Impact of sunspots on climate and hydrology of Shatt Al-Arab Delta

H.A. Al-Sayaab
Physics Dep., Marine Science Center, Basrah University,
Basrah, Iraq

Abstract

The varying length of the 11-year cycle has been found to be strongly correlated with long-term variations of the northern hemisphere land surface air temperature since the beginning of systematic temperature variations from a global network, i.e. during the past 40 years. Comparison of the extended sunspot record with the temperature series confirms the high correlation between sunspot numbers and air temperature, water surface temperature and shows that the relationship has existed through the whole 40 years. Results are compared with field measurements and good correspondence is observed. There is an even better correlation between the lengths of the solar cycle, with years of the highest numbers of sunspots. When the sunspots are minima the temperatures are decreased, and when the sunspots are maxima the temperatures are increased on the earth. There are unusual astronomical Phenomena occur in 2012l (like increase surface air temperature and frequent hurricanes).

Keywords: Sunspot, climate change, air temperature, solar cycle, Shatt Al-Arab**.**

تأثير البقع الشمسية على مناخ وهيدرولوجية دلتا شط العرب

حازم عبد الحافظ السياب
قسم الفيزياء - مركز علوم البحار – جامعة البصرة
البصرة - العراق

الملخص

خلال الدورة الشمسية وعلى المدى الطويل لوحظ أرتباط قوي لدرجات حرارة سطح الارض في نصف الكرة الشمالي خلال الـ 40 سنة الماضية. مقارنة أمتداد دورة البقع الشمسية مع سلسلة درجة الحرارة يؤكد الأرتباط الكبير بين عدد البقع الشمسية ودرجات حرارة الهواء والماء وتظهر العلاقة واضحة خلال الـ 40 سنة كاملة. تمت مقارنة النتائج مع قياسات حقلية ووجد ان هناك علاقة واضحة بين أطوال الدورة الشمسية مع أعداد البقع الشمسية الكبيرة خلال عدة سنوات. فعندما تكون أعداد البقع الشمسية قليلة فأن درجات الحرارة تنخفض وعندما تكون أعداد البقع الشمسية كثيرة فأن درجات الحرارة تزداد على سطح الأرض. هناك ظواهر فلكية غير عادية تحدث في عام 2012 (ارتفاع درجات الحرارة وزيادة الاعاصير).

الكلمات المفتاحية: البقع الشمسية، تغير المناخ، درجة حرارة الهواء، الدورة الشمسية، شط العرب**.**

Introduction

Variations in the activity of the sun greatly influence the physics of the upper atmosphere. Thus, magnetic disturbances, occurrence of auroras at high latitudes, sporadic ionization above-80 Km altitude, and-as a consequence of the latter-reduced quality of short wave radio transmissions all appear to follow the approximately 11-year solar activity cycle .This cycle is most distinctly seen in two observed parameters the sunspot numbers; the 10.7cm radiation [1].

Jones [2] noticed a certain amount of similarity of the secular variation in globally averaged sea-surface temperature (SST) over the past 130 years to the corresponding variation of solar activity as revealed by the envelope of the 11-year running mean sunspot number. He pointed out that the two time series had severed features in commons most noteworthy was the prominent minimum in the early decades of this century, the steep rise to a maximum in the 1950s and a bride drop during the 1960s followed by a final rise. He found that the necessary range of variation in the solar constant during the total 130 year period is less than 1%.

Friis-Christenson and Lassen [3] pointed out a major difficulty with Jones interpretation. They examined the northern hemisphere land air temperature and noted that this record was leading both the SST record and the sunspot record by as much as 20 years. They pointed out that there are other parameters of solar activity which indicate that the sunspot number is probably not necessarily also a good indicator of long-term changes.

A different solar parameter showing long-term changes is the length of the approximately 11-year sunspot cycle. This quantity is far from being constant [4]. It is known to vary with solar activity so that high activity implies short solar cycles where as long solar cycles are characteristic for low activity levels of the sun. The completed list of solar cycle lengths has been compared with time series of climate data in order to extend the examination of the assumed association between climate and variability as far back in time as the climate data allow. A comprehensive reconstruction of the northern hemisphere temperature since 1579 was achieved by Groveman and Landsberg [5].

