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Field Line Code

The purpose of this document is to explain the steps for producing a field line mapping at Jupiter. The field lines that are produced use the VIP_4 combined with the CAN sheet model.

For this program, the Voyager 1 & 2 spacecraft trajectory from ephemeris and the VIPER analyzed data set are hard coded into the procedures. These data sets are used to provide spacecraft location information to the program. The locations are the basis for where the field line creation begins. When producing a given field line, the code begins at the Spacecraft location and walks along a "field line" until this walk intersects with the Jupiter's surface at which point it goes back to the spacecraft location and walks the opposite direction until it again hits the surface. The code has several keyword arguments, which are documented within the code itself that determine the functionality of the code.

Compile order: dPdtheta.pro, getSchmidtCoefs.pro, getLegendre.pro, Field_lines.pro, call_field_lines.pro

Input: example: Call_field_lines, /create_maps

Keyword Arguments

- Ephemeris_Data – Using this keyword will override the use of the Viper analysis data points and use the ephemeris trajectory instead.
- Voyager2 – This argument will use the voyager 2 data set from either ephemeris or the Viper analysis depending on how the above keywords are set.
- create_maps – Will take the input data set (Viper analysis by default) and produce field line maps given each analyzed data point.
- trajectory_csv – This keyword will use the ephemeris data set and produce a CSV file containing the spacecraft location and the centrifugal equator location along the field line prescribed by the spacecraft location

Output: The output of this program will be a CSV file containing either entire field line mappings, maps to the centrifugal equator or both. The specific output depends on whether the create_maps or trajectory_csv keyword is provided as input

The steps of the program are as follows:

To begin running, **Call_field_lines** must be run from the IDL command prompt with the appropriate keyword arguments.

- This step simply reads the appropriate files given the keyword arguments that are used.
- The functionality of the keyword arguments can be found in the documentation of the code itself

Call_field_lines then runs the **produce_field_lines**.

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-The main purpose of this procedure is to unpack the coordinate data into arrays, loop through the coordinates and save the field line model output into matrices. These matrices will be saved to CSV files if the appropriate keyword (/create_maps) is called.

-This section also calculates the location of the magnetic equator and centrifugal equator.

Produce_field_lines calls on **calculate_footpoint**.

-The purpose of this function is to determine the step size being used in the field line model as well as calculate the locations of the points along a given field line.

-This program also determines where the endpoints of the field lines are located (where the fields intersect with the planet.)

-This program calls the function jovSurface to determine if the steps along the field line have intersected with the polar flattened surface of Jupiter.

calculate_footpoint calls **JovMagField**

-This function calculates and returns the radial, theta and phi components of the magnetic field. These components are determined by combining VIP4 with CAN sheet.

-This function calls several auxiliary functions to determine field strength.

-**getSchmidtCoefs** – retrieves the Schmidt quasi-normalized coefficients

-**getLegendre** – solves the Schmid quasi-normalized legendre functions

-**dPdtheta** – solves the theta derivative of the the used legendre functions

-**CAN_SHEET** – magnetic field from current sheet

Supplementary Code

Sort_Field_Lines.pro

This IDL file contains a procedure **sort_field_lines**

-This procedure organizes the output csv file from the field line code documented above so that it is organized in a manor that Latdist can easily read the file and find the starting location of field lines, the spacecraft location and the centrifugal location along an individual field line.

-The csv file name to be modified is hard coded inside the code and must be modified by the user.

-In this file there are 4 columns, which contain the information for every field line.

-Flag – Contains information about the significance of each row or point along a field line.

- 0 – corresponds to a general point along a field line

- 1 – corresponds to the beginning of a new field line

- 2 – corresponds to the location of the centrifugal equator

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- 3 – corresponds to the spacecraft location used to produce the field line
- R – The Radial distance away from the center of Jupiter
- Phi – The SIII Right handed longitude of the field line point
- Theta – The co-latitude location of the field line point

Written by:
Kaleb Bodisch
Fran Bagenal
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