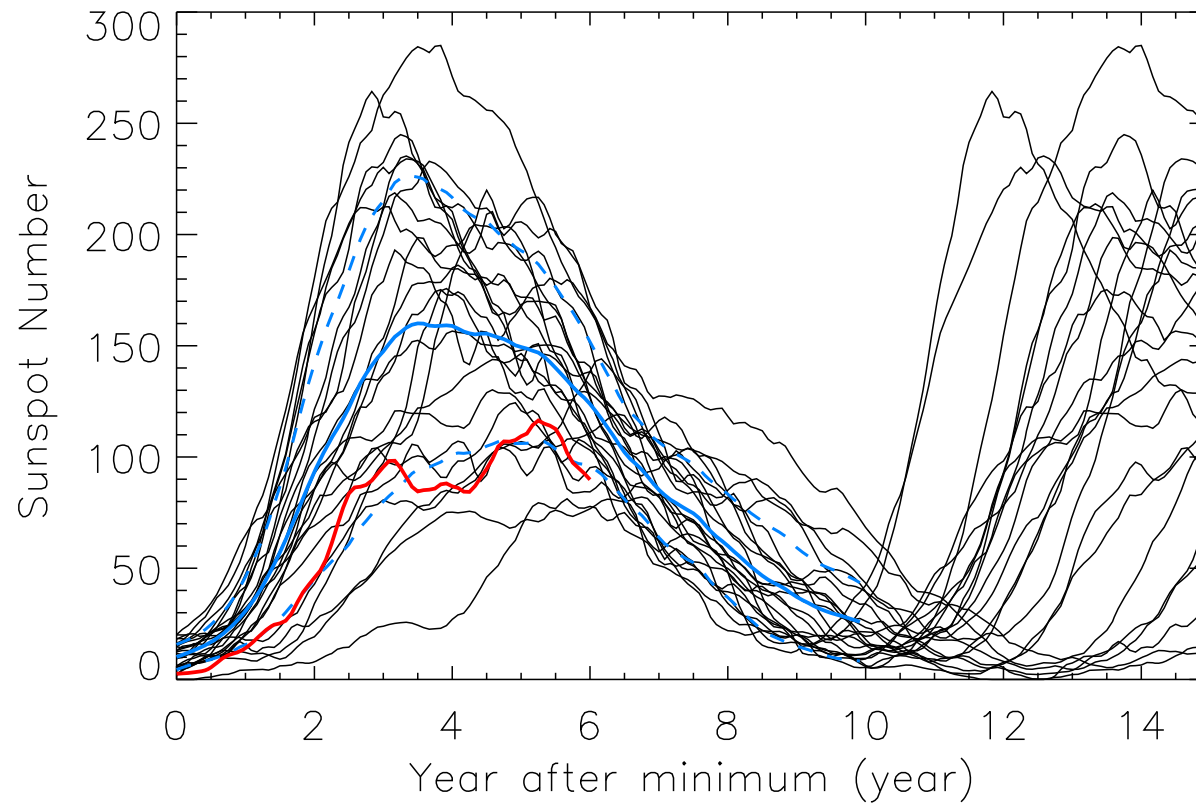


Geomagnetic storms and their solar sources in cycle 24

Shinichi Watari, Mitsue Den, and Yuki Kubo
(National Institute of Information and Communications Technology)

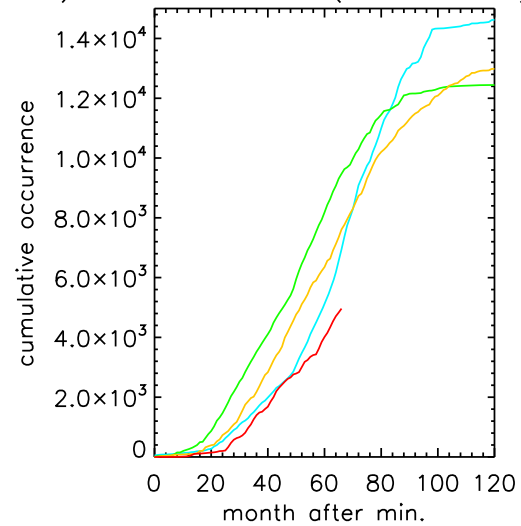
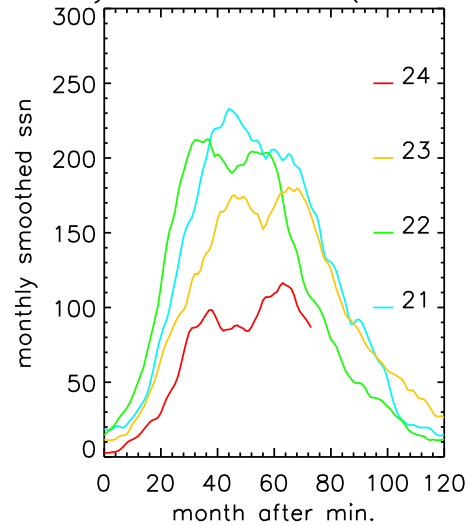
Sunspot numbers of cycle 24 and past cycles



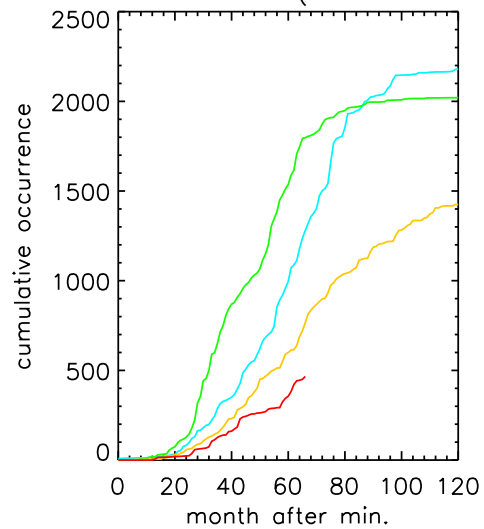
(WDC-SILSO)

Cumulative occurrence of flares

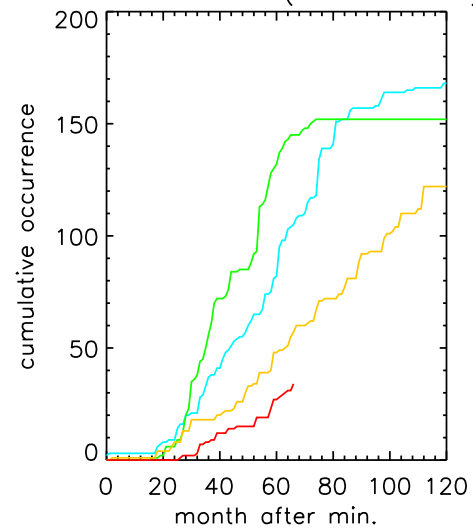
Monthly smoothed ssn (1976–2015) C-class flare (1976–2015)



M-class flare (1976–2015)



