Journal of High Energy Physics, Gravitation and Cosmology, 2024, 10, 1388-1411
https://www.scirp.org/journal/jhepgc
ISSN Online: 2380-4335
ISSN Print: 2380-4327

Bad News—The Dominant Causes of the Earth's Global Warming Are Processes on the Sun, and Humanity Can Do Nothing or Little to Stop It?

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How to cite this paper: Takuchev, N.P. (2024) Bad News—The Dominant Causes of the Earth's Global Warming Are Processes on the Sun, and Humanity Can Do Nothing or Little to Stop It? *Journal of High Energy Physics, Gravitation and Cosmology*, **10**, 1388-1411.
https://doi.org/10.4236/jhepgc.2024.104078

Received: May 22, 2024
Accepted: September 17, 2024
Published: September 20, 2024

Abstract

Arguments that global warming in the Earth's atmosphere of the last 70 years is partially or entirely caused by changes in the solar magnetic field are presented in the work. Global warming is probably a consequence of ionizing radiation emitted from the Sun mainly in the "rise" phase of solar activity. The ionizing radiation is positively charged particles with high energy. They penetrate deep into the Earth's atmosphere, creating increased content of ions serving as condensation nuclei. The condensation nuclei increase cloudiness in the lower atmosphere and lower the surface air temperature. When solar activity decreases as observed in the last 70 years, the reverse process occurs—cloud cover decreases, more solar electromagnetic radiation reaches the earth's surface and increases the temperature. An additional argument for the presence of high-energy radiation that penetrates deeply into the Earth's atmosphere and even reaches the Earth's surface is the high statistically significant correlation between the fluxes of such radiation recorded by GOES series satellites in a geostationary orbit (36,000 km above the Earth's surface) and the human mortality from deadliest diseases.

Keywords

Global Warming, Climate Change, Solar Cycle, Ionizing Radiation, Satellite Data

1. Introduction

In the Synthesis Report, "CLIMATE CHANGE 2023", Summary for Policymakers, in the first chapter "A. Current Status and Trends, Observed Warming and its Causes" the authors from the Intergovernmental Panel on Climate Change (IPCC) claim: "Human activities, mainly through emissions of greenhouse gases, have unequivocally caused global warming, with the global surface temperature reaching 1.1˚C above 1850-1900 in 2011-2020. [1]".

In modern times, the thesis quoted above has become the dominant scientific paradigm about global warming.

In the present work, the author presents arguments that global warming of the last 70 years is partially or entirely caused by changes in high-energy positive corpuscular radiation emitted mainly in the "rise" phase of the solar 11-year activity cycle. Deep in the Earth's atmosphere, this radiation increases air ionization and as a consequence—increases cloudiness. Solar activity has gradually decreased in the recent few cycles, decreasing emitted ionizing radiation, which leads to decreasing cloudiness. Less cloudiness means more solar electromagnetic radiation, reaching the Earth's surface, and higher surface temperature.

2. Material and Methods

In connection with the described study, 3 types of data were collected and processed, obtained from reliable sources—globally recognized databases of NOAA, NASA, EUROSTAT, and US National Center for Health Statistics: 1) data on the surface temperature, 2) on the solar corpuscular radiation with high energy, reaching the Earth's orbit, and 3) for mortality in the human population from causes, mostly diseases, supposedly dependent on said solar radiation. The joint study of the three types of data allowed a conclusion to be drawn as to the cause of an invisible chain of interconnected phenomena, to which, in the humble opinion of the author, global warming is also connected.

2.1. Temperature Data

In Bulgaria, a network of several dozen meteorological stations has existed since the last quarter of the 19th century. For some of the stations, such as the one in Stara Zagora, there is an almost continuous series of surface temperature data with a length of 126 years. Meteorological data for some major stations are published every year and are freely available in the country's statistical yearbook prepared by the National Statistical Institute. Meteorological data for the individual stations were also obtained upon request by the National Institute of Meteorology and Hydrology. For four of the meteorological stations in the country, data are also available through the NOAA website, National Climatic Data Center, in the Global Historical Climatology Network daily (GHCNd) database [2]. The ground temperature data for the rest of the world is also from this database. The database includes thousands of climate stations, but temperature data were retrieved only for stations whose range of continuous annual temperatures consists of the last completed solar cycle 24 (till 2018), and at least four solar cycles back in time. The total number of included stations in the study was 872.

2.2. Solar Activity Data

The solar substance is in a plasma state—a mixture of particles with a positive charge (protons and alpha particles) and a negative charge (electrons). Rising from deep to the surface of the Sun, heated flows of plasma (convection) export energy that leaves the Sun in the form of electromagnetic radiation. The solar magnetic field changes cyclically with a period of about 22 years. Its change is observable because in phases of field growth (solar activity) areas of increased magnetic field on the visible surface of the Sun (photosphere) have reduced convection, as a result of which they are cooler, emit less radiation, and from a great distance they appear darker (sunspots). Along with the appearance of spots during the active phase of the Sun, solar mass ejections (SME), explosive processes with increased radiation brightness (flares), etc. occur. Within a 22-year cycle, solar activity changes twice with a period of about 11 years (solar cycle). For more than two and a half centuries, solar activity has been monitored regularly through the Sun Spots Number (SSN, Solar Index). Each of its cycles gets a number. The Sun is currently nearing the maximum of its 25th cycle. Within the solar cycle, solar activity increases for several years ("rise" phase), reaches a maximum and decreases ("fall" phase) to a minimum (**Figure 1**). Manifestations of solar activity during a specific cycle are related to the magnitude of the SSN at the maximum of the cycle. For different cycles, the maximum SSN varies, for the last 5 cycles (from the 18th to the 24th, since the mid-1950s) there has been a decline in the number of sunspots at the maxima of the cycles. SSN data were obtained from the sites [3] [4].

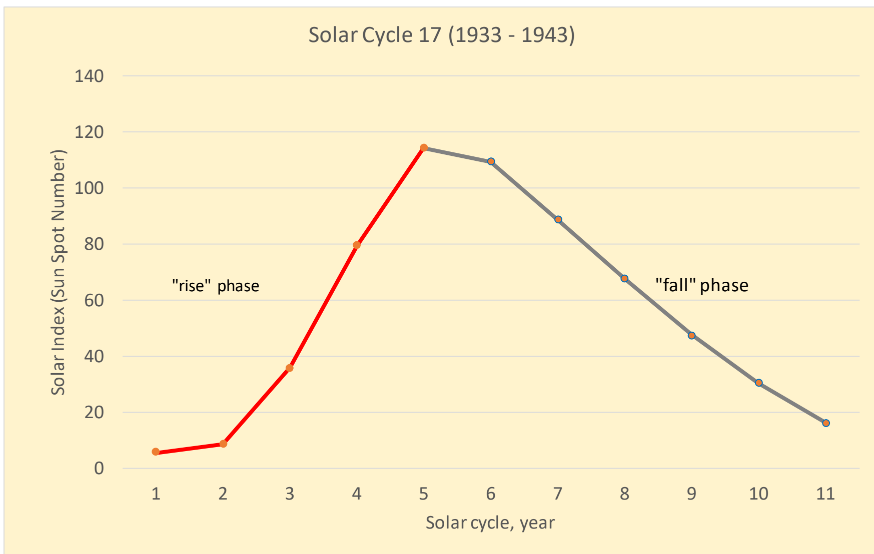

Figure 1. A cycle of solar activity in the example of solar cycle 17 (chosen for its typical shape). During the first phase of the cycle, solar activity increases, and reaches a maximum (the largest number of sunspots), then during the second phase, the activity decreases to a minimum before the start of the next cycle.

2.3. Solar Corpuscular Radiation Data

Satellite data on corpuscular radiation—protons and alpha particles recorded by the satellites of the two series SMS (Synchronous Meteorological Satellites) and

GOES (Geostationary Operational Environmental Satellites) were obtained from an NOAA site [5].

The satellites of the SMS and GOES series fly in geostationary orbit (above the Earth's equator), at an altitude of 36,000 kilometers above the Earth's surface, make one lap in 24 hours, that is, they "hang" over a certain point on the Earth's surface and are not shade by the Earth at their circumference around it.

Data on alpha-particle and proton fluxes (unit: (number of particles)$\cdot$cm$^{-2}\cdot$s$^{-1}\cdot$sr$^{-1}\cdot$MeV^{-1}) with energies of the range 3.8 - 21.3 MeV were used. The fluxes were recorded by the satellite high-energy particle detectors: 1) Energetic Particles Sensor (EPS), and 2) Energetic Proton, Electron, and Alpha Detector (EPEAD), and 3) High Energy Proton and Alpha Particles (HEPAD). The data are available averaged over a 5-minute interval, during which there are up to 25 reports of the instrument.

The frequency of solar fluxes of positively charged particles is higher during the "rise" phase in solar activity cycles.

2.4. Day and Night Cloud Data

Cloud data are recorded by the MODIS (Moderate Resolution Imaging Spectroradiometer) instruments on board the satellites EOS AM-1 (Earth Observing System, "Terra"), in orbit since December 1999, and EOS PM-1 ("Aqua"), in orbit since May 2002, flying in a sun-synchronous orbit 700 km above the Earth's surface. Data on the relative fraction of monthly mean daytime and nighttime cloud cover during the 24th solar cycle (from 2009 to 2018) were obtained from the NASA GIOVANNI database [6].

2.5. Mortality Data by Place and Cause of Death

The analysis below is based on the authoritative sources of health data—EUROSTAT [7] and the US National Center for Health Statistics (NCHS) [8].

In the study, the parameter annual mortality rate—number of deaths per 100,000 inhabitants was used as a characteristic of mortality. EUROSTAT offers free access to data on mortality rates from causes in the countries of the European Union, the European Economic Area, and the candidate countries for membership in the union. Geographically, these countries occupy Europe and the Mediterranean. Data are grouped by NUTS (Nomenclature Des Unités Territoriales Statistiques in French, the Nomenclature of Territorial Units for Statistics). Mortality data from the EUROSTAT shortlist in which mortality rates are grouped by causes of death into 88 groups, mostly diseases, were used in the study. The groups are related to the classes in the International Disease Classifier ICD-10, (10th revision). The shortlist contains mortality data for EU countries (NUTS-1) and EU regions (NUTS-2, smaller areas of the larger NUTS-1 countries). Currently (2024) the shortlist includes mortality rate data for the interval 2011-2020. Annual mortality rate data were extracted for 377 European regions (NUTS-2) separately from each of the shortlist groups for the interval 2011-2019 (the last pre-pandemic year).

