



# Pileup accident hypothesis: unexpected 2015 Mar 17 storm

Ryuhō Kataoka

National Institute of Polar Research

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### RESEARCH LETTER

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#### Key Points:

- Piled-up coronal mass ejection caused unexpectedly large major magnetic storm
- High-speed stream from coronal hole prevents the expansion of the ejecta from the behind
- Planar magnetic structures were found in the highly compressed sheath region

#### Supporting Information:

- Movie S1
- Figures S1 and S2

#### Correspondence to:

R. Kataoka,  
kataoka.ryuho@nipr.ac.jp

## Pileup accident hypothesis of magnetic storm on 17 March 2015

Ryuho Kataoka<sup>1,2</sup>, Daikou Shiota<sup>3</sup>, Emilia Kilpua<sup>4</sup>, and Kunihiro Keika<sup>3</sup>

<sup>1</sup>National Institute of Polar Research, Tachikawa, Japan, <sup>2</sup>Department of Polar Science, SOKENDAI (Graduate University for Advanced Studies), Tachikawa, Japan, <sup>3</sup>Solar-Terrestrial Environment Laboratory, Nagoya University, Nagoya, Japan, <sup>4</sup>Department of Physics, University of Helsinki, Helsinki, Finland

**Abstract** We propose a “pileup accident” hypothesis, based on the solar wind data analysis and magnetohydrodynamics modeling, to explain unexpectedly geoeffective solar wind structure which caused the largest magnetic storm so far during the solar cycle 24 on 17 March 2015: First, a fast coronal mass ejection with strong southward magnetic fields both in the sheath and in the ejecta was followed by a high-speed stream from a nearby coronal hole. This combination resulted in less adiabatic expansion than usual to keep the high speed, strong magnetic field, and high density within the coronal mass ejection. Second, preceding slow and high-density solar wind was piled up ahead of the coronal mass ejection just before the arrival at the Earth to further enhance its magnetic field and density. Finally, the enhanced solar wind speed, magnetic field, and density worked all together to drive the major magnetic storm.

