Tracking Decrements Observed in the Cosmic Ray Intensity due to Heliospheric Structures with Heliospheric Imagers onboard STEREO

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Introduction:

The primary and best-known relationship between the passage of interplanetary structures and the intensity variations of cosmic rays observed on our planet is called a **F**orbush **D**ecrease (FD). They are typically classified into two main categories: (I) non-recurrent and (II) recurrent. [**Cane, 2000**].

- **Non-recurrent FDs** are predominantly associated with the passage of ICMEs.
- **Recurrent FDs** are generally linked to high-speed solar wind streams from coronal holes.

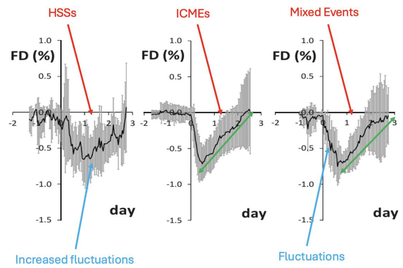

Figure 1. Different characteristics of interplanetary magnetic structures, whether ICME- or HSS-induced, result in distinct patterns of GCR suppression. Adapted from [**Dumbović et al. 2012**]

What was done in this work?

We look for

Cosmic ray decreases

apparently, with **NO** relation

From *in-situ* data observations near Earth's space to structures in the solar wind,

How was it done?

Identification of decreases in the neutron monitor data

(we set a threshold of 3% from the average count rate)

looking for a correlation

With the passage of STEREO-detected interplanetary structures on heliospheric imagers FoV.

Data used in the analysis:

- Cosmic ray intensity observed with **N**eutron **M**onitors (NMs).
- **H**eliospheric **I**magers (HIs) observations

Results:

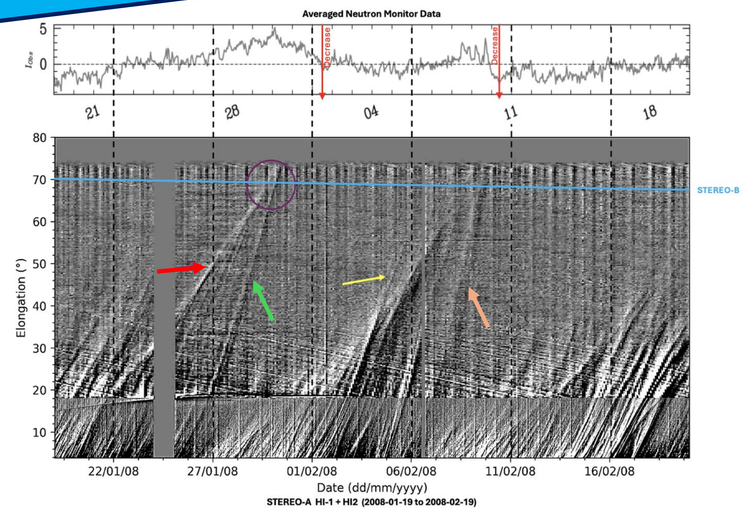

Figure 2. Combined observations of cosmic ray intensity and the heliospheric imaging track of solar wind structures from 2008-01-19 to 2008-02-19. Yellow arrows indicate stream interaction regions observed by STEREO-A.

Discussion:

Figure 2 shows a structure marked by a red arrow interacting with a solar interplanetary region (SIR) from Jian Lian's catalog (green arrow). This interaction may explain the observed intensity decrease around February 2, which was not reported in prior studies like the Izmiran catalog. Another decrease near February 10 is well-associated with two SIRs seen in the J-map from STEREO-A imagers. In-situ measurements from STEREO-B (Figure 3) confirm that these structures correlate with the observed SIRs. Notably, the WIND mission at the L1 point did not detect a significant density increase (see Figure 4) when observing the structure highlighted with the purple arrow in Figure 2. This indicates that heliospheric imagers are essential for identifying density structures that in-situ measurements might miss.

