Solar contribution to Earth's global warming?

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Abstract. Global warming is a phenomenon threatening humanity. Can we fight it? It appears that humanity has accepted the notion that the phenomenon is caused by the release of greenhouse gases resulting from human activity, and that if we cease emitting them, global warming will cease. To this end, the world allocates approximately $3 trillion annually. Are these funds being used correctly? The answer in this article is no – the phenomenon has a natural cosmic origin, and its effects can be mitigated by different measures than those used so far. A continuous series of air temperature data spanning decades is available from ground-based meteorological stations, primarily in Europe but also elsewhere. The study utilized data from over 800 stations worldwide. The combined analysis of two data series—ground temperature and Sunspot Number (SSN)—during the "rise" phase of the solar cycle reveals a high correlation between them, suggesting a possible link between Earth's global warming and a cosmic cause—a chain of solar phenomena. This changes the approach to mitigating global warming—we need to increase Earth's reflectivity. Data show that the processes in the Sun that led to today's global warming began during the 15th solar cycle.

Keywords: Global warming, climate change, solar cycle, solar corpuscular radiation, cloud formation

1 Introduction

In the Synthesis Report, "CLIMATE CHANGE 2023," Summary for Policymakers, in the first chapter titled "A. Current Status and Trends, Observed Warming and Its Causes," the authors from the Intergovernmental Panel on Climate Change (IPCC) state: "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 mentioned above has become the primary scientific paradigm on global warming.

In this work, the author argues that global warming over the past several decades has been partly or entirely caused by fluctuations in high-energy, positive corpuscular radiation, which is mainly emitted during the "rise" phase of the 11-year solar activity cycle. Deep in the

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Earth's atmosphere, this radiation increases air ionization, which in turn promotes cloud formation. Recent solar cycles have shown a gradual decline in activity, leading to decreased ionizing radiation and, consequently, less cloud cover. Reduced cloud cover allows more solar electromagnetic radiation to reach the Earth's surface, resulting in higher surface temperatures [2, 3, and 4]. In addition, the onset of global warming is discussed in the proposed work.

2 Material and Methods

In [2, 3, and 4], reliable data sources are cited, from which the information used in the article was collected and processed. The primary sources include globally recognized databases such as NOAA, NASA, EUROSTAT, and the US National Center for Health Statistics. Data was used for: 1. Surface temperature measurements from 872 stations worldwide, 2. The number of North Atlantic tropical storms, 3. Global land-surface temperature anomalies, 4. Solar activity data, 5. High-energy solar corpuscular radiation reaching Earth's orbit, 6. Day and nighttime cloud cover data, and 7. Mortality data in the human population, primarily related to diseases and supposedly dependent on solar radiation. The methods used for data processing in the analysis are also explained. The combined analysis of these data enabled the author to draw a conclusion about the cause of an invisible chain of interconnected phenomena, which, in the author's view, is also related to global warming.

3 Results

Of the 872 stations included in the study, 812, or 93%, exhibited a negative correlation between temperature and SSN during the "rise" phase of the last five solar cycles. Among these, 321 stations showed statistically significant correlations (at a significance level of 0.05 or less). Of these, 163 stations had statistically significant correlations with values below -0.900 (at the 0.05 significance level or lower). The strongest statistically significant negative correlations most frequently occurred across six consecutive cycles (171 cases). The number of statistically significant negative correlations decreases rapidly with increasing cycle count, reaching a maximum of 9 cycles.

The phenomenon can be seen worldwide. Fig. 1 shows the change in global land temperature anomaly (the difference between the global annual temperature and the global average land temperature for the period 1901-2000 [5]) during the last six cycles of solar activity "rise" phases.

The figure shows that the previously discussed inverse correlation with SSN for the "rise" phases of the last six solar cycles also applies to global surface air temperature across the entire landmass of the planet; however, the correlation is not statistically significant. The figure also indicates 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 0.05 level.

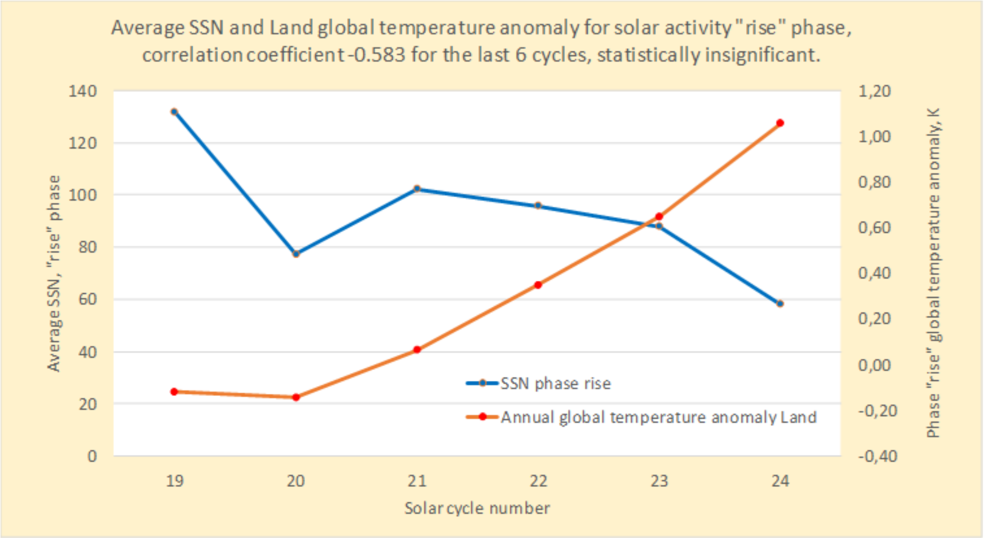

Fig. 1. For the surface air temperature anomaly on land, there is also an inverse relationship with SSN during the "rise" phase of the last six cycles of solar activity; in other words, the phenomenon discussed above applies to all land on the planet.

