MARS EXPRESS SCIENCE HIGHLIGHTS AND FUTURE PLANS. D.V. Titov[1], J.-P. Bibring[2], A. Cardesin[3], T. Duxbury[4], F. Forget[5], M. Giuranna[6], F. González-Galindo[7], M. Holmström[8], R. Jaumann[9], A. Määttänen[10], P. Martin[3], F. Montmessin[10], R. Orosei[11], M. Pätzold[12], J. Plaut[13], and MEX SGS Team[3], [1]ESA-ESTEC, 2200 AG Noordwijk, The 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 and supporting characterization of potential landing sites for the Chinese HX-1 mission. Recent discovery by the subsurface radar MARSIS of subglacial liquid water underneath the Southern polar layered deposits has proven that the mission science potential is still not exhausted. The radar will continue searching for subsurface water pockets using its high resolution mode.

More than a decade-long record of the atmospheric parameters such as temperature, dust loading, water vapor and ozone abundance, water ice and CO2 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. Spectroscopic monitoring of the global dust storm in 2018 revealed dust properties, their spatial and temporal variations and atmospheric circulation.

Recently PFS has reported a firm detection of 15.5 ± 2.5 parts per billion by volume of methane in the Martian atmosphere above Gale crater on 16 June 2013, just one day after the in-situ observation of a methane spike by the Curiosity Rover. Numerical simulations of the Martian atmosphere, using stochastic gas release scenarios, identified a potential source region east of Gale crater. Most importantly, independent geological analysis also pointed to the same region, where faults of Aeolis Mensae may extend into proposed shallow ice of the Medusae Fossae Formation and episodically release gas trapped below or within the ice.

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 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. This led to important conclusion that the ion escape at Mars is production rather than energy limited. The analysis showed that ion escape can be responsible for removal of about 10 mbar over 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. The mission operations are now confirmed till the end of 2020 and the mission is notionally extended 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.