INTERNATIONAL JOURNAL FOR INNOVATIVE RESEARCH IN MULTIDISCIPLINARY FIELD
ISSN: 2455-0620 [Impact Factor: 6.719]
Monthly, Peer-Reviewed, Refereed, Indexed Journal with IC Value : 86.87
Volume - 8, Issue - 1, JAN - 2022 Publication Date: 31/01/2022

DOIs:10.2015/IJIRMF/202201014 --:-- Research Paper

Different atmospheric parameters influence the tropospheric ozone column over Alipore, India

Dipak Kumar Saha
Department of chemistry, DinabandhuMahavidyalaya, Bongaon, 24pgs (N), WB, India
Email - dipakdeeptamsaha@gmail.com

Abstract: *The paper presents the character of variations of tropospheric and total ozone column retrieved from the Convective Cloud Differential (CCD) technique, ozone watching Instrument (OMI), and Total ozone Mapping prism spectroscope (TOMS) information, National physical science and house Administrations (NASA), USA, respectively; surface temperature, relative humidity, total precipitation, ozone precursors (non-methane organic compound, CO, NO_2, and sulphur dioxide) that area unit collected from Indian Meteorological Department (IMD), Alipore, Kolkata; Solar insolation obtained from Solar geology information Book and El-Nino index collected from National climatical information Centre, U.S.A. Department of Commerce, National Oceanic and part Administration, USA. The impact of those climatical parameters and ozone gas precursors on ozone variations is critically analyzed and explained on the idea of rectilinear regression and correlation. It's been ascertained that the most, minimum and mean temperature, relative humidity, solar insolation, tropospheric, and total ozone column (TOC) showed slight increasing tendencies from October 2004 to December 2011, whereas total precipitation and El-Nino index showed very little decreasing tendencies for identical amount. Amongst chosen climatical parameters and ozone precursors, the solar insolation and therefore the average temperature had a major influence on each, the tropospheric ozone and total ozone column formation. The solar insolation had contributed a lot in tropospheric ozone than in total ozone column, whereas El-Nino index had played a lot of important roles in total ozone column build up than in tropospheric ozone. Correlational statistics as ascertained between the almost all ozone precursors with the tropospheric and total ozone. The tropospheric ozone and total ozone gas column are conjointly considerably correlate. The extent of significance and contribution of various climatical parameters determined from correlation technique and Multiple rectilinear regression (MLR) methodology. The connected chemical dynamics for ozone production processes have been critically explained.*

Key Words: *Relative humidity, Rainfall, Surface temperature, El-Nino index, Solar insolation.*

