Atmosphere of Earth

Structure of the atmosphere

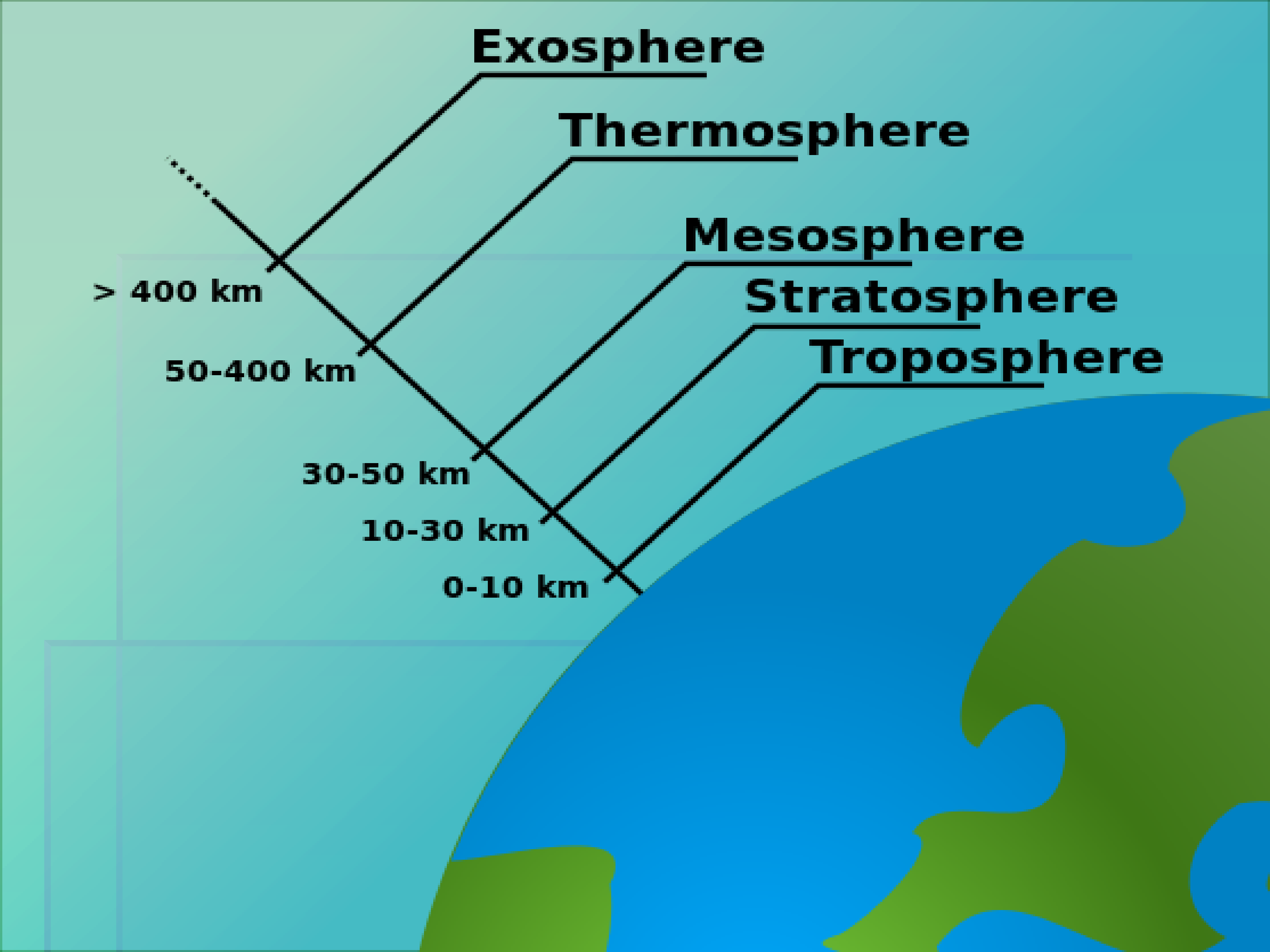
- **Principal layers**
  1. **Exosphere**
  2. **Thermosphere**
  3. **Ionosphere**
  4. **Mesosphere**
  5. **Stratosphere**
  6. **Ozone layer**
  7. **Troposphere**