“Double rarefaction” mechanism to create Super Radiation Belt

# Kataoka and Miyoshi 2008 GRL

L06S09

KATAOKA AND MIYOSHI: EXTREME ENHANCEMENT OF KILLER ELECTRONS

L06S09

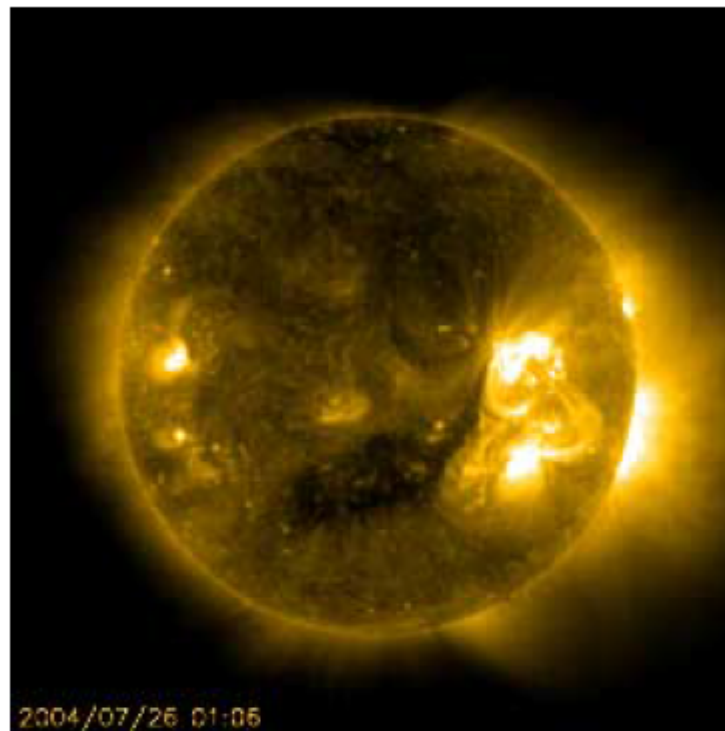
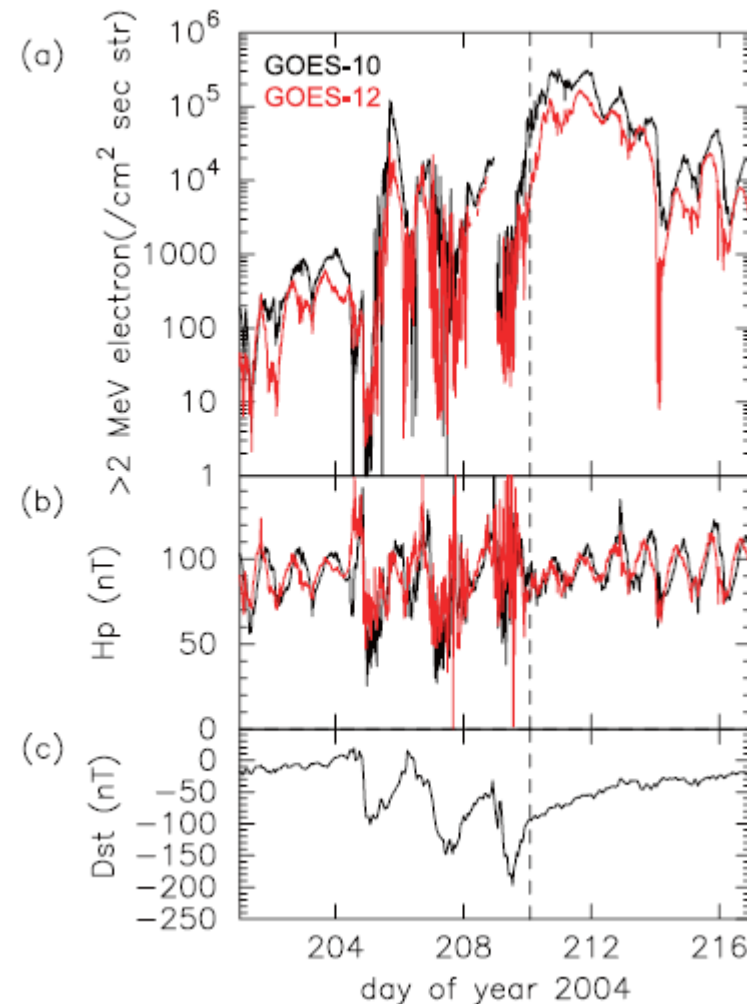
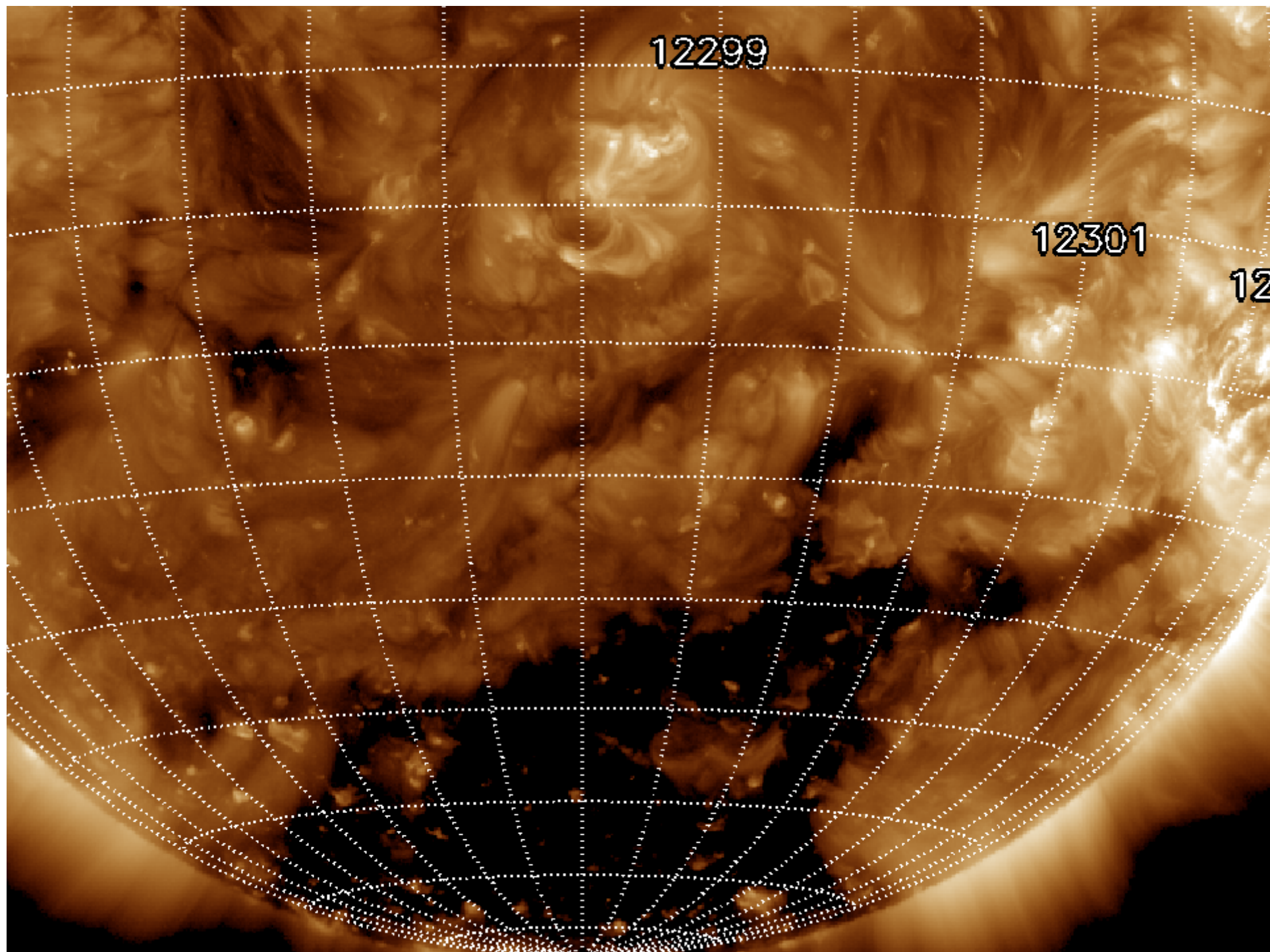


Figure 2. SOHO EIT 284 nm image on 26 July 2004 (total day 208). The coronal hole located over the central meridian in the southern hemisphere, and the active regions associated with the halo CMEs located at westside of the coronal hole.