1. INTRODUCTION:

Tropospheric ozone, in spite of being lessconcentrated than stratospheric ozone, is an important supply of hydroxyl radical, a strong oxidizer that breaks down into various pollutants, readily reacts with other chemicals to provide many harmful oxides (Wayne 2000) and a few greenhouse gases (Fowler et al. 2008). It's a dangerous pollutant and a constituent of smog. High concentrations of tropospheric ozone are toxic in nature. Moreover, tropospheric ozone itself acts as a good greenhouse emission and initiates the chemical removal of alkane series and alternative hydrocarbons from the atmosphere (Solomon et al. 2007). Recent ozone assessments reveal that though the hole ozone column is declining everyplace by a really bit (Jana et al. 2012 a, b, c, d), the dramatic decrease in TOC happens at continent throughout Antarctic spring-time causes ozone hole (Farman et al. 1985). In previous publication (Midya and Jana 2002), natural, dynamical, and chemical theories of intense stratospheric ozone depletion also as stratospheric ozone formation processes are delineated that area is completely different from tropospheric ozone formation and depletion processes that are shown by Jana et al. (2012a, b, c, d). Several studies on ozone trends are remodelled completely different places throughout the globe (Kondratyev et al. 1994; Varotsos et al. 1994; Gernandt et al. 1995; Varotsos 2004). Varotsos (2002) exhibited that in September 2002, the hole over the Antarctic as abundant smaller than within the previous six years and it absolutely splitted into 2 separate holes because of the appearance of sudden stratospheric warming that had never been ascertained before in the southern hemisphere. Ozone showed a temporal variability over hourly, diurnal, synoptic, weekly, seasonal, and long-run time scales (Varotsos et al. 2004). The typical temperature of the world is directly associated with ozone concentration of stratosphere and fall in ozone concentration within the stratosphere takes place over European country before the arrival of warm front at the bottom surface (Dobson et al. 1946). The increase in ozone content within the stratosphere occurred once cold front reached the bottom level. Climatical impacts, particularly temperatures, were robust enough to have an effect on the tropospheric ozone distribution (Valero et al. 1992; Hsu 2007). Temperature and long run urban warming had a heavy impact on urban pollution, leading to higher ozone concentrations, as heat accelerates the chemical reactions within the atmosphere (Clark and Karl 1982; Walcek and Yuan 1999). The most surface temperature as directly associated with stratospheric ozone concentration over city (Midya et al. 2003).The total ozone concentration had inflated throughout pre-monsoon and winter periods. In pre-monsoon amount, the speed of formation of ozone concentration as sharp with rise of temperature. The TOC had attenuated throughout monsoon and post-monsoon periods. During monsoon rate of depletion of ozone as over post-monsoon with inflated temperature (Midya et al. 2011a, b). The ozone commixture quantitative relation as negatively related to with temperature at higher level (i.e., 40 km) and absolutely related to a lower level (Barnett et al. 1975). A depth relation existed between barometrical height, tropospheric weather and ionospheric parameters of the higher atmosphere (Mitra 1992). It had been ascertained that the minimum height of F region and average E ionization tend to follow the variation of barometrical height. Correlation ascertained between the bottom virtual height of E layer and ground temperature at Standford, California, USA. The variation of solar UV ray radiation due to fall of stratospheric gas concentration had a pronounced influence on tropospheric climate (Bates 1981; Mackay et al. 1997).The variation of stratospheric ozone asconjointly related with relative humidity, e.g., sharp depletion of absolute humidness happens throughout Nor'wester over Calcutta (Midya and Sarkar 2007). Ozone production attenuated with increase in humidness in air contaminated by n-heptane (Pekarek 2008). Analyzing all-India summer monsoon (June–September) precipitation for the amount 1871–1978, Mooley and Parthsarathy (1984) detected continuous rise in 10-yr mean precipitation from 1899 to 1953. From the study of the surface ozone knowledge over Trivandrum (8.5◦N,76.9◦E) at the side of temperature and precipitation, Muralidharan et al. (1989) according that the day time rainfall brought a decrease in surface ozone, whereas night-time precipitation created a rise. Long term changes of seasonal and annual surface temperatures and precipitation (Govindo Rao 1993) of the Mahanadi geographic region in India showed a extremely important warming trend within the mean most, mean minimum, and average mean temperature of the basin for the amount 1901–1980. However, precipitation for monsoon and annual series didn't show any important trend for identical amount. A spring time ozonemaximum and summer minimum had been ascertained within the marine physical phenomenon over the Northern Pacific Ocean (Watanabeet al. 2005). Precipitation showed degree of increasing trend i[th] the increase of rate of amendment of TOC throughout all seasons from the study over Dibrugarh, India (Midya et al. 2012a, b). Rain occurred only ozone concentration achieved a precise concentration level (Midya et al. 2011a, b). Precipitation rates in most of the urban square measures were over the corresponding subdivision rates within the later a part of the last century however reverse trends are being seen in some cities. Subdivision precipitation, monsoon as well as annual square measure showing a decreasing trend (Ganda and Midya 2012). The pre-monsoon rate of precipitation of same year however TOC of alternative seasons square measure freelance of monsoon precipitation over Gangetic West Bengal, India. Applied math analysis of TOC showed that annual co-efficient of relative variability (ACRV) of ozone in West Africa over an amount of forty-eight months inflated bit by bit from 3.5% at angular distance zone 0−5◦N to 6.1% at zone 20−25◦N. A robust positive correlation of 0.99 as ascertained between the ARCV of ozone and average annual temperature, whereas a correlation -.99 as ascertained between the ARCV of ozone and average annual precipitation within the same region (Akinyemi 2010).

