NLFFF calculations of the solar coronal magnetic field based on Hinode observations

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Abstract

Our study focuses on understanding of the mechanism responsible for the occurrence of the solar flares. We derive 3D magnetic field structure in the corona by performing a 3D magnetohydrodynamics simulation using vector magnetic field maps mainly acquired with the Hinode spacecraft. We investigate 3D magnetic field structure formed in the solar atmosphere responsible for the occurrence of solar flares.

Ref. URL: http://www.isas.jaxa.jp/home/solar/solarPlasma/whatsSolarPlasma.html

Reasons and benefits of using JAXA Supercomputer System

We perform 3D magnetohydrodynamics numerical simulations by using vector magnetic field data acquired with the Hinode spacecraft in order to derive 3D magnetic field structures in the solar corona. We need large computational resource in order to perform three-dimensional magnetohydrodynamics simulations.

Achievements of the Year

For understanding the processes from energy build-up to trigger and plasma eruption in solar flares, it's essential to evaluate quantitatively the temporal evolution of photospheric magnetic field distributions and its coronal consequences. Reliable observationations of the coronal magnetic fields are unavailable because of poor development of techniques for high precision spectro-spectroscopy and inversion. Alternately, non-linear force free field (NLFFF) modeling has been used with the observed photospheric magnetic field distribution as the boundary condition to extrapolate the field lines to the corona. In this year, we analyzed two large-scale (X-class) flares on 6 September 2017. Using the derived coronal field distribution, we studied the spatial distribution of parameter "decay index" (Figure 1). The index is a height gradient of horizontal magnetic fields, which can be related to Lorentz force that suppresses a flaring magnetic flux rope from expansion. The result shows that we need to identify the location of the magnetic flux rope and current distribution which is required to work Lorentz force, in addition to decay index parameter.

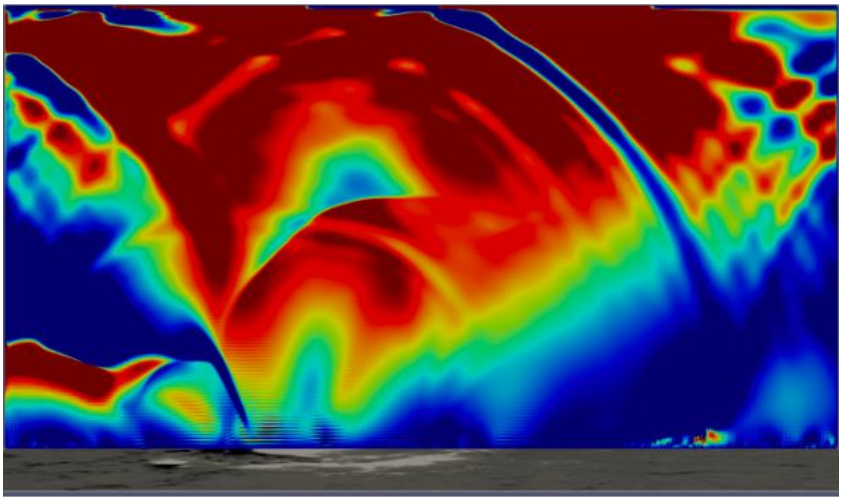

Fig. 1: The spatial distribution of "decay index" parameter, which shows the parameter along a slit crossing an eruptive flux robe as a function of the height from the solar surface in the vertical axis.

Publications

- Peer-reviewed papers

Hasegawa, T. and Shimizu, T. "Temporal Behaviros of Magnetic Helicity Injections by Self and Mutual Sunspot Rotations, " 2023, ApJ, 943, 96 (p12) doi: 10.3847/1538-4357/aca800

Usage of JSS

Computational Information

Process Parallelization Methods	MPI
Thread Parallelization Methods	N/A
Number of Processes	16
Elapsed Time per Case	3.5 Hour(s)

- **JSS3 Resources Used**

Fraction of Usage in Total Resources[*1](%): 0.03

Details

Computational Resources		
System Name	CPU Resources Used (core x hours)	Fraction of Usage[*2](%)
TOKI-SORA	790,759.00	0.03
TOKI-ST	0.00	0.00
TOKI-GP	0.00	0.00
TOKI-XM	0.00	0.00
TOKI-LM	0.00	0.00
TOKI-TST	0.00	0.00
TOKI-TGP	0.00	0.00
TOKI-TLM	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage[*2] (%)
/home	40.00	0.04
/data and /data2	2,750.00	0.02
/ssd	300.00	0.04

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage[*2] (%)
J-SPACE	0.00	0.00

[*1]: Fraction of Usage in Total Resources: Weighted average of three resource types (Computing, File System, and Archiver).

[*2]: Fraction of Usage：Percentage of usage relative to each resource used in one year.

- **ISV Software Licenses Used**

ISV Software Licenses Resources		
	ISV Software Licenses Used (Hours)	Fraction of Usage[*2] (%)
ISV Software Licenses (Total)	0.00	0.00

[*2]: Fraction of Usage：Percentage of usage relative to each resource used in one year.