

Global Warming – An Astronomical Phenomenon without Connection with Greenhouse Gases in Earth's Atmosphere?

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ABSTRACT

The now generally accepted paradigm points to greenhouse gases as the source of global warming, a significant part of which is anthropogenic, from the extraction and burning of fossil fuels and intensive agricultural production. The hope is that it is within humanity's ability to limit this biosphere-threatening process by regulating the mentioned activities. This article argues that processes on the Sun have partly or entirely caused global warming in the Earth's atmosphere over the past 70 years. Global warming is likely a consequence of streams of positively charged, high-energy particles emitted by the Sun, mainly during the "rise" phase of solar activity when the phenomena on the Sun's surface are associated with the growing magnetic field. Part of the flow of high-energy radiation reaches the Earth. It penetrates deep into the Earth's atmosphere, creating an increased content of ions that serve as condensation nuclei around which water vapor forms drops. Condensation nuclei increase cloudiness in the lower atmosphere. The upper surface of clouds and fog partly reflects electromagnetic solar radiation into space. It does not reach the Earth's surface, which leads to a decrease in the temperature of the surface and, hence, in the temperature of the ground air heated by the surface. When the solar activity decreases, as observed in the last 70 years, the reverse process occurs – the high-energy fluxes of corpuscular radiation decrease, the ionization of the air in the Earth's atmosphere decreases, the cloudiness decreases, more solar electromagnetic radiation reaches the Earth's surface and increases the temperature (Global warming). **Significance statement:** Global warming – what is this phenomenon threatening humanity, and can we fight it? It seems that humanity has accepted as true the answer that the phenomenon is due to the release of greenhouse gases, and if we stop emitting them, global warming will end. For this purpose, the world allocates about 3 trillion dollars annually. Are these funds being directed correctly? The answer in this article is negative – the phenomenon has a natural cosmic origin, and its consequences can be mitigated through measures different from those applied so far.

Keywords: Global warming, Climate change, Solar cycle, Ionizing radiation, Satellite data.

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. (IPCC, 2024)"

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

In the present work, the author argues that global warming over the last 70 years has been partially or entirely caused by changes in high-energy, positive corpuscular radiation emitted mainly in the “rise” phase of the 11-year solar activity cycle. Deep in the Earth’s atmosphere, this radiation increases air ionization and, as a result, increases cloudiness (ions are condensation nuclei). Solar activity has gradually decreased in recent cycles, decreasing emitted ionizing radiation, which leads to reduced cloudiness. Less cloudiness means more solar electromagnetic radiation reaching the Earth’s surface and higher surface temperature.

MATERIAL AND METHODS

In connection with the described study, three 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, mainly diseases, supposedly dependent on said solar radiation. The joint study of the three data types allowed a conclusion to be drawn as to the cause of an invisible chain of interconnected phenomena, to which, in the author’s opinion, global warming is also connected.

Temperature Data

The temperature data for the Stara Zagora climatic station (latitude/longitude 42.42°N/25.64°E, elevation 168 m), Bulgaria, is analyzed below. The choice of the station is based on its proximity to major sources of greenhouse gases and the long-term (126 years) accurate reporting of temperature data at the station (Takuchev 2025, Takuchev 2025a). The city of Stara Zagora is a significant source of greenhouse gases. In the vicinity of the station, about 40 km southeast of it, is located a power source of greenhouse gases emitting in the air – the “Maritsa-Iztok” energy complex covering an area of 240 km² (2.5 times the area of Paris, France). The complex has an open-pit coal mine and four thermal power plants (TPPs) around it with a total power of 3 GW. The complex has been operating since 1977. Data on relative humidity (in %) and precipitation (in mm, or which is the same l/m²) for the Stara Zagora climatic station were also analyzed.

The ground air temperature data for the other analyzed stations from the rest of the world used in the study are from the NOAA website, National Climatic Data Center, in the Global Historical Climatology Network Daily (GHCNd) database (NOAA, 2024a). 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.

The number of tropical cyclones depends on the degree of warming of the ocean water. Data on North Atlantic tropical storms were obtained from Colorado State University CSU Tropical Weather & Climate Research, Forecast Archive (CSU, 2024).

Data on global temperature anomalies for the land surface were obtained from NOAA National Centers for Environmental Information, Climate at a Glance: Global Time Series, retrieved in 2024 (NOAA, 2024b). Global land surface temperature anomaly is calculated by year as the difference (in K) between the annual mean global land surface air temperature and the global mean land surface air temperature for the hundred-year interval, 1901-2000.

Solar Activity Data

The solar magnetic field changes cyclically with a period of about 22 years. Within a 22-year cycle, solar activity changes twice for about 11 years (solar cycle). Solar activity has been monitored regularly through the Sun Spots Number (SSN, Solar Index) for over two and a half centuries. 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 five cycles (from the 18th to the 23rd, 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 (NOAA, 2024; Royal Observatory of Belgium, Brussels, 2024).

