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Investigation of possible contribution of the Solar and geomagnetic activities on global surface temperature.

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Abstract. Global warming in the troposphere and the decrease of stratospheric ozone concentration has became a major concern to the scientific community. The increase in greenhouse gases and aerosols concentration are believed to be the main cause of this global change in the lower atmosphere and in stratospheric ozone. However, there are natural sources, The present work we have investigated the effect of solar and geomagnetic parameters on the mean surface air temperatures recorded at countries which covers a wide range of geographic latitudes. In this case we have selected six countries via northern and southern hemispheres to enables us to understanding the existence of solar activity effects on the regional/global temperatures. We considered the parameters temperature and solar activity indicators data for the period data ranging from 1880 to 2011.Generally, our results displayed that the solar variability parameters played an important role in climate changes and cannot be excluded from the responsibility of continuous global or regional warming. We think that the combined effect of solar-induced changes and increase in the atmospheric greenhouse gases offer the best explanation yet for the observed rise in average global temperature over the recent years.

Key Words: Global Surface Temperatures, sunspot number, Earth's climate, solar activity changes.
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1. INTRODUCTION

It is obvious that the Sun is tremendously important for the life on the Earth, and the solar output variations interact with the atmosphere is still not well understood. We know that the energy, produced by fusion reactions in the solar core, is transferred to the outer upper layers of the Sun by radiation and convection processes to finally escape into space by radiation on all wavelengths of the electromagnetic spectrum. As the energy variations are far from the constancy, and due to the interaction between such radiations and the Earth magnetic field, we may expect changes on the terrestrial level like “auroras, proton events, geomagnetic storms” which may in turn, have some disruptive effects on the Earth such as on communications, board satellite equipments, navigation systems, electric powers, and the pipelines, etc. By considering the historical evolution of the climate changes on the Earth, the cold period lasting from the second half of the 17th century to the beginning of the 18th century (1645-1715) is called “Little Ice Age”, and the corresponding period of practically no activity on the solar surface, is called “Maunder Minimum”. In contrary to this, the positive “Medieval Warm Period” (12th-14th centuries) appears to be less distinct evidence, mostly from the Western Europe, did not suggest that this was a global phenomenon (Mann et al., 1999). During this period, temperatures had been about 0.2 ºC warmer than compared with the 15th-19th centuries, but rather below those of mid-20th century (Intergovernmental Panel on Climate Change report IPCC, 2001) (Kilcik, 2005).This might have arisen from higher solar and geomagnetic activities, as claimed by El-Borie et al., (2011a;b). Global surface temperature was chosen to be the indicator for the climate change. It plays an important role in the ongoing public debate concerning global warming and the risk of many parameters that led the climate change. The earth climate system has an irregular behavior through the recent years, many theories try to explain the reasons for this change, and some of this explains the important rule for the anthropogenic “(GHGs) and aerosols” (e.g., Mann and Park, 1996; Inter governmental Panel on Climate Change, 2001), while their effects began to dominate during the second half of the 20th century, especially during the last decades (Hegerl et al., 1997). Interest to this subject is therefore continually increasing. Since the climate system depends on many parameters, such as evaporation, wind, pressure, rainfall, temperature, etc. Other theories show that the climate change was very complex to happen by the anthropogenic only but there is another forcing that has an equivalent role in this change which called the solar forcing. (Reid , 1987; Hoyt , 1997; Haigh ,1999; Pulkkinen et al., 2001; El-Borie and Al-Thoyaib, 2006; El-Borie et al., 2011a; 2011b). The 11-yr-solar cycle and the associated variability that it has on the electromagnetic environment of Earth have been largely studied in the last decades (e.g., Eddy, 1976; Rigozo et al., 2001).

Indices of geomagnetic disturbances measure the response of energetic solar eruptions that actually affect the Earth. Geomagnetic activity aa seems to be the possible link through which the solar activity controls the Earth's climate (Landschiedt, 2000; Shahand Mufti, 2005). Near-Earth variations in the solar wind, measured by the aa geomagnetic activity index, have displayed good correlations with global temperature (Landscheidt, 2000). Lockwood et al. (1999) found that the total magnetic flux, leaving the Sun and driven by the solar wind, has risen by a factor 2.3 since 1901, leading to the global temperature has increased by 0.5º C. In addition, the solar energetic eruptions, which dragged out or/and organized by the observed variations in the solar wind, are closely correlated with the near-Earth environment (El-Borie, 2003a;b).Comparison of the geomagnetic aa with the solar wind, post-1965,showed a fairly good match, indicating that variations in aa were mostly due to similar variations in the solar wind, which must have their origin in solar physical processes (Feynman, 1982;Kane, 1997; El-Borie, 2003,2003a;b).

From the other hand, the effect of solar activity parameters upon global temperature changes have been studied by many number of researchers like (Lassen and Friis – Christensen, 2000); (EL-Borie and AL-Thoyaib, 2006). Influence of circulation indices upon winter, providing evidence for a solar forcing effect, in spite of the fact that the underlying physical processes are still not yet understood. El-Borie et al., (2010) presented a correlative study of the possible contributions for the two solar and geomagnetic activities components (aa and Rz) that may be closely associated with the climate, throughout the last 128 years (1880–2008). Studies of El-

Borie and Al–Thoyaib 2006; and El-Borie et al. 2007 displayed that the global temperature should lag the geomagnetic activity, with a correlation that reaches a maximum when the temperature lags by 6 years.

Eichler et al. 2009 studied the effect of solar forcing on the temperature in Altai. They found strong correlation between reconstructed temperature and solar activity that suggests solar forcing as a main driver for temperature variations during the period 1250–1850. The precisely dated records allowed for the identification of a 10–30 year lag between solar forcing and temperature response, underlining the importance of indirect Sun–climate mechanisms involving ocean–induced changes in atmospheric circulation. Solar contribution to temperature change became less important during industrial period 1850–2000 in the Altai region.

