Propagation

Propagation Tool

http://www.hamqsl.com/solar.html

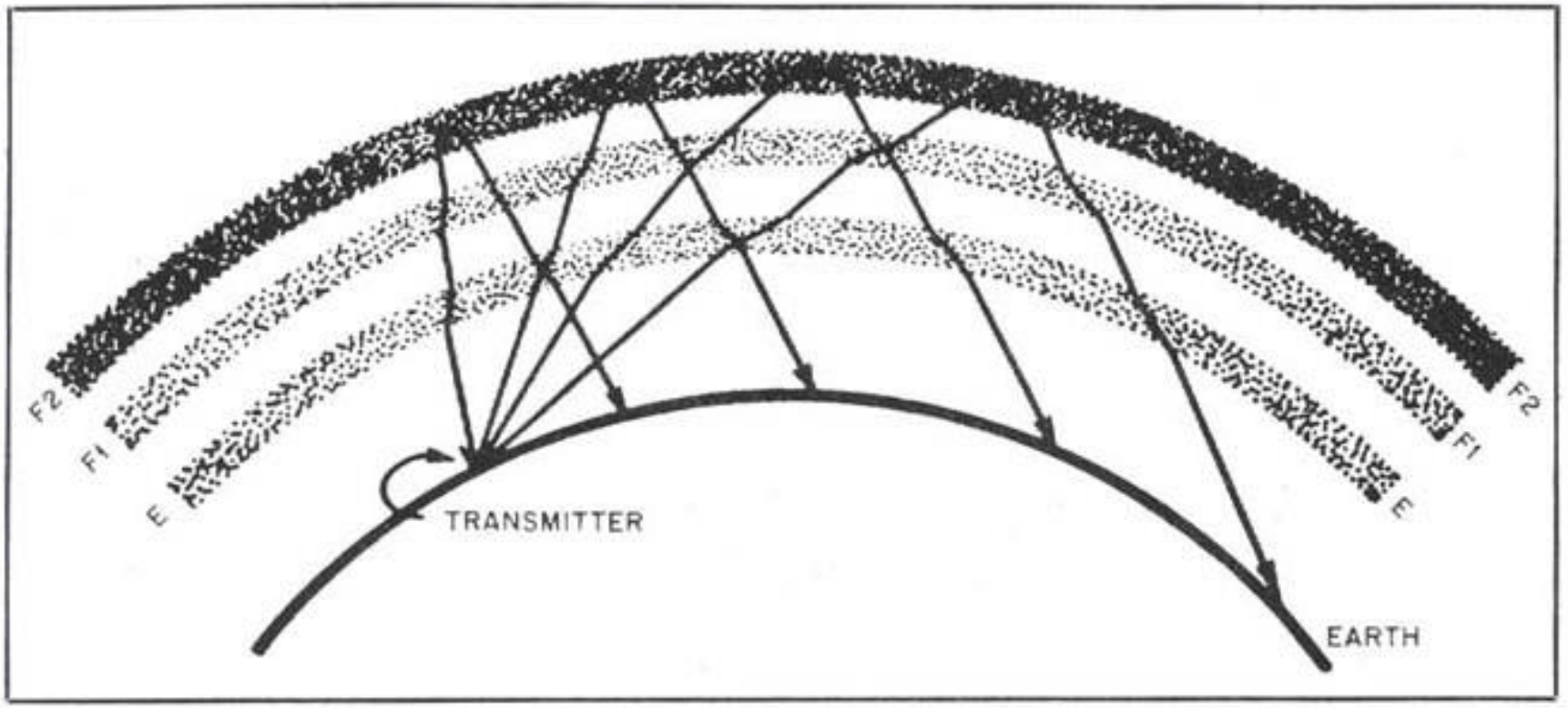
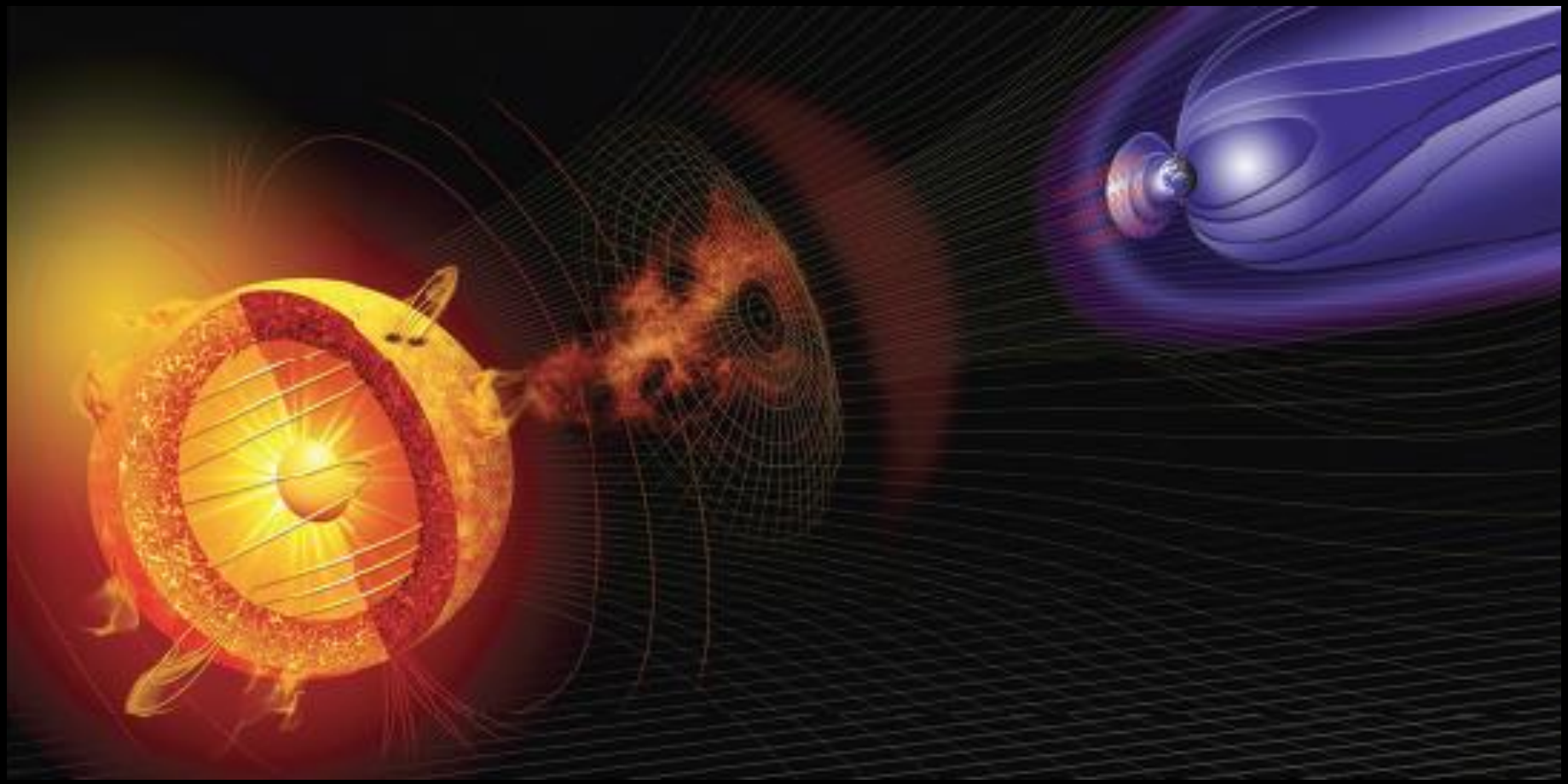
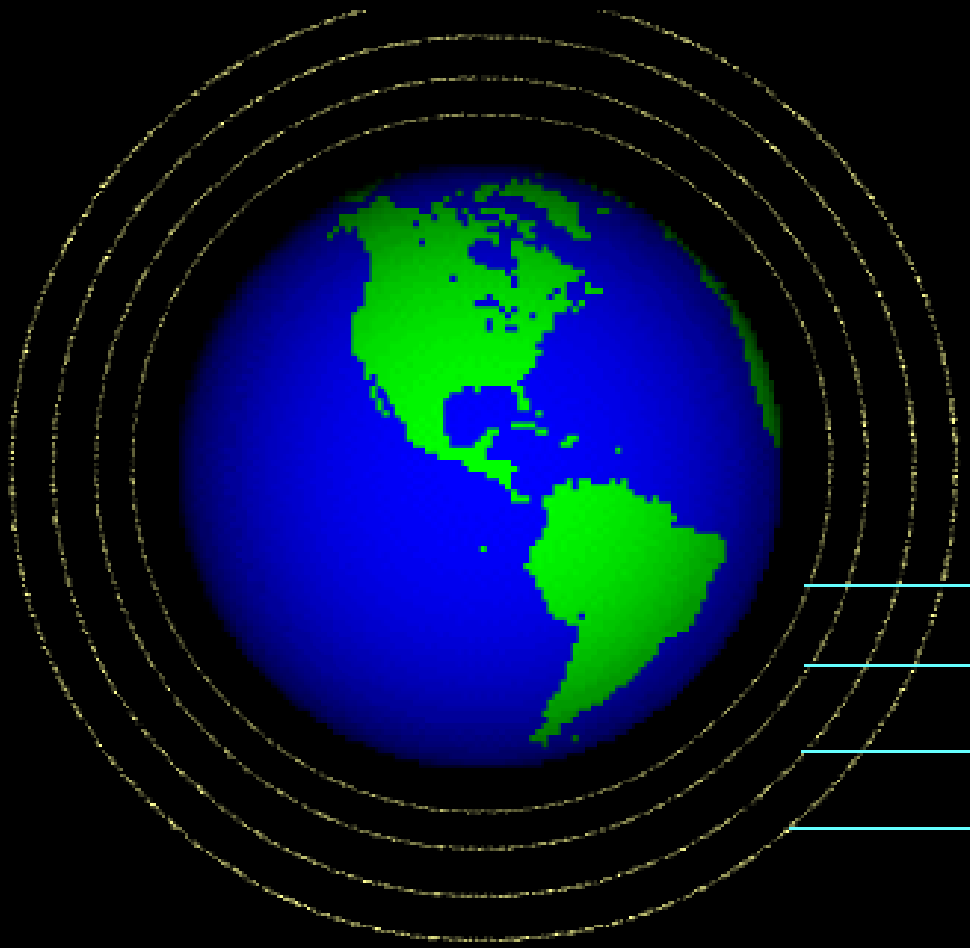


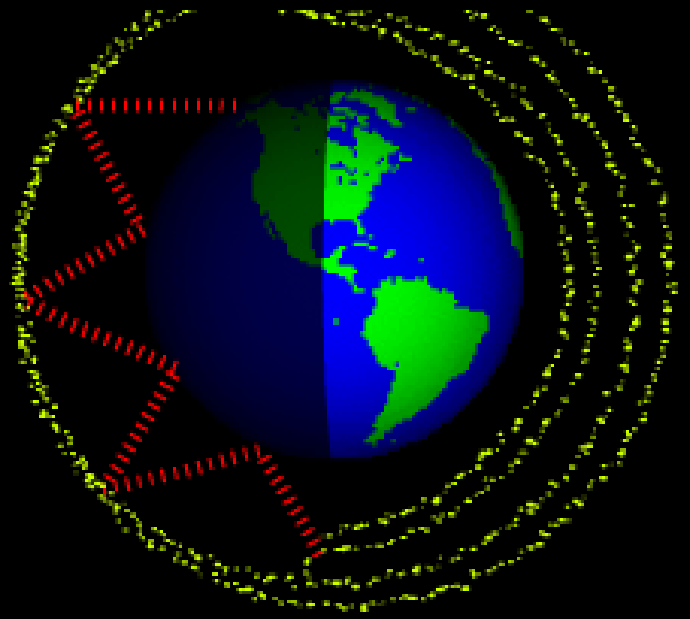
Fig. 10 — Typical daytime propagation of high frequencies (14 to 28 MHz). The waves are partially bent in going through the E and F1 layers, but not enough to be returned to earth. The actual reflection is from the F2 layer.

