Editorial Introduction: Fourth Planetary Dunes Workshop Special Issue

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Special Issue: Aeolian Research Special Issue for the Fourth International Planetary Dunes Workshop

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The Fourth International Planetary Dunes Workshop: Integrating Models, Remote Sensing, and Field Data was held May 19–22, 2015 in Boise, Idaho (see Final Announcement). More than 60 researchers and students participated in two and a half days of presentations and lively discussion, plus a full day field trip to Bruneau Dunes State Park. The workshop focused on the many landforms and deposits created by the dynamic interactions between granular material and airflow (aeolian processes). These processes are known to occur on several planetary bodies, including Earth, Mars, Titan, Venus, and possibly, cometary surfaces. The overarching purpose of this workshop was to provide a forum for discussion and the exchange of new ideas and approaches to gaining new insights into planetary aeolian processes. Meeting programs, abstracts, and E-Posters are all available at the workshop website (http://www.hou.usra.edu/meetings/dunes2015/).

This Aeolian Research special issue is intended to highlight some of the results presented at the workshop, in addition to other recent aeolian studies of planetary surfaces. Special issues for earlier dunes workshops in this series were summarized by Bourke et al. (2010), Zimbelman et al. (2013), and Zimbelman (2014). A brief summary of some of the topics covered at the 2015 workshop were also reported by Titus et al. (2015). These highly productive workshops would not be possible without the hard work and dedication of the conference convener, Timothy Titus, the other science organizing committee members (Joshua Bandfield, Mary Bourke, Lori Fenton, Rosalyn Hayward, Briony Horgan, Jani Radebaugh and James Zimbelman), session chairs, and workshop attendees. Additional thanks go to Boise State University and Bruneau Dunes State Park for hosting the venues.

We wish to thank the reviewers of these papers, for their constructive input and expertise. Jeff Lee, the Aeolian Research editor who managed this issue, provided critical tutelage and guidance. Ramya Manivasagam, the editorial journal manager, was instrumental in keeping us updated and on task. We also gratefully acknowledge Tim Horscroft for granting permission for this special issue to proceed. Finally, for the papers that relied on planetary spacecraft data, we thank the many people responsible for the successes of those missions.

The meeting brought together a diverse range of methodologies and targets for study, from longstanding research foci (e.g., terrestrial analogue studies and the dynamism of Mars' dunes), through emergent paradigms (e.g., the use of repeat-coverage remotely sensed planetary images to assess dune migration), to nascent areas of aeolian planetary science (e.g., the appearance of apparently aeolian bedforms in settings with negligible atmospheres, such as the comet 67P Churyamov-Gerasimenko). The widespread interest in monitoring and measuring dune migration rates on planetary surfaces was demonstrated by the workshop's concluding session, a well-attended...
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-resolution (1 m posting) Digital Elevation Model (DEM) (see; Kirk et al., 2008) of a dune field in the base of López crater to explore the influence of local topography on ripple orientation. Aside from demonstrating the relatively subdued topography of the dune field, with 96% of the dune field having a slope <20°, comparison of observed ripple orientation with that expected once the slope influence had been incorporated suggests that, away from slip faces, ripples can serve as good indicators of the most recent formative wind regime.

3. Dune and Ripple Migration, and Sediment Fractionation

Sand dunes and ripples on Mars have recently been documented to be active and migrating on the surface today (Silvestro et al., 2010; Bridges et al., 2011; Chojnacki et al., 2011) and a number of authors have attempted to correlate this with a variety of boundary conditions (Chojnacki et al., 2014; Banks et al., 2014, 2015). In this special issue, Bennett et al. (2016) tested the hypothesis that ripple migration rate is correlated with dune field albedo. Those authors tracked seasonal albedo of dune fields over many Mars years and report regional variations. While no strong correlation was found (i.e. dune albedo should not be used as a proxy for activity), the presence of dust devil tracks (indicating substantial dust coverage) was proposed to be an indicator of dune inactivity. A regional study of sand dunes in the Meridiani region tested whether early detections of dune mobility in Endeavour crater (Chojnacki et al., 2011, 2015) were characteristic for neighboring sand fields. Chojnacki et al. (2017) described 13 active dune fields where the majority exhibited dune migration. While those dune fields showed evidence for substantial geographic and temporal heterogeneity of crest fluxes across the area, their transport direction was consistent with a regional northeasterly-to-northwesterly wind regime indicating more variations than prior analysis had suggested.

