



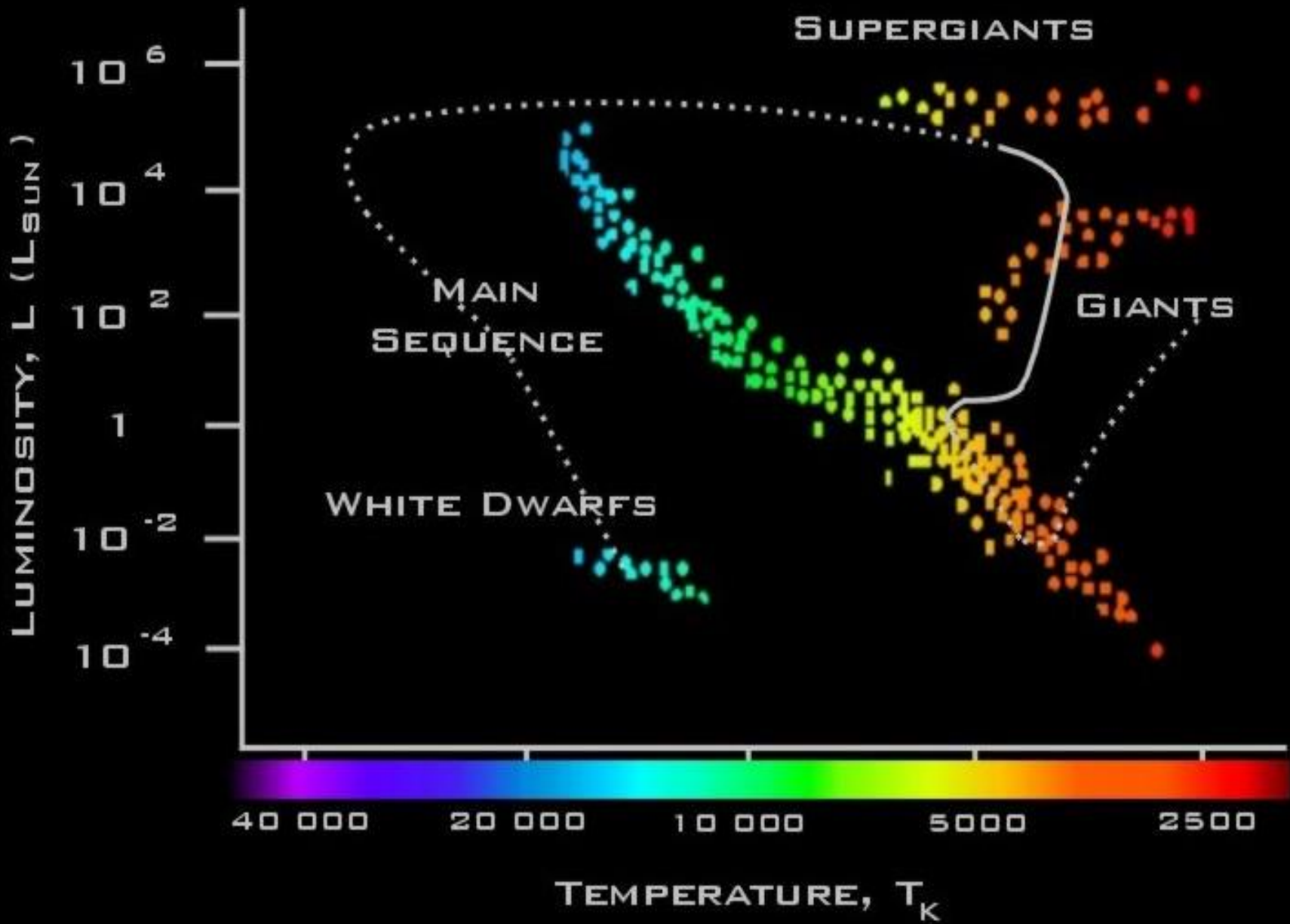
ΕΛΛΗΝΙΚΗ ΔΗΜΟΚΡΑΤΙΑ
Εθνικόν και Καποδιστριακόν
Πανεπιστήμιον Αθηνών

Γενική Αστρονομία II

Ενότητα 2: Ο Ήλιος ως αστέρας

Παναγιώτα Πρέκα
Σχολή Θετικών Επιστημών
Τμήμα Μαθηματικών



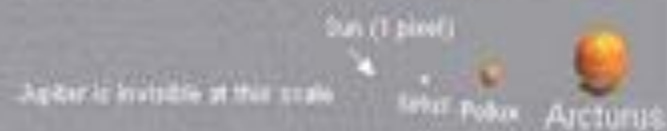




Betelgeuse



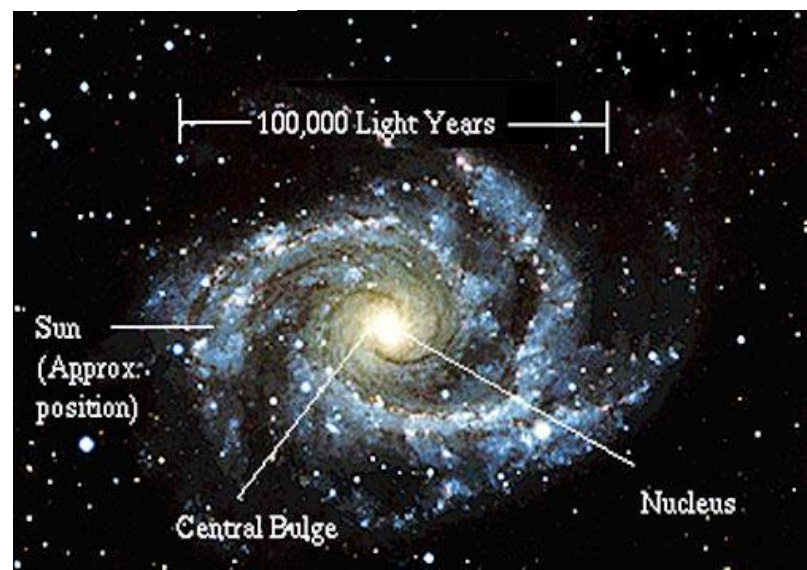
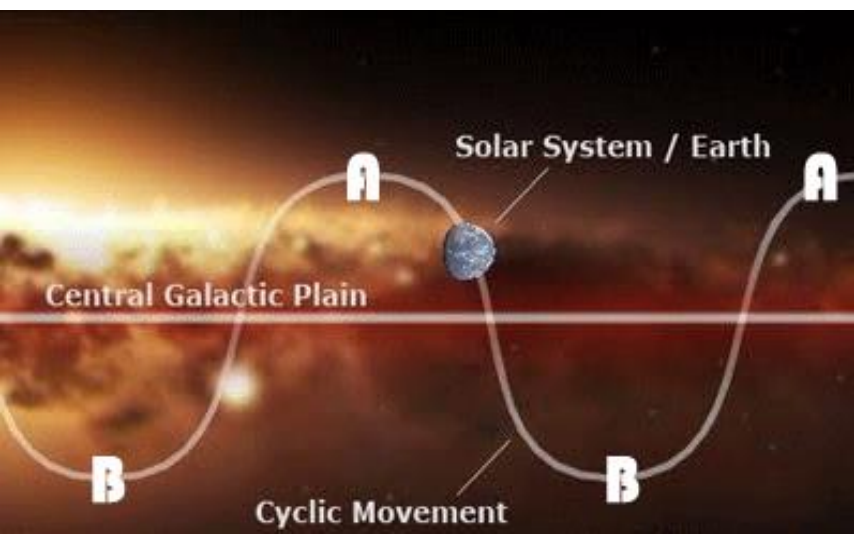
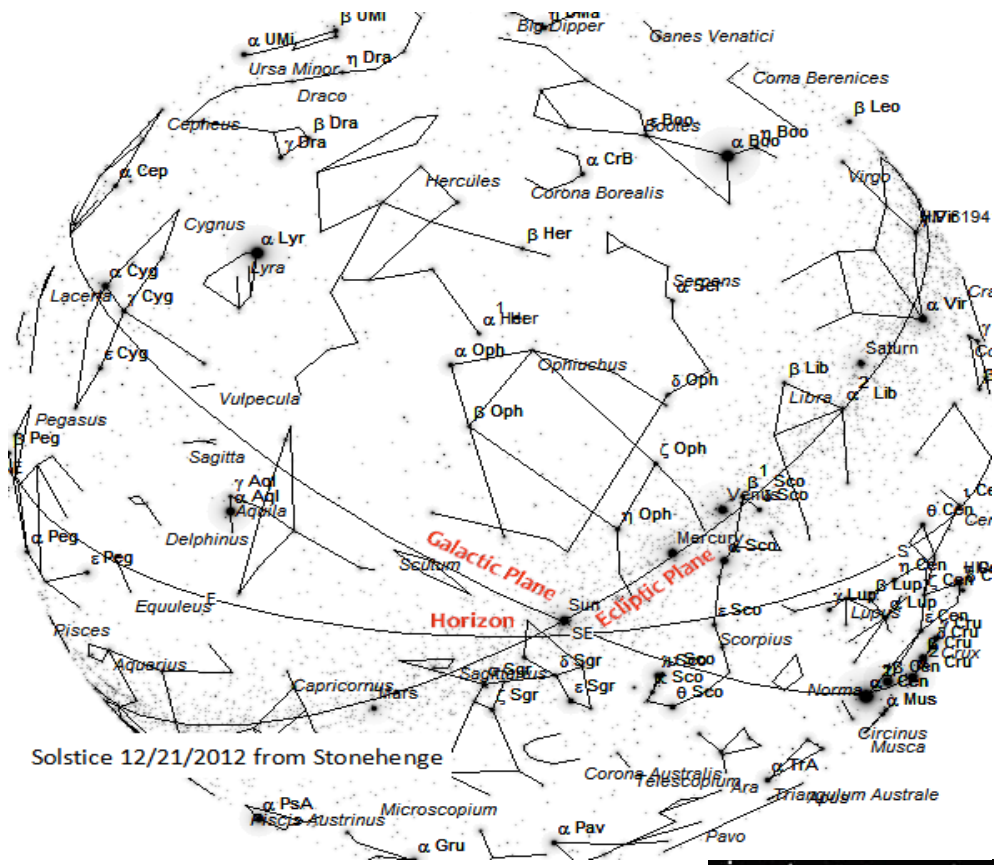
Antares

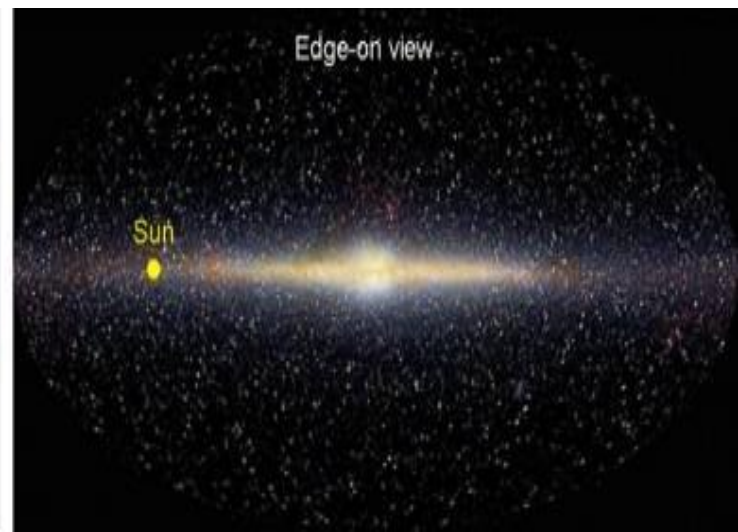
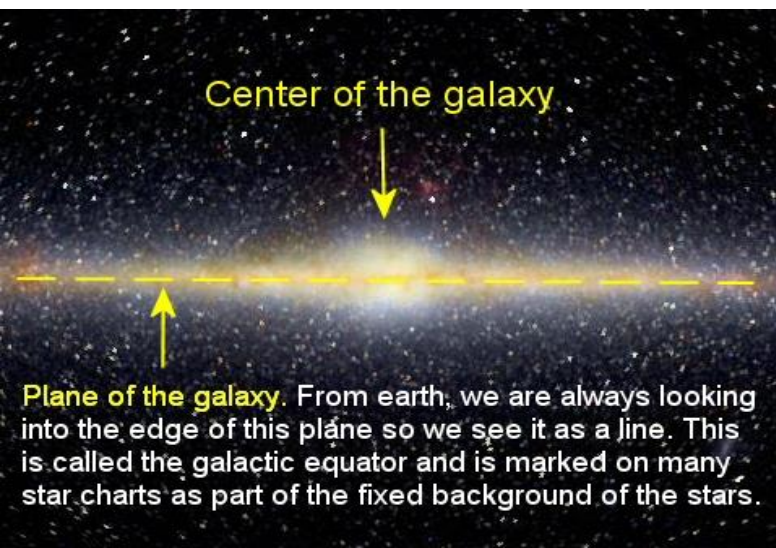
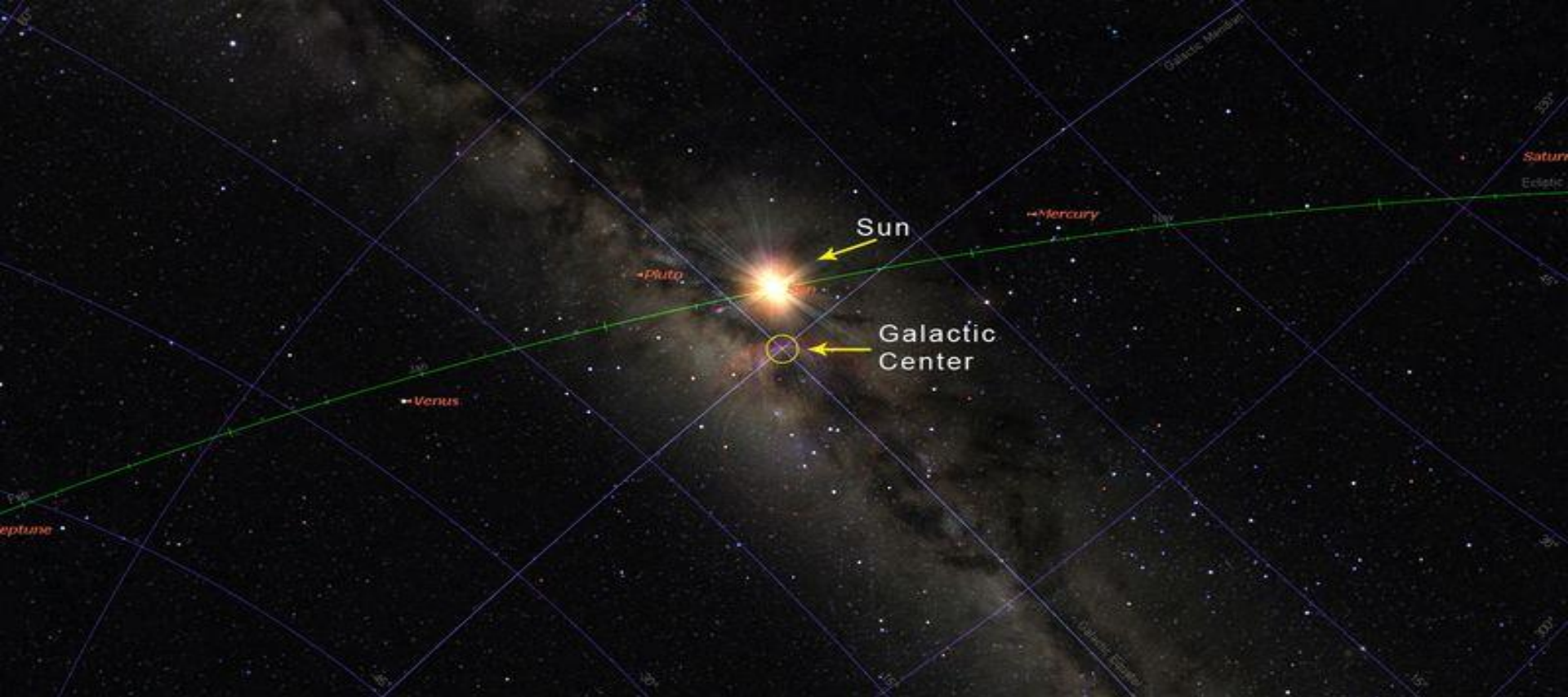


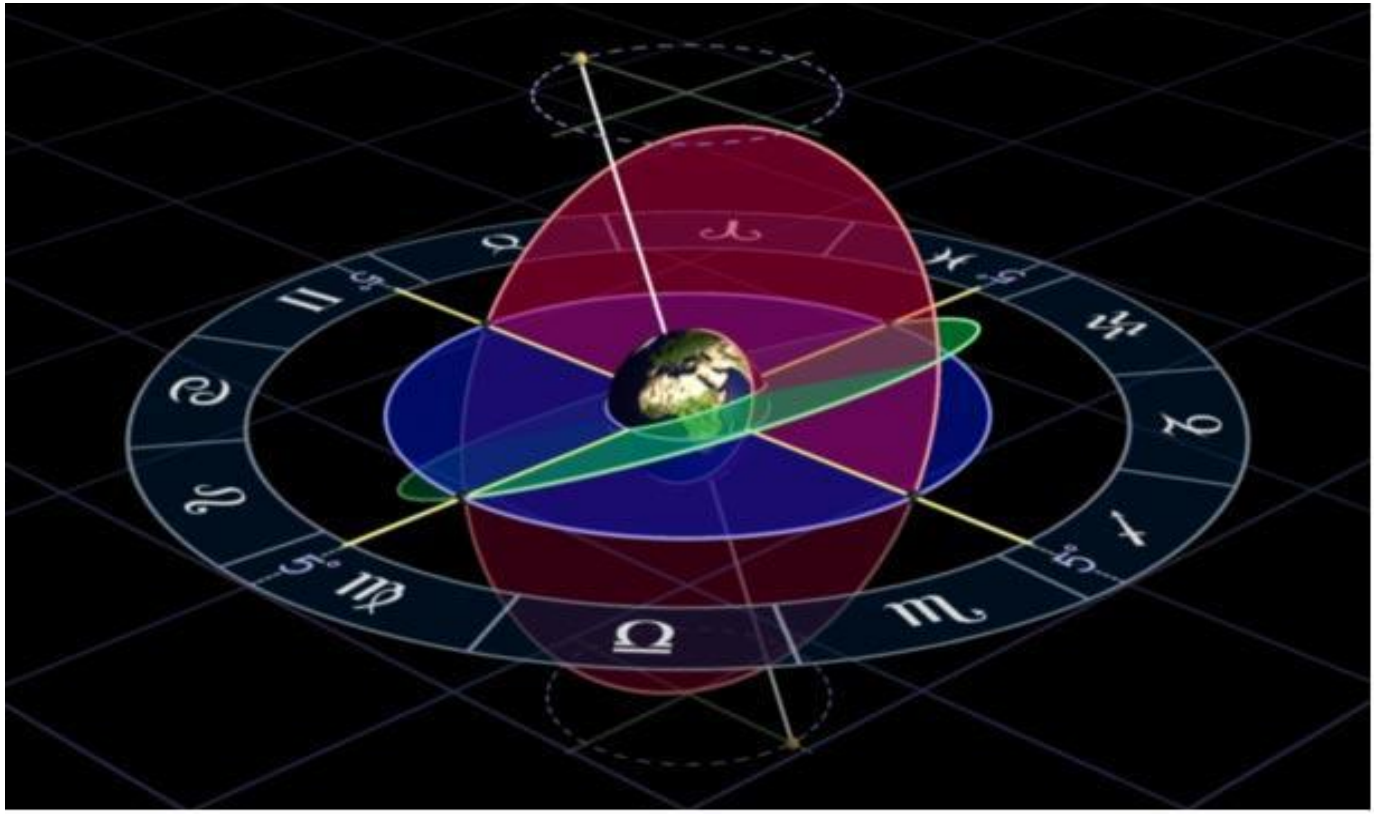
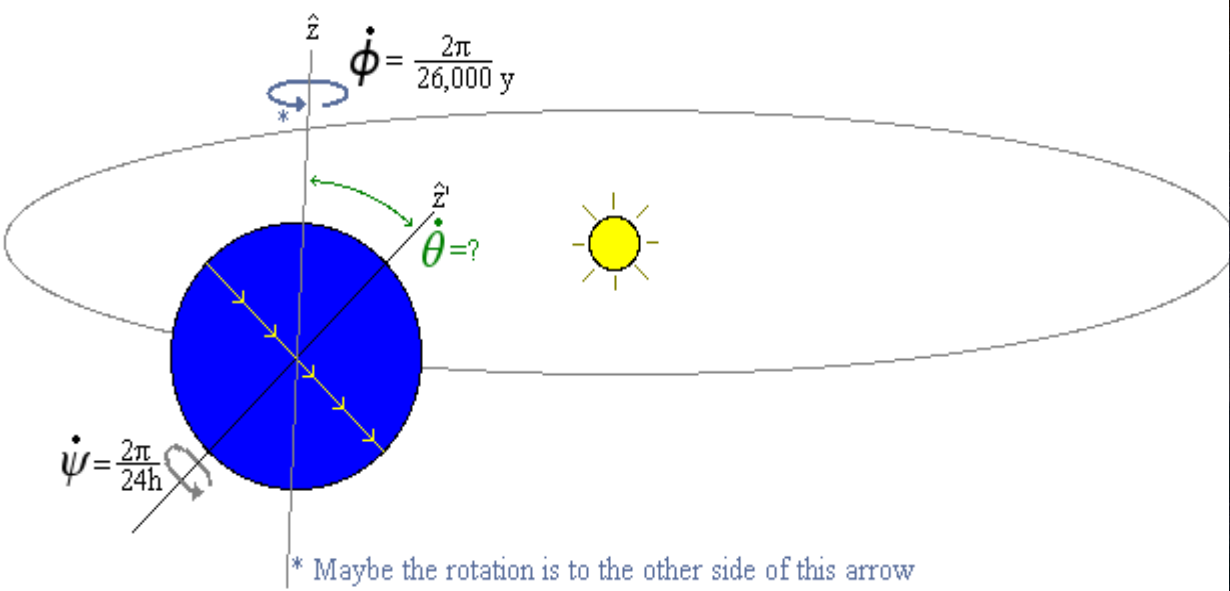
Rigel



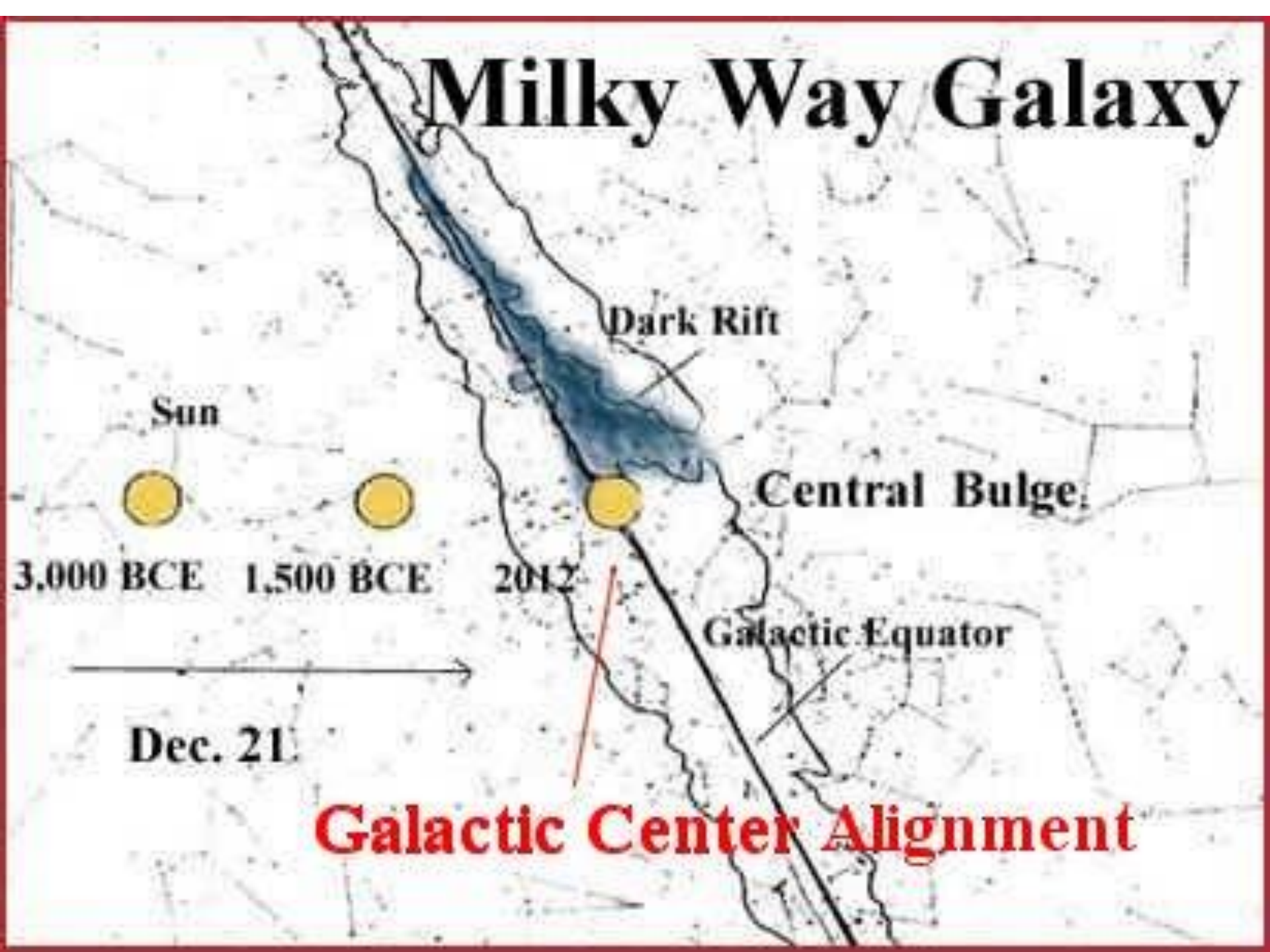
Aldebaran







Milky Way Galaxy



Sun

Dark Rift

Central Bulge

3,000 BCE

1,500 BCE

2012

Galactic Equator

Dec. 21

Galactic Center Alignment

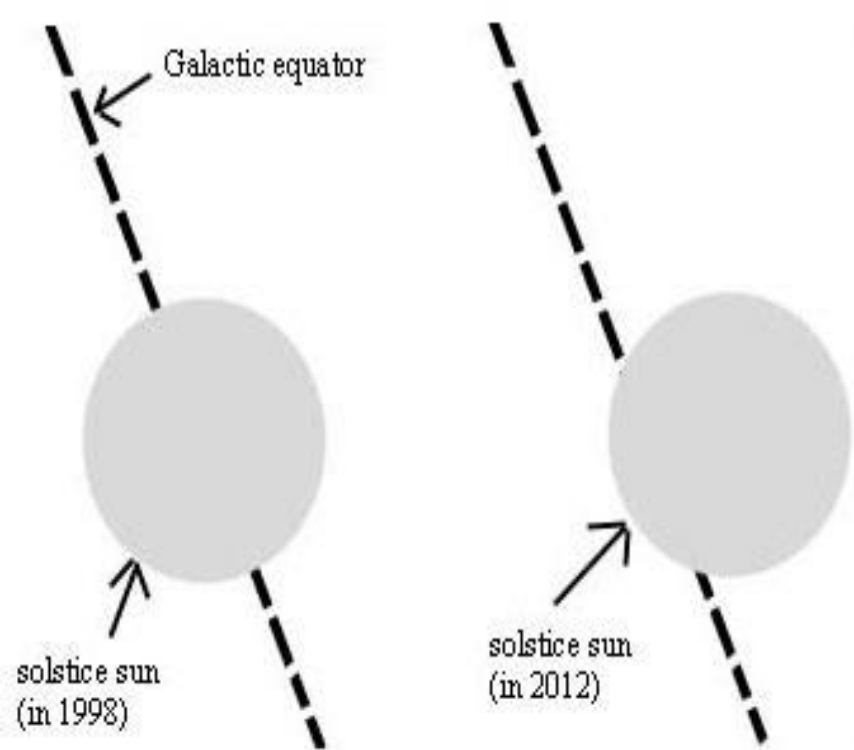
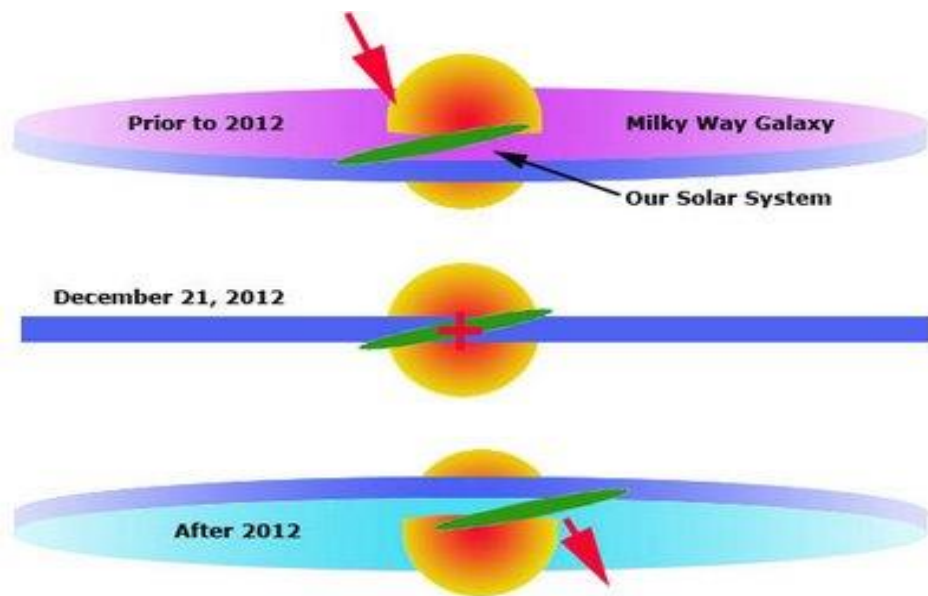
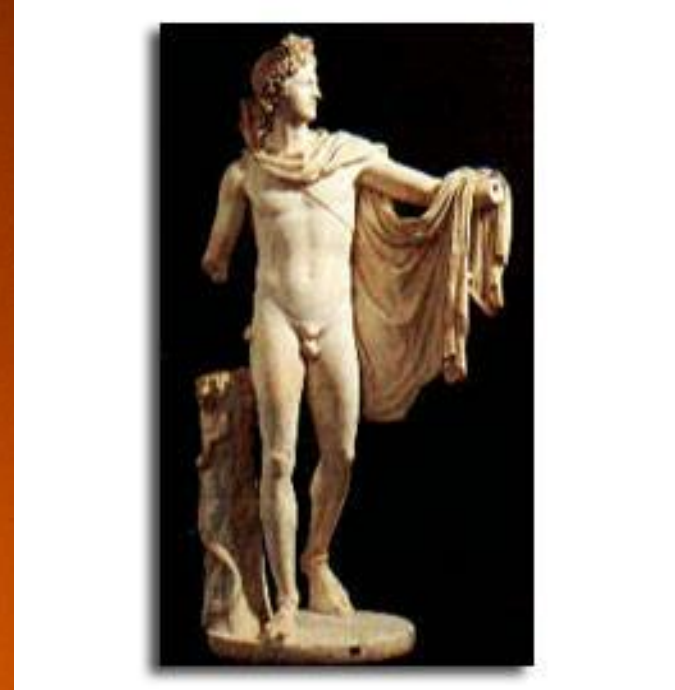


Image 1A - Galactic Alignment 2012

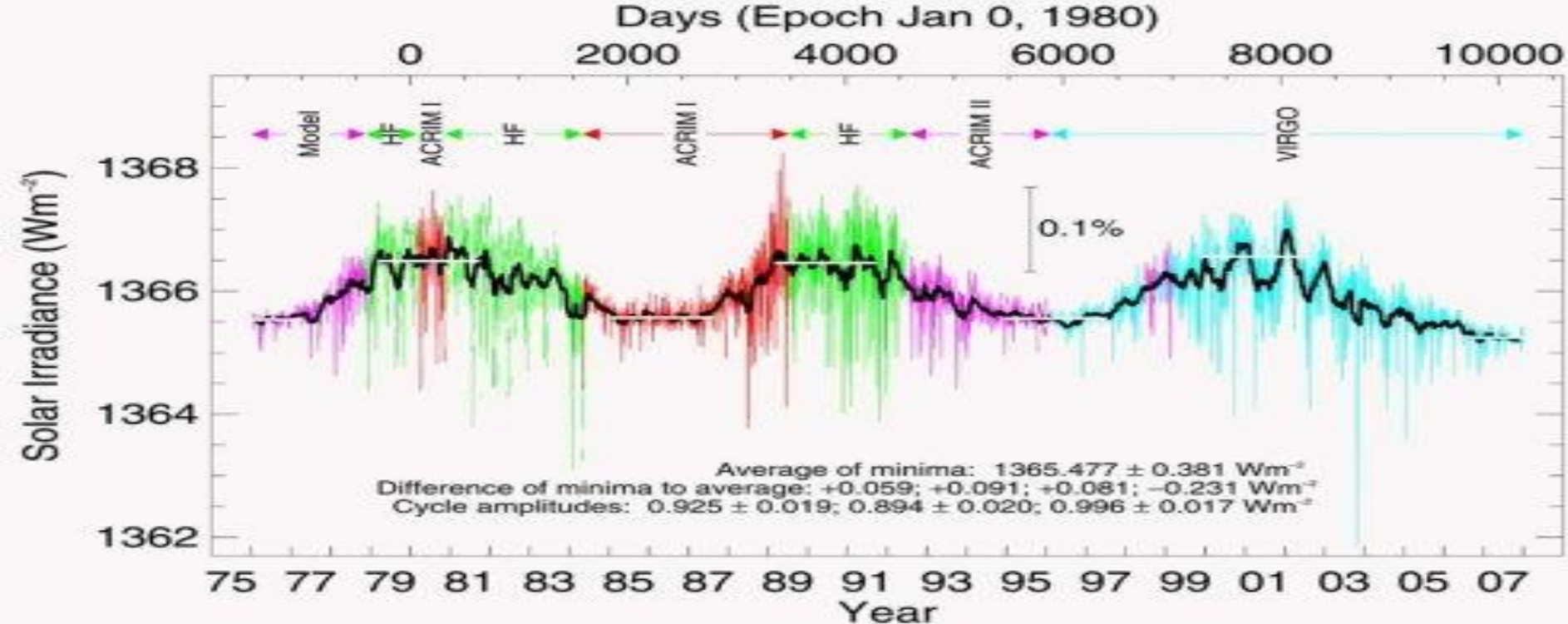




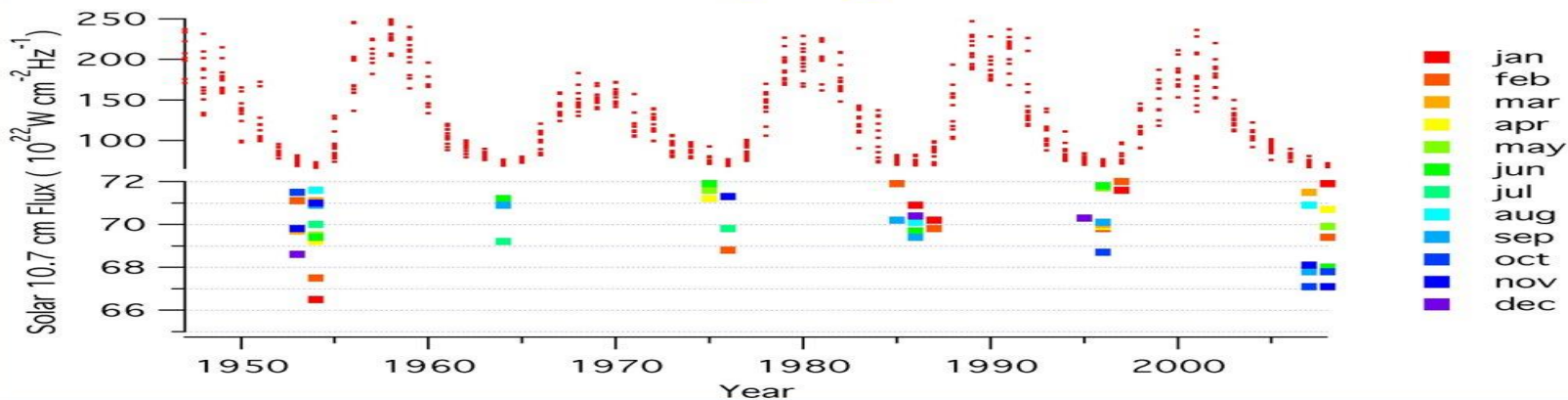
ΦΥΣΙΚΑ ΧΑΡΑΚΤΗΡΙΣΤΙΚΑ ΤΟΥ ΗΛΙΟΥ

Μέση Απόσταση	$1\text{A.U} = 149,6 \times 10^6 \text{ km}$
Διάμετρος	$1.392.000 \text{ km} = 109,3 D_{\Gamma}$
Μάζα	$2 \times 10^{33} \text{ gr} = 3,33 \times 10^5 M_{\Gamma}$
Μέση πυκνότητα	$\rho = 1,409 \text{ gr/cm}^3$
Επιφάνεια	$S = 6,087 \times 10^{12} \text{ km}^2$
Όγκος	$V = 1,412 \times 10^{18} \text{ km}^3.$
Φαινόμενη διάμετρος	$\varphi = 32'.$
Επιφανειακή βαρύτητα	27,9 φορές τη γήινη
Ηλικία	$= 4,5 \times 10^9 \text{ years}$
Περίοδος περιστροφής	<ul style="list-style-type: none"> • στους ηλιακούς πόλους → 34 days • στον ισημερινό → 27 days
Τρόπος περιστροφής	κατά την ορθή φορά

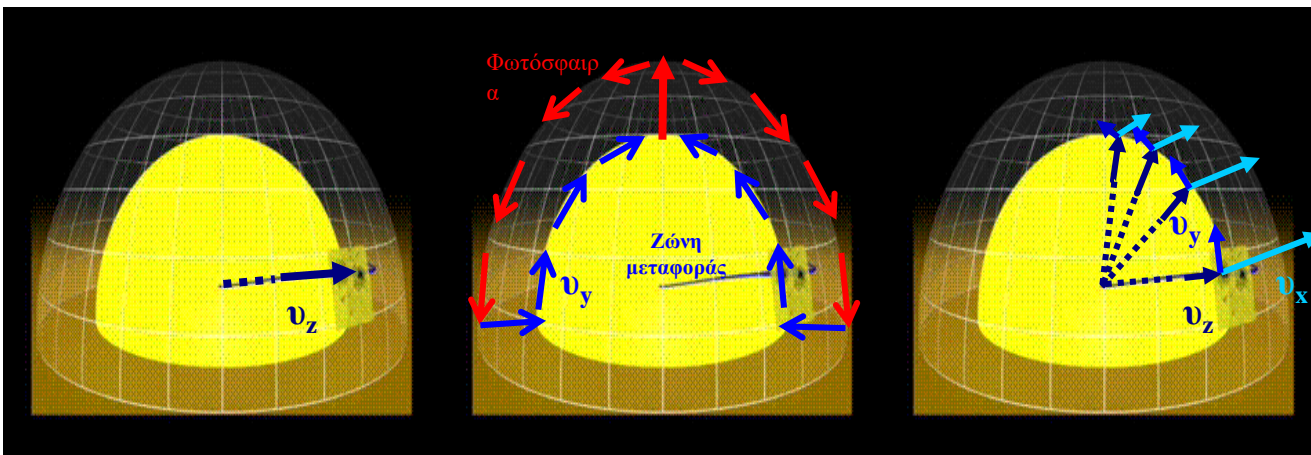
Φωτεινότητα	$= 3,82 \times 10^{33} \text{erg/s}$
Επιφανειακή θερμοκρασία	$T_{\text{eff}} = 5770 \text{ K}$
Φαινόμενο οπτικό μέγεθος	-26,8
Απόλυτο οπτικό μέγεθος	+4,71
Χρώμα	Κίτρινο
Δείκτες χρώματος	B-V= 0,7 και U-V = 0,8
Φασματικός τύπος	G2V
Γωνιώδης ταχύτητα	$\omega = 14,38^\circ - 2,77\phi$, όπου ϕ = ηλιογραφικό πλάτος
Ηλιακή σταθερά	$S = 1,36 \times 10^6 \text{ erg/cm}^2/\text{sec} = 1,3 \times 10^3 \text{ Watt/m}^2$
Κλίση ισημερινού	$7^\circ 15'$



Extremely Quiet Sun



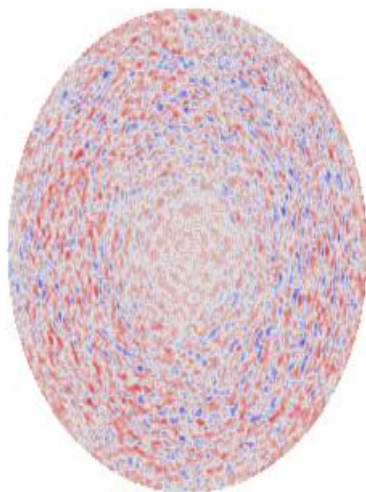
Lowest monthly average F10.7 in 50 years.
 June - November, 2008 F10.7 ~ 68



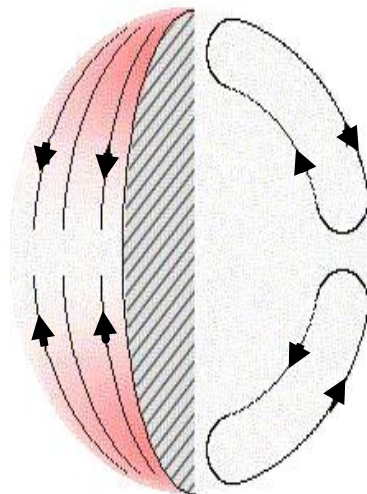
Εικ. Η κατακόρυφη συνιστώσα της ταχύτητας v_z .

Εικ. Η δημιουργία της κάθετης συνιστώσας της ταχύτητας v_y .

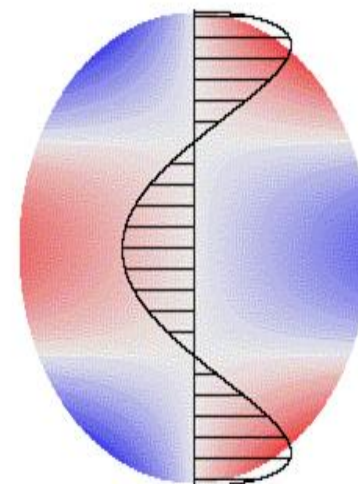
Εικ. Οι 3 συνιστώσες της ταχύτητας v_z , v_y και v_x .



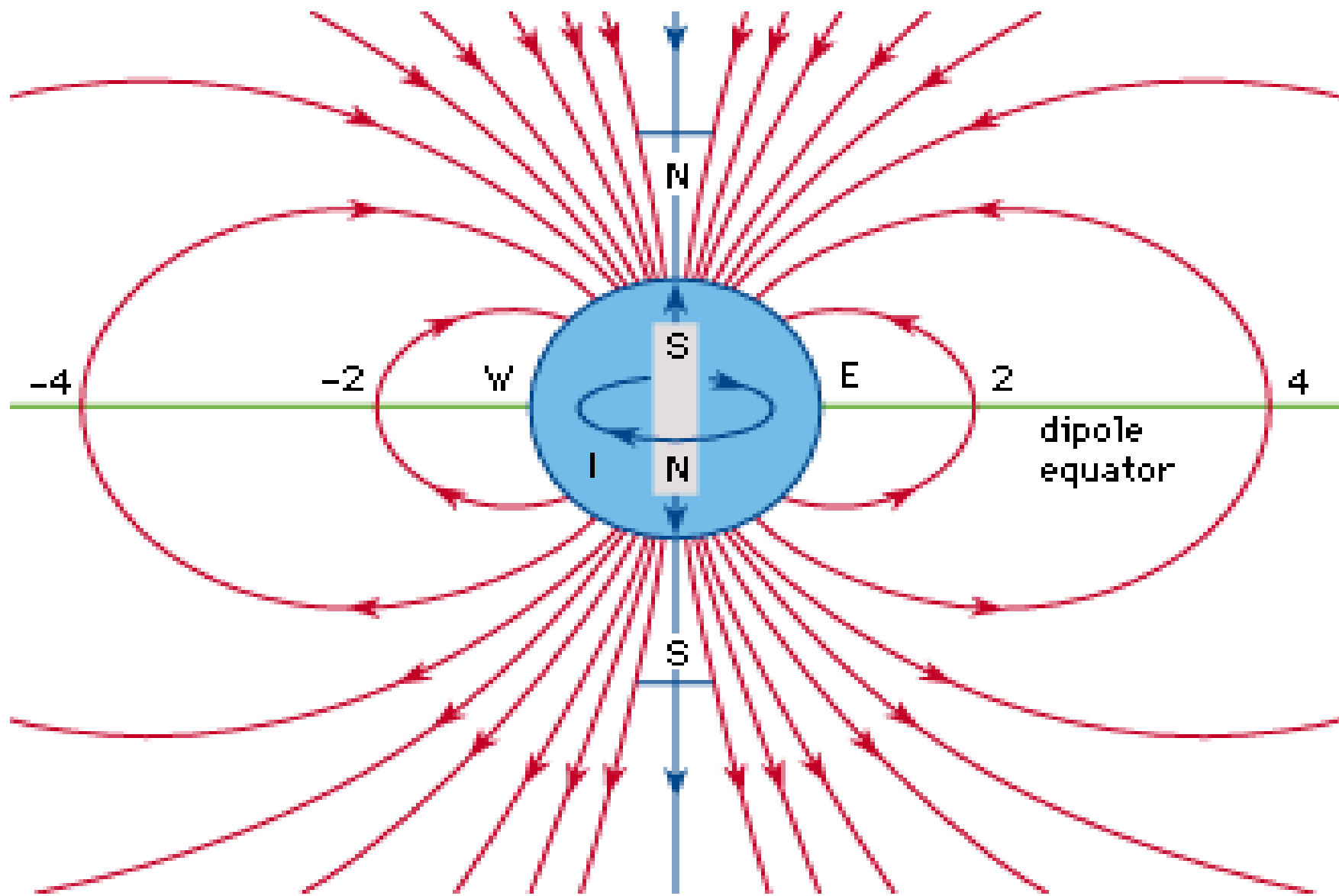
Εικ. Το αποτέλεσμα των ανοδικών ρευμάτων (υπερκοκκίαση)

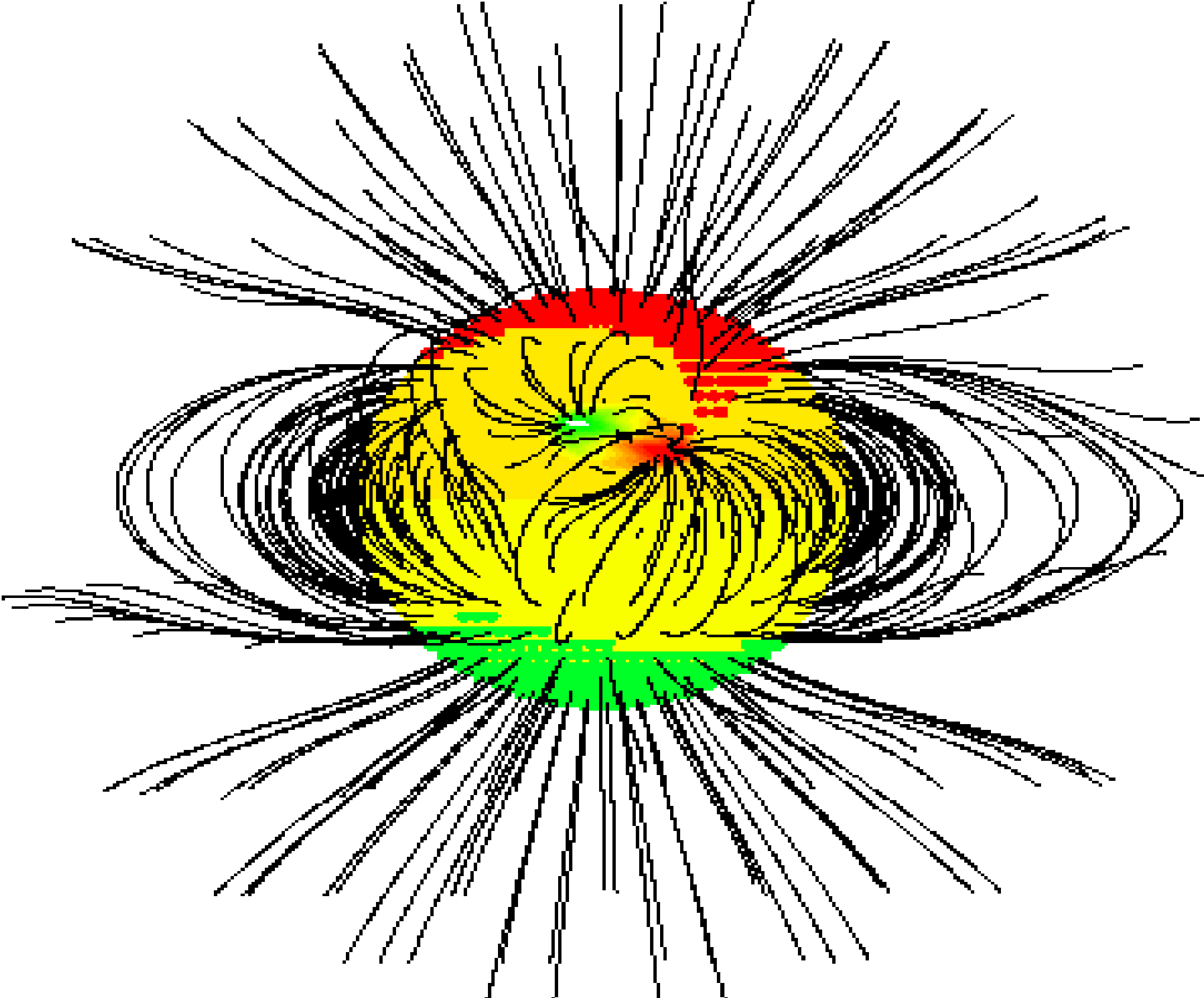


Εικ. Η ροή των μεσημβρινών ρευμάτων

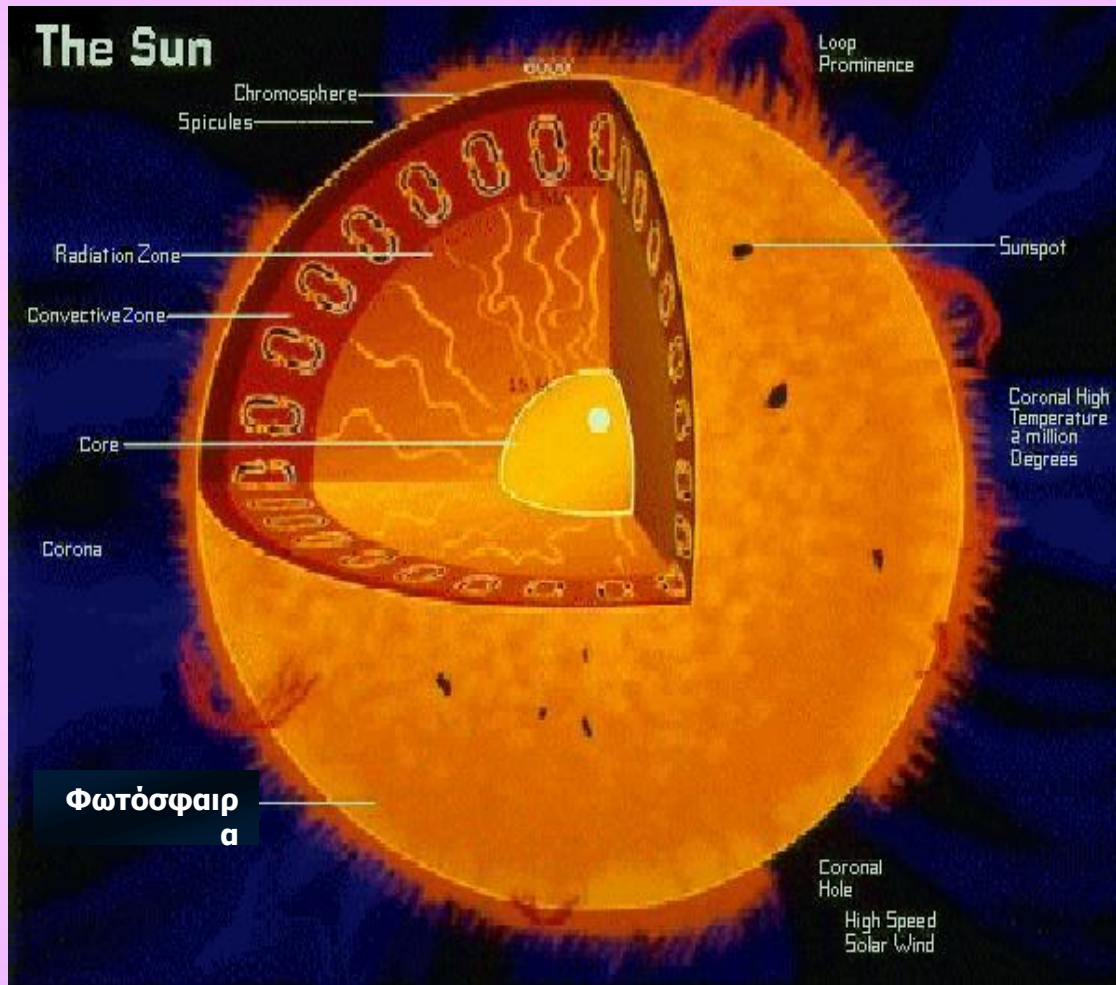


Εικ. Η οριζόντια συνιστώσα της ταχύτητας





The Sun



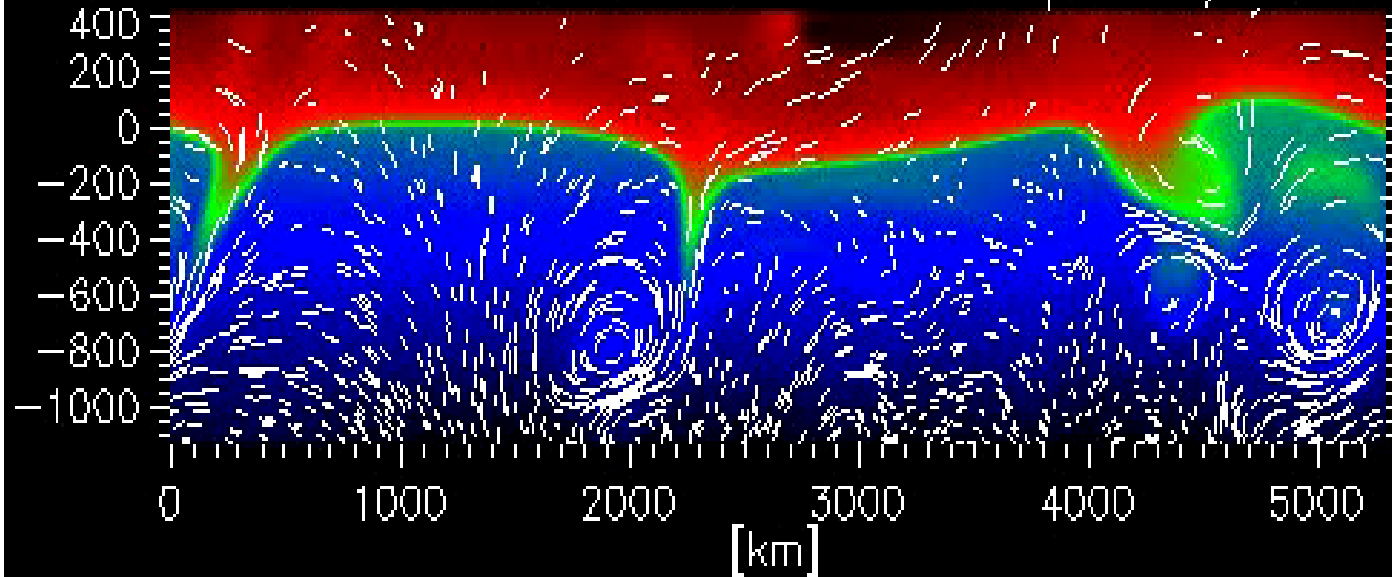
Sun (L71D09), $T_{\text{eff}}=5770$ K, $\log g=4.44$

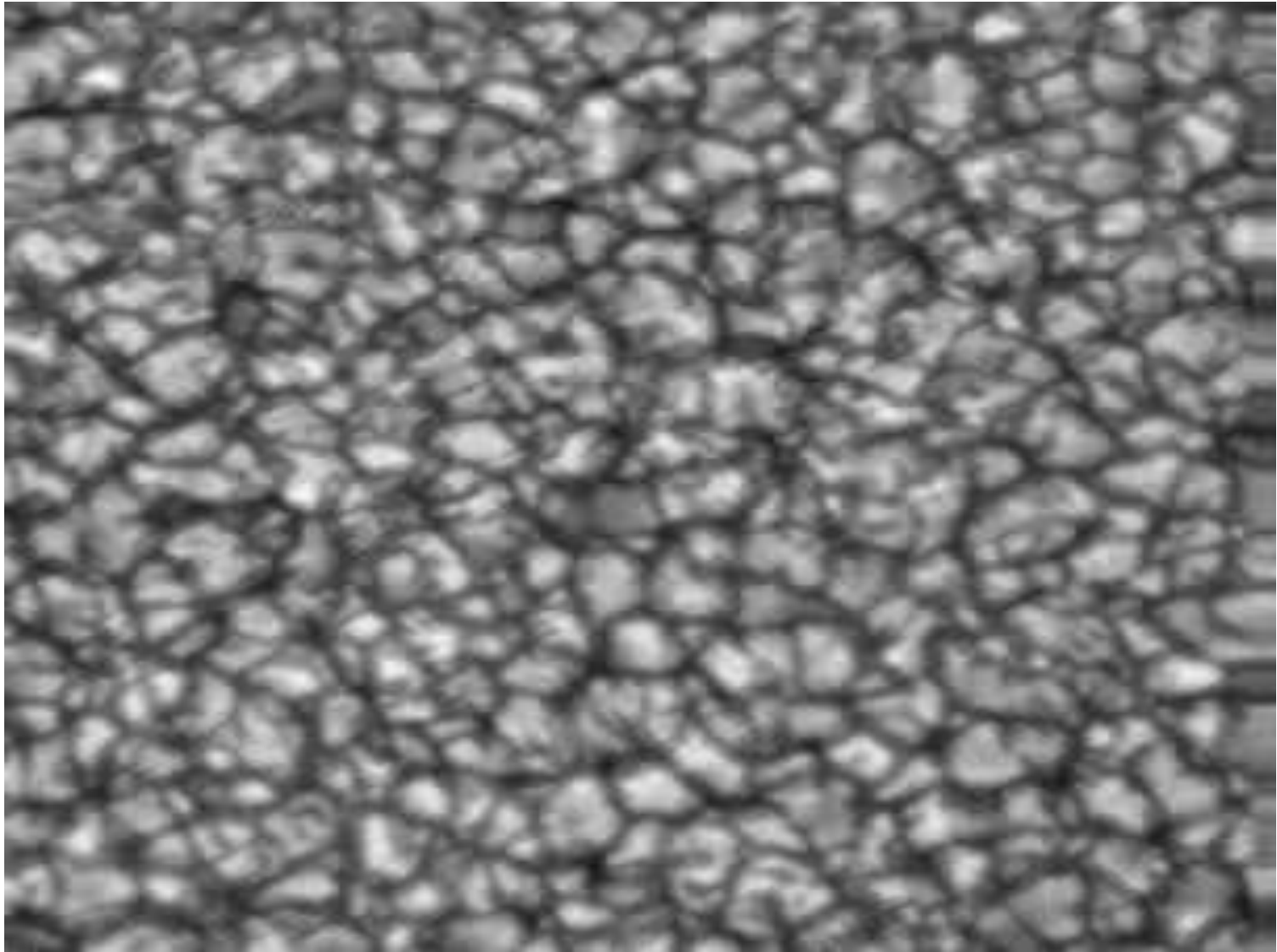
212 x 106 grid points, 11540 s ($\Delta t=20$ s)

Matthias Steffen, Bernd Freytag

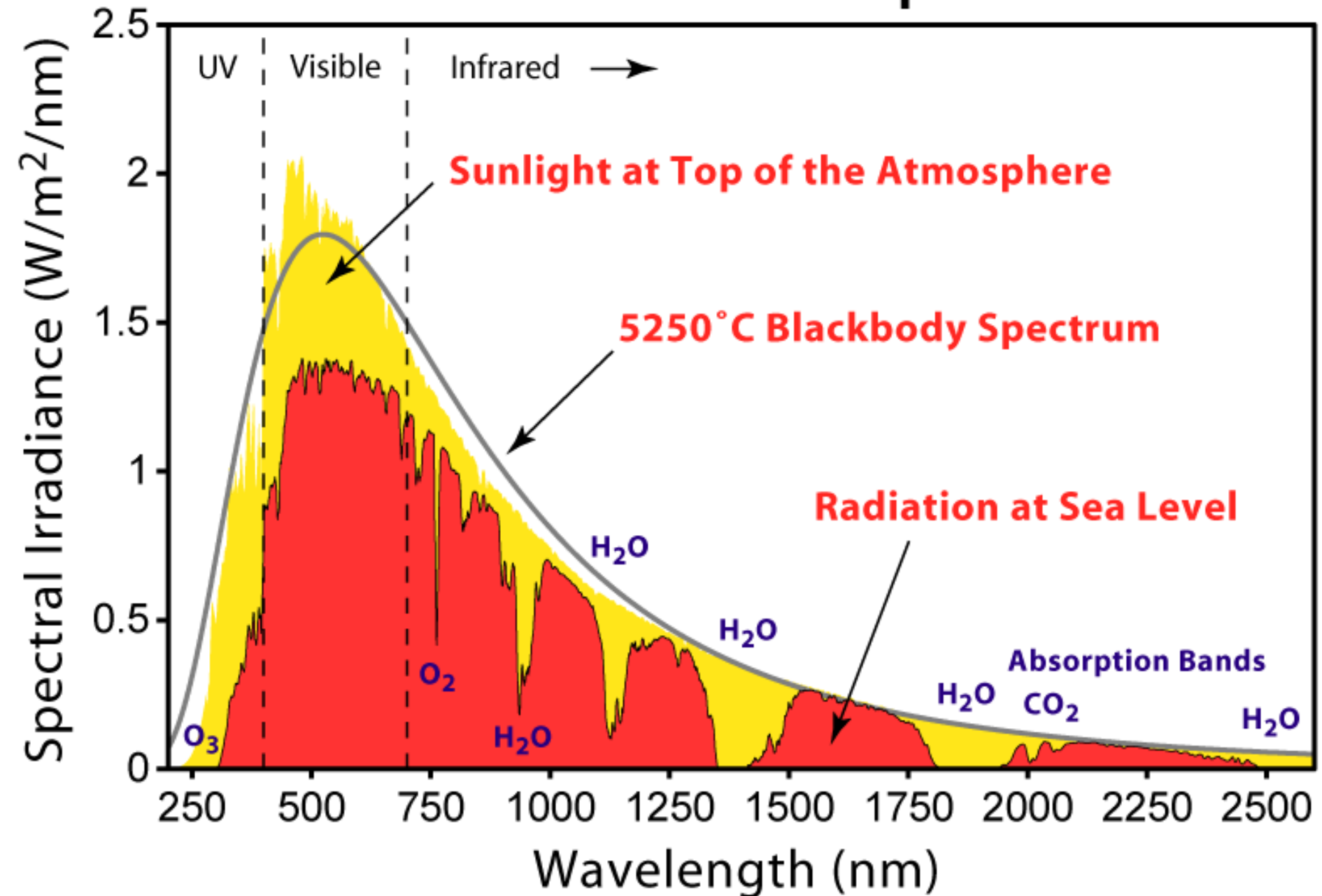
Time: 18880.0sec

Temperature, Tracers





Solar Radiation Spectrum



energy (eV)

1

2

3

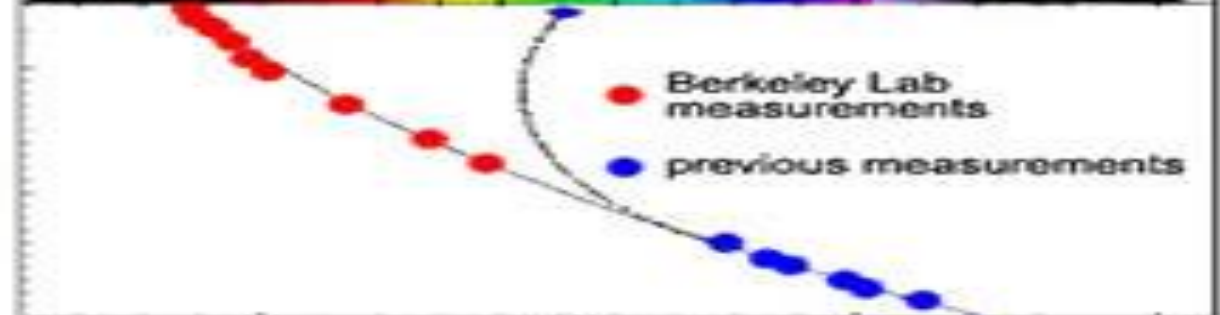
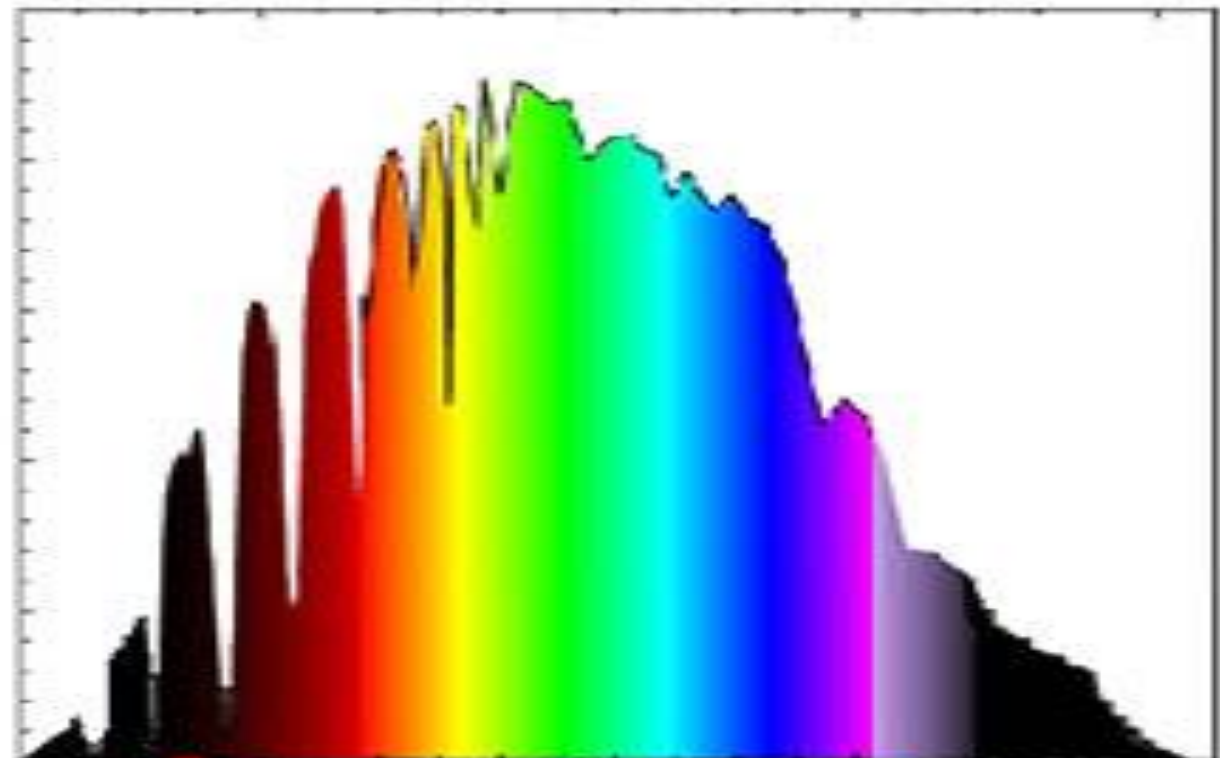
4

solar flux
(photons per
unit area per
unit time)

$\text{In}_{1-x}\text{Ga}_x\text{N}$

increasing
gallium
→

←
increasing
indium



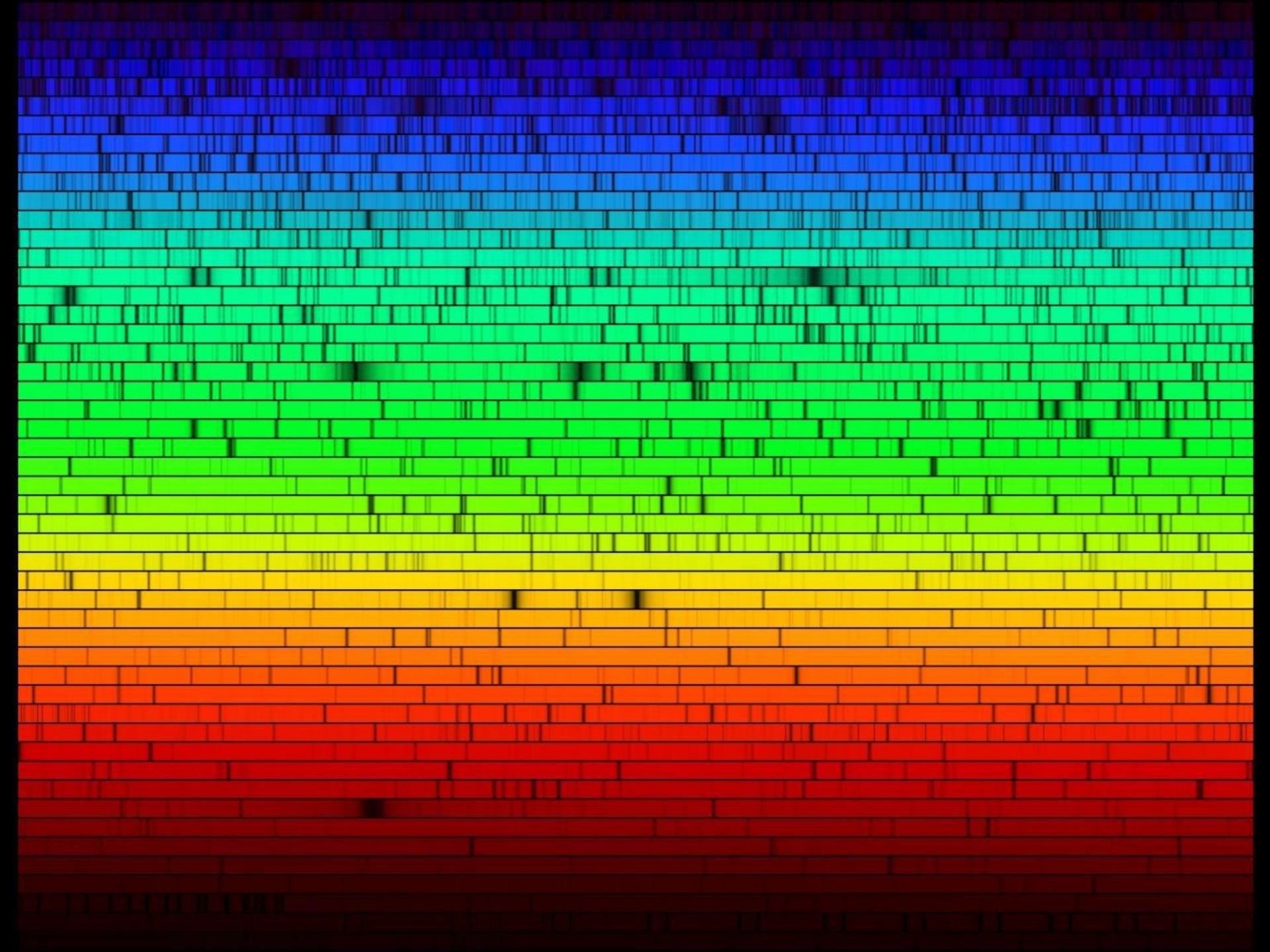
band gap (eV)

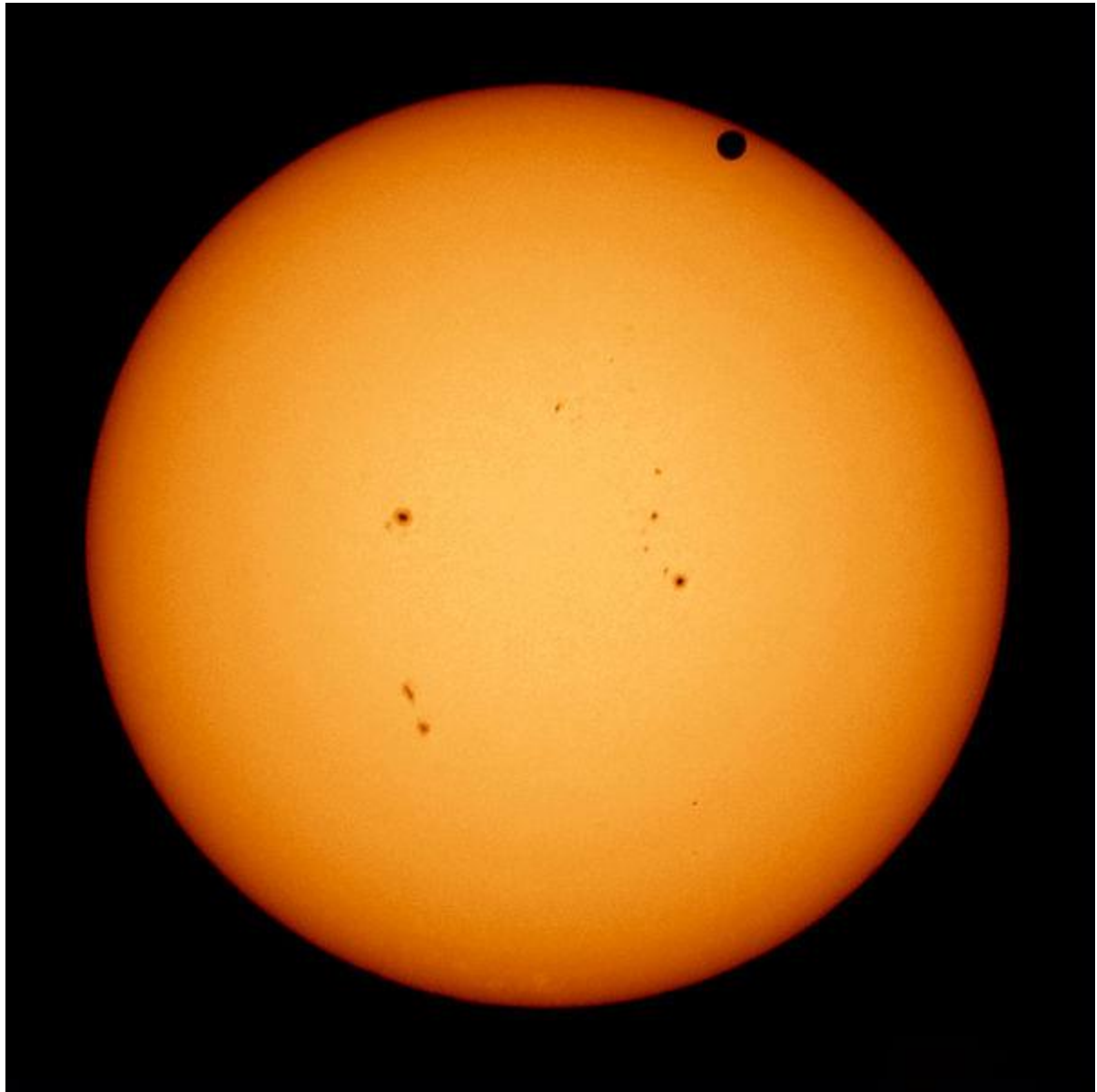
1

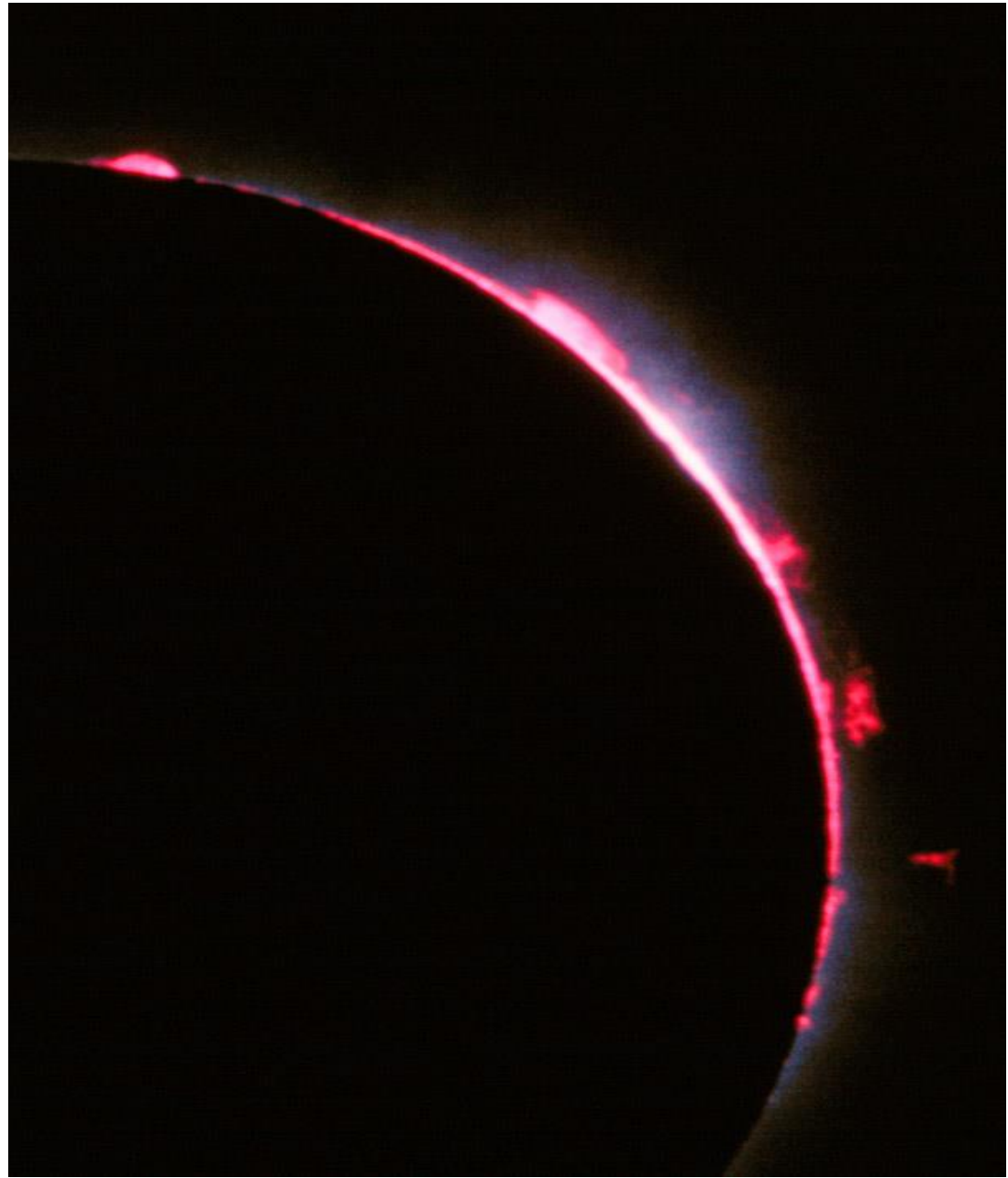
2

3

4

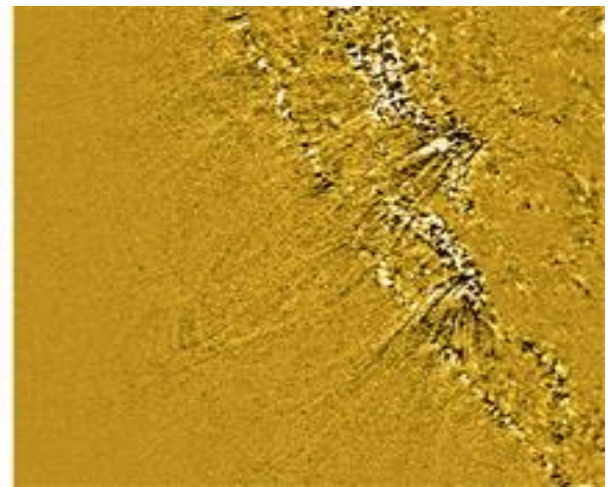
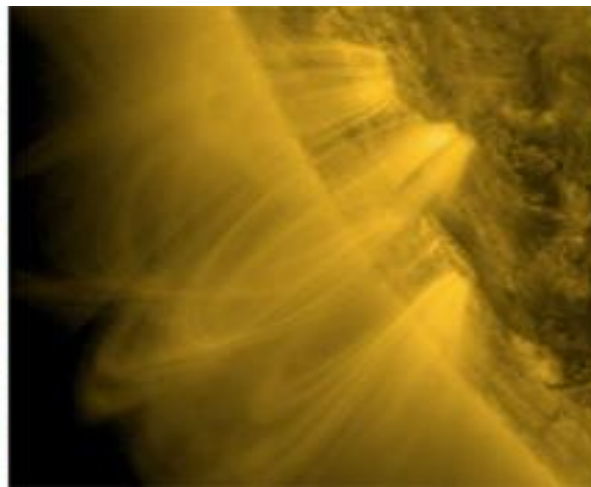
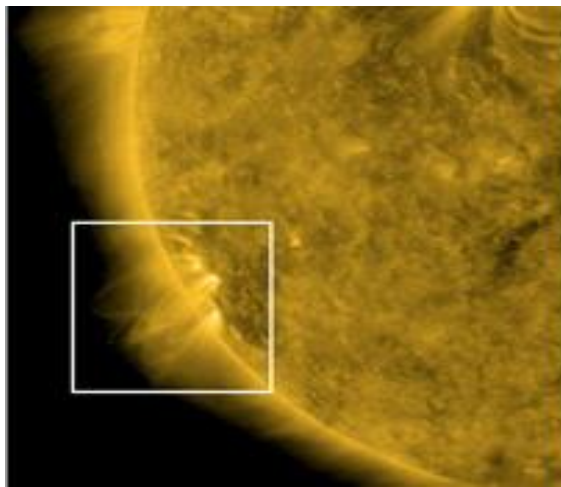
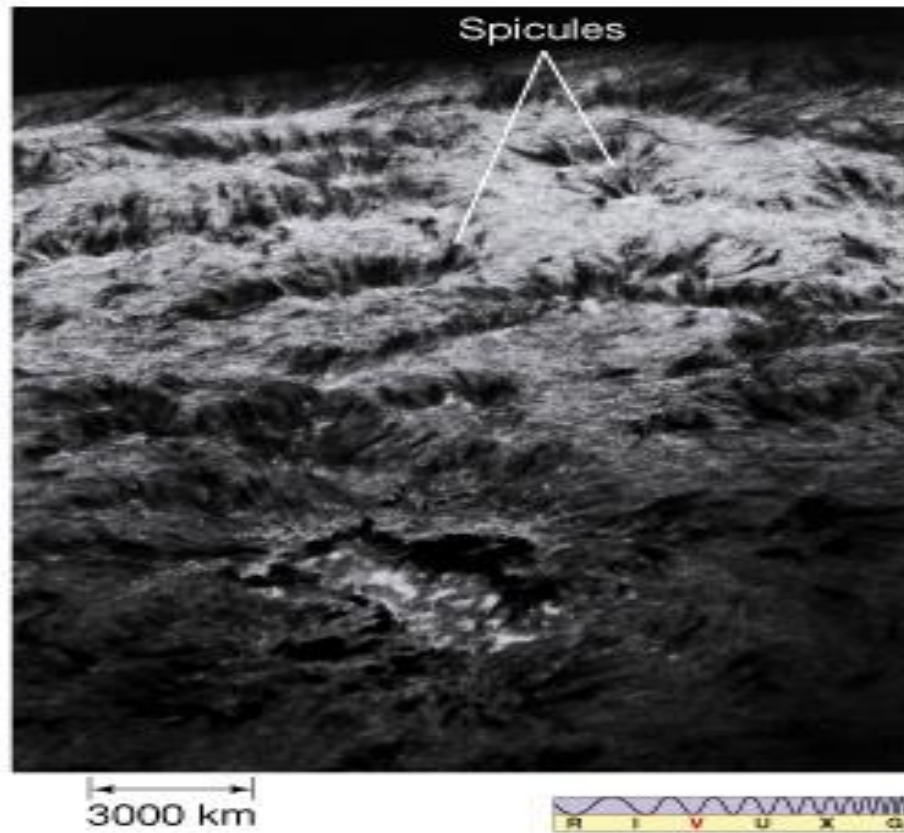




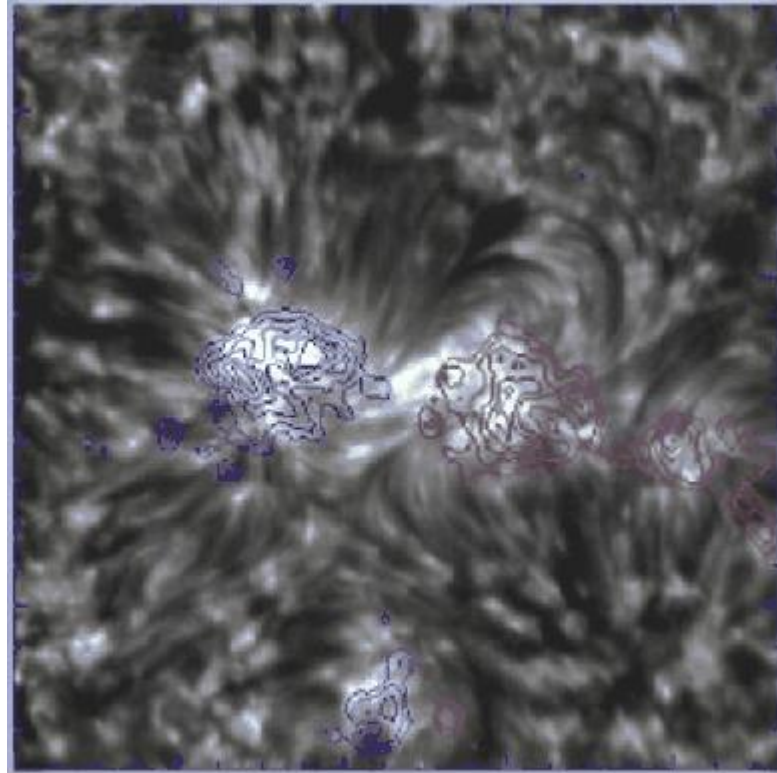


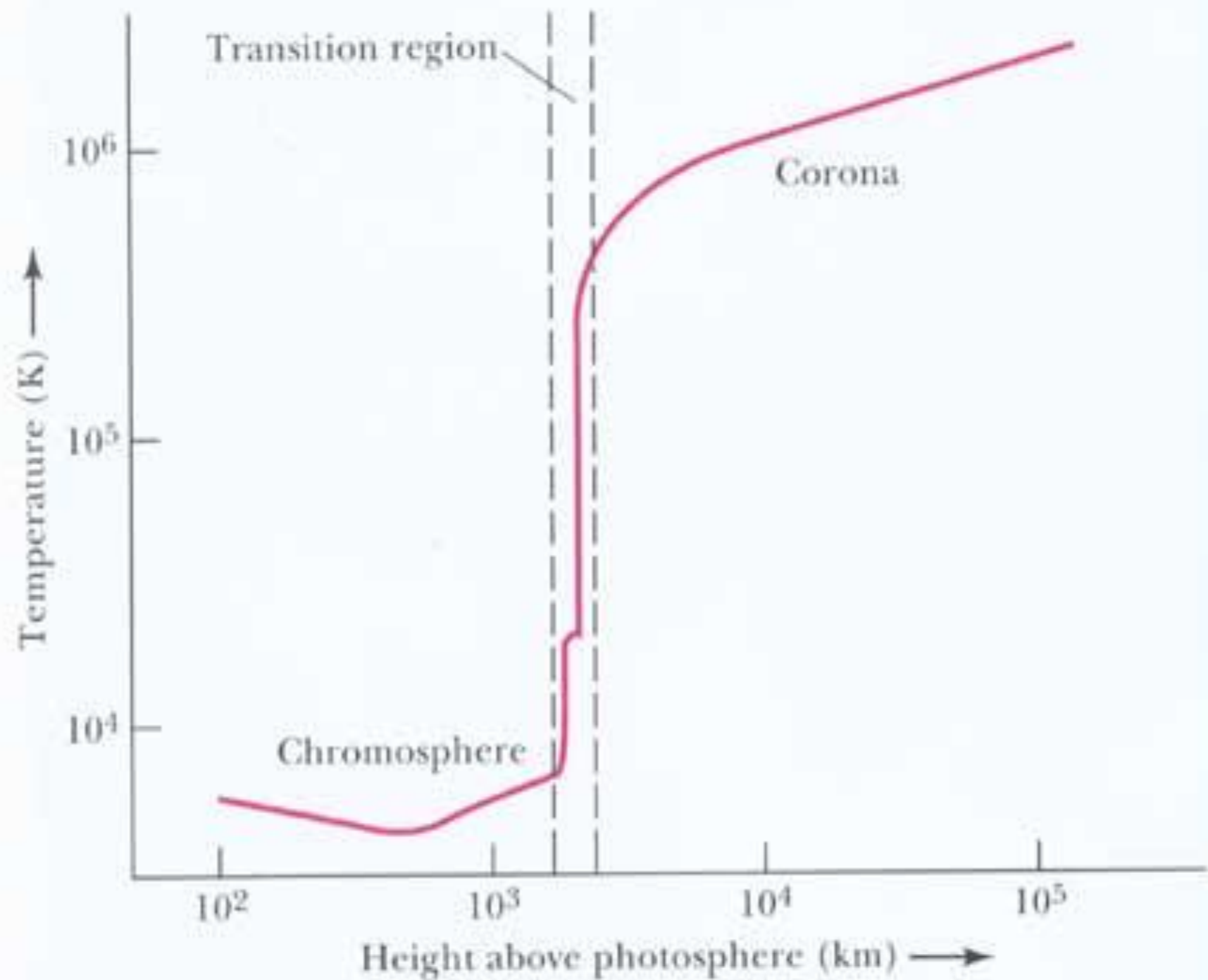


The Chromospheric
Network



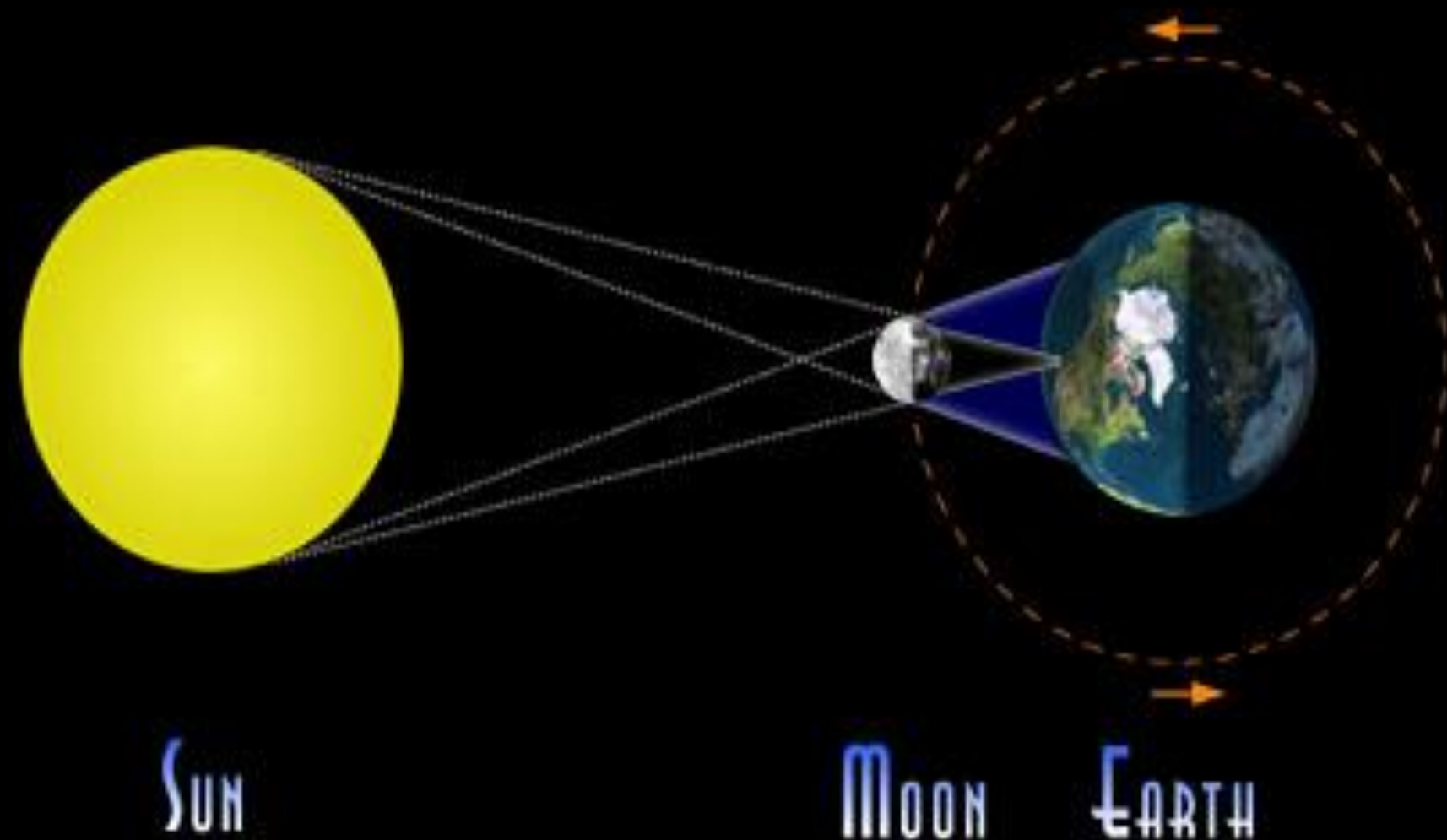
MOTTLES



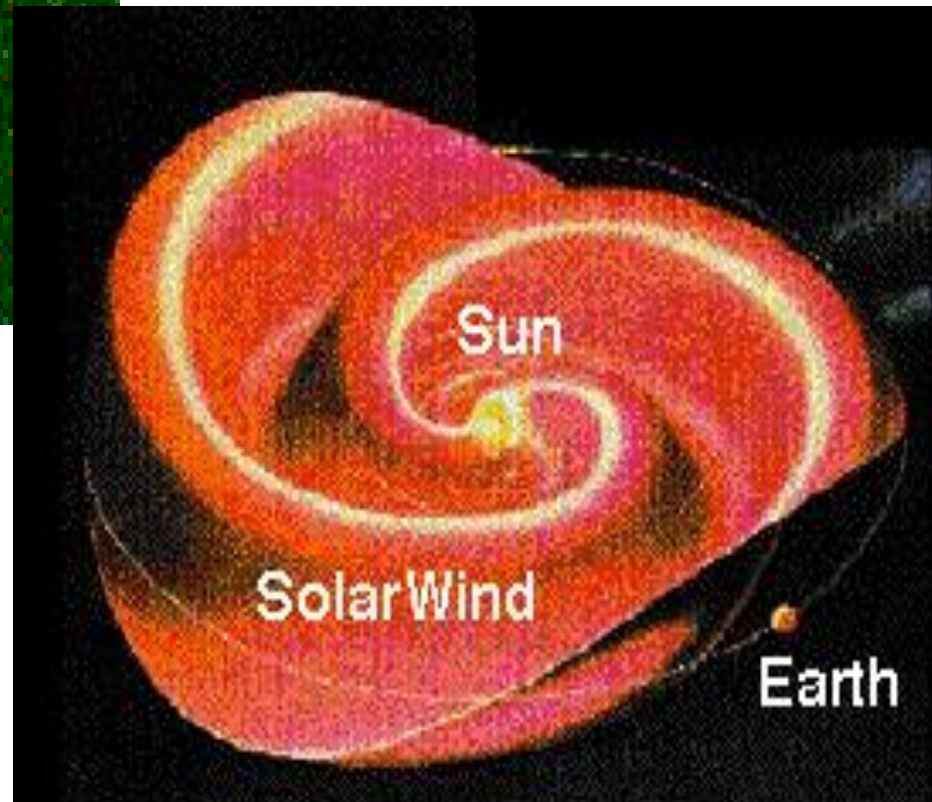


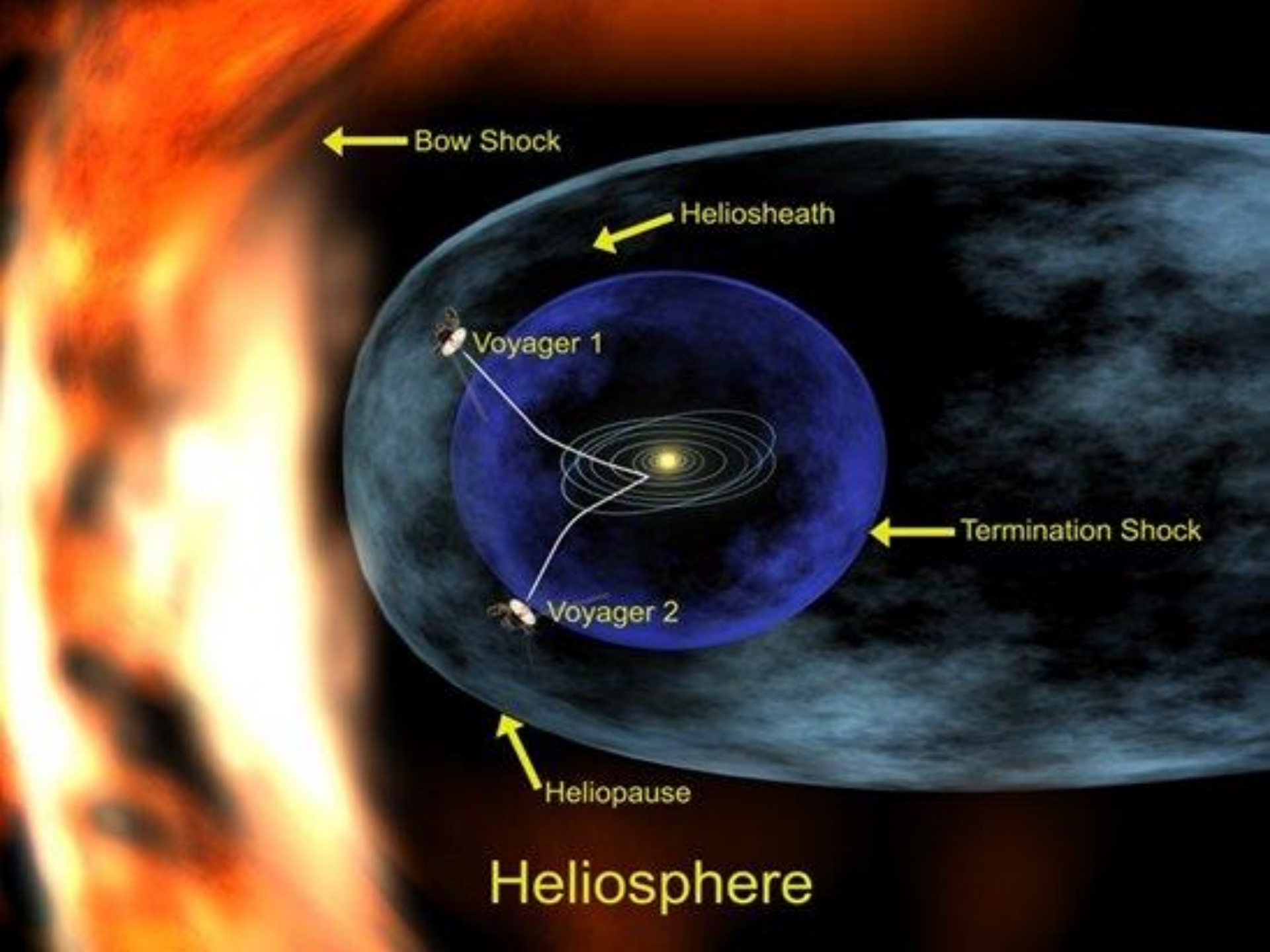


SOLAR ECLIPSE GEOMETRY









← Bow Shock

← Heliosheath

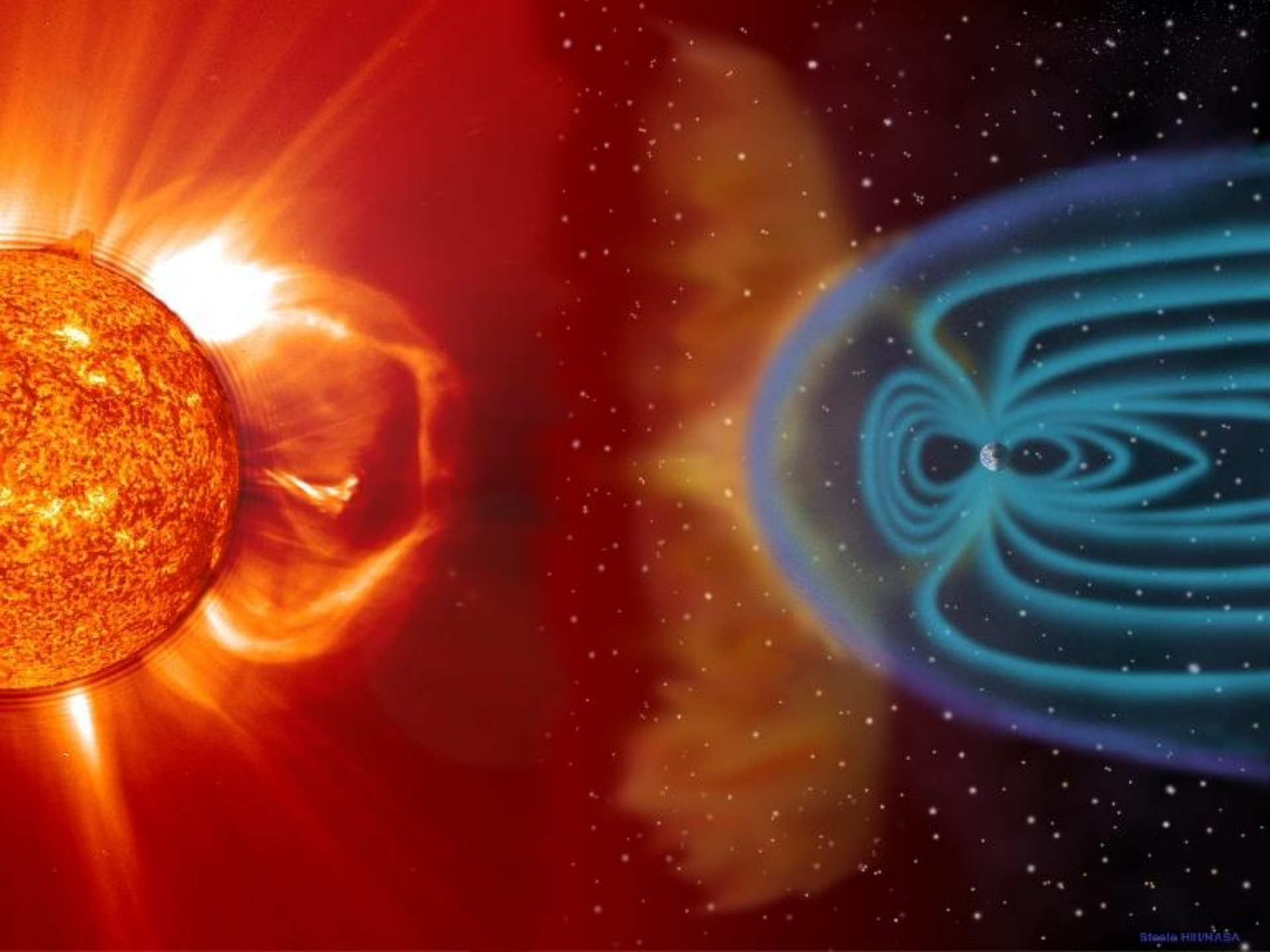
Voyager 1

Voyager 2

← Termination Shock

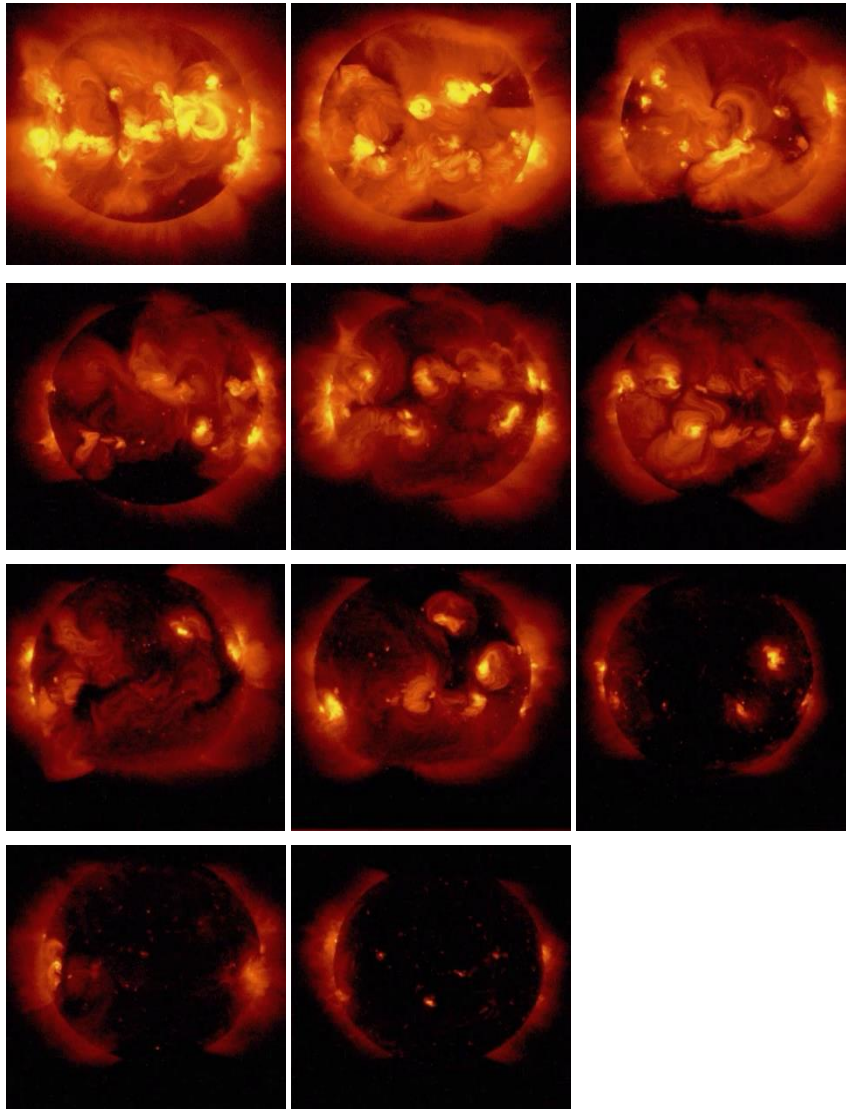
← Heliopause

Heliosphere





Ο ΕΝΔΕΚΑΕΤΗΣ ΚΥΚΛΟΣ – ΑΠΟ ΤΟ ΜΕΓΙΣΤΟ ΣΤΟ ΕΛΑΧΙΣΤΟ



Μία εικόνα
ακτίνων x για
κάθε χρόνο του
εν-δεκαετούς
κύκλου, ξεκι-
νώντας από το
μέγιστο της
δράσης και
καταλή-γοντας
στο ελάχιστο.

