

Validating the WSA-ENLIL Model

Michelangelo Romano

*The Catholic University of America
NASA Goddard Space Flight Center*

Outline

- Introduction
 - Tasks/Activities
- Background
- Motivation
- Analysis Process
- Results
- Conclusion
- Internship Experience

Tasks/Activities

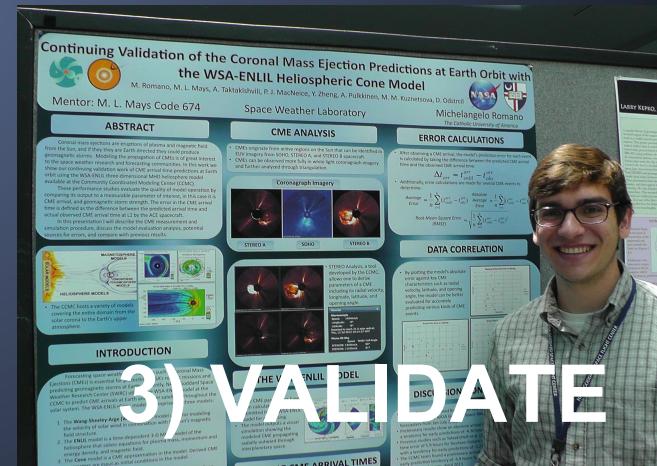
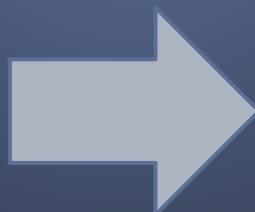
- Space Weather Forecaster (SWRC)
- Teaching Assistant for SW REDI Program
- Undergraduate Forecaster Mentor
- Model Validation
 - CME Analysis
 - Launching Simulations
 - Analyzing Data

Introduction

1) FORECAST



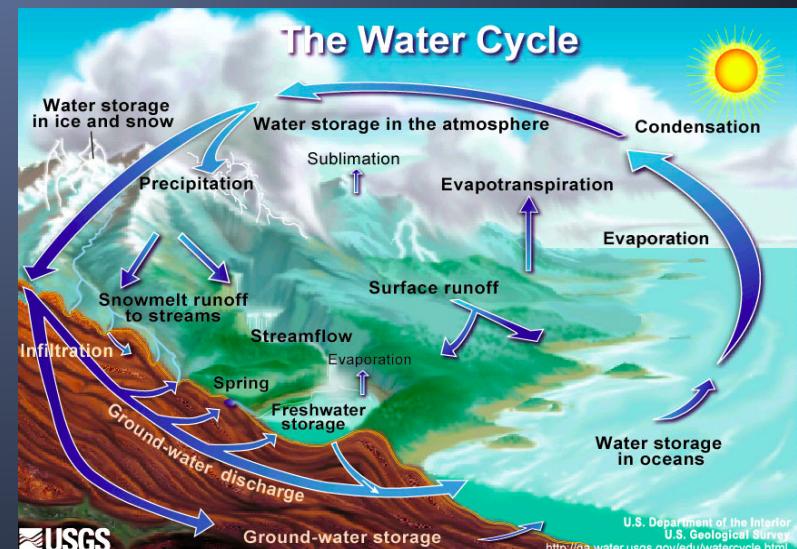
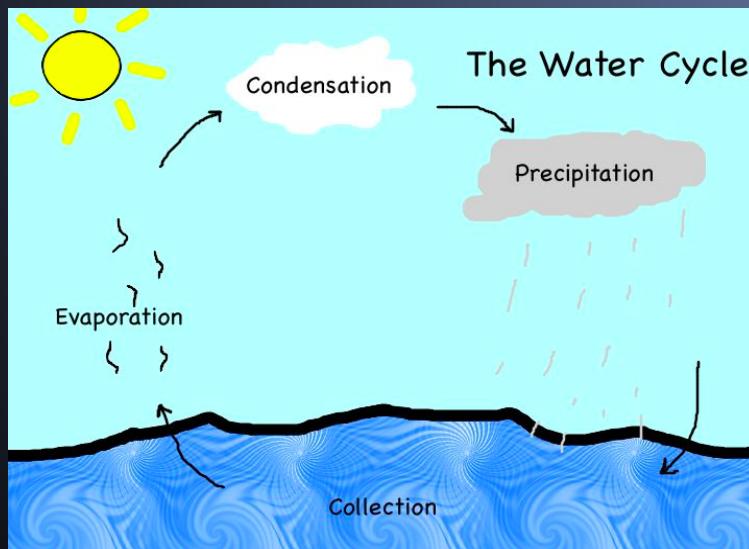
2) OBSERVE



