Project Details

ROSES ID: NNH08ZDA001N
Selection Year: 2009
Program Element: Focused Science Topic

Topic: Measure the properties of the solar dynamo that affect solar irradiance and active region generation.

Project Title:
Using dynamo models and data assimilation methods for modeling and forecasting properties of solar cycles

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Summary:
Understanding the dynamo mechanism and predicting the cyclic solar activity are among the most important key problems of the LWS program. Recent advances in dynamo modeling and magnetographic and helioseismic observations have provided important insights into the basic mechanism of the solar cycle. However, the physics-based forecasting of the strength and timing of the solar cycles is still not possible because of numerous uncertainties in the parameter values of dynamo models, such as kinetic and magnetic helicities, magnetic field diffusion and the magnetic flux transport by meridional circulation. The observational data provide only weak constraints on the surface magnetic field and on the plasma dynamics of the solar interior where the dynamo operates. We propose to investigate a new approach for modeling and forecasting magnetic properties of the solar cycles by applying data assimilation methods to solar dynamo models. This approach will allow us to determine the importance of various model characteristics for estimating of the physical state of the solar dynamo and for forecasting the future cycle.

The data assimilation methods, such as the Ensemble Kalman Filter (EnKF), have been used successfully for weather and climate modeling forecasting. They provide the best conditional estimates of past, present, and even future states for a given set of measurements, and can do so even when the precise nature of the modeled system is unknown. Our research plan is based on the implementation of data assimilation methods, in particular, the EnKF method, using previously developed 2D and 3D dynamo codes, synoptic magnetic field data for the past three cycles and helioseismology data.

Publication References:

Summary: no summary

Reference: Simitev, R. D.; Busse, F. H.; (2012), How Far can Minimal Models Explain the Solar Cycle?, The Astrophysical Journal, Volume 749, Issue 1, article id. 9, 5 pp. (2012), doi: 10.1088/0004-637X/749/1/9

Summary: no summary

Reference: Simitev, Radostin D.; Busse, Friedrich H.; (2012), Solar cycle properties described by simple convection-driven dynamos, Physica Scripta, Volume 86, Issue 1, id. 018407, doi: 10.1088/0031-8949/86/01/018407