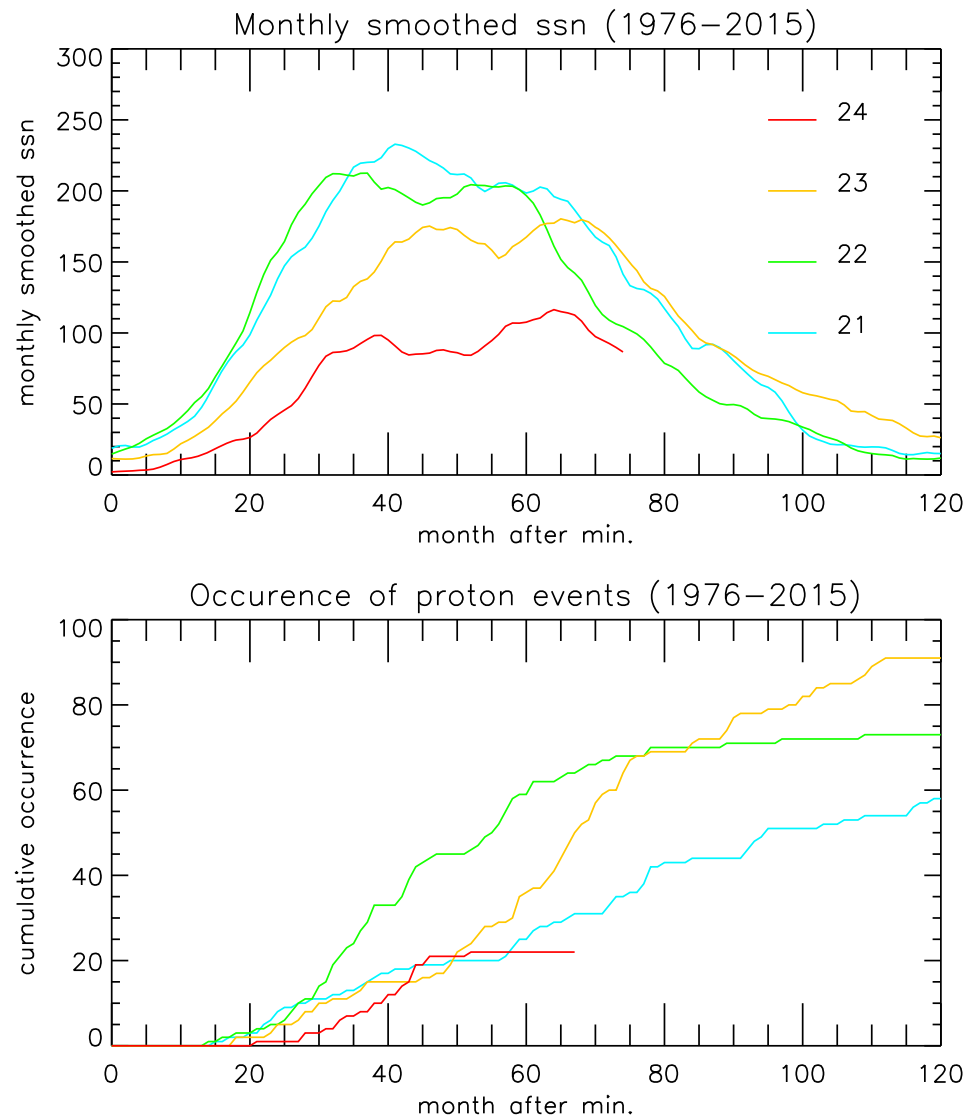
X-class flare (1976–2015)



(NOAA/SWPC)



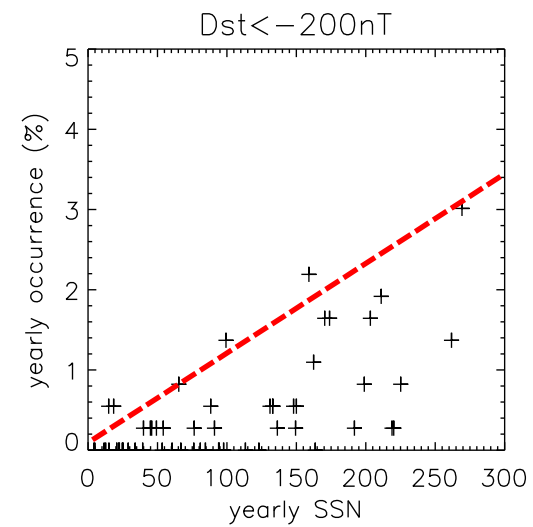
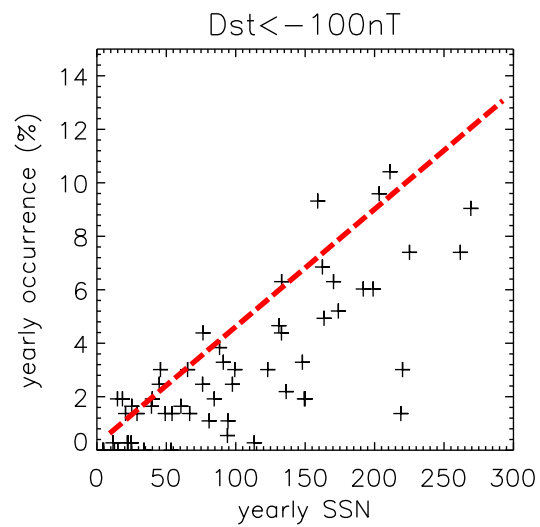
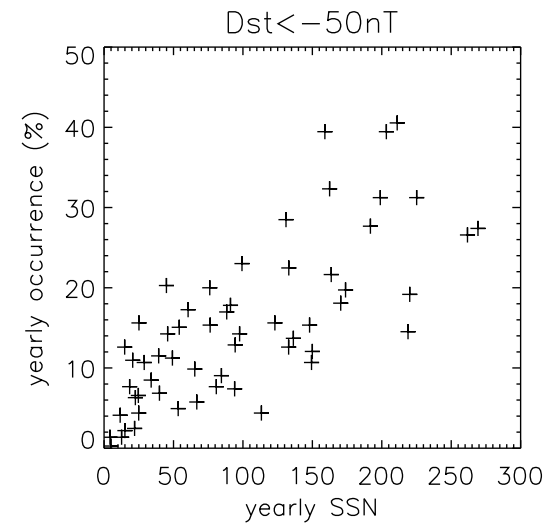
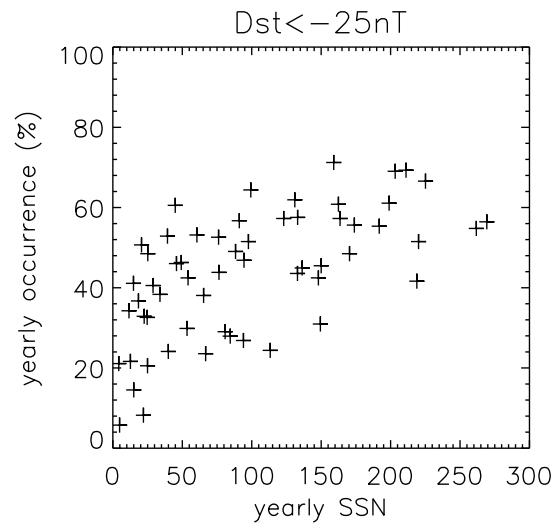
Cumulative occurrence of proton events



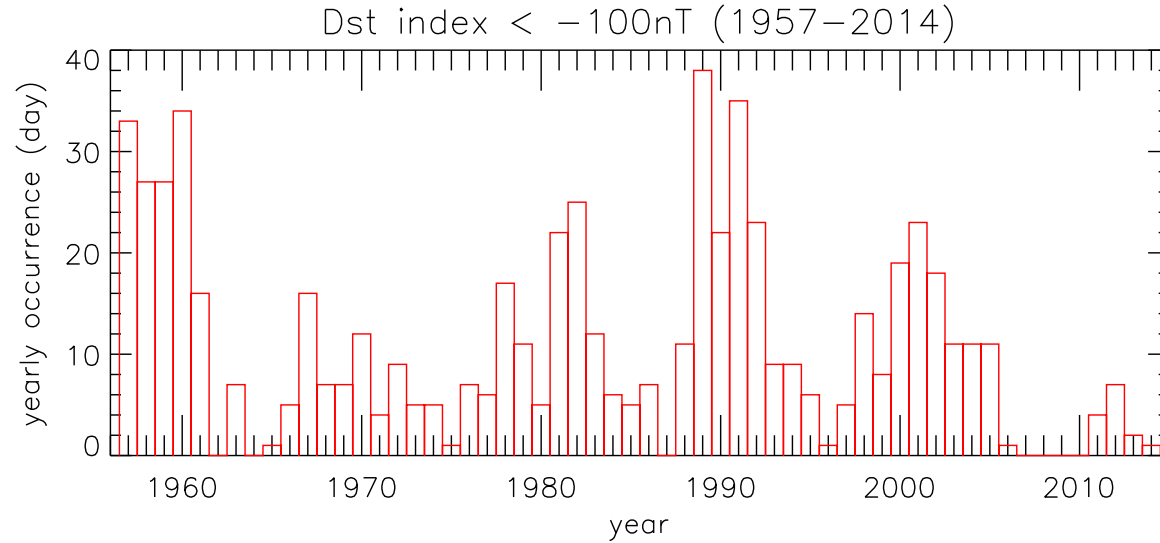
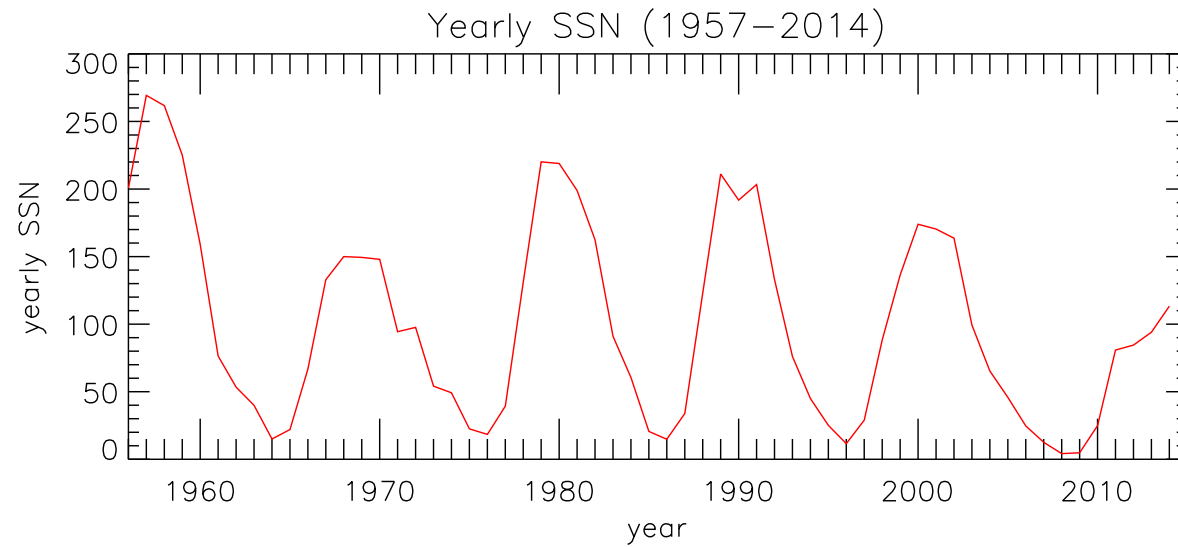
(NOAA/SWPC)



