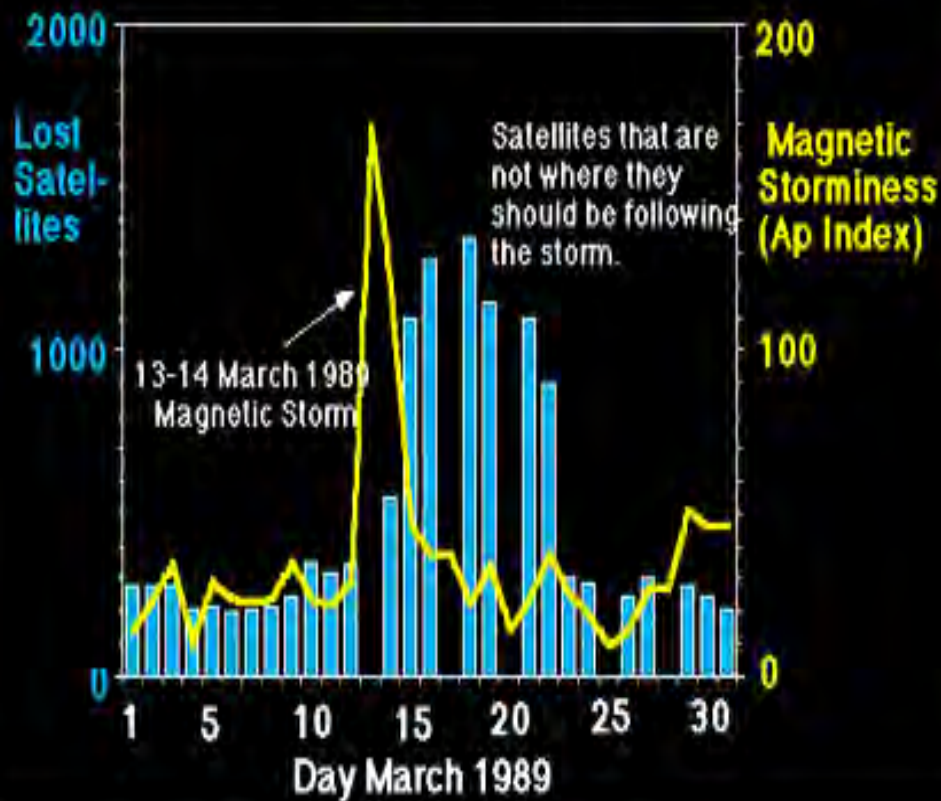


The effects of magnetic storms - what scientists call space weather - extend from the ground to geostationary orbit and beyond.





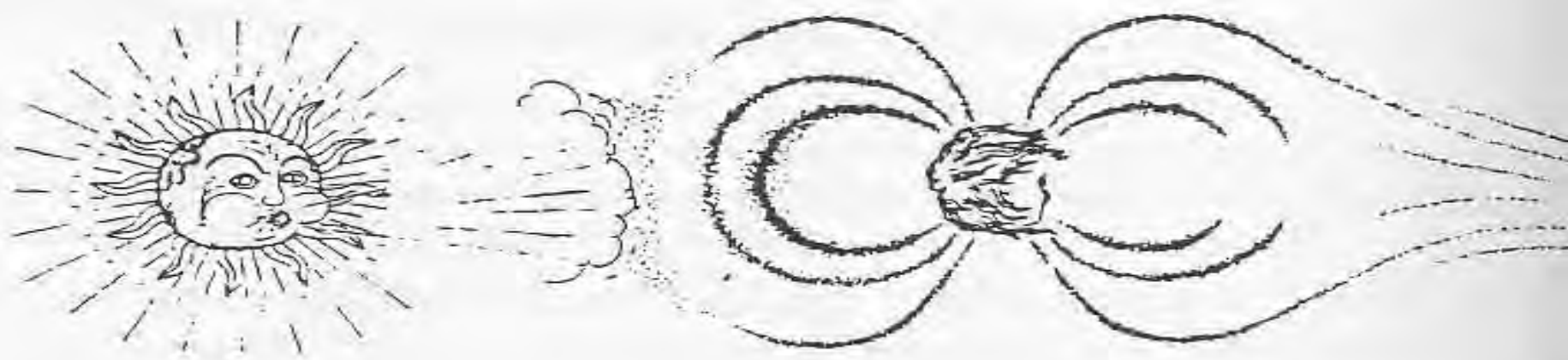
Satellite Tracking Problems After March 13-14, 1989 Storm



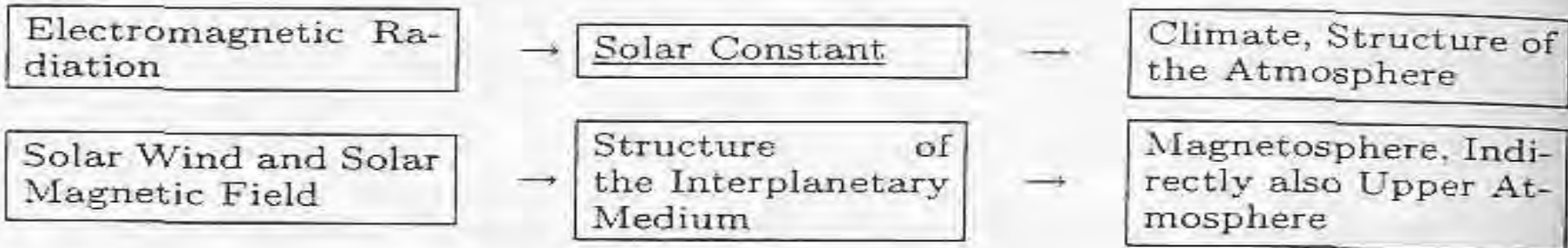
13 MARCH 1989 0745 UT



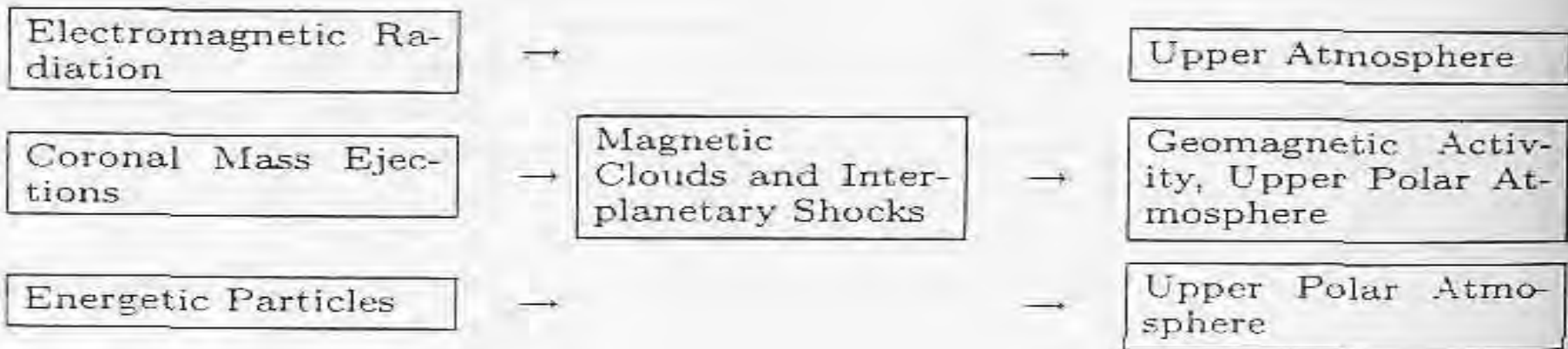
Courtesy of M. A. Shea, Geophysical Observatory, Purple Laboratory



Continuous Emission:

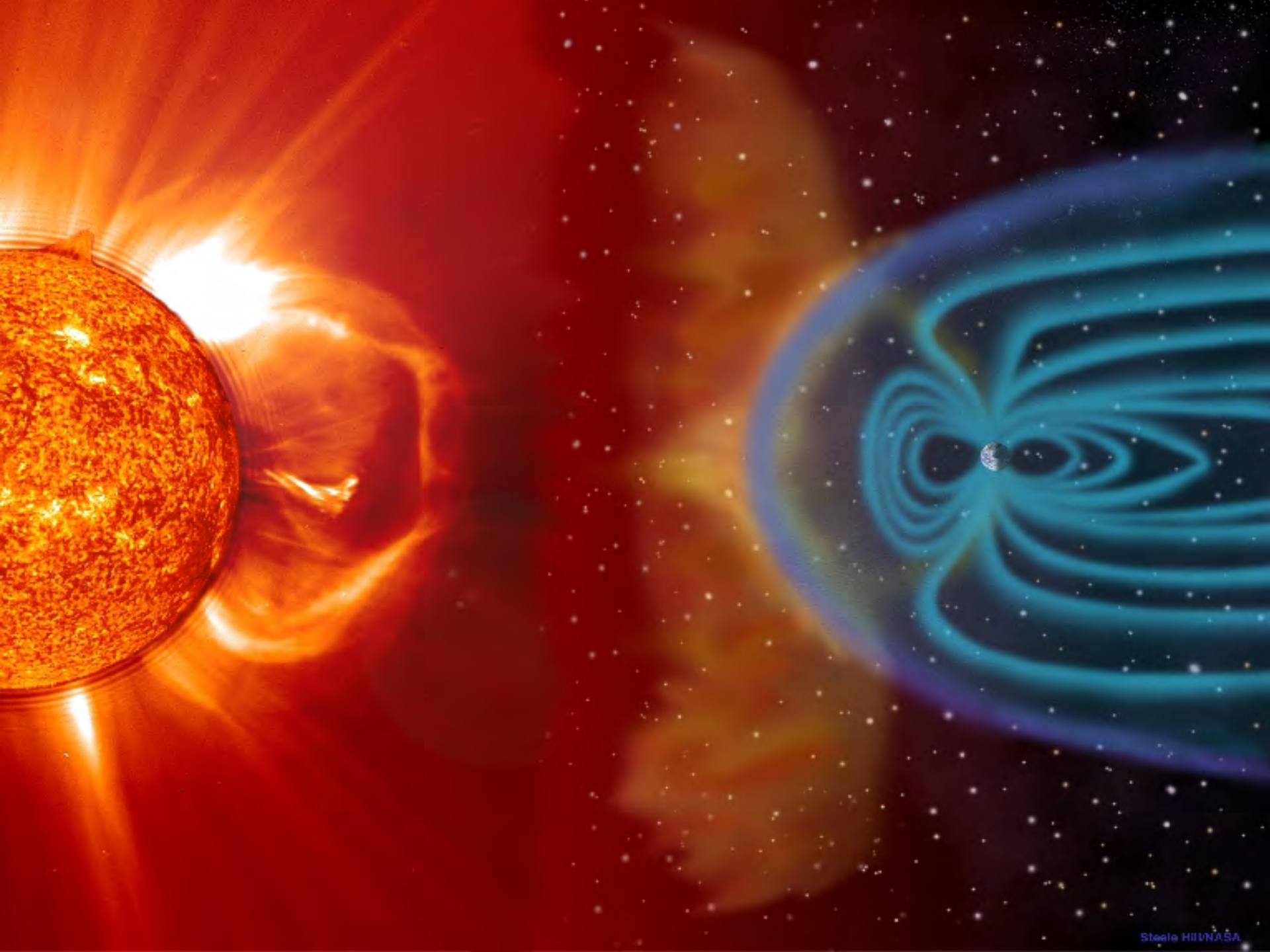


Solar-Cycle-Dependent Emission:



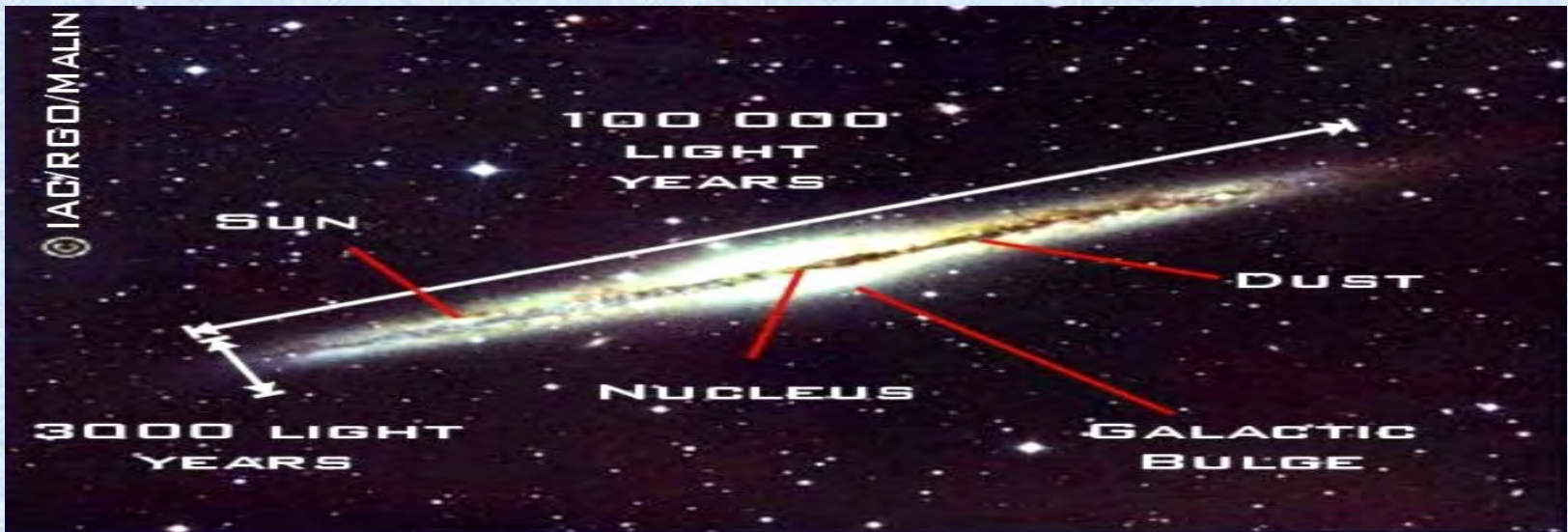
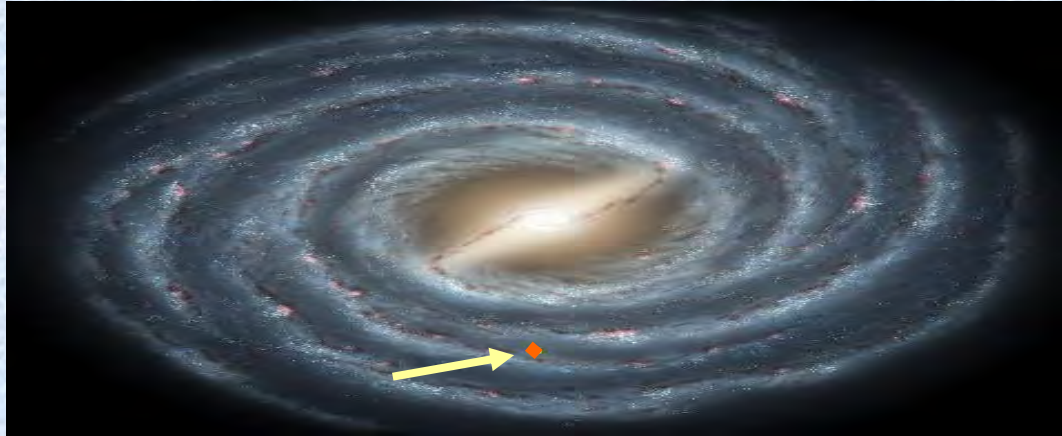


*Courtesy of M. A. Slinn, Oryzopsis Directorate,
Inupiaq Laboratory*









Εικ 1 Μειόπη από το ναό της Αθηνάς στην Τροία με ανάγλυφη παράσταση του Ήλιου πάνω στο άρμα του. (Staatliche Museen, Βερολίνο)



ΦΥΣΙΚΑ ΧΑΡΑΚΤΗΡΙΣΤΙΚΑ ΤΟΥ ΗΛΙΟΥ

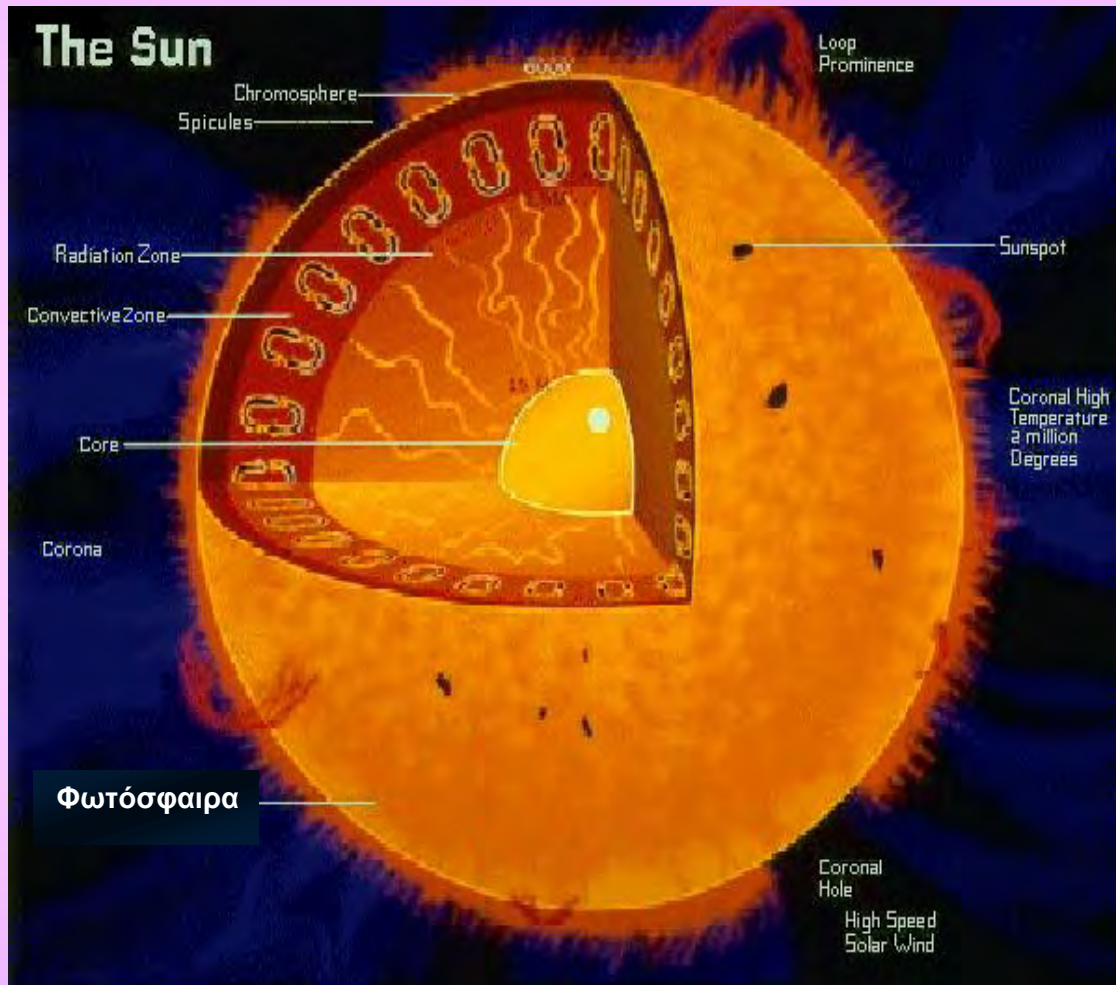
Μέση Απόσταση	$1A.U = 149,6 \times 10^6 \text{ km}$
Διάμετρος	$1.392.000 \text{ km} = 109,3 D_{\Gamma}$
Μάζα	$2 \times 10^{33} \text{ gr} = 3,33 \times 10^5 M_{\Gamma}$
Μέση πυκνότητα	$\rho = 1,409 \text{ gr/cm}^3$
Επιφάνεια	$S = 6,087 \times 10^{12} \text{ km}^2$
Όγκος	$V = 1,412 \times 10^{18} \text{ km}^3.$
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	$\omega = 14,38^\circ - 2,77\varphi$, 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	$7^\circ 15'$

Solid	Liquid	Gas	Plasma
Example Ice H_2O	Example Water H_2O	Example Steam H_2O	Example Ionized Gas $H_2 \rightarrow H^+ + H^+ + 2e^-$
Cold $T < 0^\circ C$	Warm $0 < T < 100^\circ C$	Hot $T > 100^\circ C$	Hotter $T > 100,000^\circ C$ > 10 electron Volts
			
Molecules Fixed in Lattice	Molecules Free to Move	Molecules Free to Move, Large Spacing	Ions and Electrons Move Independently, Large Spacing

Εικ. Οι 4 καταστάσεις της ύλης

The Sun



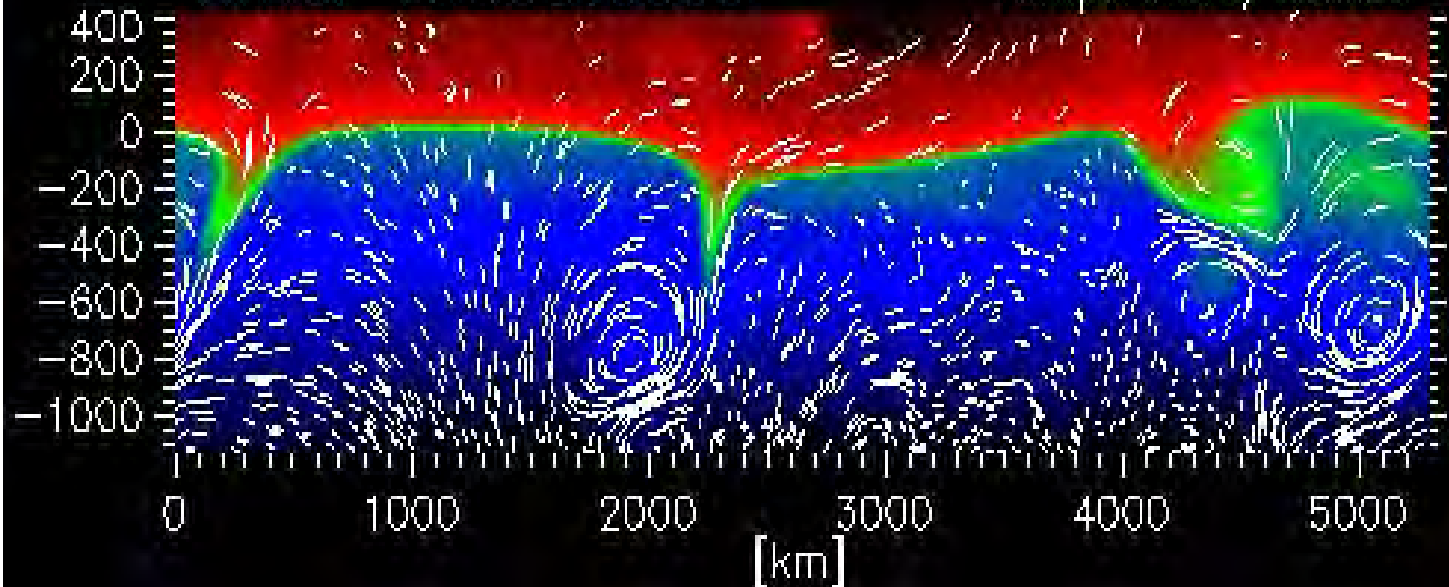
Sun (L71D09), $T_{\text{eff}}=5770$ K, $\log g=4.44$

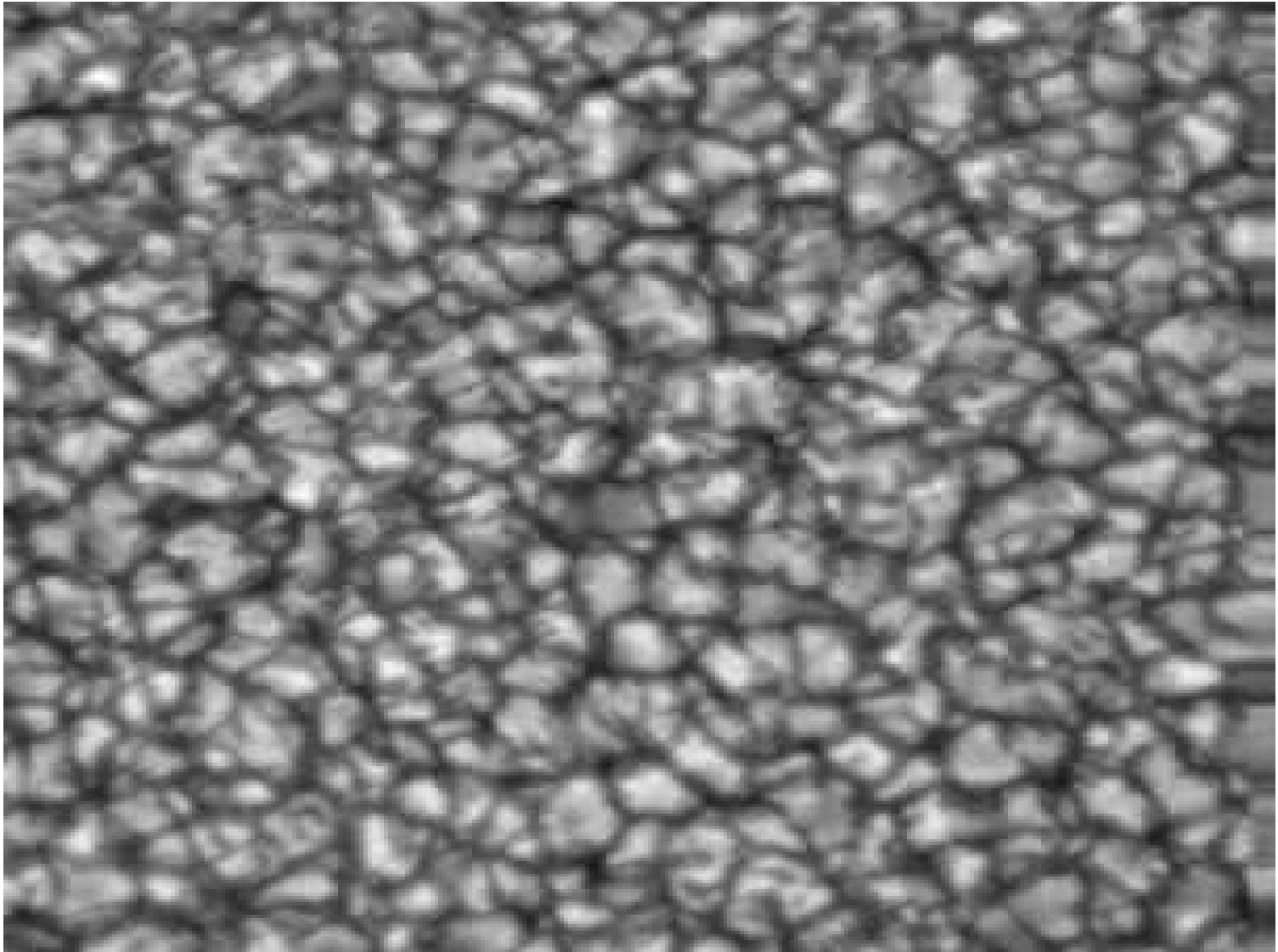
212 x 106 grid points, 11540 s ($\Delta t=20$ s)

Matthias Steffen, Bernd Freytag

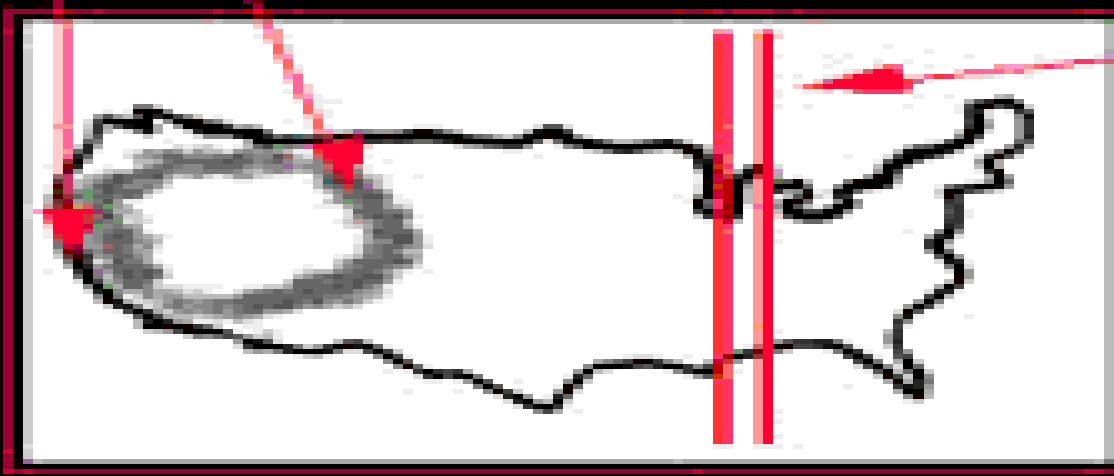
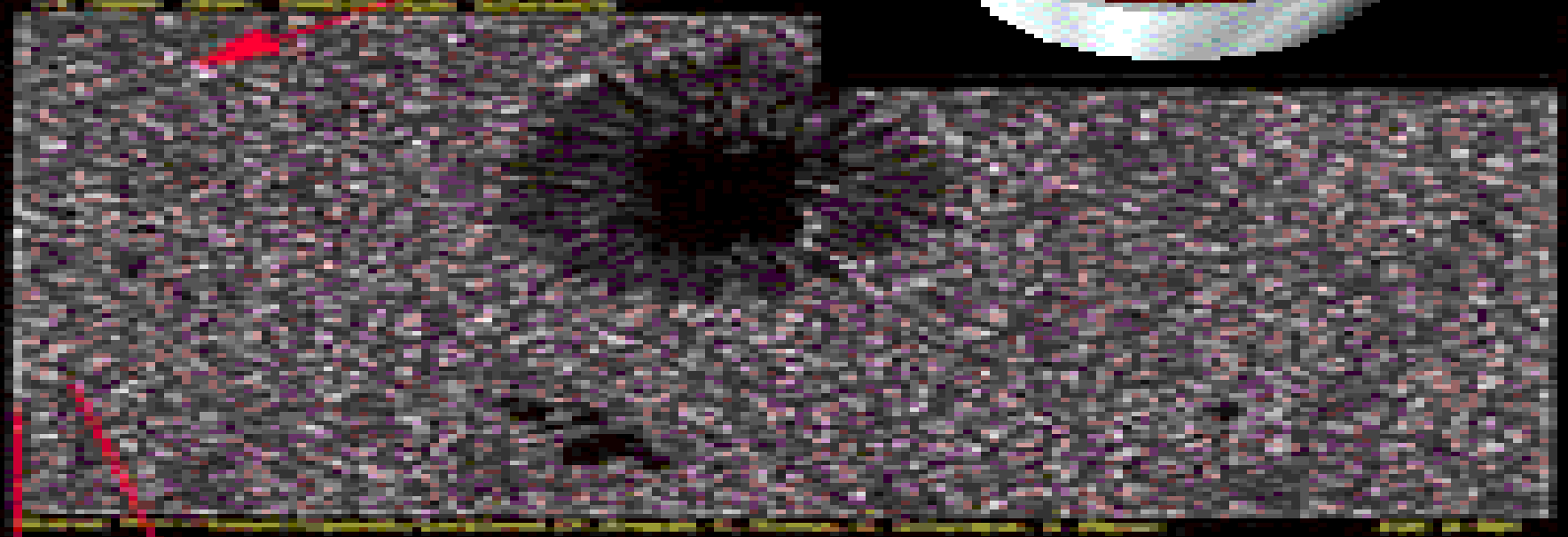
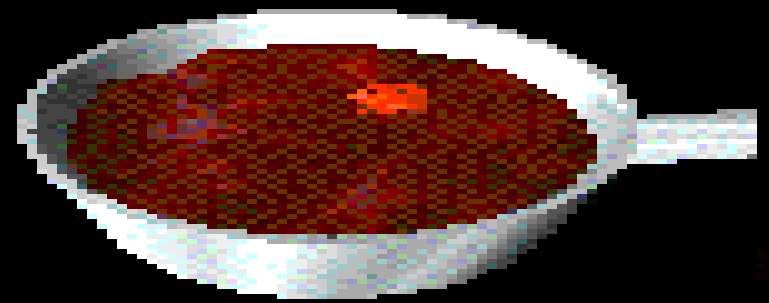
Time: 18880.0sec

Temperature, Tracers

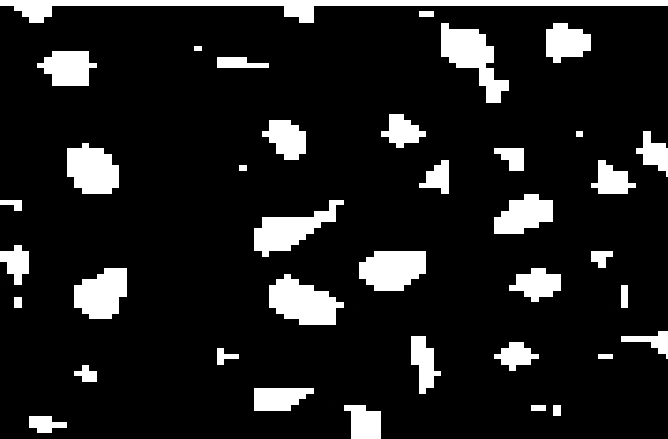
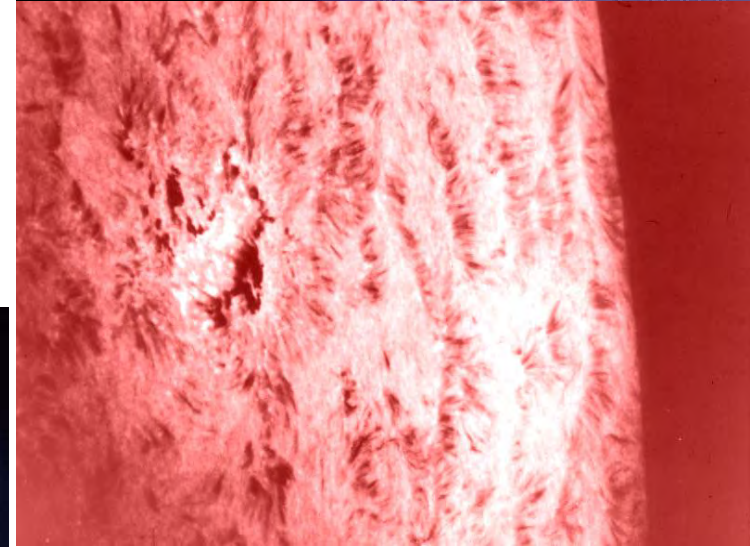
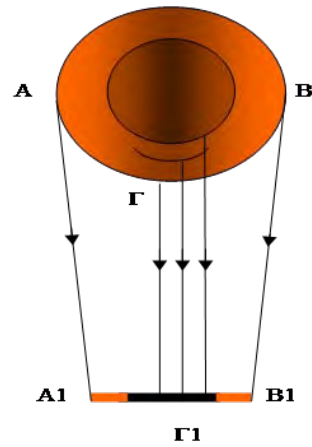
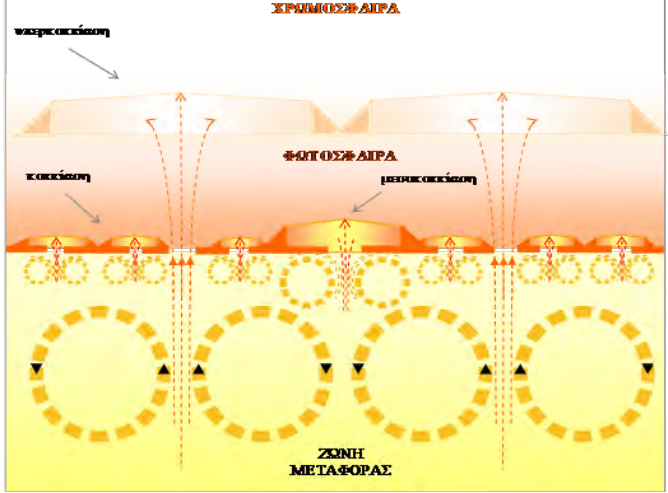
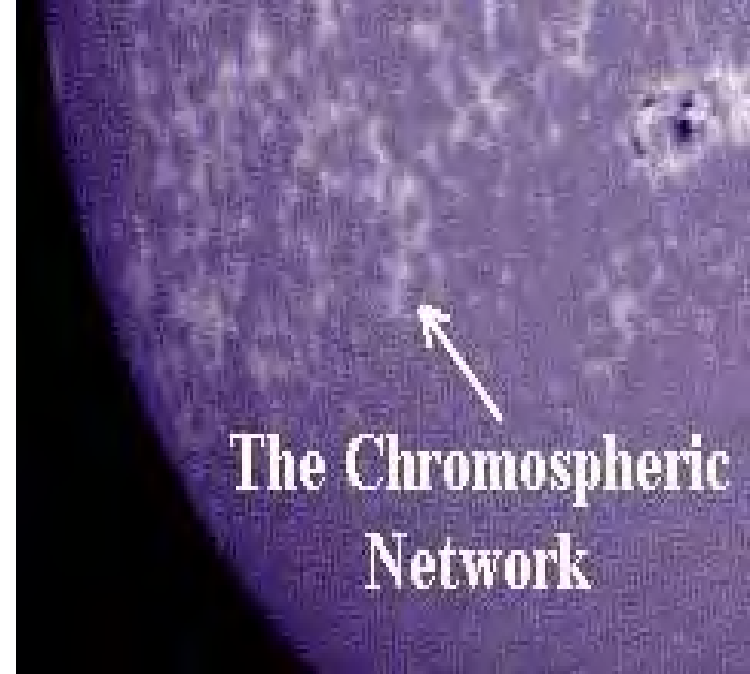
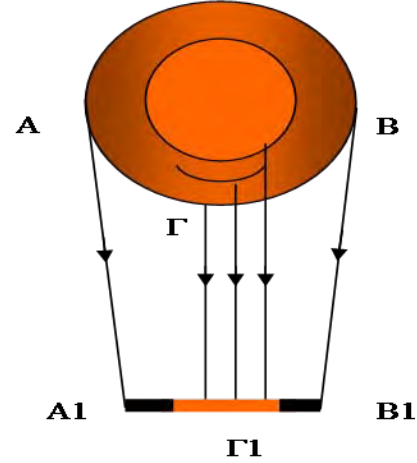
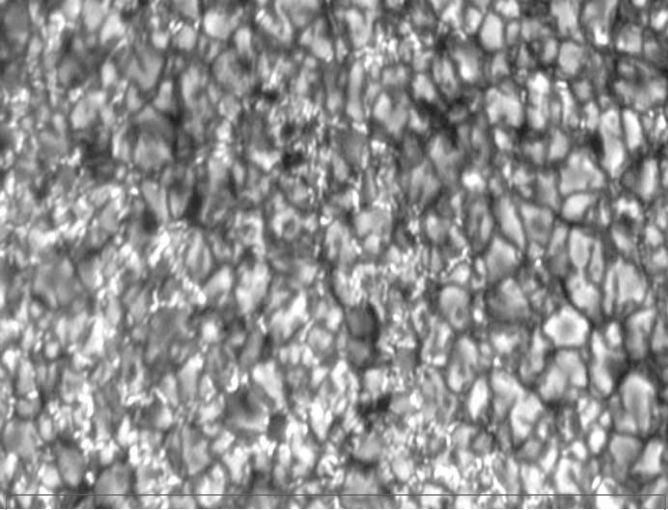




tops of rising
and sinking
gas cells



width of the
visible
layer



ΣΥ
ΝΙ
ΣΤ
ΩΣ
ΕΣ
ΣΤ
ΕΜ
ΜΑ
ΤΟ
Σ

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 μεγάλη διεύρυνση των φασματικών γραμμών (ΦΑΙΝ. DOPPLER). Επομένως έχει **συνεχές φάσμα** και είναι πολωμένο.

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

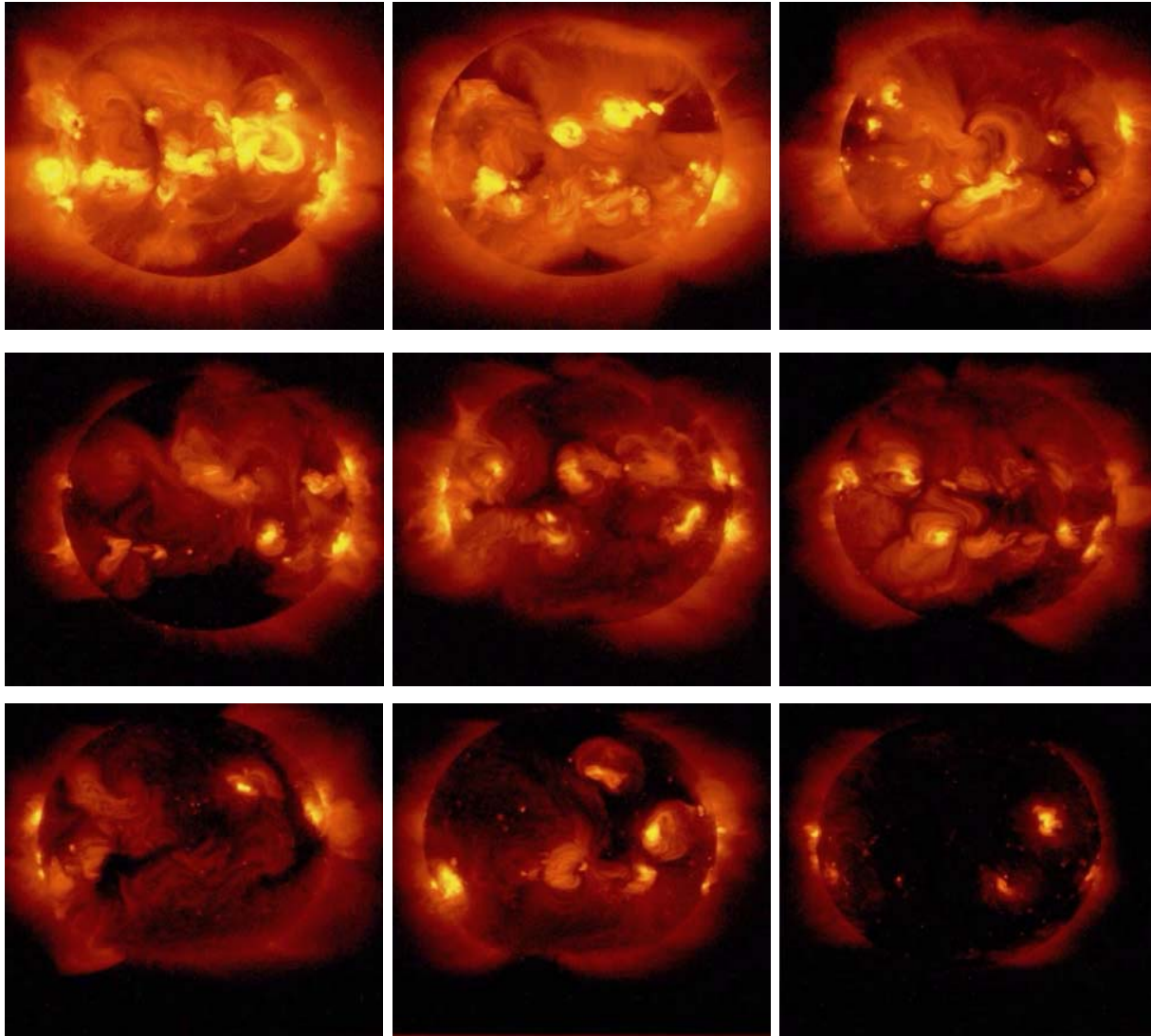
Αυτή, δε δημιουργείται μέσα στο στέμμα από το υλικό του στέμματος, αλλά οφείλεται στην περίθλαση του φωτός του Ήλιου από στερεά σωματίδια (σκόνη) που βρίσκονται διασκορπισμέ-να στο μεσοδιάστημα ΓΗΣ-ΗΛΙΟΥ, πάνω στο επίπεδο της εκλειπτικής. Δίνει **συνεχές φάσμα** με **γραμμές απορρόφησης Fraunhofer**.

