SPACE EXPLORATION SYMPOSIUM (A3)
Mars Exploration – missions current and future (3A)

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ARMONIA: FEASIBILITY STUDY ON AEROBOTS IN MARTIAN ATMOSPHERE TO ENHANCE SCIENCE RETURN

Abstract

In the framework of a prolonged Mars exploration, a mission to Mars supported by aerial vehicles has been investigated. The study exploits aerial platforms to collect high resolution ground and atmosphere data flying on extended Mars regions for prolonged period. The polar and tropical regions are to be visited: the former to collect data on the sublimation of polar caps during spring and detect source of methane, the latter to deepen the knowledge about the genesis of local dust storms, the formation of dust devils, enhance knowledge on Hellas Planitia and Valles Marineris. The Armonia Mission architecture includes 1 orbiter, 2 ground sensors stations delivered in the tropical regions, and 3 balloons, to fly over the pole and monitor the icy caps seasonal dynamics, and over the tropics investigating storms formations and winds evolution. The paper presents the whole mission design and subsystem sizing, with particular attention to the balloons technology: the Mars Climate Database has been exploited to model the seasonal evolution of the atmospheric temperature, density, wind velocities, fundamental properties to tune the balloons design. The adopted super-pressure balloons design is presented in detail, highlighting the strong interdependences among material selection, environment, path planning and GNC, operations, for those aerial vehicles. The balloons (28m and 35m and in diameter respectively for polar and tropical areas) are filled with helium and can fly a gondola of 42kg, connected to the balloon thanks to a 500m tether. Balloons materials have been selected according to strength and stiffness requirements, together with porosity barrier, to let the super-pressure mechanism working properly, and Martian atmosphere harsh properties. A three layers solution is adopted for both the tropical and the polar balloons, made of a 3,5 Mylar film with 70yarns/m of 75 denier Spectra fibers and a 6,5 LDPE film. Such a design allows flying for a 3 months period with a maximum volume loss of 0,15Requirements compliance of the design will be discussed too: polar balloon, released in mid-spring at the North Pole, spans 25,32 in latitude, 360* in longitude in 90 days, with minimum height of 6357m; tropical balloons, released in mid-fall at Hellas Planitia and over Valles Marineris at summer solstice respectively, span 33,17 in latitude, 360 in longitude with minimum height of 567m over 3 months and 40,65 in latitude and 360 in longitude over 3 months, 3517m being the lowest altitude above the surface respectively