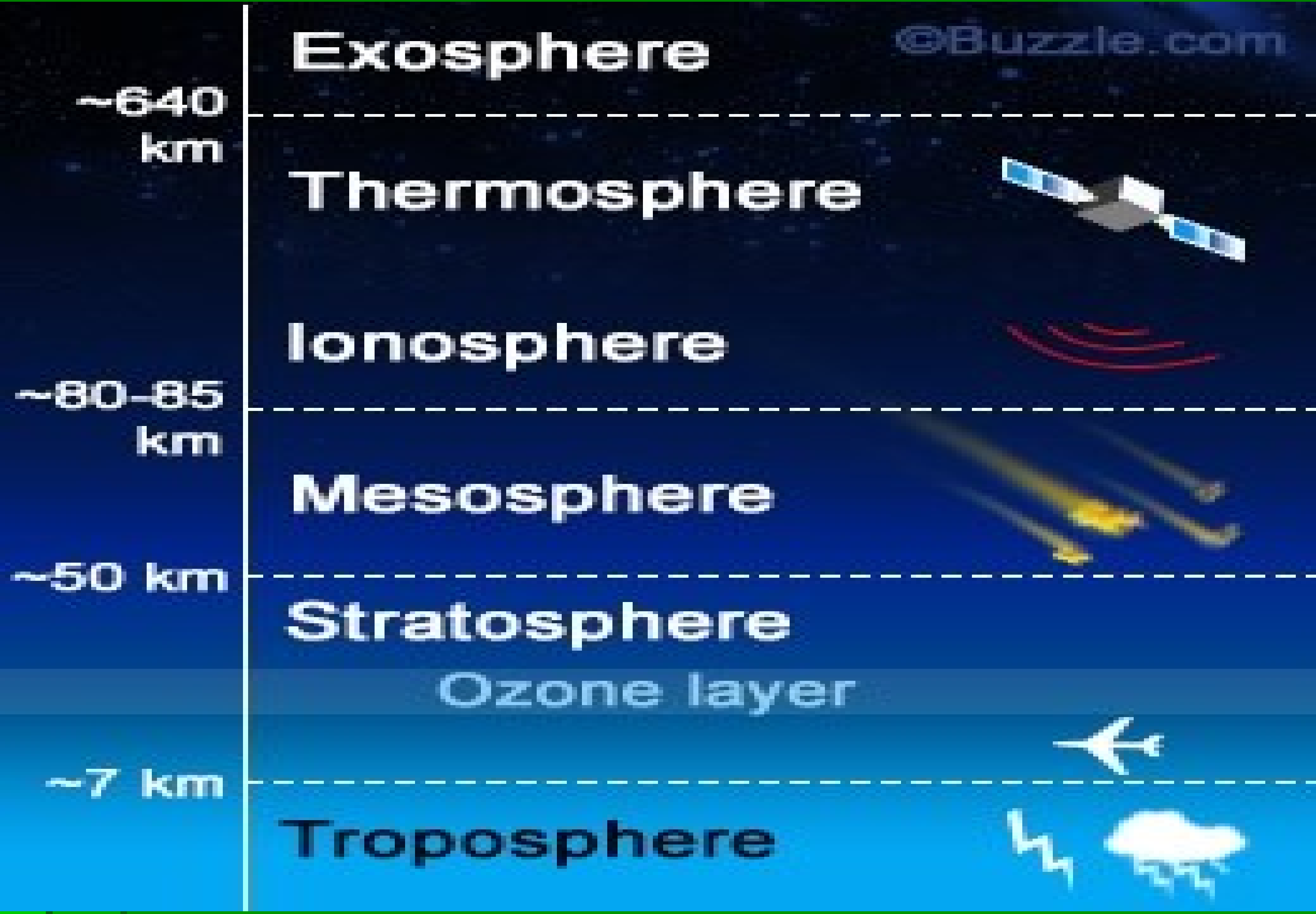
The atmosphere has a mass of about 5×1018 kg, three quarters of which is within about 11 km (6.8 mi; 36,000 ft) of the surface. The atmosphere becomes thinner and thinner with increasing altitude, with no definite boundary between the atmosphere and outer space. The Kármán line, at 100 km (62 mi), or 1.57% of the Earth's radius, is often used as the border between the atmosphere and outer space. Atmospheric effects become noticeable during atmospheric reentry of spacecraft at an altitude of around 120 km (75 mi). Several layers can be distinguished in the atmosphere, based on characteristics such as temperature and composition.

