

Ozone Science

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Outline of Presentation



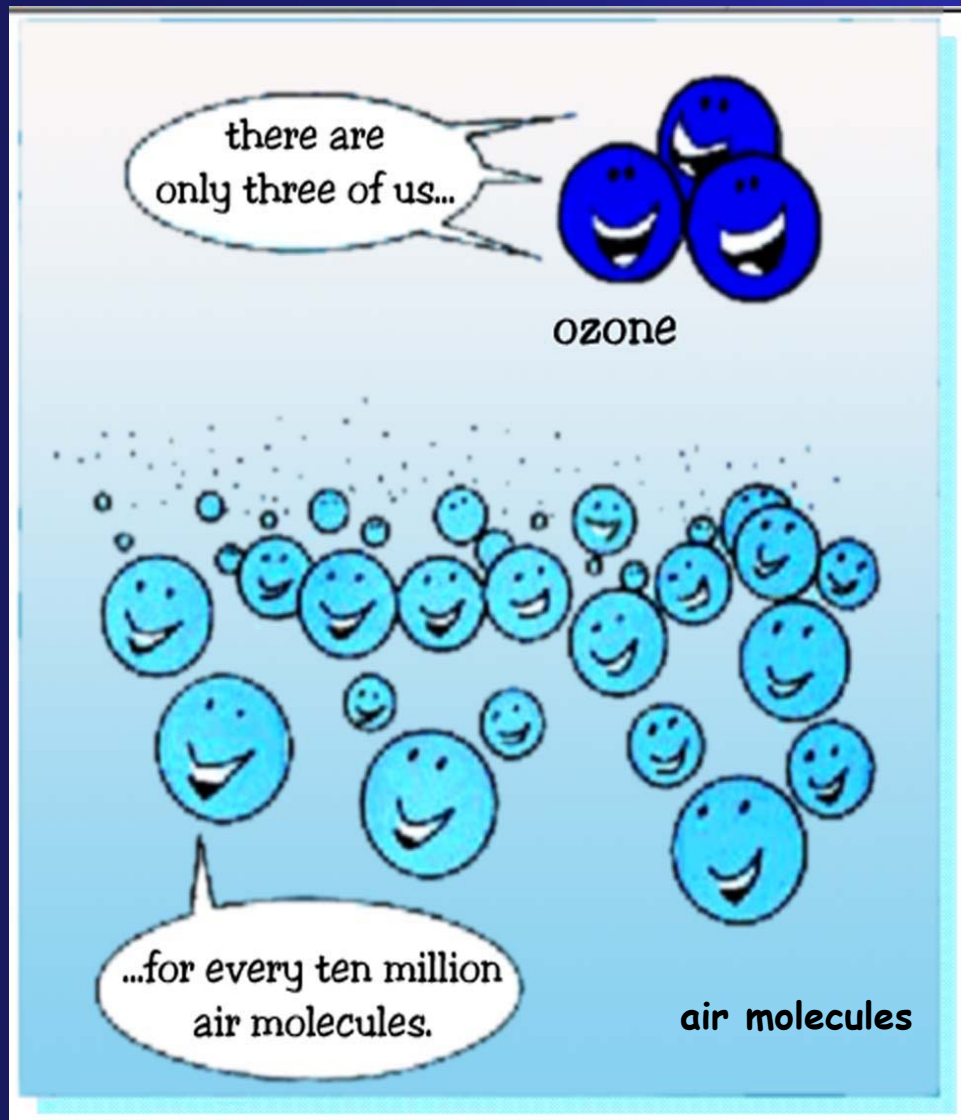
- What is ozone?
- What is the ozone layer?
- How is ozone created and destroyed?
- What is the ozone hole?
- What are the effects of ozone depletion?

Outline of Presentation



- What are the causes of ozone depletion? What are ODS?
- What can be done to save the ozone layer?
- What is the difference between ozone depletion and climate change?

WHAT IS OZONE?

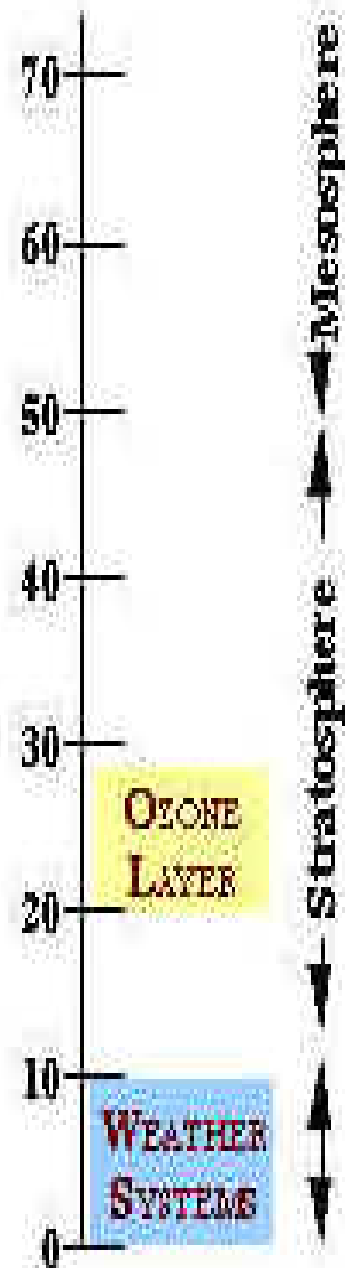


- Ozone is a gas that is naturally present in the atmosphere.

- It is a molecule made up of three oxygen atoms.

- It's chemical symbol is O_3 .

