Exp. Theo. NANOTECHNOLOGY 10 (2026) 123-130 https://doi.org/10.56053/10.1.123

Nanoparticles assessment of cloud cover distribution with sunspot and cosmic rays of Iraq region

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Received 1/9/2025, *Received in revised form* 29/11/2025, *Accepted* 9/12/2025, *Published* 15/1/2026

By analyzing the relationship between the sunspot number index and cosmic rays on low cloud cover and temperature over Iraq, which is located within latitude 33°N and longitude 43°E, the aim of this study to know solar activity affects climate change. The sunspot data for this study is obtained from the World Data Center for the International Sunspot Number (ISN), cosmic ray data from the Neutron Monitor Database and atmospheric parameters data from the Climate Data Store for the period from 1996 to 2021, representing solar cycles 23, 24, and 25. Time series and regression analysis are used. The results showed a strong inverse relationship between sunspot cycles and cosmic rays, the relationship is weak for low cloud cover with sunspots and cosmic rays. As both cosmic rays and temperatures increased, cosmic rays, which serve as nuclei for cloud condensation, did not effectively contribute to climatic cooling.

Keywords: Cosmic rays; Cloud cover; Solar; Climate.

1. INTRODUCTION

Clouds consist of a group of particles, aerosols, supercooled water droplets, and ice crystals suspended in the air. They form when the air is cooled to saturation and reaches the dew point temperature [1,2]. It is divided into three types: low clouds at about 2 km height, middle clouds at about 2-6km height, and high clouds over 6 km height [3,4]. Since clouds cover more than half of the Earth's surface, they are a significant factor in the study of climate change, represent a source of precipitation on the Earth, and have a cooling or warming effect depending on the cloud's height, thickness, and content. High clouds are believed to represent a heating factor, while low clouds represent a cooling factor [5-7]. The Sun is believed to have an impact on the climate system as it is the main source of energy on Earth, and thus the effects of solar variability on climate change are studied and understood [8-10]. To understand how solar activity affects climate change, some scientists have studied the correlation between the solar cycle and cloud cover and consider it the clearest indicator of the correlation [11,12]. One of the primary indicators used to measure solar activity is the sunspot cycle, which repeats itself every 11 years. It is monitored by observing the number of sunspots, which are spots on the sun with a high magnetic field that are cooler and darker than the surrounding areas [13,14].

They begin to appear in small numbers at the beginning of the solar cycle, reach the maximum, and then gradually decrease to the minimum, after which a new sunspot cycle begins [15-17]. The Earth is constantly exposed to cosmic ray particles coming from the supernova explosion, Still, the entry of these rays to the Earth decreases during periods of high solar activity due to the increase in the solar wind that pushes the cosmic rays away [18,19]. Therefore, the intensity of the original cosmic rays varies by 15% over the solar cycle [20-22]. Cosmic rays primarily protons at about 87%, enter the atmosphere and interact with it [23-25]. Those cosmic rays promote cloud formation by ionizing particles in the troposphere scientists found an association between 1984 and 1991 in mid-latitudes over the oceans. However, from 1992 to 1994, and with the development of cloud monitoring techniques, the curves diverged between cloud cover and cosmic rays, and the previous results are not confirmed [26-28]. These rays have been associated with low cloud cover, as it represents a cooling factor in the climate by reflecting radiation received from the sun [29-31]. The decrease in cosmic rays during solar activity maximum will lead to a decrease in low cloud cover with a cooling effect, thus contributing to global warming [32-34]. The relationship between sunspot cycles and galactic cosmic rays, clouds, and other climatic parameters is studied for the periods 1993-2009 and 1950-2012 in the region of Nigeria using time series analysis and Spearman's correlation analysis. It is found that there is a strong inverse relationship between the sunspot cycle and galactic cosmic rays, Cosmic ray Trends in cosmic ray and low cloud cover variation showed agreement between 1850 and 1995, but then they diverged from 1995 [35-37]. This study aims to identify the type of relationship between cosmic rays, solar activity, and low cloud cover that significantly contributes to precipitation during the period 1996-2021, as it represents a time frame that has not been previously addressed to understand the nature of this relationship.

