

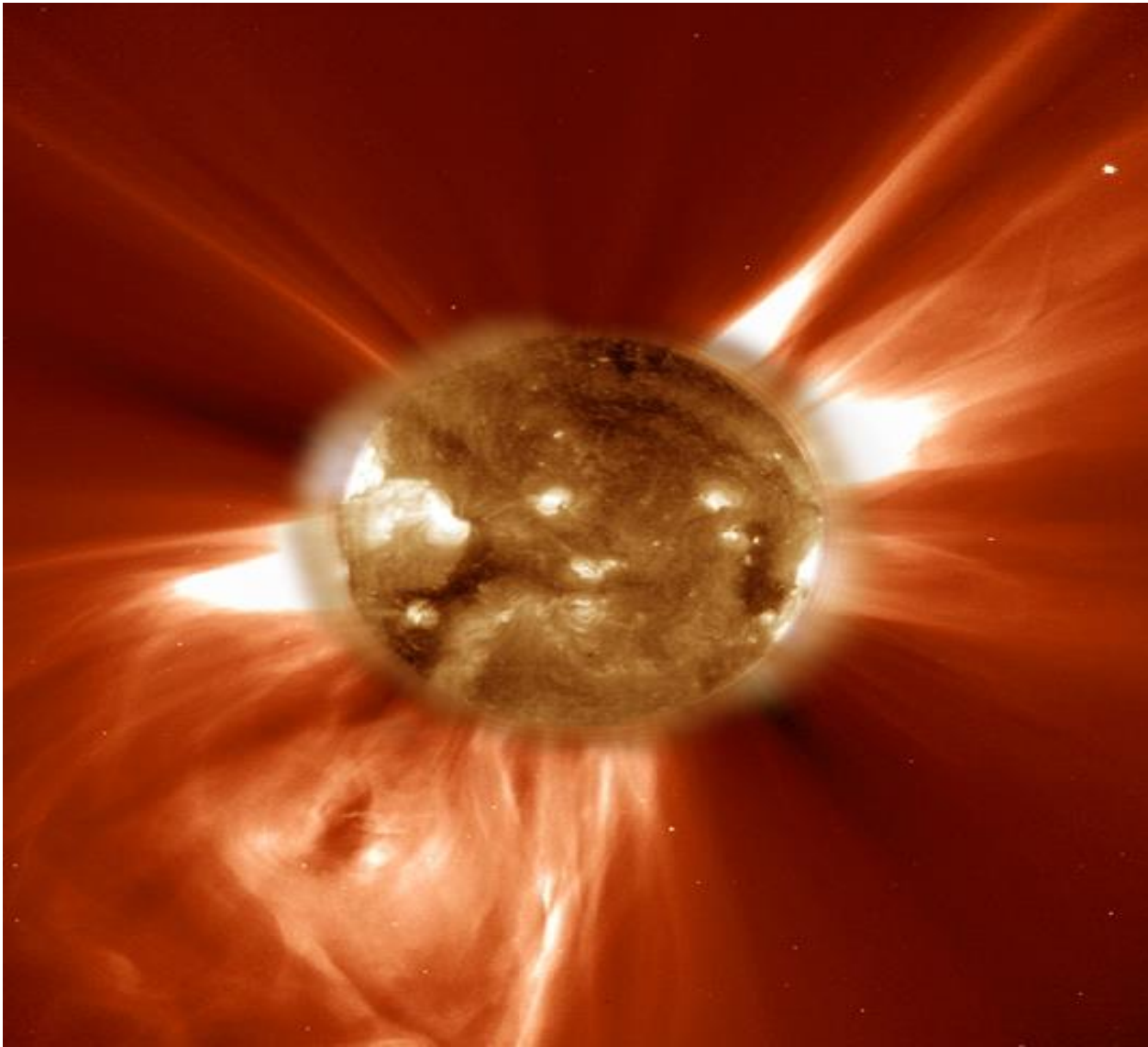


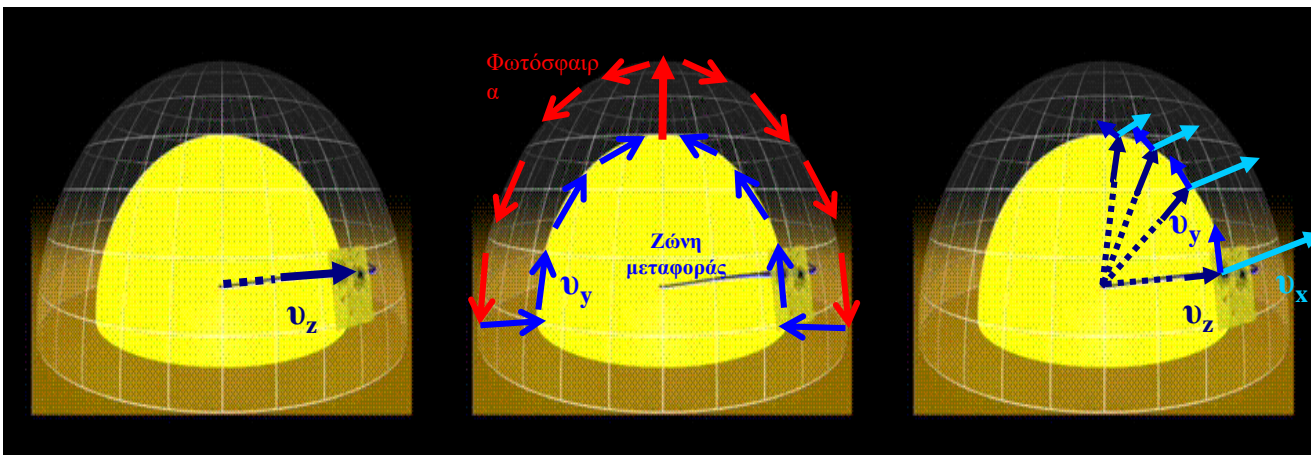
ΕΛΛΗΝΙΚΗ ΔΗΜΟΚΡΑΤΙΑ
Εθνικόν και Καποδιστριακόν
Πανεπιστήμιον Αθηνών

Ηλιακή Φυσική

Ενότητα 4: Μαγνητικό πεδίο του Ήλιου

Παναγιώτα Πρέκα
Σχολή Θετικών Επιστημών
Τμήμα Φυσικής

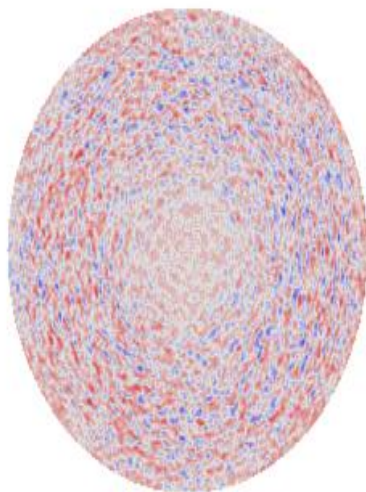




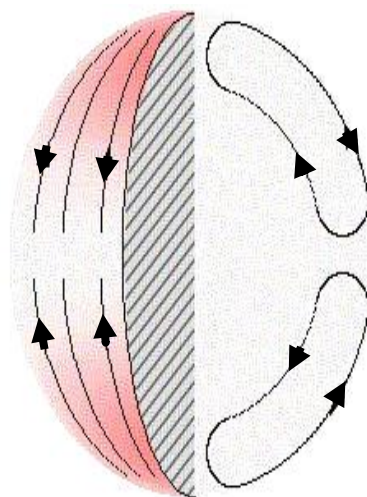
Εικ. Η κατακόρυφη συνιστώσα της ταχύτητας v_z .

Εικ. Η δημιουργία της κάθετης συνιστώσας της ταχύτητας v_y .

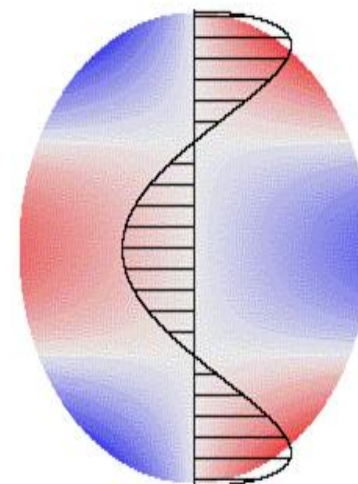
Εικ. Οι 3 συνιστώσες της ταχύτητας v_z , v_y και v_x .



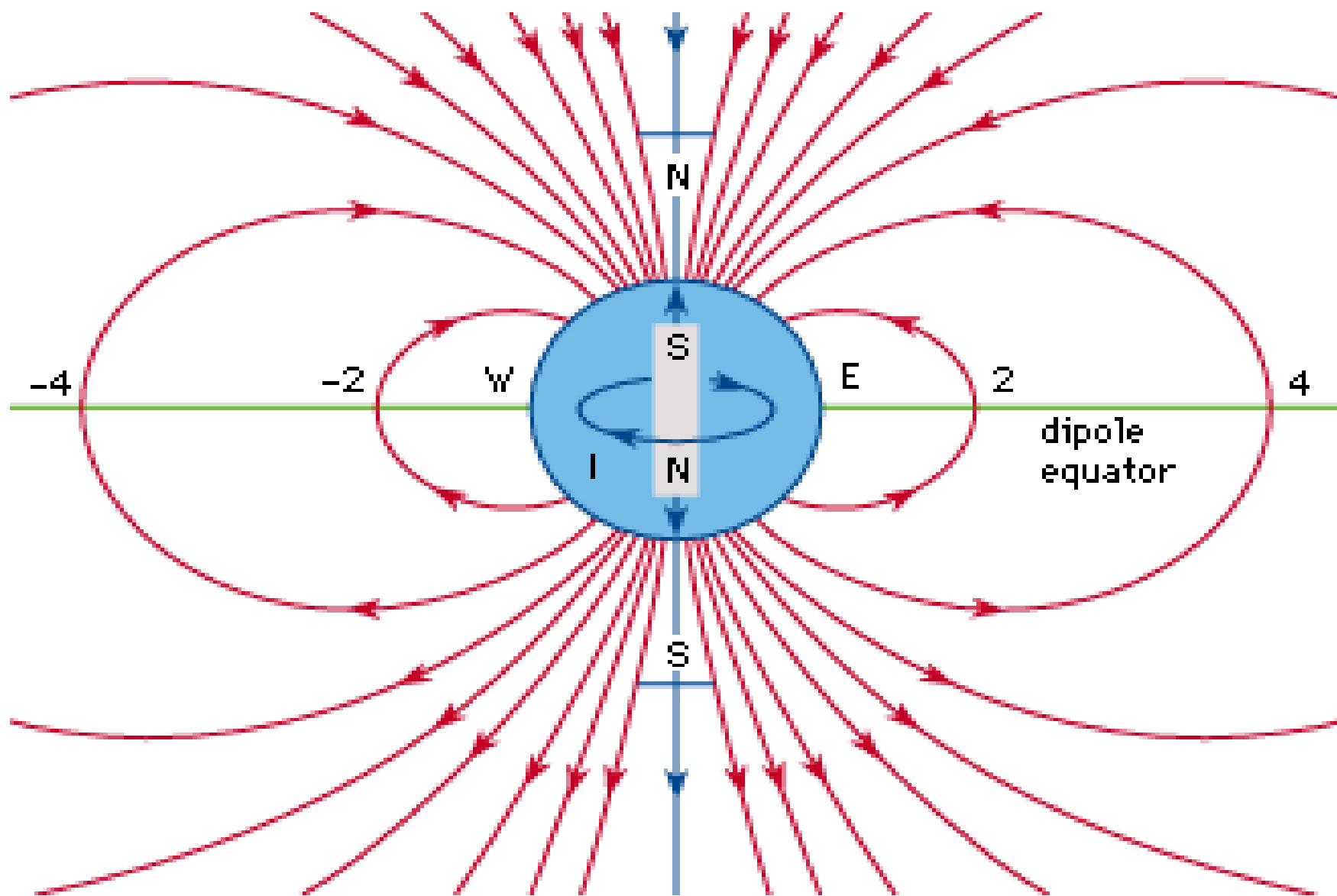
Εικ. Το αποτέλεσμα των ανοδικών ρευμάτων (υπερκοκκίαση)



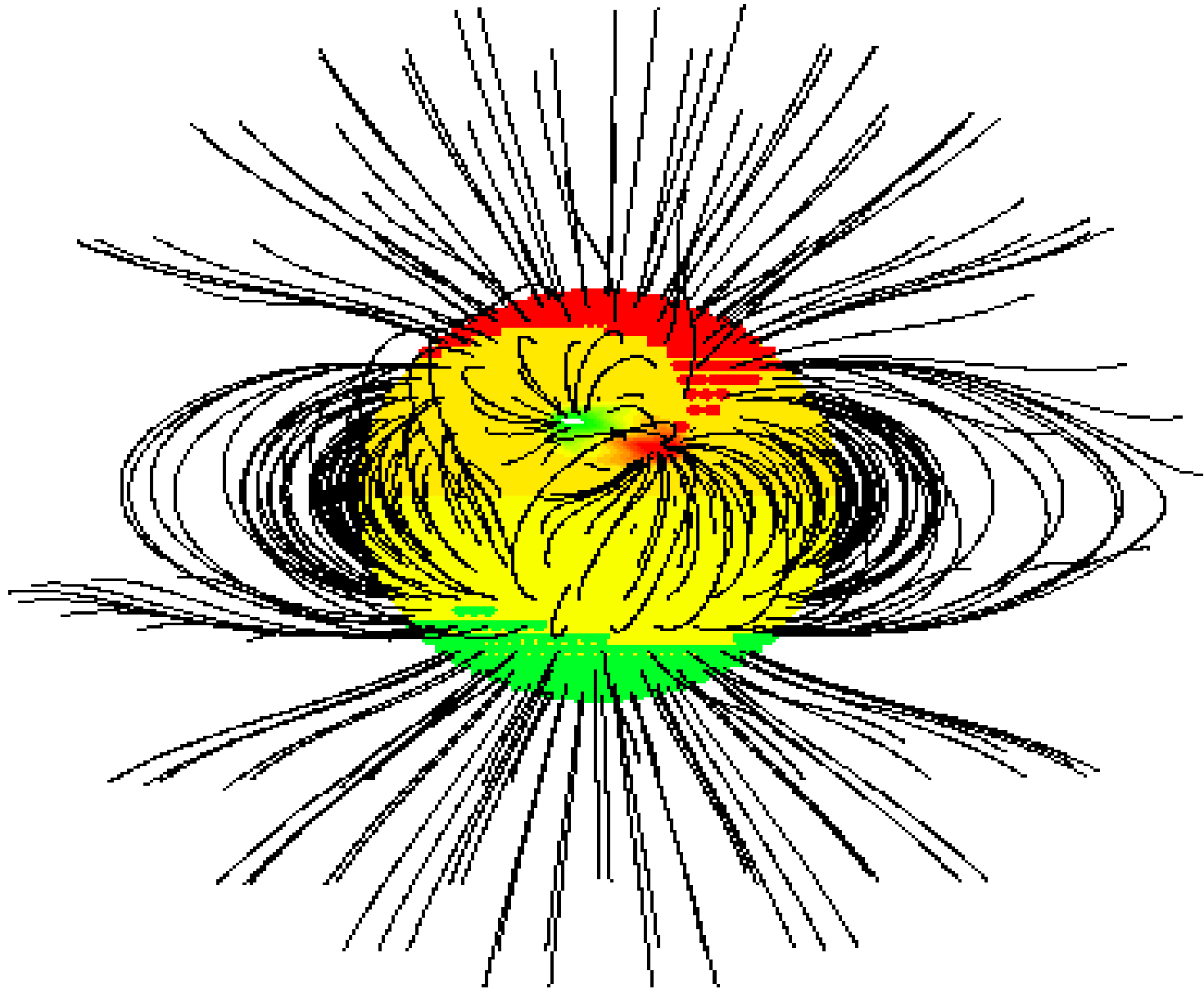
Εικ. Η ροή των μεσημβρινών ρευμάτων



Εικ. Η οριζόντια συνιστώσα της ταχύτητας



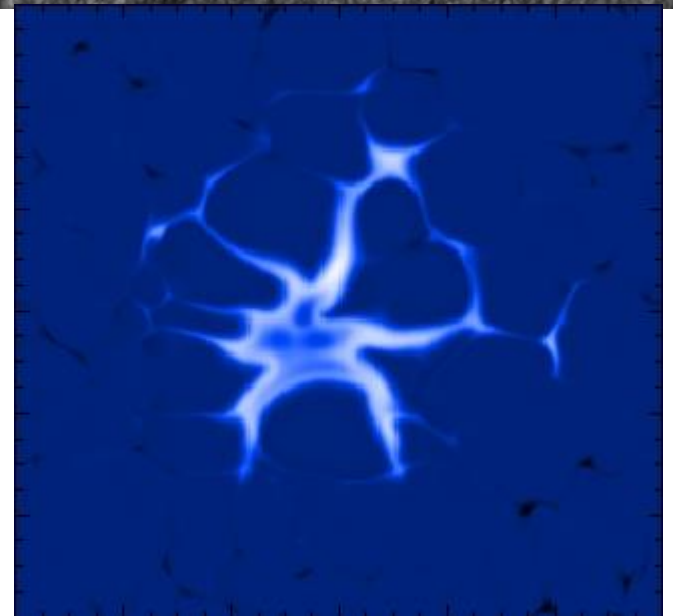
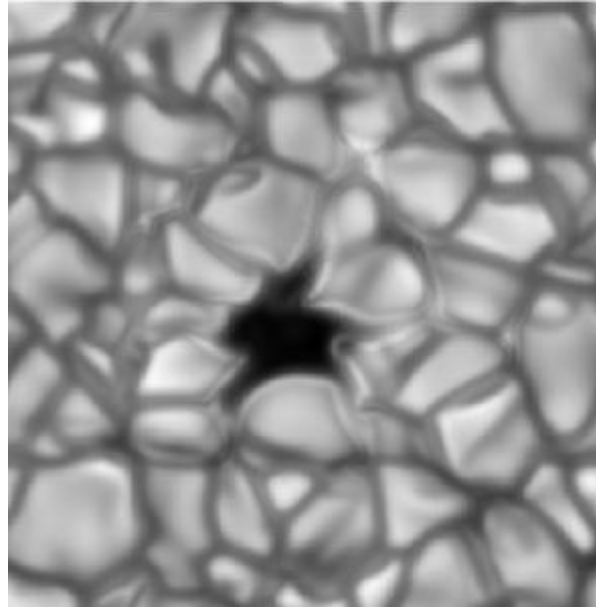
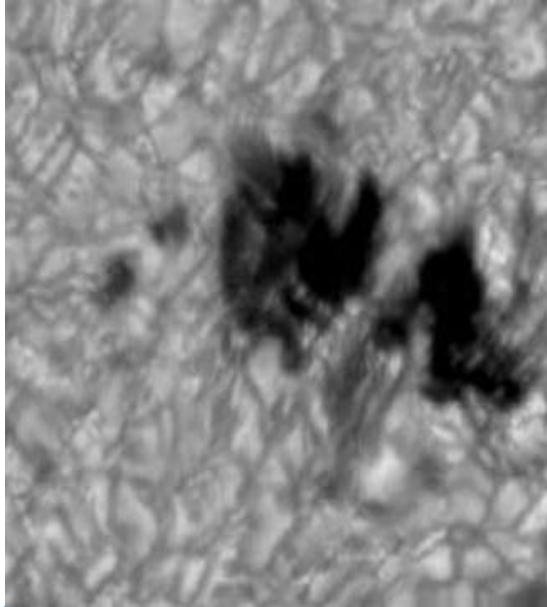
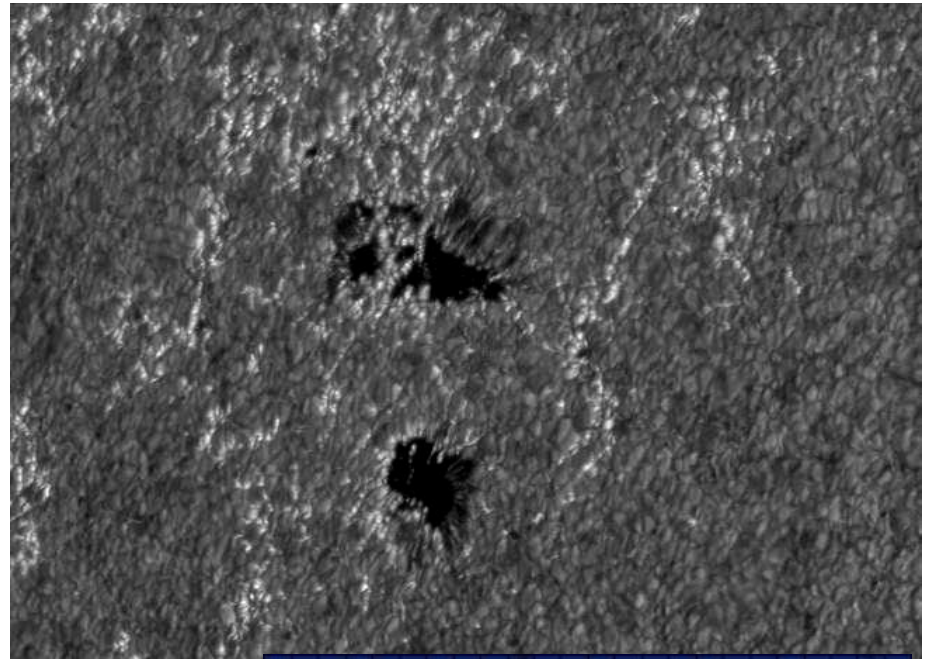
©1994 Encyclopaedia Britannica, Inc.

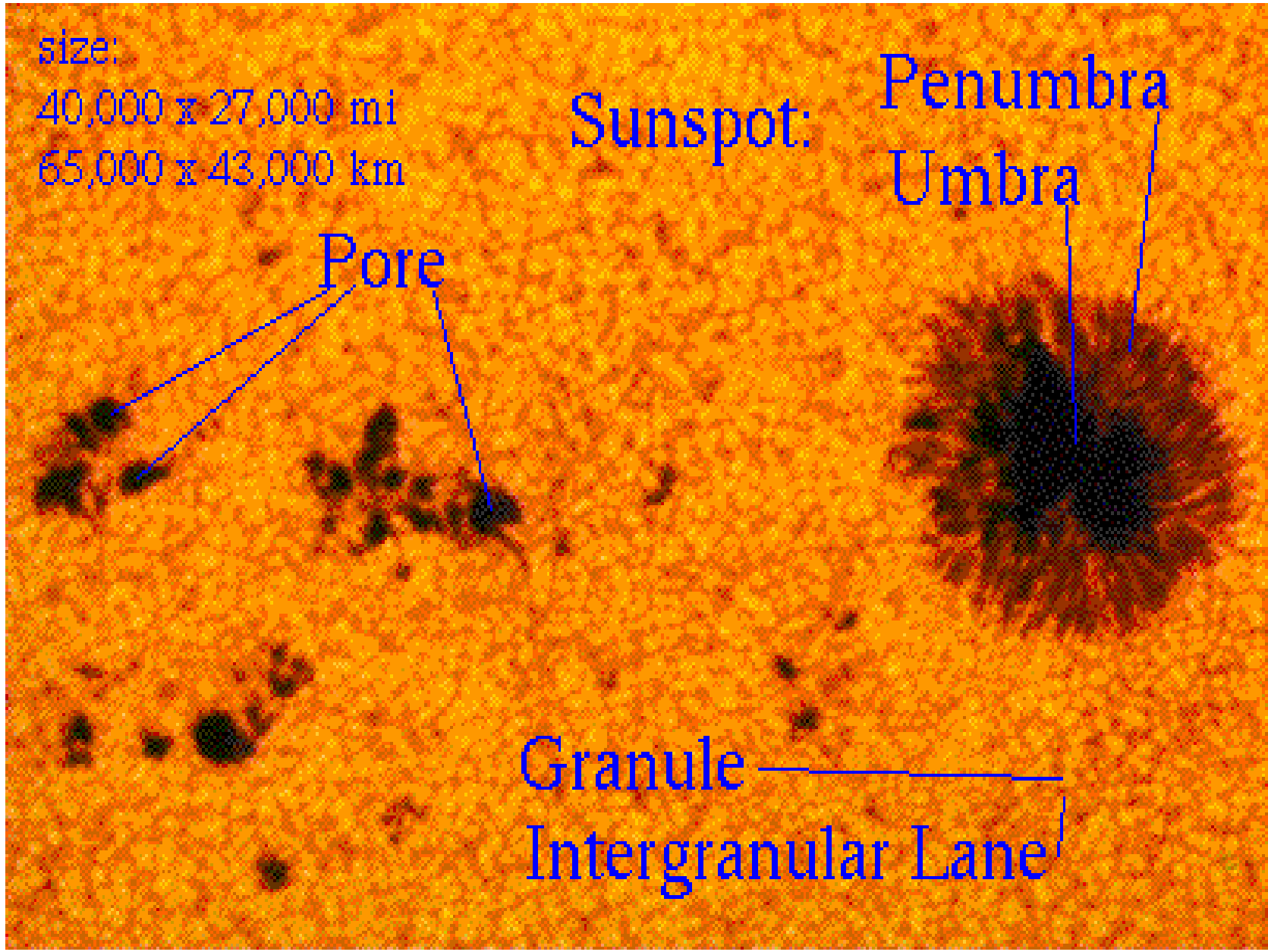






ΚΕΝΤΡΑ ΔΡΑΣΗΣ ΠΥΡΣΟΙ ΚΑΙ ΠΟΡΟΙ (Faculae-Pores)





size:

40,000 x 27,000 mi

65,000 x 43,000 km

Sunspot:

Penumbra

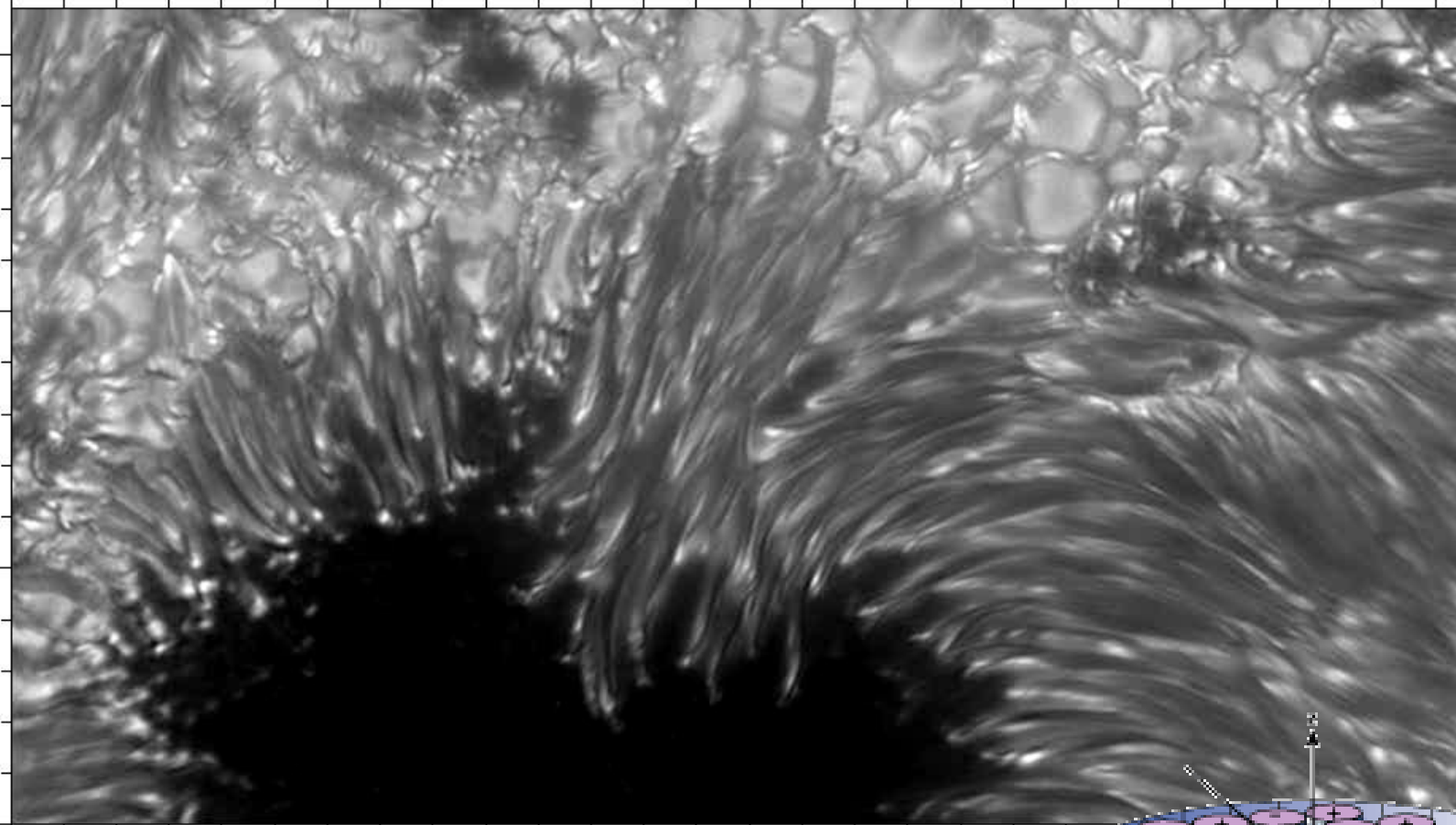
Umbra

Pore

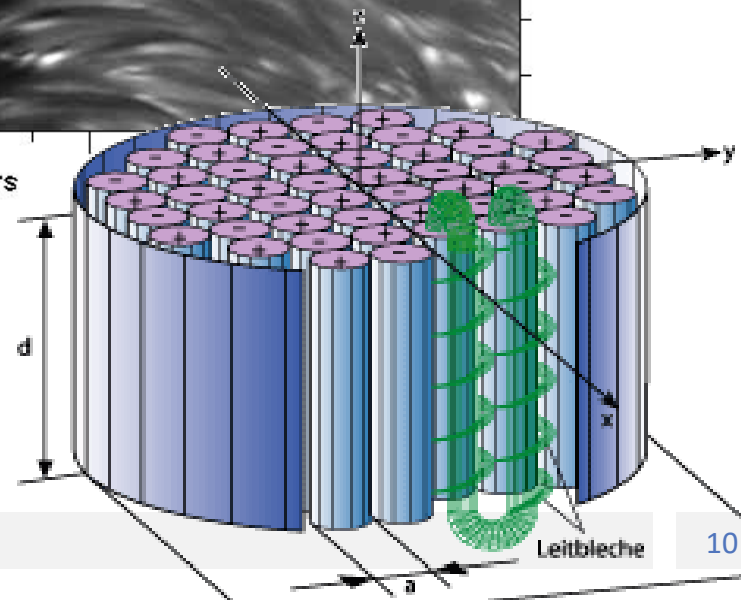
Granule

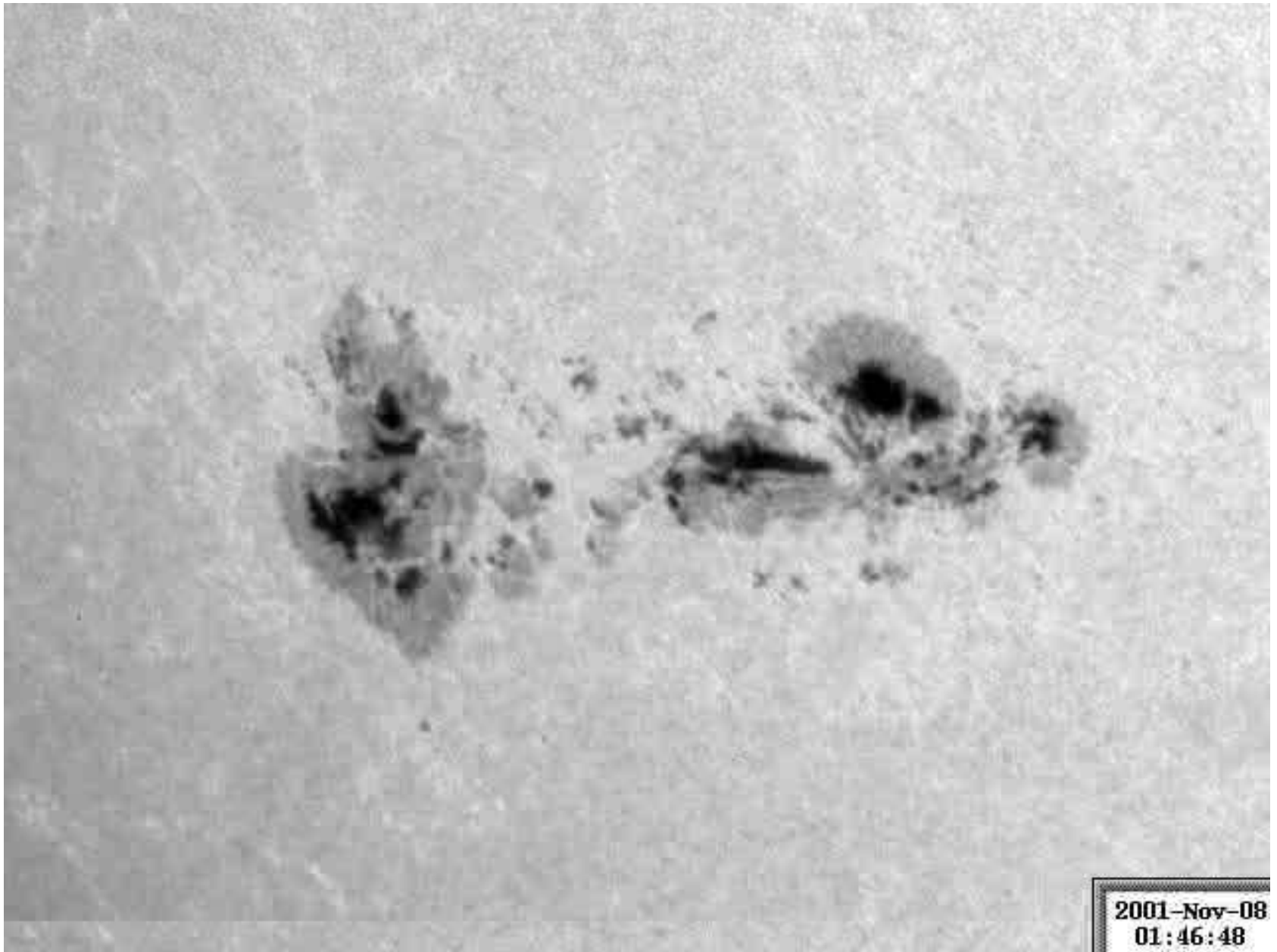
Intergranular Lane





distance in units of 1000 kilometers





ΚΗΛΙΔΑ
(sunspot)

bar magnet

S N

N

S N

S N

ΚΕΝΤΡΟ ΔΡΑΣΗΣ



Ι Σ Η Μ Ε Ρ Ι Ν Ο Σ

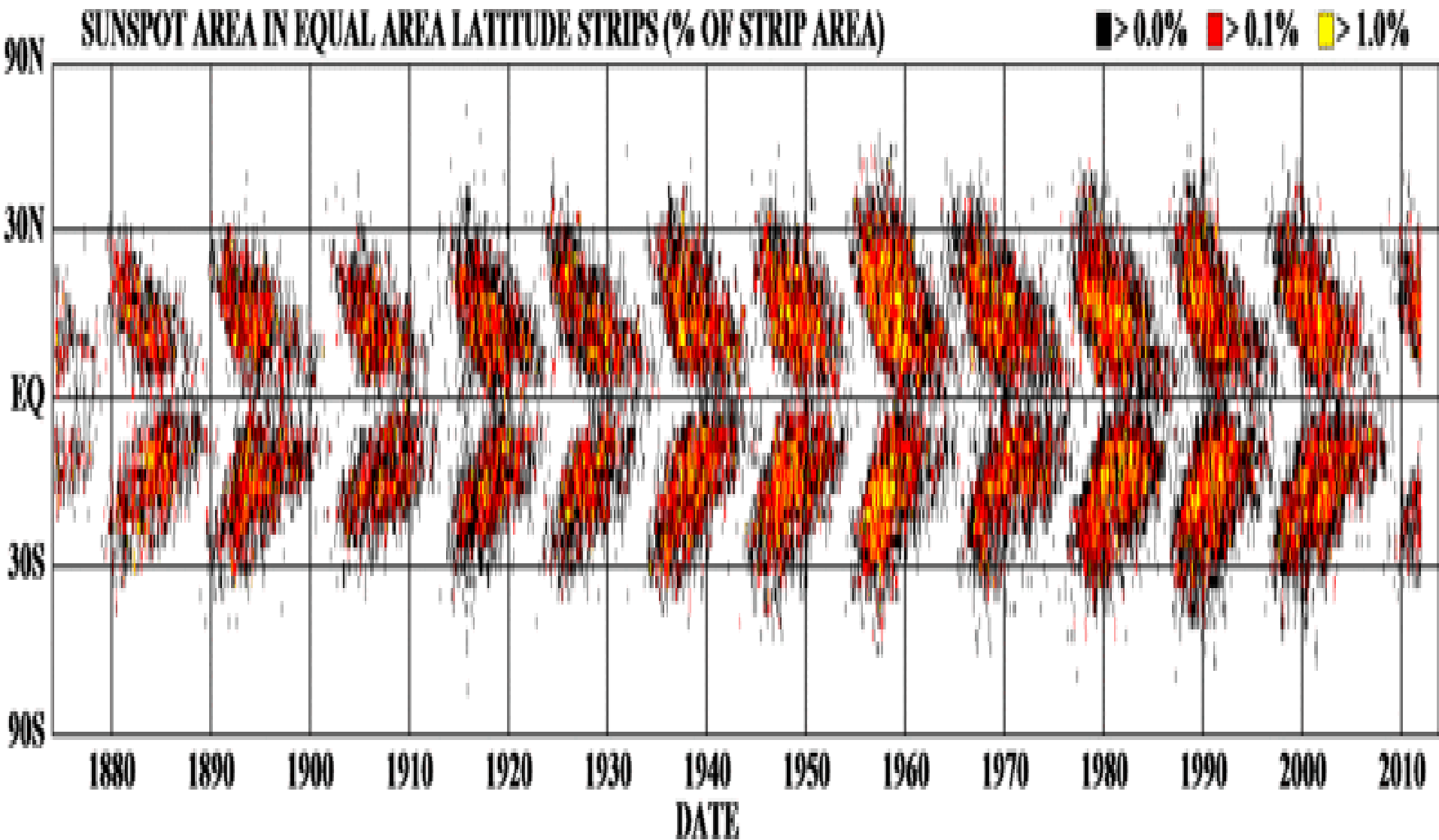
ΑΛΛΗΛΟΑΝΑΙΡΕΣΗ



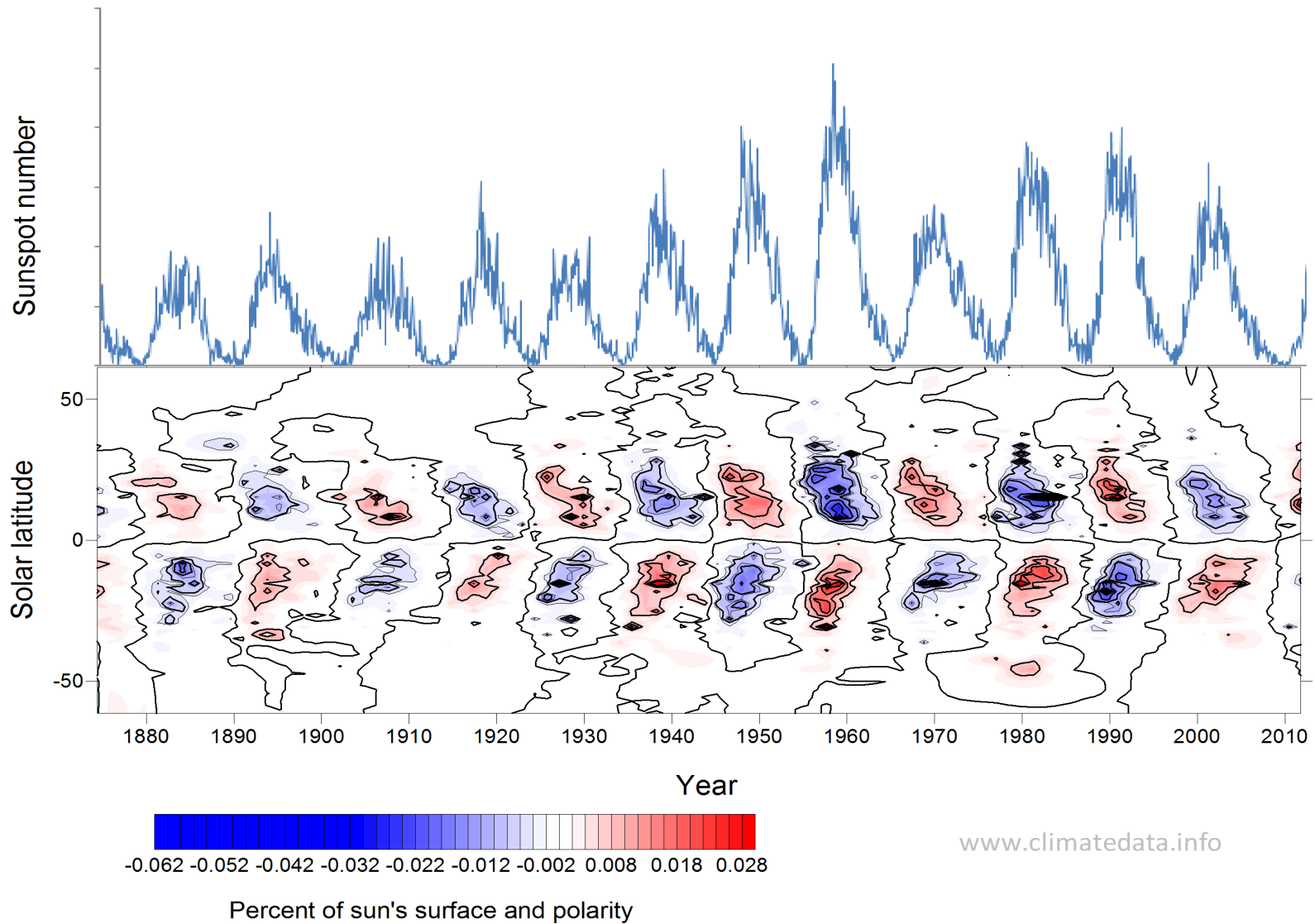
ΚΕΝΤΡΟ ΔΡΑΣΗΣ

S

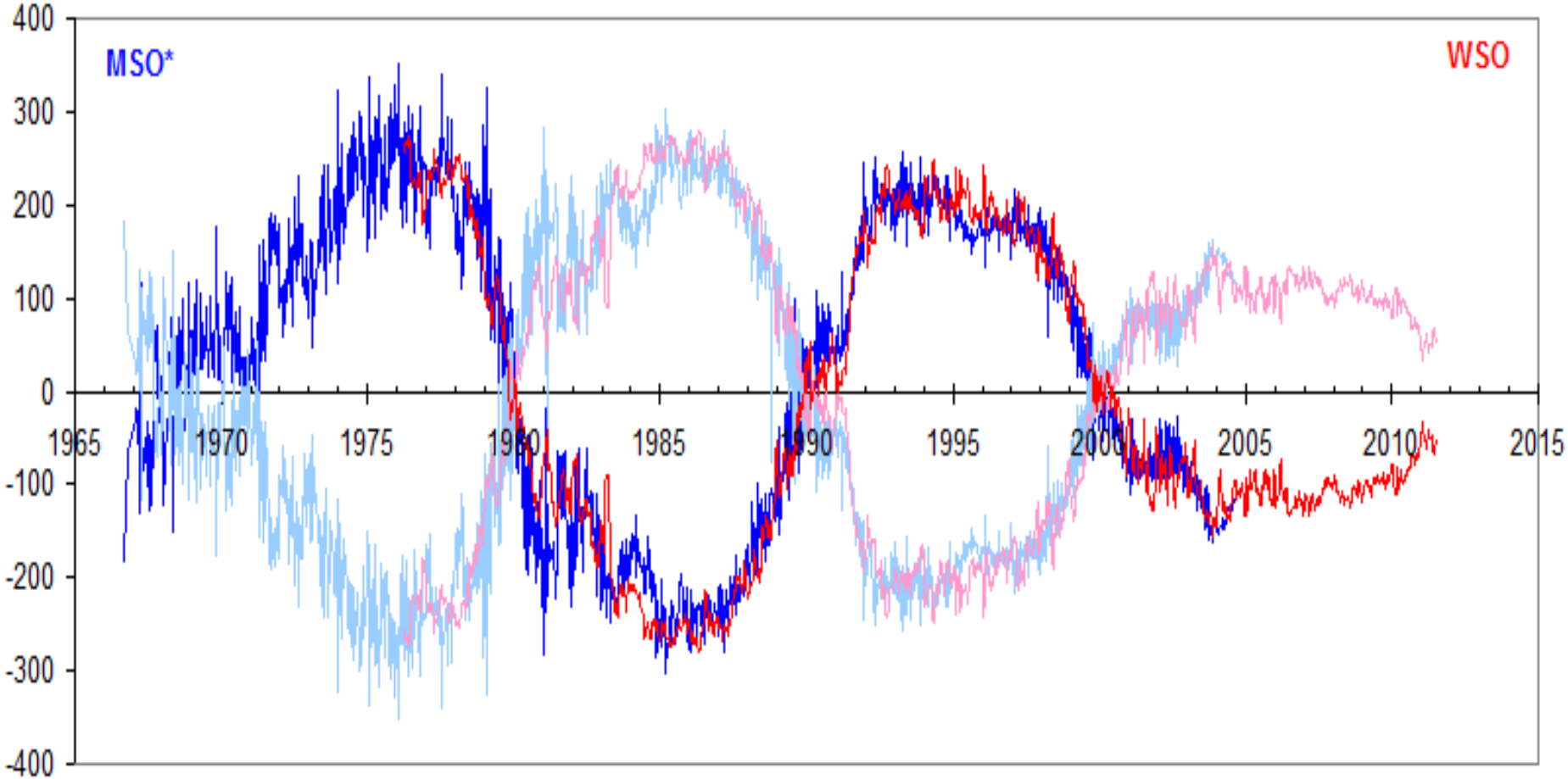
2006/07/31 00:00

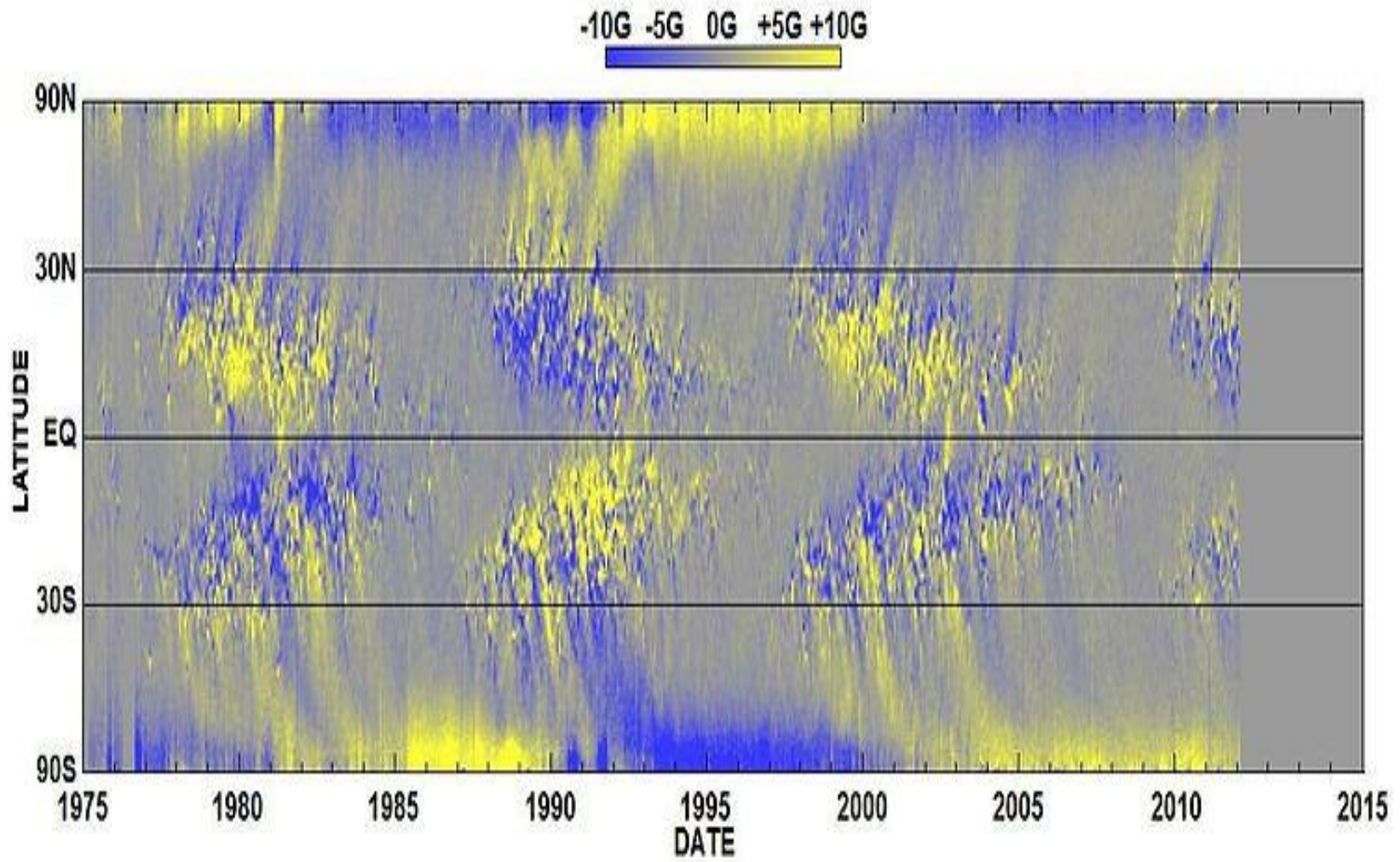


Solar cycles - variation with solar latitude and time



North - South Solar Polar fields [microTesla]

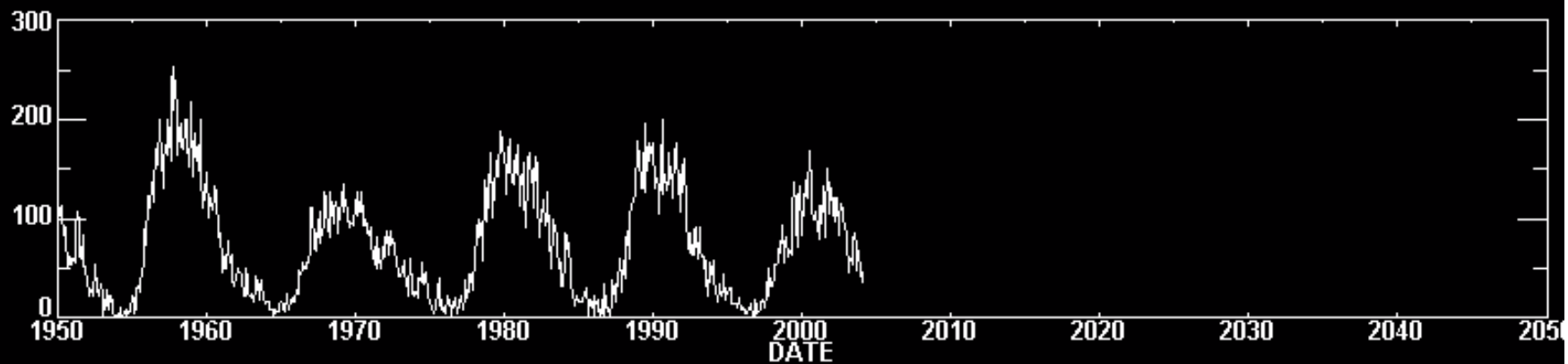
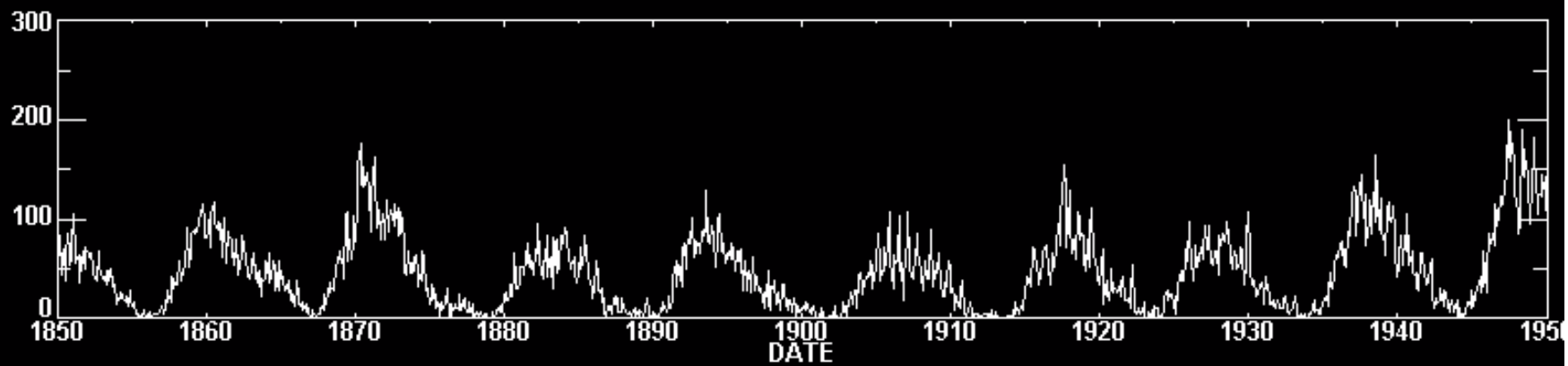
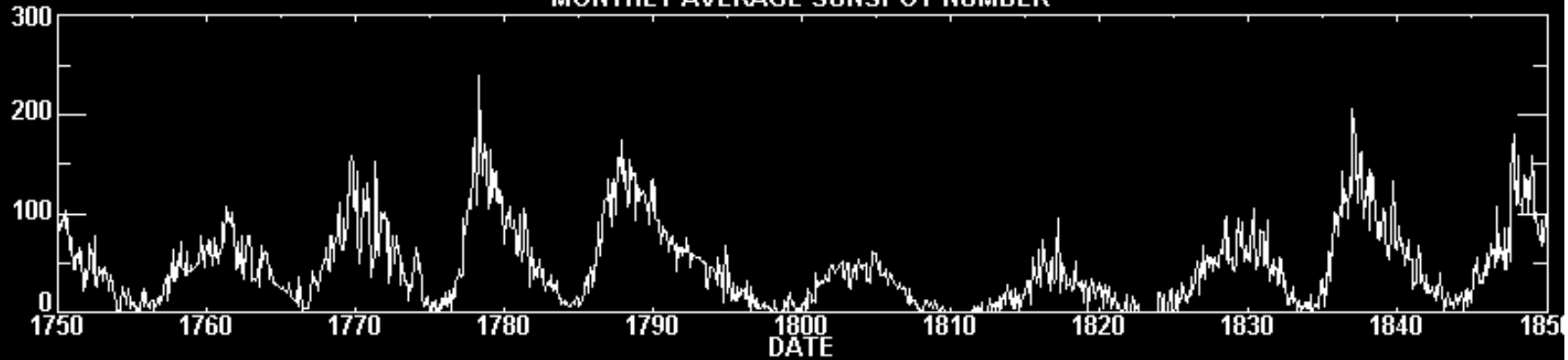


