Atmospheric Structure
AOSC 200

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Class Web Site: http://www.atmos.umd.edu/~tcanty/aosc200

Topics for today:

- Variable Gases
- Temperature structure of the atmosphere

Lecture 06

Sep 12 2019

Atmospheric Composition
(What are you breathing?)

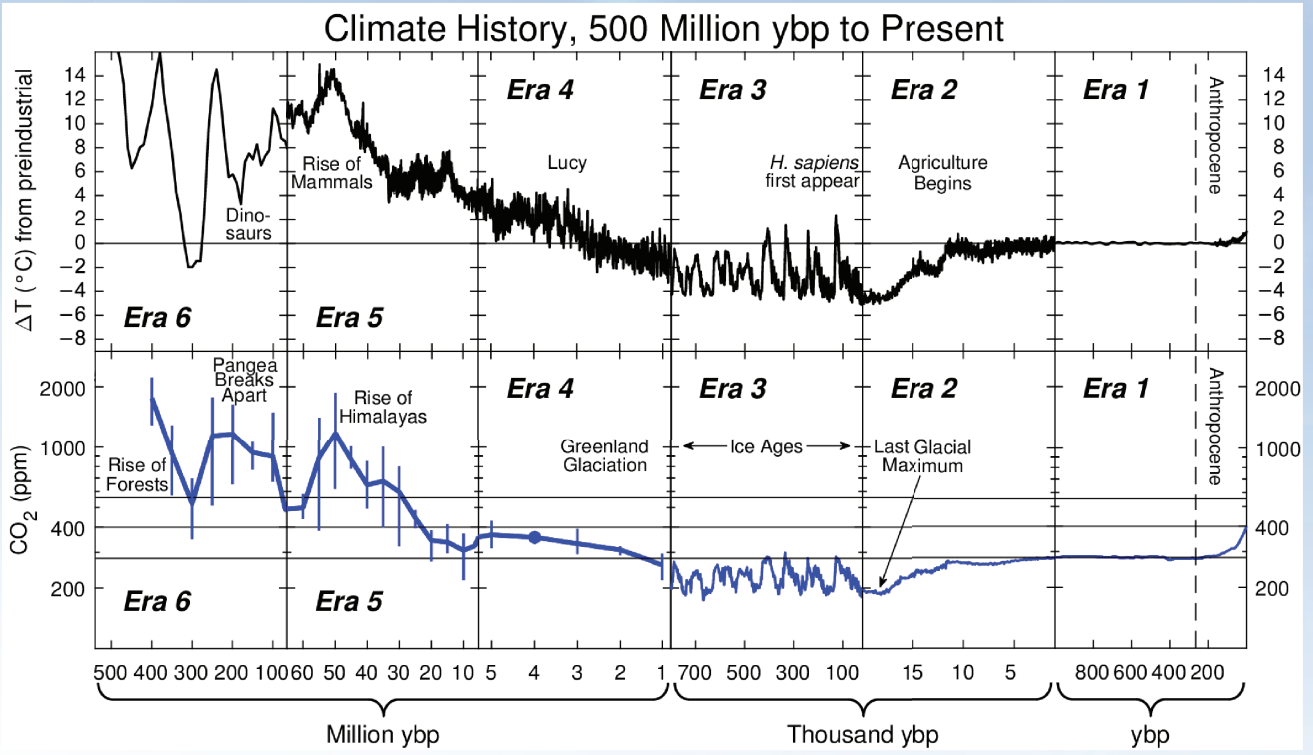
TABLE 1.1 Composition of the Atmosphere near the Earth's Surface

PERMANENT GASES			VARIABLE GASES			
Gas	Symbol	Percent (by Volume) Dry Air	Gas (and Particles)	Symbol	Percent (by Volume)	Parts per Million (ppm)
Nitrogen	N_2	78.08	Water vapor	H_2O	0 to 4	
Oxygen	O_2	20.95	Carbon dioxide	CO_2	0.040	400*
Argon	Ar	0.93	Methane	CH_4	0.00018	1.8
Neon	Ne	0.0018	Nitrous oxide	N_2O	0.00003	0.3
Helium	He	0.0005	Ozone	O_3	0.000004	0.04**
Hydrogen	H_2	0.00006	Particles (dust, soot, etc.)		0.000001	0.01–0.15
Xenon	Xe	0.000009	Chlorofluorocarbons (CFCs)		0.00000002	0.0002

*For CO_2, 400 parts per million means that out of every million air molecules, 400 are CO_2 molecules.

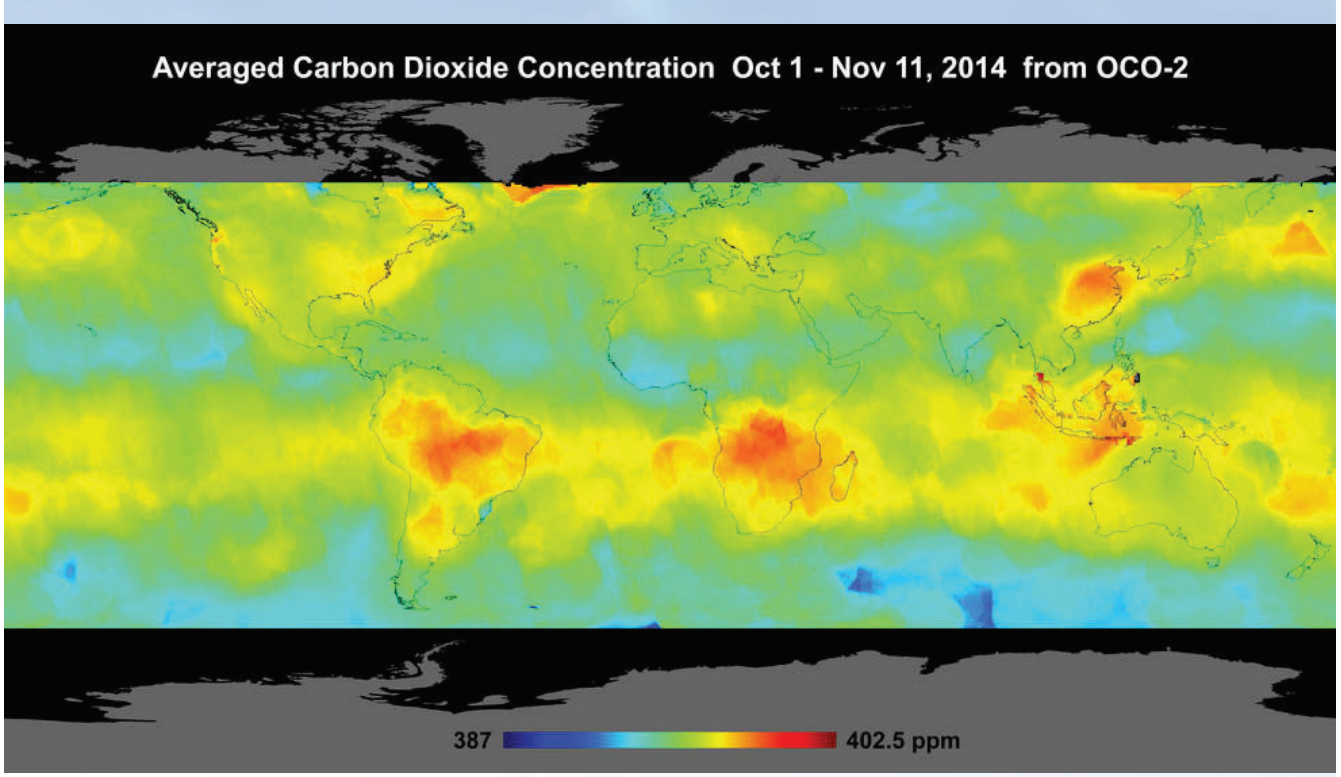
**Stratospheric values at altitudes between 11 km and 50 km are about 5 to 12 ppm.

