Излучение из атмосферы в УКВ диапазоне накануне землетрясений

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Наблюдение аномалий накануне землетрясений в электромагнитном излучении УКВ диапазона проводилось на острове Крит в течение трех лет, начиная с 1992 года. Этот мониторинг проводился с использованием сети приемников с двумя частотами 41 и 53 МГц, расположенных на четырех участках, и УКВ излучение накануне землетрясений было зарегистрировано. Показано, что генерация УКВ-излучения может происходить в результате электрических разрядов в атмосфере на высотах 1–10 км, связанных с конвективным переносом заряженных аэрозолей в зоне подготовки землетрясений. Была предложена и обоснована теория генерации УКВ-предвестника землетрясения, в основе которой лежит предположение о формировании заряженных облаков в атмосфере над зоной подготовки землетрясения и последующими электрическими разрядами, которые являются источником излучения в УКВ-диапазоне.

The observation of pre-earthquake (pre-EQ) anomalies in VHF electromagnetic radiation had been carried out on Crete Island for three years starting from 1992. This observation was carried out using receivers with two frequencies 41 and 53 MHz located on the four sites, and the pre-EQ VHF radiation had been registered. It was shown that the generation of VHF radiation could be occurred as a result of electric discharges connected with convective transport of the charged aerosols at altitudes of 1–10 km in the zone of EQ preparation. It were proposed and substantiated the theory of generation VHF earthquake precursor, which is based on the assumption that the formation of charged clouds in the atmosphere over an area of earthquake preparation and subsequent electric discharges, which are the source of radiation in the VHF band.

For the first time, the regular observation of pre-EQ anomalies in VHF electromagnetic radiation had been carried out on Crete Island Greece) for three years starting from 1992. This observation was carried out using receivers with two frequencies 41 and 53 MHz located on the four sites, and the pre-EQ VHF radiation had been registered. The center of EQs was located both on the ground and under the sea bottom. Based on the obtained data Ruzhin et al. [1] have shown that the possible VHF radiation source is located in the atmosphere (Fig.1) at altitudes of several km above the epicenter of preparing EQs. It was suggested [1-2] that the generation of VHF radiation could be occurred as a result of electric discharges connected with convective transport of the charged aerosols at altitudes of 1–10 km in the zone of EQ preparation.

Later, Yamada et al. [3] confirmed this conclusion that VHF radiation sources are located in the atmosphere at altitudes over several kilometers. VHF radiation (52.1–52.5 MHz) related to an EQ was obtained as a result of long-term observations from July 1999. Direction to the EQ epicenters was in the limits of antenna diagram. The distance to epicenters was several hundreds of kilometers, and therefore it was possible to register radiation if its source was located in the atmosphere at altitude of several kilometers.

Possible candidate was soon discovered and intensively studied at present [4]. This is a special class of lightning activity - compact intracloud discharges (in English literature, this phenomenon is known as the Compact Intracloud Discharge, CID). Compact discharges occur substantially higher than normal lightning in a range of heights from 8 to 17 km. Unusual also is the power (up to tens GWt) emitted by them in the radio - the level considered to be the most

intense in the world natural sources of radio emission at HF - VHF bands. Independent optical and radio measurements CID effects on the satellite FORTE [5-6] give the possibility to estimate the effective radiation power of VHF (ERP - Effective Radiated Power) in the 26-49 MHz frequency band, which is greater than 140 kW.

