Thunderstorm connected with Sporadic E propagation

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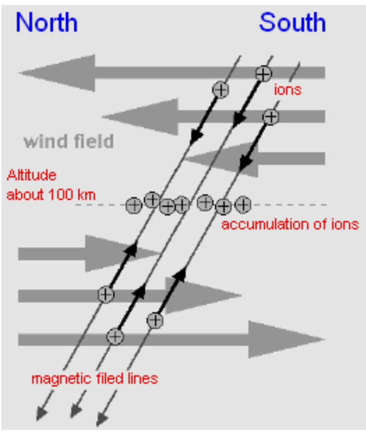
Is it possible that sporadic E propagation is connected with thunderstorms? Recent researches seem to support this hypothesis**.**

Communications are possible through the plasma irregularities into the Ionosphere in the E region, these irregularities are called sporadic E. We have therefore single and even double hop propagation. Occasionally lightning storms occur near the centre (point of reflection) of the Paths of radio contacts. The assumptions of lightning storms are a possible source of ignition for the E sporadic, especially for the more intense irregularities able to support the propagation for frequencies up to 144 Mhz.
This hypothesis, however, is not fully accepted by the international amateur radio community since the effect of thunderstorm on Sporadic E has not yet been proved with scientific evidence, although there is a recent publication of an article on the prestigious scientific journal "Nature" where discusses on the connection between Thunderstorms and ionosphere. The most likely theory to explain the mechanism is the "Wind shear theory" .
Recent measurements have found a high content of Ion metal inside the curtain of Es: Fe and Mg as well as O2 and NO: the major ions and dominant ion into the region E. Within the curtain of ions are present quantities of major metal ions, catalytic from meteoric rain. Some of the open questions are these:

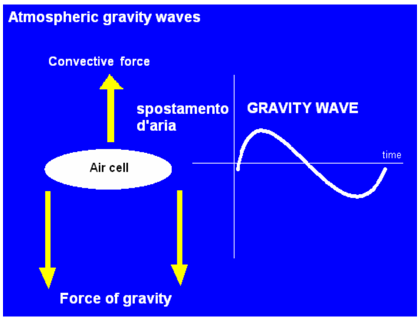
• The role of metal ions (and meteorites cosmic dust)
• The role of sprites (How is the interaction with the ionosphere?)
• The role of lightning
• The role of atmospheric gravity waves
• The role of ionospheric winds and the jet stream
• The role of the geomagnetic field
• the action of solar radiation



Atmospheric gravity waves
Atmospheric gravity waves (not to be confused with the more well note gravitational waves from the theory of relativity by A. Einstein) are variations of elastic type that spread into the atmosphere because its thermal stratification. Their wavelengths ranging from a few hundred meters to hundreds of kilometres, with periods ranging from a few minutes to several hours. The fluctuations of the resulting causing small fluctuations in atmospheric variables (pressure, temperature, humidity'...) but have a significant impact on the structure of the ionosphere. The gravity waves have a key role inside the Ionosphere and then in the propagation of radio waves. The atmospheric gravity waves interact with:

• sporadic E formation
• tropospheric propagation
• influence in the F region
• Ionospheric disturbance
• Ionospheric absorption
•D Region structure / moving ions in the Ionosphere

The influence of g.w. . seems more pronounced in the formation of the night F2 layer, which would help provide a small but continuous source of new ionization, contributing to the maintenance of residual ionization during the night. But the dynamics associated with sporadic E openings are convinced that the gravity waves play a decisive role.



Atmospheric tides
The atmospheric tides are mainly generated in the troposphere and in the stratosphere where the atmosphere is periodically heated for the absorption of solar radiation by water vapour and ozone. The tides generated are then able to spread from these regions and go up to the mesosphere and thermosphere. The atmospheric tides can be measured as regular fluctuations in the wind, temperature, density and pressure. Despite the atmospheric tides have much in common with the ocean tides, They are distingued for two key features: The atmospheric tides are caused primarily by warming from the sun (could be a link with the daytime occurrence sporadic E   as well as seasonal frequency concentrated more in summer), while those of the oceans are mainly caused by the lunar gravitational field. This means that most atmospheric tides have periods of oscillation with the length of 24 hours of the day sun, while the ocean have longer periods related to the lunar day (time between two successive transits moon) accounts for about 24 hours and 51 minutes . The atmospheric tides propagate into the atmosphere where the density varies significantly with the altitude. One consequence of this is that their amplitudes grow exponentially when the salt tide in regions progressively more rarefied air. A ground-level ozone, the atmospheric tides can be localized but slight fluctuations as regular pressure surface with periods of 24 and 12 hours. However, at a greater altitudes, the amplitude of the tides is very large. In the mesosphere (~ height of 50 - 100 km) atmospheric tides can reach speeds of 50 m /s and are often the major cause of air movement.

