Geomagnetic Storm associated with propagation opening

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Contrary to what we can expect, strong geomagnetic storms can promote propagation openings creating favorable conditions and sometimes exceptional conditions. Frequencies are most concerned the low ranges of HF and even medium waves. From the analysis of several cases emerge that this is something really connected to ionospheric conditions disrupted as a result of intense geomagnetic phenomena.

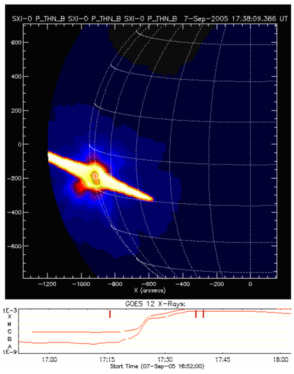

Figure 1

SOLAR FLARES
The activity on the surface of the Sun is highlighted by the density of sunspots, which appear as dark areas on the photosphere, floating in frequency within a cycle of activity approximately equal to 11 years. Because dark regions are more "cool" than at the bottom: their temperature is of the order of 4000 ° K, while that of the surrounding area is 6000 ° K. In sunspots is located intense magnetic fields and on the immediately higher in the atmosphere, often occur intense flares producing powerful burst of radio energy at frequencies between 5 MHz and 300 MHz. Often, during more intense flares, occurs an intense flow of charged particles (cosmic rays) with high-energy traveling at a speed of 500-1,000 km /s, it is the solar wind: When these particles reach the Earth's magnetic field cause strong radio noise and magnetic storms, with formations of Aurora. The map of solar emission due flares appears much wider than occupied of sunspots. Unlike radiation coming from the universe, which is not polarized, that associated with solar flares circular polarization is being caused by spiral trajectories of electrons that follow the local, intense magnetic field associated with any event.In the solar flare give rise to a jet of electromagnetic radiation, which go from the field of HF to X-ray and gamma-ray as well as expulsion of material from the solar corona, all of this is made in space and thus in the direction of the earth, where catch the magnetic field that aligns plasma following the lines of force of the Earth's magnetic field, focusing on poles, near the aurora oval. The explosion of energy that occurs during a blast is enormous, like an atomic explosion of 10 billion megaton. By convention the solar flares are divided into 3 classes, C, M and X
Depends on the flow of energy developed:
• FLARE CLASS C is the least powerful and not immediately affects the ionosphere, Although the particles emitted may affect the ionosphere several hours later.
• FLARE CLASS M is a medium energy flare and is sufficient to influence the Earth's ionosphere immediately after the event, but also to produce delayed effects of solar radiation.
• FLARE CLASS X (figure 1) is the most powerful and destructive and can cause severe geomagnetic storms and long blackout on communications.
The electromagnetic radiation of an active flare, ultraviolet, X-rays, visible light and radio spectrum, traveling with the speed of the light and reaching the Earth with a delay of about 8 minutes, so the effects on the ionosphere can begin at the same time when the flare is visually observed. The radio communications can be affected immediately after the flare, or the effects may be felt from one to two days after the beginning of the flare, however, for a limited period and immediately following the phenomenon, there may be conditions able to improve considerably the propagation. The increased intensity of the solar wind caused by the flare, put agitation the ionospheric plasma, breaking the uniformity of the layers, changing the geometry of the ionosphere and its volume.

SIGNIFICANT EVENTS
List below some strong geomagnetic events among the most significant that I have registered and have generated excellent propagation openings:
• event of 11.24.2001 index Kp = 8
• event of 11.20.2002 index Kp = 7
• event of 10.28.2003 index Kp = 7
• event of 11.04.2003 index Kp = 7
• event of 01.03.2005 index Kp = 5
• event of 09.07.2005 index Kp = 8

PRESSURE OF SOLAR RADIATION
As a result of the pressure of solar radiation, the ionosphere and the earth are not two concentric spheres. This results is a continuous deformation of the Ionosphere which highlights considerably when the sun sets on a meridian (grey line). The signals that cross for thousands of miles to the ionosphere can meet oblique surfaces in relation to the ground (tilt), as well as real curved surfaces that can give focus effects (Figure 2). This phenomenon is even more exasperated in the presence of strong solar emissions as is the case of most intense solar disturbances. In this case, as a result of solar wind, the lines of magnetic force, compressed on lighted hemisphere, are extend like a “comet tail" to the opposite hemisphere.

