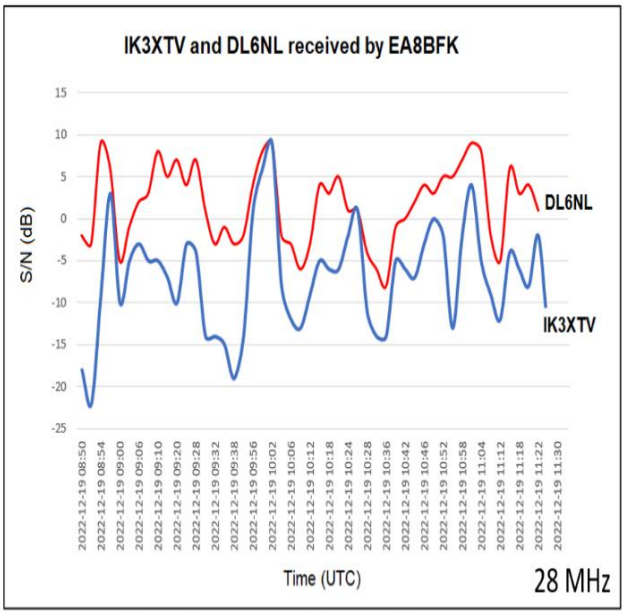
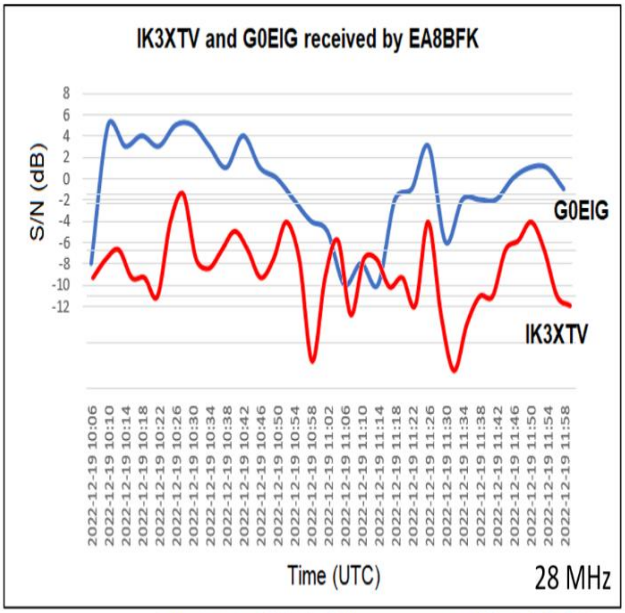
The behavior of the ionospheric path is the same for all

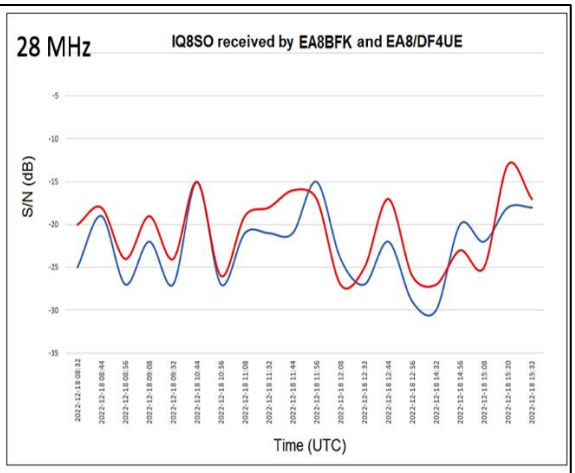
Despite all the studies and research I've done, the ionosphere always remains mysterious to me. I think this is precisely the reason for its great charm, but besides all this, the ionosphere appears to be democratic. One of the things that has always bothered me a lot during my radio activity is fading which often limits and penalizes listening, especially when the signals are not so strong. We know that sometimes the signal disappears, but then suddenly reappears, to be a radio amateur, you need patience. We have very large oscillations, which can exceed 20 dB. I have attempted to thoroughly study the phenomenon of ionospheric fading. I used WSPR software and my beacon with very low power transmissions. This tool, associated with the WSPRnet program, with a database on the web is absolutely an indispensable tool for a study like this. My goal was to check if: Is fading symmetrical? Fading is the same for all stations? How does the ionosphere behave? The only way was to apply the scientific method is the way science proceeds to reach a reliable and also verifiable knowledge of reality. The road that Galileo pointed out. What is this experiment about? I used my WSPR beacon and logged the signal received from a few stations and plotted the data on the graph. I compared them with data from other stations to see if the signal on the same ionospheric path changed or remained the same. Experiments like this are only possible thanks to digital technologies. To the WSPR beacon system and the WSPR propagation reporter system.

