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Phase "Rise" of The 11-Year Solar Cycle with Contribution to Global Warming – Examples from The Bulgarian Meteo Stations' Temperature Data

Nikolay Petrov Takuchev

Trakia University, Stara Zagora, Bulgaria

***Corresponding author**

Nikolay Petrov Takuchev,
Trakia University, Stara Zagora,
Bulgaria.

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Abstract

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 several meteorological stations – first in the temperature data from meteorological stations in Bulgaria, and then from many stations from Europe and the world. 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 surface atmosphere. The increasing concentration of greenhouse gases may be also a consequence of the processes taking place on the earth's surface as a result of solar activity and is not a cause of the increasing temperature of the earth's surface.

Keywords: Global warming, Climate change, 11-year solar cycle, temperature, satellite.

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. (CLIMATE CHANGE, 2023).

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

Arguments, that global warming of at least the last 70 years is partially or entirely caused by another entirely different cause – periodic changes in the solar magnetic field (11-year solar activity cycle) are presented below.

Material and Methods

In connection with the described study, different types of data were collected and processed:

1. Data on the Earth's surface temperature from the National Climatic Data Center of the National Oceanic and Atmospheric Administration (NOAA) (National Climatic Data Center).
2. Data on solar activity characterized by the Sun Spot number (SSN) on the visible surface of the Sun (photosphere), from NOAA and Royal Observatory of Belgium, Brussels (SunspotNumber,& National Climatic Data Center).
3. Data on the solar corpuscular radiation characterized by the fluxes of high-energy protons and alpha particles, reaching the Earth's orbit (GOES) and
4. Satellite data on Earth's cloudiness from the satellites Terra and Aqua (GIOVANNI & NASA).
5. Data on mortality in the human population from causes, mostly diseases, supposedly dependent on said solar radiation, from EUROSTAT, a European short list of deaths by cause, and the death rate by NUTS-2 regions of residence, and from Centers for Diseases Control and Prevention (CDC), USA, National Center for Health Statistics (NCHS) (European short & Centers for Diseases Control).

The joint study of the above-mentioned types of data allowed a conclusion to be drawn as to the cause of a sequence of interconnected phenomena, to which, in the opinion of the author, global warming is also connected.

Results

For more than two and a half centuries, solar activity has been monitored regularly through the number of sunspots (SSN, Solar Index). Each of its cycles gets a number. The Sun is currently nearing the maximum of its 25th cycle. Within the solar activity cycle, solar activity increases for several years

("rise" phase), reaches a maximum and decreases ("fall" phase) to a minimum, Figure 1.

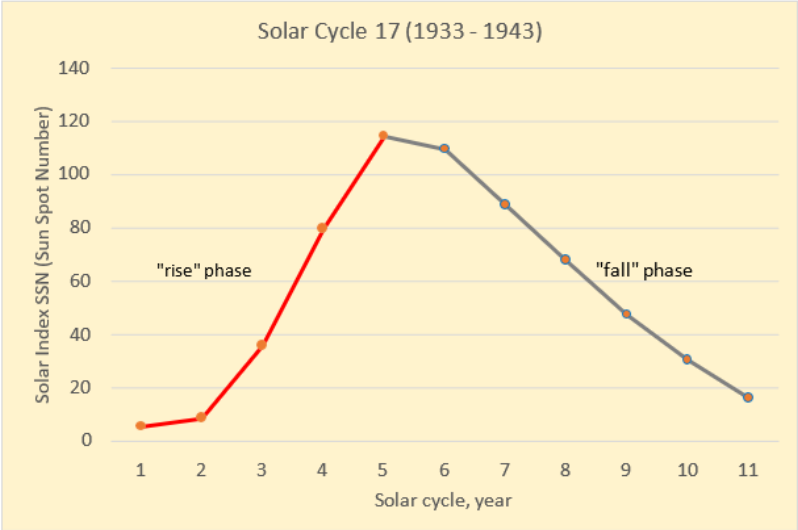

Figure 1: A cycle of solar activity in the example of solar cycle 17 (with a "nice" shape). During the first phase of the cycle (phase "rise"), solar activity increases, and reaches a maximum (the largest SSN), then during the second phase (phase "fall"), the activity decreases to a minimum before the start of the next cycle.

