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Research Paper

Variation of Total Mass Density, Oxygen and Nitrogen on Troposphere above Nepal, 2019

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Abstract
In this work, the concentration of nitrogen, oxygen, and air density at 1km altitude above Nepal is studied with the help of data, from the CCMC center for the year 2019. The observation and study give quite an interesting result that is the variation of concentration of nitrogen and air density is similar while oxygen is different. The maximum concentration is of nitrogen is found in February and March $4.852 \times 10^{18}\ cm^{-3}$ *and minimum in August* $4.698 \times 10^{18} cm^{-3}$*, while the air density is maximum in same month* $1.809 \times 10^{19} gcm^{-3}$ *and minimum in July*$1.751 \times 10^{19} gcm^{-3}$*. Also, the concentration of oxygen was observed constant and minimum throughout June to September with* $1.08 \times 10^{-3} cm^{-3}$*while January has a maximum concentration of* $1.11 \times 10^{-3} cm^{-3}$*. Hence, the study and observation of the variation of Nitrogen, Oxygen, and air density above Nepal were observed with some limitation that is without any description or knowledge of parameters that make the variation in the concentration which is future research work.*

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I. INTRODUCTION

The troposphere is closer to the earth's surface with different compositions or a mixture of gases and is called the birthplace of the weather, storms, and rain with 3.7 to 5 miles at the poles and 10.5 miles at the equator. This layer contains about 99% of atmospheric water vapors with varying air density and temperature. This layer is considered a boundary layer of the troposphere and stratosphere with a 70-80% mass of the Earth's atmosphere. The troposphere density ongoing decrease that is why temperature fall with height and temperature ranges from 62°F to -60°F ongoing higher. Also, this layer contains the world's lower and highest mountains, natural and artificial infrastructure are still within the troposphere.

Earth's surface absorption and emission the heat with the help of sun radiation. The radiation and gas density closure of the surface due to gravity helps to increase the air temperature. Therefore the temperature gradient to vary with time and place, similar phenomena also take place all planet troposphere. The smoke and aerosol trapped in cold dense air that lies beneath a cap of warmer air, at top thin layer temperature almost constant with height, this is due to cooler, denser air of the troposphere is trapped beneath the warmer, less dense air of the stratosphere.

The tropopause separates the troposphere from the stratosphere ceases the air to cool and dry. According to World Meteorological Organization the lowest level at which the lapse rate decreases to 2K km^{-1} or less, provided that the average lapse rate between this level and all higher levels within 2 km does not exceed 2K km^{-1}.Aerosols particles are small airborne with a wide range of chemical composition, either natural or anthropogenic in origin. Anthropogenic aerosols constitute about 50% of the global mean aerosol coming from fossil fuel and biomass burning. These aerosols have also an important global radiation balance and climate, the formation of clouds and precipitation, remote sensing a so on. The size of aerosol particles is usually categorized according to diameter into three categories; 0.001–0.1 µm, 0.1–1 µm, and >1 µm in diameter.

Greenhouse gases like CO, CH_4, N_2O, $CHCl_3$, OCS, C_2H_6, C_2H_2, and C_3H_8 were observed using the transport model FLEXPART and these are lie in both the troposphere and stratosphere Yang et al. (2012). The most abundant O_2 and N_2 molecules are too larger and more reactive chemicals, which include vast numbers of different volatile organic compounds (VOCs). Atmospheric pressure, temperature, density, and winds are subject to variations with 24-hour (diurnal) and 12-hour (semidiurnal) periods. Nitrogen, Oxygen, Argon, Neon, Helium, Krypton, Xenon, Hydrogen with 78.08%, 20.95%, 0.93%, 0.002%, 0.0005%, 0.0001%, 0.00009%, 0.00005% concentration with volume respectively, are permanent gases of the atmosphere, while water vapor, carbon dioxide, ozone, methane, and so on are variable gases like also abundant in the troposphere. These vary due to different natural and artificial activates like the burning of fossil fuel, biomass, and so on.

The atmospheric molecules are pulled close to the earth's surface due to gravity and cause the concentration of molecules to thinner with height. On comparison of the pressure of the atmosphere, with height above the earth surface, it is found that at the peak of Mount Everest the air pressure is 70% lower than at sea level, therefore mountain climbers at the top only inhaling 30% of the oxygen they would get at sea level.

