOE	Level of Effort
LOM	Life of Mission
LP	Land Processes
LSTE	Land Surface Temperature and Emissivity
m	meter
MB	megabytes, 10^6 bytes
Mbps	Mega bits per second
MHz	Megahertz
MMR	Monthly Management Review
MOA	Memorandum of Agreement
MODIS	Moderate Resolution Imaging Spectroradiometer
MOS	Mission Operations System
m/s	meters per second
ms	milliseconds
MS	Mission System
NASA	National Aeronautics and Space Administration
NCEP	National Centers for Environmental Protection
NCSA	National Center for Supercomputing Applications
netCDF	Network Common Data Format
NISN	NASA Integrated Services Network
NOAA	National Oceanic and Atmospheric Administration
OA	Operations Agreement
ODL	Object Description Language
OODT	Object Oriented Data Technology
ORR	Operational Readiness Review
ORT	Operational Readiness Test
PDR	Preliminary Design Review
percent	%, per hundred
PR	Problem Report
PSD	Product Specifications Document
PT-JPL	Priestly-Taylor-JPL
QA	Quality Assurance
rad	radians
RDD	Release Description Document
RFA	Request For Action
SBG-TIR	Surface Biology and Geology – Thermal Infrared
S/C	Spacecraft
SCP	Secure Copy
SDP	Software Development Plan

SDS	Science Data System
sec, s	seconds
SITP	System Integration and Test Plan
SMP	Software Management Plan
SOM	Software Operators Manual
TAI	International Atomic Clock
T_b	Brightness Temperature
TBD	To Be Determined
TBS	To Be Specified
TIFF	Tagged Image File Format
TOA	Time of Arrival
TPS	Third Party Software
USDA	United State Department of Agriculture
USGS	United States Geological Society
UTC	Coordinated Universal Time
V&V	Verification and Validation
WUE	Water Use Efficiency
XML	Extensible Markup Language