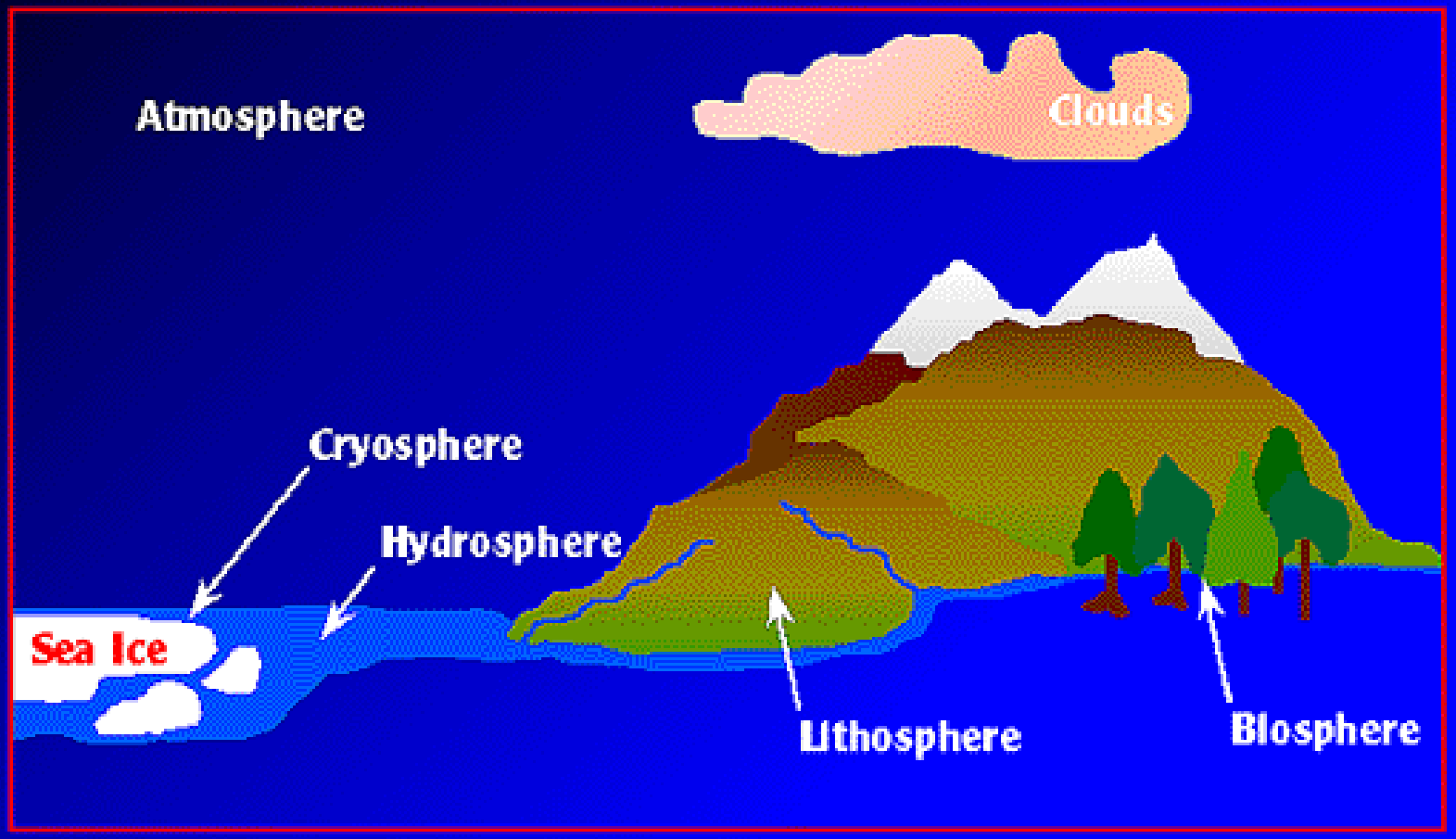
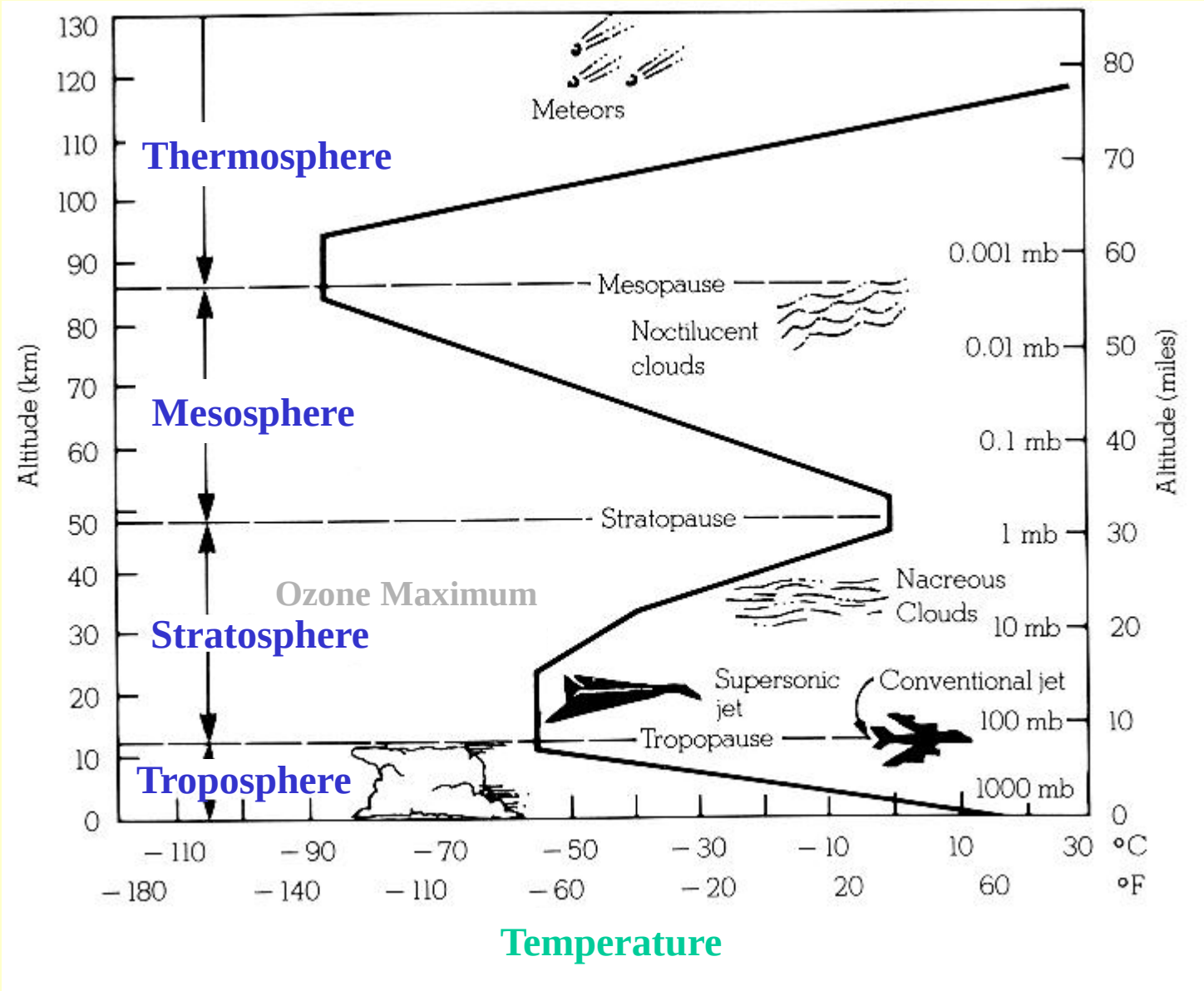
The Major Earth Systems



