Investigation on the Relation Between the Insolation and Cosmic Radiation and Their Effect on Global Warming

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ABSTRACT

The amount of heat received on 21 different cities from different countries in Northern and Southern hemisphere were analyzed and modeled .This was made by taking the annual average of temperature from 1998 to 2005 for selected cities in different countries and calculating the area under the temperature – year curve. This curve was made by using the best polynomial fitting.

The rate of change of the temperature was calculated for each city. We found that 9 cities (Doha, Amman, London, Cairo, Abu Dhabi, Muenchen, Muharraq, Kuwait and Muscat) exhibit an increase rate of change in temperature (warming) while four cities (Riyadh, Beijing, Paris, Adelaide) exhibit no change of rate and eight cities (Tokyo, Washington, Tehran, Madrid, Budapest, Buenos Aires, Lima and Wellington) exhibit a decrease rate of change in temperature (cooling). The highest negative rate of change (cooling) was in Wellington, New Zealand (-0.0004) and the highest positive rate of change was in London and Doha (+ 0.0003). The amount of heat received by each city during that period was maximum (3120.97 units) in Dhabi, United Arab Emirates, (mean temperature = 28 °C) and minimum (959.77) in Muenchen, Germany, (mean temperature = 9 °C.

The sinusoidal temperature –like curves pattern of each city were then compared with the sunspot cycle curve (minimum spots in 1998 of 64 spots, maximum in 2000 of 111 spots and minimum in 2005 of 30 spots) as well as the cosmic radiation curve (maximum flux in 1998 of 6328 counts/min, minimum in 2003 of 5710 counts/min and maximum in 2004-2005 of nearly 6070 counts/min) for the same period. The results show clear evidence of the correlation between these three parameters with more evidence in cities at the northern hemisphere. The solar radiation, the sunshine duration and the UV radiation incident on Bahrain was used to support the effect of the above three parameters on the climate change.

KEYWORDS: Cosmic radiation, Sunspot, Cloud cover, Climate change, Ultraviolet, Solar radiation.

INTRODUCTION

Cosmic rays consist mainly of protons. When cosmic ray particles enter the Earth's atmosphere they interact with the nuclei of the air molecules to produce secondary radiation. This consists of pions (which decay to muons) and a shower of protons and neutrons. The neutrons predominate in this secondary radiation because the protons, being charged are more easily attenuated in subsequent travel. The cosmic ray detector actual detects these secondary neutrons and as a consequence is referred to as a neutron monitor (www.ips.gov.au/Geophysical/1/4). It is believed that they originate from supernovae -the last stage in steller evolution and its stellar end-product, i.e. neutron stars of density 10^{15}gm/cm^3 and radii about 10km and mass from 0.2 to 2 Sun's mass-Pomerantz 1971. The rate of supernova in our galaxy is about two per century. Cosmic rays were originally discovered because of the ionization they produce in our atmosphere. Cosmic rays also have an extreme energy range of incident particles, which have allowed physicists to study aspects of their field that can not be studied in any other way. Cosmic rays are observed indirectly by a device known as a neutron monitor.

Scientists have postulated that cosmic rays can affect the earth by causing changes in weather. Cosmic rays can cause clouds to form in the upper atmosphere, after the particles collide with other atmospheric particles in our troposphere. This in turn will reduce the incident solar radiation (insolation) as well as reducing the actually measured sunshine radiation (as well as UV radiation) due to the cloud cover.

Kristjánsson et al. 2004 had studied eighteen years of monthly averaged low cloud cover data from the International Satellite Cloud Climatology Project are correlated with both total solar irradiance and galactic cosmic ray flux from neutron monitors. When globally averaged low cloud cover is considered, consistently higher correlations (but with opposite sign) are found between low cloud variations and solar irradiance variations than between variations in cosmic ray flux and low cloud cover.

Razmadze 2004 had studied the effects of the eleven-year solar activity cycle on the hard component of cosmic rays is examined on the basis of data on variations of the intensity of the meson component of cosmic rays for the period 1956-1965. Coefficients for the correlation of the activity of the solar hemispheres and the intensity of the hard and neutron components of cosmic rays are considered with particular attention paid to the effects of sunspot cycles.

Alnaser and Al-Othman 1991 found a strong correlation between the cosmic rays flux, sunspot number, temperature, solar and UV radiation. The cosmic rays and the secondary particles they create ionize enough of the atmosphere to disturb the entire planetary electrical circuit. The details of the circuit changes are still under study, but there seems no question about cosmic rays initiating thunderstorm activity (Lethbridge 1981).

Bazilevskaya 2005 studied the Influence of the Sun's Radiation and Particles on the Earth's Atmosphere and Climate. He found that Solar Energetic Particles (SEPs) constitute a distinct population of energetic charged particles, which can be often observed in the near Earth space. SEP penetration into the Earth's magnetosphere is a complicated process depending on particle magnetic rigidity and geomagnetic field structure. Particles in the several MeV energy range can only access to periphery of the magnetosphere and the polar cap regions, while the GeV particles can arrive at equatorial latitudes. Solar protons with energies higher than 100 MeV may be observed in the atmosphere above $\sim$30 km, and those with energies more than 1 GeV may be recorded even at the sea level. There are some observational evidences of SEP influence on atmospheric processes.