2. RESULT AND DISCUSSION:

Variations of monthly mean tropospheric ozone concentration and TOC from October 2004 to Dec 2011 and January 2005 to Dec 2011, respectively, over Alipore, India have been shown in figure 1(a and b), respectively. The character of each the variations of tropospheric ozone and TOC, though periodic, had discovered a small increasing tendency from October 2004 to Dec 2011 and January 2005 to Dec 2011, respectively. The concentrations of tropospheric ozone and total ozone gas had increased by nearly 0.01 DU and 0.02 DU per month, respectively. The variation of tropospheric ozone gas agrees fairly well with previous observation (Jana et al. 2012b) that showed increasing trend in troppospheric ozone over most of the places in India from October 2004 to June 2009. But the variation of TOC disagrees with previous observations of total ozone over many stations, viz., Thumba (8.5◦N, 77◦E) and urban centre (13◦N, 77.5◦E) (Jana et al. 2012a), capital of India (29◦N, 77◦E) (Jana et al. 2012c), Dumdum (22.5◦N, 88.5◦E) (Jana and Nandi 2006), etc., in India before, during and after Montreal Protocol and Kyoto agreement for various periods from 1979 to 2005, that delineate a decreasing trend in TOC. Variations of monthly mean most, minimum, and average temperature from October 2004 to Dec 2011 are depicted in figure 2. that clearly indicates periodic nature of those temperatures with a small enhancing tendency from October 2004 to Dec 2011. The improvement within the mean temperature per month as more or less 0.0078◦C. Figure 3 shows the variations of maximum, minimum, and average relative humidity for October 2004– Dec 2011. In spite of periodic nature, maximum, minimum, and average relative humidity had increased slowly from October 2004 to Dec 2011. However, the character of variation of monthly total rainfall as oscillatory and discovered a slow decrease from October 2004 to Dec 2011 as shown in figure 4. Interannual variability had been revealed each in solar insulation and El-Nino index from January 2005 to Dec 2011, however solar insolation had shown increasing tendency of 0.0043 k hr/m2/month whereas El-Nino index had shown a small decreasing tendency by 0.0169per month as pictured in figures 5 and 6, respectively. Annual cycles of monthly mean densities of nonmethane hydrocarbon (NMHC), carbon monoxide gas (CO), nitrogen dioxide (NO2), and sulphur dioxide (SO2) over Alipore are shown in figure 7 for the duration January 2005 to Dec 2011. The density of NMHC bit by bit fell from January to April, and then remained virtually steady up to September then inflated sharply. Relatively, lower concentration of NMHC as detected from May to September. The concentration of CO declined from January to June, then remained virtually unedited up to September then built up gradually. The annual cycle of the density of NO2 discovered a sharp fall from January to April, then moderate rise to August, and steep improvement up to December except in September. The concentration of SO2 steeply diminished from January to May, then earned minimum values for the months of May to July month then steeply inflated. The regular and continuous fall of concentration of NMHC, CO, NO2, and SO2 occurs due to inflated photo-induced reaction manufacturing tropospheric ozone because of rise in radiation throughout inter and pre-monsoon, and inflated absorption of those molecules by water vapour as follows:

$NO_2 + h\nu(\lambda = 424\text{ nm}) \rightarrow NO + O.$

$CO + 2O_2 \rightarrow CO_2 + O_3.$

$(NOx+OH)+VOC + 4O_2 \rightarrow 2O_3 + CARB$

$+H_2O + (NOx+OH).$

$SO_2 + h\nu \rightarrow SO + O.$

$NO_2 + H_2O \rightarrow HNO_2 + HNO_3.$

$CO_2 + H_2O \rightarrow H_2CO_3.$

$SO_2 + H_2O \rightarrow H_2SO_3.$

Where VOC denotes volatile chemical compound and CARB stands for carbonyl compounds. Moreover, westerly wind flow picked up mentioned anthropogenically derived gases from Kolkata to eastern region of India throughout pre-monsoon. All-time low densities of NO2 within the month of September, CO and NMHC throughout monsoon were largely because of washed out result of those constituents from troposphere by lot of rain. Gradual rise in concentration of NO2 from April to August as because of the reaction N2 + O2 → 2NO in presence of lightning that typically occurred throughout this period followed by the reaction 2NO + O2 → 2NO2. Steep building of those constituents throughout post-monsoontimeas because of relatively low radiation, little rain and existence of north westerly and largely north-easterly winds coming into from north-eastern and north western region transportation considerably impure airfrom the nearby cities to metropolis (Purkait et al. 2009).

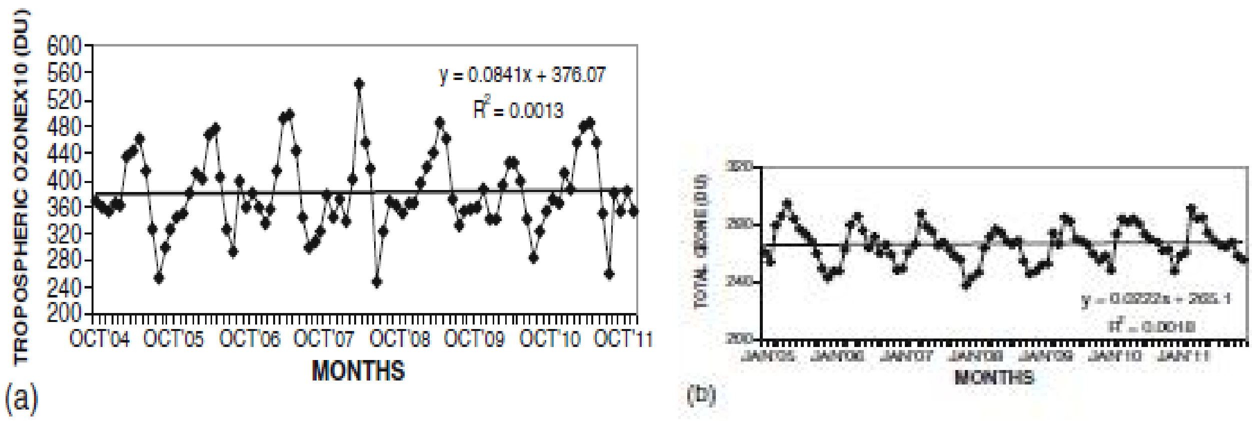


Figure 1. Variation of (a) tropospheric ozone (DU) from October 2004 to December 2011 and (b) total ozone column from January 2005 to December 2011

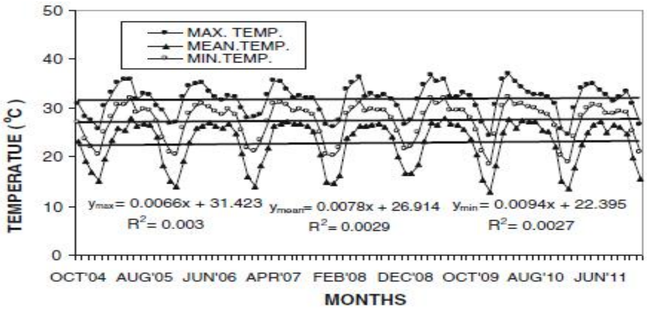
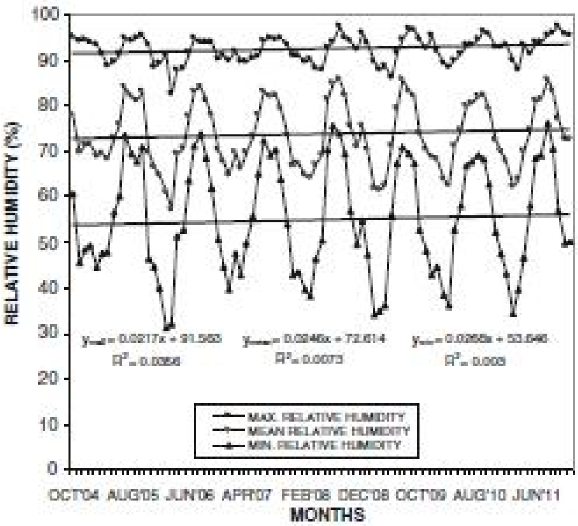


