Forecasting of Corotating Interaction Regions Geoeffectiveness opservatorij Hva

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Major driver of interplanetary disturbances and geomagnetic storms during solar minimum are corotating interaction regions (CIR) when the occurrence of interplanetary coronal ejections (ICME) is very low. CIRs are produced as fast solar wind streams, originating from coronal holes (CH), interact with the preceding slow solar wind. To improve space weather predictions, we investigated the relationship between the area of CHs, cosmic ray flux and Dst index during the minimum solar cycle 23-24 (2007-2010). Since interplanetary disturbances near Earth are delayed about 4 days after changes in CH area, this gives a good opportunity to forecast a geoeffectiveness of CIRs during the solar minimum in the absence of ICMEs.

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Coronal Hole area data

- Extracted from SOHO EIT 195 Å images
- Identified with intensity-based thresholding technique (Rotter et al., 2012, Reiss et al. 2015) • Fractional coronal hole area is derived from a central meridional slice (±7.5°) corresponding

to the solar rotation within aprox. 1 day • Period of analysis: 1.1.2007 - 31.12.2010



Operational forecast for solar wind highspeed streams (ESWF): solar wind speed & magnetic field http://swe.uni-graz.at/ index.php/services/solar-wind-forecast

Analysis



- Satellite cosmic ray measurements taken from EPHIN (Électron Proton Helium Instrument) on SOHO
- Data available from Dec. 07 1995
- Consists of several semiconductor detectors in layers (A-F) and a scintillation detector, operated in anticoincidence
- interpolation of small gaps in the data (up to 18h)





anomalies are calculated subtracting the running mean (54 days)



Jan08 Jan10





CH area vs EPHIN measurements





Correlation without ICME events

ICME list (Richardson & Cane, 2010)



only 30 ICMEs during 2007 – 2011 period
12h before ICME event removed and 72h after ICME event removed – in total 9.2% data excluded (101 days)

- Counter F: r = -0.42 (lag -4.25 days)
- Dst: r = -0.24 (lag -4.50 days)
- Very small difference in correlation when using all data and data without ICME events

Peak to peak analysis



peak values in CH area are associated with peak values in Dst



• Counter B: r = -0.23 (lag -4.75 days) Anticoincidence Counter: r = -0.40 (lag -4.50 days) Counter F: r = -0.42 (lag -4.50 days) Difference in travel time ±1 days (solar wind speed)



• Dst: r = -0.26 (lag -4.50 days)



Conclusions

- Longer analysis period 2007 2011 allows better statistics than in the previous studies Distinct correlation between Coronal Hole (CH) area and EPHIN cosmic ray flux measurements (r=0.4) as well as Dst index (r=0.26)
- Max. correlation for lag of 4.5 days
- Opportunity to forecast a geoeffectiveness of CIRs as well as their effect on the cosmic-ray flux during the solar minimum in the absence of ICMEs
- Better forecast should be obtained by including the CH polarity data (will be implemented in the future)

References:

• Reiss, A.M., Hofmeister, J.S., De Visscher, R., et al.: 2015, J. Space Weather Space Clim. 5, A23. • Rotter, T., Veronig A., Temmer, M. and Vršnak B.: 2012, Sol. Phys., 281:793-813. • Richardson, I.G. and Cane, H.V.: 2010, Sol. Phys. 264:189. **Acknowledgements:** This work has been supported by the Croatian Science Foundation project 6212 SOLSTEL. Correspondence to: jcalogovic@geof.hr