# Propagation
## Chapter 27

Propagation is the process by which radio waves get from the antenna of the transmitter to the antenna of a distant receiver.

This chapter introduces the different propagation modes used by amateurs.

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The 7 MHz band is the 42.25 to 41.37 Metre Band...

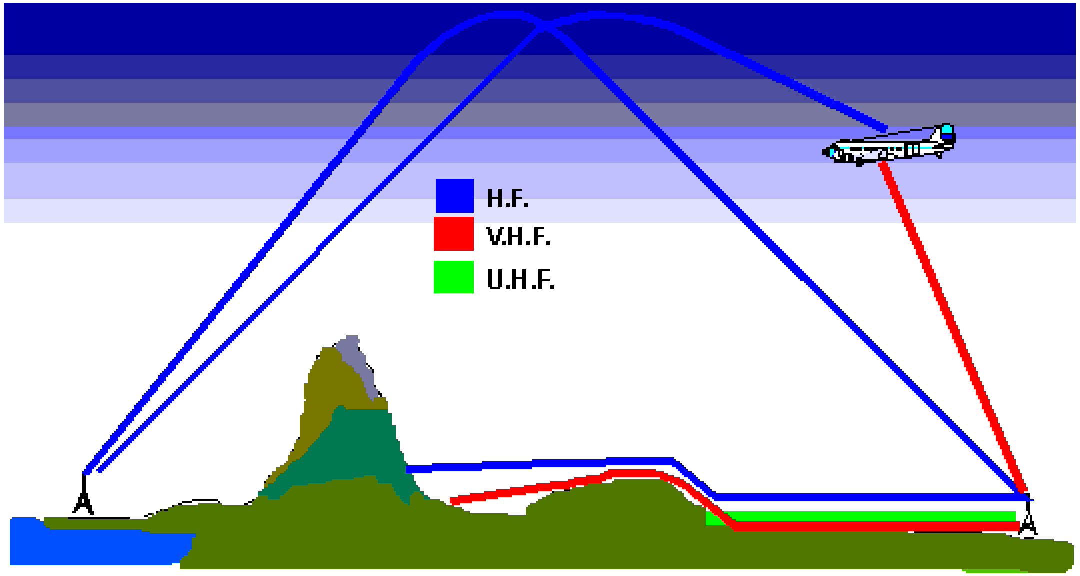
But ‘everyone’ calls it the 40 Metre Band.

| **Range** | | **Frequency** | | **Wavelength** | | Amateur bands |
|---|---|---|---|---|---|---|
| | | From | To | From | To | |
| HF | High frequency | 3 MHz | 30 MHz | 100 metres | 10 m | 80 to 10 m (9 bands) |
| VHF | Very high frequency | 30 MHz | 300 MHz | 10 metres | 1m | 6 m, 2 m |
| UHF | Ultra-high frequency | 300 MHz | 3 GHz | 1 metre | 100 mm | 70 to 23 cm |

# Line-of-sight Propagation

**Direct wave** (line of sight) propagation is when signals of any frequency travel directly from the transmitter to the receiver.

**Ground-wave** propagation is where low and medium frequency signals follow the curvature of the earth, up to a distance of several hundred kilometres.



