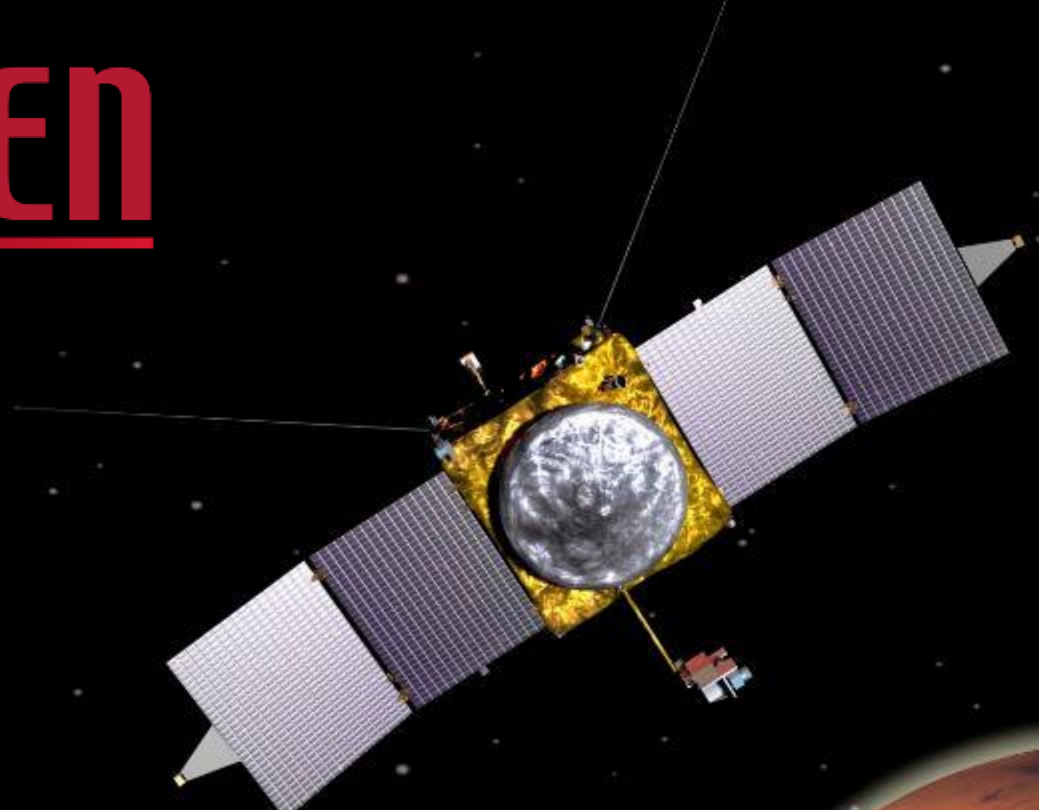
MAVEN



MAVEN Mission Update and Early Science

Dave Brain

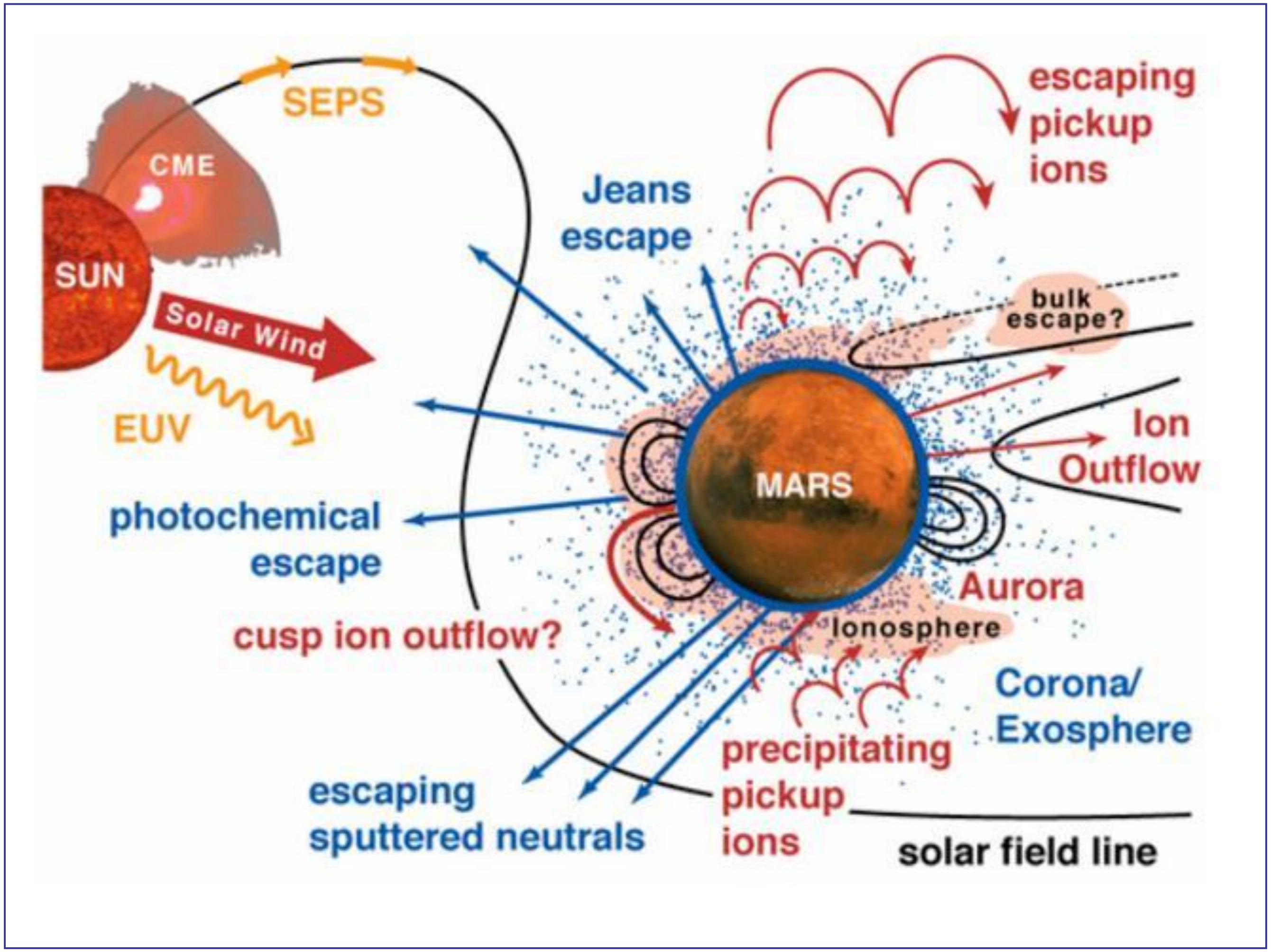
LASP / U. Colorado

MEPAG, 25 Feb. 2015

MAVEN Operational Status

- MAVEN launched on schedule on 18 Nov. 2013
- Mars Orbit Insertion occurred on 21 Sept. 2014
- Survived encounter with Comet Siding Spring, obtained exciting science results
- Completed commissioning and began science phase on 16 Nov. 2015
- Spacecraft and all instruments performing nominally, collecting science data
- Currently three months into our one-Earth-year science mission
- First “deep dip campaign” carried out week of 10 Feb.
- Planning underway for remainder of science mission and for extended mission for science and relay

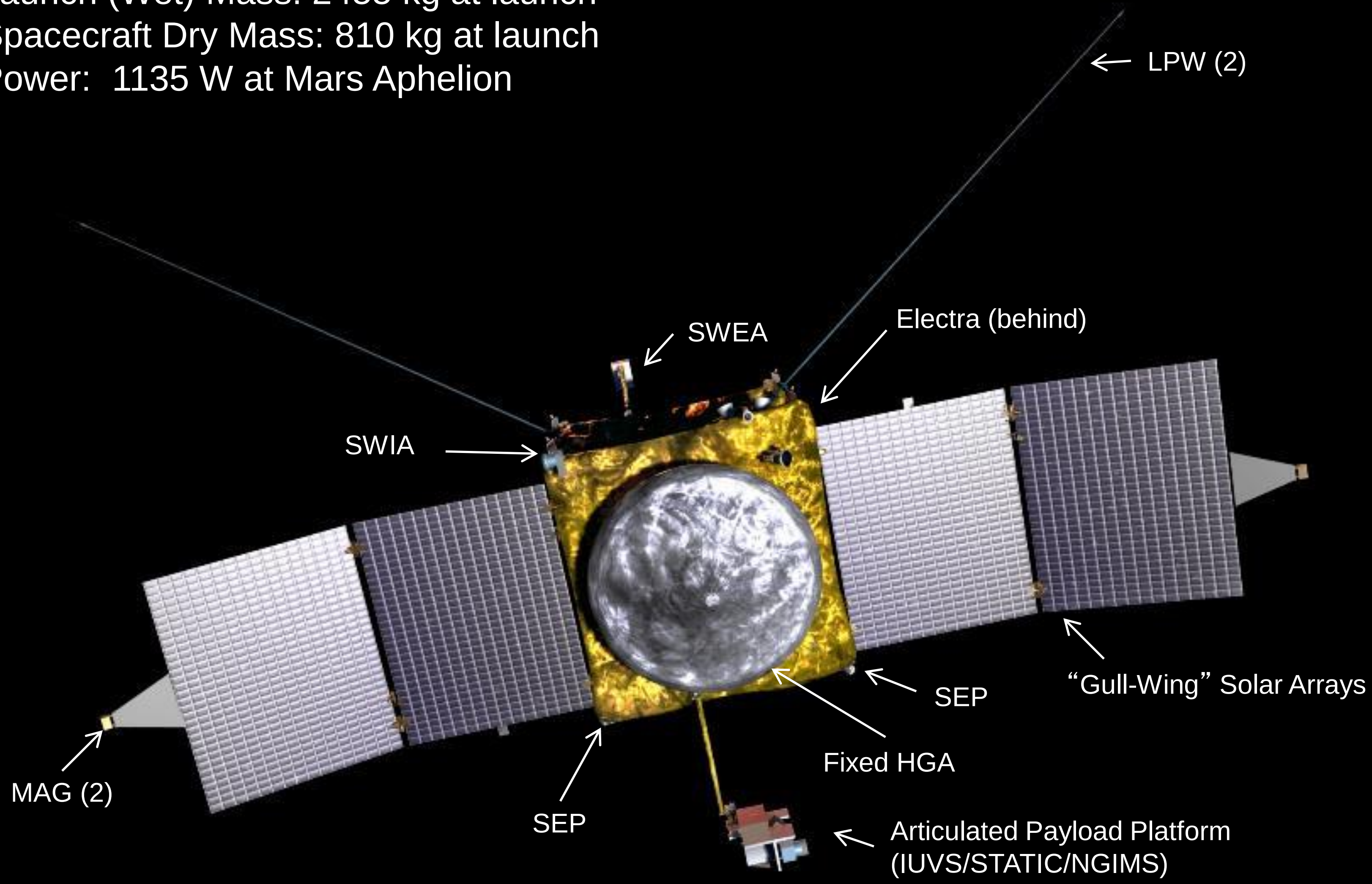
MAVEN Will Allow Us to Understand Escape of Atmospheric Gases to Space

