SUN-CLIMATE LINKAGE NOW CONFIRMED

Adriano Mazzarella
Meteorological Observatory
Department of Earth Science – University of Naples Federico II
Largo S. Marcellino 10, 80138 Naples, Italy E-mail: adriano.mazzarella@unina.it

ABSTRACT
We are experiencing a period of intense anthropocentrism: humans flatter themselves they can govern the thermal machine of the ocean-atmosphere system and build models of atmospheric circulation (that solve hundreds of non-linear equations for each box of a three-dimensional grid covering the globe) to demonstrate that Earth's recent warming is attributable to anthropogenic CO_2 emissions. However, the results of such a reductionist approach are questionable, since the atmosphere and oceans form a complex interactive system that cannot be recreated in a laboratory experiment, and where the many physical and chemical processes are regulated by dynamic and thermodynamic parameters, interconnected in a non-linear way, and there are various positive and negative feedback processes. Only a holistic approach that analyses the system in its entirety, and drastically reduces the number of degree of freedom, can provide information on the way in which the global environmental system operates. When the Sun, atmospheric circulation, Earth's rotation, and sea temperature have been investigated as a single unit, the linkage between the Sun and climate is confirmed (Mazzarella, 2007, 2008); application of this integrated model provides a forecast estimate for a gradual cooling of the Earth's atmosphere in this decade.

1. INTRODUCTION

In recent years, there has been a boom in the use of General Circulation Models (GCM) to forecast the increase in the Earth's mean temperature caused by anthropogenic CO_2 released to the atmosphere. This requires powerful computers that can provide approximate linear solutions to a set of strongly non-linear partial differential equations, which involve large quantities of input data - but which leave out available information, or ignore known or suspected processes. This approach is misleading, because the ocean-atmosphere system cannot be recreated in a laboratory experiment; and its complexity does not depend on the physical and chemical factors that govern it, but essentially on the number of their interconnections, on the intensity of such linkages, and on the feed-back processes. To properly interpret recent climatic changes as being anthropogenic, we must define the background physical processes that belong to the Earth's physiology. This was overlooked by the last IPCC (2007) report which states that solar activity is not relevant to global warming, since the incoming solar electromagnetic flux is essentially constant. However, the impacts of solar electromagnetic and corpuscular radiations should not be confused, as they show similarities in temporal behaviour - but can drive completely different terrestrial mechanisms. While electromagnetic flux is estimated to be several orders of magnitude stronger than corpuscular flux, the spatial non-uniformity of the latter becomes an important factor in affecting atmospheric processes at a worldwide scale.

2. COLLECTION OF DATA

To obtain information on how the global environmental system operates, the following historical annual series were analyzed (Mazzarella, 2007, 2008):

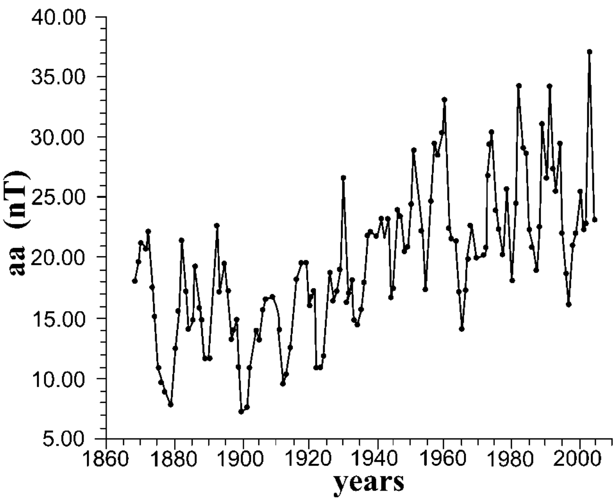

Fig 1. Time plot of yearly geomagnetic activity *aa* values

a) External geomagnetic activity *aa* expressed in nanoTeslas, (nT) over the interval: 1868–2007, which is a proxy for the turbulence of the solar wind in the ecliptic plane (Mayaud, 1972). Yearly *aa* data (Figure 1) are available from the web site: ftp://ftp.ngdc.noaa.gov/STP/SOLAR_DATA/RELATED_INDICES/AA_INDEX/Aa_month/

b) Sea level atmospheric pressure P (hPa) provided by the Climate Research Unit, University of East Anglia (interval: 1873–2003). Coverage of the Northern is much denser than the Southern Hemisphere. Hence, this analysis is confined to the Northern Hemisphere. The yearly data are available from the web site: http://www.cru.uea.ac.uk/cru/data/atmosphericpressure/.