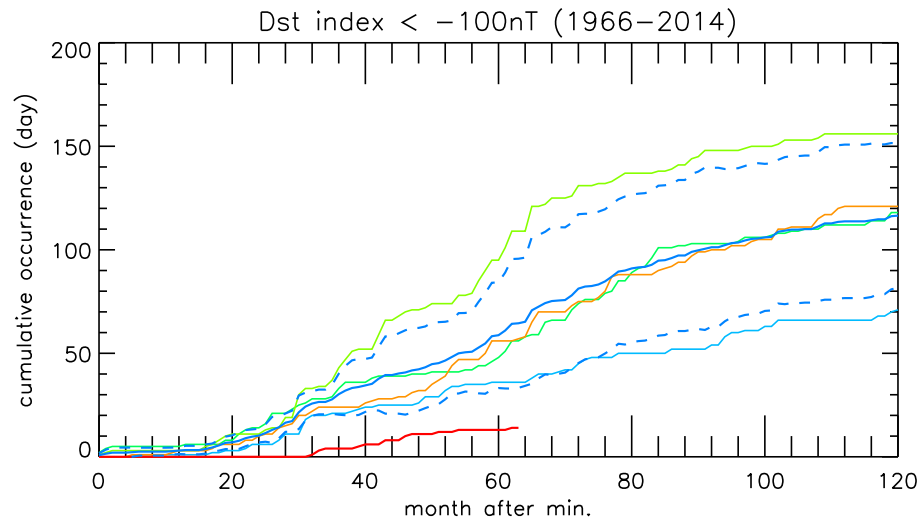
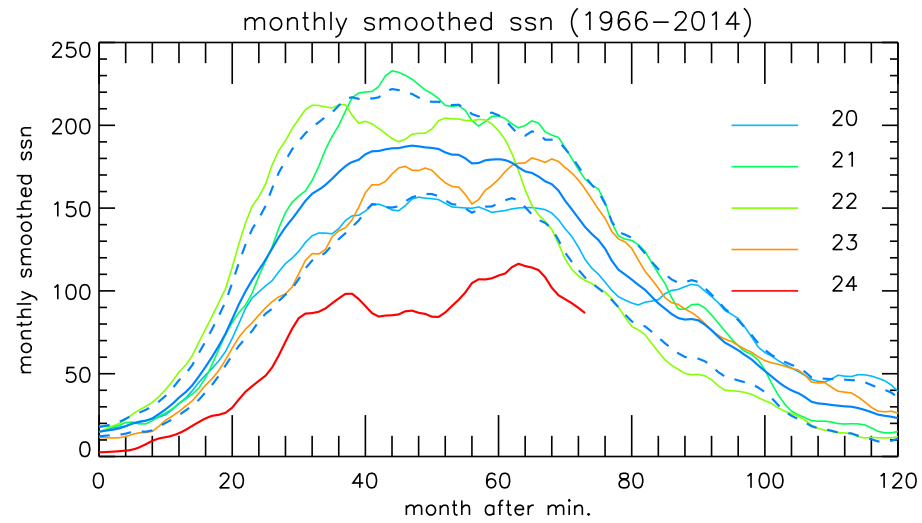
Geomagnetic activity and sunspot number



Yearly occurrence of Dst < -100 nT

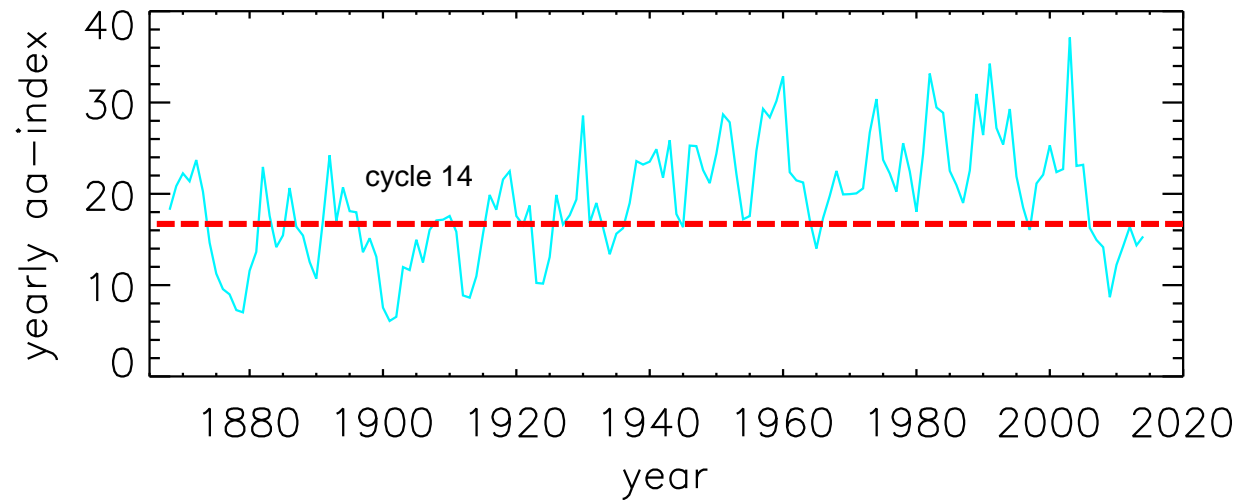
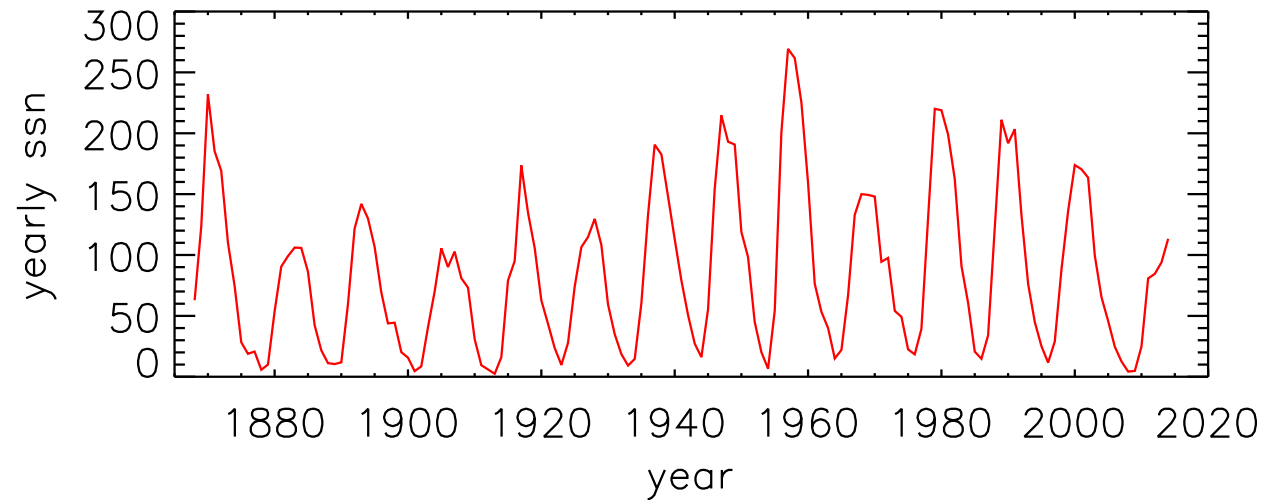