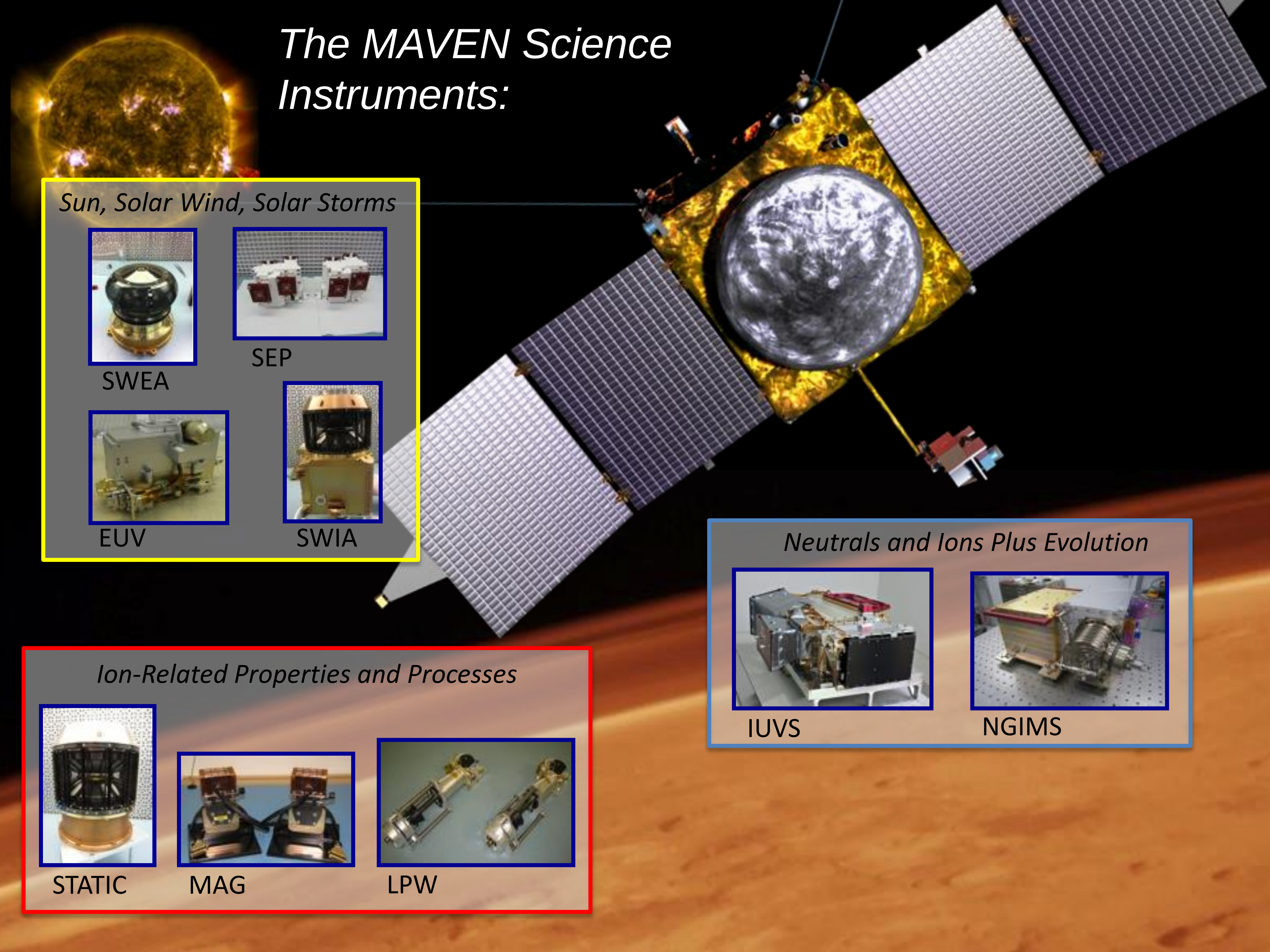


- Measure energetic drivers from the Sun, response of upper atmosphere and ionosphere, and resulting escape to space
- Understand the key processes involved, allowing extrapolation over Mars history

The MAVEN Spacecraft

- Launch (Wet) Mass: 2455 kg at launch
- Spacecraft Dry Mass: 810 kg at launch
- Power: 1135 W at Mars Aphelion

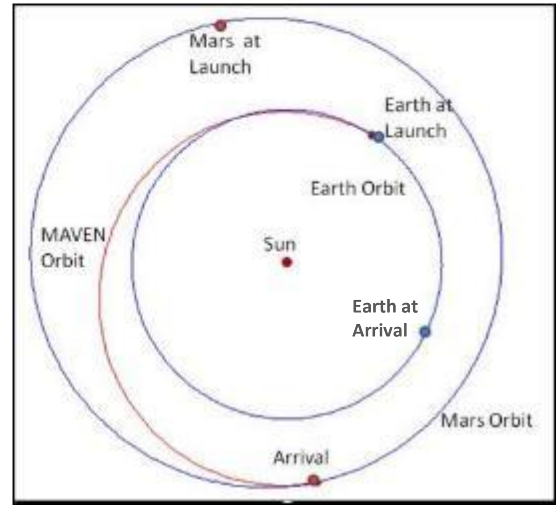


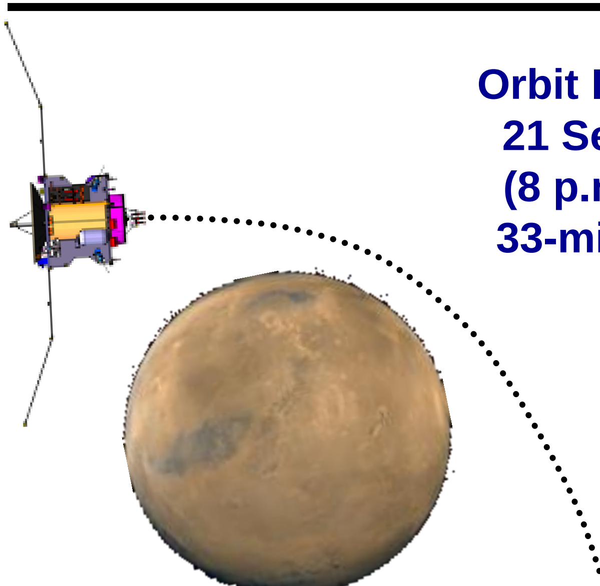

The MAVEN Science Instruments:
Sun, Solar Wind, Solar Storms
SWEA
SEP
EUV
SWIA
Neutrals and Ions Plus Evolution
IUVS
NGIMS
Ion-Related Properties and Processes
STATIC
MAG
LPW

MAVEN Mission Architecture

Launched from Cape Canaveral on 18 Nov. 2013, first day of its 20-day launch period; Launch Vehicle: Atlas – V 401

Ten-Month Type-II Ballistic Cruise to Mars



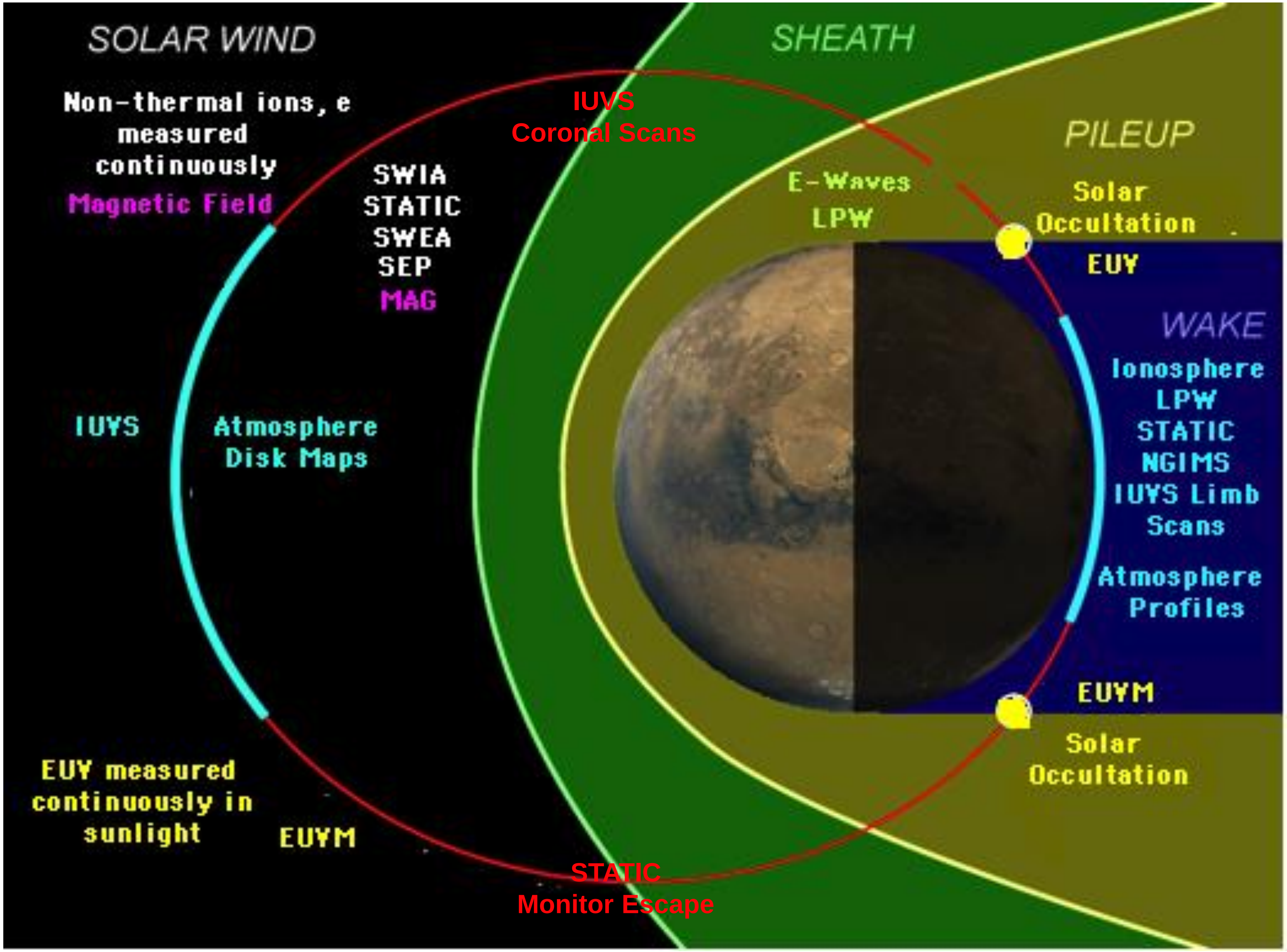


Orbit Insertion: 21 Sept 2014 (8 p.m. MDT; 33-min. burn)

One Year of Science Operations

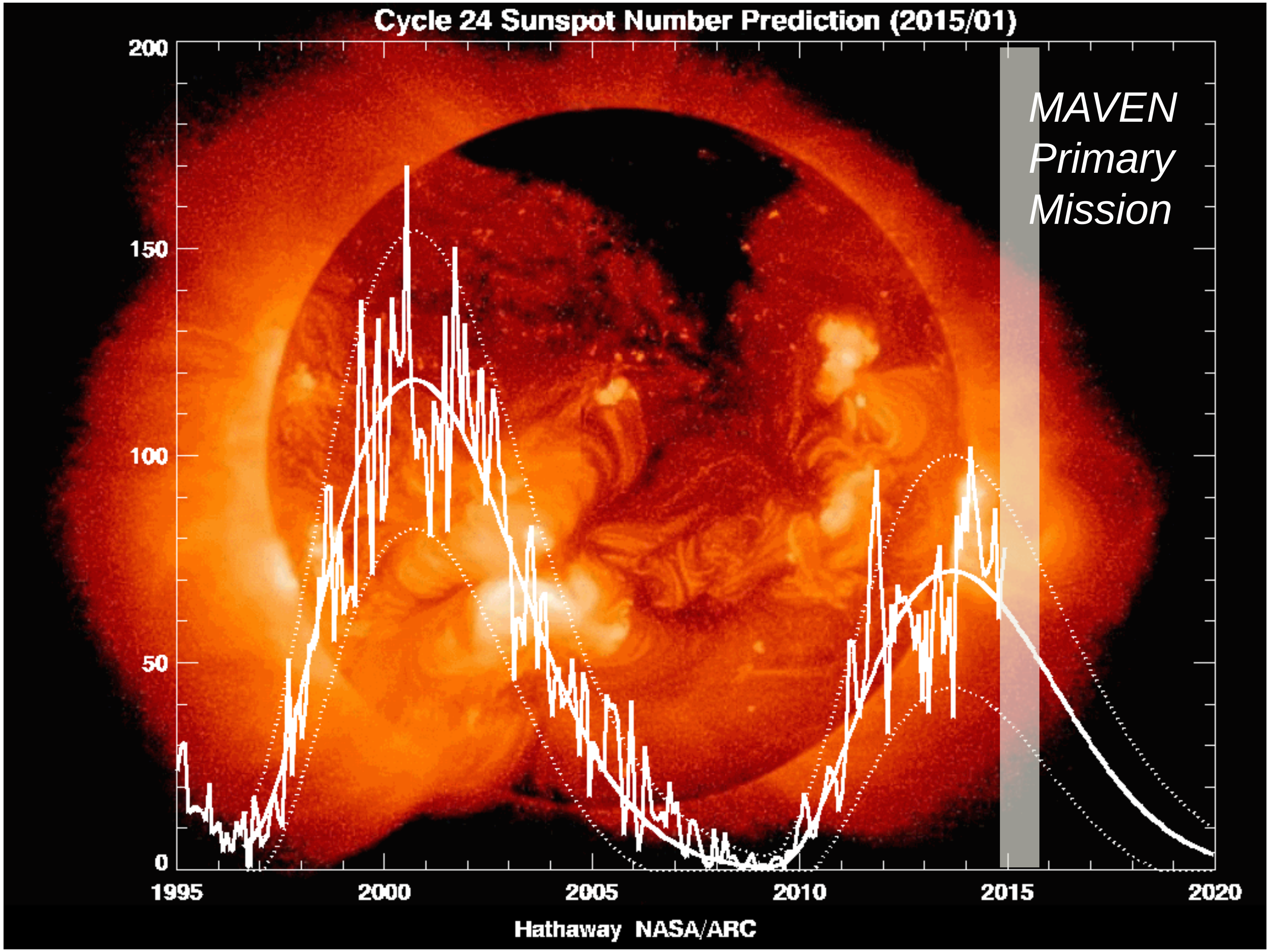
Orbit shown to scale

MAVEN Observes All Regions Of Near-Mars Space Throughout The Orbit



(Orbit precesses, so this orientation is representative.)

