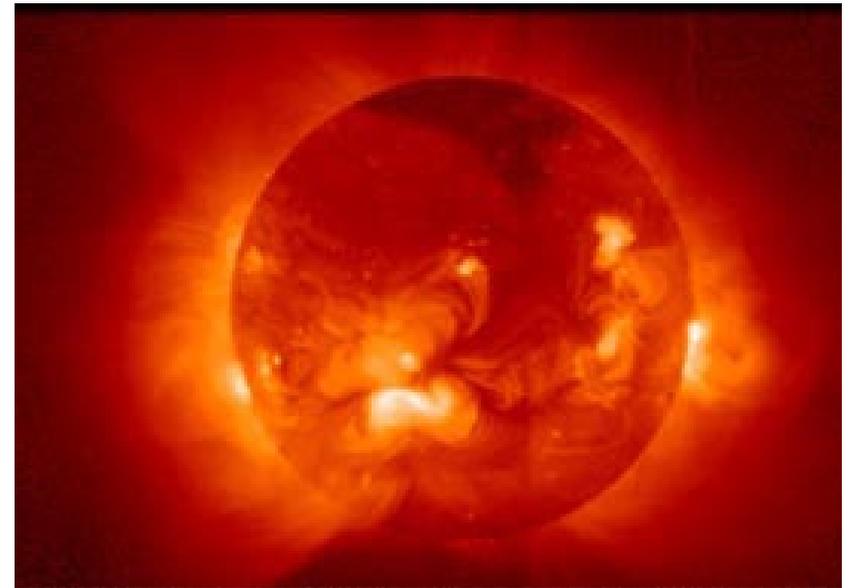
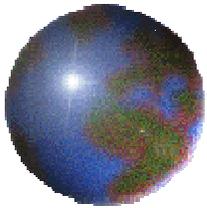
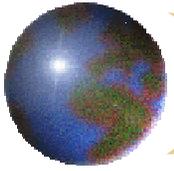