Table 1.1: *Essentials of Meteorology*



http://parisbeaconofhope.org

NASA Orbiting Carbon Observatory (2)

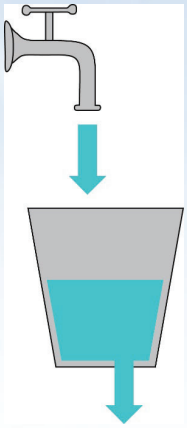


https://www.nasa.gov/jpl/oco2/nasas-spaceborne-carbon-counter-maps-new-details

"Steady State or Equilibruim"

If the sources and sinks are equal, the system is in equilibrium or steady state. Just like a bucket with a hole in it.

If the amount of water flowing into the bucket is the same as what's leaking out, the water level in the bucket doesn't change.

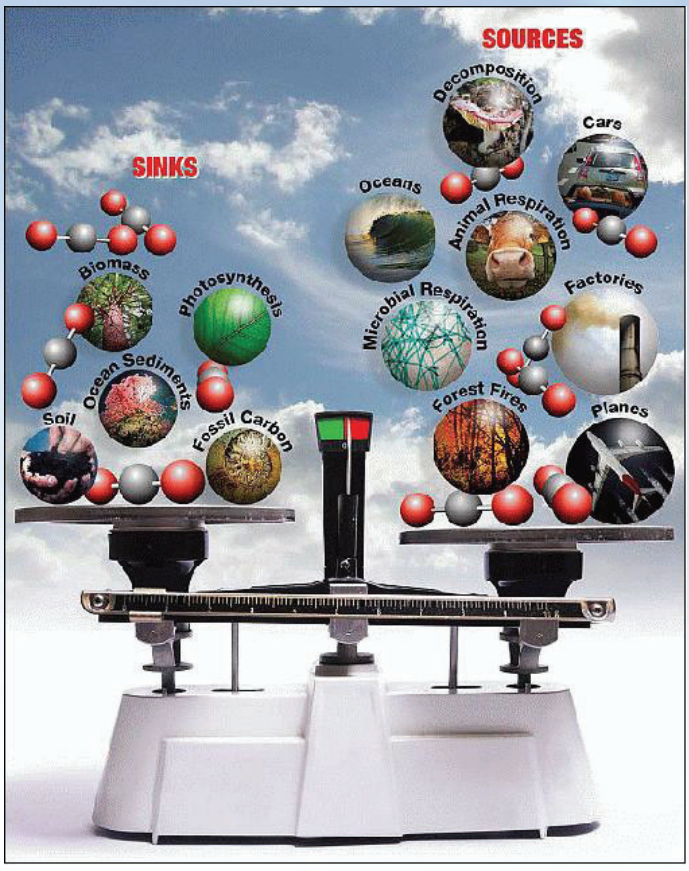


If someone closes the faucet, then the water level will start to fall.

If someone opens the faucet more then the water level will increase.

You can apply this analogy to the atmosphere and oceans

Carbon Dioxide (CO_2) Cycle



Currently, there are more sources than sinks.

As a consequence, CO_2 in the air is rising.

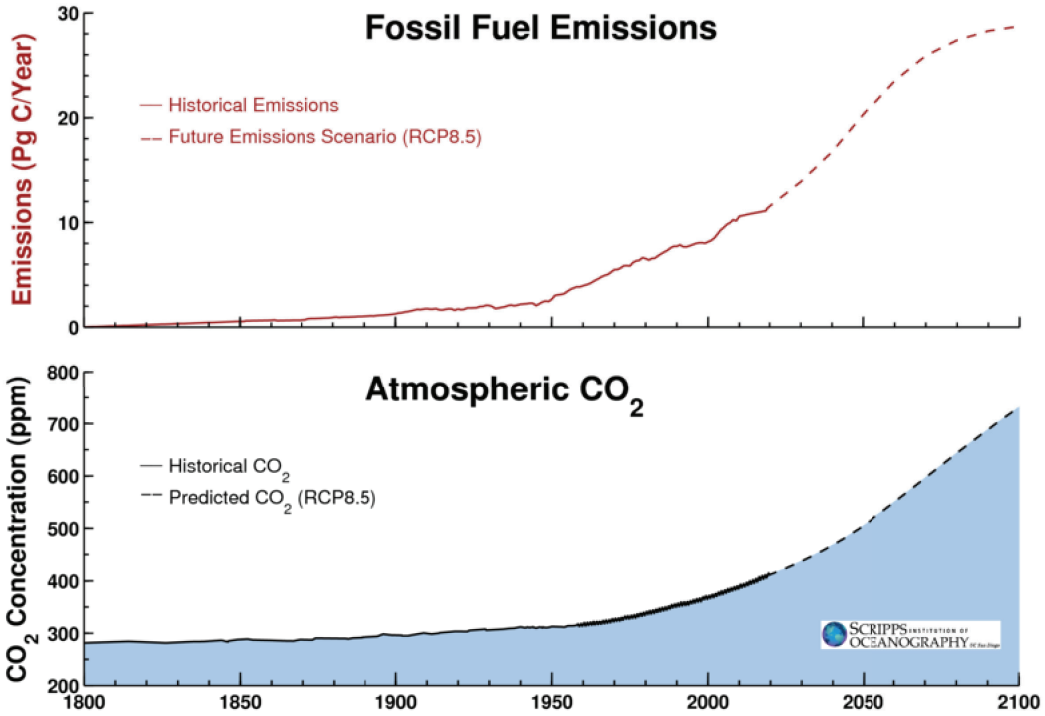
This rise is correlated with the rise in temperatures…

… but more on that in future lectures

Currently, few ways to reduce CO_2

https://directory.eoportal.org/web/eoportal/satellite-missions/o/oco-2

The Future of CO_2?