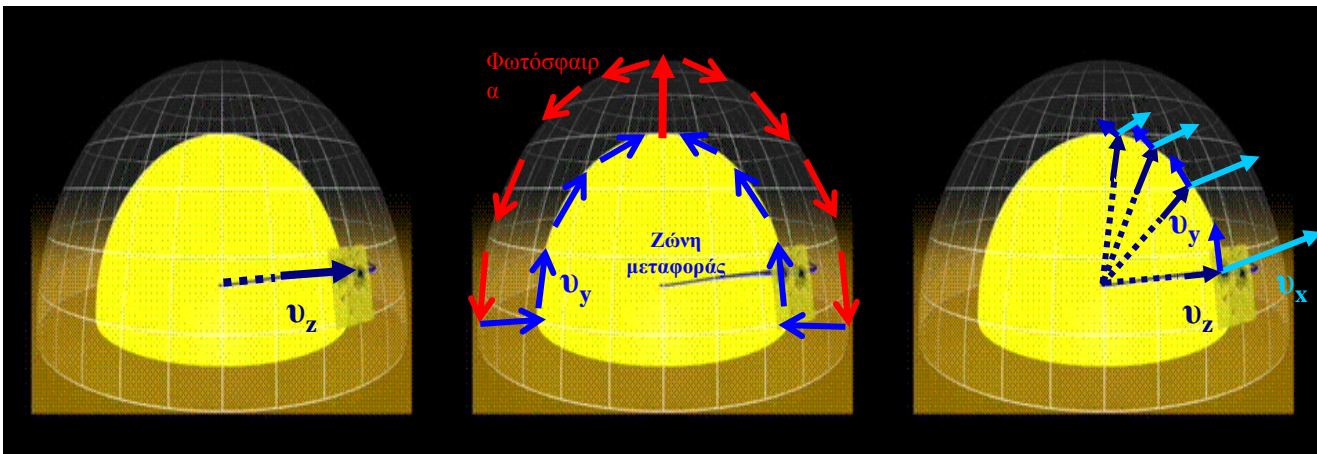
3.ΣΤΕΜΜΑ Ε (Emission corona)

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.**



Ο ΕΝΔΕΚΑΕΤΗΣ ΚΥΚΛΟΣ – ΑΠΟ ΤΟ ΜΕΓΙΣΤΟ ΣΤΟ ΕΛΑΧΙΣΤΟ

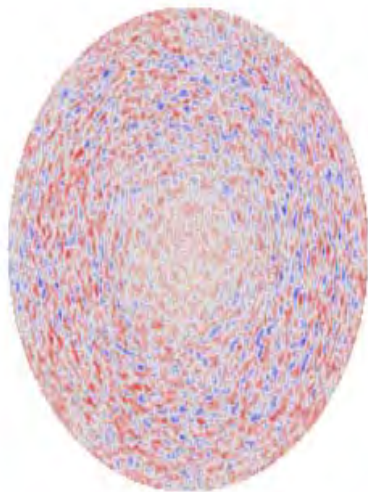




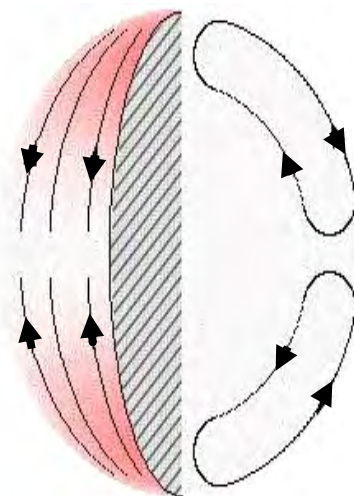
Εικ. Η κατακόρυφη συνιστώσα της ταχύτητας v_z .

Εικ. Η δημιουργία της κάθετης συνιστώσας της ταχύτητας v_y .

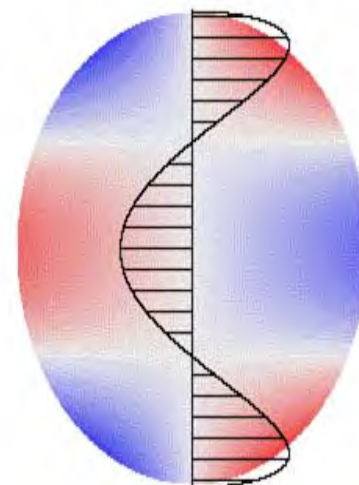
Εικ. Οι 3 συνιστώσες της ταχύτητας v_z , v_y και v_x .



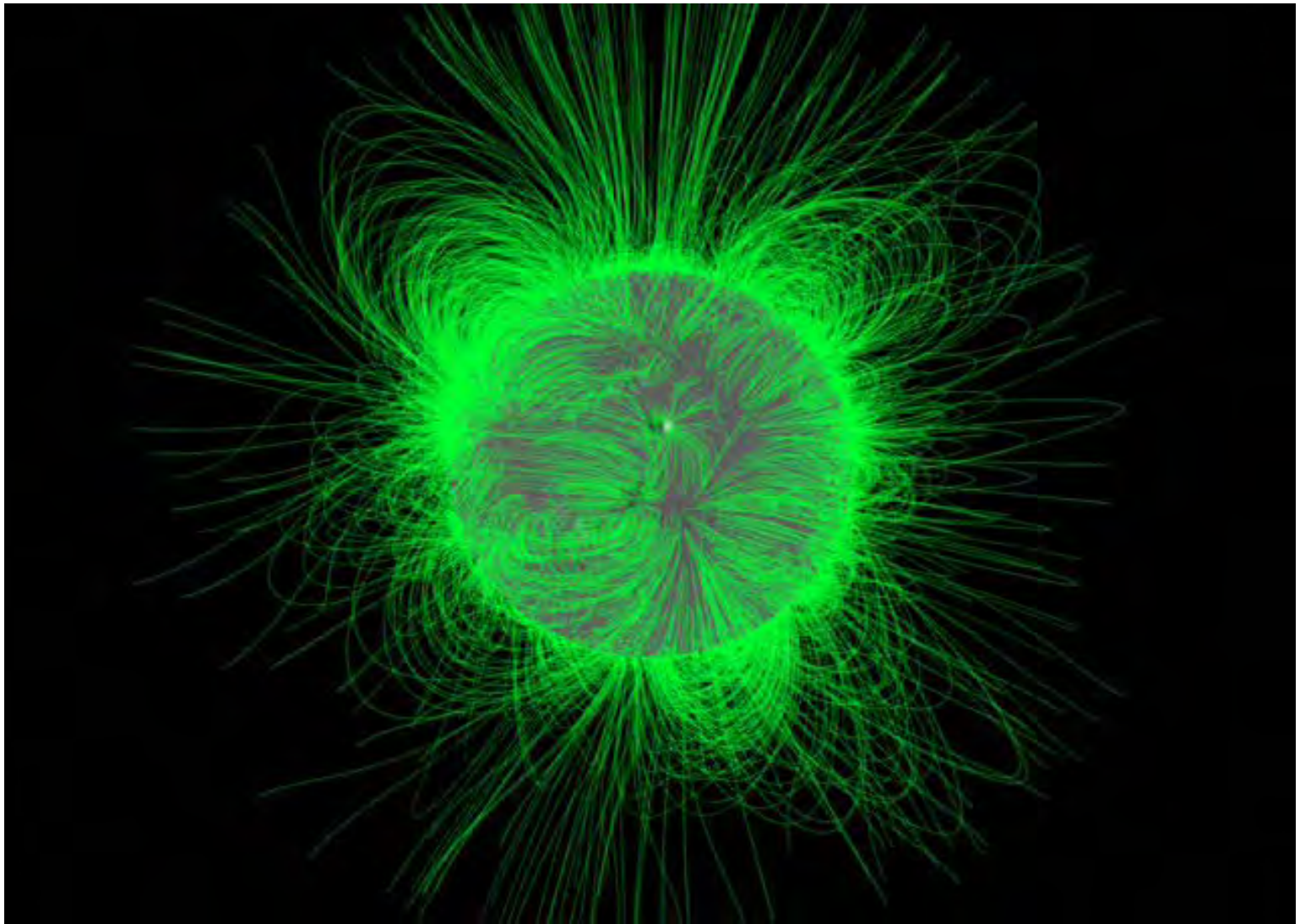
Εικ. Το αποτέλεσμα των ανοδικών ρευμάτων (υπερκοκκίαση)

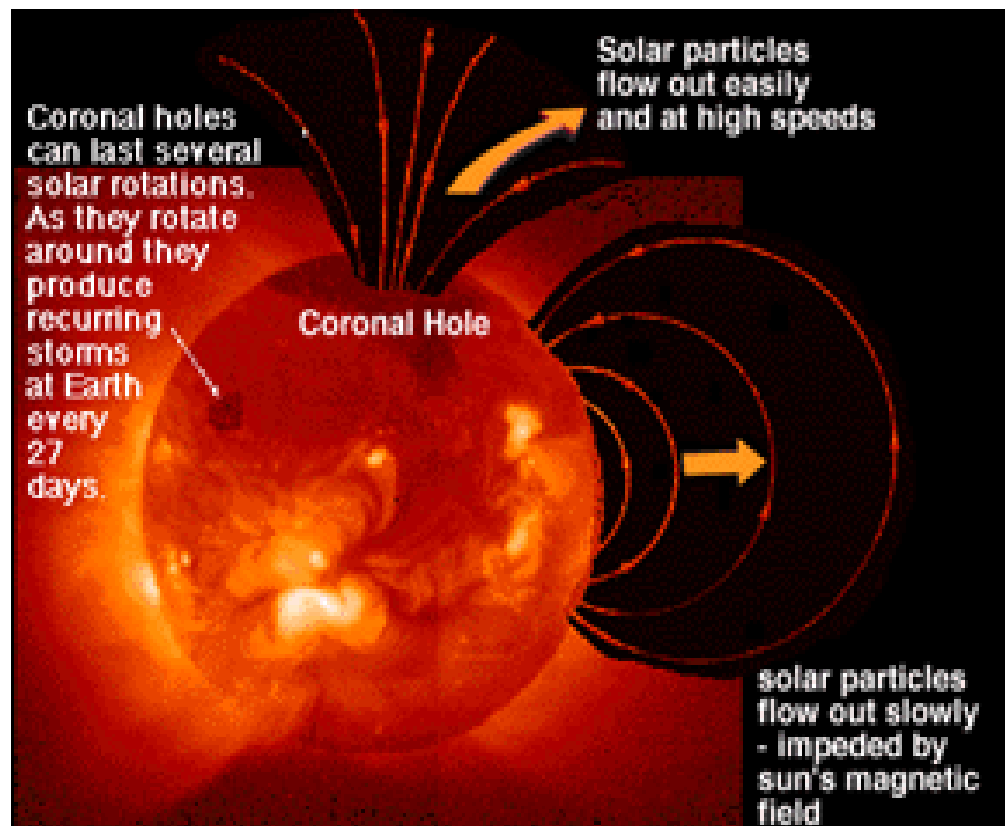
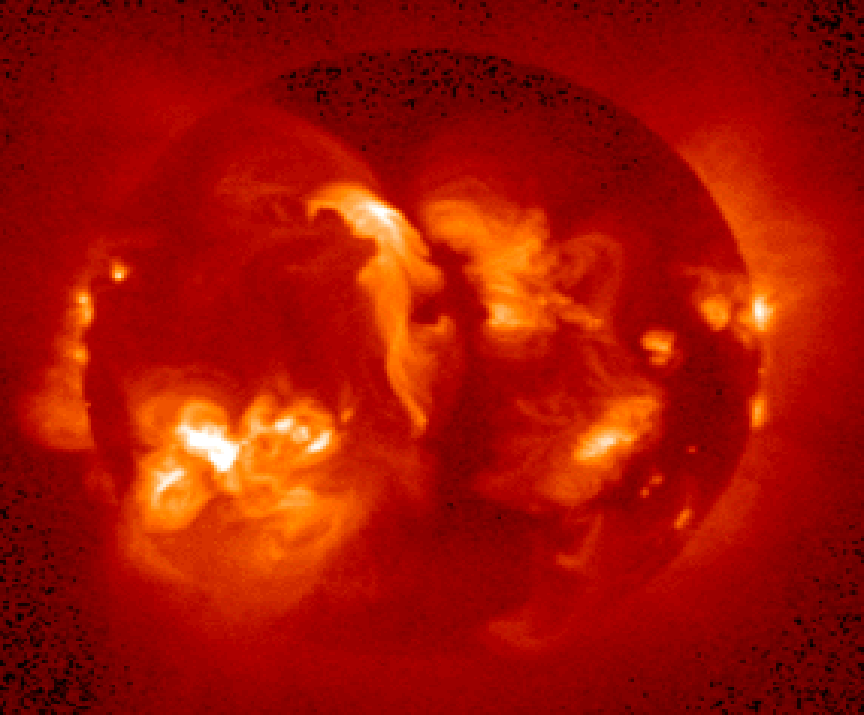


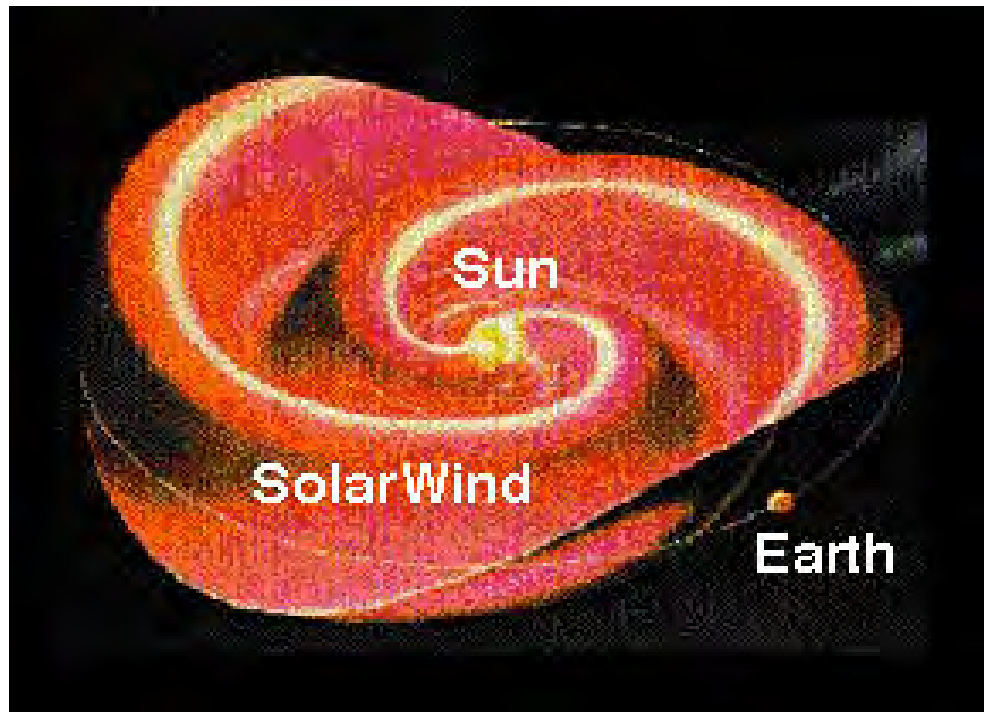
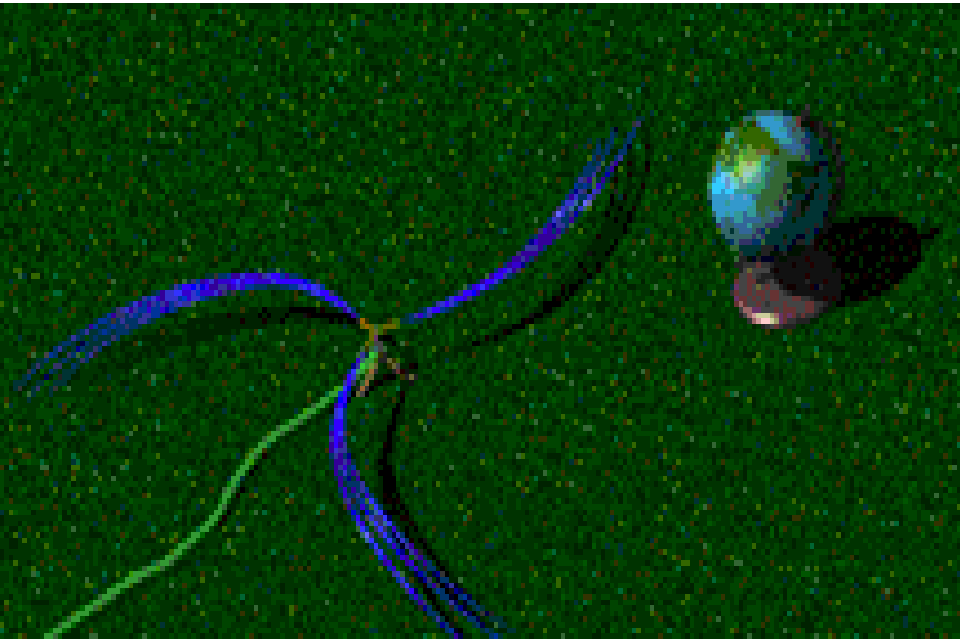
Εικ. Η ροή των μεσημβρινών ρευμάτων

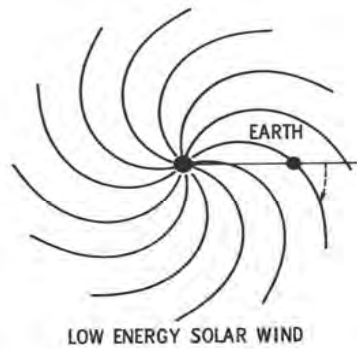


Εικ. Η οριζόντια συνιστώσα της ταχύτητας

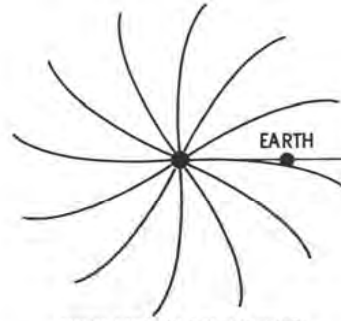






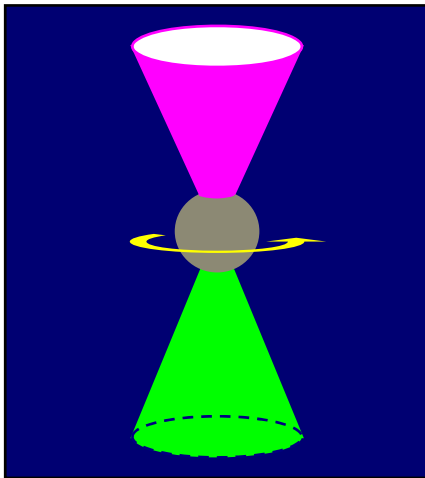


LOW ENERGY SOLAR WIND

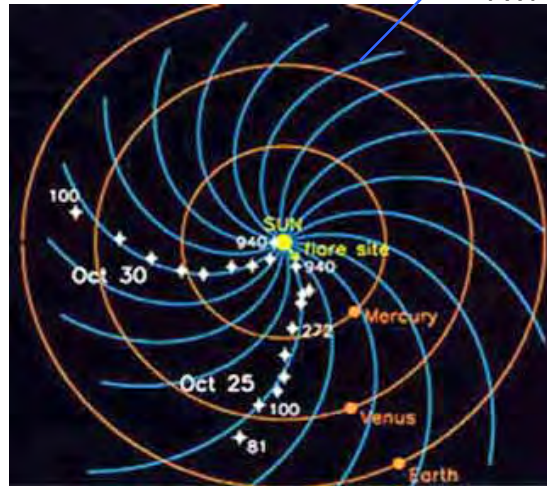


HIGH ENERGY SOLAR WIND

[Graphic from "The Interplanetary Medium," by Normal F. Ness, in *Introduction to Space Science*, ed. by Wilmot N. Hess and Gilbert D. Mead, pg. 345, 1965.]

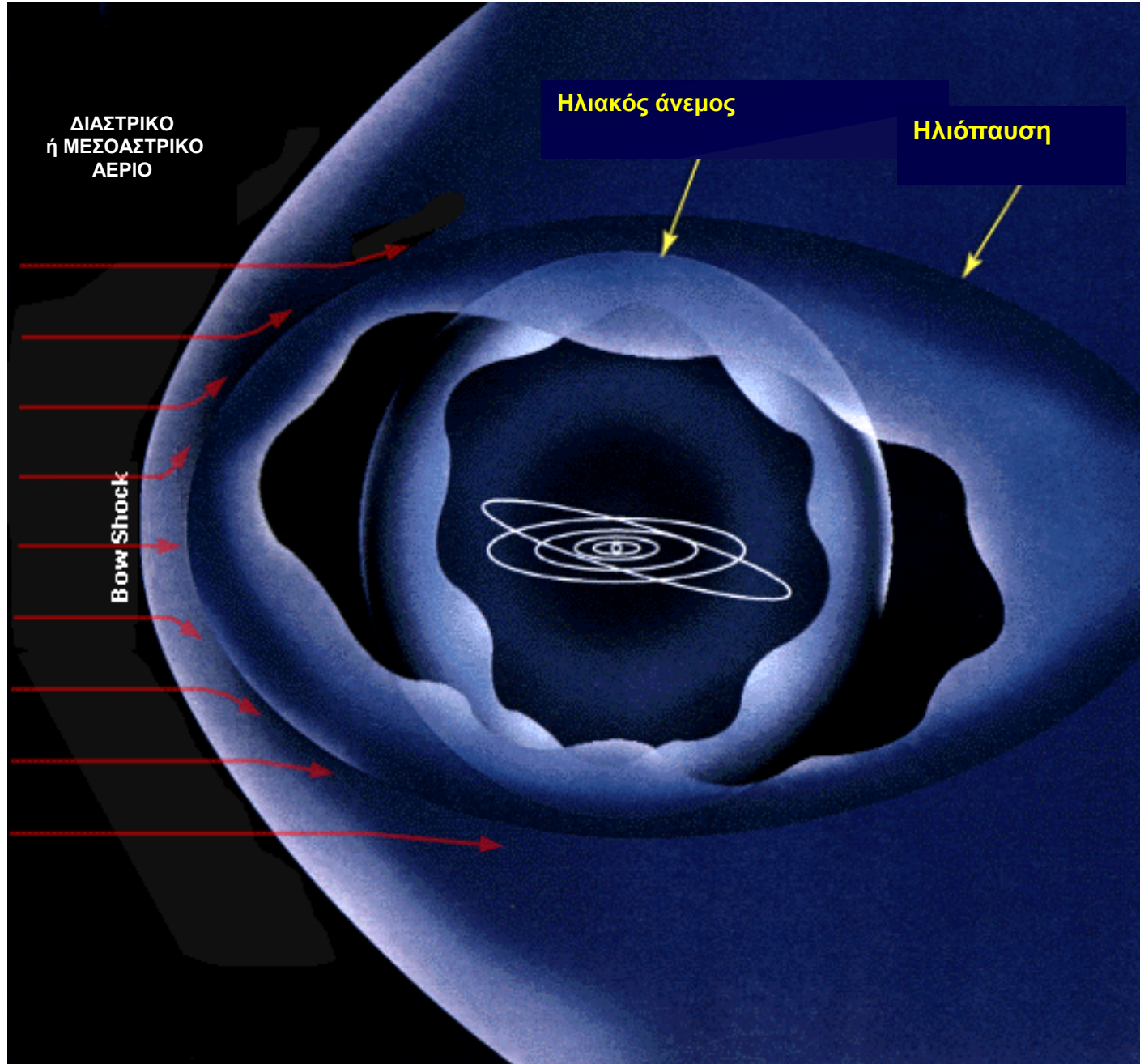


Εικ. Οι ανοιχτές μαγνητικές δυναμικές γραμμές του Ήλιου δημιουργούν κατά την περιστροφή του στους πόλους του 2 κώνους ανεστραμμένους.



Σπείρες του Αρχιμήδη

Εικ. Οι ανοιχτές μαγνητικές δυναμικές γραμμές του Ήλιου δημιουργούν κατά την περιστροφή του στο ύψος του ισημερινού του τις **σπείρες του Αρχιμήδη**.



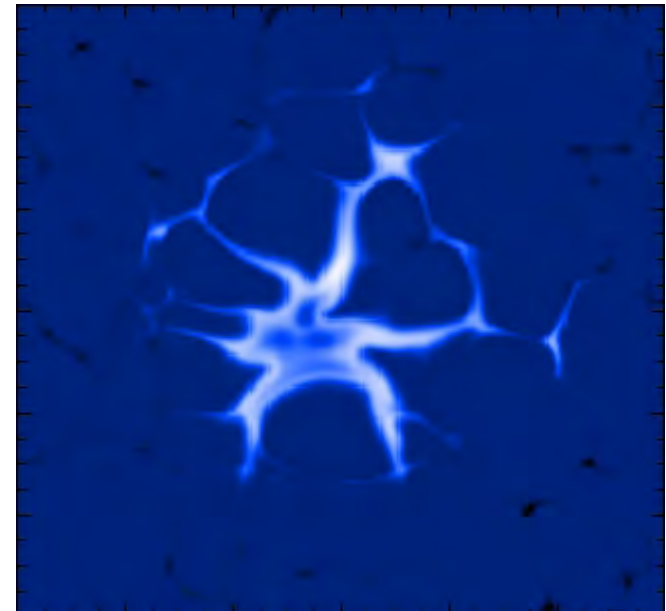
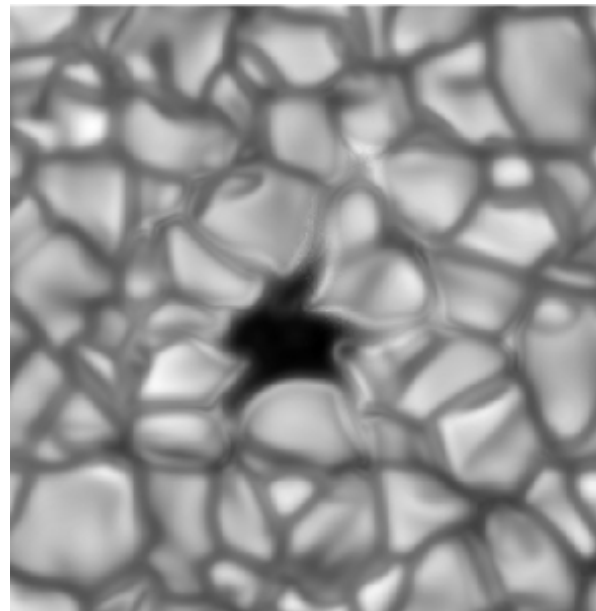
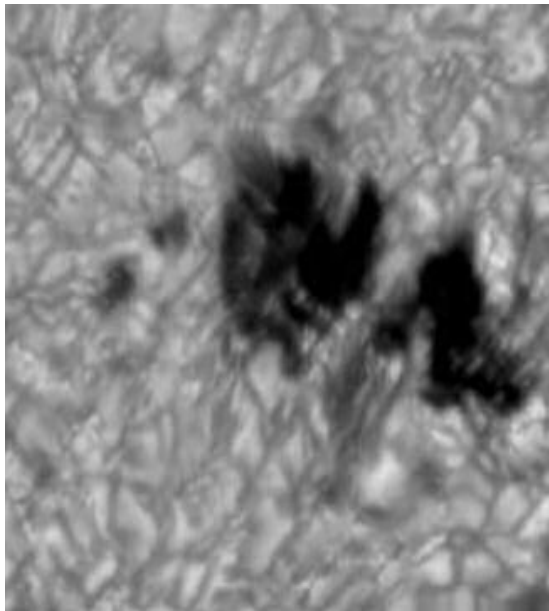
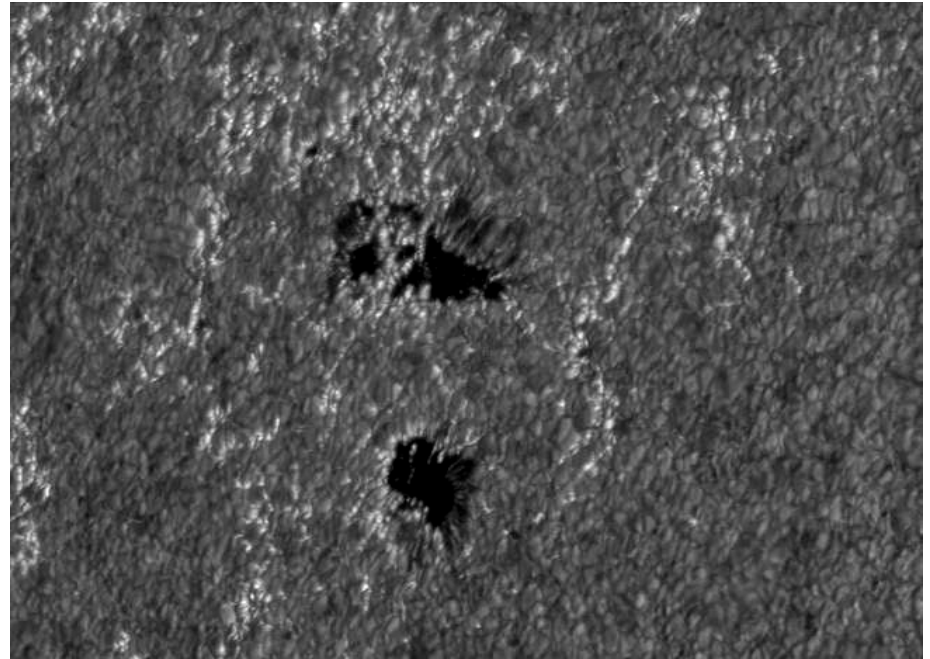
Εικ. Η ηλιόσφαιρα δέχεται το μέτωπο του κρουστικού κύματος του διαστρικού αερίου και απωθεί τις κοσμικές ακτίνες προστατεύοντας το πλανητικό μας σύστημα.

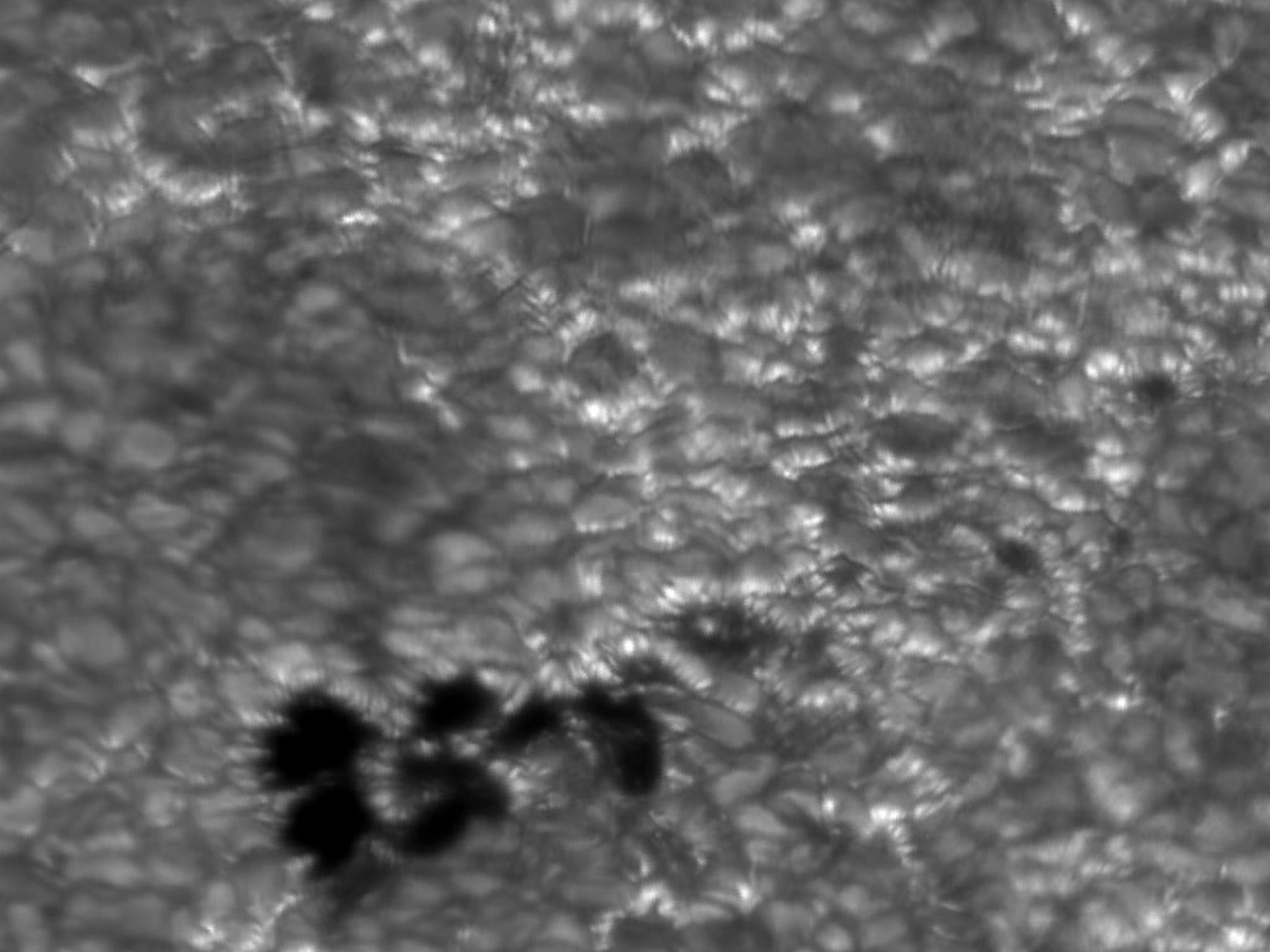


ΚΕΝΤΡΑ ΔΡΑΣΗΣ

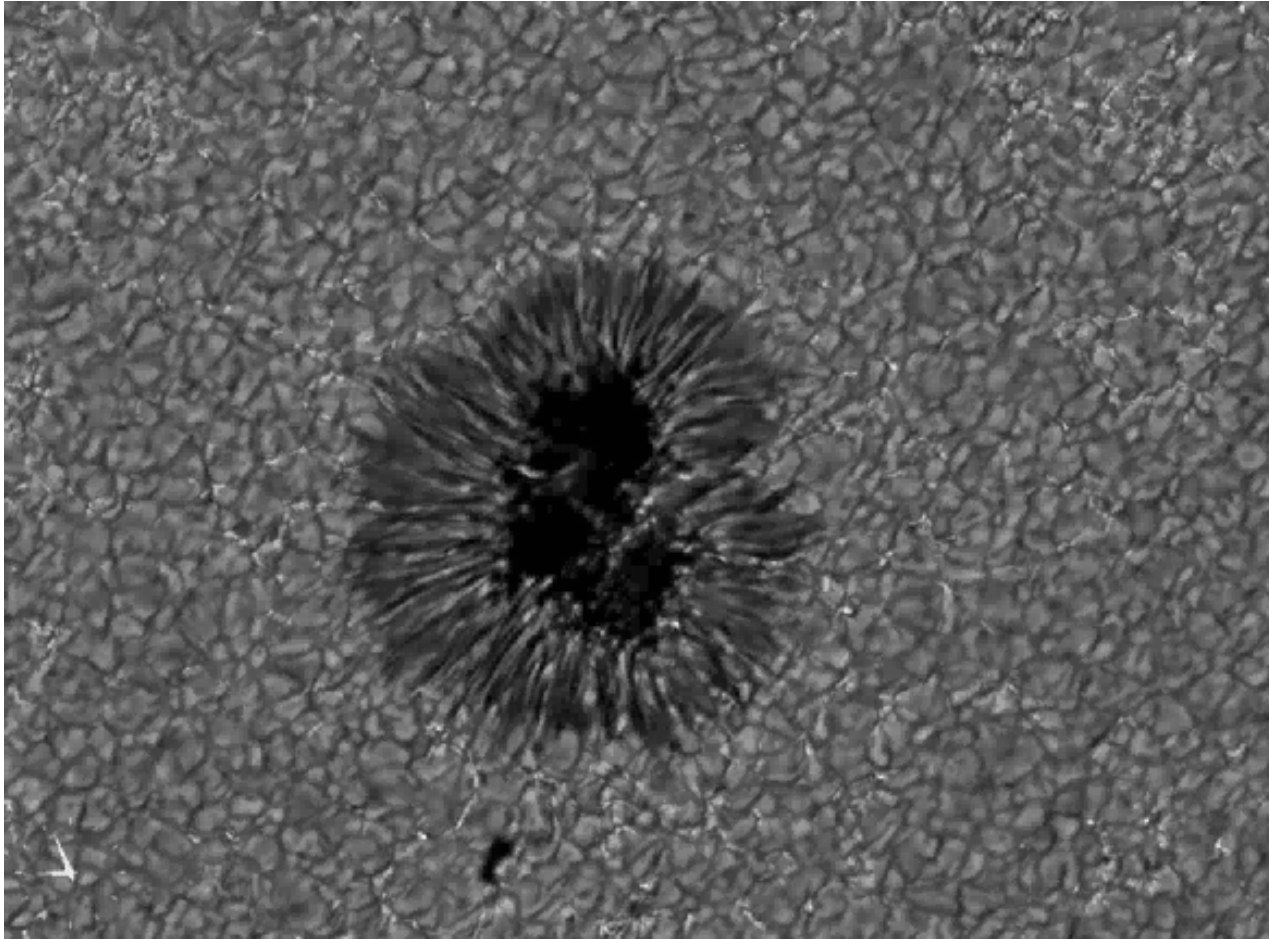
ΠΥΡΣΟΙ ΚΑΙ ΠΟΡΟΙ

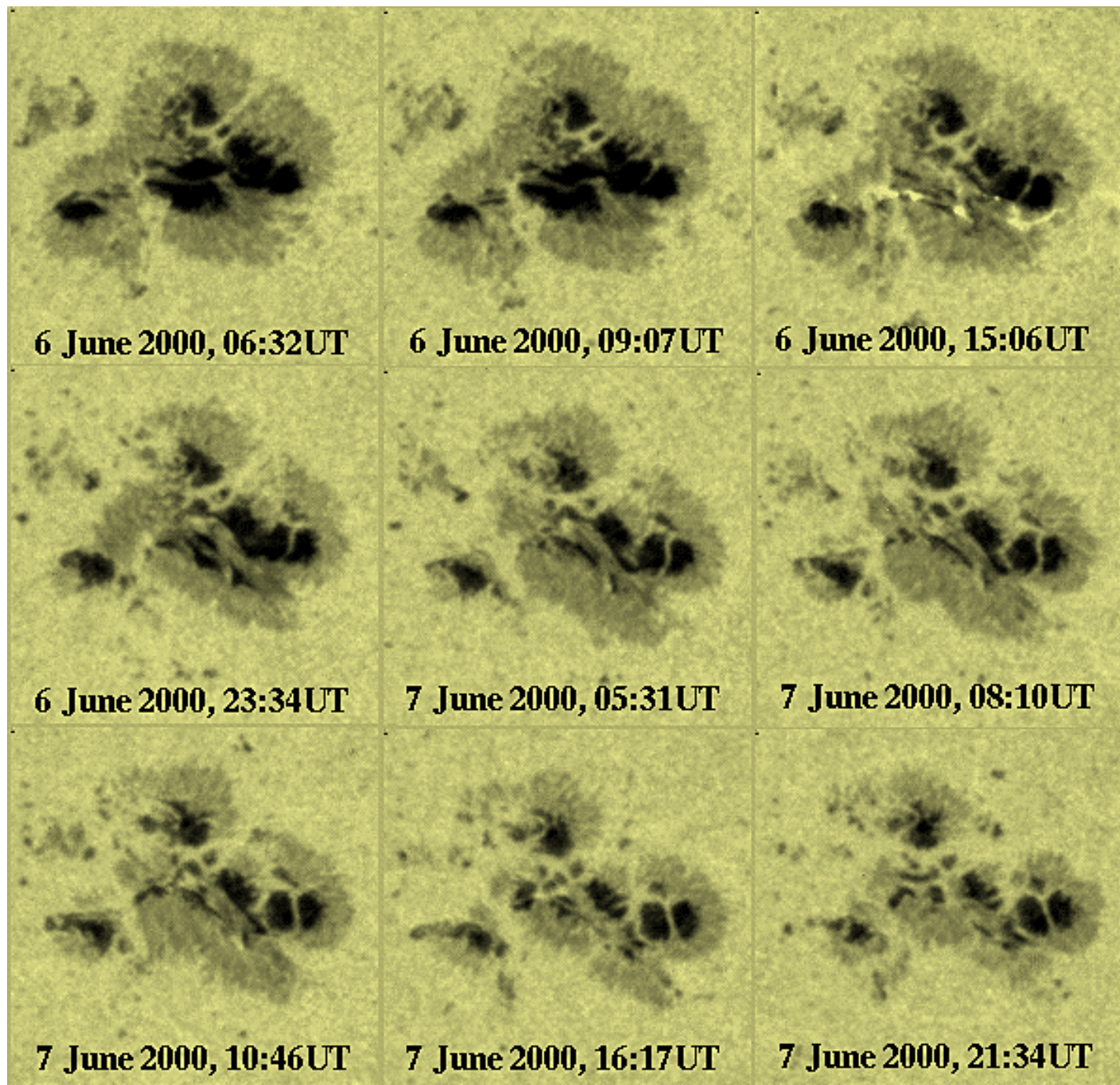
(Faculae-Pores)