Cumulative occurrence of Dst < -100 nT in cycle 24 and past cycles



(WDC for Geomagnetism, Kyoto & SIDC-SILSO)

Variation of yearly aa-index



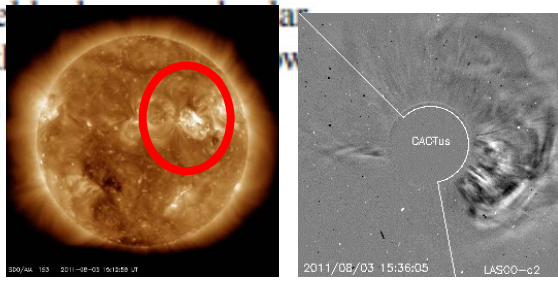
Geomagnetic storms (Dst index < -100nT) of cycle 24

no.	Date	Min. Dst (nT)	Type	Solar source	Speed at 1AU (km/s)
1	2011/08/05 1750	-115	SC	full halo CME (sheath)	<u>611</u>
2	2011/09/26 1235	-118	SC	full halo CME (sheath)	704
3	2011/10/24 1831	-147	SC	full halo CME (<u>sheath</u> , MC)	<u>534</u>
4	2012/03/08 1103	-131	SC	full halo CME (sheath, <u>MC</u>), multiple	737
5	2012/04/23 0320	-108	SC	partial halo CME (sheath, <u>MC</u>)	720
6	2012/07/14 1810	-127	SC	full halo CMEs (sheath, <u>MC</u>)	<u>667</u>
7	2012/09/30 1132	-119	SC	full halo CMEs (sheath, <u>MC</u>), multiple	<u>410</u>
8	2012/10/08 0516	-105	SC	partial halo CME (sheath, <u>MC</u>), multiple	<u>526</u>
9	2012/11/12 2312	-108	SC	partial halo CME (sheath, <u>MC</u>), multiple	<u>467</u>
10	2013/03/17 0600	-132	SC	full halo CME (<u>sheath</u> , <u>MC</u>), multiple	725
11	2013/05/31 1617	-119	SC	coronal hole	774
12	2014/02/18 1354	-112	GC	partial halo CME (<u>MC</u>), multiple	<u>530</u>
13	2015/03/17 0445	-223	SC	partial halo CME (sheath, <u>MC</u>), CH	<u>683</u>
14	2015/06/22 1833	-204	SC	full halo CME (sheath, <u>MC</u>), multiple	742

(Zurbuchen & Richardson, 2006)

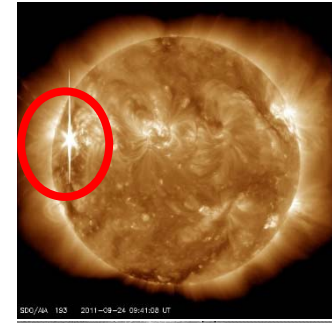
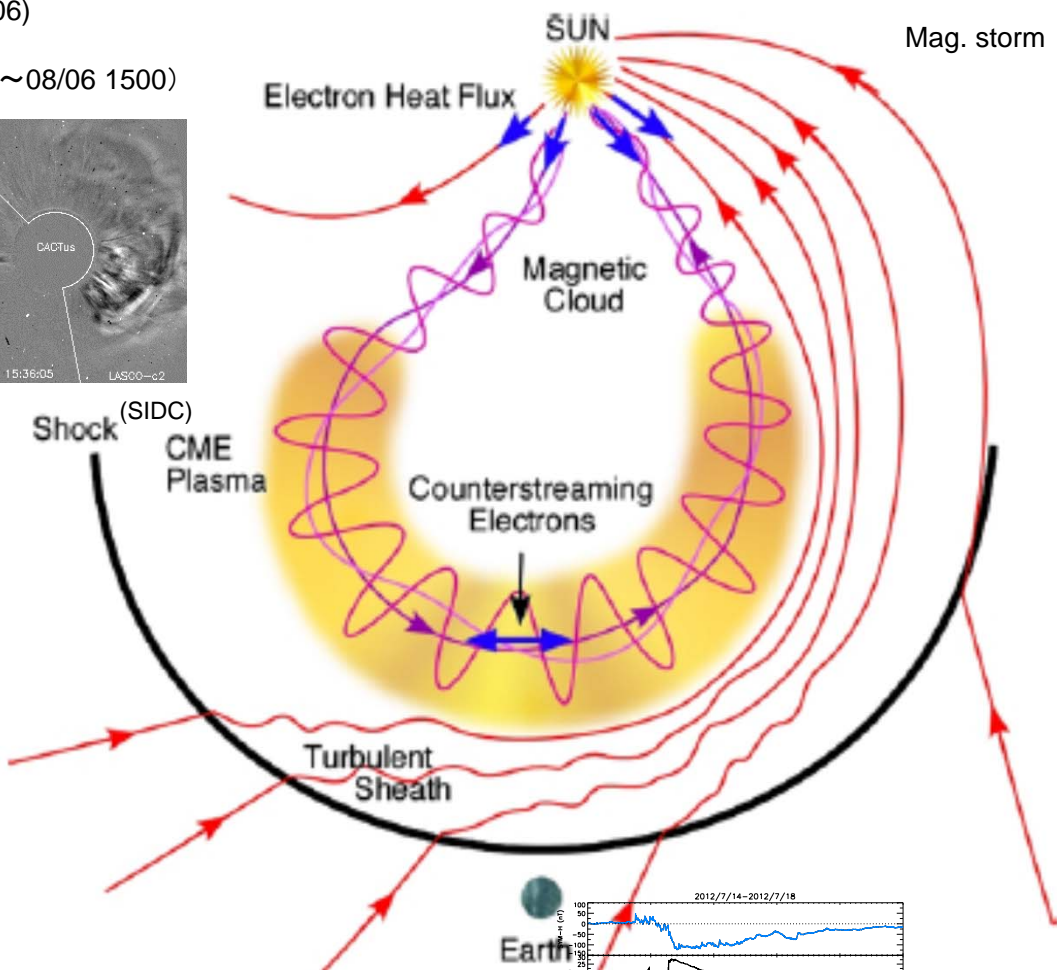
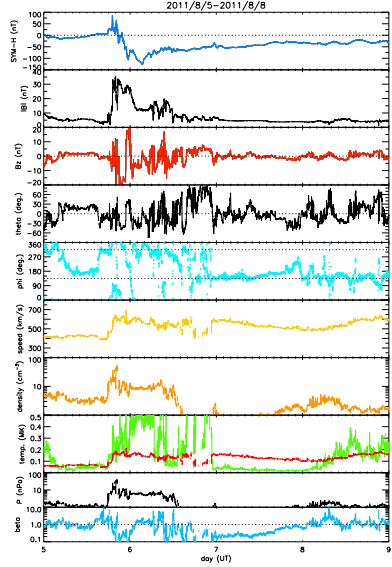
Mag. storm (2011/09/26 1235~09/28 1700)

Mag. storm (2011/08/05 1750~08/06 1500)

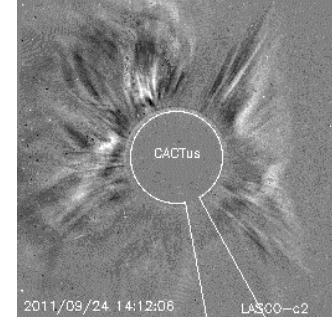


(SDO)