# *The Sun and Radio Propagation*

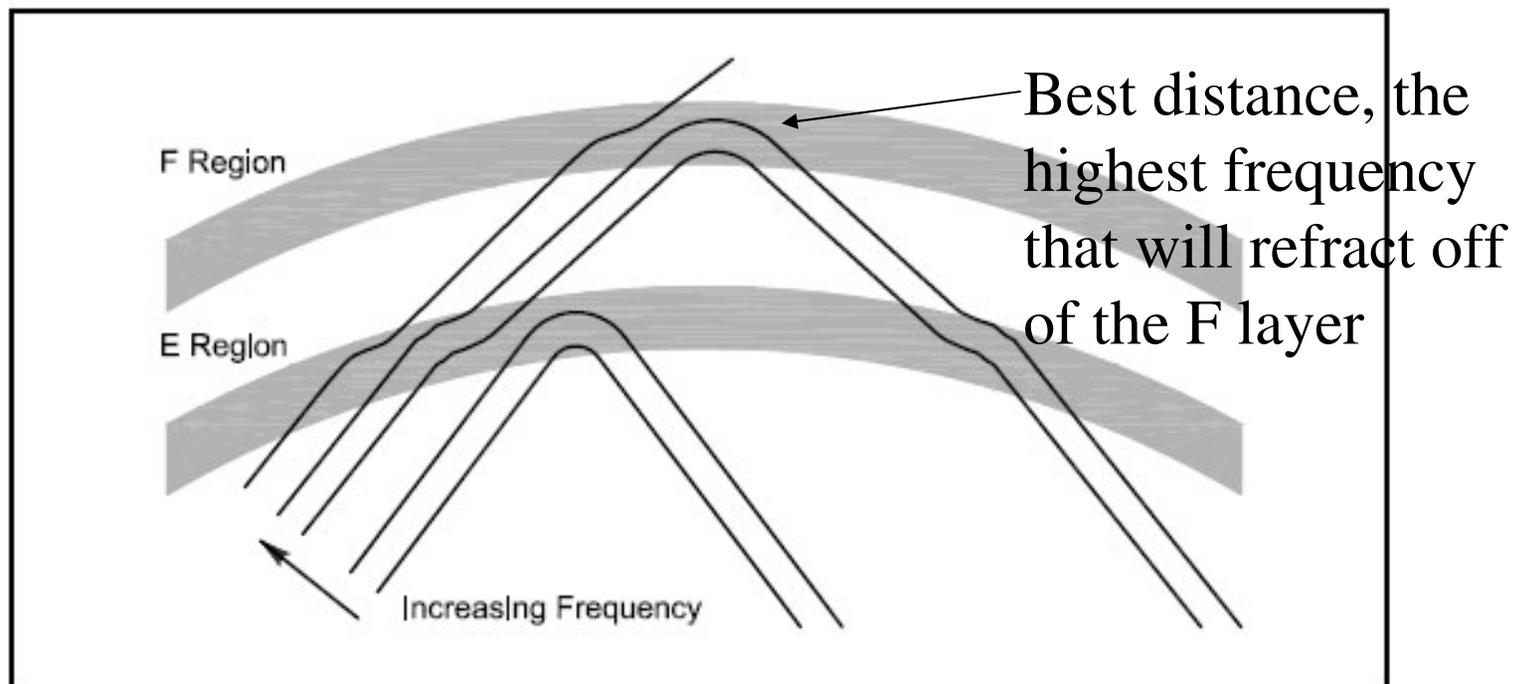


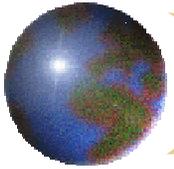
David Treharne, N8HKU  
Ford Amateur Radio League  
April 12, 2007



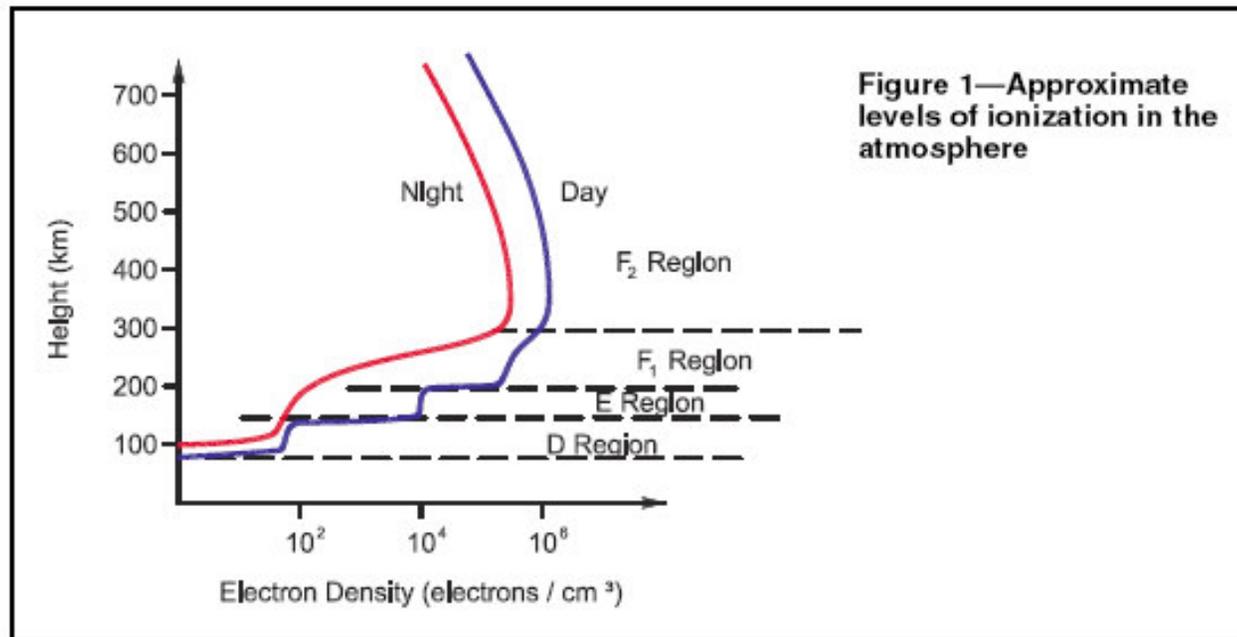
## *Why is the sun important*

- Ionization of the upper atmosphere is responsible for reflection of radio waves-allowing for skip propagation around the world.