Bago and Butler 2000 had analyzed the new ISCCP (International Satellite Cloud Climatology Project) - called D2 cloud data - which cover the period from 1983 to 1994 (three years longer than the previous ISCCP - called C2 - and believed to be superior in its detection of low clouds at high latitudes and its ability to distinguish cloud type. They concluded that much of the warming of the past century can be quantitatively accounted for the direct and indirect effects of solar activity. Over even longer periods, resort to indices based on isotope abundance such as C-14 in tree rings and Be-10 in ice cores, the inferred change in low-cloud factor from the Heliocentric Potential, an interplanetary magnetic field index - which is based on a combination of carbon isotope concentration in tree rings - the aa index (solar magnetic field) and cosmic ray flux suggests a significant increase in low-cloud factor during the Maunder Minimum (1645-1715), leading to an increased albedo for Earth and a cooler climate during this time (Bago and Butler 2000).

Herein, we are attempting to explore the relation between the cosmic rays flux on Earth and the warming or cooling of the earth. This was made by studying the average temperature of 21 countries both from north and southern hemisphere both from west and East and comparing its annual variation from 1995 to 2006. This was followed by comparing the long-term annual mean for certain cities to each individual yearly average temperature. Furthermore, we had studied the variation pattern of insolation and UV radiation as well as the sunshine duration - recorded from 1998 to 2005 - and compared with the temperature and cosmic rays pattern.

METHODOLOGY

The Temperature data are a monthly mean values averaged using an hourly data from the met stations at the local airports of the different countries.

Although cosmic ray fluxes from neutron monitors is known to vary at different sites to one another we had taken Cosmic Ray station of the University of Oulu (Sodankyla Geophysical observatory), Finland (http://cosmicrays.oulu.fi/#database). It provides a data from one long - duration site (1995-2005). There is a delay between the maximum and minimum which can be attributed to the fast solar wind and recurrent geomagnetic storms produced by near - equatorial cornol holes during the descending phase of the solar cycles (Bago and Butler, 2000).

The Sunspot data are the International Sunspot Number which is complied by the Sunspot Index Data Centre, Belgium, (http://solarscience.msfc.nasa.gov/SunspotCycle.shtml).

Matlab code where written to find the polynomial fit for each trend of temperature versus time curve and we had made the best polynomial fit. We made graphs representing the monthly mean temperature from Jan 98 to Dec 05. The total area under the curve for each fit where calculated and was called the heating units (in arbitrary units) - Figure (1).

RESULTS AND DISCUSSION

All the data used in this analysis are covering a period of eight years 1998 to 2005. Using Matlab, the polynomial fit (Equation (1)) for each set of data for a particular city were found (Table (1)).

$$T = a + a_1 \sin(\frac{2\pi x}{24}) + a_2 \cos(\frac{2\pi x}{24}) + a_3 \sin(\frac{4\pi x}{24}) + a_4 \cos(\frac{4\pi x}{24}) + a_5 \sin(\frac{6\pi x}{24})$$
$$+ a_6 \cos(\frac{6\pi x}{24}) + a_7 \sin(\frac{8\pi x}{24}) + a_8 \cos(\frac{8\pi x}{24}) \quad (1)$$

Table 1. The polynomial equation parameters

Country	a	a1	a2	a3	a4	a5	a6	a7	a8
Doha, Qatar	27.83	-0.27	-0.10	1.10	-8.09	-0.05	-0.57	-0.05	0.25
Riyadh, Saudi Arabia	26.32	-0.02	0.08	-0.95	9.55	0.16	-0.41	-0.06	0.27
Amman, Jordan	17.38	-0.09	-0.37	0.58	-8.23	0.05	0.02	-0.27	-0.27
Tokyo, Japan	15.89	-0.48	0.32	1.00	8.75	-0.02	0.00	-0.21	0.12
Washington DC, USA	14.02	-0.12	0.53	1.71	-10.50	0.23	0.19	-0.03	0.31
Tehran, Iran	17.88	-0.28	-0.40	1.79	-11.57	0.17	0.54	0.02	-0.02
London, UK	9.89	-0.24	0.19	-3.85	-4.68	0.64	-0.44	-0.09	-0.02
Cairo, Egypt	21.70	-0.02	-0.41	0.61	-6.70	0.14	-0.03	0.00	0.14
Abu Dhabi, UAE	27.91	-0.14	-0.02	0.88	-7.38	0.29	-0.09	-0.14	0.33
Muenchen, Germany	8.56	-0.25	0.12	-1.35	8.47	0.08	-0.22	-0.18	0.22
Muharraq, Bahrain	26.73	-0.18	0.12	0.42	7.87	-0.09	-0.36	-0.15	0.26
Beijing, China	12.36	-0.40	0.01	-2.11	12.81	0.09	-0.42	-0.04	0.14
Paris, France	11.33	-0.15	-0.06	-0.58	6.98	0.34	-0.09	-0.06	0.12
Madrid, Spain	13.99	0.24	-0.01	-0.60	8.45	0.21	0.2	0.16	-0.28
Budapest Ferihegy, Hungary	9.94	-0.38	0.34	-1.46	9.64	0.12	-0.35	-0.41	0.26
Buenos Aires, Argentina	17.24	0.23	-0.02	-1.08	5.45	0.38	0.17	0.05	-0.12
Lima, Peru	19.02	0.43	0.17	0.92	3.16	0.39	0.30	0.00	-0.22
Wellington, New Zealand	13.37	-0.14	0.00	0.02	3.32	0.24	-0.02	0.31	-0.04
Adelaide, South Australia	15.84	0.15	-0.23	-0.67	4.85	0.31	-0.08	-0.20	0.15
Kuwait, Kuwait	26.03	-0.33	-0.31	2.16	-11.16	0.13	-0.02	-0.05	0.15
Muscat, Oman	27.57	0.08	-0.07	2.03	-5.50	-0.22	-0.98	0.10	0.00

Using the polynomial fit equation and integrating for the whole period we were able to calculate the area under the curve along with the rate of change and the mean temperature for each country as well as the rate of change of the temperature was calculated for each city (Figure (1)). We found that 9 cities (Doha, Amman, London, Cairo, Abu Dhabi, Muenchen, Muharraq, Kuwait and Muscat) exhibit an increase rate of change in temperature (warming) while four cities (Riyadh, Beijing, Paris, Adelaide) exhibit no change of rate (since the rate – either positive or negative - is too low, i.e. less that 0.00001) and eight cities (Tokyo, Washington, Tehran, Madrid, Budapest, Buenos Aires, Lima and Wellington) exhibit a decrease rate of change in temperature (cooling). The highest negative rate of change (cooling) was in Wellington, New Zealand (-0.0004) and the highest positive rate of change was in London and Doha (+ 0.0003). The geographical location (latitude, longitude, elevation from sea level, topology of the city, and vicinity to sea) is predominating the weather pattern.

