TRUE- AND FALSE-COLOR HRSC+OMEGA IMAGE MOSAICS OF MARS P.C. McGuire[1*], J. Audouard[2,3], A. Dumke[1], T. Dunker[4,5], C. Gross[1], T. Kneissl[1], G. Michael[1], A. Ody[6], F. Poulet[2], B. Schreiner[1], S. van Gasselt[1], S.H.G. Walter[1], L. Wendt[4,7], W. Zuschneid[1]; [1]Planetary Science and Remote Sensing Group, Freie Universität Berlin, Germany, [2]Institut d'Astrophysique Spatiale, CNRS/Université Paris Sud, Orsay, France, [3](*currently at*) Department of Geosciences, Stony Brook University, Stony Brook, New York, USA, [4](*formerly at*) Planetary Science and Remote Sensing Group, Freie Universität Berlin, Germany, [5](*currently at*) Landesamt für Geoinformation und Landesvermessung Niedersachsen, Hannover, Germany, [6]Lyon 1 University, France, [7](*currently at*) Dept. Geoinformatics (Z_GIS), Universität Salzburg, Austria, [*]Email: patrick.mcguire@fu-berlin.de

Introduction: The High Resolution Stereo Camera (HRSC) on the Mars Express (MEx) orbiter has acquired 3640 images (with 'preliminary level 4' processing as described in [1]) of the Martian surface since arriving in orbit in 2003, covering over 90% of the planet [2]. At resolutions that can reach 10 meters/pixel, these MEx/HRSC images [3-4] are constructed in a push-broom manner from 9 different CCD line sensors, including a panchromatic nadir-looking (N) channel, 4 color channels (R, G, B, IR), and 4 other panchromatic channels for stereo imaging or photometric imaging.

In [5], we discussed our first approach towards mosaicking hundreds of the MEx/HRSC RGB or N images together. The images were acquired under different atmospheric conditions over the entire mission and under different observation/illumination geometries. Therefore, the main challenge that we have addressed is the color (or gray-scale) matching of these images, which have varying colors (or gray scales) due to the different observing conditions. Using this first approach, our best results for a semi-global mosaic consist of adding a high-pass-filtered version of the HRSC mosaic to a low-pass-filtered version of the MEx/OMEGA [6] global mosaic.

Herein, we will present our latest results using a new, improved, second approach for mosaicking HRSC images [7,8], but focusing on the RGB/NGB color processing when using this new second approach. Currently, when the new second approach is applied to N(adir) images, we match local spatial averages of the N images to the local spatial averages of a mosaic made from the images acquired by the Mars Global Surveyor TES bolometer. Since these MGS/TES images have already been atmospherically-corrected, this matching allows us to bootstrap the process of mosaicking the HRSC images without actually atmospherically correcting the HRSC images. In this work, we will adapt this technique of HRSC N images being matched with the MGS/TES mosaic, so that instead, HRSC NGB images will be matched with specially-constructed OMEGA NGB mosaics. Pan-sharpening is also used in order to perform image fusion of the higher-spatial-resolution N channel with the color bands.

HRSC Preprocessing: We perform a photometric correction (using a Lambertian model, by dividing by the cosine of the incidence angle). The main portion of the photometric-correction effort involves the determination of the illumination and observation angles with respect to the DTM [9].

OMEGA Preprocessing: The MEx/OMEGA NGB mosaics (Fig.1) have been constructed as a special product by integrating the atmospherically-corrected reflectance of the narrow-band channels from the OMEGA VIS sensor over the spectral band-passes for each of the five broad-band HRSC channels (Blue, Green, Nadir, Red, NIR). The combination of (i) the measured filter functions for HRSC and (ii) the solar spectrum was used to weight this integration. In order to reduce spatial gaps and to smooth some residual noise and atmospheric artifacts, the OMEGA mosaics have been smoothed by averaging all pixels within a radius of about 100 km.

Band Selection: The HRSC Nadir (N) channel was selected rather than the HRSC Red (R) channel, for making 3-band composite color mosaic images (i.e., NGB instead of RGB). The central wavelength of the HRSC Nadir channel is much closer to the central wavelength of standard visual red than is the central wavelength of the Red channel of HRSC. So constructing true-color mosaics is easier with the Nadir channel substituted for the Red Channel. This is due in part to the much higher reflectivity of bright Mars at HRSC R wavelengths than at HRSC N wavelengths.

Results: The MEx/HRSC+OMEGA NGB mosaics of the MC11 East map tile are shown in Fig. 2, both in true color and false color. The stretches for true color were chosen somewhat objectively, with minimum values of 0 and maximum values of 140 for each of the three channels. The stretches for false color were chosen manually in order to accentuate some of the detail in the darker regions and in order to not appear too garish.

Future Work: We plan to: (a) improve OMEGA NGB color mosaic, with better cloud filtering; (b) streamline the processing; and make more map tiles; (c) extend the pan-sharpening to work with 4-5 color bands instead of only 3 bands (i.e., extend to include R and NIR channels as well as N,G,B channels [11-12]).

