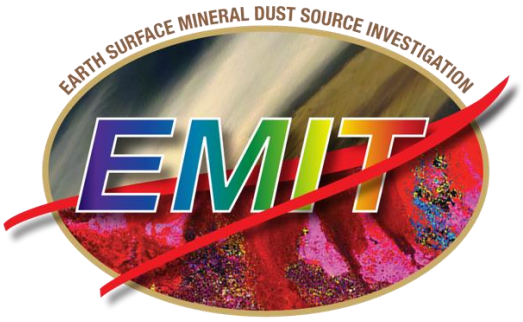

Earth Surface Mineral Dust Source Investigation (EMIT)

Level 3 Aggregated Spectral Abundance Data Product User Guide

Draft v01

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August 30, 2023
JPL D- 107862

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Change Log

Date	Sections Changed	Reason for Change	Revision
03/09/2022	All	All	Pre-release
08/30/2023	All	Revised product definition	Initial Release

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Table of Contents

1 Introduction

1.1 Identification

This document describes information about the file structure and datasets provided in the EMIT Level 3ASA data product. The algorithms and data content of the Level 3ASA data products are described briefly in this guide, with the purpose of providing the user with sufficient information about the content and structure of the data files to enable the user to access and use the data, in addition to understanding the uncertainties involved in the products.

1.2 Overview

The EMIT Project will deliver space-based measurements of surface mineralogy of the Earth's arid dust source regions. These measurements are used to initialize Earth System Models (ESM) of the dust cycle, which describe the generation, lofting, transport, and deposition of mineral dust. Earth System Models incorporate the dust cycle to estimate the impacts of mineral dust on the optical and radiative properties of the atmosphere, and a variety of environmental and ecological processes. During its one-year mission, EMIT on the ISS will make measurements over the sunlit Earth's dust source region that occur in the range of ±52° latitude. EMIT will schedule up to five visits (three on average) of each arid target region and only cloud-free acquisitions are downlinked. EMIT-based maps of the relative abundance of source minerals will advance our understanding of the current and future impacts of mineral dust in the Earth system.

The EMIT instrument is a Dyson imaging spectrometer that uses contiguous spectroscopic measurements in the visible to short wavelength infrared region of the spectrum to resolve absorption features of dust-forming minerals. From the instrument's focal plane array, on-board avionics reads out raw detector counts at 1.6 Gbps, then digitizes and stores this data to a high-speed Solid-State Data Recorder (SSDR). From there, the avionics software reads the raw uncompressed data, packages this data into frames of 32 instrument lines, screens for cloudy pixels within the frames, and performs a lossless 4:1 compression of the frame's science data before storing the processed, compressed data back onto the SSDR. The data is later read from the SSDR, wrapped in CCSDS packets and then formatted as ethernet packets for transmission over the International Space Station (ISS) network and downlinked to the EMIT Instrument Operation System (IOS). Once on the ground, the EMIT IOS delivers the raw ethernet data to the SDS where Level 0 processing removes the Huntsville Operations and Support Center (HOSC) ethernet headers, groups CCSDS packet streams by APID, and sorts them by course and fine time.

The Level 3ASA data product contains EMIT aggregated spectra abundances, and uncertainties, at 0.5 degree resolution, intended for use in Earth System Models.

All EMIT products are provided as Network Common Data Form (NetCDF) files (further information can be found at https://www.unidata.ucar.edu/software/netcdf/).

1.3 File Formats

1.3.1 1.3.1. Metadata Structure

The EMIT Mineral Aggregated Spectral Abundance collection (EMITL3ASA) contains 1 NetCDF file (Spectral Abundance and Spectral Abundance Uncertainty), and 1 quicklook PNG file (Browse) with file content described in Table 1-1.

Table 1-1: EMITL2BMIN collection file list and naming convention

Collection: EMITL3ASA	
	Aggregated Spectral Abundance and Uncertainty: EMIT_L3_ASA_<VVV>.nc
	Browse: EMIT_L3_ASA_<VVV>.png

<VVV> gives the software version number, e.g., 001

1.3.2 L3ASA Data Products

The EMIT L3 Aggregated Spectral Abundance collection contains estimated mineral spectral abundances that have been aggregated to 0.5 degrees for the intended use in Earth System Models. Each mapped pixel may contain many hundreds of thousands of individual EMIT observations, which are averaged together after adjusting for vegetation and masking for cloudcover, water, and urban environments. Mosaics used for averaging are generated using all EMIT data processed through to L2BMIN from mission start to 07/30/2023, with the minimum solar zenith angle pixel selected for each location after all masks have been applied.