Structure of the atmosphere

Principal layers

1. Exosphere
2. Thermosphere
3. Mesosphere
4. Stratosphere
5. Troposphere
6. Other layers


Exosphere
Thermosphere
Mesosphere
Stratosphere
Troposphere
> 400 km
50-400 km
30-50 km
10-30 km
0-10 km



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Exosphere
~640 km
Thermosphere
Ionosphere
~80-85 km
Mesosphere
~50 km
Stratosphere
Ozone layer
~7 km
Troposphere

Troposphere

- Nearly all atmospheric water vapor or moisture is found in the troposphere, so it is the layer where most of Earth's weather takes place. It has basically all the weather-associated cloud genus types generated by active wind circulation, although very tall cumulonimbus thunder clouds can penetrate the tropopause from below and rise into the lower part of the stratosphere. Most conventional aviation activity takes place in the troposphere, and it is the only layer that can be accessed by propeller-driven aircraft .

Stratosphere

- The atmospheric pressure at the top of the stratosphere is roughly 1/1000 the pressure at sea level .It contains the ozone layer, which is the part of Earth's atmosphere that contains relatively high concentrations of that gas. The stratosphere defines a layer in which temperatures rise with increasing altitude. This rise in temperature is caused by the absorption of ultraviolet radiation) UV) radiation from the Sun by the ozone layer ,which restricts turbulence and mixing. Although the temperature may be −60 °C (−76 °F; 210 K) at the tropopause, the top of the stratosphere is much warmer, and may be near 0°C[11].

Mesosphere

- The mesosphere is also the layer where most meteors burn up upon atmospheric entrance. It is too high above Earth to be accessible to jet-powered aircraft, and too low to support satellites and orbital or sub-orbital spacecraft. The mesosphere is mainly accessed by rocket-powered aircraft and unmanned sounding rockets .

Thermosphere

- This atmospheric layer undergoes a gradual increase in temperature with height. Unlike the stratosphere, wherein a temperature inversion is due to the absorption of radiation by ozone, the inversion in the thermosphere occurs due to the extremely low density of its molecules .a person would not feel warm because of the thermosphere's extremely low pressure.
- **and is also responsible for absorbing the most energetic photons from the Sun, and for reflecting radio waves, thereby making long-distance radio communication possible.**

Exosphere

- The exosphere contains most of the satellites orbiting Earth .

Basic Requirements for a Healthy Environment

- **Clean air**
- **Safe and sufficient water**
- **Safe and adequate food**
- **Safe and peaceful settlements**
- **Stable global environment**

Recognition of a Broader Environmental Impact

- Food security
- Climate change
- Deforestation
- Desertification
- Land degradation
- Stratospheric ozone depletion
- Loss of biodiversity

Ozone Depletion

The Main Ozone-Depleting Substances (ODS)

- Chlorofluorocarbons (CFCs)
  - The most widely used ODS, accounting for over 80% of total stratospheric ozone depletion.
  - Used as coolants in refrigerators, freezers and air conditioners in buildings and cars manufactured before 1995.
  - Found in industrial solvents, dry-cleaning agents and hospital sterilants.
  - Also used in foam products — such as soft-foam padding (e.g. cushions and mattresses) and rigid foam (e.g. home insulation.(
- Halons
  - Used in some fire extinguishers, in cases where materials and equipment would be destroyed by water or other fire extinguisher chemicals. In B.C., halons cause greater damage to the ozone layer than do CFCs from automobile air conditioners.
- Methyl Chloroform
  - Used mainly in industry — for vapour degreasing, some aerosols, cold cleaning, adhesives and chemical processing.
- Carbon Tetrachloride
  - Used in solvents and some fire extinguishers.
- Hydrofluorocarbons (HCFCs)
  - HCFCs have become major, “transitional” substitutes for CFCs. They are much less harmful to stratospheric ozone than CFCs are. But HCFCs they still cause some ozone destruction and are potent greenhouse gases.

The Impacts of Ozone Depletion

- Stratospheric ozone filters out most of the sun's potentially harmful shortwave ultraviolet (UV) radiation. If this ozone becomes depleted, then more UV rays will reach the earth. Exposure to higher amounts of UV radiation could have serious impacts on human beings, animals and plants, such as the following:

1. Harm to human health

- More skin cancers, sunburns and premature aging of the skin.
- More cataracts, blindness and other eye diseases: UV radiation can damage several parts of the eye, including the lens, cornea, retina and conjunctiva.
- Cataracts (a clouding of the lens) are the major cause of blindness in the world. A sustained 10% thinning of the ozone layer is expected to result in almost two million new cases of cataracts per year, globally (Environment Canada, 1993.(
- Weakening of the human immune system (immunosuppression). Early findings suggest that too much UV radiation can suppress the human immune system, which may play a role in the development of skin cancer .

