The High-Energy Positive Solar Particles Invading the Earth with Contribution to the Mortality from Ischemic Heart Diseases?

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Abstract

Introduction: According to the results from several studies high-energy positive solar particles fluxes, invading Earth are correlated with mortality from ischemic heart diseases. According to World Health Organization (WHO) statistics ischemic heart diseases are the first in the list of the 10 most frequent causes of death in 2016, regardless of the state's economic situation.

Objective. A possible mechanism of the observed phenomenon is discussed. An example of the short-term impact of high-energy alpha fluxes on the area of the USA, affecting the short-term female mortality in the region, is explained by the proposed mechanism.

Material and Methods: Data on solar corpuscular radiation was obtained from an NOAA site. High-energy protons and alpha particles' path length through the atmosphere and corresponding energy were calculated by PSTAR and ASTAR databases and calculators. Data for mortality of ischemic heart diseases from reliable statistical source – Centers for Disease Control and Prevention USA, were used.

Results: A high statistically significant correlation was found between a flux of alpha particles on 1 May 1976 and ischemic heart diseases mortality in several states in USA.

Discussion: A hypothetical mechanism is proposed, explaining the observable data. According to this mechanism, positively charged high-energy solar particles penetrate the atmosphere to the Earth's surface, reaching relatively small areas (spots) with typical dimensions of hundreds of kilometers, where they affect the biosphere. The spots are places, where the directions of geomagnetic field induction and the direction of the invasion of particles in the atmosphere are parallel – no deflecting force acts in this case to the charged particles. The energy required for the particles to overcome the interaction with the particles in the atmosphere was estimated. The particles reach the Earth's orbit for minutes, and penetrate the atmosphere in its thinnest part – the places where the Sun is at its culmination at the time of the arrival of particles. The described mechanism allows calculation of the width of the zone of latitudes with the most intensive impact – mainly between 28°N and 48°N. The mechanism allows calculating the dates with increased risk depending on latitude on the Earth's surface. According to satellite observational data (GOES 13), significant fluxes of alpha particles with energies above 3.4 GeV were observed in a geostationary orbit, while the proton flux with energies above 0.7 GeV is hundreds of times weaker. This makes it more likely to conclude that high-energy alpha particles reach the Earth's surface and cause death.

Introduction: According to the World Health Organization (WHO) statistics [1], ischemic (coronary) heart diseases are the first in the list of the 10 most frequent causes of death in 2016, regardless of the state's economic situation.

The data [2] recorded by satellites in the geostationary orbit show that besides the low-energy particles of the solar wind, the Earth's orbit often reaches also high-energy alpha particles and protons, emitted most probably as a result of processes in the Sun's surface and accelerated by the solar magnetic field. The onboard detectors record fluxes with particles energy tens and hundreds of MeV and even GeV.

A worrying fact is a high correlation, both diurnal and annual, observed between high-energy charged particle fluxes and mortality from several types of coronary heart diseases. This could mean the existence of a causal relationship between the two phenomena. Examples are given in [3, 4, 5 and 6].

Objective: The following is an example of a sudden flow of high-energy alpha particles reaching Earth's orbit and the simultaneous high jump in the diurnal mortality from ischemic heart diseases in several states in the USA as well as of the USA as a whole. A possible mechanism of the observed phenomenon is discussed. The proposed mechanism is used to explain the mentioned coincidence of the two phenomena.

Material and Methods: Data on solar corpuscular radiation was obtained from an NOAA site [2] – from satellite SMS-2 (Synchronous Meteorological Satellites), on the geostationary orbit – circular orbit in the plane of the equator with a center in Earth's center and a radius of 42164 km from the Earth center. Data from the detector EPS (Energetic Particles Sensor) were used. EPS alpha detector recorded fluxes with an unit: (number of alpha-particles/(cm^2.s.sr.MeV)). EPS alpha detector had six channels – for alpha particles with kinetic energy 3.8 - 9.9 MeV; 9.9 - 21.3 MeV; 21.3 - 61 MeV; 60.0 - 180 MeV; 160.0 - 260 MeV and 330.0 - 500 MeV. Data were recorded permanently and averaged in the 5 minutes interval. A sudden flux of alpha particles was recorded on 1st May, which determines the data interval, used in the study: 27 April – 5 May 1976.