Figure 2. Variations of surface maximum, minimum and mean temperature over Alipore, India from October 2004 to December 2011



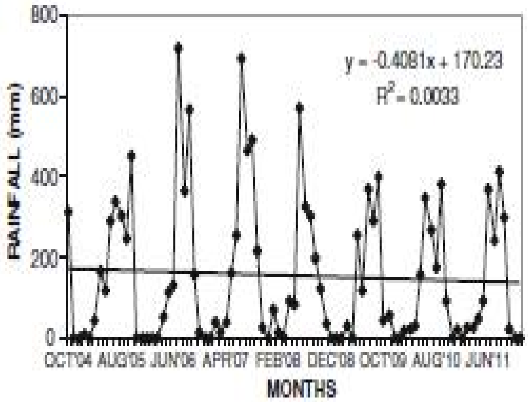
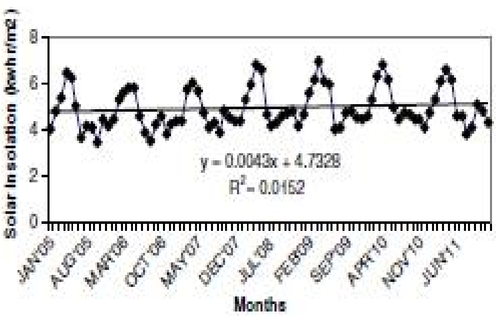


Figure 3. Variation of maximum, minimum and mean relative humidity over Alipore, India from October 2004 to December 2011

Figure 4. Variation of total rainfall (mm) over Alipore, India from October 2004 to December 2011



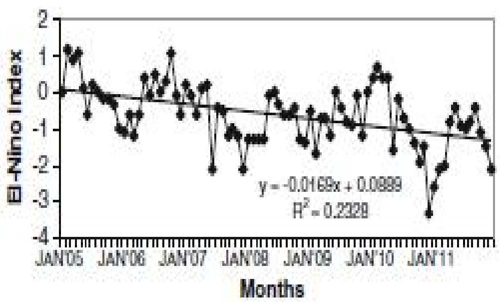


Figure 5. Variation of solar insolation over Alipore, India from January 2005 to December 2011

Figure 6. Variation of El-Nino index over Alipore, India from January 2005 to December 2011

The maximum relative humidity within the month of August as clearly results of the high incidence of monsoon winds. Afterwards, relative humidity ablated with the absence of monsoon winds, incidence of westerly wind and gradual fall of temperature. Low rain in pre-monsoon time from March to May (MAM), large rain in monsoon time from June month to September, and extremely low rain in post-monsoon from Oct to Nov and inter amount from Dec to February had been attributed to occasional existence of Nor' wester that occurred typically 2–6 times in every month from February to May in each year, high prevalence of monsoon wind throughout the monsoon time and appearance of dry retreat monsoon or north westerly wind consisting terribly lo quantity of vapor coming into from Bihar, Orissa, and province together with East Pakistan which may clash with the wet winds of Bay of geographic area, inflicting cyclones, typically because of air mass and temperature distinction in post-monsoon and inter season, respectively. The temperature dependence of tropospheric and TOC and their high correlation were because of the actual fact that ozone formation reaction from O2 is a reversible and endothermic method. So, the formation of atmospherical ozone had been favoured relatively by higher temperature. Therefore, the variation of maximum temperature had a serious role within the formation of tropospheric and TOC. Once more relatively lower correlation value just in case of tropospheric ozone indicates that not solely the surface temperature plays a serious role intropospheric ozone formation processes, however conjointly the concentrations of ozone precursors have a comparable influence on the tropospheric ozone formation. Total ozone column mostly comprises of stratospheric ozone in the layer of stratosphere where temperature is very low. Therefore, increase in surface temperature features a larger influence on stratospheric ozone formation than tropospheric ozone formation. As a result, higher correlation has been obtained for TOC with maximum temperature. The concentration of tropospheric ozone slowly ablated with increase in rain because of removal of pollutants and ozone precursors by absorption and laundry down by rain. Tropospheric ozone accumulated with increase in TOC attributable to down ward transport of stratospheric ozone. A lot of increase in tropospheric ozone contributed more to the TOC and the other way around.