CG Figure-4

Structure of the Atmosphere



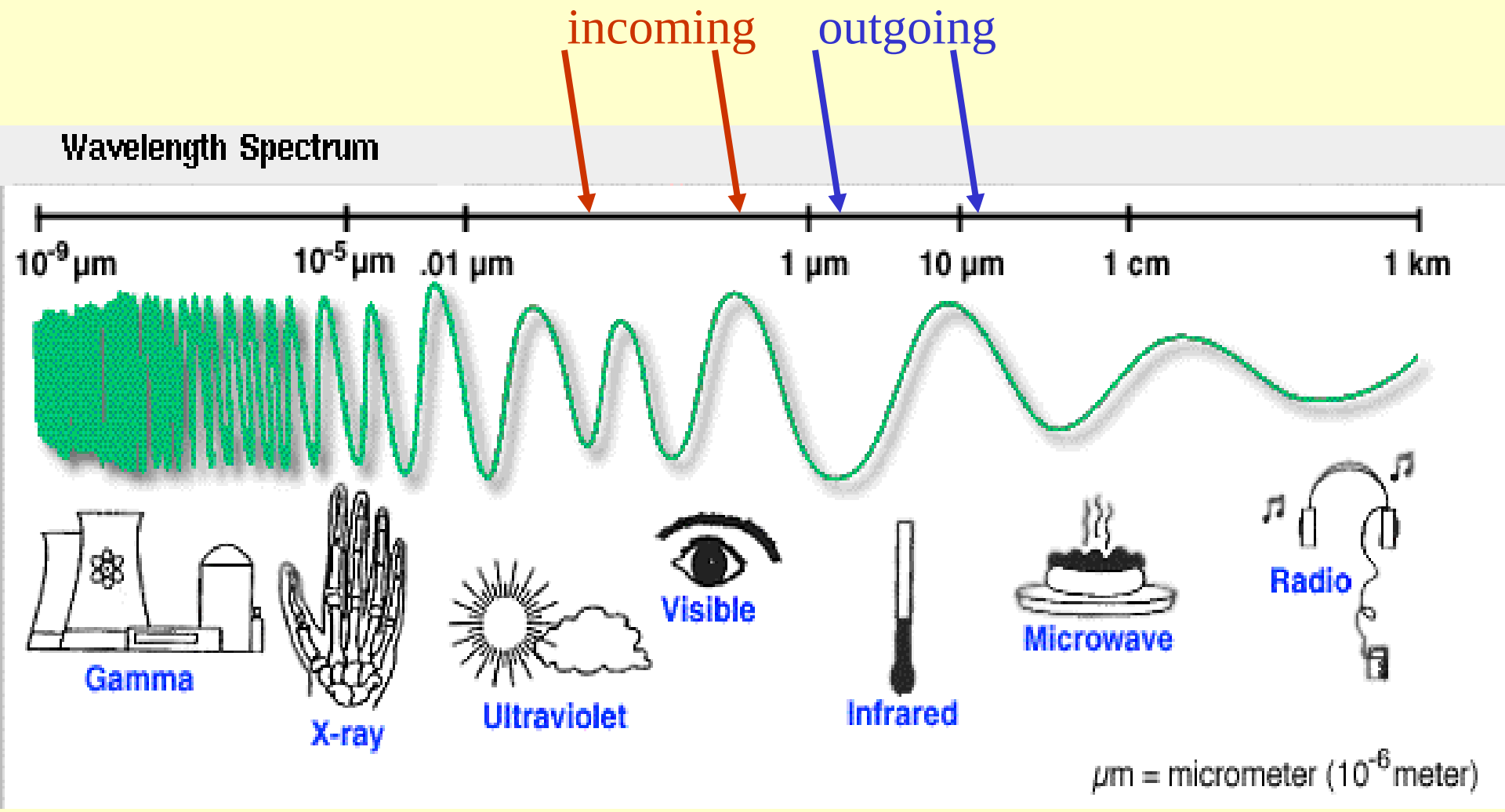
The "Greenhouse Effect"