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 23rd, since the mid-1950s) there has been a decline in SSN at the maxima of the cycles.

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. 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.

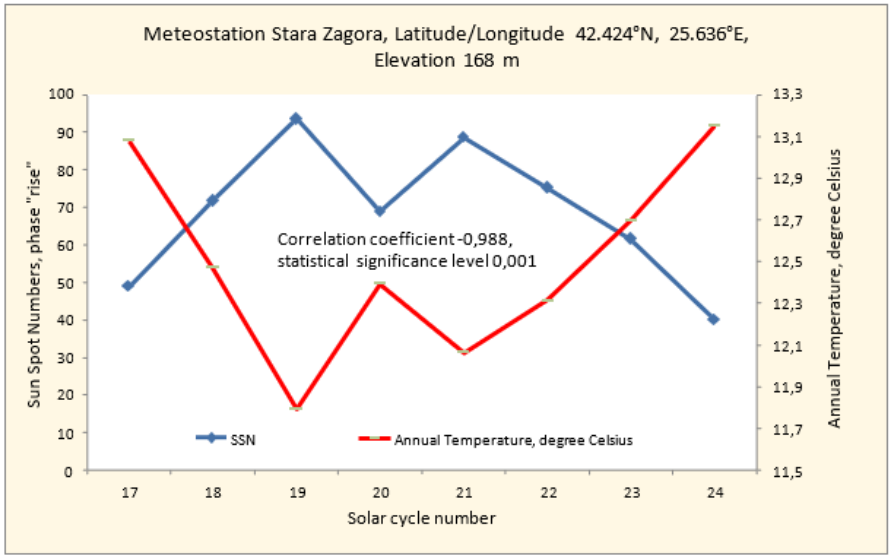

Figure 2: There is a high statistically significant negative correlation between the mean surface air temperature for the weather station STARA ZAGORA, BULGARIA, and the mean value of the number of sunspots during the phases "rise" of the last 8 cycles of solar activity.

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 3). 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.

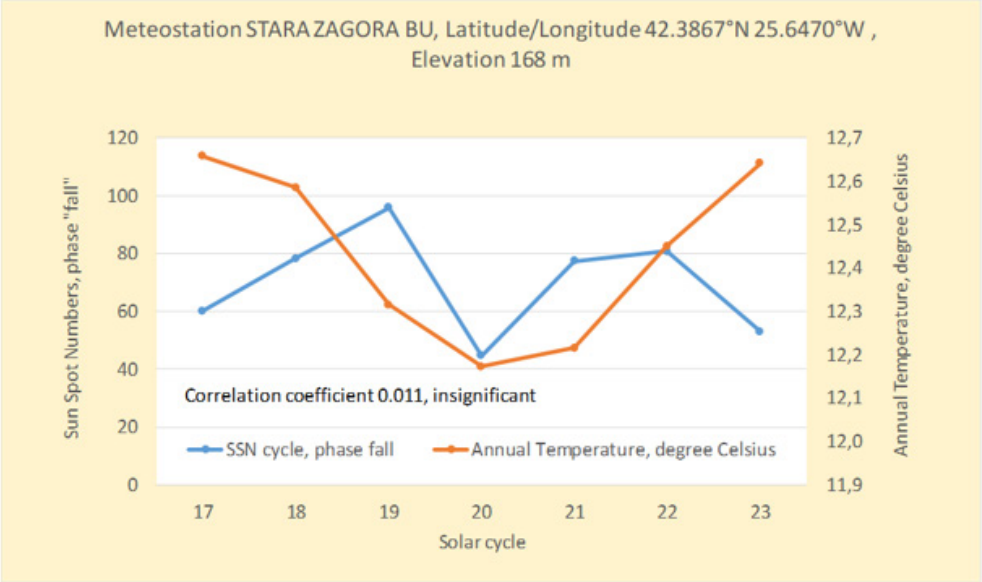

Figure 3: There is no statistically significant correlation between the mean surface air temperature for the weather station STARA ZAGORA, BULGARIA, and the mean number of sunspots during the phase "fall" of the last 7 cycles of solar activity.

Figure 4 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). 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.