To obtain a simple measure of the yearly zonal wind, the difference in pressure ZI (hPa) between the entire 35°N and 55°N circles was computed (Rossby, 1939). Using yearly ZI data (Figure 2), the prevailing flow can be derived easily from only its sign and magnitude. This computation has the advantage of integrating the complex distribution of pressure over an entire hemisphere into a single figure, thereby facilitating comparison between various situations.

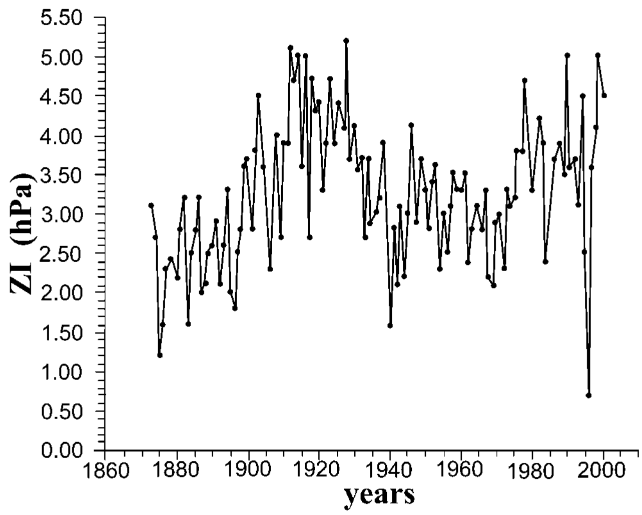

Fig 2. Time plot of yearly zonal atmospheric circulation *ZI* values

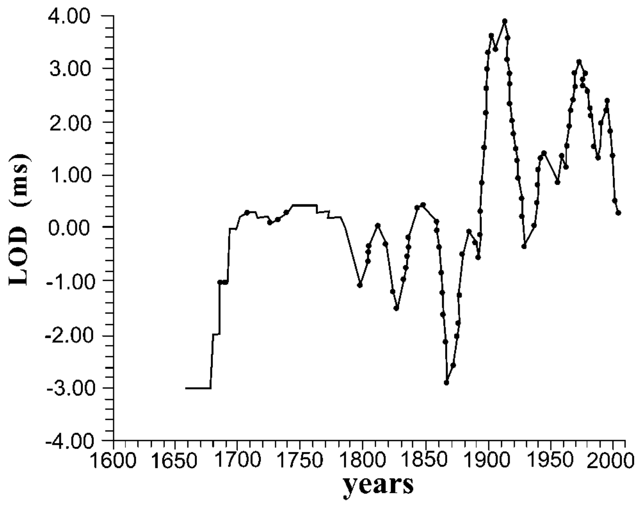

Fig 3. Time plot of yearly length of day *LOD* values

c) Earth's rotation rate, as normally measured by length of day LOD (ms). This represents the variable difference between the astronomical length of day and the standard length (interval: 1850–2007) (Stephenson and Morrison, 1995). Yearly LOD data (Figure 3) are available from the web site: http://www.iers.org/iers/earth/rotation/ut1LOD/table3.html.

