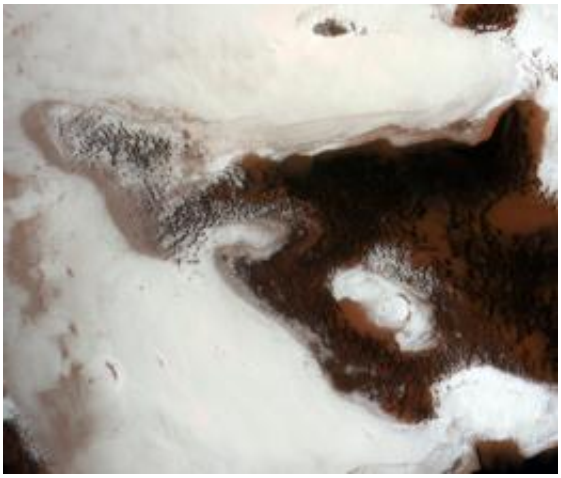
MARSIS completes measurement campaign over Martian North Pole

December 20 2011, By Olivier Witasse



This false-color nadir image, taken by HRSC onboard Mars Express on 15 December 2004, shows a relatively thin cover of what is likely to be water snow over smooth plains. A small impact crater is visible in the center-right of the image. Snow over dark areas has probably been blown away by strong winds, as the numerous dune layered deposits seem to indicate. The image is centred at 78.34 degrees North and 117.35 East and the ground resolution is 40 meters per pixel. Credit: ESA/ DLR/ FU Berlin (G. Neukum)

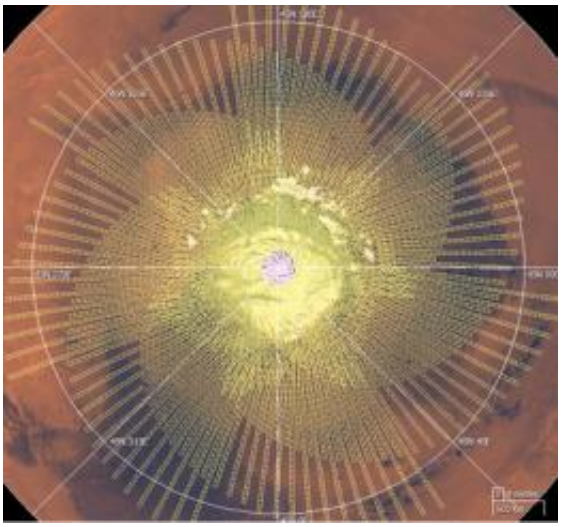
(PhysOrg.com) -- The Mars Advanced Radar for Subsurface and Ionosphere Sounding (MARSIS) instrument on board Mars Express has recently completed a subsurface sounding campaign over the planet's North Pole. The campaign was interrupted by the suspension of science observations several times between August and October due to safe

modes and to anomalies in the operation of the spacecraft's Solid-State Mass Memory (SSMM) system. As MARSIS best observes in the dark, which for the North Pole only occurs every few years, it was among the first instruments to resume observations once a partial work-around for the problems had been implemented.

The primary objective of MARSIS is to map the distribution of water and ice in the upper layers of the Martian subsurface. Using techniques similar to oil prospecting on Earth, the instrument analyses the reflection of radio waves down to a few kilometres in the subsurface; it is able to distinguish between dry, frozen and wet soil.

The polar regions of Mars are of particular interest because climate variations affect the quantities of water ice and dust found in the polar deposits.

The North Pole measurement campaign lasted from June to November 2011, taking place during orbits 9500 to 10 100. The observations extended from the pole out to just beyond 45° N. Data acquisition was affected by solar events, as well as the technical problems with the spacecraft. During the main part of the campaign, around 40 per cent of the available orbits were lost, with roughly a quarter of the losses being attributable to solar activity and three quarters to the suspension of observations.



Location of the measurements made by Mars Advanced Radar for Subsurface and Ionosphere Sounding (MARSIS) over the planet's North Pole during the recently completed campaign. Credit: ESA

The velocity of Mars Express at pericentre is extremely high and the fly-overs of the north polar cap lasted only between three and seven minutes per orbit. The accumulated observing time over ~ 600 orbits was about 3000 minutes. Mars Express therefore spent a total of about two days over the north polar cap in the whole observing season. About 25 hours were spent acquiring data while the pole was in darkness, and another 25 hours observing the pole while it was in sunlight. MARSIS can observe the subsurface with maximum sensitivity only when the pole is not illuminated, so the best observations were made between June and September. The pole was still observable until late November, but by then it was partially illuminated, so the measurements were of lower quality.

The presence of an ionosphere also impacts the MARSIS measurements with MARSIS signals being disturbed or even completely attenuated when free electrons are present in the Martian atmosphere. There is

always an ionosphere on the dayside of the planet, created by solar ultraviolet photons and energetic particles interacting with the thin atmosphere. It is, therefore, greatly preferably to observe on the nightside, where, in principle, there is no ionosphere. In practice, during periods of high solar activity an active ionosphere can be present on the nightside as well.

The careful scheduling of MARSIS measurement campaigns for polar observations is crucial to their success. Mars Express has an elliptical polar orbit, so it passes over the polar caps during every orbit; however, the altitude of the spacecraft over the poles varies as the orbit pericentre drifts with time. In the period from June to November, the spacecraft flew over the North Pole at very low altitudes – less than 1000 kilometres. Having the spacecraft in a low orbit over the target area is a requirement for operating the radar; no signal would be received at higher altitudes.

"This campaign to investigate the subsurface of Mars's North Pole is one of the highlights of the extended Mars Express mission," notes Olivier Witasse, Mars Express Project Scientist at ESA. "Despite the temporary suspension of operations during the campaign we have been able, with the excellent support of our colleagues in spacecraft operations, to complete this campaign as expected. The data that were acquired are now being analysed by the MARSIS team and we are eagerly anticipating the results."

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