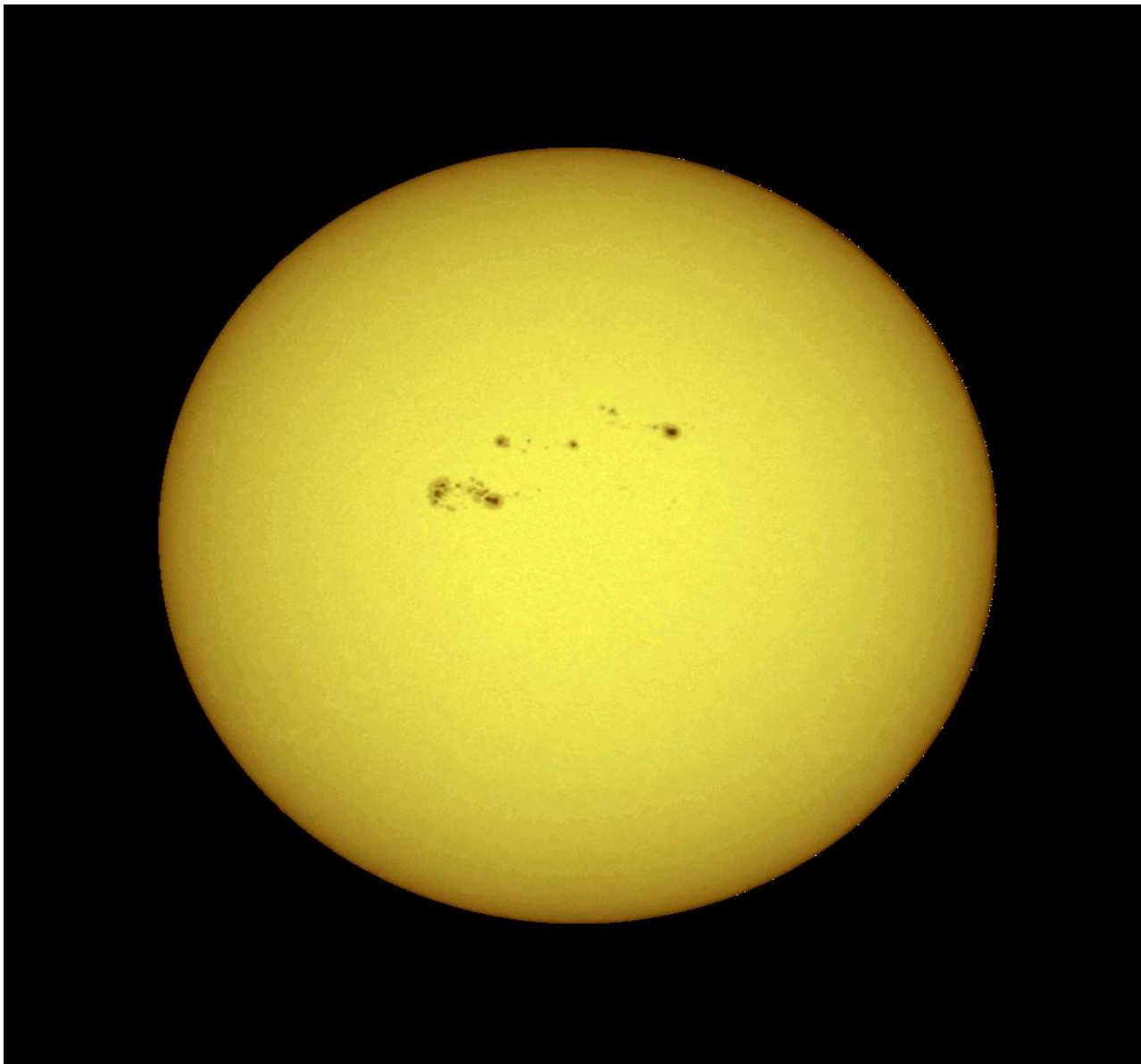


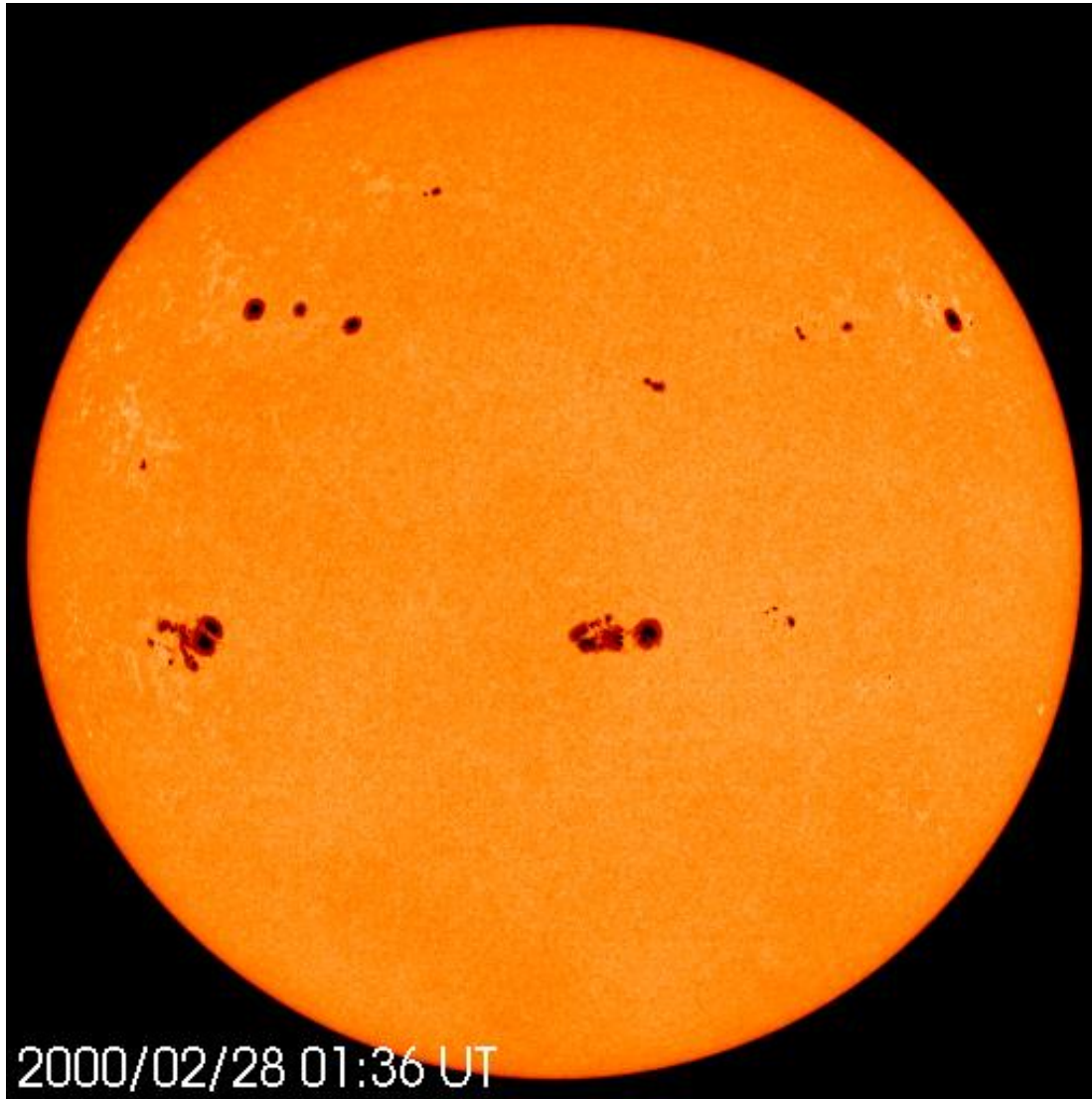
Hathaway/NASA/MSFC 2012/03



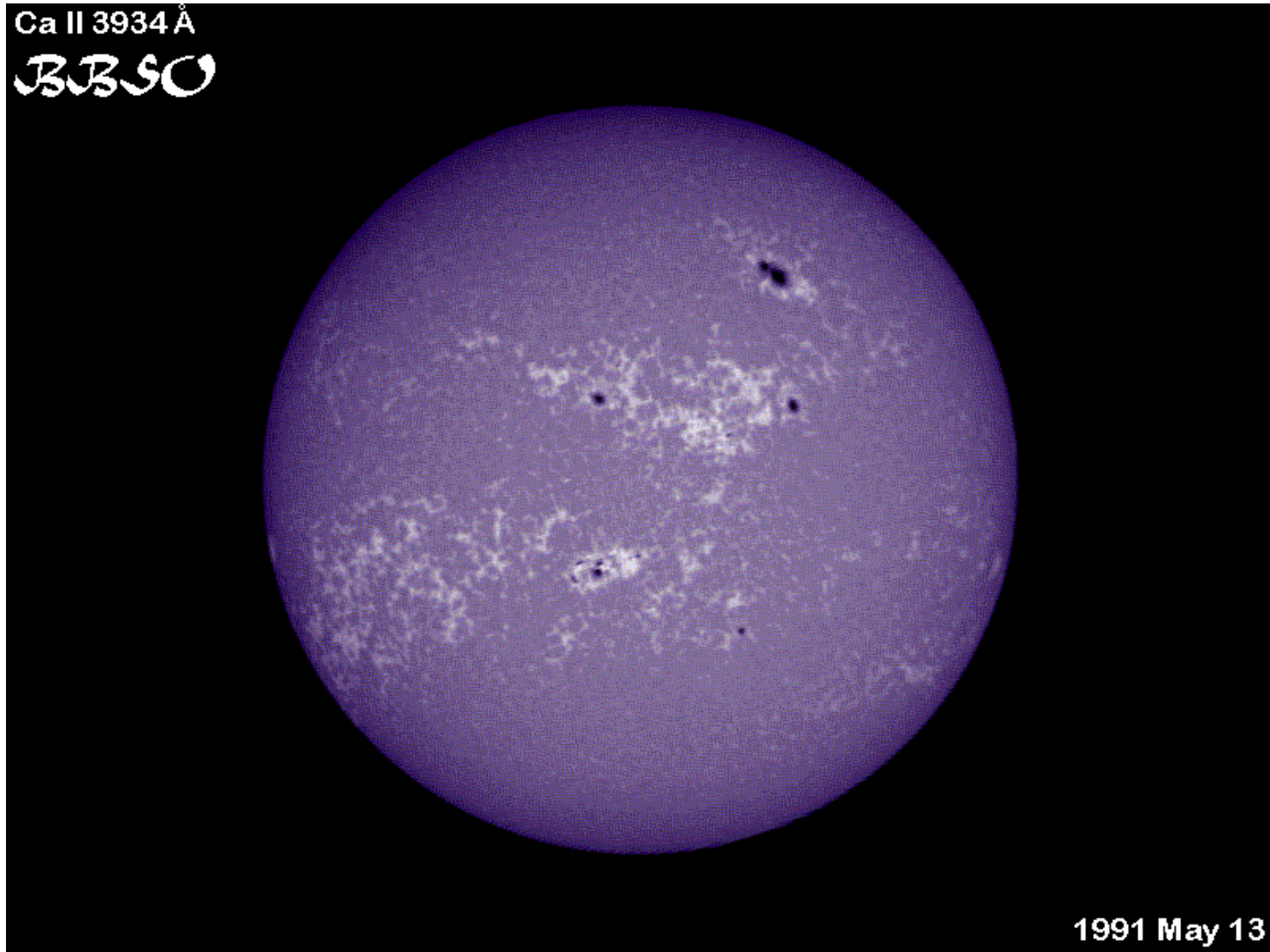
MONTHLY AVERAGE SUNSPOT NUMBER



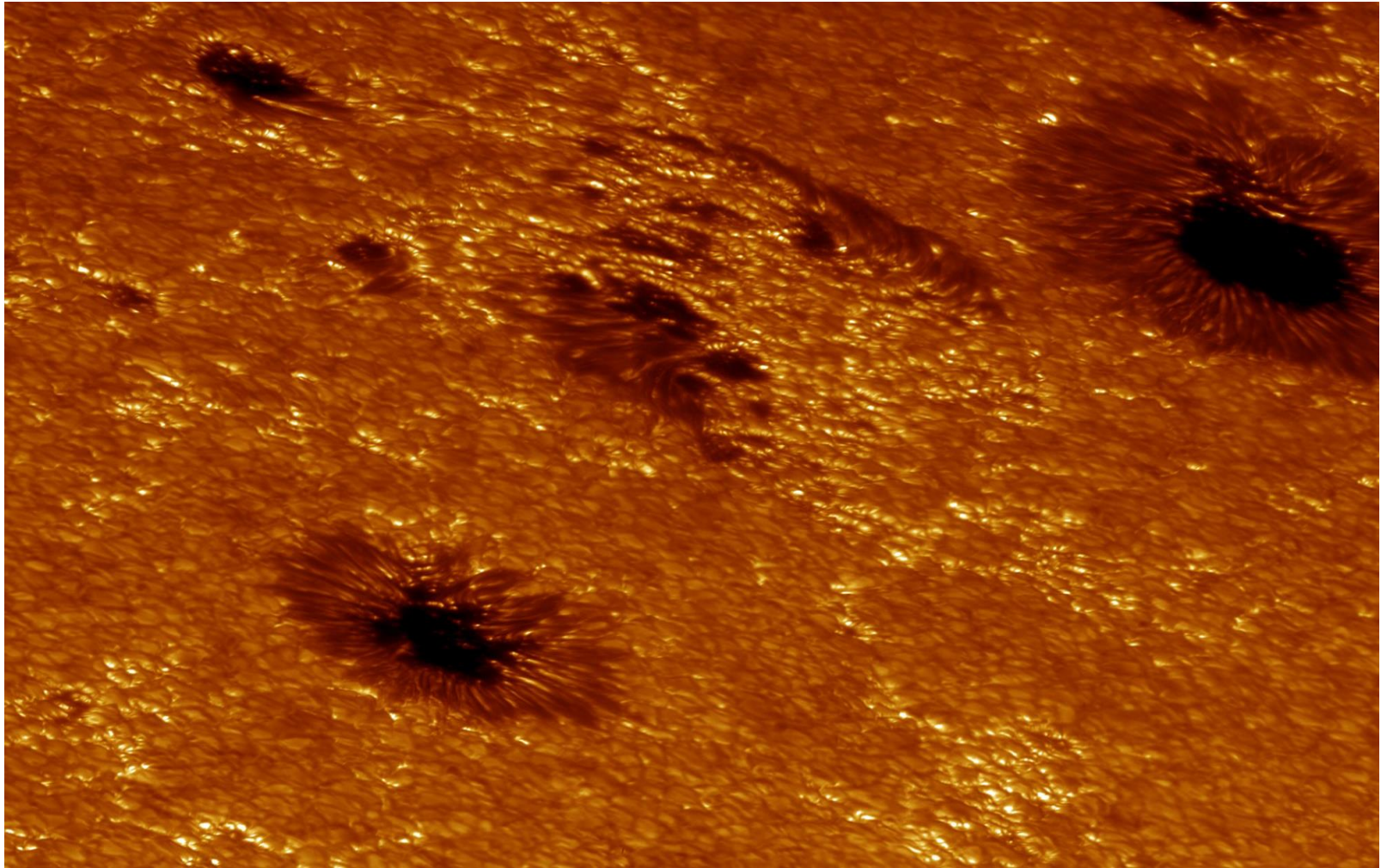




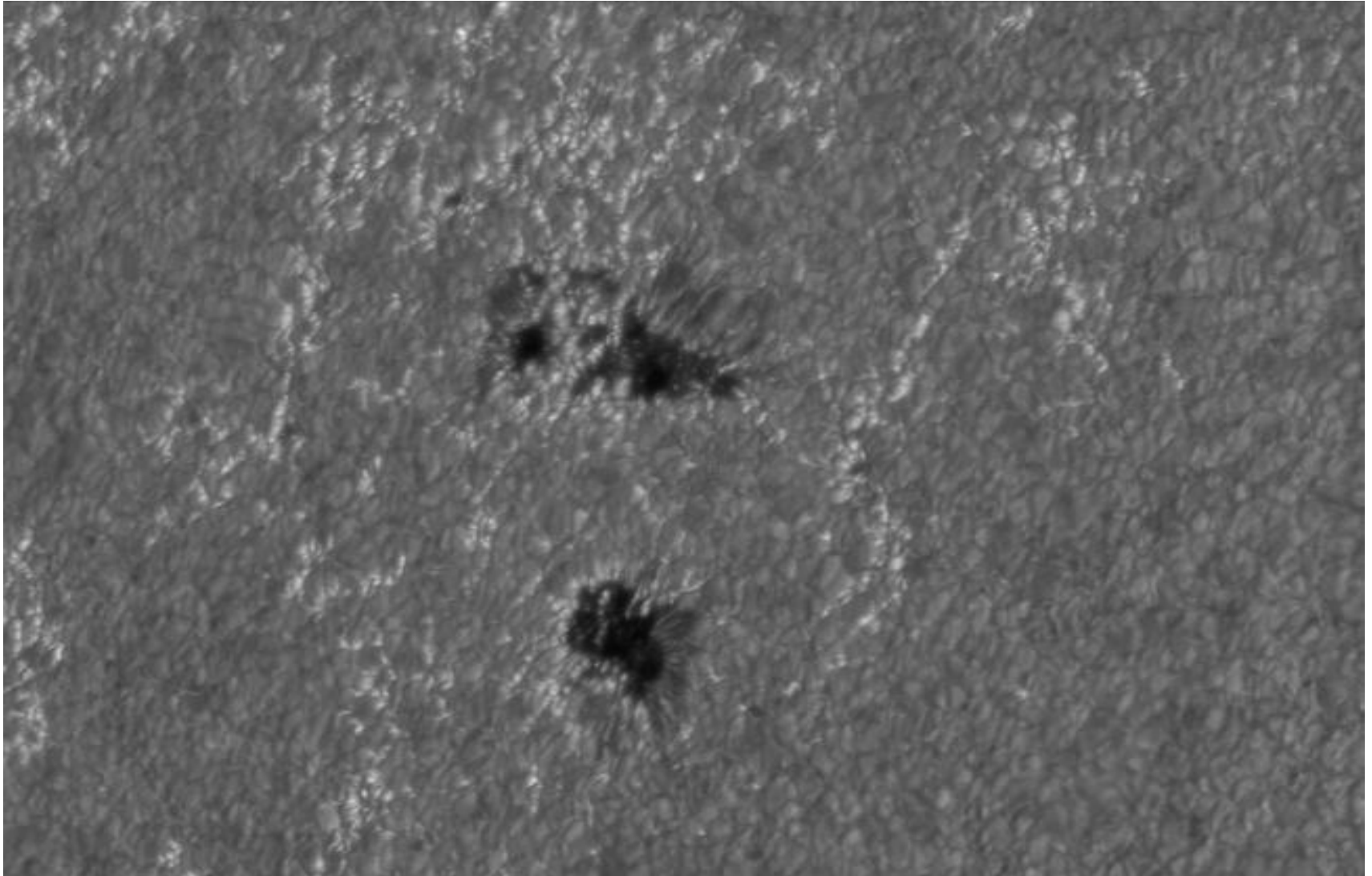
CHROMOSPHERIC NETWORK

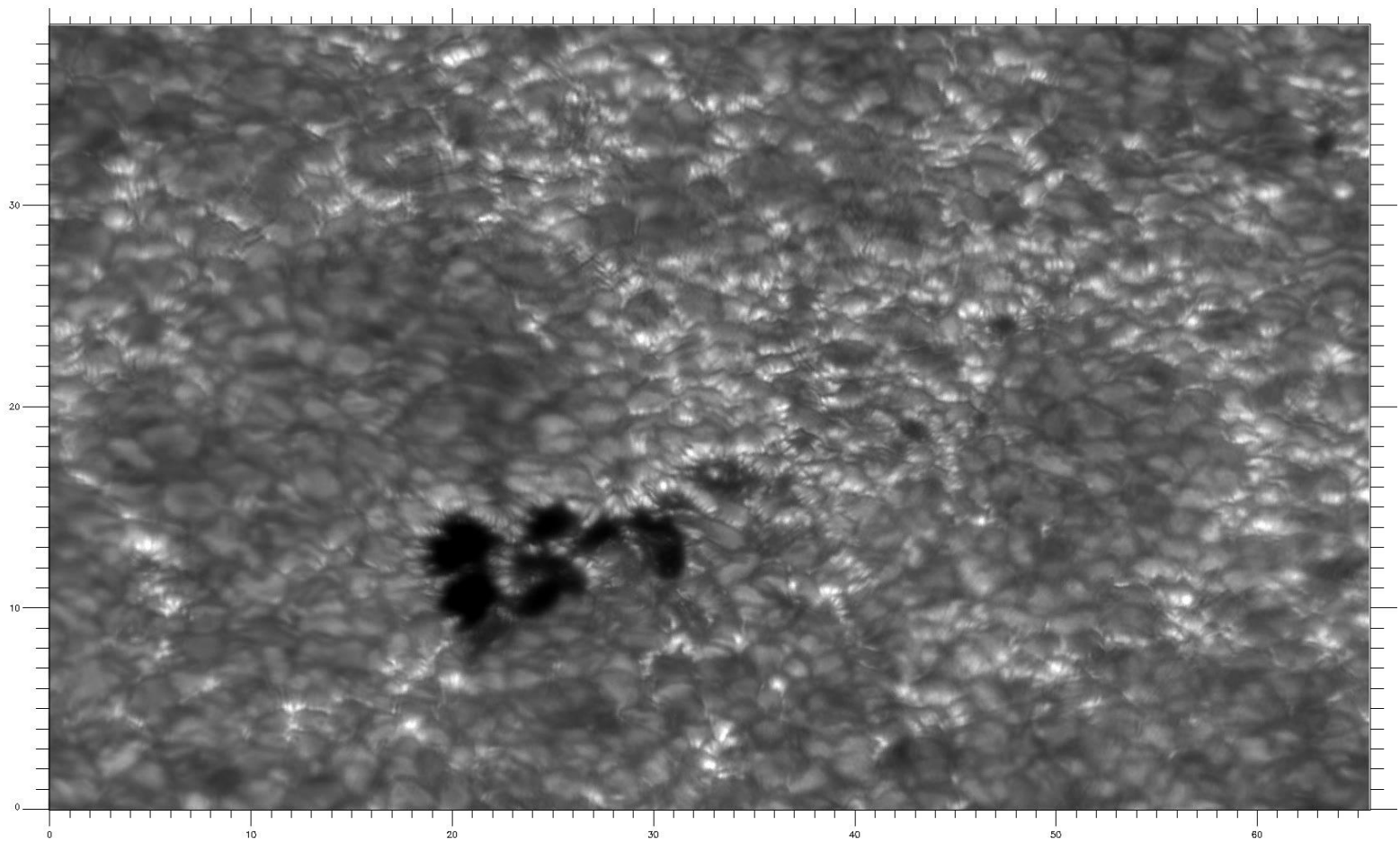


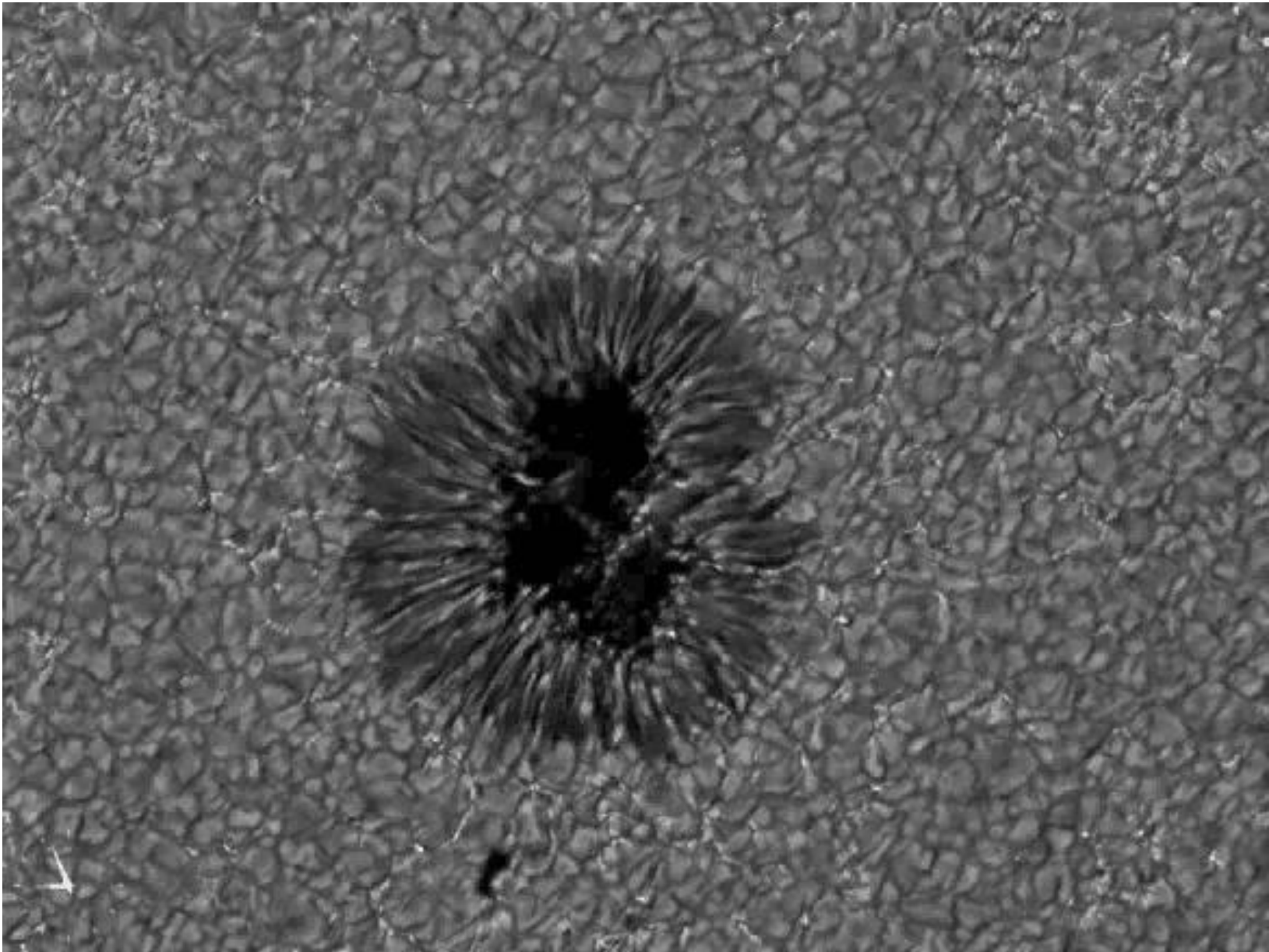
PHOTOSPHERE FACULAE

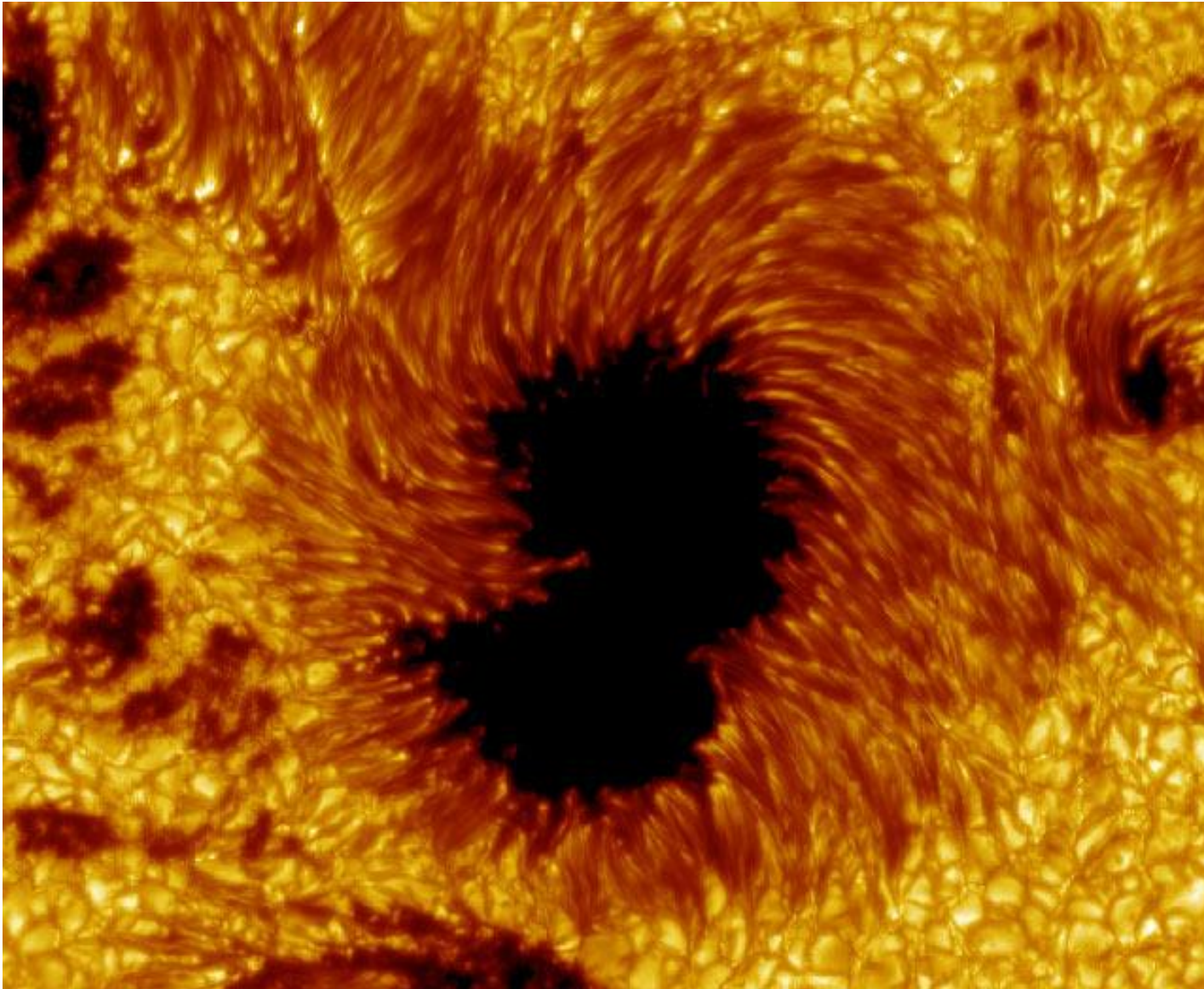


CHROMOSPHERE-PLAGE

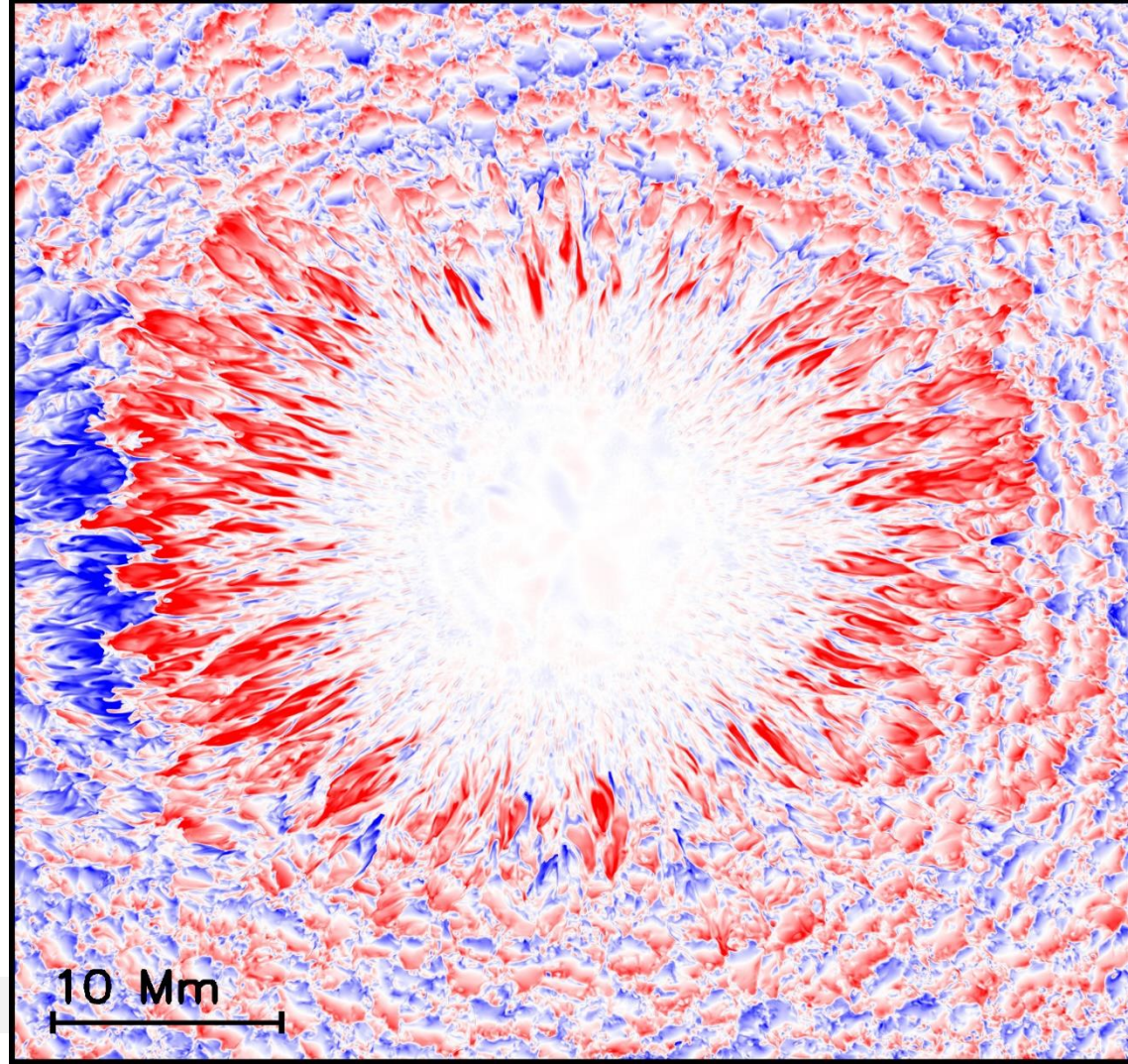
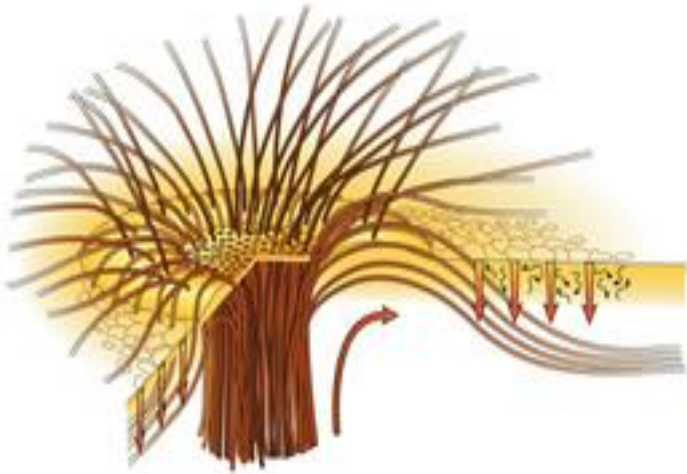




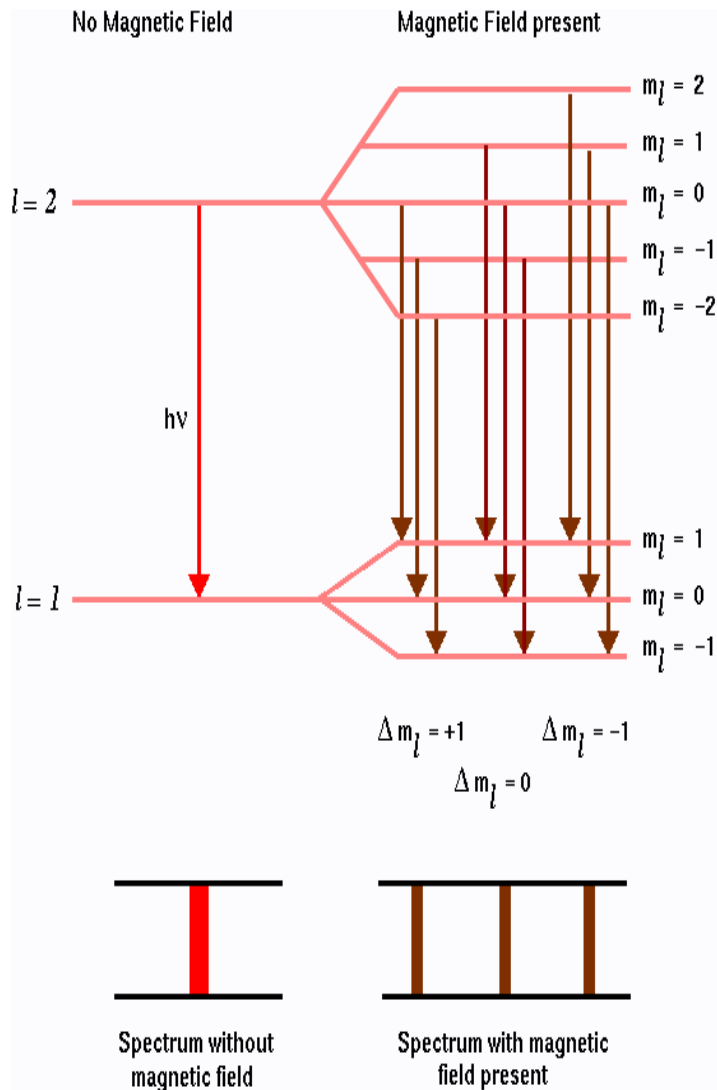




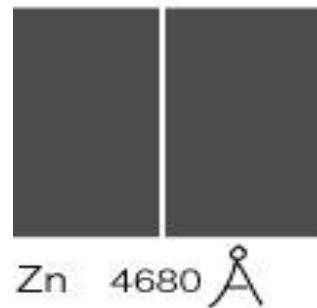
EVERSHED EFFECT



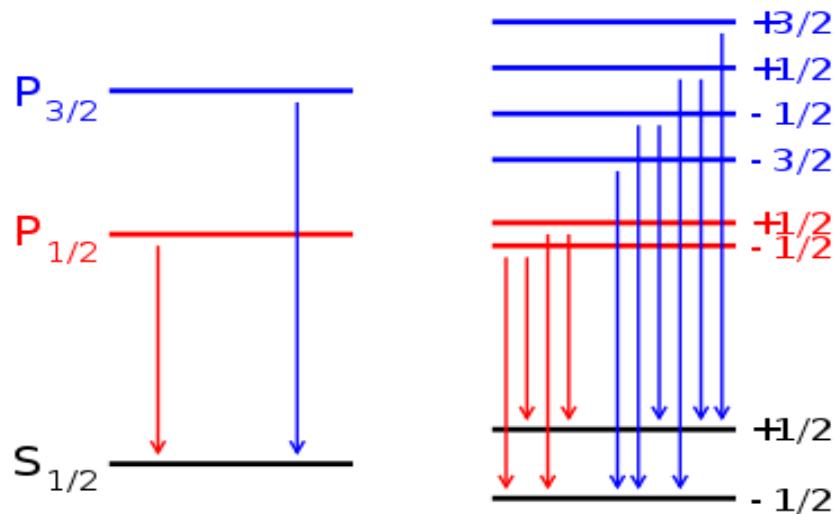
ZEEMAN EFFECT

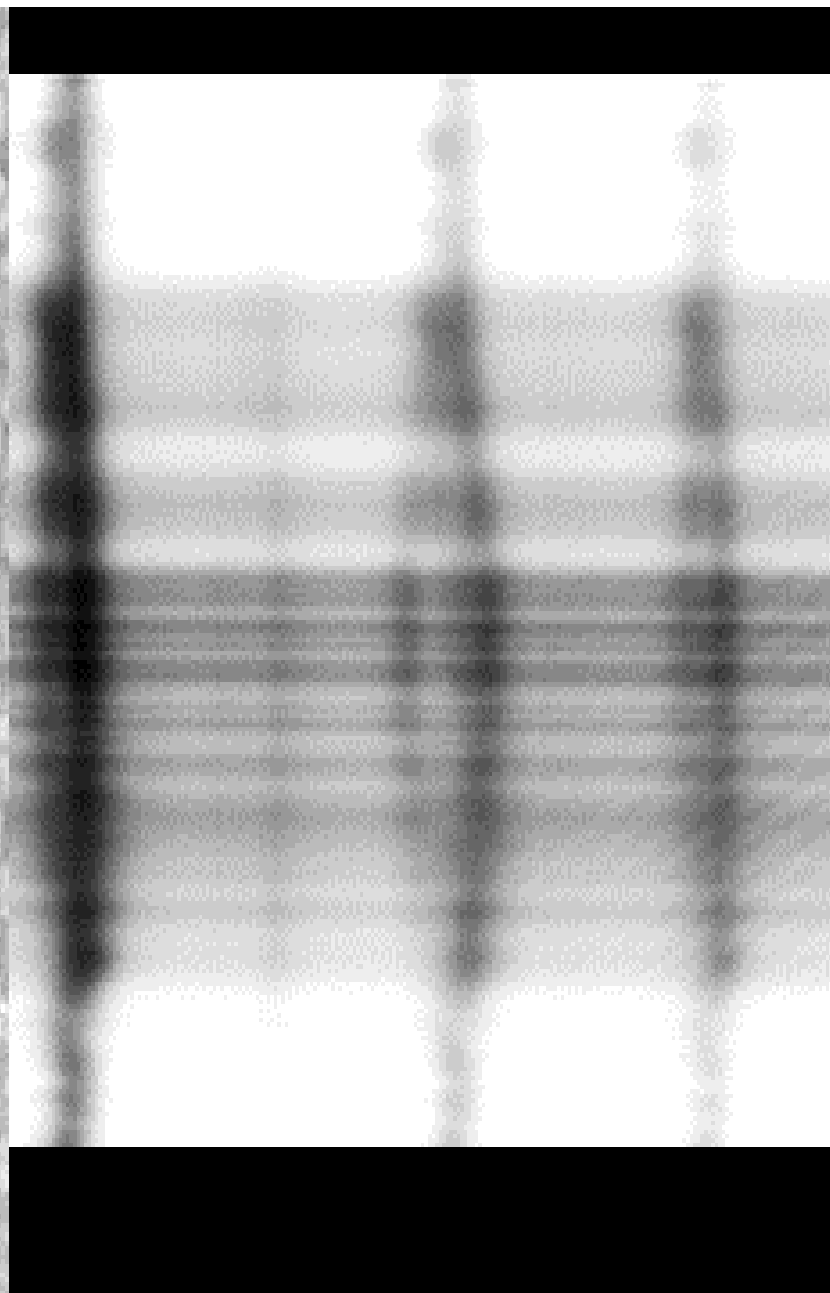
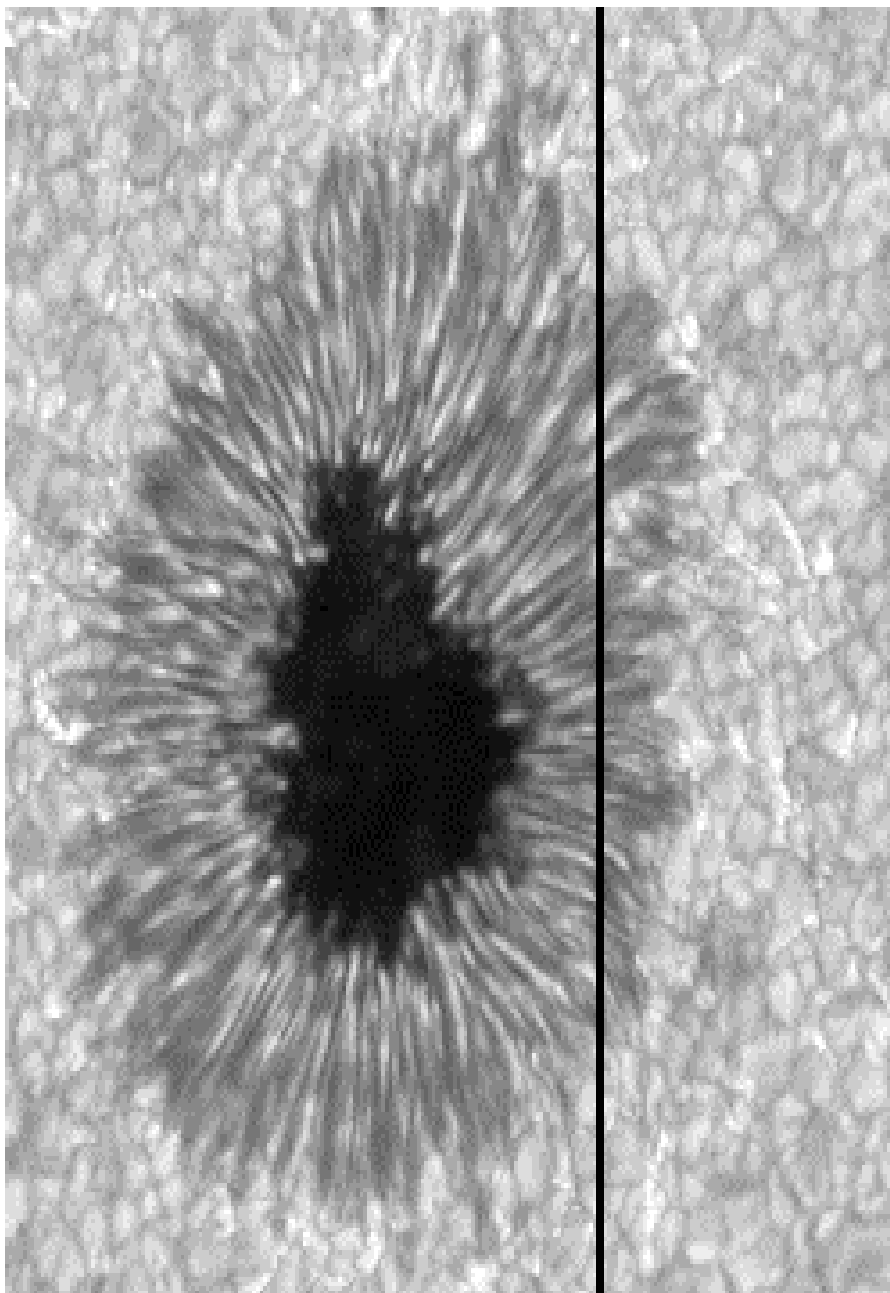


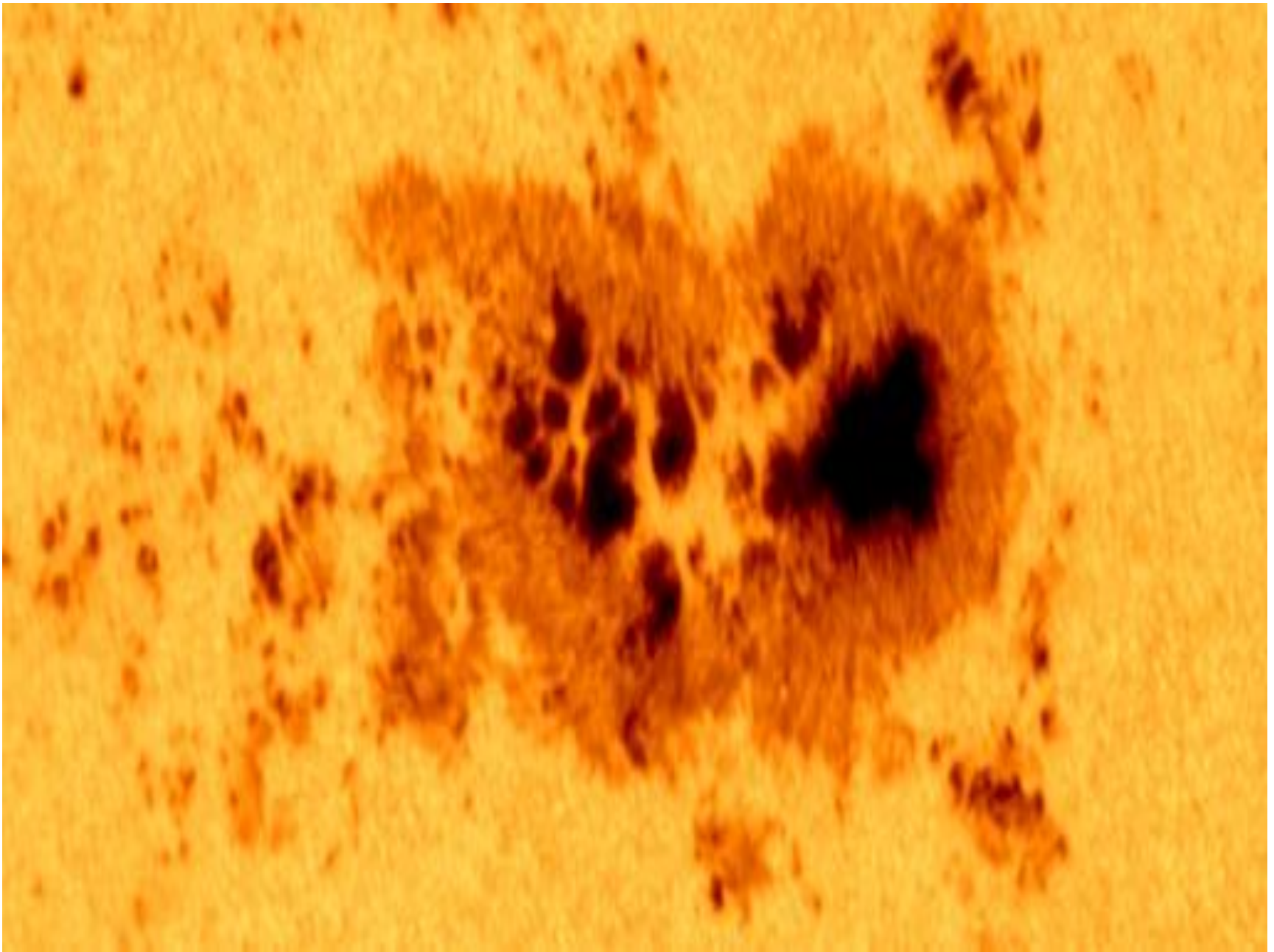
ZEEMAN EFFECT

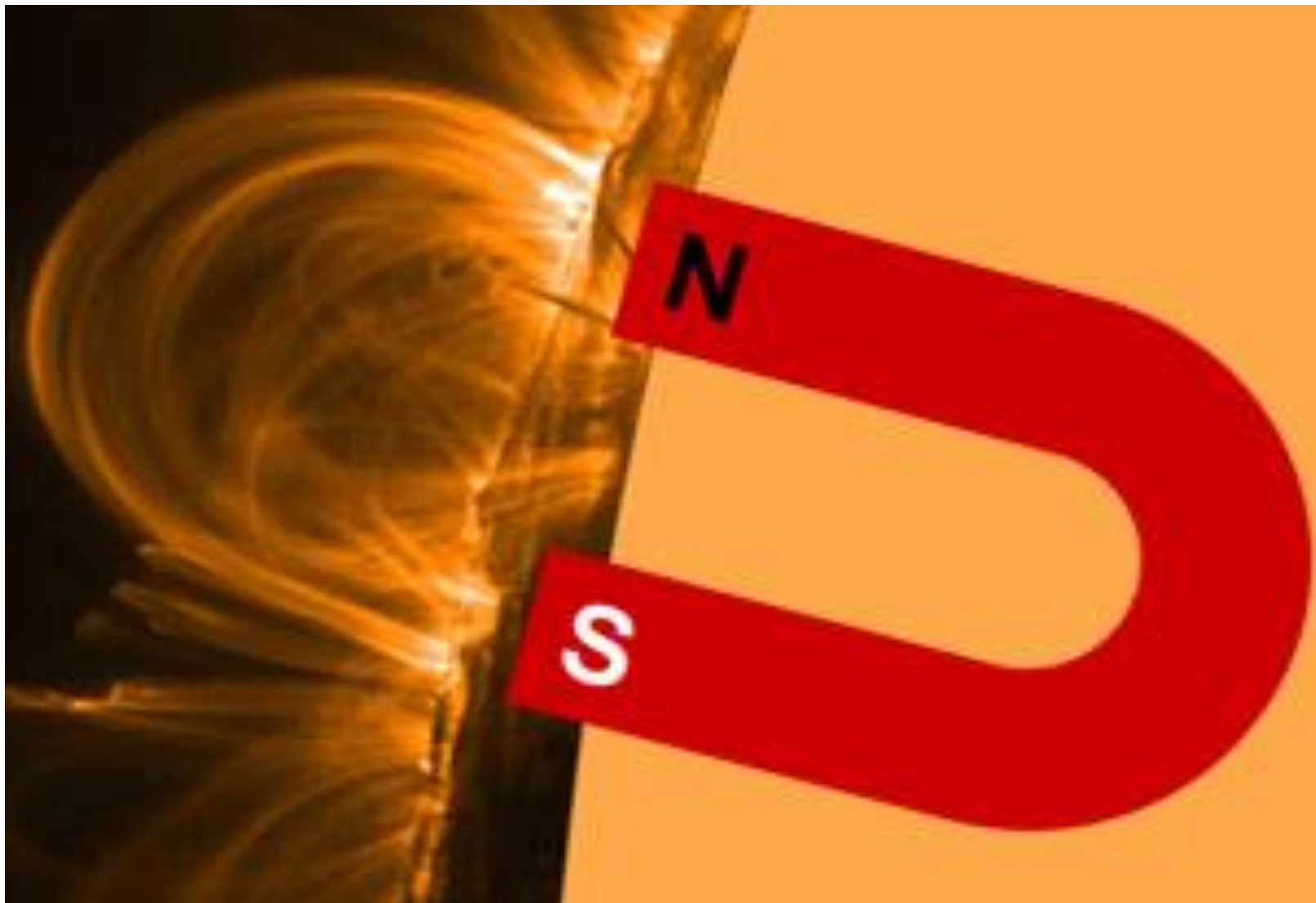


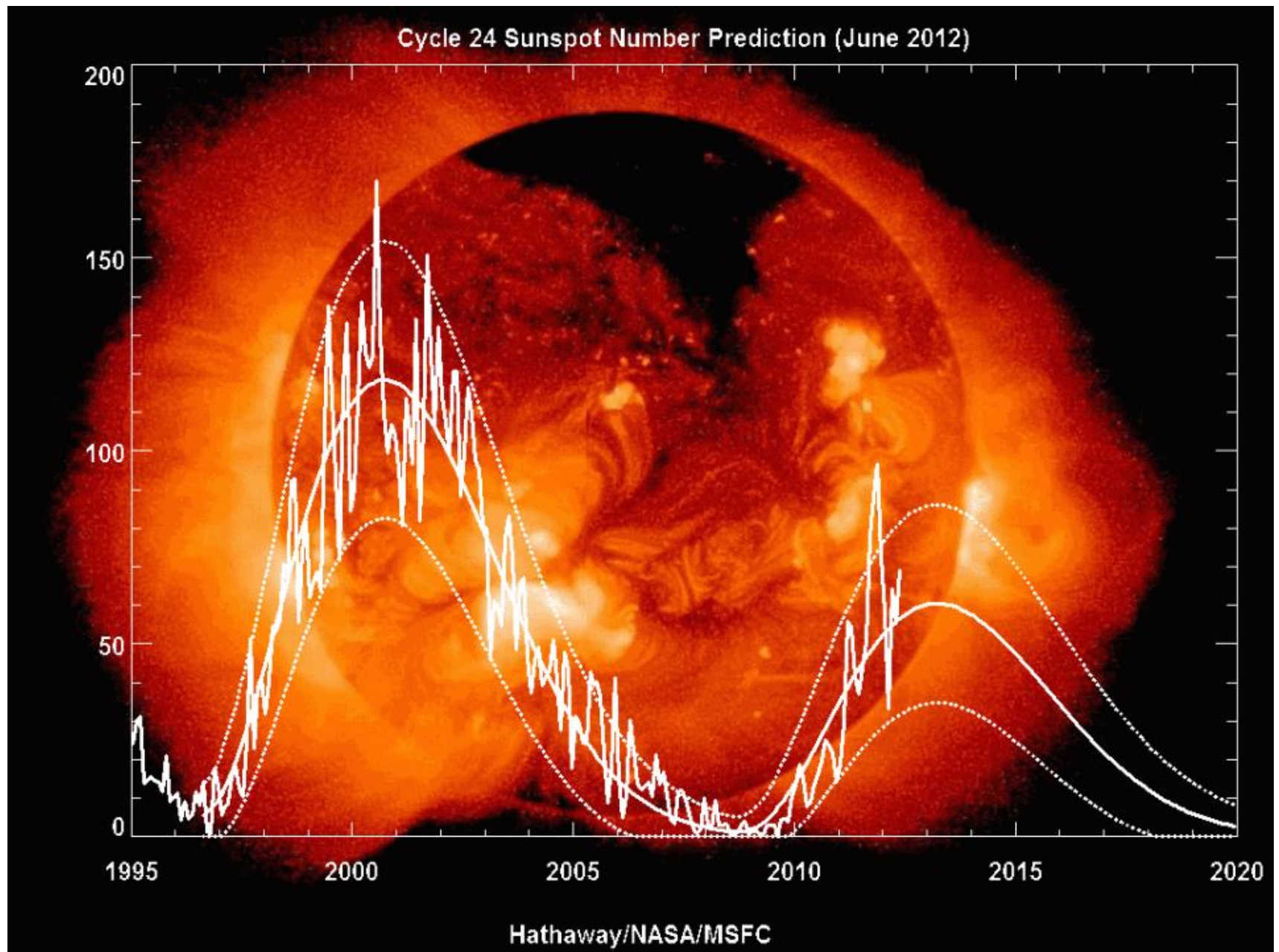
In a magnetic field the original line splits into three

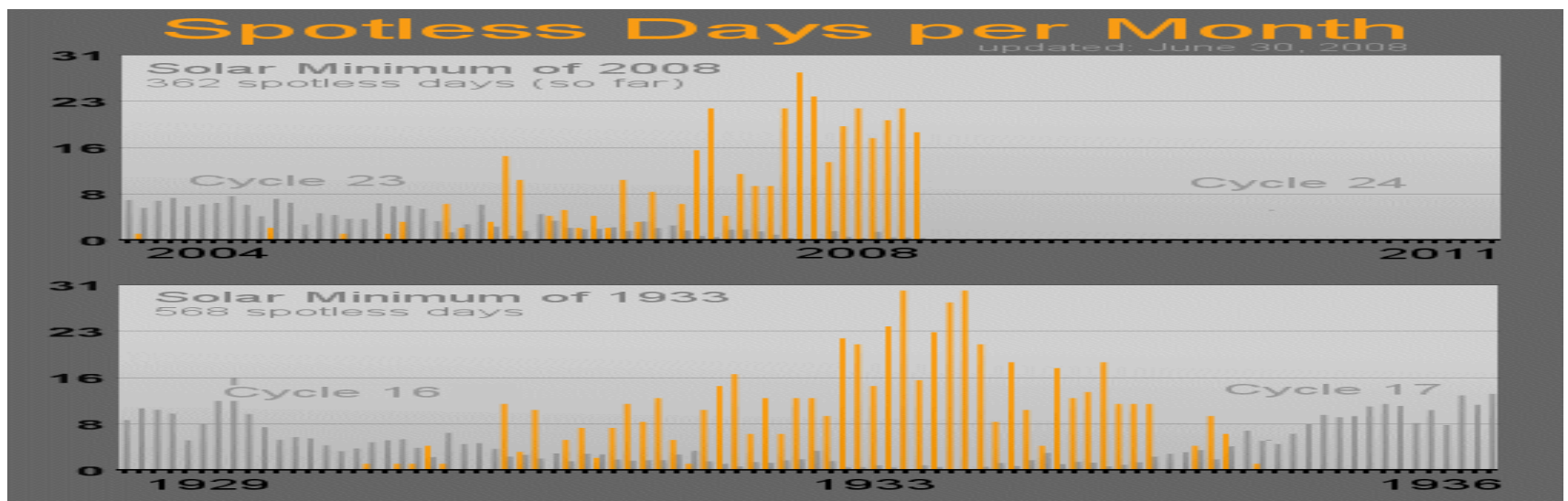
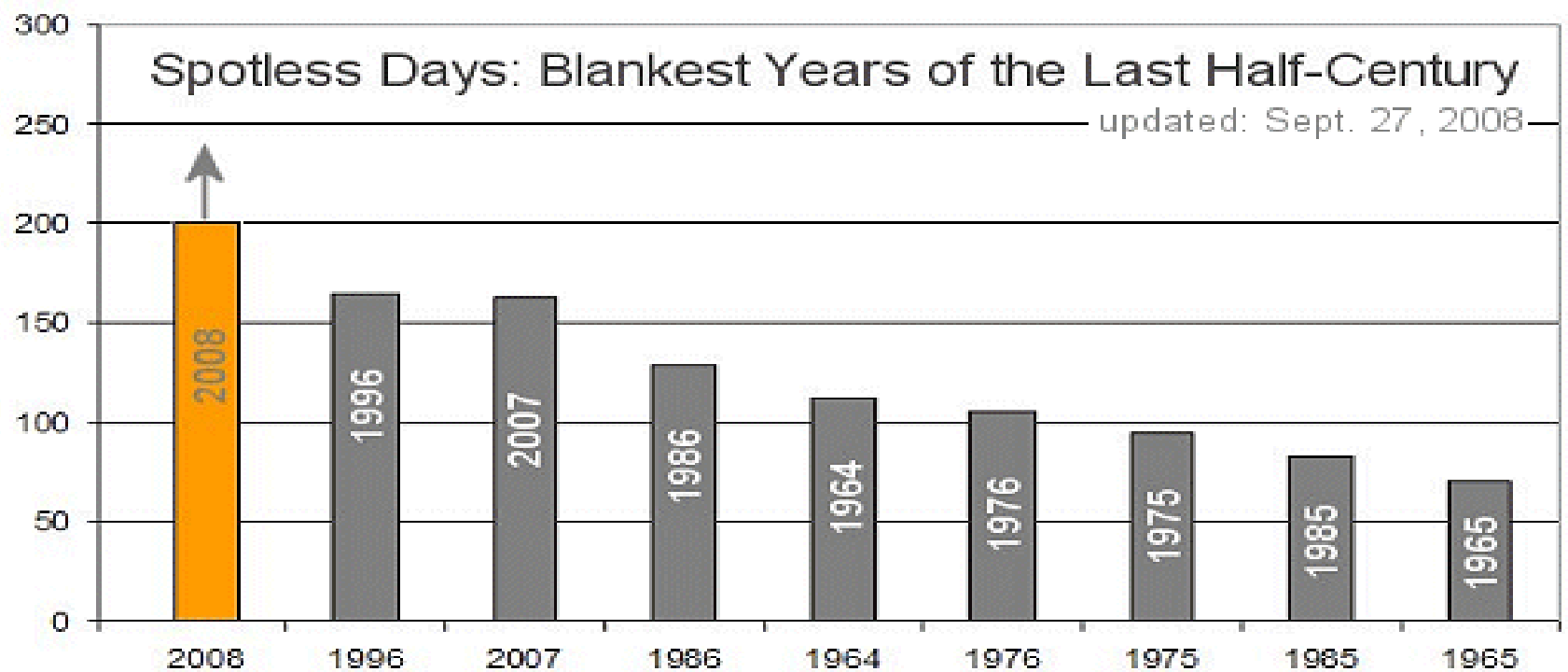




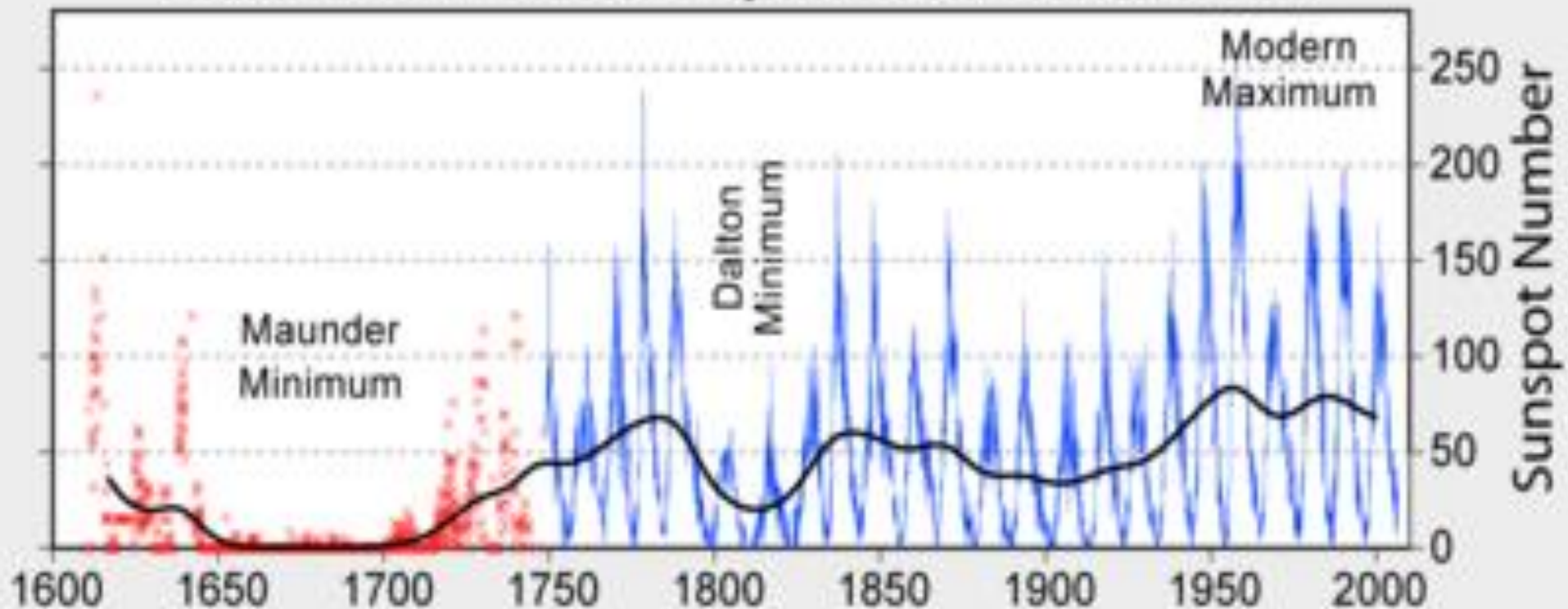


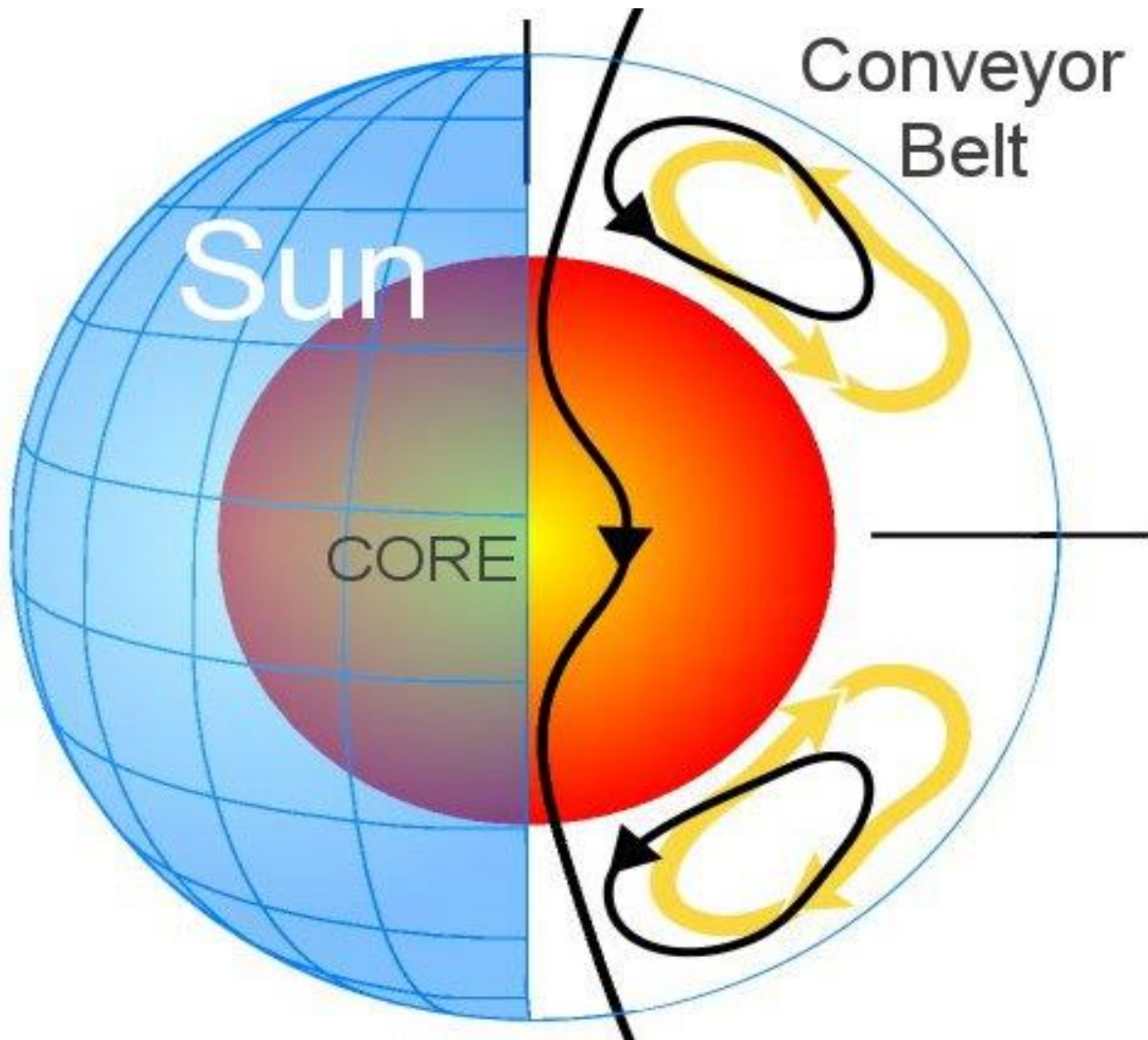


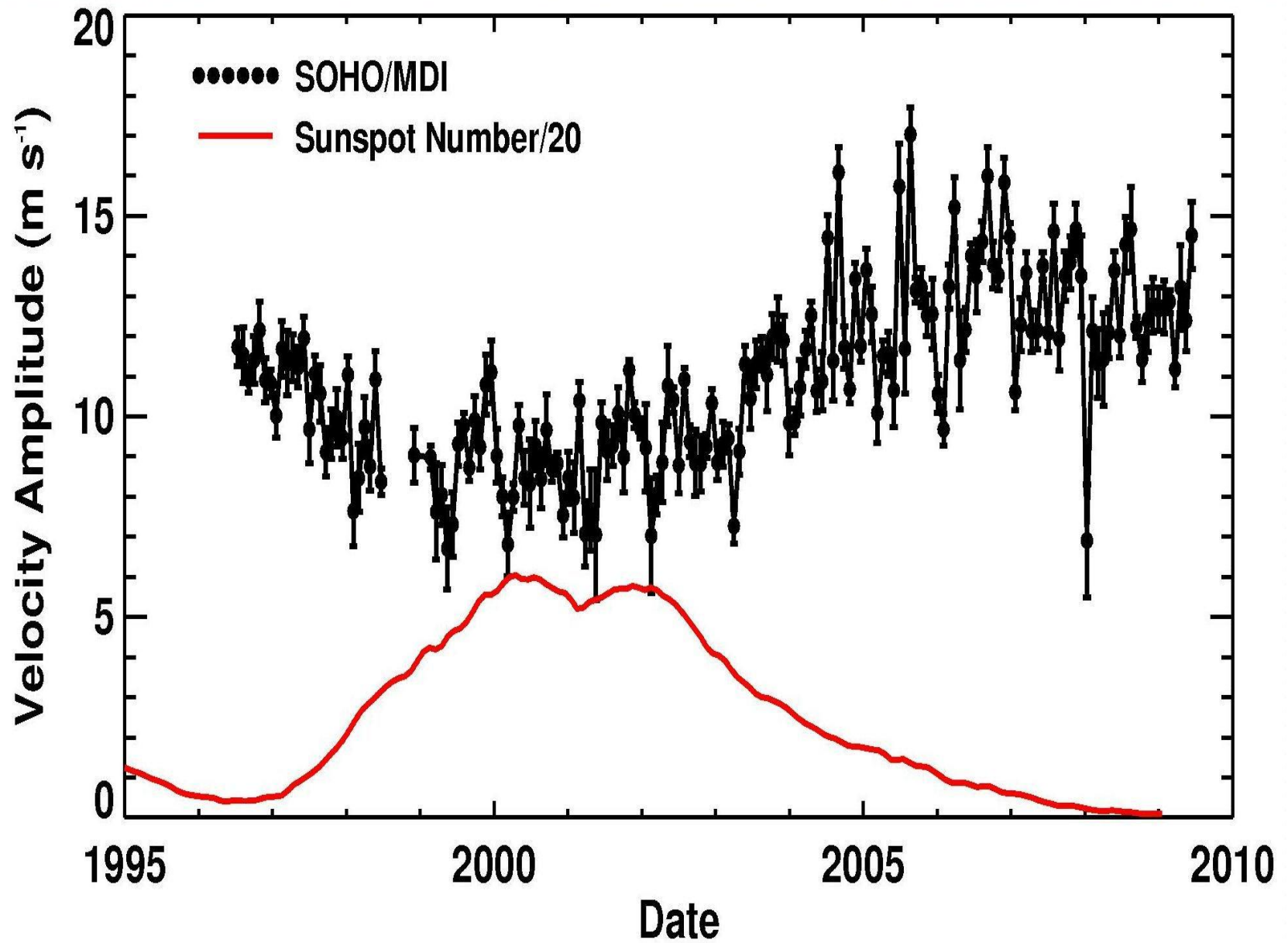




400 Years of Sunspot Observations

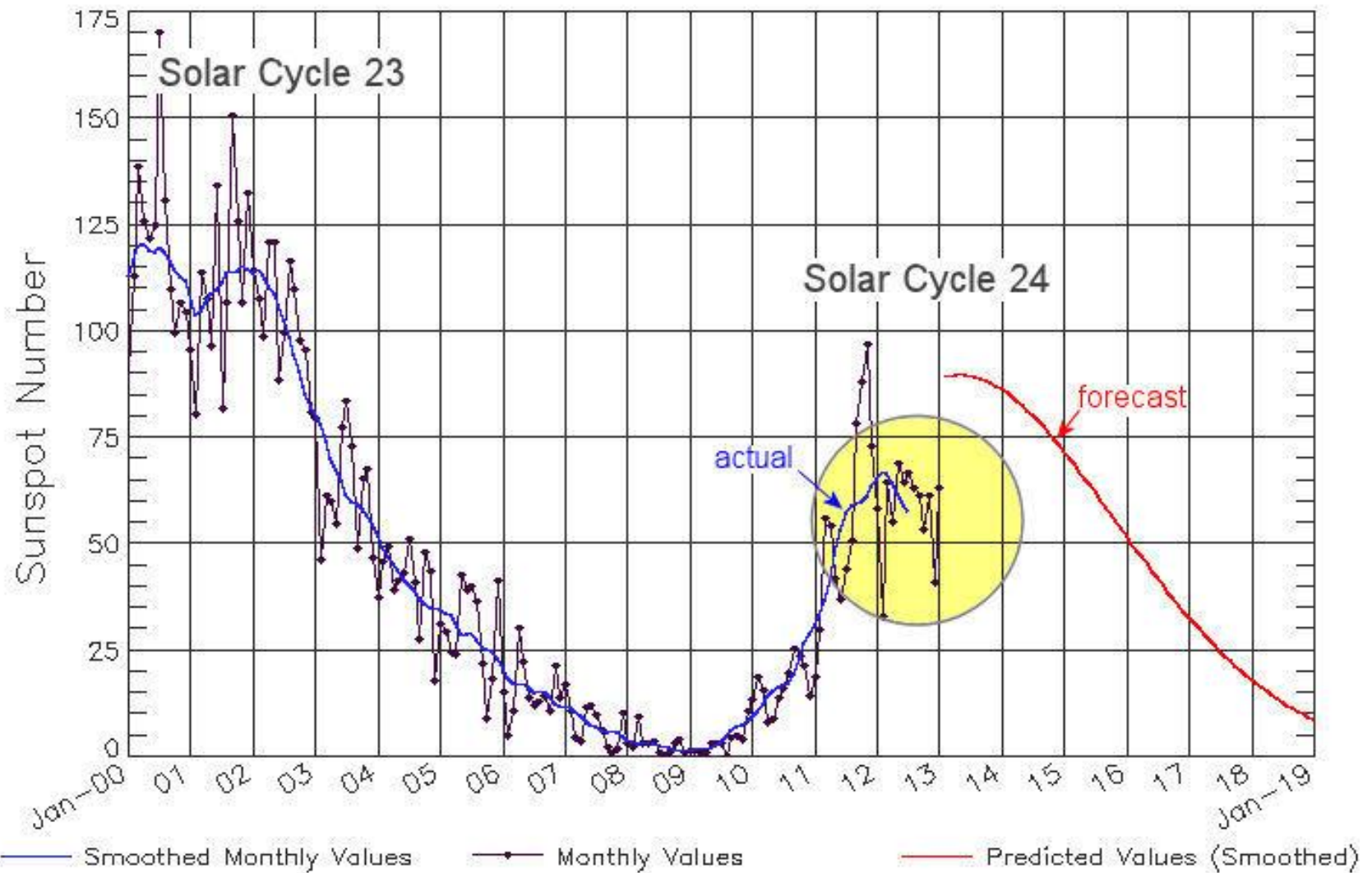






ISES Solar Cycle Sunspot Number Progression

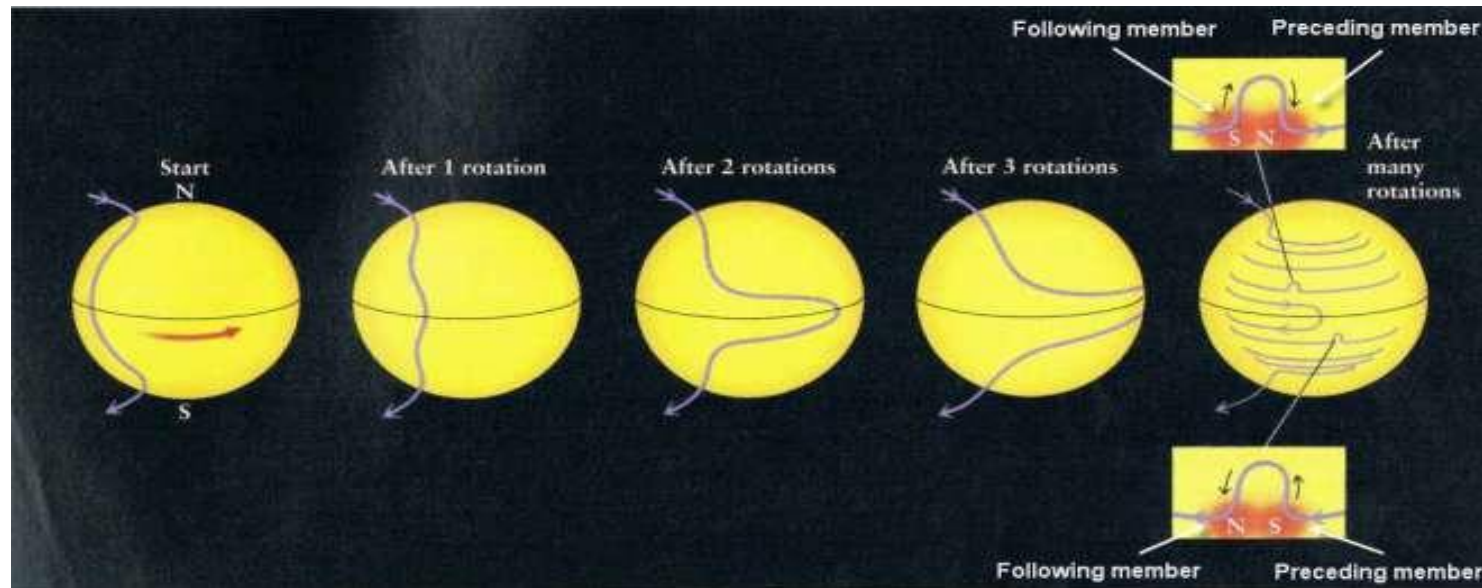
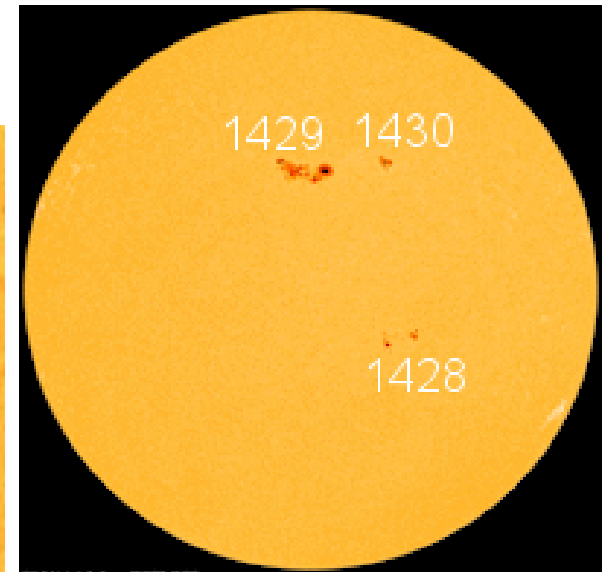
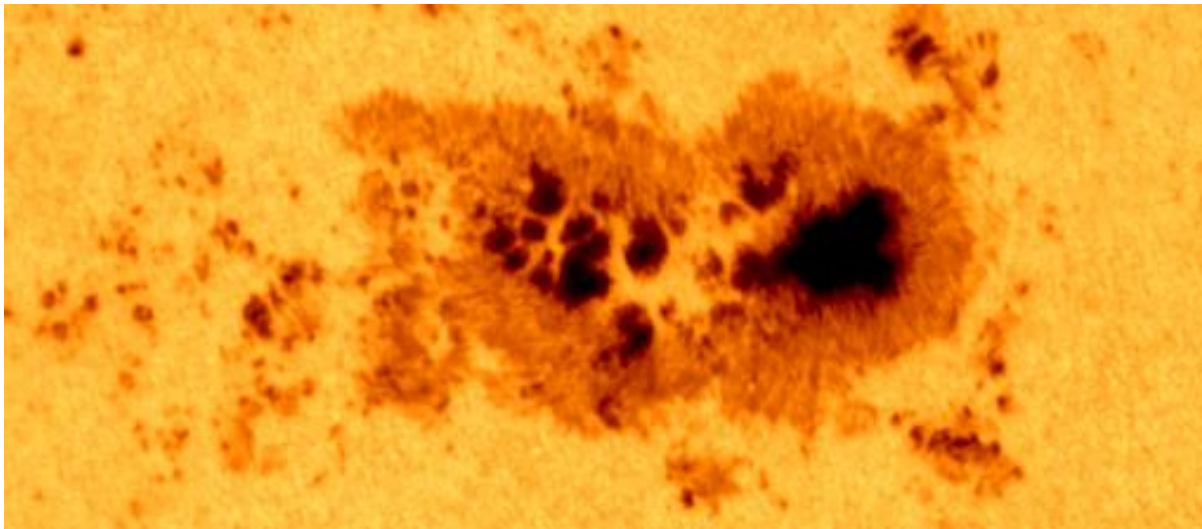
Observed data through Jan 2013