The shape of the sunspot cycle is important because the temporal behavior of a sunspot cycle, as described by the International sunspot numbers, can be represented by a simple function with four parameters: starting time, amplitude, rise time and asymmetry. The parameter that governs the asymmetry between the rise to maximum and the fall to minimum is found to vary little from cycle to cycle and can be fixed at a single value for all cycles. Sunspot numbers provide perhaps the most useful data for solar cycle predictions .While sunspot observations extend back to the time of Galileo, regular observations of use in characterizing the solar cycle did not begin until about 1750. The relative sunspot number R is derived from a formula due to Wallis and Matalas [6] that is heavily weighted by the number of sunspot groups observed: $R = k (10 g + n)$ where g is the number of sunspot groups, n is the number of individual spots and k is a factor that accounts for observer, telescope and observing conditions .For example let sunspot no. =1 , g =1 and n =1 then:-

R =1 (10 * 1 + 1) = 11

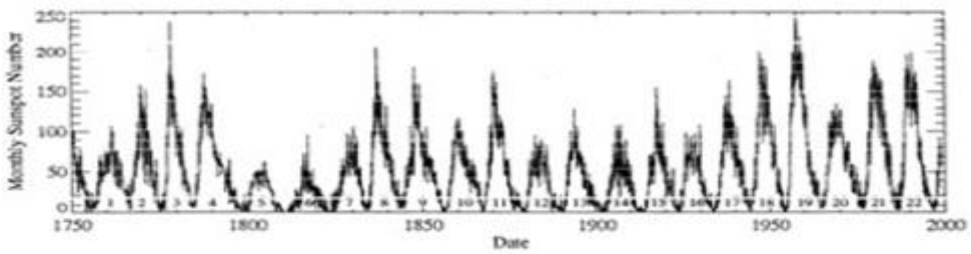

Figure 1: Monthly averaged International Sunspot Number as a function of time. The

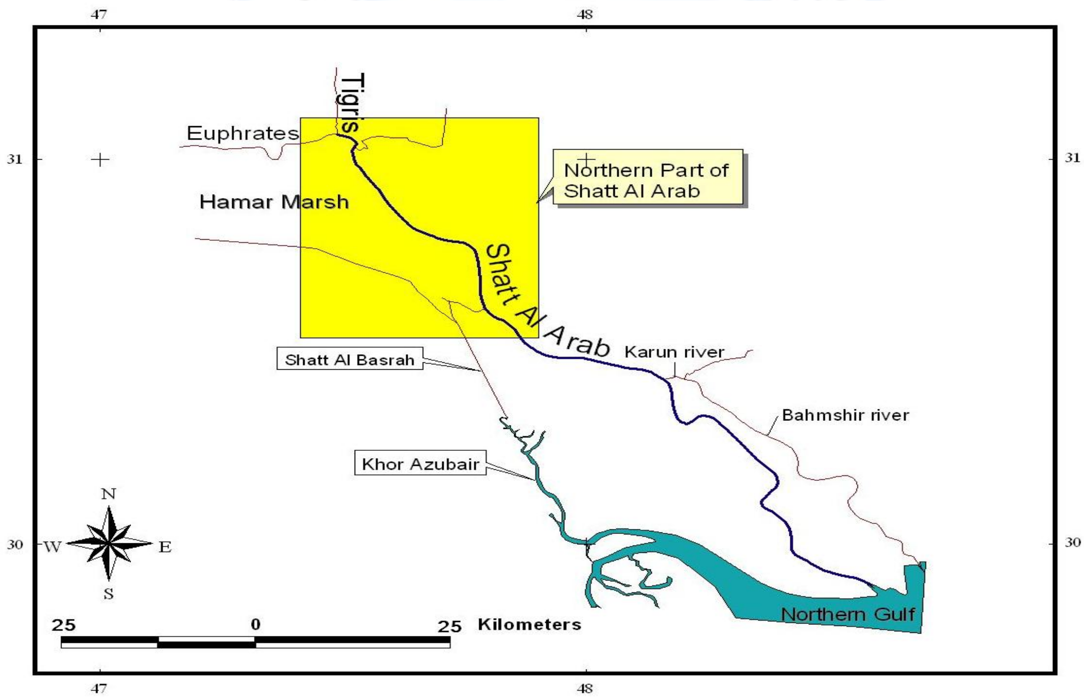

Figure 2: Study area

individual sunspot cycles (numbered along the bottom) vary in amplitude, duration and shape (World Data Center, 2005).

