Small Atmospheric Mars Payload Landed Experiment (SAMPLE) Concept and Computational Fluid Dynamics Study

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In studying the Martian environment it is important to understand the complex weather on Mars. From the complex dust devils and dust storms to the regular seasonal changes, the local weather is an important part of the study of Mars. Weather stations have been included on almost every landed mission from Viking 1 to InSight [1][2]. However, all of these sensors have been attached to the landers and rovers along with many other instruments. For all of these missions, the body of the craft and the other instruments tend to interfere with the readings from the weather station. In addition, the location of the measurements is dependent on the location of the landing site or the changing position of the rover.

Magellan Aerospace Winnipeg in conjunction with the University of Alberta and the University of York proposed to send along with a future Mars rover a small autonomous weather station, the Small Atmospheric Mars Payload Landed Experiment (SAMPLE). After landing, the rover would deploy and selectively place the weather station in a pre-defined science location. This would allow the weather station to be precisely placed and to be free from the physical interference of the rover, once it moves away. SAMPLE would then autonomously operate, providing improved high frequency measurements of the near surface weather conditions at the same location.

In designing the weather station it is important to ensure that the design minimizes the physical interference of the station with the measurements. To account for this, computational fluid dynamics (CFD) simulations of the weather conditions on Mars are used to predict the airflow and temperature conditions around the station. By using CFD simulations the flow behaviour can be investigated at Martian conditions. The simulations are used in guiding the external design of the station and the accommodation of the instruments. Using a carefully developed CFD model, the flow around the weather station is modelled for a range of diurnal and seasonal flow conditions.

Key to the weather measurements is a sonic anemometer to provide high frequency measurements of the wind speed and direction in three dimensions, as well as temperature [3]. For accurate measurements, the anemometer must be located and oriented such that physical interference from the structure is minimized. By simulating the wind from a range of directions, a preferred orientation is selected. In addition, the simulations guide the need for future calibration activities of the anemometer. Future simulations will investigate the air flow characteristics for a range of expected weather conditions throughout the Martian year inclusive of temperature effects. This will help guide accommodation of the other onboard sensors in future design phases of SAMPLE.

References:

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