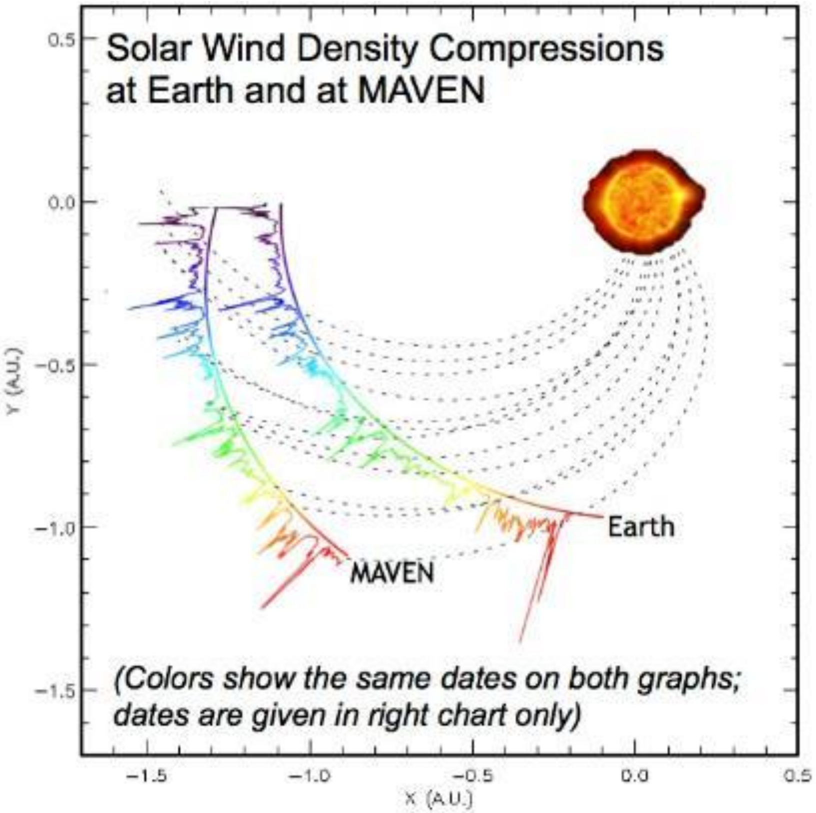
MAVEN's Primary Mission Occurs on the Declining Phase of the Solar Cycle

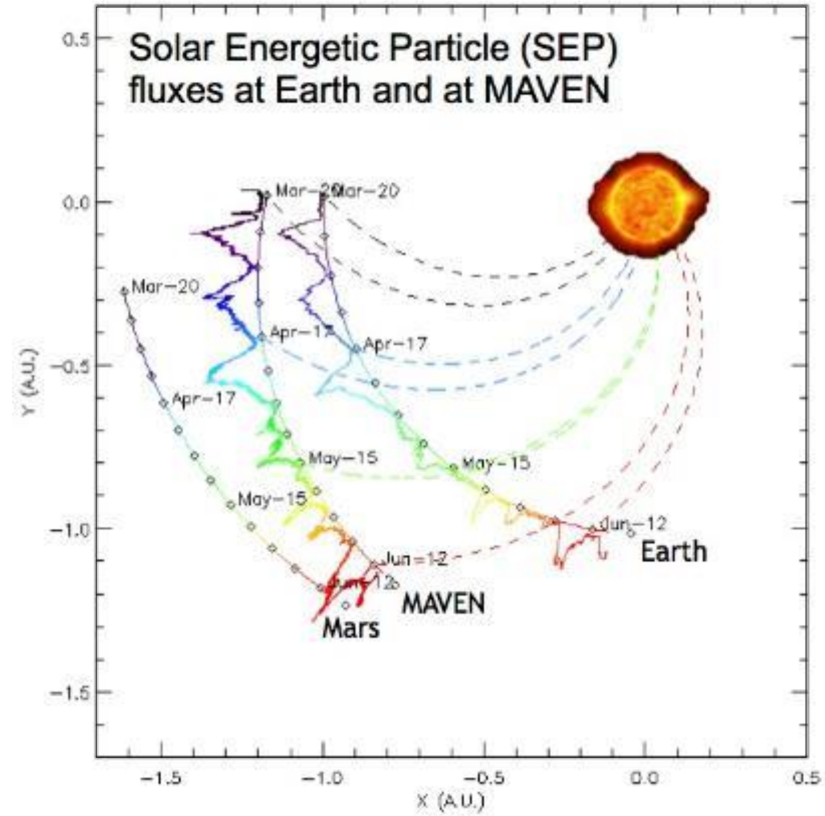


At this time, solar storms are most intense and most abundant.

MAVEN Particles and Fields During Cruise: Exploring the Solar Wind Beyond 1 A.U.

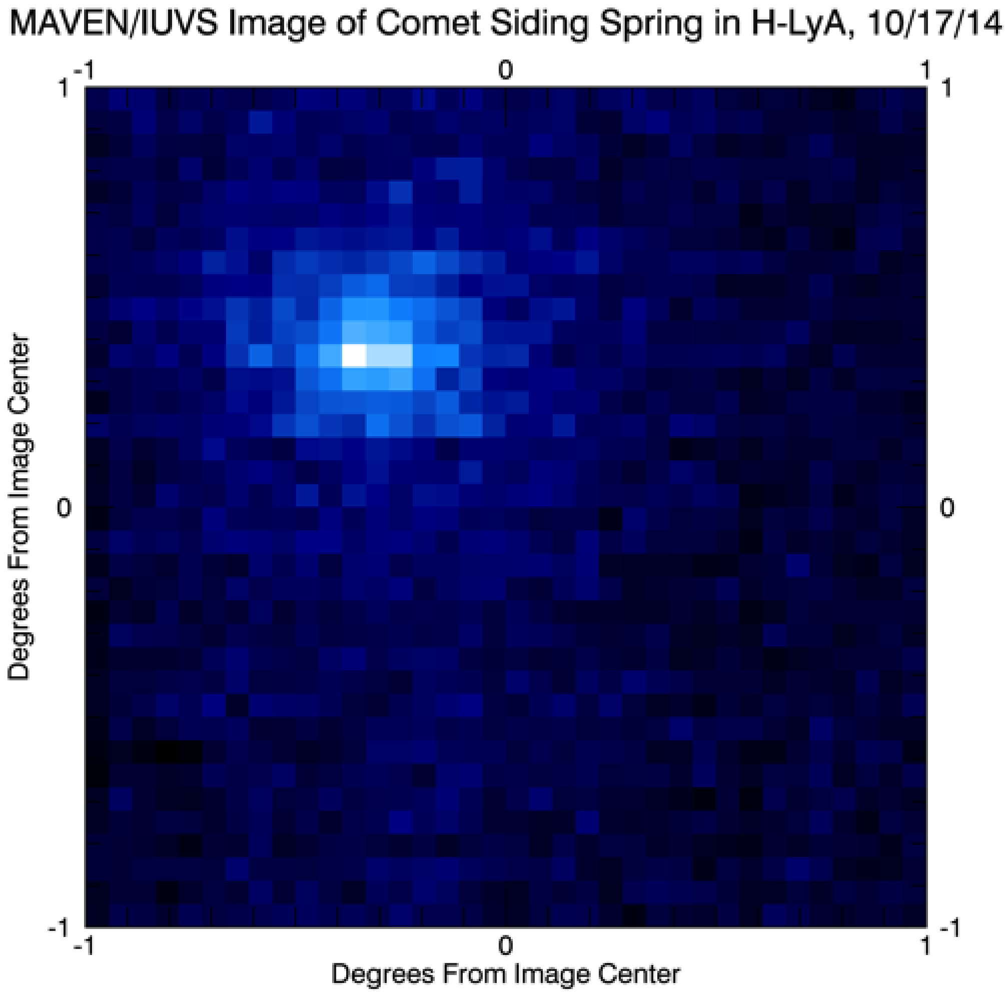
- MAVEN is exploring propagation of the solar wind and SEPs beyond 1 A.U. during its cruise to Mars.
- Solar wind density compressions from stream interactions and ICMEs (left) and Solar Energetic Particle (SEP) events (right) are seen at the orbits of Earth and MAVEN
- They show the combined effects of radial propagation and solar rotation, and features can be followed along the solar-wind spirals
- MAVEN observations are complementary to near-Earth assets, providing a valuable perspective on the structure of the solar wind.





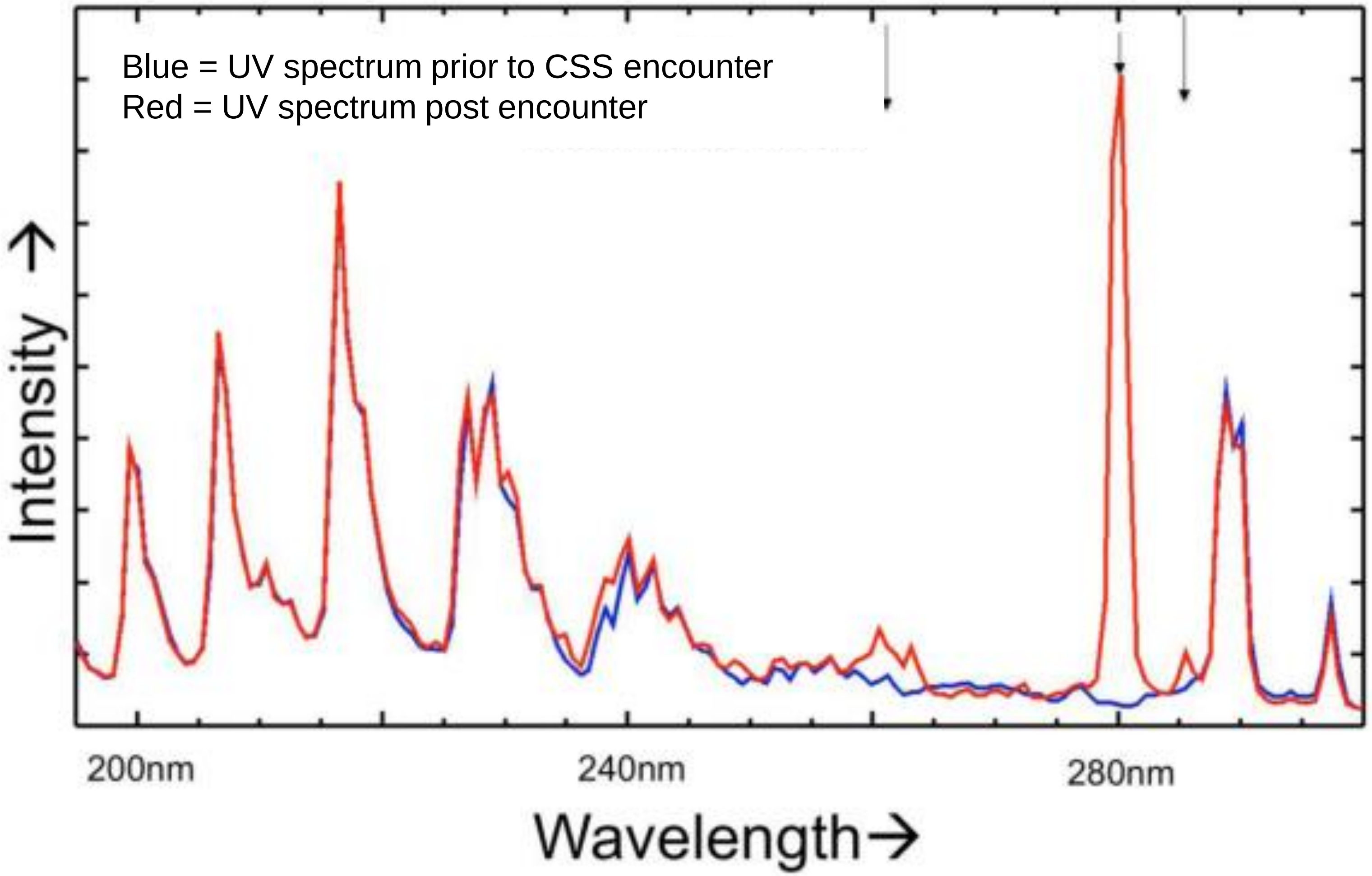
Solar wind data from MAVEN SWIA (J.S. Halekas) and OMNIWeb (N. Papitashvili), SEP fluxes from MAVEN SEP (D. Larson) and ACE EPAM (R. Gold

