FOURIER AND WAVELET BASED CHARACTERIZATION OF THE ACOUSTIC-GRAVITY WAVES OBSERVED IN THE ELECTRON CONCENTRATION VARIATION MEASURED THROUGH VERTICAL IONOSPHERIC SOUNDING

Šauli P. (1), P. Abry (2), J. Boška(1)
(1) Institute of Atmospheric Physics, Academy of Sciences of the Czech Republic, Boční II/1401, 141 31 Prague 4, Czech Republic,(2) CNRS, UMR 5672, Laboratoire de Physique, Ecole Normale Supérieure de Lyon, 46, allée d'Italie, 69364 Lyon cedex 7, France.

Abstract:

We propose here a wavelet-based detection and characterisation of the propagation of acoustic-gravity waves induced in the ionosphere during campaigns of rapid sequence sounding. The data are obtained from measurements of electron density profiles using 1-minute (solar eclipse of August 11, 1999; June 8, 2004) and 5-minute (October-November 1997; April 2001; July-August 2004) vertical incidence ionospheric sounding performed at Pruhonice (Czech Republic, 49.9N, 14.5E). The time series consist of the fluctuations of the electron concentrations at fixed heights derived from true-height density profiles. Though we obtained electron density profiles from the bottom of E layer, we restrict our study to the region ranging from 155 km to 255 km in order to avoid complications due to a valley effect between E and F layers. The upper limit of the computation is chosen so as to satisfy the conditions of validity for the study of the variations and wave bursts in the electron concentration below the F2 layer peak. We suppose that some of the wave bursts observed in the electron concentration variations constitute the signature of Acoustic-Gravity Waves that may have been produced in the neutral atmosphere and coupled into ionosphere or generated in-situ within the ionospheric plasma. The chosen 1-minute high sampling rate aims at enabling us to specifically see modes below acoustic cut-off period. We characterize the propagation of the waves in terms of times of occurrence, packet and phase velocities, propagation direction, characteristic period and lifetime of the particular wave structure. Our analysis techniques enable us to \"locate\" wave bursts in particular height of ionosphere (solar eclipse event), specify source region and give characteristics of acoustic and gravity wave movement through ionosphere. However, ionospheric vertical sounding technique enables us to deal mainly with vertical components of each characteristic. To determine horizontal components of the wave-movement we employ the dispersion relation for the acoustic-gravity waves together with Extended Australian Standard Atmosphere model 2000 for the computation of the background atmosphere. In the current work we describe wavelet-based methodology used to detect and characterise acoustic and gravity waves and explain how and why this improves the previously proposed Fourier based approaches. Mainly, we show that wavelet transforms allow us to untangle waves that would be otherwise mixed up in Fourier decompositions. The work shows day to day similarities and differences in the gravity wave activity and their propagation characteristics in the ionospheric heights and

characterise them accurately. We demonstrate the existence of acoustic waves in the F-region heights, that is possible by the combined used of both data with a high sampling rate (1 minute) and wavelet-based tools.