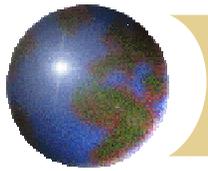
# *Ionization is the Key*



UV radiation 100-1000 Angstroms: F Layer Ionization (best)

Soft X-Rays 10-100 Angstroms: E Layer Ionization

Hard X-Rays 1-10 Angstroms: D Layer Ionization



# *Sunspots are the Key to the F Layer UV Ionization*

Sunspots emit UV radiation.

Sunspots facing the earth  
activate the F Layer

More sunspots= more F  
ionization

It takes several days of  
sunspots to build up the F  
Layer, which tends to decrease  
at night.





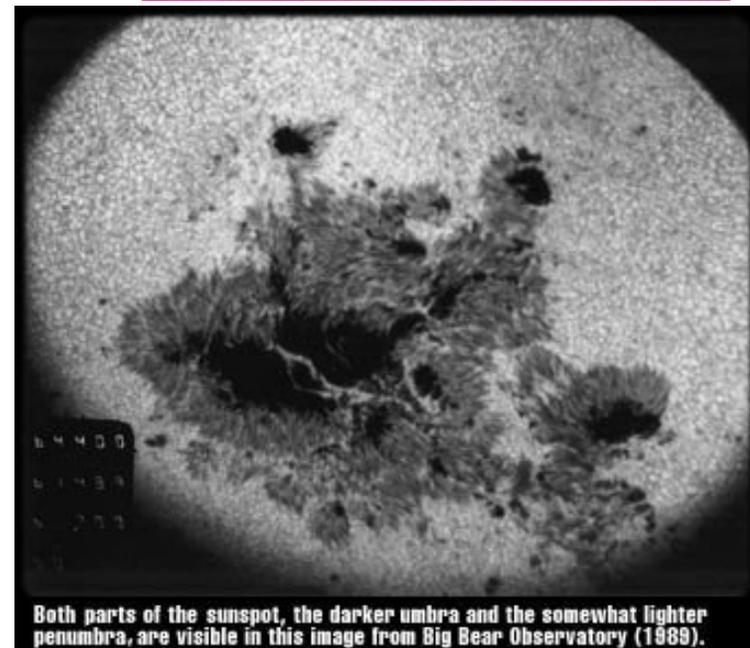
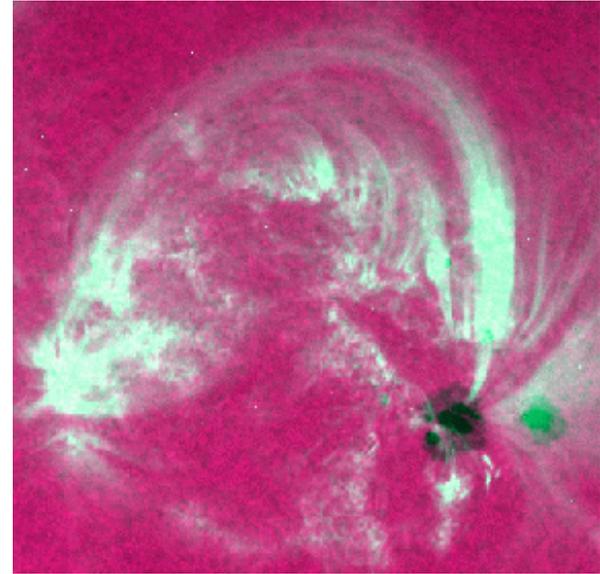
# *Magnetic Explosion on the Sun*

Each sunspot is actually a pair.