High-energy protons and alpha particles' path length through the atmosphere and corresponding energy were calculated by PSTAR and ASTAR databases and calculators [3, 4, and 8].

Diurnal data for the number of deaths from ischemic heart diseases for the USA as a whole and by states, in the interval 27 April – 5 May 1976 from a reliable statistical source – Centers for Disease Control and Prevention USA, were used. USA health statistics is probably the best in the world and the data are publicly available in a form of compressed text files [5]. The information for this study was extracted from the compressed data by programs developed by the author in the programing language VBA for MS Excel. Each death is recorded and coded in a numerical string 159 characters long. The data for 1976 included 646879 cases of death from ischemic heart diseases in the USA. The causes of death are according to ICD-9 (International Classification of Diseases, 9th Revision). The ischemic heart diseases are with codes from "400" to "413.9". In the numerical string, they are recoded from "17601" to "17902", in the columns from 125 to 129 in the numerical string record. The date of the death is coded in 4 symbols – "mm_dd" from position 31 of the string record. The state of the death is coded with two symbols – from "11" (Maine) to "95" (Hawaii) from position 50 in the string.

Correlation analysis was used to process the data.

Results: On 1 May 1976 et 21:20 UTC (Coordinated Universal Time) the satellite SMS-2 recorded in a geostationary orbit sudden intensive flux of solar alpha particles: 3589 alpha-particles/(cm^2.s.sr.MeV), with kinetic energy in the interval 3.8 - 9.9 MeV (Fig.1). The usual alpha particle fluxes in a calm cosmic situation are near to 0 alpha-particles/(cm^2.s.sr.MeV).

The flow of solar alpha radiation irradiates the entire Earth's atmosphere. Most of it is repeatedly scattered into the atmosphere and eventually absorbed into it. However, for two reasons a part of alpha radiation manages to penetrate the deepest into the Earth's atmosphere – where the atmosphere is thinnest and simultaneously, where no magnetic deflecting force is available, changing the direction of the movement.

1. The atmospheric layer is the thinnest for this Earth meridian in whose plane the radiation moves. In this plane of the meridian, the atmospheric layer is thinnest when the Sun emitting the radiation is highest above the horizon, i.e. at the Sun's culmination (local noon).
2. No deflecting magnetic force acts on alpha particles if their flow moves parallel to the geomagnetic field vector.

The moment of arrival of the particles (21:20 UTC) determines the meridian plane in which they move. The longitude of the meridian plane was calculated by the time of arrival: -140° (140W). On 1 May the Sun's culmination inclination is equal to the geomagnetic induction inclination (both are 60.4°N) for a point on Earth's surface with latitude 44.1°N [5]. The inclination is the angle of the radiant (celestial point) of arriving alpha particles over the horizon. This "optimal" point (-140°, 44.1°N) is a pint with the optimum conditions for the alpha particles flow to penetrate the deepest into the Earth's atmosphere at the local noon on 1 May 1976, at 21:20 UTC, i.e. it is the "the most dangerous" point on the Earth' surface, where the invading alpha particles are as close as possible to the Earth's surface. The point in the case is over the Pacific Ocean, near to west coast of the USA.

On the same day 1 May 1976, ischemic heart disease mortality in the USA's entire population (all ages of both sexes), has a peak (Fig.2). The mortality remains elevated for the next few days, then gradually returns to its initial levels.

