A COMMUNITY ARCHIVE OF THRESHOLD (MINIMUM) WIND SPEED DATA FROM WIND TUNNEL EXPERIMENTS: INITIATION OF AN AEOLIAN DATA ARCHIVE

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Introduction: Aeolian processes are wide-spread in the Solar System. Movement of sediment by gas flow– whether atmospheric, exospheric, or episodic – has been documented on Earth, Mars, Venus, Triton, Titan, Enceladus, and comets [e.g., 1-8]. Thus, data on aeolian processes are critical for understanding sediment behavior throughout the Solar System [3, 9].

Such data are commonly derived from wind tunnel experiments under various conditions [1, 3]. Beginning with the ground-breaking work of Bagnold [1], wind tunnel experiments have a long history of providing critical data for describing aeolian sediment transport. A review of planetary wind tunnel use illustrates their importance in parameterizing aeolian processes, for example, the threshold (minimum) wind speeds necessary to move particles [10]. Although threshold wind speeds on other planetary bodies – first on Mars, then on Venus – were not originally modeled correctly, the simulation of these extraterrestrial conditions in planetary wind tunnels enabled the development of improved models [see summary in 10]. This sequence of events is now being repeated for understanding threshold wind speeds for Titan [10, 11].

Having a record of experimental data enables this interative development and improvement of aeolian models. However, decades-old wind tunnel data are becoming unusable or inaccessible due to their (analog) publication formats. At the same time, new data are not widely distributed because no unified archive exists to store them and provide community access.

Goal of this work: The goal of this work is to facilitate the development of improved models for aeolian processes through creation of a systematic, centralized, and searchable archive of old, new, and future wind tunnel data. This archive, to be hosted at the Plaentary Data Systems (PDS) Atmospheres Node (http://pds-atmospheres.nmsu.edu/pds4_comp.html), will provide a reference database on which to advance our understanding of aeolian processes under widely varying boundary conditions. We are currently focusing this archive on threshold wind speed data, but with community input hope to expand it to other processes.

Methodology: Our complete approach to accomplish this goal includes three sequential steps: 1) increase the amount and usability of threshold wind speed data collected under a range of conditions, 2) use those data to rederive threshold wind speed model parameters, and 3) make these data broadly available via a searchable on-line archive. This abstract reports on the first and third of these three steps, namely, collecting previously published data for incorporation into a PDS threshold wind speed archive. Progress on the second step is reported in a companion abstract [12].

Data Collection: In collecting threshold wind speed data, we use two primary sources. The first data source is records published in books or peer-reviewed journals. The journals draw from the physics and geology/aeolian literature for experiments performed under both terrestrial and planetary conditions (Table 1). The second data source is unpublished records. We have such records from the NASA Ames Research Center Planetary Aeolian Laboratory, including threshold data from the Mars Surface Wind Tunnel, Venus Wind Tunnel, and Carousel Wind Tunnel (1975 to present). In addition, we seek data from other potential respositories [e.g., the Aarhus Mars Simulation Facility; 13].

For each individual record, whether published or unpublished, we collect data through several steps. Publication information and experimental boundary conditions are transcribed, along with information about the wind tunnels and the sediments used in the experiments. Relevant plots and tables are scanned and digitized; we are using GetData Graph Digitizer (http://www.getdata-graph-digitizer.com/index.php) for this purpose. Model parameters derived from these experimental data are also transcribed. Lastly, any images or videos of the experimental set-up or aeolian processes are scanned and included.

Archive creation: These collected data are compiled into spreadsheets, for archiving under the most recent PDS standard, PDS4. PDS4 format is an XML digitally-based system where products are registered so they are searchable throughout the PDS. PDS4 supports video archiving and a more flexible system for delivering data so that individual bundles can be built to best serve the needs of the community. These characteristics make the PDS4 a user-friendly digital environment for accessing wind tunnel data. Both metadata and the collected wind tunnel data, in the form of tables, plots, and images, including stacked arrays of images taken from video, can be made available.

Future work:. While this initial work focused on threshold data derived from wind tunnel experiments, we hope to expand our data collection to include 1) other types of data (e.g., saltation trajectories), and 2) other sources (e.g., field or model) data. The PDS4 provides a new and improved opportunity to store and provide aeolian data to the community, analysis of

which will improve our understanding of the wind range of aeolian proceses in the Solar System. We welcome any input on this archive and the provision of data (published or unpublished) or suggestions of data sources to explore.