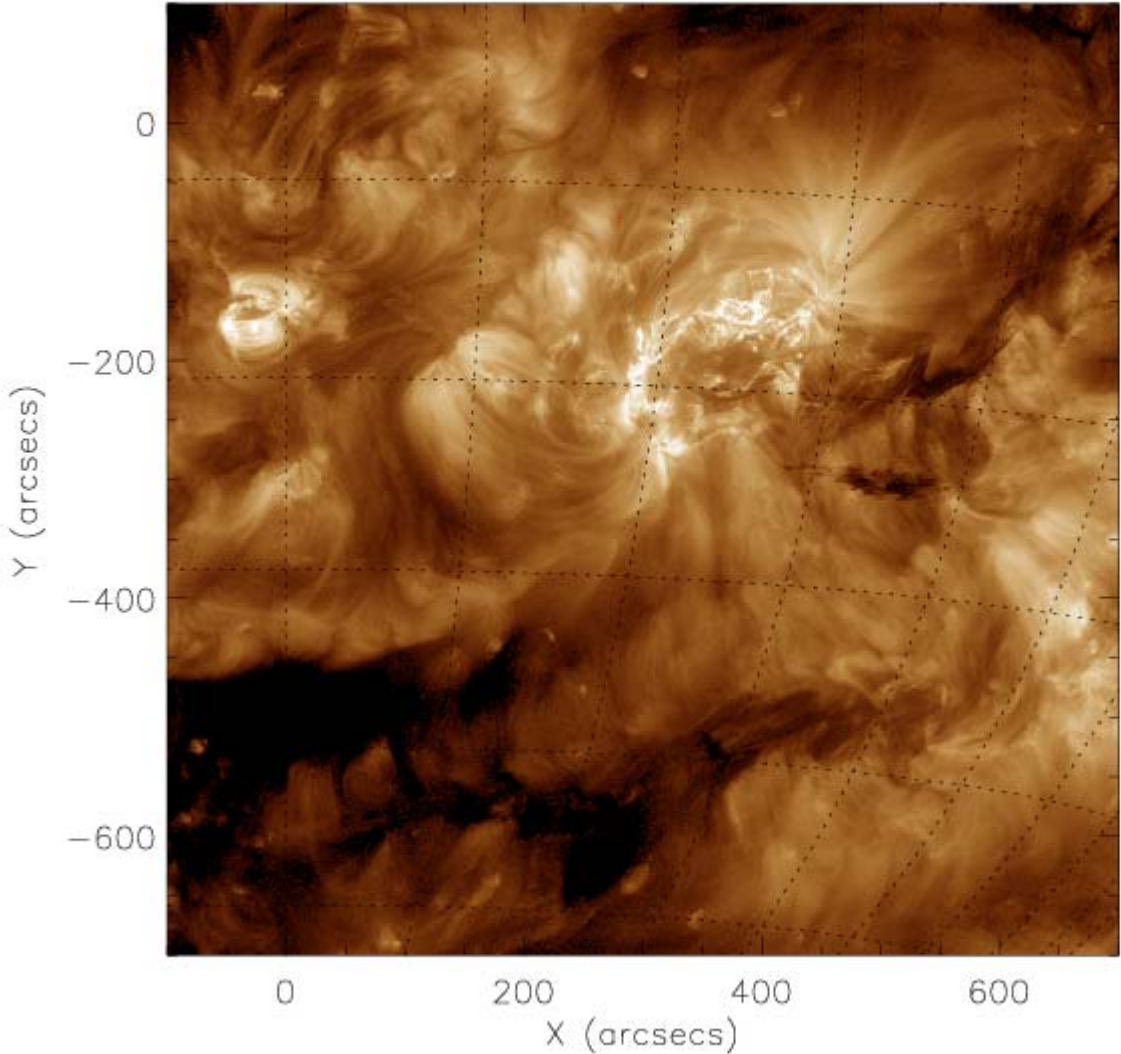






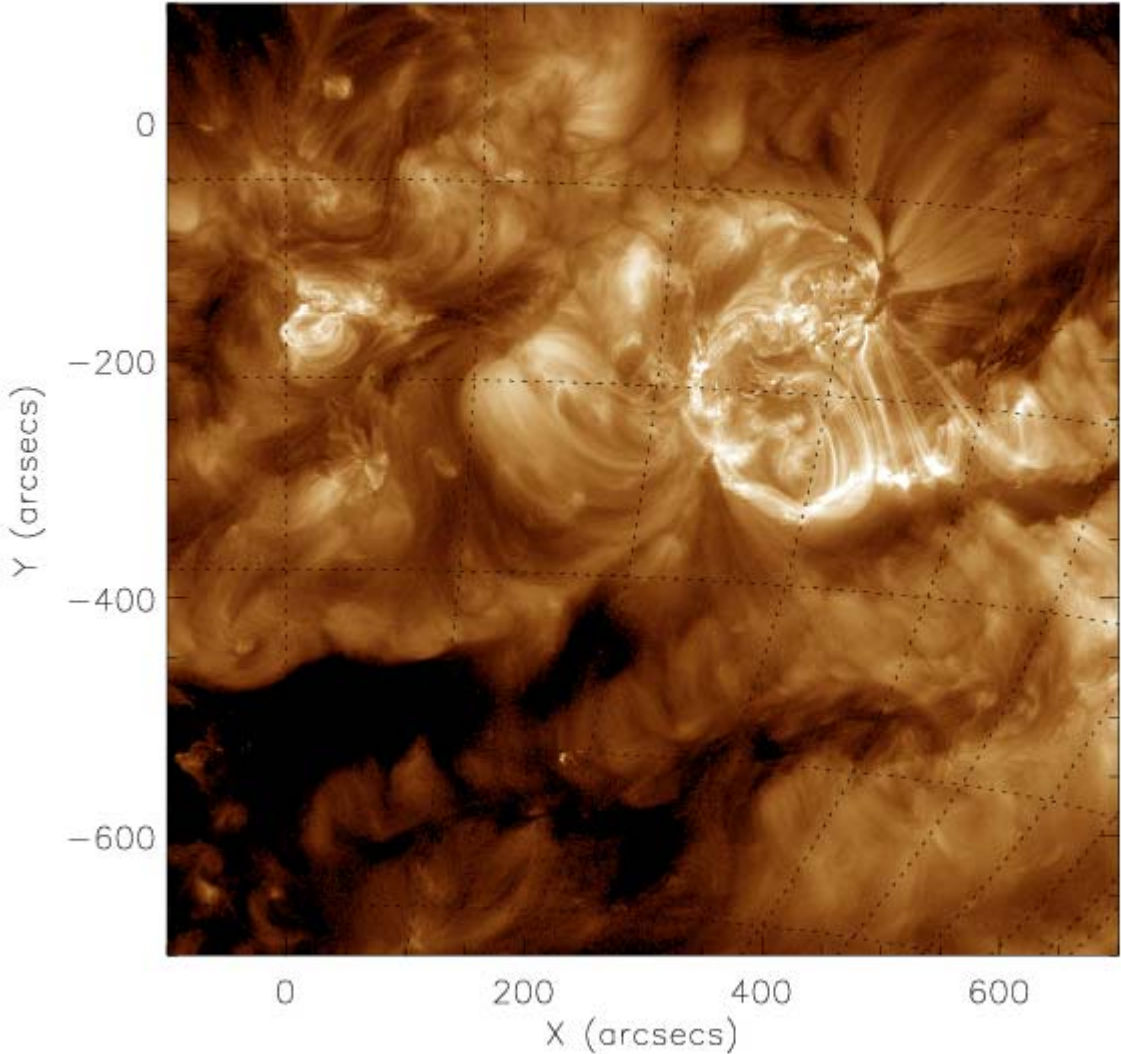
Kataoka+2015 FigS2

SDO AIA\_2 193 15-Mar-2015 00:00:06.840 UT



