Amateur Radio and Space Weather

What is space weather? Why do I care?

Rob Steenburgh AD0IU
Space Weather Prediction Center
Boulder, CO
robert.steenburgh@noaa.gov
303 497 5153

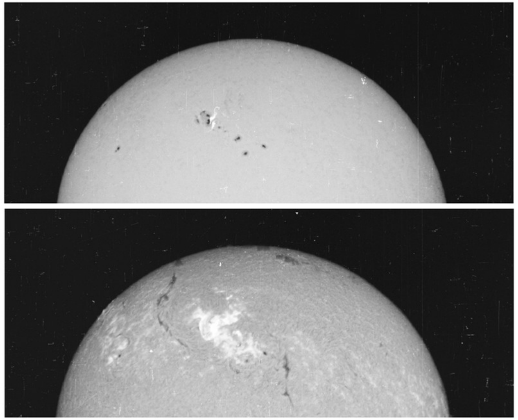
Acknowledgments

- Solar activity of September 06-08 2017: *Patricia Doherty, BU; Mihail Codrescu, George Millward SWPC*
- Solar Cycle Projections: *Doug Biesecker SWPC*
- Historical Information: *Delores Knipp, CU Boulder*

Outline

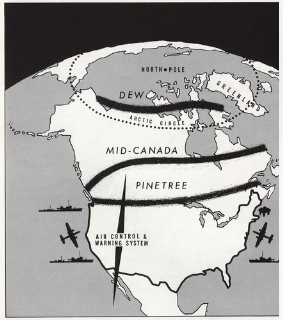
- Overview of Space Weather Phenomena and Impacts
- Events of September 2017
- July 2012 CME: "We got lucky…"
- Tips for the Radio Amateur
- Wrap-up

232	N24	5/18	East limb passage of one of the greatest activity complexes of Solar Cycle 20. Composed of three overlapped spot groups at time of first appearance, two of which were growing.
		5/20	Birth of fourth spot group on southern border of complex. Westward relative motion of this group, with respect to large spots to the north, may have contributed to conditions for great flare of 21 May in center of complex.
		5/21	"Collision" between central and western members of the complex, as growth and expansion of central member moved its leader spot into the follower plage of the western member. Large flare occurred over the neutral line between the groups.
		5/23	"Collision" and merger of leader of easternmost member with follower of central member, creating large "delta" magnetic configuration. Closest separation between the opposite-polarity spots coincided with great white-light, proton flare at 1840 UT (see *UAG Report 5*). These spots moved in a rotary pattern with respect to one another during 21-26 May.
a		5/28	Additional great flare over the "delta" configuration.



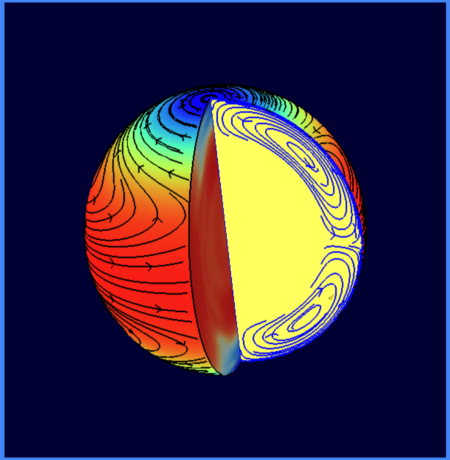
b

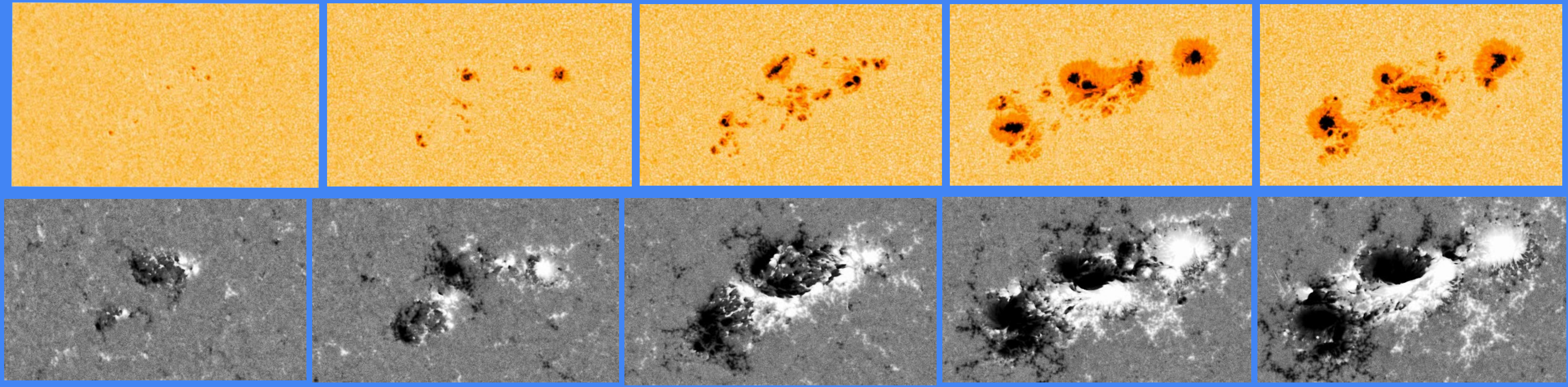
c



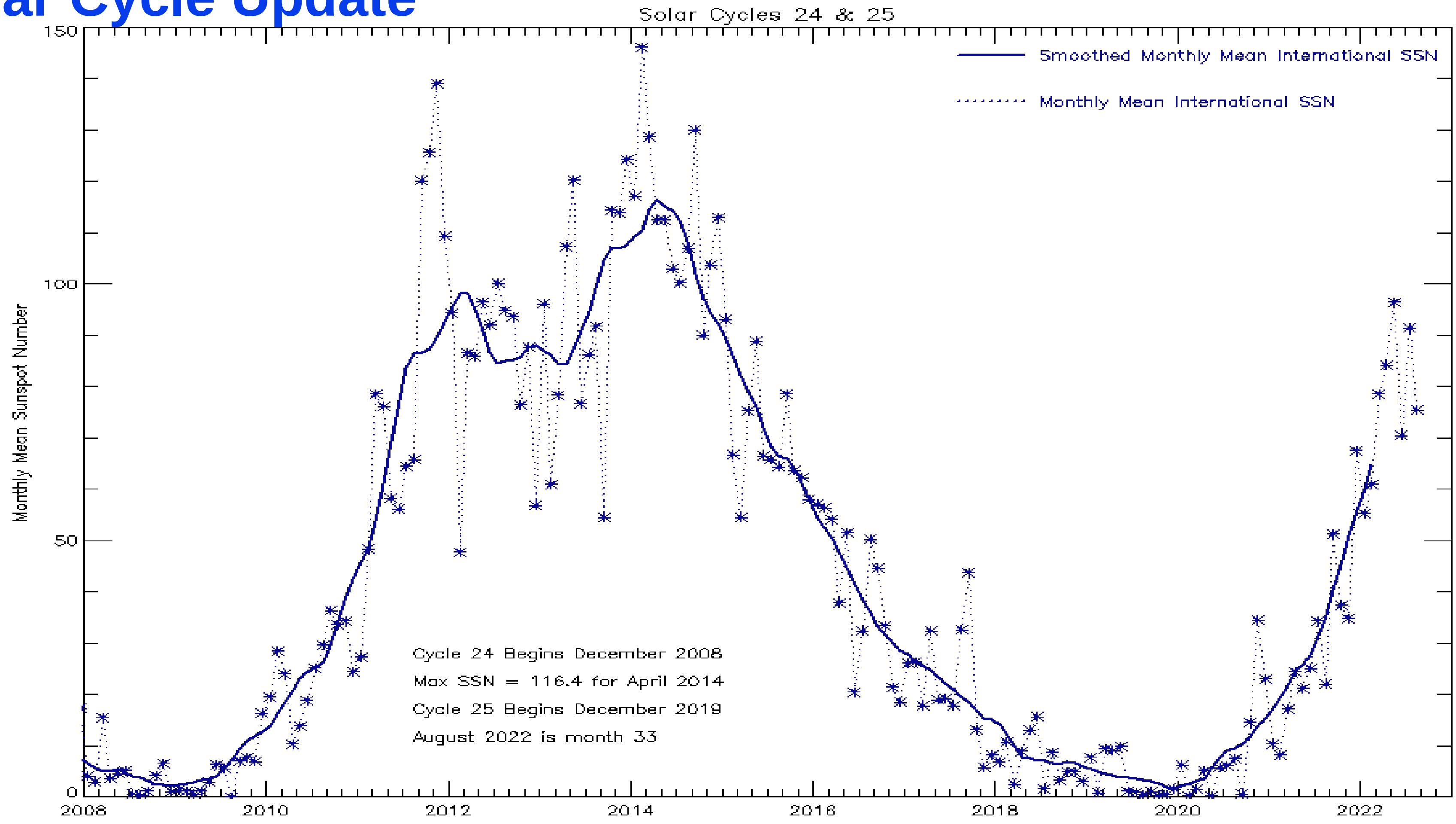
Volume 14, Issue 9,
http://onlinelibrary.wiley.com/doi/10.1002/2016SW001423/full#swe20344-fig-0001

Magnetism
Convection
Differential
Rotation
(~ 27 Days)

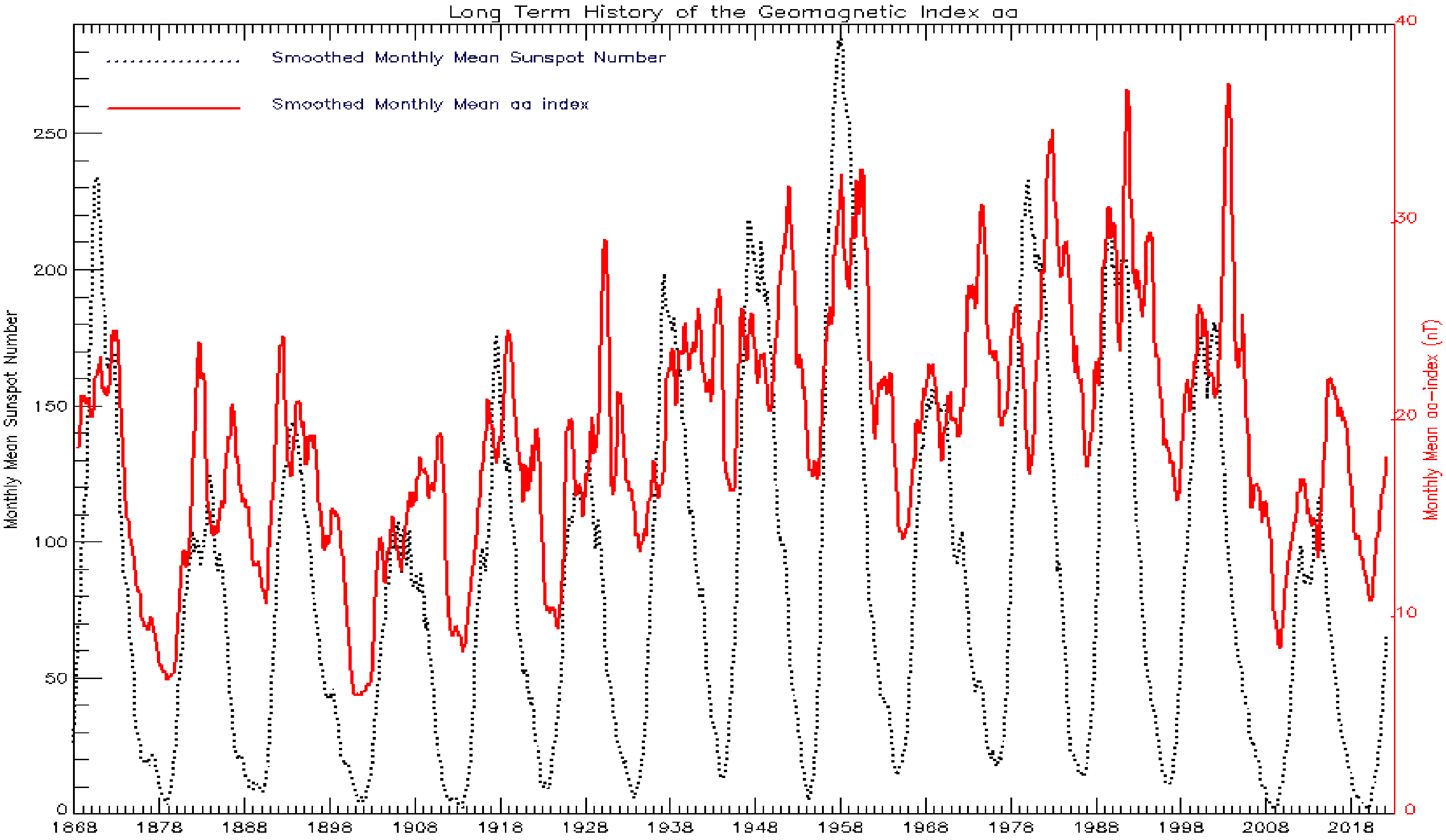




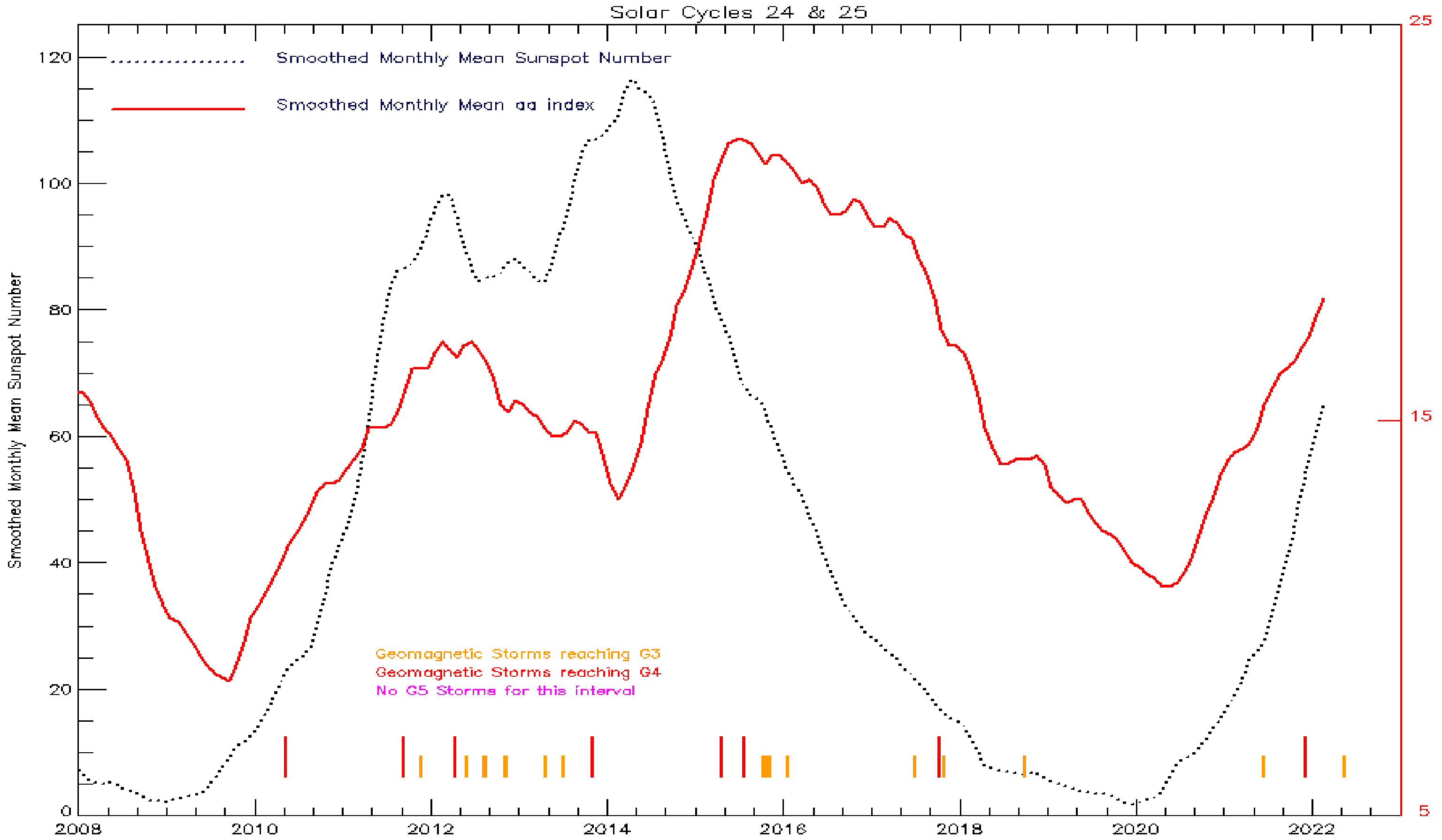
Solar Cycle Update



Long Term Sunspot and Geomagnetic Activity Cycles

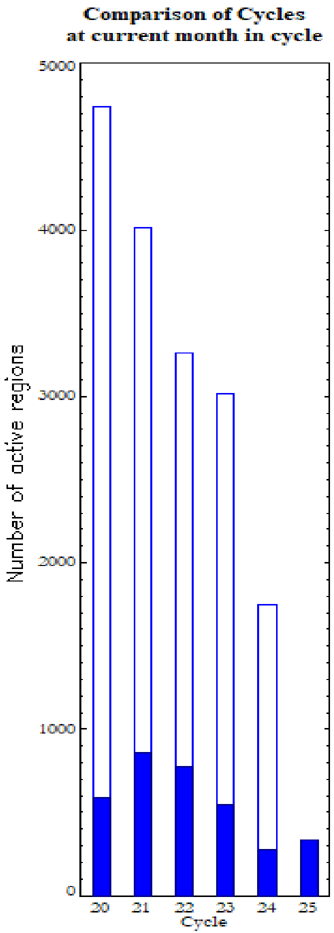


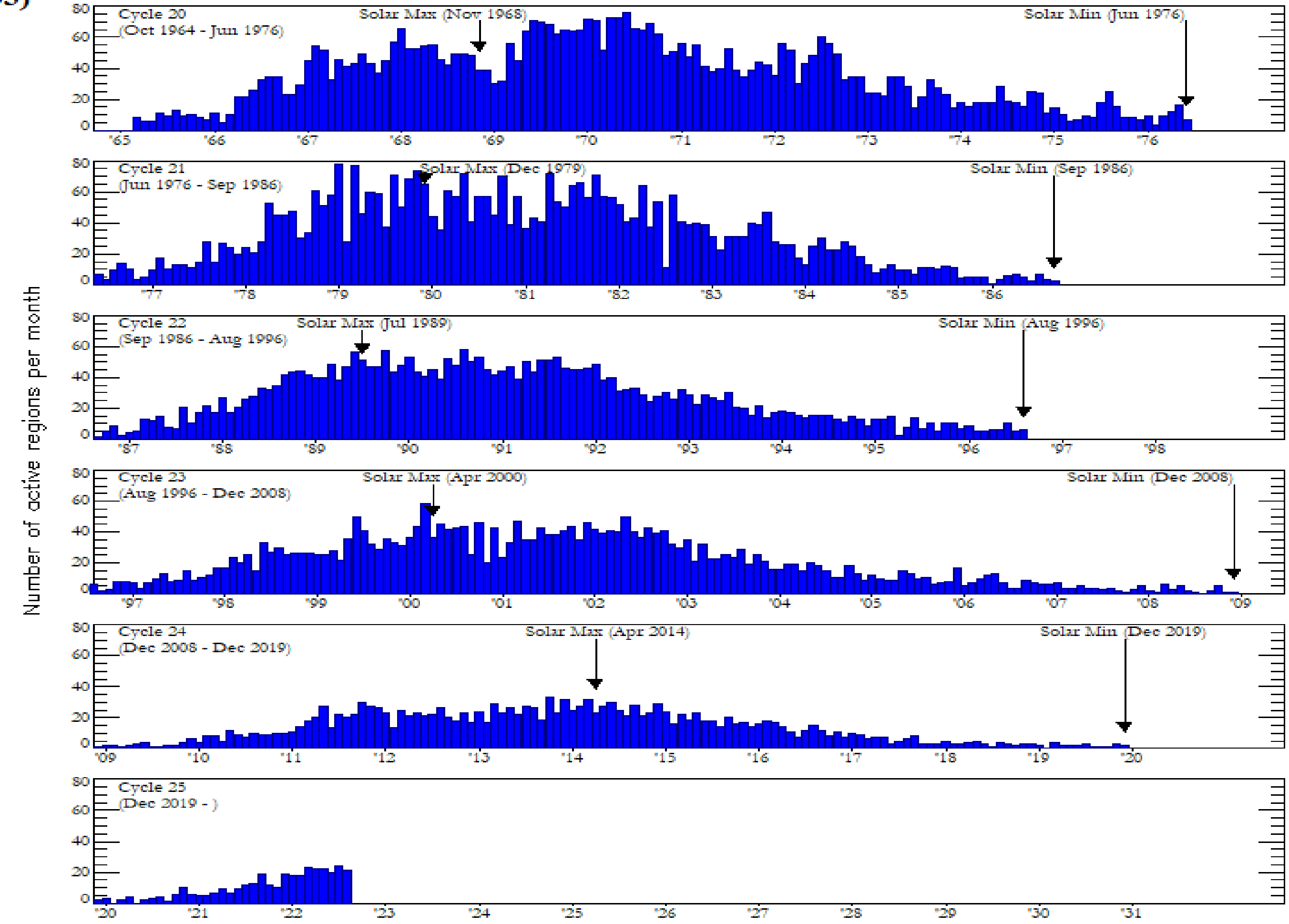
Geomagnetic Storm Occurrences for Cycles 24 & 25 (G3 and above)



