Expert program report: Comparative humidity measurements in University of Michigan, Ann Arbor

During 7th through 17th on November 2017, a measurement campaing visit to University of Michigan, Climate and Space Sciences and Engineering department in Ann Arbor was carried out in frame of the Europlanet NA1 Expert Program. The purpose of the visit was to perform comparative humidity measurements in low-pressure carbon dioxide environment between Ann Arbor laboratory and Finnish Meteorological Institute's (FMI) laboratory and thus to validate the low pressure CO_2 humidity measurement system developed in the FMI.

Department

The host laboratory in Ann Arbor has a capability to create the environmental conditions needed for calibrating humidity instruments for Mars mission. In the measurement chamber the pressure is kept in Martian pressure region and temperature and humidity can be controlled in a wide range. Temperature control is executed with a cold plate with liquid nitrogen cooling inside the measurement chamber. Humidity can be then added to the measurement chamber gradually until the desired dewpoint or frostpoint is achieved. The frostpoint is measured with Buck hygrometer through a tube leading from inside the chamber to the hygrometer outside the chamber.

The department has expertise and experience in humidity measurements from successful planetary missions. One example is recalibrating the Phoenix Mars lander humidity measuring device reference model on ground.

Instruments

The measurements were conducted with two relative humidity measurement devices manufactured in FMI and based on sensor heads developed by Vaisala Oy. One of these devices was previously calibrated inside the FMI's chamber. Another device was representing a new generation of humidity sensors and will be measured in FMI chamber later. The goal of the measurement campaign was to compare the measurements taken in Ann Arbor to those taken in FMI and in that way validate the low pressure CO_2 humidity measurement system in FMI.

Measurements

The two instruments were measured in different temperatures ranging from -62°C up to -40°C. The pressure was kept in 850 Pa during all the tests and the chamber was filled with constant flow of CO_2. Humidity was measured in stable points ranging from almost dry to 100%RH and even to supersaturation. Measurements were also performed in changing humidity to measure the response time of the instruments.

Results

The measurement facilities in Ann Arbor were good and suitable for this type of measurements. Good quality, comparable measurements were achieved in many temperature and humidity combination points. The data processing is still ongoing.

These results will help to validate the FMI’s measurement system will enhance the quality of atmospheric measurement infrastructure for planetary instrument development in Europe.

However all goals set for the campaign were not reached and full validation for temperature range down to -70°C was not yet reached due to high temperature gradient between different parts in the measurement system. The measurement setup and instrument attachment were not opitimized for this instrument type and would require some modifications to reach the lower temperatures.