THE GOOD AND BAD OZONE



Troposphere

In this region ozone is "bad".
It can damage lung tissue and plants



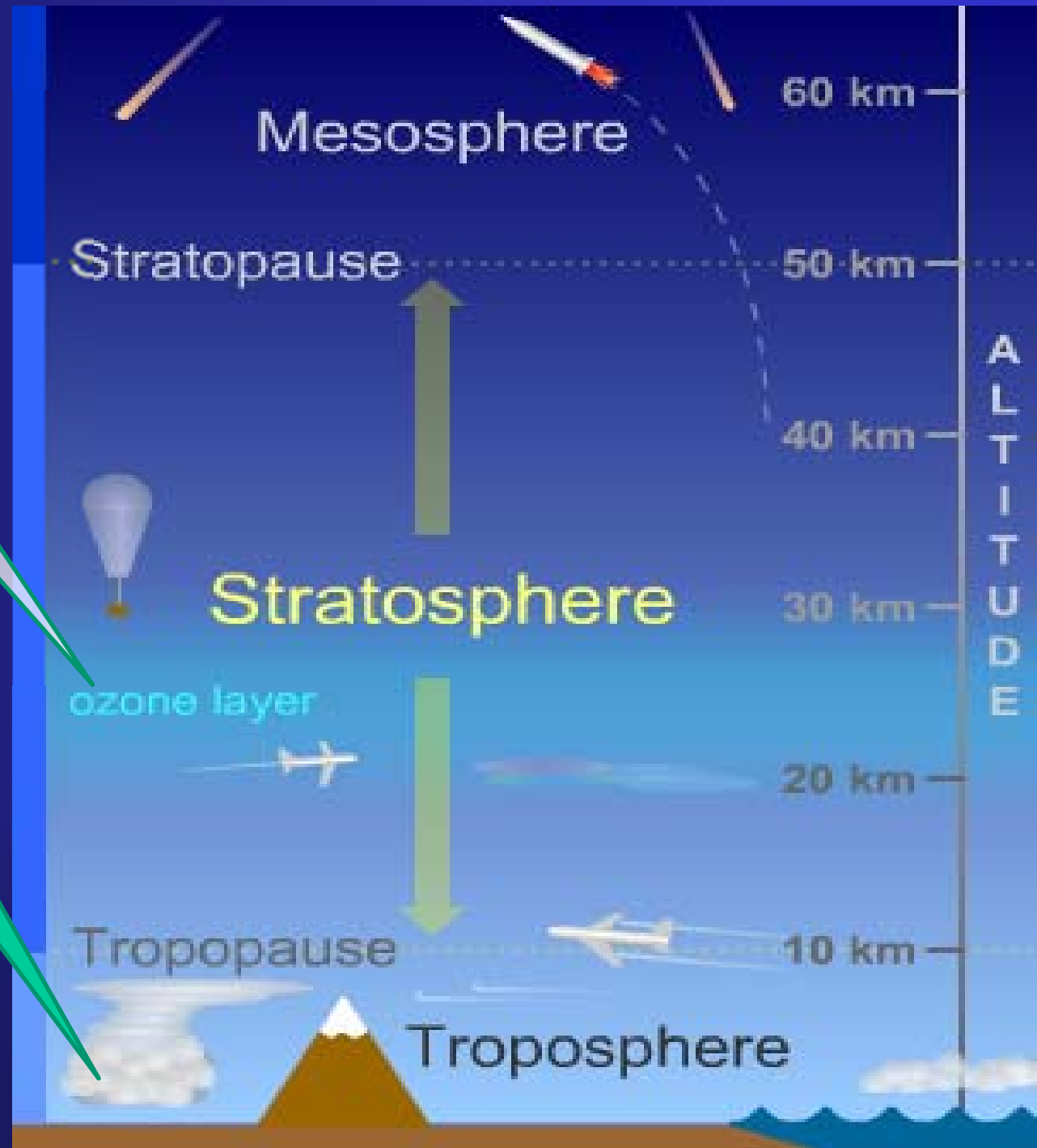
Stratosphere

In this region ozone is "good".
It protects The Earth from The Sun's harmful ultraviolet radiation

Mesosphere

OZONE
LAYER

EARTH'S
SURFACE



WHAT IS OZONE LAYER?



The Ozone Layer is a thin, fragile shield that envelops the entire earth which efficiently and effectively filters and screens almost all of the harmful ultraviolet rays



There are three categories of UV:

- UV-A:** Most UV-A is able to reach the earth's surface
- UV-B:** 90% of UV-B is blocked off by the ozone layer
- UV-C:** 100% of UV-C is blocked off by the ozone layer; Never reaches the earth

What filters the dangerous radiation from the sun that could practically burn all life on earth is the OZONE LAYER.



The Ozone Layer



- Ozone (O₃) is a naturally present gas that make up Earth's atmosphere
- Stratospheric ozone layer is the Earth's natural shield that protects us from the dangerous UV-B rays coming from the sun.

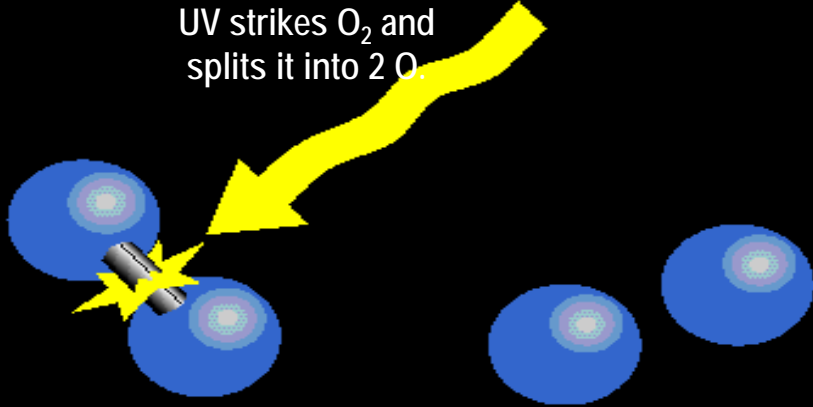
HOW IS OZONE
CREATED AND
DESTROYED?



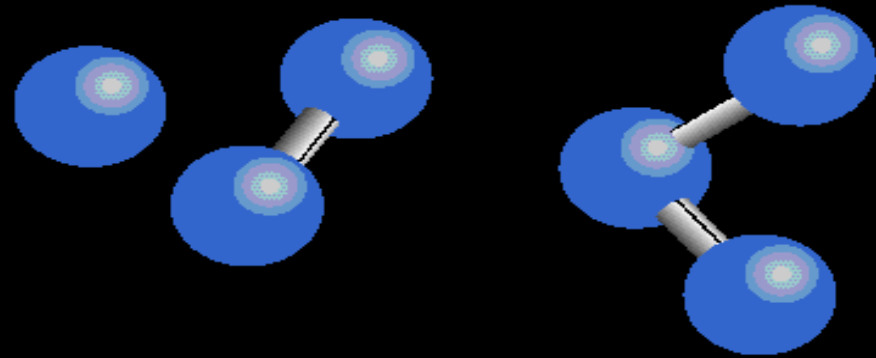
Ozone molecules are created and destroyed high above the surface of the earth, about 20-40 km above ground.

Natural Stratospheric Ozone Creation

UV strikes O_2 and splits it into 2 O.

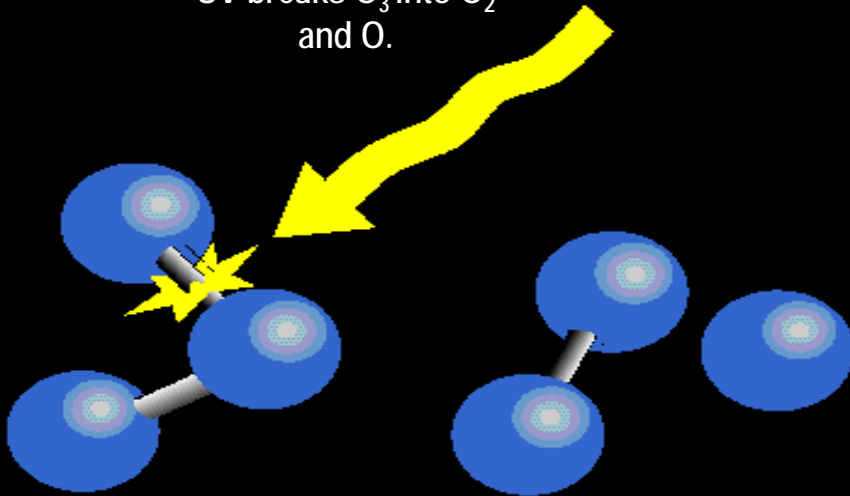


Free O reacts with O_2 to form O_3 .