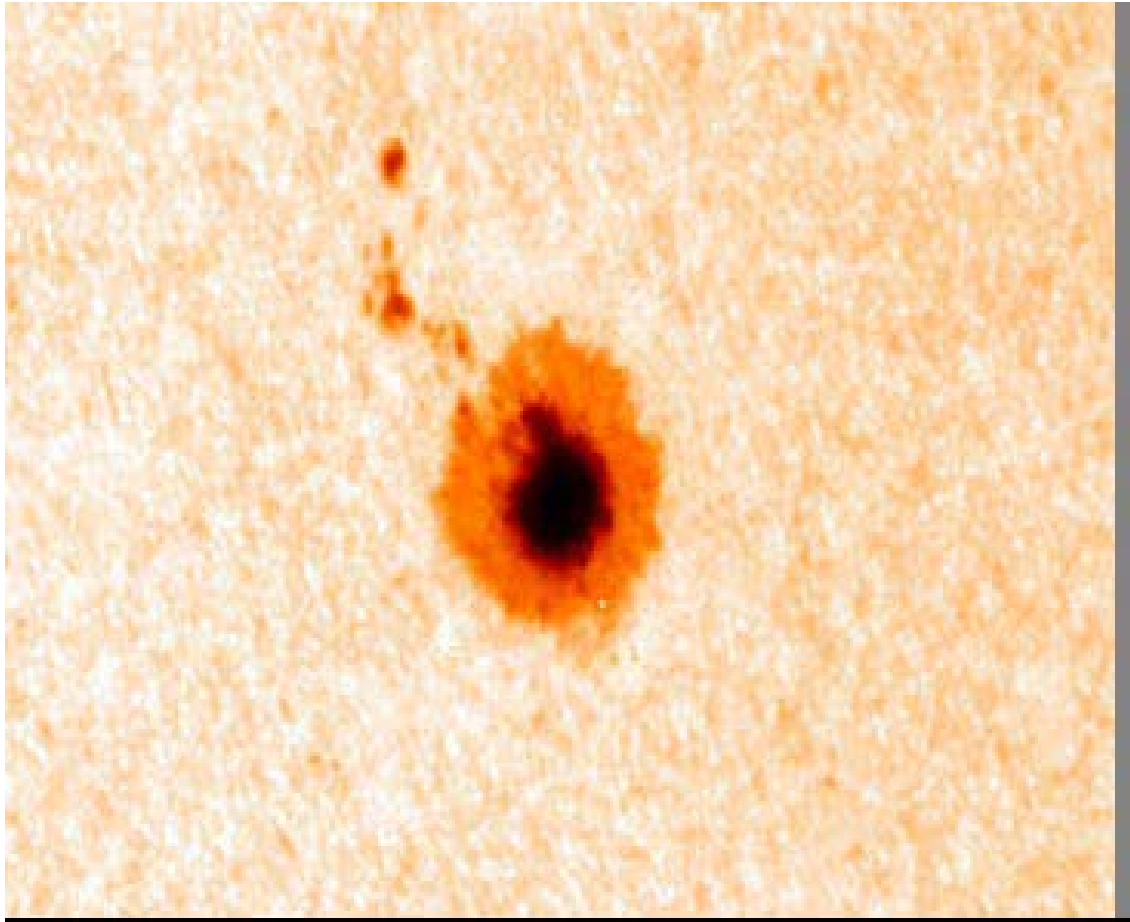


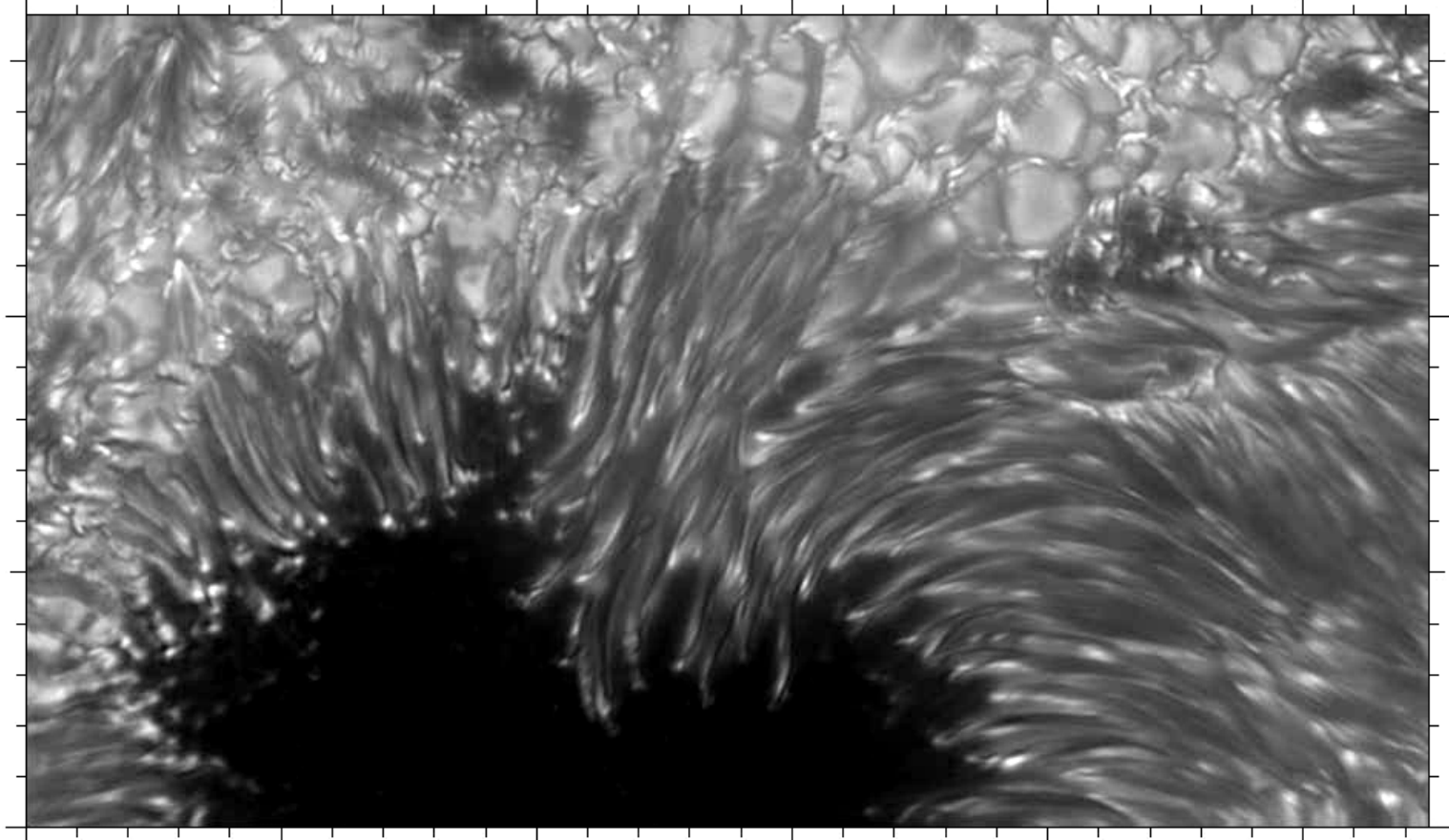


ΚΗΛΙΔΑ (Sunspot)

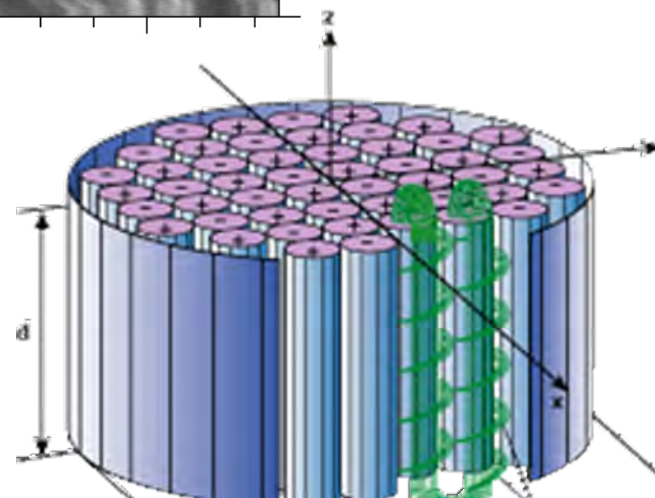




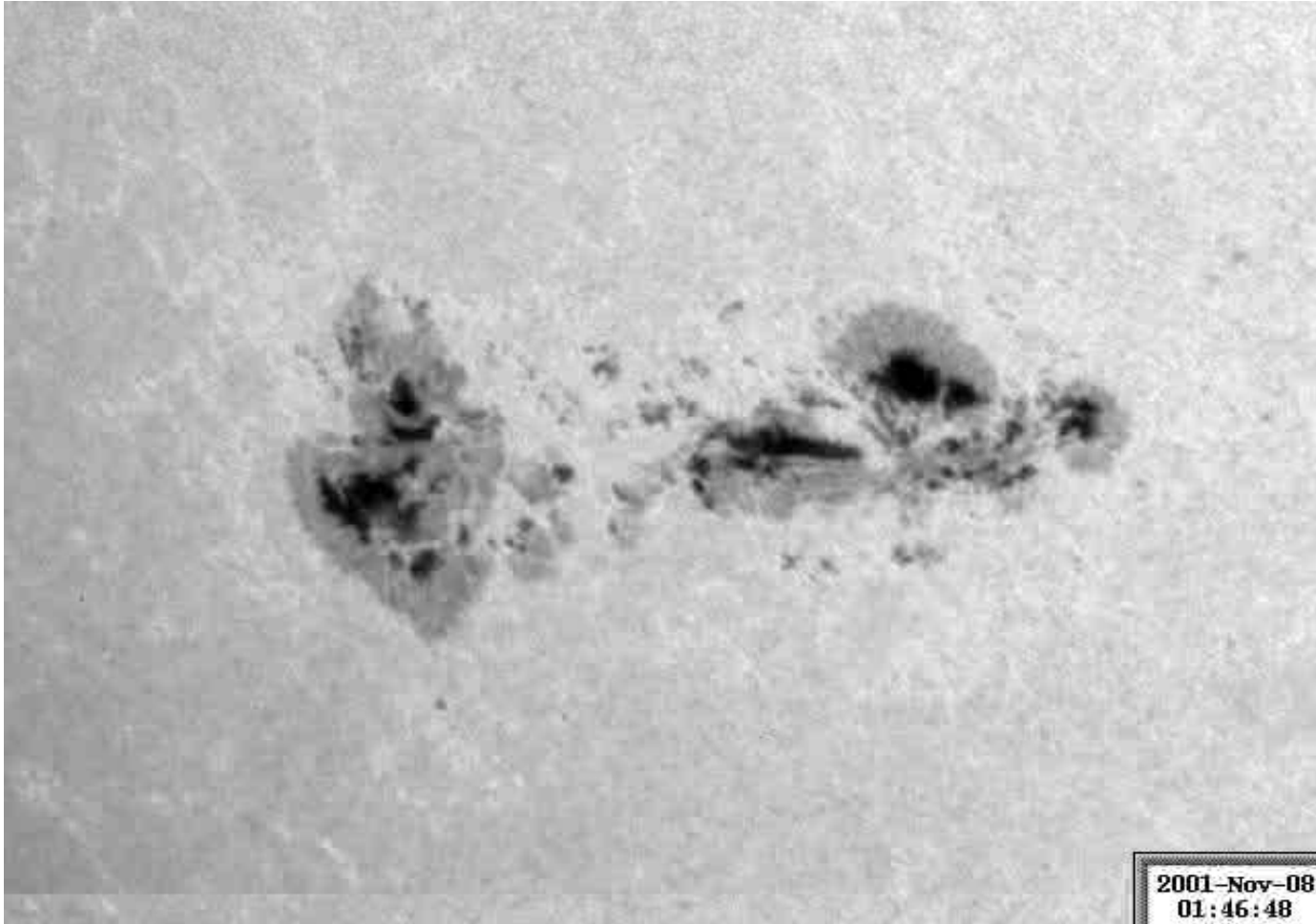




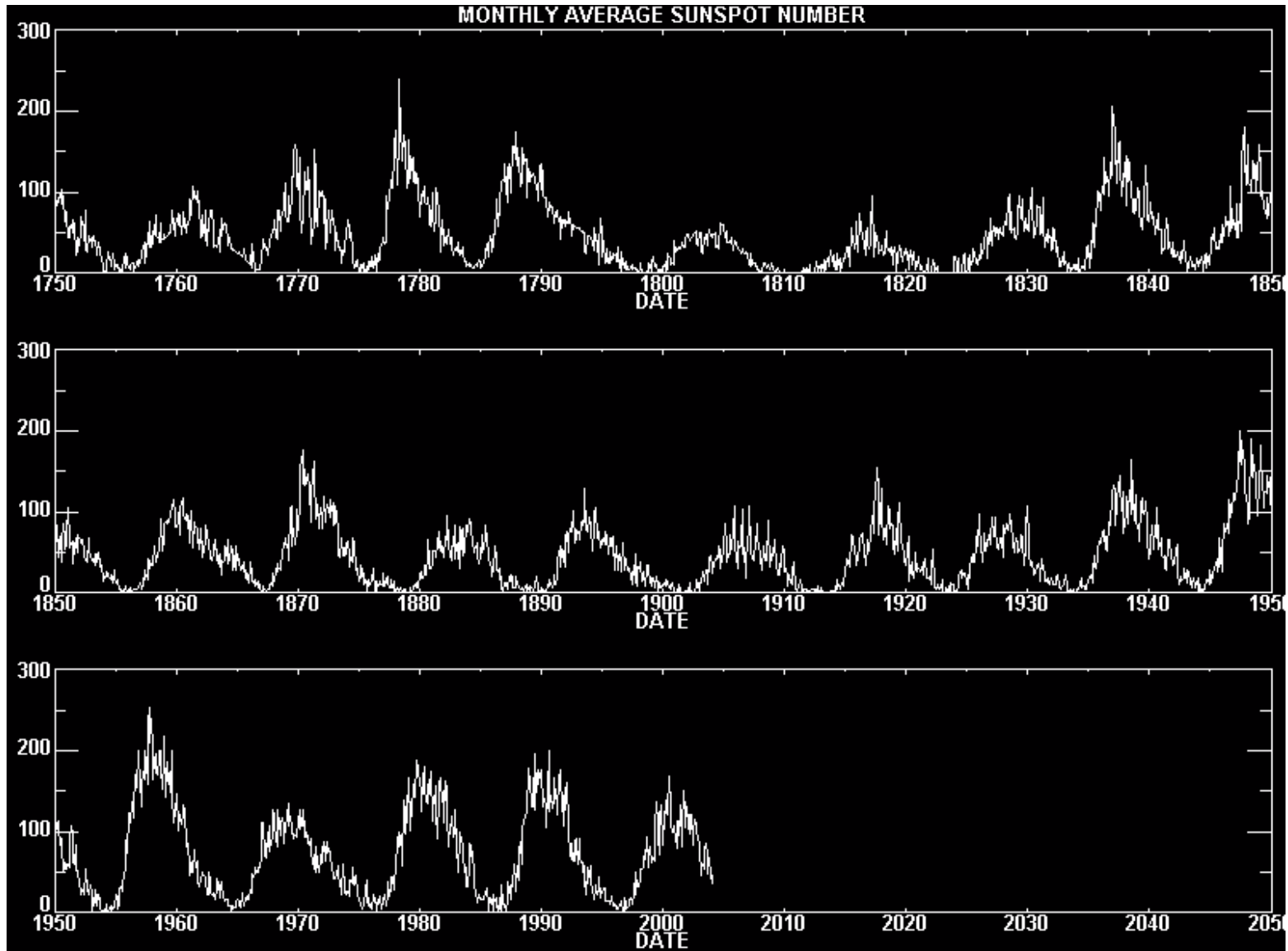
distance in units of 1000 kilometers





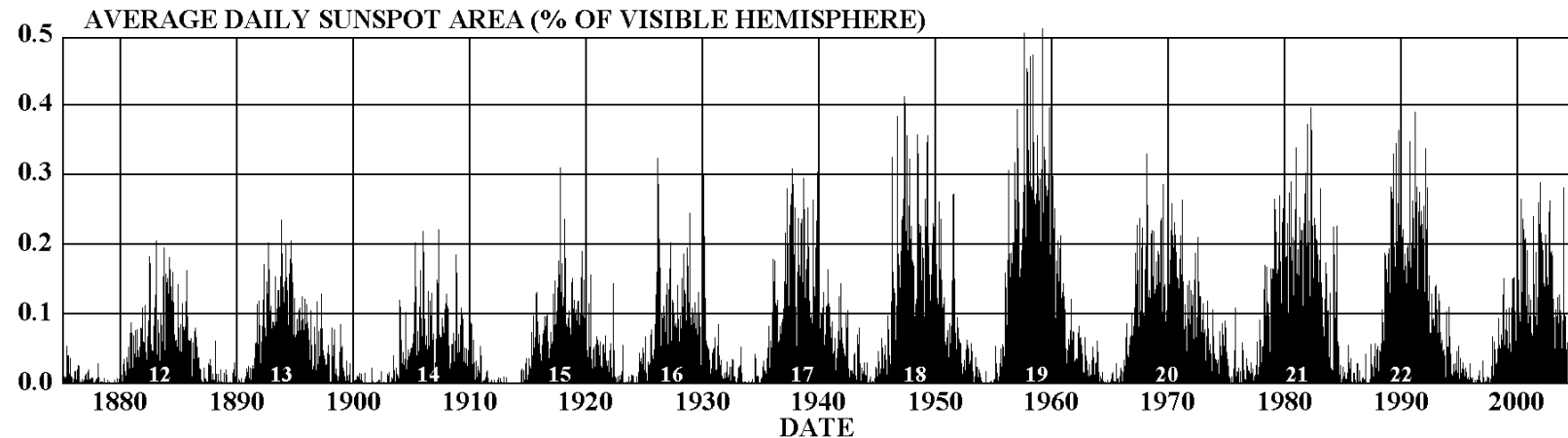
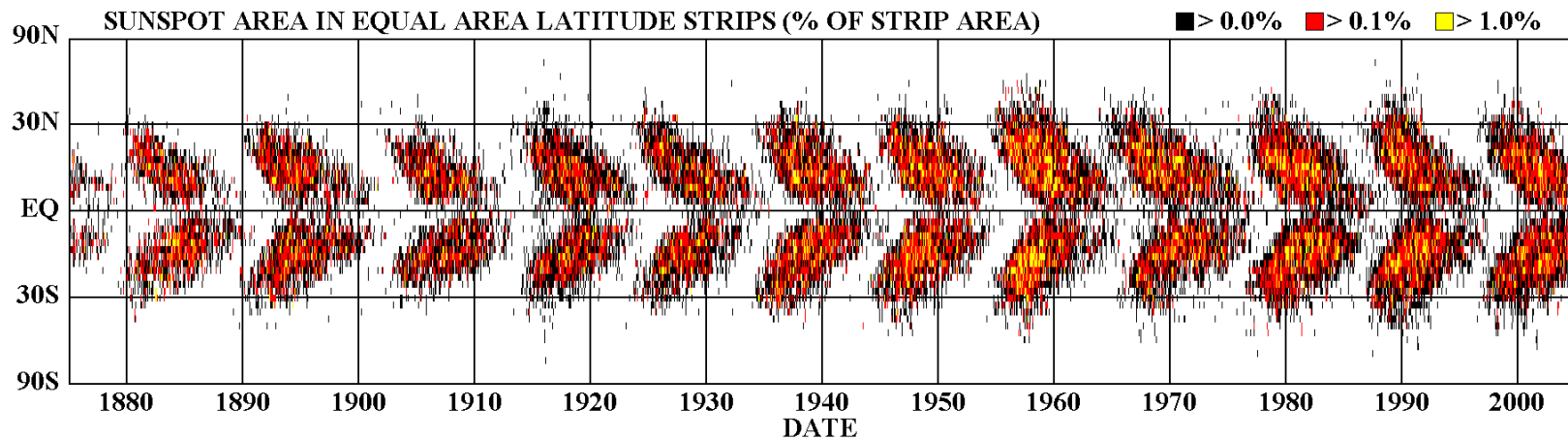


Sunspots and the Sunspot Cycle



The Latitude Drift of Sunspots

DAILY SUNSPOT AREA AVERAGED OVER INDIVIDUAL SOLAR ROTATIONS



ΚΗΛΙΔΑ
(sunspot)

bar magnet

S N

N

S N

S N

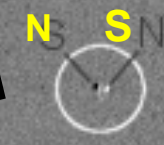
ΚΕΝΤΡΟ
ΔΡΑΣΗΣ



Ι Σ Η Μ Ε Ρ Ι Ν Ο Σ

ΑΛΛΗΛΟΑΝΑΙΡΕΣΗ

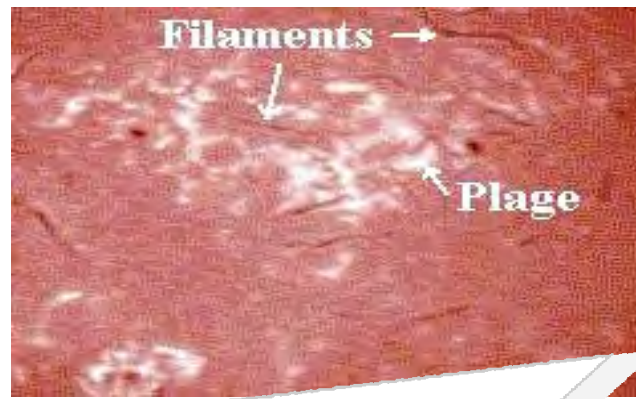
N S N S



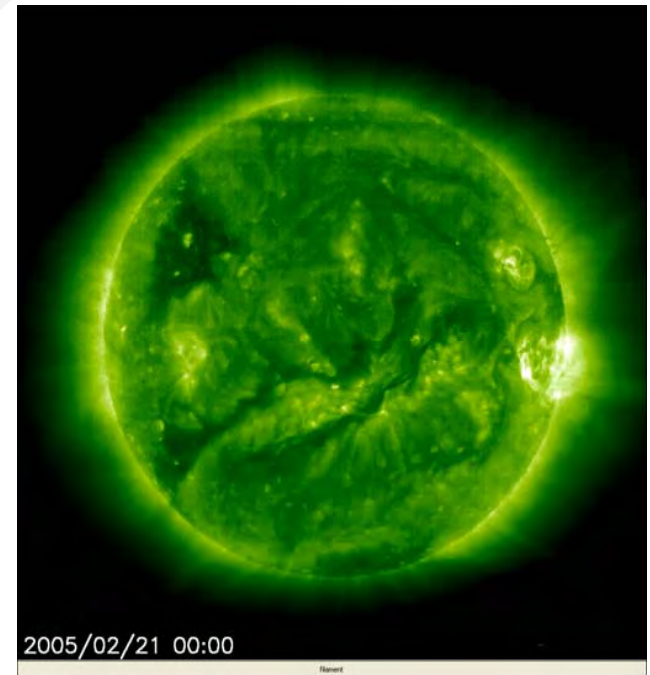
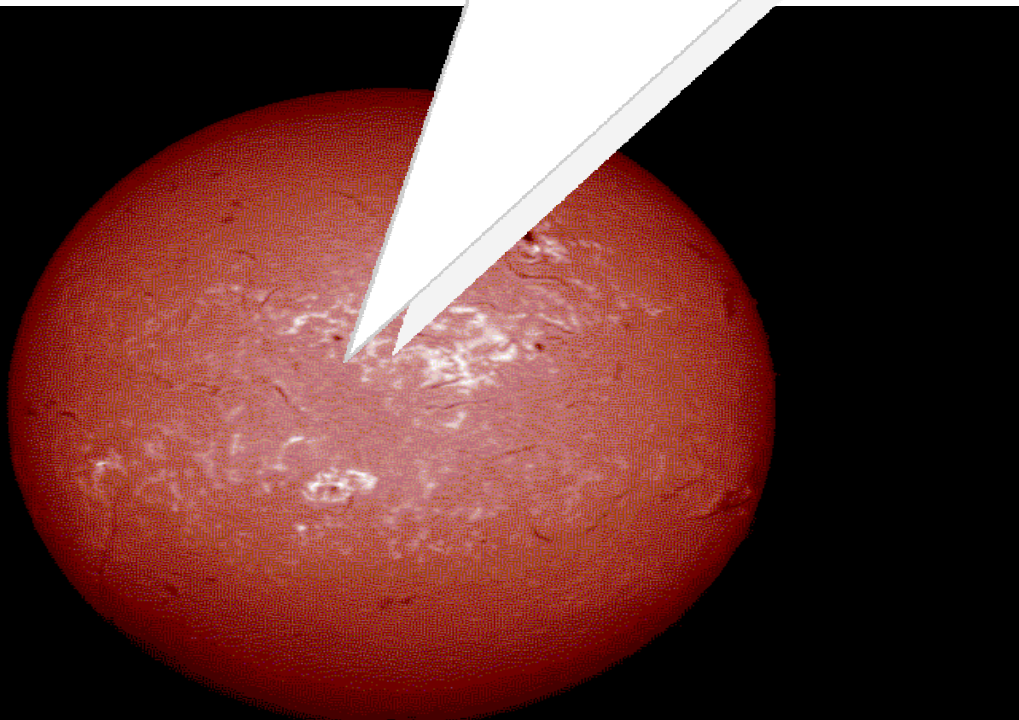
ΚΕΝΤΡΟ
ΔΡΑΣΗΣ

S

2006/07/31 00:00

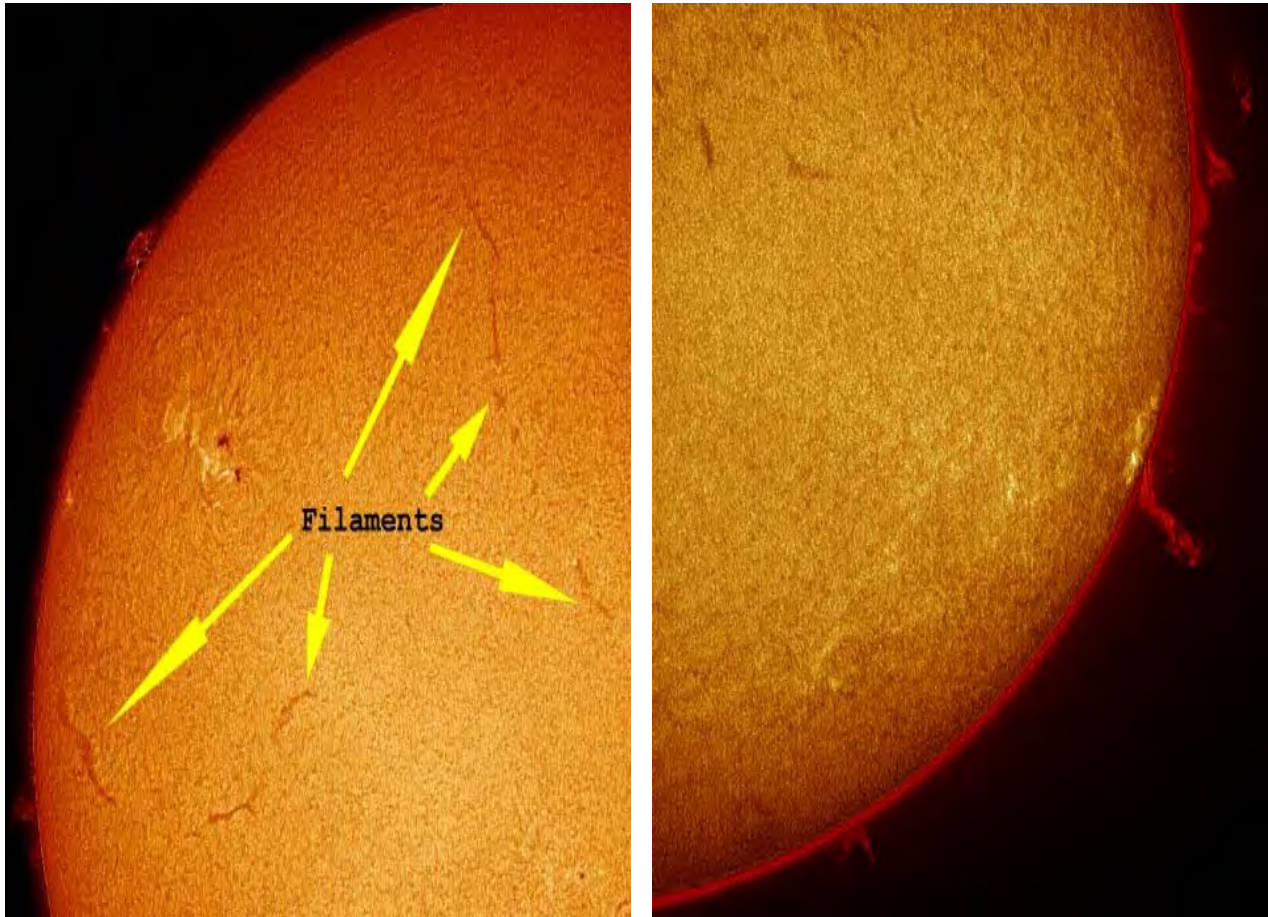


6563 Å
BSO

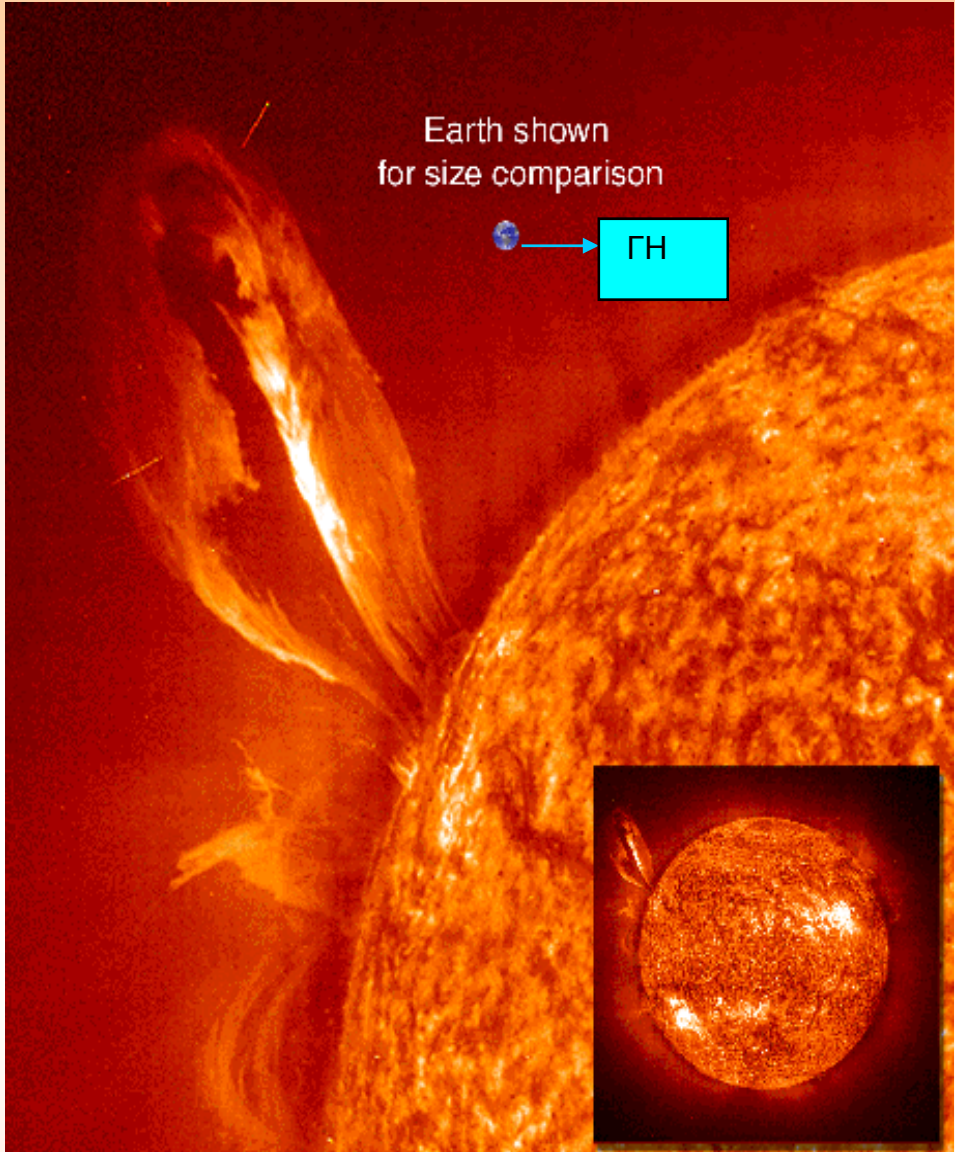
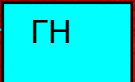


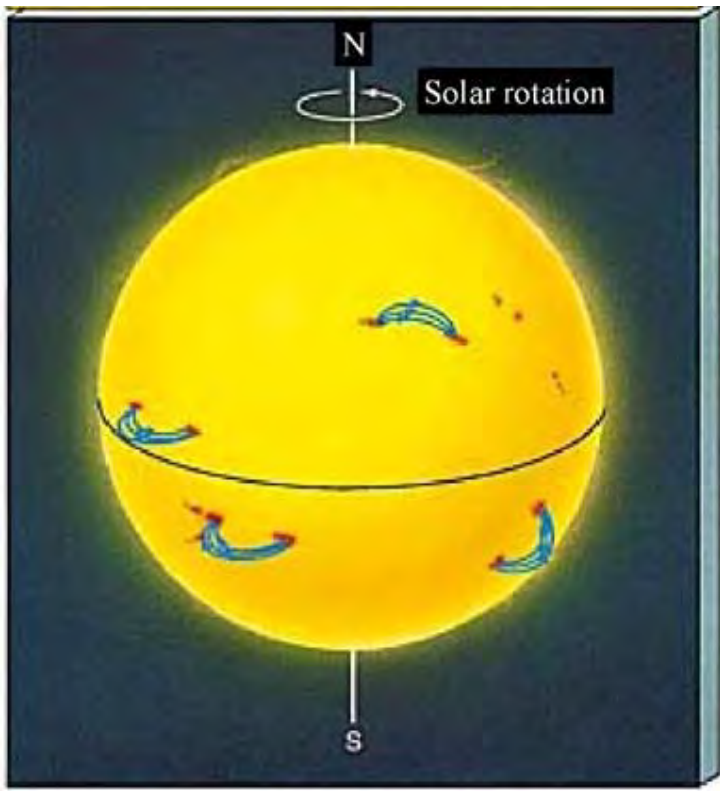
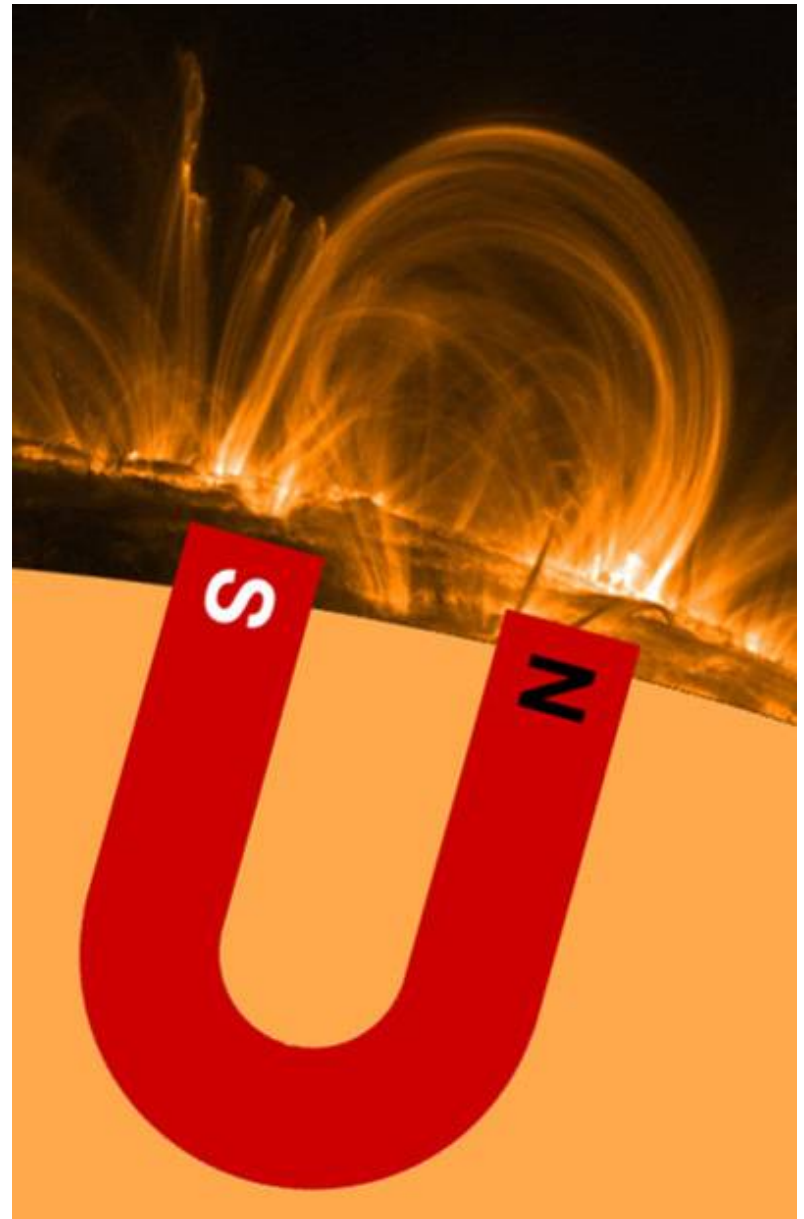
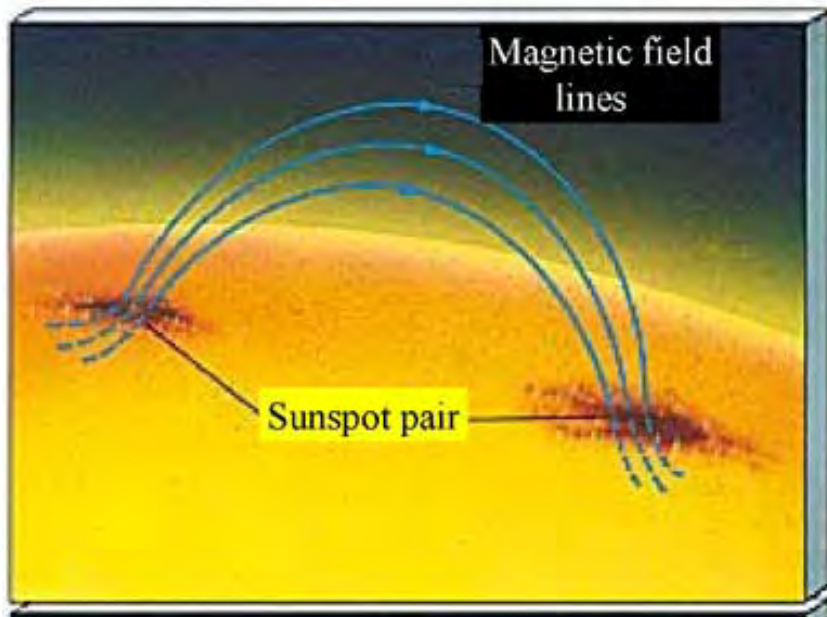
ΔΡΑΣΤΗΡΙΟΤΗΤΑ ΗΛΙΑΚΗΣ ΧΡΩΜΟΣΦΑΙΡΑΣ

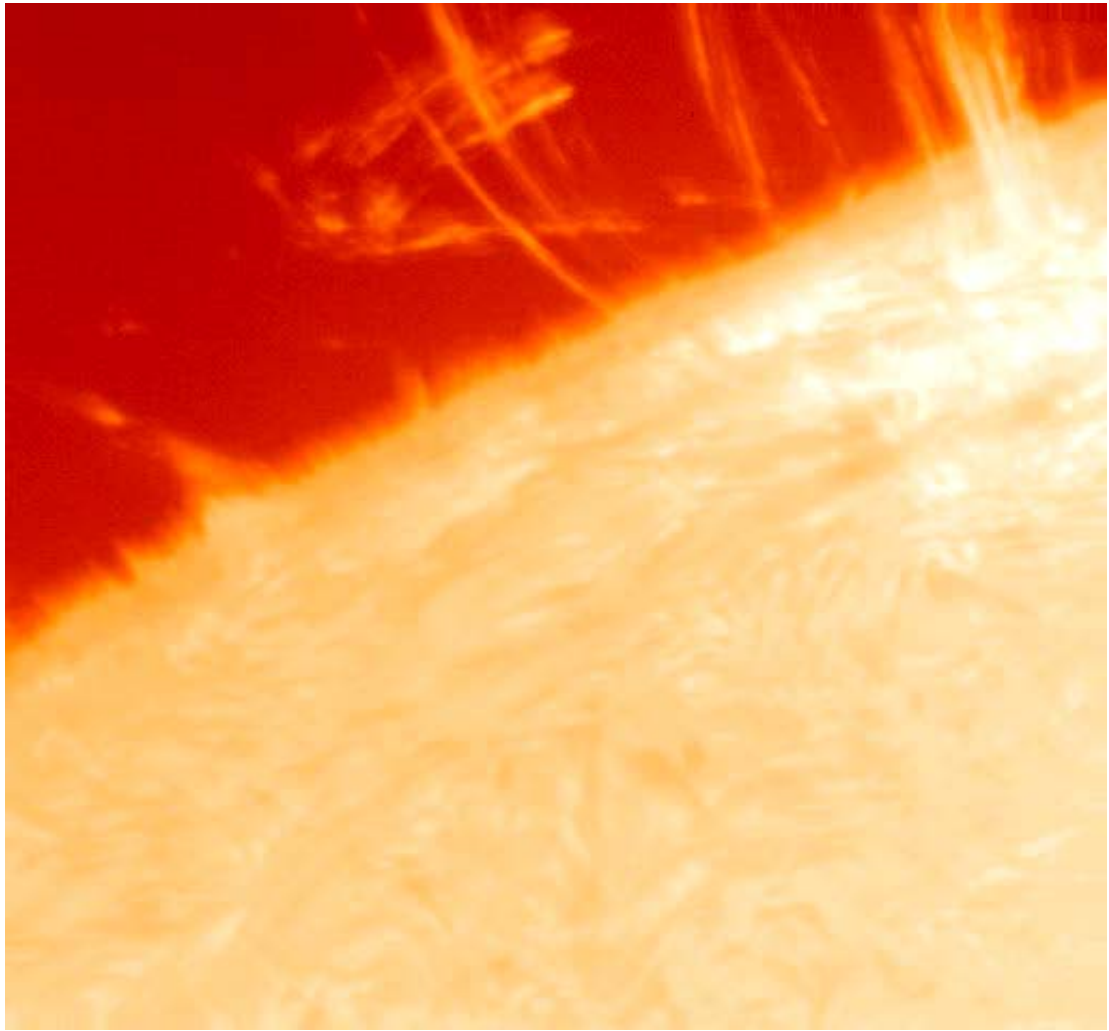
ΠΡΟΕΞΟΧΕΣ (Prominences)



Earth shown
for size comparison





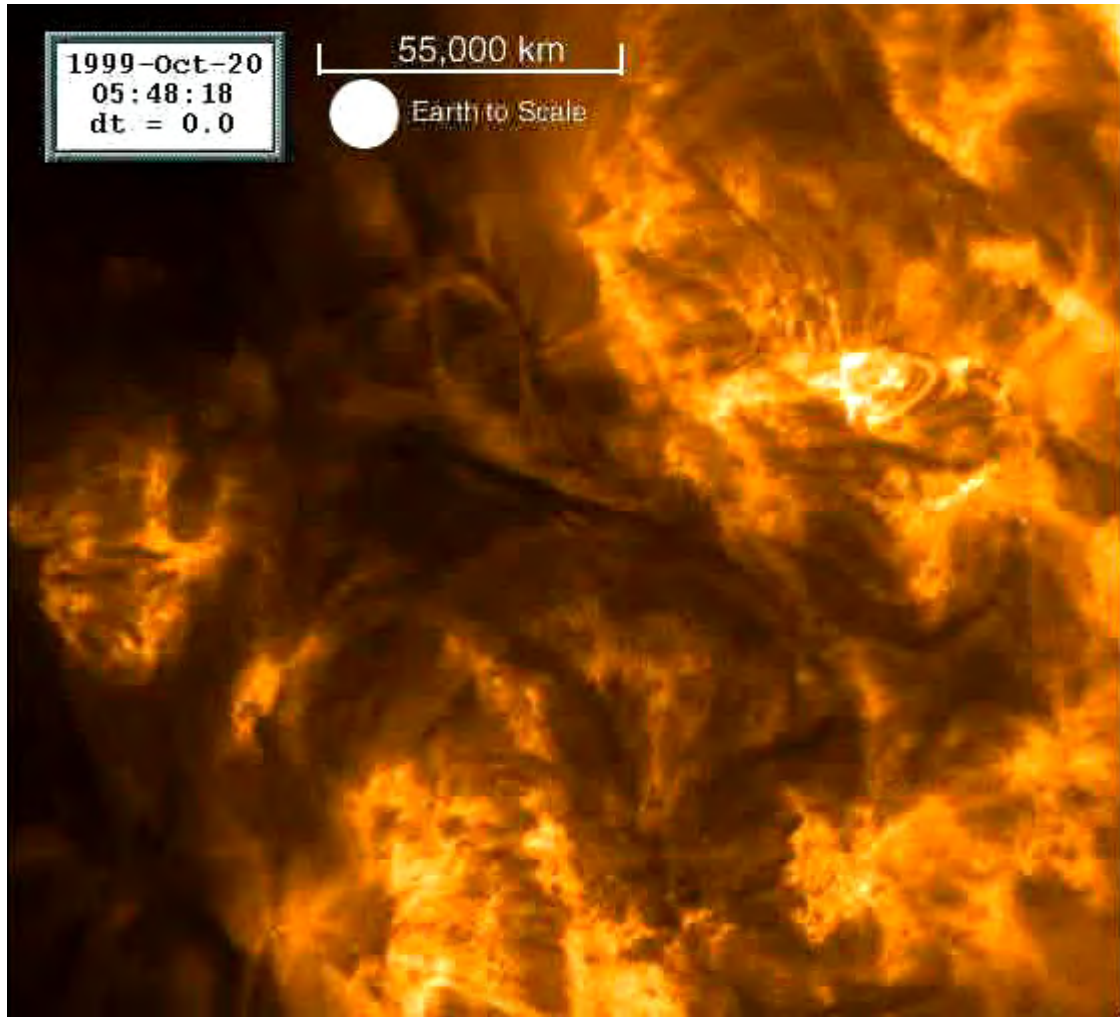


1999-Oct-20
05:48:18
dt = 0.0

55,000 km



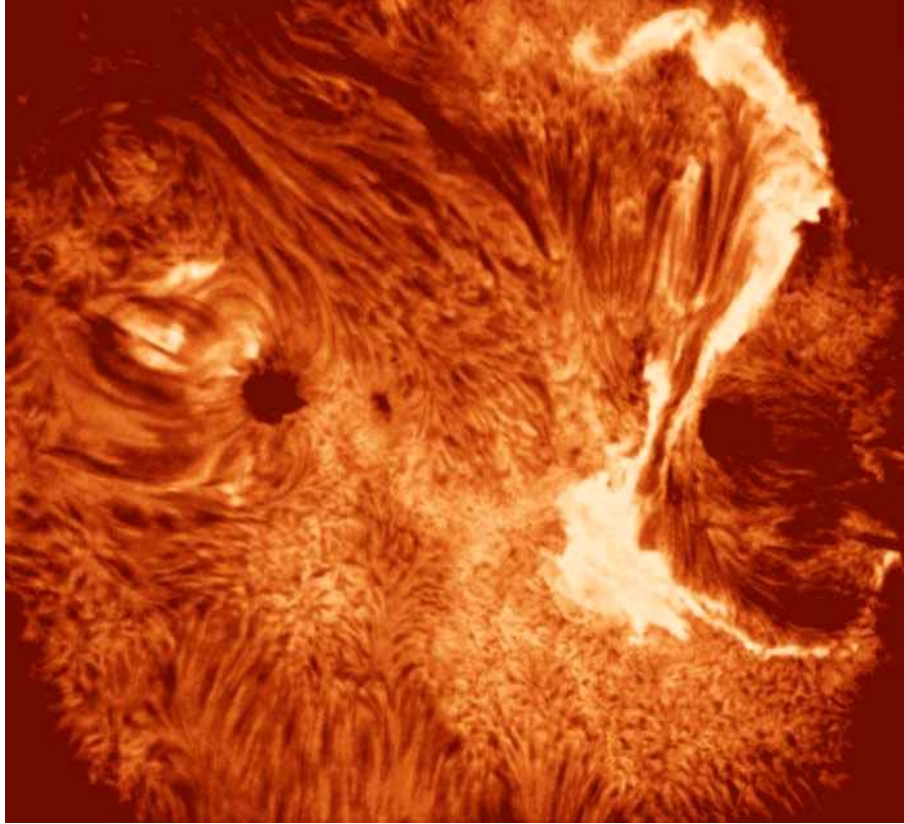
Earth to Scale



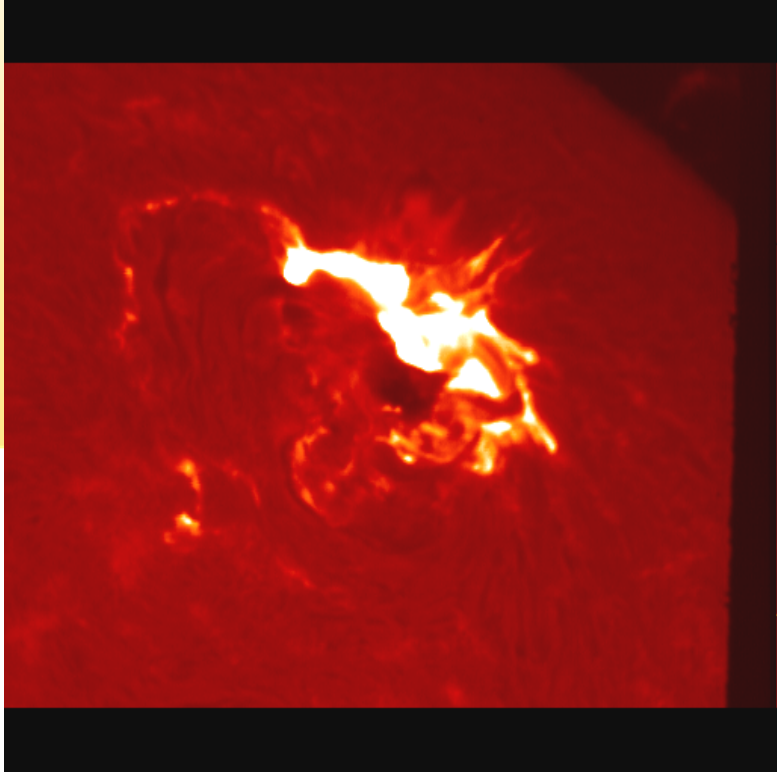
Coronal Loops







H $_{\alpha}$.