3) VALIDATE

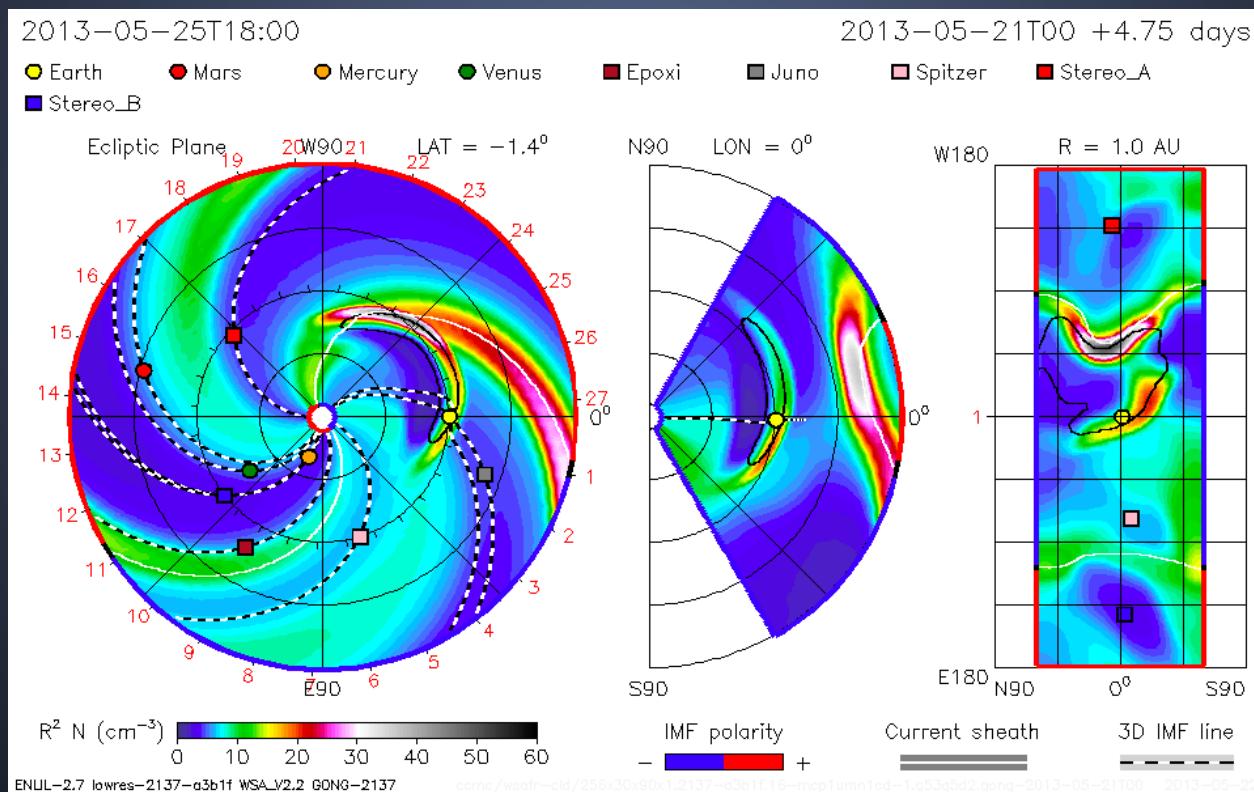
Background

- What is a model?
 - “A schematic description of a system, theory, or phenomenon that accounts for its known or inferred properties and may be used for further study of its characteristics.” - www.thefreedictionary.com