Atmosphere dynamics on Earth
Since the fluid is a continuous medium, a travelling disturbance will result. In the earth's atmosphere, gravity waves are important for transferring momentum from the troposphere to the mesosphere. Gravity waves are generated in the troposphere by frontal systems or by airflow over mountains. At first waves propagate through the atmosphere without affecting its mean velocity. But as the waves reach more rarefied air at higher altitudes, their amplitude increases, and non linear effects cause the breaking of the waves transferring their momentum to the mean flow. This process plays a key role in controlling the dynamics of the middle atmosphere. The clouds in gravity waves can look like Altostratus clouds, and are sometimes confused with them, but the formation mechanism is different.

Weather
When I began my research on propagation studies, I mainly focused on solar and geomagnetic activities and inside the ionosphere mechanism, I was convinced that only   in this area should develop research because propagation supporting was limited in this context. In reality I realized that the weather has a significant impact on propagation. Some significant studies conducted by a New Zealand OM, Bob Gide, ZL3NE , show how we can forecast openings on the 6 and 2 meters Ham bands as they are closely associated with the weather conditions. Similarly weather conditions play an important role in the sporadic E formation. Es clouds are often associated with frontal system of low pressure, the study focuses primarily on what could be the catalyst in the formation of ionized curtain: Atmospheric gravity waves are generated by these moving frontal systems associated with atmospheric tides. In other words training the more intense sporadic E (144 mhz) may be related mainly to thunderstorm effect, while the regular Es (HF range and 50 MHz) could be mostly related to dynamics of atmospheric tides. But the HF propagation may be closely related to weather conditions. We are therefore faced with a further complication.

Possible effects associated with sprites
Sprites are similar to lightning phenomena but that develop in the stratosphere at a height of between 10 and 100 km, are therefore of electric shocks lasting a few tenths of a second that develop because of the potential difference between the clouds and the high atmosphere

The project
The project consists to investigate the spatial-temporal correlation between the openings of Es in 144 MHZ and thunderstorms.
Propagation on 144 MHz: constantly monitored through reports of many active OM that record the date, time, frequency and geographic location.
Thunderstorms: represented by the recording of spherical (low pulse radio frequency emitted by lightning) published by various meteorological institutes on the internet.

Discussion
During the month of June, sporadic E and spherical are very common, and is not a surprise that both can occur in the same location. In this particular case, however, sporadic E and the position of the thunderstorm, shows a spatial-temporal distribution very similar. These results indicate that the effects of a convective storm generating gravity waves that propagate from the lower atmosphere into the upper atmosphere support and stimulate the generation of sporadic E? Is possible that this result indicates a dynamic process to medium-latitudes similar to what occurs in tropical atmosphere where some phenomena as TID (Travelling ionosphere disturbance) and equatorial spread F are really caused by convective motion ? It is not possible answering this question because the data are not yet sufficient and we can not even exclude that this is something random. But I believe that these results are cause for further studies and collaboration between scientists and OM operating on VHF. The research that I have done can only detect the presence of the Es and the simultaneous presence of storms. More scientific data are necessary to analyze the phenomenon in detail, for example using ionospheric radar and ionosonde located around Europe. Further studies should be conducted on the high dynamic atmosphere to better understand the role of gravity waves.
Analysis practice
With the help of internet I did an analysis of the various sporadic E opening on 144 Mhz occurred in recent years, comparing the distribution of Thunderstorms in Europe. I used

as database the German site www.wetterzentrale.de , charts showing the number of daily lightning in Europe and their intensity and the site www.vhf-contest.com where there is a database that maps showing the location of many vhf contacts. While not finding mathematician evidence , crossing the data I have noted a considerable statistical correlation of openings associated Es with an intense thunderstorms along the route. (See Figure 1). In radio propagation studies is not normal to find mathematical correlations, but very often the events are governed by the normal distribution of Gauss, in other words the Scale of events follows a Gaussian curve. It is also curious to note that many events in nature have a sequence that follows the statistical normal distribution of gauss . (The **normal distribution**, also called the **Gaussian distribution**, is an important family of continuous probability distributions, applicable in many fields).