One expects that most cities will exhibit highest mean temperature in 1999 (as was announced to be the warmest year to earth) but the reality is not. Only four cities shows maximum mean in 1999 (Saudi Arabia, London, Abu Dhabi, and Kuwait) - all at the northern hemisphere- while there were five cities shows maximum mean in 1998 (Washington, Beijing, Lima, Wellington, Muscat, Jordon). There were four cities showing maximum mean in 2001 (Amman, Cairo, Paris and Buenos Aires). The temperature variation shows no much systematic pattern. Although it is expected to see a trend of reducing temperature as we depart from 2002 - due to increase of cosmic rays flux and decrease of sunspot - this was not found in all cases. This surely indicates the influence of many other parameters such the increase level of CO_2 ,Ozone concentration, changing of vegetation area, Ocean temperature and its currents, volcanoes and forest fires, other natural and human made disasters.

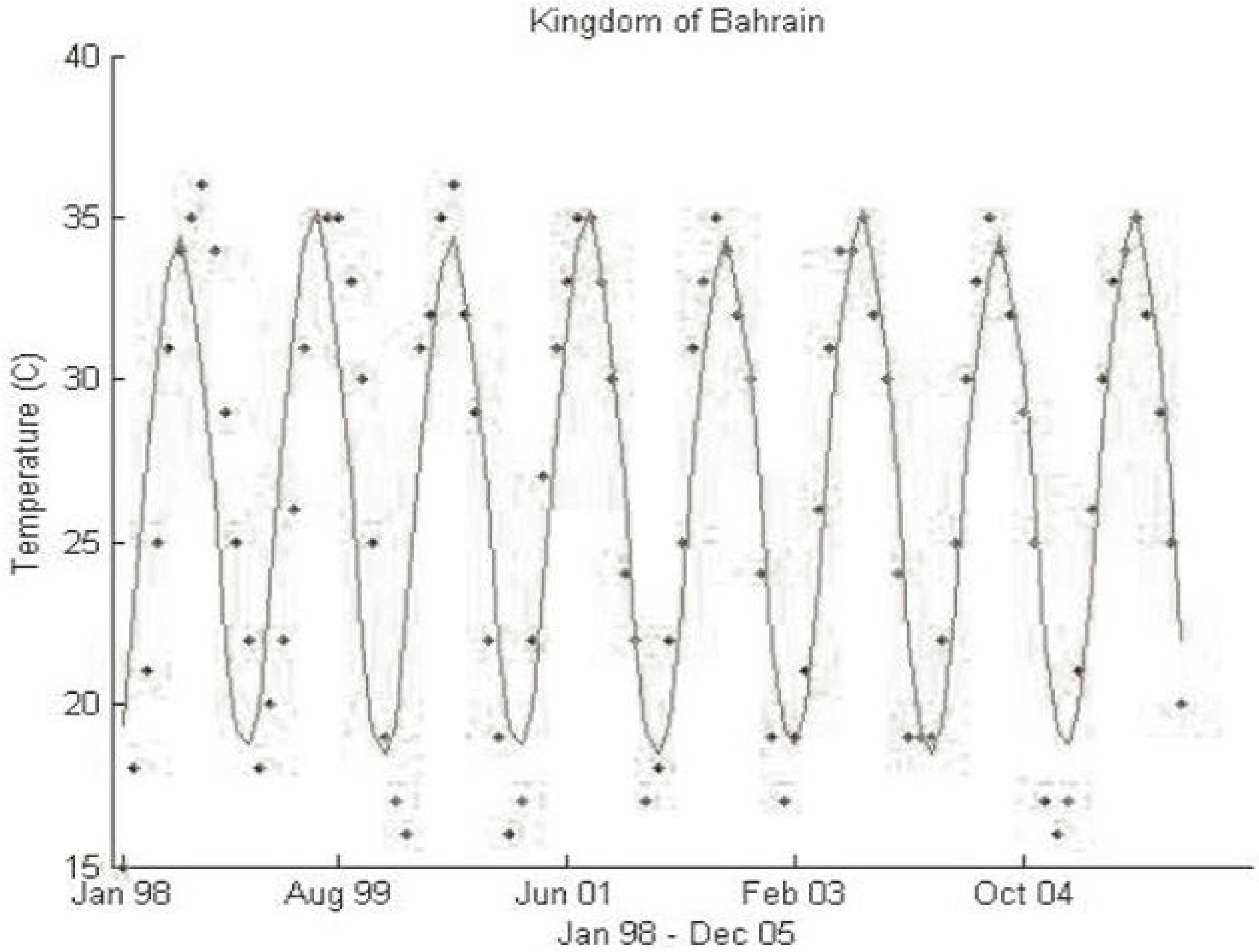

Figure 1. The yearly mean Temperature in Muharraq, Kingdom of Bahrain, for the period from 1998 to 2005.

