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Advances in a European Planetary 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 other planets (such as Mars), or for recreating extreme environments here on Earth, or in specific investigations involving aerosols or other forms of particulate transport.
Although the facility was initially constructed for the simulation of the low pressure, low temperature and dusty environment of Mars and has been further developed to allow a range of environmental applications with access given to external users and for scientific study.
This facility is additionally used for the development, testing and calibration of sensor and planetary lander systems, both for ESA and NASA.

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 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. Wind speeds in the range 1-25 m/s have been demonstrated.

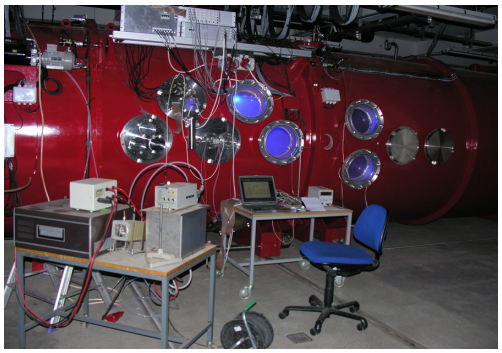

Figure 1 The new Mars Simulation Facilities at AU

Cooling is achieved by a novel liquid nitrogen flow system which has achieved temperatures below -150ºC, an electric heater system is also employed. The inner chamber is thermally isolated from the vacuum chamber.
A server based control system provides both control over wind flow, temperature, pressure, lighting, etc., but also acts as a data logger.

3. Planetary Simulation

Under the EUROPLANET trans-national access program several research groups have had access to this facility, mostly involving specific Martian environment studies.
In recent work at the facility the formation of CO_2 ice has been studied 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 has been debated for some time. Our aim has been to constrain the

conditions suitable for the formation and preservation of the transparent CO_2 layer.

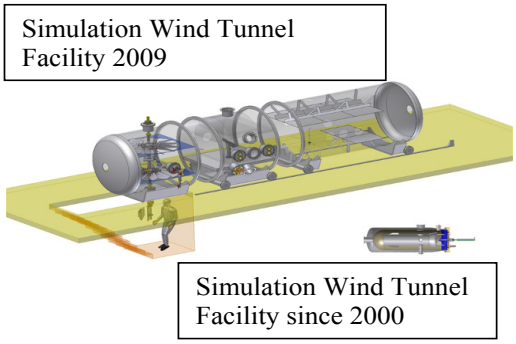

Figure 2 Mars Simulation Wind/Dust facilities at AU.

In another 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.

Figure 3 section of the multi wavelength LED light source (left) and wind tunnel tests section using two different lighting settings (center/right).

4. Meteorology and Metrology

The ability to reproduce a specific terrestrial environment and control wind flow, humidity, pressure, temperature, etc., is of use in meteorology / climatology for the calibration of sensors and traceability of their data. This work is part of the EU supported European MeteoMet collaboration and the EURAMET network. For this wind tunnel facility it involves detailed calibration and testing of the wind tunnel operational parameters and modifications where necessary.

5. Dust Aerosols and Sand transport;

A unique capability of this wind tunnel facility is the production and controlled study of suspended particulates (dust, ash, sand, etc.).
This type of experiment is a continuation of a large body of research performed over the past decade studying dust aerosols, specifically granular electrification, erosion and deposition rates [1,2]. This research has direct relevance to aerosol studies on Earth which impact air quality, the environment and climate.
An advanced type of Laser aerosol and (2D) wind flow sensor with particle sizing capability has recently been installed and is allowing detailed study and control these environmental parameters.

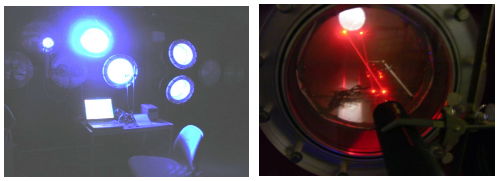

Figure 4 Optical testing in the windtunnel (left) Laser based wind/dust sensor (right).

6. 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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