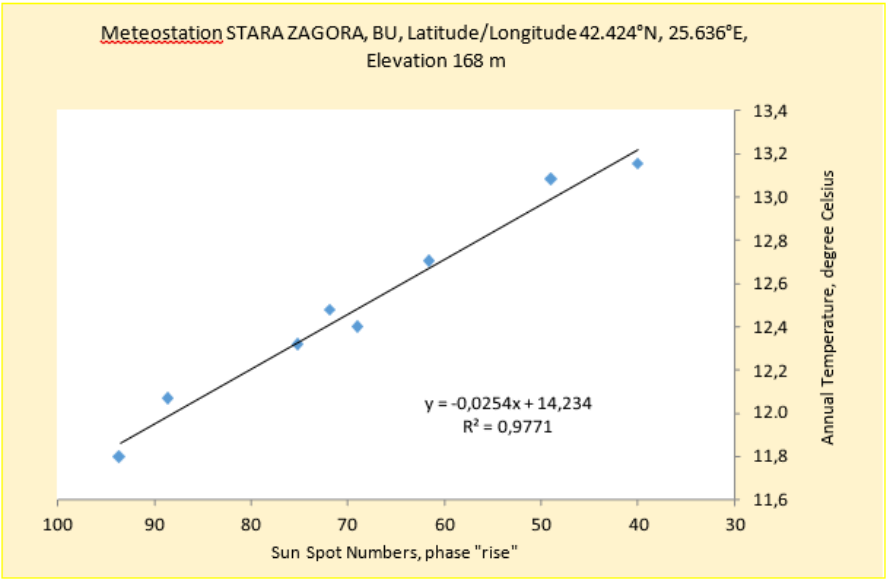

Figure 4: There is a linear relationship with a very high coefficient of determination $R^2 = 0,9771$ between surface air temperature in the region of STARA ZAGORA, BULGARIA, and the number of sunspots, both calculated for the phase "rise" of the solar cycles included in the study.

The described inverse dependence between the temperature on the solar activity in phase "rise" is observable in the data for most (dozens) stations of the meteorological network in Bulgaria, but also for many stations in Europe and the world. Examples are shown in the next three Figures 5, 6, and 7.