Data and Methodology:

Conventional sunspot cycles were used as an indicator of solar activity. The following data are from web site information distributed by the World Data Centre for the sunspot [7].From Figure (1) there were eight complete cycles during the past century. These commenced with the sunspot minimum that occurred in 1913 and ended with the sunspot minimum in 1996. The lengths of the cycles were 10,10,11,10, 10, 12, 10 and 10 years, with a mean of 10.4 years. These values are within a narrow range of between 10 (minimum) and 12 (maximum) years. A corresponding increase in solar activity during the past century is reflected in the increase in the numbers of sunspots per cycle, commencing with the cycle that started in 1913.

The alternating sunspot cycles have appreciably different effects on the hydro meteorological processes. Mean daily air temperature records for the years 1950 to 2010 and water surface temperature records for the year 2004 to 2010 were used for station in Basrah city and Shatt Al-Arab river (29 50 N , 48 43 E) (figure 2). So there are many gap for years 1950 $\rightarrow$ 2004 that we need surface temperature data. The relation between air and water surface temperature can be interpreted in a simple linear regression:

$$T_s = a + b\, T_a$$

Where T_s is the water surface temperature, T_a is the air temperature, b is the slope and a is the interception. Another way of interpreting the air and water temperature relationship is to assume that both may be described by a simple sine wave. This is a good assumption considering the annual cyclic nature of solar heating at a fixed location [8]. The curves take the form:

$$T_i = F \sin (A (D_i + B)) + C$$

T_i: is the temperature (deg.) at the day D_i.
F: is the amplitude.
D_i: is the position of the day in year ($1 \rightarrow 365$) .
B: is the phase shift (the origin of the sine curve).
C: is the yearly mean temperature (deg.).
A: is a constant factor converts the day to radians (= 0.01717).

By using least square analysis we got linear equations that can be solved by Gauss elimination method. Monthly ranges and means of air and surface water temperatures are summarized in Figure (3). The surface water temperature is always lower than air temperature during the warming season and higher during the cooling season. The month February is a transition for temperature changes. However, difference may probably arise due to the difference in time of measurements,

clouds cover and distance from the shore rather than to the variation in latitude. The only time that the water surface temperature (WST) is during spring – summer warming period is the same or slightly different from air temperature. Table (1) shows the calculated mean water surface temperatures (range of the minimum and maximum for the year 2008 are taken from estuaries physics department in Marine Science Senter - Basrah University) compared with field measurements and good correspondence is observed (RMSE was 0.01917).

Table 1: monthly mean air and water surface temperatures for the year 2008 in Basrah

Month	Air- temperature ^{o}c	Water-temp. observed ^{o}c	Water-temp. calculated ^{o}c
Jan.	15.6	14.1	14.3
Feb.	12	15.7	16.0
Mar.	14.2	19	19.3
Apr.	19	27	27.1
May.	21	33.5	33.7
Jun.	25	37.8	37.9
Jul.	26.4	38.1	38.3
Aug.	27	38.6	38.9
Sep.	24.4	34.5	34.7
Oct.	21	29.6	29.7
Nov.	13	19.7	19.8
Dec.	10.3	13.7	13.9

Air temperature is a measure of the heat content of the air. One can think of it as a measure of the average speed or kinetic energy level of molecules. The temperature of our atmosphere is controlled by a complex set of interactions between the biosphere, lithosphere and atmosphere. Energy is constantly being exchanged between the surface and the air above a place, as well as circulating around the globe. Now we'll first look at what controls the air temperature at a particular place by examining radiation and energy exchanges between the earth and air above. Then we'll see how the global circulation of air and water affect air temperature is well documented that the early part of the 20th century was much colder than it is today. A consequence of these colder temperatures is that there are changes in sea currents, temperatures and in the strength and direction of the winds at sea [9]. As a result, large icebergs from the Greenland ice sheet would often drift southward into the Atlantic Ocean and into the shipping lines between Europe and America. It was much more likely that a vessel would encounter icebergs back in the early part of the century than it is now. This is in part a consequence of a cooler climate 80 years ago [1].

