Project Details

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Topic: Magnetic Origins of the Corona and Inner Heliosphere

Project Title:
Linking Surface Magnetic Fields to the Structure and Dynamics of the Solar Corona

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Summary:
We propose a focused, four-year study to understand the links between high resolution photospheric magnetic fields and the structure and dynamics of the solar corona. Our approach will be twofold: First pushing the boundaries of what is possible with data driven coronal modeling to understand how surface fields regulate magnetic complexity, heating, and plasma dynamics in the solar corona. Second, applying what we learn towards the practical interests and goals of the LWS program. In particular, we will focus on the following key questions:

1. How does the modeled coronal connectivity, heating, and plasma structuring change with the spatial resolution of the quiet Sun network and inter-network fields measured at the surface?

2. How does the evolution of these fields at the surface modulate coronal dynamics and connectivity across a range of spatiotemporal scales?

3. How do choices made in creating photospheric boundary conditions (observables, inversions, averaging) subtly influence our coronal solutions?

4. How can we better encapsulate subgrid" structure and dynamics in our simpler models of the global corona and inner heliosphere?

To address these questions, we will conduct focused experiments using a state-of-the-art MHD model of the global solar corona, driven by high-resolution measurements of the surface magnetic field. Our experiments, divided into a series of study arcs, will use extremely high-resolution patches within a global domain to understand out how and why small-scale structure and dynamics at the surface may influence not only the properties of the low solar corona, but the solar wind and inner heliosphere as well. Leveraging high-quality spectropolarimetric measurements of surface field distributions from Hinode/SOT and simultaneous measurements from SDO/HMI, we will also study how choices of observables, inversion methods, and spatiotemporal processing methods may subtly influence coronal model solutions. To complement our analysis of the physical processes occurring in the simulations and their differences from run to run, we will use magnetic field connectivity mappings and topological indicators to inform and interpret our results. We will also place our results directly into observational contexts by forward modeling extreme ultraviolet and white-light polarized brightness observables from SDO, STEREO, SOHO, and MLSO.

Our project is designed to address much of the stated scope of LWS FST 4: Towards a Quantitative Description of the Magnetic Origins of the Corona and Inner Heliosphere". We specifically target two of the three stated goals of the FST: aiming to better understand how magnetic connectivity evolves from the photosphere to the inner heliosphere and how the magnetic field drives coronal and heliospheric structure and dynamics. Our investigation is quite relevant to the stated context of the FST, being not only a physics-based study that connects surface-field distributions to the heliosphere, but one with a specific focus on how the properties of photospheric magnetograms, both vector and line-of-sight, might influence coronal and heliospheric models. This aspect, along with our aim to explore evolution and structure at higher spatiotemporal scales than previously possible---which may play an important but subtle subgrid role in our coronal and heliospheric models---has not only scientific relevance, but implications for practical modeling and key aspects of data/model uncertainty. Lastly, our project fits naturally within the larger Focused Science Team effort, as we will be well positioned to incorporate other potential surface field data products and methods in our modeling study, to forward model other remote-sensing or in situ measurements that may be of interest, and/or to provide helpful insights, data, or modeling products for related studies on these topics.

Publication References:

no references