2. METHODOLOGY

To conduct this study, data is used of sunspot cycles 23, 24, and 25 that are ongoing, data from sunspot cycles 23, 24, and 25, which are ongoing, are used from the World Data Centre for the production, preservation, and dissemination of the international sunspot number (SILSO). Cosmic ray data from the Ionosphere Institute's Neutron Monitor, Almaty, Kazakhstan (AATB), is the closest station to the study area covered during the study period. Data Centre for the production, preservation, and dissemination of the international sunspot number (SILSO). Cosmic ray data from the Ionosphere Institute's Neutron Monitor, Almaty, Kazakhstan, (AATB) as it is the closest station to the study area covering the study period it is located at latitude 43.14° N and longitude 76.60° E Available on the Neutron Monitor Database [38,39]. For atmospheric data, low cloud cover and temperature data over Iraq are extracted from the ERA5 model of the Copernicus Climate Change Service at Climate Data Store [40,41]. For a period of 26 years, from 1996 to 2021, for all variables [42,43]. The research is carried out in Iraq, which lies between latitude 33°N and longitude 43°E. With an area of 437,072 km2 [44-46]. The figure shows the location of Iraq in the world. The Sigmaplot program has been used to study the monthly and annual behaviors of variables. Also, a simple linear regression analysis is made to determine the relationship between two variables [47,48].

2.1 Nanoparticles

Nanoparticles come from many different sources in the atmosphere. Nanoparticles in the urban environment are generally formed from various combustion processes related to energy generation and movement via petrol and diesel cars and also other industrial processes. In rural regions, new particle formation in terms of nucleation and growth of new particles is an important source of nanoparticles. Nanoparticles can also escape into the atmosphere during the manufacture and use of engineered nanoparticles.

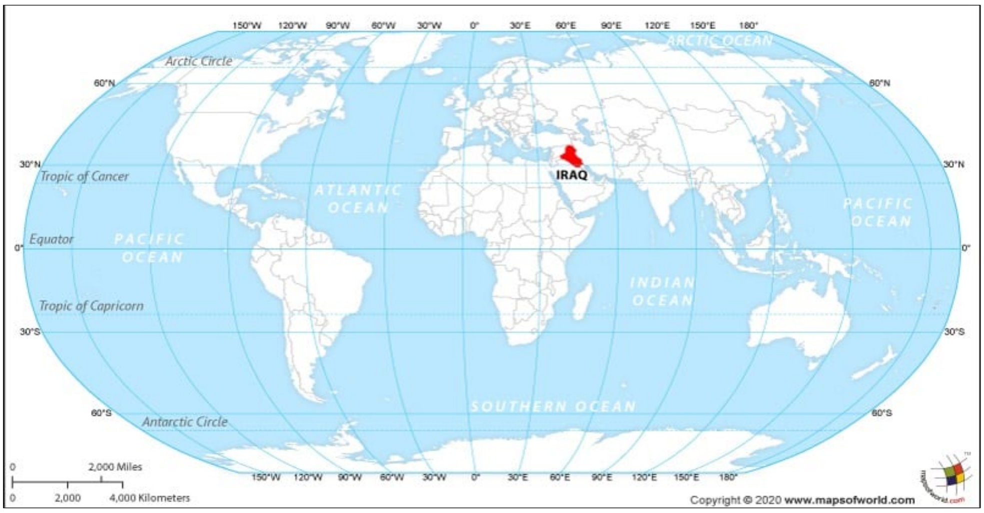

Figure 1 Location of Iraq in the world.

3. RESULTS AND DISCUSSION

To study the relationship between sunspots and cosmic rays for the period from 1996 to 2021, time series are drawn to illustrate the progression of the relationship. Figure 2 shows an opposite trend for the monthly averages, as cosmic rays increased during periods of low activity for all solar cycles 23, 24, and 25. The explanation for this is that cosmic rays are pushed away from the Earth's atmosphere by the solar wind during solar activity, and that the solar wind weakens during low activity, allowing more cosmic rays to enter the atmosphere. Figure 3, which represents the regression analysis between the monthly averages for each of the sunspot numbers and cosmic rays for the period from 1996 to 2021, shows a good inverse relationship with the value of the regression of 0.7.