ΟΠΤΙΚΟ ΦΑΣΜΑ

ΣΥΝΙΣΤΩΣΕΣ ΣΤΕΜΜΑΤΟΣ

1. ΣΤΕΜΜΑ Κ (Kontinuum corona) (ΣΤΕΜΜΑ ΗΛΕΚΤΡΟΝΙΩΝ)

Εντοπίζεται στην περιοχή $1,03-2,30 R_{\odot}$ και οφείλεται στη διάχυση του φωτός της φωτόσφαιρας από ελεύθερα e^- . Οι πολύ υψηλές ταχύτητες προκαλούν με-γάλη διεύρυνση των φασματικών γραμμών (ΦΑΙΝ. DOPPLER). Επομένως έχει **συνεχές φάσμα** και είναι πολωμένο.

2. ΣΥΝΙΣΤΩΣΑ F – (ΨΕΥΔΟΣΤΕΜΜΑ) (Fraunhofer corona)

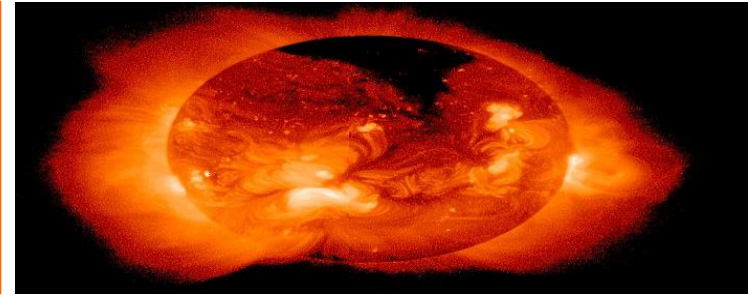
Αυτή, δε δημιουργείται μέσα στο στέμμα από το υλικό του στέμματος, αλλά οφείλεται στην περίθλαση του φωτός του Ήλιου από στερεά σωματίδια (σκόνη) που βρίσκονται διασκορπισμένα στο μεσοδιάστημα ΓΗΣ-ΗΛΙΟΥ, πάνω στο επίπεδο της εκλειπτικής. Δίνει **συνεχές φάσμα με γραμμές απορ-ρόφησης Fraunhofer**.

3. ΣΤΕΜΜΑ Ε (Emission corona)

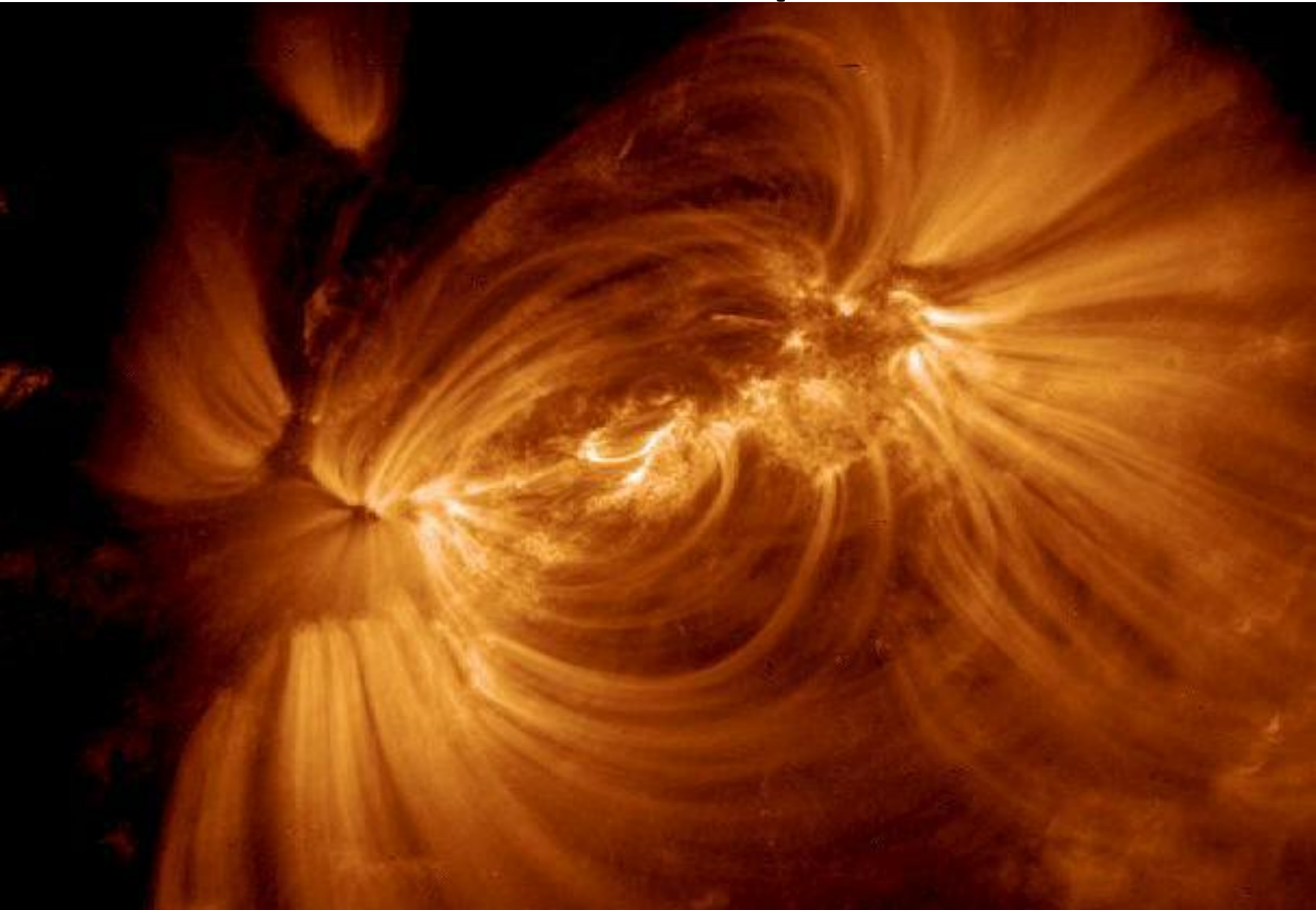
Είναι **η μόνη που παράγεται μέσα στο στέμμα**. Αυτή δεν απεικονίζεται σε τεχνητή έκλειψη, καθώς δίνει **γραμμικό φάσμα εκπομπής**. Τούτο συμβαίνει γιατί η μάζα των ιόντων που έχουν απομείνει στο στέμμα χωρίς να έχουν χάσει όλα τα e^- τους (Ca, Fe) είναι πολύ μεγάλη, επομένως η ταχύτητα τους είναι πολύ μικρή και δίνουν μικρό εύρος στις γραμμές εκπομπής, που έτσι ξεχωρίζουν. **Μπορεί να παρατηρηθεί μονοχρωματικά.**

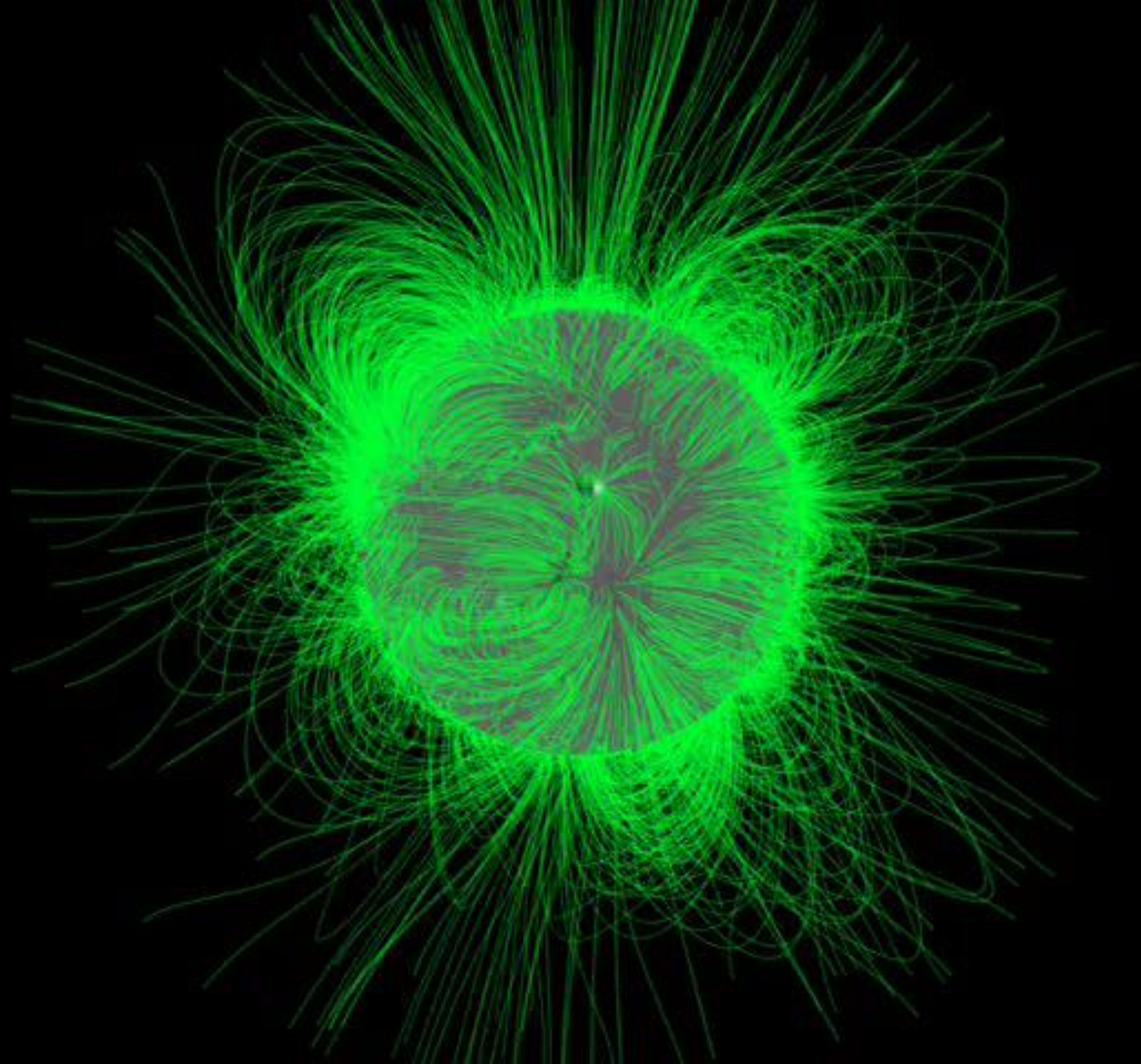


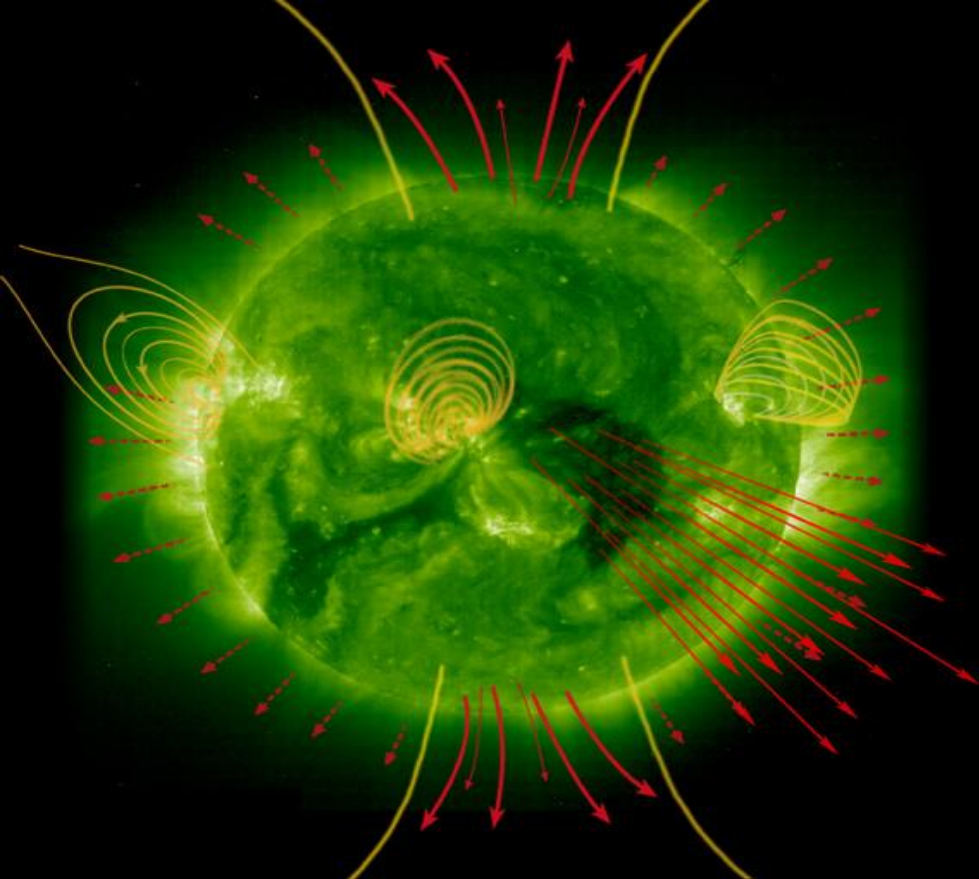
Στην περιοχή των ακτίνων-χ οι φασματικές γραμμές εκπομπής που προέρχονται από αυτές καθαυτές τις στεμματικές περιοχές είναι πολυάριθμες και έτσι μπορούμε να παρατηρήσουμε το στέμμα χωρίς να απαιτούνται συνθήκες έκλειψης.



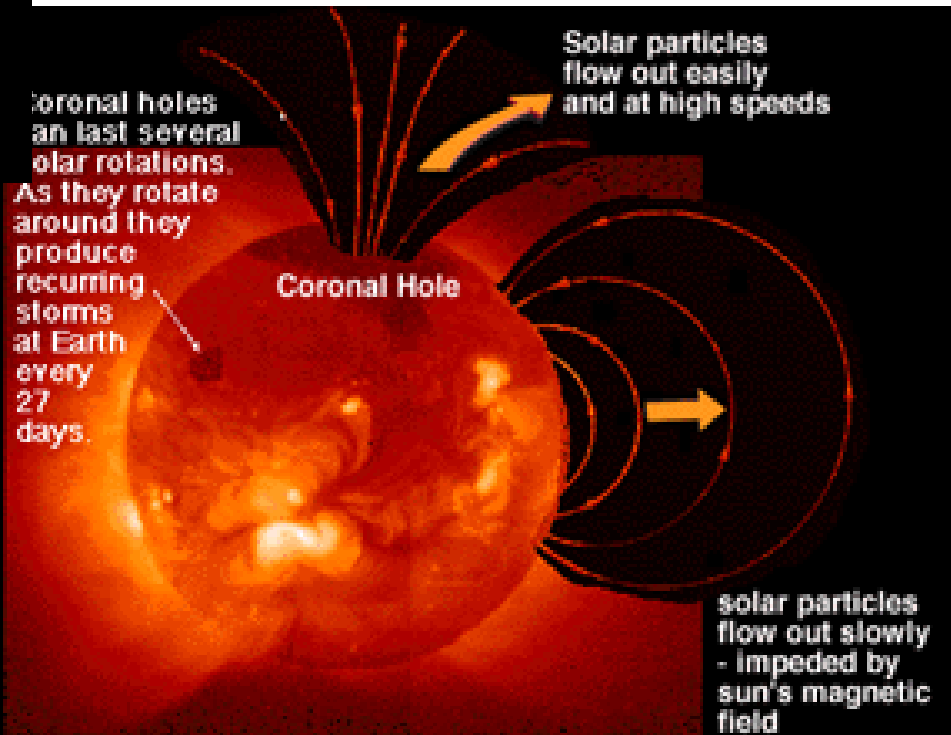
Coronal Loops







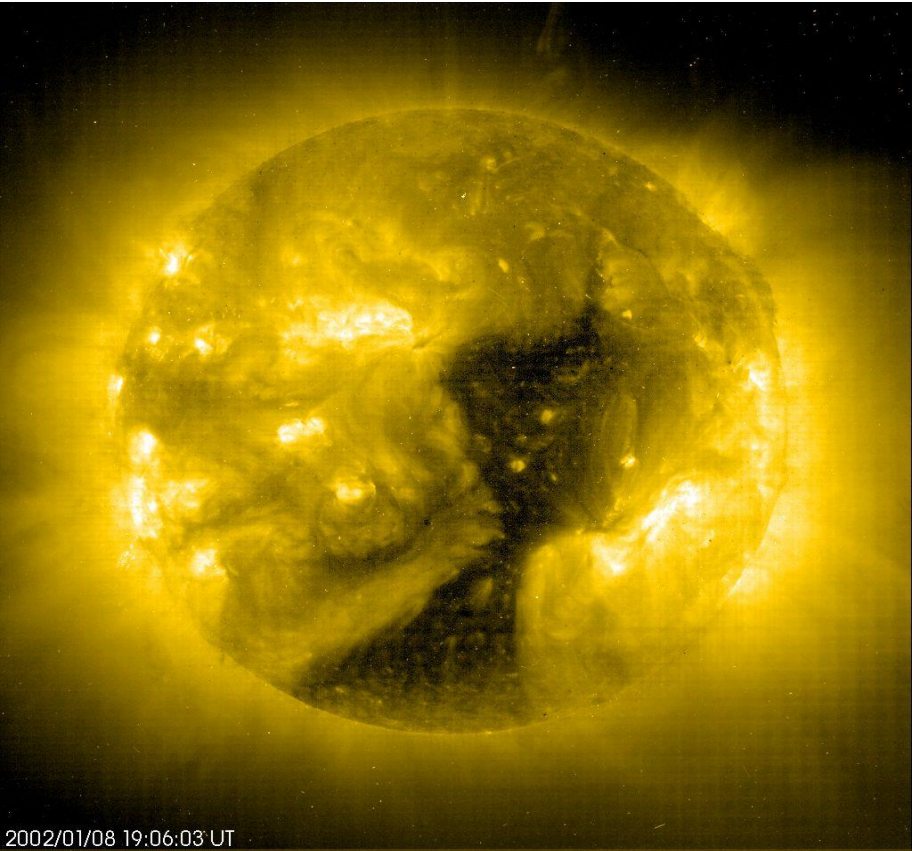
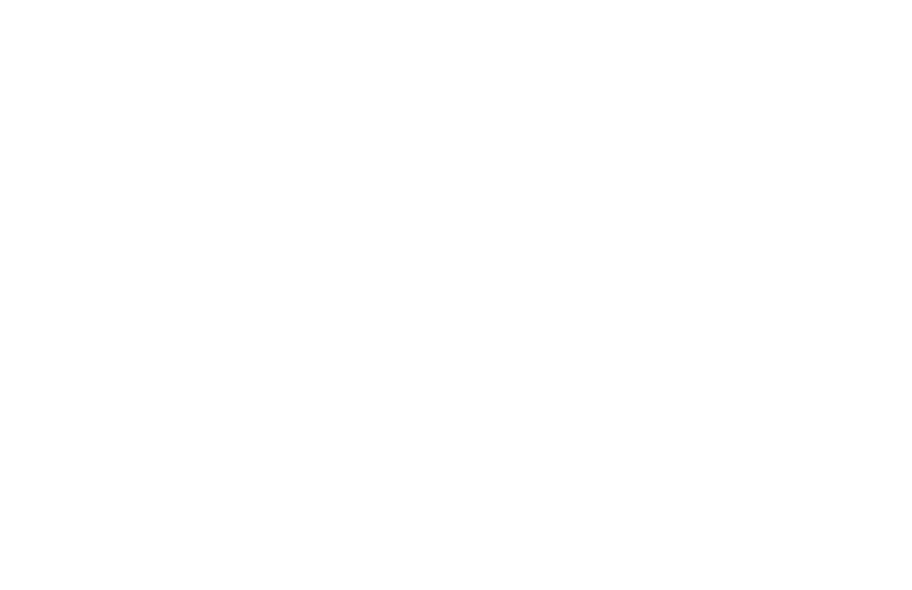
Coronal holes
appear on the Sun
after several
rotations.
As they rotate
around they
produce
recurring
storms
at Earth
every
27
days.



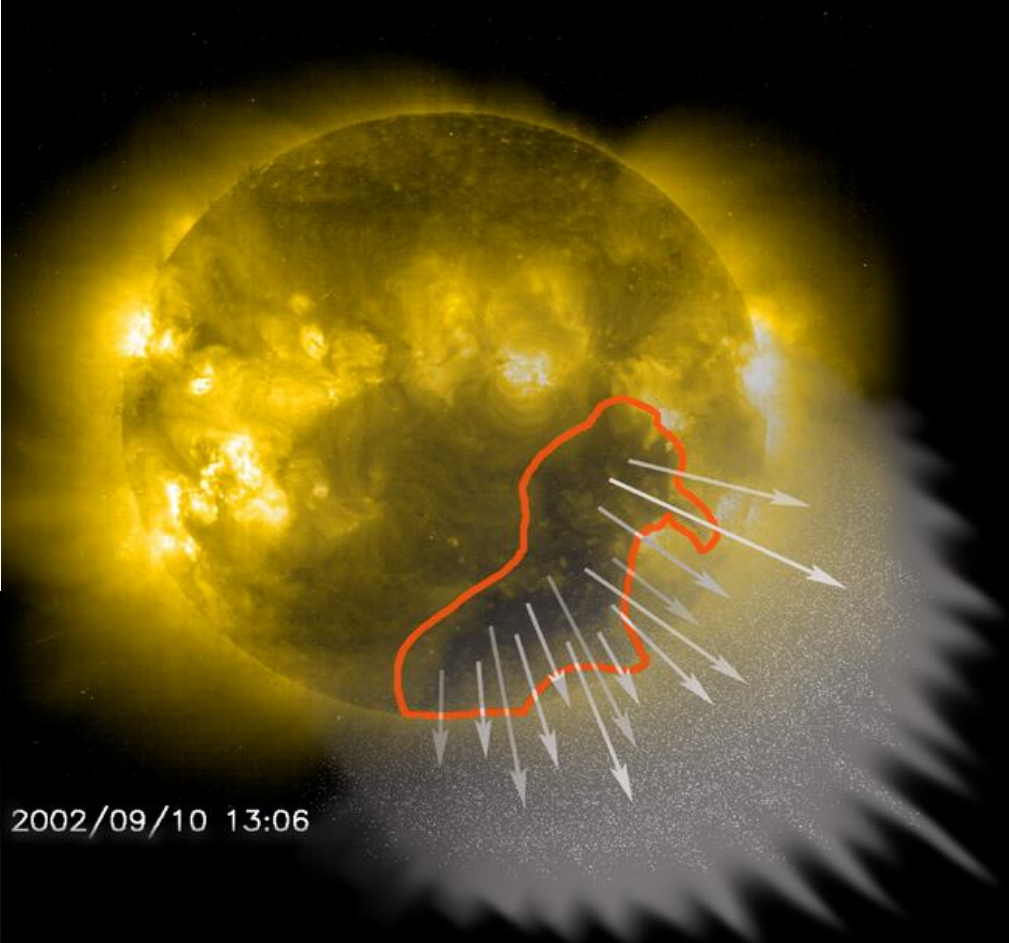
Solar particles
flow out easily
and at high speeds

solar particles
flow out slowly
- impeded by
sun's magnetic
field



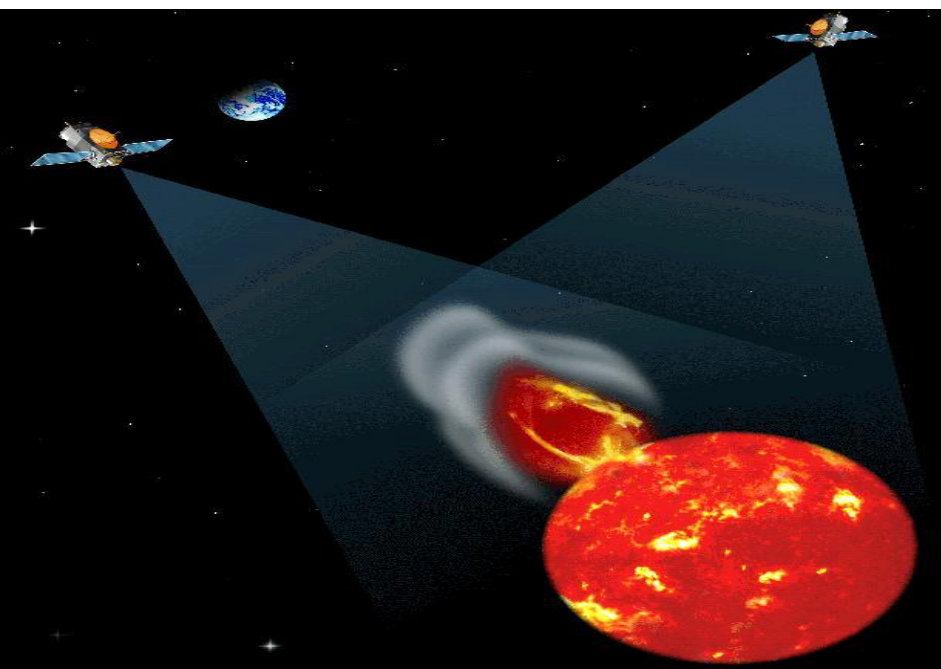
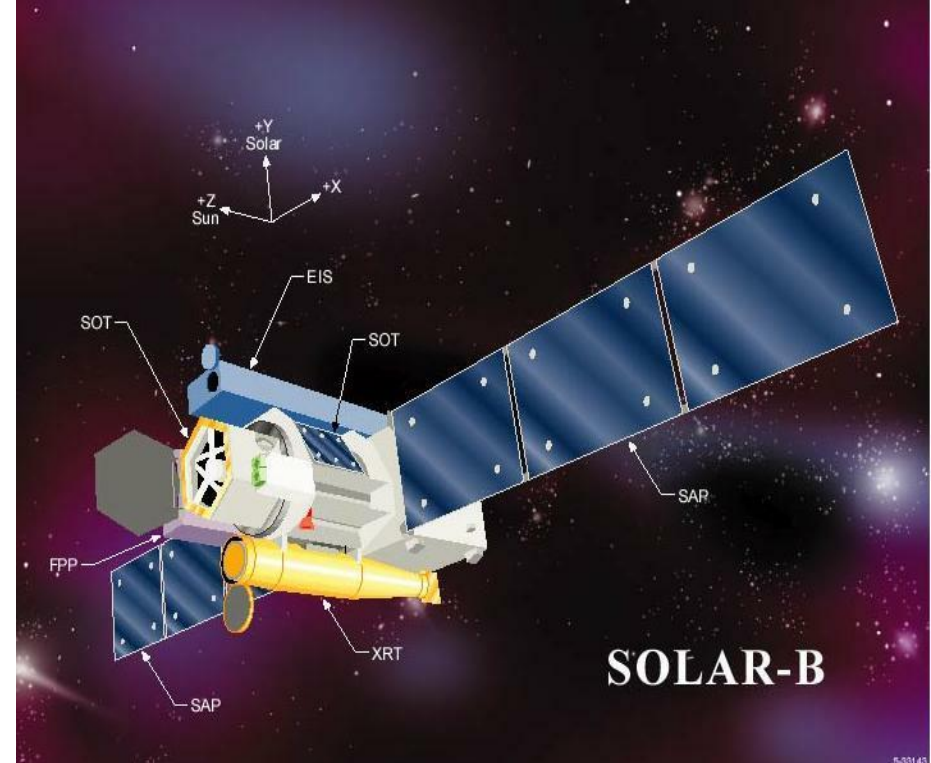
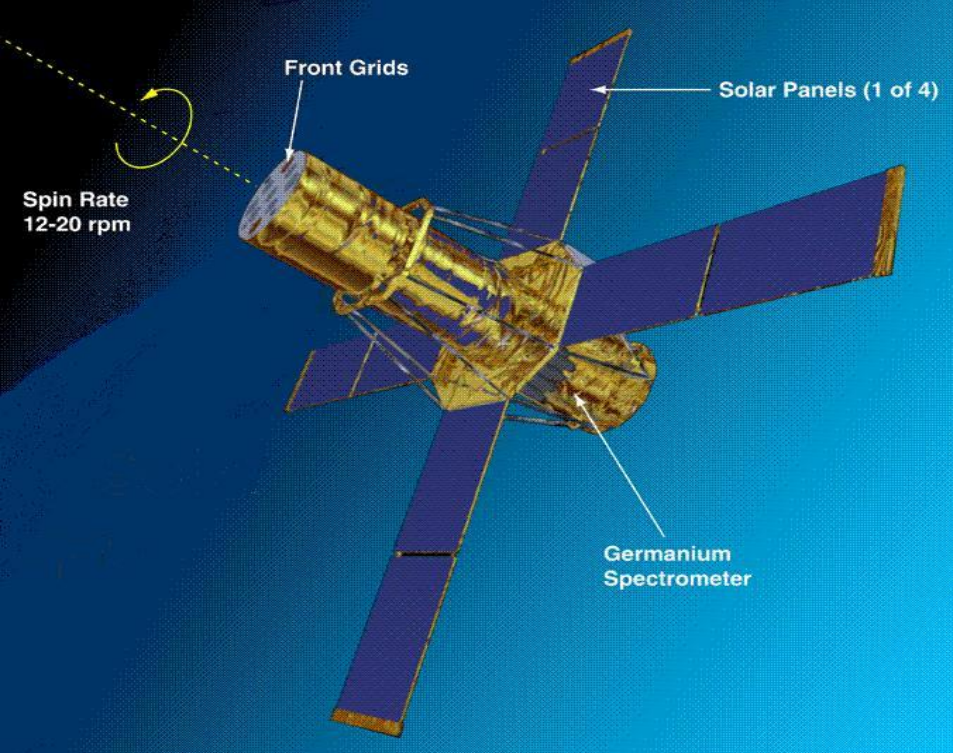


2002/01/08 19:06:03 UT

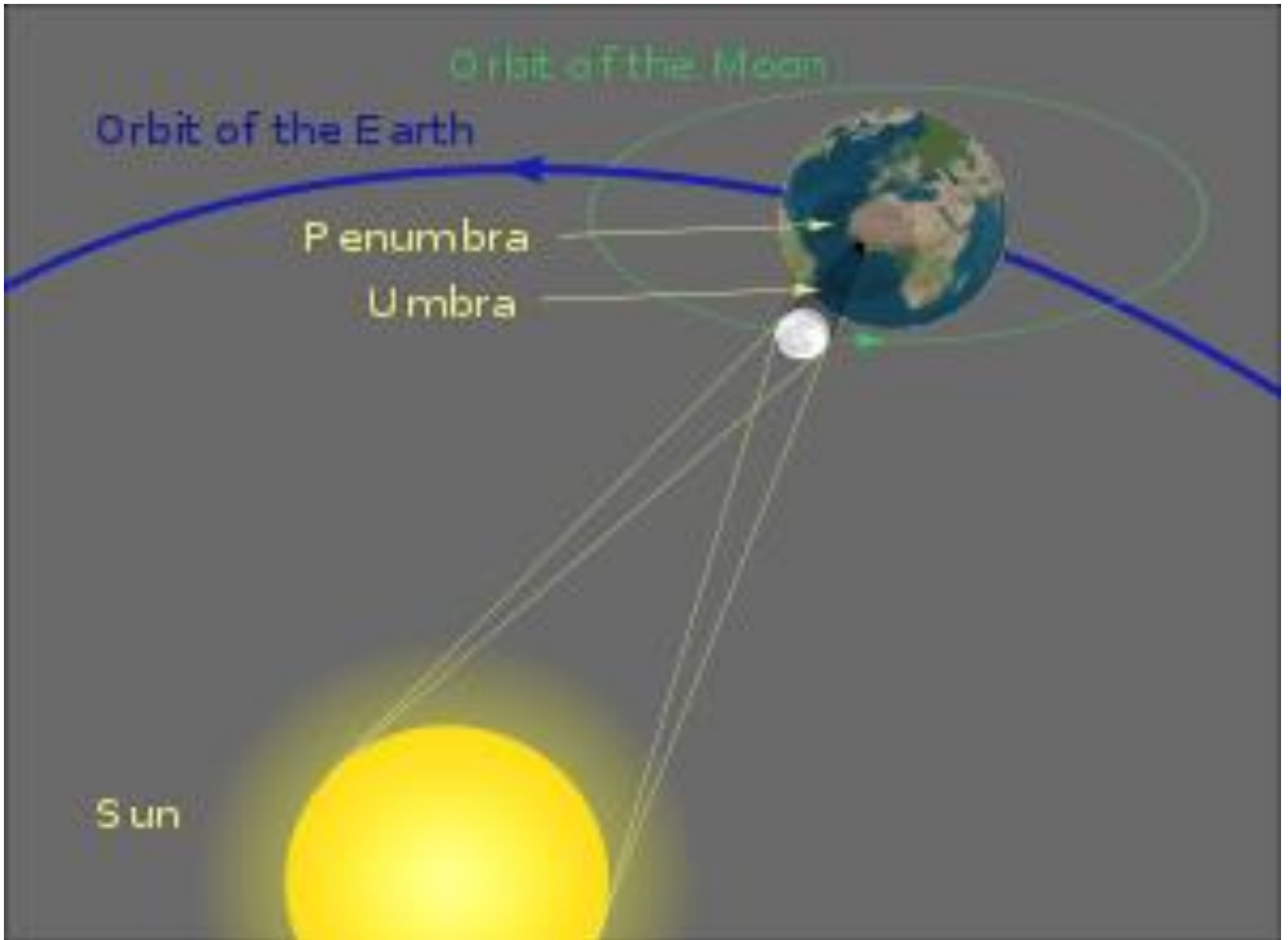


2002/09/10 13:06

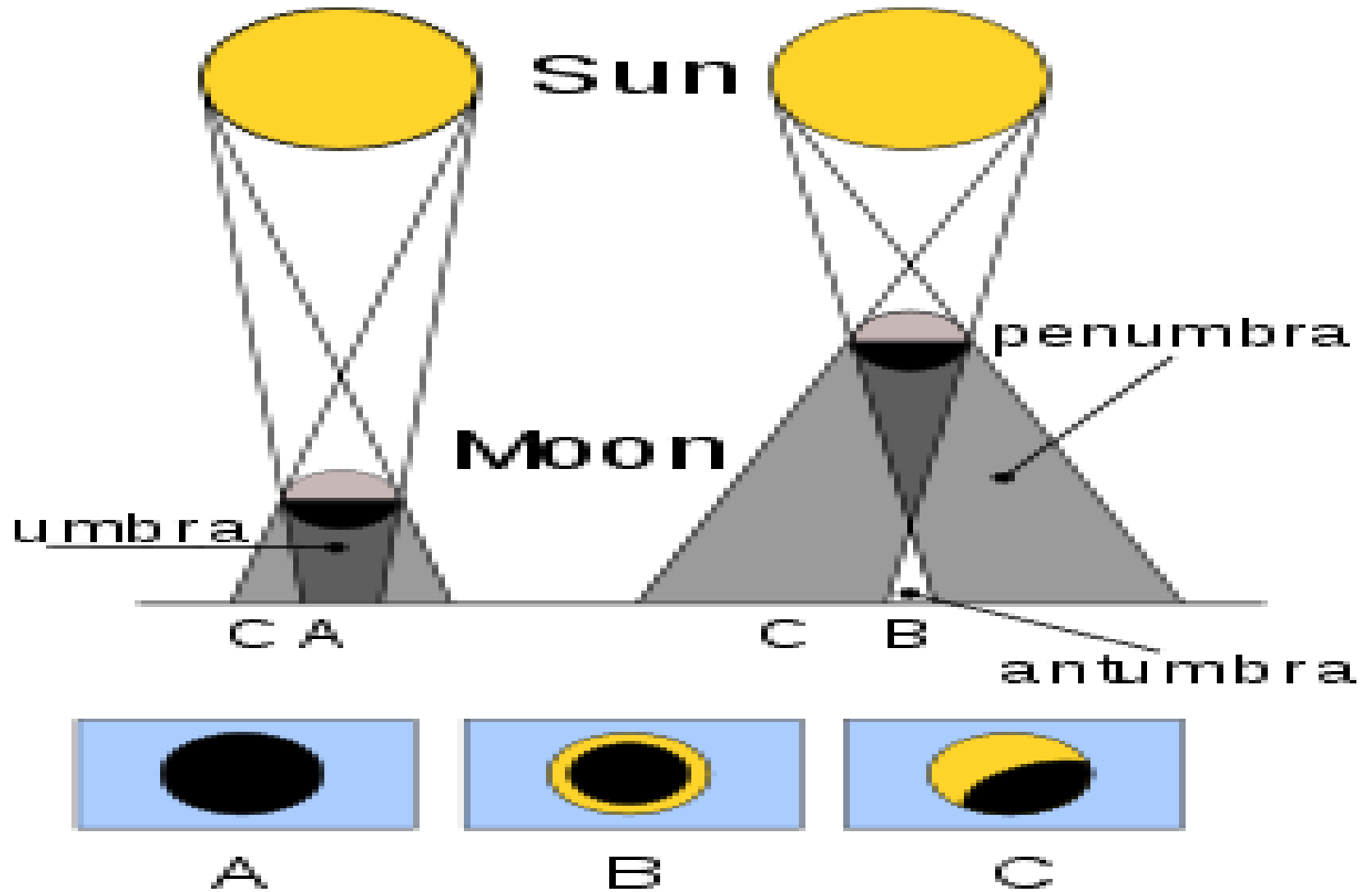




SOLAR ECLIPSE

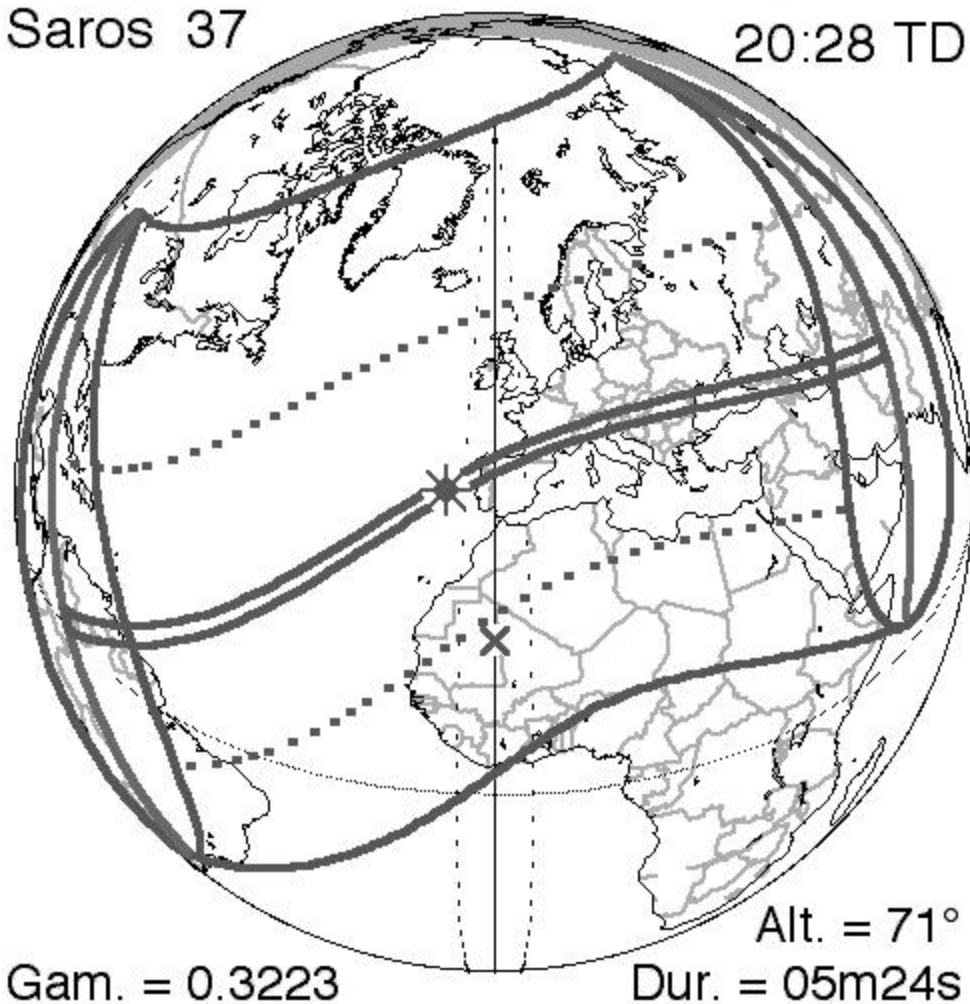


Solar eclipse



Annular
Saros 37

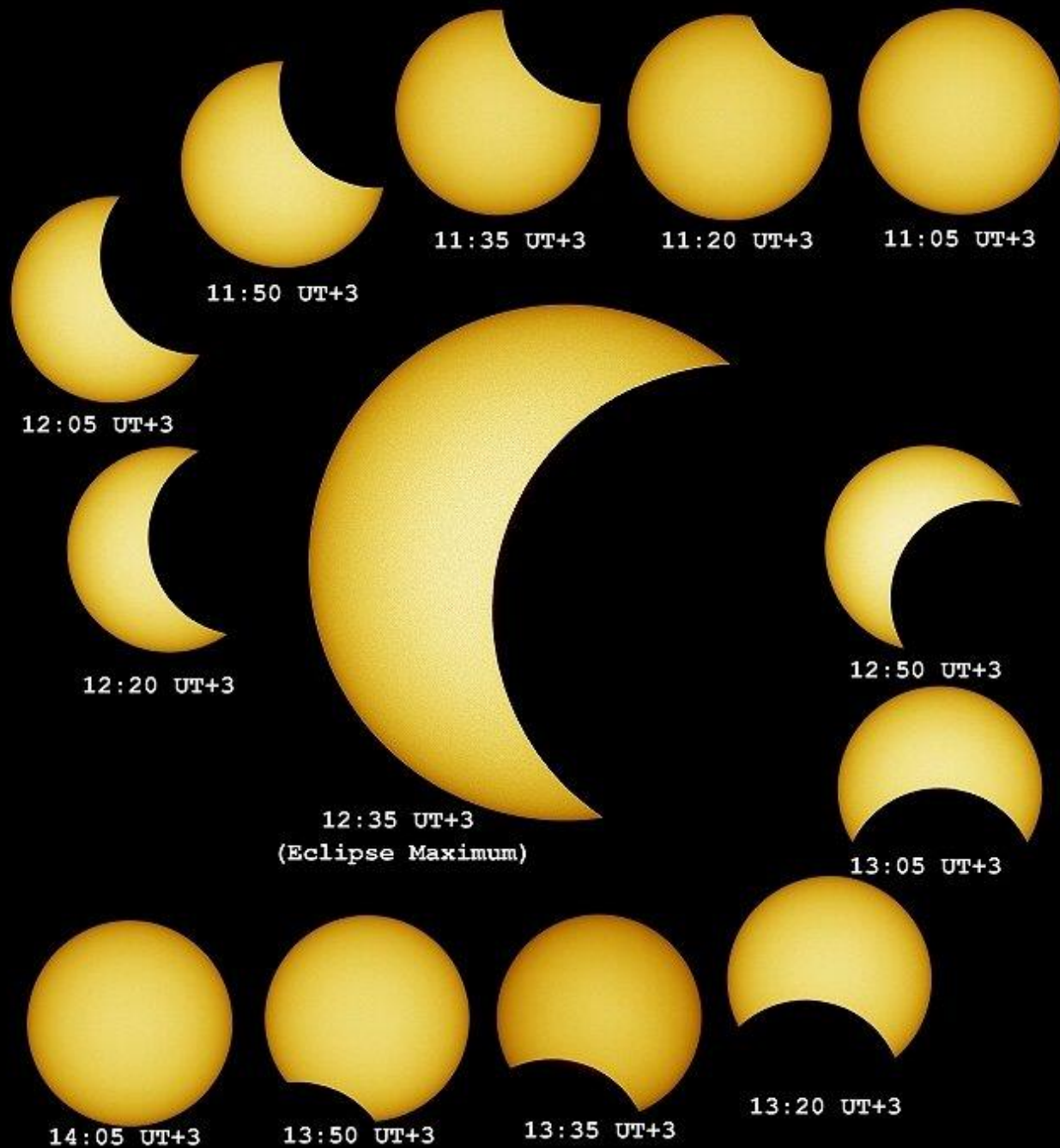
-1217 Jun 06
20:28 TD



Five Millennium Canon of Solar Eclipses (Espanak & Meeus)







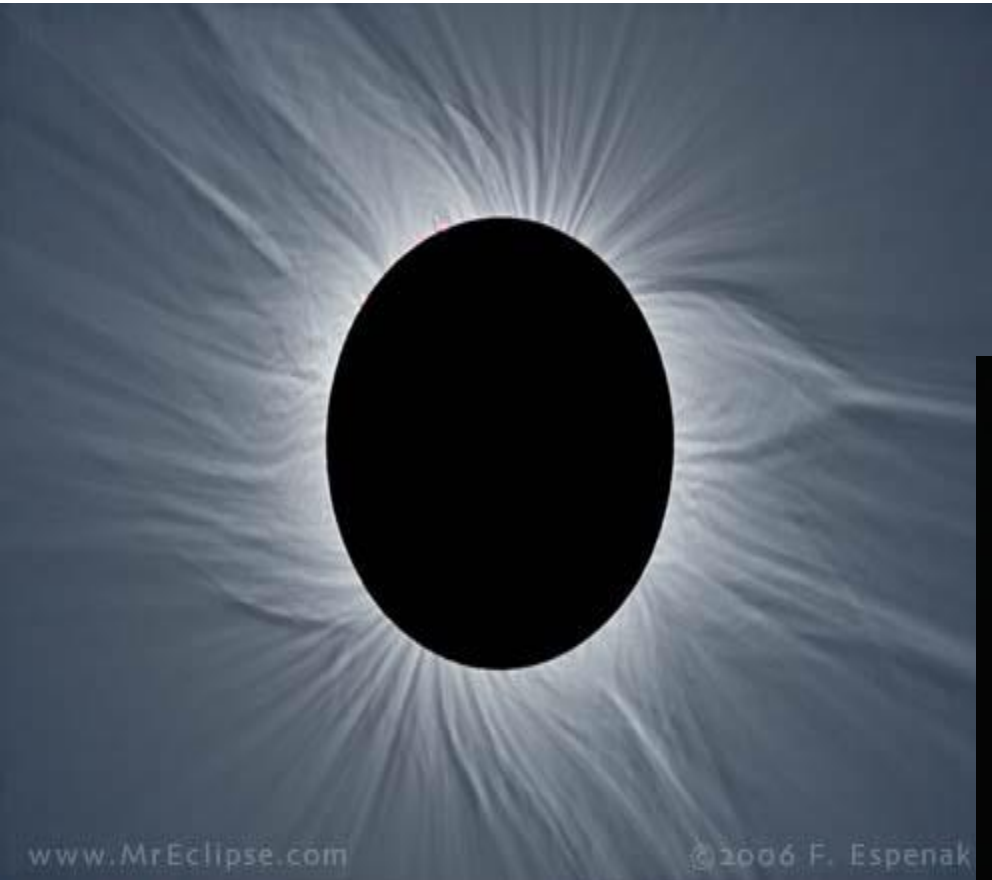


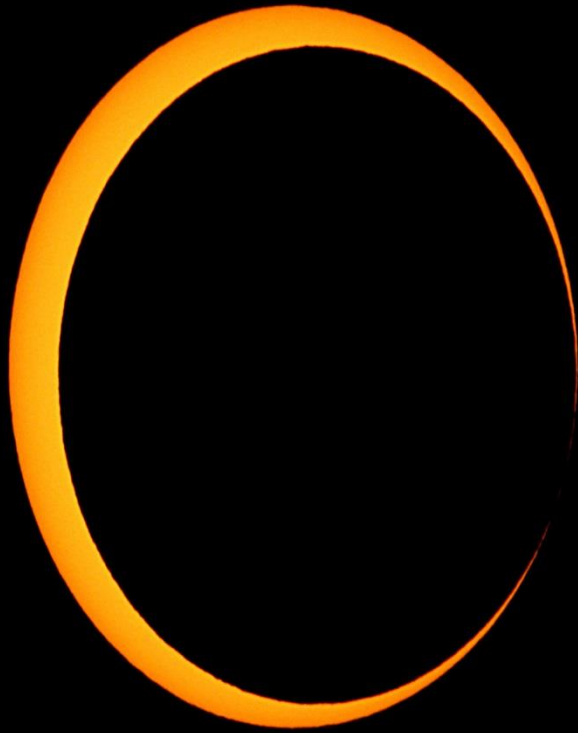


Diamond ring

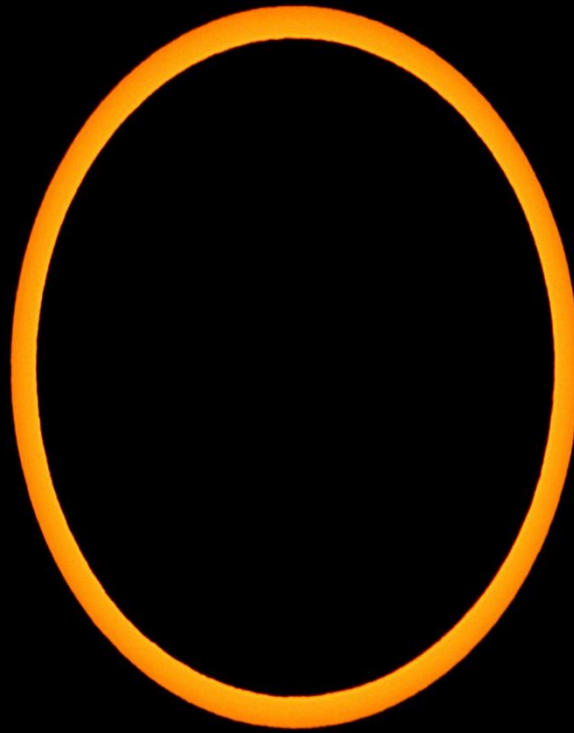


2006 and 2010





2nd Contact: 05:26:35 UT



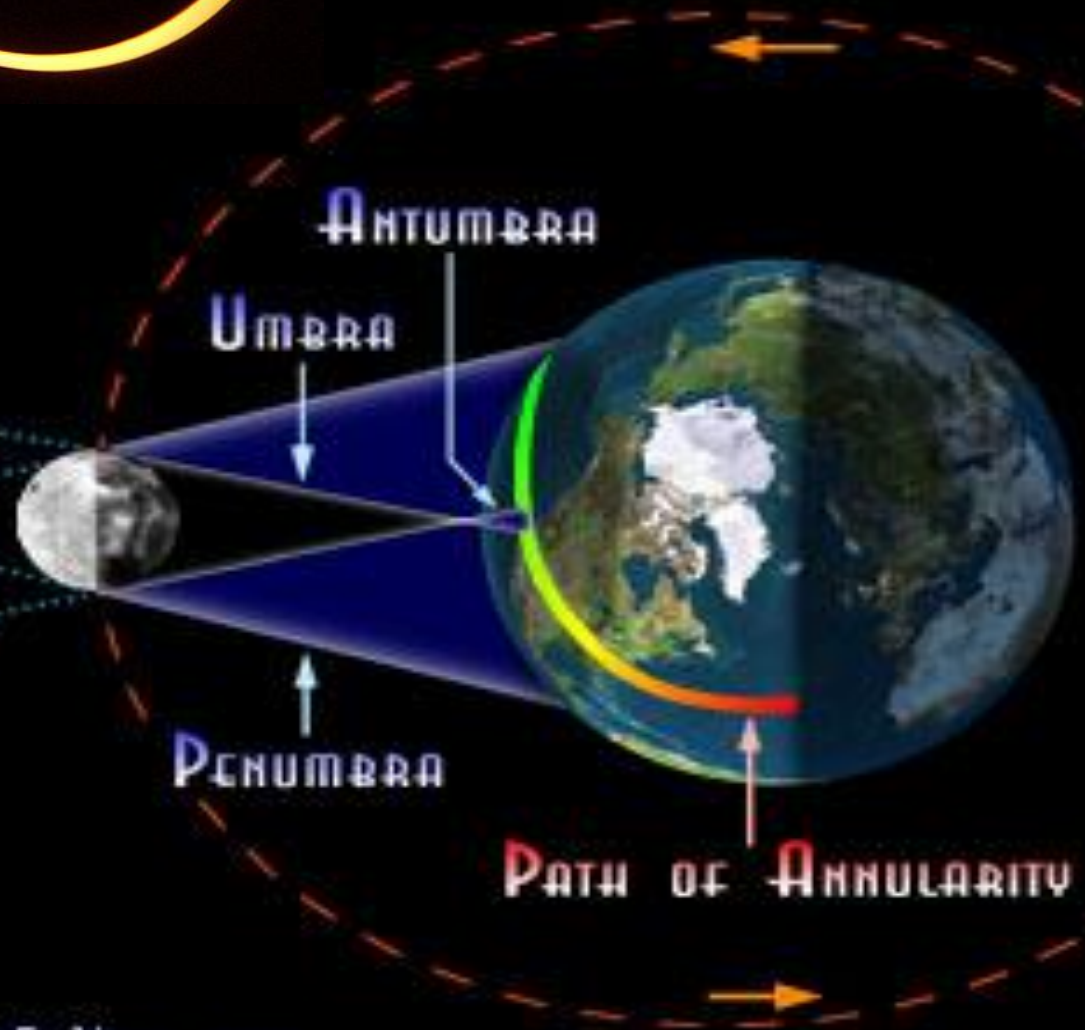
Central Phase: 05:30:53 UT



3rd Contact: 05:35:11 UT



ANNULAR SOLAR ECLIPSE





Sun

Earth

Umbra

Antumbra

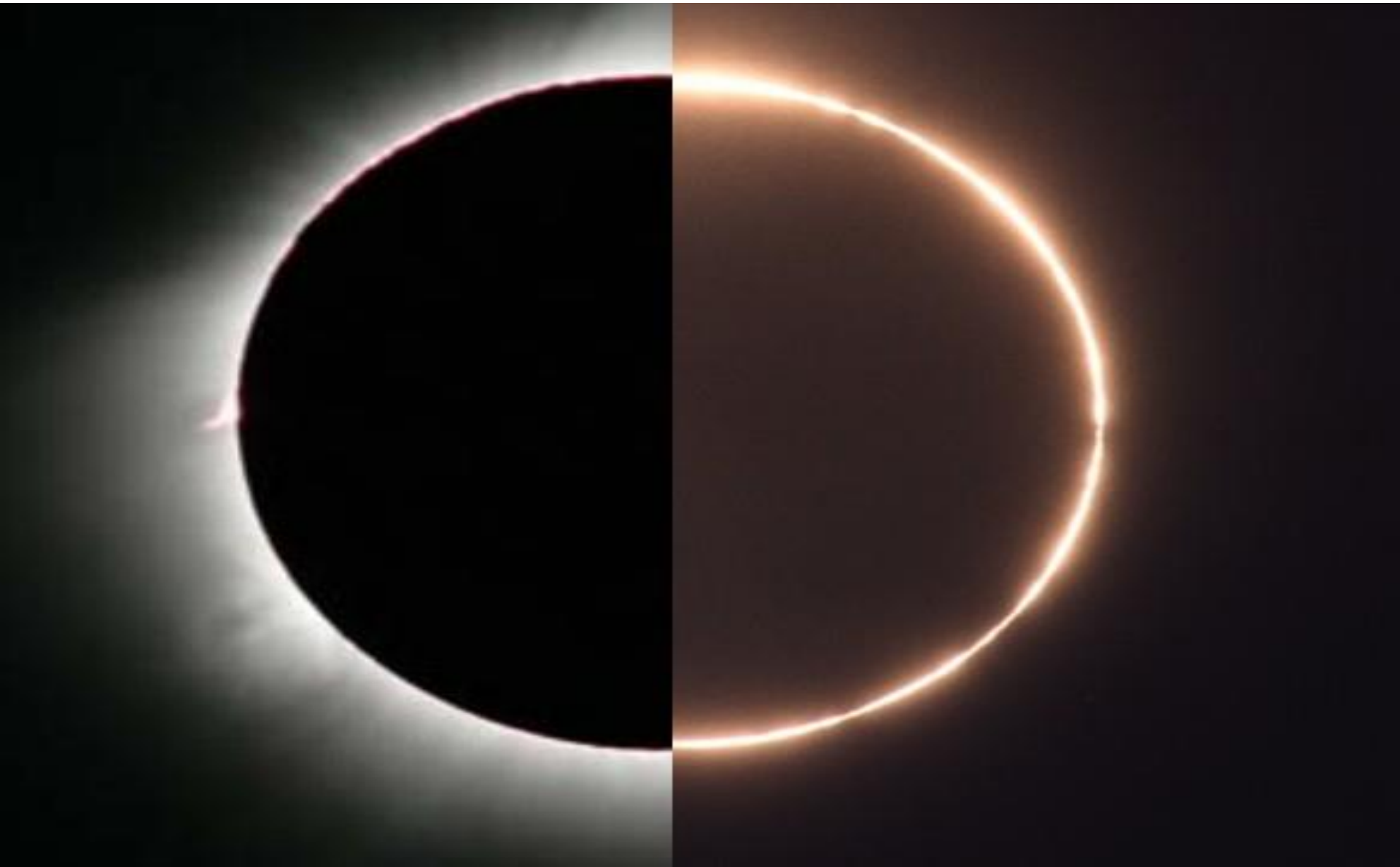
Partial
Eclipse Visible

Moon

Penumbra

Annular
Eclipse Visible

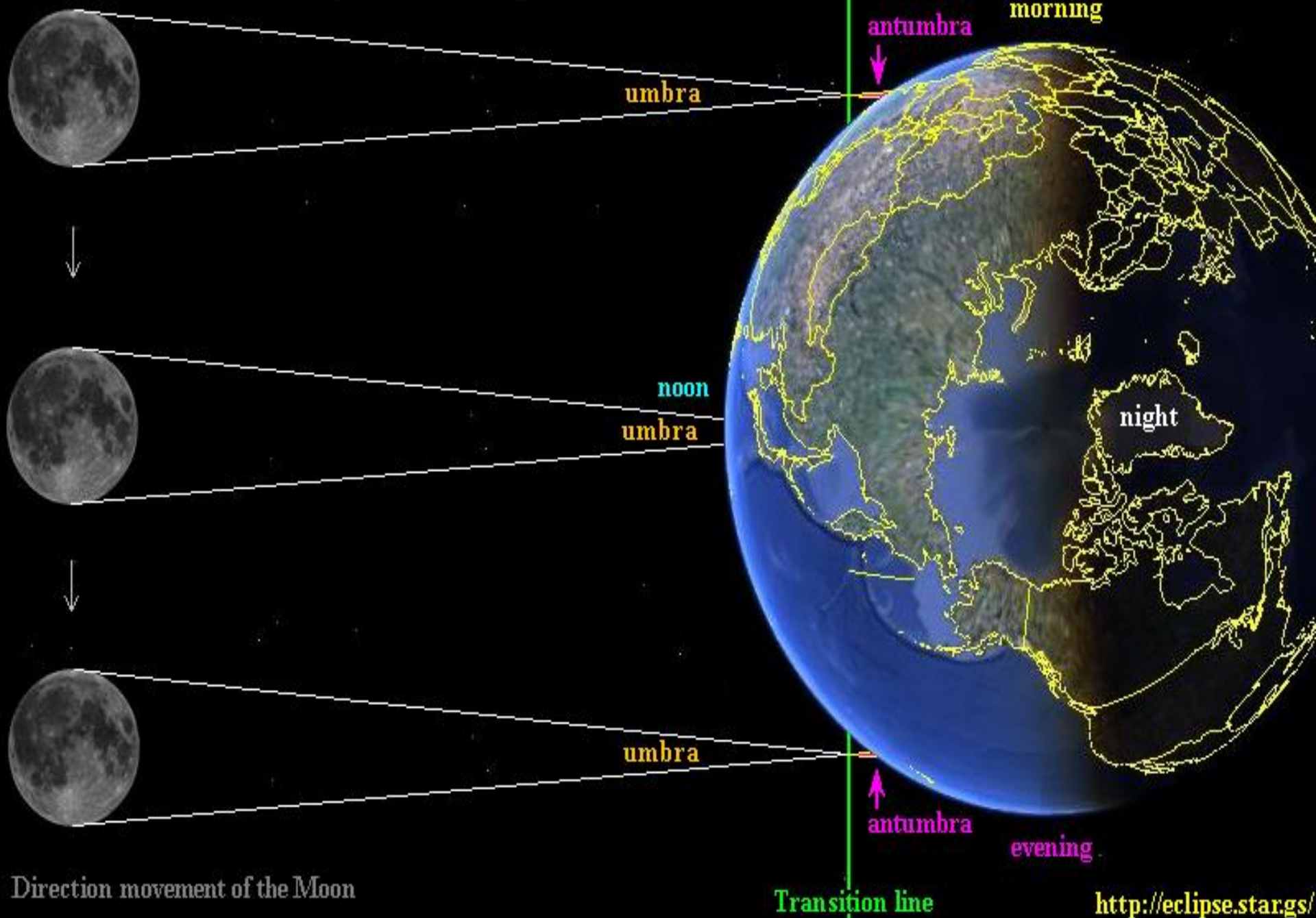
Hybrid solar eclipse



Location of the hybrid eclipse

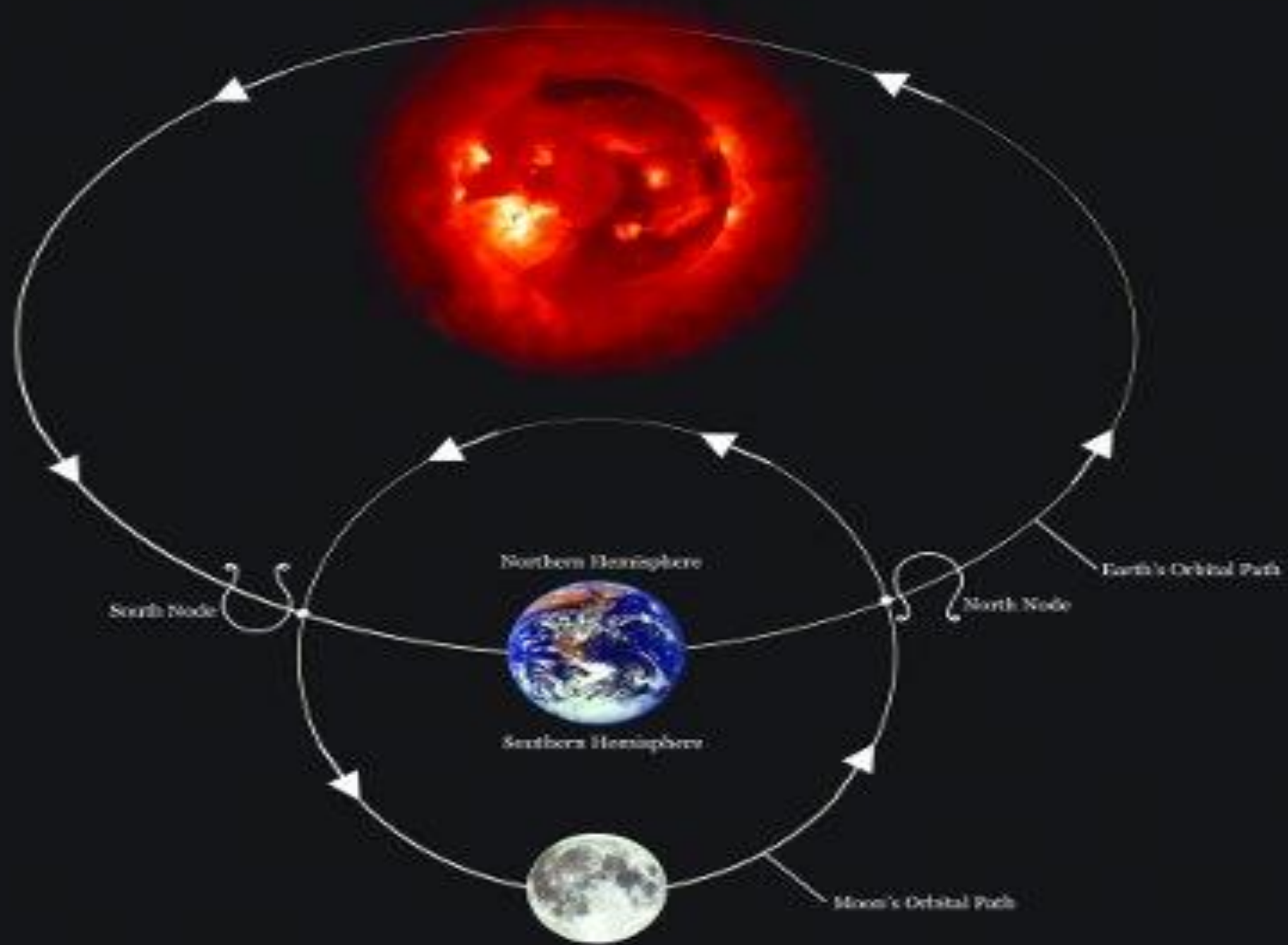
In view of total eclipse

In view of annular eclipse



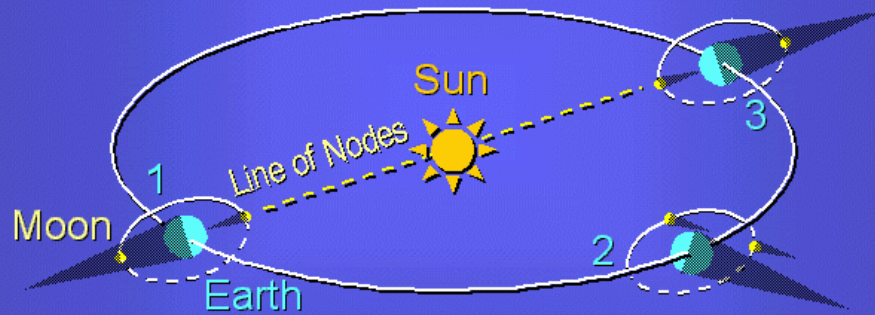
Direction movement of the Moon

<http://eclipse.starg.s/>

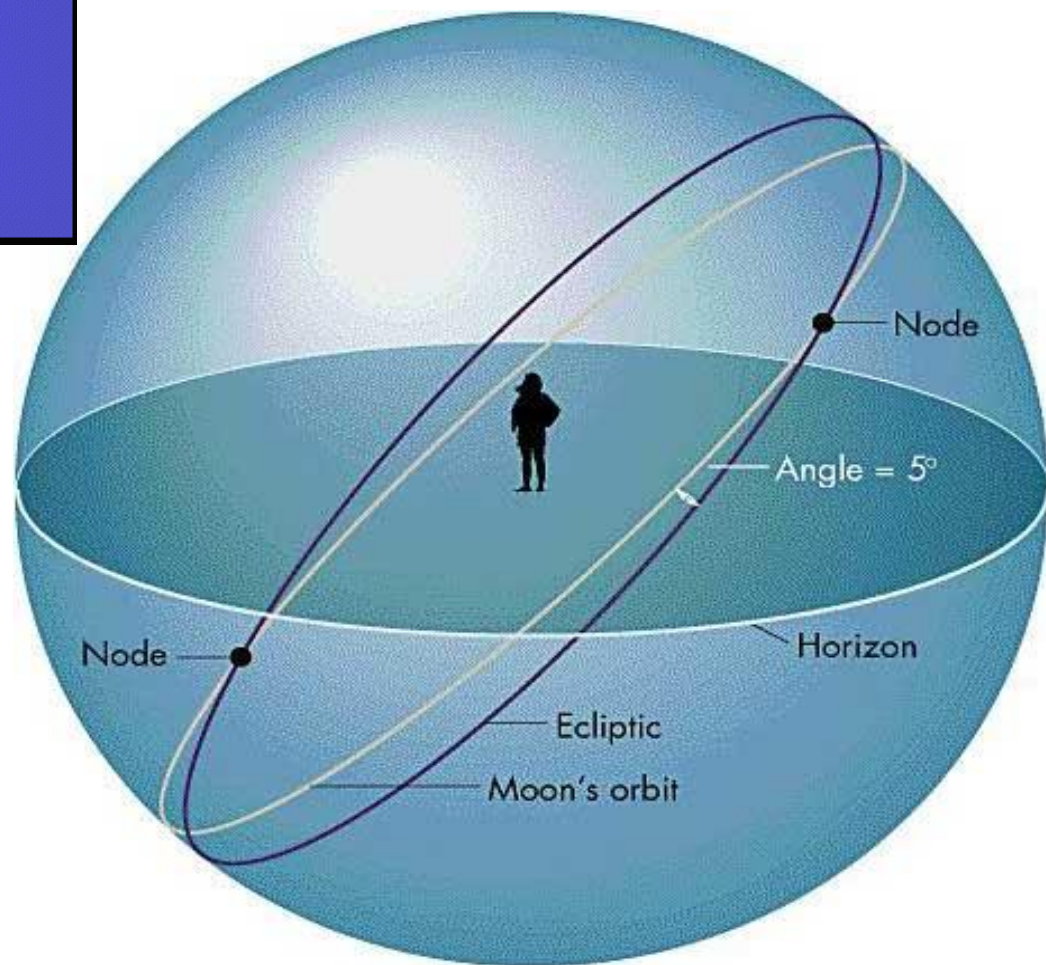


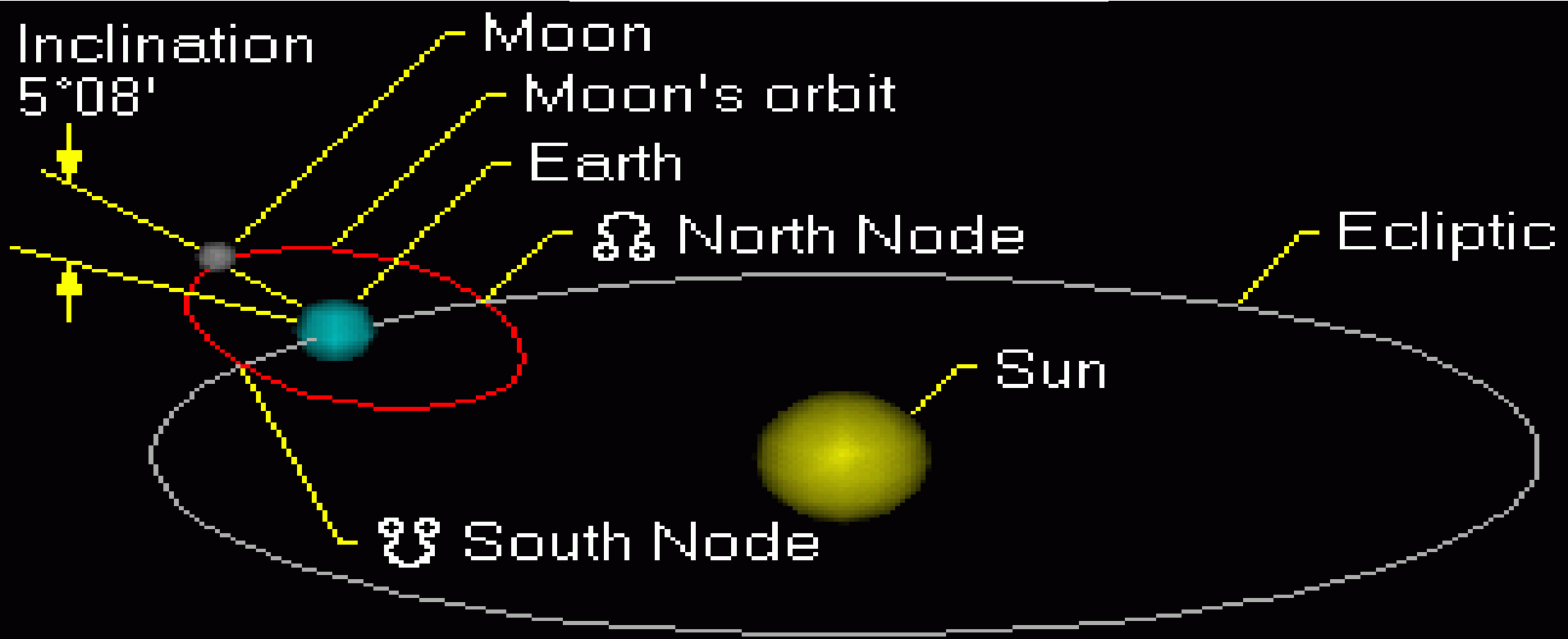
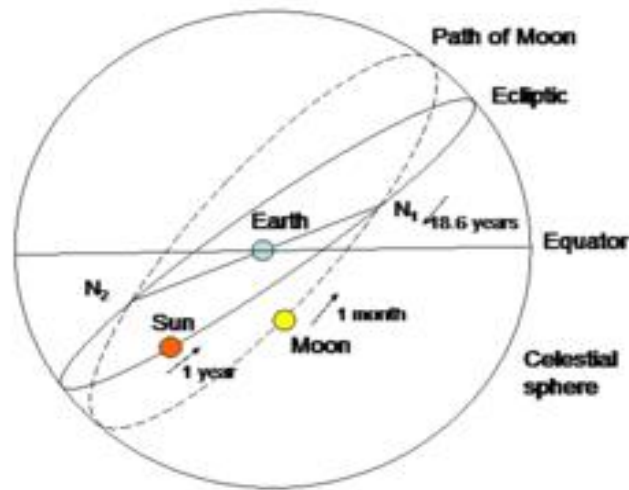
Lunar Nodes and Eclipses

Moon's orbit tilted 5° to plane of Earth's orbit around Sun



Eclipses possible only when line of nodes points toward Sun (1 & 3)



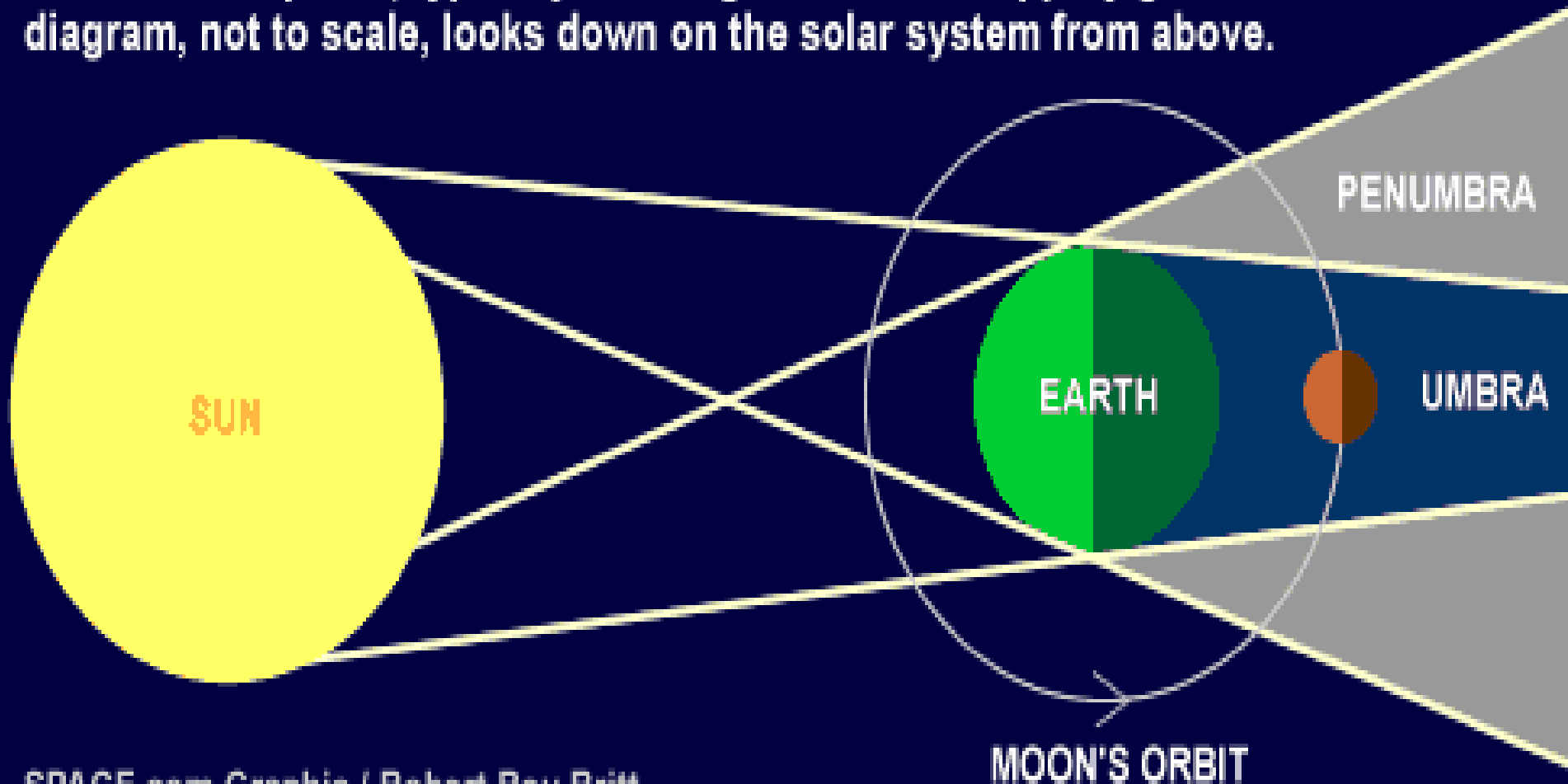


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Dwight Ennis
All Rights Reserved

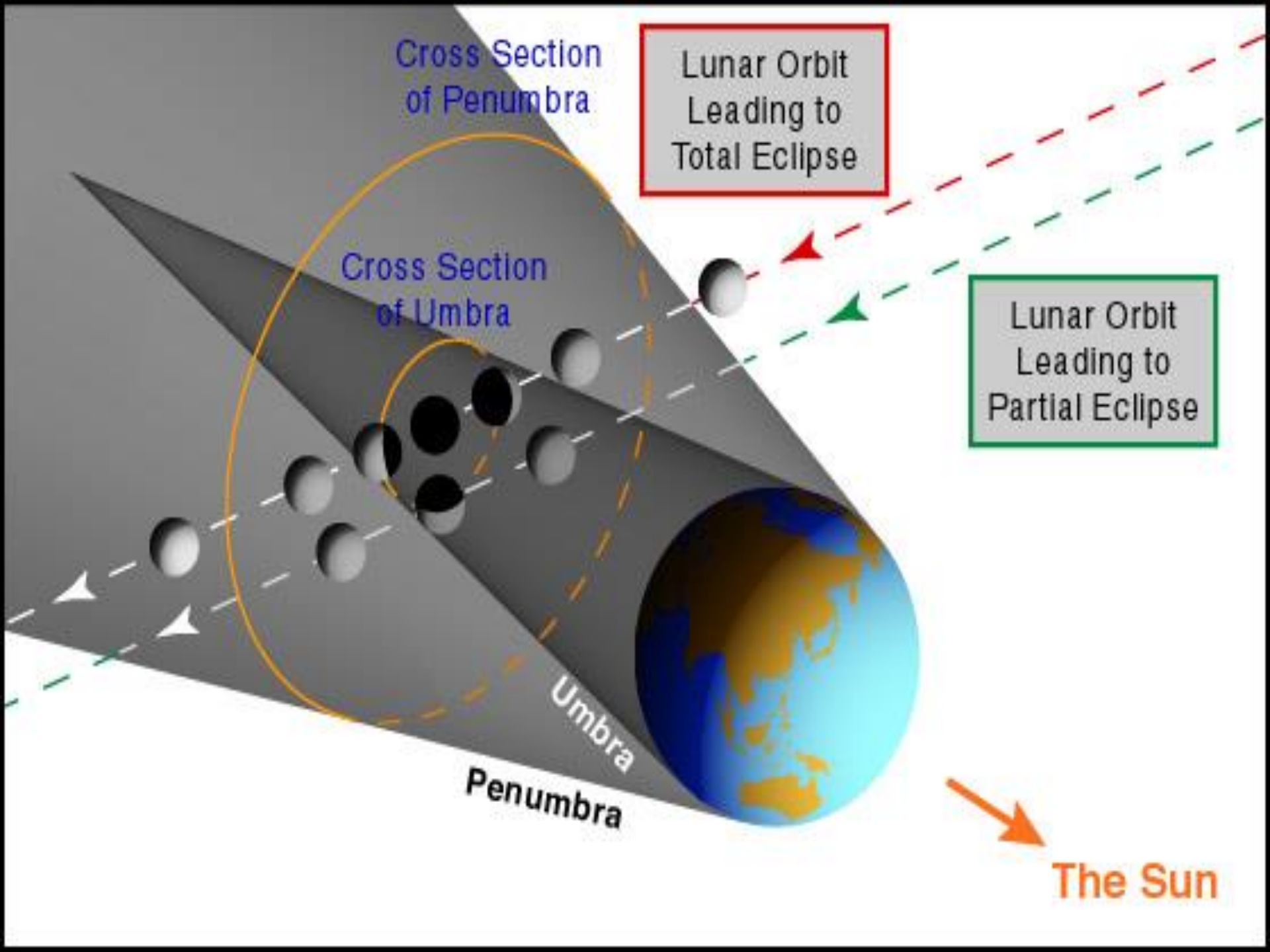


Anatomy of a Lunar Eclipse

A total lunar eclipse can only occur at Full Moon, when Earth blocks the sunlight normally reflected by the Moon. Some sunlight is bent through Earth's atmosphere, typically allowing the Moon a coppery glow. This diagram, not to scale, looks down on the solar system from above.