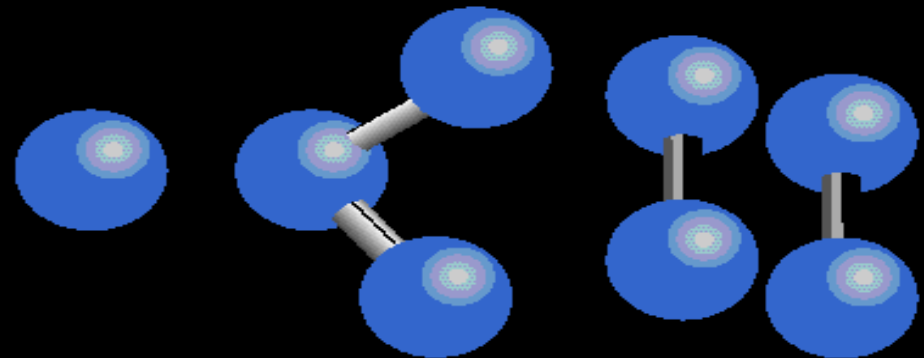


Natural Stratospheric Ozone Destruction

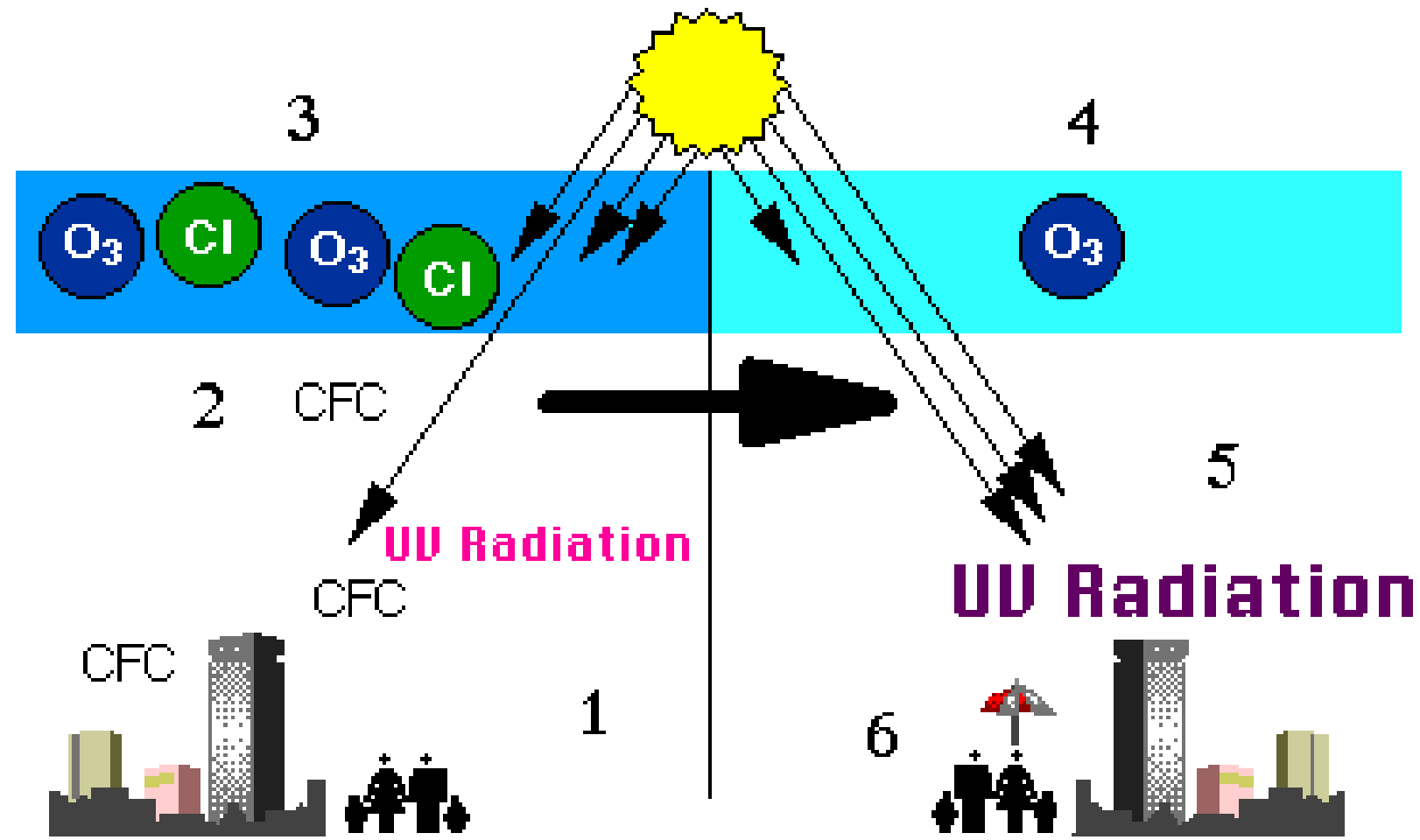
UV breaks O_3 into O_2 and O.



O can react with O_3 to form 2 O_2 .



Ozone Depletion Process

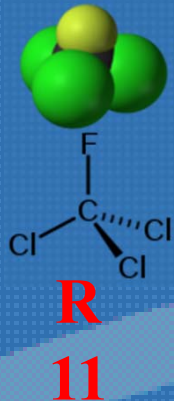


- 1 - CFCs released
- 2 - CFCs rise into ozone layer
- 3 - UV releases Cl from CFCs

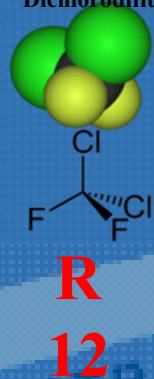
- 4 - Cl destroys ozone
- 5 - Depleted ozone -> more UV
- 6 - More UV -> more skin cancer

Ozone Destruction

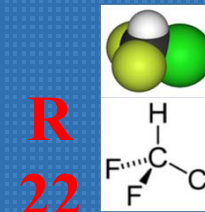
Trichlorofluoromethane



Dichlorodifluoromethane



Chlorodifluoromethane



30 miles

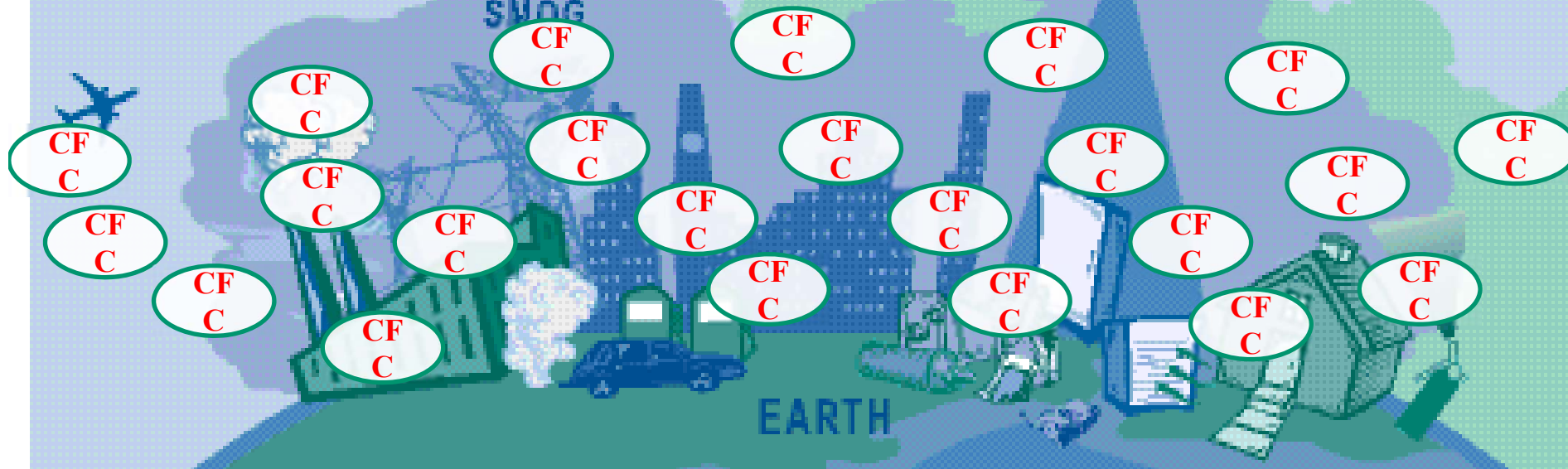
PROTECTIVE OZONE LAYER

TROPOSPHERE

10 miles

SMOG

EARTH



Ozone Destruction

Ultraviolet radiation strikes a CFC molecule. . .