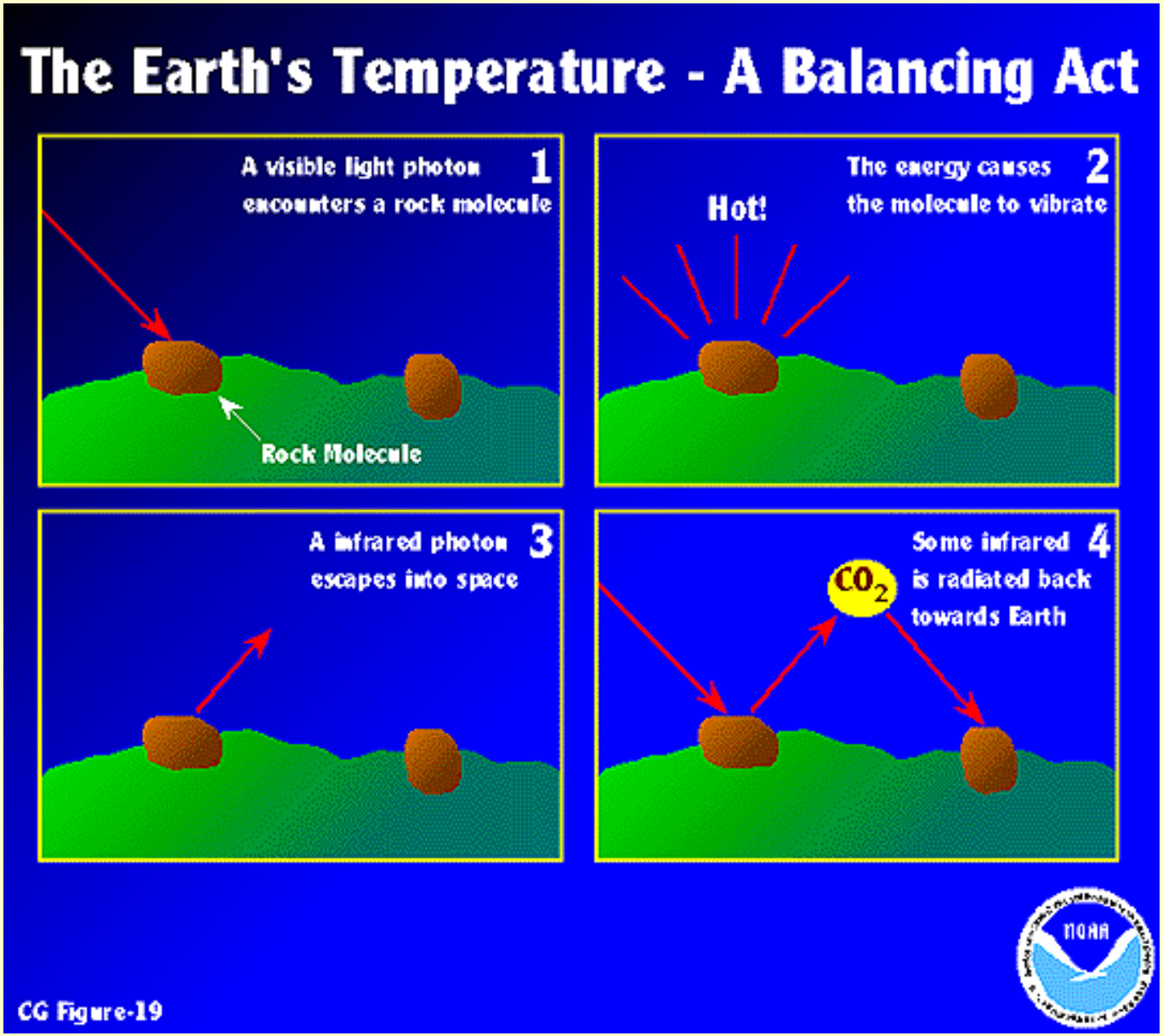
- The Earth's surface thus receives energy from two sources: the sun & the atmosphere
  - As a result the Earth's surface is ~33°C warmer than it would be without an atmosphere

