

## A statistical elucidation of the association between total column ozone concentration and surface temperature through spectral analysis

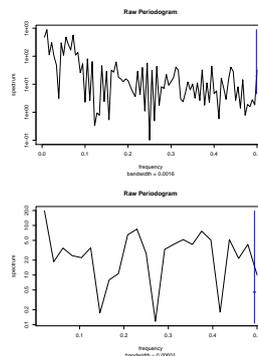
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Variation in the thermal structure of the stratosphere as well as troposphere with changes in total ozone is well documented in the literature (see [1, 2] and references therein). A considerable number of studies on ozone and temperature observations are all over the globe. It is observed through some statistical computation that both of the time series under study are positively skewed. Thus, a Box-Cox transformation is applied to the time series using the transformation formula [3]  $Z_t = \frac{X_t^\lambda - 1}{\lambda G^{(\lambda-1)}}$  where  $X_t$  is the original series,  $G$  is the sample geometric mean,  $\lambda$  is the transformation parameter, and  $Z_t$  is the transformed series. After transformation of the time series by Box-Cox method, we carry out a spectral analysis of the time series under consideration. A detailed account of the spectral analysis is available in Wilks (2006, pp. 83–86)[3]. A series of  $n$  points can be represented by adding together a series of  $n/2$  harmonic functions as:

$$y_t = \bar{y} + \sum_{k=1}^{n/2} \left\{ A_k \cos \left[ \frac{2\pi kt}{n} \right] + B_k \sin \left[ \frac{2\pi kt}{n} \right] \right\} \quad (1)$$

where  $A_k$  and  $B_k$  are Fourier coefficients,  $y_t$  represents the entry to the time series at time  $t$  [3]. In the present paper, the transition from monsoon to post monsoon period (September–November) is considered over Kolkata, India, a megacity belonging to the Gangetic West Bengal. Data have been selected in daily scale for the study of TCO and surface temperature. The TOC data are collected from OMDOAO3e: OMI/Aura Ozone (O3) DOAS Total Column L3 and the surface temperature data are provided by the India Meteorological Department.



**Figure 1.** The cumulative spectrum of TOC for 2016.

The spectrum is calculated for both the time series using Eq. (1). It is observed that the TOC time series is having more frequent oscillations than the surface temperature. However, both of them have higher spikes in the lower frequencies (see Fig. 1). For TOC the spikes are separated by shorter periods than the TOC. For both the series oscillations with frequencies near 0.052 cycles per day are having significant probability in common. Hence, it is interpreted that although the time series differ in the oscillatory pattern of the spectrum, they are characterized by common cycles. Similar behaviour has been observed in 2015 as well. Thus, we can establish the existence of common spectrum and hence we can conclude that there are fluctuations at some common cycles and this establishes a strong physical association between surface temperature and TOC in the transition period from monsoon to post monsoon over the study zone.

## References

- [1] S. J. Reid et al., *Journal of Atmospheric Chemistry*, **30**, 187 (1998).
- [2] C. Tzani, *International Journal of Remote Sensing*, **30**, 6075 (2008).
- [3] D. S. Wilks, *Statistical Methods in Atmospheric Sciences*, 2nd, Burlington, MA: Elsevier Inc. (2006).