Project Details

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Topic: Space Weather at Terrestrial Planets

Project Title:
Understanding the effects of solar flares on the upper atmospheres of Mars and Venus

PI Name: Aaron Ridley
PI Email: ridley@umich.edu
Affiliation: University of Michigan
Project Member(s):
- Bougher, Stephen Wesley; Co-I; University Of Michigan, Ann Arbor
- Champoux, Cheri L; Co-I
- Bell, Jared M; Co-I; National Institute Of Aerospace Associates
- Pawlowski, David J; Co-I; Eastern Michigan University
- Withers, Paul ; Co-I; Boston University

Summary:
The upper atmospheric reaction to solar flares and solar extreme ultraviolet (EUV) radiance has been studied extensively at Earth using both data and models. At Mars and Venus, the reaction has not been studied nearly as much. While the slowly varying solar cycle variations in the solar EUV are known to cause changes in temperature, winds and densities, it is unclear how rapid variations in the solar EUV will cause changes at Mars and Venus.

These planets are somewhat similar to each other and Earth in that they each have both thermospheres and ionospheres. While the Earth has a strong magnetic field, Mars's magnetic field is quite weak and localized and Venus has no magnetic field. Prior studies showed that the magnetic field plays a role in the ionospheric response to solar flares at Earth, but it is not clear whether this would be true at Mars.

Both Earth and Mars have a rotation period that is similar, which allows a relatively weak day-to-night temperature gradient, and therefore a weak change in the speed of propagation from the dayside to the nightside for the traveling atmospheric disturbance (TAD) from the flare. At Venus, however, the rotation rate is quite small, and a strong terminator exists. This would cause a large change in the wave speed from day to night, and may alter the propagation characteristics of the TAD.

We plan to quantify the role that traveling atmospheric disturbances play in shaping the upper atmospheres of Venus and Mars through the use of a Global Ionosphere Thermosphere Model (GITM) that has been adapted for use at both Venus and Mars as well as Earth. We will focus on disturbances that are launched as a result of solar flare activity and investigate the behavior of these waves and how they depend on the differences in the temperature and density of the upper atmosphere as well as look at the role of Mar's small-scale magnetic fields plays in the global transfer of energy and momentum.

Finally, we will perform data-model comparisons using a variety of datasets, including observations from MAVEN (IUVS, NGIMS, ACCEL), MGS (RS, ACCEL), Mars Express (MARSIS), and Venus Express, in order to better understand the physical processes that shape the upper atmospheres of each planet.

While we will not study TADs and flares at Earth, we will compare the results of the studies at Mars and Venus to the published results at Earth, in order to put the results into context.

Publication References:

no references