IUVS Imaging of Comet Siding Spring



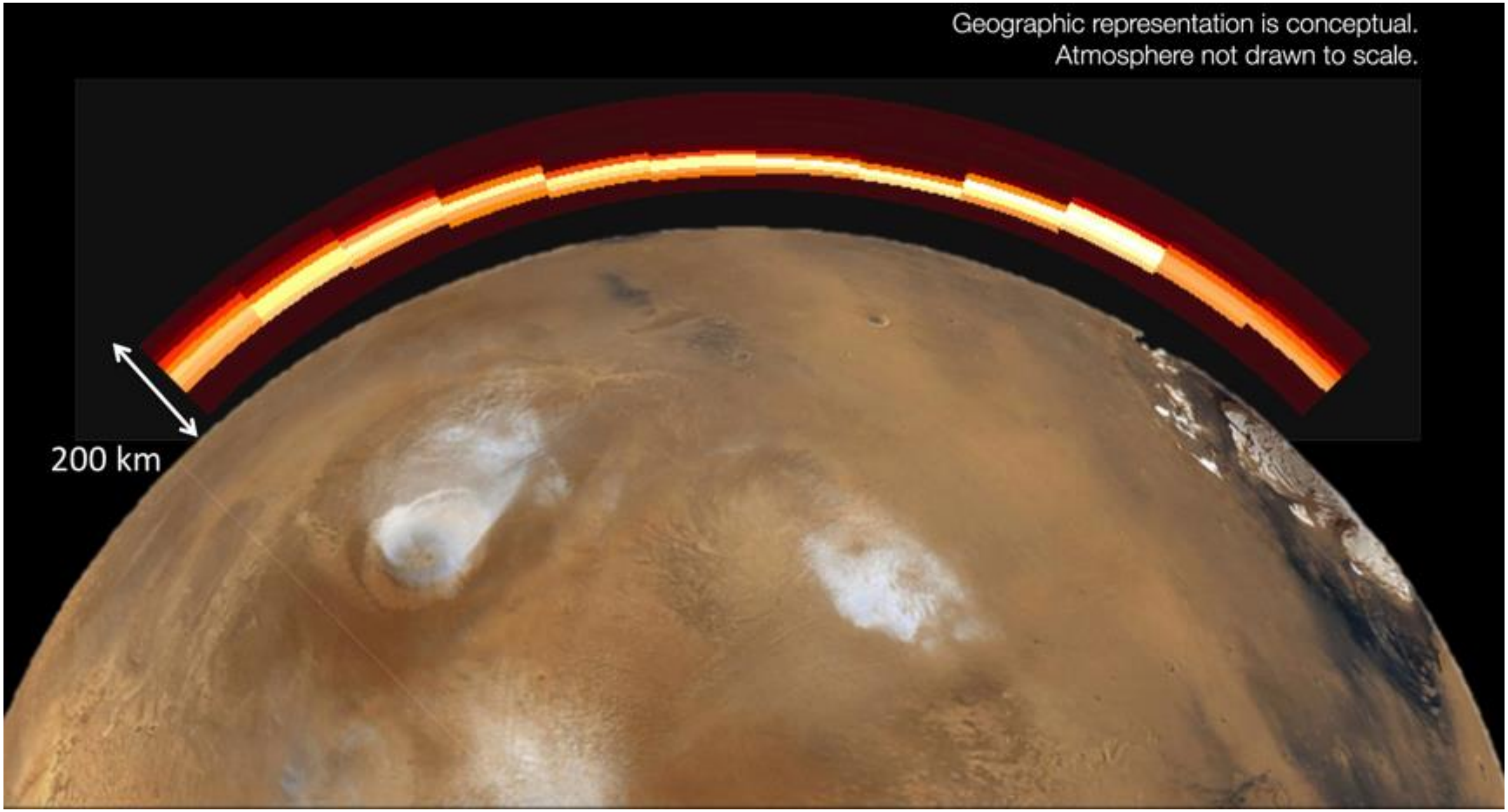
- IUVS imaged CSS in scattered solar Lyman-alpha two days before closest approach to Mars
- Reflects distribution of atomic H surrounding comet
- H detected to distance of ~150,000 km (comparable to Mars miss distance of comet)
- Gas cloud behaves differently from dust; dust comprises bulk of tail and is what is seen in visible images, so LyA images looks different from most telescopic images

Mars After Comet Encounter: IUVS Detection of Metal Ions



Strong features at 280 nm (Mg^{+2}), at 250 nm (Fe^{+2}), and 285 nm (Mg) due to comet dust

IUVS False-Color Image of Mg^{+2} Distribution

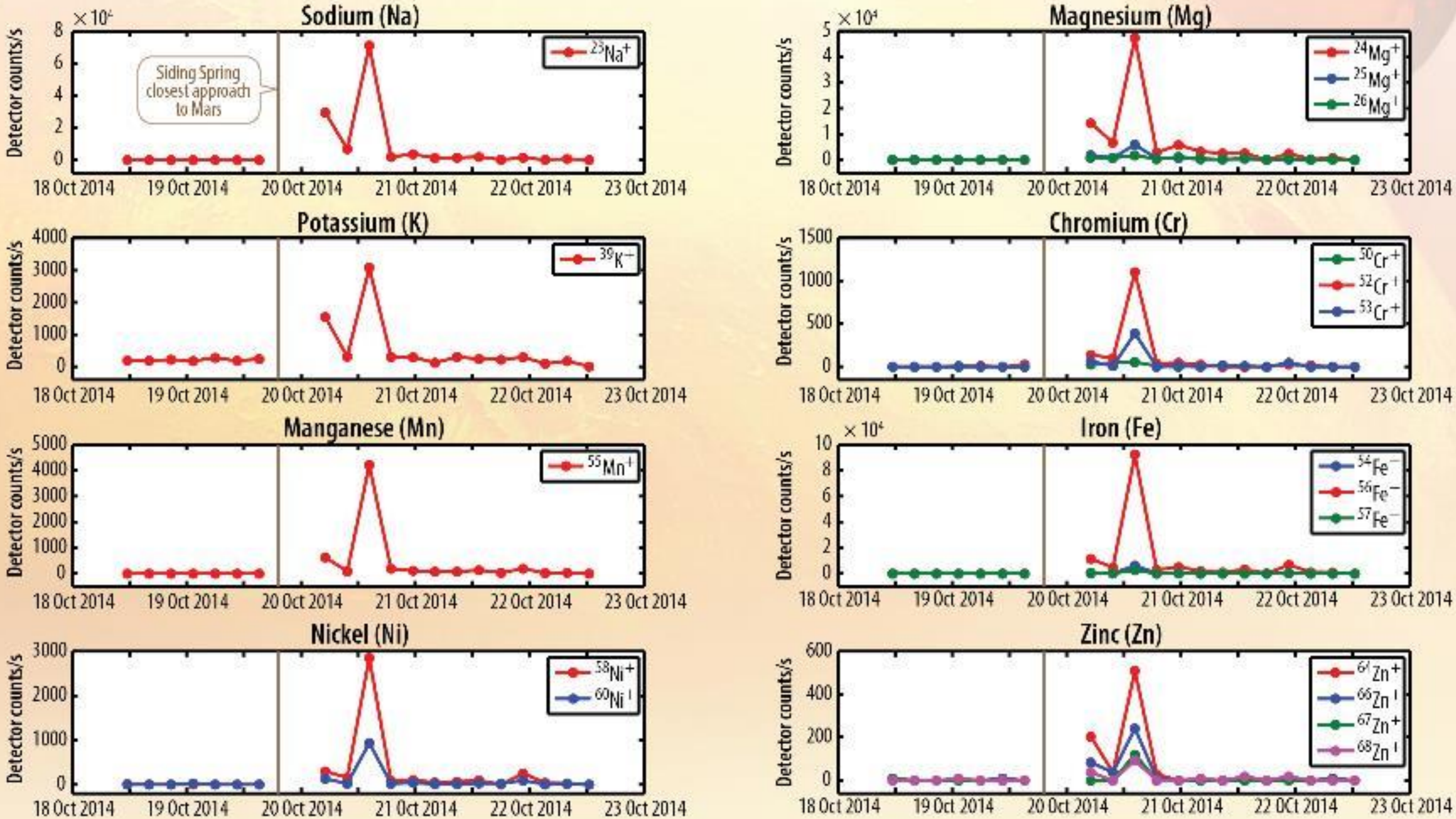


- Observed throughout periapsis pass of each orbit following comet passage
- Dust distributed quasi-globally
- Intensity of emissions decayed in hours to days, likely due to conversion of Mg and Fe to other forms

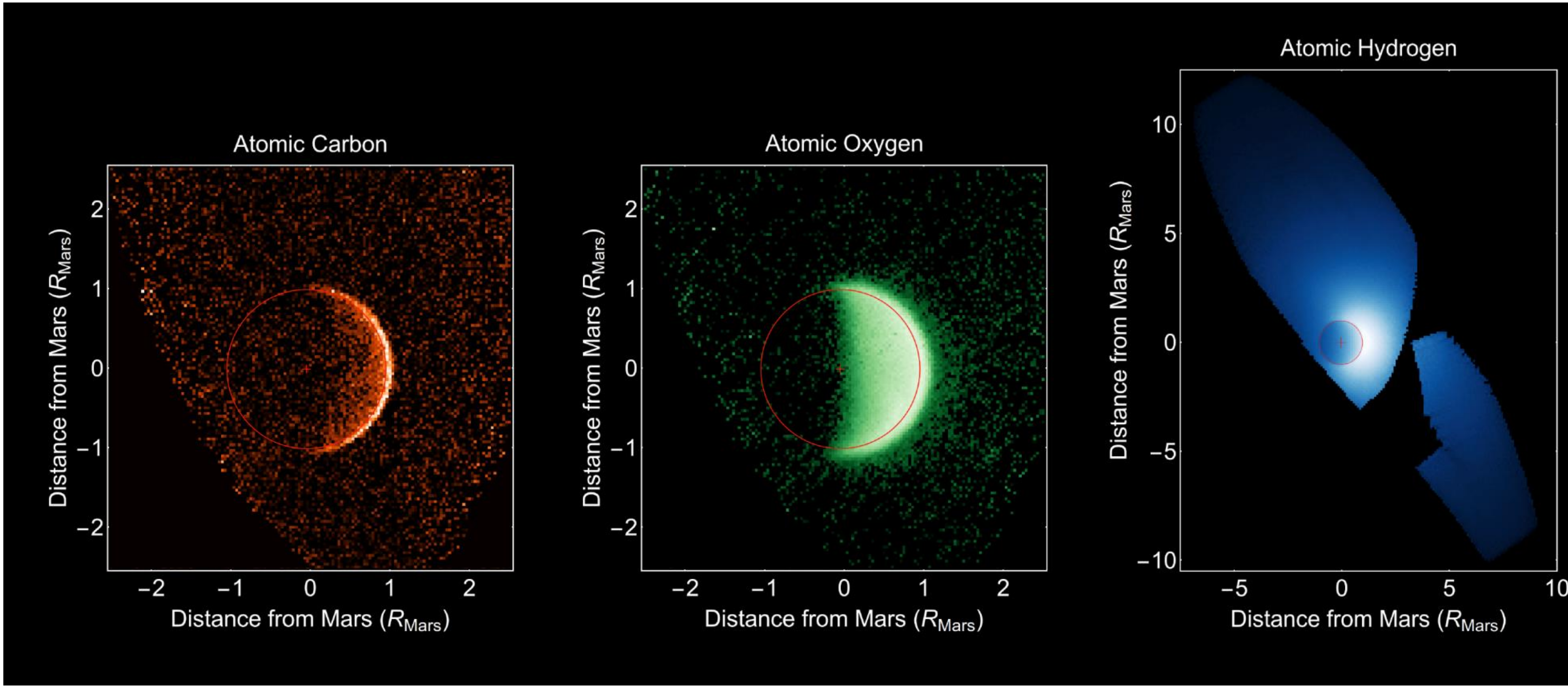
Mars After Comet Encounter: NGIMS Detection of Metal Ions

