



# One Small step to Understanding Propagation

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BY NOUC

# Study of the Sun

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The science surrounding the Sun is a life long endeavor and has been studied for centuries. Radio propagation affected by the Sun is a fairly new science and studied for less than 150 years. With the development of internet access it has allowed us quick access to real-time collection of this scientific information for analysis outside the scientific study community.

As the amateur radio community started gathering the available information many independent groups developed ways to help their fellow amateurs understand and use this information to be more successful without reinventing the science for themselves.

The use this information there are a few things we need to understand to use the tools available and hope to address some but all of them here.

# So Much to Know

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With so much to know where do we start?

What do we want to accomplish with this knowledge?

How are we expecting to put this to use in our daily routine operating our radio?

Answering these questions will help us decide.

# The Sun

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The Sun is the primary source of electromagnetic radiation on Earth. The Earth is constantly bombarded with electromagnetic radiation (EMR), but before the electromagnetic energy from the Sun reaches the Earth's surface, it must pass through the atmosphere. The atmosphere protects us from exposure to higher energy radiation that can be harmful to life – i.e. X-Ray and Gamma Rays. As the energy passes through the atmosphere, it interacts with the molecules and particles present in the atmosphere. In the atmosphere, EMR is scattered or reflected, absorbed and a portion of the energy passes through the atmosphere to reach the Earth's surface.

# What we should already know

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In studying for our amateur radio license we learned the basics of propagation so we don't need to go over that again. Maybe some terms should be refreshed though.

Atmosphere regions related to radio waves like D, E, F1 & F2

Absorption, reflection, refraction, skip zone, multi-hop, Chordal-hop, phase angle, scattering, diffuse, take-off angle, gray-line

The Time of Day, The Year, The Season, Frequency, Location, Magnetic Disturbance, QRN

# Things to Remember

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Critical Frequency – the highest frequency at which a signal transmitted straight up at 90 degree elevation angle is returned to earth.

Maximum Usable Frequency (MUF) – the highest frequency at which reliable radio communications via ionospheric propagation can be maintained over a given path.

Digisonde Station can operate in the multi-beam sounding mode using six digitally synthesized off-vertical reception beams in addition to the vertical beam. For each frequency and height on a multi-beam ionogram, the raw data from the four receive antennas are collected and processed to form seven beams , separately for the O-mode and X-mode echoes. For each frequency-range pixel, the beam with the maximum amplitude is selected, and the amplitude and beam numbers are recorded in the output data. This information is use to form an ionogram report from that station.

# Things to Know

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What are these things called indices?

The A and K indices are a measurement of the behavior of the magnetic field in and around the earth.

The K index uses a scale from 0 to 9 to measure the change in the horizontal component of the geomagnetic field

The A index is a daily value on a scale from 0 to 400 to express the range of disturbance of the geomagnetic field.

Solar flux is a measurement of the intensity of solar radio emissions with a wavelength of 10.7 cm (a frequency of about 2800 MHz)

# Things to Know

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X-Ray Flux an early warning system for the earth. X-ray flux intensity is use to classify storm levels. These levels are A, B, C, M, X being the highest.

Solar winds are predictive of solar storms. These storms result in variations in the solar wind that produces major changes in the currents, plasmas, and fields in Earth's magnetosphere. The largest storms that result from these conditions are associated with solar coronal mass ejections (CMEs) where a billion tons or so of plasma from the sun, with its embedded magnetic field, arrives at Earth.

$B_z$  indicates the direction of the flow of the magnetic currents induced by the solar winds.



# Calculating for Success

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Gathering of information

WWV/WWVB gives you time and at 18 minutes after the hours solar information at Bolder, CO

<https://www.swpc.noaa.gov/products/geophysical-alert-wwv-text>

<https://www.swpc.noaa.gov/> Space Weather Prediction Center at NOAA in Bolder, CO

<https://www.spaceweatherlive.com> SpaceWeatherLive is an initiative of Parsec vzw, a non-profit organization from Belgium which consists of several websites about astronomy, space, space weather, aurora and related subjects.

<https://hamwaves.com/> This website was developed for Amateur Radio by Serge Stroobandt, ON4AA trying to locate needed information for your station to make predictions in one place.

# The MARS experience

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What type of communication in an emergency is important?

A network of communicators is important.

A known schedule of time and frequency where to gather on a daily bases.

Use of ALE for reliable message delivery.

When all else fails by any means possible.

# What does it All Mean?

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Boy that is a loaded question!! Depends on what you are looking for. Do you want to be a scientist or just want to know if it is worth turning the radio on. Looking for some DX or just some local chat with friends in the USA. It is all in the numbers posted by the scientific community or is it?

A and K index are related and indicate unsettled conditions so higher the numbers more stormy the conditions not good for radio communications

Solar Flux is an indication of solar activity, and to determine the level or amount of radiation being received from the Sun. The solar flux is closely related to the amount of ionization and hence the electron concentration in the F2 region. As a result, it gives a very good indication of conditions for long-distance communication.

# What does it All mean?

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When we see a rising solar flux and a falling A index and a K index of 2 or less we could expect improving DX conditions.

When we see a rapidly rising x-ray flux beware a geomagnetic storm maybe on it way with degrading propagation across the bands and if strong enough radio blackouts may occurs.

The critical frequency is indicating the level of D-layer formation.

The MUF is indicating the best frequency for local NVIS communication at that point in time. When combined with other factors could indicate best frequency for longer communication also.

When gathering this real-time info and plugging it into available propagation program gives a good opportunity to increase the chances of making contact with a wanted location.

# Tools for Success

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Real-Time solar data <https://hamwaves.com/propagation/en/index.html>

Real-Time ionogram near your location <https://hamwaves.com/ionograms/en/index.html>

Near Real-Time MUF map <http://www.spacew.com/www/realtime.php>

Global Real-Time ionosphere F0F2 mapping

<https://www.sws.bom.gov.au/Images/HF%20Systems/Global%20HF/Ionospheric%20Map/WorldIMap0.gif>

Voice of America (VOA) Coverage Analysis Program (CAP) <https://www.voacap.com/hf/> makes quick work of predicting success by entering grid location of contact.



# Discussion before closing One Small step to Understanding Propagation

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