SPACE.com Graphic / Robert Roy Britt
SOURCES: Fred Espenak, NASA; The Moon Book



Cross Section of Penumbra

Lunar Orbit Leading to Total Eclipse

Cross Section of Umbra

Lunar Orbit Leading to Partial Eclipse

Umbra

Penumbra



The Sun



19980404



19960927



19970916



20000121



20010109



20031109



20040504



20041028



20060907



20070304

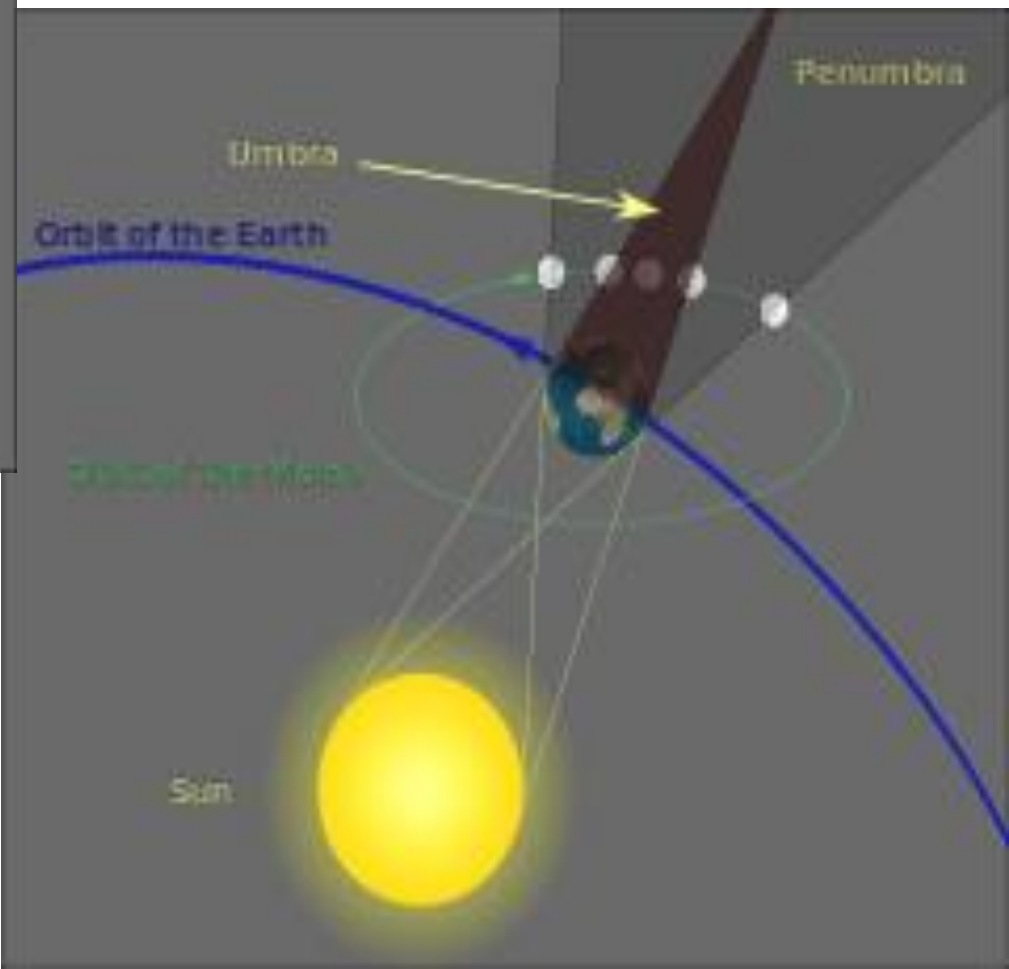
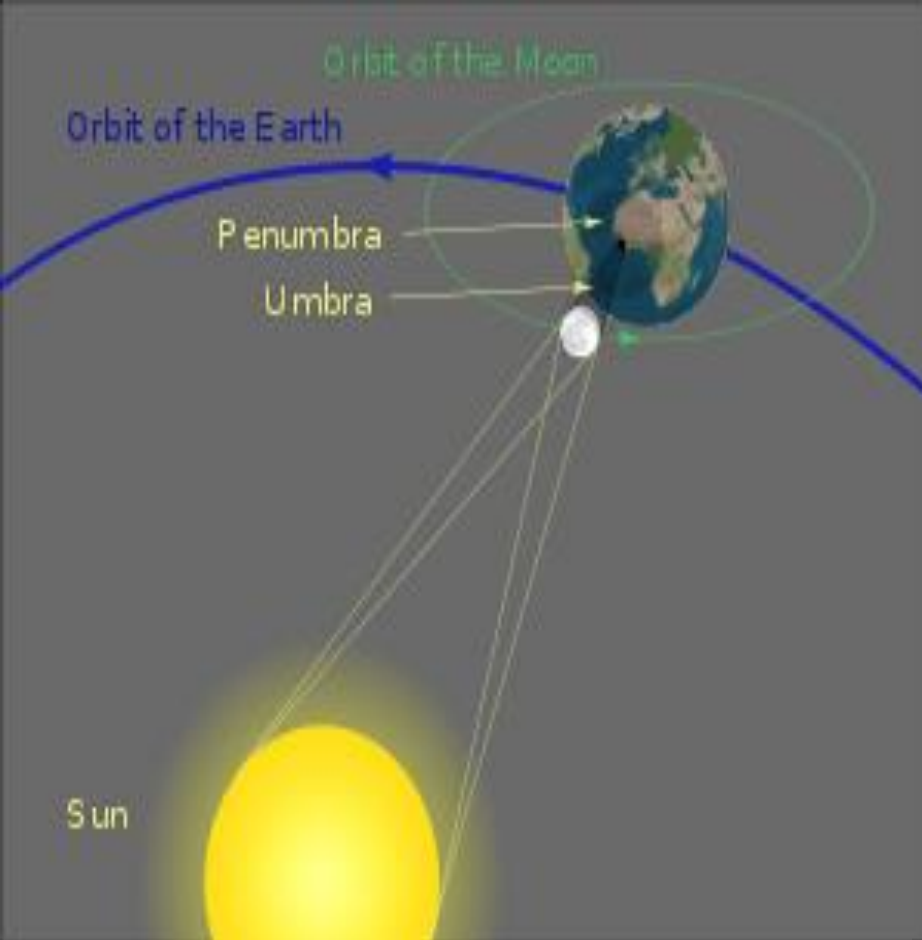


20070828

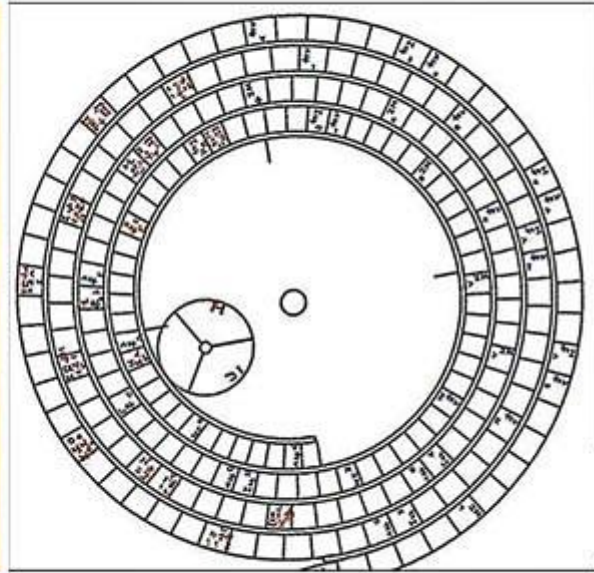
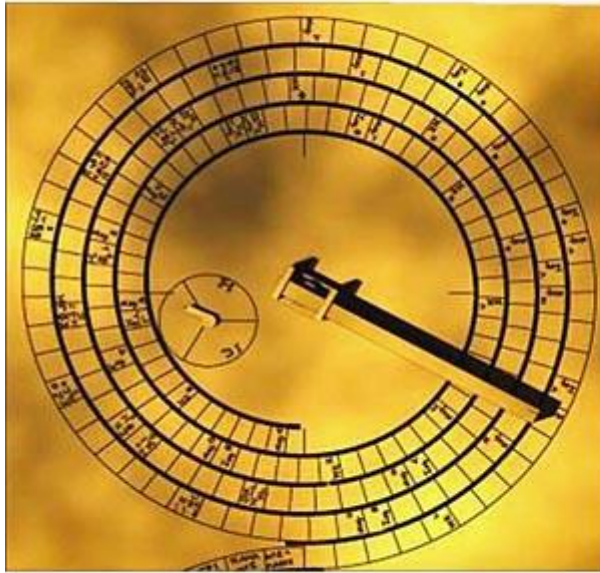


20080221

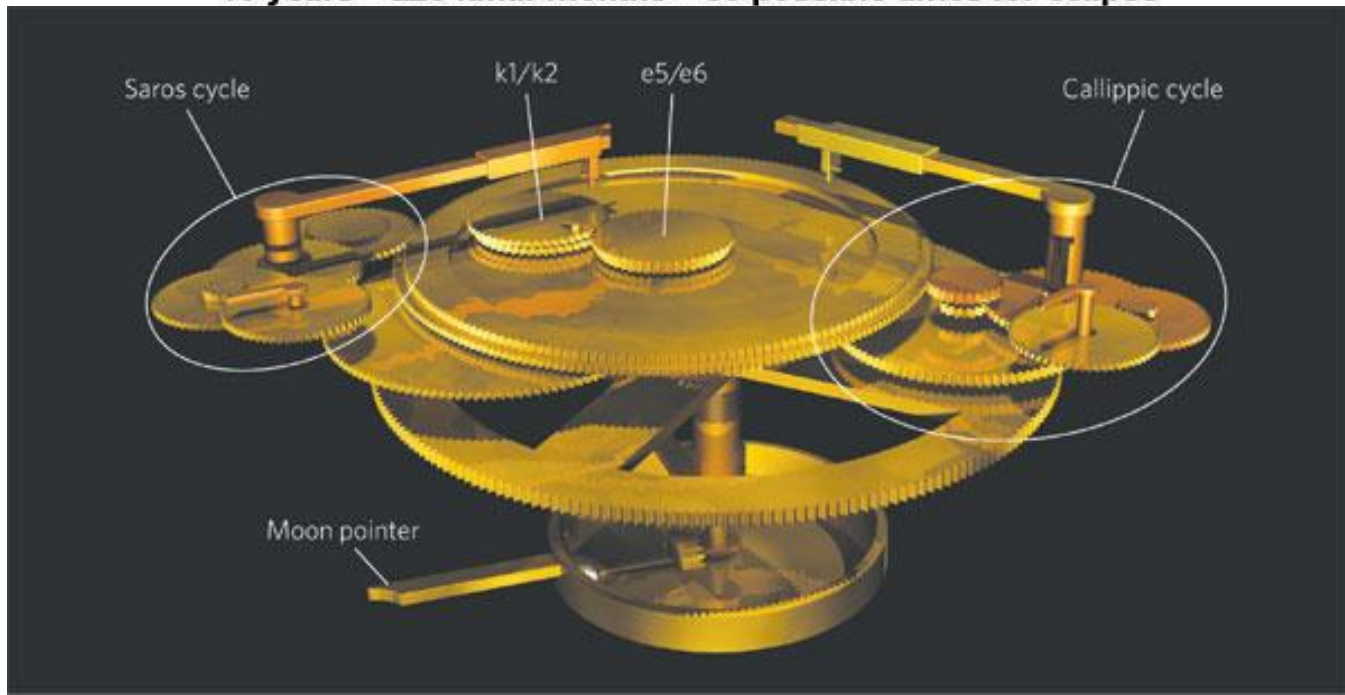


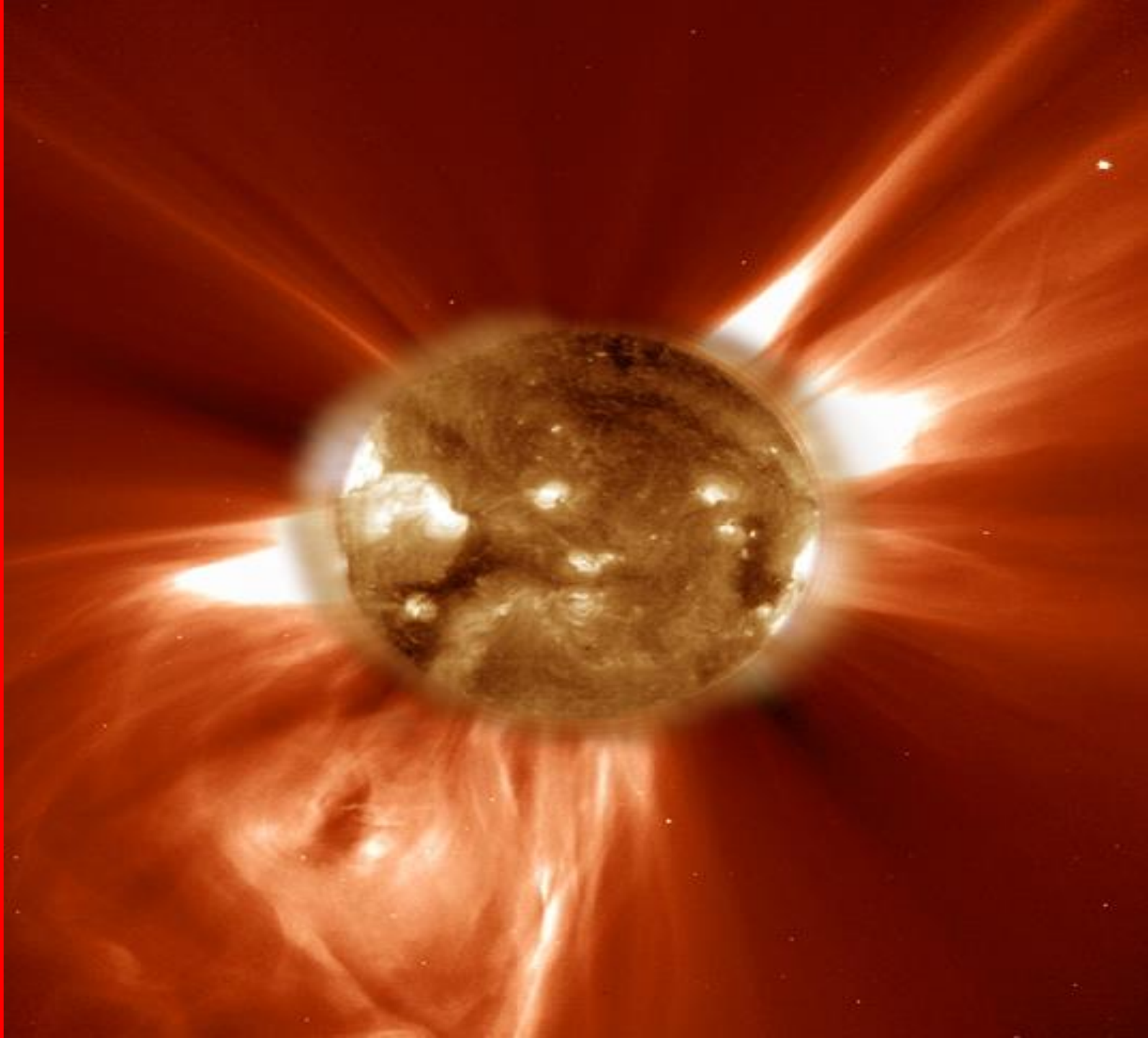


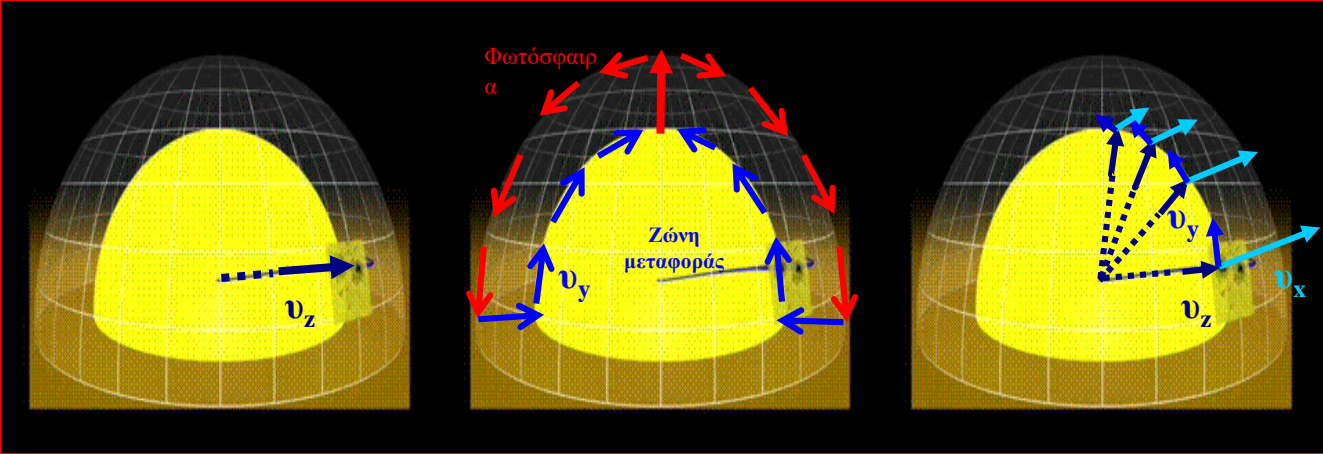
The back dial of that Antikythera device told how to predict solar or lunar eclipses over an 18-year period called the "Saros cycle"



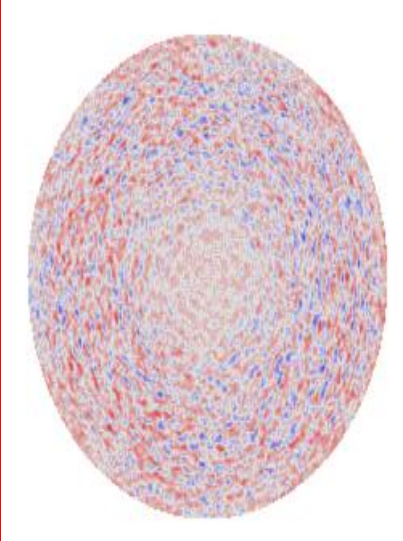
18 years = 223 lunar months = 38 possible times for eclipse





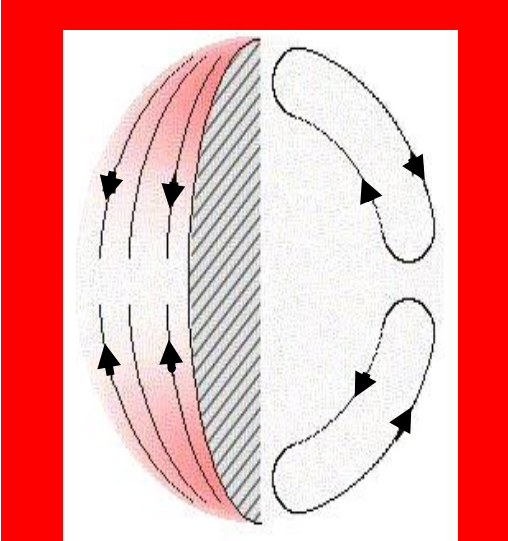


Εικ



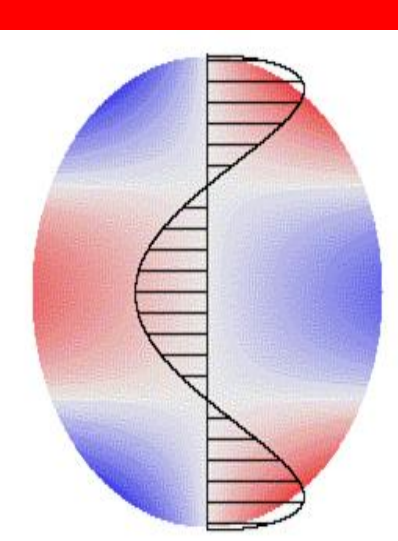
Εικ

Εικ

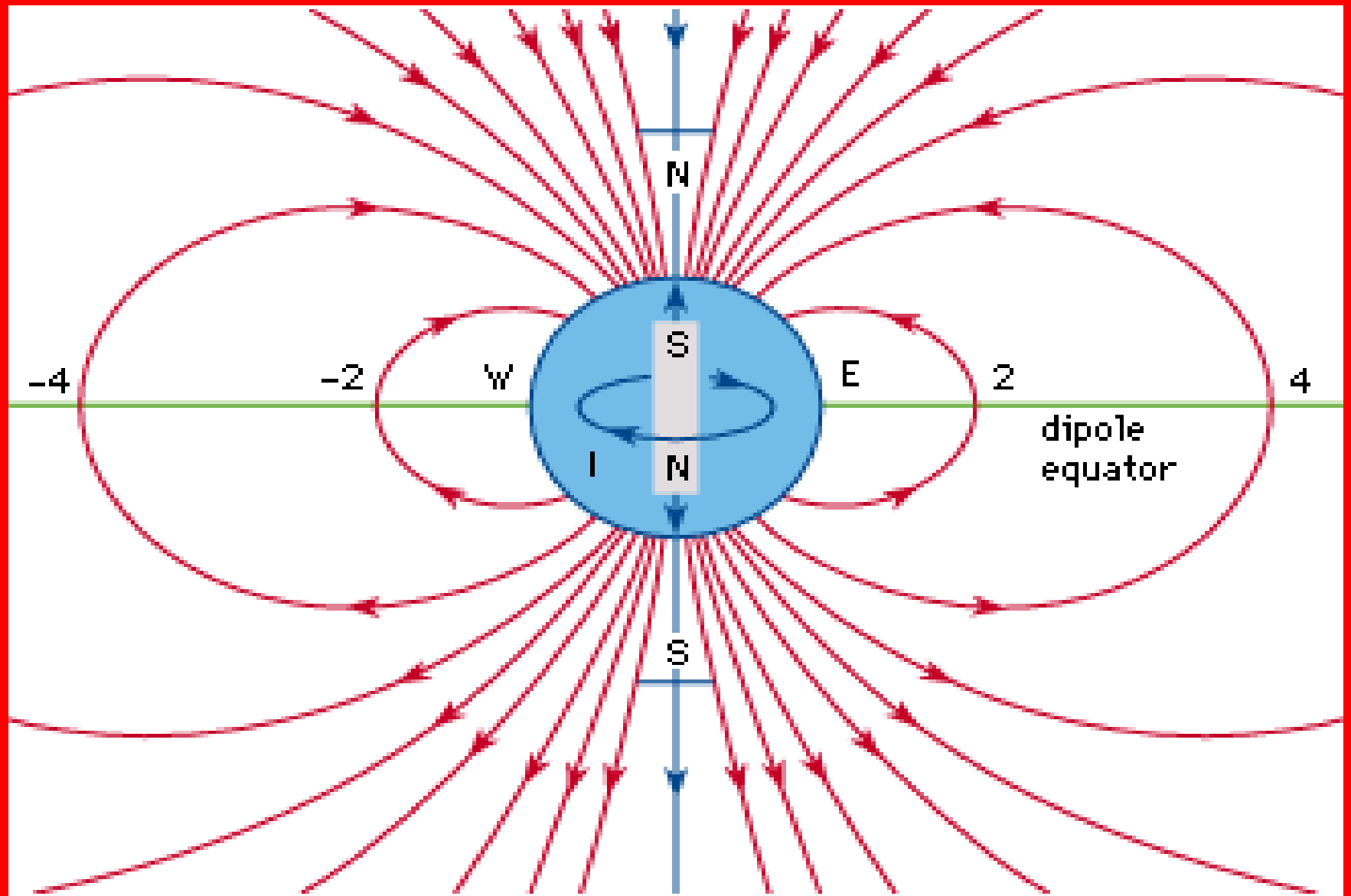


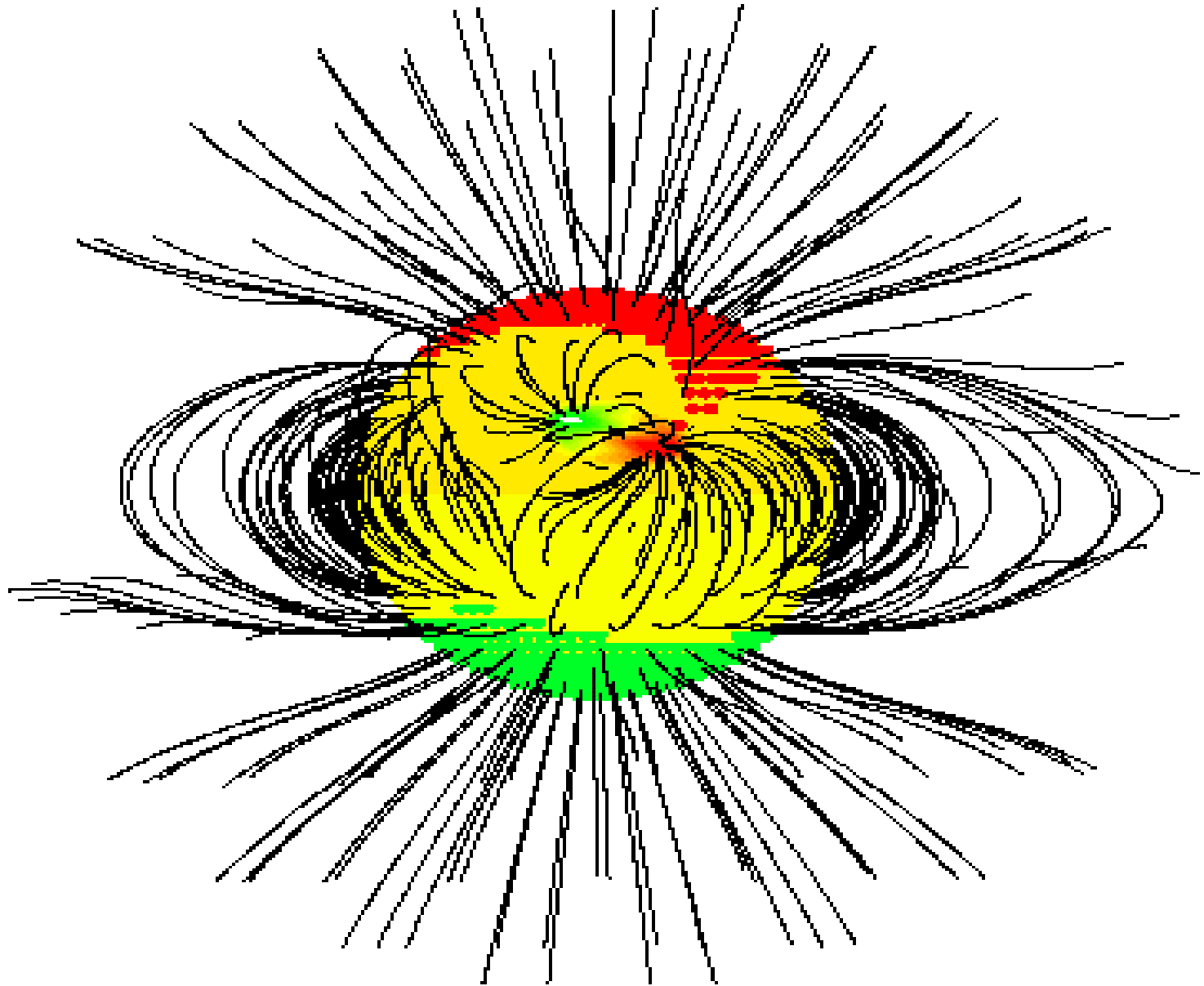
Εικ

Εικ



Εικ

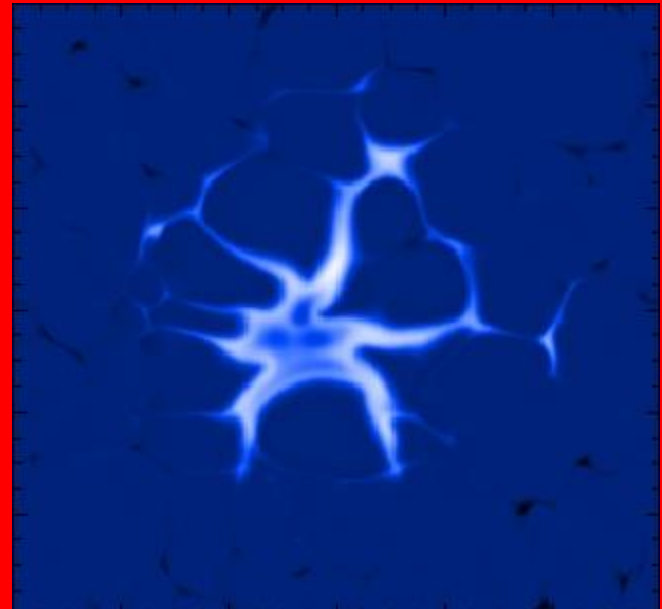
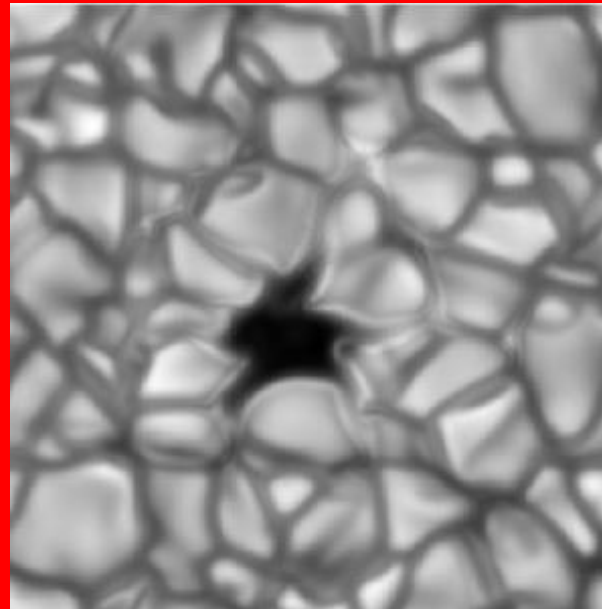
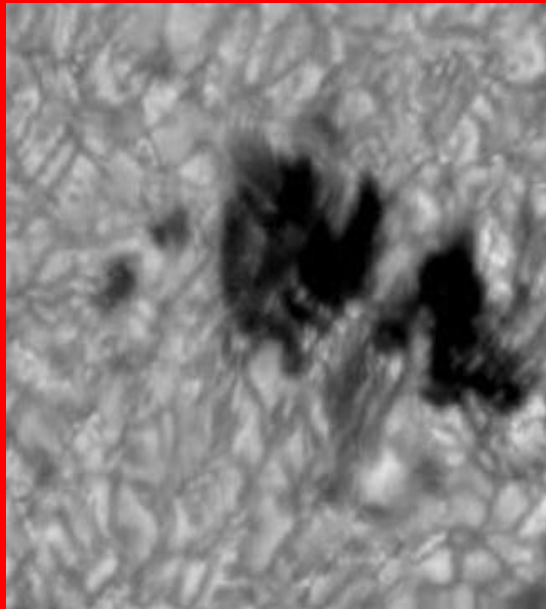
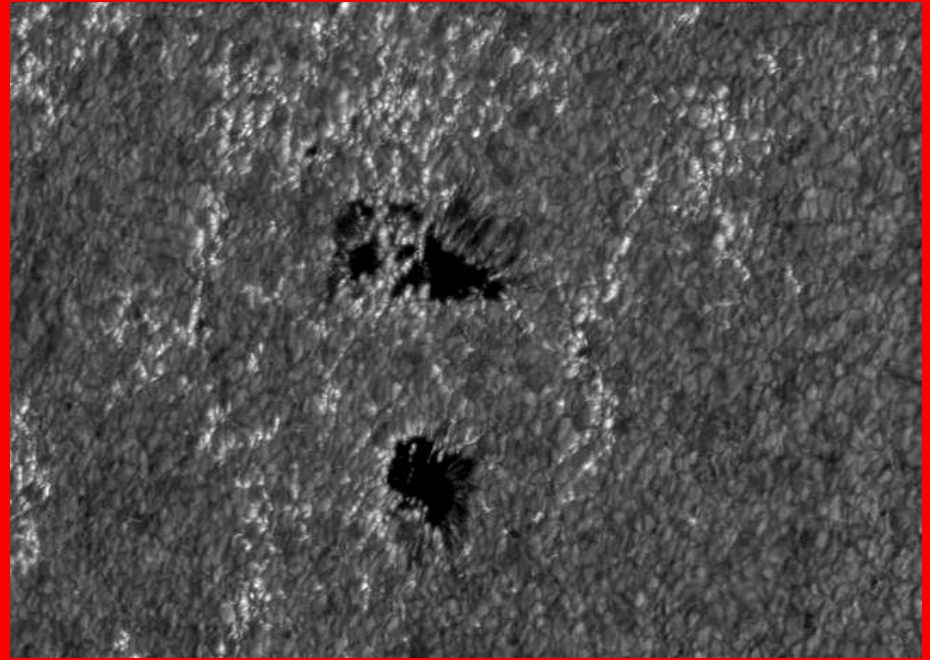








ΚΕΝΤΡΑ ΔΡΑΣΗΣ
ΠΥΡΣΟΙ ΚΑΙ ΠΟΡΟΙ
(Faculae-Pores)



size:

40,000 x 27,000 mi

65,000 x 43,000 km

Sunspot:

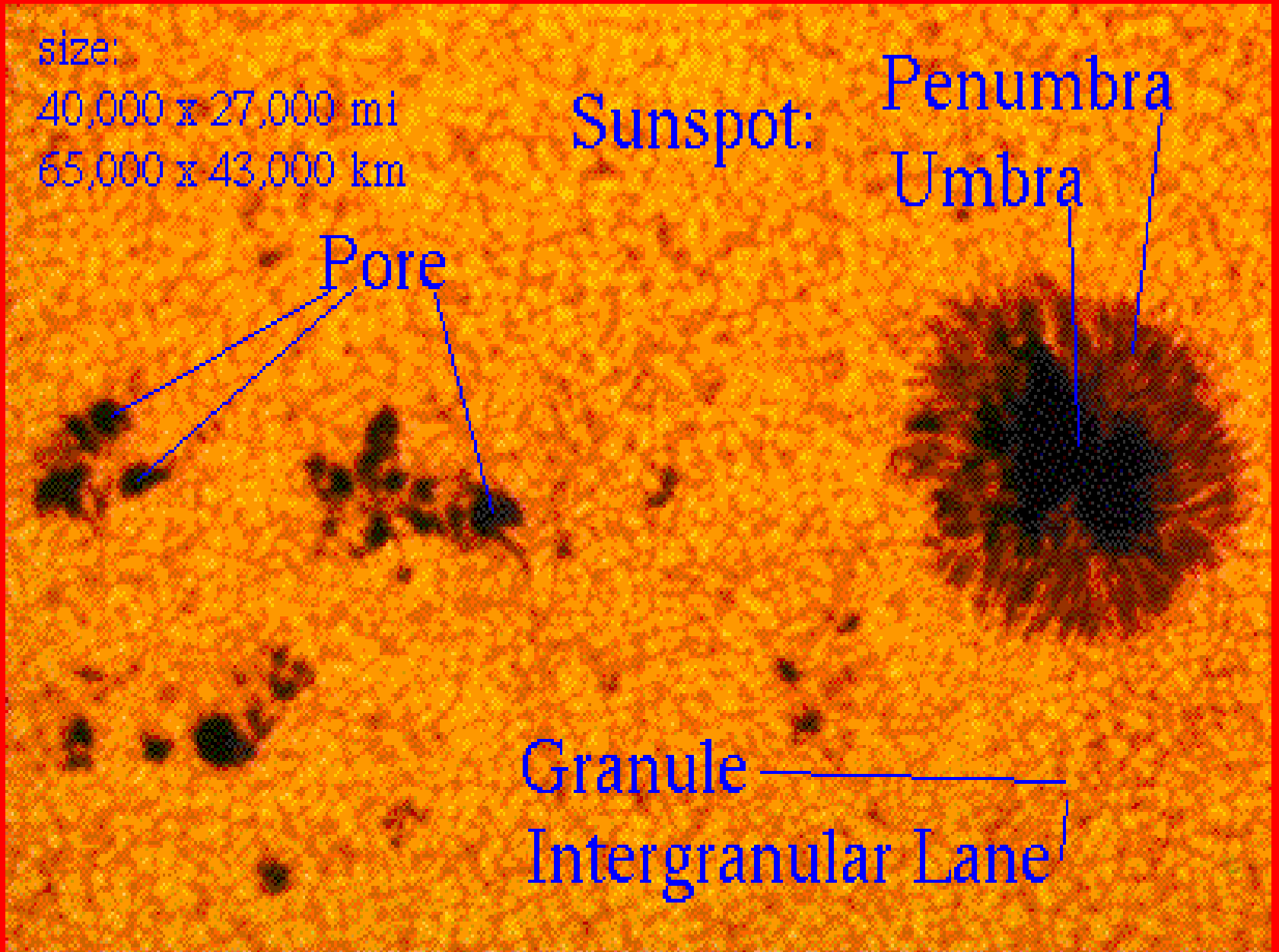
Penumbra

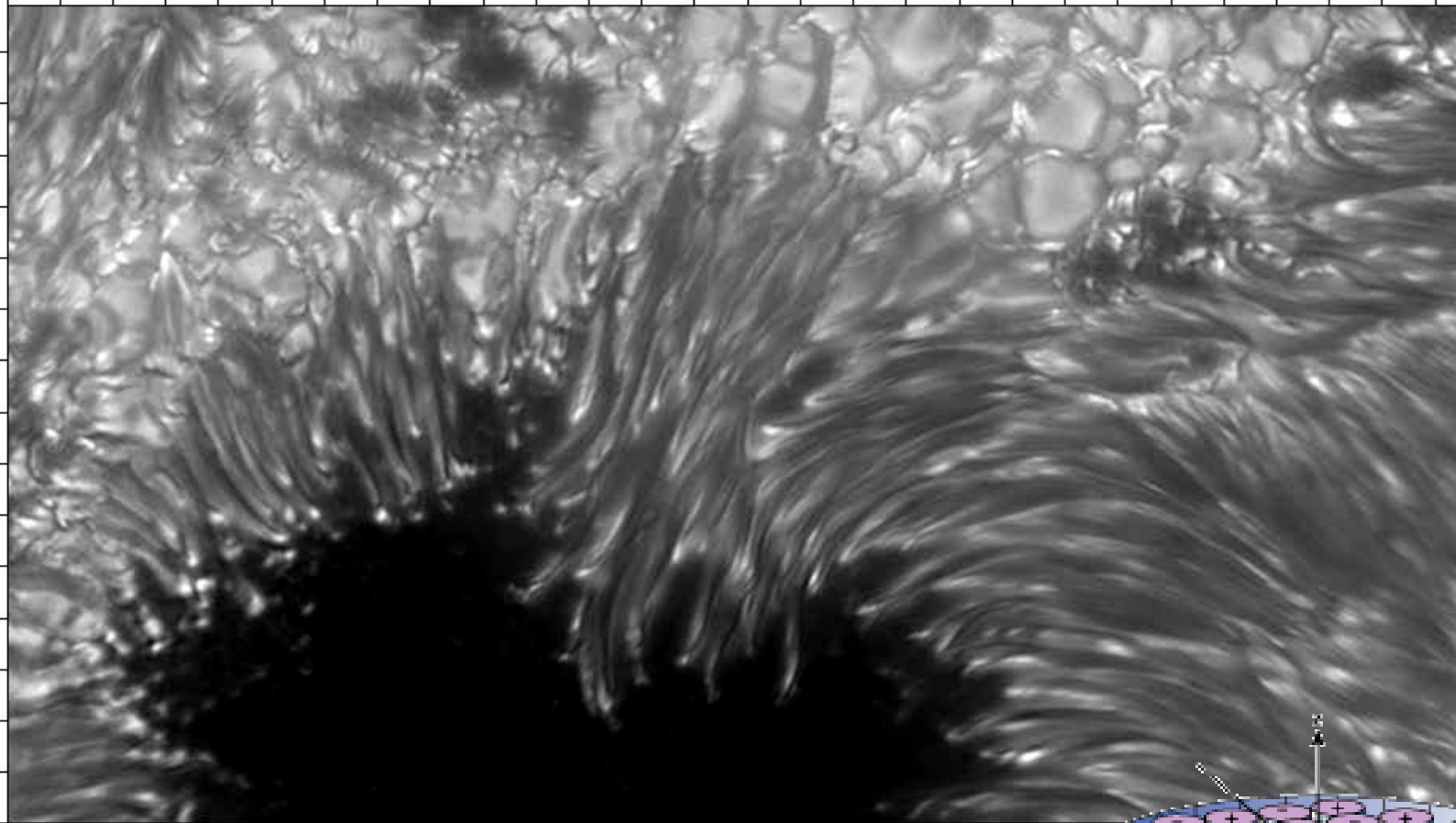
Umbra

Pore

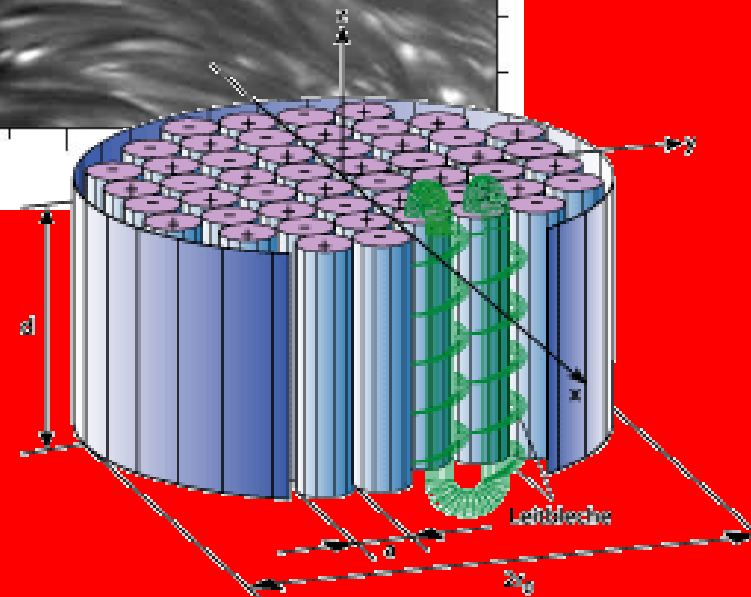
Granule

Intergranular Lane



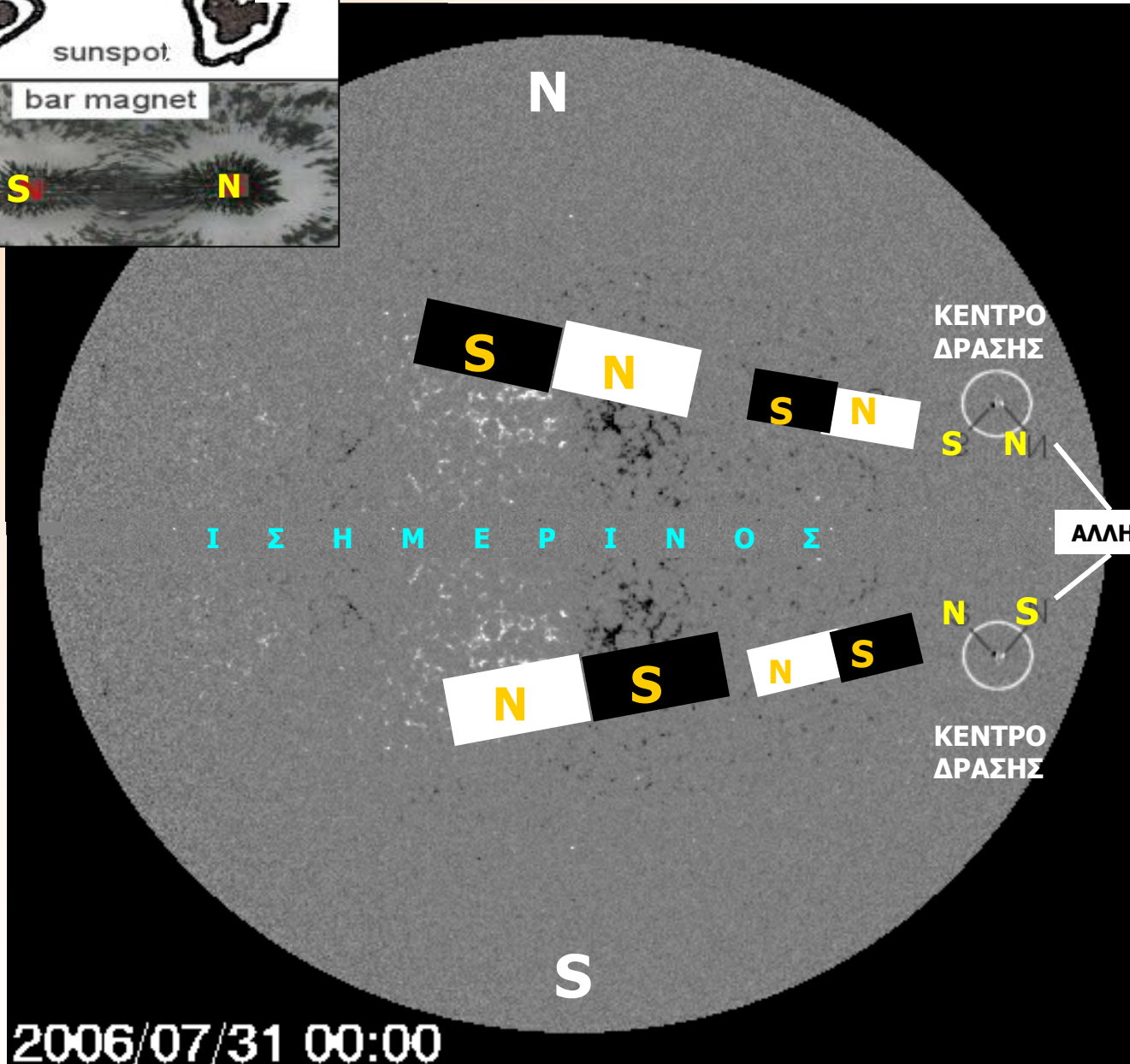
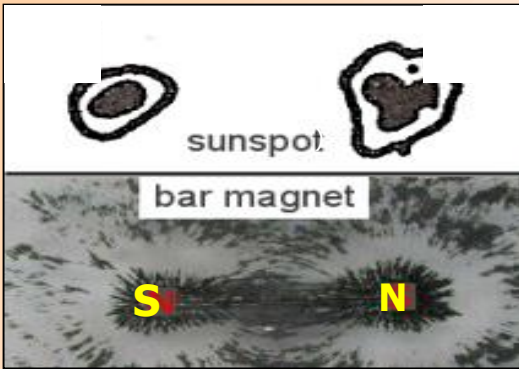


distance in units of 1000 kilometers



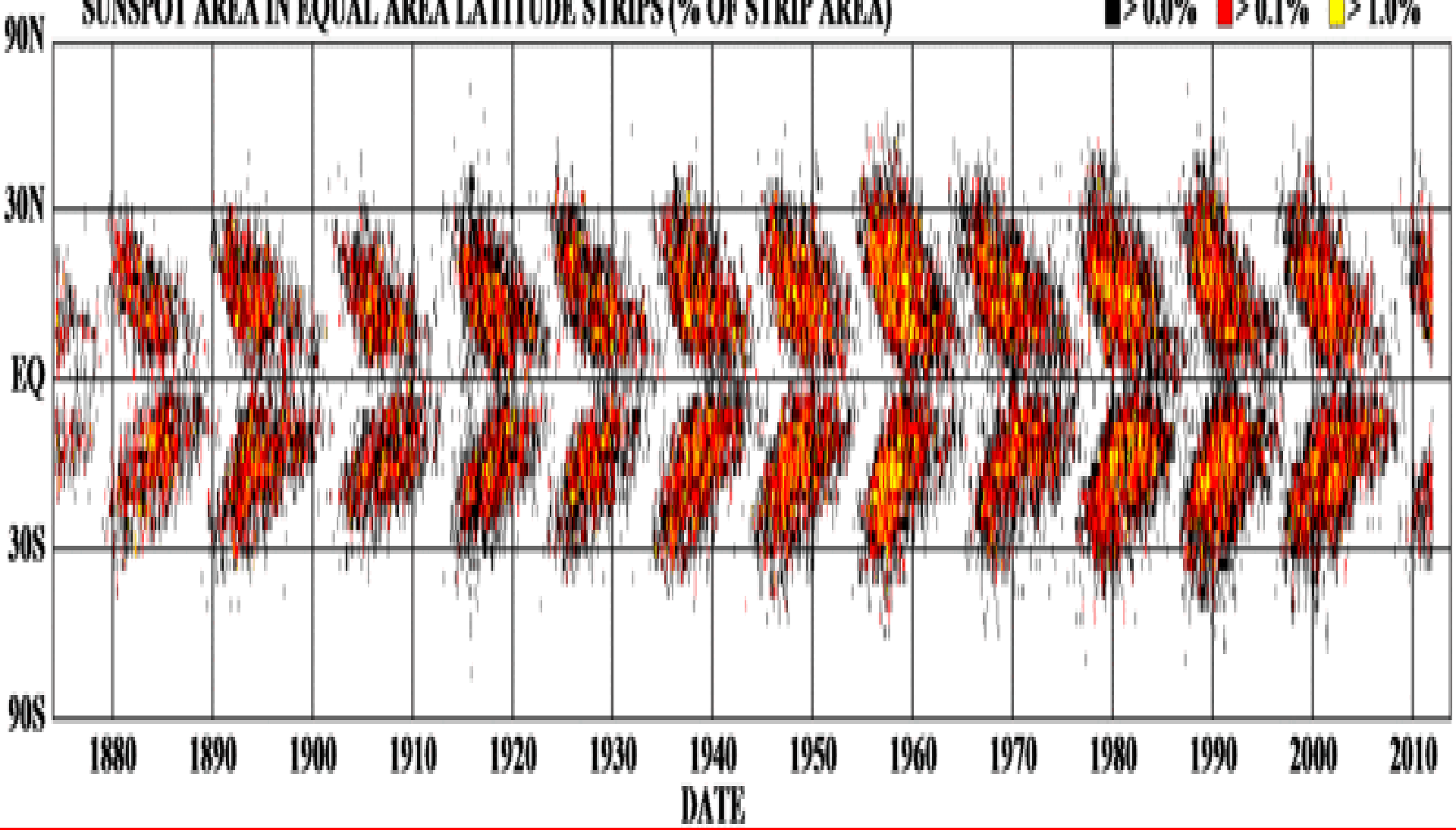


2001-Nov-08
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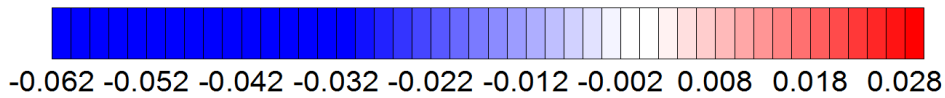
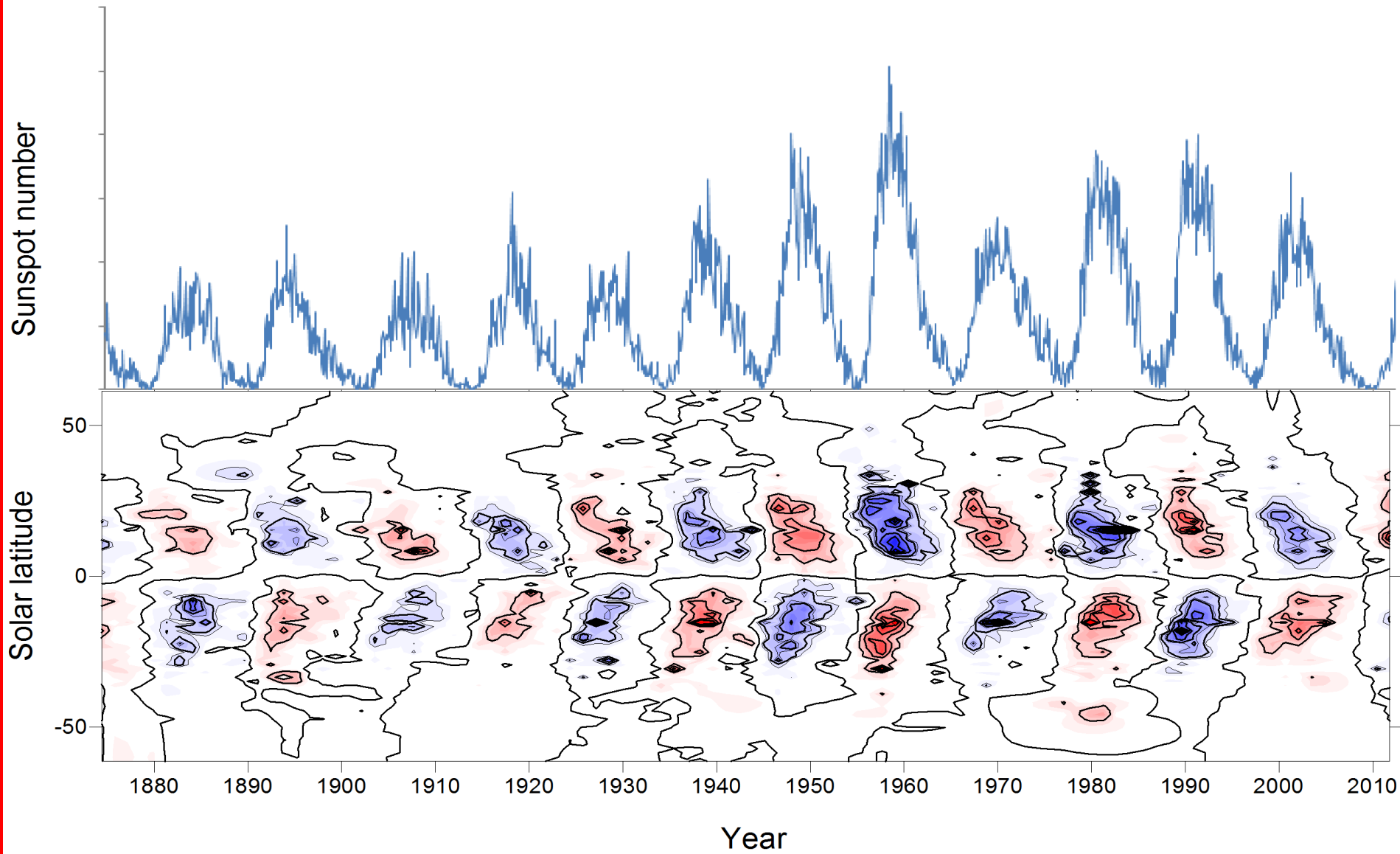


SUNSPOT AREA IN EQUAL AREA LATITUDE STRIPS (% OF STRIP AREA)

■ > 0.0% ■ > 0.1% ■ > 1.0%

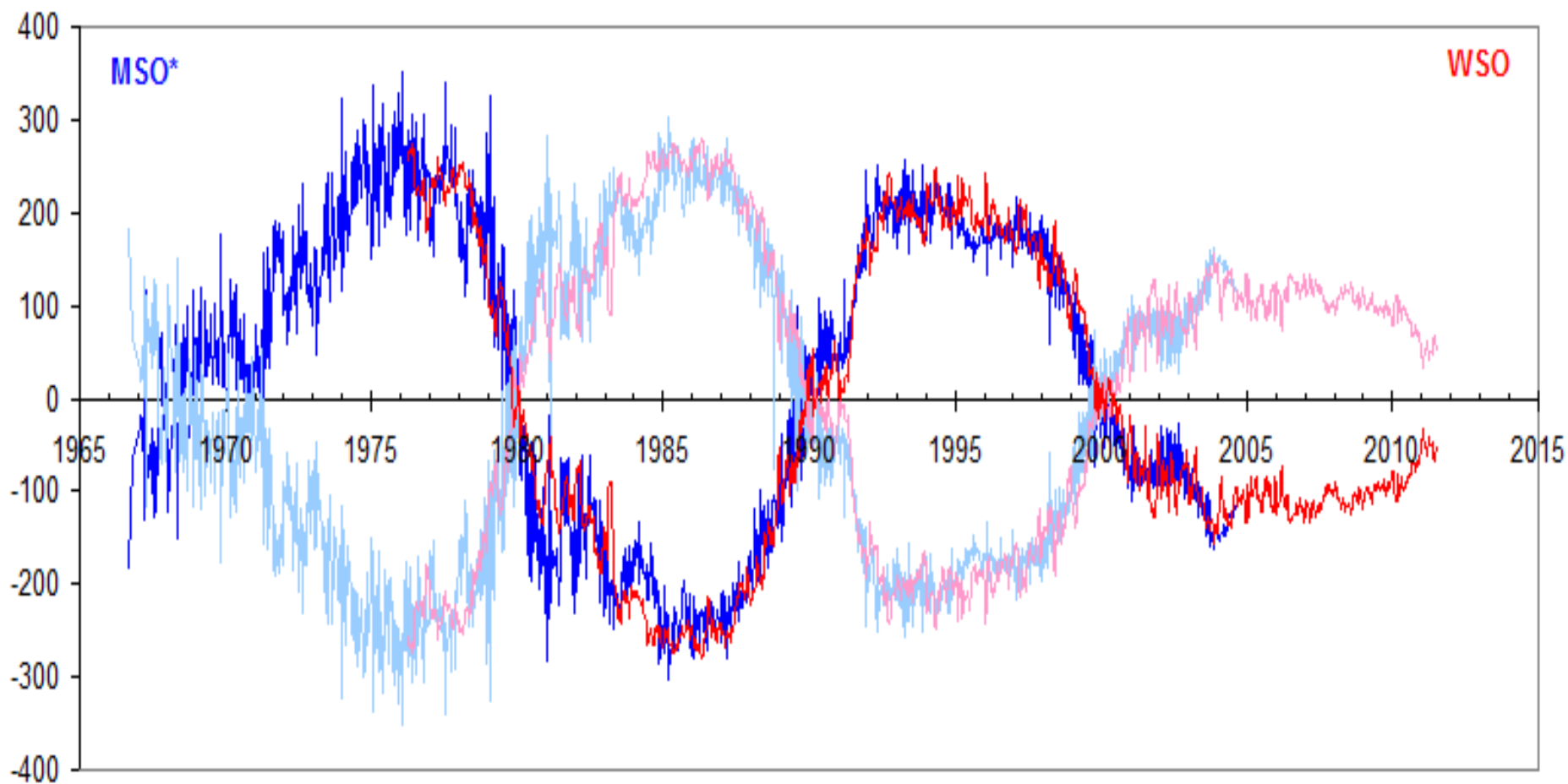


Solar cycles - variation with solar latitude and time

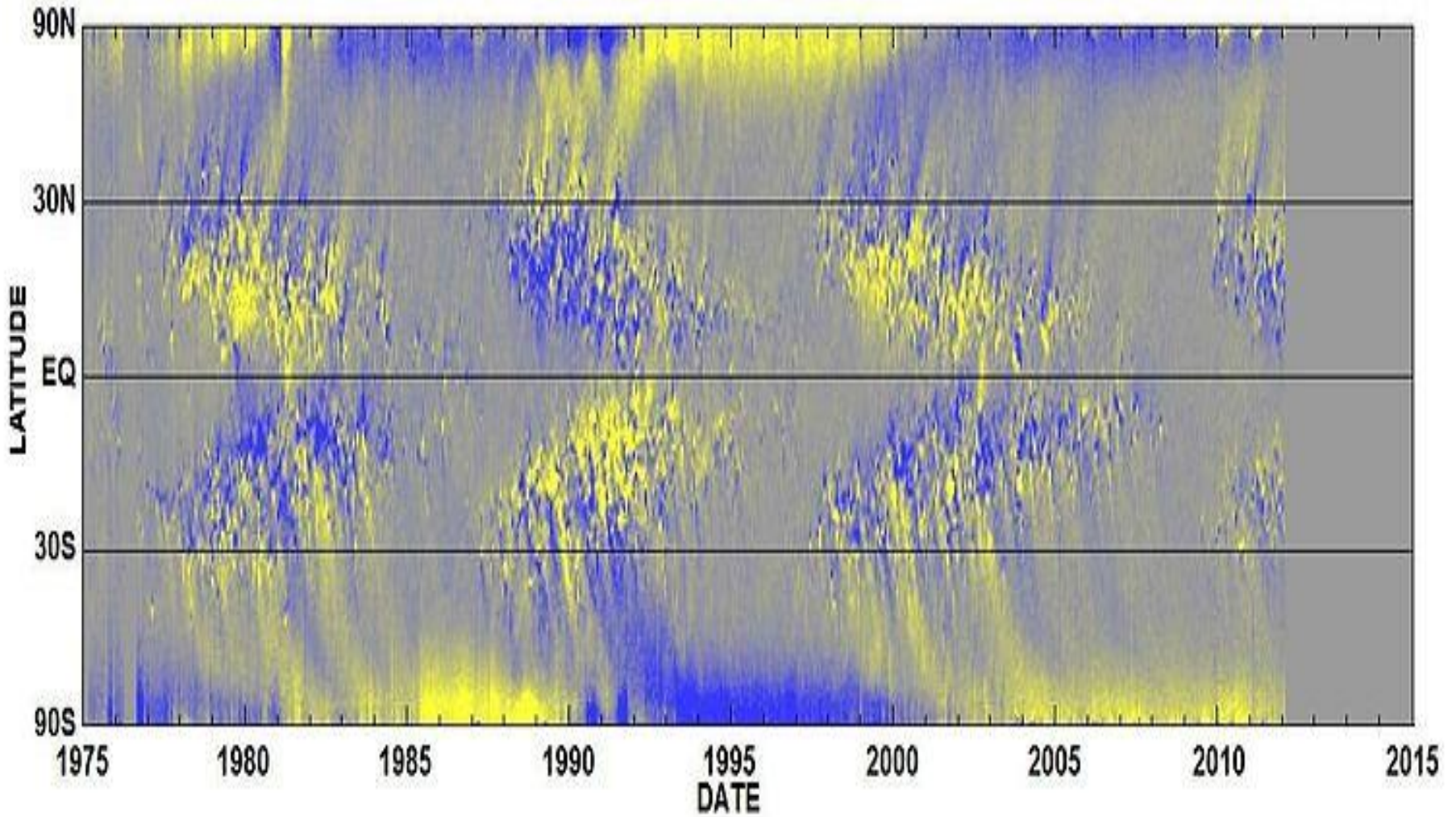


Percent of sun's surface and polarity

North - South Solar Polar fields [microTesla]

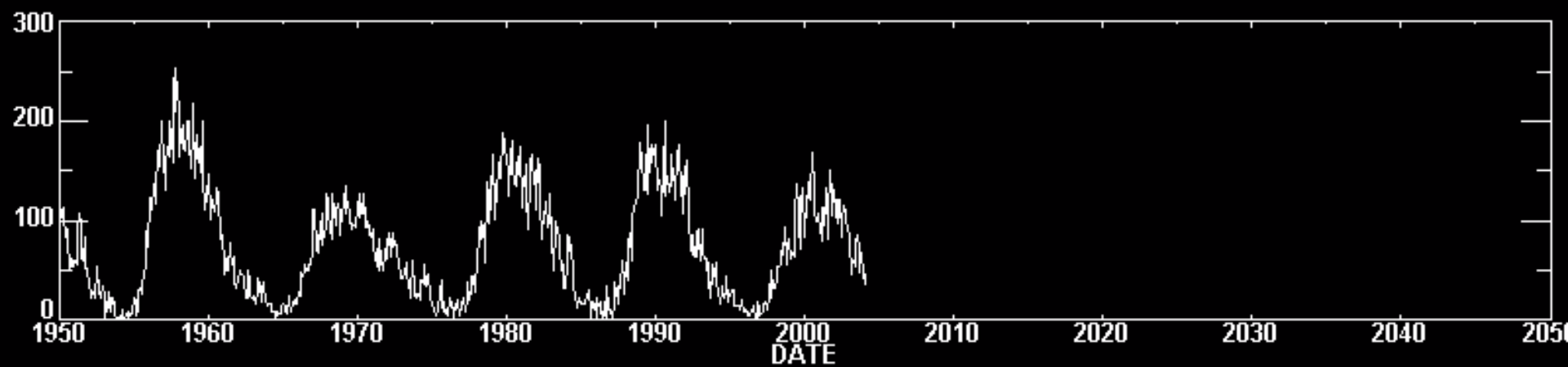
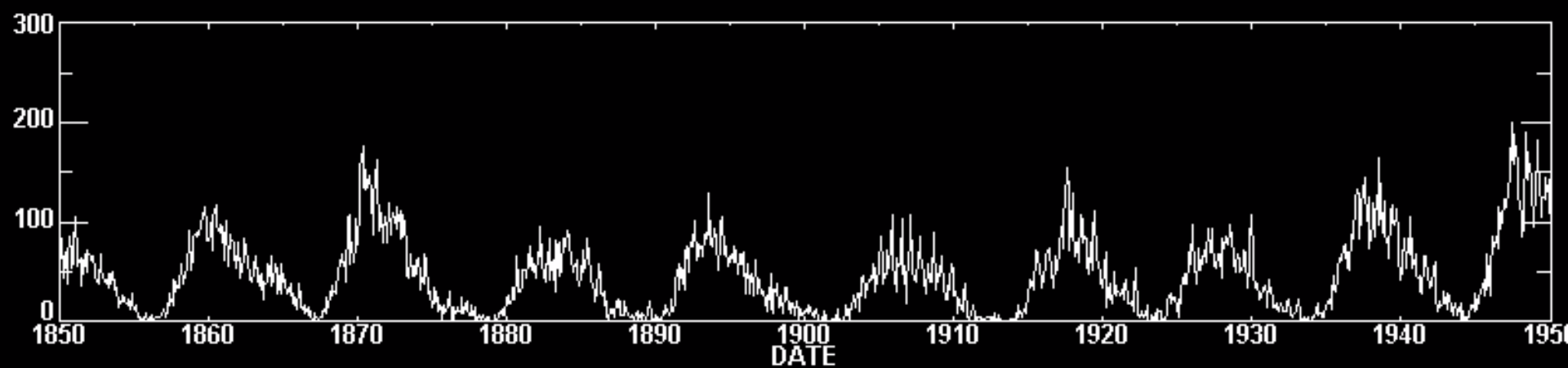
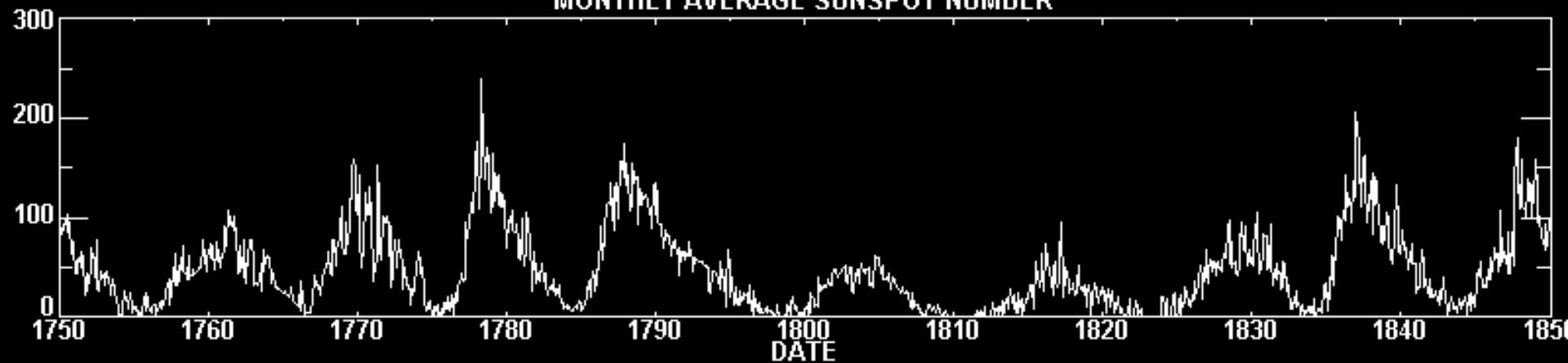


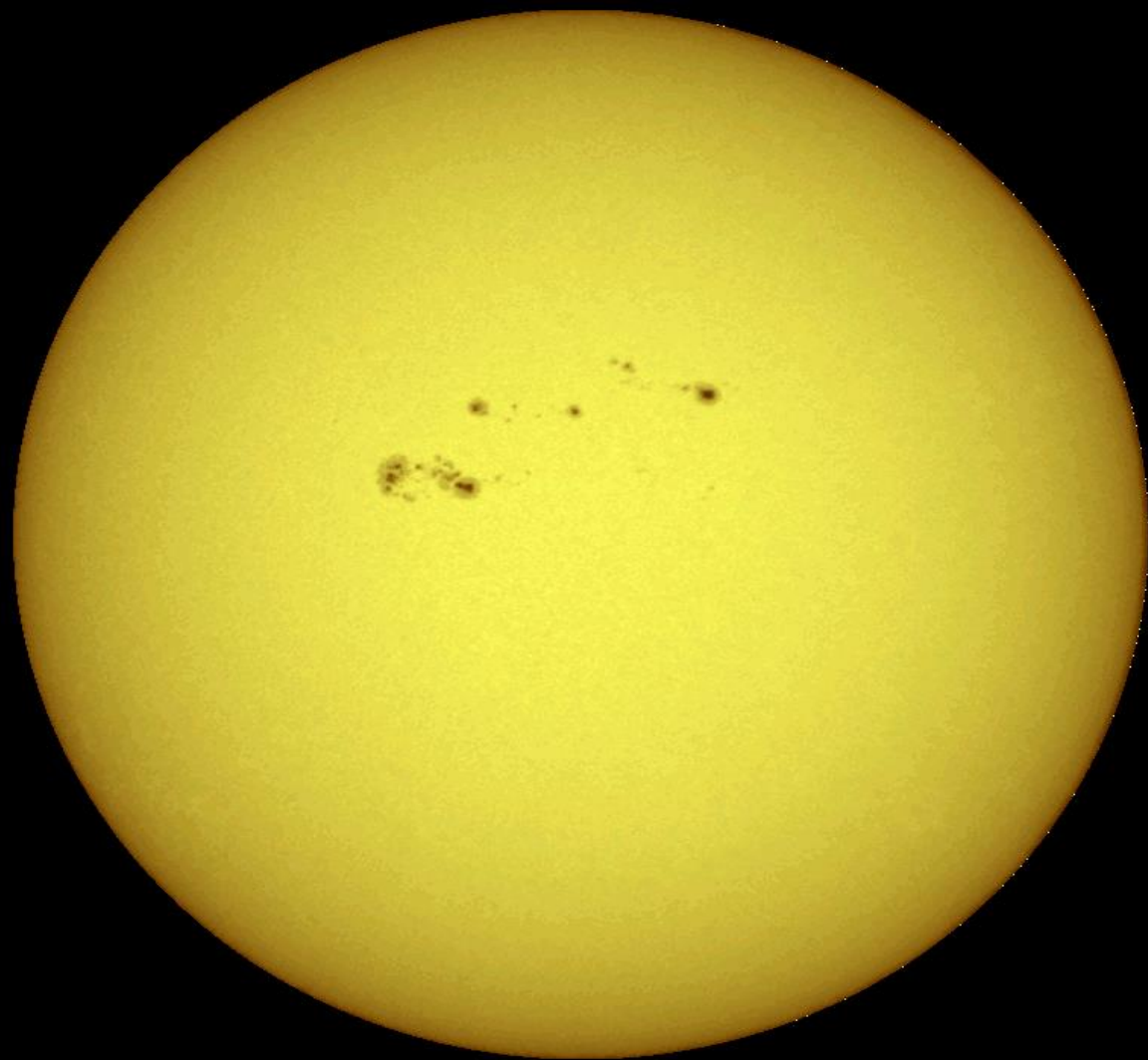
-10G -5G 0G +5G +10G

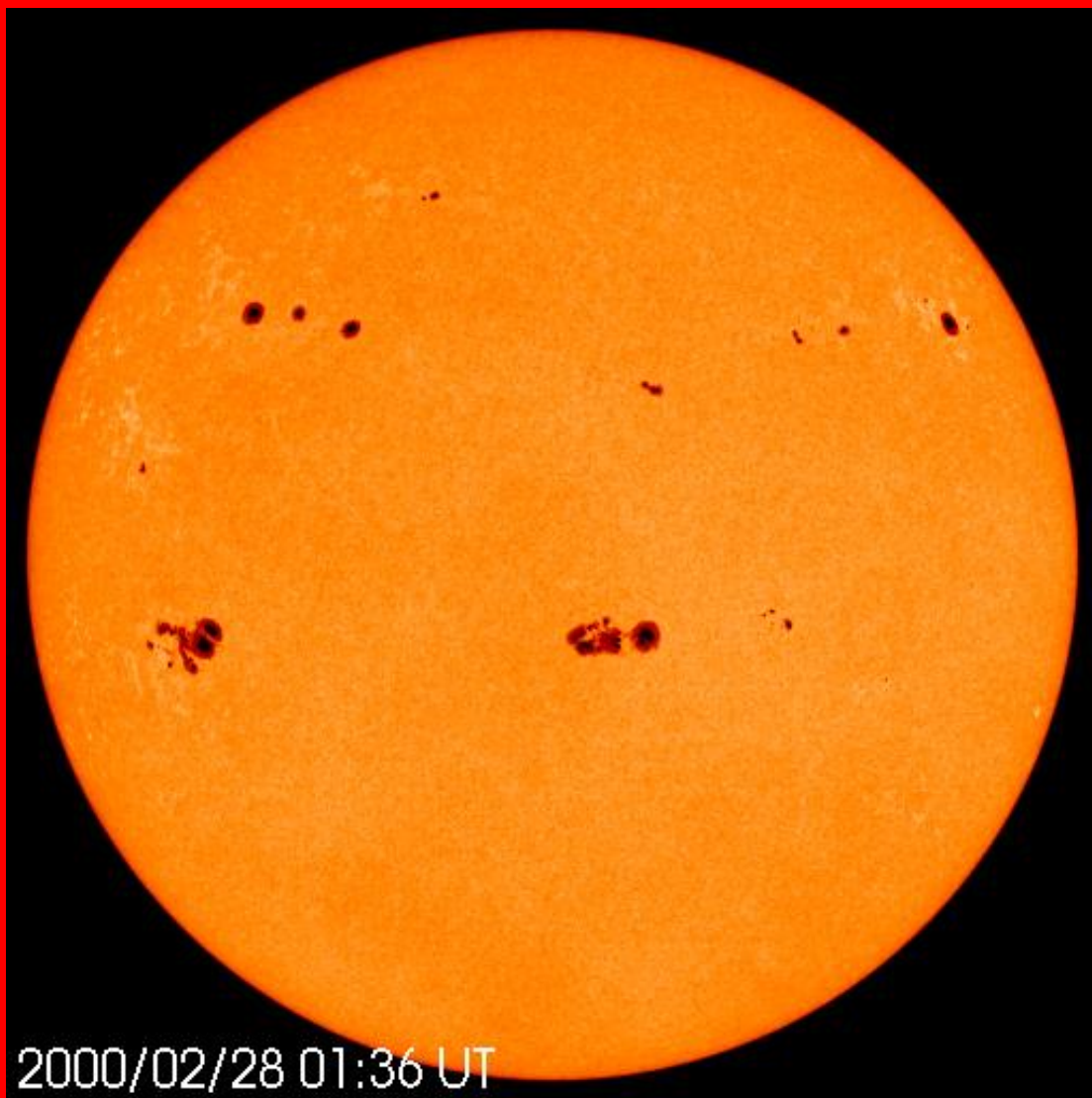


Hathaway/NASA/MSFC 2012/03

MONTHLY AVERAGE SUNSPOT NUMBER



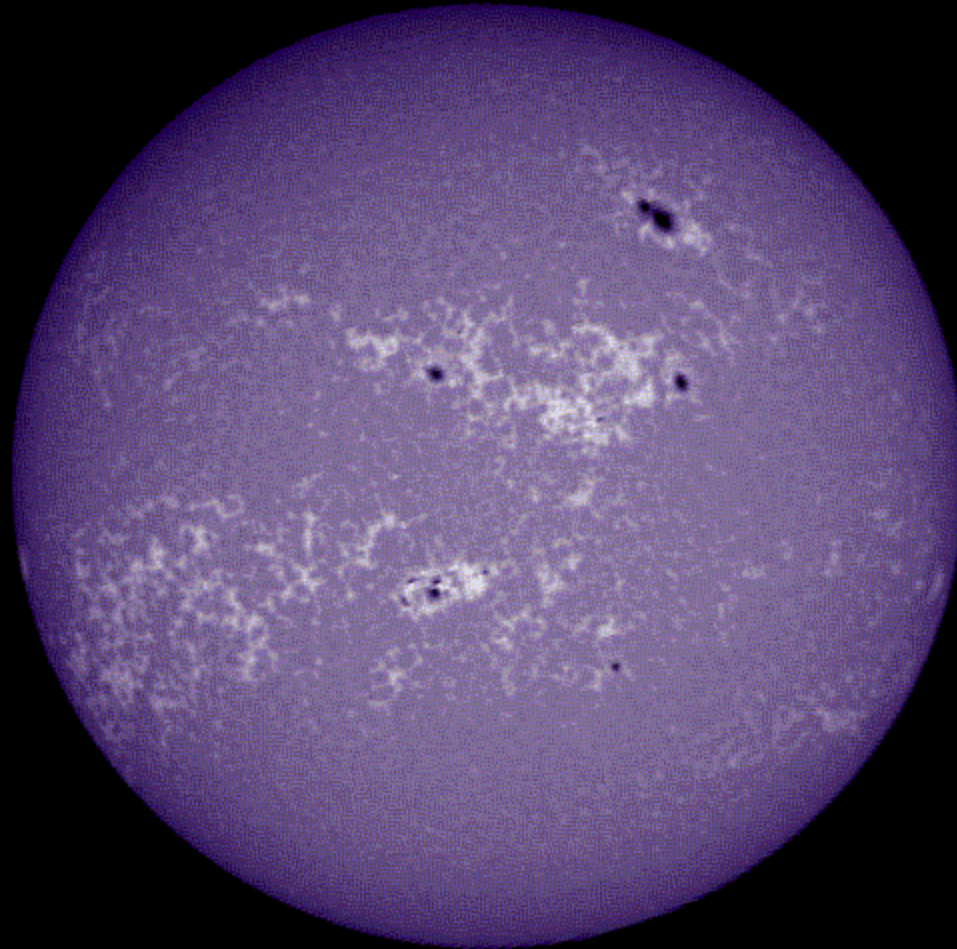




2000/02/28 01:36 UT

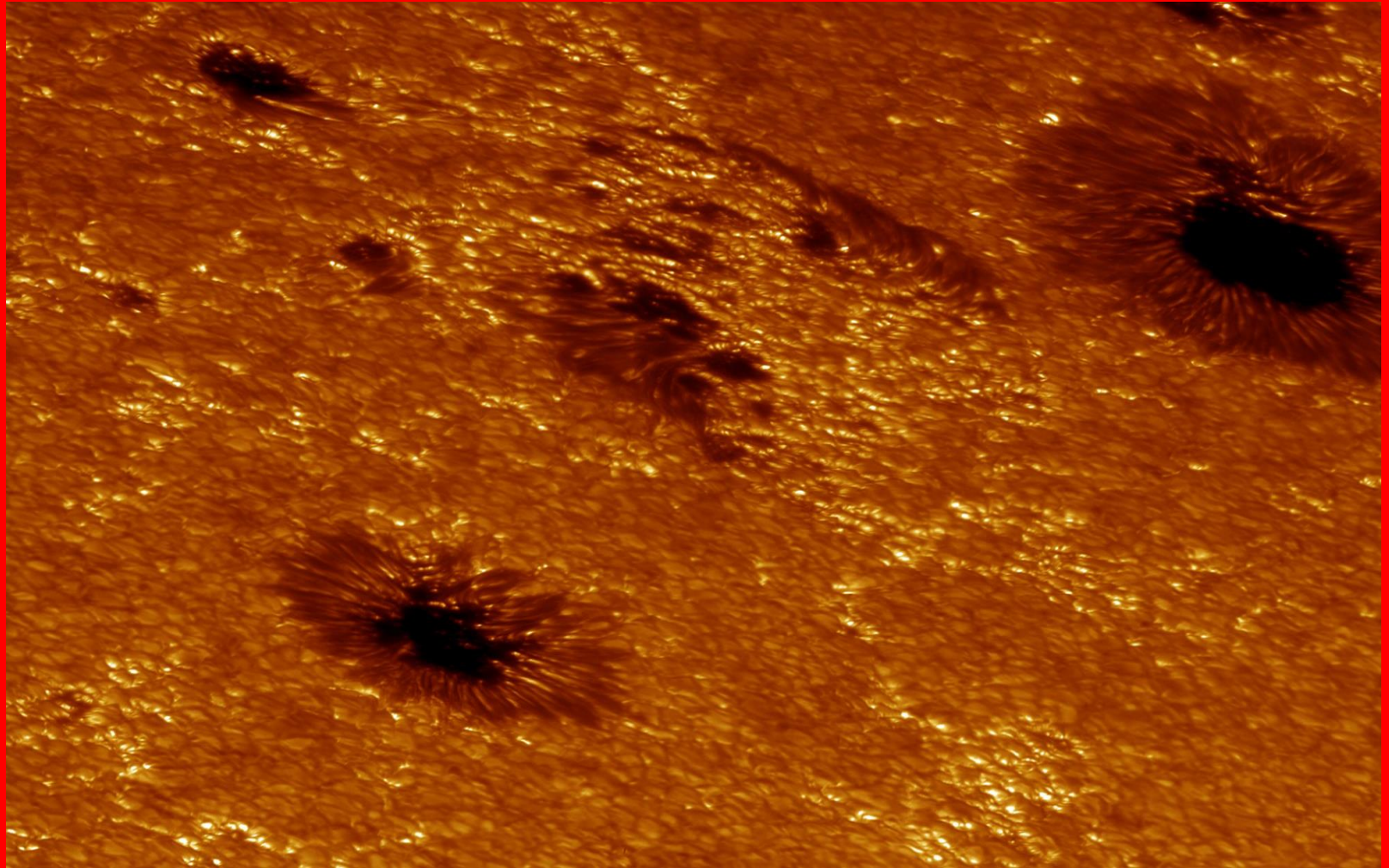
CHROMOSPHERIC NETWORK

Ca II 3934 Å
BBSO

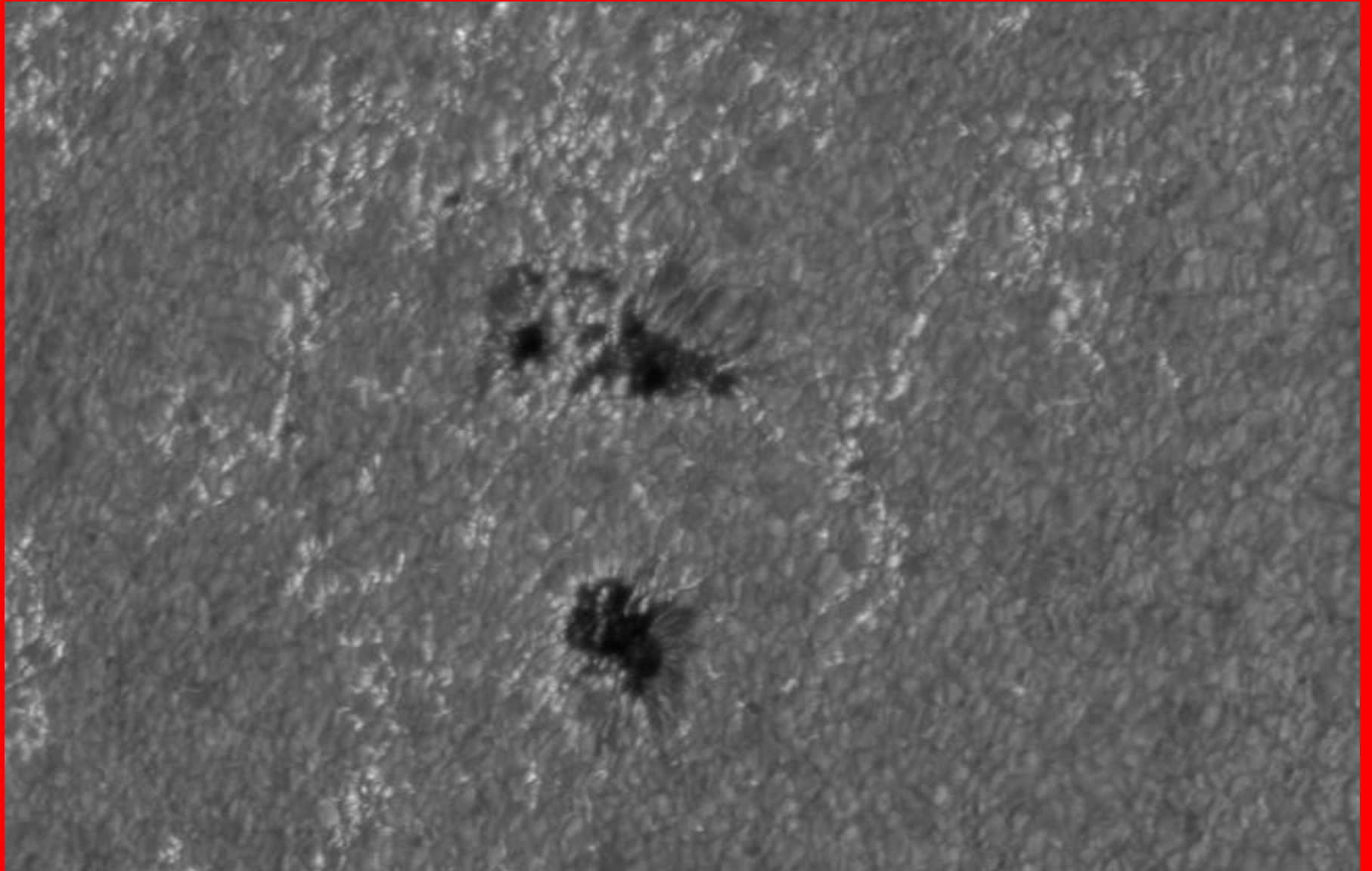


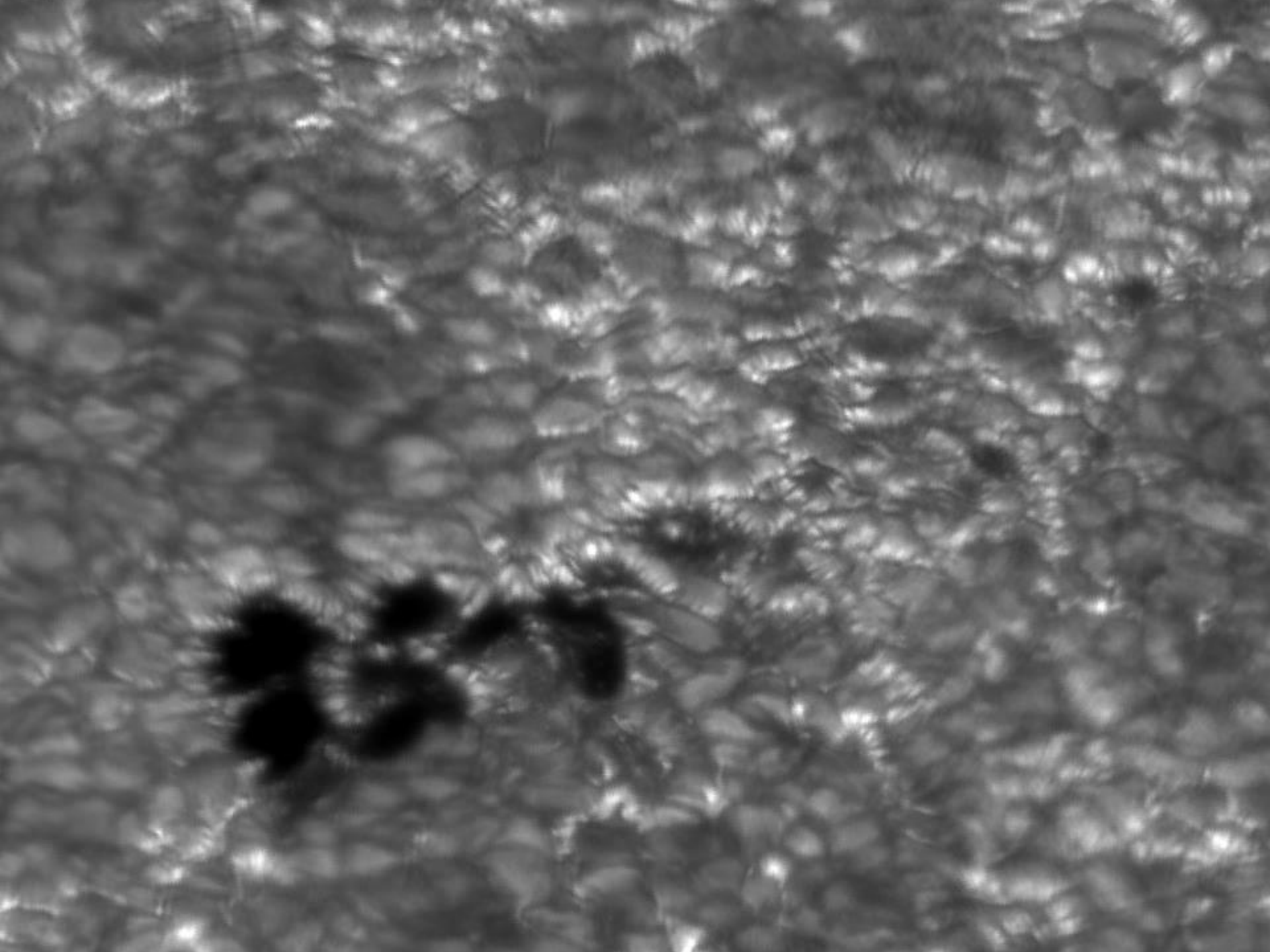
1991 May 13

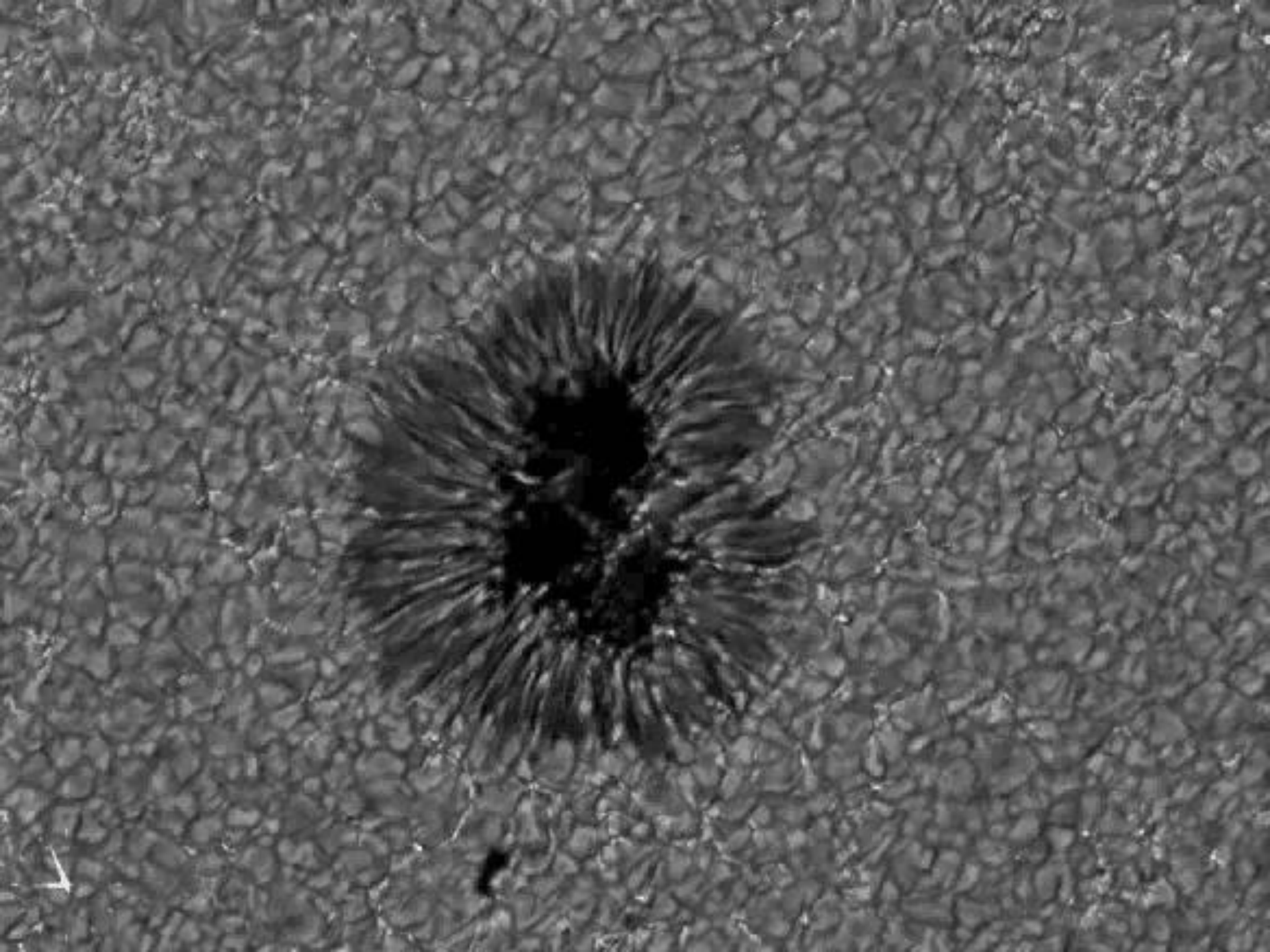
PHOTOSPHERE FACULAE

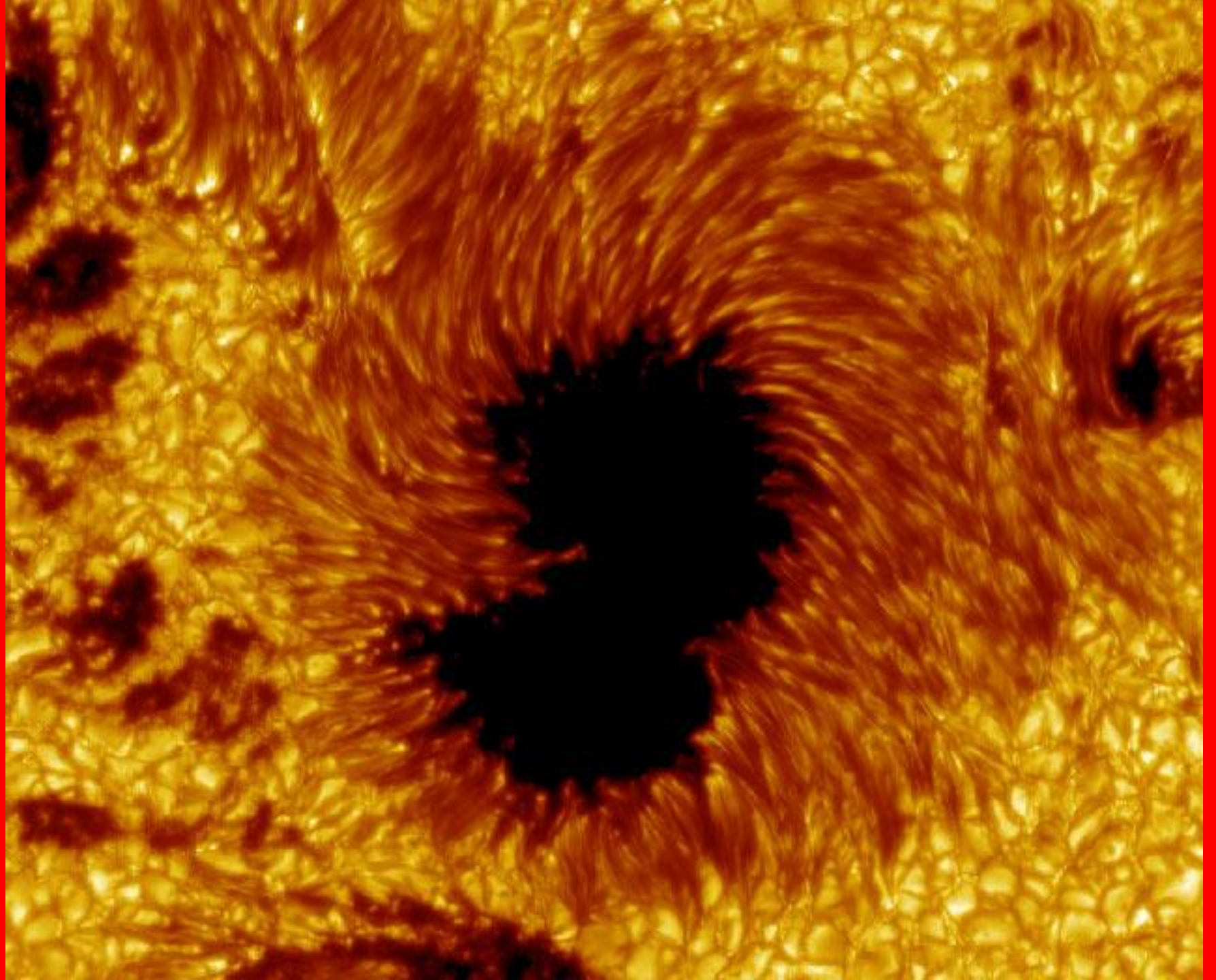


CHROMOSPHERE-PLAGE

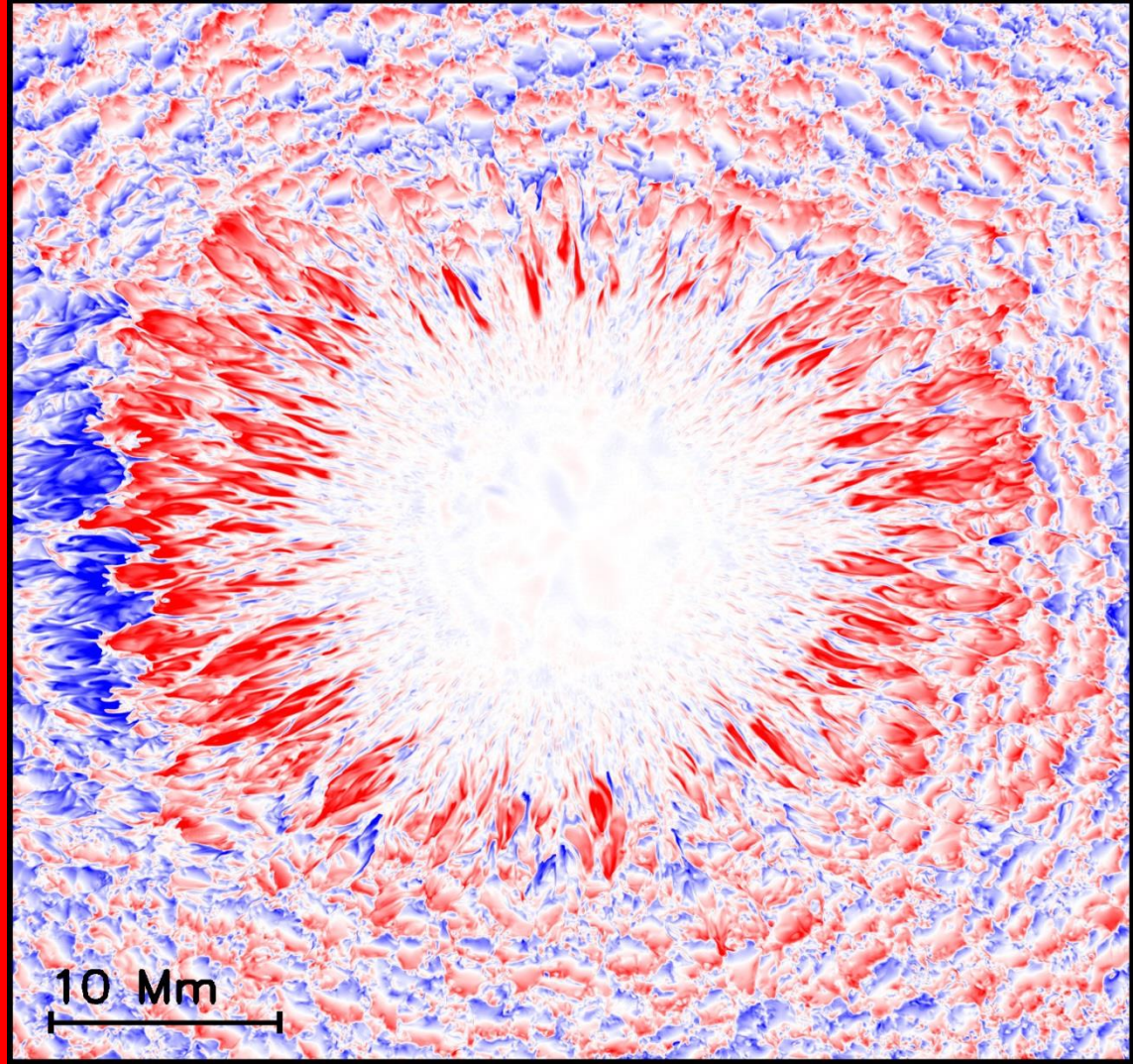
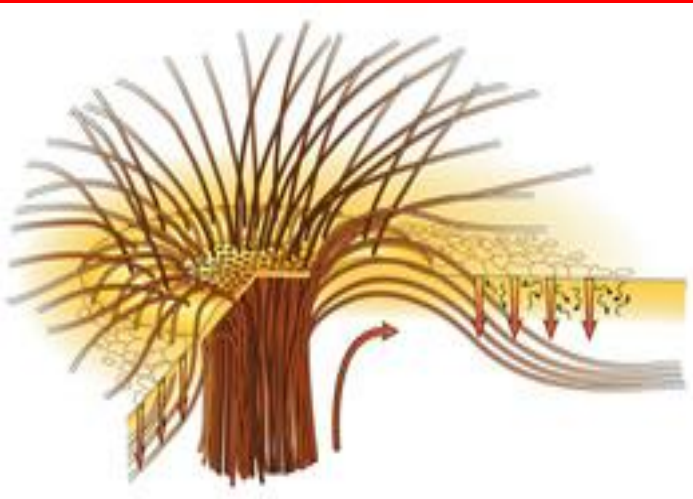




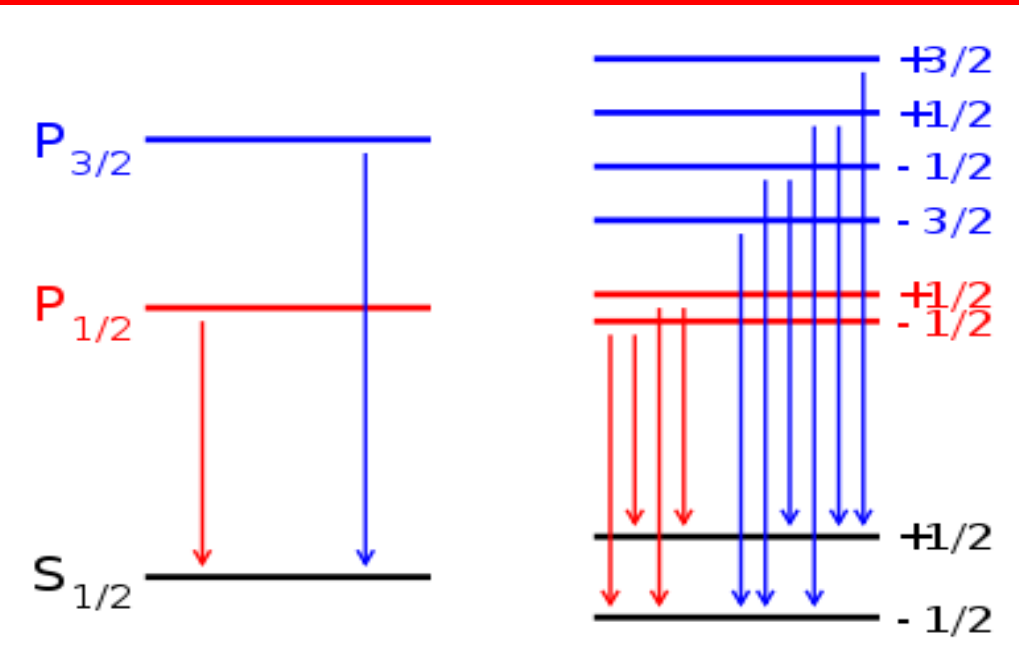
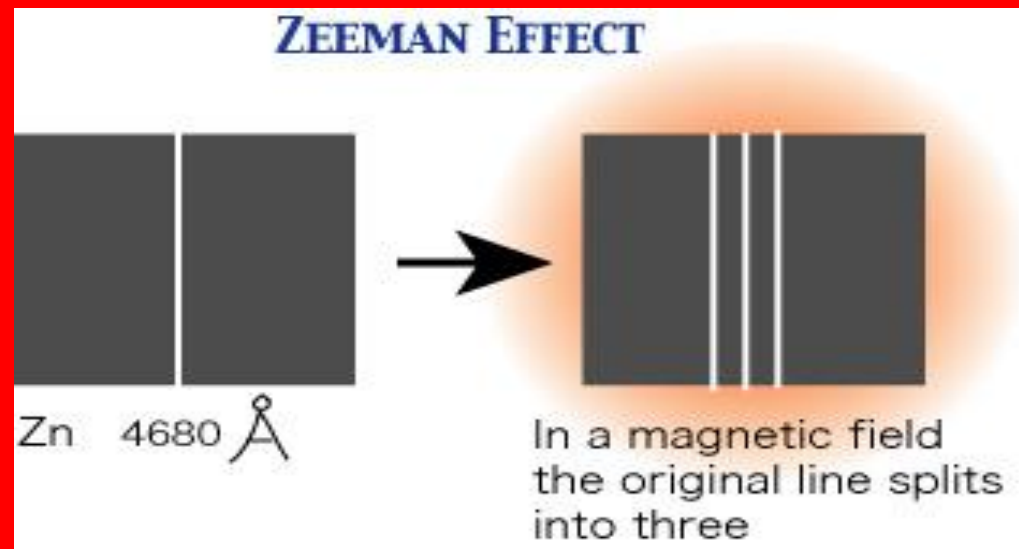
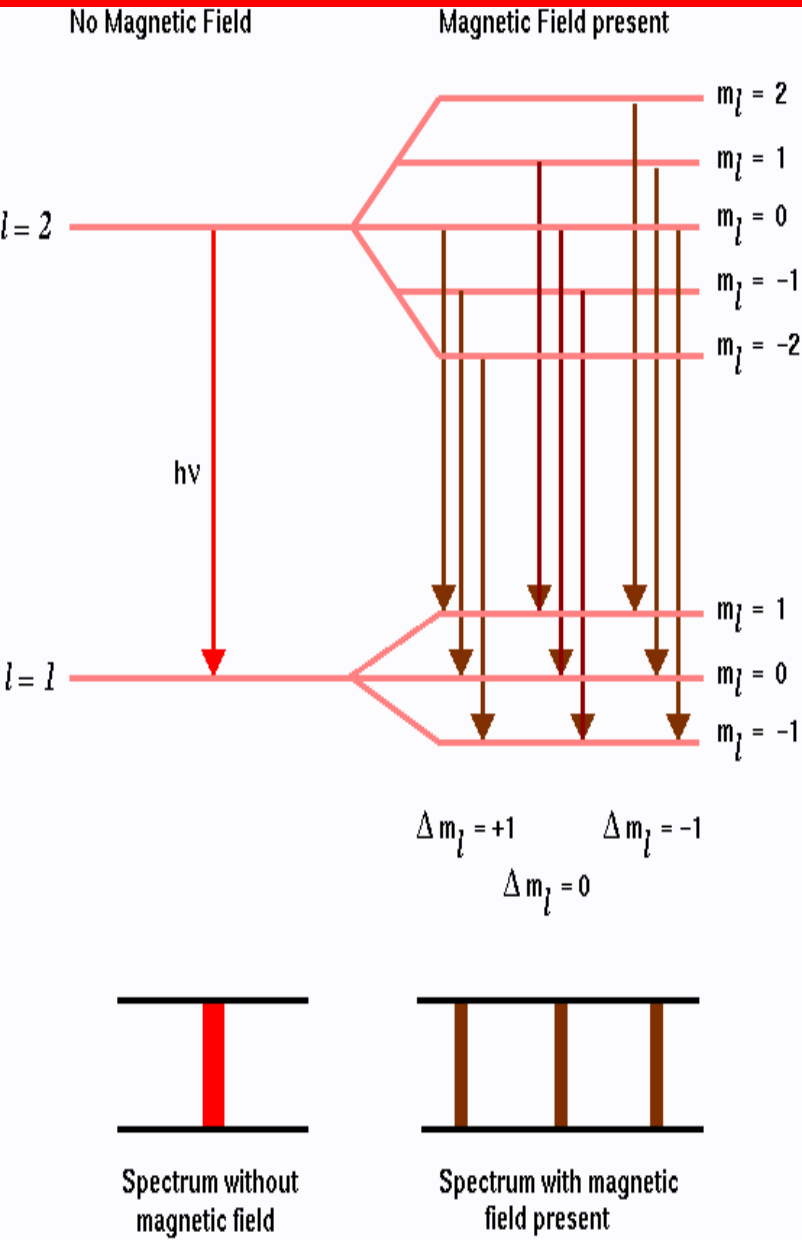