Sunspots increase and decrease through an average cycle of 11 years. Dating back to 1749 (Figure 2) earth has experienced 23 full solar cycles where the number of sunspots have gone from a minimum , to a maximum and back to the next minimum, through approximate 11 year cycles . In the 23rd cycle , the number of sunspots reached a peak in mid-2000 when the number of sunspots were measured at around 170. A secondary sunspot maximum occurred near the beginning of 2002 where the sunspot number was about 150. The sunspot minimum for cycle 23 occurred through mid-2007 [10].

In cycle 24 it is normal for the old and new sunspot cycles to overlap for a time before the old one completely fades away, but cycle 24 has been very slow to ramp up. Solar cycle 24 began in January 2008 however the reverse polarity sunspot that signaled the start of cycle 24. In fact, while 2008 was supposed to be signal of the beginning of cycle 24 and an increase in sunspot numbers, the lack of sunspots in 2008 made it a century-level year in terms of solar quiet. Remarkably, sunspot counts for 2009 have dropped even lower. If 2008 was a year of lower sunspot activity and less solar radiance, then other factors are at work relative to the earth's temperatures. Over-all temperatures for the earth were down slightly in 2008, relative to other years , but 2008 was still in the top 10 of warmest recorded years. Figure (4) shows that there were no sunspots observed on 266 of the year's 366 days. In 1913, which had 311 spotless days. Prompted by these numbers, some observers suggested that the solar cycle had hit down in 2008 [11].

The primary effect of sunspot is on our ionosphere (upper part of the atmosphere). Increased sunspot activity frequently accompanies an increase in the out flow of matter from the sun in the form a solar wind. During periods of heightened solar activity, the earth's upper atmosphere swells up slightly in response to the extra heating, which in turn increases the rate of decay of satellites in low earth orbit, then the atmosphere will vary significantly with the solar cycle. Suggestive correlations between solar activity and global temperature. In California-report the planet cooled by about 0.7 degree in 2007. This is the fastest temperature change (drop) since science began instrumental record keeping and seems to set global temperatures back to where they were in 1930. There is also plenty of anecdotal evidence that 2007 (Global cold) was exceptionally cold, most not ably that snowed in Baghdad for the first time in centuries.

There exist, of course, year –to- year variations due to internal oscillations in the climate, El Nino effects, volcanic eruptions, etc. Taking these variations into consideration, the comparison between the temperature record and the solar activity indicators is a good association between the long-term variations in the temperature and in the solar cycle length record. There is even better correlation between the length of the solar cycle and years of the highest numbers of sunspots. When the sunspots are minima the temperatures are decreased and when the sunspots are maxima the temperatures are increased on the earth [1].

Although sunspots themselves produce only minor effects on solar emission the magnetic activity that accompanies the sunspots can produce dramatic ultraviolet and soft x-ray changes in levels. These changes over the solar cycle have important consequences emission for the Earth's upper atmosphere Table (2):

Nearly, all solar / climate correlations have suffered from lack of physical connections and have proven to be inaccurate when put to the test of prediction. Arguments against solar forcing of climate are:

1. Insufficient changes in solar brightness.
2. Correlation break downs and sign changes.
3. Terming problems between cause (solar changes) and effect (climate variations).
4. The lack of solar / terrestrial theories to account for any postulated long-term changes [12].