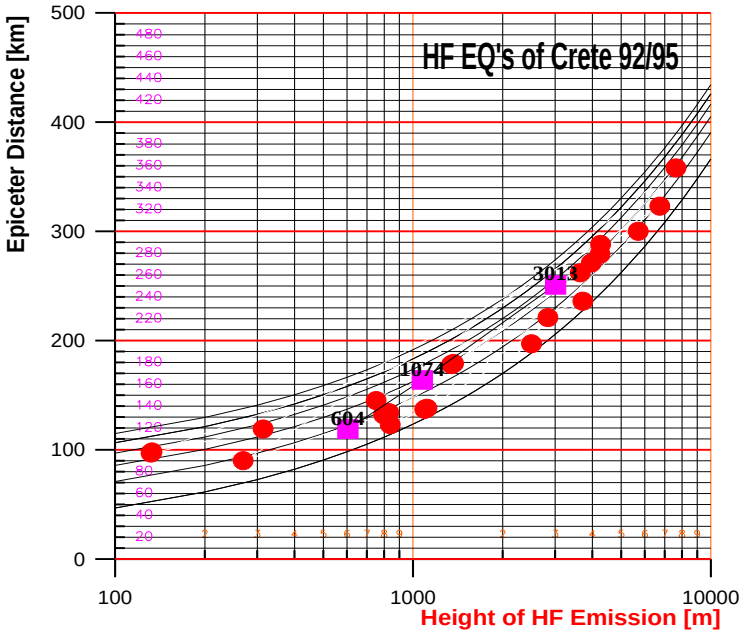

Fig.1. The minimum VHF emitting heights.

It were proposed and substantiated the theory of generation VHF earthquake precursor [7], which is based on the assumption that the formation of charged clouds in the atmosphere over an area of earthquake preparation and subsequent electric discharges, which are the source of radiation in the VHF band. Enhancement of the DC electric field up to the value of the order of 10 mV/m in the ionosphere is observed by the satellite during the same period. The occurrence of such a strong DC electric field in the ionosphere is related to the electric current flowing into the atmosphere–ionosphere circuit. The current source is an electromotive force [8] in the ground-air layer occurring by injection of charged aerosols with soil gases in the atmosphere during seismic activity. The electric field of conducting current flowing between the atmosphere and ionosphere can reach the breakdown value in the lower atmosphere.

Electric field forms the electric discharges in this region of the atmosphere which are the source of VHF radiation [7]. The theory based calculations of the spatial distribution of the ratio of the electric field to its breakdown value showed that the troposphere may have areas under some conditions where the field reaches the breakdown value. Figure 2 shows an example of the spatial distribution of the electric field with an indication of the area (for $E/E_k > 1$) where the field reaches the breakdown value. This area contains one or two layers of a thickness of 1–2 km located at a height of 10 km. The characteristics of these layers are determined by atmospheric and aerosol parameters. With an increasing rate of vertical convection of the atmosphere, the height of the breakdown field area in the lower troposphere increases and then a second layer appears above (at a height of 10 km). In this case, the lower layer disappears.

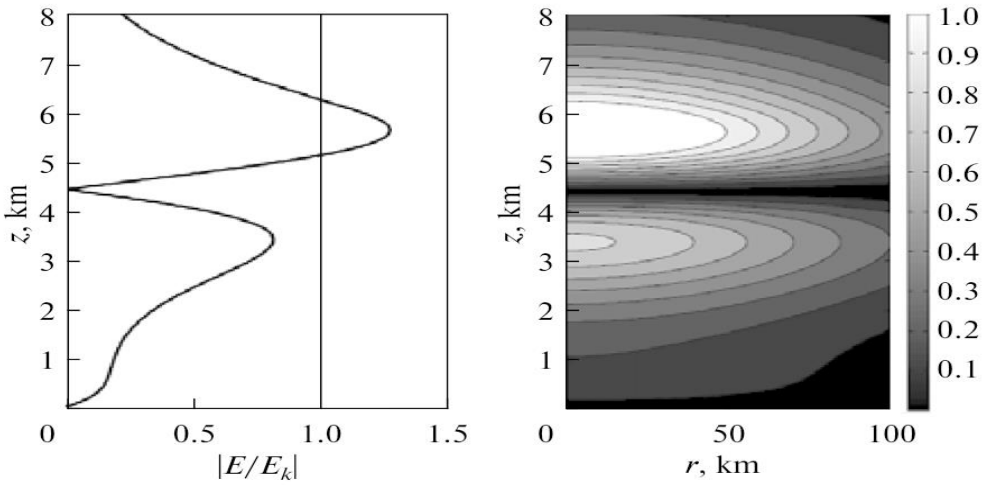

Fig.2. Spatial distribution of the ratio of the vertical component of the electric field to its breakdown value.

As an example, the earthquake anomalies associated with the Mw 6.3 L'Aquila earthquake have been widely reported (see overview - [9]).