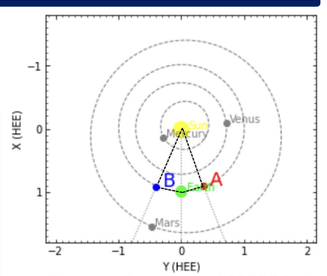

Figure 5. Positions of STEREO-A and STEREO-B, corresponding to the observations in Figure 2.

In-situ measurements:

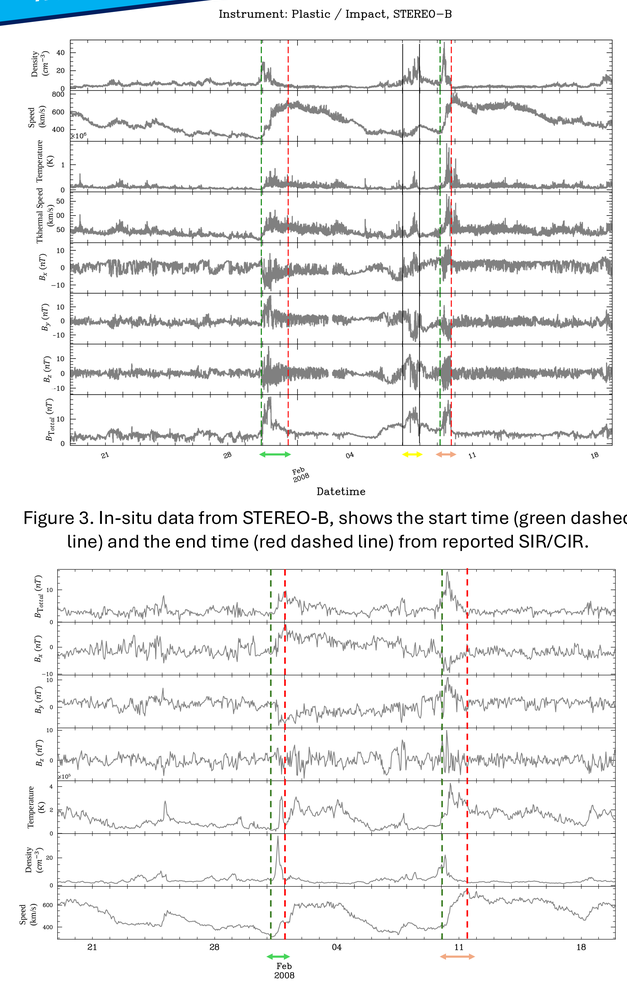

Figure 3. In-situ data from STEREO-B, shows the start time (green dashed line) and the end time (red dashed line) from reported SIR/CIR.

Figure 4. In-situ data from WIND shows the start time (green dashed line) and the end time (red dashed line) for SIR/CIR, as observed by STEREO-B.

Conclusion:

- Heliospheric imagers have proven to be valuable in studying cosmic ray decreases, offering new insights into the global physical mechanism of Forbush Decreases or GCR depressions, providing observations that cannot be detected in situ, such as with STEREO-B or WIND.
- This work presents the density structure detected in the J-map on January 22, 2008. This structure is likely associated with a coronal mass ejection (CME) and interacts with a stream interaction region (SIR). The heliospheric cameras and in-situ measurements observed this interaction, leading to the cosmic ray decrease observed on February 2, 2008.

REFERENCES:

Dumbović, M., Vršnak, B., Čalogović, J., & Karlica, M. (2011). Cosmic ray modulation by solar wind disturbances. *Astronomy & Astrophysics*, *531*, A91.

Cane, H. V. (2000). Coronal mass ejections and Forbush decreases. *Space Science Reviews*, *93*(1), 55-77.

Jian, L. K., Luhmann, J. G., Russell, C. T., & Galvin, A. B. (2019). Solar Terrestrial Relations Observatory (STEREO) observations of stream interaction regions in 2007–2016: Relationship with heliospheric current sheets, solar cycle variations, and dual observations. *Solar physics*, *294*(3), 31.