MARTIAN SONIC ANEMOMETER

Don Banfield[(1)]
[(1)] *Cornell Astronomy, 420 Space Sciences, Cornell University, Ithaca, NY 14853, USA,*
Email: banfield@astro.cornell.edu

We have developed a 3-D sonic anemometer for use on Mars that exceeds the performance of previous martian wind gauges by at least an order of magnitude in sensitivity as well as sampling rate. This improvement in performance is important because it opens up new avenues of research at Mars, in the interaction of the surface and atmosphere. Fast response and sensitive wind measurements allow the direct measurement of the turbulent eddies in the martian atmospheric boundary layer. By correlating these turbulent motions with their associated vertical wind, temperature, humidity or other trace gas perturbations, we can directly measure the exchange of momentum, heat, water or other tracers with the surface. Additionally, if discrete sources of biogenic effluents are found at Mars, similar approaches may be useful to guide a rover to the precise source of the effluent plumes using a technique known as plume tracing, akin to how lobsters (among other animal predators) hunt their prey.

Sonic anemometers are the gold standard for similar boundary layer studies on Earth, but terrestrial instruments are non-functional in the extremely low density atmosphere at Mars. Our instrument uses novel micro-machined capacitive transducers that more efficiently couple with the low acoustic impedance martian atmosphere, thus retaining as much acoustic signal strength on transmission under martian conditions as possible. These transducers have been specifically optimized for use on Mars including durability to the extreme temperatures, optimization for lower spacecraft power availability and miniaturization. The remainder of the instrument is a mix of analog and digital electronics to produce the acoustic signals and then process them to yield wind speeds and temperatures. The signal processing involves sophisticated algorithms borrowed from the field of RADAR to extract as much information content as possible from the signals.

We are currently finishing development on this instrument using PIDD funding, and are testing it in a thermal vacuum chamber at Ball Aerospace. We are also in the process of preparing for a stratospheric balloon flight (which mimics martian surface conditions to a high degree) to raise our instrument's TRL to between 5-6. Our performance goals are 3-D wind measurements with sensitivity down to better than 10 cm/s, an accuracy of ~10 cm/s, and with a sampling rate of 20 Hz or more. In a full flight configuration, the instrument is expected to draw ~2W while operating and 0W when quiescent, with an instantaneous startup. It should total about 1kg in mass and stow into a volume of about 1500 cm^3. We are eager to include this instrument on any and ALL future landed or aerial missions to Mars. We are quite confident that it will open up exciting new avenues of research at Mars. It may also prove to be a valuable instrument at Titan.