ATMIS EXPERIMENT - OVERVIEW AND CURRENT INSTRUMENT DESIGN STATUS.

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1 Introduction

The international Netlander Mission encompasses four Netlander vehicles (slated for launch in 2007), which are planned to form a geophysical measurement network on the surface of Mars. Atmospheric science is among the scientific disciplines benefiting most of the network concept, and is one of the prime objectives of the mission. A key instrument onboard the Netlanders is ATMIS (the Atmospheric and Meteorological Instrumentation System), a versatile suite of atmospheric instrumentation.

Time resolved in situ meteorological measurements acquired by the Viking and Mars Pathfinder landers, and remote sensing observations by the Mariner 9, Viking, Mars Global Surveyor Orbiter and the Mars Odyssey 2001 mission have provided the basis for our current understanding of the behaviour of the weather and climate of the Martian atmosphere. However, detailed characterisation of the Martian circulation patterns, boundary layer phenomena, and climatological cycles requires simultaneous in situ meteorological measurement posts on various locations on the Martian surface.

The goal of the ATMIS instrument is to provide new observations on the atmospheric vertical structure, regional and global circulation phenomena, the Martian Planetary Boundary Layer (PBL) and atmosphere-surface interactions, dust storm triggering mechanisms, as well as the climatological cycles of H_2O, dust and CO_2. To reach the goal of characterization of a number of phenomena exhibiting both spatial and temporal variations, simultaneous observations of multiple variables at spatially displaced sites —forming a network — are made use of. The in situ observations made by the ATMIS sensors will be supported by extensive modeling efforts.

The main responsibility of providing the ATMIS experiment for all the four Netlander vehicles rests with the Finnish Meteorological Institute, with instrument subsystems provided by Oxford University (UK), Risoe National Laboratory (Denmark), Service d'Aeronomie (France) and the Jet Propulsion Laboratory (USA). The list of affiliations of ATMIS co-investigators comprises altogether 14 science organizations. The ATMIS sensor system benefits from the heritage of instruments already built for missions as Mars-96, Huygens, Pathfinder, and the Mars Polar Lander.

2 Objectives

The key components of the Martian global circulation identified to date are ([5]): a Hadley cell, baroclinic eddies in the winter hemisphere (Northern identified todate), stationary eddies induced by topographical and other surface variations, condensation - sublimation flow between the CO2 polar caps,

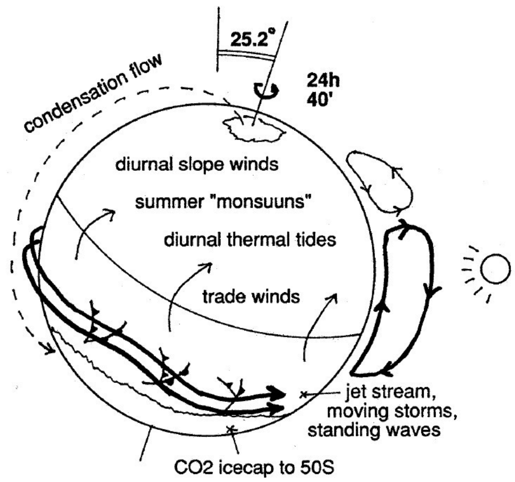

Figure 1: Schematic representation of the main Martian atmospheric flow systems during northern hemisphere midsummer [4].

thermal tides, and normal mode oscillations (Figure 1). The main ATMIS-measured variable is pressure, supplemented by temperature, wind, relative humidity (RH) and optical thickness (τ) observations (Figure 2). In the landing site selection the number of landers (four) forces a choice between either a more regional/sub-global focus or a wide site dispersion and hence poor observational correlations between the landers. As a result the four-lander network's global circulation investigations are limited to some — but not all — of the circulation components above. Longitudinal site coverage can account for the effect of large topography features and to resolve atmospheric waves extending over many longitudes. A robust characterisation of the full global circulation requires a spatially more comprehensive surface network, such as a concept proposed in [6]. It is anticipated that these measurements aresupplemented by global/synoptic scale orbital measurements.

Based on the in situ surface observations, estimates have been made of planetary boundary layer parameters such as stability, fluxes and the growth of the mixed layer up to the first inversion, ([7]). Resolution of PBL height and similar questions as well as the improvement of the descriptive models require observations at different latitudes, and sites with differing roughness and albedo.

