Project Details

ROSES ID: NNH15ZDA001N
Selection Year: 2015
Program Element: Focused Science Topic

Topic: Space Weather at Terrestrial Planets

Project Title:
Improving Solar EUV Spectral Irradiance Models with Multi Vantage Point Observations

PI Name: Francis G. Eparvier
PI Email: eparvier@colorado.edu
Affiliation: University Of Colorado, Boulder
Project Member(s):
- Woods, Thomas N.; Co-I; University Of Colorado, Boulder
- Chamberlin, Phillip C; Co-I; NASA Goddard Space Flight Center
- Thiemann, Ed ; Co-I; University Of Colorado, Boulder
- Peterson, William K; Co-I; University Of Colorado, Boulder

Summary:
Solar EUV irradiance is a primary source of energy for the upper atmospheres of terrestrial planets. First-principles-based thermo/ionosphere models (e.g. TIE-GCM for Earth and MGITM for Mars) require solar EUV spectra as input. Simple F10.7-based proxy models are often used, but TIMED-SEE and SDO-EVE data have shown that models using four proxies from distinct temperature regions of the Sun better estimate the solar EUV. In addition, photoelectron models require 0.1 nm resolution spectra between 0-6 nm to properly account for Auger electrons that further ionize by electron impact in the planet , " s atmosphere.

The MAVEN mission to Mars is the first planetary probe to directly measure solar EUV in-situ with its EUVM instrument, providing an unprecedented opportunity to develop and validate new methods to estimate the solar EUV input at other planets, addressing the objectives of Focused Science Topic (FST) 1, Space Weather at Terrestrial Planets: Comparative Climatology. We propose to use MAVEN and Earth-based solar observations to meet the following three objectives: (1) Improve models of daily solar EUV irradiance at other planets; (2) Improve models of flaring solar EUV irradiance at other planets; (3) Develop a 0.1 nm resolution model of flaring irradiance in the 0-6 nm band validated by photoelectron measurements.

Objective 1 is met by developing a model using a variety of Earth-based proxies to produce daily irradiance values elsewhere in the solar system and validating the model against MAVEN-EUVM measurements made at different heliospheric longitudes. The EUVM measures transition-region, hot and cool corona emissions and hence covers a variety of solar irradiance variability. Earth-based proxies to be considered include linear interpolating standard proxies via Carrington Rotation, flux transport models (e.g. Air Force Data Assimilative Photospheric-flux Transport (ADAPT)), and helioseismology-derived far-side , imagery , " such as those derived by SDO HMI and GONG. The comparison of the Earth-based proxies to EUVM measurements will help advance the understanding of center-to-limb variations (CLV) for EUV wavelengths and to improve the ability to forecast the effects of active region evolution as related to behind-the-limb active regions from Earth , " s view but visible to Mars.

Objective 2 is met by using simultaneous flare observations from Earth and Mars to characterize CLV effects, and updating flare irradiance models with recent advances to accurately capture the EUV gradual phase. Simultaneous measurements from Earth and Mars of both optically thick and thin emissions, a variety of which have already been made, provide an unprecedented opportunity to validate our capability of estimating solar flare irradiance elsewhere in the solar system. Flare irradiance models for Mars driven with Earth proxies will be validated with MAVEN measurements, and models for Earth driven with Mars proxies will be compared against Earth asset measurements.

Objective 3 is met by developing a model that uses the EUVM bands (as simulated using Earth measurements) as proxies and SXR reference spectra from the TIMED-SEE XPS model, spectral rocket measurements, and new SXR spectral measurements from the NASA MinXSS cubesat that is expected to be launched in June 2015. Validations will include using the new spectra in photoelectron models and comparing the results to photoelectron observations at both Mars and Earth.

This proposal meets the FST 1 goals by advancing the , understanding , of various planets , to solar forcing at various time-scales , " as well as providing improved solar EUV spectral models catered to planets other than Earth which will , improve modeling and characterization of response of various terrestrial environments to varying solar output , " by using , current observations to validate and calibrate models and allow these models to explore historical and climatological trends , " .

Publication References:

Summary: no summary

Reference: Thiemann, Edward M. B.; Chamberlin, Phillip C.; Eparvier, Francis G.; Templeman, Brian; Woods, Thomas N.; Bougher, Stephen W.; Jakosky, Bruce M.; (2017), The MAVEN EUVM model of solar spectral irradiance variability at Mars: Algorithms and results, Journal of Geophysical Research: Space Physics, Volume 122, Issue 3, pp. 2748-2767, doi: 10.1002/2016JA023512

Summary: no summary

Reference: Lee, C. O.; Hara, T.; Halekas, J. S.; Thiemann, E.; Chamberlin, P.; Eparvier, F.; Lillis, R. J.; Larson, D. E.; Dunn, P. A.; Espley, J. R.; Gruesbeck, J.; Curry, S. M.; Luhmann, J. G.; Jakosky, B. M.; (2017), MAVEN observations of the solar cycle 24 space weather conditions at Mars, Journal of Geophysical Research: Space Physics, Volume 122, Issue 3, pp. 2768-2794, doi: 10.1002/2016JA023495