MAVEN
Mars Atmosphere and Volatile Evolution Mission
CU/LASP • GSFC • UCB/SSL • LM • JPL

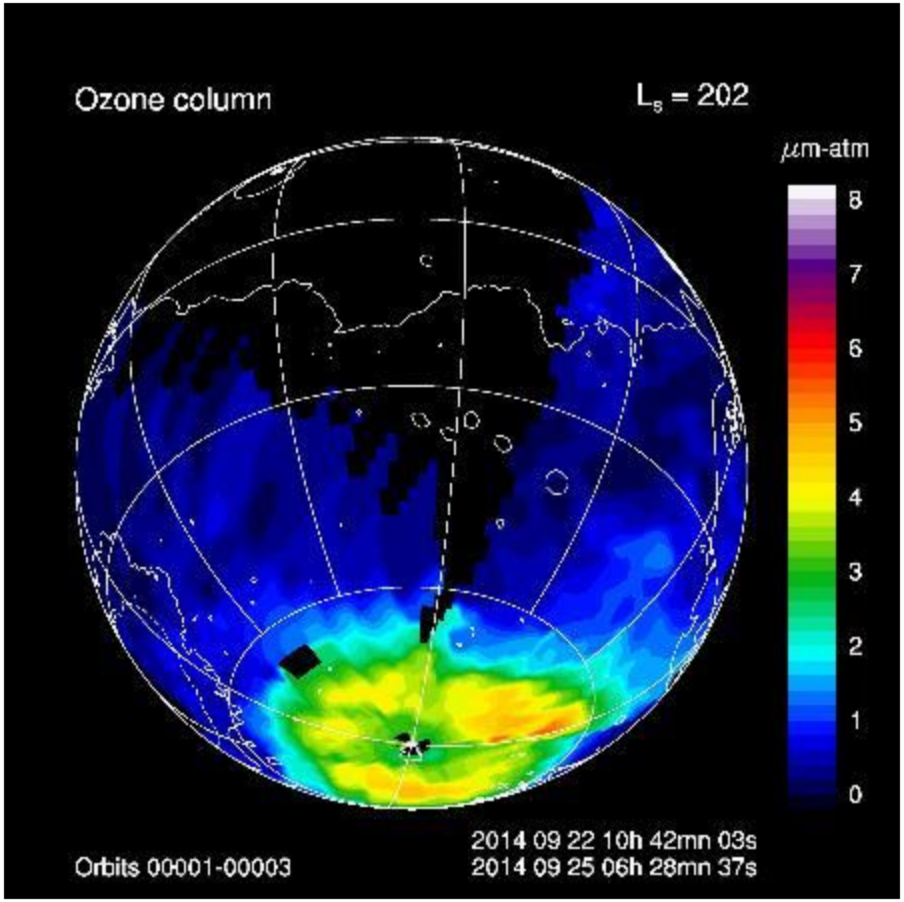
Eight different metal ions from comet Siding Spring were detected by NGIMS

