Thermal Model- Rotationally Resolved Thermal Inertia

Overview

Estimate thermal inertia from disk integrated OTES thermal flux spectra taken in Approach phase as a function of rotation.

History

Draft - 17 Aug 2013

Baseline - 30 Nov 2013

Algorithm Description

1. Read in OTES spectra for a range of times.
    - Input data may be down-selected based on quality parameters such as signal-to-noise.
2. Allow user the option of averaging OTES spectra over some time interval
    - For example, if OTES spectra are taken on a few second cadence, it may be desirable to bin these over several minutes to improve signal-to-noise prior to thermal inertia fit
    - Would have to properly compute average time and position information as well
3. Read in or set required information on the shape, spin state, global albedo or albedo map, and surface roughness of Bennu.
4. Determine best-fit thermal inertia for each OTES spectrum (raw or binned, depending on step 2). The following set of steps may run iteratively within a minimization routine (e.g., Brent's method, Levenberg-Marquardt method) to efficiently zero-in on the best-fit thermal inertia. Alternatively, a grid of thermal inertias can be set up, and the following steps iterated over the explicit grid.
    1. For each facet in the shape model, use the Thermal Model Lookup Table to determine the temperature for the given thermal inertia and time/geometry of the observation
    2. For each facet, calculate the spectral flux, as seen by the spacecraft.
    3. Sum all fluxes from all facets visible to the spacecraft at the time of the OTES observation
    4. Compute the chi-square goodness-of-fit of the model spectrum to the data
5. Uncertainty in thermal inertia will be assessed as the range around the best-fit that corresponds to a delta-reduced-chi-square of 1.
6. Write output file: ascii table of rotational phase, thermal inertia, uncertainty, chi-square

Parameters

Input

- OTES disk-integrated spectral fluxes
    - 3 x n_wavelength array of wavelengths, fluxes, and flux uncertainties
- Shape of Bennu
    - vector-facet format of shape model
- Spin state of Bennu
    - 3 floating point values: rotation period and ecliptic coords of spin pole
- Bennu position relative to Sun
    - 3 floating point values: distance, ecliptic longitude and latitude relative to the Sun
- Bennu position relative to spacecraft

    - 3 floating point values: distance, ecliptic longitude and latitude relative to the Sun
- Average albedo or albedo map
    - single floating point value, or file of albedo for each facet in the shape model

- User inputs for constraints (quality, local time, etc)

Output

- Ascii table
    - Rotational Phase
    - Thermal Inertia
    - Thermal inertia uncertainty
    - Chi-square of best-fit
- Header data
    - Start/end time of OTES observations
    - Version/calibration set of OTES observations
    - Bennu position relative to the Sun (distance, ecliptic longitude and latitude)
    - Bennu position relative to the spacecraft (distance, ecliptic longitude and latitude)
    - Bennu rotational state (ecliptic coordinats of spin-pole, rotation period)
    - Name/location of shape file used in model
    - Name/version of thermal model used
    - Average albedo used for model, or name/location of albedo map
    - Bolometric emissivity used for model

Keywords

- Option for pre-binning of input OTES spectra over some time interval