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Application of Soft Computing (ANN) Techniques to study the relationship between Solar Activity Features and Total Column Ozone

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Abstract: Using 30 years data (1986-2015) we have made an attempt to study the dependency of total column ozone (TCO) on solar activity features: solar flares (SF), solar active prominence (SAP) and sunspot numbers (SN) for two hill stations of Uttarakhand viz. Nainital (29.4^0 N.79.47^0E) and Mussorie (30.27^0 N 78.06^0 E) by Artificial neural network (ANN) technique. Our study supports the fact that solar activity features contribute to the production of ozone.

Keywords: Solar activity features, Total colomn ozone, Artificial neural network.

1. Introduction

Ozone is an important part of the Earth's atmosphere which absorbs harmful radiation from the Sun and also plays an important role in the variation of the Earth climatic conditions. The total column ozone (TCO) is the total amount of ozone found in a column of air above the Earth from its surface to the top of the atmosphere. There have been some statistical studies between solar activity and TCO (Angell & Korshover, 1976, Bojkov 1987, Zahid & Rasul,2010, Selvaraj et al., 2010b, Bisht et al., 2014). Bisht et al., have attempted a statistical study and found that solar activity contributes to the production of ozone. In this paper, we have ued feed forward neural network model and trained the function of data from 1986 to 1996.

TCO of two hill Station from 1997 to 2012 has been predicted through testing process.

2. Data and Analysis

The atmospheric TCO and solar activity data are obtained from following websites:

http://ozoneaq.gsfc.nasa.gov./ozone_overhead_all_v8.md.

http://www.ngdc.noaa.gov/stp/space-weather/solar-data/solar-indices/sunspot-numbers.
http://www.ngdc.noaa.gov/stp/space-weather/solar-data/solar-features/solar_ares/h-alpha/ http://www.ngdc.noaa.gov/stp/space-weather/solar-data/solar-features/prominences/filaments/

Here, we have used solar activity features sunspot numbers (SN), solar flares (SF) and solar active prominences (SAP) as input data for training of neural network. First we trained the input solar activity with target TCO of two hill stations of Uttarakhand. There are 3 inputs (SN, SF &SAP) connected by 10 neurons with 1 hidden layer network. The inputs are related with the neurons by following equation

$$y = \sum_{i=1}^{10} a_i x_i \qquad (1)$$

The hidden layer forms a sigmoid function and defines the relationship between input and target TCO. Now, from 1997 to 2012 we have taken only input data, this is called testing of model by which we simulate the function for the prediction of TCO of two hill stations of Uttarakhand (Nainital and Massorie). We found that the predicted values are very close to the observed values. On comparing the observed and predicted values and we found

that there is very small error found between observed and predicted values as can be seen in fig 1. (a) and fig1(b)

