Project Details

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Topic: Magnetic Origins of the Corona and Inner Heliosphere

Project Title:
Toward a Consensus for Multi-Sourced Photospheric Magnetic Field Cross-Calibrations

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Summary:
Magnetic fields drive solar activity that ranges from long-term variability of the solar cycle to short-term eruptions of flares and CMEs. Consistent magnetic field measurements over the solar surface is the first step toward establishing reliable magnetic configuration and connectivity in the heliosphere enabling better understanding and prediction of solar activity.

Full-disk, line-of-sight (LOS) photospheric magnetic field has been measured for many years at various observatories, including MWO, GONG, KPVT, SOLIS, WSO, MDI, and HMI. While these measurements exhibit remarkable agreement in distribution and patterns of magnetic flux, appreciable difference has been found in their measured values. Difference in instruments, calibration, and data processing contributes to this. To produce magnetic field data over the entire solar surface, several issues also need to be addressed. Those include (1) polar field that is poorly obseserved, (2) magnetic field in the far-side where direct observation is not available to date and technology to infer magnetic flux remains to be made robust, and (3) deriving consistent radial field (Br) from LOS, or vector field. Accurate Br is the data many models of coronal and interplanetary fields use. Data from different observatories, together with different methods to deal with those issues, has led to significant discrepancy in model results. This seriously influences efforts to advance knowledge in understanding solar activity and its impact. Thus achieving consensus of magnetic field over the Sun's surface is vital.

We propose three tasks: 1) To seek a consensus for those magnetic field measurement cross-calibrations; 2) To derive synoptic maps of Br by addressing issues of polar field, use of far-side inferred flux, and conversion from vector and LOS data; and 3) To investigate the implied open flux problem by using our consensus field data in the photosphere.

We propose to employ a comprehensive methodology for this investigation. For task 1, we will use existing methods to examine the saturation correction, center-to-limb dependence of measurement, and spatial resolution of the data.
We will employ NSO's simulators of GONG and HMI extended to other instruments to validate and understand instrument differences. These will help develop cross-calibration between data from MWO, WSO, KPVT, GONG, MDI, SOLIS, and HMI.

For task 2, we will test existing schemes and develop new methods to correct polar field estimates. We will use observations and surface flux transport models to evaluate the methods. If it becomes available, we will also use SO/PHI to improve validation. We will examine impact of newly-emerging active regions on the far-side to the modelings by use of our recent O2R project that maps the far-side magnetic flux from helioseismic data. We will incorporate full-disk vector magnetograms from SOLIS and HMI to improve current model-dependent synoptic maps of Br. We will evaluate our final true synoptic (aka synchronic) maps by applying various models to the data and by comparing model results with observation.

For task 3, we will employ heliospheric models using final synoptic maps of Br and examine the modeled open flux with in-situ observations.

The proposed work cross-calibrates full-disk magnetograms taken by various observatories, provides consensus photospheric magnetic field over the Sun's disk, and produces reasonably reliable synoptic maps of Br. This work is relevant to the science goal from the Heliophysics Decadal Survey: to "Determine the origins of the Suns activity and predict the variations in the space environment". This is directly relevant to the objectives of the Focused Science Topic 4, "Towards a Quantitative Description of the Magnetic Origins of the Corona and Inner Heliosphere." The resulting data will be available to the other members of the LWS/FST as well as the world at large.

Publication References:

no references