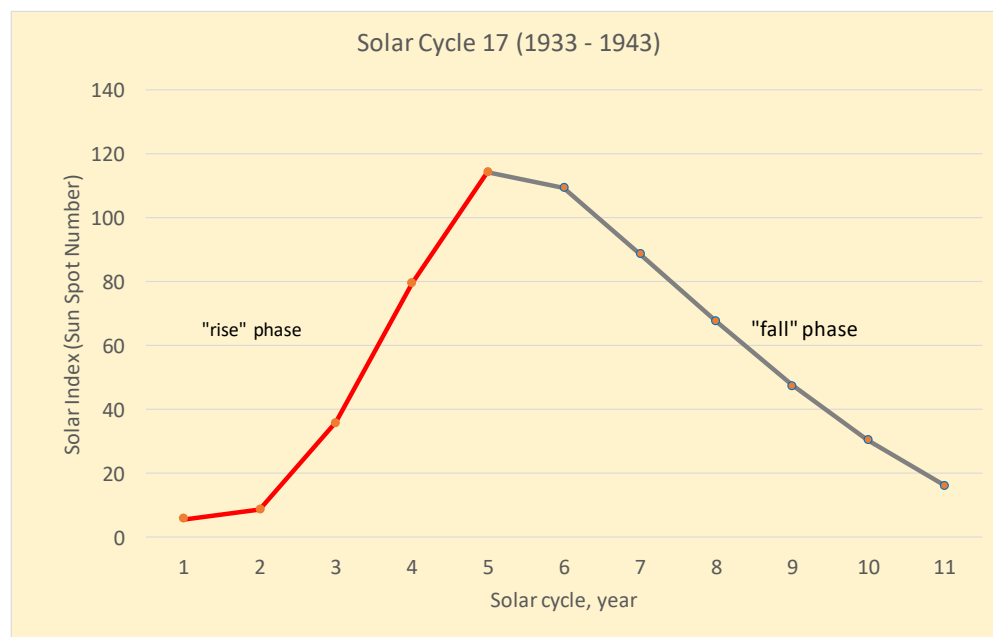


Figure 1: A solar activity cycle in the example of solar cycle 17 (chosen for its typical shape). During the first phase of the cycle, solar activity increases and reaches a maximum (the largest number of sunspots). Then, during the second phase, the activity decreases to a minimum before the start of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

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 a site, NOAA, 2024b.

The SMS and GOES series satellites fly in geostationary orbit (above the Earth's equator) at 36,000 kilometers above the Earth's surface, making one lap in 24 hours. They "hang" over a specific point on the Earth's surface and are not shaded by the Earth at their circumference around it. Data on alpha-particle and proton fluxes (unit: (number of particles).cm⁻².s⁻¹.sr⁻¹.MeV⁻¹) with energies in the range 3.8 – 21.3 MeV (detectors' channels A1 and A2) were used. The fluxes were recorded by the satellite high-energy particle detectors: 1. Energetic Particles Sensor (EPS), 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.

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 NASA, 2024.

Mortality Data by Place and Cause of Death

The analysis below is based on the authoritative sources of health data – EUROSTAT (EUROSTAT, 2024). The parameter annual mortality rate – number of deaths per 100,000 inhabitants – was used as a mortality characteristic in the study. 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 92 groups, mostly diseases, were used in the study. The groups are related to the International Disease Classifier ICD-10 (10th revision) classes. 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. For each of 377 European regions (NUTS-2) and each of the EUROSTAT shortlist groups, annual mortality rate data were extracted for the interval 2011 – 2019 (the last pre-pandemic year).

Data Processing

For each of the hundreds of meteorological stations on the surface of the planet with sufficient length of annual mean temperature data (24th solar cycle and no less than four consecutive solar cycles back in time (from 1933 to 2018)), mean surface air temperatures were calculated for the years of solar activity phase "rise" (Figure 1). When the length of the temperature data series for a given station was five consecutive solar cycles, the correlation coefficient was calculated from the data for the five cycles. When the series was longer than five solar cycles, the maximum correlation coefficient calculated for each length after the fifth cycle was taken

as the result. For example, for a station with a temperature data length of eight solar cycles, the correlation coefficients were calculated for series lengths of five, six, seven, and eight cycles. The data series length for the maximum of these coefficients was chosen.

The typical consecutive temperature data length for the stations included in the study was six solar cycles. The maximum length was eight cycles. The obtained mean temperatures for each station were compared with the corresponding series of mean SSNs for the phase “rise” of the same cycles. Correlation analysis (Lakin, 1990) was used for data processing. The correlation coefficient indicates the degree of connection (a causal relationship) between two variable processes. If the processes are synchronously changing in the same direction, they are positively correlated, to a greater extent, the closer to +1.000 the correlation coefficient is. The processes are negatively (inversely) correlated if they are synchronously changing in opposite directions, to a greater extent, the closer to -1.000 the correlation coefficient is. A correlation coefficient close to 0.000 indicates a lack of connection between the two processes. The correlation coefficient between the two series of values, 1. mean temperatures and 2. mean SSNs, was calculated to assess whether there is a causal relationship between the solar activity phenomena and surface air thermal changes for a given station.

In mathematical statistics, the *level of statistical significance* (Lakin, 1990) 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 example, for the eight solar cycles (the maximum consecutive data length for temperature), a minimum correlation coefficient of 0.708 (or -0.708 for negative correlation) corresponds to a statistical significance level of 0.05, a minimum correlation coefficient of 0.835 (or -0.835) corresponds to a statistical significance level of 0.01, and a minimum correlation coefficient of 0.925 (or -0.925) corresponds to a statistical significance level of 0.001 (Lakin, 1990).

In scientific studies, a level of statistical significance of no more than 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, i.e., 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 eight solar cycles.

The *coefficient of determination*, 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, can be calculated using the statistical method of regression analysis. 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 process effect. Suppose the dependence between two variables is linear, and the value of the coefficient of determination is close to unity. In that case, the dependence is close to deterministic; the effect is influenced by only one cause, and no independent cause 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, particularly greenhouse gases in the air. Of course, the hypothetical possibility remains that solar activity is related to the emission of greenhouse gases. Still, such a hypothesis should explain why their concentration has increased with the decreasing trend of solar activity in the last few decades.

RESULTS

Of the stations included in the study, 812, i.e., 93%, had a negative correlation between temperature and SSN during the “rise” phase (Figure 1) of the last five solar cycles. Of these, 321 stations had statistically significant correlations (significance level at least 0.05). Of these, 163 stations had statistically significant correlations between -0.900 and -1.000 (significance level at least 0.05). Most often, maximum statistically significant negative correlations were obtained in six continuous cycles (171 cases). The number of statistically significant negative correlations quickly decreases with the increase of the series of cycles’ length, reaching a length of up to 8 cycles. There are also stations (7%) for which this phenomenon is barely noticeable or not observed. The phenomenon is observable worldwide. Figure 2 shows the change in global land temperature anomaly (NOAA, 2024c) for the last six cycles of solar activity “rise” phases. The figure shows that the above-discussed inverse correlation with SSN for the “rise” phases of the last six solar cycles also holds for the global surface air temperature over the entire landmass of the planet, but the correlation is statistically insignificant. The figure also shows that for the last four cycles of solar activity, from the 21st to the 24th, the mentioned negative correlation of -0.958 becomes statistically significant at the significance level of 0.05.