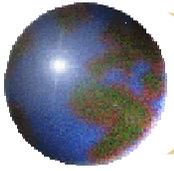
Strong magnetic fields form  
and explode from the surface

UV radiation radiates from  
around these explosions

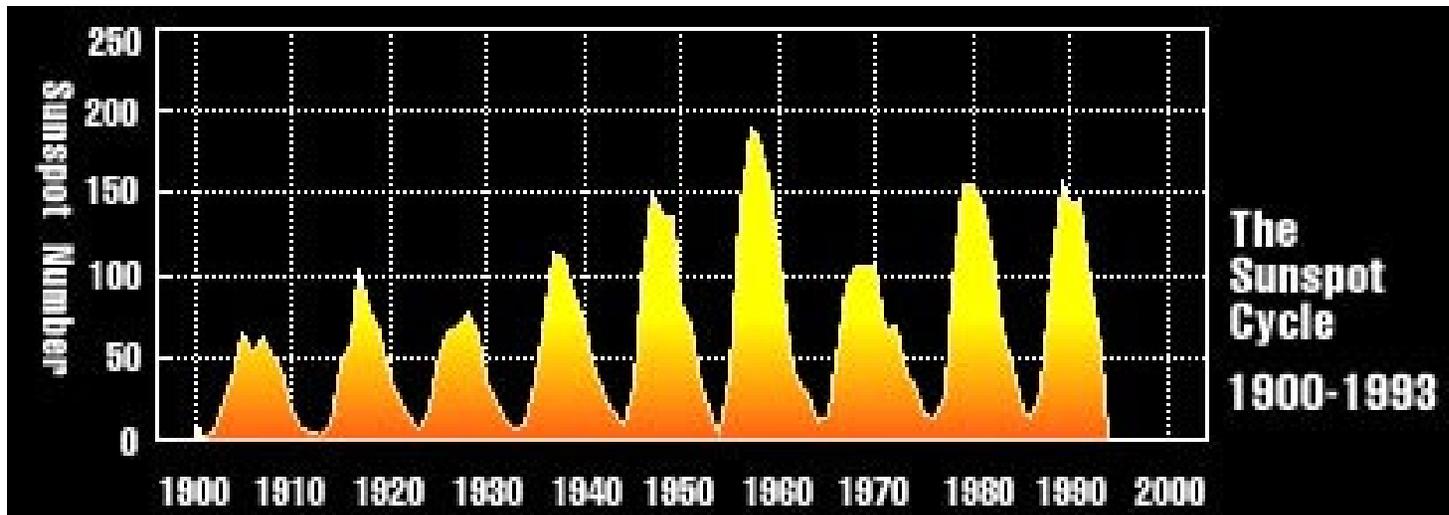
Sunspots are cooler than the  
regular surface of the sun,  
hence they appear darker.



Both parts of the sunspot, the darker umbra and the somewhat lighter penumbra, are visible in this image from Big Bear Observatory (1989).



# *How Many Sunspots = Excellent Propagation?*

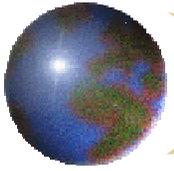


Numbers higher than 100 = 10 mtrs open.

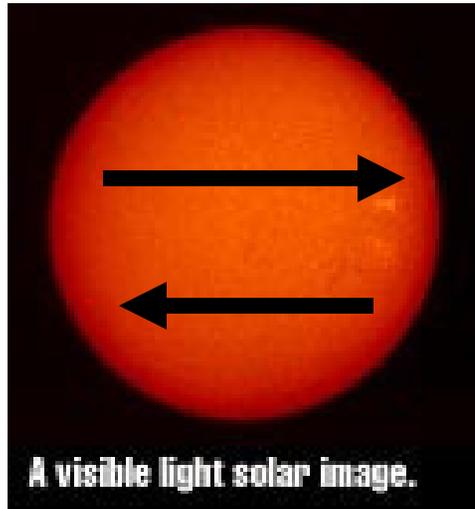
Current numbers: Jan: 22.7, Feb: 18.5

Many consider the bottom to be less than 10!

Sunspot Cycle:  
Ave = 11 yrs



# *What is causing Sunspots, and How they Appear*



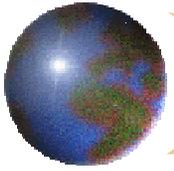
Magnetic bands appear North and South of the Sun's equator.

These bands generate sunspots.