2.6. Data Processing

Correlation analysis [9] was used for data processing.

The study included hundreds of meteorological stations on the planet's surface with a continuous series of annual (or monthly) temperature data. For each station, the data series included the last full solar cycle (24th) and at least 4 more complete solar cycles back in time. The average length of the temperature data run was 6 consecutive cycles and the maximum was 8 cycles. Mean surface air temperatures were calculated for the years of solar activity phase "rise" (**Figure 1**). For each station, the obtained series of mean temperatures were compared with the corresponding series of mean SSNs for the phases "rise" of the same cycles. To assess whether there is a causal relationship between the solar activity phenomena and surface air thermal changes for a given station, the correlation coefficient between the two series of values—mean temperatures and mean SSNs—was calculated.

In mathematical statistics, the level of statistical significance [9] is a parameter indicating the degree of reliability of the calculated correlation coefficient. The smaller the number of this parameter, the more reliably the correlation coefficient is established, *i.e.* the more reliably a cause-and-effect relationship has been established.

The correlation coefficient and the level of statistical significance are related. For the 8 solar cycles, a minimum correlation coefficient of 0.708 corresponds to a statistical significance level of 0.05, a minimum correlation coefficient of 0.835 corresponds to a statistical significance level of 0.01, and a minimum correlation coefficient of 0.925 corresponds to a statistical significance level of 0.001 [9].

In scientific studies, a level of statistical significance of 0.05 is accepted as a criterion for the reliability of the correlation coefficient. Correlation coefficients with a significance level less than 0.05 are of high reliability (the higher the number of the significance level, the lower the significance level of the correlation coefficient) *i.e.* the existence of a causal relationship between ground air temperature and SSN can be considered reliably established if their correlation coefficient is no less than 0.708 for data including 8 solar cycles.

Using the statistical method regression analysis, the coefficient of determination can be calculated, indicating the extent to which the variation in the independent variable, in this case, mean SSN, explains the variation in the dependent variable, in this case, surface air temperature. If the coefficient of determination is 1.000, the dependence between two processes is deterministic—the process effect depends only on the process cause. If the dependence is deterministic, there is no other cause independent of the first to intervene in the course of the process effect. An example of a deterministic process is the change in the magnitude of the electric current through a given wire—the effect depends on a single cause—the change in voltage between the two ends of the wire. If the dependence between two variables is linear and the value of the coefficient of determination is close to unity, the dependence is close to deterministic, the effect is influenced by only one cause and there is no other independent cause that affects the effect. In particular, if the variation of the surface air temperature is a linear consequence of the solar activity and the dependence has a coefficient of determination close to unity, only the solar activity intervenes in the variation of the surface air temperature. No other cause, independent from solar activity intervenes, in particular greenhouse gases in the air. Of course, the hypothetical possibility remains that solar activity is related to the emission of greenhouse gases, but such a hypothesis should explain why their concentration increases with the decreasing trend of solar activity in the last few decades.

3. Results

The examples shown below are for the Stara Zagora station, Bulgaria, due to the long accurate operation at the station—the surface air temperature data has a row length of 126 years. Figure 2 shows the relationship between the average value of the annual surface air temperatures measured at the Stara Zagora station, averaged for the phase "rise" of solar activity cycles with numbers from 17 to 24 (the cycles have a total duration of 86 years), and the average value of the annual SSNs for the rising phases for the same cycles of solar activity. There is a high negative statistically significant correlation between the two series of data, indicating the existence of a causal relationship between the two phenomena—temperature changes in the Stara Zagora region and solar activity. As solar activity increases within a particular cycle, the temperature decreases.

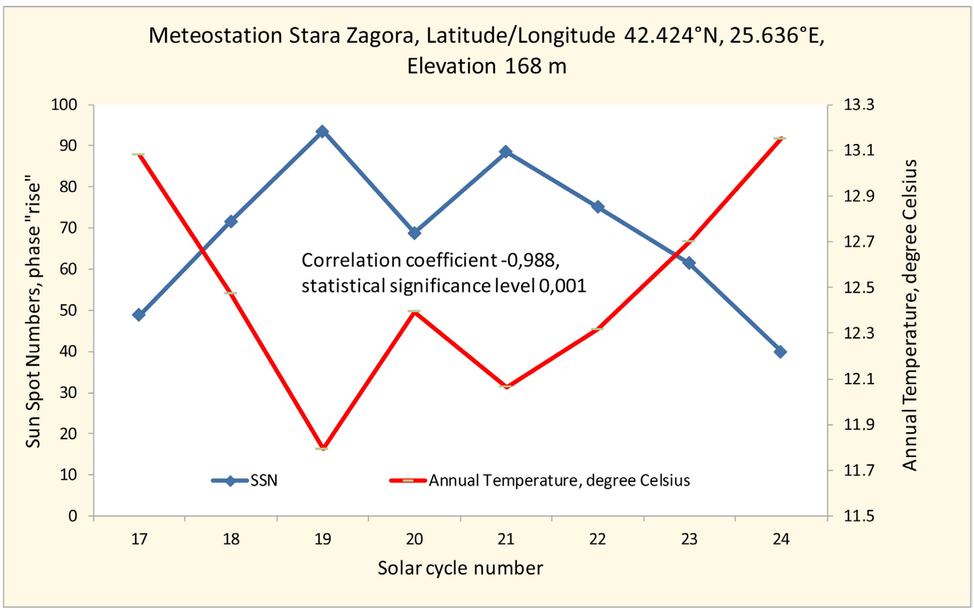

Figure 2. There is a high statistically significant negative correlation between the mean surface air temperature for the weather station STARA ZAGORA, BULGARIA, and the mean value of the number of sunspots during the phases "rise" of the last 8 cycles of solar activity.

Relative air humidity is inversely correlated with air temperature by definition, *i.e.* if the described dependence between SSN in "rise" phase and temperature is an observable fact, a positive correlation should be observed between SSN in the "rise" phase and the relative air humidity measured over the years during the "rise" phases of the SSN. **Figure 3** shows the dependence on time of the average values of SSN during the "rice" phase and their corresponding average values of the relative humidity of the air obtained from the Stara Zagora meteo station. The existence of a high, statistically significant positive correlation between the relative humidity of the air and the SSN in the "rise" phase is an independent confirmation of the existence of an inverse relationship between the air temperature and the SSN in the "rise" phase.

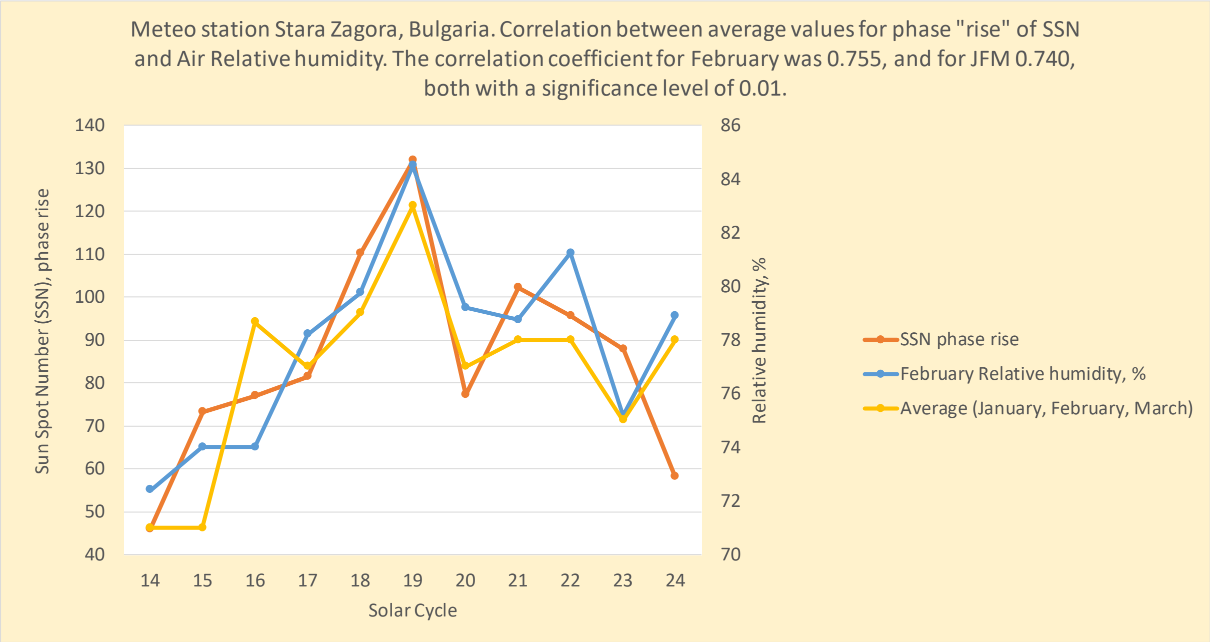

Figure 3. Between SSN in the "rise" phase and the relative air humidity measured over the years during the "rise" phases of the SSN, in meteo station Stara Zagora, Bulgaria, there is a statistically significant positive correlation.

Due to the decreasing trend in SSN values over the last five cycles and their negative correlation with temperature, the surface air temperature for the Stara Zagora region has been increasing in recent years.

There is no correlation between the change in surface air temperature for the Stara Zagora region and the SSN for the phase "fall" of the solar cycles included in the study (**Figure 4**). The change in temperature during the phase "fall" in solar activity cycles is below 0.5˚C, while during the phase "rise" the temperature changes almost 3 times more—by 1.4˚C.

It can be summarized that during the last several tens of years, the surface air temperature for the Stara Zagora region has been increasing during the phase "rise" of the solar cycles, because:

- it is negatively correlated with SSN during the same phase,
- and SSN has been decreasing over the past few cycles.