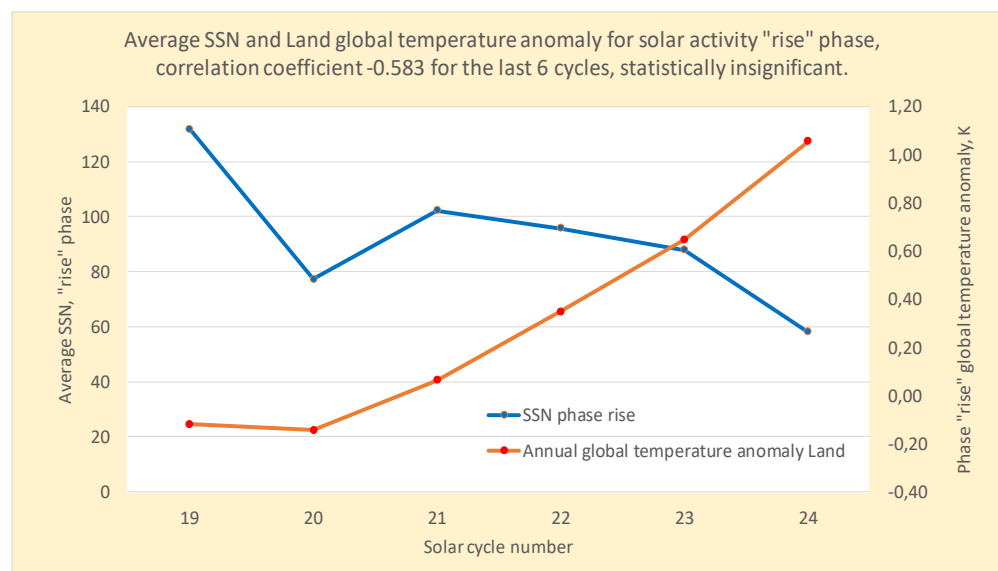


Figure 2: For the surface air temperature anomaly on land, there is also an inverse relationship with SSN for the “rise” phase of the last six cycles of solar activity, i.e., the phenomenon discussed above covers all land on the planet.

The number of tropical cyclones depends on the degree of warming of the ocean water. Figure 3 shows the change in the number of named Atlantic tropical cyclones (with wind speed above 61 km/h or 33 knots) and solar activity in the „rise“ phase, with a correlation coefficient (-

0.934), statistically significant at the 0.05 level (CSU, 2024). The dependence shows that the increasing ocean temperature is related to the decreasing solar activity during the last few cycles.

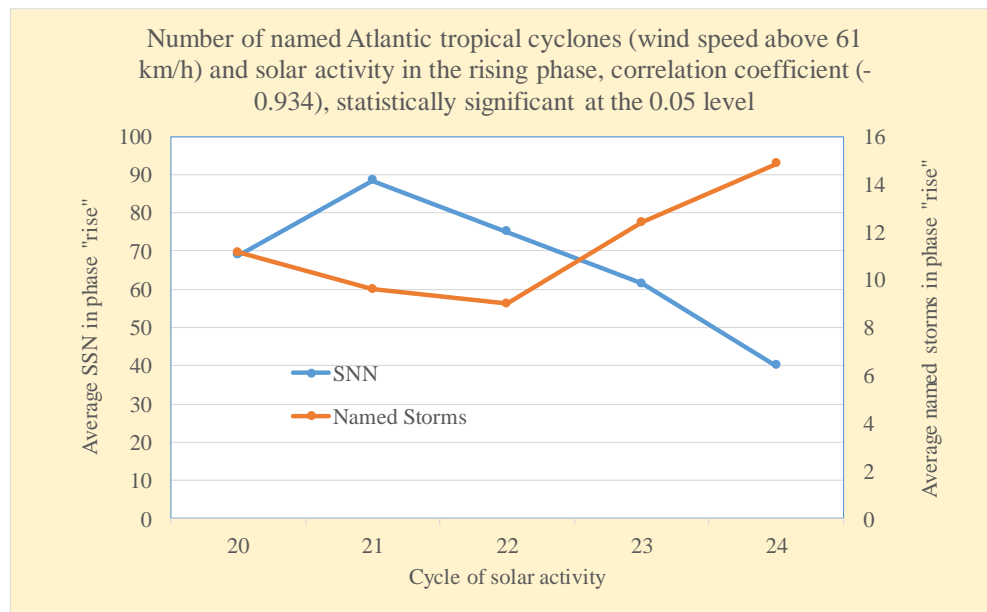


Figure 3: The increasing ocean temperature depends on the decreasing solar activity over the last few cycles.

Sufficiently long temperature data are available mainly for Europe. Figure 4 shows on a Google Earth map the location of stations included in the study with very high statistically significant correlations between -0.900 and -1.000 in Europe and Africa.



Figure 4: The stations with the correlation between surface air temperature and SSN for the phase "rise" of the solar cycles, with coefficients between -0.900 and -1.000.

The example below is for the Stara Zagora meteorological station in Bulgaria, located near the power sources of greenhouse gas emissions in the air. Figure 5 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 “rise” phases for the same cycles of solar activity. A high negative statistically significant correlation between the two data series indicates 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. Due to the decreasing trend in SSN values over the last six cycles and their negative correlation with air temperature, the surface air temperature for the Stara Zagora region has been increasing in recent years.

This phenomenon is observed at each station of the meteorological set in Bulgaria. Air temperature data for some of them are included in the GHCNd database NOAA, 2024a.