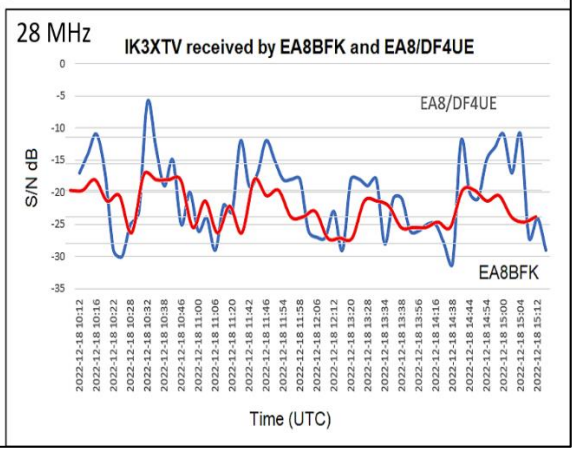


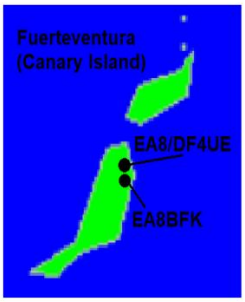


The trend of the left graph curves are very similar. When the path is very different, the correspondence between the two curves decreases, as seen in the graph on the right.

Map of the paths

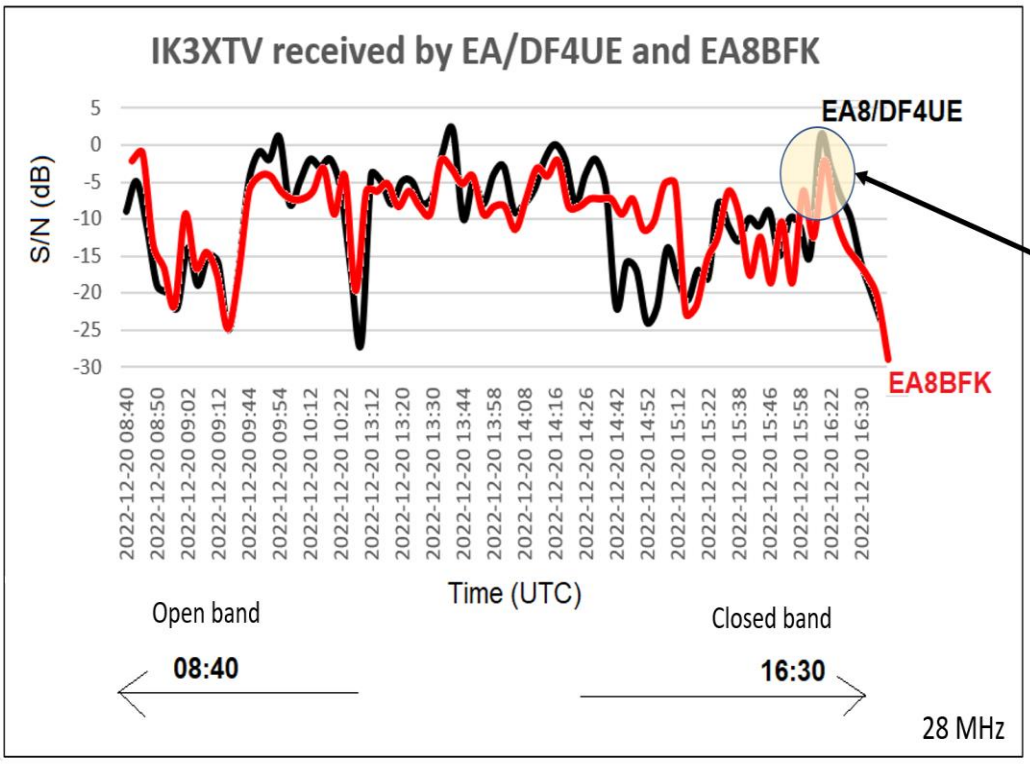




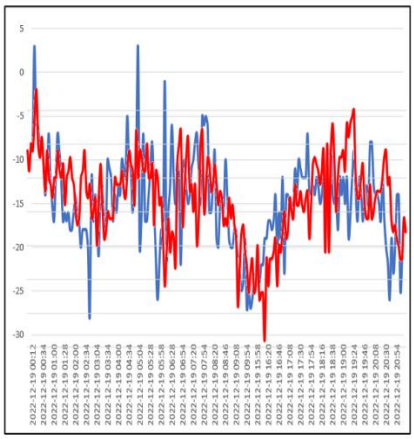