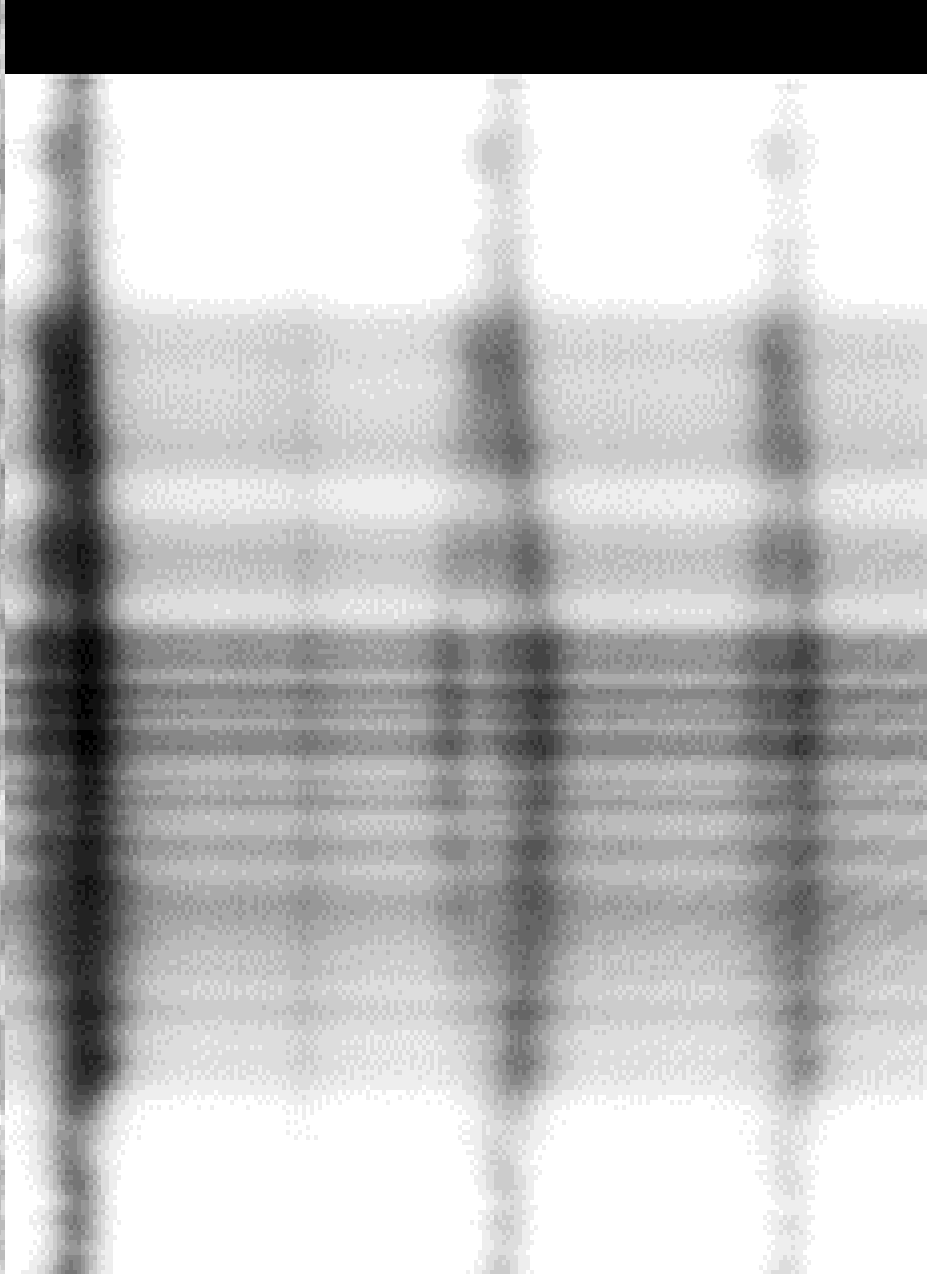
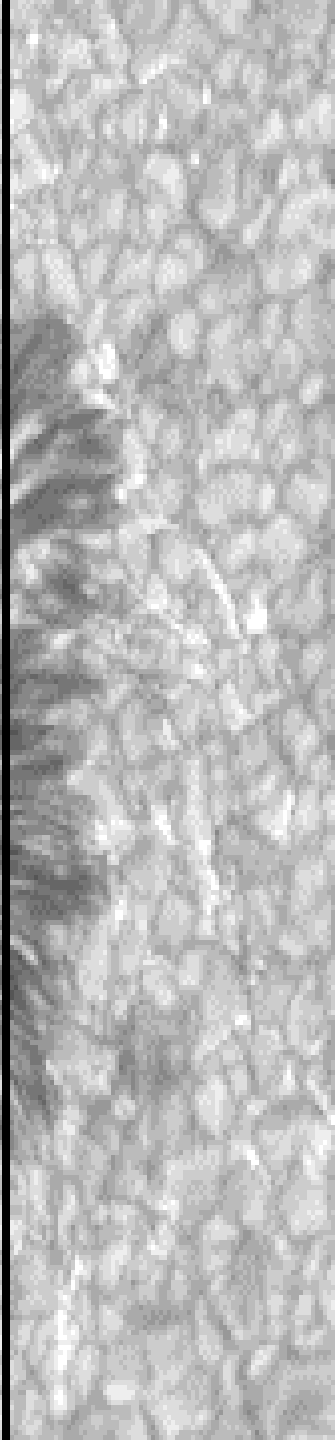
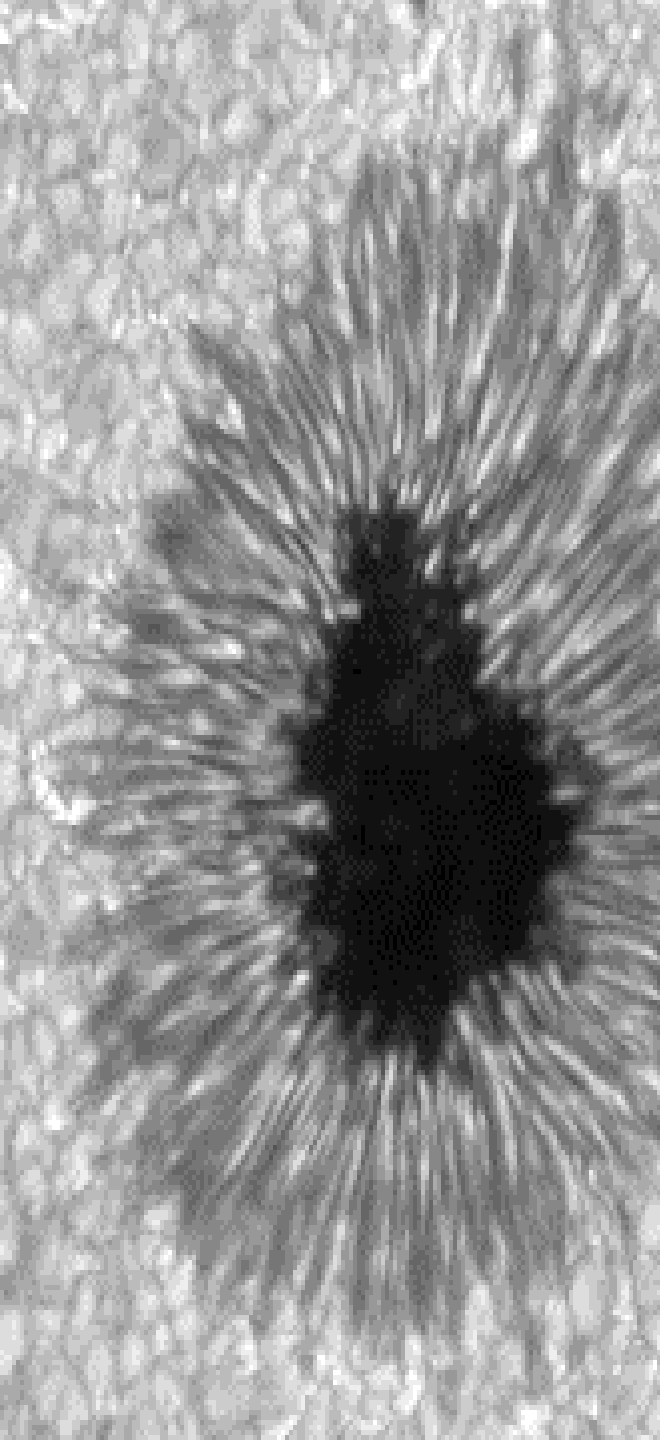


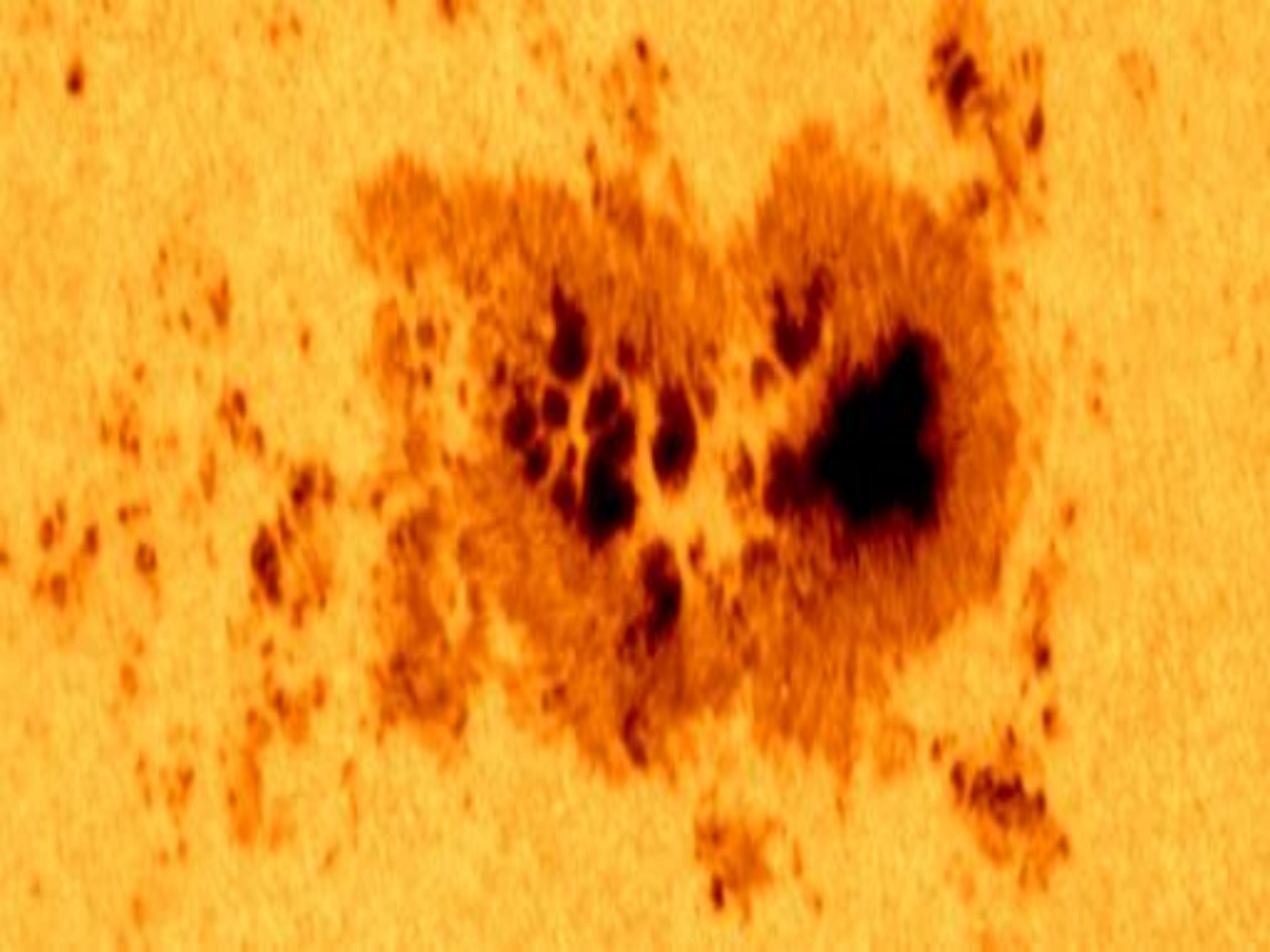
EVERSHED EFFECT



ZEEMAN EFFECT

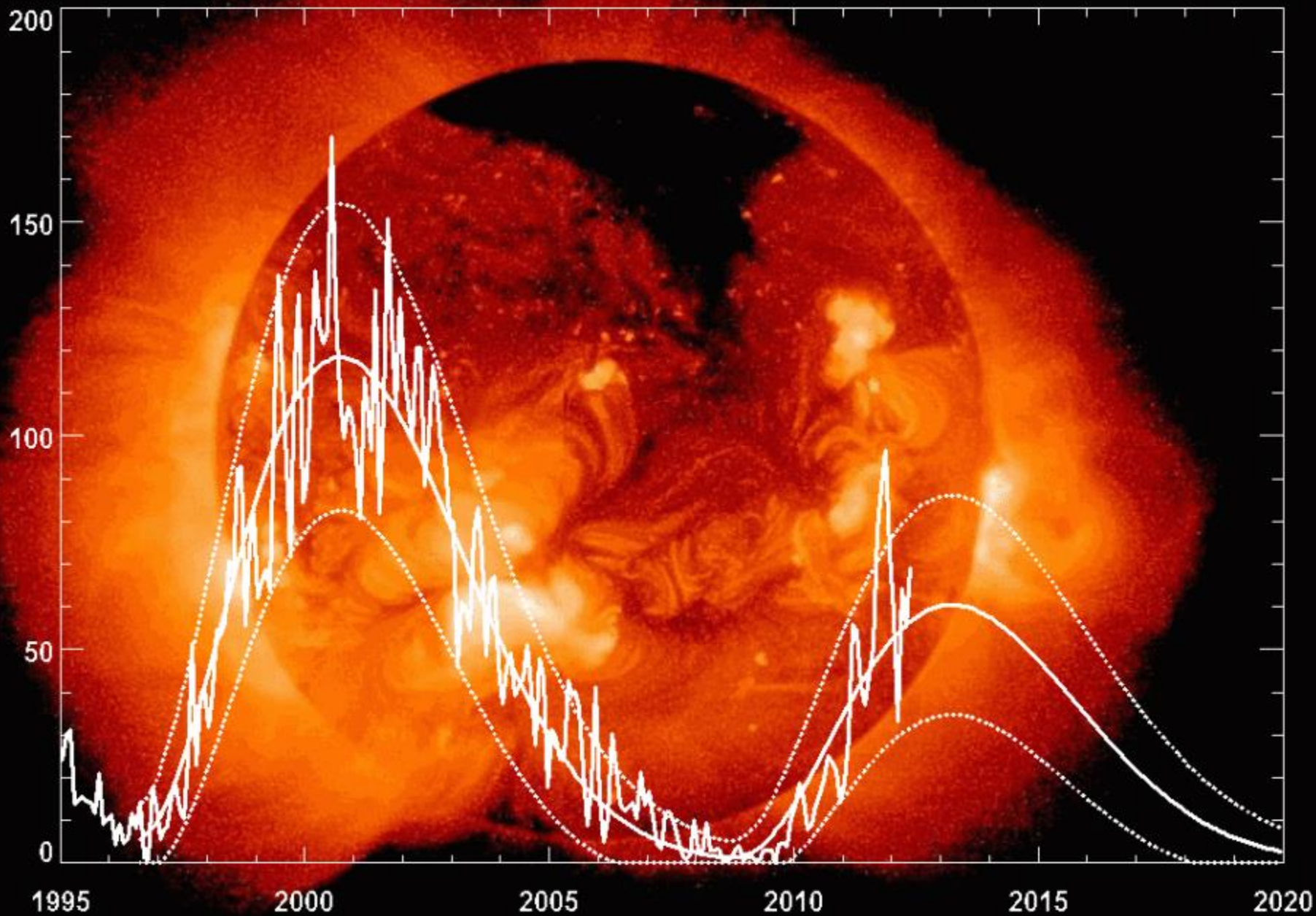








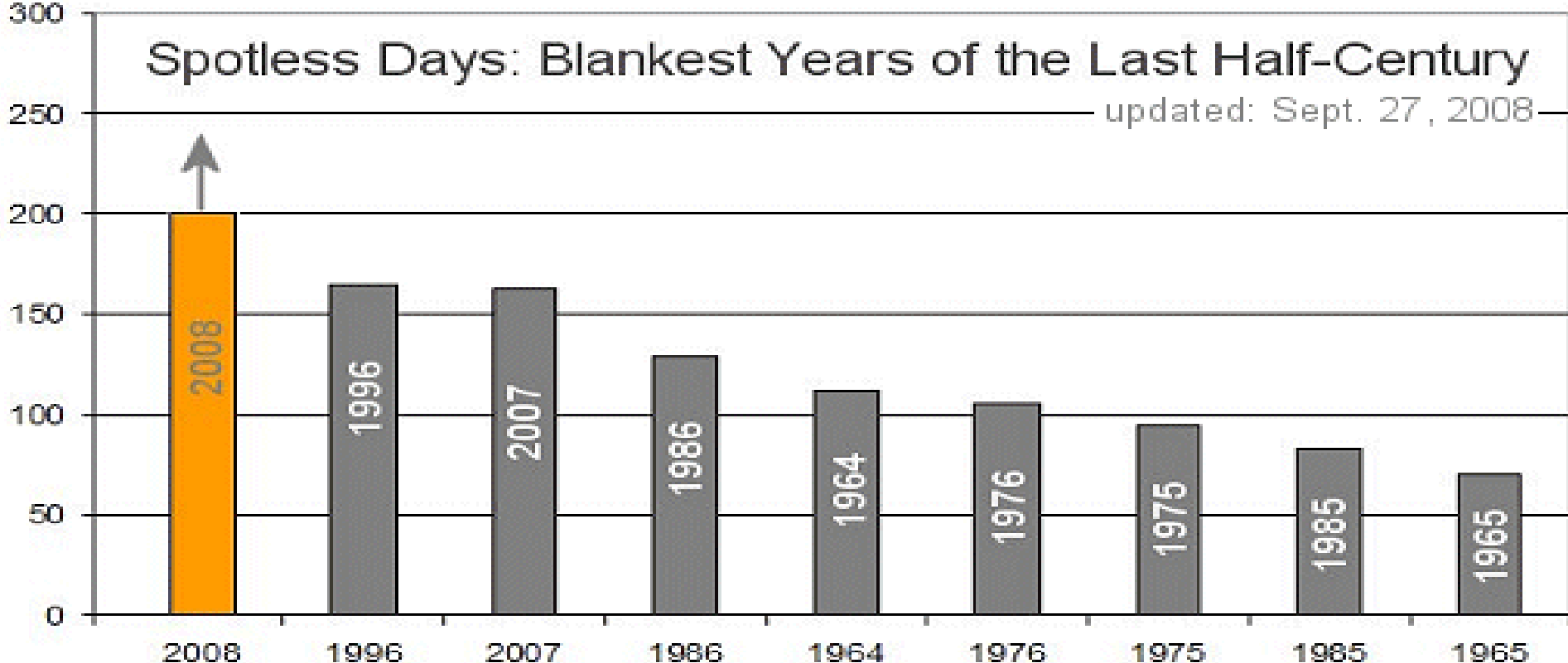
Cycle 24 Sunspot Number Prediction (June 2012)



Hathaway/NASA/MSFC

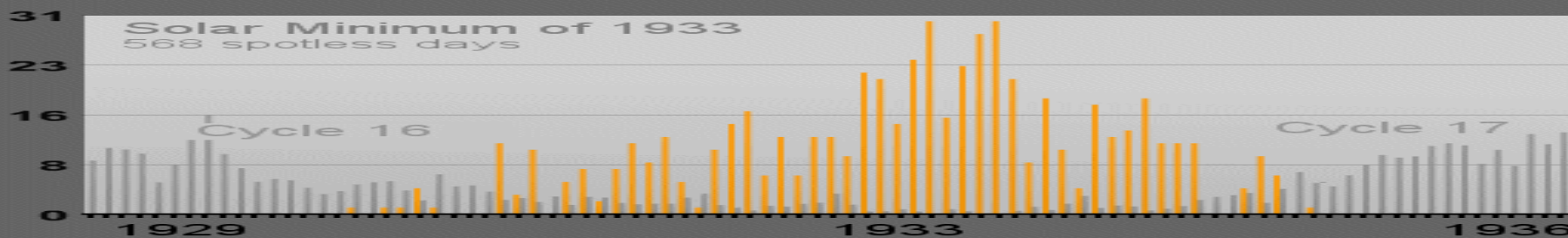
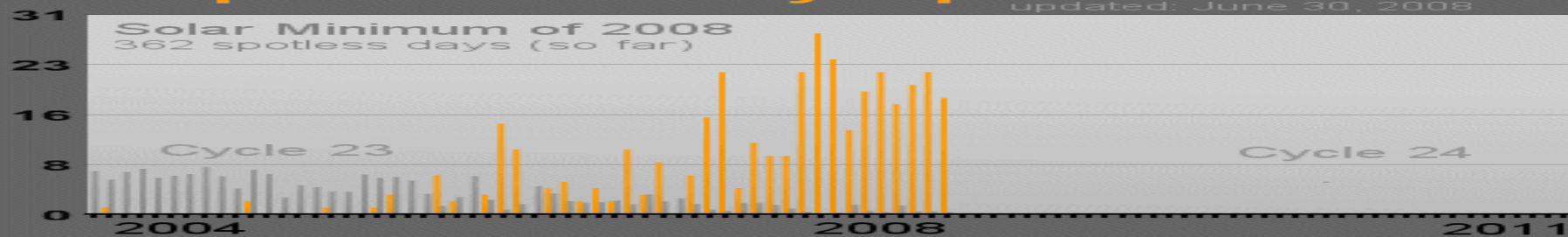
Spotless Days: Blankest Years of the Last Half-Century

updated: Sept. 27, 2008

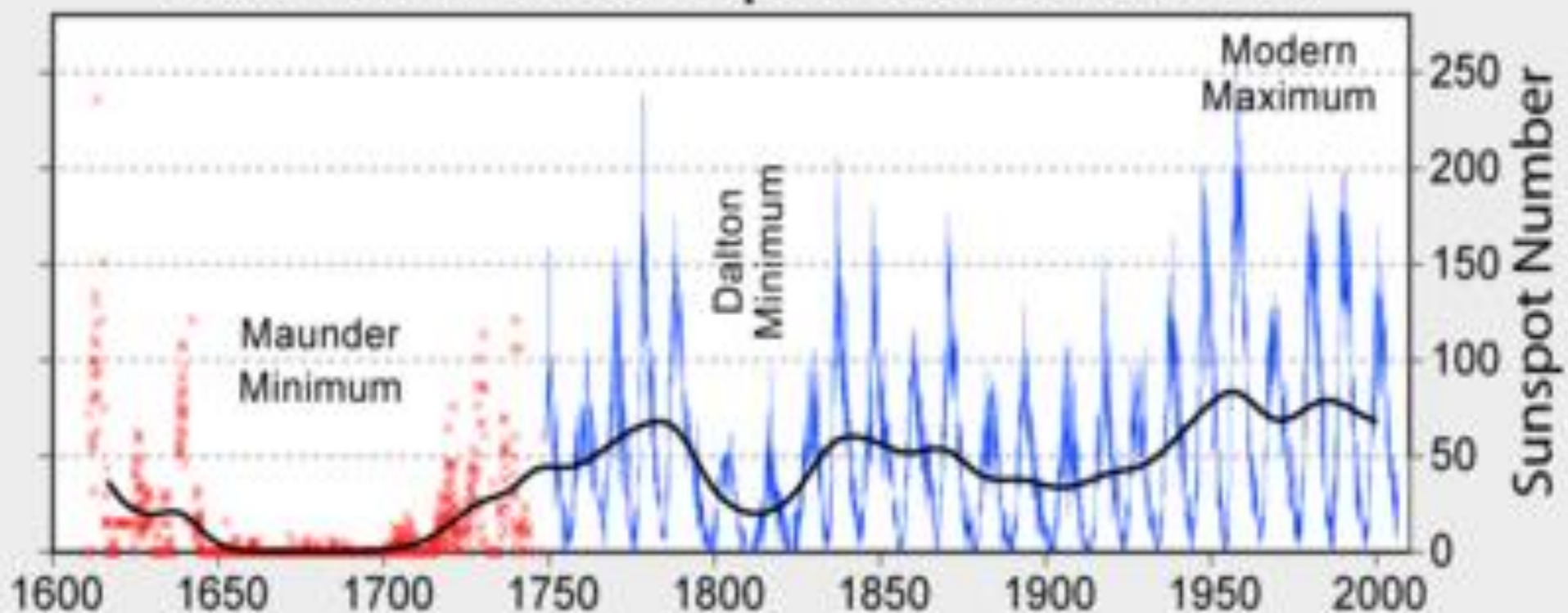


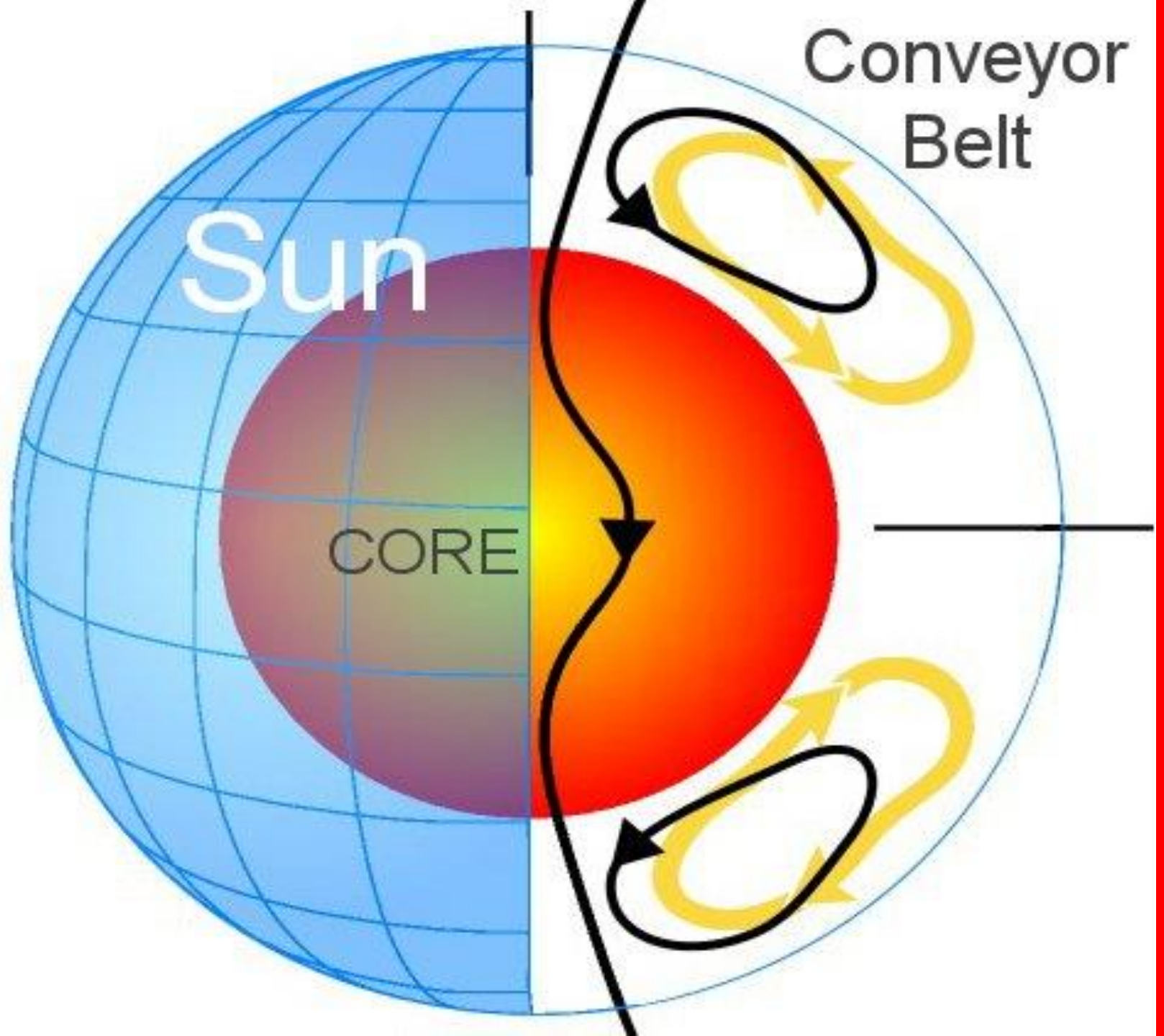
Spotless Days per Month

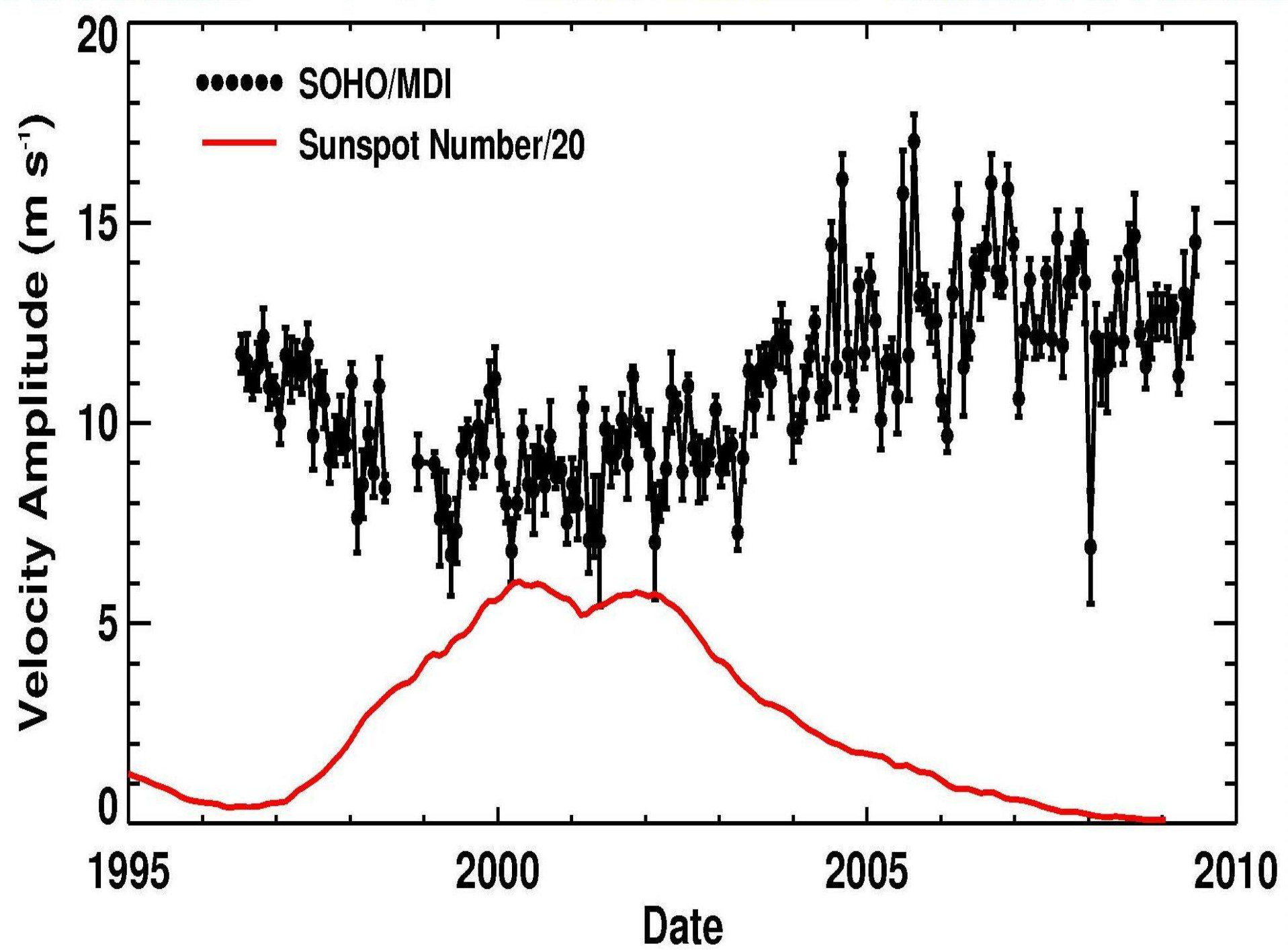
updated: June 30, 2008



400 Years of Sunspot Observations

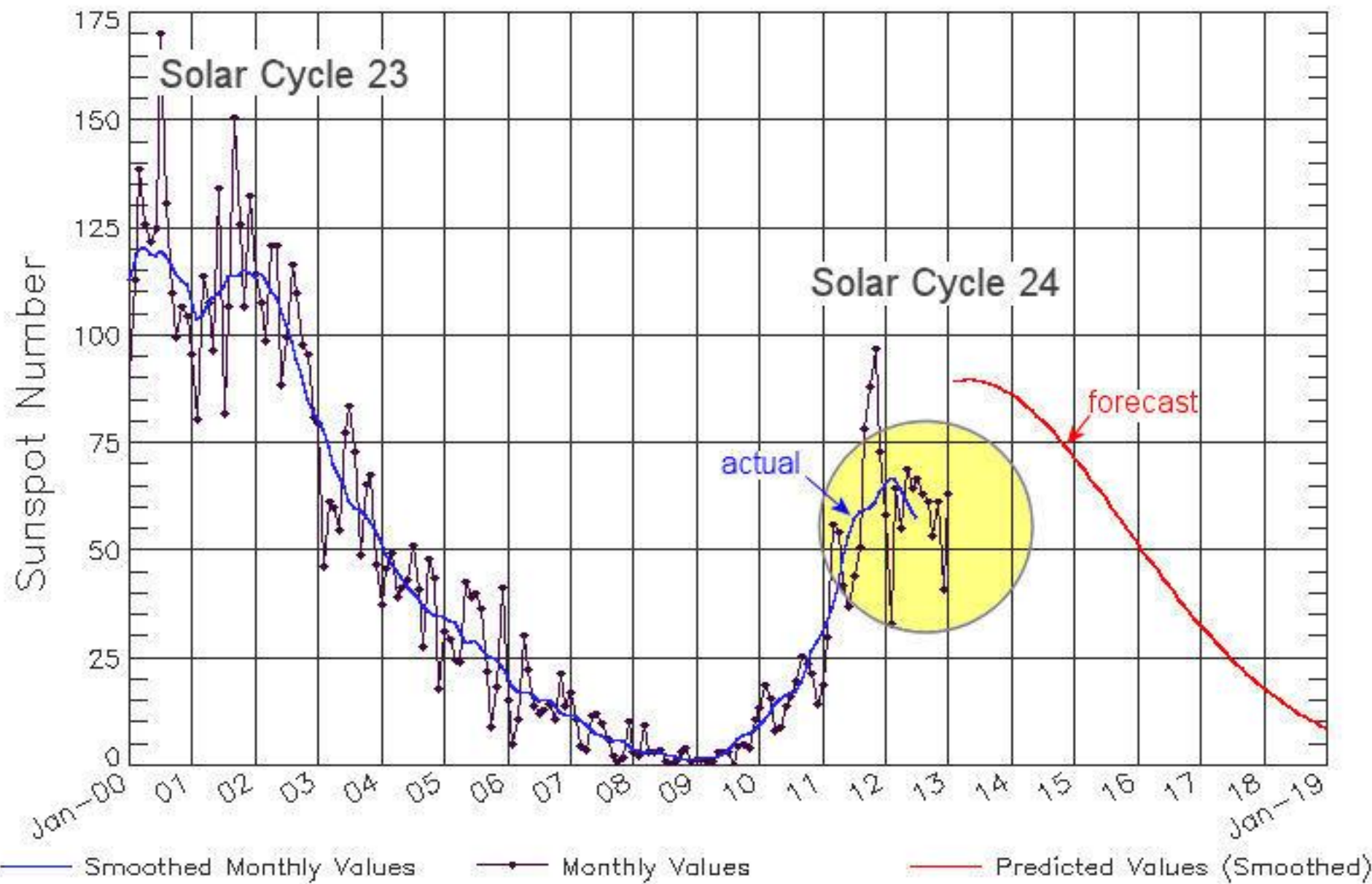




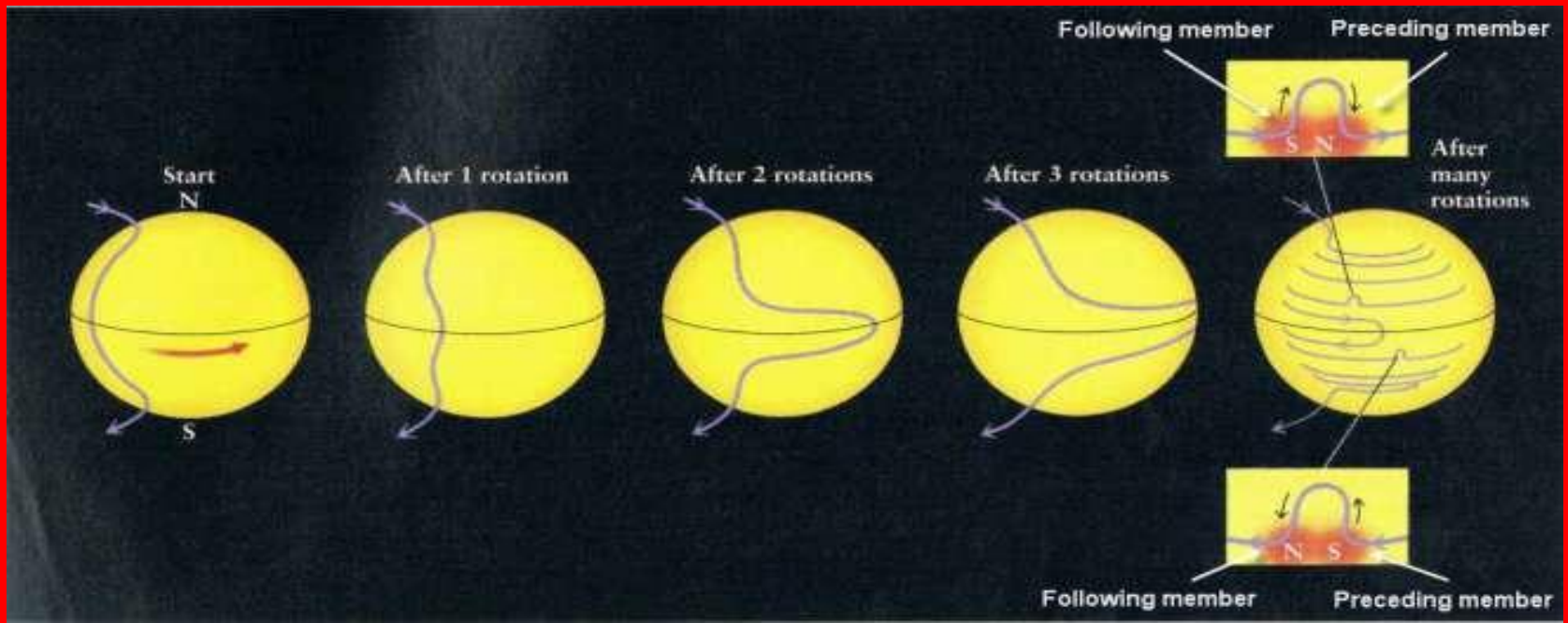
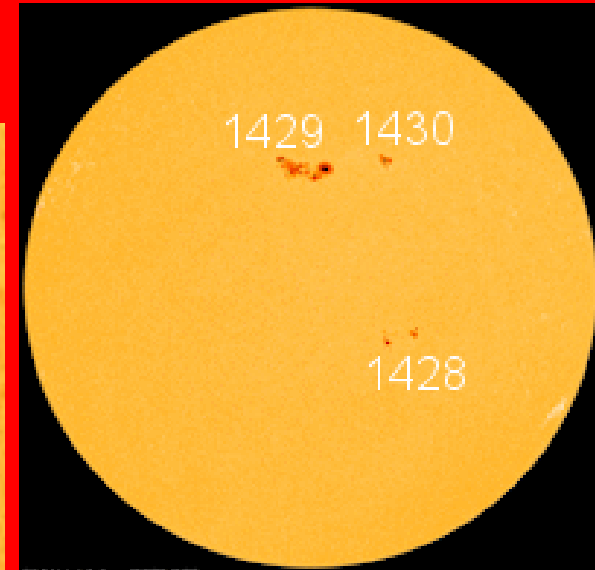
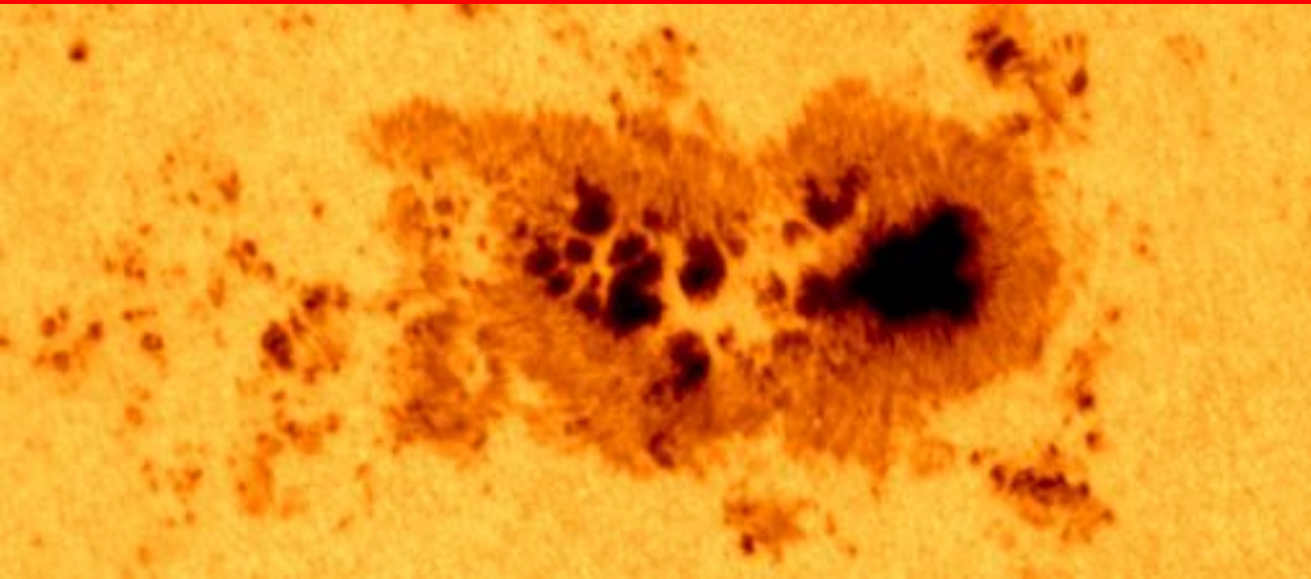


ISES Solar Cycle Sunspot Number Progression

Observed data through Jan 2013

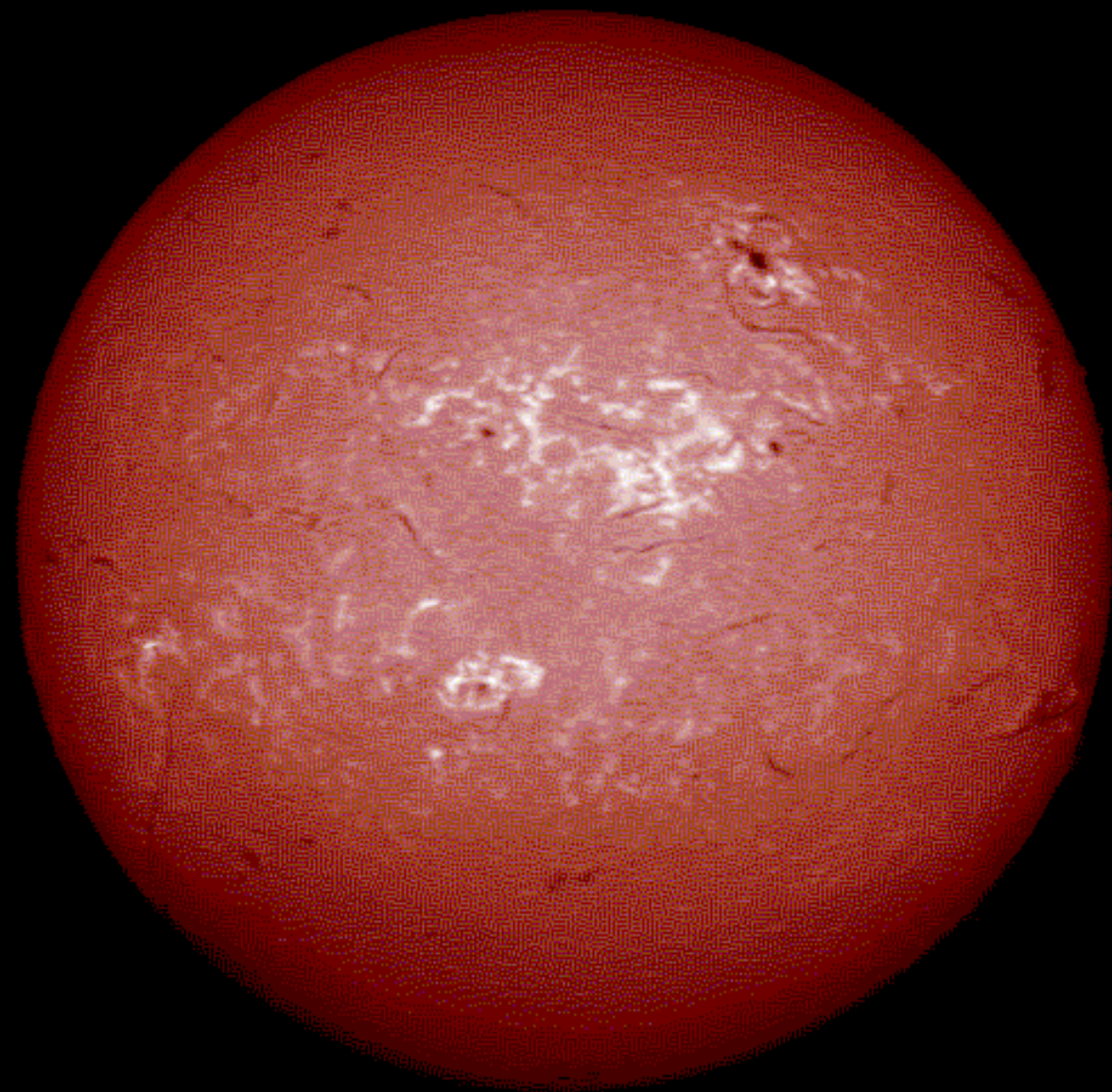


MARCH 2012

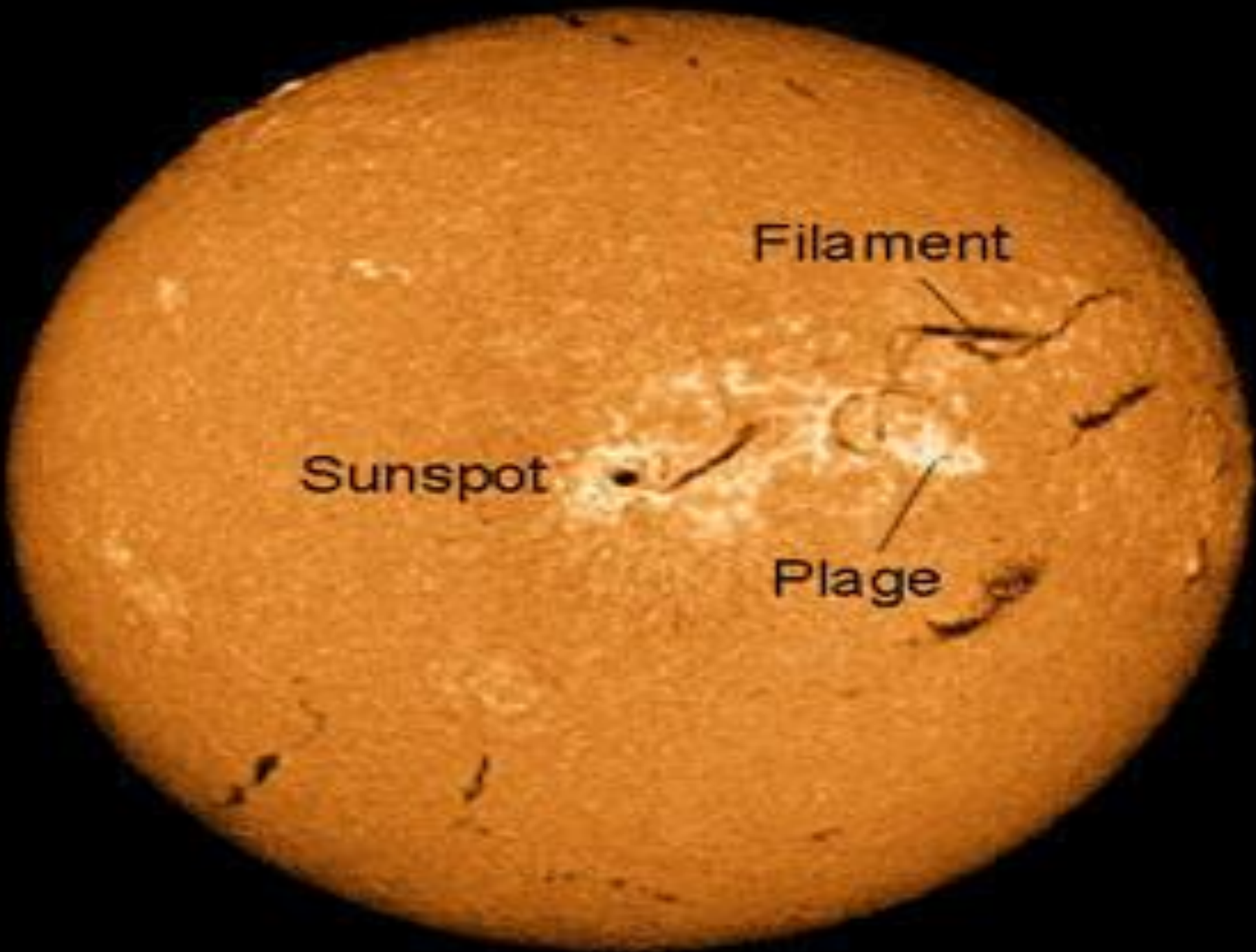


HI 6563 Å

BB50



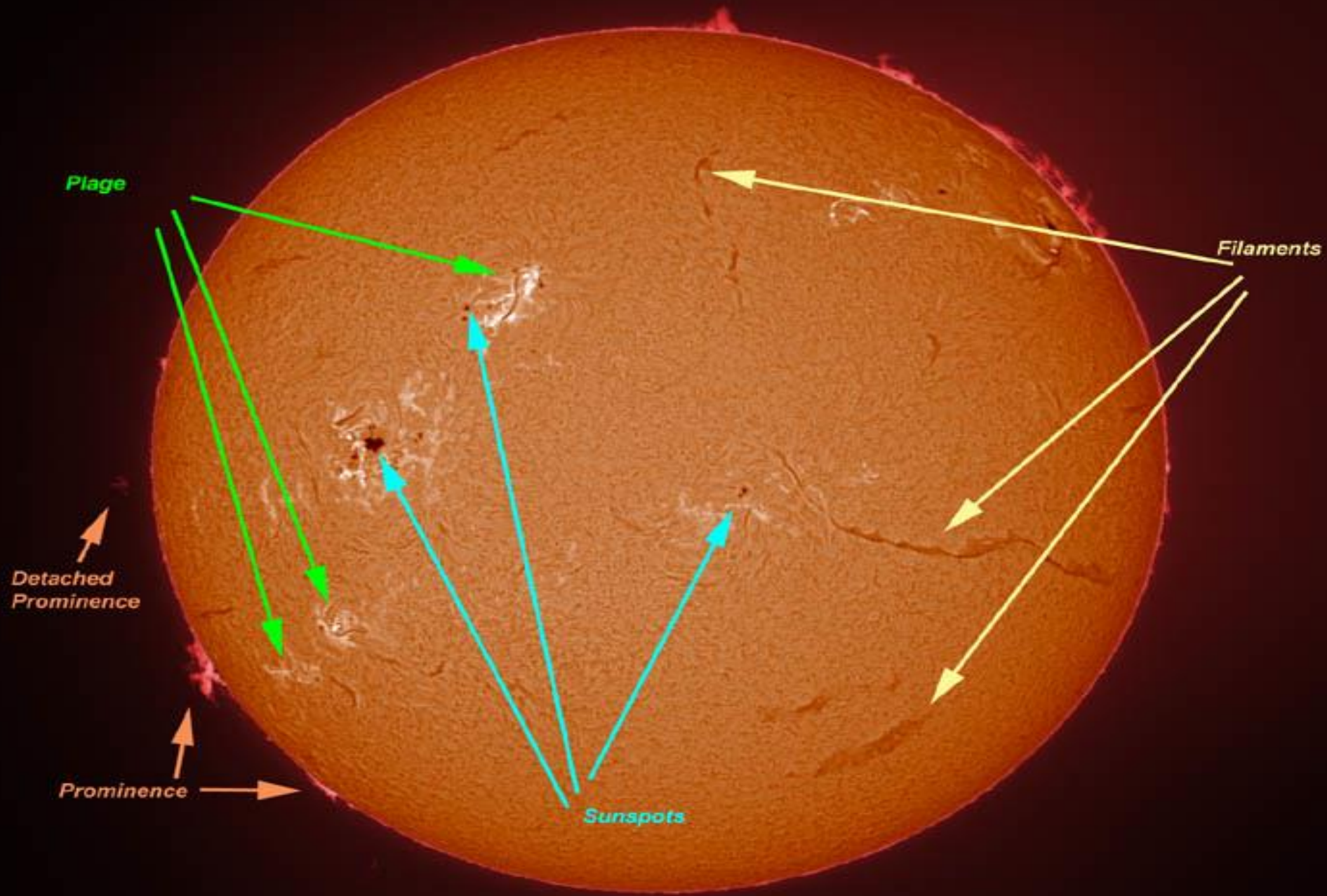
1991 May 13



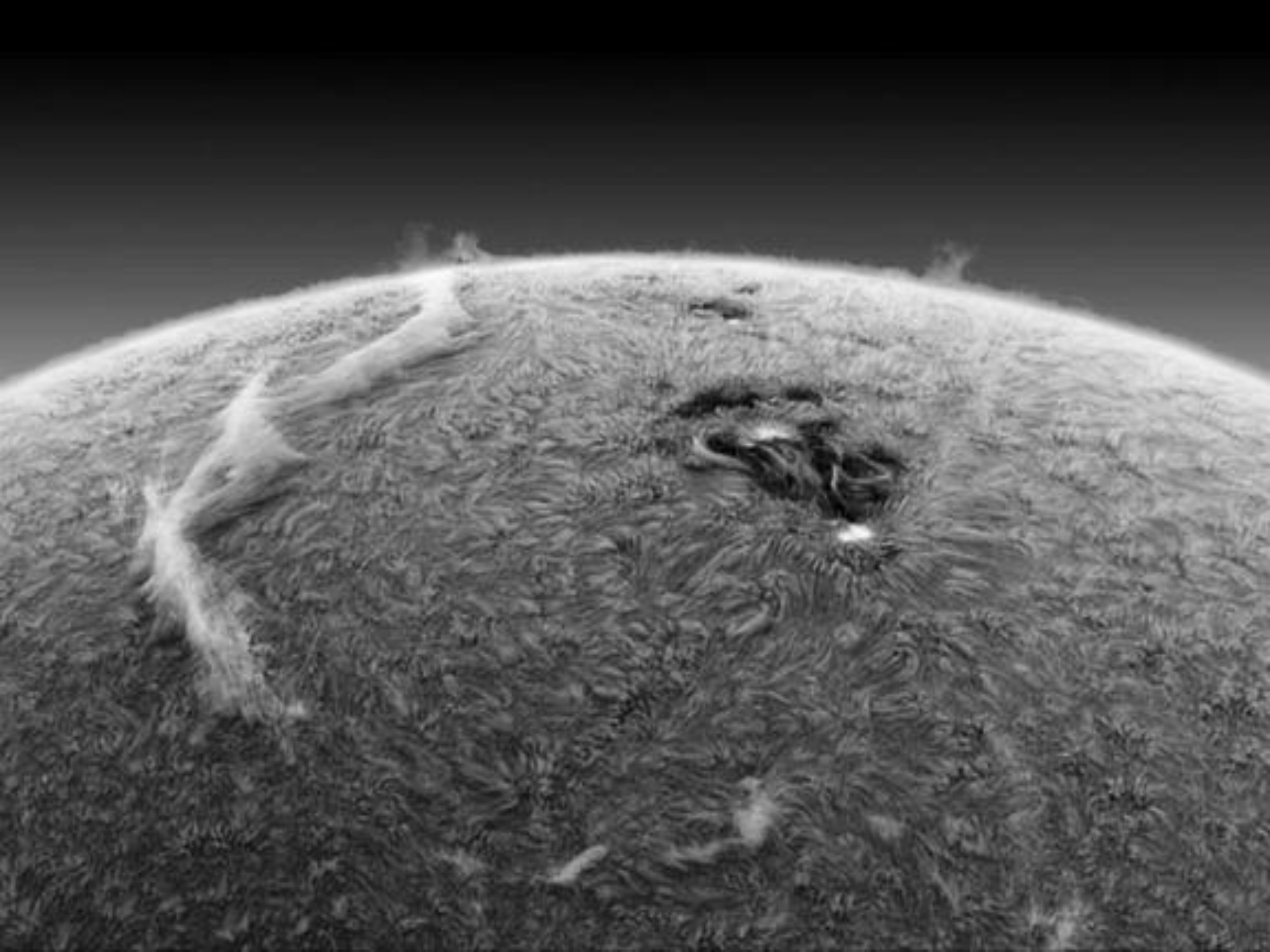
Filament

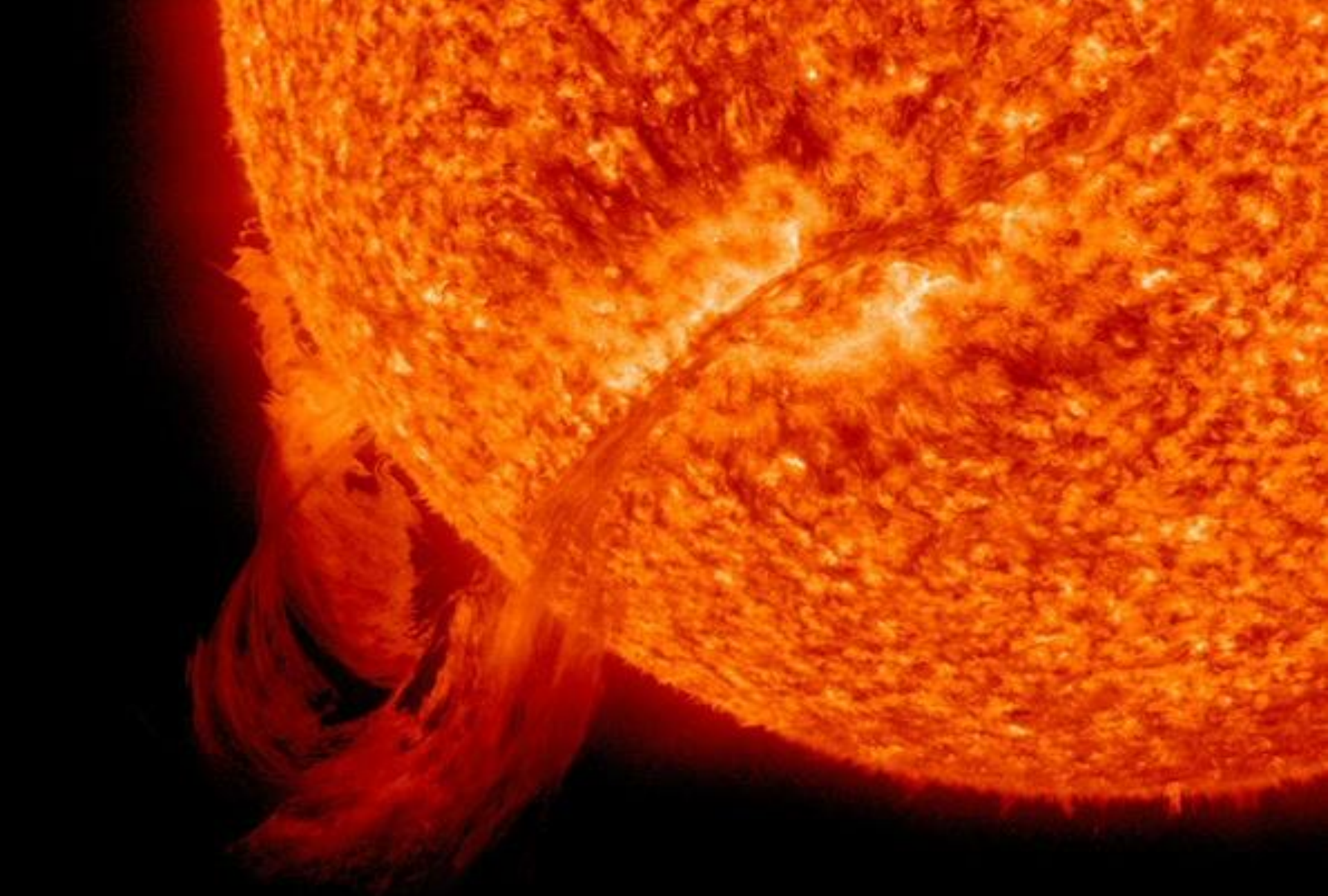
Sunspot

Plage

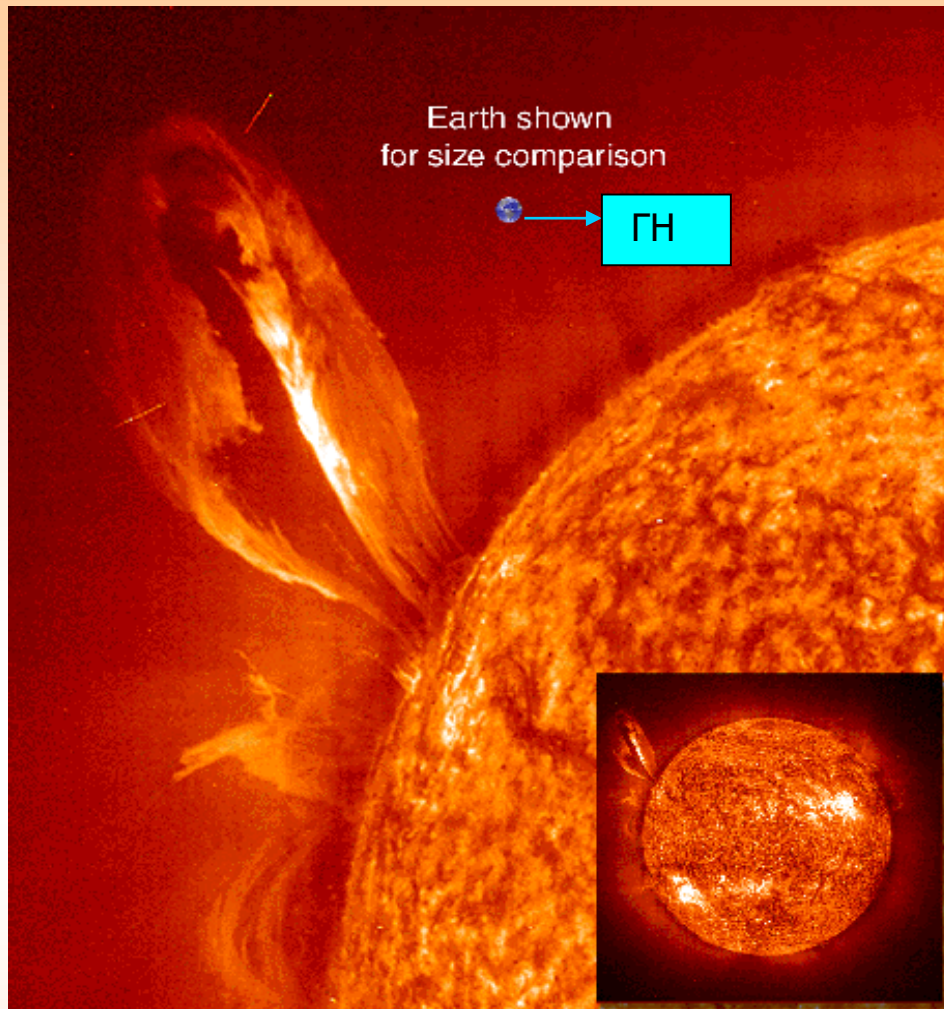




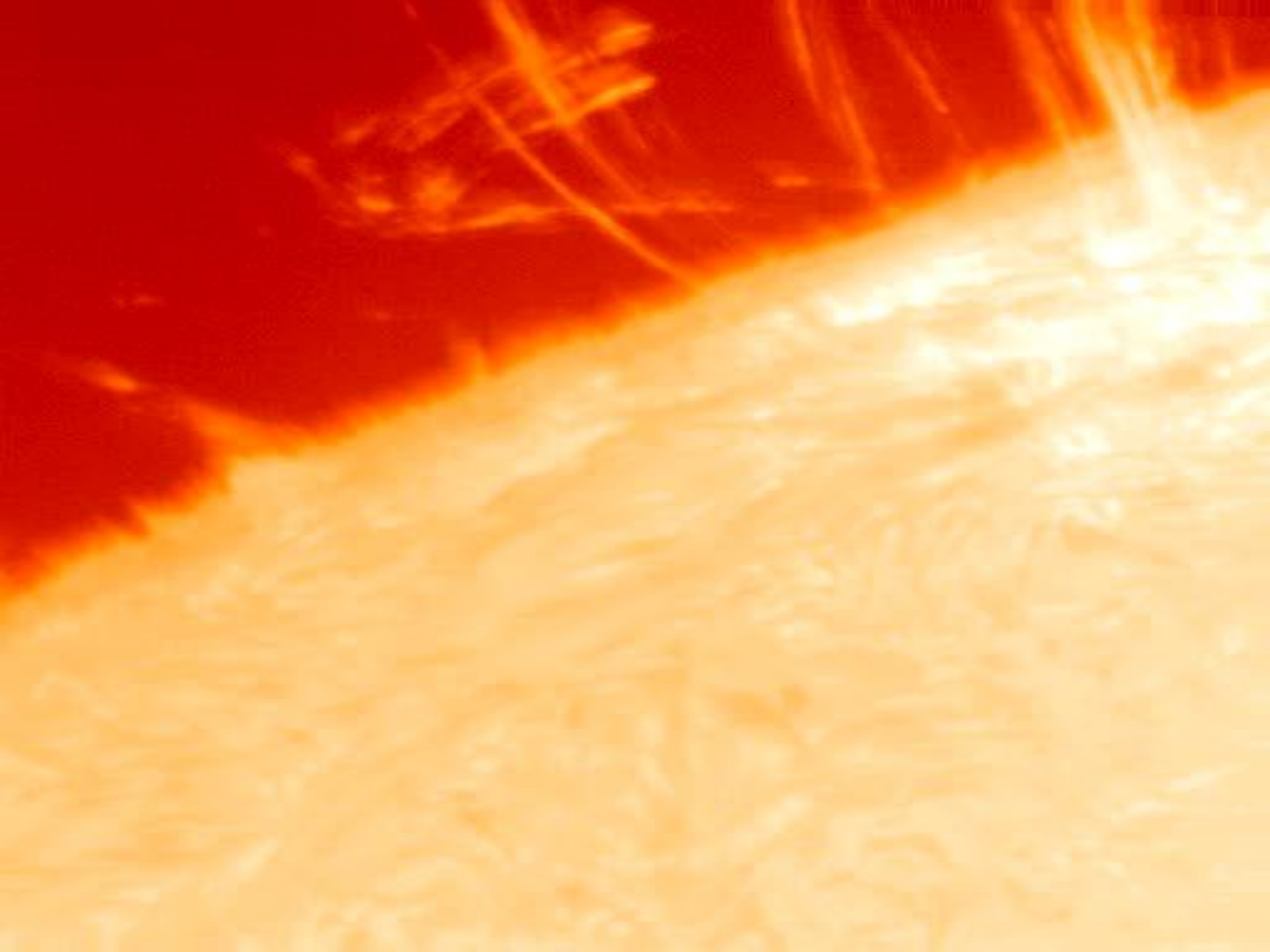




SDO/AIA 304 2010-12-06 17:49:57 UT



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.

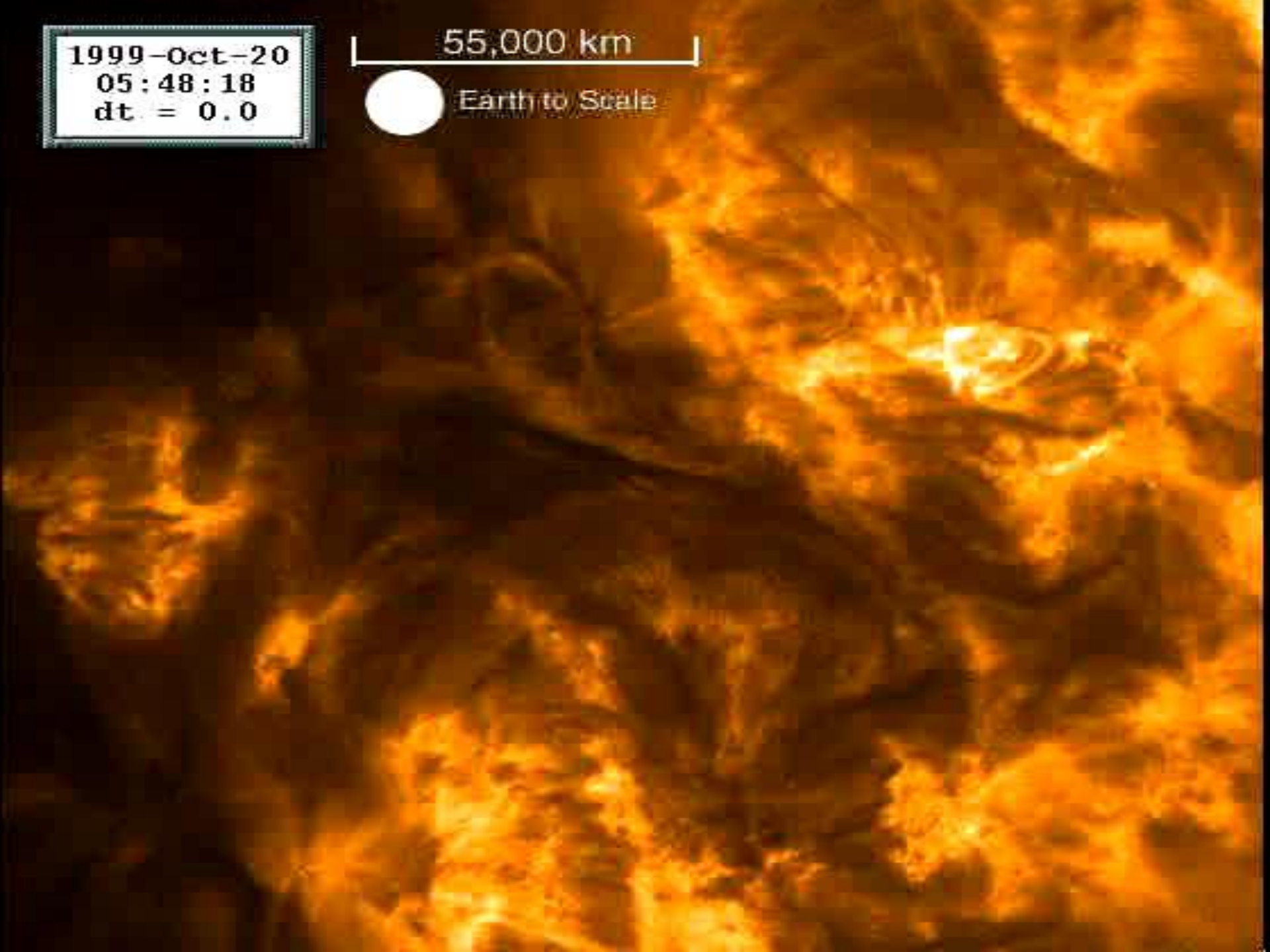


1999-Oct-20
05:48:18
dt = 0.0

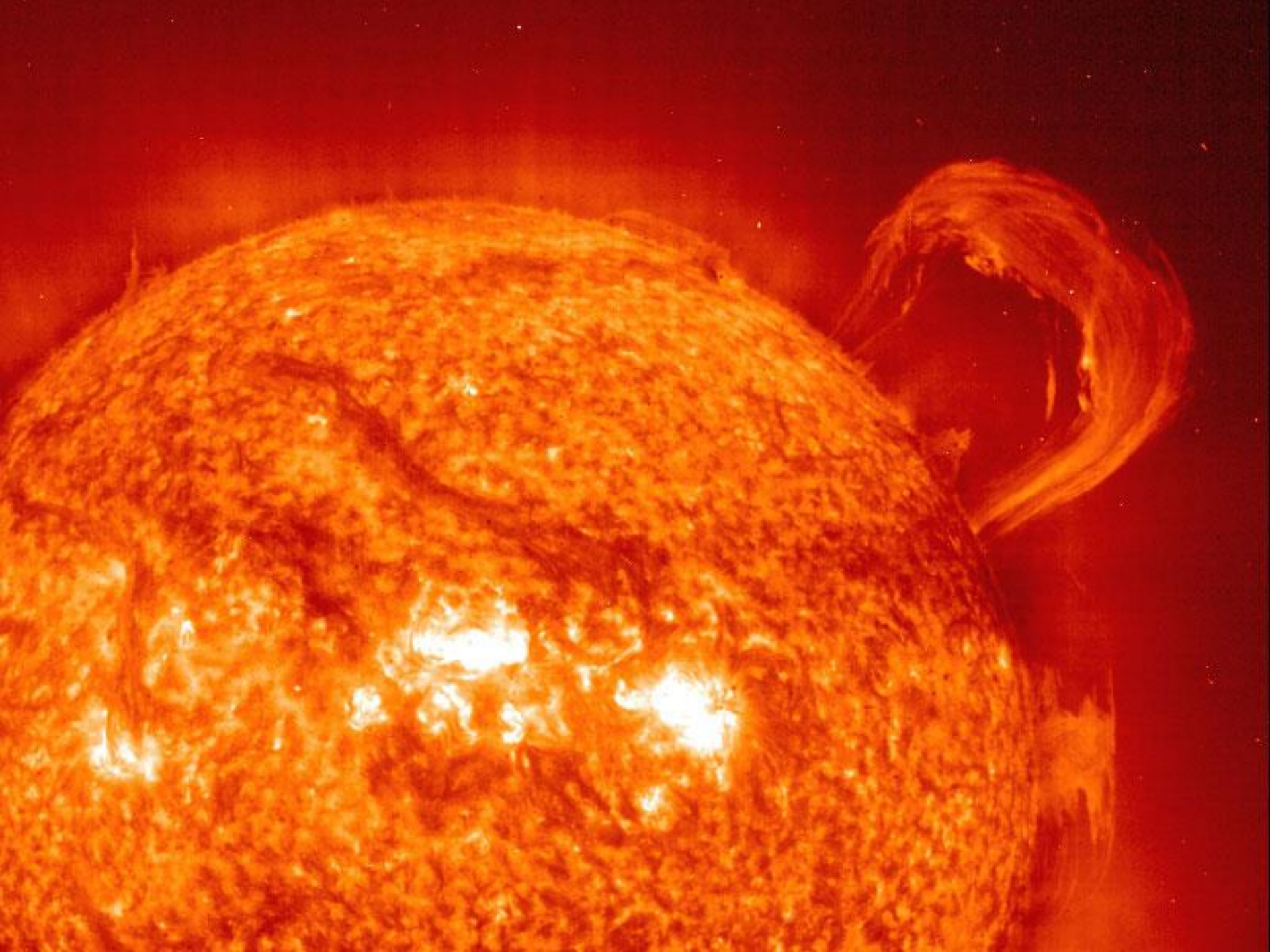
55,000 km

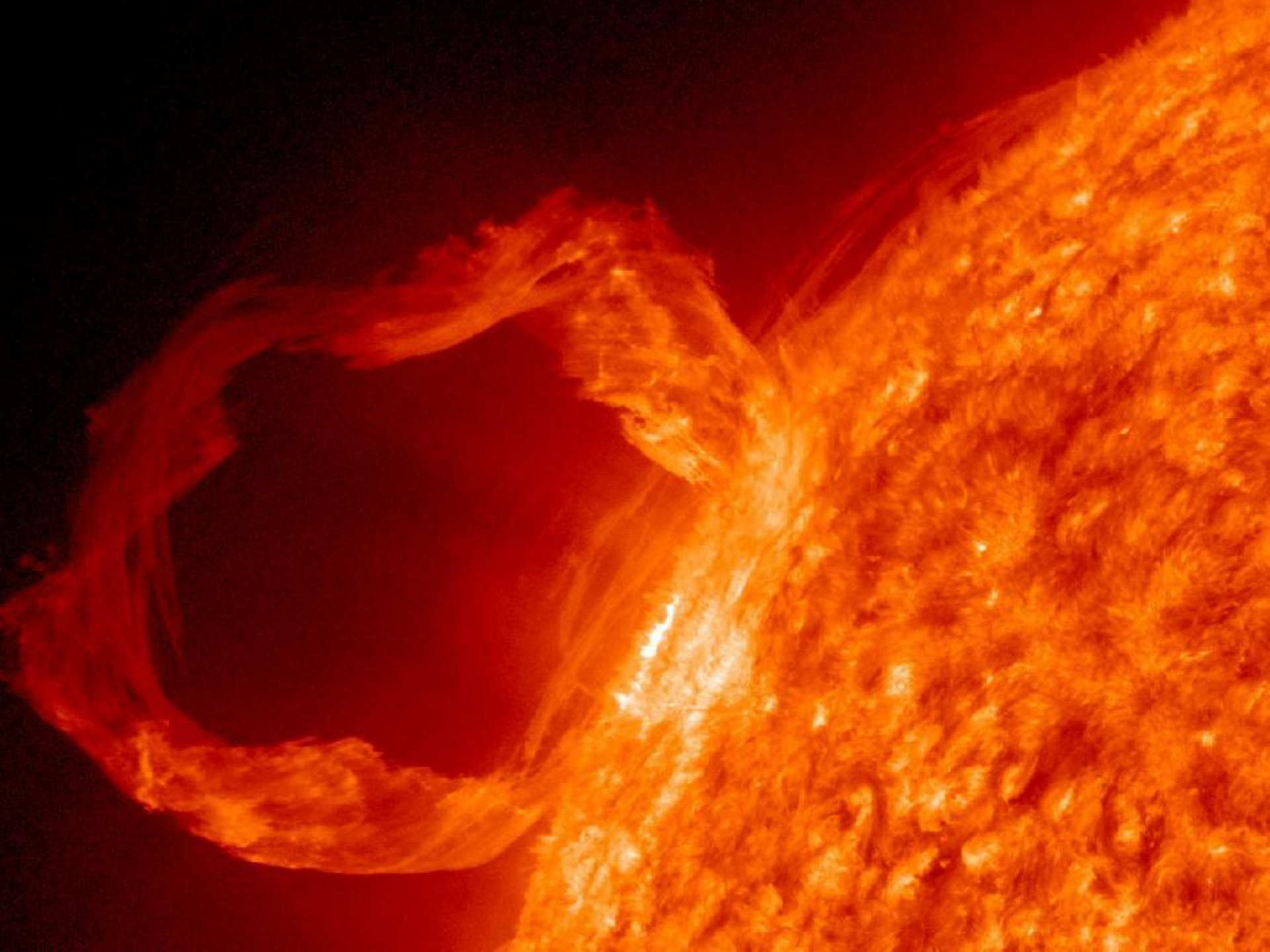


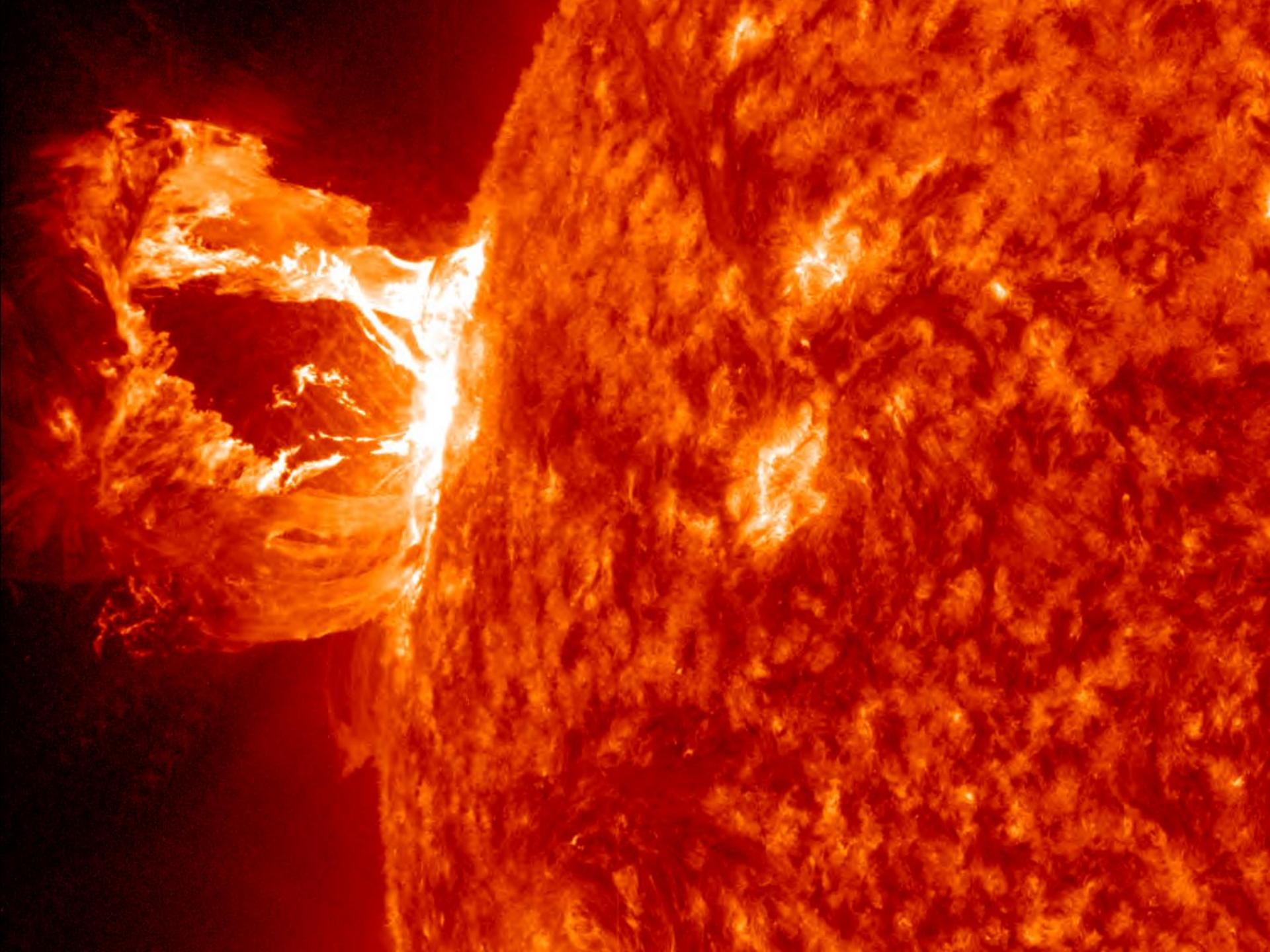
Earth to Scale

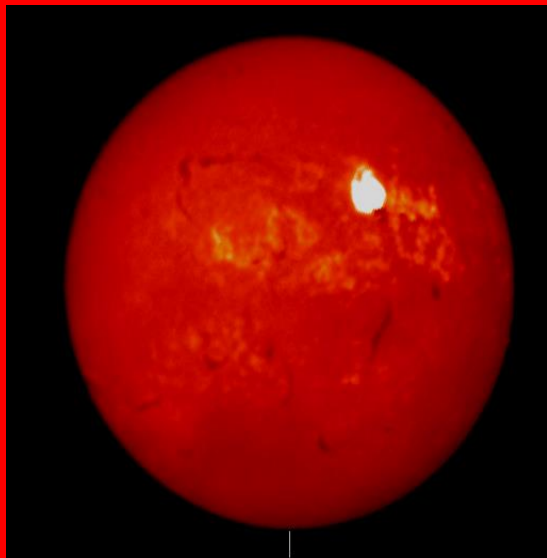
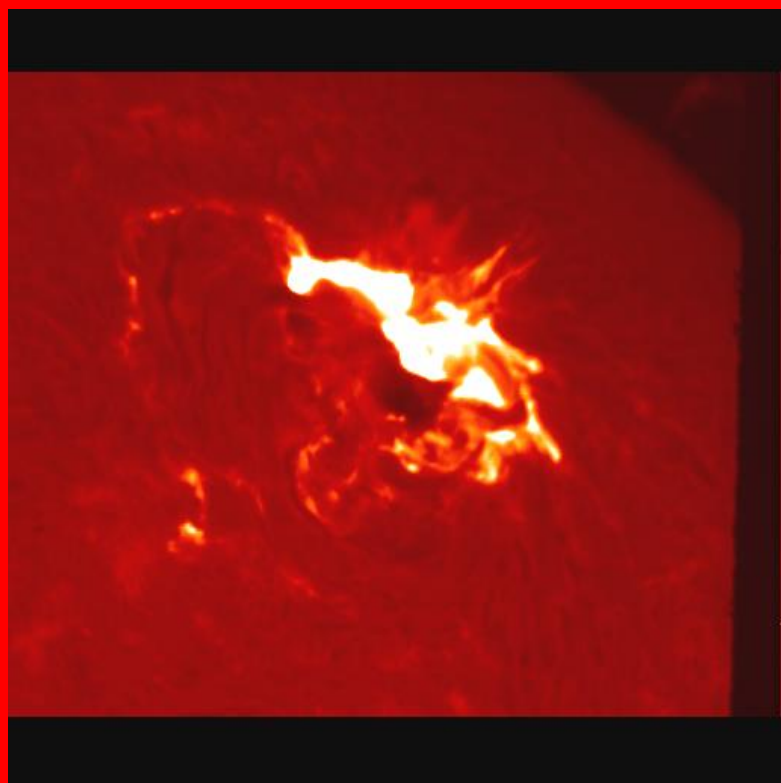
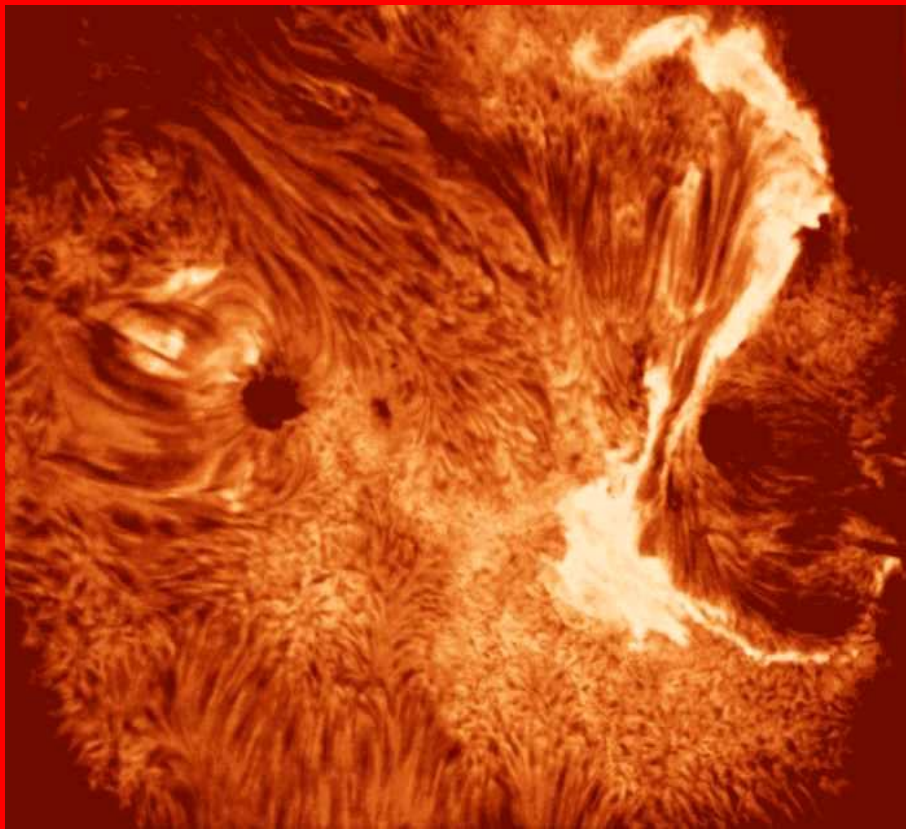


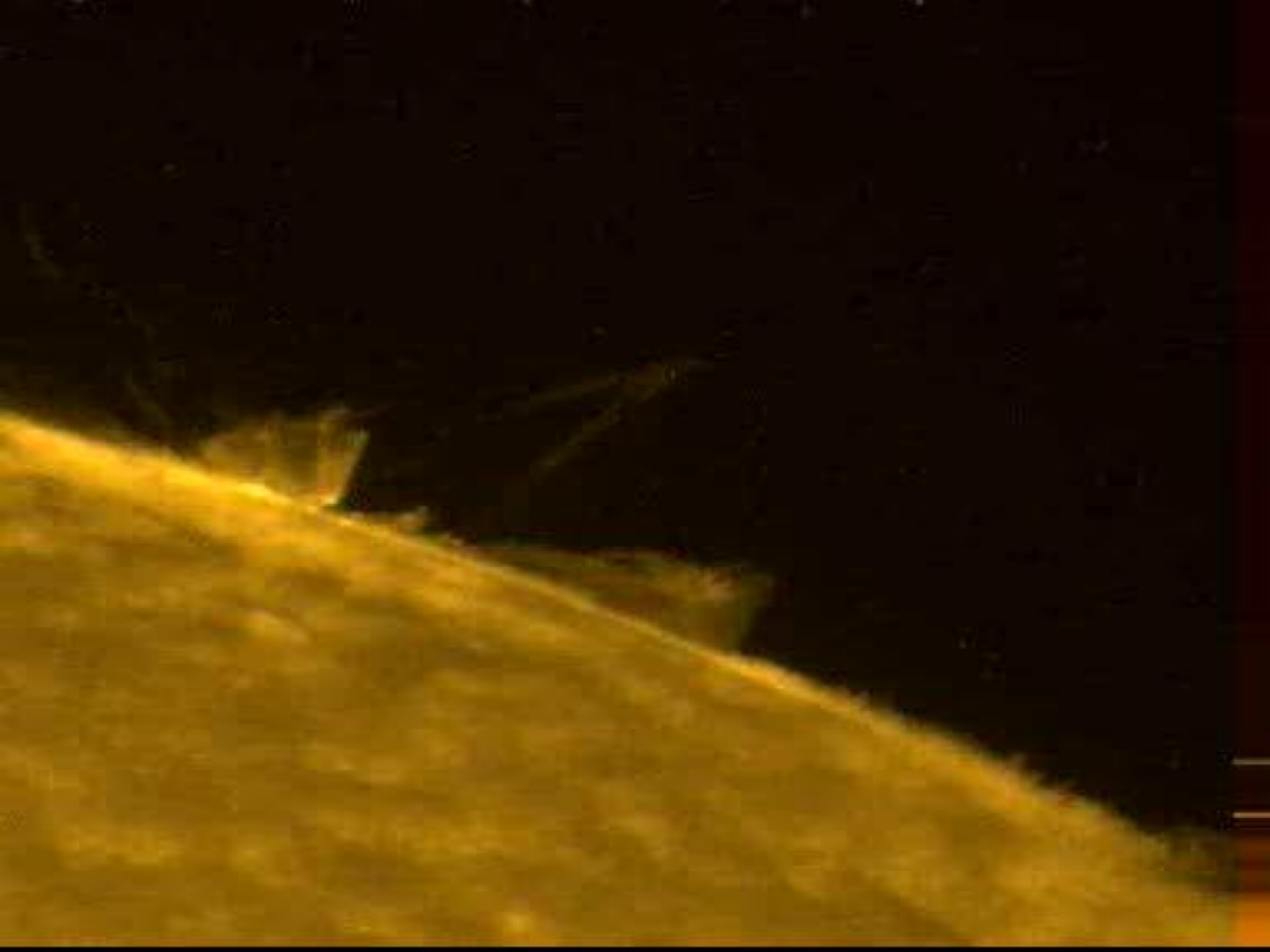




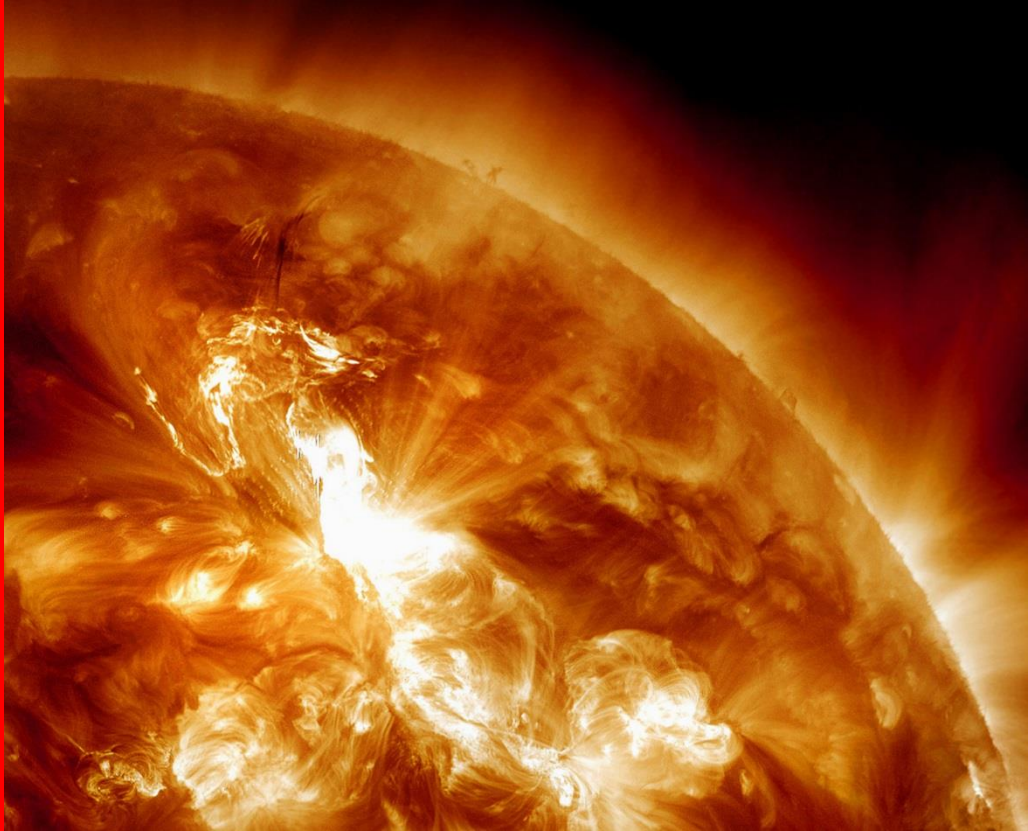
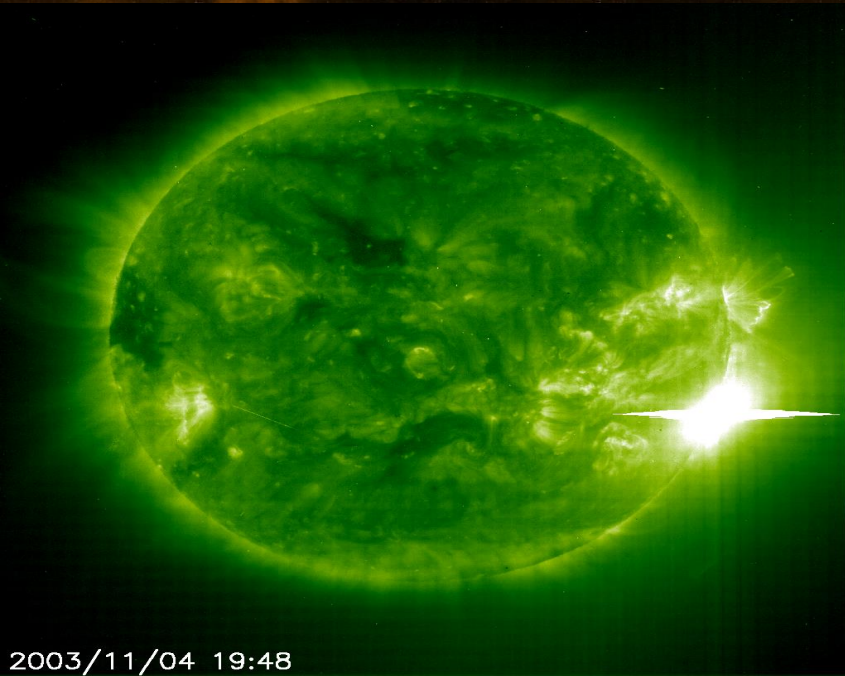
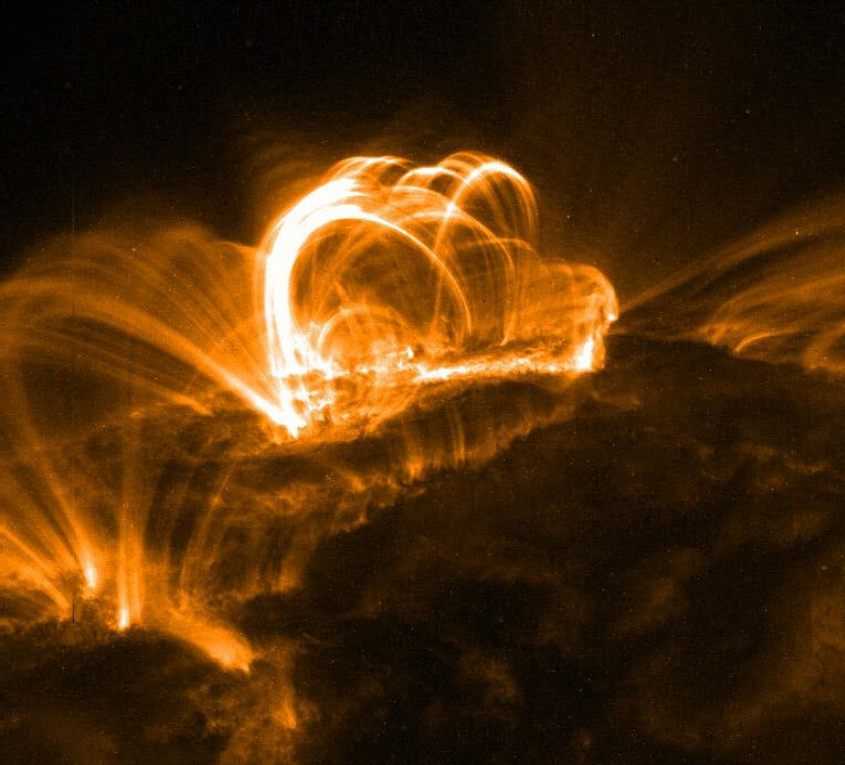