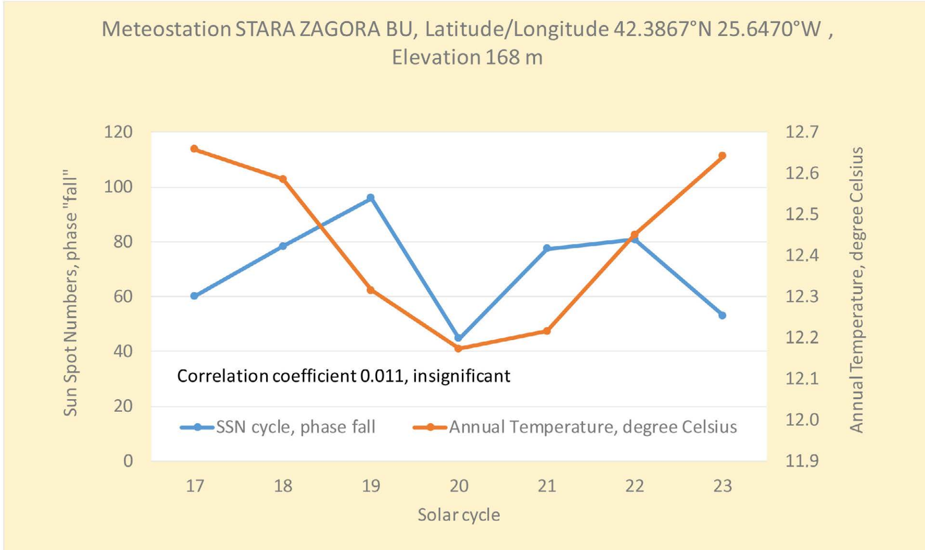

Figure 4. There is no statistically significant correlation between the mean surface air temperature for the weather station STARA ZAGORA, BULGARIA, and the mean number of sunspots during the phase "fall" of the last 7 cycles of solar activity.

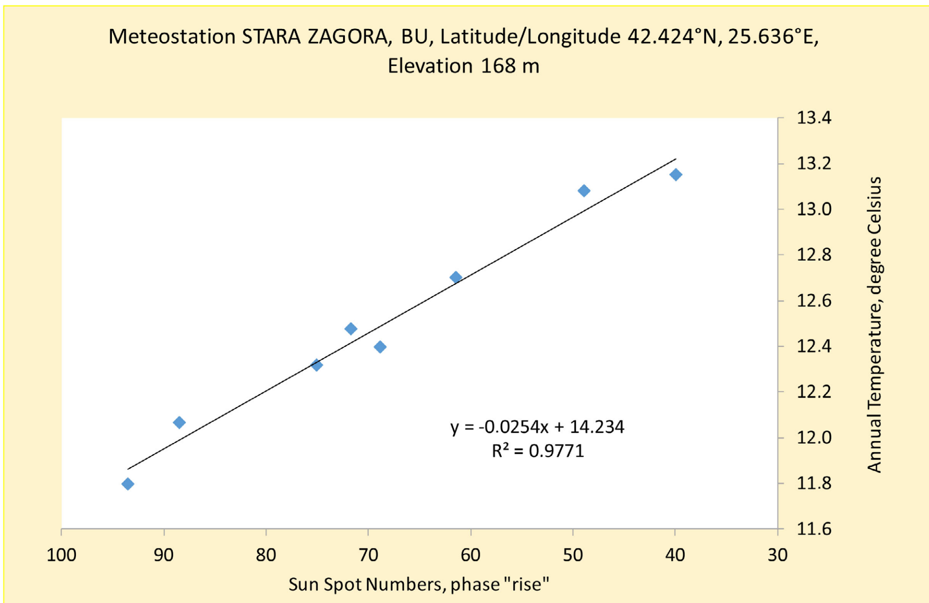

Figure 5. There is a linear relationship with a very high coefficient of determination between surface air temperature in the region of STARA ZAGORA, BULGARIA, and the number of sunspots, both calculated for the phase "rise" of the solar cycles included in the study.

Figure 5 shows the dependence of the surface air temperature for the Stara Zagora region on the SSN for the phase "rise" of the solar cycles included in the study. The dependence is linear, with a high coefficient of determination $R^2 = 0.9771$ (maximum value of 1.000). According to the explanation above, there is an almost deterministic linear dependence of the surface temperature due to a single cause—the solar activity characterized by SSN. The obtained result rejects the hypothesis of dependence of the temperature on the concentration of greenhouse gases, at least for the region of Stara Zagora. This conclusion is particularly impressive, as it was made for the Stara Zagora region, the air above which should contain an increased amount of carbon dioxide released from the burning coal in the powerful energy complex with five thermal power plants located in the area. Since in a source region of greenhouse gases, their influence on the rising air temperature is negligible, the conclusion is that solar activity is the dominant, if not the only, cause of the global increase in air temperature in the last few decades.

Figures 6-8 show other examples from meteorological stations in Bulgaria, showing the same dependence of surface air temperature on solar activity in the rising phase of the solar cycle, with a statistically significant correlation coefficient large in absolute value. The examples shown are only for some of the stations where this phenomenon is observed on the territory of Bulgaria.

In varying degrees of manifestation, the described phenomenon is also observed in other weather stations around the world. Examples of a part of the hundreds of stations where the phenomenon is observable are shown in Figures 9-12.

Of the stations included in the study, those with a negative correlation between temperature and SSN during the "rise" phase of the studied series of several recent solar cycles were 812, *i.e.* 93% of the surveyed stations. Of these, 321 stations had statistically significant correlations (significance level at least 0.05). Of these, 163 stations had statistically significant correlations less than −0.900 (significance level at least 0.05). Most often, maximum statistically significant negative correlations were obtained in a continuous series of cycles with a length of six cycles (171 cases). Their number quickly decreases with the increase in the length of the series of cycles, reaching one case for a length of 9 cycles.

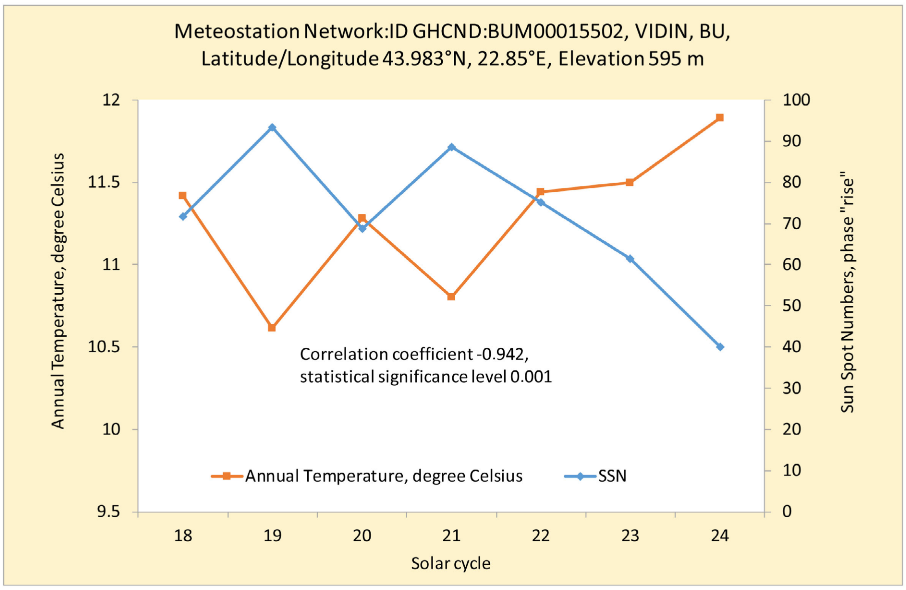

Figure 6. There is a high statistically significant negative correlation between the mean surface air temperature for the weather station VIDIN, BULGARIA, and the mean value of the number of sunspots during the phase "rise" of the last 7 cycles of solar activity.

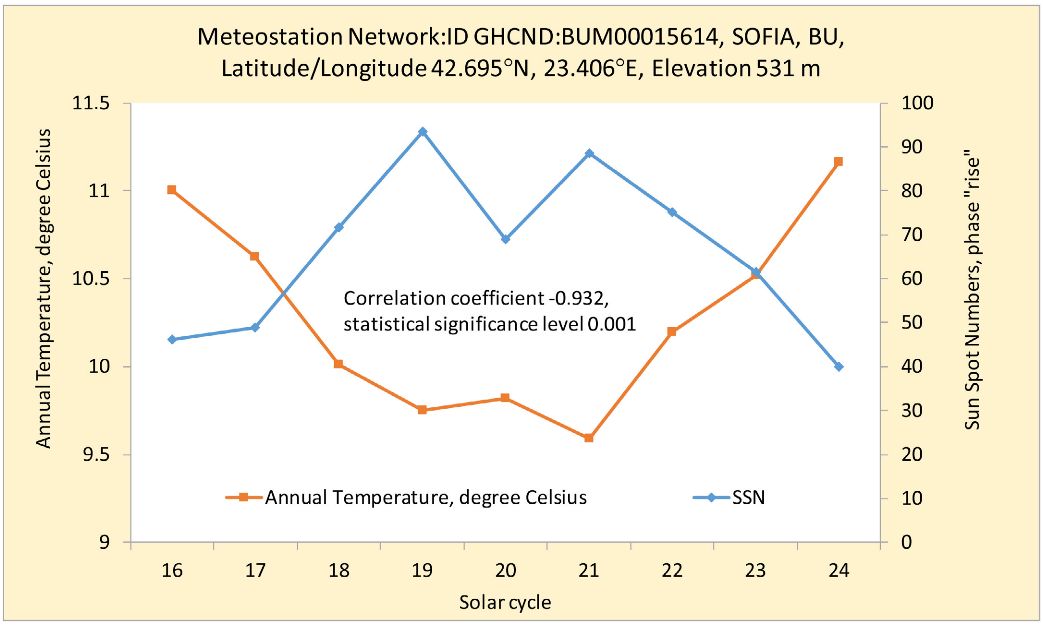

Figure 7. There is a high statistically significant negative correlation between the average surface air temperature for the SOFIA, BULGARIA weather station, and the average sunspot number during the phase "rise" of the last 9 cycles of solar activity.

