Compositional units on Mercury from MESSENGER spectral observations: comparison of clustering techniques

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The Mercury Atmospheric and Surface Composition Spectrometer (MASCS) obtained spectra of much of the surface of Mercury during the first two MESSENGER flybys of the planet [1]. The data have been converted to reflectance but are not yet corrected for the effect of observing geometry [2]. We have characterized spectral units by statistical techniques. In order to extract the spectral shapes of the primary surface components exposed in the surface area analyzed, we applied an R-mode factor analysis [3] [4]. That approach leads to the evaluation of the eigenvectors of the covariance matrix and their abundances along the track. The results indicates that the near-infrared spectral range carries less information than the visible portion and that the eigenvectors are unchanged if the full wavelength range is selected rather than limiting observations to the visible. The analysis shows that seven eigenvectors are needed to reconstruct the original data, where each eigenvector can be regarded as a representative of a spectral class that varies in abundance along the track. The first eigenvector always displays a strong positive or "red" slope, carrying the effects associated with viewing geometry, and all eigenvectors show distinctive spectral signatures. The eigenvector abundances show marked geographical variation and a strong correlation with surface units mapped by MESSENGER's Mercury Dual Imaging System. We apply a decorrelation technique (Mahalanobis transformation [5]) to remove dependence on observation angle in the retrieved eigenvector abundances and then use the corrected abundances to classify or cluster the measurements and identify spectral units. We use three clustering techniques, and then we compare the output from the different algorithms. At the same time, we make use of newly available high-temperature spectra from our Planetary Emissivity Laboratory [6] to assist in the identification of the components of each unit. Application to data from the first flyby provides us with confidence in the ability of these techniques to extract physical properties of surface materials.

References

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