8. PROPAGATION – AI6JB

Chapter 8 Propagation

ARRL General Class
Sections 8.2 – The Sun

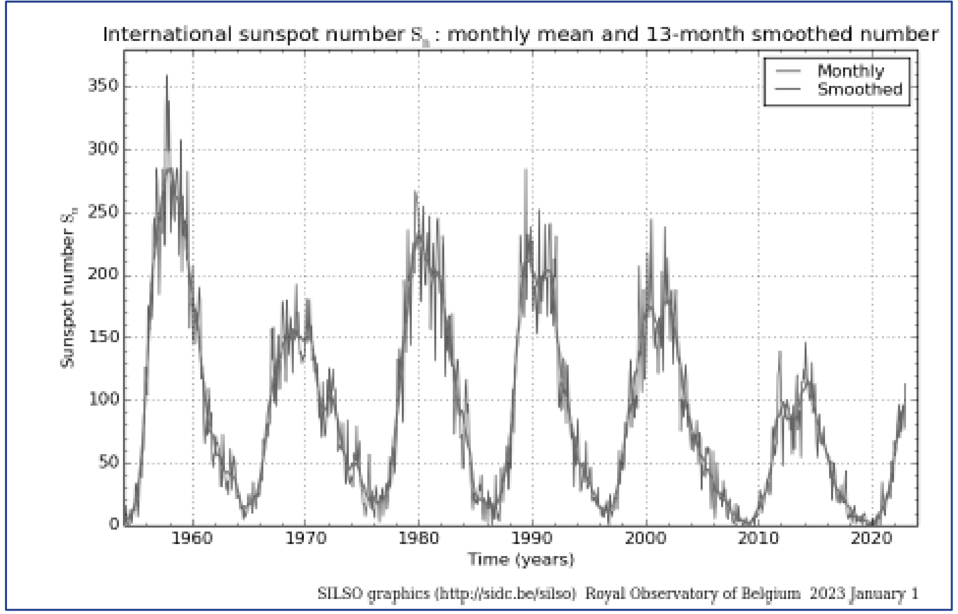
Sunspots and Cycles

Ionosphere is dependent on solar UV to separate electrons from atoms

Much of the variation in UV radiation is due to sunspot activity

One complete sunspot cycle lasts about 11 years

When more sunspots are observed, more UV is being generated, creating more intense ionization and improving propagation on higher frequency bands above 10 MHz and even into lower VHF range



This graph shows the monthly mean sunspot numbers for several past cycles through October 2018. The NASA Solar Physics web page maintains complete data on the sunspot cycle.

In mid 2023, when this book is being published, Cycle 25 is heating up and propagation on 10 meters and other bands is increasing.

Sunspots and Cycles (cont.)

At peak of cycle, there may be sufficient solar UV to cause higher frequency bands (10 meters) to stay open for long-distance contacts at night

High ionization negatively impacts low frequency bands (80 and 160 m) because it increases absorption

When solar activity is low, lower HF bands have good propagation and higher HF bands above 20 MHz (15 m and up) are often closed