http://keelingcurve.ucsd.edu/

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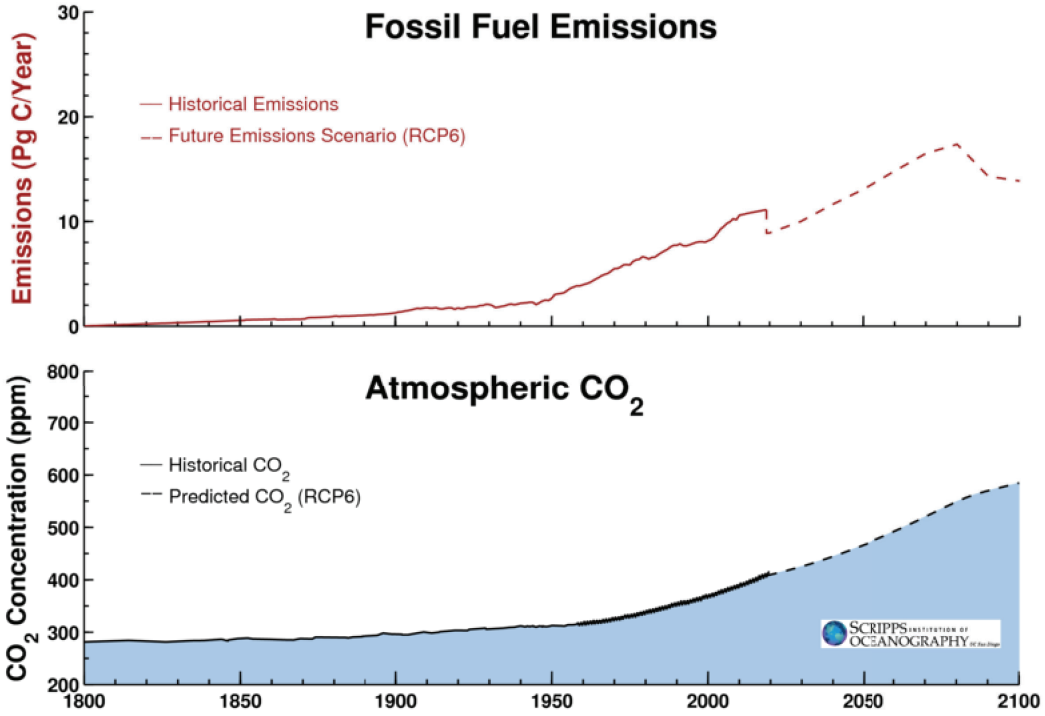

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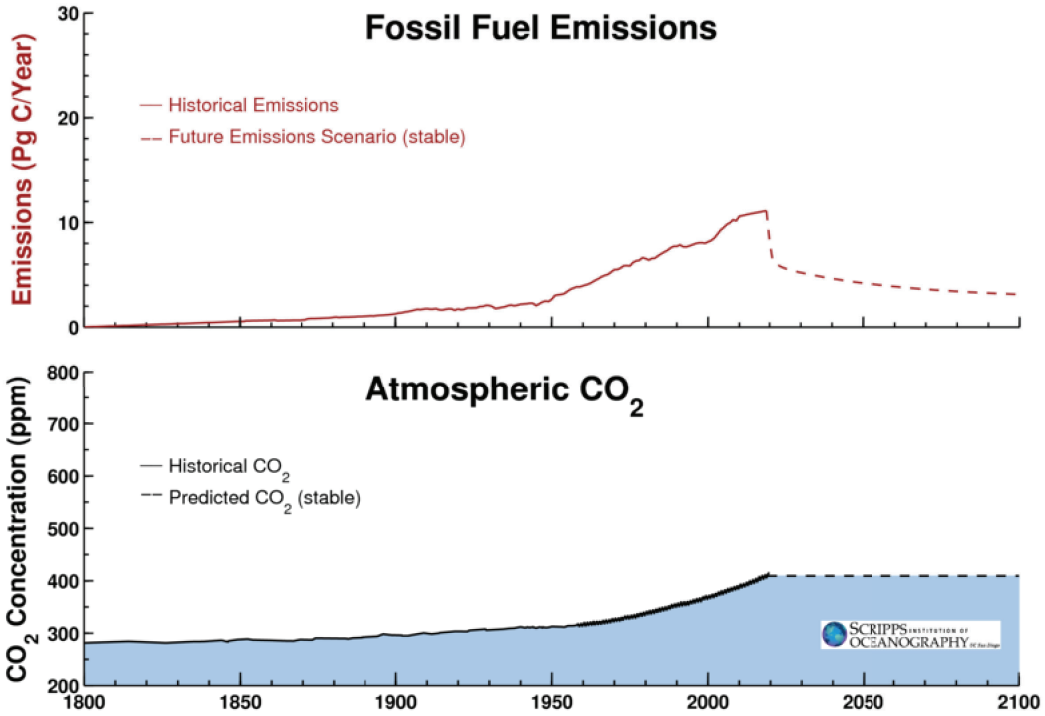

