MARS GLOBAL DIGITAL DUNE DATABASE: SOUTH POLAR REGION AND GLOBAL TRENDS

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Introduction: Work on the south polar (SP) portion of the Mars Global Digital Dune Database (MGD^3) is underway. When released, the SP portion will add ~55,000 km^2 of medium to large-size dark dunes and ~15,000 km^2 of smaller dune fields and sand deposits to the previously released equatorial (EQ) and north polar (NP) portions of the database [1, 2, 3]. The EQ (~70,000 km^2) and NP (~845,000 km^2) portions of MGD^3 were built based on Thermal Emission Imaging System infrared (THEMIS IR) imagery because THEMIS IR coverage of Mars was nearly complete at the time the database was begun. Because THEMIS IR has a resolution of 100 m/pixel, the EQ and NP portions of the database contain only medium to large size dune fields. THEMIS visible (VIS, 18 m/pixel resolution) and Mars Orbital Camera Narrow Angle (MOC NA, 1.5 m/pixel resolution) images were used to classify and further study the dunes, but were not used to locate smaller features. The SP is also based on THEMIS IR imagery. However, as part of a study of aeolian inactivity in southern high latitude dune fields, Fenton [4] used THEMIS VIS, MOC NA, Mars Reconnaissance Orbiter Context Camera (MRO CTX, 6 m/pixel resolution) and MRO High Resolution Imaging Science Experiment (HiRISE, 0.5 m/pixel resolution) images to locate aeolian features (smaller dune fields, eroded dunes and sand sheets) not detected using THEMIS IR. When the SP portion of MGD^3 is released, features that would not have been included based on the criteria used for the EQ and NP, will be labeled as such so that researchers can exclude them and maintain consistency across regions if desired. Absence of similar features in the EQ and NP portions of the database does not imply that such features do not exist.

Geographic distribution: The global distribution of dune fields is displayed on the map in Figure 1. Note that for the SP we have chosen to map and plot only the ~55,000 km^2 of dune fields that would have been found using criteria applied in the EQ and NP regions. EQ and SP dune fields are shown in yellow. For the NP region we display areas densely covered by dunes (80%-100%) in red, areas with less complete coverage (10% to 80%) in reddish pink, and areas of widely scattered barchan dunes in pink.

The areal extent of dunes was calculated in increments of 10 degrees latitude and longitude and plotted in Figure 1. In the NP the dune field areas were multiplied by the percent areal coverage before plotting. The bar charts emphasize the uneven distribution of dune fields across Mars. The latitudinal disparity is quite dramatic, with 47% of mapped dune fields located between 80°N and 90°N, and another 28% between 70°N and 80°N. Together they account for 75% of the dune fields on Mars. The latitudinal zone between 60°S and 70°S contains the next highest concentration of dune fields, 8%. The adjacent latitudinal band between 70°S and 80°S holds 7%. Together they account for 15% of dune fields. Combined, these north and south polar regions hold 90% of the dune fields on Mars.

The longitudinal variations, though less dramatic, are pronounced. When all 3 regions are combined, there is a distinct peak between 310°E to 320°E and a broader peak from about 160°E to 230°E. There is a fairly abrupt low between 250°E and 270°E and a broader low between 0°E and 60°E. These distribution patterns are due to the dominant NP erg. The EQ dunes also peak at 310°E to 320°E, but at most other longitudes do not follow the NP pattern. The SP dunes peak between 110°E and 120°E and, for the most part, do not follow the patterns seen in either the EQ or NP distribution.

Future Applications: As MGD^3 approaches completion, we will be able to compare it to global data sets. For example, Fenton and Hayward [4] and Feldman et al. [5] have used Mars Odyssey Neutron Spectrometer epithermal neutron fluxes to study dune mobility. Epithermal fluxes yield an estimate of water-equivalent hydrogen mass fraction in near surface material, which can provide limits on ice content in dunes. Fenton and Hayward [4] classified dunes south of 50°S according to apparent activity level. They found that a change in the epithermal neutron flux at about 60°S roughly corresponds to a change in dune morphology that may indicate a change in dune mobility. We plan to expand Fenton and Hayward's classification to include all dune fields and compare their distribution to the global epithermal flux map. Comparisons to other global data sets will also be made.

References: [1] Hayward R.K., et al. (2007) U.S.G.S. Open File Rep., 2007–1158. [2] Hayward R.K., et al. (2010) U.S.G.S. Open File Rep., 2010–1170. [3] Hayward R.K., et al. (2007) JGR, 112, E11007, doi 10.1029/2007JE002943. [4] Fenton, L.K. and Hayward, R.K., 2010, Geomorphology, doi: 10.1016/j.geomorph.2009.11.006. [5] Feldman et al., (2008) Icarus, 196, 422-432.