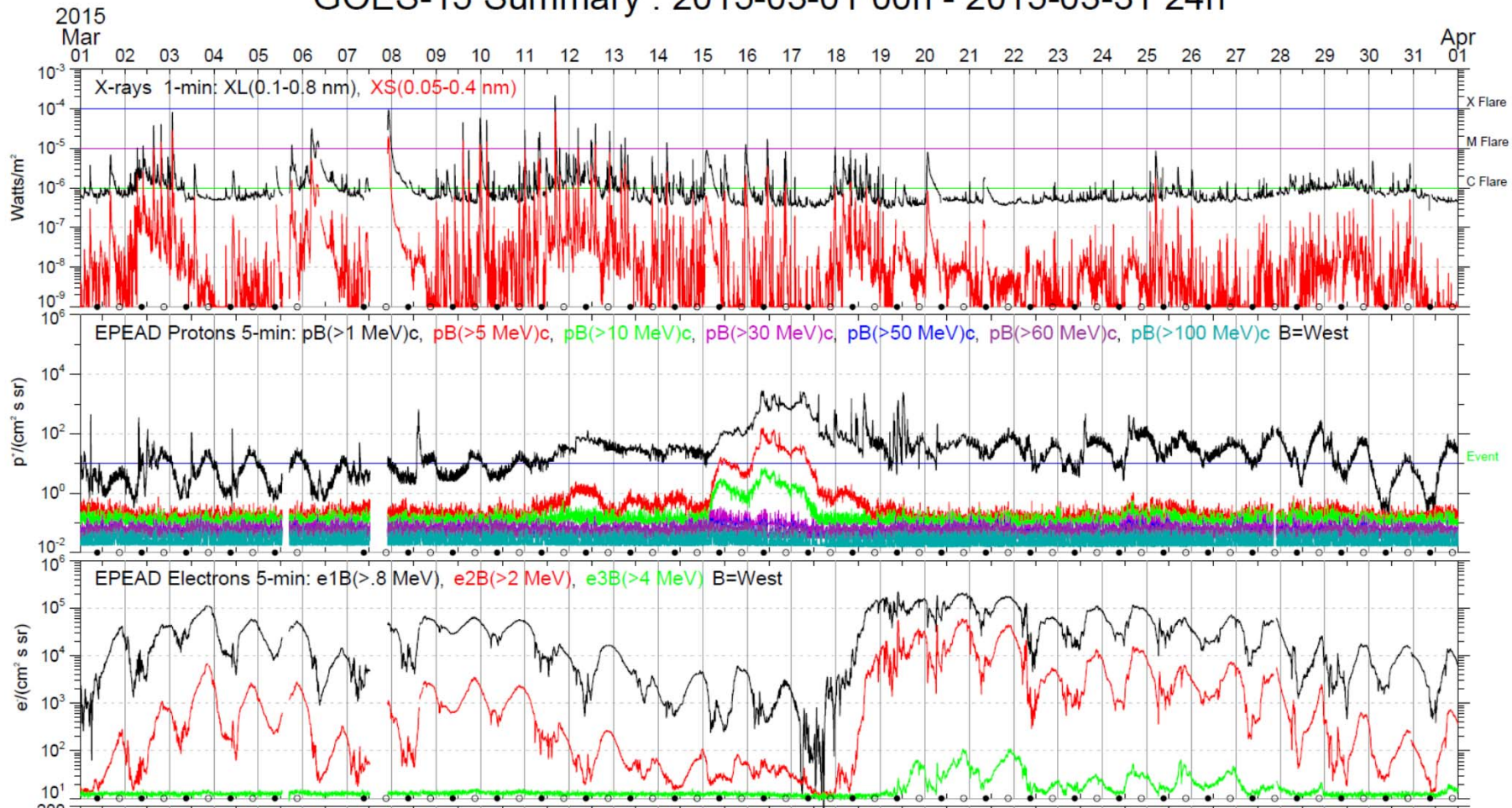
Kataoka+2015 FigS2

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# GOES-15 Summary : 2015-03-01 00h - 2015-03-31 24h