Active Regions

August 2022 **(Month 33)**

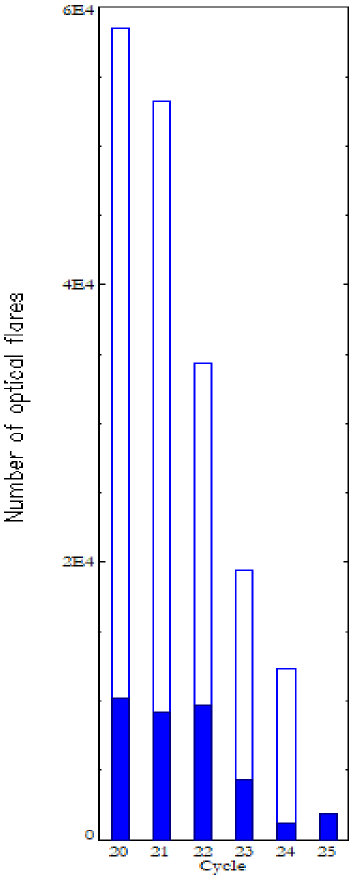


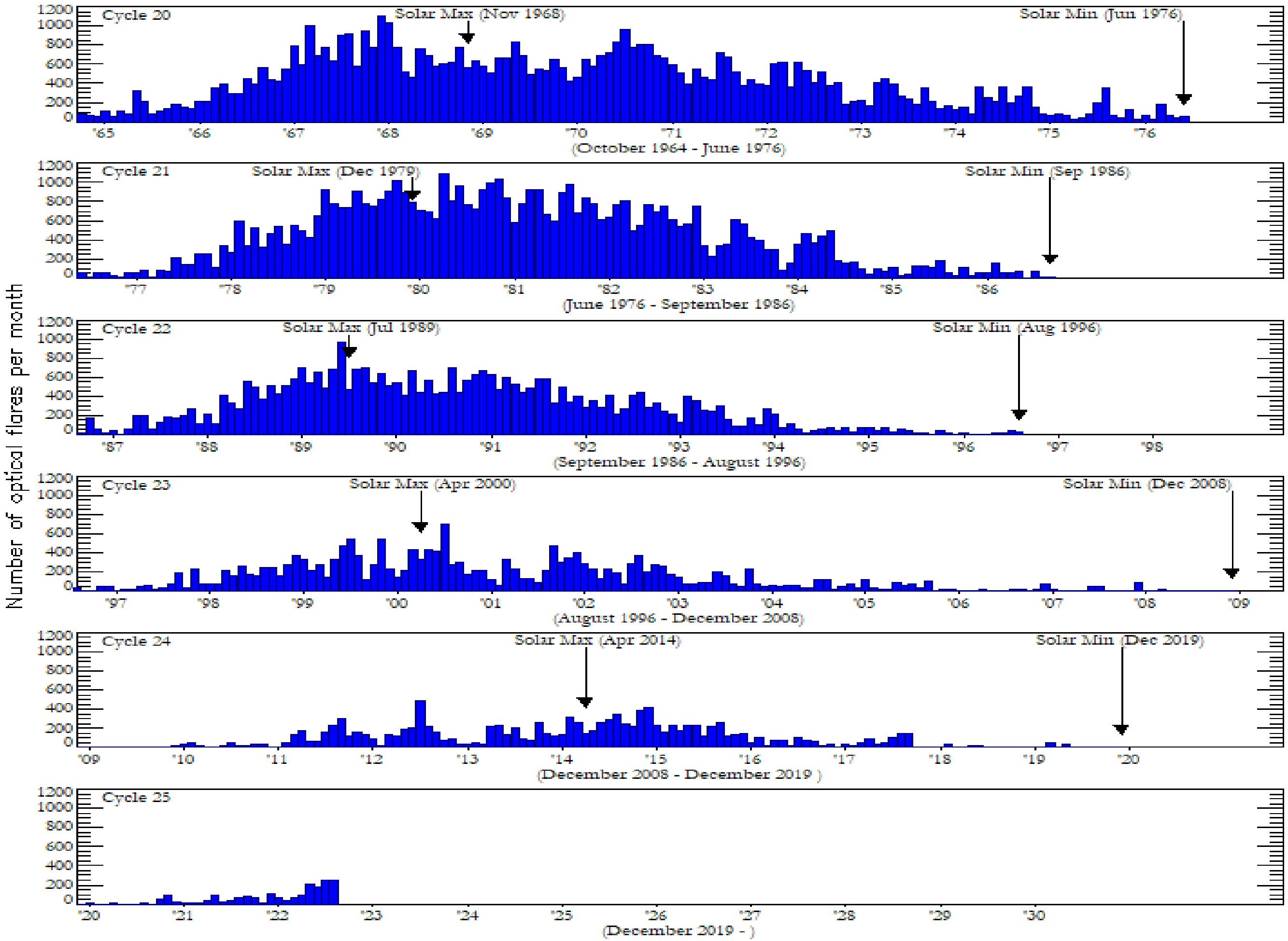


Optical Flares

August 2022 (Month 33)

Comparison of Cycles at current month in cycle

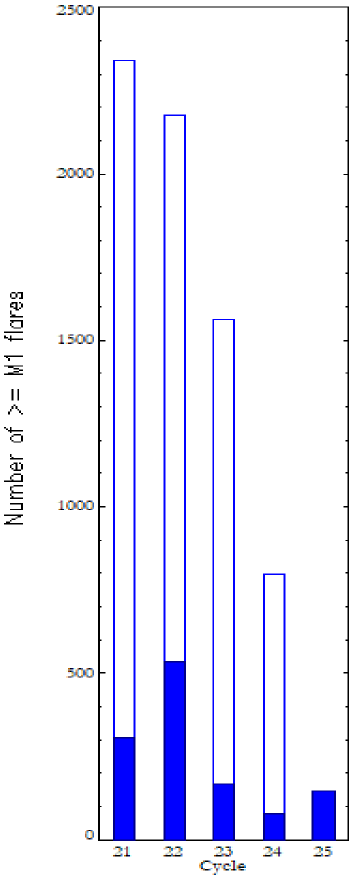


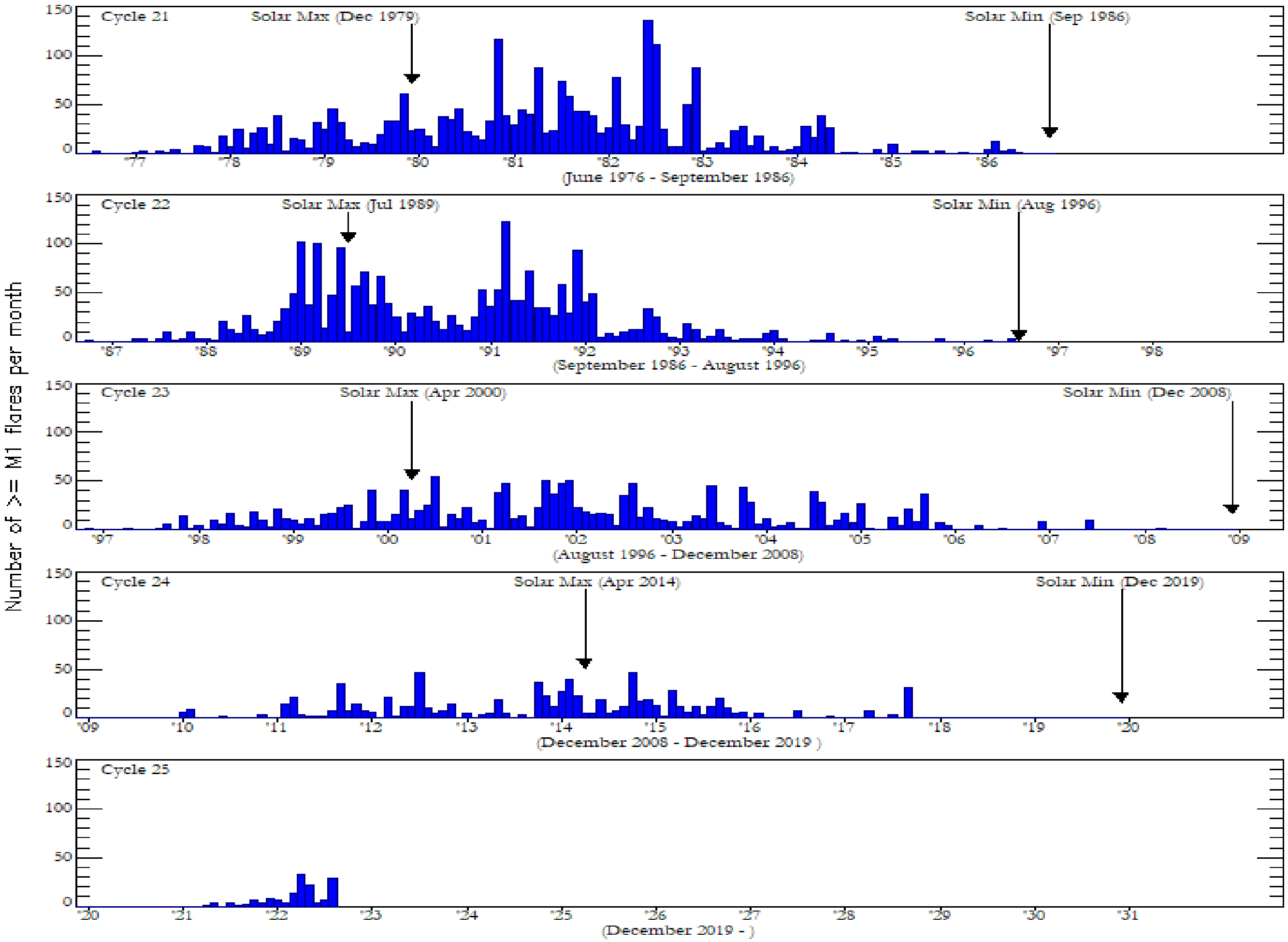


X-ray flares >= M1

August 2022 (Month 33)

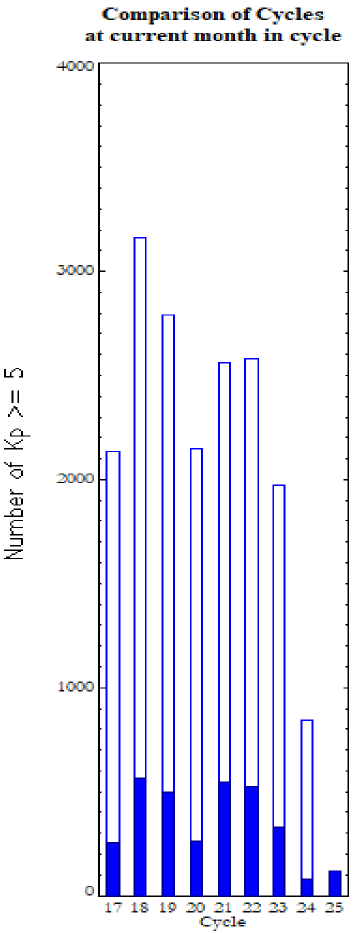
Comparison of Cycles at current month in cycle

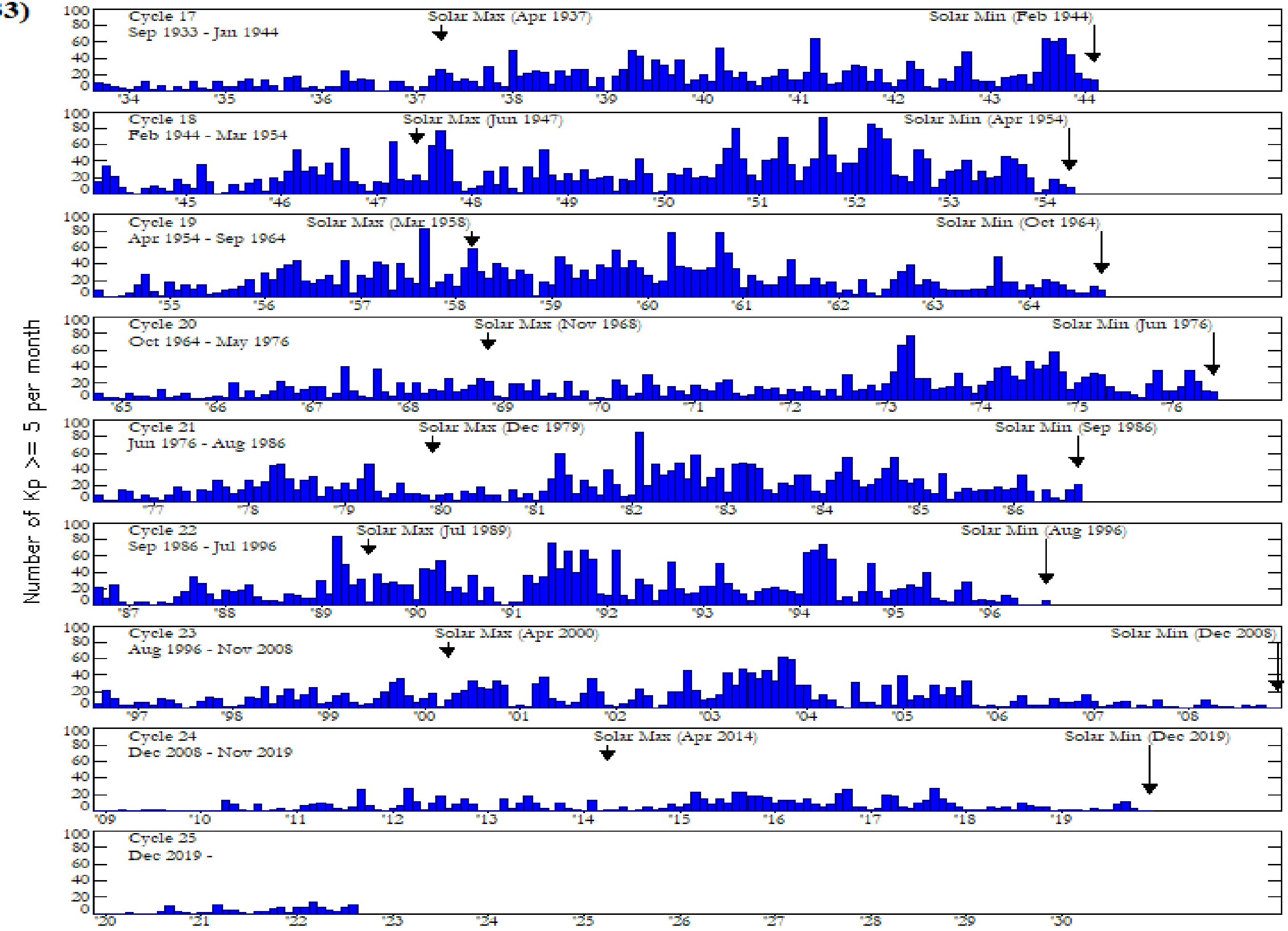




Periods with Kp >= 5

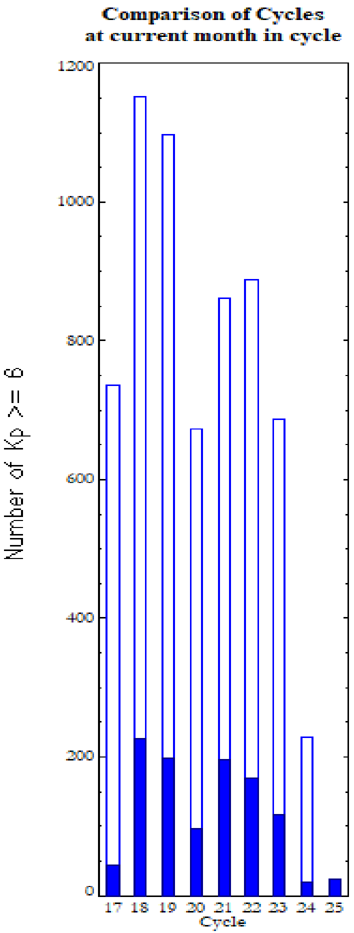
August 2022 (Month 33)

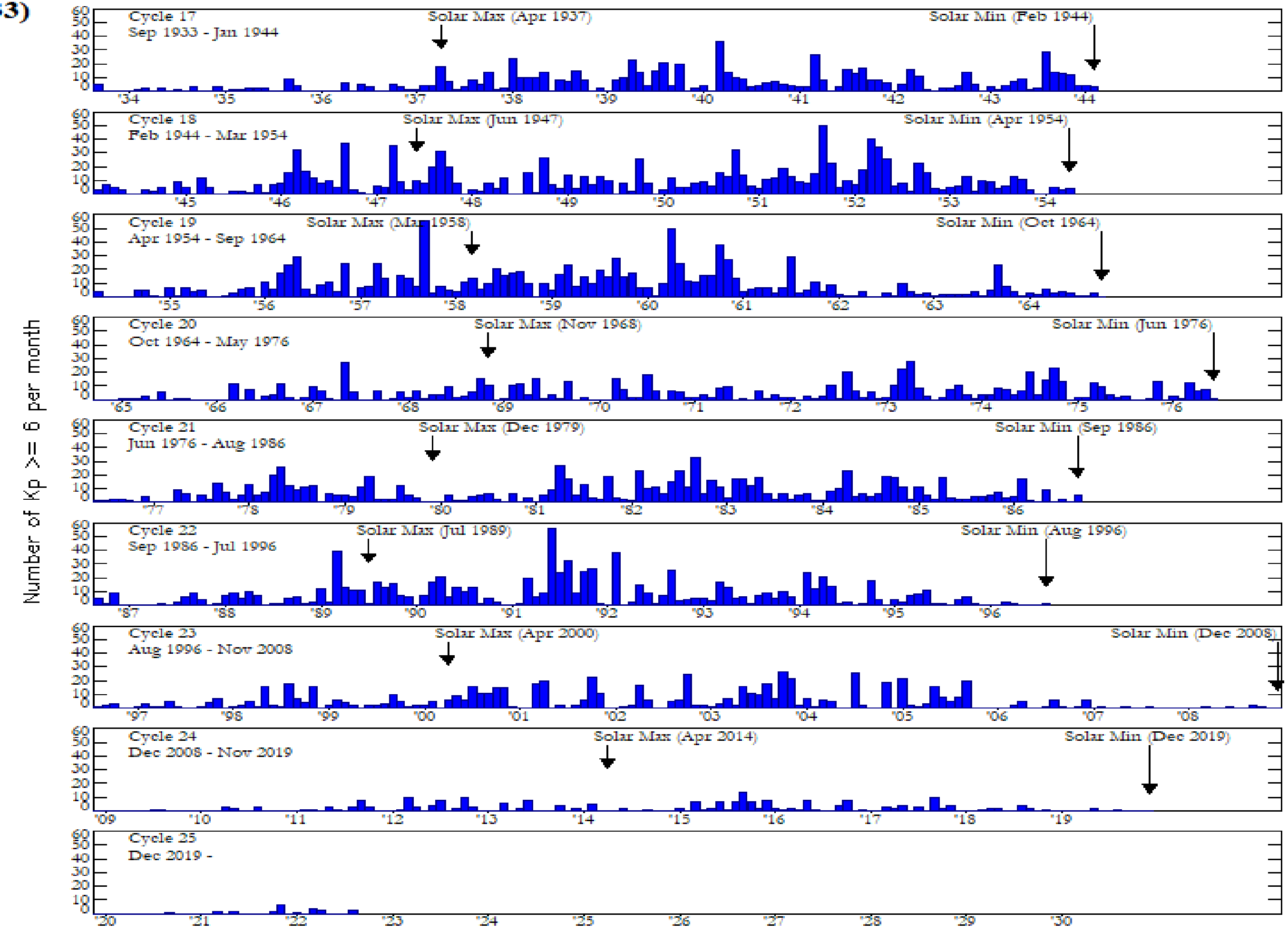




Periods with Kp >= 6

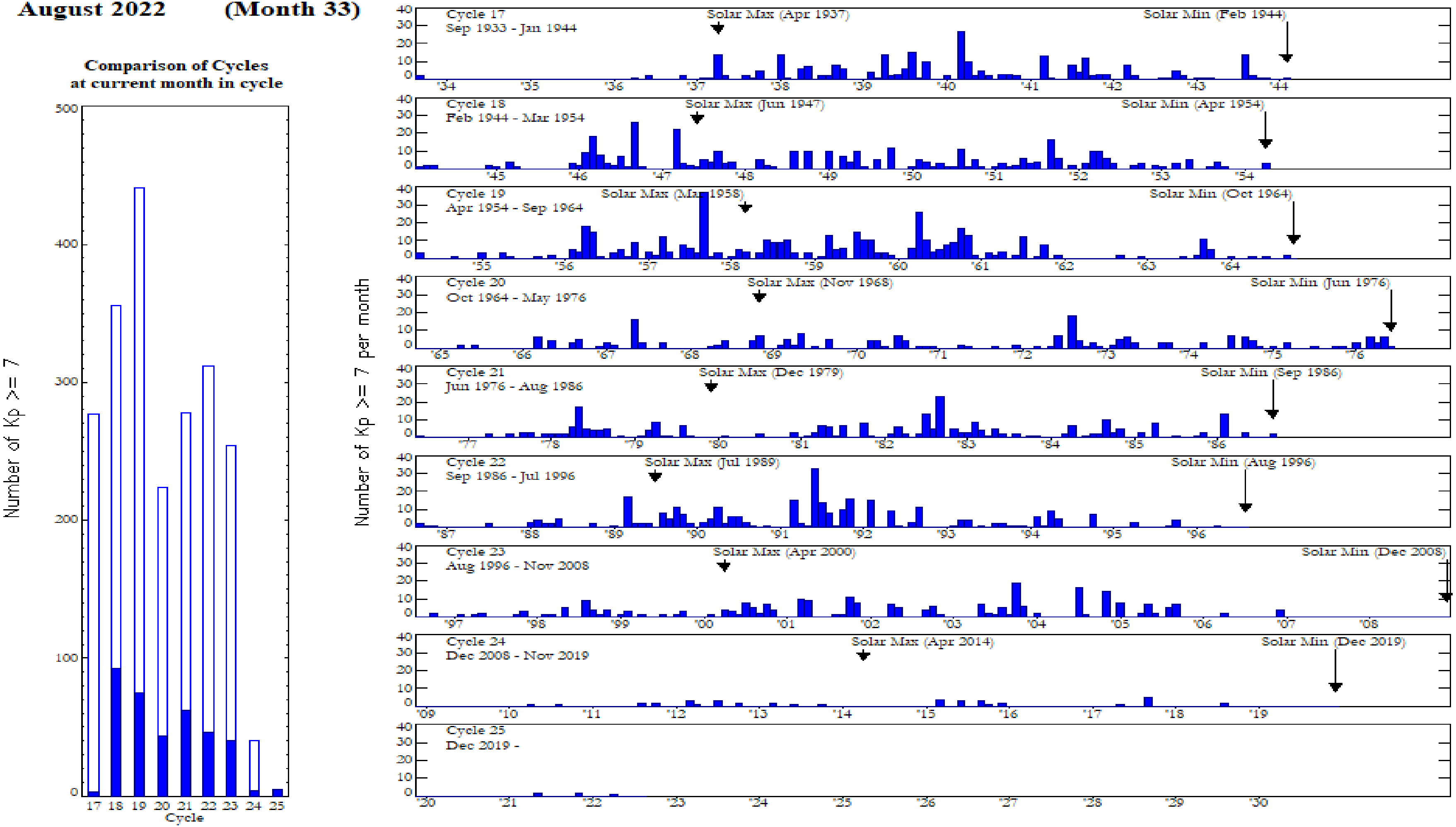
August 2022 (Month 33)





Periods with Kp >= 7

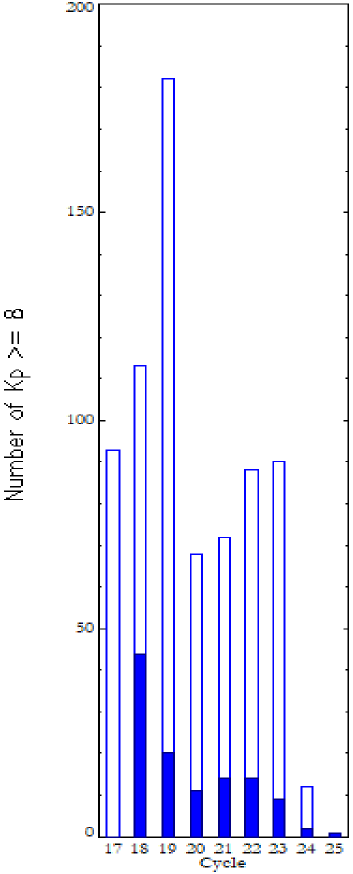
August 2022 **(Month 33)**

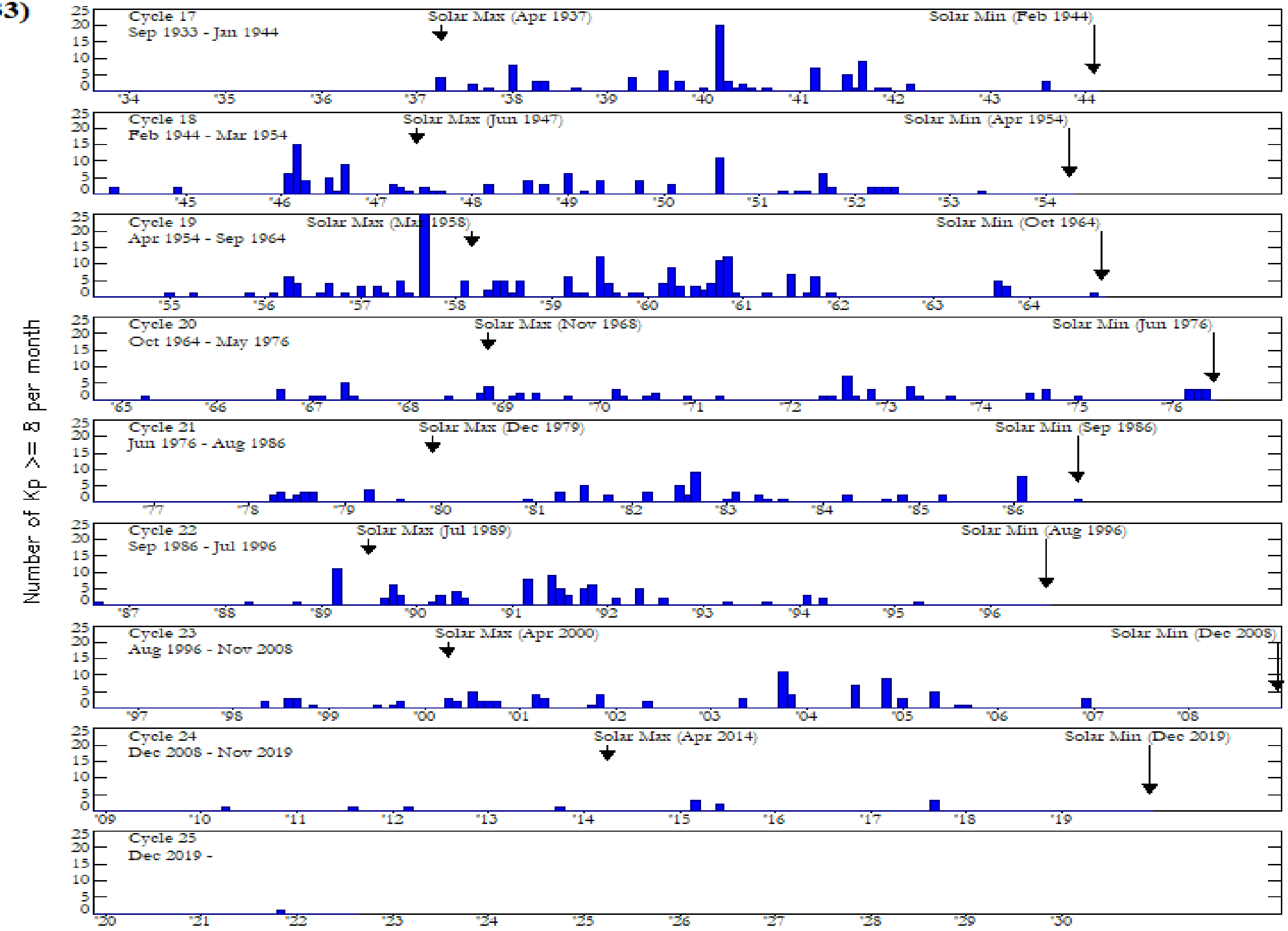


Periods with Kp >= 8

August 2022 (Month 33)