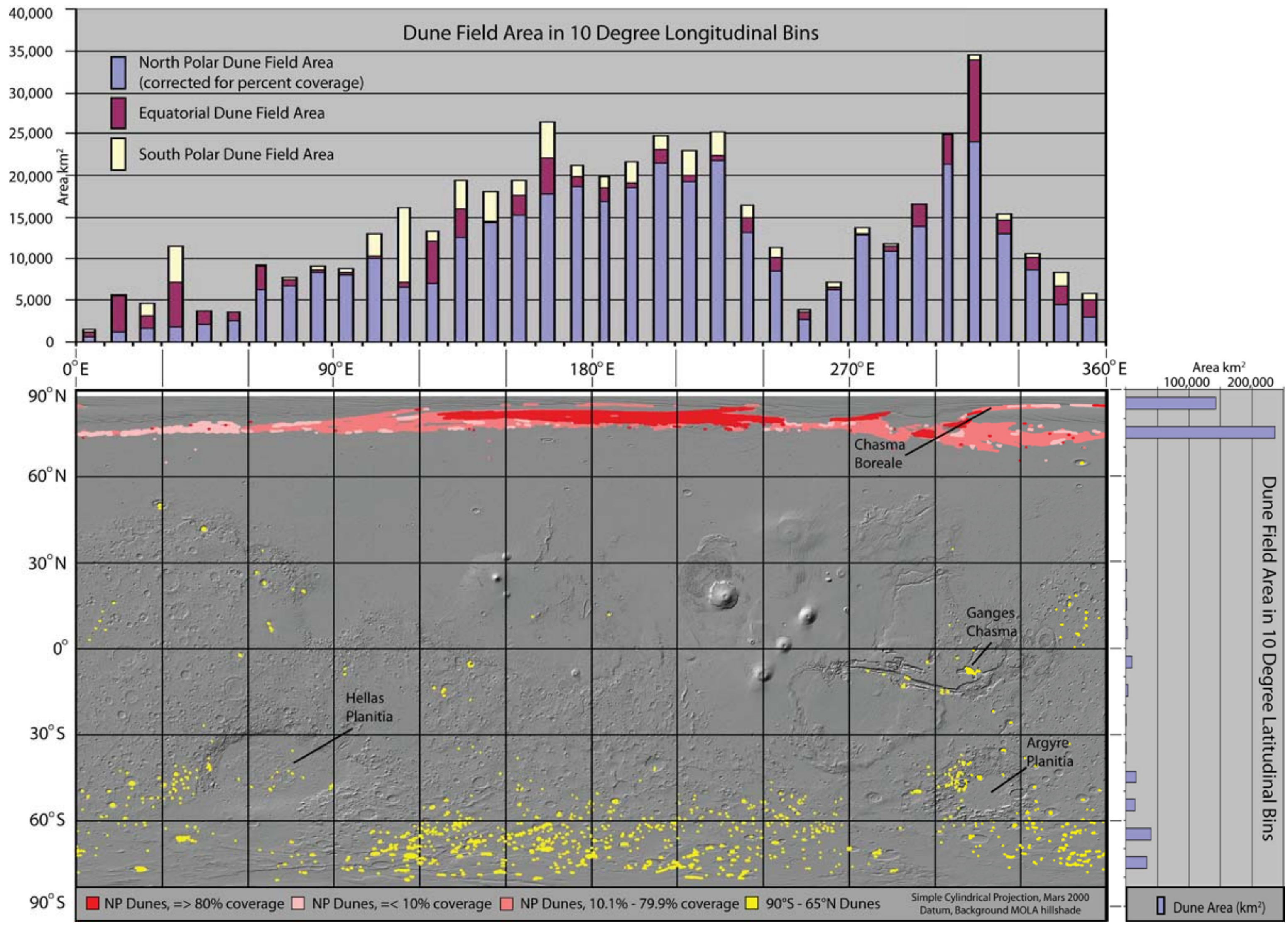

Figure 1. Global distribution of dune fields. NP dune fields are shown in shades of red based on percent of area that is covered by dunes. Equatorial and SP dune fields are shown in yellow. Area of dune fields plotted in 10 degree longitudinal bins and 10 degree latitudinal bins. Map background is MOLA hillshade, Simple Cylindrical projection.