Refraction and reflection of HF radio waves, from *The ARRL Antenna Book*.

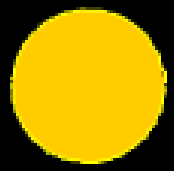




The four distinct regions of the Ionosphere are labeled **D**, **E**, **F1**, and **F2**.



At night, the D layer dissapears and E becomes very weak since they can't stay ionized very long.



Also, F1 and F2 combine to create a single layer. Lower frequencies are now useful since the D layer is no longer there to absorb them. This is why you can hear AM radio stations from all over the country at night.

The Ionosphere is made up of several layers at varying heights above the ground:

The lowest level is the D Layer (37 to 56 miles), which does not contribute to propagation, but actually works against world wide reception by absorbing most of the energy in the transmitted wave.

The dominant gases in the D layer are Nitric Oxide and Hydrogen, which is forced to emit ultra-violet and infra red emissions during the daytime hours. Ionization is mainly by hard X rays

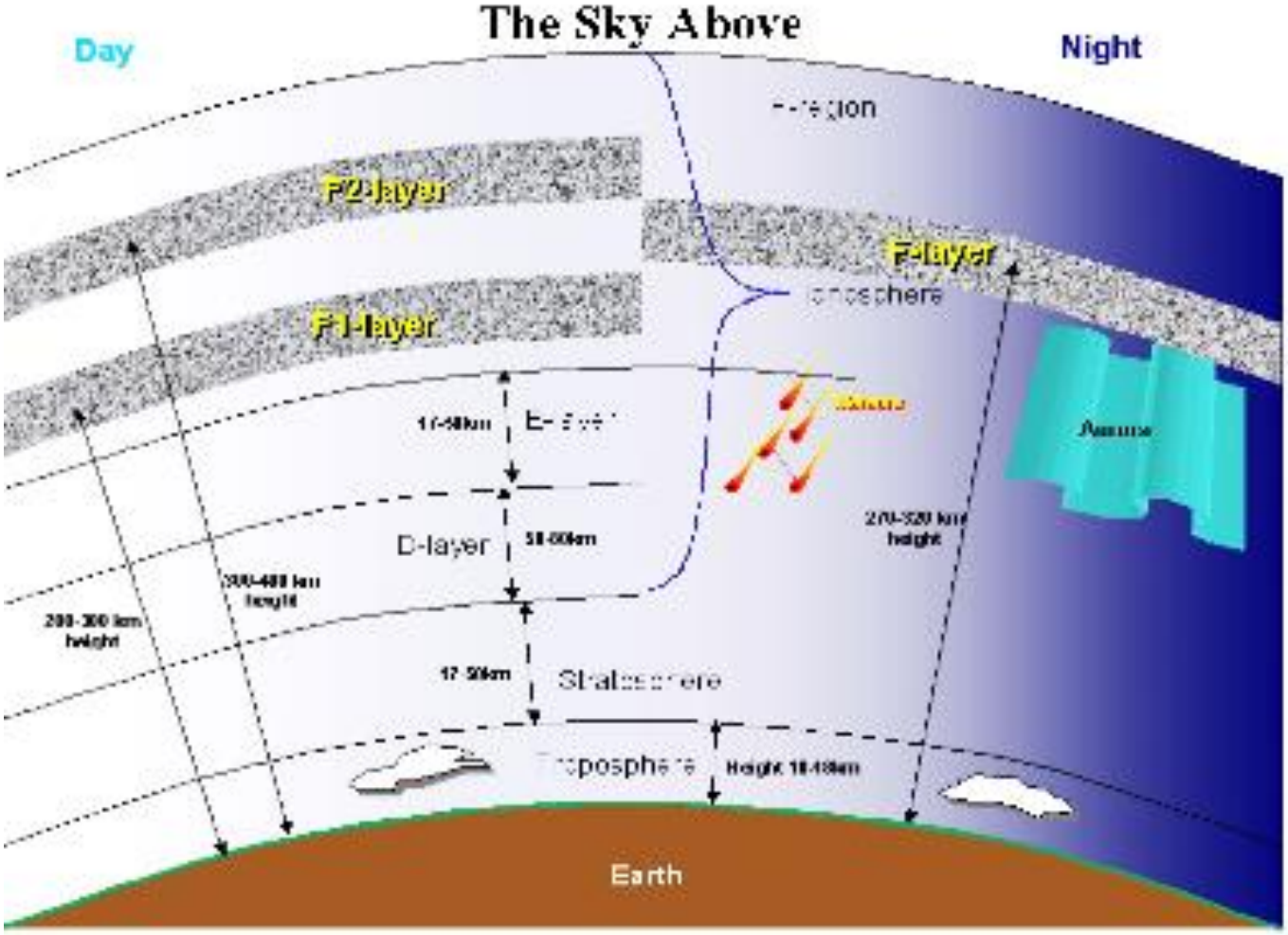
These gases cannot hold ionization very long, hence, the D layer disappears rapidly after local sunset.

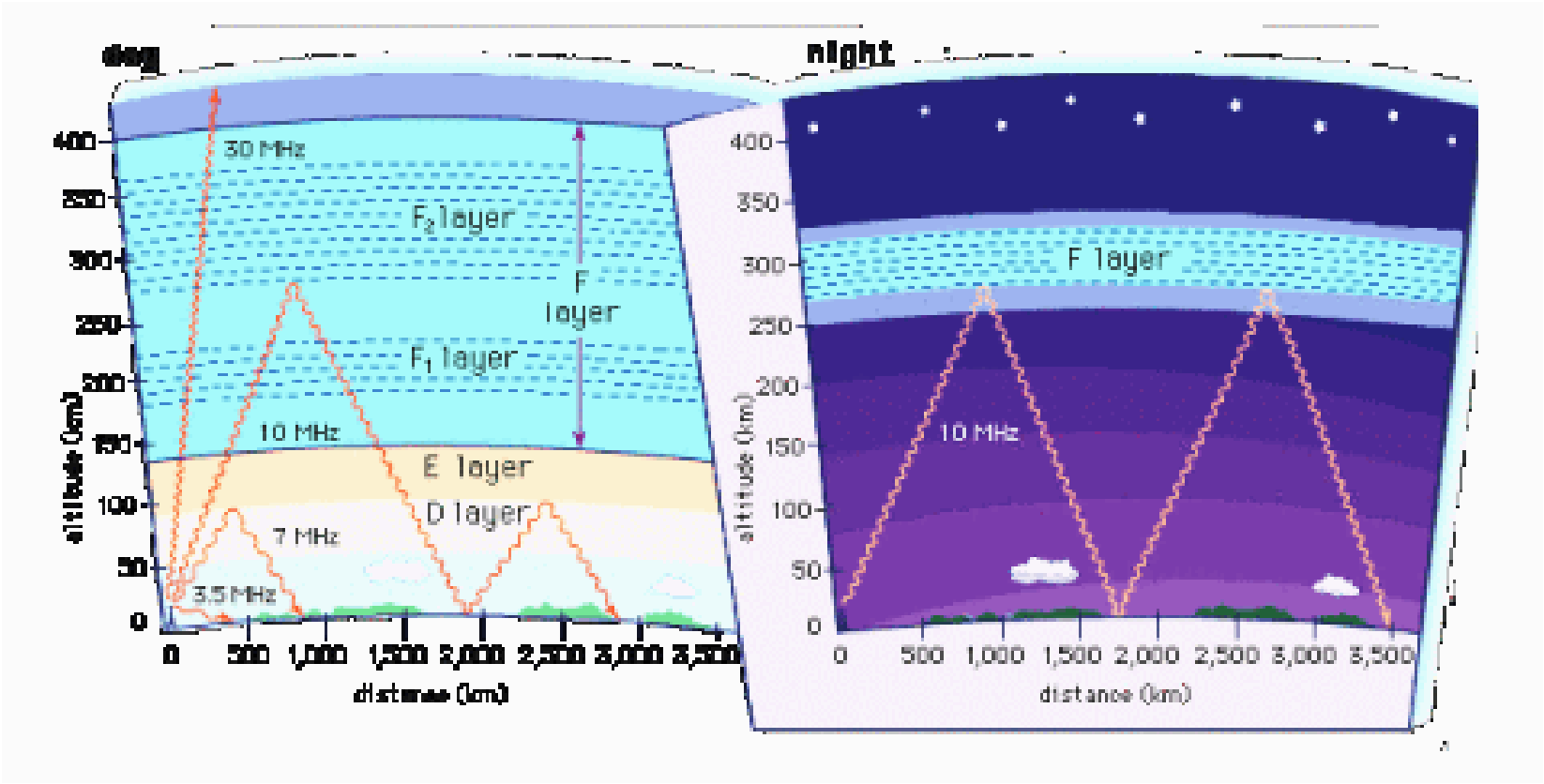
The E layer (56 to 75 miles) sometimes can produce sporadic HF propagation due to soft X ray emission and ultra-violet stimulation of Molecular oxygen (O2). Sporadic E propagation is still not well understood and still is being investigated by planetary science.

The F1 and F2 layers (75 to 320 miles) are the layers that most contribute to HF propagation. Dominant gases are Hydrogen and Helium, with trace components of Neon, Argon, Xenon, and Krypton.

At night, the two layers merge and form a single F layer.

Ionization is mostly via solar UV emission.

