2ND ANNUAL REFRIGERATION CONFERENCE 2018

CFC HCFCs HFC Natural refrigerants ODP

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Depletion of CFCs, HCFCs & their impact on ODP

INTRODUCTION

- **CFCs, HCFCs, HFCs & 1930**
- **CFCs R-11, R-12, R-500, R-502. R-11 = CCl_3F**
- **HCFCs R-22, R-123**
- **HFCs R-134a, R-31, R-32, R-125**
- **Stable, do not react with other system material, non- toxic, non- flammable**
- **1974 by remote sensing & aero-space technology, Dr Molina discovered the ozone hole.**

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DEFINITIONS

- **Ozone = O3:** It starts at 20 kM above our heads
- **Atmosphere:** The gaseous fluid surrounding the earth; the air.
- **Troposphere:** The inner layer of atmosphere, varying in height between about 6 miles and 12 miles, within which there is a steady fall of temperature with increasing altitude of about 2^{o}C per 1000 ft. and within which nearly all cloud formations occur and weather conditions manifest themselves.
- **Stratosphere:** The region of the atmosphere outside the troposphere characterized by relatively uniform temperature over considerable differences in altitude or by a markedly different lapse rate from that of the troposphere below.
- **Tropopause:** The transition layer between the troposphere and the stratosphere. Temperature does not change by height (Still area)
- **Ionosphere:** The succession of ionized layers that constitute the outer regions of the earth's atmosphere beyond the stratosphere, considered as beginning with the Heavy side layer at about 60 miles, and extending several hundred miles up.
- **Mesosphere:** The stratum of atmosphere between the ionosphere and the exosphere (250-600 mi), the stratum of atmosphere between the top of the stratosphere and an unnamed layer where the minimum of temperature occurs (20-50 mi)

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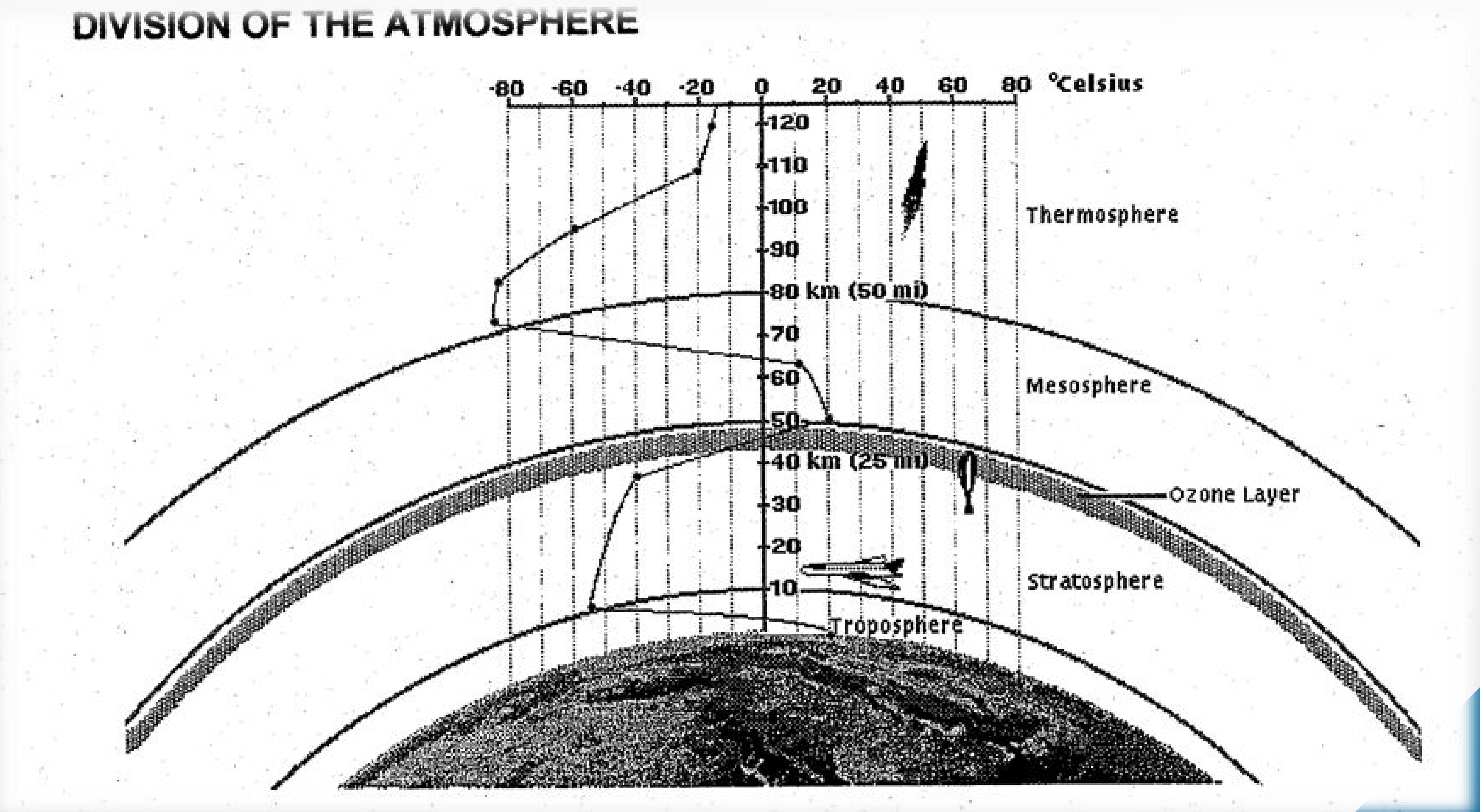