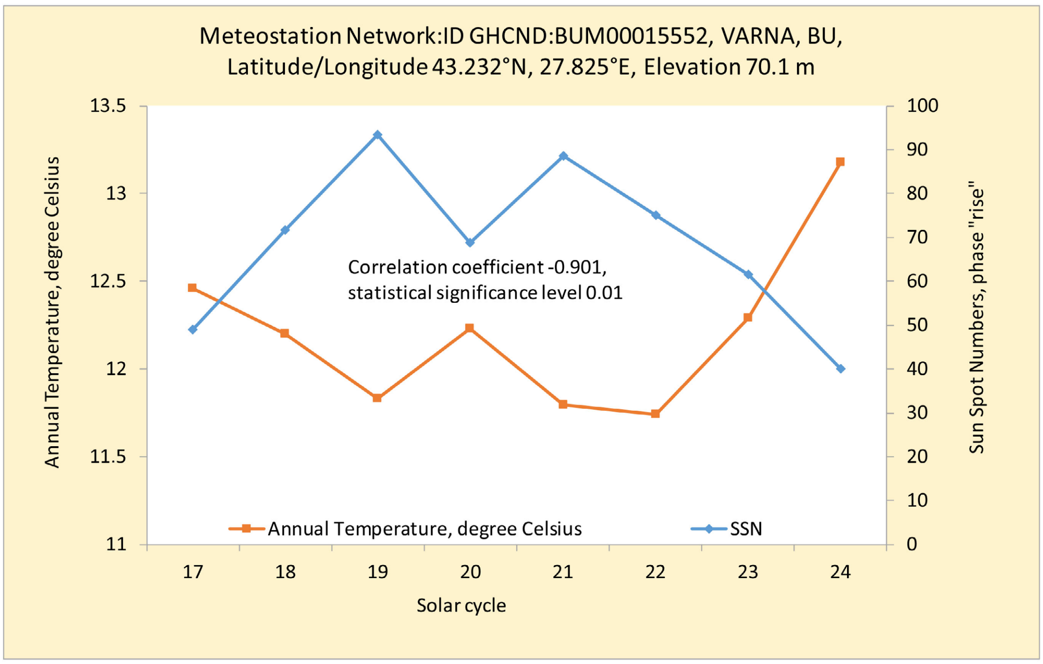

Figure 8. There is a high statistically significant negative correlation between the mean surface air temperature for the weather station VARNA, BULGARIA, and the mean value of the number of sunspots during the phase "rise" of the last 8 cycles of solar activity.

There are also stations for which this phenomenon is barely noticeable or not observed.

Figures 13-15 on a Google Earth map show the location of stations included in the study with very high statistically significant correlations of less than −0.900, in the region of Europe and Africa, Asia, and the Americas.

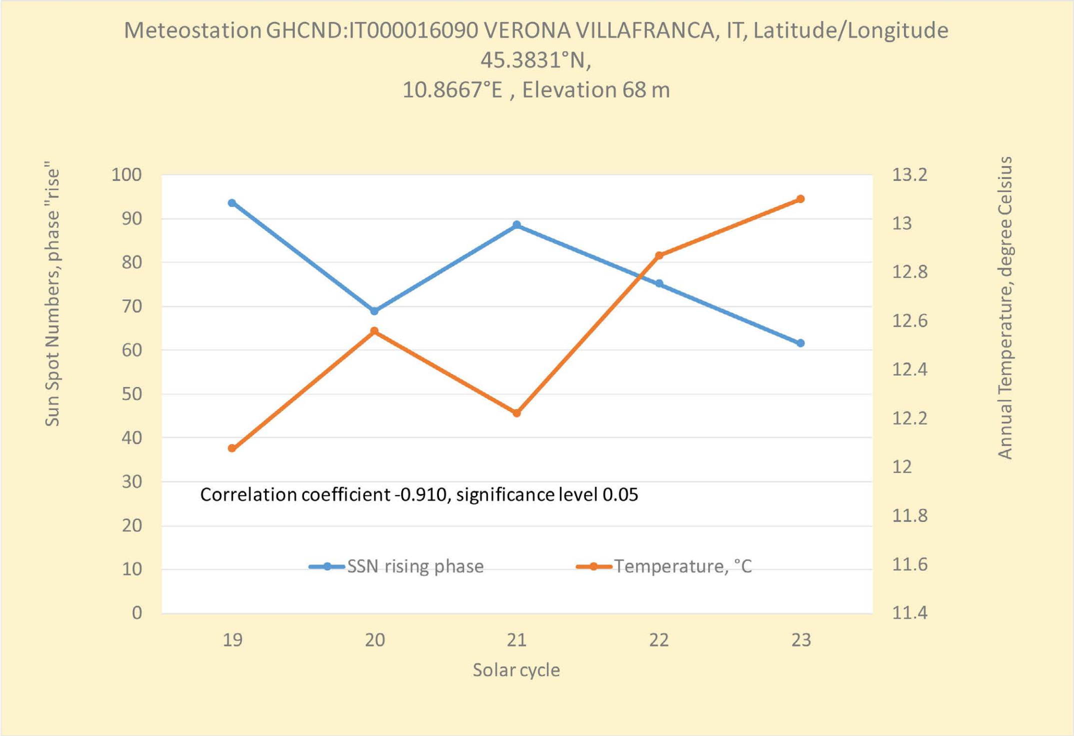

Figure 9. There is a high statistically significant negative correlation between the mean surface air temperature for weather station VERONA VILLAFRANKA, ITALY, and the mean sunspot number during the phase "rise" of the 5 cycles of solar activity (for which data are available).

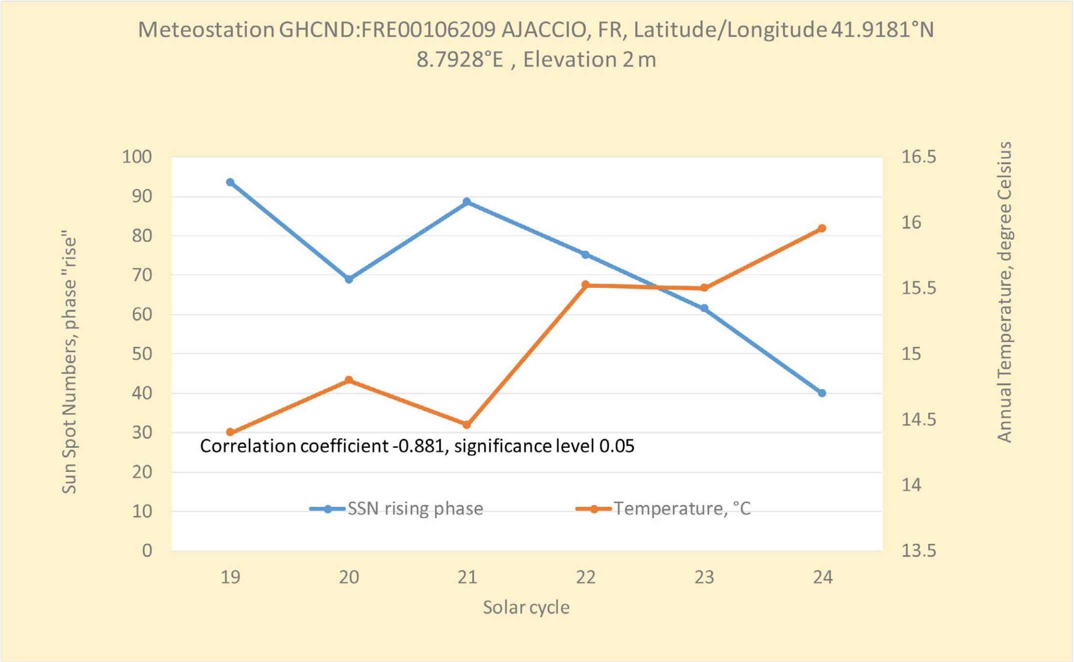

Figure 10. There is a high statistically significant negative correlation between the mean surface air temperature for weather station AJACCIO, FRANCE, and the mean sunspot number during the phase "rise" of the 6 solar activity cycles (for which data are available).

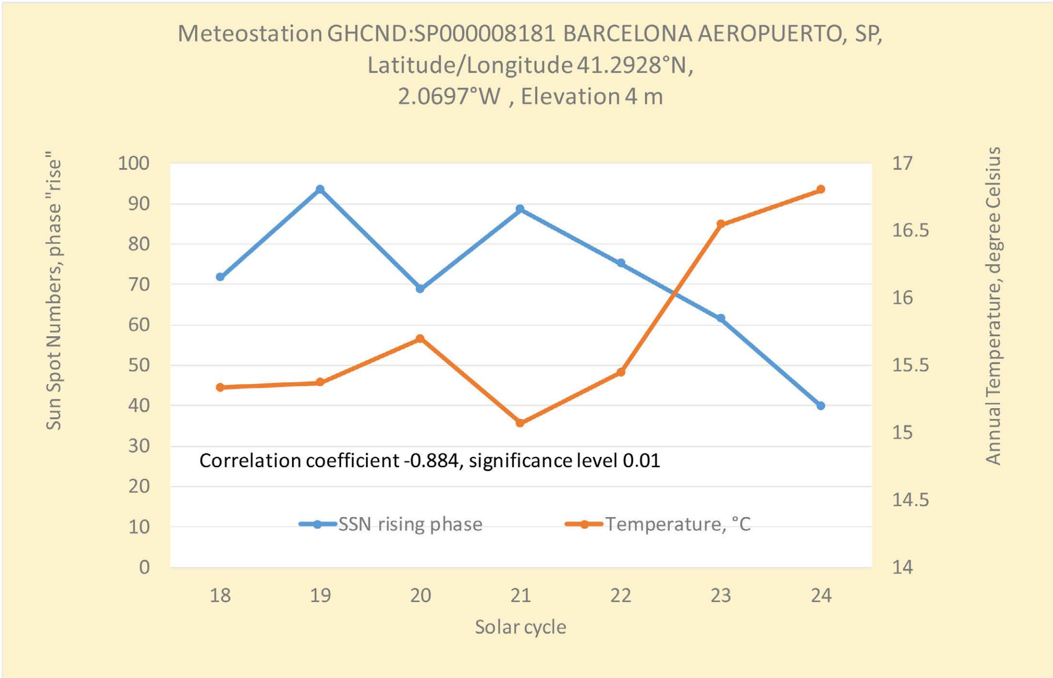

Figure 11. There is a high statistically significant negative correlation between the mean surface air temperature for weather station BARCELONA AEROPUERTO, SPAIN, and the mean sunspot number during the phase "rise" of the 7 cycles of solar activity (for which data are available).

