KMAG - Kronian Magnetic Field Model - FORTRAN User Guide

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Introduction

KMAG is a global magnetic field of the Saturn's field (Khurana et al., 2006) that includes modules that specify (1) the internal spherical harmonic field, (2) the ring current and the magnetotail current system, (3) the field from the radial current system which reinforces corotation on the outflowing plasma, (4) the shielding fields from an axially symmetric but hinged magnetopause and (5) the interconnection magnetic field from the solar wind IMF. The current sheet field is based on models of disk-shaped current sheets by Tsyganenko and Peredo (1994). The tilt, and hinging of the current sheet is based on the general deformation technique of Tsyganenko (1998, 2002a, 2002b). The shielding fields are derived using a model of the magnetopause by Arridge et al. (2006) constructed from magnetopause crossings observed by both Cassini and Voyager. Saturn's internal field uses magnetic moments derived from the Cassini Saturn Orbital Insertion (SOI) measurements (Dougherty, 2005). KMAG is based on a previous Euler-potential model of Jupter's magnetospheric field (Khurana, 1997).

Installation

The model is fully self-contained in a single Fortran file. Call the relevant subroutines from your custom Fortran code.

Tested using GNU Fortran (Homebrew GCC 10.2.0) 10.2.0.

Usage

The main subroutine that computes the magnetic field strength is called KMAG(). It requires the following parameters to be passed through:

INPUT:

- TIME (REAL) - a double precision variable denoting number of seconds from an epoch
- EPOCH (STRING) - a five letter character which can be either 'ctime', 'etime' or 'J2000'/upper or lower case
- R, THETA, PHI (REAL) - position of the field in a right-handed System III coordinate system (THETA and PHI are in radians)
- BY_IMF, BZ_IMF (REAL) - Y and Z component of the interplanetary magnetic field in right-handed KSM coordinate system.

OUTPUT:

- RLT (REAL) - local time
- BRM, BTM, BPM (REAL) - model magnetic field in a spherical SYSTEM III coordinate systemCALL

The supported coordinate systems are:

- S3C System III Cartesian (right-handed)
- KSO Kronian-Sun-Orbital
- KSM Kronian-Sun-Magnetic (So far same as KSO)

- DIP Dipole (cartesian)

Example:

To call the main subroutine from your custom Fortran code, you can simply write:

```
CALL KMAG(TIME,EPOCH,R,THETA,PHI,RLT,BY_IMF,BZ_IMF,BRM,BTM,BPM,Dp)
```

In order to compile and run the model from within Python, you can use the 'os' module. For example, if your custom Fortran code is called 'KMAG_pipe.f', you can pass the following commands to compile and run the code, assuming 'KMAG2012.f' is in the same directory, and you have a gfortran compiler installed:

```
import os
# -w to inhibit Fortran2018 warnings
os.system("gfortran -c KMAG_pipe.f -w")
os.system("gfortran -c KMAG2012.f -w")
os.system("gfortran -o KMAG KMAG_pipe.o KMAG2012.o")
os.system("./KMAG")
```

References

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