1.1. Research area

Nepal is one of the three landlocked countries lie in South Asia, The highest tropopause is seen over South Asia during the summer monsoon season, and where the tropopause occasionally peaks above 18 km. Nepal has an area of 56,956 square miles with a roughly trapezoidal shape about 500 miles long and 120 miles wide. Nepal lies between latitudes 26° and 31°N, and longitudes 80° and 89°E. Above this geographical coordinate, we are trying to study the density of air, concentration of oxygen, and nitrogen, at an altitude of 1.0km, at a latitude of 28.39^{o}N and longitude of 84.12^{o}E, for 2019.

II. REVIEW

The carbon dioxide distribution from the upper troposphere to the stratosphere over the 2000–2010 time period, based on a Lagrangian backward trajectory model driven by ERA-Interim reanalysis meteorology and tropospheric CO_2 measurements. The concentration variation is seen in the summer, and autumn hemispheres in 15–20 km ranges, which is due to the transport of long-lived trace gases by the stratospheric Brewer-Dobson circulation Diallo et al. (2017). The atmosphere is a blanket of Earth with the composition of gases and protects the life of living terrestrial, aquatic, and aerial. Greenhouse gases varying (increase) from year to year due to both natural and artificial activities. The gases trap infrared radiation and warm the atmosphere while aerosols reflect and cool the atmosphere (NASA, 2020).

The concentration of free radicals (HO_x, $NO_{x,}$ and XO_x (X=Cl, Br, and I)) is low in the atmosphere due to photochemical and chemical phenomena with an atmospheric constituent, these concentration balance the atmospheric composition. The concentrations of constituents, oxygen, and nitrogen remain the same while some other rare but no negligible gases vary. The troposphere is the lowest region of the atmosphere extending from the Earth's surface up to 10– 18 km, this contains about 90% of the total atmospheric mass resides with 78% N_2, 21% O_2, 1% Ar, and 0.036% CO_2 with varying amounts of water vapor depending on temperature and altitude Monks (2005).

Literature reviews show the distribution of CO_2 during 6 different months in 2010, is dominant in the Northern Hemisphere by a strong seasonal cycle, reflecting the biosphere activity and increases to a maximum in April–May and minimum in July– August but much weaker in Southern Hemisphere Haynes and Shuckburgh (2000a), Sawa et al. (2012), and Nakamura et al. (1991). Mass of atmosphere according to different authors estimated approximately $5 \times 10^{18} kg$ from 1965 to 2017 by Verniani, Anderson, et al., Trenberth, Guillemot and Smith, Simpson, etc. The uniform composition of gases ~85 km called the homosphere and lighter molecules increase the more abundant call heterosphere. The variation of the air mass also varies and funds in the order of 10% Orbe et al. (2013).

The upper tropospheric air masses close to the tropopause level are nearly saturated concerning ice and contain a significant fraction of ice-supersaturated regions (ISSR) with a distinct seasonal cycle of minimum values in summer and maximum values in late winter Petzold et al. (2019), also the vertical distribution of water vapor around the tropopause is characterized by a steep decrease of H_2O. Across the tropopause layer, H_2O decreases further but less steep until it reaches near to stratospheric value at about 2 km altitude above the tropopause layer Hoor et al. (2004).

III. METHODOLOGY

One of the useful way to estimate atmospheric mass via density changes from sea level to outer space with the help of equation (1),

$$M_A = \int_0^{\infty} A\rho dz - \int_0^{f_L} \int_0^{z_L} A\rho dz\, df \text{ ……………..} (1)$$

Where,$A = A_e\left(1+\frac{z}{r_e}\right)^2$ and $A_e = 5.10065622 \times 10^{14} m^2$ is the surface area, $r_e = 6{,}371{,}007.18\, m$, is the radius of a sphere withA_e, ρ is the air density, z is a geometric elevation f_L is a fraction of the earth's surface area, z_L = elevation at the surface of the land above sea level, which is a function of f WGS84 (2014) and

Simpson & Simpson (2020). For dry air as the water, steam behaves like ideal gases, the empirical laws that relate pressure (p), volume (V), and temperature (T)

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots..(2)$$

For this work, data are used from the Community Coordinated Modeling Center (CCMC) and study the density of air, oxygen, and nitrogen concentration consider a major part of the study. The pressure of the atmosphere is maximum at sea level and decreases with altitude, hydrostatic equilibrium. The change in pressure above a point with altitude is given via equation (3),

$$\frac{dP}{dz} = -\rho \times g_n = -\frac{mPg_n}{RT} \ldots\ldots\ldots\ldots\ldots(3)$$

Where, g_n is the standard gravity, ρ is the density, z is the altitude, P is the pressure, R is the gas constant, T is the thermodynamic (absolute) temperature, m is the molar mass.

