Surface Emissivity

Product ID: AST05
Product Level: 2
Absolute Accuracy: 0.05-0.1
Horizontal Resolution: 90 m
Product Size (MB): 9

Lead Invest: Gillespie/Rokugawa
Production Mode: on-request
Relative Accuracy: 0.005
Units: none

Product Description

The Level-2 land surface emissivity product contains surface emissivity at 90-m resolution generated only over the land from ASTER's five thermal infrared channels. Surface emissivity is required to derive land surface temperature (AST08) data, also at a resolution of 90 meters. The emissivity product is critical for deriving accurate land surface temperatures. It is therefore important in studies of surface energy and water balance. The emissivity product is also useful for mapping geologic and land-cover features.

Current sensors provide only limited information useful for deriving surface emissivity and researchers are required to use emissivity surrogates such as land-cover type or vegetation index in making rough estimates of emissivity and hence land surface temperatures. The five thermal infrared channels of the ASTER instrument enable direct surface emissivity estimates. Mapping of thermal features from optical sensors such as Landsat and AVHRR has been used for many developmental studies. These instruments, however, lack the spectral coverage, resolution and radiometric accuracy that will be provided by the ASTER instrument.

Algorithm Description

Read in the land-leaving radiance and down-welling sky irradiance vectors for each pixel. Estimate the emissivity spectrum using the Normalized Emissivity Method and iteratively compensate for reflected skylight. Normalize the emissivity spectrum using the average emissivity for each pixel. Calculate the min-max difference (MMD) of the normalized spectrum and estimate the minimum emissivity using a regression that relates the MMD and the minimum emissivity. Scale the normalized emissivities using the minimum emissivity. Compensate for reflected skylight using the refined emissivities. Use the emissivity value to calculate a temperature using Planck's Law.

Applications

Emissivity is useful in identifying surface composition. Many minerals -- especially silicate minerals that make up the bulk of the Earth's surface -- have distinctive thermal infrared emissivity spectra, but ambiguous or non-distinctive VNIR spectra. Quartz, feldspars, amphiboles, and pyroxenes all are in this category. Carbonate rocks also have distinctive spectra, although the diagnostic features are unresolved by ASTER. Because other minerals -- especially iron-bearing and hydrated minerals -- have distinctive VNIR and SWIR spectra, surface composition mapping is best undertaken with the full range of ASTER bands, not just the TIR bands alone.

Rock and soil emissivities also contrast with vegetation, snow and water. Therefore, emissivity data are useful for mapping forest clearings and snow coverage.

Atmospheric gases such as SO_2, emitted from volcanoes, absorb ground-emitted thermal radiation selectively. Therefore, emissivity maps are useful in recognizing the presence of volcanic emissions, although special processing is required to quantify them. The same comments apply to industrial pollution.

Constraints

Currently there are no constraints, and the algorithm should work with TIR data acquired during the day or night. The algorithm will return incorrect values for clouds, however, because the atmospheric corrections will have been inaccurate due to a lack of knowledge of cloud height. Therefore, if a pixel is classified as "cloud" on the basis of its spectral and temperature characteristics a notation to that effect will be made in the QA plane. Because clouds radiate to the ground, pixels not covered by clouds but in their vicinity will also have inaccurate emissivties and spectra, and therefore these pixels are also noted in the QA plane. For cold surfaces viewed through a warm or humid atmosphere correction for reflected skylight can be inaccurate, leading to inaccurate emissivity estimates.