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Summary of Requirement

MRD-143 (2.11.2) Characterize the spectral properties of any detected dust and gas plumes.

Gas-phase molecules and dust may have absorption and emission features in the spectral regions of interest, allowing identification of certain species. This requirement applies to contingency observations in the event that one or more plumes are detected at Bennu.

The requirement is verified by establishing that SAWG has developed and tested the requisite algorithms for producing resampled OVIRS I/F and OTES apparent emissivity spectra, which are the minimum products required to characterize dust/gas plumes (see Liens for further discussion of this point).

Data Products Required

OVIRS: OVIRS calibrated radiance from the Detailed Survey phase, resampled and converted to I/F using a standard solar spectrum.

OTES: OTES calibrated radiance from the Detailed Survey phase, processed to apparent emissivity, where "apparent" indicates that the measured quantity is not expected to be in thermal equilibrium with the background (i.e., will likely be more akin to a transmission spectrum).

No other dependencies exist for these products.

Ability/Availability of the System to Generate Sufficient Observations

Details of spacecraft orientation for instrument pointing and spacecraft trajectories will depend on the characteristics of the plume(s), and hence, will not be decided until the plume(s) have been detected. Characterization of any dust/gas plumes is on a best-effort basis, with no requirement for minimum detection by the spectrometers. If the plume(s) is/are sufficiently optically dense to be measurable by the spectrometers, the algorithms for species detection will be applied to the data.

Minimum Success Criteria

The spectrometers can make observations of the plume location(s) as determined from OCAMS observations, but successful detection of species of interest will depend on the physical nature of the plume(s), which cannot be predicted in advance. If the plume(s) is not sufficiently optically dense or lacks thermal contrast that would produce spectral features in either the OVIRS or OTES (or both) dataset, characterization will nonetheless have been accomplished.

Dependencies by Mission Phase

The search for plumes using OCAMS will occur during the Approach phase and the Detailed Survey phase. The characterization of any identified plumes will take place after the plume search campaign, in Detailed Survey phase.

Adequacy of the DRM

These observations will only take place in the event that one or more plumes are detected; to the degree that the DRM sets aside time for the characterization observations during Detailed Survey (even if they are not yet planned), the mission profile is adequate.

Data Products per Mission Phase

Data products will be produced whenever plumes are detected in the Approach or Detailed Survey mission phases.

OVIRS: The output product is one or more I/F spectrum(-a), depending on signal strength. Several individual, weak signatures may be co-added to obtain a high(er) signal-to-noise spectrum.

OTES: The output product is one or more apparent emissivity (or flux) spectrum(-a), depending on signal strength. Several individual, weak signatures may be co-added to obtain a high(er) signal-to-noise spectrum.

Overview of Processing

OVIRS: OVIRS L2 calibrated radiance will be resampled and converted by SAWG to I/F (two steps).

OTES: OTES L2 calibrated radiance spectra will be converted by SAWG to apparent emissivity using the emissivity-temperature algorithm (one step).

Provenance of Algorithms, Software and Techniques

OVIRS: The resampling, thermal tail removal, and I/F processing steps can all be considered common knowledge. The specific IDL scripts delivered by the SAWG were written expressly for the SAWG.

OTES: The emissivity-temperature separation script for the Davinci environment is an update to code used for analysis of thermal infrared spectra on prior spaceflight missions (Mars Exploration Rovers, Mars Odyssey, Mars Global Surveyor) and has been used extensively for OTES data processing through instrument-level testing and ATLO. Script version control is included. [References would be to science data or early literature describing separation of E and Tb.]

Expected/Simulated Data

SAWG does not possess, and does not plan to produce, data simulating these observations because the observing geometry is not known in advance, nor the optical/thermal parameters of the potential plumes. Data loosely representative of what would be produced are available as the inputs to the CMWG/SAWG Blind Test, available at this
link: https://sciwik.lpl.arizona.edu/wiki/pages/S0x0o874/Spectral_Analysis_Working_Group.html

Analysis & Verification Methods

OVIRS: The SAWG implementation of resampling and I/F generation has been tested internally with known value, synthetic spectral data.

OTES: The SAWG emissivity-temperature script has been tested during OTES instrument-level testing, and is a heritage algorithm with many derived publications.

Existing or Potential Liens

Lien-SPEC-2 has closed. The database search, input, and output currently implemented in the JSON database at the SPOC for meeting the MRD Requirements on spectral data processing(MRD-118, MRD-140, MRD-143, MRD-147, MRD-154, MRD-159 and MRD-540), are ready for operations. These database uses have been completed, validated, verified and used successfully by SAWG and TAWG scientists during the first Science Operations Proficiency Integrated Exercise (SOPIE-1). The SAWG and TAWG teams demonstrated that the database IO is complete -- by correctly using it to create data products during the SOPIE-1 exercise. Only minimal support was required from Sanford Selznick (Director of Science Data Processing) and his staff to use the database structure to download datasets and upload higher level data products. The software and database structures for extracting L2 OTES and OVIRS data from the database, and handing them off to the various data processing algorithms, then returning them to the database, has been completed (i.e., science database tables have been implemented), and Lien-SPEC-2 can be closed.

Lien-SPEC-2: Lien on the SPOC: The second lien on successfully meeting this requirement is the implementation of needed database access and data processing linkages at the SPOC. SAWG has delivered individual algorithms for conducting the required analyses, but there is currently no defined procedure for SAWG to extract L2 OTES and OVIRS data from the database, and hand it off to the various algorithms, then return it to the database (i.e., science database tables have not been implemented). Removing this lien will require work on both the part of the SPOC and the SAWG to generate algorithms and update existing algorithms once a process is defined.

There are currently no known liens on the OVIRS/OTES instruments or spacecraft system that would preclude success.

SPOC Requirements

SPOC must produce OVIRS and OTES instrument L2 products, enable these to be fed to the SAWG algorithms for calculating I/F (OVIRS) and emissivity-temperature separation (OTES). Geometric information (solar distance) is required for calculation of I/F, but is not required for derivation of apparent emissivity.

The SPOC-Spectral Analysis ICD is posted on ODOCS: \OSIRIS-REx Ground Systems\9.4 SPOC\9.4.2 Systems Eng\ICDs\WG ICDs\

The Spectral Analysis flowchart is in draft form, undergoing active revision (as of 15 May 2016) and will be linked here when it is finalized.

External Interfaces

There are no external interfaces for spectral characterization of plumes.