NOTES:
- Sporadic E theory
Into the E region strong horizontal winds occur, these high winds move in the ionosphere and are separated by a few kilometres of altitude. Their action, combined with the action of gravity waves in the troposphere and under the cooperation of Earth's magnetic field, pushes up the gaseous ions within accumulating in layers that form the ionized clouds. That would be a real vertical compression of ions which focuses forming thin agglomerations of high electronics concentration, the thickness of 2-4 km at the height between 90 and 110 km altitude. Normally, the extension of these spots is about 50 - 100 km in diameter (at temperate latitudes), their area is a few thousand square kilometres, and the concentration of electrons per cm3 is very higher compared to ordinary E layer. These winds east-west direction within the E layer, move vertically as a result of gravity waves and in the presence of the Earth's magnetic field compress the ions slender stored in high-ionization, because the mass of ions is possible are needed metal ions such as magnesium ions (Mg), iron ions (Fe) and Nickel (Ni), because their skills of recombination is slower compared to other ions and this then allows storage in dense layers and subtle. Ions are atoms or groups of atoms with an electrical charge from atoms or groups of neutral atoms that have lost or purchased one or more electrons (process of recombination). Recent measurements have shown that the curtain of Es has a high content of metal ions (Fe and Mg), as well as O2 and NO, major ions present and dominant in the E region. The metal ions are the residue left by meteoric dust that enters in the Earth's atmosphere captured by the gravitational force of the earth. The thunderstorms activity is not the only cause but should have a catalytic effect throughout the system, especially the phenomena of Es more intense (affecting the higher frequencies 50 Mhz and especially 144 Mhz). The intensity of Es depends on the ionization of residual layer, the number of heavy ions (related to precipitation meteoric) and the strength of the ionospheric winds.

Bibliography:
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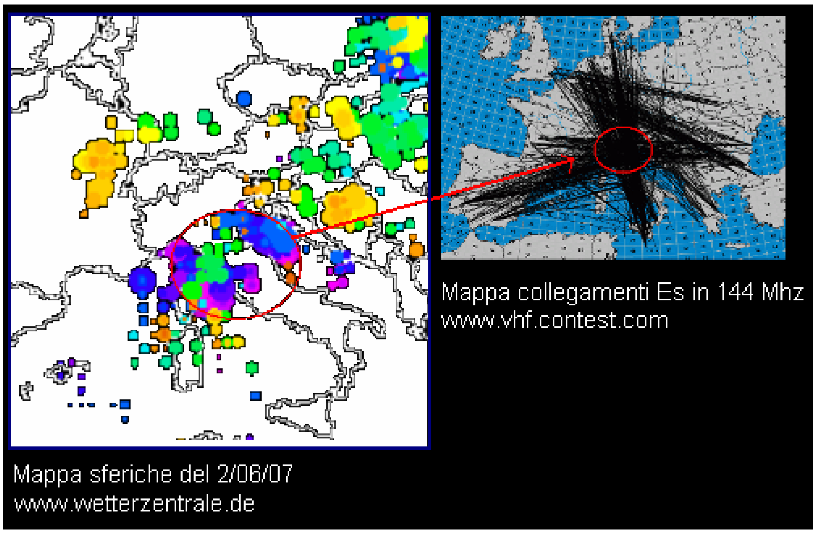

Figure 1: Example of work and comparison of overlap between the openings of Es and the dislocation of time. The scheme is shown opening Es 144 mhz on the afternoon of June 2, 2007. In this case, the intense traffic in both east-west and north-south could be associated with strong fronts Thunderstorms located in central Italy.