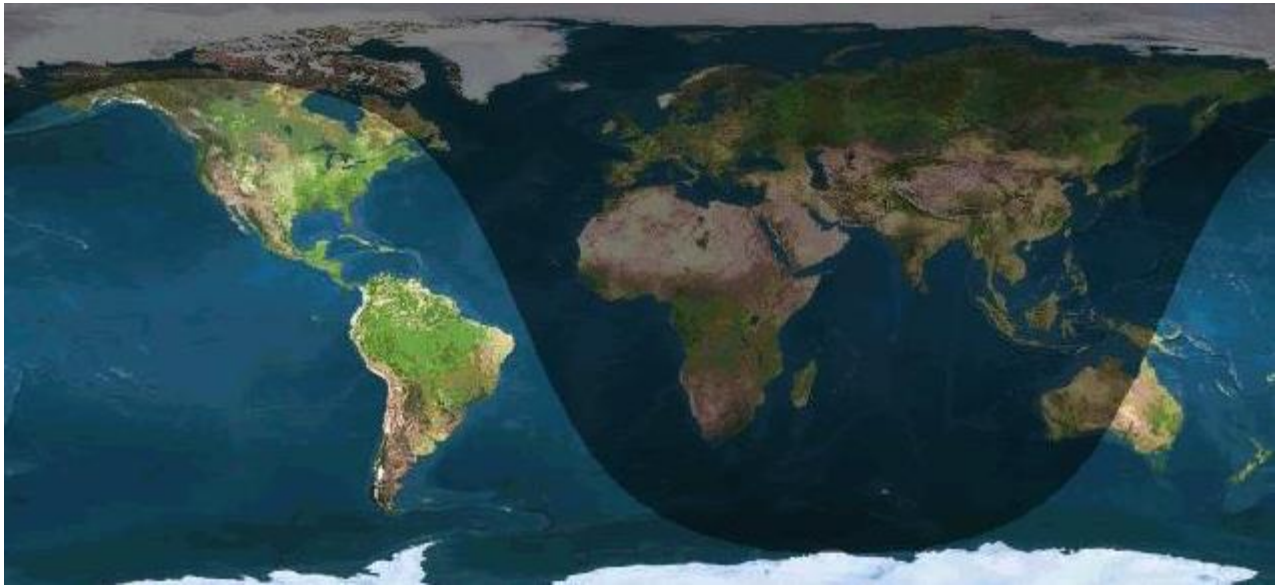

The Sky Above
Day
Night
F2-layer
F1-layer
F-layer
D-layer
Earth

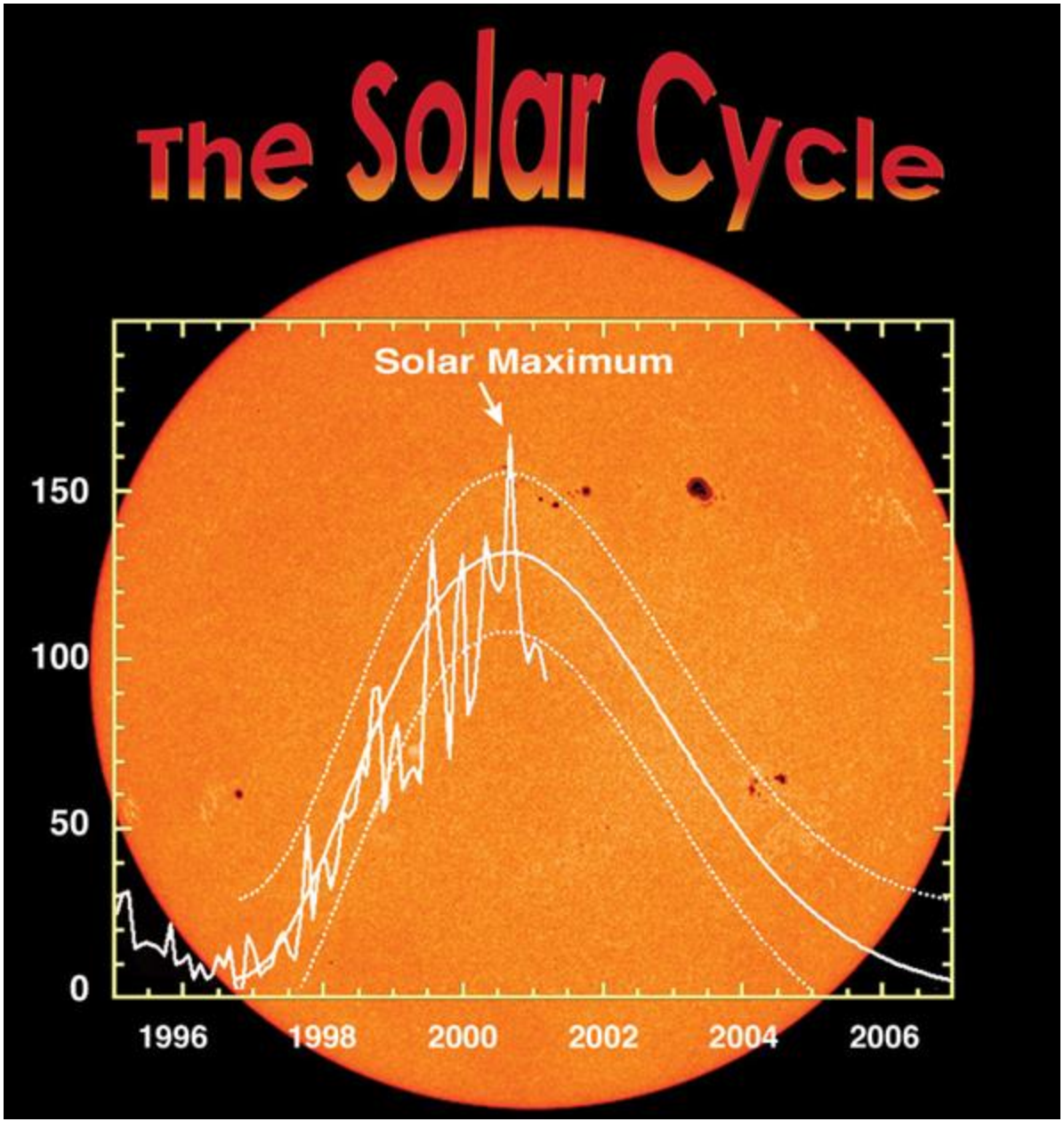


Specific ionization conditions vary greatly between day (left) and night (right), causing radio waves to reflect off different layers of the ionosphere or transmit through them, depending upon their frequency and their angle of transmission. Under certain conditions of location, ionization, frequency, and angle, multiple "skips," or reflections between ionosphere and Earth, are possible. At night, with no intervening layers of the ionosphere present, reflection off the F layer can yield extremely long transmission ranges

Grey Line Map

The grey line is a band around the Earth that separates the daylight from darkness. Radio propagation along the grey line is very efficient. One major reason for this is that the D layer, which absorbs HF signals, disappears rapidly on the sunset side of the grey line, and it has not yet built upon the sunrise side. Ham radio operators and shortwave listeners can optimize long distance communications to various areas of the world by monitoring this area as it moves around the globe. This map shows the current position of the grey line terminator




The Solar Cycle
Solar Maximum
150
100
50
0
1996
1998
2000
2002
2004
2006

How Big is the SUN?

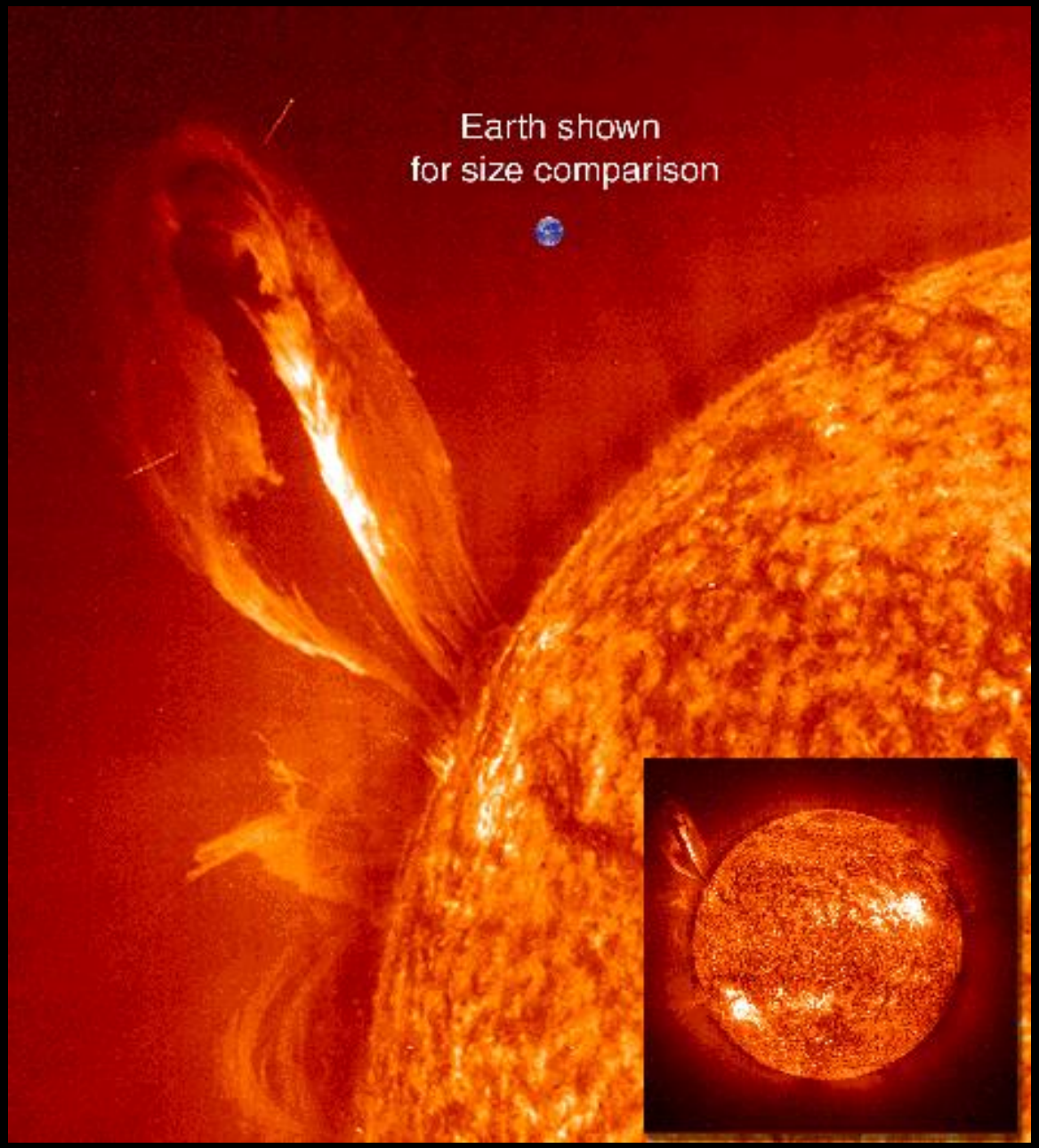
Our Sun has a diameter of 1.4 million km and Earth a diameter of almost 13,000 km