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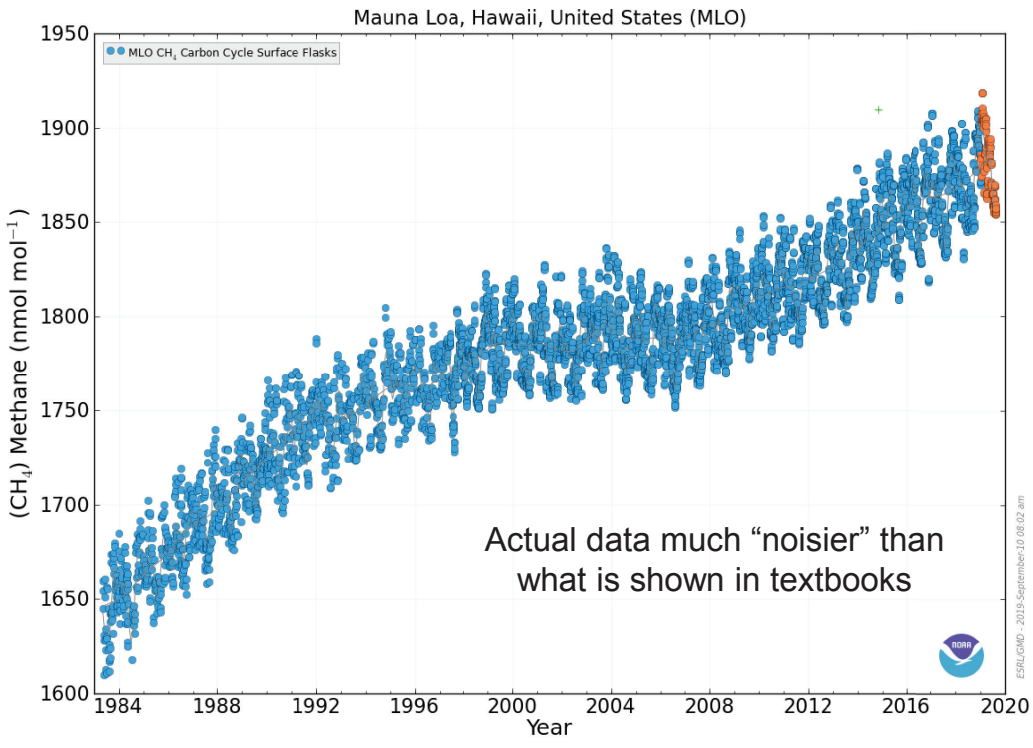
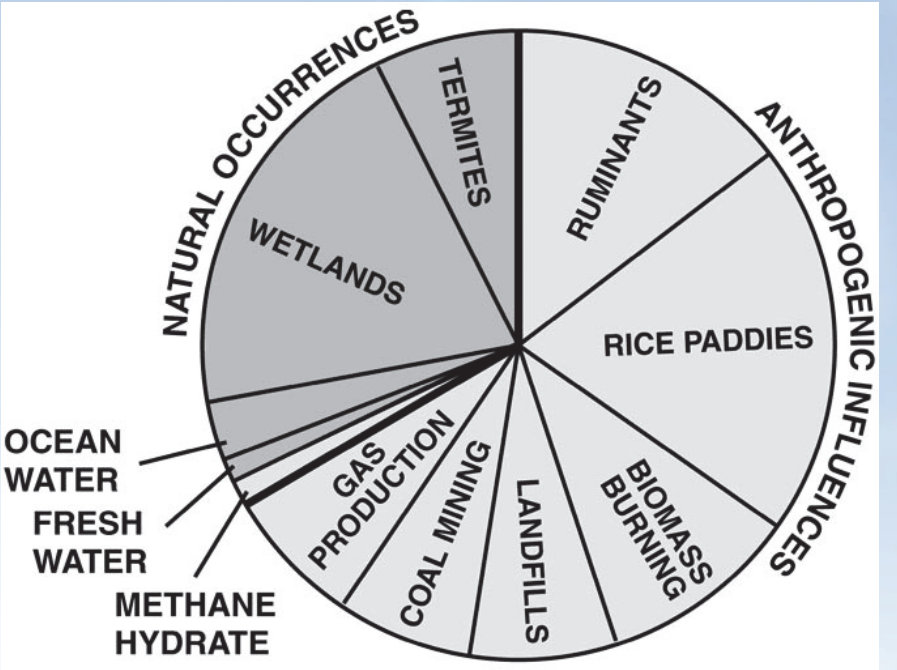
Methane (CH_4)



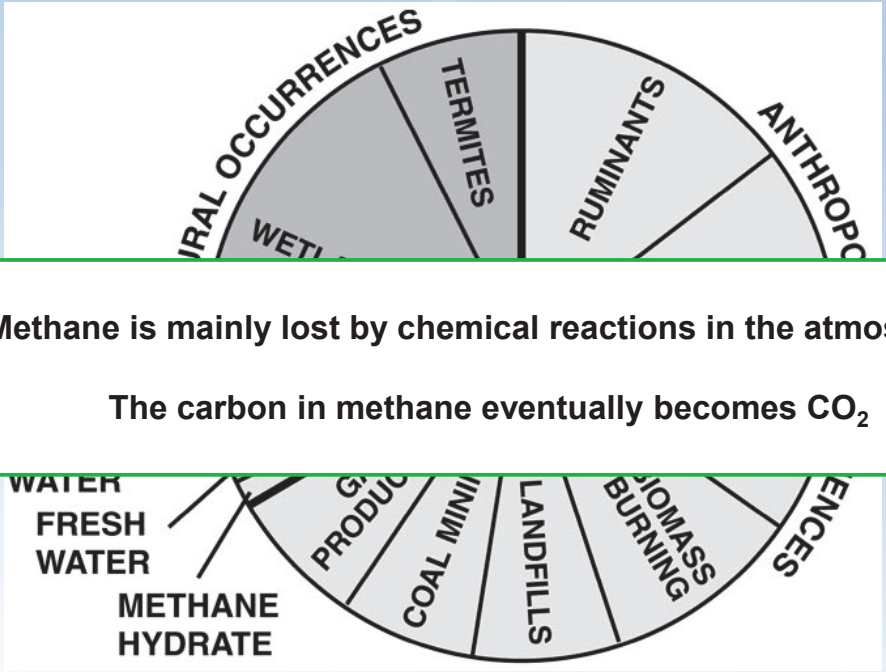
http://www.esrl.noaa.gov/gmd/dv/iadv/graph.php?code=MLO&program=ccgg&type=ts

Methane Sources and Sinks



http://www.giss.nasa.gov/research/features/200409_methane/

Methane Sources and Sinks

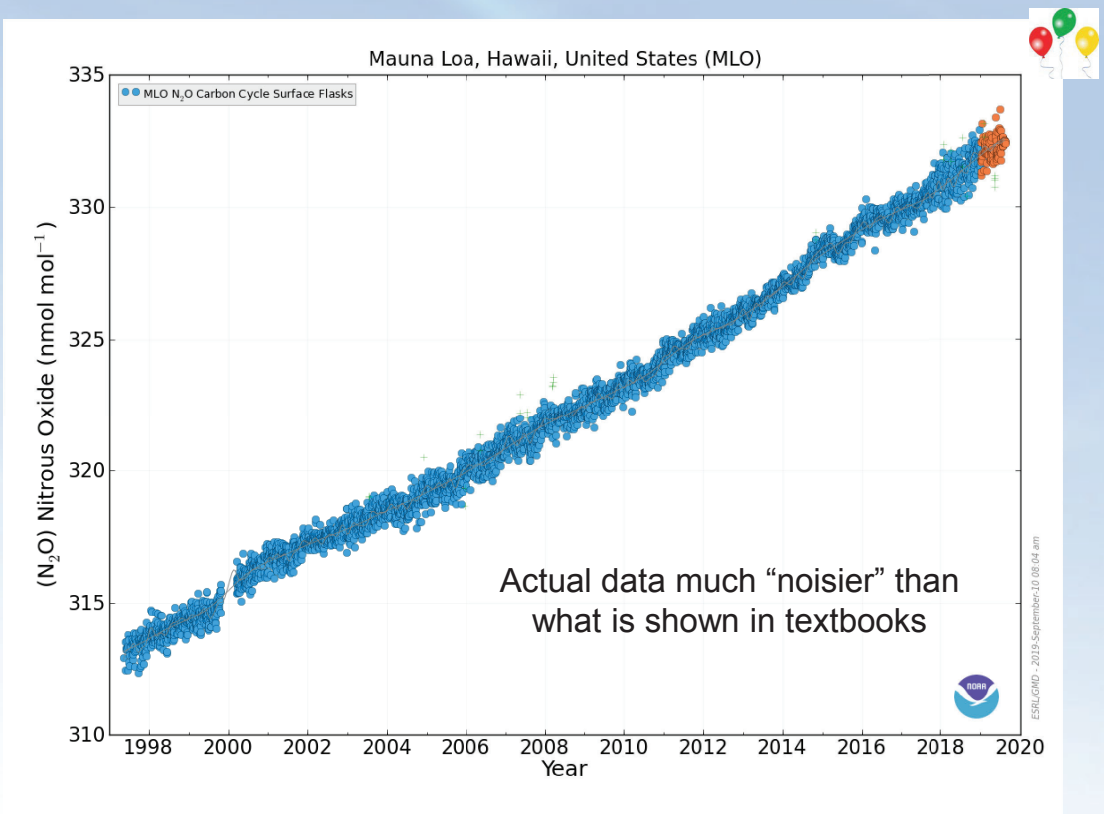


Methane is mainly lost by chemical reactions in the atmosphere

The carbon in methane eventually becomes CO_2

http://www.giss.nasa.gov/research/features/200409_methane/

Nitrous Oxide (N_2O)