Greenhouse gases are transparent to shortwave but absorb longwave radiation

  - Thus the atmosphere stores energy

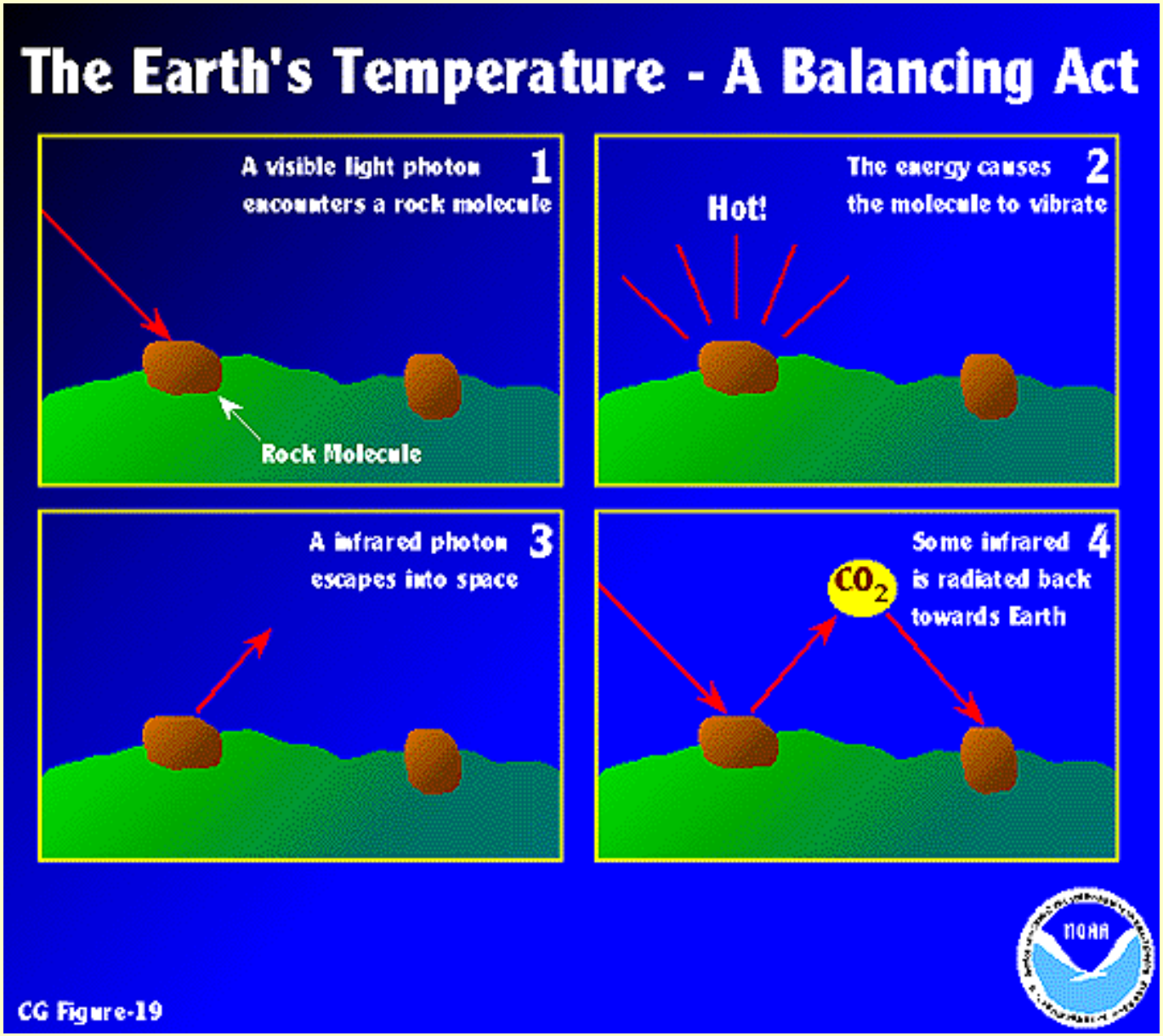
Electromagnetic Spectrum





1. Shorter, high Energy wavelengths Hit the earths Surface

2. Incoming energy Is converted to heat



3. Longer, infrared Wavelengths hit Greenhouse gas Molecules in the atmosphere