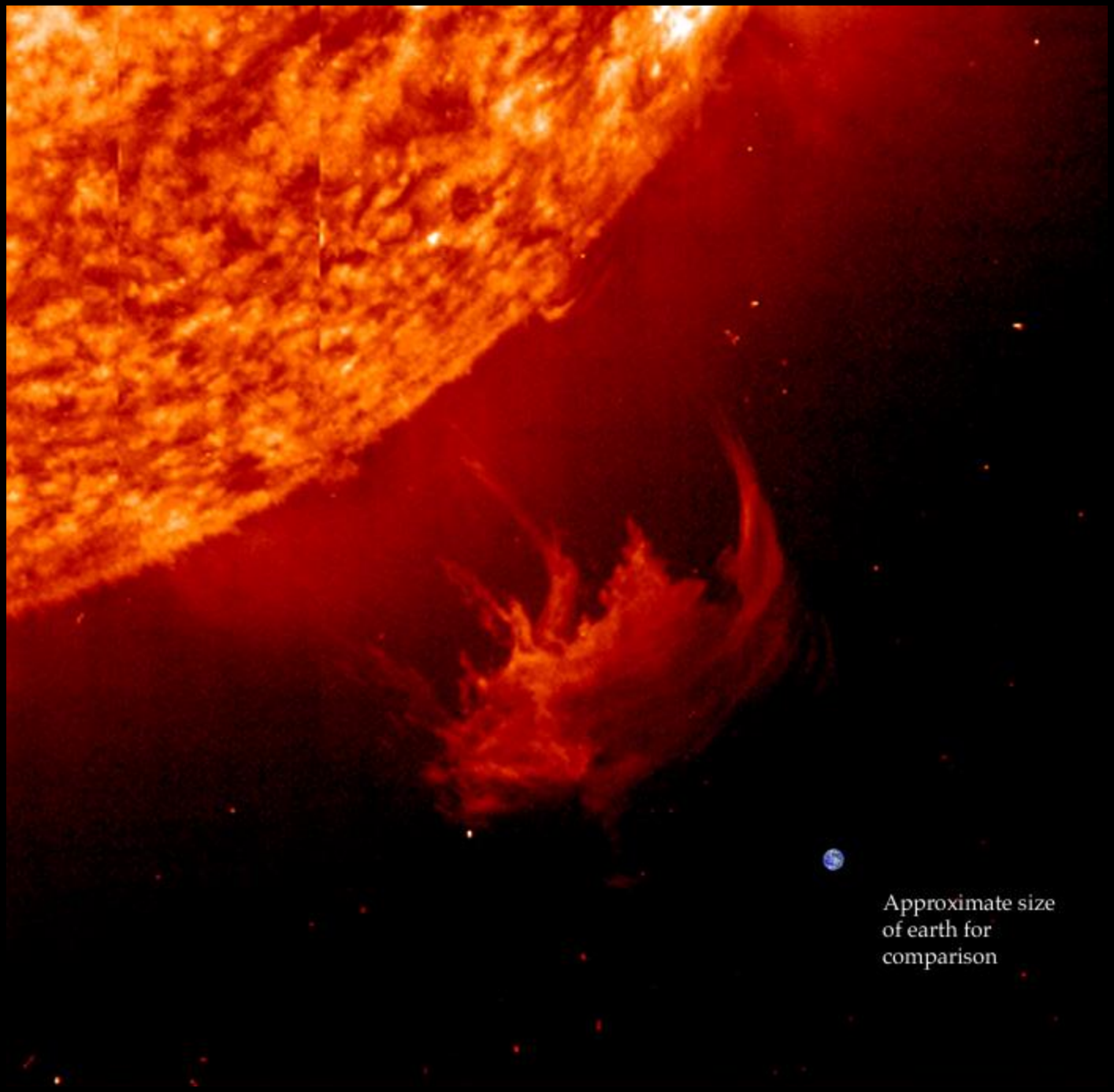
If the Sun were the size of an official league basketball, Earth would be a little dot no more than 2.2 millimeters

See how our Solar System's planets would look like in the same scale

Orbital distances are not depicted proportionally

DESIGN BY ALEX LUTKUS

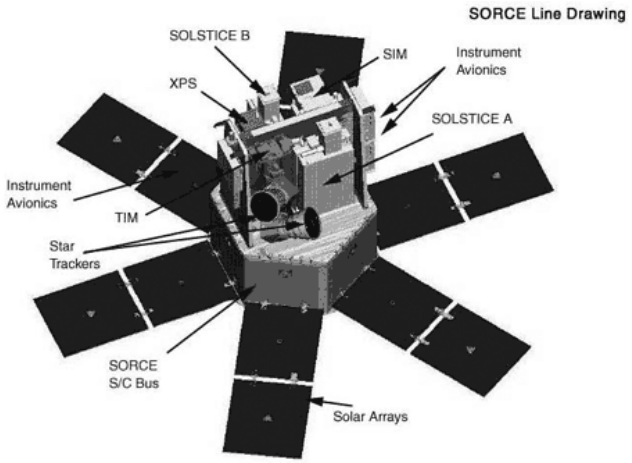

Earth shown
for size comparison


Approximate size
of earth for
comparison

Observation of Solar Weather From Earth

- SOHO – The Solar & Heliospheric Observatory 1995
- SDO - THe Solar Dynamics Observatory 2010

SOHO, the Solar and Heliospheric Observatory, is a project of international cooperation between ESA and NASA to study the Sun, from its deep core to the outer corona, and the solar wind.
Together with ESA's Cluster mission, SOHO is studying the Sun-Earth interaction from different perspectives.
SOHO's easily accessible, spectacular data and basic science results have captured the imagination of the space science community and the general public alike.

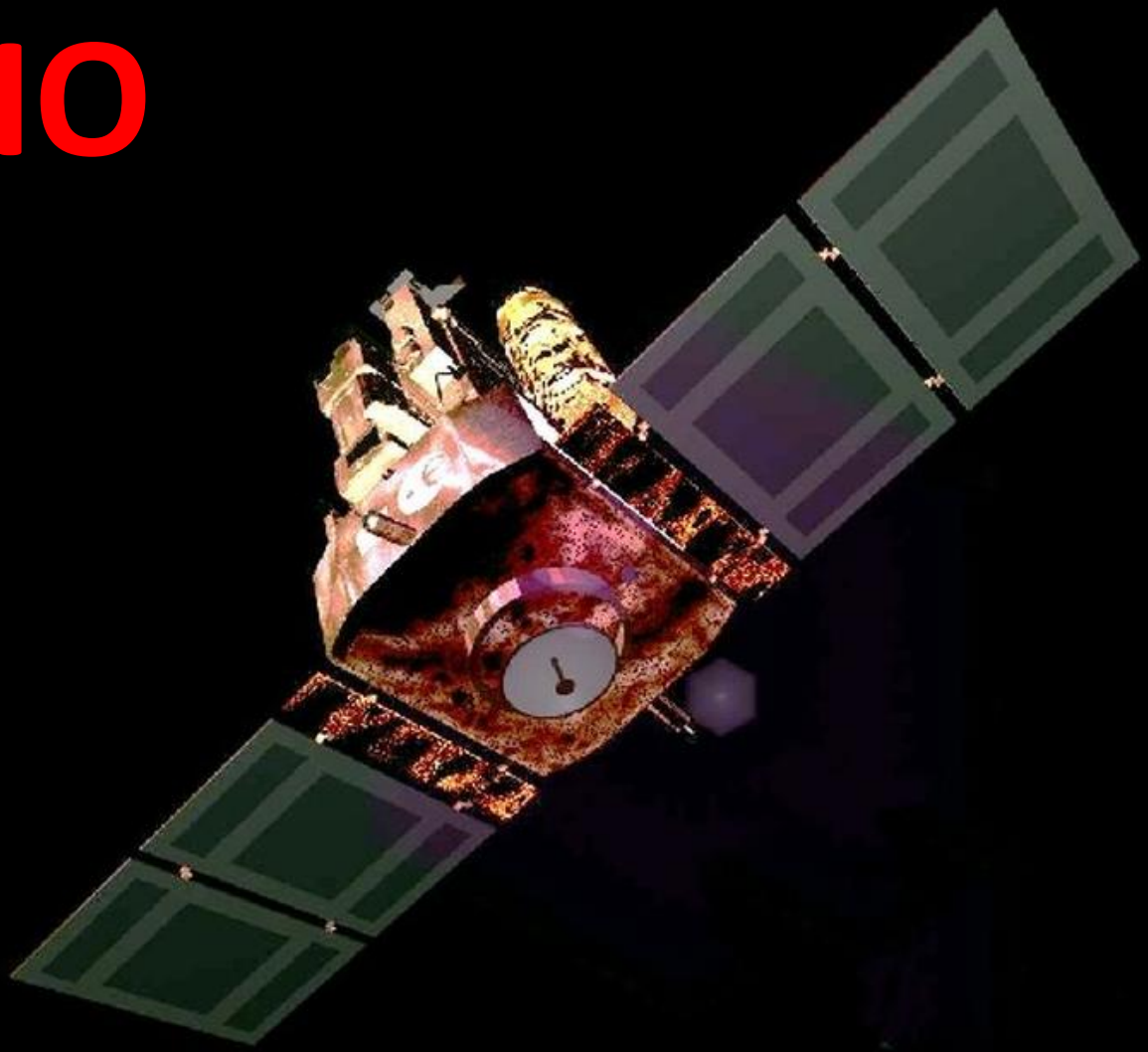


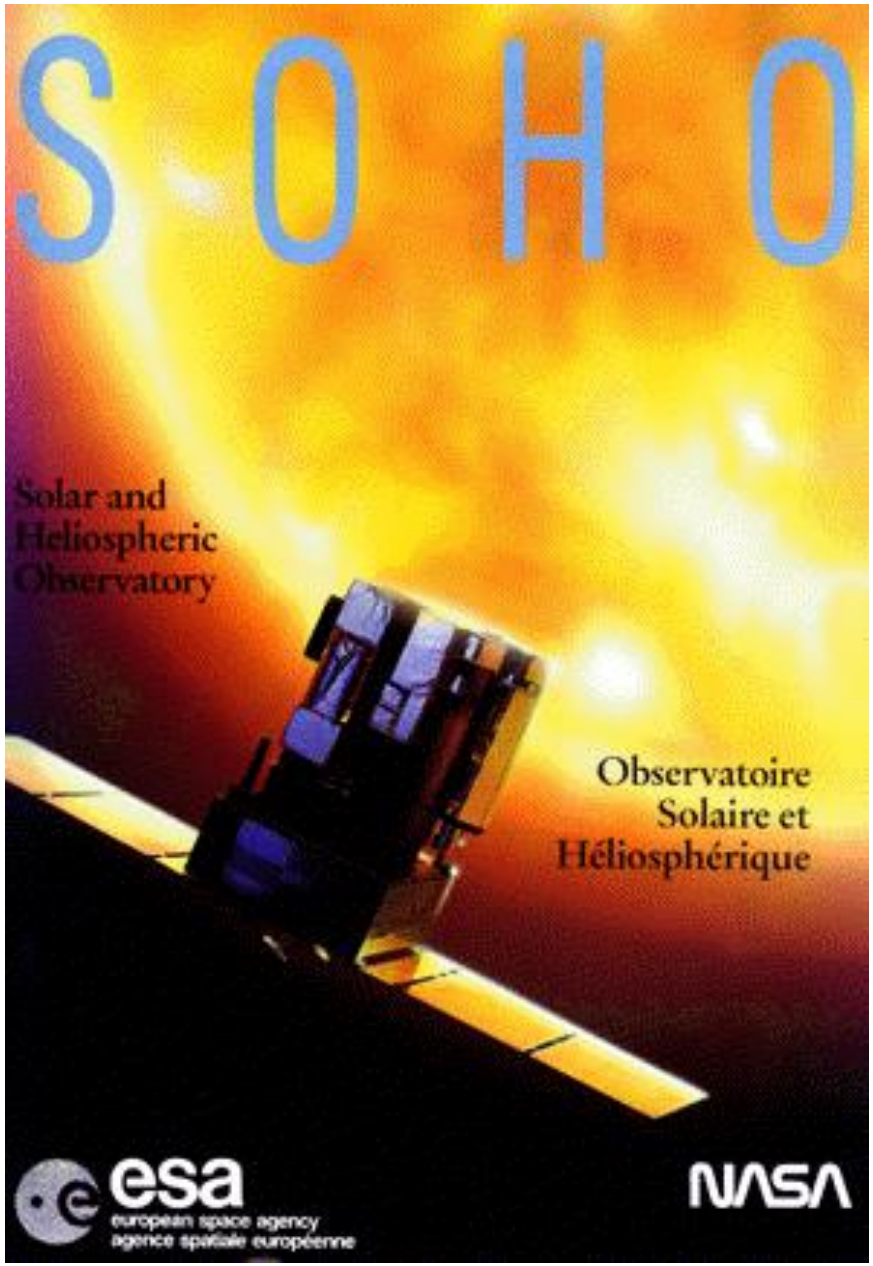
SOHO is operated from NASA's Goddard Space Flight Center (GSFC) near Washington. There an integrated team of scientists and engineers from NASA, partner industries, research laboratories and universities works under the overall responsibility of ESA. Ground control is provided via NASA's Deep Space Network antennae, located at Goldstone (California), Canberra (Australia), and Madrid (Spain).