The examples below are from the Stara Zagora meteorological station in Bulgaria [6, 7], located near the energy complex "Maritsa-Iztok," which is the source of carbon dioxide air pollution. The station has a long, accurate record of surface air temperature data, dating back 126 years. Fig. 2 shows the relationship between the average annual surface air temperatures measured at Stara Zagora during the "rise" phases of solar cycles 17-24 (spanning 86 years) and the average annual SSNs during the same "rise" phases. A statistically significant negative correlation between these two data series suggests a causal relationship between temperature changes in the Stara Zagora region and solar activity. As solar activity increases within a given cycle, the temperature tends to decrease. Conversely, the rising surface air temperature in the Stara Zagora region in recent years can be attributed to the declining trend in SSN values over the last five cycles and their negative correlation with temperature.

This phenomenon is observed at every station in the Bulgarian meteorological network. Air temperature data from some stations are included in the GHCNd database [5].

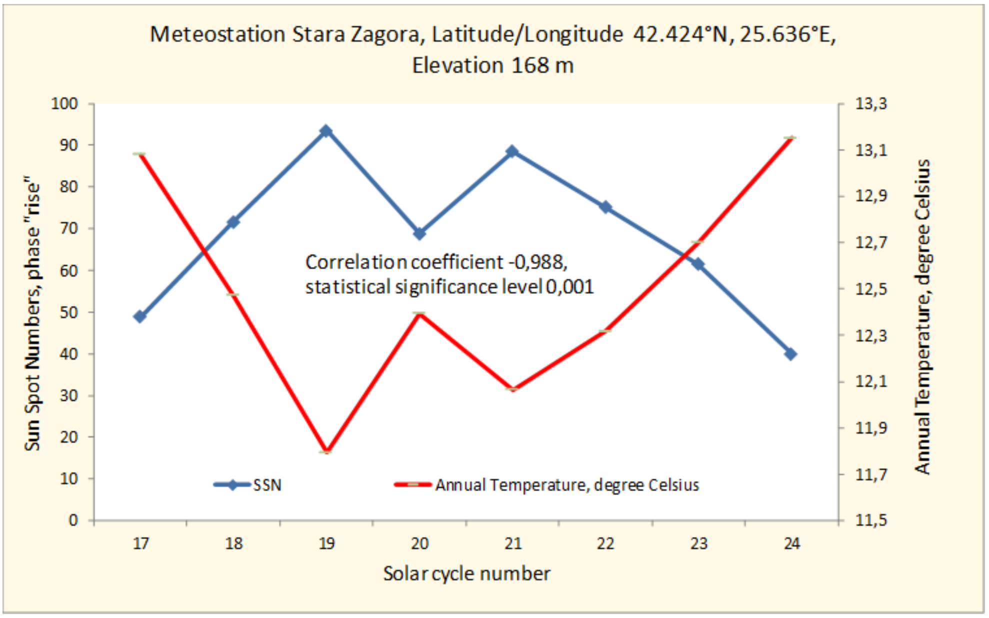

Fig. 2. There is a highly statistically significant negative correlation between the mean surface air temperature at the weather station STARA ZAGORA, BULGARIA, and the average number of sunspots during the "rise" phase of the last eight solar activity cycles.

Relative air humidity is inversely related to air temperature by definition. This means that if the relationship between SSN in the "rise" phase and temperature is an observable fact, then there should be a positive correlation between SSN in the "rise" phase and the relative surface air humidity measured at the same station over the years during these "rise" phases. Fig. 3 shows how the average SSN values during the "rise" phase change over time, along with the corresponding average relative humidity from the same weather station in Stara Zagora [6, 7]. The strong, statistically significant positive correlation between the air's relative humidity and SSN in the "rise" phase confirms an inverse relationship between air temperature and SSN during that phase.

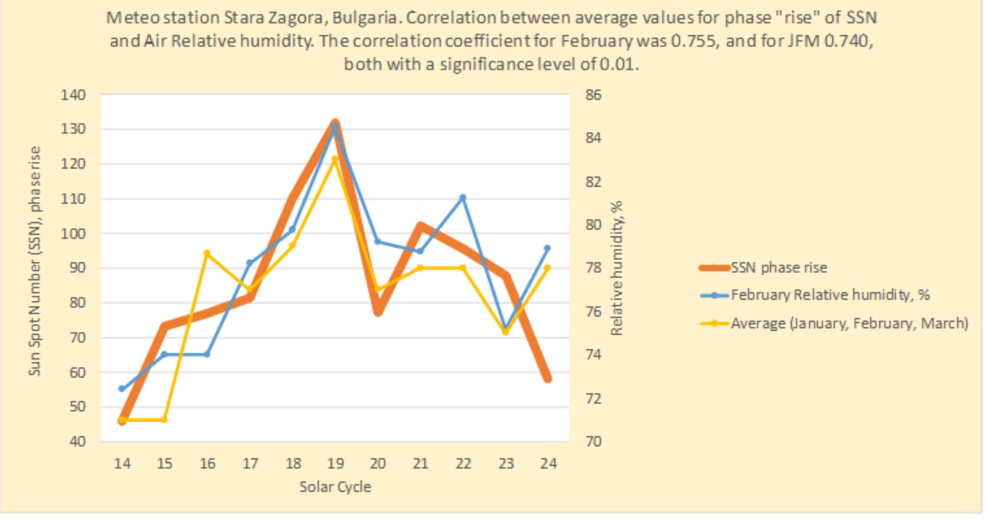

Fig. 3. There is a statistically significant positive correlation between SSN during the "rise" phase and the relative air humidity measured over the years during the "rise" phase of the SSN at the meteorological station in Stara Zagora, Bulgaria.