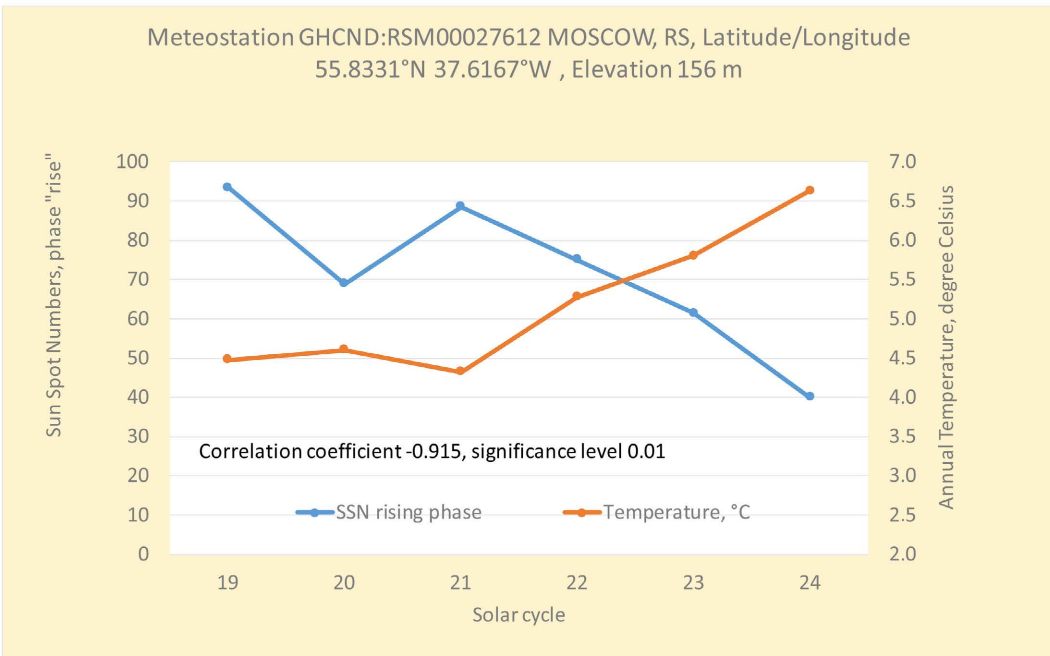

Figure 12. There is a high statistically significant negative correlation between the mean surface air temperature for weather station MOSCOW, RUSSIA, and the mean sunspot number during the phase "rise" of the 6 solar activity cycles (for which data are available).

During a cycle with a high SSN maximum, a reduced emission of electromagnetic radiation from the solar photosphere should be expected due to the large number of sunspots darker than the average photosphere brightness. As a result, less solar energy would reach the Earth's surface. This would explain the lower temperature of the ground air during the "rise" phase of the solar cycle, as electromagnetic radiation absorbed by the Earth's surface supplies the energy that is converted into heat for the ground air. Such an effect is not observed due to the accompanying sunspot areas (faculae), brighter than the average brightness of the photosphere. The increased brightness of the faculae completely compensates for the decreased brightness of the photosphere in the sunspots region.

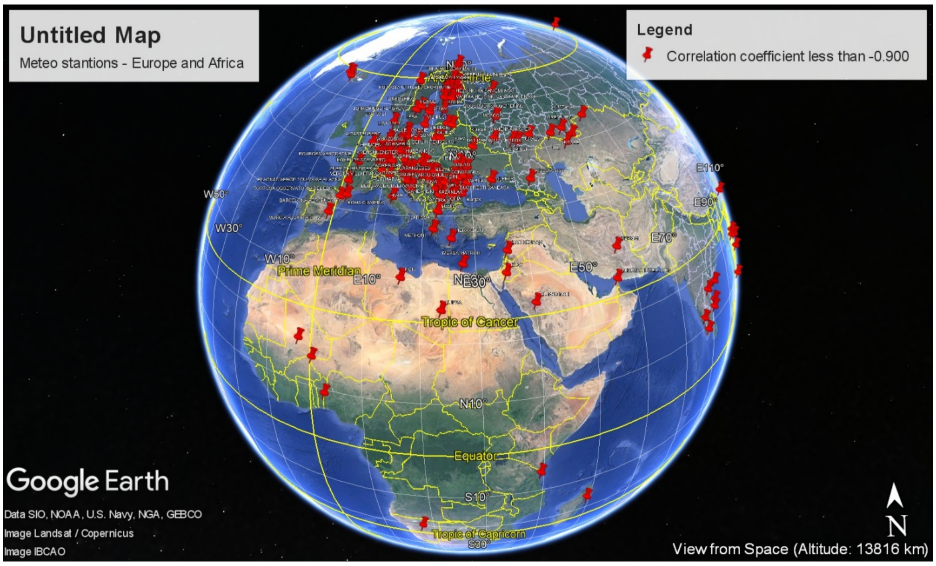

Figure 13. Google Earth map with stations from Europe (long over time and reliable data) and Africa, with very high statistically significant correlations of less than −0.900 between surface air temperature and SSN for the phase "rise" of the solar cycles.

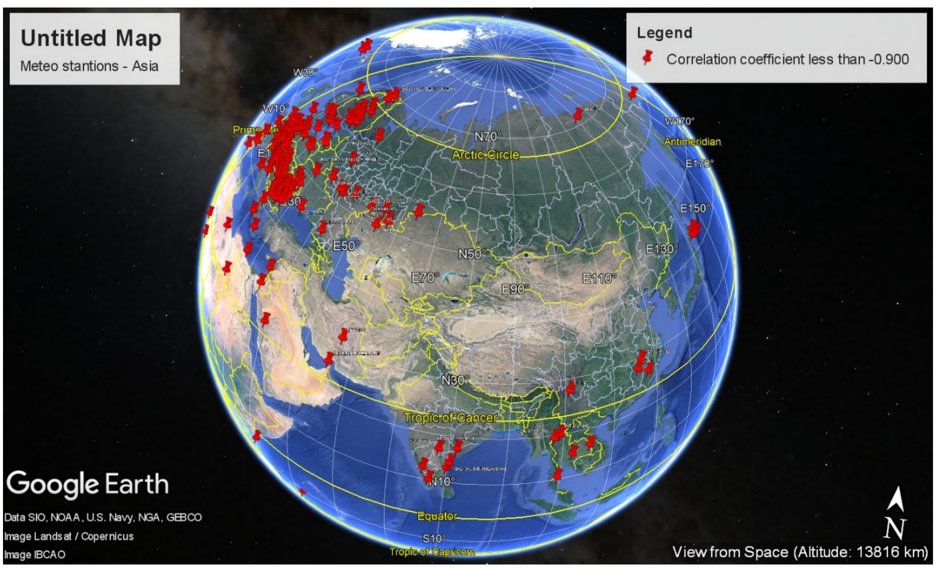

Figure 14. Google Earth map with stations from Asia, with very high statistically significant correlations of less than −0.900 between surface air temperature and SSN for the phase "rise" of the solar cycles.

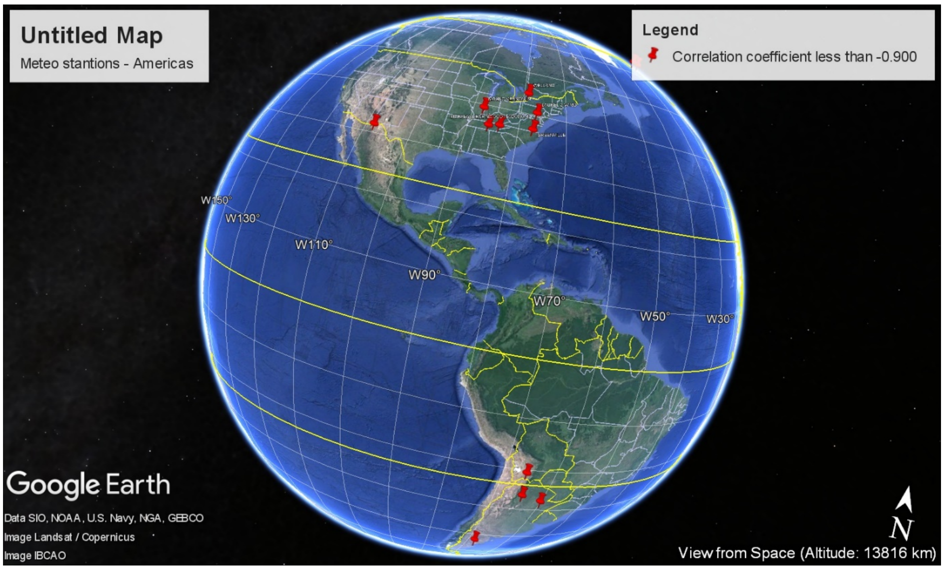

Figure 15. Google Earth map with stations from the Americas, with very high statistically significant correlations of less than −0.900 between surface air temperature and SSN for the phase "rise" of the solar cycles.

The area of the Earth's surface in which the above-described phenomenon of negative correlation between the number of sunspots and the temperature of the surface air during the "rise" phase of the solar cycles is most clearly expressed is with reference coordinates 20˚E, 40˚N, 30˚E, 50˚N, covering part of the Balkans. Average monthly data on the flux of solar electromagnetic radiation reaching the Earth's surface since 1980 have been obtained for this area [6]. The data covers the last four solar cycles—a total of 7 phases of solar activity of both types—"rise" and "fall" with values between 212 $W \cdot m^{-2}$ and 220 $W \cdot m^{-2}$. The comparison between the average fluxes of electromagnetic radiation during the two phases showed that there was no statistically significant difference between the fluxes. There are also no statistically significant correlations between the change in flows and the change in air temperatures in each of the phases, *i.e.* follows the conclusion that the described phenomenon is not related to changes in the Sun's electromagnetic radiation.

Data on the relative fraction of clouds covering the sky, separately for daytime and nighttime cloudiness, for two areas with high correlation coefficients between SSN and surface air temperature—the Balkans and the Western Mediterranean—were obtained from the onboard MODIS (or Moderate Resolution Imaging Spectroradiometer) instruments on the Terra and Aqua satellites [6]. The data has a row length only for the last complete solar cycle 24 (the planned life of the mentioned satellites was 6 years, Terra has been operating so far for more than 25 years, Aqua—22 years). The short length of the data series makes the difference between daytime cloudiness for the two phases of the solar cycle—rising and falling—statistically insignificant. For both studied areas—the Balkans and the Western Mediterranean, during the "rise" phase of the solar activity cycle, the daily cloud fraction is higher than that of the "fall" phase according to the data of both satellites. The difference reaches 1.5% cloud fraction (Figure 16). Increasing cloud shading during the daytime during the "rise" phase is a reasonable explanation for the decrease in surface temperature for this phase. The increased cloudiness may be due to the increased number of condensation nuclei in the atmosphere at the condensation level where the cloudiness forms. Condensation and, as a result, the formation of clouds depends on the presence of ions, which at a height of a few kilometers are the only type of condensation nuclei around which water vapor forms droplets and, as a result, clouds.

