Magnetic Clouds and their Geoeffectiviness

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A brief introduction:

- **Magnetic Clouds' characteristics**

The study:

- **Event types in this study and their geoeffectiviness**
- **_t, -Bzmax, and (-VBz)max in relation with the Dst index**
- **Correlation between (-VBz)max and Dst index**
- **Solar cycle 23**
- **Conclusions**

SHINE WORKSHOP 2005

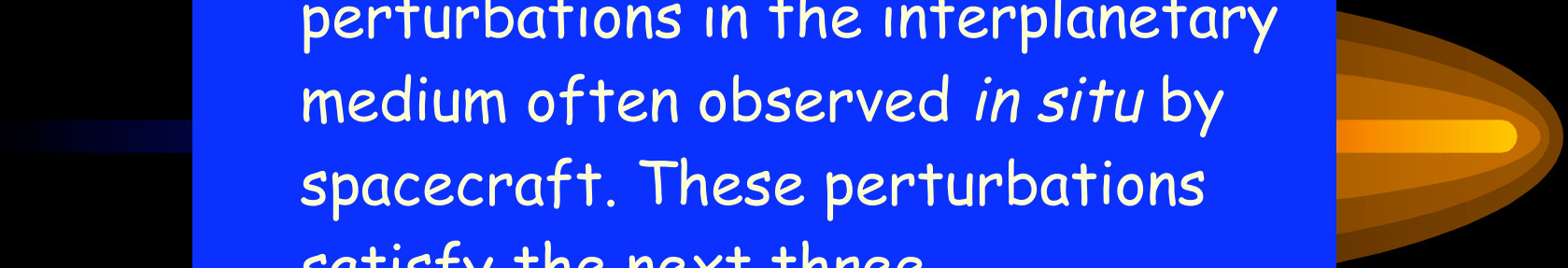
STUDENT'S SESSION

Magnetic Clouds (MCs) are perturbations in the interplanetary medium often observed *in situ* by spacecraft. These perturbations satisfy the next three characteristics:

(1) the magnetic field is higher than the ambient solar wind field

(2) the magnetic field rotates smoothly on a plane, and

(3) the temperature is lower than in



MCs are good candidates to study their geoeffectiviness

B (nT)

Lat. angle

Temperature (K)

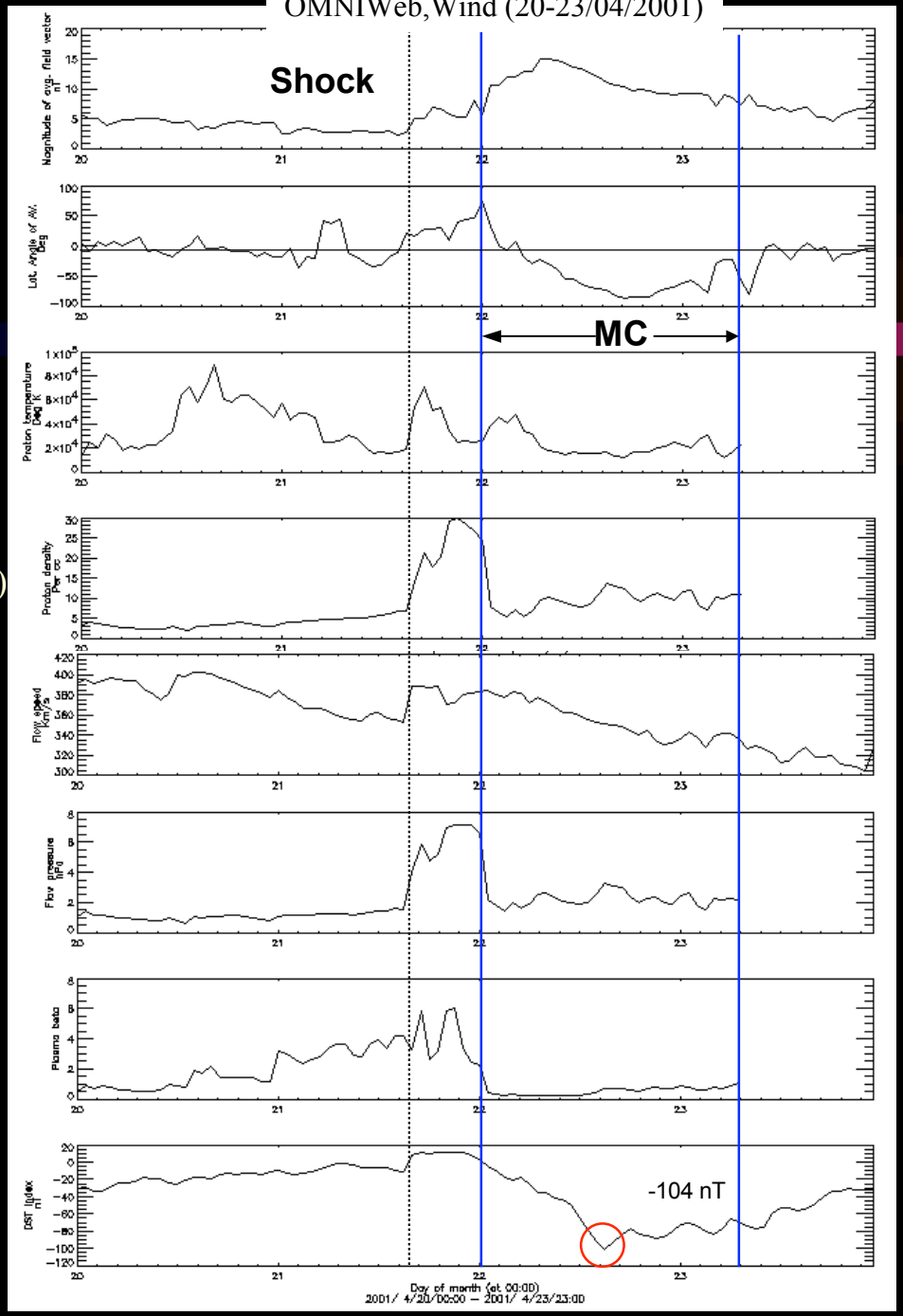
Density (p/cm^3)