Background

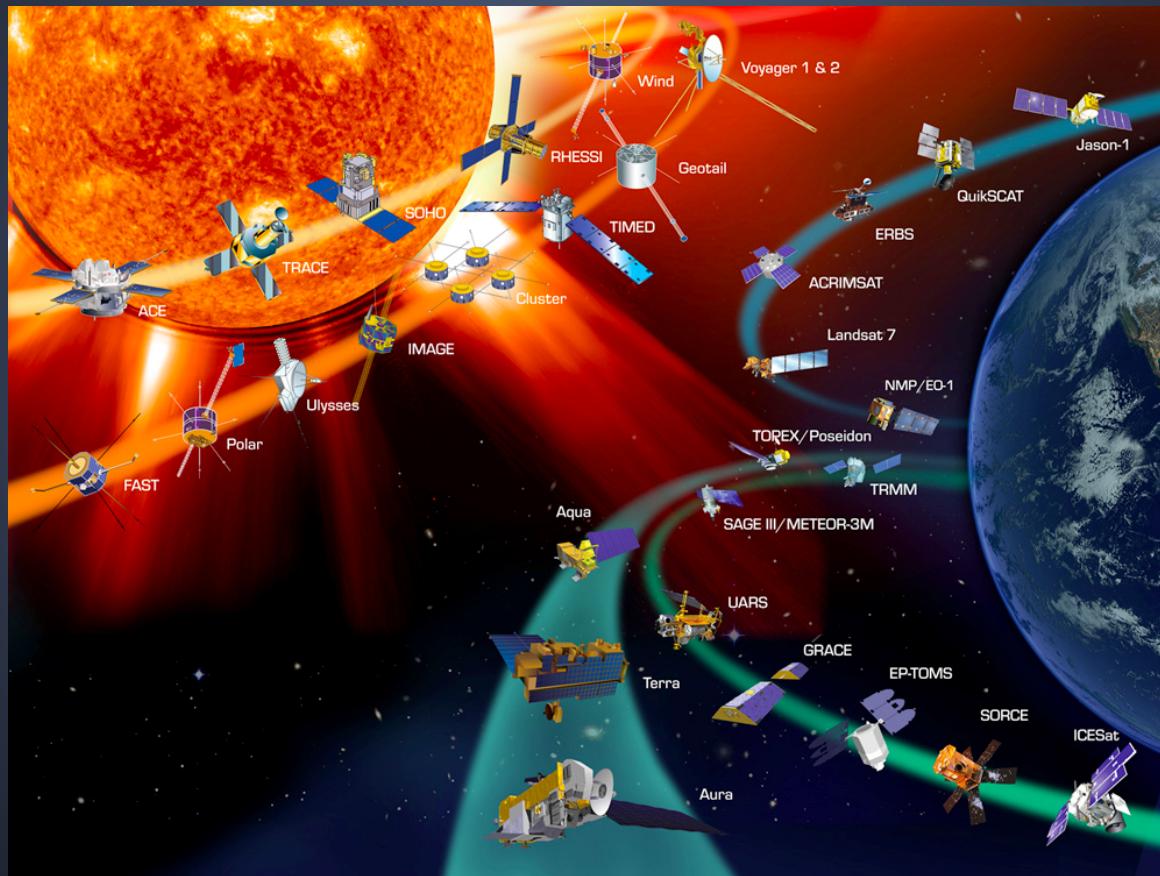
- What is the WSA-ENLIL+Cone Model?