The idea of a relationship between long-term changes in solar activity and climate published by Eddy (1976) was re-examined in detail by Reid (1987). He looked at the record of the globally averaged sea surface temperature (SST) and noticed a striking similarity between SST and the long- term variation of solar activity represented by the 11 year running mean Zurich sunspot number. Among the particular features he pointed out, was the prominent minimum in the early decades of this century, the steep rise to a maximum in the 1950s, a brief drop during the 1960s and early 1970s followed by a final rise. Based on model calculations Reid suggested that the solar irradiance may have varied by approximately 0.6% from 1910 to 1960 in phase with the 80-90 year cycle (the Gleissberg period) of solar activity represented by the envelope of the 11 year solar activity cycle (Friis-Christensen and Svensmark., 1997).

Several studies have been published reporting correlations between solar/geomagnetic activities and various climatic parameters. But the results were quite contradictory, even when highly statistically significant; both positive and negative correlations have been found between solar activity and climatic parameters (e.g., El-Borie et al. 2010). Over a solar cycle, Sun's activity has a dramatic effect on Earth's surface and atmosphere such as the variation in Earth's climate, which may be caused by varying UV and total radiation from the Sun (Haigh 2007; Souza Echer et al. 2009). Georgieva and Kirov 2000 found that the correlation between solar activity and surface air temperature in the 11 years sunspot cycle was positive during the 18th and 20th centuries and negative during the 19th century, and seemed to change systematically in consecutive secular solar cycles (Gleissberg) solar cycles.

Kilcik et al. 2008 investigated the effects of solar activity on the surface air temperature of Turkey and found a significant correlation between solar activity and surface air temperature for the solar cycle 23. Kilcik et al. 2010 considered the temperatures at different mid latitude zones and flare index data for the period from January 1975 to the end of December 2005, which covers almost three solar cycles, (21st- 23rd). They found significant correlations between solar activity and surface air temperature over the 50º–60º and 60º –70º zones for cycle 22 and over the 30º – 40º, 40º –50º, and 50º –60º zones for cycle 23, but have not any significant correlation for the cycle 21.

In the present work, we investigate the possibility role of some solar indices on climatic variable represented by changes of surface air temperature have mostly been studied on the global (NH, SH) temperature series which are available since 1880. Indices of solar disturbance measure the near-Earth variations in the solar wind, have been studied. Here, we present a correlative study of the possible contributions for the three components that may be closely associated with the climate which are the geomagnetic activity, aa, the planetary equivalent amplitude, Kp, and the sunspot number, Rz, throughout a period of (1880-2011) have been examined.

2. Data analysis

We investigate the effects of solar and geomagnetic parameters on the mean surface air temperatures (MSAT) recorded at countries which covers a wide range of geographic latitudes. In this case, we have selected three countries via northern hemisphere which are; USA, Russia, and India, as well as, Australia, Argentina and South Africa via southern hemisphere. This enables us to understand existence of solar activity effects on the regional and global temperatures. We used surface air temperature as climate parameters and geomagnetic activity index aa, sunspot number Rz and the planetary equivalent amplitude, Kp data as solar activity indicators. We considered the parameters temperature and solar activity indicators data for the period data ranging from the beginning of 1880 to the end of 2011.

To investigate Sun-climate relationship on local/global scales, we used only monthly surface air temperature data of USA, Russia, India, Australia, Argentina and South Africa since the ‘‘temperature is the most commonly, and presumably the most accurately, measured paramet er’’ (Hoyt and Schatten, 1997). The regional land-surface-air temperature data are available via (http://data.giss.nasa.gov/gistemp/table data/GLB.Ts.txt). In addition, data for sunspot numbers Rz were provided by the National Geophysics and Solar Terrestrial Data Center ,(http:// www. ngdc.noaa.gov/ stp/GEOMAG/aastar.shtml), The geomagnetic index Kp is available via (http:// www.swpc.noaa.gov/ftpdir/weekly/RecentIndices.txt), as well as, geomagnetic activity aa are available from the (http://www.wdcb.rssi.ru/stp/data/geomagni .ind/aa/aa/AA_ MONTH).

The raw temperature data used in this paper cover 53 stations at northern hemisphere and 44 at southern hemisphere whose chosen for which continuous records data were available. It is well known that the surface air temperature shows serious variations with the altitude. Altitudes of our data station vary between 0 and >850m. Thus, we obtained five sub-regions .Table (1) shows station number in each group and their elevation in meter.

TABLE 1.MSAT temperature groups

Temperature groups	**Number of Northern hemispheric stations**	**Number of Southern hemispheric stations**	**Elevation (m)**
G1	17	15	0-100
G2	14	15	100-300
G3	8	3	300-500
G4	8	8	500-<850
G5	6	3	>850
Total	53	44	0->850

There are few missed values in our raw data and the methodologies studies so far assume complete data, so we are forced to fit models and make statistical inference based on partially observed time series. The cubic Spline interpolation method was applied to obtain the continuity within the data. The temperature data used in this study covers the period from 1880 to 2011. To remove monthly and seasonal changes, all griddled monthly data were smoothed with 12-month running average. Removing a trend from the data enables you to focus your analysis on the fluctuations in the data about the trend. So we apply trend removal method by using MATLAB to all data set used in this study.

A series of power spectral density (PSD) of the monthly values for geomagnetic index aa, sunspot number Rz, the planetary equivalent amplitude, Kp and the mean surface air temperature (MSAT) of northern and southern hemisphere at different altitudes G1, G2, G3, G4, G5and G's that the average of the groups have been performed. The results of PSDs were smoothed using the Hanning window function. This is necessary since most of the disturbed features will completely disappear, while the significant peaks are clearly defined. Nevertheless, the particular window chosen dose not shifts the positions of the spectral peaks. Next, each spectrum is independently normalized to the largest peak in the complete spectrum. This restriction was chosen in order to avoid spurious strengths often associated with peaks near the start and end of the data set. This normalization dose not introduces any errors into our identification of the peaks because it changes only the relative amplitude and not the position of the peak spectrum.