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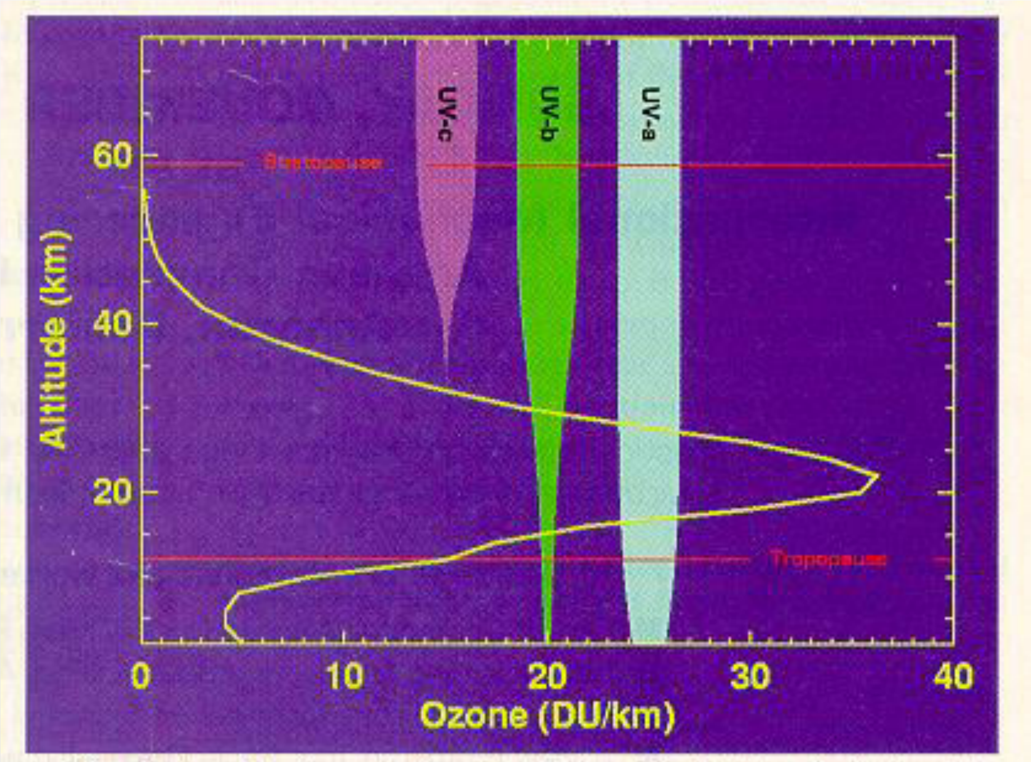
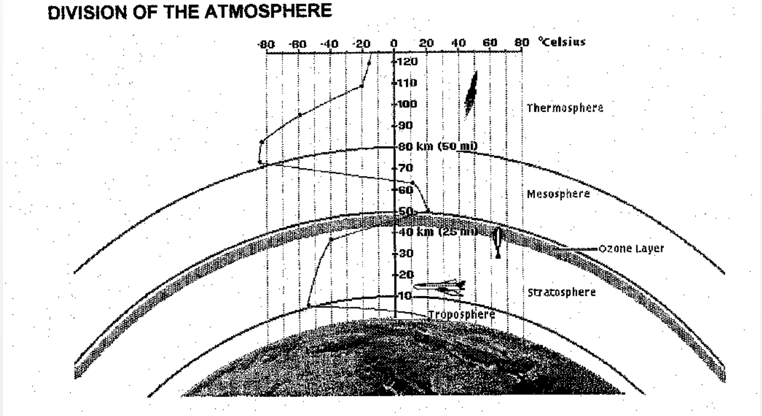
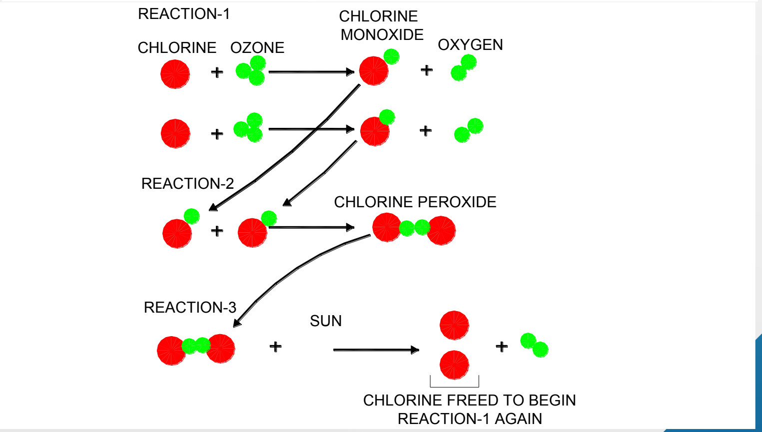
How CFCs can affect ozone layer



In this vertical profile of ozone in the mid-latitudes of the Northern Hemisphere, the width of each bar indicates the amount of energy as a function of altitude.





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Preserving earth's stratosphere

- 90% of ozone in earth's atmosphere is contained in the stratosphere (10 to 50 kM above our heads) & 10% is contained in the troposphere being the lowest layer of the atmosphere were weather patterns are observed.
- While ozone is lethal when breathed at high dosage levels, it remains a critical component of Earth's atmosphere because it absorbs harmful solar ultraviolet radiation-that is, radiation at wavelengths less than about 320 nanometers (nm). Ozone concentrations are reatest between about 15 and 30 km above the surface of the Earth.
- Since ozone is the principal factor in the screening of such radiation, it is critical to understand both the distribution of ozone in the atmosphere and the processes that control the levels of ozone. Because of the strong absorption of solar ultraviolet by ozone in the stratosphere, it is virtually impossible for ultraviolet rays between 200 and 300 nm to penetrate to the earth's surface.

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Preserving earth's stratosphere

- At 290 nm, the radiation is 350 million times weaker than at the top of the atmosphere. If our eyes detected light at 290 nm instead of in the visual range, the ozone would make the world very dark indeed.
- Ozone's absorption of ultraviolet rays is critical for the well being of humankind, since this radiation is energetic enough to break the bonds of DNA molecules. While plants and animals are generally able to repair damaged DNA, on occasion damaged DNA molecules can continue to replicate, leading to dangerous forms of skin cancer in humans. The probability that UV can damage DNA varies with wavelength, shorter wavelengths being the most dangerous. Wavelengths that easily damage DNA are strongly absorbed by ozone. The longer wavelengths absorbed weakly, DNA damage is unlikely
- But given a 10% decrease in ozone in the atmosphere, the amount of DNA-damaging UV would be expected to increase by about 22 percent. UV radiation is typically broken down into three parts: UV-a (320 to 400 nm), UV-b (280 – 320 nm), and UV-c (200 to 280 nm). UV-c is quickly absorbed by small amounts of ozone, so that none gets to the Earth's surface. UV-b is partially absorbed and about half of the UV-a is absorbed by ozone or scattered. Ozone is so effective at absorbing the extremely harmful UV-c. UV-b radiation levels are critical, since ozone doesn't fully absorb them.

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The Ozone life cycle

- An ozone molecule's career begins when intense ultraviolet radiation at wavelength less than 240 nm breaks apart an oxygen molecule "O_2" into two oxygen atoms & these atoms react with other oxygen molecules to form two ozone molecules. O_2 + UV radiation = O + O $<$240nm. Ozone molecule spends most of its life absorbing UV which will cause it to break into O_2 & O, then it recombines again. Total cycle is presented by O_3 + UV radiation = O_2 + O, and O + O_2 = O_3. Net UV is converted into heat.

- The molecule life ends when it reacts with one of a variety of chemicals in the stratosphere, such as chlorine, nitrogen, bromide or hydrogen compounds. These loss reactions are catalytic whereby the ozone molecule is lost while the catalyst is reformed to destroy another ozone molecule. One catalyst can destroy 1,000 ozone molecule before it is converted to an ozone benign compound such as HCl. The net effect is a balance between formation & catalytic reactions. We cannot control formation but we can control catalytic reactions.

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Chlorine and Ozone

- Although vast amount of chlorine are found on the earth in the form of NaCl, it is water soluble so it is completely rained out. However CFCs are not water soluble & very non reactive. This means that they can only be destroyed through photolysis by extremely energetic UV that exists above most of the ozone layer in the upper stratosphere. A CFC release takes about one year to reach ozone, but due to recycling into troposphere, it takes several decades to completely reach ozone layer.

The Antarctic hole

- This famous hole was the first discovered. Due to extreme cold weather during the winter of the Antarctic polar, chlorine & bromide get very active on the surfaces of cloud particles which would not be dangerous at normal weather conditions elsewhere. The ozone layer between 12 to 20 km is destroyed within few weeks & reaches the peak in October, but it recovers again during summer.

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The Arctic hole

- This is used to be a much smaller one than the Antarctic due to deference in temperature levels, but recently it started to be a problem because of caused by green house phenomena which resulted in very cold winters in the Arctic polar.

The future of the stratosphere

- Due to the awareness of the problems of ODP & GWP, the ozone layer is expected to catch up & recover, as long as every one does his best to protect the layer by adopting the set standards. It will take few decades before we see such thing happen.

Thank you