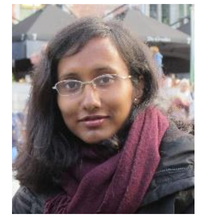
Thomas Metcalf Award 2018 Report
Solar Dynamic Observatory Conference, October 29- November 2, 2018
Srimoyee Samaddar



Research Interest

I am a graduate student at Virginia Polytechnic Institute and State University working towards my PhD. In my research, I study the variability of the solar soft x-rays and their effects on the structure and chemistry of the Earth's upper atmosphere. In the Solar Dynamic Observatory (SDO) 2018 workshop, I have presented my results in the format of a poster.

Contribution to the SDO Conference

The Role of the Solar Soft X-ray Irradiance on Thermospheric Structure

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We have used the newly developed ACE1D (The Atmospheric Chemistry and Energetics 1D) model by Dr. Karthik Venkataramani for our studies. The model is a global average model that self consistently solves the continuity and energy equations to give the densities and temperatures of the ions, electrons as well as major and minor neutral species. The model includes all important radiative, chemical, and conductive processes. Calculations of neutral densities and exospheric temperatures are found to be in good agreement with empirical data for a wide range of solar activity. The primary input to the model is the solar irradiance (0.05-175 nm).

We ran the ACE1D model by scaling the solar spectrum in individual ~1nm wavelength bins. We performed 37 models runs with one wavelength bin scaled by zero and all others by 1.0. By looking at the change in modeled exospheric temperature (compared to the case where all scaling factors are 1.0), we saw that neutral thermospheric temperature is especially sensitive to solar soft X-ray wavelengths to a maximum factor of 8 K/nm in the 22.4 and 29 nm bin out of all the bins from 0.05- 175nm. Upon further analysis of the upper ionosphere, we observed that the change in the soft x-rays, in the wavelength range below 30.4nm, changes the thermospheric temperature drastically, although, it is well known that most of its energy is deposited low in the thermosphere. We continued by looking at cases where the entire solar soft X-ray spectrum was scaled and looked at the terms in the heat equation in order to explain how solar soft X-rays heat the entire thermosphere.

We believe that the increase in thermospheric temperature is due to the increase in thermal conductivity, which increases dramatically with solar soft x-ray irradiance. This is primarily due to an increase in electron densities. That increase is due to ambipolar diffusion from the altitude of photoionization to the F-region. Heat generated by the collisions of electrons and ions with neutrals then leads to increased temperature.

We have also shown the effect of variability of the solar soft X-ray irradiance on the important He 30.4 nm emission. The shorter wavelengths together with the 30.4nm play a significant role in the determination of thermospheric temperature. Comparing this 30.4nm and the soft x-ray bins below it, we see that the shorter wavelengths play a combined role that is significantly larger than the 30.4 nm feature.

Our results found an uncertainty of a factor-of-two in the thermospheric temperatures, for factor of two uncertainties in the solar soft X-ray irradiances. The uncertainties in temperature were estimated by running the model at various F10.7 (driving EUVAC irradiances), scaling the wavelength $\lambda < 30.4\ nm$ by factors of 0.5 and 2 and taking the averages of the differences between runs with the unity scaling.

Benefits from the Conference

I would like to thank the Solar Physics Division of the American Astronomical Society for giving me the opportunity to present my work as a Metcalf Lecturer. It has been a pleasure and privilege to be able to be attend this conference and workshop, to be able to participate in the discussions, mini-workshops and the myriad of research at the frontier of the space weather and collaborate with experts with similar interests as my own, from all over the world.