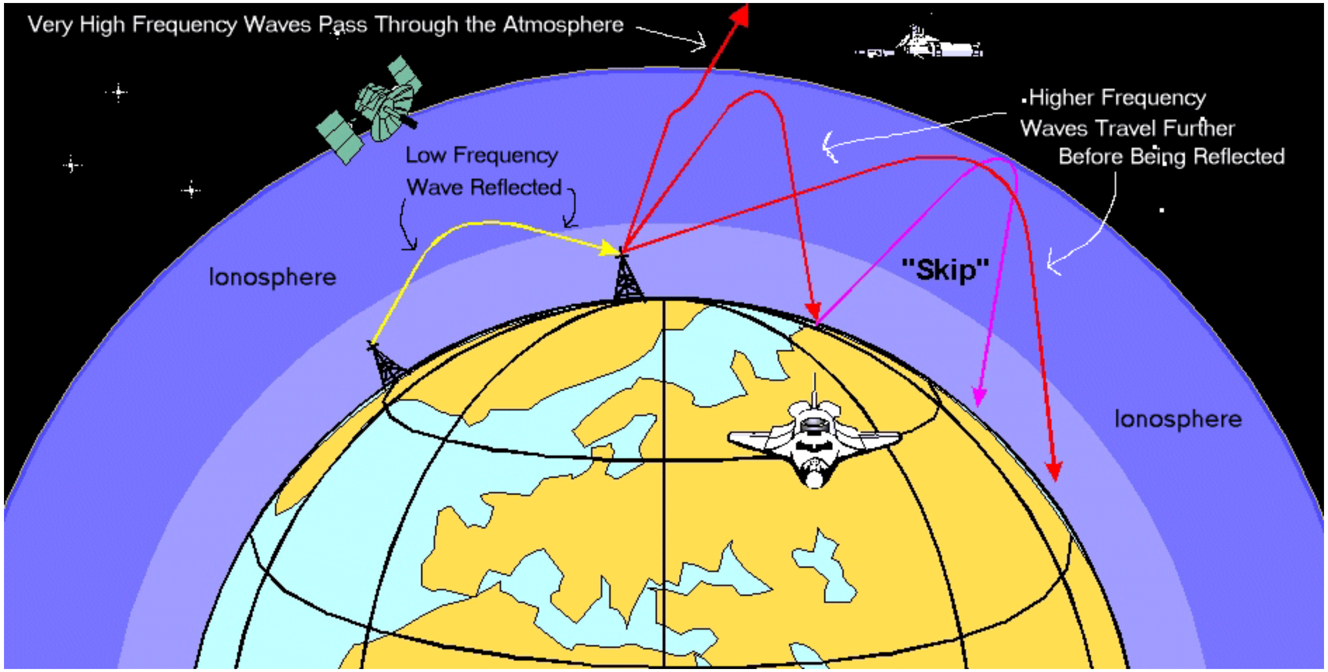
# Ionospheric Propagation

Ionospheric propagation results from the refraction of radio waves by the E, F1 and F2 ionospheric layers.

During daylight hours, the D layer absorbs low-frequency signals, so only higher frequencies are usable.

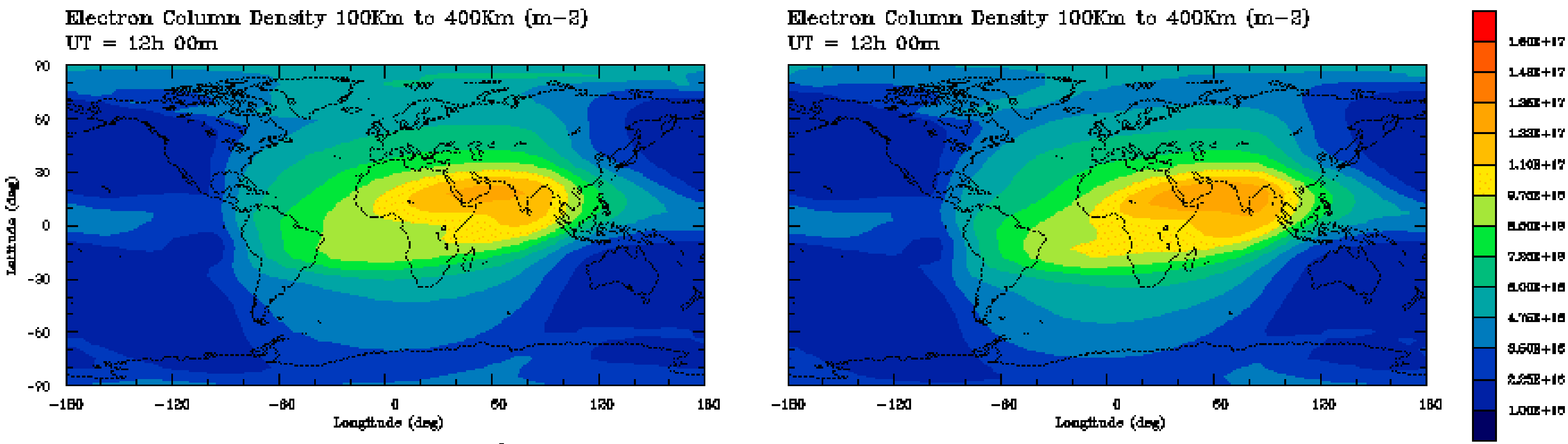
The D layer dissipates rapidly after dark, allowing even low frequency signals to reach the F layer. Higher frequency signals are not refracted sufficiently by the ionosphere to return to earth, but are lost into space.

