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Mars Exploration – missions current and future (3A)

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MARS ATMOSPHERE SOUNDING BALLOON: SCIENCE CASE AND SYSTEM DESIGN

Abstract

Measurements of the state and the variability of the Martian atmosphere significantly contribute to the scientific goal to understand the atmospheric processes on Mars and the engineering goal to prepare for and to de-risk entry, descent and landing operations for future large landing crafts. Balloon-borne instruments could bridge the gap in both temporal and spatial resolution in mesoscale distances between local, stationary landers and global orbiter observations in a similar way as balloon-radiosondes still used today on Earth. The idea to use balloon systems on Mars is not new in essence and has already been proposed in past decades. While those concepts considered an aerial deployment during entry and descent, the concept outlined here revisits a launch off the payload deck of a lander from the Martian surface. This deployment option profits today mainly from the technological advances in micro-electronics and sensor miniaturization which enable designing a balloon-probe significantly smaller than earlier proposed systems. This balloon-probe responds to the afore mentioned high level investigations with the following sensor suite: Measurements of upwelling radiation are performed in the 7 to 16 m wavelength range to determine soil surface temperature, the temperature of the air column underneath the gondola and the aerosol (dust) content. Onboard humidity and temperature sensors measure the relative humidity at the balloon's altitude. The vertical wind component and turbulence spectra are measured by air data around the gondola with a constant temperature anemometer. Large scale horizontal wind components are deduced from the balloon trajectory obtained from radio tracking. The entire instrument consisting of the balloon flight-system, its sensors and electronics, its storage container and inflation system, has a total mass of about 15 kg and is designed to be accommodated as a scientific payload (among others) on the payload deck of a landing vehicle. The primary components of the proposed balloon instrument have been subject to testing to mature the concept's critical functions. Particularly, the hull inflation was tested with a subscale model in a low speed wind tunnel to determine the hull's aerodynamic properties in ground proximity and inflation characteristics under wind load. The basic avionic and sensor package has been flown as a radiosonde payload. This talk presents the development status for this instrument and gives further details on the scientific and operational concept, its technical components and is complemented by the assessment of the risks involved in automatically launching such balloon-system off the Martian surface.