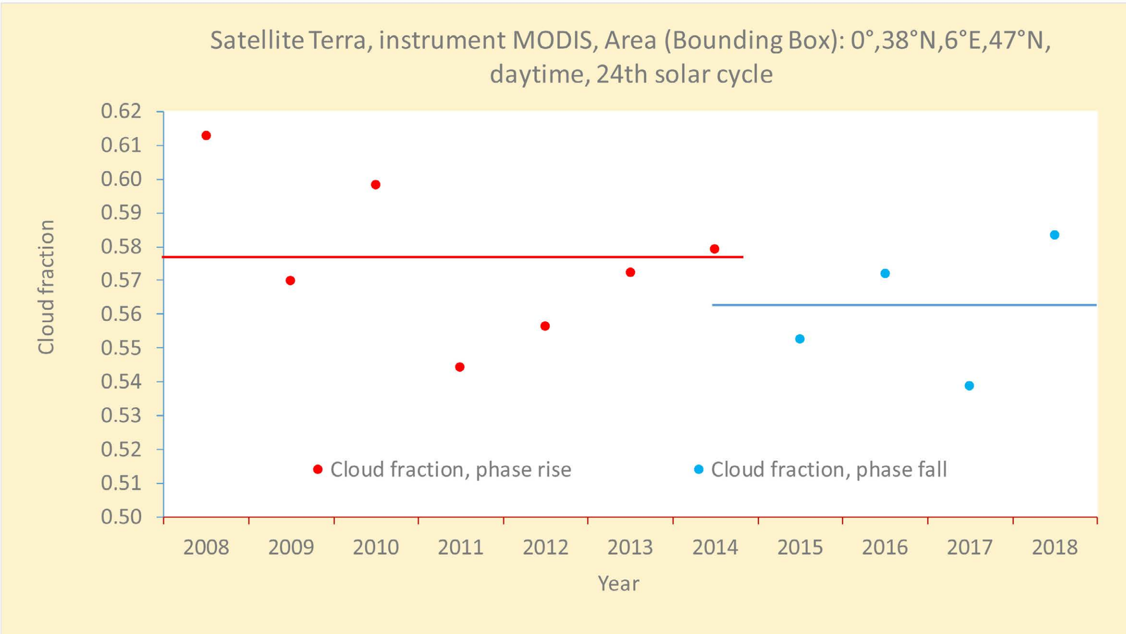

Figure 16. Daytime cloudiness over the western Mediterranean is about 1.5% more during the phase "rise" of the solar cycle than during the phase "fall".

The GOES series satellite data show that the positively charged particles with high energy—hydrogen and helium nuclei (protons and alpha particles), capable of ionizing the air, arrive from the Sun to the Earth [5]. Most often these particles do not penetrate deep into the Earth's atmosphere to the ground layer—the troposphere, where clouds are formed, due to the deflecting effect of the Earth's magnetic field and the energy losses in the collisions with the particles of the Earth's atmosphere.

However, a study shows that positively charged high-energy solar particles, *i.e.* with a high ionization potential, probably penetrate the atmosphere and even reach the Earth's surface [10]-[23]. The study reveals a high positive statistically significant correlation between fluxes of positively charged solar particles registered by GOES satellites and human mortality, a phenomenon that could be explained by penetrating the particles through the atmosphere to the Earth's surface. The most affected are the inhabitants of Europe and the Mediterranean.

Figure 17 shows with blue isolines the distribution of mortality by the group cause "All causes of death (A00-Y89) excluding S00-T98" of EUROSTAT shortlist in 2012—the year with the highest mortality for the studied interval years 2011-2019. The map was made from data for 377 NUTS-2 regions on the territory of Europe and the Mediterranean. A region with increased mortality stands out over Eastern Europe with a maximum over the Central Balkans.

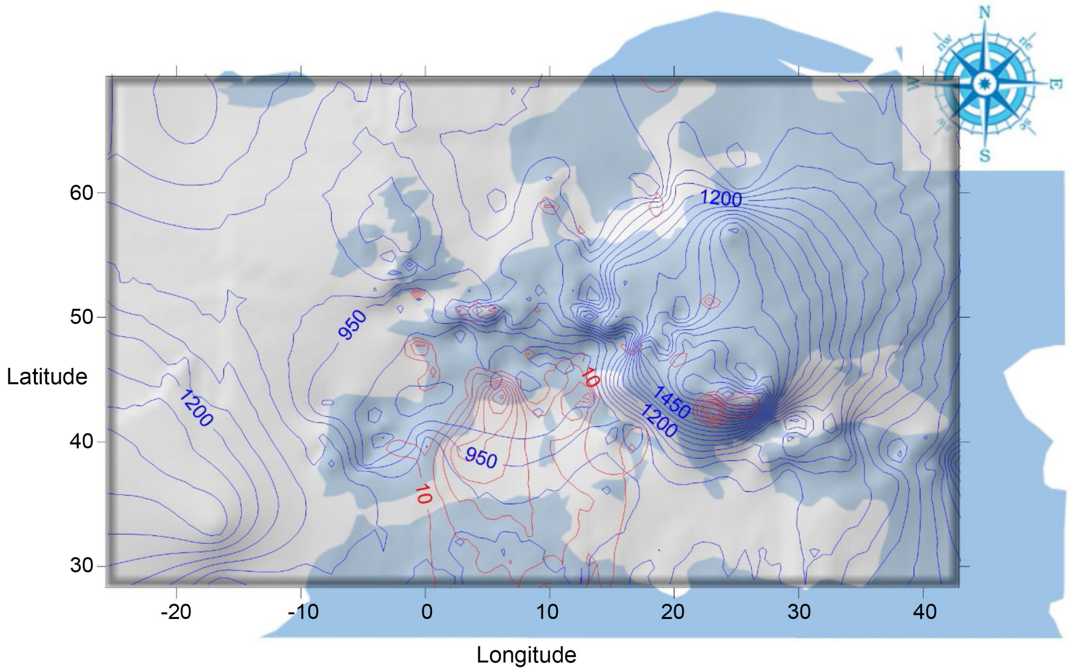

Figure 17. The main areas of influence of solar alpha radiation on mortality in the Europe and Mediterranean region are the Balkans and, to a lesser extent, the Western Mediterranean. (Software Surfer 10).

Red isolines show the distribution of the impact index of the annual flux of solar alpha radiation recorded by the GOES series satellites for the studied interval years 2011-2019 on mortality in each of the NUTS-2 regions. The index was calculated as a weighted sum of the number of statistically significant correlations for the studied interval of years between the annual mortality by groups of causes and the annual flux of solar alpha radiation for each of the regions separately. The number of correlations is divided into three groups depending on their levels of statistical significance—most significant, above 0.001, with medium significance between 0.001 and 0.01, and with least significance between 0.01 and 0.05. In the weighted sum, the weighting factor for the most significant group is 3, for the intermediate 2, and for the least significant 1. For individual NUTS-2 regions, the impact index varies from 0 to 30. The impact index reaches the maximum value of 30 for the region "Yugozapadna i yuzhna tsentralna Bulgaria" (Balkans). Two areas of maximum impact stand out—the Balkans and the Western Mediterranean. And while in the Western Mediterranean, this does not lead to a significant increase in mortality, in the Balkans there is a marked coincidence between mortality and solar alpha radiation recorded by the GOES satellites.

Figures 18-20 give examples of a strong correlation, indicating the presence of a cause-and-effect relationship, between the annual mortality for some of the deadliest causes listed in the EUROSTAT shortlist and the annual flux of solar alpha radiation.

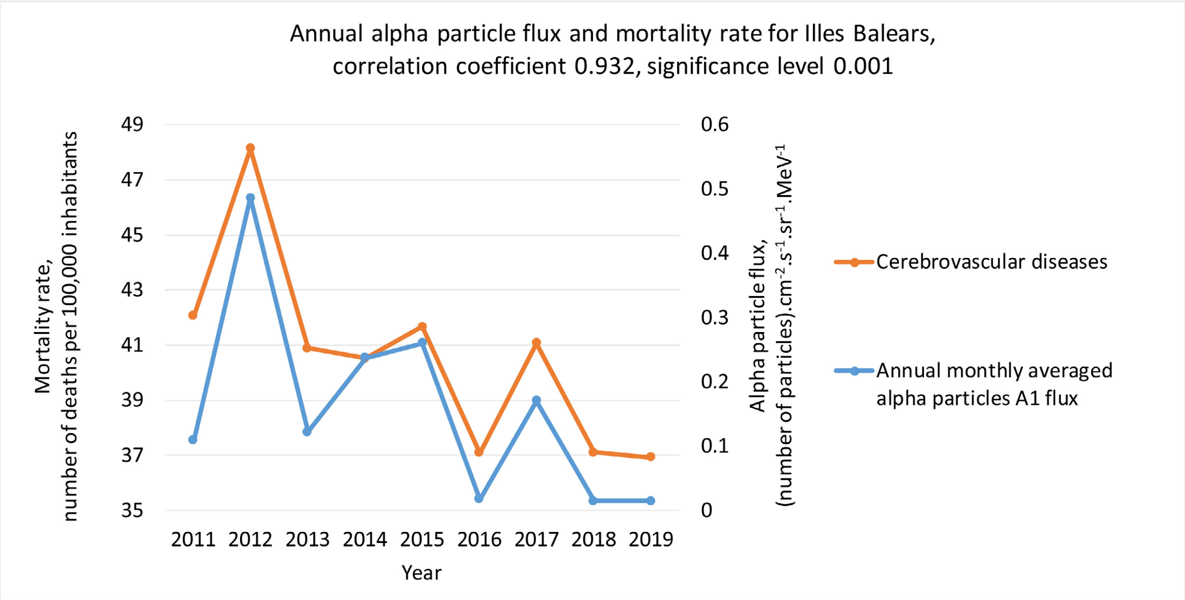

Figure 18. There is a high statistically significant correlation between the annual flux of high-energy solar alpha particles and cerebrovascular disease mortality in the Western Mediterranean, *i.e.* it is very likely that there is a causal relationship between the two phenomena.