SOHO, the Solar & Heliospheric Observatory, is a project of international collaboration between ESA and NASA to study the Sun from its deep core to the outer corona and the solar wind.

SOHO was launched on December 2, 1995. The SOHO spacecraft was built in Europe by an industry team led by prime contractor Matra Marconi Space (now EADS Astrium) under overall management by ESA. The twelve instruments on board SOHO were provided by European and American scientists. Nine of the international instrument consortia are led by European Principal Investigators (PI's), three by PI's from the US. Large engineering teams and more than 200 co-investigators from many institutions supported the PI's in the development of the instruments and in the preparation of their operations and data analysis. NASA was responsible for the launch and is now responsible for mission operations. Large radio dishes around the world which form NASA's Deep Space Network are used for data downlink and commanding. Mission control is based at Goddard Space Flight Center in Maryland.

SOHO




S O H O
Solar and
Heliospheric
Observatory
Observatoire
Solaire et
Héliosphérique
esa
european space agency
agence spatiale européenne
NASA

How Big is SOHO ?

SOHO DIMENSIONS	
Height	4.30 m
Breadth	2.70 m
Width	3.65 m

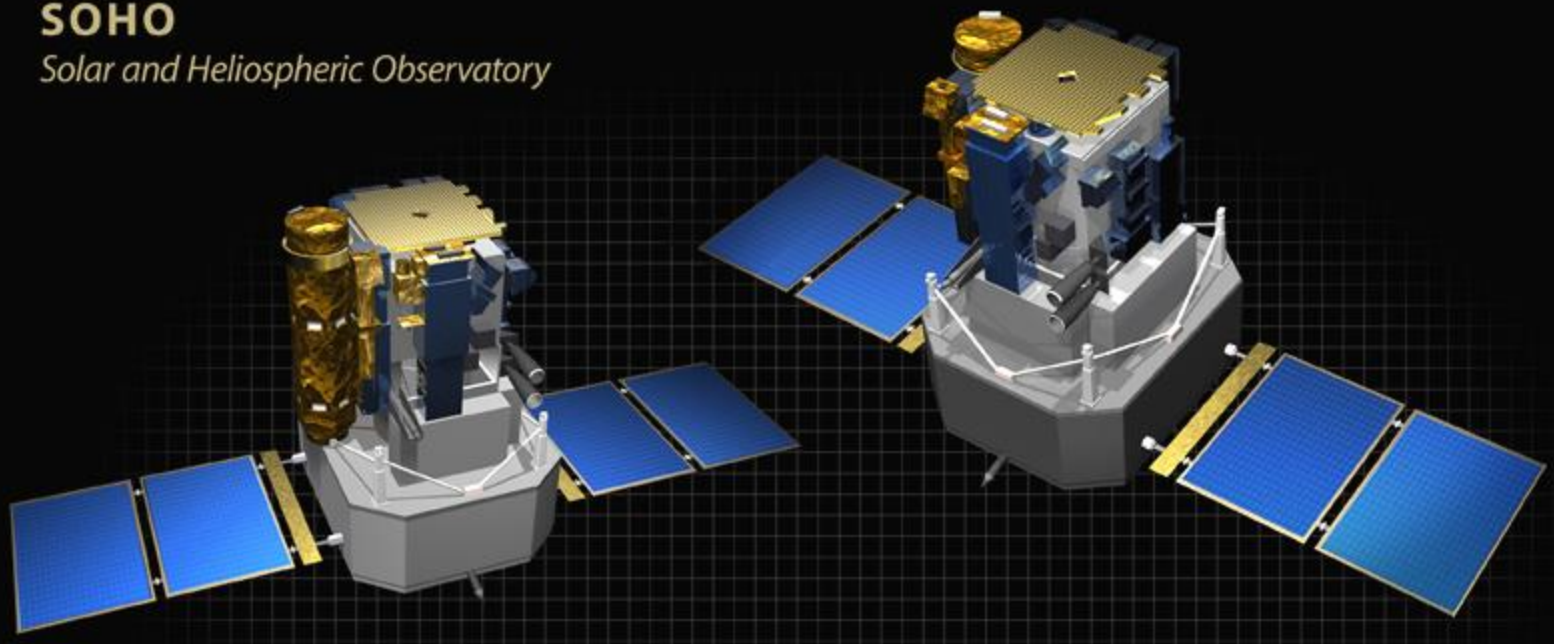
SOHO is almost as tall as a one-story house.

With the solar array deployed SOHO is 9.5 meters wide. Bigger than a large school bus!

DESIGN BY ALEX LUTKUS

SOHO

Solar and Heliospheric Observatory



Since its launch on 2 December 1995, SOHO – a project of international cooperation between ESA and NASA – has revolutionized our understanding of the Sun.

In an orbit 1.5 million kilometers from Earth it has provided the first images of structures and flows below the Sun's surface and of activity on its far side . It has revealed the Sun's extremely dynamic atmosphere, provided evidence for upward transfer of magnetic energy from the surface to the corona through a "magnetic carpet", and identified the source regions of the fast solar wind.

It has revolutionized our understanding of solar-terrestrial relations and dramatically improved our space weather forecasting capabilities by providing a continuous stream of images covering the dynamic atmosphere, extended corona, and activity on the far side of the Sun.

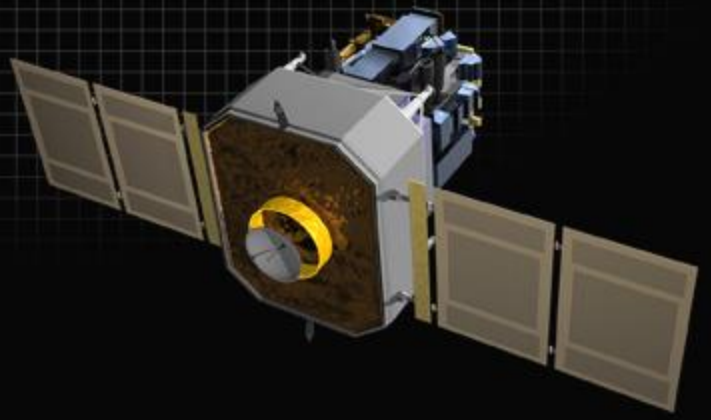
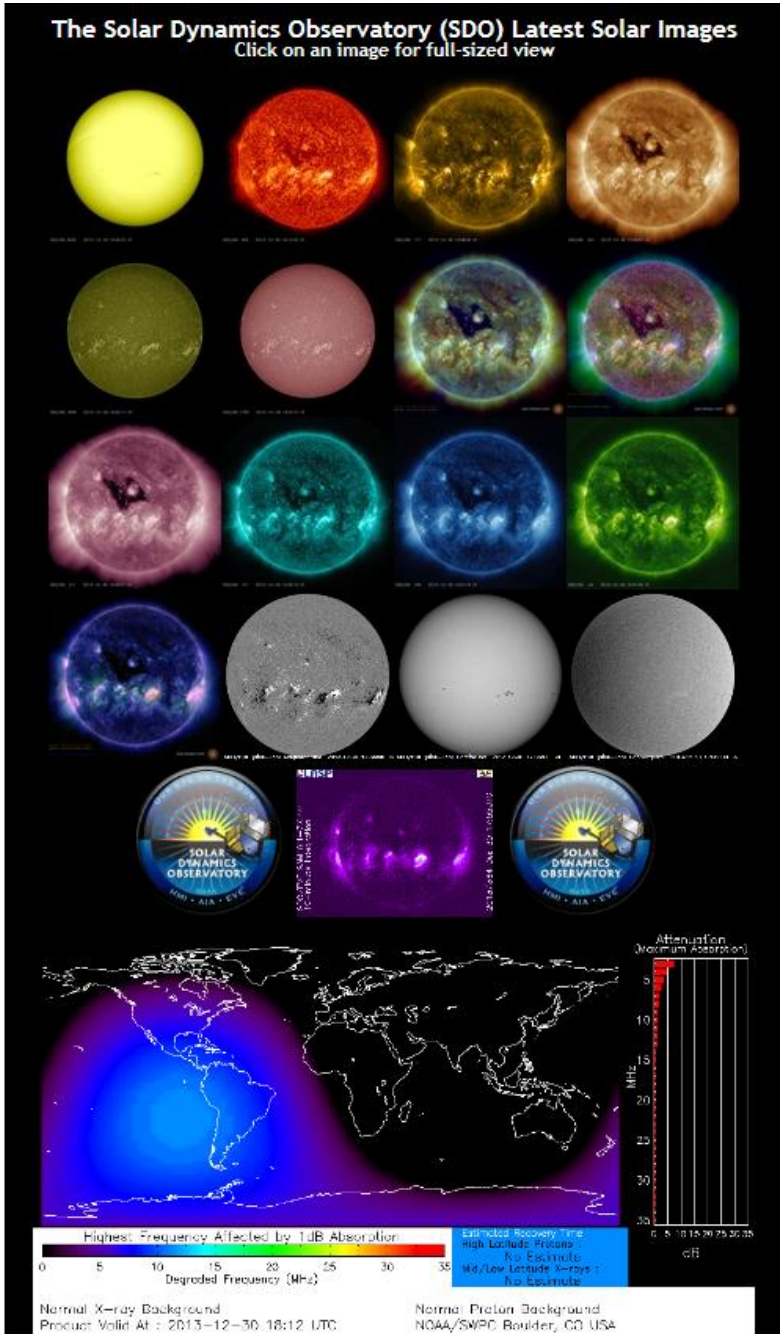
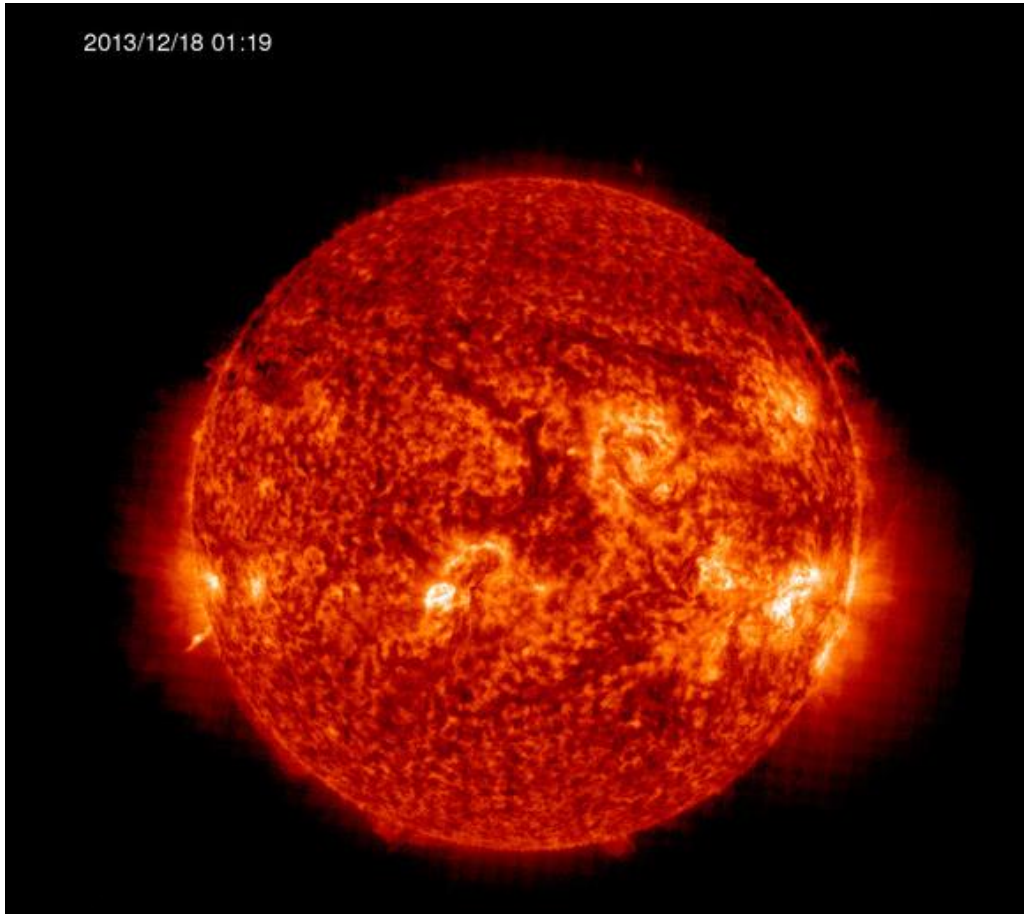