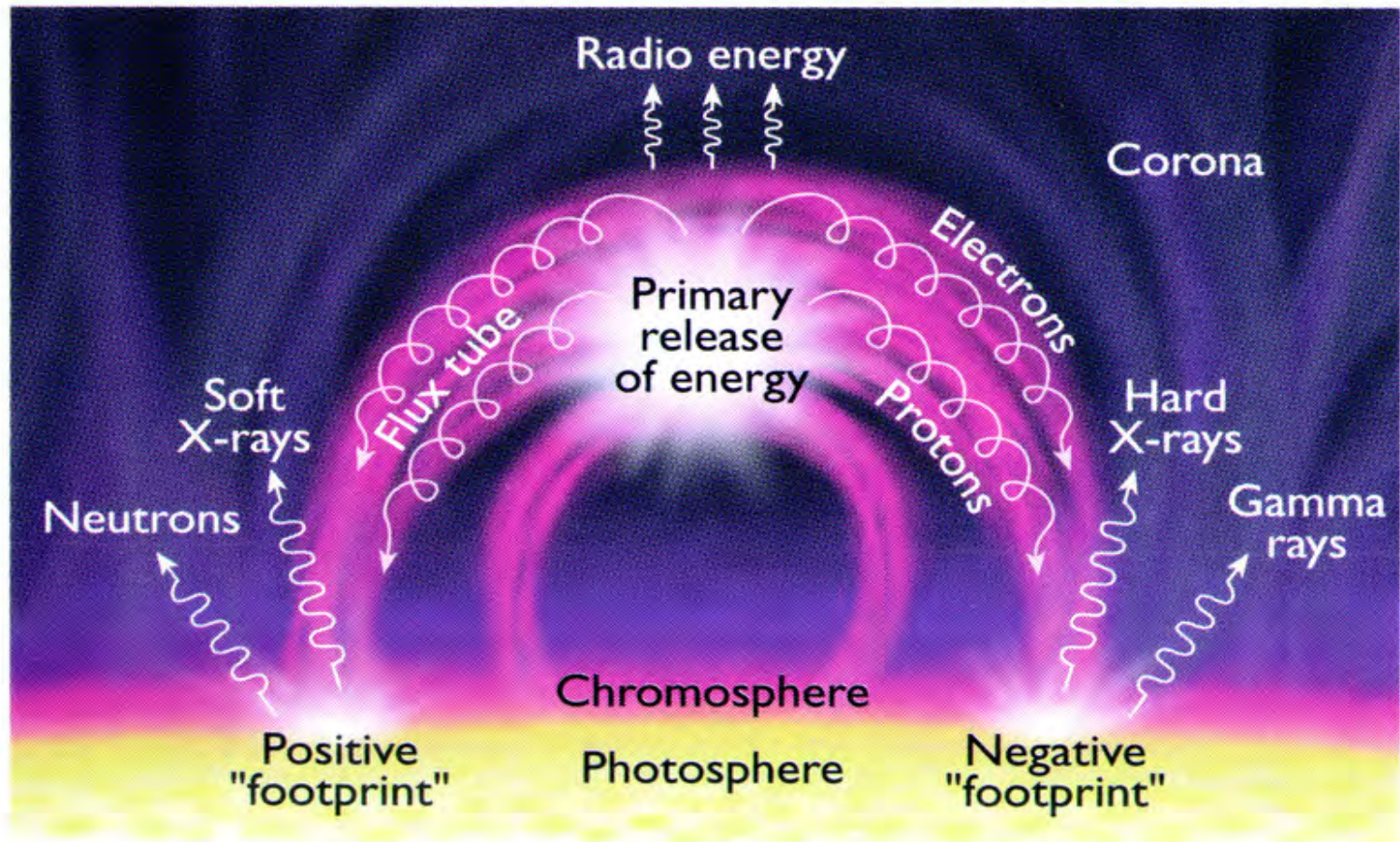
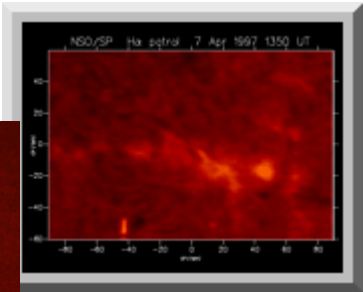
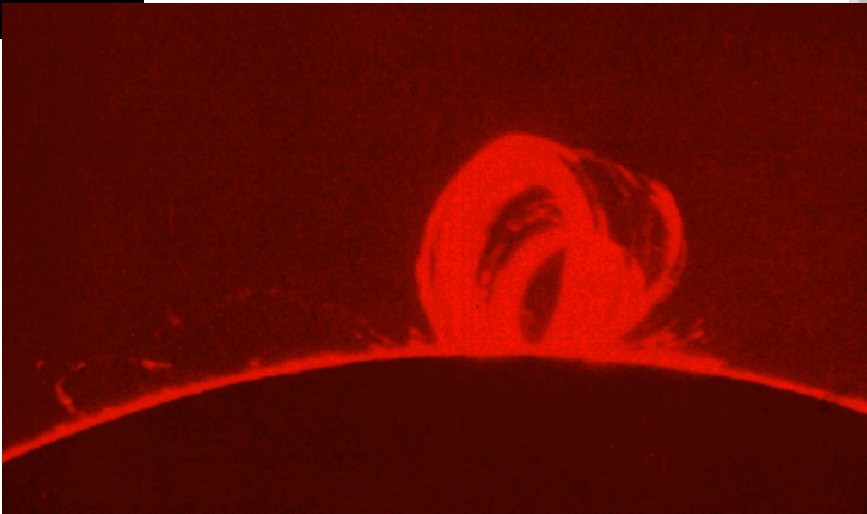
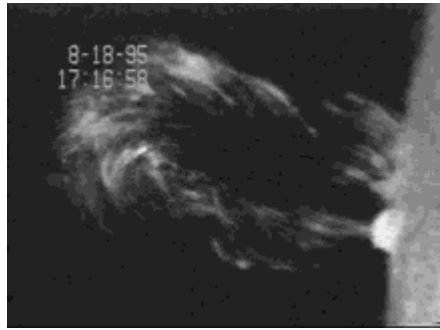
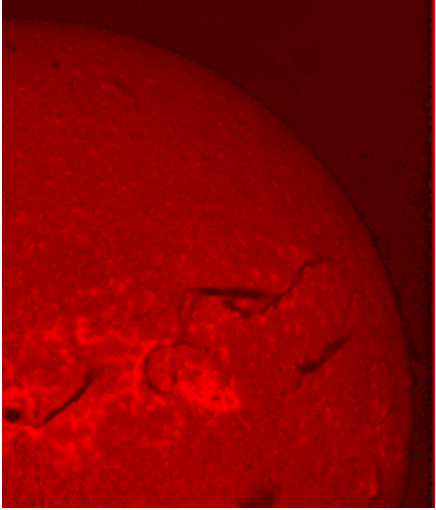
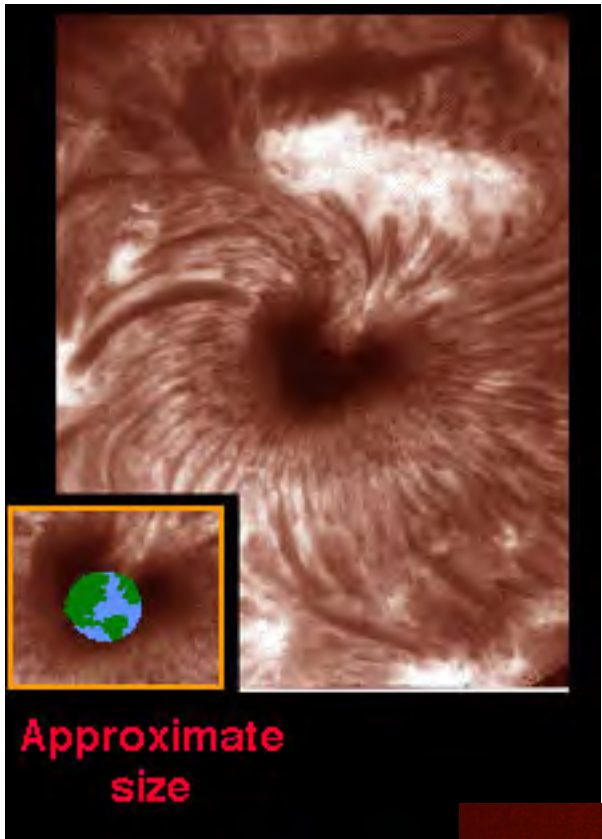
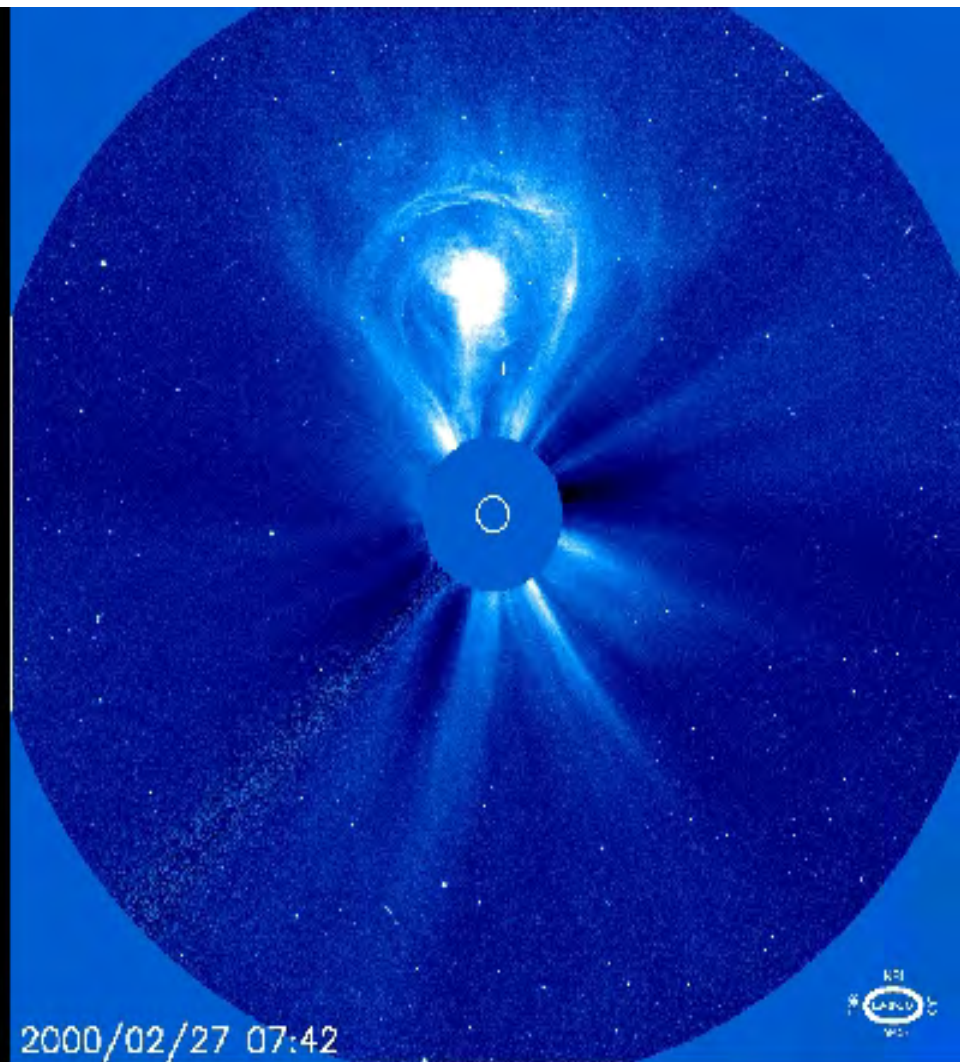
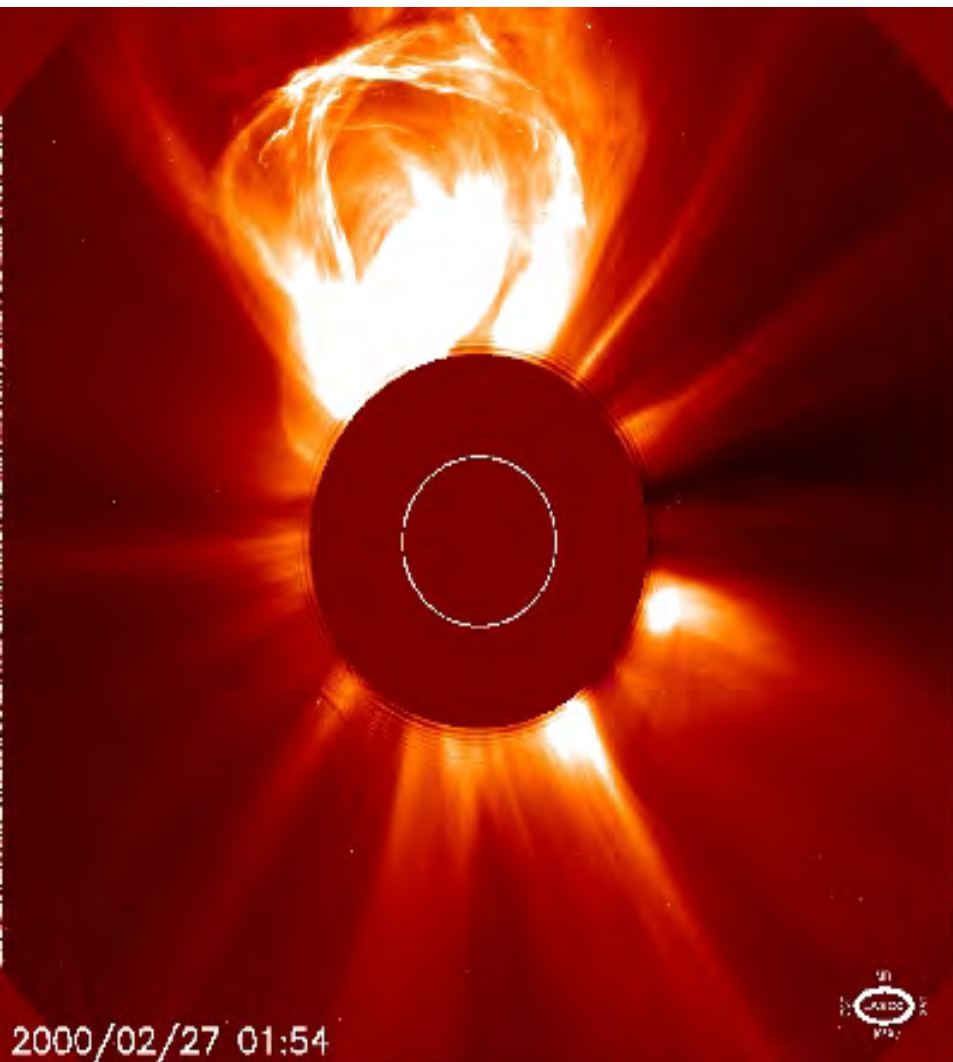
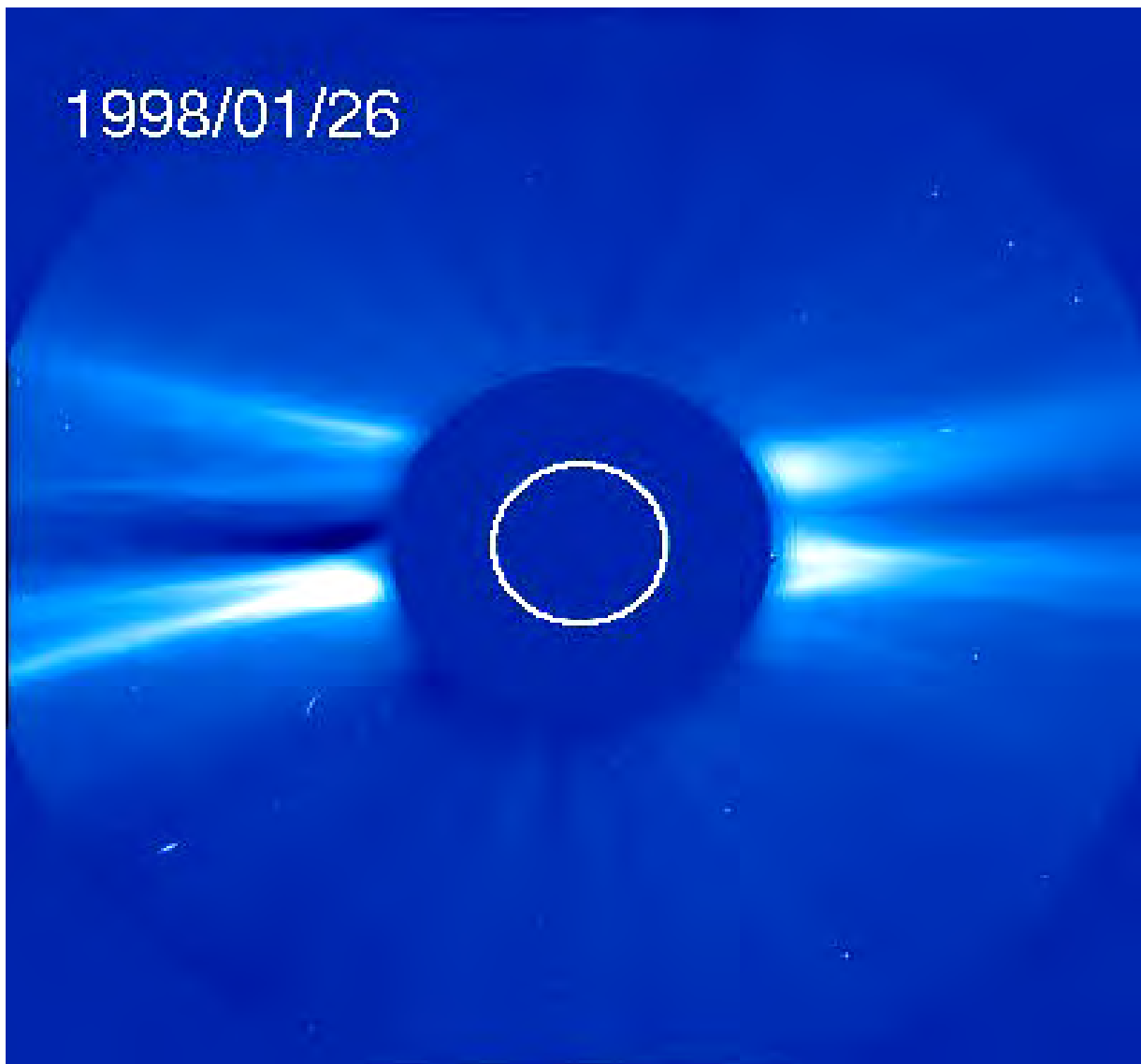


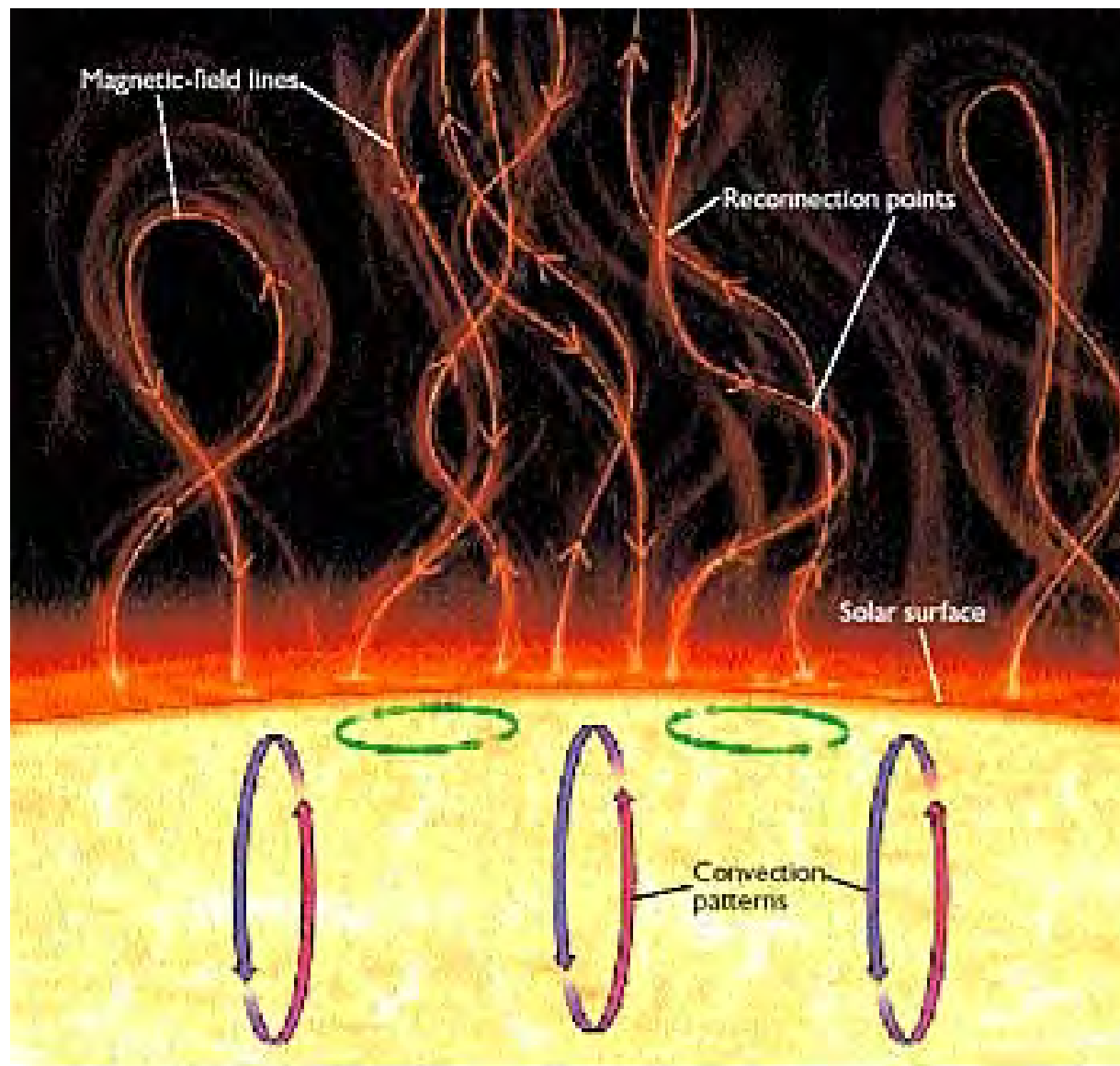
Figure 10 (bottom). Solar flares tend to occur within concentrated magnetic loops extending from the photosphere into the corona. Energy released at the top of the loop creates a burst of radio energy. It also accelerates great numbers of electrons and protons. These are channeled down the loop and strike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



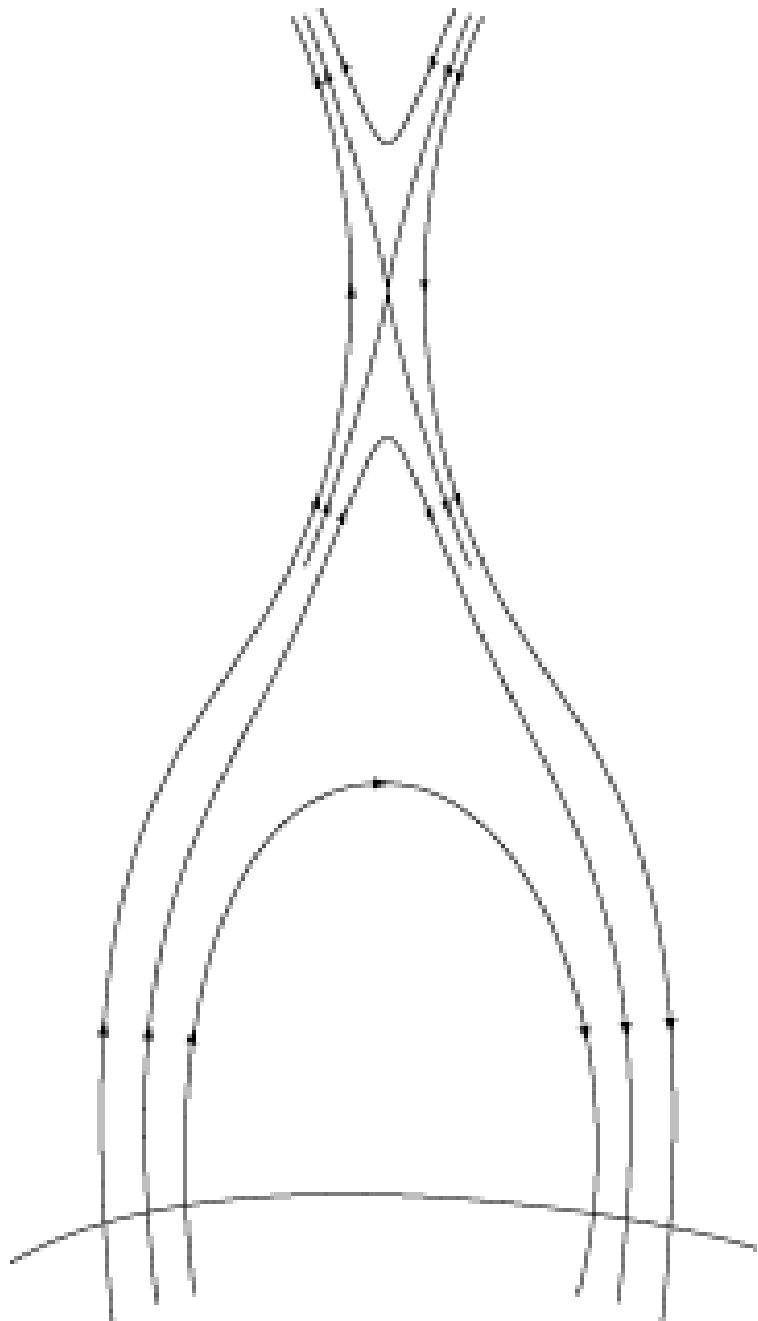


1998/01/26



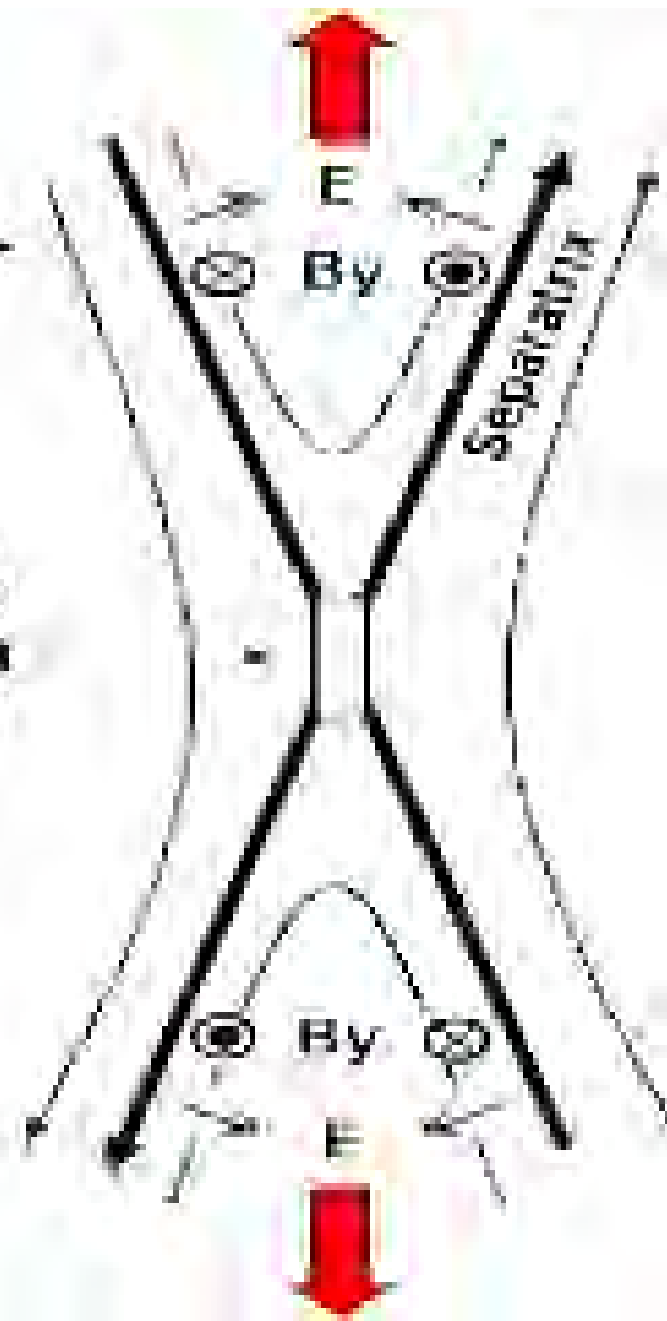


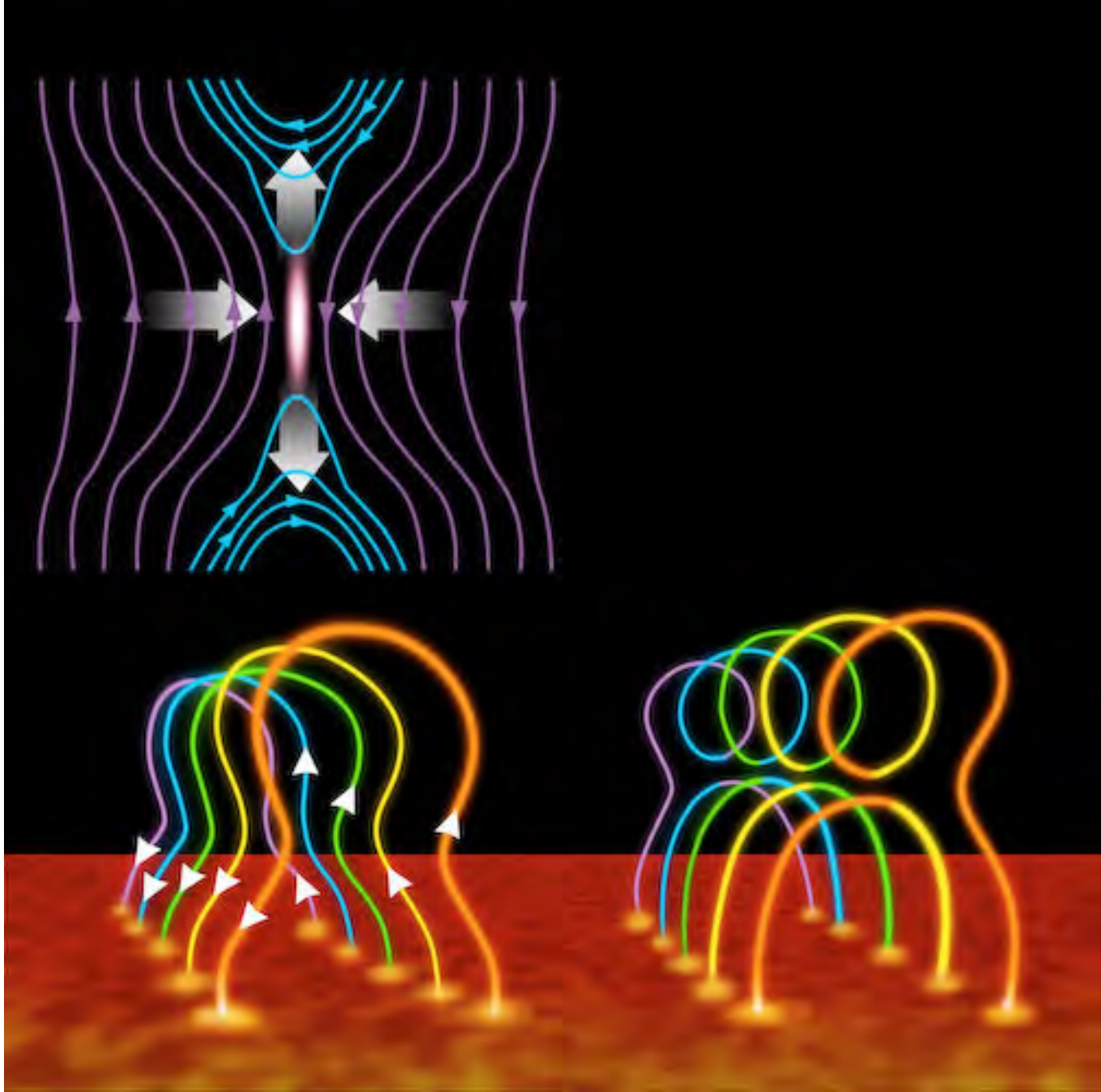
Οι σωλήνες μαγνητικής ροής περιέχουν αρκετές μαγνητικές δυναμικές γραμμές, κατά μήκος των οποίων κινούνται σωματίδια. Δεν ανοίγουν λόγω της μαγνητικής τάσης