The two stations of the Canary Islands are very close. They are only separated by a few kilometers.

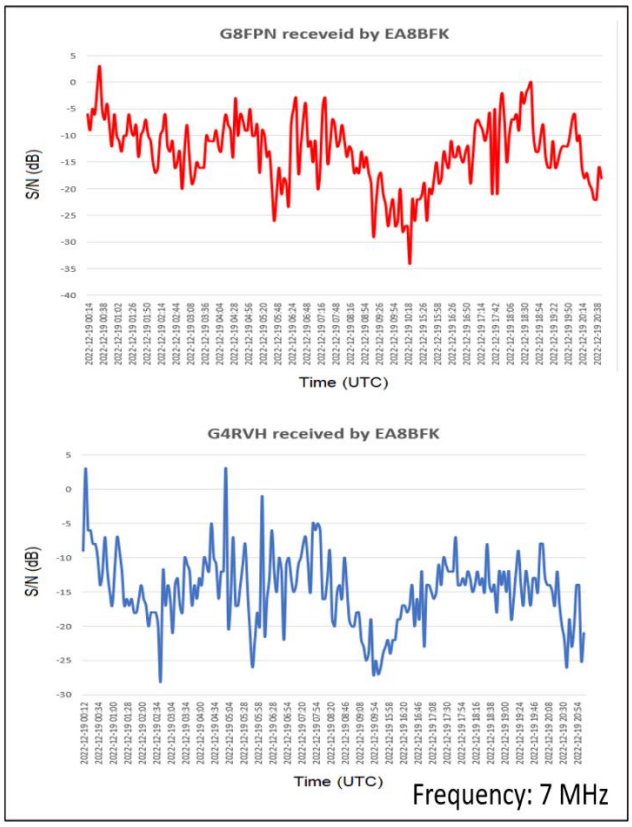
Full day reception of my WSPR beacon IK3XTV received by two stations from the Canary Islands EA8/DF4UE and EA8BFK. The two signal curves have been superimposed on the same graph and show almost perfectly the same shape.