4. Greenhouse gas Molecules in the Atmosphere emit Infrared radiation Back towards earth

78% nitrogen

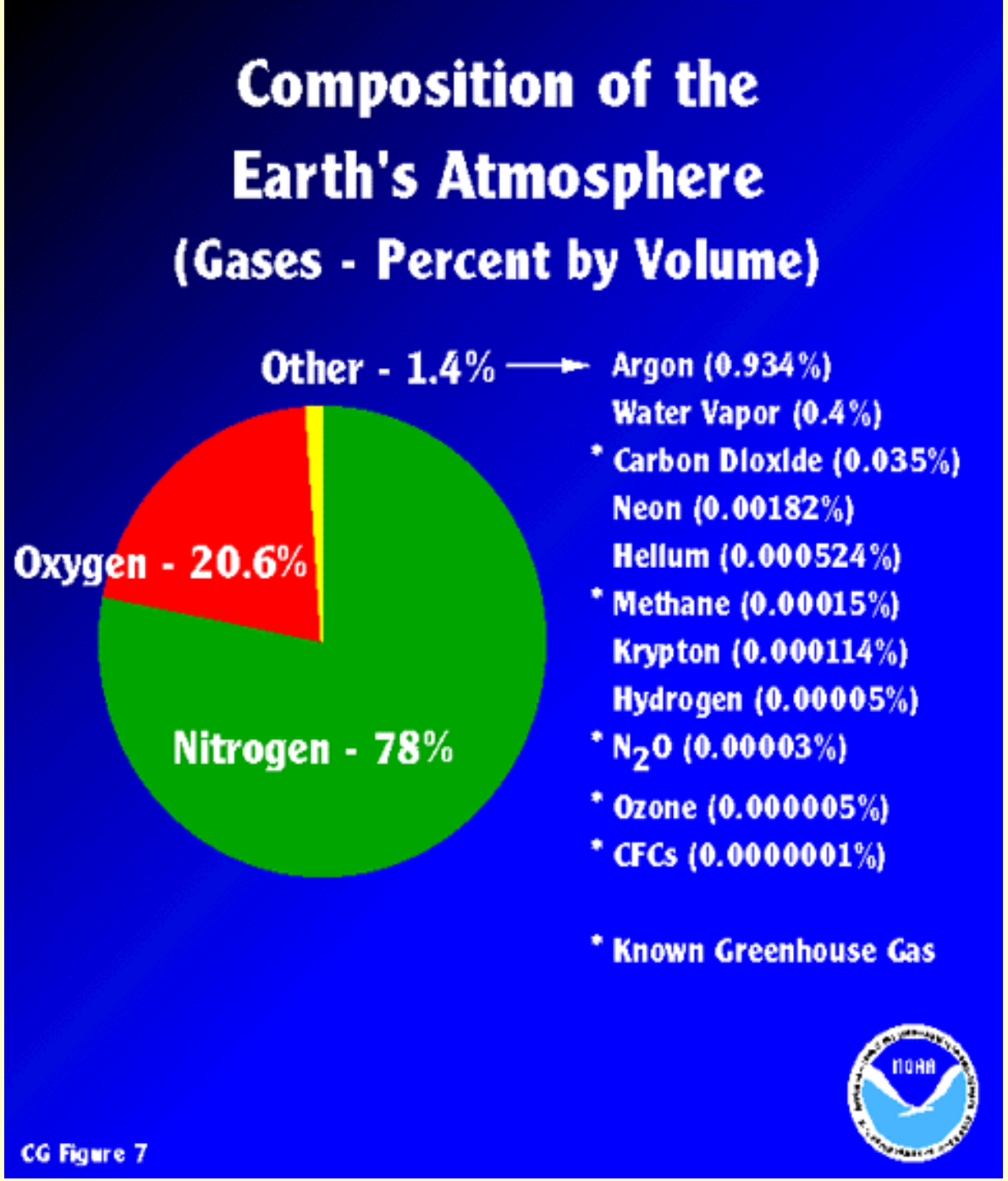
20.6% oxygen

< 1% argon

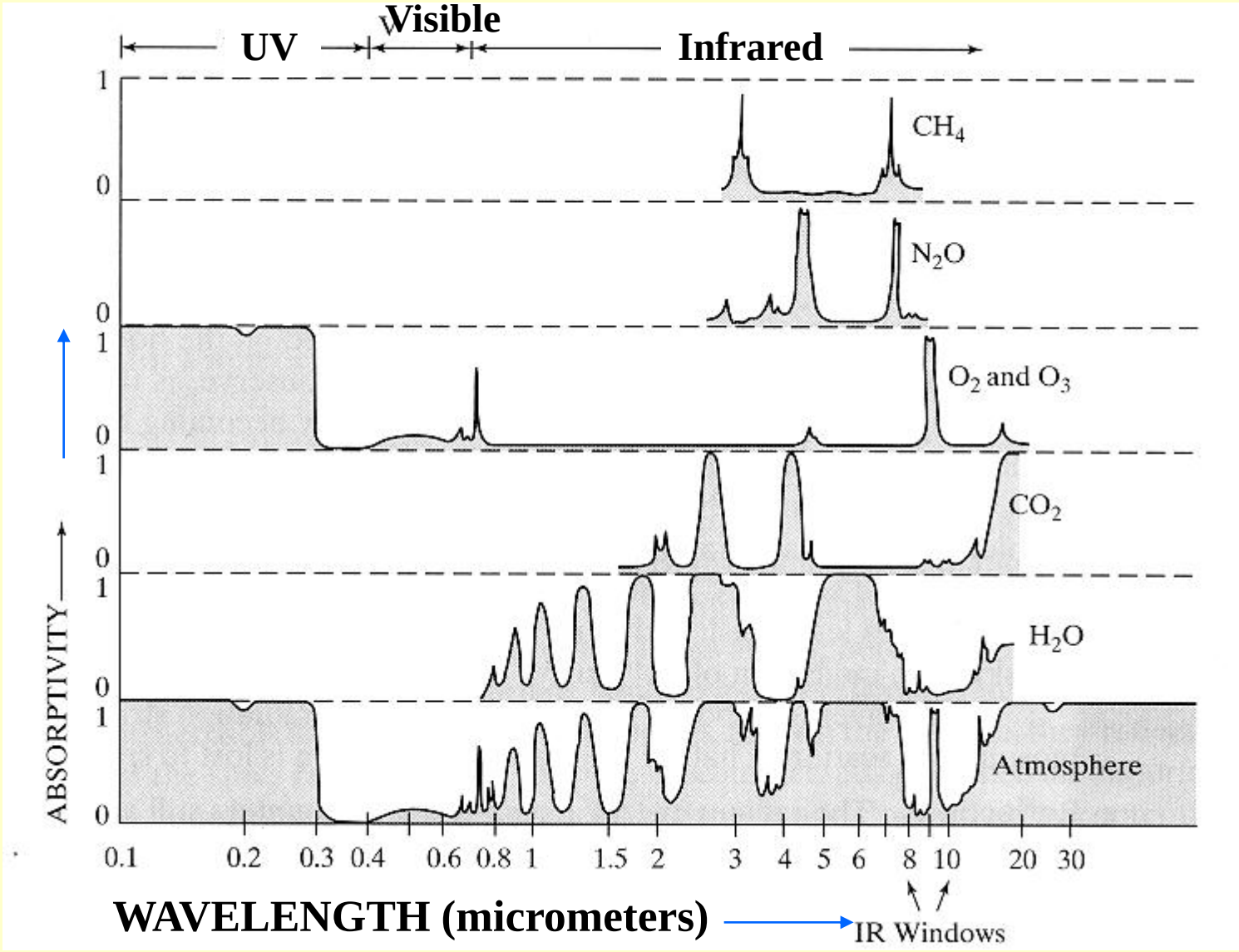
0.4% **<u>water vapor</u>**

0.036% **<u>carbon dioxide</u>**

traces gases:
Ne, He, Kr, H, O_3
<u>Methane</u>, **<u>Nitrous Oxide</u>**



Absorption Spectra of Atmospheric Gases



CH_4

N_2O

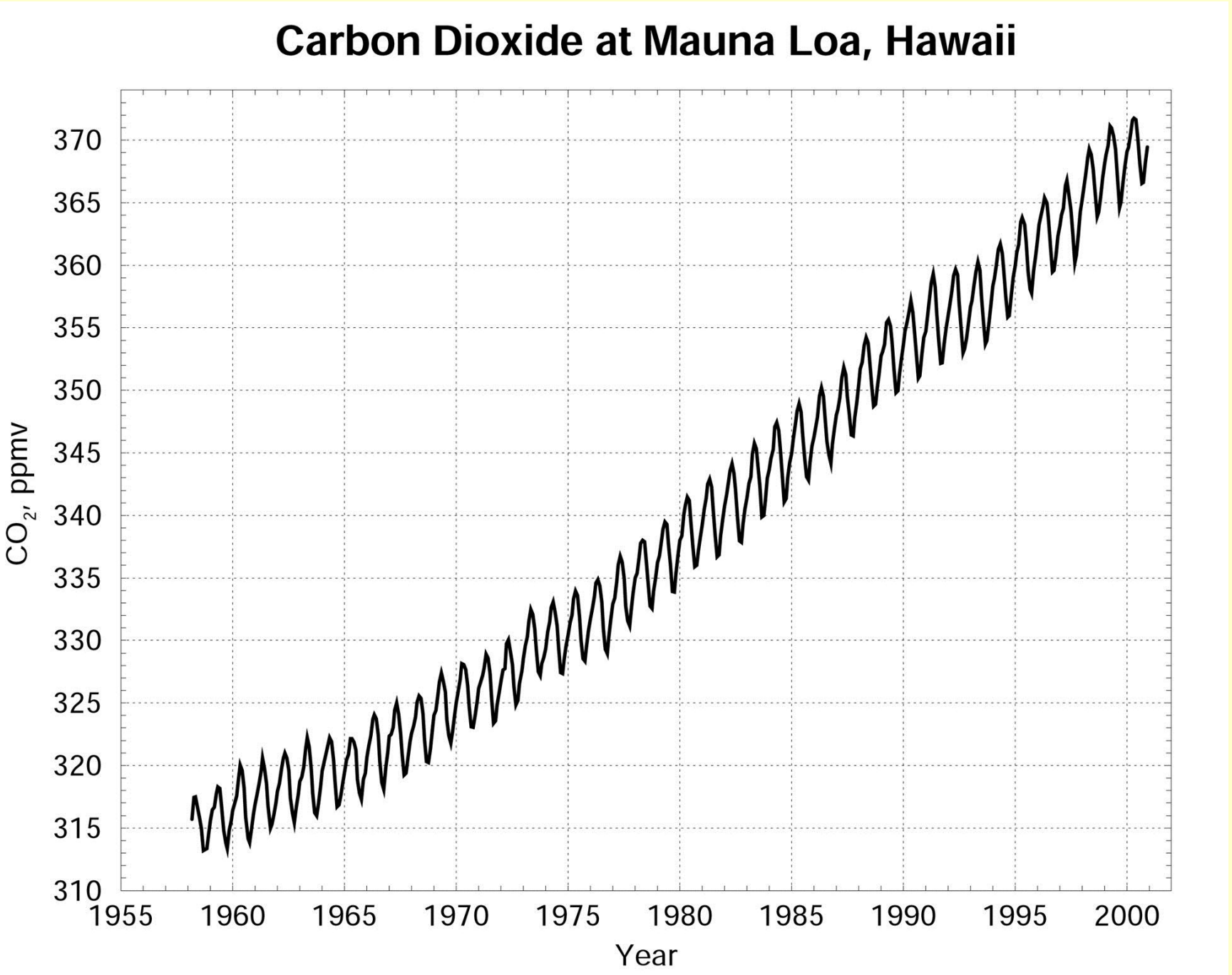