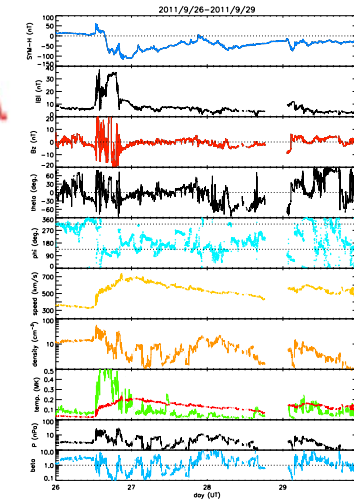
(SIDC)



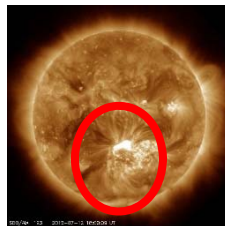
(SDO)



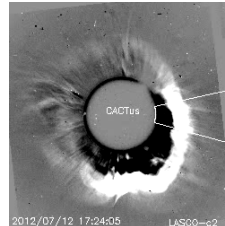
(SIDC)



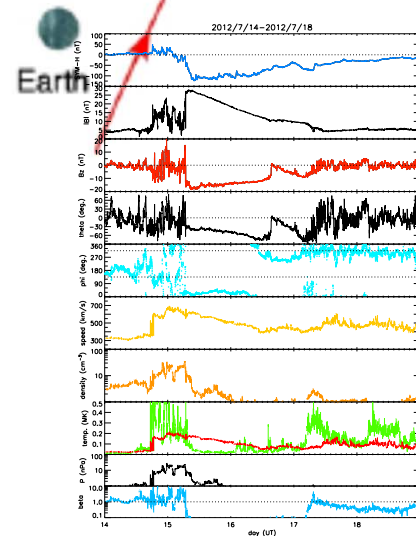
Mag. storm (2012/07/14 1810~07/17 1200)



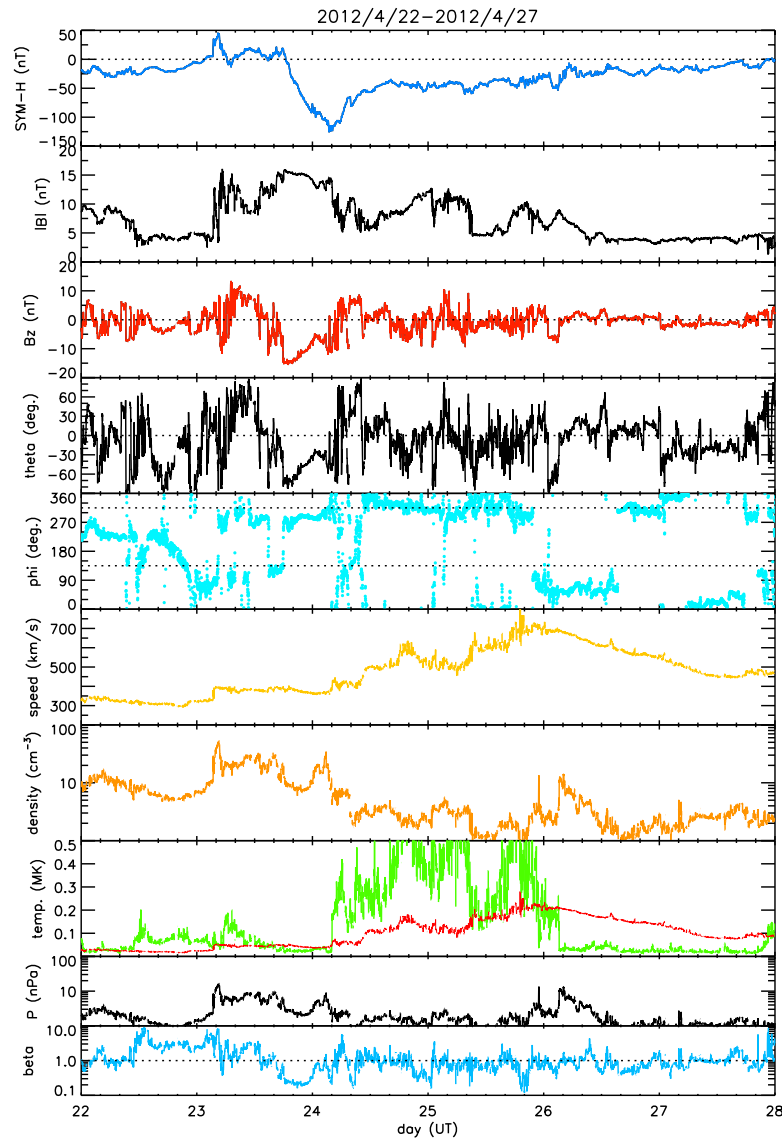
(SDO)



(SIDC)



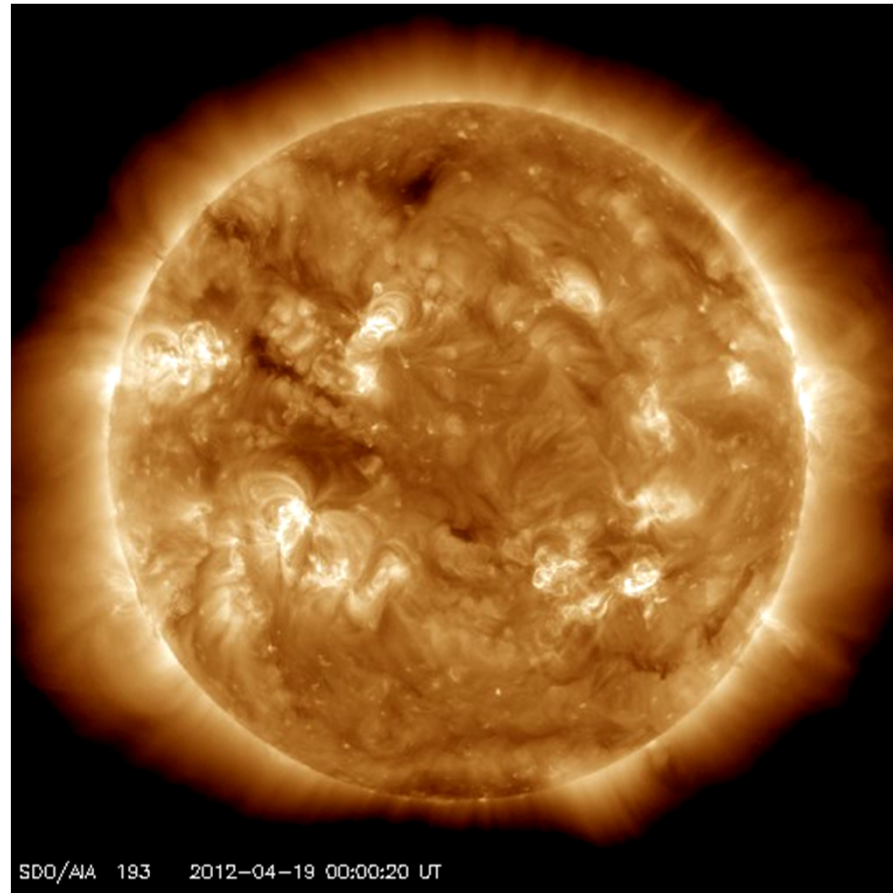
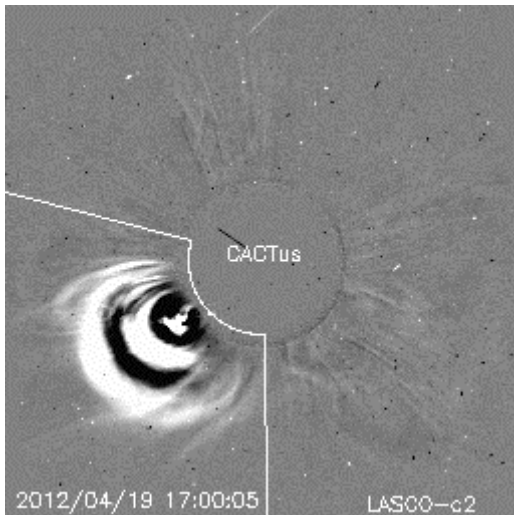
Geomagnetic storm (2012/04/23 03:20UT)



(NASA/OMNI-data)

