Detection of Ozone Layer Depletion Using Image Processing and Data Mining Technique

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Abstract— **There are many situations where human activities have significant effects on the environment. Ozone layer damage is one of them. This paper presents methodology for detection of ozone layer depletion using satellite imagery of O_3. The chlorofluorocarbon and the Greenhouse gases are potent ozone depletors. One of the main reasons for the widespread concern about depletion of the ozone layer is the anticipated increase in the amounts of ultraviolet radiation received at the surface of the earth and the effect of this on human health and on the environment. The present analysis applies k-means clustering on the satellite imagery in order to compute normality for O_3. By using normality, pH value is computed and if the value lies in the range of $1 \leq pH \leq 5$, it is identified as ozone layer depletion. The proposed methodology is addressed for the first time using data mining and image processing. The resulted outcome indicates that the amount of rainfall with the concentration of O_3 have a strong influence on the occurrence of ozone layer depletion.**

Keywords- Ozone Layer Depletion, K-means clustering; Normality, pH value, Satellite imagery.

I. INTRODUCTION

The ozone layer is a layer in Earth's atmosphere which contains relatively high concentrations of ozone (O3). This layer absorbs 93-99% of the sun's high frequency ultraviolet light, which is potentially damaging to life on earth[1] . Over 91% of the ozone in Earth's atmosphere is present here.It is mainly located in the lower portion of the stratosphere from approximately 10 km to 50 km above Earth, though the thickness varies seasonally and geographically[2].

A. Ozone

Ozone(O3) is the major component of smog. Without ozone, life on Earth would not have evolved in the way it has. The first stage of single cell organism development requires an oxygen-free environment. This type of environment existed on earth over 3000 million years ago. As the primitive forms of plant life multiplied and evolved, they began to release minute amounts of oxygen through the photosynthesis reaction (which converts carbon dioxide into oxygen) [3]. The buildup of oxygen in the atmosphere led to the formation of the ozone layer in the upper atmosphere or stratosphere. This layer filters out incoming radiation in the "cell-damaging" ultraviolet (UV) part of the spectrum. Thus with the development of the ozone layer came the formation of more advanced life forms. Ozone is a form of oxygen. The oxygen we breathe is in the form of oxygen molecules (O2) two atoms of oxygen bound together. Normal oxygen which we breathe is colorless and odorless. Ozone, on the other hand, consists of three atoms of oxygen bound together (O3).

B. Ozone Hole

The term "ozone hole" should be applied to regions where stratospheric ozone depletion is so severe that levels fall below 200 Dobson Units (D.U.), the traditional measure of stratospheric ozone. Normal ozone concentration is about 348 to 380 D.U [3]. Such ozone loss now occurs at Australia, where special meteorological conditions and very low air temperatures accelerate and enhance the destruction of ozone loss by man-made ozone depleting chemicals (ODCs).

C. Ozone Layer

The ozone layer is a layer, become known as such because most ozone particles are scattered between 19 and 30 kilometers (12 to 30 miles) up in the Earth's atmosphere, in a region called the stratosphere. The concentration of ozone in the ozone layer is usually under 10 parts ozone per million [5]. Without the ozone layer, a lot of ultraviolet (UV) radiation from the Sun would not be stopped reaching the Earth's surface, causing untold damage to most living species. In the 1970s, scientists discovered that chlorofluorocarbons (CFCs) could destroy ozone in the stratosphere. Ozone is created in the stratosphere when UV radiation from the Sun strikes molecules of oxygen (O2) and causes the two oxygen atoms to split apart. If a freed atom bumps into another O2, it joins up, forming ozone (O3). This process is known as photolysis. Ozone is also naturally broken down in the stratosphere by sunlight and by a chemical reaction with various compounds containing nitrogen, hydrogen and chlorine. These chemicals all occur naturally in the atmosphere in very small amounts. In an unpolluted atmosphere there is a balance between the amount of ozone being produced and the amount of ozone being destroyed. As a result, the total concentration of ozone in the stratosphere remains relatively constant. At different temperatures and pressures (i.e. varying altitudes within the stratosphere), there are different formation and destruction rates. Thus, the amount of ozone within the stratosphere varies according to altitude. Ozone concentrations are highest between 19 and 23 km [6]. Most of the ozone in the stratosphere is formed over the equator where the level of sunshine striking the Earth is greatest. It is transported by winds towards higher latitudes. Consequently, the amount of stratospheric ozone above a location on the Earth varies naturally with latitude, season, time-to time and from day-to-day.
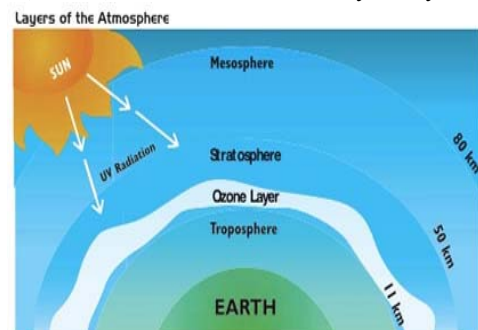