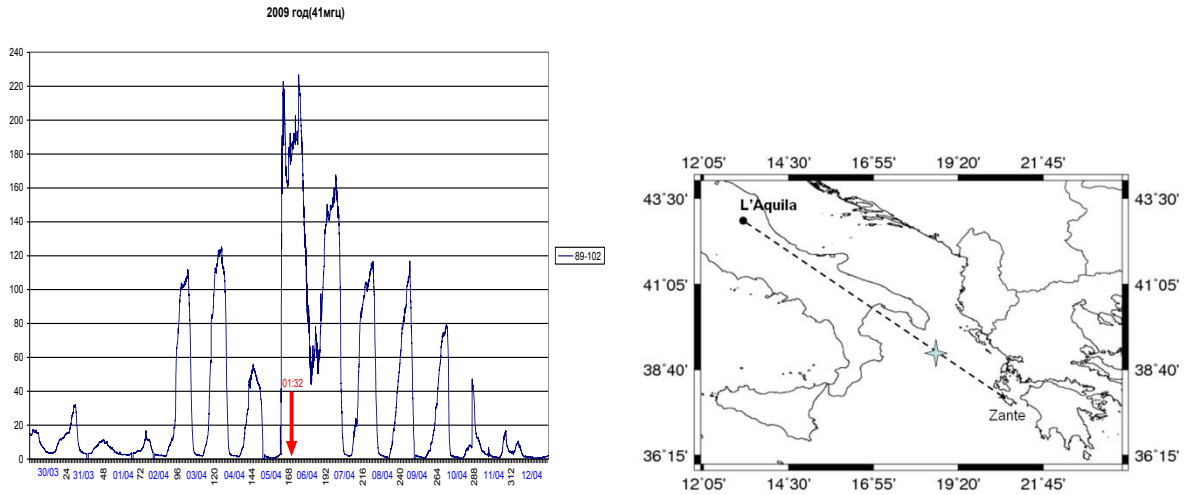

Fig.3. VHF amplitude of 41 MHz (left) and map (right) of Zante - L'Aquila location.

Since 1994, a Greece station has been installed and operating at a mountainous site of Zante Island in the Ionian Sea (Western Greece). Its purpose is the detection of EM precursors. VHF electromagnetic (EM) anomalies were recorded prior to the L'Aquila catastrophic earthquake that occurred on 6 April 2009. The figure 3 shows the progress of the signal received at a frequency of 41 MHz. Time period is taken from 30 March to 12 April. In this time interval, namely the 06 April at 1:32 UTC, there was an earthquake in Italy a magnitude M=6.3. It is shown by the red arrow in the picture. As the graph shows, the maximum surge around the time of the earthquake, after which the signal decreases with a 225mv (output) at the time of the earthquake, to 10mv. Also, the graph shows that over the three days to push bursts of signal that reaches up to 125mv that can be taken for a precursor of the earthquake. It should be noted that the daily course of the

signal is quite regular. By April 12, the signal weakens, going down to the lowest levels. Daily max occur at night, and minima are marked by day.

From Fidani report [9] the complex pre-earthquake events were observed. The main part of them were phenomena that can be accompanying random electrical discharges in the lower atmosphere: (1) random electrical discharges, (2) atmospheric heating in the discharge area and generation of outgoing microwave radiation, (3) wideband VHF radio emission observed on the Earth and in space, (4) glow in the visible range of the spectrum, (5) refraction and scattering of VHF radio waves in the troposphere, leading to receipt of transmitted signals beyond the horizon on the Earth and on the satellite.

As result, the VHF radio-receiver and recording system onboard China satellite (CSES-2) will be useful in this study. An advantage of VHF recordings from space is that it is frequently possible to reliably identify an intracloud emitter. This is because an emitted impulse of VHF has two paths to the satellite, the first being direct, and the second being downward to the reflective ground and thence (via reflection) up to the satellite [5-6].

Our model makes it possible to couple the satellite data of electromagnetic and plasma measurements with electrophysical and meteorological characteristics of the lower atmosphere at the stage of earthquake preparation and typhoon initiation. The model explains the numerous effects on cosmic plasma by a single cause: the change in the conduction current flowing in the atmosphere–ionosphere circuit. At the initial stage of seismic activity and typhoon formation (until the catastrophic phase), aerosol injection or vapor condensation over the ocean surface occurs with a redistribution of charge carriers and a change in their mobility, which, together with vertical convection, leads to the effect described above in the Earth–ionosphere electric circuit.

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