EPSC Abstracts
Vol. 5, EPSC2010-141, 2010
European Planetary Science Congress 2010

Europlanet Research Infrastructure: Planetary Simulation Facilities

G.R. Davies (1), N. J. Mason (2), S. Green (2), F. Gómez (3), O. Prieto (3), J. Helbert (4), L. Colangeli (5), R. Srama (6), M. Grande (7), D. Barnes (7), J. Merrison (8)

(1) Department of Petrology, Vrije Universiteit, Amsterdam, The Netherlands, gareth.davies@falw.vu.nl; 31-205989942, (2) Centre of Earth, Planetary, Space & Astronomy Research, Open University, Milton Keynes, United Kingdom, (3) Instituto Nacional de Técnica Aerospacial - Centro de Astrobiología, Madrid, Spain, (4) Deutsches Zentrum für Luft-und-Raumfarhrt, Berlin, Germany, (5) Laboratory of Istituto Nazionale di AstroFisica-Napoli, (6) Max Planck Institüt Nuclear Physics, Heidelberg, Germany, (7) Institute of Mathematics & Physics, University of Wales, Aberystwyth, United Kingdom, (8) Institute of Physics & Astronomy, Aarhus University, Denmark.

1. Introduction

The Europlanet Research Infrastructure consortium funded under FP7 aims to provide the EU Planetary Science community greater access for to research infrastructure. A series of networking and outreach initiatives will be complimented by joint research activities and the formation of three Trans National Access distributed service laboratories (TNA's) to provide a unique and comprehensive set of analogue field sites, laboratory simulation facilities, and extraterrestrial sample analysis tools. Here we report on the infrastructure that comprises the second TNA; Planetary Simulation Facilities. 11 laboratory based facilities are able to recreate the conditions found in the atmospheres and on the surfaces of planetary systems with specific emphasis on Martian, Titan and Europa analogues. The strategy has been to offer some overlap in capabilities to ensure access to the highest number of users and to allow for progressive and efficient development strategies. For example initial testing of mobility capability prior to the step wise development within planetary atmospheres that can be made progressively more hostile through the introduction of extreme temperatures, radiation, wind and dust.

2 Europlanet Research Infrastructure Facilties:

Mars atmosphere simulation chambers at VUA and OU

These relatively large chambers (up to 1 x 0.5 x 0.5 m) simulate Martian atmospheric conditions and the dual cooling options at VUA allows stabilised instrument temperatures while the remainder of the sample chamber can be varied between 220K and 350K. Researchers can therefore assess analytical protocols for instruments operating on Mars; e.g. effect of pCO_2, temperature and material (e.g., ± ice) on spectroscopic and laser ablation techniques while monitoring the performance of detection technologies such as CCD at low T & variable p H_2O & pCO_2.

Titan atmosphere and surface simulation chamber at OU

The chamber simulates Titan's atmospheric composition under a range of pressures and temperatures and through provision of external UV light and or electrical discharge can be used to form the well known Titan Aerosol species, which can subsequently be analysed using one of several analytical techniques (UV-Vis, FTIR and mass spectrometry). Simulated surfaces can be produced (icy surfaces down to 15K) and subjected to a variety of light and particles (electron and ion) sources. Chemical and physical changes in the surface may be explored using remote spectroscopy.

Planetary Simulation chamber for low density atmospheres INTA-CAB

The planetary simulation chamber-ultra-high vacuum equipment (PSC-UHV) has been designed to study planetary surfaces and low dense atmospheres, space environments or any other hypothetic environment at UHV. Total pressure ranges from 7 mbar (Martian conditions) to $5x10^{-9}$ mbar. A residual gas analyzer regulates gas compositions to ppm precision. Temperature ranges from 4K to 325K and most operations are computer controlled. Radiation levels are simulated using a deuterium UV lamp, and ionization sources. 5 KV electron and noble-gas discharge UV allows measurement of IR and UV spectra and chemical compositions are determined by mass spectroscopy.

Planetary Simulation chamber for high density planetary atmospheres at INTA-CAB

The facility allows experimental study of planetary environments under high pressure, and was designed to include underground, seafloor and dense atmosphere environments. Analytical capabilities include Raman spectra, physico-chemical properties of materials, e.a. thermal conductivity. P-T can be controlled as independent variables to allow monitoring of the tolerance of microorganisms and the stability of materials and their phase changes.

Planetary Simulation chamber for icy surfaces at INTA-CAB

This chamber is being developed to the growth of ice samples to simulate the chemical and physical properties of ices found on both planetary bodies and their moons. The goal is to allow measurement of the physical properties of ice samples formed under planetary conditions to assess how rheology varies with pressure and temperature and grain size to gain a far better understanding of how tectonics may operate on icy moons.

Hot planetary surfaces simulation chamber at DLR

The planetary simulation chamber is to study the behaviour of planetary analogue materials on the surface of hot (airless) bodies in the solar system. Samples can be heated up to temperatures of 500°C simulating conditions found on the surface of Mercury and Venus. This enables highly accurate thermal emission measurements using the integrated infrared spectrometer and calibrated sources. Thermal gradients can be applied to samples to simulate diurnal thermal cycles and examine thermal stresses in materials. The chamber can be placed under vacuum or purged with gas. In addition, to the high temperature chamber a number of further planetary simulation chambers are available equipped with LIBS and Raman-spectroscopy equipment.

Dust analogue simulation chamber at INAF/OACN

This chamber produces and characterises dust analogues (arc discharge, laser ablation, grinding of minerals, ices) in a variety of simulation chambers under variable pressure (10^{-6} – 10^{-3} mbar), temperature (80 - 330 K) and gas composition. Dust and analogues are characterised by a variety of Spectroscopic (absorption, transmission, diffuse-specular reflectance) and imaging techniques (SEM) and can be subjected to thermal annealing, ion bombardment and UV irradiation.

Dust accelerator facility at Max Planck Institüt Nuclear Physics, Heidelberg.

This facility allows the investigation of hypervelocity dust impacts onto various materials. Dust grain materials from nano to micron sizes are accelerated using a 2 MV Van-de-Graaff to velocities between 1 and 60 km/s comparable to the planetary rings of the giant gas planets and impact ejecta processes on the surface of small bodies (asteroids, comets) as well as moons and planetary surfaces. Potential phenomena for study include dust charging, dust magentosphere interactions, dust impact flashes and the possibility of obtaining compositional measurements of impact plasma plumes.

Mars surface simulation Laboratory, Aberystwyth University.

A Planetary Analogue Terrain Laboratory facilitates comprehensive mission operations emulation experiments designed to interpret and maximise scientific data return from robotic instruments. This facility includes Mars Soil Simulant and 'science target' rocks that have been fully characterised. The terrain also has an area for sub-surface sampling. An Access Grid Node allows simulation of remote control operation and diminishes the need for direct on-site attendance. PAT Lab has a large selection of software tools for rover, robot arm and instrument modelling and simulation, and for the processing and visualisation of captured instrument data. Instrument motion is measured using a Vicon motion capture system with a resolution < 0.1 mm.

Dusty wind tunnel at Aarhus University, Denmark

The Aarhus wind tunnel simulates wind driven dust exposure on Mars. This allows study into analogue materials, dust/surface processes, meteorological condition and microbiological survival under Martian conditions. The multi-purpose facility is used to quantify dust deposition (i.e. on optical surfaces, electrical or mechanical components) and examine the operation of instrumentation in dusty/windy environment under Martian conditions (pressure, gas composition & temperature). This includes calibration of wind flow instrumentation and dust sensors.