Figure (2) shows the inverse relation between the cosmic rays flux on Earth and the sunspot numbers, i.e., as the sunspots peaks (in 2000) the cosmic rays flux become nearly least. One shall not forget that there is a time lag due to various mechanisms (Alnaser & Merza 2003). It is well known that during periods of higher solar activity (large sunspot numbers) the interplanetary magnetic field sector structure is distorted and hence less cosmic rays flux is detected on earth (Svensmark & Friis – Christensan 1996). In plotting the temperature variation versus the cosmic rays flux for each city (Figure (3) as a sample) we had found that the inverse proportionality between these two parameters was clear and obvious in Eight cities (Budapest, Paris, Muenchen, Riyadh, Kuwait, Buenos Aries, Wellington, and Cairo) and to a less extent in Six cities (Adelaide, Muscat, Doha, Amman, Washington and Madrid) and to even least extent in Seven cities (Lima, Beijing, Abu Dhabi, Tokyo, London, Tehran, and Bahrain). We have to mention that although the solar radiation incident on earth is affected by solar activity it affects is rather insignificant.

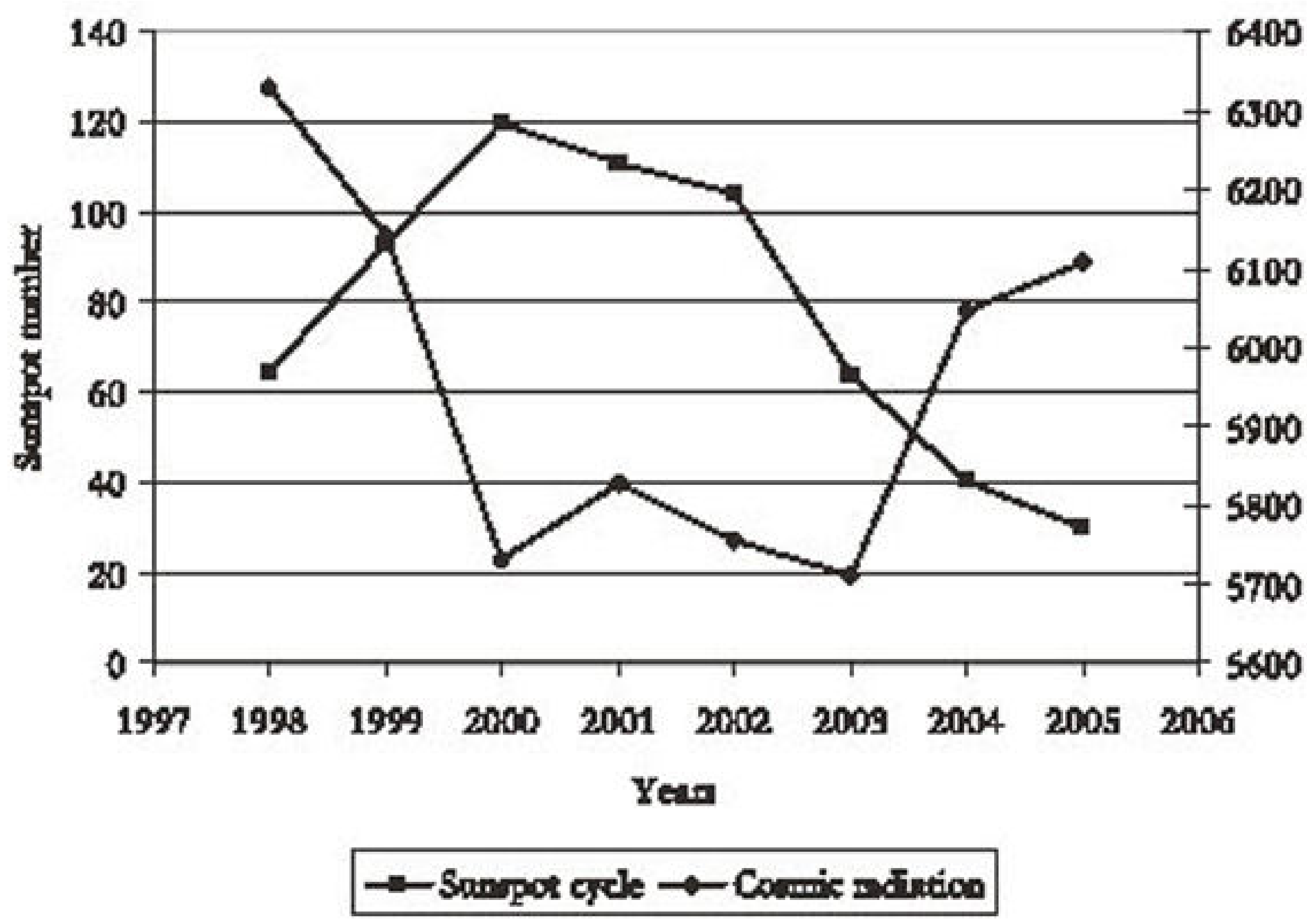

Figure 2. The relation between the sunspot number and the cosmic radiation.