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References: [1] Bagnold R. A. (1941) *The Physics of Blown Sand and Desert Dunes*. [2] Iversen J. et al. (1976) *J. Atm. Sciences* 33, 2425-2429. [3] Greeley R. and Iversen J. D. (1985) *Wind as a Geological Process*. [4] Sagan C. and Chyba C. (1990) *Nature* 346, 546-548. [5] Weitz C. et al. (1994) *Icarus* 112, 282-295. [6] Lorenz R. et al. (2006) *Science* 312, 724-727. [7] Porco C. et al. (2006) *Science* 311, 1393-1401. [8] A'Hearn M. et al. (2011) *Science* 332, 1396-1400. [9] Lorenz, R. D., and J. R. Zimbelman (2014) *Dune Worlds*. [10] Burr D. M. et al. (2015) *Aeolian Res.* 18, 205-214. [11] Burr D. M. et al. (2015) *Nature* 517, 60-63. [12] Nield E. V. et al. (2016) *this conf.* [13] Merrison J. P. et al. (2009) *Lunar Planet Sci.* abs. 1544.

Publication Information				Paper Summary	Experimental Parameters			
Year	Author(s)	Title	Journal	Wind Tunnel(s)	Particle ρ (g/cm^3)	Particle Dia. (μm)	Fluid	Pressure
1941	R.A. Bagnold	The Physics of Wind Blown Sand	Book published by Dover	Imperial College Wind Tunnel		180-300	air	1 bar
1974	R. Greeley, J. D. Iversen, J.B. Pollack, N. Udovich, B.R. White	Wind tunnel studies of Martian aeolian processes	Proceedings of the Royal Society of London.	Iowa State University	1.3-11.35	8-1290	air	1 bar
1976	J.D. Iversen, J.B. Pollack, R. Greeley, B.R. White	Saltation threshold on Mars: The effect of interparticle force, surface roughness, and low atmospheric density	Icarus	Iowa State University	0.21-11.35	8-1290	air	1 bar
1976	J.D. Iversen, R. Greeley, J.B. Pollack	Windblown Dust on Earth, Mars and Venus	Journal of the Atmospheric Sciences	Iowa State University				
1976	R. Greeley, B.R. White, R.N. Leach, J.D. Iversen, J.B. Pollack	Mars: Wind friction speeds for particle movement	Geophysical Research Papers	Martian Surface Wind Tunnel	1.1-3	5-700	air	5.3 mb
1977	R. Greeley, B.R. White, J.B. Pollack, J.D. Iversen, R.N.Leach	Dust storms on Mars: Considerations and simulations	NASA Techinal Memorandum 78423	Martian Surface Wind Tunnel	1.1-3	5-700	air	5.3 mb
1980	R. Greeley, R. Leach, B.R. White, J.D. Iversen, J.B. Pollack	Threshold windspeeds for sand on Mars: Wind tunnel simulations	Geophysical Research Papers	Martian Surface Wind Tunnel	1.1	23-800	95% CO_2, 5% air	4-80 mb
1982	J.D. Iversen, B.R. White	Saltation threshold on Earth, Mars, and Venus	Sedimentology	Iowa State University, Martian Surface Wind Tunnel	1.1-2.65	37-673	air; 95% CO_2, 5% air	2.95 mb- 1.6 bar
1984	R. Greeley, J.D. Iversen, R.N. Leach, J. R. Marshall, B.R. White, S. Williams	Windblown sand on Venus: Preliminary results of laboratory simulations	Icarus	Venus Wind Tunnel	2.65	30-650	air	30 bar
1985	R. Greeley, J.D. Iversen	Wind as a geological process on Earth, Mars, Venus and Titan	Book published by Cambridge	Iowa State University, Martian Surface Wind Tunnel				
1987	J.D. Iversen, R. Greeley, J.R. Marshall, J.B. Pollack	Aeolian saltation threshold: the effect of density ratio	Sedimentology	ISU, MARSWIT, VWT, water and oil flumes				
1994	J.D. Iversen, K.R. Rasmussen	The effect of surface slope in saltation threshold	Sedimentology	University of Aarhus Wind Tunnel	~2.65	125-545	air	1 bar
2003	C. McKenna Neuman	Effects of temperature and humidity upon entrainment of sedimentary particles by the wind	Boundary Layer Meteoroogy	Trent Environmental Wind Tunnel	~2.65	210-610	air	1 bar
2004	W. M. Cornelis, D. Gabriels, R. Hartmann	A conceptual model to predict the deflation threshold shear velocity . . .	Soil Science Society of America Journal	Wind Tunnel, Ghent University, Belgium				
2008	C. McKenna Neuman and S. Sanderson	Humidity control of particle emissions in aeolian systems	Journal of Geophysical Research	Trent Environmental Wind Tunnel	not stated	75-210	air	1 bar
2015	D.M. Burr, N.T. Bridges, J.R. Marshall, J.K. Smith, B.R. White, J.P. Emery	Higher-than-predicted saltation threshold wind speed on Titan	Nature	Titan Wind Tunnel	1.1-3.0	81-917	air	12.5 bar

Table 1: Illustration of metadata collected for the PDS archive of threshold wind speed data, including sources of data, wind tunnels used, and experimental parameters. Other (meta)data, redacted here for space, include other experimental conditions, derived model parameters, data plots, and the digitized wind speed data themselves.