Project Details

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Topic: Magnetic Origins of the Corona and Inner Heliosphere

Project Title:
The Origin of the Photospheric Magnetic Field: Mapping Currents in the Chromosphere and Corona

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Summary:
Science Goals and Objectives: Our science goal is to quantitatively determine the origin of photospheric magnetic fields. In particular, our goal is to distinguish between fields produced by currents in the solar atmosphere and the solar convection zone and to use this information to determine the magnetic origins of the corona and inner heliosphere. The photospheric magnetic field forms both the theoretical and observational foundation for understanding the structure, evolution, and eruptive potential of the solar atmosphere. Indeed, the magnetic field at the solar photosphere is a crucial input to both empirical and physics-based models of the corona and solar wind." Our objectives are to use this determination of the origin of photospheric magnetic fields to address the following fundamental science questions:

1. What is the origin of the photospheric field?

2. What is the non-potential state of the solar corona? Do active regions emerge with current? How common are partially dressed currents in the solar atmosphere?

3. How does the photosphere generate coronal non-potentiality?

Methodology: The PI has developed a sophisticated tool CICCI for distinguishing the coronal and chromospheric contribution to the photospheric magnetic field from the convection zone contribution with vector magnetograms. Preliminary work has demonstrated that a measurable fraction of the photospheric field in active regions is produced by current systems above the photosphere in the chromosphere and corona. This tool will be applied to a statistically significant sample of full-disk SDO/HMI vector magnetograms and a representative sample of Carrington maps and Hinode vector magnetograms to produce CICCI magnetic maps, with rigorous uncertainties, of the fingerprints of chromospheric and coronal non-potentiality in the photosphere. These tools will also be applied to simulations of both boundary driven energization of the corona and of dynamic flux emergence from the convection zone to the corona, for comparison with the results of the observational study.

Relevance to FST Science Objectives: This work directly addresses and impacts all three of the Focused Science Team objectives. (1) Understand how the magnetic field drives coronal and heliospheric structure and dynamics." Using CICCI magnetograms we will quantify the detailed development of the fingerprints of coronal and convection zone currents in the photosphere to ultimately characterize coronal and heliospheric structure. (2) Understand how magnetic connectivity evolves from the photosphere to the inner heliosphere." Using the CICCI radial fields we will determine the connectivity of the inner heliosphere with just the convection zone sources and compare this against traditional results using the total radial magnetic field. (3) Understand how plasma processes or time-dependent evolution lead to global non-potentiality." Using the CICCI decomposition we will determine the photospheric signature of chromospheric/coronal non-potentiality in both full-disk vector magnetogram observations and in a suite of flux-shearing, -cancelling, and -emerging simulations.

Potential Contributions to Team Effort: The evolution of the radial field produced by the convection zone determined by our CICCI analysis will prove useful to the FST team for modeling global solar and heliospheric phenomena such as surface flux-transport, fast versus slow solar wind acceleration, the structure of the global solar magnetic field, and the location of the heliospheric current sheet. Similarly, any boundary driven simulations of the corona or solar wind will benefit from the insight provided by CICCI analysis of the driven boundary. For global-scale modeling CICCI can provide the convection zone field in the photosphere which may be a better boundary condition for the heliosphere than the total field that conflates the convection zone and coronal current sources.

Publication References:

no references