THE AERODYNAMIC ROUGHNESS OF MARS-LIKE SURFACES. L. Kerber[1], C. W. Hamilton[2], S. P. Scheidt[2]. [1]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109, kerber@jpl.nasa.gov, [2]Lunar and Planetary Laboratory, University of Arizona Tucson, AZ, 85721.

Introduction: Accurate knowledge of near-surface winds is important for understanding many atmospheric and geologic processes. In the case of dunes, high-resolution surface winds are needed—sometimes down to the scale of an individual valley or crater—to determine how the dunes were shaped and whether or not they are active in the present era [1]. Knowledge of the surface wind environment on Mars is vital for many other scientific and engineering concerns as well, including the entry, descent, and landing of martian probes; the understanding of dust storm initiation; the characterization of wind-induced vibrations; and the study of landscape modification through aeolian erosion. However, despite the importance of surface winds, they remain the least well characterized winds on Mars [2]. For most applications, both scientists and engineers rely upon the results of atmospheric models such as global circulation models, mesoscale climate models, and large eddy simulations for information about the surface winds [e.g., 1].

One of the major variables affecting the character of the surface wind is the terrain roughness at the air/land boundary, which is parameterized by an "aerodynamic roughness length" [3]. On the Earth, roughness lengths are measured experimentally over various terrains (e.g., tundra, grasslands, corn fields, suburbs, forest, etc.). On Mars, volcanic terrains constitute over a third of the planet's surface, yet their areodynamic roughness properties have not been thoroughly characterized. In 1976, wind profiles over an alluvial plain were compared to those over a rough volcanic surface, and it was found that the wind changes significantly because of the change in surface roughness [4]. Due to a lack of measurements, however, these effects are not reflected in Martian wind modeling studies. For example, in present martian climate models, a single roughness value is often chosen to represent the entire planet. In some cases surface roughness is based on rock abundance data, but such an approach neglects the effects of the local-scale topography, which falls between the scale of rocks and the orographic-scale [5].

A pilot study investigating the relationship between aerodynamic roughness and volcanic terrain type was conducted on the Kīlauea Volcano in Hawai'i (**Fig. 1**) from May 6th to May 27th, 2014. During this this time, wind profiles were recorded over Mars-like volcanic landscapes, including fresh ʻaʻā lava, platy lava, slabby pāhoehoe lava, weathered ʻaʻā lava infilled with sand, and a tumuli field (**Fig. 2**). Each represents a different kind of surface roughness which is seen on Mars.

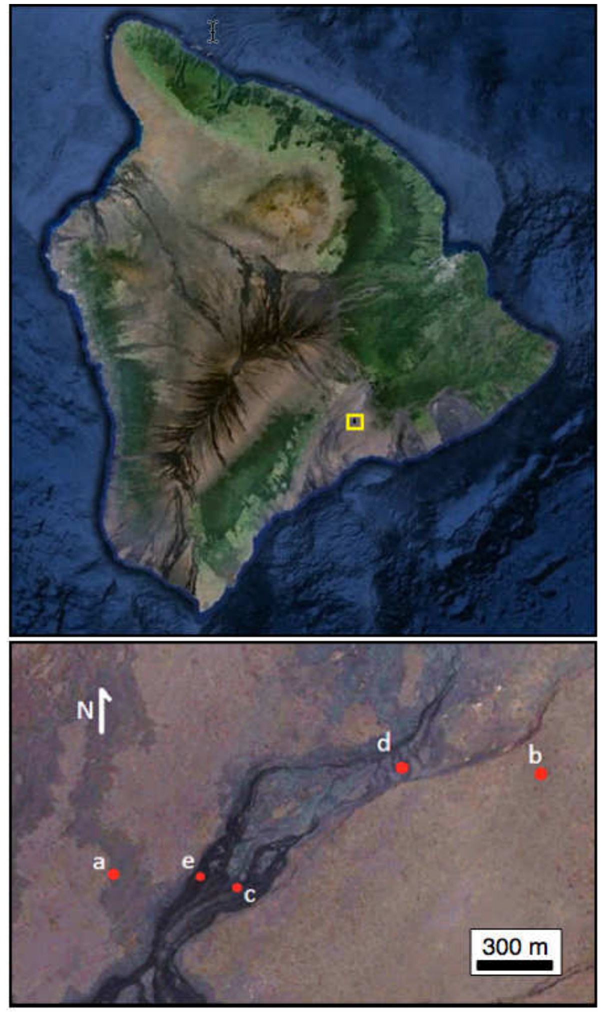


Fig. 1. Location of the field site on the main island of Hawaiʻi (top). Image from Google Earth. Data SIO, NOAA, U.S. Navy, NGA, GEBCO, MBARI, Landsat, LDEO-Columbia, NSF, NOAA. Close up of the December 1974 flow and roughness measurement locations (bottom). (a) sediment-covered ʻaʻā, (b) tumuli field, (c) slabby pāhoehoe, (d) fresh ʻaʻā, (e) lava plates. Image from Google Earth; data from Digital Globe, 2015.