The dependence of solar activity on air humidity indicates a similar connection with precipitation. Fig. 4 shows the annual patterns of these relationships [6, 7]. One curve displays the yearly precipitation trend (in l/m^2 or in mm) for the Stara Zagora weather station in the city of Stara Zagora, averaged monthly from 1899 to 2023. The other curve depicts the yearly trend of the correlation coefficient between precipitation at the station and SSN, averaged monthly for the years with a "rise" phase during the last seven solar cycles (18–24). There is a statistically significant correlation between the two variables, with a coefficient of 0.731, significant at the 0.01 level.

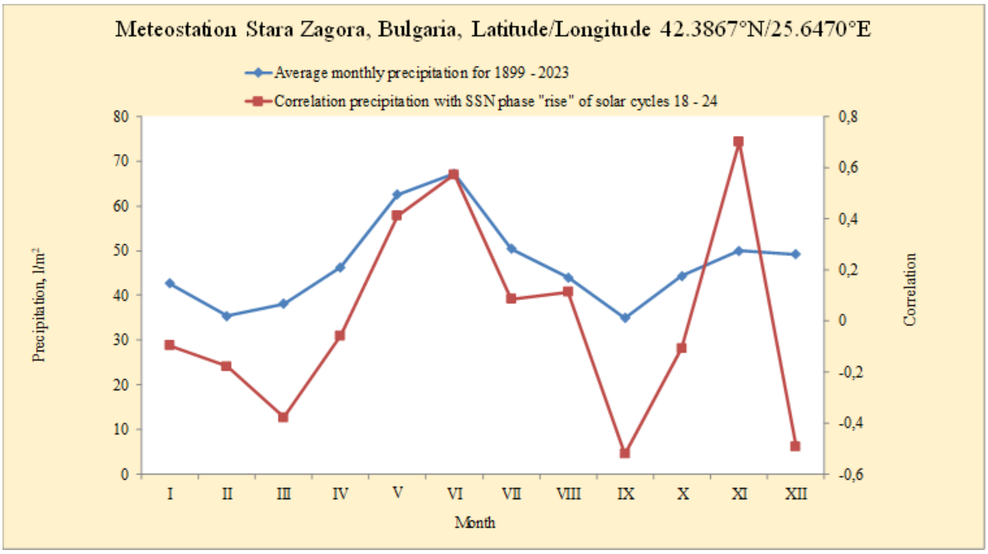

Fig. 4. There is a statistically significant correlation between annual precipitation and its correlation coefficient during the "rise" phase of the solar activity cycle for the last seven cycles.

There is no link between surface air temperature changes in the Stara Zagora area and SSN during the "fall" phase of the solar cycles studied. The temperature change during the "fall" phase of solar activity cycles is less than 0.5°C, while during the "rise" phase it varies almost three times as much, by 1.4°C.

It can be summarized that, over the past several decades, surface air temperature in the Stara Zagora region has been rising during the "rise" phase of solar cycles because:

• It is negatively correlated with SSN during the same phase.

• Additionally, SSN has been declining over the past few cycles of solar activity.

Fig. 5 shows how surface air temperature in the Stara Zagora region depends on the SSN during the 'rise' phase of the solar cycles included in the study. The relationship is linear, with a high coefficient of determination (R^2 = 0.9771, maximum = 1.000). As previously explained, the surface temperature exhibits an almost deterministic linear dependence primarily driven by a single factor—solar activity, as indicated by the SSN. The results challenge the hypothesis that temperature depends on greenhouse gas concentrations, at least in the Stara Zagora region. This is especially noteworthy because the area's air is likely more affected by carbon dioxide emissions from the nearby "Maritsa-Iztok" energy complex, which burns coal. Since, in an area with significant greenhouse gas emissions, their impact on air temperature increase appears minimal, this suggests that solar activity is the main, if not the only, driver of the global rise in air temperature over the past few decades. The phenomenon described is also observed at other weather stations worldwide, with varying frequencies. Several examples are given in [2, 3, and 4].

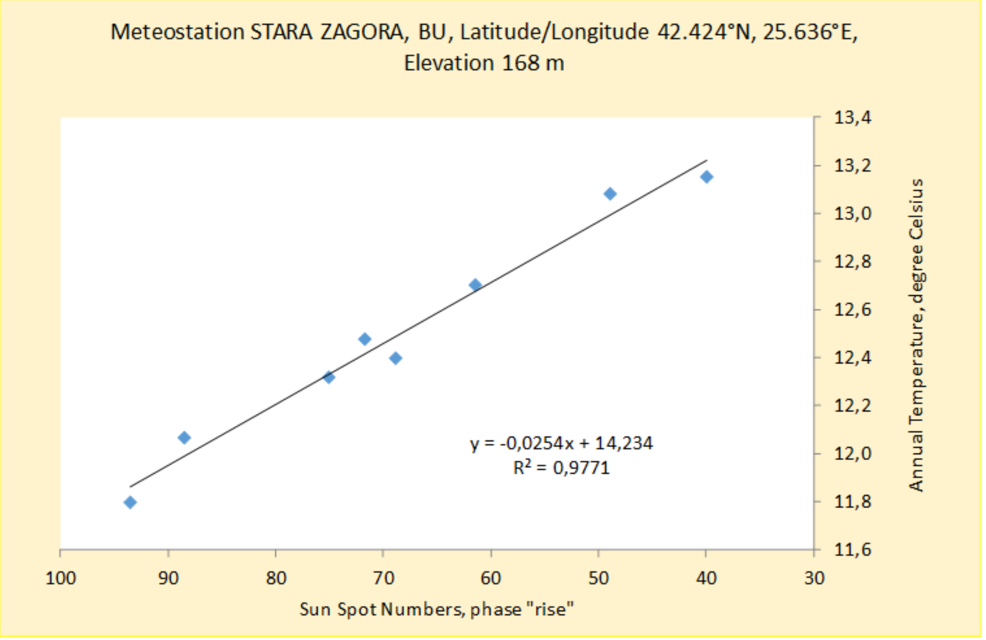

Fig. 5. There is a very strong linear relationship, with a high coefficient of determination, between surface air temperature in the STARA ZAGORA region, BULGARIA, and the number of sunspots, both calculated for the 'rise' phase of the solar cycles included in the study.