1



. . .and causes a chlorine atom to break away.

2



The chlorine atom collides with an ozone molecule. . .

3



. . .and steals an oxygen atom to form chlorine monoxide and leave a molecule of ordinary oxygen.

4



When a free atom of oxygen collides with the chlorine monoxide. . .

5



. . .the two oxygen atoms form a molecule of oxygen. The chlorine atom is released and free to destroy more ozone.

6



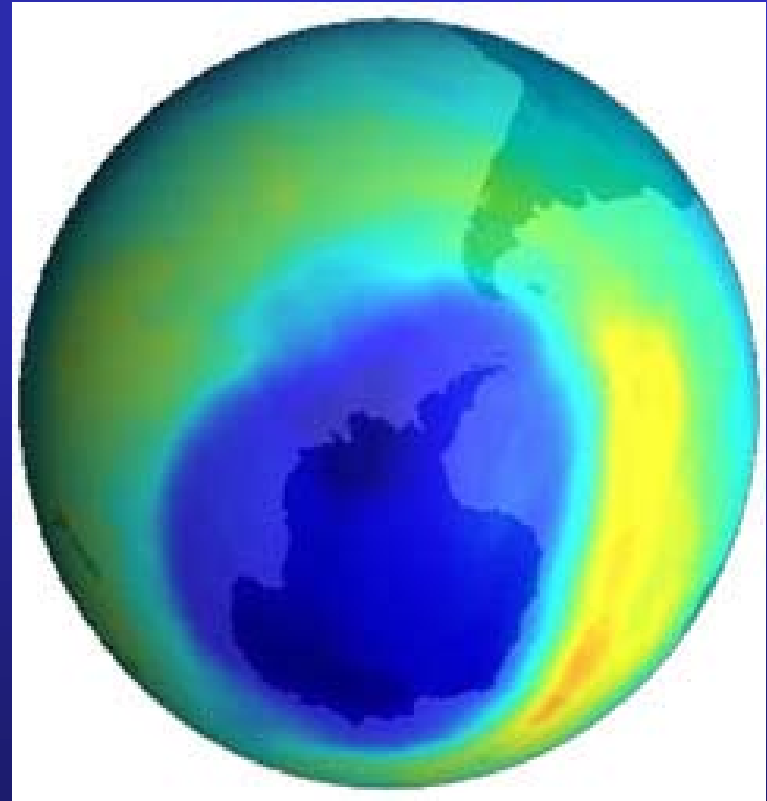
WHAT IS THE OZONE HOLE?

The depletion or the loss of the blocking effect of the ozone layer against ultraviolet rays is what we call the **OZONE HOLE**

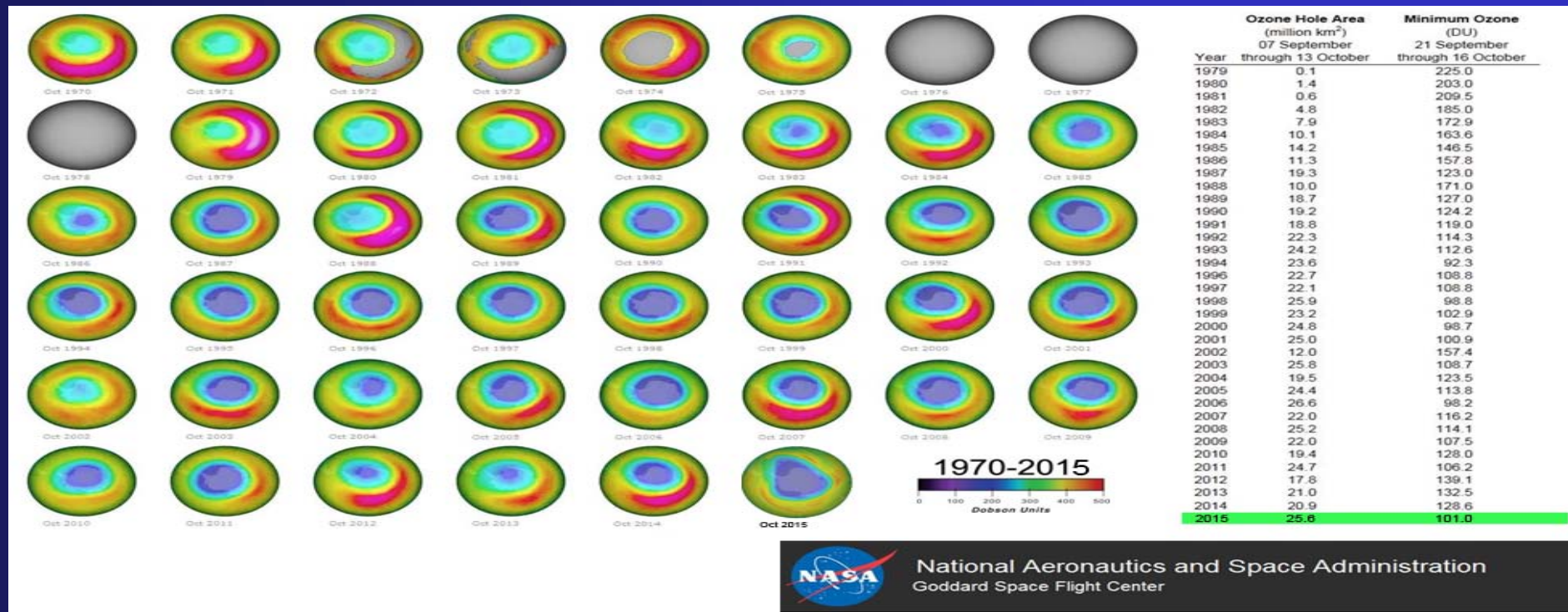


The Ozone Hole

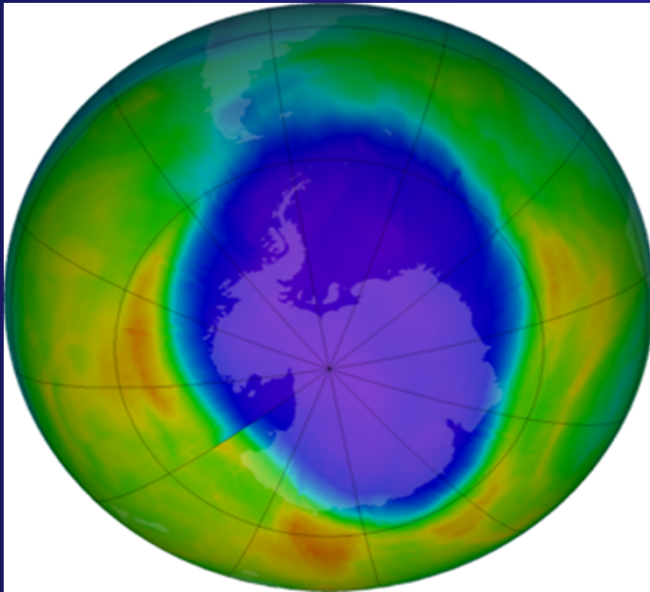
- **In 1970s, scientists began to warn the society that ozone-depleting CFC emissions were damaging the ozone layer over Antarctica. Between 1970s and the 1990s, the Antarctic ozone concentration diminished by up to 70%. This large-scale phenomenon is often called the ozone hole. In 2006, the Antarctic ozone hole reached a record 29 million km².**