Table (2): changes on the upper atmosphere

Solar cycle	Sunspot no.	Ozone (transparence)	Ultra-Violet (flow)	Temperature
Low	Low	Low	Low	Decrease
High	High	High	High	Increase

For example, the temperature (in Europe) anomaly was (-0.4 K) in 1890 when the cycle was 11.7 years, but (+0.25K) in 1989 when the cycle was 9.8 years. This means that more sunspots deliver more energy to the atmosphere, so that global temperatures should rise.

Even the climate changes of the 20th century may have a significant solar component. Figure (3) shows a strong correlation between surface air temperature and sunspots, which confirms increase with the increase in solar activity as well as in the case of surface water temperatures Shatt al-Arab and sunspots changes in the figure (5). Figure (5) shows variation of water surface temperatures and the sunspot numbers. For the years 1970-2012 both sunspots number and solar cycle length are proxies for the amount of solar energy that earth receives [13]. The similarity of these curves is evidence that the sun has influenced the climate of the last 40 years.

Results & Discussion:

70 – 90 years oscillations in global mean temperature are correlated with corresponding oscillations in solar activity. Whereas the solar influence is obvious in the data from the last four centuries, signatures of human activity are not yet distinguishable in the observations. Given all the evidence of a solar influence on the upper atmosphere it has been natural to expect a similar relation in the variability of weather and climate.

The period is known as the 'little ice age' the sunspot cycle resumed in 1720 and the levels of solar activity have increased since then with a sunspot peak in the 1960 solar maximum.

The global mean temperature in 2008 was the lowest since about 2000. There is continual heating of the planet, referred to as radiation forcing, by accelerating increases of carbon dioxide. So expect there are more events for this case (solar activity) like earthquake , catastrophes , storms and others may happened in the year 2012$_s$.There are reasons for that like in 2012 the magnetic field of the sun reveres during each Schwab cycle, so the magnetic poles return to the same state after two reversals. The table below explains another reason Table (3):

Table (3): Relation between spotless day and sunspots

Year	Spotless day	Year (high sunspot)
1913	311	1917
1956	120	1960
2008	266	2012

The phase-locked orbital cycle that is based on a 13:8 ratio is derived from the fact that Venus revolves around the sun 1.6 times faster than earth so that 13 Venus revolutions is equal to 8 years. This is a relation between the Transit of Venus and solar output cycles. In addition to it just so happens that the 2012 and data corresponds to a Venus Transit cycle (it is earth's sister planet). From Figure (2) the actual peak of this 300-year cycle of increasing solar output occurred in 1960 when the number of sunspots exceeded 200, the usual peak is around 100-150. Now, what is interesting is that during the first half of the 20th century the earth's seismic and volcanic activity was comparatively quiet. Then after 1960 the level of seismic and volcanic activity increases steadily to the point that the 1990s can accurately be called the (decade of disasters). It is coincidence that 2012 also coincides with the next solar sunspot maximum. The next sunspot cycle will be between 30 and 50 percent stronger than the current cycle, with a peak in activity in 2012.

The sun's output is going to change, and then we are going to enter the flip side or a new 13,000 year cycle. The earth is overheated and so is the sun, the result being planetary instability manifested in rising earthquakes, volcanic eruptions and erratic weather patterns, These will increase further starting in 2004. The Venus Transit acted like a circuit breaker switching off the sunspot cycle and impacting the Sun-Moon-Earth-Venus system. Other unusual astronomical Phenomena occur in 2012 are:

1. A transit of Venus, in which Venus will pass directly in front the Sun – something only happens every 120 years.

2. A solar eclipse in which the Sun and Moon conjunct the Pleiades, on May 20th 2012.

3. A second solar eclipse, in which the Sun and Moon align with head of the constellation Serpents.

4. The alignment of the solstice Sun with the galactic equator, which started in 1987 and will finish in 2012.

5. Venus returns to the same area of the sky every 8 years, and each time, is getting nearer and nearer to the Pleiades. In 1972, Venus was 1 degree from Alcyone, the central star of the Pleiades, but in 2012, Venus will be right next to Alcyone.

Below is the list of events and changes to our solar system (Scientist ideas predictions):

1.400 A % increases in the speed that solar particle emissions are capable of traveling through the energy of interplanetary space [14].

