

MRD 140- Emissivity Spectra

Data Product Overview

Emissivity spectra consist of emissivity as a function of wavenumber (where emissivity is a dimensionless value between 0 - 1 and wavenumber is equivalent to $10,000/\text{wavelength}$ in microns). They are the basic unit of science data derived from OTES and provide information about the mineralogical composition of the surface of Bennu.

Overview

An OTES calibrated radiance spectrum is the product of the target object's emissivity and a Planck function at the target's temperature (as a function of wavenumber), where wavenumber-dependent emissivity is diagnostic of composition. Removal of the temperature component enables the direct comparison of emissivity spectra from different surfaces that were measured at different temperatures. One output of the emissivity-temperature (E-T) separation algorithm is the emissivity spectrum, which is then saved out to the SPOC database (the other output is the derived target temperature). The time required to process a single spectrum is less than one second. Although the primary value of emissivity spectra is for compositional analysis of warm, dayside surfaces, the default approach will be to run the E-T separation for all OTES calibrated radiance spectra because the temperatures that are simultaneously derived are needed for temperature and thermal model data products.

Data Product Structure and Organization

Emissivity spectra are stored as individual one-dimensional, floating-point arrays. The SAWG has adapted existing, heritage software for generating the emissivity data product based on the OTES-specific data format. The x-axis (in units of wavenumber) will be identical for all spectra, so will be stored as a separate file with dimensions of $1 \times 1 \times 191$ (representing floating point values from $2000 - 100 \text{ cm}^{-1}$ in steps of $\sim 10 \text{ cm}^{-1}$). (*5 March 2016 NOTE: The length and sampling may change slightly if the sampling rate of the OTES is updated to avoid interference from the s/c IMUs.*)

Data Format Descriptions

At present, the emissivity data will be archived in the PDS in HDF format according to the algorithm description page and SAWG SIS. The emissivity spectra returned to the SPOC database will be in the format below and the version of the emissivity software used will accompany the spectra. The spacecraft clock time will be used to associate the emissivity spectra with the predecessor data (calibrated radiance) and other ancillary information in the database (e.g., geometry).

Data Product Generation

Processing of OTES calibrated radiance spectra will produce spot values for emissivity. Davinci is the software package/programming language in which the [E-T separation algorithm](#) has been written - this heritage software has been adapted for specific details of the OTES instrument. This software will be installed on the SPOC system for use on all spectral data processing. At present, the default processing values will be: maximum emissivity = 1.0; wavenumber range over which the temperature is determined = 1350 - 300 cm^{-1} . (Users wishing to test the effects of non-default values will have access to the E-T separation algorithm via the Davinci data processing software and will be free to generate their own emissivity product for personal use.)

Required inputs and formats are:

- OTES spot calibrated radiance data
 - Two-dimensional floating-point array (1x1x191 spectrum)

Co-I Hamilton has been assigned to this product.

Data Product Validation

Data processing at each step is rapid (<1 sec/spectrum), but validation for science requires human examination; e.g., to verify that there is no evidence of anomalous signatures in the data (such as excessive noise for the observing conditions). The validation step (at a high level) can be done at a rate of a few seconds/spectrum.

Data Flow

OTES (pipeline) spot calibrated radiance spectra will be retrieved from the SPOC and run through the E-T separation algorithm to produce the emissivity and temperature data products. This occurs prior to any spectral science data processing (e.g., linear mixture analysis or spectral parameter calculation).

Observation Requirements

An emissivity spectrum will be generated from all OTES calibrated radiance spectra of the target (Bennu). The expectation, described above, is that emissivity will be produced from all target spectra because the associated temperature is a required input to thermal models. For the resulting data to meet the expected areal coverage and spatial resolution requirements, the spacecraft must be within the stated delivery uncertainty of the range, latitude, and longitude.

