MARS GLOBAL DIGITAL DUNE DATABASE (MGD[3]): User's Guide R. K. Hayward[1], K. F. Mullins[1], L. K. Fenton[2], T. N. Titus[1], K. L. Tanaka[1], M. C. Bourke[3], A. Colaprete[4], T. M. Hare[1], and P. R. Christensen[5], [1]U.S.G.S. 2255 N. Gemini Dr., Flagstaff, AZ 86001, rhayward@usgs.gov. [2]Carl Sagan Center/Ames Research Center, [3]Planetary Science Institute, Tucson, AZ, [4]NASA/Ames Research Center, [5]Arizona State University, Tempe, AZ.

Introduction: The Mars Global Digital Dune Database (MGD[3]) is a GIS-based database of moderate- to large-size dark dune fields on Mars. The database currently covers the area from 65°N to 65°S and will soon be expanded to include the entire planet. MGD[3] can be accessed at a variety of internet locations in a variety of formats, including a non-GIS table. The database makes it possible to look at dunes in a global context, comparing their geographic locations and attributes to other global coverages, such as the NASA/Ames General Circulation Model (GCM) [1] that is included with this database. The Viking-based Atlas of Mars 1:15,000,000 Geologic Series maps (USGS I-1802A-C) [2] and the Mars Orbiter Laser Altimeter (MOLA) elevation data set [3], two existing coverages that are not part of the database, are also included with MGD[3] for the user's convenience.

Comparisons between dune field distribution and global coverages provide significant perspective on global and regional-scale aeolian processes that have shaped and continue to influence the surface of Mars. MGD[3] can also be used to locate areas of potential interest for local studies by querying the attributes provided for each dune field. These attributes include, but are not limited to: longitude, latitude, dune type, dune field area, estimated mean height of dune field, estimated dune field volume, average elevation, and slip-face orientation (if measured). Also listed are the ID numbers of Thermal Emission Imaging System (THEMIS) infrared (IR), THEMIS Visible (VIS) [4], and Mars Orbiter Camera narrow angle (MOC NA) [5] images used to create the MGD[3] database. In addition, the following information is provided for dune fields that are located within craters: crater centroid to dune centroid azimuth, crater diameter, and crater area.

Discussion: *Where to find MGD[3] and how to access the database once you have found it.* MGD[3] was released as United States Geological Survey (USGS) Open-File Report (OFR) 2007-1158. It can be downloaded from the following website (http://pubs.usgs.gov/of/2007/1158/) as a complete package, ready to use, with many layers and backgrounds. For users that do not require the entire package, its shapefiles, tables, images, and documentation are also available as separate, smaller downloads. Parts of MGD[3] can also be accessed at other internet locations. The following is a guide to finding and accessing the level of MGD[3] that suits individual user needs.

Accessing MGD[3] if you do not want to use GIS. While MGD[3] is GIS-based, we recorded data within its attribute tables that would make MGD[3] valuable to non-GIS users as well. The Dune Field layer table (547 rows, 37 columns) summarizes most of the information in the database, with the notable exception of the GCM output. The table is available in both a tab delimited text version and an Excel spreadsheet format. The table can be downloaded from the USGS OFR 2007-1158 website (http://pubs.usgs.gov/of/2007/1158/). Under "Database Organization group," the table is in the "Tables.zip" file. For those with access to the online *Journal of Geophysical Research Planets*, the table can be downloaded as "Table S2" in the auxiliary material associated with Hayward et al. [6].

Accessing MGD[3] if you do not have GIS software, but would like to use MGD[3] in a GIS environment. **Option 1.** The easiest way to view MGD[3] in a GIS environment is through the USGS Planetary GIS Web server – PIGWAD (http://webgis.wr.usgs.gov). The most important part of MGD[3], the Dune Field layer, and its attribute table, can be viewed at this location with no need for downloads or special software. The user can access the Dune Field layer from the PIGWAD home page by selecting "Mars" under "PIGWAD Maps," then selecting "Crater/Dunes Database Viewer" under "Intermediate," or use the following direct link to the MarsCrater/Dune Image Viewer page, http://webgis.wr.usgs.gov/website/mars%5Fcrater%5Fhtml/viewer.htm. On the Mars Crater/Dune Image Viewer page, choose the "Dune_Field (Dune Consortium)" layer and click the Refresh Map button. Using the identify tool, click on an individual dune field to display its attributes, which will appear at the bottom of the screen.

Option 2. If you want to view all the layers, backgrounds, and images included in MGD[3], you can do so by downloading the entire database at the OFR website http://pubs.usgs.gov/of/2007/1158/ (of2007-1158.zip). Be aware that the entire database, zipped, is a 1.8 Gigabyte download. For users that would like the entire database but encounter difficulty with the large download, MGD[3] is available on DVD upon request (contact rhayward@usgs.gov). Users will also need to download the free ArcReader software at http://www.esri.com/software/arcgis/arcreader/download.html. Unzip the database and find the ArcReader folder. The folder contains a series of ArcReader projects that cover the equatorial region. If you double

click on an ArcReader project file, ArcReader will open it and you will be able to view all layers in MGD[3], and their attributes.