2. Adverse impacts on agriculture, forestry and natural ecosystems

- Several of the world's major crop species are particularly vulnerable to increased UV, resulting in reduced growth, photosynthesis and flowering. These species include wheat, rice, barley, oats, corn, soybeans, peas, tomatoes, cucumbers, cauliflower, broccoli and carrots.
- The effect of ozone depletion on the Canadian agricultural sector could be significant.
- Only a few commercially important trees have been tested for UV (UV-B) sensitivity, but early results suggest that plant growth, especially in seedlings, is harmed by more intense UV radiation .

3. Damage to marine life

- In particular, plankton (tiny organisms in the surface layer of oceans) are threatened by increased UV radiation. Plankton are the first vital step in aquatic food chains.
- Decreases in plankton could disrupt the fresh and saltwater food chains, and lead to a species shift in Canadian waters.
- Loss of biodiversity in our oceans, rivers and lakes could reduce fish yields for commercial and sport fisheries.

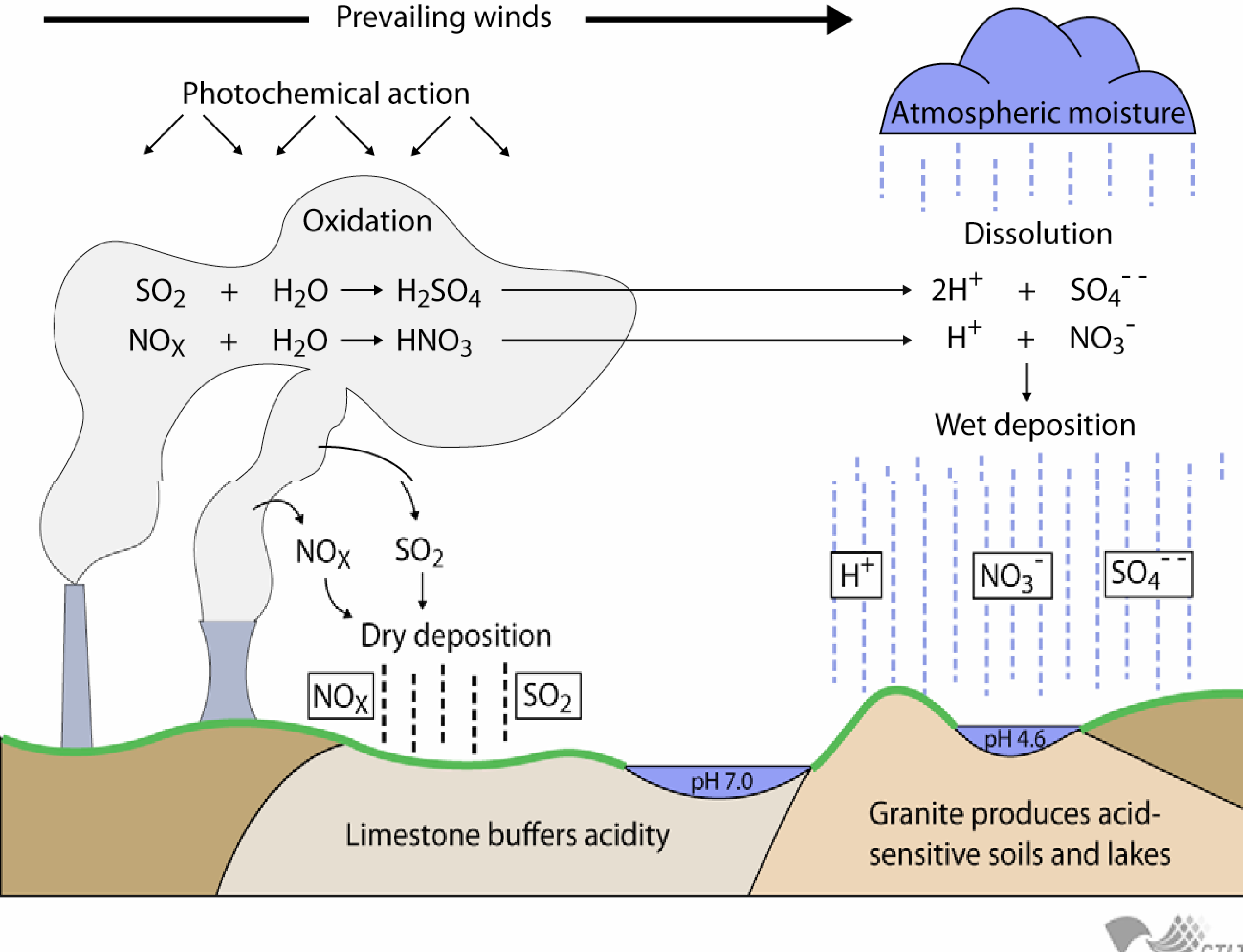
4. Animals

- In domestic animals, UV overexposure may cause eye and skin cancers. Species of marine animals in their developmental stage (e.g. young fish, shrimp larvae and crab larvae) have been threatened in recent years by the increased UV radiation under the Antarctic ozone hole .

5. Materials

- Wood, plastic, rubber, fabrics and many construction materials are degraded by UV radiation.
- The economic impact of replacing and/or protecting materials could be significant.

Dry and Wet Deposition of Air Pollutants



Prevailing winds
Photochemical action
Oxidation
$SO_2 + H_2O \rightarrow H_2SO_4$
$NO_X + H_2O \rightarrow HNO_3$
Atmospheric moisture
Dissolution
$2H^+ + SO_4^{--}$
$H^+ + NO_3^-$
Wet deposition
H^+
NO_3^-
SO_4^{--}
NO_X
SO_2
Dry deposition
NO_X
SO_2
pH 7.0
pH 4.6
Limestone buffers acidity
Granite produces acid-sensitive soils and lakes
CTLT

Global warming and Greenhouse effects

The Greenhouse Effect

Physics: Earth absorbs incoming solar radiation and then trys to cool by emitting long wavelength infrared radiation. This radiation is absorbed by Greenhouse Gases and hence can't escape → net effect should be to increase mean annual temperature.

Greenhouse Gases:

- CO_2 → burning of carbon based fuels
- CH_4 → anerobic bacteria in rice fields, cows, sewage
- N_20 → fossil fuels and fertilizer
- CFCs → refrigeration and spray cans

Importance:

- CO_2 → 65% ; 0.4 % (150 years) ; 1
- CH_4 → 25% ; 1 % (70 years) ; 25
- CFCs → 10% ; 5 % (14 years) ; 10,000 !

In principle, CFCS are very bad and will dominate the greenhouse gases in our atmosphere if their terrestrial usage remains high. CFC worldwide production, however, has been significantly reduced because of concern about The Ozone Layer

Methane is more directly related to food production and population growth so it could also dominate in the near future

Frozen methane is also found in the Arctic Ice Caps and will be released due to global warming thus exacerbating the problem. This is far more serious that people realize or has been reported.

Manifestations of the GreenHouse Effect

- Increase in global mean temperature ???
- Increase in Ocean Temperature!
- Increase in cloud cover of the earth?
- Disruption of seasonal Jet Stream Patterns?
- increased hurricane strength
- 1-2 m increase in sea level over next 50 - 100 years
- increased growing season at northerly latitudes ???

Predictions:

- 3-5 C rise in global mean temperature by 2050
- 5 -10 C rise in polar temperature! (heat flow from equator to poles, less surface area, bigger effect)
- lag time?

Note:

Little ice ages have 5 C variation. (10,000 years)

Big ice ages have 9 C variation. (100,000 years)

Note also: deforestation is a myth! Agriculture has boomed so there is still plenty of biomass outthere.

- Global Warming: This is caused by the build up of CO_2 and CH_4 in the lower atmosphere of the earth. These gases increase the infrared absorption potential of the lower atomsphere and hence increases its ability to retain heat.
- Ozone Depletion: This occurs in the stratosphere at a height of about 15 km above the surface. The depletion of Ozone means that more UV radiation from the sun reaches the surface. This does not make the surface hotter, as only a small percentage of sunlight is in the form of Ultraviolet radiation.
- The ozone layer itself does not reduce the overall amount of visible radiation which reaches the surface and does most of the heating. Hence removal of the ozone layer does not make the earth substantially warmer.

Thank you