Consistency of Component Variations of Ionizing Radiation and Atmospheric-Electric Values

P. M. Nagorskiy[1*], M. S. Cherepnev[2], P. P. Firstov[3,4], I. I. Ippolitov[1], E. O. Makarov[3], S. E. Smirnov[4], S. V. Smirnov[1], A. V. Vukolov[2], and V. S. Yakovleva[2]

1. Institute of Monitoring of Climatic and Ecological Systems, Siberian Branch, RAS, Tomsk, Russia
2. National Research Tomsk Polytechnic University, Tomsk, Russia
3. Institute of Volcanology and Seismology, Far-Eastern Branch, RAS, Petropavlovsk-Kamchatskiy, Russia
4. The Institute of Cosmophysical Research and Radio Wave Propagation, Far-Eastern Branch, RAS, Paratunka, Petropavlovsk-Kamchatskiy, Russia

ABSTRACT: The report discusses the agreed variations of ionizing α-, β- and γ-radiation, atmospheric electrical and meteorological quantities in the surface layer on basis of observations in Tomsk, Western Siberia (continental climate) and Paratunka, Kamchatka (maritime climate) during 2006–2014.

INTRODUCTION

Research level variations caused by natural radioactivity need to assess the role of ionizing radiation in the atmospheric boundary layer physics, radioecology, seismology. Exchange with surface atmosphere soil air leads to the removal of the surface layer of the atmosphere and radioactive soil gas emanations (222Rn, 220Tn, 219An) and penetration into the soil atmospheric gases. Factors, governing the speed and direction of gas exchange between the soil surface and atmosphere, are variations of meteorological variables, solar radiation, as well as state of the geological environment. In seismic areas on the spatio-temporal variations in the flux density of ionizing radiation associated with changes in stress in the lithosphere, overlap "background" variations due to weather and other causes that are not associated with the processes of earthquake preparation. These background variations are of interference in terms of the search for earthquake precursors. The spectrum of the interference and the factors that control them, are poorly understood. The combined impact of these factors affects the complex dynamics of the ionizing radiation of the surface layer of the atmosphere [Hoppel, 1967; Firstov, 2007; Mercier, 2009; Nagorskiy, 2011].

COORDINATED MONITORING STATIONS

Measurement stations of coordinated monitoring, located in the Petropavlovsk-Kamchatsky geodynamic proving ground and in the eastern outskirts of Tomsk, include the equipment allowing to perform continuous automated measurements of physical fields: radon and thoron radiometers, gas and scintillation counters to measure fluxes of alpha, beta and gamma-radiation, automated system measuring

∗ Contact information: Peter M. Nagorskiy, Institute of Monitoring of Climatic and Ecological Systems SB RAS, 10/3, Akademicheskii Ave., Tomsk, 634055, Russian Federation; npm_sta@mail.ru

pressure, temperature, humidity, total and UV radiation, electric field, atmosphere conduction, atmospheric turbulence characteristics, total ozone [Firstov, 2007; Nagorskiy, 2011].

EXPERIMENTAL RESULTS

Consider the features of the annual variation of α-, β- and γ- radiation in Tomsk. The maximum of atmospheric β- and γ-radiation in Tomsk is observed in summer, the minimum – in February and March (Fig. 1).

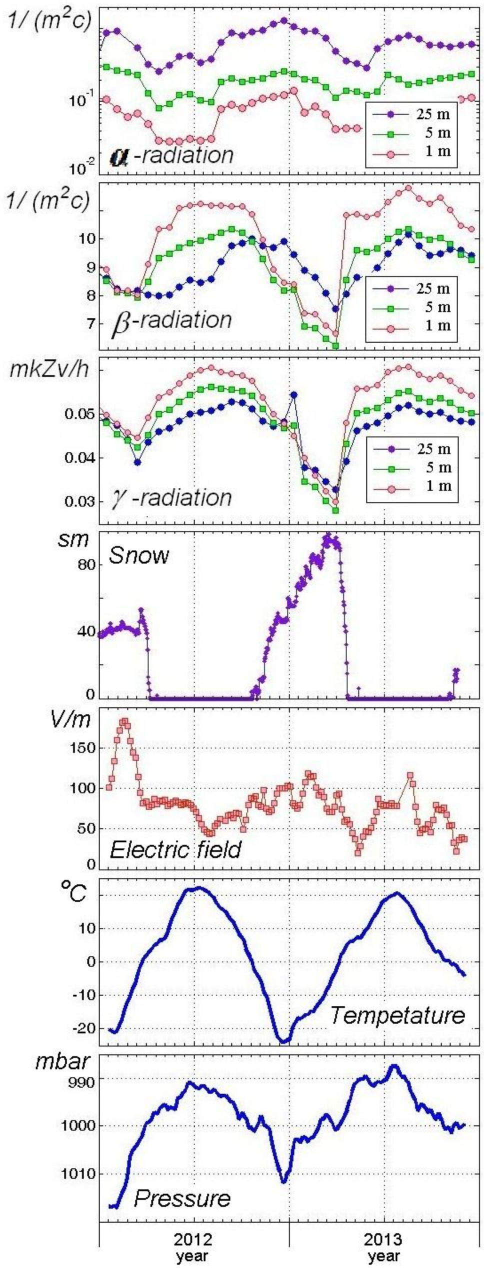

Fig. 1. Dynamics of alpha, beta, gamma radiation and meteorological variables in the annual cycle (Tomsk)

The agreed variations of β- and γ-fields are observed in summer and autumn. Variations of β- and γ- background radiation are closely related to variations of atmospheric pressure in scale from synoptic to annual.