Comparison of Cycles at current month in cycle

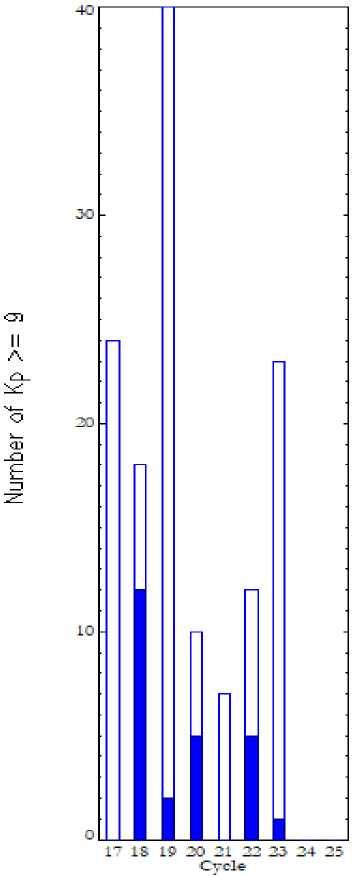


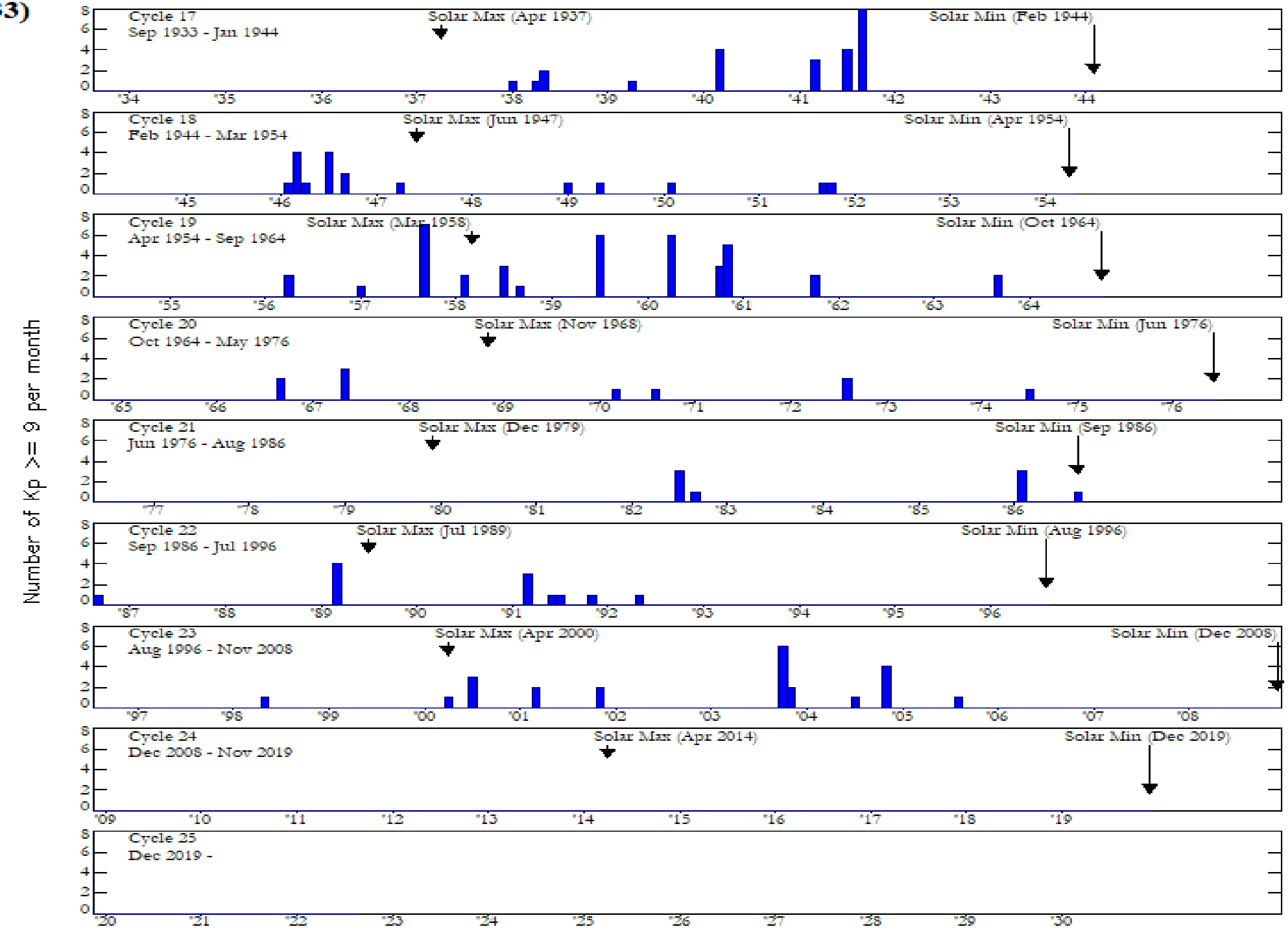


Periods with Kp >= 9

August 2022 (Month 33)

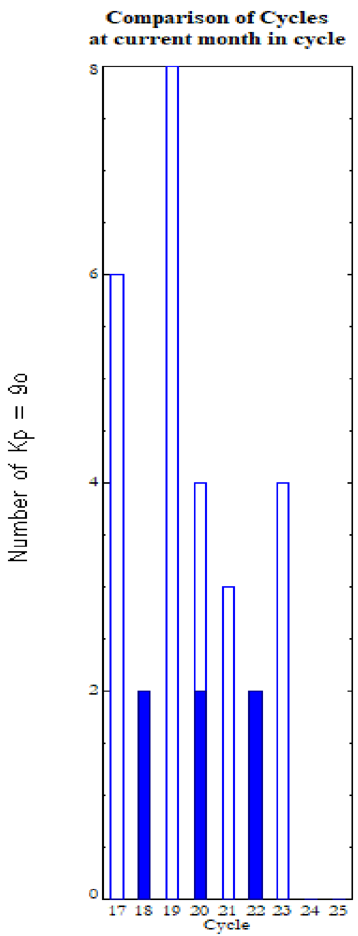
Comparison of Cycles at current month in cycle

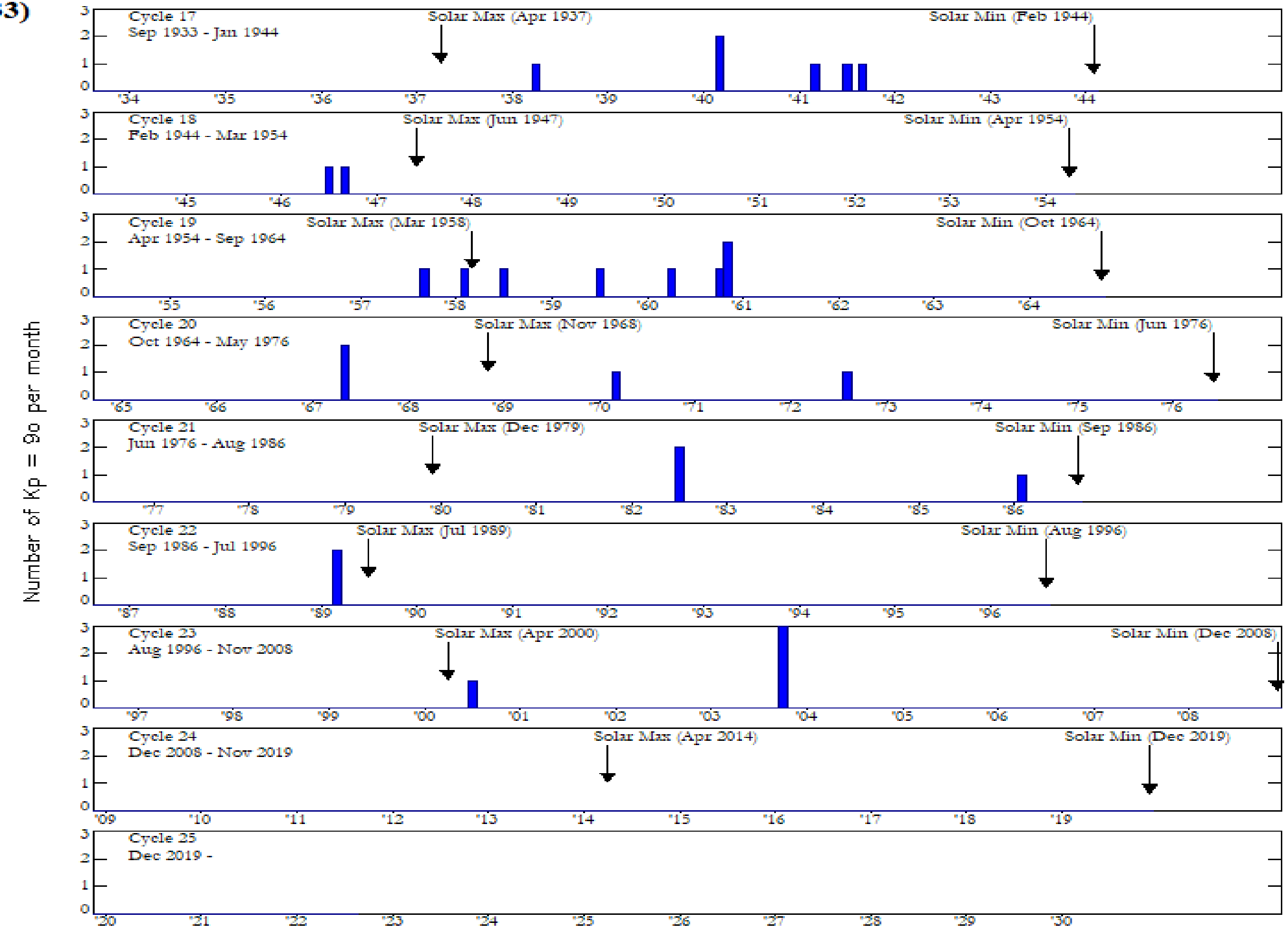




Periods with Kp = 9o

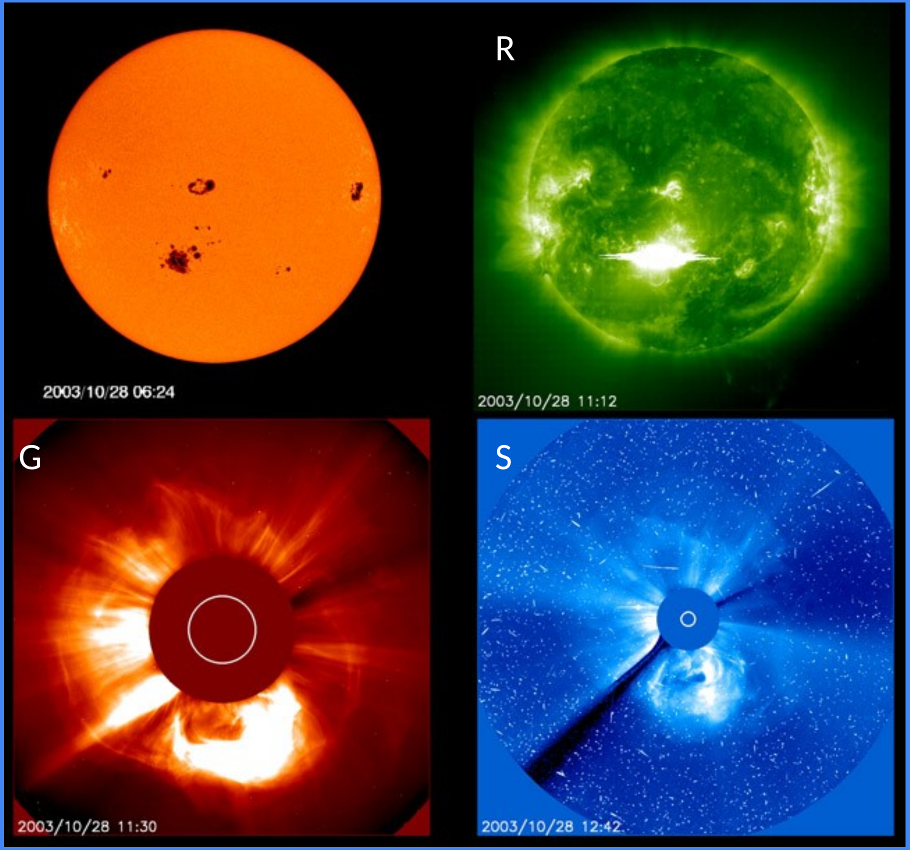
August 2022 (Month 33)

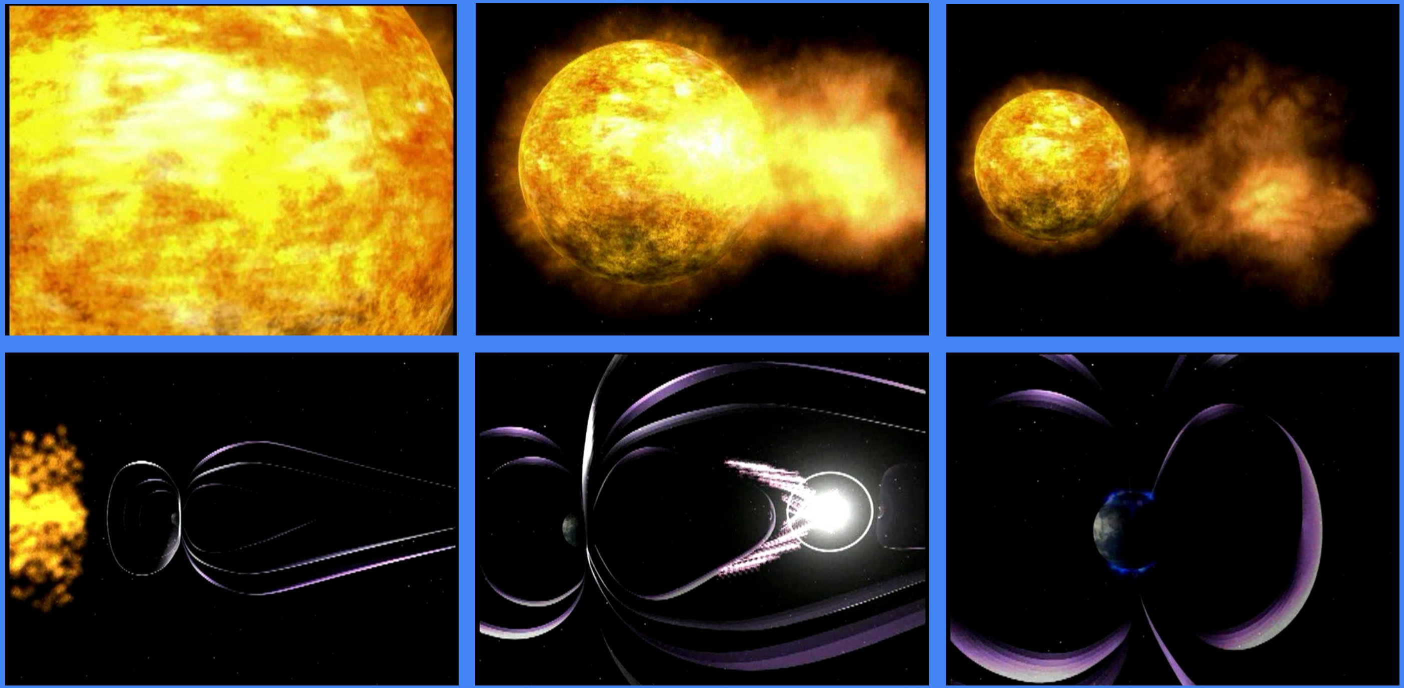




The Big 3 – R, S & G

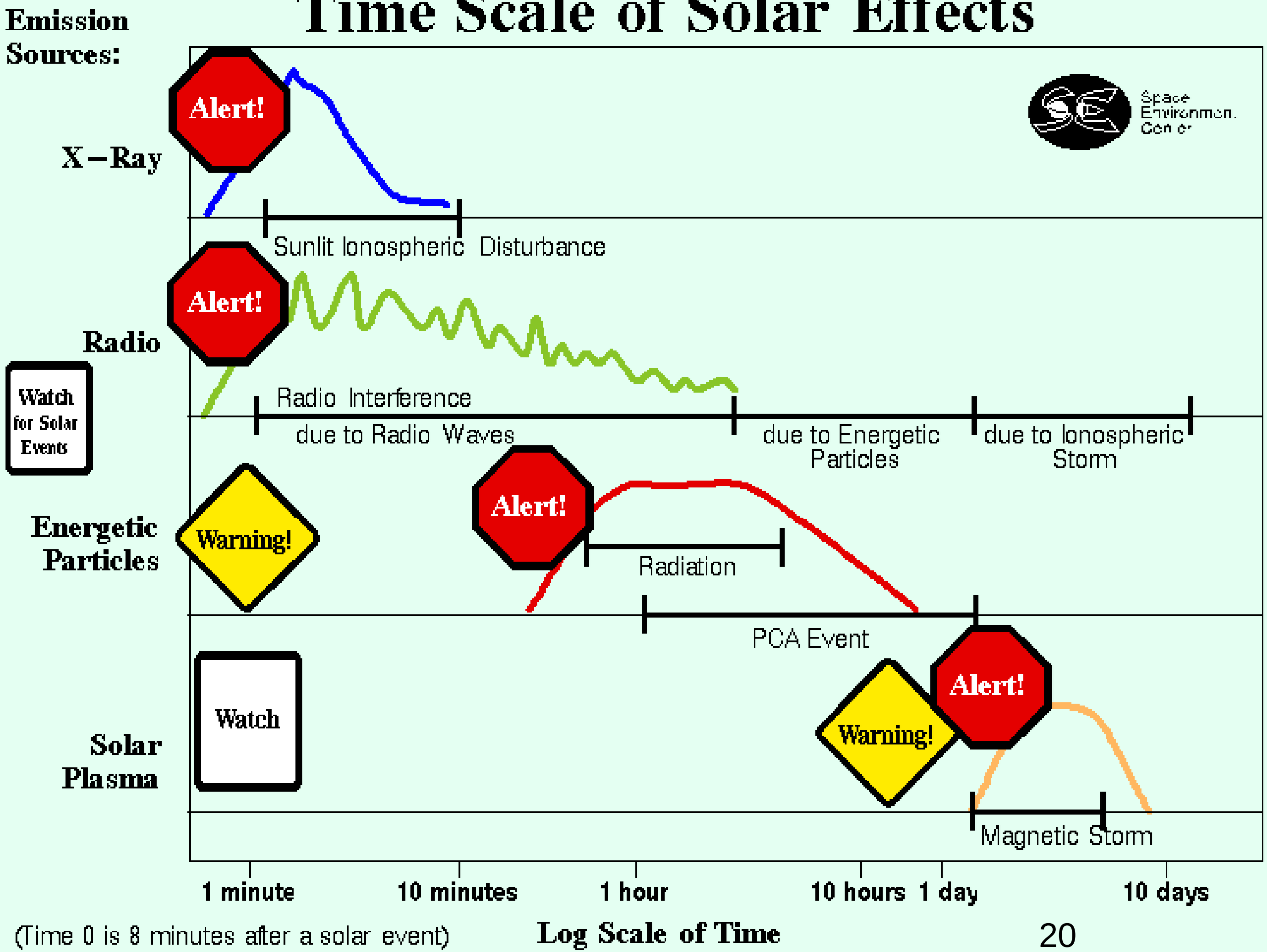
- R = Radio Blackout
- S = Space Radiation Storm
- G = Geomagnetic Storm





Artist’s conception of solar storm, courtesy NASA

Time Scale of Solar Effects



NOAA Space Weather Scales

http://www.swpc.noaa.gov/NOAAscales/

Category		Effect	Physical measure	Average Freq. (1 cycle = 11 yrs)
Scale	Descriptor	Duration of event will influence severity of effects		
		Radio Blackouts	GOES X-ray peak brightness by class and by flux*	Number of events when flux level
R 5	Extreme	**HF Radio:** Complete HF (high frequency**) radio blackout on the entire sunlit side of the Earth lasting for a number of hours. This results in no HF radio contact with mariners and en route aviators in this sector. **Navigation:** Low-frequency navigation signals used by maritime and general aviation systems experience outages on the sunlit side of the Earth for many hours, causing loss in positioning. Increased satellite navigation errors in positioning for several hours on the sunlit side of Earth, which may spread into the night side.	X20 (2×10^{-3})	
R 4	Severe	**HF Radio:** : HF radio communication blackout on most of the sunlit side of Earth for one to two hours. HF radio contact lost during this time. **Navigation:** Outages of low-frequency navigation signals cause increased error in positioning for one to two hours. Minor disruptions of satellite navigation possible on the sunlit side of Earth.	X10 (10^{-3})	(8
R 3	Strong	**HF Radio:** Wide area blackout of HF radio communication, loss of radio contact for about an hour on sunlit side of Earth. **Navigation:** Low-frequency navigation signals degraded for about an hour.	X1 (10^{-4})	
R 2	Moderate	**HF Radio:** Limited blackout of HF radio communication on sunlit side, loss of radio contact for tens of minutes. **Navigation:** Degradation of low-frequency navigation signals for tens of minutes.	M5 (5×10^{-5})	
R 1	Minor	**HF Radio:** Weak or minor degradation of HF radio communication on sunlit side, occasional loss of radio contact. **Navigation:** Low-frequency navigation signals degraded for brief intervals.	M1 (10^{-5})	

* Flux, measured in the 0.1-0.8 nm range, in $W \cdot m^{-2}$. Based on this measure, but other physical measures are als
considered.
** Other frequencies may also be affected by these conditions.