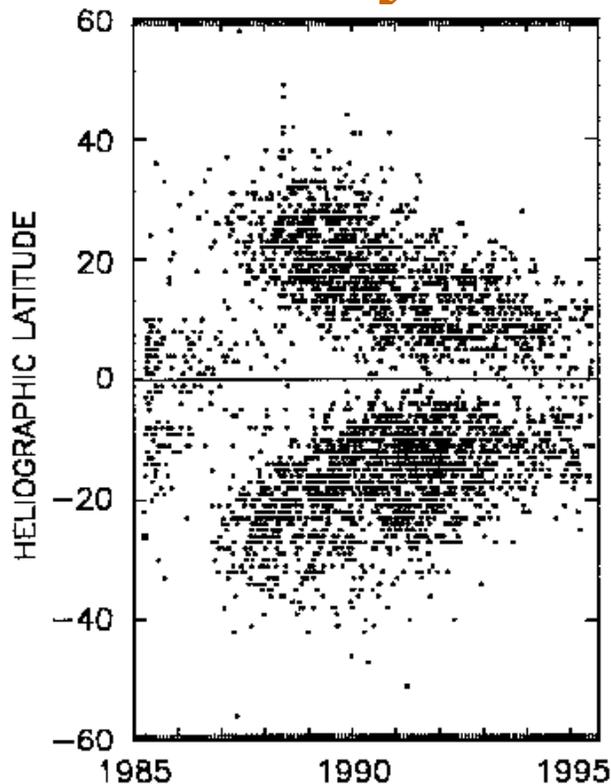
The bands travel toward the equator.

The solar cycle is actually 22 years.

The bands have a E-W or W-E polarity. During alternate cycles, the bands shift polarity!



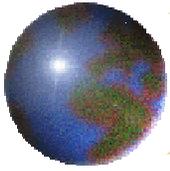
# *Sunspots Peak Quickly and Decline Gradually During the Cycle*



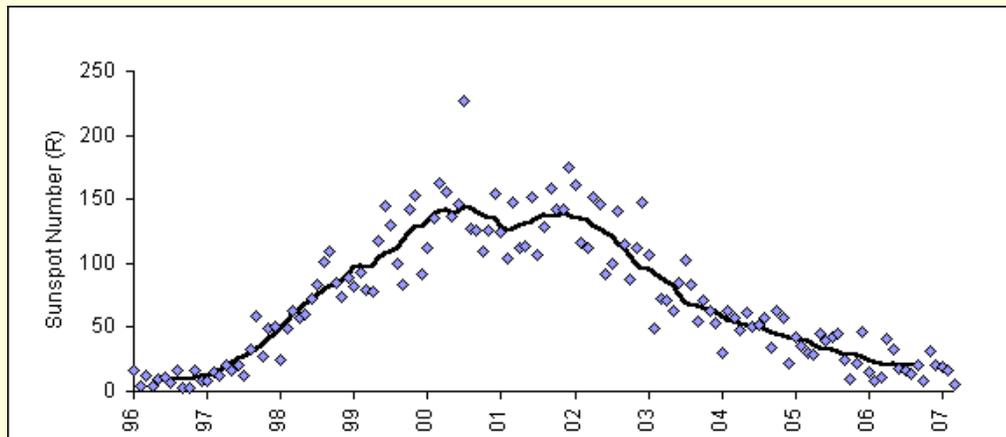
Sunspots start far from the equator, then work their way to the equator.