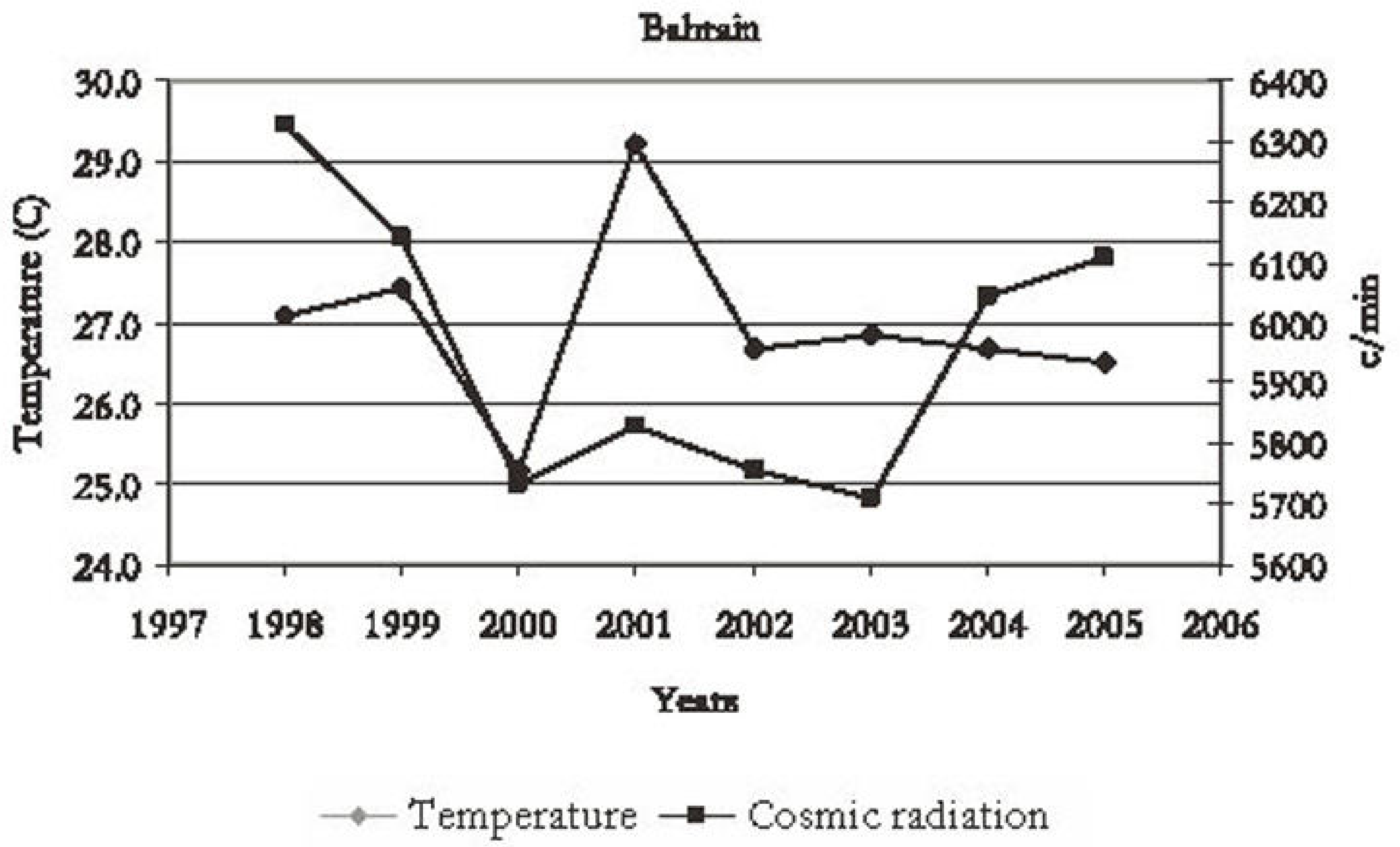

Figure3. Comparison between the cosmic radiation and the temperature in Muharraq, Bahrain.

One useful way to explore the cooling or warming trend of each city - due to variation of sun activity, and subsequently the cosmic radiation - is to compare these 8 years average temperatures (1998 to 2005) with the long term mean annual temperature.

Unfortunately, we managed to obtain few information on the long-term average temperature T_m. We found only Bahrain (T_m= 26.1°C refer to Alnaser & Merza 2005), London (T_m = 10.4°C, refer to http://roehampton.ac.uk/weather/pastcl.asp), Washington (Tm = 13.2°C, refer to www.bbc.co.uk/weather/world/city_guides/results.shtml?tt=TT001140), Budapest (Tm = 11.2°C refer to www.budapest.com/weather.htm), and Wellington (Tm = 12.1°C, refer to www.niwascience.co.nz/edu/resources/climate/modelling/). The results show that it tends to be, in general, cooler after the year 2003 - may be due to influence of the relatively high cosmic rays, as shown in Table (2).

Table 2. The increase (+) or decrease (-) in the average yearly temperature compared to the long term mean annual temperature, in °C.

City/ Year	1998	1999	2000	2001	2002	2003	2004	2005
Washington	+1.8	+1.2	+0.7	+0.9	+1.5	0	+1.1	+1.1
London	-0.5	-0.2	-0.5	-0.8	-0.2	-0.2	-0.2	-0.3
Muharraq	+1	+1.3	-0.9	+3.1	+0.6	+0.7	+0.5	+0.4
Budapest	-1.2	-0.5	+0.1	-1.0	+0.1	-1.2	-2.5	-2.7
Wellington	+1.7	+1.3	+1.0	+1.4	+1.4	+1.1	+0.5	+0.5

The table clearly shows that there was a trend of less warming in the years with high solar rays and less sunspot numbers. Budapest was toward cooling as well as Wellington but still its premature to draw a global observation .The generally accepted global mean near-surface air temperature is about 14°C. The ten warmest years of the global record (land plus ocean) have all occurred since 1990. These are, in descending order, 2005, 1998, 2002, 2003, 2004, 2001, 1997, 1995, 1990, and 1999. The average near-surface air temperature of the globe (land plus ocean) has warmed about 0.8°C since the late nineteenth century (http://cdiac.ornl.gov/trends/temp/hansen/hansen.html).

