SUNSPOT NUMBER EFFECTS ON EARTH'S CLIMATE CHANGE AND WATER SUSTAINABILITY FOR LONG ISLAND, NY

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Abstract

The sun is the center of our solar system and the primary source of energy for the climate system of the earth. Sunspots influence climate around the world, contributing to a significant portion of the earth's warming and weather. The purpose of this research is to bring attention to the theory that sunspots influence the climate of the earth, in particular groundwater activity. This has been an important topic that has been discussed within the scientific community, and there is much research supporting this idea but there is limited research related to Long Island groundwater activity. It is significant because the answer could majorly change the face of the research of water sustainability issues on Long Island, and develop technology to enhance societal resilience against those issues. It has been proven that there are certain multidecadal cycles that demonstrate a pattern between sunspots and the Earth's temperatures. Temperature affects the water cycle, therefore the groundwater can be influenced. The size and volume of the sunspots can also have differing effects regarding the magnitude of their impact. Sunspots can also block electrical signals and absorb electromagnetic energy, making communication difficult. This study compares numerous research articles worldwide and at Long Island, NY to retrieve significant evidence to explore this hypothesis.

Introduction

The effect of sunspots on the Earth's atmosphere and climate sunspots are very influential when it comes to the climate of Earth and its atmosphere, along with being indirect contributors to global warming (NASA, 2019) and more specifically to the water cycle. It has been proven that there are certain multidecadal cycles that demonstrate a pattern between sunspots and the Earth's temperatures (Fig. 1), and we assume that water cycles in isolated places like islands may also have a significant effect. The size and volume of the sunspots can also have differing effects regarding the magnitude of their impact (Krzykowska, 2020). Although sunspots can also block electrical signals and absorb electromagnetic energy, making communication difficult, there are other effects such as the increase of beryllium and lead in the atmosphere.

A study conducted at Stony Brook University (Renfro et al., 2013) has shown an effect of solar activity on precipitation in Long Island (Atmospheric fluxes of ^{7}Be and ^{210}Pb) on monthly time scales and during rainfall events. Concentrations of Beryllium and Lead were found in the atmosphere with a more impactful amount of these elements in the summer, due to the increase in storms which transport these elements from the troposphere to the Earth's surface. It also talked about how the concentration varied between the seasons, which largely influenced rainfall patterns. Their results demonstrated that there was a significant increase in Beryllium during sunspot minimums, which indicates that sunspots do have effects on rainfall patterns. Sunspots and precipitation/groundwater has been noticed around the world. Identification of the relationship between sunspots and natural runoff in the Yellow River in China (Wang and Zhao, 2012; Li et al., 2017) based on discrete wavelet analysis was found that described the effect of sunspots on natural runoff. It explained how sunspots and solar activity are related to natural events such as runoff and precipitation, along with hydrological and meteorological processes. They discovered that although there was no long-term connection seen, there are phases in which the sunspots and runoff coincide with one another. During one 11-year cycle for the sunspots, there is a positive correlation, while in the next cycle, there is a negative one.

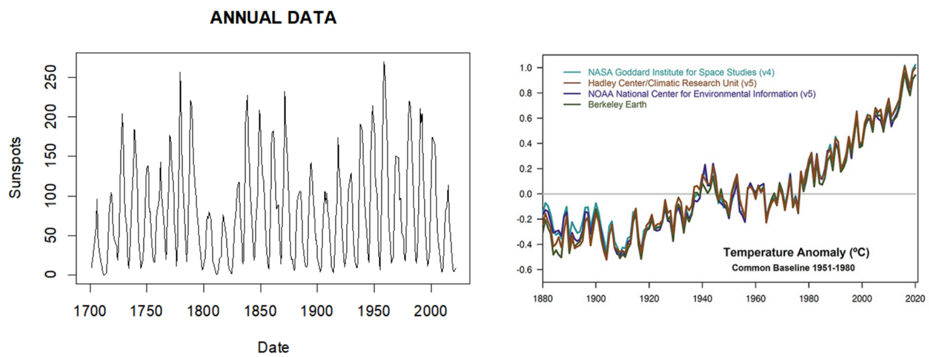

Figure 1: Monthly sunspot numbers originated from R software (left plot), and monthly temperature data from various sources (right plot).