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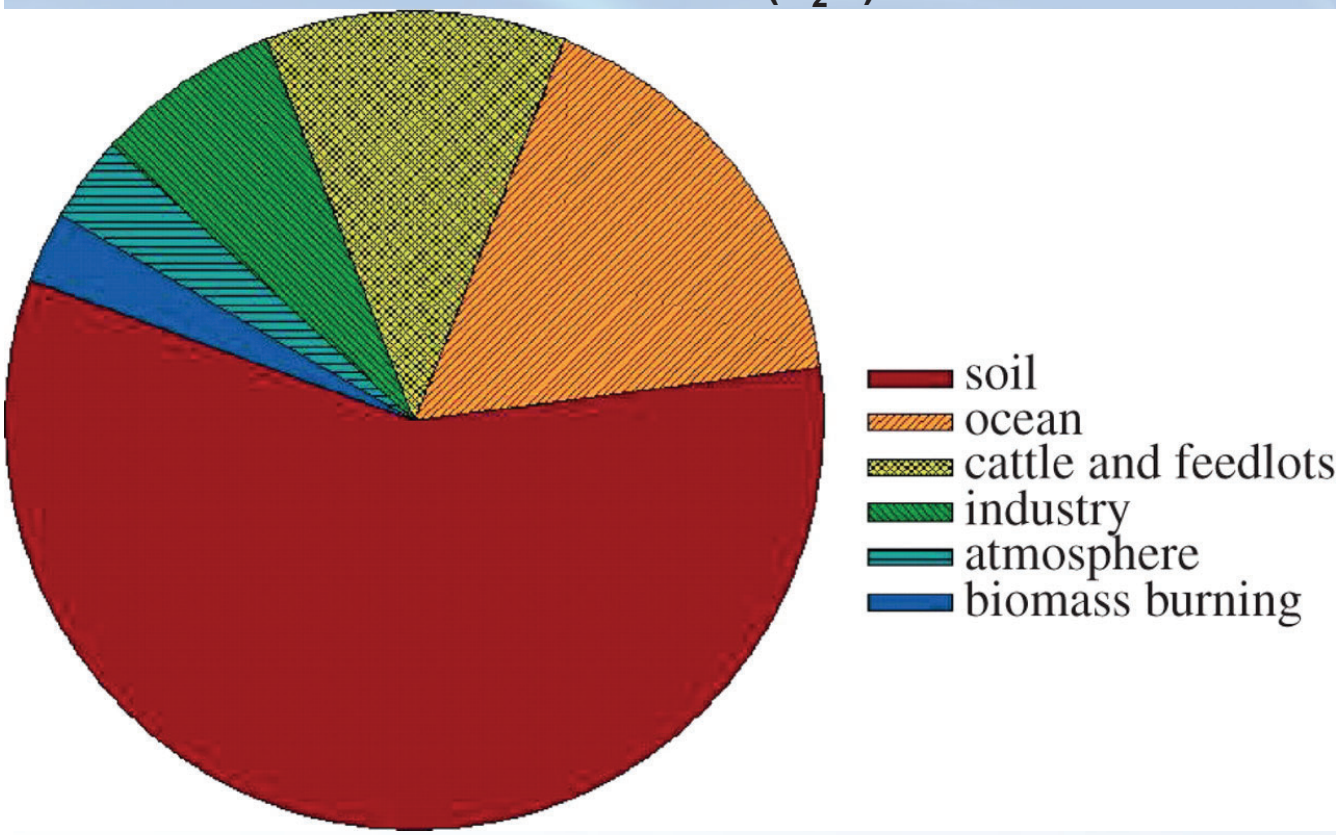

http://rstb.royalsocietypublishing.org/content/367/1593/1157

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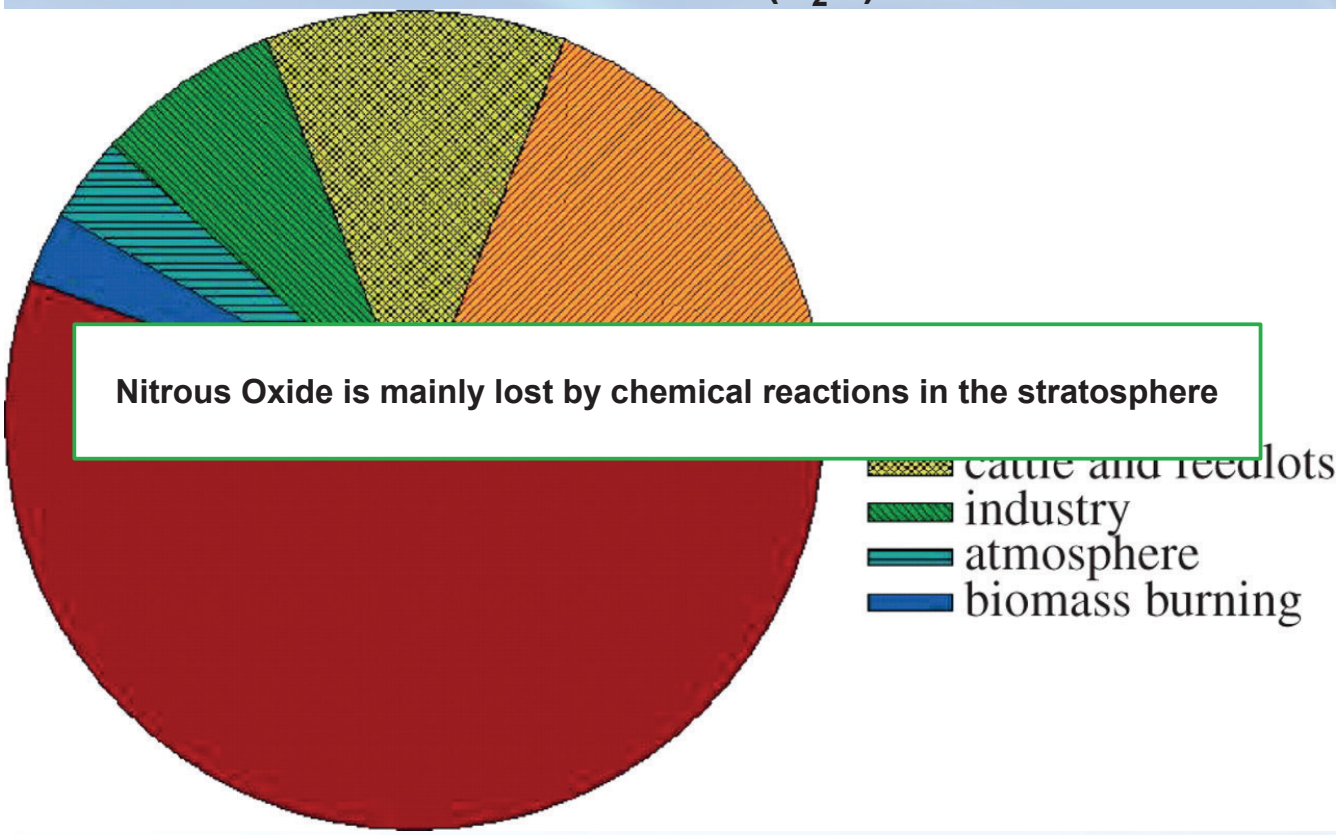