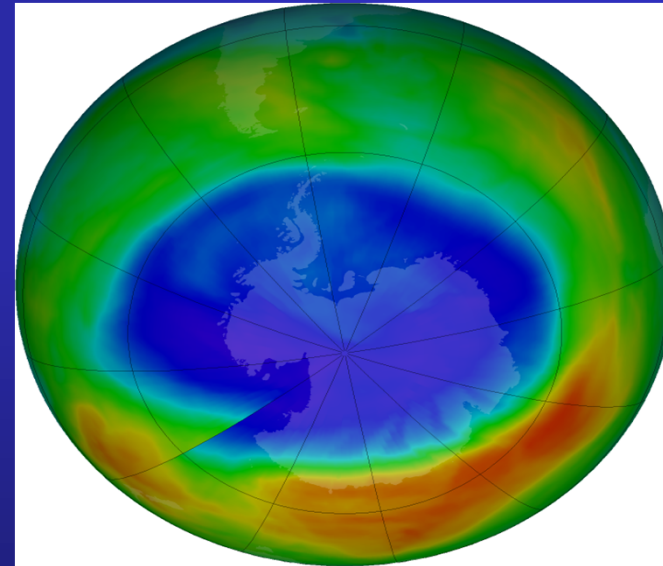
Historical trend in the size of the ozone hole (1970-2015)



Historical trend in the size of the ozone hole 2016-2017

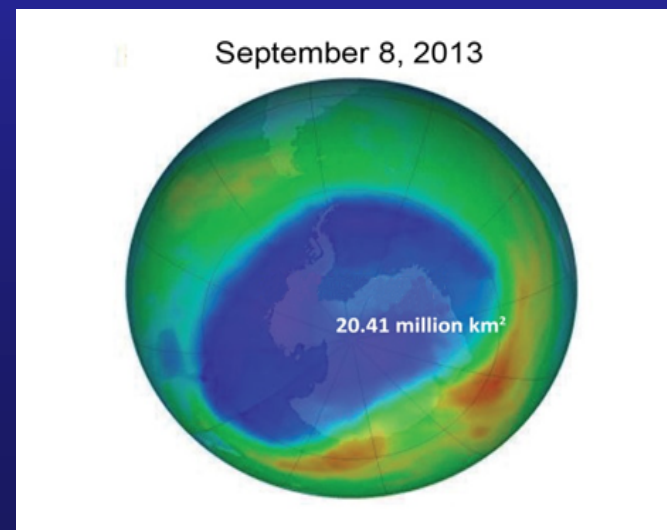
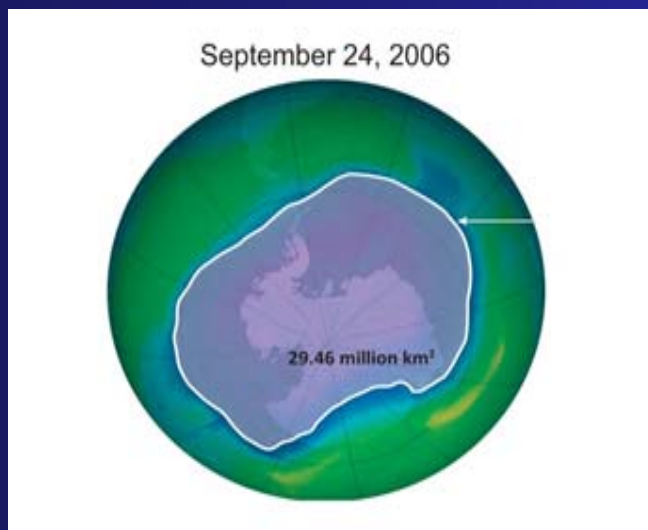
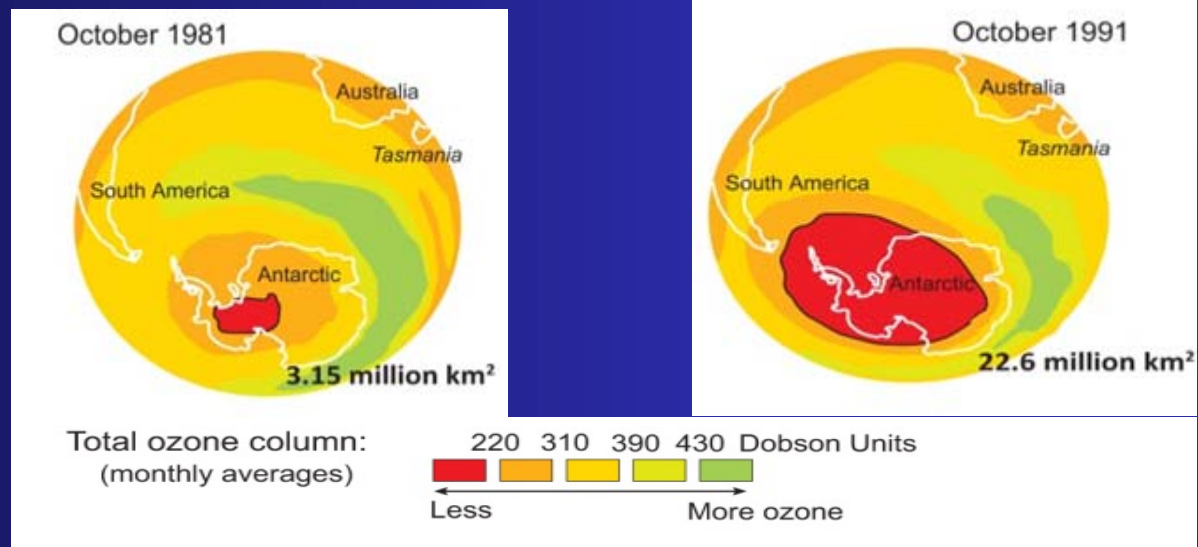