Radio Blackouts

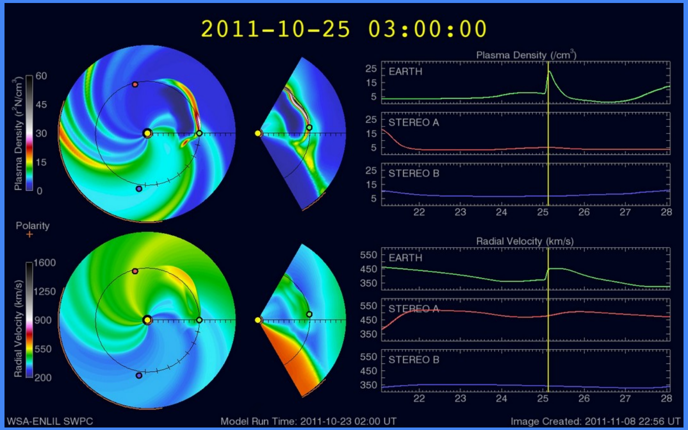
Category		Effect	Physical measure	Average Freq. (1 cycle = 11 yr)
Scale	Descriptor	Duration of event will influence severity of effects		
		Solar Radiation Storms	Flux level	Number of
S 5	Extreme	**Biological:** unavoidable high radiation hazard to astronauts on E vehicular activity); high radiation exposure to passengers and cre commercial jets at high latitudes (approximately 100 chest x-rays **Satellite operations:** satellites may be rendered useless, memory cause loss of control, may cause serious noise in image data, star- be unable to locate sources; permanent damage to solar panels po **Other systems:** complete blackout of HF (high frequency) comm possible through the polar regions, and position errors make navi operations extremely difficult.		
S 4	Severe	**Biological:** unavoidable radiation hazard to astronauts on EVA; radiation exposure to passengers and crew in commercial jets at h (approximately 10 chest x-rays) is possible. **Satellite operations:** may experience memory device problems a imaging systems; star-tracker problems may cause orientation pr solar panel efficiency can be degraded. **Other systems:** blackout of HF radio communications through th regions and increased navigation errors over several days are like		
S 3	Strong	**Biological:** radiation hazard avoidance recommended for astrona passengers and crew in commercial jets at high latitudes may rec radiation exposure (approximately 1 chest x-ray). **Satellite operations:** single-event upsets, noise in imaging syste reduction of efficiency in solar panel are likely. **Other systems:** degraded HF radio propagation through the pola navigation position errors likely.		
S 2	Moderate	**Biological:** none. **Satellite operations:** infrequent single-event upsets possible. **Other systems:** small effects on HF propagation through the pol navigation at polar cap locations possibly affected.		
S 1	Minor	**Biological:** none. **Satellite operations:** none. **Other systems:** minor impacts on HF radio in the polar regions.		

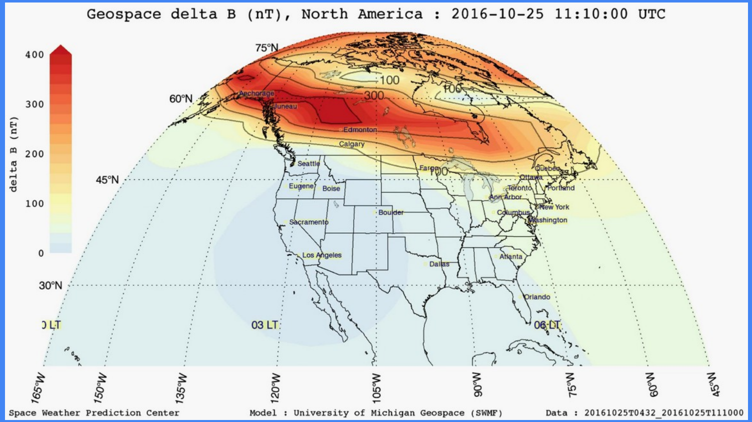
Radiation Storms

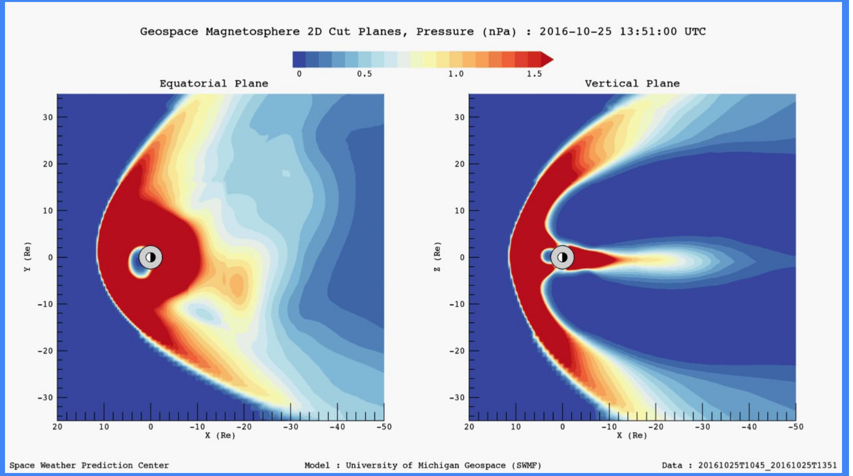
Category		Effect	Physical measure	Average Freq. (1 cycle = 11 yrs)
Scale	Descriptor	Duration of event will influence severity of effects		
		Geomagnetic Storms	Kp values* determined every 3 hours	Number of storm events when Kp level was met
G 5	Extreme	**Power systems:** : widespread voltage control problems and protective system problems can occur, some grid systems may experience complete collapse or blackouts. Transformers may experience damage. **Spacecraft operations:** may experience extensive surface charging, problems with orientation, uplink/downlink and tracking satellites. **Other systems:** pipeline currents can reach hundreds of amps, HF (high frequency) radio propagation may be impossible in many areas for one to two days, satellite navigation may be degraded for days, low-frequency radio navigation can be out for hours, and aurora has been seen as low as Florida and southern Texas (typically 40° geomagnetic lat.)**.	Kp = 9	4 per cycle (4 days per cycle)
G 4	Severe	**Power systems:** possible widespread voltage control problems and some protective systems will mistakenly trip out key assets from the grid. **Spacecraft operations:** may experience surface charging and tracking problems, corrections may be needed for orientation problems. **Other systems:** induced pipeline currents affect preventive measures, HF radio propagation sporadic, satellite navigation degraded for hours, low-frequency radio navigation disrupted, and aurora has been seen as low as Alabama and northern California (typically 45° geomagnetic lat.)**.	Kp = 8, including a 9-	100 per cycle (60 days per cycle)
G 3	Strong	**Power systems:** voltage corrections may be required, false alarms triggered on some protection devices. **Spacecraft operations:** surface charging may occur on satellite components, drag may increase on low-Earth-orbit satellites, and corrections may be needed for orientation problems. **Other systems:** intermittent satellite navigation and low-frequency radio navigation problems may occur, HF radio may be intermittent, and aurora has been seen as low as Illinois and Oregon (typically 50° geomagnetic lat.)**.	Kp = 7	200 per cycle (130 days per cycle)
G 2	Moderate	**Power systems:** high-latitude power systems may experience voltage alarms, long-duration storms may cause transformer damage. **Spacecraft operations:** corrective actions to orientation may be required by ground control; possible changes in drag affect orbit predictions. **Other systems:** HF radio propagation can fade at higher latitudes, and aurora has been seen as low as New York and Idaho (typically 55° geomagnetic lat.)**.	Kp = 6	600 per cycle (360 days per cycle)
G 1	Minor	**Power systems:** weak power grid fluctuations can occur. **Spacecraft operations:** minor impact on satellite operations possible. **Other systems:** migratory animals are affected at this and higher levels; aurora is commonly visible at high latitudes (northern Michigan and Maine)**.	Kp = 5	1700 per cycle (900 days per cycle)

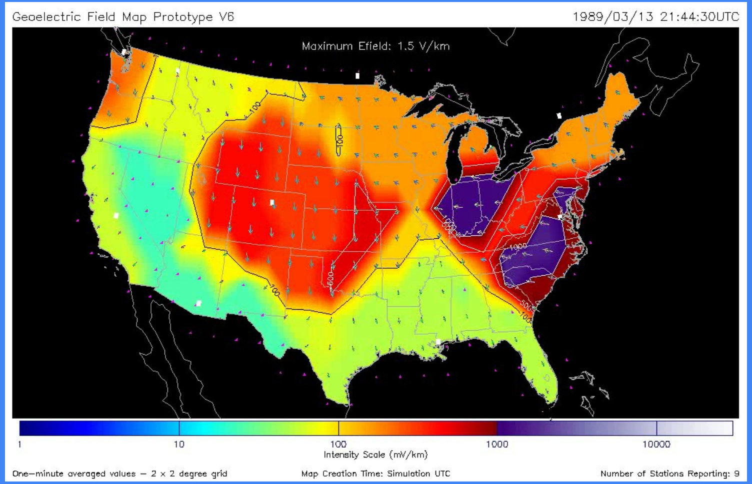
Geomagnetic Storms

Modeling the Space Environment









Phenomena Reference/Impacts

Solar Flare Radio Blackout (**R** Scale):

- No advance warning
- Effects last for 10's of minutes to several hours
- High Frequency (HF) communication on the sunlit side of the Earth
- VHF/UHF communication if significant radio burst on frequency (e.g. GPS)
- First indication significant S and G scale activity may be possible

Solar Radiation Storm (**S** Scale):

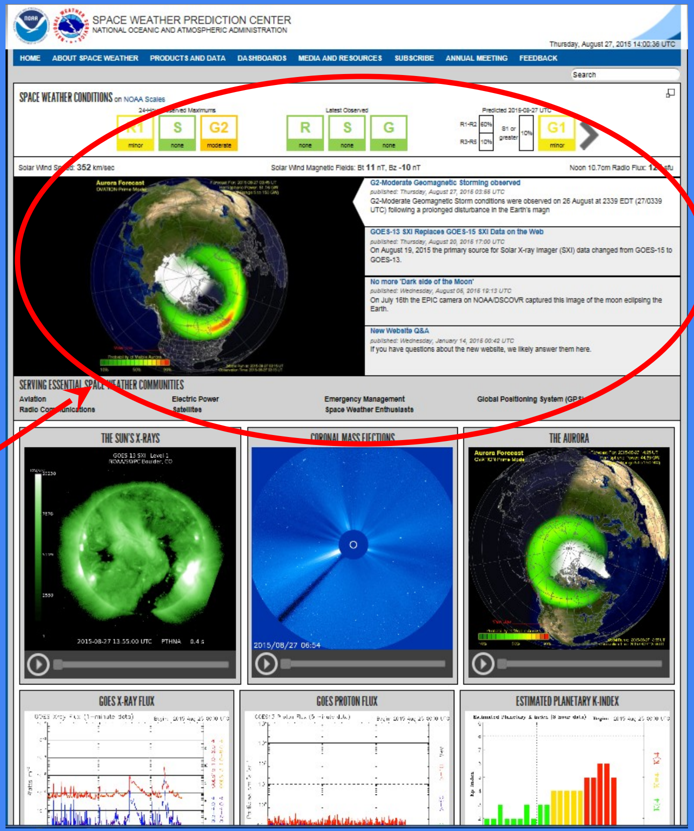
- Warnings possible on the minutes to hours time scale
- Effects can persist for several days
- Health and operation of satellites and International Space Station
- HF comm in the polar regions, affecting commercial airline ops

Geomagnetic Storm (**G** Scale):

- Advance notice possible from just under a day to several days
- Effects last for one or more days
- Power grid operations and stability
- Post-Storm Maximum Usable Frequency (MUF) depression possible.
- Global Navigation Satellite System (GNSS) accuracy and availability
- Aurora

Information Dissemination

- Phone Contact for Critical Stakeholders: NASA, Commercial Airlines, Power Generation and Distribution, FEMA, etc.
- Product Subscription Service: Email-based, no cost subscription service open to all
- Website: Data, products, and models all available there. Top News heading that will provide updates for elevated space weather
- Social Media (Twitter, ~~Facebook~~)
- Traditional Media Support during significant events



September 2017 Events

Summer of 2017 was generally uneventful until...

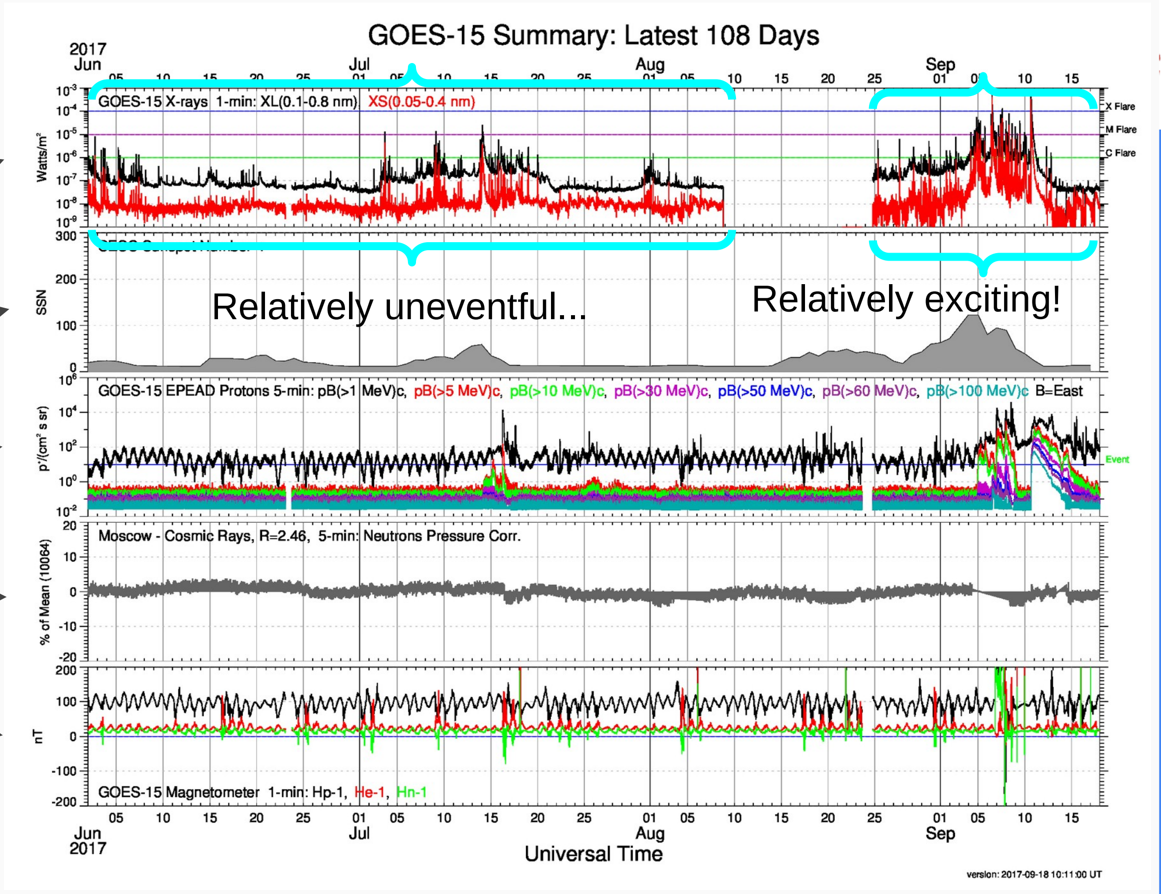
X-rays (@ Geo)

Sunspots

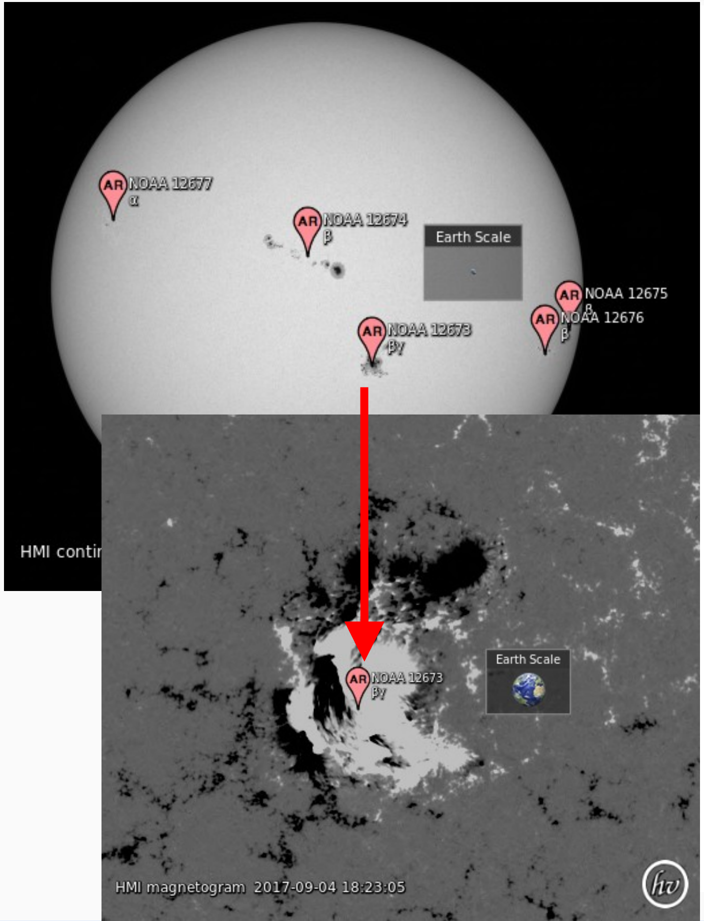
Particles (@ Geo)

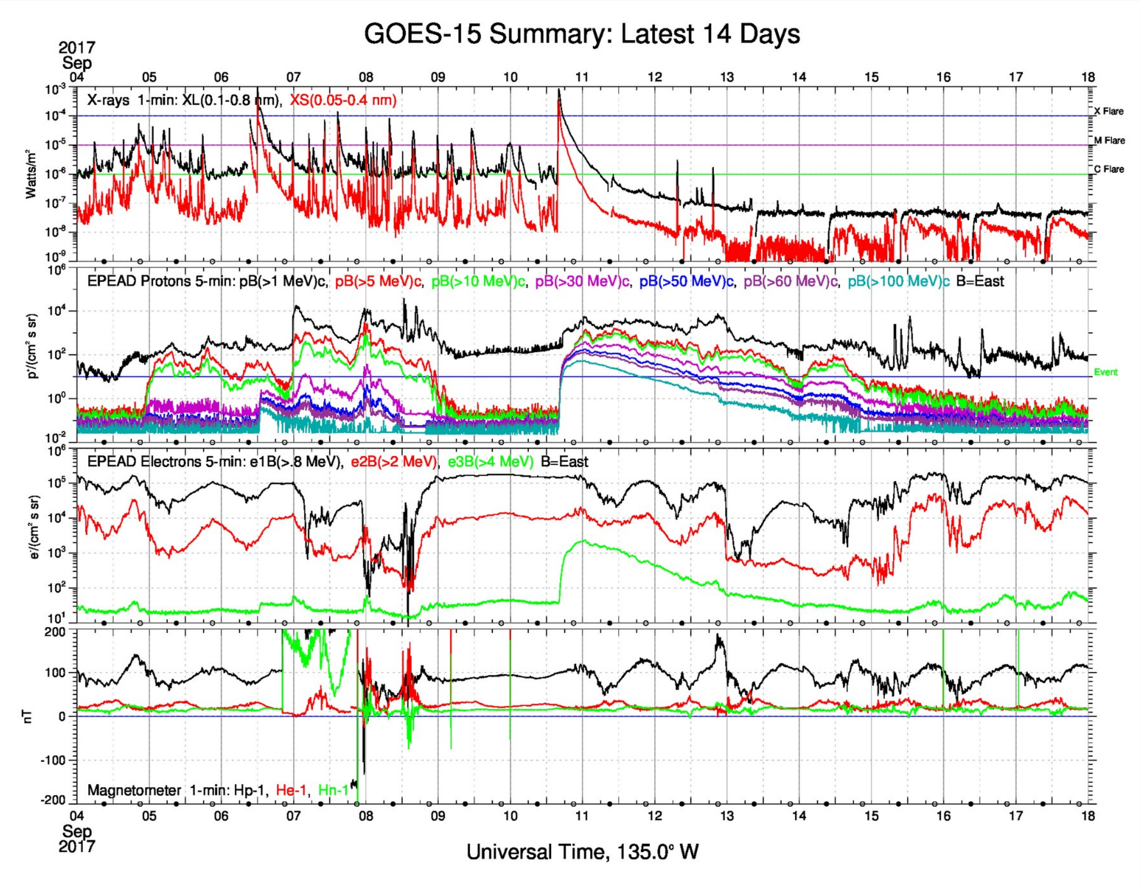
Cosmic Rays

Magnetometer (@ Geo)

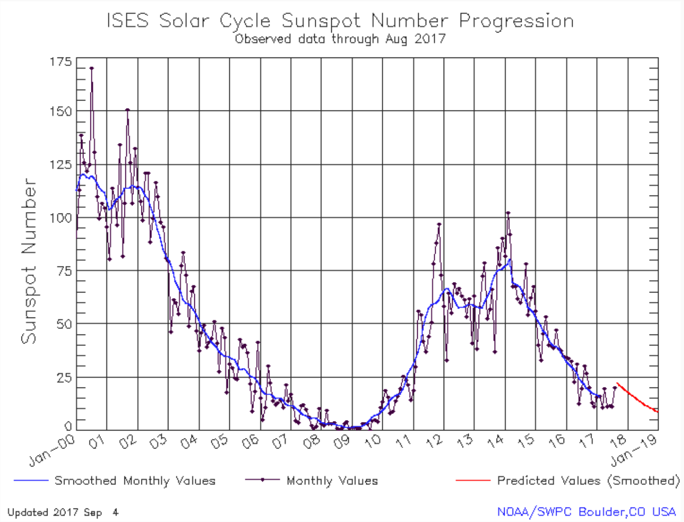


Region 12673

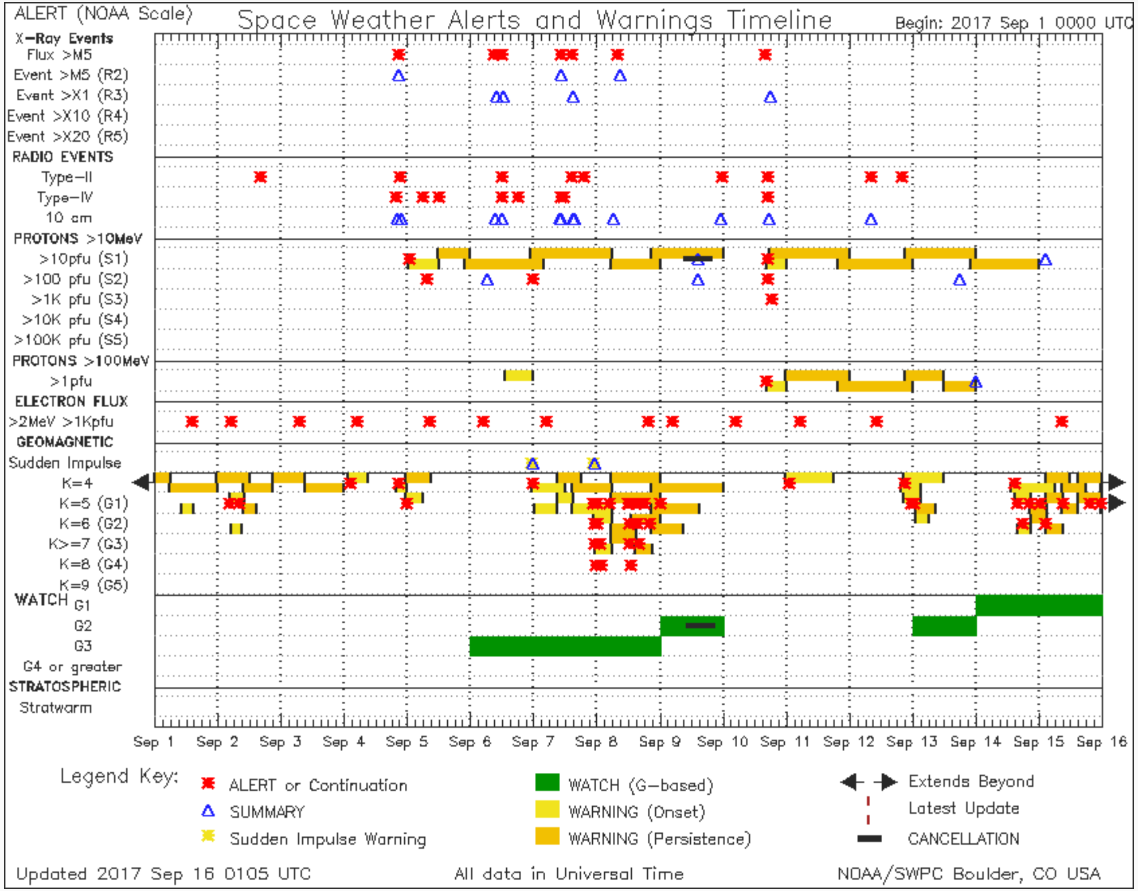




Cycle vs Watches, Warnings and Alerts Timeline 01 Sep - 16 Sep 2017



04 Sep 1200 UTC - 11 Sept 1200 UTC **123** Alert, Watch Warning and Summary Products issued. This was 5 more than issued the *entire month* before.



