

## [SE-11] Empirical forecast of corotating interacting regions based on coronal hole information

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In this study, we suggest an empirical forecast of CIRs (Corotating interaction regions) based on the information of coronal holes (CHs). For this we used CH data obtained from He I 10830 Å maps at National Solar Observatory-Kitt Peak from 1996 to 2003 and the CIR data that Choi et al. (2009) identified. Considering the relationship among coronal holes, CIRs, and geomagnetic storms (Choi et al. 2009), we propose the criteria for geoeffective coronal holes ; the center of CH is located between N30 and S30 and between E40 and W20, and its area in percentage of solar hemispheric area is larger than the following areas: (1) case 1 : 0.36%, (2) case 2 : 0.66%, (3) case 3 : 0.36 % for 1996-2000, and 0.66 % for 2001-2003. Then we present contingency tables for three cases and their dependence on solar cycle phase. From the contingency tables, we determined several statistical parameters for forecast evaluation such as PODy (the probability of detection yes) , FAR (the false alarm ratio), Bias (the ratio of "yes" predictions to "yes" observations) and CSI (critical success index). Considering the importance of PODy and CSI, we found that the best criterion is case 3 ; PODy=0.78, FAR=0.66. Bias=2.26, and CSI=0.31. It is also found that the parameters near solar minimum are much better than those near solar maximum. As a next step, we are developing a forecast method of geomagnetic storms based on coronal hole information.

## [SE-12] Source identification of back side solar proton events

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Solar proton events, whose fluxes are larger than 10 particles cm<sup>-2</sup> sec<sup>-1</sup> ster<sup>-1</sup> for >10 MeV protons, have been observed since 1976. NOAA proton event list from 1997 to 2006 shows that most of the events are related to both flares and CMEs but a few fraction of events (5/93) are only related with CMEs. In this study, we carefully identified the sources of these events. For this, we used LASCO CME catalog and SOHO MDI data. First, we examined the property of CMEs related with the events. The CMEs are found to eject from the western hemisphere and their velocities are all above 1200Km/s. Second, we searched a major active region in the front solar disk for several days before the proton events occurred by taking into account two facts : (1) The location of the active region is consistent with the position angle of a given CME and (2) there were several flares in the active region or the active region is the largest among several candidates. As a result, we were able to determine active regions which are likely to produce proton events without ambiguity as well as their longitudes at the time of proton events by considering solar rotation rate, 13.2° per day. From this study, we found that the longitudes of five active regions are all between 90°W and 120°W. When the flare peak time is assume to be the CME event time, we confirmed that the dependence of their rise times (proton peak time - flare peak time) on longitude are consistent with the previous empirical formula. These results imply that five events should be also associated with flares which were not observed because they occurred from back-side. This fact suggests a sufficient possibility that all solar proton events are related with both flares and CMEs. Finally we discuss how to predict back-side solar proton events.