Such a coincidence is too rare to be accidental. In this case, the interval 27 April - 5 May and the USA were included in the study of ischemic mortality as a result of an expected coincidence in time and place with the peak of the alpha particles flux, mentioned above. The expectation was justified by the hypothetical mechanism of the phenomenon, briefly described below and described in detail in [8]. The same phenomenon was observed in several states (Fig.3 and Fig.4).

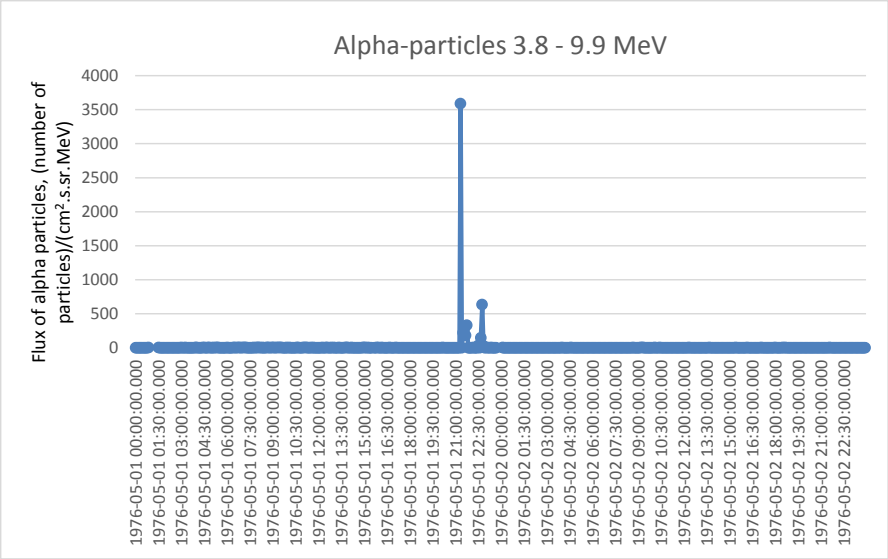

Figure 1. Time diagram of the alpha particles flux, reaching Earth's orbit on 1 May 1976, 21:20 UTC.

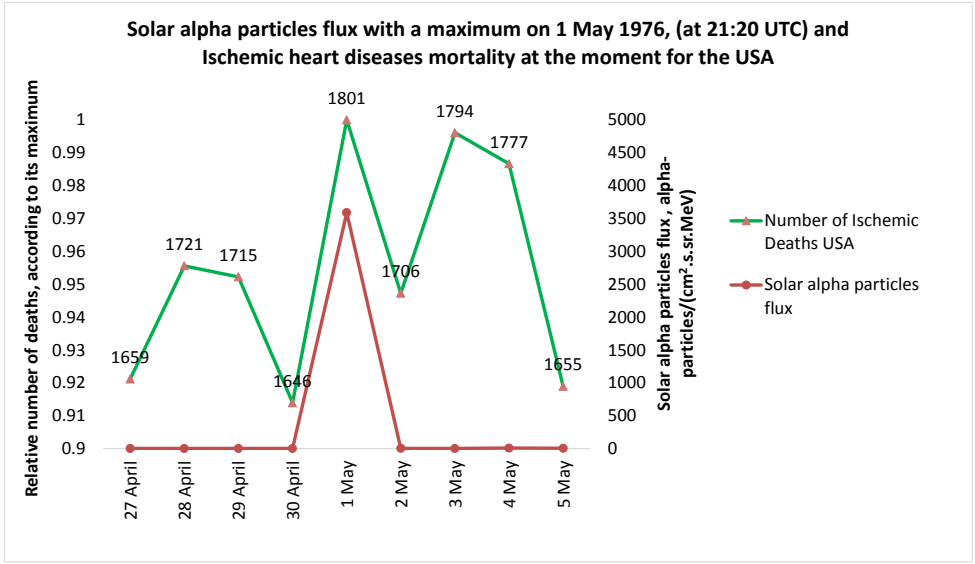

Figure 2. The peak of mortality from ischemic heart diseases in the USA coincides with the alpha particles flux peak.