# Key points: Mar 17 storm

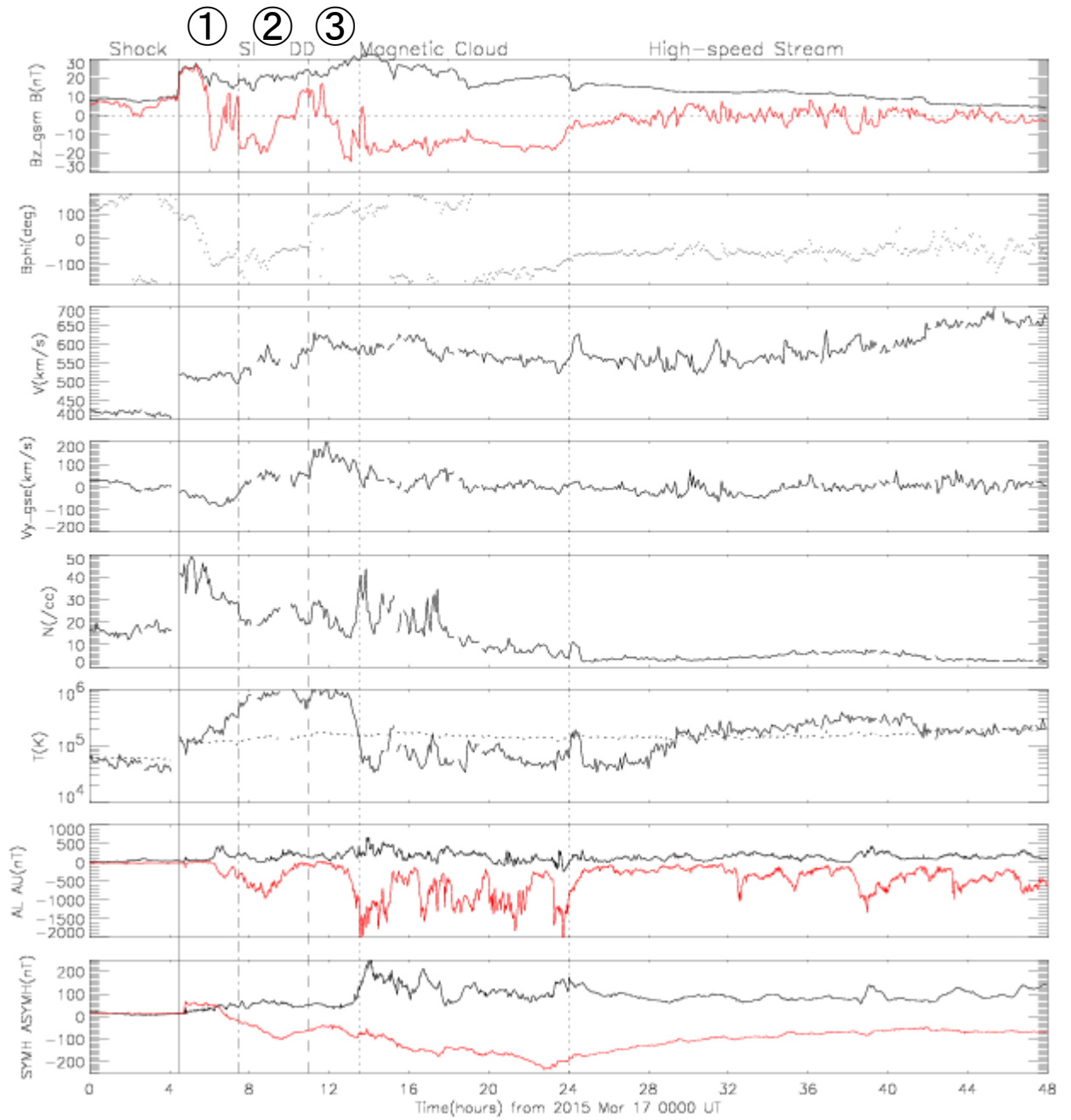
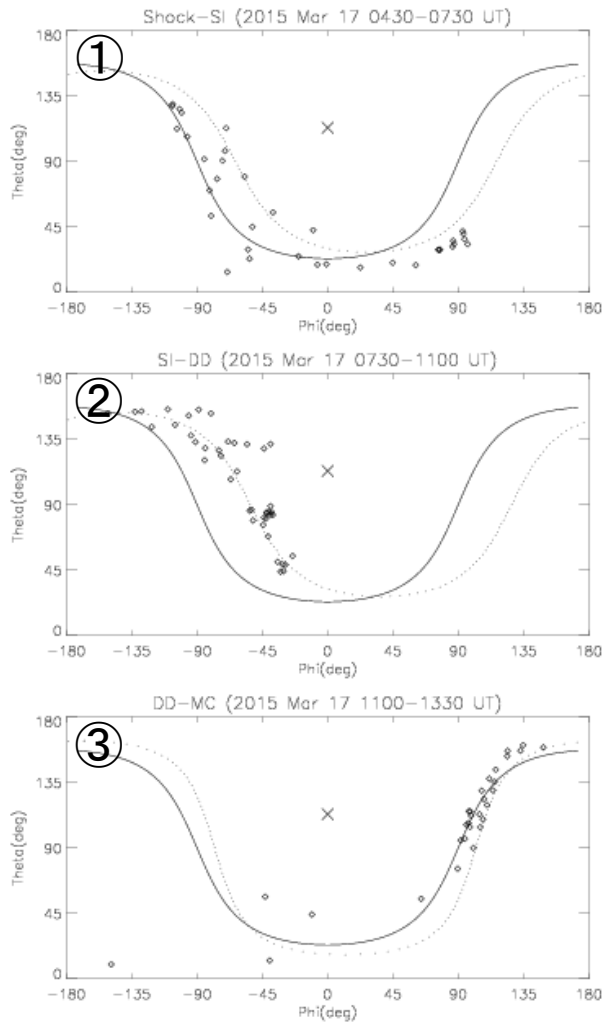
- Piled-up coronal mass ejection caused unexpectedly large major magnetic storm.
  - No major flares, no fast halo CMEs
- High-speed stream from coronal hole prevents the expansion of the ejecta from the behind.
  - “High-density” magnetic storm
- Planar magnetic structures (PMS) were found in the highly compressed sheath region.
  - Consistent with “piled-up”