IV. RESULT AND ANALYSIS

4.1 Concentration of oxygen at 1km altitude above Nepal, 2019

The representation of the graph below represents the concentration of oxygen above Nepal's atmosphere, 28°N and 84°E at an altitude of 1km. It is shown that oxygen concentration varies from month to month, moreover also varies with days. The concentration of oxygen in February and March is $1.11 \times 10^{-3}cm^{-3}$ over the month while for June, July, August, and September is $1.08 \times 10^{-3}cm^{-3}$ respectively in 2019, but the concentration goes on decrees from February to September.

The concentration of oxygen in January and April varies from $1.11 \times 10^{-3}cm^{-3}$ to $1.10 \times 10^{-3}cm^{-3}$, in May and December $1.10 \times 10^{-3}cm^{-3}$ to $1.09 \times 10^{-3}cm^{-3}$, in October and November $1.09 \times 10^{-3}cm^{-3}$ to $1.08 \times 10^{-3}cm^{-3}$. This shows the concenter increase from December to April and decrees from May to November. This increase and decrees over year taken place or seen because of temperature, as the temperature is high, moderate and normal in between May to November, also the temperature is maximum or high in June, July and August around the year and temperature in this month are seen $1.08 \times 10^{-3}cm^{-3}$, which is lowest in our study and concentration, one can also visualize the graph for more clear.

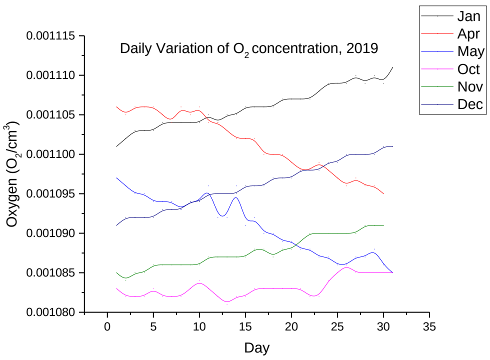

Figure 1: Concentration of oxygen above Nepal at 1km altitude

4.2 Concentration of Nitrogen at 1km altitude above Nepal, 2019

The representation of the graph below represents the concentration of Nitrogen above Nepal's atmosphere, 28°N, and 84°E at an altitude of 1km. It is shown that air varies from month to month, moreover also varies with days. The concentration of nitrogen in January ranges from, $4.803 \times 10^{18}cm^{-3}$ to $4.843 \times 10^{18}cm^{-3}$, in February ranges $4.842 \times 10^{18}cm^{-3}$ to $4.852 \times 10^{18}cm^{-3}$, in March ranges $4.819 \times 10^{18}cm^{-3}$ to $4.852 \times 10^{18}cm^{-3}$, in April ranges $4.775 \times 10^{18}cm^{-3}$ to $4.823 \times 10^{18}cm^{-3}$, in May ranges $4.736 \times 10^{18}cm^{-3}$ to $4.783 \times 10^{18}cm^{-3}$, in June ranges $4.704 \times 10^{18}cm^{-3}$ to $4.730 \times 10^{18}cm^{-3}$. In July ranges $4.698 \times 10^{18}cm^{-3}$to $4.711 \times 10^{18}cm^{-3}$, in August ranges $4.701 \times 10^{18}cm^{-3}$to $4.721 \times 10^{18}cm^{-3}$, in September ranges $4.706 \times 10^{18}cm^{-3}$to $4.730 \times 10^{18}cm^{-3}$,

In October ranges $4.718 \times 10^{18}cm^{-3}$ to $4.733 \times 10^{18}cm^{-3}$, in November ranges from $4.729 \times 10^{18}cm^{-3}$ to $4.757 \times 10^{18}cm^{-3}$in December ranges $4.759 \times 10^{18}cm^{-3}$ to $4.800 \times 10^{18}cm^{-3}$ minimum to maximum, respectively. January, February, March, and December have high concentration than other months, in 2019.