Speed (km/s)

Pressure (nPa)

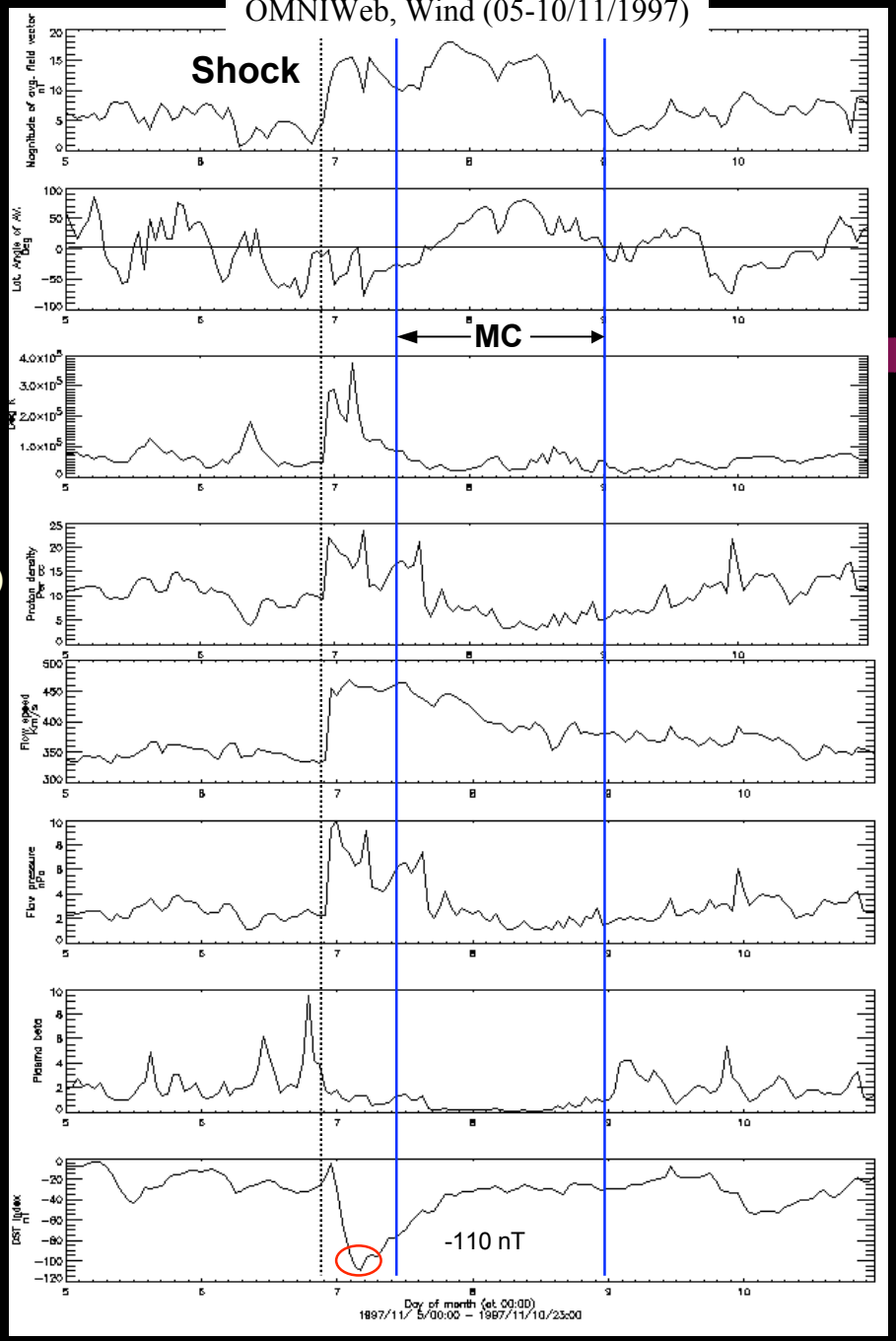
Plasma _

Dst (nT)



STORM CAUSED BY MC

In this event the storm is caused by a MC which has a long-lasting and well order magnetic field in the south Bz component



STORM CAUSED ONLY BY SHEATH REGION

In **this event** the storm is caused by the sheath region and not by the MC

In our data set, sheath regions with south Bz component (9 events) generate Dst dips of around -127nT

B (nT)

Lat. angle

Temperature (K)