Figure: 1. Layers of Atmosphere

D. Measuring Ozone Depletion

The most common stratospheric ozone measurement unit is the Dobson Unit (DU). The Dobson Unit is named after the atmospheric ozone pioneer G.M.B. Dobson who carried out the

earliest studies on ozone in the atmosphere from the 1920s to the 1970s. A Dobson Unit measures the total amount of ozone in an overhead column of the atmosphere. Dobson Units are measured by how thick the layer of ozone would be if it were compressed into one layer at 0 degrees Celsius and with a pressure of one atmosphere above it. Every 0.01 millimeter thickness of the layer is equal to one Dobson Unit. The average amount of ozone in the stratosphere across the globe is about 300 DU (or a thickness of only 3mm at 0°C and 1 atmospheric pressure).

Many studies have focused on developing effective methods for detection of ozone layer depletion patterns by applying algorithms like TOMS, DOAS, ,SCIAMACY, DIAL and techniques like decision trees, artificial neural networks, numerical weather prediction models and statistical approaches and uses different spectrometers like ozone sonde , gome etc. Unfortunately they do not seem able to provide accurate detection of ozone layer depletion predictions at the temporal and spatial resolutions required for meteorology. Therefore interesting options is offered by the use of remote sensing observations through satellite images whose output may provide useful information about detection of ozone layer depletion patterns and also allow obtaining now casting with improved performances. The methodology is based on four stages: Firstly, satellite images containing ozone(O_3) and water vapour($h20$) images are segmented using k-means clustering technique [8-10] to identify the O_3 concentration parts and water vapour concentration parts. Secondly, on the feature extracted images of O_3 and H_2O, compute the mean wavelength (μ) and Area. Thirdly, Normality (N) measure is done to find the concentration of O_3. Finally in the last stage, based on Normality, pH value is computed and if it lies in the range between $1 \leq pH \leq 5$, it is treated as ozone layer depletion.

The rest of the paper is organized as follows: Section II gives a glance to all the recent research carried on for the prediction of ozone layer depletion. Section III depicts the formation of ozone layer depletion. Section IV describes the experimental methodology. Section V illustrates the experimental results and finally Section VI concludes the paper.