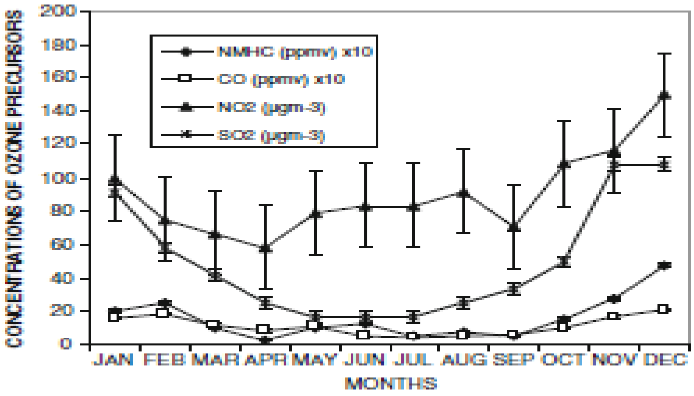
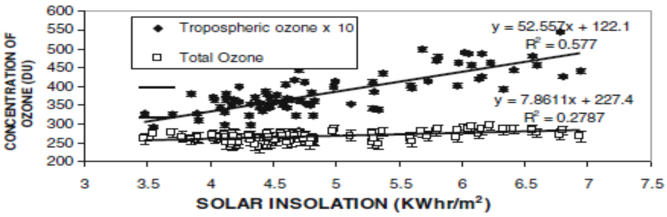
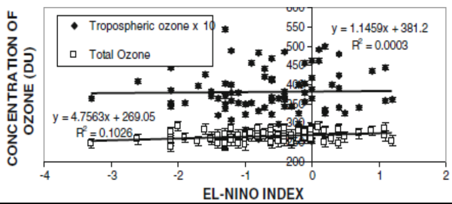


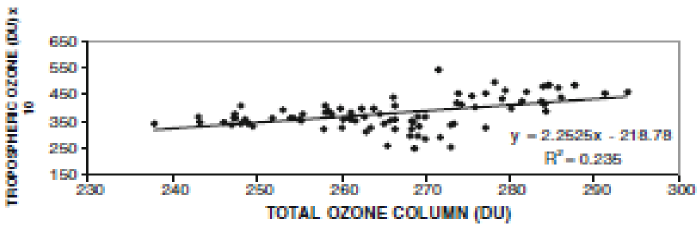
Figure 7. Annual cycles concentrations of NHMC, CO, NO_2 and SO_2 over Alipore, India from January 2005 to December 2011



Scattered diagram of (a) tropospheric ozone (b) total ozone column with solar insolation kwhr/m^2



Scattered diagram of (a) tropospheric ozone (b) total ozone column with El-nino index



Scattered diagram of tropospheric ozone (DU)with total ozone column (DU)