September 6, 2017 & other flares

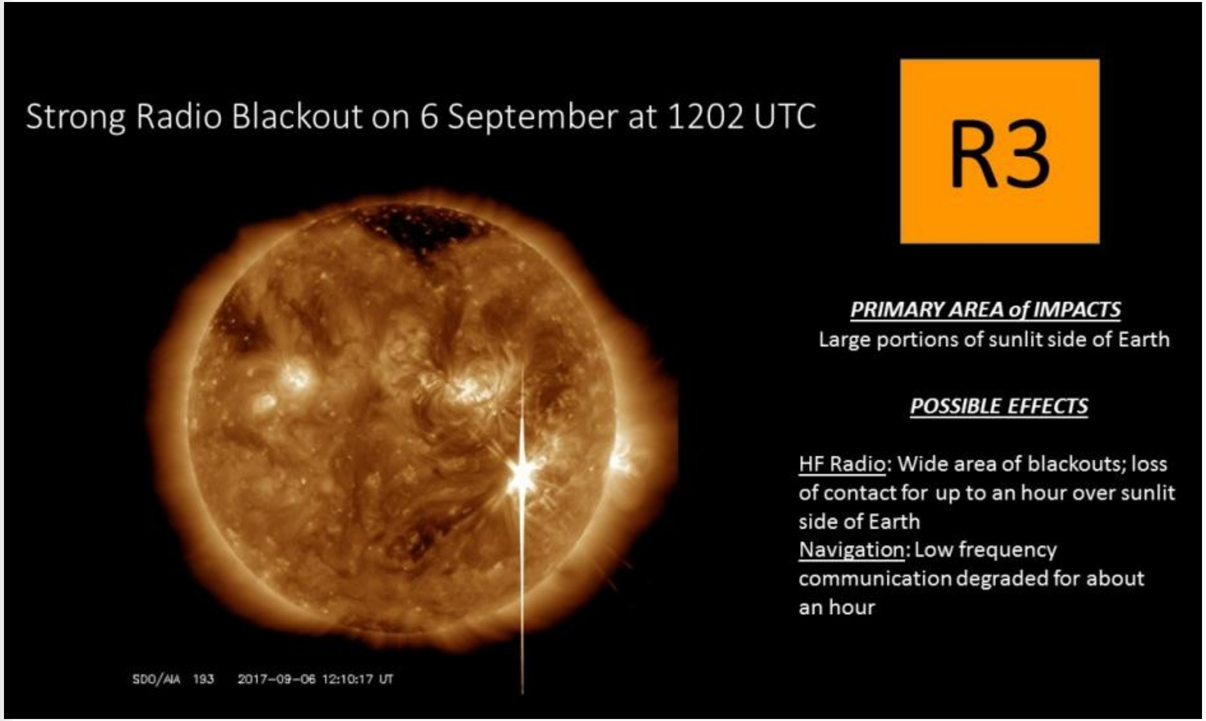
The X9.3 flare son Sep 6 at 1202 UTC was the largest of the solar cycle, and the largest since Sep 7, 2005 (an X17) + S3

An X2.2 preceded the X9.3 flare on Sep 06 at 0910 UTC

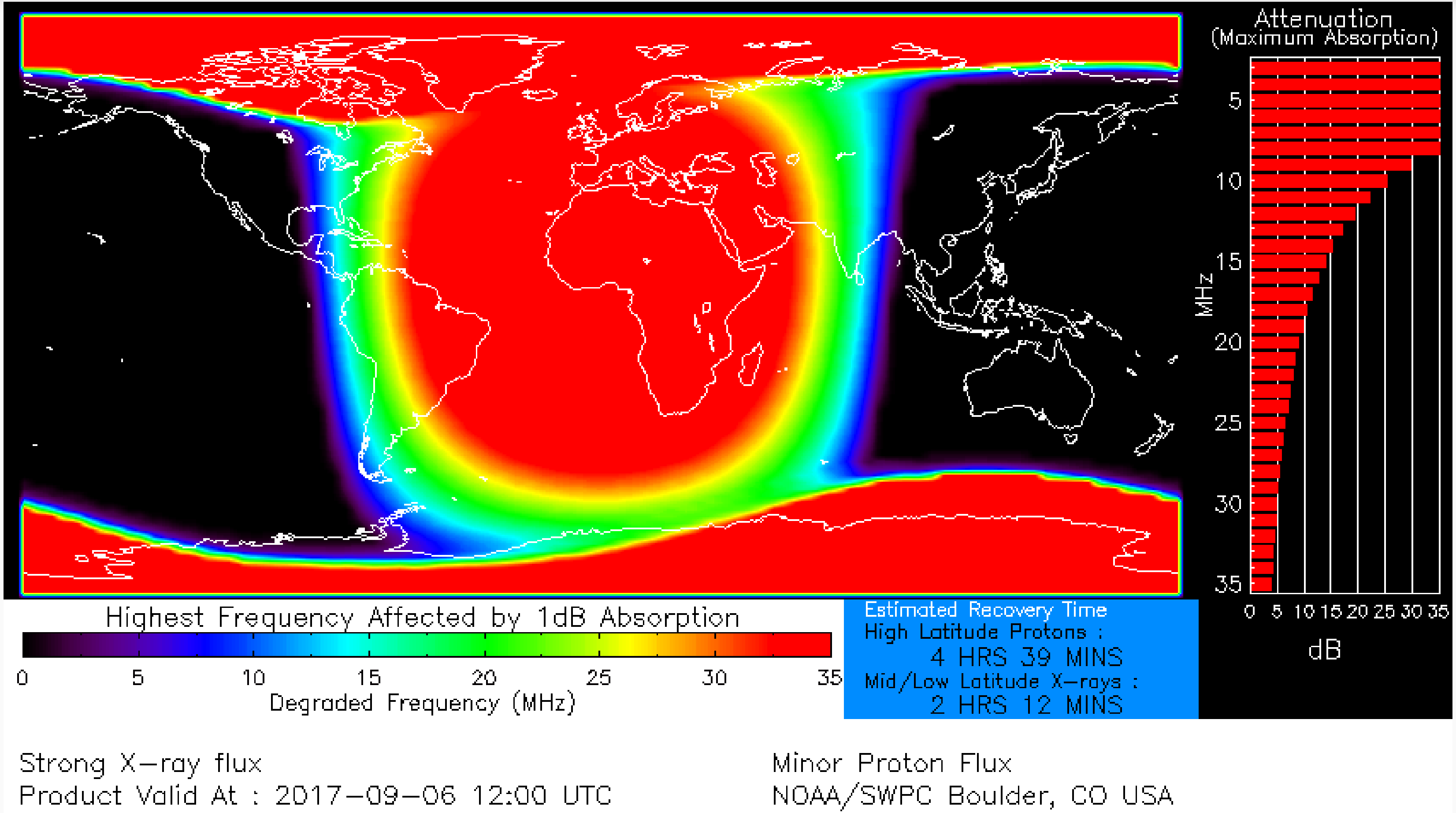
An X1.3 event followed on Sep 07 at 1436 UTC

An X8.2 event followed on Sep 10 at 1606 UTC + S3

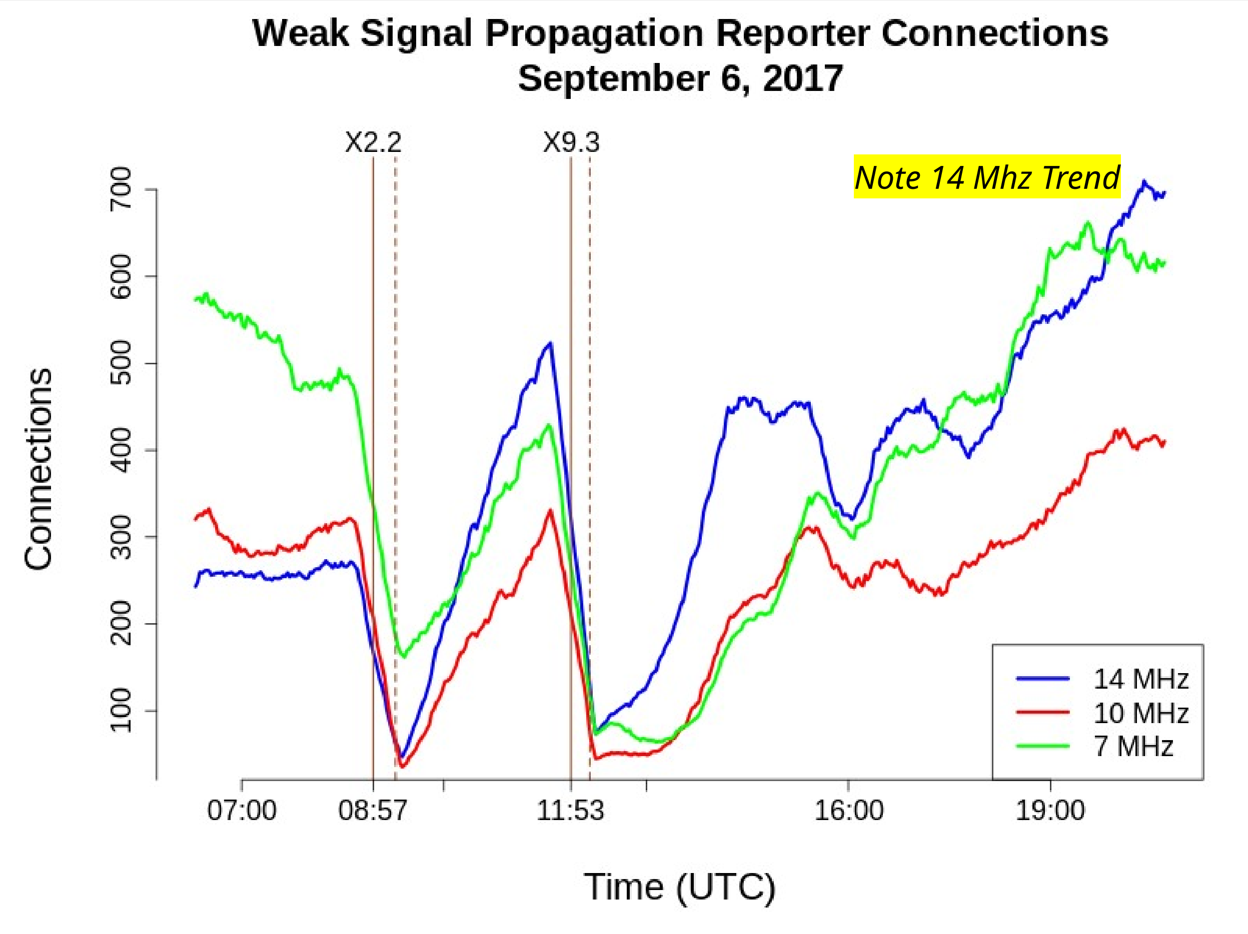
Intense Solar Activity Viewed From Space (NASA)



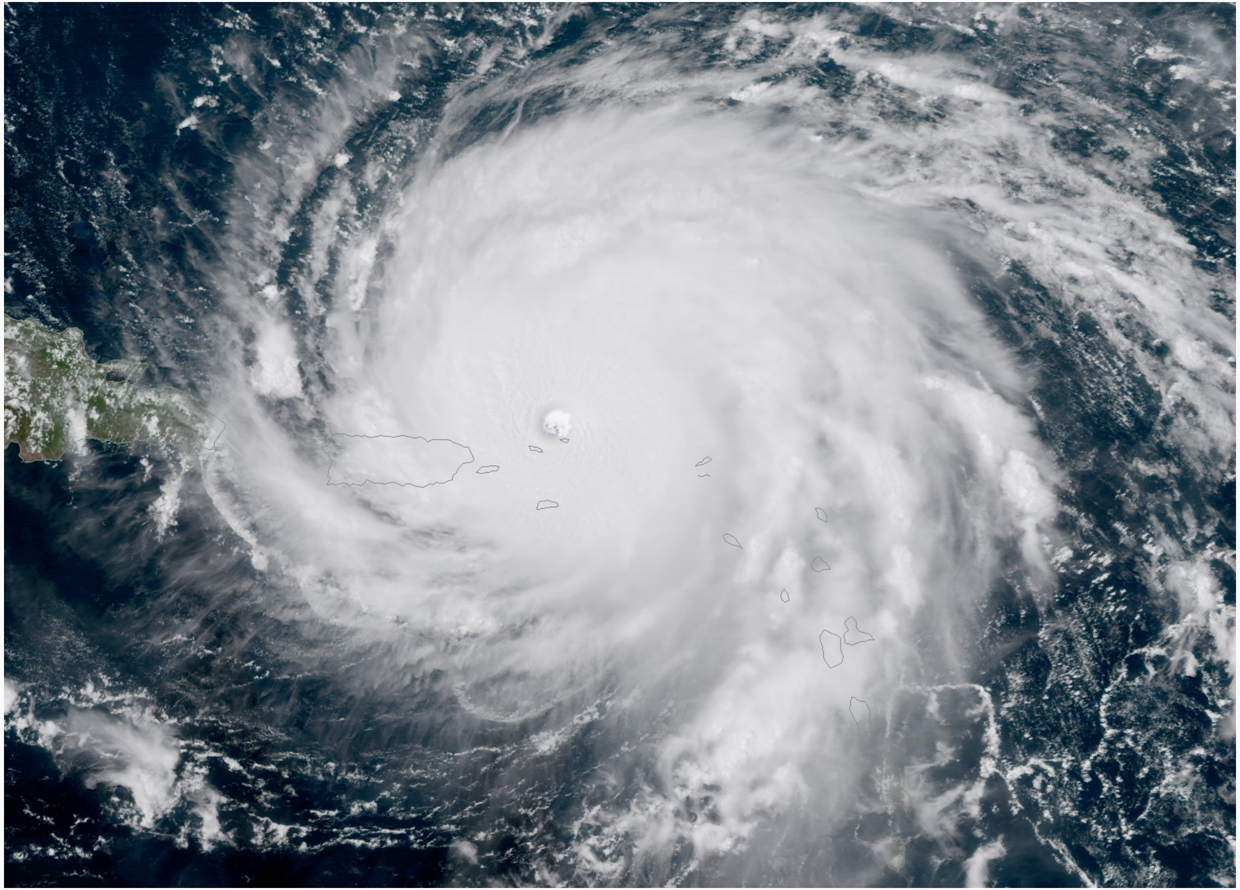
D-Region Absorption 06 Sep 2017



Impact on WSPR Network



Hurricane + Solar Flare = ?

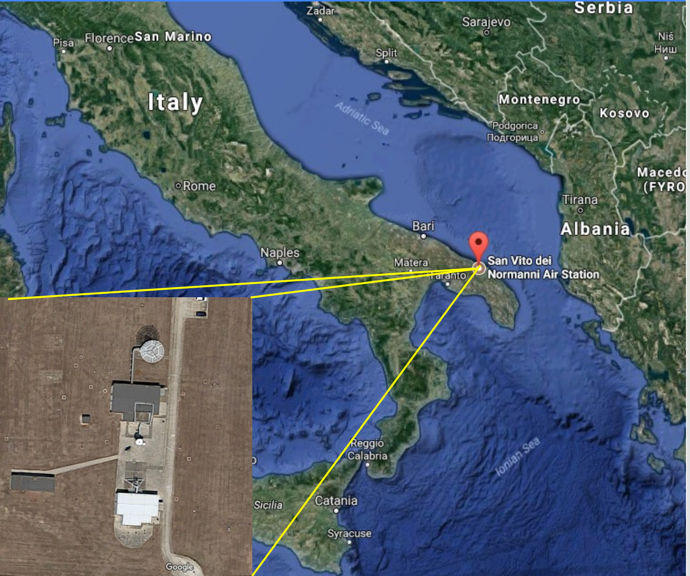


"...I'm not sure how long this blackout will last, but, **these flares could not happen at a worse time. We are looking at 3 hurricane threatening land and we cannot make contact with anyone on the 20 meter or 40 meter amateur bands…"**

Mother Nature is not playing well.

Solar Radio Burst Activity 06 Sep 2017

Solar Radio Burst reported by USAF optical/radio observatory at San Vito, Italy.



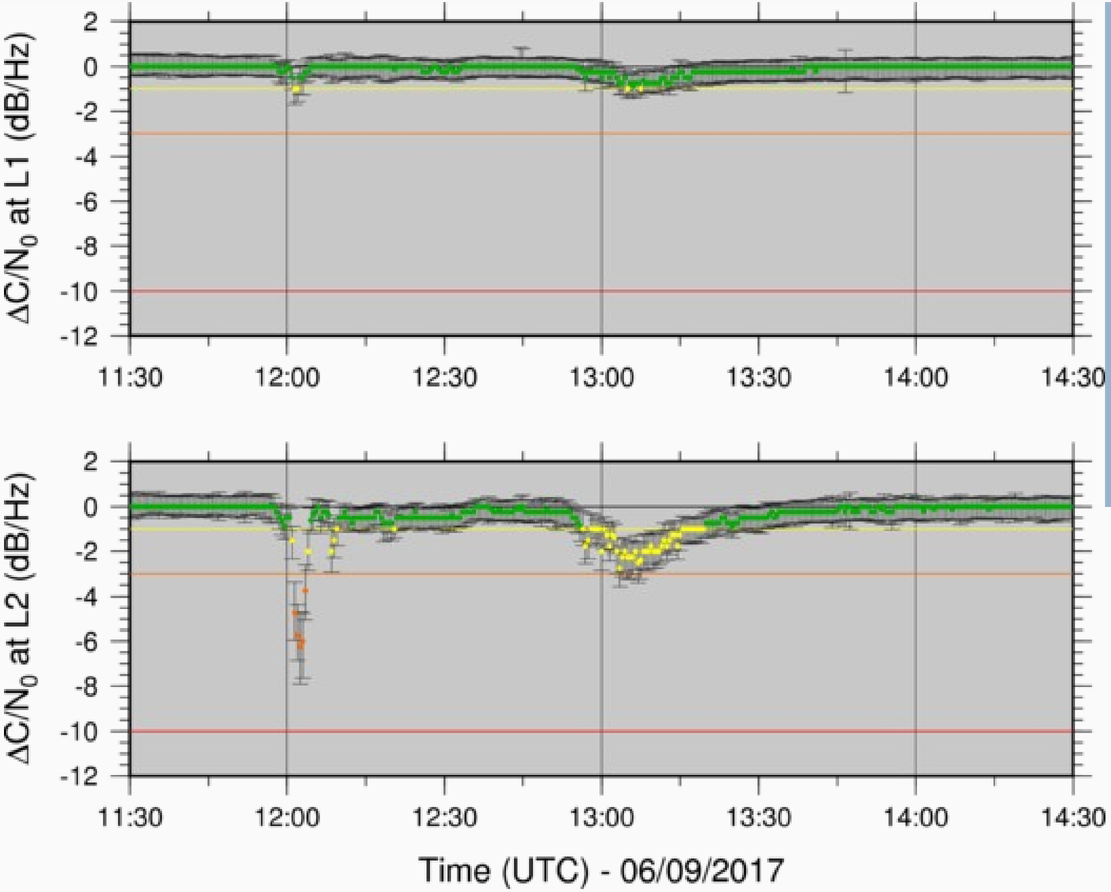

```
:Product: 20170906events.txt
:Created: 2017 Sep 09 0357 UT
:Date: 2017 09 06
# Prepared by the U.S. Dept. of Commerce, NOAA, Space Weather Prediction Center
# Please send comments and suggestions to SWPC.Webmaster@noaa.gov
#
# Missing data: ////
# Updated every 5 minutes.
#                       Edited Events for 2017 Sep 06
#
#Event    Begin    Max       End  Obs  Q  Type  Loc/Frq   Particulars       Reg#
#-------------------------------------------------------------------------------

7160       0000    ////      0433  PAL  C   RSP  025-180   VI/1

7340 +     1153   1202      1210  G15  5   XRA  1-8A      X9.3    5.7E-01   2673
7340 +     1154   1156      1432  SVI  G   RBR  2695      14000   CastelliU 2673
7340 +     1154   1156      1351  SVI  G   RBR  15400     8100    CastelliU 2673
7340 +     1155   1202      1232  SAG  G   RBR  410       6300    CastelliU 2673
7340 +     1155   1156      1356  SVI  G   RBR  8800      6500    CastelliU 2673
7340 +     1156   1157      1405  SVI  G   RBR  4995      5900    CastelliU 2673
7340 +     1156   1202      1424  SVI  G   RBR  1415      19000   CastelliU 2673
7340       1157   ////      1202  SVI  C   RSP  025-170   III/2             2673
7340 +     1158   1202      1232  SAG  G   RBR  610       9400    CastelliU 2673
7340 +     1201   ////      1515  SVI  C   RSP  025-180   IV/2              2673
7340 +     1202   1203      1411  SVI  G   RBR  245       3200    CastelliU 2673
7340       1202   ////      1208  SAG  C   RSP  025-061   VI/1              2673
7340       1202   ////      1221  SVI  C   RSP  025-081   II/2    1765      2673

7790      B1224   ////     A1630  SOH  4   CME  XUV,EUV,UV227-226/FS1429    2673
```

Summary of Radio Burst Impact to GPS - 06 September from ROB

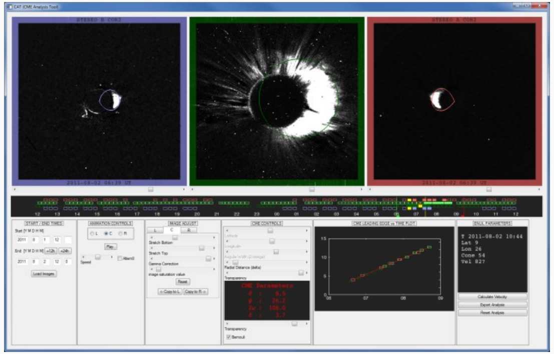


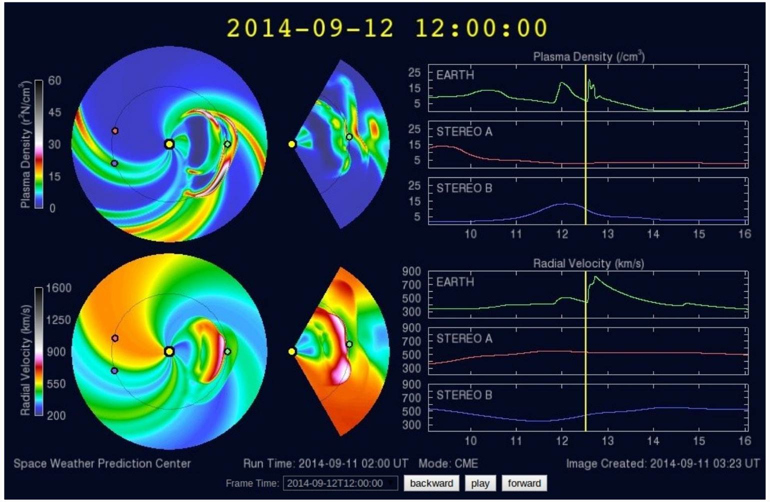
[Royal Observatory of Belgium GNSS Research Group]

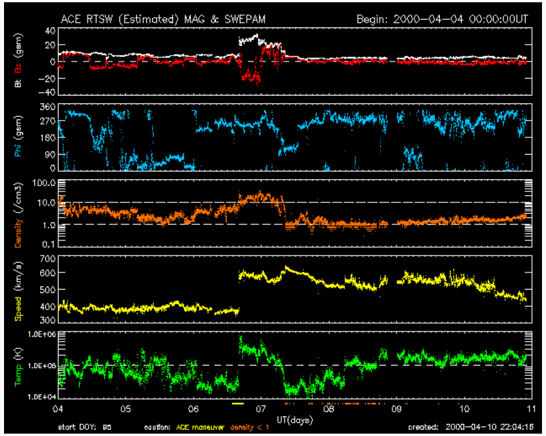
IMPACT OF THE EVENT:

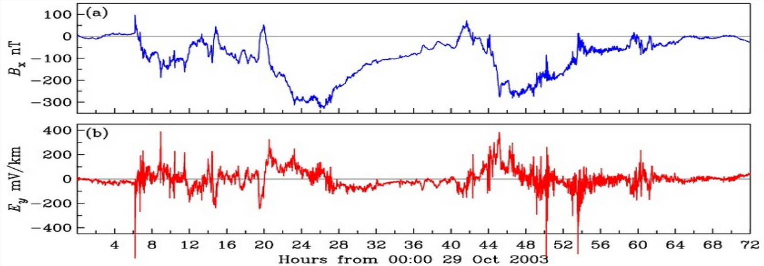
- On L1, two fades above 1dB/Hz were detected at 12h01 and 12h05.
- On L2, a first fade above 3dB/Hz which could potentially affect the GNSS application, occurred for 3 min with a maximum of -6.25±1.6dB/Hz at 12h02.
- It was followed by a second lower fade above 1dB/Hz at 13h03.