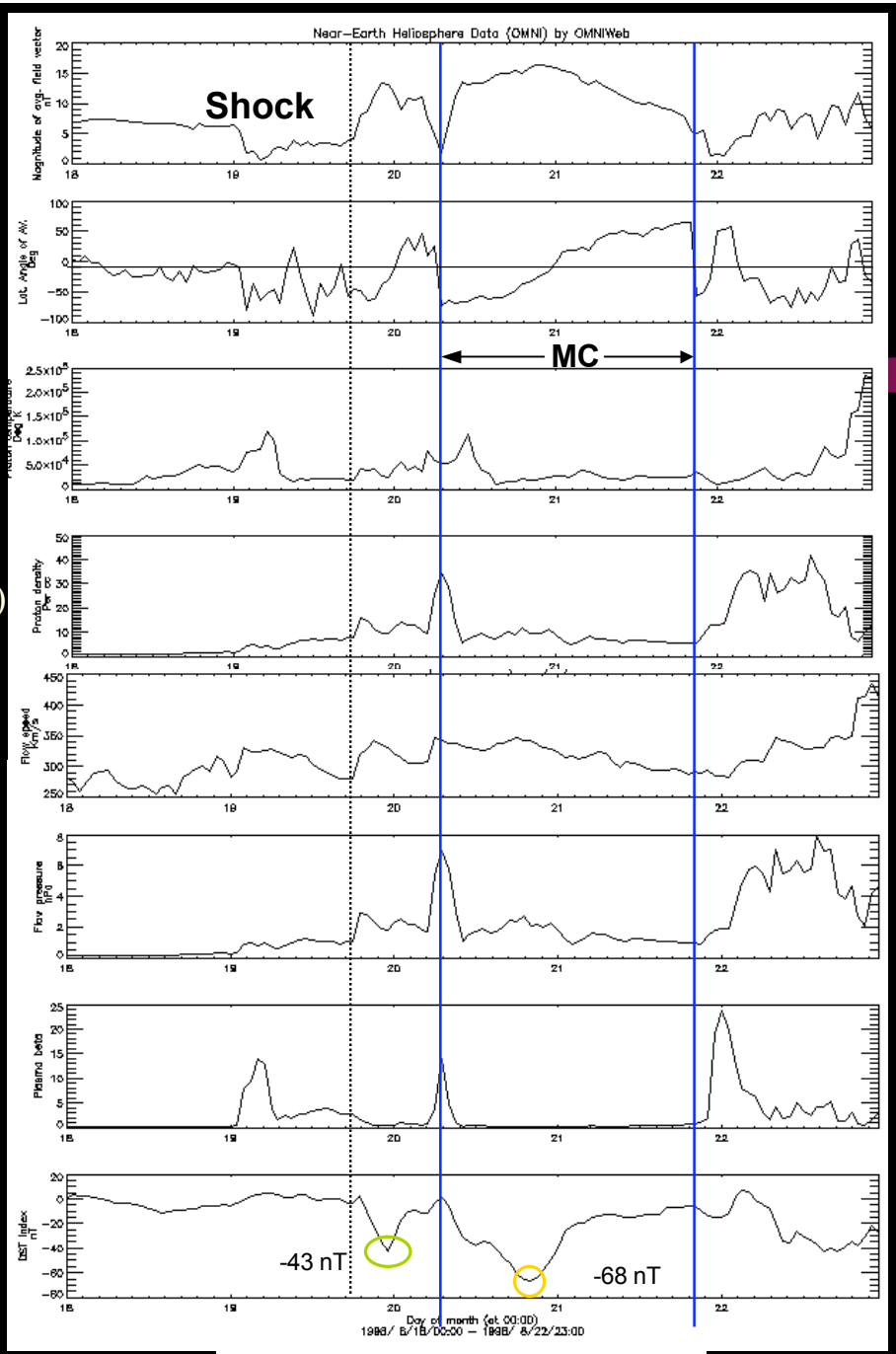
Density (p/cm^3)

Speed (km/s)

Pressure (nPa)

Plasma _

Dst (nT)



OMNIWeb, Wind (18-22708/1998)

TWO- STEP STORMS EVENT

A two-step storm event has the next three conditions (*Kamide et al., 1998*):

(1) the first dip must be less than -30nT, and be separated from the second dip by more than 3 hours

(2) the later dip must be greater than the previous one, and

(3) there must be no storm sudden commencement (SSC) between the two dips

In this event sheath and MC are geoeffective causing a two-step storm event.

Two-step storm events

Dst caused by sheath	Dst caused by MC	MF Distribution
-55	-68	S S S
-105	-150	S S S
-30	-83	S N S
-70	-105	S N S
-43	-68	S S N
-120	-152	S S N

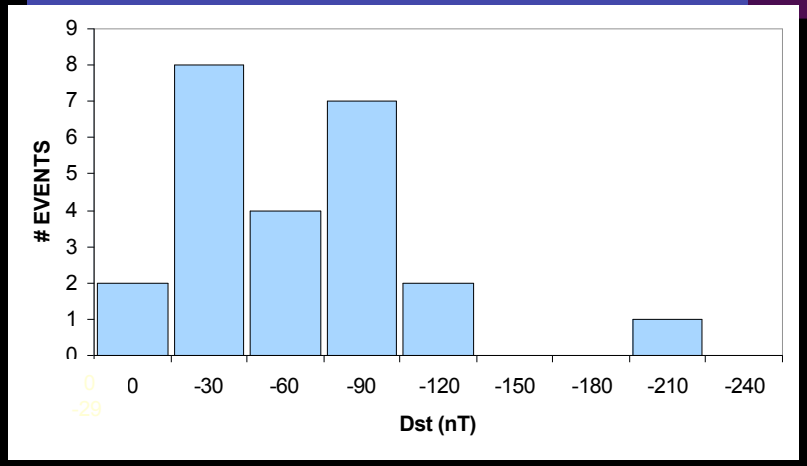
In the table the first S indicates that the sheath has a south Bz component, the second letter indicates the MF distribution in the leading part of MC, and the last letter indicates the MF distribution in the trailing part of MC.

Two-step storms do not show a prefence related to the magnetic field (MF) distribution.