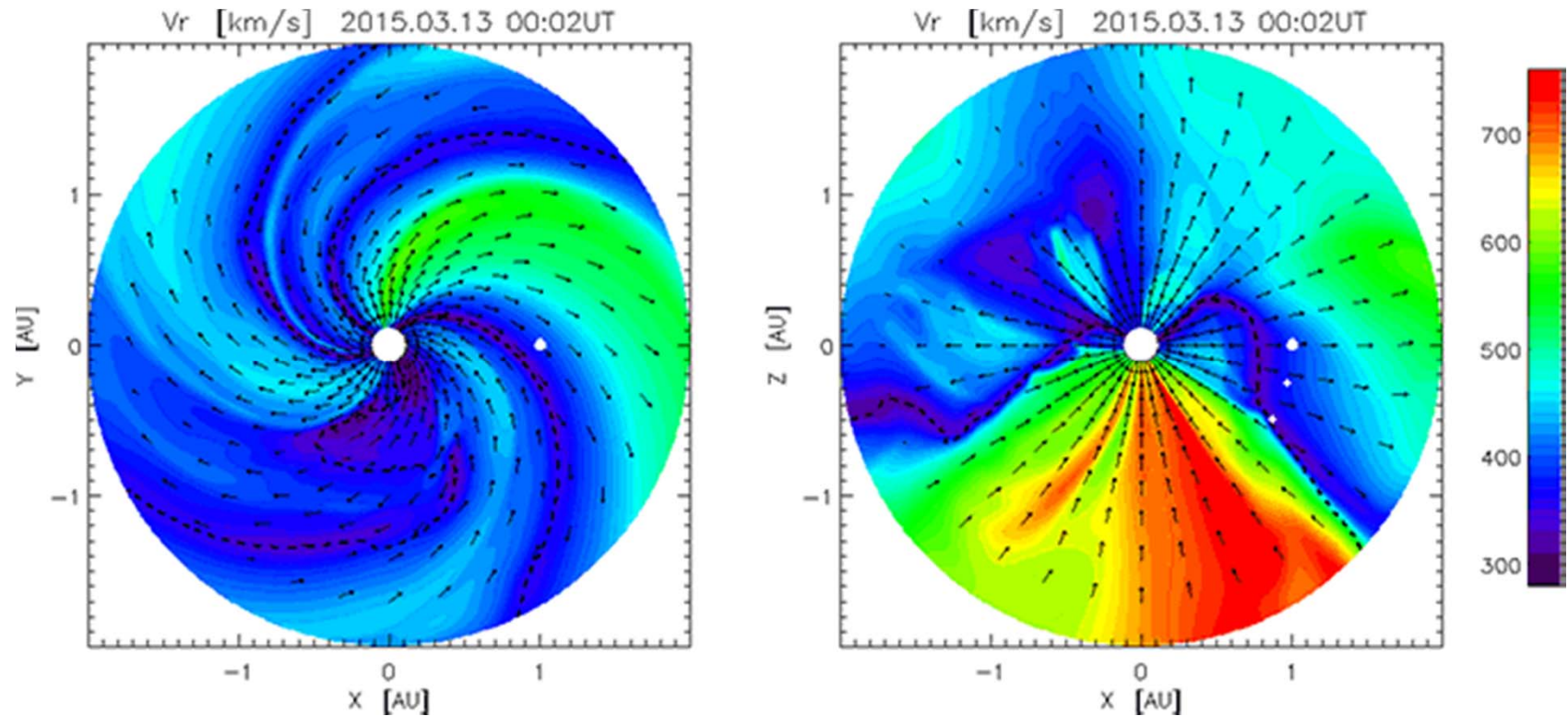
# Kataoka+2015 Fig1+Fig2

Mar 17 (CIR+CME)

Mar 18 (Coronal hole)