3. CONCLUSION:

The concentration of tropospheric ozone had exaggerated slowly over Alipore, India from Oct 2004 to December 2011 due to the periodical nature and slow increase within the quantity of ozone precursors like oxides of element (NOx), nonmethane organic compound (NMHC), oxides of sulphur (SOx), monoxide (CO), etc. and surface temperature attributable to increase radiation and warming, that catalyzed a lot of tropospheric ozone formation processes and down ward transport of stratospheric ozone. The concentration of TOC had increased slightly from January 2005 to December 2011 as a result of the implementation of Montreal protocol (1987) that controlled the assembly and emission of ozone depleting substances (ODS), expedited the terminate programme of those substances and evolved the trail of conversion from ODS to non-ODS. Kyoto Protocol (1997) restricted emissions of greenhouse gases (GHGs) and upward transport of elevated tropospheric ozone. Among surface temperature, relative humidity, total rain, ozone precursors, solar insolation and El-Nino index, solar insolation, surface temperature and El-Nino index vie a serious role in dominant the number of tropospheric and TOC. The concentration of tropospheric ozone as significantly controlled by the variations of solar insolation, total O3 and mean surface temperature and El-Nino index; whereas total O3 by solar insolation and El-Nino index from 2005 to 2011.

4. ACKNOWLEDGEMENT:

The author is highly thankful to Prof. S.K. Midya, department of Atmospheric Science, University of Calcutta and Dr. P.K. Jana, for critical and valuable discussions.

REFERENCES:

1. Akinyemi M L 2010 Total ozone as a stratospheric indicator of climate variability over West Africa; Int. J. Phys. Sci. 5(5) 447–451.
2. Barnett J J, Houghton H and Pyle J A 1975 the temperature dependence of ozone concentration near stratospause; Quart J. Roy. Meteorol. Soc. 101 245–257.
3. Bates J R 1981 A dynamical mechanism through which variations in solar ultraviolet radiation can influence tropospheric climate; Solar Phys. 74(2) 399–415.
4. Bojkov R D and Fioeltov V E 1995 Estimating the global ozone characteristics during last 30 years; J. Geophys.Res. 100 16,537–16,551.
5. Chandra S, Ziemke J R, Duncan B, Diehl T L, Livesey N and Froideyaux L 2009 Effects of the 2006 El Ni˜no on tropospheric ozone and carbon monoxide: Implications for dynamics and biomass burning; Atmos. Chem. Phys. 9 4239–4249.
6. Clark T L and Karl T R 1982 Application of prognostic meteorological variables to forecasts of daily maximum one-hour ozone concentrations in the northeastern United States; J. Appl. Meteorol. 21 1662–1671.
7. Dobson G M B, Brewer AandCurilong 1946 Meteorology of the lower stratosphere; Proc. Roy. Soc. A (London) 185 144–175.
8. Farman J C, Gardiner B G and Shankline J D 1985 Large losses of total ozone in Antarctica reveal seasonal ClOx/NOx interaction; Nature 315 207–210.
9. Ganda S C and Midya S K 2012 Comparison of long-term rainfall trends in urban and nonurban region of Indian land mass and its probable implication; J. Indian Geophys. Union 16(2) 37–40.
10. Gernandt H, Goersdorf U, Claude H and Varotsos C A 1995 Possible impact of polar stratospheric processes on midlatitude vertical ozone distribution; Int. J. Remote Sens.16 1839–1850.
11. Govindo Rao P 1993 Climate changes and trends over a major river basin in India; Clim. Res. 2 215–222.
12. Hsu K J 2007 Relationships beteen 10-year trends of tropospheric ozone and temperature over Taian; Sci. TotalEnviron. 374 135–142.
13. Jana P K and Nandi S C 2006 Ozone decline and its effect on night airglow intensity of Na 5893 ˚A at Dumdum (22.5◦ N, 88.5 ◦ E) and Halley Bay (76 ◦ S, 27 ◦); J. Earth Syst. Sci.115 607–613.
14. Jana P K and Saha I 2011 Correlation of greenhouse molecules with global and surface temperature and its effect on environment; Indian J. Phys. 85(5) 667–682.
15. Jana P K, Sarkar D, Saha D K and Midya S K 2012d Effect of cloud occurrences on tropospheric ozone over Alipore India; J. Earth Syst. Sci. 121(3) 711–722.
16. Jana P K, Saha D K and Sarkar D 2013 Contribution of some ozone depleting substances (ODS) and greenhouse gases (GHG) on total column ozone growth at Srinagar India; J. Earth Syst. Sci. 122(1) 1–14.