II. RECENT RESEARCH

With so much worry about the rapid ozone depletion taking place in various parts of the earth, Indian scientists are closely monitoring the ozone layer over India for possible depletion trends. Opinions are many and varied. According to S K Srivastava, head of the National Ozone Centre in New Delhi, there is no trend to show total ozone depletion over India. V.Thaphyal and S M Kulshresta of the Indian Meteorological Department also point out that for the period 1956 to 1986 "ozone measurements exhibit year to year variability, but do not show any increasing or decreasing trend over India." However, former director of the National Ozone Centre, K Chatterji, now with Development Alternatives, warns that there is no case for complacency. He asserts that his calculations exhibit an ozone depletion trend in the upper, layers of the stratosphere over New Delhi and Pune from 1980 to 1983 in the month of October when the Antarctic ozone hole is at its maximum. Since India already receives high doses of ultraviolet (UV-B) radiation, and is at the threshold go to speak, effects of ozone layer depletion could he far more disastrous in India. A P Mitra, former director general of the Council of Scientific and Industrial Research, clarifies that while there is no trend in the total ozone value, there is some evidence of ozone depletion at higher altitudes - at about 30 to 40 km even over the tropics. He argues, however, that there is insufficient data and that the depletion may be due to solar cycles and other natural phenomena. However, the effects of CFCs and belong cannot be ruled out.

According to a recent study conducted by the Centre for Science and Environment (CSE), the ground-level ozone, a highly reactive and harmful gas, has far been exceeded the permissible limit. the ozone layer has increased due to the heat waves Delhi is experiencing in June. The harmful ozone gas is very dangerous for people suffering from asthma and respiratory problems as it may cause premature death. "With heat wave raging in early June, ozone peaks to dangerous levels. Rising NOx levels and volatile gases in the air, primarily from vehicles, form the recipe for ozone when exposed to intense sunlight and high temperature. Ozone is a serious threat to those suffering from asthma and respiratory problems and can cause premature deaths if it is high even for a short duration during the day," said executive director, research and advocacy and head of CSE's air pollution program, Anumita Roy Chowdhury. The study claims that within a week Ozone levels have gone up by 315% at Delhi's Mandir Marg and 82% at Indira Gandhi International airport. In addition, 87% have gone up in Civil Lines and 171% in Punjabi Bagh, in just a week. At all locations the average ozone level was 73 micrograms per cubic meter on June 1, which hastily doubled further than the standards by June 5.

Research carried out by real-time air quality data from key monitoring stations of the Delhi Pollution Control Committee (DPCC) from January to early June reveals that ozone level has rapidly been built and has gone beyond the permissible limits. According to Dr. Randeeep Guleria, head of the department of pulmonary medicine at All India Institutes of Medical Sciences (AIIMS), "A person with chronic respiratory problems and bronchitis is prone to more attacks when he or she is exposed to high level of pollution. The person will have breathing difficulties and cough when exposed to the heat. One should avoid places with high levels of pollution like crossings and terminals.""It is advisable for them to stay indoors and drink lot of fluids and electrolytes and wear loose clothes. People suffering from chronic respiratory problems should increase their medication and a consult doctor. Elderly people should be very careful and always carry an umbrella when stepping out," he advised.

Many of the researchers implemented various methodologies for the prediction of detection of ozone layer depletion, till date none of the research could provide an accurate and efficient model for this prediction. Current work focuses on developing improved ozone layer depletion identification methodology that pushes the limits of prediction accuracy over the existing techniques.

III. FORMATION OF OZONE LAYER

Ozone is a gas found in the atmosphere consisting of three oxygen atoms: O_3. Ozone is formed in the atmosphere when energetic ultraviolet (UV) radiation dissociates molecules of oxygen, O_2, into separate oxygen atoms. Free oxygen atoms can recombine to form oxygen molecules but if a free oxygen atom collides with an oxygen molecule, it joins up, forming ozone. Ozone molecules can also be decomposed by ultraviolet radiation into a free atom and an oxygen molecule. Ozone is thus continuously created and destroyed in the atmosphere by UV radiation coming from the sun. This highly energetic UV radiation is called UVC (wavelength 280 nm) and is very harmful for human health. UVC is fully absorbed in the atmosphere by oxygen and ozone molecules. Ozone also absorbs UVB radiation that is less energetic (wavelength 280 - 325 nm) but is also harmful, before it reaches the surface of the Earth. In this creation/destruction process the amounts of ozone molecules created and destroyed are roughly equal, so that the total amount of ozone in the atmosphere is nearly constant. The absolute concentration of ozone in the atmosphere is very low: out of 10 million air molecules only 3 are ozone molecules.
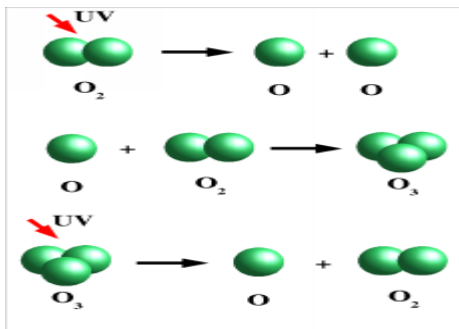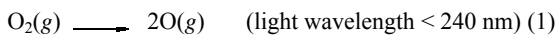
Figure: 2. Ozone formation and destruction.