It is highly believed now that cosmic rays affect the earth's weather, by encouraging clouds to form in the earth's atmosphere, i.e. less incident solar radiation (insolation) and hence sunshine hours or cloud cover. We attempted to explore this relation by comparing the variation of the insolation and the sunshine hours in Bahrain - since we have a very precise data recorded at Bahrain Airport and the equipment is relatively new - for the period from 1998 to 2005. This is shown in Tables (3) and (4). For further evidence we had also studied the variation of the recorded UV radiation in Bahrain, since its proportional to the intensity of the insolation. These results are shown in Table (5).

Table 3. The variation of the insolation in Bahrain (W/m^2) from 1998 -2005.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave
1998	339.6	371.2	473.0	505.1	470.4	461.2	446.3	436.3	421.6	368.3	323.4	319.5	411.3
1999	396.7	446.1	472.1	474.7	456.1	479.7	492.0	456.2	448.3	418.6	428.4	401.3	447.5
2000	460.7	508.2	629.6	596.9	558.8	602.1	636.4	563.5	543.2	459.9	497.4	413.3	539.2
2001	404.1	534.9	632.3	536.6	594.5	551.2	574.0	574.2	510.1	481.1	444.4	455.4	524.4
2002	480.4	547.5	669.0	642.2	589.5	564.0	559.0	561.5	540.9	464.1	412.2	521.6	546.0
2003	462.2	548.5	644.4	676.9	736.6	618.0	622.3	605.8	552.2	478.2	412.1	457.5	567.9
2004	459.8	525.8	578.0	643.3	644.1	589.1	572.7	545.4	499.2	481.2	455.4	420.3	534.5
2005	455.1	555.4	635.2	647.3	666.1	574.8	589.7	575.5	533.1	481.0	445.1	412.1	547.5
Ave	432.3	504.7	591.7	590.4	589.5	555.0	561.6	539.8	506.1	454.1	427.3	425.1	514.7

Table 4. The variation of the sunshine hours in Bahrain from 1995 - 2005.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave
1998	7.0	9.1	7.8	9.1	11.3	11.9	11.5	11.1	10.6	10.5	9.7	8.5	**9.8**
1999	6.9	6.1	8.9	10.4	11.2	11.6	10.5	10.9	10.5	10.1	9.2	8.7	**9.6**
2000	7.2	8.1	8.9	8.2	11.0	10.9	9.7	10.2	10.1	10.0	6.0	7.7	**9.0**
2001	9.0	7.8	8.3	10.1	10.8	11.8	11.1	10.6	10.4	10.2	8.9	6.6	**9.6**
2002	6.8	7.6	6.9	8.7	10.9	11.6	11.4	11.2	10.4	9.7	8.8	5.8	**9.2**
2003	7.4	6.5	7.3	8.0	7.8	10.6	10.0	9.1	10.4	9.8	8.1	6.6	**8.5**
2004	6.6	8.2	8.8	7.7	10.1	11.9	11.1	11.0	10.3	9.8	7.8	6.4	**9.1**
2005	7.4	7.1	7.3	8.9	9.1	11.1	10.0	10.1	10.2	9.9	8.0	7.9	**8.9**
Ave	**7.3**	**7.6**	**8.0**	**8.9**	**10.3**	**11.4**	**10.7**	**10.5**	**10.4**	**10.0**	**8.3**	**7.3**	**9.2**

Table 5. The variation of the UV radiation in Bahrain (UV-B Joules/cm^2) .The ozone layer blocks the sun's output of UVC, most UVB but none of the UVA radiation from 1995 to 2005.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave
1998	20.4	15.7	18.3	15.7	12.6	12.0	12.4	12.8	13.4	13.6	14.7	16.8	14.9
1999	20.7	23.4	16.0	13.7	12.7	12.3	13.6	13.1	13.6	14.1	15.5	16.4	15.4
2000	19.8	17.6	16.0	17.4	13.0	13.1	14.7	14.0	14.1	14.3	23.8	18.5	16.3
2001	15.8	18.3	17.2	14.1	13.2	12.1	12.8	13.4	13.7	14.0	16.0	21.6	15.2
2002	21.0	18.8	20.7	16.4	13.1	12.3	12.5	12.7	13.7	14.7	16.2	24.6	16.4
2003	19.3	21.9	19.5	17.8	18.3	13.4	14.3	15.7	13.7	14.5	17.6	21.6	17.3
2004	21.6	17.4	16.2	18.5	14.1	12.0	12.8	13.0	13.8	14.5	18.3	22.3	16.2
2005	19.3	20.1	19.5	16.0	15.7	12.8	14.3	14.1	14.0	14.4	17.8	18.0	16.3
Ave	19.7	19.1	17.9	16.2	14.1	12.5	13.4	13.6	13.8	14.3	17.5	20.0	16.0

The UV irradiance is highest in the tropics, in the summer at noon. However, for a given location, the most important factors that affect the UV irradiance are ozone, clouds and aerosols. The effect of ozone depletion is negligible at lower latitude (between 30°N and 30°S) latitudes, including Bahrain (lat .26 N). Clouds have a variable effect on UV irradiance; depending upon the height and amount of clouds, the reduction in irradiance can vary from 7% to as much as 87% compared to a clear sky. Aerosols can also affect UV irradiance with reductions exceeding 50% in the presence of dust and smoke plumes and sulfates and other industrial pollutants absorb UV only weakly and reduce the surface irradiance by 10%- 20% (Balasaraswathy, 2004).