For example, in one study, (Correa, 2020) there was a goal to identify a possible correlation between the two. To achieve this, the researchers selected nine different parts of Iran at different latitudes, each representing a different climate. They knew that the solar force was strongest near the equator and tropics, so they wanted to see whether there would be any climate variations from these sunspots. The results of this experiment indicated that there was an 11-year cycle relationship between the amount of sunspots and the region's temperatures. However, this result might not be directly related to the sunspots since there were many other possible variables that could have influenced the experiment. Furthermore, it was discovered that the maritime tropical average temperature was not directly correlated with sunspots, but instead an indirect warming of the tropical atmosphere. This was due to lower temperatures in the stratosphere caused by ozone absorbing UV radiation from the sun. So, even though sunspots do not have a direct effect on the temperatures and climates of this region, there are still indirect effects (Yamaguchi, 2020), and they might contribute to water cycle. When the sun is in a period of low sunspots, there is low solar magnetism, so less UV radiation reaches Earth. However, when the sun is in a period of high sunspot concentration, there is a high solar magnetism and more ultraviolet radiation reaches earth, causing temperatures to rise and consequently water cycle to change.

Climate change and subsequent water cycle anomalies may increase the intensity of storms such as hurricanes or change the water table and related groundwater level. Water cycles may also be affected by the resulting rising sea level due to thermal expansion, which makes coasts more vulnerable such as Long Island coasts in NY, and susceptible to flooding. Therefore, sunspots may have a contributing impact on Long Island, and we explore here general trends of temperature and sunspots number using a moving average filter that may hypothesize an effect to the groundwater levels of Long Island in the long term.

Methodology

To reveal the trend of the sunspots number between 1700-2021 data a low-pass filter Kolmogorov-Zurbenko filter named KZ has been applied in the time series data. The KZ filter is defined as a low-pass filter, and it was defined by three iterations of a simple moving average of 13 points, that is the 12 months of the year plus one to create an odd window size. Implementation has taken place in the R programming language using the package (kza) (Brian et al., 2020).

Results

Uptrend of temperature between 1880-2020 overlaps with annual data from the KZ moving average of sunspots number. The application of the KZ moving average with a window of 365 and three iterations has shown no significant activity between 1840-1880 (this study). Before and after this sunspots number anomaly there is a consistent uptrend.

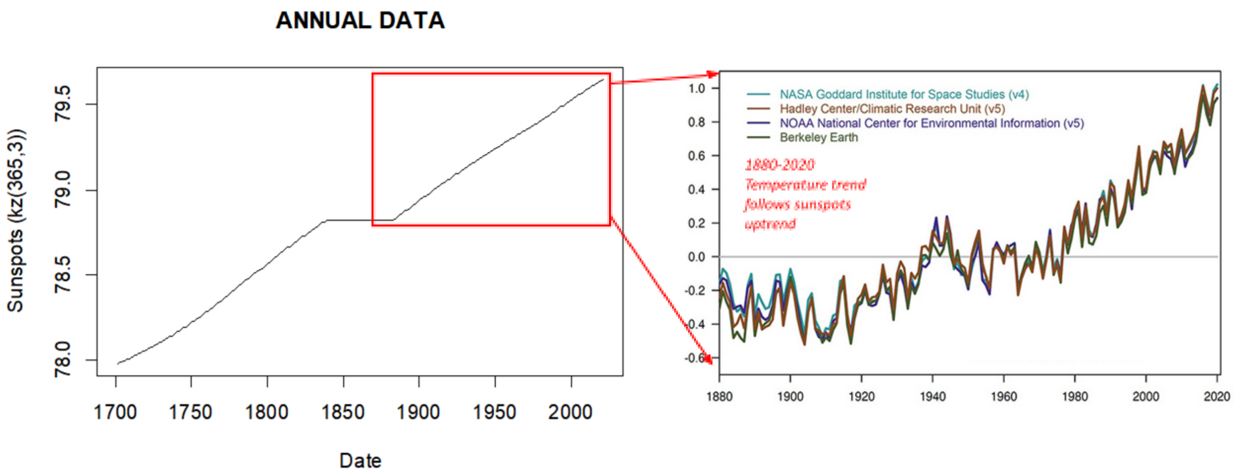

Figure 2: Trend of sunspots number compared with climate change (temperature) from 1700 to 2021 worldwide.

Conclusions

The observed uptrend of sunspots number has shown an overlap with the temperature trend. This may be an indirect effect that may influence the water cycle in various areas on Earth, especially islands susceptible to sea level rise and very dependent to water sustainability such as Long Island, NY.

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