The atmospheric vertical structure is a function of local time, latitude, season, and dust loading. Currently only three vertical in situ profiles of density, pressure, wind, and temperature have been obtained, two daytime profiles from the Viking Landers and one nighttime profile from the Pathfinder

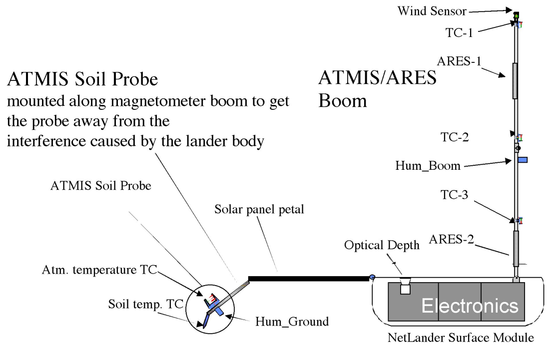

Figure 2: A conceptual illustration of the ATMIS sensor subsystems [8].

([1], [2], [3]). The NetLander will measure deceleration profiles during the entry into the Martian atmosphere thereby also contributing to this data base.

3 Instrument

ATMIS is divided into four components. The main electronics are located in the lander electronics bay and called ATMIS Electronics Module. Most of the ATMIS sensors are deployed onto the ATMIS/ARES boom (wind, atmospheric temperature and humidity). There is also a small Soil Probe which will be deployed onto the Martian ground by Magnetometer boom. Optical sensor head looks upward from top of the surface module. The locations of ATMIS sensors are presented in the figure 2, and the approximated heights from the surface in Table 1.

The ATMIS electronics module (is located inside the Netlander Surface Module's electronics Compartment (SEC) . This module includes the measurement control and interface electronics, the pressure sensors, the control, readout and the sample handling electronics for all ATMIS sensors, the DC-DC converters, power switches, and the interface electronics that connect the ATMIS experiment to the NetLander Command and Data management System (CDMS).

Table 1: Approximate ATMIS sensor locations measured from the surface. Accuracy is of the order of 0.1 m.

Dimension	Value (m)
Lander top	0.25
Height of the wind sensing element	0.05
Bottom of the wind sensing element	1.40
Thermocouple 3	1.25
Thermocouple 2	1.00
Thermocouple 1	0.50
Humidity sensor	0.65

The modules can be calibrated separately. This is important because the modules will be provided by several laboratories.

4 Operations

During the cruise and coast phase ATMIS sensors are sampled once every few weeks in health mode to monitor the instrument health and calibration stability. Zero-point measurements are performed for calibration of the pressure sensors. The last calibration must be performed less than one month before entering Martian atmosphere, as close to the separation as possible.

During the surface phase the measurements are controlled by daily cyclograms. Ground commands determine which cyclograms to use. The basic background cyclogram (cyclogram 1) is run if no other information is available.

The main operational objective of ATMIS is to provide a regular time series of the meteorological parameters. The requirement to achieve this is to sample all ATMIS sensor at least once every 15 minutes (nominal) during the NetLander surface operation phase. Of highest importance is that regular sampling of all ATMIS sensors continues from day to day.

The ATMIS will sample sensors more frequently (nominal: continuous measurement campaigns) during meteorologically interesting time periods of Martian day. These periods are dawn and dusk (since atmospheric parameters are changing rapidly) and early afternoon (since the convection is strongest).

Continuous measurements shall also be conducted during special meteorological events, like dust storms or front passages. Detection of these events will be aided by remote observations of the orbiters and by combined efforts of the other NetLander experiments.

Determination of the turbulence structure of Martian surface layer, and its seasonal behavior, is pursued by sampling all sensors continuously in so-called a slice mode. The aim is to cover the full Martian sol with high time-resolution measurements. Because of the power constraints this, of course, can not be done during a single sol. Instead a slice -measurement window will be shifted forward during consecutive sols to gradually cover a full sol.

For ATMIS housekeeping purposes, twice each sol (night and day) rapidly sampled raw data will be gathered for 5 minutes (nominal) periods. This data will be used to identify, characterize, and calibrate variations in instrument performance, that may vary with age, dust loading.

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