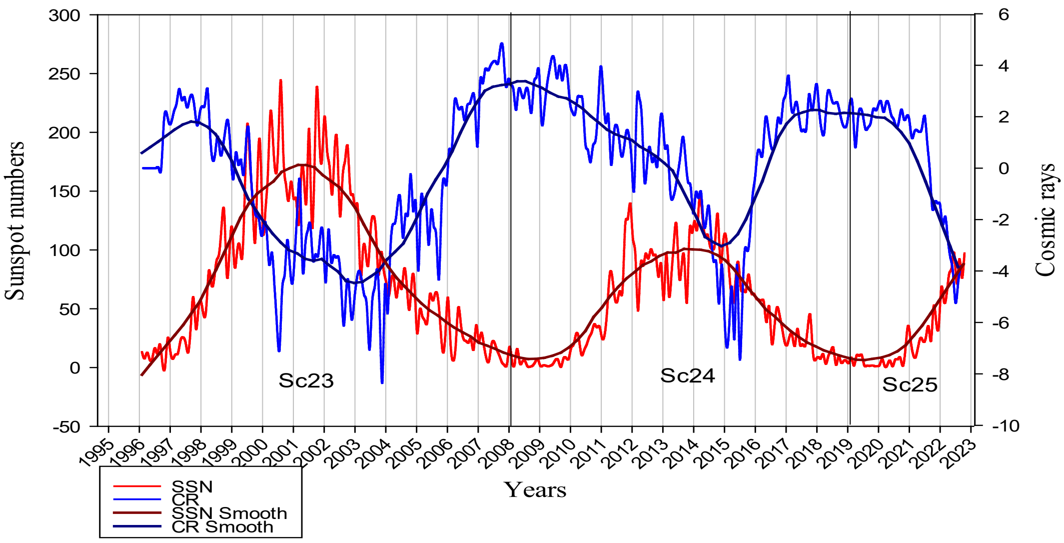

Figure 2 The relationship between monthly sunspot number and cosmic ray for solar cycles 23, 24, and 25 from 1996 to 2021.

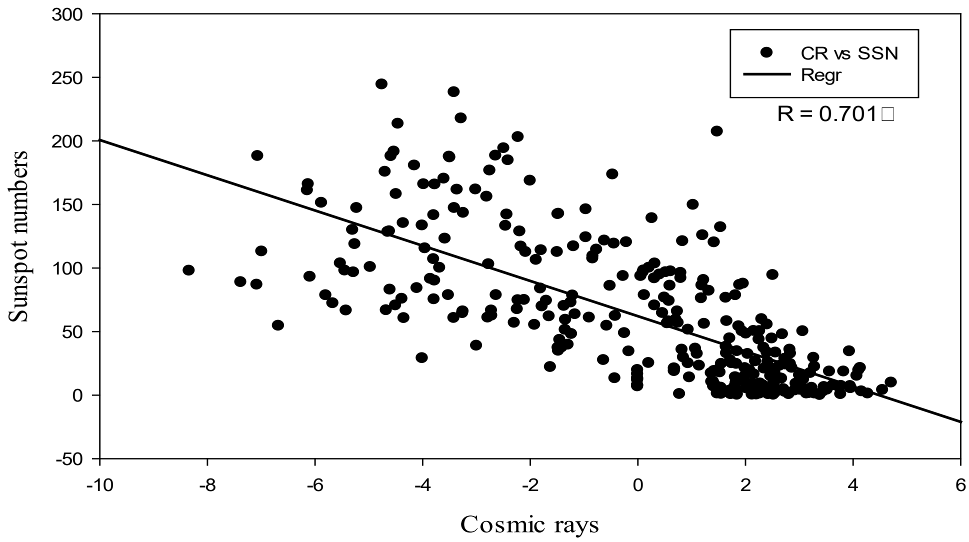

Figure 3 The regression between monthly sunspot number and cosmic ray for solar cycles 23,24, and 25 from 1996 to 2021.

Figure 4 shows the relationship between the annual average of low cloud cover over Iraq and sunspot numbers from 1996 to 2021. An unstable relationship appeared between sunspots and low clouds, where the relationship is inverse from 1996 to 1999 and from 2017 to 2021, and some periods of positive correlation are also shown during the years of maximum activity, 2000 to 2012 and 2011 to 2016.

