Medical Ecology
Spring 2004
Basic Sciences:

- Geology
- Ecology
- Oceanography
- Hydrology
- Biochemistry and Molecular Biology
- Physics
- Atmospheric Sciences
- Chemistry
- Remote Sensing

Click on any Basic Science to obtain useful links
Applied Sciences:

Biostatistics  Medical Sciences

Epidemiology  Anthropology

Environmental Health Sciences  Agronomy

Socio-Medical Sciences  Toxicology

Medical Geography

Click on any Applied Science to obtain useful links
The Atmosphere
Water
Food
Infectious Diseases
Atmosphere
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<th>Epoch</th>
<th>M. Years</th>
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Atmosphere = 20% oxygen
Evolution of Terrestrial Ecosystems Begins
Mitochondrion Chloroplast

Each has a genome

The Gaia Hypothesis

Lynn Margoulis

James Lovelock

<table>
<thead>
<tr>
<th>VENUS</th>
<th>EARTH</th>
<th>MARS</th>
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| N (<2%) CO2 (95%)  
No oxygen atmosphere in chemical equilibrium | N (77%), CO2 (0.03%)  
21% Oxygen atmosphere not in chemical equilibrium | N (<3%) CO2 (95%)  
No oxygen atmosphere in chemical equilibrium |
Thermostat

Temperature Setting Level

Mounting Hole

Contacts

Adjustable Heat Anticipator

Off Switch (Optional)
One Example Of How Gaia Hypothesis Works:

Cloud Formation

Postulated Feedback Mechanism of Cloud Formation

LWP = Liquid Water Path

CNN = Cloud Condensation Nuclei

NSS = Non-sea-salt Sulfate

DMS = Dimethyl Sulfide
The Children's Ecology Project

The Secret Life of a Cloud:
Puffy's Story

By Dickson Despommier

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Fax: 212-781-1830

E-mail: ddd1@columbia.edu
Coccolithic Phytoplankton
Emiliania huxleyi Home Page

http://www.soes.soton.ac.uk/staff/tt/
UV Protection by the Ozone Layer
Measuring Ozone in the Atmosphere

Satellites

High-altitude aircraft

Large aircraft

Laser beams

Balloon sondes

Ground-based systems
Stratospheric Ozone Production

Step 1

\[ \text{O}_2 + \text{Ultraviolet Sunlight} \rightarrow \text{O} + \text{O} \]

Step 2

\[ \text{O} + \text{O}_3 \rightarrow \text{O}_3 \]

\[ \text{O} + \text{O} + \text{O}_3 \rightarrow \text{O}_3 \]

Overall reaction: \(3\text{O}_2 \xrightarrow{\text{sunlight}} 2\text{O}_3\)
Ozone Destruction Cycle 1

Oxygen molecule ($O_2$)  Chlorine atom (Cl)  Ozone ($O_3$)

Oxygen atom (O)  Chlorine monoxide (ClO)

$ClO + O \rightarrow Cl + O_2$
$Cl + O_3 \rightarrow ClO + O_2$

Net: $O + O_3 \rightarrow 2O_2$
The Nobel Prize in Chemistry 1995

"for their work in atmospheric chemistry, particularly concerning the formation and decomposition of ozone"

Paul J. Crutzen  Mario J. Molina  F. Sherwood Rowland
Electromagnetic Spectrum of Energy

- **Radio waves**
- **Infrared rays**
- **Ultraviolet rays**
- **Visible rays**
- **X-rays**
- **Gamma rays**

**Micrometers (\(\lambda\))**

- \(10^4\) to \(10^{-6}\)

**Frequency/sec. (\(v\))**

- \(10^{10}\) to \(10^{20}\)
CRS Issue Brief for Congress

IB97003: Stratospheric Ozone Depletion: Implementation Issues

Larry Parker
Resources, Science, and Industry Division

July 12, 2000

http://www.NCSEonline.org/NLE/CRSreports/Stratospheric/strat-5.cfm?&CFID=12207930&CFTOKEN=7083239
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<th>GWP**</th>
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Montreal Protocol