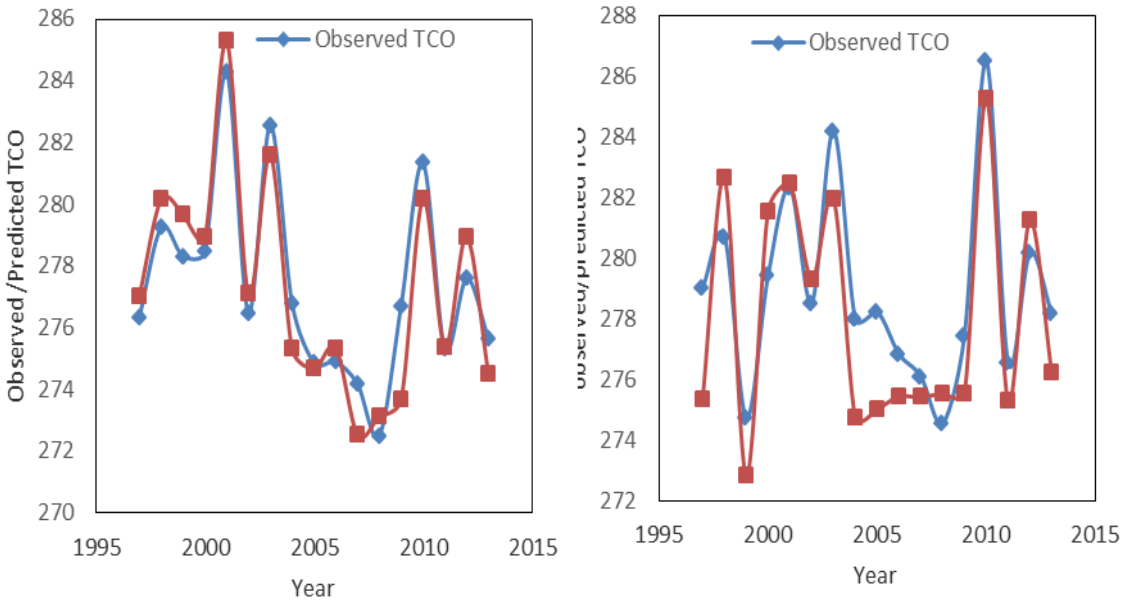

Figure 1 (Color online). Comparison between predicted and observed value of TCO for Hill station of Uttrakhand (left) Nainital (right) Mussorie by artificial neural network model

Table 1. Observed, predicted and error by ANN for two hill stations of Uttarakhand (Nainital and Mussorie

Year	TCO of Nainital			TCO of Mussorie		
	Observed	Predicted	Error(%)	Observed	Predicted	Error(%)
1997	276.4	277.3	0.24	279	275.3	1.31
1998	279.3	280.2	0.32	280.7	282.6	0.68
1999	278.3	279.7	0.48	274.7	272.8	0.69
2000	278.5	278.9	0.17	279.4	281.5	0.77
2001	284.3	285.3	0.35	282.3	282.4	0.28
2002	284.3	285.3	0.22	278.5	279.4	0.39
2003	276.5	277.1	0.33	284.2	282	0.78
2004	282.6	281.6	0.53	278	274.7	1.17
2005	276.8	275.3	0.08	278	274.7	1.15
2006	274.9	274.7	0.16	278.2	274.4	0.5
2007	274.9	275.3	0.59	276.8	27540	0.29
2008	274.2	272.5	0.22	276.1	274.5	0.57
2009	272.5	273.1	1.09	274.5	274.5	0.69
2010	276.7	273.7	0.41	286.5	285.2	0.43
2011	281.3	280.2	0.08	276.6	275.2	0.46
2012	277.6	279	0.41	280.2	281.2	0.38

3. Results and Discussion

In the present study, we have used a soft computing ANN technique for studying the relation between TCO and solar activity features. We have predicted the TCO of two hill stations of Uttarakhand (Nainital and Mussurie) by taking solar activity features as input for neural network model and found that the predicted values are very close to observed values of TCO. We have predicted TCO from 1997 to 2012. Fig 1 (a) and (b) indicated the comparative plots of observed and predicted values and found the mean square error which is very small. There error varies from 0.08% to 1.5% for Nainital and 0.25 % to 1.5% for Mussorie seen in Table 1. This technique indicates that the solar active features strongly contribute to the production ozone in the stratosphere and troposphere. The statistical study by Bisht et al., 2014 also indicates that the solar activity plays an important role in the production of TCO but the results obtained by ANN technique are better than statistical technique results. Hence, our study supports the fact that the solar activity features (SN, SAP, SF) contribute to the production of ozone.

References

1. Angell J K & Korshover J , 1976 Mon Weather Rev (USA),104 63-75.
2. Bojkov R. D. 1987, Mon Weather Rev (USA),115 2187-2201.
3. Bisht, H., Pande. B., Chandra R., Pande.S.,2014,Indian Journal of Radio and Space Physics, 43 , 251-262.
4. Selvaraj R. S., Gopinath T, Jayalakshami K, 2010b., Indian J Sci Technol, 3(7),792-794.
5. Zahid M &Rasul G, 2010, J Environ prot(China),374-383

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