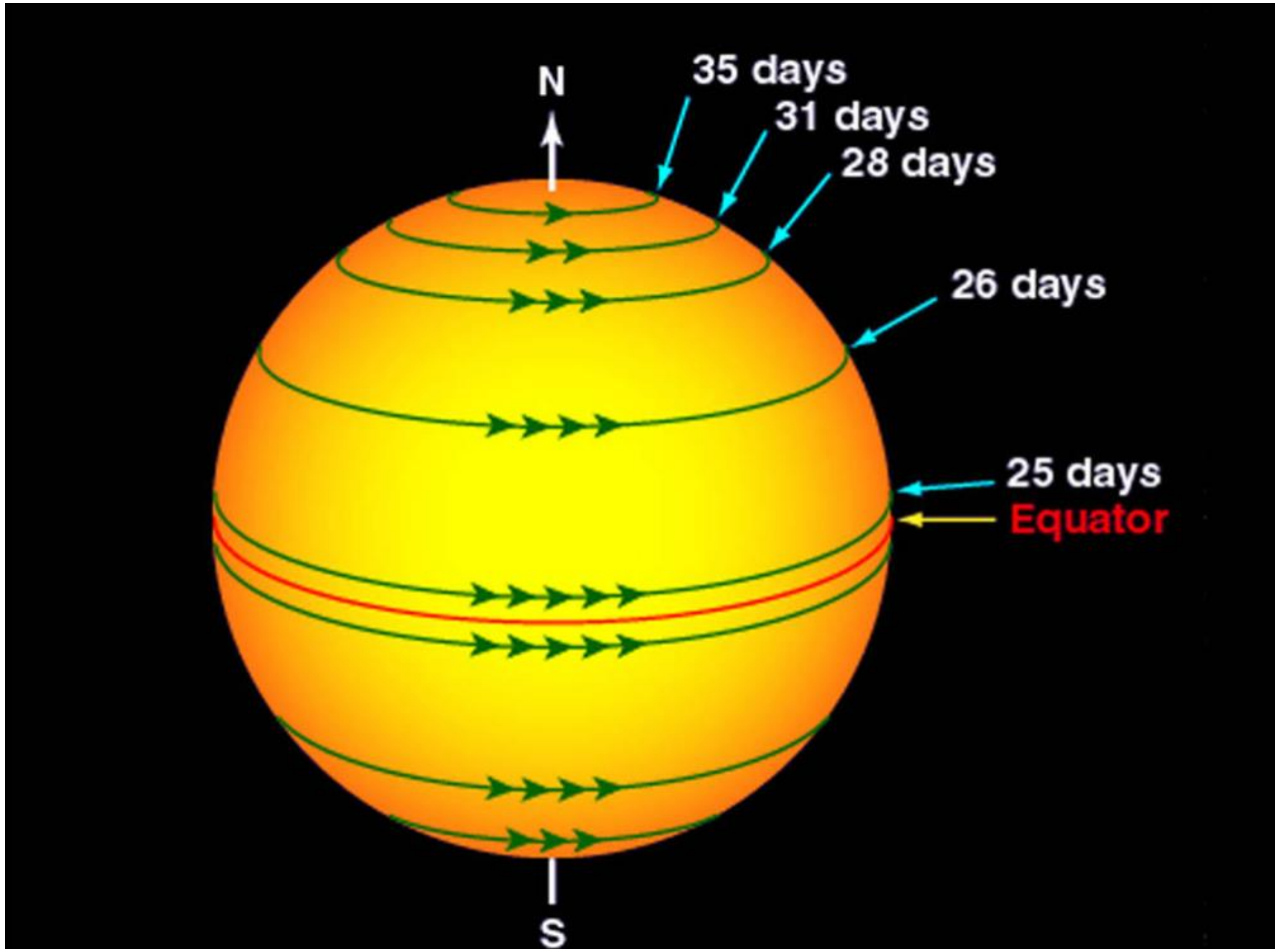
One band that seems to do well at all times in sunspot cycle is 20 meters (14 MHz), supporting daytime communications worldwide nearly every day

Daytime/Nighttime HF Propagation

HF BAND (m)	DAYTIME	NIGHTTIME
160, 80, 60	Local and regional to 100 – 200 miles	Local to long distance with DX best near sunset or sunrise at one or both ends of the contact
40, 30	Local and regional to 300 – 400 miles	Short-range (20 or 30 miles) and medium distances (150 miles) to worldwide
20, 17	Regional to long distance, opening at or near sunrise and closing at night	20 meters is often open to the west at night and may be open 24 hours a day
15, 12, 10	Primarily long distance (1000 miles and more), opening to the east after sunrise and to the west in the afternoon	10 meters is often used for local communications 24 hours a day

Sunspots also seem to move across the sun's surface because the sun rotates once every 28 days.
That is why propagation conditions (good and bad) on the HF bands often repeat themselves in 28-day cycles as sunspots rotate back into view from Earth.

Sunspots and Cycles (cont.)