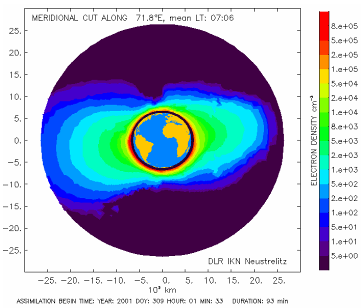

Figure 2

THEORETICAL ASSUMPTIONS
Because the random nature of Ionospheric propagation, is not possible to identify with certainty the elements that support propagation. One thing, however, is sure and is derived from years of research and listening to the radio frequencies: the classic model of propagation (ionospheric jumps) is unable to explain the phenomena that govern and support propagation. I am convinced that we should try something of different from the classical model that under a certain point of view it results to be obsolete. So I tried to make a few plausible scenarios that could explain why these extraordinary openings may occur. One thing is sure that as a result of solar wind, the geometry of the ionosphere is changed. The ionosphere is compressed in the hemisphere lighted by the sun and there is a gradual extension on the opposite side, where up most extreme to be confused with the tail of the magnetosphere. (Figure 3). I think that this geometric variation can be favorable for the signal propagation.

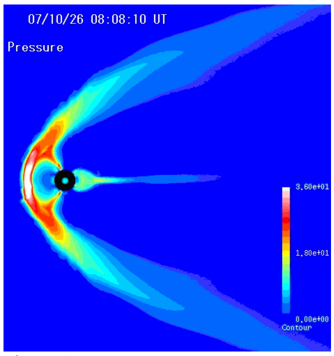

Figure 3

The favorable skips are only in the darkness side of the earth, because they are not directly affected by the flow of energy from the sun. An explanation quite extreme, brings me to look over the earth's ionosphere within the magnetospheric plasma, and near the tail of the magnetosphere where as a result of recombination of electric charges, there may be some potential points of reflection or perhaps best possible waves ducts in the magnetosphere on the dark side of the earth (Figure 4).This is a fascinating idea but at the same time difficult to prove. These ducts for the conduction of signals can have the length of 60000/70000 km, or just over. The round trip distance of the signal could also justify the signal delay that I most often found during the geomagnetic events more intense. Very often the signal does not follow the geodetic line between two points, but follows the strong distortion of the magnetic field, so we can have large HF bearing errors for propagation paths and sometimes can follows a wave duct inside the magnetosphere. I am planning a project that requires the use of software for tracking Beacons: "Faros" of VE3NEA that allows recording time delay signal beacon, although It is designed to record the beacons of NCDXF that transmit over 20 meters while openings extend until medium waves. It is clear, however, as noted in all analyzed events that the “propagation opening window " is relatively brief (a few hours) because the subsequent electronic recombination in the ionosphere, increases the ion density in the D region and block the propagation.

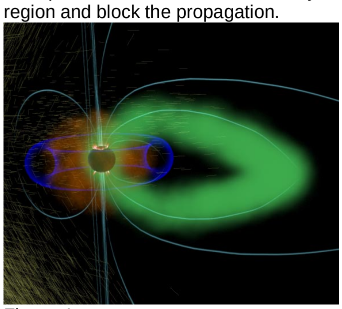
Figure 4

Bibliography: Ionosfera of M.Miceli, I4sn
Radioastrolab of F.Mancinelli
ESA European Space Agency and NASA
Images from ESA-NASA-SOHO

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