An upgraded European Mars Simulation Wind Tunnel Facility
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Introduction
The Mars Simulation Wind Tunnel Facility at Aarhus University is a unique ESA and EU supported facility capable of simulating a wide range of environmental conditions with the ability to control e.g. temperature, pressure and wind flow. The facility is available to the scientific community for collaborative research. Testing of wind tunnel variables have been performed to upgrade and optimize the wind tunnel for calibration of meteorological sensors.

Wind tunnel design
• 50 m³ environmental chamber.
• Re-circulating wind tunnel.
• Pressure range: 0.02 - 1000 hPa.
• Temperature range: -130 °C up to +60 °C.
• Capable of generating wind speeds up to 25 m/s.
• Dust injection system can produce suspended particulates.
• Employs a unique LED based optical illumination system.
• Laser based optoelectronic instrumentation is used to quantify and monitor dust suspension and deposition.
• Advanced network based control system.

Fig. 1: Schematic of the wind tunnel.

Fig. 2: The wind tunnel fan section and test section seen from outside.

Fig. 3: The wind tunnel utilizes a LED based lighting system with over 200 LEDs in all, covering the spectrum from far-red (peak: 660 nm) to near-UV (peak: 410 nm) (solar simulator).

Fig. 4: Image of the commercial LDA system measuring wind speeds in the wind tunnel.

Wind flow calibrations
By use of a commercial Laser Doppler Anemometer (LDA) system wind flow and turbulence have been measured in the wind tunnel at a series of pressures and motor rpm. Insertion of meshes between the test section and upwind section has lowered the turbulence in the wind flow to an acceptable level for calibration of anemometers.

Fig. 5: Average wind speeds at pressures of 3, 10, 30, 100, 300 and 1000 hPa.

Fig. 6: Average wind speeds at 10 hPa as a function of meshes inserted in the wind tunnel.

Fig. 7: Turbulence in the wind flow at 10, 100 and 1000 hPa in free flow and with mesh inserted in the wind tunnel.

MeteoMet project
The MeteoMet project (Meteo for Meteorology) focuses on the traceability of measurements involved in climate change. In order to improve the robustness and reliability of atmospheric measurements, improved calibration procedures and facilities for ground based observations are needed. The aim is to use the Aarhus Wind Tunnel Facility for the testing, development, calibration and comparison of meteorological sensors under a wide range of (terrestrial) environmental conditions. This requires improvements to the control system, sensor systems and mechanical design of the facility.

Fig. 8: Turbulence versus average wind speed

Fig. 9: Average wind speed versus pressure

Facility testing and upgrades
A series of tests has been performed on the environmental wind tunnel to assess the stability and uniformity of the wind flow, temperature and pressure in the wind tunnel. Analysis of these results have led to improvements, which have, in particular, improved wind flow and turbulence control. Pressure sensors have been calibrated and temperature control of humidity quantified to enable better control of the system for future use.

MeteoMet project

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