SOLAR ALBEDO HIGH RESOLUTION GLOBAL MAP OF THE MARTIAN SURFACE FROM OMEGA/MEX.
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Introduction: The solar albedo is formally defined as the fraction of the sunlight reflected by the surface, over the entire solar spectra. It represents the amount of energy available for the heating of a material (it controls the energy budget) and thus is a key thermo-physical parameter of the Martian surface. Accurate and finely resolved solar albedo values are therefore essential for climate modeling and thermal inertia retrieval studies.

Bolometers measure the radiance integrated over a wide spectral range and have therefore been the main source of solar albedo values. A bolometer operating bewteen 0.3 and 2.9 µm where most of the sunlight power is was included in the Thermal Emission Spectrometer (TES) instrument [1] and produced a widely-used set of solar albedo global maps of the Martian surface [2] at a resolution of 20 pixel per degree (ppd).

In this work, we use data from the Observatoire pour la Minéralogie, l'Eau, les Glaces et l'Activité (OMEGA), an imaging spectrometer operating bewteen 0.36 and 5.1 µm [3], to construct a high resolution global map (60 ppd) of accurate solar albedo, following the methodology of [4]. This map is is available for download for the community through the PSUP portal (http://psup.ias.u-psud.fr) [5].

Data: The OMEGA instrument has been orbiting Mars since 2004 onboard Mars Express (MEX) and is composed of three separate detectors or channels : VIS (0.4-1µm), C (1-2.7 µm) and L (2.6-5.1 µm). The record unit of OMEGA is a 3D cube (2 spatial dimension forming an image and a third spectral dimension composed of 352 elements called spectels). Since MEX is on an elliptical orbit around Mars, the spatial resolution of the data varies between ~ 300 m and 5 km. The VIS channel uses a separate telescope, causing a slight difference in the field observed by VIS on one hand and C and L on the other hand. A correction for the shift of the VIS channel data has been developed by [6] and is used in this work. VIS and C channel data are now co-referenced to the pixel.

Pursuing the work of [4], we implement conservative data cube selection and pixel filtering based on calibration quality, detector temperature, instrumental artifacts, geometric conditions, absence of ices at the surface and in the atmosphere.

The radiance data is corrected from atmospheric gas absorption using the volcano-scan technique, and the scattering contribution of aerosols is compensated using lookup tables computed with a Monte-Carlo based model of optical paths in the atmosphere [7] using CRISM aerosols properties [8] and observation geometry. It is then converted to surface reflectance factor (lambertian assumption). A very important and specific filter developed for this work hence concerns the atmospheric dust load. We want to keep only the least perturbed data and we estimate the dust opacity with the MER measurements of solar occultation [9] scaled to the local pressure or with 3D dust maps obtained from a compilation of thermal IR dataset [10]. Both methods yield similar results. All these steps are detailed in [4] and are applied to about 700 million individual pixels spanning 4 Martian years.

Solar albedo: Some of the OMEGA spectels have strong second order contributions and artifacts and thus are not reliable for our work. This concerns the spectels of VIS below 0.43 µm and all the spectels between 0.95 and 1.08 µm. Since 11.5% of the solar power is between 0.25 and 0.43 µm, we use a dataset from the STIS instrument on the Hubble Space Telescope [11] to extend OMEGA data down to 0.25 µm. At these wavelengths, the Martian surface is very dark and homogeneous, hence justifying the use of lower resolution data. The region between 0.95 and 1.08 µm is interpolated from OMEGA VIS and C channel data. We use data from the VIS channel between 0.43 and 0.95 µm and from the C channel between 1.08 and 2.5 µm. 3.4% of the solar power (below 0.25 µm and above 2.5 µm) is neglected. The OMEGA surface reflectance spectra (with it's STIS UV extension) is summed over the solar spectra, producing a solar albedo value for every pixel.

Uncertainties: The radiometric uncertainty on OMEGA data has been addressed by comparison with other datasets by [12] and is estimated to be about 10% for VIS and C. In addition, the uncertainty on the correction of diffusive contribution of aerosols is between 2 and 15%, with a mean of 6% and a 1 sigma of 4 %. These values make the OMEGA solar albedo product one of the most accurate ever.

Results: We have constructed several maps with different thresholds on the data selection criteria, namely on the atmospheric dust load, geometric angles values and C channel detector temperature. We've taken the most conservative one (with a global coverage of about ~70%) and we have progressively filled it with lower and lower quality maps. The north pole area was filled with ice-containing data (where it is present even during the summer) in order to obtain a map filled at 94.79%. This map is compared with TES values [2] in figure 1 and is displayed in figure 2.

