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Abstract:

Solar activity across the scales: from small-scale quiet-Sun dynamics to magnetic activity cycles

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Observations as well as numerical and theoretical models show that solar dynamics is characterized by complicated interactions and energy exchanges among different temporal and spatial scales. It reveals magnetic self-organization processes from the smallest scale magnetized vortex tubes to the global activity variation known as the solar cycle. To understand these multiscale processes and their relationships, we use a two-fold approach: 1) pealistic 3D radiative MHD simulations of local dynamics together with high-resolution observations by IRIS, Hinode, and SDO; and 2) modeling of solar activity cycles by using simplified MHD dynamo models and mathematical data assimilation techniques. We present recent results of this approach, including the interpretation of observational results from NASA heliophysics missions and predictive capabilities. In particular, we discuss the links between small-scale dynamo processes in the convection zone and atmospheric dynamics, as well as an early prediction of Solar Cycle 25.