Project Details

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Project Title:
Predicting the Strength of New Solar Cycles by Fitting Old-cycle Magnetic Field and Meridional Flow Data Into a Flux-transport Dynamo

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Summary:
Predicting the strength of a new solar cycle by using old cycle data has so far been attempted either by using an empirical "precursor method" or by a dynamo-based scheme with thin physical foundations (see the discussion and criticism in Joselyn et al. 1997, Eos, vol. 78, No. 20, p.205, 211-212). Such prediction may now be possible by using a flux-transport type solar cycle dynamo model. The cyclic evolution of the solar magnetic field on 11-year timescales is generally believed to be the consequence of an oscillatory dynamo, operating inside the Sun. Over the past six years, flux-transport-type kinematic, mean-field dynamos have been most successful in reproducing large-scale solar cycle features (Durney 1995, SolP, 160, 213; Choudhuri, Schuessler and Dikpati 1995, A&A, 303, L29; Dikpati and Charbonneau 1999, ApJ, 518, 508; Charbonneau and Dikpati 2000, ApJ, 543, 1027; Dikpati and Gilman 2001, ApJ, Sep 20 issue, in press). All these models show that the observed mean meridional circulation may determine the cycle-period. Fluctuations in this weak flow and in the poloidal field source-term can also reproduce the amplitude-duration anticorrelation and clock-setting properties of the observed solar cycle. We propose the following steps for future research aimed at predicting the strength of the new solar cycle: (i) develop a scheme to make the model operate with observational data, (ii) process the observational data for magnetic field and meridional circulation from the previous cycle (prior to 1996) to initialize the flux-transport dynamo model, and evolve the model, (iii) form suitable proxies for the model output to compare with observations, (iv) investigate whether this model can reproduce the known magnetic field strength and pattern in later years. As the project progresses, with further experience and knowledge gained, we plan to explore the effect of a back-reaction on the meridional circulation by generalizing the model to include such back-reactions. This process may lead to the first dynamo based prediction models for the solar cycle based on data like that from the SOHO MDI instrument or the proposed SDO Helioseismic and Magnetic Imager.

Publication References:

Summary: ''

Reference: Predicting the Strength of New Solar Cycles by Fitting Old-cycle Magnetic Field and Meridional Flow Data Into a Flux-transport Dynamo - Dikpati, Mausumi NCAR

Summary: no summary

Reference: Dikpati, Mausumi; de Toma, Giuliana; Gilman, Peter A.; (2006), Predicting the strength of solar cycle 24 using a flux-transport dynamo-based tool, Geophysical Research Letters, Volume 33, Issue 5, CiteID L05102, doi: 10.1029/2005GL025221