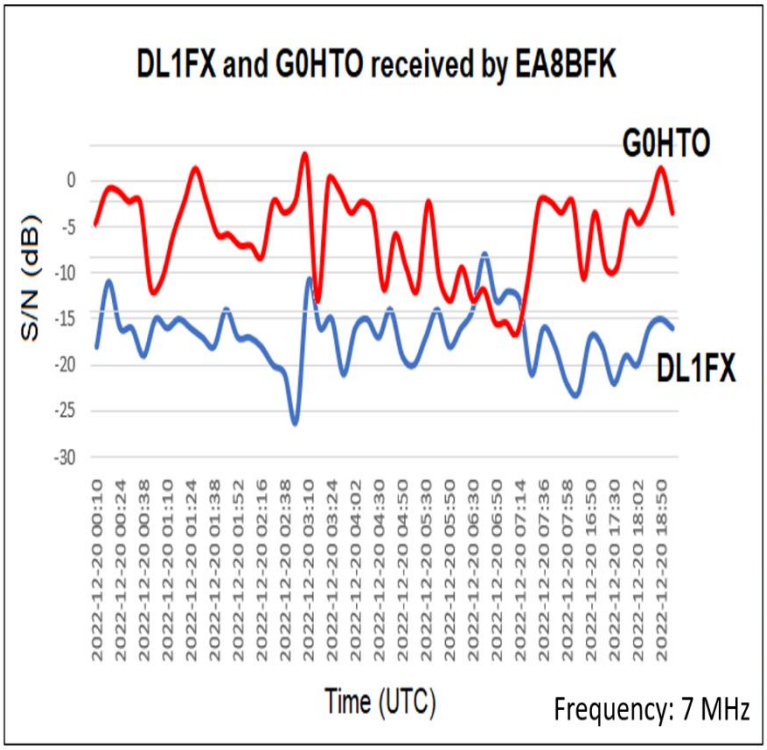
IK3XTV side sunset deep



The two curves of the right graphs superimposed on each other

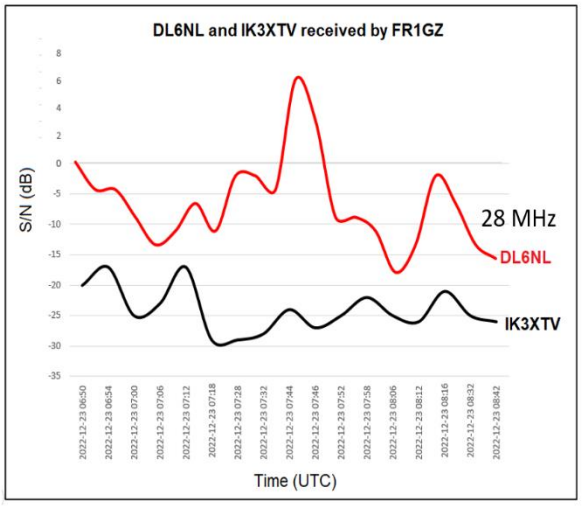


The distance between G0HTO and DL1FX is approximately 1200 chilometers and the path is completely different. The result is that the signal trend curves are very different. The profile of ionosphere and TEC in this very large area is different.