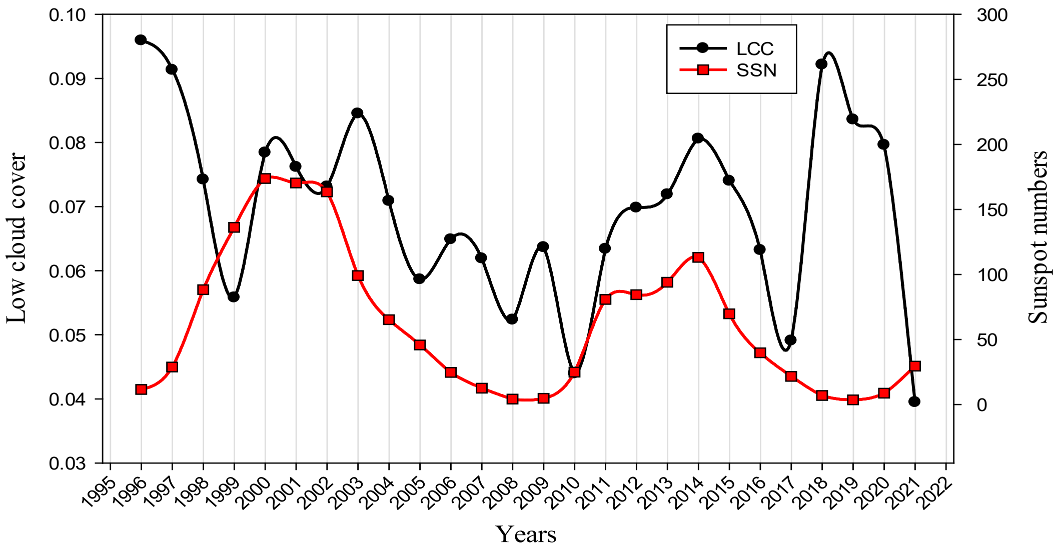

Figure 4 The relationship between the annual average of low cloud cover with sunspot numbers from 1996 to 2021 over Iraq.

Figure 5 illustrates the relationship between the annual average of cosmic rays and the low cloud cover over Iraq from 1996 to 2021. For the majority of the research years, the association between low cloud cover and cosmic rays showed an inverse tendency, where the cloud cover increased during low cosmic ray periods.

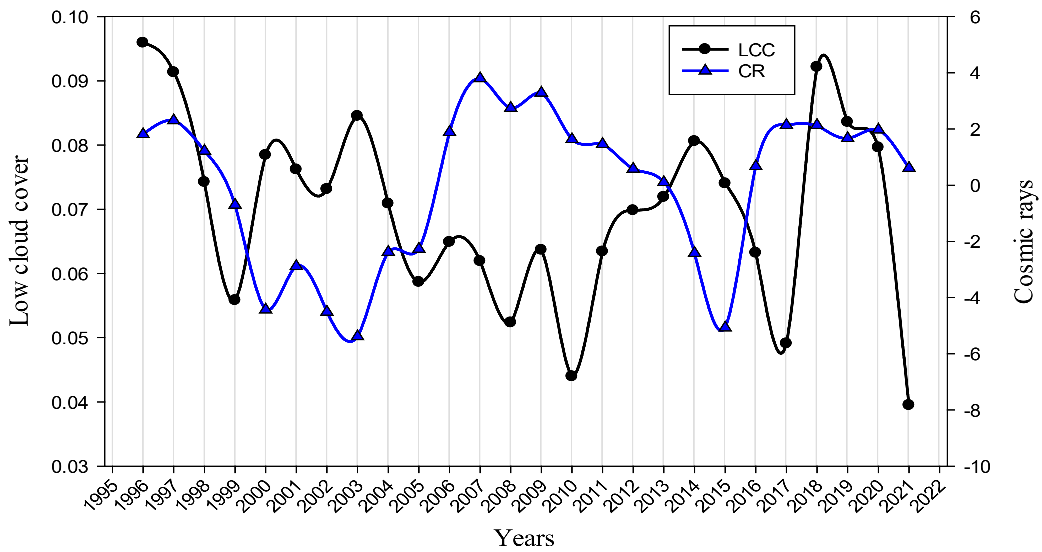

Figure 5 The relationship between the annual average of low cloud cover with cosmic rays from 1996 to 2021 over Iraq.

The regression is determined for the low cloud cover with each of (a) sunspots and (b) cosmic rays in Figure 6. The Figure showed that the relationship of the low cloud cover is Weak and positive with sunspot numbers with a regression coefficient of 0.13 and an inverse relationship with cosmic rays with a regression coefficient of 0.2.

