On the nature of VLF propagation perturbations induced by meteors

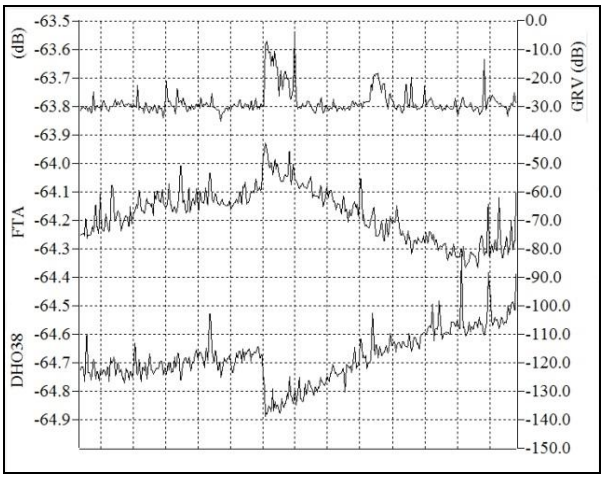
J.J. Delcourt, Dr.Sc. **J.-L. Rault**,
International Meteor Organization

Introduction

Various phenomena such as UV and X rays bursts radiated by the Sun, γ rays radiated by distant stars, electrons precipitations induced by wave-particle interactions within the magnetosphere, nuclear explosions, etc., create transient VLF propagation disturbances by modifying the electron content of the D layer of the ionosphere [1].
A first evidence for amplitude sudden changes induced by single meteors on signals received from distant VLF transmitters was found during a Geminids 2010 observation campaign [2].
This paper is an attempt to clarify the causes of such VLF propagation modifications induced by meteors.

Experimental results

Further to a first observation in 2010 of a VLF amplitude disturbance induced by a single meteor (see below),

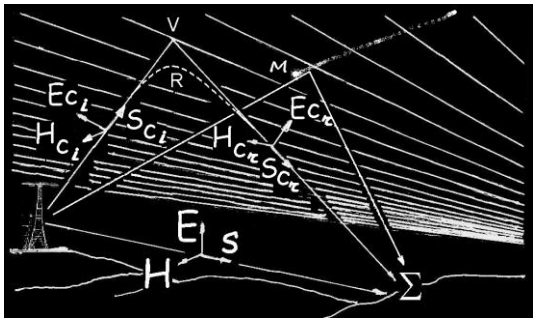


First evidence of a meteor-induced VLF amplitude perturbation (Geminids 2010). Upper trace: VHF ping showing the presence of a meteor; middle trace: corresponding constructive interference on FTA VLF transmission; lower trace: destructive interference on DHO38.

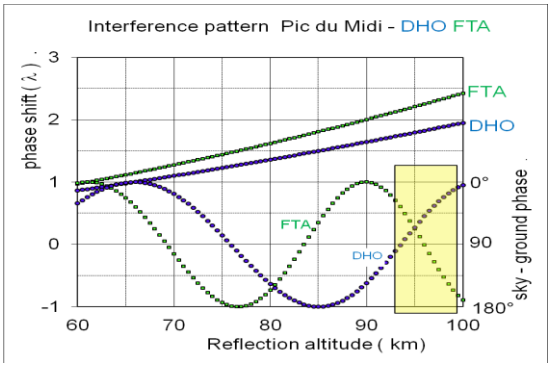
some of the 24h a day VHF/VLF records performed between 2008 and 2015 during 29 different meteor showers were examined for VLF meteor perturbations. Numerous coincidences between meteors apparitions and corresponding VLF disturbances were identified, thus confirming the existence of the phenomenon.

Discussion

Looking at the geometry of a VLF sub-ionospheric circuit path between a transmitter and a receiver (see below), it can be inferred that, depending on the electronic content at the point of "reflection" of the sky wave, the amplitude of the received signal is linked to the density and/or altitude of the reflecting free electrons. An ionized meteor trail appearing at the altitude of the D layer of the ionosphere can therefore modify the amplitude of the received signals.

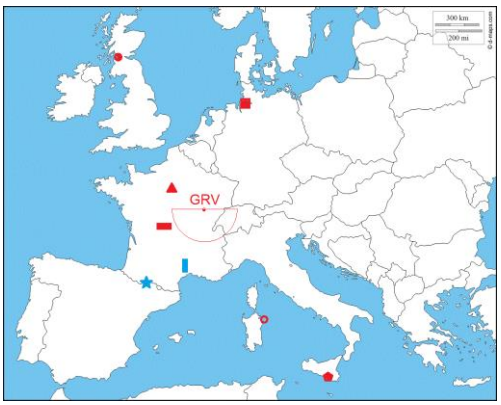


VLF sub-ionospheric circuit path



Evolution of the interference fringe with altitude at Le Pic du Midi .

In this paper, we look in detail at the relationship between the constructive or destructive VLF interferences and the locations of the transmitters and observation places, i.e. at the geometry of the paths.



● GBZ 19,6 KHz , GQD 22,1 KHz ■ DHO 23,4 KHz ▲FTA 20,9 KHz
■ HWU 21,75 KHz ICV 20,27 KHz ▌ Lozère monitoring station
★Pic du Midi : monitoring station **GRV** VHF radar used for meteor scatter detection

References

[1] Barr R., et al., 2000, Journal of Atmospheric and Solar-Terrestrial Physics, 62, 1689
[2] Rault J.-L., Meteoroids 2013, Proceedings of the Astronomical Conference, held at A.M.University, Pozna´n, Poland, Aug. 26-30, 2013,pp. 345–351, 2013.
[3] Delcourt J.-J. Basse ionosphère, région D, http://www.coucheD.be