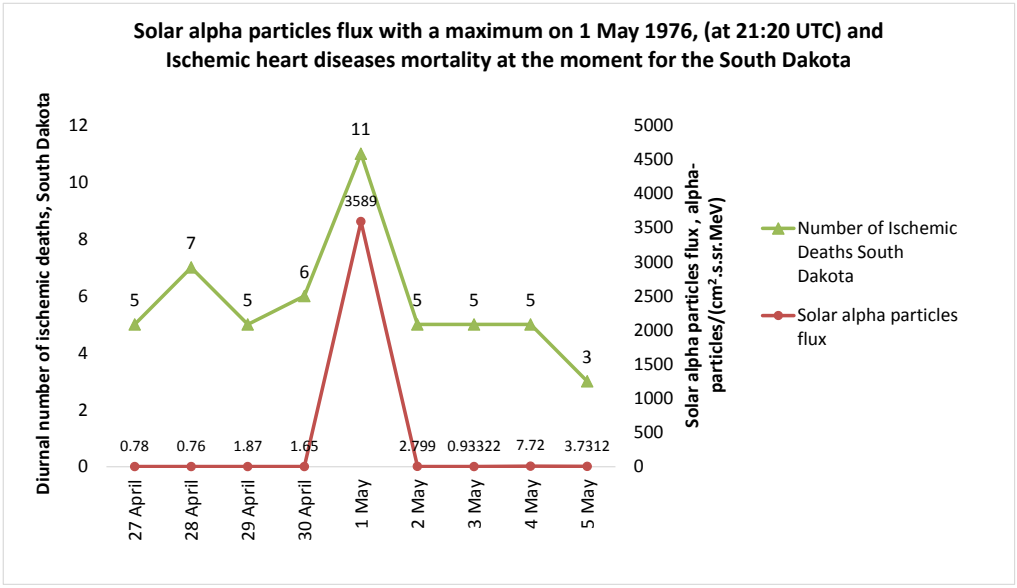

Figure 3. The mortality peak from ischemic diseases in South Dakota coincides with the alpha particles flux peak. Their correlation coefficient is 0.881 (from maximum of 1,000), and the significance level is 0.05.

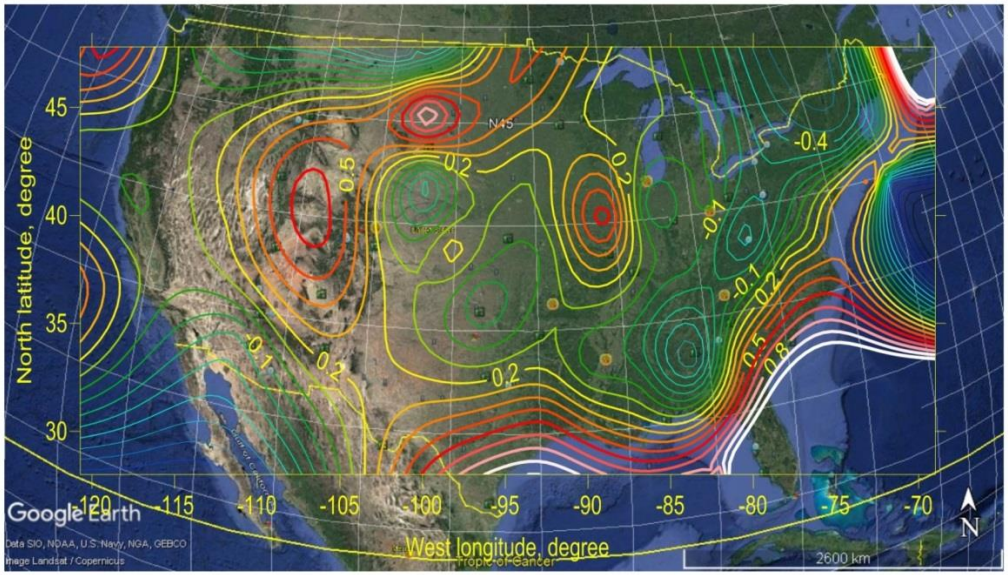

Figure 4. Distribution of the correlation coefficients of dependence between daily ischemic heart diseases morality for the states of USA and alpha particles fluxes in the studied interval 27 April – 5 May 1976. Every state is presented by its mean coordinates and a correlation coefficient.

