EPSC Abstracts
Vol. 13, EPSC-DPS2019-653-1, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

Updated dust scattering properties derived from the 2018 global dust storm

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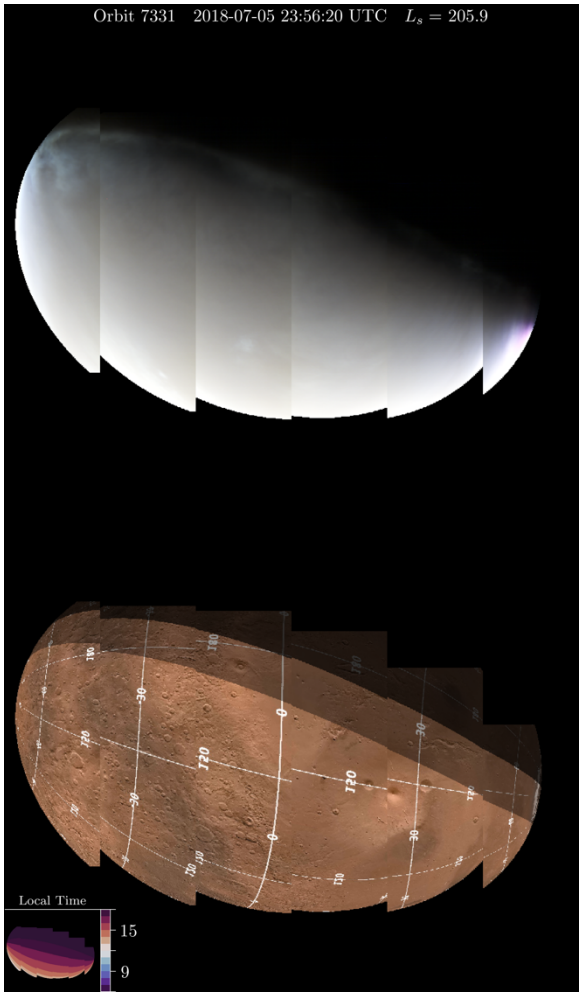
Abstract

The Imaging Ultraviolet Spectrograph (IUVS) instrument on the Mars Atmosphere and Volatile EvolutioN (MAVEN) spacecraft takes mid-UV spectral images of the Martian surface and atmosphere. From these apoapse images, information about dust and ice aerosols can be retrieved and comprise the only MAVEN observations of clouds and airborne dust. Measuring local time variability of large-scale recurring features is made possible with MAVEN's ~4.5-hour elliptical orbit, something not possible with sun-synchronous orbits.

The 2018 planetary-encircling dust storm provides a unique opportunity to improve measurements of aerosol properties. The presence of a thick layer of dust allows us to sample the single scattering albedo (SSA) at a range of UV wavelengths unmeasured by previous missions. Having an optically thick atmosphere in the UV minimizes retrieval errors due to imprecise knowledge of surface reflectance properties. To do this we employ the DIScrete Ordinates Radiative Transfer (DISORT) code to derive a wavelength-dependent SSA from the measured reflectance spectra given atmospheric parameters obtained from a general circulation model. The SSA is converted into an imaginary index of refraction using a T-matrix-based set of optical properties (with the real part of the index of refraction calculated using a subtractive Kramers-Kronig analysis.) With the new refractive indices, the scattering properties for the SSA retrievals are recalculated and the SSA is retrieved again until convergence is reached. Our analysis should be particularly valuable at shorter mid-UV wavelengths (200—250 nm) where the SSA has not been well-characterized, and thus beneficial for IUVS retrievals during lower dust-loading conditions.

An example IUVS observation used in this work is shown next.



This orbit was chosen to investigate the UV dust scattering properties as dust is engulfing the planet, as indicated by the bland, gray-brown coloring above. The lack of brightening over the planet indicates a lack of clouds over the global dust storm, reducing systematic errors in our retrievals. This orbit contained roughly 200,000 on-disk pixels with low emission angles, making this single observation sufficient for these retrievals.