Option 3. If you want to go beyond viewing the layers and attributes included in MGD[3], and manipulate them and compare them to other data sets, you can download the shapefiles (Shapefiles.zip only is needed, NOT the entire download) from the OFR website and upload them to a free GIS software package. Arizona State University's JMARS, http://jmars.asu.edu, is an excellent choice for this. Be sure to upload the geocentric version of the shapefiles to JMARS, as the sinusoidal version will not project correctly in JMARS. Also note that when loading the shapefiles, choose "ESRI™ Shape File" in the "Files of Type" dropdown box, then choose "Dune_Field.shp" as the "File Name." For more help with loading shapefiles in JMARS go to http://jmars.asu.edu/wiki/index.php/Shape_Layer. When using the Dune_Field layer attribute table, bypass the "Shape_Area" column and use the "Area_sinu_" column for accurate dune field areas.

Accessing MGD[3] if you have GIS software. **Option 1.** MGD[3] was created using ESRI ArcMap9® software. For users with ArcMap9® software, the ArcMap projects included in the database are the most powerful option, allowing access to all layers included in the database, with the opportunity to manipulate existing layers and add more data. Download the entire database (of2007-1158.zip) from the OFR website, http://pubs.usgs.gov/of/2007/1158/. As noted in the section above, be aware that the entire database is quite large and may be difficult to download. When opened, the projects in the ArcMap folder will provide all the layers, backgrounds, and map projected THEMIS IR, THEMIS VIS, and MOC NA images used to create the database.

Option 2. If you do not want to use all the backgrounds and projected images included in MGD[3], or if you use a GIS software that will not open ArcMap9 project files, you can download just the shapefiles (Shapefiles.zip, 58 MB) and add them to your own project. The shapefiles are provided in both ESRI™ shapefile format and Geography Markup Language (GML) format for maximum compatibility.

Future versions of MGD[3]. The north pole region of MGD[3] will soon be released as a USGS OFR, followed by an OFR of the south pole region. We plan to combine the three regions and release a streamlined version of the MGD[3] as a USGS Data Series.

Summary: MGD[3], a GIS-based database of moderate- to large-size dark dune fields on Mars, can be a useful tool in Mars aeolian research. Although MGD[3] is GIS-based, non-GIS users can access the database through spreadsheet tables, while those without GIS software can view MGD[3] with easy to use, free online GIS software. The planet-wide scope of the database, combined with the detailed attributes of the dune fields, allows MGD[3] to be used to address global, regional, and local research questions. MGD[3] has been released as USGS OFR 2007-1158 and can be found at http://pubs.usgs.gov/of/2007/1158/. A more complete description of MGD[3] can be found in the "Dunes_ReadMe" file and the "ReadMe_GIS" file in the Documentation folder at the OFR website. The Mars Dunes Consortium website, http://www.mars-dunes.org/, is a central location that provides links to the websites in this abstract.

Links to MGD[3] and related sites.
USGS OFR 2007-1158
http://pubs.usgs.gov/of/2007/1158/
JMARS
http://jmars.asu.edu
PIGWAD
http://webgis.wr.usgs.gov
Mars Dunes Consortium
http://www.mars-dunes.org/
ArcReader
http://www.esri.com/software/arcgis/arcreader/download.html

Suggested Citation for MGD[3]. If you use MGD[3] in your research, please use the following citation: Hayward, R.K., Mullins, K.F., Fenton, L.K., Hare, T.M., Titus, T.N., Bourke, M.C., Colaprete, A., and Christensen, P.R., 2007 Mars Global Digital Dune Database: MC2 - MC29: U.S. Geological Survey Open File Report 2007-1158. [http://pubs.usgs.gov/of/2007/1158/] or, Hayward, R.K., K.F. Mullins, L.K. Fenton, T.M. Hare, T.N. Titus, M.C. Bourke, A. Colaprete, and P.R. Christensen (2007), Mars Global Digital Dune Database and initial science results, J. Geophys. Res., 112, E11007, doi:10.1029/2007JE002943.

References: [1] Haberle, R.M., et al. (1999), General circulation model simulations of the Mars Pathfinder atmospheric structure investigation/meteorology data, *JGR., 104* (E4), 8957-8974. [2] Skinner Jr., J. A. et al. (2006) *LPSC XXXVII*, Abstract #2331. [3] Smith, D., et al. (1999), NASA PDS, MGS-M-MOLA-3-PEDR-L1A-V1.0. [4] Christensen, P.R., et al., THEMIS Public Data Releases, PDS node, ASU, http://themis-data.asu.edu. [5] Malin, M.C., et al., Malin Space Science Systems Mars Orbiter Camera Image Gallery http://www.msss.com. [6] Hayward, R.K., et al. (2007), JGR., 112, E11007, doi:10.1029/2007JE002943.