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DEVELOPMENT OF AN OPEN SOURCE MODELLING PACKAGE FOR THERMAL BALANCE OF CREWED MARS HABITATS

Abstract

Thermal control of crewed spacecraft and long-duration surface habitats is an essential function for maintaining habitability and crew function, and demands attention at all stages of the development process for mission architectures. The thermal environment on the surface of Mars is particularly challenging, as it includes both a substantial element of convective losses and extreme temperature ranges. This environment makes high-level assessments of thermal balance difficult, and requires intensive numerical analysis to comprehensively analyse.

This work presents a new open-source software tool intermediate between these roles, utilising semi-empirical formulae to quickly determine thermal balance for many configurations of habitat-scale structure. Modelled heat flows include insolation, radiative heat loss to atmosphere and terrain, convection with atmosphere and conduction to regolith. The software provides a wide range of options for both the architecture of the analysed habitat and external environmental conditions. Output data from this tool are validated against numerical analysis for a range of existing and speculative designs for Mars habitats, with results in both methods agreeing closely. This is a powerful tool for preliminary system-level analyses of thermal balance of Mars habitats, allowing a broader study of different architectures and substantially faster design iteration.