A critical gap: in-situ meteorological and aeolian measurements beyond Earth
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

Point of Contact: Serina Diniega, Jet Propulsion Laboratory/California Institute of Technology (serina.diniega@jpl.nasa.gov)

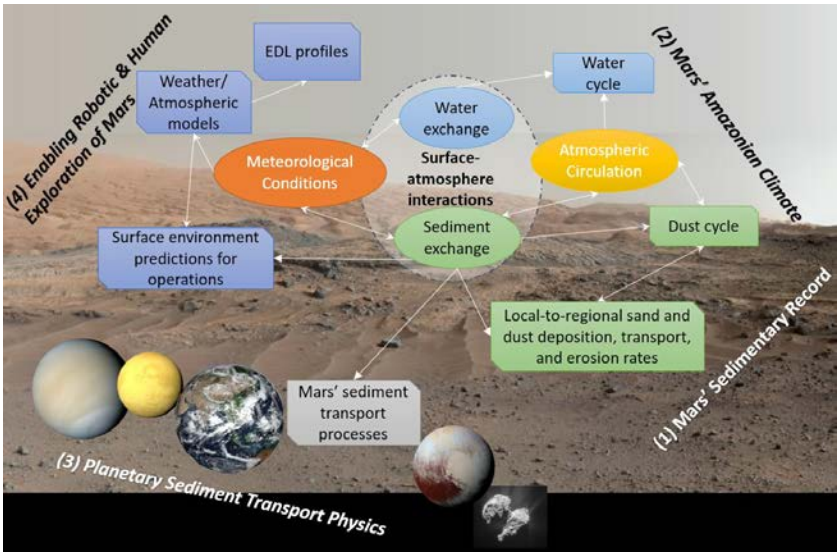
Additional authors (so far, more are welcome!): Devon Burr (N Arizona U), Ingrid Daubar (Brown U), Colin Dundas (USGS), Laura Kerber (JPL), Brian Jackson (Boise State U), Scot Rafkin (SwRI), Robert Sullivan (Cornell U), Christy Swann (Naval Res Lab), Timothy Titus (USGS), Ian Walker (Arizona State U)

Intended General Content

This white paper aims to outline (1) why direct observation of surface-atmosphere processes and exchange rates is a critical gap within Planetary science, limiting our ability to answer many Planetary and Mars Big Questions, (2) what type of measurements are needed to fill this critical gap, (3) establish that acquisition of these types of measurements from the surface of Mars is technically, scientifically, and fiscally feasible in the next decade, and (4) identify key areas of technology investment that would enable or enhance the ability to acquire needed measurements. While the science focus of this white paper includes fundamental physics and planetary science, the type and frequency of opportunities to visit Mars and the large amount of contextual data that has been acquired at Mars makes that body the natural planetary target for relevant in-situ studies in the next decade.

This white paper will focus on science questions and needed measurements. High-level description of mission/instrument concepts will be included only to (1) establish feasibility to acquire these measurements in the next decade and (2) identify key technology gaps where NASA investment would provide important benefits (e.g., small lander technologies can help enable this science, in a unique and possibly better way than larger spacecraft). Any such mission/instrument concepts will not be prioritized, discussed with specific advocacy, or described in detail (but we are interested in cross-referencing to relevant mission/instrument concept white papers where more details could be found).

This figure is from past work by Diniega and colleagues and it shows how in-situ aeolian and meteorological investigations – focused on quantitative investigations of surface-atmosphere interactions – fit into broad-scale, high-priority Mars and Planetary science questions – such as questions relating to the rates of erosion and deposition of sand and dust (key for interpreting sedimentary deposits, aeolian excavation of Gale Crater, or exposure ages for deposits of astrobiological interest), rates and pathways of dust lofting (key input for climate models), and the saltation layer profile within a dry, low-density atmosphere and low gravity (the latter can't be tested on Earth).



Desired Contributions

Diniega expects to do the bulk of the writing and has ample information based on past work by her and colleagues (e.g., LPSC 2020 abstract #2343), but welcomes co-authors. Some areas where more input would be especially welcome are:

- **Identifying the broad Mars and Planetary Science questions that can't be fully answered without in-situ meteorological/aeolian measurements and explaining those connections**. A key aim of this white paper is to demonstrate that the broader Mars and planetary science community should support acquisition of these types of measurements, so contributors who don't identify as aeolian, meteorological, and/or atmospheric scientists or who are not specifically Mars scientists are especially welcomed to help convey this message to a broad audience.
- **Identifying the measurements needed to sufficiently track and characterize surface atmosphere-exchange.** There are many measurements that could be made, but we seek to identify those of highest priority (i.e., which would enable the biggest advancements in Mars or planetary science)? These measurements need to be defined in type, frequency/duration, dynamic range, location (e.g., on Mars or altitude above the ground), etc. The focus will be on defining the measurements, not the implementation/instrument. However, background information will be needed about the limitations of existing in situ measurements (and if these are instrument or accommodation-based limitations).
- **Connecting Mars measurements to studies of the fundamental processes involved in surface-atmosphere exchange.** This aspect relates to (1) the need for concurrent measurements of the sediment and volatile fluxes and environmental drivers, and (2) treating Mars as a "natural laboratory" for testing models and generating comparative data (there will be a separate white paper focusing on using Mars as a natural laboratory).
- **Describing how we can use established terrestrial field study methodologies/designs and existing models to connect dynamics across spatial and temporal scales.** On another planet, we are likely to obtain in-situ measurements in only one or a few locations, so the usefulness (and importance) of these types of measurements relies upon our ability to connect specific, high-frequency/short time-baseline, in situ measurements to the larger picture – which has been done extensively within analogous terrestrial studies.
- **Developing mission or instrument concepts that could help acquire relevant measurements.** As noted above, this will be a science-focused white paper, but information about instruments and mission concepts under-development is important to establish technical feasibility and to identify key technology gaps that NASA investment could address.

General Schedule

Diniega 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 signatories.