Vertical distribution of β- and γ- ionizing radiation depends on the presence of snow cover: the level of β- and γ- radiation increases with altitude in the presence of snow cover.

Oscillations of γ-radiation in Paratunka are constant until the transition of surface temperature to negative values (Fig. 2). Then γ-background radiation is linearly decreased until transition of surface temperature to positive values. Such change of γ-background is related to soil freezing and radon emission blocking. Variations of β-background have the global summer minimum.

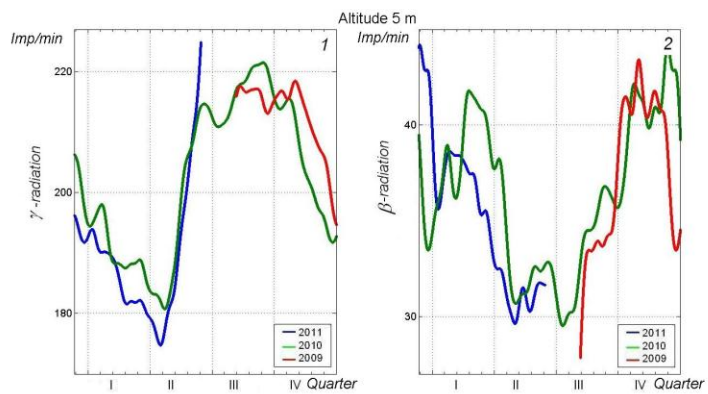

Fig. 2 Dynamics of beta and gamma radiation in the annual cycle (Paratunka, Kamchatka)

The period (3–24 h) of increasing a value of ionizing radiation in soil during precipitation is longer than similar period in air. Recovering a background of ionizing radiation in soil lasts a few days. Fig. 3 shows the variation of the parameters studied in the spring during the passage of atmospheric fronts.

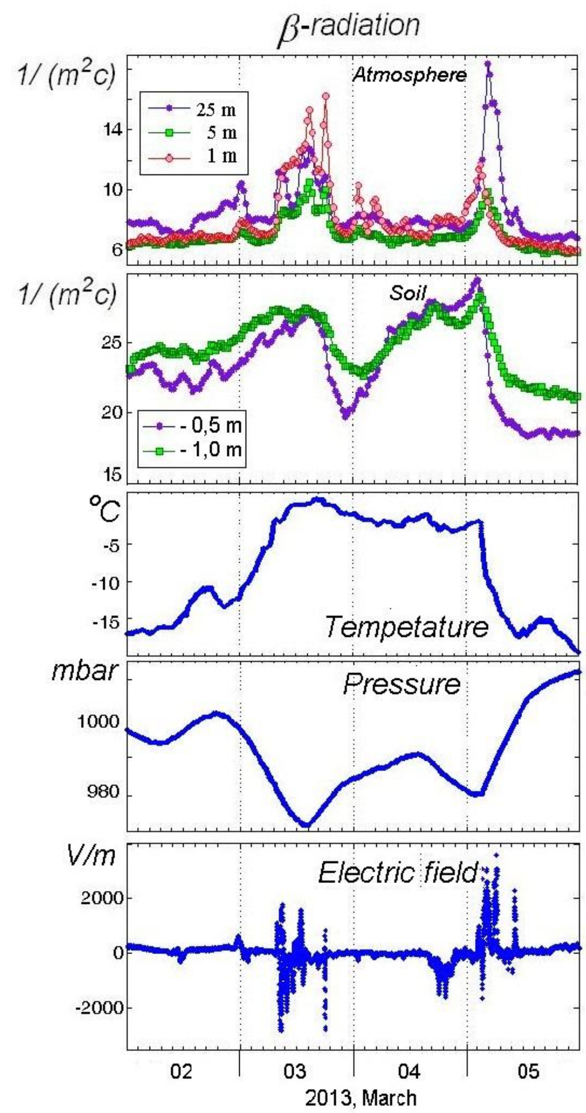

Fig. 3. Variations β- radiation at different levels in the passage of atmospheric fronts (Tomsk)

