Surface emissivity

In the community commitment to understanding the history and evolution of Mars, an emphasis has been put on characterizing the Martian surface properties during the past decades. Near-infrared spectrometers (like CRISM, <3µm) measure the sunlight reflected by the surface and thermal infrared spectrometers measure the radiance emitted by the surface (THEMIS, TES > 6µm). In the transitionnal domain, the radiance measured from orbit (with OMEGA, 0.4-5.1µm) is a combination of reflected sunlight and thermally emitted radiance:

\[
I_{\text{sat}}(\lambda) = H_{\text{atm}}(\lambda) r(\lambda) I_{\text{Sun}}(\lambda) \cos(i) + H_{\text{atm}}(\lambda) \epsilon(\lambda) I_{\text{Planck}}(\lambda, T)
\]

In this work, we perform a computation and mapping of the emissivity of the Martian surface at 5 to 5.1 µm, using more than four Martian years of OMEGA data. We produce four 40 ppd global maps, filled at more than 98%. These maps can help interpreting other instruments data and are distributed to the community.

Comparison of the thermal and sunlight components of the radiance viewed from orbit. Conditions are idealized: \(i=30°\), \(D_{\text{Mars}}=1.53\) AU, reflectance and emissivity are constants.

**Algorithm**

**Method 1**
Comparison of 2.4 µm reflectance with Erard and Calvin (1997) composite spectra and extrapolation at 5 µm

\[
I_{\text{sat}}(\lambda) = H_{\text{atm}}(\lambda) r(\lambda) I_{\text{Sun}}(\lambda) \cos(i) + H_{\text{atm}}(\lambda) \epsilon(\lambda) I_{\text{Planck}}(\lambda, T)
\]

For each of the four last spectels of OMEGA, we have:

\[
I_{\text{sat}}(\lambda) = H_{\text{atm}}(\lambda) r(\lambda) I_{\text{Sun}}(\lambda) \cos(i) + H_{\text{atm}}(\lambda) \epsilon(\lambda) I_{\text{Planck}}(\lambda, T)
\]

4 equations, 5 unknowns (1 is shared) - a simplex can solve for emissivities and temperature

**Method 2**
Numerical solver

If 2.4 µm data is reliable and if 5 µm data has low signal to noise ratio, use method 1. Otherwise, use method 2. Excellent agreement between the two.

Download and use the maps!

NETCDF files!

Temperature (K)

- 180
- 200
- 280
- 300

Surface emissivity at 5.03µm. 40 ppd (~1.5 km/pixel at the equator), Mollweide projection. Similar maps are available at 5.05, 5.07 and 5.09 µm. White indicate no data, global coverage is 98%.

Using the Planetary Surface Portal PSUP at http://psup.ias.u-psud.fr/