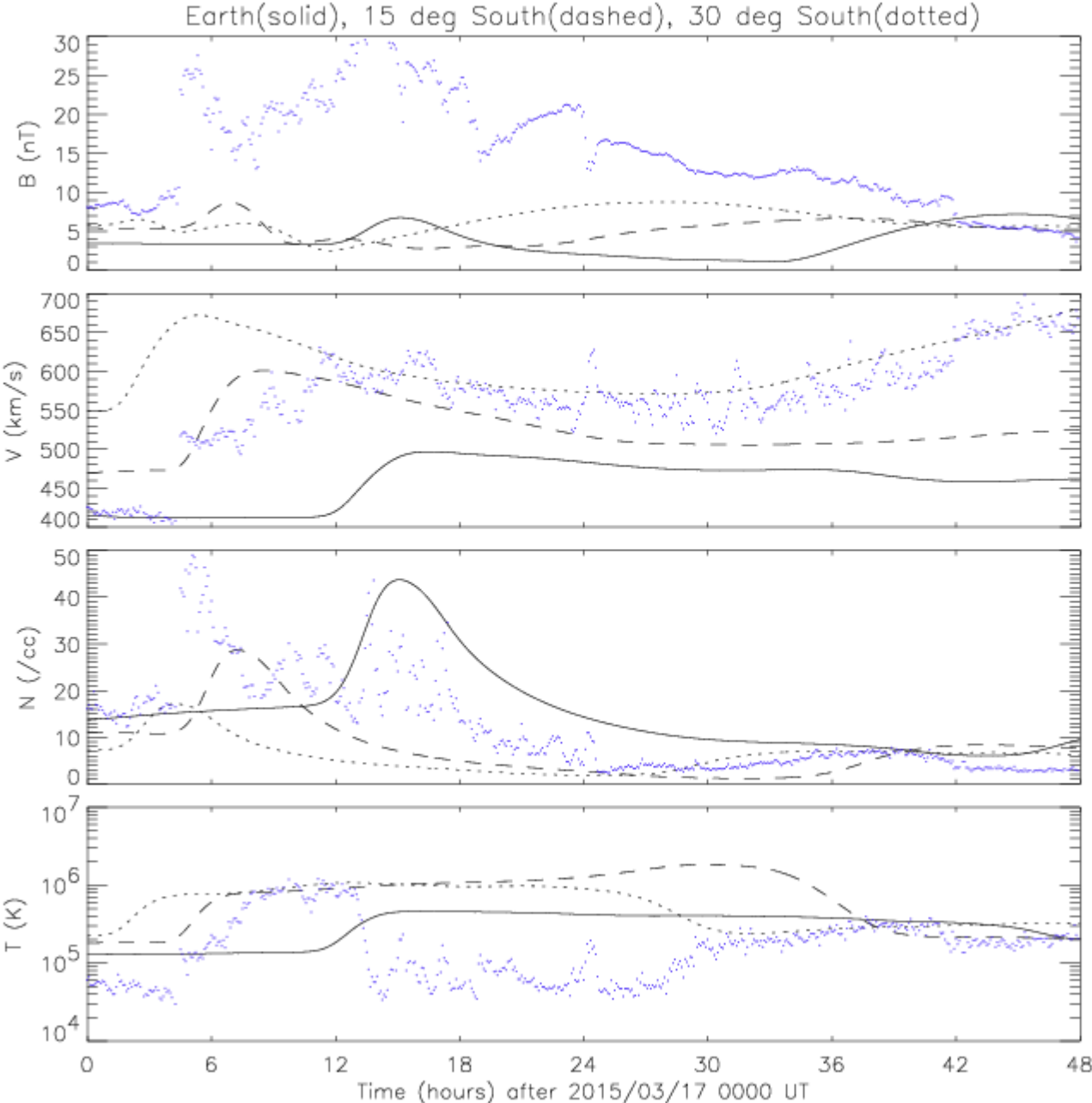


# SUSANOO-CME simulation



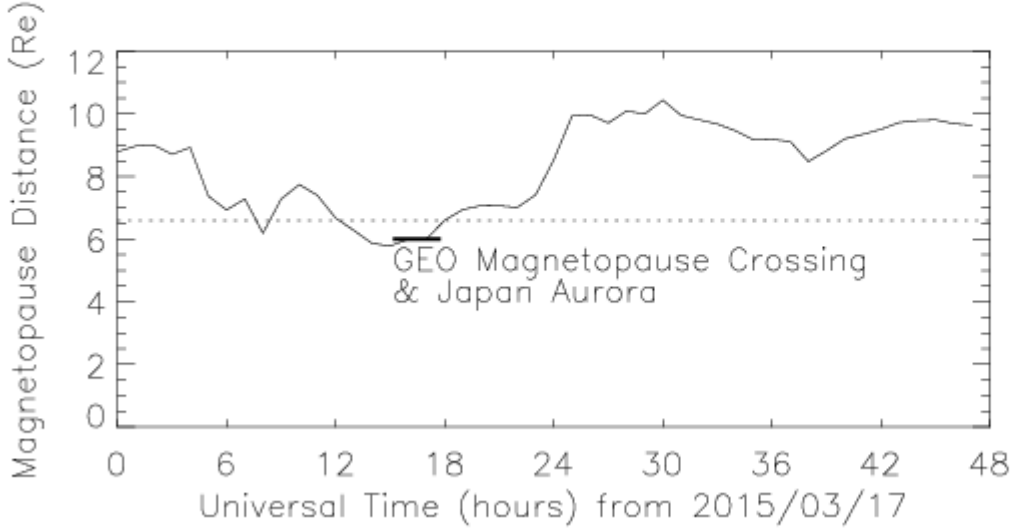
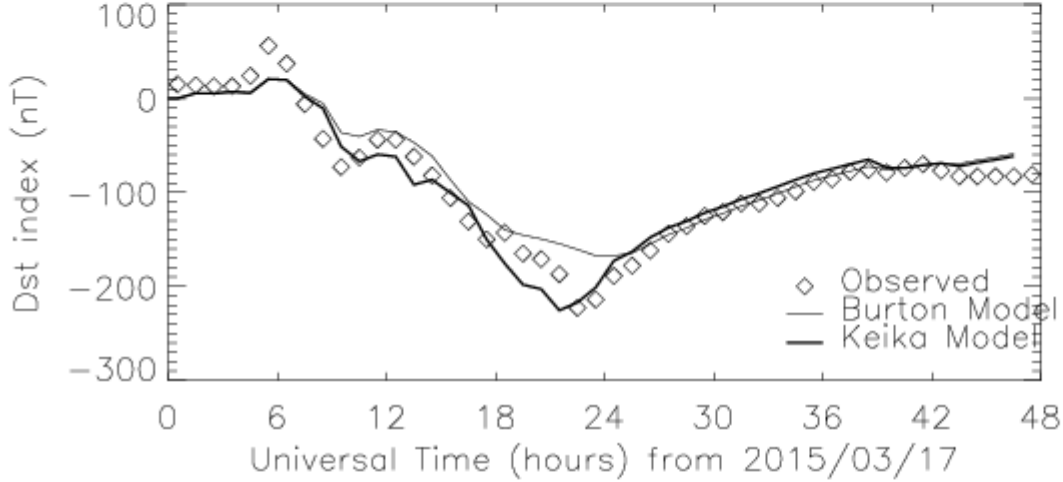
Technical description >> Shiota & Kataoka (2015 submitted to Space Weather)