Updated 2013 Feb 4

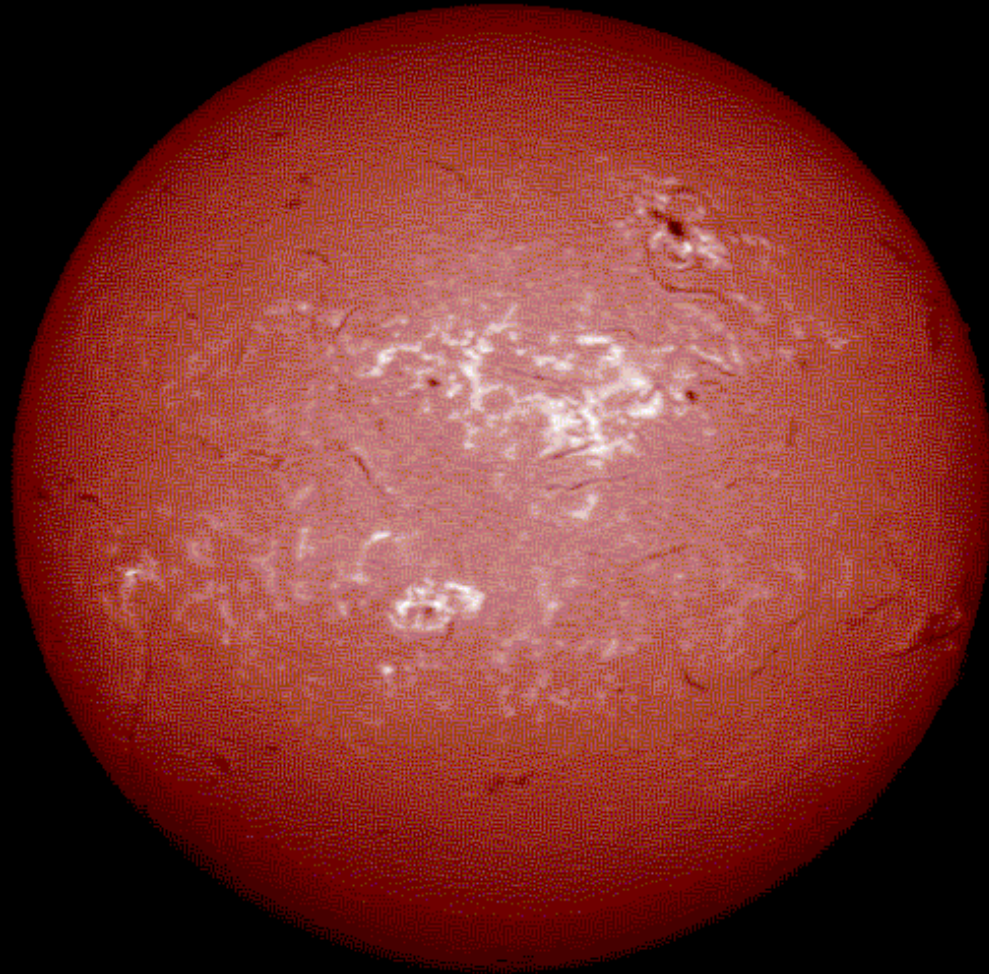
NOAA/SWPC Boulder, CO USA

MARCH 2012



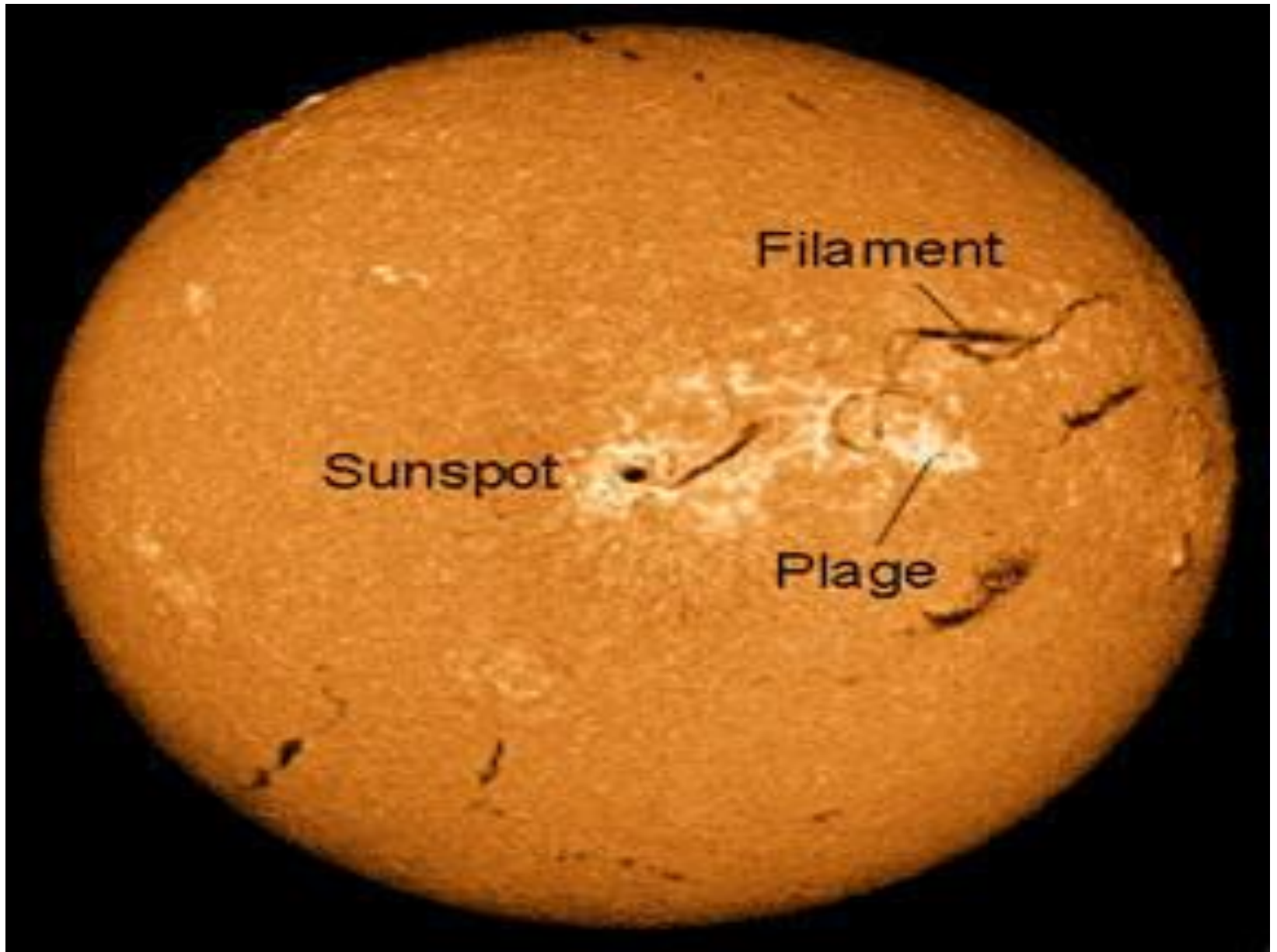
H I 6563 Å

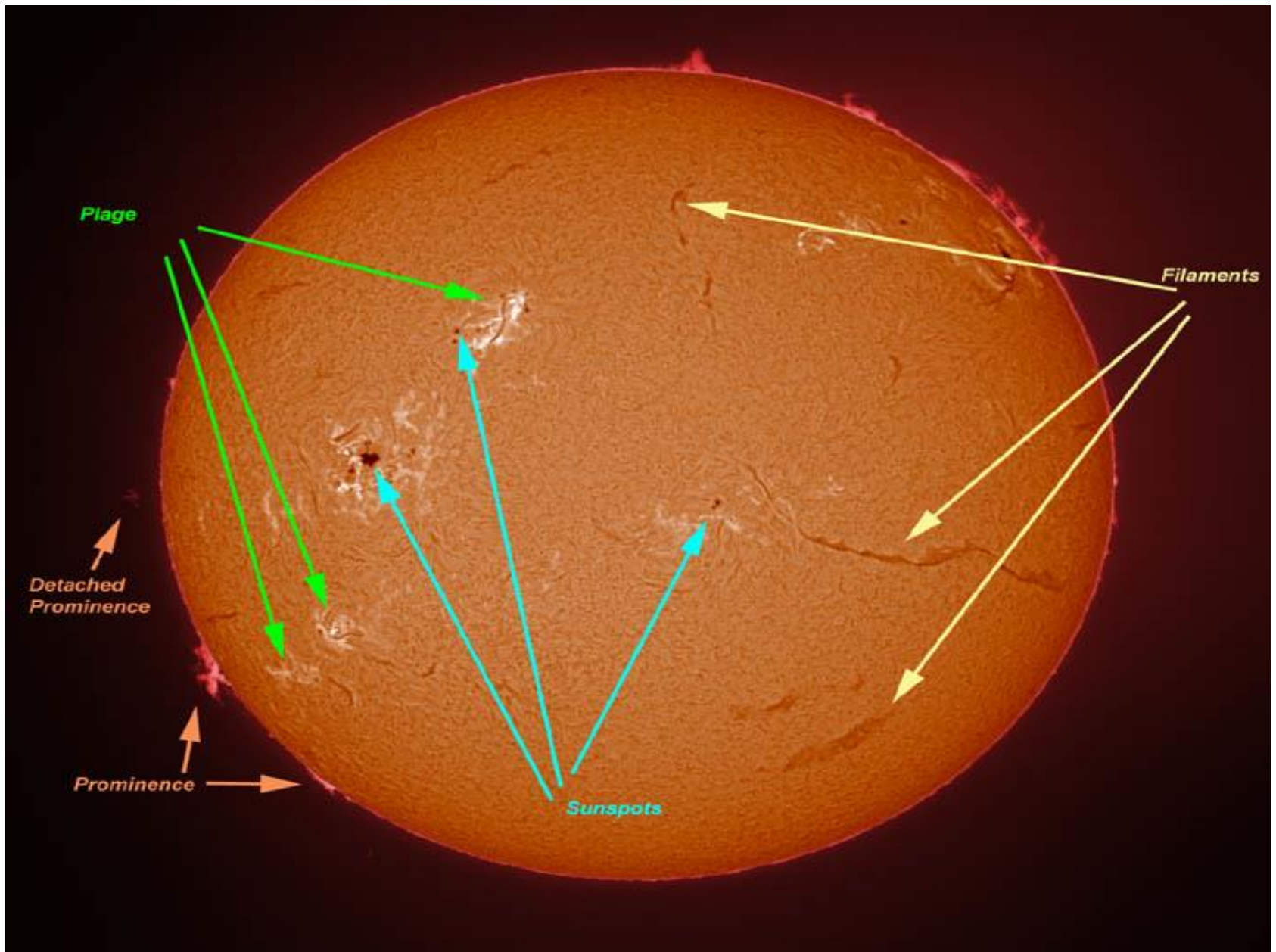
BBSO



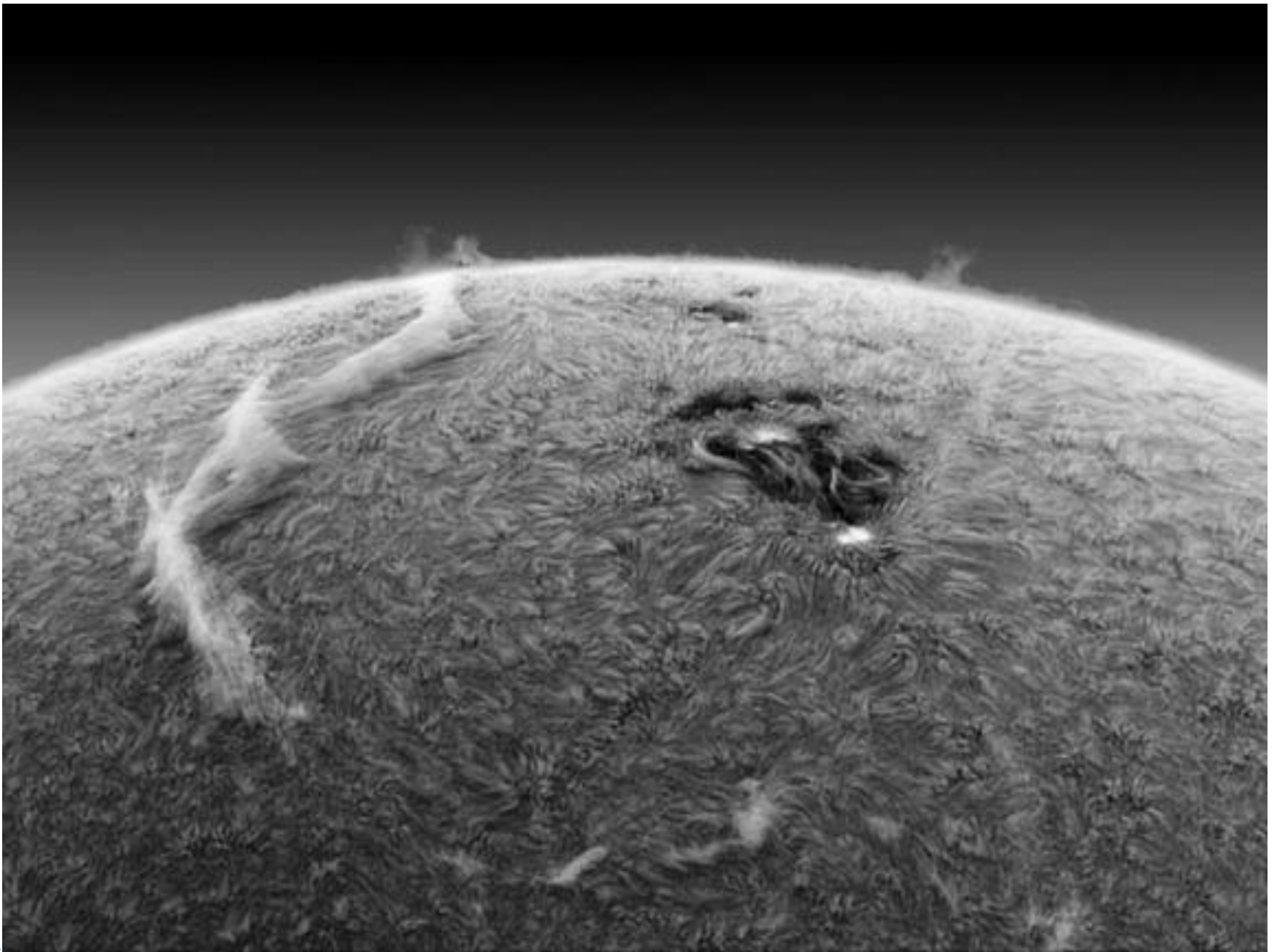
1991 May 13

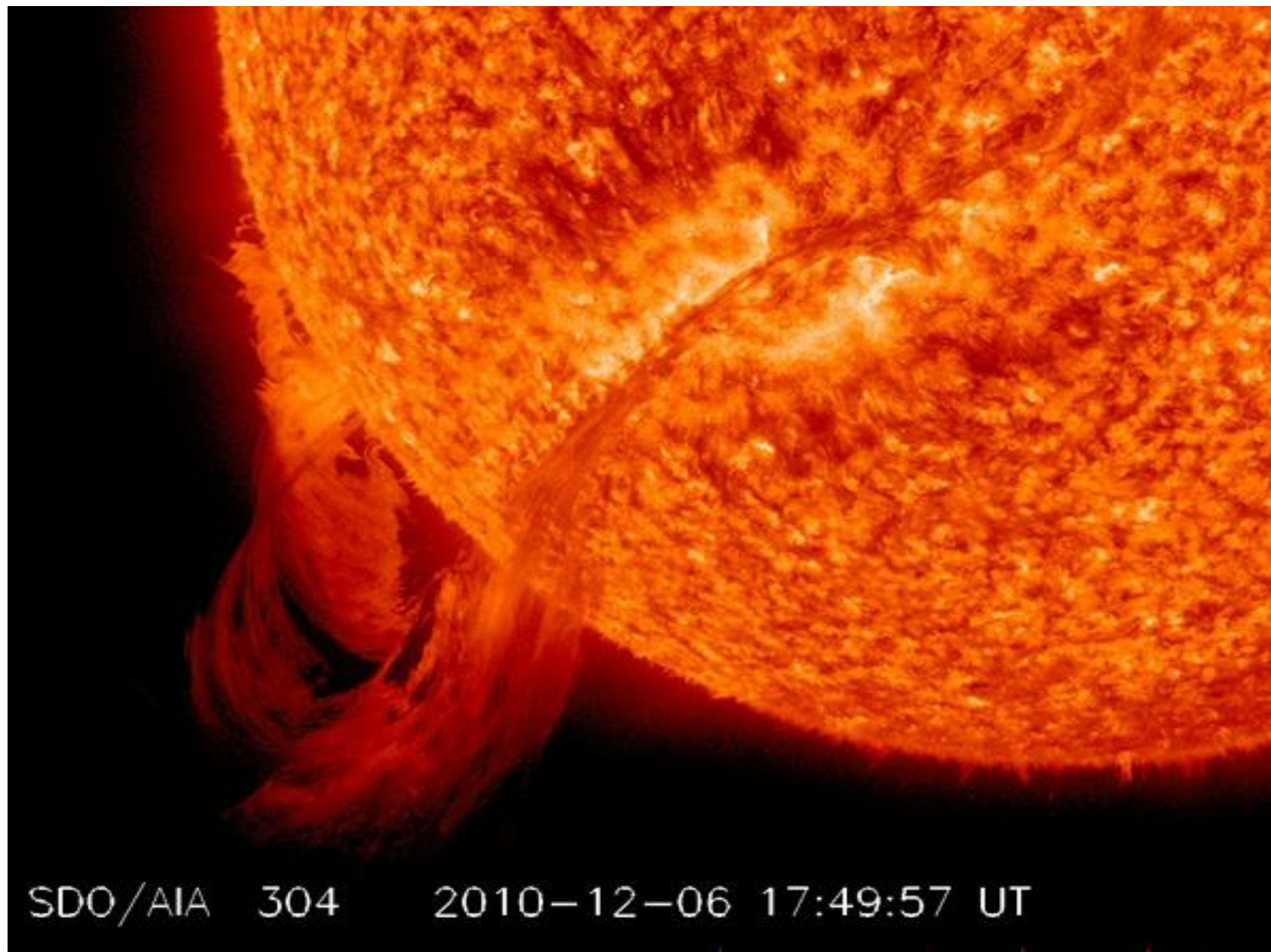






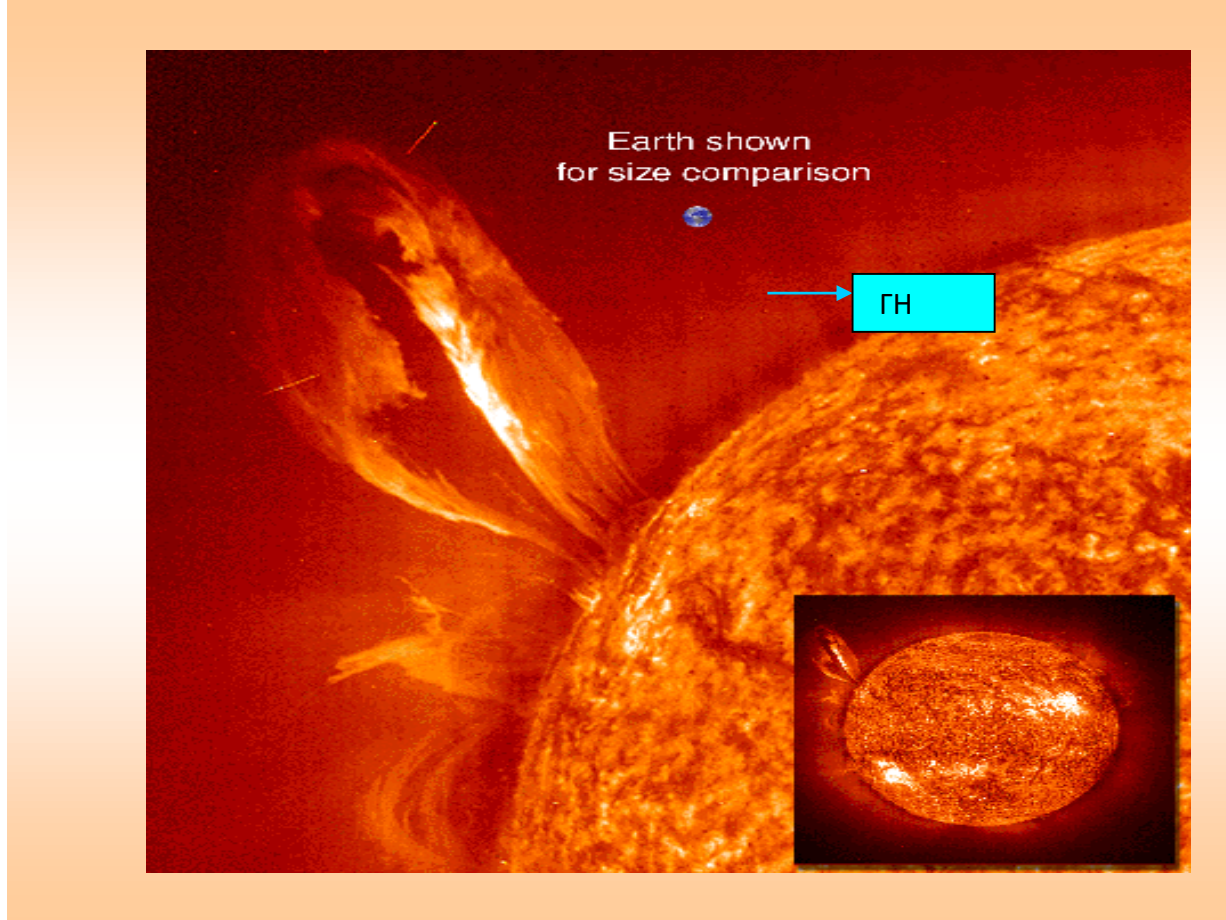






SDO/AIA 304 2010-12-06 17:49:57 UT



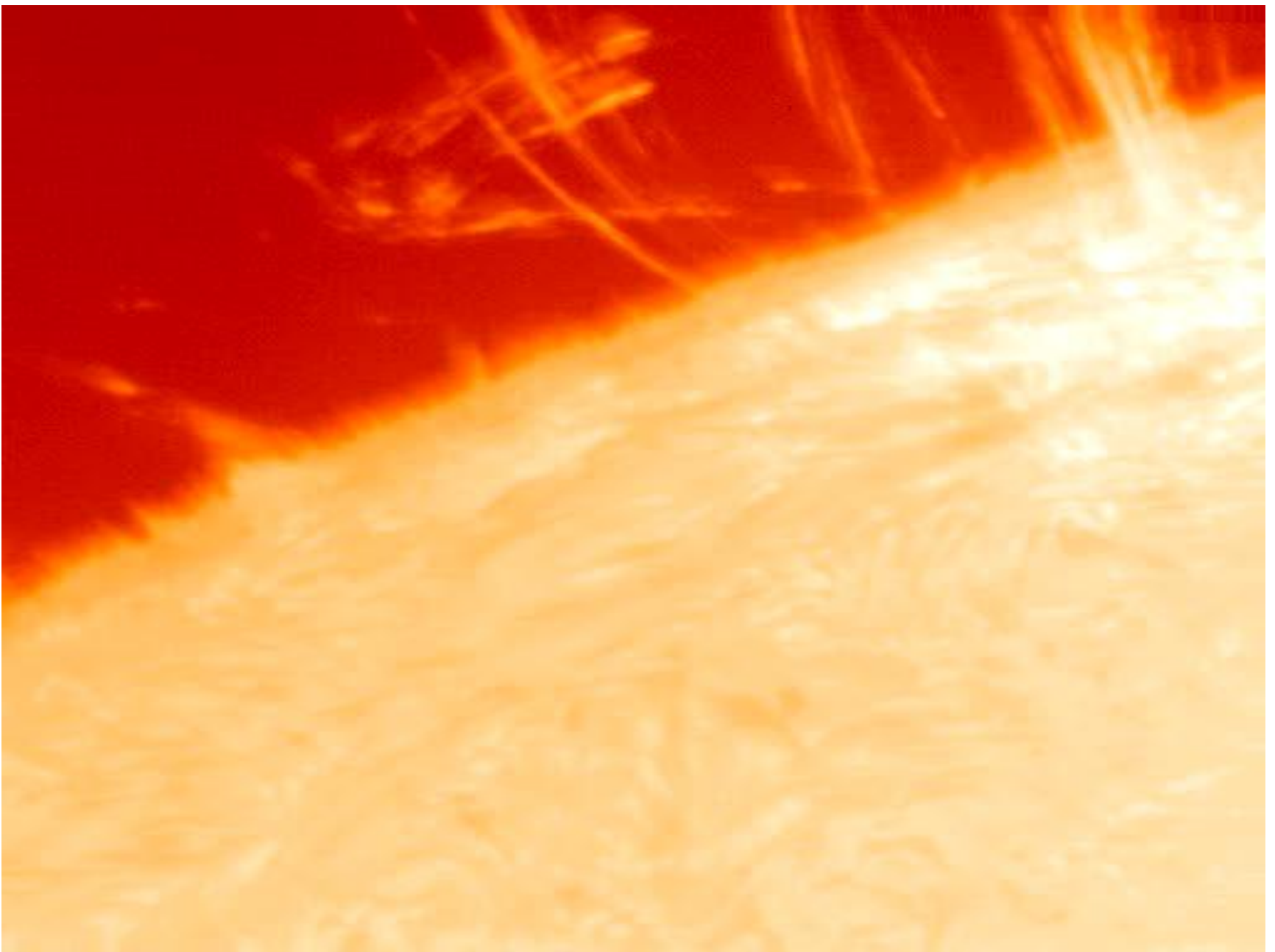


Οι προεξοχές όπως και τα νήματα μπορούν να παρουσιάζουν πολλές φορές βίαιη συμπεριφορά ως απόρροια της αποσταθεροποίησης του μαγνητικού πεδίου που υποβόσκει. Έτσι αυτές διακρίνονται ανάλογα με την **ένταση** και την **ισχύ** τους σε:

ήρεμες (quiescents)

ενεργές (actives)

τις οποίες εξετάζουμε ευθύς αμέσως.

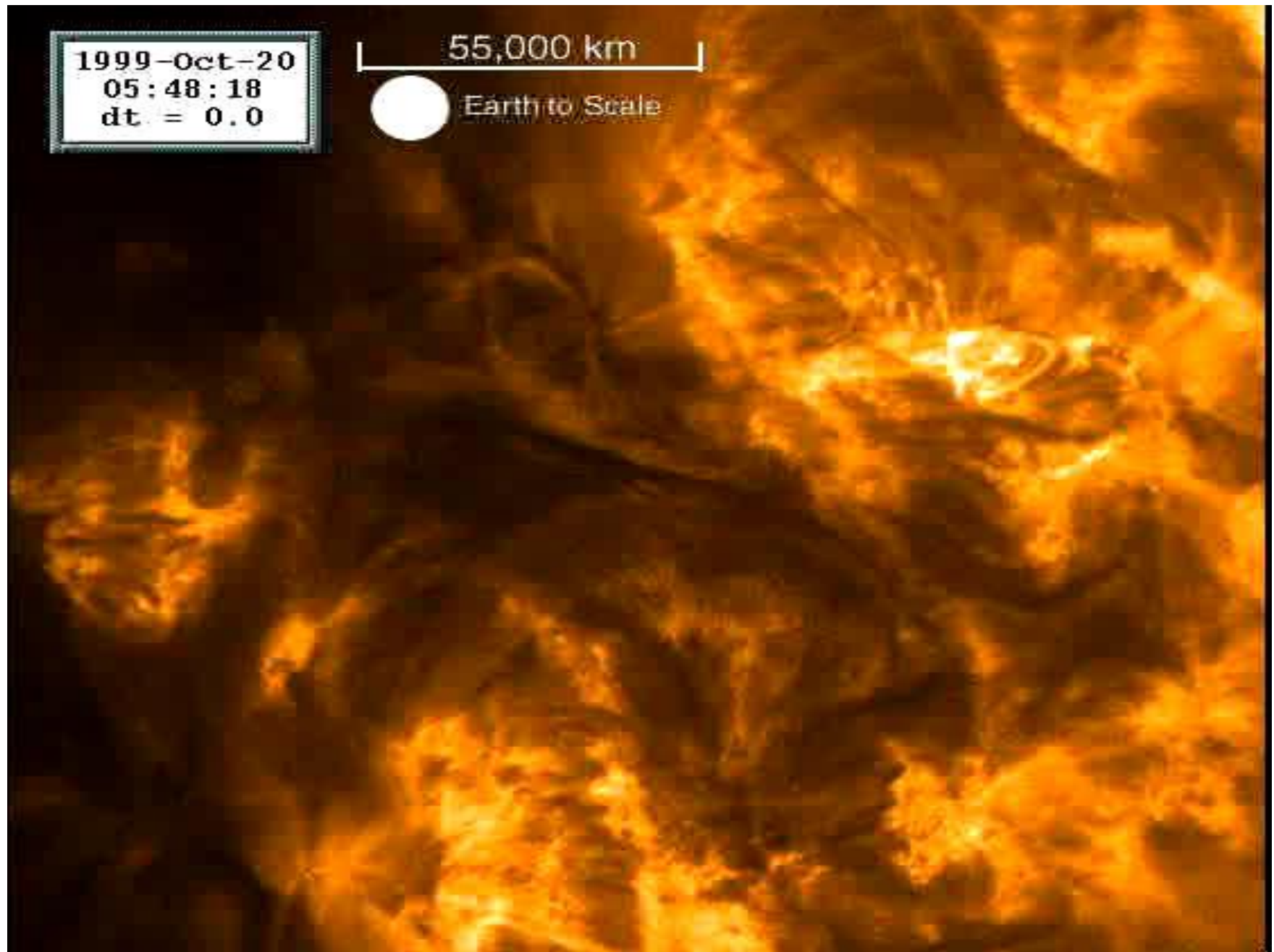


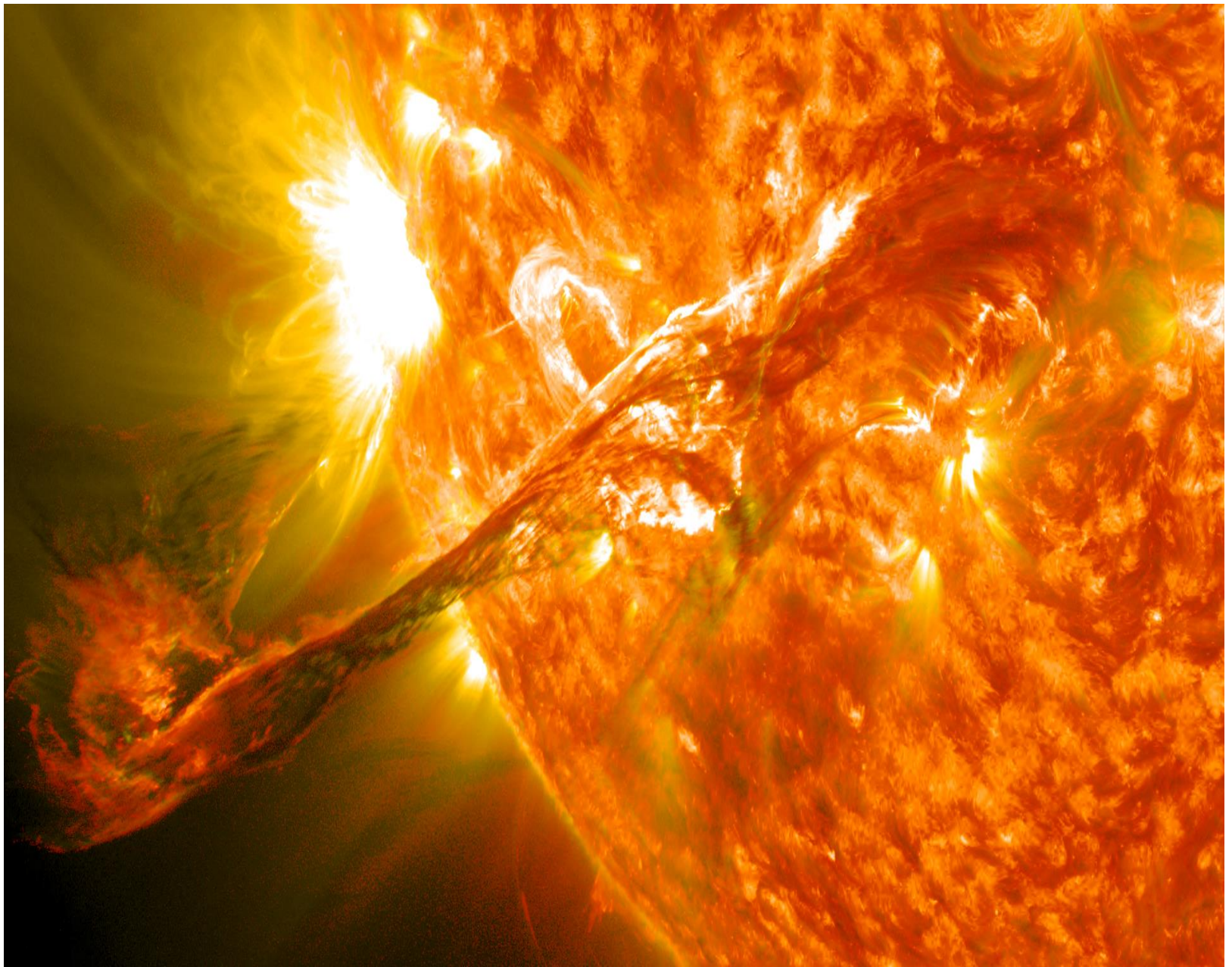
1999-Oct-20
05:48:18
dt = 0.0

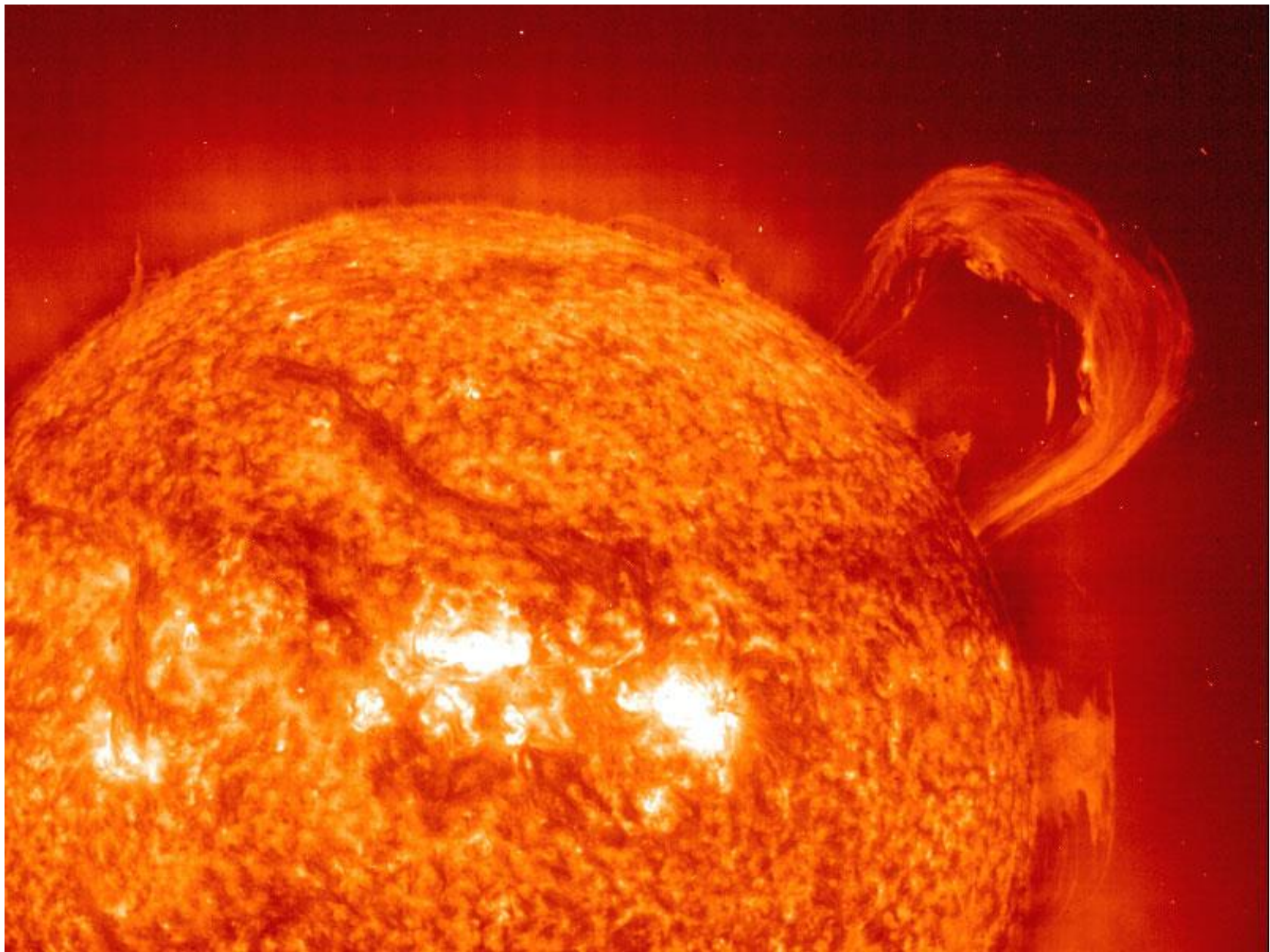
55,000 km

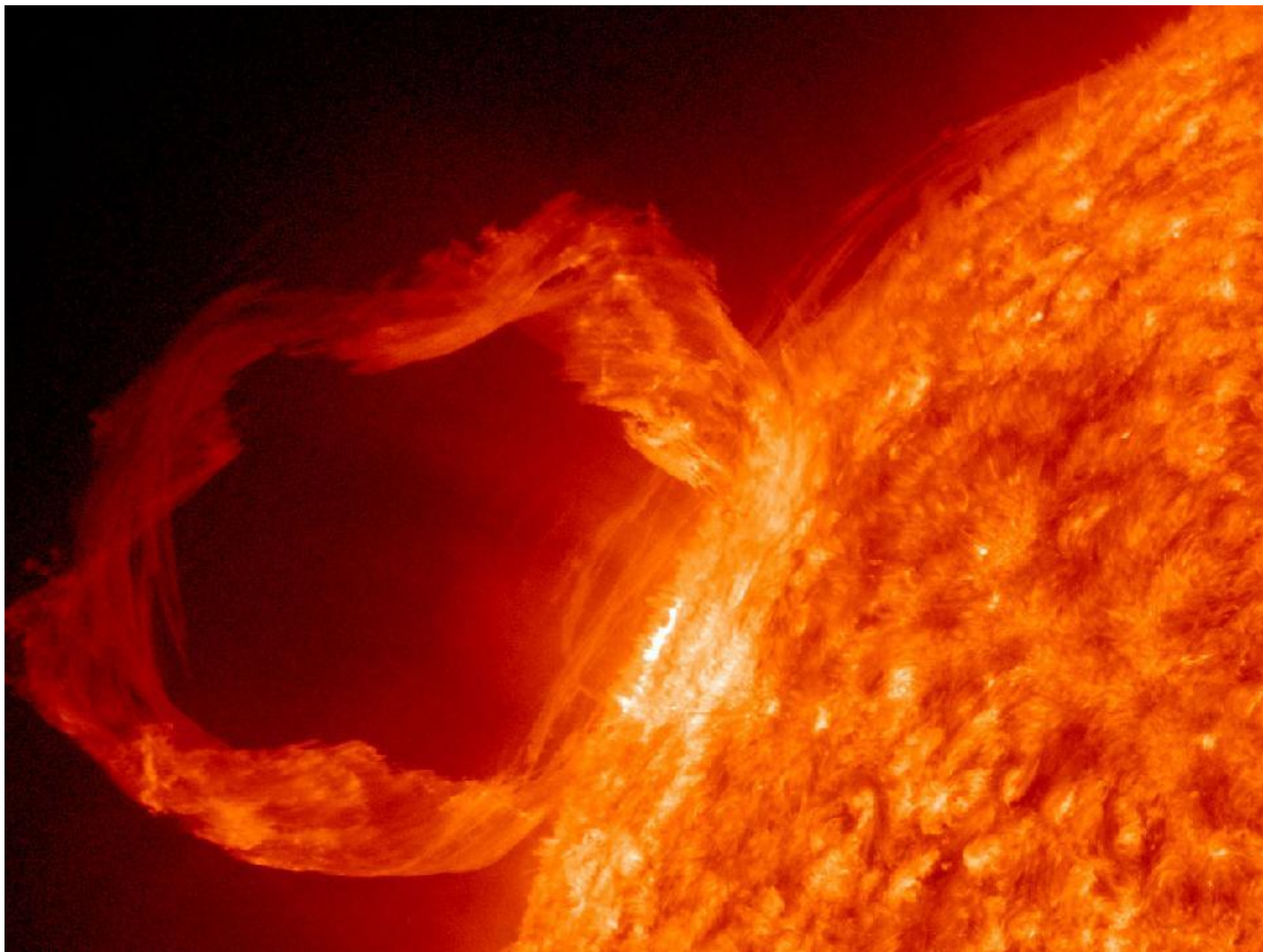


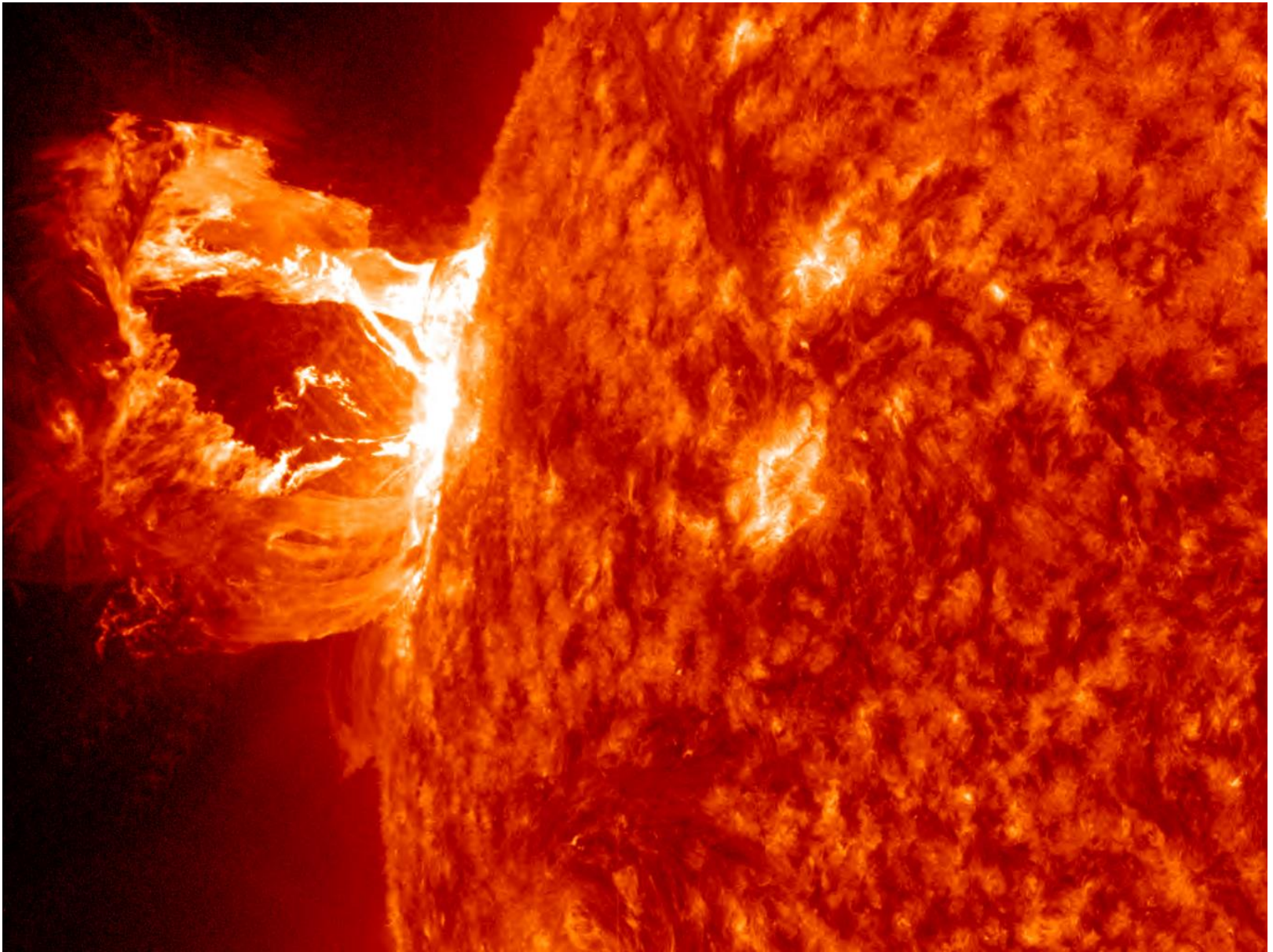
Earth to Scale

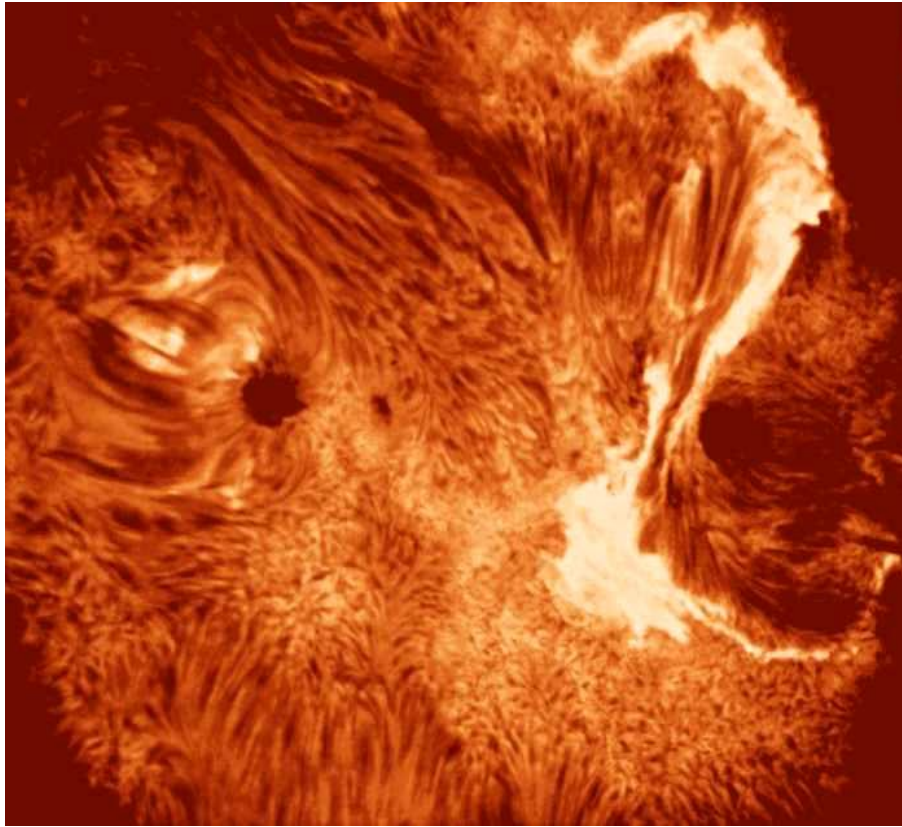




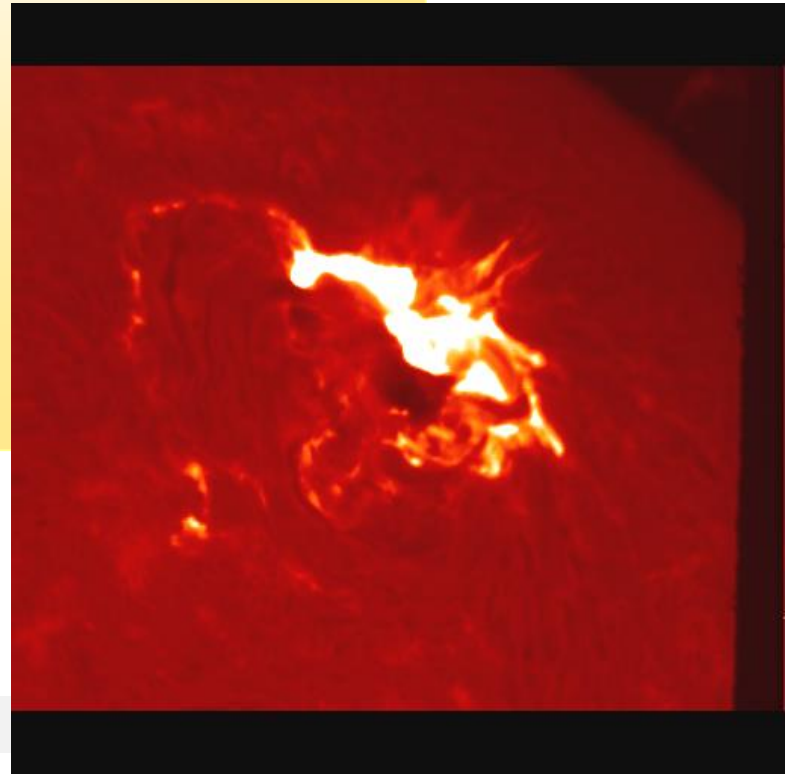


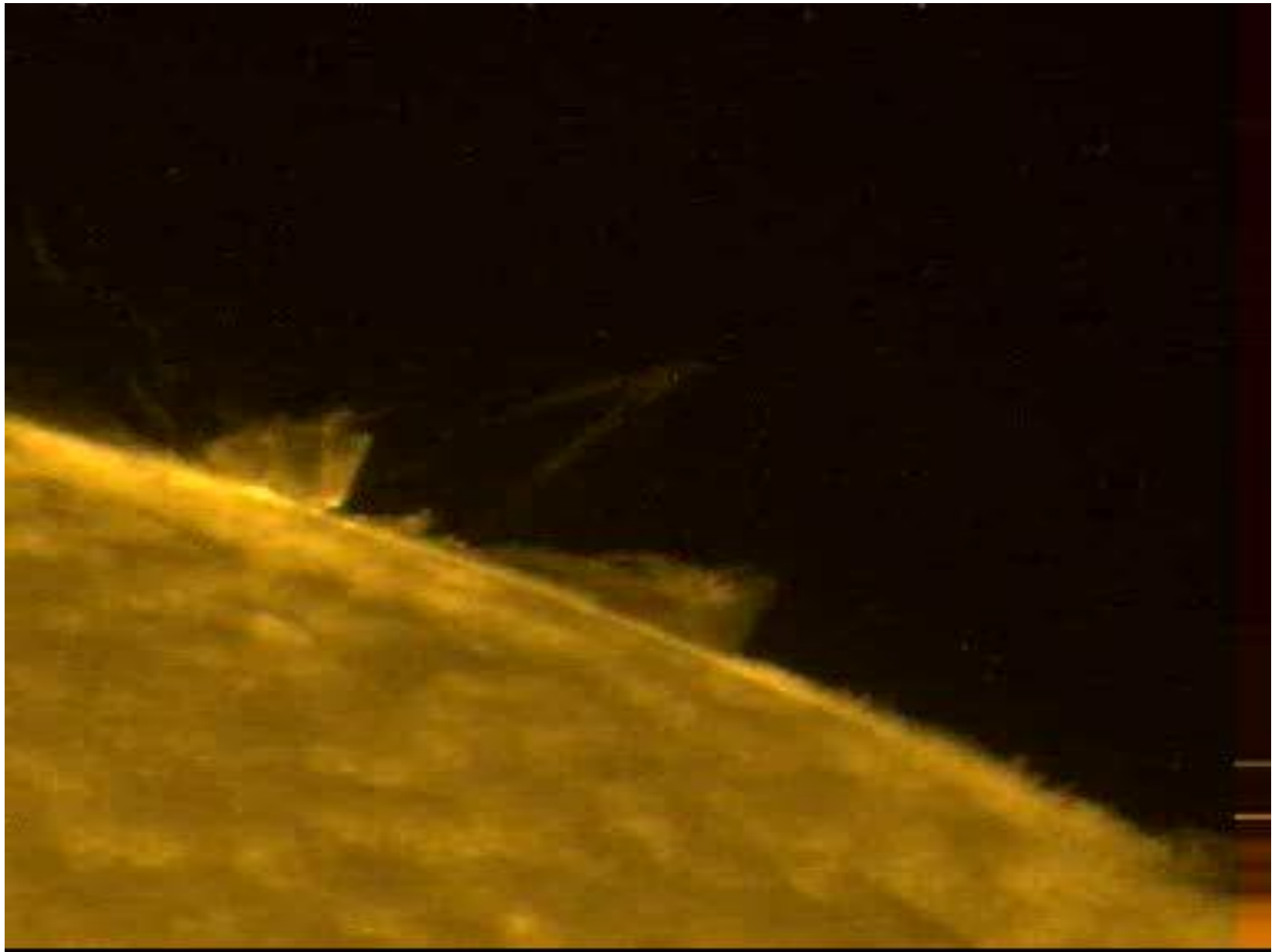




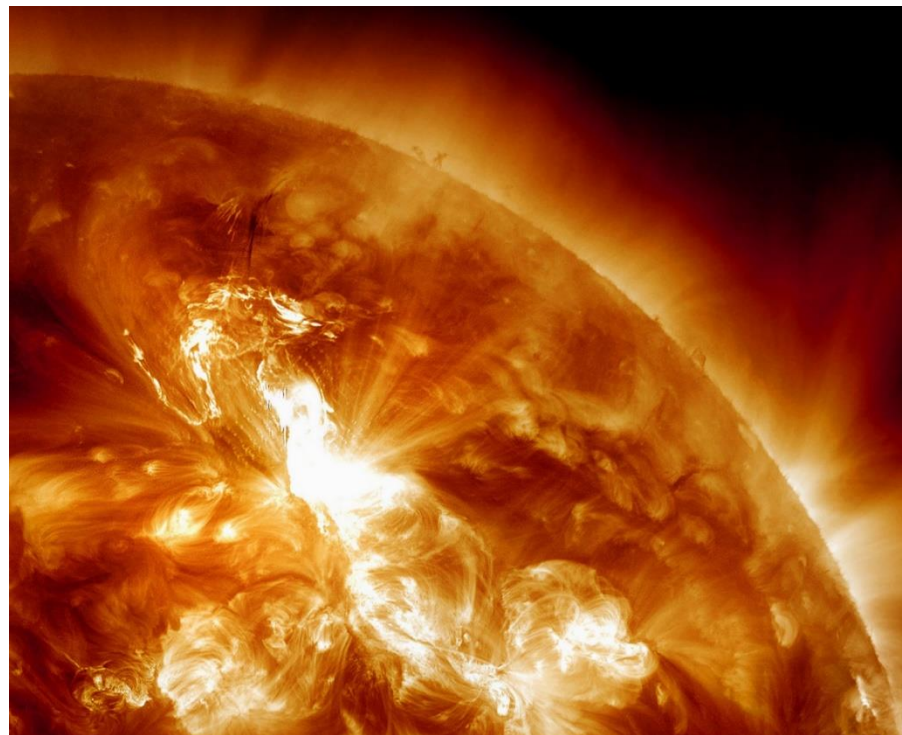
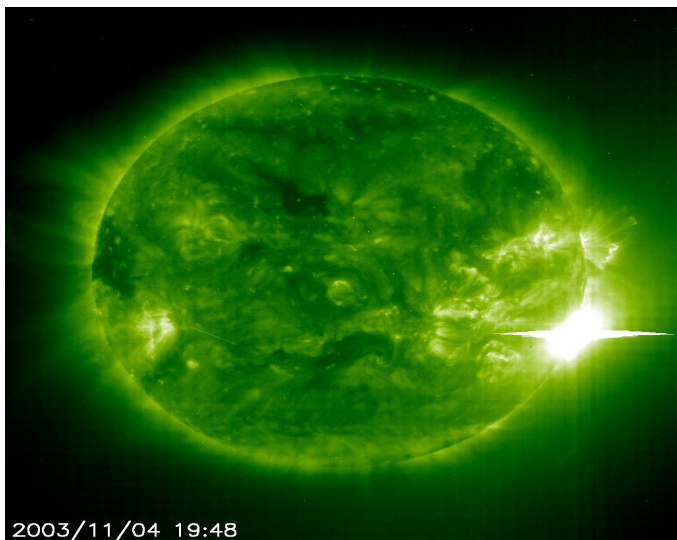
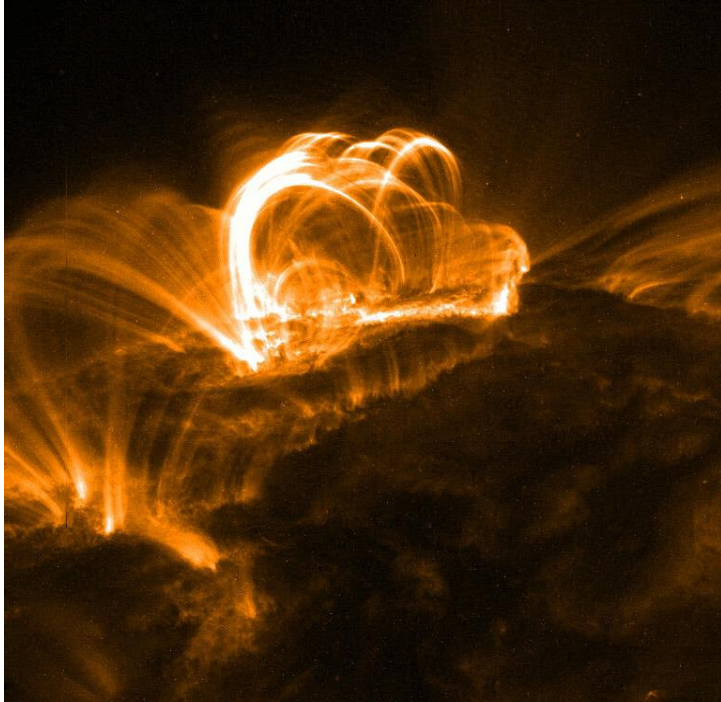


H_α.

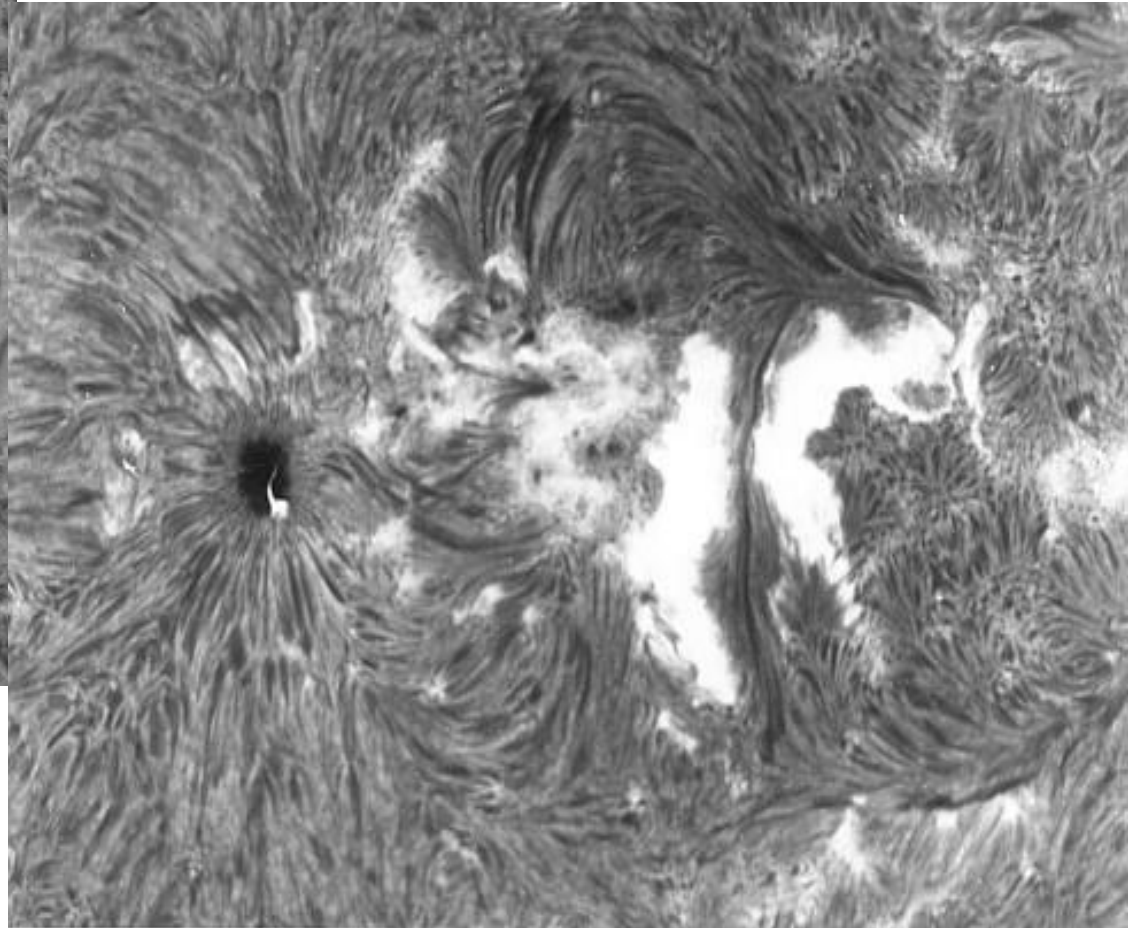
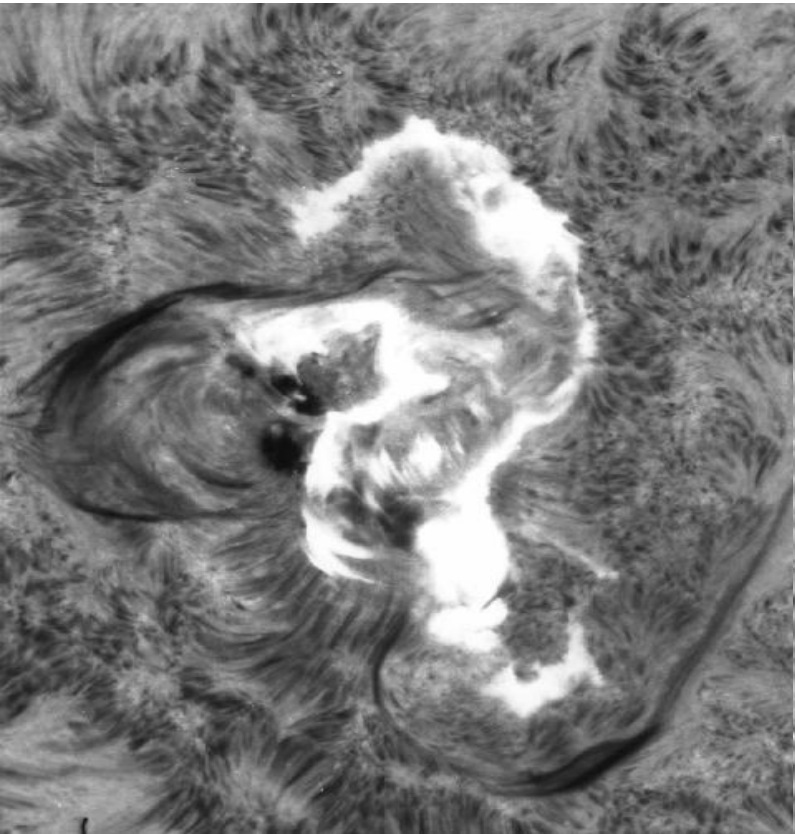




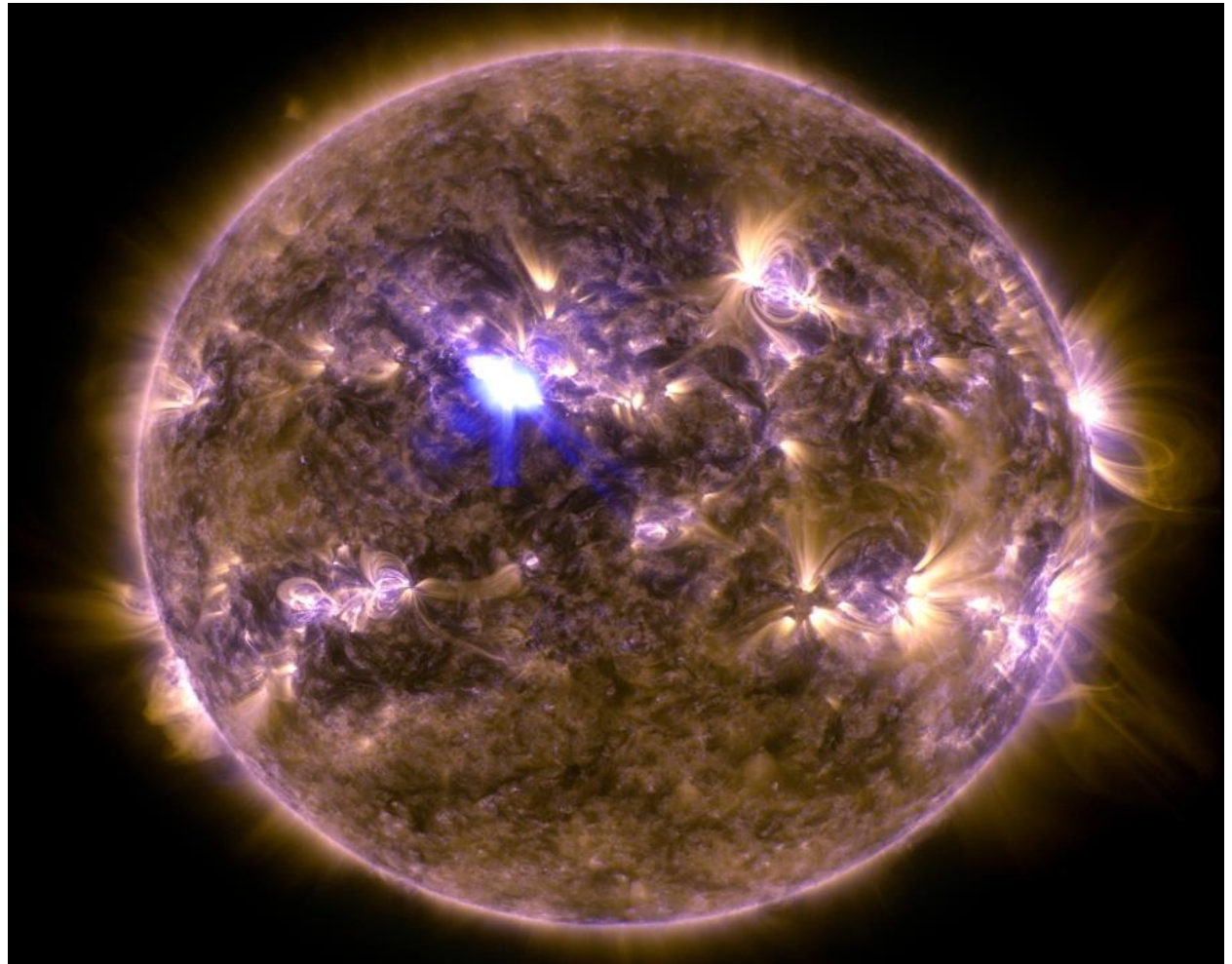
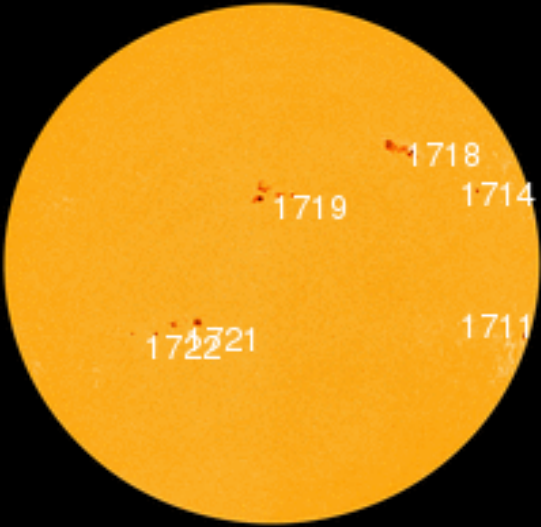




