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Latest Results from the European Mars Simulation Wind Tunnel Facility

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Abstract

The Mars Simulation wind tunnel at Aarhus University is a unique ESA and EU supported simulation facility designed for studies of the Martian environment. Specifically it is capable of recreating the key physical parameters such as temperature, pressure (composition), wind flow and importantly the suspension of dust particulates. This facility is available to the scientific community for collaborative research. Preliminary results from the first year of facility operations will be presented.

1. Motivation

This environmental simulator facility can be used for a broad range of research including the study of the Martian surface and atmosphere, but also for Terrestrial studies where extreme temperatures, low pressures, aerosols or wind flow are required.

Some examples of planned and current research programs are;

- Martian dust aerosols; opacity and spectroscopy
- Martian polar CO_2 ice formation
- Terrestrial volcanism; pyroclastic flows
- Bacterial transport and planetary protection
- Granular Electrification
- Erosion Studies

In addition to scientific research this facility is intended for the development, testing and calibration of sensor and planetary lander systems, both for ESA and NASA.

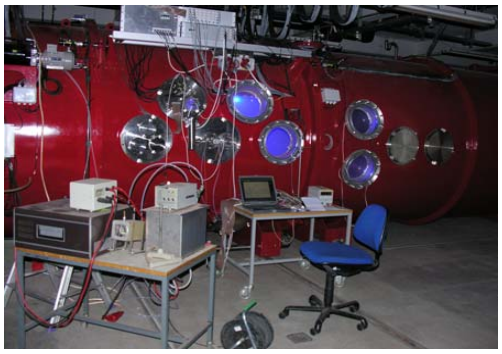

Figure 1 The new Mars Simulation Facilities at AU

2. Simulator Design

The simulator has been loosely based on a previous smaller facility operating since 2000 and consists of an environmental (thermal-vacuum) chamber within which a re-circulating wind tunnel is housed [1,2]. The wind is generated by a set of two 1.8m diameter fans which draw flow down the 2m×1m tunnel section and return it above and below. The test section can be fully removed for access.

A server based control system provides both control over wind flow, temperature, pressure, lighting, etc., but also acts as a data logger. Cooling is achieved by a novel liquid nitrogen flow system which has achieved temperatures below -120ºC, an electric heater system is also employed. The inner chamber is thermally isolated from the vacuum chamber. Wind speeds in the range 1-20 m/s have been demonstrated.

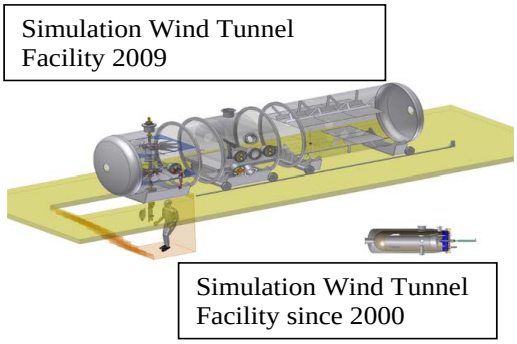

Figure 2 Mars Simulation Wind/Dust facilities at AU.

3. Dust Aerosols; Light Scattering and Opacity

In this study the scattering of light by suspended dust particulates was simulated to better understand the observed scattering of sun light by dust in the Martian atmosphere. Specifically the spectral variation in scattering of the optical and ultraviolet light by different minerals and Mars analogue dust materials was quantified using effective opacities in the range of 0.5 – 2.0. A secondary goal for this study was to test a prototype optical (UV) sensor under Mars simulation conditions to support its application as a lander/rover based instrument.

Figure 3 Optical testing in the windtunnel (left) Laser based wind/dust sensor (right).

This type of experiment is a continuation of a large body of research performed over the past decade studying dust aerosols [1,2]. This research has direct relevance to aerosol studies on Earth which impact air quality, the environment and climate.

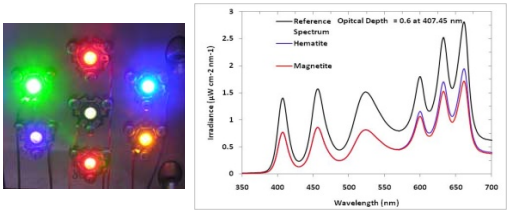

Figure 4 section of the multi wavelength LED light source (left). Spectra showing light scattering/absorption for different dust minerals (right).

4. CO_2 ice

The most recent work at the facility has been investigating the formation of CO_2 ice in order to resolve speculation as to the optical properties of the (seasonal) Martian polar CO_2 ice. The existence of highly transparent CO_2 ice layer in Martian polar areas is debated for a long time. It is required by diverse models of polar activity, however it was not indisputably confirmed by the observations. Our aim is to constrain the conditions suitable for the formation and preservation of the transparent CO_2 layer. This study makes use of the liquid nitrogen flow-through cooling system and the large chamber volume allows significant and rapid precipitation of CO_2.

Conclusion

This new European Mars simulation facility has many unique features which make it the most advanced simulator of its kind allowing new science and technology development/testing to be performed. Details of the Experimental facility will be presented and some of the first research results obtained using it. Note that European researchers may be eligible for financial support to carry out experiments using this facility through the Europlanet (EU, FP7) Trans National Access program.

References

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