Dst frequency

15 events

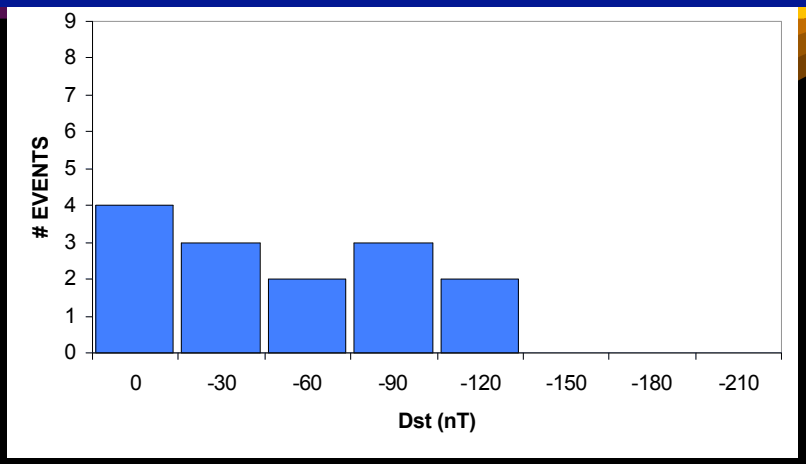
Magnetic Clouds with south Bz



Averaged storm intensity
(minimum Dst) = -90 nT

24 events

Magnetic Clouds with south-north Bz



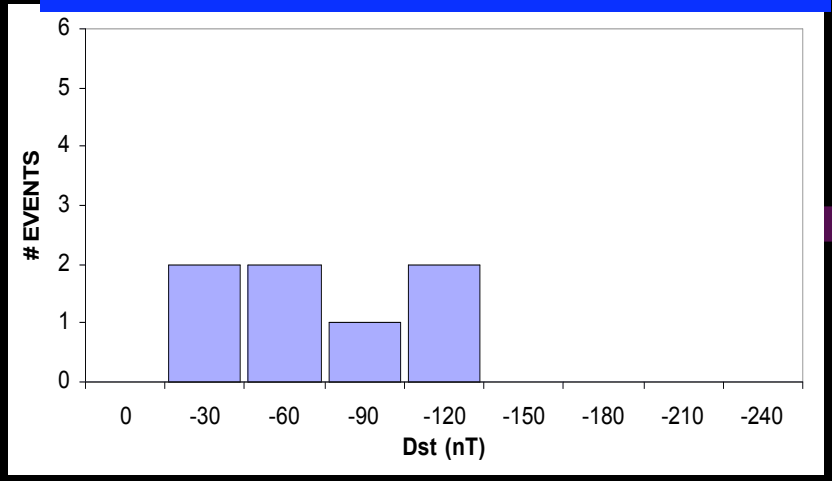
Averaged storm intensity
(minimum Dst) = -81 nT

MCs with a south Bz configuration are more geoeffective than MCs with south-north Bz configuration.

Dst frecuency

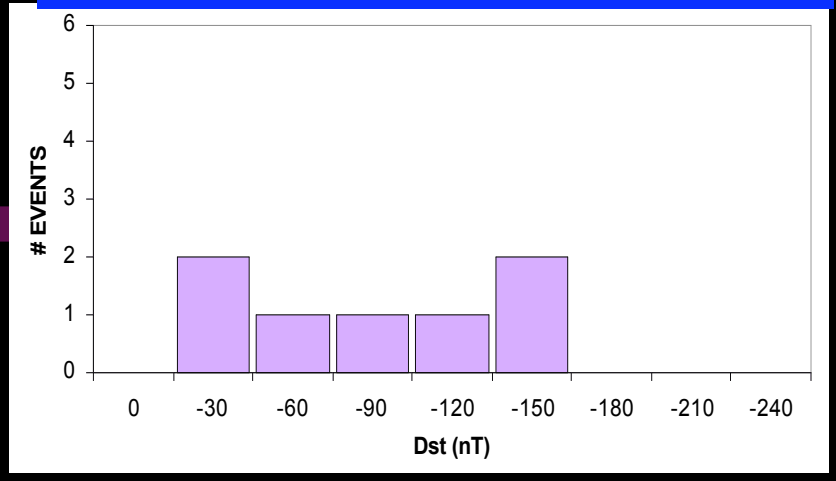
7 events

MCs with South Bz + Sheath with North Bz



7 events

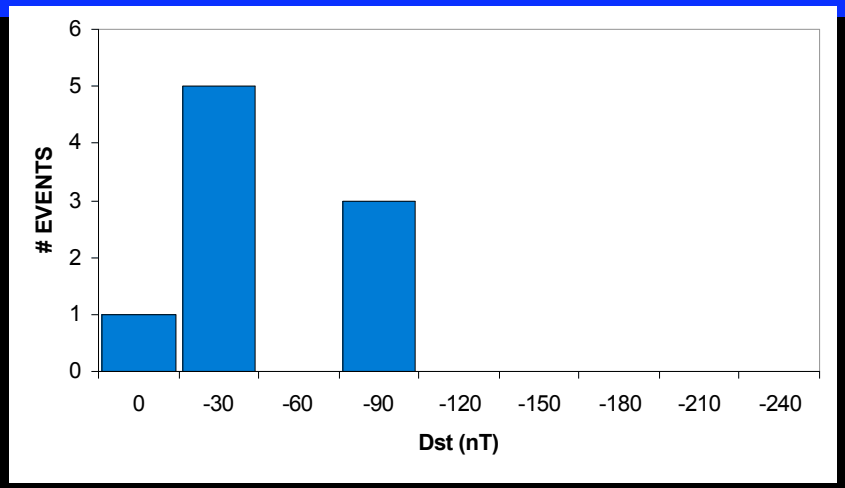
MCs with South Bz + Sheath with South Bz