Nitrous Oxide is mainly lost by chemical reactions in the stratosphere

http://rstb.royalsocietypublishing.org/content/367/1593/1157

Aerosols (really tiny!!!!)

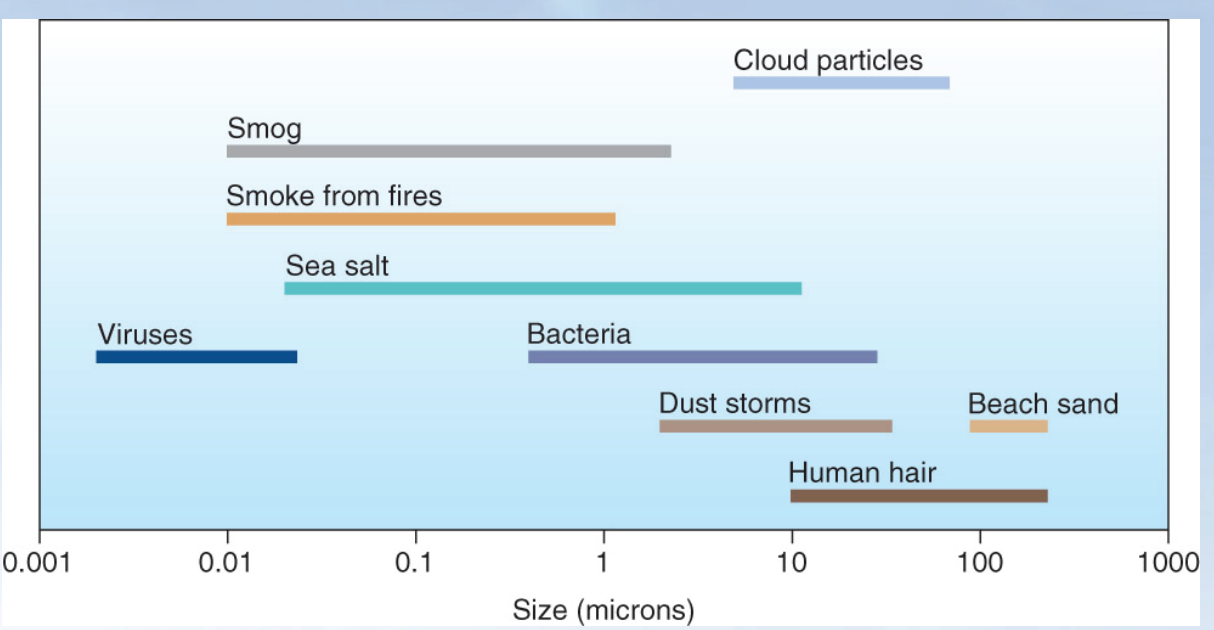


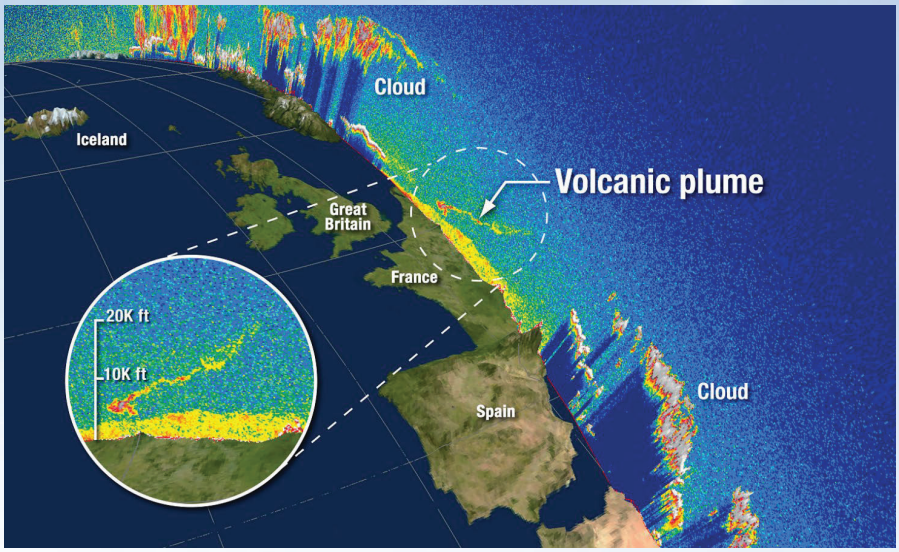
Fig 1-10 *Meteorology: Understanding the Atmosphere*

Aerosol Observations

Fig 1.6: ***Essentials of Meteorology***

Aerosol Observations – Satellite

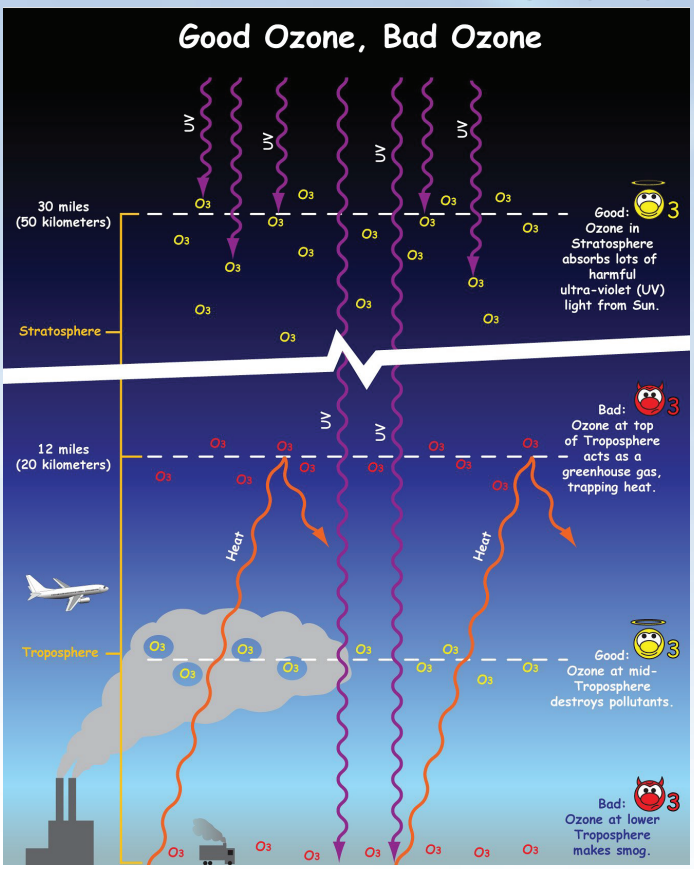
Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO)