2. A 400 % increase in the overall number of natural catastrophes on earth between 1963 and 1993 [15] .

3. A 230 % increase in the strength of the sun's magnetic field since 1901 [16] .

4. 9 out of the 21 most severe earthquakes from 856-1999 AD occurred in the 20th century [17] .

5. A 500% increase in earth's volcanic activity between 1875 and 1993.

These increases seem to be due to increased activity from the sun. If that is true, such events will continue to increase over the next few years. Earthquake numbers can be misleading and a lot of medium and smaller earthquakes can keep the number of larger earthquakes lower. Disregard the numbers of larger earthquakes and observe the numbers for the medium earthquakes. If we remember that the sun contains fully 99.86% of the mass in the solar system, then we can easily see that it wields the strongest thermal, gravitational and electromagnetic influence.

Conclusions

There are some conclusions which can be included in the present study, first there is a relationship between sunspots with the rest of the weather variables (rain, atmospheric, wind and storm tracks), second variables (temperature, rain, atmospheric, wind and storm tracks)can predict the weather through the sunspot. So we need to monitor atmospheric changes continuously in the future.

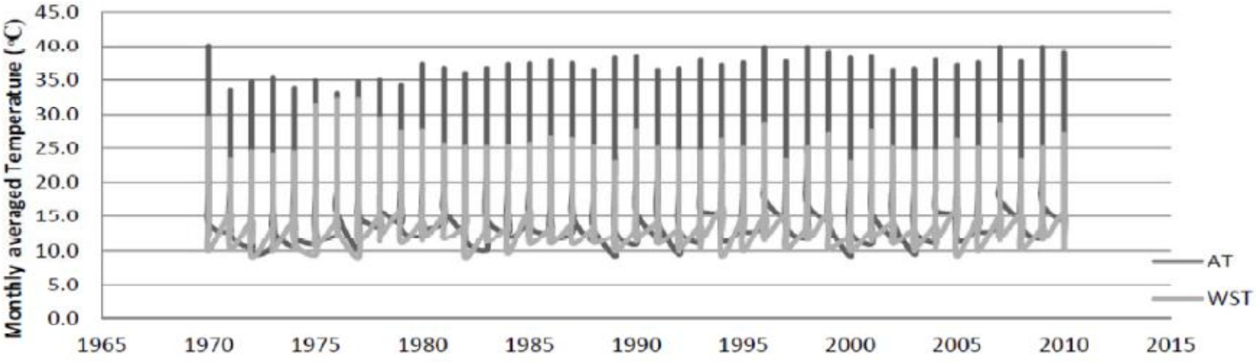

Figure 3: Monthly averaged air and water surface temperature for the period 1970-2012