Figure 4 outlines 2 areas of peak ischemic mortality. The first area starts from northeast to southwest – the states of Maine, Florida, Louisiana, and Texas. The second zone is 5 degrees wide around the latitude of the optimal point on May 1, 1976 – Illinois, South Dakota, Wyoming, and Colorado. The westernmost zone (Wyoming and Colorado) is located about 30 degrees from the mentioned optimal point.

As the average coordinates of the state move away from the optimal point, a tendency of decreasing correlation between alpha radiation flux and mortality from ischemic heart disease is observed (Fig. 5). I.e. the zone of maximum penetration of solar alpha radiation into the atmosphere is the "danger" zone, and there is a tendency for lower mortality in states further from this zone

As the average elevation of the state increases, there is a trend toward an increase in mortality from ischemic heart disease (Fig. 6). I.e. as the atmospheric layer over the state decreases, the protection from the cause of ischemic death decreases, clearly indicating that the threat comes from above.

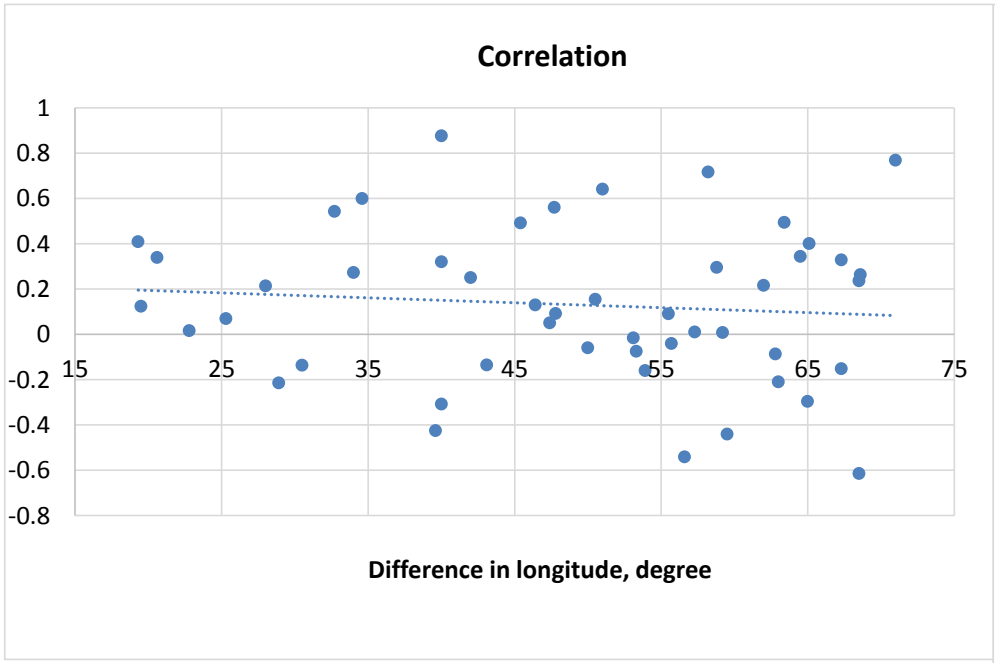

Figure 5. The distance from the optimal point on 1 May (-140°, 44.1°N) and the center of each US state's is given in the abscissa. The correlation coefficients for mortality for each USA state and the flux of alpha radiation depend of this distance and are shown with points. The negative trend indicates a decrease in threat with the distance increase from the "danger" optimal point.