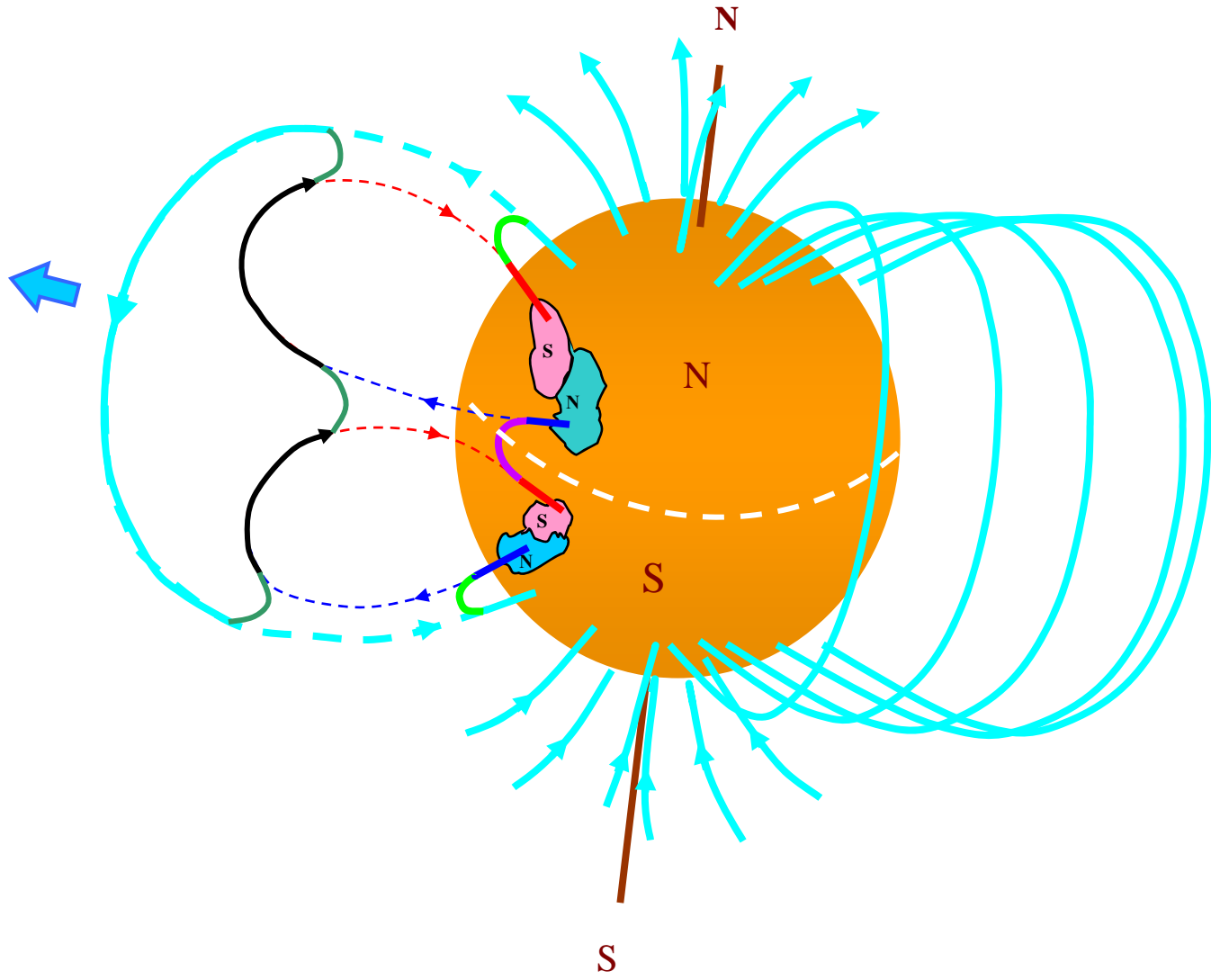


Ion
Diffusion
Region

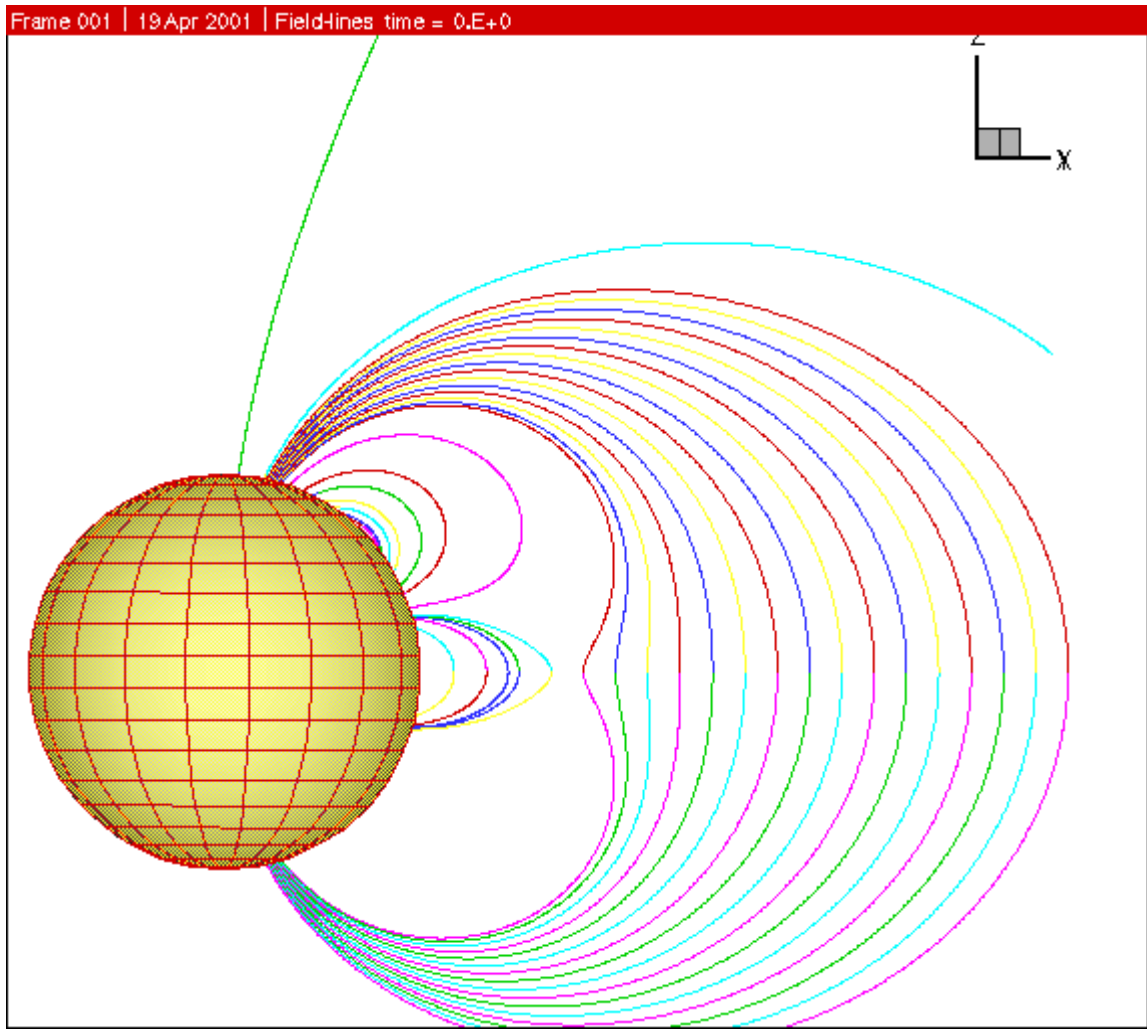
Electron
Diffusion
Region

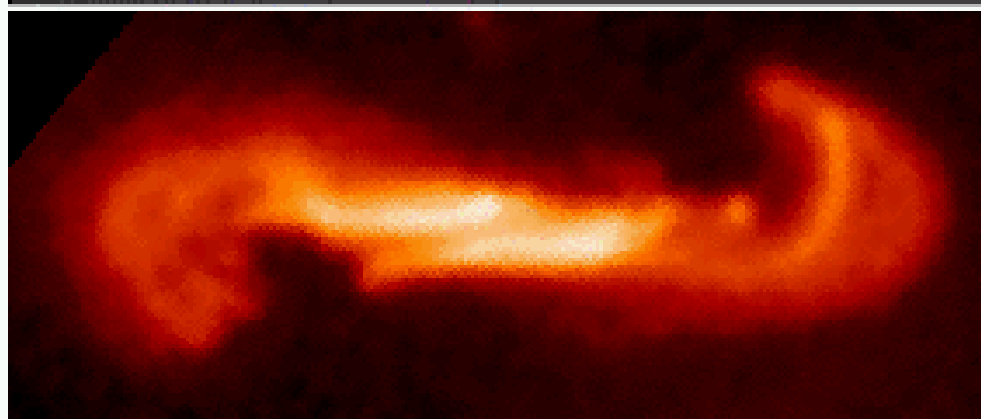
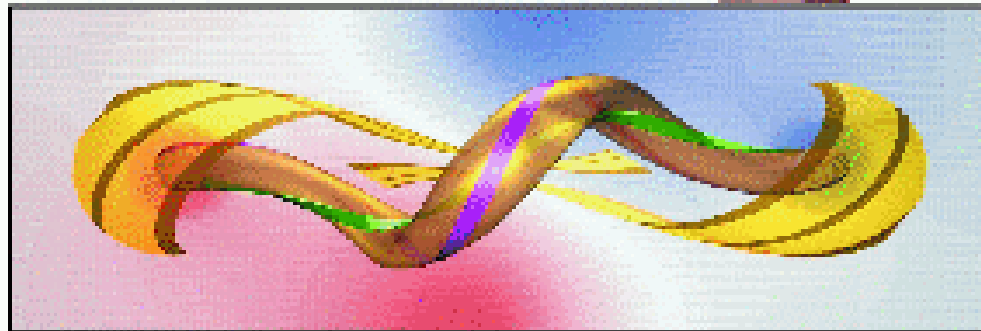
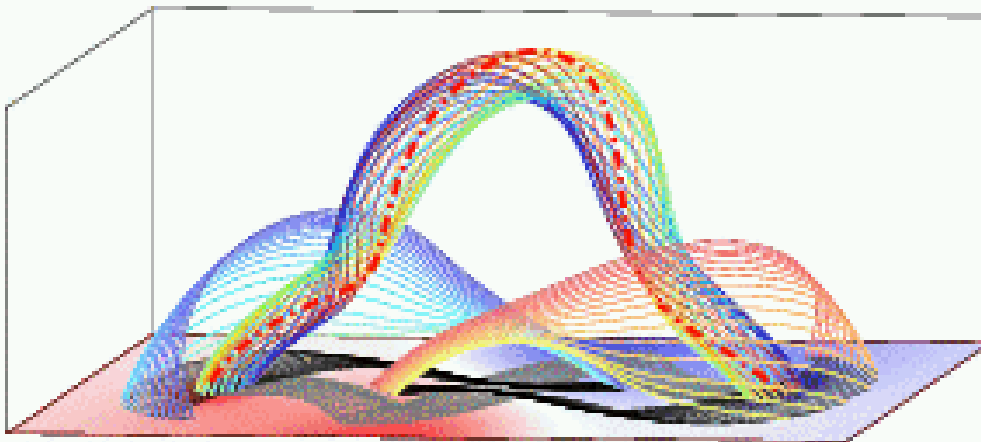


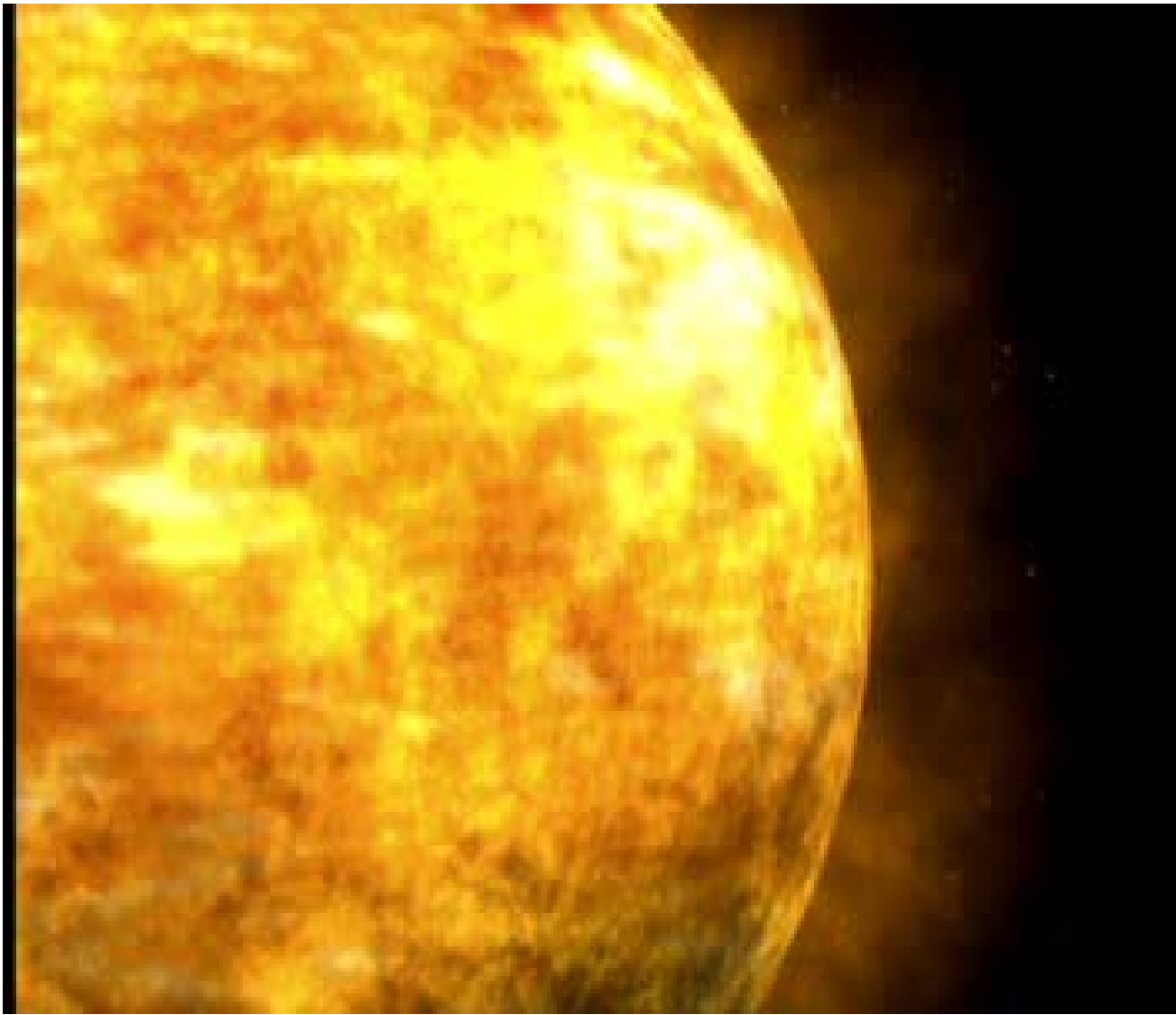


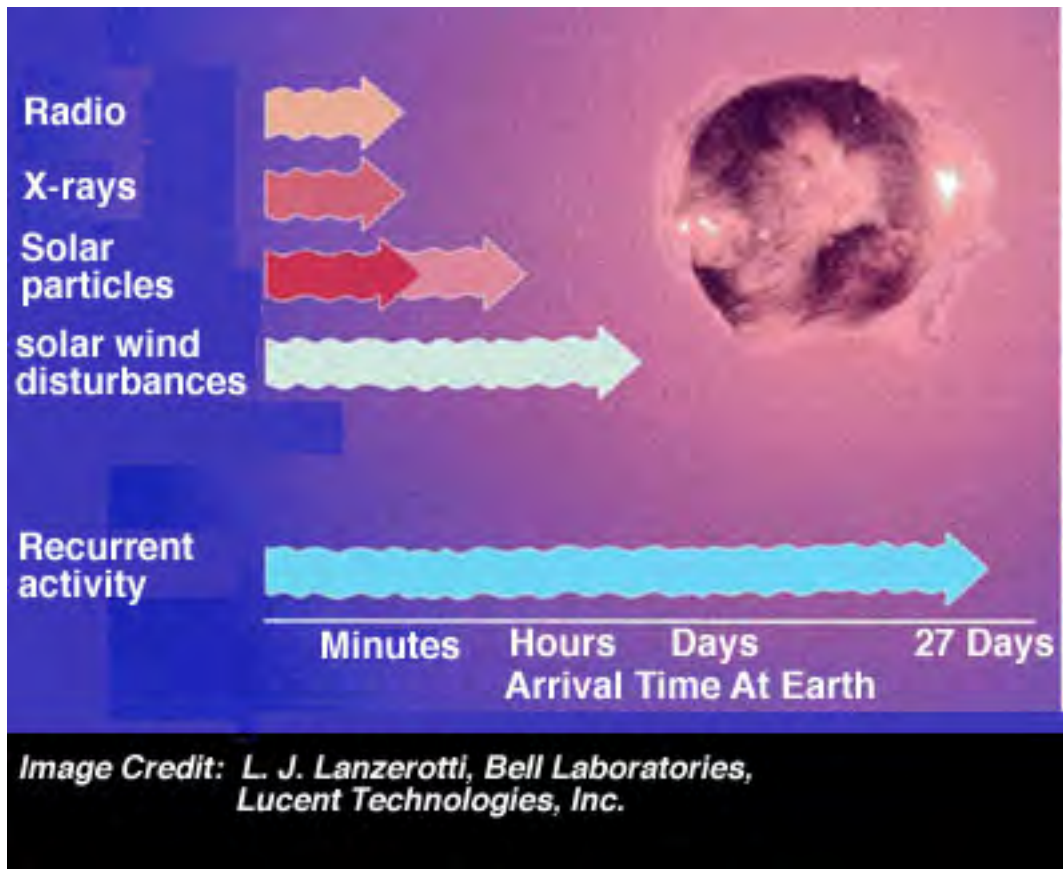


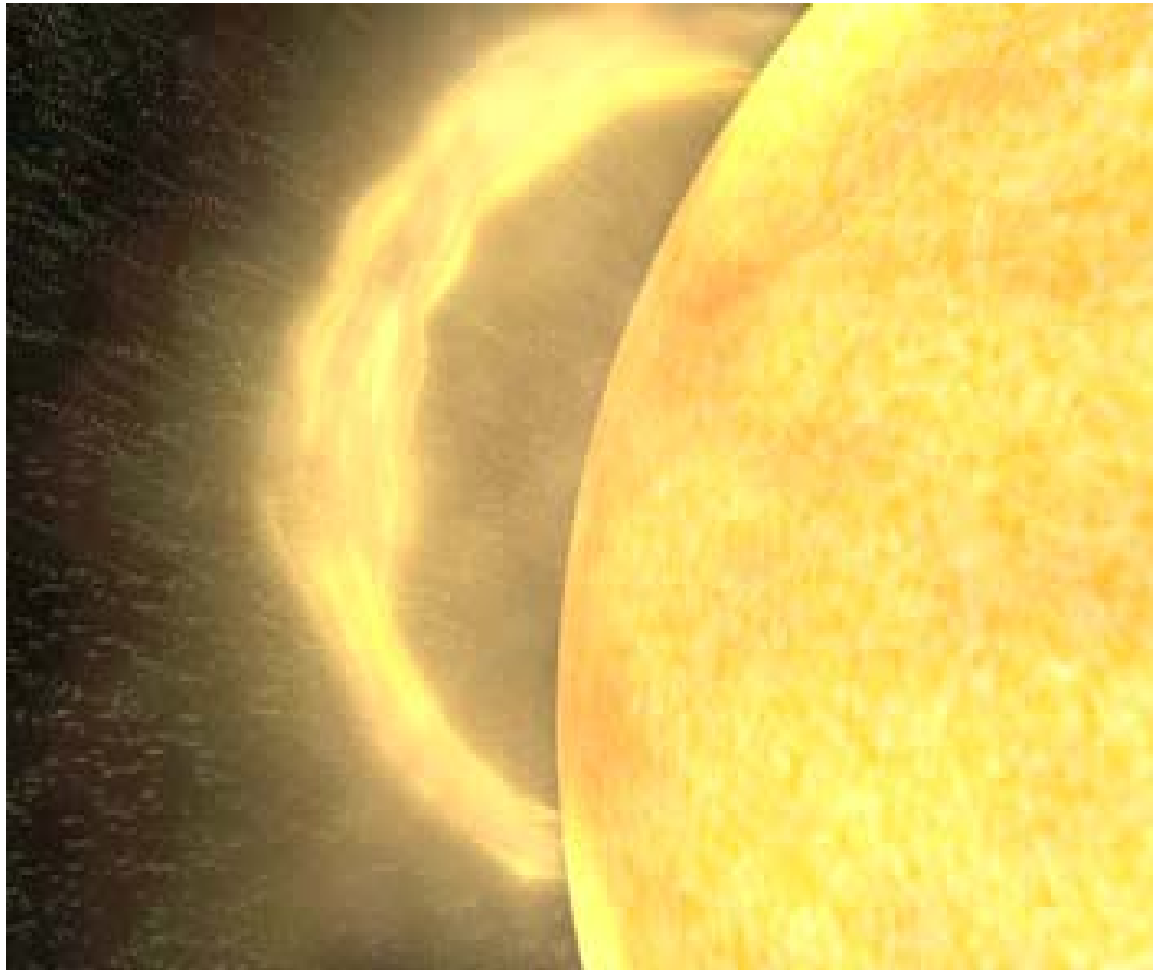


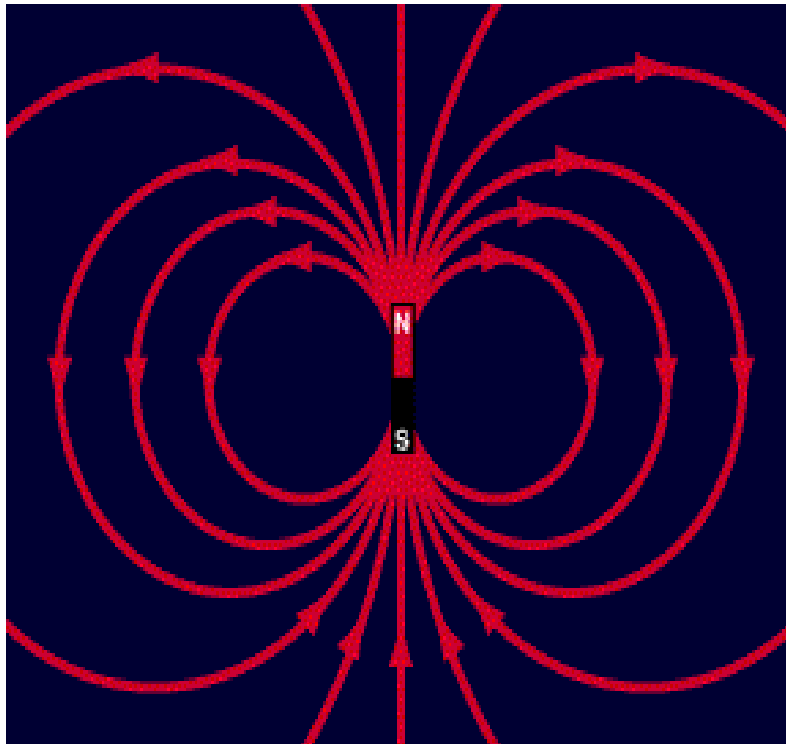




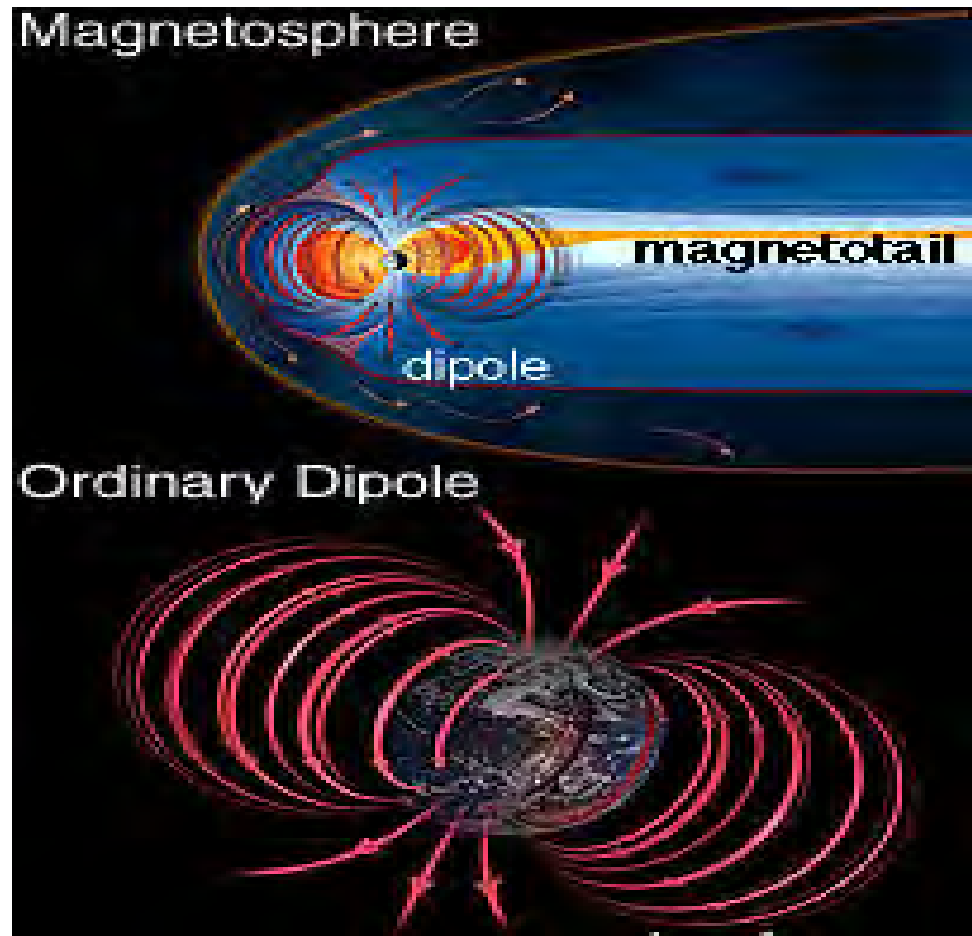




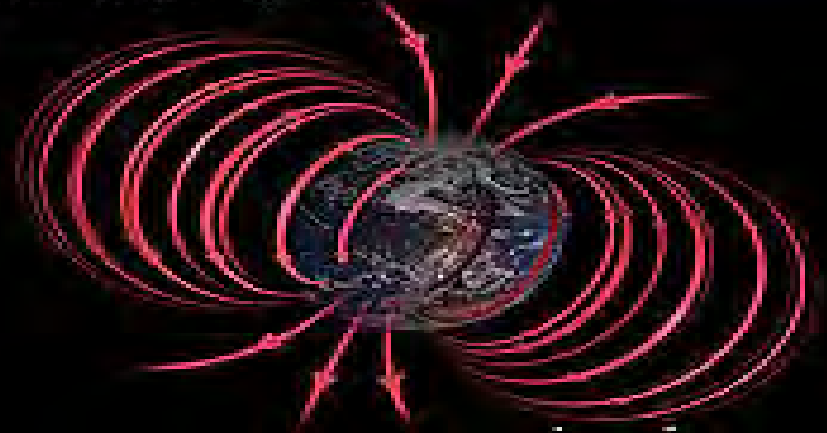


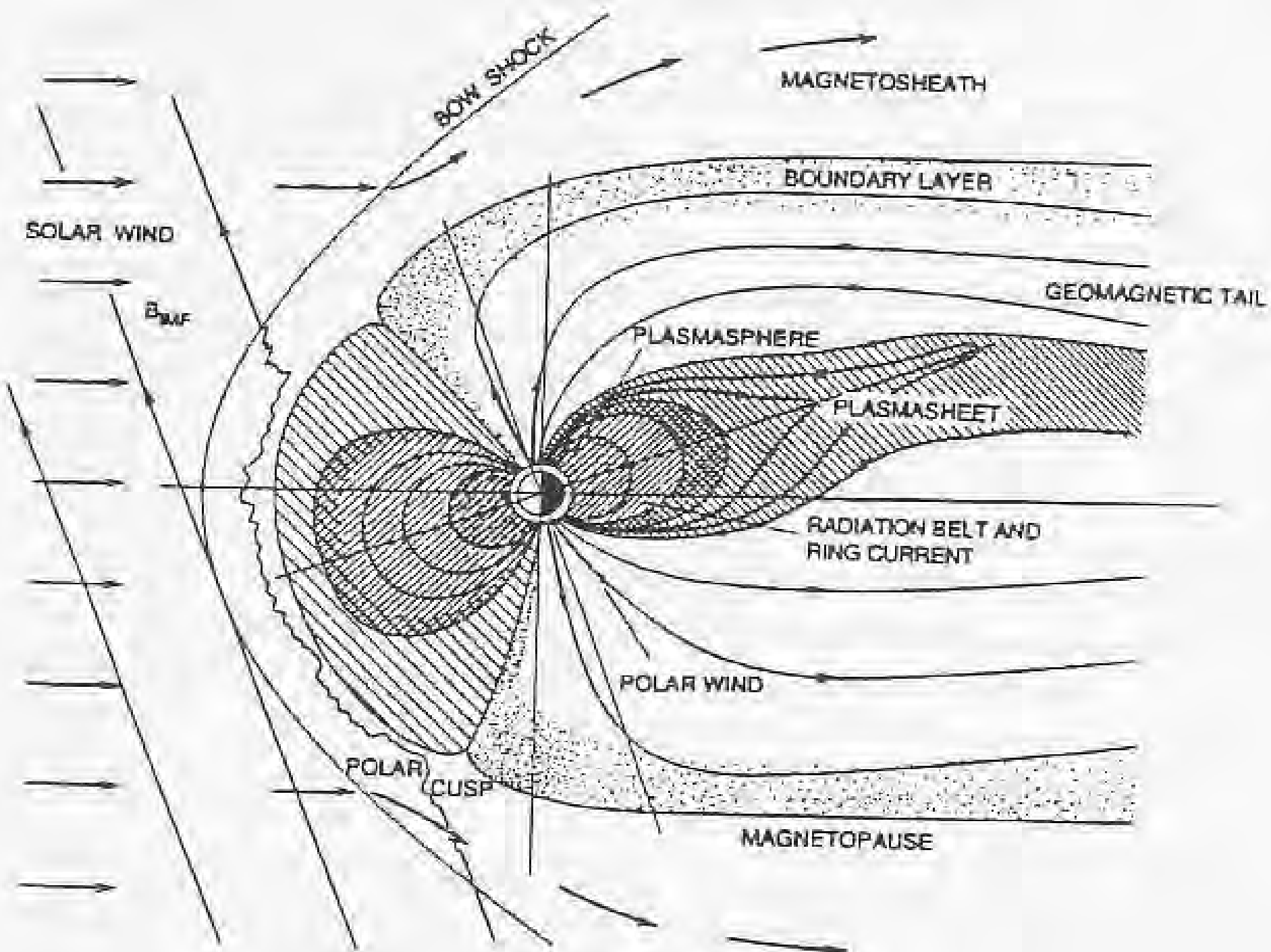


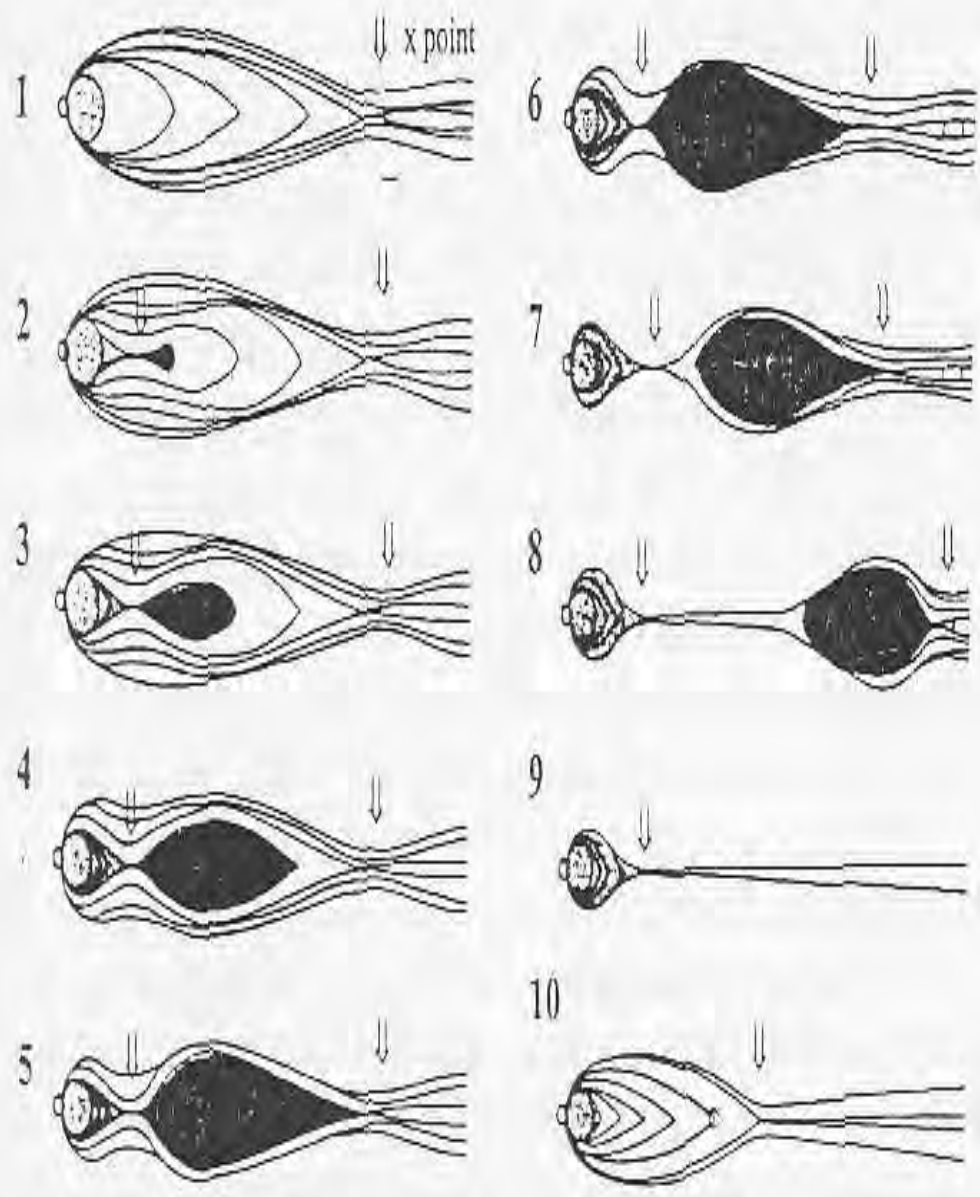
Magnetosphere

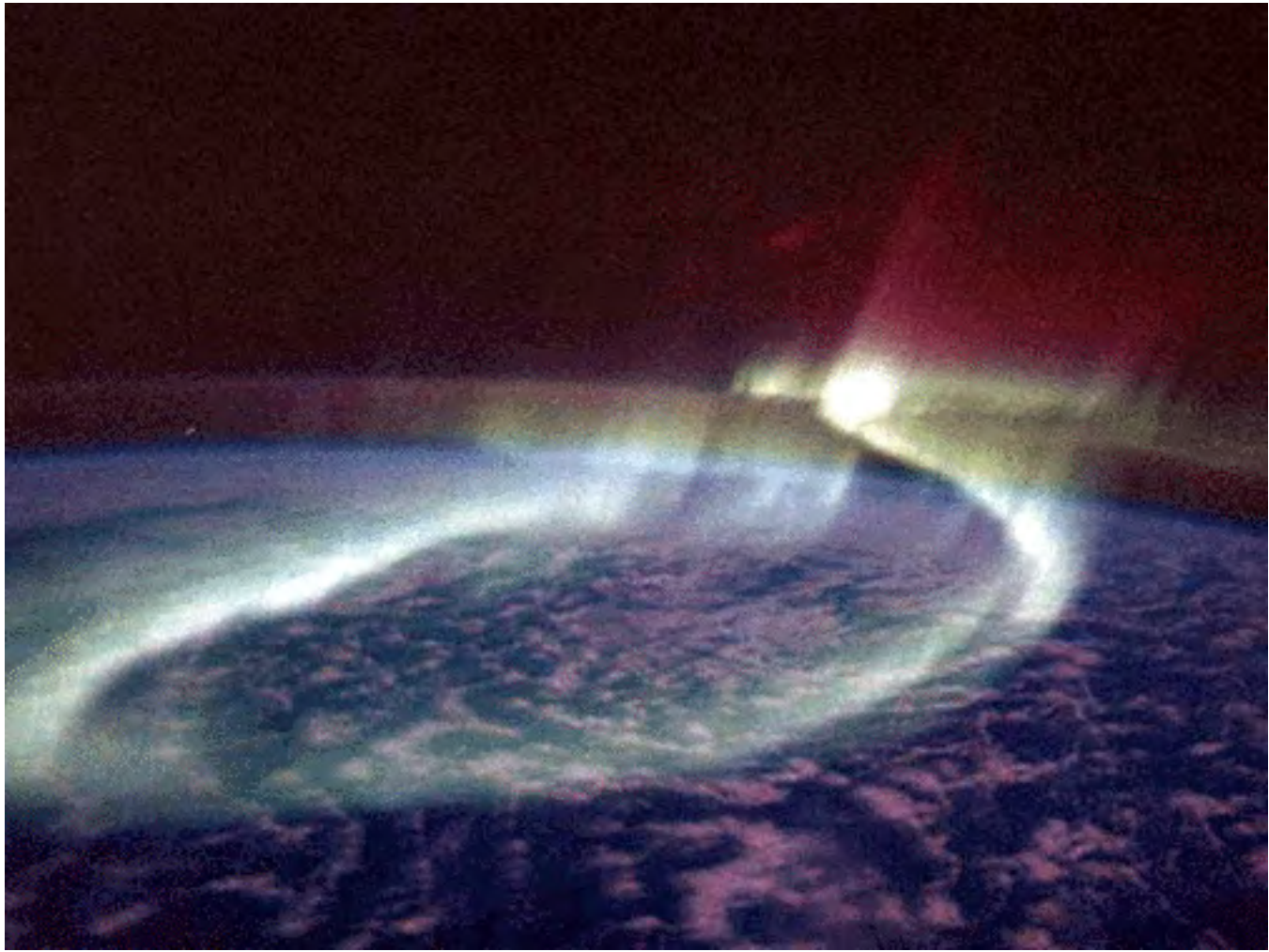


Ordinary Dipole



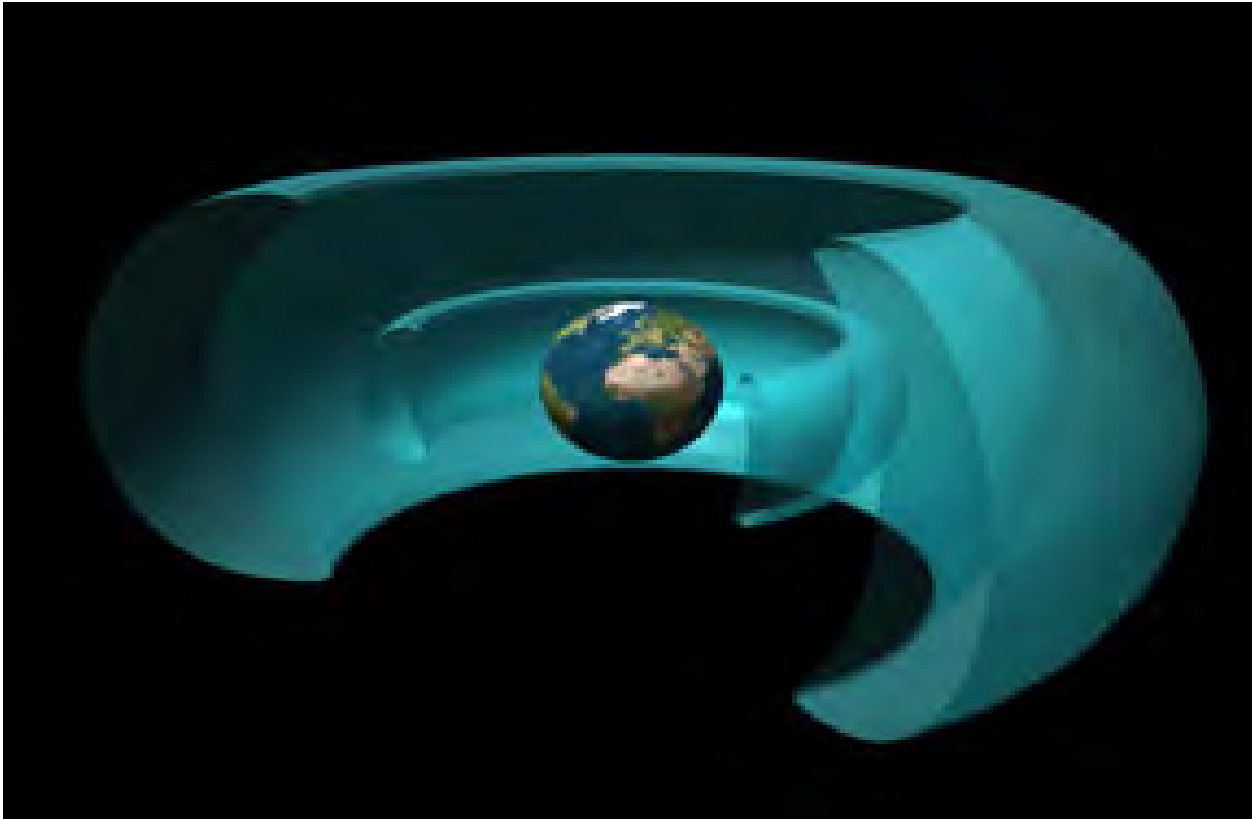


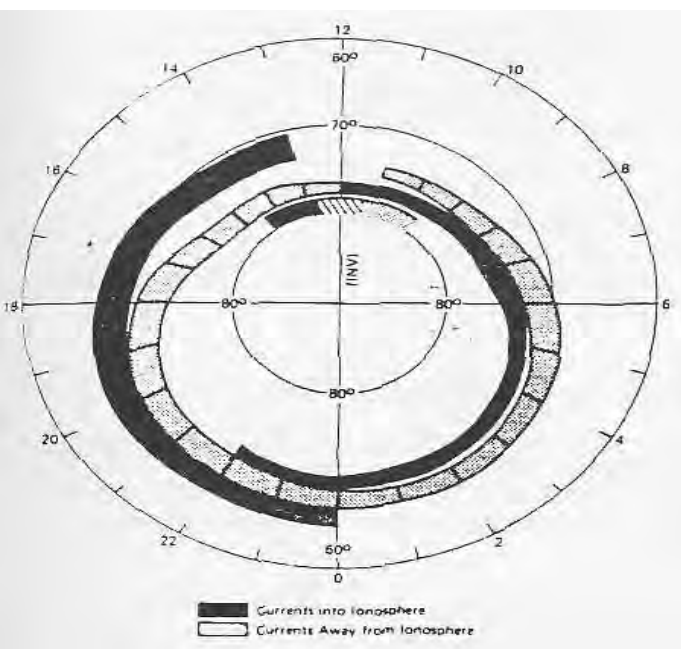
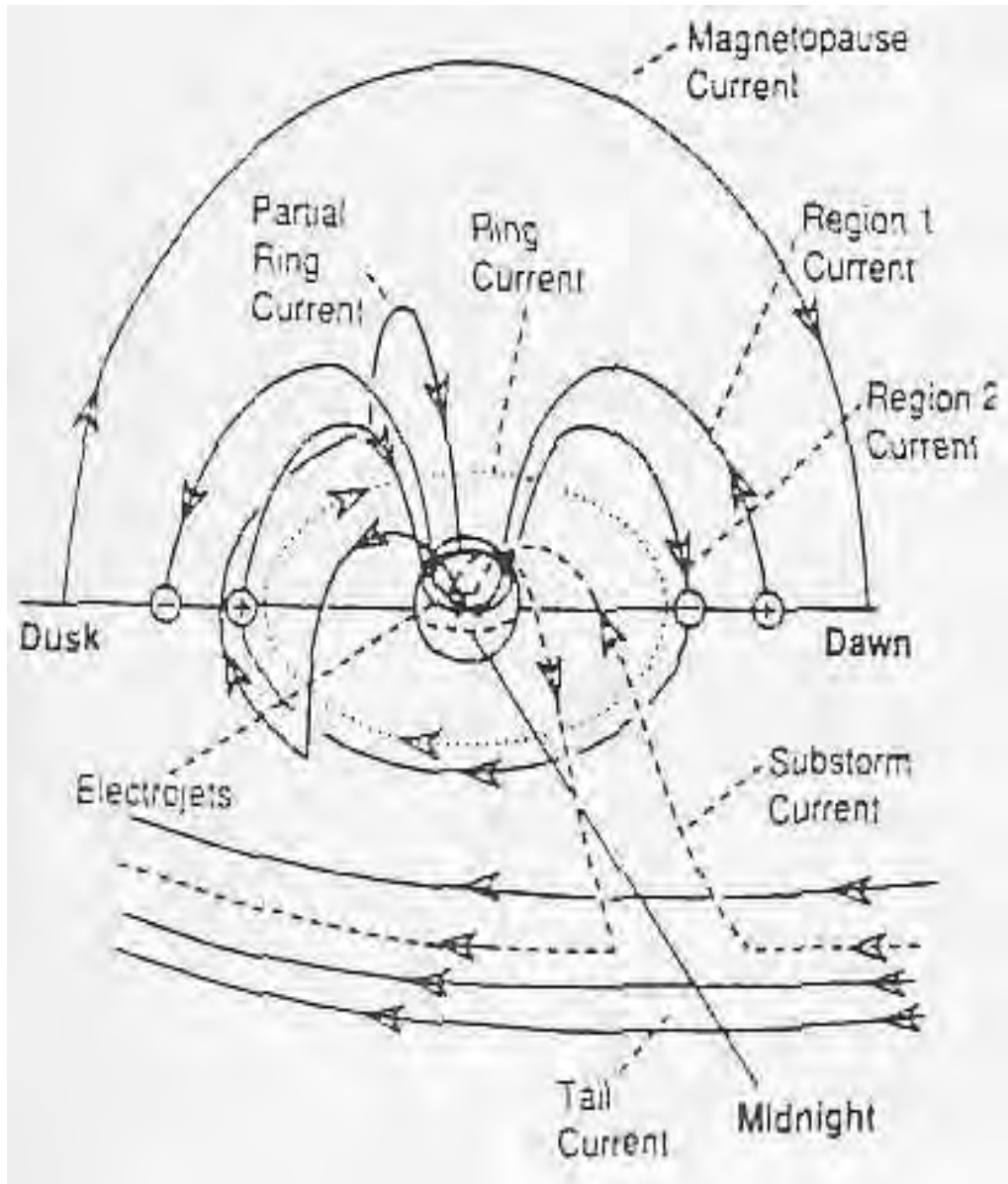
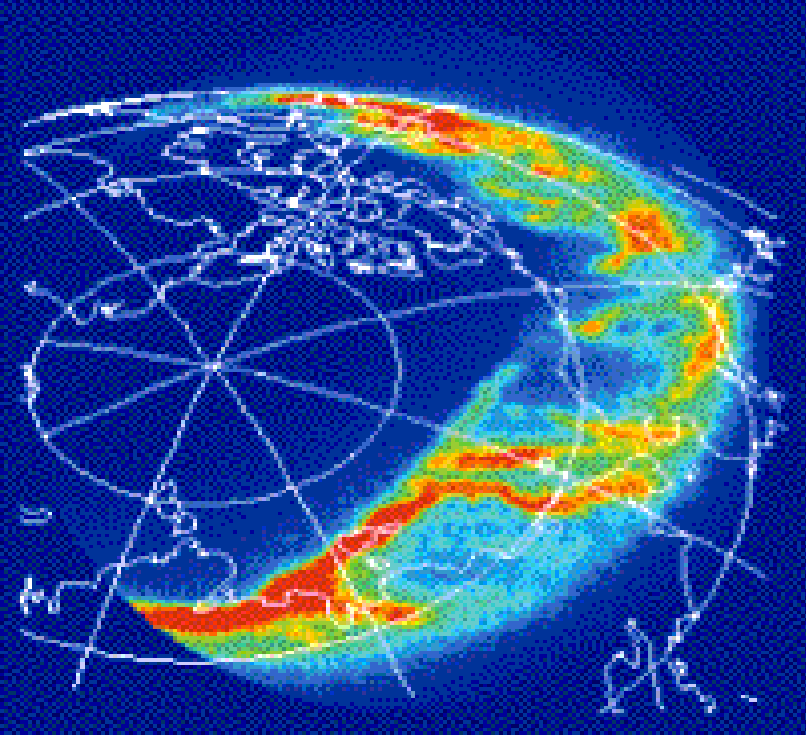