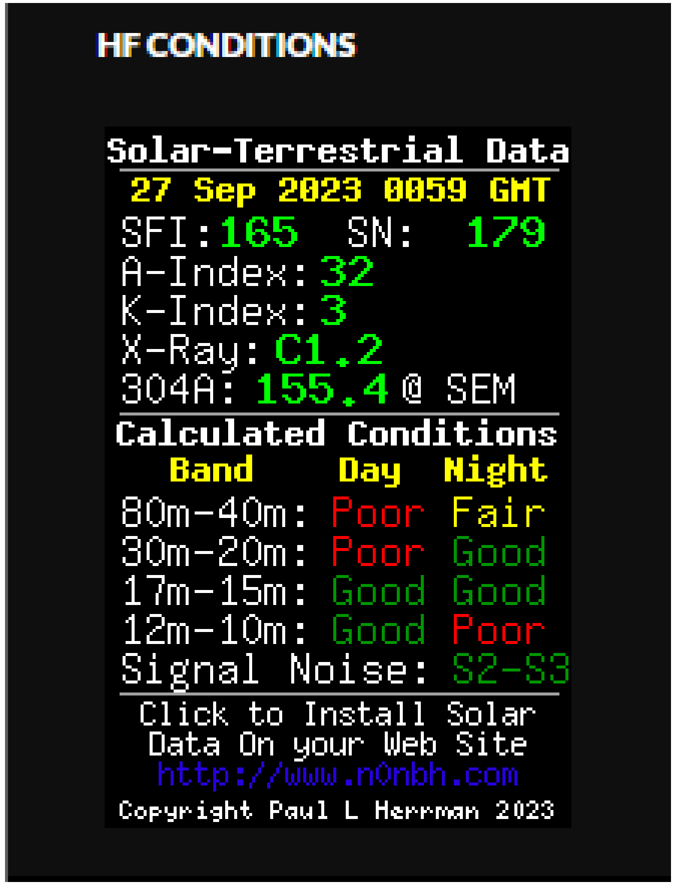


Measuring Solar Activity, Sunspot number

Solar-Flux Index (SFI): Describes amount of 2800 MHz (λ = 10.7 cm) radio energy. Higher levels indicate higher solar activity and better HF propagation above 10 MHz (Fig 8.6)

K-index: Values from 0 to 9 represent the short-term stability of the Earth's magnetic or geomagnetic field. Higher values indicate geomagnetic field is disturbed, which disrupts HF.

A-index: Gives a good picture of long-term geomagnetic field stability. Ranges from 0 (stable) to 400 (greatly disturbed). Calculated from K-index.



Solar activity is so important to propagation and communications that it is monitored constantly by solar observatories worldwide

Assessing Propagation

MUF: Maximum usable frequency. Highest frequency at which propagation exists between two points.

LUF: Lowest usable frequency. Waves below the LUF will be completely absorbed by the ionosphere.

MUF & LUF depend on specific path between two points — location and distance apart

Varies with time of day, season, amount of solar radiation, and ionospheric stability

Operating near MUF often gives excellent results; absorption is lowest just below it

One way to check actual band conditions is to listen for propagation beacons; some provide real-time propagation information

- Many stations between 28.190 and 28.225 MHz that are excellent sources of information about 10-meter propagation

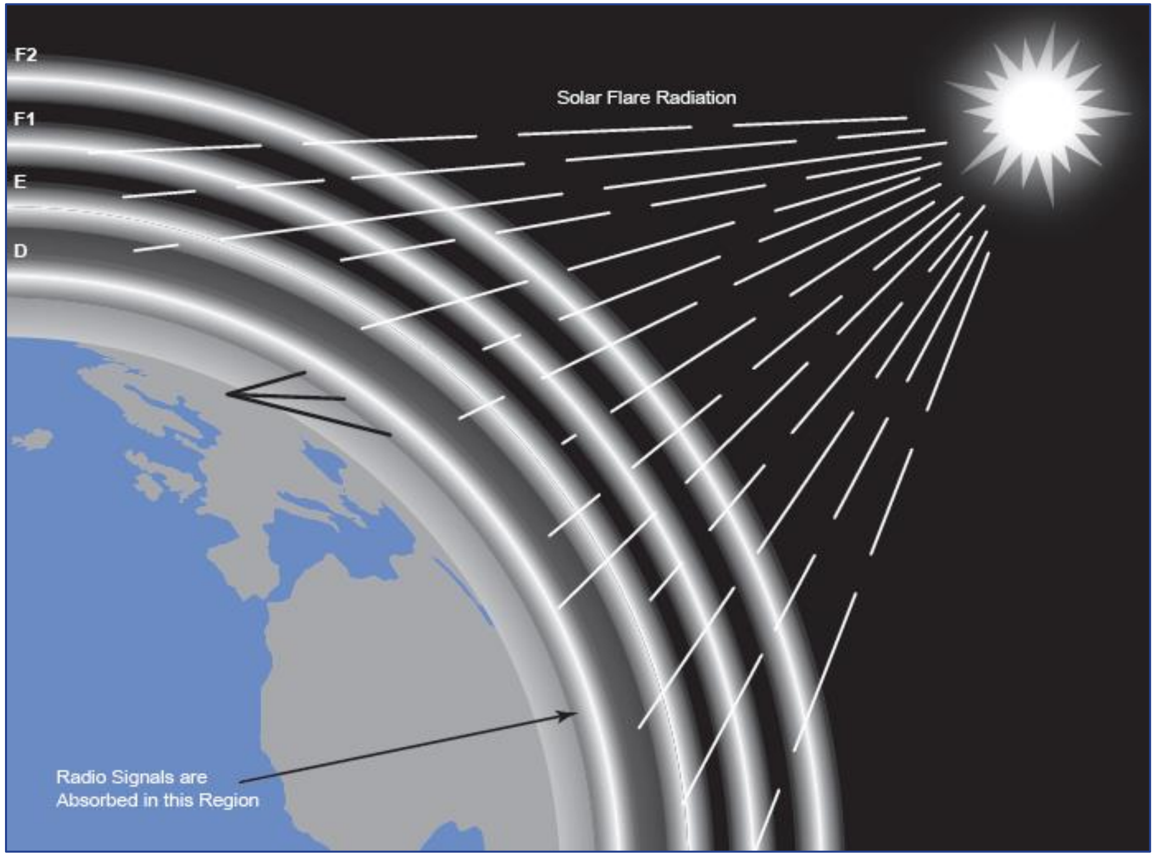
To make contact with a distant station, you will have to use a frequency between LUF and MUF so the wave is bent back to Earth but isn’t absorbed