The ozone in the stratosphere is produced by photochemical reactions involving O_2. When diatomic oxygen in the stratosphere absorbs ultraviolet radiation with wavelengths less than 240 nm, it breaks apart into two oxygen atoms.

$$O_2(g) \longrightarrow 2O(g) \qquad \text{(light wavelength < 240 nm) (1)}$$

The resulting oxygen atoms combine with O_2 molecules to form ozone.

$$O(g) + O_2(g) \longrightarrow O_3(g) \qquad (2)$$
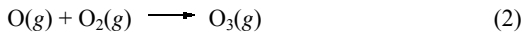
This reaction is exothermic, and the net effect of the previous two reactions is the conversion of three molecules of O_2 to two molecules of ozone with the simultaneous conversion of light energy to heat. Ozone absorbs ultraviolet radiation with wavelengths as long as 290 nm. This radiation causes the ozone to decompose into O_2 molecules and oxygen atoms.

$$O_3(g) \longrightarrow O_2(g) + (g) \qquad \text{(light wavelength <290nm)(3)}$$
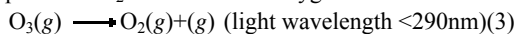
This, too, is an exothermic reaction. The overall effect of this reaction and the previous reaction is the conversion of light energy into heat. Thus, ozone in the stratosphere prevents highly energetic radiation from reaching the Earth's surface and converts the energy of this radiation to heat. Rain water is never always pure as it contains impurities from dust particles or from absorbing gases from the air. It forms when clean rain comes in contact with pollutants like ozone (O_3), sulphur Dioxide (So_2), Carbon Dioxide (Co_2), and Nitrogen dioxide (NO_2). The major oxide that contributes to the formation of ozone layer depletion is ozone. Ozone is produced in the high temperatures of combustion chambers of power stations and motor vehicles [7].
Ozone also oxidizes nitric oxide to nitrogen dioxide:

$$NO + O_3 \rightarrow NO_2 + O_2 \qquad (4)$$
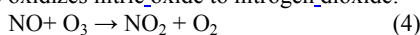
This reaction is accompanied by chemiluminescience .The NO2 can be further oxidized:

$$NO_2 + O_3 \rightarrow NO_3 + O_2 \qquad (5)$$
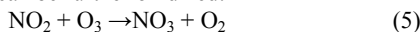
The NO3 formed can react with NO2 to form N2O5: Solid nitronium perchlorate can be made from NO_2, ClO_2, and O3 gases:

$$2\ NO_2 + 2ClO_2 + 2\ O3 \rightarrow 2NO_2ClO_4 + O2 \qquad (6)$$
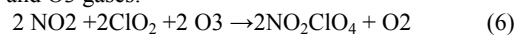
Sulfuric acid can be produced from ozone, water and either elemental sulfur or sulfur dioxide:

$$S + H_2O + O_3 \rightarrow H_2SO_4 \qquad (7)$$
$$3\ SO_2 + 3\ H_2O + O_3 \rightarrow 3\ H_2SO_4 \qquad (8)$$
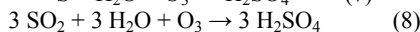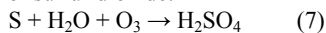
Nitrogen oxides (NO) are formed through fossil fuel use. In contrast to sulphur, nitrogen is not an impurity but rather an integral part of the organic material making up fossil fuels. Fossil fuel combustion releases nitrogen into the atmosphere, usually in the form of nitric oxide (NO). Nitric oxide (NO) is oxidized by atmospheric molecules, such as ozone (O3) or hydrogen dioxide (HO2), to form nitrogen dioxide (NO2). Nitrogen dioxide (NO2) reacts with OH in the atmosphere to form nitric acid (HNO3). Nitric acid can also form when nitrogen dioxide (NO2) reacts with the nitrate radical (NO3) in the presence of atmospheric water or aldehydes. These pollutants can be converted, through a series of complex chemical reactions, into sulphuric acid, nitric acid,

increasing the ozone precipitation and other precipitation such as snow and fog and the formation of ozone layer depletion is shown in Fig.3.
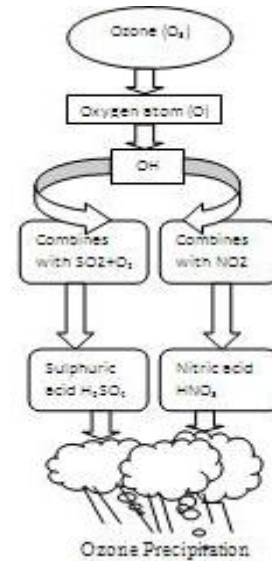

Fig: 3. Formation of ozone layer Depletion

The pH scale ranges in values from 1 to 14. The pH scale is used to indicate the nature of the substance as shown in Fig. 3. When pH is below 7, it is ozone layer depletion and no ozone layer depletion when pH is above 7[7]. Any substance with a pH value 7 is considered a neutral substance. This means that the substance is neither ozone nor no ozone. Precipitation is considered as ozone precipitation if it has a pH of less than or equal to 5.

IV.   EXPERIMENTAL METHODOLOGY

The goal of this processing is to examine the satellite images and tell whether the gathered satellite image is an ozone image or not. The overall process involved is shown in Fig.4. In this implementation satellite images containing O3 emissions are taken as input, which may or may not contain noise. But any satellite images most probably may contain noise which is to be removed. There are different types of noise in satellite images such as speckle noise, blurs and so on. When a satellite image containing such types of noise is analyzed, the value obtained may deviate from original value. Hence, the image must be de noised.

As an original image may contains various textures these textures are to be separated to obtain the region of interest and exclude the non affecting region for ozone layer depletion prediction. In order to segment the image and capture the region of interest, k-means clustering [8-10] is used as one of the technique. Pixel values of different textures are used for this segmentation which is shown in Table 1. Based on these pixel values the satellite image is segmented into various clusters to obtain the region of interest which is containing ozone. In order to predict the occurrence of ozone layer depletion at higher range k-means algorithm is used to cluster the objects into 8 regions and ozone emission objects into 8 regions using Euclidean distance metric to avoid local minima.

The segmentation process is applied for images shown in Fig.5 & Fig.6.The feature extracted cluster images shown in Fig.7 & Fig.8 are selected for the further analysis to calculate mean wavelength(μ) and area.
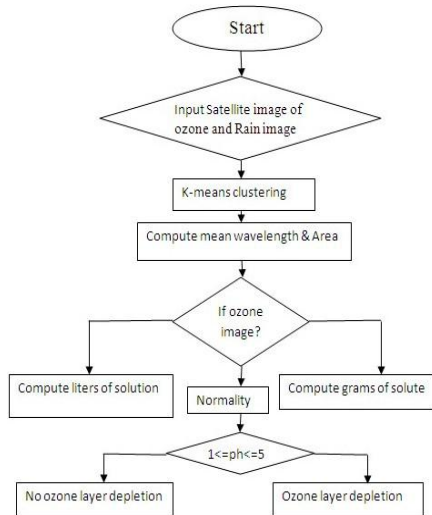
Figure: 4. Real time detection of ozone layer depletion