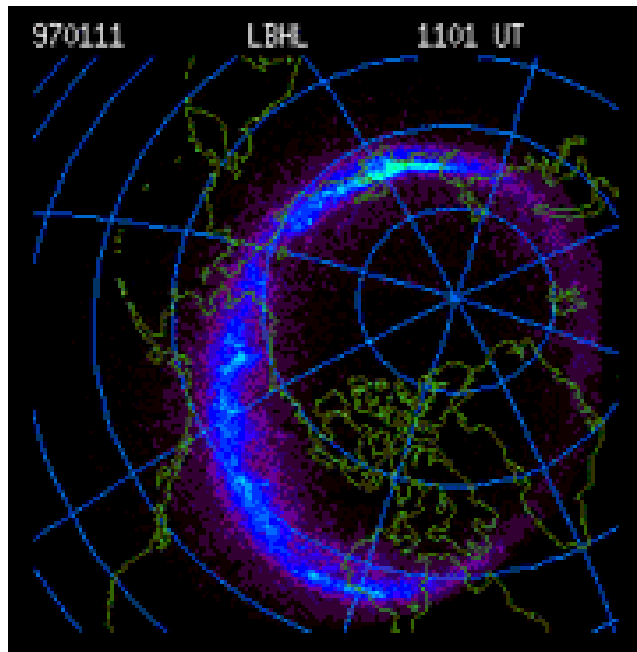
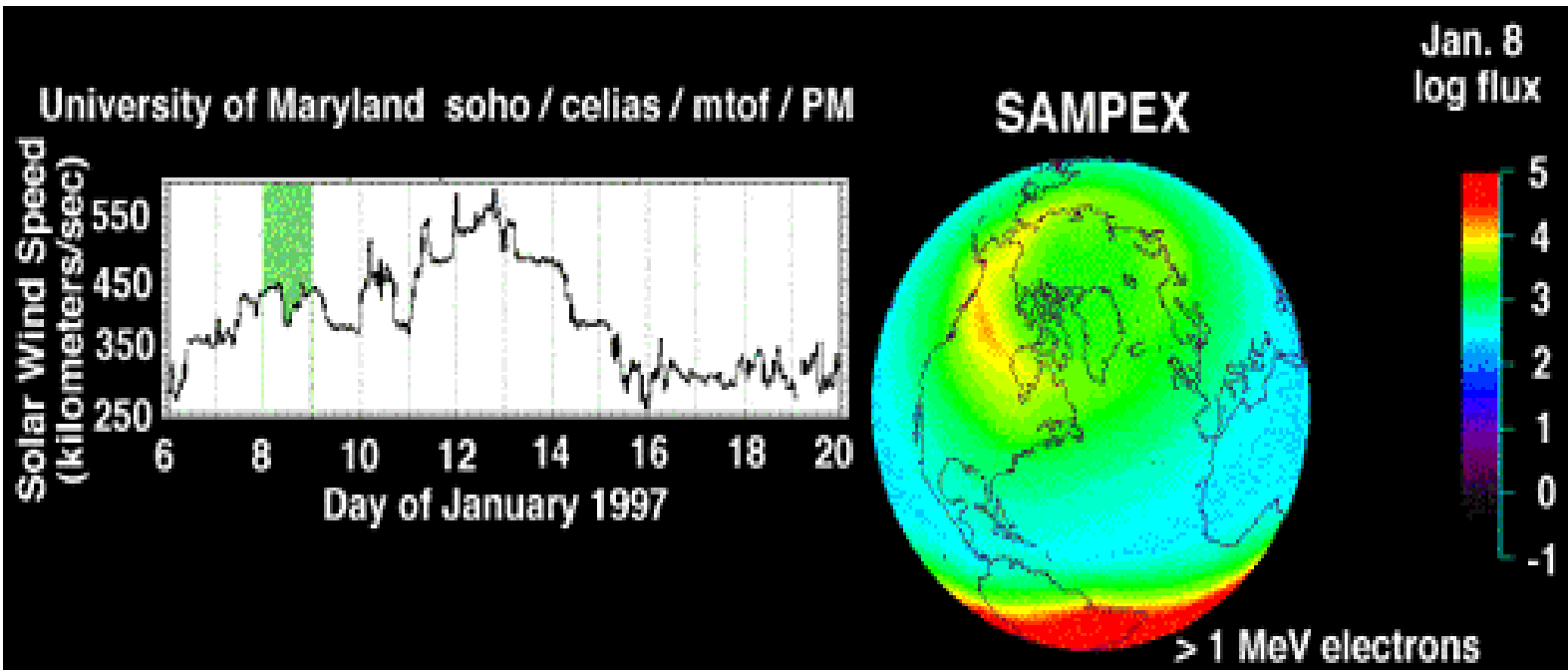






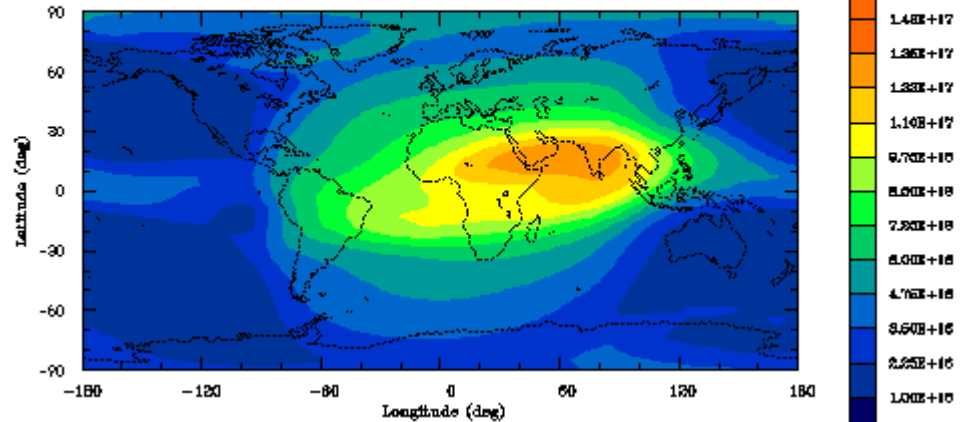


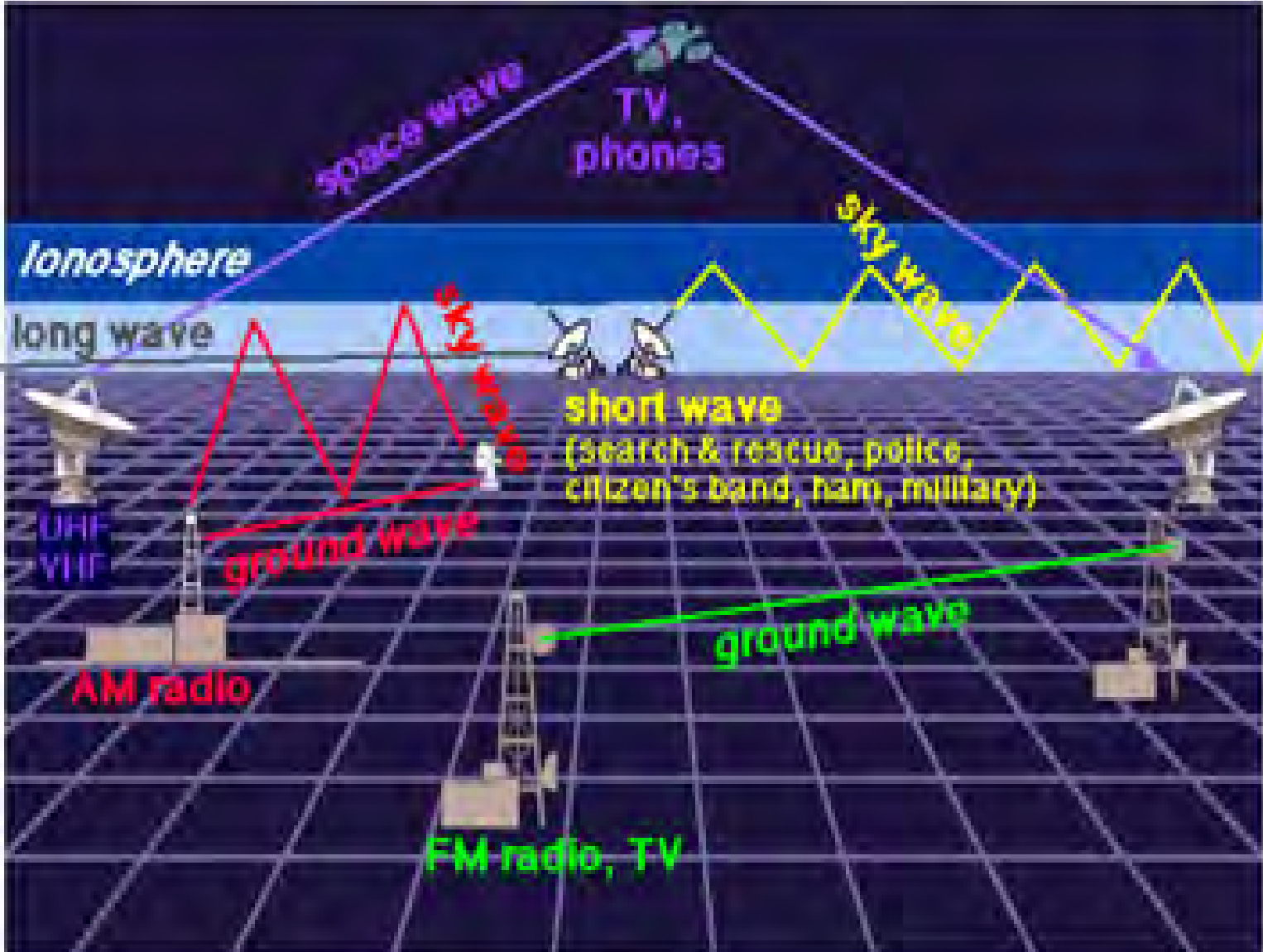




Ionospheric Storm UT = 12h 00m

Electron Column Density 100Km to 400Km (m^{-2})
 UT = 12h 00m





Previous Missions

Skylab (1973)



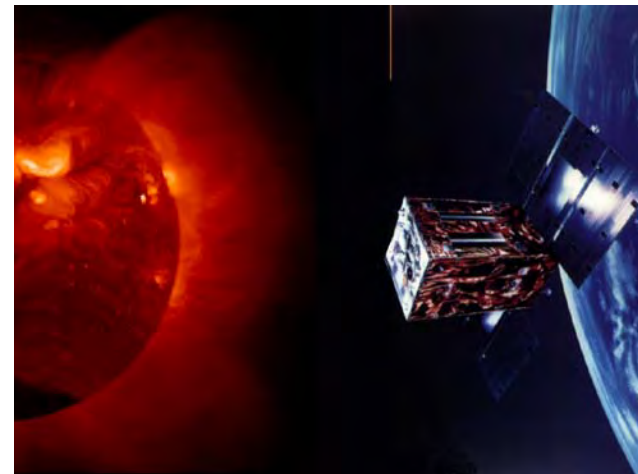
Solar Maximum Mission (1980-1989)



Spacelab 2 Mission (1985)



Yohkoh (Japan/NASA 1991-2001)



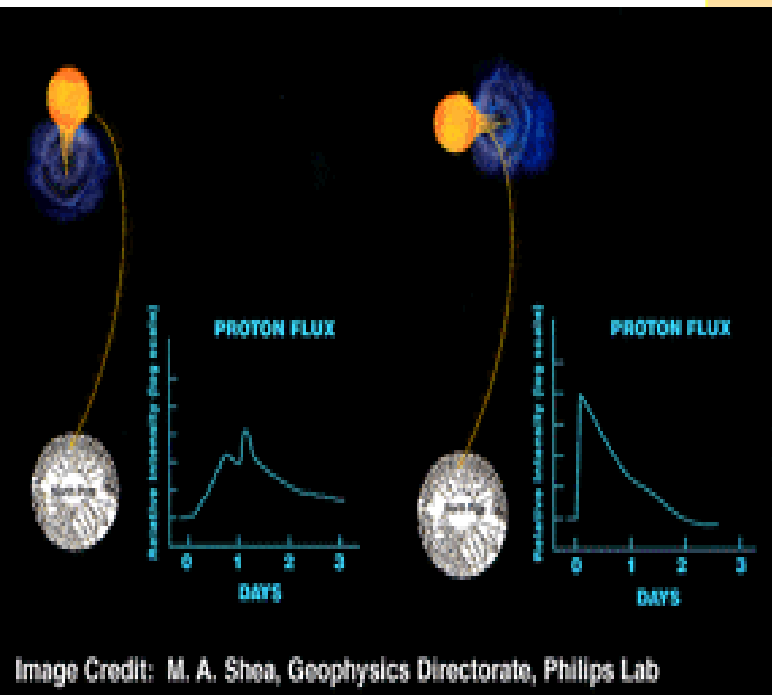
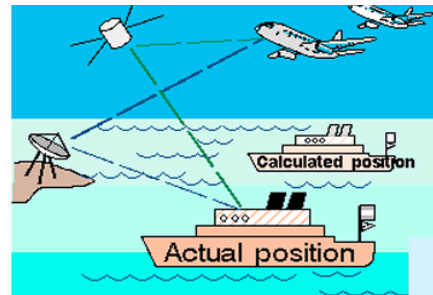


Image Credit: M. A. Shea, Geophysics Directorate, Phillips Lab



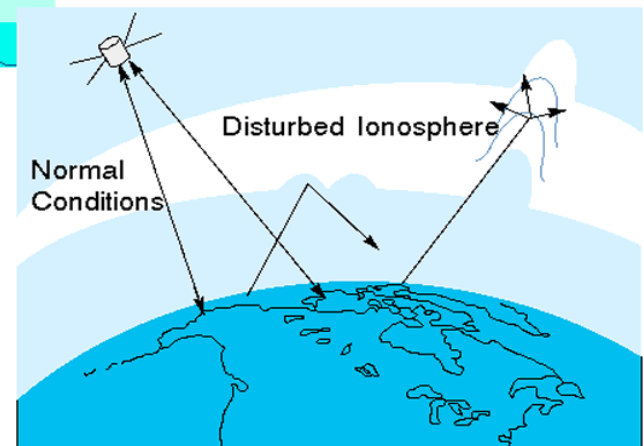
Precision GPS and LORAN signals are adversely affected by a varying ionosphere.



Communications can break down in critical areas and times:

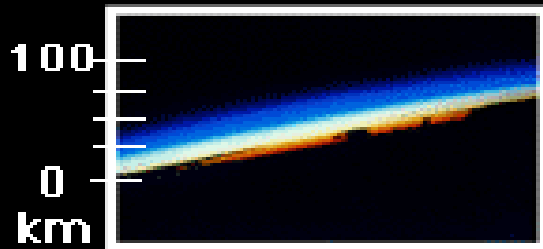
- Desert Storm
- Alaska
- Satellite pagers and Cellular Phones

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

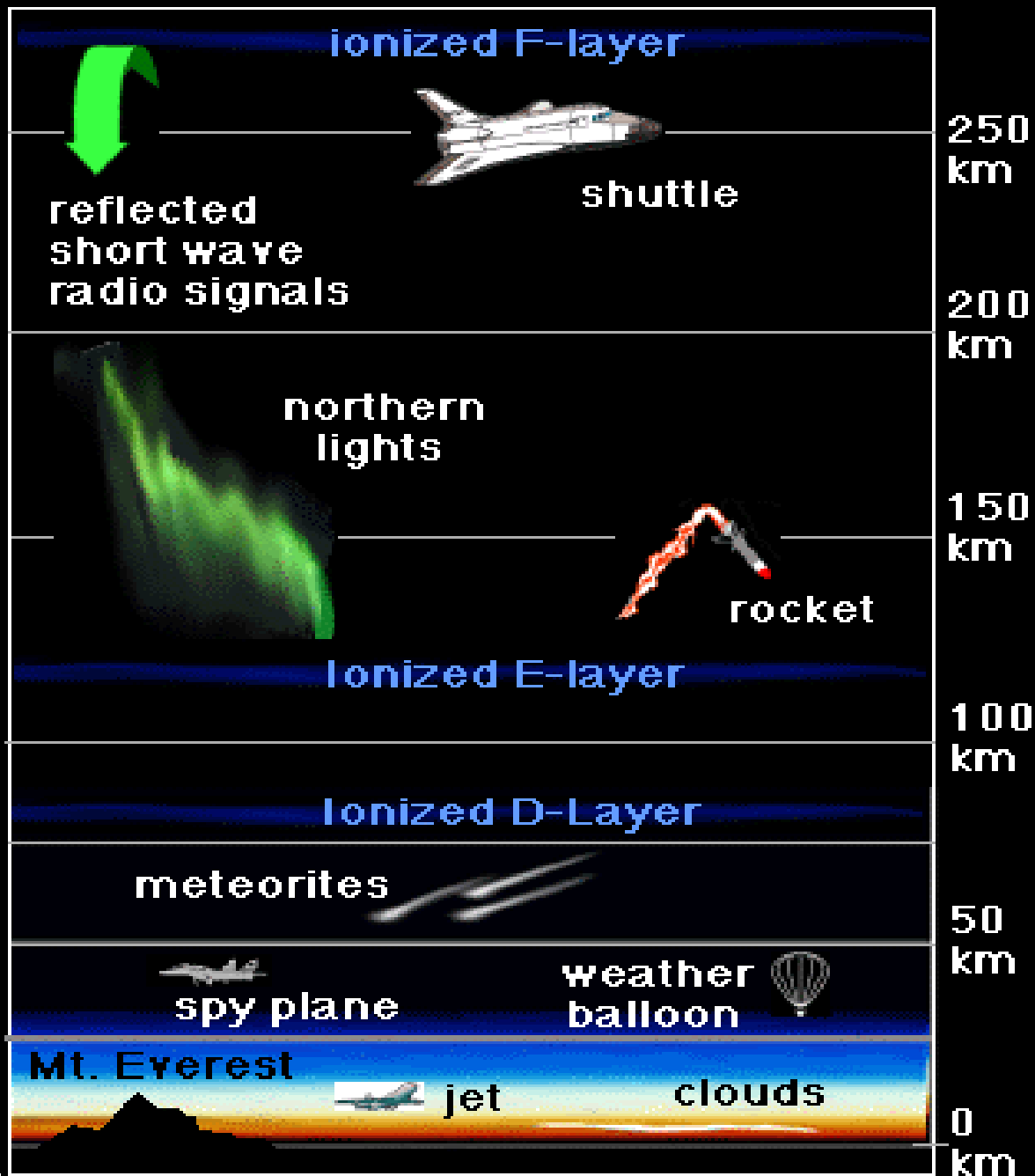




The Atmosphere and the Earth-Space Interface



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





Communications



GOES East
(75 W Long)

Weather



Navigation

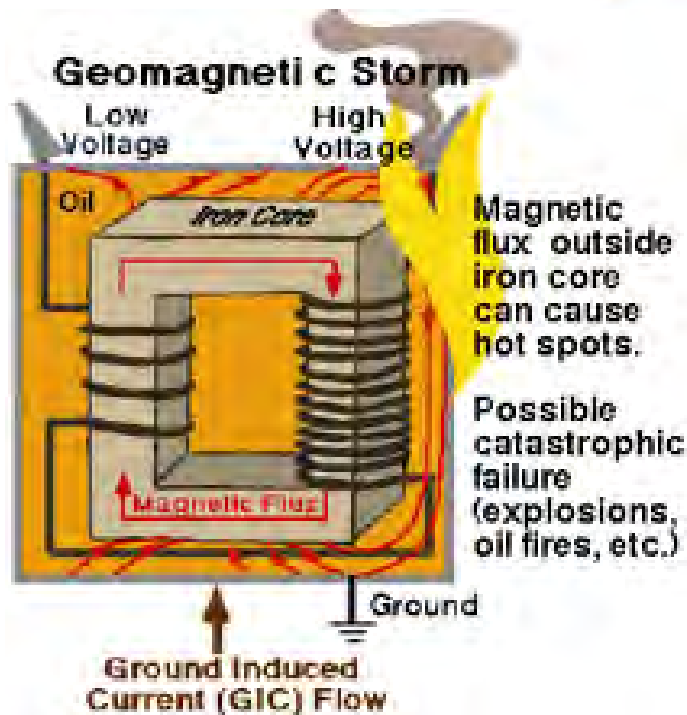
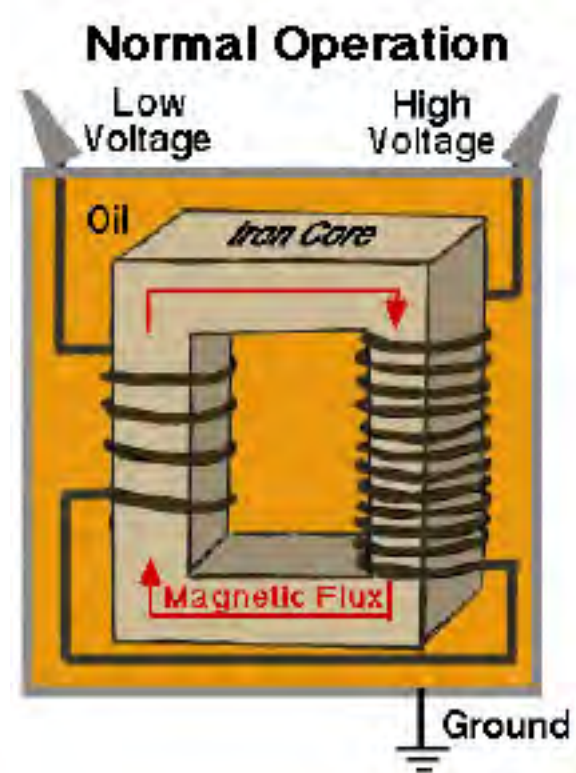
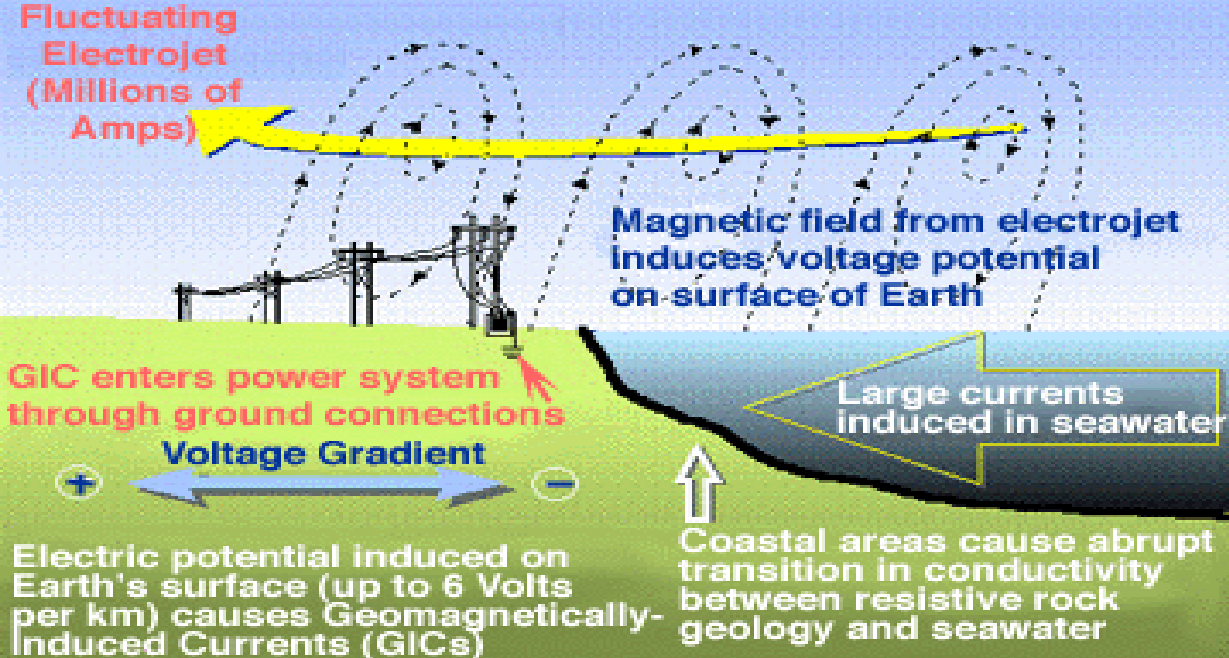


Scientific Research

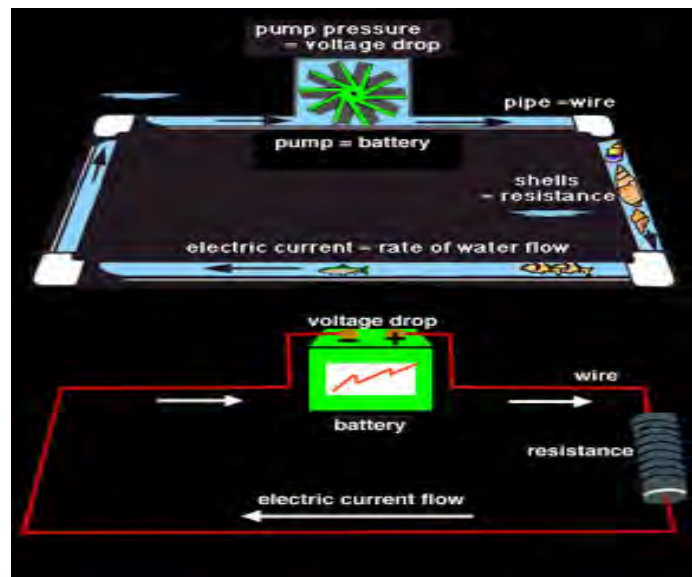
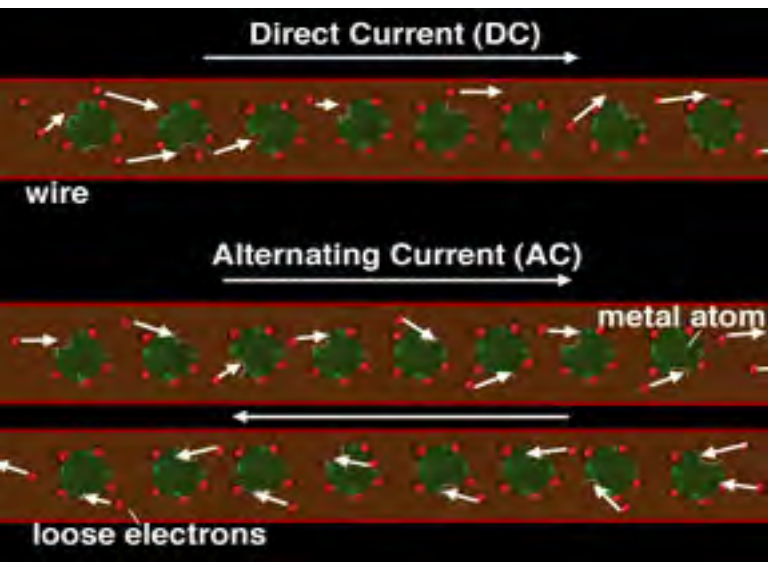
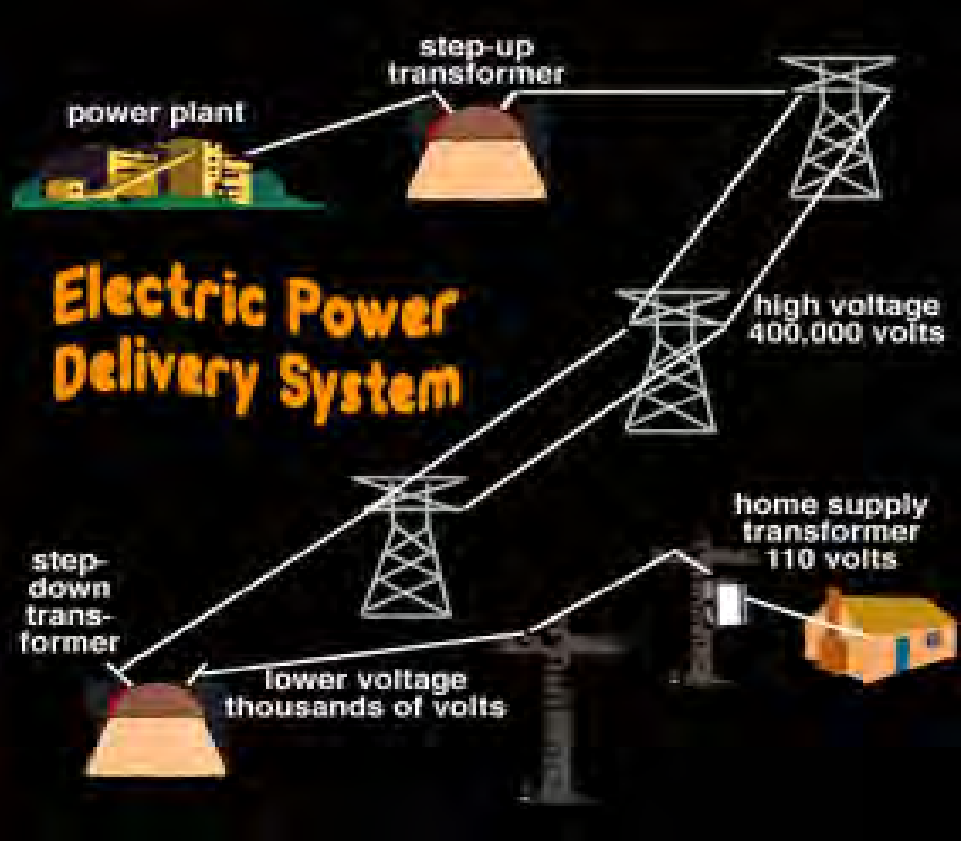


Remote Sensing



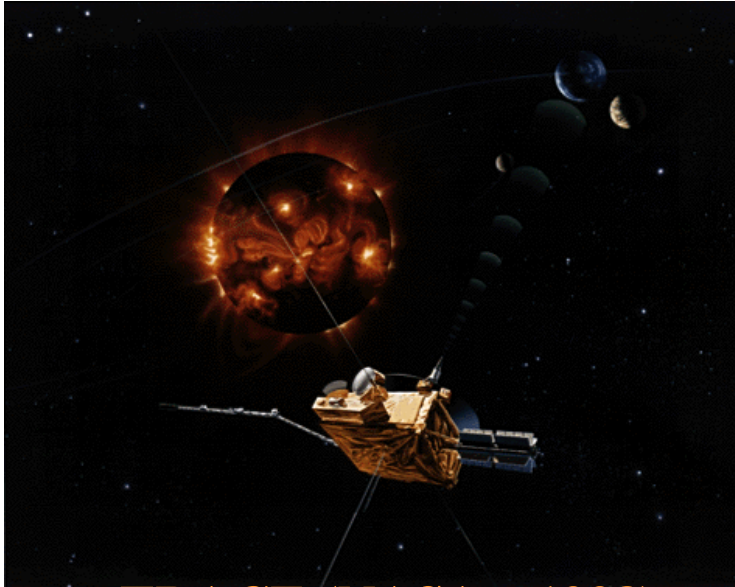


Major Problems in Restoring Power after Grid Collapse

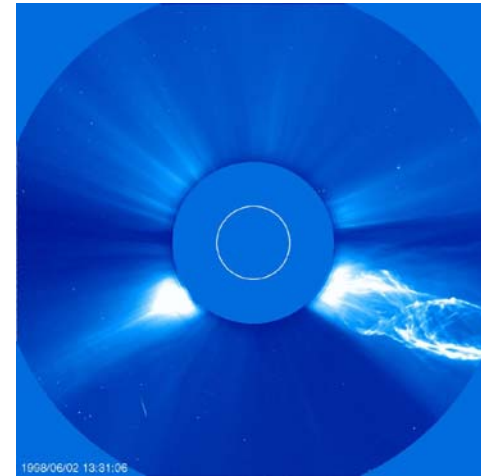


Current Missions

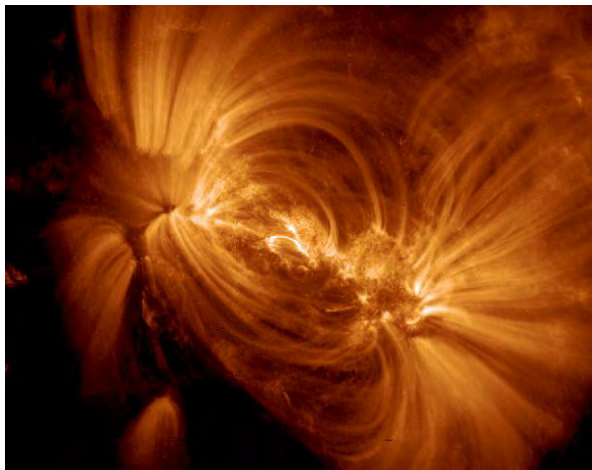
Ulysses (ESA/NASA – 1990)



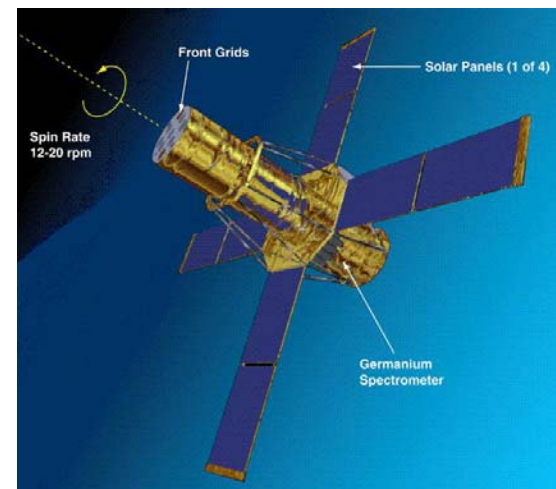
SOHO(ESA/NASA – 1995)



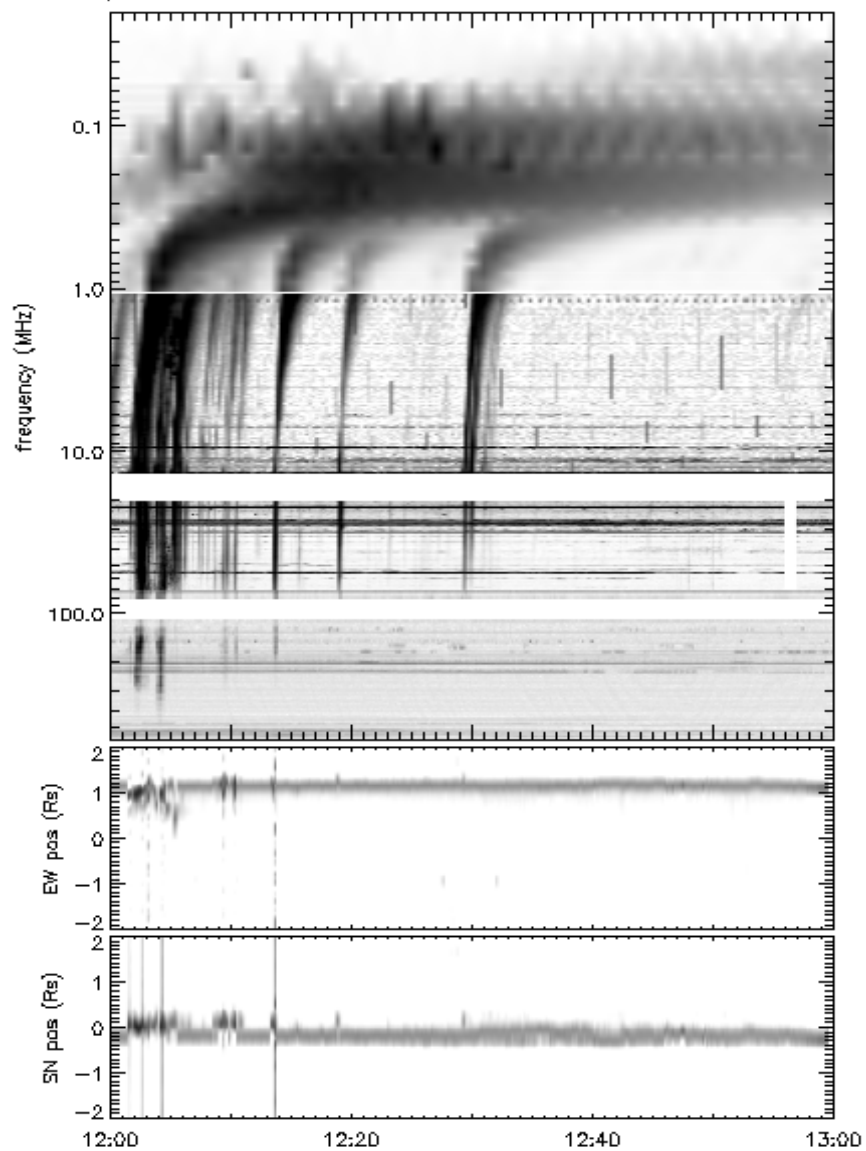
TRACE (NASA – 1998)



RHESSI (NASA – 2002)



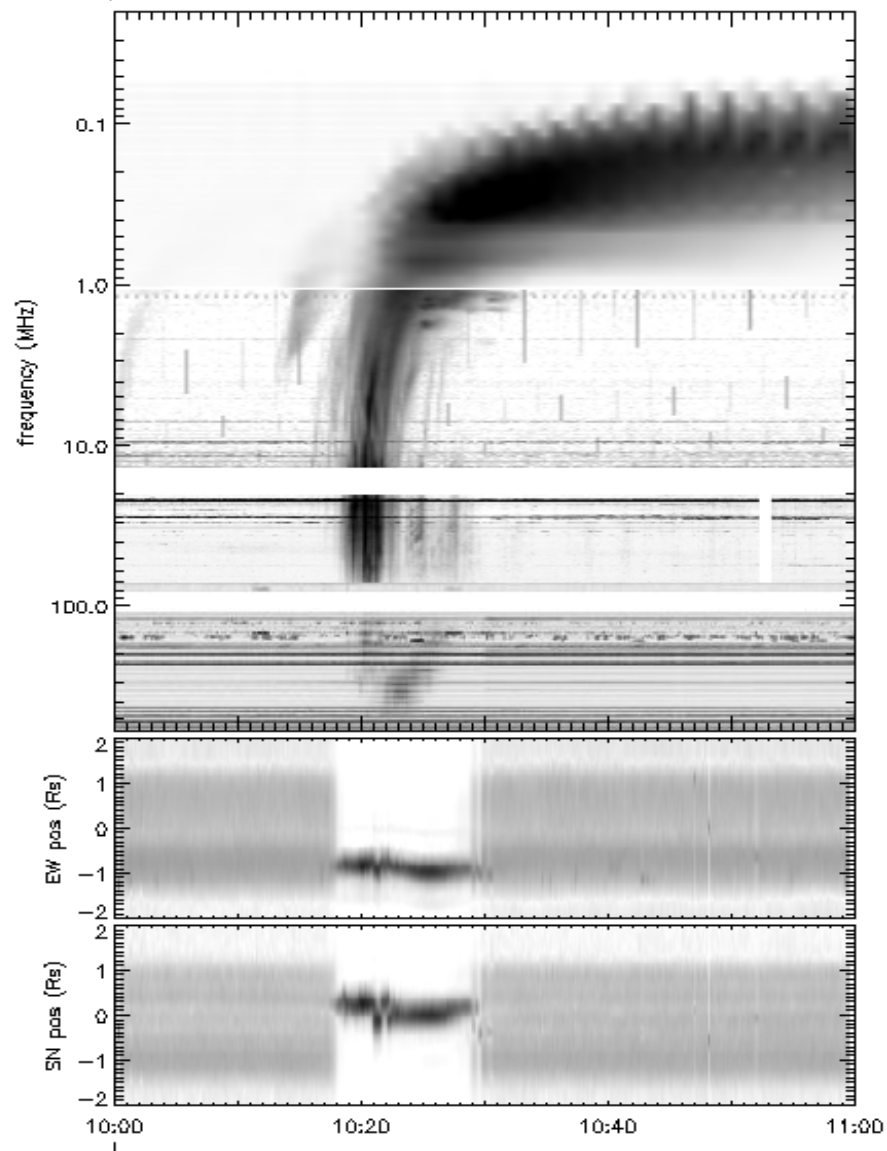
WIND/WAVES, DAM, ARTEMIS, NRH, CME, 07JUL2006



W,V:

Assembled the 20DEC2006

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



W,V: 76,1047

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



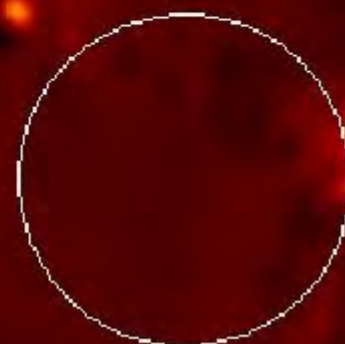
327.0 Mhz 14:03:10 UT

NRH 13-Jul-2005



327.0 Mhz 14:05:09 UT

NRH 13-Jul-2005

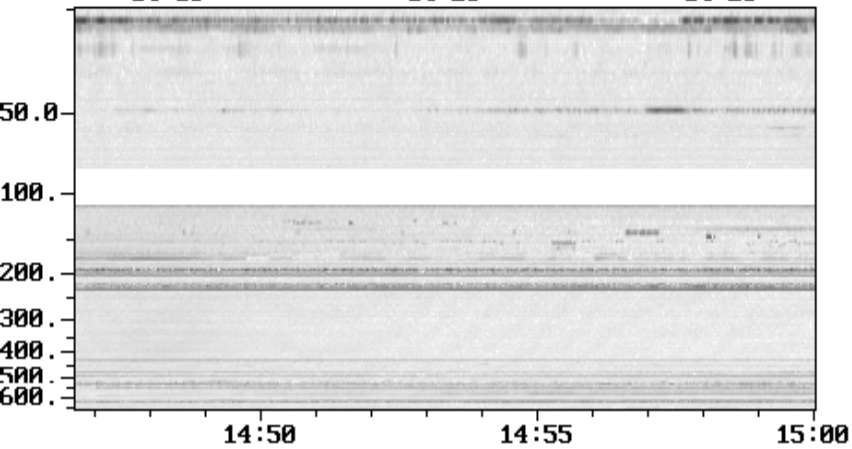
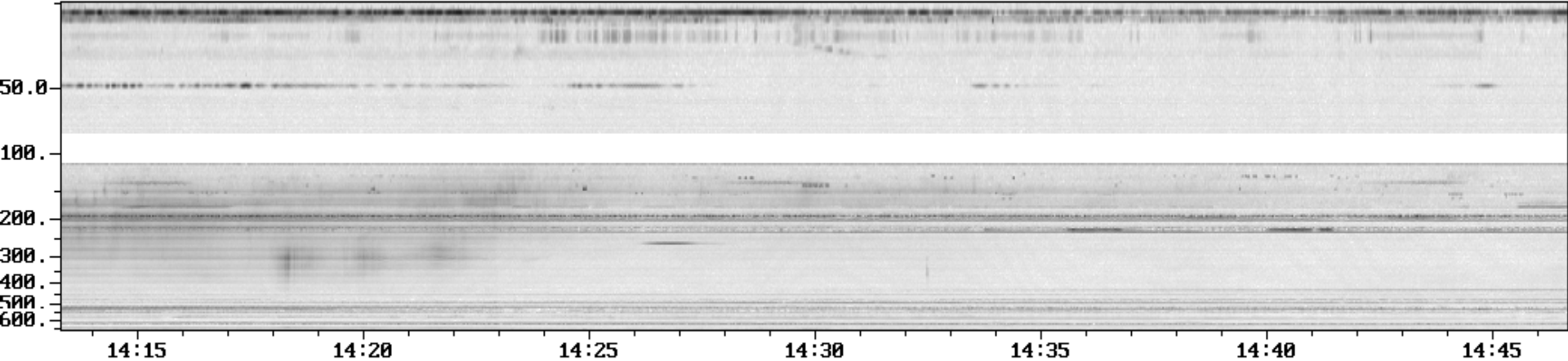
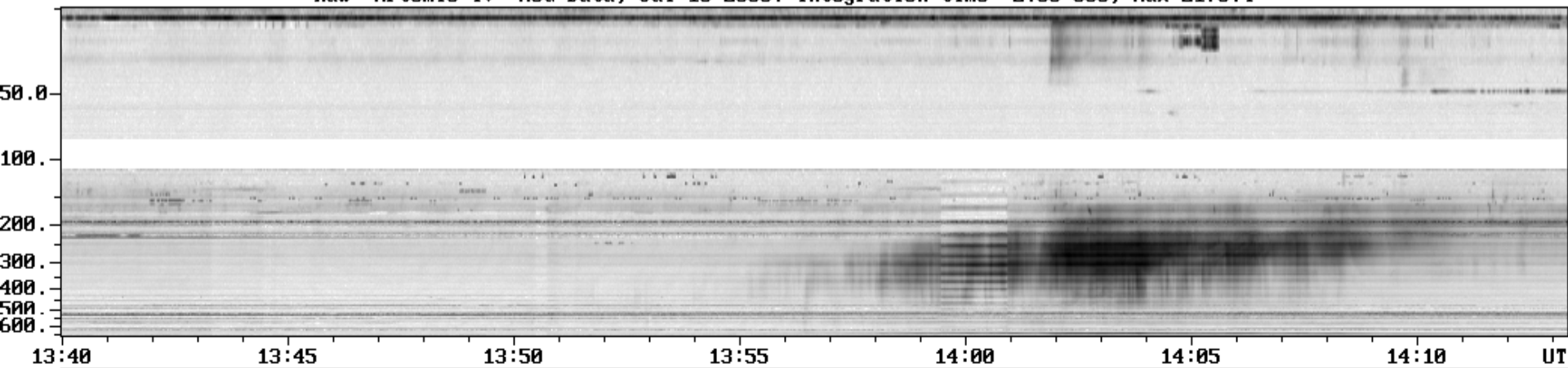