The number of tropical cyclones increases as ocean water warms. Fig. 6 shows the change in the number of named Atlantic tropical cyclones (with wind speeds above 61 km/h) and solar activity during the „rise“ phase, with a correlation coefficient of -0.934, which is statistically significant at the 0.05 level [8]. The relationship indicates that rising ocean temperatures are linked with decreasing solar activity over recent cycles.

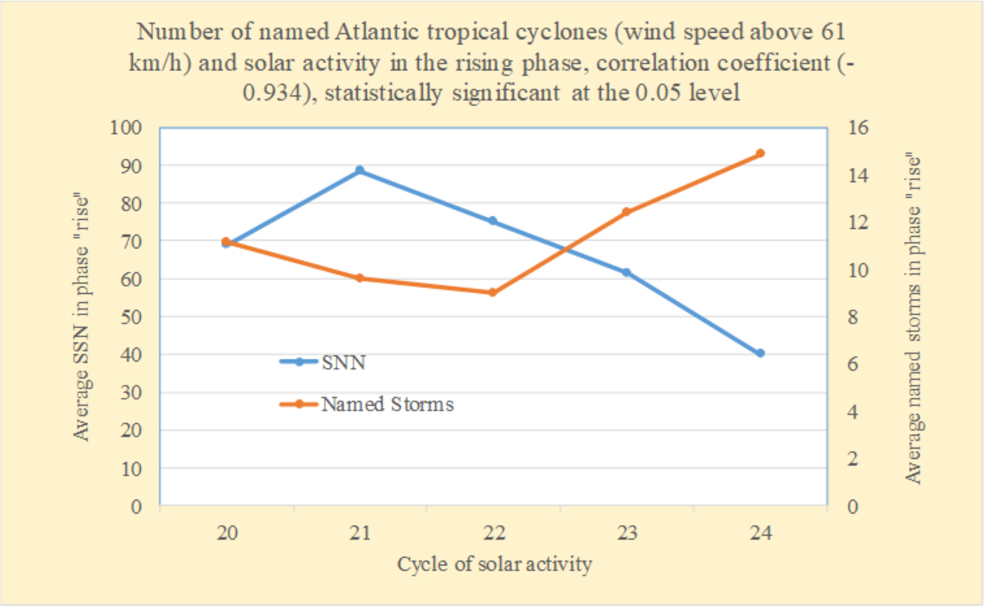

Fig. 6. The rising ocean temperature is connected to the decrease in solar activity during recent cycles.

In [2, 3, and 4], arguments are made that the decreasing surface temperature during the rise phase of the solar activity cycle is caused by a slight increase in cloudiness during this period (Fig. 7).

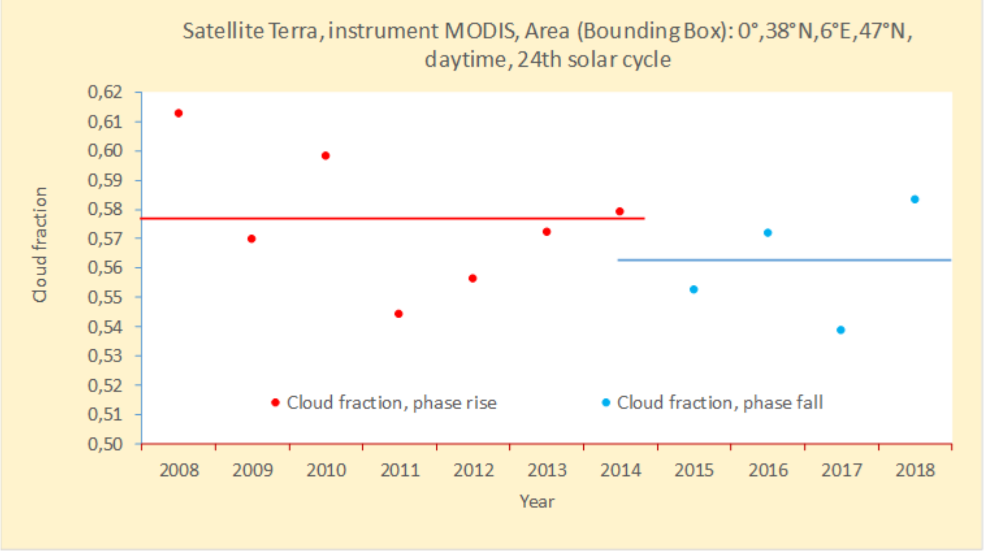

Fig. 7. Daytime cloudiness over the western Mediterranean is approximately 1.5% higher during the "rise" phase of the solar cycle than during the "fall" phase.

GOES satellite data indicate that positively charged, high-energy particles—specifically hydrogen and helium nuclei (protons and alpha particles)—capable of ionizing the air arrive from the Sun to Earth [9]. Usually, these particles do not penetrate deeply into the Earth's atmosphere to the troposphere, where clouds form, because of the deflecting effect of the Earth's magnetic field and energy losses during collisions with atmospheric particles.

However, a study shows that positively charged, high-energy solar particles — i.e., those with high ionization potential — are likely to penetrate the atmosphere and even reach the Earth's surface, thereby increasing human mortality. Figures 8, 9, 10, and 11 reveal a strong correlation, suggesting a possible cause-and-effect relationship between the annual and diurnal death rates for some of the deadliest causes and the yearly flux of solar alpha radiation [2, 3, and 4].