Comparing the UVB recorded in India with that recorded in Bahrain we found that this radiation is larger (refer to Table (5)) in Bahrain than India (0.28 W/m^2) by nearly 17.25 times!).This is expected as Bahrain lies in the desert or arid zone, which is known to have clear sky more than 80% of the year. The noticeable thing in Table (5) is that the UVB in Bahrain is not systematically decreasing or increasing, although it starts to decline systematically from 2003 to 2005 (reduction in the sunspot number and increase in cosmic radiation), and this can be attributed to the sensitivity of the interaction of this radiation by aerosol and different height clouds. According to Balasaraswathy 2004, clouds attenuate UVA and UVB to the same extent but in certain conditions and for short times a small amount of cloud may even enhance UV irradiance compared to the fully clear skies. The role of clouds in climate has two opposite effects. They tend to cool the climate by reflecting short-wave solar radiation back to space and on the other hand warm the climate by trapping the long-wave radiation emitted from the Earth's surface. The balance of these two effects is in part determined by the cloud height; on average low clouds are believed to cool and high clouds to warm the climate (Ockert-Bell and Hartmann, 1992; Ramanathan et al. 1989).

Svensmark and Friis-Christensen, 1997 suggested that cosmic rays promote the formation of terrestrial clouds through ionization of particles in the troposphere. Svensmark and Friis-Christensen 1997 and Svensmark 1998, reported previously that the total cloud cover over mid-latitude oceans, excluding the tropics, correlates strongly with cosmic ray flux. Bago and Butler 2000 noted that a close correspondence between the cosmic ray flux and total cloud cover is maintained from 1983 till 1994. The correlation coefficients between these three activity indices and the low-cloud factor are -0.82, -0.89 and 0.87 respectively, leading to a probability of occurrence by chance less than 0.2% for all three as shown in Figure (5).

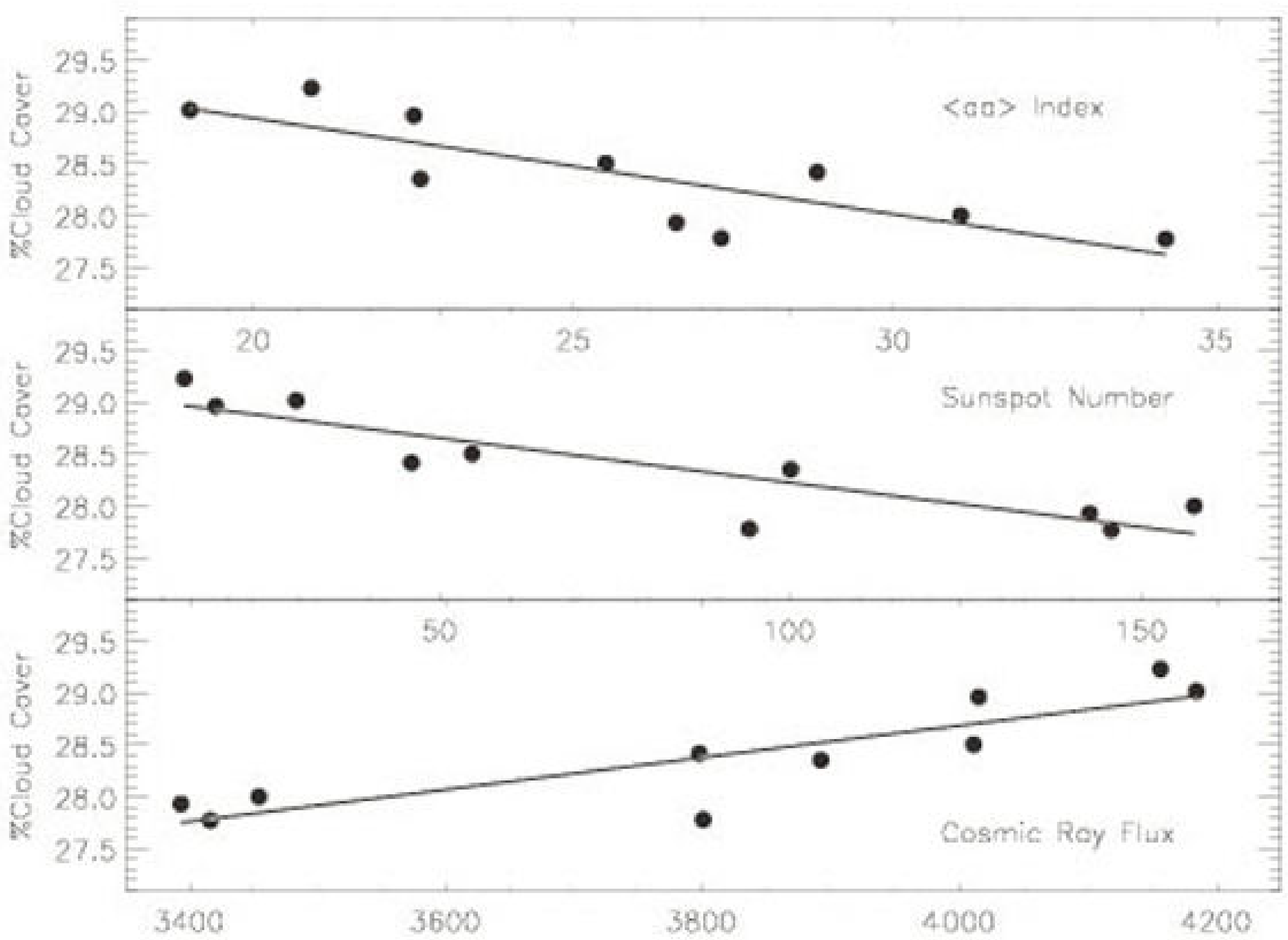

Figure 5. Regression of the annual means of the low cloud cover over the whole Earth and the aa index or effect of magnetic field (top panel), the Zurich Sunspot Number (middle panel) and the Climax Cosmic Ray Flux (bottom panel), for the period 1984-1993. The cosmic ray flux is the scaled count rate per hour (Bago and Butler, 2000).