April 17, 2010, CALIPSO captured this image of the Eyjafjallajökull ash cloud.

http://eosweb.larc.nasa.gov/PRODOCS/calipso/featured_imagery/iceland_volcano_ash_cloud.html

Ozone



Absorbs UV radiation

Smog!!!

http://www.aoas.org/article.php?story=20080522125225466

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*For CO_2, 400 parts per million means that out of every million air molecules, 400 are CO_2 molecules.

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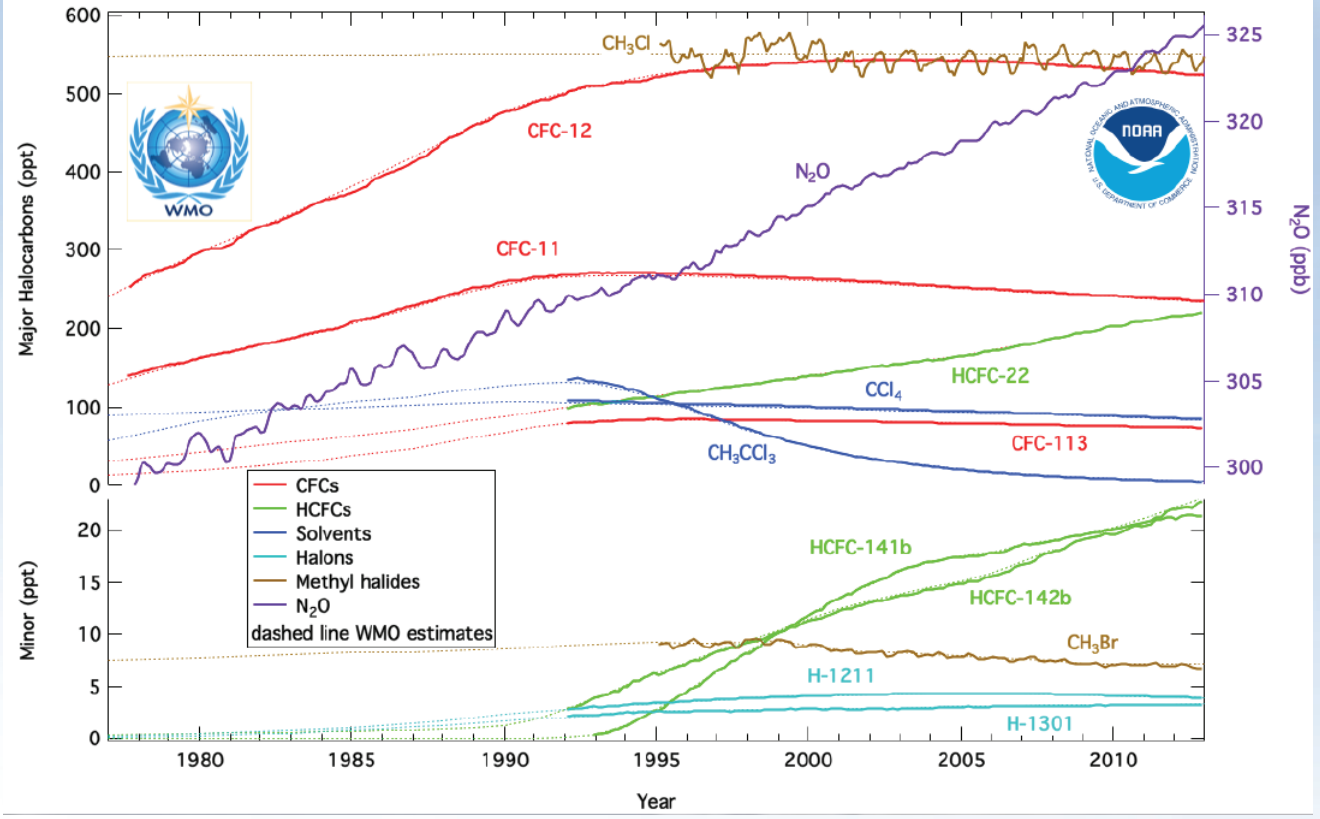
These gases control the chemistry of the atmosphere "variable gases" or "trace gases"