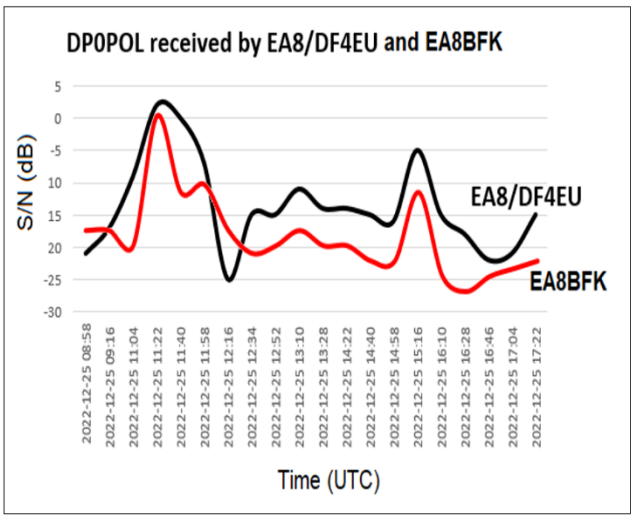


No correspondence between the two curves

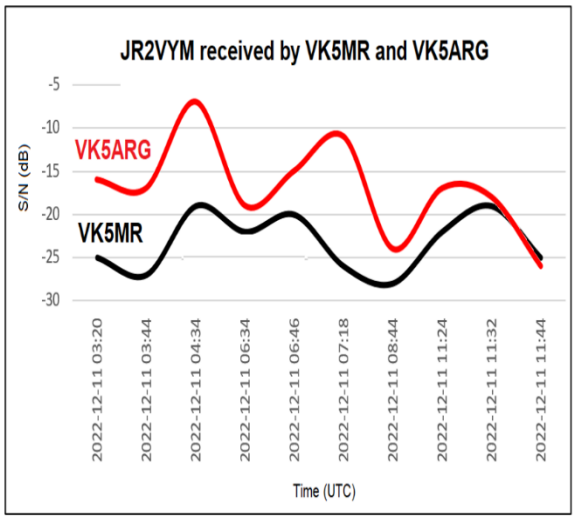
The ionospheric conditions seem repeatable even along a transequatorial ionospheric path of over 8000 kilometers. The two curves in the graph below show how the shape of the curves is very similar, only the absolute values change. IK3XTV and DL6NL are almost on the same geodesic line towards FR1GZ.



Ionosphere around the world

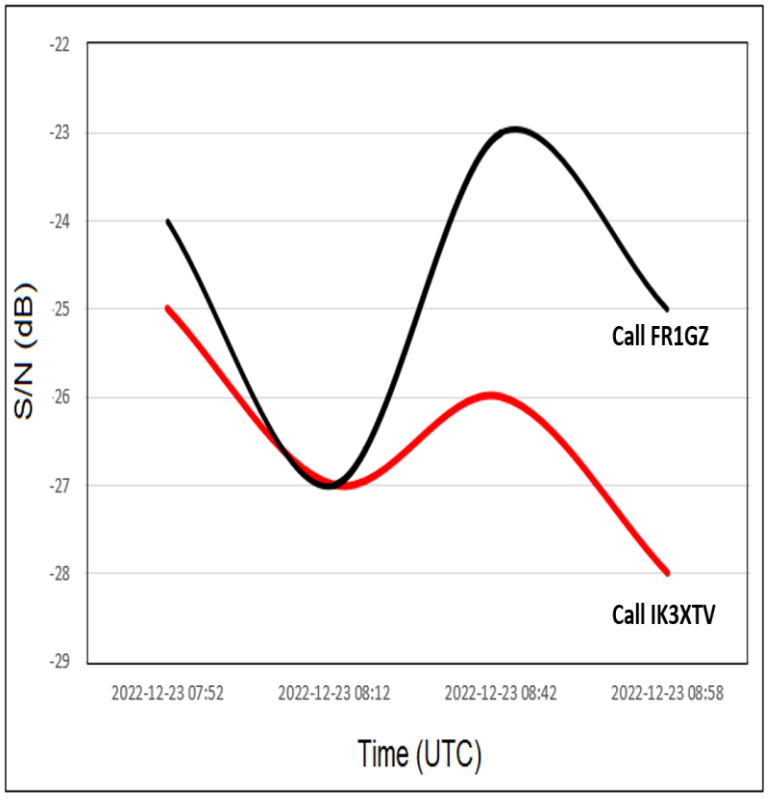


Ionospheric path 8300 Km.



Ionospheric path 7800 Km.

Reciprocity of the ionosphere



The two curves respectively show the trend of the signal transmitted by IK3XTV and received by FR1GZ in the Reunion Islands (Indian Ocean) and the signal transmitted by FR1GZ and received by IK3XTV with a 2-minute phase shift. The ionospheric path is 8635 km. Note the transmitted signal from FR1GZ (call FR1GZ) is stronger as the transmitted power is 4 times stronger than IK3XTV