In order to predict the occurrence of ozone layer depletion the mean wavelength (μ) is to be estimated from the feature extracted image using MATLAB 2011a Tool. Further, other parameters such as number of ozone molecules, grams of ozone and liquid molecules present in ozone gas are to be calculated using equations 1, 2, 3, 4 and 5. As a satellite image is visible image which lies in a wavelength between 400nm-700nm. Since this is taken as input, this range is taken as a total of 300nm and the scale for the input satellite image is given as 2 Dobson units. According to the study 1nm consists of 0.0067 Dobson units and has a constant value of $2.69 \times 10^{20 \text{ molecule}}/m^2$ [11]. To calculate the number of ozone molecules equation 1 is used and is shown below. Avogadro's number 6.023×10^{23} mol^{-1} is a quantity of mole which is used to calculate the number of atoms present in the substance.

$$Ozone\,Molecules = \frac{Area\,of\,O_3\,x\,0.0067\,x\,2.69\,x10^{20}}{Quantity\,of\,a\,mole} \quad (9)$$

The expression to calculate the grams of O_3 is shown below:

$$Grams\,of\,O_3 = \quad\quad\quad\quad (10)$$

$$\mu\,of\,O_3\,x\,Ozone\,molecules\,x\,Molecular\,weight\,of\,so_2$$

Where, Molecular weight of so2 is 63.066 g/mol.

The Liquid molecules present in humidity image are computed by using equation 3.

$$Liquid\,Molecules =$$

$$\mu\,of\,H_2O\,x\,Ozone\,molecules\,x\,\frac{Molecular\,weight\,of\,H_2O}{Valence\,of\,O_2} \quad (11)$$

Where, Molecular weight of H_2O is 18 and Valence of Oxygen is 2.

From equation 3, the amount of liquid present in the ozone gas can be analyzed by using the specific gravity of water i.e., 1.003 liters.

$$Liters\,of\,solution = \frac{Liquid\,Molecules}{Specific\,gravity\,of\,water} \quad (12)$$

Normality is a way of expressing the concentration of a solution. The normality of a solution is the concentration expressed as the number of equivalent weight of solute per liter solution. Where, Equivalent weight of Solute HNO_3 is 63 grams.

$$Normality = \frac{Grams\,of\,solute}{Equivalent\,weight\,of\,solute\,x\,Liters\,of\,solution} \quad (13)$$

Since, it is a monoprotic the normality is used as a measure of reactive species in solution. In chemistry, normality is used to express the concentration of protons (H^+). Hence,

$$Normality = \left[H^+\right] ions. \quad (14)$$

To measure the ozone of a solution pH value is considered which is defined as negative logarithmic value of a hydrogen ion H+ concentration. This pH value is also included with a correction factor as shown in equation 6.

$$pH = \left\{\left(-log\left[H^+\right]x\,10\right) - 14\right\} \quad (15)$$
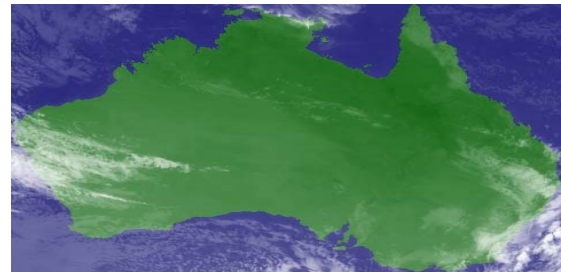
Figures: 5. Original image of water vapour(h_2o)
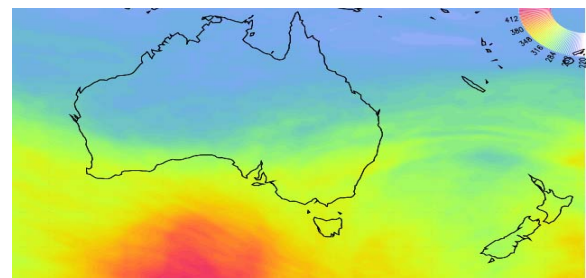
Figure:6. Original image of ozone(o_3)