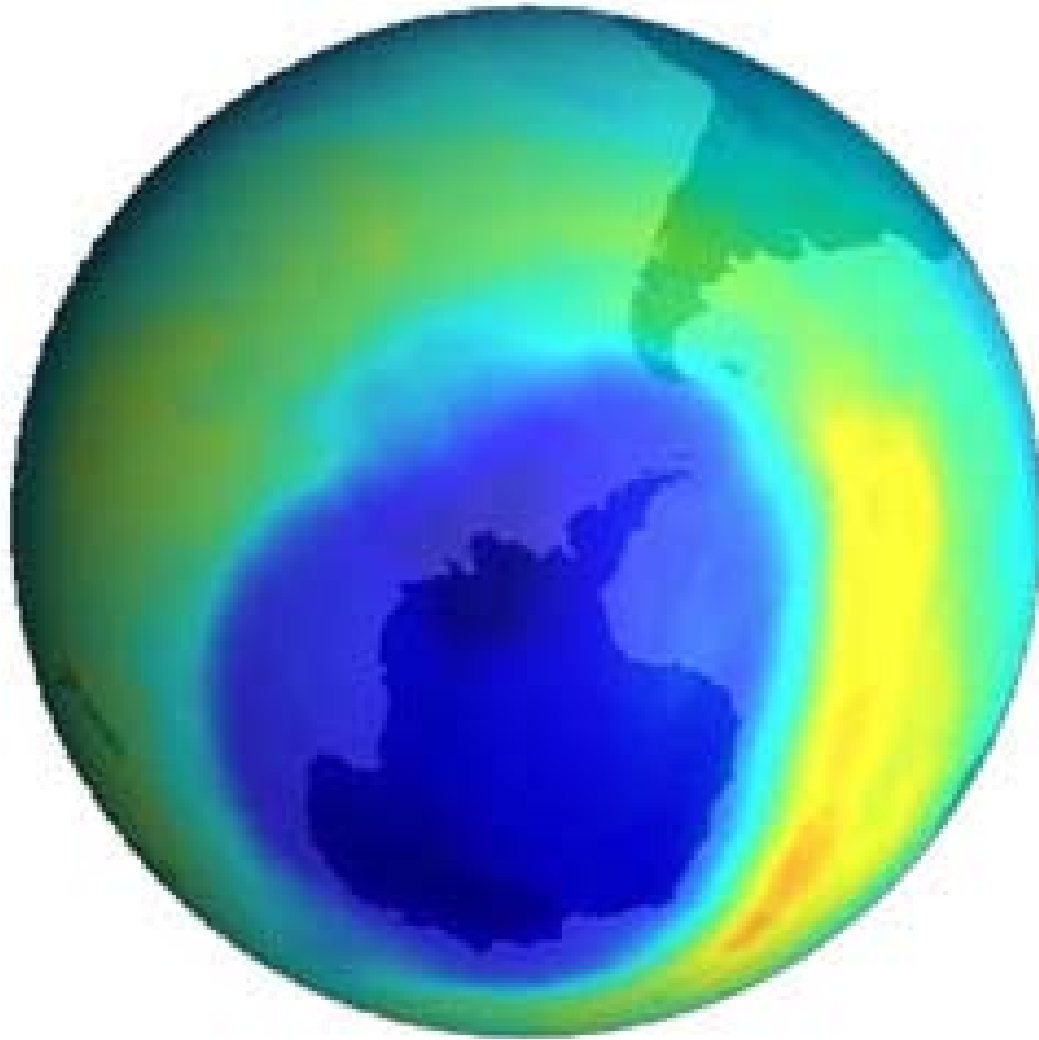
This year, the ozone layer reached a minimum concentration of 114 Dobson Units on Oct. 1, 2016



This year, the ozone concentration reached a minimum over the South Pole of 136 Dobson Units on September 25, 2017— the highest minimum seen since 1988.

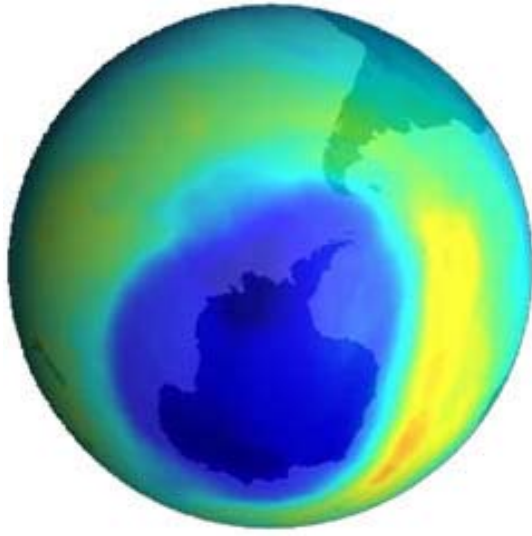
THE ANTARCTIC HOLE





**The largest
ozone hole is
the size of
North America**

Although the ozone hole is found in the Antarctica, the global ozone level throughout the stratosphere has also decreased by 3% every decade.



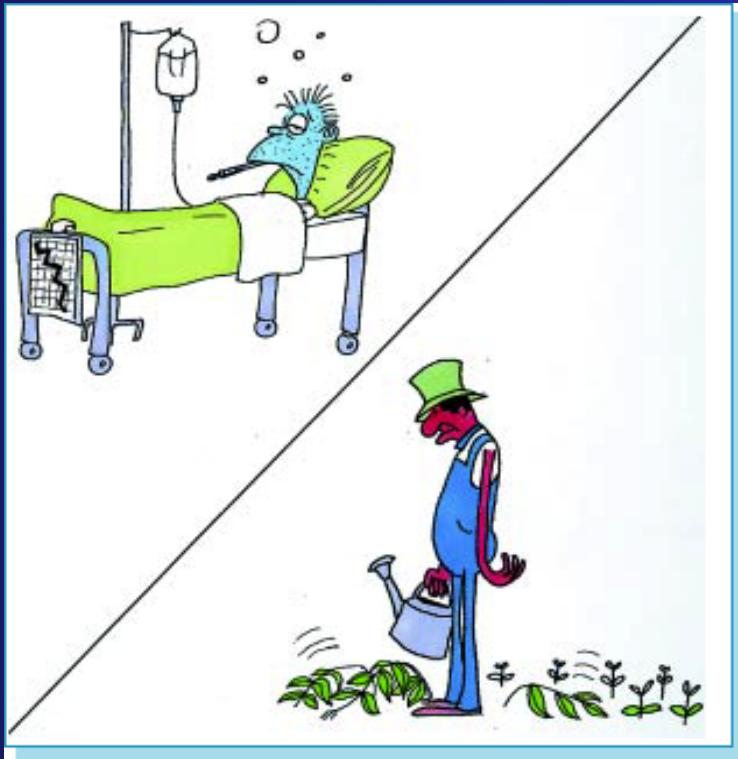
**The largest ozone hole
is found in Antarctica
because:**

- ODS are present throughout the atmosphere regardless of where they are released**
- The symmetry of the land of Antarctica affects the very cold climate**
- The temperature leads to chemical changes that promote the production of chemically active chlorine and bromine from ODS**

WHAT ARE THE
EFFECTS OF
OZONE
DEPLETION?

Ozone depletion allows the entry of UV-B radiation

Effects of increased UV-B radiation



- More skin cancers
- More eye cataracts
- Weakened immune systems
- Reduced plant yields
- Damage to ocean ecosystems and reduced fishing yields
- More damage to plastics and other building materials

WHAT
CAUSES
OZONE
DEPLETION?

Ozone Depletion

- Certain chemicals upset the ozone balance, called **ozone depleting substances**
- **Ozone-depleting substances (ODS)** are chemical substances that have the potential to react with ozone molecules in the stratosphere.
- The ability to deplete the ozone layer is referred to as the **ozone depleting potential (ODP)**

Ozone Depleting Substances

- ODS are chemical substances that have the potential to react with ozone molecules in the stratosphere
- CFCs are being used in many applications:
 - Refrigeration and air-conditioning
 - Foam blowing
 - Solvents
 - Aerosol sprays
- Ozone Depleting Potential (ODP) is the ability of ODS to deplete the ozone layer
- Each substance is assigned an ODP relative to CFC-11 whose ODP is defined as 1
- ODP values of selected ODS

– CFC-11	1.0	
– CFC-12	1.0	
– Halon-1301		10.0
– CTC	1.1	
– Methyl chloroform	0.1	
– HCFC-22	0.055	
– HBFC-22B1		0.12
– Methyl bromide	0.6	

HOW CAN
THE OZONE
LAYER BE
SAVED?

