The Coronal Global Evolutionary Model (CGEM): Current Status

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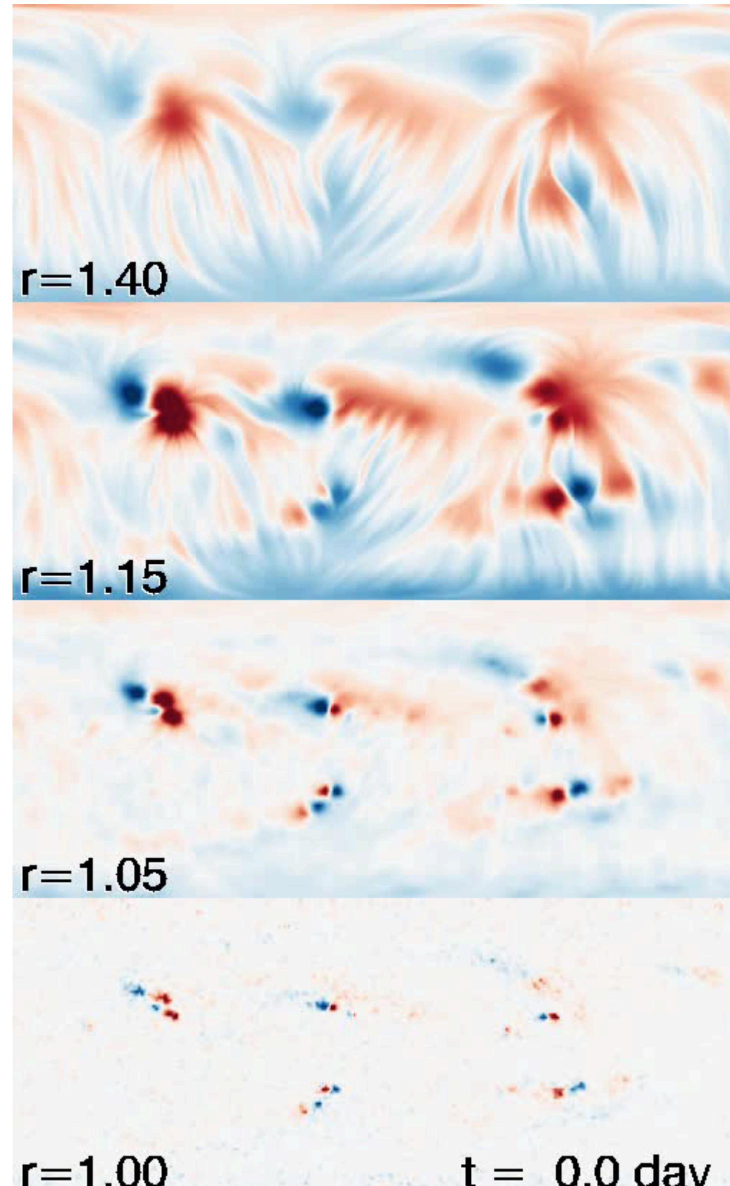
The Coronal Global Evolutionary Model (CGEM)

Main features of the Model:

- CGEM uses the magnetofrictional (MF) technique to study the buildup of electric currents and free magnetic energy in the solar corona, using only photospheric Doppler and Vector Magnetogram data from SDO/HMI. The MF approximation makes the computational model much faster than using the MHD approximation. *Practical for future space weather applications.*
- Time derivatives of the magnetic field **B** at the photosphere in the CGEM model are determined through Faraday's Law from electric field (**E**) inversions of HMI data.
- Where no data is available (e.g. farside of Sun) a flux transport model is used to determine **E** instead of inversions of the HMI data.
- Unstable configurations can be evolved using MHD models starting from MF configurations as an initial state.
- Output from the MF model can also be used to drive outer corona and heliospheric MHD simulations, addressing an existing gap in current operational models.
- Specialized data products needed to find **E** also result in other useful quantities such as impulse from Lorentz force, Poynting fluxes, and helicity injection rates.
- For more information: see http://cgem.ssl.berkeley.edu

