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The Heat Flow and Physical Properties Package HP^3 on InSight - First Results

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On Nov 26th, 2018, the NASA InSight mission landed on Mars at Homestead Hollow, Elysium Planum as the first geophysical observatory on another terrestrial planet. The payload includes the Heat Flow and Physical Properties Package HP^3 whose primary goal is to measure Mars' geothermal heat flow.

HP^3 consists of a mechanical hammering device called the "Mole" for penetrating into the regolith, an instrumented tether which the Mole pulls into the ground, an infrared radiometer (RAD) mounted below the lander deck to determine the surface brightness temperature, and an electronics box. The tether is equipped with 14 platinum resistance temperature sensors to measure temperature differences with a 1-σ uncertainty of 6.5 mK. Depth is determined by a tether length measurement device that monitors the amount of tether extracted from the support structure and a tiltmeter that measures the angle of the Mole axis to the local gravity vector. The Mole includes temperature sensors and heaters to measure the regolith thermal conductivity to better than 3.5% (1-σ).

The surface heat flow is calculated by multiplying the geothermal gradient and the thermal conductivity of the regolith. It is expected to vary across the surface of Mars, but modeling suggests that at Elysium Planitia, the surface heat flow is close to the average value.

The Mole is planned to penetrate to a depth of at least 3 m but at most to 5 m. The requirement of a minimum depth of 3 m will help to significantly reduce errors introduced by the annual surface temperature variation.

The properties of the landing site are favorable for HP^3 as significant slopes are absent from the deployment area as well as rocks (on the surface) of sizes that could hamper both deployment and Mole advancement to depth. All the mission requirements for safe HP^3 placement have been satisfied.

By the time of writing, HP^3 is still on the deck of the lander waiting for deployment. RAD successfully deployed its dust cover and performed inflight calibrations. The initial assessment shows that the expected noise equivalent temperature difference of less than 1 K is achieved. The primary sensor observing in 1.5 m distance from the lander center shows only small deviations from the ground calibration. RAD found the diurnal temperature near the lander varying between 180 K and 286K, using ground calibration coefficients. By the time of the EGU conference it is expected that the measurements of the brightness temperature have been complemented by observation of shadows of the lander passing through the field of view of the instrument.

Assuming deployment by the end of January and Mole advancement as planned taking 44 sols, the instrument should be fully emplaced by the time of the EGU conference and should have started to monitor the temperature depth profile. We expect to have measured the variation of the thermal conductivity with depth up to 5 m at the time and have the first data on the temperature gradient below the thermal skin depth of the annual surface temperature variation.