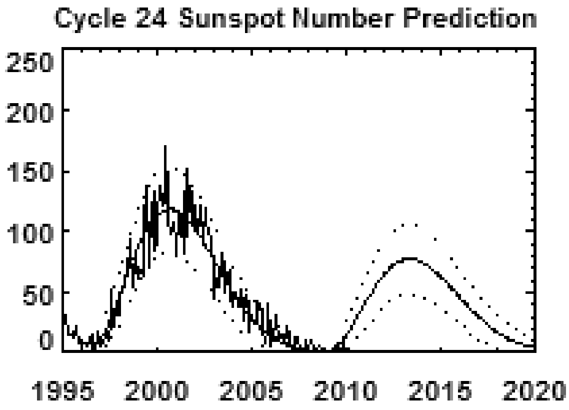

Figure 4: Monthly averaged sunspot number as a function of time

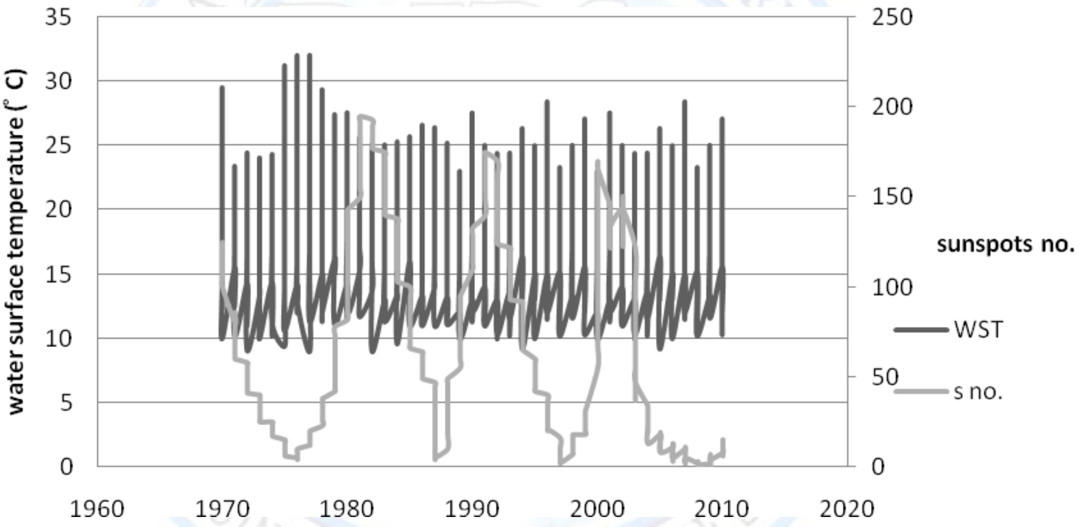

Figure 5: Average sunspot number & water surface temperature as a function of time

References

[1] Lassen, K. and E. Friis-Christensen, 1995, Variability of the solar cycle length during the past five centuries and the apparent association with terrestrial climate, *J. Atm.Terr. Phys.*, 57, 835-845.

[2] Jones, P. D., 1988, Hemispheric surface air temperature variations: Recent trends and an update to 1987, *J. Climate* 1, 654-660.

[3] Friis-Christensen, E. and K. Lassen, 1991, Length of the solar cycle: an indicator of solar activity closely associated with climate, *Science* 254, 698-700.

[4] Hath away, D .H . , R.M. Wilson, and E. J. Reichmann, The shape of the solar cycle, Sol.Phys. , 151,177-190, 1994 .

[5] Groveman, B.S. and Landsberg, H.E., 1979, Simulated Northern Hemisphere temperature departures 1579-1880, *Geophys. Res. Lett.* 6, 767-769.

[6] Wallis, J R and Matalas. NC 1971. Correlogram analysis revisited , Water Resources Research. 7(6).

[7] World Data Centre, Index 2005, for the sunspot. Yearly sunspot numbers from 1750 to 2004.Available at http://side.oma.be.

[8] Walker,T.A. 1981 .Annual temperature cycle in Cleveland Bay, Great Barrier Reef Province.Aust.J.Mar.Fresh water Res.v32, pp987-991.

[9] Alexander. WJR 2002_a . Climate change- the missing links. Science in Africa. September 2002.

[10] Wilson, R. M., D. H. Hathaway, and E. J. Reichmann,1998a , An estimate for the size of cycle 23 based on near minimum conditions, J. Geophys., 103, 6595-6603.

[11] Wilson, R. M.,1992, An early estimate for the size of cycle 24 Sol. Phys., 140, 181-193.

[12] Hoyt, D.V. , and Schatten K. H. (1997).Group sunspot numbers: A new solar activity reconstruction. Solar physics,179(1),189-219.

[13] Richard Reichel, R.,P. Thejll, and K. Lassen(2001) Journal of Geophysical Research, Vol. 106, No. A8, Pages 15,635-15,642.

[14] NASA report to congress regarding a plan for the international space station national laboratory, may 2007.

[15] Danske Meteorologiske Institute,1997 (*Nautical-Meteorological Annual*, 1899-195& The Ice-conditions in the Greenland Waters, 1957-1981).

[16] Lockwood. R., Stamper, R., Wild, M. N., 1998: A doubling of the Sun's coronal magnetic field during the past 100 years. Nature 399, 437-439.tation national laboratory, may 2007.

[17] Russian National Earthquakes Information Centre,1999. http:// www.howtosurvive 2012.com.