Methods: The apparatus used to make measurements consisted of a 7.64-m mast instrumented with anemometers spaced at logarithmic heights (**Fig. 3**). Simulaneous wind speed measurements were recorded at five heights, at increments of 30 seconds. The mast was left at each site for several days (**Fig. 4**). From the

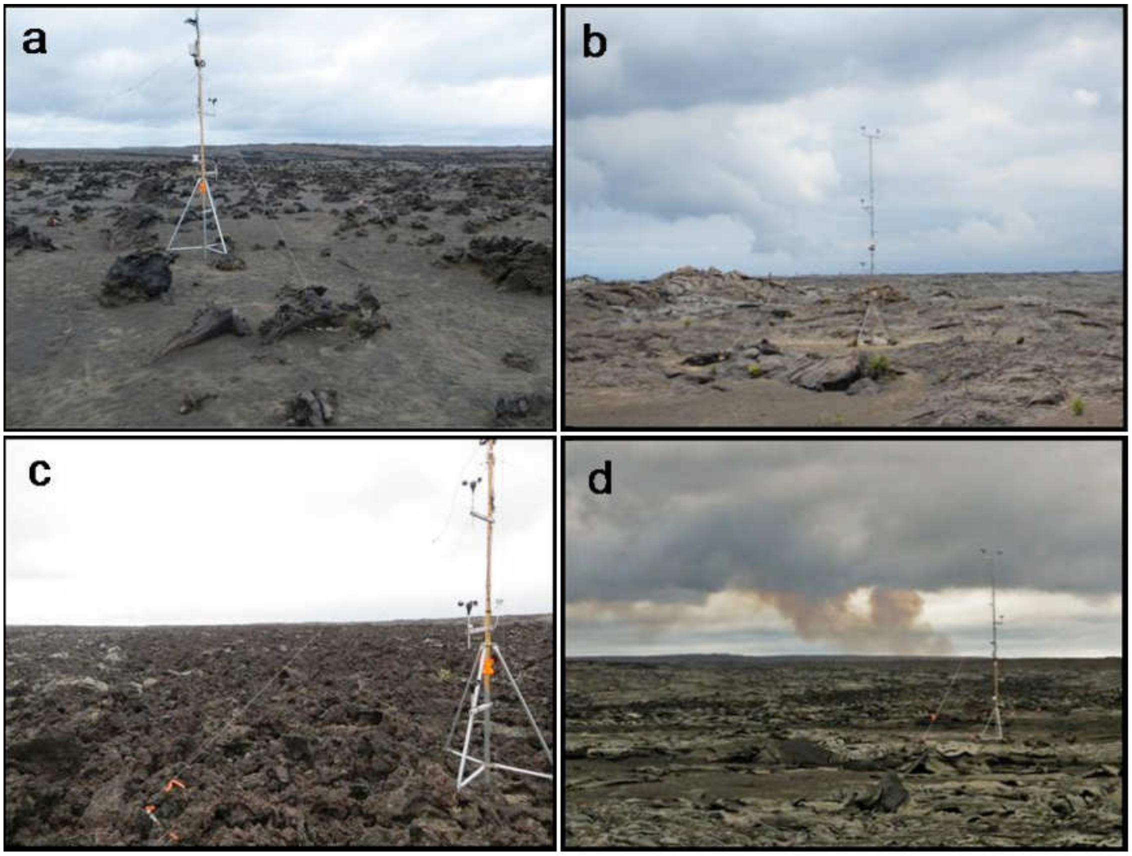
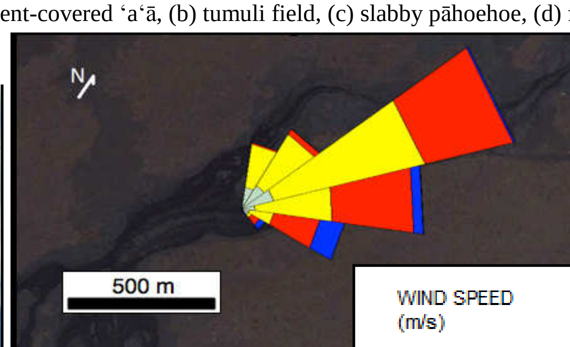


Fig. 2 Aerodynamic roughness measurement sites. (a) sediment-covered ‘a‘ā, (b) tumuli field, (c) slabby pāhoehoe, (d) fresh ‘a‘ā, (d) lava plates. Fresh ‘a‘ā from **Fig 1e.** is not shown.

Fig. 3. Anemometer mast, instrumented with five anemometers, a wind vane, and temperature sensors at the top and bottom to measure atmospheric stability.



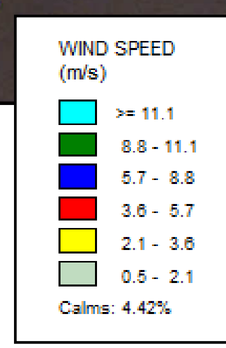


Fig. 4. Results: A wind rose displaying wind strength and relative frequency over several days of measurement on slabby pāhoehoe flows (c).

resulting logarithmic profiles, the aerodynamic roughness constant can be calculated as the height above the surface at which the wind’s velocity goes to zero [3].

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