Table 1.1: ***Essentials of Meteorology***



https://www.esrl.noaa.gov/gmd/hats/about/cfc.html

Atmospheric temperature

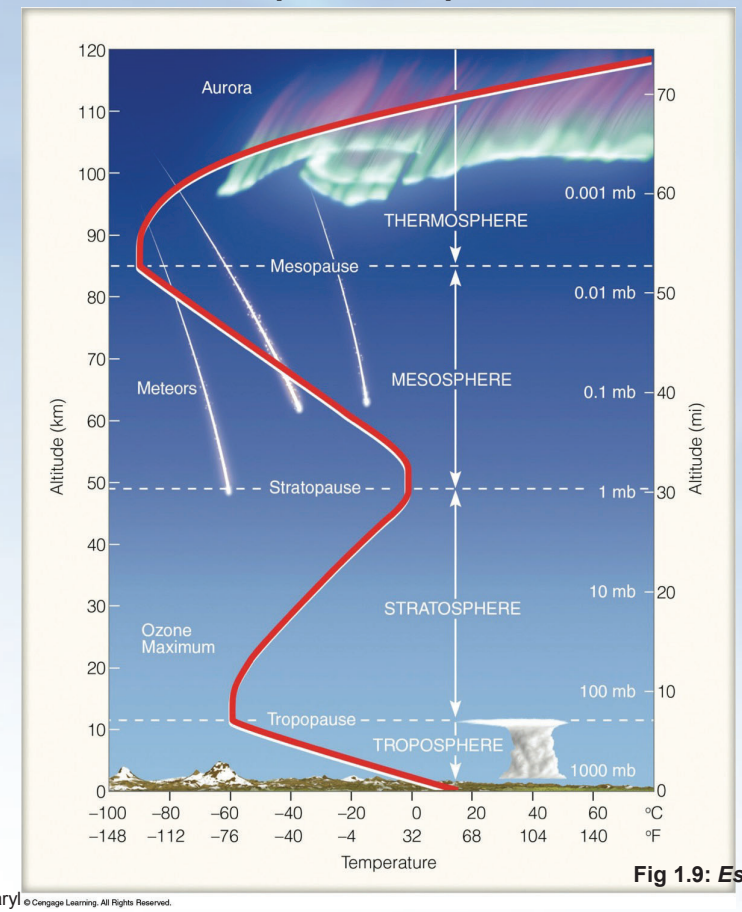
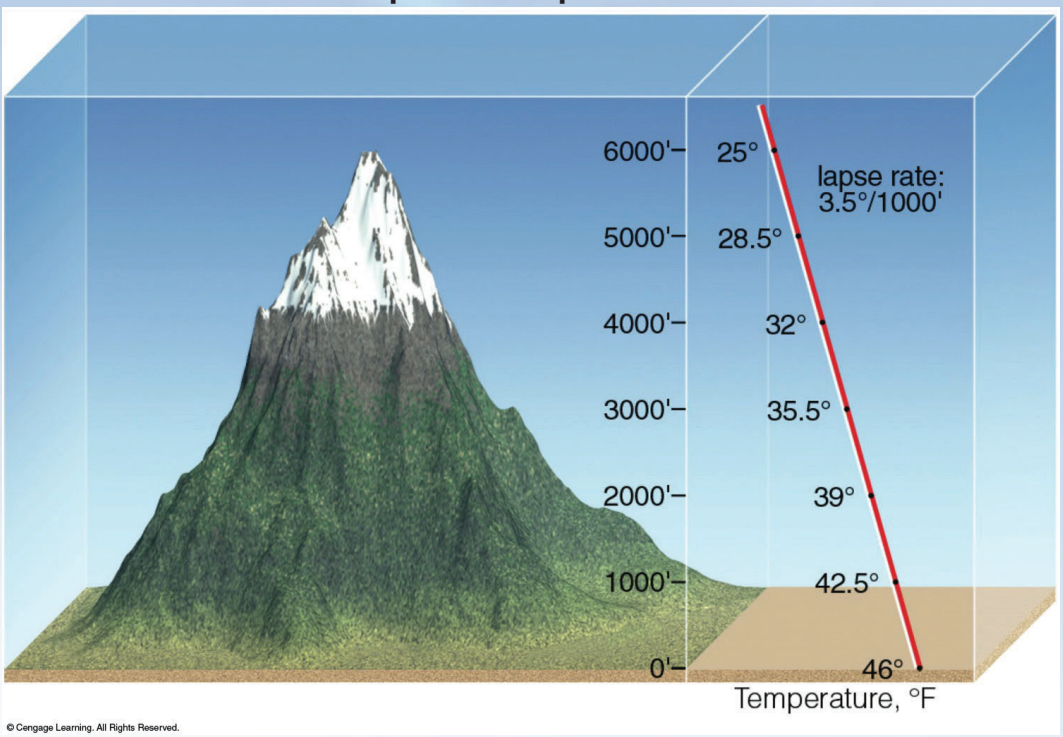


Fig 1.9: ***Essentials of Meteorology***

Atmospheric temperature



The rate that temperature decreases with height is called the Lapse Rate
(6.5°C per km –or– 3.5°F for every 1000 ft)

Fig 1.10: ***Essentials of Meteorology***

Energy Transfer

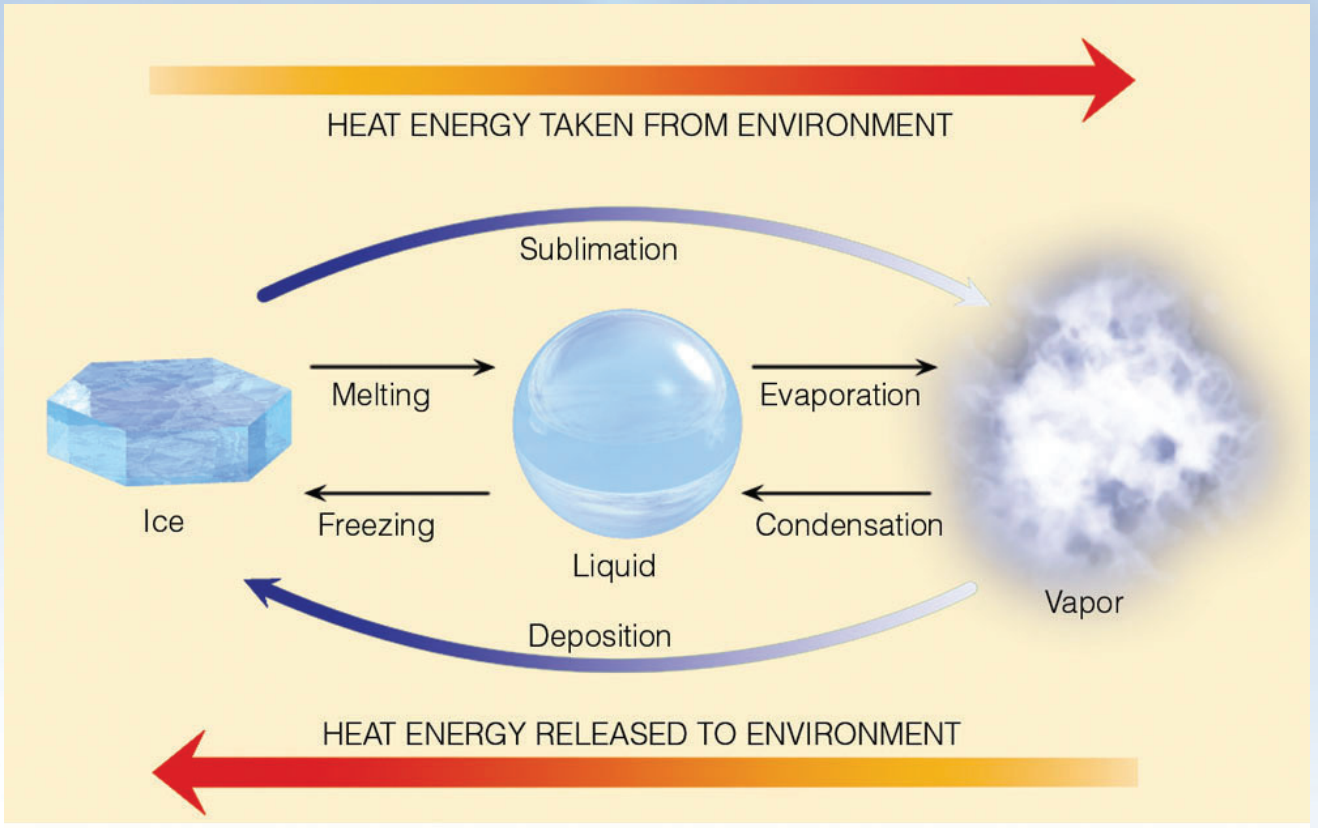


Fig 2.3: ***Essentials of Meteorology***