The ionosphere of Mars and its importance for climate evolution

A community white paper for the 2009 Planetary Decadal Survey

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My objectives

- MAVEN is worthwhile
- Extension of MAVEN beyond nominal one Earth year duration will be extremely valuable
- The science of the ionosphere of Mars will not end with MAVEN
- Present some ideas for future ionospheric instruments and missions (with realism)

Structure of white paper

- Introduction
  - Ionospheres in general and the martian ionosphere in particular are great
- What MAVEN will do
  - Excellent neutral/plasma composition
  - First in-depth look at the nightside
  - Effects of magnetic topology
  - Boundary between ionosphere and solar wind
- Important questions that it is clear MAVEN will not answer
- Measurements to answer those questions
- Conclusions

Important questions that MAVEN’s nominal mission will not answer

- Q1 - Solar cycle variations
- Q2 - Below 125 km
- Q3 - Links between solar forcing and ionospheric properties
- Q4 - Temporal variations
- Q5 - Global coverage
- Q6 - Hot atom escape fluxes
- Q7 - Dynamical coupling between neutral atmosphere and ionosphere

Desired measurements and instruments (1)

- M1 – High cadence magnetic field measurements from surface to study currents induced by plasma motion [surface magnetometer] (Q2, Q4)
- M2 – High cadence vertical profiles of bottomside electron density [surface ionosonde] (Q2, Q4)
- M3 – High cadence total electron content measurements [surface riometer] (Q4)
- M4 – All-sky camera images of airglow [simple surface camera] (Q4)

Desired measurements and instruments (2)

- M5 – Upstream measurements of solar wind and irradiance simultaneous with ionospheric measurements [various small instruments on an orbiter] (Q3)
- M6 – Spacecraft-to-spacecraft radio occultations [minor modification to typical comm system of orbiters] (Q5)
- M7 – Simultaneous neutral winds, ion velocities, plasma density and magnetic field [Fly CINDI payload from C/NOFS on Mars orbiter] (Q7)

Aeronomy Constellation Mission

- This is a PROGRAM - What missions will be inspired by MAVEN's discoveries?
- No chance of near-term flight, but a good place to plant idea of future mission-level concepts
- Upstream monitor of solar conditions, downstream observations of escaping volatiles, plus simultaneous observations of the ionosphere