They further found that most of the global warming over the past century can be accounted for by the combined direct (solar irradiance) and indirect (cosmic ray induced cloudiness) effects of solar activity without the need for any artificial amplification factor. They had further noticed that at epochs of sunspot maxima, solar irradiance is enhanced and the low cloud cover is reduced together with the Earth's albedo. The opposite effect occurs at sunspot minima. Thus, the low cloud albedo change, and the increase in solar irradiance which accompanies increasing solar activity, both operate to warm the climate and the respective radiative forcing contributions are compounded.

According to Bago and Butler 2000, the correlation of low cloud factor and cosmic ray flux is unexpected as the maximum degree of ionization by cosmic rays occurs in the altitude range 12-15km, i.e. close to or above the tropopause. The altitude ranges covered by clouds of different type are: 0 - 3.2 km for the low clouds, 3.2 - 6.5 km for the mid-level clouds and 6.5 - 16 km for the high clouds. Thus any cosmic ray induced cloud effect would be expected to be stronger for high rather than low cloud layers (Kernthaler et al. 1999; Jorgensen and Hansen, 2000). An explanation may lie in the fact that, as the neutron detectors are located at ground level, the measured flux is more representative of lower than higher regions of the atmosphere. Also, it was suspected that the physical state of the cloud droplets may play a significant role in the cosmic ray-cloud interaction. Finally, the greater sensitivity of low cloud to cosmic rays may result from the preponderance of liquid phase cloud types at lower altitudes(less than 6-7 km).

CONCLUSION

This work indicates that the weather is affected to a noticeable degree by the sunspot number, and subsequently the cosmic rays flux. No systematic variation of the temperature with these two parameters with latitude is apparent in this study. This can be attributed to the different physical state of the cloud droplets over the polar and equatorial regions with ice clouds over higher latitudes, > 60.0 degrees, is less affected by cosmic rays than liquid cloud droplets over low latitudes, < 22.5 degrees, (Bago and Butler 2000), although there is a tendency of more influence of the cosmic rays flux in the temperature at mid latitudes (22.5 < lat < 60.0 degrees). Thus one could expect cosmic ray induced cloud to be more prevalent at the poles than low latitudes.

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دراسة العلاقة بين الإشعاع الشمسي والأشعة الكونية وتأثيرهما على ظاهرة الدفء العالمي

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الملخص

في هذا البحث تم دراسة كمية الحرارة التي استلمتها 21 مدينة موزعة جغرافيا على الكرة الأرضية (النصف الشمالي والنصف الجنوبي من الكرة الأرضية) حيث تم تحليلها ونمذجتها حيث تم أخذ متوسط درجة الحرارة فيها من عام 1998 حتى عام 2005 وحساب المساحة أسفل منحنى درجة الحرارة في كل سنة إذ تم حساب ذلك من خلال استخدام معادلات بولونوميال لأفضل تمثيل للمنحنيات.

في هذا البحث تم حساب معدل التغير في درجة الحرارة لكل مدينة. وقد بينت الدراسة أن هناك 9 مدن (الدوحة، عمان، لندن، القاهرة، أبوظبي، ميونخ، المحرق، الكويت، مسقط) تأخذ في الزيادة في معدل الحرارة (تتجه نحو الاحتباس الحراري) بينما هناك أربع مدن (الرياض، بكين، باريس، اديليد بـ استراليا) معدل زيادة الحرارة فيها غير متغير أو ثابت، كما أن هناك ثمان مدن (طوكيو، واشنطن، طهران، مدريد، بودابست، بونس إيريس، ليما بـ شيلي وولنجتون بـ نيوزلاندا) تأخذ في النقصان في معدل الحرارة (أي تبتعد من الدفء العالمي أو تبريد محلي). وكان أكثر انخفاض في معدل التغير في درجة الحرارة هو مدينة ولنجتون (-0.0004) وأقله ارتفاعاً لندن والدوحة (-0.0003).

كما تم حساب كمية الحرارة المستلمة في تلك المدن من عام 1998 على 2005 - بوحدات اختيارية - حيث تبين أن مدينة أبوظبي (متوسط درجة حرارة 28 درجة مئوية) قد استلمت أكثر الوحدات الحرارية (312.97) بينما مدينة ميونخ (متوسط درجة حرارة 9 درجات مئوية) قد استلمت أقل الوحدات الحرارية (959.77).

بعدها تم مقارنة منحنى الحرارة المشابه لدالة الجيب لكل مدينة ومقارنته مع منحنى عدد البقع الشمسية للأعوام من 1998 حتى 2005 (أقلها عام 1998 بمقدار 64 بقعة، وأكثرها 111 بقعة عام 2000، ثم أقلها 30 بقعة في عام 2005) وكذلك مع منحنى الأشعة الكونية (أكثرها عام 1998 بمقدار 6328 عدة لكل دقيقة، وأكثرها عام 2003 بمقدار 5710 عدة لكل دقيقة، ثم أكثرها عام 2004- 2005 بمقدار 6070 عدة لكل دقيقة). وأشارت النتائج أن هناك ارتباط شديد بين تلك المعاملات الثلاثة (الحرارة، والبقع الشمسية، والأشعة الكونية)، كما وجدت الدراسة أن الارتباط بين تلك المعاملات هو أكثر في المدن الواقعة في نصف الكرة الشمالي من تلك الواقعة في نصف الكرة الجنوبي.

كما تم الاستفادة من قياسات الإشعاع الشمسي، وساعات سطوع الشمس، والأشعة فوق البنفسجية المسجلة في مملكة البحرين لدعم تلك التأثيرات الثلاث (الحرارة، والبقع الشمسية، والأشعة الكونية) على التغير المناخي.