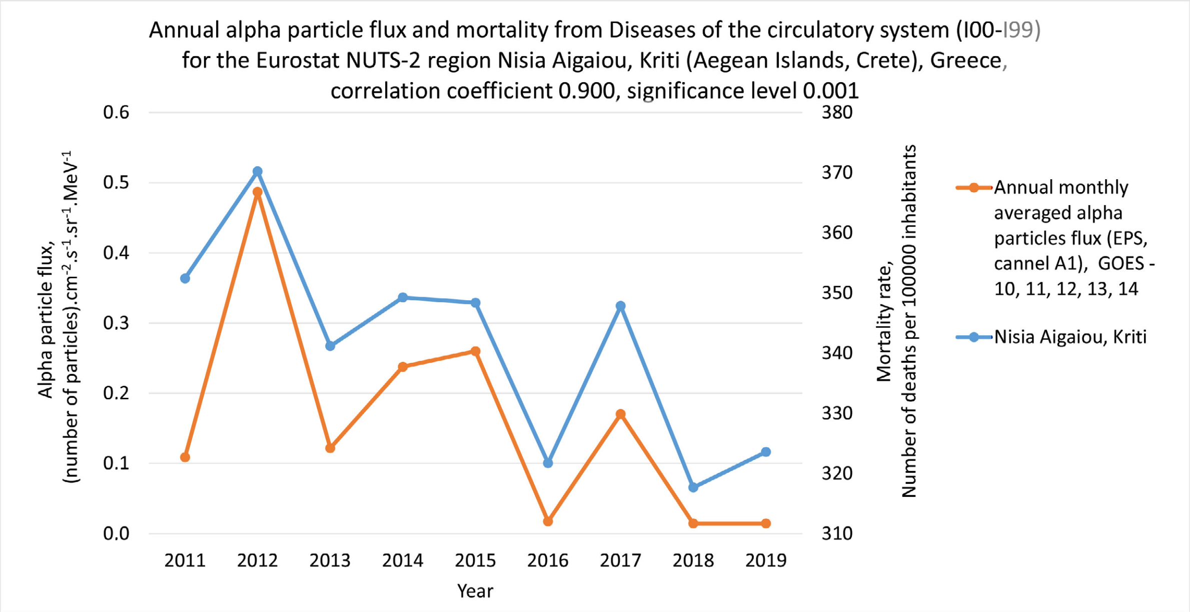

Figure 19. Between the annual flux of high-energy solar alpha particles and mortality from circulatory system diseases in the Aegean Islands and Crete, Greece, there is a high statistically significant correlation, *i.e.* it is very likely that there is a causal relationship between the two phenomena.

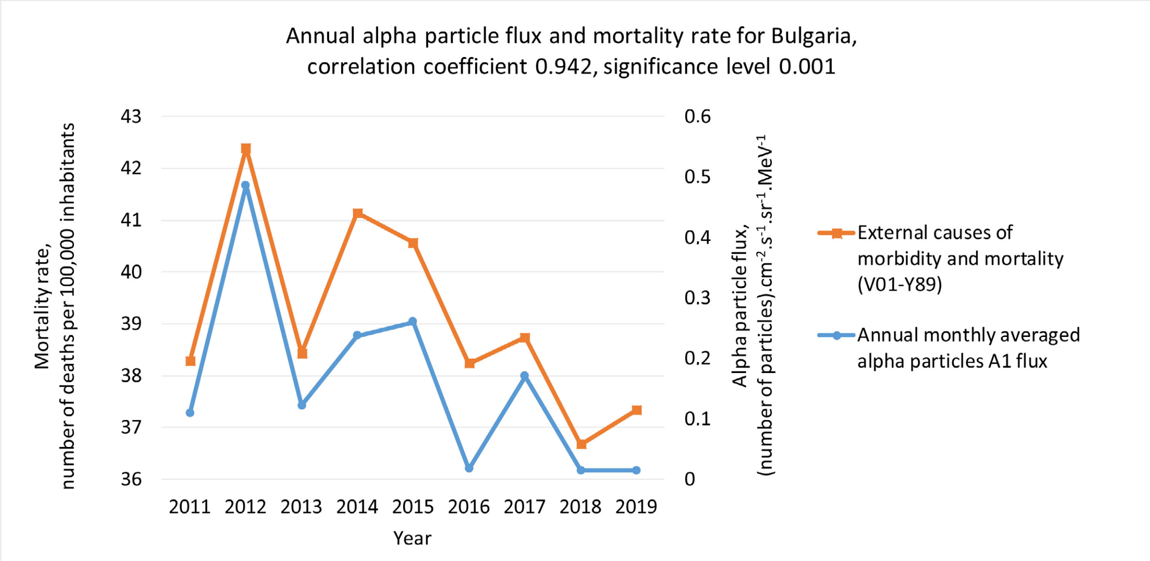

Figure 20. There is a high statistically significant correlation between the annual flux of solar alpha particles with high energy and the mortality from external causes of death in Bulgaria, *i.e.* it is very likely that there is a causal relationship between the two phenomena.

Further arguments are presented below in support of the hypothesis that the cause of death in the listed cases is streams of (so far unrecorded) solar alpha particles with very high energy, allowing them to penetrate to the Earth's surface, and therefore to pass through the atmosphere and with ionization within it to increase condensation nuclei and associated cloudiness.

A hypothetical mechanism, explaining described human mortality with the impact of invading high-energy solar alpha particles [10] [23]

1) An observed phenomenon—in the statistics of several countries located mainly in the 30˚N - 50˚N band, mortality from certain diseases, mainly those of the circulatory system, is strongly correlated with flows of positively charged particles with energy of the order of 4 - 21 MeV, recorded by the SMS and GOES series satellites in Earth orbit.

2) The recorded alpha particle flows are mostly pulses with a few minutes to a few days.

3) Proposed hypothesis—positively charged particles with high energy penetrate through the Earth's atmosphere to the Earth's surface and damage human health, to the greatest extent the human circulatory system, causing death mainly in elderly people with an already damaged circulatory system.

4) As the average altitude of the affected countries increases, the particle flux-correlated mortality from diseases of the circulatory system shows an increasing trend [12] [18]. It is probably due to the more intense radiation flux penetrating the thinner atmosphere over the mountainous region of Earth's surface—an argument favoring the hypothesis.

5) The source of the flows of positively charged particles is the Sun—mortality increases with observable processes on the Sun photosphere—from SME and flares directed to Earth (phenomenon on the solar surface that could be observed

with other astronomical means) [12] [18]. The Alpha Magnetic Spectrometer (AMS-02) on the International Space Station measures cosmic rays, excluding those of solar origin (when shielded from the Sun by the station's solar panels). In particular, it measures the flow of 3He and 4He (alpha particles) in cosmic rays. The measurements show [24] increasing annual flux of alpha particles in cosmic rays for the interval of years from 2011 to 2017 (last available data), while the flux of GOES registered (solar?) alpha particles for the same interval of years is decreasing (**Figures 18-20**). Indirect evidence for the Sun as a source of high-energy alpha particles is that this assumption convincingly explains the downstream processes that ultimately lead to death from circulatory system diseases.

6) Positively charged solar particles capable of penetrating through the Earth's atmosphere to the Earth's surface are high-energy alpha particles. Calculators PSTAR [25] and ASTAR [26] calculate the penetration parameters of protons, respectively alpha particles in different substances, in particular in air. Calculations with data for a homogeneous atmosphere—an atmospheric model with constant density, temperature, and pressure decreasing with height [12] show that only particles whose energy is above 2.4 GeV for protons and over 6.2 GeV for alpha particles can penetrate the Earth's atmosphere to the surface. There are no registered from GOES satellites protons above 0.7 GeV, but there are registered alpha particle fluxes with energy above 3.4 GeV, hypothetically also those with energy above 6.2 GeV [12] [18] [20], *i.e.* the particles that penetrate to the Earth's surface are probably high-energy alpha particles. Only registered fluxes of alpha particles with a magnitude of at least (hundreds of particles)$\cdot$cm$^{-2}\cdot$s$^{-1}\cdot$sr$^{-1}\cdot$MeV^{-1} is correlated with the mortality of the Earth's surface.

7) It is assumed that the alpha particles recorded by the satellites were emitted simultaneously with the hypothetical fast alpha particles in a common explosive process on the solar surface. It can be calculated that particles with an energy of 7 GeV need 8.87 min to reach the Earth's surface from the Sun's surface, and registered from satellites particles with energies of 5 - 10 MeV travel about 2 hours. The registered alpha particles do not have enough energy to penetrate the atmosphere, unlike the hypothetical fast alpha particles that reach the surface of the Earth in minutes from the center of the solar disk. However, the registered alpha particles are an indicator that two hours earlier there was an irradiation of the Earth's surface with fast alpha particles.

8) Although alpha particle streams irradiate the entire illuminated part of the atmosphere, penetration of fast alpha particles to the surface occurs only in a limited area of the surface (death spot), for which two conditions favoring penetration are combined:

a) The Sun is culminating for the center of the death spot—the path through the atmosphere of the invading positively charged particles to the point of observation is the shortest at the moment of the maximum rise of the Sun above the horizon (the culmination of the Sun). The point of registration is a point on the Earth's surface where the solar disk is at its culmination at that moment of the alpha particle flux registration by satellites. Its longitude can be determined from the data (time tag) for the hours and minutes of registration by the GOES satellites. And its latitude—from the date of registration. The approximate center of the dead spot can be calculated—the Earth's angular velocity is 15˚ per hour, therefore dead spot center is approximately 30˚ east of the registration point. The examples from the USA mortality are shown in Figure 21 and Figure 22.