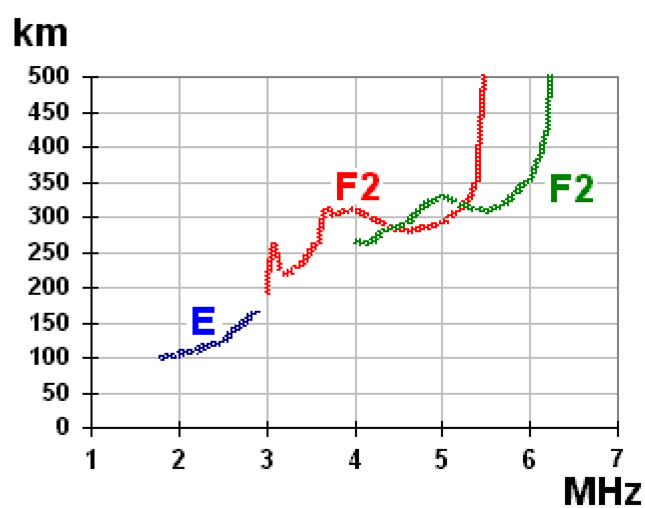
The skip zone is the area within the first hop in which a signal cannot be heard, as it is too far for direct and ground wave, and too close for skip (perhaps 100 to 1000 km).



# Ionospheric Propagation 2

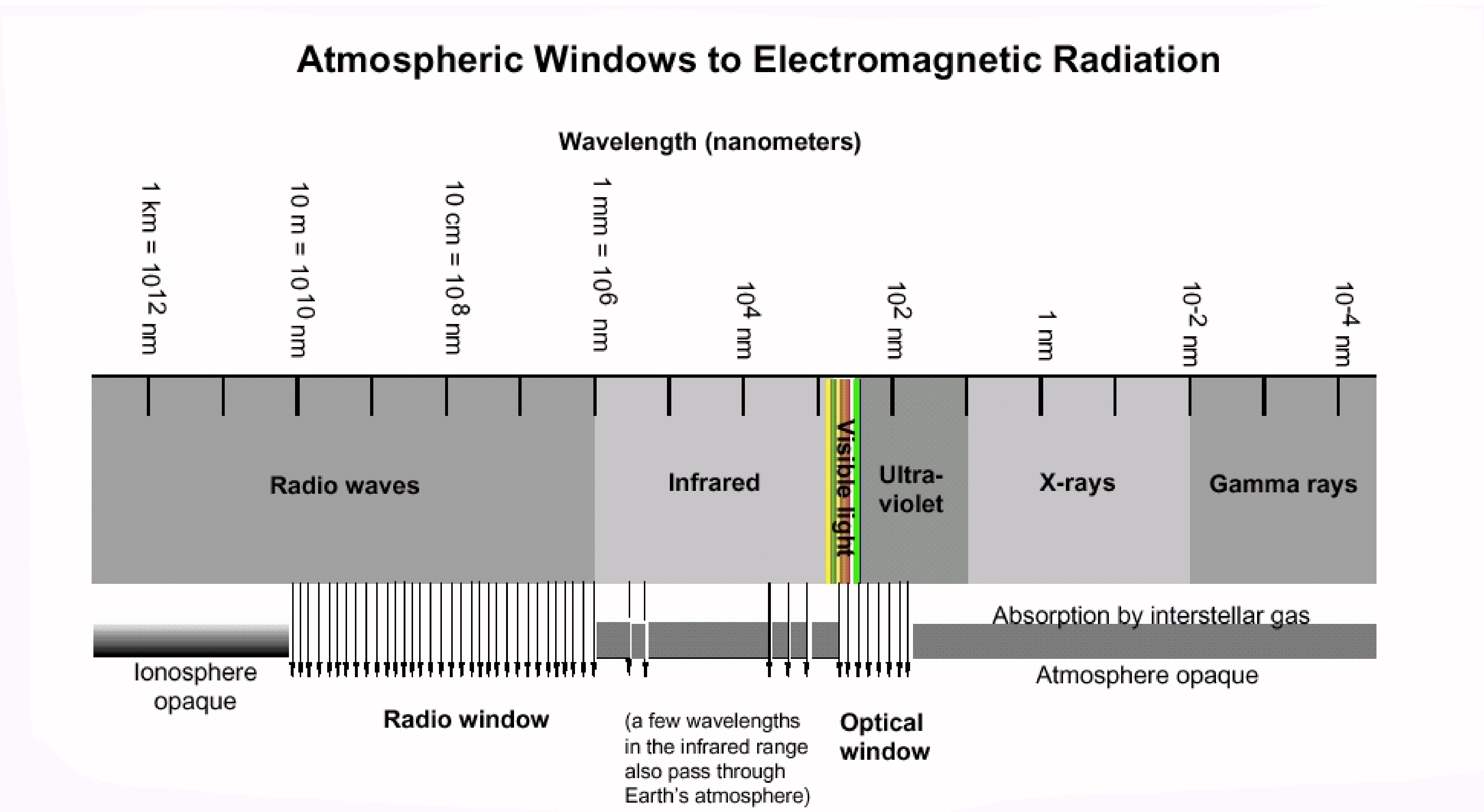
Quiet Ionosphere UT = 12h 00m | Ionospheric Storm UT = 12h 00m