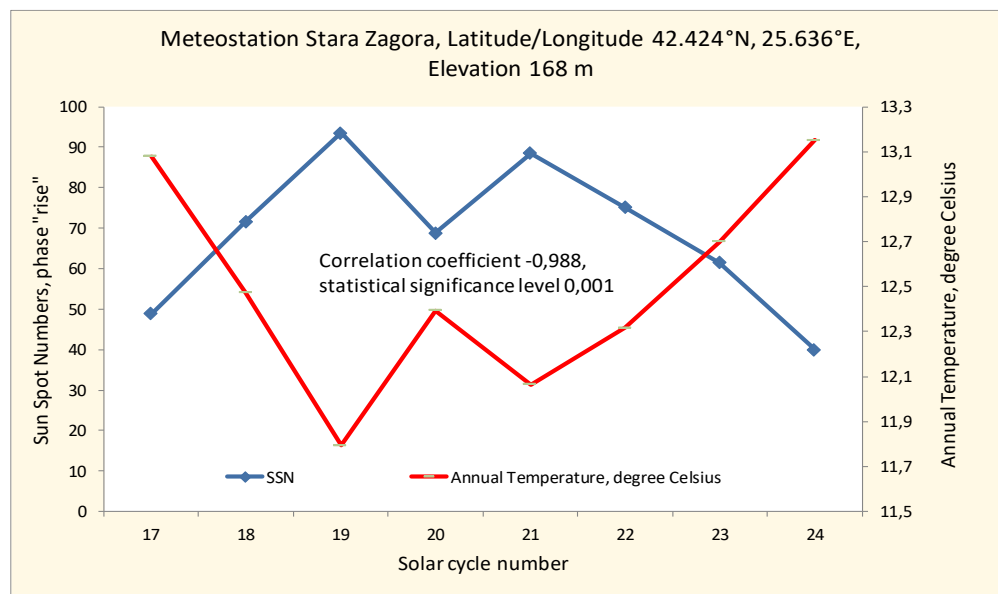


Figure 5: There is a highly statistically significant negative correlation between the mean surface air temperature for the weather station STARA ZAGORA, BULGARIA, and the mean value of the number of sunspots during the phase “rise” of the last eight solar activity cycles (Takuchev 2025, Takuchev 2025a).

Relative air humidity is inversely correlated with air temperature by definition. Figure 6 shows the dependence on time of the average values of SSN during the “rise” phase and their corresponding average values of the relative humidity of the air obtained from the same climatic station of Stara Zagora. 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 an inverse relationship between the air temperature and the SSN in the “rise” phase.

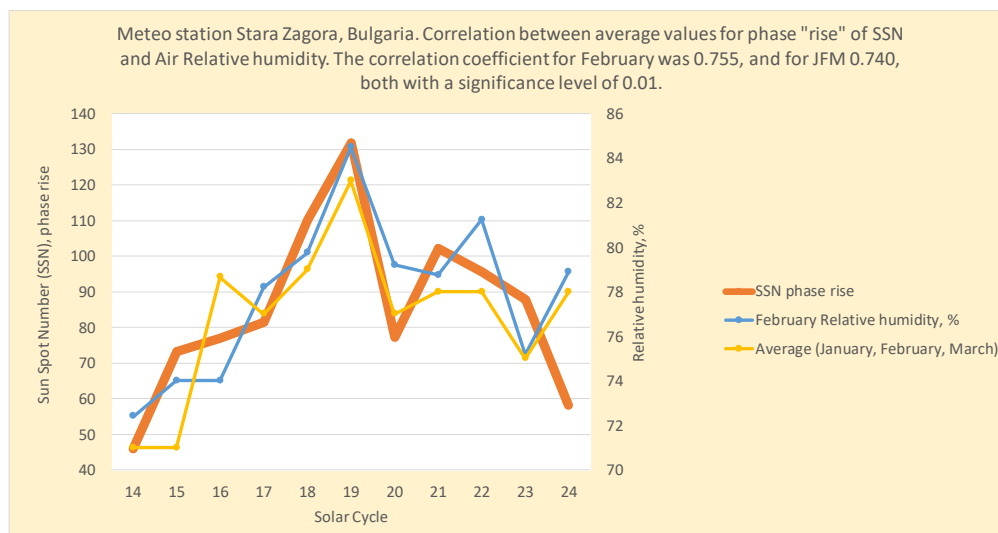


Figure 6: There is a statistically significant positive correlation between SSN in the "rise" phase and the relative air humidity measured over the years during the "rise" phases of the SSN in the meteorological station Stara Zagora, Bulgaria (Takuchev 2025, Takuchev 2025a).

The existence of a dependence between solar activity and air humidity implies the existence of a dependence between solar activity and precipitation, too. Figure 7 shows two time dependencies (curves) during the year (annual courses). One curve is the yearly precipitation trend for the city of Stara Zagora climatic station by month, averaged over 1899 – 2023. The other curve is the annual trend of the correlation coefficient between the precipitation for the Stara Zagora weather station and SSN, monthly averaged for the years with a "rise" phase for the last seven solar cycles 18 – 24. Between the two dependencies, there is a statistically significant correlation with a correlation coefficient of 0.731, statistically significant at the 0.01 level.