Figure: 7. Clustered image of h2o
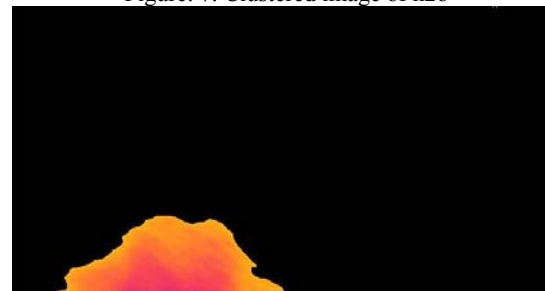
Figure: 8. Clustered image of Ozone

V. EXPERIMENTAL RESULTS

In the present research, the problem is extensively studied on 300 ozone images and examined on 200 images obtained from Japan metrological department to estimate the ozone at Australia location. The pH values on a sample of 10 ozone layer depletion images are tabulated in Table I.

Estimating mean wavelength and area of ozone in ozone image and mean of water vapour in h_2o image is one of the challenging tasks that researchers of present day are experiencing. The

detection of ozone layer depletion from satellite images is even more challenging as the images are always covered with different textures. A lot of research has been performed on the development of accurate techniques for the prediction of ozone layer depletion. But, these techniques are unable to perform up to their true extent.

The preliminary results in Table II show that the pH of the ozone images is in the range of 1 and 5. Consider image 1, its calculated pH value is 4.39, lies in the established range, hence it is ozone layer depletion. In the similar method, consider the other images and their calculated pH value are in between 1 and 5 which lies in the established range and hence they are ozone layer depletion. From Table II, consider image 4, its calculated pH value is 5.97, which doesn't lie within the range, hence it is not ozone layer depletion. Similarly, consider image 5 whose

calculated pH value is 2.39, lies in the range 1 and 5 hence it is an ozone layer depletion image. Consider image 29 whose calculated pH values is 4.60, lies in the range 1 and 5 hence it is an ozone layer depletion image. Consider image 39, whose calculated pH value is 4.82, lies in the established range for ozone layer depletion. Hence, it is an ozone layer depletion image. As the recognition of ozone layer depletion obtained from the present research is more than previous model, the proposed model proves to have more potential.

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TABLE I: Estimation Of PH In Precipitation

Image no.	Mean of Ozone	Mean of H2O	Area of ozone	Grams of Ozone	Ozone Molecules	Liquid Molecules	Litres of solution	Normality	ph value
Image 1	107.87	79.0515	75786	1.5428x 104	2.2678	1.6135x 103	1.6086 x 103	0.1522	4.8232
Image 2	110.26	60.3465	80204	1.6690x 104	2.4000	1.3035 x 103	1.2996x 103	0.2039	1.9037
Image 3	107.20	123.5297	78070	1.5794x 104	2.3361	2.5972 x 103	2.5895x 103	0.0968	9.3495
Image 4	110.52	87.33540	78972	1.6472x 104	2.3631	1.8575x 103	1.8591 x 103	0.1412	5.5770
Image 5	114.20	129.2997	96520	2.0802x 104	2.8882	2.6630x 103	2.6550x 103	0.1244	6.8454
Image 6	108.36	108.9999	62995	1.2883x 104	1.8850	1.8492x 103	1.8437x 103	0.1109	7.9901
Image 7	107.09	139.0542	66920	1.3525 x 104	2.0025	2.5061x 103	2.4986 x 103	0.0859	10.5435
Image 8	116.91	100.9331	71281	1.5727x 104	2.1330	1.9376x 103	1.9318x 103	0.1292	6.4621
Image 9	117.96	65.15950	101972	5.4806x 104	3.0514	1.7894 x 103	1.7841 x 103	0.2020	1.9961
Image 10	100.47	107.6880	110257	2.0906x 104	3.2993	3.1976 x 103	3.1881x 103	0.1041	8.6250

TABLE II: Analysis of ozone layer depletion

Image No.	Observed	Normality	P^H value	Experimental	Prediction
Image 1	Depletion	0.1589	4.394	Depletion	TRUE
Image 2	Depletion	0.2103	1.5922	Depletion	TRUE
Image 3	Depletion	0.1918	2.5122	Depletion	TRUE
Image 4	Depletion	0.1356	5.979	No Depletion	FALSE
Image 5	Depletion	0.1942	2.3905	Depletion	TRUE
Image 6	Depletion	0.157	4.5128	Depletion	TRUE
Image 7	Depletion	0.1281	6.546	No Depletion	FALSE
Image 8	Depletion	0.1422	5.5025	No Depletion	FALSE
Image 9	Depletion	0.1002	9.0031	No Depletion	FALSE
Image 10	Depletion	0.0969	9.3454	No Depletion	FALSE
Image 11	Depletion	0.1272	6.6196	No Depletion	FALSE
Image 12	Depletion	0.1031	8.7169	No Depletion	FALSE
Image 13	Depletion	0.109	8.1639	No Depletion	FALSE
Image 14	Depletion	0.1077	8.2798	No Depletion	FALSE
Image 15	Depletion	0.0922	9.7331	No Depletion	FALSE
Image 16	Depletion	0.1522	4.8232	Depletion	TRUE
Image 17	Depletion	0.1831	2.9762	Depletion	TRUE
Image 18	Depletion	0.1412	5.577	No Depletion	FALSE
Image 19	Depletion	0.1244	6.8454	No Depletion	FALSE
Image 20	Depletion	0.0733	12.1299	No Depletion	FALSE
Image 21	Depletion	0.1109	7.9901	No Depletion	FALSE
Image 22	Depletion	0.1237	6.8985	No Depletion	FALSE
Image 23	Depletion	0.1357	5.9725	No Depletion	FALSE
Image 24	Depletion	0.1385	5.7711	No Depletion	FALSE
Image 25	Depletion	0.1186	7.3205	No Depletion	FALSE
Image 26	Depletion	0.1291	6.4696	No Depletion	FALSE
Image 27	Depletion	0.1222	7.0179	No Depletion	FALSE
Image 28	Depletion	0.1239	6.8834	No Depletion	FALSE
Image 29	Depletion	0.1555	4.6088	Depletion	TRUE
Image 30	Depletion	0.0859	10.5435	No Depletion	FALSE
Image 31	Depletion	0.1146	7.6625	No Depletion	FALSE
Image 32	Depletion	0.1292	6.4621	No Depletion	FALSE
Image 33	Depletion	0.2039	1.9037	Depletion	TRUE
Image 34	Depletion	0.1638	4.0894	Depletion	TRUE
Image 35	Depletion	0.202	1.9961	Depletion	TRUE
Image 36	Depletion	0.0968	9.3495	No Depletion	FALSE
Image 37	Depletion	0.1	9.0225	No Depletion	FALSE
Image 38	Depletion	0.1166	7.4908	No Depletion	FALSE
Image 39	Depletion	0.1522	4.8287	Depletion	TRUE
Image 40	Depletion	0.1041	8.625	No Depletion	FALSE

VI. CONCLUSION

In this paper, we presented a methodology to find ozone layer depletion in precipitation using ozone imagery. This problem is addressed for the first time which is computationally efficient and adapt to as well with respect to measured pH value. Ozone depletion gets worse when the stratosphere (where the ozone layer is), becomes colder. Because global warming traps heat in the troposphere, less heat reaches the stratosphere which will make it colder. Greenhouse gases act like a blanket for the troposphere and make the stratosphere colder.

Due to this, prediction of ozone layer depletion has become a major concern and this study investigated the risk of ozone layer get depleted from precipitation and ozone satellite imagery. Clustering and finding mean wavelength (μ), area of clustered image are used as one of the efficient technique for the prediction purpose. A more detail study on the data is planned to incorporate estimation of ozone in other places, however the present method became a base for future research.

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