3. Results and Discussion

The Sun expels several products of its activity to the interplanetary medium, namely electromagnetic radiation, energetic particles, solar wind and transient ejecta with a frozen in magnetic field. The solar radiation is the fundamental source of energy that drives the Earth's climate and sustains life. The variability of this output certainly affects our planet. The solar wind is pumped up with intense magnetic fields that extend far out into interplanetary space, blocking more cosmic rays that would otherwise arrive the Earth. The resulting decrease in cosmic rays mean that fewer energetic particles penetrate to lower atmosphere where there may help produce cloud, particularly at higher latitudes where the shielding by Earth's magnetic field is less. The reduction of clouds, that reflect sunlight, would explain why the global surface temperature gets hotter when the Sun is more active. The variability in ultraviolet radiation expels from the Sun affects the ozone in the upper atmosphere and thus may lead to a temperature change. Thus, solar variability provides a reasonable match to the detailed ups and downs of the temperature record (Lang, 2001). The longest historical records of the solar variability are the sunspot number. It is the number of the dark spot that appear in photosphere and it is reflected the magnetic activity of the sun. In the middle of the 19th centuries it was discovered by druggist H.Schwabe that the number of spots on the sun varied in a cyclic manner with a characteristic time of about 11 years. After the sunspot numbers, aa index, the time series characterizing the geomagnetic activity provides the longest data set of solar proxies which goes back to 1868 (Mayaud,1972). The role of geomagnetic activity in the climate change becomes a topic theme of many recent studies. Close relations during the last 60 years were found between the geomagnetic activity and surface air temperature (Valv, 2006).

Figure 1, shows the 12-month running averages of the Northern and southern hemispheric surface air temperatures Plot (1a,1b) and trend for each (G's) that the average of the groups have been performed, they have similar long-term variations and they closely correlate. It displays a substantial month-month variability of both hemispheric surface air temperature, as well as, coherent long-term change over the period 1880 to 2010. The time interval is based on the coverage of both pre- and post-industrial growth era witnessed (~1930's). The Hemispheres are seen to show a broad variation with clear minimum near the ending of the 19th century (~1882).

Trends in monthly mean temperatures for both hemispheres time series shows quite a bit of variability from the beginning of the record through about 1920. A significant warming of about 0.3°C is observed in both series from about 1920 through the early- to mid-1940s, followed by a less dramatic cooling in both series through about the mid-1960s. From the 1970s through recent years, rapid warming is observed in both series. The northern and southern hemisphere trends series show some general similarities, e.g., little sign of trends before about 1920, an increasing trend ending with a peak in the early 1940s, some cooling from the 1940s through the mid-1970s, followed by strong warming thereafter, with the highest temperatures occurring after 1990. The overall trend for the northern hemisphere is somewhat higher than that of the southern hemisphere. The relatively cool years of the early 1990s (mainly 1992 and 1993) are believed to have resulted from the effects of the dust veil produced by the eruption of Mt. Pinatubo (Parker et al. 1996).

It should be noted that Hemispheres climate system has displayed irregular and progress changes (or increases) during the second half of the 20th century to the beginning of the 21st century, especially for the last four decades (1970-2010). Thus, the interesting to this subject is therefore continually increasing. The Southern Hemispheric temperature variability showed a strong warming trend over the earlier period (1881-1912) than for the past 40 years (1970-2010). The increase in hemispheres temperature for the earlier years was faster and smoother than in the second warming phase.

An important feature is that the hemispheres temperature rose between 1881 and 1912, which it was considered as the first warming period. The concentration of the man-made gases (greenhouse gases) increased and occurred after 1930 and therefore, it cannot be the cause of the warming that occurred within earlier years. Then, there was a cooling period (or constant period) from 1913 to around 1970, followed by a second phase of warming from 1970 to 2010.
In the Northern Hemisphere plot(1a), The 2001 meteorological year was the warmest year over the record (+1.1 ºC), while the second and third warmest years were 1948 (+0.9 ºC) and 1931 (+0.8 ºC), respectively. In contrast, the coolest monthly mean temperature was (-1ºC) in 1968 and increased to the highest one in 2001, as well as, The 1914 was warmest year in the Southern hemisphere over the record (+1.17 ºC) and 1907 was the coolest monthly mean temperature .On the other hand, the constant period maintained of high temperatures and it had a tendency (or behavior) to slowly cooling. These results might have progressively played a dominant role in the Hemisphere's climate change during the last few years.

Figure (1) displays the time series of 12-month averages for aa, Rz, and Kp. Plot (1d) illustrates that Rz has a cyclic variation with a minimum reaching the same level of the preceding cycles, while Plot (1c) displays the monthly aa running means, showing the increasing trend of aa with double peaks during the maxima solar activities. Some periodic structures are seen.

For a comparison between Northern and Southern hemispheric surface air temperatures and aa, we notice the following: during the period 1970-2008, the aa geomagnetic magnitude values have greatly increased than the previous years. The largest peak, over the considered period was in 2003, and the warmest year was 2008, of 5-yr apart. El-Borie's hypothesis displayed that the present changes in aa geomagnetic may reflect partially some future changes in the global surface temperatures (El-Borie and Al-Thoyaib, 2006). The magnitudes of aa have greatly increased throughout the last four decades and the highest peak over the considered period was found in 2003 corresponding to the warm year was 2008. On the other hand, the second largest peak in aa spectrum occurred in 1992. For comparison, the separation-time between the second warmest year in 2003 and the greatest geomagnetic is about a few years, which may be indicated that the geomagnetic index aa is a considerable future factor on the magnitude of the mean surface air temperature with a lag time.