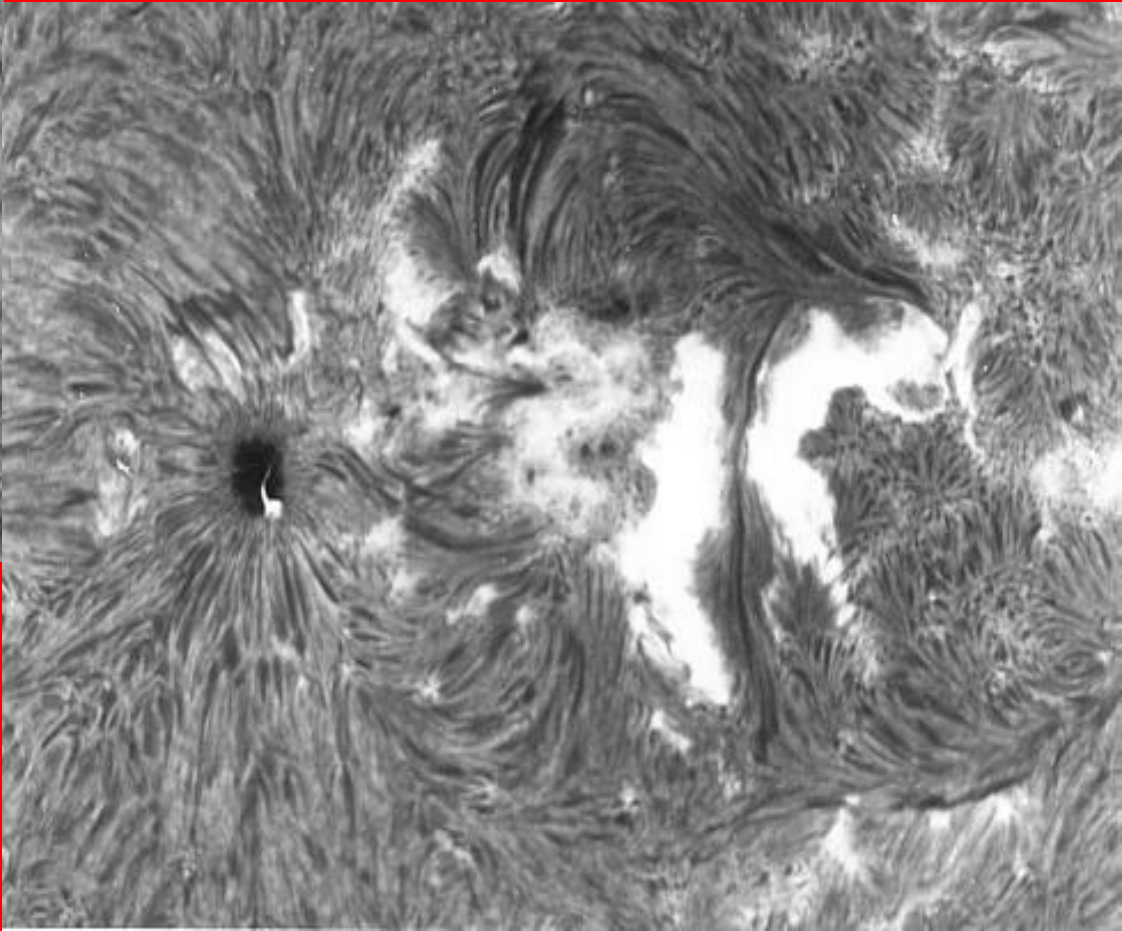
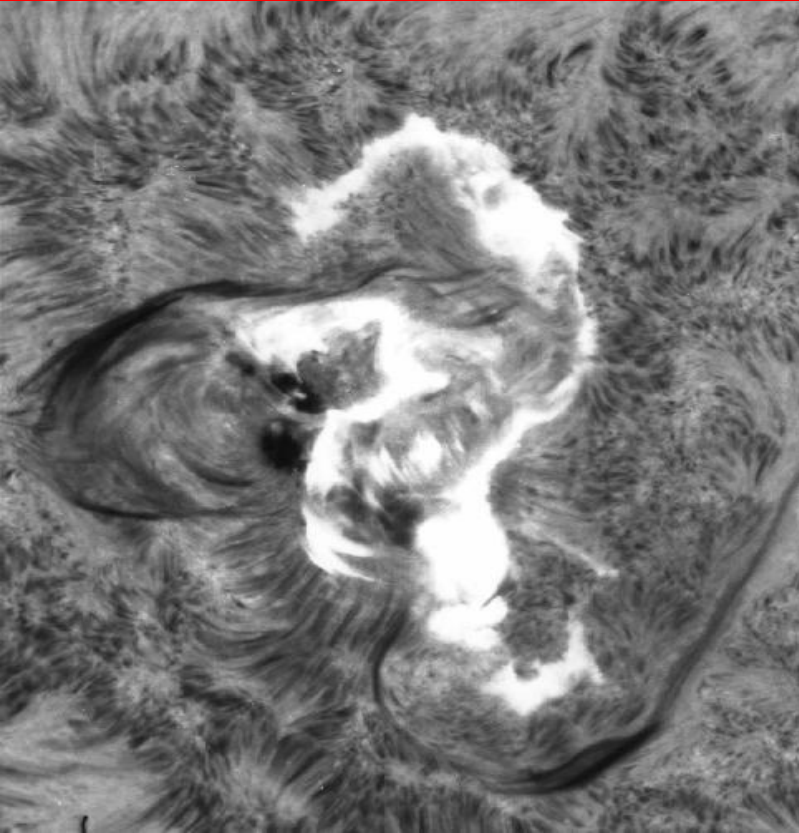




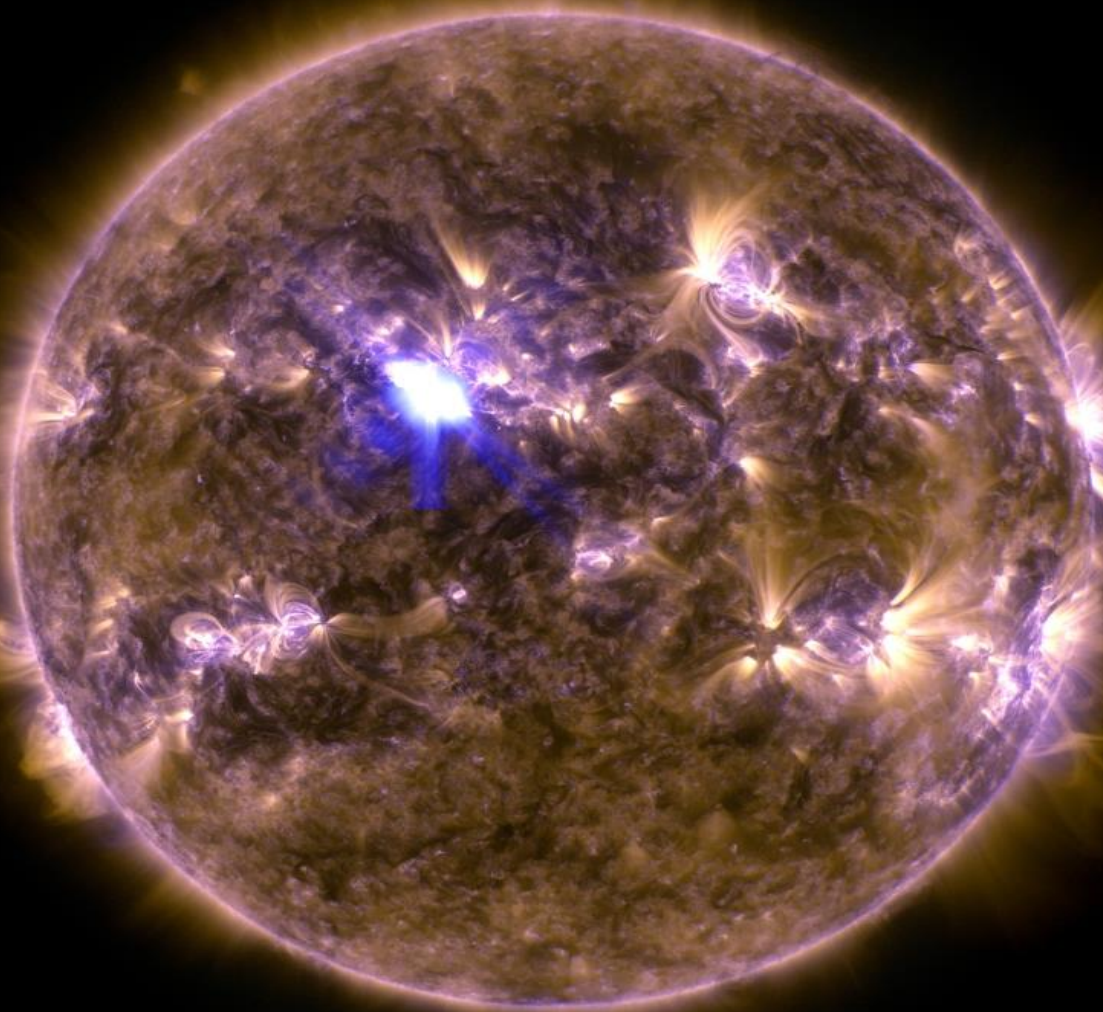
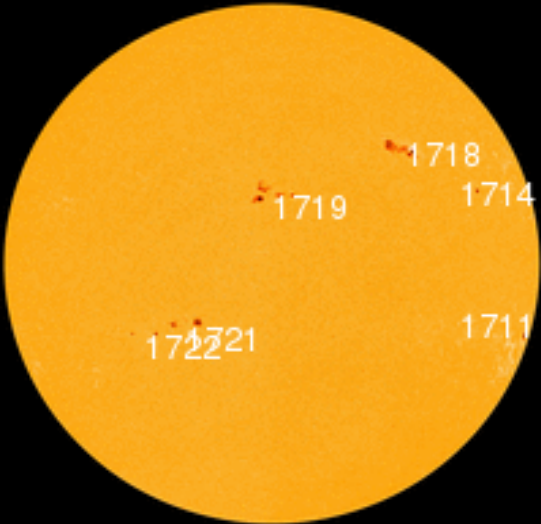


2003/11/04 19:48

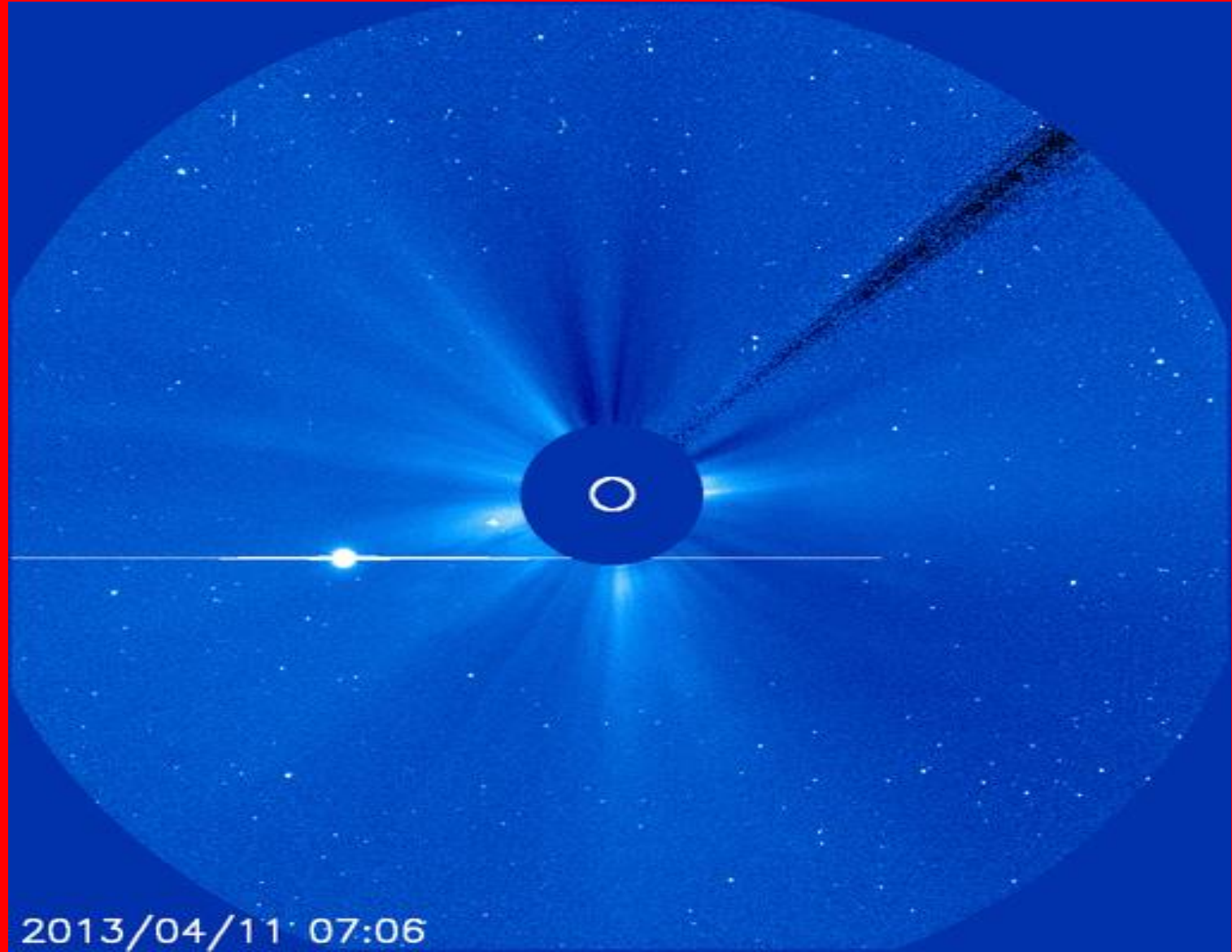
7 AUGUST 1972



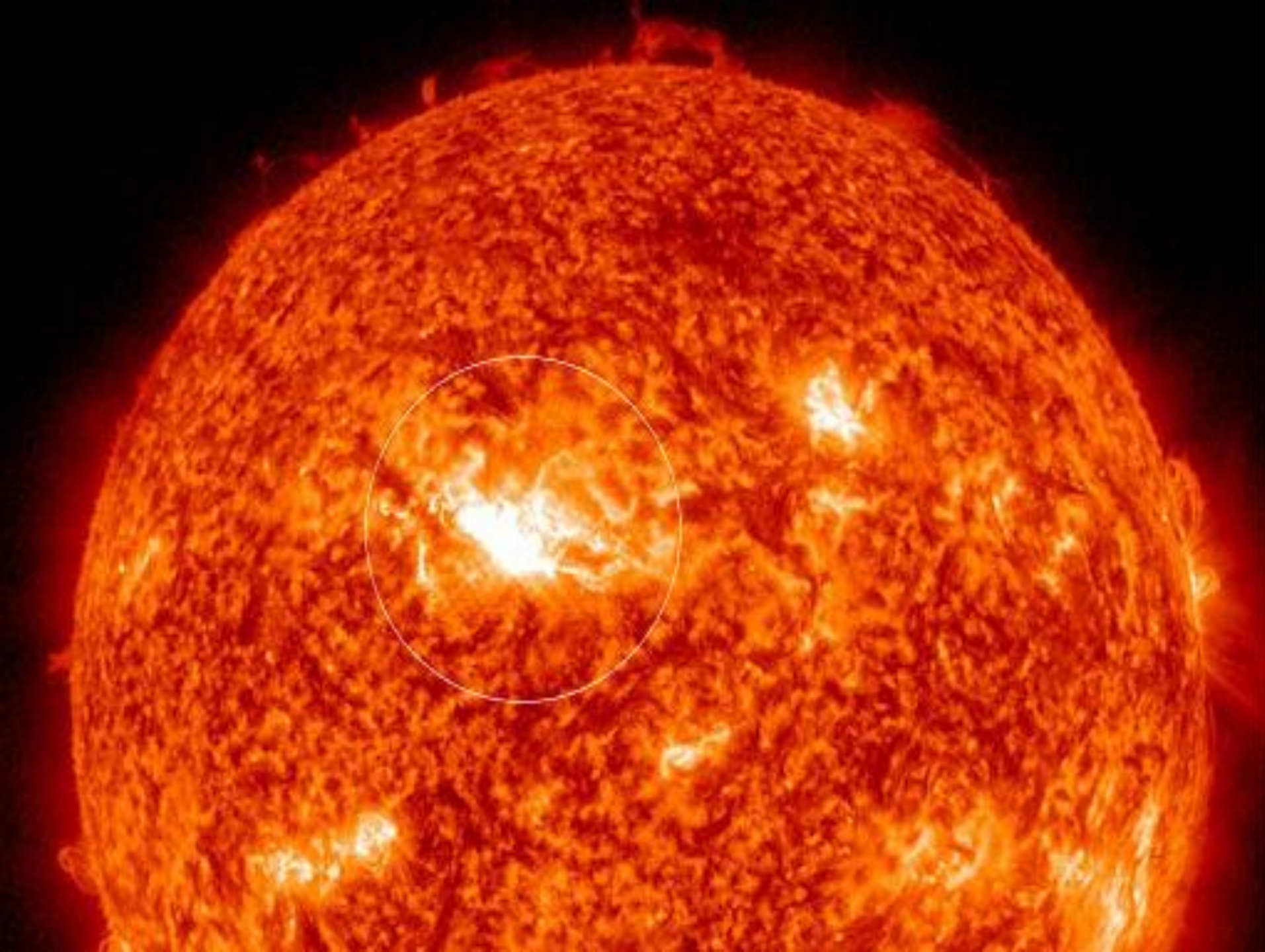
11 APRIL 2013



11 APRIL 2013

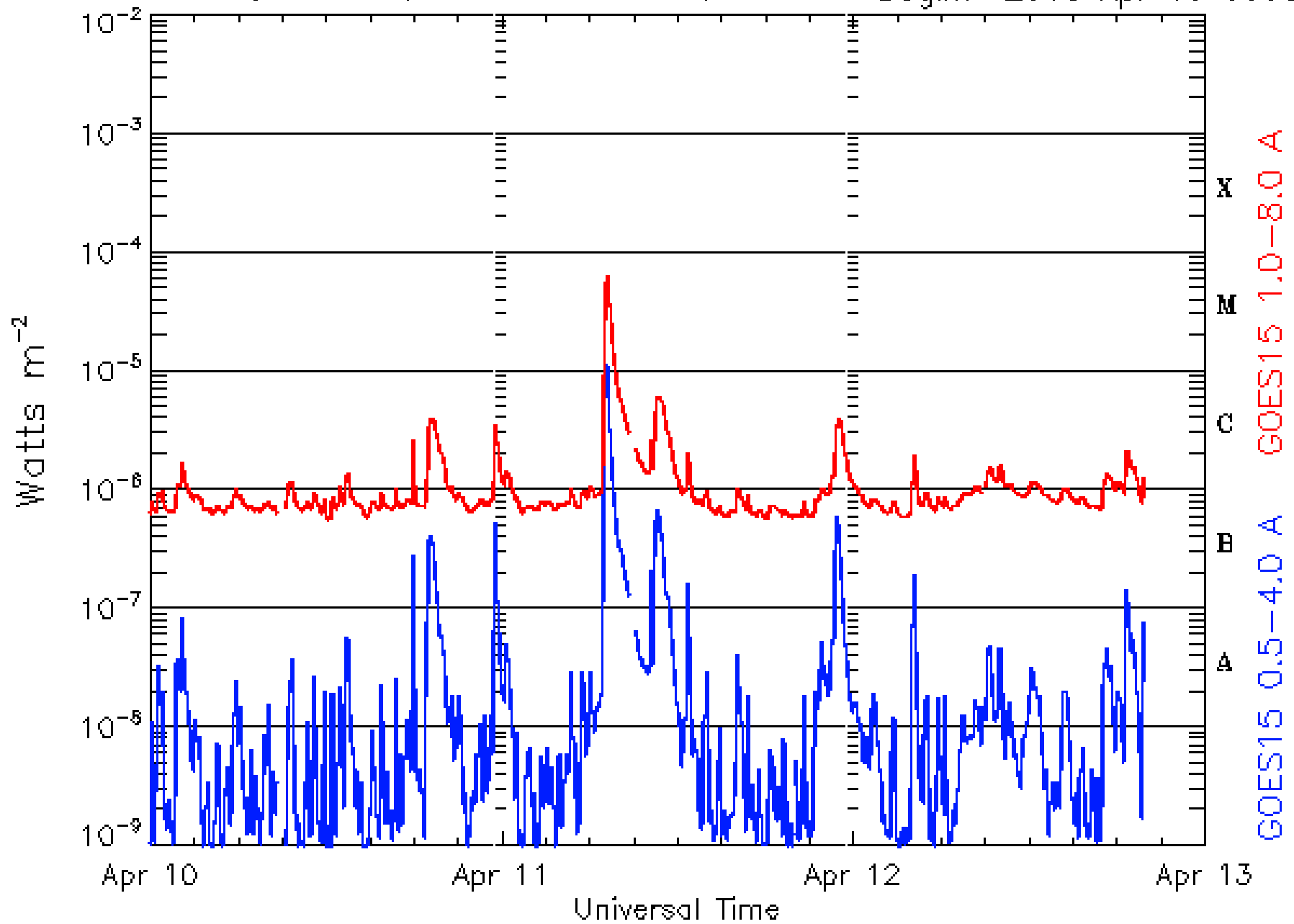


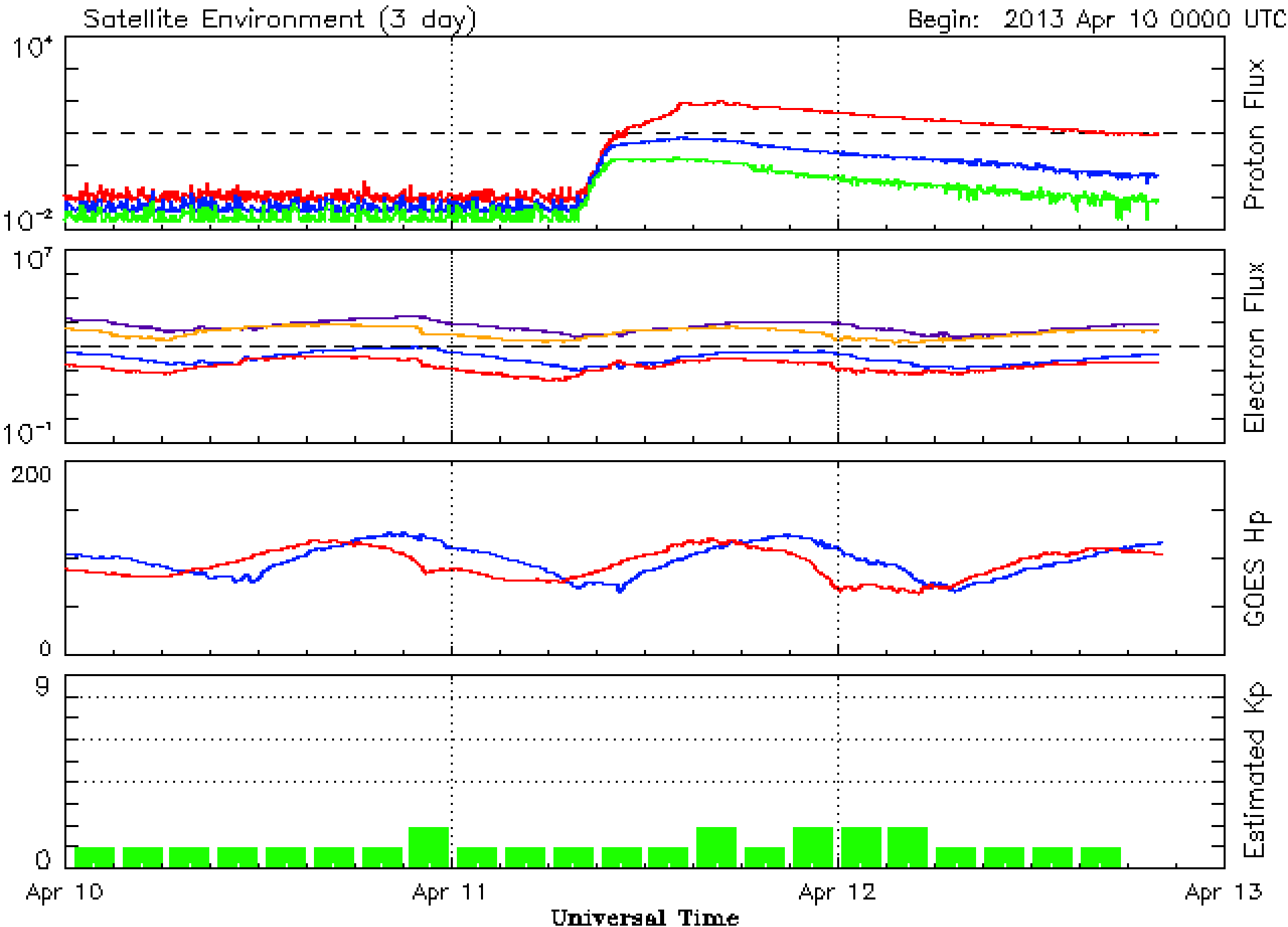
2013/04/11 07:06



GOES Xray Flux (5 minute data)

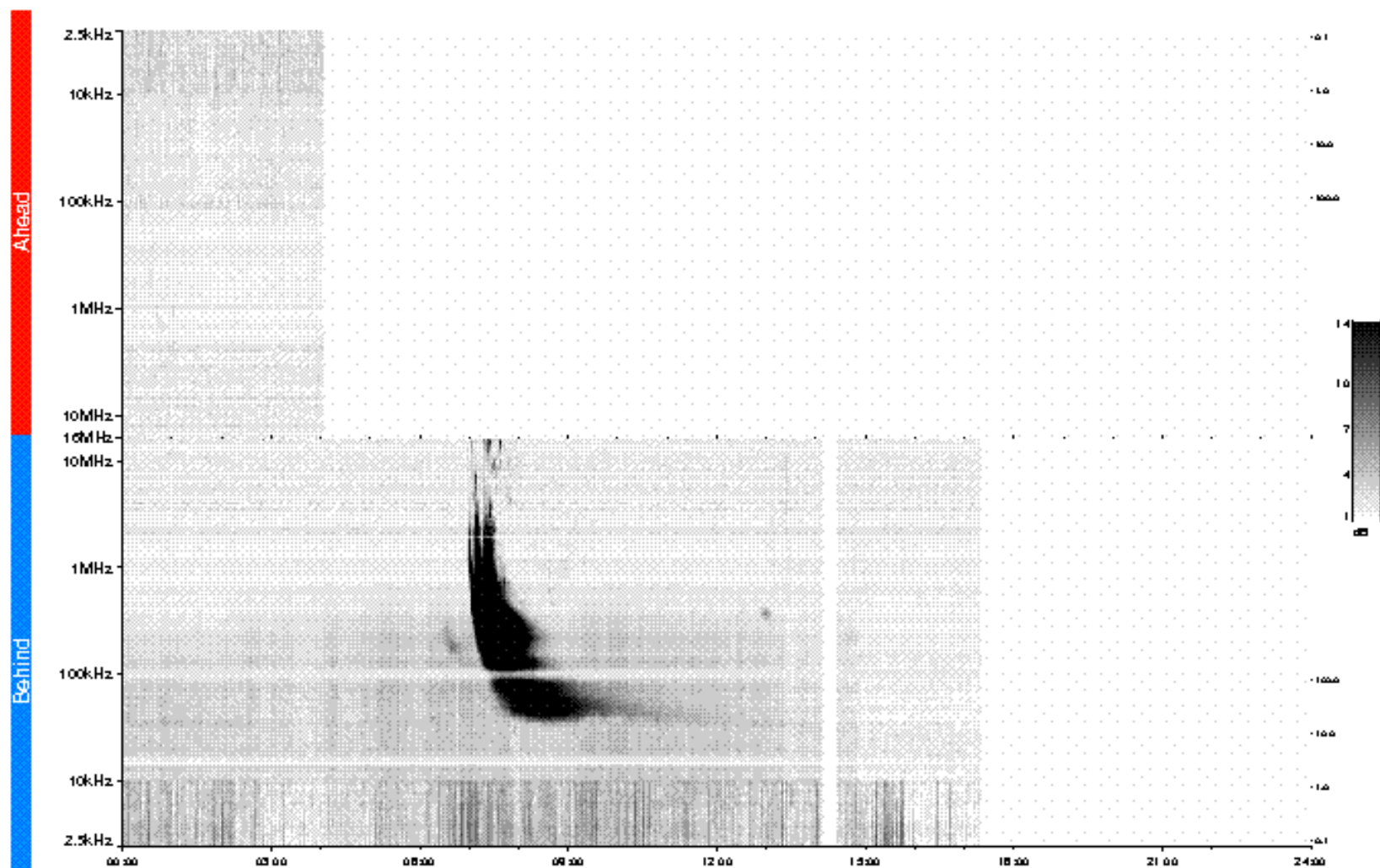
Begin: 2013 Apr 10 0000 UTC





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

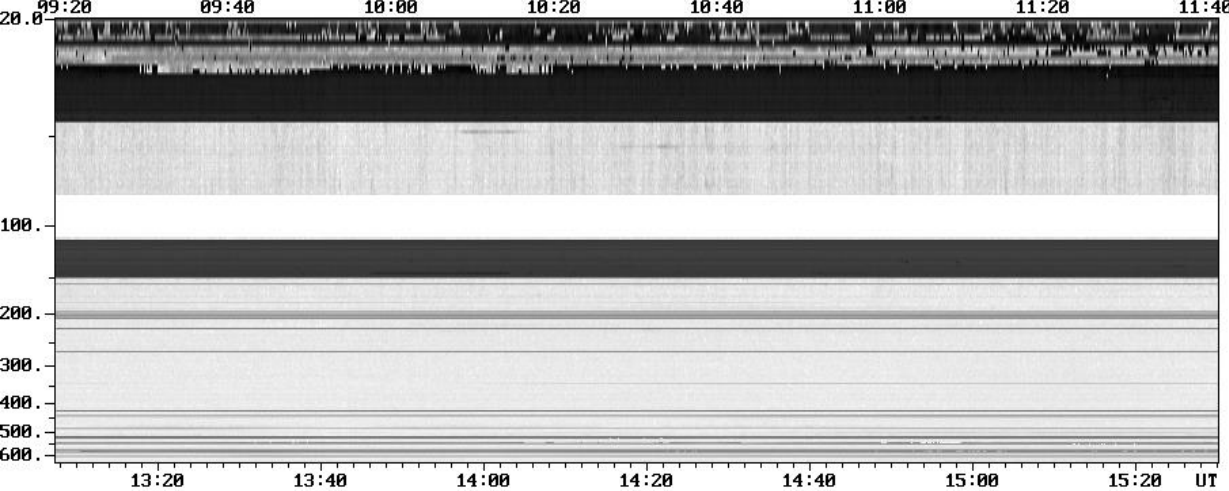
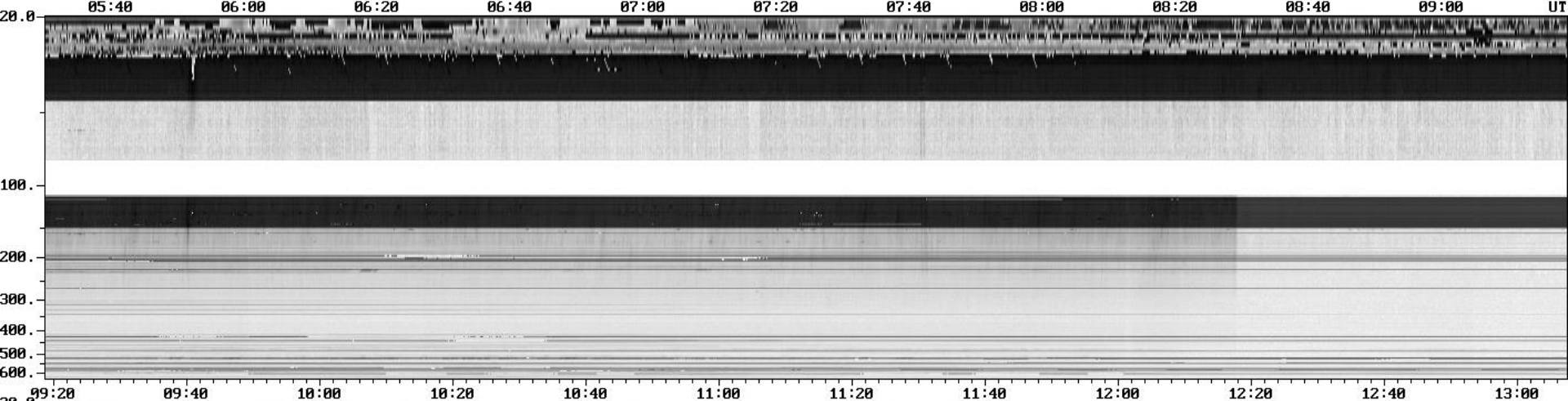
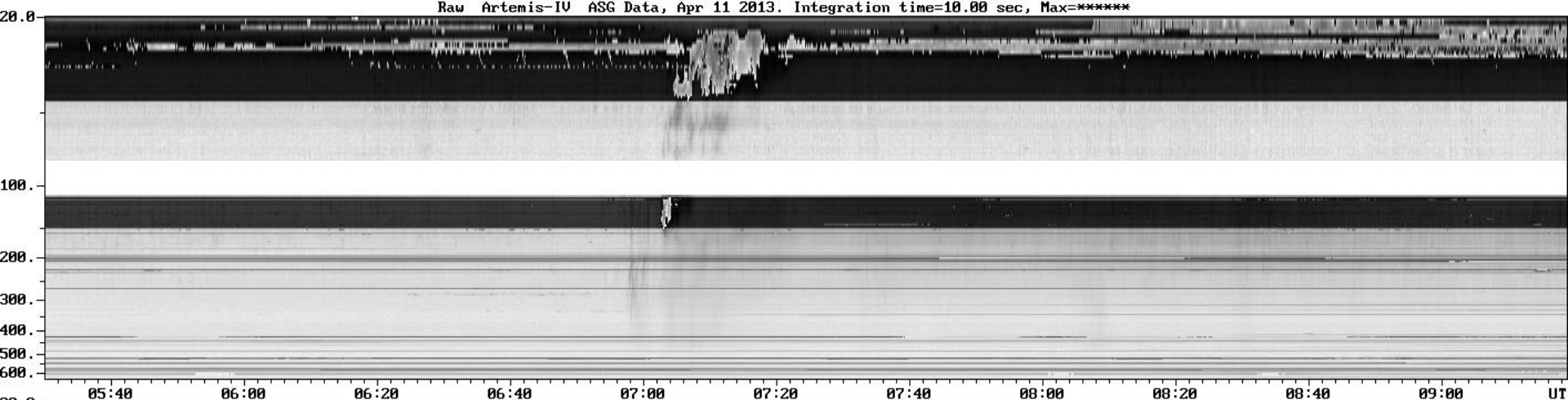
Ahead source file = stereo_ahead_2012_101_1_01.plp
Ahead PSE Angle = 333.3



Behind PSE Angle = 333.3
Behind source file = stereo_behind_2012_101_1_01.plp

Time (UTC)

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



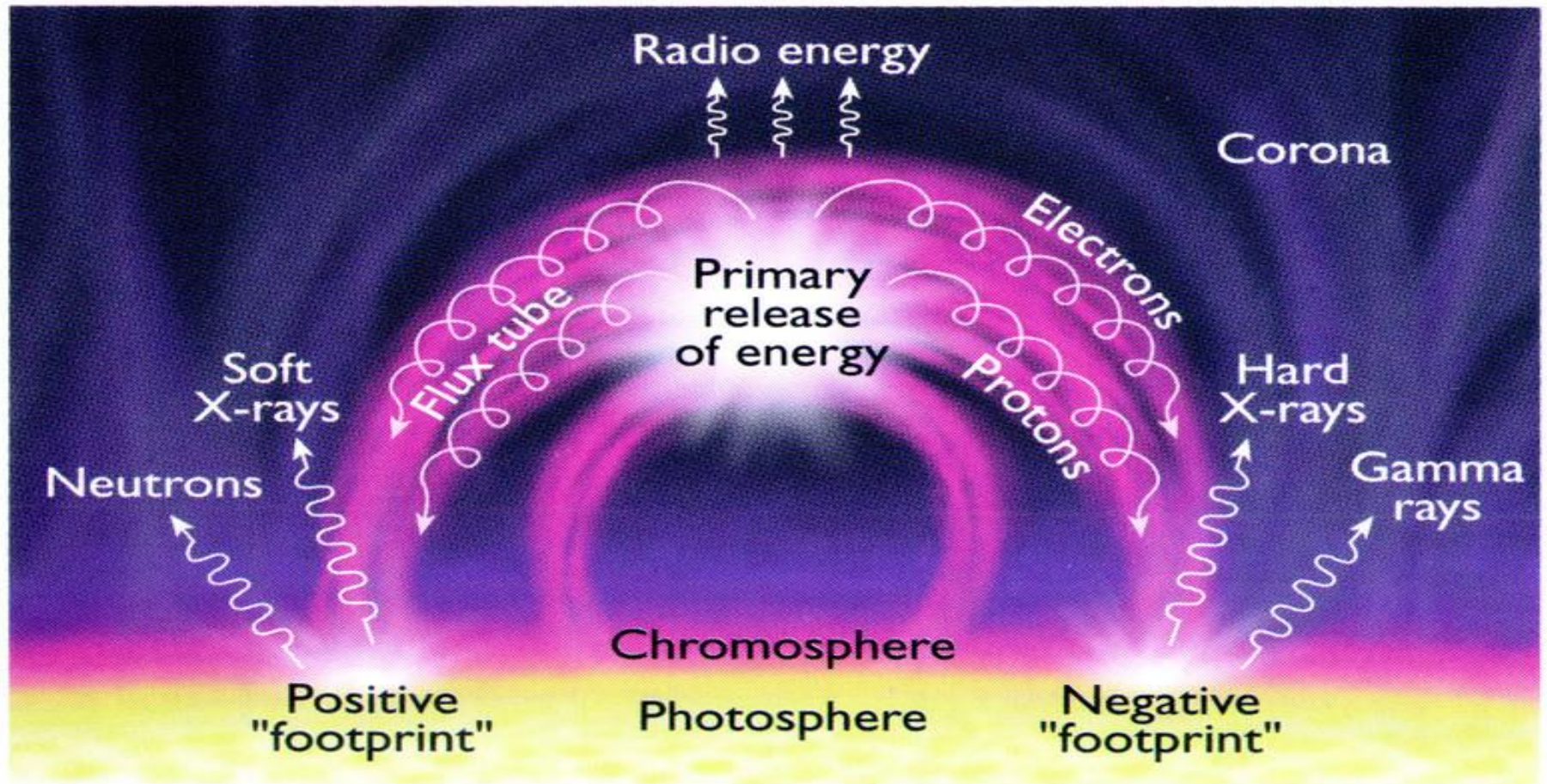
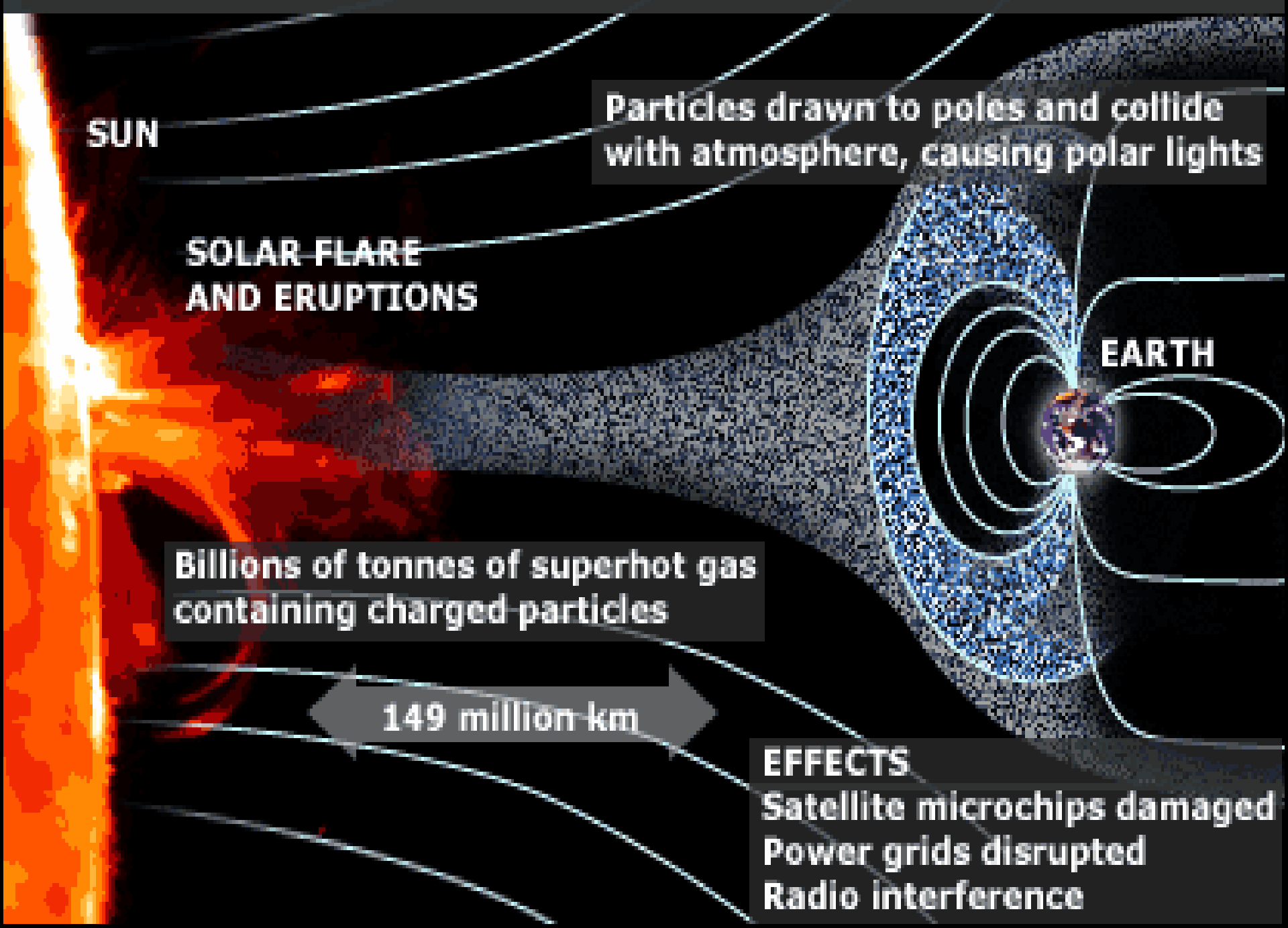


Figure 10 (bottom). Solar flares tend to occur within concentrated magnetic loops extending from the photosphere into the corona. Energy released at the top of the loop creates a burst of radio energy. It also accelerates great numbers of electrons and protons. These are channeled down the loop and strike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

SOLAR ACTIVITY AND ITS EFFECTS ON EARTH



SUN

Particles drawn to poles and collide with atmosphere, causing polar lights

SOLAR FLARE AND ERUPTIONS

EARTH

Billions of tonnes of superhot gas containing charged particles

149 million km

EFFECTS

Satellite microchips damaged
Power grids disrupted
Radio interference

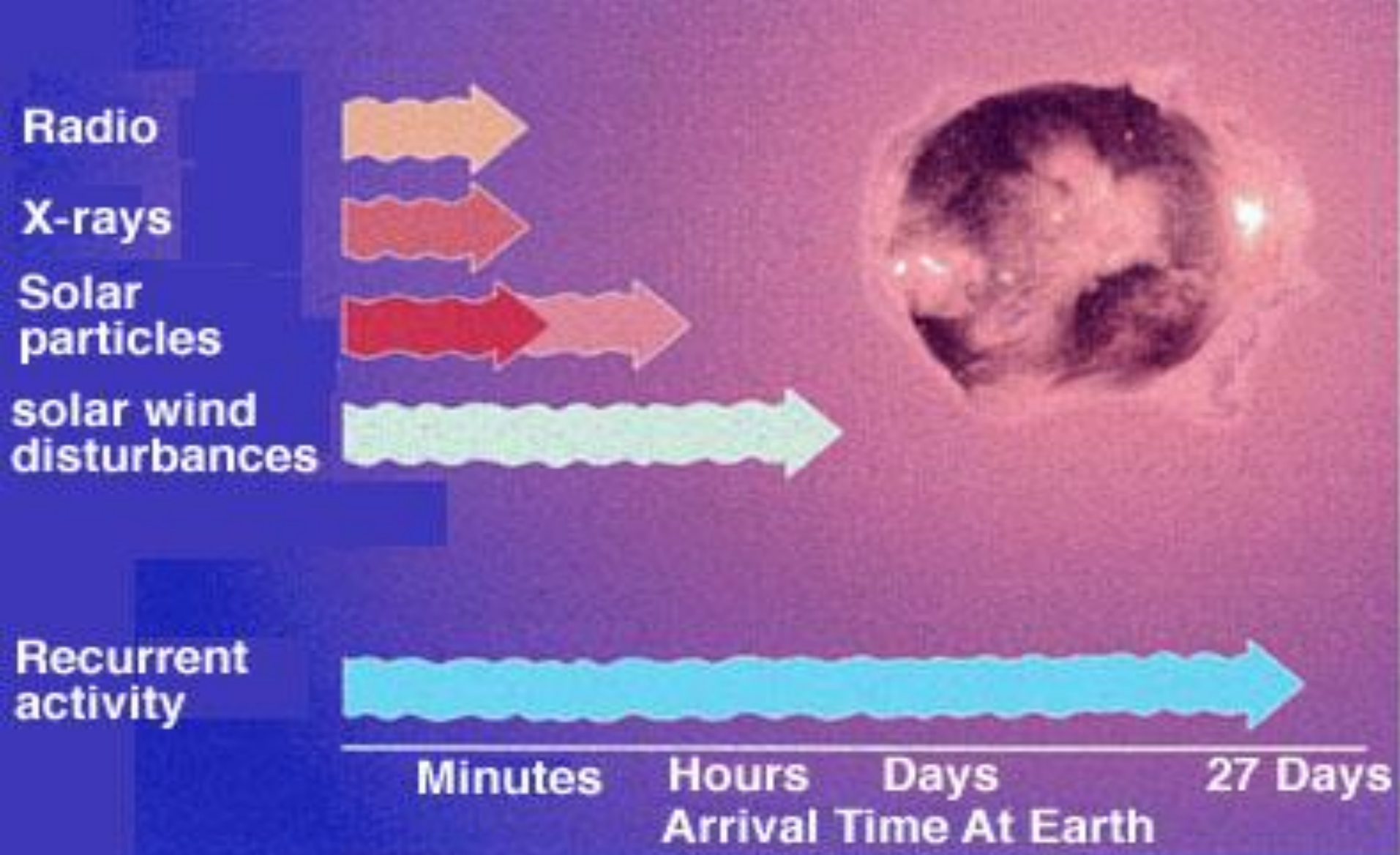
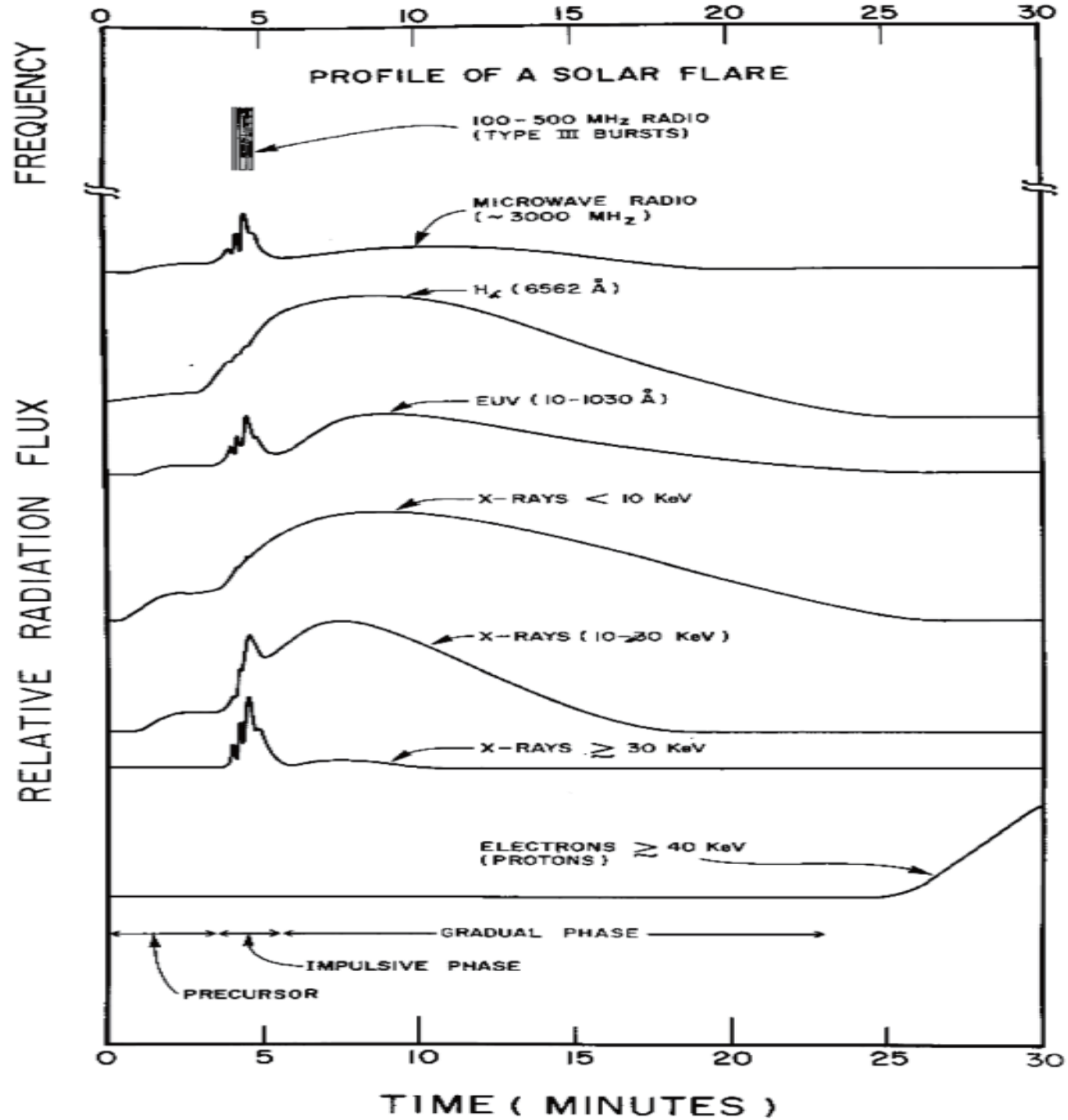
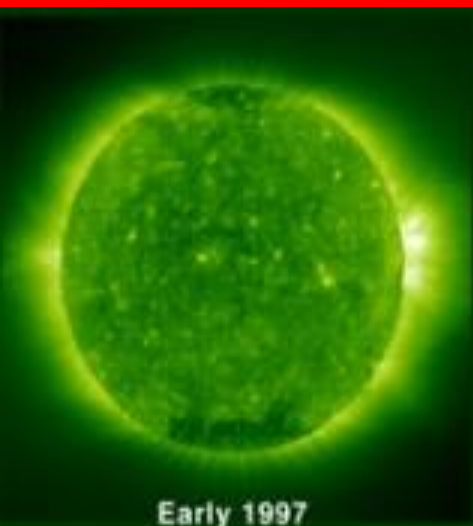


Image Credit: L. J. Lanzerotti, Bell Laboratories, Lucent Technologies, Inc.







(a)

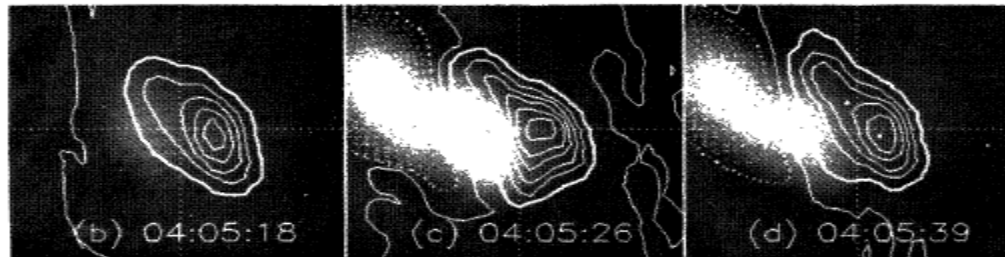


Figure 2. Radio images obtained by Nobeyama Radioheliograph. (a) is a full disk image. (b), (c) and (d) are partial images of the first peak and the second peak just before the onset, of the burst.

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.

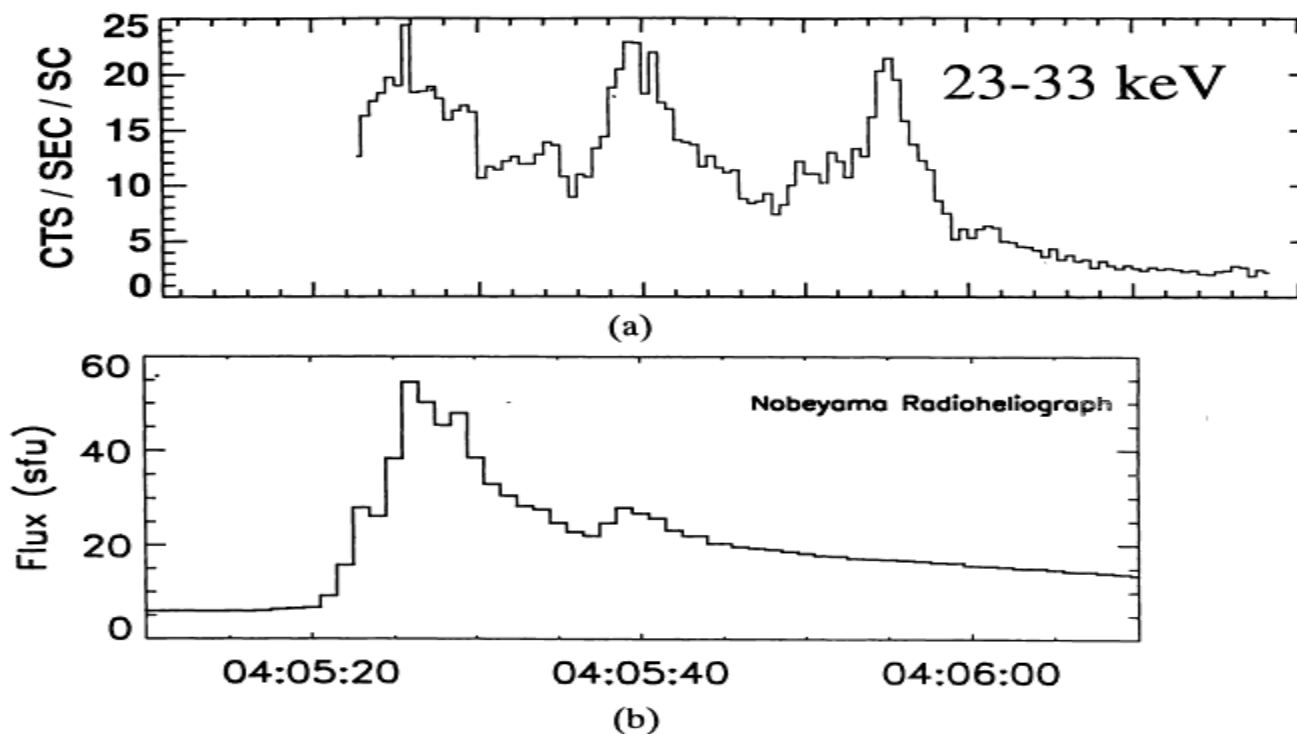
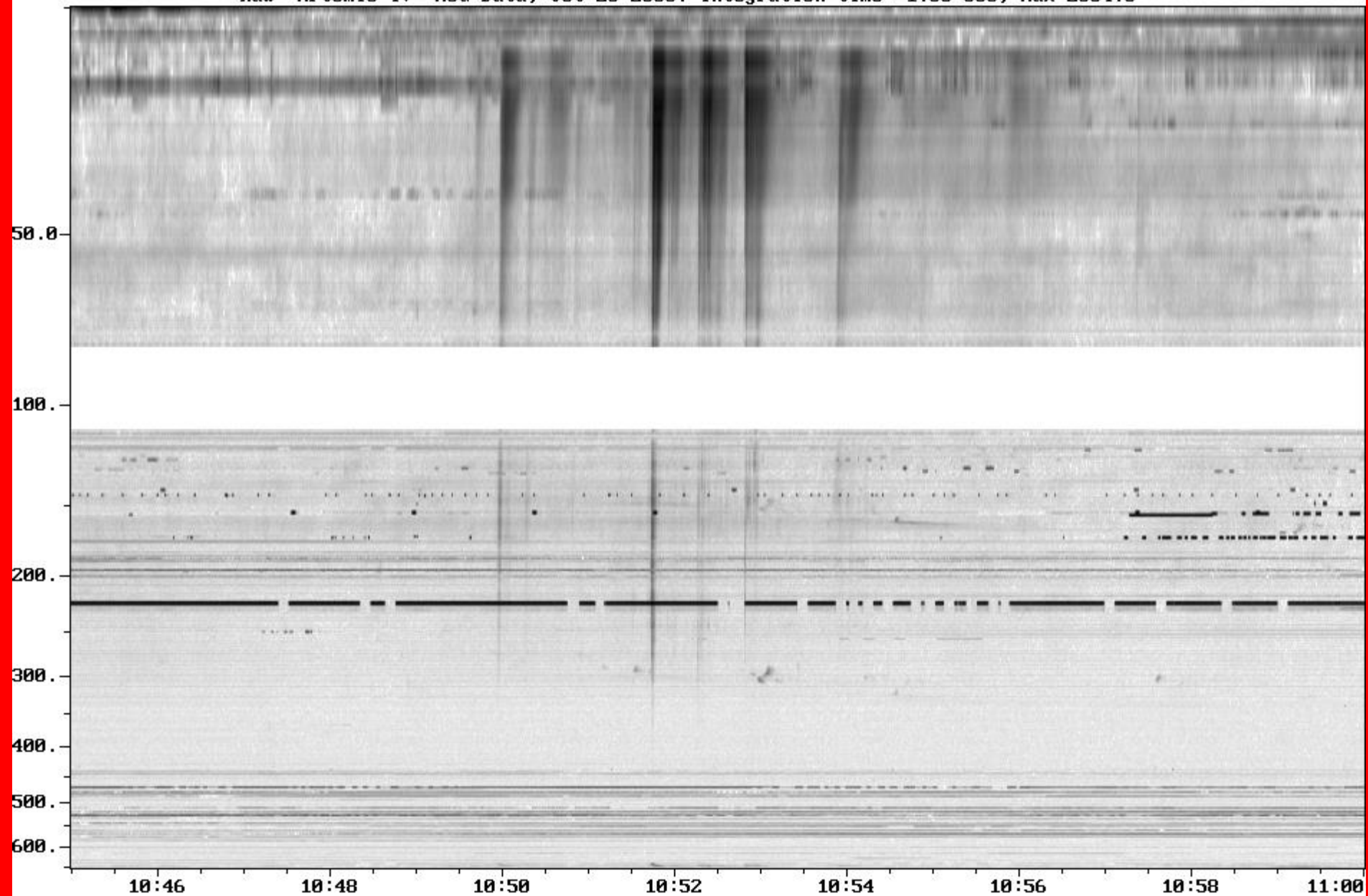
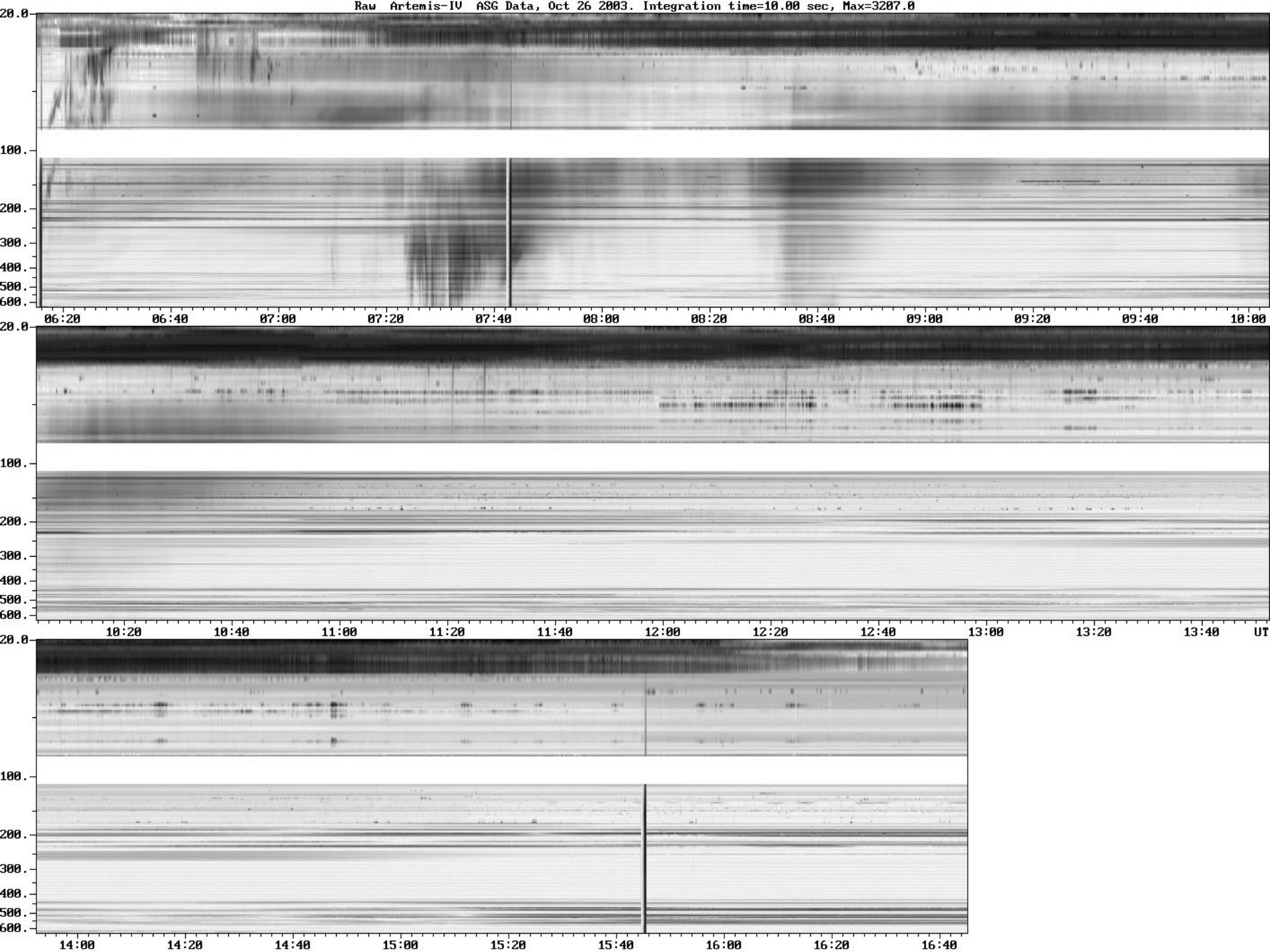


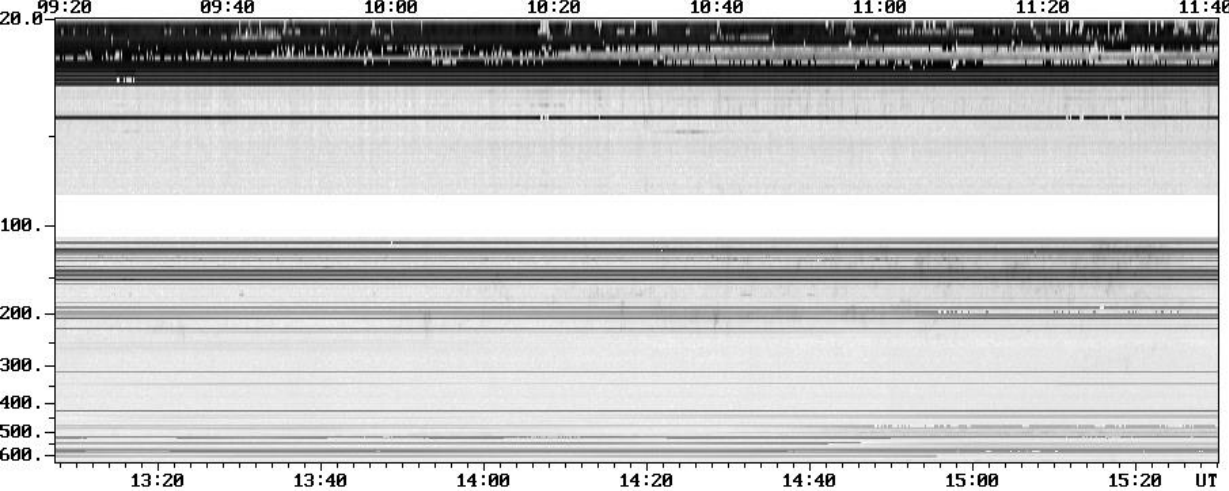
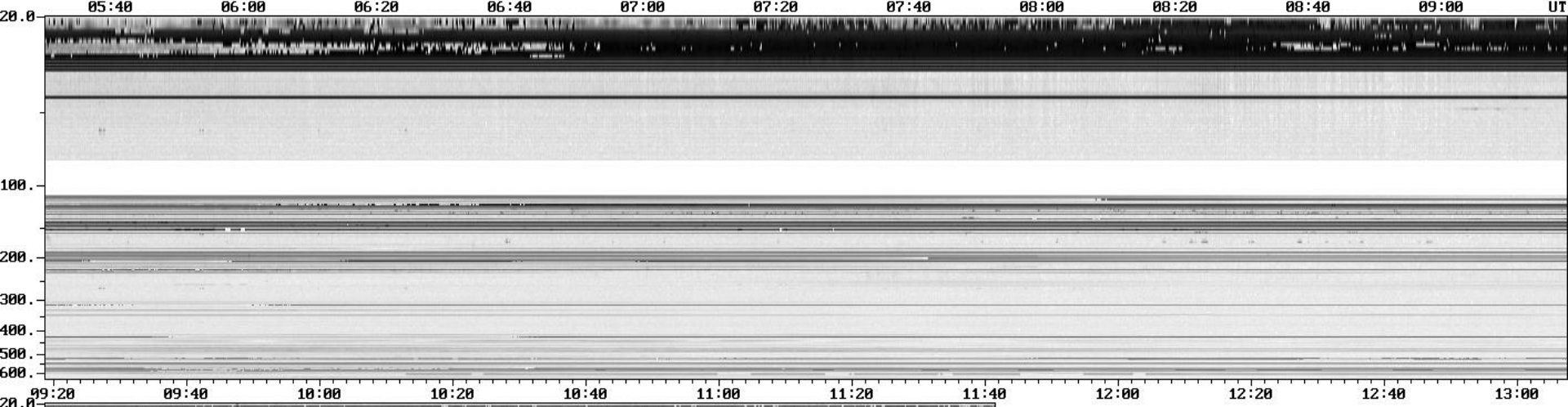
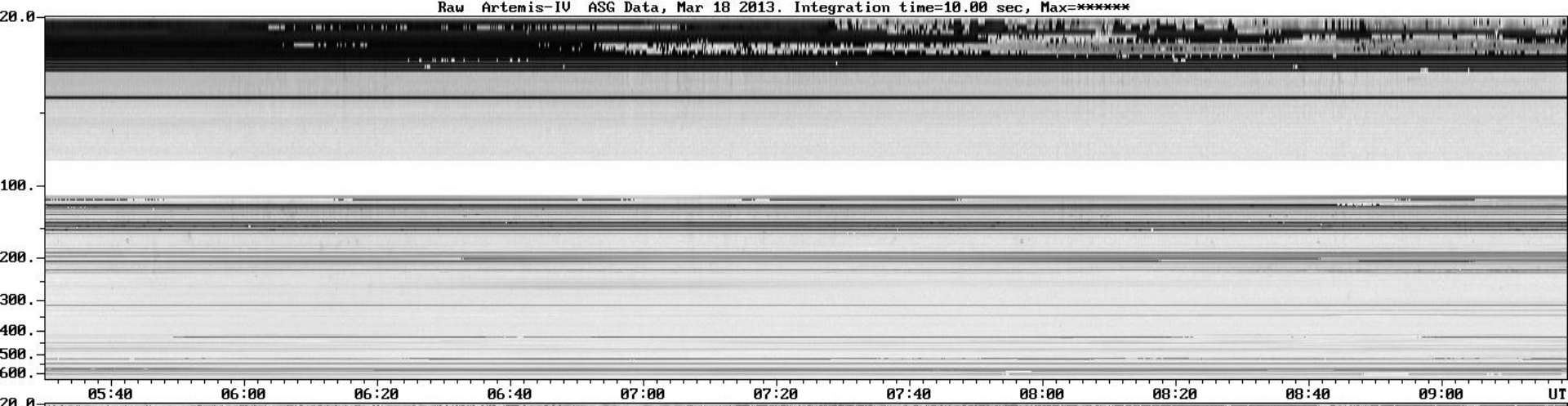
Figure 1. Time profiles of the burst on January 6, 1994. (a) Yohkoh HXT M1 channel, and (b) flux density at 17 GHz.

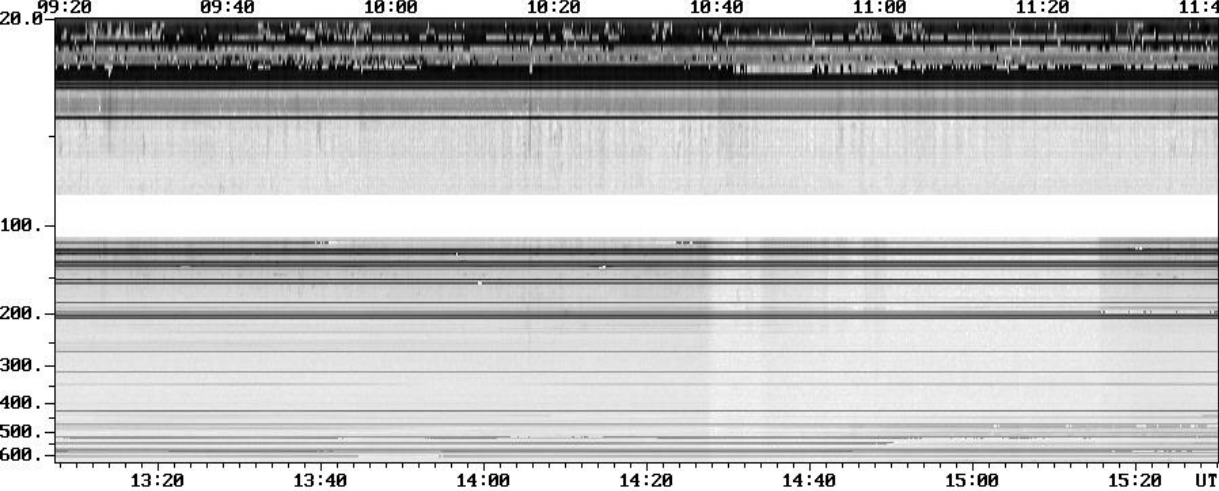
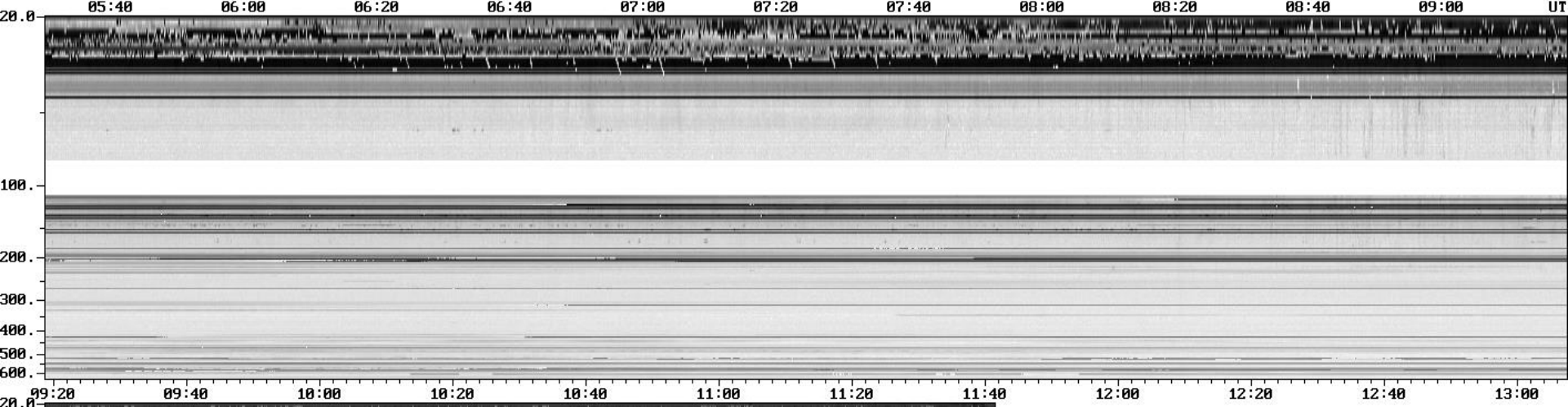
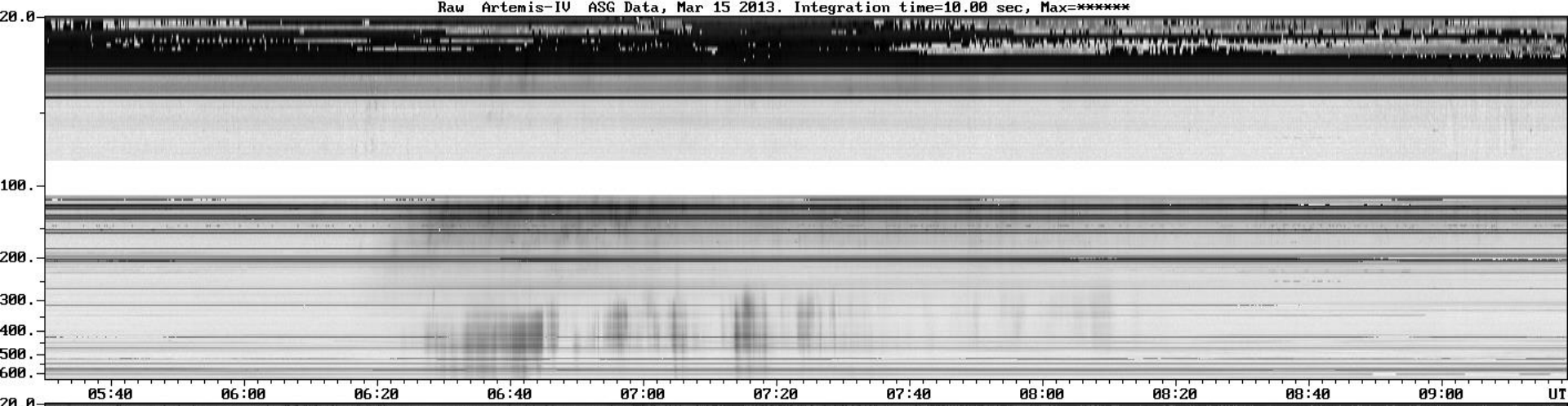
Spiky flux variations and high brightness temperature of the radio sources imply that the emission is accounted for by gyrosynchrotron radiation from a power-law distribution of electrons. The radio flux spectrum of the burst obtained by the radio polarimeters at Nobeyama and Toyokawa give a peak frequency 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

Raw Artemis-IV ASG Data, Oct 23 2003. Integration time= 1.00 sec, Max=2634.0







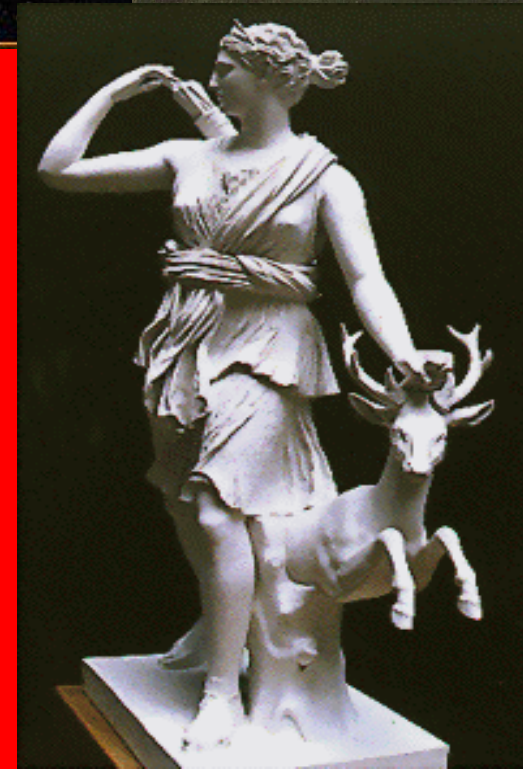


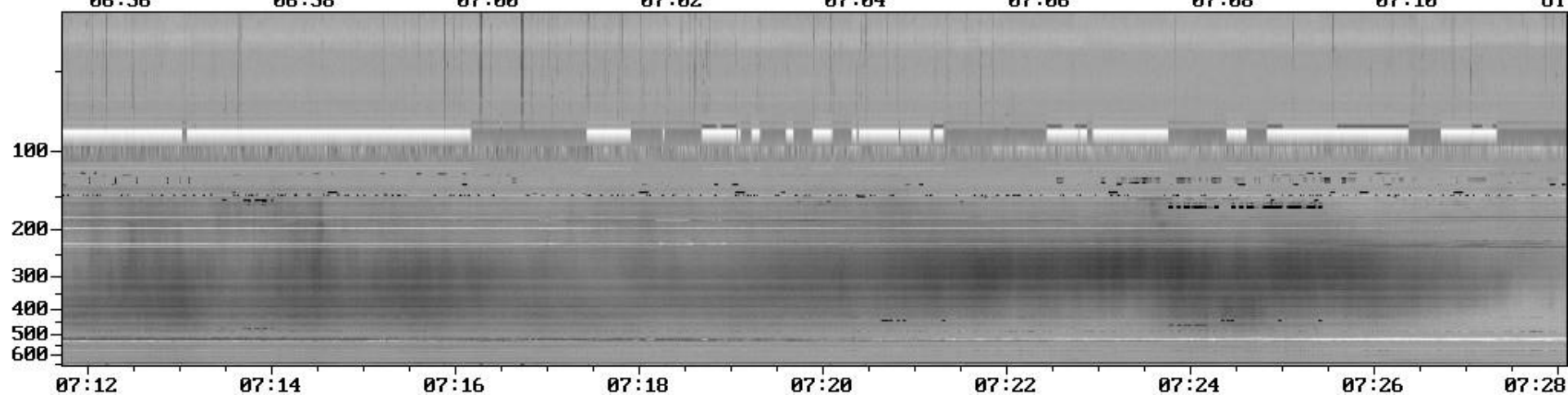
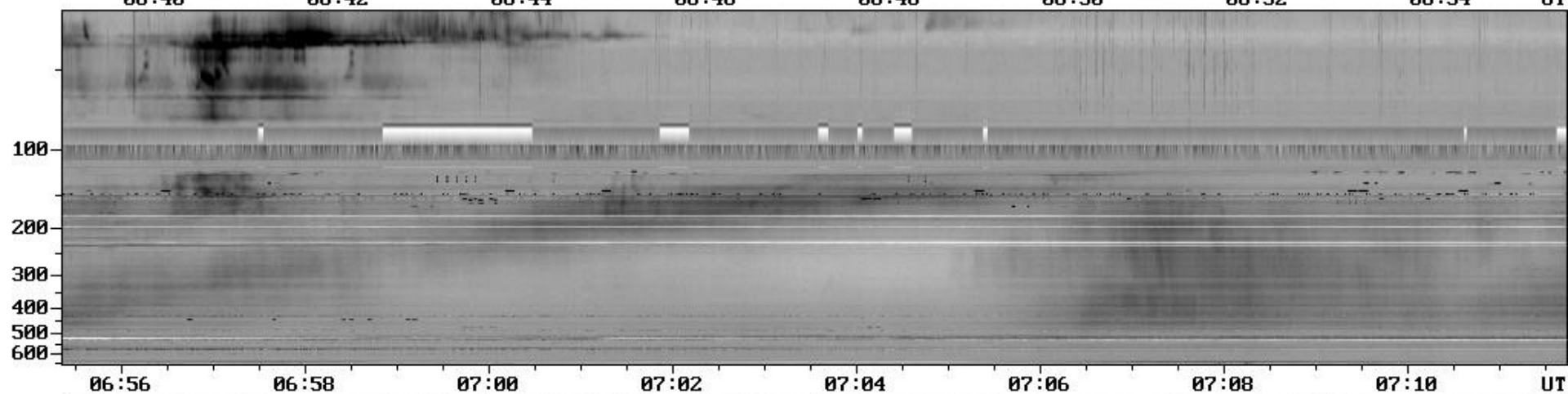
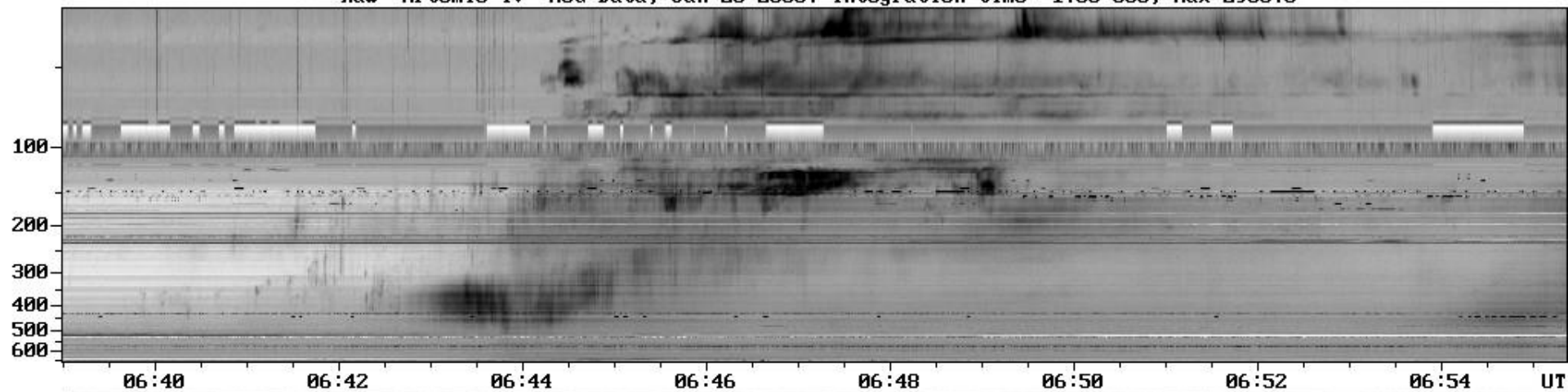


Εικόνα 1: Οι δύο κεραιές του ARTEMIS IV στις Θερμοπύλες

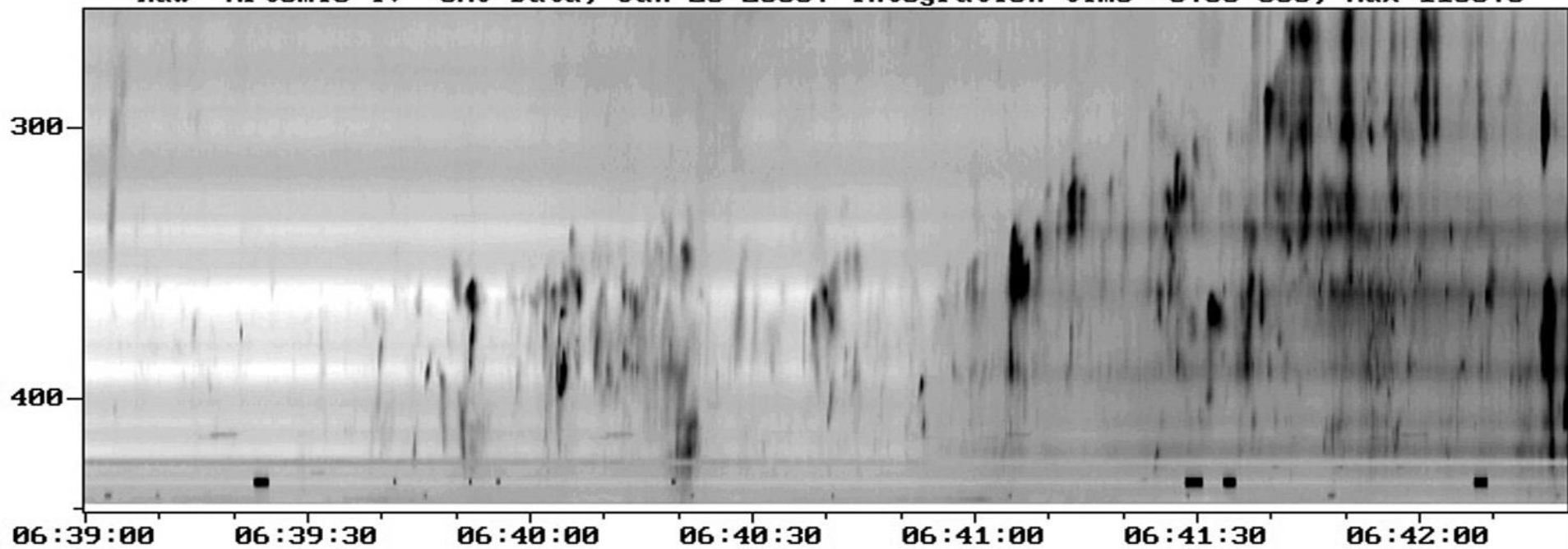


Εικόνα 3: Φωτογραφία του ακίνητου παχέως διπόλου σχήματος ανεστραμμένου V. Στην κορυφή του στύλου διακρίνεται το κουτί με τους ενισχυτές και τα φίλτρα.

