NOAA ROSES Semi-Annual Report

Reporting Period: March 2021 – August 2021 (2nd report)

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Project Title: Determination of Exospheric Neutral Hydrogen Density from GOES-R

Executive Summary (1 paragraph max)

At this point, our project is well underway and we are accomplishing our milestones. The goals for this first year were to develop two exospheric model, revise the Monte Carlo model, and to create and make publicly available a Lyman-alpha data set. The models have been developed and are being exercised and revised. The Lyman-alpha data set should be released within the next two months as well as an additional ephemeris data set that was found to be needed by the project. The team has been meeting monthly for progress updates and technical discussions.

Progress toward FY20 Milestones and Relevant Findings (with any Figs)

Milestone 1: All three models implemented for GOES-R data.

Dolon Bhattacharyya modified her Monte Carlo model to simulate Earth's exospheric conditions; the model had been previously used to study Mars' exosphere. This model was run for 6 different exospheric temperature conditions, 700 K - 1200 K in steps of 100 K, for an exospheric H density of 1E5 cc in order to determine the line of sight velocity distribution of these H atoms for 274 different GOES-R lines of sight. The results were verified against a theoretical model which was constructed based on Vidal-Madjar and Bertaux [1972], and Bertaux [1978]. These velocity distributions were then provided to team member and Co-I Ed Thiemann as input to his model.

Ed Thiemann developed a preliminary data processing code to retrieve H density above ~1500 km altitude. Methods for incorporating accurate altitude and temperature dependent cross sections provided by Dolon have been implemented. Methods for accounting for solar variability have been implemented. Methods for accounting for atmospheric shape over the spatial extent of the solar disk have been implemented. Approximately 20 observations have been analyzed and observations are in excellent agreement with TWINS measurements near solar minimum above 3 R_E and model expectations below 3 R_E.

Janet Machol determined an optimized proxy for Lyman alpha irradiance at a 1-minute cadence. The chosen proxy is based on the He II (30.4 nm) irradiance as measured with the GOES-R EUVS instrument. Using this proxy, she wrote a code for a preliminary optically thin model of the exospheric hydrogen density. This model can be easily run and compared with earlier results in journal articles and the results obtained from team member Ed Thiemann with the Wavelength Integrated Model. The model has been run for one full year of data. These results show the necessity of reprocessing the GOES 14/15 30.4 nm data.

Milestone 2: GOES-14/15 Lyman-α calibrations complete.

Allyssa Riley has completed much of the work towards the creation of a dataset of reprocessed GOES 14-15 Lyman-alpha (121.6 nm) irradiances. For the Lyman-alpha irradiances, the raw counts data have been cleaned and new data quality flags were created. The data still requires averaging and instrument degradation correction. This data, along with a readme, will be publicly released in the next reporting period. The code created for this reprocessing will be reused with small changes to reprocess a different GOES channel to create a dataset at 30.4 nm which will be publicly released in 2022. Allyssa also created a netCDF version of the previously generated GOES 14/15 Lyman alpha data for 2010-2016 was made publicly available while the new version is being developed.

Stefan Codrescu developed and tested software to produce the ephemeris from the L0 data. Satellite location data is essential for these exosphere models, and the current GOES-R L1b data has major errors in the first two years and so is not usable. This data, along with a readme, will be publicly released from the NCEI GOES-R website in the next reporting period.

Janet created netCDF files in GOES-R format with GOES 8-15 ephemeris data. This data was made publicly available from the NCEI GOES-R website and was announced in a bulk email to about 100 people in the EUVS community mentioned the GOES 8-15.

Plans for Next Reporting Period

The team will continue to meet monthly to discuss progress and have technical discussions. Presentations on the project will be made at the AGU Fall Meeting, the Solar-Terrestrial Physics Symposium (STP-15), and at a NOAA ROSES Science Meeting associated with the launch of GOES-T. The team will also start drafting one or two journal articles on the method and results.

Bhattacharyya: Streamline the velocity distribution calculation procedure as well as running the model for more GOES satellite lines of sight. Satellite particles may be incorporated based on the initial best-fit densities retrieved by fitting the model results to the GOES satellite data.

Thiemann: Develop a detailed, Monte-Carlo based analysis of the measurement random uncertainty and systematic error in both the optically thin and thick regions of the corona.

Machol: Evaluate and optimize the optically thin model. Consider adding a functional term for the longitude. Compare model results with other models. Cross compare results with TWINS data.

Machol, Codrescu: Publicly release GOES-R ephemeris data files at 1-minute cadence and associated Readme.

Machol, Riley: Complete and publicly release reprocessed science-quality netCDF version of GOES 14/15 Lyman alpha data for 2010-2020. Release associated documentation. Begin work on reprocessing GOES 14/15 30.4-nm data.