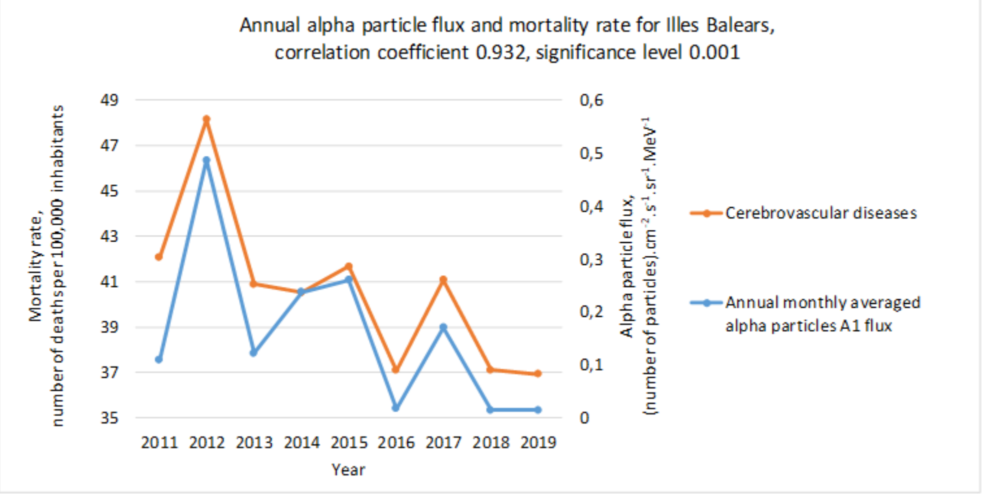

Fig. 8. There is a highly statistically significant correlation between the annual flux of high-energy solar alpha particles and cerebrovascular disease mortality in the Western Mediterranean, suggesting a likely causal relationship between the two phenomena.

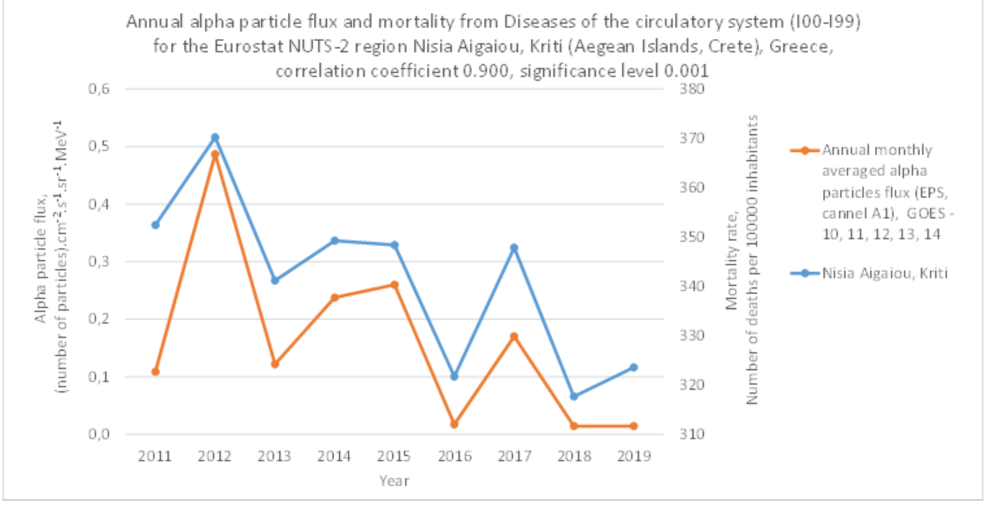

Fig. 9. There is a statistically significant correlation between the annual flux of high-energy solar alpha particles and mortality from circulatory system diseases in the Aegean Islands and Crete, Greece, suggesting that a causal relationship may exist between them.

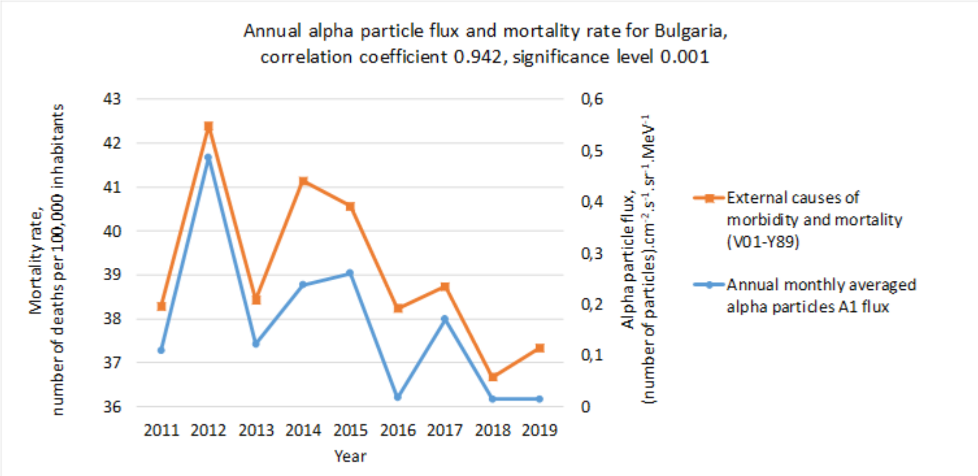

Fig. 10. There is a highly statistically significant correlation between the annual flux of high-energy solar alpha particles and deaths from external causes in Bulgaria. This suggests a very likely causal relationship between the two phenomena.