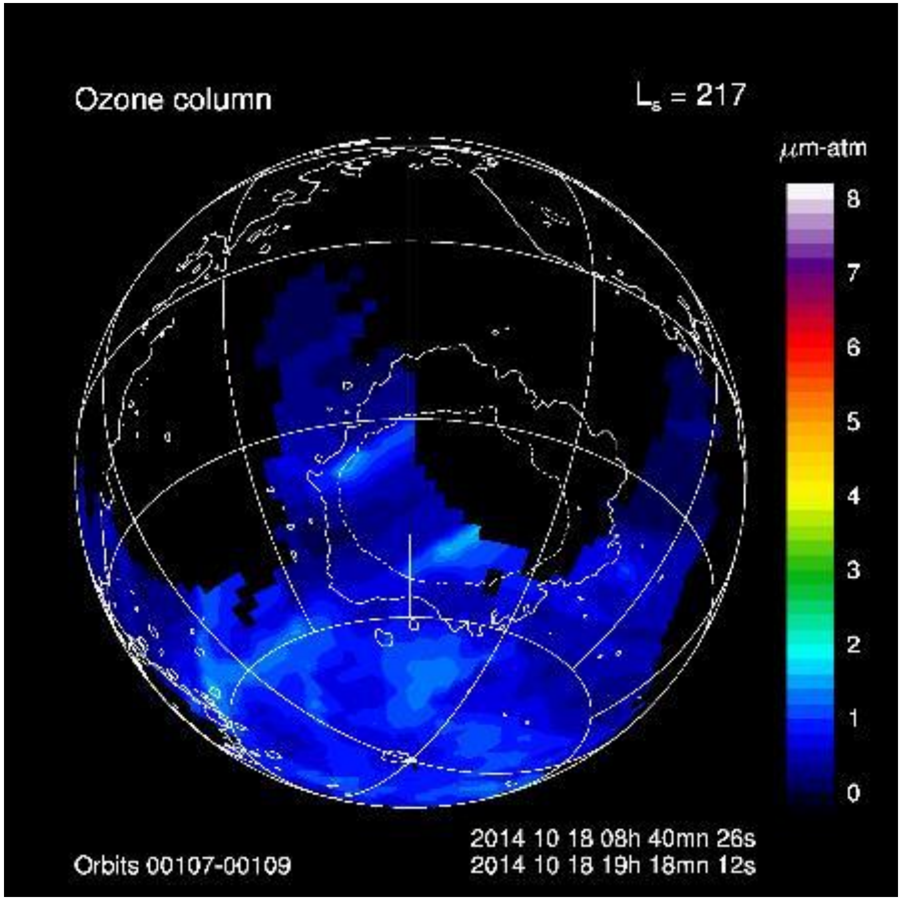


IUVS Observations of Atomic Components of H_2O and CO_2 on Their Way to Escaping



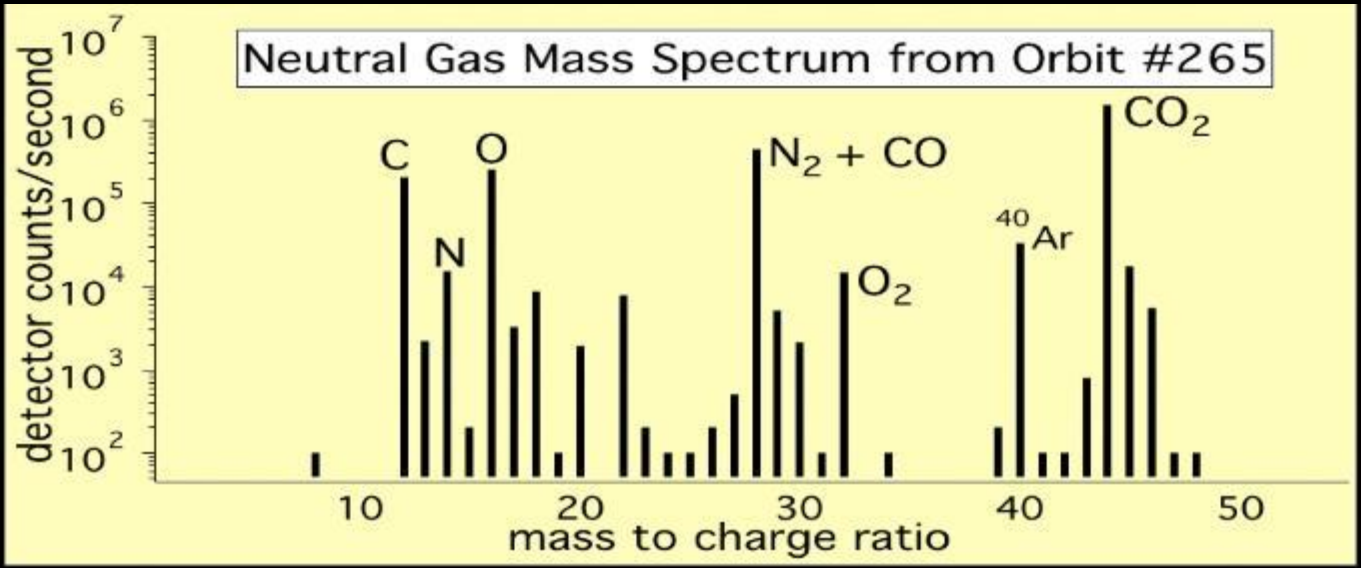
IUVS Maps Changing Mars Ozone

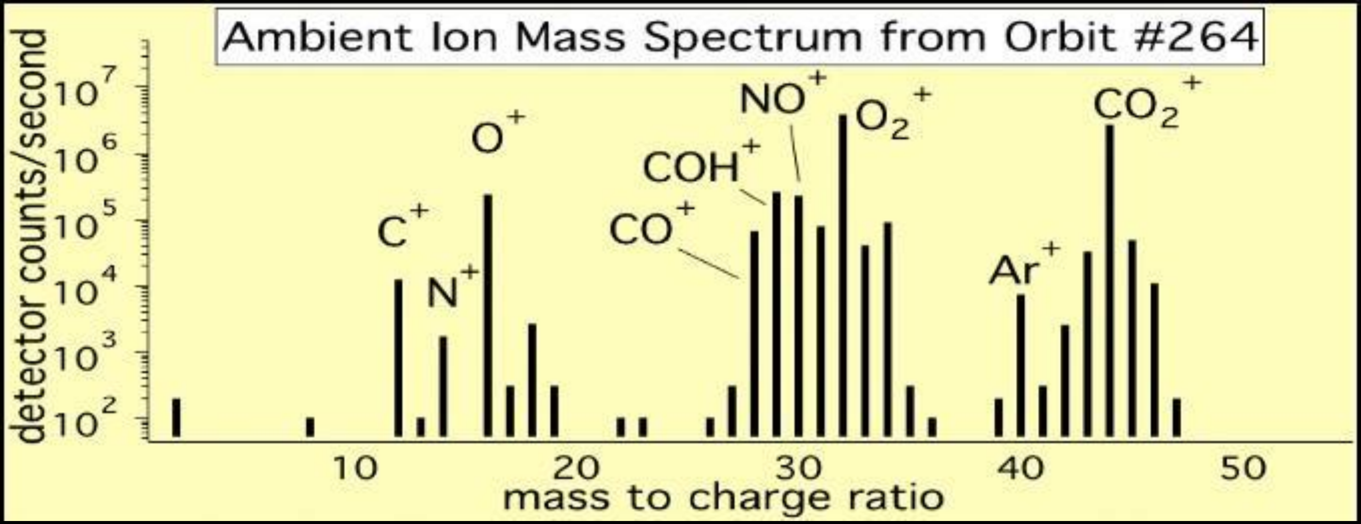




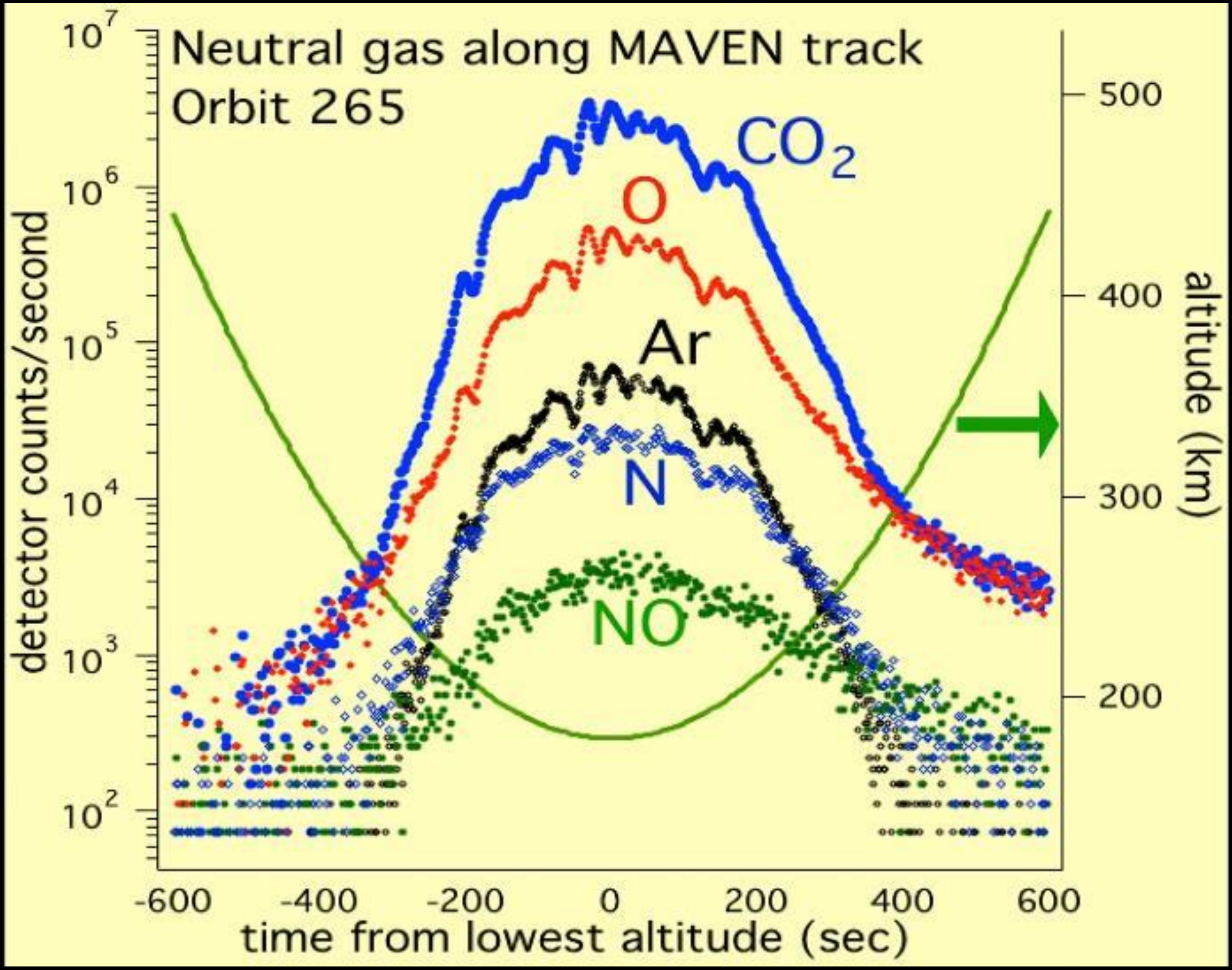
- Maps made one month apart show significant changes
- Likely due to appearance of water vapor in spring atmosphere in south; dissociation products of H2O destroy ozone
- Rapid changes seen here are real