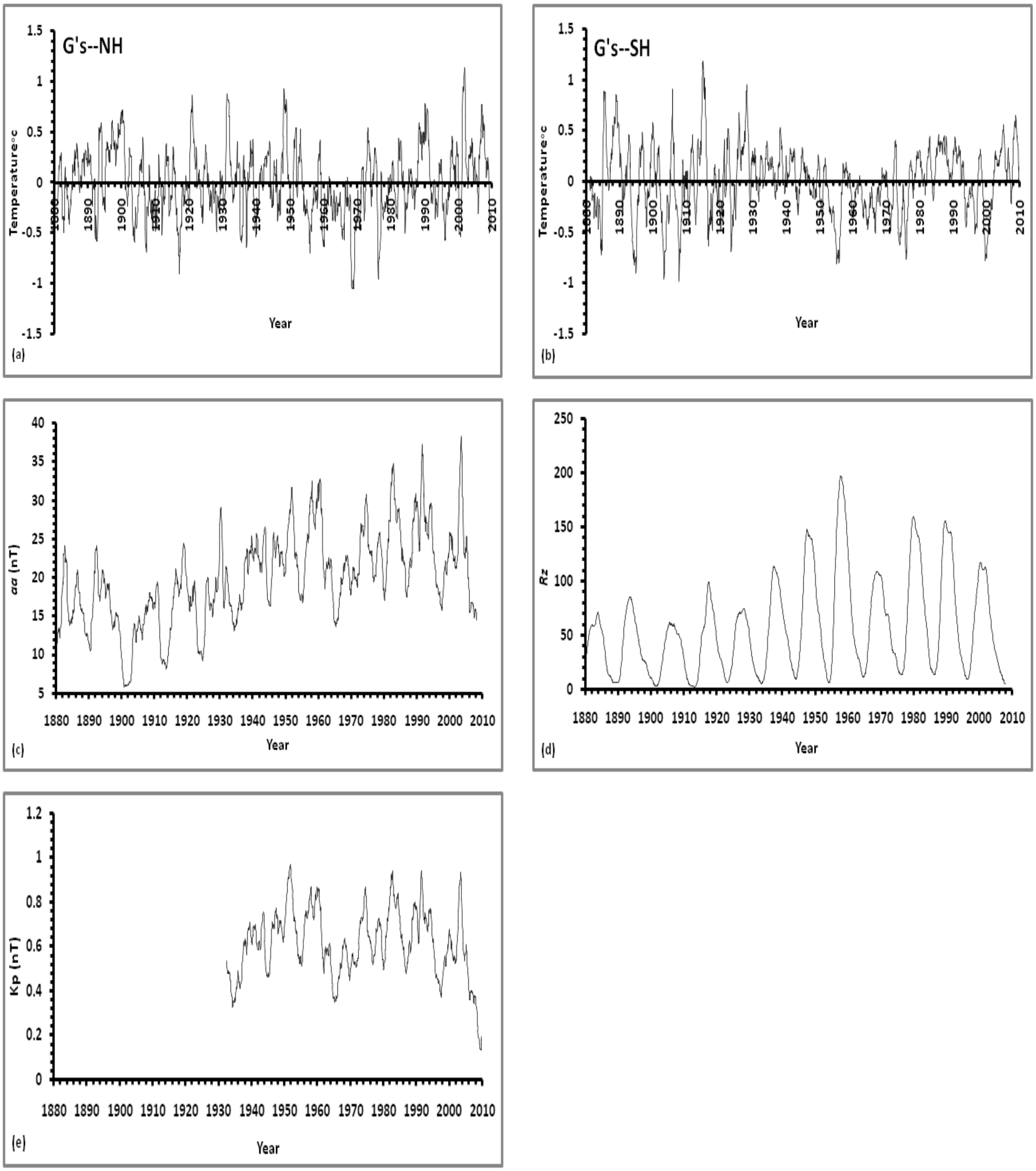


FIGURE 1. Northern hemisphere, Southern hemisphere surface temperature monthly relative to the period 1880-2011, sunspot number, Rz, aa, and Kp .A 12-year running mean was applied to the monthly time series.

Figure 2.1, 2.2 (plots a-e) displays the normalized power spectral density for mean hemispheric temperature monthly for all groups (G1 to G5). The power spectrum density is calculated for the wide range of frequencies (2.5x10-3 - 0.5 c/m), which corresponding to a range from 33.3 year to 1 month.

Plots show that there are no significant peaks observed in the high-frequency region > 4x10-2 c/m corresponding to the period from 1 month to less than 2 yr. A flat spectrum for the short-term fluctuations is observed. At the selected frequencies (>5 yr) the spectral density is high and it shows significant variations.

In plot 2.1a, there are remarkable spectral peaks for G1 that located at 14.2, 10, 8.1, 7.4, 5.8, 5.3, 4.6, 4.1, 3.1, 2.6, 2.4, and 1.8 years. The following plot (2.1c), for the spectra of G3, display significant peaks at wavelengths of 14.2, 10, 8.5, 4.8, 4.1, 3.1, and 2.6 year. Furthermore, the plot (2.1e) shows significant peaks of G5 at 14.2, 9.4, 8.5, 5.8, 4.4, 3.4, 2.6, 2.1, and1.8 year. So, significant peaks in the three plots exists 14.2, 10, 3.1-4.6 and 2.6 yr, indicating the same origin effect. We can easily see that the various peak along the spectra of G2 and G4. Significant peaks in the two plots exist at wavelengths of 17, 13.1, 10, 8.5, 7.4, 5.3, 4.6, 2.6, and 2.2 yrs for G2 and at 18.9, 13.1, 10, 8.1, 5.3, 4.6, 3.3, and 2.9 for G4. It has been noticed that the spectrum variations observed for G2 and G4 are more pronounced than that other, indicating to different formation mechanism causes. There exists a difference in the peak amplitude by a factor of two hundreds.