Background

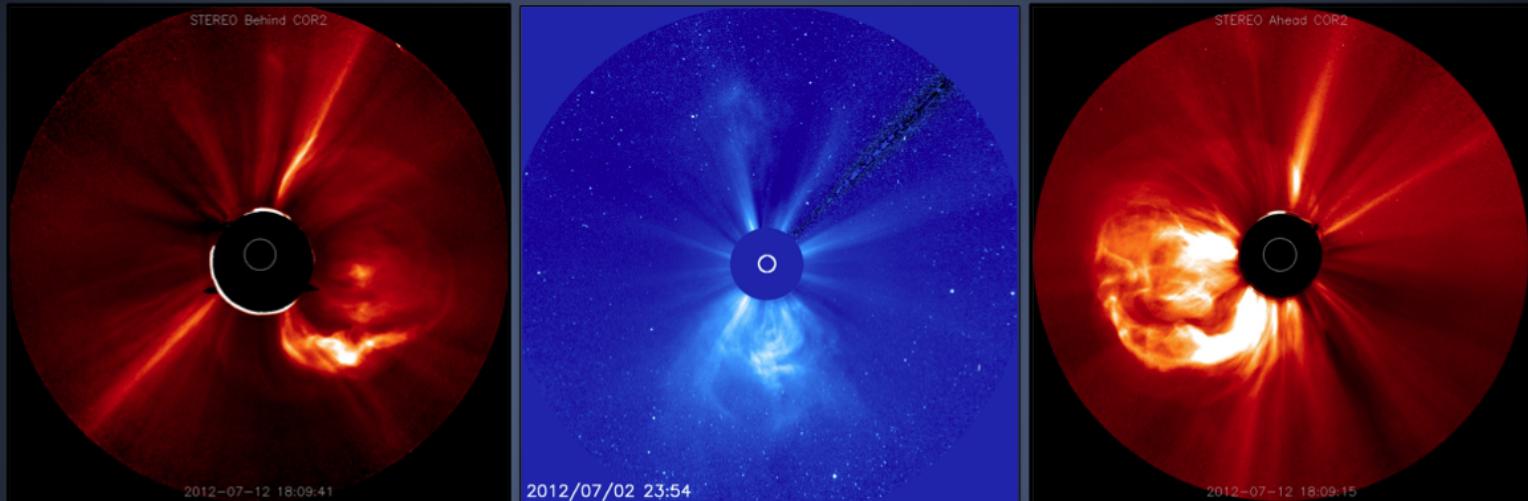
- What is the Wang-Sheely-Arge (WSA) Model?
 - A model for solar wind velocity in combination with the Sun's magnetic field structure.
- What is the ENLIL Model?
 - A time-dependent 3-D MHD model of the heliosphere that solves equations for plasma mass, momentum, energy density, and magnetic field.
- What is the Cone Model?
 - A model for deriving and approximating CME parameters (i.e. radial velocity, latitude, etc.)