illustration by Alex Lutkus

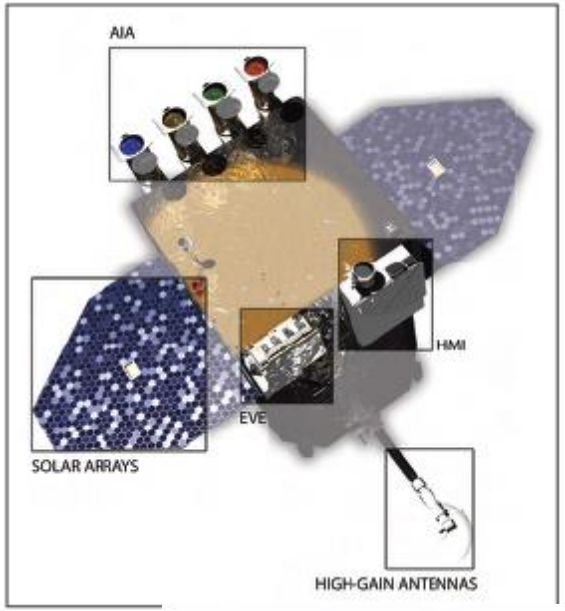




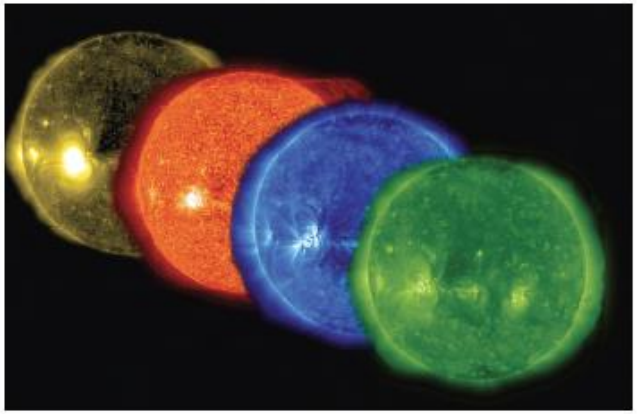
http://sohodata.nascom.nasa.gov/cgi-bin/data_query_search_url?Session=web&Resolution=2&Display=Images&NumImg=30&Types=instrument=EIT:wavelength=304

http://prop.hfradio.org/

Solar Dynamics Observatory



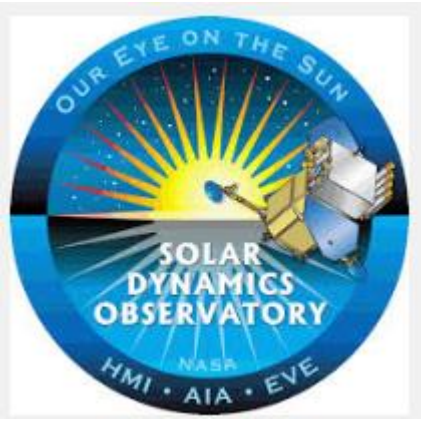
Feb 2010



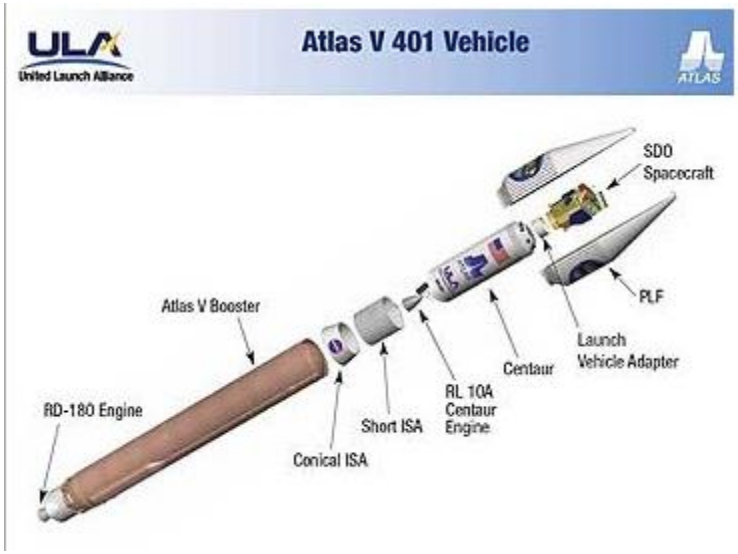
The Sun, as observed by STEREO, in four wavelengths of extreme UV light and taken at nearly the same time. SDO will take images in 10 wavelengths every 10 seconds.

The AIA instrument as it is being assembled. It is like an IMAX® camera for the Sun.

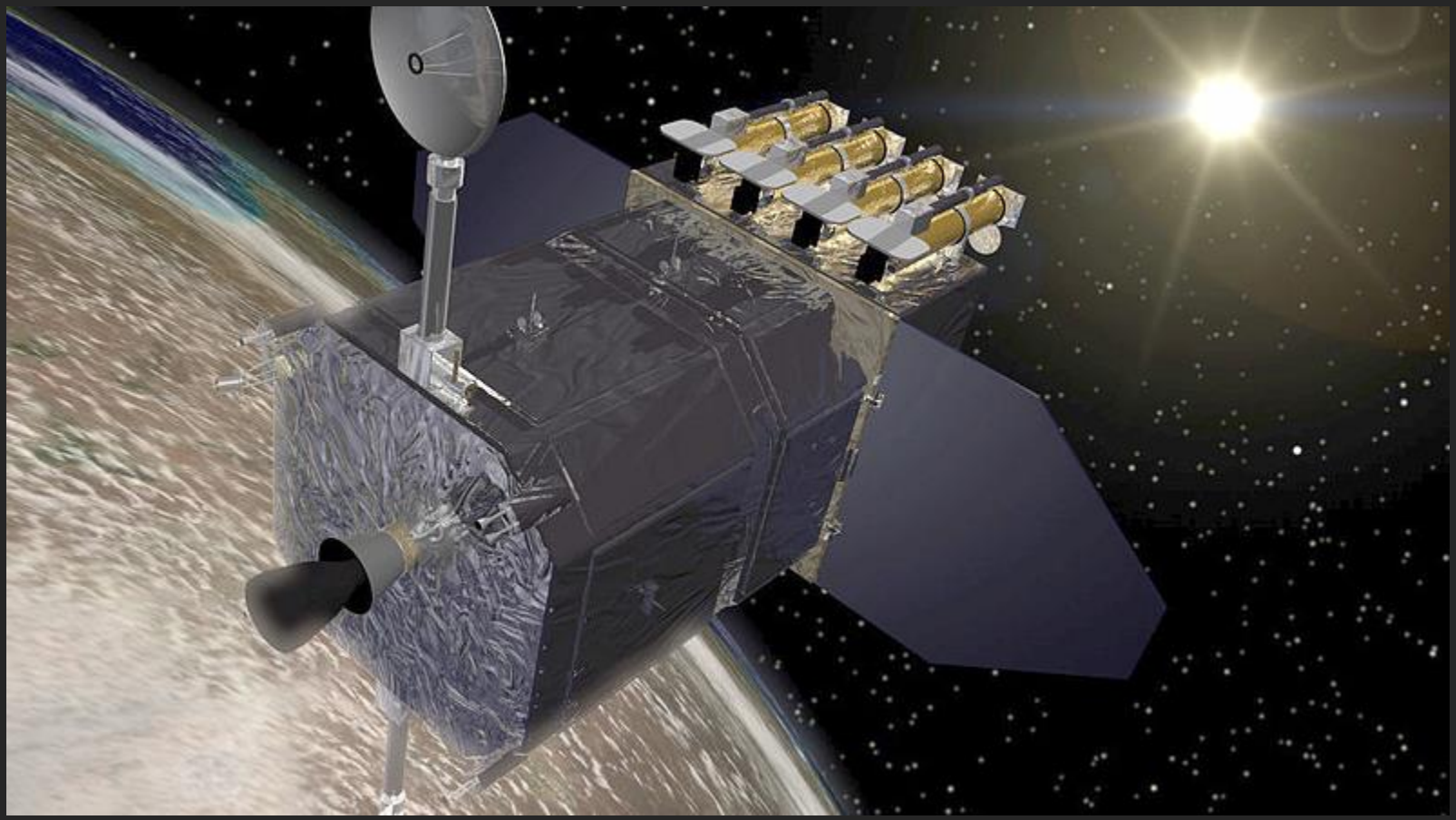

Our Eye on the Sun
SDO
AV-021
Solar Dynamics Observatory


OUR EYE ON THE SUN
SOLAR
DYNAMICS
OBSERVATORY
NASA
HMI • AIA • EVE


SOLAR
DYNAMICS
OBSERVATORY


ULA
United Launch Alliance
Atlas V 401 Vehicle
ATLAS
SDO
Spacecraft
PLF
Launch
Vehicle Adapter
Centaur
RL 10A
Centaur
Engine
Short ISA
Conical ISA
Atlas V Booster
RD-180 Engine