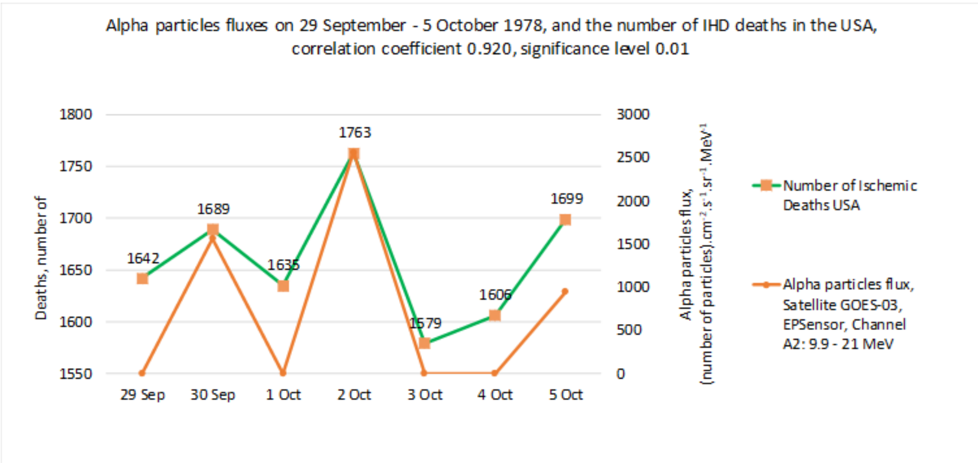

Fig. 11. There is a highly statistically significant correlation between alpha particle fluxes on September 29 and October 2, 1978, and the daily number of ischemic heart disease deaths in the USA.

In [2, 3, and 4], additional arguments are provided to support the hypothesis that the cause of death in the listed cases is streams of (so far unrecorded) solar alpha particles with very high energy. These particles can pass through the atmosphere, causing ionization that increases the number of condensation nuclei and, in turn, cloudiness.

The hypothesis also accounts for the positive link between solar activity and precipitation, as illustrated in Fig. 4.

The positive link between solar activity and rainfall is most pronounced in May-June when:

1. The Sun is at its highest point (at noon), meaning the atmosphere is the thinnest for incoming streams of ionizing solar particles. For Stara Zagora, the maximum angle is 66.12° on June 21, [10].

2. The direction of incoming particles aligns with the inclination of the geomagnetic field. For Stara Zagora, the geomagnetic field points from south to north and intersects the Earth's surface at an angle of 58.72° [10, 11]. The upper solar culmination for Stara Zagora coincides

with the inclination of the geomagnetic vector and occurs on May 4 [10, 11]. When the direction of particle influx matches the inclination of the magnetic field vector, the particles are not deflected by any force. They penetrate the atmosphere and ionize gases, contributing to local precipitation.

The positive correlation between solar activity and November precipitation (Fig. 4) can be attributed to the flux of ionizing solar particles hitting the same latitude at right angles around solar lower culmination (midnight).

During the day, positively charged particles emitted by the Sun in late autumn fall at an oblique angle to the Earth's surface due to the long path through the atmosphere and are significantly deviated from the inclination of the geomagnetic vector, which remains constant at the observation location (58.72° for Stara Zagora). This combination of factors prevents positive solar particles from penetrating deeply into the atmosphere and affecting cloud formation during the day.

Some solar particles from the November streams pass by 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 reaches the Earth around midnight (lower solar culmination) at specific locations on the surface. If, at a certain point, the geomagnetic induction inclination matches the lower solar culmination, similar to daytime at local noon, it creates favorable conditions for solar particles to penetrate deep into the atmosphere above that point. This increases the chances of more nighttime cloudiness and precipitation in that area.

The coincidence of the lower solar culmination for Stara Zagora with the inclination of the geomagnetic vector occurs on November 8th (*latitude for Stara Zagora* (42.42°) – *solar declination on November 8th* (-16.3°) equals *the inclination of the geomagnetic vector* (58.72°) [10, 11]. Combined with the low temperature at November midnight, favorable conditions for increased condensation and cloudiness are created. These conditions explain the strong positive correlation with November precipitation. Increased cloudiness at night also helps trap longwave radiation from the Earth's surface in the lower atmosphere, raising its temperature and contributing to global warming.

4 Discussion

The main explanation for surface air warming in recent decades is the burning of fossil fuels; it is widely accepted that human activity plays a significant role in global warming. This idea offers hope for a possible solution if strong measures are taken worldwide to cut fossil fuel use.

In the exposition above, a more pessimistic conclusion was drawn, suggesting that solar activity is the main driver of rising temperatures. This conclusion dampens hopes that humanity can take effective measures to solve the problem. Some steps can be taken to adapt to the unavoidable changes caused by nature. Since human civilization's level of development may not allow us to influence the Sun's processes, efforts should shift from reducing greenhouse gases to increasing the planet's reflectivity. Such a measure could help lower the Earth's temperature regardless of the cause of global warming, for example, by dispersing light-reflecting aerosols into the stratosphere.

Some aspects of the described phenomenon still remain unclear.

1. The described phenomenon is unevenly distributed across Earth's surface. A likely reason for this uneven spread is the historically inconsistent placement of weather stations on land, with the highest density in Europe. The later establishment of many stations and their early discontinuation before 2018 resulted in data series that are either too short or not comparable with those from European stations.

2. The phenomenon varies over time; it has only been observed in data from the last 90 years and at stations where the inverse relationship between temperature and solar activity's

"rise" phase is clearly evident. Figure 12 shows the moving average of SSN over a five-solar-cycle window plotted against the solar cycle number. The curve is mostly cyclical, with two peaks and two troughs. The approximate period between the two peaks is about 130 years. The moving average, using a five-solar-cycle window, of the correlations between temperatures and SSN during the "rise" phase is also included for three Central European stations with long data series. Notably, there is a sharp shift from positive to negative correlations around the solar activity cycle 15 "rise" phase (1913–1917), coinciding with the second increase of the SSN moving average. The temperature data series is too short to accurately track temperature behavior around the first maximum. The earlier hypothesis, suggesting increased cloudiness during the "rise" phase, becomes more valid after the 15th cycle. This raises the question: Did the emission of high-energy, positively charged particles from the Sun begin during the "rise" phase of the 15th solar cycle about a hundred years ago?