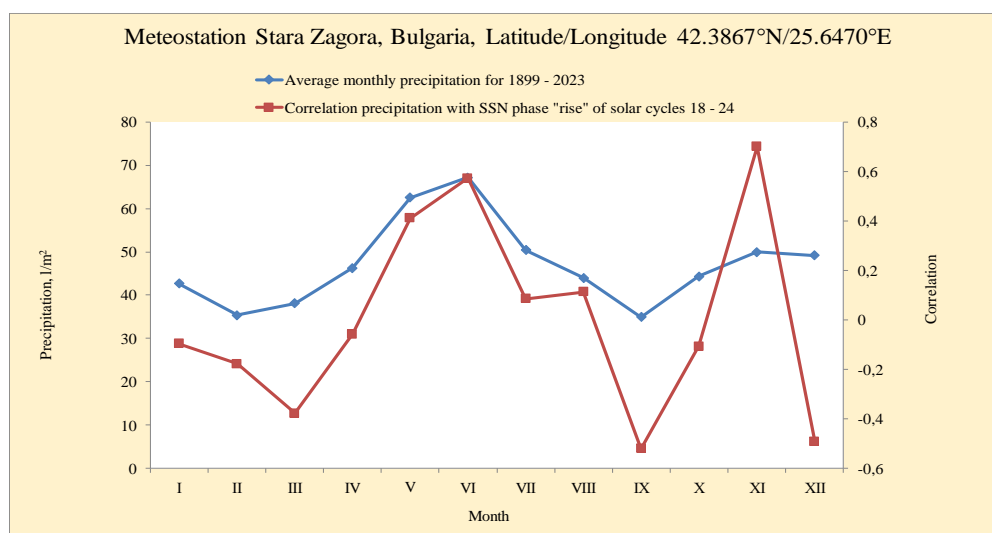


Figure 7: There is a statistically significant correlation between the annual course of precipitation and its correlation coefficient for the "rise" phase of the solar activity cycle for the last seven cycles (Takuchev 2025, Takuchev 2025a).

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 8). 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.

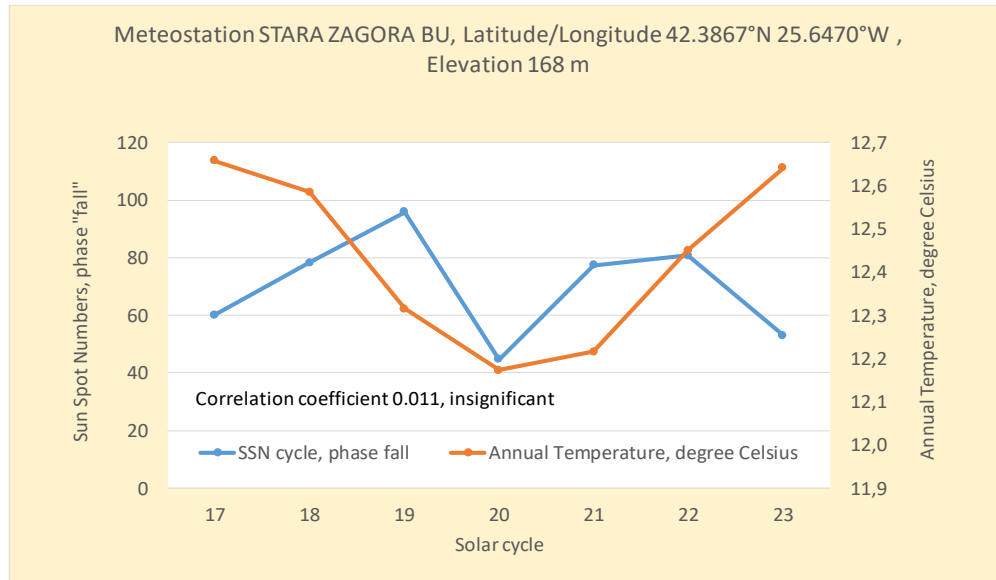


Figure 8: There is no statistically significant correlation between the mean surface air temperature for the climatic station STARA ZAGORA, BULGARIA, and the mean number of sunspots during the phase “fall” of the last seven solar activity cycles (Takuchev 2025, Takuchev 2025a).

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 the SSN has been decreasing over the past few cycles of solar activity.

Figure 9 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, the surface temperature has an almost deterministic linear dependence due to a single cause – the solar activity characterized by SSN. The obtained result rejects the hypothesis of temperature dependence 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, where the air should contain more greenhouse gases released from the burning coal in the above-mentioned “Maritsa-Iztok” energy complex. Since in a region with a power source 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.*

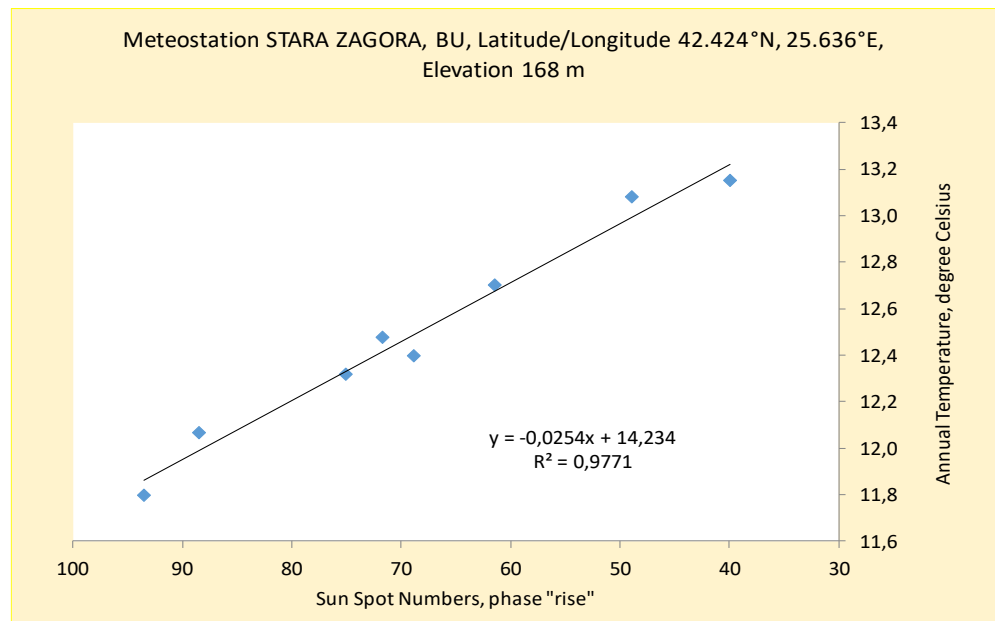


Figure 9: There is a linear relationship with a very high coefficient of determination between surface air temperature in the region of STARA ZAGORA, BULGARIA, and the number of sunspots calculated for the phase “rise” of the solar cycles included in the study (Takuchev 2025, Takuchev 2025a).

