Project Details

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Selection Year: 2017
Program Element: Focused Science Topic

Topic: Understanding The Onset of Major Solar Eruptions

Project Title:
Investigating Magnetic Flux Emergence with Modeling and Observations to Understand the Onset of Major Solar Eruptions

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Summary:
Science Goals and Objectives

We propose to address the Living with a Star Focused Science Topic (LWS FST):

``Understanding the Onset of Major Solar Eruptions.'' To achieve this, we propose

to investigate the injection of free energy and helicity in the corona, and the

subsequent triggering of major solar eruptions, focusing on the emergence of

magnetic flux into the corona. Our goal is to understand how emerging magnetic

flux either injects helicity and free energy into the corona to generate eruptions,

or destabilizes pre-existing structures so that they erupt. To achieve this, we

will investigate flux-emergence sources of active region eruptive capacity by

simulating the emergence of magnetic flux into the corona in eruptive configurations.

In parallel, we will use these simulations to develop observables for predicting

the occurrence and timing of eruptions. We will use FST team observations to

test these metrics on both eruptive and non-eruptive ARs.

Methodology:

Our proposed methodology is to simulate eruptions driven by flux emergence in two

prominent theoretical eruption scenarios: the formation of unstable sheared fields

and flux ropes via flux emergence; and the destabilization of pre-existing sheared

fields and flux ropes via flux emergence. The configurations studied will include

both the ``breakout'' and the ``torus instability'' eruption paradigms. To simulate

these scenarios, we will use both the LaRe3d (Lagrangian Remap in Three Dimensions) code and the MAS (Magnetohydrodynamics outside A Sphere) code.

With these simulations and analyses, we propose to answer the following questions:

Question 1: How does flux emergence inject free energy and helicity into the corona?

What are the critical magnetic configurations which are built up by emerging magnetic flux into pre-existing coronal fields? We will use our simulations to determine the observable signatures of this buildup of free energy and helicity by flux emergence, and to determine which simulated configurations of emerging flux do, or do not, lead to eruptions.

Question 2: How does flux emergence trigger eruptions?

What aspects of emerging flux act as the trigger which sets off an eruption?
By freezing the emergence of flux at earlier and earlier times in our simulations during eruptions until the eruption no longer occurs, we will isolate the time at which this trigger is injected into the corona.

Question 3: How can the models explored in this project be used to develop predictive observables for eruptions?

Using the modeling results, we will establish a well-defined set of rules for determining, from observed magnetic field and velocity signatures, when an eruption-driving flux emergence event is occurring on the Sun.

We will combine the insight gained from answering these questions to develop an understanding of which key factors energize pre-eruptive active regions and lead to the onset of major solar eruptions. This project will therefore advance the LWS goal of ``Developing physics based understanding for predicting electromagnetic, particle and plasma outputs driving the solar system environment...''

(Strategic Science Area 0).

Publication References:

no references