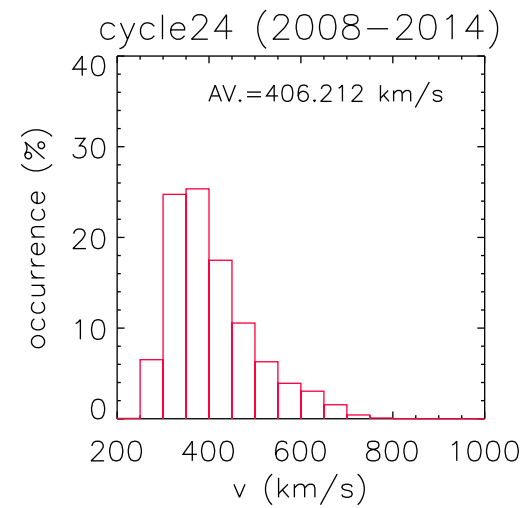
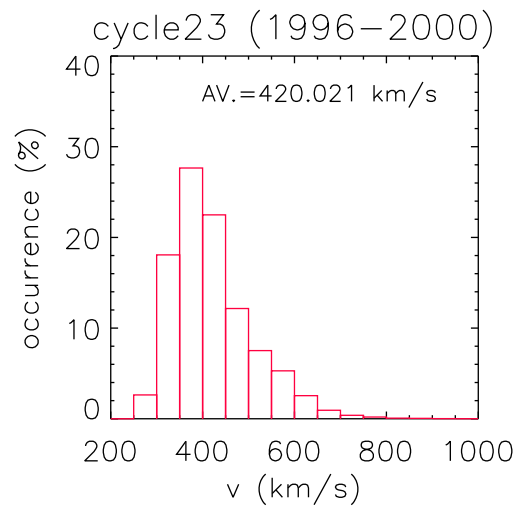
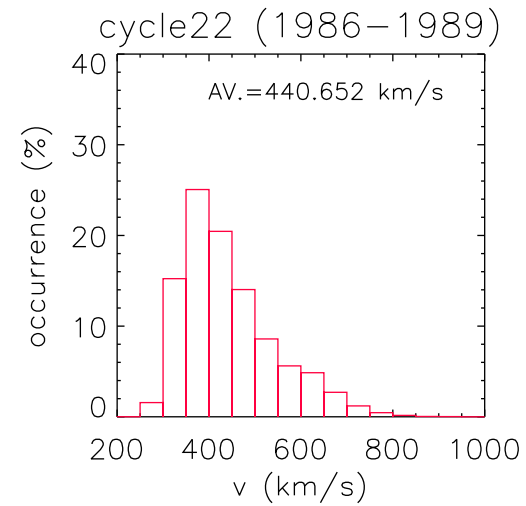
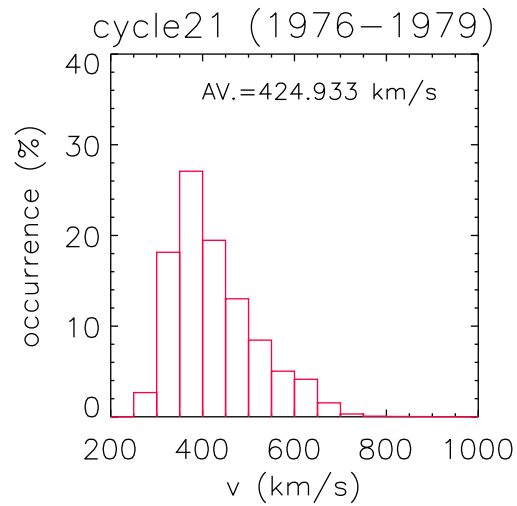


SDO (2012/04/19-20)



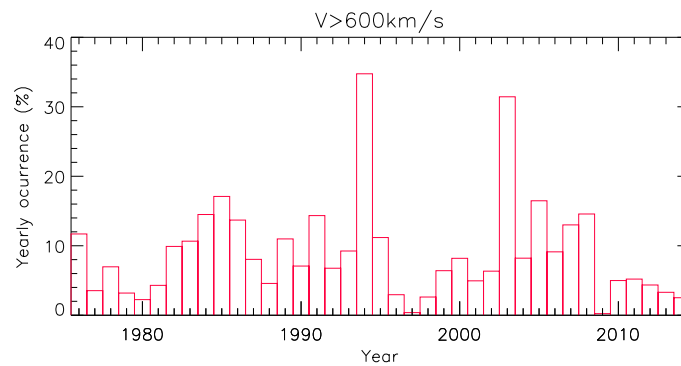
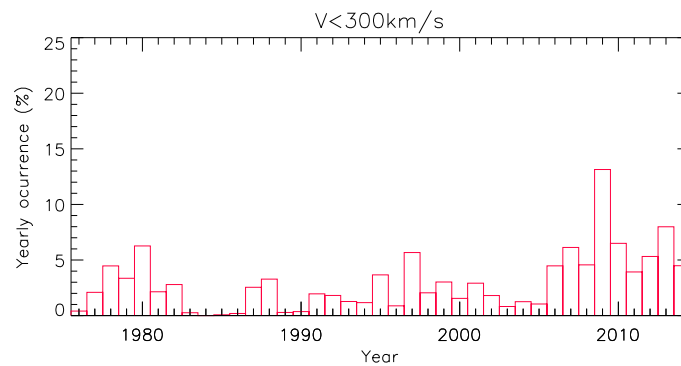
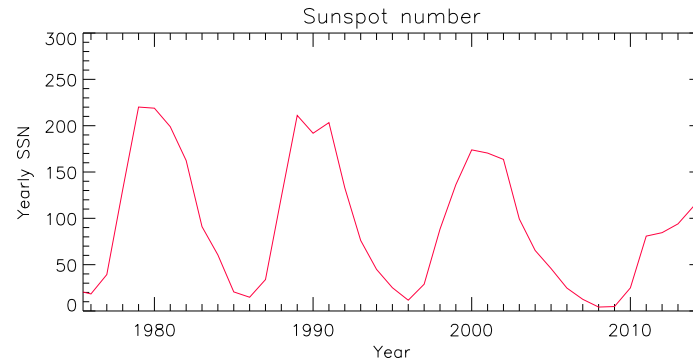
(SIDC)

Solar wind speed (one-hour values)



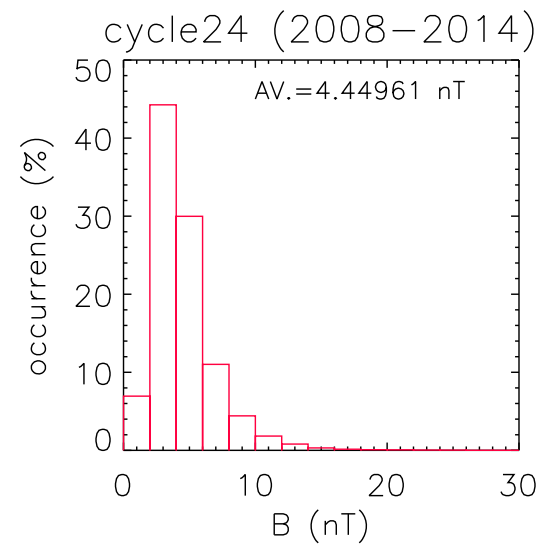
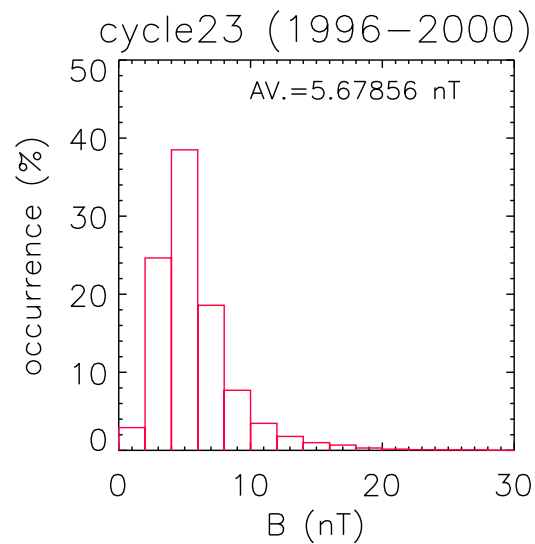
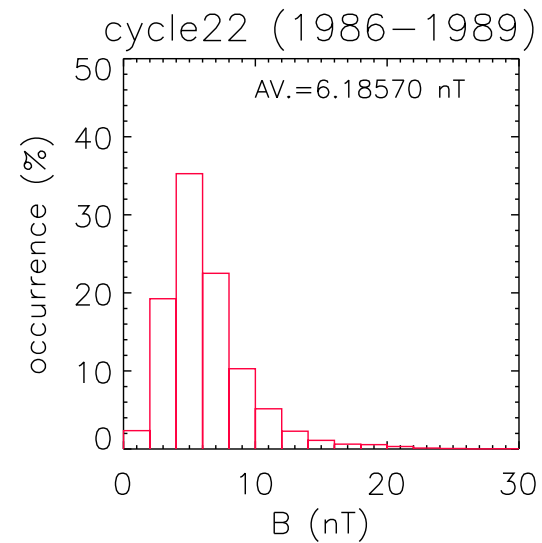
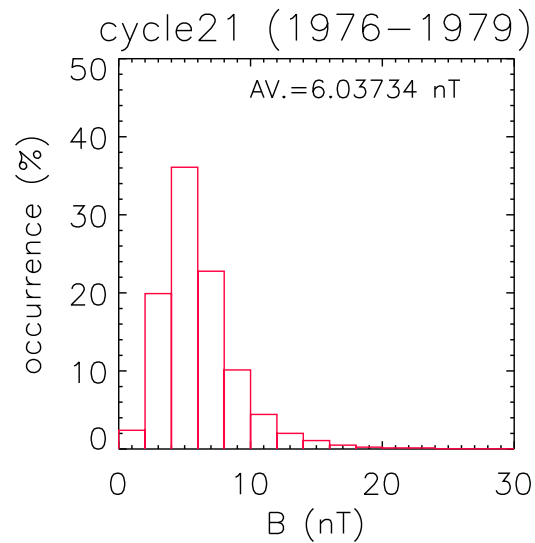
(NASA/OMNI-data)