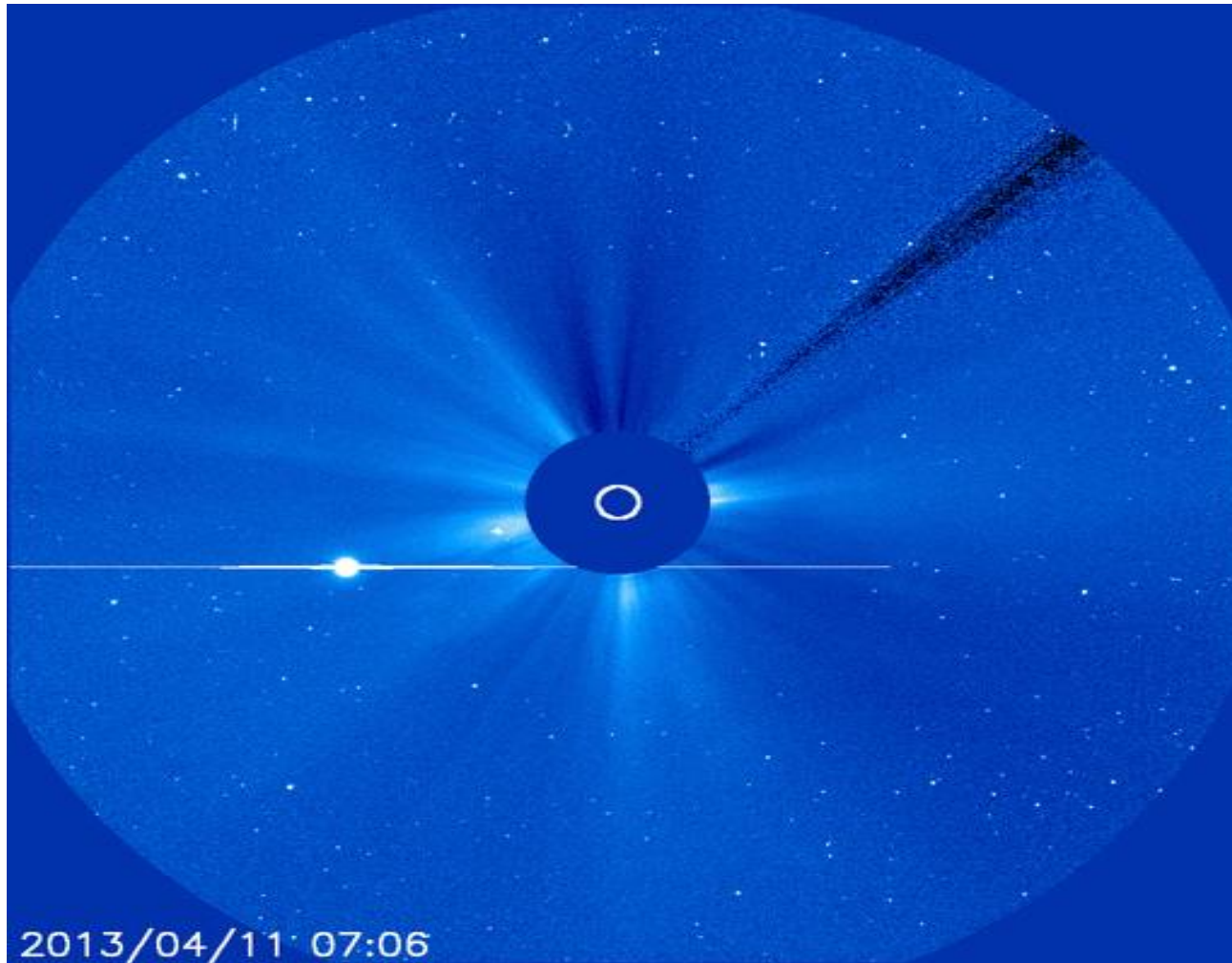
7 AUGUST 1972

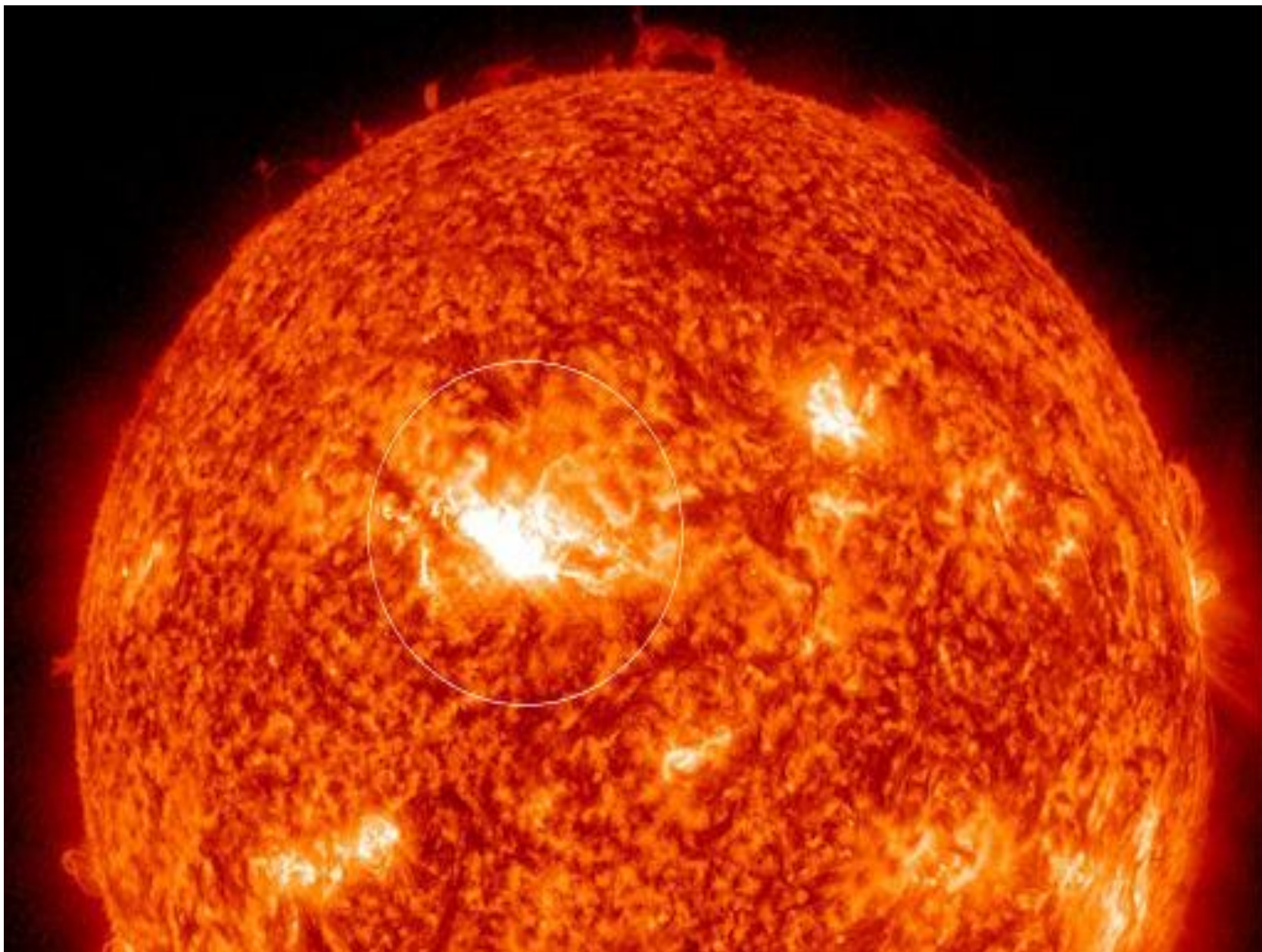


11 APRIL 2013



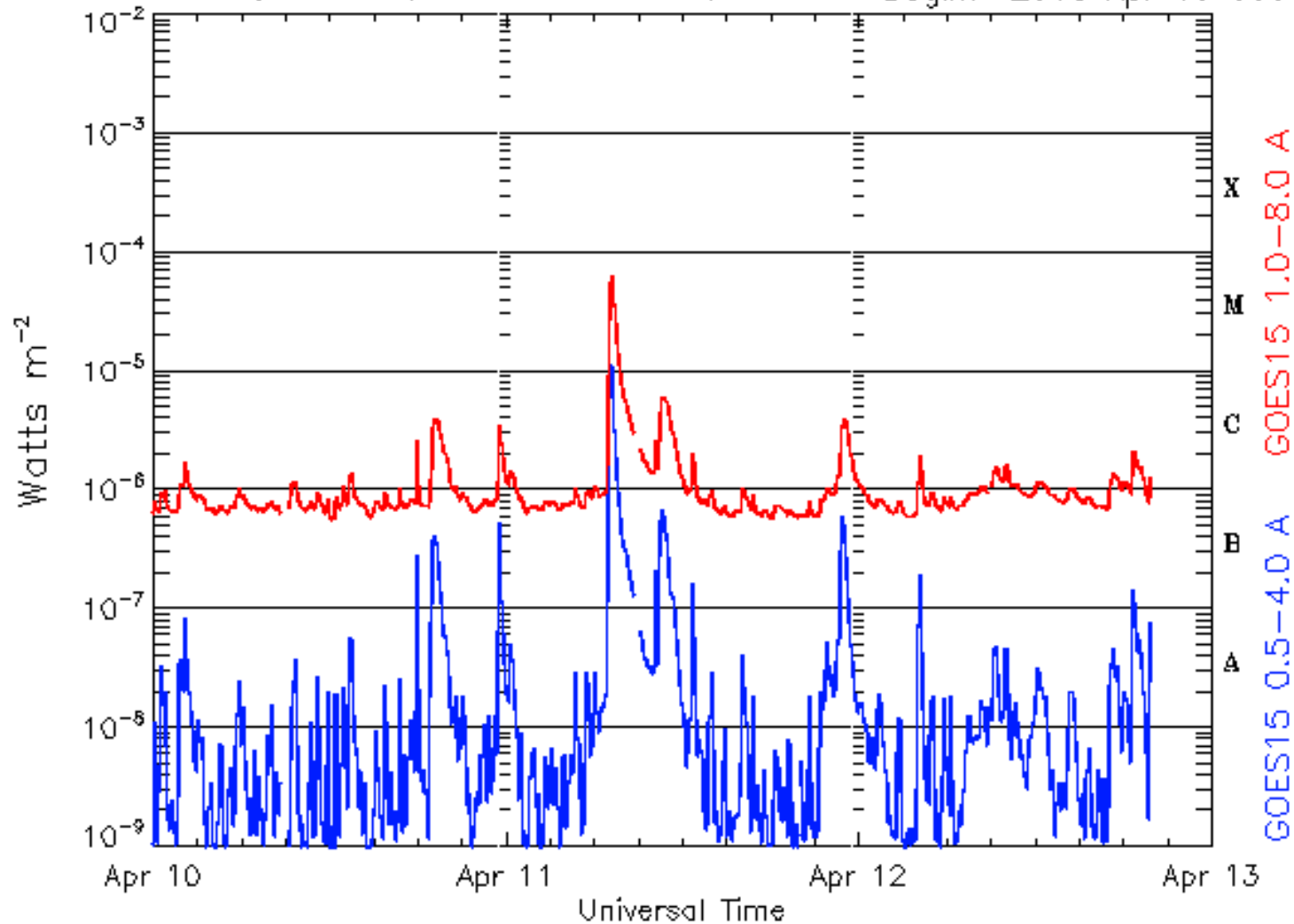
11 APRIL 2013





GOES Xray Flux (5 minute data)

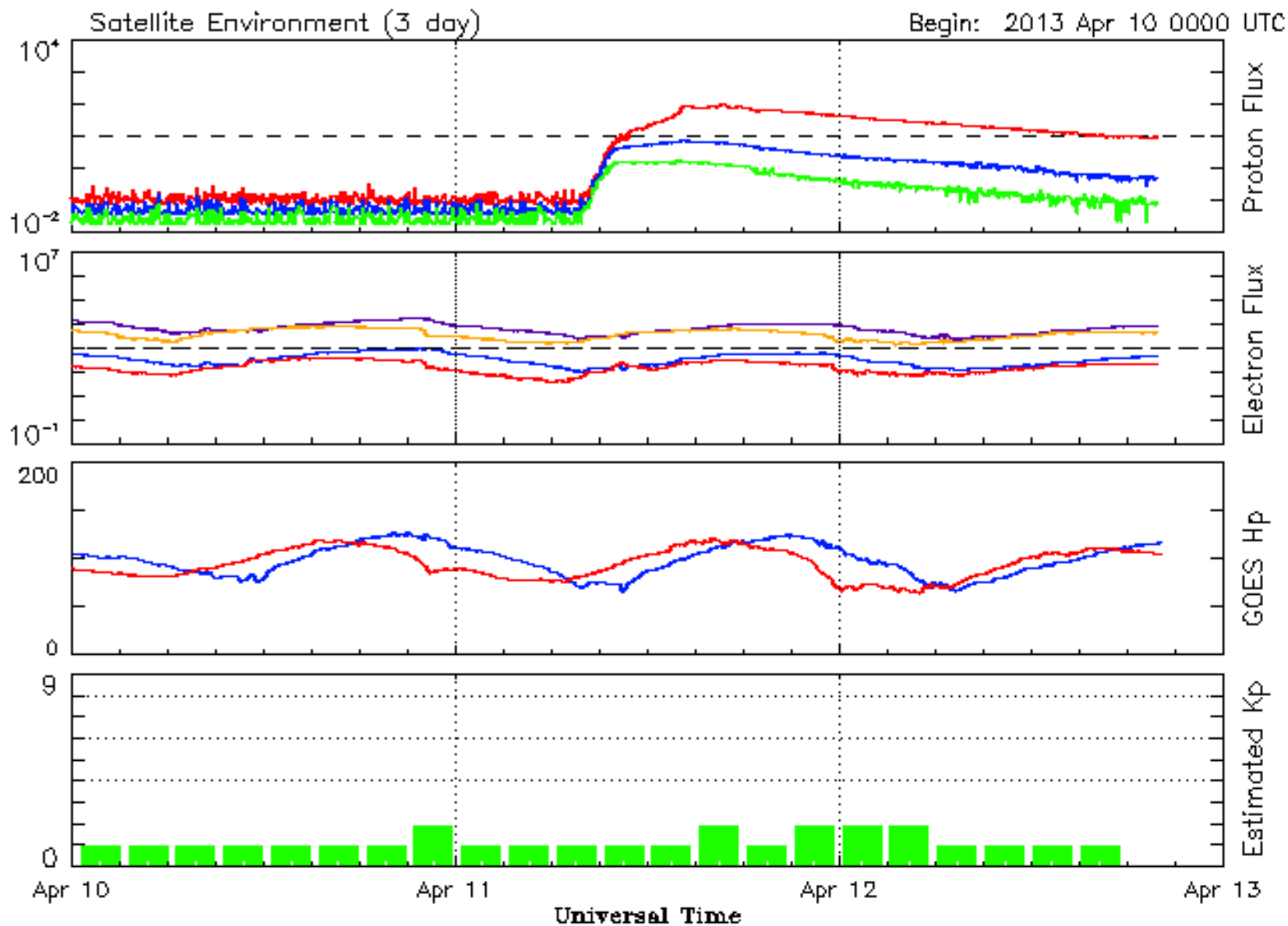
Begin: 2013 Apr 10 0000 UTC



Updated 2013 Apr 12 20:05:12 UTC

NOAA/SWPC Boulder, CO USA





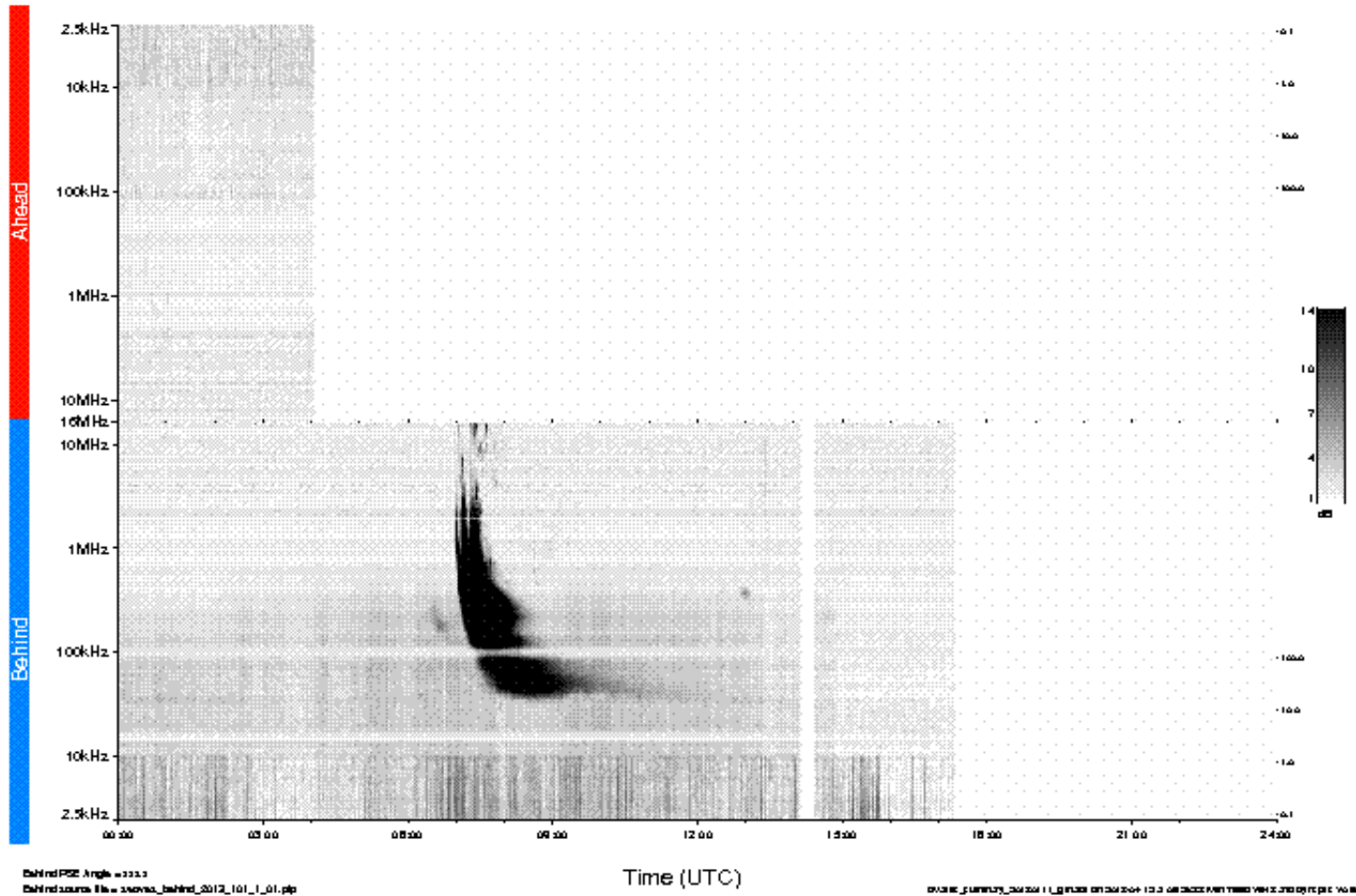
Updated 2013 Apr 12 20:06:07 UTC

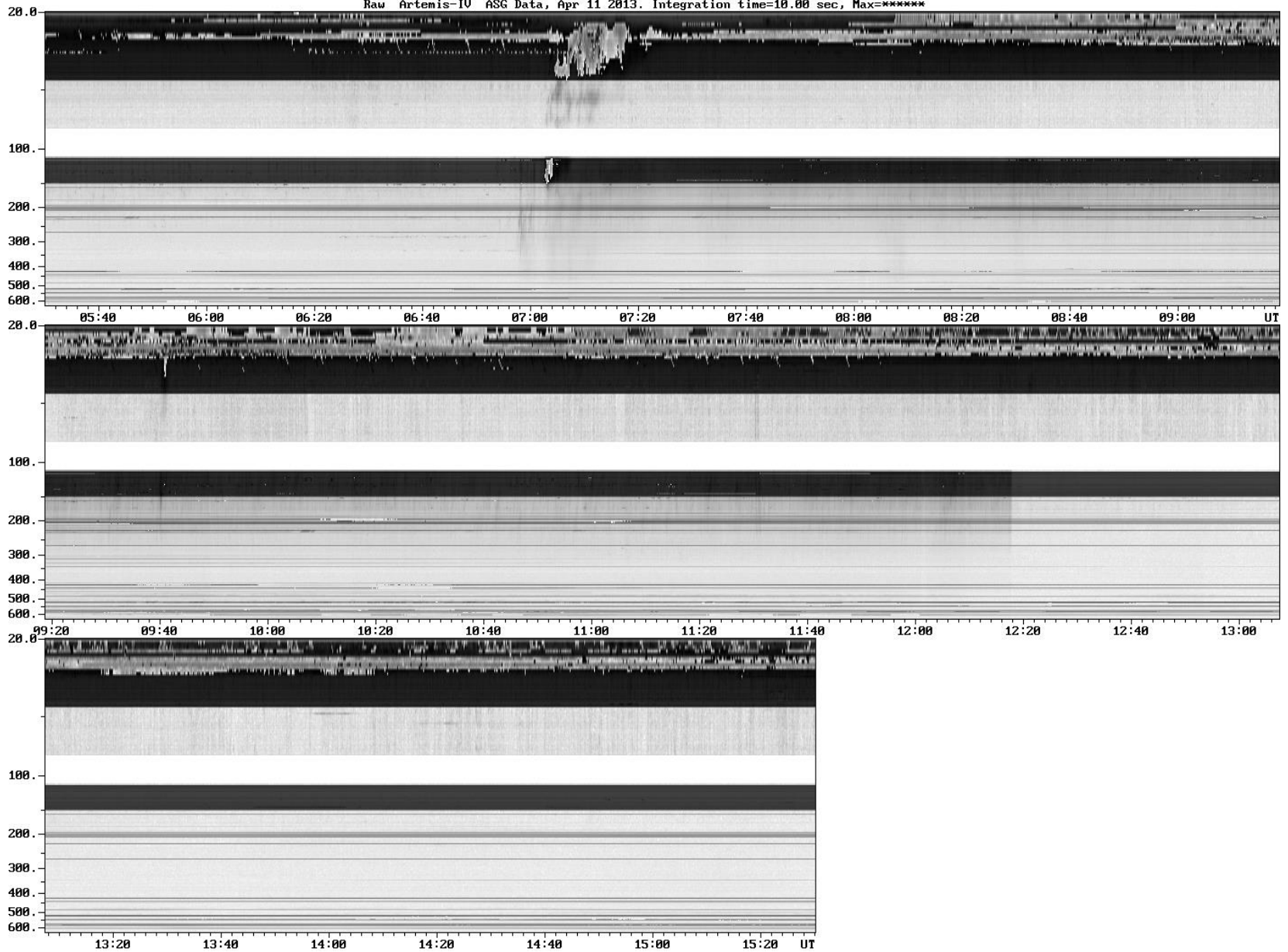
NOAA/SWPC Boulder, CO USA



STEREO/WAVES Daily Summary - 11-Apr-2013 (DOY 101)

Ahead source file = stereo_ahead_2013_101_1_01.pfp
Ahead P2Z Angle = 333.3





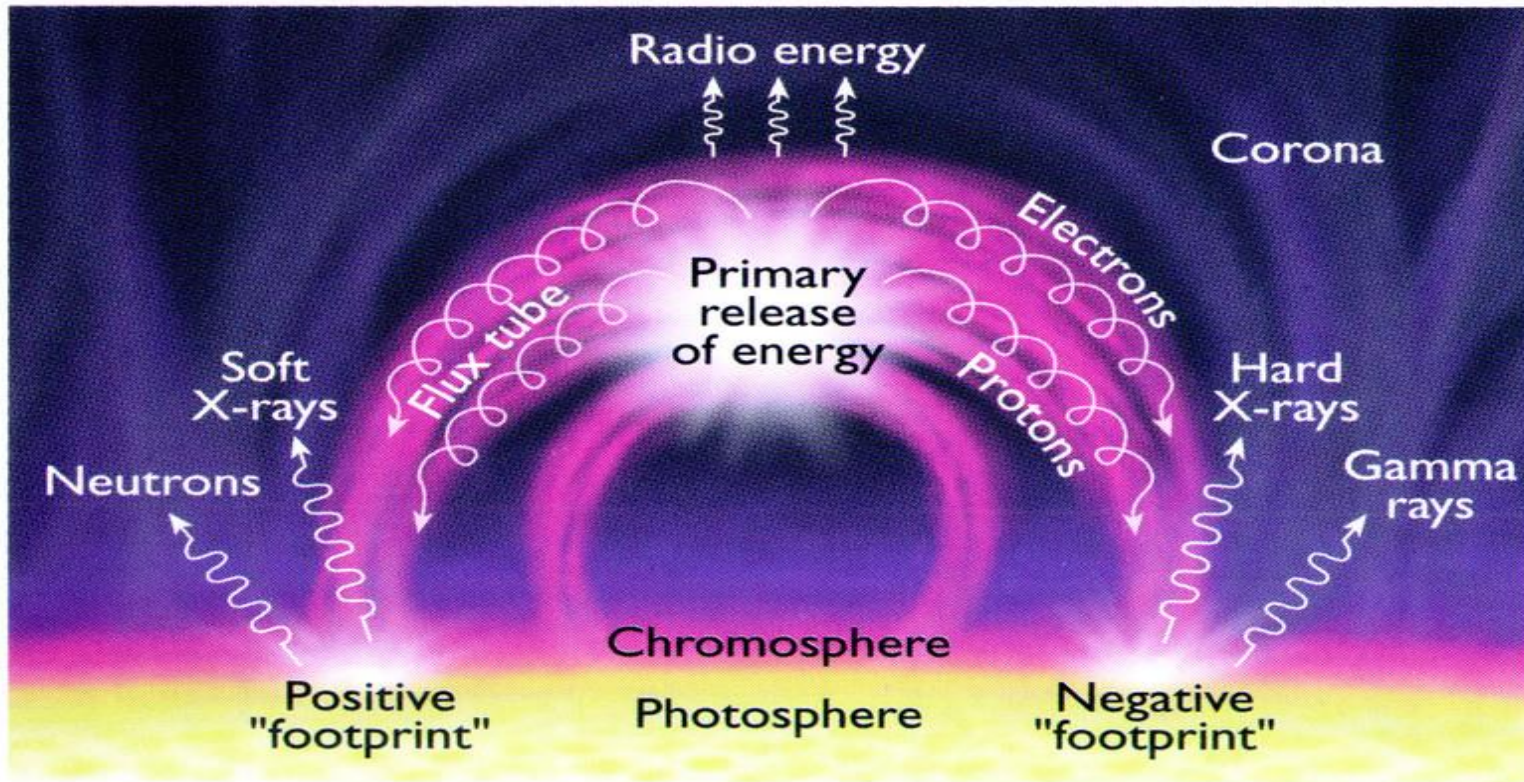
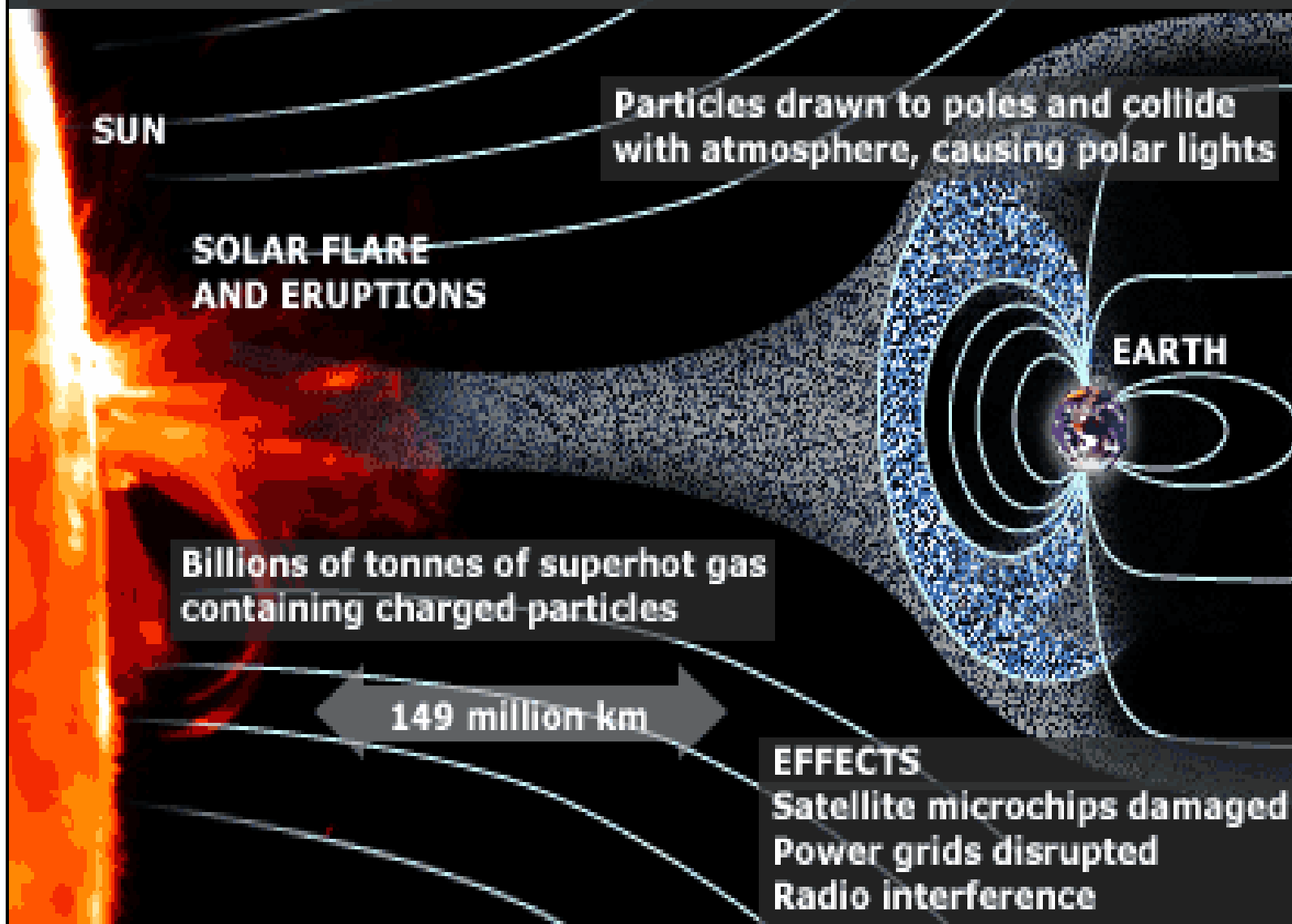
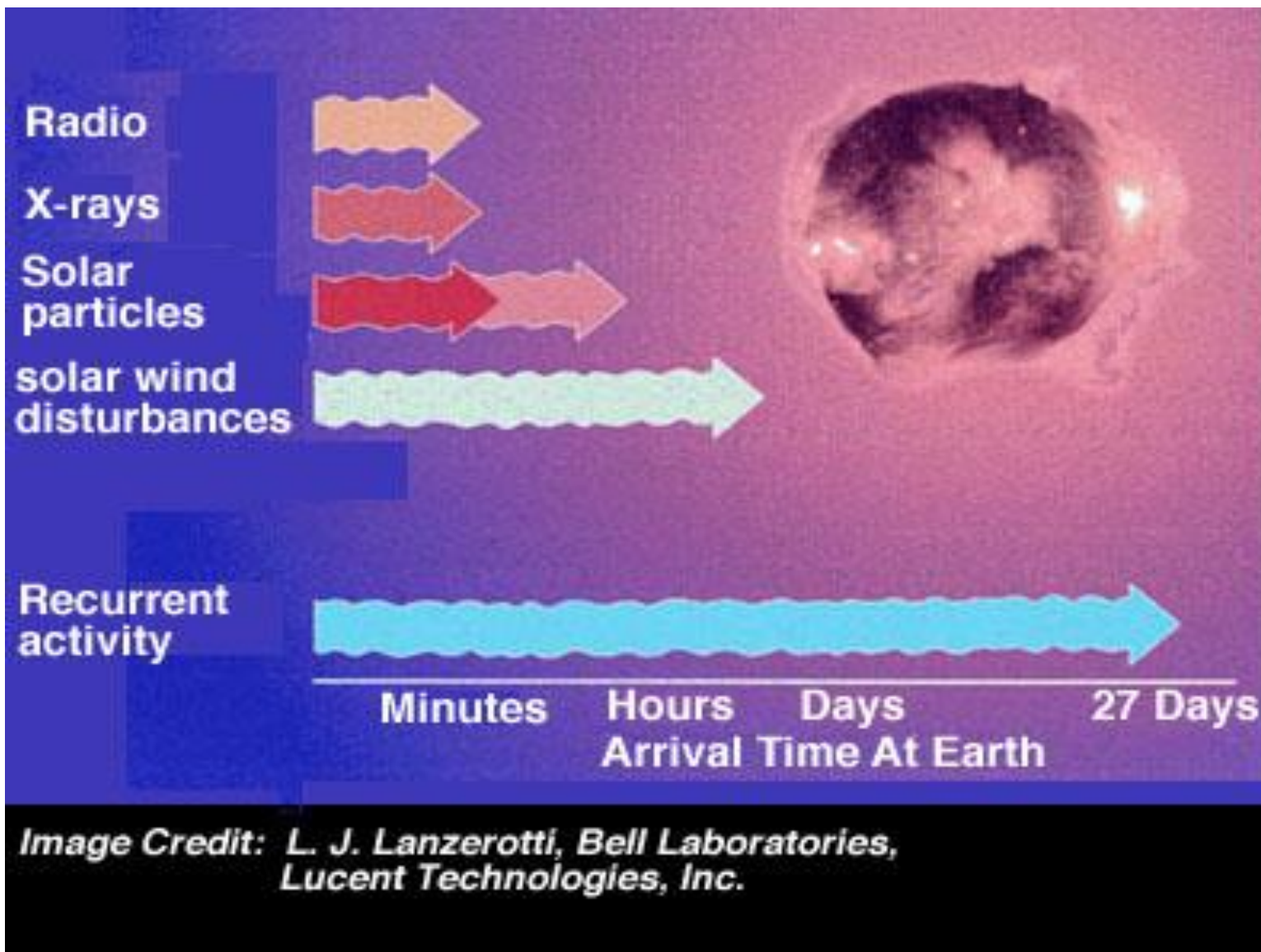
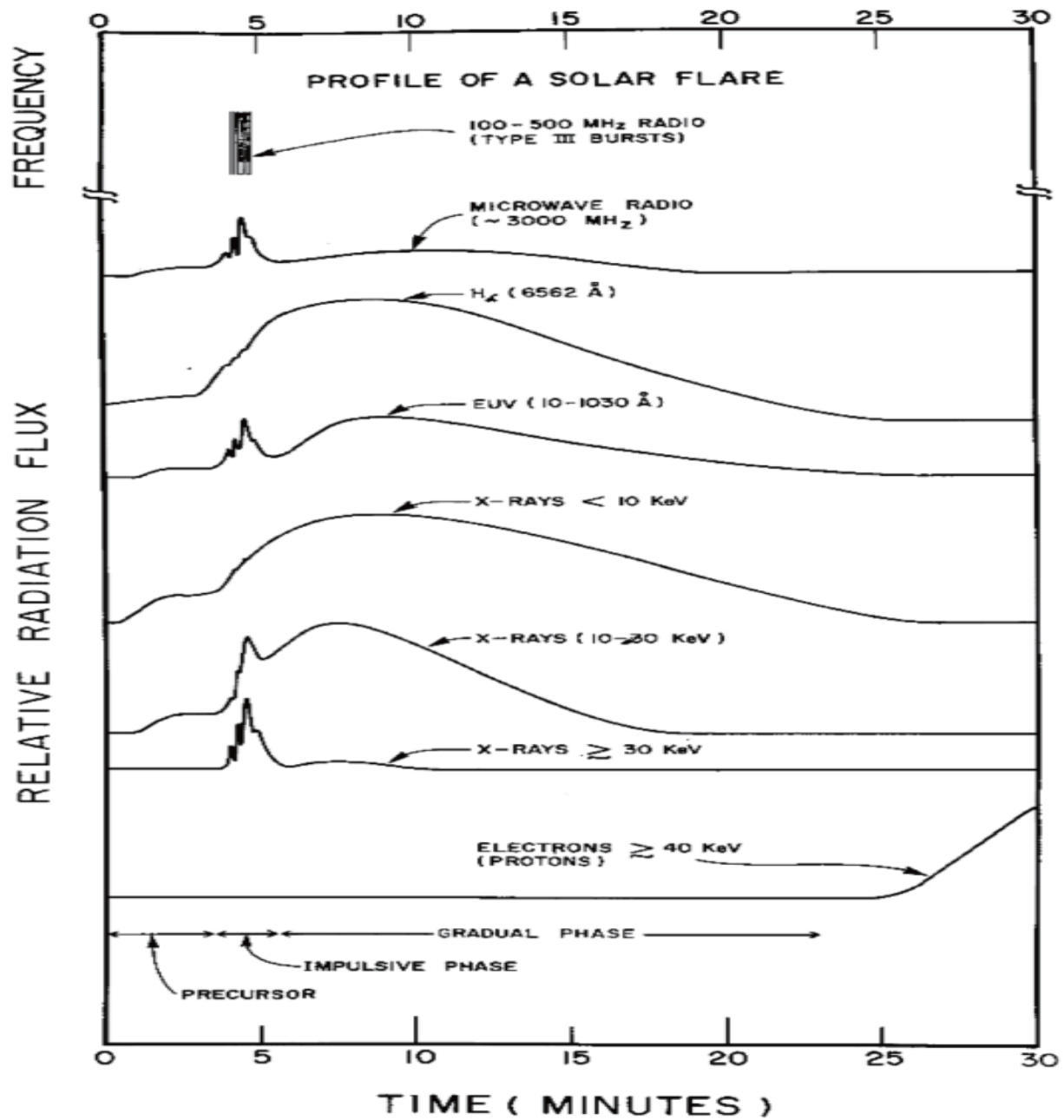


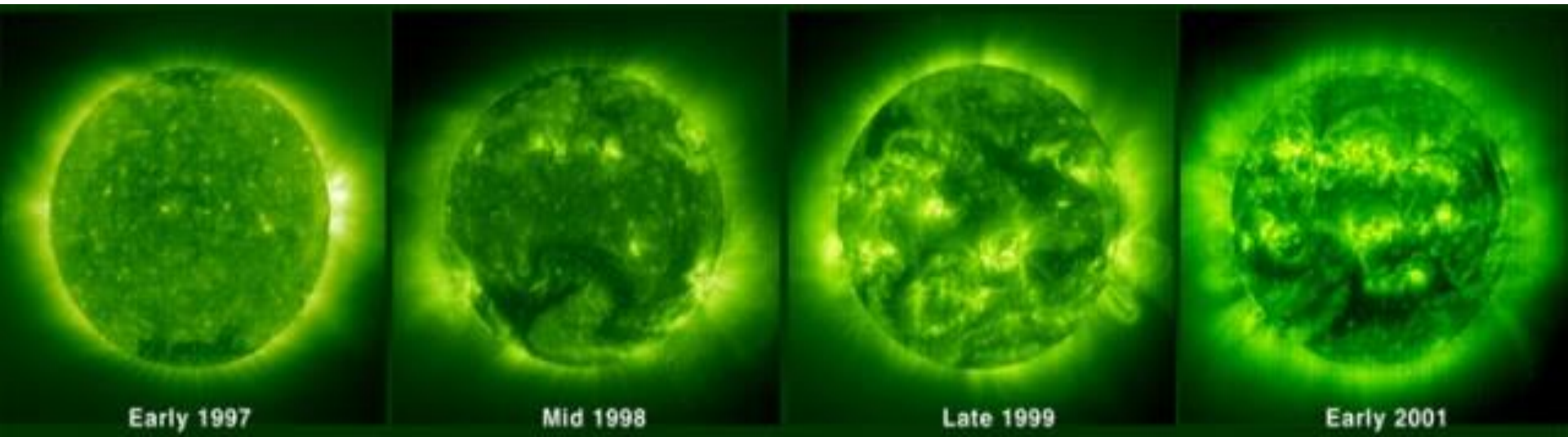
Figure 10 (bottom). Solar flares tend to occur within concentrated magnetic loops extending from the photosphere into the corona. Energy released at the top of the loop creates a burst of radio energy. It also accelerates great numbers of electrons and protons. These are channeled down the loop and strike the chromosphere at relativistic speeds, which creates X-rays and gamma rays.

SOLAR ACTIVITY AND ITS EFFECTS ON EARTH









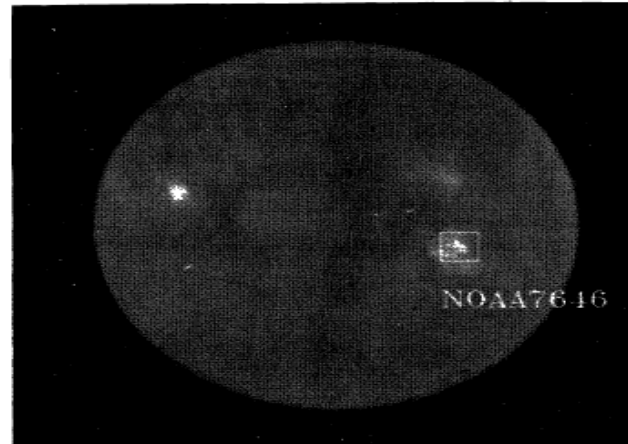
Early 1997

Mid 1998

Late 1999

Early 2001





(a)

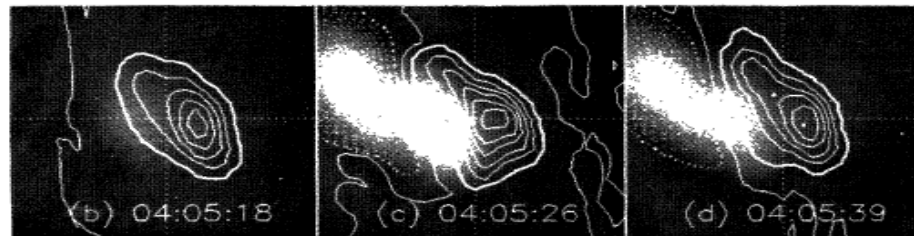


Figure 2. Radio images obtained by Nobeyama Radioheliograph. (a) is a full disk image. (b), (c) and (d) are partial images of the first peak and the second peak just before the onset, of the burst.

emitting electrons was derived and was 3.6 and 4.2, where we assumed thick target model. The results that the indices of radio emitting electrons and hard X-ray emitting electrons have similar values and decrease with similar ratios between the first and the second peaks imply that the electrons emitting the microwave and the hard X-ray are accelerated by the same mechanism at the same site.

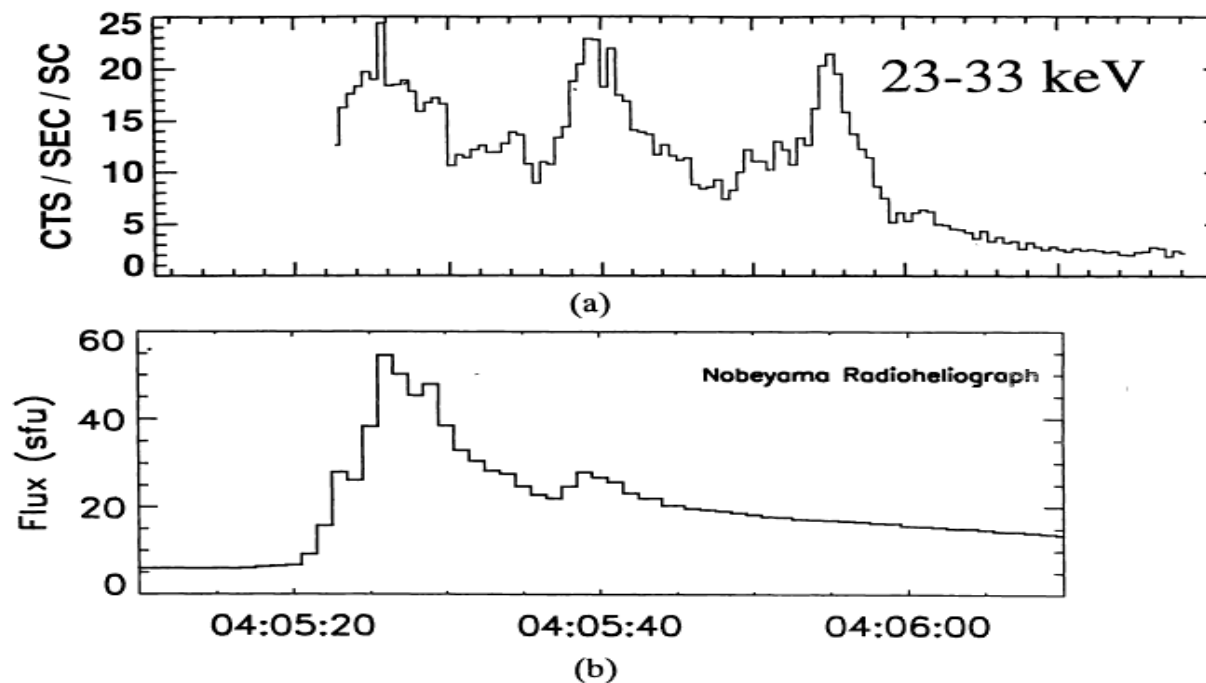
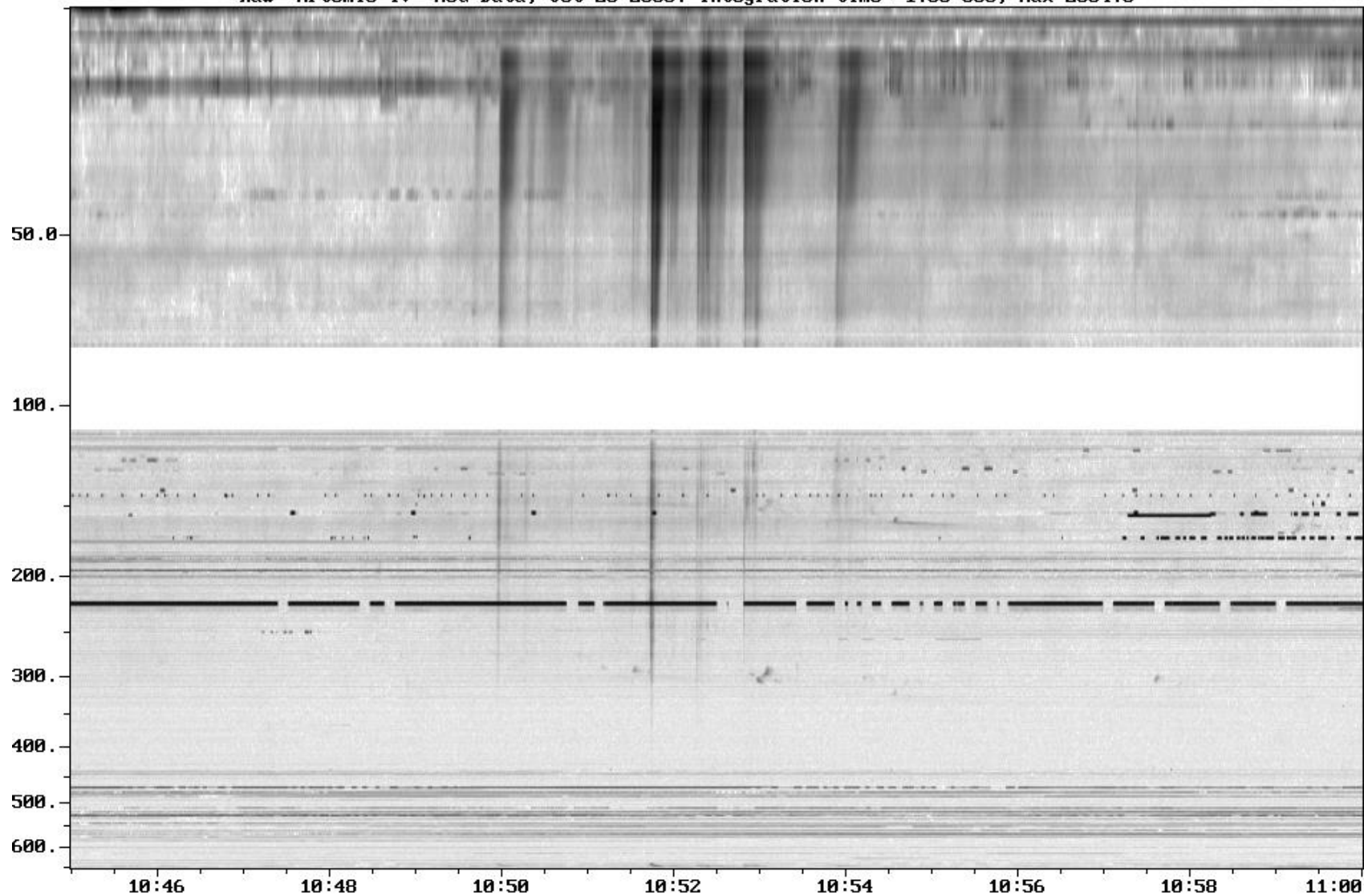
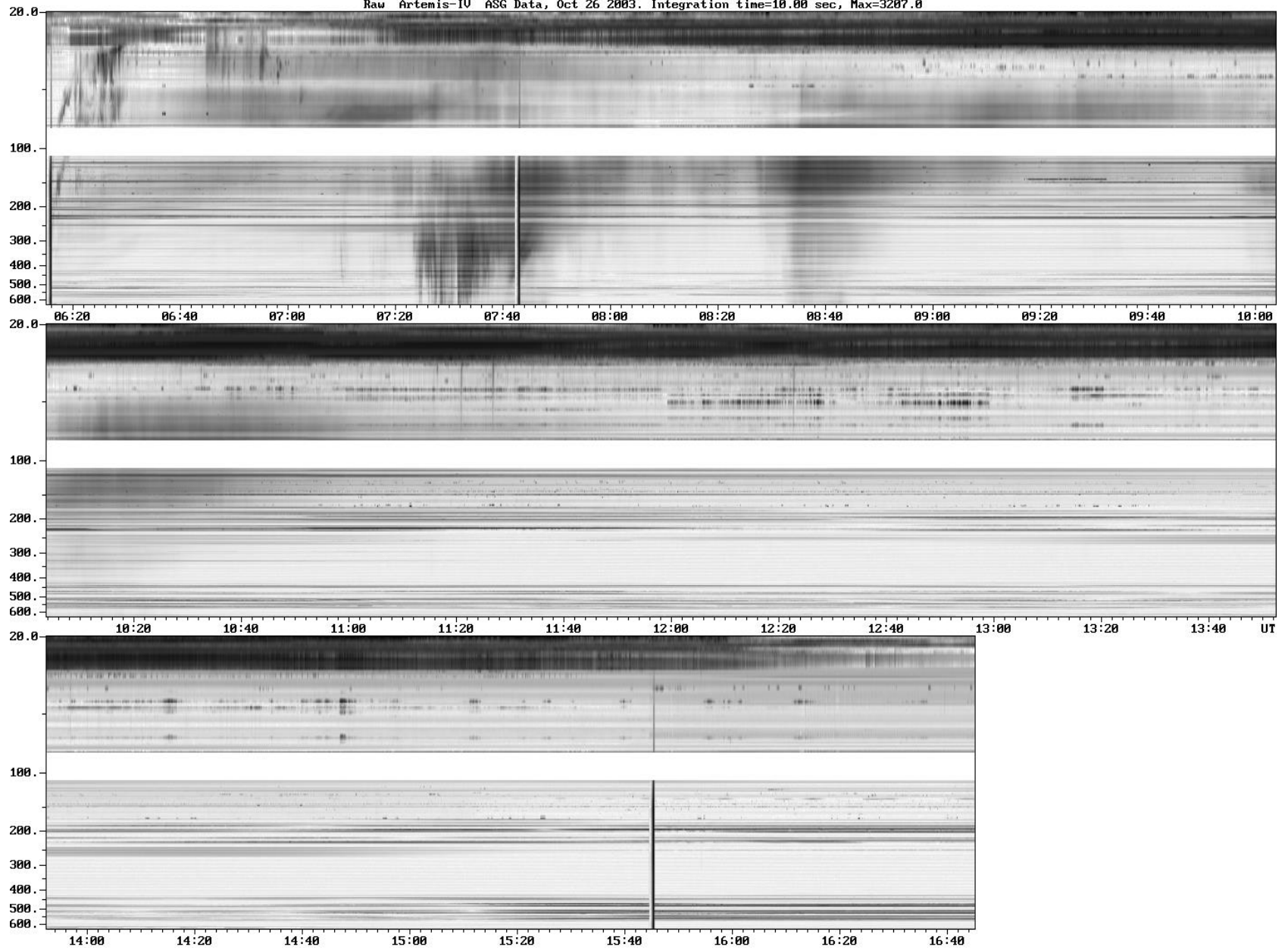


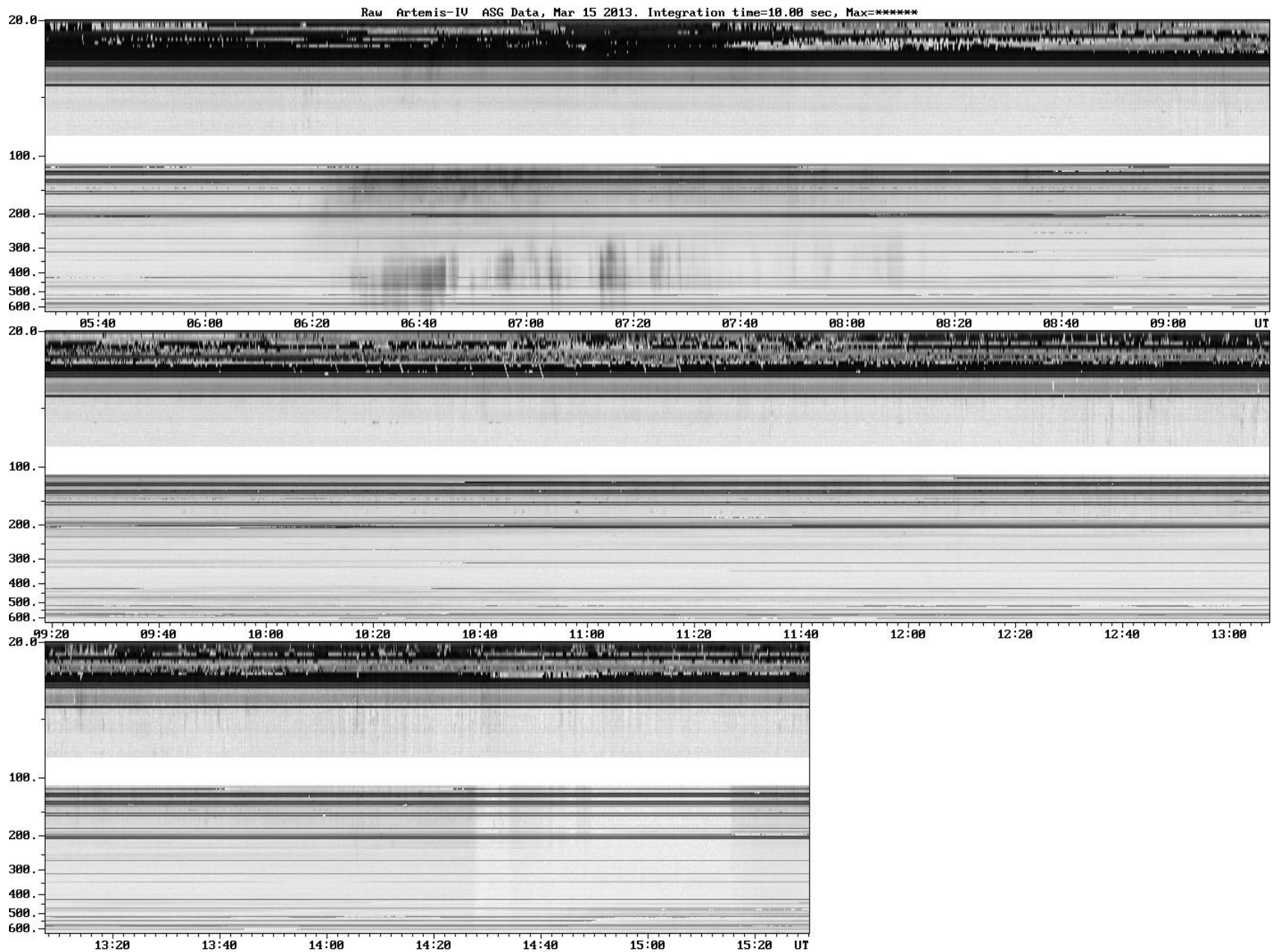
Figure 1. Time profiles of the burst on January 6, 1994. (a) Yohkoh HXT M1 channel, and (b) flux density at 17 GHz.

Spiky flux variations and high brightness temperature of the radio sources imply that the emission is accounted for by gyrosynchrotron radiation from a power-law distribution of electrons. The radio flux spectrum of the burst obtained by the radio polarimeters at Nobeyama and Toyokawa give a peak frequency between 3.75 GHz and 9.4 GHz, and the flux spectral index in the optically thin part was -1.8 and -2.4 at first and second peaks. Assuming the gyrosynchrotron radiation, the energy spectral index of radio emitting electrons is 3.3 and 4.0 (Dulk 1985). From the Yohkoh HXT observations, the energy spectral index of hard X-ray





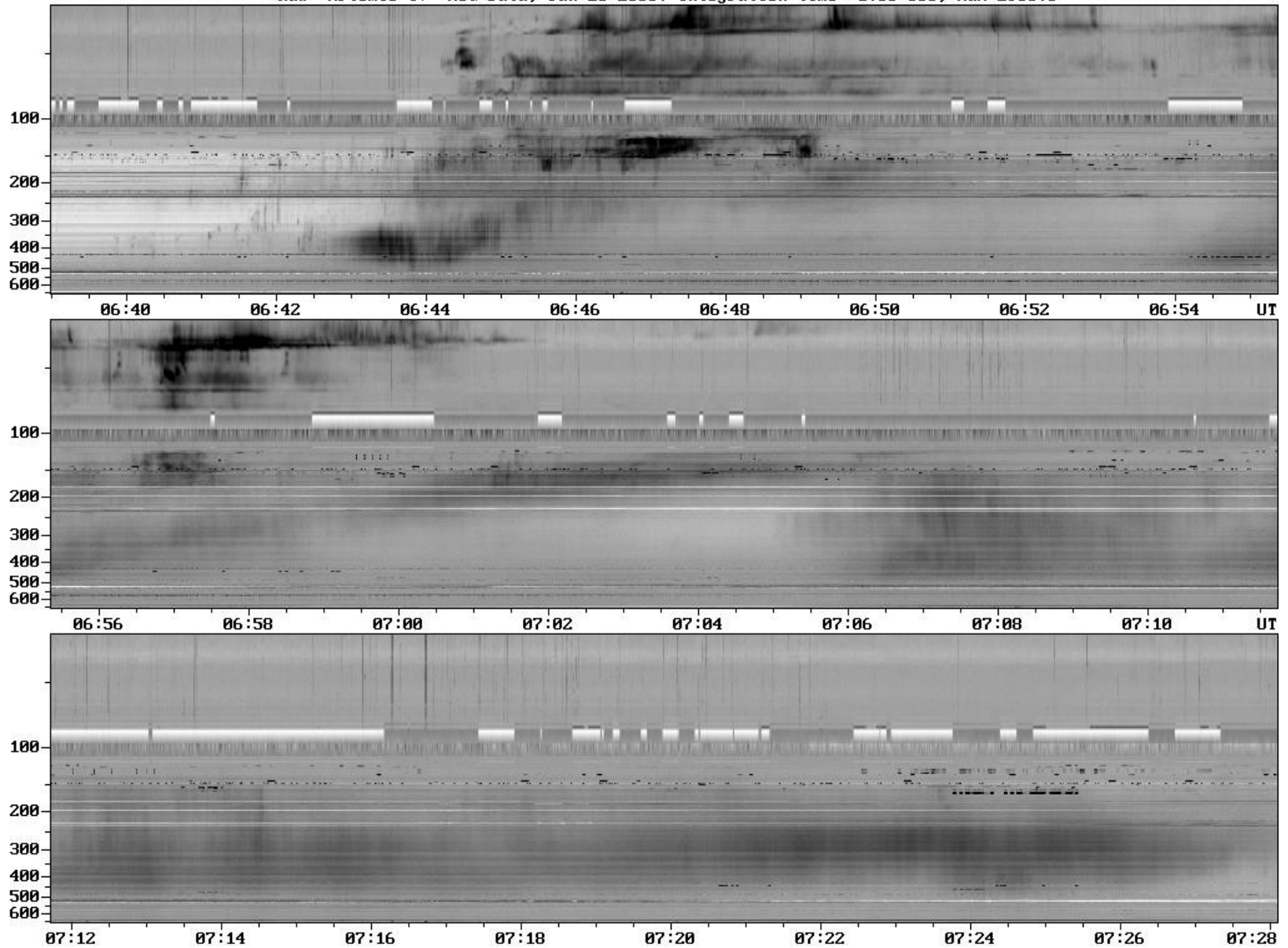




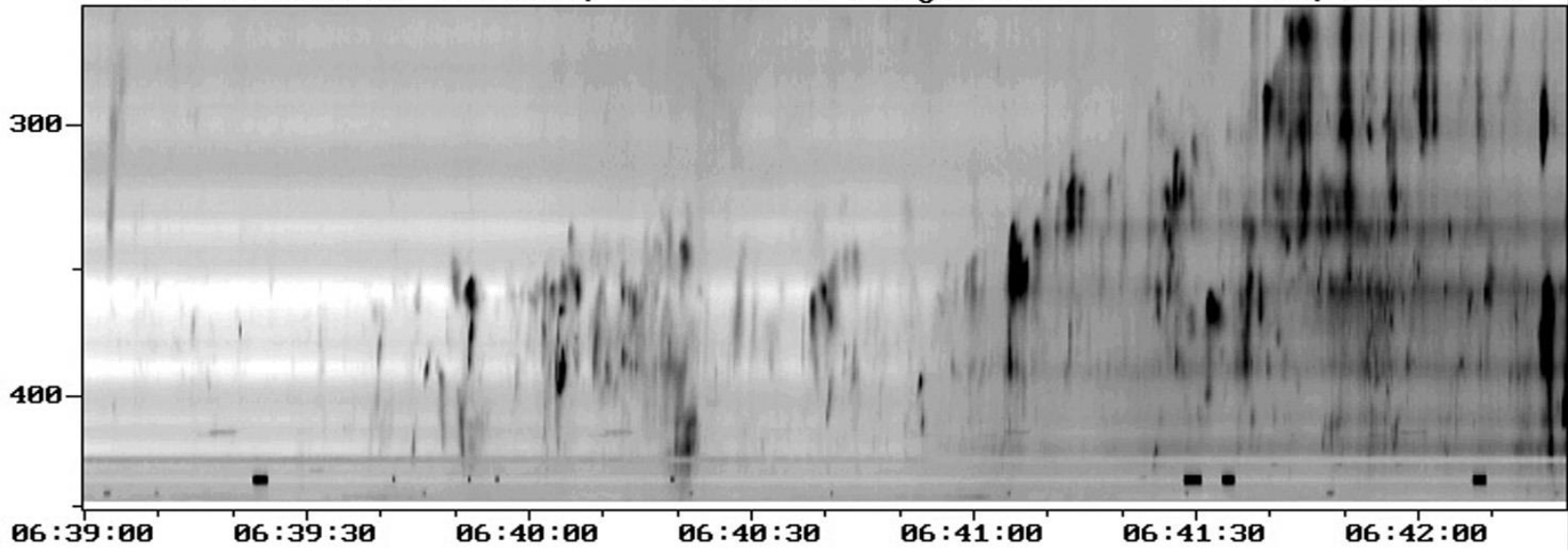


Εικόνα 1: Οι δύο κεραίες του ARTEMIS IV στις Θερμοπύλες

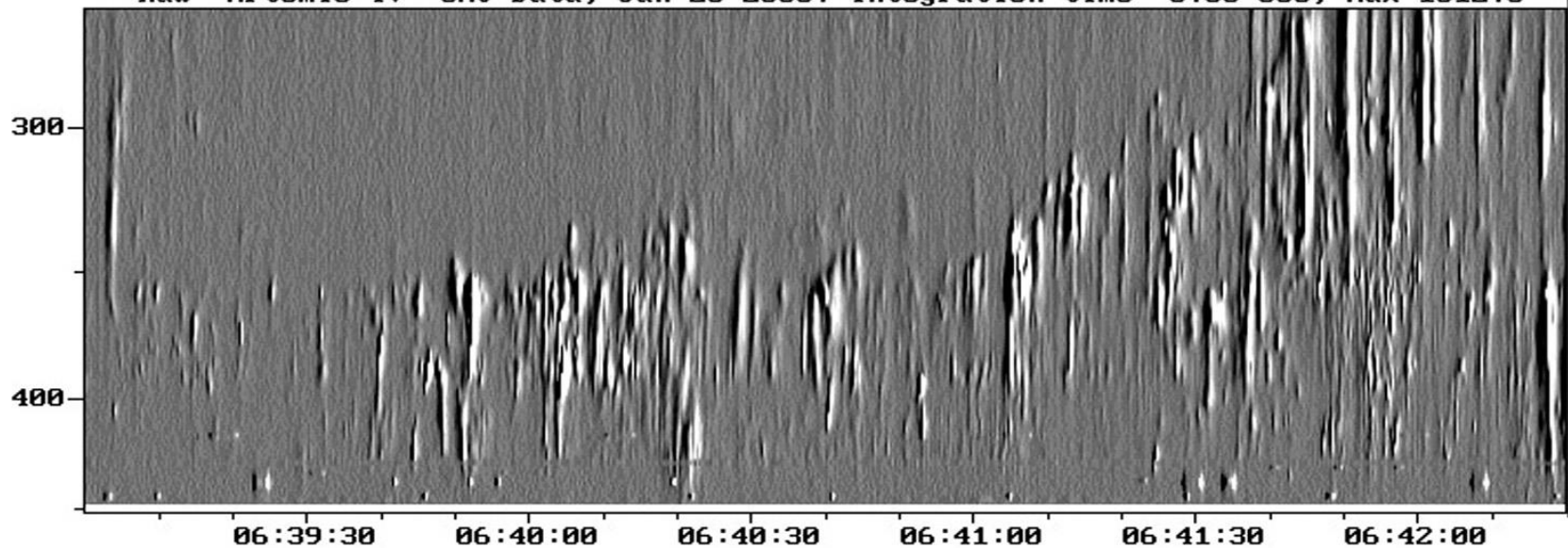




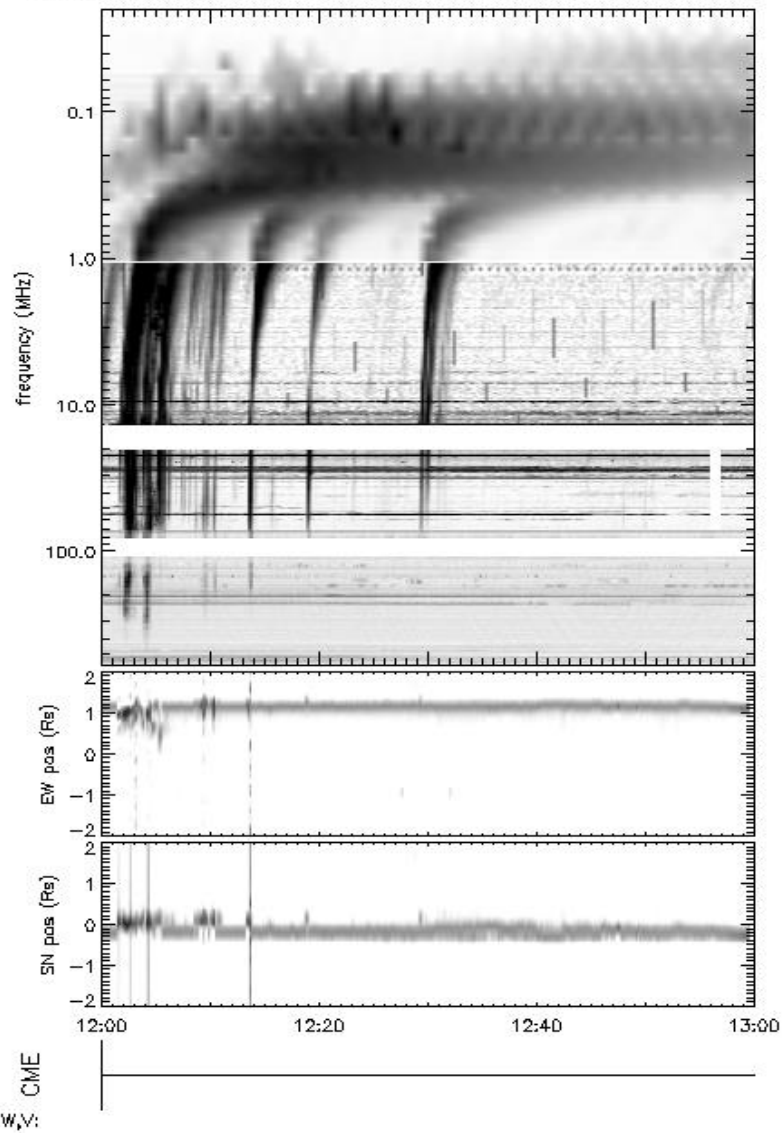
Raw Artemis-IV SAO Data, Jan 20 2005. Integration time= 0.30 sec, Max=1166.0



Raw Artemis-IV SAO Data, Jan 20 2005. Integration time= 0.30 sec, Max=1012.0

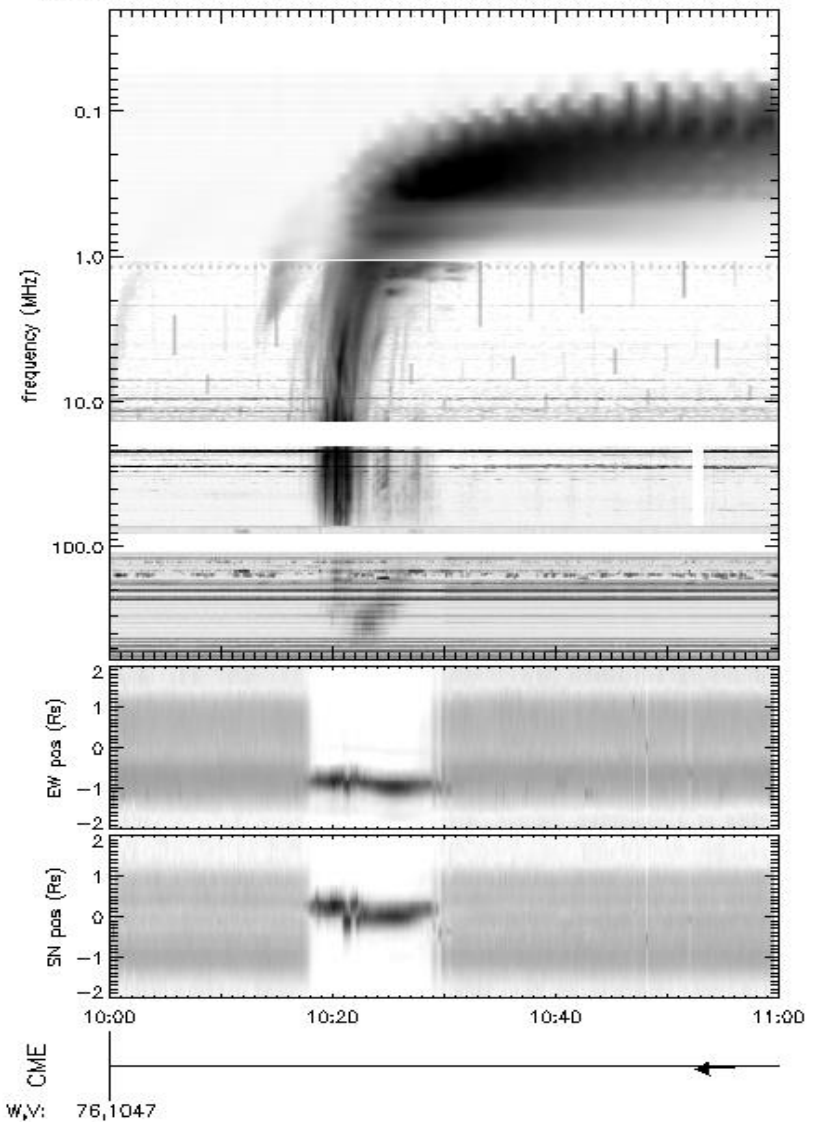


WIND/WAVES, DAM, ARTEMIS, NRH, CME, 07JUL2006

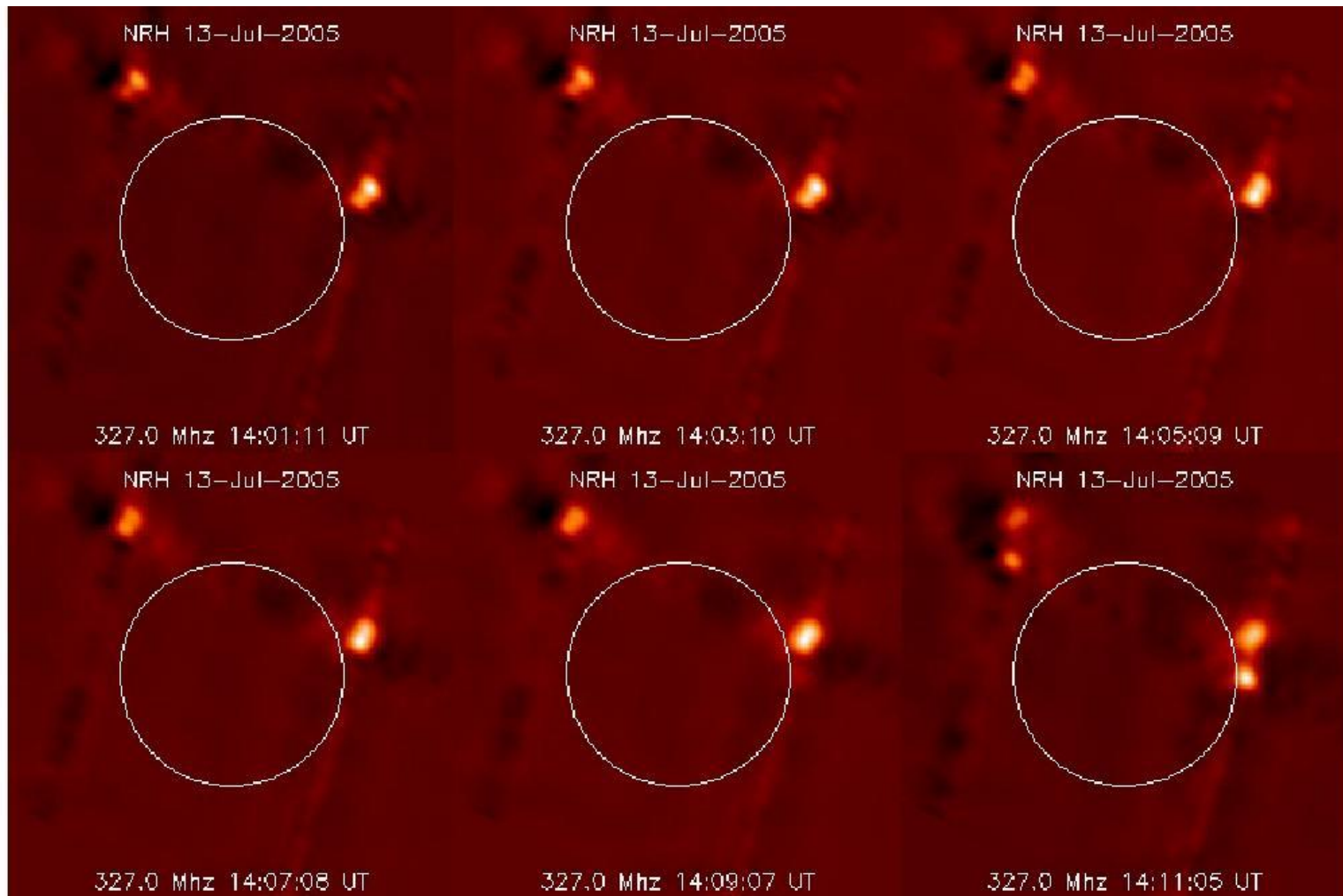


Assembled the 20DEC2006

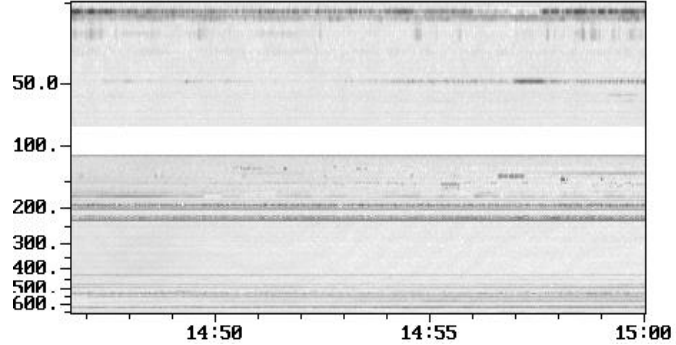
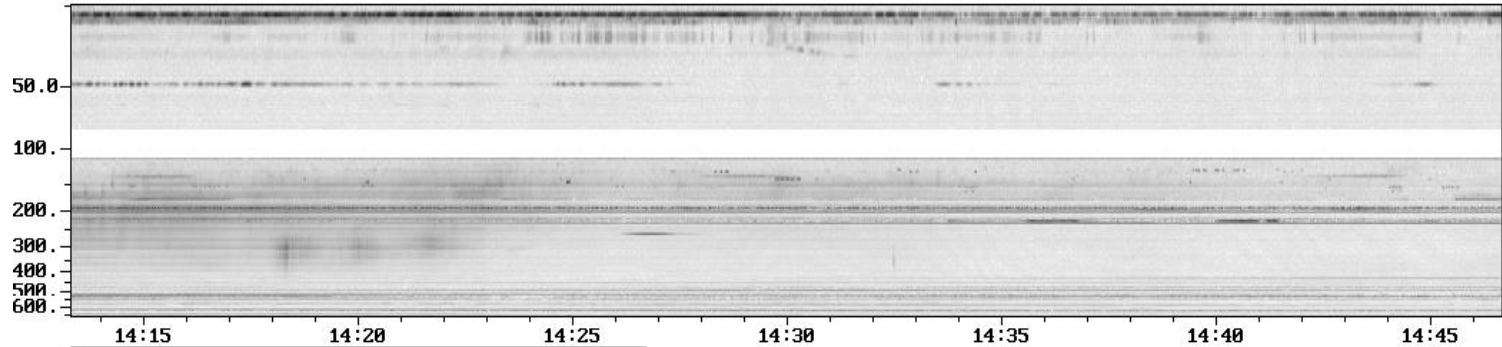
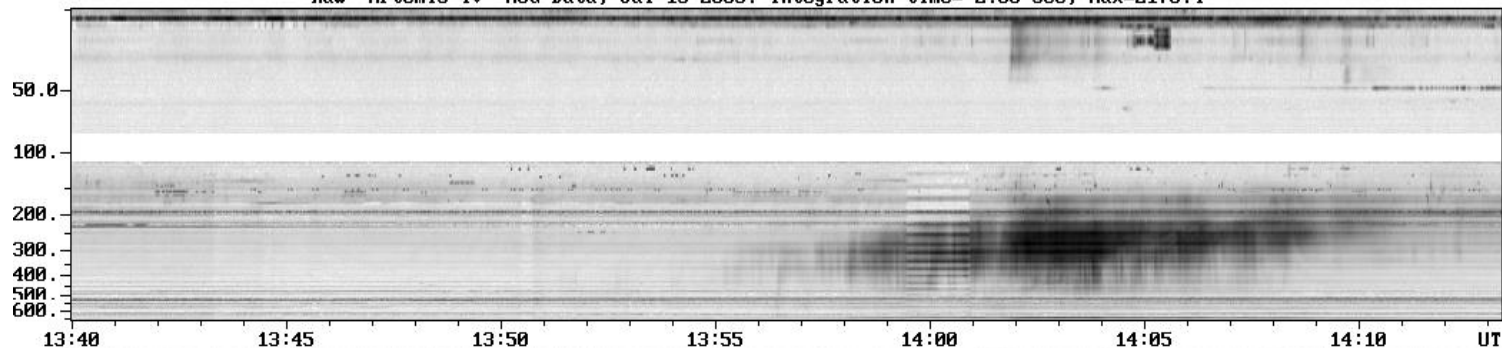
WIND/WAVES, DAM, ARTEMIS, NRH, CME, 28AUG2005

