Mars Express highlights on Mars habitability

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Science themes

Comprehensive study of the surface, atmosphere and plasma environment of Mars in space and time, and Phobos

Geology, interior & history

Meteorology & climate

Aeronomy & evolution

Phobos
Footprints of early warm and wet climate on Mars

Flight over Mawrth Vallis
Distribution and chronology of the outflow channels and valley networks

Chryse Planitia

Tharsis

Elysium Planitia

Hellas Basin
Distribution and chronology of hydrated minerals

Carter et al., 2013
Mars evolution paradigm

Volcanism

Time before present (Gyr)

4 3 2 1 0

Valley networks

Outflow channels

Layered sulphates
Layered clays
Anhydrous ferric oxides

Noachian
Hesperian
Amazonian

Deep alteration

ESLAB #51, 4
8 December, 2017
Mars climate today (1)

- **Water Vapor** (column-integrated in pr-µm)
- **Ozone** (column-integrated in µm-atm)
- **O$_2$ \(\^\Lambda_g\) (brightness in MR)
- **Dust** (UV opacity)

Latitude vs. Solar Longitude Ls for MY 27, MY 28, MY 30, and MY 31.
Mars climate today (2)
Methane on Mars

- Methane mixing ratio 0-45 ppb
- Non-homogeneous distribution suggesting sources and sinks
- Increase of methane column density occurs in the winter hemisphere
- Observations of methane in Gale crater (Curiosity)
Mars climate modelling

<table>
<thead>
<tr>
<th>Dataset</th>
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<tbody>
<tr>
<td>Temperature &amp; Pressure</td>
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<td>Aerosols &amp; Clouds</td>
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<tr>
<td>Water vapour</td>
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<tr>
<td>Chemical species &amp; ions</td>
<td>16</td>
</tr>
<tr>
<td>Surface frost</td>
<td>3</td>
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</tbody>
</table>

LMD Global Climate Model

MEX Legacy Archive
Interaction with the solar wind and atmospheric escape

- Ion escape at Mars is production limited
- Losses ~100 g/s → ~1By to remove the atmosphere
- Heavy Venus vs light Mars?
Does magnetosphere shield a planet?

- **Venus**
  - **McComas et al., 1986, Max**
  - **Brace et al., 1982, Max**

- **Mars**
  - **Fedorov et al., 2010, Min**
  - **Vaisberg et al., 1974, Min**
  - **Fedorov, et al, 2009, Min, E > 10 eV**
  - **Barabash et al., 2004, Min, E > 30 eV**

- **Earth**
  - **Lundin et al., 1989, Max**
  - **Verigin et al., 1989, Max**
  - **Nilsson et al., 2010, Min**
Characterisation of landing sites
Extension science case 2019-2020

2. Meteorology and climate

- Filling gaps in the meteorological parameters coverage (late night – early morning)
- Impact of dust on the atmospheric state
- Transient phenomena on the surface and in the atmosphere (cyclones, waves, “plumes”)
- Couplings between the lower and middle atmosphere (in collaboration with ExoMars-2016)
Extension science case 2019-2020

3. Aeronomy, plasma environment and escape

- Augmenting the ionospheric coverage in latitude, longitude, season and local time
- Continue monitoring the plasma environment
- Aeronomy, ionosphere and escape in the solar minimum #24 compared to the cycle #23
- Coupling between the lower/middle and upper atmosphere (in collaboration with MAVEN)
Thank you!
ESLAB #52
Comparative aeronomy of terrestrial planets

ESTEC, May 14-18, 2018
Key strengths of Mars Express

- Multidisciplinary mission covering all layers:
  - subsurface → surface → atmosphere → ionosphere → plasma environment

- Non-sun-synchronous elliptical orbit
  - All local times
  - Phobos encounters

- Payload capabilities
  - Global Digital Elevation Model with 50 m/px resolution
  - Sounding the structure of the entire ionosphere with two frequencies
  - Simultaneous monitoring of H$_2$O and CO abundance in the lower atmosphere

- Longest continuous record of climate and plasma parameters

- Together with Venus Express - significant contribution to comparative climatology of terrestrial planets