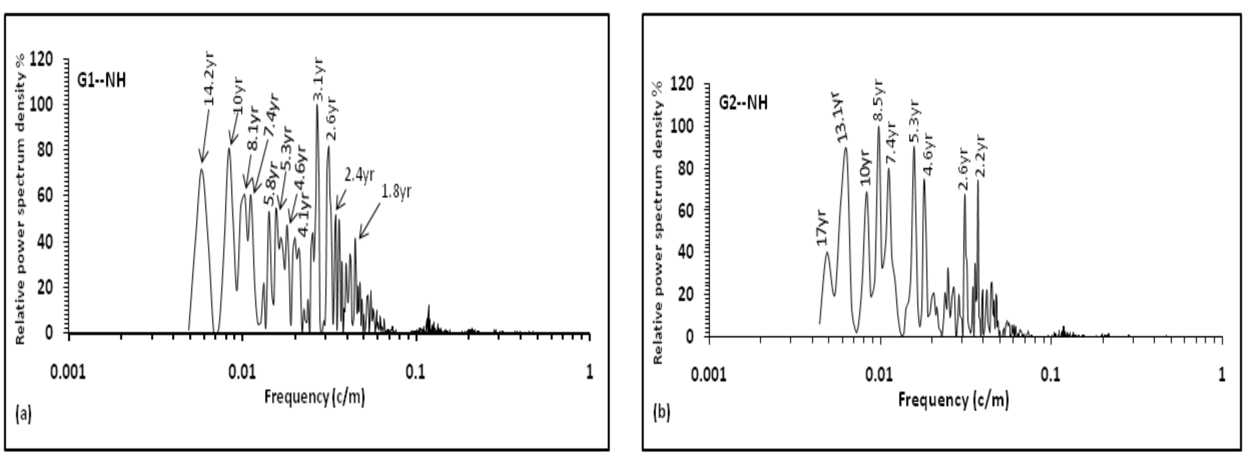
It is obvious from Figure 2.2 that prominent period of ~22 year corresponding to Hale cycle have been detected on group G1only, with different amplitudes. It is necessary to point out that absence of the role of solar activity every 11-year. This displays that the interplahnetary magnetic field (IMF) effect is a solar forcing and more effect on MSAT than the solar activity cycle. Significant peaks are observed (plot 2.2a) for G1 at wavelengths of 21.3, 15.5, 11.3, 10, 5.8, 5, and 2.1yr, while (plot 2.2b) of G2 displayed peaks at wavelengths 9.4, 6, 4.7, 3.8, and 3.2 yr. In addition, the spectra (plot 2.2c) of G3 shed the significant peak at 10.6, 7.7, 5.6, 3.7, 2.5, and 2.3 yr. In (plot 2.2d), the G4 spectrum showed the remarkable peak of 24.3, 17, 13.1, 11.3, 8.9, 7.4, 5.6, 5.1, 4.2, 3.2, and 2.5 yr. Also in (plot 2.2e) of G5 displayed peaks at wave length 12.1, 8.5, 6.5, 5, 4.2, 3.2, and 2.3 yr.

A common significant peaks appear in all the spectra of mean northern and southern hemisphere surface air temperature, which is caused by the dual-peak structure of the geomagnetic activity or it is caused by sector boundary of crossings of the achieved regions in the solar, as previously reported (Prestes et al ., 2006).

Figure (2.3) shows the spectral analyses of Northern, Southern hemispheric surface air temperature and solar indices which significant peaks are observed (plot 2.3a) for the northern surface air temperature at 28.4, 14.2, 10, 8.5, 5.8, 5.3, 4.6, 3.2, 3, 2.6, 2.4 and 1.8 year, While (plot 2.3b) of southern surface air temperature displayed peaks at wavelengths 24.3, 15.5, 11.3, 8.9, 6.3, 5.8, 5.1, 3.7, and 2.5 year. In addition, (plot 2.3c) display peaks of aa at 21.3, 14.2, 10.6, 8.9 and 5.1 year. In (plot 2b), the spectra of Rz shed the significant peak at 10.6 yr. Also in (plot 2d) of Kp displayed peaks at wave length 10.6, 8.5, 5.3, and 3.5 yr. Furthermore, significant peak at 10.67 year appear in all solar indices, which is the most established cycle of the solar activity.

A simple explanation for ~ 8.2 - 8.3 year peak in aa is that it may be related to the formation rate and the magnetic structure of achieving regions in the solar southern hemisphere (McIntosh et al.,1992). The period of 5.1 years in aa could be the 11-year solar cycle first harmonic, or it could be caused by a solar wind density periodicity. Stamper et al, (1999) have determined that solar wind density is one of the most important parameters that controls geomagnetic activity, thus it is possible that this period in geomagnetic aa data could be a consequence of solar wind density variation (Dmitriev, et al; 2000; Prestes et al., 2006). We found similar fluctuations of 14.2-15.5, 10-10.6-11.3, 8.5-8.9, 5.1-5.3, 3.7-4.3-4.6 between aa, Northern Hemisphere & Southern Hemisphere. Also, we found similar peaks 10-11.3-10.6, 8.5-8.9, 5.1-5.3, 3.2-3.5-3.7 between Kp & Northern Hemisphere, Southern Hemisphere surface air temperatures.

Table (2) indicates the observed periodicities for the five temperature regions and the studied solar indices for the 1880–2011. The observed spectra of Northern Hemisphere, and Southern Hemisphere showed peak of 28.4-24.3 yr, which it is related to the solar magnetic cycle polarity reversals (Hale cycle). Another peak of 10.6 yr is seen with lower magnitude than that of 22-cycle obviously (KasatKina et al., 2007). The 10.6 yr appear in spectra of aa, Kp and Rz with a little shift in NSAT&SSAT spectrum. The 5.1-5.3 year variation found in temperature groups and solar geomagnetics aa may be attributed to the different paths of the ion particles (cosmic rays). Similar periodicities of 5-5.2 years in the solar wind speed and ion spectral density were found (El-Borie, 2002; El-Borie and Darwish, 2006).



