Planetary Aeolian Processes – Mars as an analog for the rest of the Solar System

A white paper planned for the upcoming Decadal Survey on Planetary Science and Astrobiology
Submitted to MEPAG meeting 38 for advertisement to the Mars community

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Intended General Content

This white paper aims to outline (1) the widespread nature of aeolian processes across the Solar System (2) identify high-priority general and Mars-specific science questions related to these processes, (3) illustrate that Mars has become a viable analog for other Solar System bodies, and (4) identify technological approaches and developments needed over the next decade.

Dunes have been observed on Venus, Earth, Mars, and Titan, but we have only "physically (including robotics) touched" the dunes on Earth and Mars. Aeolian bedforms and erosional features are expected to occur on any rocky world which has an atmosphere and a source of sediment of the appropriate grain size/density for creep, saltation, and/or suspension to occur. Over the past two decades of exploration, remote sensing and in-situ studies have elevated our understanding of Martian surface processes to the extent that we now identify comparable conditions and behaviors on other Solar System bodies, meaning that Mars may be an effective Solar System analog for aeolian surface properties.

Mars is an advantageous planetary aeolian analog for environments that are dry and/or low in atmospheric density, because terrestrial deserts are modified by other processes such as rainfall and biological activity. The aeolian bedforms and erosional features found on Mars, a range of features largely unaltered by fluvial and other recent geologic processes, capture a record of Amazonian climate. The sediment and composition of these bedforms and features are a record of geology.

In addition to the lack of recent modification from any hydrological activity, Mars may present aeolian processes not typically observed in terrestrial dryland regions. For example, wavelengths of sand ripples observed on Mars may suggest both fluid-drag and saltation as viable formation and modification processes.

While aeolian processes are a major change agent for the surface of modern dynamic Mars, polar/ice processes also occur. Often these processes occur in tandem – resulting in niveo-aeolian features, such

as those found on Olympia Undae. Could such niveo-aeolian features preserve signs of past life? Could these features be "mined" for resources (e.g. water ice)? Lessons learned from answering these questions could then be applied to extremely cold planetary bodies (e.g. Titan).

Mars also provides a test bed for the deployment of new exploration technologies. The Mars 2020 drone is an example of a new platform that could be used to explore aeolian features and processes on Mars (and the rest of the Solar System). Future missions carrying high frequency radar could improve our understanding of Mars aeolian and niveo-aeolian features, which could provide additional insights for future missions to planetary bodies with thick, opaque, atmospheres (e.g. Venus and Titan).

Beyond the Earth, Mars is the best studied planetary body with an atmosphere. One of the successes of the Mars Exploration Program has been a regular cadence of spacecraft which continues to this day. If this cadence continues, Mars will continue to be an excellent analog site for the next decade.

Desired Outcome

The desired outcome is one or two white papers that are effectively summaries of a Planetary Aeolian Processes Goals Document and a Planetary Aeolian Processes Exploration and Technology Roadmap. These documents would be loosely organized similar to NASA's Analysis/Assessment Groups' goals and/or road map documents.

Desired Contributions:

- Community effort that spans all disciplines and planets
- Contributions from the modern dynamic Mars community
- Identification of strategic knowledge gaps
- Identification of enabling technologies
- Identification of enabling programmatic approaches

General Schedule

Tim plans to present an updated version of this white paper presentation to the 6th International Planetary Dunes Workshop, 13 May 2020. Tim plans to complete a draft of this white paper by the end of May, then put the draft out for additional feedback from the community and to solicit for signatories.