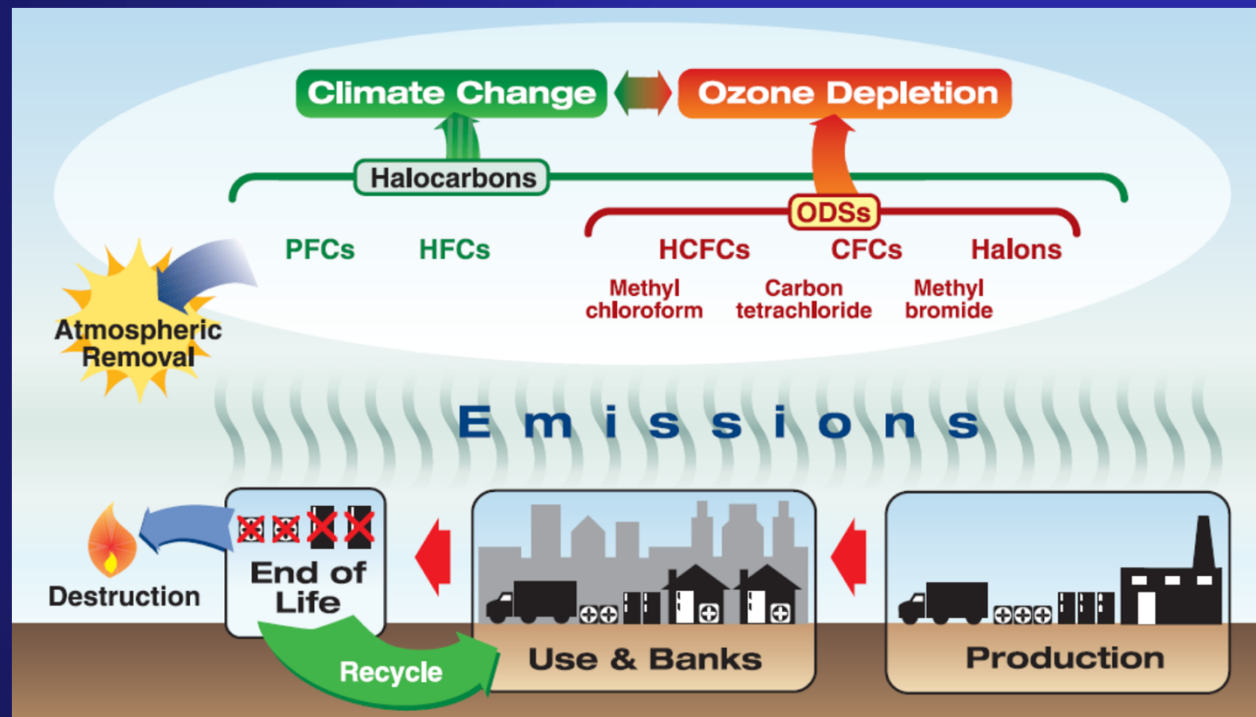
**The ozone layer can be saved
only by phasing out the use of
ozone depleting substances**



OZONE DEPLETION AND CLIMATE CHANGE

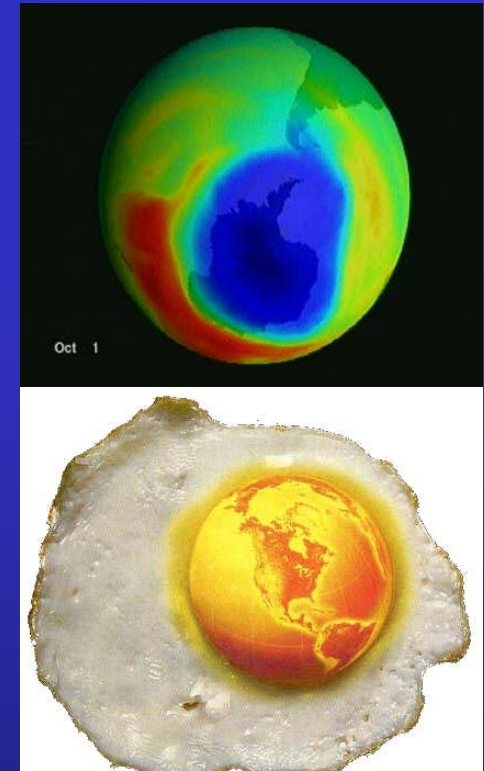
Linkage between ozone depletion and global warming

- Most ODS are greenhouse gases (GHGs)
- ODS contribute to climate change when released



- Ozone depletion and climate change are often misconceived as one and the same, but the heat generated from the two phenomena are different.

- What is common between them are their causes: most ODS are also greenhouse gases.



OZONE DEPLETION

- allows entry of UV-B which harms the earth.

CLIMATE CHANGE

- significant changes in the earth's climate affecting nature's balance.

- Climate change can either be global warming or global cooling.

- Global warming refers to an increase in the Earth's temperature causing changes in climate.

- The main cause of this phenomenon are **GREENHOUSE GASES (GHGs)** in the atmosphere trap energy from the sun.

- Human activities have increased the emissions of GHGs over the years.

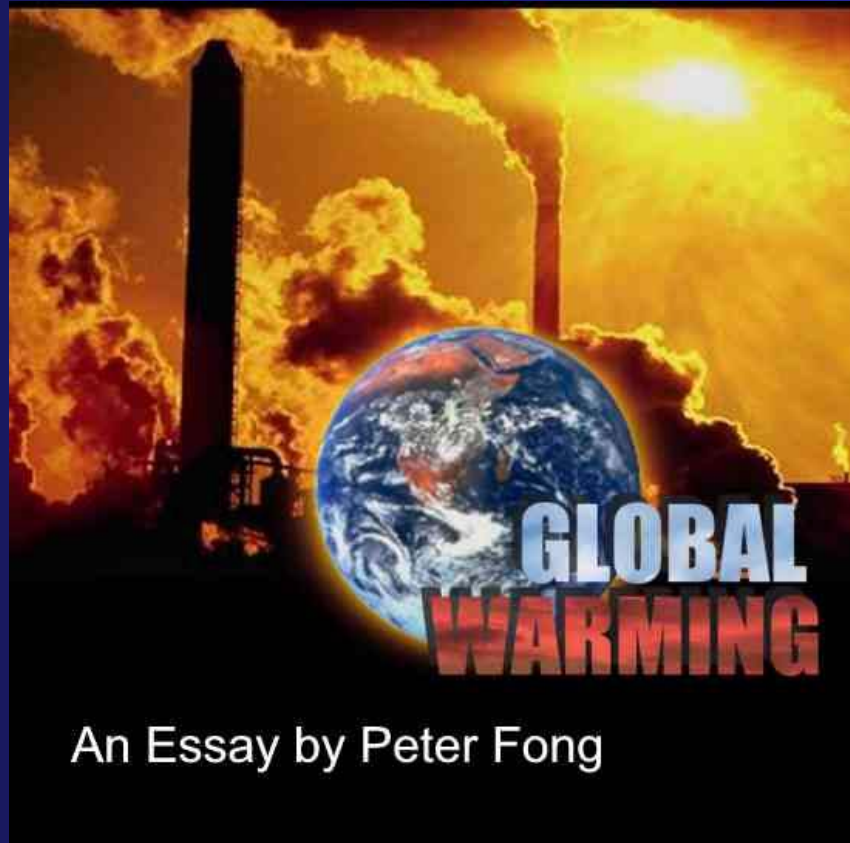


Some ODSs and their GWP

CFC	ODP*	GWP**
CFC-11	1.0	4,680
CFC-12	1.0	10,600
CFC-113	0.8	6,000
CFC-114	1.0	9,800
CFC-115	0.6	7,200
HCFC	ODP*	GWP**
HCFC-22	0.055	1,700
HCFC-123	0.02	120
HCFC-141b	0.11	700
HCFC-142b	0.065	2,400

