SPD Thomas Metcalf Travel Award Report

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Bio: I am a research associate at the Laboratory for Atmospheric and Space Physics, University of Colorado Boulder, supported by George Ellery Hale Postdoctoral fellowship. My work focuses on using highly sophisticated 3D magnetohydrodynamic simulations to study evolution of magnetic field from the convection zone to the corona. I did my PhD at Max Planck Institute for Solar System Research in Goettingen. After that I worked at High Altitude Observatory in Boulder.

The main interests of my collaborators and mine spread over all layers of the solar atmosphere and over a wide energy spectrum: flux emergence and sunspots formation in the photosphere, coronal heating in both the quiet Sun and active region, and solar eruptions like flares and CMEs.

Presentation: Realistic simulations of solar active regions: From emergence to eruption

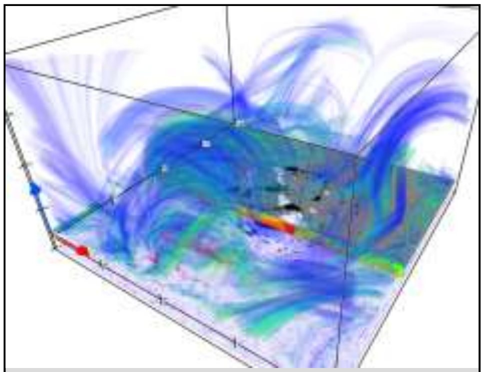

Figure: An overview of the simulation domain. The box is 200 Mm wide, with a height of 123 Mm. The photosphere is 10 Mm above the lower boundary. Magnetic flux bundles emerge from the convection zone to the photosphere and give rises to several strong sunspot pairs. This snapshot is at 27 hours after the start. The grayscale image is Bz in the photosphere, and blue- and greenish features show coronal plasma at 1-2 MK.

Our understanding on the process of magnetic flux emergence developed greatly in the Hinode era by both observations with higher resolution and cadence, and more sophisticated numerical simulations. In this talk, I presented some first results from recent realistic simulations of magnetic flux emergence and active regions. These simulations are designed to represent the conditions of the real Sun and account for the important physical process in the solar atmosphere. This allows the model to synthesized observables that can be quantitatively compared with real observations.

These method has been very successful in studying dynamics in quiescent solar atmosphere and non-eruptive active regions. In a recent work, we conducted the first comprehensive 3D simulation for a solar flare, which can successfully reproduce many observational properties. Furthermore, we also coupled a solar convective dynamo simulation to a large-scale realistic flux emergence simulation, as shown in the figure. In the 50 hours evolution, more than 100 solar flares occur, Many of which reach C class as defined by the synthetic GOES flux. The largest one is in M class and releases 4E31 erg of magnetic energy. It is accompanied by an astonishing eruption of a highly twisted magnetic flux rope. Connecting realistic simulation and observations is so far the best approach to exploit the power of sophisticated numerical models and state-of-the-art observations, and will help us on interpreting observations and developing theories.

I appreciate the support from the SPD Thomas Metcalf Travel Award, as well as the further financial support from the LOC. They made this trip possible.