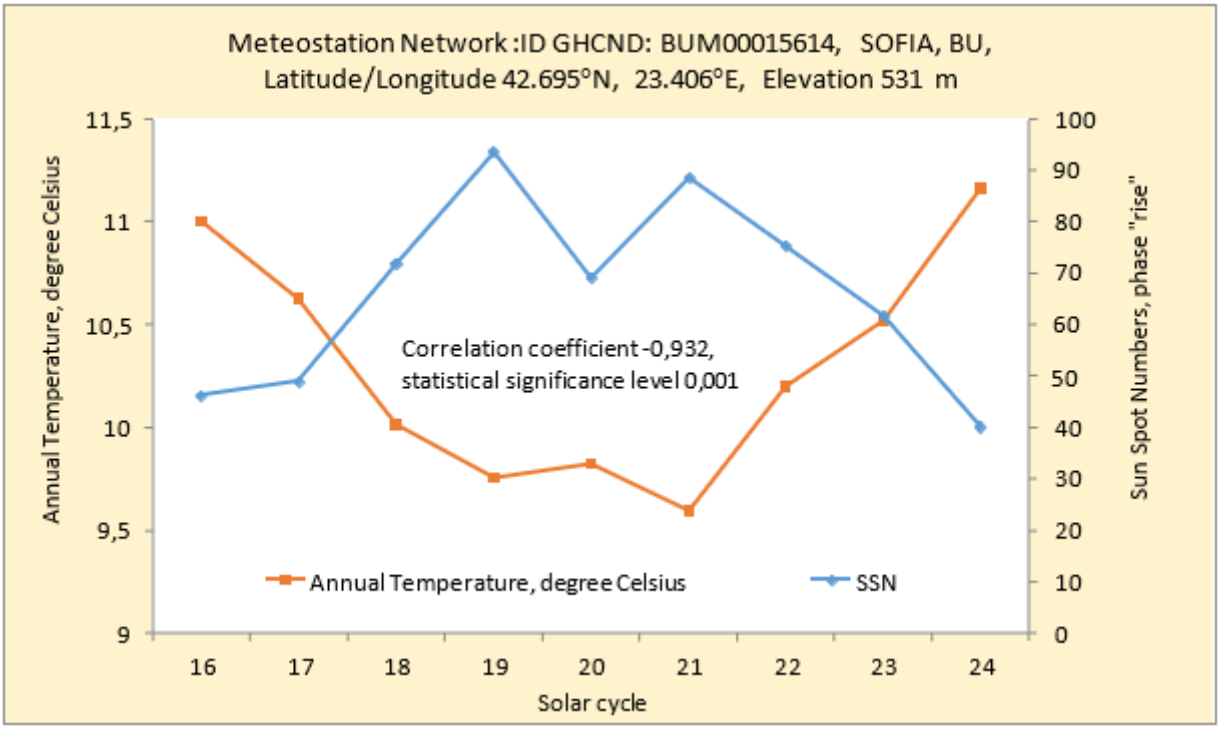

Figure 5: There is a high statistically significant negative correlation between the average surface air temperature for the SOFIA, BULGARIA weather station, and the average SSN during the phase "rise" of the last 9 cycles of solar activity.

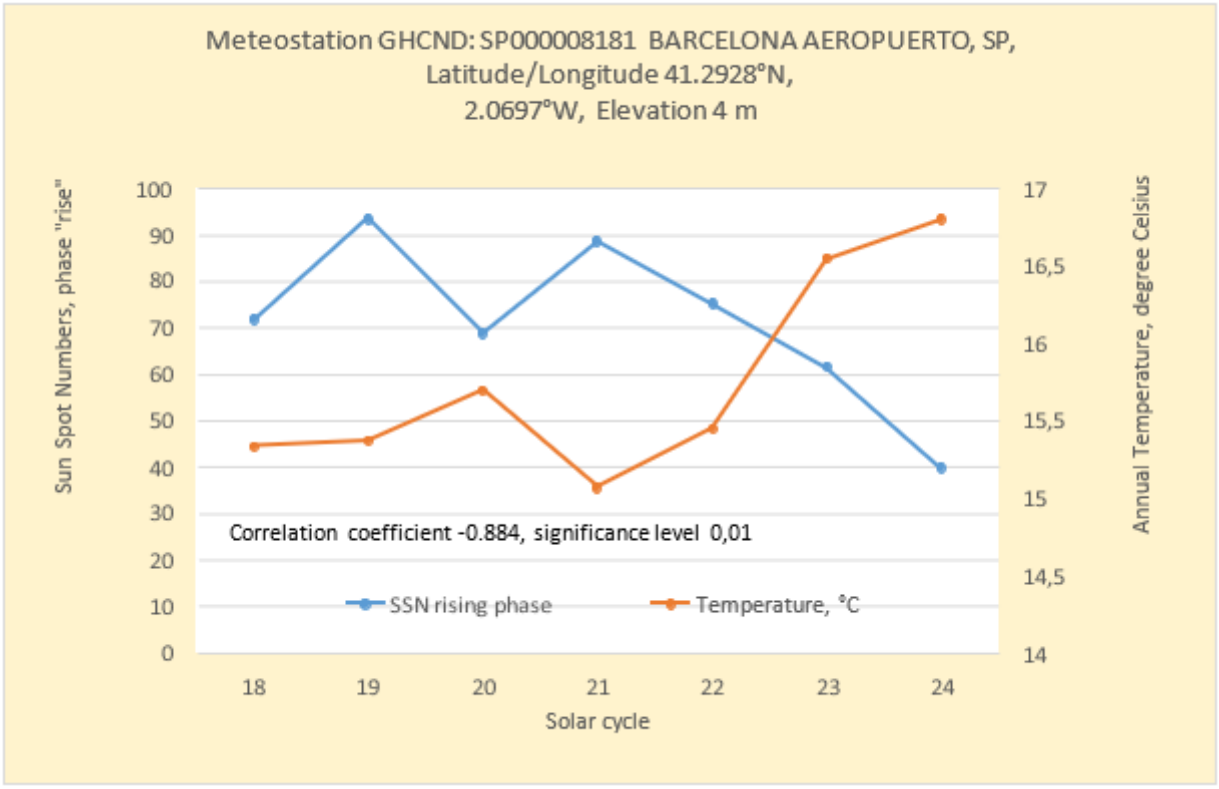

Figure 6: There is a high statistically significant negative correlation between the mean surface air temperature for weather station BARCELONA AEROPUERTO, SPAIN, and the mean sunspot number during the phase "rise" of the 7 cycles of solar activity (for which data are available).

