SOFIE (Solar-wind with Field-lines and Energetic-particles)

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ENGINEERING CLASP

2022 SHINE

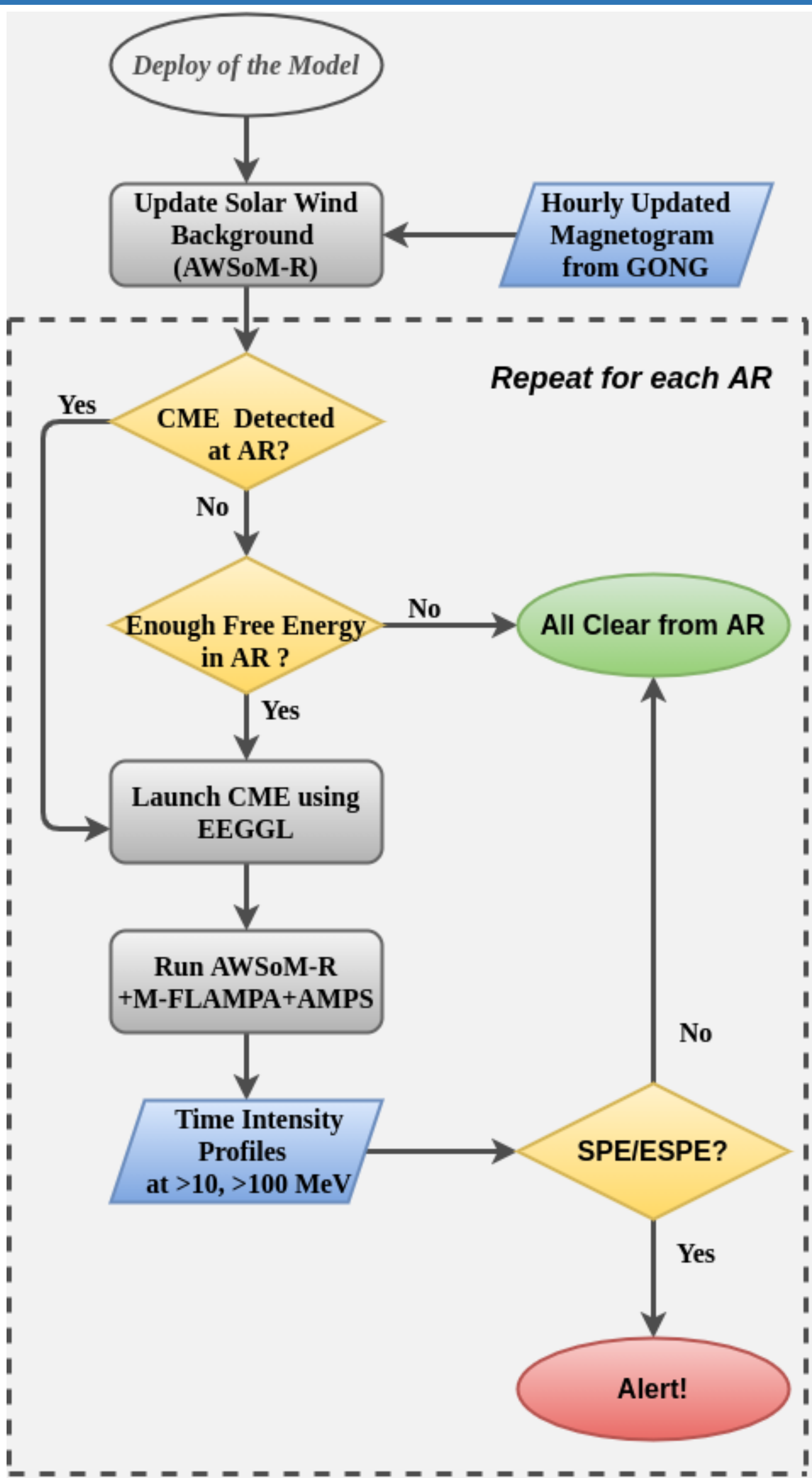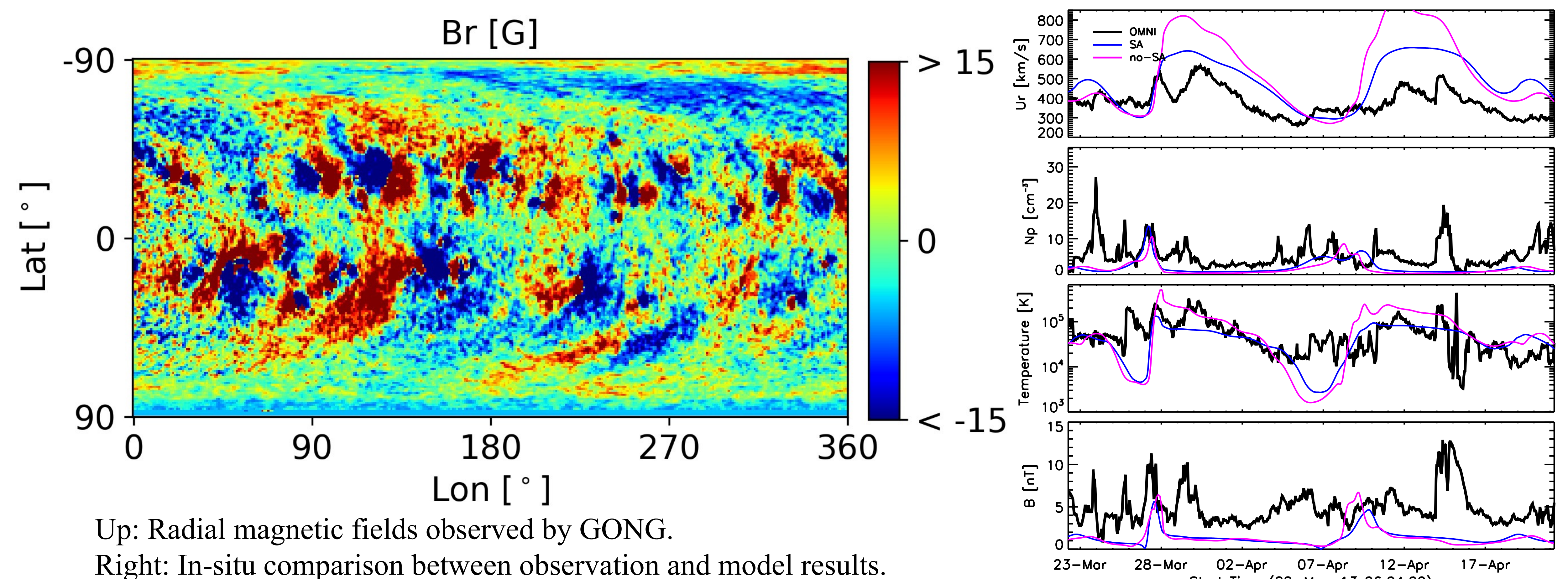**CENTER FOR SPACE ENVIRONMENT MODELING — CSEM**