Geomagnetic Storm Forecasting

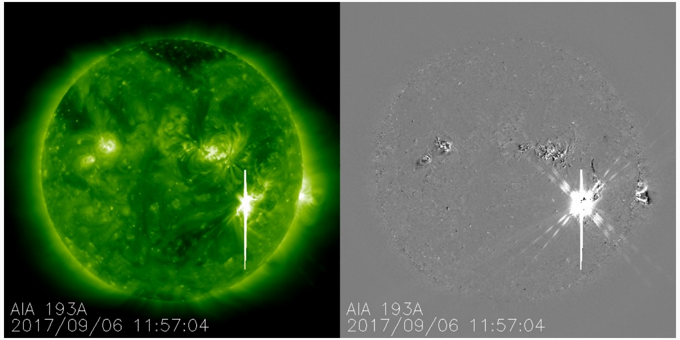


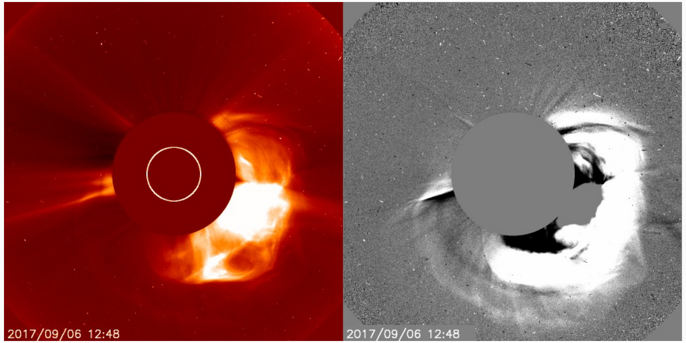






06 September CME





A. NOAA Geomagnetic Activity Observation and Forecast

The greatest observed 3 hr Kp over the past 24 hours was 4 (below NOAA Scale levels).
The greatest expected 3 hr Kp for Sep 07-Sep 09 2017 is 7 (NOAA Scale G3).

NOAA Kp index breakdown Sep 07-Sep 09 2017

	Sep 07	Sep 08	Sep 09
00-03UT	4	5 (G1)	7 (G3)
03-06UT	6 (G2)	6 (G2)	6 (G2)
06-09UT	7 (G3)	5 (G1)	5 (G1)
09-12UT	5 (G1)	4	4
12-15UT	5 (G1)	4	4
15-18UT	4	6 (G2)	4
18-21UT	4	6 (G2)	4
21-00UT	4	7 (G3)	4

Rationale: G3 (Strong) geomagnetic storm levels are likely for the next three days (07-09 Sep) as a result of an inbound CME from 04 Sep, followed by the arrival of the CME associated with the X9 flare, mid-to-late on day two (08 Sep).

Geospace

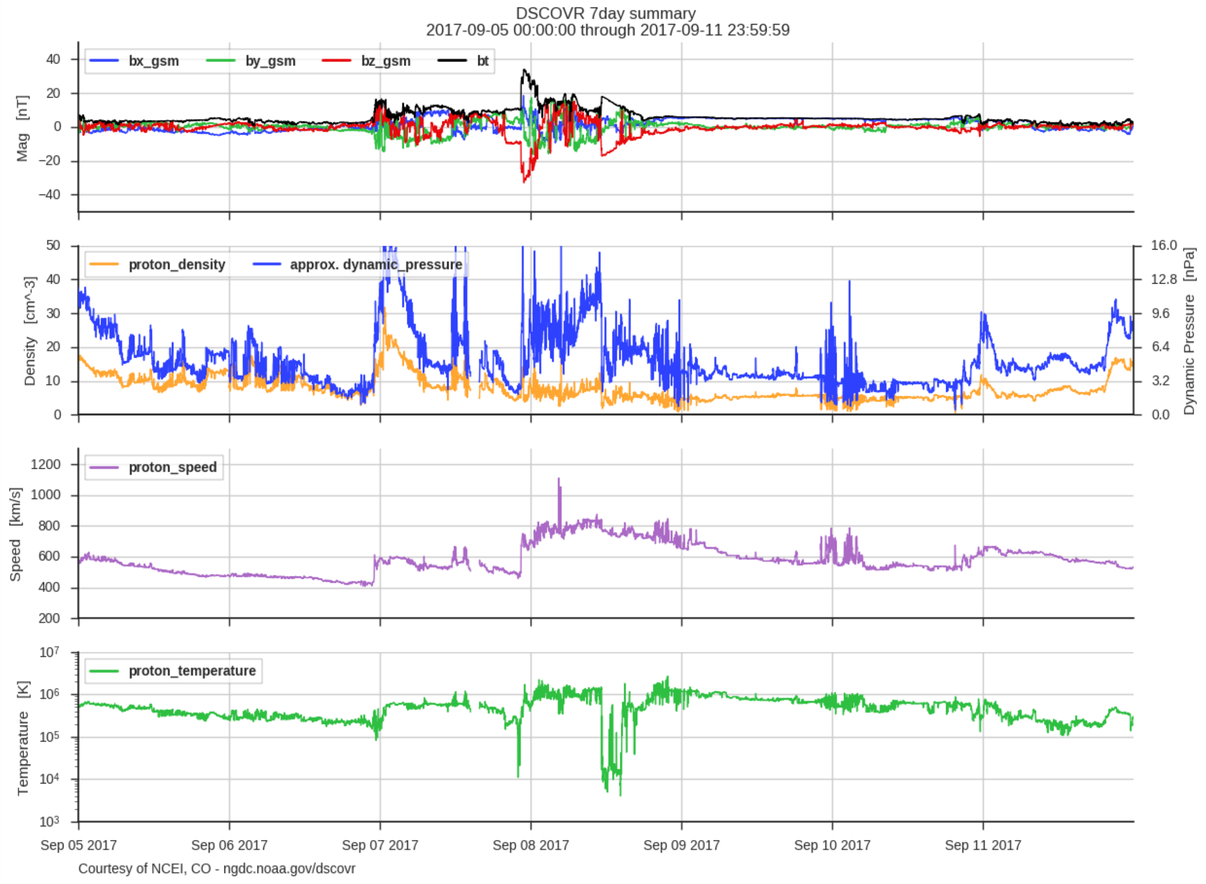
Sept 7, 2017 0030 UTC Forecast

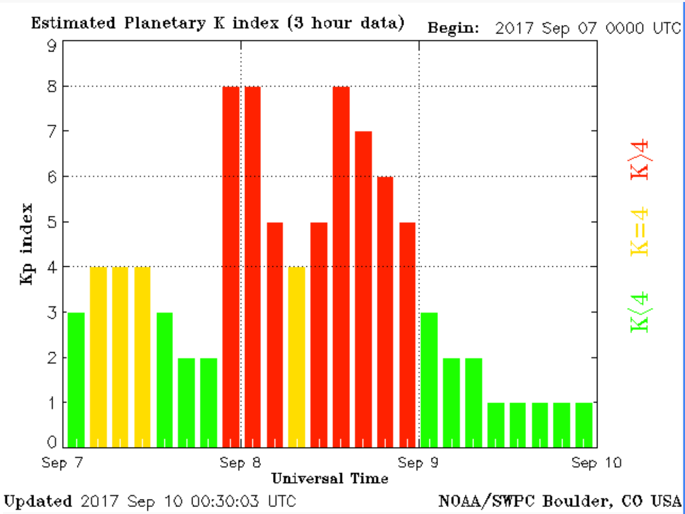
.24 hr Summary...
The geomagnetic field was quiet to unsettled, with an isolated active period the last synoptic period of the day.

.Forecast...
G3 (Strong) geomagnetic storm levels are likely for the next three days (07-09 Sep) as a result of an inbound CME from 04 Sep, followed by the arrival of the CME associated with the X9 flare, mid-to-late on day two (08 Sep).

SOHO LASCO Halo CME Record

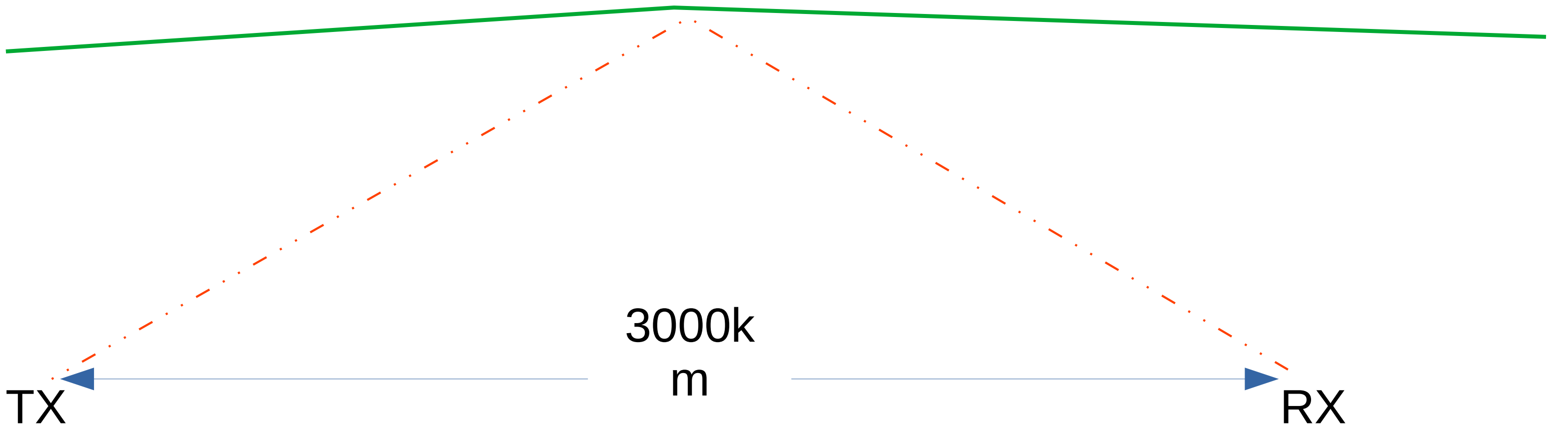
Solar Wind Environment 05-11 September, 2017





What? - MUF Defined

University of Colorado Boulder



“The Maximum Usable Frequency (MUF) is then the product of critical frequency and an appropriate transmission factor M for a given distance d, MUF (d) = M (d) × fp.

For example, the instantaneous MUF for a 3000 km circuit is simply given by MUF(3000)F2 = M(3000)F2 × foF2” *Ionospheric Space Weather, Cander, 2019*

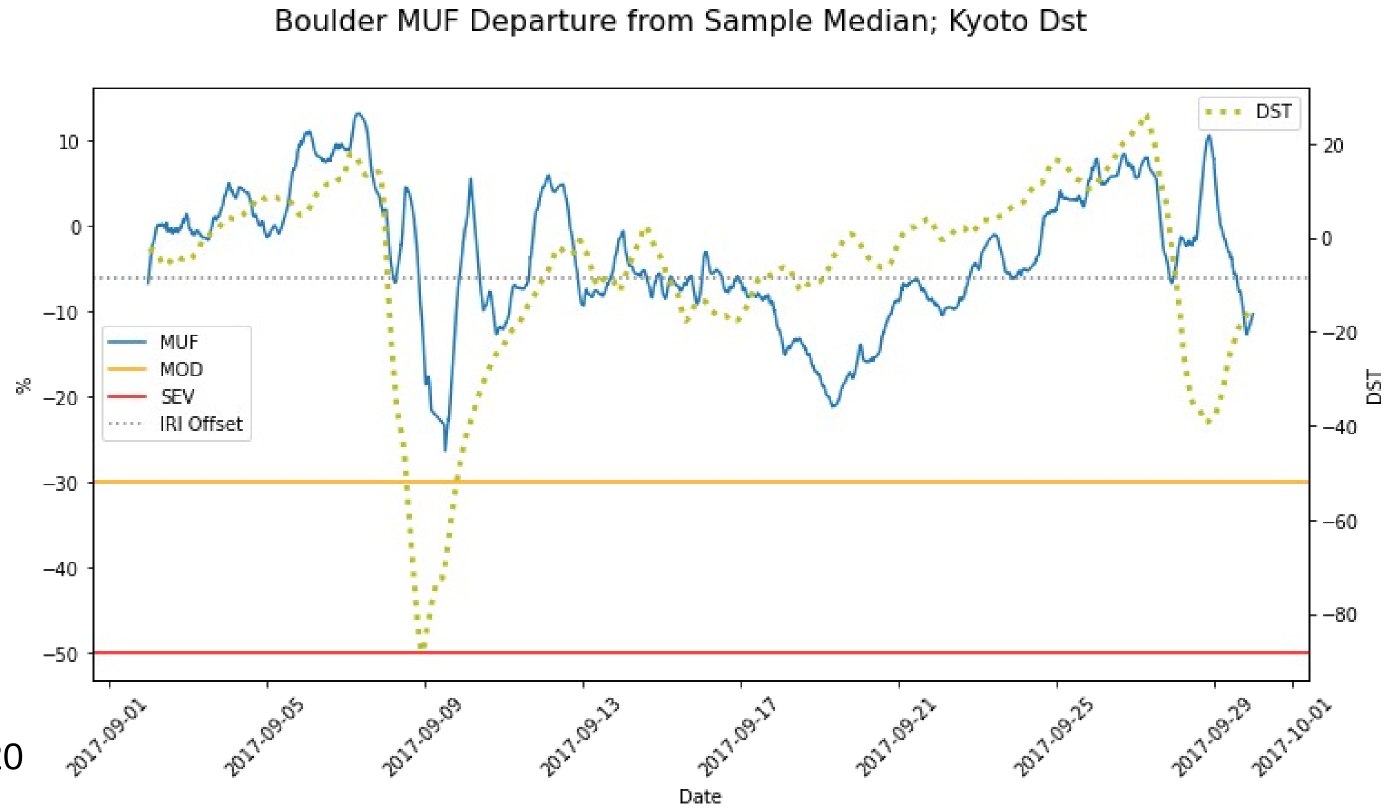
What? MUF and Geomagnetic Storms

University of Colorado Boulder

Geomagnetic Storms	Positive Phase	Negative Phase
Neutral Winds	Meridional winds push plasma up B-field lines into regions of lower molec neutrals; decreased loss rate of e^-	Upwelling of molec neutrals into F-region; increased loss rate of e^-
E-Fields	Eastward E-field, upward vertical motion; decreased loss rate of e^-	Energy deposition / heating increases loss rate of e^-
Neutral Composition Change	O/N^2 increasing	O/N^2 decreasing