Sunspots are stronger and more numerous at the start of the cycle

The beginning of the cycle peaks quicker, then the numbers slowly fall off



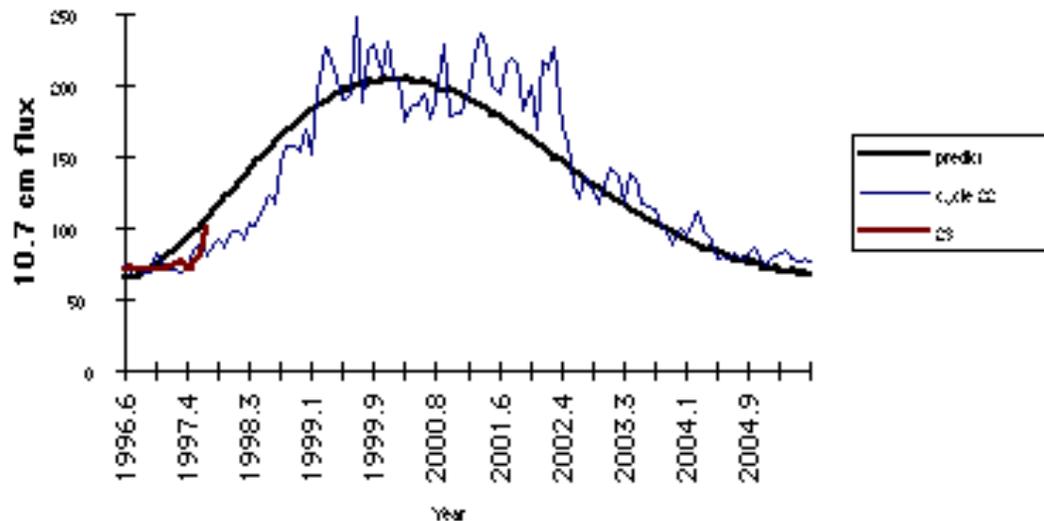
# Solar Flux vs Sunspot Cycles

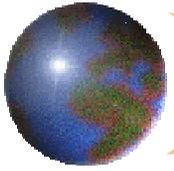


2800 MHz Solar Flux is sometimes used as an approximation for the smoothed sunspot number:

Smoothed Sunspot number is 6 mo late!

Solar flux is well below UV, but some use it as a measurable approximation.





## *Solar Storms*

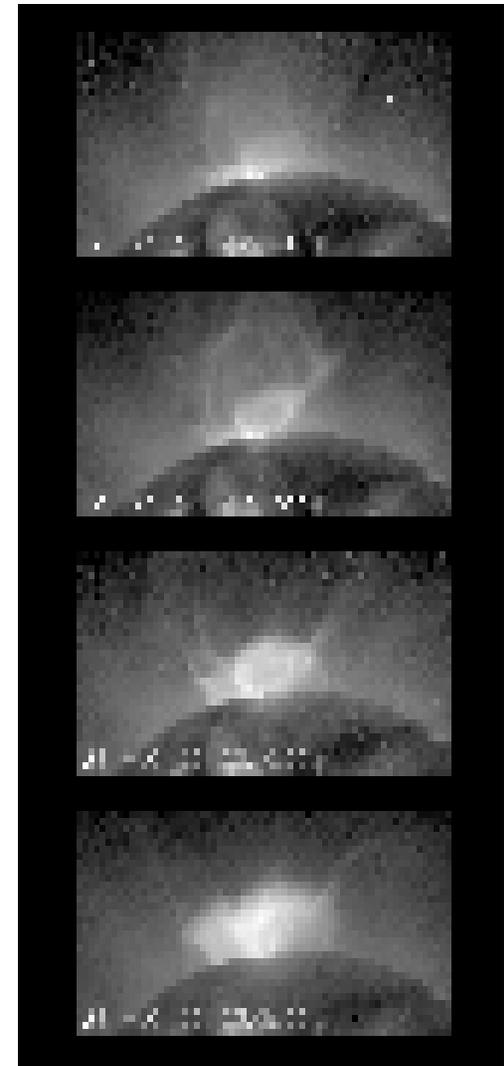
The Sun also has storms, which dramatically disrupt communications, and can damage satellites

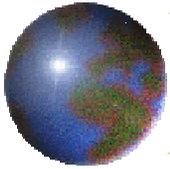
Solar Flares: An eruption that sends RF from VLF to X-Rays into the Earth

RF blast causes atmospheric absorption from 2-30 MHz. Lasts an hour

Particles arrive hours later. They interact with the magnetic field, disabling satellites

Corona Holes can travel around the sun for months, sending communications down for days