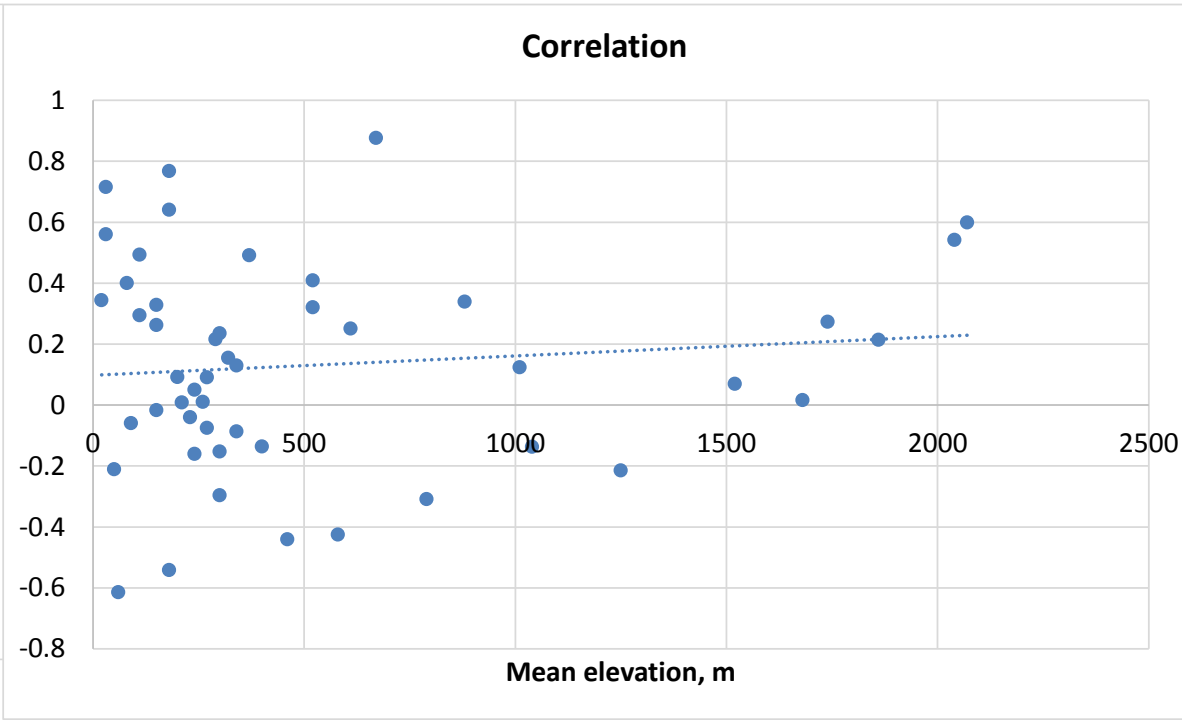

Figure 6. Dependence between correlation coefficients between mortality and the flux of alpha radiation, on the mean elevation of the state. The positive trend indicates an increase in threat from above.

Discussion: The results indicate a possible causal relationship between mortality from ischemic heart disease and the fluxes of positive solar corpuscular radiation.

A hypothetical mechanism is proposed [8], explaining the observable data. According to this mechanism, positively charged solar particles with enough kinetic energy to overcome the collisions with the atmospheric gases could penetrate the atmosphere to the Earth's surface only at the optimal points for that. The optimal point is the place, where in the local noon the directions of induction of the Earth's magnetic field and the direction of the invasion of particles into the atmosphere are parallel. For a part of invading Earth particles, the above-mentioned conditions are fulfilled to a sufficient extent, and they reach the surface in relatively small areas (spots) with typical dimensions of hundreds of kilometers, where they affect the biosphere.