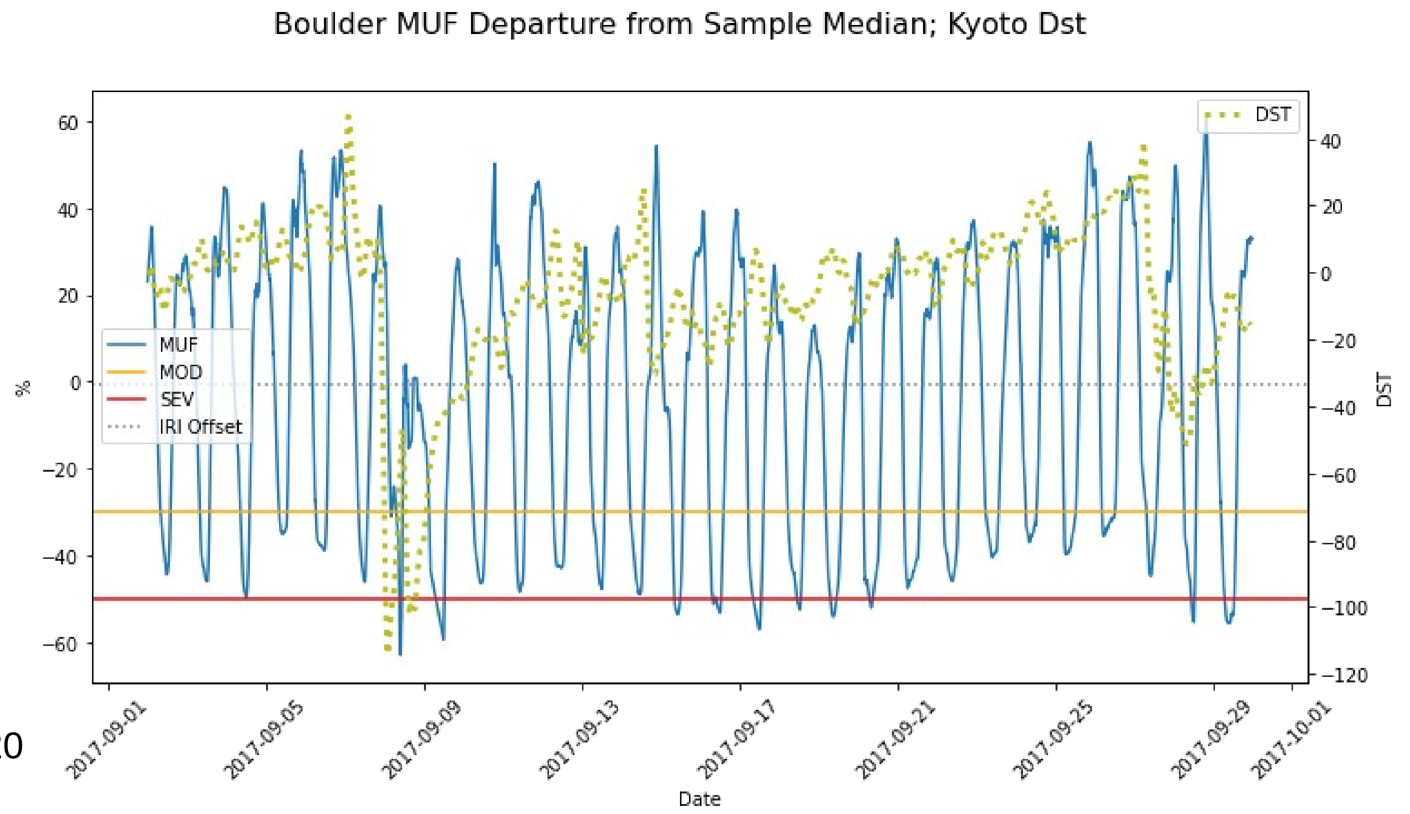
Case Study: September 2017 Storm

University of Colorado Boulder



Case Study: September 2017 Storm

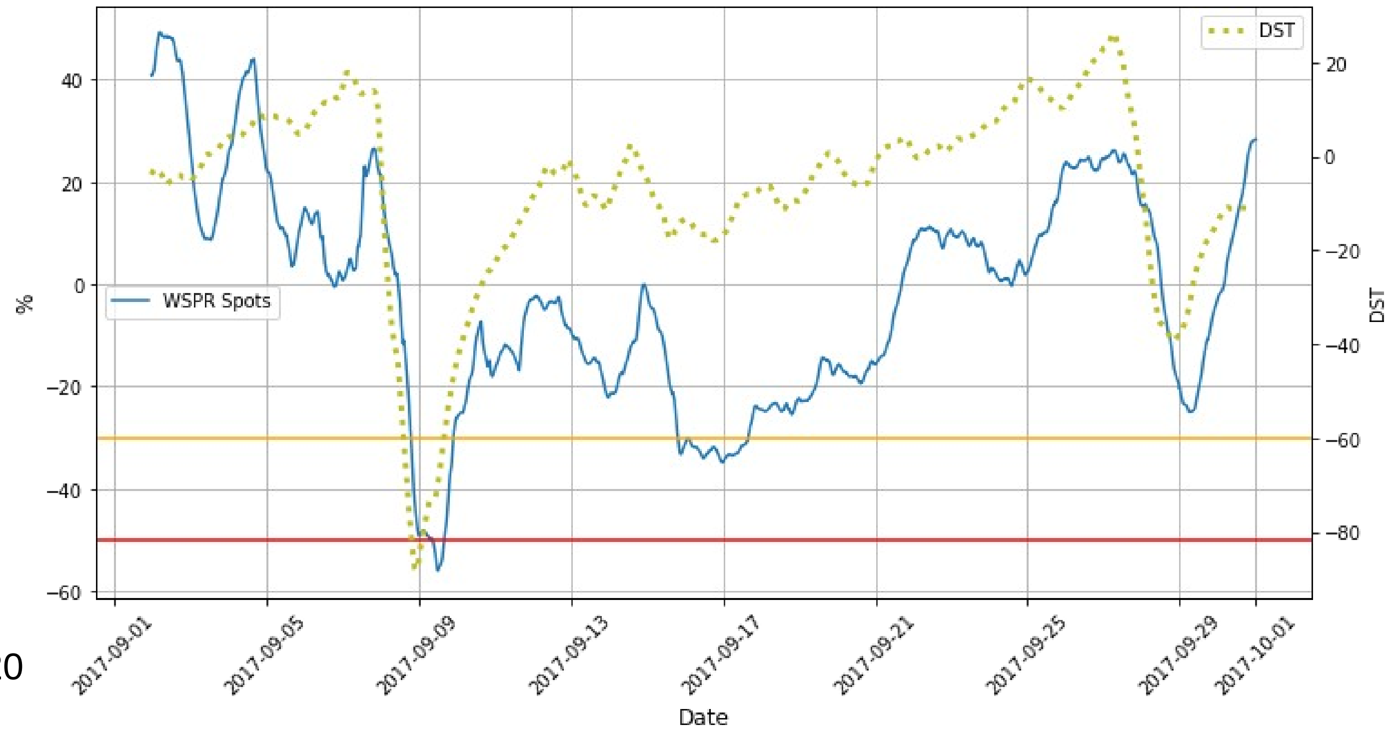
University of Colorado
Boulder



Case Study: September 2017 Storm

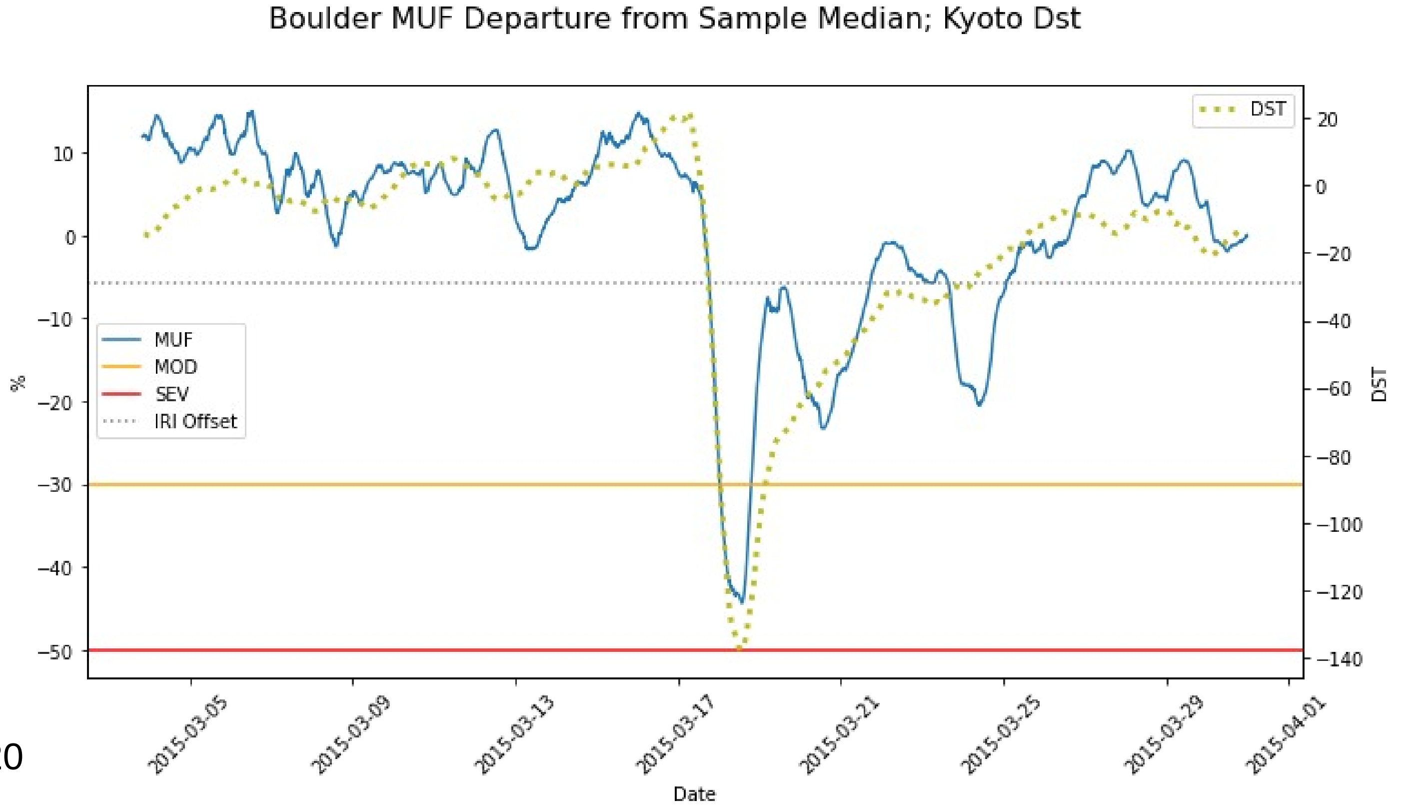
University of Colorado Boulder

WSPR Spots Departure from Sample Median; Kyoto Dst



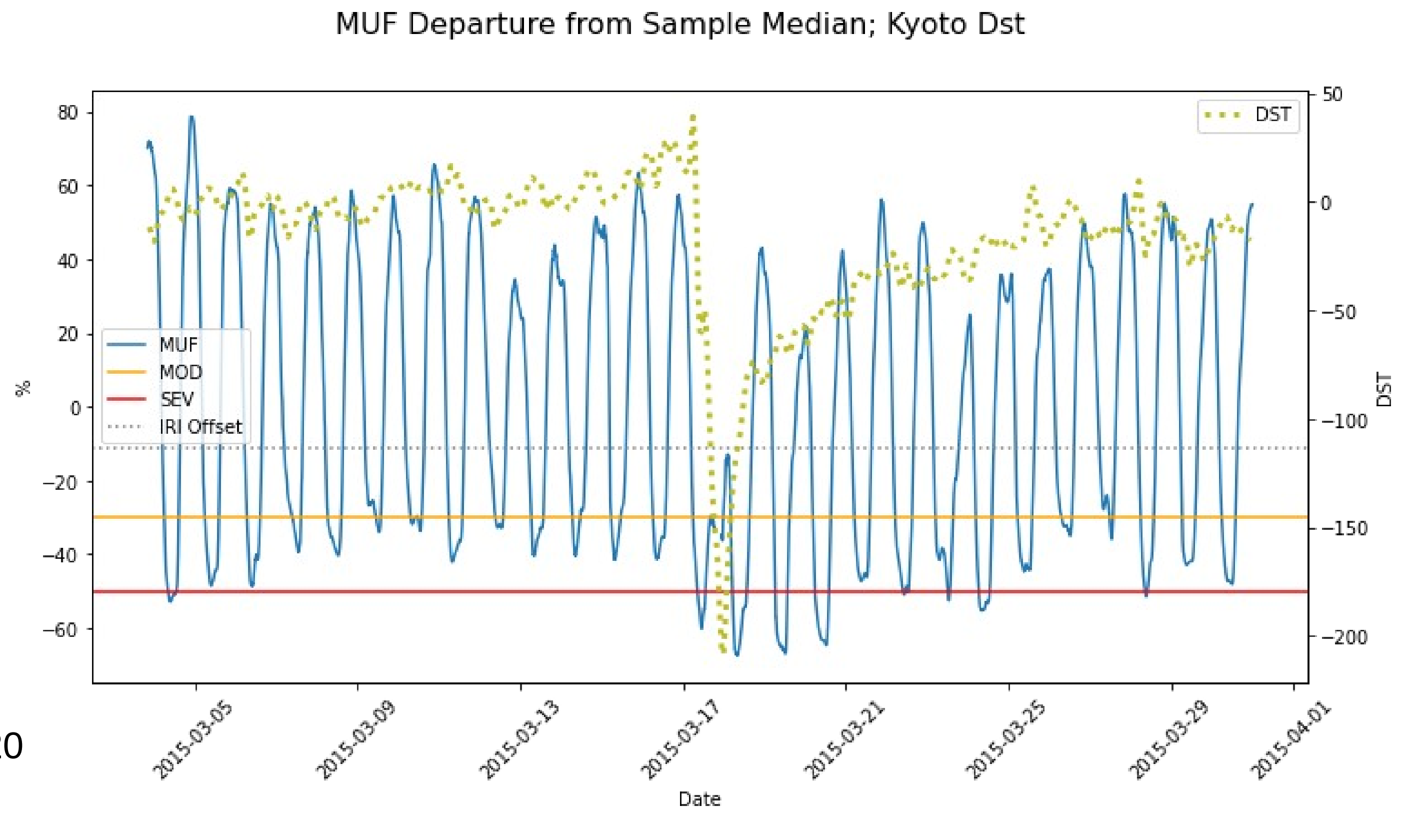
March 2015 St Patrick's Day Storm

University of Colorado Boulder



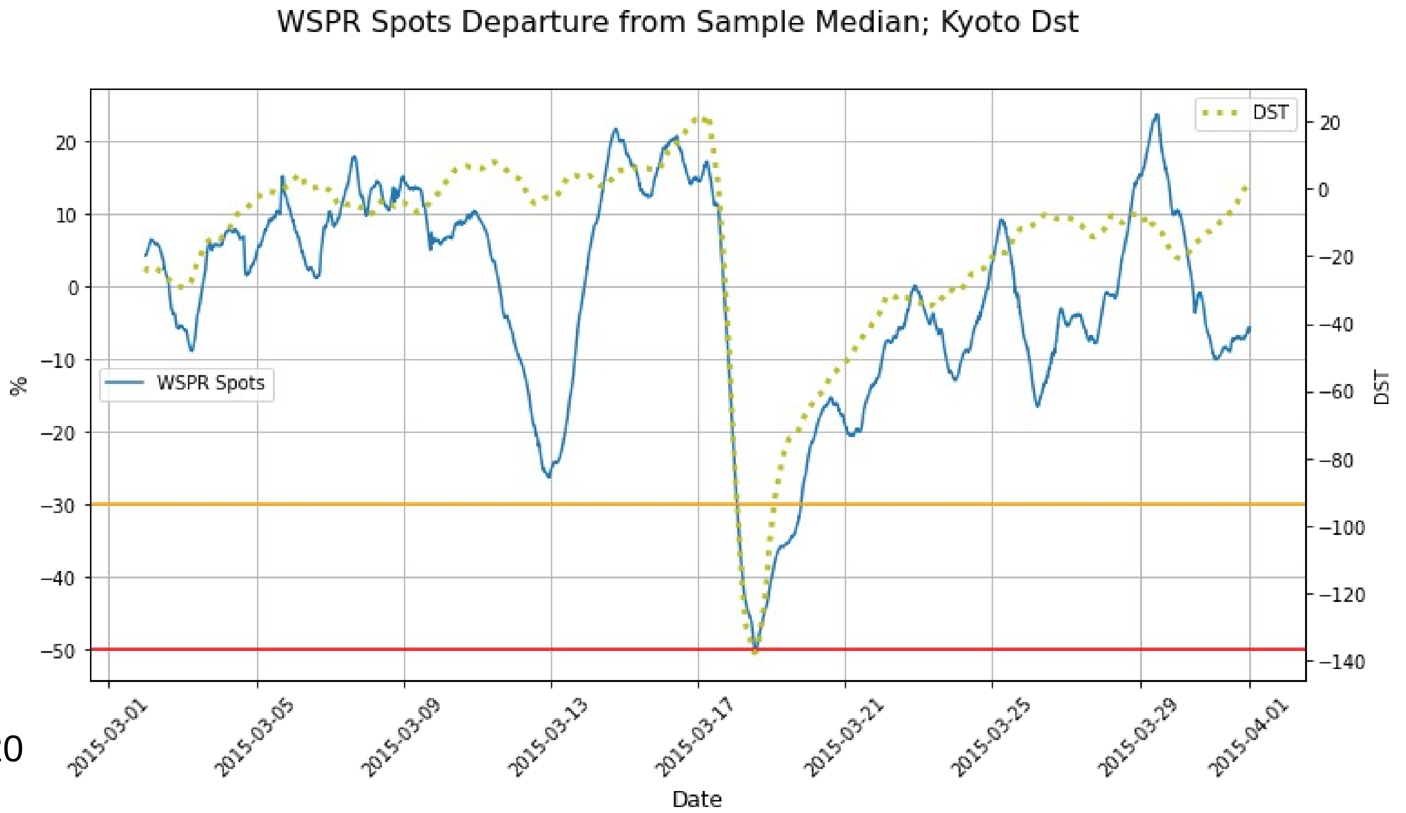
March 2015 St Patrick's Day Storm

University of Colorado
Boulder



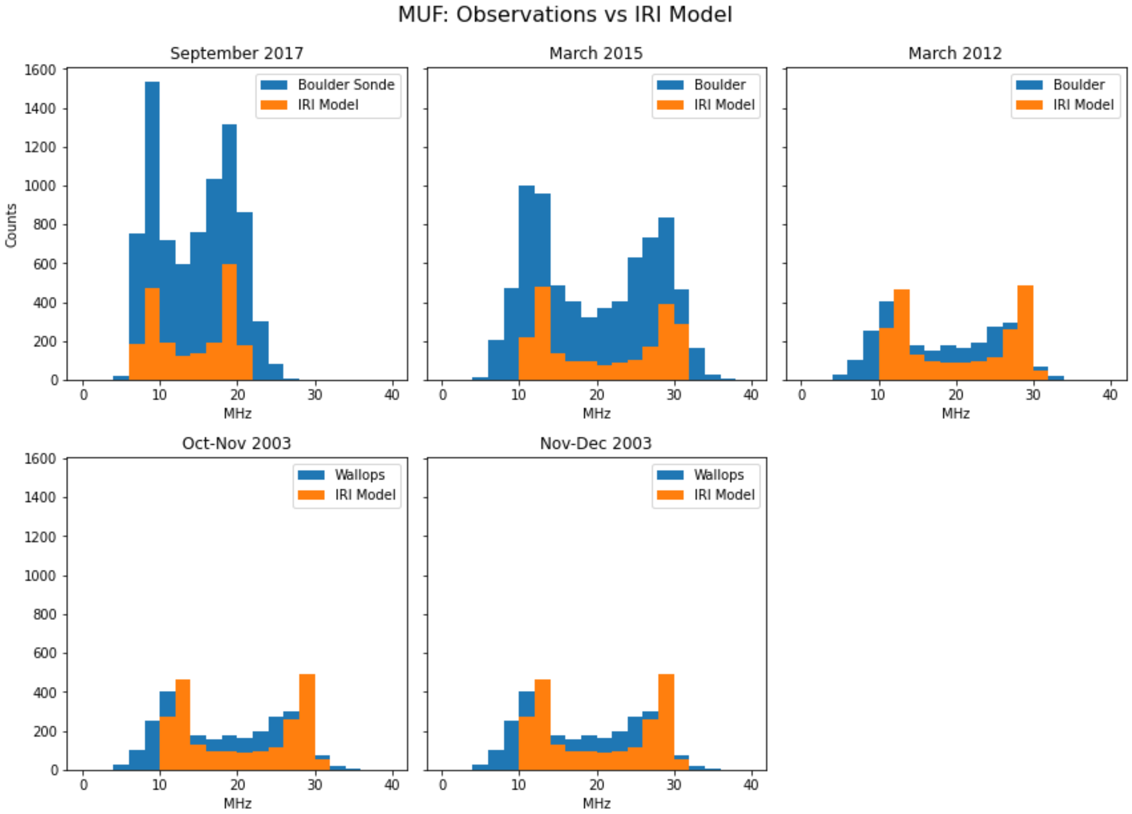
March 2015 St Patrick's Day Storm

University of Colorado Boulder

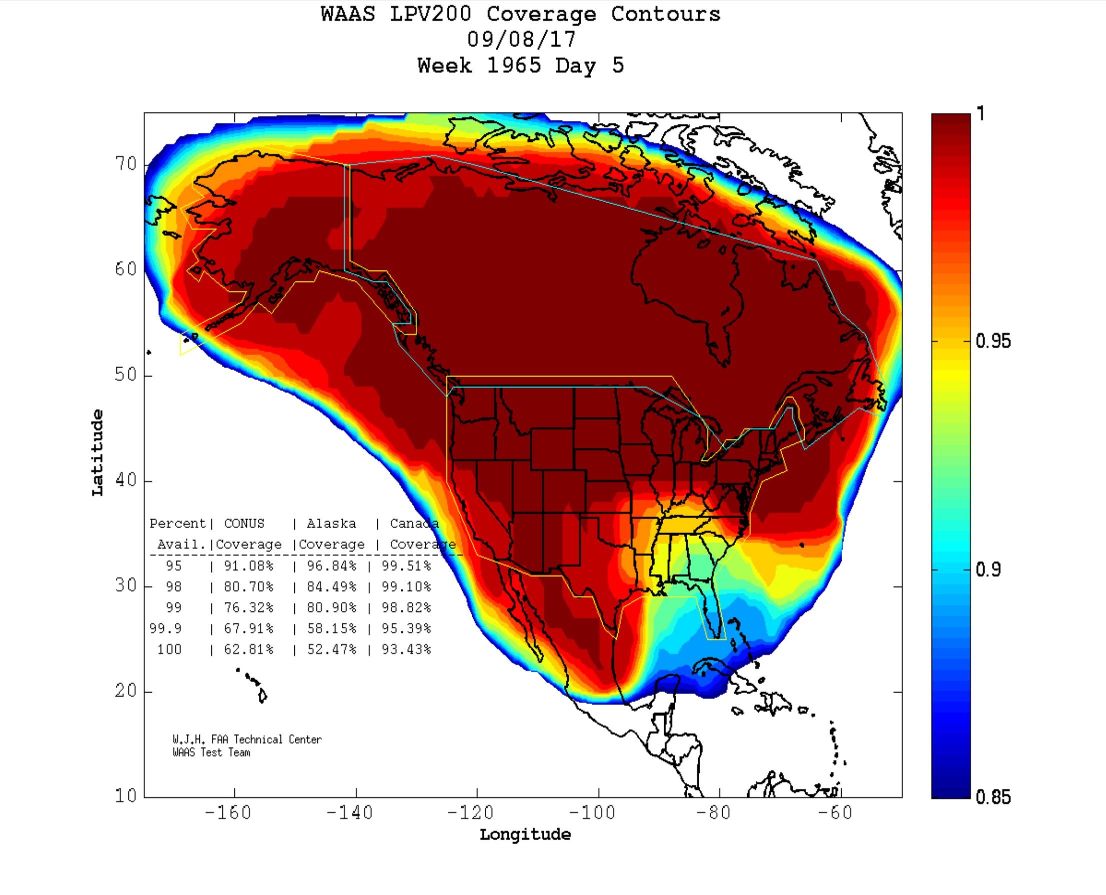


Case Study: Observations vs IRI

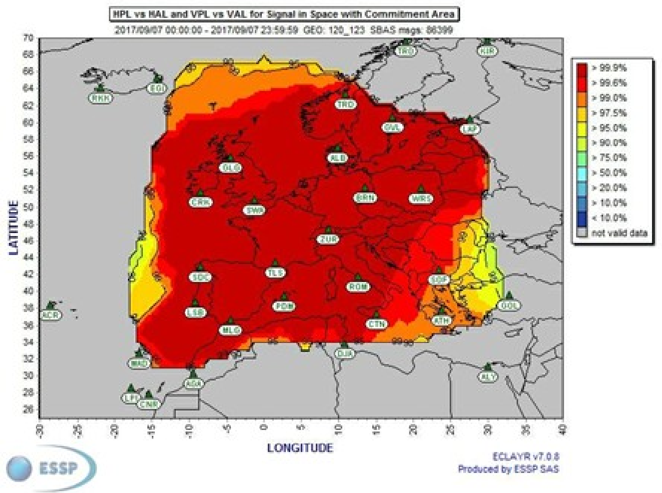
University of Colorado Boulder

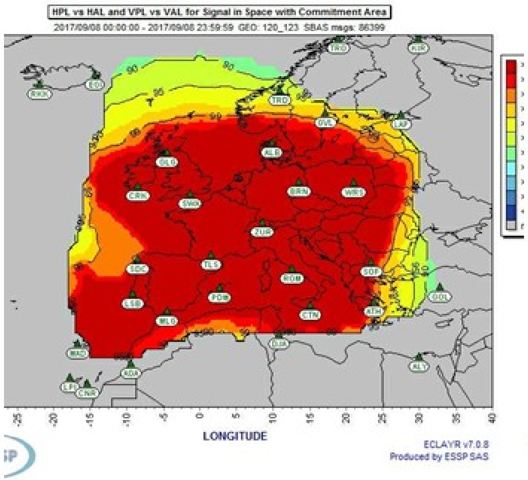


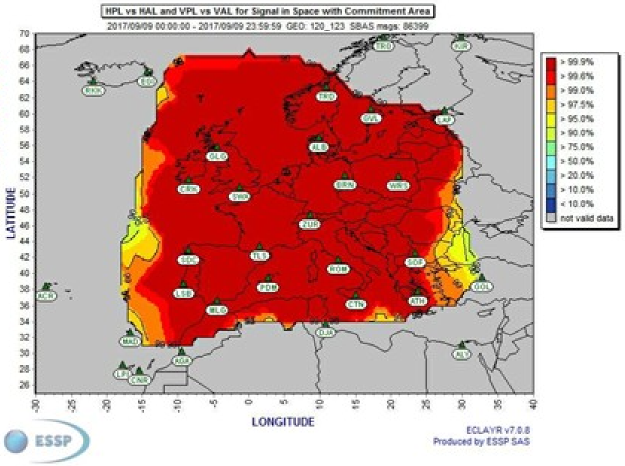
Localizer Performance with Vertical Guidance coverage 08 September 2017



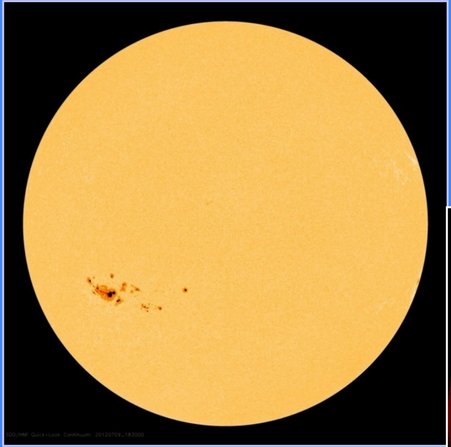
European Geostationary Navigation Overlay Service (EGNOS) performance