9 events

Average Dst = -84.4 nT

MCs with South-North Bz + Sheath with North Bz

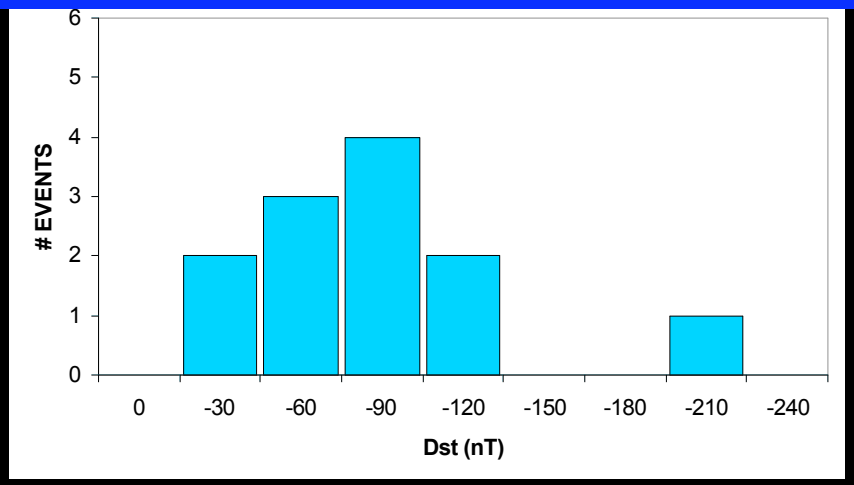


Average Dst = -58.3 nT

Average Dst = -101 nT

12 events

MCs with South-North Bz + Sheath with South Bz

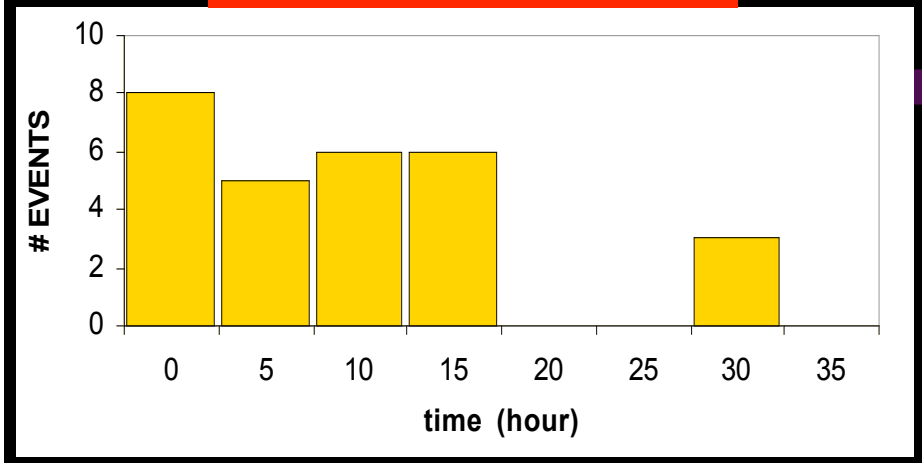


Average Dst = -106.2 nT

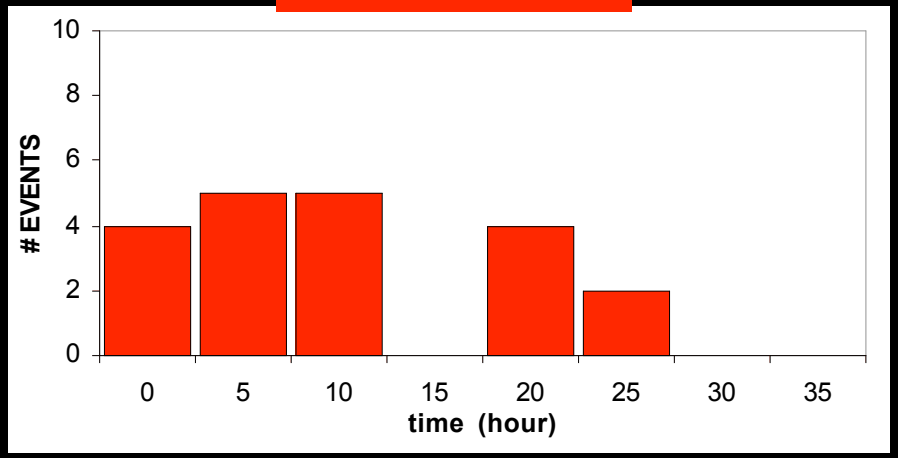
Sheath regions with south Bz configuration enhance the MC-magnetosphere interaction. This is more notorious MCs that have a S-N configuration.

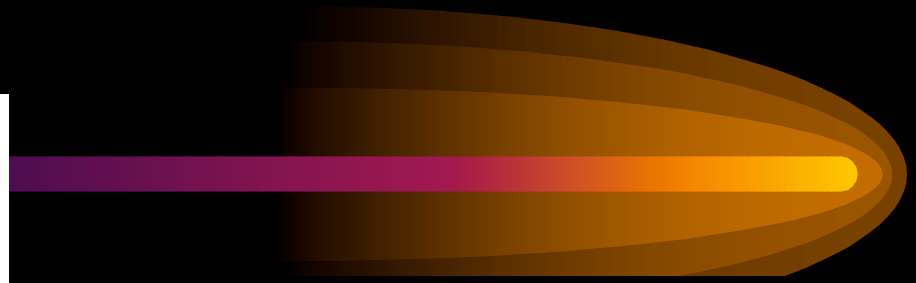
_t parameter for MCs and sheath regions

-100 nT < Dst < = -20 nT



Dst < = -100 nT



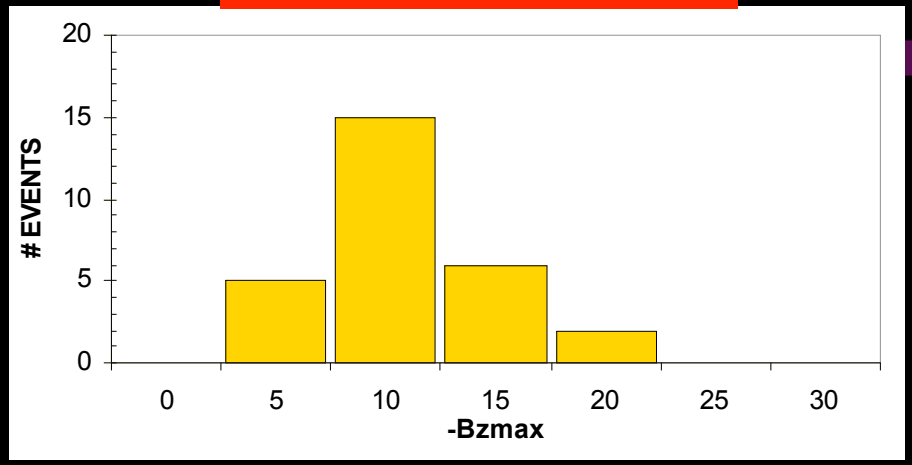


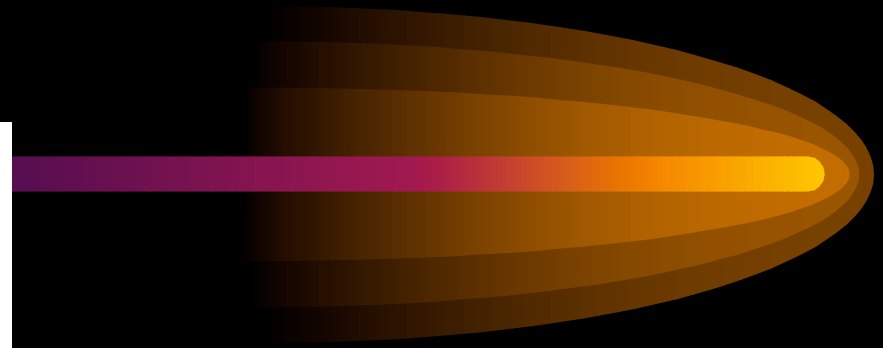
_t is the temporal interval where the MCs and sheath regions have a south Bz component.