Solar wind speed (one-hour values)



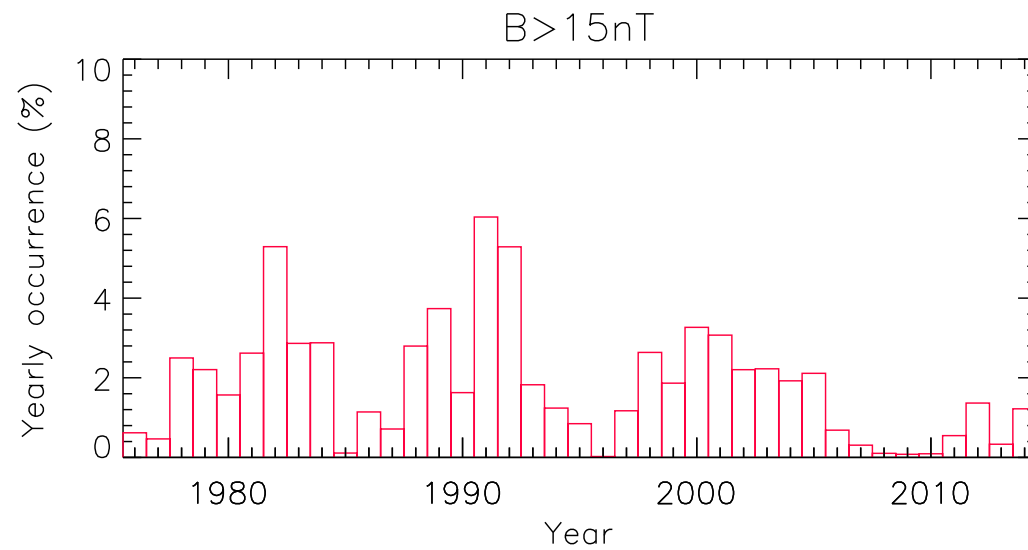
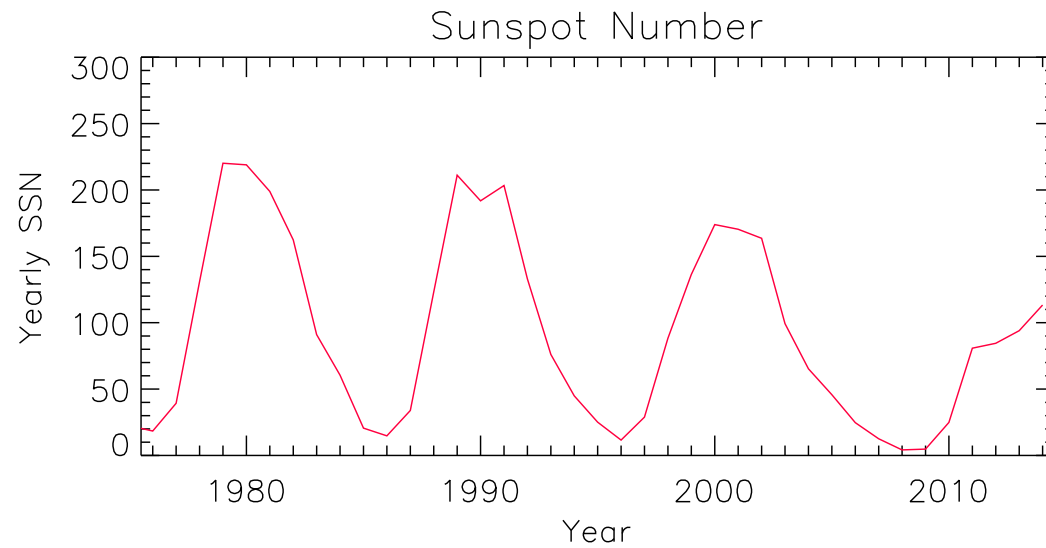
(NASA/OMNI-data)

Solar wind magnetic fields (one-hour values)



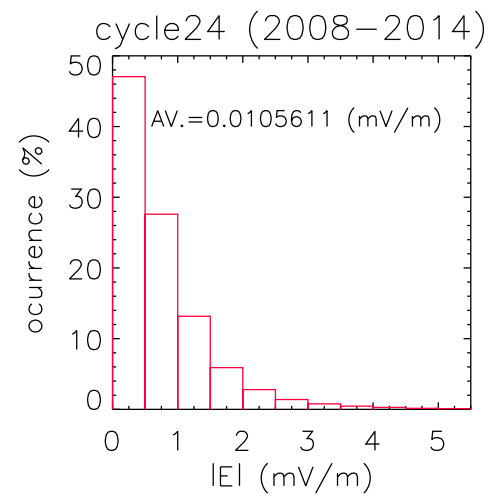
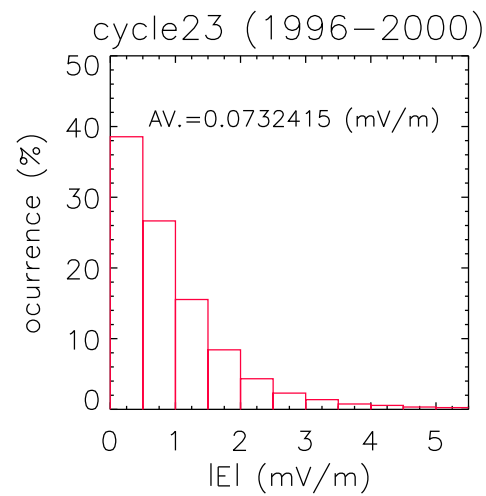
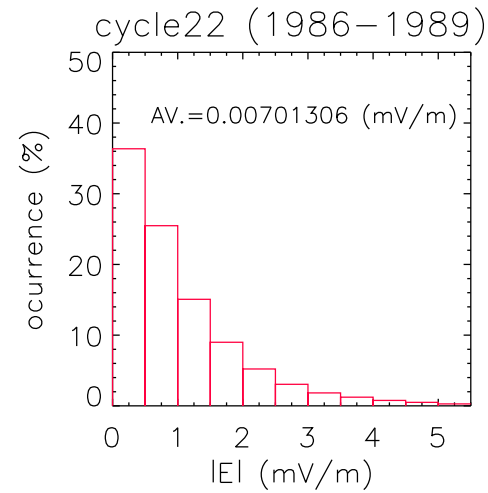
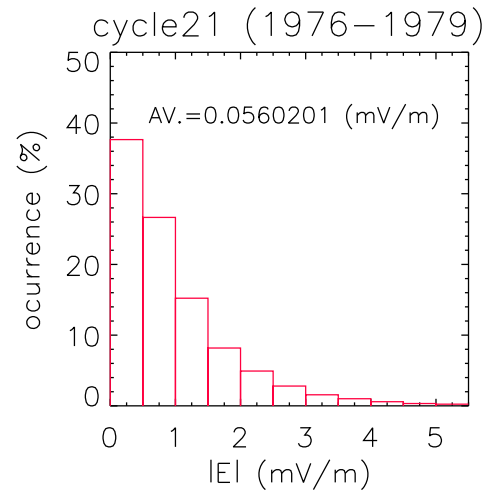
(NASA/OMNI-data)