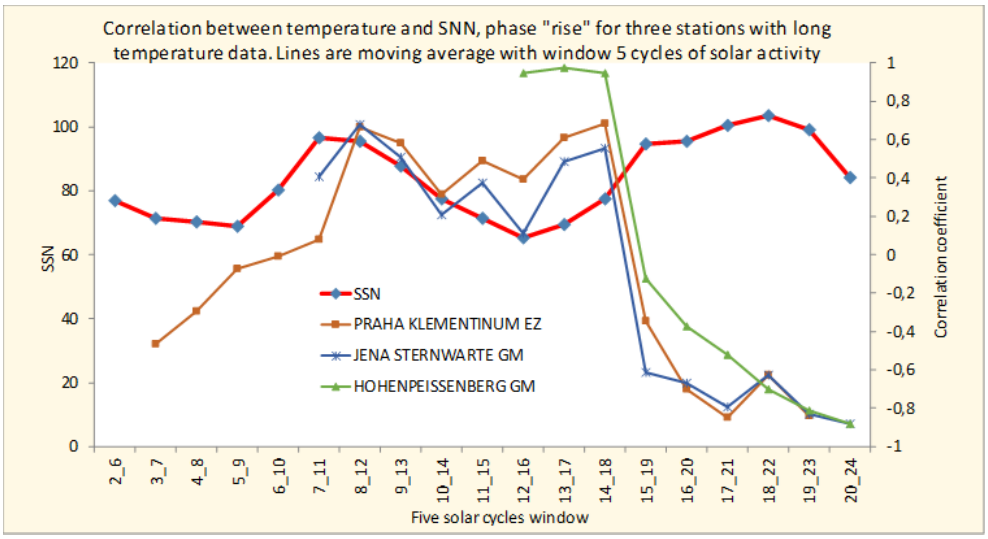

Fig. 12. The temperature at three stations with long data series in Central Europe is inversely correlated with SSN only during the last 90 years (from the 15th solar cycle) [5].

The precipitation at the stations shown in Fig. 13, which have long observation series, also shifts to a positive correlation coefficient with the SSN during the "rising" phase, after the 15th cycle of solar activity, when, according to the proposed hypothesis, cloudiness increases during the "rising" phase.

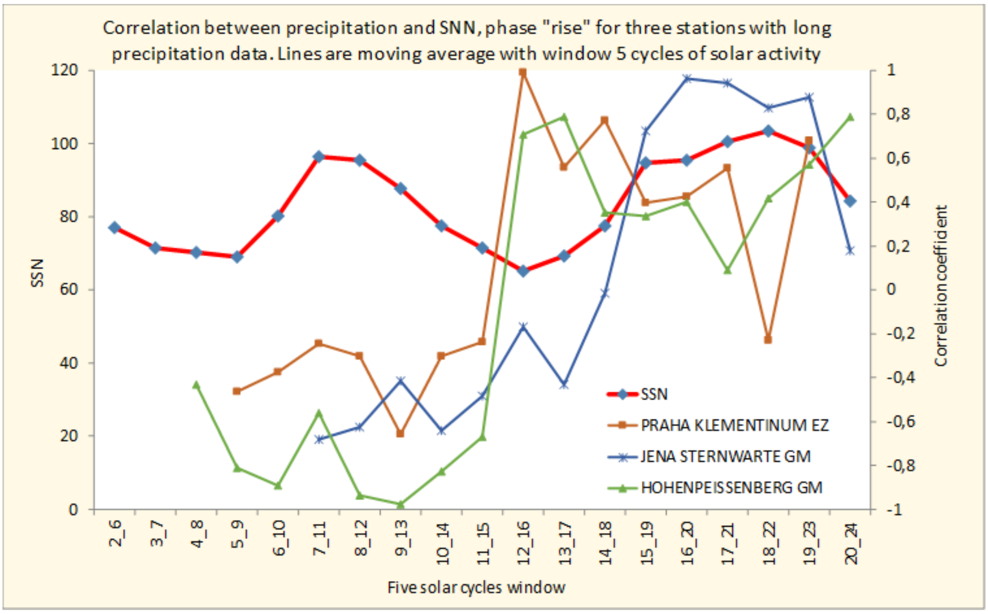

Fig. 13. The correlation coefficient between precipitation amount and SSN during the "rising" phase of solar activity cycles becomes positive after the 15th cycle [5].

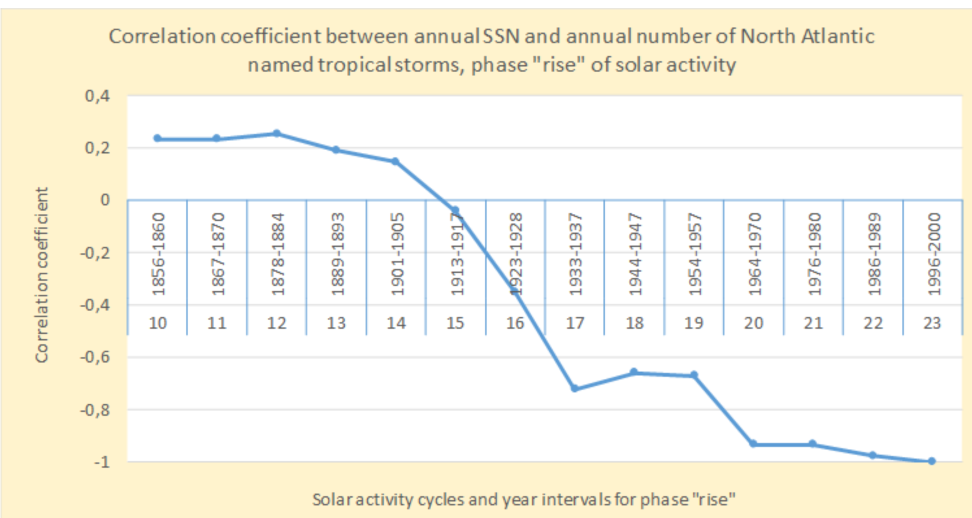

Fig. 14. The correlation coefficient between the number of named tropical storms in the North Atlantic and the SSN during the "rising" phase of solar activity cycles becomes negative after the 15th cycle [8].