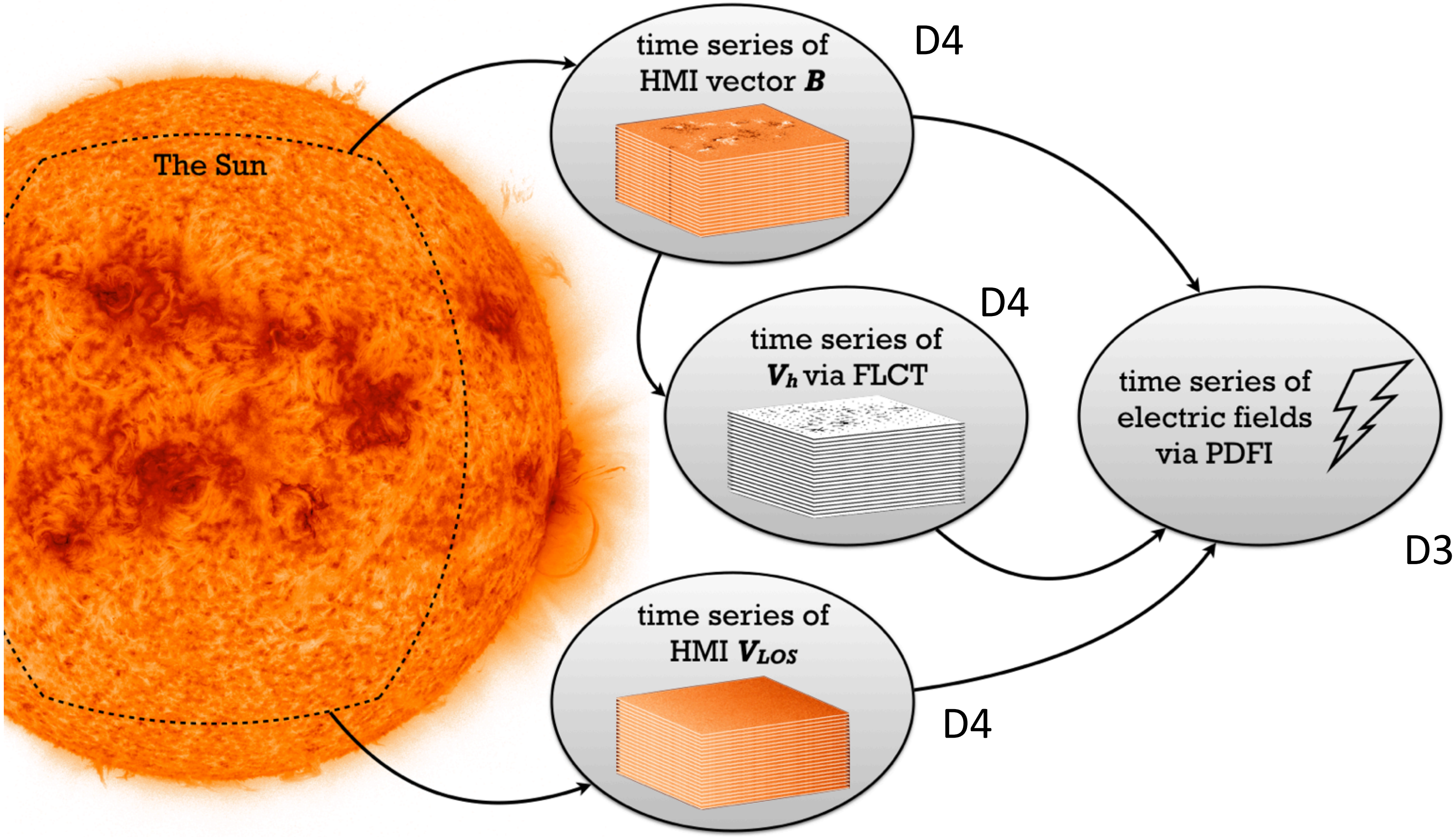
One month of B_r from CGEM MF model



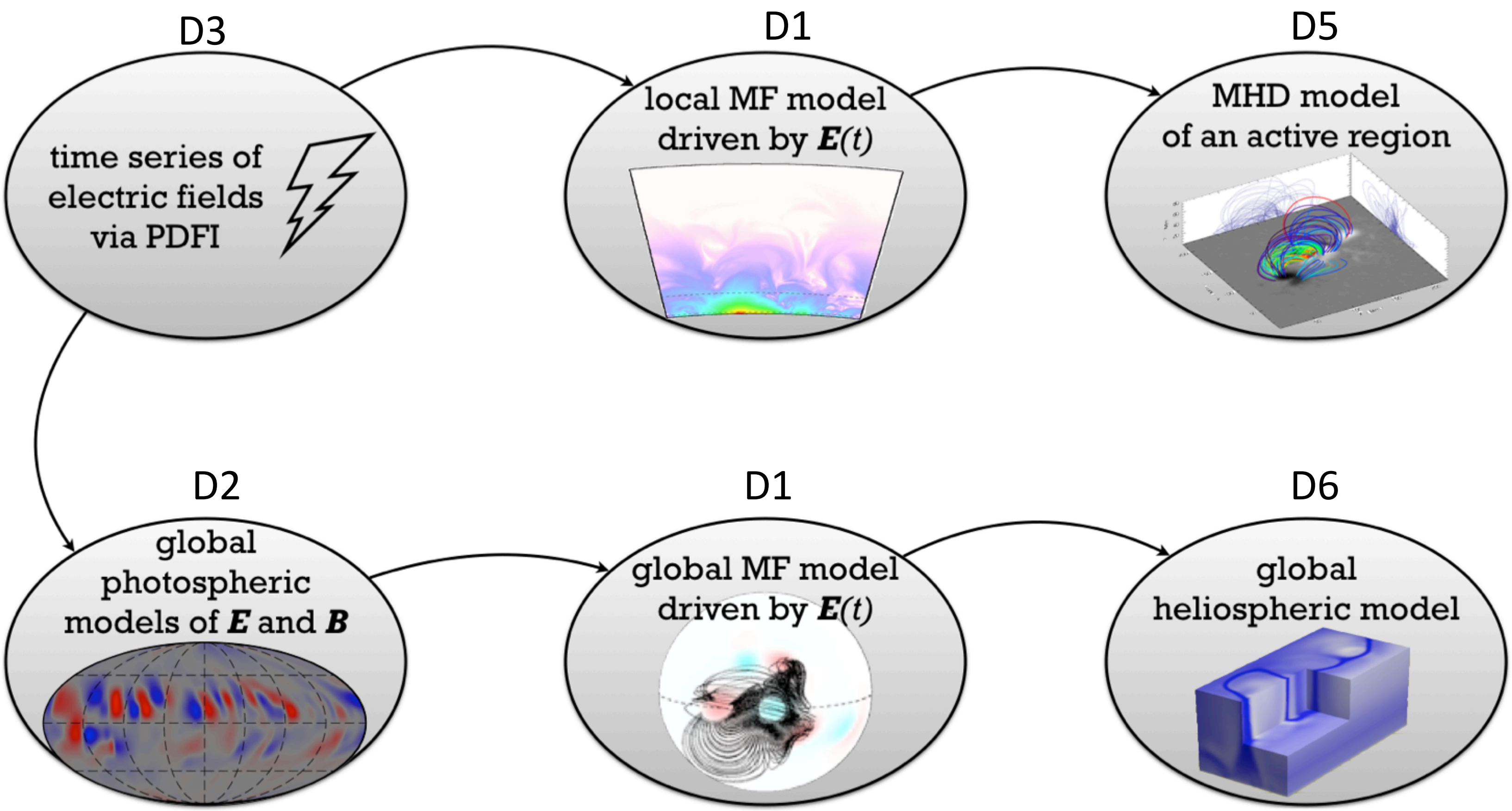
Six Deliverables Are Needed to Achieve the CGEM Goal

- D1: A Magnetofrictional (MF) Model of the Sun's coronal magnetic field
- D2: A Global Flux Transport (FT) Model used for unobserved parts of the Sun's photosphere
- D3: Electric Fields at the Photosphere derived from HMI magnetic field and Doppler data
- D4: Enhanced data products (for input to D3) and for other scientific and space-weather purposes
- D5: An MHD model of the corona in active regions, initialized by the MF model, to study erupting magnetic geometries
- D6: A Global Coronal MHD model driven by the global MF or active-region MHD models

CGEM Workflow Diagram 1



CGEM Workflow Diagram 2



Executive Summary of CGEM Progress Years 1-5:

- D1 (MF Model): Code written, working in both localized and global geometries. Will be delivered to CCMC along with scripts to retrieve needed input data from JSOC (POC: Mark Cheung)
- D2 (FT Model): Code written, working, its output will be a JSOC data project, and is one of the possible inputs for the global version of D1 model (POC: Marc DeRosa, Mark Cheung).
- D3 (Electric Field Inversions): Code written, working, delivered to JSOC. Code is an open-source fortran library, written for a broad spectrum of uses, including both data analysis and for use in MHD codes. Output for AR patches will be available as a JSOC data product, or can be used independently. Developer site: http://cgem.ssl.berkeley.edu/cgi-bin/cgem/PDFI_SS/index . (POC: George Fisher, Maria Kazachenko)
- D4 (Enhanced Data Products) Codes written, working, delivered and installed JSOC. Output available as a JSOC data product (POC: Xudong Sun, Todd Hoeksema)
- D5 (Active Region MHD Models) Code written, working, source code released to public, will be installed at CCMC if desired. Selected case studies (simulation output) will be publicly available (POC: Bill Abbett)
- D6 (Heliospheric MHD Model) Code written, working, delivered to JSOC, and ready to be delivered to CCMC at any time (POC Todd Hoeksema, Keiji Hayashi)