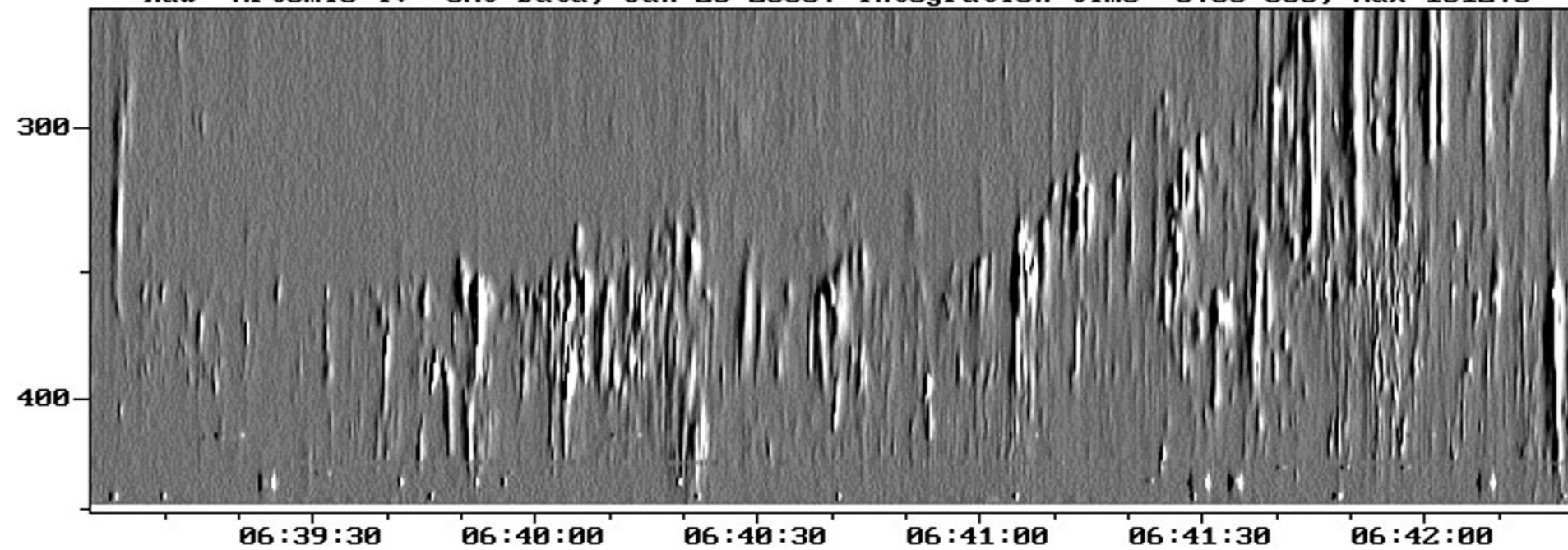




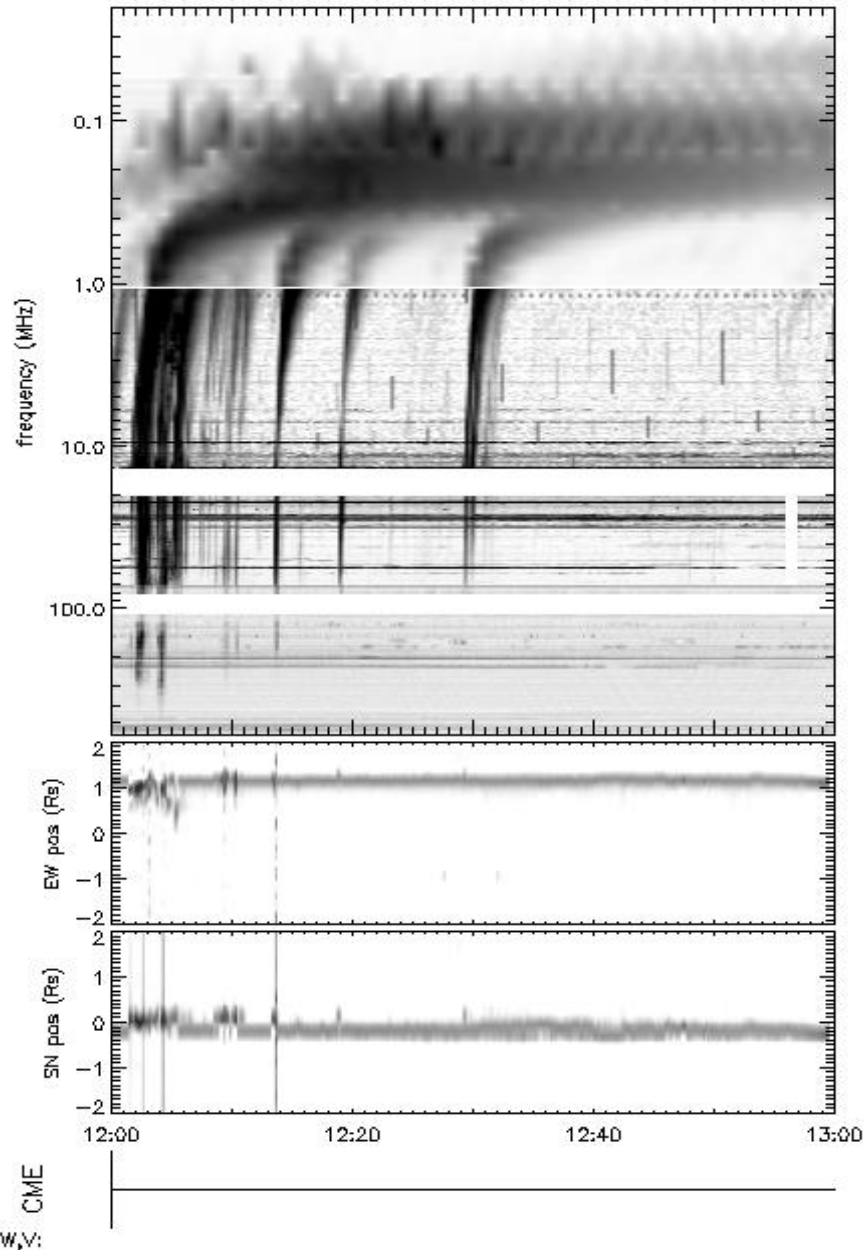
Raw Artemis-IV SAO Data, Jan 20 2005. Integration time= 0.30 sec, Max=1166.0



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

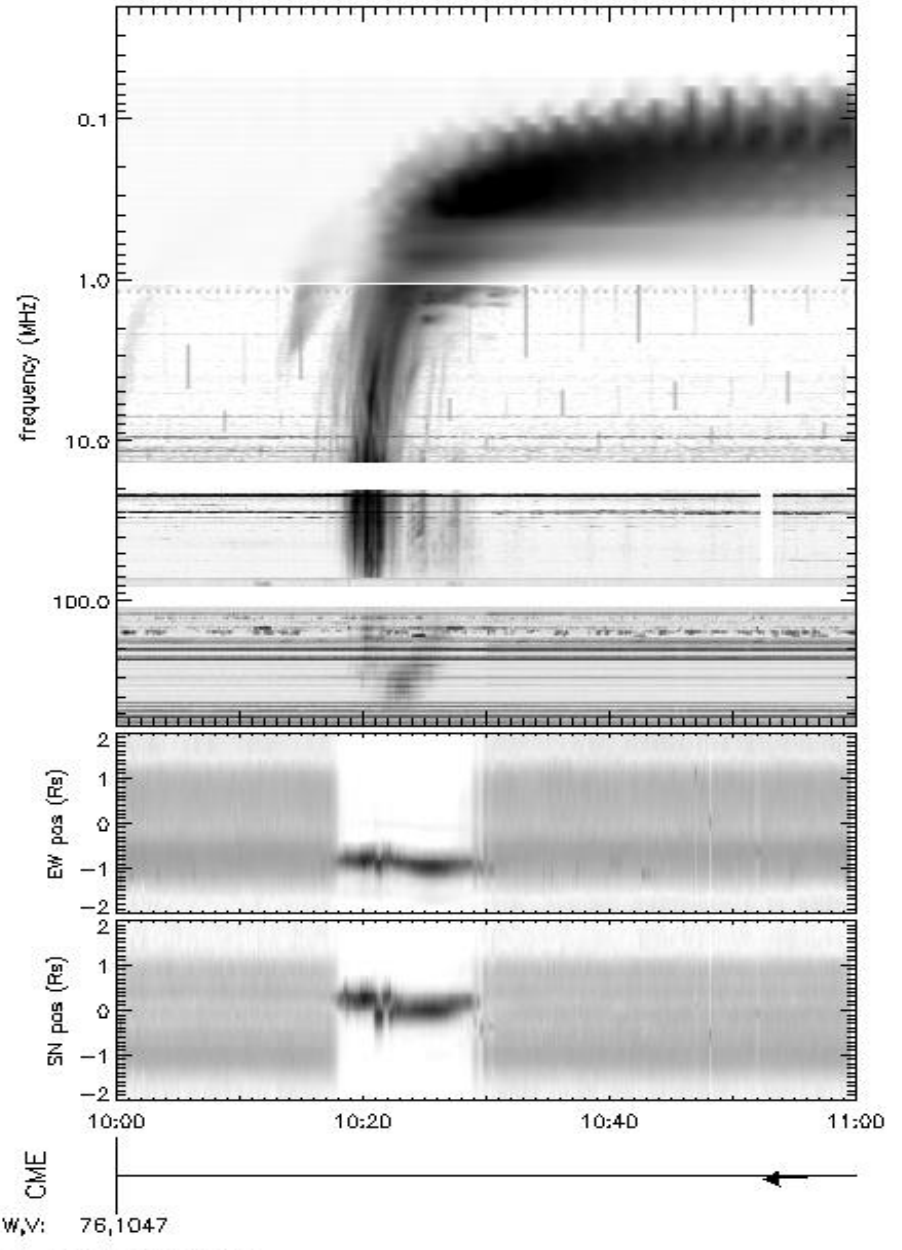


WIND/WAVES, DAM, ARTEMIS, NRH, CME, 07JUL2006



Assembled the 20DEC2006

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



Assembled the 19OCT2006

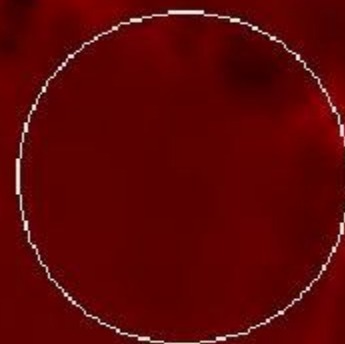
NRH 13-Jul-2005



NRH 13-Jul-2005

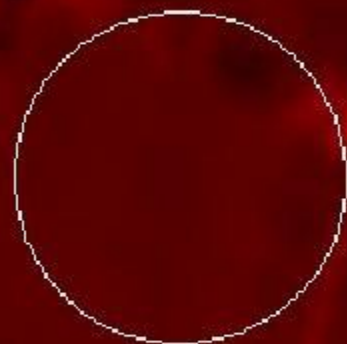


NRH 13-Jul-2005



327.0 Mhz 14:01:11 UT

NRH 13-Jul-2005



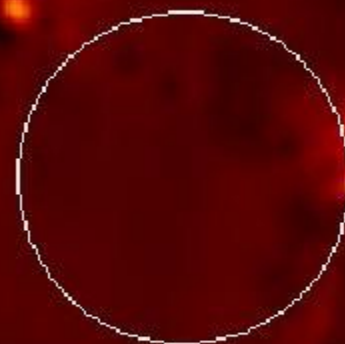
327.0 Mhz 14:03:10 UT

NRH 13-Jul-2005



327.0 Mhz 14:05:09 UT

NRH 13-Jul-2005

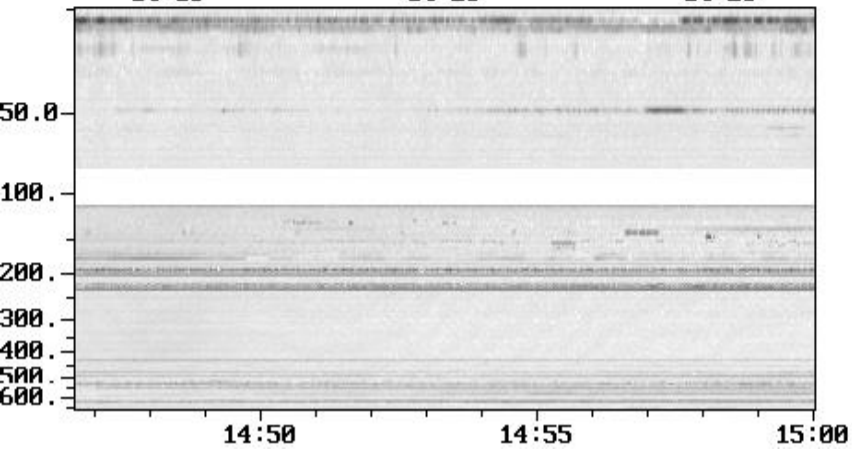
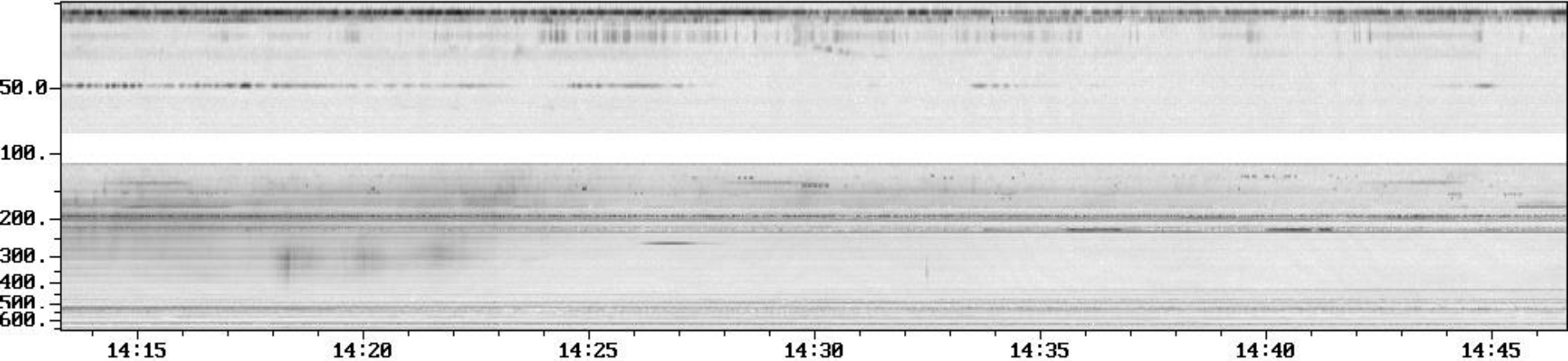
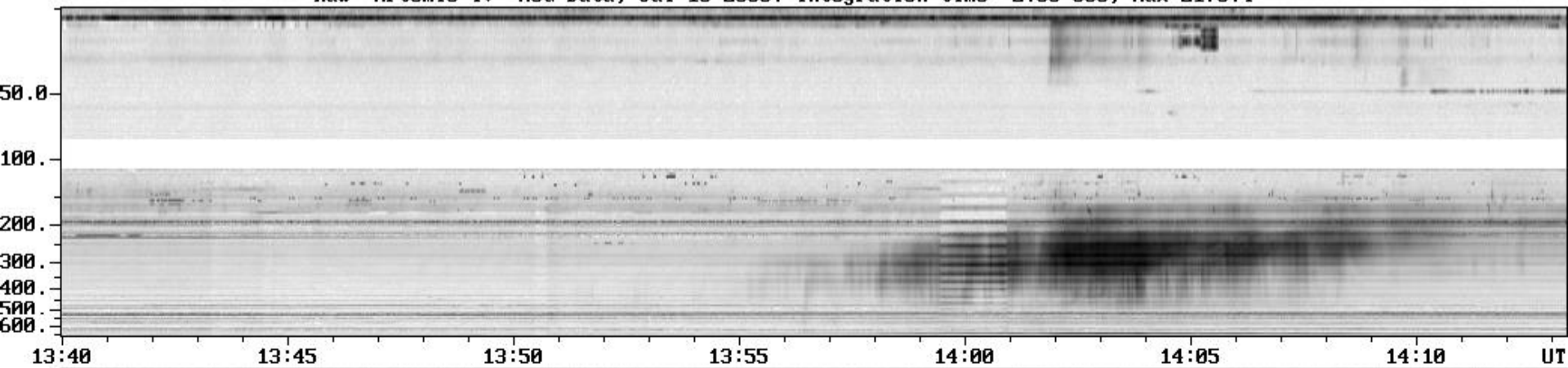


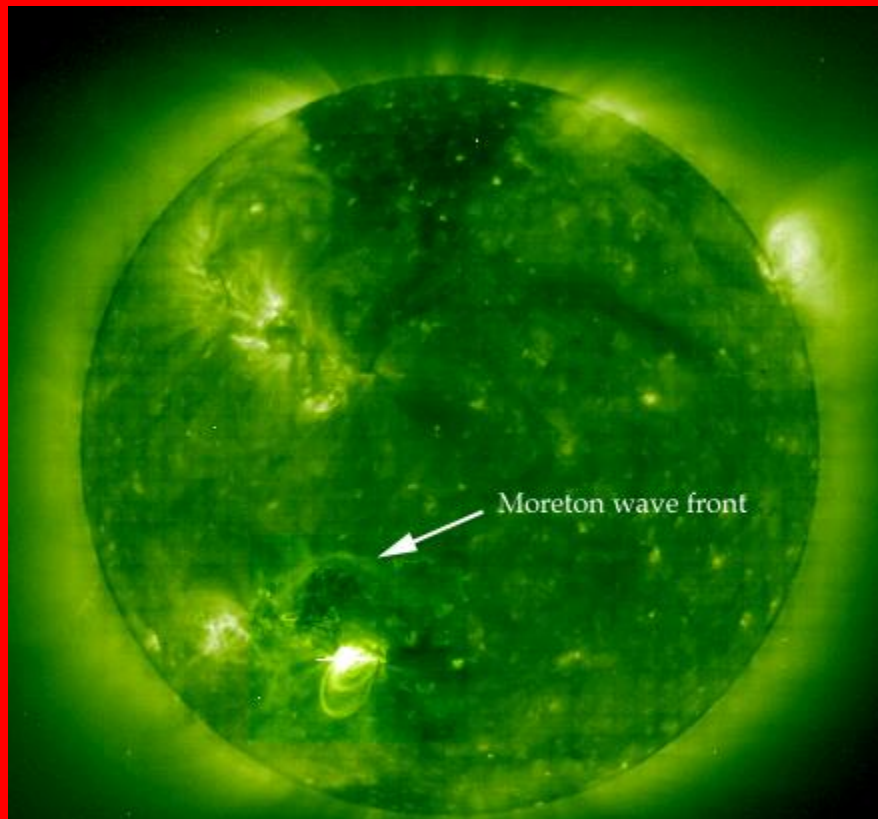
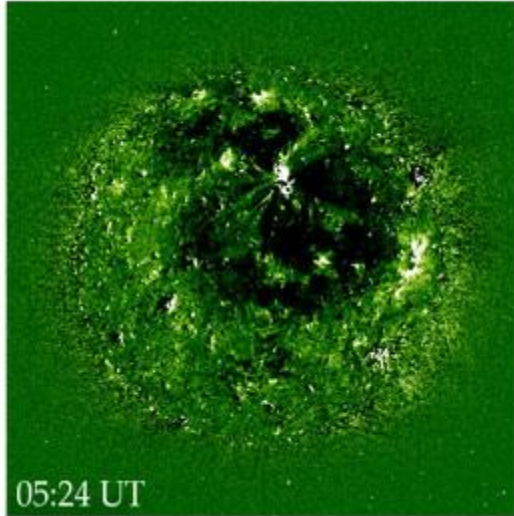
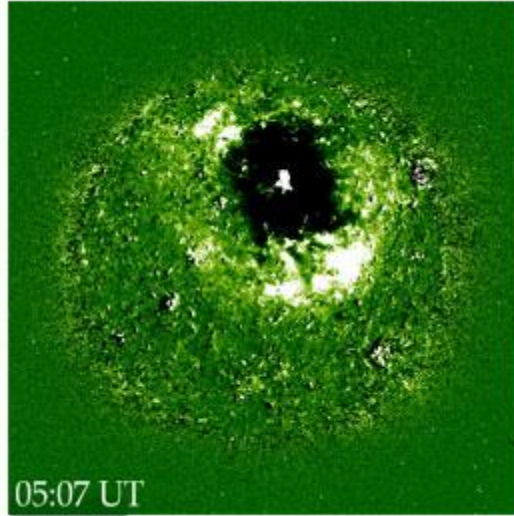
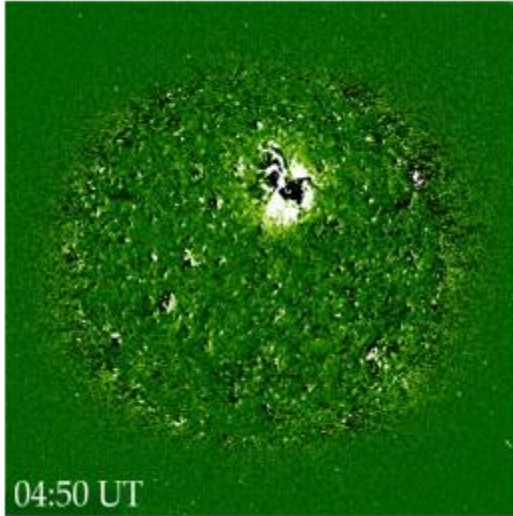
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327.0 Mhz 14:09:07 UT

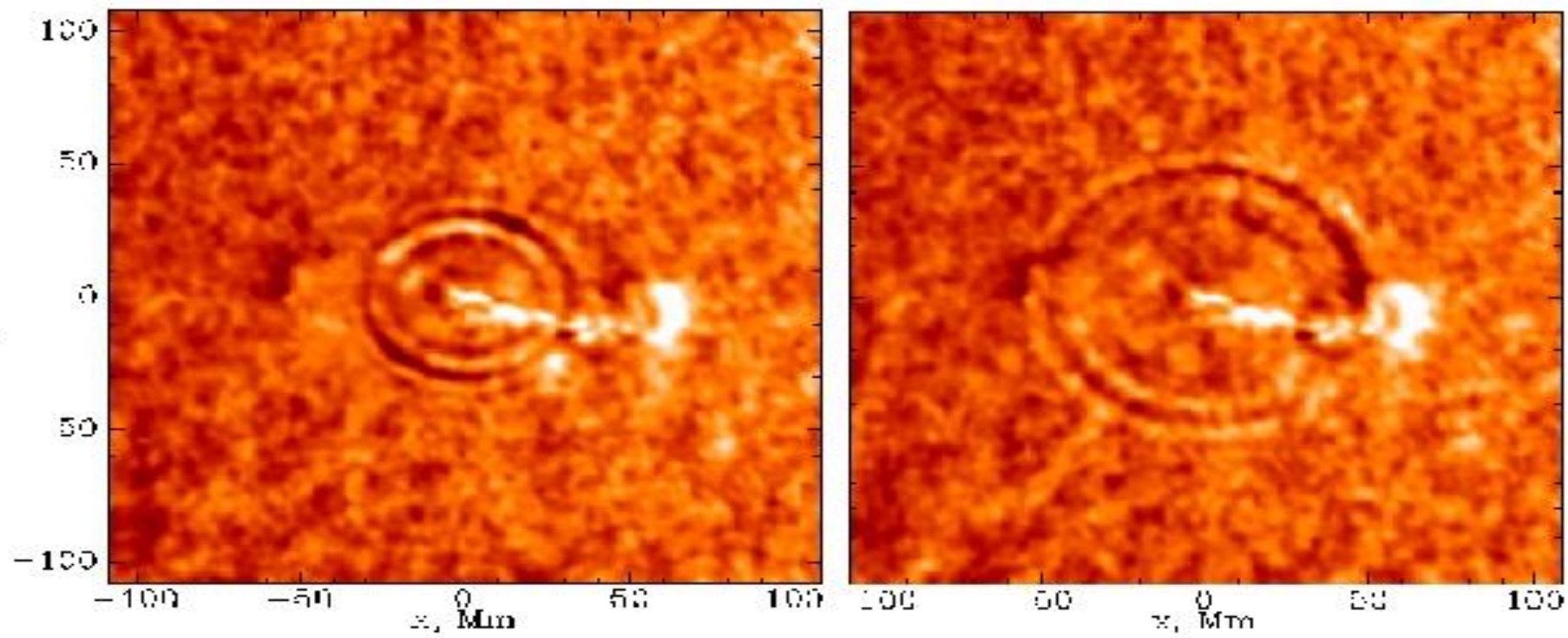
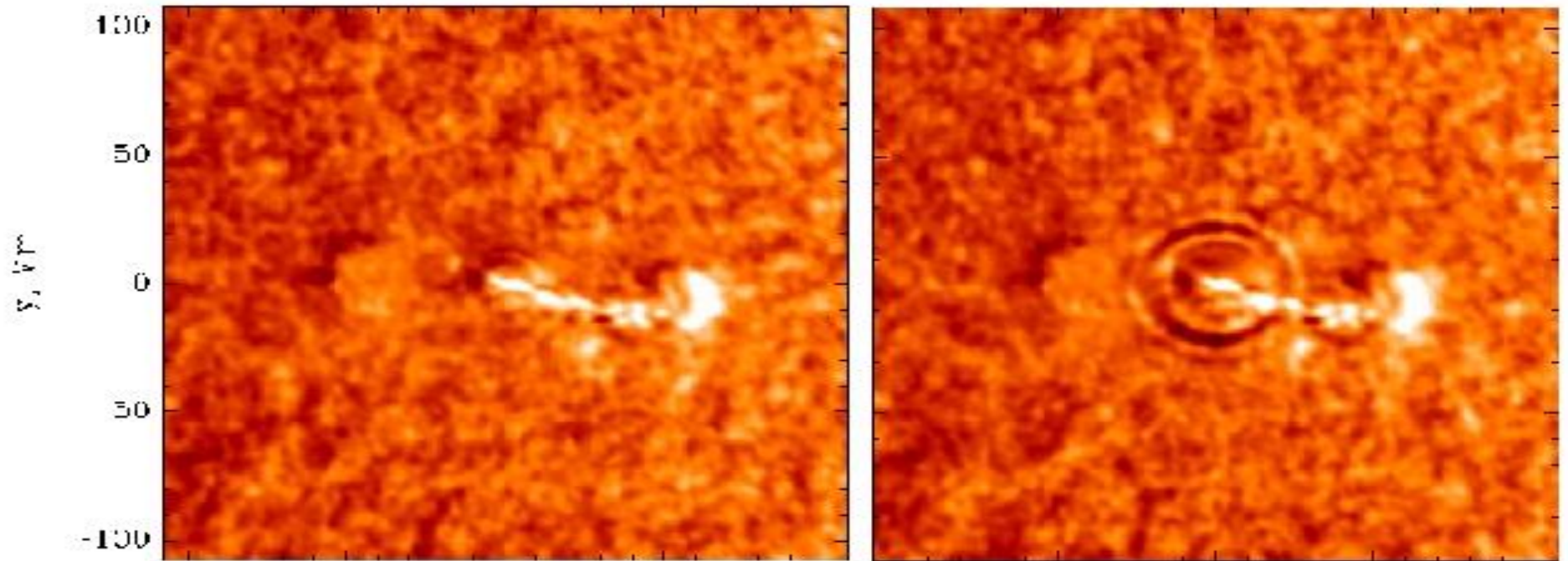
327.0 Mhz 14:11:05 UT

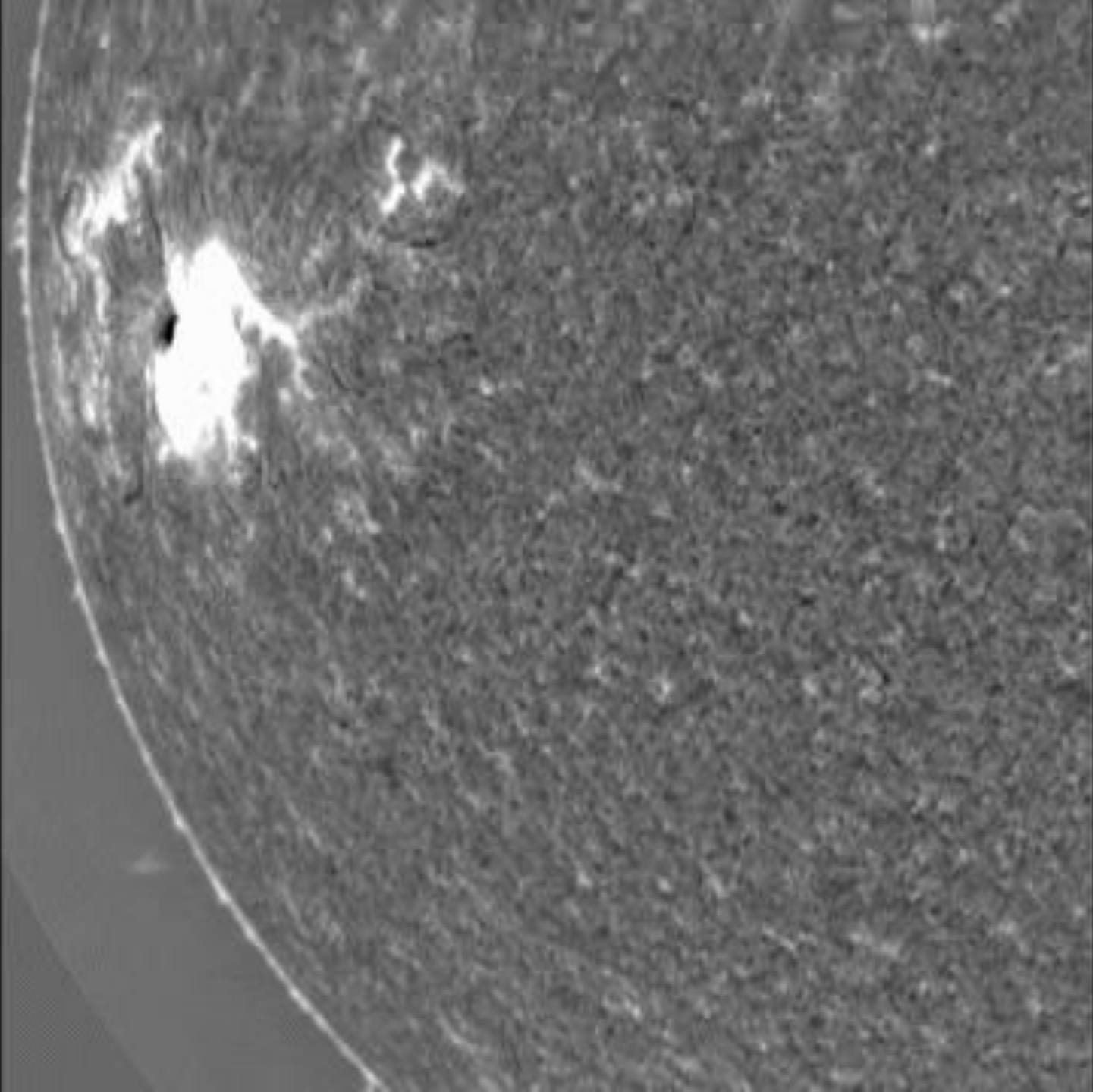
Raw Artemis-IV ASG Data, Jul 13 2005. Integration time= 2.00 sec, Max=2170.4

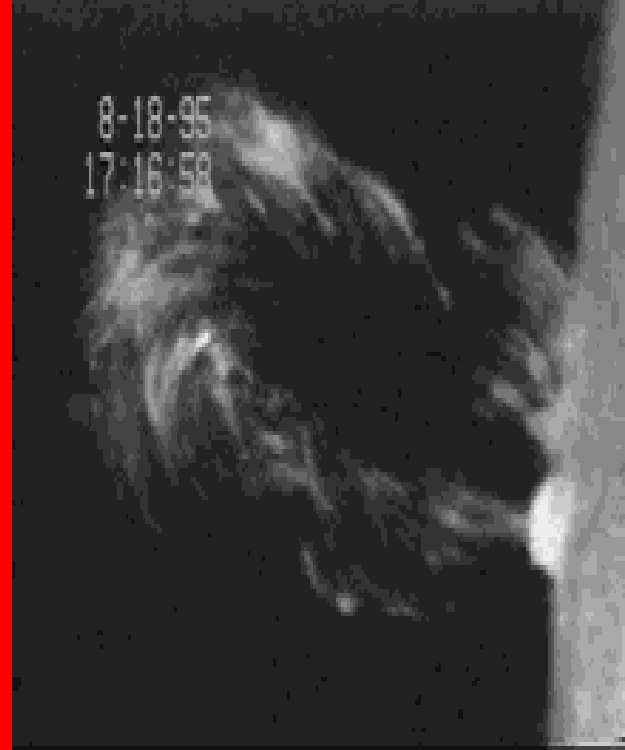
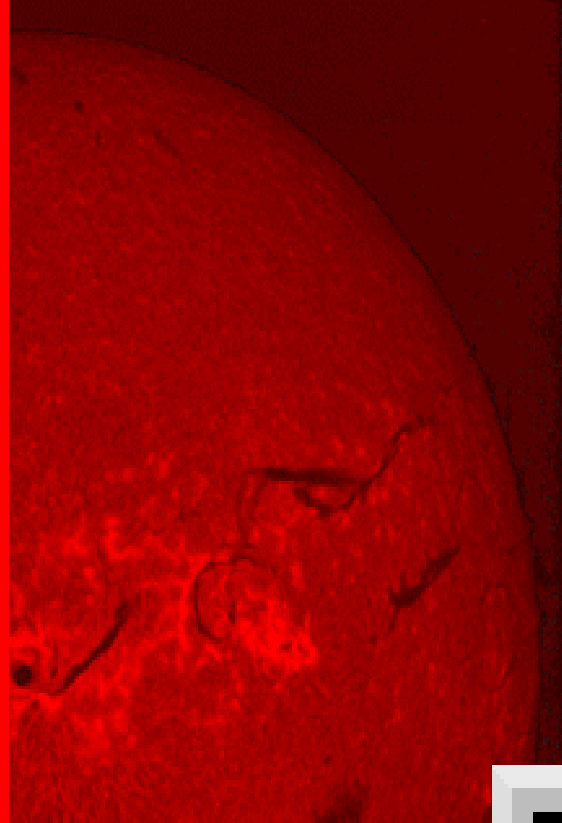
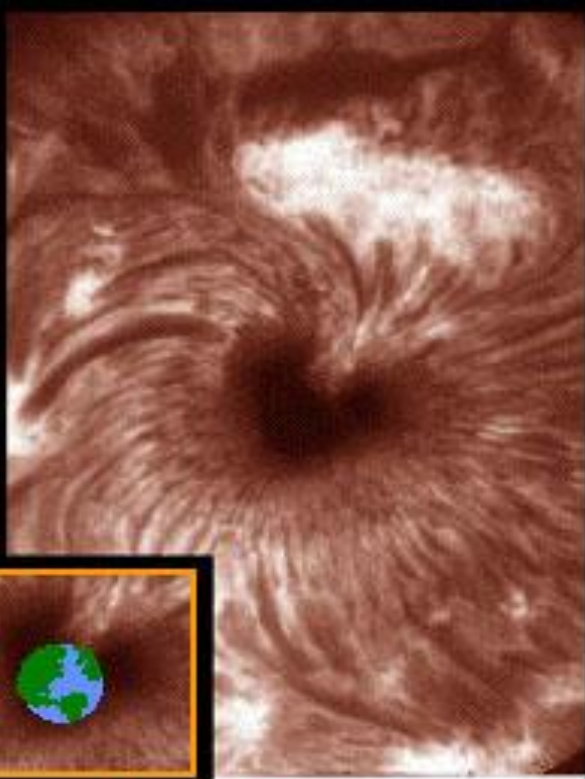




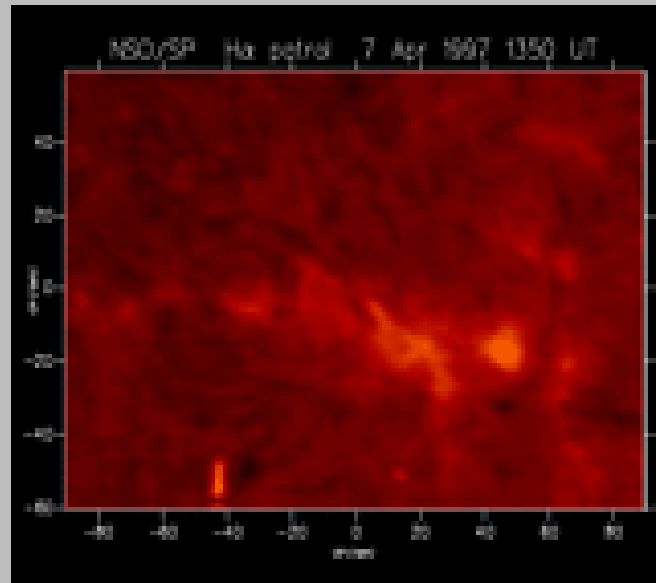
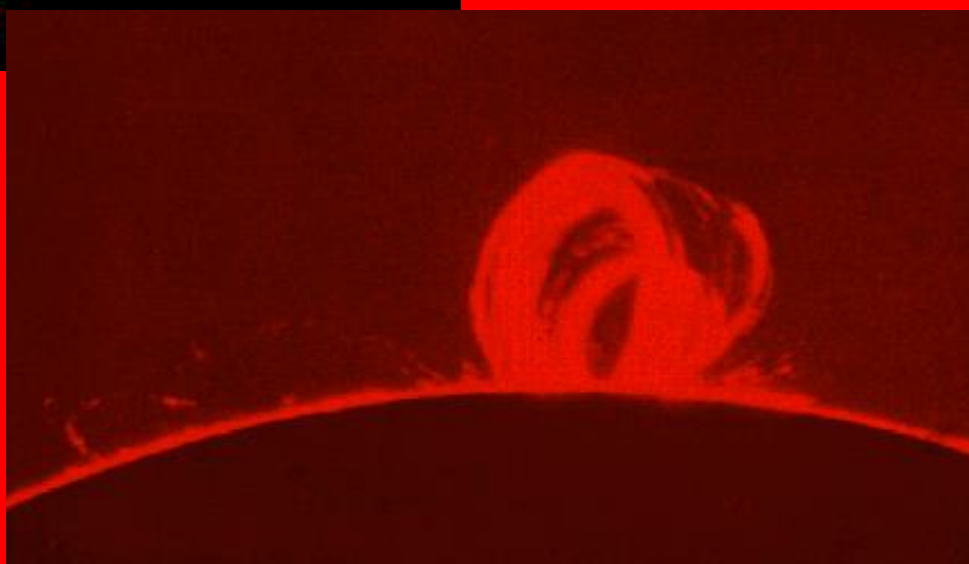
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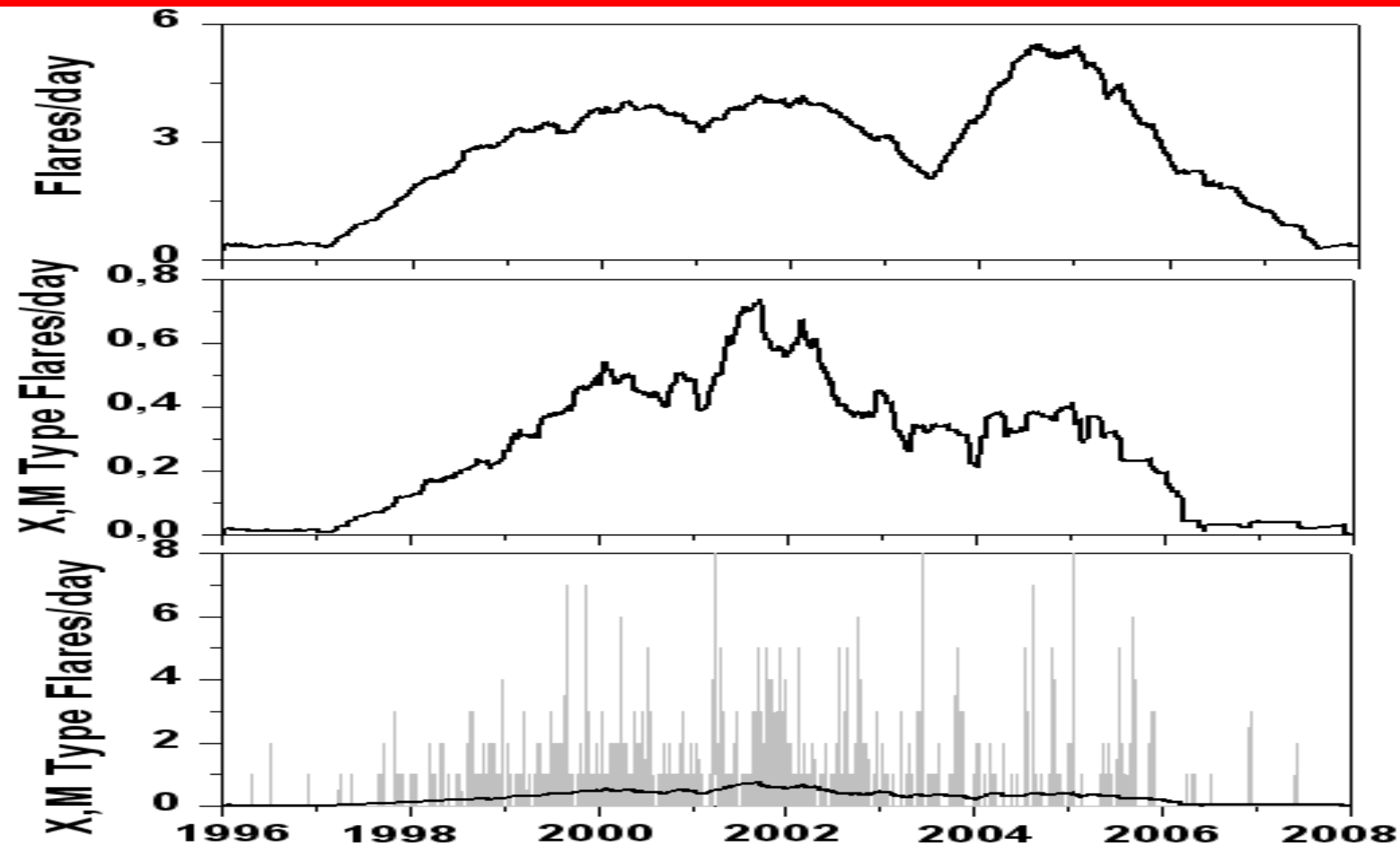




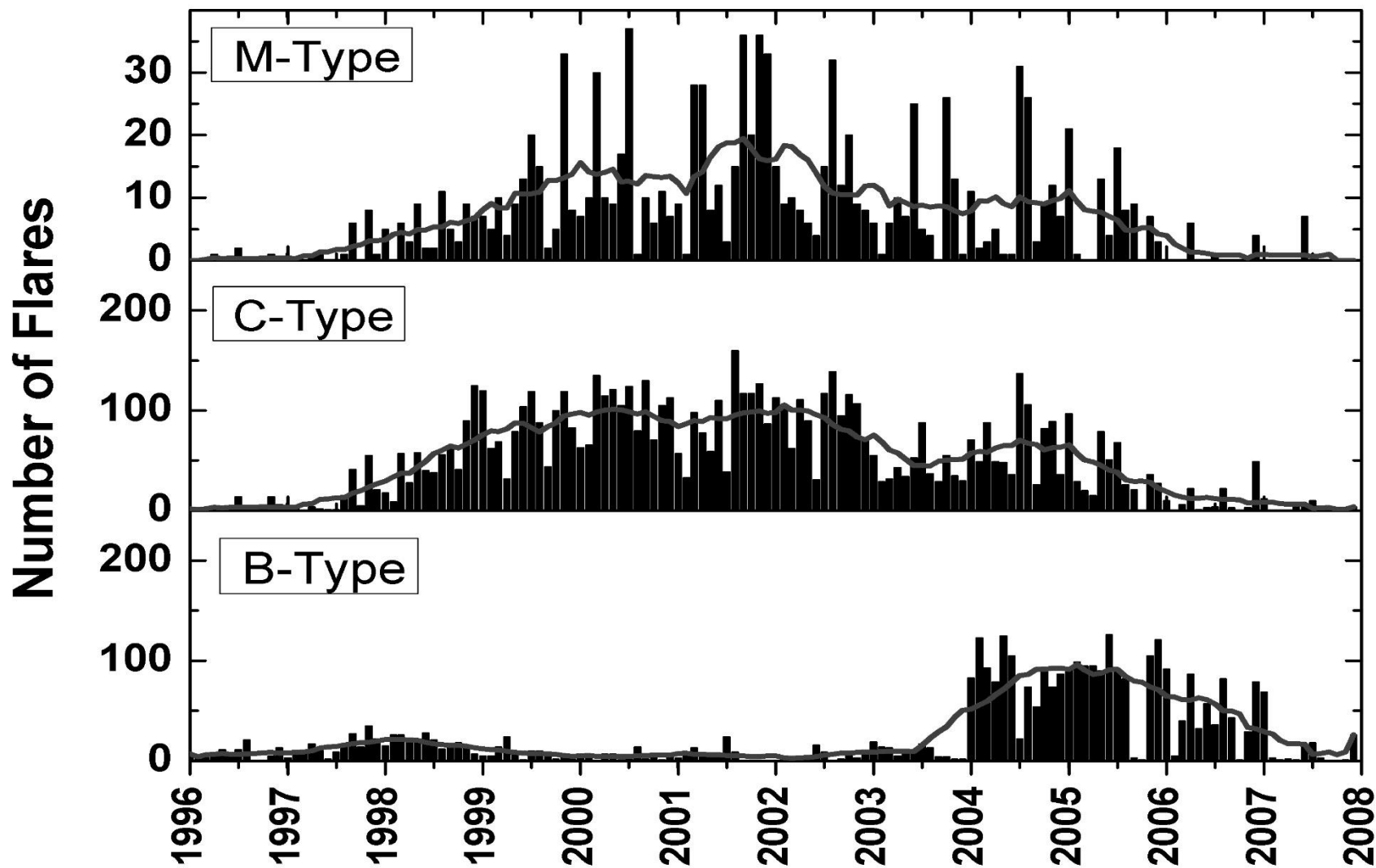
Approximate
size



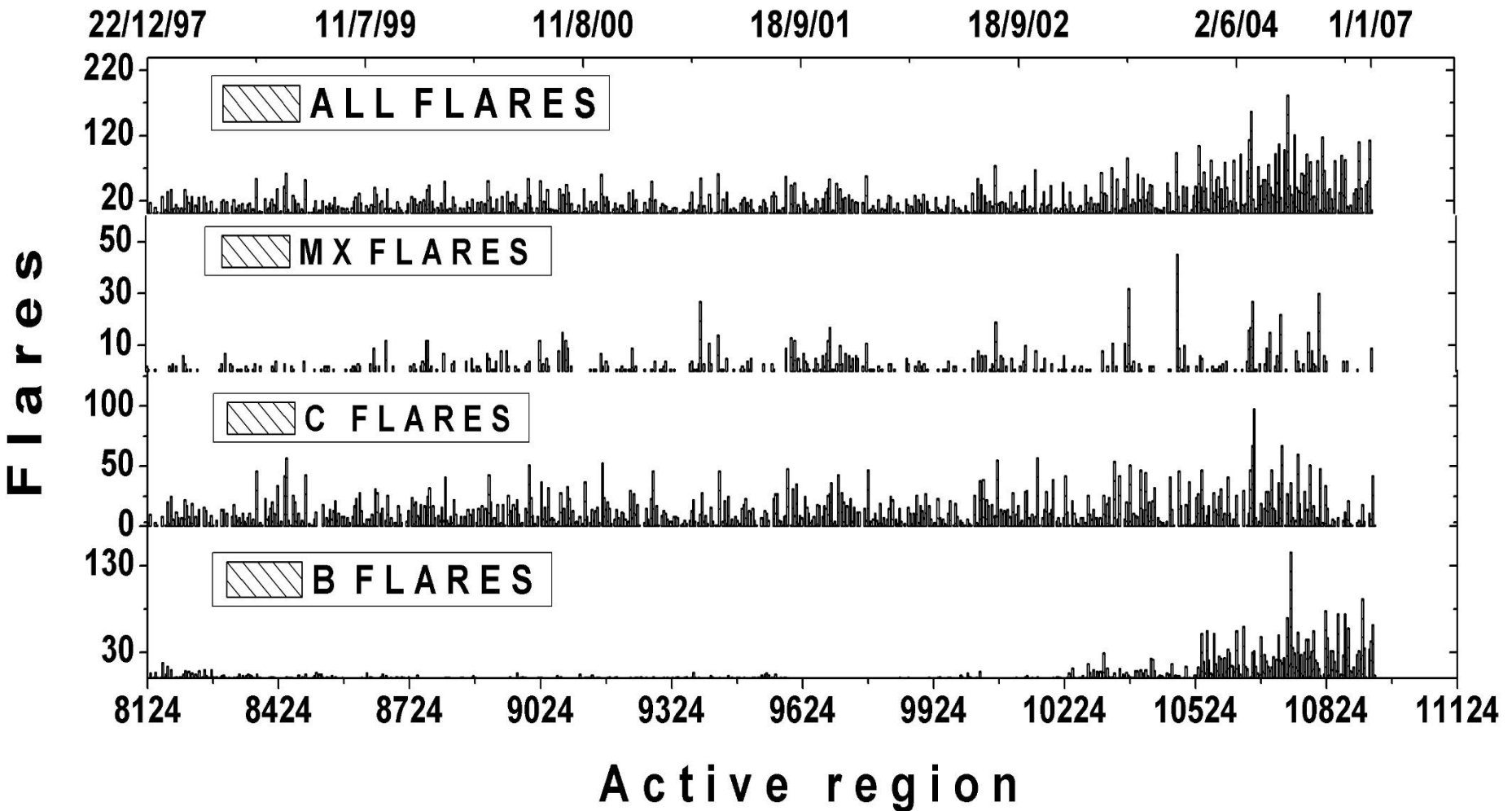
Flare Analysis

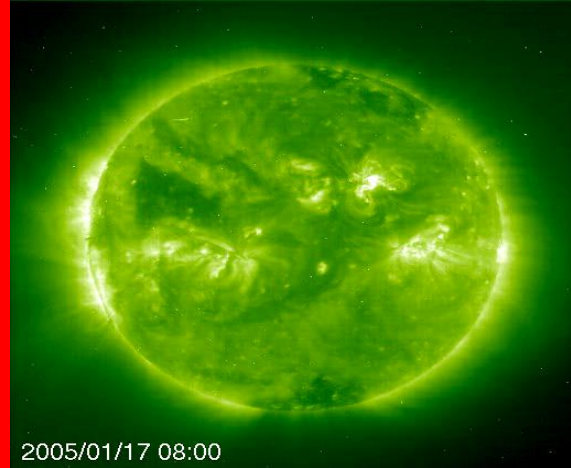


Flares Classification

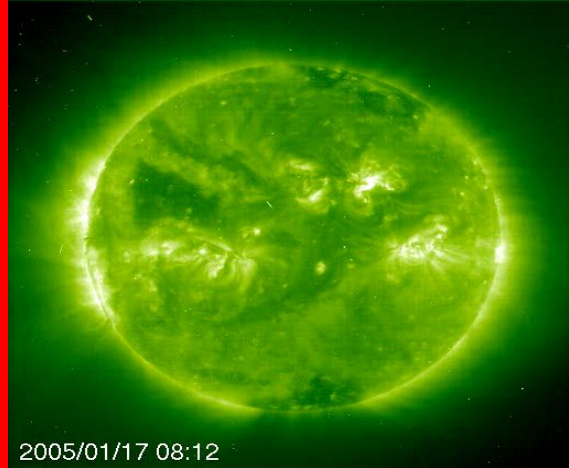


A.R Flare Productivity

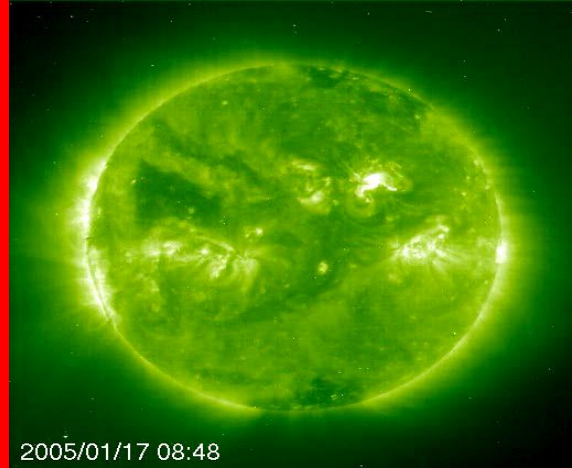




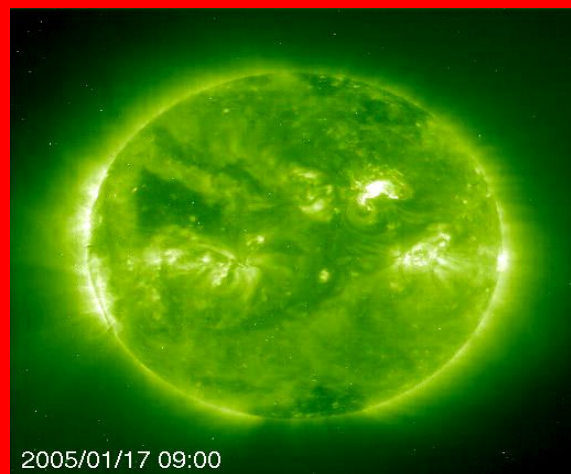
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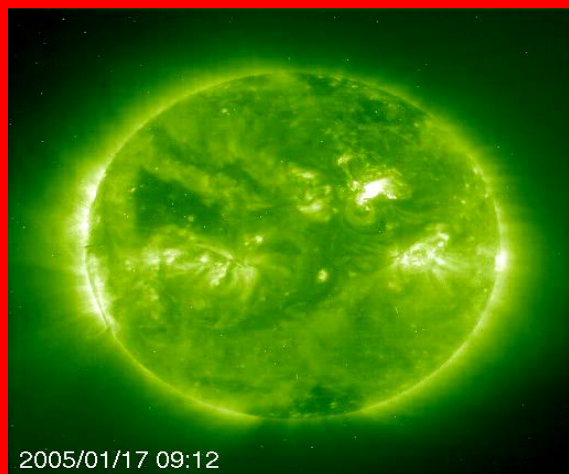
2005/01/17 08:12



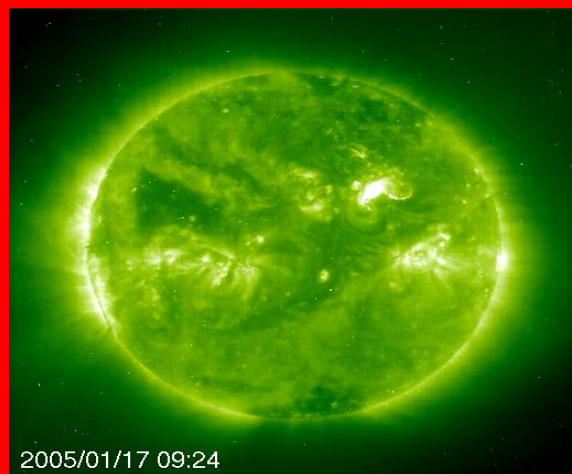
2005/01/17 08:48



2005/01/17 09:00



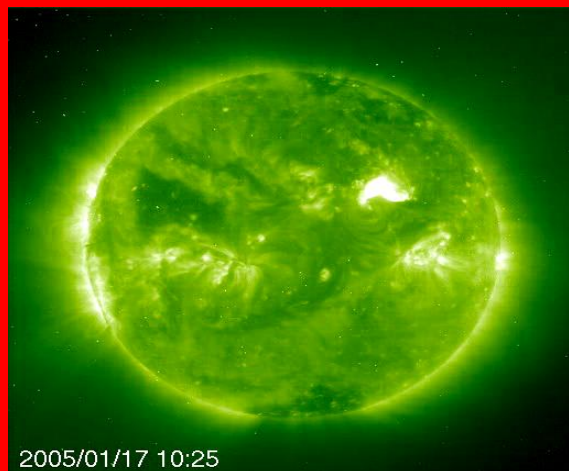
2005/01/17 09:12



2005/01/17 09:24



2005/01/17 10:00

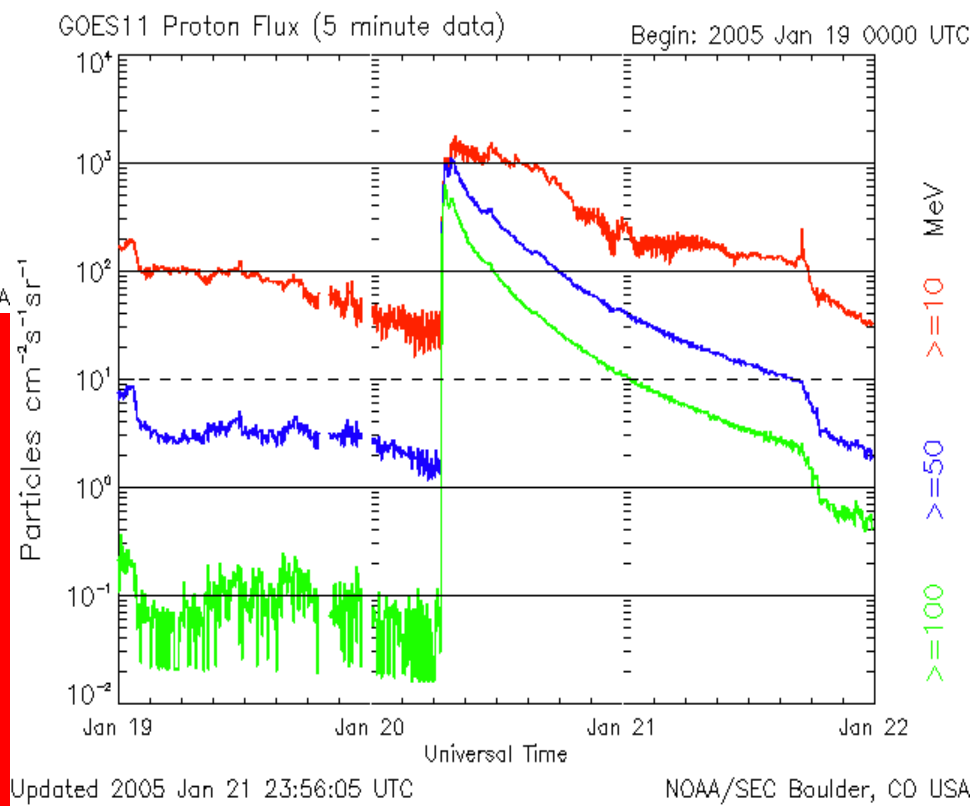
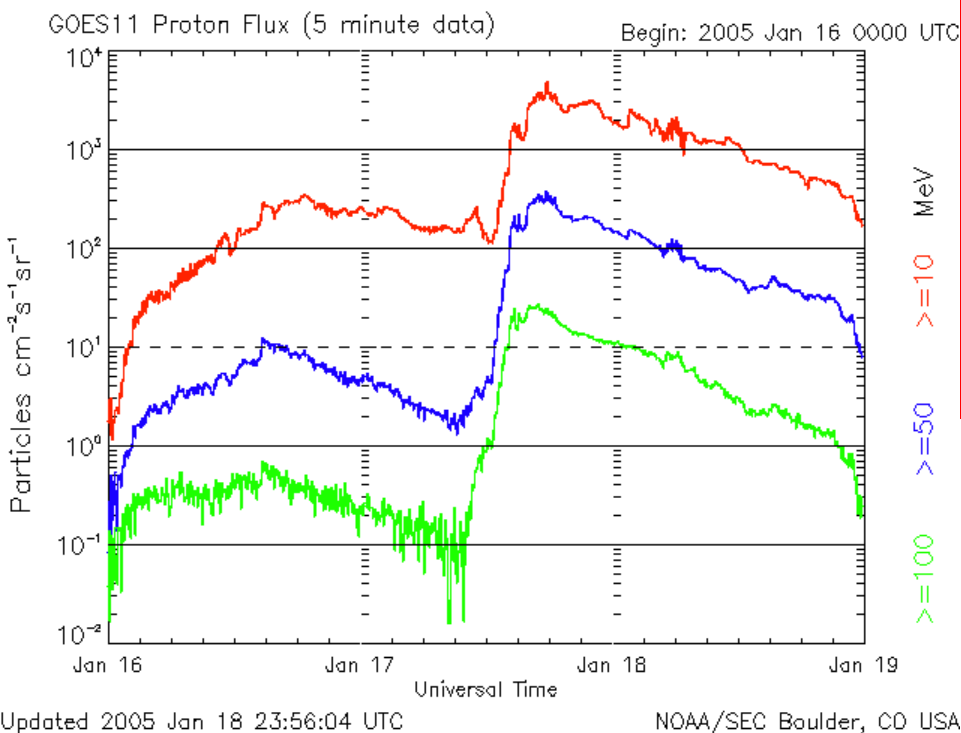


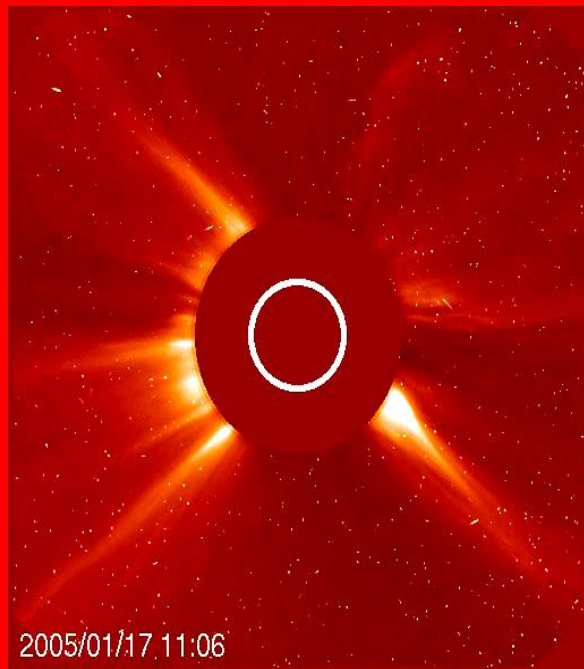
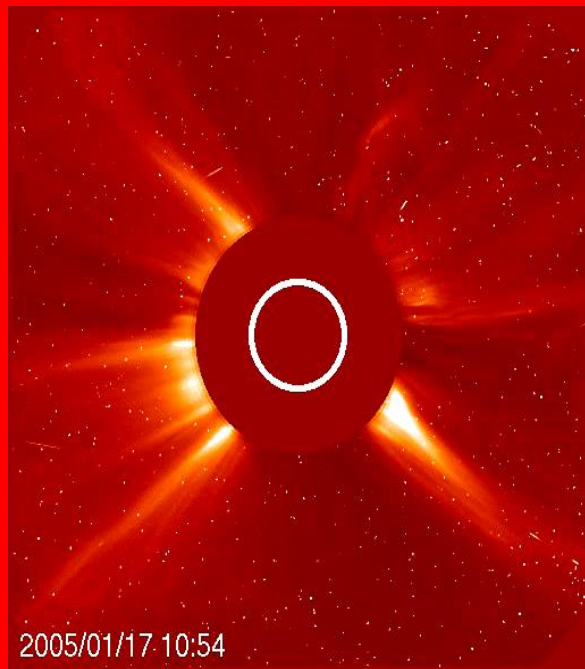
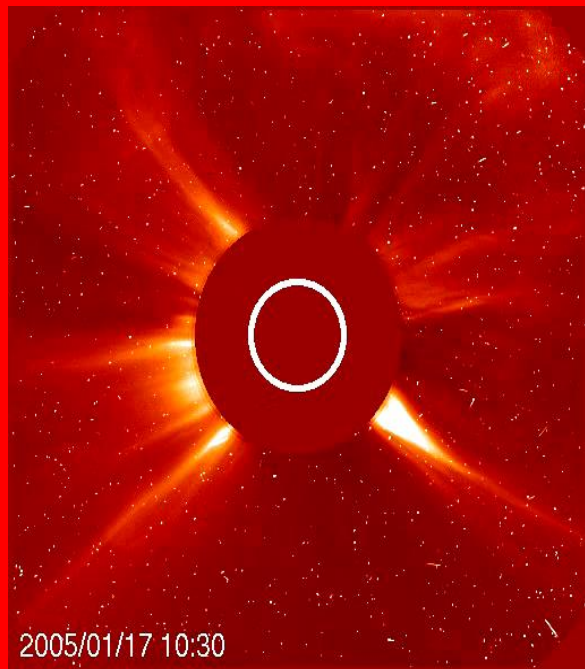
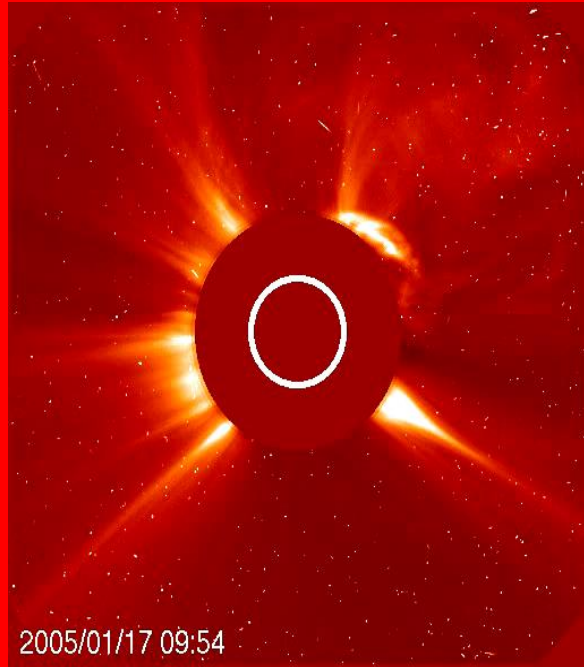
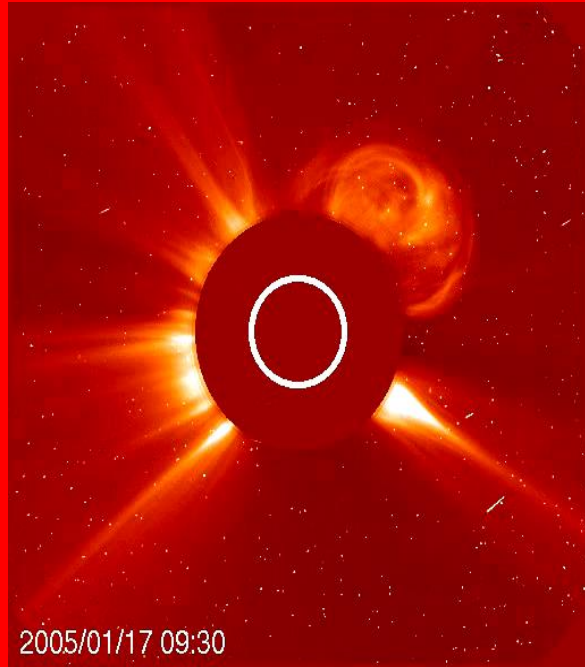
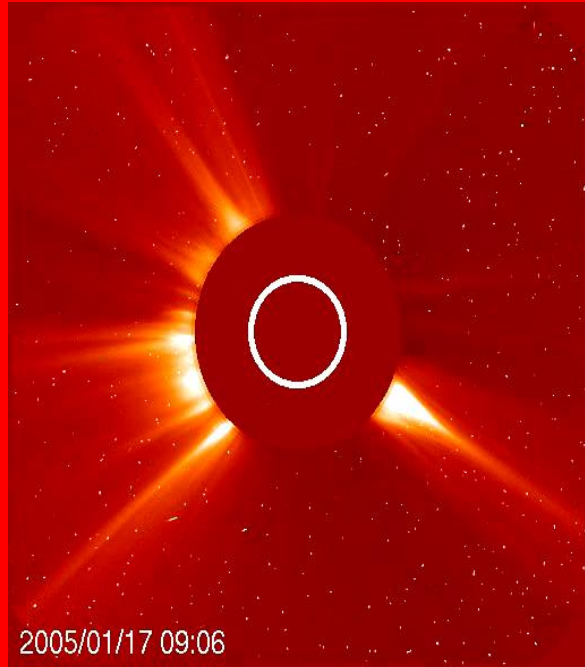
2005/01/17 10:25

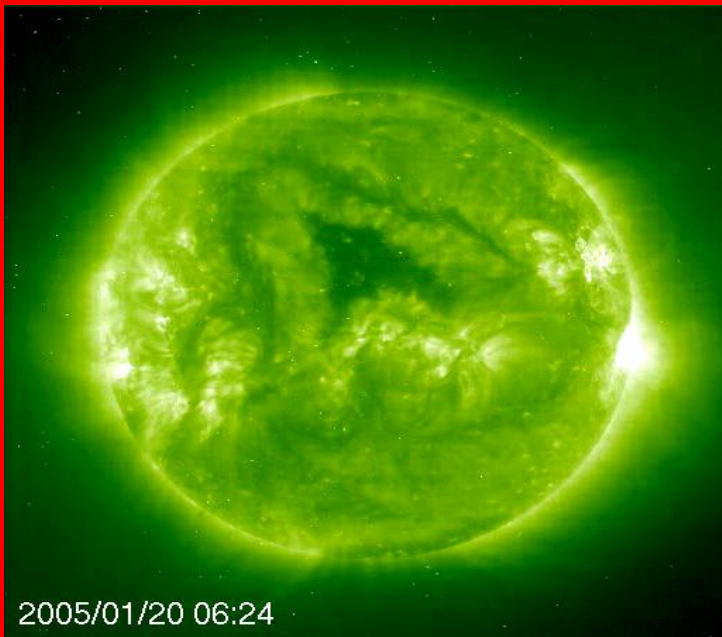


2005/01/17 11:12

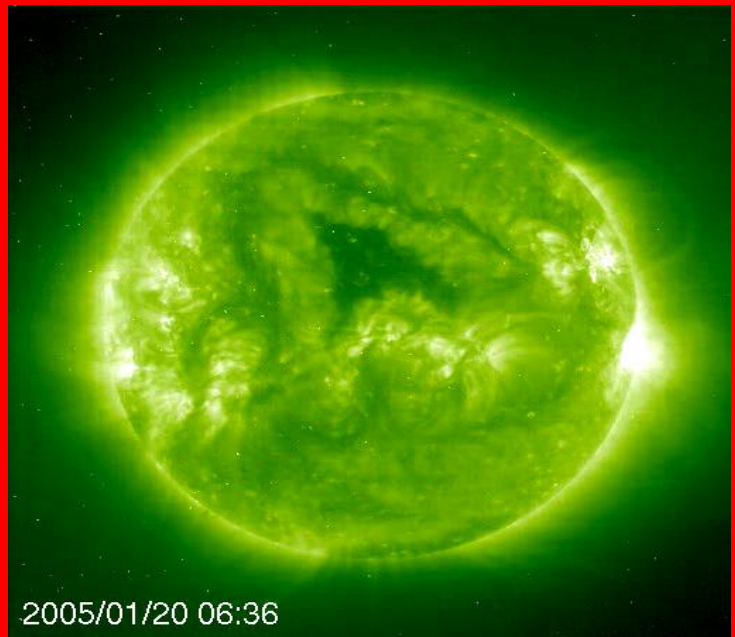
ΠΡΩΤΟΝΙΑ/ GOES SAT



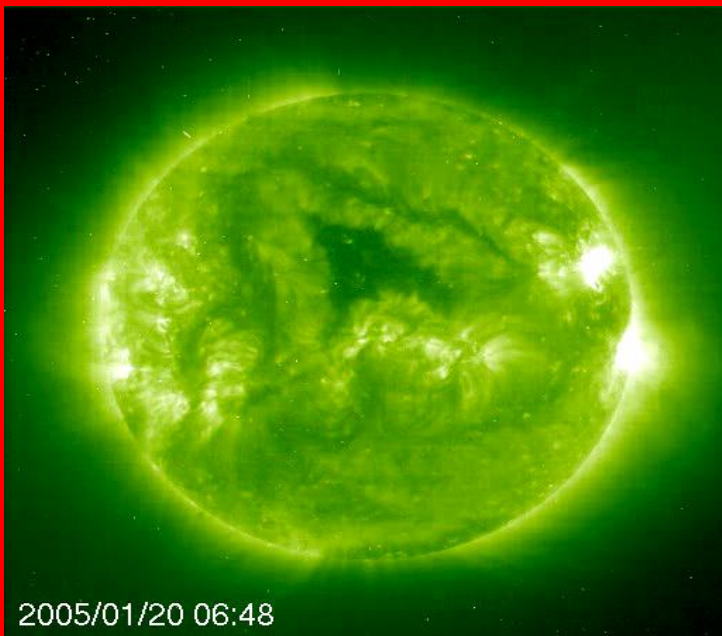




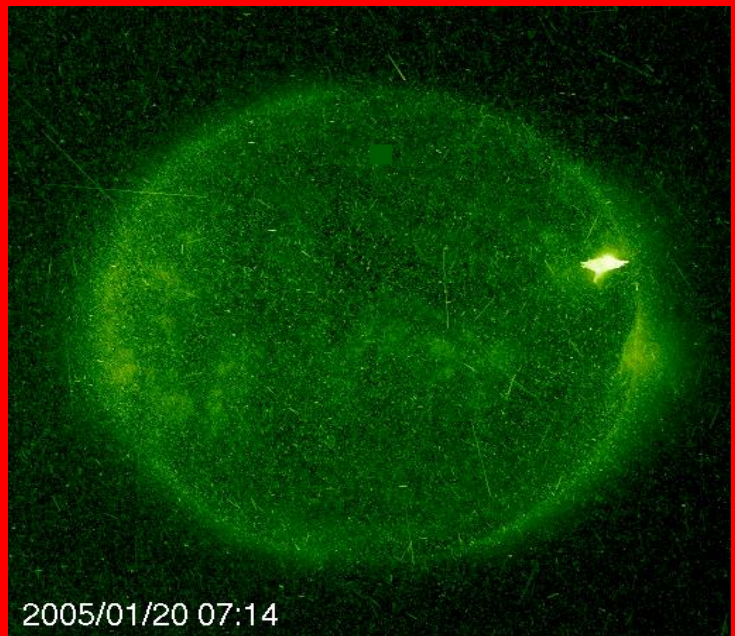
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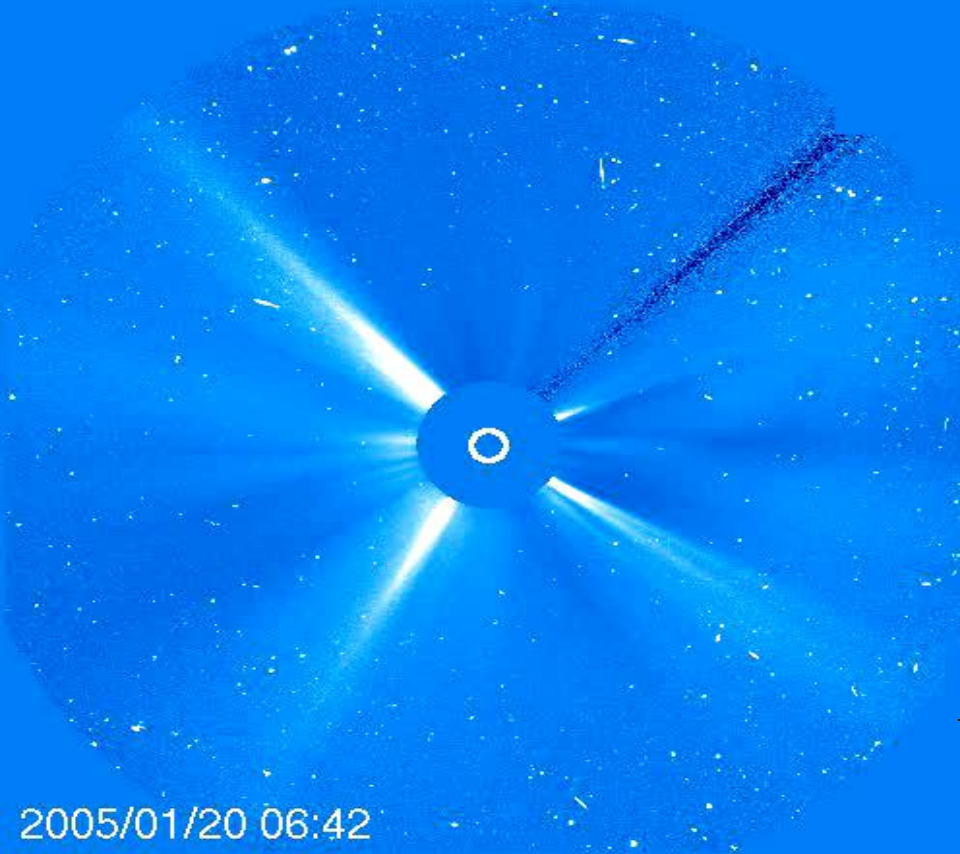
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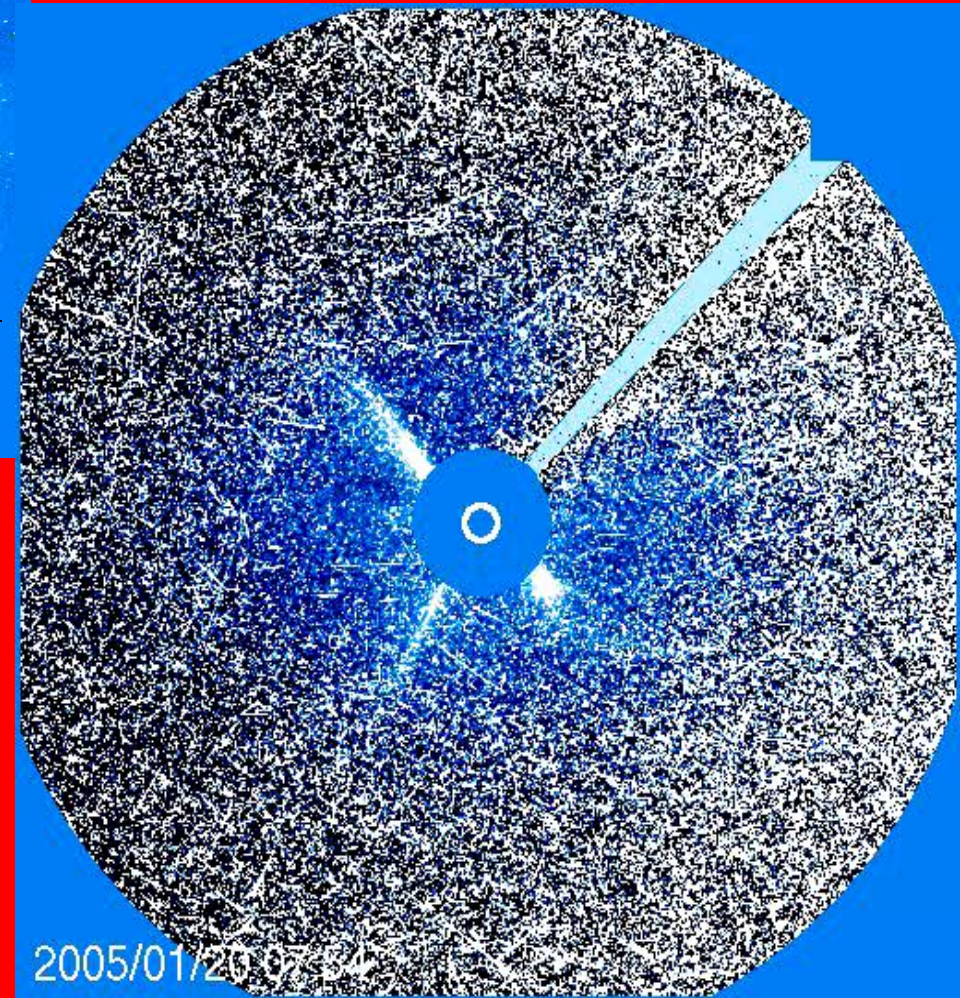
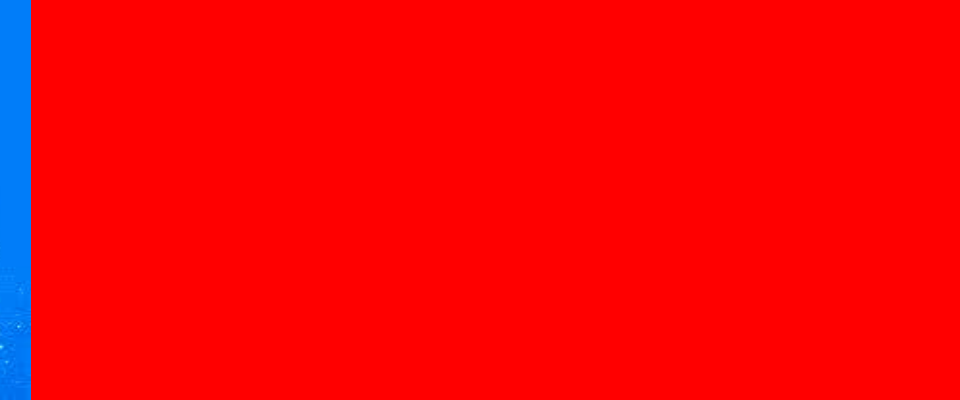
2005/01/20 06:48



2005/01/20 07:14

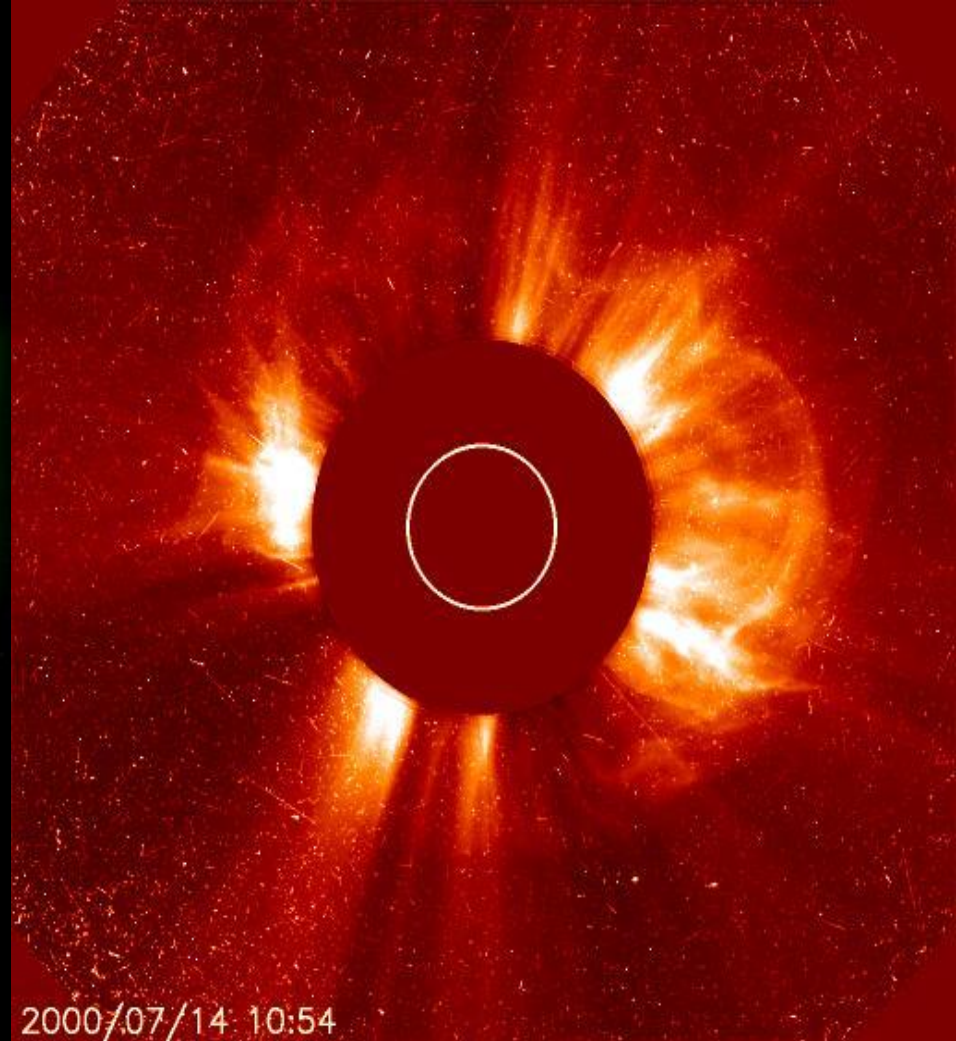
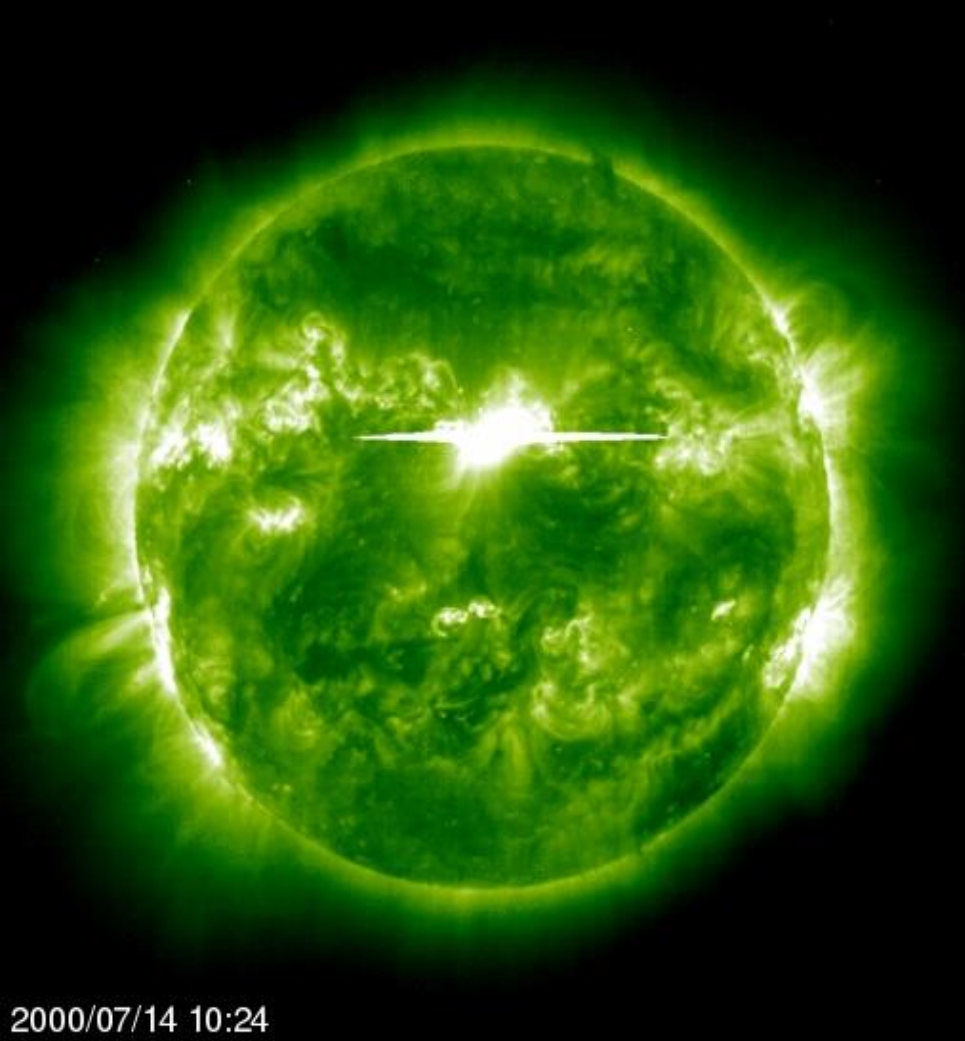


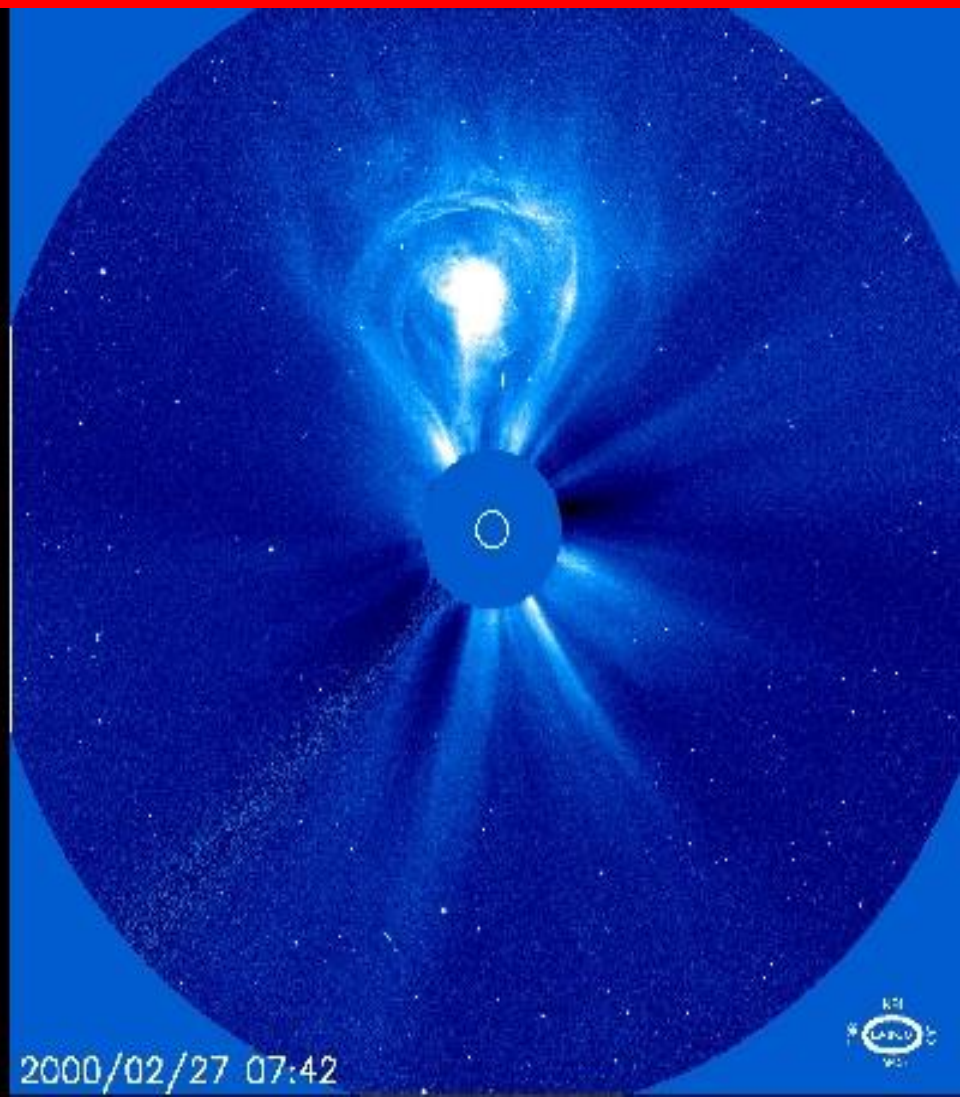
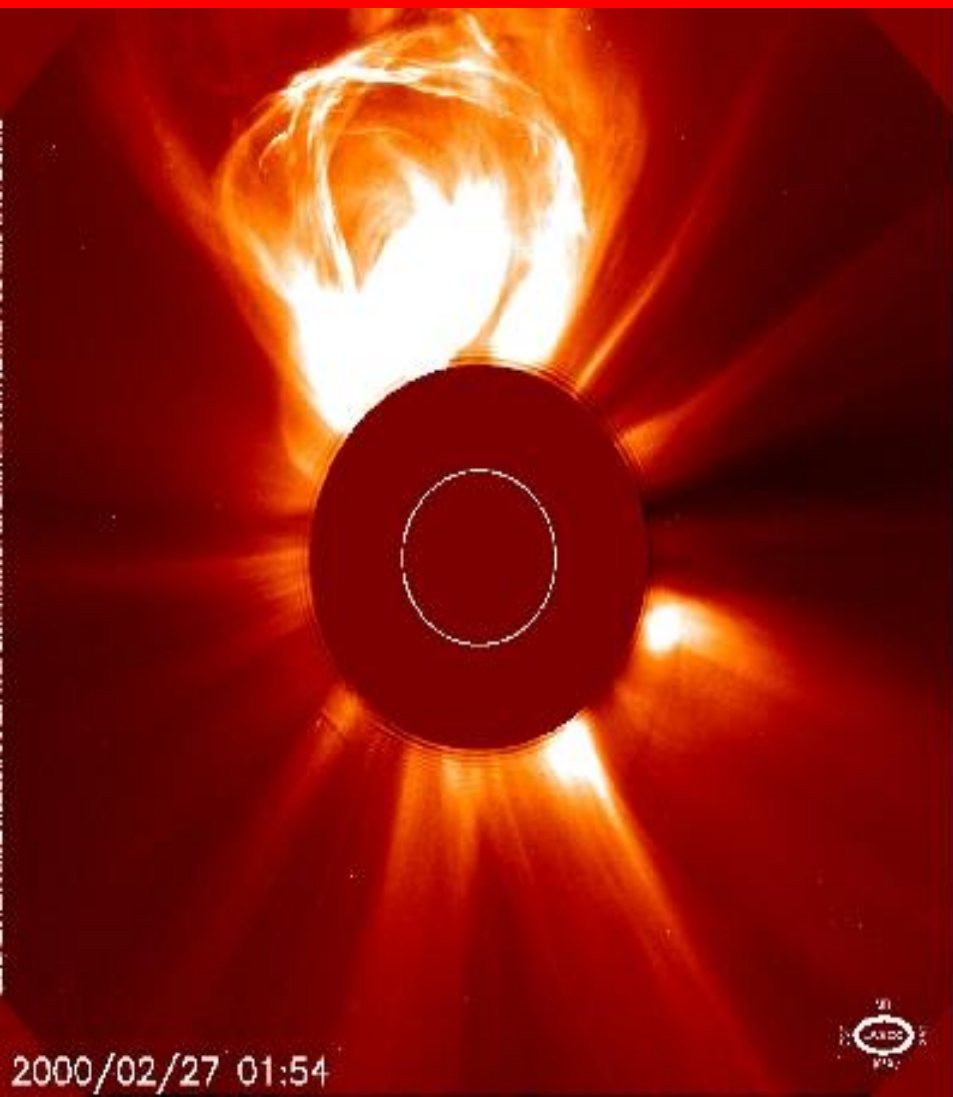
2005/01/20 06:42



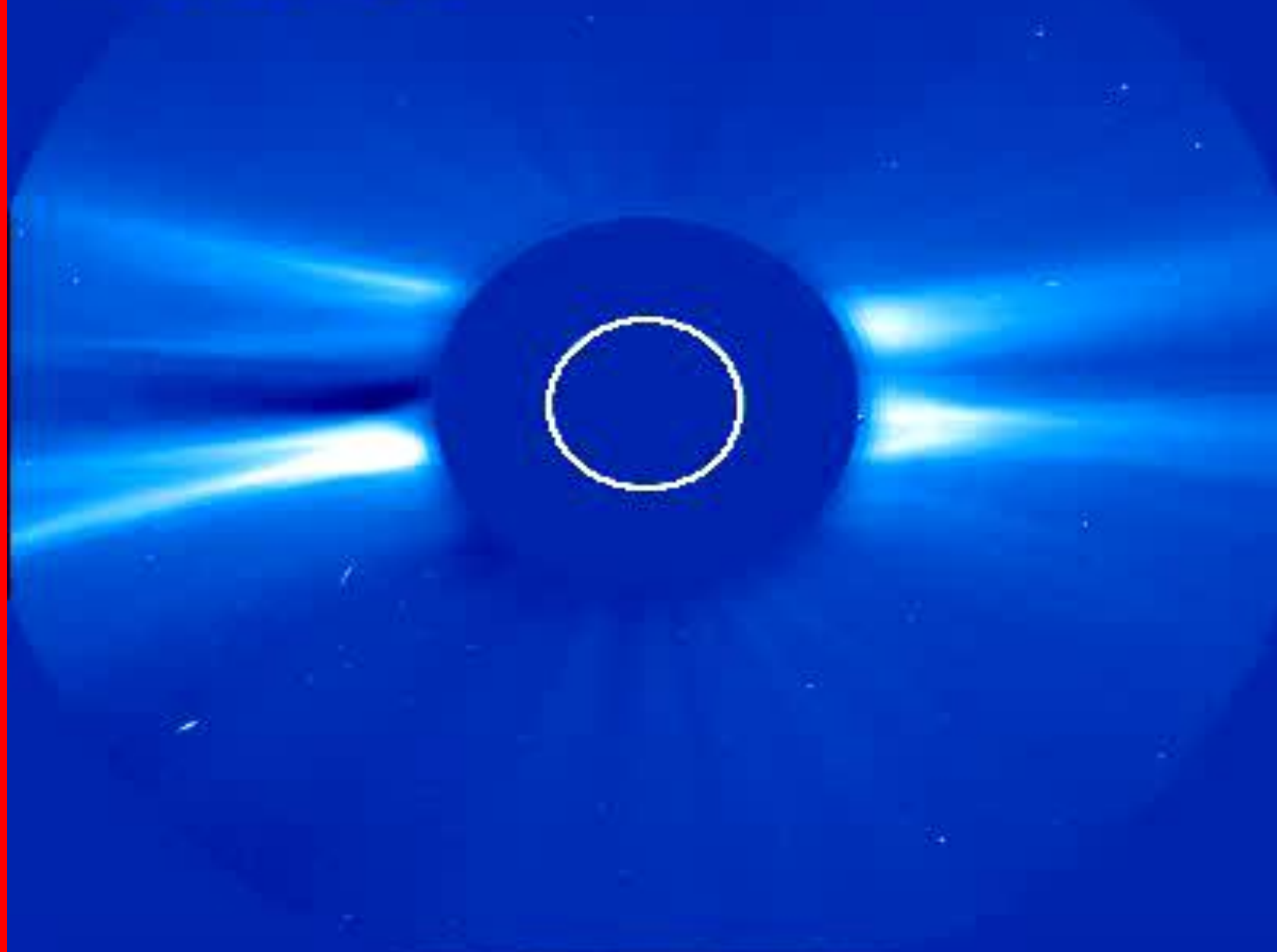
2005/01/20 07:54

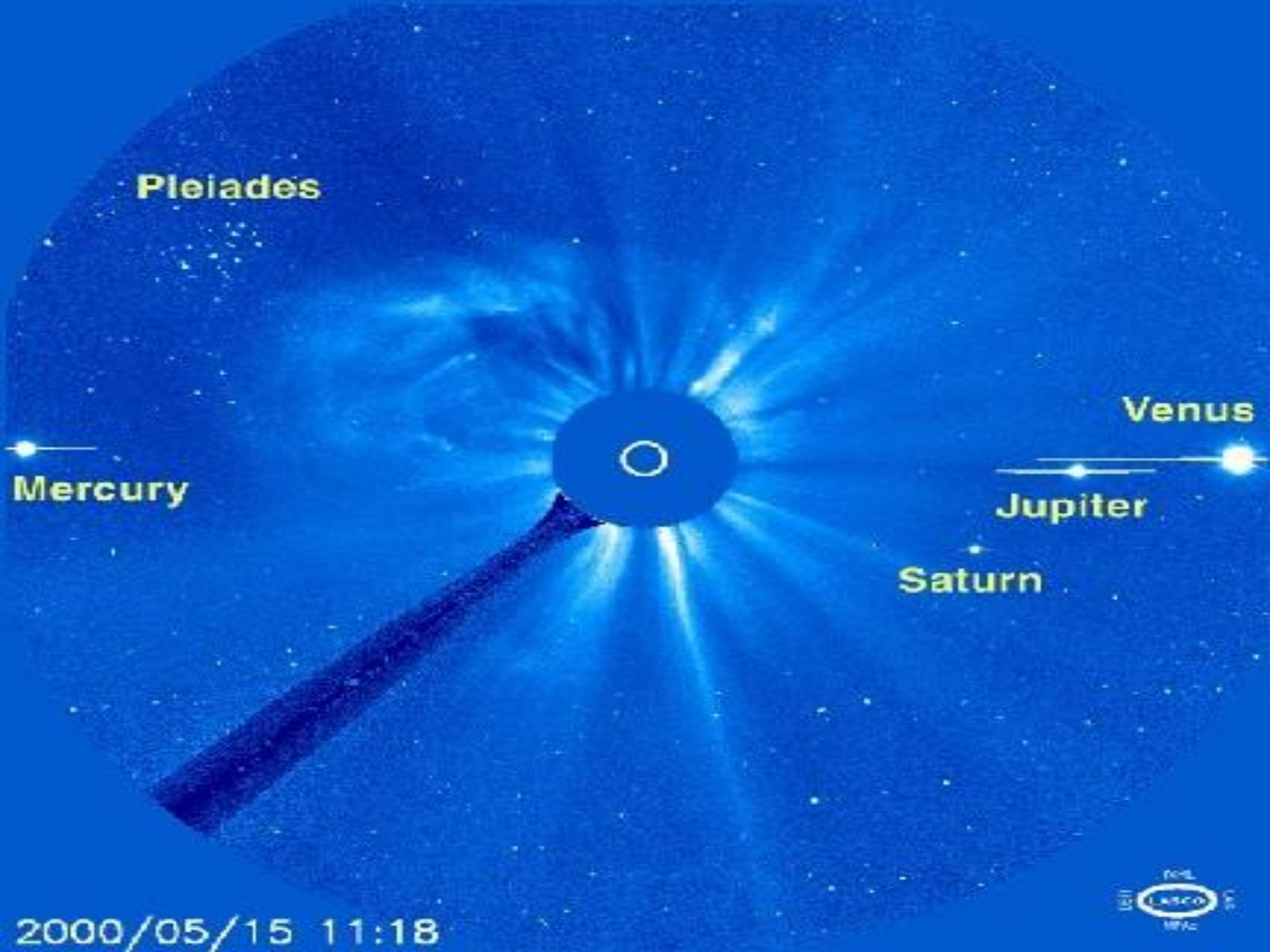
14 ΙΟΥΛΙΟΥ 2000 BASTILLE EVENT





1998/01/26





Pleiades

Venus

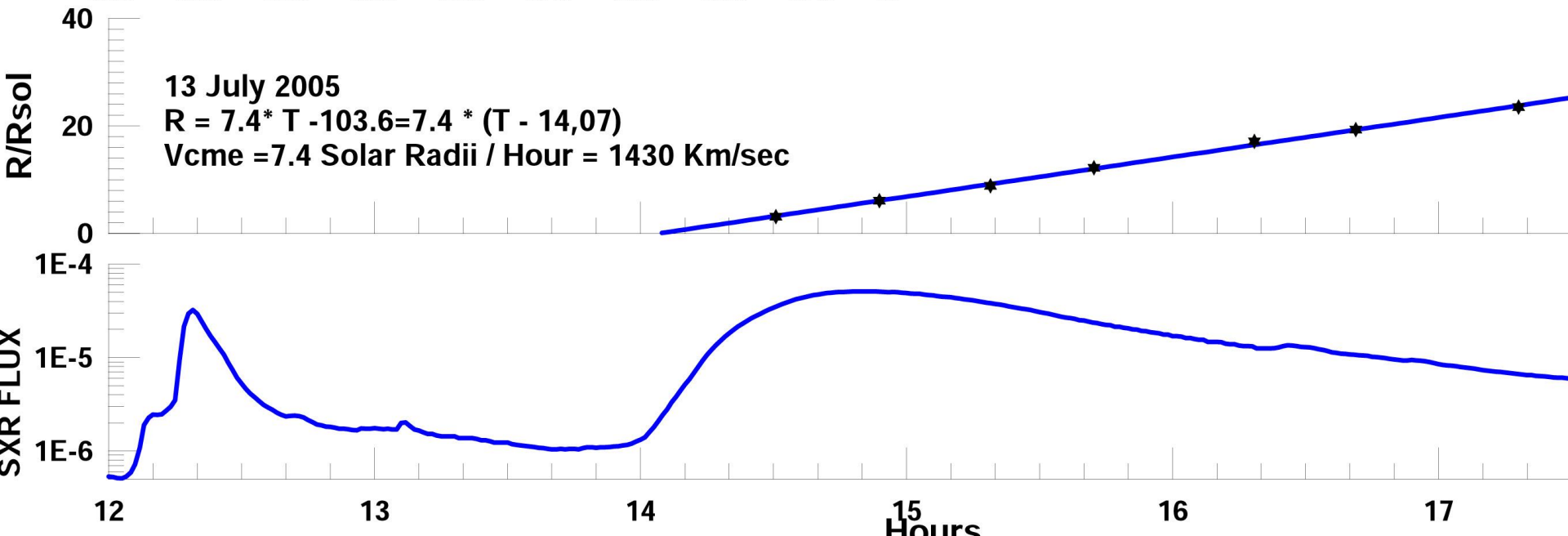
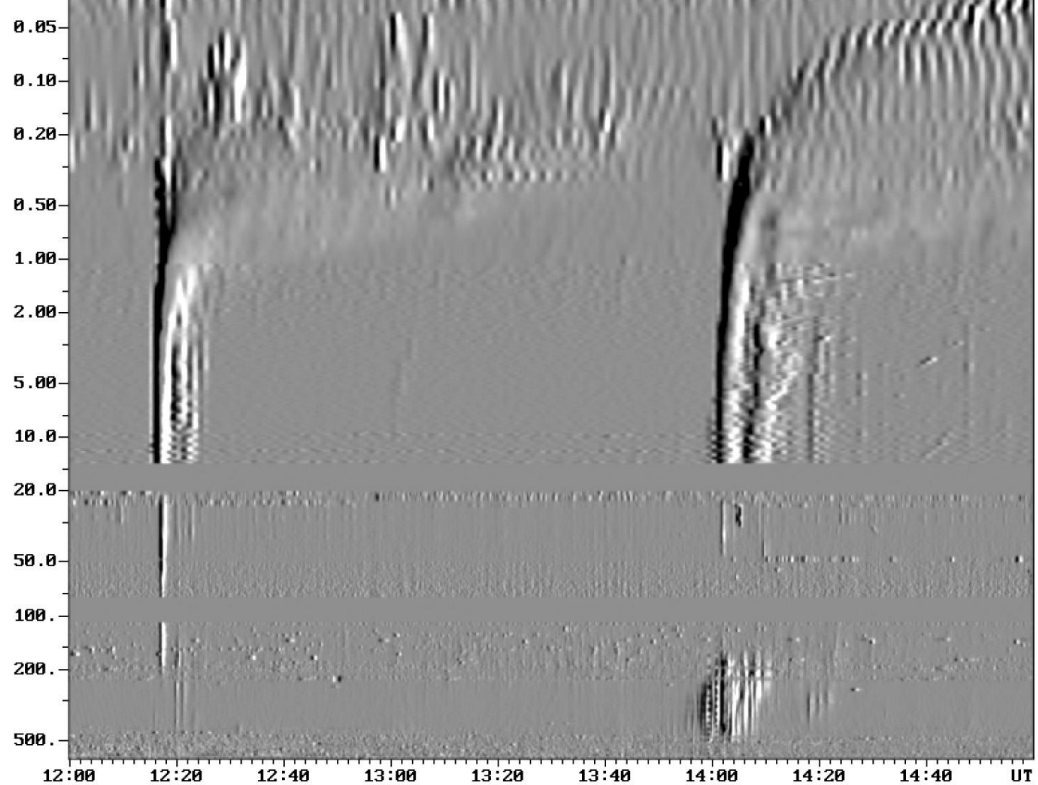
Mercury

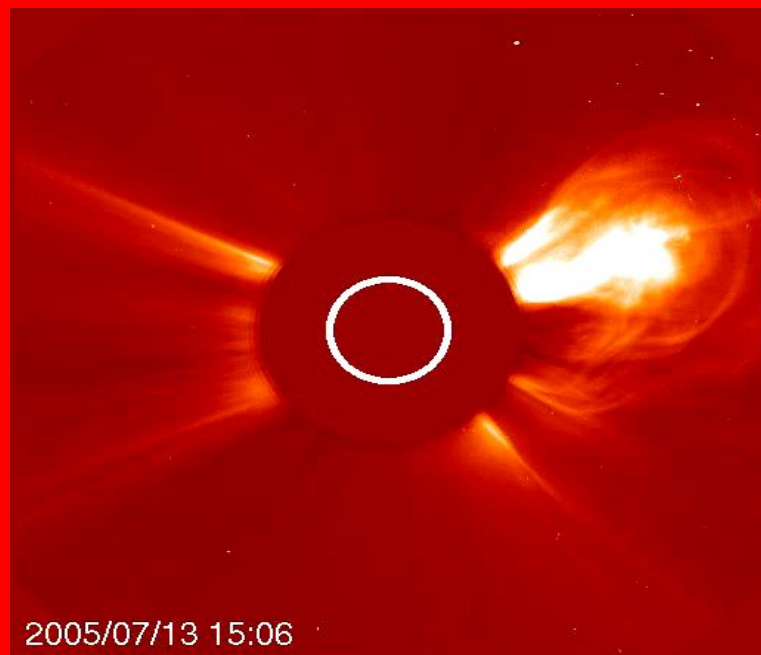
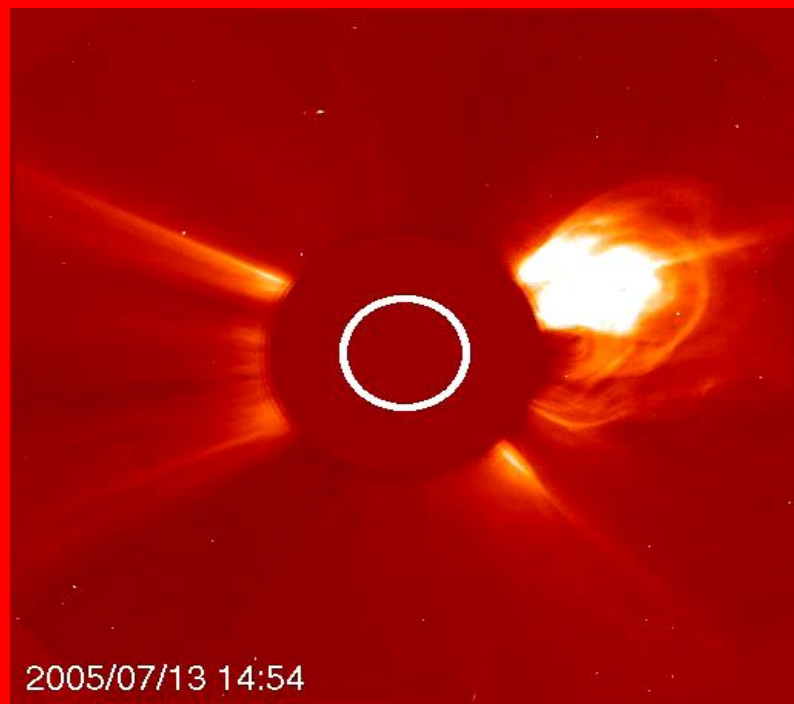
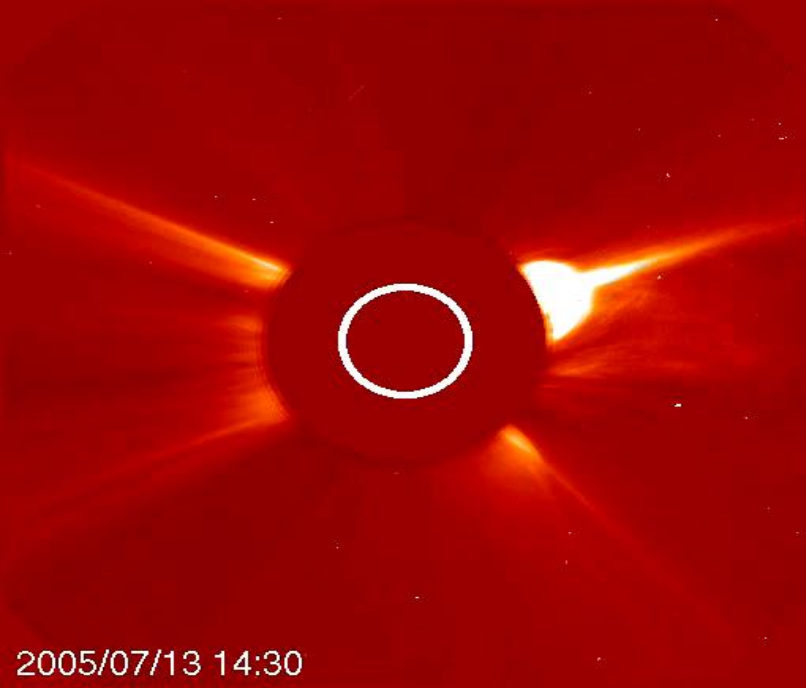
Jupiter

