CLIMATE AND SPACE SCIENCES AND ENGINEERING
UNIVERSITY OF MICHIGAN

Solar Wind Propagation for Planetary Space Weather Research

NSF

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INTRODUCTION

Space weather at various planets has been of great interest in the last few decades. This is due to the interest of reaching other planets in our solar system, such as Mars and the possibility of colonizing them. To be able to even consider those possibilities various studies are necessary. Knowledge of the solar wind conditions is necessary for understanding the space environment and the space weather at other planets. Even though there is constant monitoring of the solar wind at Earth there is rarely any in-situ solar wind monitoring for other planets. For this reason, a solar wind propagation model has been designed and developed, called mSWiM (Michigan Solar Wind Propagation Model). mSWiM allows the user to propagate solar wind measurements obtained at Earth's orbit to other planets for planetary space weather research.

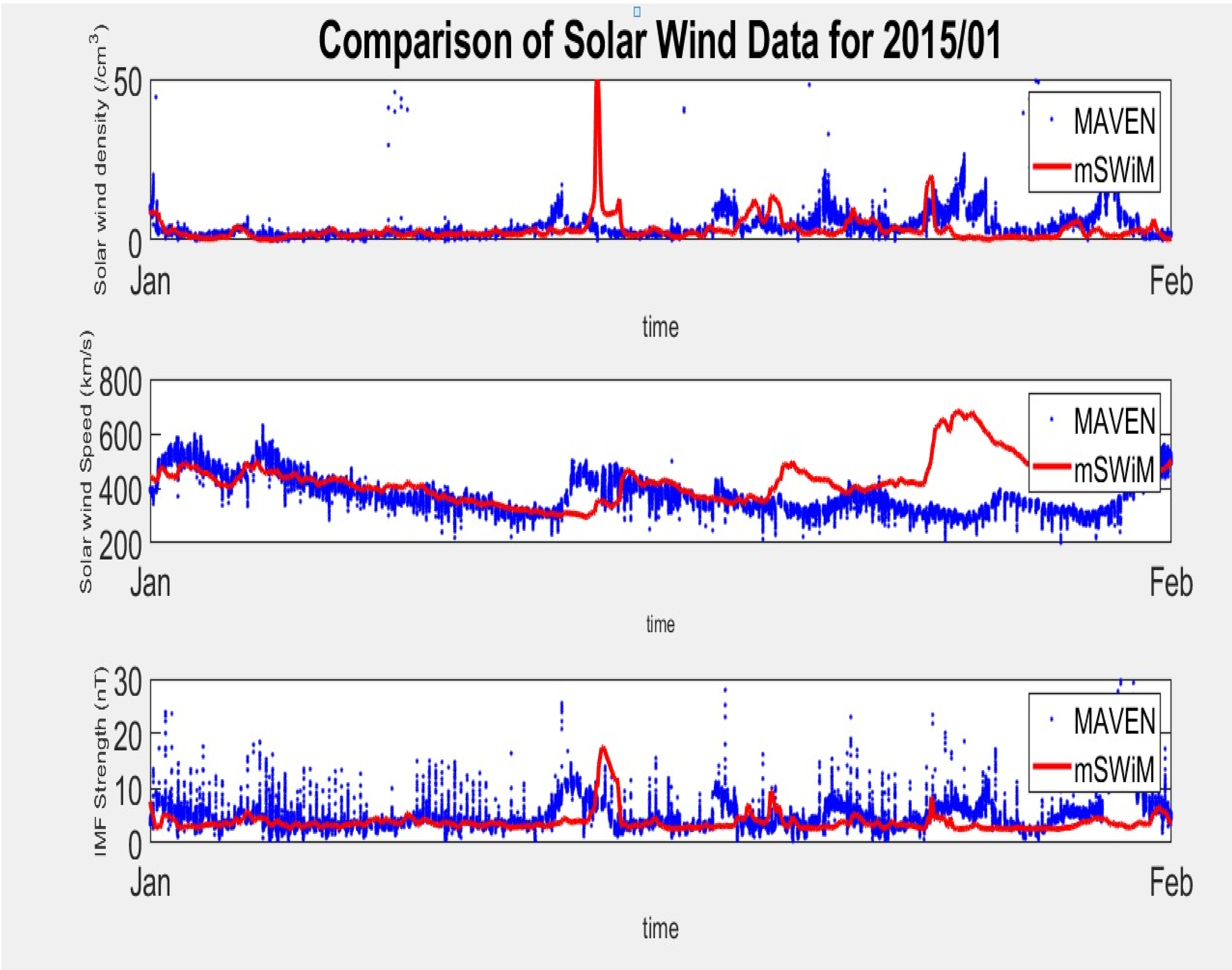
OBJECTIVE

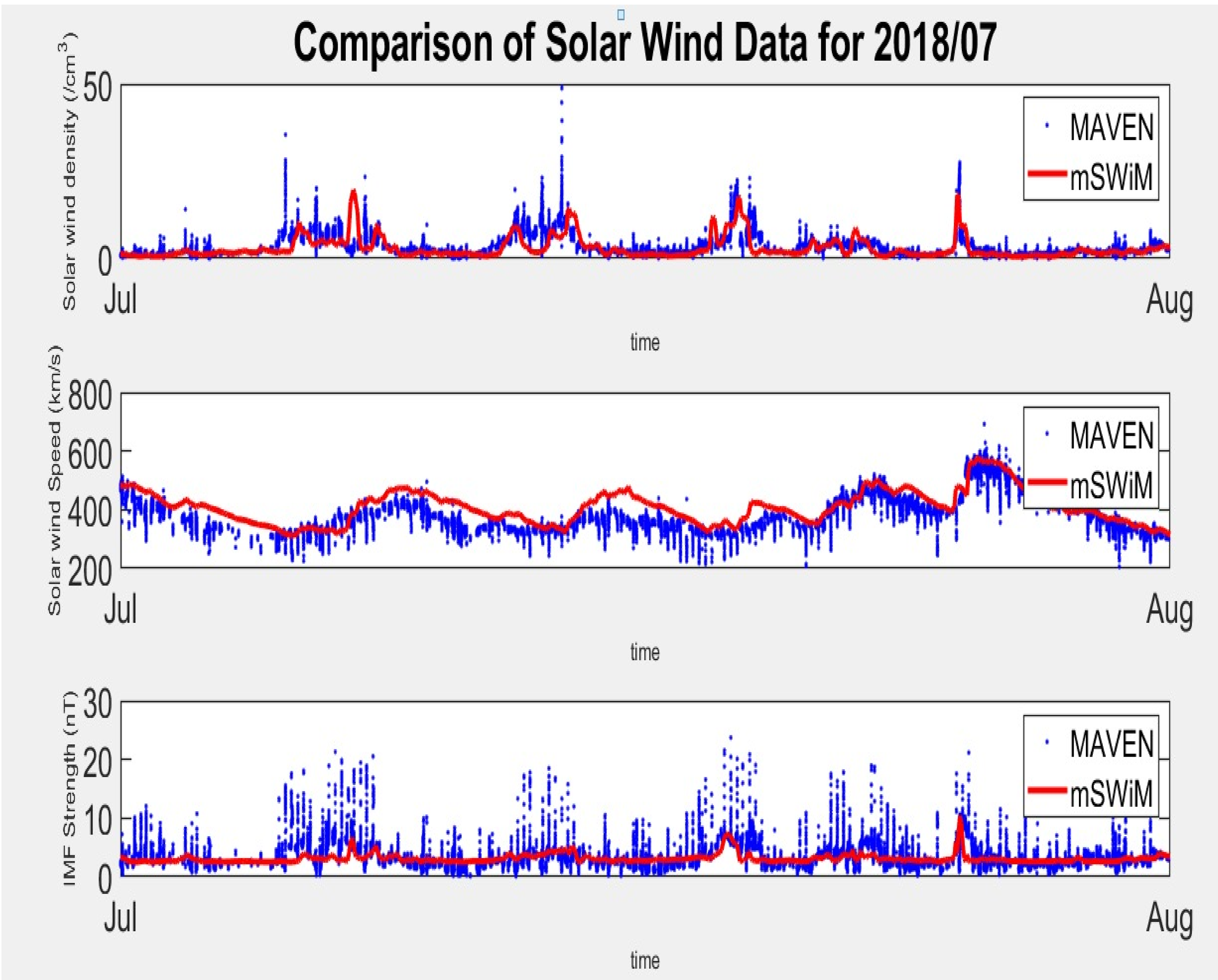
The objective of this research project is to undertake new simulations to enhance and upgrade mSWiM, preform new simulations to propagate solar wind data to Mars, and validate the simulation results using the MAVEN mission data. Also, to demonstrate that mSWiM could be an economical option for predicting solar wind conditions at Mars and to make this data publicly available to the science community for further studies.

METHODOLOGY

