Dune and ripple migration in Herschel crater, Mars.

Marco Cardinale

Dipartimento di Scienze Psicologiche, della Salute e del Territorio, Università degli Studi

G.d'Annunzio, Chieti, Italy.

marco.cardinale@unich.it

S. Silvestro[2], D. A. Vaz[3,4], T. I. Michaels[2], L. Marinangeli[1], G. Komatsu[5], C.H. Okubo[6].

[1]Dip.to di Scienze Psicologiche, della Salute e del Territorio, Università Degli Studi G.d''Annunzio, 66013, Chieti, Italy. [2]Istituto Nazionale di Astrofisica, Napoli, Italy.[3]Observatório Astronómico da Universidade de Coimbra, Almas de Freire, 3040-004 Coimbra, Portugal. [4]CERENA, Instituto Superior Técnico, Av. Rovisco Pais, 1049-001 Lisboa, Portugal.[5]1International Research School of Planetary Sciences, Università D'Annunzio, Viale Pindaro 42, 65127 Pescara, Italy. [6] U.S. Geological Survey, Flagstaff, AZ 86001, U.S.A.

Abstract: Up until the Mars Reconnaissance Orbiter (MRO) era direct evidence of sand movement on the Martian surface was scarce and limited to a few isolated areas [1, 2]. The advent of the MRO HiRISE instrument [3] with images at up to 25 cm/ pixel, provided evidence of ripple and dune migration in diverse zones [4, 5, 6, 7] on Mars, demonstrating that the Martian dunes are active under the current atmospheric conditions. In this work, we performed further analysis in Herschel Crater (Fig.1) where ripple and dune migration has been detected and quantified. Furthermore, with the aid of the Mars Regional Atmospheric Modeling System (MRAMS) [8], we compare the observed aeolian changes with modeled wind stresses and directions. We analyzed two areas in Herchel crater using six overlapping HiRISE images. The images were processed using ISIS software and orthorectified over two digital terrain models (DTMs) obtained with the commercial photogrammetry software SOCET Set (© BAE Systems, Inc.). An automatic algorithm was used to map the ripple pattern [9]. MRAMS output, are compared with the experimental stress threshold for saltation initiation calculated by [10]: In the studied area three overlapping HiRISE images cover a dune field made up of barchan and barchanoid dunes [11] which show diverse types of modifications. The pattern of the ripple superposing the dune's slopes is complex and changes consistently, due to the diverse wind flows blowing over the dunes. The lee fronts of the dunes advanced toward the south (162±37º) by approximately 0.8m (measurements performed on 211 dunes during a time span of 1359 Earth days). This suggests that strong northerly winds blew during the investigated time interval. Moreover, grainflow activity seems to have occurred during this time as well. This area is characterized by the presence of a vast sand sheet, lee dunes and isolated barchans. Also, in this area we detected ripple pattern changes as well as a dune migration of ~1 m (over a 629 Earth day period). The migration occured toward the south (172±44°), indicating that wind flows are predominantly north-south. The MRAMS model predicts winds mainly from the north, with magnitudes that locally exceed the threshold for the initiation of sand motion over the rim of the crater. The direction of the modeled winds is in agreement with the observed dune migrations. **Conclusions:** Our analysis shows that the predominant winds from the north are able to keep the ripples and dunes active in the current atmospheric conditions. This confirms the results of other workers [4,5,6,7] and gives further indications of sand motion in the martian tropics. The northerly winds seem to blow all over the Herschel basin and are well predicted by the MRAMS. However, the pattern of the ripples suggests a more complex wind regime at the local scale. We are currently evaluating the ripple displacement to better constrain this wind complexity.

References: [1] °Sullivan, R. R., et al. (2008), JGR, 113, E06S07. [2] °Bourke, M. C., et al. (2008), *Geomorphology,* 94, 247-255. [3] °McEwen A. S. et al. (2007) *JGR*, 112, E05S02. [4] °Silvestro, S. et al. (2011), *GRL* 38, L20201. [5] °Chojnacki, M., et al. (2011), *JGR*, 116, E00F19.. [6] °Bridges, N.T., et al. (2012), *Geology.* [7] °Hansen, C. J., et al. (2011), *Science*, 331(6017), 575–578. [8] °Rafkin et al. (2001) *Icarus, 111*, 228-256. [9] °Vaz D. A. (2011), PSS, 59,. 1210–122. [10] °Greeley R. and Iversen J. D. (1985) Cambridge University Press, 333p. [11] °Cardinale, M., et al. (2012), *Earth Surf. Process. Landforms*, 37: 1437–1443.