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Mars Express and Trace Gas Orbiter – status, science highlights, plans

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Mars Express

With almost two decades of Mars observation behind it, Mars Express remains a dependable and highly productive mission.

Recent science highlights include (1) continued mapping of subsurface reflectors beneath the south polar layered ice deposits, and associated work to explain the cause of these reflections; (2) a global map of minerals on Mars with 200 m/px resolution, obtained from analysis of infrared spectra; (3) release of 50 m resolution Digital Elevation Models based on HRSC stereo topography for quadrangles covering an ever-increasing proportion of the global surface; (4) detailed characterization of the landing sites of the ESA, NASA and Chinese rovers; (5) a global climatology of ozone and water from both nadir and occultation observations and its relation to atmospheric dust; (6) transient atmospheric phenomena, such as a recurrent orographic cloud feature at Arsia Mons; (7) detailed investigation of the ionospheric structure, its variability, and coupling to the lower atmosphere; (8) continued monitoring of both the upstream solar wind conditions and of downstream escaping ions; (9) detailed study of Phobos during flybys at altitudes as low as 50 km.

Spacecraft and instrument teams continue to implement new and improved observation modes. One example is new MARSIS instrument software which now allows raw data to be returned from much longer subsurface sounding passes, improving the search for basal reflectors beneath polar ice caps; another example is mutual radio occultation observations between Mars Express and ExoMars Trace

Gas Orbiter, potentially providing vertical profiles of ionospheric electron content with good spatial and temporal coverage.

ExoMars Trace Gas Orbiter

TGO has now completed two full Martian years of observations.

Highlights include (1) continuing non-detection of methane, with upper limits as low as 20 ppt by volume. Reconciling this continued non-detection by TGO with the background levels of several hundred ppt in Gale crater by MSL remains an enigma, stimulating further research. (2) detection of HCl, the first reported halogen-containing species in the atmosphere of Mars. (3) further detail of the transport of water to high altitudes, a critical step in the escape of water from Mars. (4) mapping of atomic hydrogen in the top 1-2 m of regolith, indicative of water ice and hydrated minerals, suggesting surprisingly high abundances of subsurface water ice in low latitude regions including one in central Valles Marineris; and (5) continued acquisition of 5 m colour imagery and digital elevation models over a wide range of terrain and target types, including landing site characterization.

Future plans: Mission extension cases for both missions have been submitted for the years 2023-2025 and 2026-2028. The extension of the observations would allow several new and optimized observation types; in particular, it will allow many collaborative observation opportunities with other missions and with ground- and space-based observatories. Of particular note are joint observations with James Webb Space Telescope, for which dedicated observations of Mars are due to be conducted in 2022-2023. Science goals include mapping of the water D/H ratio, search for trace gases including methane, and mapping of thermospheric structure using 4.3 μm CO2 emission; the full-disk views provided by JWST are highly complementary to the vertical profiling and long temporal coverage provided by MEx and TGO.