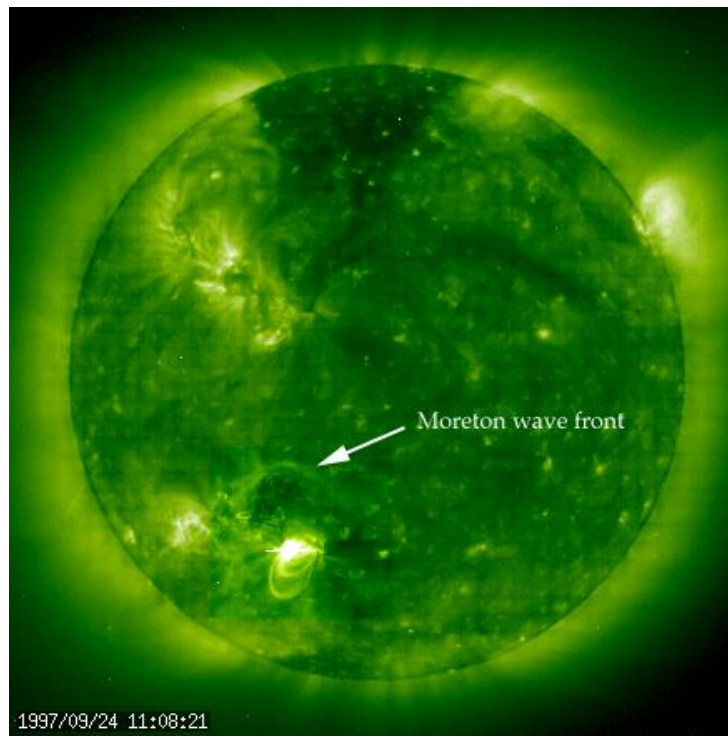
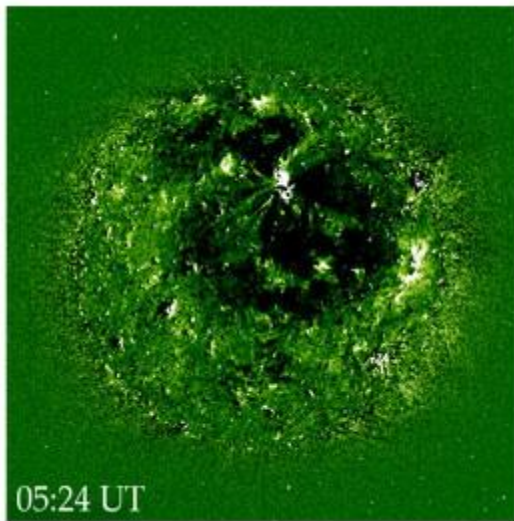
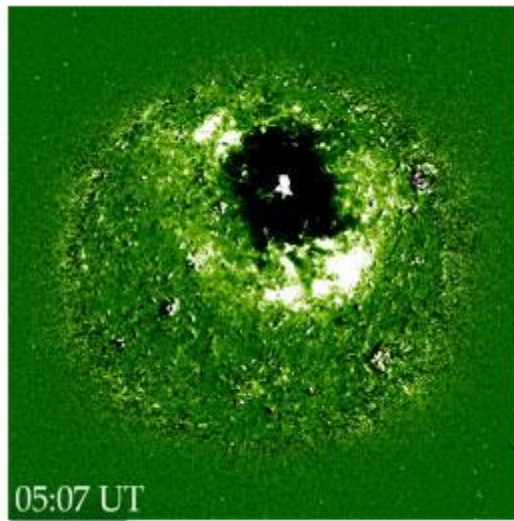
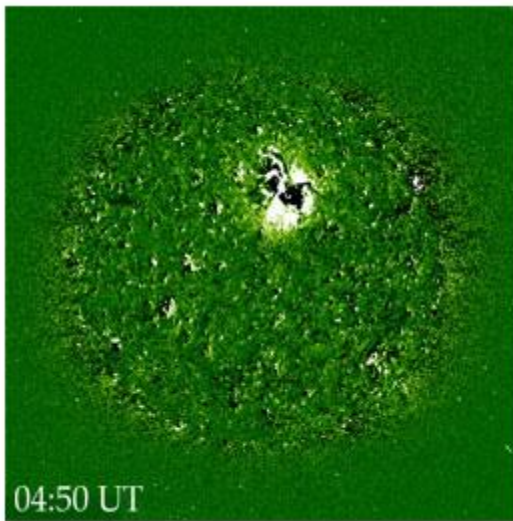


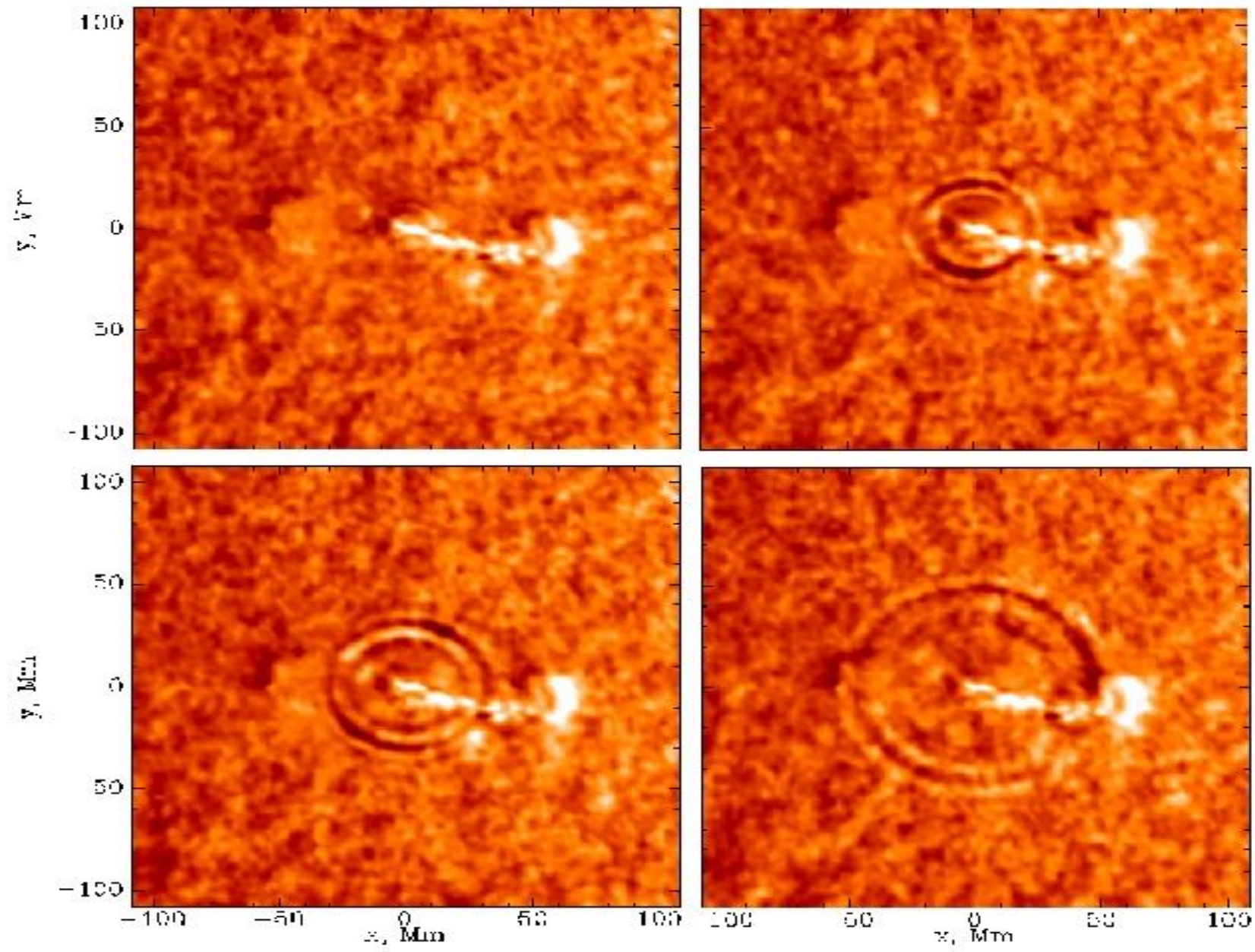
Assembled the 19OCT2006

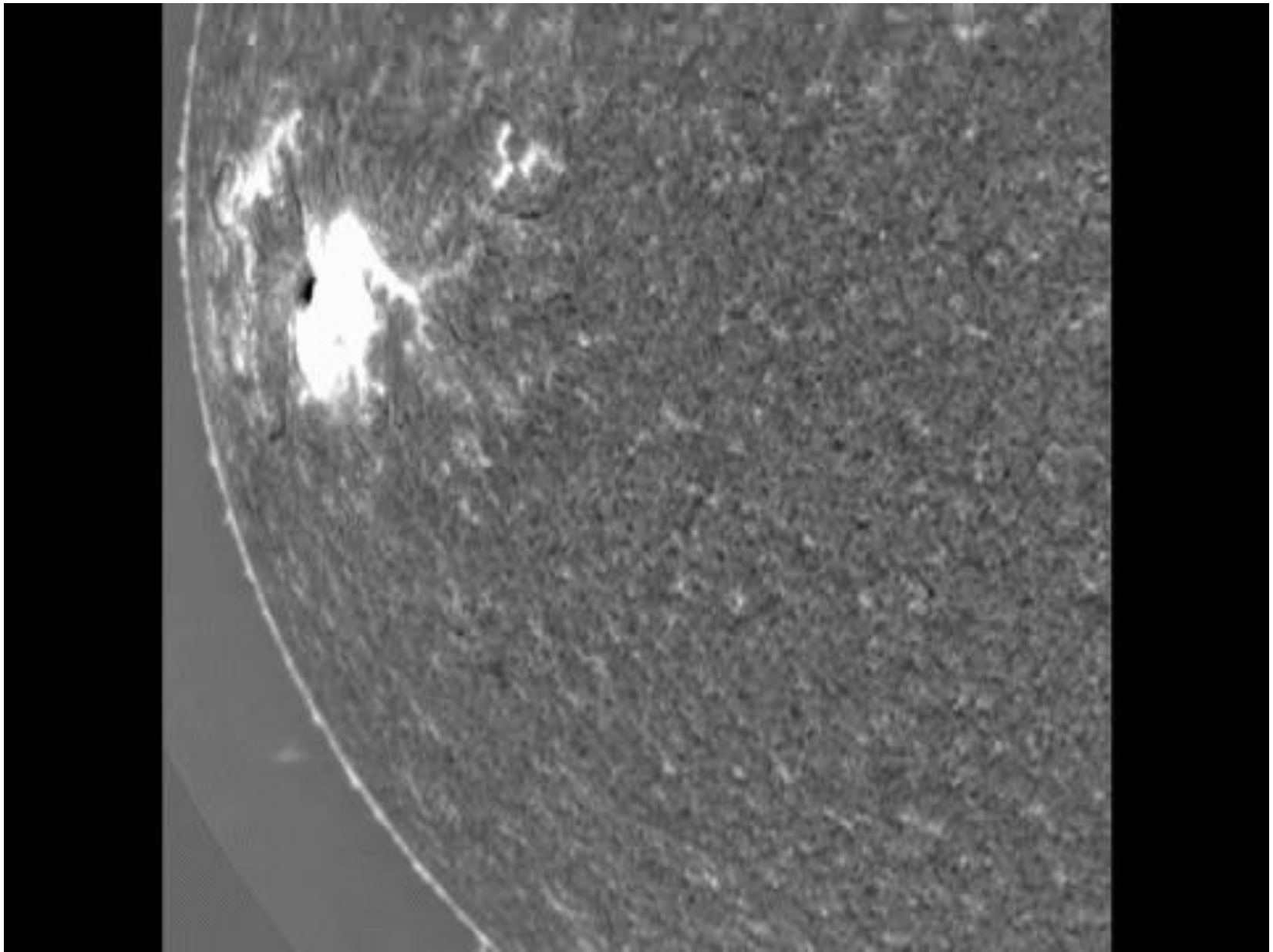


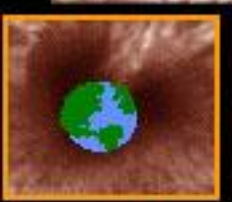
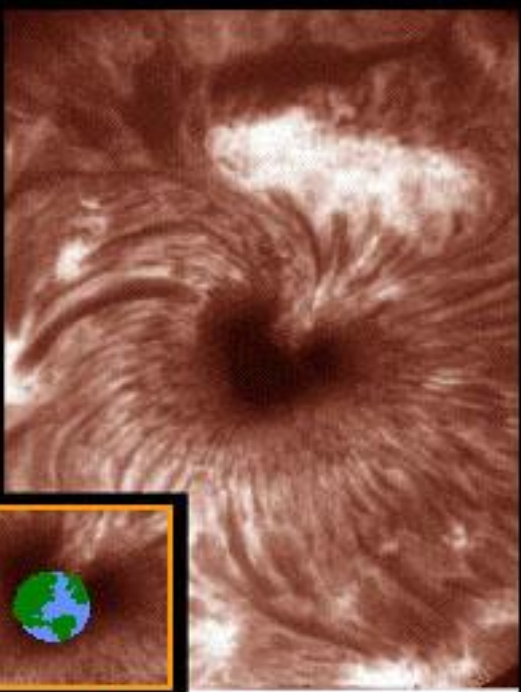
Raw Artemis-IV ASG Data, Jul 13 2005. Integration time= 2.00 sec, Max=2170.4



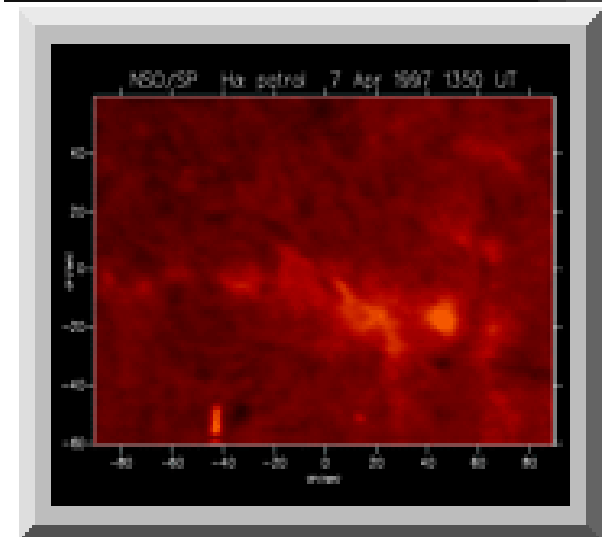
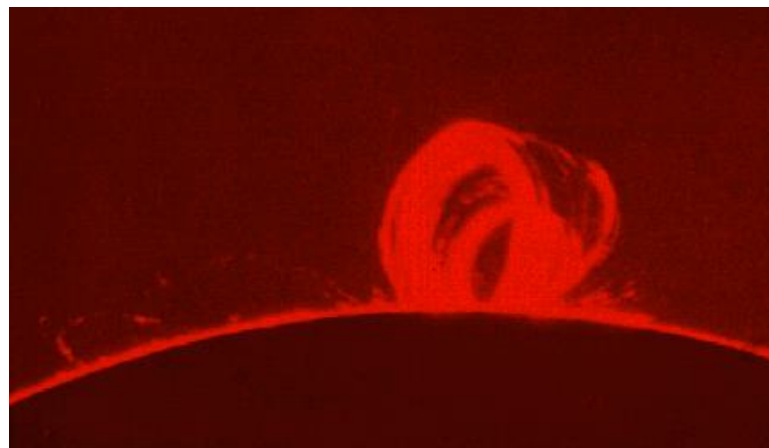
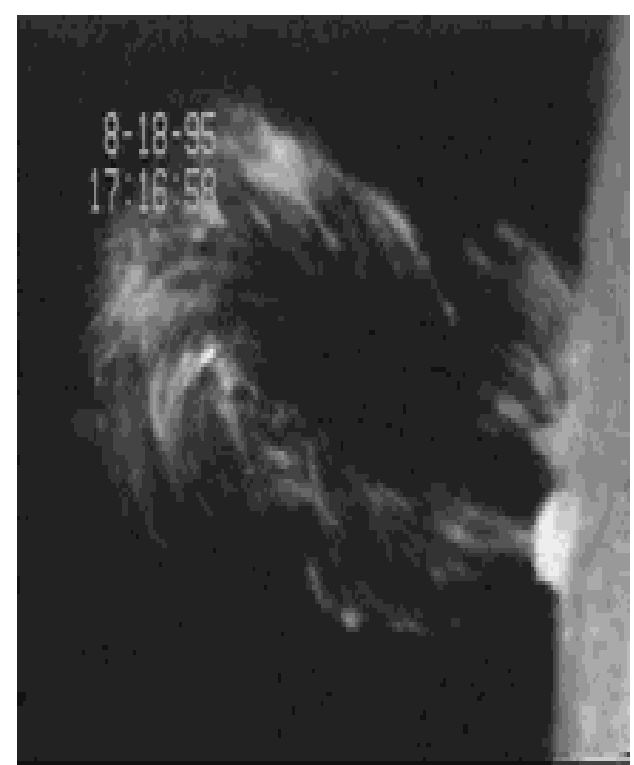
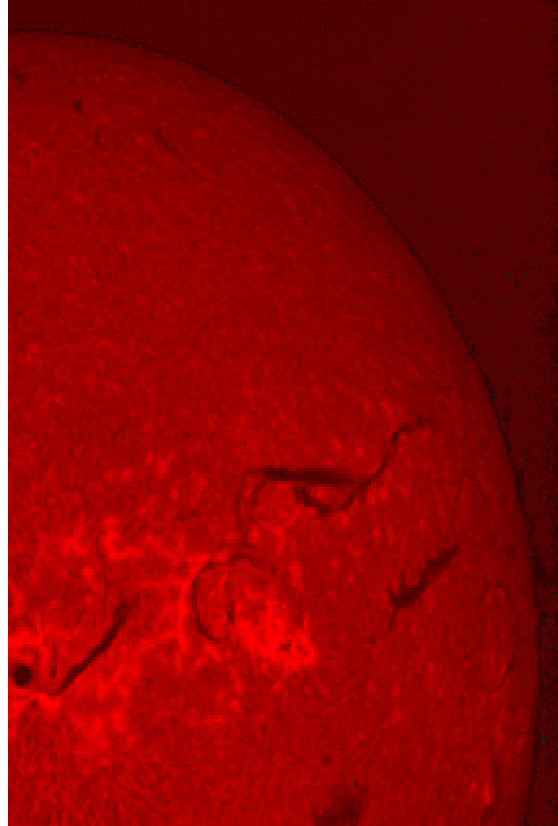


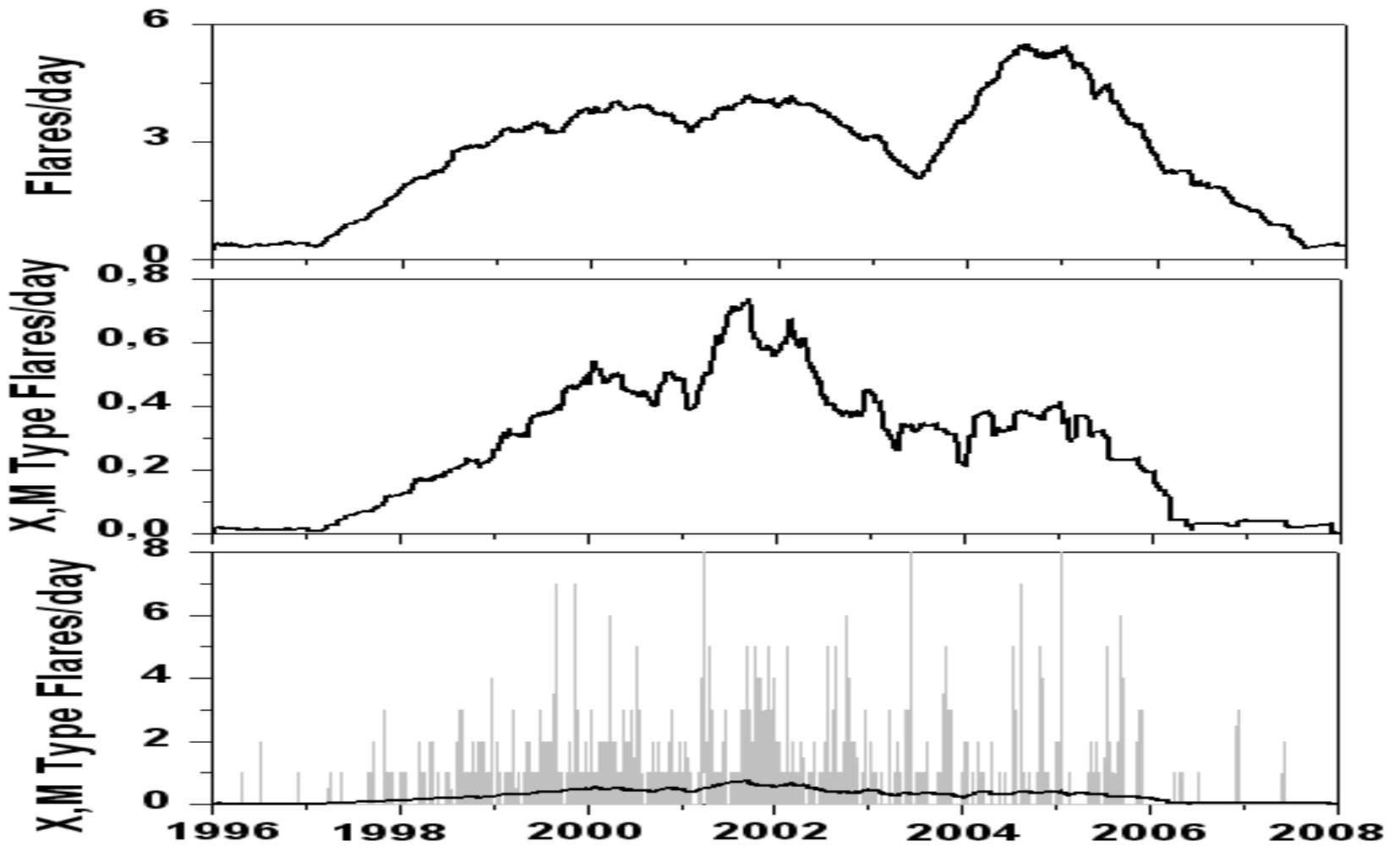






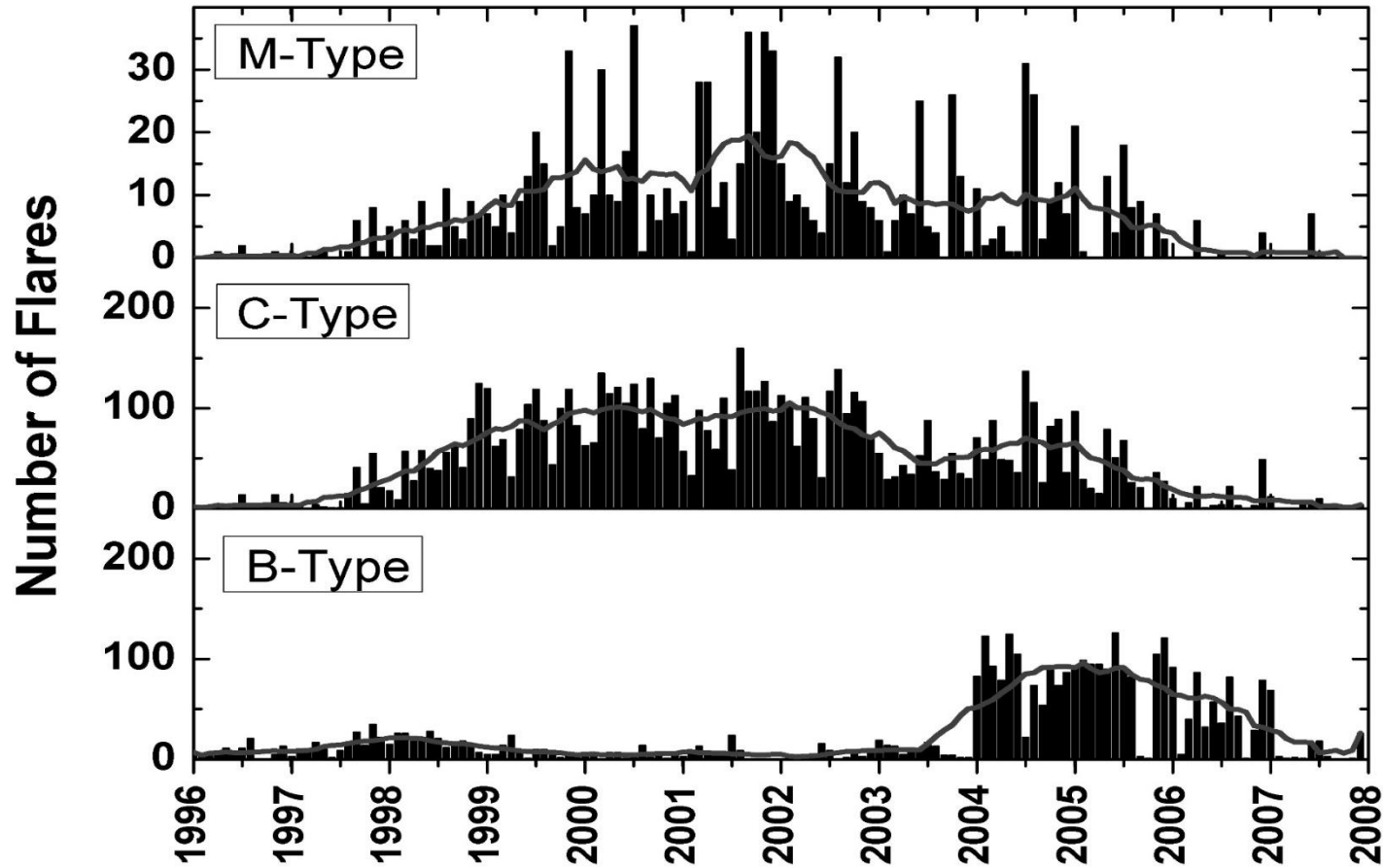
Approximate size





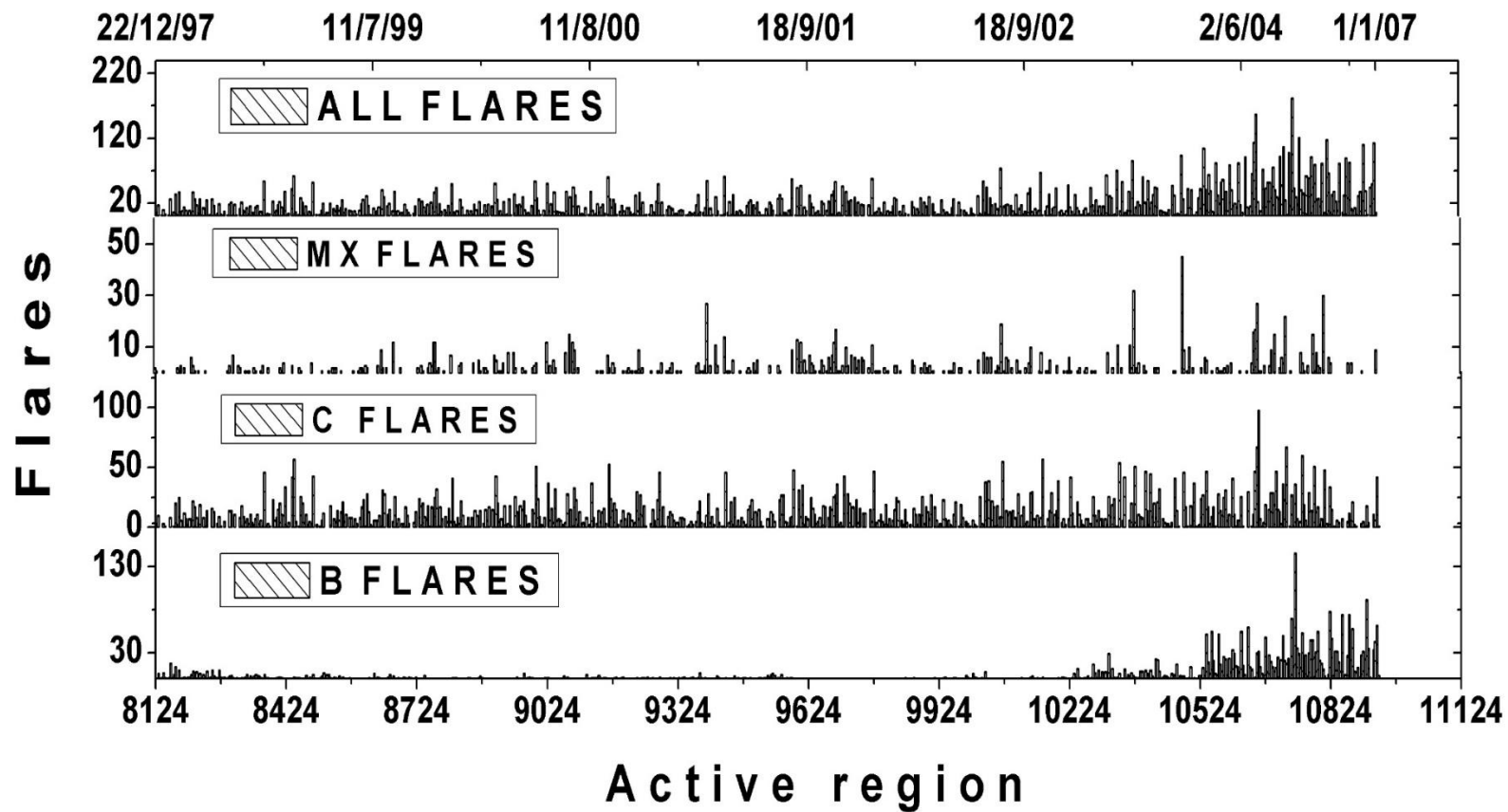
38th COSPAR Scientific Assembly Bremen, Germany, 18-25 July 2010





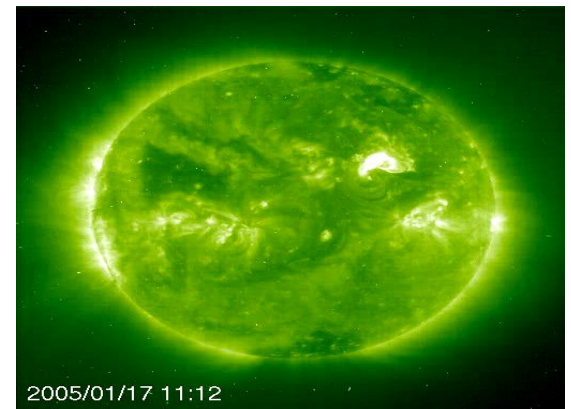
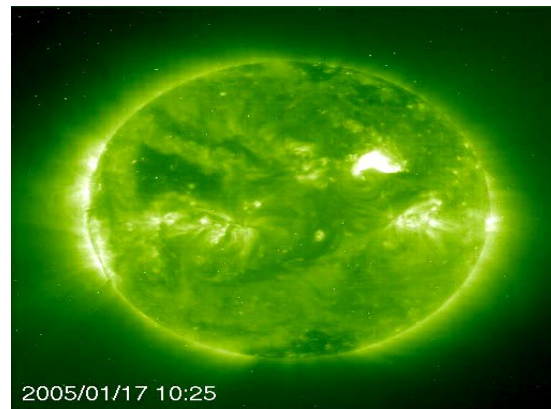
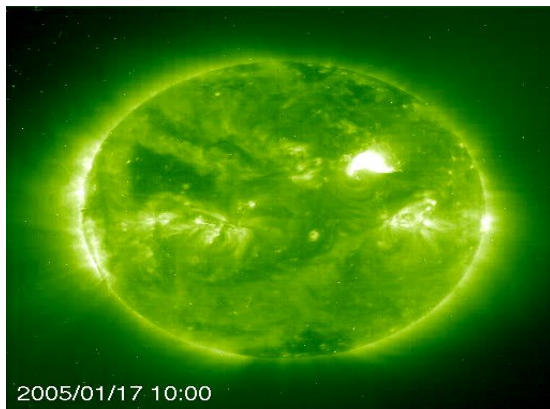
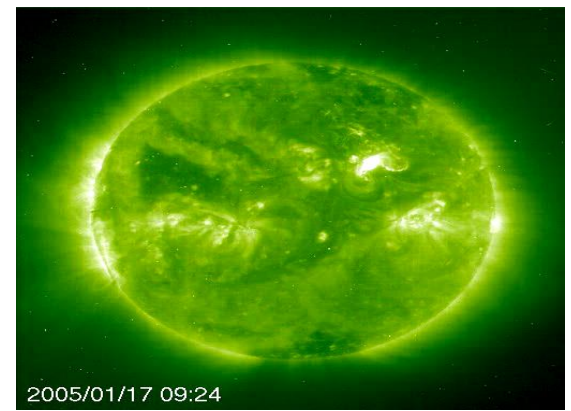
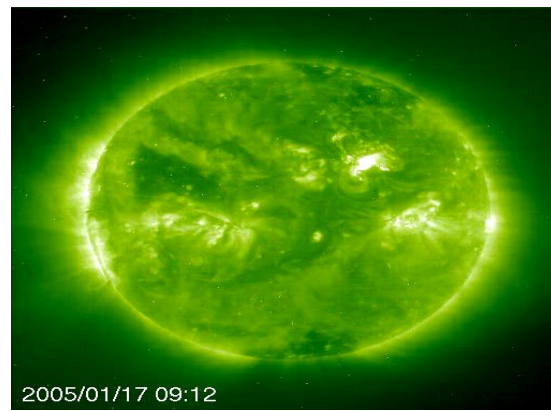
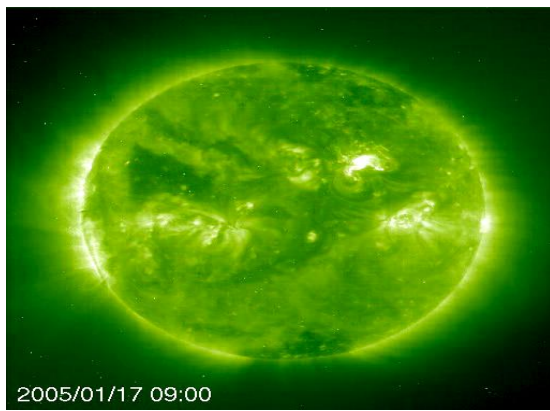
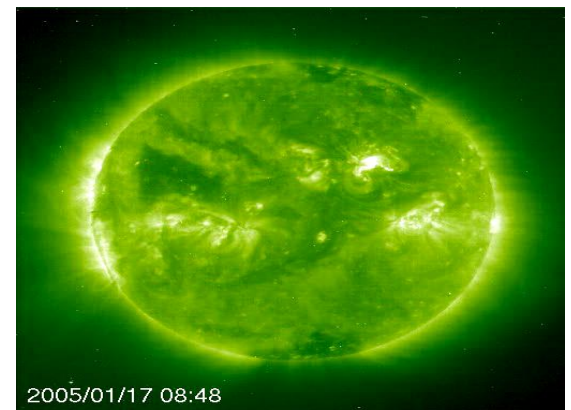
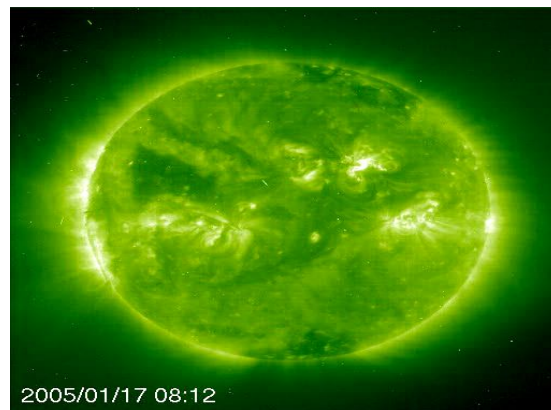
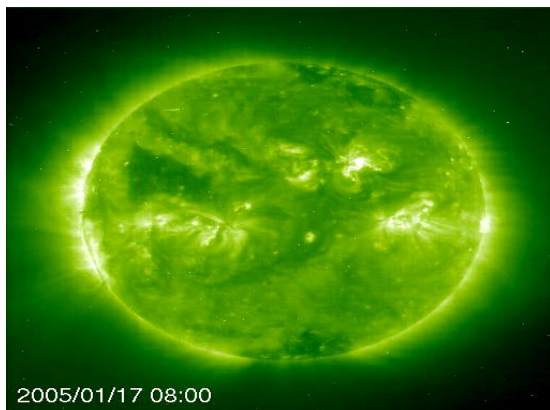
38th COSPAR Scientific Assembly Bremen, Germany, 18-25 July 2010



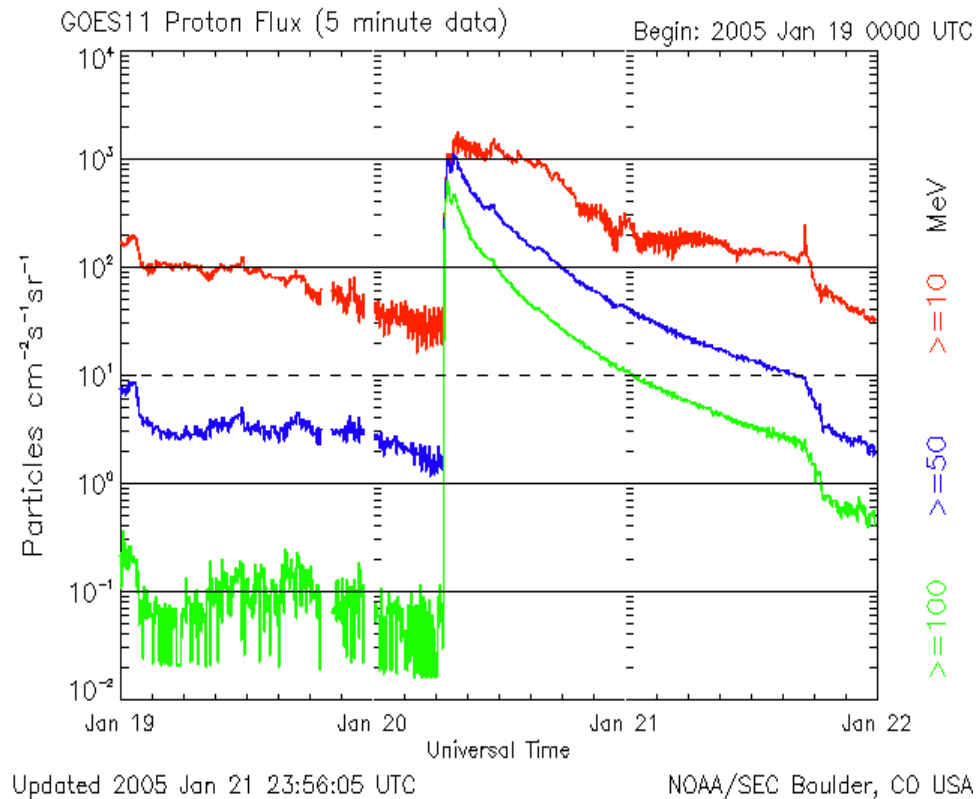
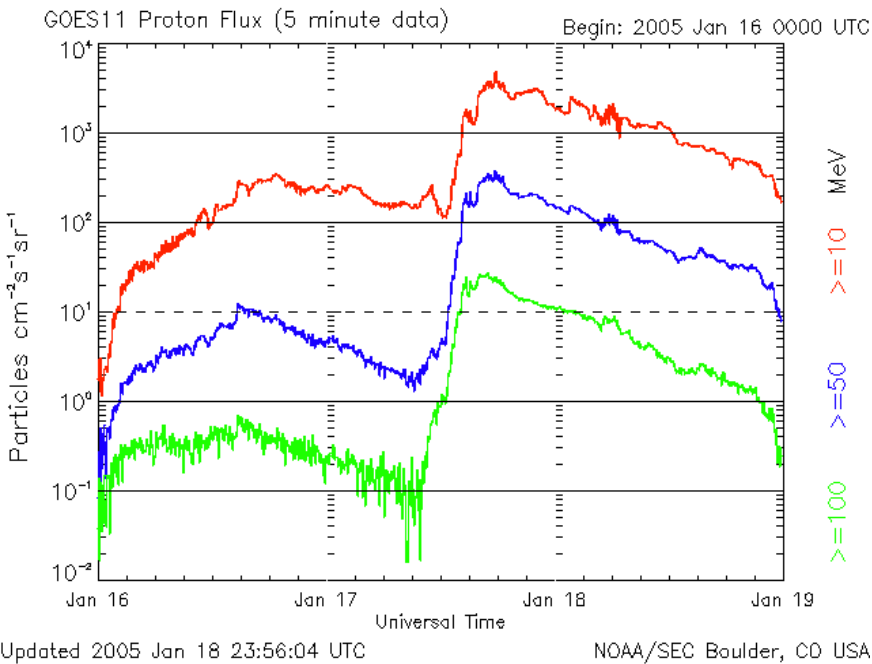


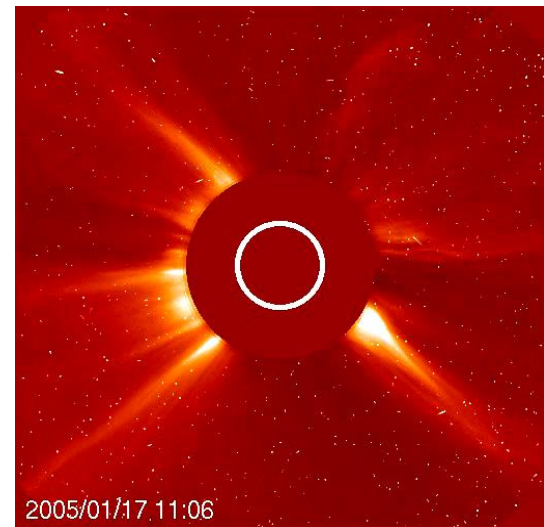
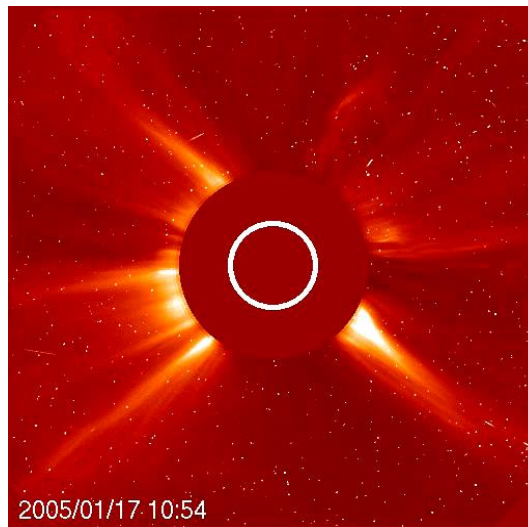
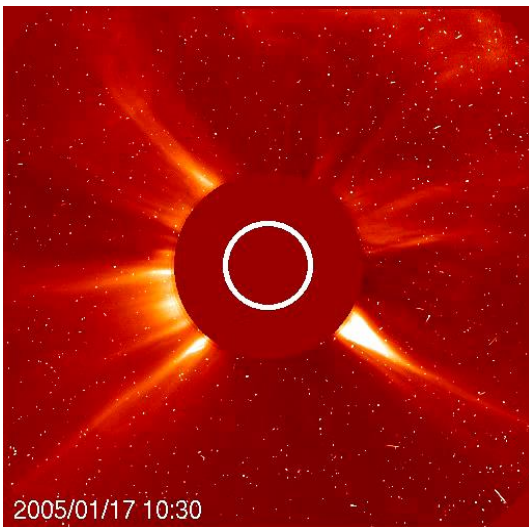
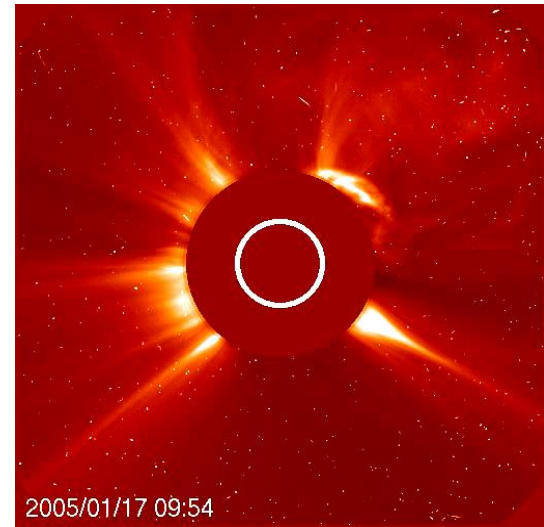
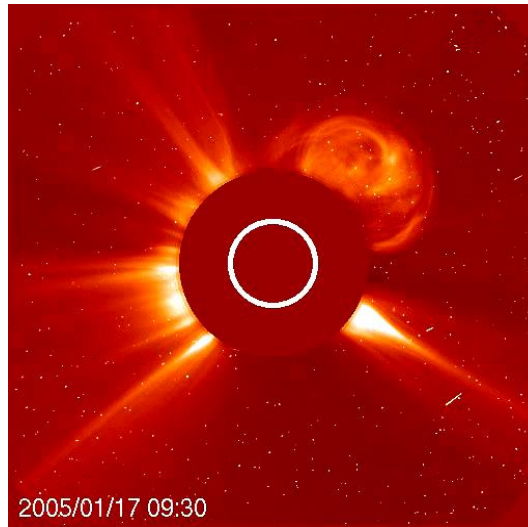
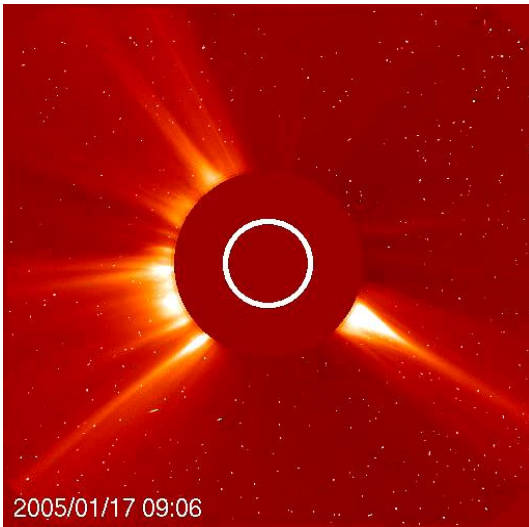
38th COSPAR Scientific Assembly Bremen, Germany, 18-25 July 2010

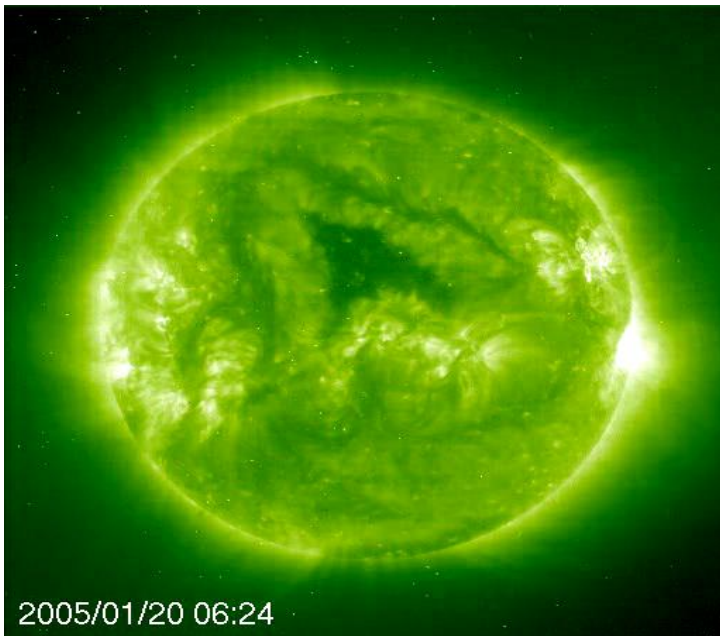




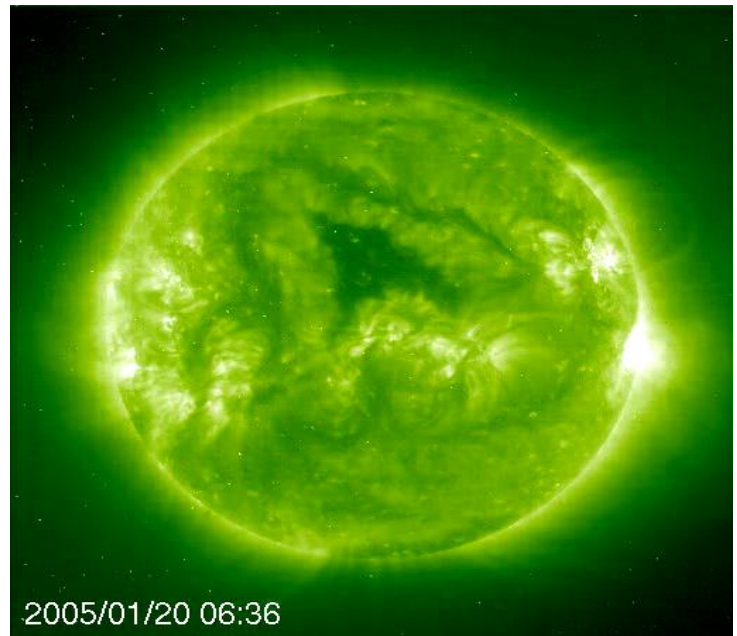
ΠΡΩΤΟΝΙΑ/ GOES SAT



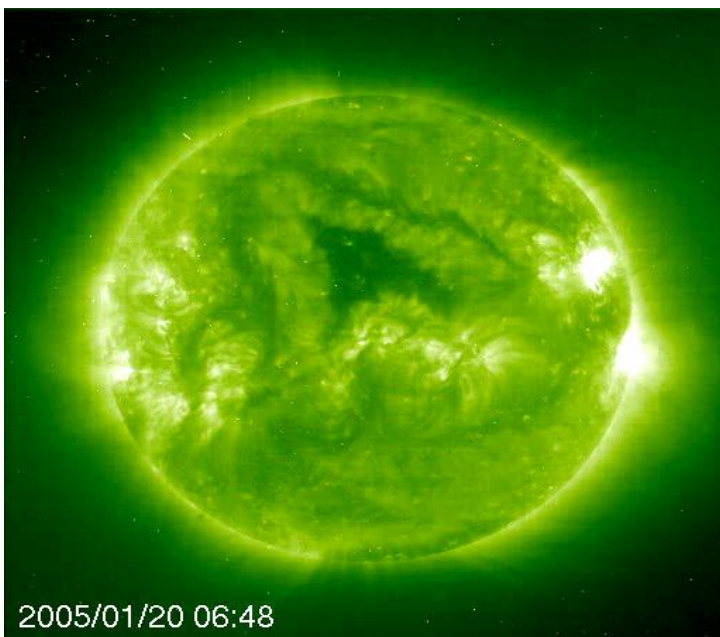




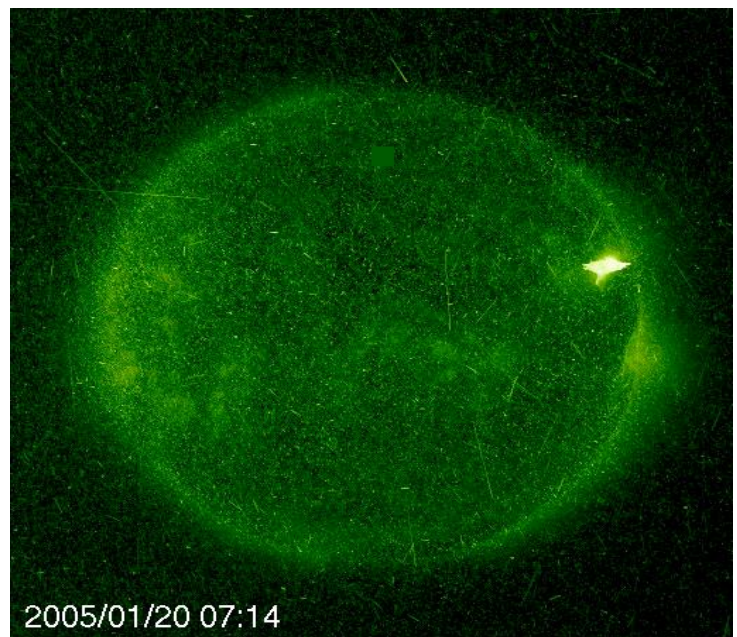
2005/01/20 06:24



2005/01/20 06:36

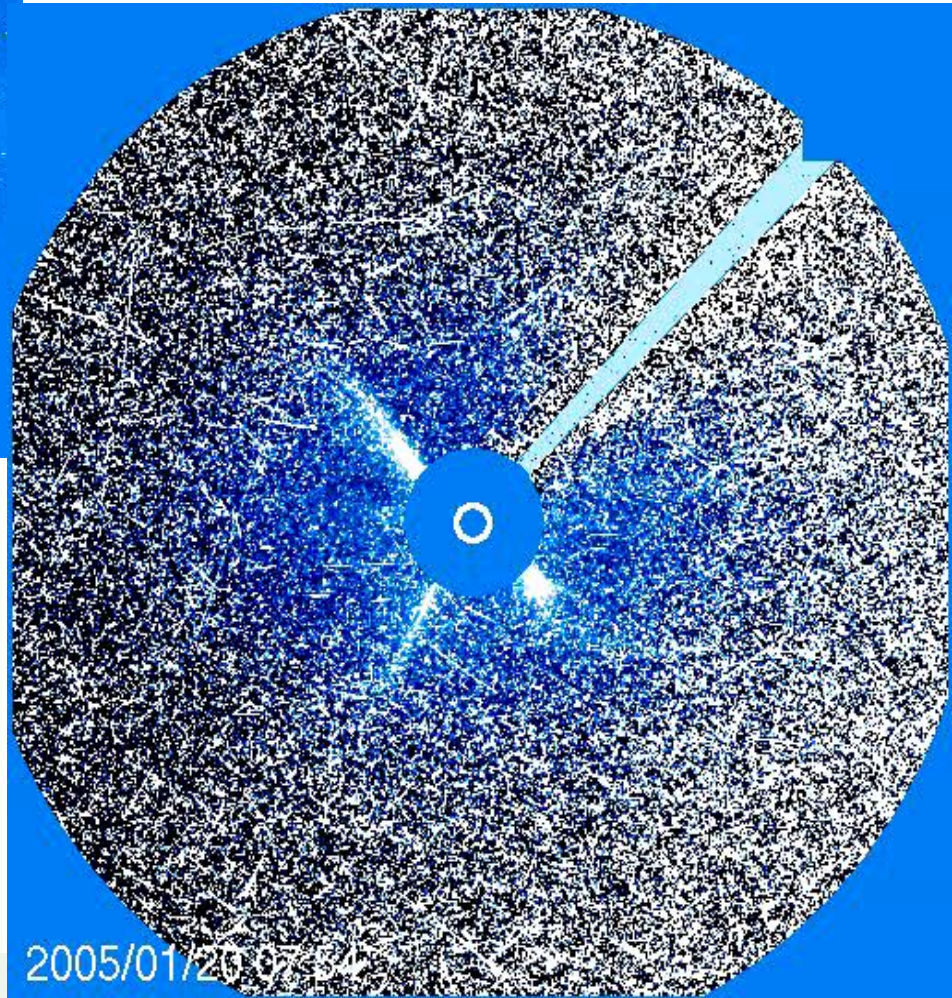
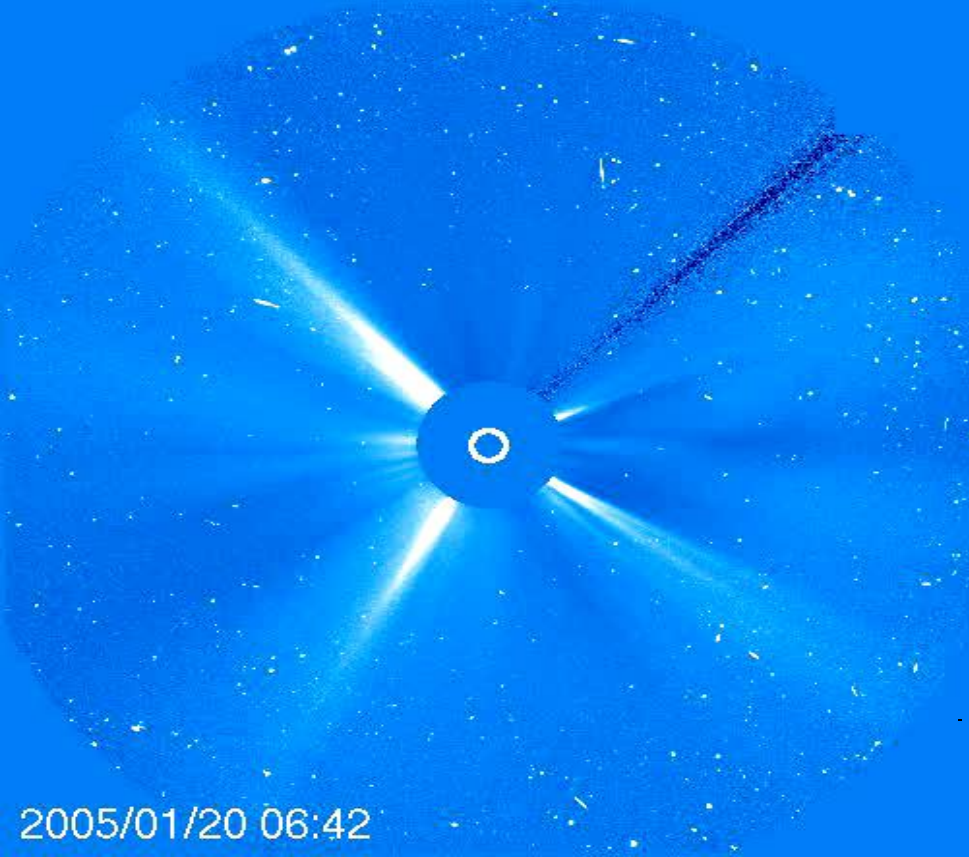


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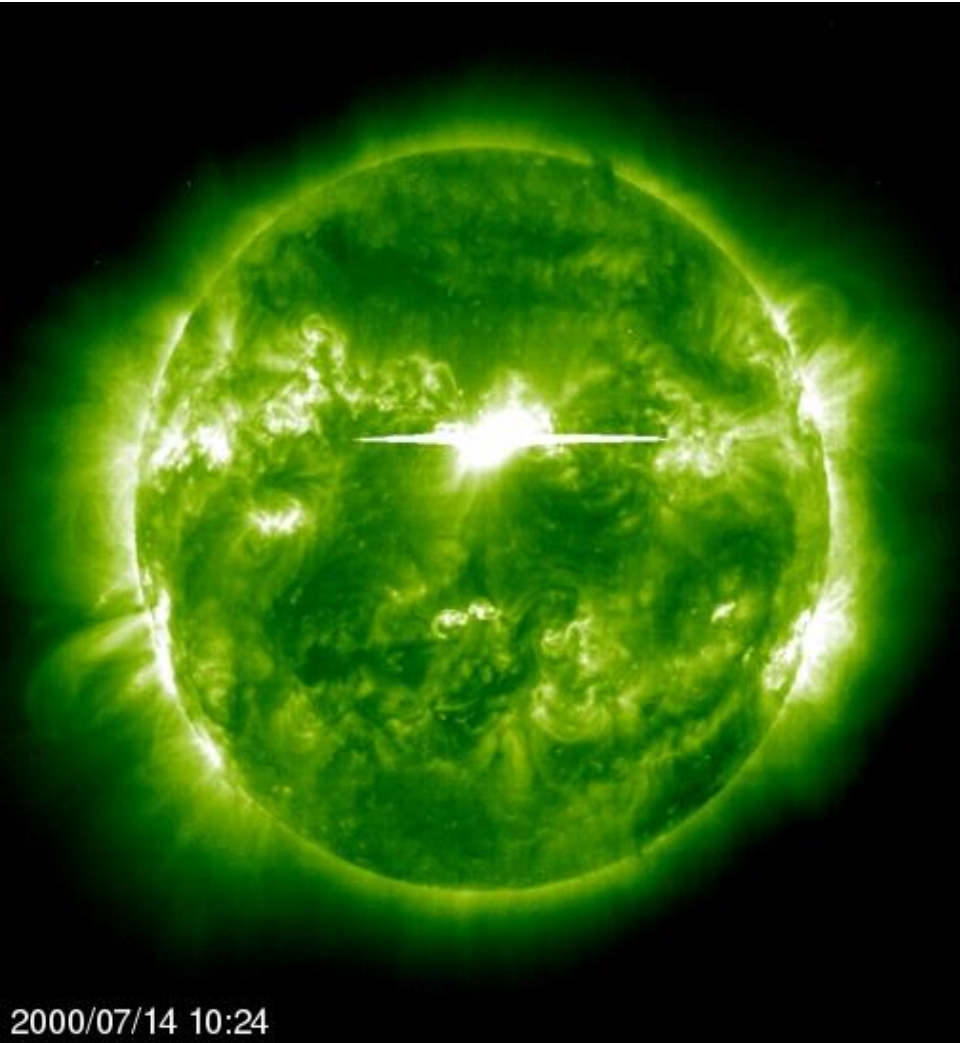


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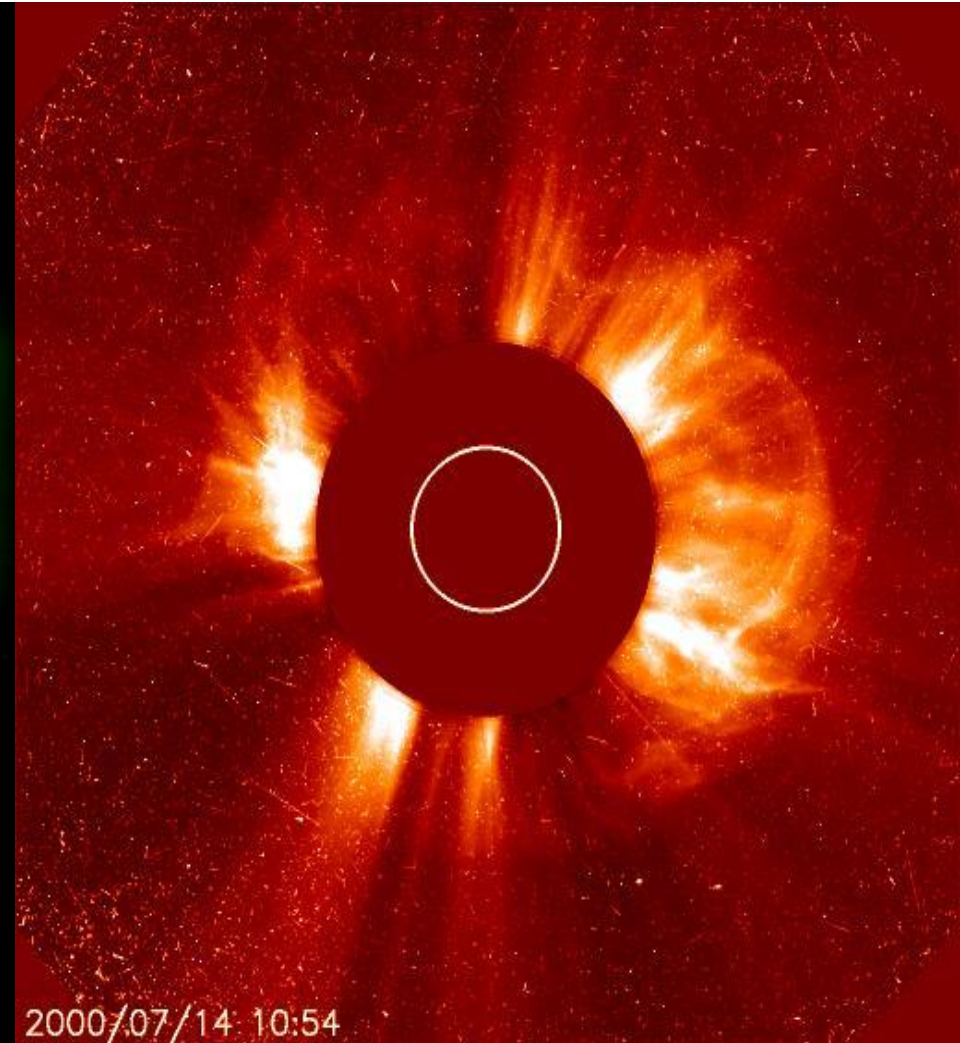