Average monthly data on the flux of solar electromagnetic radiation reaching the Earth's surface since 1980 have been obtained for the area with reference coordinates 20°E, 40°N, 30°E, and 50°N, covering part of the Balkans, where 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 clearly expressed (NASA, 2024). 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.m⁻² and 220 W.m⁻². The comparison between the average fluxes of electromagnetic radiation during the two phases showed 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 phase, i.e., it 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 instruments on the “Terra” and “Aqua” satellites (NASA, 2024). The data set covers only 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 – “rise” and “fall” 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 10). Increasing cloud shading during the daytime during the “rise” phase reasonably explains this phase's decrease in surface temperature. The increased cloudiness may be due to the increased number of condensation

nuclei in the atmosphere at the condensation level where the clouds form. 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 condensation nuclei around which water vapor forms droplets and, as a result, clouds.

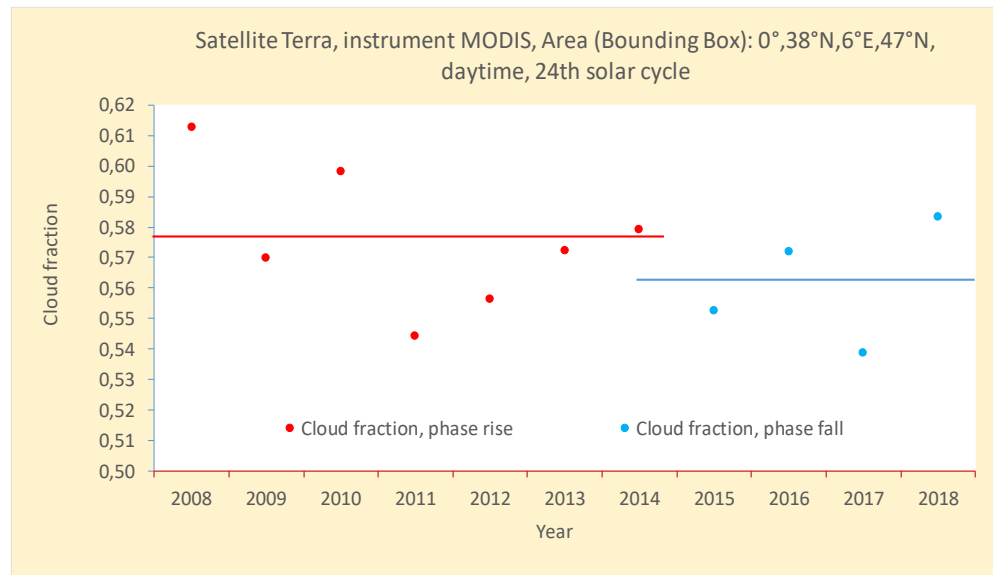


Figure 10: Daytime cloudiness over the western Mediterranean is about 1.5% more during the phase “rise” of the solar cycle than during the “fall” phase.

The GOES series satellite data show that the positively charged particles with high energy – protons and alpha particles, capable of ionizing the air, arrive from the Sun to the Earth (NOAA, 2024d). Most often, these particles do not penetrate deep into the Earth’s atmosphere to the ground layer 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, positively charged high-energy solar particles, i.e., with a high ionization potential, probably penetrate the atmosphere and even reach the Earth’s surface (Takuchev, 2019; Takuchev, 2021; Takuchev, 2023; Takuchev, 2023a; Takuchev, 2023b). The studies reveal 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 the penetration of the particles through the atmosphere to the Earth’s surface. The most affected are the inhabitants of Europe and the Mediterranean.

Figure 11 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 NUTS-2 European and Mediterranean regions. A region with increased mortality stands out over Eastern Europe, with a maximum over the Central Balkans.

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 yearly flux of solar alpha radiation for each region separately. The number of correlations is divided into three groups depending on their levels of statistical significance: most significant, less than 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.

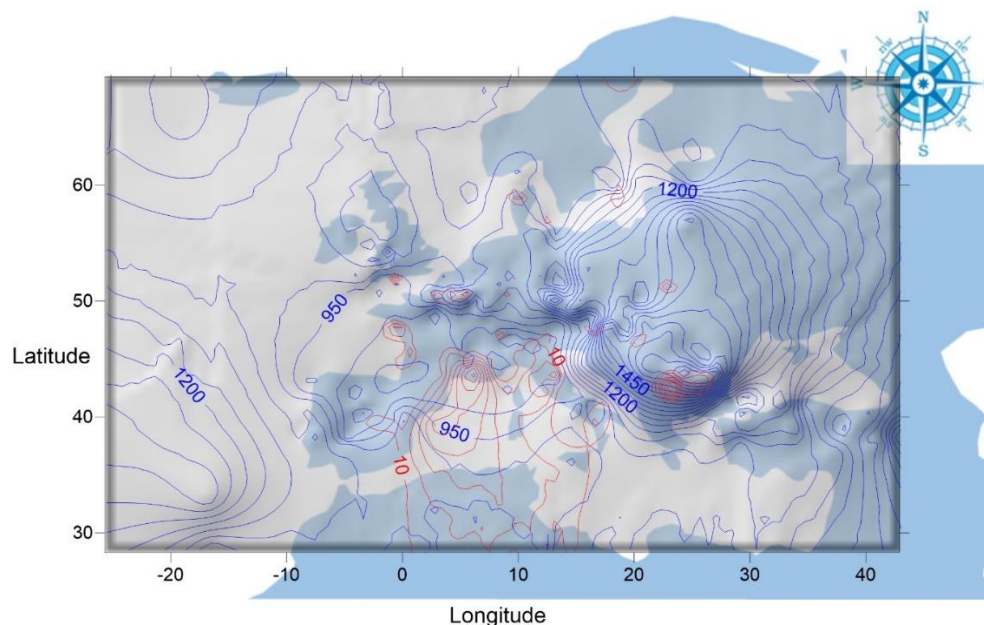


Figure 11: The main areas of influence of solar alpha radiation on mortality in Europe and the Mediterranean are the Balkans and, to a lesser extent, the Western Mediterranean. (Software Surfer 10).

