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Convective Heat Transfer at the Martian Boundary Layer, Measurement and Model

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We present a measuring concept to measure the convective heat transfer coefficient h near a spacecraft operating on the surface of Mars. This coefficient can be used to derive the speed of the wind and direction, and to detect its modulations. This measuring concept will be used in the instrument HABILIT (HabitAbility: Brines, Irradiance and Temperature) for the Surface Platform of ExoMars 2018 (ESA-Roscosmos). The method is based on the use of 3 Resistance Temperature Thermodetectors (RTD) that measure the temperature at 3 locations along the axial direction of a rod of length L : at the base of the rod, T_b , an intermediate point $x = L/n$, T_{Ln} , and the tip, T_a . This sensing fin is called the Air Temperature Sensor (ATS). HABILIT shall incorporate three ATS, oriented in perpendicular directions and thus exposed to wind in a different way. Solving these equations for each ATS, provides three fluid temperatures T_f as well as three m parameters that are used to derive three heat transfer coefficients h . This magnitude is dependent on the local forced convection and therefore is sensitive to the direction, speed and modulations of the wind. The m -parameter has already proven to be useful to investigate the convective activity at the planetary boundary layer on Mars and to determine the height of the planetary boundary layer. This method shall be presented here by: 1) Introducing the mathematical concepts for the retrieval of the m -parameter; 2) performing ANSYS simulations of the fluid dynamics and the thermal environment around the ATS-rods under wind conditions in Mars; and 3) comparing the method by using data measurements from the Rover Environmental Monitoring Station (REMS) at the Curiosity rover of NASA's Mars Science Laboratory project currently operating on Mars. The results shall be compared with the wind sensor measurements of three years of REMS operation on Mars.