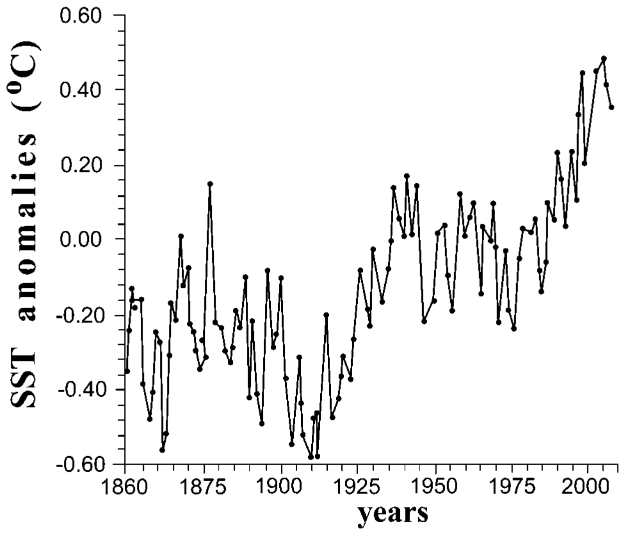

Fig 4. Time plot of yearly sea surface temperature *SST* values

d) Sea surface temperature (SST, in °C) provided by the Climate Research Unit, University of East Anglia (interval: 1850–2007), as anomalies from the period with the best coverage (1961–1990) (Rayner et al., 2003). As with b) above, coverage is much denser over the Northern Hemisphere. Hence, the analysis was confined to this region. Yearly SST data (Figure 4) may be found at the web site: http://www.cru.uea. ac.uk/cru/data/temperature/.

SST is the true thermometer of the atmosphere-ocean system, owing to higher thermal capacity of the ocean. Daily SST variability is much more limited than that of near-surface air temperature; so SST behaves as a natural filter that eliminates all the short time variations that normally affect air temperature. Moreover, 70% of the Earth's surface is occupied by ocean, which is why SST is more representative than air temperature - the latter being measured at stations on land which are often highly biased by their immediate environment. Thus SST integrates all the different air temperature measures available.

3. ANALYSIS AND RESULTS

It is well known that *aa* geomagnetic activity shows large fluctuations at 11 and 22 years, as well as a statistically significant increasing secular trend (Mazzarella, 2007, 2008). Records of this geomagnetic proxy for solar activity have only been since available 1868. Hence, to investigate long-term modulation of aa on the same basis as the other investigated variables, it is advantageous to smooth all the yearly available series by using a 23-yr running mean and normalize them with respect to their mean linear trend. Indeed, the variations in the residuals can be subjected to more accurate low-frequency spectral analysis, than when they are biased by high-frequency waves and by non-cyclic variation.

It is useful to recall that the main role of *aa* and ZI is that of a buffer zone, where energy inputs from external sources are accumulated, modulated and re-transmitted. Observable effects from this type of process would more than likely be cumulative, and would affect long-term climatological changes - rather than induce sudden changes in tropospheric weather. Thus application of Riemann integrals to detrended yearly values of *aa* and ZI, i.e., the sequential summation of the detrended aa and ZI, provides the values of Iaa and IZI that are also indicative of solar wind and zonal wind speed.

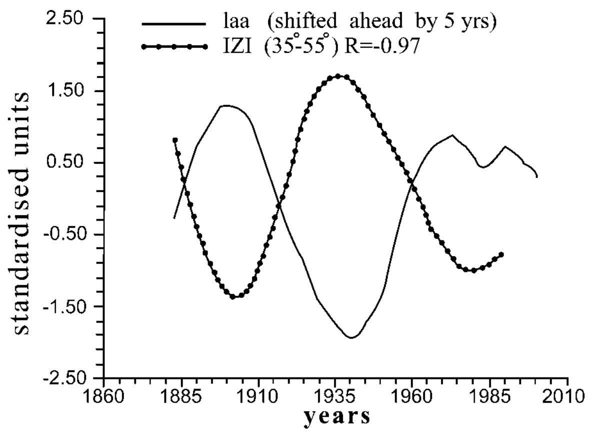

Fig 5. Time plot of yearly Iaa and IZI values, detrended and smoothed according to the 23-yr running mean