Table 1-1: EMIT L3 Data Products Summary

Earth Science Data Type	Product Level	Data Dimension	Spatial Resolution	Swath Width	Map Projection
Collection	*EMITL3ASA*				
Spectral Abundance	L3	690 x 220 x 20	0.5 degree	NA	WGS-84

1.4 Product Availability

The EMIT L3ASA products will be available at the NASA Land Processes Distributed Active Archive Center (LP DAAC, https://lpdaac.usgs.gov/) and through NASA Earthdata (https://earthdata.nasa.gov/).

2 File Structure

The NetCDF files are for easy utilization in Earth System Models. Each variable (except latitude and longitude), is a two dimensional grid with dimensions (lat, lon). Latitude and longitude bands contain the location of the upper left corner of the reference location.

The NetCDF file contains a list of global attributes describing mission relevant information. The following table provides the EMIT L3 Aggregated Spectral Abundance and Uncertainty bands contained in the NetCDF file.

Table 2-1: EMIT_L3_ASA File Structure and Content

Name	Fill Value	Type	Units
Calcite	-9999.0	float32	%
Chlorite	-9999.0	float32	%
Dolomite	-9999.0	float32	%
Goethite	-9999.0	float32	%
Gypsum	-9999.0	float32	%
Hematite	-9999.0	float32	%
Illite+Muscovite	-9999.0	float32	%
Montmorillonite	-9999.0	float32	%
Vermiculite	-9999.0	float32	%
Calcite_Uncertainty	-9999.0	float32	%
Chlorite_Uncertainty	-9999.0	float32	%
Dolomite_Uncertainty	-9999.0	float32	%
Goethite_Uncertainty	-9999.0	float32	%
Gypsum_Uncertainty	-9999.0	float32	%
Hematite_Uncertainty	-9999.0	float32	%
Illite+Muscovite_Uncertainty	-9999.0	float32	%
Montmorillonite_Uncertainty	-9999.0	float32	%
Vermiculite_Uncertainty	-9999.0	float32	%
latitude	-9999.0	float32	Decimal Degrees
longitude	-9999.0	float32	Decimal Degrees

Appendix A: Acronyms

Term	Definition
ADC	Analog to Digital Converter
APID	Application Identifier
ASCII	American Standard Code for Information Interchange
BIL	Band Interleaved by Line
CCSDS	Consultative Committee for Space Data Systems
DAAC	Distributed Active Archive Center
DCID	Data Collection Identifier
DN	Digital Number
EMIT	Earth Mineral dust source InvesTigation
ENVI	Environment for Visualizing Images
ESDIS	Earth Science Data and Information System
ESM	Earth System Model
FPA	Focal Plane Array
FPGA	Field Programmable Gate Array
FPIE	Focal Plane Interface Electronics
FPIE-A	Focal Plane Interface Electronics - Analog
FSW	Flight Software
Gbps	Gigabits per second
GLT	Geometry Lookup Table
HOSC	Huntsville Operations and Support Center
ICD	Interface Control Document
IOS	Instrument Operations System
ISS	International Space Station
JPL	Jet Propulsion Laboratory
kHz	Kilohertz
L0	Level 0 (compressed, raw packets)
L1A	Level 1A (reconstructed, uncompressed data reassembled into scenes)
L1B	Level 1B (calibrated radiances with geolocation parameters)
L2A	Level 2A (atmospherically-corrected surface reflectance)
L2B	Level 2B (mineral feature depth maps)
L3	Level 3 (gridded global map of mineral composition and abundances)
L4	Level 4 (model runs of GISS ModelE2 and NCAR CESM)
LP DAAC	Land Processes Distributed Active Archive Center
LSB	Least Significant Bit
MSB	Most Significant Bit
NASA	National Aeronautics and Space Administration
NetCDF	Network Common Data Format
PGE	Product Generation Executable
PLRA	Program Level Requirements Appendix
ROIC	Readout Integrated Circuit
SDS	Science Data System
SIS	Software Interface Specification

SSDR	Solid State Data Recorder
UTC	Universal Time Coordinated