Geophysical Research Abstracts
Vol. 14, EGU2012-11442, 2012
EGU General Assembly 2012

Implementing sequential data assimilation in a flux-transport solar dynamo model for reconstructing meridional flow

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Data assimilation in atmospheric and oceanic models started about 40 years ago, but that in solar models has started only recently. We develop here a sequential data assimilation approach for the application in a flux-transport solar dynamo model, with the motivation of building a better tool for predicting global solar cycle features, such as amplitude, duration and shape of a cycle. A key ingredient in flux-transport type dynamo models is meridional circulation. Time-variation of this flow plays a crucial role in determining the duration, onset and peak timings, rise and decline patterns of a solar cycle. We generate artificial data of magnetic flux from our flux-transport dynamo model with a time-varying meridional flow, and use that as the observational proxy for a solar cycle. We then sequentially assimilate these data into our dynamo model, and implement an Ensemble Kalman Filter using the framework of Data Assimilation Research Testbed (DART) developed at IMAGe/NCAR, to reconstruct the time-variation in this flow. The reconstructed flow reveals this is a very powerful technique and can be applied for building a sophisticated predictive tool for simulating the shape, rise and fall patterns of a cycle, if the flow variation is known apriori.