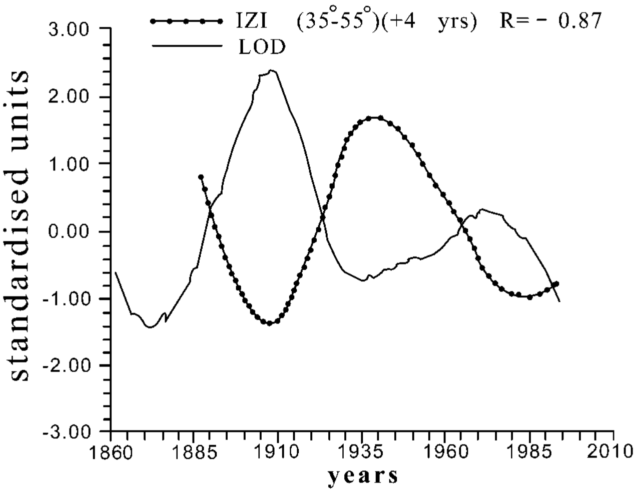

Fig 6. Time plot of yearly IZI and *LOD* values, detrended and smoothed according to the 23-yr running mean

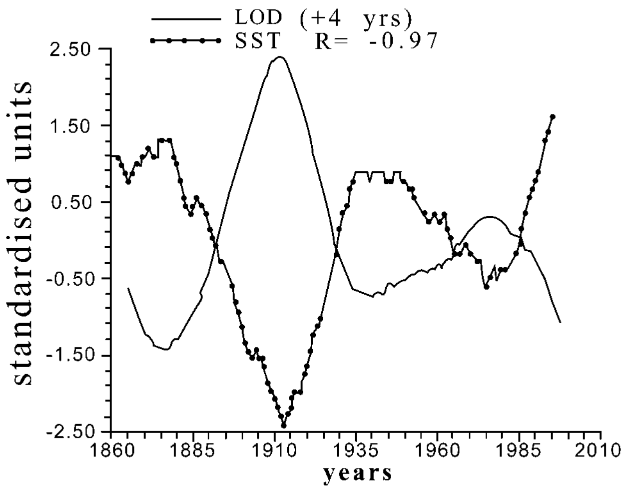

Fig 7. Time plot of yearly *LOD* and *SST* values, detrended and smoothed according to the 23-yr running mean

For visual inspection, all the time plots of the investigated yearly variables, detrended and smoothed according to the 23-yr running mean, are normalized to a mean of zero and to a standard deviation of 1. The time plot of yearly Iaa and IZI values (Figure 5) shows that Iaa and IZI are strictly inversely related with a correlation coefficient of -0.97 when Iaa is shifted forward 5 years. *This indicates that an increase in solar wind speed causes a decrease in zonal atmospheric wind speed after 5 years*. The time plot of yearly IZI and LOD values (Figure 6) shows that IZI and LOD are inversely related with a correlation coefficient of -0.87 when IZI is shifted forward 4 years. *This indicates that a decrease in zonal wind speed causes a deceleration of the Earth's rotation after 4 years*. The time plot of yearly LOD and SST values (Figure 7) shows that LOD and SST are strictly inversely related with a correlation coefficient of -0.98 when IZI is shifted forward 4 years. This indicates that an increase in day-length causes a decrease in sea surface temperature after 4 years. The highest correlation coefficients computed for each pair of the investigated variables indicate that the variables of each pair are statistically inter-related at a confidence level greater than 99% (Bendat and Piersol, 1971).

4. DISCUSSION AND CONCLUSION

GCMs are currently a standard part of the tool kit of the atmospheric sciences. They are used to forecast the increase in the Earth's mean temperature caused by anthropogenic atmospheric CO_2 for the next 100 years (a result that none of us will be able to verify!) in the conviction that mathematical reductionism can provide forecasts starting from ever-smaller boxes containing portions of atmosphere and ocean - where algorithms are forced to operate. In this regard, it is useful to consider the numerous failures of GCMs when compelled to forecast the summer from the preceding winter or vice versa! This reductionist approach is misguided, since the model will never be able to correctly evaluate physical processes when it is compelled to operate from the inside. To overcome this weakness, the scientist must have the courage to emerge from within the investigated phenomenon and view it from the outside - as if in front of a TV screen. Classical laws simply vanish if you look too closely; and they will emerge only when you move away, as happens with paintings by Monet.