If MUF drops below LUF, then no propagation exists between those two points via ordinary skywave

Solar Disturbances

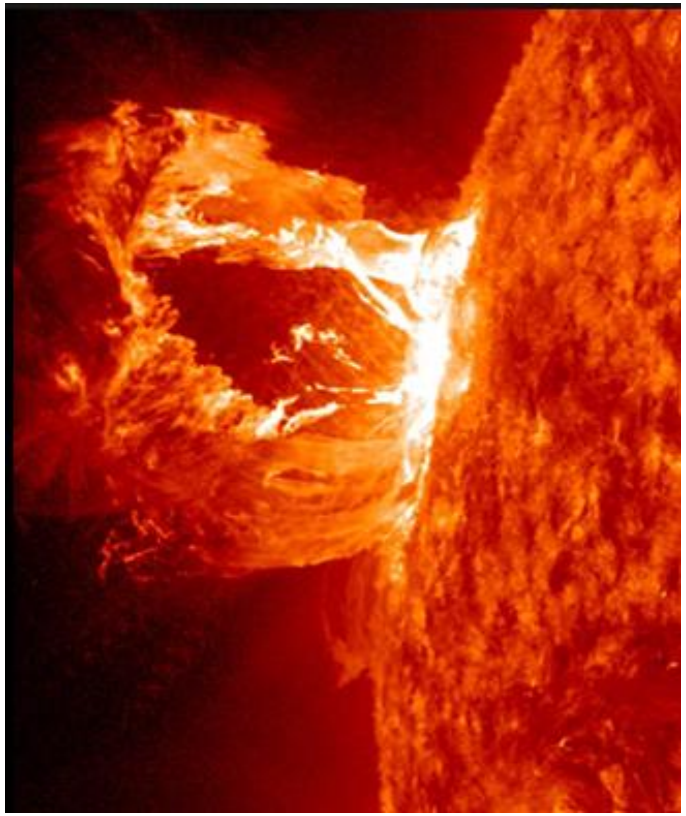
Approximately eight minutes after a solar flare occurs on the sun, the ultraviolet and X-ray radiation released by the flare reaches the Earth.

This radiation causes increased ionization and radio wave absorption in the *D* region.



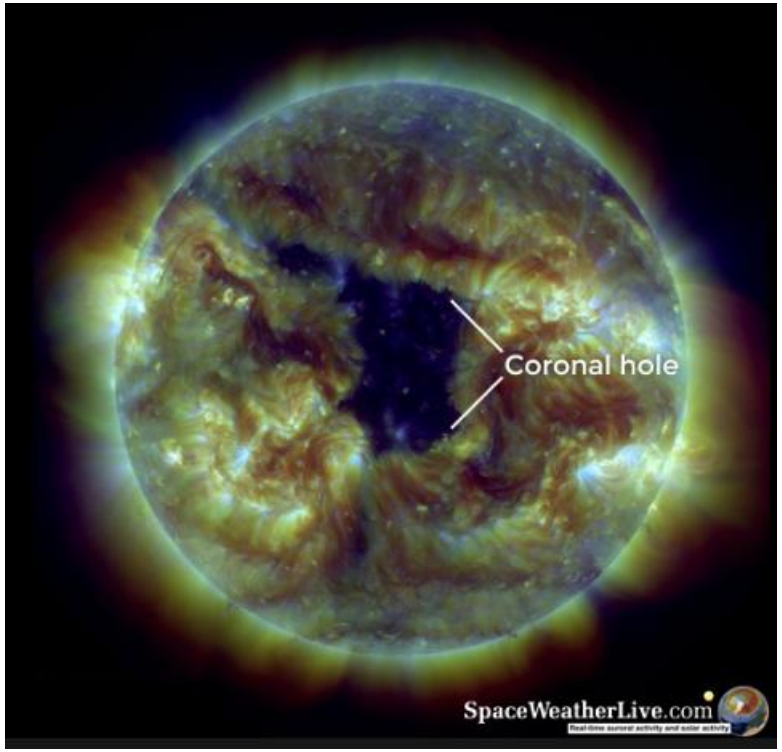
Solar Disturbances (cont.)