* Ozone Depleting Potential (ODP) values from the 2006 Montreal Protocol Handbook

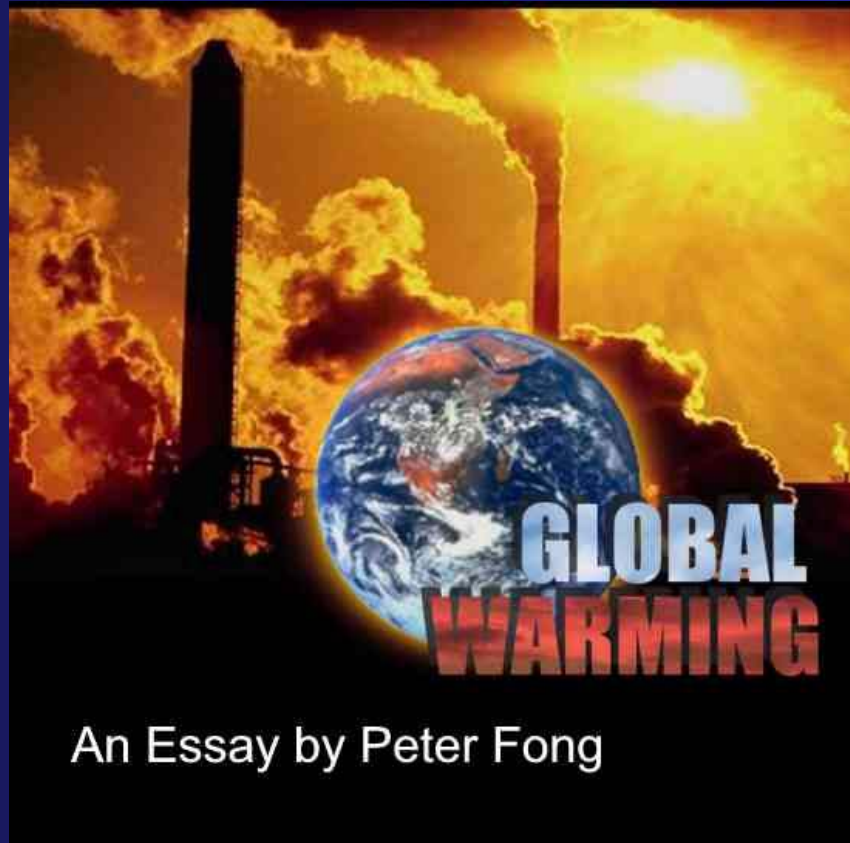
** Global Warming Potential (GWP) values from IPCC Third Assessment Report: Climate Change 2001



NATURALLY OCCURRING GREENHOUSE GASES

- *water vapor*
- *carbon dioxide**
- *Methane**
- *nitrous oxide**
- *ozone*

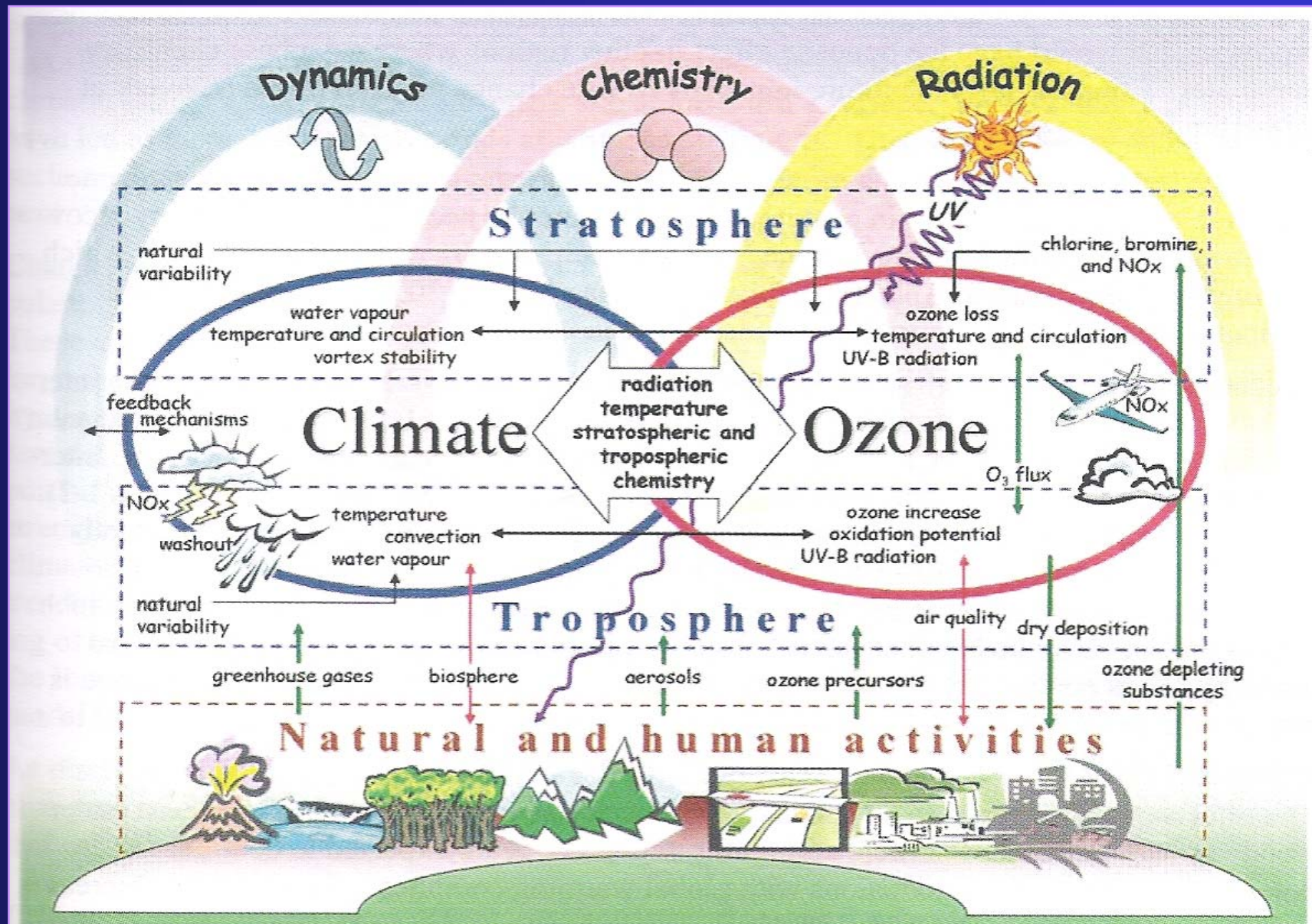
**Certain human activities
add to the levels of these*



MAN-MADE GREENHOUSE GASES

- *halogenated fluorocarbons (HCFCs, CFCs)*
- *perfluorinated carbons (PFCs)*
- *hydrofluorocarbons (HFCs)*
- *sulfur hexafluoride (SF₆)*

Ozone Layer-Climate Interaction Diagram



Wrap-Up

- **OZONE and the OZONE LAYER**
- **Creation and destruction of OZONE**
- **The OZONE HOLE**
- **The effects of ozone depletion**
- **The causes of ozone depletion**
- **Ways to help save the ozone layer**
- **The similarity and difference between climate change and ozone depletion**



Thank you!



For more information:

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