Motivation



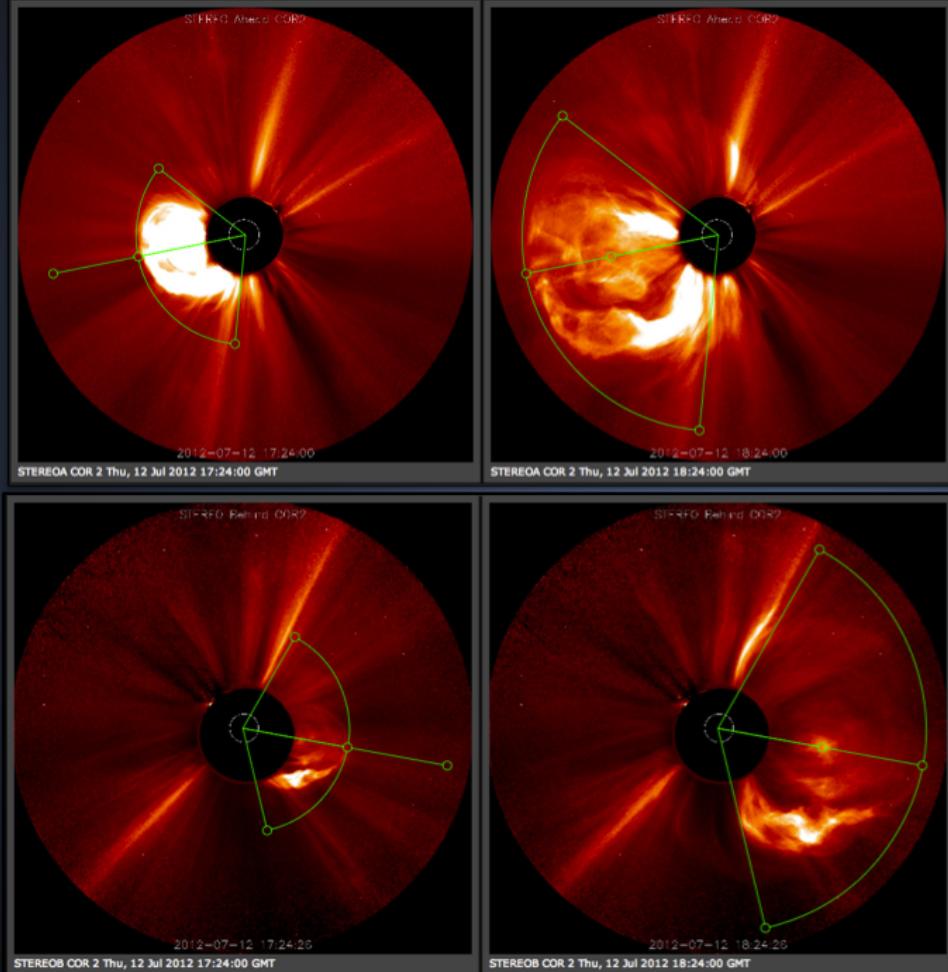
PROCESS

CME Analysis



- CMEs originate from active regions on the Sun that can be identified in EUV imagery from SOHO, STEREO A, and STEREO B spacecraft.
- CMEs can be observed more fully in white light coronagraph imagery and further analyzed through triangulation.

PROCESS CME ANALYSIS



- StereoCat, a tool developed by the CCMC (Jack), allows one to derive parameters of a CME including its radial velocity, longitude, latitude, and opening angle.

Results

Stereoscopic

Speed:	1404km/s
Longitude:	-9°
Latitude:	-9°

Expected to reach 21.5 solar radii at:
Thu, 12 Jul 2012 19:14:37 GMT

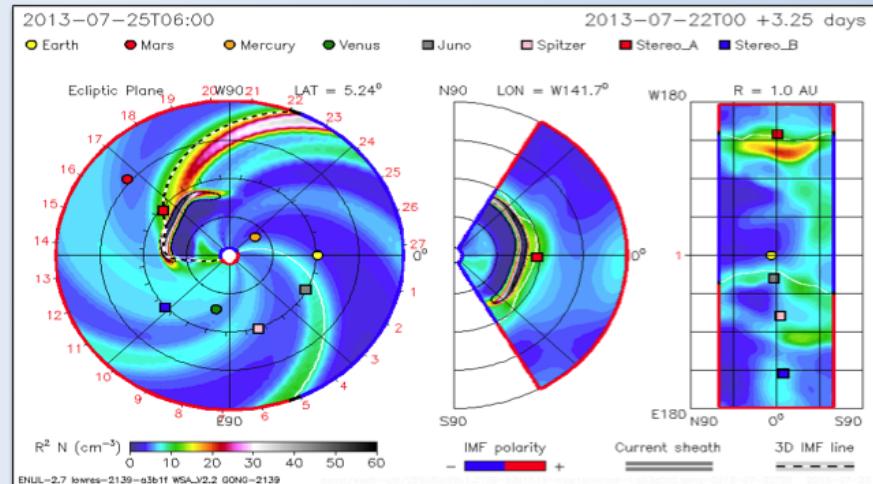
Plane-Of-Sky

	Speed	Width	Half-Angle
STEREOB:	1350km/s		69°
STEREOA:	1102km/s		61°

PROCESS

Launching the Model

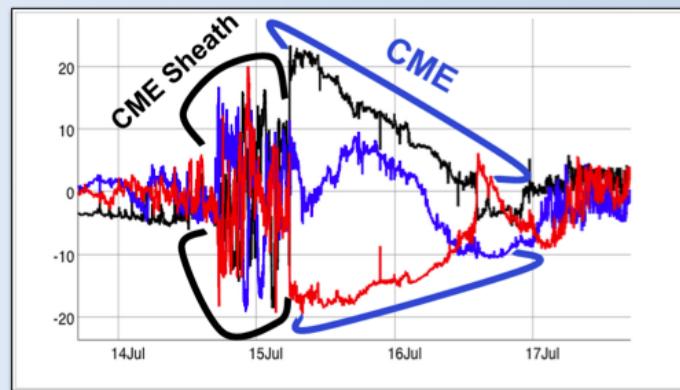
- Once CME parameters have been calculated, this data is submitted to the WSA-ENLIL model for processing.
- The model outputs a visual simulation showing the modeled CME propagating radially outward through interplanetary space.



PROCESS

Verifying CME Arrival Times

- Irregular disturbances and fluctuations in the magnetic field and solar wind data from these satellites often indicate the arrival of a CME.