NGIMS Measurements of Neutrals and Ions During Periapsis Pass

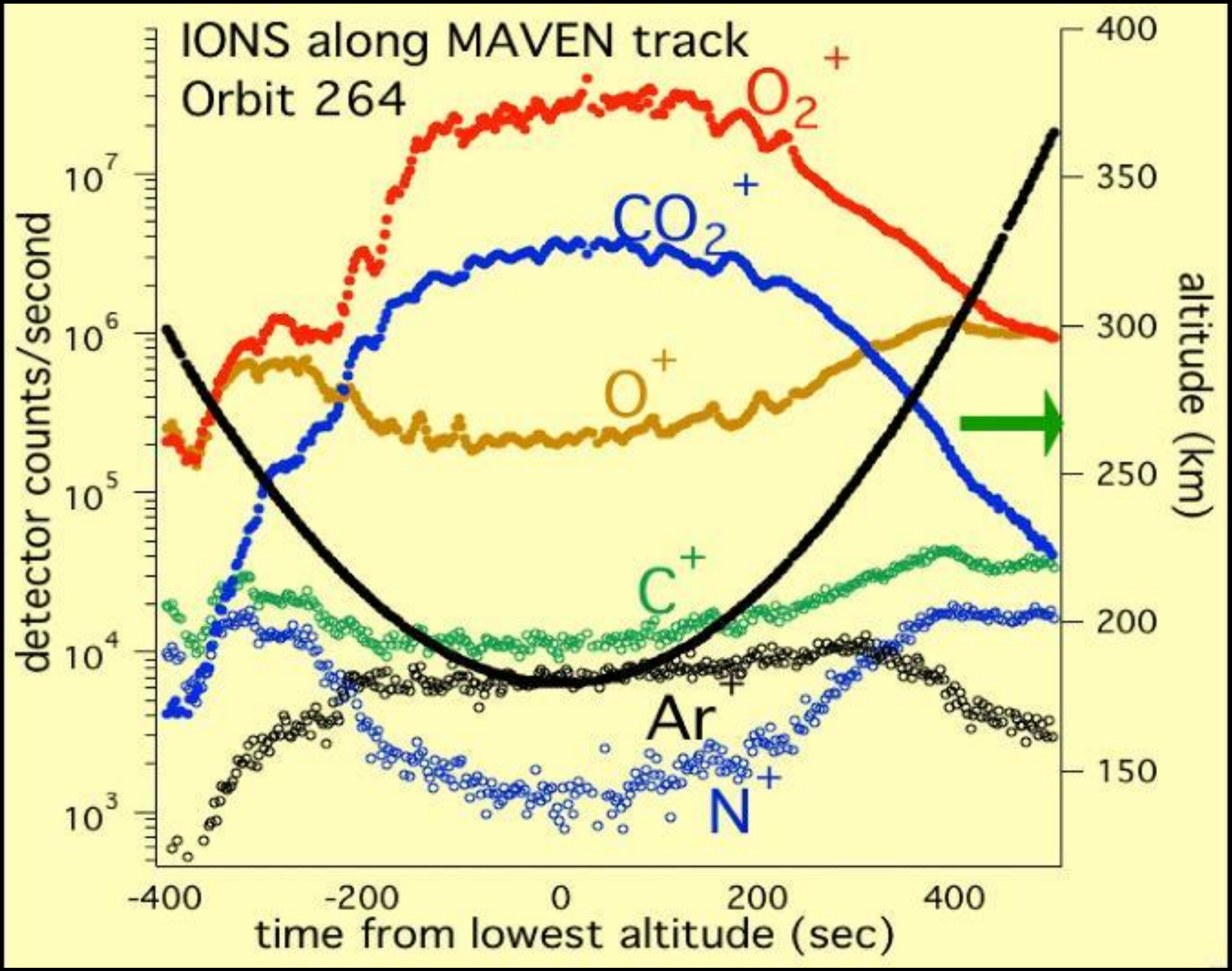




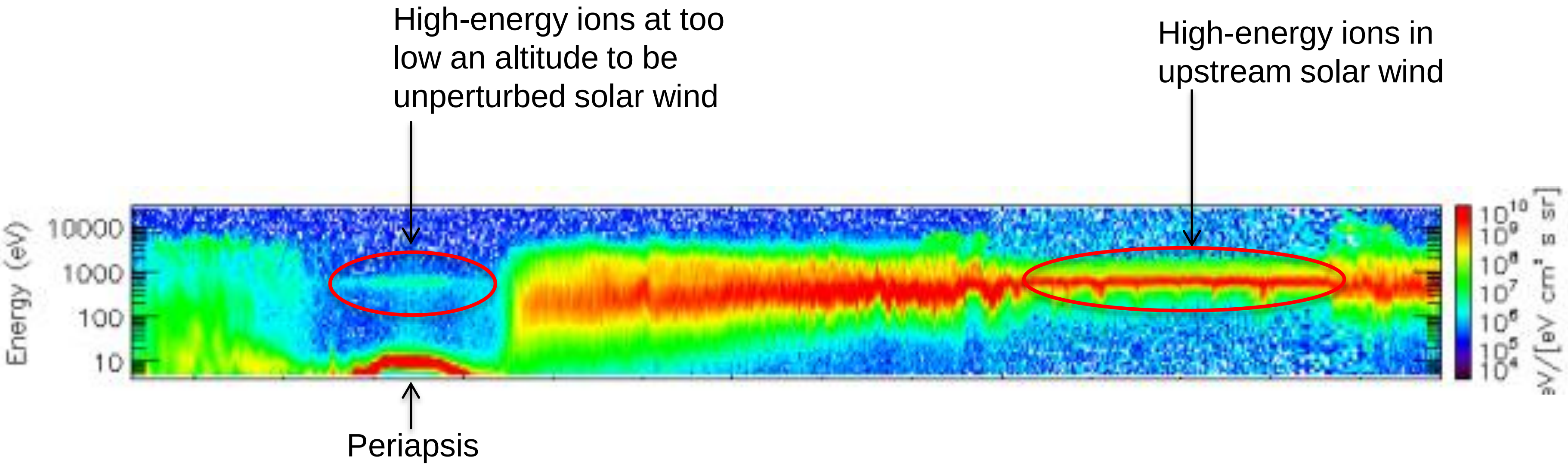
NGIMS Measurements of Neutrals



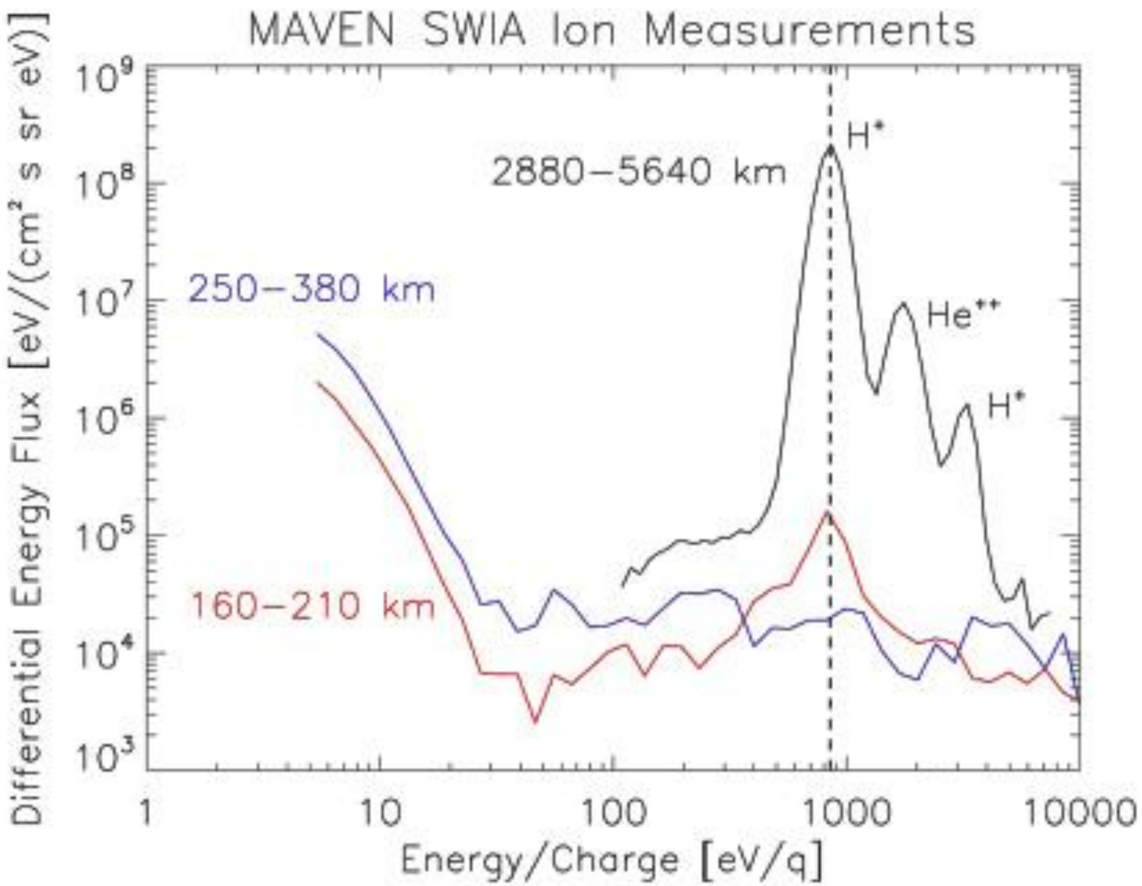
NGIMS Measurements of Ions



SWIA: New Solar-Wind Penetration Process

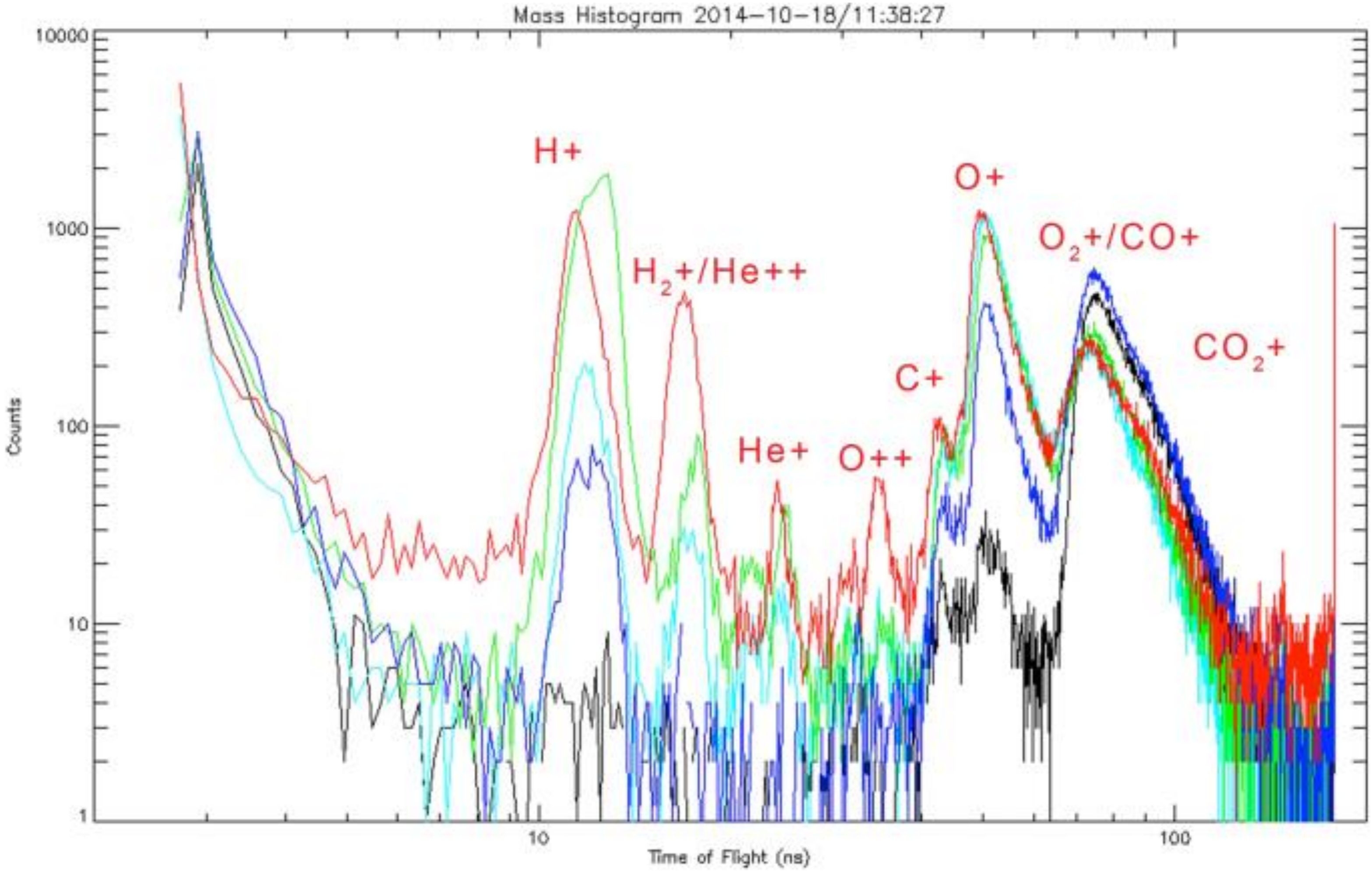


SWIA Energy Spectrum of Ions at Different Altitudes

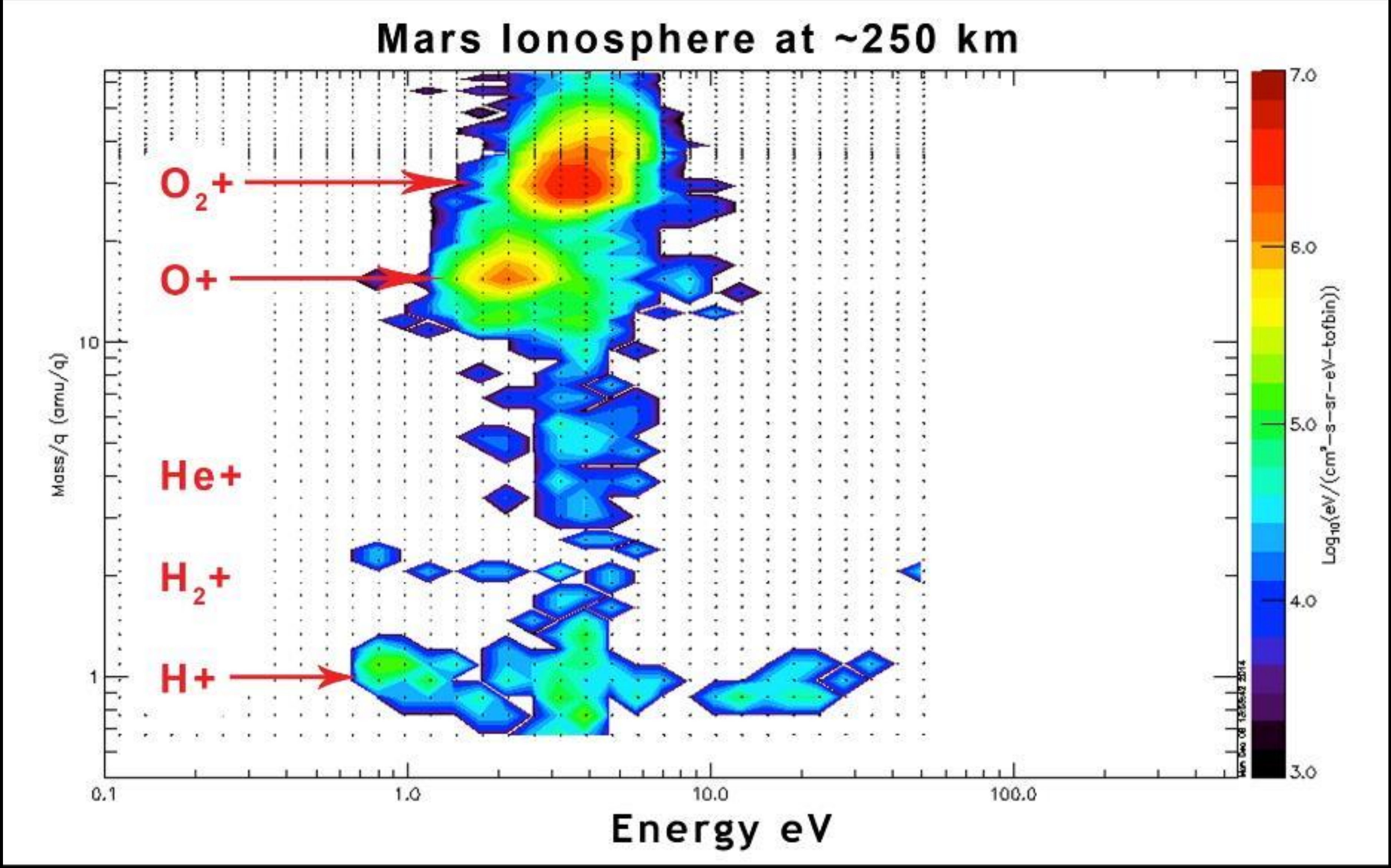


- Energy spectrum shows solar-wind ions at high altitudes, disappearing at intermediate altitudes, reappearing at low altitudes
- Thought to be charge exchange, allowing penetration through magnetosphere as neutrals

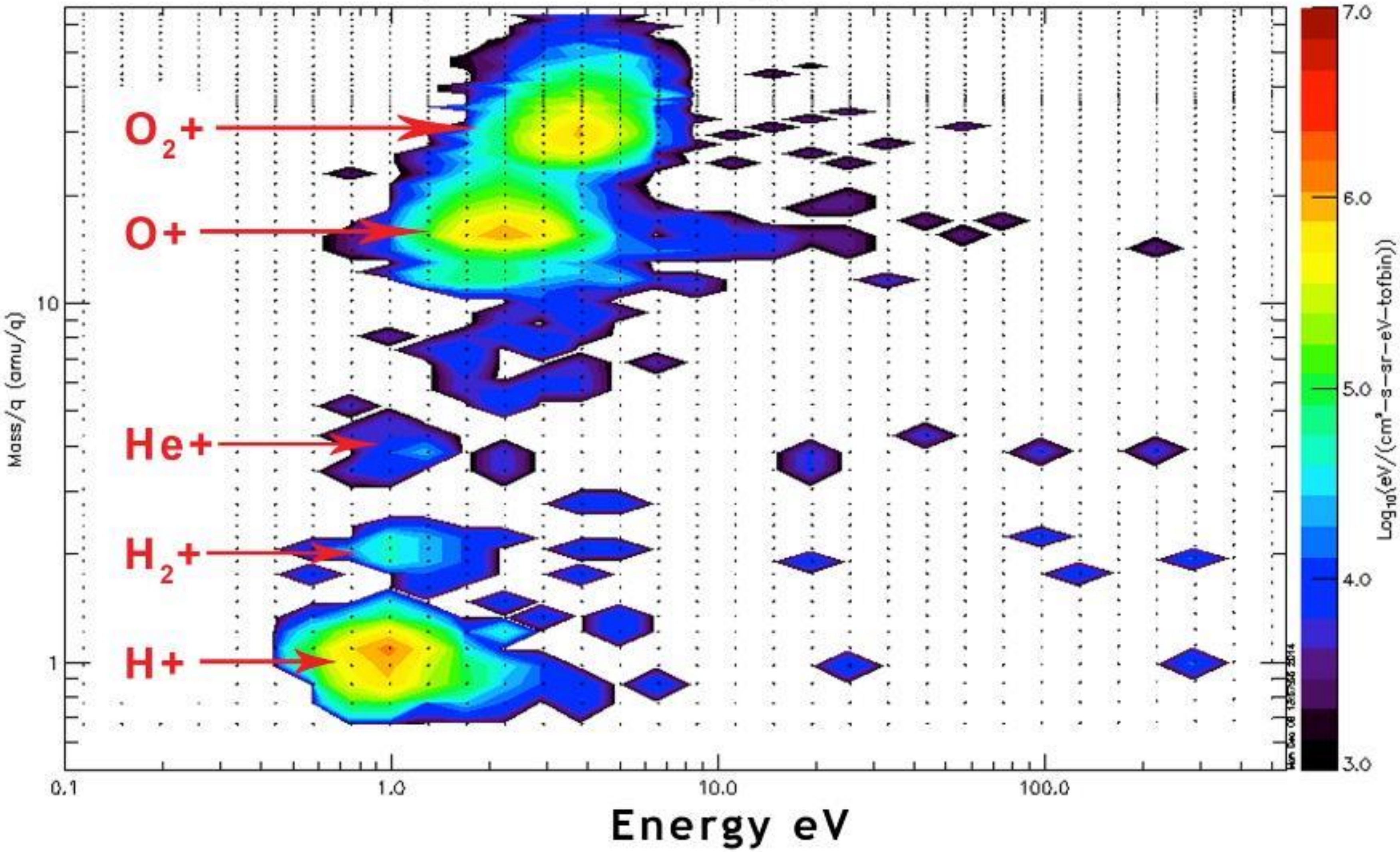
STATIC Measures High-Energy Ions in Process of Escaping