- Chirp transmitter ?
- Ionosonde

# Ionospheric Propagation 3



# Critical Frequency

The **‘critical frequency’** is the highest frequency at which radiation directed vertically upwards will return to earth. The **‘maximum usable frequency’** (MUF) for a particular path is the maximum frequency that will be refracted by the ionosphere along that path and it may be considerably higher than the critical frequency. The **‘lowest usable frequency’** (LUF) is the lowest frequency that can be used for communication on a particular path, and depends on the EIRP of the transmitter and the receiver noise level as well as the extent of ionisation. Ionospheric propagation via the F layer occurs most commonly for the high frequency (HF) bands, although there are occasional openings on the 6 metre (50 MHz) band. The amount of ionisation depends on the time of day, season and the eleven-year solar cycle.

# Multipath

**Multipath** propagation could result in enhancement and destruction of the signal, leading to fading.

[Multi-path propagation is why Frequency Modulation is NOT used for aircraft communication.]

**Fading** could vary the signal strength by tens of dB and could have a period of milliseconds to hours.

[Fading occurs at H.F. It was NOT originally called the Luxembourg effect. For that you should go to:-
the Luxembourg Effect ]

# Sporadic E Propagation

Sporadic E propagation consists of the refraction of VHF signals by intensely-ionised patches of the E layer.

These patches occur sporadically but may last for several hours and allow VHF communication at ranges from a hundred to several thousand kilometres.

# Back and Tropospheric scatter

**Backscatter** allows close-in contact on the high bands, when signals are scattered from the surface after the first hop.

**Meteor scatter** mostly uses specialised digital modes to communicate using the very brief periods of intense ionisation caused by meteors entering the earth's atmosphere.

**Tropospheric scatter** results from signals being reflected by temperature and humidity differences in the troposphere and can result in consistent VHF and UHF communications over ranges of 100 to more than 500 km with suitable equipment.

**Tropospheric ducting**, when VHF signals are trapped between the ground and an inversion layer or between two inversion layers, is much less common but can result in signals being received with good strength thousands of kilometres away. Auroral scatter reflects rough signals from the polar regions, allowing long-distance VHF and UHF contacts.

# Oscar 0 - EME

**Earth-moon-earth** (EME) is technically challenging because of the extreme path loss. [250 dB+]

Nevertheless, EME is possible with relatively modest stations using weak signal digital modes.

# Amateur Radio via Sattelite

Amateur satellites retransmit signals received on one frequency band onto another frequency band, functioning similarly to repeaters in space but over much greater distances than terrestrial repeaters.

Some satellites require high-gain antennas that have to track the satellite in azimuth and elevation.

Operators may have to compensate uplink and downlink frequencies to compensate for Doppler shift.

Do not use more power or antenna gain than necessary, to avoid inconveniencing other users.

# Oscar 0 ?
# "Moonbounce"

**Link budget calculations** can be done by calculating **free-space path loss** or using a propagation forecasting tool.

The calculations take into account **transmitter power**, **antenna gain** and **cable losses**, **receiver sensitivity**, antenna gain and losses and other factors like **polarisation loss**. [one signal is Horizontal, other is Vertically polarised.]

The link margin provides an indication of how robust the link will be, what power is required, what antennas are required and what the **reliability** of the link is likely to be.

# Propagation

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# Propagation



Questions ...