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References: [1] Scholten F. *et al.* (2005) *Photogrammetric Engineering and Remote Sensing*, **71**, pp. 1143-1152. [2] Jaumann R., Neukum G., & Tirsch D. (2014) *8th Int'l. Conf. on Mars #1078.* [3] Neukum G. & Jaumann R. (2004) *Mars Express: the Scientific Payload, ESA Special Publ.* **1240**, pp. 17–35. [4] Jaumann R. *et al.* (2007) *Planet. Space Sci.* **55**, pp. 928–952. [5] McGuire P.C. *et al.* (2014) *8th Int'l. Conf. on Mars #1118.* [6] Ody A. *et al.* (2012) *JGR Planets*, **117**, E00J14. [7] Michael G. *et al.* (2015) *LPS XLVI* #2387. [8] Michael G. *et al.* (2015, *accepted*) *Planet. Space Sci.* [9] Walter S.H.G. *et al.* (2015) *LPS XLVI* #1434. [10] Bell J.F. & Ansty T.M. (2007) *Icarus* **191**, pp. 581–602. [11] Tu *et al.* (2004) *IEEE Geosci. & Remote Sensing Lett.* **1**, pp. 309-312. [12] Wang *et al.* (2005) *IEEE Trans. Geosci. & Remote Sensing* **43**, pp. 1391-1402.

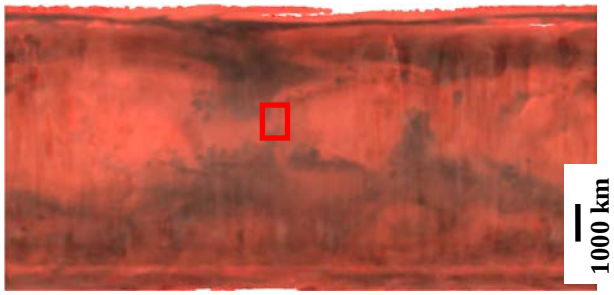

Figure 1A: True-Color NGB OMEGA mosaic of Mars

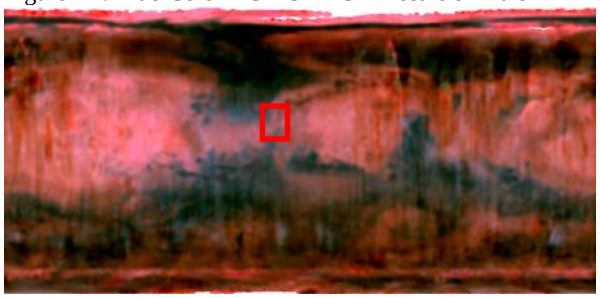

Figure 1B: False-Color NGB OMEGA mosaic of Mars. The red box indicates the location of Fig. 2.

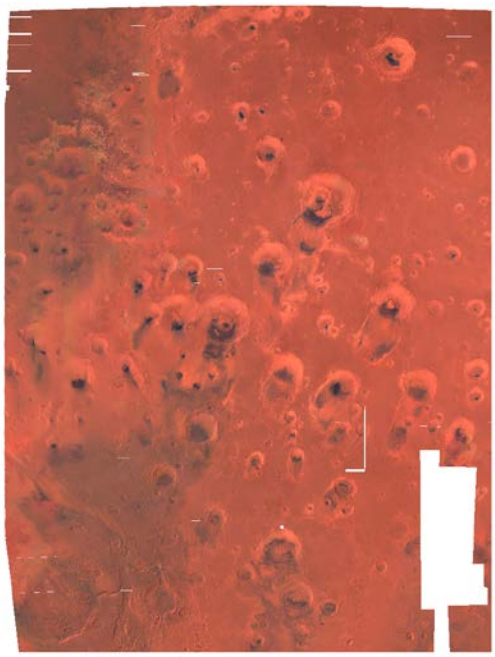

Figure 2A True-Color NGB HRSC+OMEGA mosaic of MC11East.

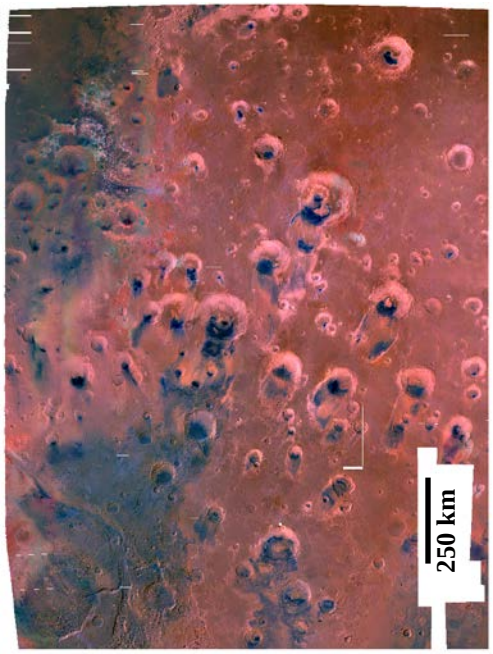

Figure 2B False-Color NGB HRSC+OMEGA mosaic of MC11East.