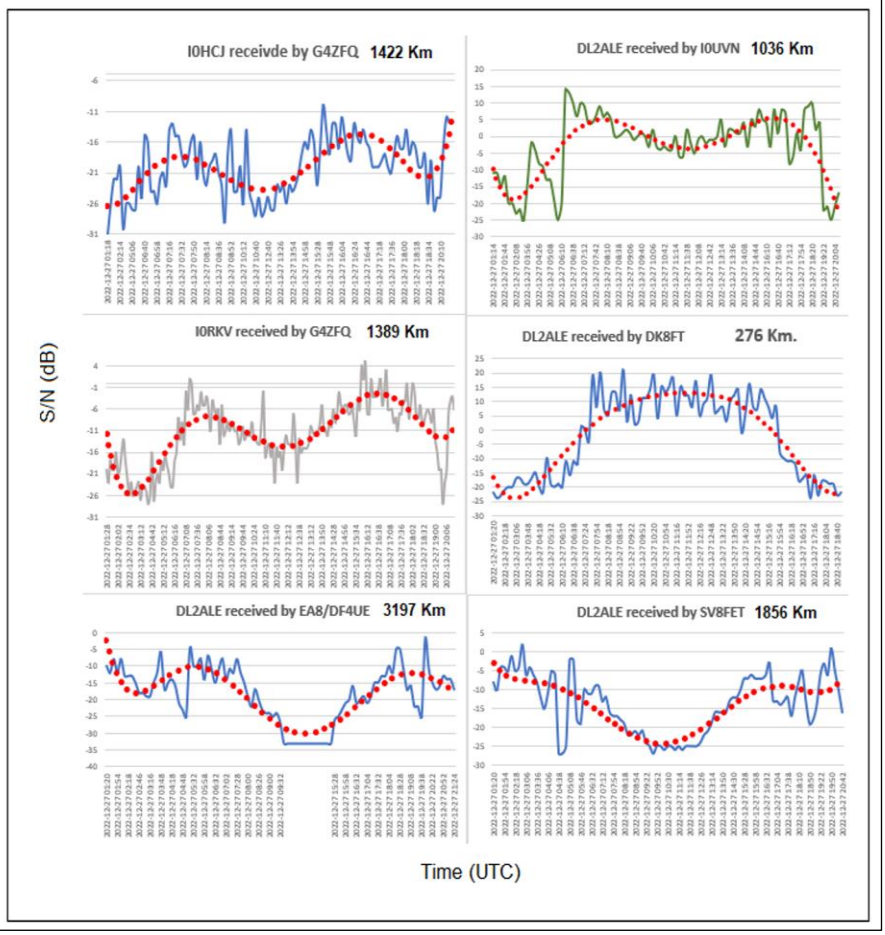
Tx power IK3XTV 0,5 W
Tx power FR1GZ 2 W

Ionospheric path 8635 Km.

Ionospheric macro trend (7 MHz)

As the distance between stations increases, the period of the ripple increases.

Study of the behavior of the ionosphere in relation to the path length. More similar behaviors become apparent as path length decreases. Note how the local path of 276 km has a different behavior with a typical Gaussian trend.



Conclusions

- The signal strength in absolute value varies, but signal trend is the same.
- It doesn't depend on the frequency. I have experimented on both 10 and 40 meters.
- The closer the path is, the more similar the trend is. For very close ionospheric paths the reception curves are almost perfectly superimposable.
- As you move away from the same path, the inhomogeneities increase.
- Some differences between the curves are due to a slight lag of a few minutes between one station and another
- Everything leads me to think that the conditions are reversible (fading on one side is the same as on the other side of the path).

In practice I want to demonstrate that on the same path, (connection on the same geodetic line, within a 100/200 km wide slice of the ionosphere) the ionosphere it is predictable and behaves the same for all stations. Only the absolute value of the received signal changes, because the signal level obviously depends on external factors, such as the transmitted power, the type of antenna and the location of the stations.

All maps were created with DXATLAS software by Alex Shovkoplyas, VE3NEA.
Thanks to all the WSPR stations featured in this experiment: DL6NL, IQ8SO, G0EIG, EA8/DF4UE, EA8BFK, G8FPN, G4RVH, G0HTO, DL1FX, FR1GZ, VK5MR, VK5ARG, DO0POL, JR2VYM.

Date: December 27, 2022 – IK3XTV, Amateur Radio Propagation Studies.