327.0 Mhz 14:07:08 UT

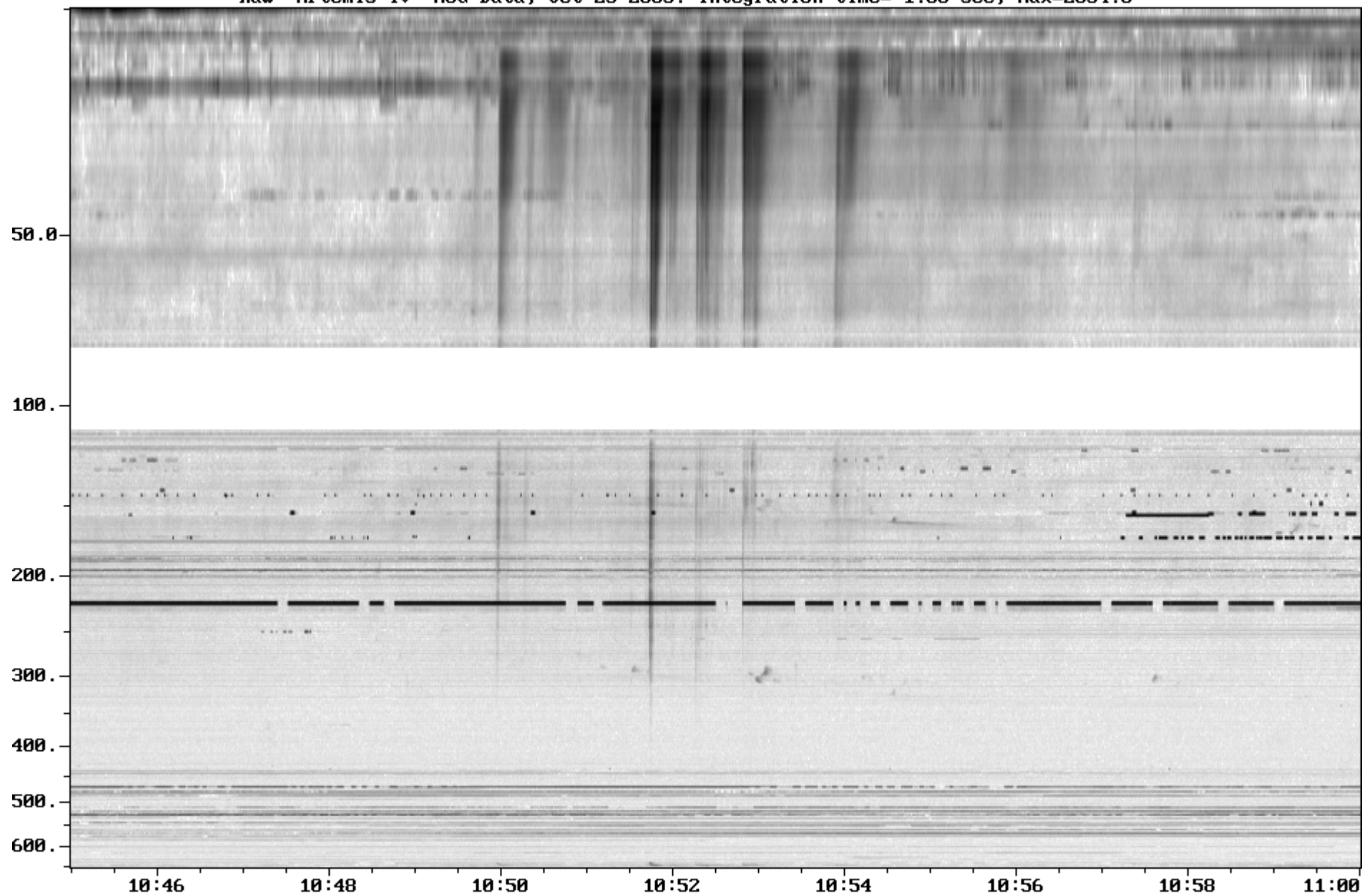
327.0 Mhz 14:09:07 UT

327.0 Mhz 14:11:05 UT

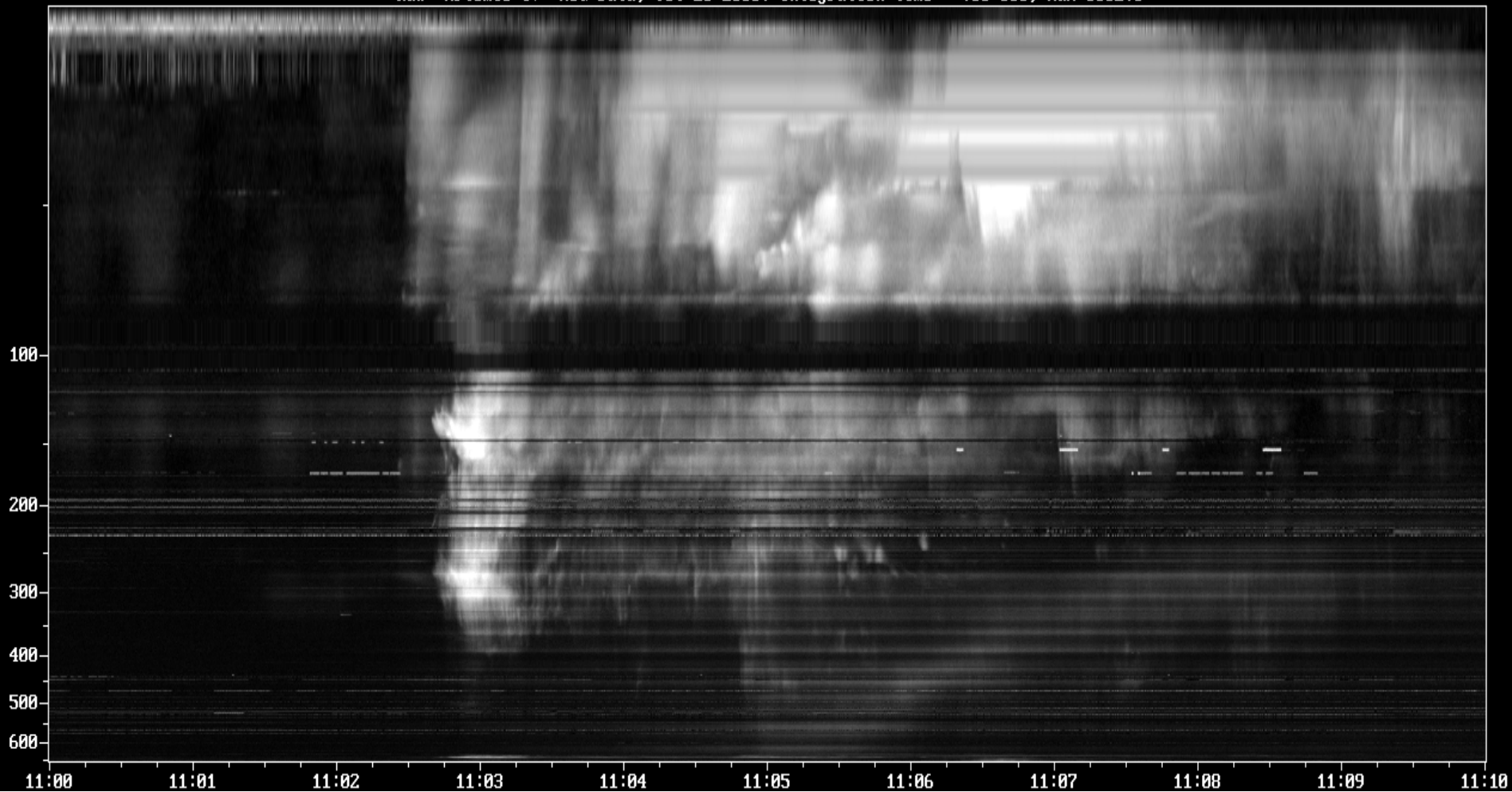
Raw Artemis-IV ASG Data, Jul 13 2005. Integration time= 2.00 sec, Max=2170.4



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



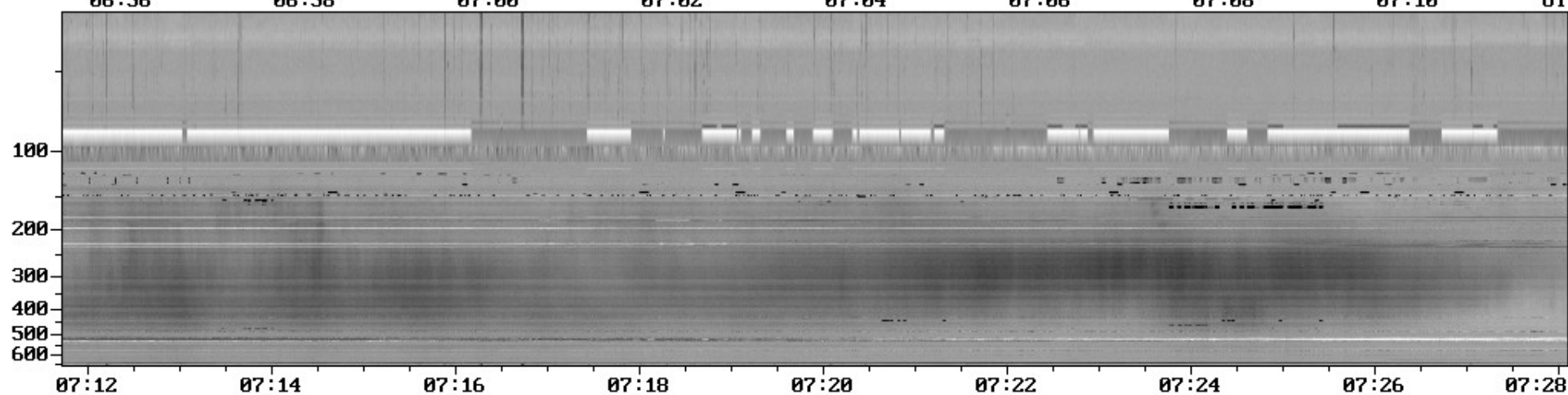
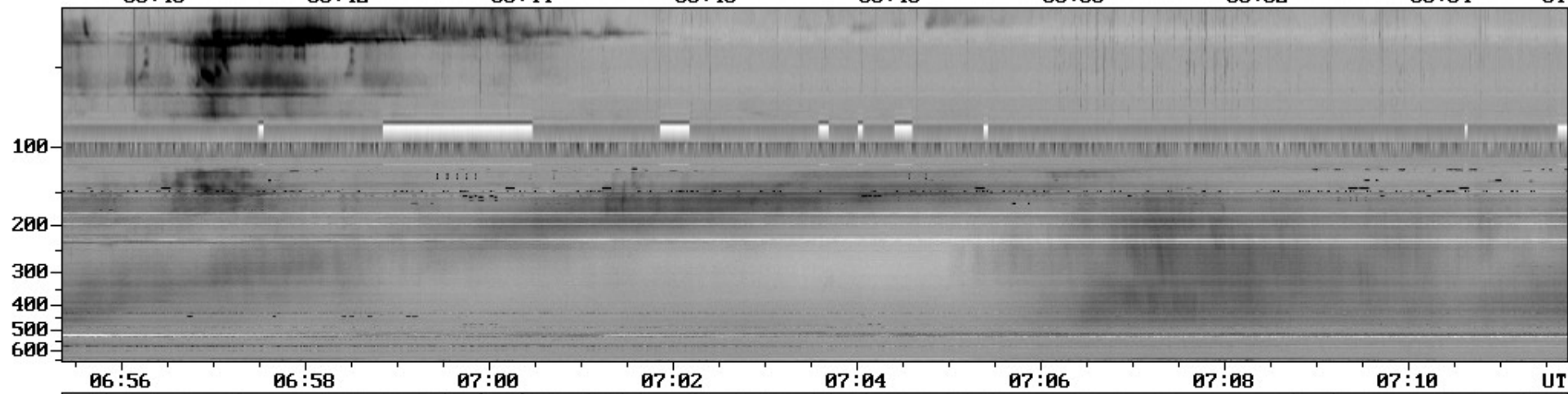
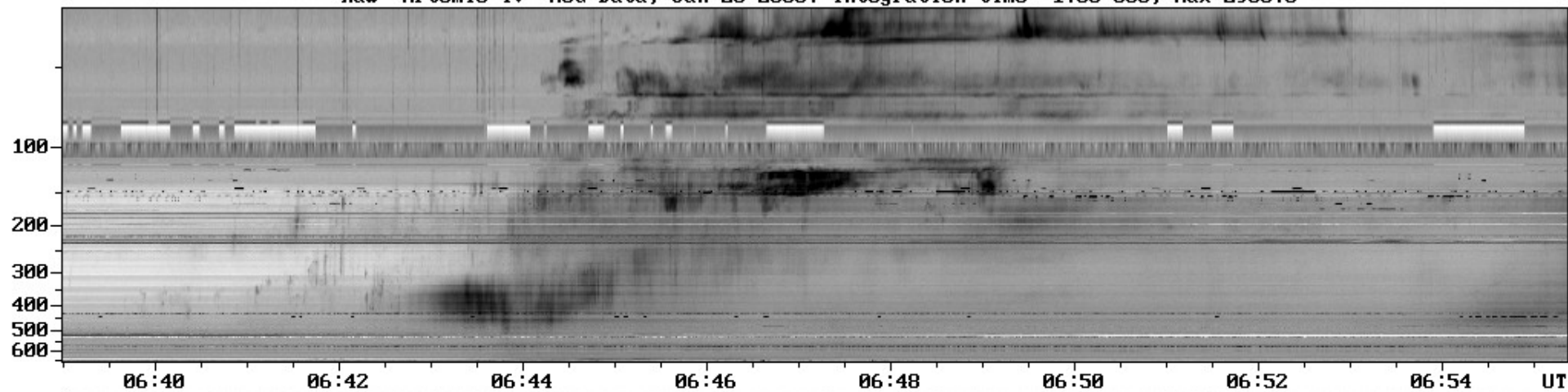
Raw Artemis-IV ASG Data, Oct 28 2003. Integration time= .50 sec, Max=3052.0



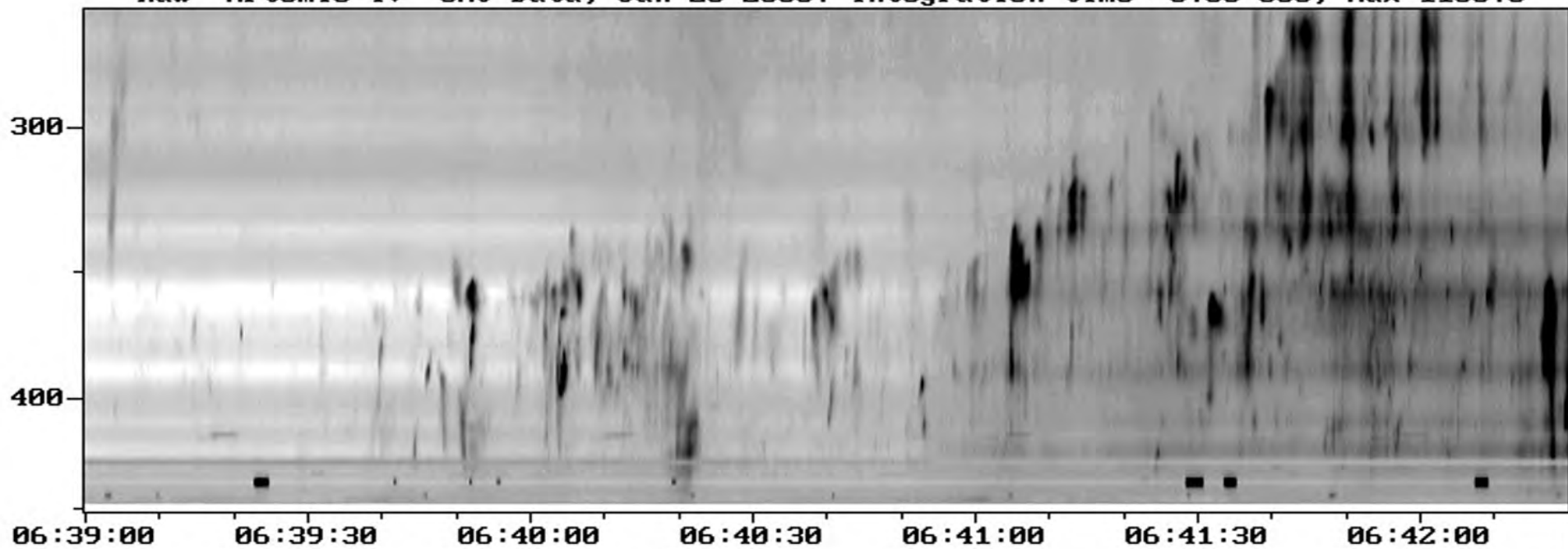


Εικόνα 1: Οι δύο κεραίες του ARTEMIS IV στις Θερμοπύλες

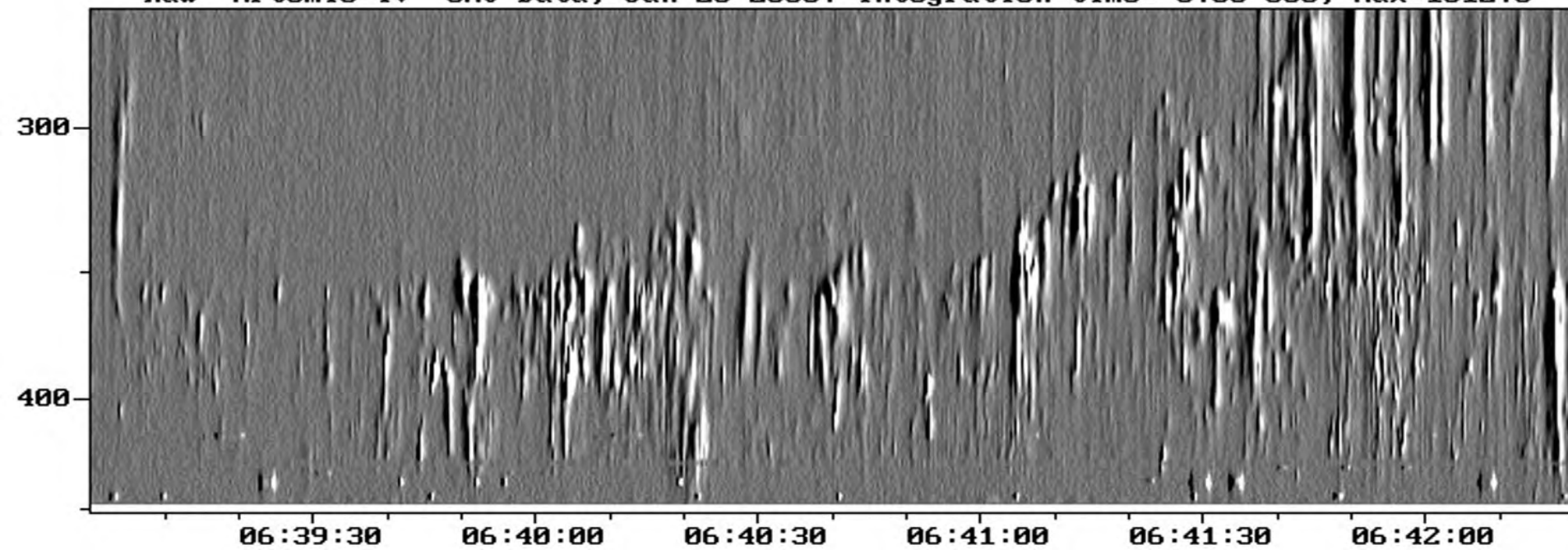


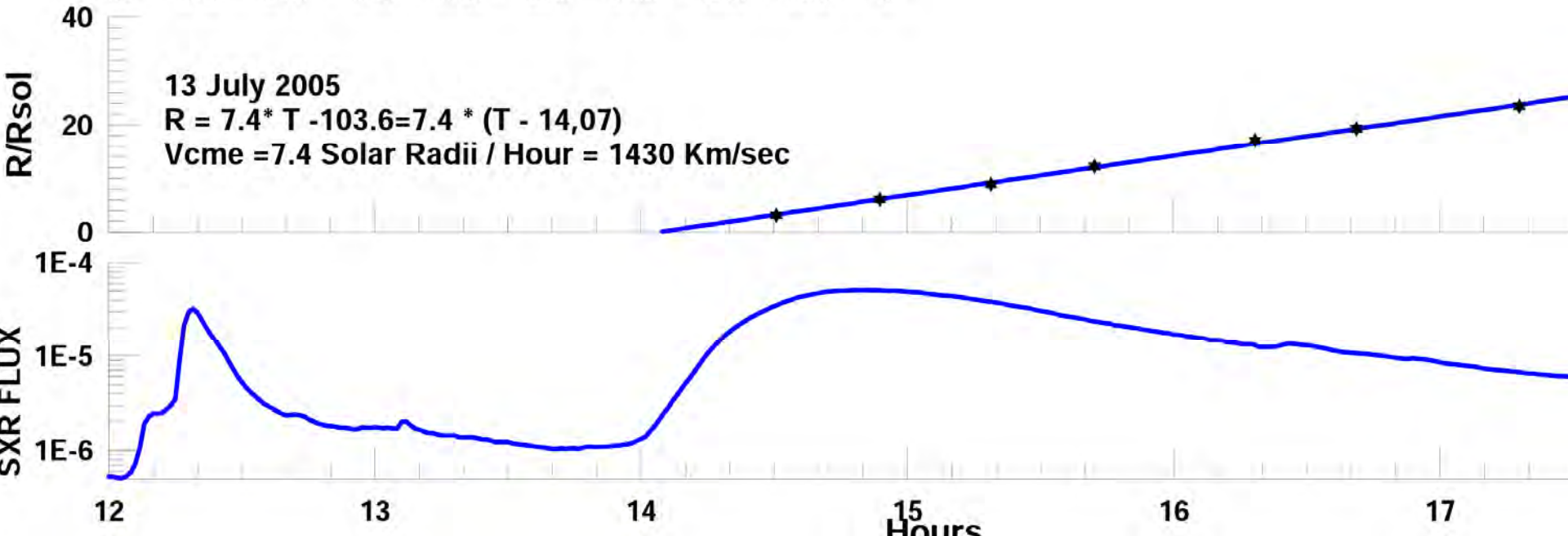
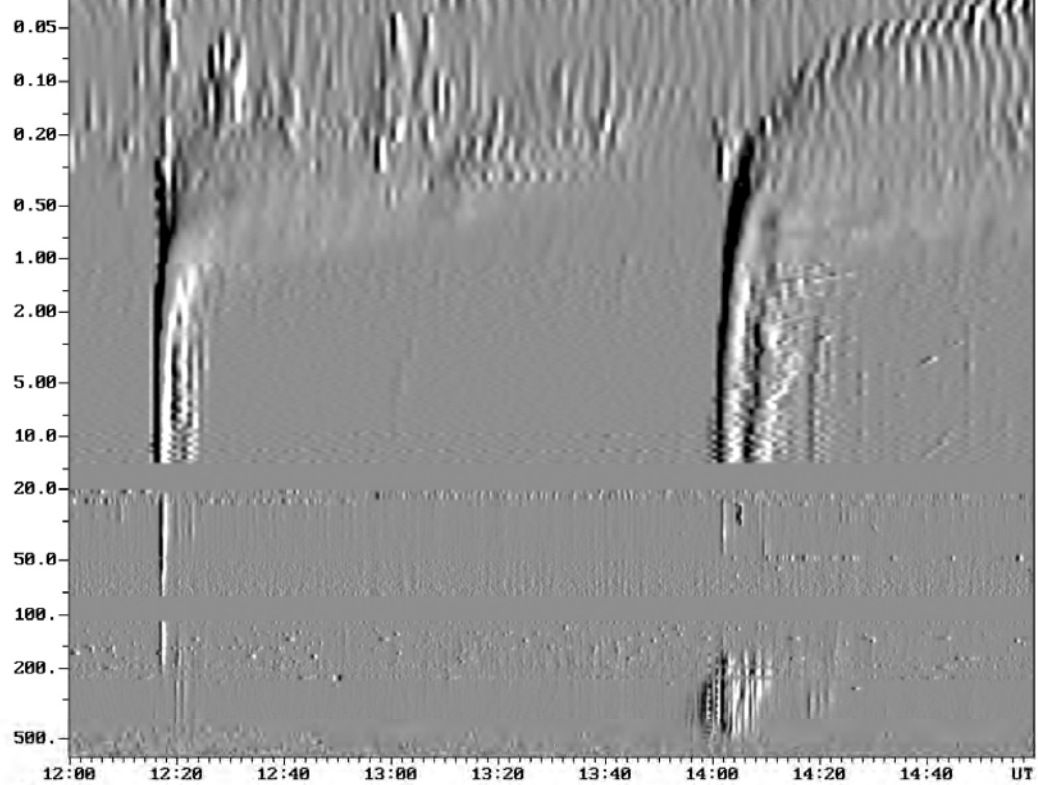


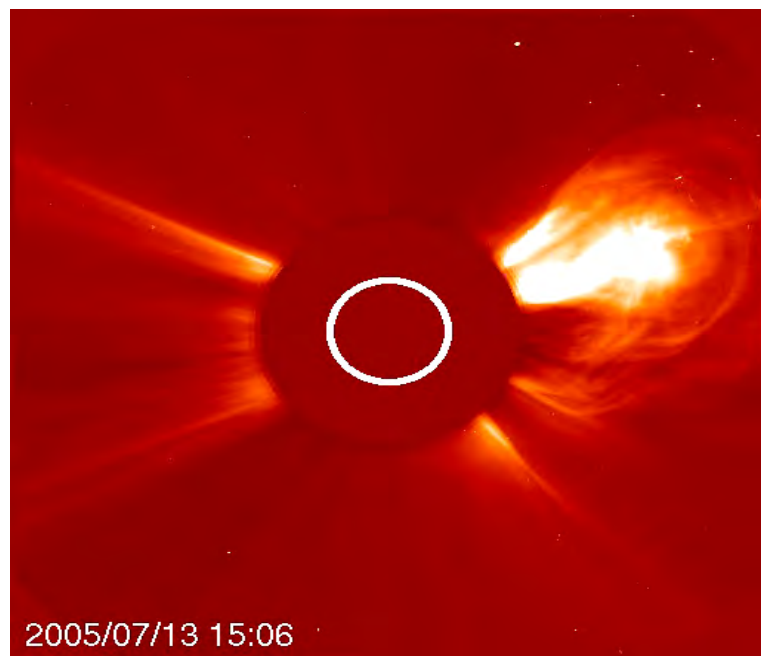
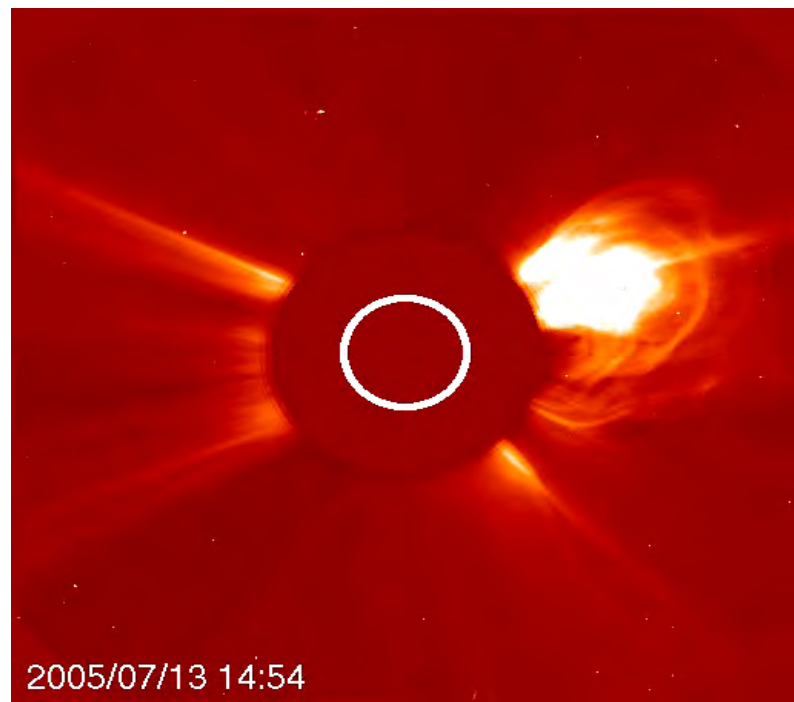
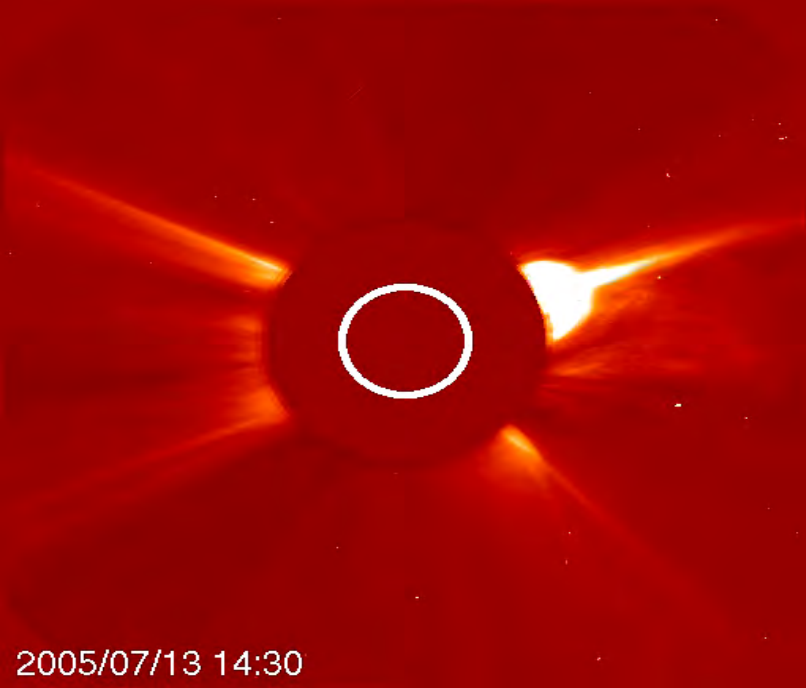
Raw Artemis-IV SAO Data, Jan 20 2005. Integration time= 0.30 sec, Max=1166.0



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



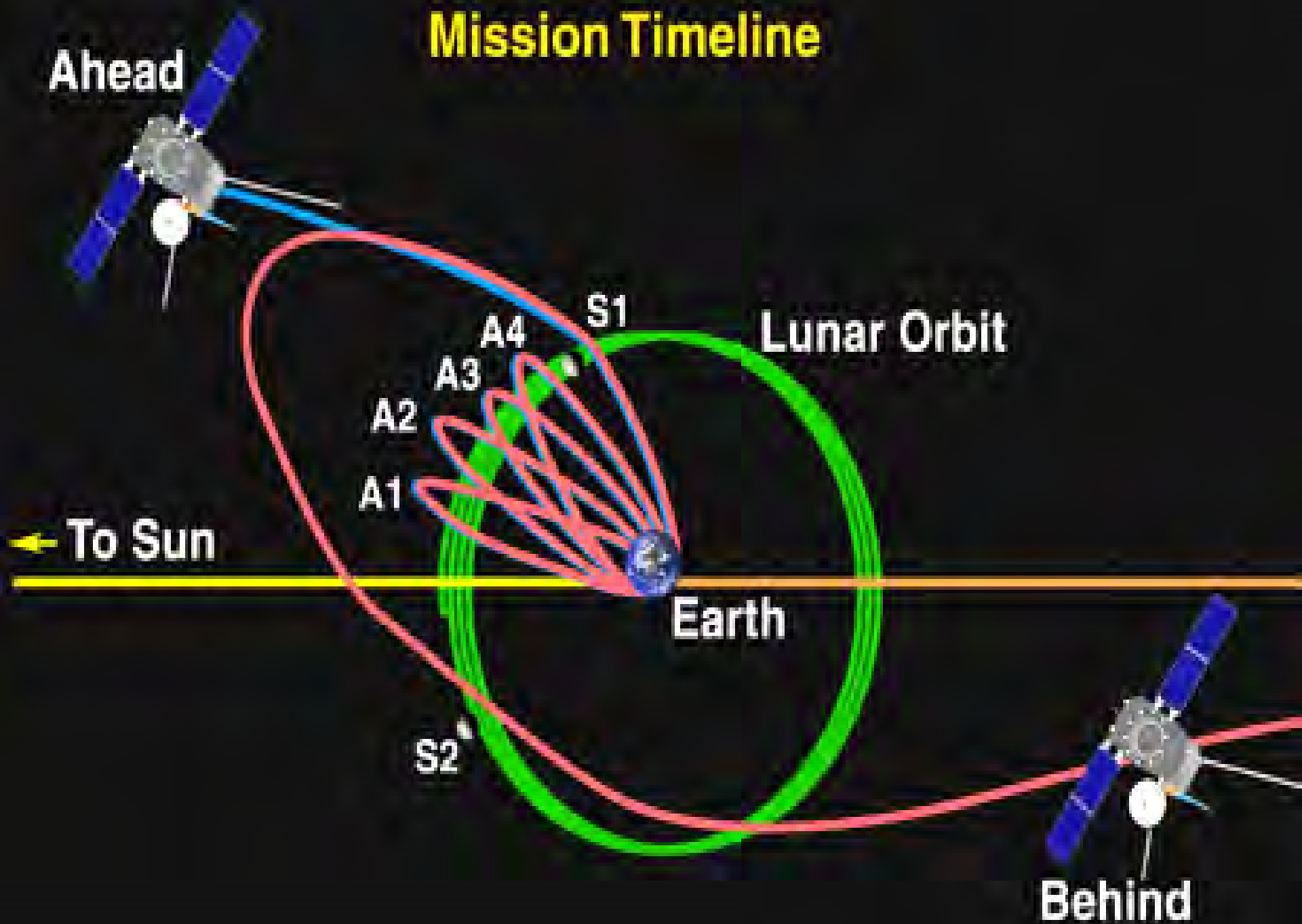


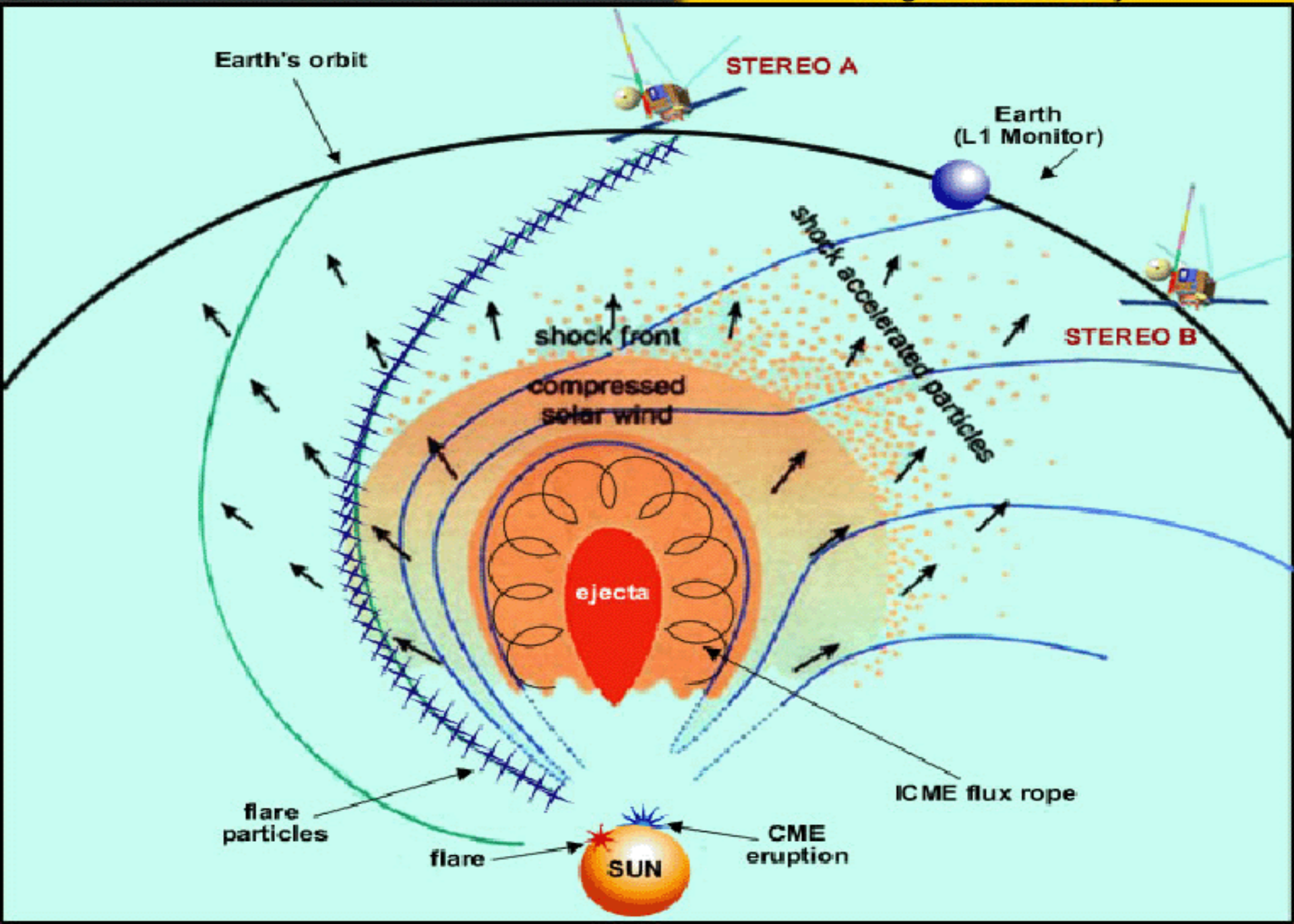






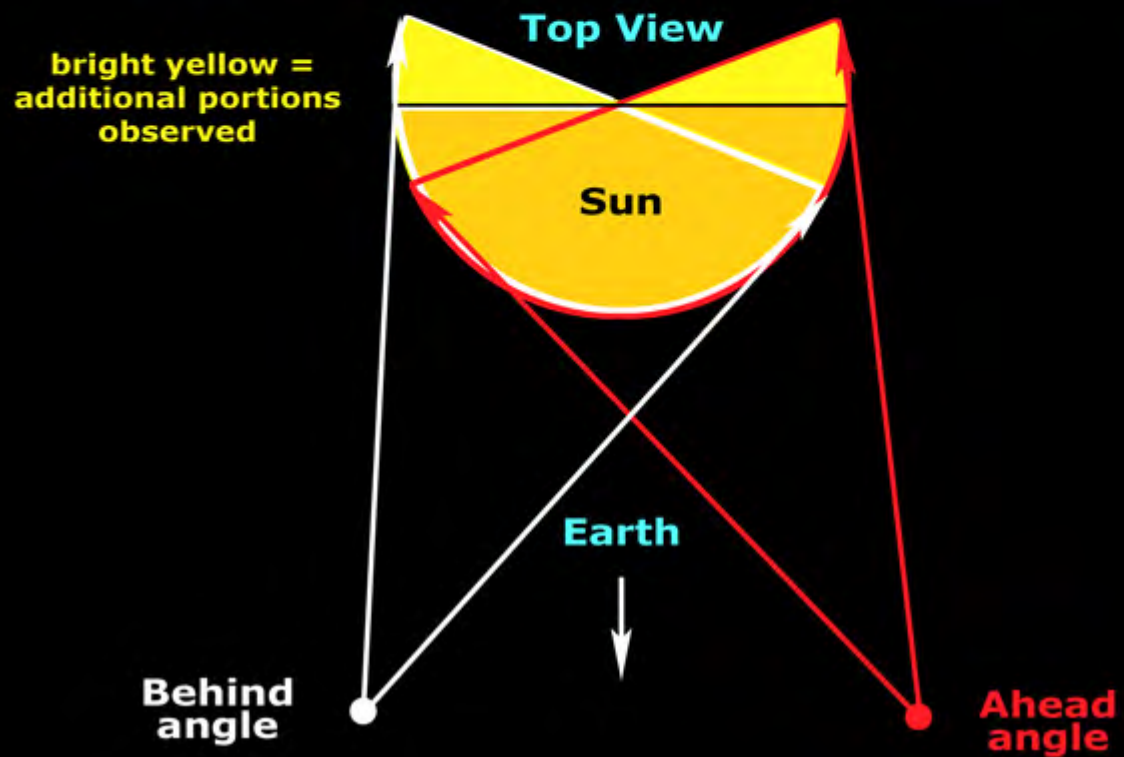
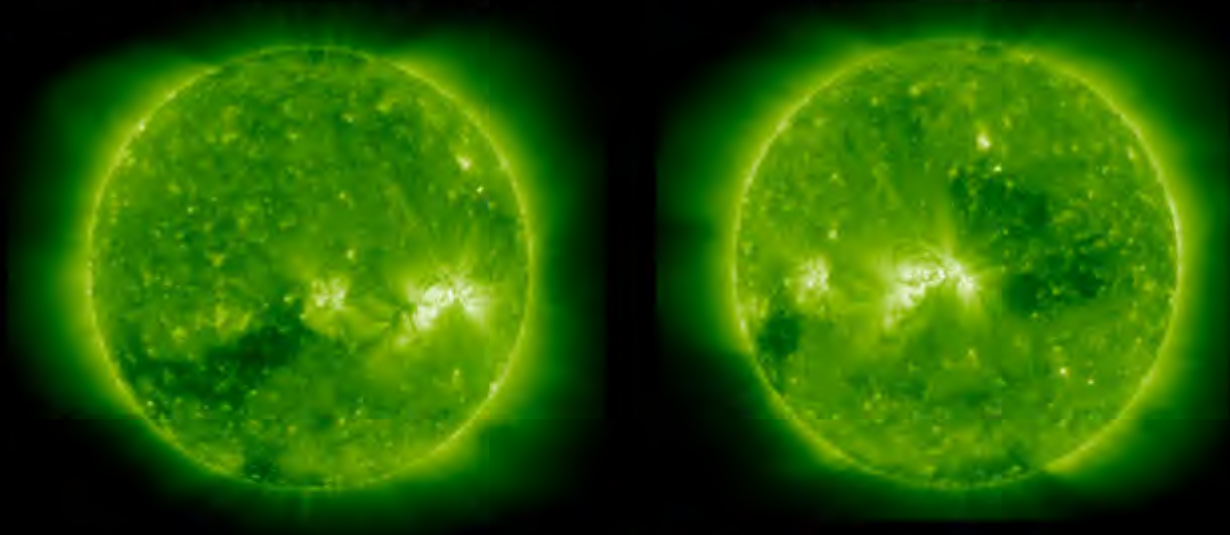
Mission Timeline