Duration of south Bz component does not determine alone the strength of the geomagnetic storm.

-Bzmax parameter for MCs and sheath regions

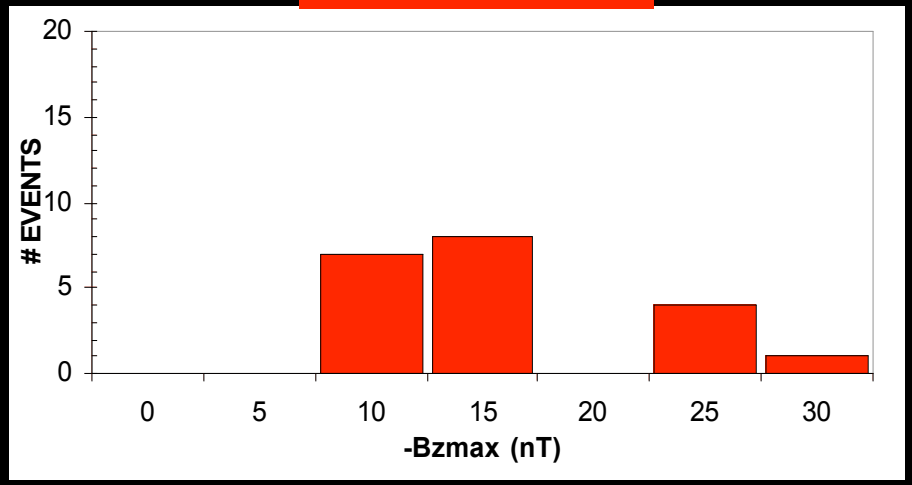
-100 nT < Dst < = -20 nT





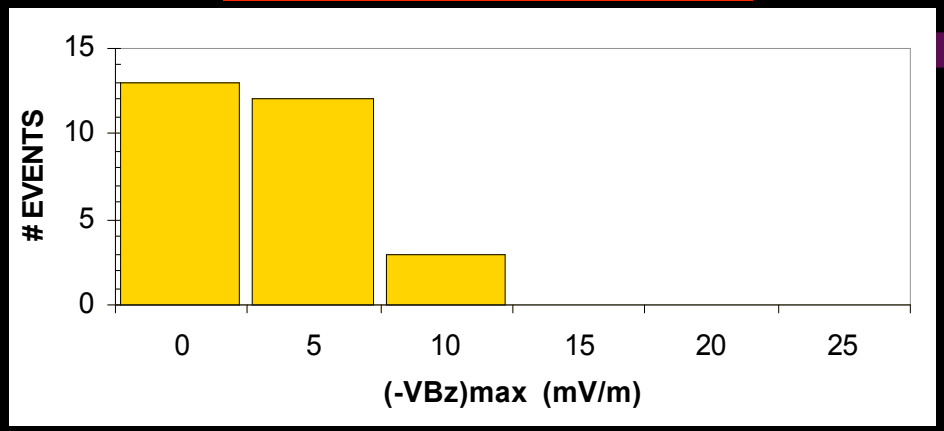
-Bzmax has higher values for extreme storms and lower values for low to high intensity storms.