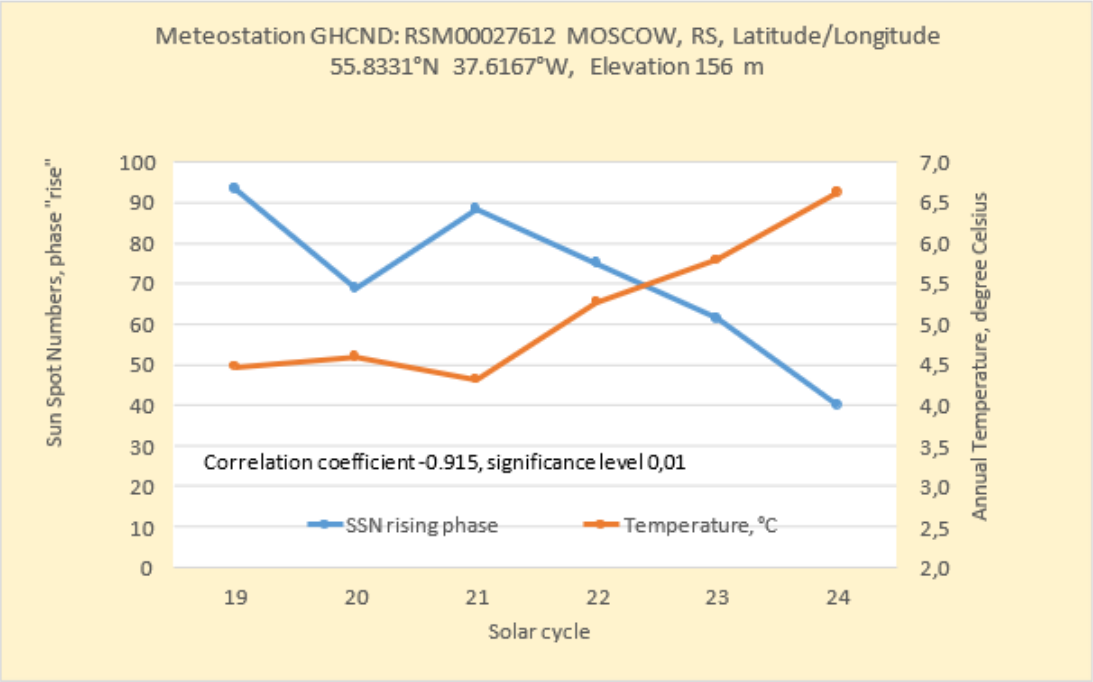

Figure 7: There is a high statistically significant negative correlation between the mean surface air temperature for weather station MOSCOW, RUSSIA, and the mean sunspot number during the phase "rise" of the 6 solar activity cycles (for which data are available).

There are also stations for which this phenomenon is barely noticeable or not observed. A few examples of stations with different correlation coefficients between SSN and the surface air temperature are shown in Figure 8. The highest correlation coefficients – strongest dependence SSN – temperature is shown in red, with orange are shown statistically significant coefficients, and with yellow are shown statistically insignificant correlation coefficients.

