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Forecasting the global temperature trend according to the predicted solar activity during the next decades

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Abstract. A historical studies of the sunspot numbers and the geomagnetic index-aa pointed toward the reality of a long cycle (of 100-yr). This cycle is considered the small hand behind the performance of the short ones (the 11-yr cycles). On the other side the solarclimate correlation was proven during the last decade as well as the solargeomagnetic relationship. From this point of view we carried out a prediction of the sunspot numbers and the global temperature during the next three solar cycles to recognize the situation of this period on the curve of the 100-yr cycle, We developed the model of neural network, which considered the recent and favorable approach of prediction, into what we called NeuroFuzzy model.

1. Introduction

Climate variability can profoundly influence human and natural systems. Global mean surface temperatures have increased 0.5-1.0 F over the past century, the last 10 years were the warmest Recent climate models of Earths temperature variation (see Folland et al). Also the sea level has risen 4-8 inches. Levitus et al. (2005) found that, during 1955-1998 world ocean heat content increased 14.5×10^{22} J corresponding to a mean increase of 0.037 C at a rate of 0.20 Wm^{-2} (per unit area of Earths total surface area) include human activity, greenhouse gases and ozone, as well as natural forcing such as solar variability and volcanic eruptions, Meehlet al. (2004) explained combination of both forcing. Solar output has played a major role in determining the long term trends in global climate (see Dergachev et al. 2002). However it is considered of limited importance in comparison with the anthropology effect. Recently Pang and Yau (2004) explained how a variable Sun has changed the climate. North (2004) concluded that the response over the last few solar cycles is rather large at some latitudes, and the cause might originate in dynamical alternations of the general circulation rather than the often-suggested energy balance considerations. The response of the 11-year cycle is likely to be roughly equal combination of both dynamical and simple energy balance effects at least at some latitudes. The solar variations, however, act over periods ranging from decades to centuries. Current researches activities on climate variability and change are directed toward advancing understanding of this change and improving climate predictions. Huang, Shaopeng, 2004 offered an independent estimate of the transient climate-forcing

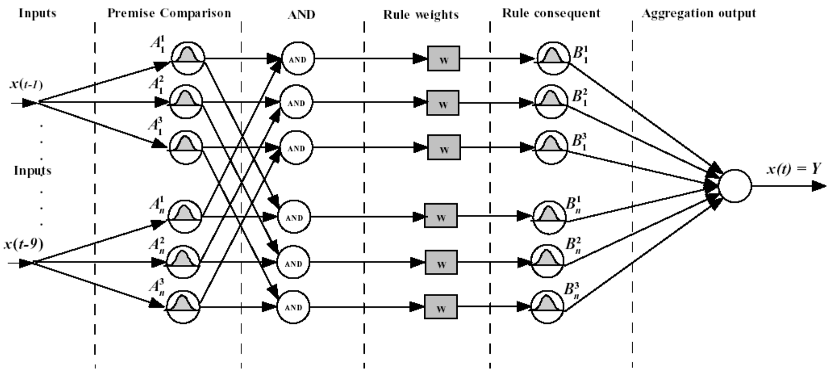

Fig. 1. Fuzzy logic neural network topology.

response rate of 0.4-0.7 K/Wm^{-2} and predicted a temperature increase of 1.0-1.7 K in 50 years. Scientists are more confident about their projections for large-scale areas (e.g., global temperature and precipitation change, average sea level rise) and less confident about the ones for small-scale areas (e.g., local temperature and precipitation changes, altered weather patterns, soil moisture changes). This is largely because the computer models used to forecast global climate change are still ill equipped to simulate how things may change at smaller scales.

2. Data and Methodology

Historical records of Wolf sunspot number for the period (1700-2004), published in the NGDC (ftp:// ftp.ngdc.noaa.gov/STP/) on one side and the global temperature anomalies, for the period since 1880 up to present on the other side, were analyzed. The NASA GISS (GISTEMP) provides a measure of the changing global surface temperature with monthly resolution in http://data.giss.nasa.gov/gistemp/tabledata/GLB.ts.txt, when a reasonably global distribution of meteorological stations was established. We applied the Fuzzy Logic Neural Network (FLNN) Model to analyze each of the time series of Wolf number as a measure of solar activity and the global temperature anomalies independently. The FLNN model as a general nonlinear interpolator is built using the multi-layer fuzzy logic neural network shown in Fig. 1, proposed by Lin and Lee (1991) and Horacek (1995) with some modification by Kolinsky (2000). This is a particular implementation of a fuzzy system equipped with fuzzification and defuzzification interfaces (for details see Attia (2004) and references within). The statistical method of the moving average was used, to distinguish the state of the long cycle, the result described by simple methods of graphics.