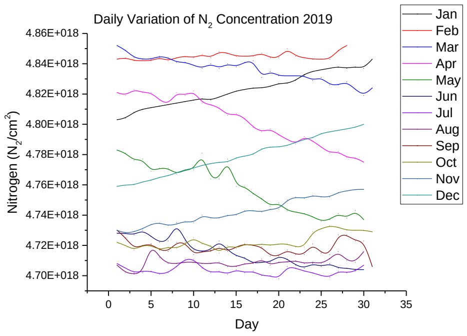

Figure 2: Concentration of air above Nepal at 1km altitude

4.3 Concentration of air density at 1km altitude above Nepal, 2019

The representation of the graph below represents the concentration of air density above Nepal atmosphere, 28°N and 84°E at an altitude of 1km. It is shown that air density varies from month to month, moreover also varies with days. The concentration of air in January ranges from, $1.790 \times 10^{19} gcm^{-3}$ to $1.805 \times 10^{19} gcm^{-3}$, in February ranges from $1.805 \times 10^{19} gcm^{-3}$ to $1.809 \times 10^{19} gcm^{-3}$, in March ranges $1.796 \times 10^{19} gcm^{-3}$ to $1.809 \times 10^{19} gcm^{-3}$, in April ranges $1.780 \times 10^{19} gcm^{-3}$ to $1.798 \times 10^{19} gcm^{-3}$,

In May ranges $1.763 \times 10^{19} gcm^{-3}$ to $1.783 \times 10^{19} gcm^{-3}$, in June ranges $1.753 \times 10^{19} gcm^{-3}$ to $1.765 \times 10^{19} gcm^{-3}$, in July ranges $1.751 \times 10^{19} gcm^{-3}$ to $4.756 \times 10^{19} gcm^{-3}$, in August ranges from $1.752 \times 10^{19} gcm^{-3}$ to $4.763 \times 10^{19} gcm^{-3}$, in September ranges $1.757 \times 10^{19} gcm^{-3}$ to $1.763 \times 10^{19} gcm^{-3}$,

In October ranges from $1.758 \times 10^{19} gcm^{-3}$ to $1.764 \times 10^{19} gcm^{-3}$, in November ranges from $1.762 \times 10^{19} gcm^{-3}$ to $1.773 \times 10^{19} gcm^{-3}$, while in December ranges from $1.774 \times 10^{19} gcm^{-3}$ to $1.789 \times 10^{19} gcm^{-3}$ minimum to maximum, respectively. January, February, March, and December have high concentration than other months, in 2019.

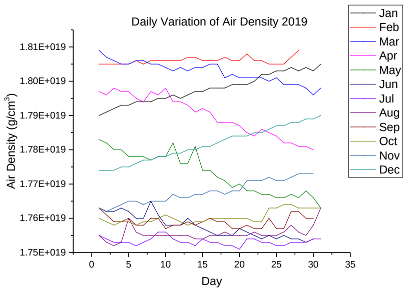

Figure 2: Concentration of air above Nepal at 1km altitude

4.4 Comparison of maximum and minimum concentration of air and nitrogen

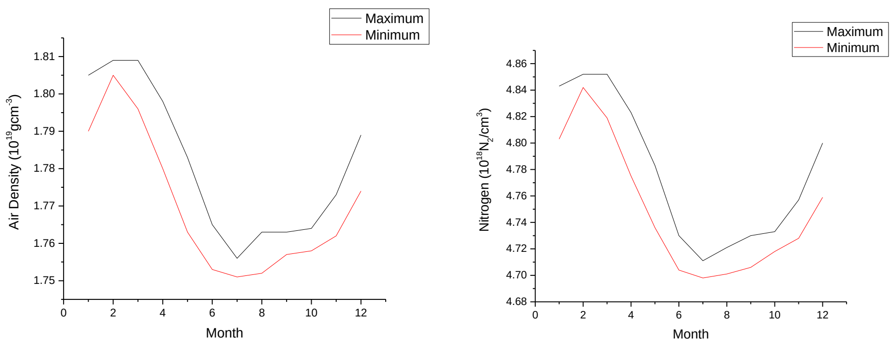

Figure 3: Variation of maximum and minimum density, Nitrogen concentration with month 2019, at 1km altitude above Nepal.

On comparison and study the maximum and minimum density of 2019 months, the air density decrease from February to July and then increases to December as shown in figure 3 above, while nitrogen concentration is also seen similarly. A similar concentration of air density and nitrogen is seen in the summer season of Nepal country. This temperature is one of the most parameters because this 6 to 7 months is warmer months of the summer season.

V. CONCLUSION

The observation and study show the nature of the concentration of oxygen and nitrogen, and air density above Nepal and found the variation in the concentration with days and months both at the same altitude. The variation in concentration of nitrogen and air density is quite similar while oxygen is different.

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