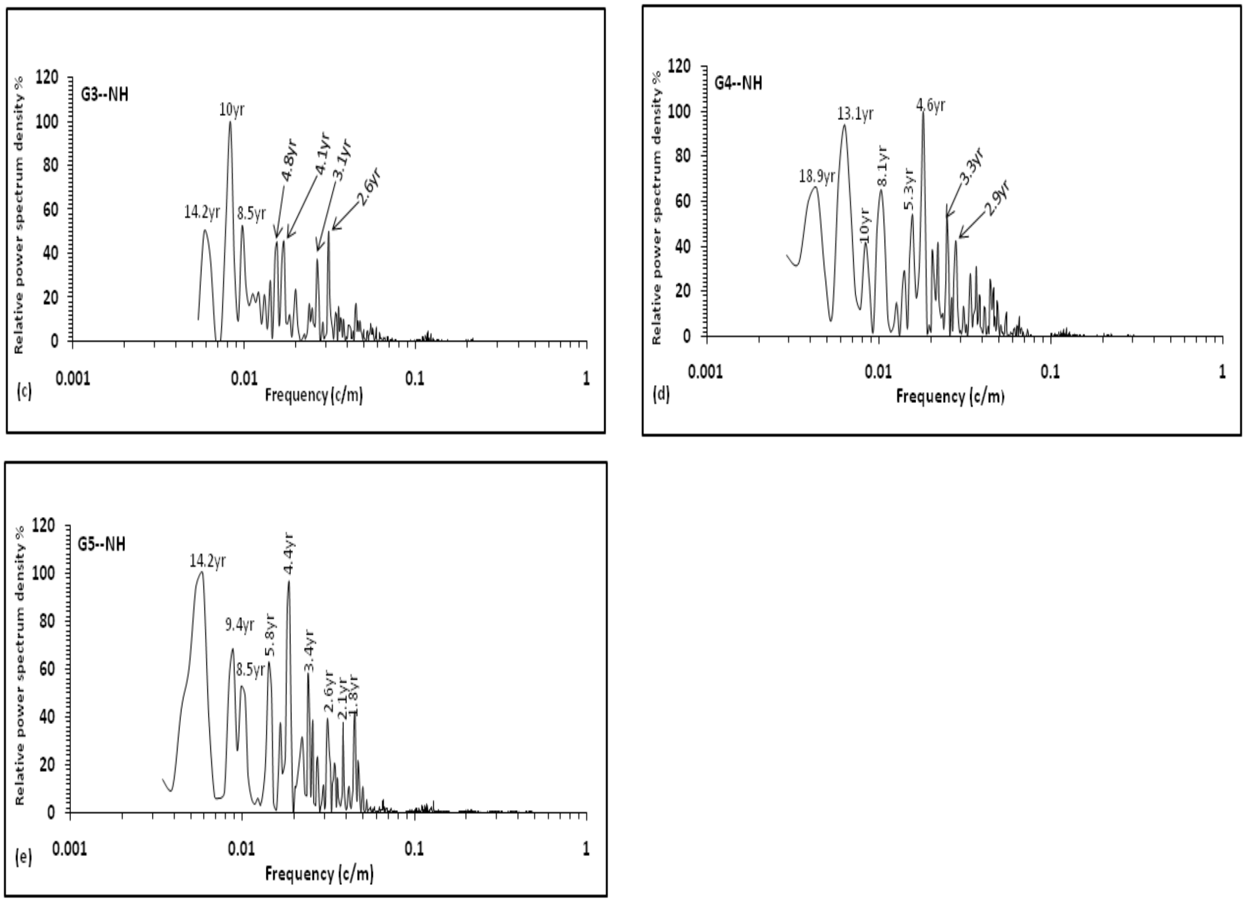
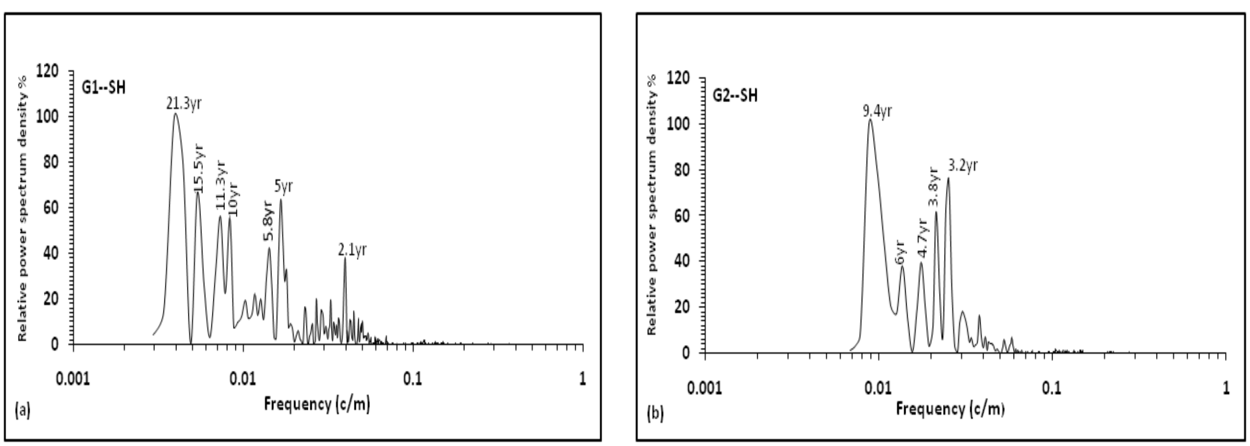


FIGURE 2.1. The normalized power spectra density for each group.