Dst < = -100 nT

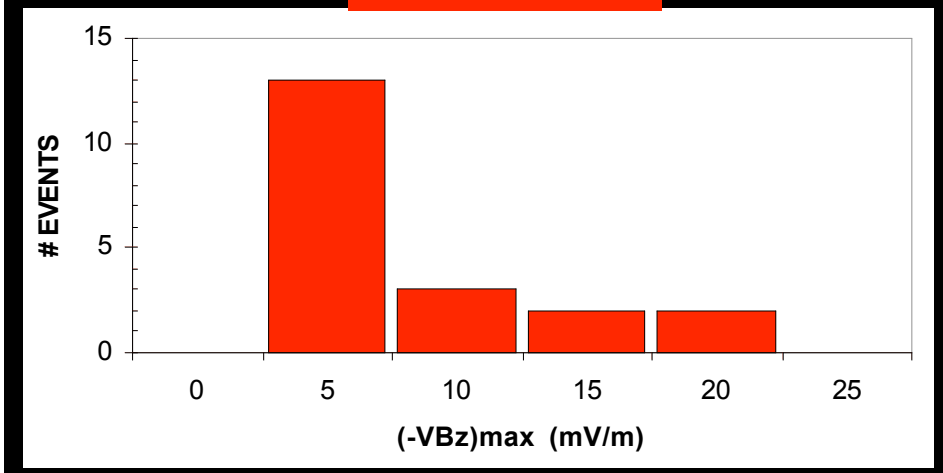


(-VBz)max for MCs and sheath regions

-100 nT < Dst < = -20 nT



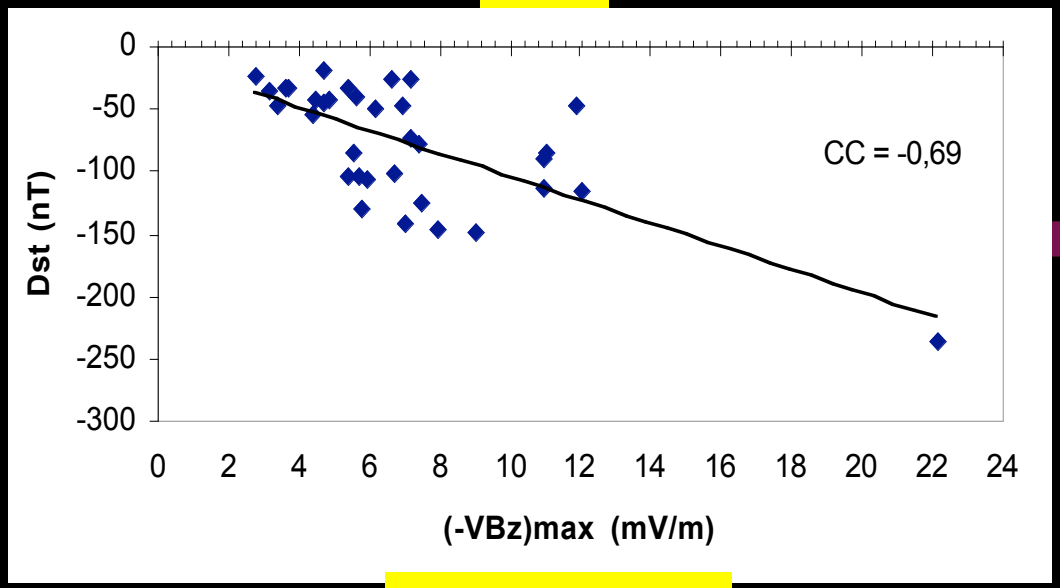
Dst < = -100 nT



High values for (-VBz)max are related to extreme storms and low values are related to medium storms. This is in agreement with previous results, i.e. R. K. Burton et al., 1975; Yuming Wang et al., 2003; and X. H. Xue et al., 2004.

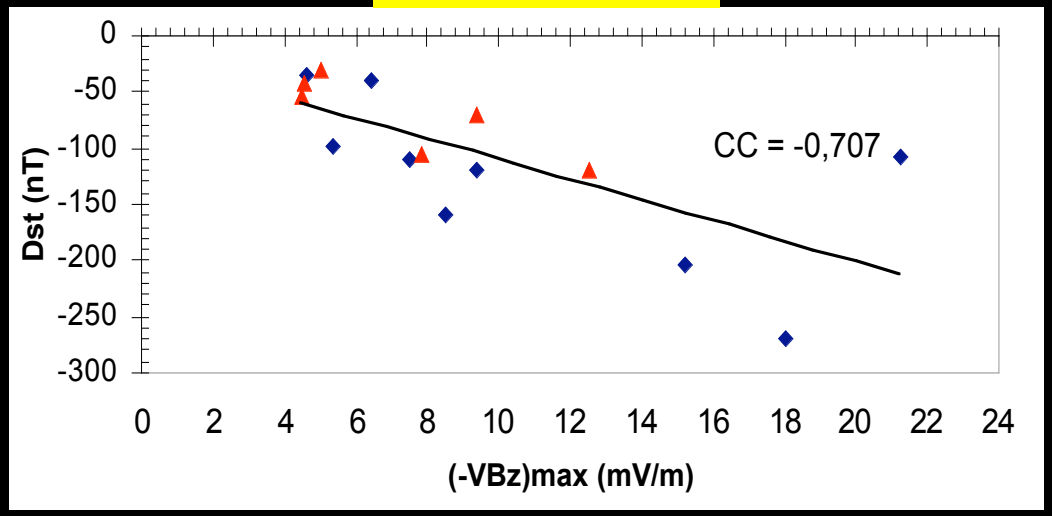
Correlation between (-VBz)max and Dst index

MCs



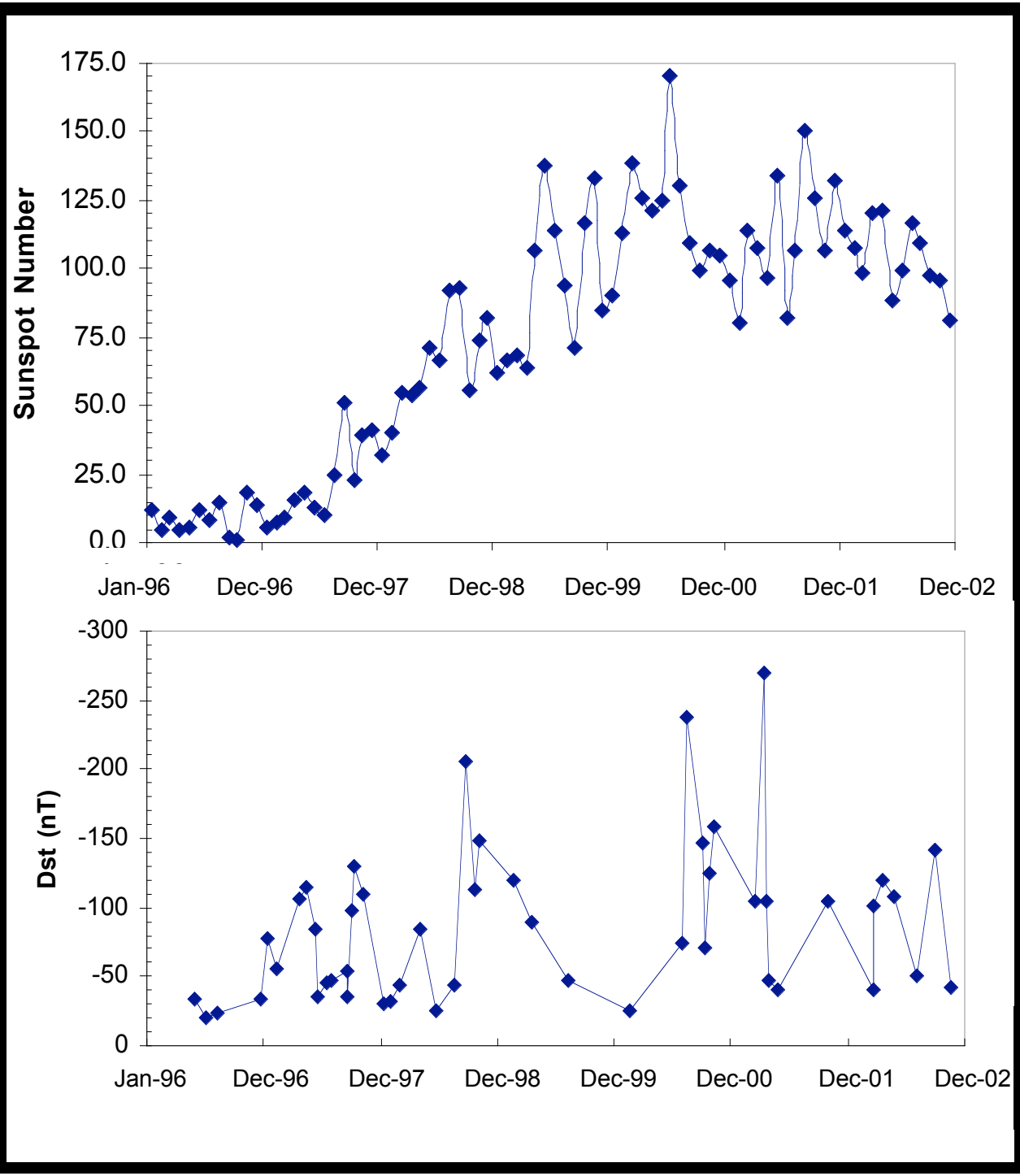
It shows that the most intense storms are related to high values of (-VBz)max, and vice versa.