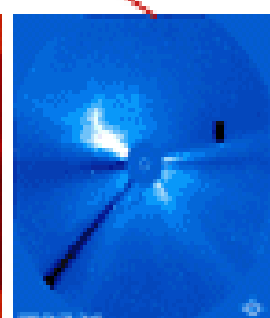
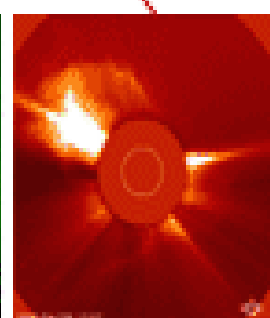
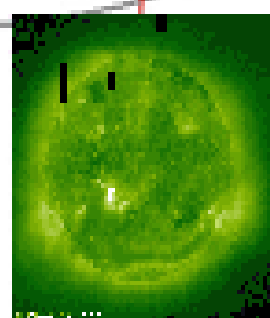
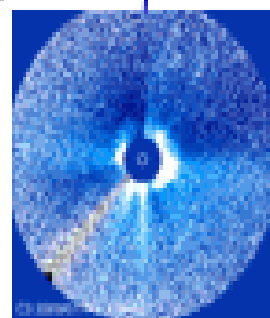
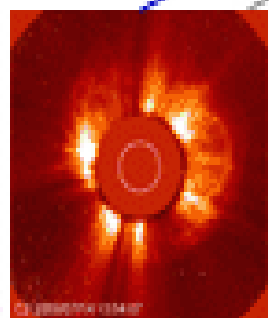
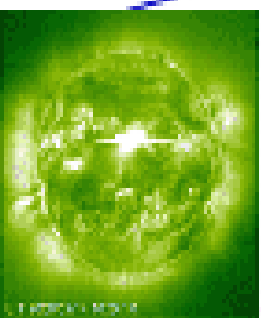
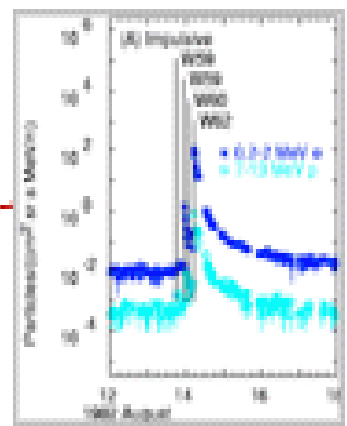
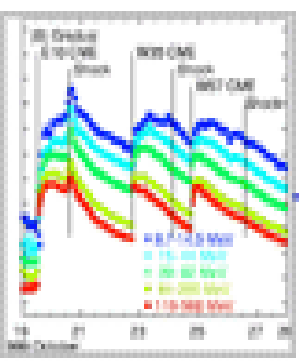
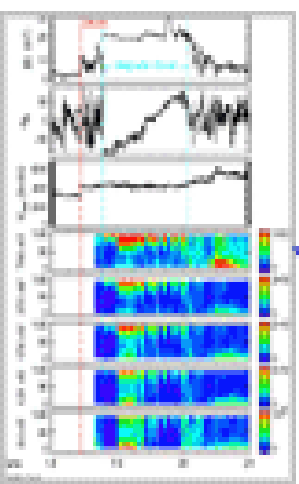
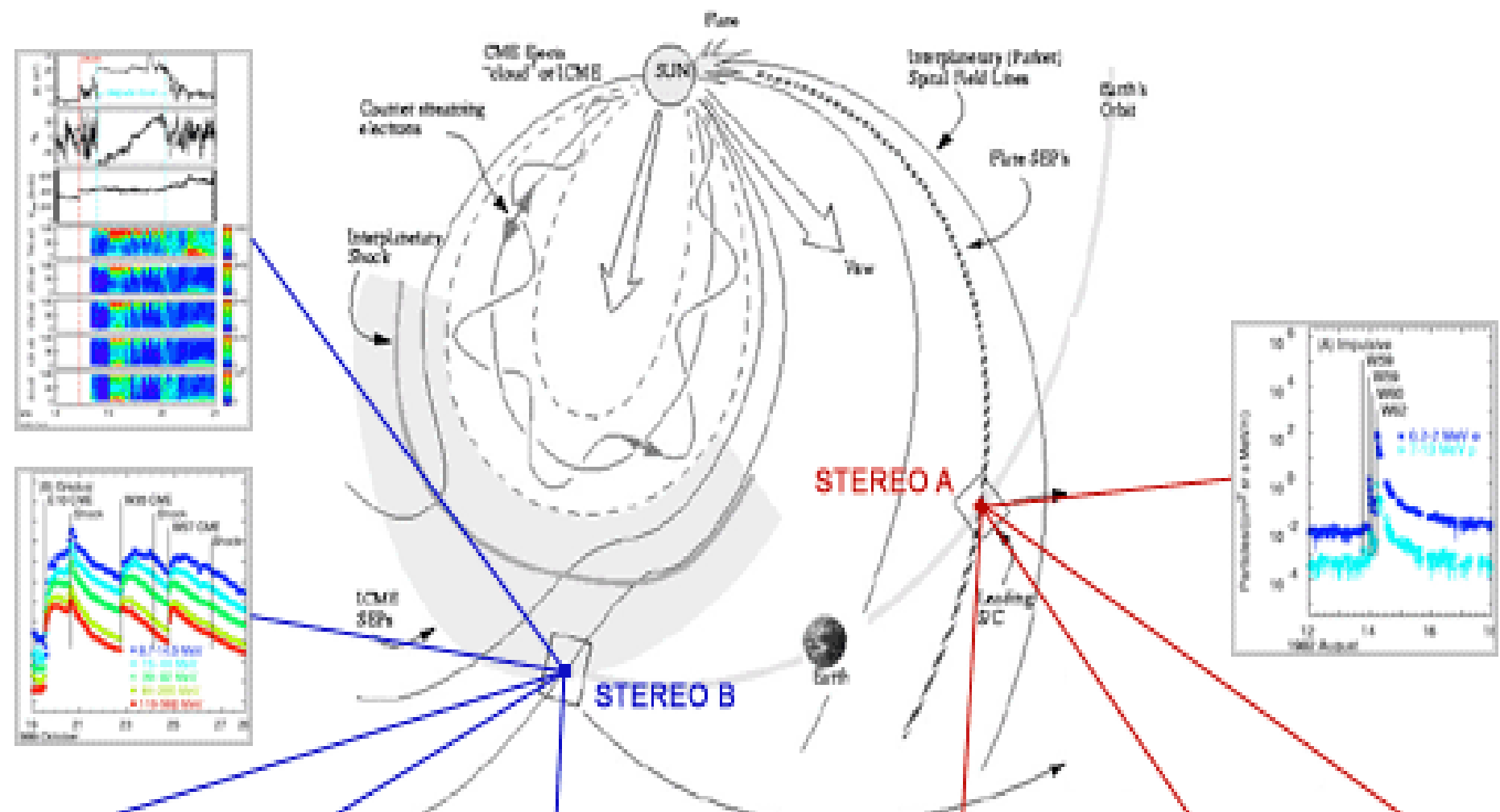




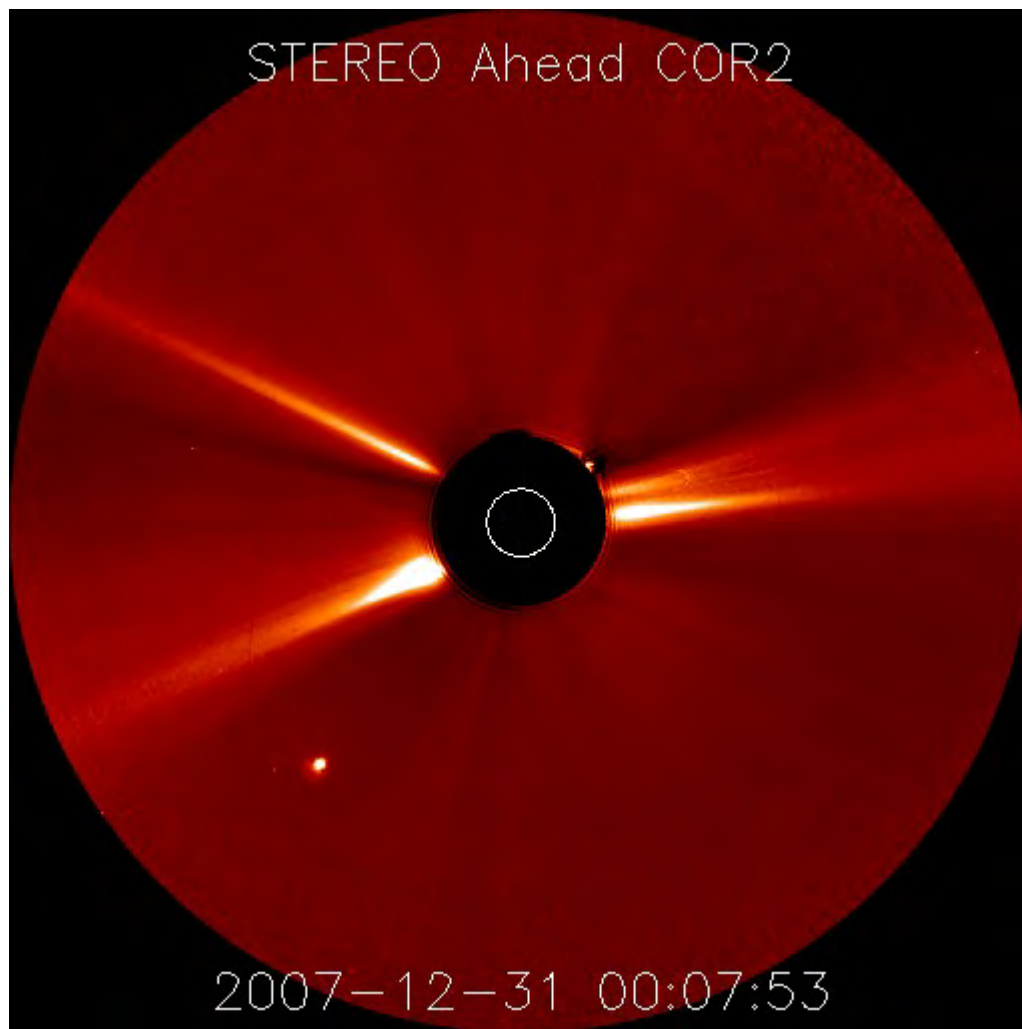
STEREO (Behind)

STEREO (Ahead)

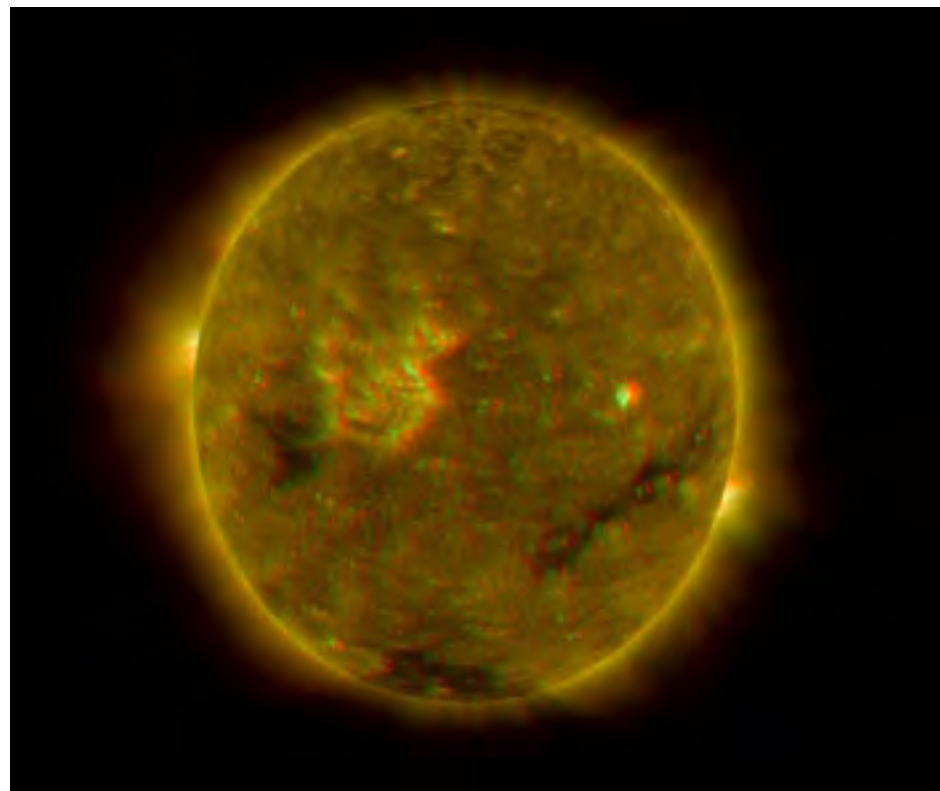
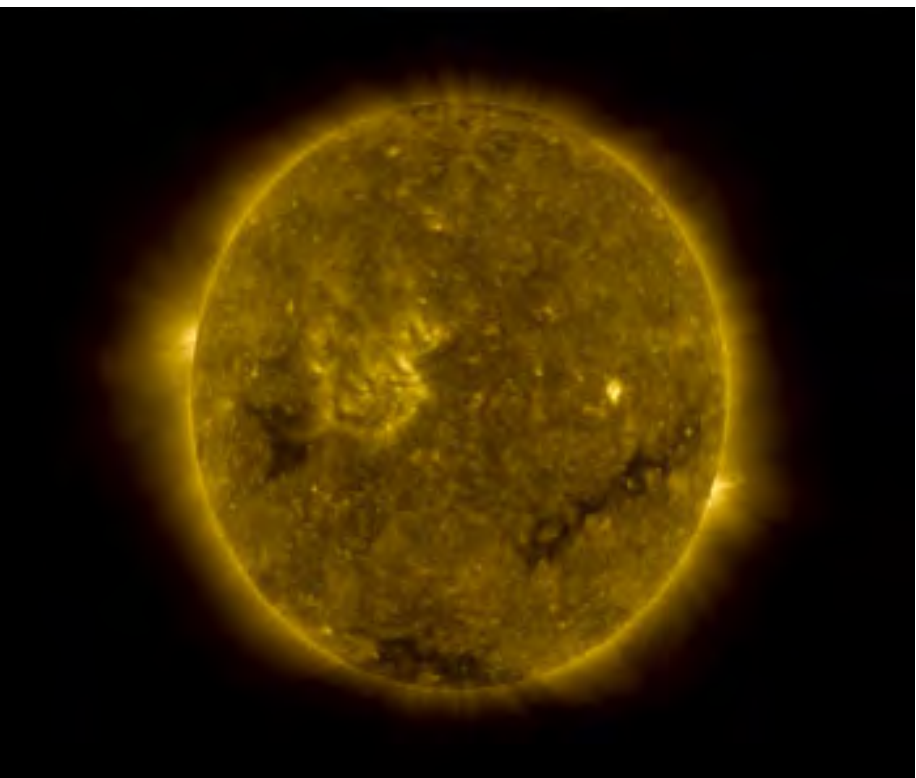




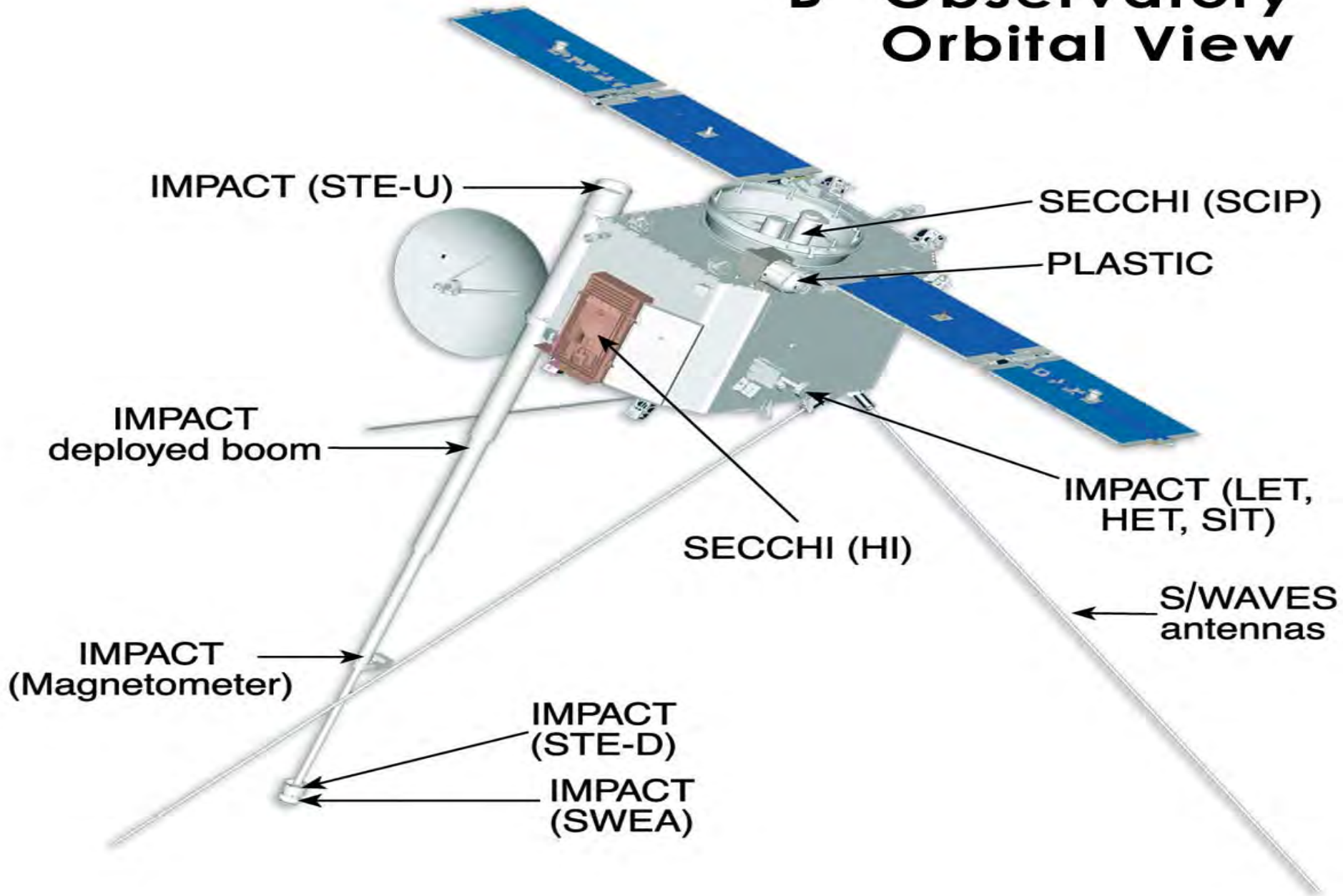
STEREO Ahead COR2



2007-12-31 00:07:53



"B" Observatory Orbital View



STEREO/WAVES.

Science Objectives

Type III
Radio Bursts

Type II
Radio Bursts

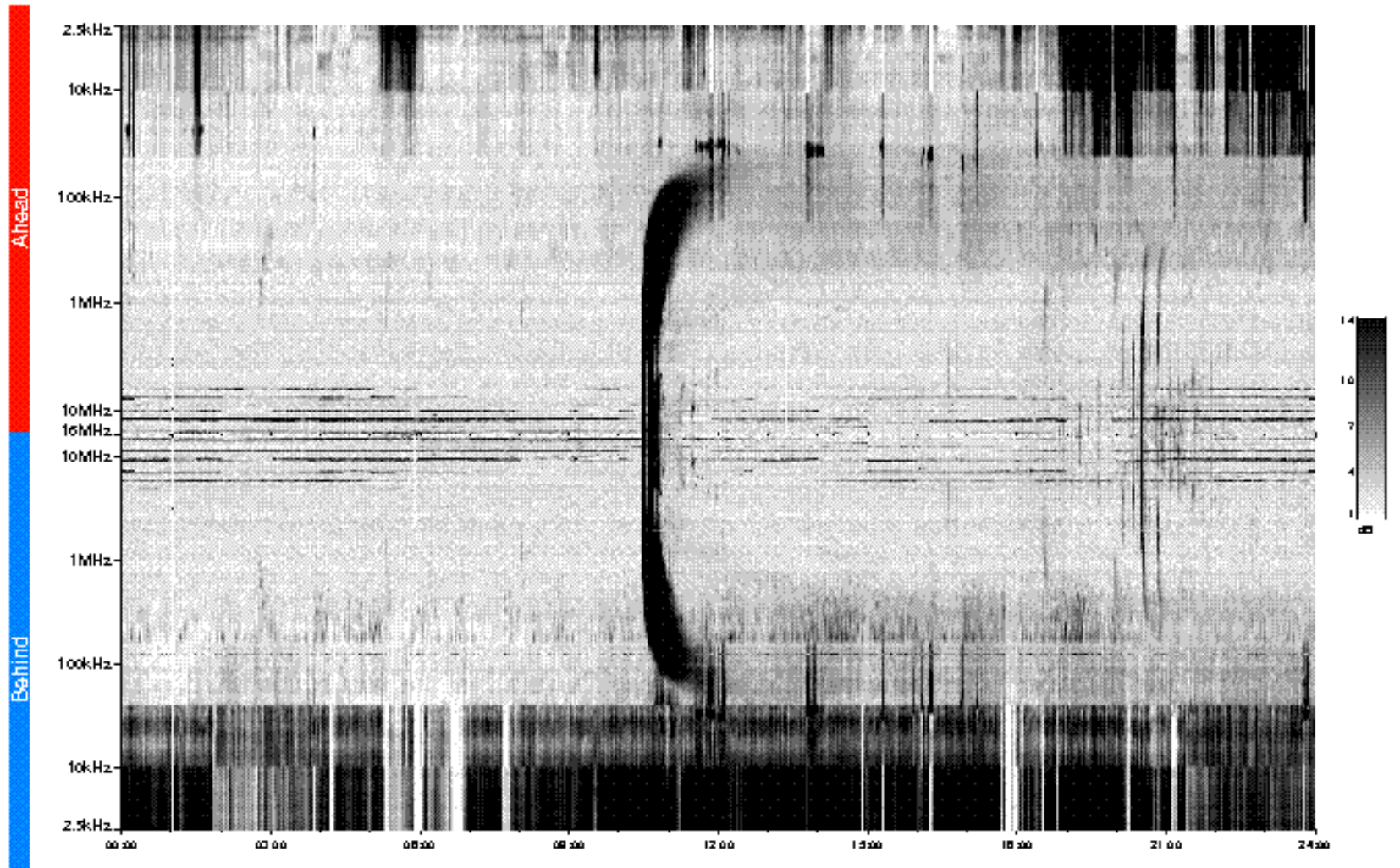
The STEREO/WAVES experiment will

- Track and probe CME-driven shocks from the corona to 1 AU
- Map the in situ structure of CME-driven shocks and flare electron beams
- Probe the density and IMF structure of the heliosphere before and after CMEs
- Understand the radio emission process and beam pattern of radio bursts
- Measure electron density and temperature of filament material in clouds

Receiver/role	Frequency	Sensitivity	Steps	Channels	Sample Rate/Period	Bit-Rate	Compressed Bit-Rate
HFR2 (spectrum)	2.025-16.025 MHz	6nV/sqrt(Hz)	200 kHz	71	16 sec	71	50
HFR1 (direction)	175 kHz-1.975 MHz	6nV/sqrt(Hz)	50 kHz	37	16 sec	148	100
LFRhi (direction)	40-160 kHz	6nV/sqrt(Hz)	log	16	16 sec	97.5	70
LFRlo (spectrum)	10-40 kHz	6nV/sqrt(Hz)	log	16	16 sec	25.5	18
FFR2	236.6 MHz	6nV/sqrt(Hz)	1	1	10s/sec	12	10
FFR1	50 MHz	6nV/sqrt(Hz)	1	1	10s/sec	12	10
TDS (waveform)	up to 250ks/s	33µV/m .2pTesla	8.192	4	12Mb/s	60	20
Housekeeping						8	8
Packet overhead						21	14
Total						455	300

STEREO/Waves Daily Summary - 05-Dec-2006 (339)

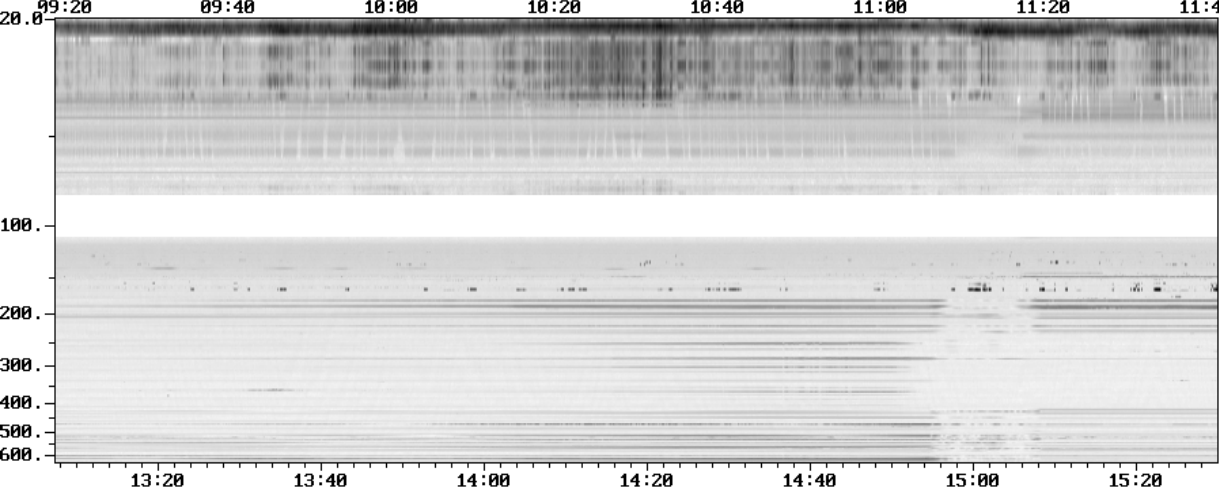
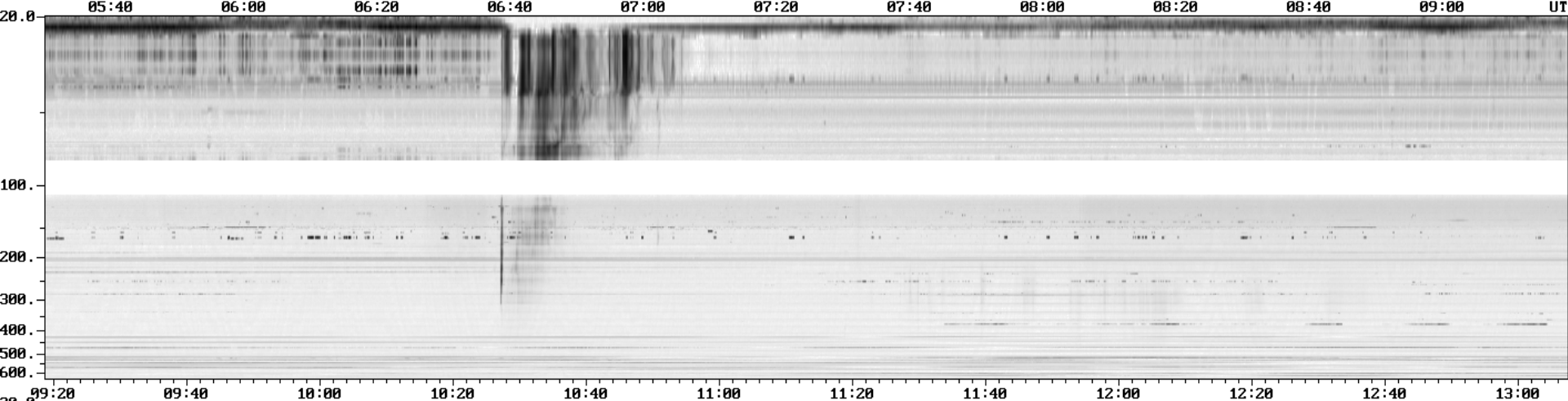
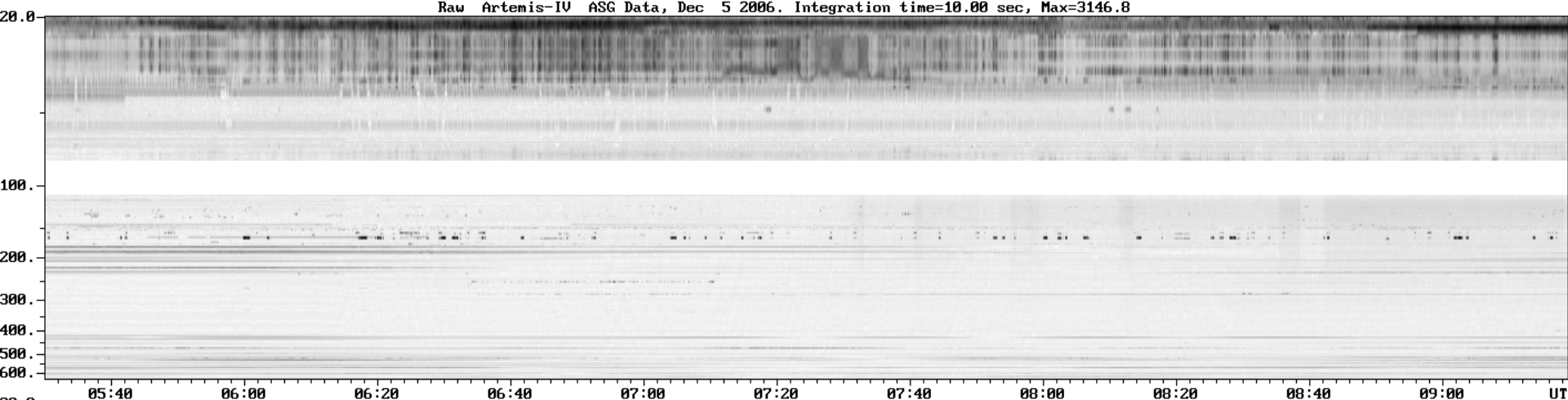
Ahead source file = swaves_ahead_2006_339_1_00.fn
Ahead PSE Angle = 3000x



Behind PSE Angle = 3000x
Behind source file = swaves_behind_2006_339_1_00.fn

Time (UTC)

swaves_summary_20061205_g
Produced on 05 Dec 2006 00:01:00 by the STEREO Data Center







Solar Proton Event August 1972

06:20 UT
Optical flare
observed

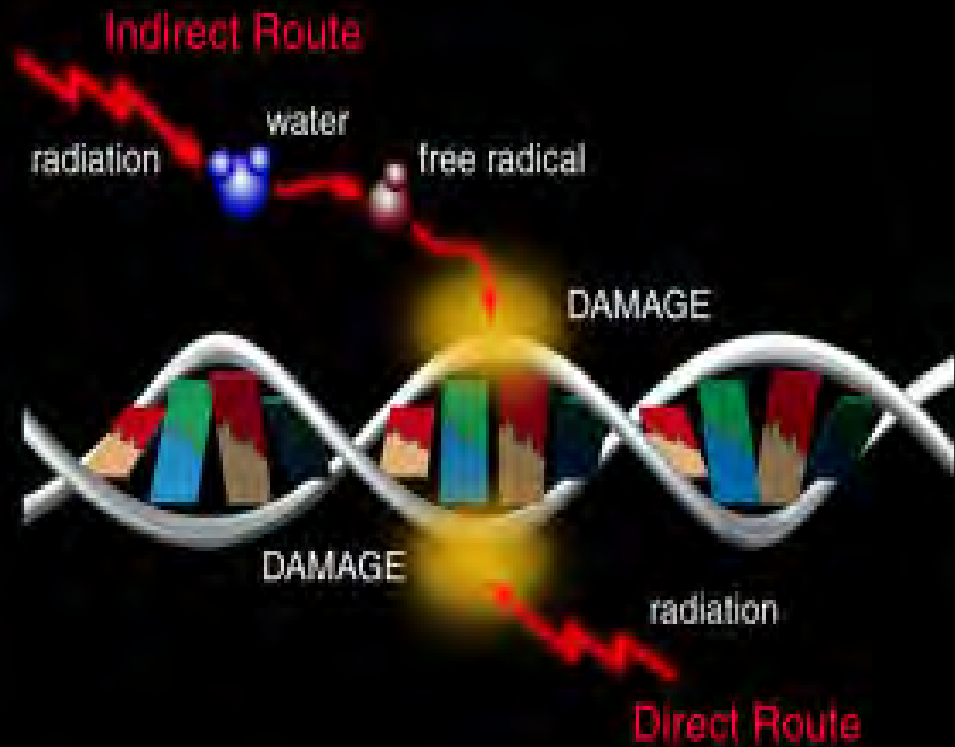
17:00 UT
Career radiation
limit for skin
exceeded

16:00 UT
yearly limit for
blood-forming
organs and
career limit for
eyes exceeded

15:00 UT
yearly limit
exceeded
for skin

14:00 UT
30-day radiation
exposure limit for blood-
forming organs (BFO) and
yearly limit for eyes exceeded

13:00 UT
Astronaut's allow-
able 30-day radia-
tion exposure to
skin & eyes
exceeded










Radiation Dose Limits (milliSieverts = mSv) for the Astronauts

	Time Period	Blood Forming Organs (BFO)	Eyes	Skin
	30 days	250	1000	1500
	Annual	500	2000	3000
	Career for Males	2000 mSv + 75 x (age in years-30) mSv	4000	6000
	Career for Females	2000 mSv + 75 x (age in years-38) mSv	4000	6000
	<p>* Cells (such as in the skin, eyes and blood-forming organs) that reproduce rapidly are the most susceptible to damage because they cannot repair themselves easily while replicating.</p>			
<p>** Limits set by the National Council on Radiation Protection and Measurements (NCRP) for all missions except exploratory circumstances in space (e.g., mission to Mars).</p>				

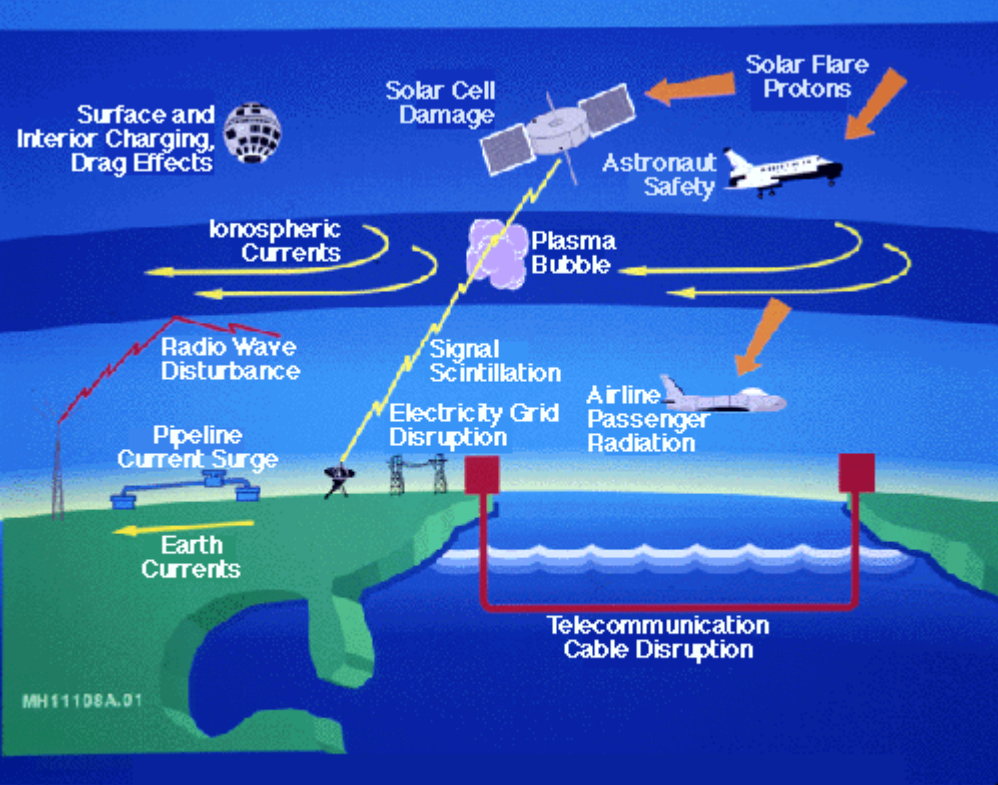
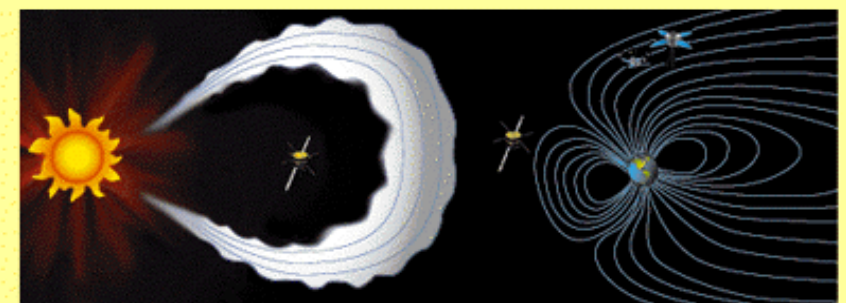
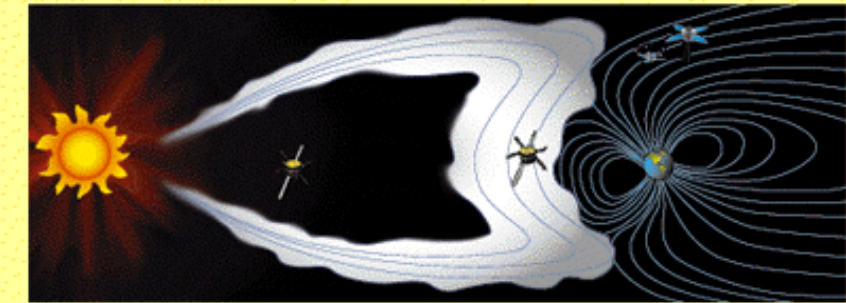


Image Credit: L. J. Lanzerotti, Bell Laboratories, Lucent Technologies, Inc.



Magnetic Cloud Event October 18-20, 1995





2003/10/28 08:24



2003/10/28 11:12



2003/10/28 11:30



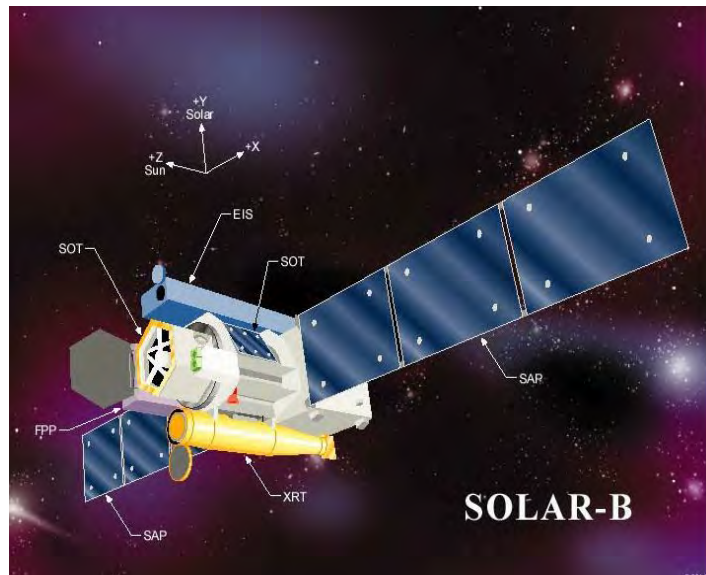
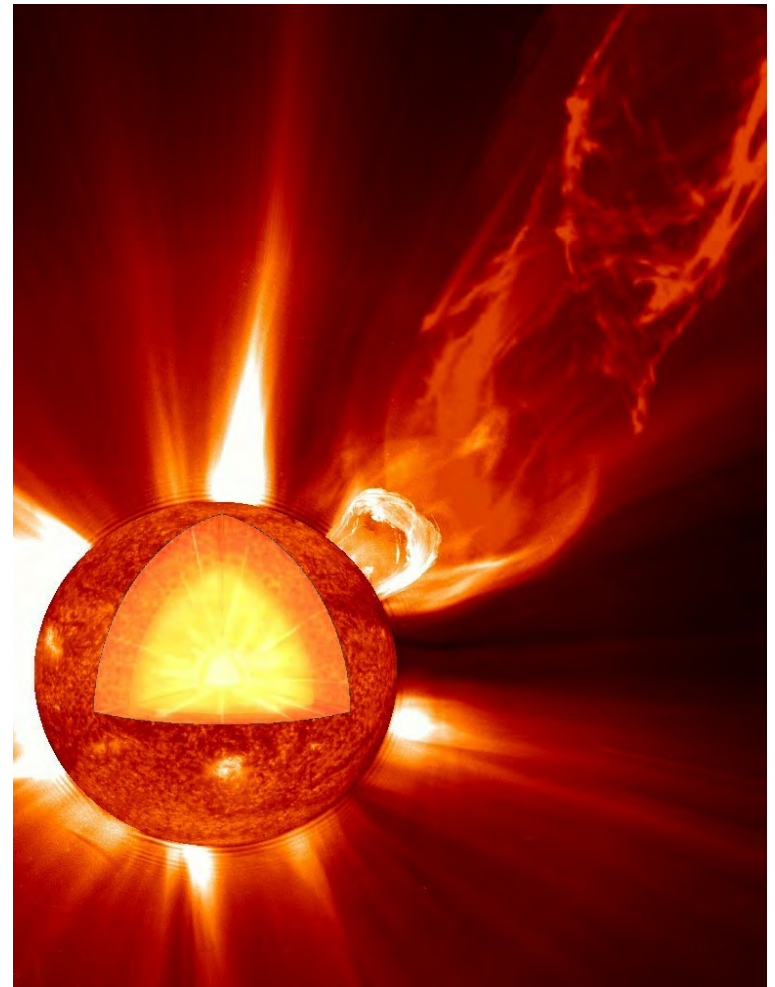
2003/10/28 12:40

Future Missions

STEREO (NASA -2005/11)



**Solar Dynamics Observatory
(NASA -2008/04)**



SOLAR-B



