ARC7 - A 2.5D MHD Model for Studying Time Dependent Coronal Structure

Preliminary Draft

Introduction

ARC7 is a 2.5D time dependent MHD model of the Solar Corona. The code is designed for parametric style studies of transients in the solar corona.

Physics Included

The code solves the ideal MHD equations in spherical coordinates with the assumption of azimuthal symmetry. The solution variables are functions or radius and latitude. The code solves for all 3 components of momentum density and magnetic field, hence the code is 2.5D. The energy equation includes field aligned thermal conduction, optically thin radiative losses and an explicit heating function. The radial momentum equation includes an explicit acceleration force to enable tuning of the solar wind solution.

Numerical Methods

The code uses an FCT algorithm to advance the MHD equations, and a sub-cycling GMRES implict solver to integrate the anisotropic thermal conduction term.

The code uses a spherical grid which can extend to 1AU.

Boundary Conditions

The code applies symmetry conditions at the north and south poles. At the models inner radius the flow is assumed to be subsonic. i The boundary conditions at the inner radial boundary are based on the assumption that the flow is field-aligned and that the hydrodynamic boundary values can be set using characteristic analysis for a quasi-1D flow aligned with the field.

The boundary temperature is kept fixed (with a default value of 500,000K). The plasma velocity is computed by solving the characteristic equation for the v-c outgoing pressure wave. When the plasma flow is outward at this boundary the boundary mass density is set using the REB approach pioneered by Withbroe. When the boundary plasma flow is inward the density is computed by solving the entropy characteristic.

At the outer radial boundary the solution is assumed to be supersonic and super-alfvenic.

User Interface

The code has a simple intuitive GUI designed to assist users in configuring the code for the calculations they wish to run.

Visualization Tools

The tarball include some basic graphics utilities written in Idl.

Documentation

The tarball includes a README file with a simple list of installation instructions. It also described how to visualize run output. The GUI is still under development, and its documentation will be added shortly.

Portability

The code is in parallelized Fortran 95 using MPI. It has been tested on numerous platforms. The tarball includes sample Makefile for user assistance with compilation, including settings for the Nag, Intel and Gfortran compilers.

Download

arc7.tar

References

Allred,J. and MacNeice,P.J., "An MHD Code for the Study of Magnetic Structures in the Solar Wind", 2009, in prep.

Contacts

Peter MacNeice, NASA/GSFC

Joel Allred, Drexel University