O_2 & O_3

CO_2

H_2O

atmosphere

Anthes, p. 55


Carbon Dioxide at Mauna Loa, Hawaii
370
365
360
355
350
345
340
335
330
325
320
315
310
CO_2, ppmv
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
Year

Selected Greenhouse Gases

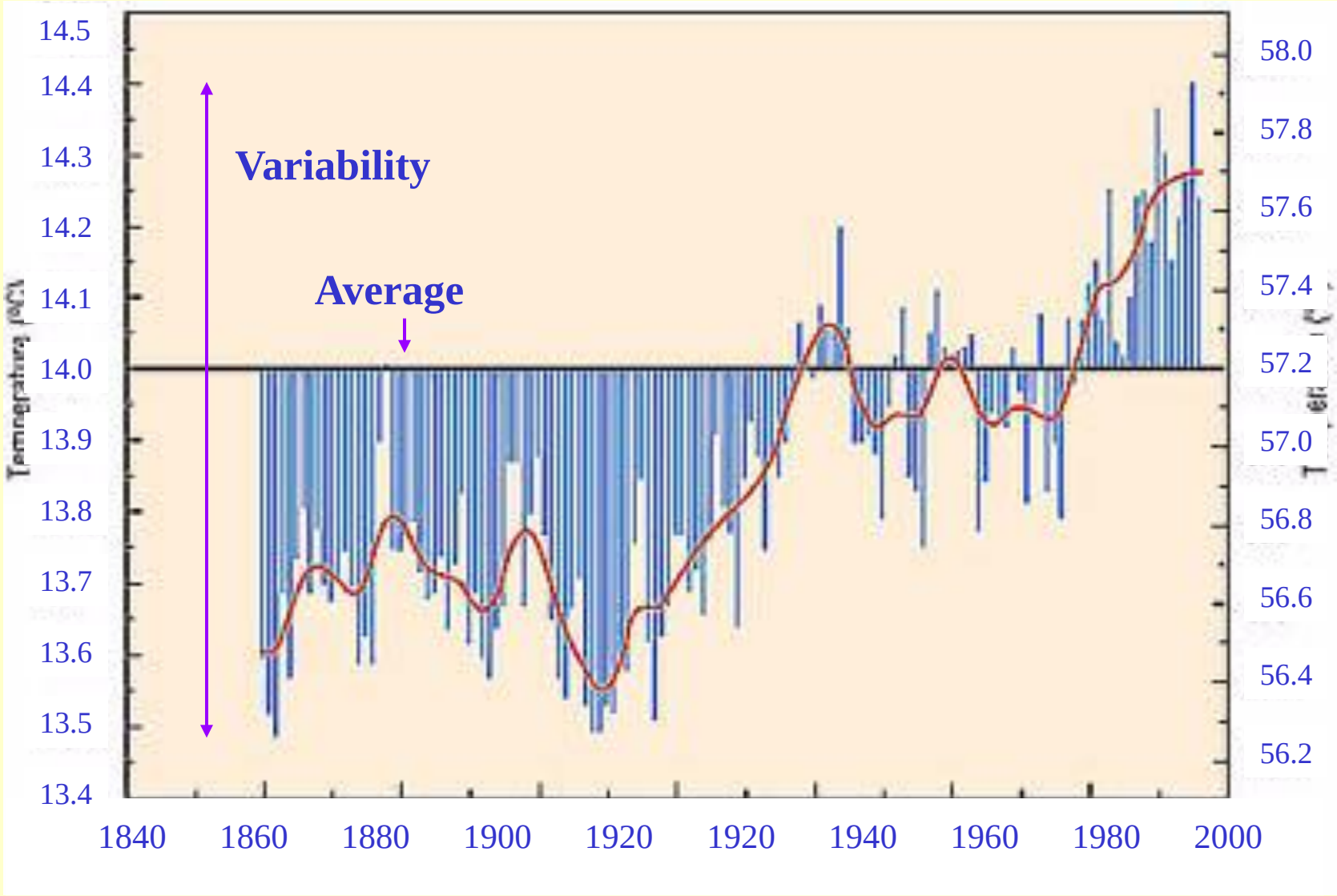
- **Carbon Dioxide (CO_2)**
  - Source: Fossil fuel burning, deforestation
  - Anthropogenic increase: **30%**
  - Average atmospheric residence time: **500 years**
- **Methane (CH_4)**
  - Source: Rice cultivation, cattle & sheep ranching, decay from landfills, mining
  - Anthropogenic increase: **145%**
  - Average atmospheric residence time: **7-10 years**
- **Nitrous oxide (N_2O)**
  - Source: Industry and agriculture (fertilizers)
  - Anthropogenic increase: **15%**
  - Average atmospheric residence time: **140-190 years**

