OPEN ACCESS Freely available online

Journal of Geology & Geophysics

ISSN: 2381-8719

Opinion Article

The Evolution of Earthquakes Based on its Acoustic Impact on the Ionosphere

Michael S Zhdanov*

Department of Geology and Geophysics, University of Utah, Utah, USA

DESCRIPTION

Infrasonic acoustic waves, also known as IAWs, can be excited in the earth's atmosphere to accompany both natural and man-made disasters. Infrasonic waves fall below the low-frequency threshold of human hearing, or 20 Hz. IAWs are known to be produced at solid-air interfaces, and one well-known source is seismically induced surface deformations. IAW propagation and characteristics are influenced by the atmosphere, winds, and their nonlinear evolutions. These factors can be studied by analyzing the fluctuations that these factors cause in the densities, temperatures, and pressures of air and the ionospheric plasma. The linked nature of the geophysical processes involving earthquakes and the atmosphere inspires significant cross-disciplinary research and applications.

The concept "Total Electron Content" (TEC) is used to describe the Earth's ionosphere. The electron columnar number density, or TEC, is the total number of electrons integrated between two points along a tube with a one-meter squared cross-section. One of the primary data sources for indirect studies of atmospheric waves in the upper atmosphere caused by natural disasters like earthquakes, tsunamis, volcano eruptions, tornadoes, and hurricanes continues to be observations of total electron content (TEC). TECs are based on measurements of group delays and phase advances of Global Positioning System (GPS) signals that propagate from GPS satellites to ground-based receivers through the dispersive ionised part of the upper atmosphere at 80 km to 1,000 km ionospheric plasma. TECs represent the integrated number of free electrons between the GPS satellite and the receiver along the Line-Of-Sight (LOS) between them. By analysing GPS signals, it is possible to detect changes in the ionosphere caused by atmospheric waves reaching the high atmosphere and the interaction of air particles with plasma. The number of LOSs with GPS satellites in their fields of view that are spatially and temporally adequate for the investigation of small-scale and short-period IAW signals in the ionospheric plasma is increasing as a result of networks of ground-based GPS receivers with high-rate data sampling (up to 50 Hz).

After significant on-land and underwater earthquakes, seismically produced IAWs, which cause changes in the ionospheric plasma, are now frequently found in the TEC. However, at great distances from their sources, TEC only partially reveals coseismic IAW dynamics, and it is still difficult to analyze them (at altitudes between 250 km to 350 km). The majority of modelling studies are based on simplified approaches, such as considering dynamics only in the atmosphere or ionosphere with analytical solutions for linear IAW propagation from the ground, due to the complexity and variety of dynamics that should be taken into account, from Earth's interior to the upper atmosphere and ionosphere. In addition, a variety of phenomena, such as the spread of ruptures slips in the Earth's crust during an earthquake, cannot be studied using the conventional method of using point or axisymmetric (evenly distributed) IAW source models. In order to better understand coupled geophysical processes, extensive modelling studies that quantify the dynamics of IAWs and generate Coseismic Ionospheric plasma Disturbances (CIDs) are essential.

Given the much shorter time of rupture propagation compared to CID periods (4 min), it may be impossible to separate the numerous tectonic causes of IAWs around the epicentre within rupture durations of less than 100 s. Through the examination of various earthquake finite-fault models and their capacity to replicate identified ionospheric perturbations, TEC data may support seismological investigations. These results might be especially important for major submarine earthquakes when geophysical and near-field data are scarce. Full 3D-coupled atmosphere-ionosphere modelling, parametric case studies and sTEC reconstructions are all expected to be able to shed further light on the interactions between the earth's atmosphere and the ionosphere. Although currently computationally costly, such simulations could pave the way for considerable advancements in constraining finite-fault models of large earthquakes, particularly for complex events.

Correspondence to: Michael S Zhdanov, Department of Geology and Geophysics, University of Utah, Utah, USA, E-mail: zhdanov.smichael@gmail.com

Received: 04-Oct-2022; Manuscript No. JGG-22-20803; **Editor assigned:** 06-Oct-2022; PreQC. No. JGG-22-20803 (PQ); **Reviewed:** 20-Oct-2022; QC. No. JGG-22-20803; **Revised:** 27-Oct-2022; Manuscript No. JGG-22-20803 (R); **Published:** 04-Nov-2022, DOI: 10.35248/2381-8719.22.11.1049.

Citation: Zhdanov MS (2022) The Evolution of Earthquakes Based on its Acoustic Impact on the Ionosphere. J Geol Geophys. 11:1049.