Saturn

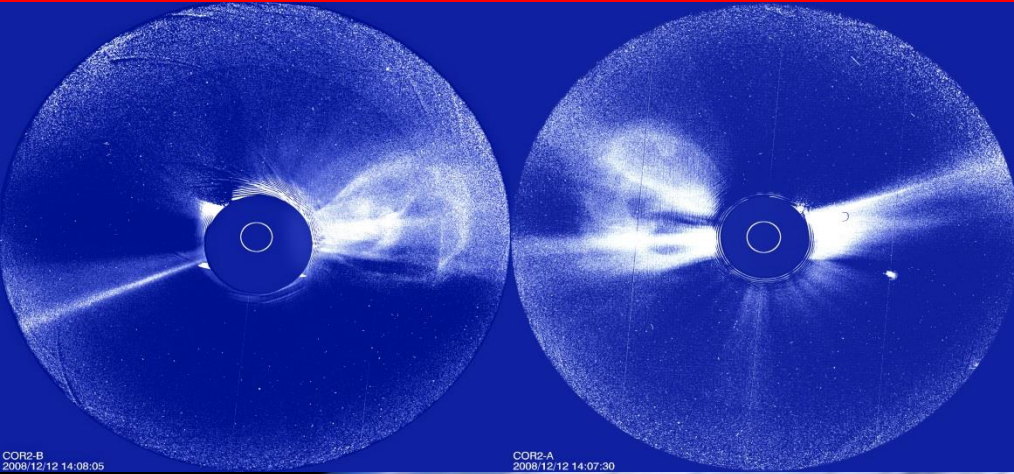
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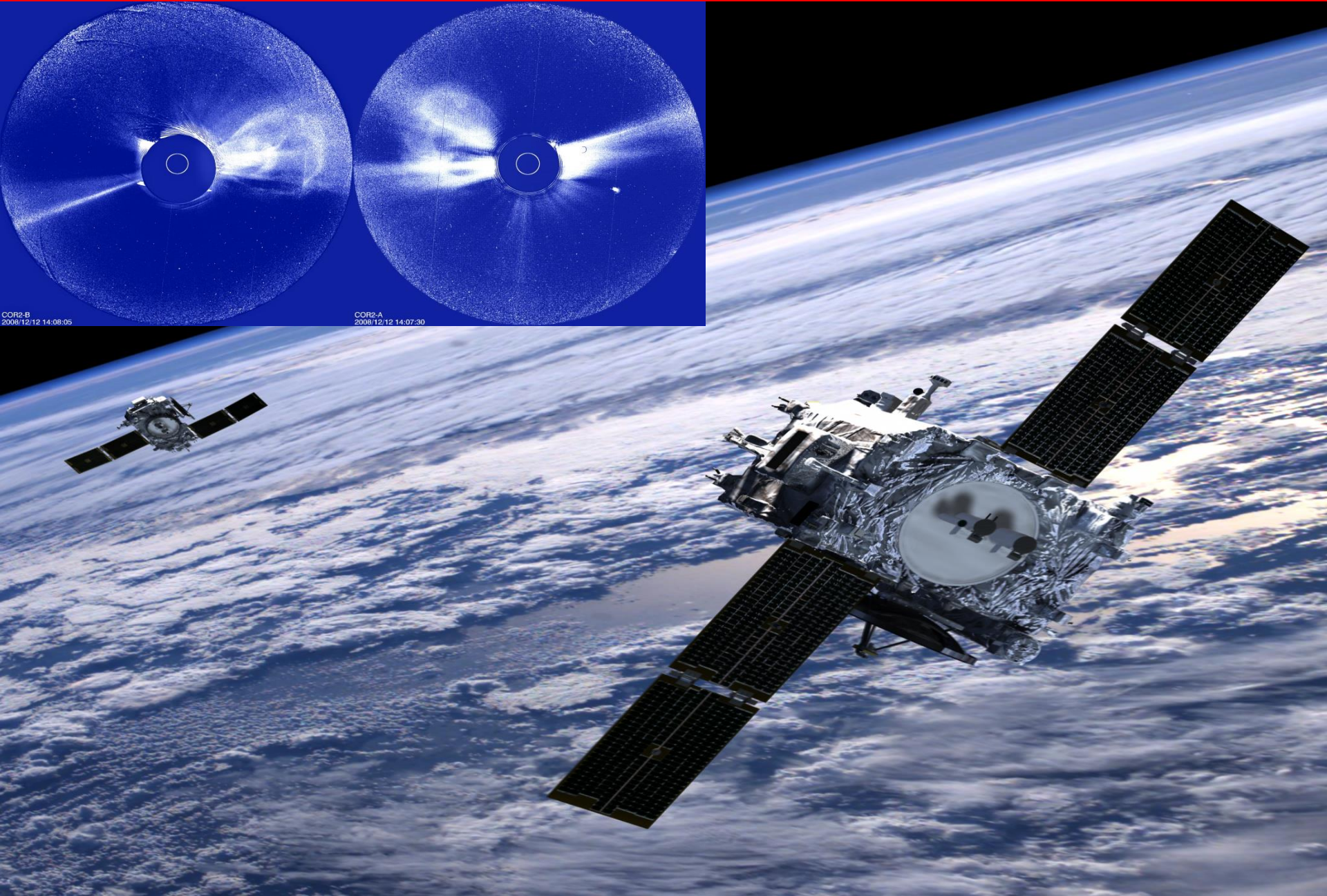


STEREO CME 12/12/2008

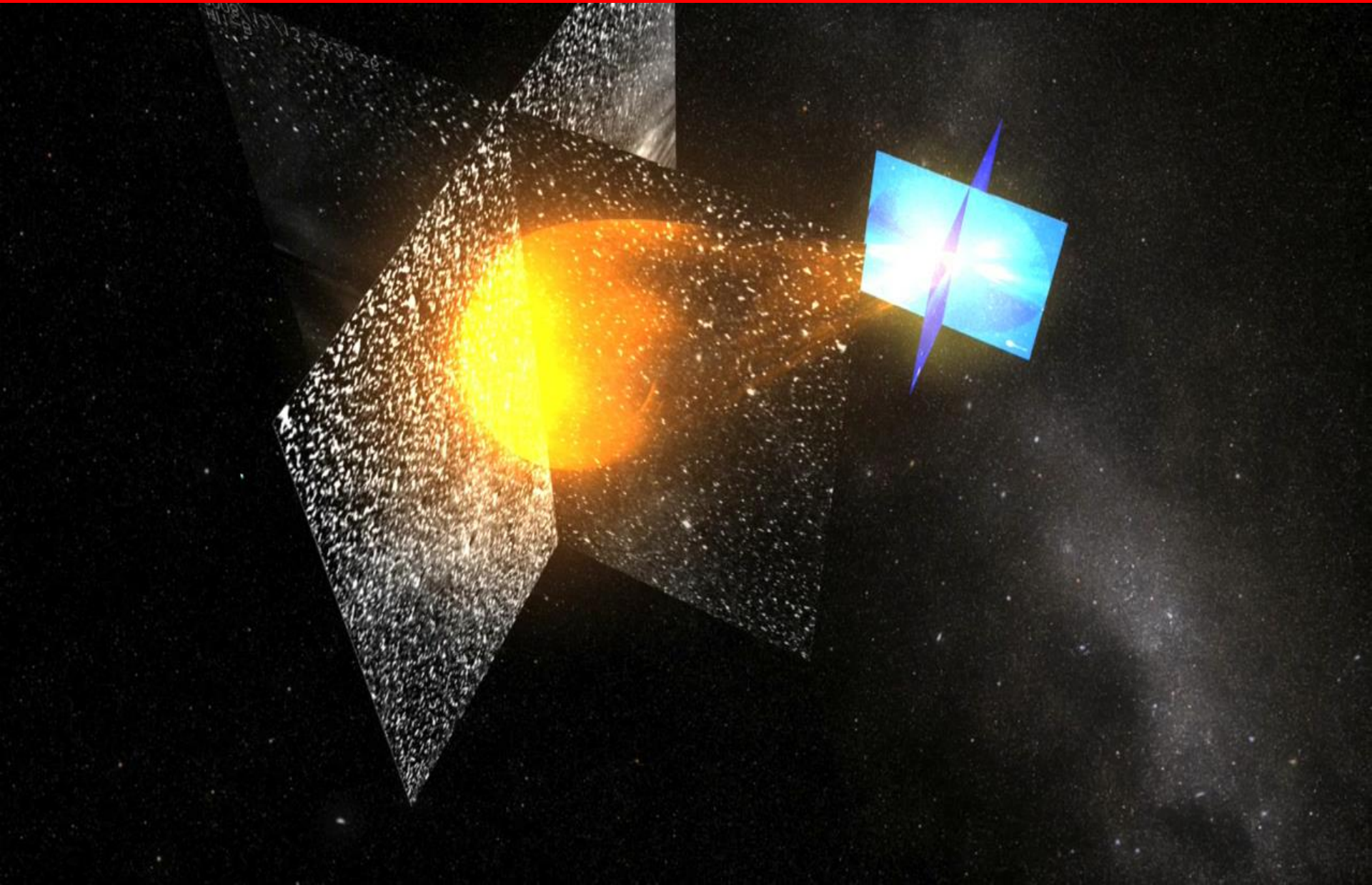


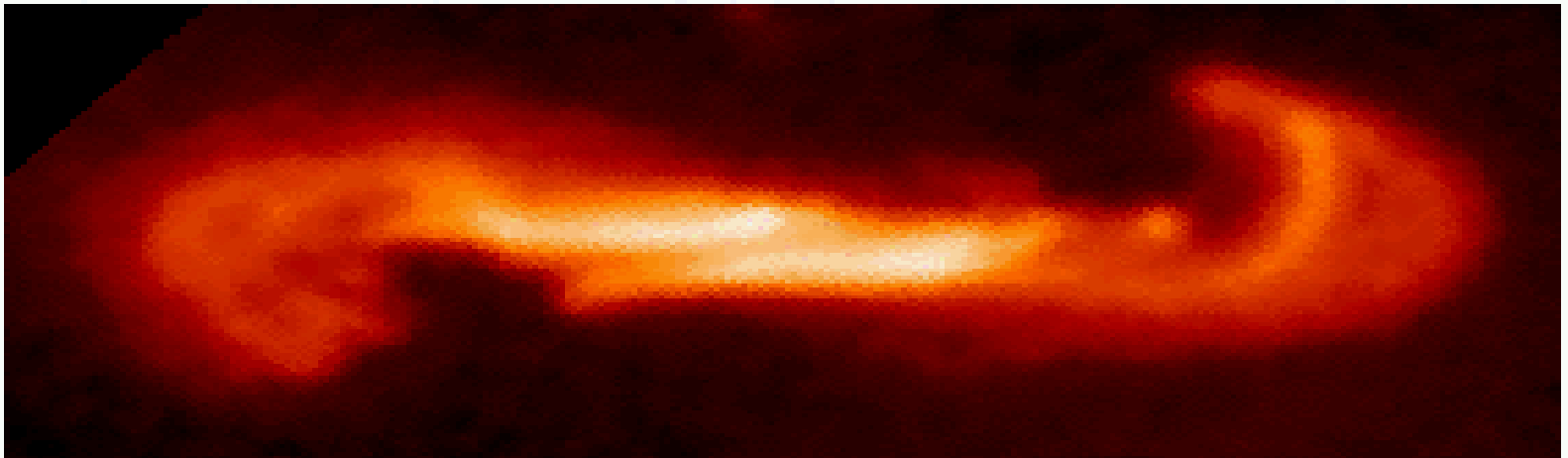
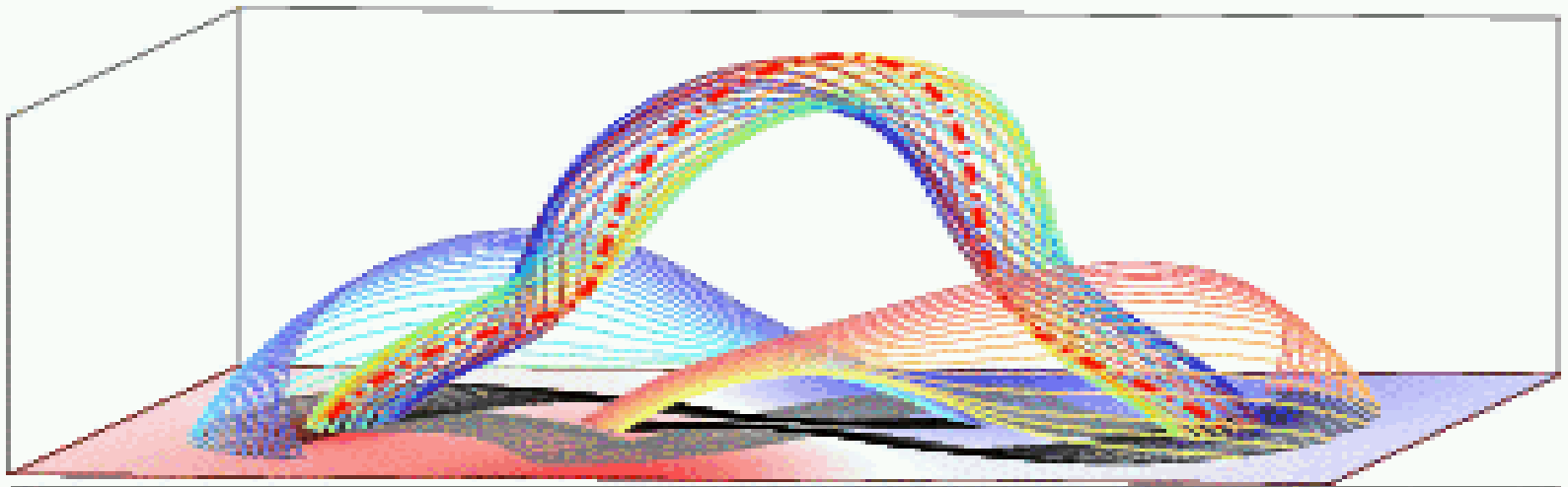
COR2-B
2008/12/12 14:08:05

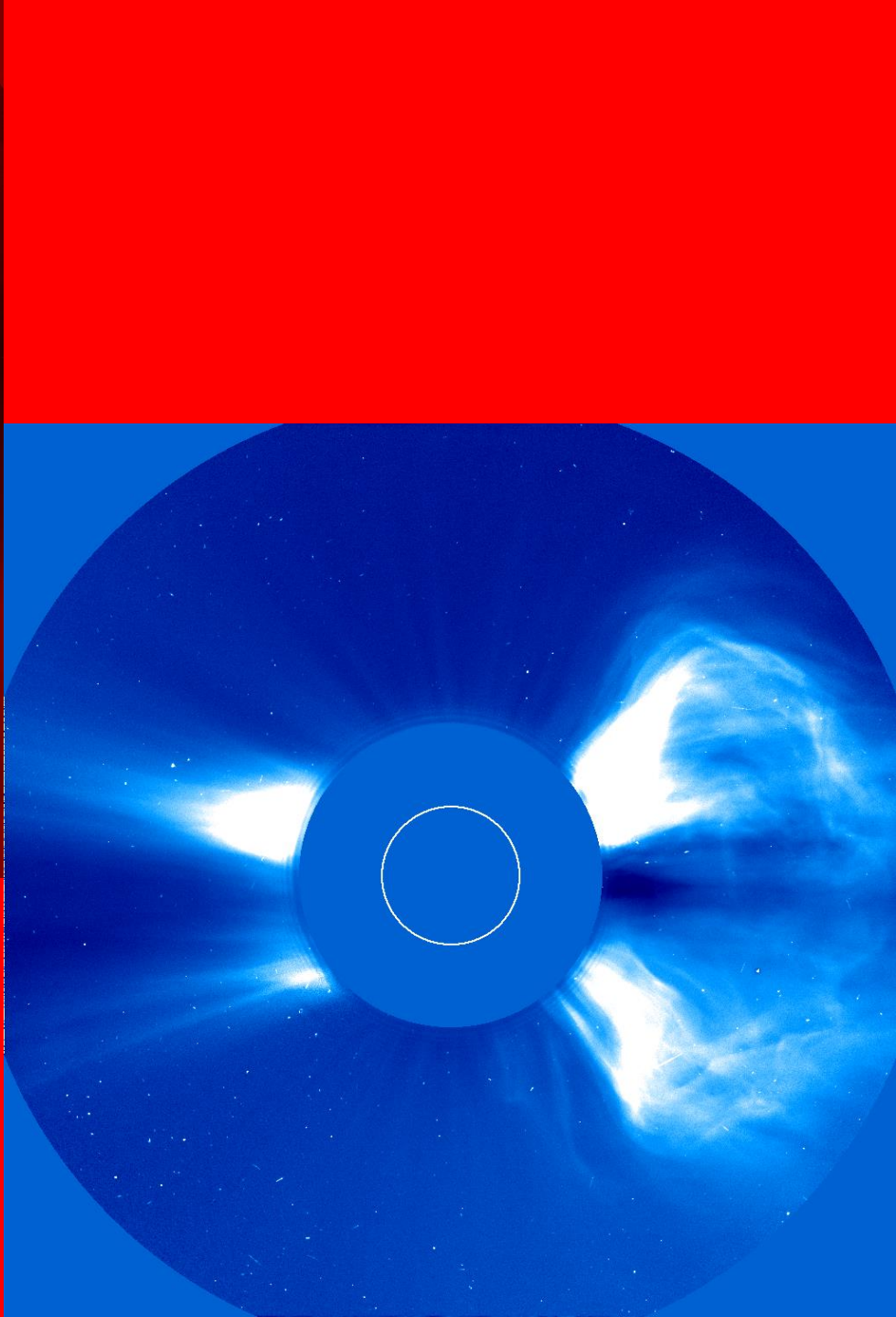
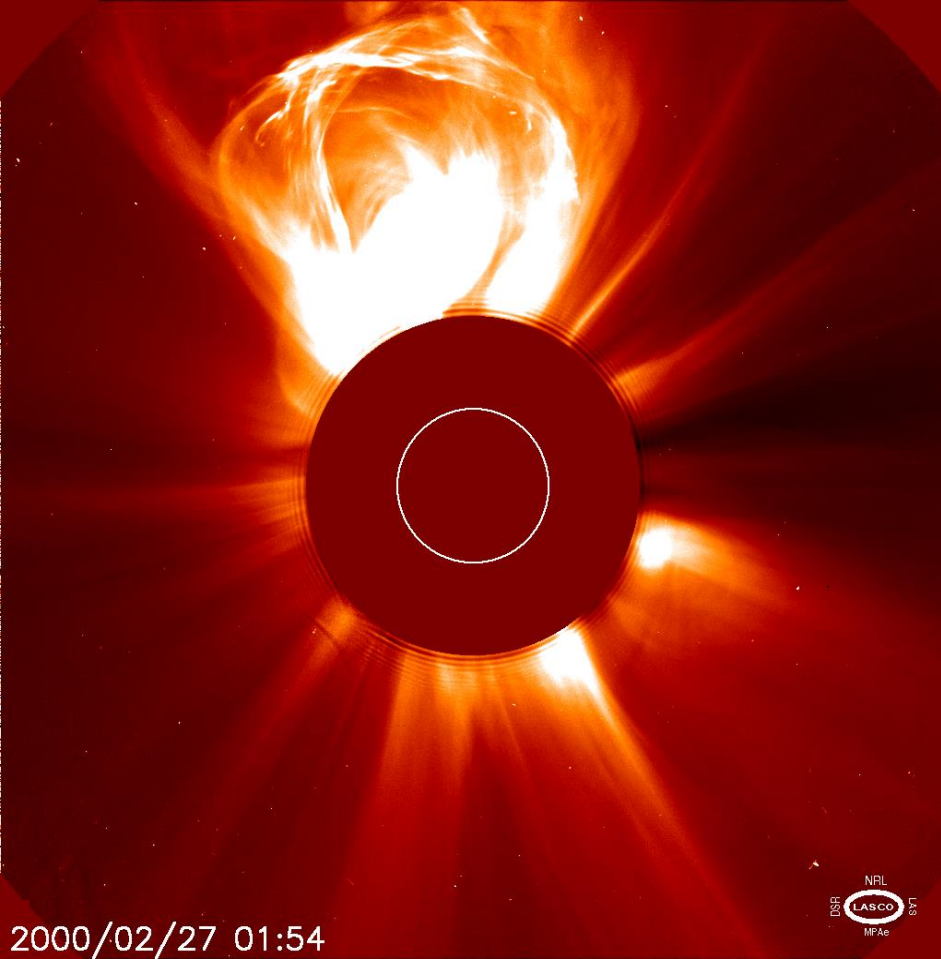
COR2-A
2008/12/12 14:07:30



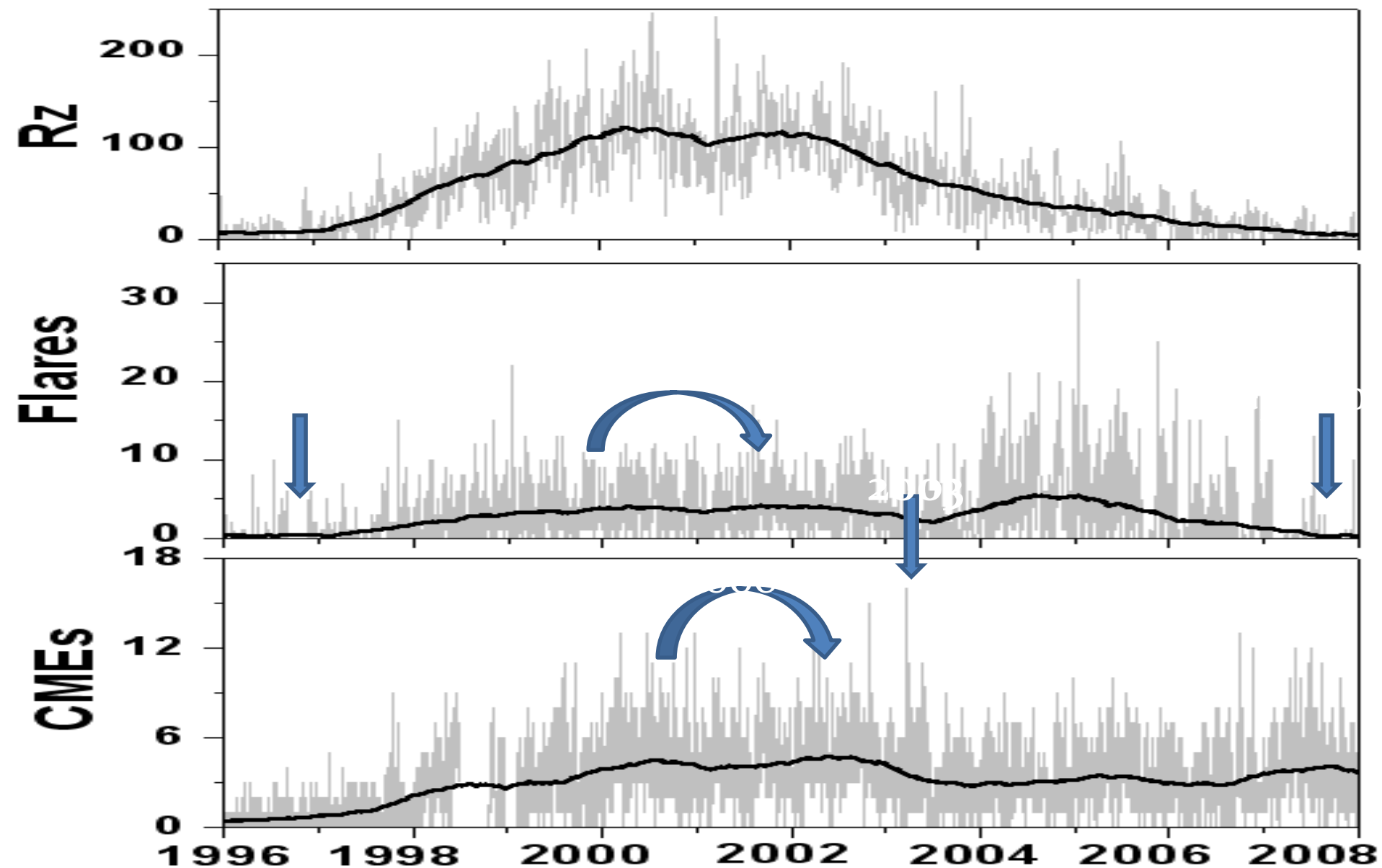
STEREO CME 12/12/2008



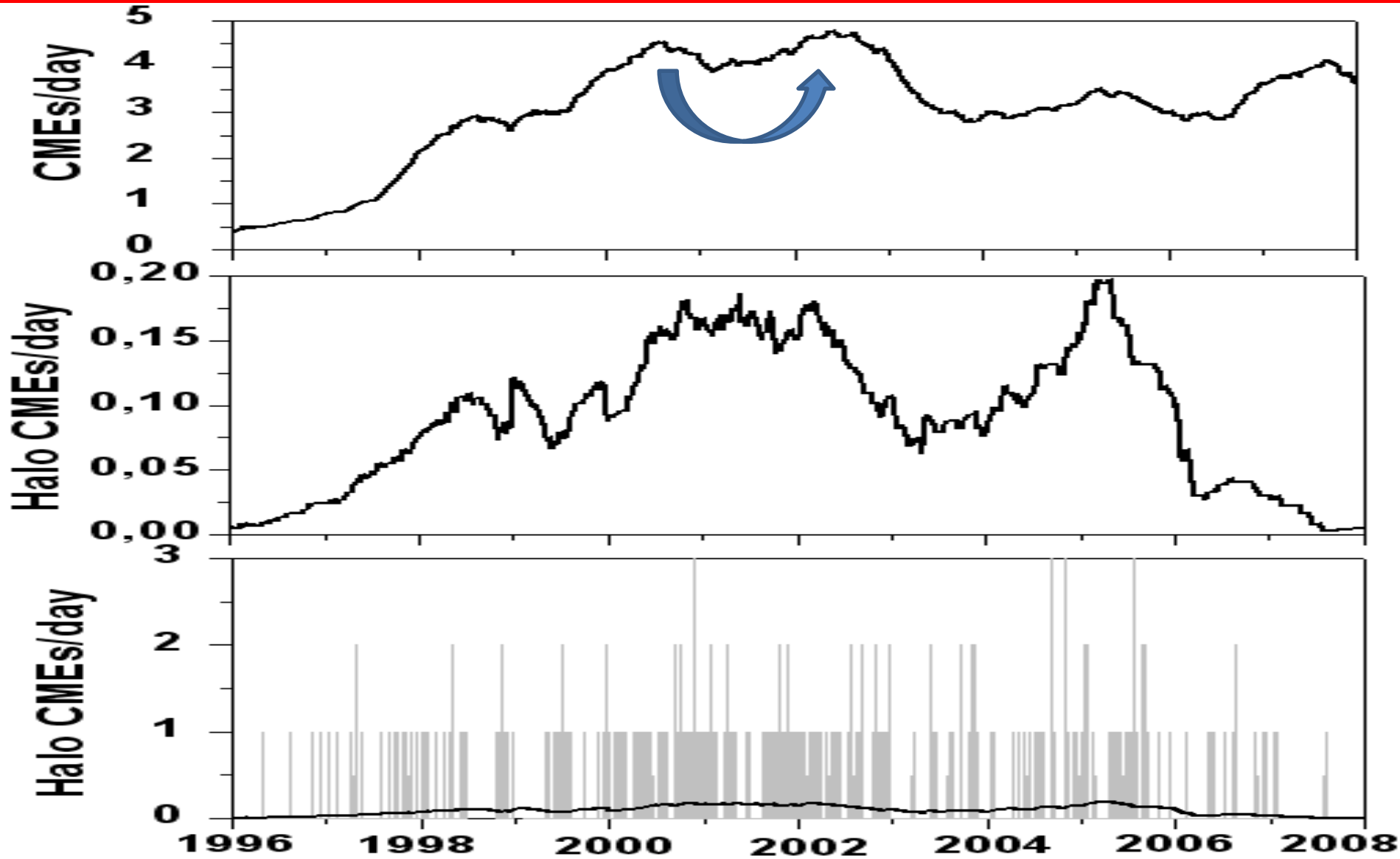




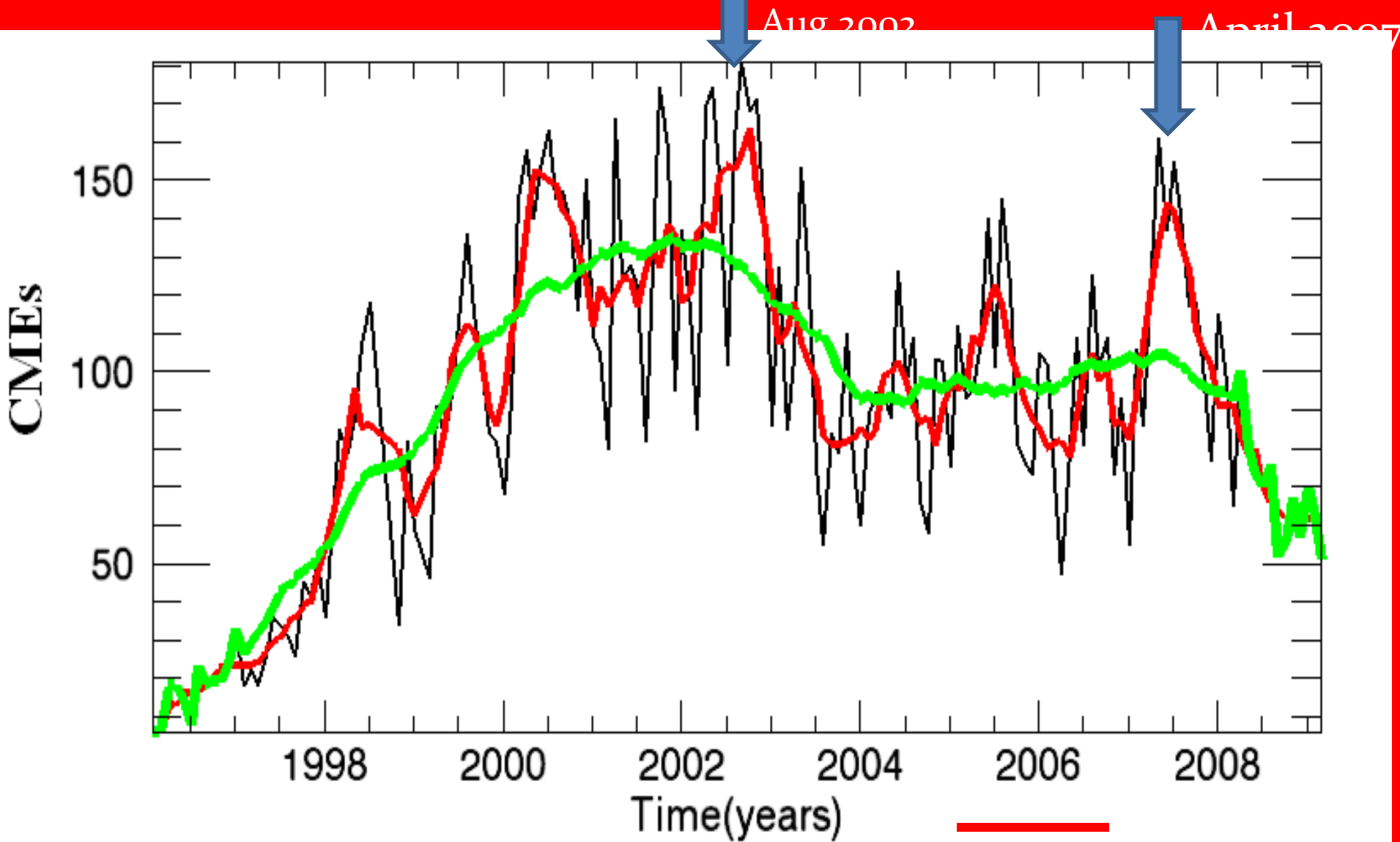
Solar Flares and Coronal Mass Ejections



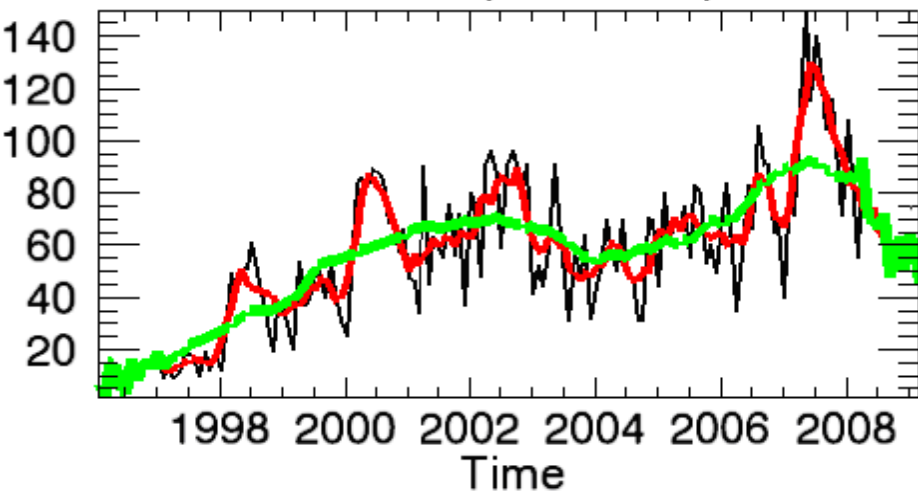
CMEs Analysis



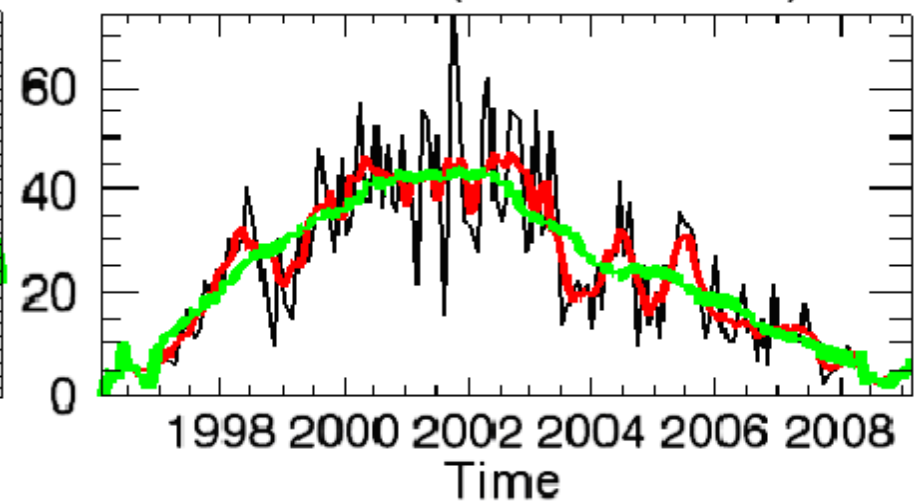
Monthly Distribution CMEs



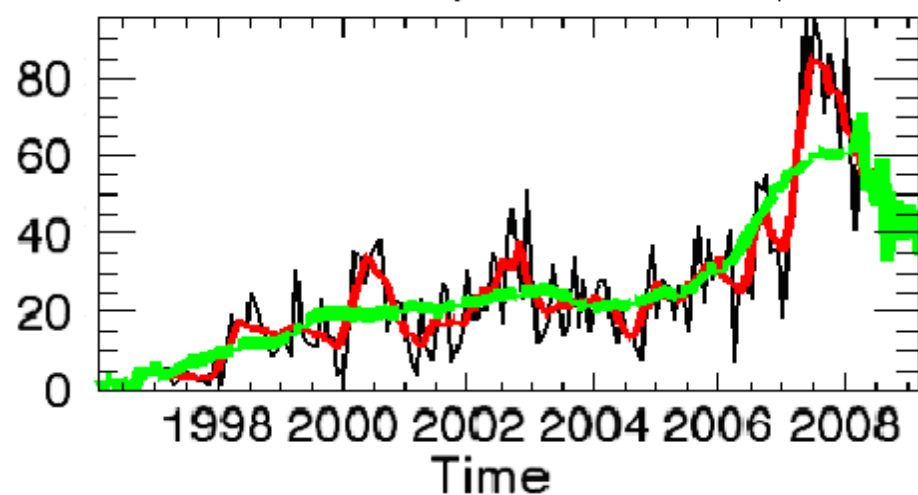
CMEs (width < 50)



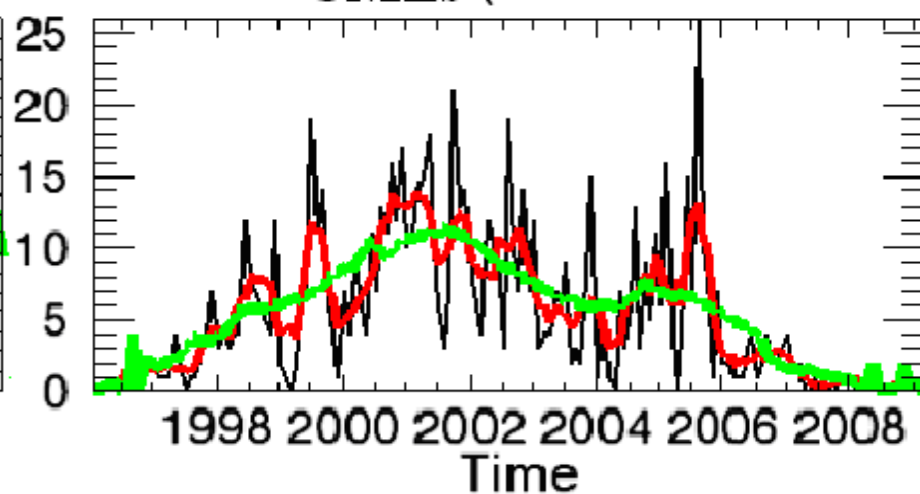
CMEs (50 < width < 100)



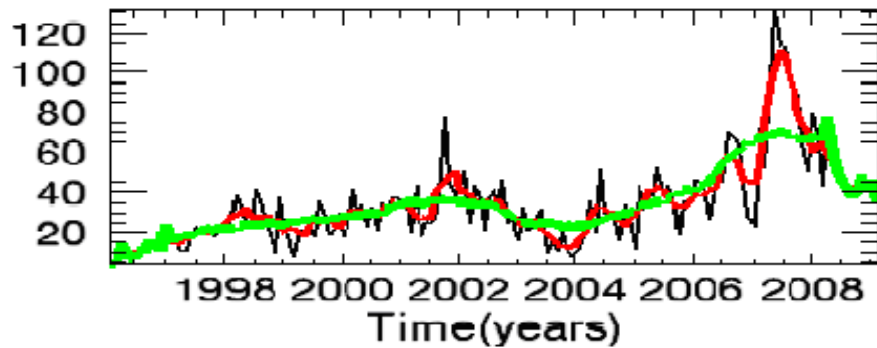
CMEs (0 < width < 20)



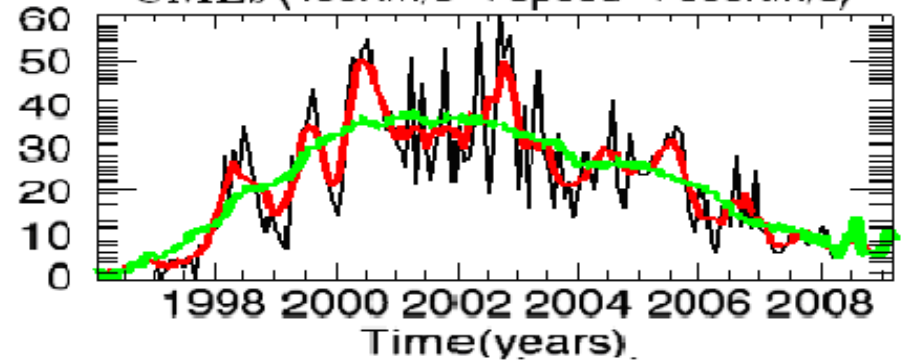
CMEs (width > 150)



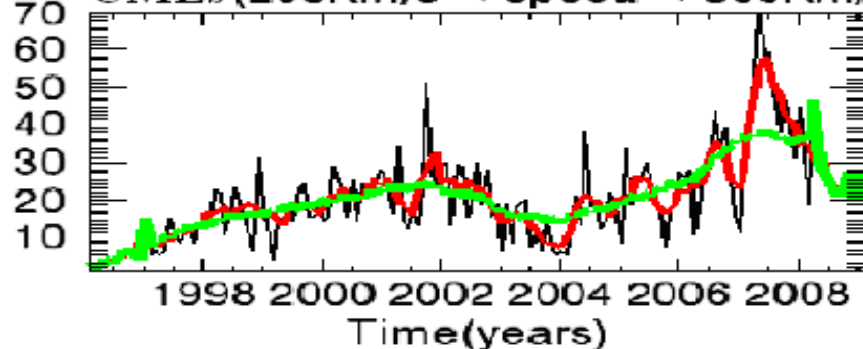
CMEs (speed < 300Km/s)



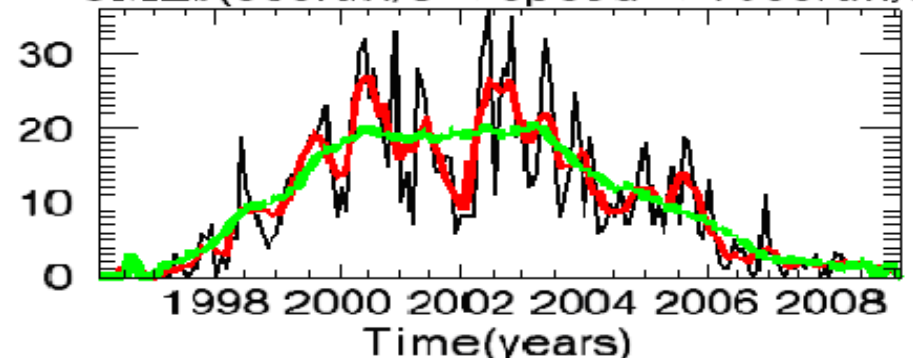
CMEs (400Km/s < speed < 600Km/s)



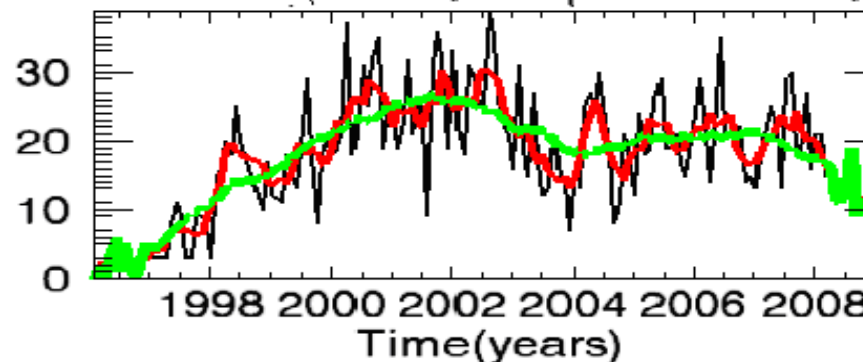
CMEs (200Km/s < speed < 300Km/s)



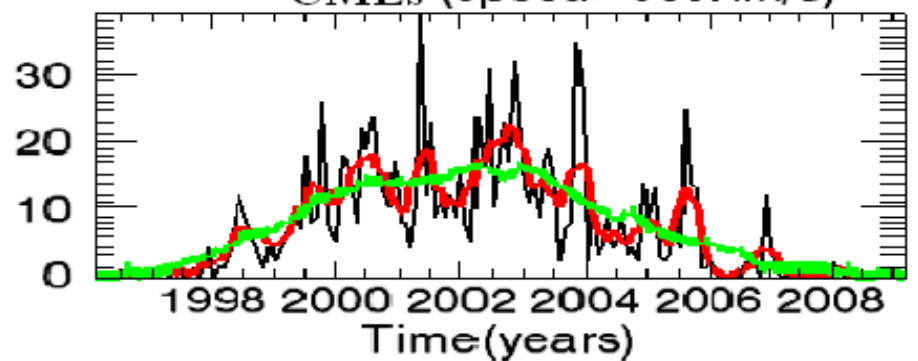
CMEs (600Km/s < speed < 1000Km/s)



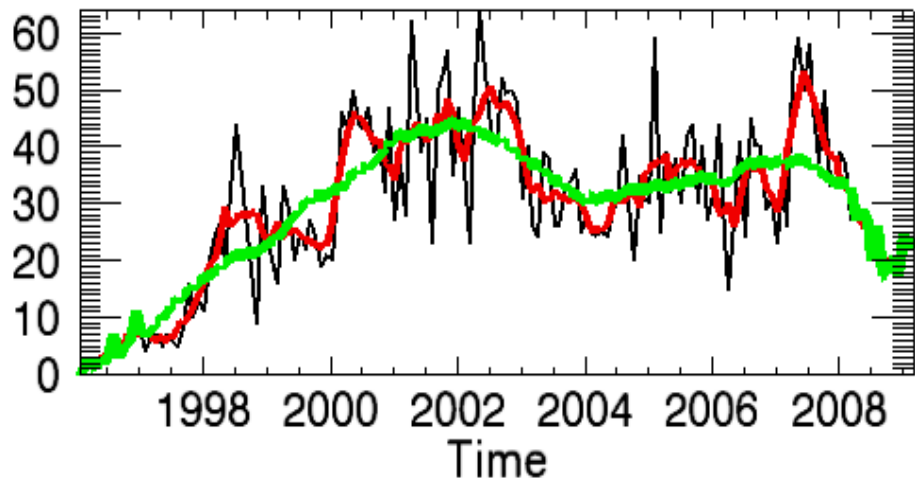
CMEs (300Km/s < speed < 400Km/s)



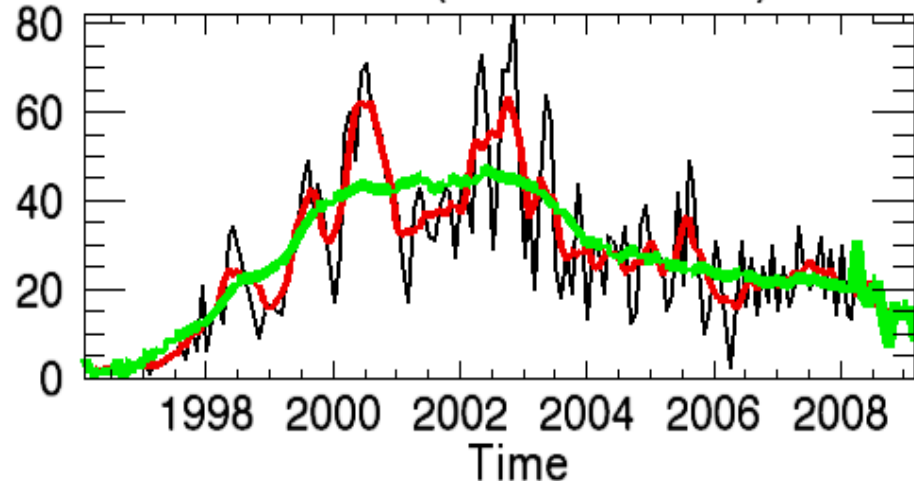
CMEs (speed > 800Km/s)



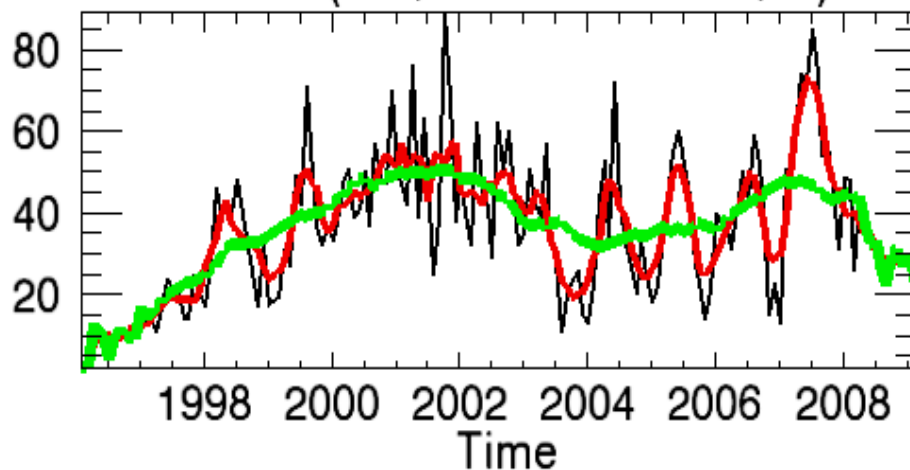
CMEs (accel. > 5 m/s²)

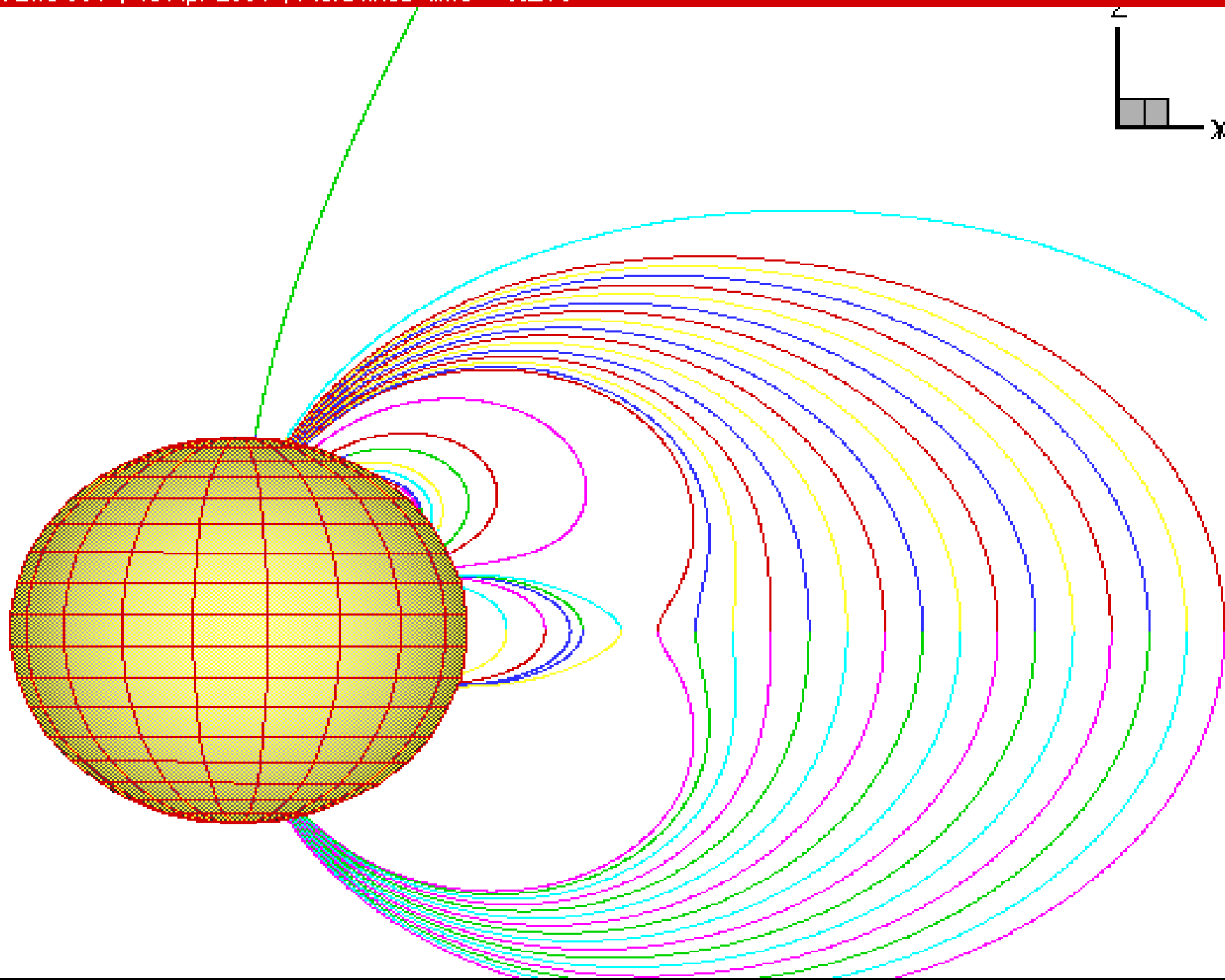
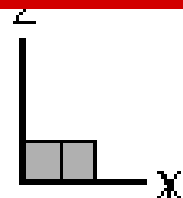


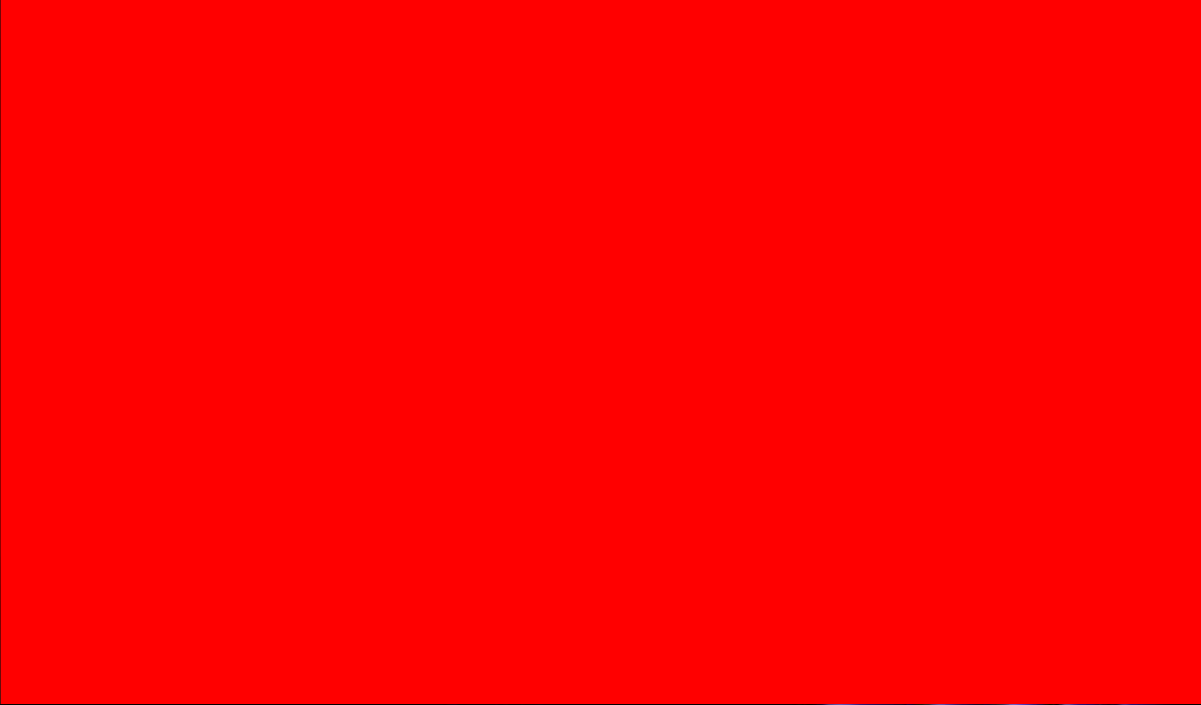
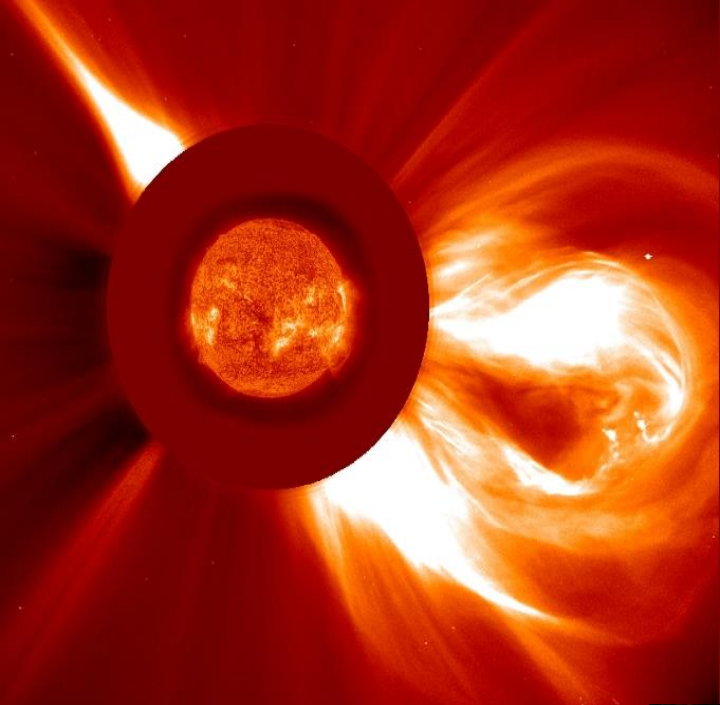
CMEs (accel. < -5 m/s²)



CMEs (-5 m/s² < accel. < 5 m/s²)

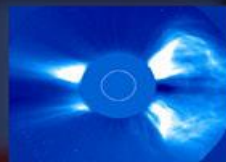




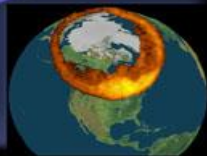


Storms from the Sun

Coronal Mass Ejections Light Up the Sky



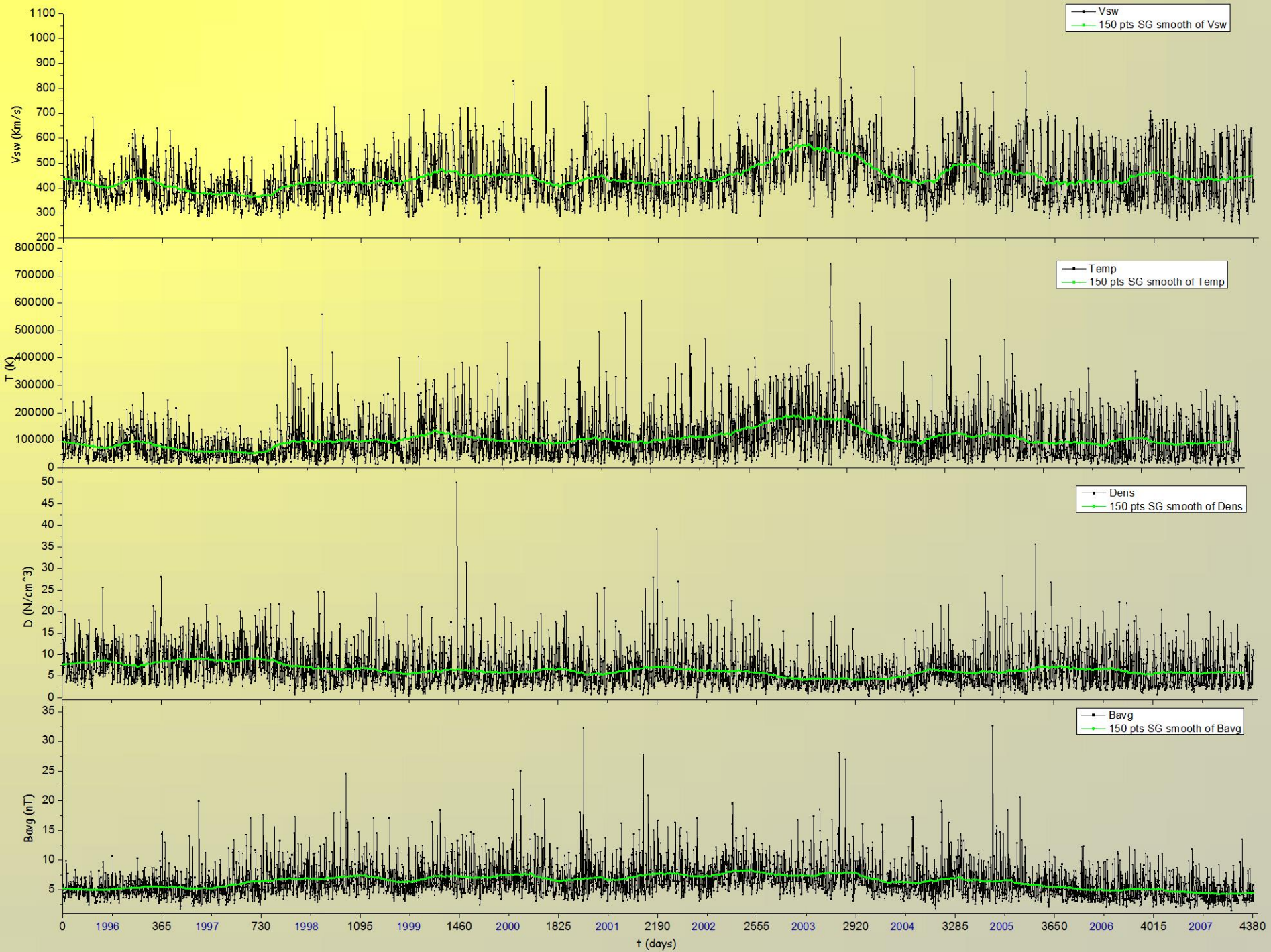
Particles are blasted from the Sun. . .

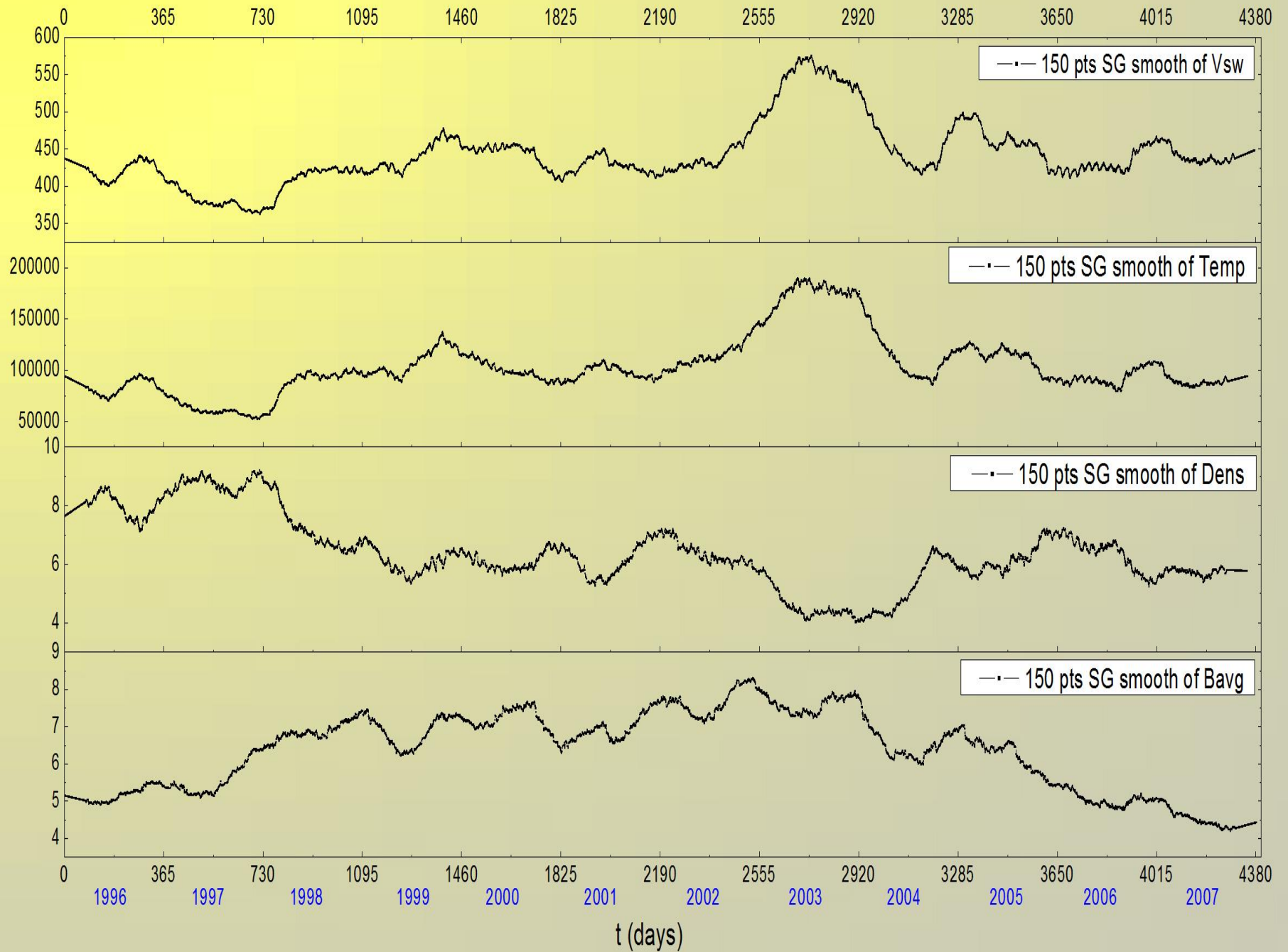


Millions of amps surge through our atmosphere ...

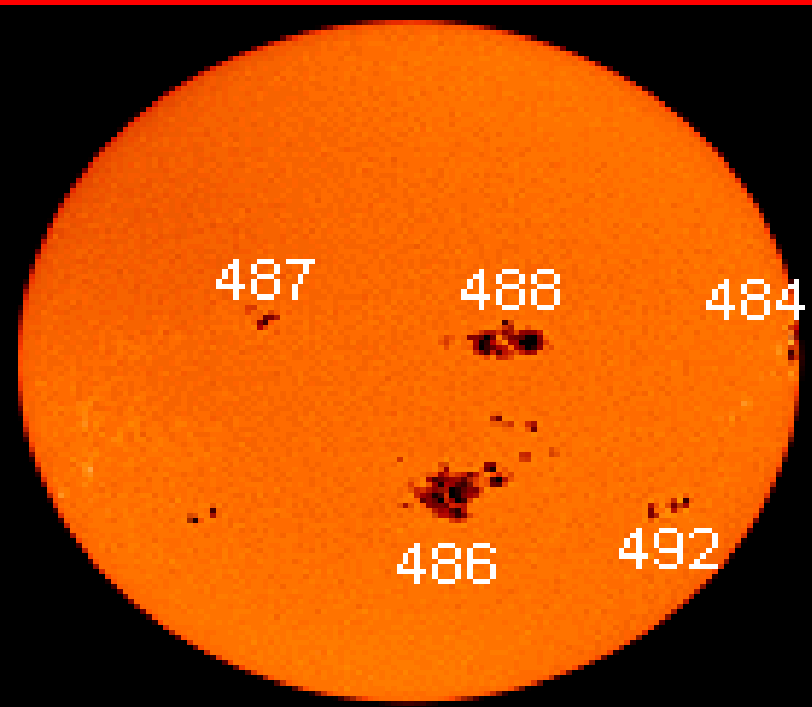


...And make bright Northern lights





SUNSPOTS OCT-NOV 2003



Sunspot Group 4848 29 October, 2003 11:08 UT
David L. Parker, Cape Canaveral, FL
Data courtesy of the Tull Computer Group
© 2003 by David Parker





2003/10/28 06:24



2003/10/28 11:12

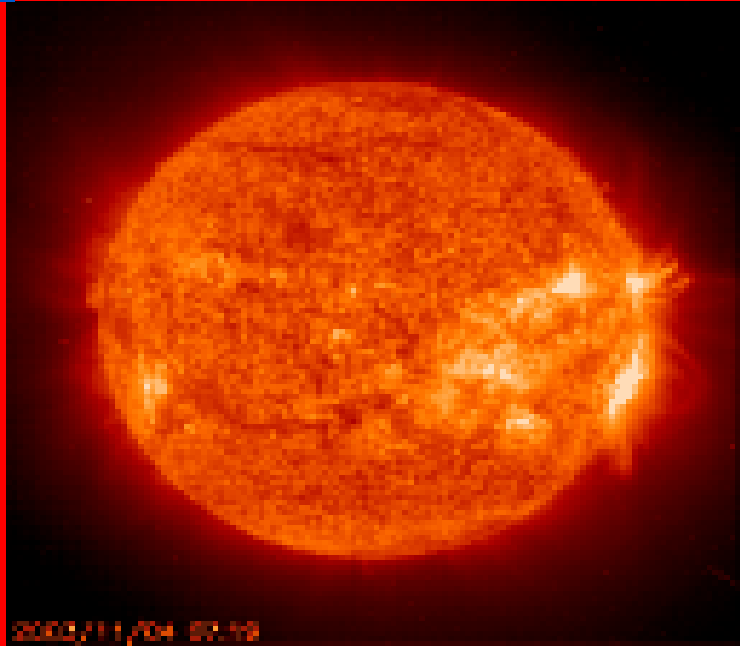
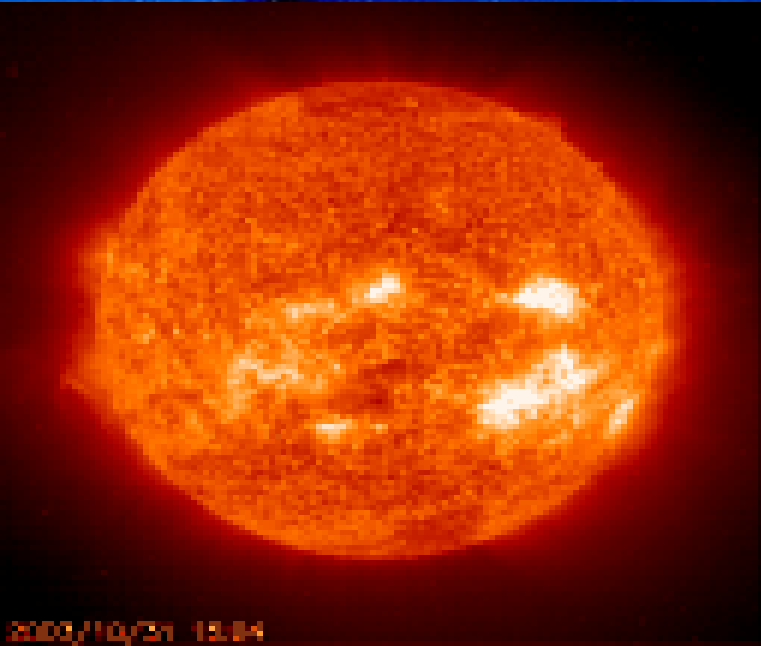
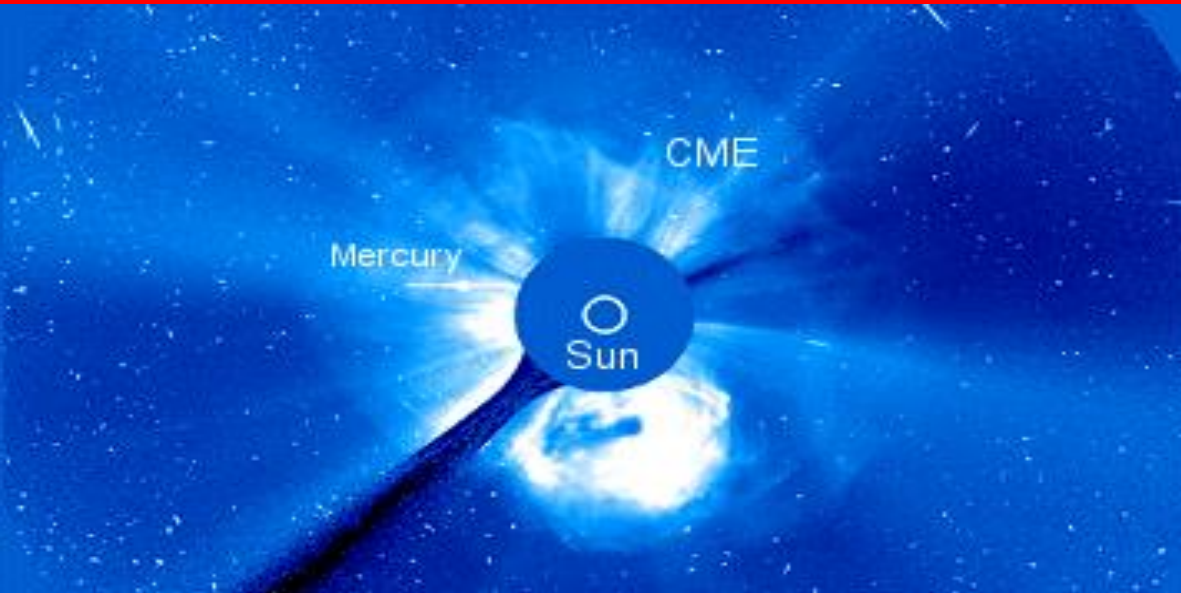


2003/10/28 11:20

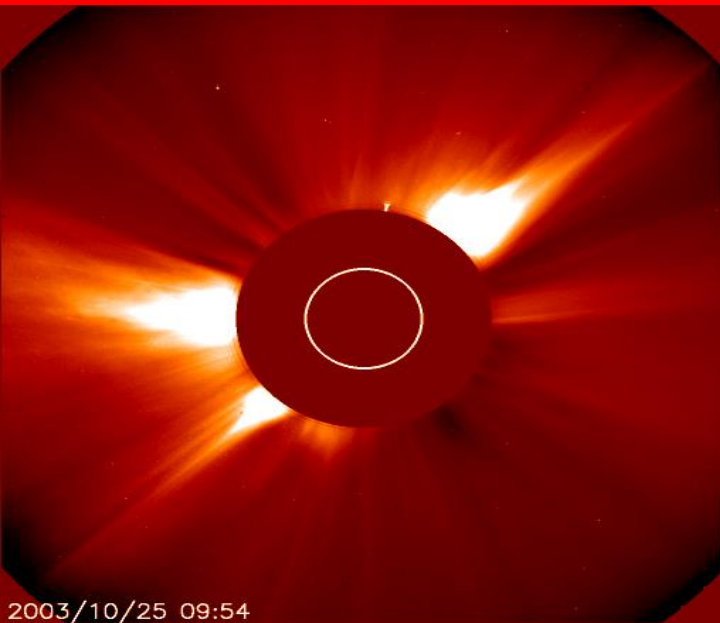


2003/10/28 18:40

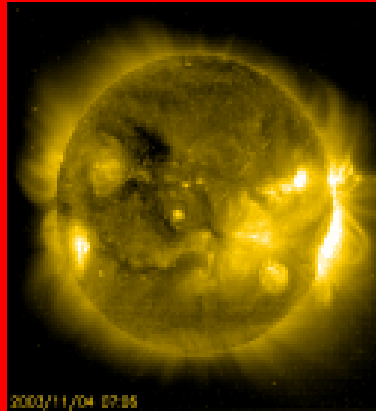
SOLAR ACTIVITY OCTOBER-NOVEMBER 2003



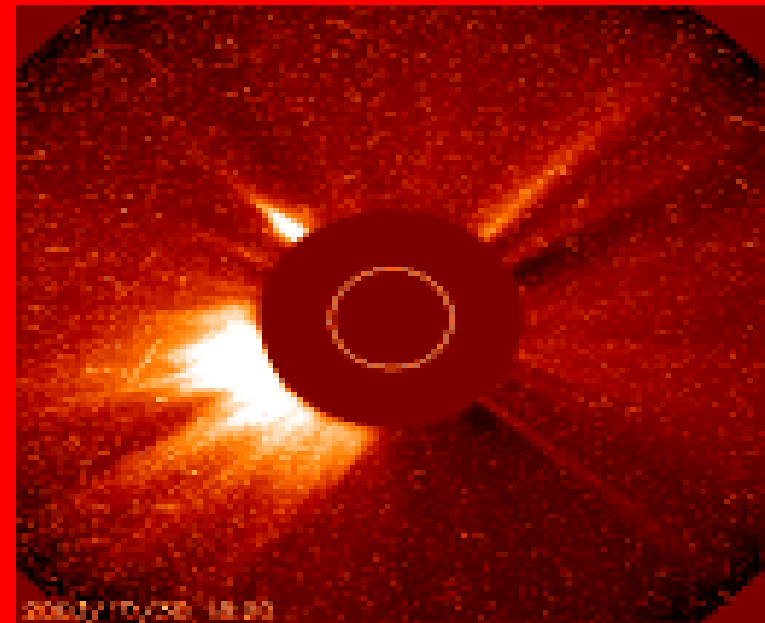
CORONAL MASS EJECTIONS OCTOBER-NOVEMBER 2003



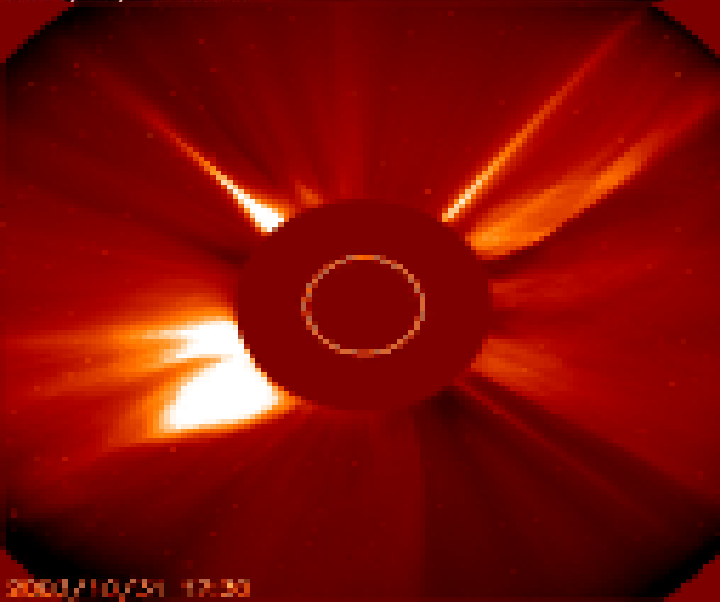
2003/10/25 09:54



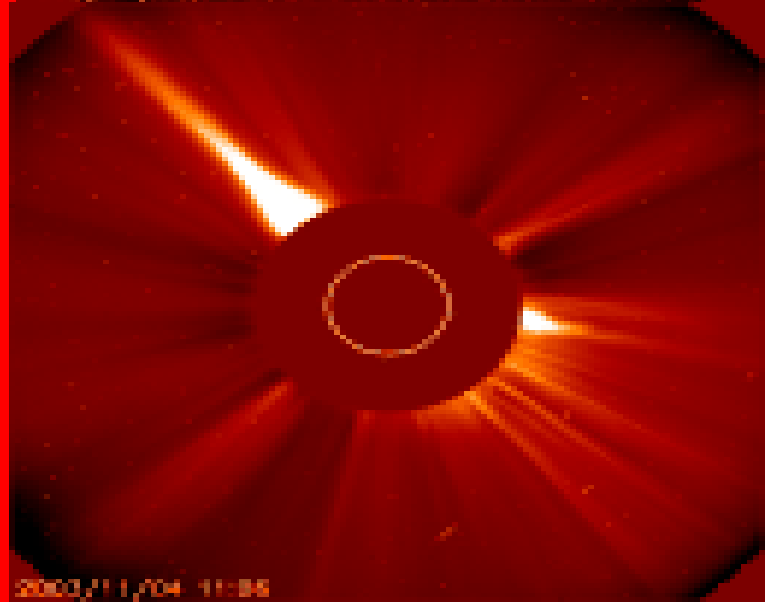
2003/11/04 07:06



2003/10/30 18:33



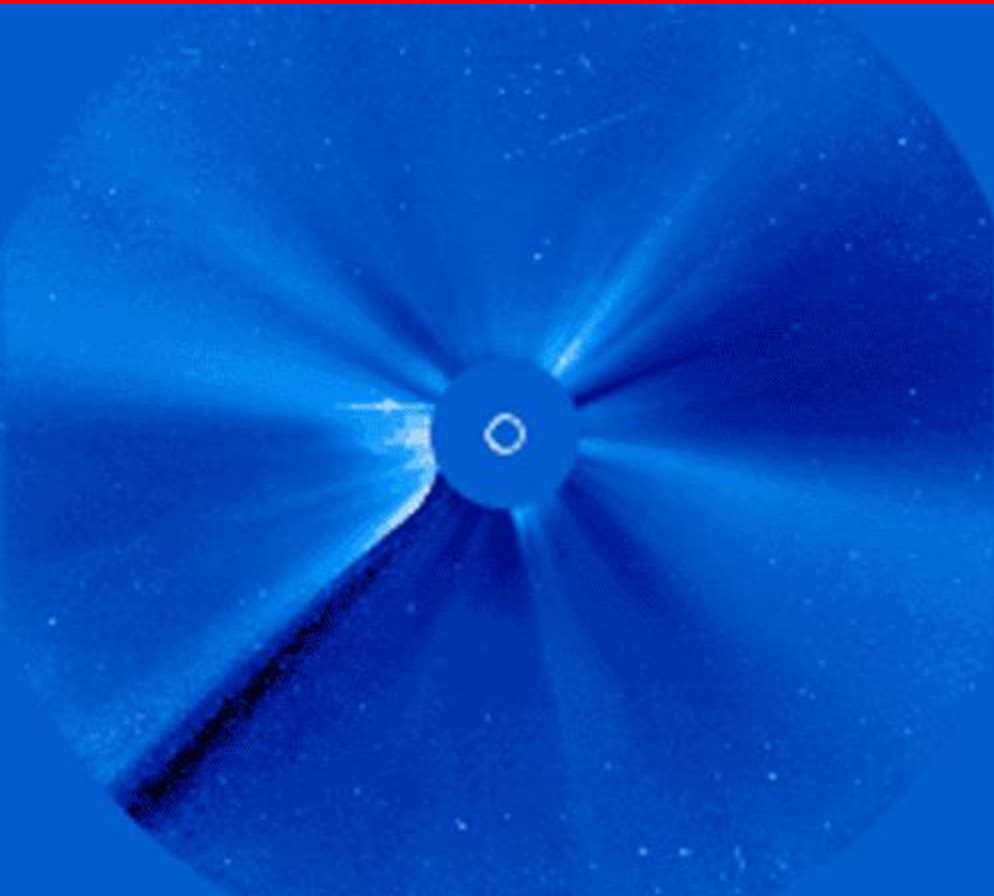
2003/10/25 17:33



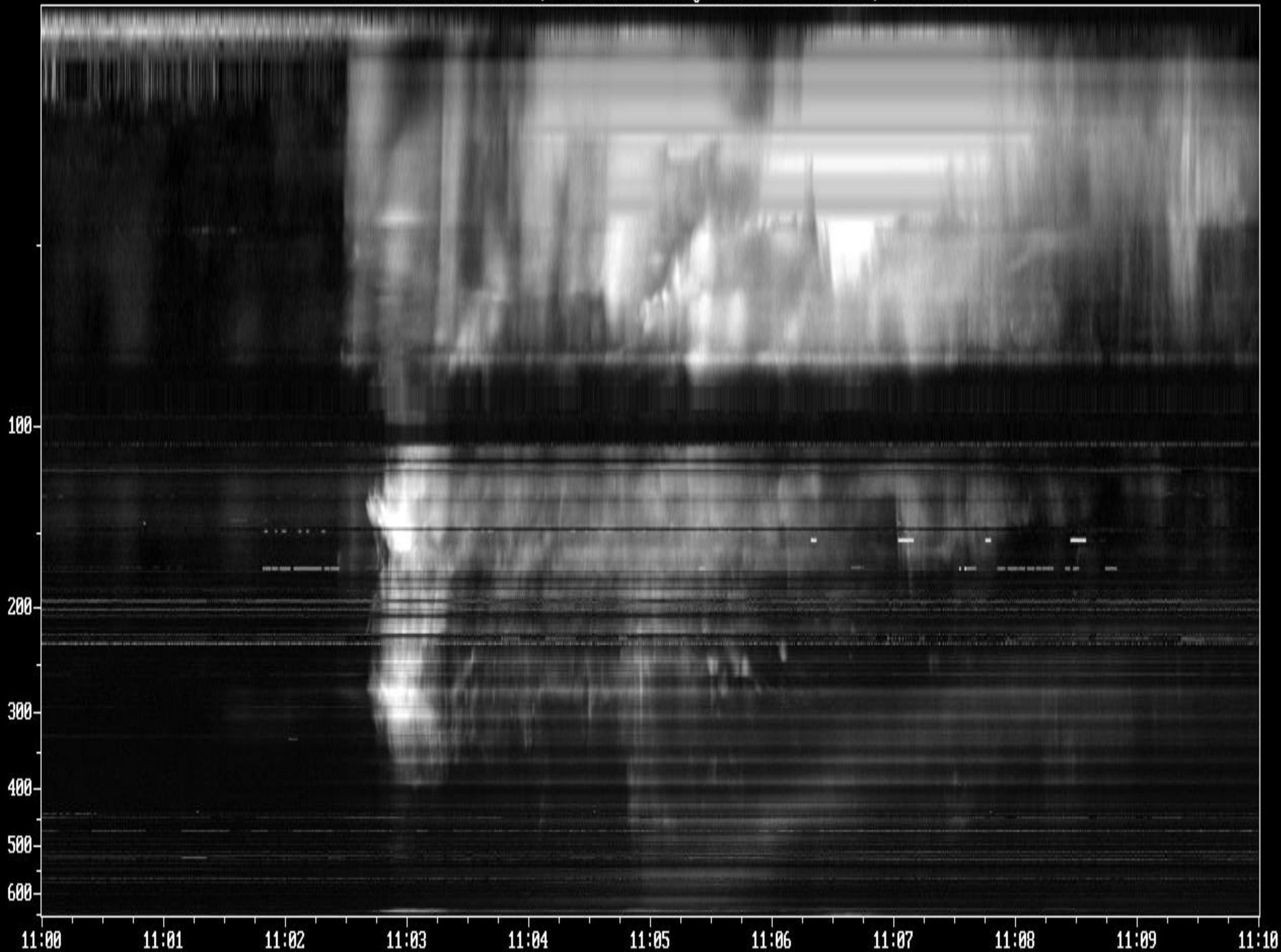
2003/11/04 11:06

CME (SOHO/LASCO)

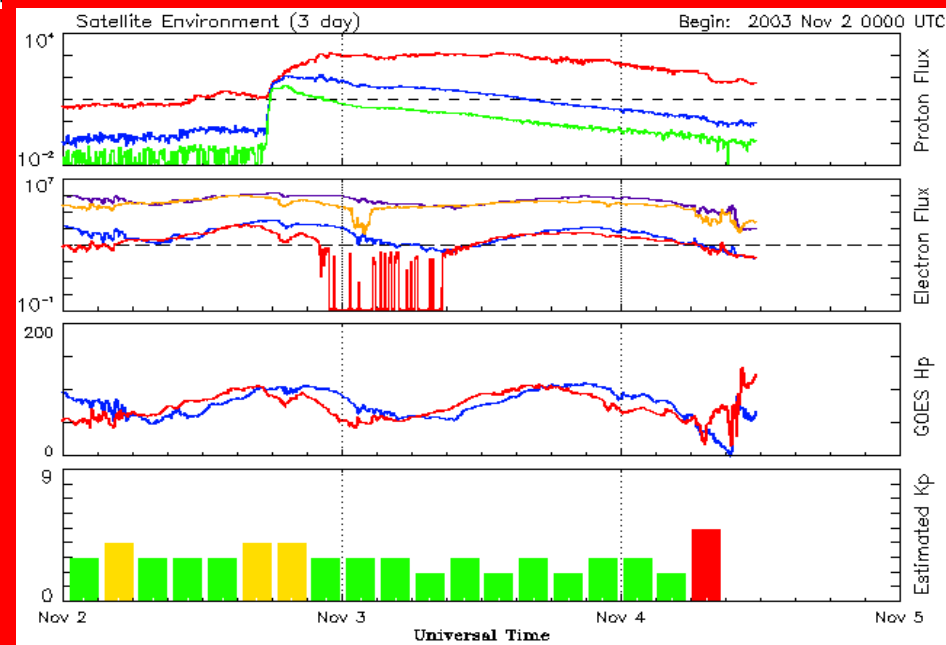
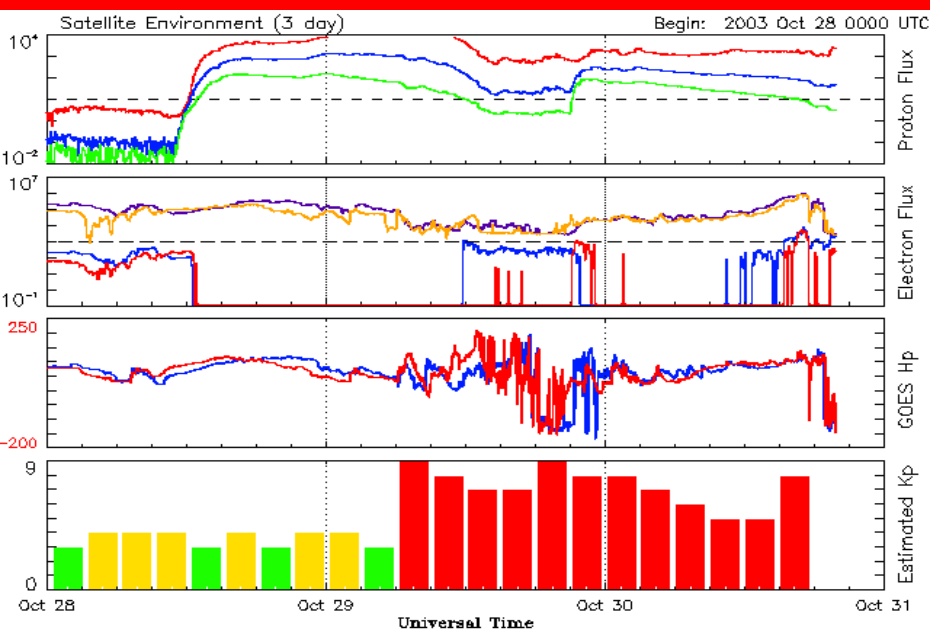
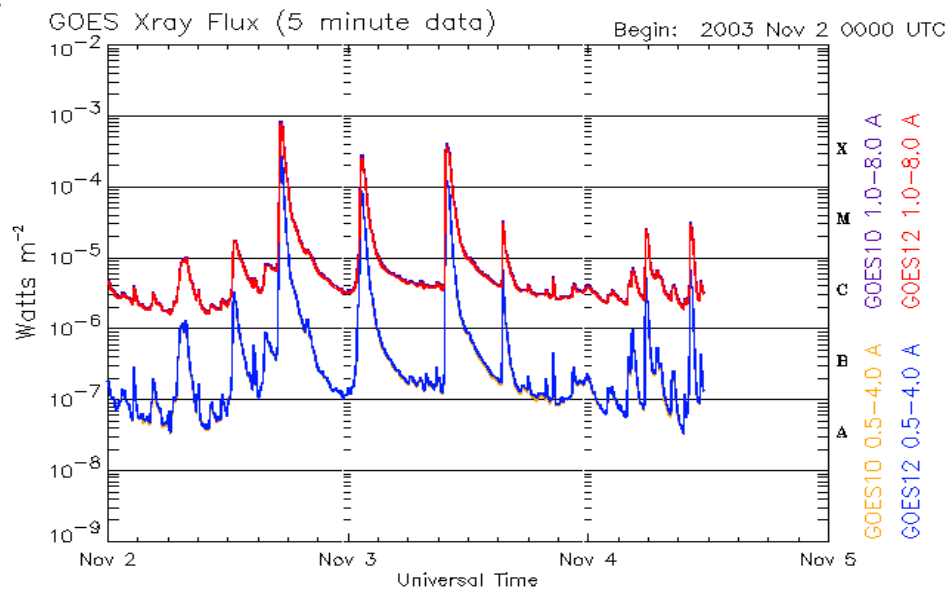
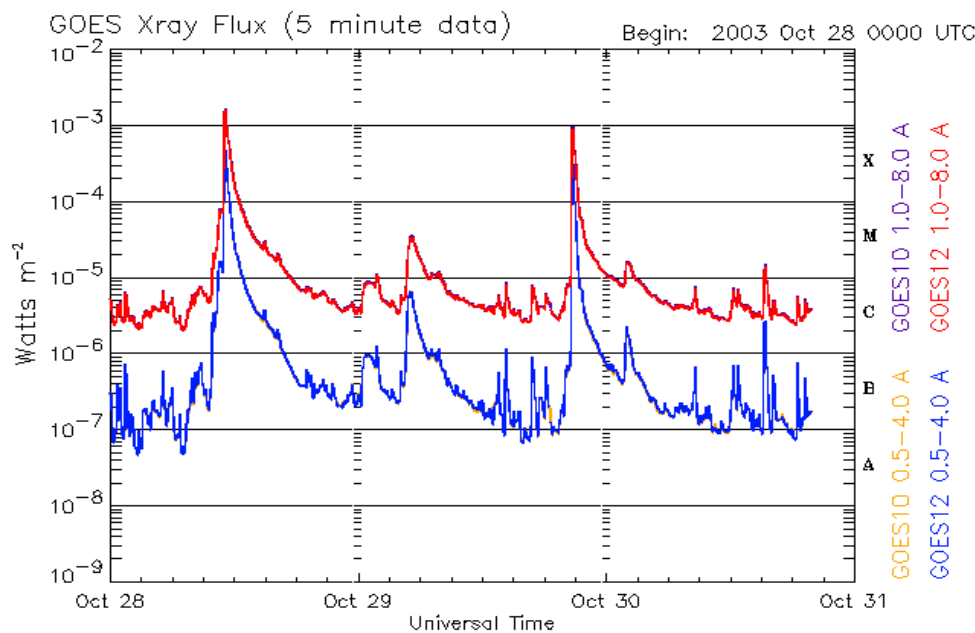
29/10/2003



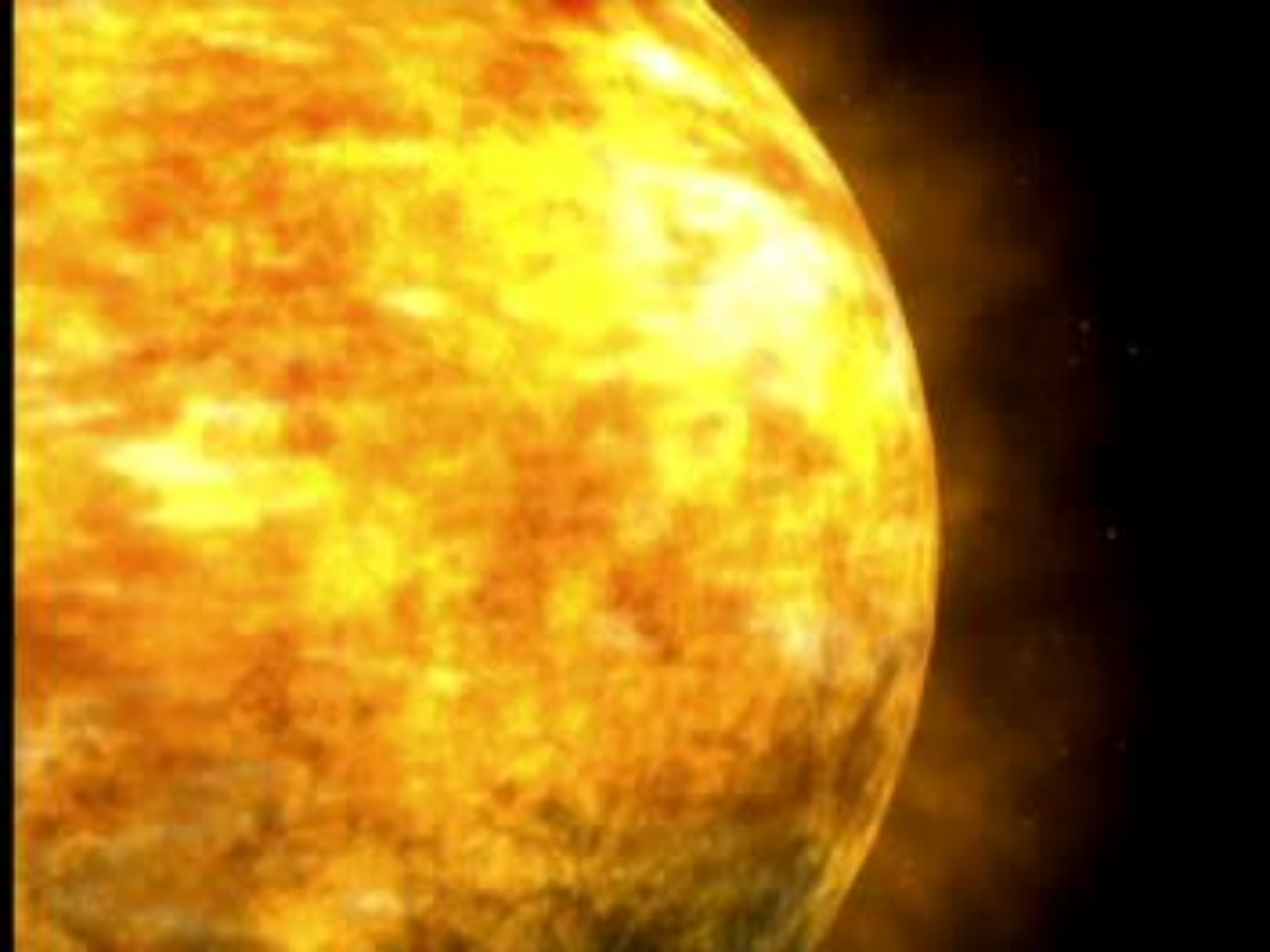
Raw Artemis-IV ASG Data, Oct 28 2003. Integration time= .50 sec, Max=3052.0