ABSTRACT

We present a data-driven and self-consistent SEP model, SOFIE, to simulate the acceleration and transport processes of energetic particles using the Space Weather Modeling Framework (SWMF) developed at the University of Michigan. In this model, the background solar wind plasma in the solar corona and interplanetary space is modeled by the Alfven Wave Solar-atmosphere Model(-Realtime) (AWSoM(-R)), which is driven by the near-real-time hourly up- dated GONG (bihourly ADAPT-GONG) magnetogram. In the background solar wind, the CMEs are launched employing the Eruptive Event Generator using Gibson-Low configuration (EEGGL), by inserting a flux rope estimated from the free magnetic energy in the active region. The acceleration and transport processes are then modeled self-consistently by the multiple magnetic field line tracker (M-FLAMPA) and the Adaptive Mesh Particle Simulator (AMPS). We will demonstrate the capability of SOFIE to demystify the acceleration processes by the CME-driven shock in the low corona and the modulation of energetic particles by the solar wind structures. Besides, using selected historical SEP events, e.g. 2013 Apr 11 event, we will illustrate the progresses toward a faster-than-real-time prediction of SEPs.
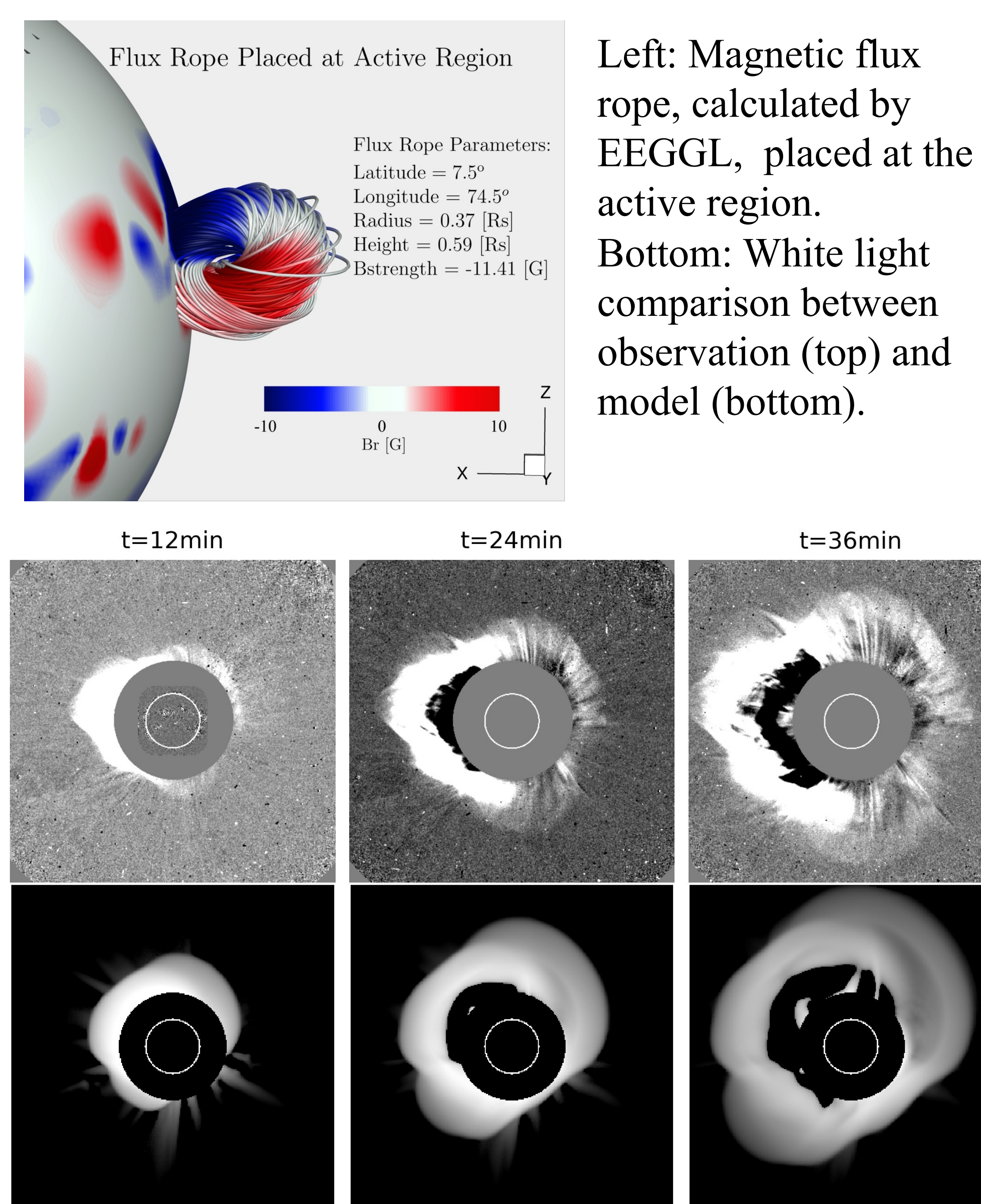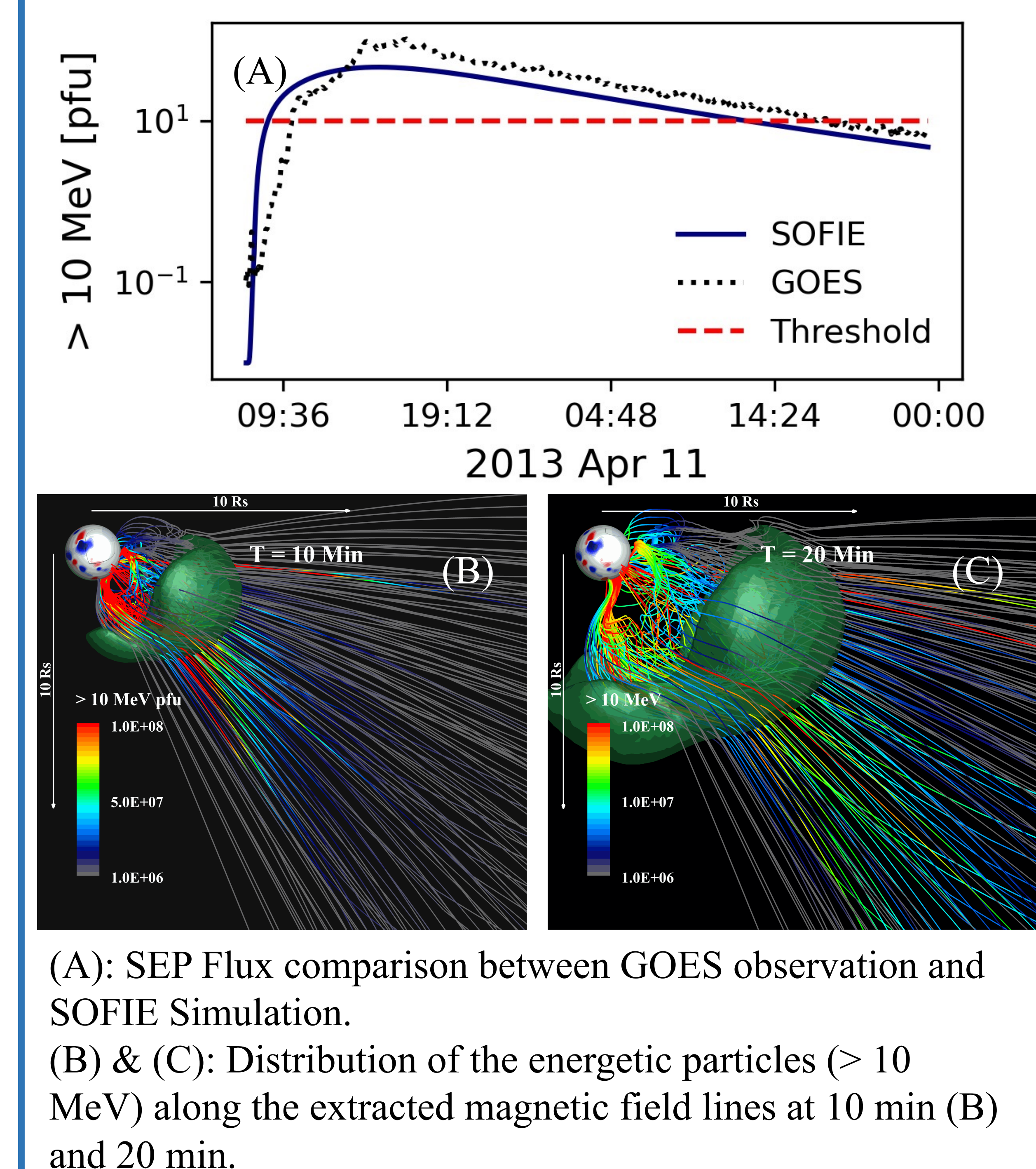
SOFIE WORKFLOW

BACKGROUND SOLAR WIND (AWSoMR)

Up: Radial magnetic fields observed by GONG.
Right: In-situ comparison between observation and model results.

CME INITIATION (EEGGL)

Left: Magnetic flux rope, calculated by EEGGL, placed at the active region.
Bottom: White light comparison between observation (top) and model (bottom).

Flux Rope Parameters:
Latitude = 7.5°
Longitude = 74.5°
Radius = 0.37 [Rs]
Height = 0.59 [Rs]
Bstrength = -11.41 [G]

SEP FLUX

(A): SEP Flux comparison between GOES observation and SOFIE Simulation.
(B) & (C): Distribution of the energetic particles (> 10 MeV) along the extracted magnetic field lines at 10 min (B) and 20 min.

REFERENCES

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[2] I.V. Sokolov, I.I. Roussev, T.I. Gombosi, M.A. Lee, J. Kota, T.G. Forbes, W.B. Manchester, J.I. Sakai, A New Field Line Advection Model for Solar Particle Acceleration. The Astrophysical Journal 616(2), 171–174 (2004)