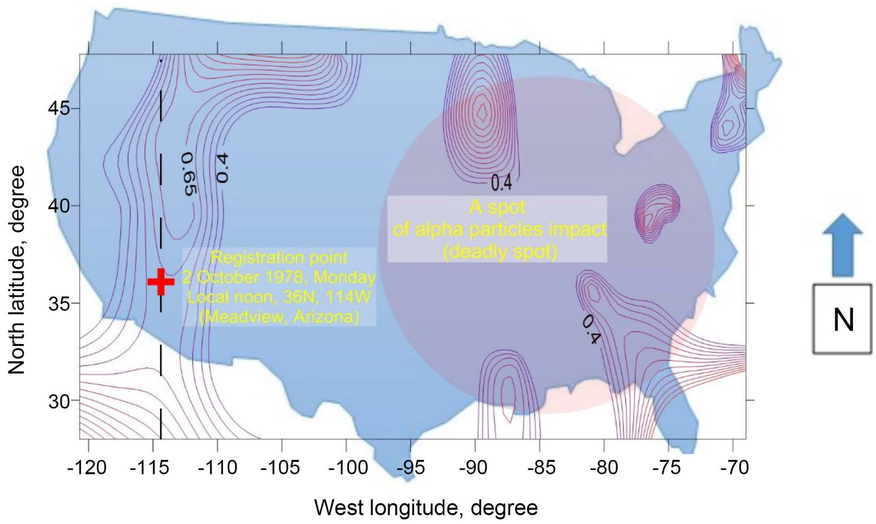

Figure 21. Alpha radiation flux registration point (red cross) from October 2nd, 1978, in the western USA, and the dead spot in the eastern US, tentatively denoted by a circle centered 30˚ eastward from the registration point.

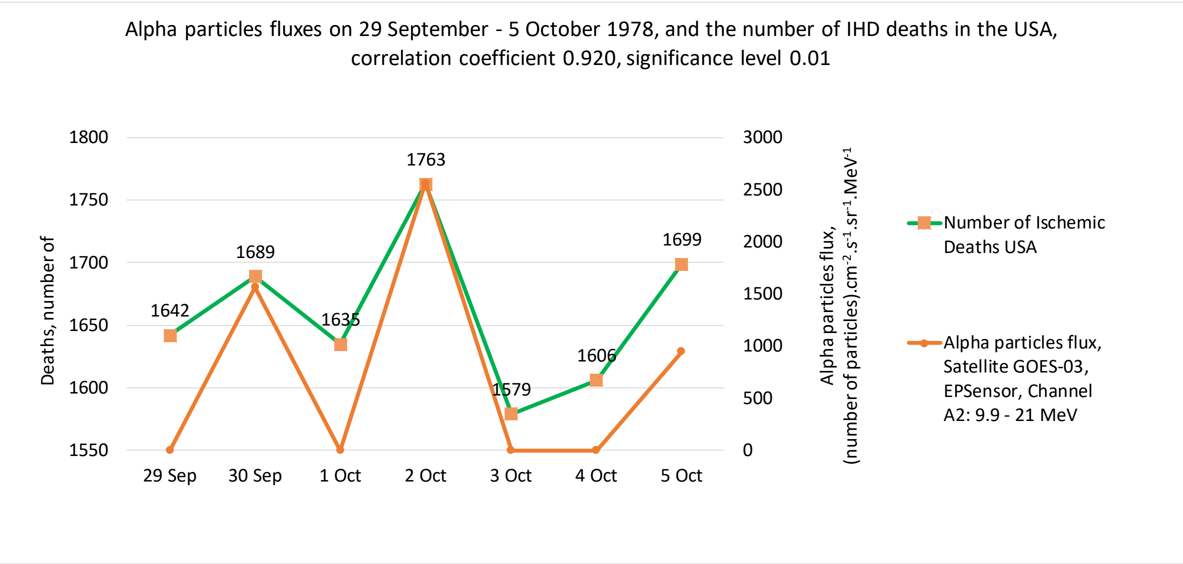

Figure 22. There is a high statistically significant correlation between alpha particle fluxes on September 29th, and October 2nd, 1978, and the daily number of ischemic heart disease deaths in the USA.

b) For the center of the death spot, a coincidence is in effect—the direction of the geomagnetic vector coincides with the direction of the alpha particle intrusion—then the alpha particle movement is not affected by the deflecting magnetic force. Such a coincidence occurs twice a year for latitudes in the band from 28˚N to 48˚N

[12]. For latitudes outside this band, such a coincidence is impossible, the fast alpha particles do not reach the Earth's surface (but still can ionize the air), which explains why for countries located near the North Pole no correlation is observed between alpha radiation fluxes and mortality from circulatory system diseases.

US Medical Statistics provides free access for research purposes to the world's most complete mortality information for US citizens, in particular information on each death. For some interval of years in the recent past, US mortality statistics have also collected information on an individual's date of death. This made it possible, in sync with the temporal specificity of the flows of alpha particles with high kinetic energy recorded by the satellites, to track the rapid changes in the number of deaths in the United States.

4. Conclusions

A high negative correlation between the average Sun Spot Number in phase "rise" in the 11-year cycle of solar activity and the annual average Earth's surface temperature was observed in the data from many meteorological stations all over the world, mainly in Europe. As solar activity has decreased over the last 70 years—the last few solar cycles up to the 24th number have had a monotonically decreasing number of sunspots—their negative correlation with temperature results in a rising surface air temperature. This increase is related to processes in the Sun's magnetosphere and has nothing to do with the increasing concentration of greenhouse gases in the Earth's surface atmosphere.

If part of the mortality on the Earth's surface is caused by solar alpha particles, then on their path to the surface they create an increased concentration of ions (condensation nuclei) in the lower troposphere as well. Fluxes of solar alpha particles are more frequent during the "rise" phase of solar activity (Figure 23).

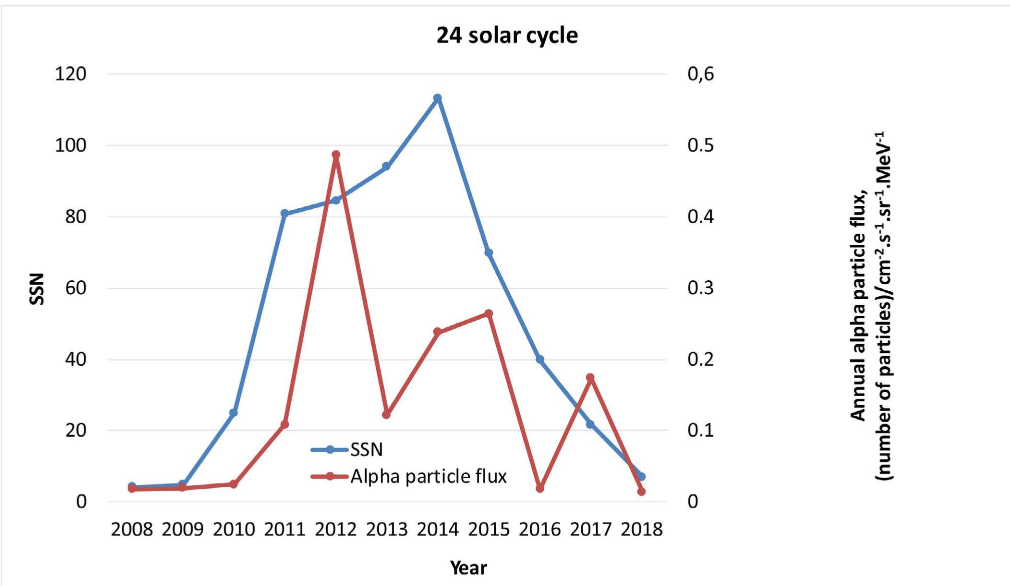

Figure 23. Annual alpha particle flux is about 20% higher magnitude during the phase "rise" than the phase "fall" of the last full (24th) cycle of solar activity.

The phenomenon decreases and even shows a trend of change towards a positive correlation for high mountain stations, *i.e.* it affects the low layers of the troposphere, below the high peaks, for which, as a result of the increased low cloud cover, the reflection from the upper surface of the clouds and the fogs below them increases. As a result of the increased number of condensation nuclei, daytime cloudiness is increased (the illuminated part of the atmosphere irradiated by solar ionizing radiation), and this increases the reflection of solar electromagnetic radiation from the upper surface of the clouds back into space. Less electromagnetic solar radiation reaches the Earth's surface during the day as a result of increased shading from additional cloud cover. The Earth's surface, absorbing electromagnetic radiation, heats up less, *i.e.* the ground air temperature is reduced. From the 19^{th} to the 24^{th} cycle, solar activity decreases. To the extent that the frequency of solar alpha particle fluxes is related to solar activity, especially during the "rise" phase, high-energy alpha radiation fluxes also decrease in frequency and intensity. As a result, daytime cloud cover decreases and more electromagnetic radiation reaches the Earth's surface, raising the temperature of the Earth's surface and surface air in the last decades of declining solar activity.

5. Discussion

At the moment, the dominant idea for the cause of the global warming of the surface air in the last few decades is the burning of fossil fuels, *i.e.* it is accepted as reliably established that global warming is caused by human activity. This idea offers hope for a possible solution to the problem if drastic measures are taken across the planet to limit the use of fossil fuels.

In the exposition above, the more pessimistic conclusion was drawn that the main cause of the rising temperature is solar activity. This conclusion takes away the hope that humanity can take measures to deal with the problem. Measures can be taken to adapt to the inevitable changes imposed by nature. To the extent that the level of development of human civilization does not allow it to influence the processes of the Sun, the efforts of humanity must be redirected from efforts to reduce greenhouse gases to measures to increase the reflectivity of the planet (e.g. by dispersing light-reflecting aerosols into the stratosphere).

What can be expected in the future?

Of course, it is not excluded that the natural processes will change a direction desired by humanity with the normalization of the temperature. There is nothing we as humanity can do to help such a change. Changes in temperature with a short-term nature of a few tens of years have also occurred in the recent past—for example, from the middle of the 17th century, for about 70 years, temperatures were lowered compared to previous years—the time interval is known as the "little ice age", supposedly also associated with changes in solar activity. The continued increase in global temperature, regardless of its cause, risks triggering an uncontrollable melting process of the polar and Greenland ice sheets, due to the absorption of more heat from the ever-larger areas of ocean and land freed from the ice—

i.e. so-called positive feedback between the decreasing ice areas reflecting light to space and the heat absorbed by the planet.

Some circumstances in connection with the described phenomenon—the inverse relationship between temperature and solar activity in the "rise" phase, remain unclear:

1) The phenomenon is not constant over time—it is observed only in the data for the last 90 years and for the stations for which this dependence is strongly emphasized.

2) It is unevenly distributed over the Earth's surface. It is most noticeable in Europe, especially in its southern part, and in the Mediterranean.

The possibility that the phenomena associated with solar alpha particle fluxes may have been manipulated for a reasonable reason is discussed in [21].

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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