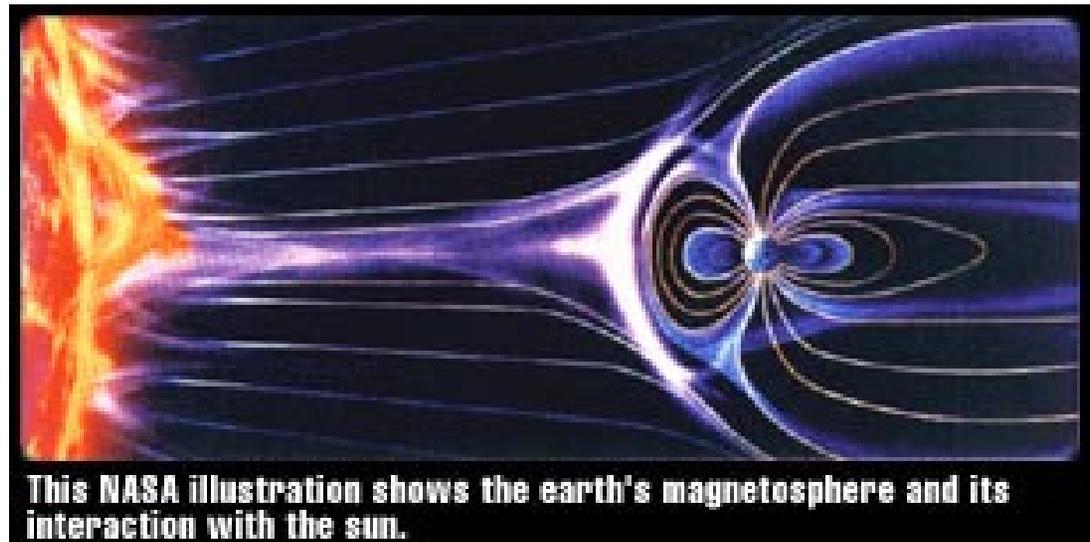




# Storm Intensity Measurements

**Table 1**  
**The General Relationship between A and K Values**

A	K	Comments
0	0	Quiet
2	1	Quiet
3	1	Quiet
4	1	Quiet to unsettled
7	2	Unsettled
15	3	Active
27	4	Active
48	5	Minor storm
80	6	Major storm
132	7	Severe storm
208	8	Very major storm
400	9	Very major storm



K readings are quasi-logarithmic. A ratings are an average of K readings. Kp and Ap are planetary averages. High Ap or Kp are BAD for propagation!



## *April 2007 K7RA Solar Update*

Current Average Sunspot  
numbers:

Jan, 07: 28.2

Feb, 07: 17.3

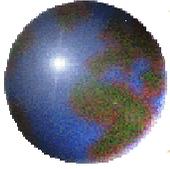
Mar, 07: 9.8

A-Index:

10.4 to 11.7

(Active)

NOAA has yet another revised forecast for the bottom of the cycle, and it moves the minimum out by one month. The last projection we saw in the Weekly Preliminary Report and Forecast had the cycle minimum covering this month and the two previous -- February through April. The revised numbers extend it out another month, spreading the minimum over February through May.



# *Latest NOAA Information*

:Product: Geophysical Alert Message wwv.txt

:Issued: 2007 Apr 12 0003 UTC

# Prepared by the US Dept. of Commerce, NOAA, Space Environment Center

#

# Geophysical Alert Message

#

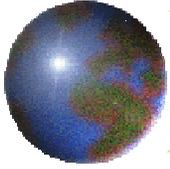
Solar-terrestrial indices for 11 April follow.

Solar flux 69 and mid-latitude A-index 4.

The mid-latitude K-index at 0000 UTC on 12 April was 1 (6 nT).

No space weather storms were observed for the past 24 hours.

No space weather storms are expected for the next 24 hours.



# *Bibliography*

- ARRL QST Sunspot Cycle.pdf, Sept. 2002
- <http://www.petermeadows.com/html/trends.html>
- <http://www.sec.noaa.gov/info/Cycle23.html>
- <http://cse.ssl.berkeley.edu/segwayed/lessons/sunspots/research.html>
- <http://www.arrl.org/w1aw/prop/2007-arlp015.html>
- <http://www.sec.noaa.gov/wwire.html#swx3hrcon>