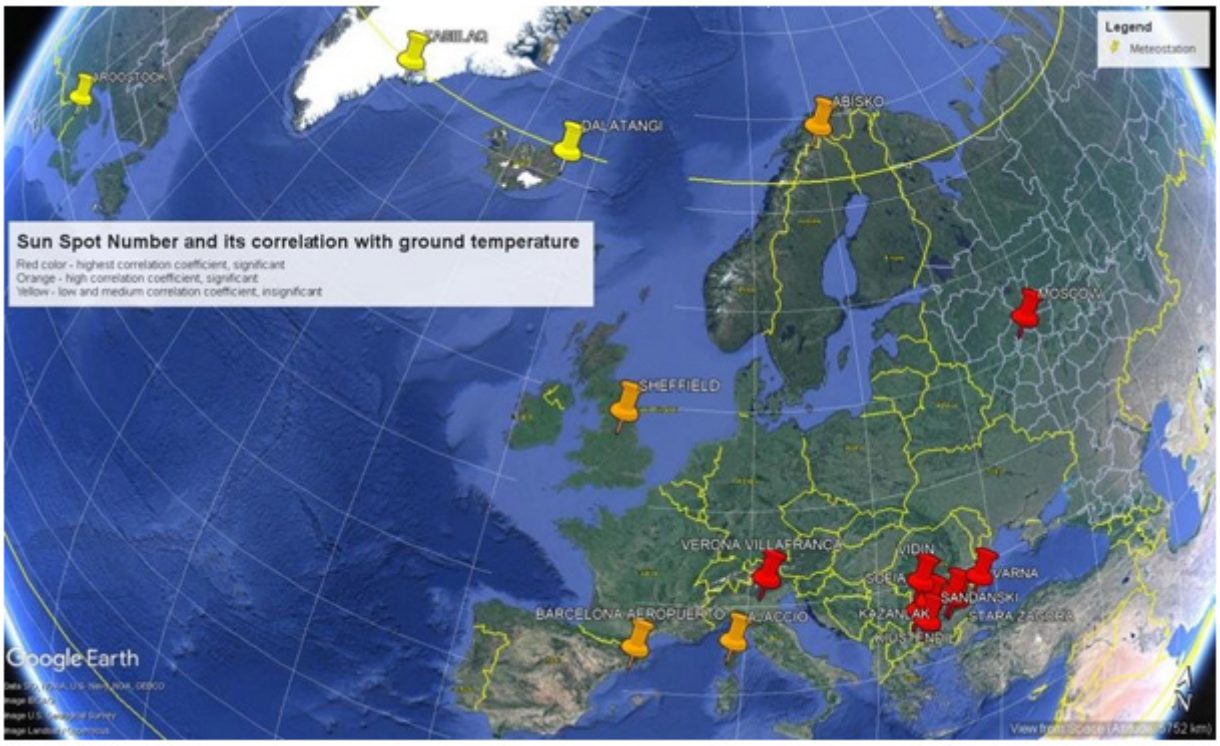

Figure 8: Google Earth map with stations from the Northern Hemisphere, the markers for which are colored depending on the magnitude of the correlation coefficient between surface air temperature and SSN for the phase "rise" of the solar cycles. With red color – a very high statistically significant correlation; with orange color high statistically significant correlation; with yellow color – a statistically insignificant correlation.

Average monthly data on the flux of solar electromagnetic radiation reaching the Earth's surface since 1980 have been obtained for the NASA site GIOVANNI for two areas – the Balkans and the Western Mediterranean (GIOVANNI). 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 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. it follows the conclusion that the described phenomenon is not related to changes in the Sun's electromagnetic radiation, which warms the Earth's surface and the air with contact with it.

A possible explanation for the observed inverse relationship SSN - surface air temperature is the presence of a relationship between solar activity and the cloud cover. If daytime cloudiness is increased during the phase "rise" of the solar cycle compared to that during the phase "fall", this would explain the aforementioned inverse relationship with the increased reflection back to space of solar electromagnetic radiation, resulting in less absorbed solar radiation from the surface and as a result to lower surface air temperature. Figure 9 shows the fraction of the average annual daily cloud cover for the "rise" phase and for the "fall" phase for the 24th solar cycle based on data from the satellites Terra and Aqua (GIOVANNI). Cloudiness during the "rise" phase is increased by about one and a half percent compared to that during the "fall" phase.

