Project Details

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Project Title:
The interaction between magnetic fields and large-scale flows, and its effects on modeling and forecasting the photospheric magnetic field

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Summary:
The LWS program aims to improve our understanding of the Sun-Earth connection to enable space-weather forecasting. Crucial to that effort is an understanding of the Sun's surface magnetic field which drives the corona and heliosphere. Active regions (ARs) and their decay products are important contributors to the coronal brightness and to the heliospheric field and plasma flows. Modeling the evolution and decay of the AR fields remains problematic, however: even though a diffusion model matches flux dispersal on time scales of weeks to a few years, ARs are remarkably resistant to decay in their first few weeks. The relative coherence of ARs is likely caused by magneto-convective coupling. We propose a two-pronged approach to improve our understanding of AR decay: we plan (1) to use our existing surface-field dispersal model in comparison to observations to study how recently discovered inflows around ARs affect flux dispersal, and (2) to use numerical models of compressible magnetoconvection to study the cause of these inflows. The AR inflows likely impede flux dispersal and thus increase flux cancellation within ARs, thereby decreasing the flux escaping into the network. Such AR inflows, and the modulation of the meridional flow which converges onto the activity belts, have been mapped with SOHO/MDI. The AR inflows appear to strengthen with the magnetic flux within them, suggesting a non-linear coupling between flux dispersal and inflow strength. We propose to study AR decay by combining observations and models. First, we will measure the decay of sample ARs by comparing magnetogram sequences to simulations made with our surface-dispersal data-assimilation model which will be modified to incorporate AR inflows. In parallel, we will study the causes and effects of AR inflows using our numerical model for compressible magnetoconvection in a spherical segment by modifying it to allow for converging surface flows through, e.g., field-dependent cooling. Our project will improve our understanding of the evolution of the patterns in the solar magnetic field, and will help eliminate ad-hoc processes from current flux dispersal models. This will provide a better understanding of large-scale field that determines space weather. The required observations are available online, our model codes need but modest adaptation, and the team is familiar with both data and models; hence, the support requested here will be applied effectively to analysis and interpretation.

Publication References:

no references