PROCESS

Error Calculations

- After observing a CME arrival, the model's prediction error for each event is calculated by taking the difference between the predicted CME arrival time and the observed CME arrival time:

$$\Delta t_{err} = t_{enlil}^{arr} - t_{obs}^{arr}$$

- Additionally, error calculations are made for several CME events to determine:

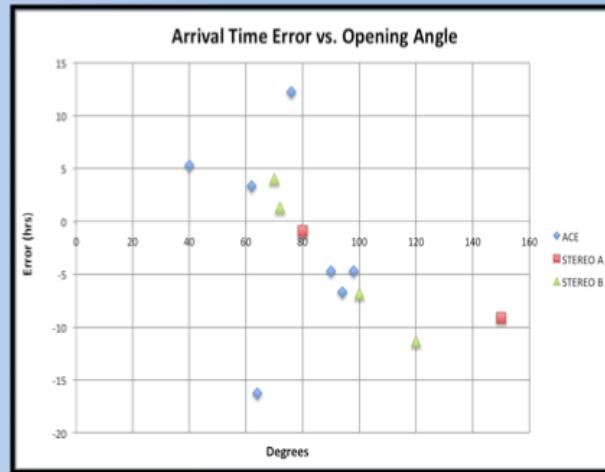
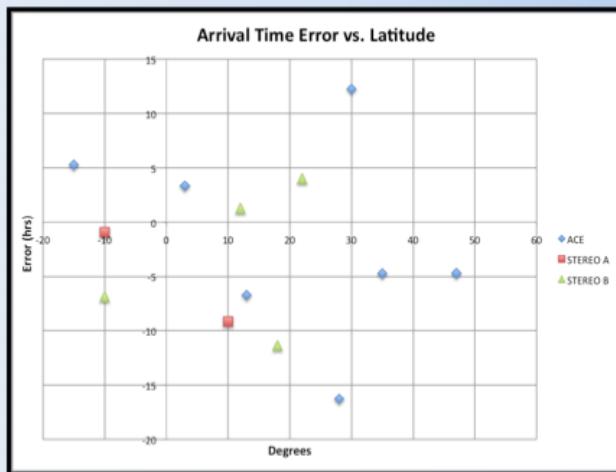
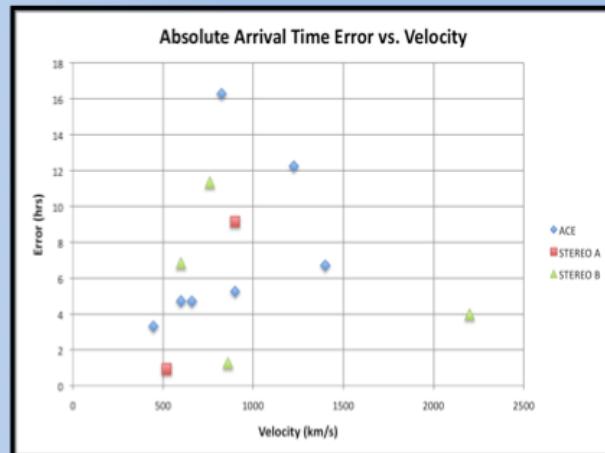
$$\text{Average Error} = \frac{1}{n} \sum_{i=1}^n (t_{enlil}^{arr} - t_{obs}^{arr})$$

$$\text{Absolute Average Error} = \frac{1}{n} \sum_{i=1}^n |(t_{enlil}^{arr} - t_{obs}^{arr})|$$

$$\text{Root-Mean-Square Error (RMSE)} = \sqrt{\frac{1}{n} \sum_{i=1}^n (t_{enlil}^{arr} - t_{obs}^{arr})^2}$$

Results

- By plotting the model's absolute error against key CME characteristics such as radial velocity, latitude, and opening angle, the model can be better evaluated for accurately predicting various kinds of CME events.



Conclusion

- This study was performed for thirteen real-time WSA-ENLIL+Cone model runs performed by NASA Goddard Space Weather Research Center forecasters from Jan-July 2013.
- Preliminary results show an absolute arrival time error of 11.15 hours and a tendency for early predictions of -4.30 hours.

Internship Experience

- Advanced my skills as a space weather forecaster.
- Explored an area of research with which I was unfamiliar.
- Learned to be more analytical and methodical with my research practices.
- Made great friends and found companions willing to explore the sciences with me!

Acknowledgments

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Questions or Comments?