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Mars Express science highlights and future plans

Dmitrij Titov (1), Jean-Pierre Bibring (2), Alejandro Cardesin (3), Thomas Duxbury (4), Francois Forget (5), Marco Giuranna (6), Francisco Gonza´lez-Galindo (7), Mats Holmström (8), Ralf Jaumann (9), Anni Määttänen (10), Patrick Martin (3), Franck Montmessin (10), Roberto Orosei (11), Martin Pätzold (12), Jeffrey Plaut (13), and Mexsgs Team (3)

(1) ESA / ESTEC, SSO, Noordwijk ZH, Netherlands (dmitri.titov@esa.int), (2) IAS-CNRS, Orsay, France, (3) ESA / ESAC, Madrid, Spain, (4) George Mason University, Fairfax, VA, USA, (5) LMD, Paris, France, (6) IAPS-INAF, Rome, Italy, (7) IAA, Granada, Spain, (8) IRF, Kiruna, Sweden, (9) IPF-DLR, Berlin, Germany, (10) LATMOS/ IPSL, CNRS, Guyancourt, France, (11) IRA-INAF, Bologna, Italy, (12) RIU-Uni Cologne, Cologne, Germany, (13) JPL, Pasadena, CA, USA

After 15 years in orbit Mars Express remains one of ESA's most scientifically productive Solar System missions whose publication record now exceeds 1200 papers. Characterization of the geological processes on a local-to-regional scale by HRSC, OMEGA and partner experiments on NASA spacecraft has allowed constraining land-forming processes in space and time. Recent results suggest episodic geological activity as well as the presence of large bodies of liquid water in several provinces (e.g. Eridania Planum, Terra Chimeria) in the early and middle Amazonian epoch and formation of vast sedimentary plains north of the Hellas basin. Mars Express observations and experimental teams provided essential contribution to the selection of the Mars-2020 landing sites. Recent discovery of subglacial liquid water underneath the Southern polar cap has proven that the mission science potential is still not exhausted.

More than a decade-long record of the atmospheric parameters such as temperature, dust loading, water vapor and ozone abundance, water ice and CO_2 clouds distribution, collected by SPICAM, PFS, OMEGA, HRSC and VMC together with subsequent modeling have provided key contributions to our understanding of the martian climate. Recent spectroscopic monitoring of the 2018 dust storm revealed dust properties, their spatial and temporal variations and atmospheric circulation.

More than 10,000 crossings of the bow shock by Mars Express allowed ASPERA-3 to characterize complex behavior of the magnetic boundary topology as function of the solar EUV flux. Observations of the ion escape during complete solar cycle revealed important dependencies of the atmospheric erosion rate on parameters of the solar wind and EUV flux and established global energy balance between the solar wind and escaping ion flow. The observations showed that ion escape can be responsible for removal of about 10 mbar over the Mars history that implies existence of other more effective escape channels.

The structure of the ionosphere sounded by the MARSIS radar and the MaRS radio science experiment was found to be significantly affected by the solar activity, the crustal magnetic field, as well as by the influx of meteorite and cometary dust. MARSIS and ASPERA-3 observations suggest that the sunlit ionosphere over the regions with strong crustal fields is denser and extends to higher altitudes as compared to the regions with no crustal anomalies. Several models of the upper atmosphere and plasma environment are being developed based on and in support of the collected experimental data. The models aim at creating user-friendly data base of plasma parameters similar to the Mars Climate Database that would be of great service to the planetary community.

A significant recent achievement was the flawless transition to the "gyroless" attitude control and operations mode on the spacecraft, that would allow mitigating the onboard gyros aging and extending the mission lifetime. In November 2018 ESA's Science Programme Committee (SPC) confirmed the mission operations till the end of 2020 and notionally approved its extension till the end of 2022. The talk will give the Mars Express status, review the recent science highlights, and outline future plans focusing on synergistic science with TGO.