Project Details

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Selection Year: 2022
Program Element: Focused Science Topic

Topic: FST #1: Beyond F10.7: Quantifying Solar EUV Flux and its Impact on the Ionosphere - Thermosphere - Mesosphere System

Project Title:
Characterization and Validation of Solar EUV and Soft X-Ray Spectral Irradiance Models Using Photoelectron Spectra as an Absolute Irradiance Reference

PI Name: Shaosui Xu
PI Email: atn@g.ucla.edu
Affiliation: University of California, Berkeley
Project Member(s):
- Mitchell, David L.;Co-I;THE REGENTS OF THE UNIVERSITY OF CALIFORNIA
- Thiemann, Ed;Co-I;University Of Colorado, Boulder

Summary:
Science Goals and Objectives: Solar extreme ultraviolet (EUV) and X-ray photons are a primary source of energy for the upper atmospheres of terrestrial planets. To best characterize how the solar EUV flux impacts Earth's Ionosphere-Thermosphere-Mesosphere system, more accurate models of the solar EUV spectrum are needed. Simple F10.7-based proxy models are often used, but studies have shown that models using four proxies from distinct temperature regions of the Sun better estimate the solar EUV. Meanwhile, photoelectrons are a product of solar EUV photoionizing the neutral atmosphere, whose energy spectra preserve distinctive features of the solar EUV spectra and can be used to validate solar irradiance models. In this project, we utilize a unique combination of observations and models available at Mars, the quality of which are unparalleled by measurements at any other planet including Earth, to best validate the solar irradiance modeling for both Mars and Earth, which addresses FST#1: Beyond F10.7: Quantifying solar EUV flux and its impact on the IMT system. Our proposed objectives are: (1) characterize and validate a solar irradiance model, Synthetic Reference Spectra (SynRef) Model, using a combination of MAVEN (Mars Atmosphere and Volatile EvolutioN) observations and photoelectron modeling with the SuperTheraml Electron Transport (STET) model; (2) compare validated SynRef irradiances with those measured by the TIMED and SORCE X-ray Photometer System (XPS) Level 4 modeled irradiances; (3) develop a soft X-ray proxy based on the Auger electron fluxes (photoelectrons produced by soft X-rays _x000D_
Methodology: To achieve Objective 1, the SynRef model provides the solar irradiance spectrum for 0.1 190 nm, which is fed into the STET model to simulate photoelectron energy spectra. The modeled photoelectron energy spectra can then be compared with observed photoelectron energy spectra by MAVEN. The free parameters of Synref are the reference spectra and the instrument response function (within its known uncertainty range). We will conduct data-model comparisons over a range of solar activity to best calibrate the SynRef model. We will then compare the improved SynRef model with irradiance observations made at Earth by SORCE and TIMED XPS and quantify any differences (Objective 2). We will make the comparison when the Sun-Mars-Earth angle is small, as well as compare 27-day smoothed values to minimize differences due to different vantage points. For Objectives 3 and 4, we utilize the linear correlation between the photon flux and the photoelectron flux to develop a proxy for soft X-rays. We will find the linear regression relationship between the Auger electron fluxes observed by MAVEN and the best-fit band-passes predicted by the SynRef irradiance model (Objective 3). This linear regression relation will be then applied to Auger electron observations by both MAVEN and MGS to generate a soft X-ray proxy and then a catalog of solar flare events for 1999-2006 (MGS) and 2014-2022 (MAVEN) (Objective 4). _x000D_
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Relevance and Impacts: Our Objectives of improving the solar irradiance modeling directly address FST #1: Beyond F10.7: Quantifying solar EUV flux and its impact on the IMT system" by identifying new and/or improved EUV indices for driving model predictions of ITM structure." In addition, our Objectives 3 and 4 provide a long-term proxy for soft X-rays at an additional vantage away from Earth. This additional catalog of flares observed at Mars is of particular interest for studying over-the-limb and far-side flare effects on near-side disk radiance and radiative transport in the solar corona, which improves our general understanding of the solar flare generation and thus also helps a better quantification of solar EUV fluxes.

Publication References:

no references