In contrast to the prevailing reductionism, a holistic approach was set up - the first to confirm the Sun–climate linkage as a single unit (*ut unum sint*) through atmospheric circulation and the Earth's rotation (Mazzarella, 2007, 2008). *The arrival on Earth of fronts of hydrodynamic shock waves during epochs of strong ejection of particles from the Sun, gives rise to a compression of the Earth's magnetosphere and to a deceleration of zonal atmospheric circulation which, like a torque, causes Earth's rotation to decelerate which, in turn, leads to a decrease in sea-surface* temperature.

Under this unitary approach, the turbulence of solar wind, and the zonal atmospheric wind, behave cumulatively rather than instantaneously - energy inputs are first accumulated, and then transmitted. Zonal wind speed (IZI) is obtained by integrating ZI with the Riemann algorithm. This allows the relative dominance of either zonal (conforming to latitude) or meridianal (conforming to longitude) transport of air masses at the Northern Hemisphere scale to be classified. Northern circulation is found to have been dominant in the years 1885-1915 and 1960-2000, and zonal circulation in the period 1915-1960, and at the present time (Figure 5). There is almost equilibrium between zonal and meridianal components of air flow. Strong zonal circulations and a contracted circumpolar vortex are related to an increase in SST; while weak zonal westerly circulations or, equivalently, strong northern circulations with meandering or cellular patterns with an expanded circumpolar vortex, are related to a decrease in SST. Zonal epochs correspond to periods of global warming, and northern meridianal epochs to periods of global cooling (Lamb, 1972; Lambeck, 1980). LOD behaves as a variable that integrates all its inner dynamics relative to the different cellular tropospheric circulations. It is worth noting the obvious asymmetry between the time behaviour of LOD and SST; when LOD has a maximum, SST has a minimum of similar amplitude after 4 years and so on.

This holistic approach can also supply a reliable estimate of future climate since changes in LOD can be reasonably used as indicators of future changes in SST. Crucially, and provided that the observed past correlation between LOD and SST continues into the future, the identified 60-yr cycle (Mazzarella, 2007) suggests a decline in SST starting from 2005. Recent data tends to support this result.

REFERENCES

Bendat, J.S. and Piersol A. G. 1971, Random data analysis: measurement procedures. Wiley-Interscience, New York, 407 pp.

IPCC, 2007, Climate change 2007: The physical science basis, WMO, 550 pp.

Lamb, H.H. 1972, Climate, Present, Past and Future, Methuen, London, 613 pp.

Lambeck, K. 1980, The Earth's variable rotation, Cambridge University Press, 449 pp.

Mazzarella, A. 2007, The 60-year modulation of global air temperature: the Earth's rotation and atmospheric circulation connection. Theor. Appl. Climatol., 88, 193-99.

Mazzarella, A. 2008, Solar forcing, of changes in atmospheric circulation, Earth's rotation and climate. Open Access Atmospheric Science Journal, 2, 181-184.

Mayaud, P.N. 1972, The aa indices: a 100-year series characterizing the magnetic activity. J. Geoph. Res., 77, 6870-6874.

Rayner, N.A., Parker, D.E., Horton, E.B., Folland, C.K., Alexander, L.V., Rowell, D.P., Kent, E.C., Kaplan, A. 2003, Globally complete analyses of sea surface temperature, sea ice and night marine air temperature, 1871-2000. J. Geoph. Res., 108, 4407, doi:10.1029/2002JD002670.

Rossby, C.G. 1939, Relation between variation in the intensity of the zonal circulation of the atmosphere and the displacements of the semipermanent centers of action. J. Marine Res., 2, 38-50.

Stephenson, F. R. and Morrison L.V. 1995, Long-term fluctuations in Earth's rotation: 700 BC to AD 1990. Phil. Trans. R. Soc. A, 351, 165-202.