Retrieval of CRISM Single Scattering Albedos from 1-3.8 μm Over the Curiosity Rover Traverse

K.E. Powell\(^1\) (kpowell@levee.wustl.edu), R.E. Arvidson\(^1\), L. He\(^2\), D.V. Politte\(^1\), J.A. O’Sullivan\(^2\), S.L. Murchie\(^3\), R.V. Morris\(^4\)

\(^1\)Dept. of Earth & Planetary Sciences, Washington University in St. Louis, \(^2\)Dept. of Electrical & Systems Engineering, Washington University in St. Louis, \(^3\)Johns Hopkins University Applied Physics Laboratory, \(^4\)NASA Johnson Space Center

Summary

- CRISM I/F data contain solar reflection, plus thermal emission at wavelengths >2.6 μm
- When surface kinetic temperature is unknown, SSA retrievals are under-determined >2.6 μm
- We use a neural network to simultaneously determine T and SSA from 1-3.8 μm
- We measure the broad OH- and H₂O-related absorption features near 3 μm in thermally-corrected data
- Results are applied to the Curiosity traverse in Gale Crater
- Sulfate-rich layers in lower Mount Sharp show areally distinct expressions of mono- and polyhydrated sulfates

Neural Network Approach

We use a neural network approach to simultaneously determine surface albedo and temperature. We use the DISORT radiative transfer code to solve for single scattering albedo (SSA) for each pixel in the CRISM scene.

The neural network is trained with a set of laboratory spectra of Mars-analog materials. With each iteration the internal weights are adjusted until the results are sufficiently close to the inputs.

Application to Lower Mount Sharp

The trained neural network is applied to a CRISM scene. The output temperature map can be used to retrieve SSA for the entire CRISM wavelength region. The final product is run through the maximum likelihood method (MLM) procedure for spatial and spectral regularization [4,5].

Validation

Blind test: Can the neural network method accurately retrieve a known SSA cube and temperature map?
- Simulate SSA cube from laboratory data not included in training set
- Use atmospheric parameters and i.e.g, from a real CRISM scene
- Generate simulated IOF cube by applying DISORT look-up table to ramp temperature map and simulated SSA
- Train NN and apply to retrieve T map and SSA cube

Conclusions and Future Work

- The neural network method can retrieve temperature from CRISM data, allowing thermally-corrected SSA retrievals out to 3.8 μm
- NN-derived temperature maps are broadly consistent with orbital and ground-based measurements of temperature
- 3.0 μm band depth maps correspond well to previously-identified geochemical and morphological units
- Within the layered sulfate strata in Mount Sharp, monohydrated and polyhydrated sulfates can be distinguished and mapped in areally distinct regions
- Ongoing work includes detailed examination of 3.0 μm absorption shape and its relationship to surface albedo and atmospheric aerosols
- Mapping of sulfate strata will continue to support future MSL traverse

References