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Analysis of Noachian valley networks in Aeolis region, Mars, from HRSC/MEx images and DTM

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Since visible images were acquired by Viking orbiter in 1976, valley networks have been identified mainly in the heavily cratered uplands dated Noachian (>3.5 Gyr). MOLA altimetric data allow the study of geometry and topography of valley networks at spatial resolution of typically 500m- to 1 km. This resolution is sufficient to map large valleys but not small tributaries that we can map on high resolution images. The Mars Express High Resolution Stereo Camera (HRSC) allows us to extract DTMs from stereoscopic images with typical spatial resolutions of 50 m or better, but vertical resolution not as good as that of MOLA, typically 20 to 100 m depending on terrain roughness and image quality. In this study, we analyse the organization of valley networks in Aeolis region using both spatial information from HRSC DTMs and manual mapping from HRSC images, to quantify the differences in geometry between these two datasets. Aeolis is characterized by densely cratered terrains dated of the Noachian period. HRSC images show that the densely cratered terrain has been modified by numerous valley networks with a mature organisation (branching pattern with high bifurcation ratio) similar to that of terrestrial valley networks. The DTMs generated from stereo images give quantitative information about the morphometry of valleys. Using the triplet of images (nadir and two stereo), we used the DLR software to generate a DTM with a spatial resolution of 22.4m/pixel and a height accuracy of 20m. This greatly improves the topography of this area compared to previously observed MOLA data. We used a hydrologic analysis (hydromod) included in ARCVIEW GIS [10] to extract the valley networks from DTMs. MOLA gives drainage density of 0.1 to 0.2 km^{-1} with Strahler order of 3 whereas HRSC DTM gives drainage density of 0.1 to 0.3 km^{-1} with 4 Strahler's orders. With manual mapping from nadir HRSC images at

22.4m/pixel, the drainage density is between 0.1 and 0.5 km^{-1} with Strahler order of 5. HRSC DTMs thus give a strong improvement in the drainage characterization compared to MOLA, but still not sufficient to reproduce manual mapping. Compared to MOLA, HRSC DTMs improve the quantification of valley networks properties such as drainage densities and aspect ratios, showing that the manual mapping of valleys with previous Viking or THEMIS images were justified. Nevertheless, mapping from HRSC images show that the manual mapping is still better than any automatic method and will continue to be useful to characterize valleys, at least in 2D. This study shows that valley networks incising Noachian terrains are relatively well preserved, although small tributaries are missing over Noachian terrains.