Cosmic rays and natural hazards from dangerous space weather effects

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This report based on many original papers of author and his colleagues on the using of cosmic rays (CR) for continue monitoring and forecasting of great natural hazards for people and technologies from space weather effects. It consists from 5 parts.

Part 1. Cosmic rays and space weather influence on global climate change (determining of the part of global climate change caused by the long-term change of CR intensity through influence on air ionization and planetary clouds formation; examples from the past; method of forecasting of the part of global climate change caused by space weather effects).

Part 2. Global natural disaster from great magnetic storms connected with big CR Forbush-decreases and their assessment by using world-wide network of CR stations (great geomagnetic storms affect adversely global technology systems, high frequency radio communications are disrupted, electric power distribution grids are blacked out when induced currents causes safety devices to trip, and atmospheric warming causes increased drag on satellites and anomalies in their operation, increasing of frequency of infarct myocardial, brain strokes, car and train accidents; examples of electric power and long oil tubes catastrophes in the past in Canada and other countries; we show that by using on-line one hour CR data from world-wide network of stations is possible to made exact assessment of this natural hazard for 15-20 hours before of the storm sudden commencement).

Part 3. Global natural disaster from great intense radiation hazards for astronauts, crew and passengers on regular airline flights (on the standard altitude about 10 km), and some time for people on the ground due to great solar flare CR events (statistical distribution, examples from the past; we show that this advertisement, with high occurrence probability, can be given 30-60 minutes before the arrival of the more dangerous particle flux). This method is based on the well known fact that the main part of

radiation hazard in space and in atmosphere is caused by particles with small energy (few hundreds MeV) that reach the Earth 1-2 hours after their acceleration on the Sun; on the contrary the relatively small flux of high-energy ($\geq$ 2 GeV) particles, which can be detected by super neutron monitors and practically are not involved in the radiation hazard, reach the Earth much more quickly. Several minutes of observation of the first-coming solar high-energy particles can give enough information on intensity, energy spectrum, transport parameters, and source function to make it possible to predict the time-space distribution of radiation hazard in interplanetary space (for astronauts and space-probe technology) and in the Earth atmosphere as a function of latitude (geomagnetic cut-off rigidity) and altitude.

Part 4. Prediction of the interaction of a dust-molecular cloud with the solar system by measurements of changes in the galactic CR distribution function. From the past we know that the dust from clouds between the Sun and the Earth leads to decrease of solar irradiation flux with sufficient decreasing of global planetary temperature (on 5-7° in comparison with 0.8° from green effect). The plasma in a moving molecular dust cloud contains a frozen-in magnetic field; this field could modify the stationary galactic CR distribution outside the Heliosphere. The change in the distribution function can be significant, and it should be possible to identify these changes when the distance between the cloud and the Sun becomes comparable with the dimension of the cloud. The continuous observation of a time variation of the CR distribution function for many years should provide the possibility of determining the direction and the speed of the cloud relative to the Sun, as well as its geometry. Therefore one could predict its evolution in space and determine whether it will catch the Sun or not. In the case of high probability of capture, we could predict the time of the capture and how long the solar system will be inside the cloud.

Part 5. Prediction of the radiation hazard produced by CR particles generated in a nearby Supernova explosion (SE). From the energetic balance of CR in the Galaxy it was estimated that the full power for CR production is $W_{CR} \sim 3\times10^{40}$ erg/s. Now it is common accepted that the Supernova explosions are the main source of galactic CR. At each explosion the average energy transferred to CR is $E_{SE} \sim 10^{50}$ - 10^{51} erg. From this we can determine the expected frequency of SE in our Galaxy and in vicinity of the Sun. We estimate the probability of Supernova explosions inside different distances from the Sun and expected radiation hazard, and its variation with time. We show that in some cases the level of radiation may increases about 1000 times in comparison with present level, and it will be very dangerous for the Earth's civilization and biosphere. But we show that by high energy CR measurements by ground and underground muon telescopes and low-latitude neutron monitors on the Earth will be obtain information on the source function and diffusion coefficient for many years

before when real radiation hazard will be formatted on the Earth. We show how on the basis of this information we can made exact forecasting on developing in time of the radiation hazard in space and in the atmosphere on different altitudes and cutoff rigidities (different geomagnetic latitudes) by using method of coupling functions, and experts must to decide how to prevent the Earth's civilization (in some cases it will be necessary for people to live underground or in special protected buildings for several hundred years, and go out only for very short time). It is important that on the basis of obtained forecast the Earth's civilization will have time at least several tens years to prepare the life underground and in special protected buildings.

References:

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