Solar Dynamics Observatory

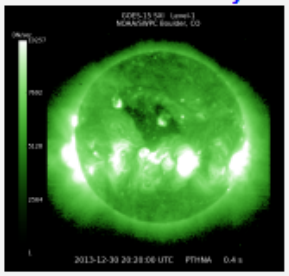


NOAA / Space Weather Prediction Center

Space Weather Now

2013 Dec 30 20:28 UTC (Dec 30 13:28 MST)

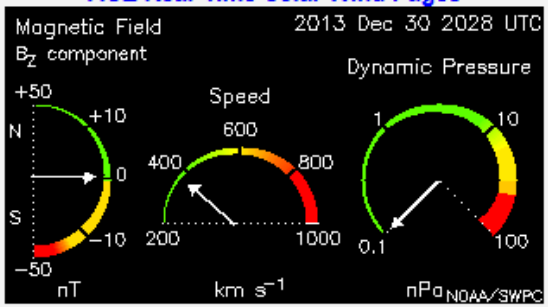
Latest GOES Solar X-ray Image



Alerts

Latest Alert: Dec 29 1538 UTC SUMMARY: Proton Event 10MeV Integral Flux exceeded 10pfu

ACE Real-Time Solar Wind Pages



Average over last 15 minutes

◁| ▷ ■ |▷ |▷▷ 10 frames/sec

Space Weather User Groups

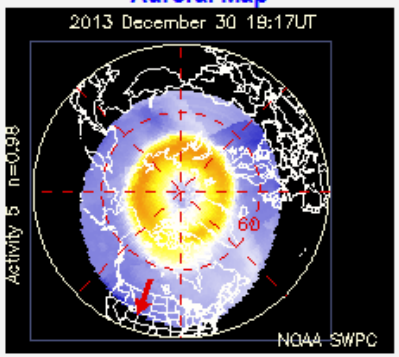
- Navigation
- Radio
- Electric Power
- Satellite Operators
- Aurora
- News Media

NOAA Scales Activity

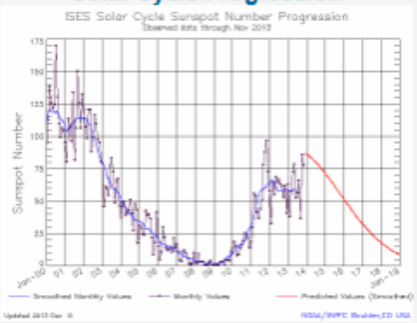
Range 1 (minor) to 5 (extreme)

NOAA Scale	Past 24 hrs	Current
Geomagnetic Storms	none	none
Solar Radiation Storms	none	none
Radio Blackouts	none	none

Auroral Map



Solar Cycle Progression



Related pages

Today's Space Weather
SW for Aviation Service Providers

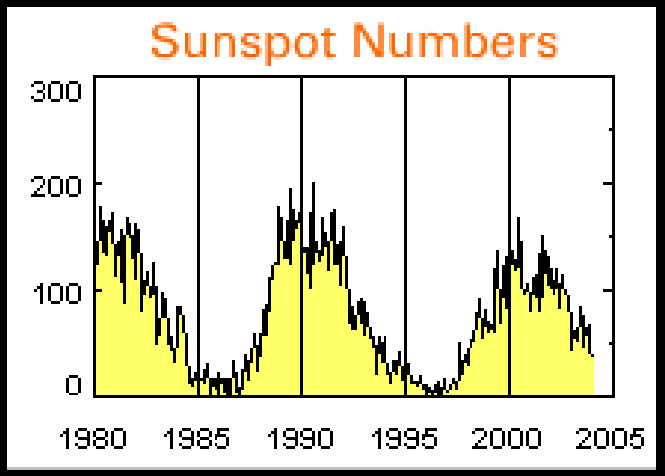
Our Sun has a 11 year cycle during which its activities increase and decrease progressively. Each cycle is different, meaning that sometimes we get great ones, sometimes weak ones. These cycles have a direct influence on these propagation condition reports.

The quintessential event in a solar cycle is the number of sun spots seen on its surface.

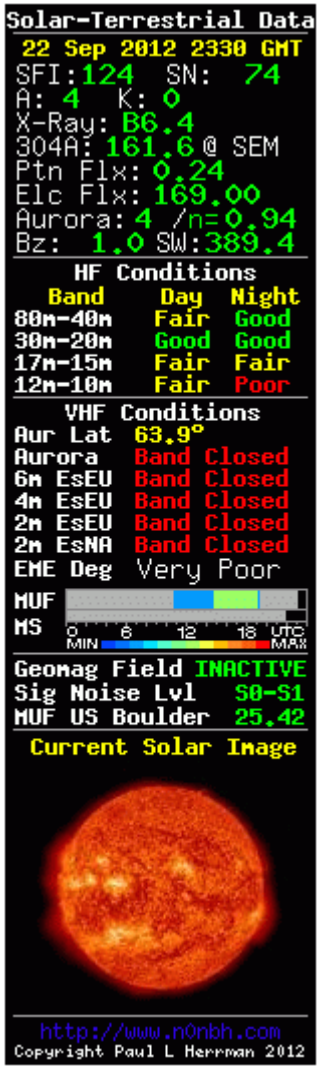
The number of spots on our Sun predicts the number of solar flares that may occur, which in return will generate all sorts of measurements that are very useful in understanding and most importantly, predicting radio signals propagation.

A propagation condition report is similar to a weather report but give information relative to the Sun's weather and it will affect radio signal propagation conditions back here on earth. Most reports use terminological terms such as SFI, SN, N, K, A. What do they mean?

The 11 year Solar Cycle is graphed on the right for the last 25 years. During peaks in the sunspot numbers even very low-power stations can often be heard around the world. Sunspot numbers can also vary on 27 day cycles due to the rotation of the sun.



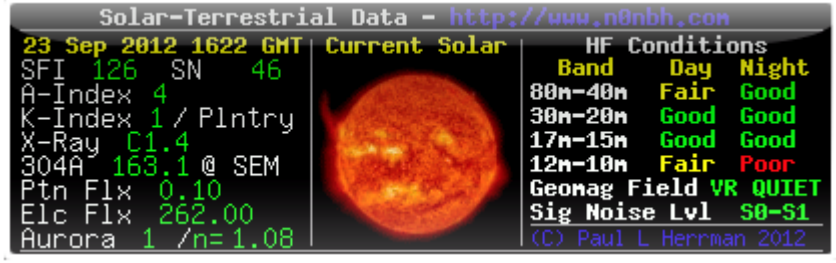
Of course the tilting of the Earth on it's axis (which causes our Seasons) affects propagation, too, as well as the time of day. As a very general rule of thumb, frequencies above 10 MHz are useful during the day and below that are good at night. Predicting the actual Maximum Usuable Frequency is an art and a science and depends on many factors.



Paul Herrman
N0NBH
2012

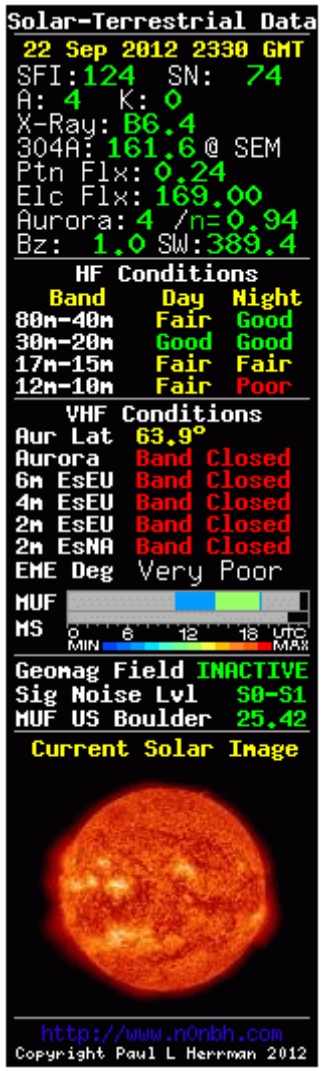
Albert Einstein said ...

"I am often asked how radio works. Well, you see, wire telegraphy is like a very long cat. You yank his tail in New York and he meows in Los Angeles. Do you understand this? Now, radio is exactly the same, except that there is no cat."



SFI

- >150 = Ideal
- **10m,12m,15m,17m,20m**



SFI index:

Solar Flux Index ; it is a gauge of how much solar particles and magnetic fields reaching our atmosphere. In other words, this value informs us on solar winds reaching our planet and their influence on creating HF propagations conditions. For this measurement, the higher the number, the better HF propagation should be. The index value also suggest propagation on bands between 10 meter and 20 meter (ie: 10m,12m,15m,17m,20m). It has a scale between 30 and 300, and can be interpreted as follow:

< 70: propagation potentially bad.

80-90: propagation potentially are somewhat low

90-100: propagation tend to be average

100-150: propagation will tend to be good

>150: propagation will tend to be ideal

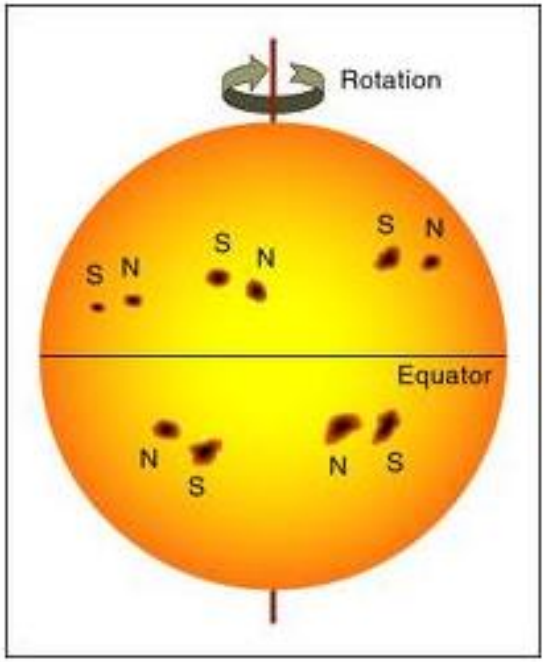
High SFI values has almost no influence on 30m,40m,80m and 160m bands. SFI value over 150 indicates ideal HF propagation conditions and people with small HF installations can begin exploiting these conditions. At these high SFI values, you might consider stopping what you are doing and take advantage of these conditions while they last because they are far and few between. It might be here today, gone tomorrow.