Figure 12 gives an example of a strong correlation, indicating the presence of a cause-and-effect relationship between the annual mortality rate from the EUROSTAT shortlist cause “External causes of morbidity and mortality (V01-Y89)” and the annual flux of solar alpha radiation.

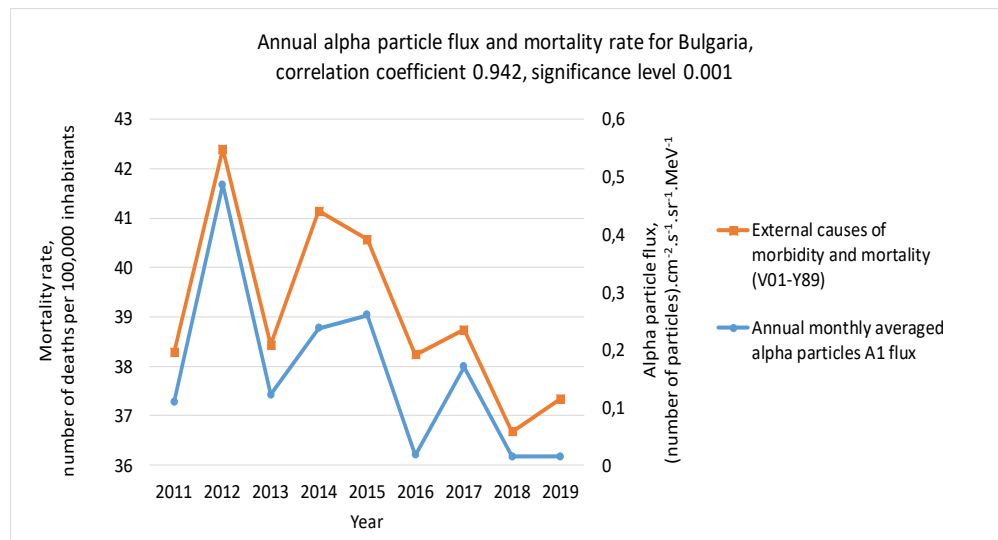


Figure 12: There is a highly statistically significant correlation between the annual flux of solar alpha particles with high energy and the mortality from external causes of death in Bulgaria. I.e., there is very likely a causal relationship between the two phenomena.

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 both increased cloudiness and human mortality with the impact of high-energy solar alpha particles (Takuchev, 2019; Takuchev, 2021; Takuchev, 2023; Takuchev, 2023a; Takuchev, 2023b)

1. An **observed phenomenon** – in the statistics of several countries located mainly in the 30°N – 50°N band, mortality from many diseases, primarily those of the circulatory system, is strongly correlated with flows of positively charged particles with an energy of the order of 4 – 21 MeV, recorded by the SMS and GOES series satellites in Earth orbit. The recorded alpha particle flows are mostly pulses that last a few minutes to a few days.
2. **Proposed hypothesis** – positively charged particles with high energy penetrate the Earth's atmosphere and reach the Earth's surface, where they damage human health, to the greatest extent, the human circulatory system, causing death, mainly in older adults with an already damaged circulatory system.
3. As the average altitude of the affected countries increases, the particle flux-correlated mortality shows an increasing trend (Takuchev, 2021; Takuchev, 2023a). It is probably due to the more intense positively charged particle flux penetrating the thinner atmosphere over the mountainous region of Earth's surface – an argument favoring the hypothesis.
4. The source of the flows of positively charged particles is the Sun – mortality increases with observable processes on the Sun's photosphere – from Solar Mass Ejections and flares directed to Earth (phenomena on the solar surface that could be observed with other astronomical means) (Takuchev, 2021; Takuchev, 2023a). 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 (Cosmic Rays, 2024) 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 (Figure 12). 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.

5. Positively charged solar particles capable of penetrating the Earth's atmosphere to the Earth's surface are high-energy alpha particles. Calculators PSTAR (PSTAR, 2023) and ASTAR (ASTAR, 2023) 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 (Takuchev, 2021) 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 protons above 0.7 GeV by GOES satellites. Still, there are registered alpha particle fluxes with energy above 3.4 GeV, hypothetically also those with energy above 6.2 GeV (Takuchev, 2021; Takuchev, 2023a), i.e., the particles that penetrate the Earth's surface are probably high-energy alpha particles. Only registered fluxes of alpha particles with a high enough magnitude of at least (hundreds of particles). $\text{cm}^{-2} \cdot \text{s}^{-1} \cdot \text{sr}^{-1} \cdot \text{MeV}^{-1}$ is correlated with the mortality of the Earth's surface.
6. 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 the GOES satellite registration. And its latitude, from the date of registration.
 - 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 (Takuchev, 2021). For latitudes outside this band, such a coincidence is impossible, fast alpha particles do not reach the Earth's surface (but can still ionize the air), which explains why no correlation is observed between alpha radiation fluxes and mortality from circulatory system diseases in countries near the North Pole.

The described hypothesis also explains the positive correlation between solar activity and precipitation, as shown in Figure 7.

The positive correlation between solar activity and precipitation is maximal in May-June when:

1. The Sun is at its upper culmination (at noon), i.e., the atmosphere is the thinnest for intruding streams of ionizing solar particles. For Stara Zagora, the maximum solar culmination is 66.12° on June 21st (ASTRONOMICAL CALENDAR, 2023).
2. The direction of the intruding particles is close to the inclination of the geomagnetic induction. For Stara Zagora, the geomagnetic induction is directed from south to north, entering the Earth's surface at an angle of 58.72° (Takuchev, 2021; ASTRONOMICAL CALENDAR, 2023). The coincidence of the upper solar culmination for Stara Zagora, with the inclination of the geomagnetic vector, is on May 4 (Takuchev, 2021; ASTRONOMICAL CALENDAR, 2023). When the direction of particle invasion coincides with the inclination of the geomagnetic induction vector, the particles are not acted upon by a force deflecting their direction of motion. They penetrate the atmosphere and ionize atmospheric gases, contributing to the local precipitation.
3. The positive correlation between solar activity and precipitation in November, coinciding with the November precipitation maximum (Figure 7), can be explained by fluxes of ionizing solar particles impinging on the same latitude at the appropriate angle around solar lower culmination (midnight). Some of the solar particles of the November streams pass along the Earth and are swirled by the Earth's magnetic field in the opposite direction, entering the night side of the Earth's atmosphere. The return stream arrives at midnight for specific locations on the Earth's surface. If, for a particular point, the geomagnetic induction inclination coincides with the lower solar culmination, similarly to during the day at local noon, favorable conditions are created for the penetration of solar particles deep into the atmosphere above this point of the Earth's surface, i.e., conditions are created for increased nighttime cloudiness and precipitation above that point. The coincidence of the lower solar culmination for Stara Zagora with the inclination of the geomagnetic vector is on November 8th (latitude for Stara Zagora (42.42°), solar declination on November 8th is (-16.3°) and their difference is equal to Inclination of the geomagnetic vector (58.72°) (ASTRONOMICAL CALENDAR, 2023). Combined with the low temperature at November midnight, favorable conditions for increased condensation and cloudiness are created. These conditions explain the high positive correlation with precipitation in November. Increased cloudiness at night also helps to trap longwave radiation from the Earth's surface in the lower atmosphere, which increases its temperature and contributes to global warming.

CONCLUSION

A high negative correlation between the average Sun Spot Number in phase "rise" in the 11-year solar activity cycle and the annual average Earth's surface temperature was observed in the data from several meteorological stations, 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. Once initiated as a result of declining solar activity over the past few decades, the global warming process has the potential to be self-sustaining, evaporating into the surface atmosphere more water than the warmer atmosphere retains for longer, and water vapor is a major greenhouse gas with the potential to increase global

warming. As discussed above, the contribution of other greenhouse gases in the Earth's atmosphere to this process is small or negligible.

If solar alpha particles cause part of the mortality on the Earth's surface, then on their path to the surface, they also create an increased concentration of ions (condensation nuclei) in the lower troposphere. Fluxes of solar alpha particles are more frequent during the „rise“ phase of solar activity.

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), increasing the reflection of solar electromagnetic radiation from the upper surface of the clouds back into space. Due to increased shading from additional cloud cover, less electromagnetic solar radiation reaches the Earth's surface during the day, and less Earth's longwave electromagnetic radiation leaves the Earth's surface at night. The Earth's surface absorbs less electromagnetic radiation and heats less, i.e., lower ground air temperature. From the 19th to the 24th 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.

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 solar activity is the leading cause of the rising temperature. This conclusion removes 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. Humanity's efforts must be redirected from efforts to reduce greenhouse gases to measures to increase the reflectivity of the planet – a measure that would act in the direction of lowering the planetary temperature, regardless of the cause of global warming.

The phenomenon described is not constant over time; it has been observed only in the data for the last 90 years. The dynamics of the phenomenon's change over time can be traced through data on storms in the Atlantic Ocean. The frequency and strength of tropical storms depend on the warmth of the ocean waters. Figure 13 shows the dependence of the number of named tropical storms for the North Atlantic Ocean (the ocean with the longest series of temperature data) on the “rising” phase of the solar activity cycles. Their correlation coefficient becomes negative after the 15th cycle. Within the framework of the hypothesis presented above, during the “rising” phase of the 15th cycle and after that, cloudiness becomes dependent on the phase “rise” of solar cyclicity.

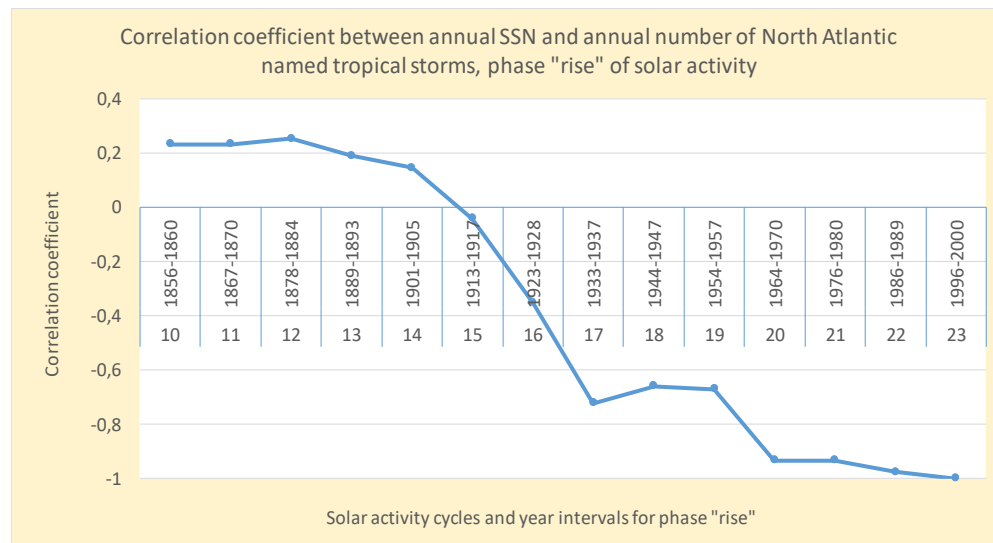


Figure 13: The correlation coefficient between the number of named tropical storms in the North Atlantic and the SSN during the “rising” phase of solar activity cycles becomes negative after the 15th cycle (CSU, 2024).

Acknowledgement

I express my deep gratitude to the thousands of colleagues around the world who participated in collecting the data on which the conclusions in this article were drawn.

Availability Statement

All information used in the article is freely available on the Internet on the official websites of the sources. Data for the climate station Stara Zagora, Bulgaria, were obtained under an agreement with Trakia (Thracian) University – Stara Zagora, according to which the university provides the terrain on which the station is located. In return, researchers from the university have free access to the climate data from the station and the right to use it in their research and publish the results.

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