The frequency and intensity of tropical storms depend on the warmth of ocean waters. Fig. 14 illustrates how the number of named tropical storms (with wind speeds over 61 km/h, 33 knots) in the North Atlantic Ocean—which has the most extensive set of temperature data—relates to the "rising" phase of solar activity cycles. The correlation coefficient between the number of named tropical storms and the SSN during the "rising" phases of these cycles turns negative after the 15th cycle. According to the hypothesis mentioned earlier, during the "rising" phase of the 15th cycle and afterward, cloudiness is influenced by the "rise" phase of solar cyclicity.

What can we expect in the future? We, as humanity, have no control over the solar processes that cause global warming. It is possible that these solar processes are cyclical, as suggested by the SSN curve in Figures 12 and 13. Short-term temperature fluctuations, lasting a few decades, have also occurred recently – for example, from the mid-17th century, temperatures were lower for about 70 years than in previous periods. This era, known as the "Little Ice Age," is thought to be related to changes in solar activity. The ongoing rise in global temperature, regardless of its cause, risks triggering an uncontrollable melting of the Polar and Greenland ice sheets because of increased heat absorption from the expanding areas of ocean and land freed from ice, creating a positive feedback loop where less ice means less reflection of sunlight and more heat absorption by the planet.

5 Conclusion

A strong negative correlation was observed between the average Sun Spot Number during the "rise" phase of the 11-year solar activity cycle and the annual average Earth's surface temperature, based on data from several meteorological stations, mainly in Europe. As solar activity has declined over the past 70 years, the last few solar cycles, including up to the 24th, have shown a steady decrease in sunspots. This negative correlation with temperature results in rising surface air temperatures. The decline in solar activity over recent decades has initiated a global warming process that could become self-sustaining, as the warmer atmosphere retains more water vapor—a major greenhouse gas—potentially amplifying global warming. As noted above, the contribution of other greenhouse gases in the Earth's atmosphere to this process is minimal or negligible.

If solar alpha particles contribute to mortality on Earth's surface, they also increase the number of ions (condensation nuclei) in the lower troposphere during their journey. Fluxes of solar alpha particles are more common during the „rise" phase of solar activity (Fig. 15).

The phenomenon decreases and even shows a positive trend at high-altitude stations, indicating it influences the lower tropospheric layers beneath the high peaks. This leads to increased low cloud cover, which enhances reflection from the upper cloud surfaces and the fog below. As the number of condensation nuclei rises, daytime cloudiness increases in the illuminated part of the atmosphere exposed to solar ionizing radiation, thereby boosting the reflection of solar electromagnetic radiation back into space. With more cloud cover causing additional shading, less solar electromagnetic radiation reaches the Earth's surface during the day. Consequently, the Earth's surface absorbs less radiation and heats less, resulting in lower ground air temperatures. From the 19th to the 24th cycle, solar activity declines (Fig. 2). Since the frequency of solar alpha particle fluxes correlates with solar activity—especially during the "rise" phase—high-energy alpha radiation fluxes also decrease in both frequency and intensity. This leads to a reduction in daytime cloud cover, allowing more electromagnetic radiation to reach the Earth's surface and raising surface and near-surface air temperatures during the last decades of declining solar activity.

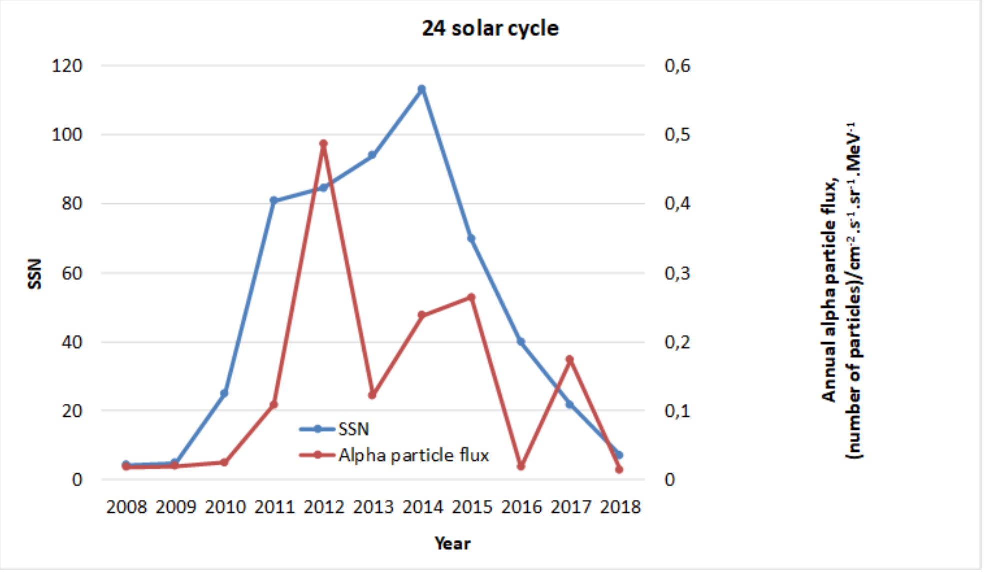

Fig. 15. The annual alpha particle flux is approximately 20% higher during the "rise" phase than in the “fall" phase of the last complete (24th) cycle of solar activity.

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