Solar wind magnetic fields (one-hour values)



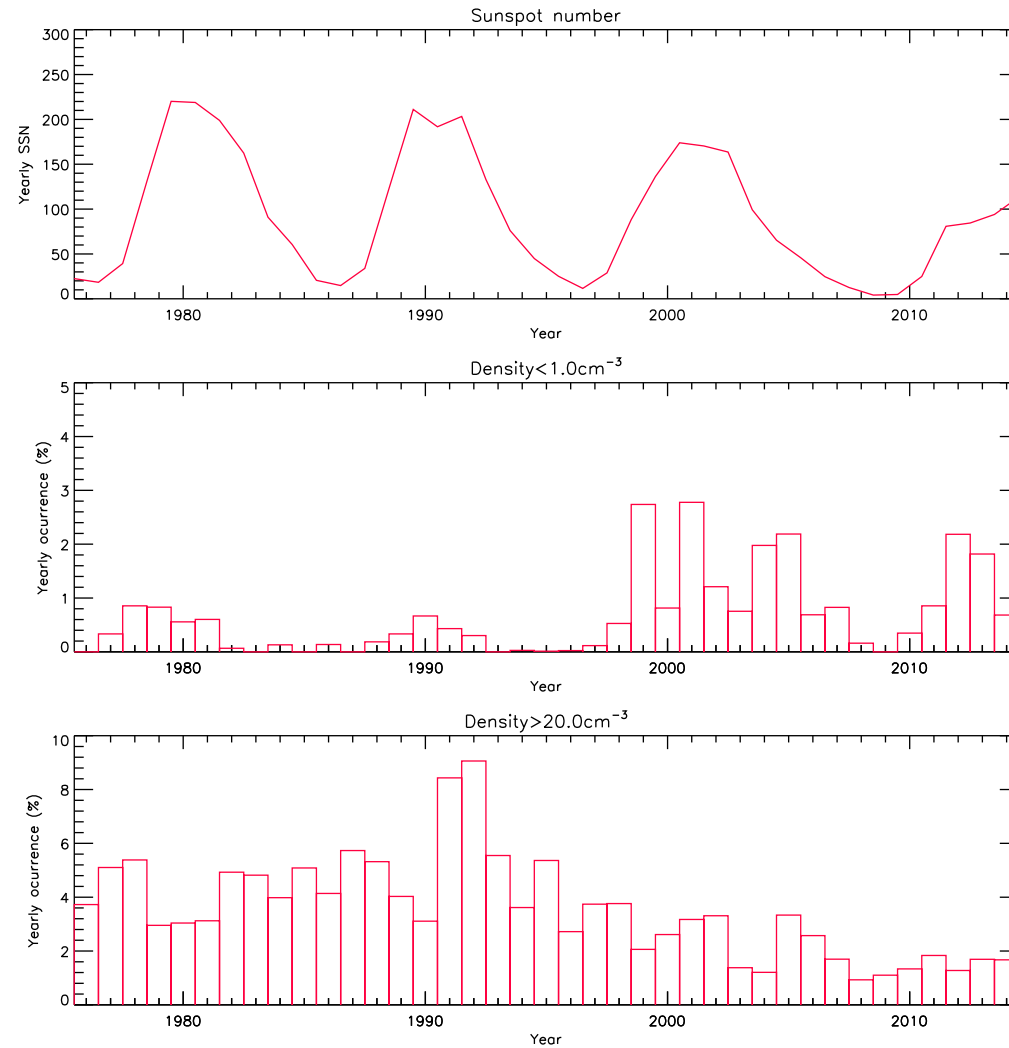
(NASA/OMNI-data)

Electric field (one-hour values)



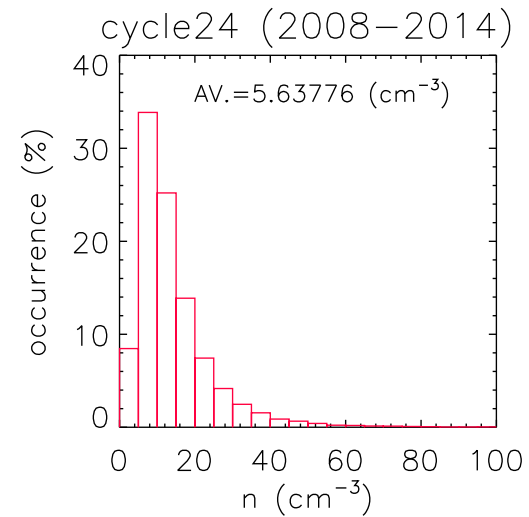
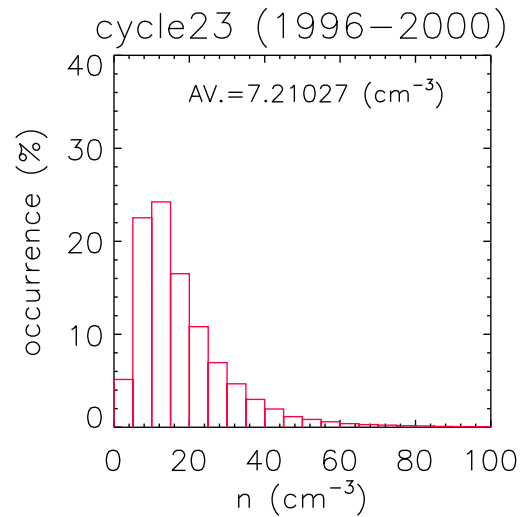
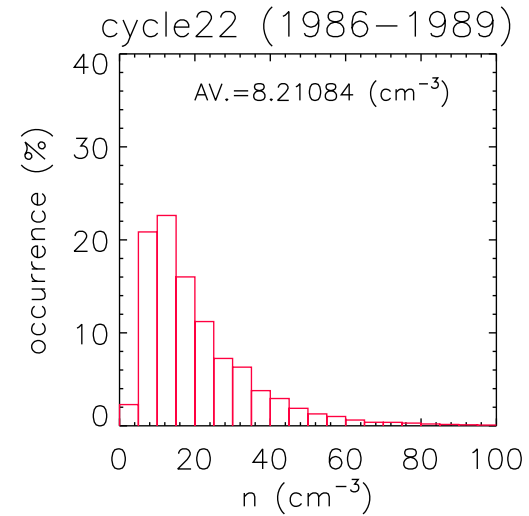
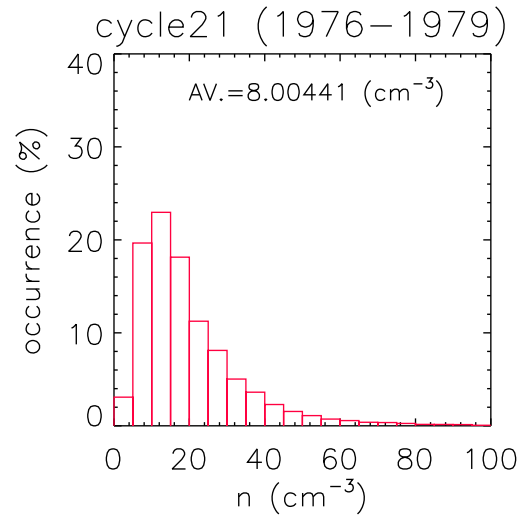
(NASA/OMNI-data)

Solar wind density (one-hour values)



(NASA/OMNI-data)

Solar wind density (one-hour values)



(NASA/OMNI-data)

Summary

- ✓ Occurrence number of geomagnetic storms in cycle 24 is small comparing with that in past cycles.
- ✓ Solar wind parameters in cycle 24 are small comparing with those in past cycles.
- ✓ Main sources of geomagnetic storms were CMEs for the rising and maximum phase of cycle 24.
- ✓ Speeds of interplanetary disturbances at 1AU associated with geomagnetic storms were generally low in cycle 24,

Thank you.