Greenhouse Effect & Global Warming

- The ***"greenhouse effect"*** & ***global warming*** are **not** the same thing.
  - Global warming refers to a rise in the temperature of the surface of the earth

- An increase in the ***concentration of greenhouse gases*** leads to an increase in the the ***magnitude of the greenhouse effect***. (Called enhanced greenhouse effect)
  - This results in global warming

Climate Change vs. Variability

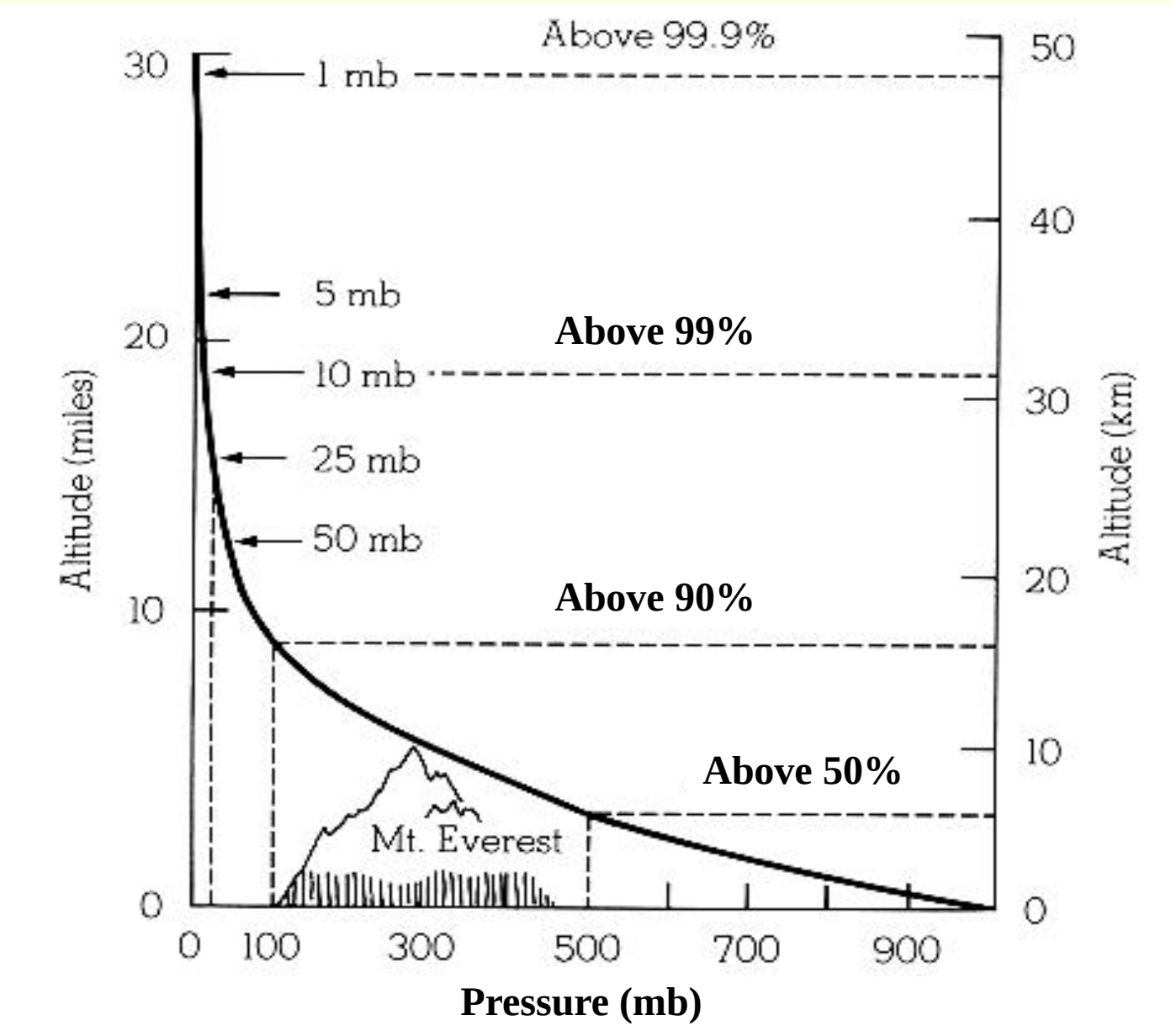


www.gcrio.org/ipcc/qa/cover.html (modified)

Atmospheric Pressure Decreases With Height

Most of the energy is captured close to the surface

That energy drives climate and weather



50 percent of mass of the atmosphere is within 6 km of the surface