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Using Data Assimilation Methods for Prediction of Solar Activity

I. N. Kitiashvili (NASA Ames/BAERI) & N. S. Collins (UCAR)

The variability of solar magnetic activity known as the 11-year solar cycles has the longest history of observations. These solar cycles dramatically affect conditions in the heliosphere and the Earth's space environment. Our current understanding of the physical processes that make up global solar dynamics and the dynamo that generates the magnetic fields is sketchy, resulting in unrealistic descriptions in theoretical and numerical models of the solar cycles. The absence of long-term observations of solar interior dynamics and photospheric magnetic fields hinders development of accurate dynamo models and their calibration. In such situations, mathematical data assimilation methods provide an optimal approach for combining the available observational data and their uncertainties with theoretical models in order to estimate the state of the solar dynamo and predict future cycles. In this presentation, we will discuss the implementation and performance of an Ensemble Kalman Filter data assimilation method based on the Parker migratory dynamo model complemented by the equation of magnetic helicity conservation and long-term sunspot data series. This approach has allowed us to reproduce the general properties of the solar cycles and has already demonstrated a good predictive capability for the current cycle, 24. We will discuss further development of this approach, which includes a more sophisticated dynamo model, synoptic magnetogram data, and employs the DART Data Assimilation Research Testbed.