Fenton et al. (2016) investigated the gypsum-dominated dune field of White Sands National Monument in New Mexico, USA as a planetary analog to dunes partially composed of gypsum sand found in the north polar region of Mars. The low density of gypsum grains compared to grains of dolomite (at White Sands) and mafic rocks (on Mars) leads to differential potential for aeolian processes, and thus sorting, and eventually spatial variability in the distribution of different mineralogies. By demonstrating the role of saltation especially of relatively large, low-density grains in driving this segregation of mineral species, the authors open the possibility of constraining the formative wind speeds of the Martian polar dune fields.

4. Planetary Aeolian Review Articles

The Special Issue also includes two review articles that illustrate how planetary sand dunes are important sedimentary components of geologic environments that can both modify the landscape and respond to changes in climate. The article by...
Kreslavsky and Bondarenko (2016) provides a thorough review of the current state of knowledge related to sand transport and aeolian deposits on Venus. Those authors provide an excellent overview of evidence for aeolian-driven morphologies (e.g., wind streaks, yardangs, dune fields etc.) from orbital radar and atmospheric data and surface observations by Soviet-era Venera missions, including the limitations of those missions. This review article culminates in a thorough discussion on how factors such as climate change, impacts, volcanism, and sedimentary processes all could have played a role in producing (or inhibiting) aeolian processes on Venus.

Neakrase et al. (2017) take a forward-looking view of Venusian dune science, and draw attention to the potential analogue use of Earth's subaqueous, marine dunes. By considering the similarities of the processes of grain entrainment and movement, and comparing examples of resultant bedforms from both environments, the article serves as a call for closer collaboration and discussion between these two disciplines.

In Diniega et al. (2016), a broad overview of the numerous elements of planetary aeolian research is presented. This work highlights how the community has studied bedforms found on Mars, Venus, the Saturnian moon Titan, and putative candidates on Comet 67P/Churyumov-Gerasimenko, the Jovian moon Io, and Pluto. Those authors go on to describe how that investigations of planetary words proceed in a consistent sequence, which is largely driven by the acquisition of data, mission type (e.g., flyby orbiter, surface lander etc.), and by the maturation of knowledge about that planetary body. The contrasts between the development of terrestrial dune science (which, whilst still exploratory in its early phases, has essentially followed a bottom-up trajectory beginning with field exploration) and planetary dune science (typically following a top-down research trajectory, beginning with remote identification of evidence of aeolian activity at the dune field scale) are highlighted and used to critique different epistemological approaches.

5. Conclusion

The nine papers herein demonstrate the high quality of data available to the community and the diverse and novel approaches employed by planetary researchers. These papers also display vastly different planetary bodies that come with specific boundary conditions that create variations in the production, transport, accumulation, and composition of aeolian sediments. They highlight the paradox that despite such dramatically different environments as, say, Venus and Titan, the resultant dunes and other aeolian landforms form a geomorphological suite, which is recognizable across very diverse worlds. Moreover, the Special Issue demonstrates the effectiveness of science-driven community workshops like the International Planetary Dunes Workshop in instigating meaningful research. We hope that this Aeolian Research Special Issue serves as a source of intellectual stimulus for future research. A fifth International Planetary Dunes Workshop is scheduled for May of 2017 in St. George, Utah (see http://www.hou.usra.edu/meetings/dunes2017/), and the themes of the next meeting (subaqueous dunes as a planetary analogue, the role of sediment composition in aeolian processes)
processes, the importance of bedform scaling and the concept of equifinality) suggest
that these workshops continue to develop the science of planetary aeolian processes
and landforms.

References:


