Chapter 1

Introduction

(1-1) General:

This chapter is an introductory section and provides a background to the atmosphere physics and chemistry. A thin layer of air is surrounding our planet. It is becoming less and less dense the higher we go from the Earth's surface. We call this layer the atmosphere. It is a word from Greek roots:

atmos = gas, vapour; sphaira = sphere.

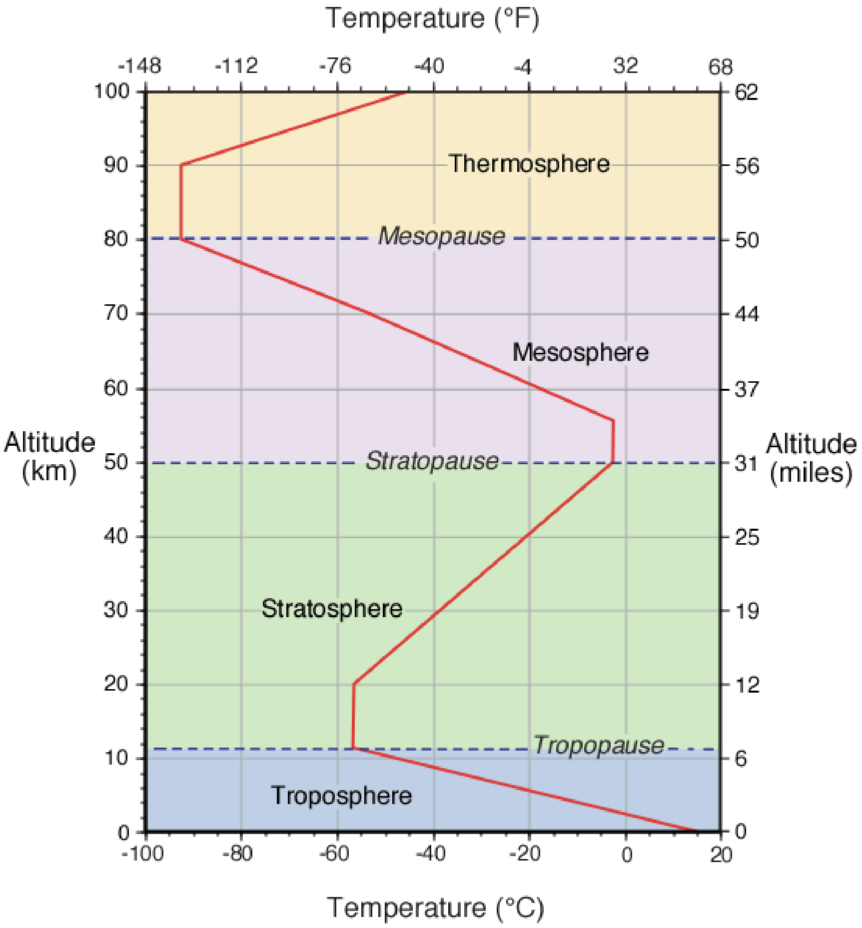


Figure (1-1): Vertical change of Atmosphere with temperature

The composition of the air we breathe and its properties are not only essential for the life of plants, animals and human beings. They also define the climate on Earth.

Looking upward on a clear day we cannot see anything than a blue sky. However, measuring the temperature, we would observe several changes in the trend if we go up from the ground to 100 km of altitude. Therefore we can say that there are several invisible layers in the atmosphere.

The Earth is surrounded by a blanket of air, which we call the atmosphere. It reaches over 560 kilometers (348 miles) from the surface of the Earth, so we are only able to see what occurs fairly close to the ground. Early attempts at studying the nature of the atmosphere used clues from the weather.[1][2]

Life on Earth is supported by the atmosphere, solar energy, and our planet's magnetic fields. The atmosphere absorbs the energy from the Sun, recycles water and other chemicals, and works with the electrical and magnetic forces to provide a moderate climate. The atmosphere also protects us from high-energy radiation and the frigid vacuum of space.

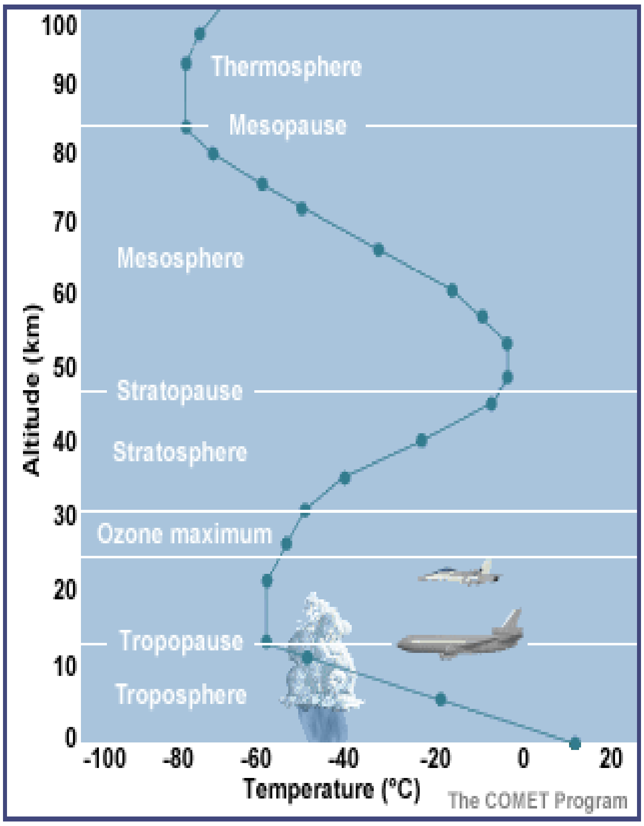


Figure (1-2): Vertical temperature profile

The envelope of gas surrounding the Earth changes from the ground up. The atmosphere protects us by filtering out deadly cosmic rays, powerful ultraviolet (UV) radiation from the Sun, and even meteors on collision course with Earth. The atmosphere is divided vertically into four layers based on temperature: The Troposphere, Stratosphere, Mesosphere, and Thermosphere.

Another well-known layer of the atmosphere is the ozone layer, occupying much of the stratosphere. This layer is defined by its chemical composition - where ozone is especially abundant. The composition of the atmosphere is Homosphere and Heterosphere).

(1-2) Atmospheric Physics and Solar radiation:

Electromagnetic radiation coming from the sun travels at 300,000 km/s. This radiation comprises wavelengths that vary from the very short (gamma rays and X-rays) to the very long (microwaves). The visible spectrum contains wavelengths between about 0.4 and 0.7 µm (400 and 700 nanometers, or nm).

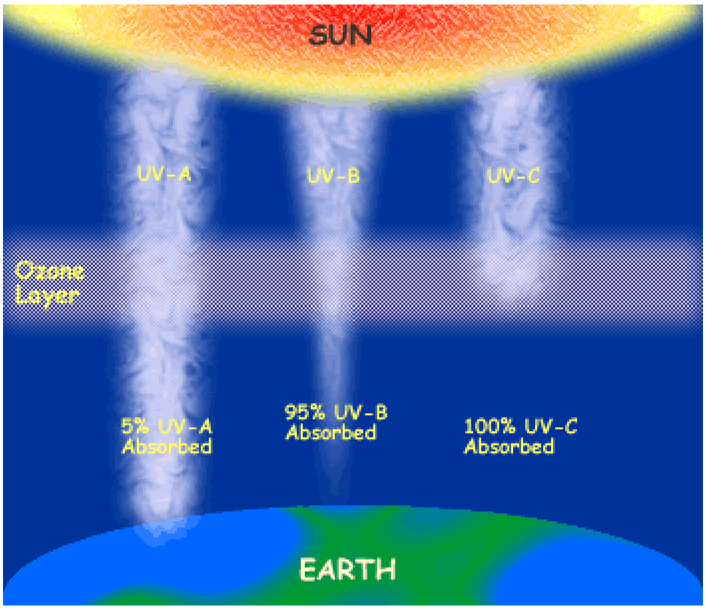


Figure (1-3) UV band ratios

Radiation at wavelengths less than about 400 nm is ultraviolet and accounts for about 7% of total solar radiation. When discussing ozone, we are concerned with radiation in the ultraviolet region of the electromagnetic spectrum. In addition to gamma rays and X-rays, which are absorbed high in the atmosphere.[3][4] [5] [6]

Ultraviolet (UV) radiation in the atmosphere is divided into three spectra: UVA, UVB, and UVC. UVA falls right below visible light, with wavelengths that vary from 320 to 400 nm. Although it is not absorbed by ozone, UVA is the least energetic and the least damaging of all UV radiation. UVB radiation, which ranges in wavelength from 280 to 320 nm, is more energetic than UVA and thought to be harmful to the biosphere. Fortunately, it exists in lesser amounts and is largely absorbed by ozone. UVC radiation, which ranges in wavelength from 200 to 280 nm, which is the most energetic and most damaging but least prevalent of the UV radiation types, is totally absorbed by ozone and normal diatomic oxygen high in the atmosphere.

Ozone is most effective at absorbing radiation at the 250 nm wavelength. In fact, it is 100 times more efficient at 250 nm than it is at 350 nm. After ozone absorbs this shortwave radiation, it reradiates it at generally longer a wavelength which initially goes in all directions.

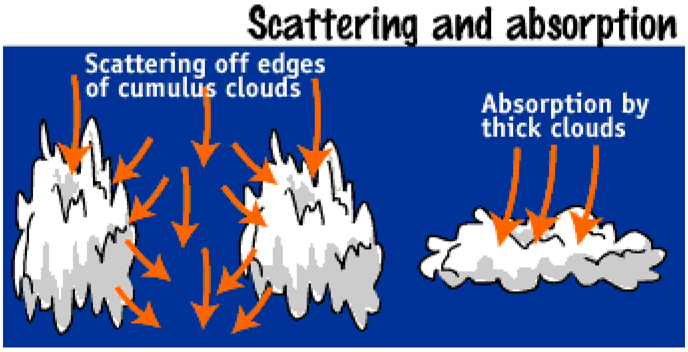


Figure (1-4) Scattering and Absorption of Radiation

Some is reabsorbed by other atmospheric constituents, some makes it to Earth's surface, and some returns to space.

The net effect, however, is an increase in temperature in the upper stratosphere. Many factors affect the amount of UV radiation that reaches Earth's surface.

Thick clouds absorb UV radiation effectively. However, cumulus clouds can sometimes have the opposite effect as UV radiation is scattered at the edges of these clouds and subsequently reaches Earth's surface. UV radiation that makes it all the way to Earth's surface can be either reflected or absorbed. Snow is very efficient at reflecting UV radiation, reflecting 85%. Sand reflects 12%, and water, 5%.

Shortwave Radiation Budget:

About 50% of incoming solar radiation is actually absorbed by the Earth's surface. Solar radiation entering the Earth's atmosphere (called "shortwave" radiation) can be reflected off clouds, the surface, and air molecules and dust. On a global average this accounts for about 30% of incoming radiation. This percentage is quantified as the albedo of the system. Another 19% on average is absorbed by the atmosphere, mainly by ozone in the Earth's stratosphere. The remaining 51% is absorbed by the Earth's surface.

Long wave Radiation Budget

The shortwave radiation absorbed by the Earth's surface heats the surface. But as the surface heats the black body surface radiation it emits radiation in the infrared back into the atmosphere.

The atmosphere traps radiation through the action of certain gases, called Greenhouse Gases. These gases (e.g., CO_2, H_2O, NO, CFCs, CO) are very good at absorbing and re-emitting infrared radiation. They intercept the IR radiation from the ground and reflect some of the energy back to the ground, warming it up more than would occur otherwise.

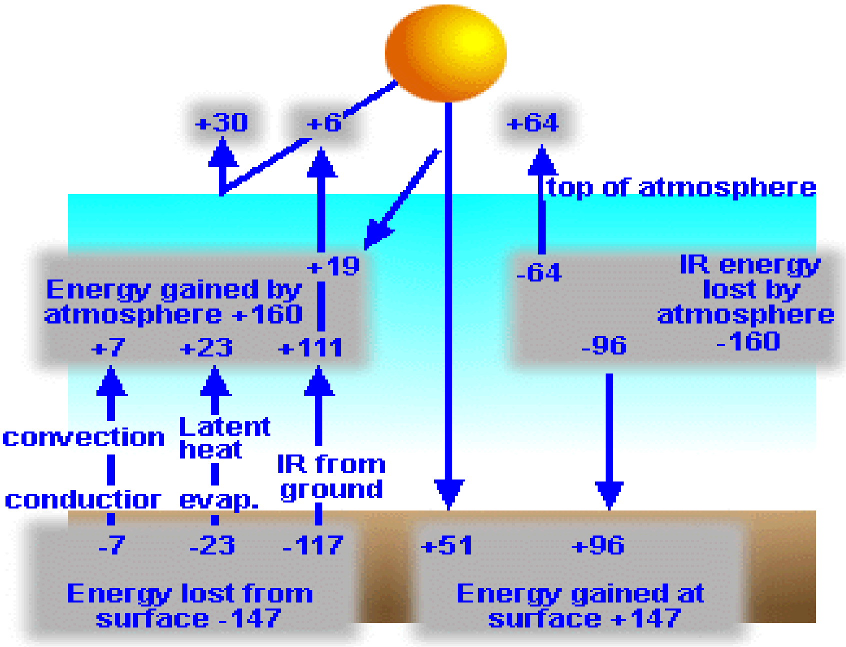


Figure (1-5) The Solar Radiation Distribution.

(1-3) Atmospheric Chemistry:

The composition of the atmosphere—its gases and a particle—plays a critical role in connecting human welfare with global and regional changes because the atmosphere links all of the principal components of the Earth system.

Subsequent responses to changes in atmospheric composition by the stratospheric ozone layer, the climate system, and regional chemical composition (air quality) create multiple environmental effects that can influence human health and natural systems.

The atmosphere divided to two parts (Homosphere and Heterosphere).

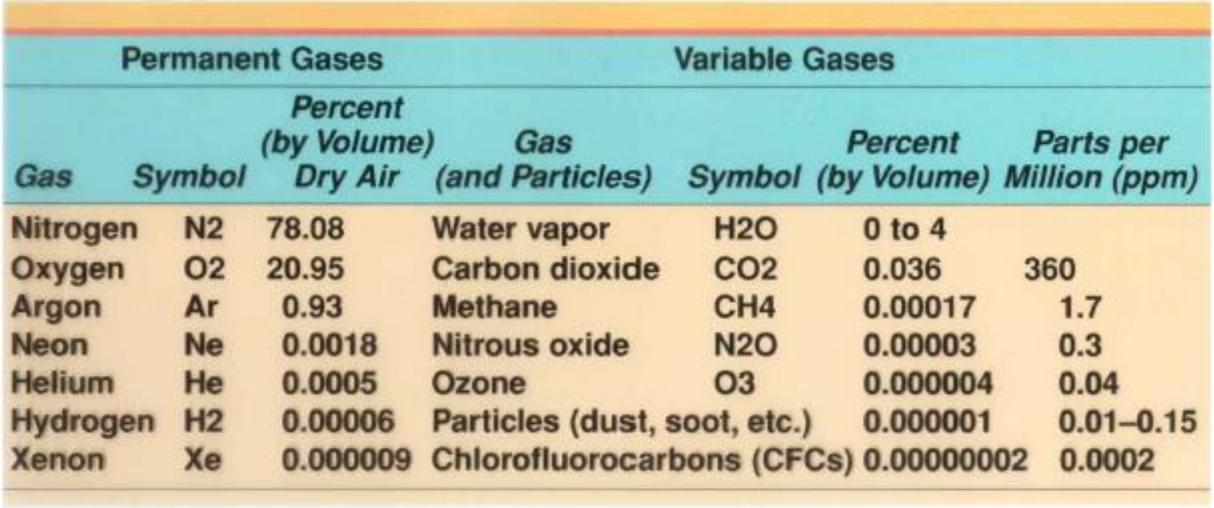
(1-3-1) Homosphere:

This layer of the atmosphere is below 100 km (62 miles) where the mixing ratio of permanent gases is constant. Nitrogen (N_2) and oxygen (O_2) are the most abundant species in the homosphere making up 78% and 21% of the atmosphere by volume, respectively.

(1-3-2) Heterosphere:

This layer of the atmosphere is above 100 km (62 miles) where the mixing ratio of permanent gases changes with altitude. The most abundant species from 100 to 500 km are and N_2 and monatomic oxygen (O). The most abundant species from 500 to 1000 km is O. The most abundant species above 1000 km are helium and hydrogen. [1][2]

Table (1-1) Composition of the Homosphere



Permanent Gases			Variable Gases			
Gas	Symbol	Percent (by Volume) Dry Air	Gas (and Particles)	Symbol	Percent (by Volume)	Parts per Million (ppm)
Nitrogen	N2	78.08	Water vapor	H2O	0 to 4	
Oxygen	O2	20.95	Carbon dioxide	CO2	0.036	360
Argon	Ar	0.93	Methane	CH4	0.00017	1.7
Neon	Ne	0.0018	Nitrous oxide	N2O	0.00003	0.3
Helium	He	0.0005	Ozone	O3	0.000004	0.04
Hydrogen	H2	0.00006	Particles (dust, soot, etc.)		0.000001	0.01–0.15
Xenon	Xe	0.000009	Chlorofluorocarbons (CFCs)		0.00000002	0.0002

(1-3-3) The Chapman reactions:

Ozone is a form of oxygen which has both harmful and beneficial qualities. While each molecule of the normal oxygen we breathe is composed of two oxygen atoms, each ozone molecule has three. [1][2] [7]

At ground level, ozone is considered a pollutant, formed in urban areas by reactions of volatile organic compounds (hydrocarbons) and oxides of nitrogen (NO_x). It is highly reactive and harmful to humans, animals, and plants. Because of its high reactivity and ability to harm microscopic organisms, ozone is used in some parts of the world to purify water. Ozone protects the lower atmosphere and Earth's surface by absorbing ultraviolet radiation in the stratosphere. Understandably, we are concerned with the decreases in stratospheric ozone concentrations.

In 1929 and 1930 S. Chapman published the theory of ozone formation and depletion for how is the ozone formed and removed again.

The reactions are still valid and called the 'Chapman cycle' or the 'Chapman reactions'. Oxygen and ozone are transformed into each other. The bonds are broken by photolysis due to solar radiation.

In order to break the bond in O_2 the energy of the sunlight has to be higher (wavelength shorter than 240 nm), than for ozone (wavelength shorter than 900 nm).

(1-4) Types of Ozone (O_3):

Ozone is a triatomic molecule, consisting of three oxygen atoms. It is an allotrope of oxygen that is much less stable than the diatomic species O_2. It is present in low concentrations throughout the Earth's atmosphere. It has many industrial and consumer applications as well as being used in ozone therapy.

Ozone, the first allotrope of a chemical element to be described by science, was discovered by Christian Friedrich Schönbein in 1840, who named it after the Greek word for smell (*ozein*), from the peculiar odor in lightning storms. The odor from a lightning strike is from electrons freed during the rapid chemical changes, not the ozone itself.[3][4][5] [8]

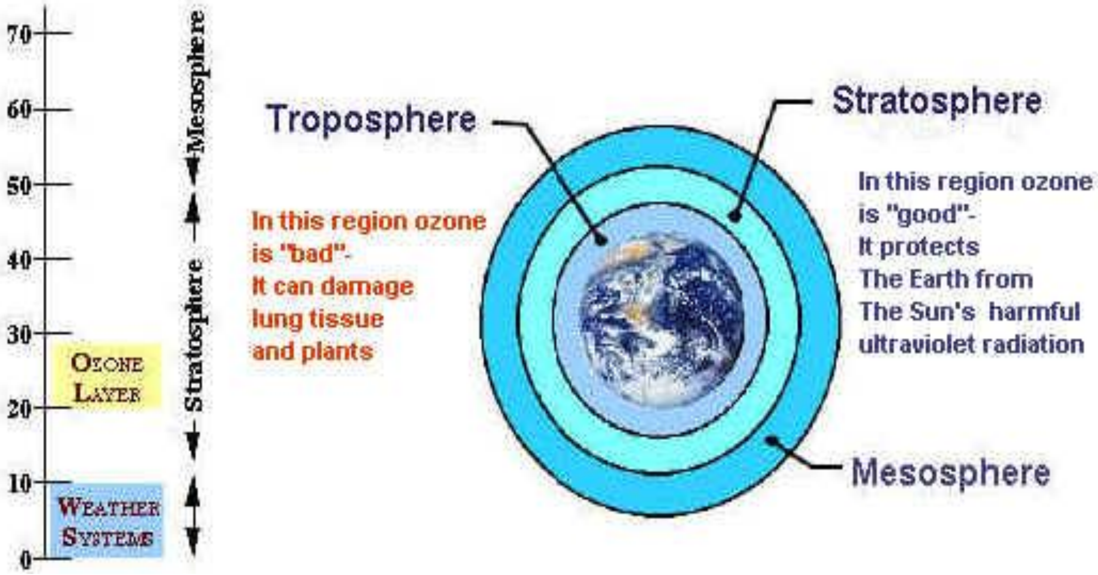


Figure (1-6) the types of Ozone

(1-4-1) Physical properties

Undiluted ozone is a pale blue gas at standard temperature and pressure; it forms a dark blue liquid below −112 °C and a violet-black solid below −193 °C. At concentrations found in the atmosphere it is colorless. The concentration above which it can be smelt (odor threshold) is between 0.0076 and 0.036 ppm.

(1-4-2) Chemistry properties

Ozone is a powerful oxidizing agent. It is also unstable at high concentrations, decaying to ordinary diatomic oxygen: $\mathbf{2\,O_3 \rightarrow 3\,O_2}$

This reaction proceeds more rapidly with increasing temperature and decreasing pressure.

Ozone is both good news and bad news! When ozone exists in the stratosphere, it protects us from the sun's harmful ultraviolet rays; however, when ozone exists in our troposphere along with the air we breathe, we consider it a major health and environmental concern.

Ozone in the Stratosphere: Ozone Layer

Ozone and oxygen molecules in the stratosphere absorb ultraviolet light from the sun, providing a shield that prevents this radiation from passing to the earth's surface. While both oxygen and ozone together absorb 95 to 99.9% of the sun's ultraviolet radiation, only ozone effectively absorbs the most energetic ultraviolet light, known as UV-C and UV-B, which causes biological damage.

About 90% of the ozone in the earth's atmosphere lies in the region called the stratosphere between 16 and 48 kilometers (10 and 30 miles) above the earth's surface. Ozone forms a kind of layer in the stratosphere, where it is more concentrated than anywhere else, but even there it is relatively scarce. Its concentrations in the ozone layer are typically only 1 to 10 parts of ozone per 1 million parts of air, compared with about 210,000 parts of oxygen per 1 million parts of air.

Chapman theory says that ozone is formed in the upper atmosphere as the result of two successive physical processes. The first is the photo dissociation of molecular oxygen (O_2) by the absorption of certain wavelengths of solar ultraviolet radiation. This leads to the production of oxygen atoms.

$$O_2 \longrightarrow O + O$$

The second process involves the formation of ozone by the collision of oxygen atoms and molecules in the presence of a third particle (M).

$$O_2 + O + M \longrightarrow O_3 + M$$

This reaction takes place in the upper stratosphere. In that region the density of the air is such that a relatively high proportion of diatomic oxygen molecules are present.

Then ozone is itself decomposed by photo dissociation. This process involves the absorption of ultraviolet radiation of different wavelengths to those involved in the separation of the atoms of diatomic oxygen molecules.

$$O_3 \longrightarrow O_2 + O$$

Ozone in the Troposphere (Surface ozone):

In the Earth's lower atmosphere, near ground level, ozone is formed when pollutants emitted by cars, power plants, industrial boilers, refineries, chemical plants, and other sources react chemically in the presence of sunlight. Ozone at ground level is a harmful pollutant. Ozone pollution is a concern during the summer months, when the weather conditions need to form it lots of sun, hot temperatures normally occur.

10% of the ozone in the earth's atmosphere is found in the troposphere, which is the portion of the atmosphere from the earth's surface to about 12 km or 7 miles up. In the troposphere, ozone is not wanted. Ozone is even more scarce in the troposphere than the stratosphere with concentrations of about 0.02 to 0.3 parts per million. But even in such small doses, this molecule can do a lot of damage.

Ozone in the troposphere is one of the greenhouse gases. Scientists are very concerned about the warming effects of increased greenhouse gases caused by human activity.
So, in the troposphere, ozone levels deal us ingredient in smog and as powerful.

Ozone as a greenhouse gas:

Ozone is not directly emitted into the atmosphere but forms when oxides of nitrogen (NO_x) and volatile organic compounds (VOCs) are in the air and sunlight is present. Motor vehicle exhaust and industrial emissions, power plants, gasoline vapors, and chemical solvents are some of the major human-made sources of NO_x and VOC. Significant natural sources of NOx include lightning, biomass burning, and soil. Vegetation also releases substantial amounts of VOCs. NO_x and VOCs are gases that are referred to collectively as ozone precursors. Strong sunlight and hot weather cause ground-level ozone to form and reach highconcentrations.

High levels, or concentrations, of ozone at the earth's surface can damage people's health, plants, and animals. Ozone at the ground level occurs naturally but human activities can increase concentrations and cause ozone to reach unhealthy levels.

When air with high concentrations of ozone is inhaled, it adversely affects the respiratory system. The most sensitive people to ozone concentrations are children, the elderly, and those with asthma or other respiratory illnesses. Ozone can injure plants (sometimes the injuries are visible, such as changes in leaf color) and can decrease their crop yields on farms. [9][10] [11]

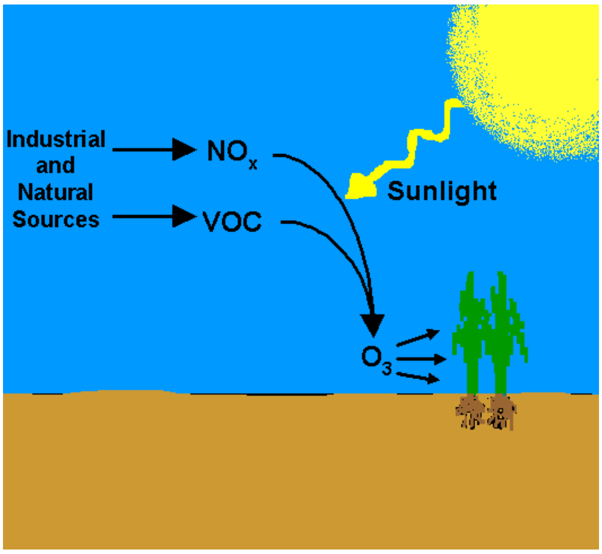


Figure (1-7) the role of Ozone

Ozone pollution:

There is a great deal of evidence to show that high concentrations (ppm) of ozone, created by high concentrations of pollution and daylight UV rays at the earth's surface, can harm lung function and irritate the respiratory system. It has also been shown that there is a connection between increased ozone caused by thunderstorms and hospital admissions of asthma sufferer.

(1-5) Ozone Hole:

This beneficial ozone which protective layer that shields us from the sun’s harmful ultraviolet rays which is gradually being destroyed by manmade chemicals.

Ozone depletion occurs when the natural balance between the production and destruction of stratospheric ozone is tipped in favor of destruction. Although natural phenomena can cause temporary ozone losses, chlorine and bromine released from man-made synthetic compounds such as CFCs are now accepted as the main cause of this depletion.

A common misconception is that there is an ozone hole above us in the sky which is letting in harmful ultraviolet (UV) radiation from the Sun. Ozone depletion, in fact, is occurring all over the world due to man-made pollution, However, in certain parts of the world, ozone depletion is particularly severe, and it is in the regions where the term "ozone hole" strictly applies.

Every September and October during the Southern Hemisphere springtime, significant ozone destruction is observed in the stratosphere above Antarctica, with losses of up to 60%. Levels of ozone are measured in Dobson Units (D.U.). The average amount of stratospheric ozone throughout the world is about 300 D.U. Ozone concentrations over Antarctica during the period of greatest depletion usually fall well below 200 D.U. When ozone concentrations are plotted on a map, the presence of a large ozone hole over the continent is striking.

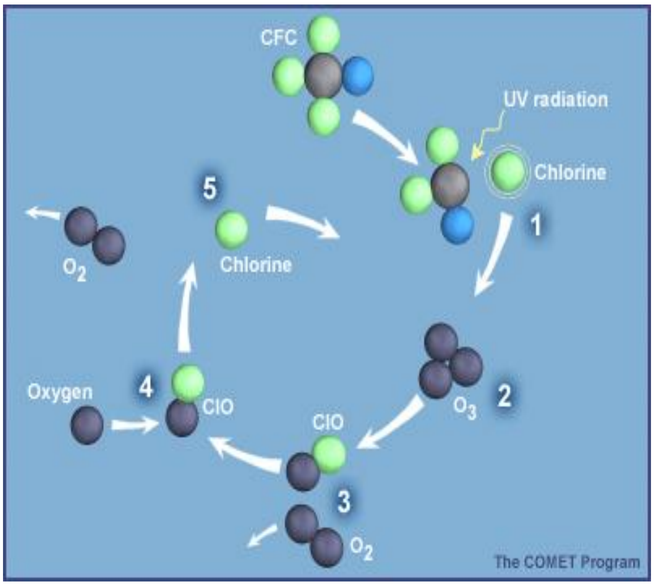
The formation of the ozone hole over Antarctica is a consequence of the special atmospheric conditions which occur there, in particularly the very low stratospheric temperatures (below -80°C), the isolated wind patterns and the presence of continuous sunlight after the September equinox.

Every summer the hole repairs itself when stratospheric temperatures rise and the air above Antarctica mixes with the rest of the world's atmosphere. This cycle of Ozone Hole formation and reparation is repeated every year. The ozone hole over Antarctica has been forming every year since the early 1970s. In recent years the hole has become both larger and deeper, in the sense that more and more ozone is being destroyed. [4][5]

Every March to April during the Northern Hemisphere springtime similar, but less pronounced ozone hole forms above the Arctic. The natural circulation of wind - the polar vortex - which isolates Antarctica from the rest of the world during the Southern Hemisphere winter and early spring, contributing to the ozone loss there, is much less developed in the Northern Hemisphere above the Arctic.

The natural circulation of wind - the polar vortex - which isolates Antarctica from the rest of the world during the Southern Hemisphere winter and early spring, contributing to the ozone loss there, is much less developed in the Northern Hemisphere above the Arctic. In addition, stratospheric temperatures there are not as low as in the Antarctic, and consequently the loss of ozone is not as severe.

However, the formation of even a moderate ozone hole above the Arctic region can give cause for considerable concern due to the greater populations in the higher latitudes of the Northern Hemisphere.



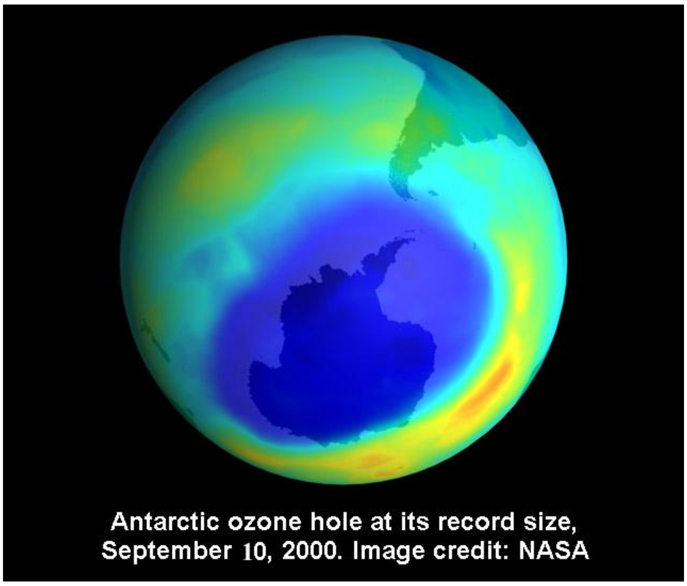

Antarctic ozone hole at its record size, September 10, 2000. Image credit: NASA

Figure (1-8) the role CFC in Ozone Hole Figure (1-9) photo of Ozone Hole

(1-6) Greenhouse Gases

Greenhouse gases are gases in an atmosphere that absorb and emit radiation within the thermal infrared range. This process is the fundamental cause of the greenhouse effect.[12][13]

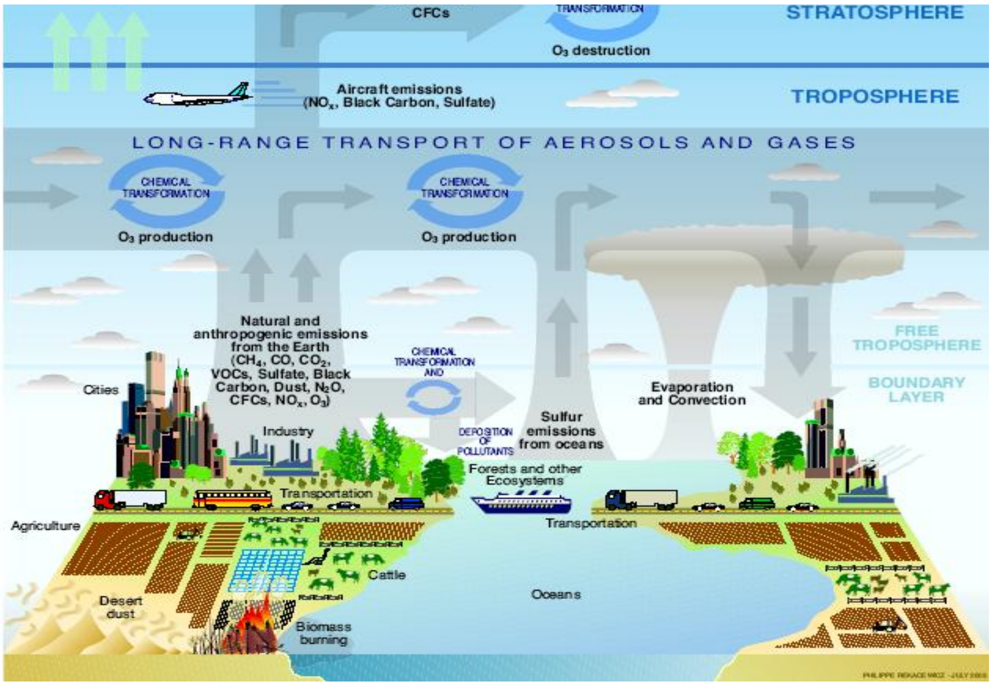


Figure (1-10) Schematic of chemical and transport processes related to atmospheric composition.

The main greenhouse gases in the Earth's atmosphere are water vapor, carbon dioxide, methane, nitrous oxide, and ozone. In our solar system, the atmospheres of Venus, Mars and Titan also contain gases that cause greenhouse effect. Greenhouse gases greatly affect the temperature of the Earth; without them, Earth's surface would be on average about 33 °C (59 °F) colder than at present. [14][15]

Human activities since the start of the industrial era around 1750 have increased the levels of greenhouse gases in the atmosphere.

These processes link the atmosphere with other components of the Earth system, including the oceans, land, and terrestrial and marine plants and animals.

The main greenhouse gases are constituents in the atmosphere (CO_2, CO, H_2O, CH_4, N_2O, and Tropospheric ozone which act as "selective absorbers", meaning that each compound absorbs outgoing IR radiation at a specific wavelength or range/set of wavelengths. Note that global warming contribution from ozone is NOT the ozone in the stratosphere ("good" ozone, which blocks harmful UV-B band in solar radiation), but the ozone generated by exhausts which remain in the lower troposphere ("bad" ozone).

(1-6-1) Greenhouse Effects in Earth's Atmosphere:

The contribution to the greenhouse effect by a gas is affected by both the characteristics of the gas and its abundance. For example, on a molecule-for-molecule basis methane is about eight times stronger greenhouse gas than carbon dioxide[16], but it is present in much smaller concentrations so that its total contribution is smaller. When these gases are ranked by their contribution to the greenhouse effect, the most important are: 1- water vapor, which contributes 36–72%

2- Carbon dioxide, which contributes 9–26%
3- Methane, which contributes 4–9%
4- Ozone, which contributes 3–7%

It is not possible to state that a certain gas causes an exact percentage of the greenhouse effect. This is because some of the gases absorb and emit radiation at the same frequencies as others, so that the total greenhouse effect is not simply the sum of the influence of each gas. The higher ends of the ranges quoted are for each gas alone; the lower ends account for overlaps with the other gases.[14][16] The major non-gas contributor to the Earth's greenhouse effect, clouds, also absorb and emit infrared radiation and thus have an effect on radiative properties of the greenhouse gases.[15][16]

In addition to the main greenhouse gases listed above, other greenhouse gases include sulfur hexafluoride, hydrofluorocarbons and perfluorocarbons (see IPCC list of greenhouse gases). Some greenhouse gases are not often listed. For example, nitrogen trifluoride has a high global warming potential (GWP) but is only present in very small quantities.

Atmospheric absorption and scattering at different electromagnetic wavelengths. The largest absorption band of carbon dioxide is in the infrared.

Scientists who have elaborated on Arrhenius's theory of global warming are concerned that increasing concentrations of greenhouse gases in the atmosphere are causing an unprecedented rise in global temperatures, with potentially harmful consequences for the environment and human health.[13] Although contributing to many other physical and chemical reactions, the major atmospheric constituents, nitrogen (N_2), oxygen (O_2), and argon (Ar), are not greenhouse gases. This is because molecules containing two atoms of the same element such as N_2 and O_2 and monatomic molecules such as Ar have no net change in their dipole moment when they vibrate and hence are almost totally unaffected by infrared light. Although molecules containing two atoms of different elements such as carbon monoxide (CO) or hydrogen chloride (HCl) absorb IR, these molecules are short-lived in the atmosphere owing to their reactivity and solubility. As a consequence they do not contribute significantly to the greenhouse effect and are not often included when discussing greenhouse gases.

Late 19th century scientists experimentally discovered that N_2 and O_2 did not absorb infrared radiation (called, at that time, "dark radiation") and that water as a vapour and in cloud form, CO_2 and many other gases did absorb such radiation. It was recognized in the early 20th century that the greenhouse gases in the atmosphere caused the Earth's overall temperature to be higher than it would be without them.

On the other hand, when sunlight reaches the Earth's surface, some is absorbed and warms the earth. Because the earth is much cooler than the sun, it radiates energy at much longer wavelengths than the sun some of these longer wavelengths are absorbed by greenhouse gases in the atmosphere before they are lost to space. The absorption of this long wave radiant energy warms the atmosphere (the atmosphere is also warmed by transfer of sensible and latent heat from the surface).

(1-7) Atmospheric Particles and Dust:

(1-7-1) Particulates and Aerosol:

Aerosols are minute particles suspended in the atmosphere. When these particles are sufficiently large, we notice their presence as they scatter and absorb sunlight. Their Particulates alternatively referred to as particulate matter (PM) or fine particles, are tiny subdivisions of solid or liquid matter suspended in a gas or liquid , but aerosol refers to particles and the gas together and an aerosol is a suspension of fine solid particles or liquid droplets in a gas. Examples are smoke, oceanic haze, air pollution, and smog. Sources of particulate matter can be man made or natural.[17]

Sources of particulate matter can be man made or natural. Particulate Matter[18]. (Water quality) In water pollution, particulates can either be in a solid or dissolved state. Solid particulates can be removed by filters or settle from the water, and is referred to as insoluble particulate matter. Whereas, dissolved particulate matter in water is collected by allowing the water to evaporate, leaving behind the dissolved particulate matter. Salt is an example of dissolved particulate matter. Some particulates occur naturally, originating from volcanoes, dust storms, forest and grassland fires, living vegetation, and sea spray. Human activities, such as the burning of fossil fuels in vehicles, power plants and various industrial processes also generate significant amounts of aerosols. Averaged over the globe, *anthropogenic* aerosols—those made by human activities—currently account for about 10 percent of the total amount of aerosols in our atmosphere.[2] Increased levels of fine particles in the air are linked to health hazards such as heart disease, altered lung function and lung cancer. Aerosols also can act as sites for chemical reactions to take place (heterogeneous chemistry). The most significant of these reactions are those that lead to the destruction of stratospheric ozone. During winter in the Polar Regions, aerosols grow to form polar stratospheric clouds.

Scale classification

The notation PM_{10} is used to describe particles of 10 micrometers or less and $PM_{2.5}$ represents particles less than 2.5 micrometers in aerodynamic diameter.[16] below 100 nm, down to the size of individual molecules is classified as ultrafine particles (UFP or UP).[17] Wherease PM_{10}-$PM_{2.5}$ is the difference of PM_{10} and $PM_{2.5}$, so that it only includes the coarse fraction of PM_{10} as listed in table (1-1).

Table (1-2) shows the classification.

Fraction	Size range
PM_{10} (thoracic fraction)	<=10 μm
$PM_{2.5}$ (respirable fraction)	<=2.5 μm
PM_1	<=1 μm
Ultrafine (UFP or UP)	<=0.1 μm
PM_{10} - $PM_{2.5}$ (coarse fraction	2.5 μm – 10 μm

(1-7-2) Effects of aerosols on electromagnetic radiation

All aerosols both absorb and scatter solar and terrestrial radiation. This is quantified in the *Single Scattering Albedo* (SSA), the ratio of scattering alone to scattering plus absorption (*extinction*) of radiation by a particle. The SSA tends to unity if scattering dominates, with relatively little absorption, and decreases as absorption increases, becoming zero for infinite absorption. For example, sea-salt aerosol has an SSA of 1, as a sea-salt particle only scatters, whereas soot has an SSA of 0.23, showing that it is a major atmospheric aerosol absorber.

(1-7-3) Climate Effects:

Firstly Climate effects can be extremely catastrophic; sulfur dioxide ejected from the eruption of Huaynaputina probably caused the Russian famine of 1601 - 1603, leading to the deaths of two million. Three types of aerosols significantly affect the Earth's climate Volcanic Aerosol, Desert Dust, human activities. Aerosol (very fine particles/droplets in the atmosphere) has two effects, direct and indirect. [26]Aerosols can modify the Earth’s radiative balance through the aerosol direct and indirect effects.

Aerosol direct effect:

Aerosols directly scatter and absorb radiation. The scattering of radiation causes atmospheric cooling, whereas absorption can cause atmospheric warming.

Aerosol indirect effect:

Aerosols modify the properties of clouds through a subset of the aerosol population called cloud condensation nuclei (CCN). Increased CCN concentrations lead to increased cloud droplet number concentrations (CDNC). A greater number of cloud droplets leads to increased cloud albedo, increased light scattering and radiative cooling (first indirect effect). Increased CDNC also leads to reduced precipitation efficiency and increased lifetime of the cloud (second indirect effect).

Table (1-3) The Most Polluted World Cities by PM.

Most Polluted World Cities by PM[18]	
Particulate matter, μg/m^3 (2004	**City**
169	**Cairo, Egypt**
150	**Delhi, India**
128	**Kolkata, India (Calcutta)**
125	**Tianjin, China**
123	**Chongqing, China**
109	**Kanpur, India**
109	**Lucknow, India**
104	**Jakarta, Indonesia**
101	**Shenyang, China**

Oxides of nitrogen (NO_x) in the atmosphere are a form of pollution which can give rise to smog and act as a greenhouse gas. Their persistence in the atmosphere is affected by aerosol droplets of water.

(1-7-4) Dust and Optical Properties:

Dust is a general name for minute solid particles with diameters less than 20 thou (500 micrometres). Particles in the atmosphere arise from various sources such as soil dust lifted up by wind, volcanic eruptions, and pollution. Dust in homes, offices, and other human environments contains human skin cells, small amounts of plant pollen, human and animal hairs, textile fibers, paper fibres, minerals from outdoor soil, and many other materials which may be found in the local environment.[19] Airborne dust is considered an aerosol and can have a strong local radiative forcing on the atmosphere and significant effects on climate. In addition, if enough minute particles are dispersed within the air in a given area (such as flour or coal dust), under certain circumstances can cause an explosion hazard.

Coal dust is responsible for the lung disease known as Pneumoconiosis, including black lung disease, that occurs among coal miners. The danger of coal dust resulted in environmental legislation regulating work place air quality in some jurisdictions.

Optical depth, or optical thickness:

is a measure of transparency, and is defined as the negative logarithm of the fraction of radiation (or light) that is not scattered or absorbed on a path.

One way of visualizing optical depth is to think of a fog. The fog between you and an object that is immediately in front of you has an optical depth of zero. As the object moves away, the optical depth increases until it reaches a large value and the object is no longer visible.

The optical depth expresses the quantity of light removed from a beam by scattering or absorption during its path through a medium. If I_0 is the intensity of radiation at the source and I is the observed intensity after a given path, then optical depth τ is defined by the following equation:[17]

$$I/I_0 = e^{-\tau}.$$

Aerosol optical depth (Mie Scattering)

If the size of particles is larger than the wavelength of the incident light, the radiation undergoes Mie scattering (Iqbal, 1983). Mie theory was introduced by Gustav Mie in 1908. The theory determines how an electromagnetic wave interacts with homogenous spherical particles. The assumptions of spherical shape and homogeneity for the particle enable Mie theory to determine the extinction coefficient, the single scattering albedo, the asymmetry factor, and the phase functions of a particular wavelength that may be used in multi-stream radiative transfer calculations. This type of scattering depends on aerosol size distribution and refractive indices.

(1-7-5) Dust Storm:

A dust storm or sandstorm is a meteorological phenomenon common in arid and semi-arid regions. Dust storms arise when a gust front blows loose sand and dust from a dry surface. Particles are transported by saltation and suspension, causing soil erosion from one place and deposition in another. The Sahara and drylands around the Arabian peninsula are the main source of airborne dust, with some contributions from Iran, Pakistan and India into the Arabian Sea, and China's storms deposit dust in the Pacific. It has been argued that recently, poor management of the Earth's drylands, such as neglecting the fallow system, are increasing dust storms from desert margins and changing both the local and global climate, and also impacting local economies.

The term *sandstorm* is used most often in the context of desert sandstorms, especially in the Sahara, when, in addition to fine particles obscuring visibility, a considerable amount of larger sand particles are blown closer to the surface. The term *dust storm* is more likely to be used when finer particles are blown long distances, especially when the dust storm affects urban areas.

As the force of wind passing over loosely held particles increases, particles of sand first start to vibrate, then to saltate ("leap"). As they repeatedly strike the ground, they loosen smaller particles of dust which then begin to travel in suspension. At wind speeds above that which causes the smallest to suspend, there will be a population of dust grains moving by a range of mechanisms: suspension, saltation and creep.[19]

A recent study found that the initial saltation of sand particles induces a static electric field by friction. Saltating sand acquires a negative charge relative to the ground which in turn loosens more sand particles which then begin saltating. This process has been found to double the number of particles predicted by previous theory.[17]

Particles become loosely held mainly due to drought or arid conditions, and wind has varied causes. Gust fronts may be produced by the outflow of rain-cooled air from an intense thunderstorm, or they may represent a dry cold front, that is, a cold front that is moving into a dry air mass and is producing no precipitation. In desert areas, dust and sand storms are most commonly caused by either thunderstorm outflows, or by strong pressure gradients which cause an increase in wind velocity over a wide area.The vertical extent of the dust or sand that is raised is largely determined by the stability of the atmosphere above the ground as well as by the weight of the particulates. In some cases, dust and sand may be confined to a relatively shallow layer by a low-lying temperature inversion. In other instances, dust (but not sand) may be lifted as high as 20,000 feet (6,100 m) high. Drought and wind contribute to the emergence of dust storms, as do poor farming and grazing practices by exposing the dust and sand to the wind. [18]

A Review on Previous Works

Short- and long-term changes of total ozone investigated by means of an ensemble simulation with the coupled chemistry-climate model E39/C for the period 1960 to 2020 studied by M. Dameris, et al, [20]. Past total ozone changes are well simulated on both, long (decadal) and short (monthly) timescales. Even the 2002 Antarctic ozone anomaly appears in the ensemble. The model results indicate that the 11-year solar cycle will delay the onset of a sustained ozone recovery. The lowest global mean total ozone values occur between 2005 and 2010, although stratospheric chlorine loading is assumed to decline after 2000. E39/C results exhibit a significant increase of total ozone after the beginning of the next decade, following the upcoming solar minimum. The observed ozone increase in the second half of the 1990s is reproduced by E39/C and is identified as a combined post- Pinatubo and solar cycle effect rather than the beginning of a sustainable ozone recovery.

The global (50°N – 50°S) distribution of stratospheric column ozone (SCO) is derived using SBUV profiles and compared with SCO amounts derived from SAGE and ground based measurements studied by Amy E. Wozniak, et al, [27]. An evaluation of archived SBUV (Version 6) ozone profiles with ozone-sonde profiles shows that the low resolution of the SBUV instrument in the troposphere and lower stratosphere leads to a low bias in the SBUV profile in the troposphere and a high bias in the lower stratosphere in regions where anthropogenic tropospheric ozone production influences the climatology. An empirical correction applied to the SBUV profile prior to separating the stratosphere from the troposphere reduces the bias in the lower stratosphere and results in a SCO distribution in good agreement with SCO derived from SAGE ozone profiles. Because the empirical correction is most pronounced at northern middle latitudes we compare these resultant SCO values with those measured at two northern middle latitude sites (Wallops Island and Hohenpeissenberg) using concurrent measurements from Dobson spectrophotometers and ozonesondes. Our analysis shows that the empirically corrected SCO at these sites captures the seasonal cycle of SCO as well as the seasonal cycle derived from SAGE stratospheric ozone profiles. These results have important implications for the derivation of tropospheric ozone derived from SBUV ozone profiles in conjunction with TOMS total ozone measurements using the tropospheric ozone residual (TOR) methodology.

The newly reprocessed solar backscatter ultraviolet (SBUV) and Total Ozone Mapping Spectrometer (TOMS) version 8 data from 1979 to 2003 are used to estimate the seasonal cycle, latitude dependence, and long-term trends in ozone averaged over the Pacific region (120_W to 120_E) in three broad layers of the atmosphere: upper stratosphere (32 hPa and above), lower stratosphere (32 hPa to tropopause), and the troposphere, studied by J. R. Ziemke1, et al, [21].

The ozone amount in these layers is derived by first determining stratospheric column ozone in the Pacific from TOMS using deep convective clouds, which are numerous in the region. Tropospheric column ozone (TCO) for the Pacific is then determined by taking the difference between total column ozone and stratospheric column ozone. This ‘‘cloud-slicing’’ technique is extensively tested from the tropics extending to ±60_ latitude using stratospheric ozone data from the Stratospheric Aerosol and Gas Experiment II instrument.

The validity of the cloud-slicing technique in obtaining TCO is also tested using data from ozonesondes over a wide range of latitude. SBUV ozone profiles are used to measure upper stratospheric column ozone for the Pacific region.

Lower stratospheric column ozone is then derived from the difference between stratospheric column ozone and upper stratospheric column ozone. This process yields a unique 25-year record of Pacific mean ozone in three atmospheric layers covering all latitudes and seasons. The analysis of the data shows that the seasonal cycles, latitude dependence, and trends in these layers are substantially different. Over the 25-year record most ozone depletion has occurred in the lower stratosphere below _25 km altitude.

In middle and high latitudes, ozone losses are 3–4 times larger in the lower stratosphere compared with the upper stratosphere, even though the ozone amounts in the two regions are about the same. For the troposphere, TCO shows a statistically significant upward trend in the midlatitudes of both hemispheres but not in the tropics.

An important issue in satellite remote sensing techniques for retrieving tropical tropospheric ozone is understanding the cause of the disagreement between ozone derived from satellite residual-based methods and the precursor distributions seen in both the fire count distribution and the Measurements Of Pollution In The Troposphere (MOPITT) CO distribution over northern tropical Atlantic and Africa in boreal winter and spring studied by Jae H. Kim1, et al, [22].

This discrepancy has been called the Northern Atlantic paradox; however, it actually extends eastward all the way to Indonesia. We define the disagreement as the northern tropical paradox. We employ the scan angle method (SAM) to solve the paradox. This algorithm takes advantage of the difference in the Total Ozone Mapping Spectrometer (TOMS) retrieval information between nadir and high viewing angles. The averaging kernel for this difference exhibits a broad maximum centered at _5 km in the troposphere and thereby can be used to estimate tropospheric ozone information. The seasonal distribution of tropospheric ozone derived from the SAM algorithm shows remarkably good agreement with fire counts from Along Track Scanning Radiometer (ATSR), CO from MOPITT, TOMS aerosol index, and ozone distribution from the GEOS-CHEM model in four seasons over the tropics.

In meridional distribution, all of these products clearly reveal the seasonal oscillation between northern tropical Africa in boreal winter and over southern tropical Africa in boreal summer. The residual-based methods (TOR, CCD, CCP, and modified residual), however, always show the ozone maximum over the southern Atlantic off the coast of southwest Africa. A further comparison with the in situ measurements from the Measurement of Ozone and Water Vapor by Airbus In-Service Aircraft (MOZAIC) campaign at three locations over the northern tropics, Abidjan (5_N, 4_W), Madras (13_N, 80_E), and Bangkok (14_N, 101_E), supports our results. The seasonality of ozone from the SAM and the model, which shows the ozone maximum in boreal summer and the minimum in boreal winter, is in accordance with the MOZAIC measurements. However, the seasonality of the RBMs does not agree with the seasonality of in situ measurements. We conclude that the northern tropical paradox does not actually exist.

The report ozonesonde observations from the following four locations across the United States: Trinidad Head, CA; Boulder, CO; Huntsville, AL; and Wallops Island, VA. These ozone profiles clearly indicate evidence of stratosphere-troposphere exchange, boundary-layer pollution, and strong seasonal variations studied by M. J. Newchurch, et al, [23]. Significant variation at the shortest inter-launch frequencies (typically weekly) appears in all seasons, at all stations throughout the troposphere. Activity near the tropopause dominates in the winter and spring, while boundary layer ozone maximizes in the summer.

The vertical extent and maximum values of boundary-layer ozone are larger at the eastern stations. Comparisons to the TOMS overpasses indicate agreement to within 2% for the total-column ozone at all stations, with station-to-station mean biases less than 2%. The seasonal variation of the total ozone column is essentially identical at Trinidad Head and Wallops Island, while the summer-time values at Boulder are significantly smaller by comparison, and the amplitude of the annual cycle at Huntsville is smaller than the amplitude of the other three stations. The longitudinal character of upper tropospheric ozone shows amounts generally increasing westward from Huntsville, and in the lower troposphere, ozone decreases westward from Huntsville in all seasons. Values to the east of Huntsville increase at all altitudes and seasons, with the possible exception of August when Huntsville’s boundary layer and free tropospheric ozone dominate.

Two consecutive increases in surface ozone, occurring after the cessation of photochemical ozone production, are investigated by Lisa S. Darby, et al, [24].

A unique suite of instruments, including ozone profiling lidar, a Doppler lidar, surface chemistry sensors, surface meteorological sensors, and a radar wind profiler, was deployed during the Southern

Oxidants Study of 1999 in Nashville, Tennesee. Time series of ozone at 10, 405, and 1035 m above ground level (AGL) on 22 June 1999 showed variations in the vertical gradient of ozone over the course of the afternoon and evening. Analysis of time series of vertical velocity at 8 m AGL and its standard deviation, the variance in Doppler lidar calculated horizontal wind speed from near the surface to 500 m AGL, wind profiles, and meteorological surface station data, revealed mechanisms responsible for these changes in ozone. An early evening rise in surface ozone occurred with the passage of a thunderstorm gust front. Analysis showed that downward mixing of ozone-rich air from a residual layer (RL) of ozone above 400 m caused a sharp rise in ozone at the surface and a decrease of ozone in the RL. Doppler lidar measurements showed details of the post gust front wind flow, such as the depth of the air mass behind the front, the turbulent wake region, and inferred vertical velocities throughout a layer several hundred meters deep. The second rise in surface ozone was caused by turbulent mixing due to elevated directional wind shear, which mixed ozone-rich air down to the surface.

A comparison and analysis of modeled and measured O_3 profiles from the INDOEX campaign presented. European Centre for Medium-Range Weather Forecast (ECMWF) meteorological analyses has been assimilated into the model to represent actual meteorology studied by T. J. de Laat [25].

The focus of this study is on two commonly observed features 5 in the O_3 profiles: mid tropospheric O_3 maxima (300–500 hPa) over the tropical Indian Ocean, and the upper tropospheric O_3 laminae that occur above approximately 14km (>150 hPa) altitude. A comparison of model simulated O_3 profiles with measured O_3 profiles indicates that the model realistically simulates the observed midtropospheric O_3 maxima.

An analysis of the model simulations shows that the major 10 source of the mid-tropospheric O_3 maxima is advection of polluted air masses from continental biomass burning areas over Africa, with generally only a small contribution of stratospheric O_3. Previous studies hinted at Stratosphere-Troposphere exchange (STE) along the subtropical jet (STJ) as the primary source of the mid-tropospheric O_3 maxima over the Indian Ocean.

Analysis of the model simulations shows that the mechanism causing the mid-tropospheric transport of African biomass burning pollution and stratospheric air masses are frontal zones or waves passing along the subtropical jets, causing advection of tropical air masses in the prefrontal zone. Furthermore, these frontal zones or waves also cause STE at the mid-latitudinal side of the STJ. The model simulations 20 also indicate that the contribution of STE in general is minor compared to advection and in situ tropospheric production of O_3 for the mid-tropospheric O_3 budget over the Indian Ocean region. An analysis of the model simulations shows that the model cannot exactly reproduce the measured upper-tropospheric O_3 maxima. However, modeled O_3 mixing ratios at 14 and 16km altitude are significantly higher than at 8 to 12 km altitude, indicating that the model does simulate an upper-tropospheric layer. According to the model simulations, the sources of O_3 at 14 and 16km altitude are advection of both tropospheric and stratospheric O_3 as well as in situ O_3 formation.

Vertical profiles of ozone, partial pressure, and meteorological parameter are obtained from ozonesondes and rawinsondes launched at Pohang (36.031N, 129.401E) in Korea studied by Y.K. Kima, et al, [26]. Stratosphere troposphere exchanges (STE) of ozone and aerosols associated with the upper trough/surface high pressure system have been analyzed by TOMS data, and reanalyzed data of NCEP/NCAR and meteorological mesoscale model such as potential temperature, geopotential height, potential vorticity, and ageostrophic and vertical wind velocity. The secondary ozone peak in the upper troposphere over Pohang corresponded to the central axis of the jet stream near the tropopause, and then an enhancement of ozone in the upper troposphere was observed when the jet stream with a cut-off low was located over Korea. The maximum flux of ozone by STE over Korea occurs in wintertime and springtime.

It was estimated that the downward fluxes observed in winter and spring for the period of 5 yr (1995–1998) at Pohang were the source of _7.72_107 ozone molecules/cm2 s between 100 and 300 hPa, and 5.72_107 ozone molecules/cm2 s between 300 and 500 hPa.

The annual average flux during the period also was presented as a decrease of 3_107 ozone molecules/cm2 s between 100 and 500 hPa. It indicates that ozone flux is decreasing in the lower stratosphere and increasing in the troposphere. The gradients of potential temperature and isentropic potential vorticity near the upper troposphere in East Asia sloped steeply like the frontal zone between the polar and the subtropical jet core. Therefore, it was regarded that ozone and aerosols of the upper level over East Asia penetrated into the lower level or the ground over Korea because of the downstream due to tropopause folding near the jet streams and the sinking of surface high pressure. In particular, yellow-sand occurring in springtime in East Asia was determined by the distribution of weather systems associated with STE. The results of observation and modeling indicate that the enhancements of ozone and aerosols in springtime occur in the advection and the downward motion due to the upper trough/cut-off low and the high surface pressure.

Total ozone data from some European stations have been analyzed to detect the ozone decrease in different seasons from 1979 to 1995 studied by Janusz W. Krzyscin, et al, [27].The differences between the winter-spring (December-March) and summer (May-August) total ozone means have decreased distinctly during the last three decades, by ~ 10 Dobson Units per decade, showing that the winter-spring decrease is significantly stronger than the summer one. Applying a multiple regression model to the monthly means of tropopause height, positive trends in the summer and winter-spring seasons have been found, especially since 1979. This corresponds to the accelerating ozone decrease then. The possibility of using tropopause height variations as an indicator of dynamical variability in the total ozone trend model is discussed. The total ozone response to the changes of tropopause height seems to be independent of timescale over which the tropopause-total ozone relationship has been examined (month-to-month, interannual).

The total ozone trends, as well as the accelerated rate of ozone decrease since 1979 in the winter-spring and summer seasons, respectively, are reduced by about 0.5-1% per decade after inclusion of the tropopause height effect on the ozone model.

In March 1995, a tropopause fold observed at the Observatory de Haute Provence (448N, 68E) using simultaneous high-resolution measurements of ozone, temperature, and wind studied F. RAVETTA, et al, [28]. This unique dataset was provided by an ozone lidar, a temperature lidar, and wind field radar. These data are described and related to the meteorological context. Comparisons with mesoscale modeling of this episode are conducted to answer the question of whether there is any spatial or temporal shift between the model outputs and the observations. Temperature comparison shows a very good agreement between the modeled and the measured static stability, discarding the hypothesis of any vertical shift. Comparison of the measured and modeled meridional components of the wind insures that the model reproduces the horizontal structure of the front and its temporal evolution. To check further the model’s ability to reproduce mesoscale structures of the flow, the relationship between ozone and potential vorticity is investigated.

First, a significant association is found between potential vorticity and ozone. Their distributions are in phase and the fold can be equally defined using ozone or potential vorticity. However, second-order differences are found in the vicinity of the jet streak where turbulent mixing entrains tropospheric air within the lowermost stratosphere. Second, ozone and potential vorticity ratios, which are calculated for the different air masses in the front, compare well with climatological ratio values. This is in good agreement with the well-known view of tropopause folding as an isentropic deformation of a zone of strong ozone and potential vorticity gradients. Third, this dataset is used to model the relationship between ozone and potential vorticity, which gives an easy way to switch from one field to the other.

Strong ozone depletions and large natural variations in total ozone have been observed at high latitudes studied by WEINE JOSEFSSON [29]. Accurate measurements of total ozone are important so as not to misinterpret the involved processes and to track correctly the variations. The primary basis for ground-based monitoring of total ozone is the network of Dobson and Brewer ozone spectrophotometers. However, these instruments have limitations. At high latitudes, the fundamental direct sun observation used by these instruments is not possible during large parts of the year.

In particular, the low sun and the resulting weak signals present a challenge. The focused sun observation method can extend the possible range of measurements using the Brewer instrument. Here, this method is discussed from the point of accuracy. Direct (synchronized) validation against the fundamental direct sun method is not possible with the current instrument configuration. Alternative methods to overcome the obstacle of no synchronous observations are applied. An estimate of the uncertainty of the validation is provided. The results show that the focused sun method gives data that are in line with the estimated uncertainty of the validation. No major additional uncertainty is needed to explain the observed scatter. The main conclusion is that the focused sun observation method can have an uncertainty close to the fundamental direct sun method and thus can be used to extend the possible range of observation for the Brewer ozone spectrophotometer.

A short overview of atmospheric chemical data assimilation and satellite observation, with a focus on ozone and on tropospheric chemistry measurements studied by Henk Eskes, [30]. Ozone data assimilation is receiving increasing attention over the past five years. This development is related to vertical extensions of numerical weather prediction models that include the full stratosphere. In particular assimilation-based reanalysis runs that include ozone as prognostic variable are valuable for atmospheric chemistry research, protocol monitoring and NWP. Satellite ozone observations, ozone data assimilation and ozone forecasting are discussed. The focus will be on aspects related to numerical weather prediction. The performance of the KNMI ozone assimilation system is discussed in more detail.

Satellite observations of the tropospheric chemistry composition are a field of active research: the retrieval uncertainties are large, related to the presence of clouds, aerosols and complicated surface properties. Very recently several new data sets have become available on tropospheric CO, CH_4, NO_2, SO_2, CH_2O and aerosols. New instruments like OMI and AIRS can deliver air-quality data on a daily basis for different trace gases. It will be a major challenge to set up data assimilation and inverse modeling analysis systems that can make optimal use of these new data sets.

The need for forecasting the level of harmful UVB radiation has stimulated the search for strong and reliable relations between total column ozone can be predicted regionally in mid-latitudes with an uncertainty of about 15 Dobson units (DU; 1 DU = 2.69×10^{-16} molecules cm^{-2})

Diagnosing and forecasting total column ozone by statistical relations studied by D. Spankuch, et al, [31]. Maximum deviations are of the order of +/- 20 DU. Deviations of more than about 20 DU between prediction and occurrence are traced back to doubtful measurements, ground-based as well as satellite.

The proposed regressions are hence a suitable tool to check the quality of satellite retrievals and of current and historic Dobson series.

Assessing surface solar irradiance in Northern Africa desert climate and its long-term variations from Meteosat images studied by MAGDY ABDEL WAHAB, MOSSAD EL-METWALLY, REDA HASSAN, MIREILLE LEFÈVRE, ARMEL OUMBE and LUCIEN WALD, [32]. This paper deals with the irradiance observed at ground level on horizontal surfaces, also called surface solar irradiance (SSI).Two databases of solar surface irradiance (SSI) derived from satellites are compared to ground measurements for Algeria, Egypt, Libya and Tunisia. It is found that it is possible to accurately derive the SSI from geostationary meteorological satellites, even with a coarse spatial resolution.

The two databases HelioClim-1 and SSE exhibit similar and good performances. The bias is lower for SSE than for HelioClim-1, as a whole; inversely, HelioClim-1 exhibits a smaller scattering of data compared to ground measurements (smaller standard-deviation) than the SSE, allowing better performances when mapping the long-term variations in the SSI. These long-term variations from 1985 to 2005 show that these four nations experience dimming as a whole. Detailed analyses of the range of dimming at sites with long-term records and of its spatial distribution have been performed. It has been found that the analysis of SSI from HelioClim-1 supports the findings for the individual sites.

Several phenomena may explain the dimming. One is the transportation of sand dust northwards from the Sahel; another one is the increase in urbanization and a third one is the increase in cloud cover and aerosol loading.

Southwest Asian Dust Storm of 25-27 March 2003 studied by *Richard H. Grumm*, [33]. On Tuesday, 25 March a strong dust storm limited visibility and in all likelihood reduced military activity over Iraq. This dust storm was relatively well forecast and has been referred to as a *Shamal*. It is unclear whether this event would truly classify as a Shamal as this term is often used to speak about a 40- day low intensity dust event in the Persian Gulf region. A *Shamal* is defined as “a summer northwesterly wind blowing over Iraq and the Persian Gulf often strong during the day but decreasing during the night.” This definition appears linked to heat lows and the intensity of a low-level inversion modulating the winds in the boundary layer.

Other, less strict, definitions suggest that the Shamal is a wind and dust storm. They begin in the spring, often defined to begin in February and are at peak intensity during the spring. A key feature with the more intense spring Shamal is an intense low-level jet (LLJ), the interaction with the subtropical jet, and a surface cyclone moving through the region. The longer duration events, which tend to be weaker, appear to be more thermally driven. The event of 25- 27 March 2003 clearly met the loser definition of a *Shamal.* Forecasting a strong dust storm requires knowledge of the strength of the LLJ. It will be shown that the Shamal of 25-27 March 2003 was associated with a very anomalous surface cyclone that tracked across northern Iraq. The 500 hPa heights and mean sea level pressure fields were on the order of 2-5 standard deviations below seasonal norms. This was a storm of record proportion and was more than likely at least a once in a decade type of event.

A STATISTICAL ANALYSIS OF INHALABLE (PM10) AND FINE PARTICLES (PM2.5) CONCENTRATIONS IN URBAN REGION OF PATRAS, GREECE studied by E. MARAZIOTIS, et al, [34]. In this study, the relationship between inhalable particulate (PM10), fine particulate (PM2.5), coarse particles (PM2.5-10) and meteorological parameters such as temperature, relative humidity, solar radiation, wind speed was statistically analyzed and modeled for the urban region of Patras during winter-spring of 2005-2006. Ambient air quality was monitored with a sampling frequency of twenty-four hours at three monitoring sites ("A", "B", "C"), covering a period of four months from December 2005 to March 2006. The monitoring sites were located near highly trafficked and congested areas. The 24-h average PM10 were measured using a FH 62-I-R in the fixed station "A", and "B", and a Teccora low-volume samplers in the site "C". The 24-h average PM2.5 was measured in "A", "B", "C" sites using Teccora low volume samplers.

Meteorological parameters such as temperature, relative humidity, solar radiation, and wind speed were also recorded during the sampling period. It was found that approximately 36% of PM10 concentrations were exceeding the standard value of 50 μg m-3. The ratios between PM2.5 and PM10 were found to be in the range of 0.49 to 0.86 and the highest ratio was found in the most polluted urban site. Concentrations of PM10, and PM2.5 showed temporal and spatial variations during winter-spring. Statistical analyses have shown a strong positive correlation between PM10 and PM2.5. The highest correlation (0.98) was obtained between PM10 and PM2.5 at station "A" followed by 0.97 at station "B" and 0.54 at station "C". The negative correlation was observed between particulate matter (PM10 and PM2.5) and wind speed. Finally, a regression equation for PM10 and PM2.5 and meteorological parameters were developed.

Potential Contribution of Traffic to Air Pollution in the State of Kuwait studied by N. Al-Mutairi and P. Koushki, [35]. The reduction in ambient air pollution is a universal goal-particularly in urban areas, the lack of resources often necessitates identification and prioritization of sources of air pollutants. Efficient planning and effective management of environmental pollutants is thus important for optimum utilization of limited resources.

This study examined seven years of data from three air pollution monitoring stations in the State of Kuwait. The stations-each located at a different district-were selected such that the influence of traffic source and oil refineries/power stations on ambient air pollution contaminants could be detected. A sampling plan was developed and CH4, CO, O3, SO2, NO, NOX and TS concentrations were measured both during peak-traffic hours as well as off peak hours.

Analyses of the data showed that concentrations of the air pollutants had slightly increased over the seven-year study period and only those of the NOX and SO_2, exceed the permitted standard levels. Traffic was the main source of air pollution in the district located adjacent to the city centre, while oil refineries contributed most to ambient air pollution in the rural district.

The concentration levels of NO, NOX and Total Sulfate (TS) were significantly less at the district located away from urban traffic and oil refineries compared to those of with heavy daily traffic congestions and those of the district in proximity to oil refineries.

Aim of the present work:

1) The aim of this work is to investigate the concentration of ozone and its variability over Middle East and North Africa (MENA).
2) Study the variation in atmospheric CO_2 and its direct and indirect effects.
3) Study the sandstorms formations and their trajectory over two available sites.
4) By using regional climate model study the effect of increase in CO_2 concentration over Egypt by 20 %.