FLARES-PROTONS-Kp INDEX





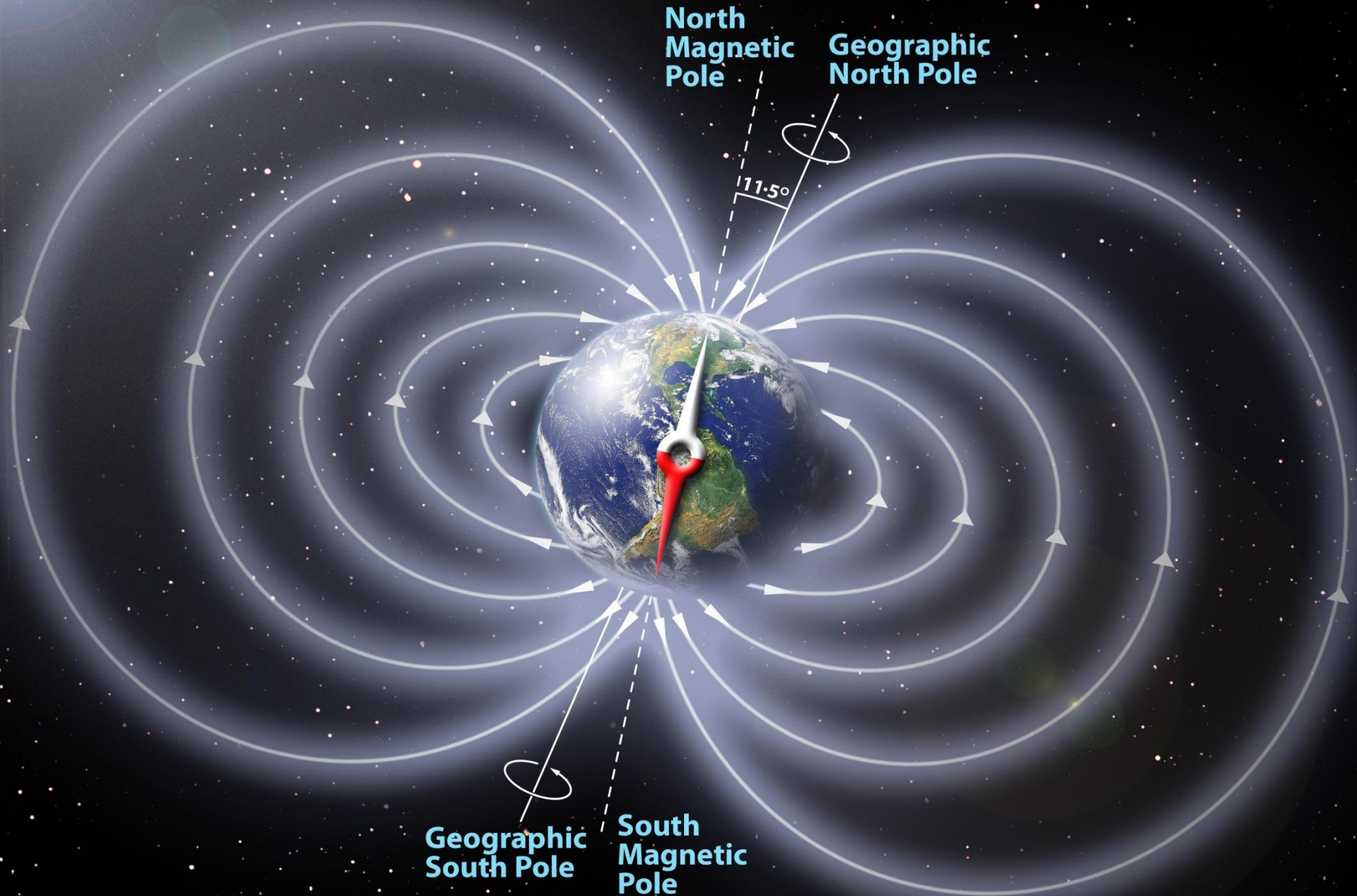


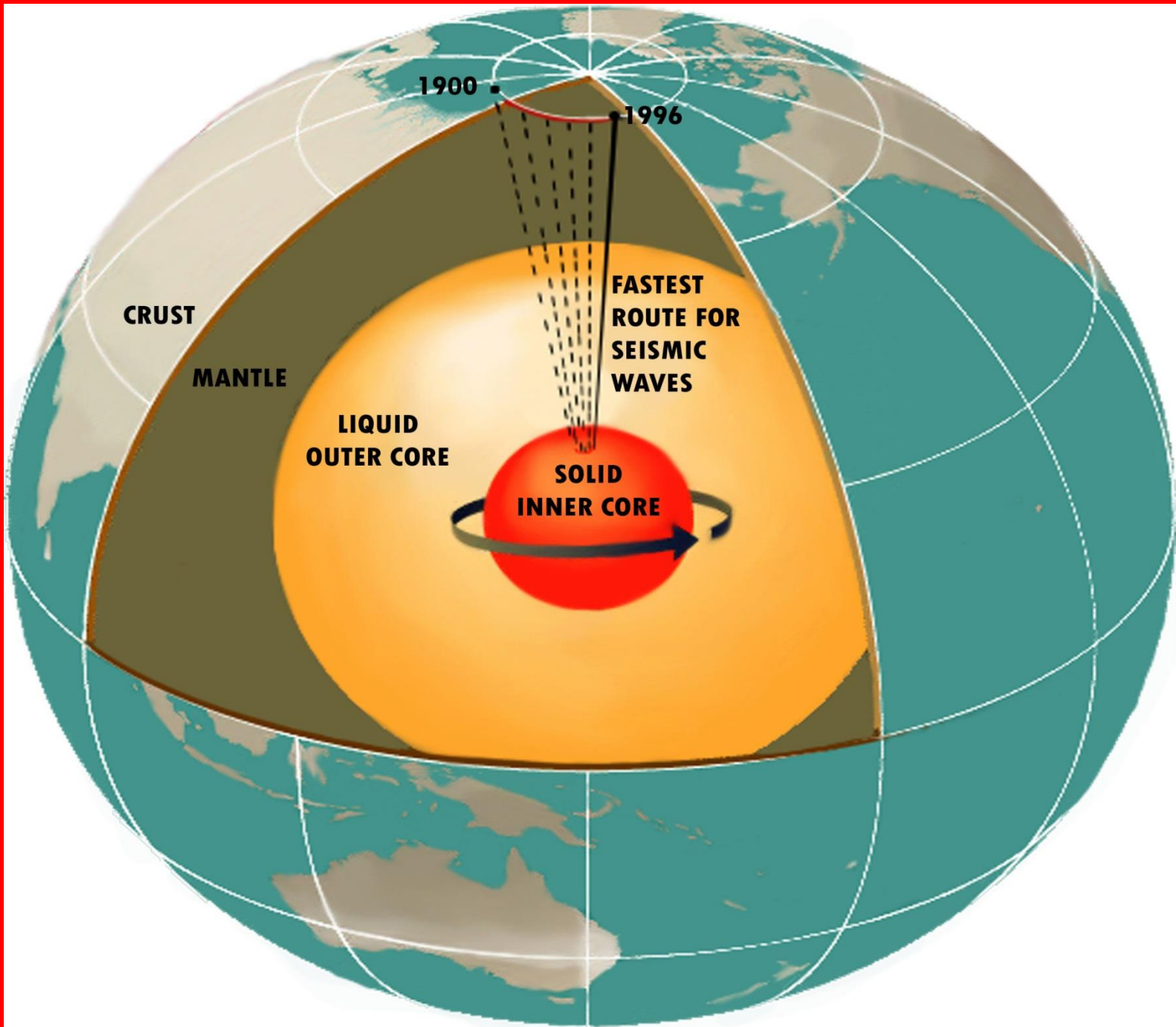


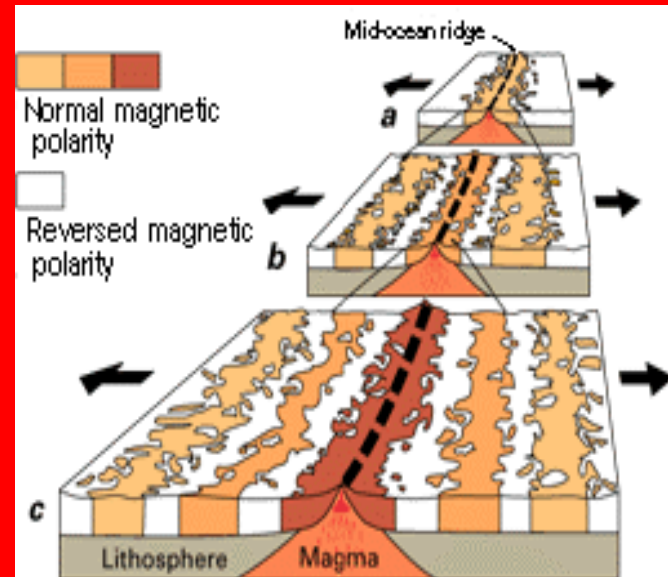
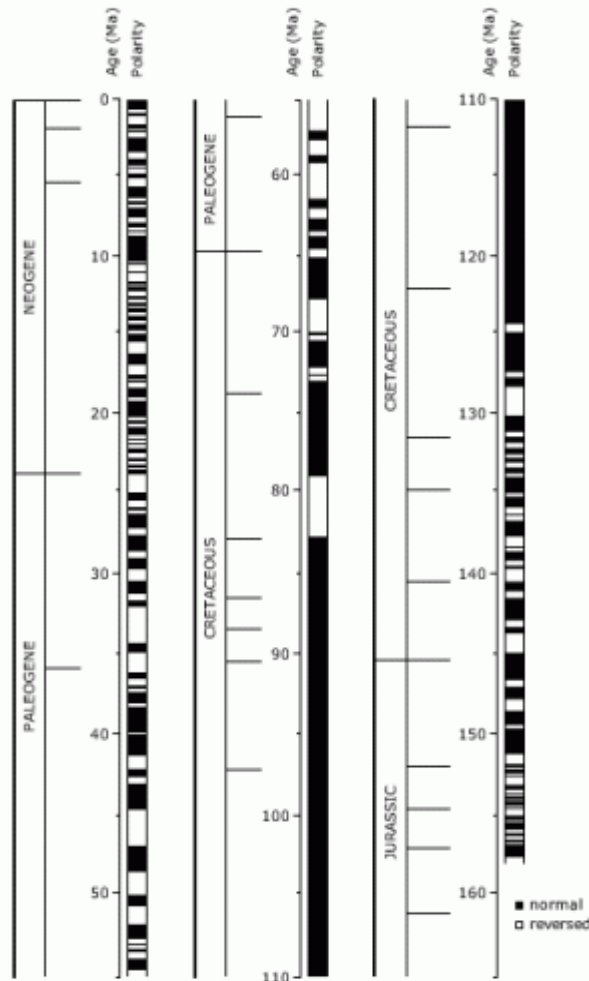
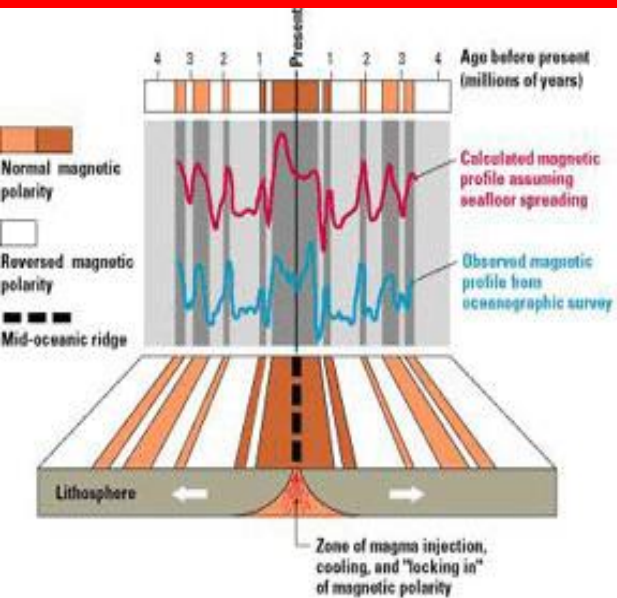
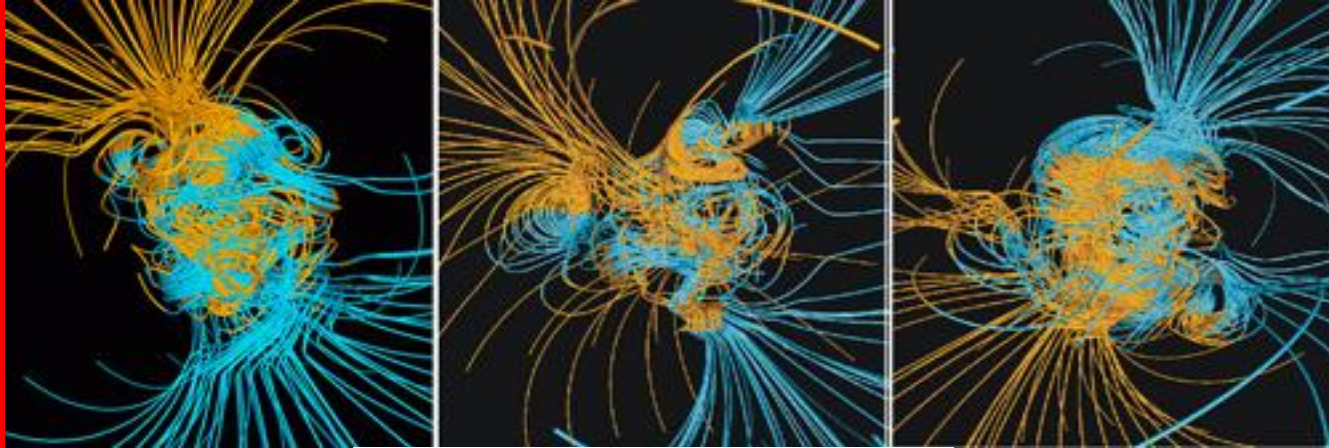
8-13 SEPTEMBER 2010

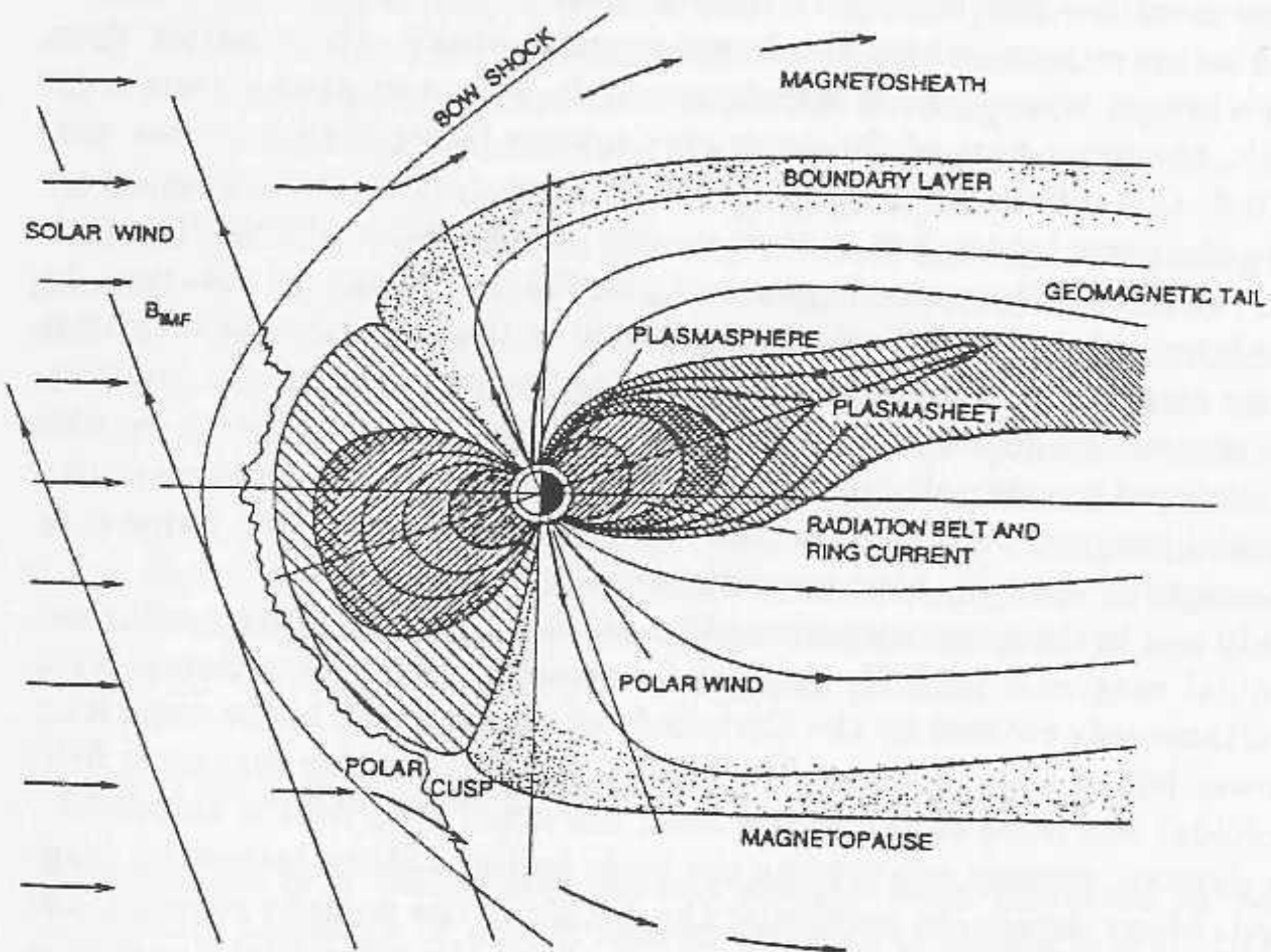


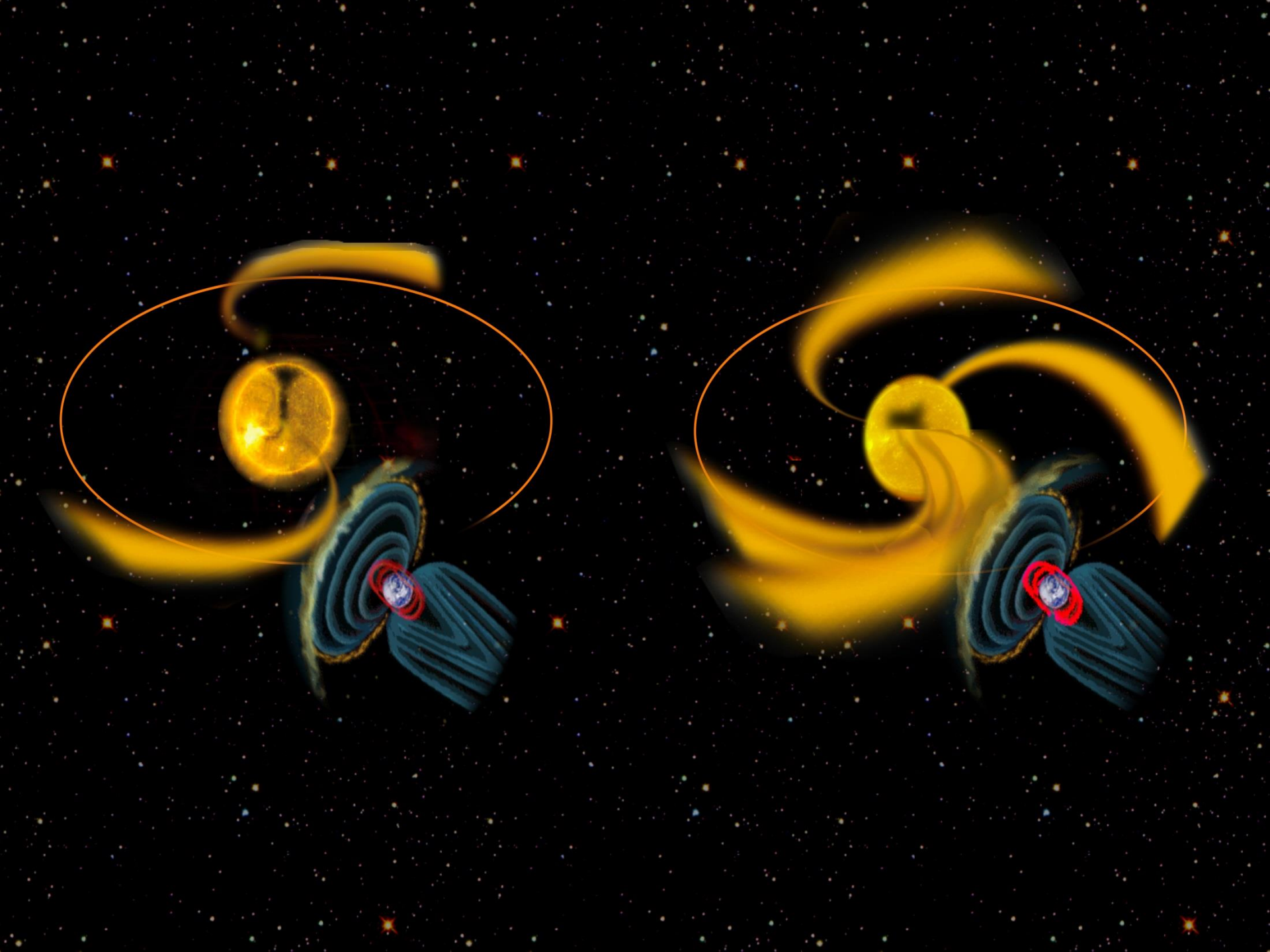
The Earth's Magnetic Field



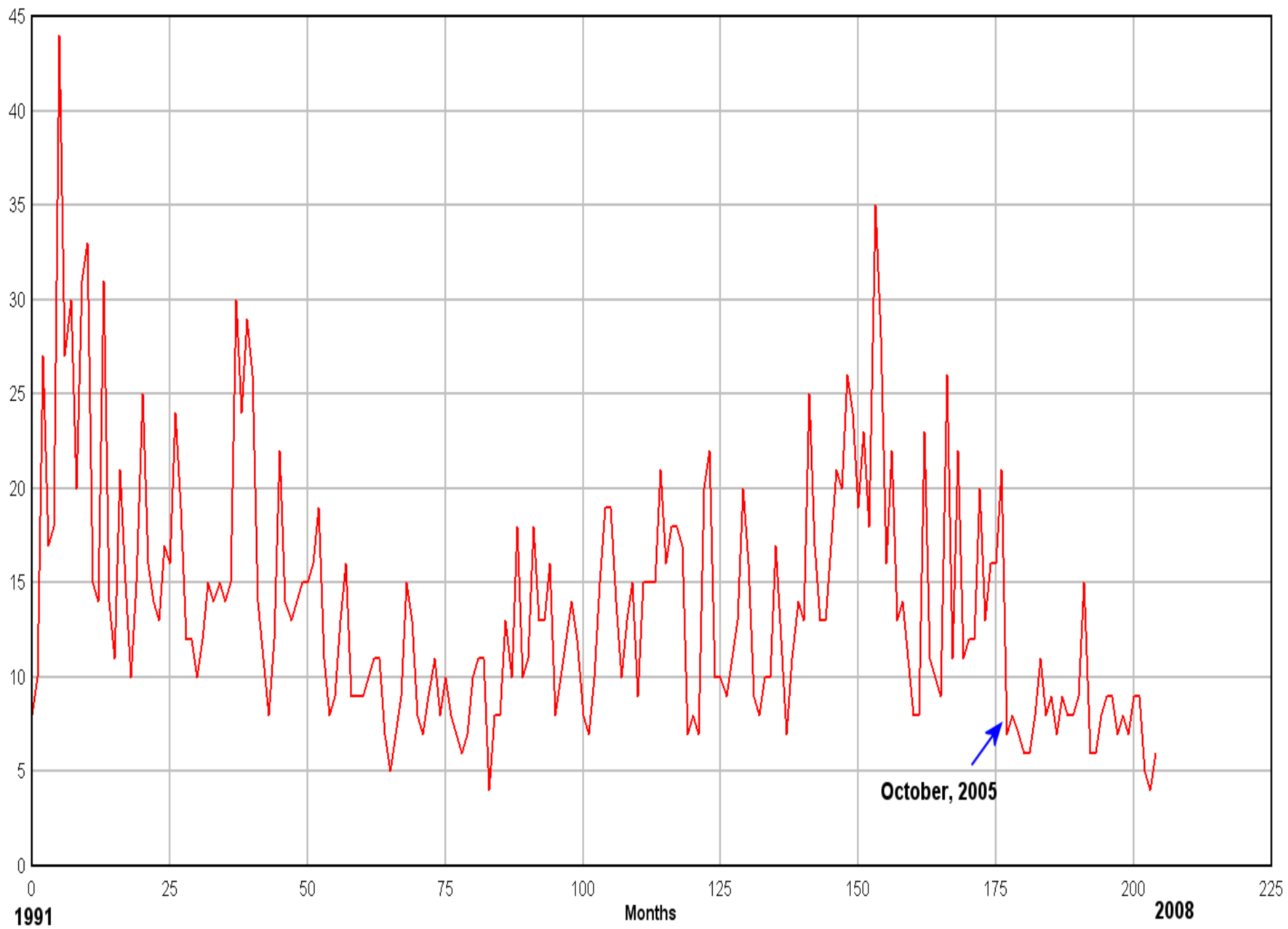








Observed Geomagnetic Averaged Planetary Index (Ap)

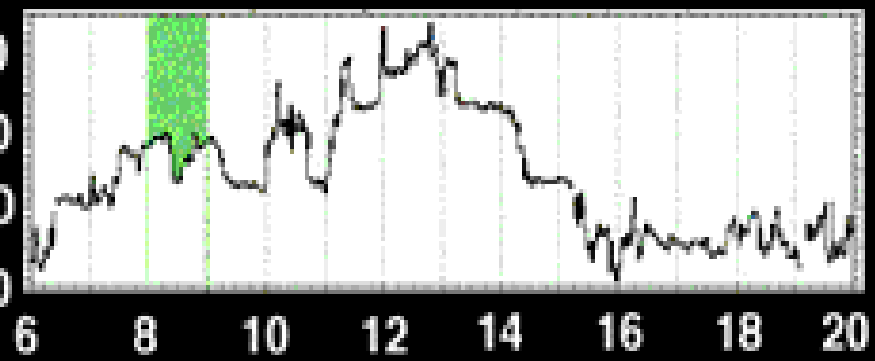


Jan. 8
log flux

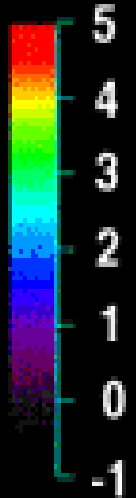
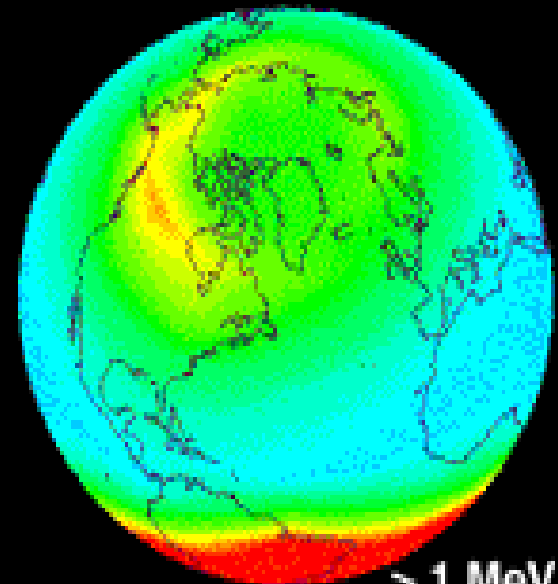
University of Maryland soho / celiac / mtof / PM

SAMPEX

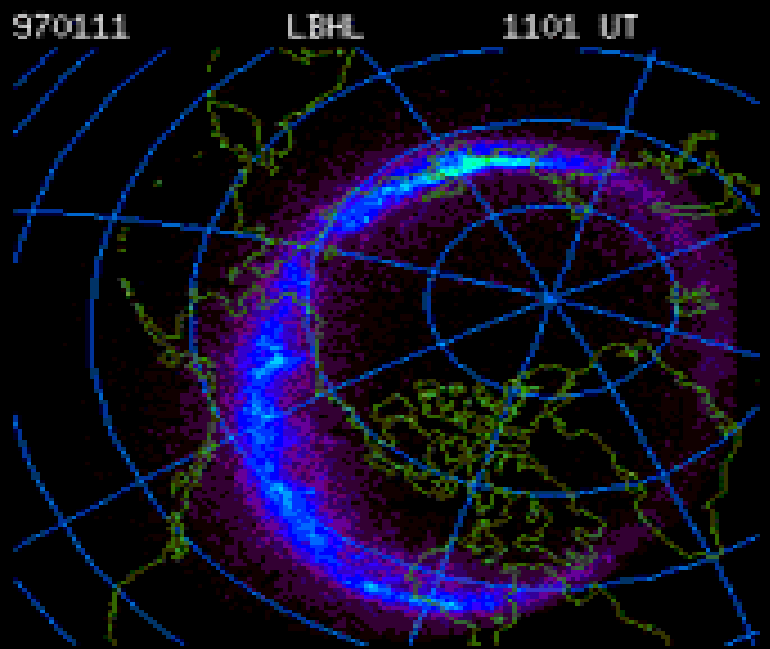
Solar Wind Speed
(kilometers/sec)



Day of January 1997

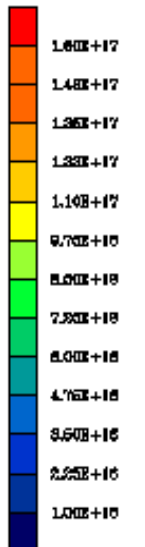
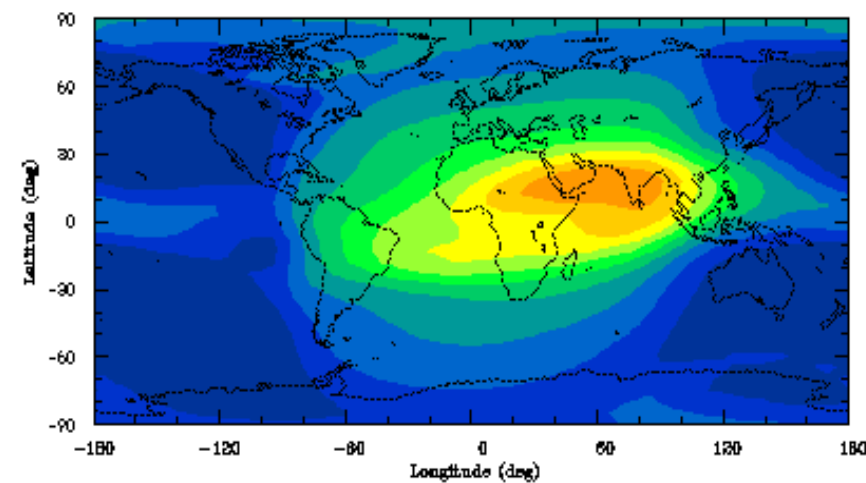


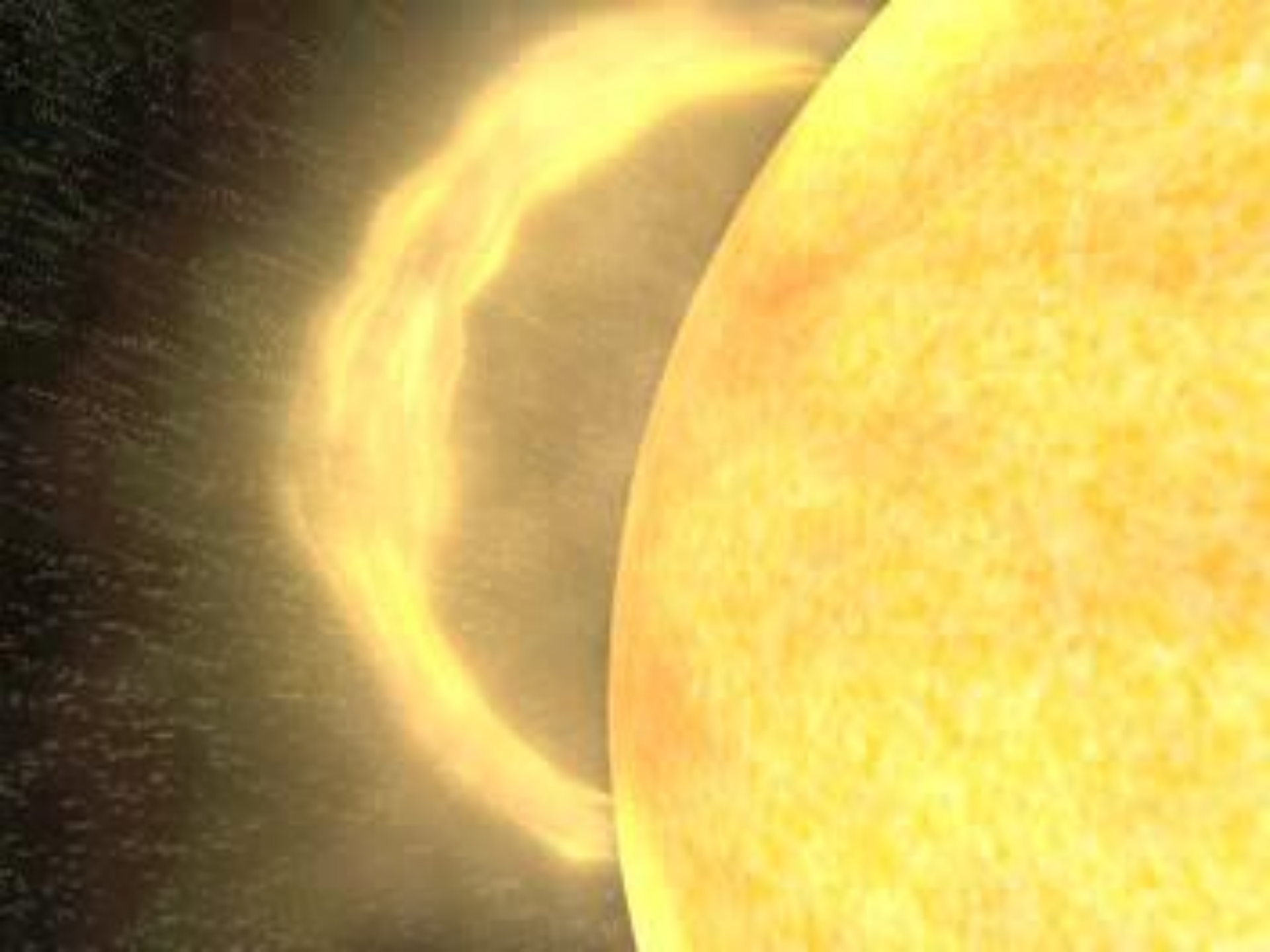
> 1 MeV electrons

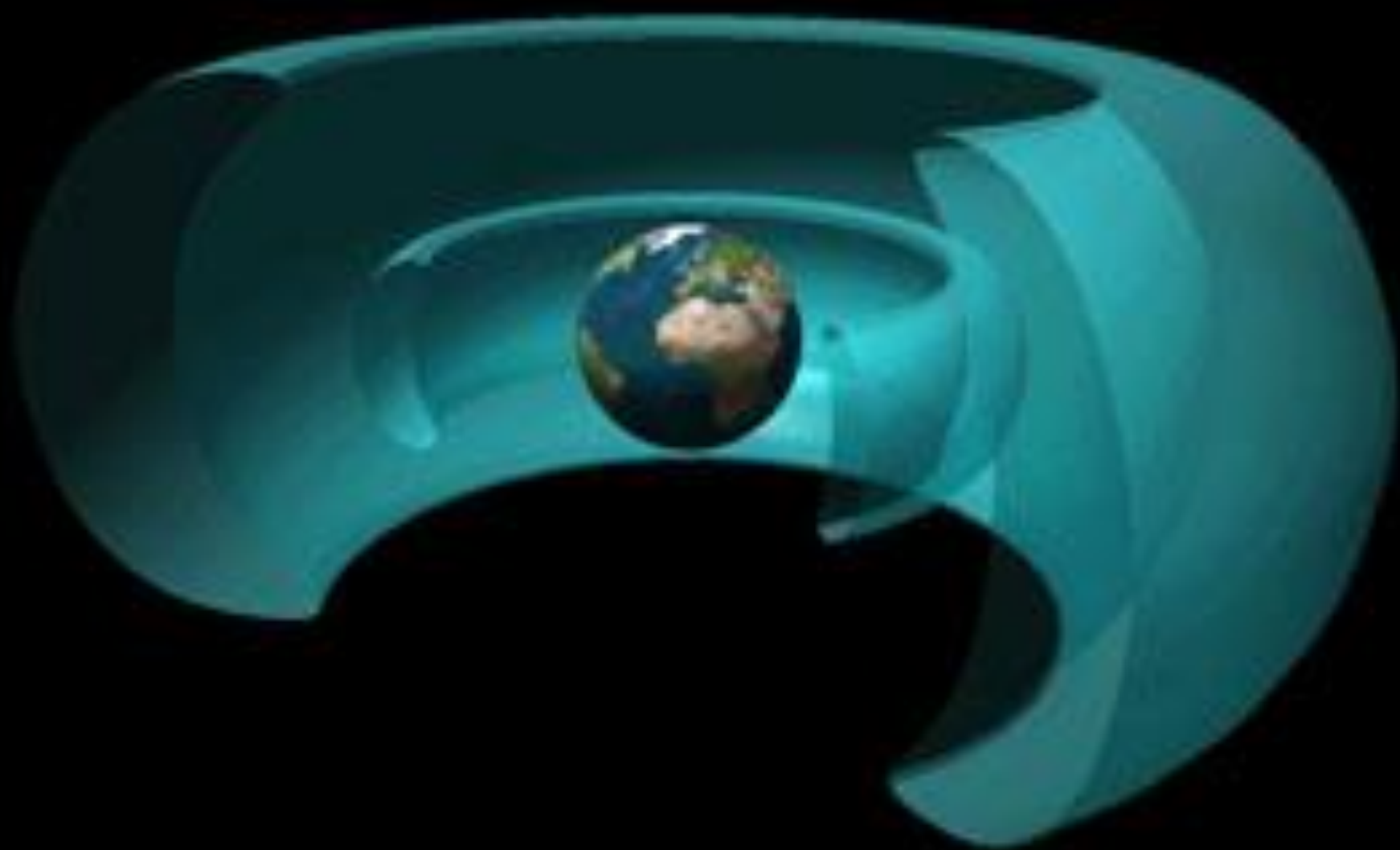


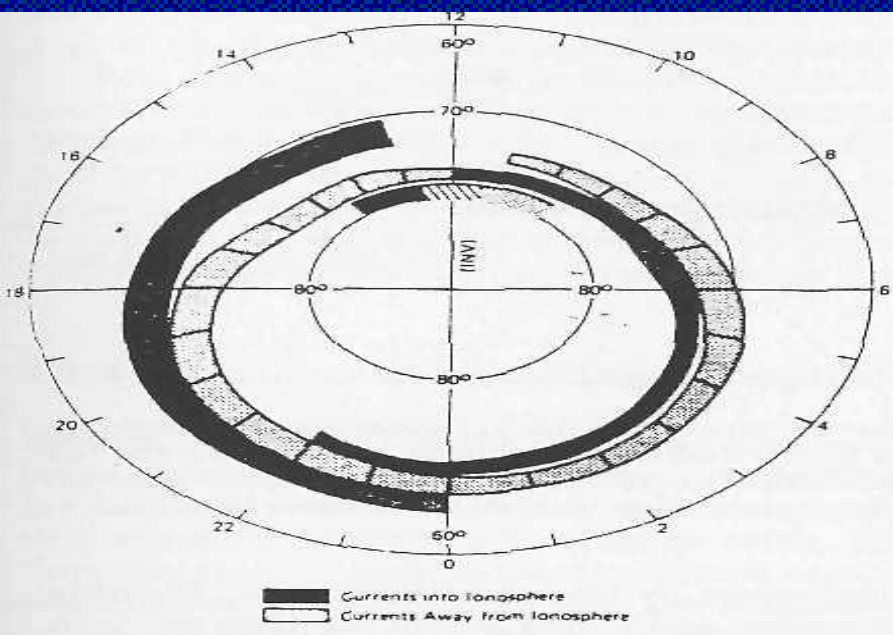
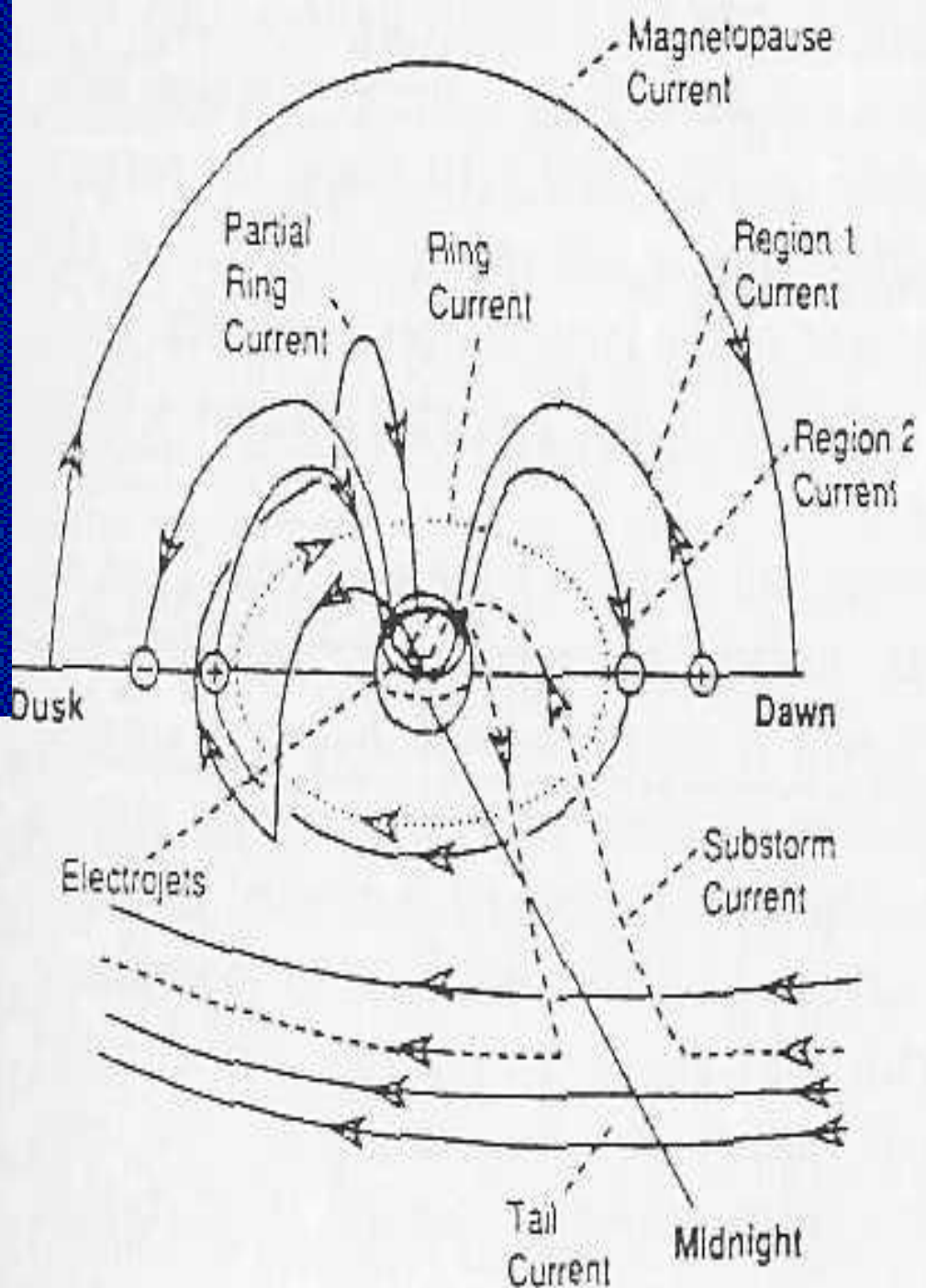
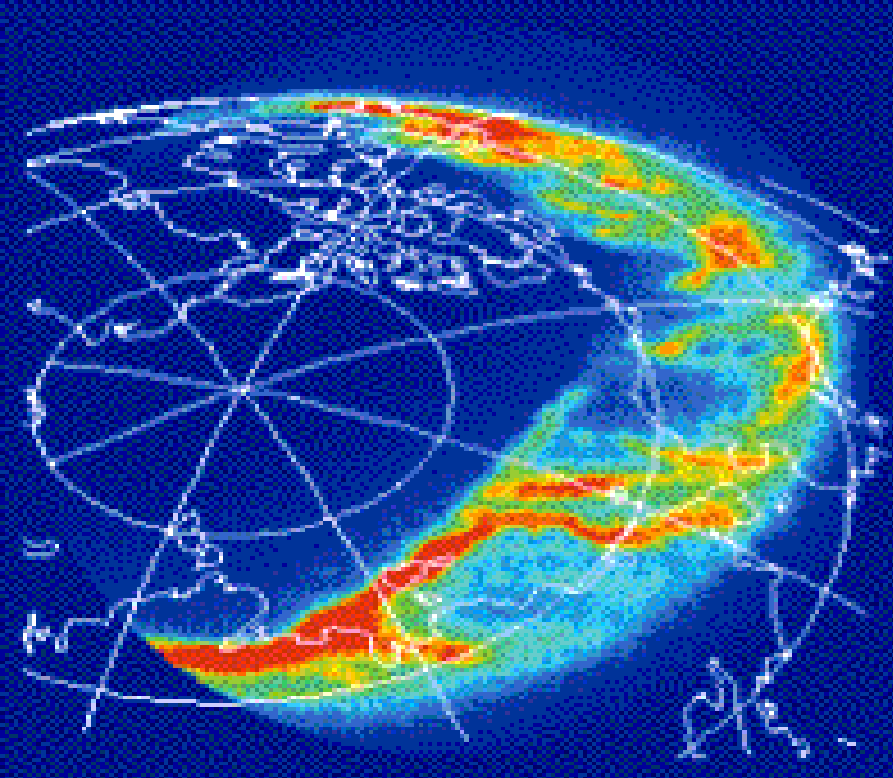
Ionospheric Storm UT = 12h 00m

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



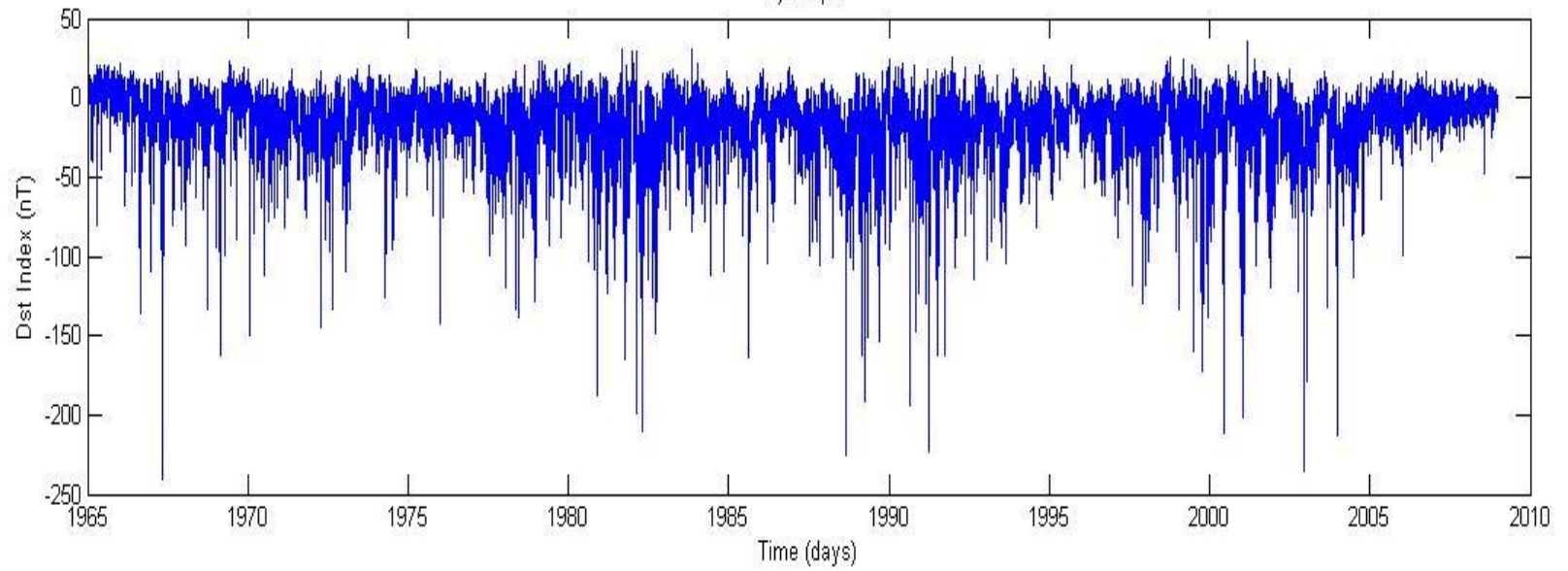




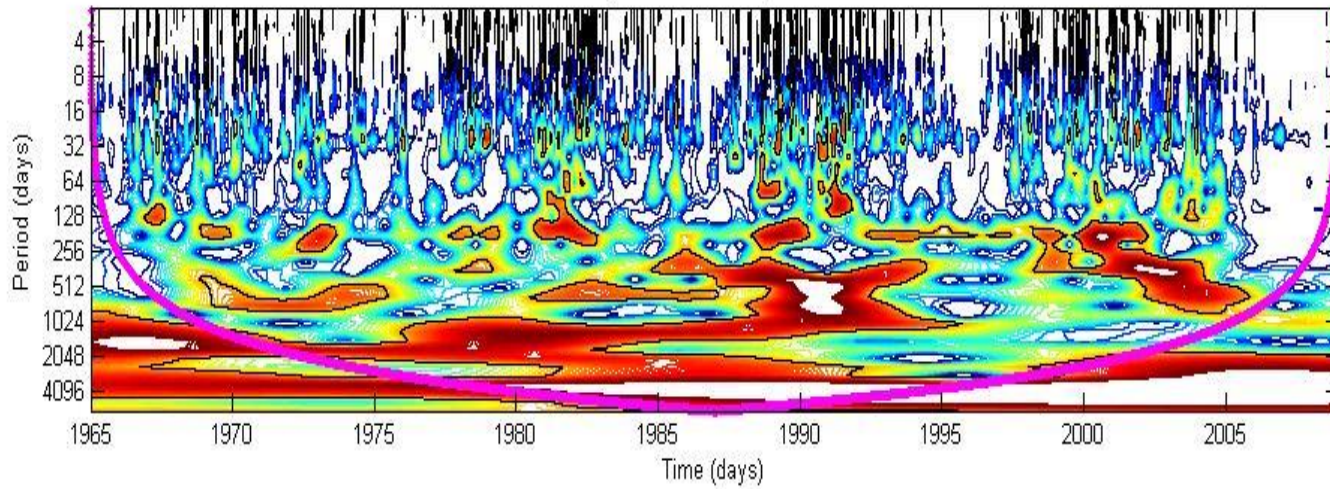


Currents into Ionosphere
 Currents Away from Ionosphere

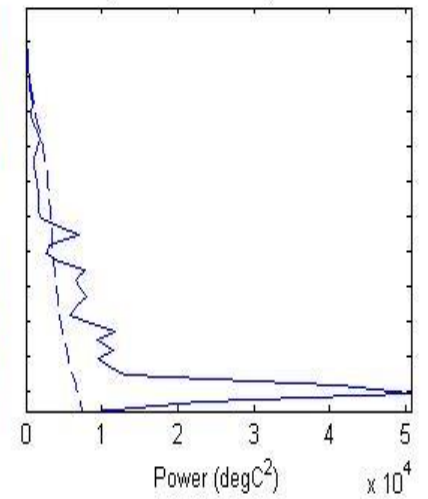
a) Graph

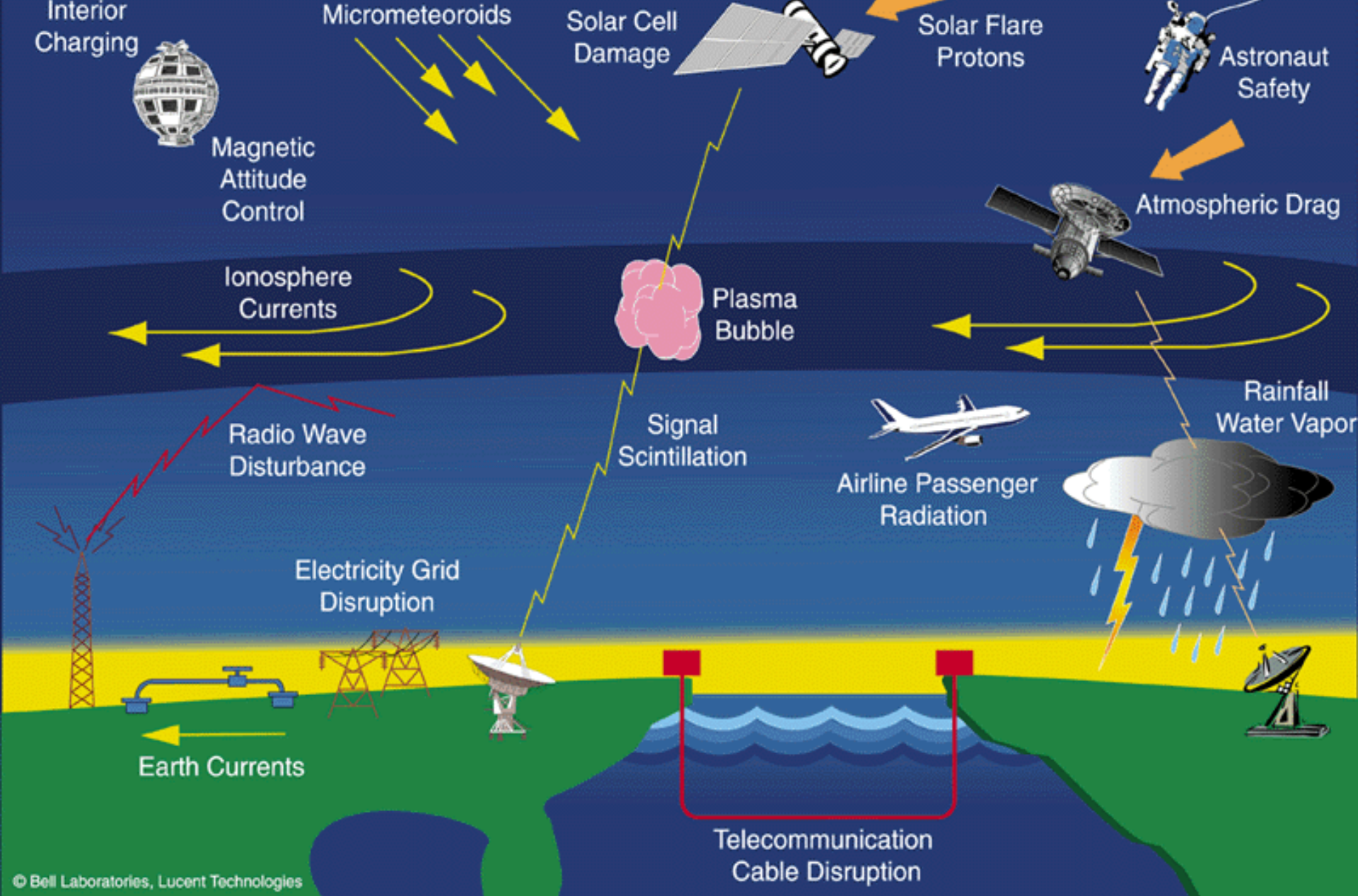


b) Wavelet Power Spectrum



c) Global Wavelet Spectrum

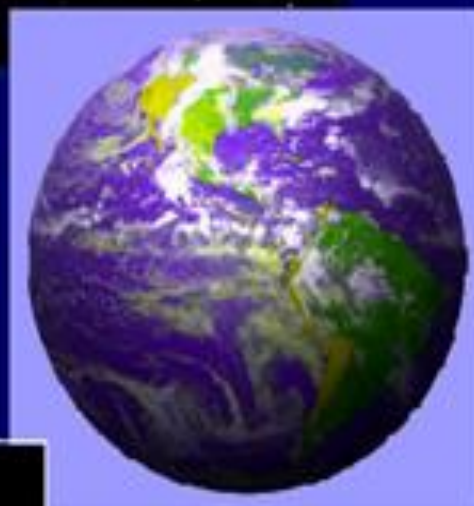




The effects of magnetic storms - what scientists call space weather - extend from the ground to geostationary orbit and beyond.

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



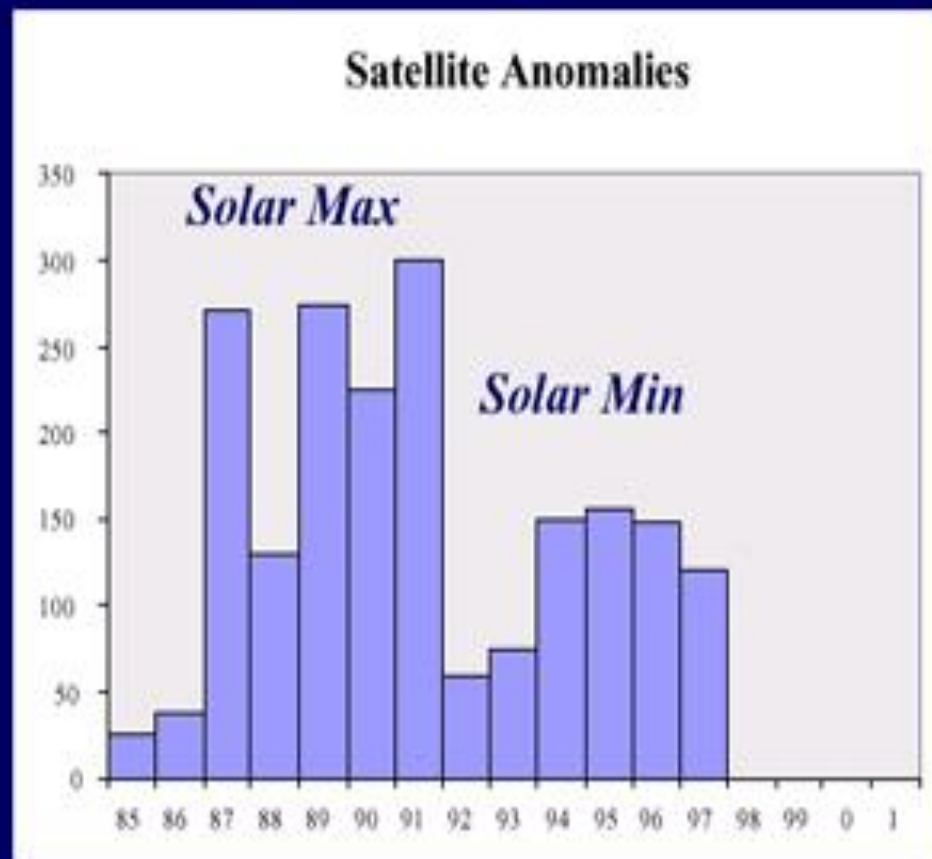
Solar Variability Can Affect Space Systems

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.

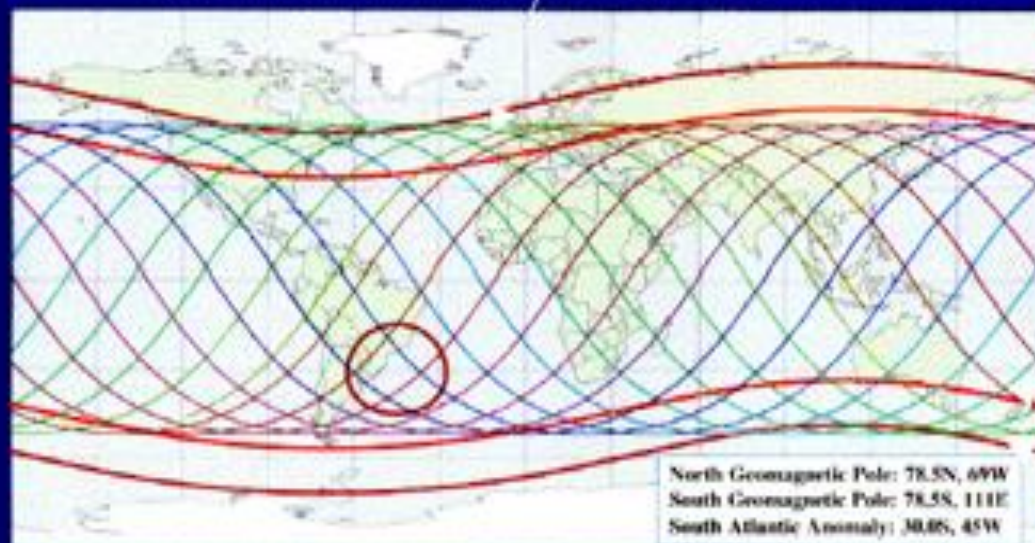


Solar Variability Can Affect Human Space Flight

- 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



Geomagnetic Storm

Quiet Conditions







Communications

Intelsat V
Intelsat k

GOES East
(75 W Long)

Weather

Navigation

GPS

DMSP

NOAA-11

Scientific Research

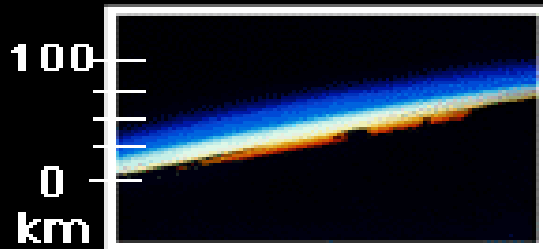
Remote Sensing

SOHO

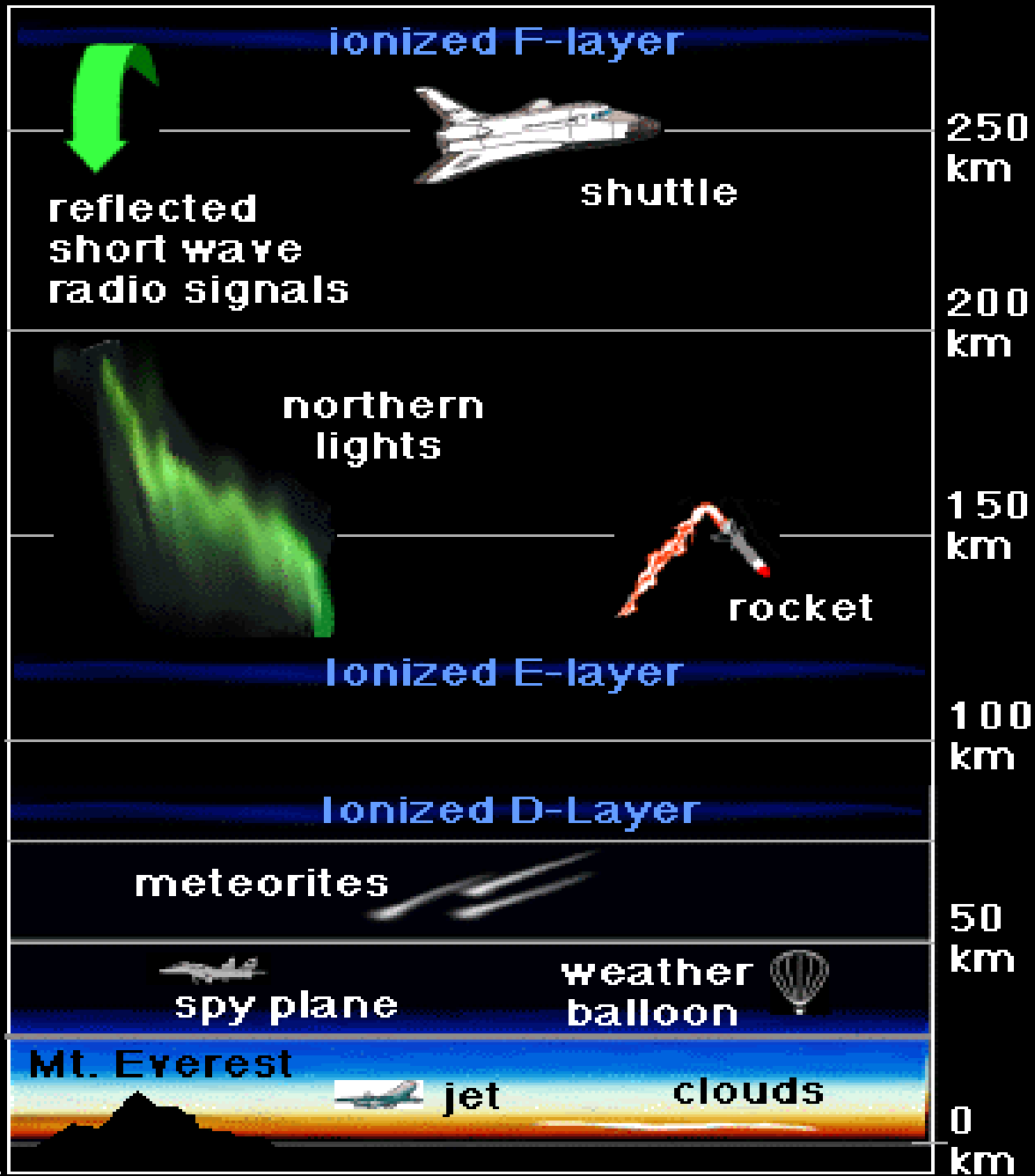
Sampex

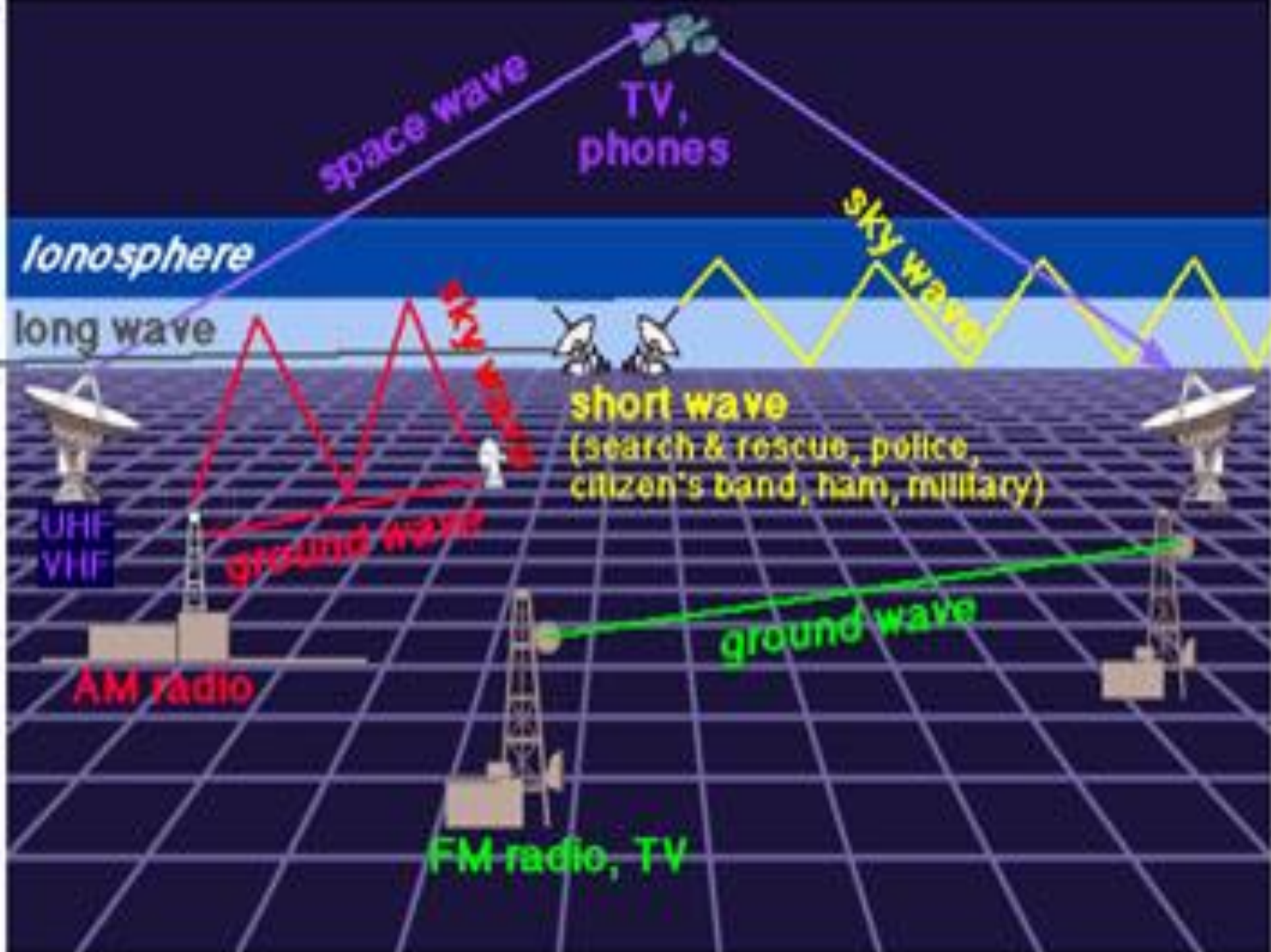
Landsat

The Atmosphere and the Earth-Space Interface

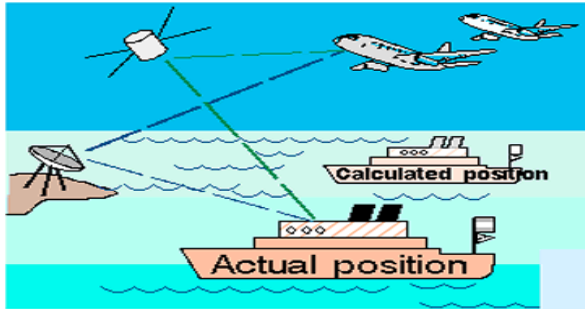


View of the entire atmospheric layer from the space shuttle (courtesy of NASA)





Effects on Radio-Navigation and Communications



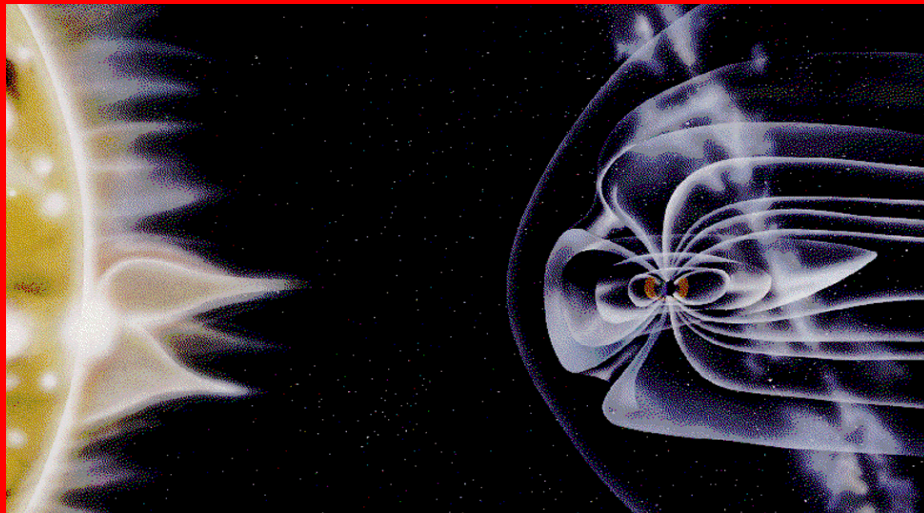
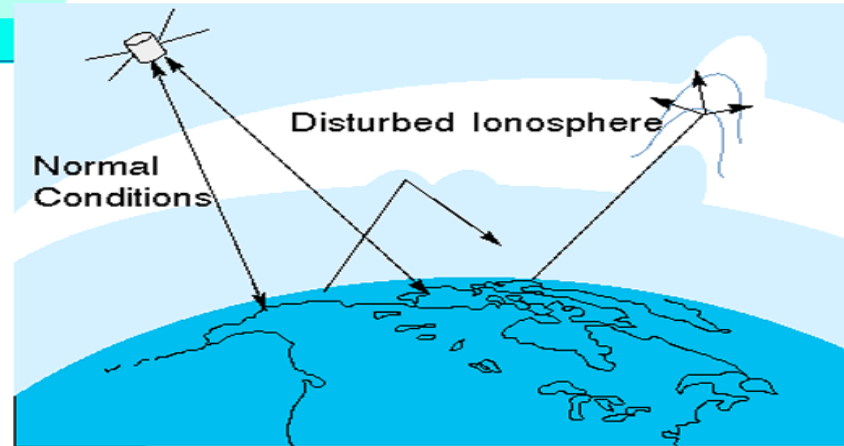
Precision GPS and LORAN signals are adversely affected by a varying ionosphere.



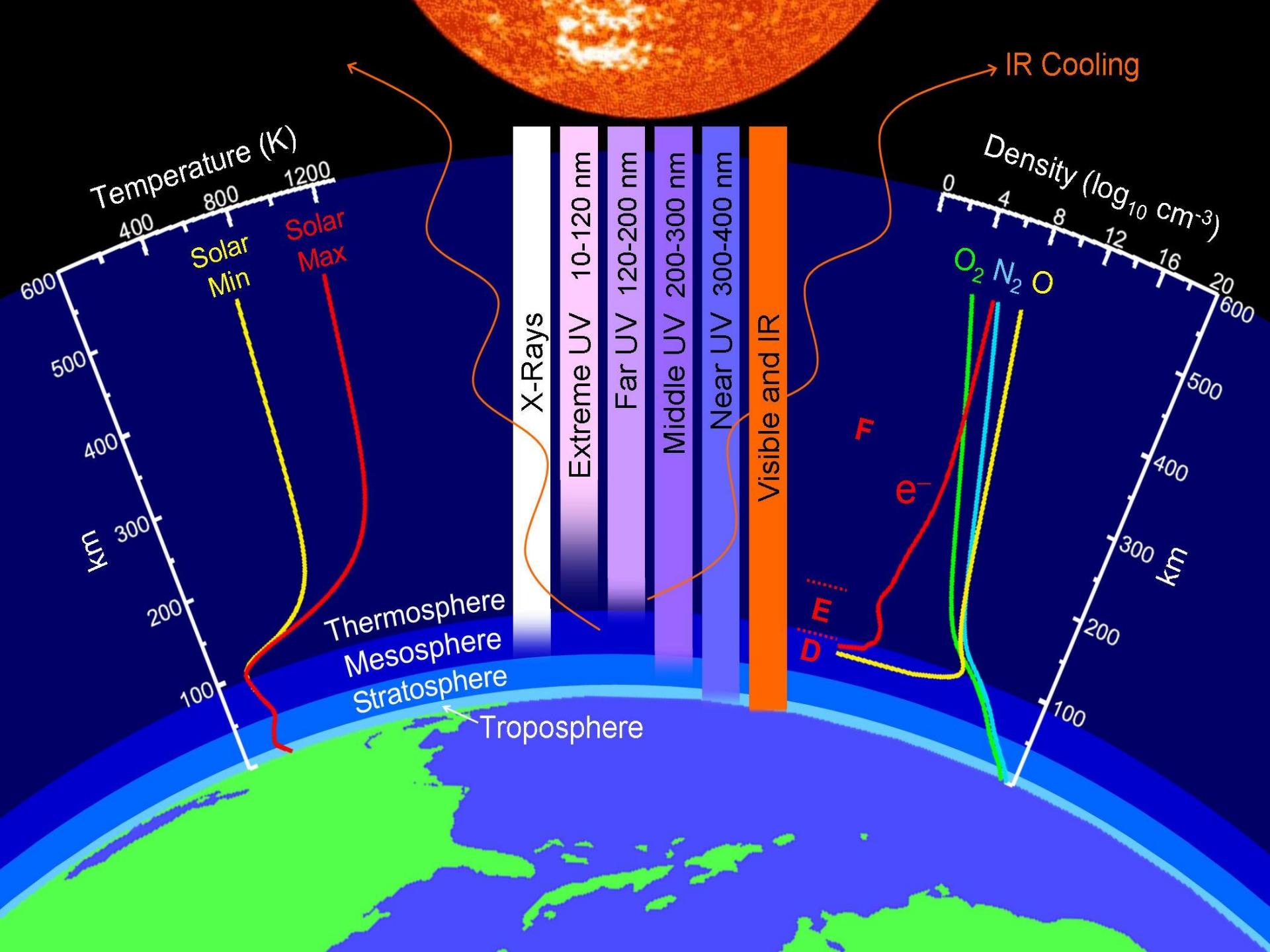
Communications can break down in critical areas and times:

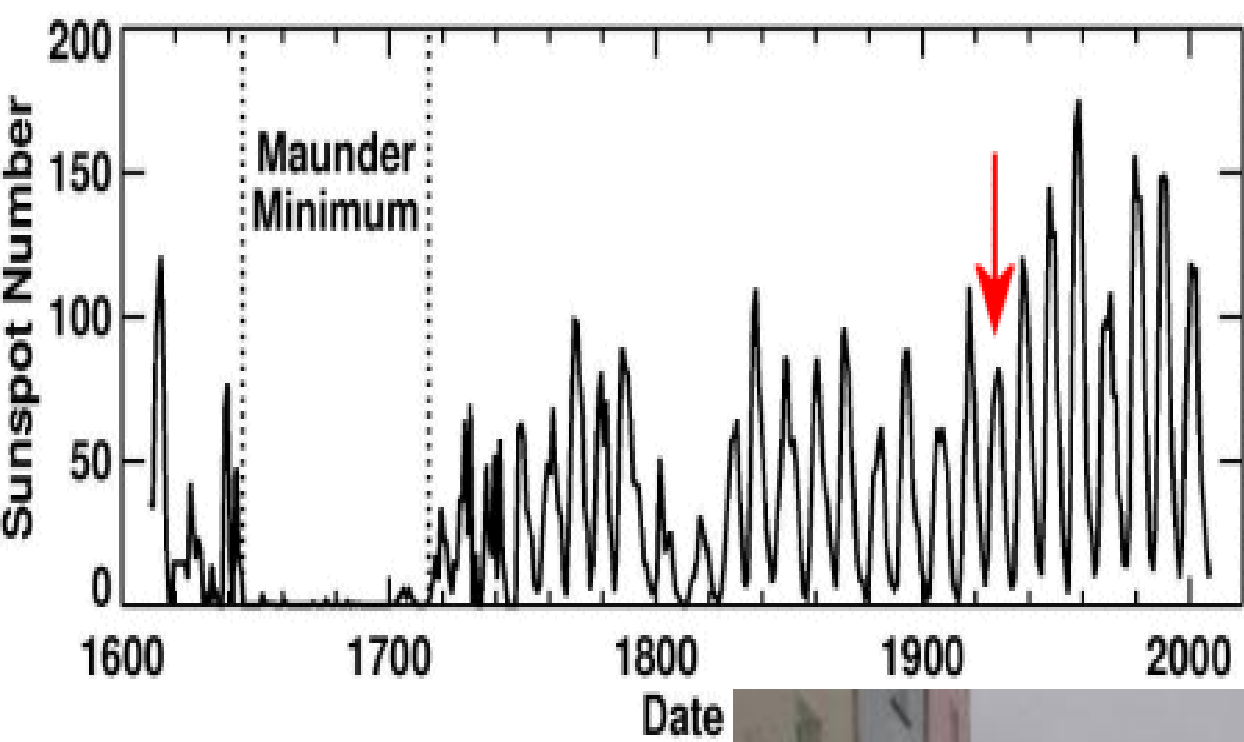
- Desert Storm
- Alaska
- Satellite pagers and Cellular Phones

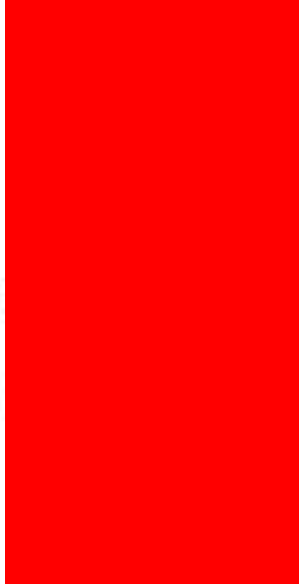
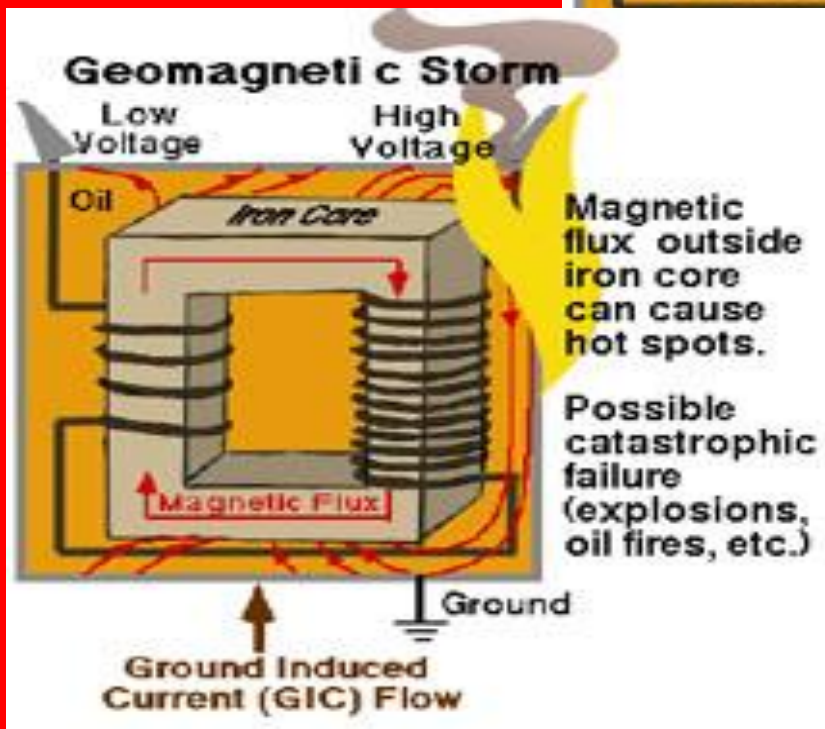
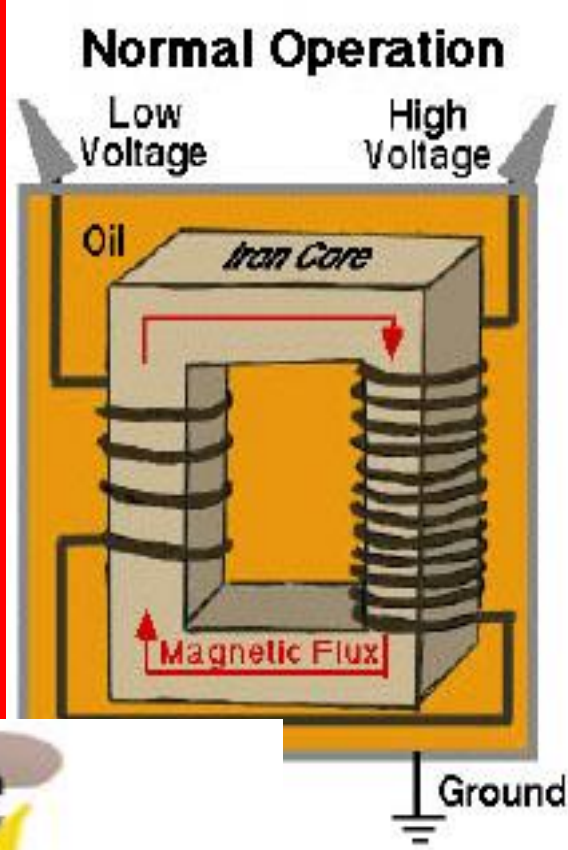
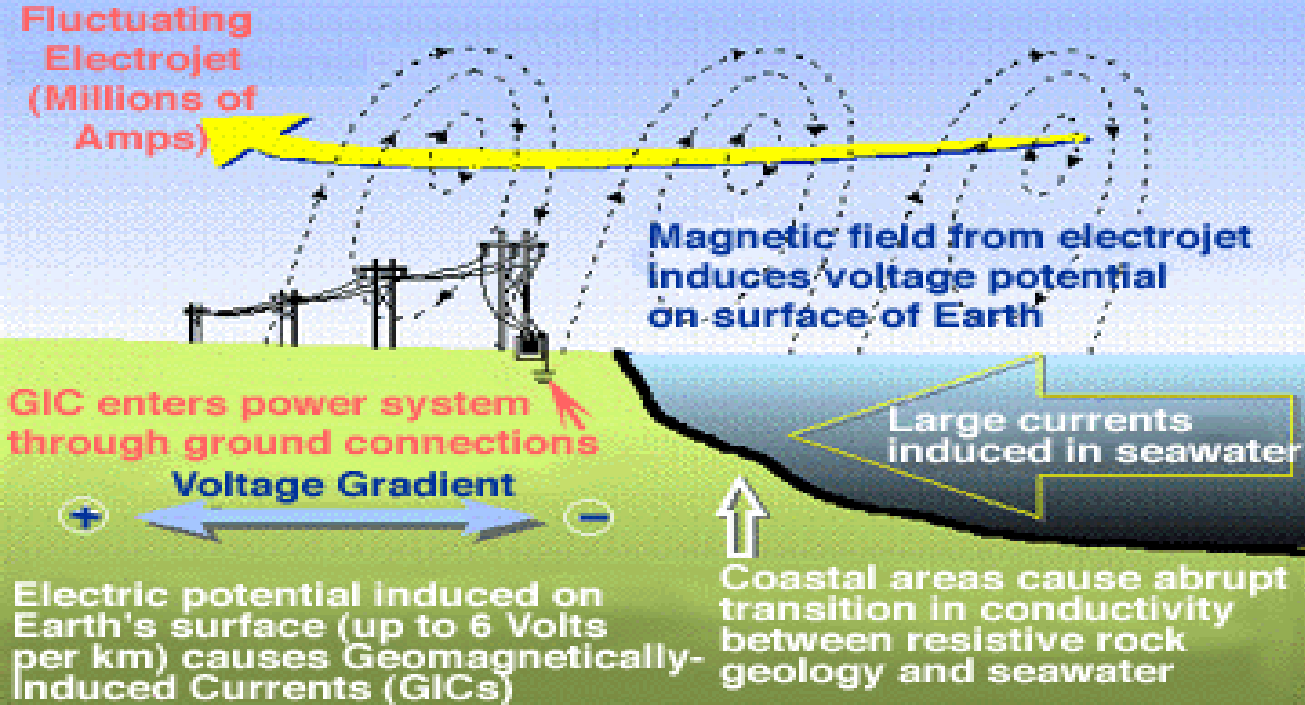
Over-the-horizon radars are also degraded by ionospheric variation.







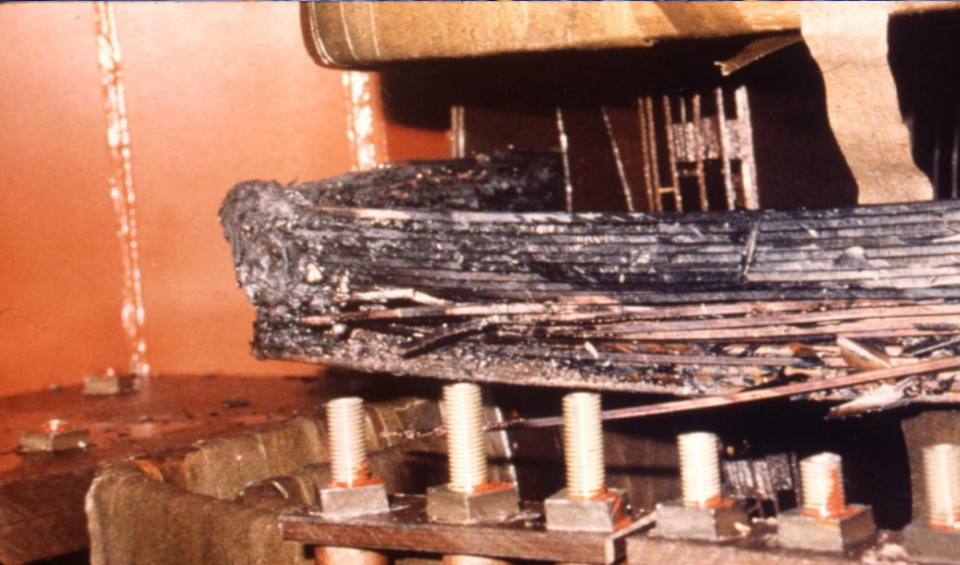




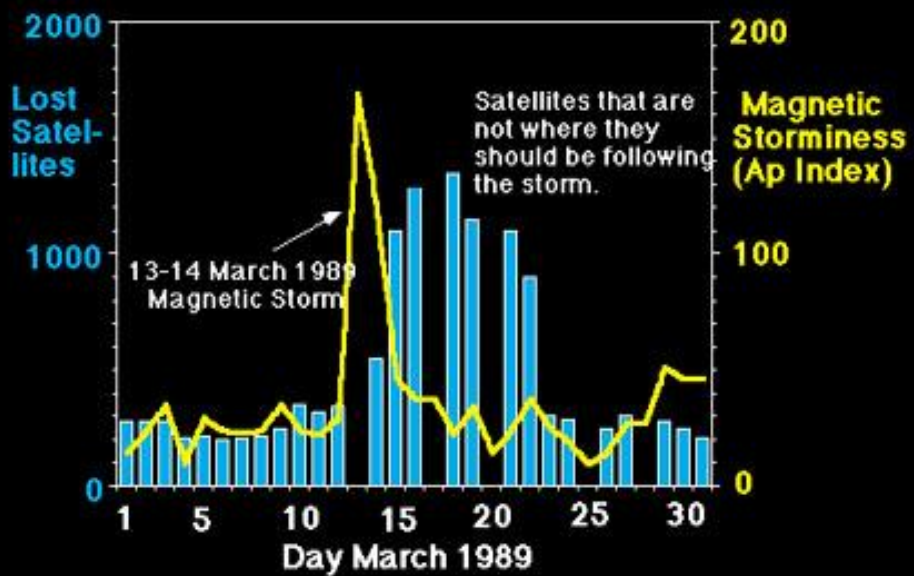
13 MARCH 1989 0745 UT



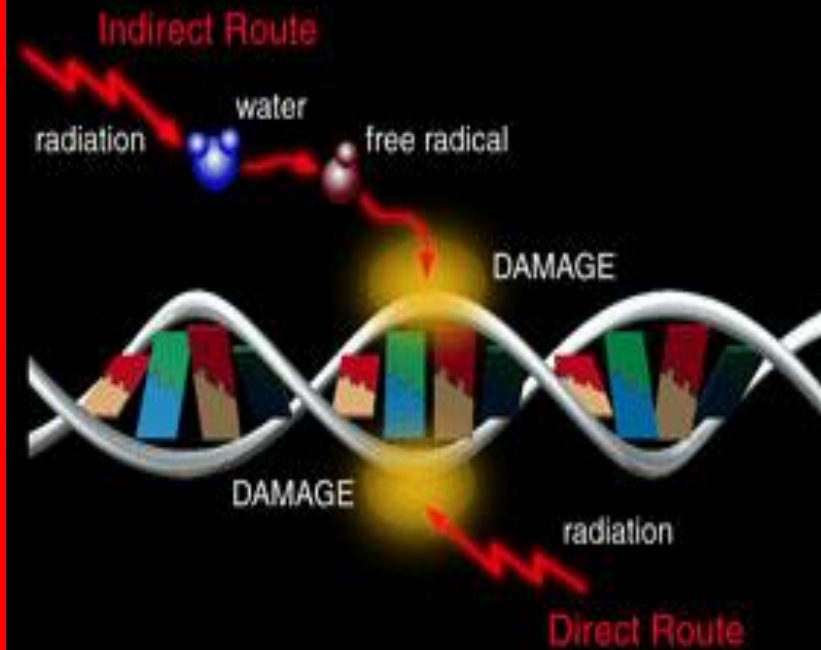
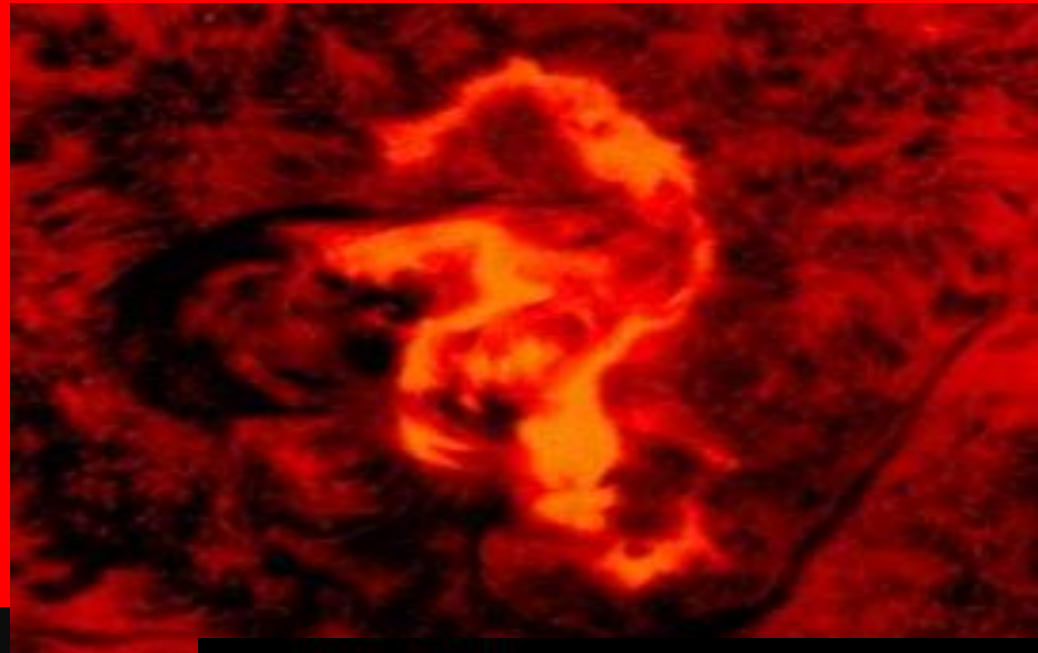
Courtesy of M. A. Stanley, Geophysical Observatory, Appleton Laboratory



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

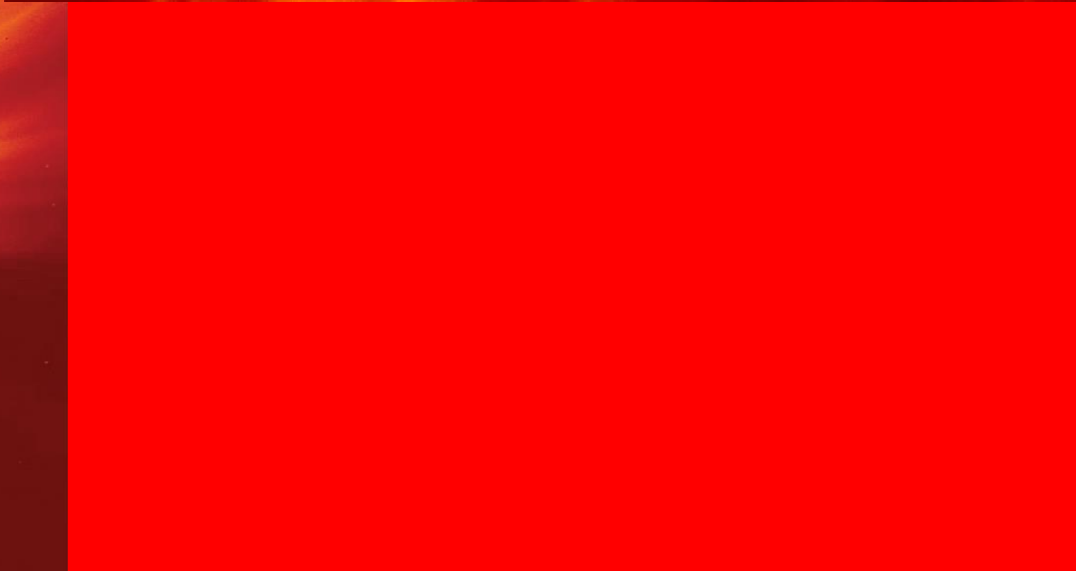
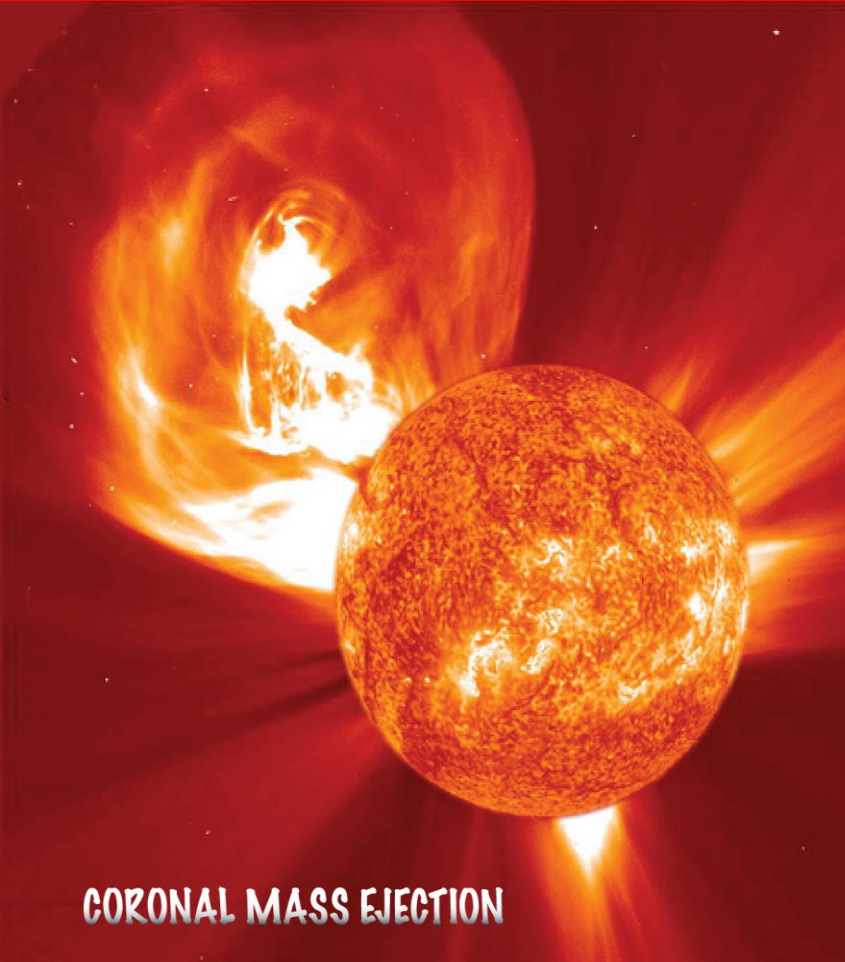
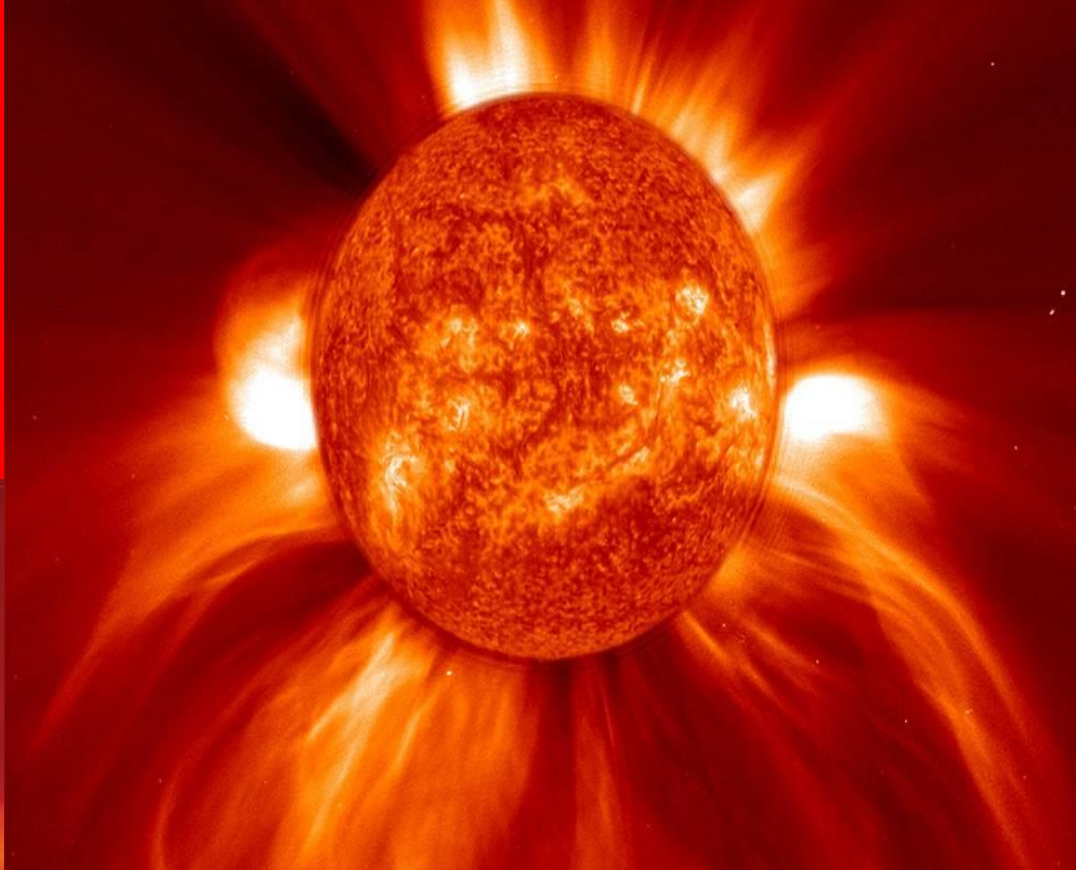
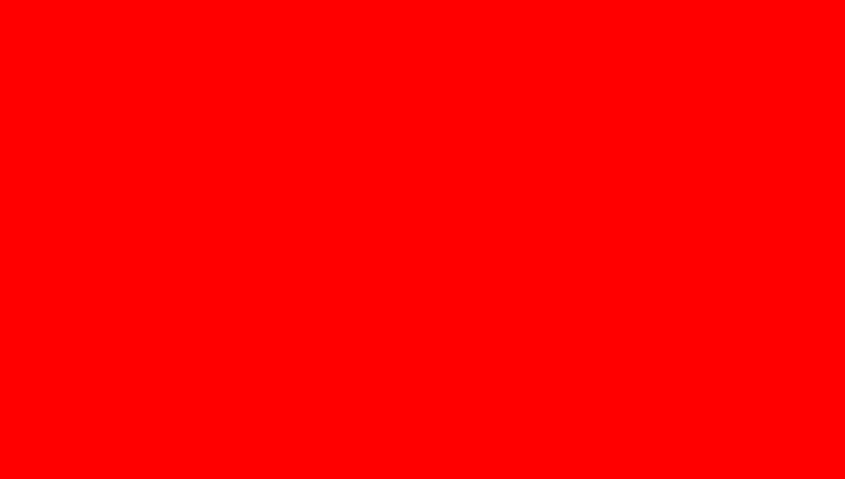


ΣΚΟΠΟΣ

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

ΔΙΕΘΝΗ ΒΙΒΛΙΟΓΡΑΦΙΑ





CORONAL MASS EJECTION

Τέλος Ενότητας

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