EPSC Abstracts
Vol. 5, EPSC2010-491, 2010
European Planetary Science Congress 2010

Scientific Goals and Operations of the MetNet Precursor Mission

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Abstract

In the next years a series of small landing vehicles concentrating on Martian meteorology should be deployed to the surface of our planetary neighbor in preparation of the planned manned missions to Mars. Here we present the Finnish – Russian – Spanish precursor mission of such network landers, its scientific goal and principle of operation.

1. Introduction

The Mars MetNet Precursor Mission (MMPM) is the technology demonstration project for the deployment of a larger network of small meteorological stations onto the surface of Mars. The development is done in collaboration between the Finnish Meteorological Institute (FMI), the Russian Lavoshkin Association (LA), the Russian Space Research Institute (IKI) and the Spanish National Institute for Aerospace Technology (INTA).

Figure 1: MetNet Logo.

The purpose of MMPM is to confirm the concept of deployment for the mini-meteorological stations onto the Martian surface, to get atmospheric data during the descent phase, and to get information about the meteorology and surface structure at the landing site from the meteorological station during one Martian year or longer. Inside a total payload mass of 4 kg the Magnetometer MOURA, Solar Irradiation Sensor MetSIS, Dust Sensor DS, Panoramic Camera PANCAM, Scientific Accelerometer, 3 Temperature Sensors, Pressure Sensor MetBaro and the Humidity Sensor MetHumi will characterize the near environment of the landing site close to the equator and the variation of atmospheric parameters like temperature, pressure, humidity, dust content and opacity in different wavelength bands. For more details see the project home page [1].

2. Scientific Goals

With the help of the meteorological lander network the following scientific questions will be addressed:

- Atmospheric dynamics and circulation
- Surface to Atmosphere interactions and Planetary
- Boundary Layer
- Dust raising mechanisms
- Cycles of CO_2, H_2O and dust
- Evolution of the Martian climate

The understanding of these topics is important for the preparation of any future manned mission to Mars where reliable weather forecasts for the envisioned landing sites will be needed. The gained knowledge will also be important to understand the more complex Earth climate development.

3. Operations Concept

As there will be no or only limited commanding possibilities during the mission, the operations concept is based on an autonomous selection of different measurement scenarios, optimized for the local day – night cycle, telemetry and energy availability or special pre-programmed events.

3.1 Cyclogram control

As long as data storage and battery charge allow the instruments will be commanded according to a predefined command sequence stored as so called cyclogram, which is defined before launch or updated during the transfer phase. The operating system of the Lander will select one of several cyclograms depending on selection criteria which can be automatically adjusted during the mission. Implemented selection criteria are

- the absolute time as set before separation from the orbiter. This is used for Phobos eclipse measurements, when the shadow of the Martian moon moves across the landing site.
- Day/night calibration: using the MetSIS instrument around sunrise and sunset, the exact day/night cycle can be established and adjusted.
- Day/night status: optical measurements with the camera or MetSIS are not useful during the night and will be skipped.
- Low battery status not allowing instrument operation with high energy demand like the PANCAM.

Additionally the cyclogram interpreter contains the possibility to skip a command in case certain conditions are not met. This allows to utilize the same cyclogram structure even if an instrument should not be operated at the moment. This is the case if from the time of day and accelerometer-based impact angle measurement it can be deducted that the Dust Sensor is directly illuminated by the Sun, making infraread measurements impossible, or if previous operations indicated a severe failure.

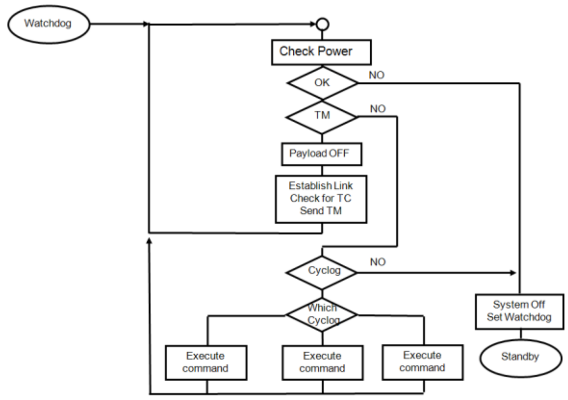

Figure 2: Operations schematics.

3.2 Limiting Factors

In order to maximize the success possibilities for the landing of the semi-hard Lander, the precursor mission is aiming only at low altitude landing sites with high enough atmospheric pressure to support the airobreaking unit. The envisaged equatorial descent insertion limits the possible latitude range to close to the equator. As the main goal for the precursor mission is the demonstration of the landing concept, some of the payload mass allocation was used to implement two additional beacons monitoring the separation and descent phase. Therefore the first mission does not include wind sensors or a LIDAR planned for the follow-up missions.

As the unit is battery powered with flexible solar panels for re-charging, only a limited amount of energy is available for operating the instruments. Opposed to the RadioThermalGenerator (RTG)-powered American Viking Landers night operations of the pressure sensors will therefore be drastically limited. For future missions especially to higher altitudes and latitudes other options are under investigation.

Acknowledgements

The contributions to the mission and the development of the concept by all MetNet team members in Finland, Russia and Spain is gratefully acknowledged.

References

[1] Home page of the MetNet mission: http://metnet.fmi.fi