[VII-2-1] Contribution of Space Weather Proxies to Global Warming and Its Comparison with CO2

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We have examined the contribution of representative space weather proxies (sunspot number and geomagnetic aa index) to global warming (Global temperature anomaly) and compared with that of green house effect characterized CO2 content from 1868 to 2005. For this we used Hadcrut3 temperature anomaly (Ta) data, aa index taken at two anti-podal subauroral stations (Canberra Australia and hartland England), and the CO2 data come from historical ice core records. A correlation between Ta and aa index is similar to but slightly higher than that between Ta and sunspot number. From the comparison between Ta and aa index, we found several interesting things: (1) the linear correlation coefficient between two parameters increases until 1990 and then decreases rapidly, and (2) the scattered plot between two parameters shows a bifurcation of the correlation tendency near 1990. A partial correlation of Ta and two quantities (aa, CO2) also shows that the geomagnetic effect (aa index) is dominant until about 1990 and the CO2 effect becomes much more important after then. These results imply that the CO2 effect become very important since at least 1990. For a further analysis, we simply assume that Ta = Ta(aa)+Ta(CO2) and made a linear regression between Ta and aa index from 1868 to 1990. A linear model is then made from the linear regression between energy consumption (a proxy of CO2 effect) and Ta-Ta(aa) since 1990. This linear model makes it possible to project the temperature anomaly in 2030, about 1 degree higher than the present temperature.

[VII-2-2] Solar wind-Magnetosphere Coupling: correlation between substorm injections and solar wind parameters

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We have examined the relationship between magnetospheric substorms identified by LANL particle injections and daily interplanetary parameters observed by ACE and Geotail during the second half (from July to December) of 2003, which is the declining phase of solar cycle 23. From a statistical study of the relationship between substorms and interplanetary parameters, the following observational results are obtained: (1) Substorm injection occurrence is very well associated with high-speed stream geomagnetic activity and the correlation coefficient between daily substorm injection occurrence and daily median solar wind speed is ~0.7, implying that solar wind speed itself strongly modulates substorm injection; (2) The average of negative IMF Bz is not responsible for the increase in injections with solar wind speed and (3) There is the evidence that IMF Bz triggering might be important to substorm injection occurrence. In addition, we tested if the substorms in our study are triggered with several types of northward triggering criteria (a) growth phase duration time, (b) average Bz during the growth phase, and (c) increase value of Bz after northward turning. We found that the correlation coefficients between the tested IMF Bz triggers and substorm injection occurrence range from 0.60 to 0.80, implying that the tested types of northward turning are responsible for a large fraction of substorms and thus are a significant contributor to the increase in onsets with increasing solar wind speed though the limitation of usage of daily parameters.

[VII-2-3] Longitudinal dependence of solar proton events and their relationships with X-ray flares.

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Solar proton events have been regarded to be very important in that they may cause the damage of spacecrafts and human activities in space. The NOAA proton prediction model (PROTONS) has been used to predict solar proton flux using solar X-ray flux. In this study, we examined the longitudinal dependence of solar proton events and their relationships with x-ray flares. For this we used GOES X-ray flare data from 1976 to 2006 and the corresponding NOAA SEP events, which is defined as a flux of >10 MeV protons greater than 10 particles cm-2 sec-1 ster-1. We selected the proton events whose solar locations were identified. As a result, we found 191 proton events, of which most of them (178/191) are associated with major flares (90 X-class and 88 M-class). Then we examined the fraction of proton events relative to total major X-ray flares and its longitudinal dependence. We found that about only 3.2% (1.6% for M-class and 20.6% for X-class) of the flares are associated with the proton events. We found for the first time that this fraction strongly depends on heliolongitude; for example, the fraction for 30W<L<60W is about three times larger than that for 30E<L<60E. In addition, the relationship between X-ray flux and proton flux for each longitude region as well as its correlation coefficient are much better than those used for the NOAA model. Our new findings will be very useful for improving the NOAA proton prediction model.