The energy required for the invading particles to overcome the interaction with the atmospheric particles was estimated – from 2.5 GeV to 3.4 GeV for the protons and from 6.2 GeV to 7.5 GeV for the alpha particles [3, 4, and 8]. The particles with such energy are relativistic – they reach Earth's orbit in minutes after being emitted from the Sun's surface. Such high-energy particles can induce ionization and a nuclear reaction (even particles' showers) in the air and the human body. Even a single high-energy particle could cause a series of physiological reactions in the human body, leading to heart attack and death. Alpha particles with kinetic energy 3.8 - 9.9 MeV (channel 1, on average 6.9 MeV) reach the Earth's orbit for 136.88 min. If from the Sun's surface simultaneously emitted also alpha particles with a kinetic energy of 1000 MeV, they reach the Earth's orbit two hours earlier – for 9.20 min.

Therefore, the kinetic energy of 3.8 - 9.9 MeV, which is that of the alpha particles in the described case, is insufficient for their penetration through the atmosphere to the Earth's surface. In the proposed hypothetical mechanism, it is assumed that the solar alpha radiations registered by the satellite detectors are accompanied by alpha radiations emitted by the solar surface at close moments (in particular at the same moment) with an energy of the order of several gigawatts, which the satellite detector cannot register. Such radiations can penetrate through the atmosphere to the Earth's surface and affect the biosphere. The flow of solar alpha particles registered by the satellite detector is an indicator that alpha particles with a kinetic energy of the order of gigawatts may have reached the Earth's orbit. The synchronicity between the indicator flux of alpha radiation and mortality from ischemic heart disease is an indirect confirmation of the presence of such high-energy fluxes of solar alpha radiation emitted at the same time as the lower-energy ones.

What kind of particles – protons or alpha particles – pass through the atmosphere and reach the Earth's surface?

According to satellite observational data (GOES 13), a significant flux of alpha particles with energies above 3.4 GeV is observed in geostationary orbit, while the proton flux with energies above 0.7 GeV is hundreds of times weaker (Fig.7). This makes it more likely to conclude that high-energy alpha particles reach the Earth's surface, and act as a trigger for blood circulatory processes that cause death.

A case of a possible effect of high-energy alpha particle flux on ischemic heart diseases in the United States is interpreted below under the above-mentioned hypothetical mechanism. As a result of explosive processes on the solar surface on 1 May 1976, streams of alpha particles with different energies are directed toward the Earth. As particles with higher kinetic energy have a higher velocity, it should be expected that the impact of high-energy particles on Earth's surface would be earlier than the arrival of the indicator particles, registered by the satellite (if all particles are emitted by the Sun at the same time). The estimated delay for the indicator alpha particles with a kinetic energy of an average of 6.9 MeV with respect to particles with an energy of 5 GeV is about 2 hours. That is, it is expected that the indicator flux with energy 3.8 – 9.9 MeV, will be shifted to the west of about 30° from the presumed spot in which the high-energy particles have struck (The Earth rotates around its axis at an angular velocity of 15° per hour.) I.e. if the indicator flux is with longitude -140° it is assumed that an unregistered flux of high-energy solar alpha particles hits longitudes -105°; -110° two hours earlier. The affected area coincides with states of Wyoming and Colorado, where increased ischemic mortality would be expected according to the proposed mechanism. Figure 4 shows that the conclusions following the proposed mechanism correspond to the recorded data for the states of Wyoming and Colorado. This is an argument in favor of the adequacy of the proposed mechanism. The increased mortality on May 1, 1976, for the states along the southwest-northeast line could be due to high-energy alpha rays with no indicator radiation recorded.

The date also contributes to the increased mortality (May 1st is a holiday). It is assumed that people in the open are at higher risk, i.e. the probability of a direct hit of a high-energy alpha particle on a person increases with the time spent by people outdoors, i.e. when weather conditions are more favorable.

The contribution of the invading Earth alpha-particles flows to the risk of mortality from ischemic heart diseases could be estimated from the statistical data. For Bulgaria, this contribution was estimated at 10%, but in some countries such as Malta the share of positive solar particle flows on mortality from ischemic heart diseases could reach up to 40% [8].