Solar flare: A large eruption of energy and solar material when magnetic field disruptions occur on the surface of the sun.



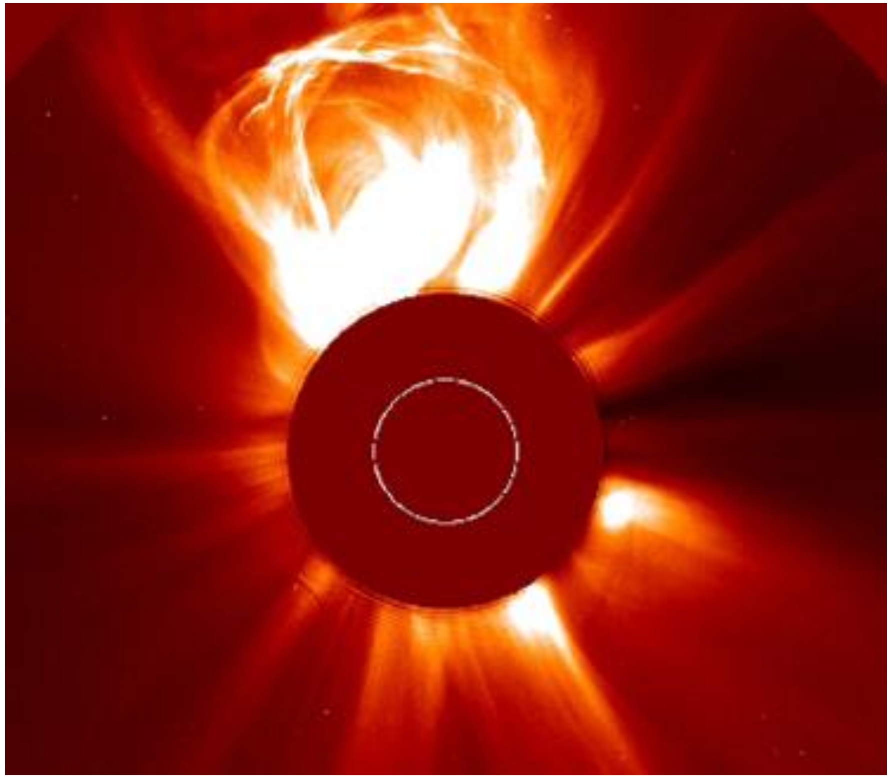
Solar Disturbances (cont.)

Coronal hole: A weak area in the sun’s corona (the outer layer) through which plasma (ionized gas and charged particles) escapes the sun’s magnetic field and streams away into space at high velocities.



Solar Disturbances (cont.)

Coronal mass ejection (CME): An ejection of large amounts of material from the corona.



All of these disrupt HF propagation

Sudden Ionospheric Disturbances

UV and X-ray radiation from a solar flare travels at speed of light to impact the ionosphere about 8 minutes later

When radiation hits the ionosphere, the level of ionization increases rapidly, particularly in D region

This increases absorption dramatically, causing a sudden ionospheric disturbance (SID) also known as a radio blackout

Lower bands are more strongly affected, but communication may still be possible on a higher band

SIDs affect only the sunlit side of the Earth; dark-side communications may be relatively unaffected

Geomagnetic Disturbances

Interaction between solar wind and geomagnetic field creates a region of space called the magnetosphere

Charged particles from coronal holes and coronal mass ejections travel considerably slower and take longer to reach Earth (15 to 40 hours)

These particles deposit their energy into Earth's geomagnetic field and increase ionization in E region, causing auroral displays and creating a geomagnetic storm … affects higher HF bands first

Long-distance paths that traverse high latitudes, particularly those that pass near the magnetic poles, may be completely wiped out for hours to days

Can create auroras that reflect radio waves above 20 MHz

Auroral propagation is strongest on 6 and 2 m, modulating the signals with a hiss or buzz

QUESTIONS?

ONLINE EXAM REVIEW AND PRACTICE QUESTIONS:

http://www.arrl.org/examreview