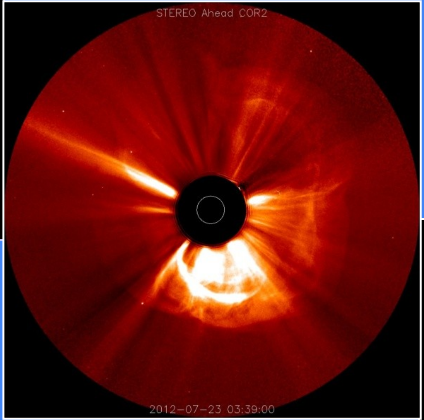


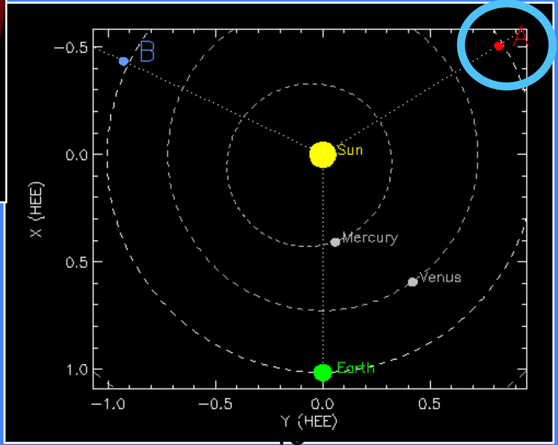


July 23, 2012 Close Call

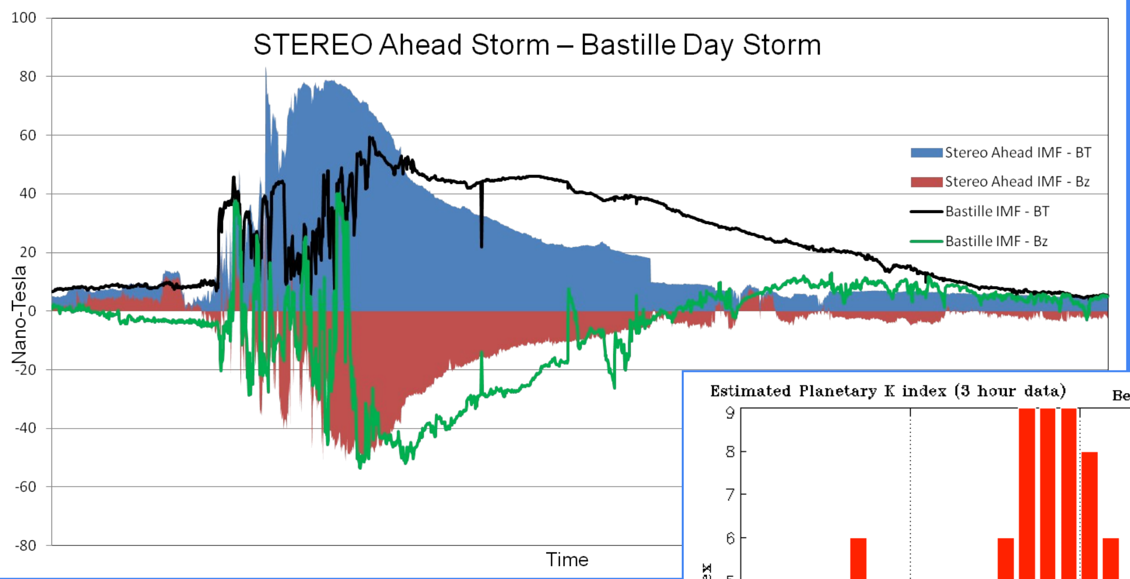


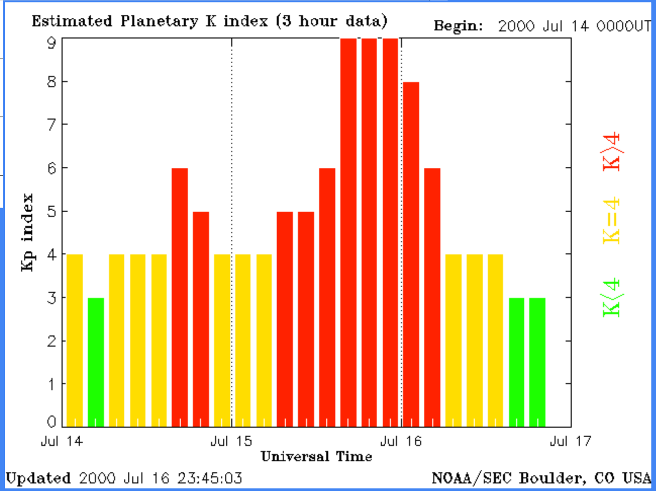
Region 1520





July 23, 2012 STEREO vs July 2000 Earth

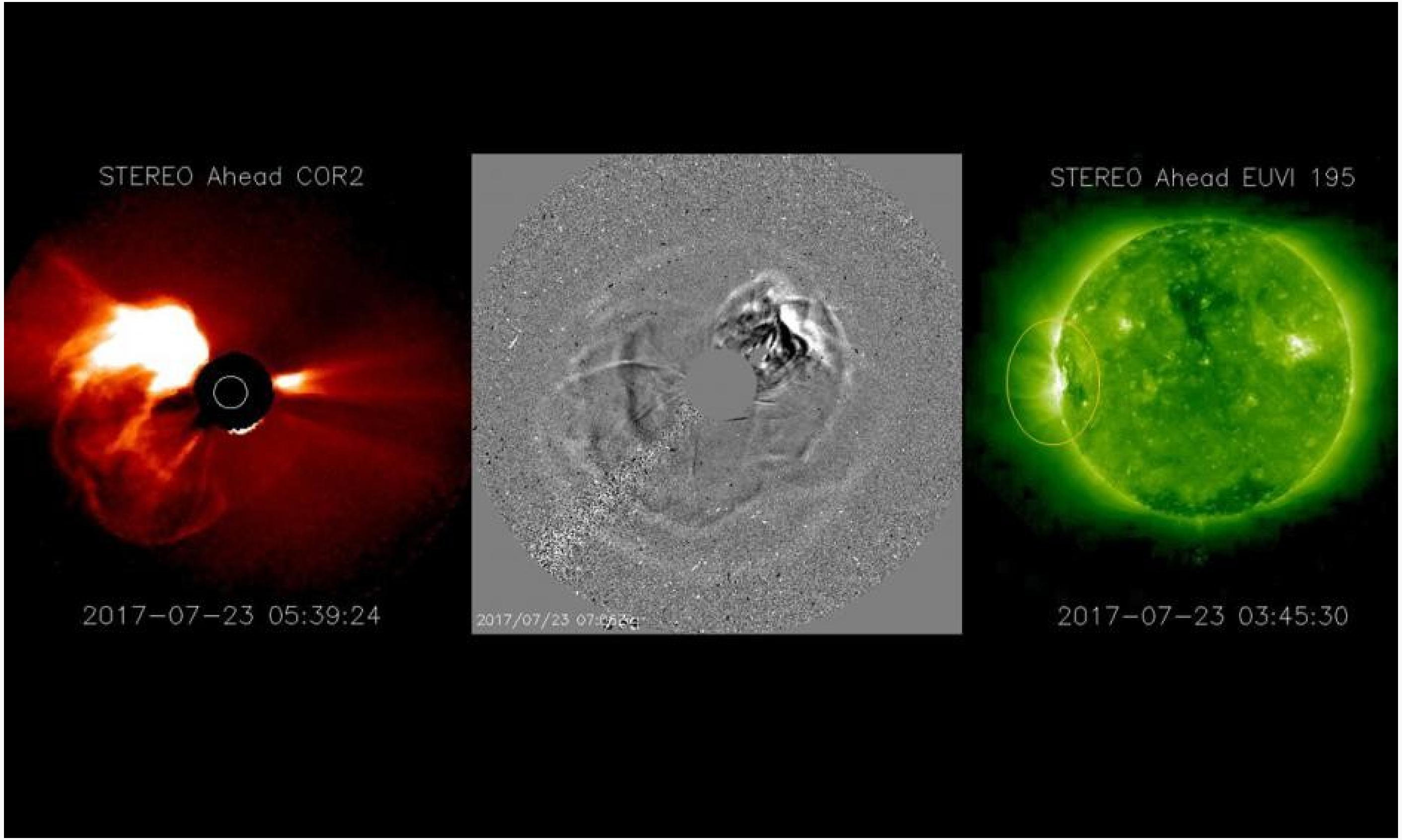




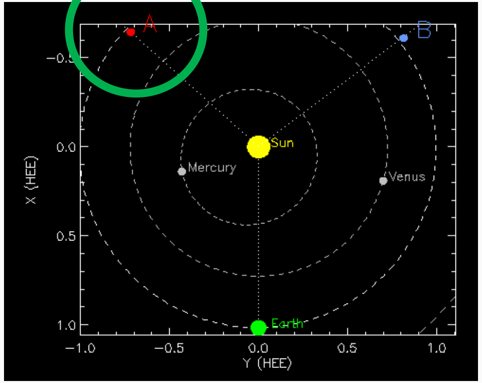
"If it had hit, we would still be picking up the pieces,"

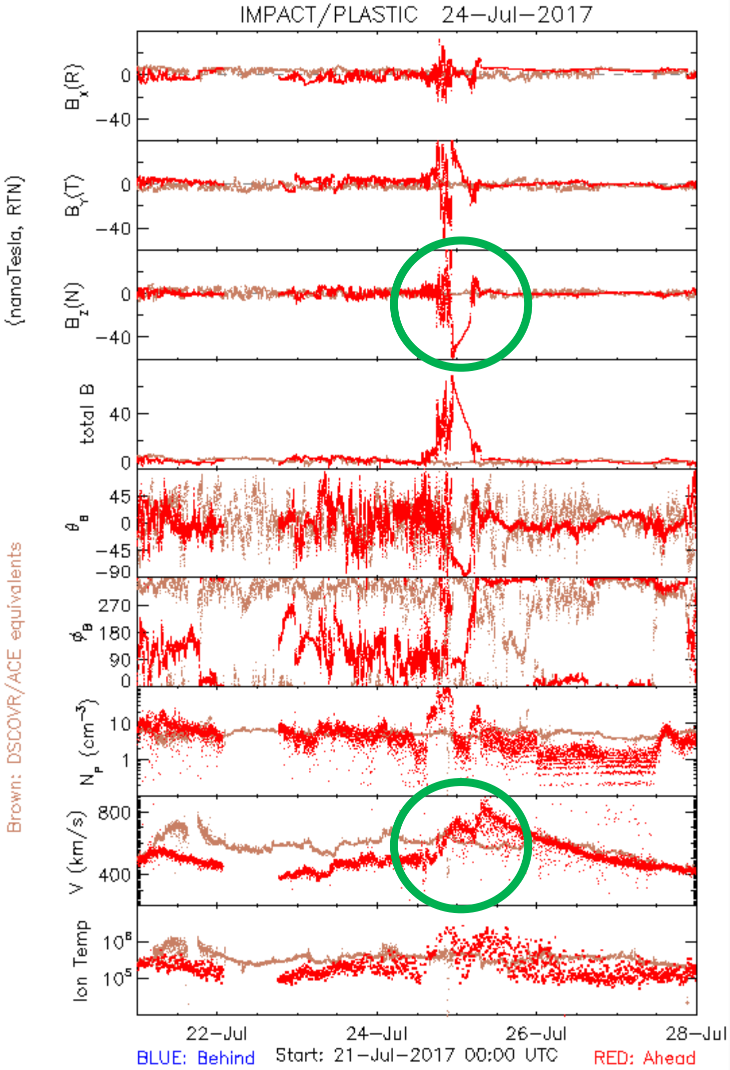
Daniel Baker, University of Colorado.

July 23, 2017 Far Side CME



CME Impact STEREO-A 24-25 July 2017





Tips for Radio Amateurs

So What? Hints from NA5N and QRPARCI

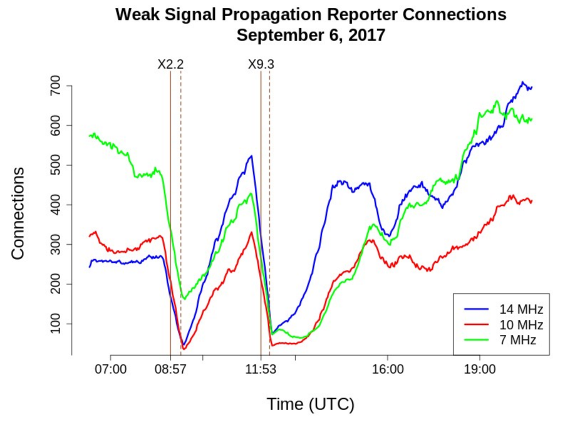
QRP Propagation Hint: If you're in a QSO when a major flare causes an HF blackout, it seldom lasts more than an hour. If you're working a contest, this hint could be useful. Take a break, but don't QRT!

These x-rays do provide extra ionization to the E/F layers for improved reflectivity and a higher MUF. Exploit the benefits of a solar flare.

QRP Propagation Hint: Good DX contacts are possible immediately following a solar flare until sundown due to the improved reflectivity (better signal-to-noise ratio for QRP signals) and the higher MUF opening the higher bands – especially during the solar minimum years.

QRP Propagation Hint: The most important thing to remember about a solar flare is this: the HF effects are generally *only for the duration of the flare event* (20-60 minutes) and seldom effect frequencies <10 MHz.

QRP Propagation Hint: Often our magnetic field gets very quiet following a strong geomagnetic storm for 12–24 hours. This is an excellent time to work 40–160M due to very low noise levels.



QRP Propagation Hint: Use the current ***K-Index*** from WWV or the internet to determine the current geomagnetic conditions. The ***A-Index*** is actually ***yesterday's*** geomagnetic condition, and does not represent present conditions.

So What? Tips for the Radio Amateur from NA5N, Paul Harden

A Few Final Thoughts

1. The ***solar flux***, indicating the level of ionization, affects HF propagation ***above*** about 10 MHz. The solar flux does not affect 40M and below, since the MUF seldom drops below 10 MHz. This is why the lower bands are ***always*** open.
2. The ***K-index***, indicating the geomagnetic condition, indicates HF noise primarily ***below*** about 10 MHz, except in severe cases. During a storm, high noise levels on 40M doesn't mean high noise on 20M.
3. 30M is the ham band caught between the 2 worlds. It can be affected by both solar flux and the K-index. On the other hand, it is more often ***not*** bothered by either. It is a good band throughout the solar cycle.
4. Every solar flare and the resultant storm is different. No two are alike, nor accurately predictable.
5. Never let reports of flares or geomagnetic storms scare you from getting on the air and checking it out.

SPACE WEATHER PREDICTION CENTER
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Friday, August 13, 2021 18:13:41 UTC

HOME | ABOUT SPACE WEATHER | PRODUCTS AND DATA | DASHBOARDS | MEDIA AND RESOURCES | SUBSCRIBE | ANNUAL MEETING | FEEDBACK

Search

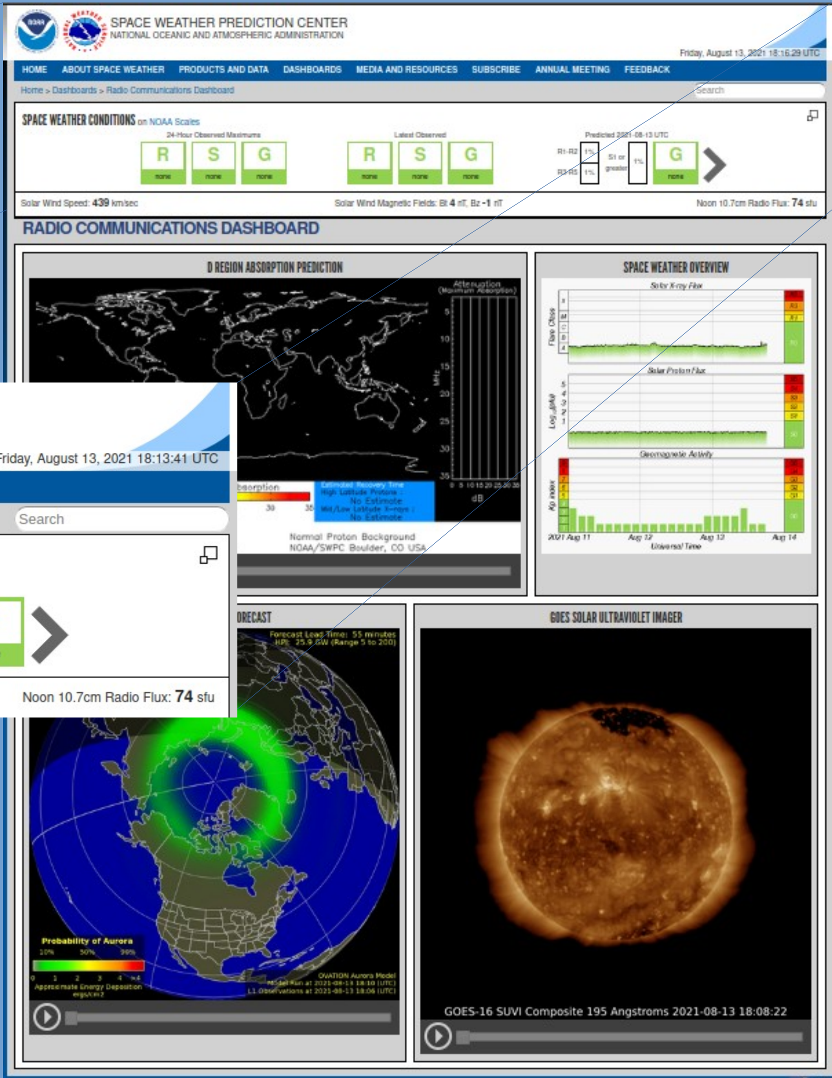
SPACE WEATHER CONDITIONS on NOAA Scales

24-Hour Observed Maximums			Latest Observed			Predicted 2021-08-13 UTC			
R	S	G	R	S	G	R1-R2 1%	S1 or greater	1%	G
none	none	none	none	none	none	R3-R5 1%			none

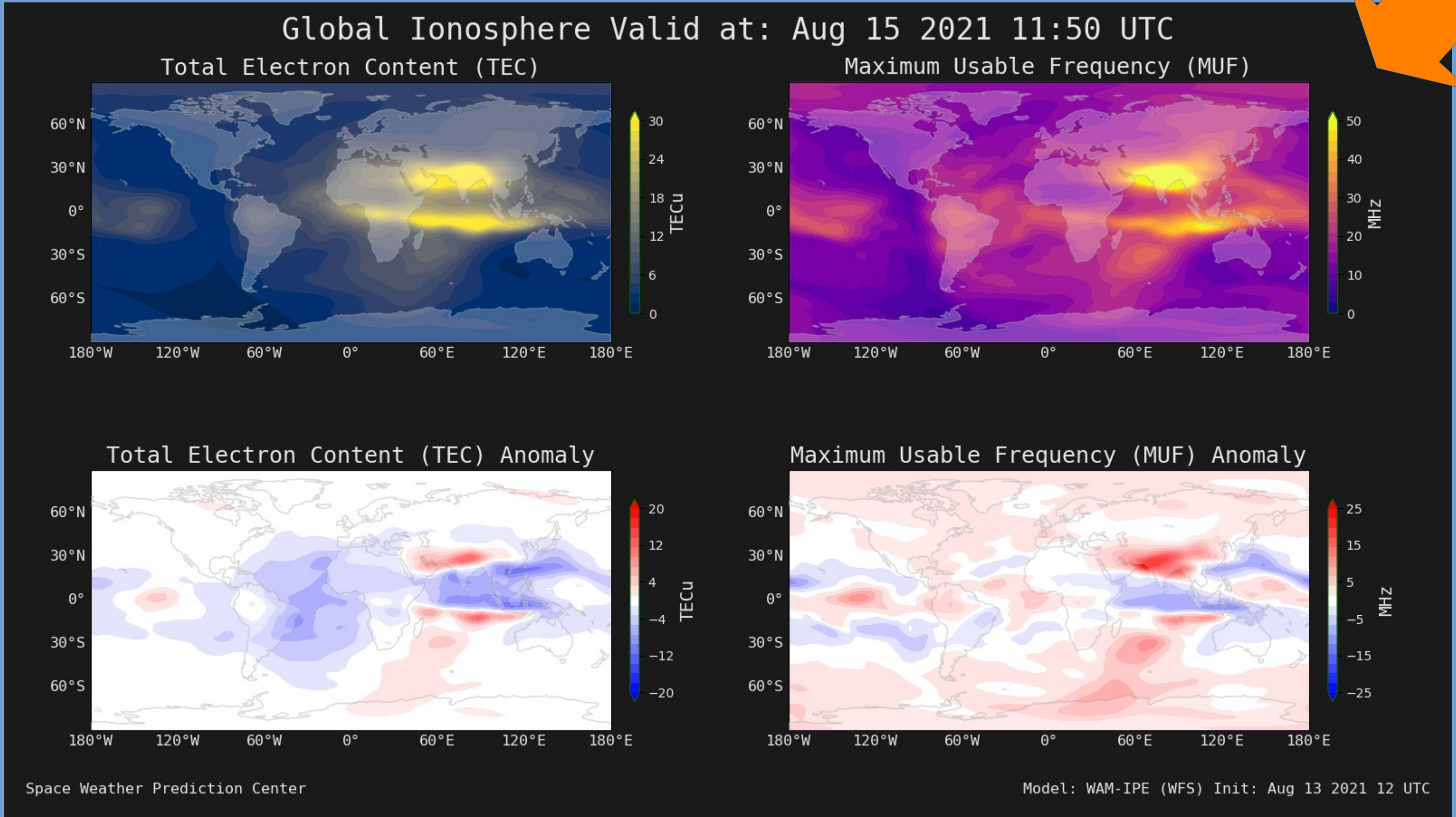
Solar Wind Speed: **437** km/sec

Solar Wind Magnetic Fields: Bt **4** nT, Bz **0** nT

Noon 10.7cm Radio Flux: **74** sfu



WAM-IPE Model

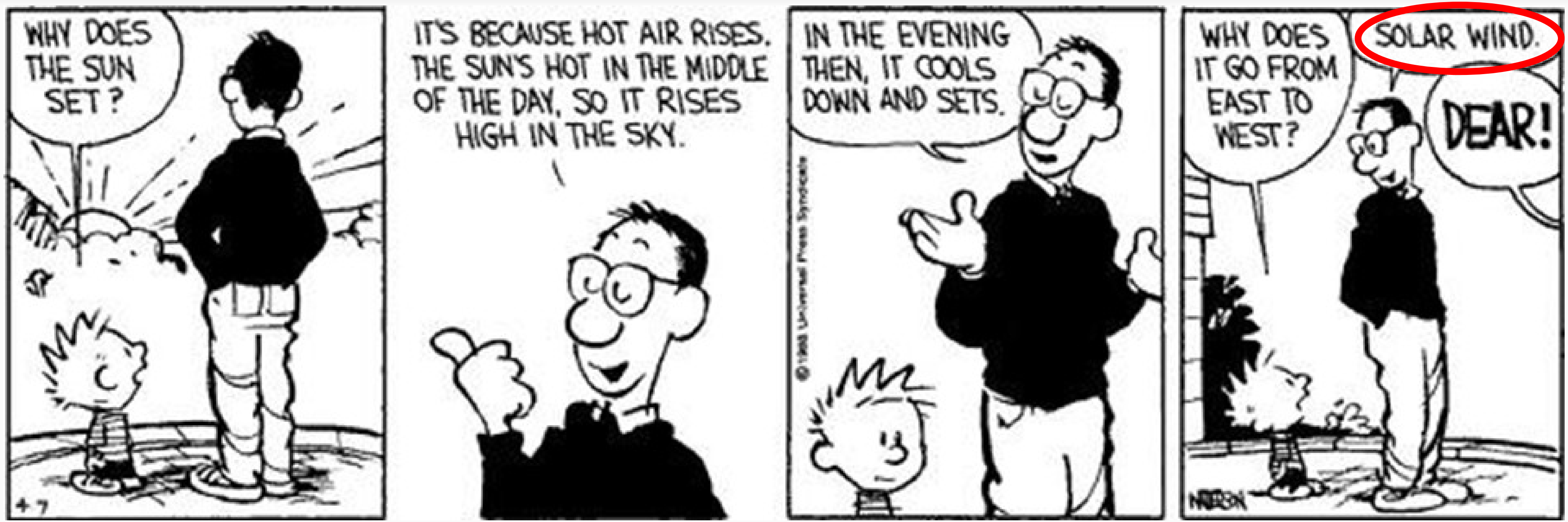


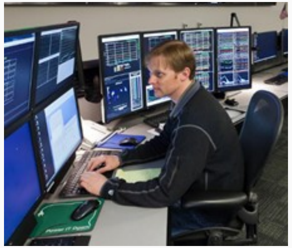
```
: Product : adapt_f10_forecast.txt
: Created : 2021 08 13 1805 UT
: Date : 2021 08 13
: DOY : 225
: Model: ADAPT/SIFT-Adjusted F10.7
: SIFT Version :  1.10
: ADAPT Version : 2.01
: POC : Carl Henney (USAF/AFRL)
: POC Email:adapt@nso.edu
: Data Input : GONG (NSO/NISP)
: Resolution [deg / pixel] :  1.00
: Fit-function : m0 + m1*M_P + m2*M_A
: M_P (plage mag-field) Lower Limit [G] :  20.0
: M_A (active region mag-field) Lower Limit [G] : 150.0
: Record Count : 15
#
#| Table Notes
#
#   JD - Julian Date
#    M - Missing = 0 - forecast available
#                = 1 - forecast missing or pending
#    Q - Quality = 0 - good: input data nominal
#                = 1 - pending or missing (M=1)
#                = 2 - poor: large diff, but applied to forecast
#                = 3 - bad: possible flare, diff not applied to forecast
#                = 4 - poor: model values lower than expected
#                = 5 - poor: >1 day w/o mag; >0.25 day w/o obs
#                = 6 - bad: >2 day w/o mag or  >1.5 day w/o obs
#    H - Helioseismic data within forecast window:
#                = 0-none, 1-farside, 2-nearside, 3-both far & near
#   UT - forecast time, Coordinated Universal Time, HHMM format
#   LastMag - fractional days since last mag data assimilation
#   LastObs - fractional days since last Index obs differenced w/ 0d value
#   Diff - obs_model offset = (Index obs value) - (0-day model prediction)
#   Index Forecast - 0day, 1day, 3day, 7day model estimates plus diff offset
#
#| Observed Index Data Source
#
#   NRC of Canada w/ Canadian Space Agency:
#   ftp://ftp.seismo.nrcan.gc.ca/spaceweather/solar_flux/daily_flux_values/fluxtable.txt
#
#| ADAPT/SIFT - F10.7 Forecast [s.f.u. @ earth distance]
#
#      JD        M  Q  H   UT    LastMag  LastObs  Diff    0d     1d     3d     7d
#----------------------------------------------------------------------------------
  2459439.2500  0  0  0  1800    0.039    0.053    -0.5   73.5   74.9   77.5   83.9
  2459439.3333  0  0  0  2000    0.122    0.011    -0.1   73.6   74.9   77.4   84.1
  2459439.4167  0  0  0  2200    0.038    0.095    -0.7   73.6   75.2   77.6   84.0
  2459439.5000  0  0  0  0000    0.122    0.053    -0.3   73.6   74.9   77.9   84.0
  2459439.5833  0  0  0  0200    0.040    0.136     0.2   73.6   74.9   77.4   83.1
```

ADAPT F10.7 cm Flux Forecast

https://gong.nso.edu/adapt/sift/adapt_f10_forecast.txt

Questions?


WHY DOES THE SUN SET?
IT'S BECAUSE HOT AIR RISES. THE SUN'S HOT IN THE MIDDLE OF THE DAY, SO IT RISES HIGH IN THE SKY.
IN THE EVENING THEN, IT COOLS DOWN AND SETS.
WHY DOES IT GO FROM EAST TO WEST?
SOLAR WIND.
DEAR!



Radio Evolution – KA8JBY to AD0IU