Overview of CISM Solar/Heliosphere Research

This poster provides an update on the approach that CISM is taking to develop a physics-based model of the corona and solar wind, including the transient disturbances known as CMEs. As a first case study of a Coronal Mass Ejection (CME) event, CISM chose a relatively simple halo CME in May 1997 that was well-observed at the Sun and had geospace effects. Other potential case studies and interim approaches are described here. CISM Solar/Heliosphere modeling uses MHD simulations based on observed photospheric magnetic fields for the coupled corona and solar wind model, and a particle code for the associated Solar Energetic Particles (SEPs).

Magnetogram-based quiet MAS MHD coronal models
SOHO MDI synoptic map for CR1913 (left) and (below) modeled magnetic field lines, and simulated coronal X-ray and EUV images, illustrating result of improved energy treatment (observations from Yohkoh SXT and SOHO EIT)

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March 2006 MAS Eclipse Prediction (left to right) Model field lines, simulated white light image, observations

Time-dependent MAS corona and CME initiation
Selected Halo CME Event, May 12, 1997

SOHO (LASCO, EIT, MDI) Images and magnetograms

A simplified model field of the involved active region + background boundary field

MAS Active Region Dynamics are Introduced

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An eruption ensues, with properties resembling CME takeoff

Other CME Case Study Candidates

Cone Model Interim Approach to CMEs

Observed sites of CMEs are being used to identify the variety of coronal magnetic field settings for Study. A subset of CMEs involving long filament eruptions shows initial field geometries with both simple (parallel) active region and overlying fields and antiparallel (multipolar) geometries characteristic of the “breakout” mechanism.

Velocities and solar cycle dependence of the two geometries

Cone Model of CMEs uses coronagraph images to define the site and orientation of a cone-shaped “channel” through which a halo CME enters the Solar wind. These define the location, shape and speed of a dynamic pressure pulse introduced at the ENLIL solar wind model boundary as an optional part of CORHEL 3.0. (see Riley et al. poster)

The SEPs are modeled as a passive test particle (ion) population in a post-process approach that uses the MHD shock to characterize shock source “injections”, and the time-dependent modeled magnetic field lines between the Sun and Earth to define the path of transport from the shock. We currently assume parameterized scattering and an ad-hoc isotropic shock source. Ion hybrid code results will eventually be used to obtain a physics-based shock source description. (See SEP poster for details)

Geospace Connections

Local Solar Wind parameters drive the magnetosphere simulation; SEPs enter the polar caps and plasma sheet along open field lines and at low latitudes on occasion (see Kress et al. poster)

SEP Model Overlay

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Lynch et al. Simulation of a Breakout geometry CME (Apj 2005)

Earth-Shock-connected field lines in the Cone model give shock location and a measure of SEP source strength