14 ΙΟΥΛΙΟΥ 2000 BASTILLE EVENT

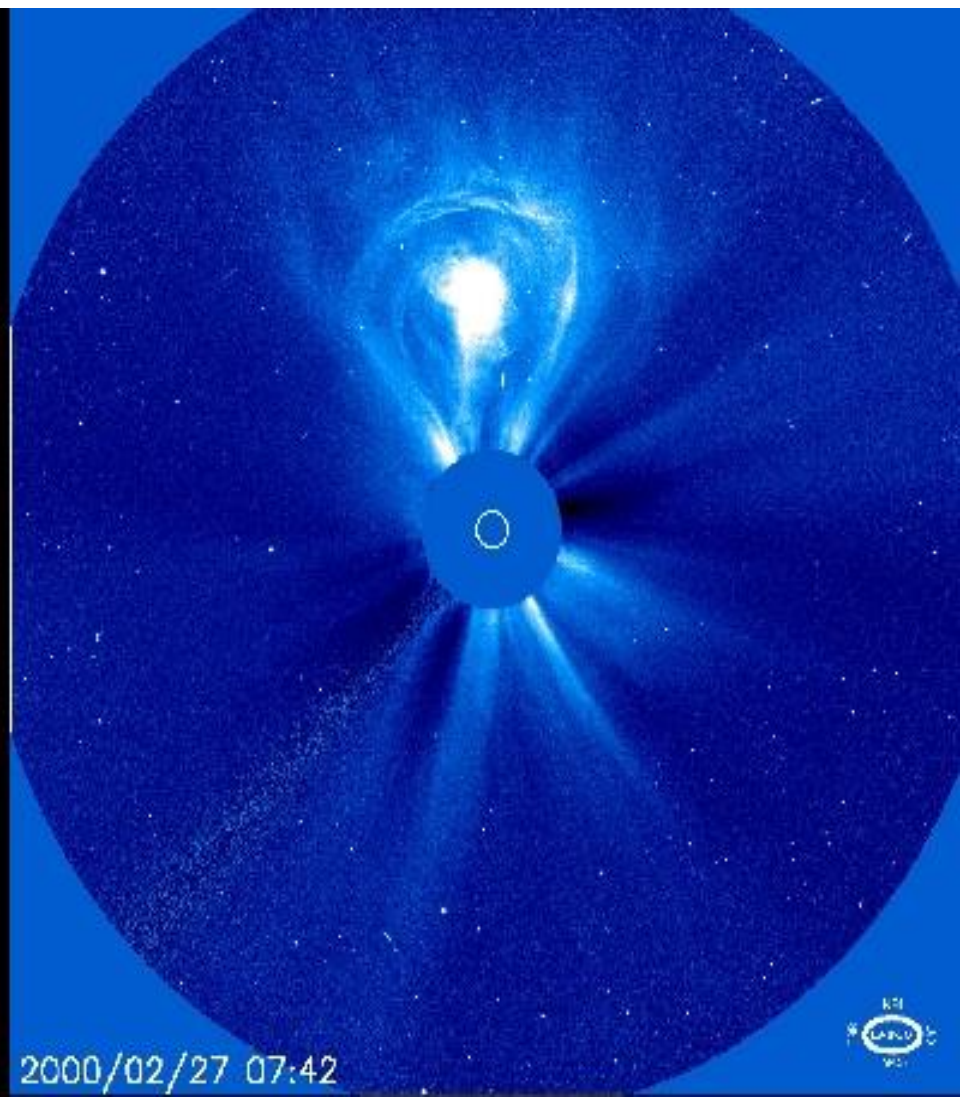
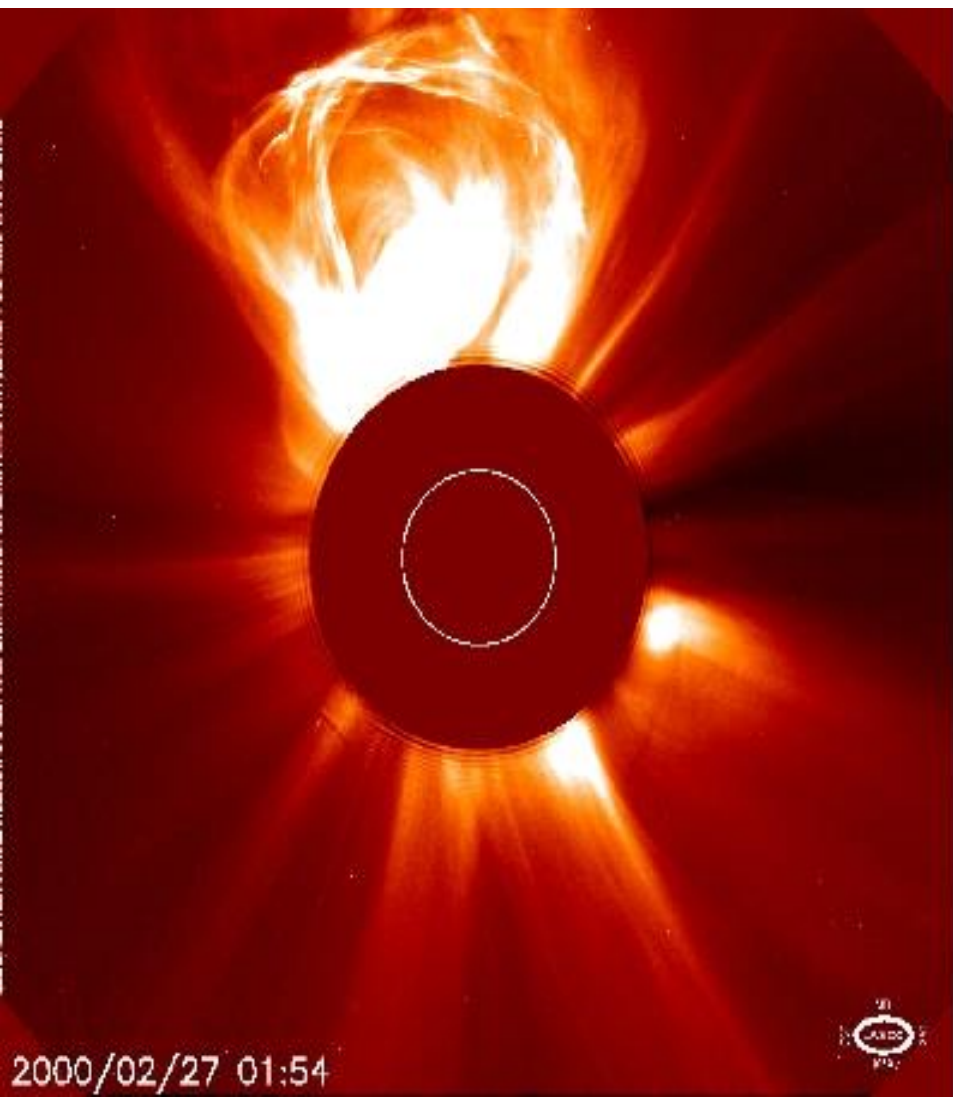


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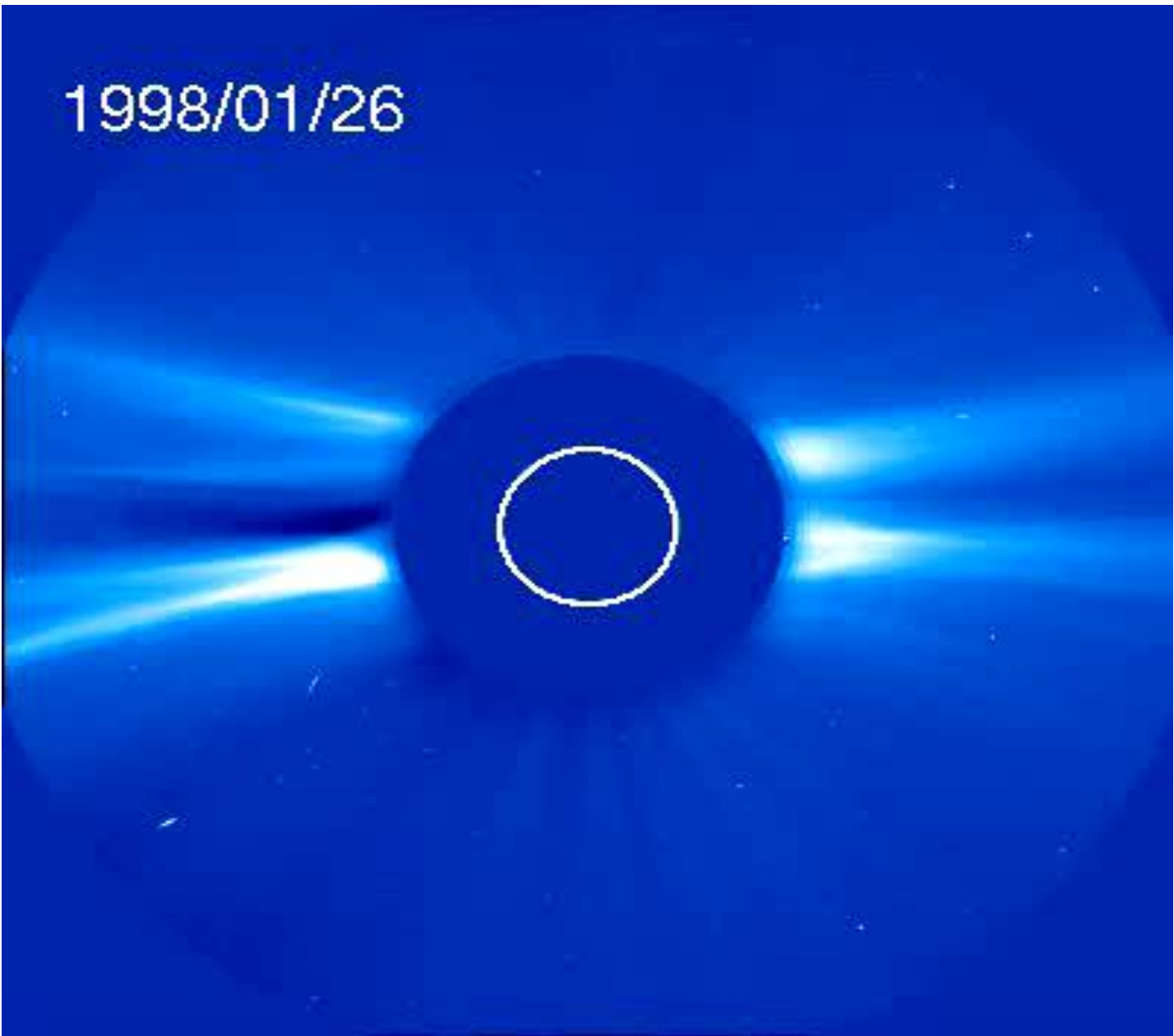


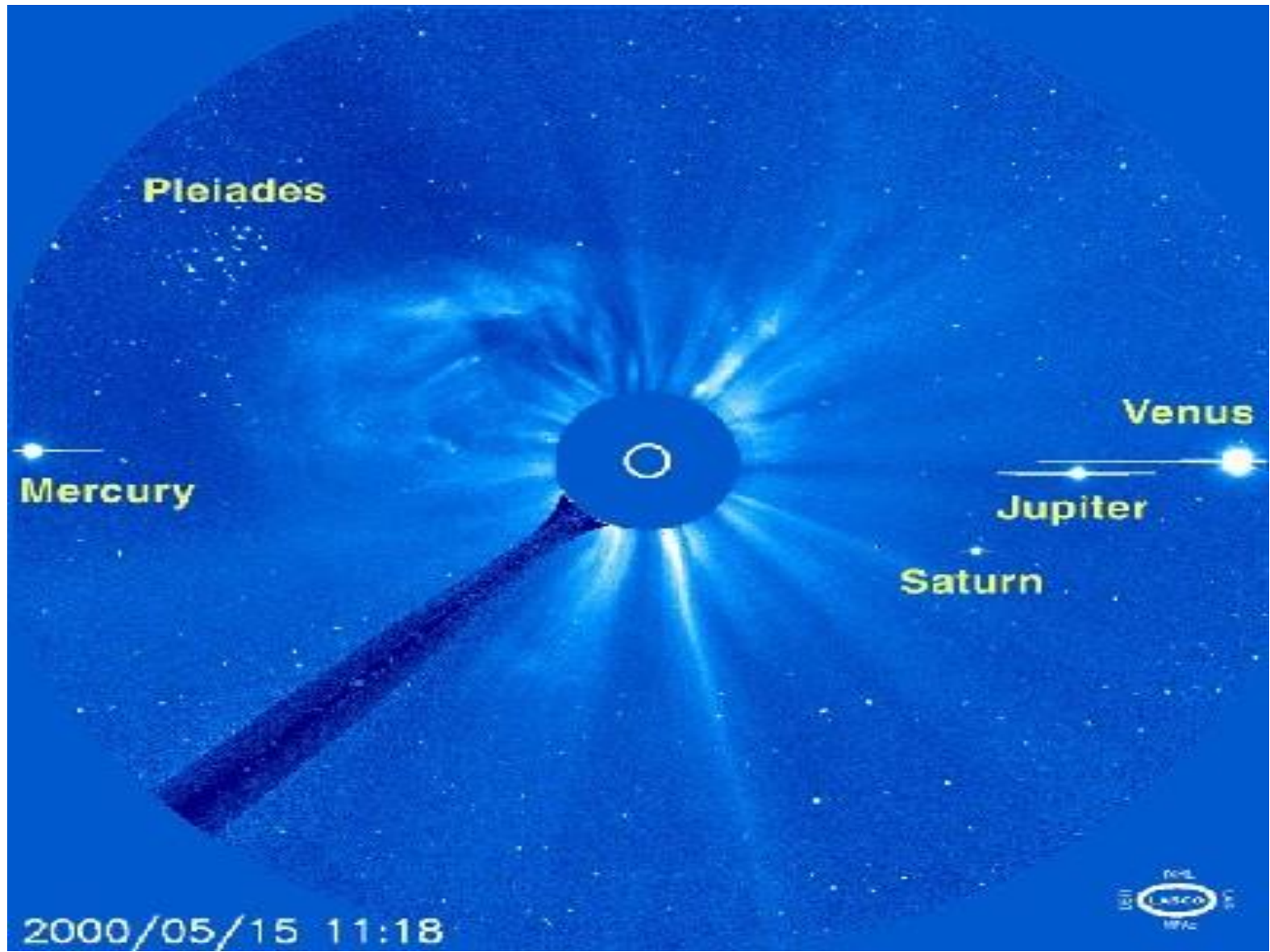
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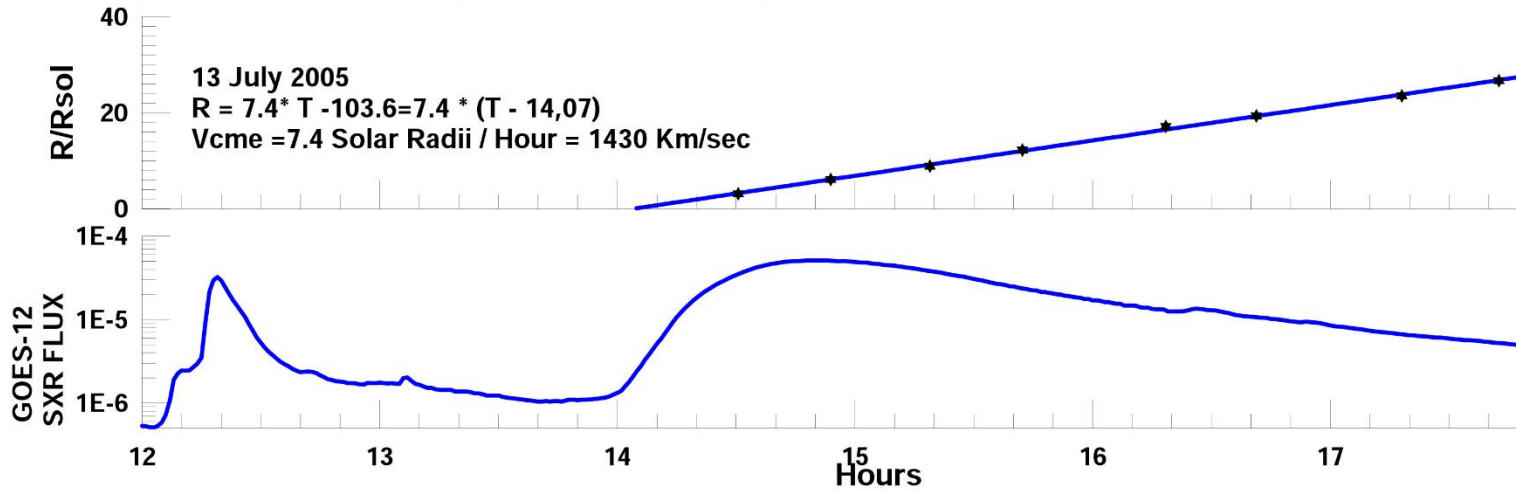
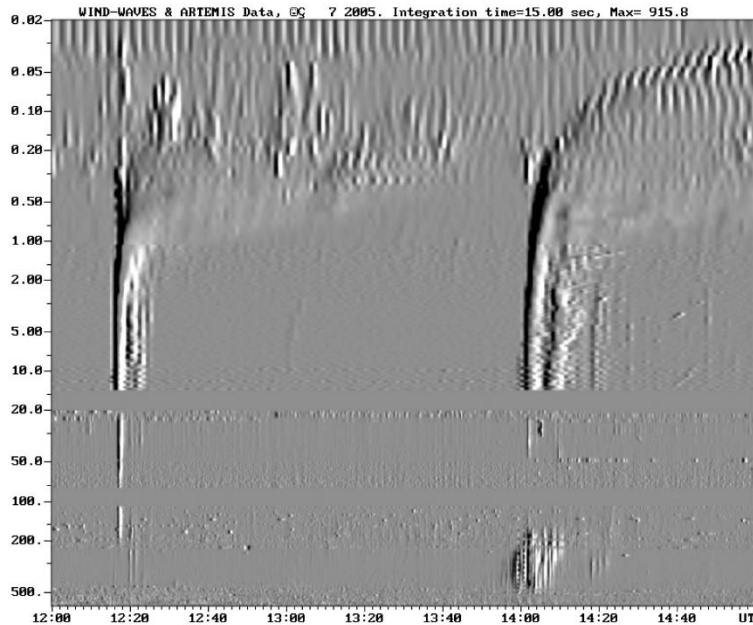


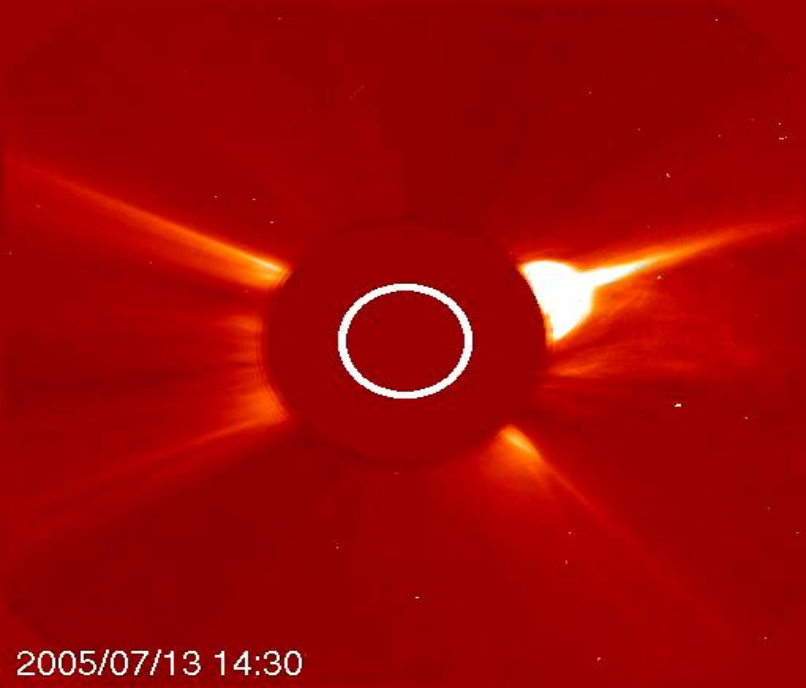


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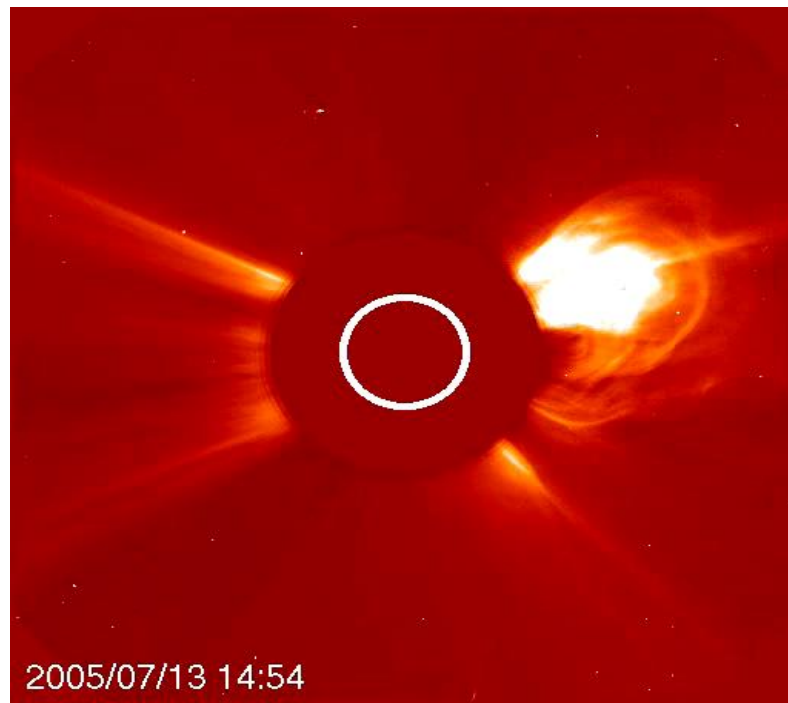




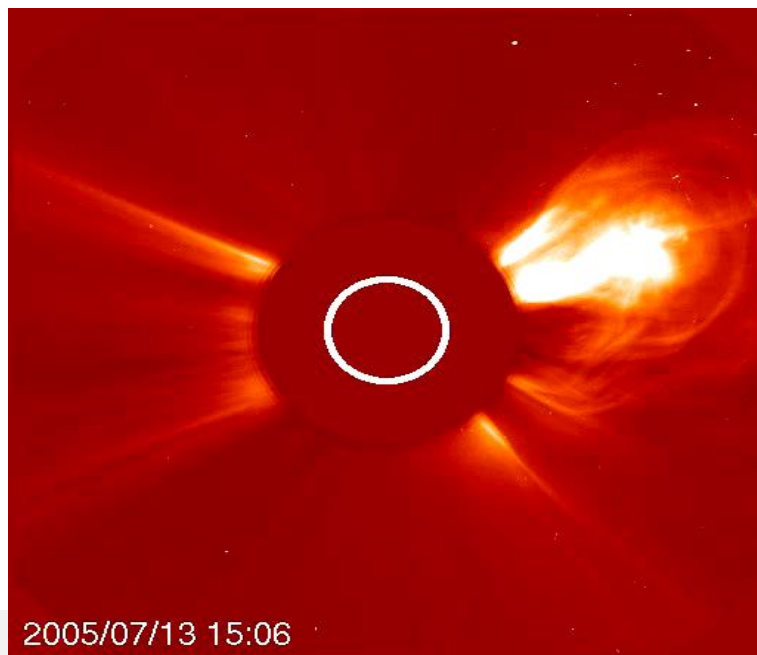




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2005/07/13 14:54

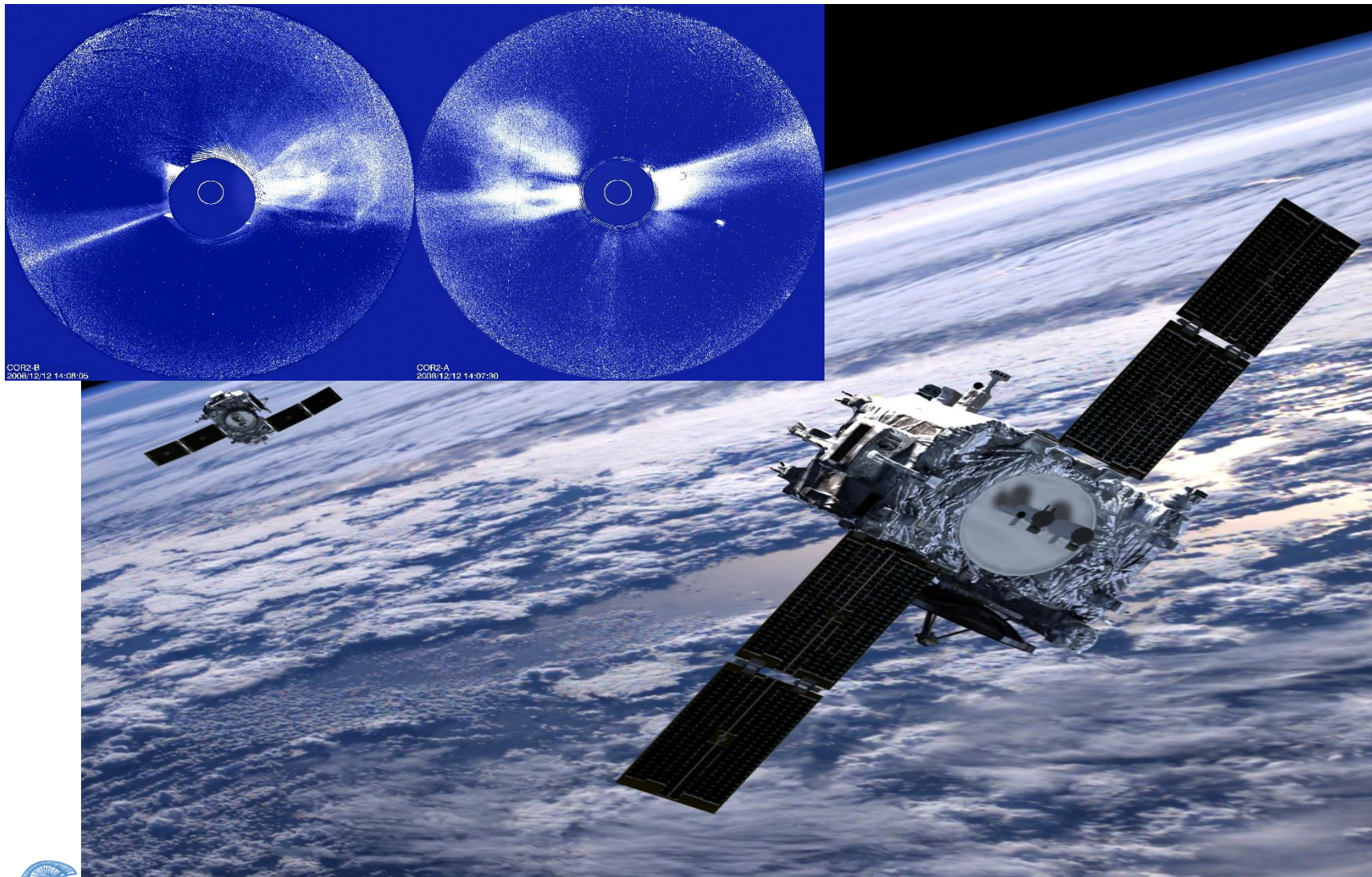


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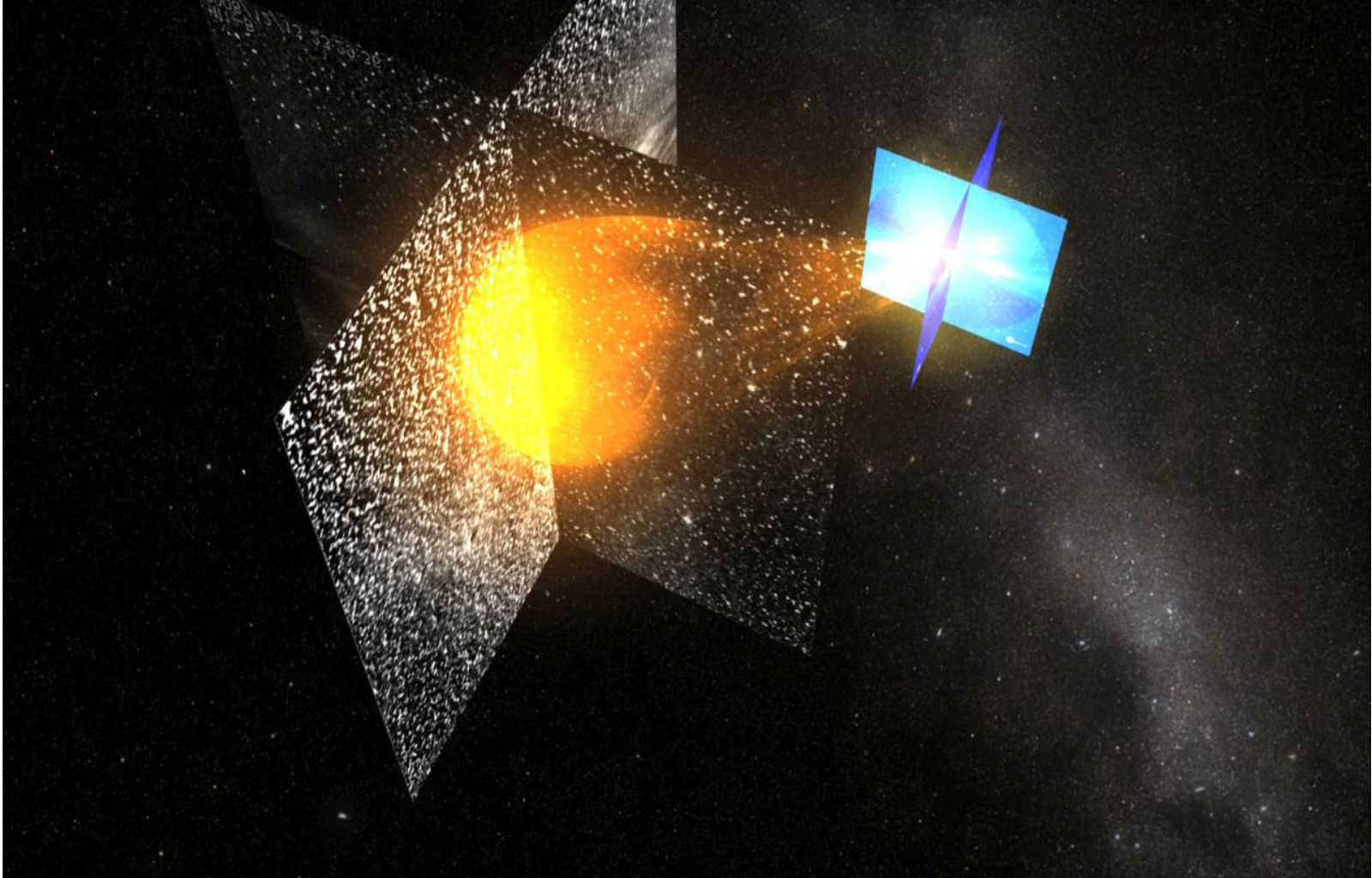
4. Μαγνητικό πεδίο του Ήλιου

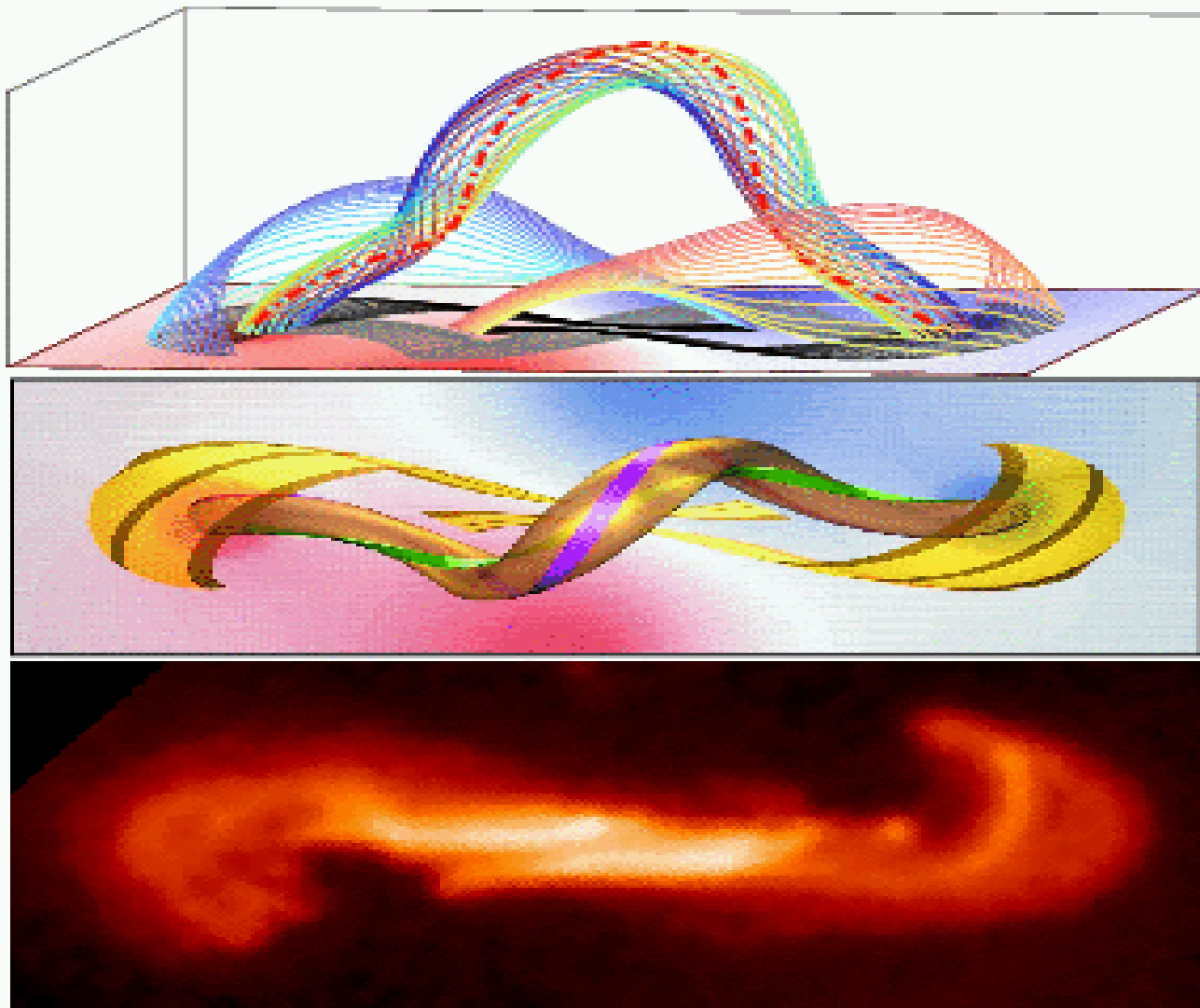


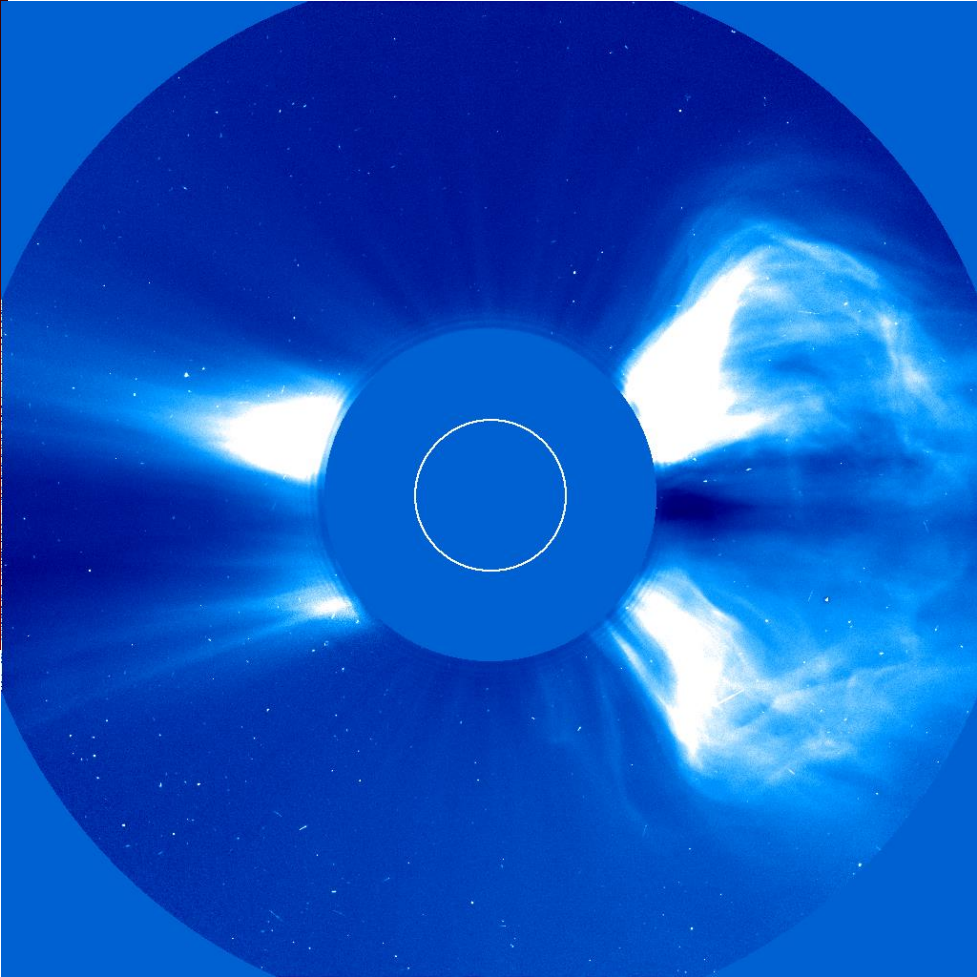
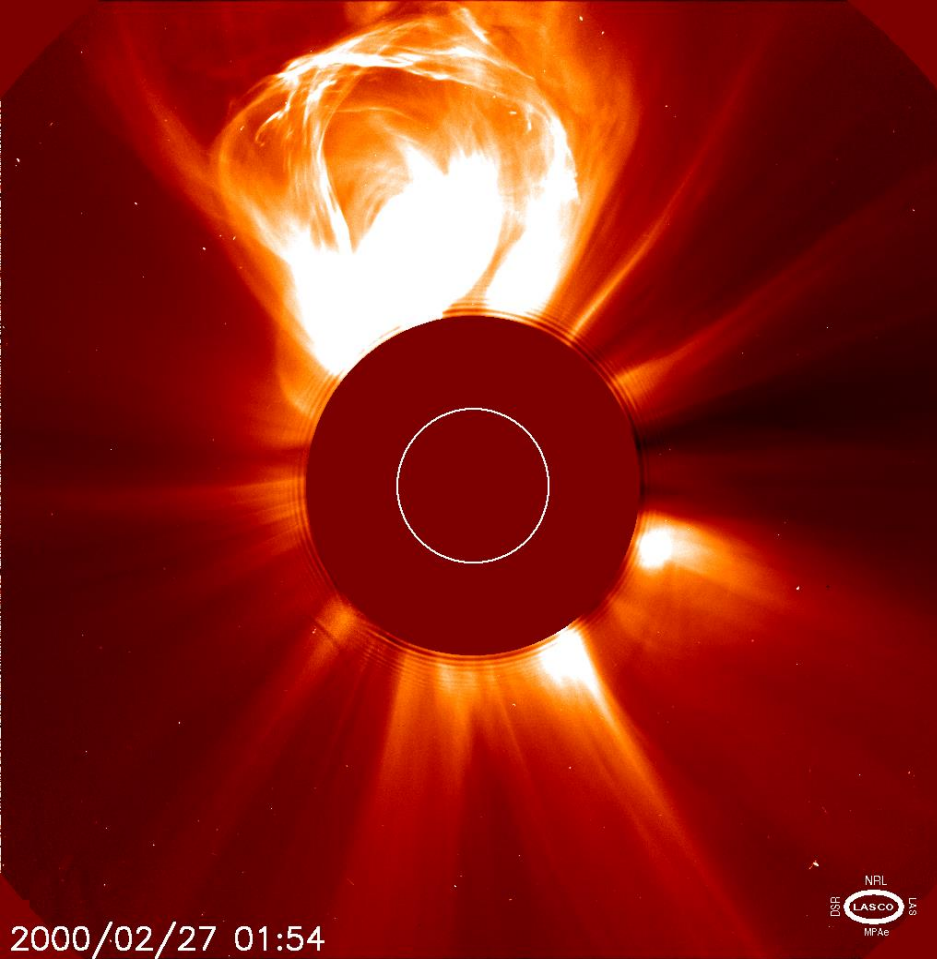
STEREO CME 12/12/2008



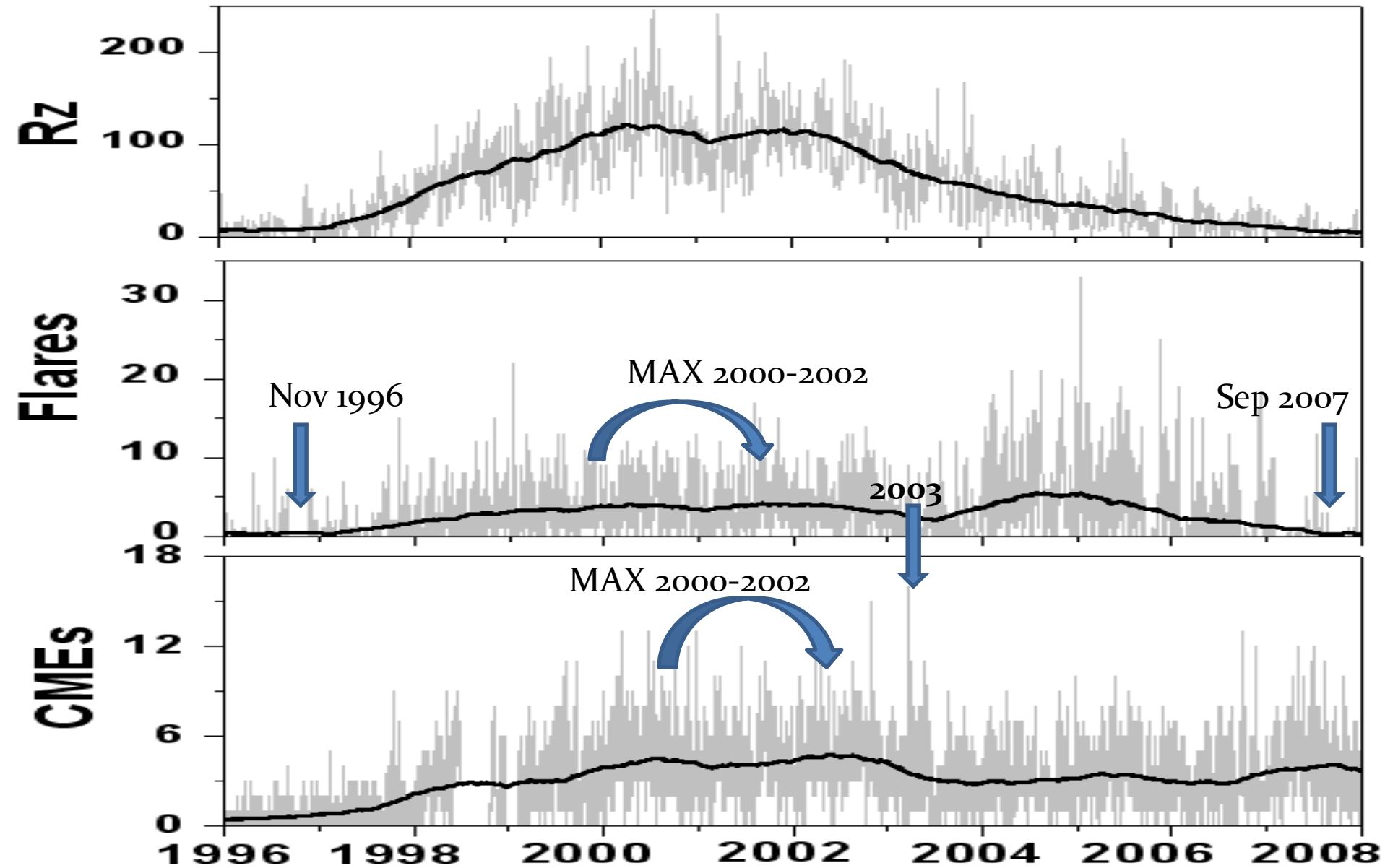
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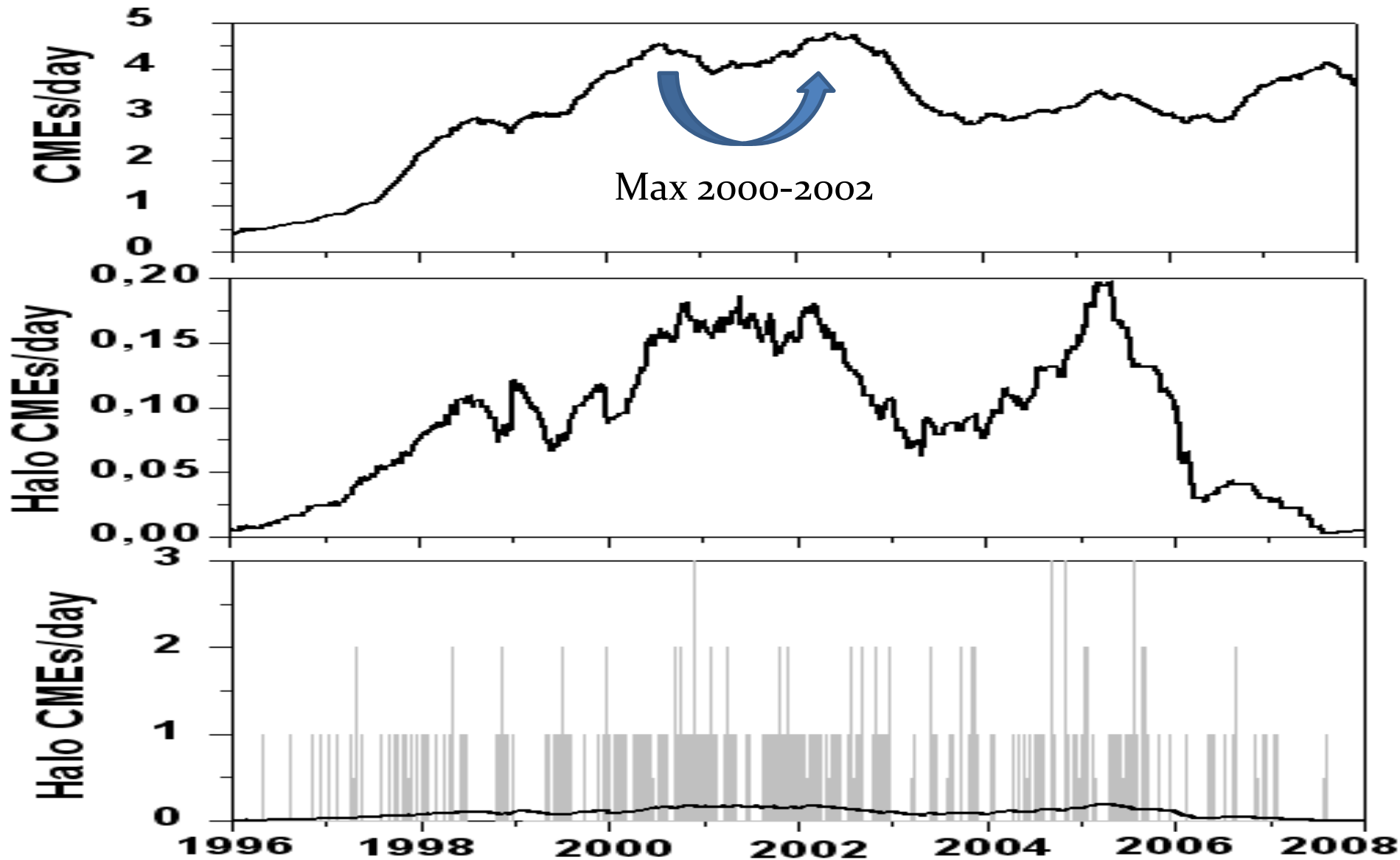




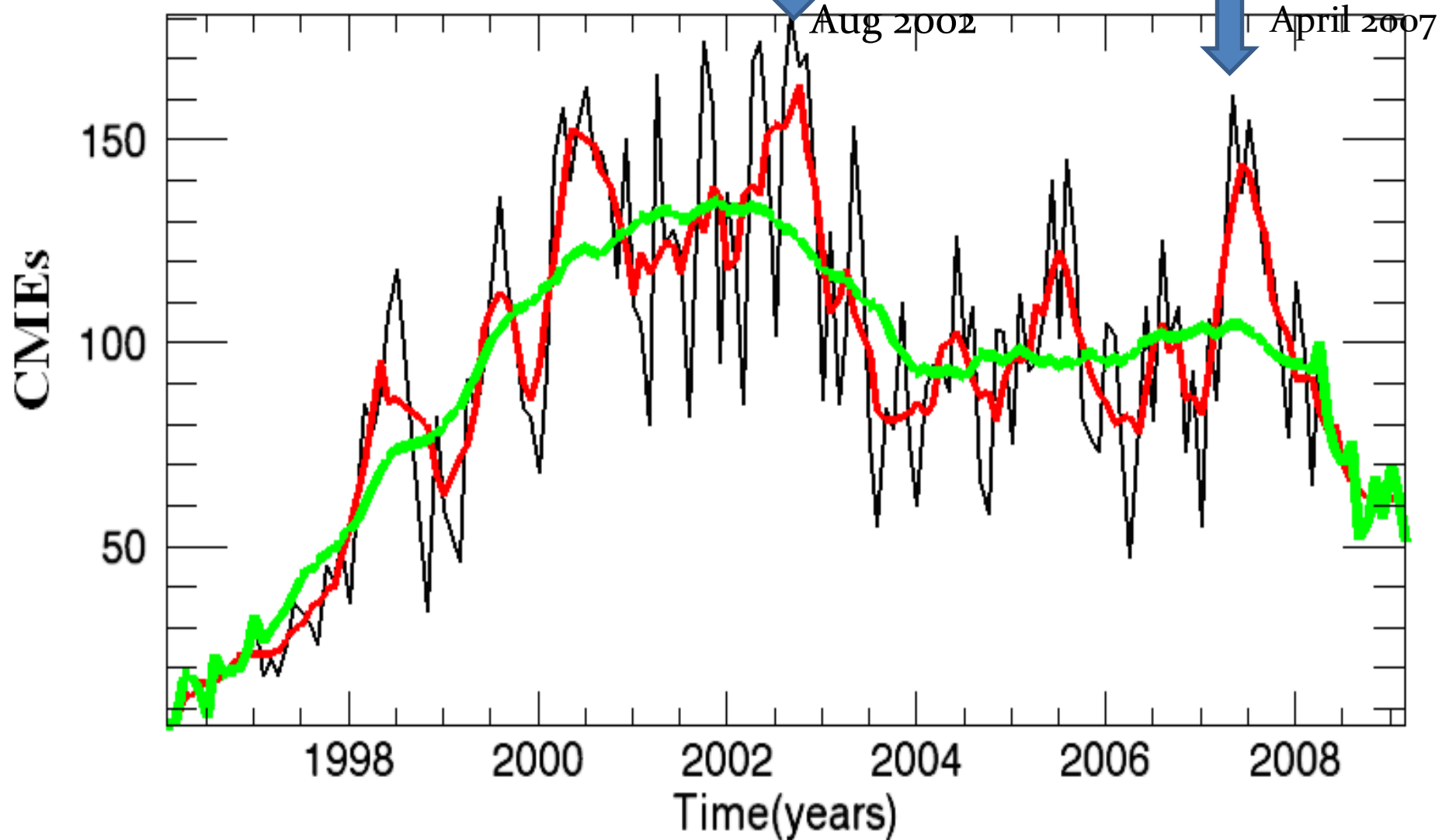
Solar Flares and Coronal Mass Ejections



CMEs Analysis

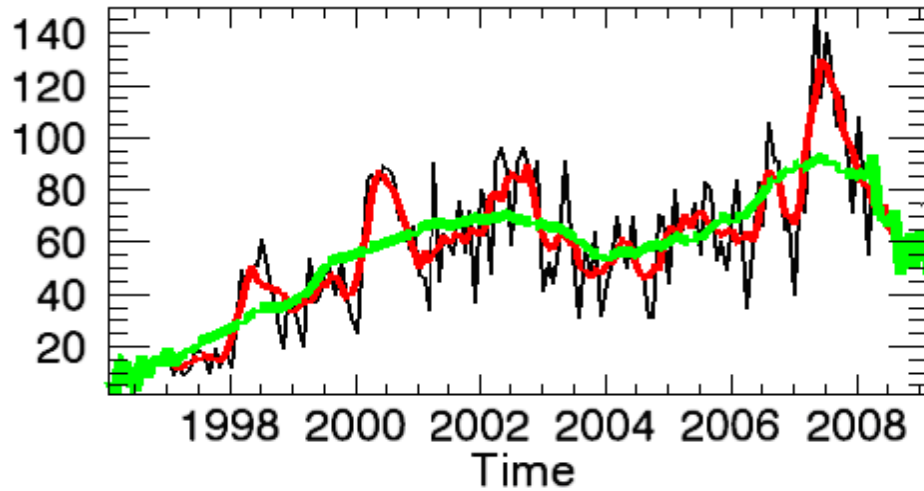


Monthly Distribution CMEs

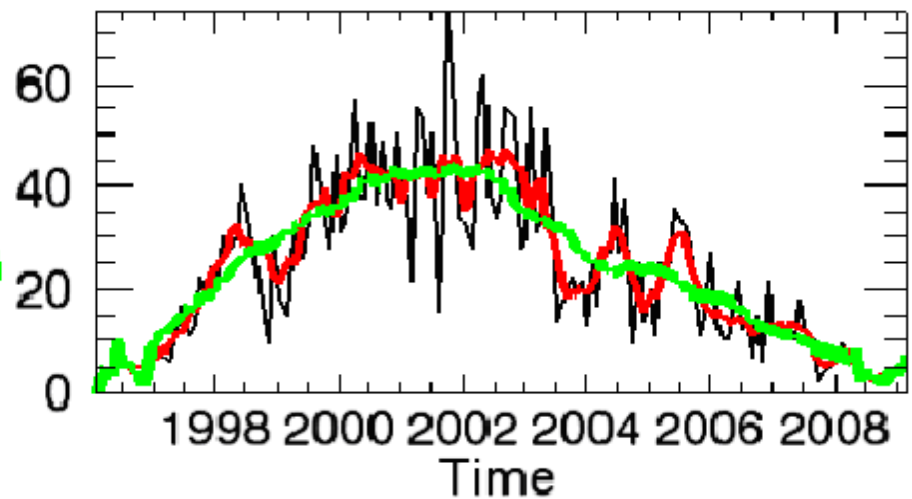


— 5 months
— 25 months

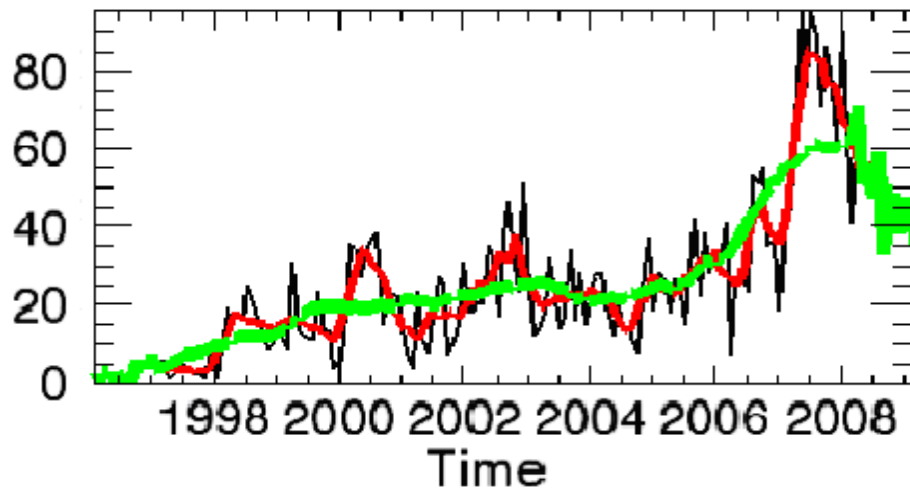
CMEs (width < 50)



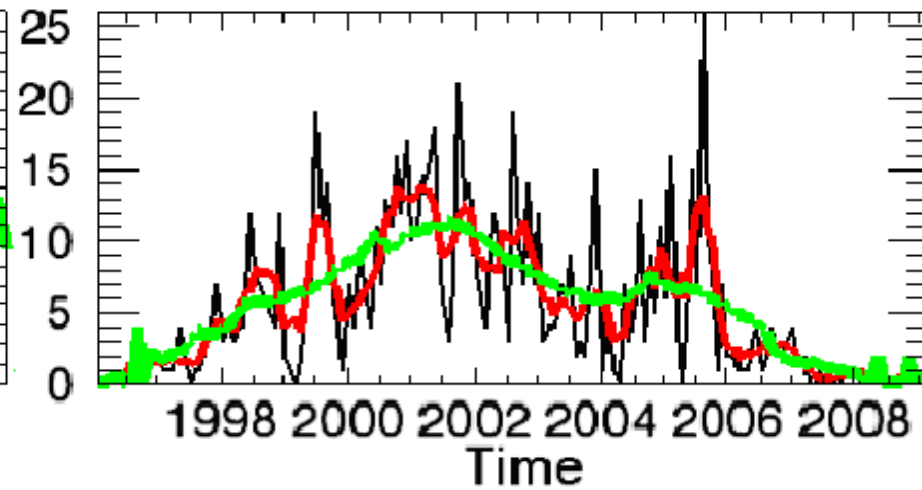
CMEs (50 < width < 100)



CMEs (0 < width < 20)



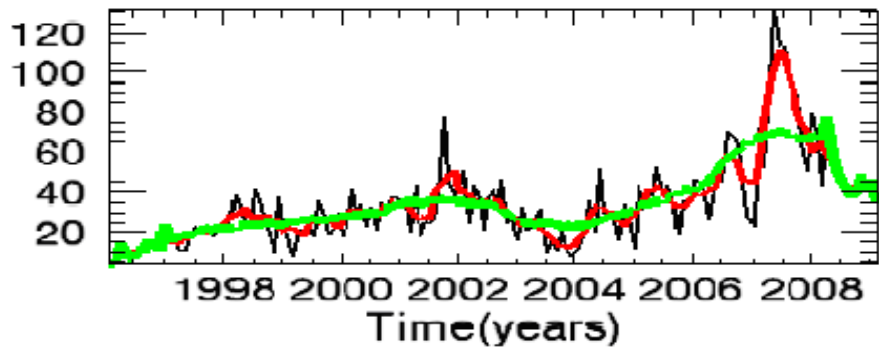
CMEs (width > 150)



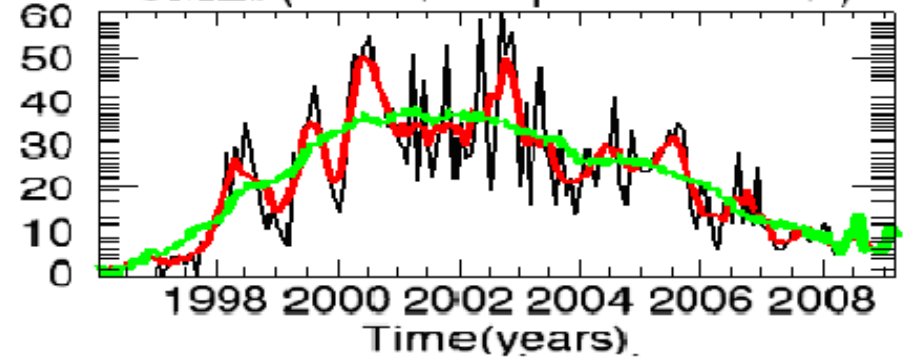
38th COSPAR Scientific Assembly Bremen, Germany, 18-25 July 2010



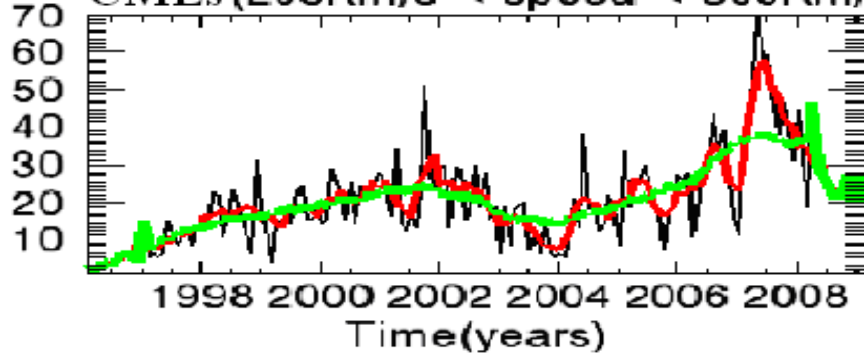
CMEs (speed < 300Km/s)



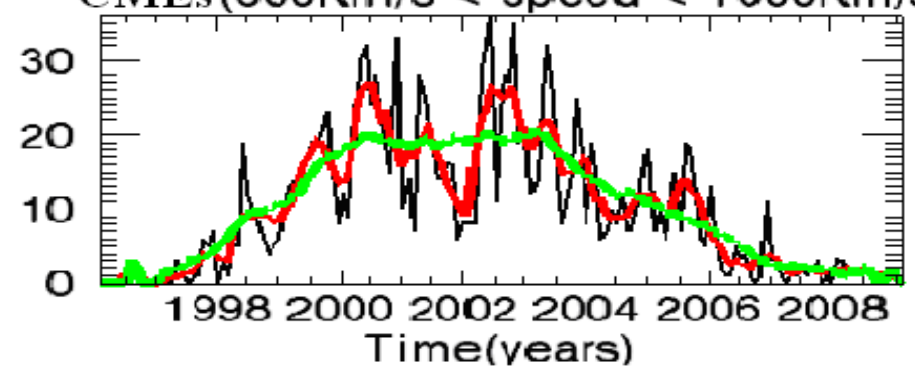
CMEs (400Km/s < speed < 600Km/s)



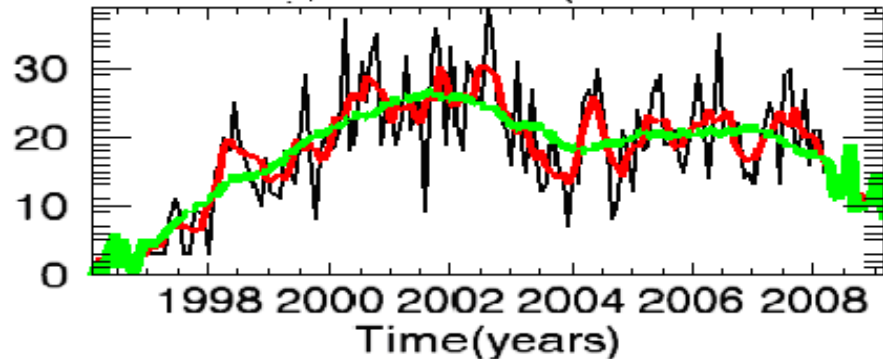
CMEs (200Km/s < speed < 300Km/s)



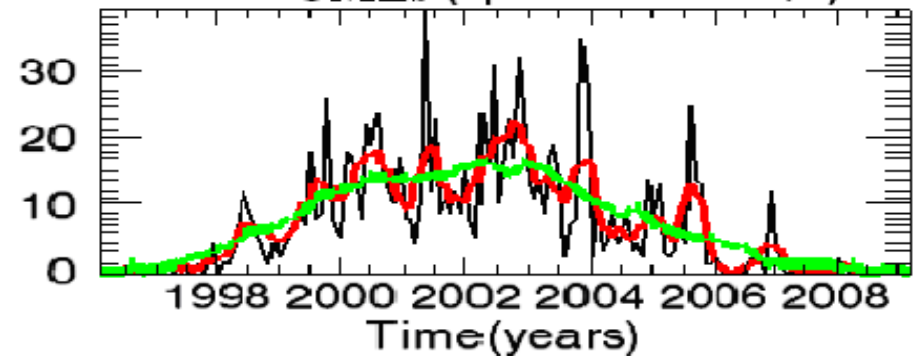
CMEs (600Km/s < speed < 1000Km/s)



CMEs (300Km/s < speed < 400Km/s)



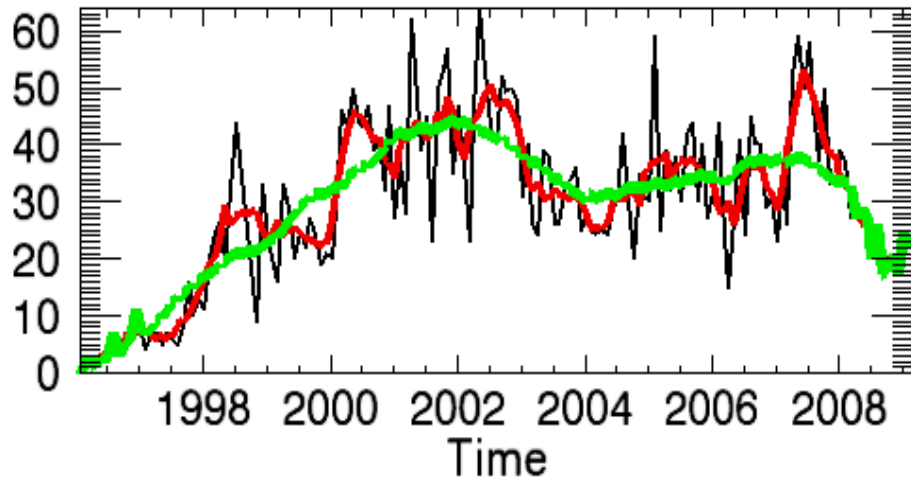
CMEs (speed > 800Km/s)



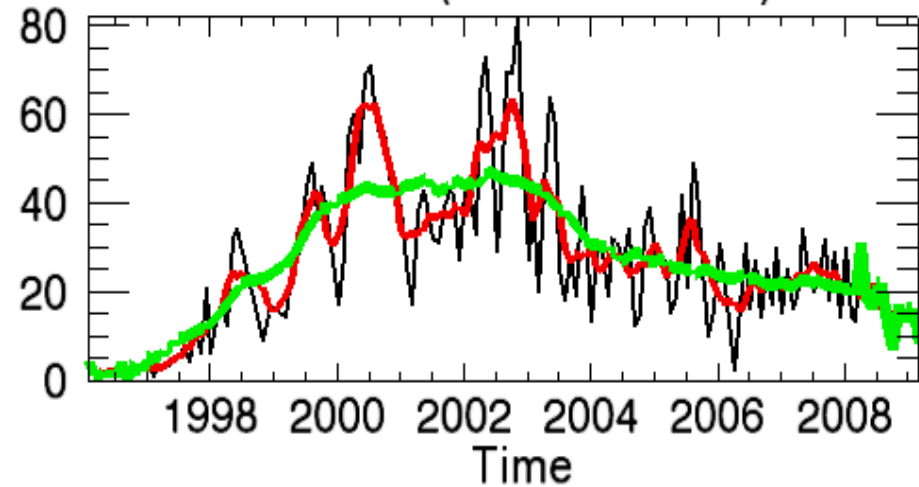
38th COSPAR Scientific Assembly Bremen, Germany, 18-25 July 2010



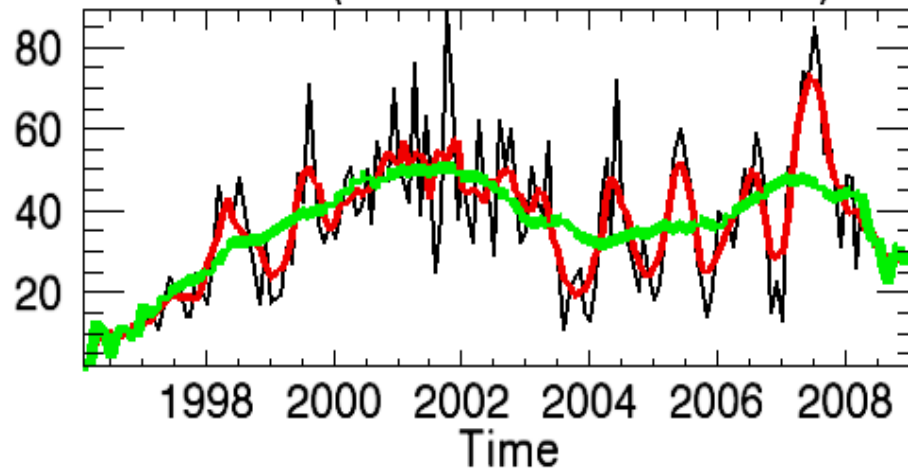
CMEs (accel. > 5 m/s²)



CMEs (accel. < -5 m/s²)

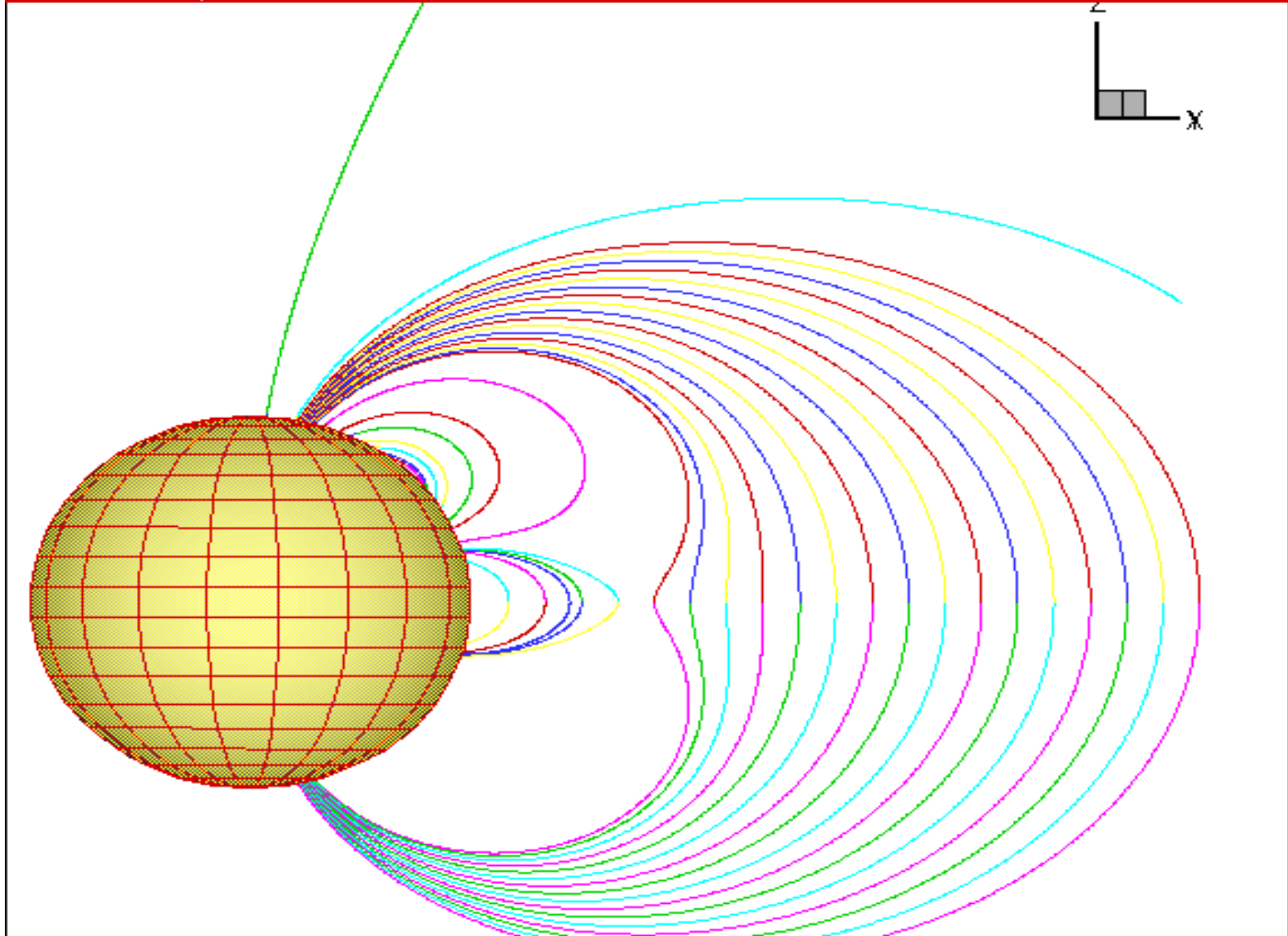


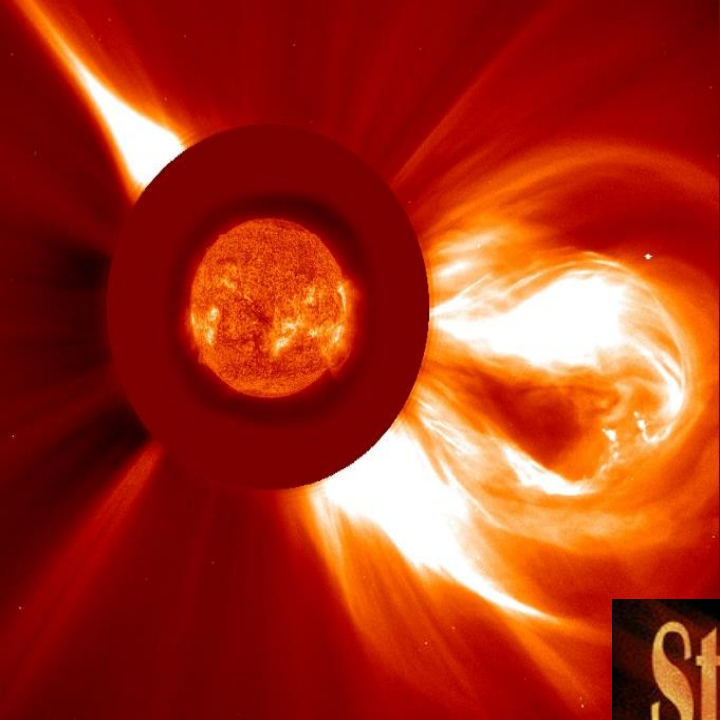
CMEs (-5 m/s² < accel. < 5 m/s²)



38th COSPAR Scientific Assembly Bremen, Germany, 18-25 July 2010







Storms from the Sun

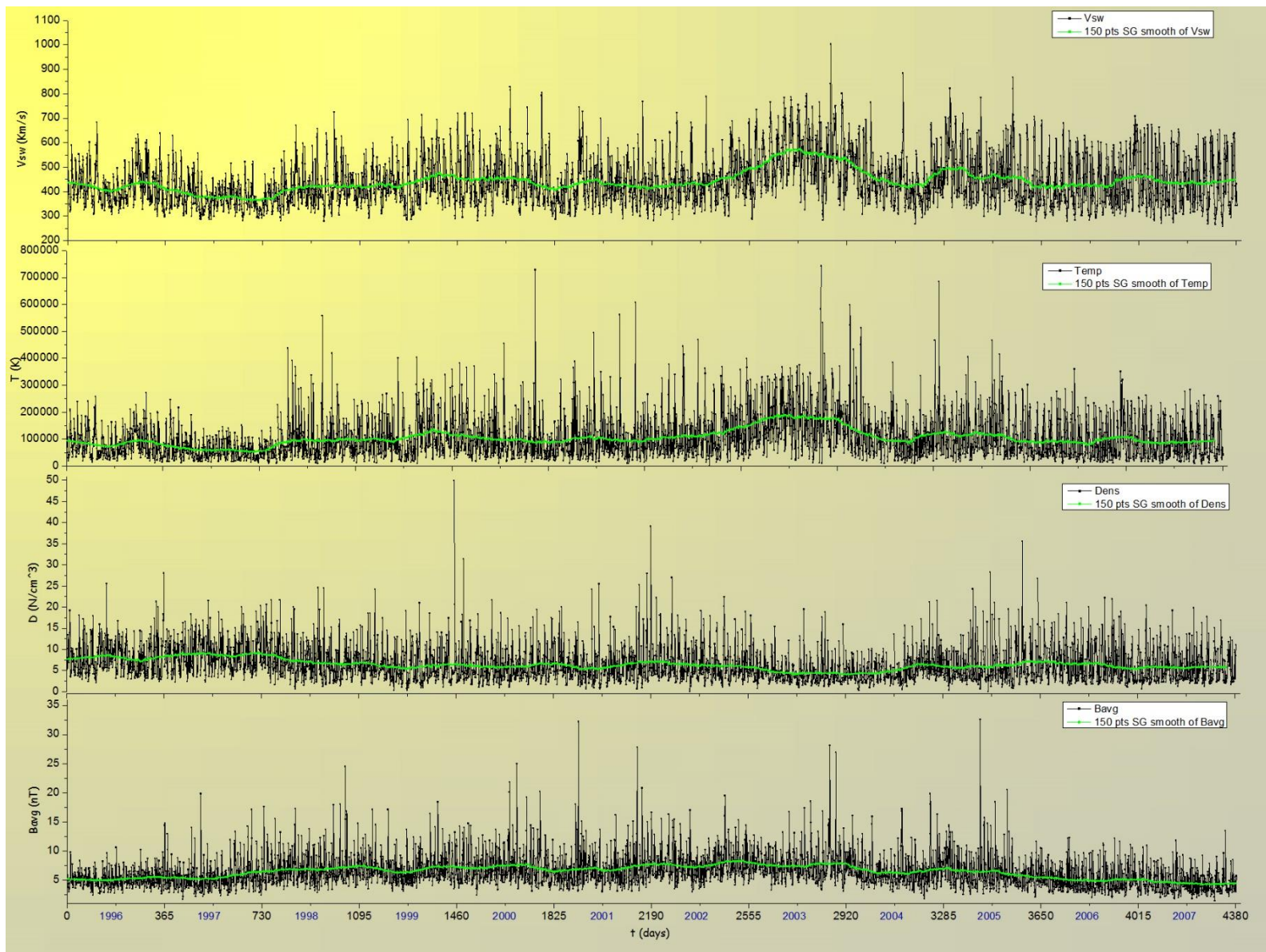
Coronal Mass Ejections Light Up the Sky

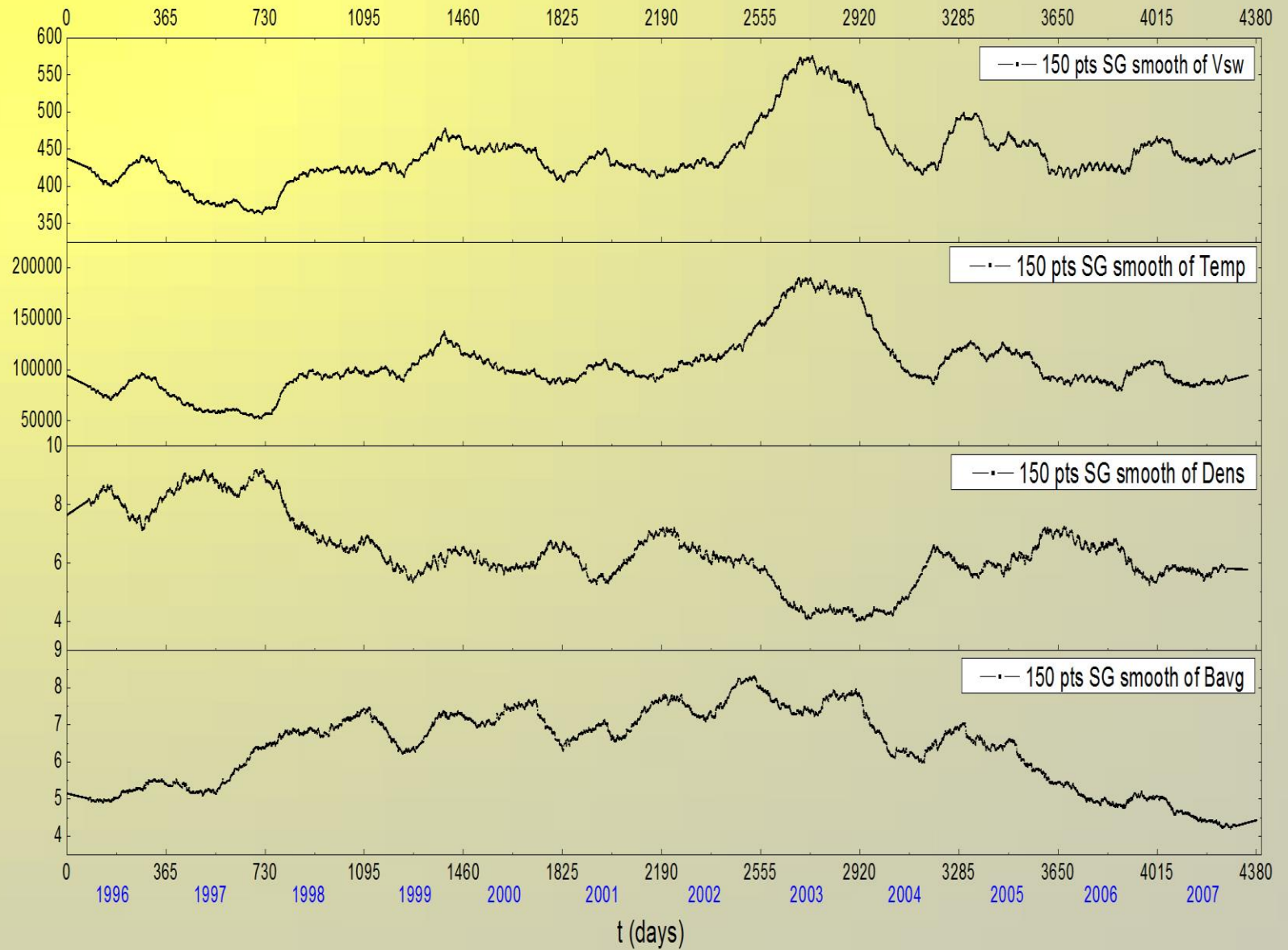
Particles are blasted from the Sun...