SN:

Sunspot Numbers: This value is the visible number of spots on the Sun's surface. Traditionally, the higher the number, the better the ionization of our atmosphere which will help create great HF propagation conditions. The range of SN can be between 0 and up to 250, sometimes more. It is somewhat rare that we see over 200 sun spots, and when we do, it might be an ideal time to turn on your Transceiver!

High SN numbers indicate large amounts of electromagnetic active fields on the surface of the Sun, potentially erupting as solar flares, but before they erupt into solar flares, they can create excellent HF propagation. If Sun spots turn into flares, this can diminish substantially HF propagation, even create total radio blackouts on all bands. Also, knowing that the Sun's equator rotates on itself, the Sun spots and its fields may or may not be facing us at all times. This said, radio propagation conditions could become excellent for a few days, then down until the Sun rotate those spots back toward us again, which is between 18-25 days later.

So, if you see SN numbers over 100, you can expect good propagation conditions, if and when these spots are facing us.



< 50: propagation conditions potentially very bad
50-75: propagation conditions attenuated
75-100: propagation conditions might be good
100-150: propagation conditions should be ideal
>150: propagation conditions possibly exceptional

The K-Index (or Boulder K) is a gauge of geomagnetic activity relative to an assumed quiet-day. Falling numbers mean improving conditions and better propagation particularly in northern latitudes and areas where aurora activity can occur. The scale is between 0 and 9. You never want to see value above 8 because this indicates our planet going thru a solar storm of great intensity. This value can be interpreted as follow:

From 0 to 1: Best conditions for 10,12,15,17,20 meter bands.

From 2 to 3: Good conditions for 10,12,15,17,20 meter bands.

From 4 to 5: average conditions for 10,12,15,17,20 meter bands.

From 5 to 9: Very bad conditions for 10,12,15,17,20 meter bands.

The A Index:

It's simply an index of geomagnetic activity derived from a scaled average of the previous 24 hours K-index readings. Your should use this as a reference for general conditions on the bands. Lower A index means better conditions for propagation. This scare goes between 0 and 400, but typically never above 100. This value should be interpreted as follow:

Between 1 and 5: Best conditions on 10,12,15,17,20 meter bands.

Between 6 and 9: Average conditions on 10,12,15,17,20 meter bands.

From 10 and above: Very Bad conditions on 10,12,15,17,20 meter bands.

X-Ray: NOAA reported value from A0.0 to X9.9. Intensity of hard x-rays hitting the earth's ionosphere. Impacts primarily the D-layer (HF absorption). The letter indicates the order of magnitude of the X-rays (A, B, C, M and X), where A is the lowest. The number further defines the level of radiation. Updated eight times daily.

304A: NOAA reported value from 0 to unknown. Relative strength of total solar radiation at a wavelength of 304 angstroms (or 30.4 nm), emitted primarily by ionized helium in the sun's photosphere. Two measurements are available for this parameter, one measured by the Solar Dynamics Observatory, using the EVE instrument, and the other, using data from the SOHO satellite, using its SEM instrument. Responsible for about half of all the ionization of the F layer in the ionosphere. 304A does loosely correlate to SFI. Updated hourly

Ptn Flx: NOAA reported value from 0 to unknown. Density of charged protons in the solar wind. The higher the numbers, the more the impact the ionosphere. Primarily impacts the E-Layer of the ionosphere. Updated hourly.

Elc Flx: NOAA reported value from 0 to unknown. Density of charged electrons in the solar wind. The higher the numbers (>1000), the more the impact the ionosphere. Primarily impacts the E-Layer of the ionosphere. Updated hourly

N: NOAA reported value from 0 to 5. When <2.0, high confidence in Aurora measurement. When >2, low confidence. Updated hourly.

Bz – Bz Component

Value from +50 to -50. Strength and direction of the interplanetary magnetic field as impacted by solar activity. Positive is same direction as the earth's magnetic field, and negative is the opposite magnetic polarity. Cancels out earth's magnetic field when negative, which increases the impact of solar particles in the ionosphere.

SW = Solar Wind

Value from 0 to 1000. Speed (kilometers per second) of the charged particles as they pass earth. The higher the speed, the greater the pressure is exerted on the ionosphere. Values greater than 500 km/sec have impact on HF communications. Updated hourly.

Aur Lat – Auroral Latitude

Reports Band Closed for No/Low Auroral activity, High LAT AUR for Auroral activity >60°N, or MID LAT AUR for Auroral activity from 60° to 30°N. Updated every ½ hour.

EME Deg - Earth-Moon-Earth Degradation

Reports EME path attenuation as Very Poor (>5.5dB), Poor (4dB), Moderate (2.5dB), Good (1.5dB), Very Good (1dB), Excellent (<1dB). Updated every ½ hour.

MUF – Maximum Useable Frequency

Provides the Maximum Usable Frequency in a colored bar. Gray indicates No Sporadic E (ES) activity , blue indicates ES reported @ 6M, green indicates ES reported @ 4M, yellow indicates conditions support 2M ES, and red indicates reported @ 2M. Updated every ½ hour.

MS - Meteor Scatter Bar

Provides the Meteor Scatter activity in a colored bar. Gray indicates no activity. See the color coded graph at the bottom of the bar for activity level. Updated every 1/4 hour

Geomag Field = Geomagnetic Field

Indicates how quiet or active the earth's magnetic field is based on the K-Index value. Reports as Inactive, Very Quite, Quiet, Unsettled, Active, Minor Storm, Major Storm, Severe Storm, or Extreme Storm. Higher indications can cause HF blackouts and auroral events. Updated every three hours.

Sig Noise Lvl

Indicates how much noise (in S-units) is being generated by interaction between the solar wind and the geomagnetic activity. A more active and disturbed solar wind, the greater the noise. Updated every ½ hour.

Cheat Sheet For The Tool

SFI Solar Flare Index- Higher Better - 90 – 100 Average – Over 150 Ideal

SN Sunspot Number- Higher Better – 75 – 100 Average- 150 Good

A Index – 24 Hr. Avg. K - Lower Better – 6-9 Avg – 1-5 Good

K Index (Boulder K) - Lower Better – 4-5 Avg – 1-5 Best

X-Ray - D Layer Density – A Lowest – X Highest

304A – F layer Ionization (Same as SFI) – Higher Better

PTN FLX – E Layer Density – Higher Better

ELC FLX – E Layer Density – Higher Better

Aurora – Confidence In Aurora Measurements 1-5 Higher Better

Glossary of terms for the data available in the N0NBH solar banners (© Paul L Herrman 2012)

ITEM	ELEMENT	DESCRIPTION
SFI	Solar Flux Index	DRAO Penticton reported value from 62.5 to 300. Intensity of solar radiation measured at 2800MHz (10.7 cm). Good indication of the F layer ionization (layer that gives us most of our DX on HF). The higher the number, the greater the level of ionization is, and the higher the frequency. Measured three times daily, and the last received value is reported.
SN	Sunspot Number	NOAA reported value from 0 to 250. Daily Sunspot Number provided by NOAA is computed using a formula [R=k (10g+s)] by Rudolph Wolf in 1848, where **R** is the sunspot number; **g** is the number of sunspot groups on the solar disk; **s** is the total number of individual spots in all the groups; and **k** is a variable scaling factor (usually <1) that accounts for observing conditions and the type of observing device. SN does loosely correlate to SFI. Updated once daily.
A	Planetary A Index	NOAA reported value from 0 to 400. Provides a daily average level for geomagnetic activity. Uses the average of eight 3 hour K-Index values (magnetic value measured in nanotesla or nT) to provide the level of instability in the earth's geomagnetic field. When used with K-Index: Both high indicates geomagnetic field is unstable, and HF signals are prone to sudden fades, and some paths may close while others open up abruptly and with little warning. High K index/Low A indicates a sudden, abrupt disturbance in the geomagnetic field, which can cause an intense but brief disruption in HF propagation, but can cause an auroral event. Updated once daily.
K	Planetary K Index	NOAA reported value from 0 to 9. Measures disturbances in the horizontal component of earth's magnetic field. Value in nT is measured using a magnetometer during a three-hour interval, and then converted to a factor. Use with A-Index – sees above to determine HF conditions. Updated eight times daily.
X-Ray or XRY	Hard X-Rays	NOAA reported value from A0.0 to X9.9. Intensity of hard x-rays hitting the earth's ionosphere. Impacts primarily the D-layer (HF absorption). The letter indicates the order of magnitude of the X-rays (A, B, C, M and X), where A is the lowest. The number further defines the level of radiation. Updated eight times daily.
304A	304 Angstroms	NOAA reported value from 0 to unknown. Relative strength of total solar radiation at a wavelength of 304 angstroms (or 30.4 nm), emitted primarily by ionized helium in the sun's photosphere. Two measurements are available for this parameter, one measured by the Solar Dynamics Observatory, using the EVE instrument, and the other, using data from the SOHO satellite, using its SEM instrument. Responsible for about half of all the ionization of the F layer in the ionosphere. 304A does loosely correlate to SFI. Updated hourly.
Prt Flx or PF	Proton Flux	NOAA reported value from 0 to unknown. Density of charged protons in the solar wind. The higher the numbers, the more the impact the ionosphere. Primarily impacts the E-Layer of the ionosphere. Updated hourly.
Elc Flx or EF	Electron Flux	NOAA reported value from 0 to unknown. Density of charged electrons in the solar wind. The higher the numbers (>1000), the more the impact the ionosphere. Primarily impacts the E-Layer of the ionosphere. Updated hourly.
Aur	Aurora	NOAA reported value from 0 to 10++. Indicates how strong the F-Layer ionization is in the polar regions. Higher values cause auroral events (including northern/southern lights) to move to lower latitude. Updated hourly.
n	Normalization	NOAA reported value from 0 to 5. When < 2.0, high confidence in Aurora measurement. When >2, low confidence. Updated hourly.
Bz	Bz Component	ACE reported value from +50 to -50. Strength and direction of the interplanetary magnetic field as impacted by solar activity. Positive is same direction as the earth's magnetic field, and negative is the opposite magnetic polarity. Cancels out earth's magnetic field when negative, which increases the impact of solar particles in the ionosphere. Updated hourly.

Summary

The Gadget tool for propagation information is available to sit on your desktop and updates automatically every few minutes.

It gives data a summary extracted from the NASA space weather centre which is helpful in predicting band conditions.

This presentation has explained the data displayed and hopefully may help hams to use the tool effectively

Free tool – Free data - just the way hams like it.