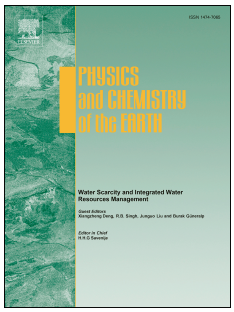
Accepted Manuscript



Anomalous behavior of ionospheric parameters above the Kamchatka peninsula before and during seismic activity

Vadim V. Bogdanov, Aleksandr V. Kaisin, Aleksey V. Pavlov, Anastasia L. Polyukhova, Claudia-Veronika Meister

PII: S1474-7065(16)30015-8

DOI: 10.1016/j.pce.2016.04.002

Reference: JPCE 2482

To appear in: *Physics and Chemistry of the Earth*

Received Date: 22 October 2015

Revised Date: 22 March 2016

Accepted Date: 5 April 2016

Please cite this article as: Bogdanov, V.V., Kaisin, A.V., Pavlov, A.V., Polyukhova, A.L., Meister, C.-V., Anomalous behavior of ionospheric parameters above the Kamchatka peninsula before and during seismic activity, *Physics and Chemistry of the Earth* (2016), doi: 10.1016/j.pce.2016.04.002.

Anomalous behavior of ionospheric parameters above the Kamchatka peninsula before and during seismic activity

Vadim V. Bogdanov[1], Aleksandr V. Kaisin[1], Aleksey V. Pavlov[1], Anastasia L. Polyukhova[1], Claudia-Veronika Meister[2,*]

1 Institute of Cosmophysical Research and Radio Wave Propagation FEB RAS, 684034 Paratunka, Mirnaya 7, Russia, vbogd@ikir.ru

2 Institut für Kernphysik, Technische Universität Darmstadt, Schlossgartenstr. 9, 64289 Darmstadt and Graduate School of Excellence Energy Science and Engineering, Jovanka-Bontschits-Str. 2, 64287 Darmstadt, Germany, c.v.meister@skmail.ikp.physik.tu-darmstadt.de

Abstract

In the present work, searching for new methods of earthquake prediction, variations of ionospheric plasma parameters and ionospheric turbulence before and during seismic activity are studied applying complex radiophysical methods and a theoretical probabilistic approach. The analysis of radiophysical observations of some seismic events of February-March (28.02.–02.03.) 2013 shows, that *K*-layer formation (appearance of a corpuscular layer due to precipitation of particles from the radiation belts), E_s- and F-spread effects as well as an increase of the critical f_oF2-frequency occurred about one day before earthquakes with a magnitude $M \geq 6.5$. F2-spread was even observed at low geomagnetic activity. One seismic shock was preceded by an abnormal increase in the value of the critical frequency f_oF2, and about two hours after the shock, f_oF2 was again well below the median value although a geomagnetic storm happened. Therefore, it may be concluded that, in future, variations of ionospheric plasma parameters and turbulence may be used as additional tool to determine the magnitude of preparing strong earthquakes. The propabilistic method which is applied in the present work is already described in (Bogdanov et al., J. Volcanology and Seismology, 4(6), 412–422, 2010). It allowed to detect a growth of seismic activity in the Kamchatka region in 2013.

Keywords:
earthquake precursors, ionosphere, F-spread, E_s-spread, critical f_oF2-frequency, K-layer

1. Introduction

The study of solar-terrestrial links revealed a direct influence of the solar activity and of the relative motion of Sun and Earth on physical processes in the Earth's magnetosphere, ionosphere, and even lithosphere. However, in seismically active regions, also lithospheric processes modify the ionosphere and the magnetosphere. For instance, by degassing of the Earth's core, emanation of radon, local heating of fracture regions, upward air flow, as well as propagation of infrasound and magneto-acoustc gravity waves of seismic origin in the atmosphere, the degree of ionization of the ionosphere may change and turbulent waves may propagate in the Earth's ionosphere. Consequently, any changes of the degree of ionization of the ionospheric layers, the occurrence of additional K-shells or turbulent waves, variations of amplitudes and phases of artificial waves, and atmospheric heating processes may give information on earthquake preparation processes (Sorokin et al. 1998; Molchanov and Hayakawa 1998; Pulinets and Boyarchuk 2004; Liperovsky et al. 2008; Liperovskaya et al. 2009, 2011, 2015a,b; Contadakis et al. 2015; Maggipinto et al. 2015; Rozhnoi et al. 2015). If this is the case, the related processes and/or their observable consequences are called to be earthquake precursors.

In this connection, it is very important to note, that any minor effects on the ionosphere can trigger phenomena with energies far exceeding the energy of the primary perturbing factors of Sun-lithospheric origin. On the other

*Corresponding author
URL: http://www.elsevier.com (Claudia-Veronika Meister[2,*])