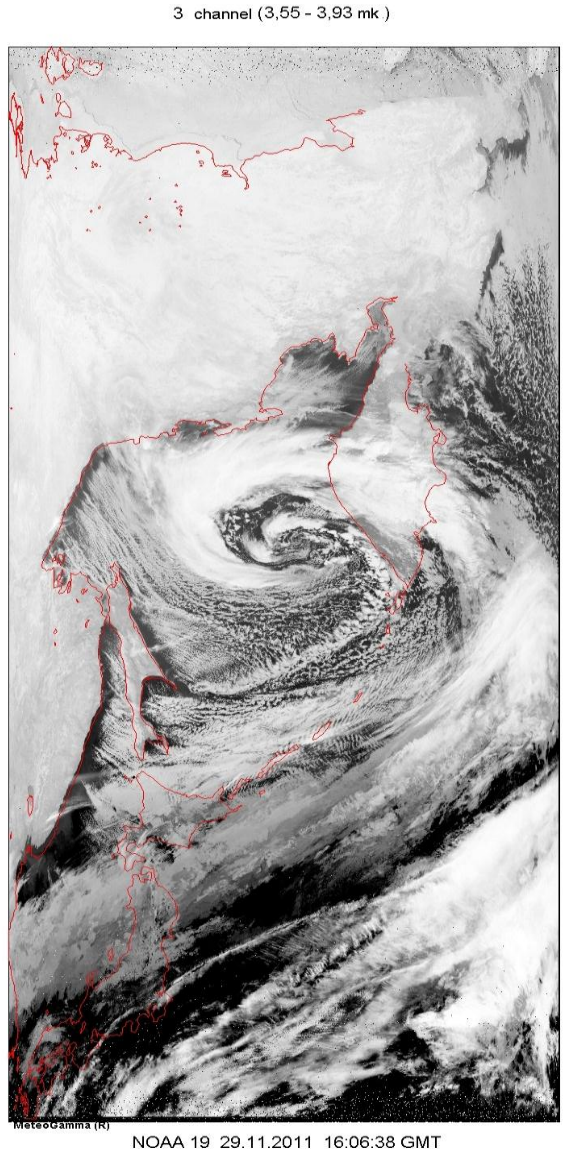

Fig. 4. Typhoon on the territory of Kamchatka (Paratunka) and Japan (Fukushima)

Synoptic processes play a major role in the variations of atmospheric γ- radiation and may lead to its increase in tens or hundreds times (Fig. 3-5). The variations of atmospheric β- and γ- radiation, meteorological and atmospheric electrical quantities connected with passing a cyclone through the area of Fukushima (Japan) to Kamchatka shown in Fig. 4, 5. The spectral composition of the variations of the electric field and the β- and γ- background radiation is shown in Fig 5.

On the territory of Kamchatka regularly recorded increased levels of β- and γ- radiation background in passing typhoon. Wavelet spectra of β- and γ- radioactivity indicate this. Nevertheless, the emission in the time dependence of the ratio of the count rates β- and γ- pulses was recorded only in the case of typhoon passage through the territory of Japan (Fukushima) and Kamchatka.

Possible cause of the release have a seizure typhoon radioactive aerosols of anthropogenic origin in Japan (Fukushima).

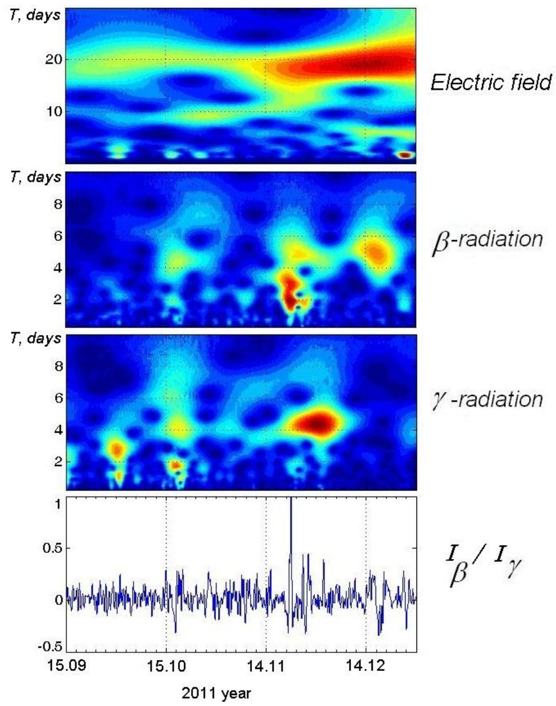

Fig. 5. Wavelet scale perturbations (days) in an electric field, β- and γ- radiation at an altitude 5 m, and normalized ratio of pulse count rate β- and γ- probes during the passage of the typhoon. Downwards, respectively. Baseline data were passed through bandpass filters. Electric field: band periods is 1-30 days. β-, γ- radioactivity, and their relationship: band periods is 0,25-10 days.

CONCLUSIONS

As a result of multivariate monitoring aseismic region with sharply continental climate and in a seismically active region with a marine type of climate. Identified differences in the dynamics of variations of ionizing radiation. We consider the relations of ionizing radiation with atmospheric and lithospheric processes.

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