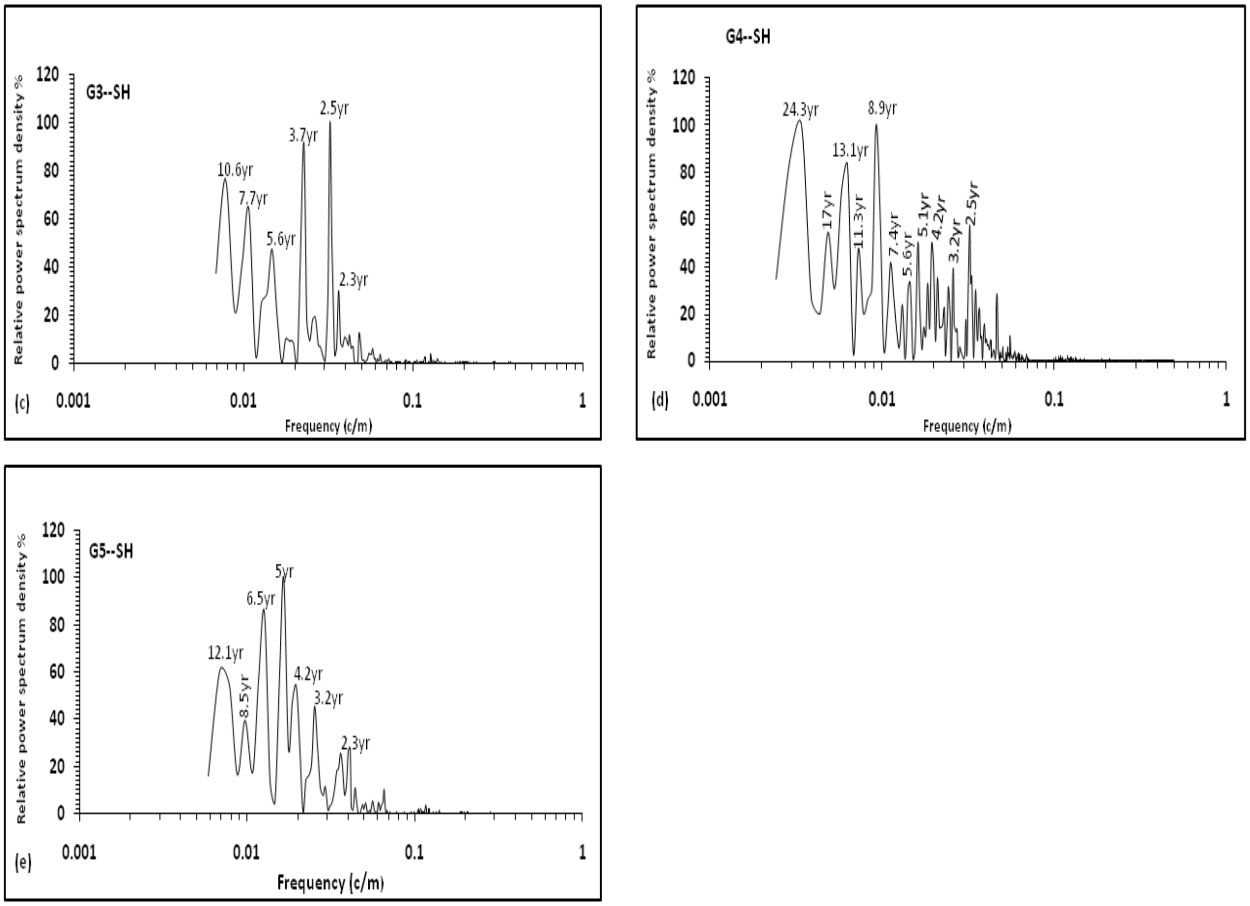
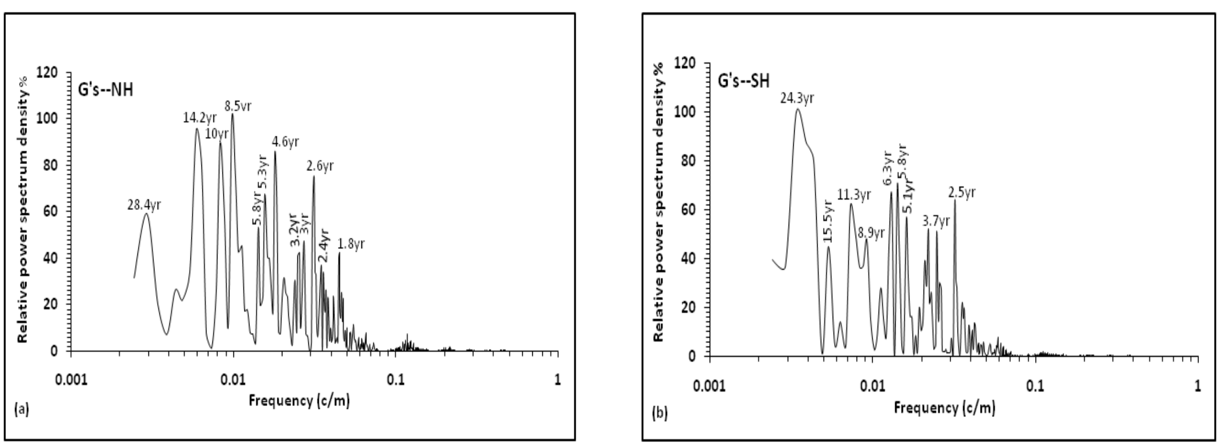


FIGURE 2.2. The normalized power spectra density for each group.