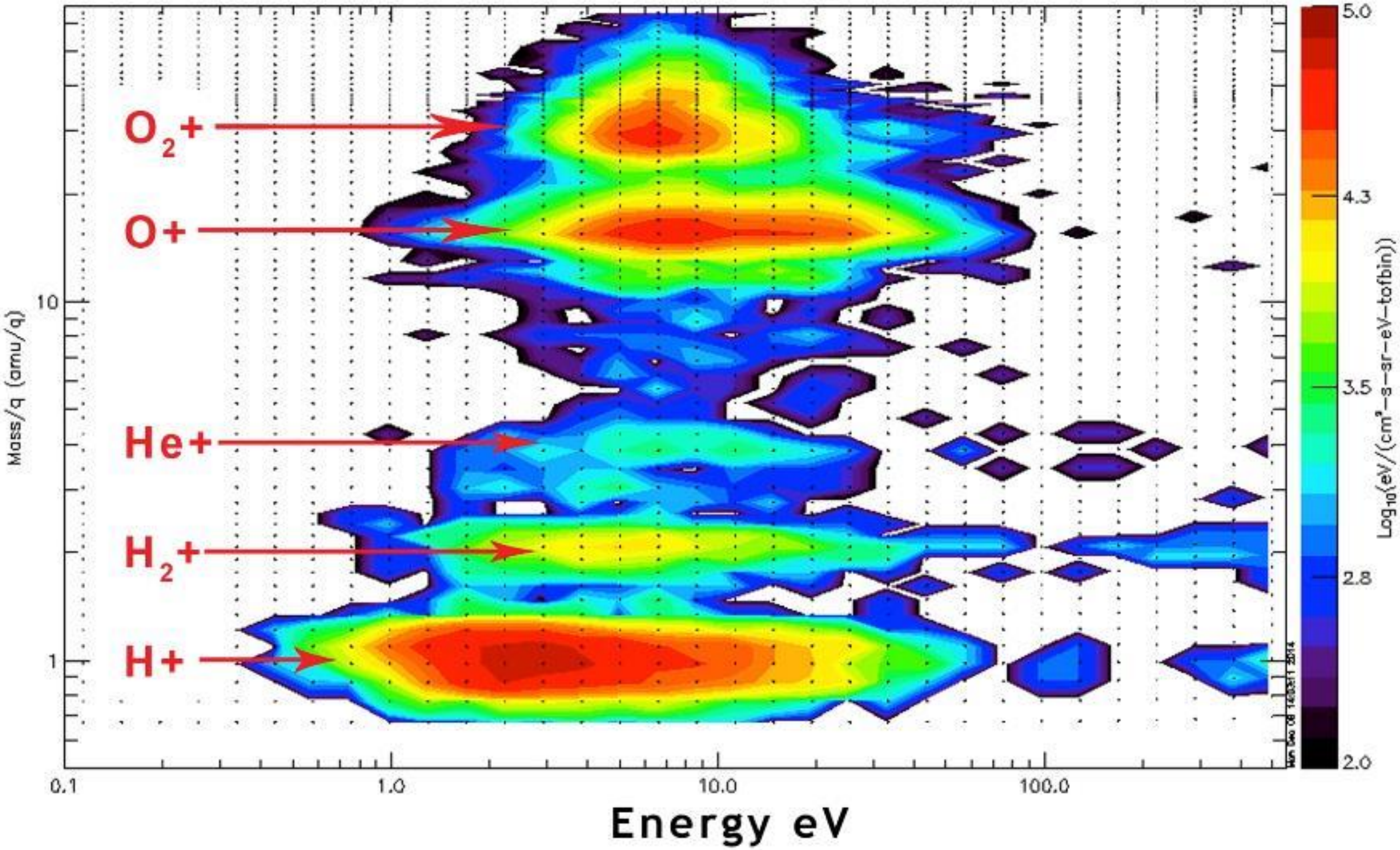
Example spectra at different times show species measured


Mars Ionosphere at ~250 km
O2+
O+
He+
H2+
H+
Mass/q (amu/q)
10
1
0.1
1.0
10.0
100.0
Energy eV
7.0
6.0
5.0
4.0
3.0
Log10(eV/(cm²-s-sr-eV-tofbin))

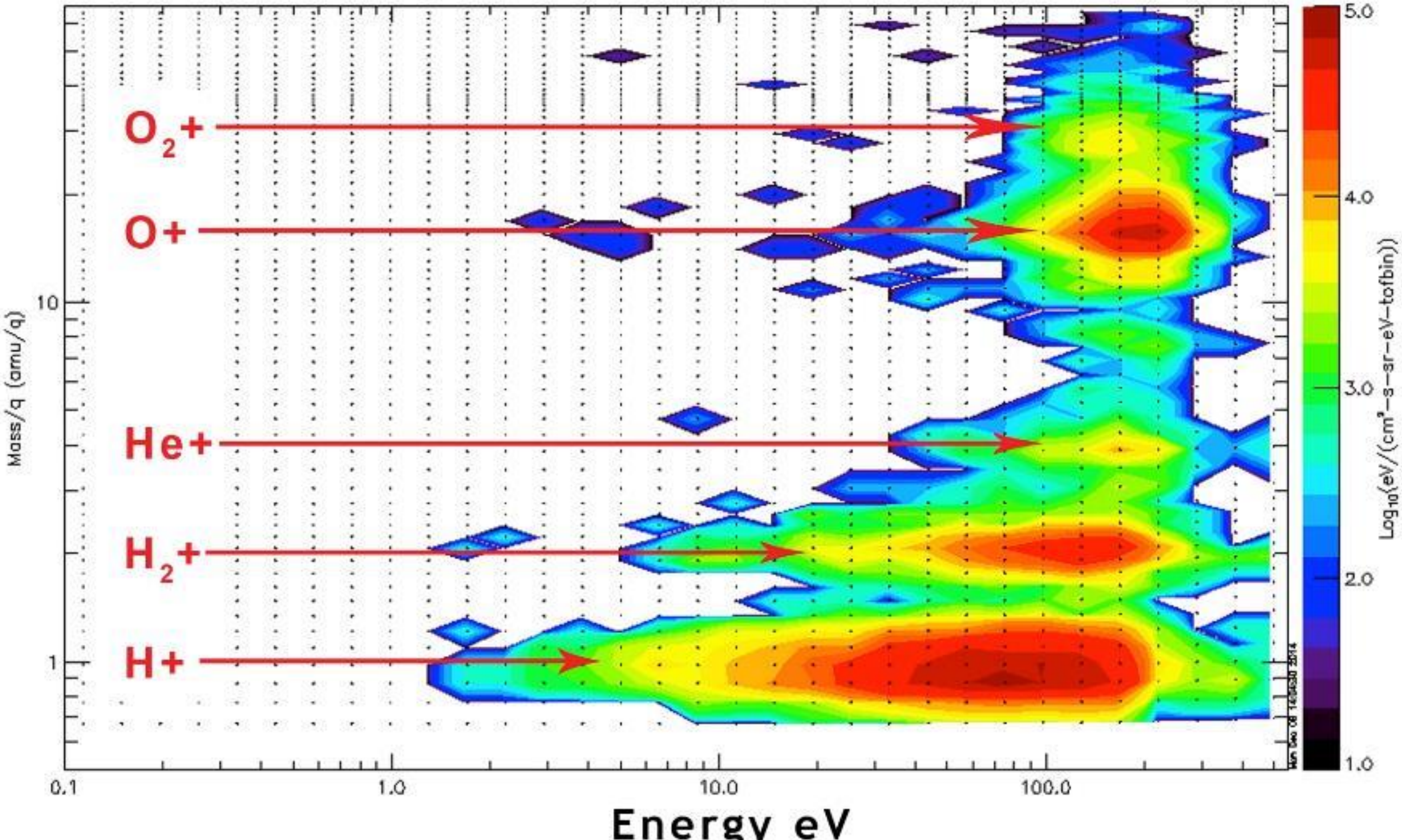
Composition change at ~300 km



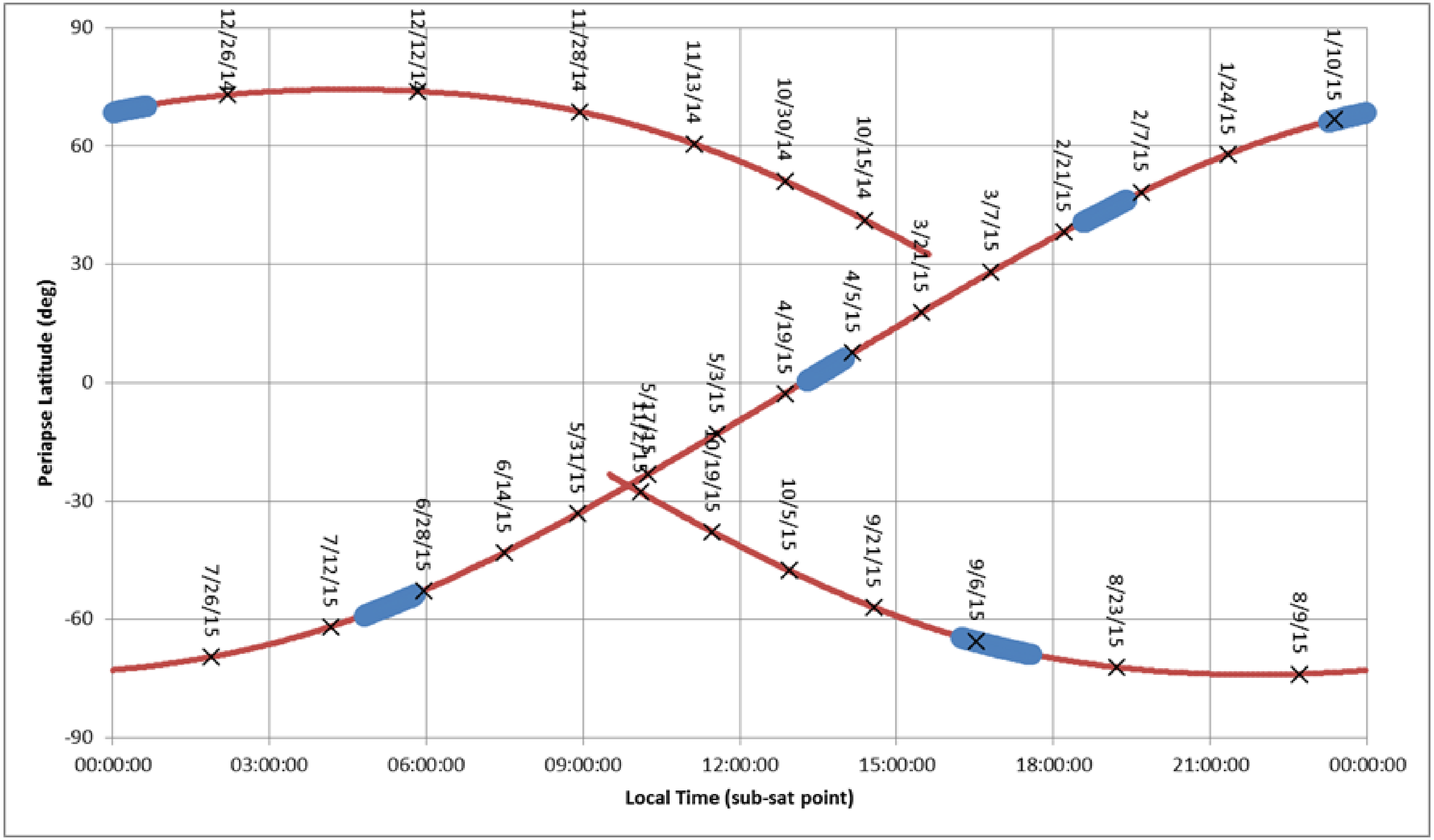
Ionospheric Heating ~400 km



Ionospheric Acceleration ~500 km



MAVEN Orbit Evolution During Primary Mission: Geographic Latitude and Local Solar Time At Periapsis



MAVEN's First Deep-Dip Campaign

- Five deep-dip campaigns will be carried out during primary misison.
- During deep dip, periapsis is lowered from ~150 to ~125 km.
- The additional 25 km takes us down to near the top of the well-mixed lower atmosphere; this allows us to make connections from upper atmosphere all the way to the surface.
- The first deep-dip campaign was carried out successfully, starting on 10 Feb. and ending on 18 Feb.
- Deep dip involved 3 maneuvers to walk in, 5+ days (~20+ orbits) in deep dip, and 2 maneuvers to take periapsis back to nominal mapping altitude
- Continual orbit analysis and daily opportunities for maneuvers to ensure that periapsis stays within our atmospheric density corridor
- Special observing sequences and S/C orientation to ensure instrument safety and obtain science measurements
- All science instruments operated as planned; data analysis ongoing

MAVEN Data Users Workshop

- First delivery of MAVEN data to PDS is planned for mid-May
- MAVEN team will host a one-day "data users' workshop" to help new users become familiar with data access, data products, user tools; to be held in conjunction with next science-team meeting
- Workshop to be during week of 22 June, at LASP in Boulder, CO
- Those attending workshop, or already using MAVEN data, can participate in science team meeting; allows broader science return and more-effective interaction with team on understanding and interpreting data
- Participation in users' workshop or in team meeting by application only (a consequence of conference travel rules); send email with your justification for participating to bruce.jakosky@lasp.colorado.edu.
- These are not open meetings; no drop-ins or those just wanting to hear MAVEN results

Summary of MAVEN Science Status

- Observations at Comet Siding Spring: H coma surrounding comet nucleus imaged; discovery of new metal ion layer due to comet dust
- First “deep dip campaign” carried out week of 10 Feb.
- Three months into our one-Earth-year science mission
- All instruments returning high-quality data; some early observations released for public engagement
- Team now beginning analysis of data emphasizing science results
- Planning first major presentation of results at Lunar and Planetary Science Conference (week of 16 March, Houston, Texas; 56 abstracts submitted)
- Planning underway for remainder of primary mission and for extended mission for science and relay