Sheath regions



▲ Sheath regions for the 2-step storms events

The correlation shows that the most intense storms are related to high values of (-VBz)max, and vice versa.



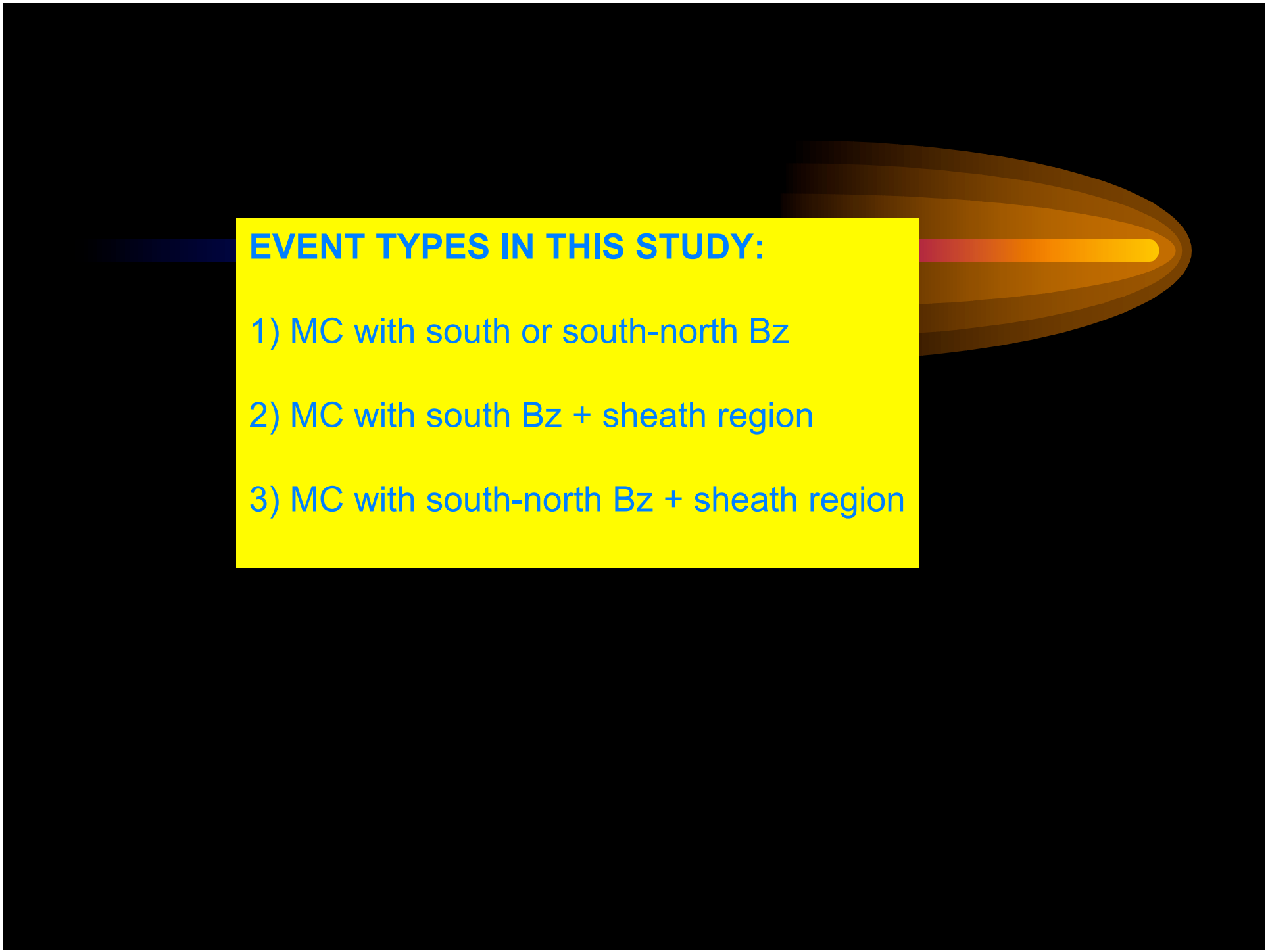
Solar cycle 23

Comparison between the sunspot number and temporal evolution of the Dst index for geomagnetic storms caused by MCs and sheath regions.

MCs and sheath regions

CONCLUSIONS

- MCs with south Bz configuration are more geoeffective than MCs with s-n Bz configuration.
- Sheath regions with south Bz enhance the MC-magnetosphere interaction.
- In some cases the sheath is the only region which interacts geoeffectivily.
- Two-step storm events are generated by a sheath region with south Bz followed by a MC with south Bz somewhere inside the cloud.
- When MC or a sheath region has a south Bz component for a long time it does not mean it will cause a storm of extreme intensity.
- –Bzmax has high values for extreme storms and low values for moderate storms.
- High values of (-VBz)max are related to extreme storms and low values are related to moderate storms.
- The correlation between (–VBz)max and Dst index for MCs is CC = -0.69 and for sheath regions is CC = -0.71.
- The most intense storms caused by MC and sheath regions occur during the solar maximum.


EVENT TYPES IN THIS STUDY:
1) MC with south or south-north Bz
2) MC with south Bz + sheath region
3) MC with south-north Bz + sheath region