The described mechanism allows for the calculation of the width of the zone of latitudes with the most intensive impact – mainly between 28°N and 48°N, but the phenomenon could be observable at latitudes outside this zone too [6].

It is not possible to predict when a stream of fast charged solar particles will head to Earth, but if the proposed mechanism adequately explains the phenomenon described, days at high risk can be calculated for each latitude [8]. The wide dissemination of such information would increase life expectancy, especially for the elderly.

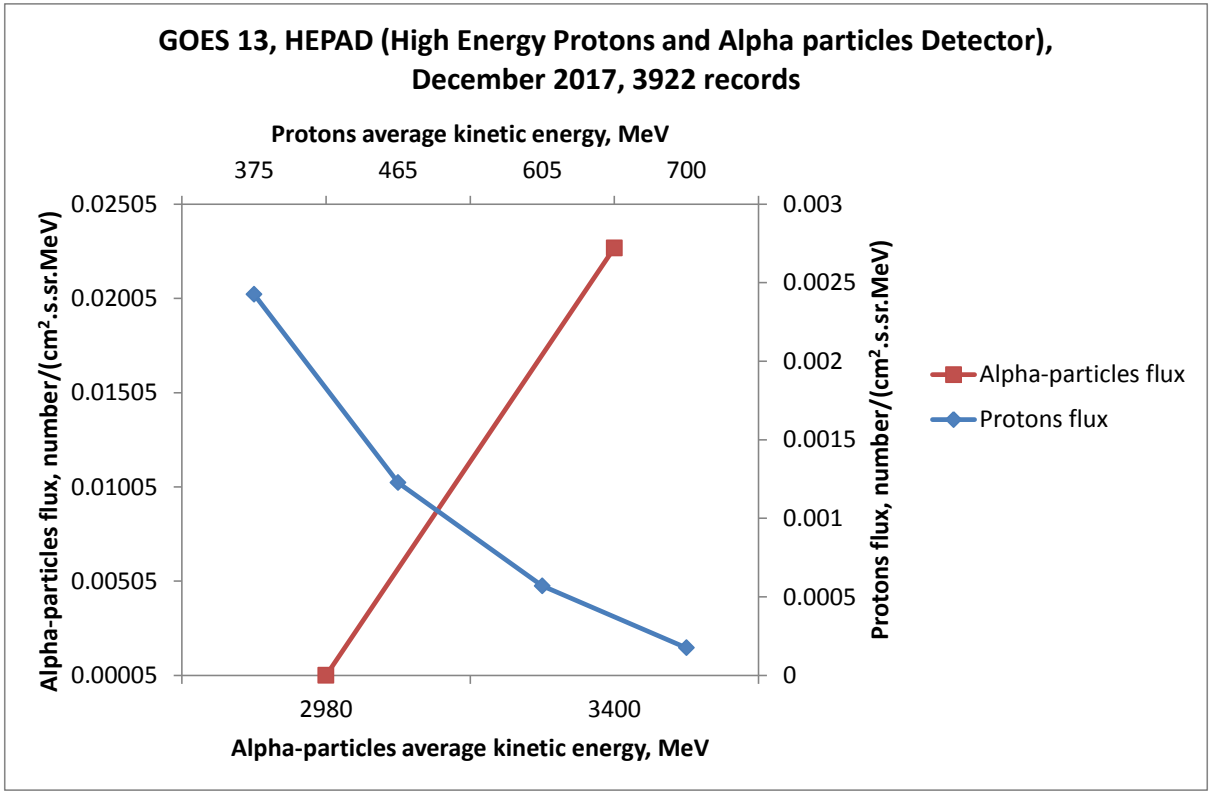

Figure 7. The fluxes of gigawatts of solar alpha particles increase with the kinetic energy increase, but the fluxes of several hundred megawatts of solar protons decrease with their kinetic energy increase.

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