Millions of amps surge through our atmosphere ...

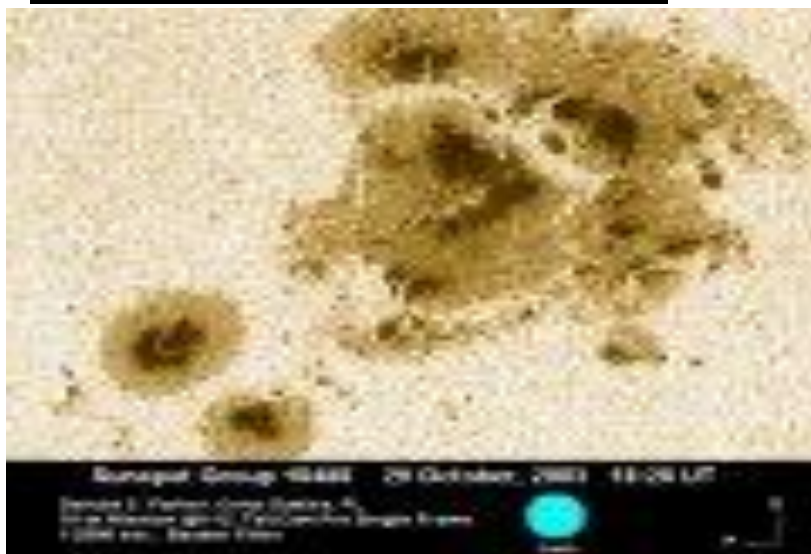
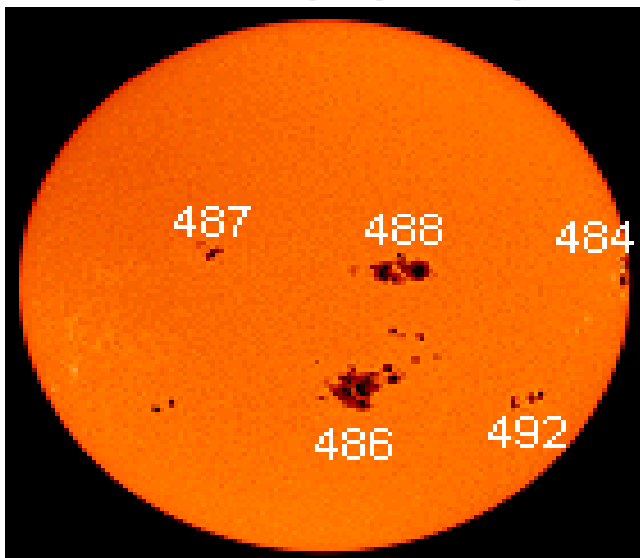
...And make bright Northern lights

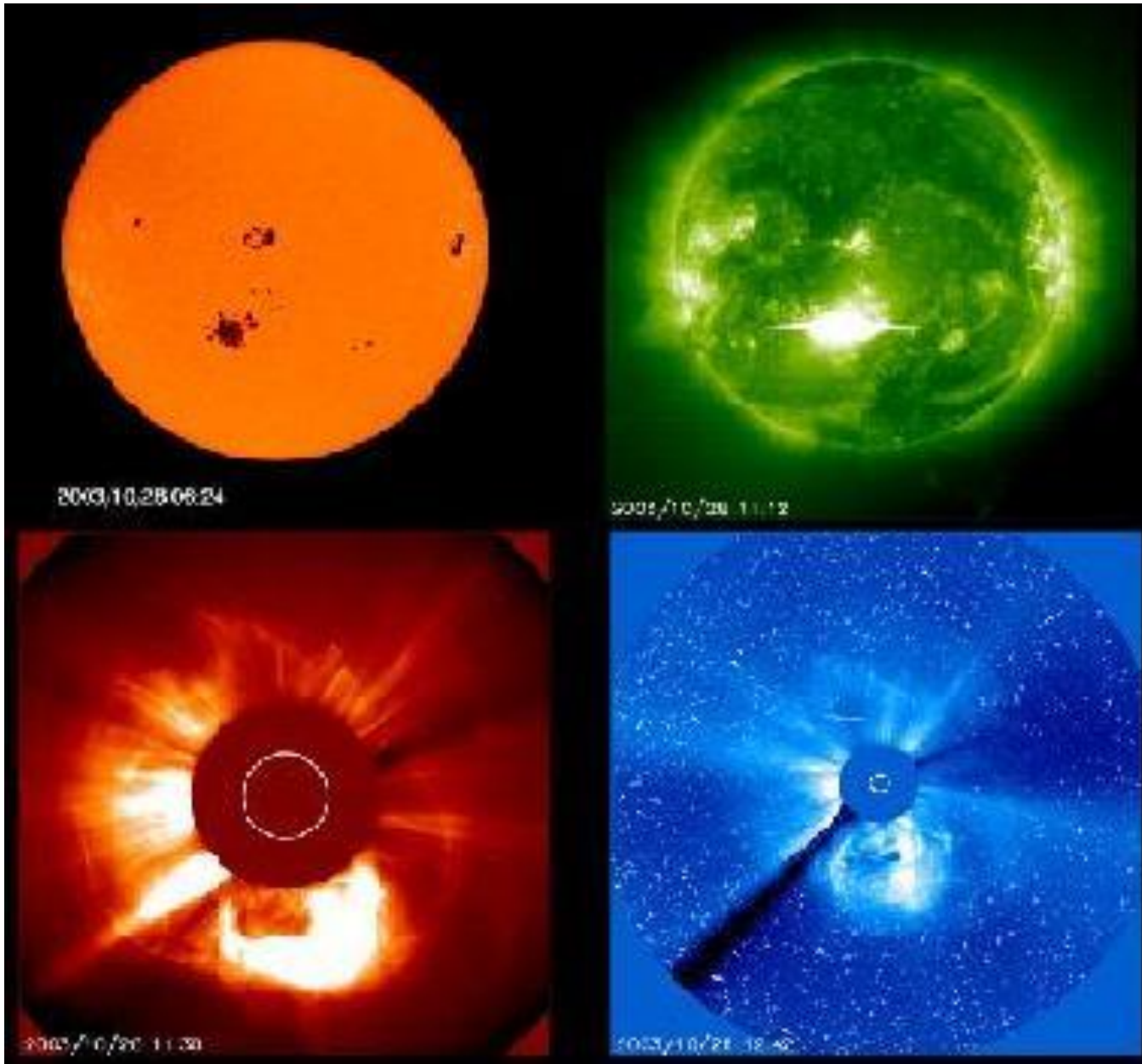






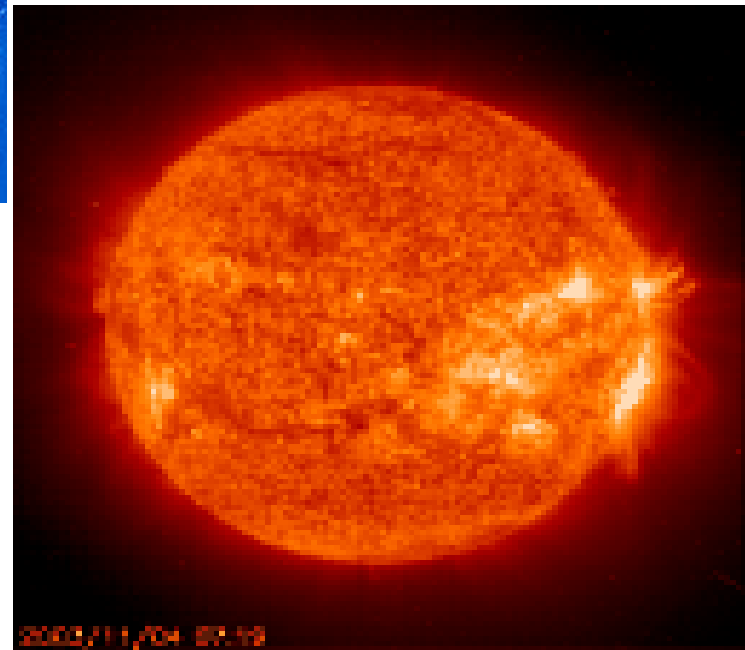
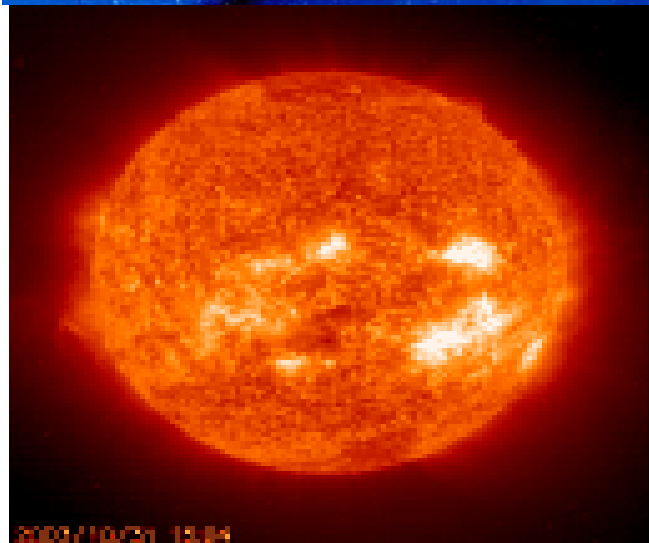
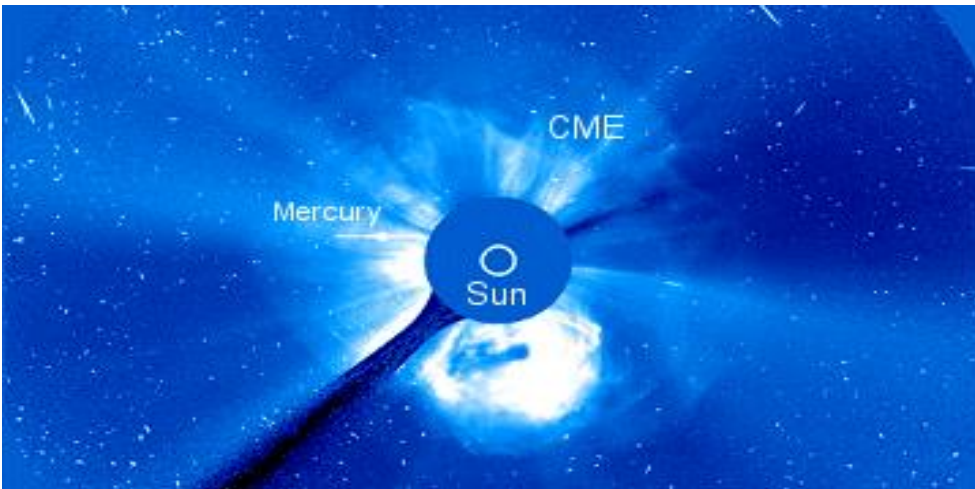
SUNSPOTS OCT-NOV 2003



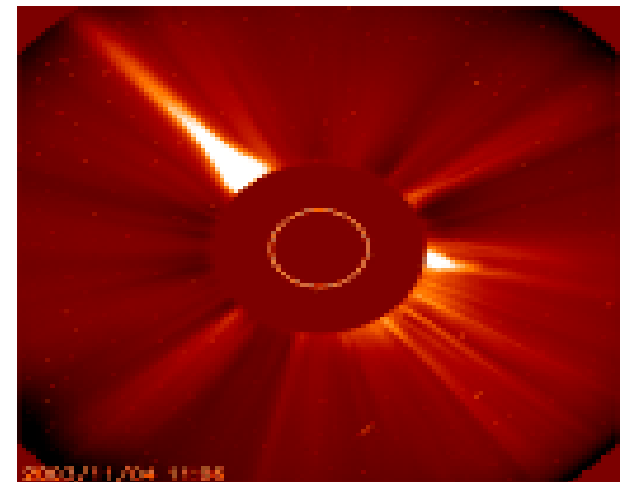
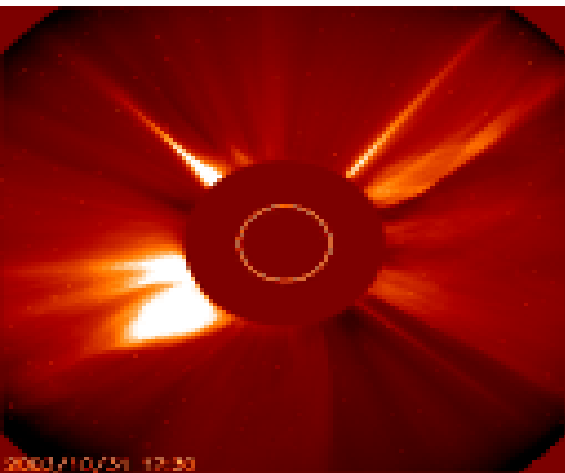
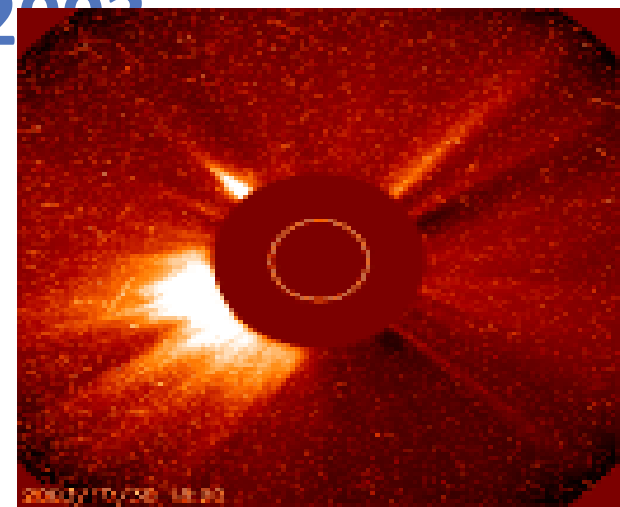
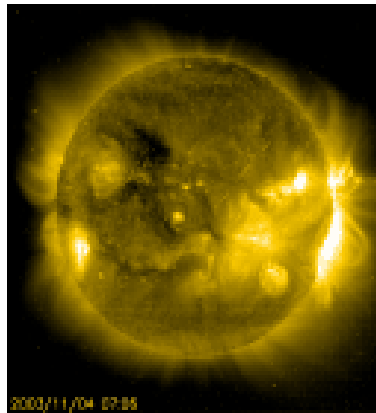
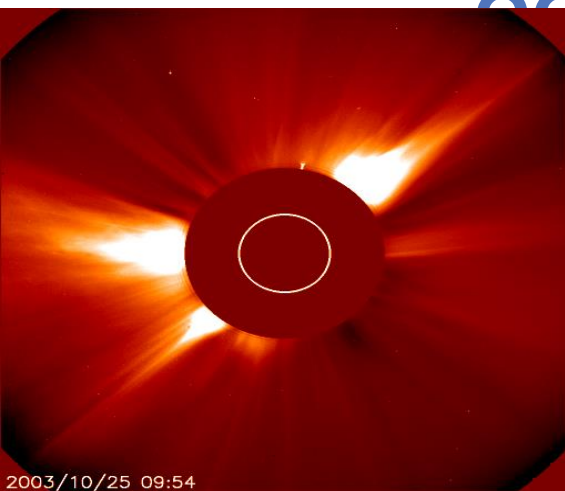


SOLAR ACTIVITY

OCTOBER-NOVEMBER 2003

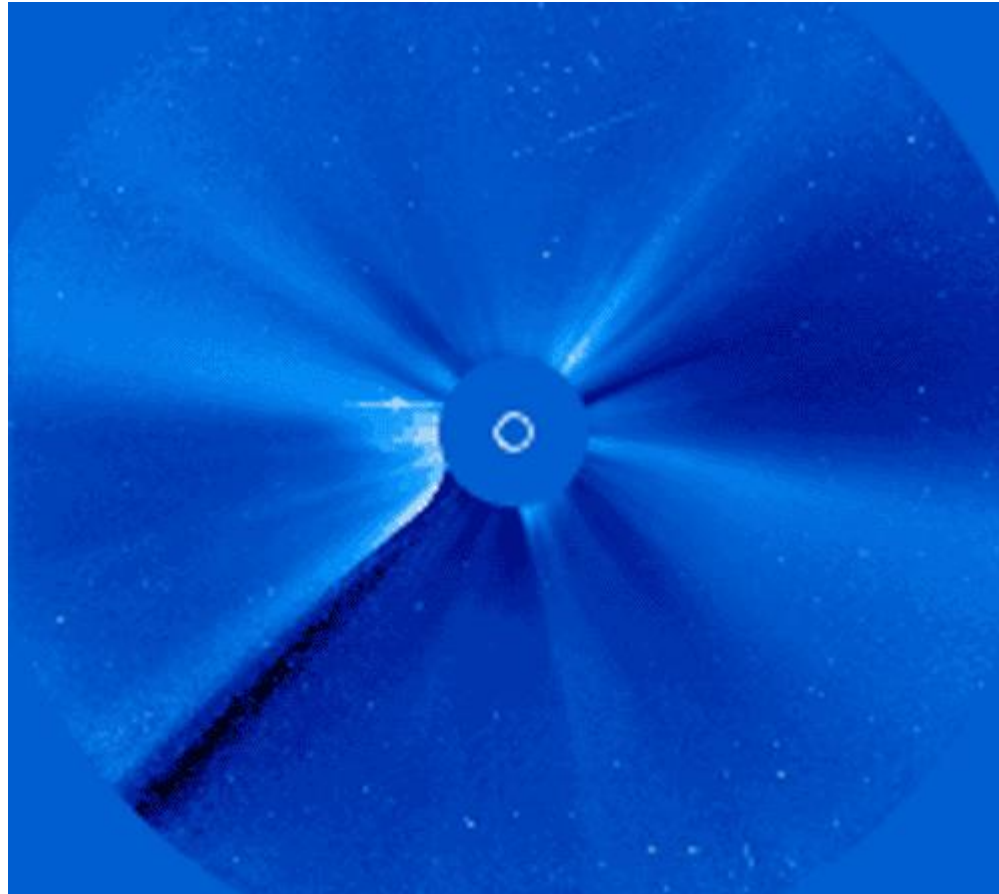


CORONAL MASS EJECTIONS OCTOBER-NOVEMBER 2003

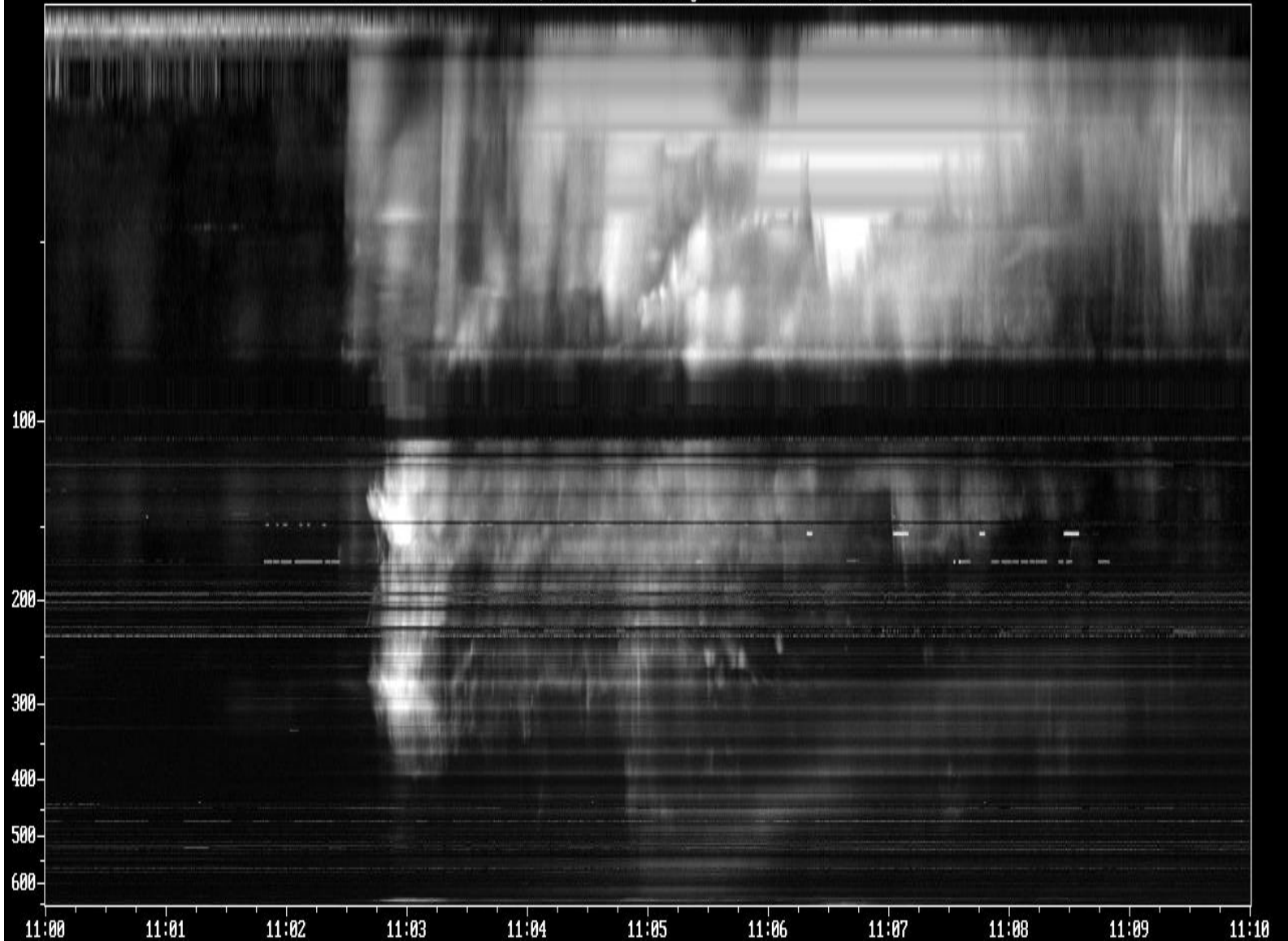


CME (SOHO/LASCO)

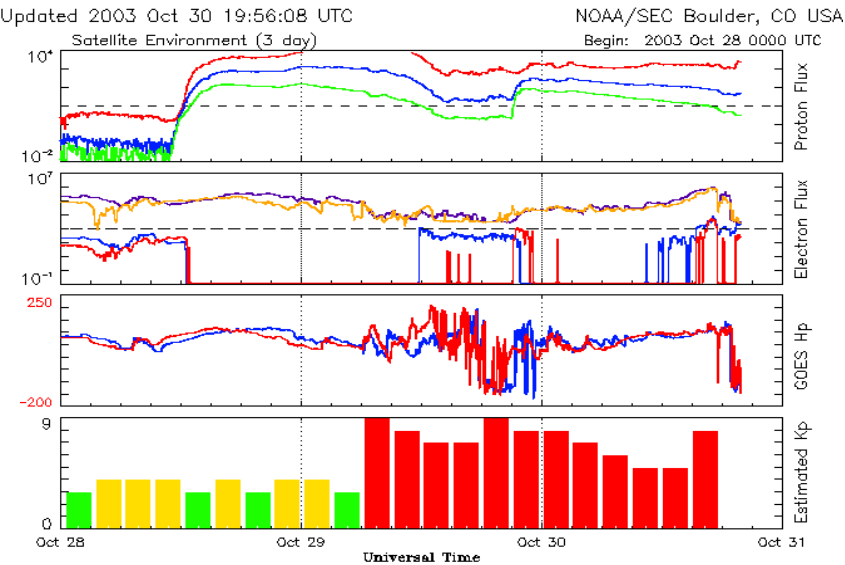
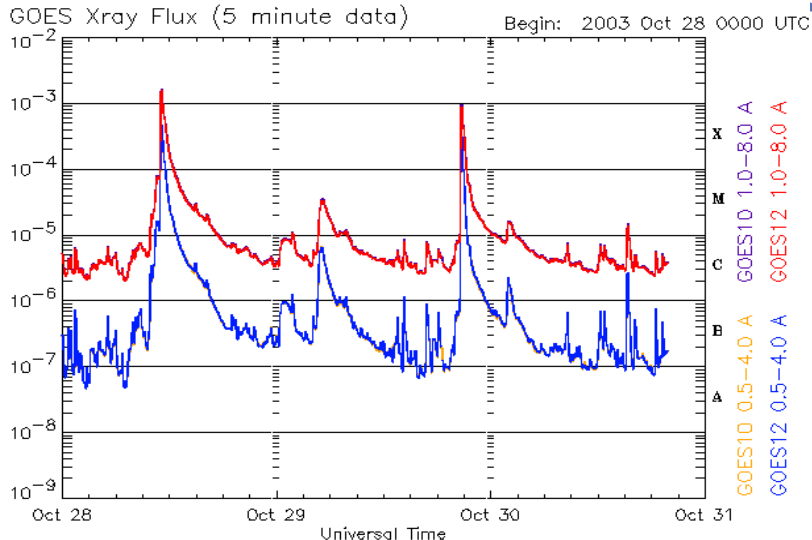
29/10/2003



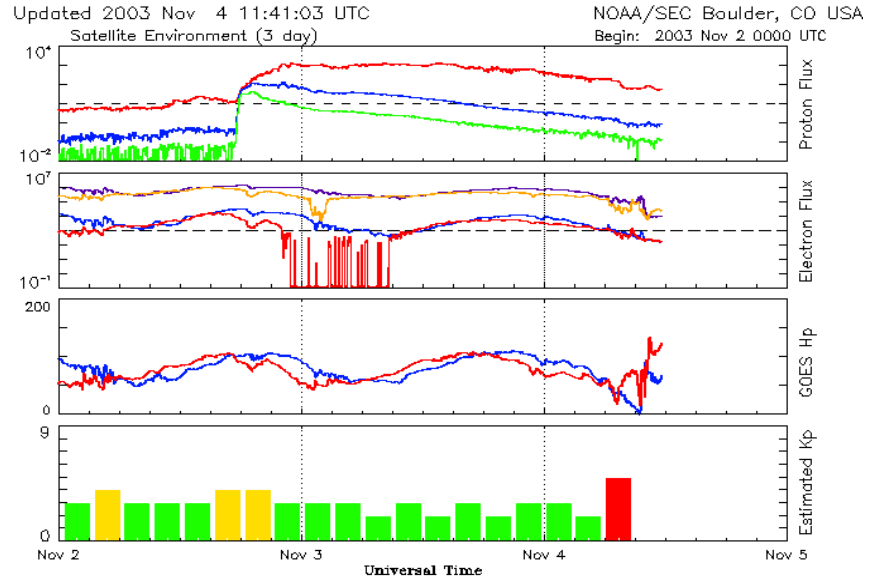
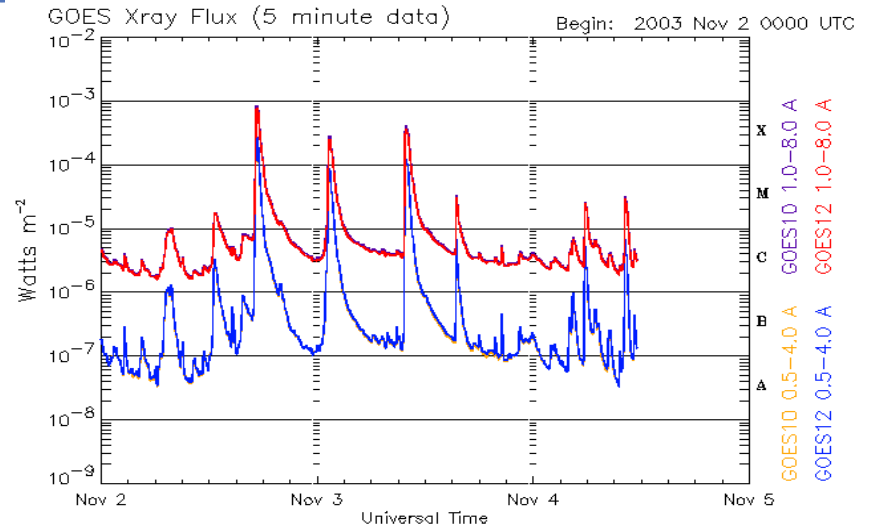
Raw Artemis-IV ASG Data, Oct 28 2003. Integration time= .50 sec, Max=3052.0



FI ΔRFS-PROTONS-Kp INDEX

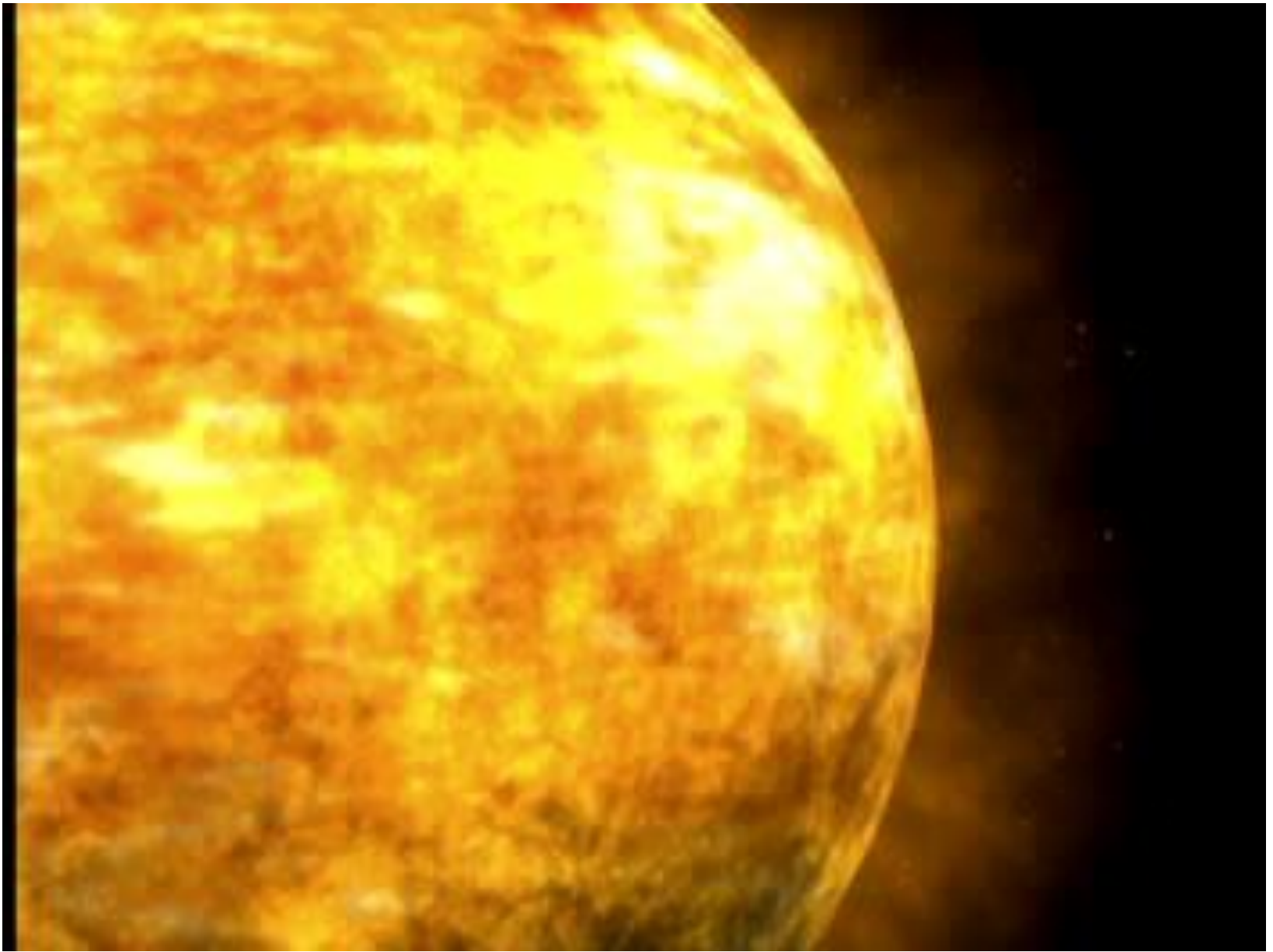


Updated 2003 Oct 30 19:56:11 UTC NOAA/SEC Boulder, CO USA



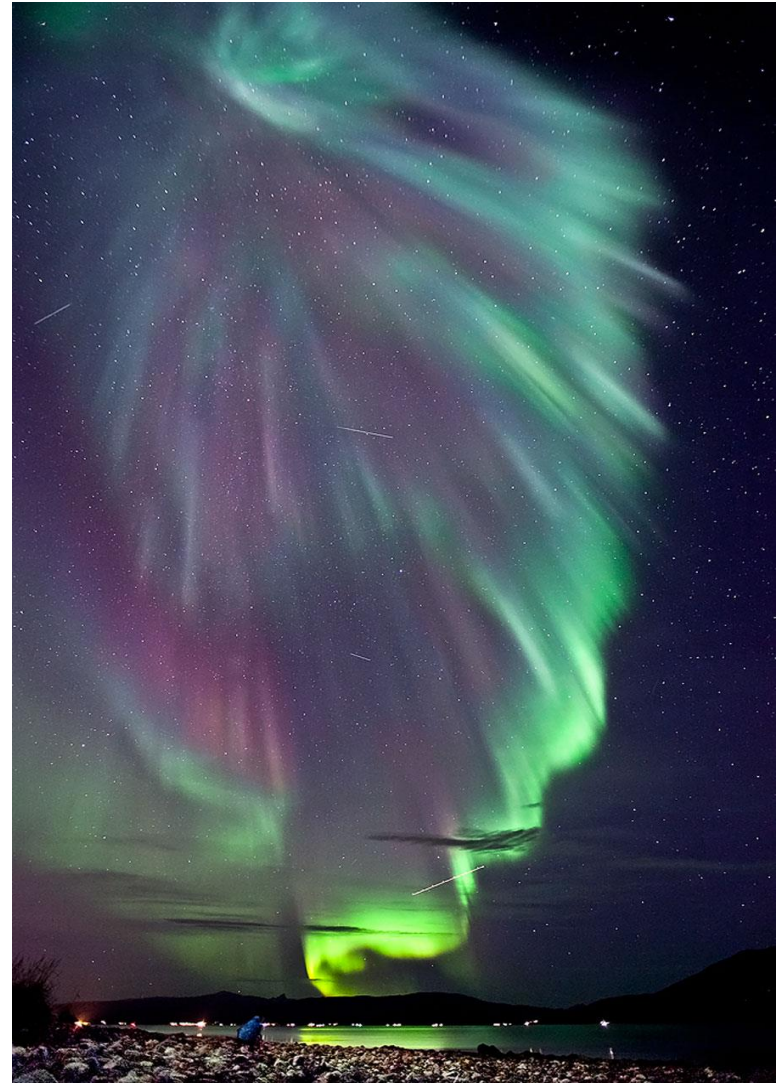
Updated 2003 Nov 4 11:41:10 UTC NOAA/SEC Boulder, CO USA



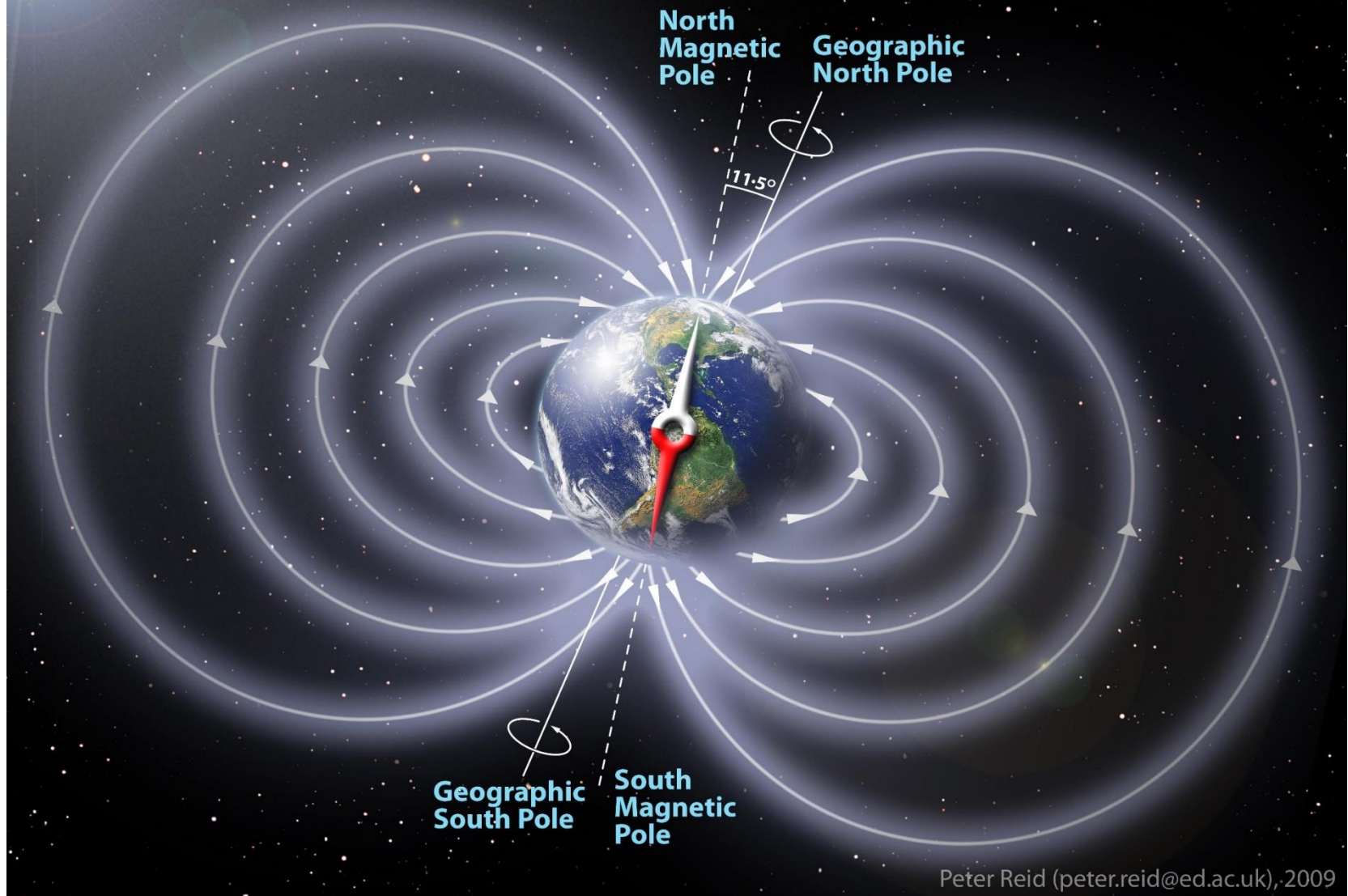


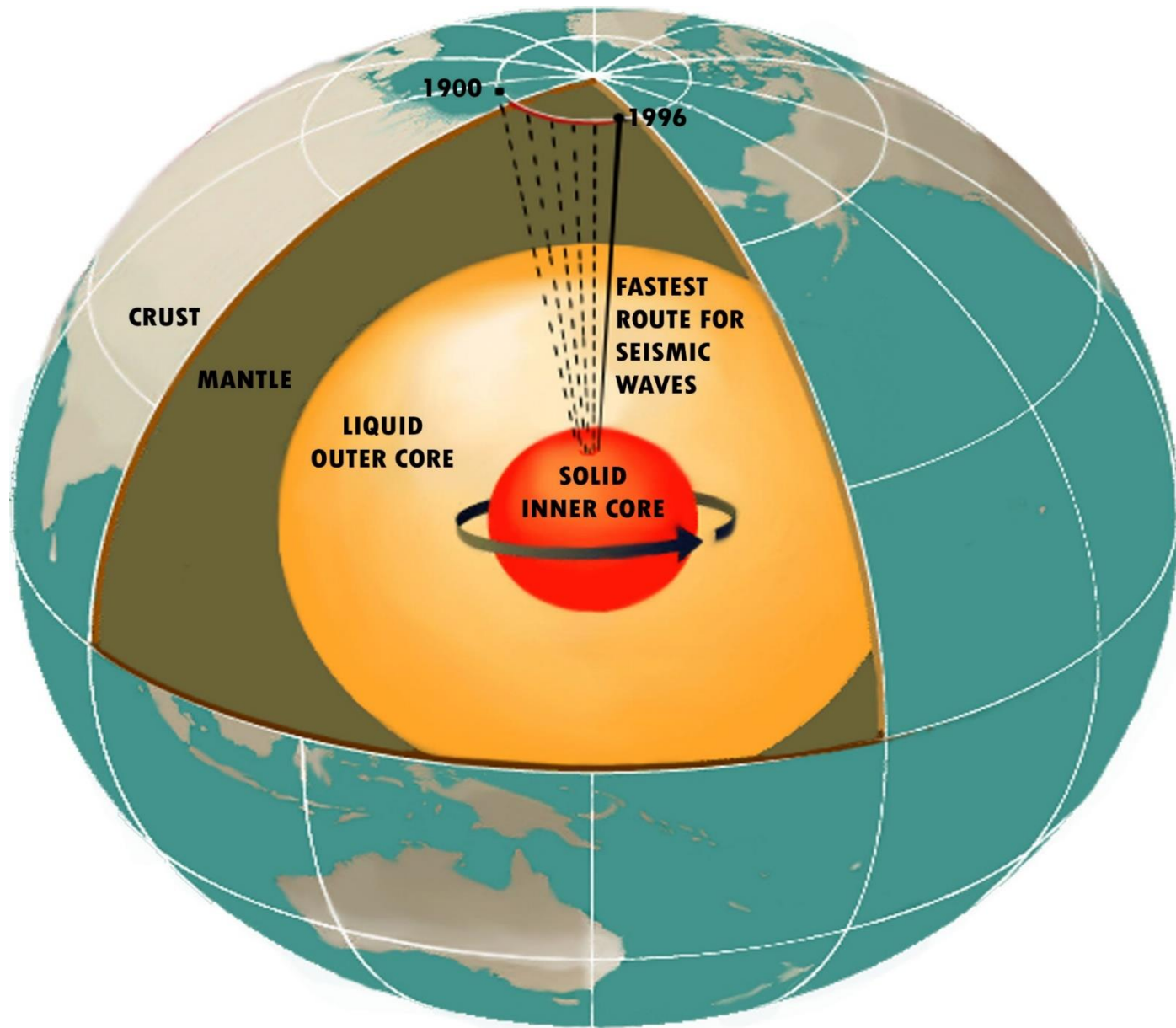


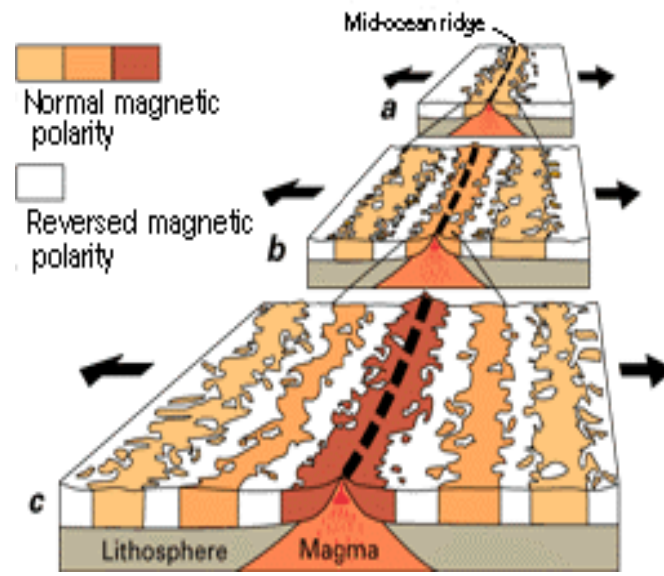
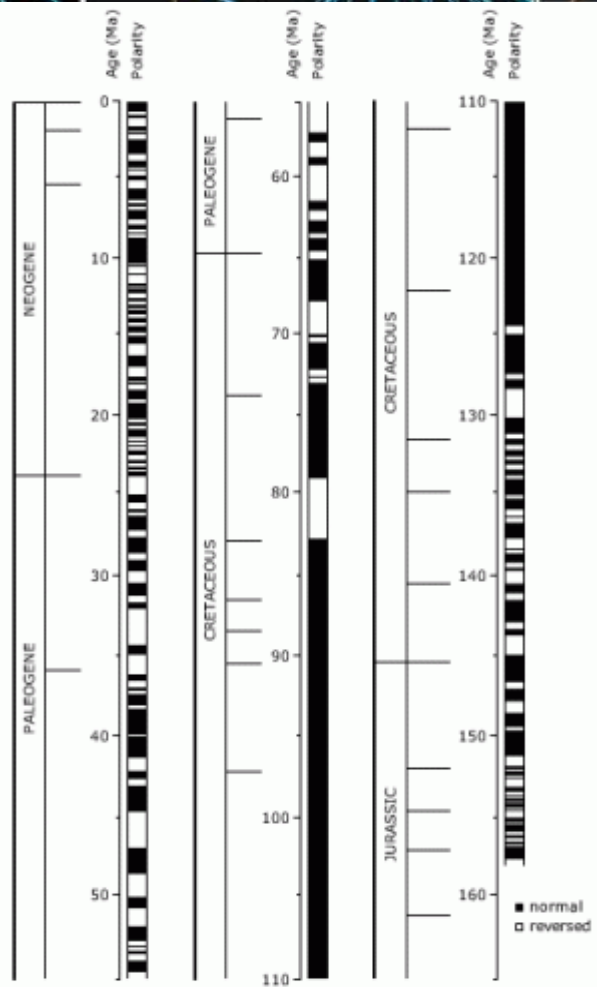
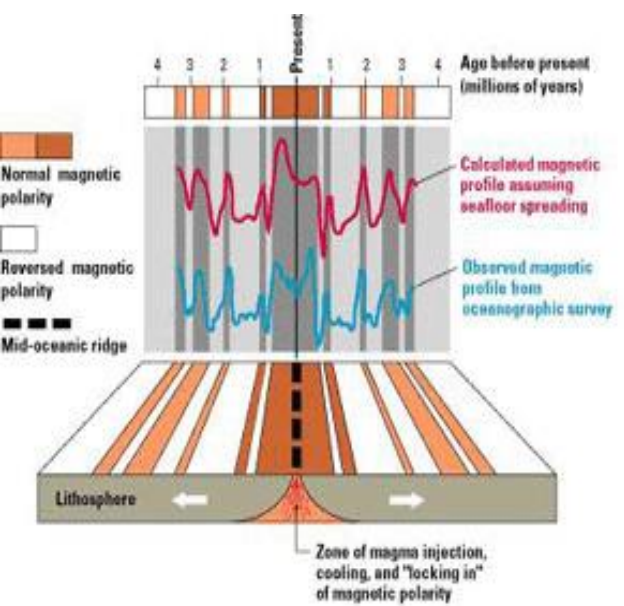
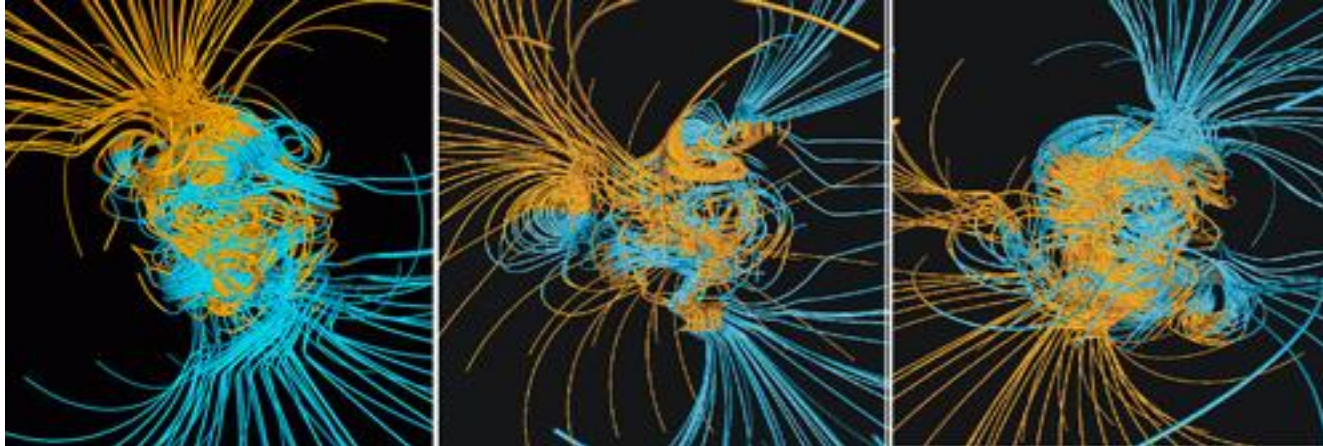
8-13 SEPTEMBER 2010

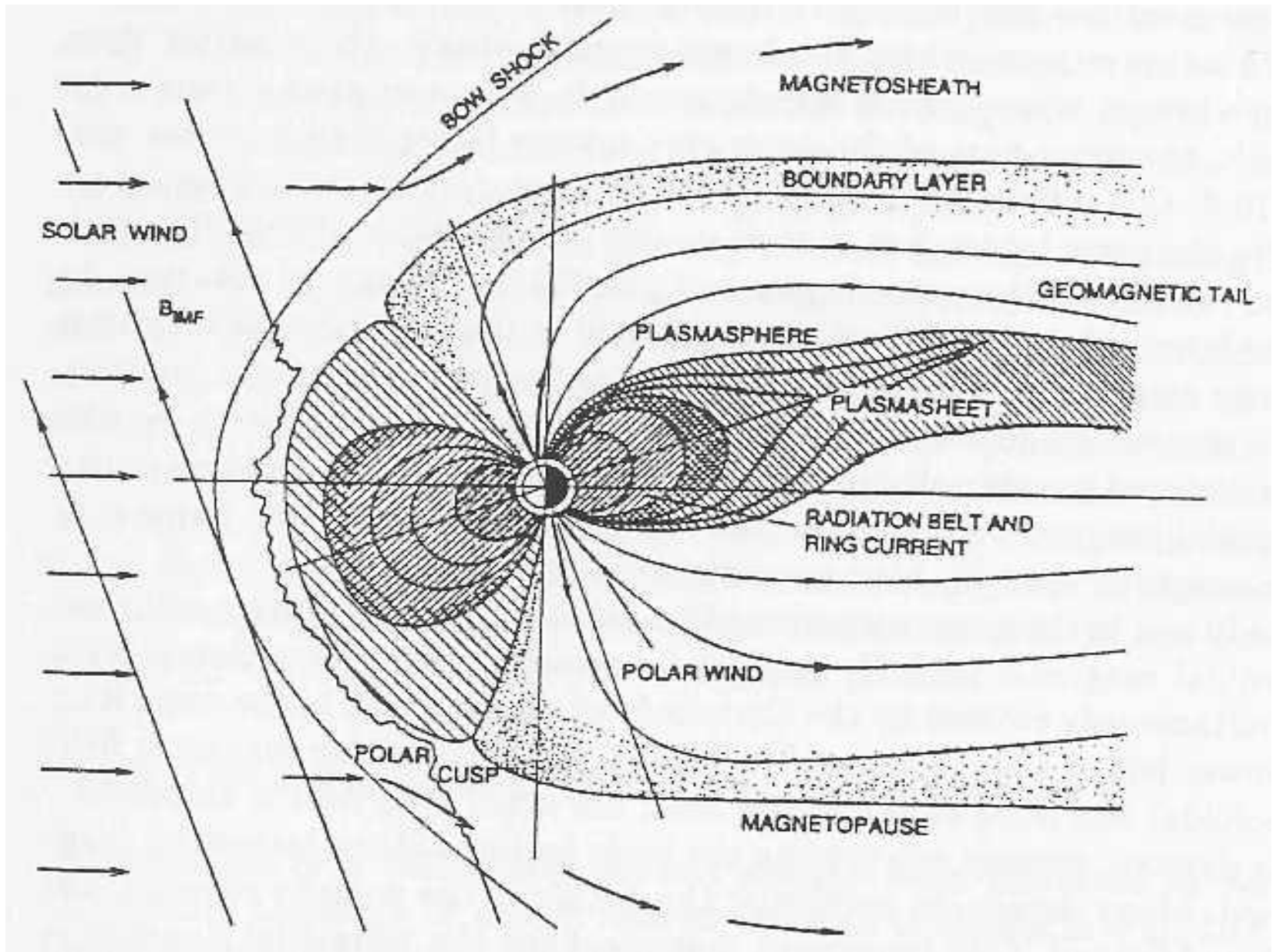


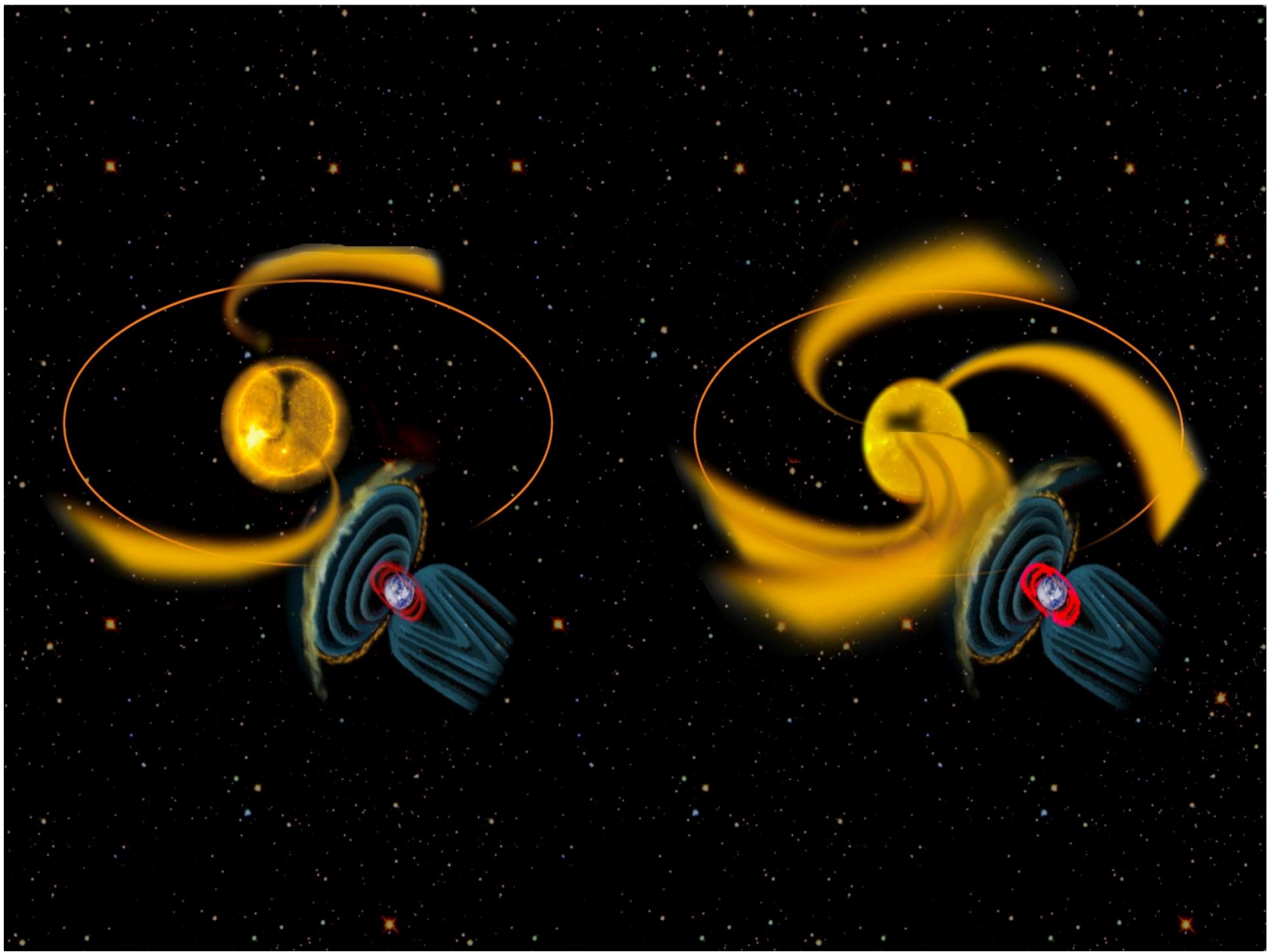
The Earth's Magnetic Field



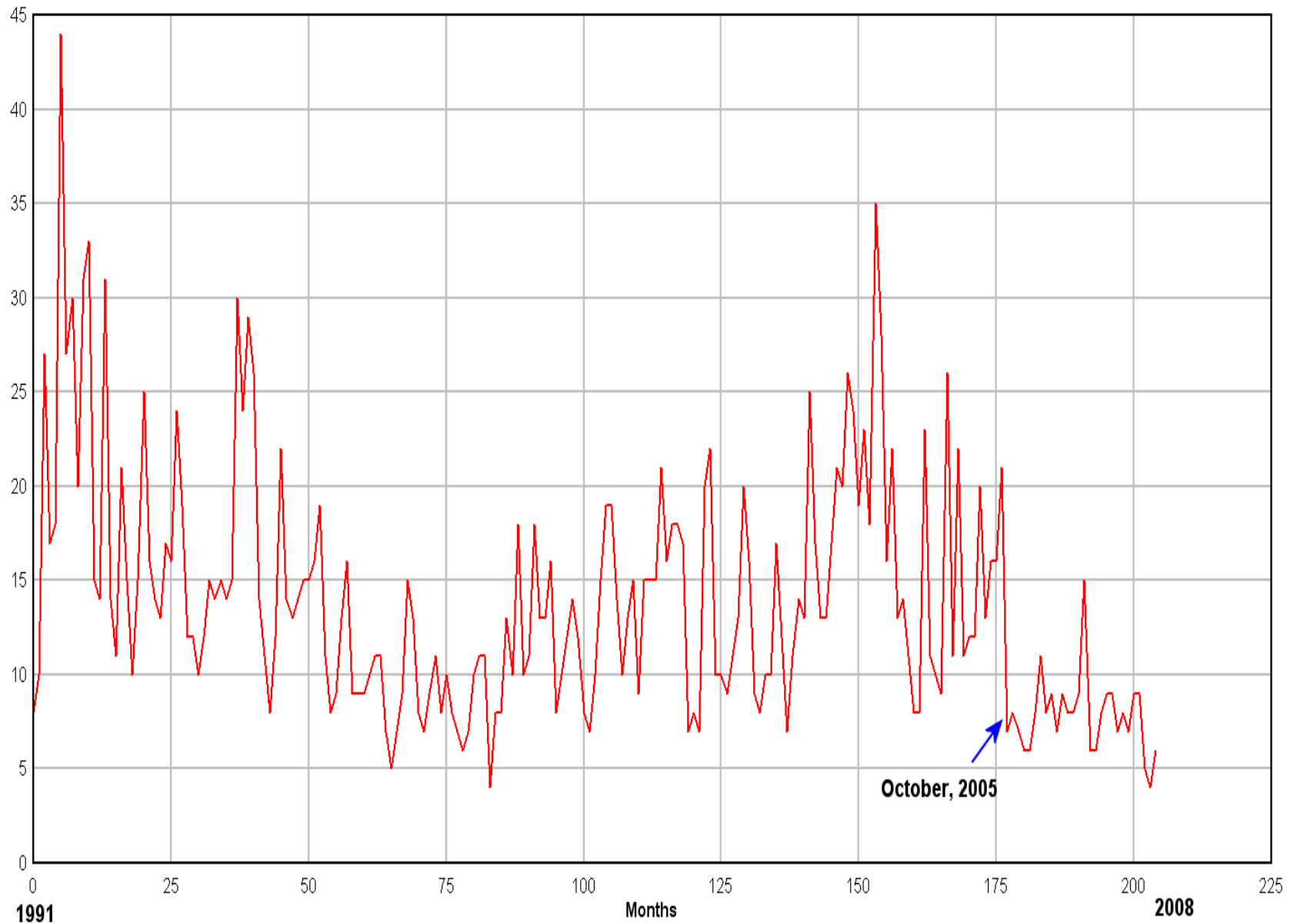








Observed Geomagnetic Averaged Planetary Index (Ap)



October, 2005

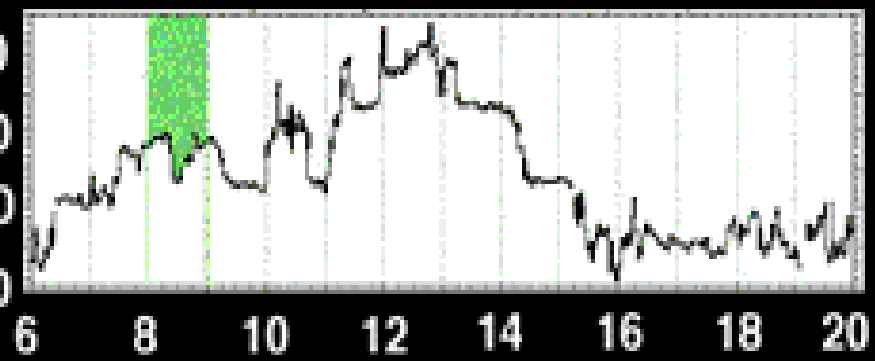


Jan. 8
log flux

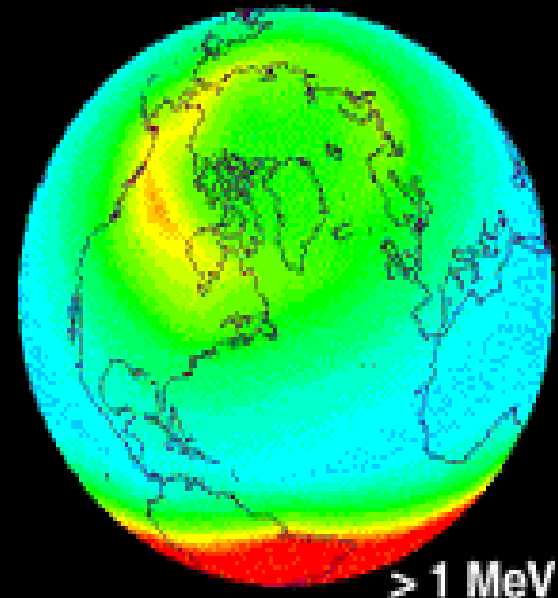
University of Maryland soho / celiac / mtof / PM

