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) realistic 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 the new observations, the theoretical models, and the data assimilation results.

**Elements of the Solar Cycle Prediction Approach**

- Variations of solar activity are a result of complicated dynamical processes in the convective zone and lower layers. The current real world models address only the helioseismological observations at the photosphere level and assume the existence of the toroidal magnetic field at the foot point.

**Realistic modeling of local dynamics**

- **Small-scale dynamics**
  - Variations of solar activity are a result of complicated dynamical processes in the convective zone and lower layers.
  - The current real world models address only the helioseismological observations at the photosphere level and assume the existence of the toroidal magnetic field at the foot point.

**Small-scale dynamics**

- Magnetic helicity shows significantly better correlation with the evolution of the surface magnetic field in comparison with other magnetic invariants.

**Preliminary Analysis of Prediction Solar Cycle 25 Uncertainties**

- **Data Assimilation**
  - The data assimilation technique is a sequential approach to estimation of the dynamical model parameters. The estimated parameters are used as updated initial conditions for the dynamical model.

**Testing the Prediction Capabilities**

- The prediction capabilities for solar cycle 24, 25.

**Conclusion**

- The successful prediction of the solar activity demands a comprehensive understanding of the underlying physical processes, including the role of magnetic fields and the solar dynamo action.