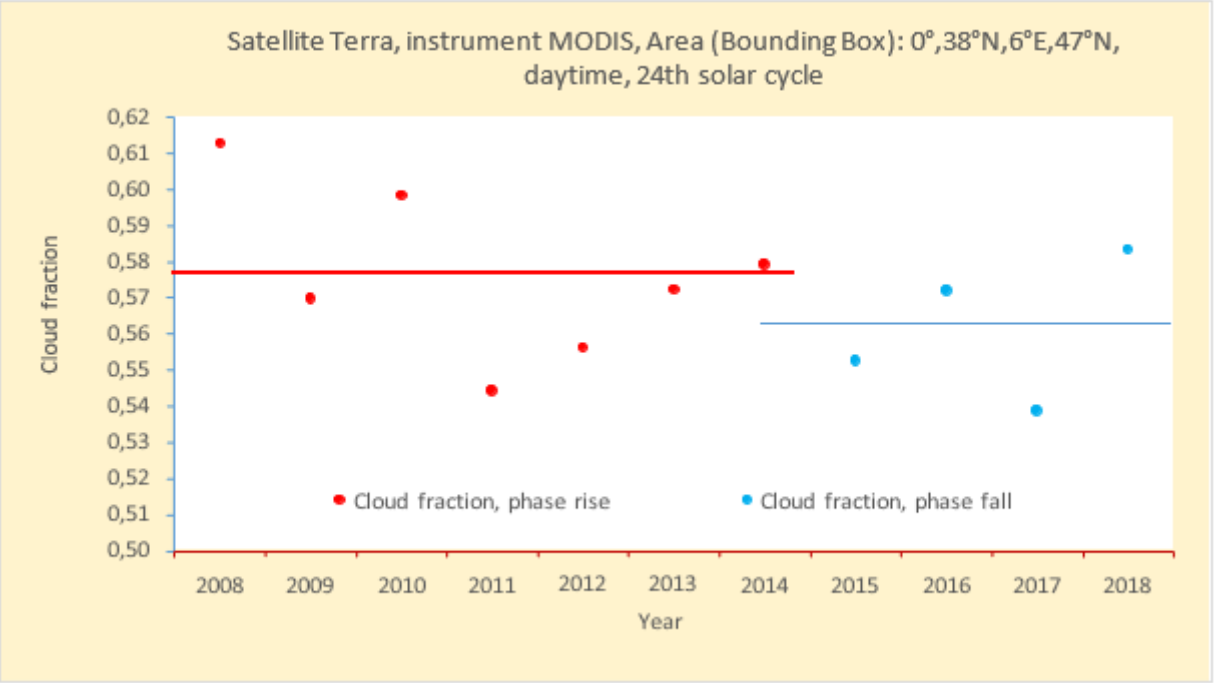

Figure 9: Daytime cloudiness over the western Mediterranean is about 1.5% more during the phase "rise" of the solar cycle than during the phase "fall".

Discussion

Increasing daytime cloud shading 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 several kilometers are the only type of condensation nuclei around which water vapor forms droplets and, as a result, clouds.

The additional ionization is probably due to the increased flow of positively charged solar particles - protons and alpha particles with high energy during the "rise" phase of the solar cycle. They are capable of penetrating deep into the dense layers of the atmosphere, where they increase cloudiness (GOES; Takuchev, 2019; Takuchev, 2024). Fluxes of solar ionizing radiation with the mentioned characteristics reaching the Earth's orbit are recorded by the high-energy charged particle detectors of the GOES series of satellites flying in geostationary orbit (36000 km above the Earth's surface). Alpha particles penetrate deeper into the dense layers of the atmosphere, since in their stream there is a significant share of particles with energy above several GeV, necessary for penetrating the deep layers of the atmosphere. The protons have lower energy.

An additional argument in favor of the statement of the presence of solar positively charged particles with high energy, causing ionization in the atmosphere and, as a consequence, additional cloudiness, is the observational fact that some of the high energy particles also reach the earth's surface, where they increase mortality from several diseases (Takuchev, 2019; Takuchev, 2024).

The reason such particles are not recorded on the Earth's surface is the specificity of their flows – for the most part, they are short-lived pulses, often lasting less than 5 minutes, and reach

the Earth's surface in a limited area (death spot) the size of a small country (GOES; Takuchev, 2019; Takuchev, 2024). 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 – the sky becomes clearer, more solar electromagnetic radiation reaches the surface and warms it. 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 surface atmosphere.

Conclusion

To the extent that the level of development of human civilization does not allow it to be able to influence the processes of the Sun, if the above statements are true, the efforts of humanity must be redirected from efforts to reduce greenhouse gases to measures to increase the reflectivity of the planet.

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