Flux Rope Visualizing Tool to Link Local and Global Views

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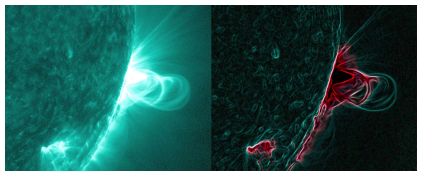
PROBLEM STATEMENT

The entrained magnetic structure associated with Coronal Mass Ejections (CMEs) are the main drivers of geomagnetic activity. Thus, a reliable prediction of the ICME internal magnetic field structure is a requisite for developing a robust space weather forecast capability. Often, the in-situ imprints of the Interplanetary CMEs (ICMEs) display signatures of a confined magnetized plasma wrapped by helical magnetic field lines. The modeling and 3D reconstruction efforts are based on flux-rope topologies; locally (in-situ observations) based on axial-symmetric geometry, and globally (remote-sensing observations) based on a toroidal geometry. Still today, the reconciliation of both view-points is lacking a model or reconstruction that connects both sides.

OBJECTIVES

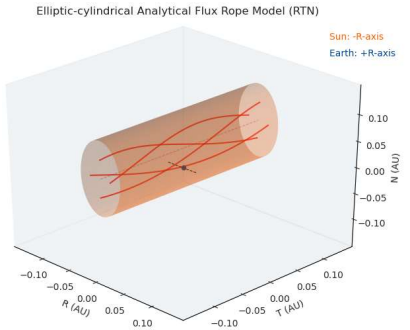
1) Provide a 3D visualization tool that can reconstruct the flux rope model described in Nieves-Chinchilla et. al 2018 (ApJ).
2) Create an interactive Graphical User Interface (GUI) where users can interact with the 3D model.
3) Develop an Application Programming Interface (API) to interactively load spacecraft insitu data from NASA servers and compare it to the reconstruction models described in Nieves-Chinchilla et. al 2018 (ApJ).
4) Develop 3D animations for users to interact with the model parameters and insitu data in the GUI.



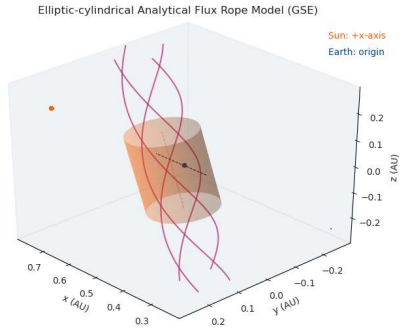
Flux rope forming from a Coronal Mass Ejection (Image Credit: NASA's Solar Dynamics Observatory)

3D RECONSTRUCTION

The GUI allows users to change the input parameters of the flux rope reconstruction model to see how they affect the geometry of the 3D model.



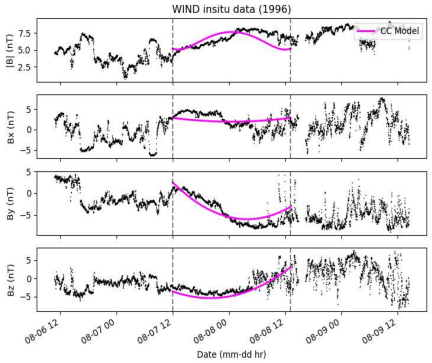
Users can choose between different reference frames (RTN, GSE, HEE), toggle the visual elements, and change the length of the field lines and flux tubes interactively within the GUI.



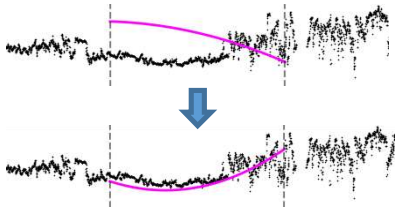
All these reconstructions can be animated in 3D and saved to a local computer. The GUI also allows users to save the still images in 3D.

2D RECONSTRUCTION

The flux rope reconstruction can be tested against insitu data from spacecraft. The GUI can fetch information from NASA servers and plot hundreds of insitu flux rope events against the flux rope model established in Nieves-Chinchilla et. al 2018 (ApJ).



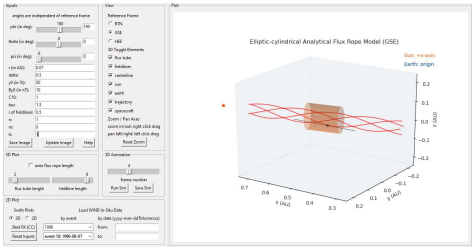
The inputs from the user are pictured in the 2D reconstruction of the flux rope model. Users can check how these inputs affect the line of best fit



Data can be loaded by know flux rope events or by date. This allows users to have a full autonomy to choose what data they want to choose from.

CONCLUSION

This contribution aspires to closing the gap between the local and the global view-points by providing a tool to exhibit a 3D global perspective based on the results from the in-situ reconstruction of the heliospheric magnetic flux-ropes. We have developed an interactive tool for users to easily visualize a magnetic flux rope based on the model developed in Nieves-Chinchilla et al. 2018 (ApJ). The tool allows the user to change the model's input parameters in a graphical user interface (GUI) and see the effect of these changes on the model. It illustrates flux ropes in a Sun-Earth system and for different observatories (i.e. Wind, STEREO, Bepi Colombo, PSP or Solar Orbiter), where users can visualize a spacecraft's trajectory through a flux rope in an interactive animation.



REFERENCES

Nieves-Chinchilla, T., Linton, M. G., Hidalgo, M. A., et al. 2016, ApJ, 823, 27

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