It is rare to have the solar wind data routinely available for other planets due to lack of dedicated upstream monitors. The mSWiM (Michigan Solar Wind Propagation Model) is based on magnetohydrodynamics that allows us to propagate solar wind measurements obtained at the Earth's orbit to other planets in the solar system. mSWiM provides solar wind information for planets like Mars, Jupiter, Saturn, etc. To gain a better understanding and visualization on how efficient and reliable this model is in capturing this data, it was determined to preform solar wind propagation for Mars and to compare the simulation results with MAVEN in situ observations for model validation. The data sets in used were MAVEN_01_2015, MAVEN_07_2018, OMNI_2015 and OMNI_2018. The two data sets were smoothed, filtered, and interpolated in the MATLAB program to provide a clear visualization of the data. The variables considered for MAVEN and OMNI data set were MAVEN_SW_Np, MAVEN_SW_Vmag, MAVEN_SW_Bmag, rho (solar wind density), vr (solar wind radial speed) and sqrt (br^2 + bt^2 + bn^2) (Interplanetary Magnetic Field Strength). The two data sets were plotted and visualized to have a better view of how well the program is performing.

RESULTS





CONCLUSION

With the data collected, simulated, and studied it was determined that the mSWiM model could potentially provide a reasonable means for predicting the solar wind conditions at Mars. The next step will be to quantify the performance of mSWiM by conducting correlation analysis for various solar wind and IMF parameters and to expand the analysis to include different time intervals in order to evaluate the model's robustness for solar wind prediction.

REFERENCES

Zieger, B., & Hansen, K. C. (2008, August 12). Statistical validation of a solar wind propagation model from 1 to 10 AU. https://pdfs.semanticscholar.org/3f2e/10990d9252b8c15a4331b1e781db5175ff49.pdf. Received 18 January 2008; revised 22 April 2008; accepted 9 May 2008; published 12 August 2008.

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