3. Results

Although sunspots themselves produce only minor effects on solar emissions, the magnetic activity that accompanies the sunspots can produce dramatic changes in the ultraviolet and soft x-ray emission levels. These changes over the solar cycle have important consequences for the Earth's magnetic field and the upper atmosphere. We used the sunspot number to apply our model because it is more familiar with the long cycle 80-100 yr. Seeking to estimate the future global temperature as consequence of the evolution of solar activity. The model forecasts coming of two weak cycles (24th and 25th), of amplitude comparable to that of the 23rd (see Attia 2005) which means a reduction in solar outputs on the next decades. Moreover Shahinaz (2003) has followed the historical turning points in the level of the Lake

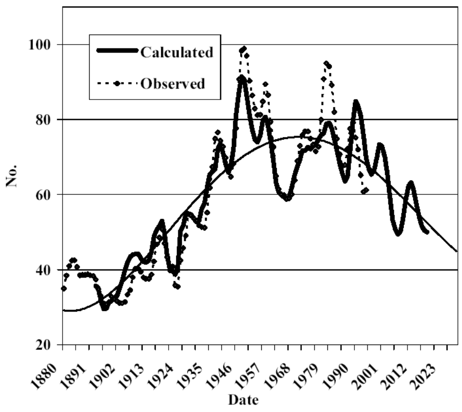

Fig. 2. The observed and predicted values of the Wolf No.

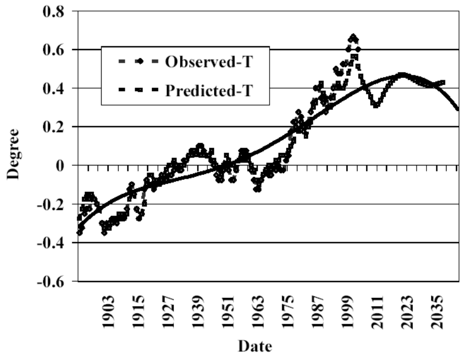

Fig. 3. The observed and predicted values of the Global temperature anomalies.

Victoria comparing with the strength of solar cycles. She pointed to a drop of Lake Victoria till the end of cycle 23 leading to drought conditions around 2009 by two or three years, also she predicted, by a different model, coming of three weak solar cycles. Fig. (2) shows the smoothed curve of the predicted Wolf numbers, using the running moving average (of 7 terms). It describes the development of the solar activity through the 100-yr cycle; it had started after 1914 tilling its maximum phase during1935 1998. This course can explain the enhancement occurred during this interval; cycles 19 and 22 were considered the maxims of two successive cycles of 33-yr, which superimposed on the maximum phase of the 100-yr cycle, Maha (2004). Our prediction indicates that the long cycle goes down to its end gradually up to 2024. The tendency of the global temperature variation, actual and predicted values, is distinguished in Fig. (3). It is parallel to the growth of the sunspot numbers shown above, the rate of rising started by the start of the last century tends to reduce during the next years. A drop can be noted after 2002 and reaches its minimum rate in 2012, and then it will go up slightly but with slower rate. Generally we could say that in case of reduction of the term of solar output the rate of increase in the global temperature will be reduced by a factor equal to the ratio of solar effect to the human made, if so we are going through an era of relatively stable temperatures.

4. Conclusions

The connection between solar activity and terrestrial climate is complicated and needs more understanding so it is still an area of on-going research.

The solar activity may be of limited effect on the atmospheric warming on the short timescale but it have played a more significant role in determining the long term trends in the global warming model. Because it is the term we cannot impose, so it is important to guess approximate values to take it into the calculation of the global warming model.

According to our prediction, the Gleissberg Cycle have been started its declining phase and it seems to be slower than the increasing phase. I.e. the firing of solar activity is going to its end and it is expected to return to the average level detected through the far cycles 13, 14 and 15.

A relative reduction in heating rate is predicted; it will reach its minimum in 2012, next increasing with slow rate, but lesser than the previous rate, is expected. Because of the large contribution of the artificial influence we are still in the critical stage.

We have to invest the period of low solar activity to get good results towards controlling the rate of warming. If the international efforts succeed to manage the influence of industry and on the other hand the individuals regulate their behavior of life, we can stop the decay of environment.

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