SAMPEX

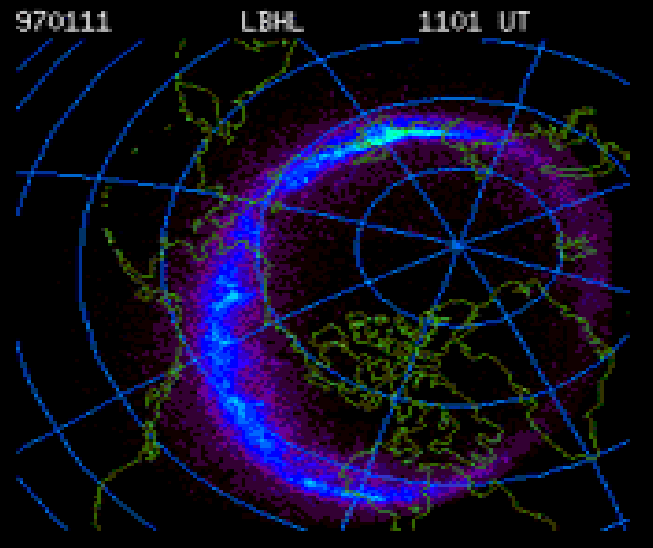
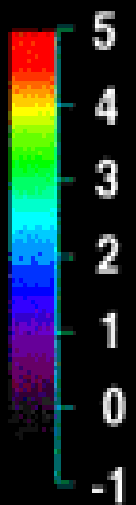
Solar Wind Speed
(kilometers/sec)



Day of January 1997

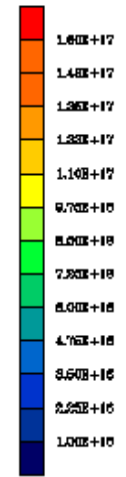
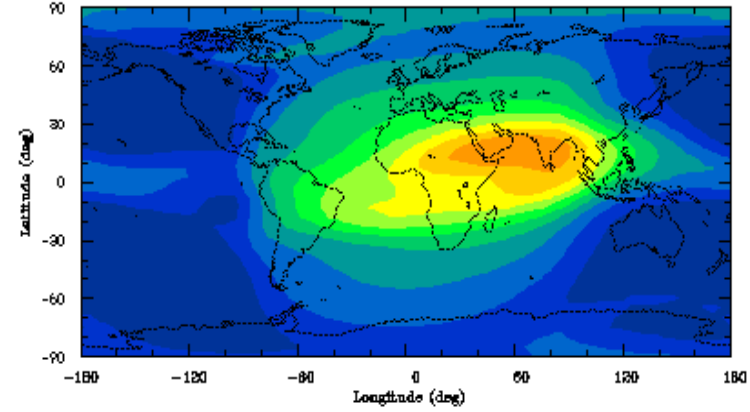


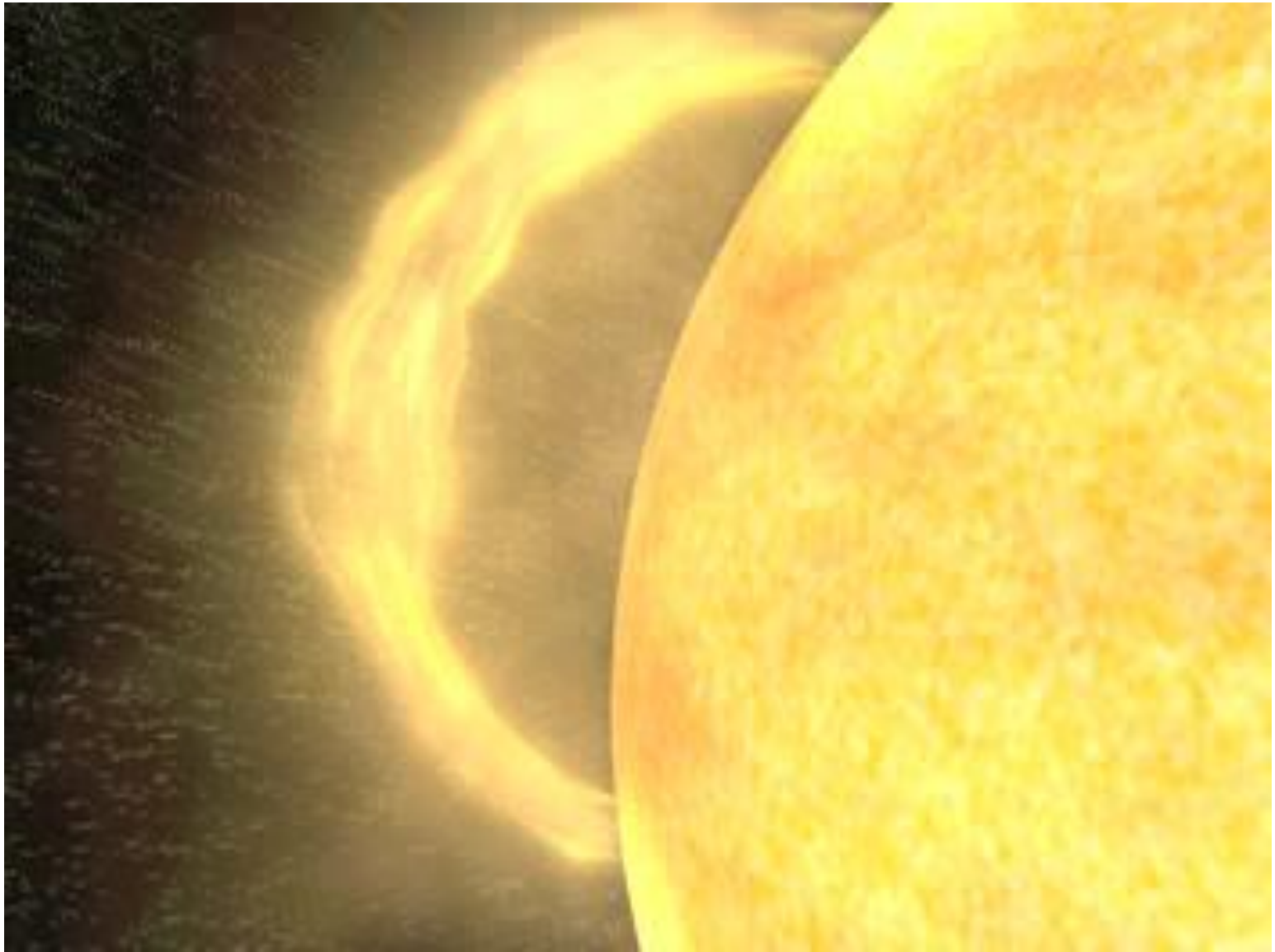
> 1 MeV electrons

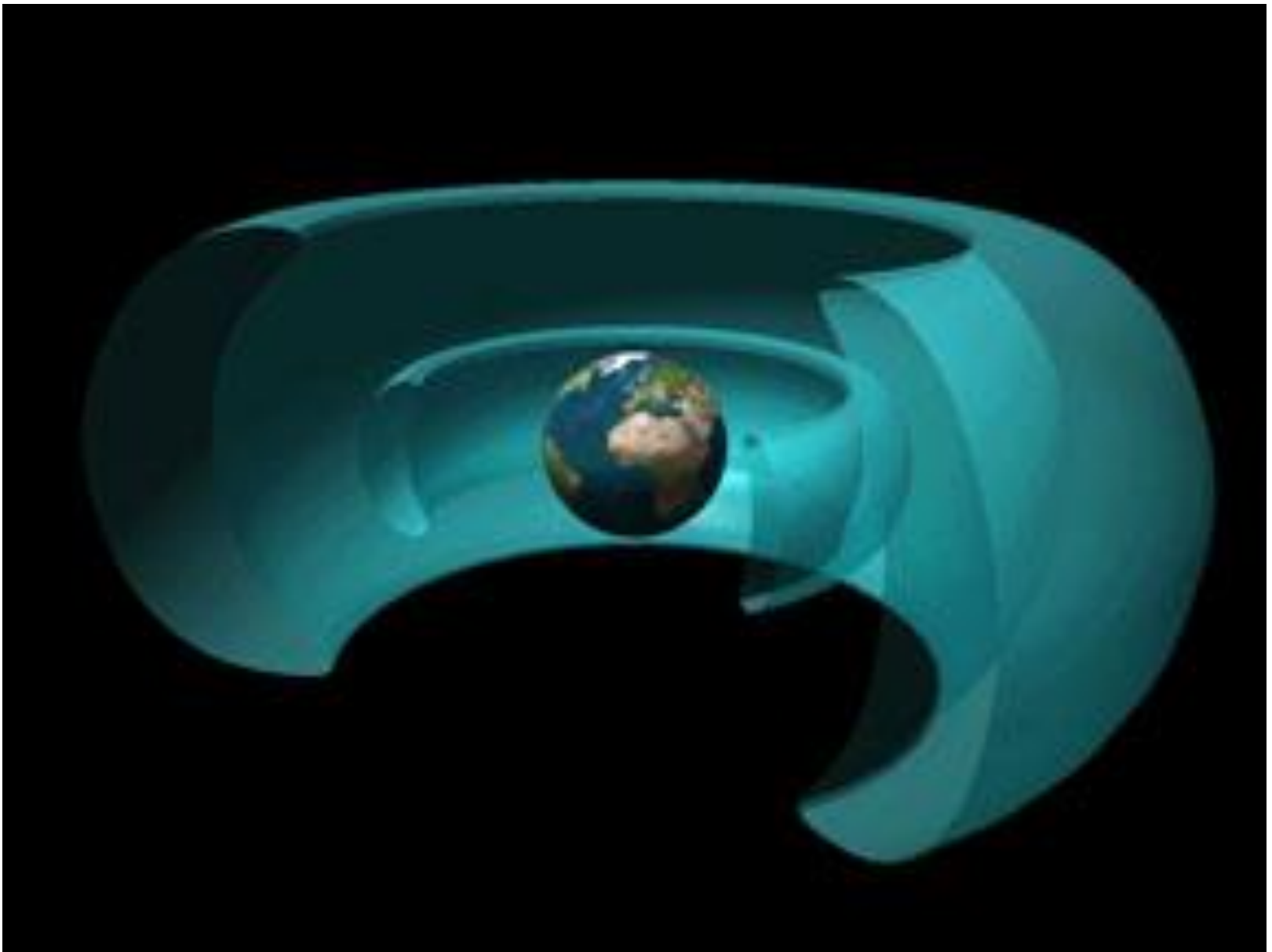


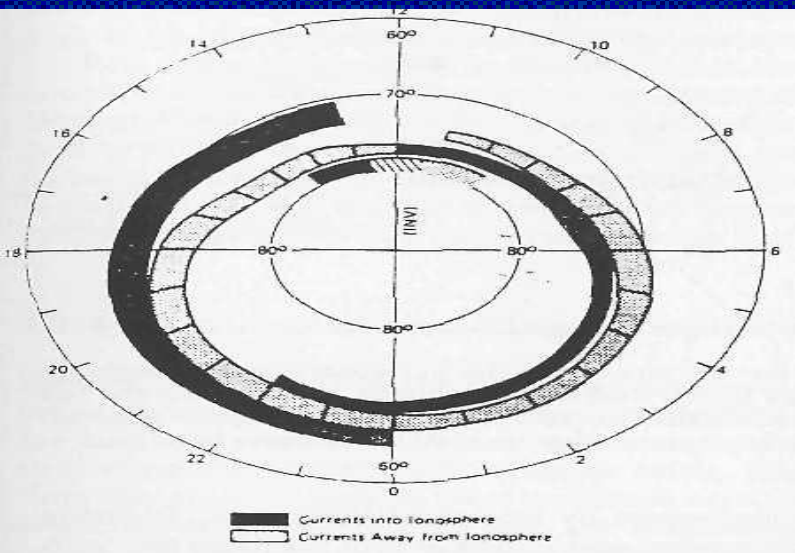
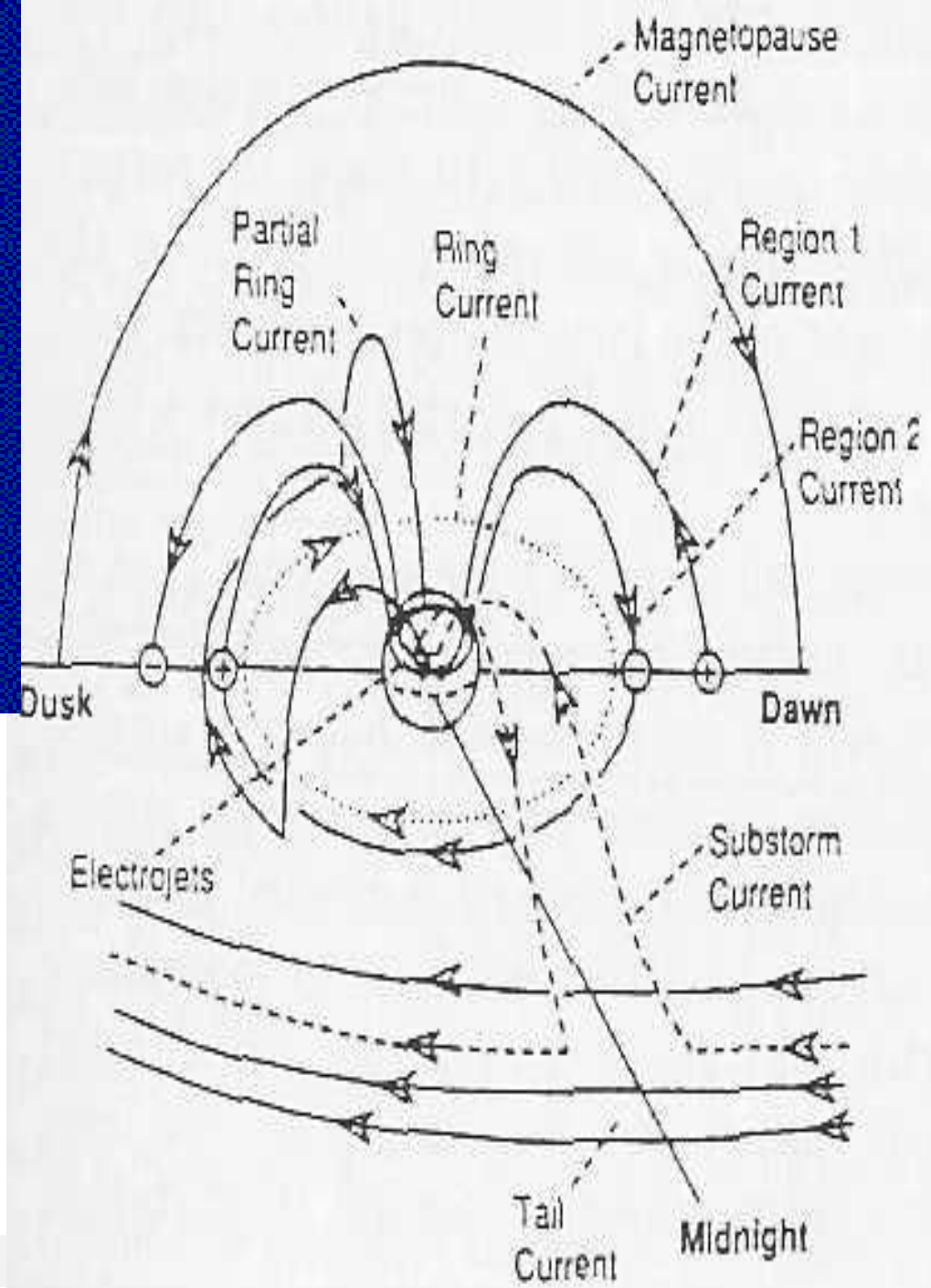
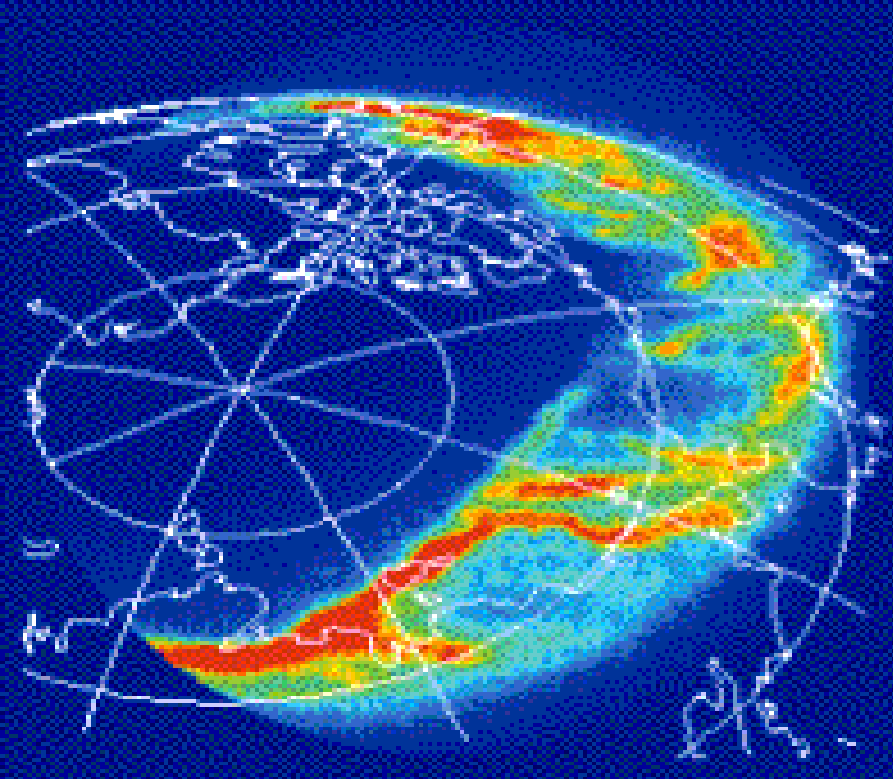
Ionospheric Storm UT = 12h 00m

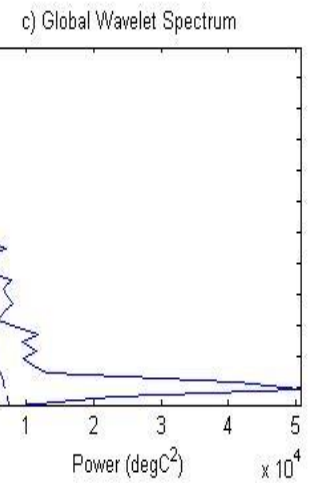
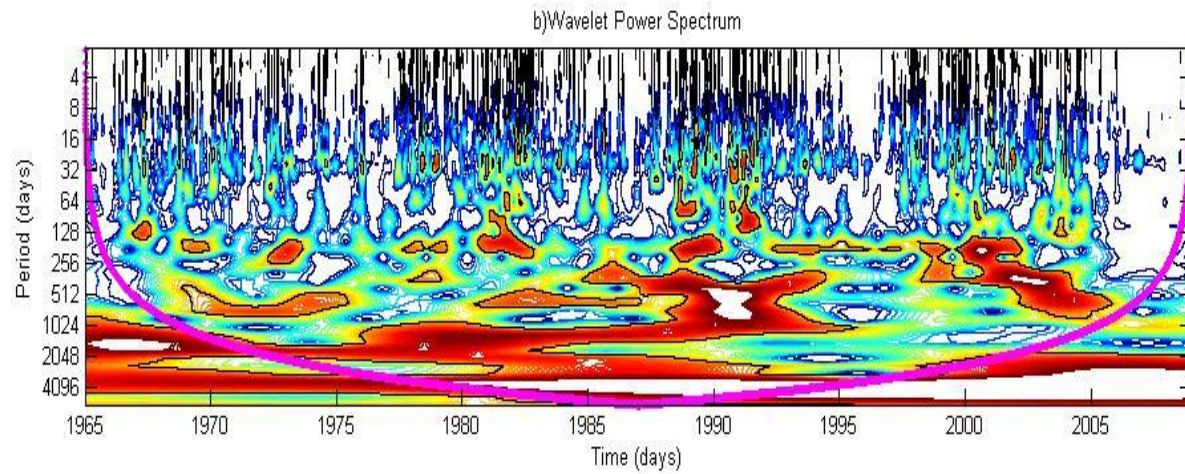
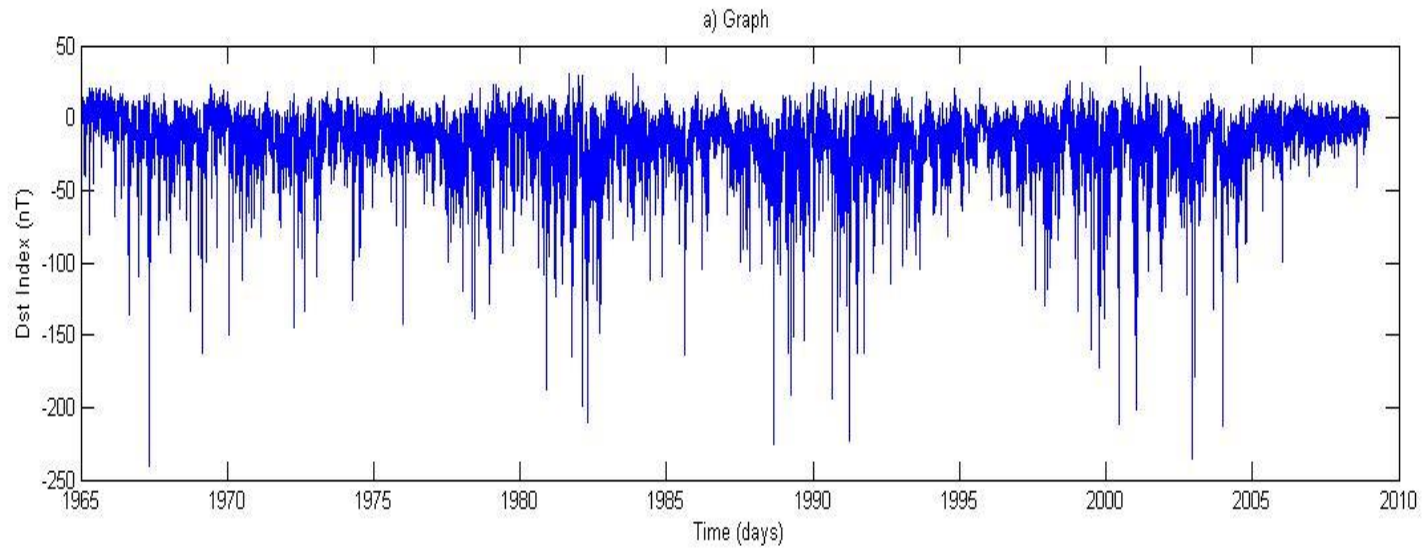
Electron Column Density 100Km to 400Km (m⁻²)
UT = 12h 00m

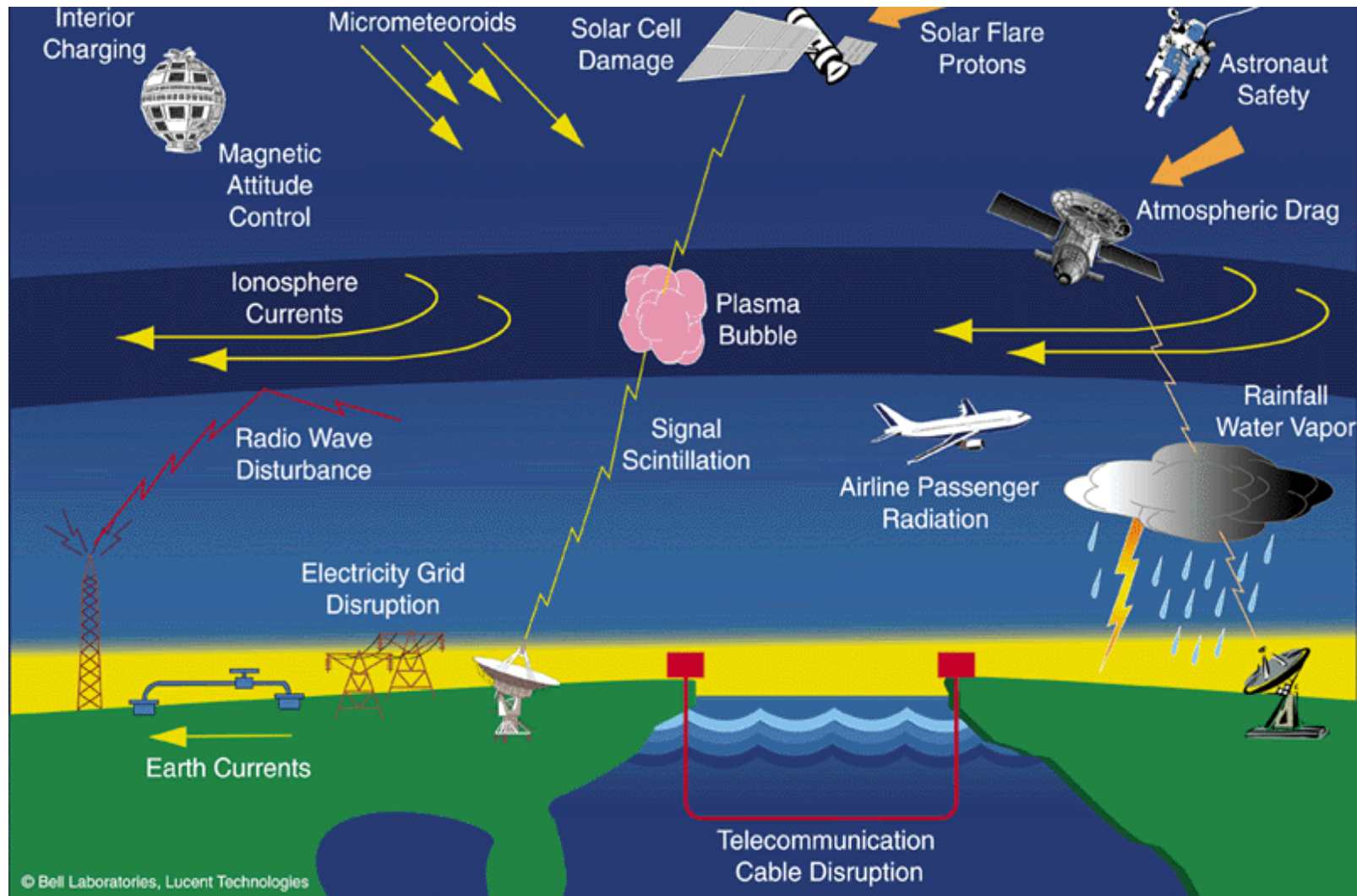








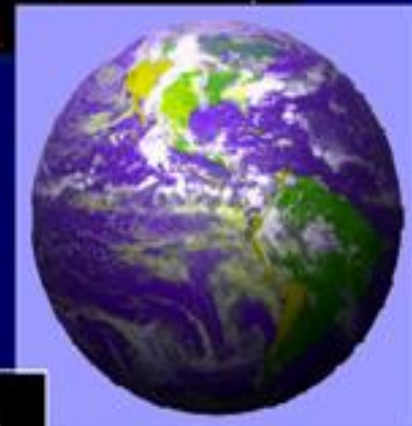




The effects of magnetic storms - what scientists call space weather - extend from the ground to geostationary orbit and beyond.

Why Do We Care?

- **Solar Variability Affects Human Technology, Humans in Space, and Terrestrial Climate.**
- **The Sphere of the Human Environment Continues to Expand Above and Beyond Our Planet.**
 - Increasing dependence on space-based systems
 - Permanent presence of humans in Earth orbit and beyond



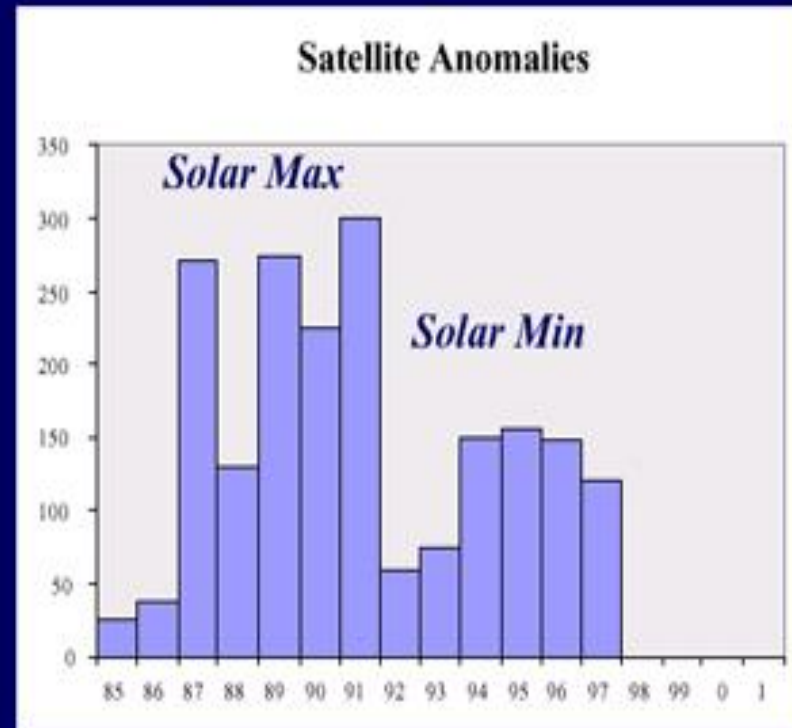
Solar Variability Can Affect Space Systems

How?

- Spacecraft charging.
- Solar cell damage.
- SEU's & damage to electronics.
- Atmospheric drag.

So What?

- **Society's dependence on space assets is increasing.**
- **Space assets vital to world economy, communications, weather forecasts.**
- ***Prudence demands that we understand the space environment affecting space systems.***

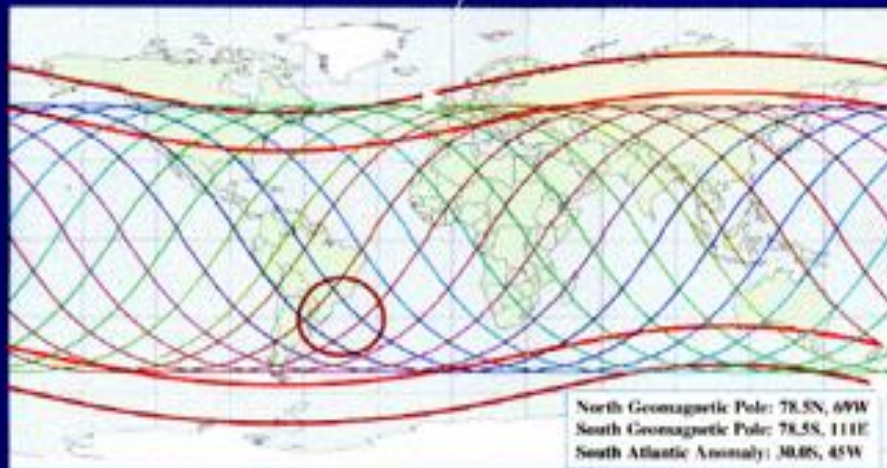


Solar Variability Can Affect Human Space Flight

- Biological effects of energetic particle radiation are largely unknown. [Goal: To make radiation exposure *As Low As Reasonably Achievable*.]
- Space Station: "Solar energetic particle events have a significant impact on crew exposures and station operation related to crew safety."
- Mars: "The capability to predict solar particle events 8 hours in advance of their occurrence is thought to be an operational requirement for a safe interplanetary mission."



Space Station Orbit is Exposed to High Energy Solar Particles



Exclusion Regions: 30.0, 45.0 For Geomagnetic Poles
15.0 For South Atlantic Anomaly

Chart courtesy Ron Turner, ANSER



Geomagnetic Storm

Quiet Conditions





Communications

Intelsat V
Intelsat K

Weather

GOES East (75 W Long)
NOAA-11

Navigation

GPS

Scientific Research

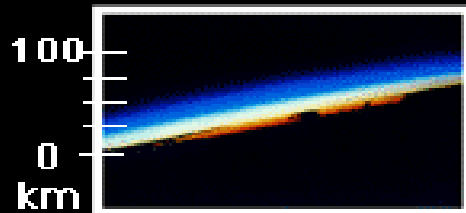
SOHO
Sarpex

Remote Sensing

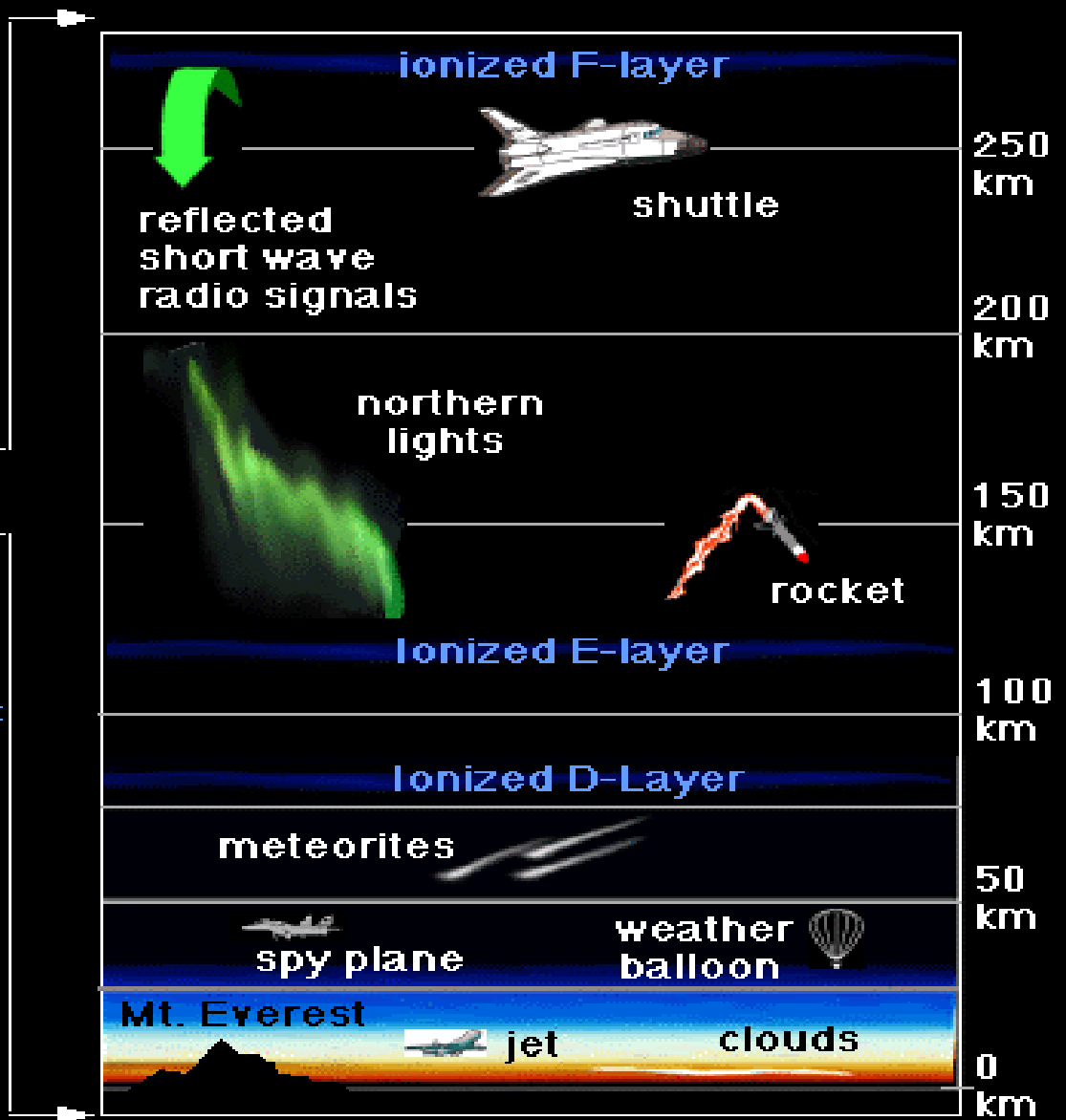
DMSP
Landsat

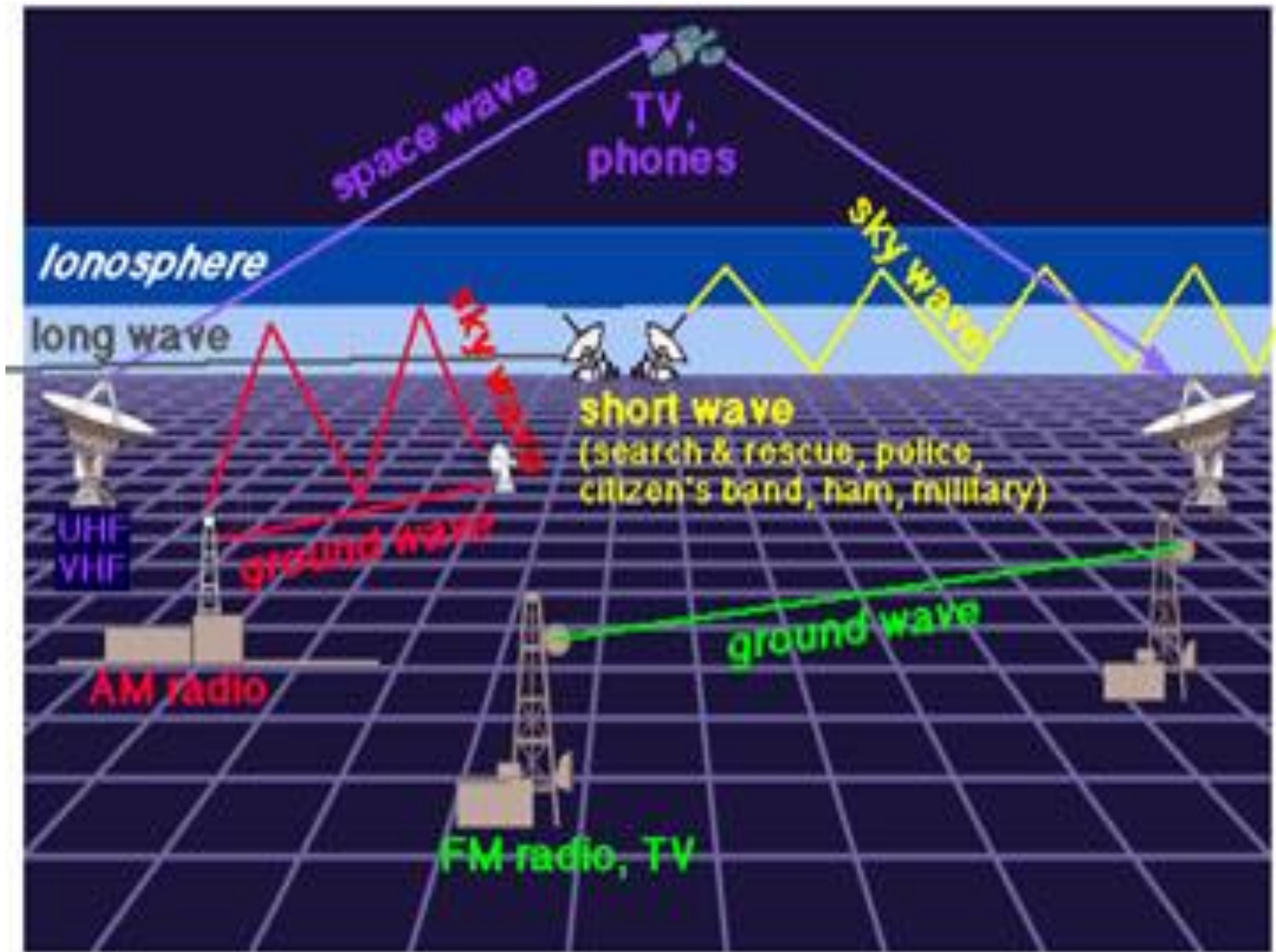


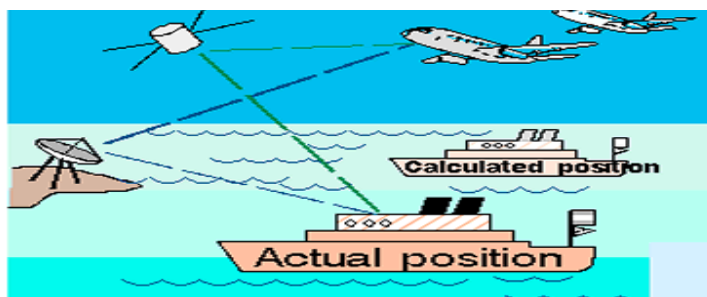
The Atmosphere and the Earth-Space Interface



View of the entire atmospheric layer from the space shuttle (courtesy of NASA)







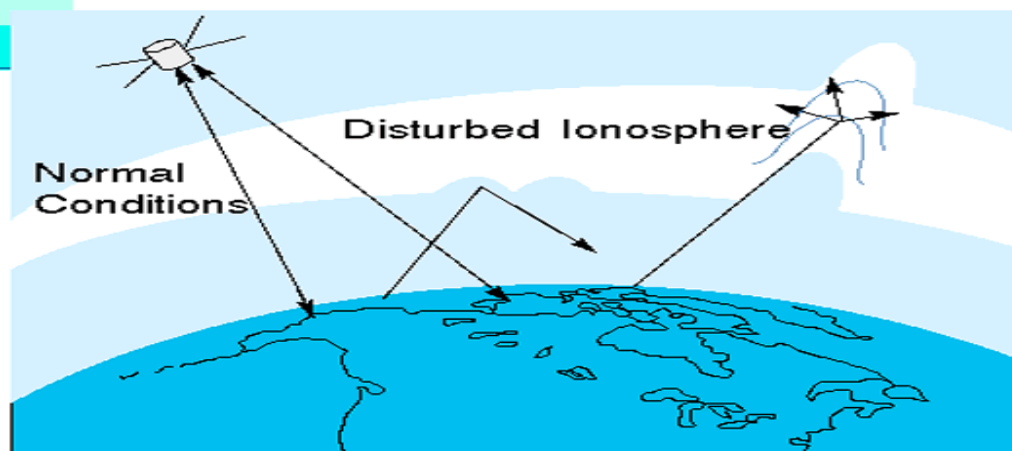
Precision GPS and LORAN signals are adversely affected by a varying ionosphere.



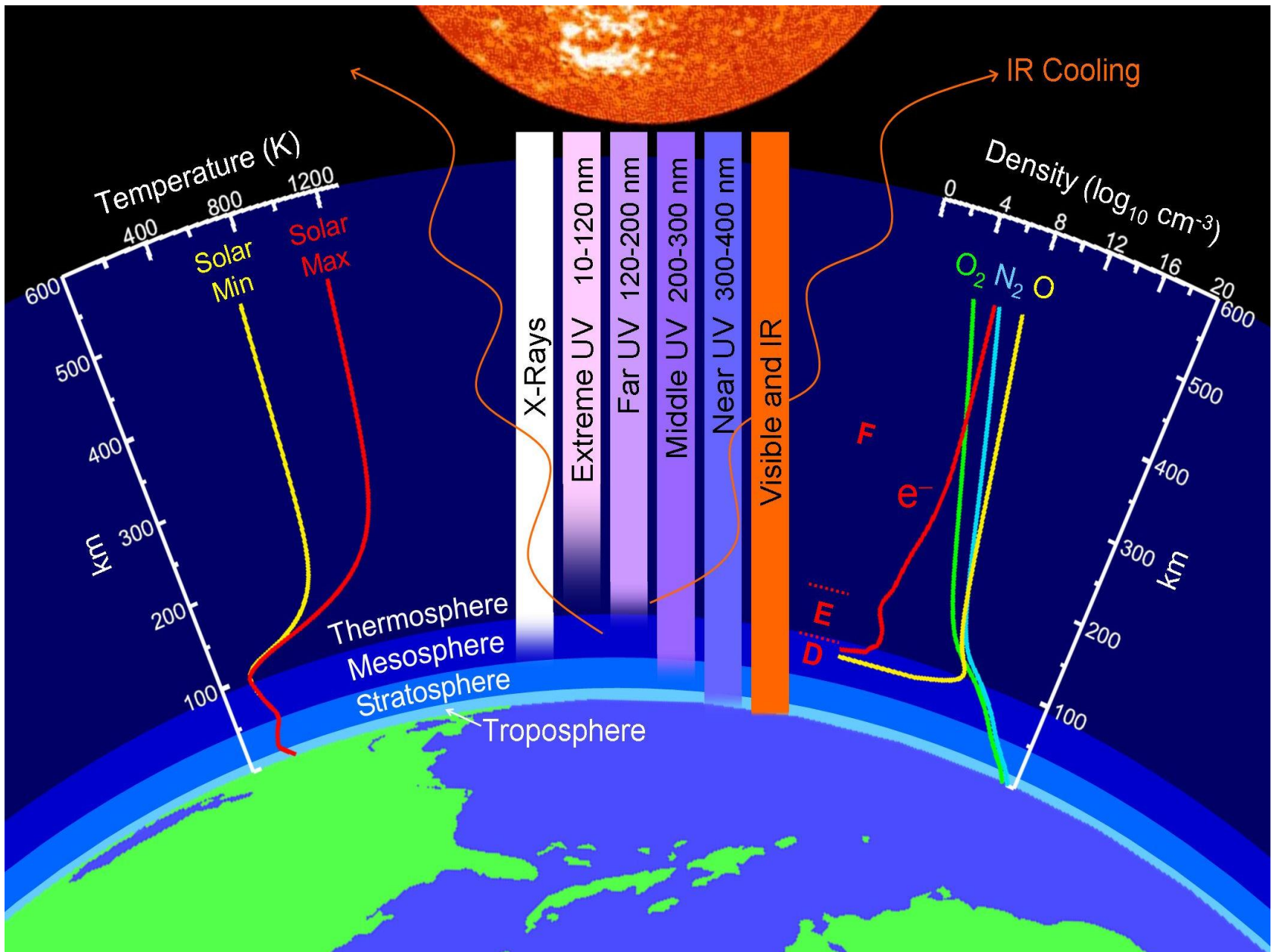
Communications can break down in critical areas and times:

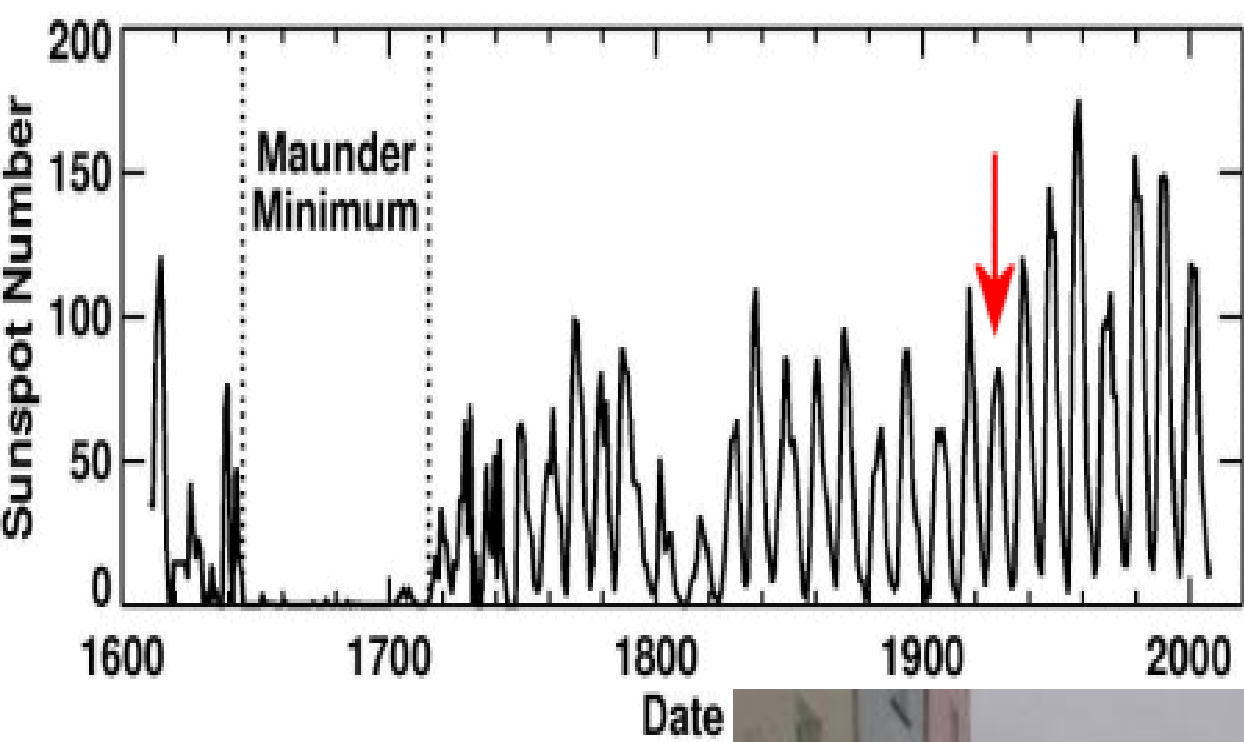
- Desert Storm
- Alaska
- Satellite pagers and Cellular Phones

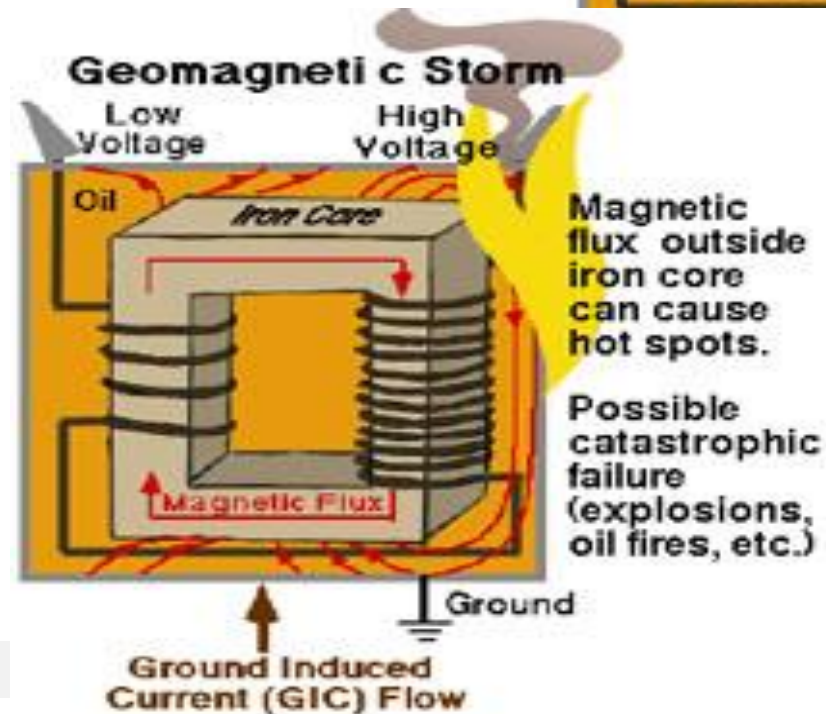
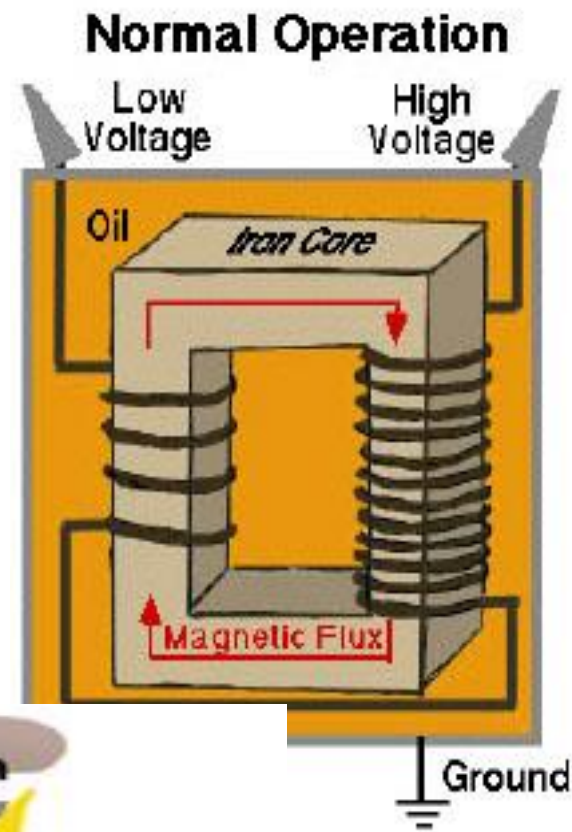
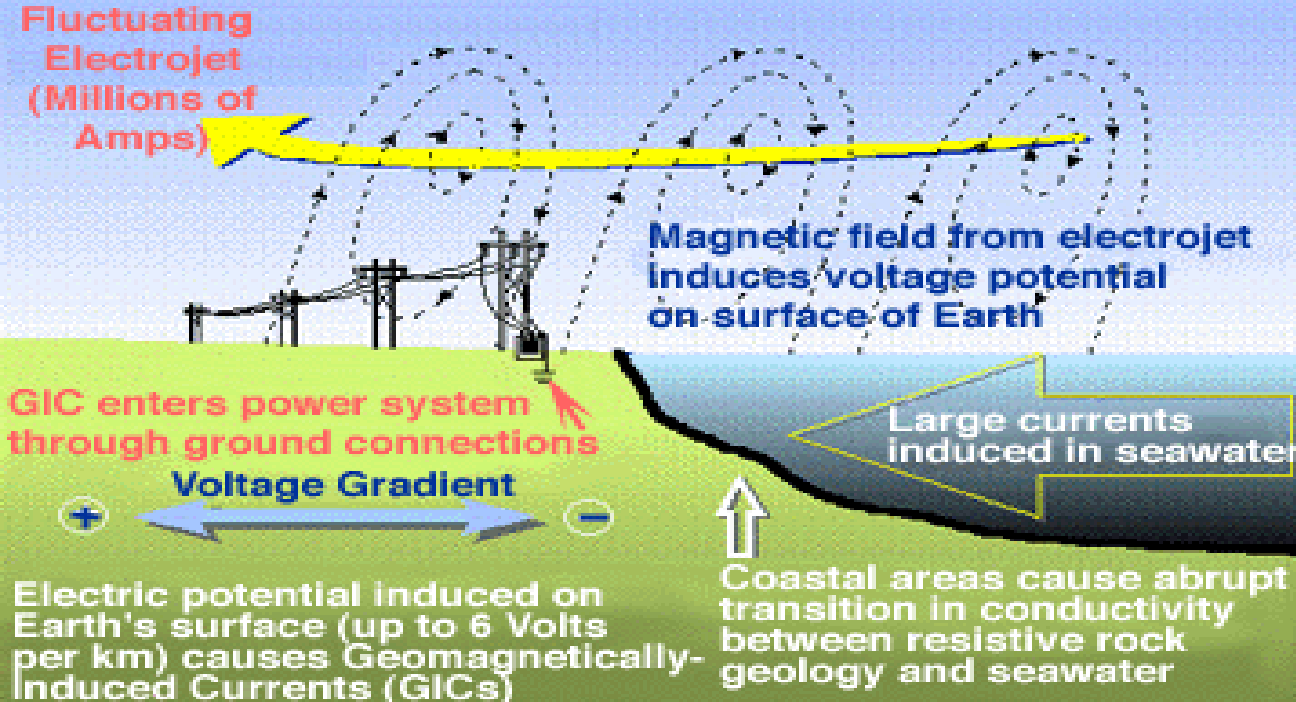
Over-the-horizon radars are also degraded by ionospheric variation.











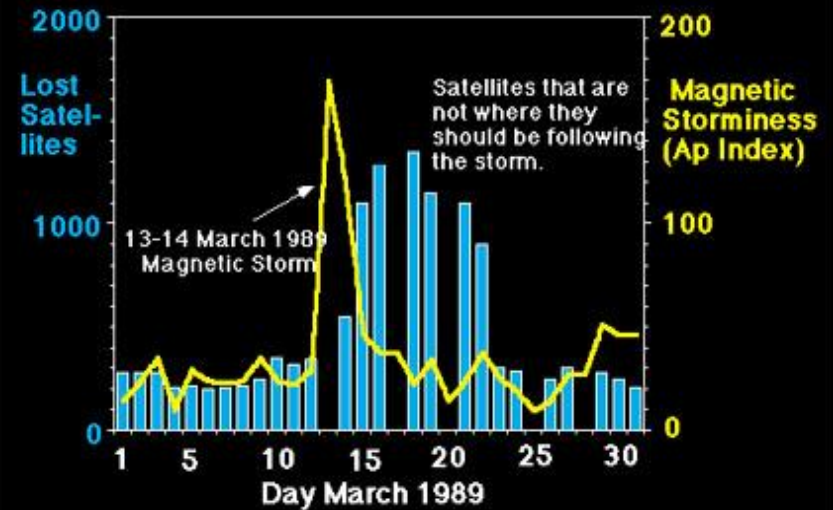


13 MARCH 1989 0745 UT

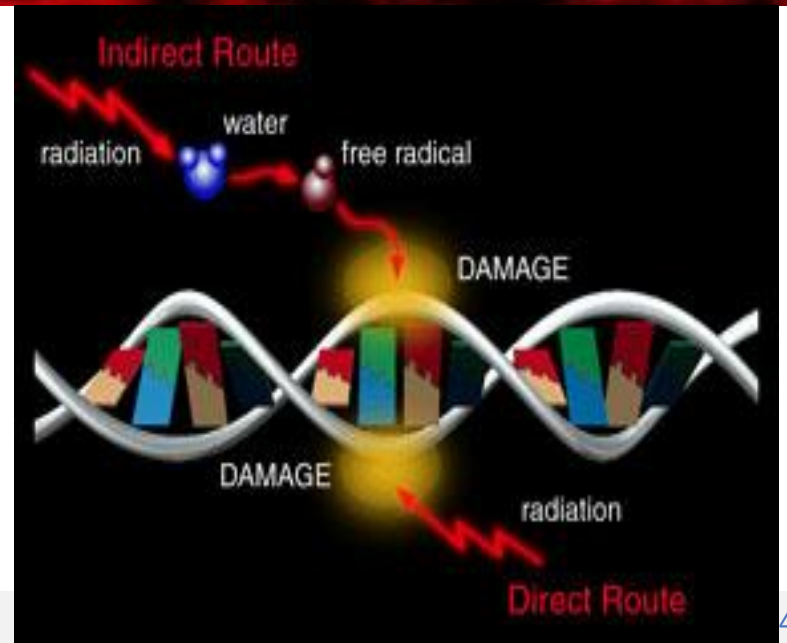
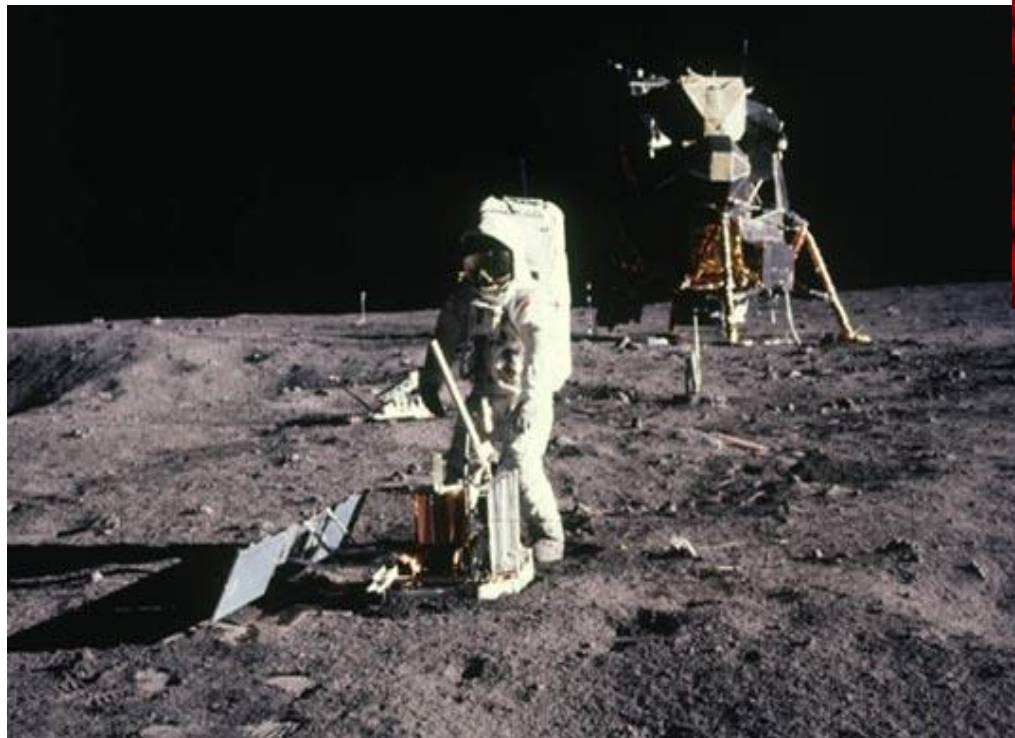
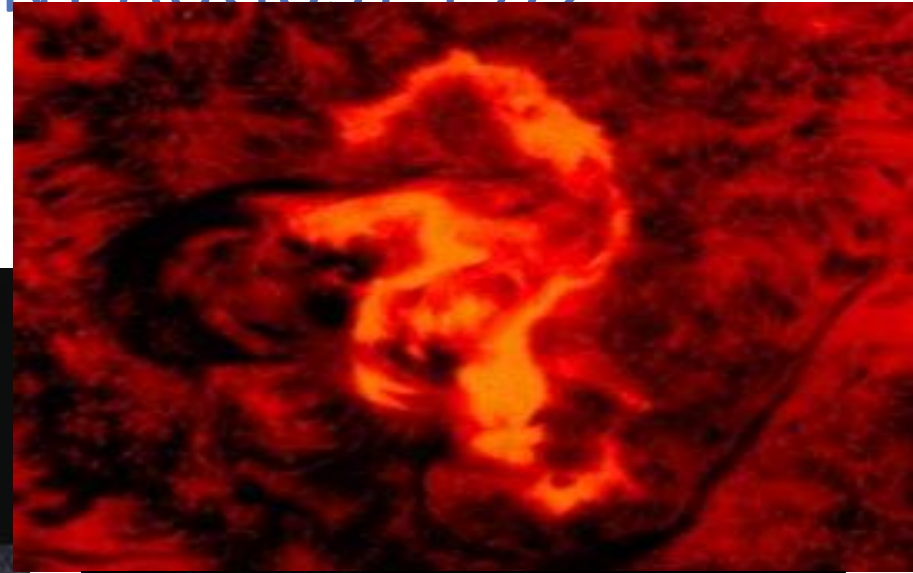


Courtesy of M. A. Stanley, Geological Observatory, Appleton Laboratory

Satellite Tracking Problems After March 13-14, 1989 Storm



SOLAR PROTON EVENT AUGUST 1972



ΗΛΙΟΒΙΟΛΟΓΙΑ (HELIOBIOLOGY)



- Η επίδραση της ηλιακής δραστηριότητας στην ανθρώπινη υγεία

Photic solar effects

Non-photic solar effects

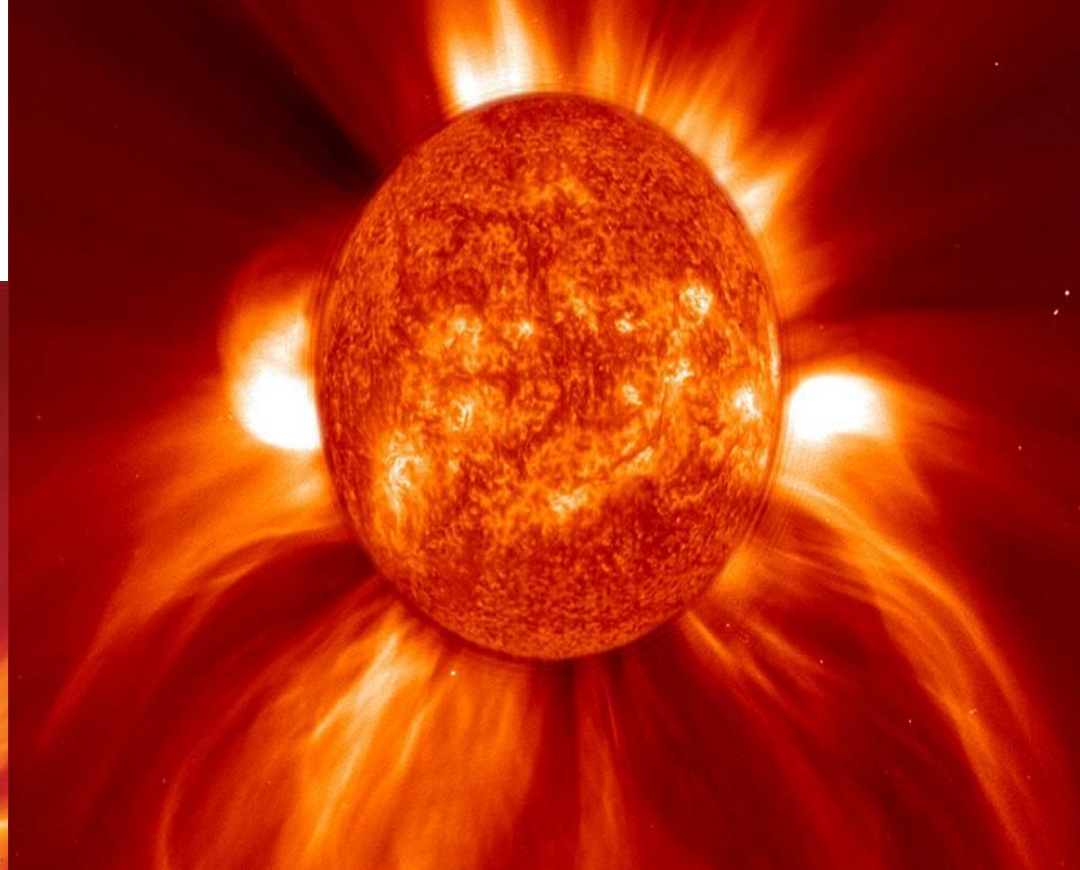
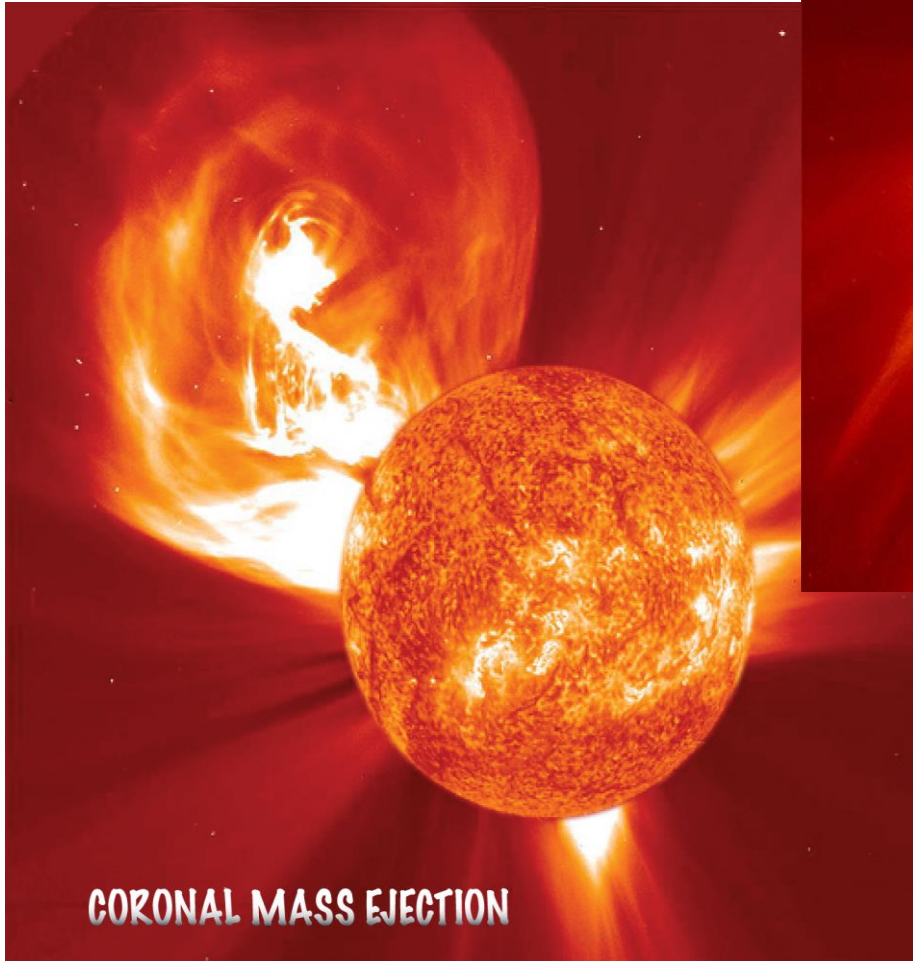


Κατανόηση της σχέσης μεταξύ ηλιακής και γεωμαγνητικής δραστηριότητας και της ανθρώπινης υγείας



ΔΙΕΘΝΗ ΒΙΒΛΙΟΓΡΑΦΙΑ





CORONAL MASS EJECTION



Τέλος Ενότητας

Χρηματοδότηση

- Το παρόν εκπαιδευτικό υλικό έχει αναπτυχθεί στο πλαίσιο του εκπαιδευτικού έργου του διδάσκοντα.
- Το έργο «**Ανοικτά Ακαδημαϊκά Μαθήματα στο Πανεπιστήμιο Αθηνών**» έχει χρηματοδοτήσει μόνο την αναδιαμόρφωση του εκπαιδευτικού υλικού.
- Το έργο υλοποιείται στο πλαίσιο του Επιχειρησιακού Προγράμματος «Εκπαίδευση και Δια Βίου Μάθηση» και συγχρηματοδοτείται από την Ευρωπαϊκή Ένωση (Ευρωπαϊκό Κοινωνικό Ταμείο) και από εθνικούς πόρους.



Σημειώματα

Σημείωμα Ιστορικού Εκδόσεων Έργου

Το παρόν έργο αποτελεί την έκδοση 1.0.0.



Σημείωμα Αναφοράς

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<http://opencourses.uoa.gr/courses/PHYS2/>



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- που δεν περιλαμβάνει άμεσο ή έμμεσο οικονομικό όφελος από την χρήση του έργου, για το διανομέα του έργου και αδειοδόχο
- που δεν περιλαμβάνει οικονομική συναλλαγή ως προϋπόθεση για τη χρήση ή πρόσβαση στο έργο
- που δεν προσπορίζει στο διανομέα του έργου και αδειοδόχο έμμεσο οικονομικό όφελος (π.χ. διαφημίσεις) από την προβολή του έργου σε διαδικτυακό τόπο

Ο δικαιούχος μπορεί να παρέχει στον αδειοδόχο ξεχωριστή άδεια να χρησιμοποιεί το έργο για εμπορική χρήση, εφόσον αυτό του ζητηθεί.



Διατήρηση Σημειωμάτων

Οποιαδήποτε αναπαραγωγή ή διασκευή του υλικού θα πρέπει να συμπεριλαμβάνει:

- το Σημείωμα Αναφοράς
- το Σημείωμα Αδειοδότησης
- τη δήλωση Διατήρησης Σημειωμάτων
- το Σημείωμα Χρήσης Έργων Τρίτων (εφόσον υπάρχει)

μαζί με τους συνοδευόμενους υπερσυνδέσμους.

