IAF SPACE EXPLORATION SYMPOSIUM (A3)
Interactive Presentations - IAF SPACE EXPLORATION SYMPOSIUM (IP)

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MONARCH: DESIGNING MARS' FIRST METEOROLOGICAL OBSERVATION NETWORK FOR FUTURE HUMAN EXPLORATION

Abstract

In recent history, missions directed towards Mars have gained an always increasing importance among the interplanetary context: planned missions for the near future aspire to achieve plenty of groundbreaking milestones and promising technological advancements. While non-manned missions are the focus at present time, human presence on the red planet is the ultimate long-term goal; to be ready for this objective, a detailed climate predictive model, based on meteorologically focused missions, is of paramount importance.

The MONARCH (*Mars Observing Network for Atmospheric Research and CHaracterization*) study explores the feasibility of a 5-years long Mars exploration network mission, aimed at describing atmospheric aspects, landing site characteristics, safety-related environmental aspects, and climatological risks, to build an effective and reliable weather and climate forecasting model, following MEPAG (*Mars Explo-*

ration Program Analysis Group) guidelines for Martian climate. The study begins with an environmental study, along with a literature review of current and past Mars-related projects; interplanetary environment and planetary characteristics are assessed, to evaluate their impact on the mission plan and architecture, but also on the future human presence.

Successively, starting from a given a set of payloads for meteorological and climate planetary observation, this study explores the rating of possible landing sites for the surface segment of the network, with a final selection based on science return and human-favorability; for the orbital segment, instead, a nominal orbit is fully established and described, as final target of the mission analysis, with the perturbations expected and the corrective maneuvers planned along the lifetime of the vehicle. Operations, requirements, and phases of the mission are presented, along with an exhaustive trade-off between possible vehicles network architectures. A final framework is then selected and evaluated in depth: each vehicle is sized in all its subsystems, with an insight into the motivations and margins adopted, and a final risk analysis and general planning of the mission. The feasibility of the MONARCH mission is confirmed, with a well margined architecture and intrinsic versatility. The science return is fixed as a driver of the mission, and by following the proposed outline of the mission, it's entirely possible to build satisfying meteorological observing network, for the Martian weather study and forecast.