Kataoka+2015 Fig4





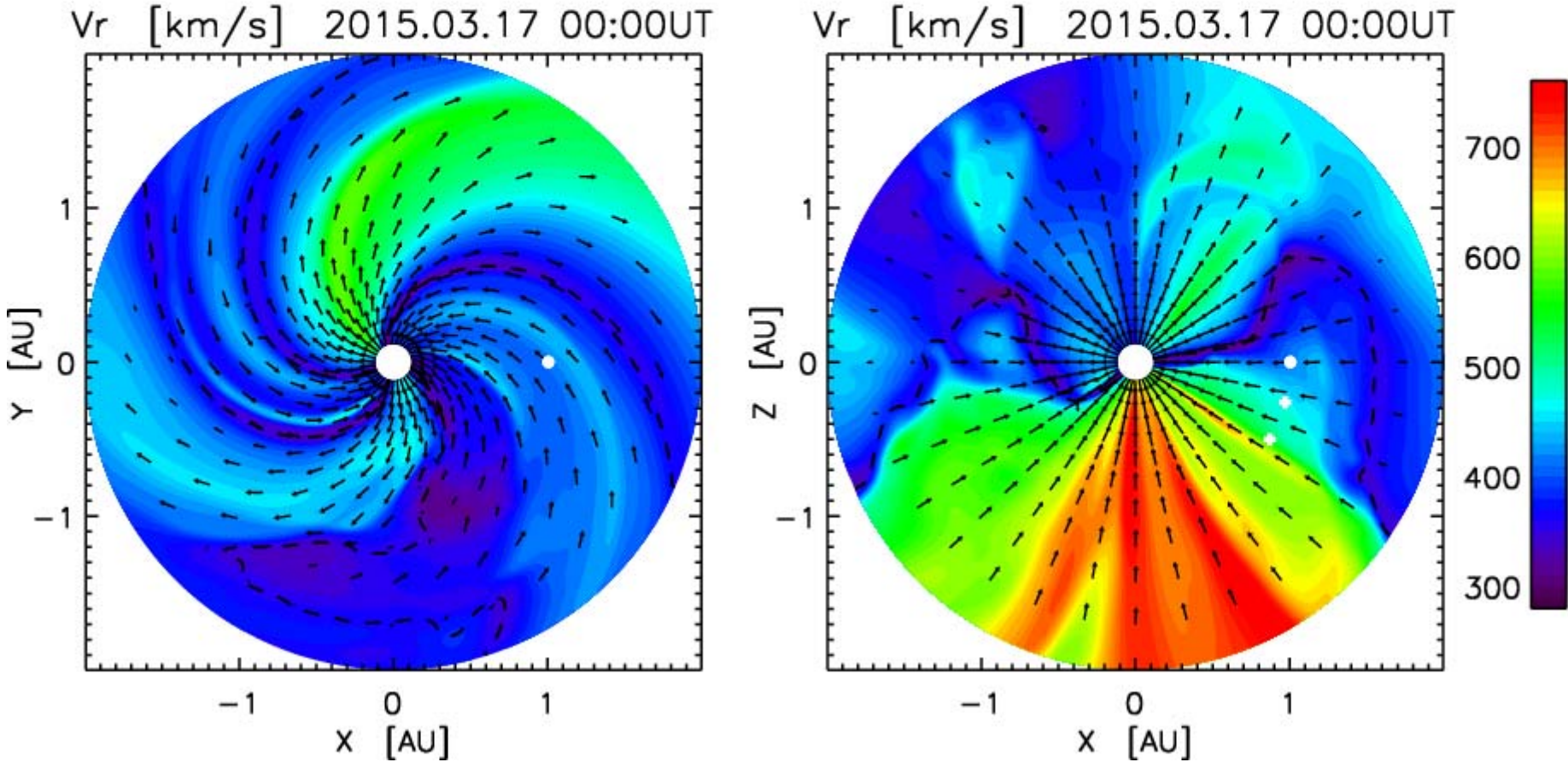
Kataoka+2015 Fig5



# Summary

- Piled-up coronal mass ejection caused unexpectedly large storm on Mar 17.
  - No major flares, no fast halo CMEs
- High-speed stream from coronal hole prevents the expansion of the ejecta from the behind.
  - “High-density” magnetic storm
- Planar magnetic structures (PMS) were found in the highly compressed sheath region.
  - Consistent with “piled-up” CIR

Kataoka+2015 Fig3





2006年12月13日の磁気嵐の原因



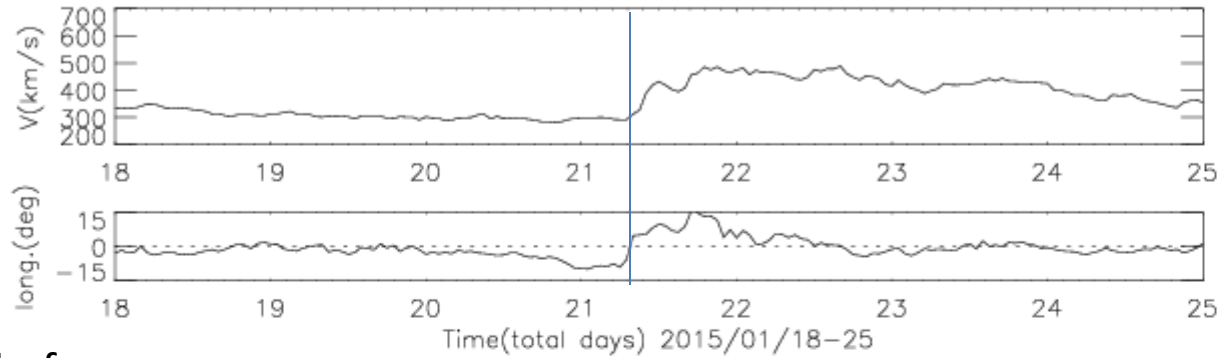
2015年3月17日の磁気嵐の原因



# Kataoka+2015FigS1

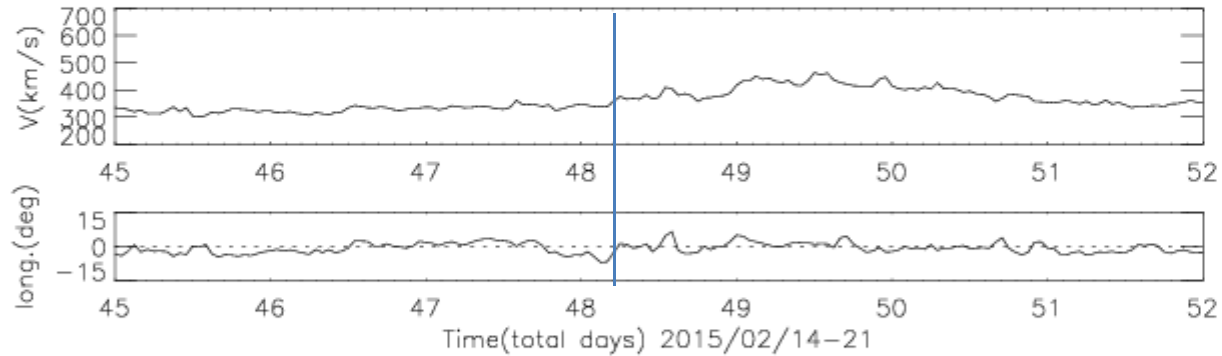
54 days before

Stream Interface



27 days before

Stream Interface



Stream Interface

