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Atmospheric and ionospheric electrical parameter variations inferred from sub - ionospheric seismo - electromagnetic VLF/LF observations

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Subionospheric VLF/LF radio links are an essential tool to investigate seismo - electromagnetic phenomena.
The propagation of very low (VLF) and low frequency (LF) frequency radio waves is mainly controlled by the index of refraction and electrical conductivity in the waveguide between the surface and the ionosphere.
These parameters can be disturbed during seismic active periods by the lithospheric - atmospheric - ionospheric coupling.
The signals of various navigational and time service transmitters are received by a European network of VLF/LF receivers.
Several methods have been developed to analyse the received VLF/LF amplitude and phase in order to get information on the seismic activity along the radio path.

We present a simple model for the estimation of the VLF/LF radio wave propagation parameters using mainly the amplitude observations of receivers in Italy, Austria and Russia.
The main emphasis is on the L'Aquila earthquake from April 2009 with a magnitude of 6.3.
This event has been observed with ground based VLF/LF radio links as well as with satellite VLF receivers.
The influence of the electrophysical parameters in the immediate vicinity of the active-seismic region on ionospheric parameters is a hot debated issue, where definite physical answers are still expected to be found.
Its consequences for the VLF/LF propagation in the sub-ionospheric waveguide are theoretically not well understood up to now, although empirically the issue is well established.
For the analysis of pre-seismic activity the systematic variation of the terminator time (TT) and the night time amplitude variations (residual method) seem to be an important indicator.
Therefore we studied theoretically the propagation and the influence of ionospheric parameter changes on the VLF/LF mode conversion at the solar terminator and near the seismic region. Our method is based on analytical models of Ledinegg et al. (1982).
In particular, we will present prelininary results of the influence of conductivity variations in the wave guide on the received VLF/LF amplitude.
This is a first step in solving the inverse problem of VLF/LF seismo-electromagnetism.

References:
[1] E. Ledinegg, VLF mode conversion at terminator taking into account Earth's curvature,
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