The Montreal Protocol on Substances that Deplete the Ozone Layer was adopted in 1987 as an international treaty to eliminate the production and consumption of ozone-depleting chemicals, with developing countries benefiting from a ten-year grace period.
Periodic Table Of The Elements
Principal Steps in the Depletion of Stratospheric Ozone

1. **Emissions**

   *Halogen source gases* are emitted at Earth's surface by human activities and natural processes.
2 **Accumulation**

*Halogen source gases* accumulate in the atmosphere and are distributed throughout the lower atmosphere by winds and other air motions.
Transport

*Halogen source gases* are transported to the stratosphere by air motions.
Conversion

Most halogen source gases are converted in the stratosphere to reactive halogen gases in chemical reactions involving ultraviolet radiation from the Sun.
Chemical reaction

Reactive halogen gases cause chemical depletion of stratospheric total ozone over the globe except at tropical latitudes.

Polar stratospheric clouds increase ozone depletion by reactive halogen gases, causing severe ozone loss in polar regions in winter and spring.
6 Removal
Air containing **reactive halogen gases** returns to the troposphere and these gases are removed from the air by moisture in clouds and rain.
Primary Sources of Chlorine and Bromine for the Stratosphere in 1999

Chlorine source gases

- Methyl chloroform \((\text{CH}_3\text{CCl}_3)\)
- HCFCs (e.g., HCFC-22 = \(\text{CHClF}_2\))
- CFC-113 \((\text{CCl}_2\text{FCCIF}_2)\)
- Carbon tetrachloride \((\text{CCl}_4)\)
- CFC-11 \((\text{CCl}_3\text{F})\)
- CFC-12 \((\text{CCl}_2\text{F}_2)\)
- Methyl chloride \((\text{CH}_3\text{Cl})\)

Total chlorine amount (parts per trillion)

- Human-made sources
- Natural sources

16% 32% 23% 12% 7% 5% 4% 1% Other gases
Methyl Bromide Alternatives Project
MAP to a Healthy Harvest

Methyl bromide alternatives projects
**Los Angeles, California**
Before the Clean Air Act was enacted.

**Clean Air Act**
of 1963

**Los Angeles, California**
Ten years after the Clean Air Act was enacted.
Global Atmospheric Circulation

- Polar easterlies
- Mid-latitude westerlies
- Northeast trade winds
- Southeast trade winds

Diagram showing the main atmospheric circulation patterns around the globe.
Antarctic Ozone Hole

4 October 2001

Total Ozone (Dobson units)

These maps show the mean 1978-1988 level estimated using Total Ozone Mapping Spectrometer (TOMS) data for all areas except the Antarctic and from the pre-1980 level estimated using Dobson data over the Antarctic.
Ozone Hole over Antarctica

http://www.sdsc.edu/tmf/Examples/Ozone/ozone.html
Ozone Hole Monitoring

Daily Estimates of Ozone Hole Area

Daily Minima in Southern Hemisphere


Reference archives

1. Envirolink Click on the Ozone folder. Note in particular the FAQ's by rparson(Robert Parson, Univ.of Colorado), they are by far the **best tutorials on Ozone depletion on the entire net**!

2. NOAA has written up several research summaries on [History and overview of Ozone shield](http://www.pbe.noaa.gov/zoonet/), [Stratospheric Ozone](http://www.pbe.noaa.gov/zoonet/) and [Tropospheric Ozone](http://www.pbe.noaa.gov/zoonet/); all written at a laymans level.

3. Earthwatch Radioscripts on Ozone: Earthwatch ph# is (608)263-3063, and I have found them to be quite helpful in giving further information and contacts used in their broadcasts.

4. NSF index this is the National Science Foundation's search index; type in 'ozone' and hit the enter key.

5. Galaxy directory service for EINET Contains a wide assortment of articles on different aspects of the depletion problem and the remedies for it; not necessarily the best place to start if you are just starting to learn about the problem. 7. [Ozone lesson-plans from the University of Kansas](http://www.ku.edu) Nice summaries of lesson plans which teach about the Ozone problem. You can download details of these lessons if you have Claris works.

9. [CIESIN (Consortium for International Earth Science Information Networks) homepage](http://www.ciesin.org) this file has a nice summary of many of the various protocols and international meetings that have been conducted in order to combat ozone depletion.