Overall, TES and OMEGA are in good agreement (+/- 15 %), well within the relative uncertainties on the two products. OMEGA solar albedo is more contrasted than TES solar albedo: bright surfaces appear brighter and dark surfaces are darker. This is caused by the correction of the aerosols scattering : aerosol scattering blurs the surface and reduces the apparent contrast more in TES solar albedo than in the OMEGA solar albedo.

The map presented in figure 3 can be combined with lower resolution TES data to obtain a high resolution (60 ppd) global map of solar albedo 100 % filled, for answering a need of the climate modeling community. These maps (94.79% filled and 100% filled) will be further commented and discussed at the conference and are available for download through the PSUP portal (http://psup.ias.u-psud.fr) [5].

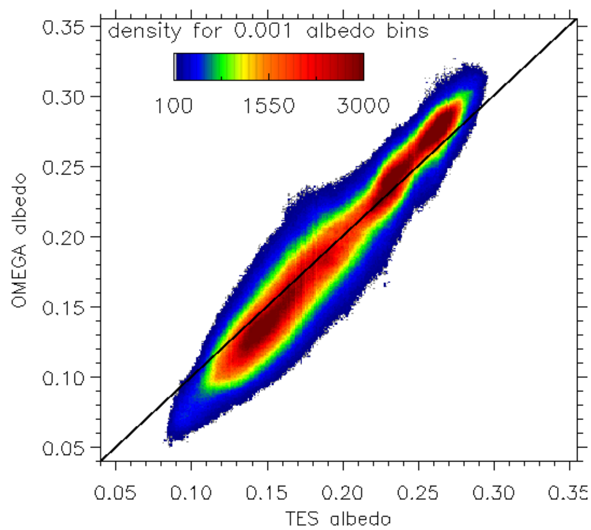

Figure 1: *Crossplot of TES [2] and OMEGA solar albedos (this work). OMEGA albedo was previously downgraded to TES resolution. The solid line is the y=x line.*

References: :

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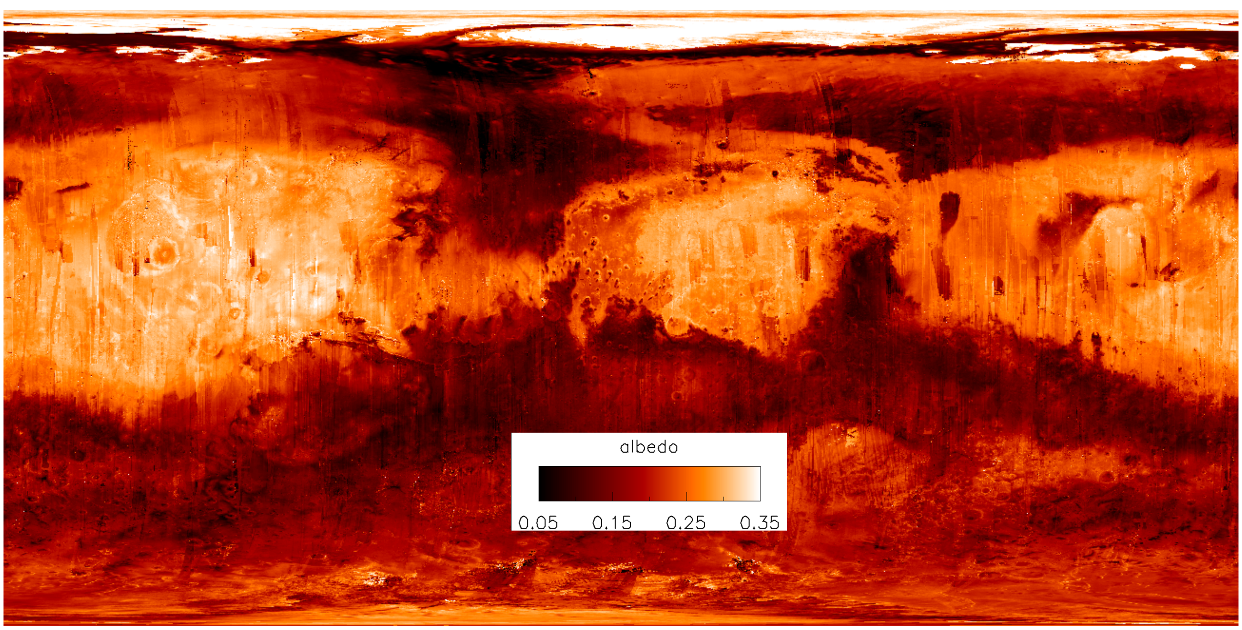

Figure 2: *60 ppd global map of solar albedo computed from OMEGA data*