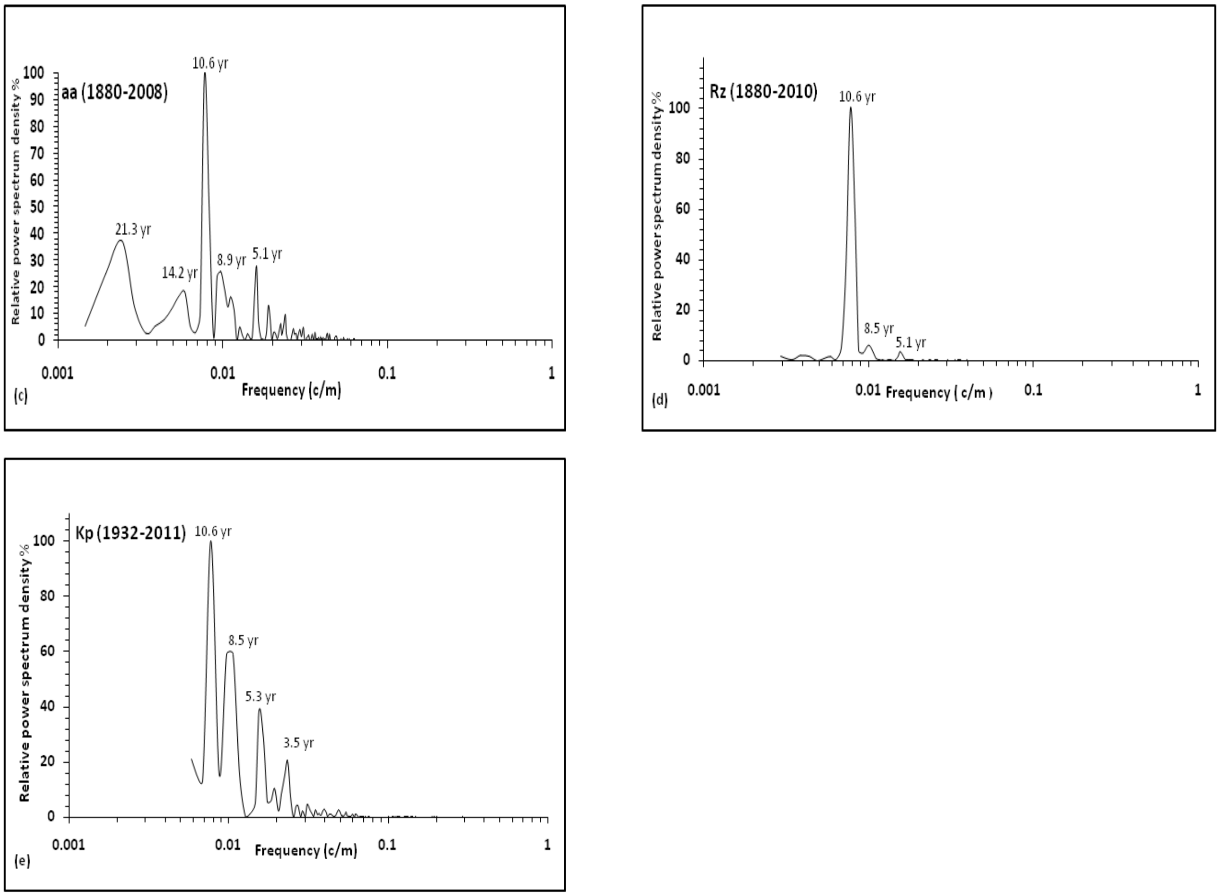


FIGURE 2.3. The normalized power spectra density for the Northern, Southern hemispheric temperatures, the geomagnetic indices aa and Kp and the sunspot number Rz.

TABLE 2. Observed spectral periodicities for the five temperature regions and the solar indices

Period Years	Main period existence significant														
	Groups of Northern hemisphere						Groups of Southern hemisphere						Index		
	G1	G2	G3	G4	G5	G’s	G1	G2	G3	G4	G5	G’s	aa	Kp	Rz
1.8-1.9	1.8	---	---	---	1.8	1.8	---	---	---	---	---	---	---	---	---
2.1-2.9	2.4, 2.6	2.2, 2.6	2.6	2.9	2.1, 2.6	2.4, 2.6	2.1	---	2.3, 2.5	2.5	2.3	2.5	---	---	---
3-4.8	3.1, 4.1, 4.6	4.6	3.1, 4.1, 4.8	3.3, 4.6	3.4, 4.4	3, 3.2, 4.6	---	3.2, 3.8, 4.7	3.7	3.2, 4.2	3.2, 4.2	3.7	4.3	3.5	---
5-7.7	5.3, 5.8, 7.4	5.3, 7.4	---	5.3	5.8	5.3, 5.8	5, 5.8	6	5.6, 7.7	5.1 ,5.6, 7.4	5, 6.5	5.1, 5.8, 6.3	5.1	5.3	---
8.1-9.5	8.1	8.5	8.5	8.1	8.5, 9.4	8.5	---	9.4	---	8.9	8.5	8.9	8.9	8.5	---
10-11.3	10	10	10	10	---	10	10, 11.3	---	10.6	11.3		11.3	10.6	10.6	10.6
12.2-15.5	14.2	13.1	14.2	13.1	14.2	14.2	15.5	---	---	13.1	12.1	15.5	14.2	---	---
17-21.3	---	17	---	18.9	---	---	21.3	---	---	17	---	---	21.3	---	---
24.3-28.4	---	---	---	---	---	28.4	---	---	---	24.3	---	24.3	---	---	---

CONCLUSION

In this paper we tried to find out the relation, over a long time period from 1880-2011, between the change in the regional/global surface temperature and solar geomagnetic activist represented by sunspot number (Rz) and geomagnetic indices (aa , Kp), and to what degree they are connected. We divided our temperature data into five groups. A series of power spectral density (PSD) have been performed for the 12-month running averages for solar indices and all groups from 1880 to 2011. PSD graphs shows that the aa geomagnetic activity index has the strongest effect on temperature groups. We conclude that solar variability parameters play an important role in climate change and cannot be excluded from the responsibility of continuous global warming. We think that the combined effect of solar-induced changes and increase in the atmospheric greenhouse gases offer the best explanation yet for the observed rise in average global temperature over the recent years.

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