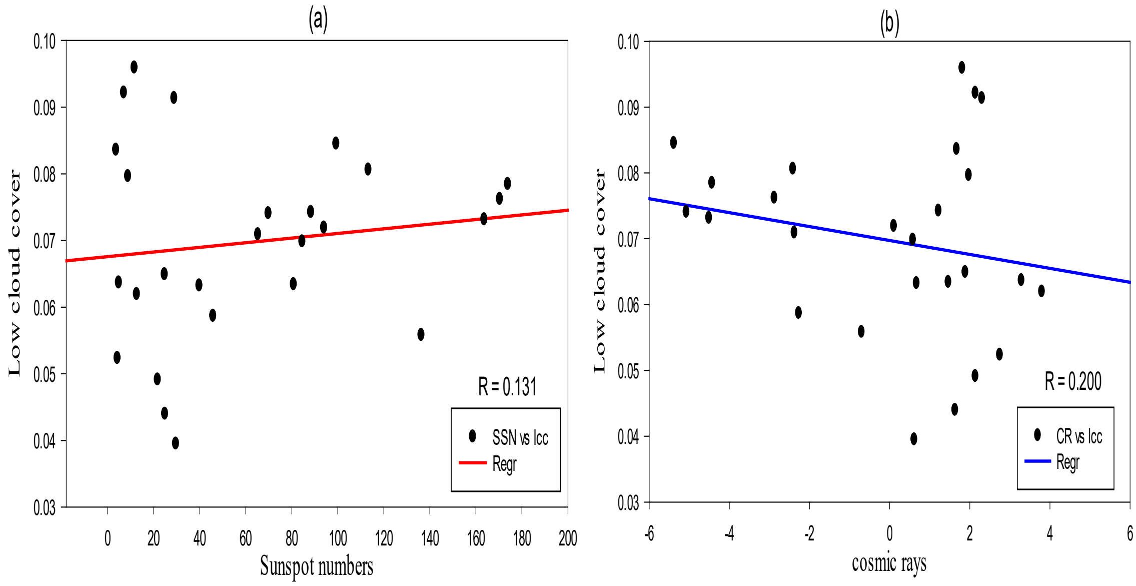

Figure 6 The regression correlation between Low cloud cover with (a) sunspot numbers and (b) cosmic rays from 1996 to 2021 over Iraq.

The relation between the annual averages of cosmic rays and temperatures over Iraq between 1996 and 2021 is shown in Figure 7. It showed that while temperatures and cosmic rays tended to rise, their behaviors are different. The increase in temperatures is linked to other weather elements like radiation and cloud cover, which are unaffected by the increase in cosmic rays. The increase in cosmic rays is caused by a decrease in solar cycle activity.

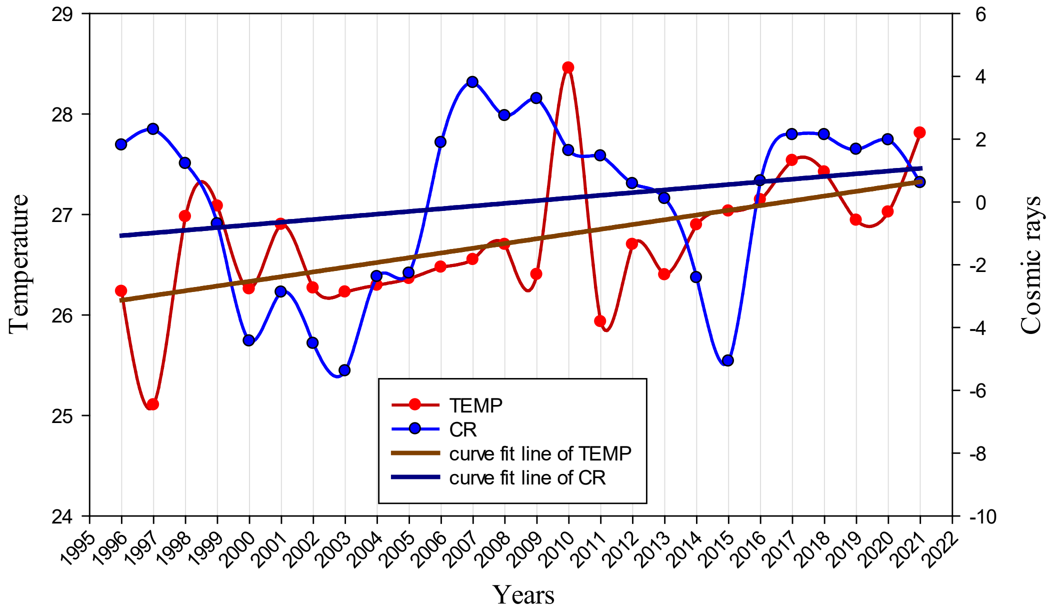

Figure 7 The relationship between annual average cosmic rays with temperature from 1996 to 2021 over Iraq.

4. CONCLUSIONS

According to the findings of this study, the inverse association between each of the sunspot numbers and cosmic rays persisted for cycles 23, 24, and 25 from 1996 to 2021. The results revealed that low cloud cover has a positive association with solar activity and an opposite relationship with cosmic rays. These associations are weak, according to a simple linear regression analysis. The results also showed a decrease in sunspot solar activity of recent cycles, an increase in cosmic rays, and an increase in temperatures. It indicates that the ionization of cosmic ray particle protons did not produce clouds that were effective enough to chill the climate.

ACKNOWLEDGMENTS

Acknowledgment of each global data center for producing, maintaining, and publishing the International Sunspot Number (SILSO), the Institute's Ionosphere Neutron Monitor, Almaty, Kazakhstan (AATB), at the Neutron Monitor Database and Climate Data Store for supplying data to this paper.

CONFLICT OF INTEREST

According to the researchers, this effort does not interfere with other people's interests.

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