CANDAC

Canadian Network for the Detection of Atmospheric Change

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- In 2002, a group of university researchers joined together under the title of the Canadian Network for the Detection of Atmospheric Change (CANDAC) with the objective of improving the state of observational atmosphere research in Canada.
- This group recognized the need for an Arctic laboratory and identified the Polar Environment Atmospheric Research Laboratory (PEARL) in Eureka, Nunavut as the ideal station.
- They worked enthusiastically to raise funds to run the facility and had a fully-functional Arctic lab operating in 2005.
- Since then, researchers have been taking various measurements to monitor and better understand current atmospheric conditions.

Funding for CANDAC has been provided by:

Canadian Foundation for Climate and Atmospheric Sciences (CFCAS)
Fondation canadienne pour les sciences du climat et de l'atmosphère (FCSCA)

Ontario Innovation Trust

Canada Foundation for Innovation
Fondation canadienne pour l'innovation

Environment Canada

Environnement Canada

NSERC CRSNG

Ontario MINISTRY OF RESEARCH & INNOVATION

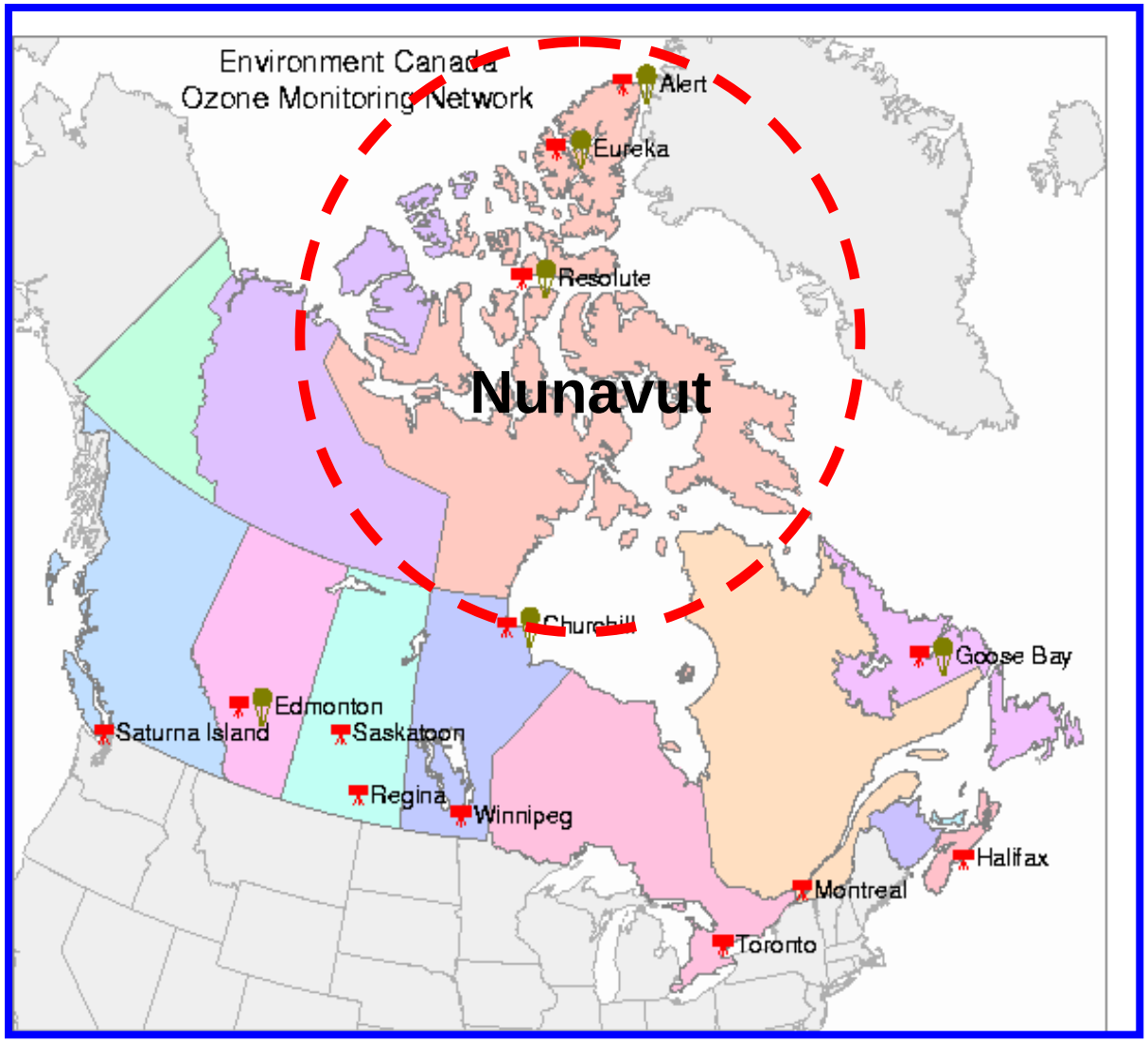
CSA ASC

NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

INTERNATIONAL POLAR YEAR
2007-2008

Nova Scotia Research and Innovation Trust

Where do we take measurements?



- CANDAC researchers collect data in Eureka, Nunavut.
- Nunavut is geographically the largest of all thirteen Canadian provinces and territories, but is the least populated.

http://exp-studies.tor.ec.gc.ca/e/ozone/ozonecanada.htm

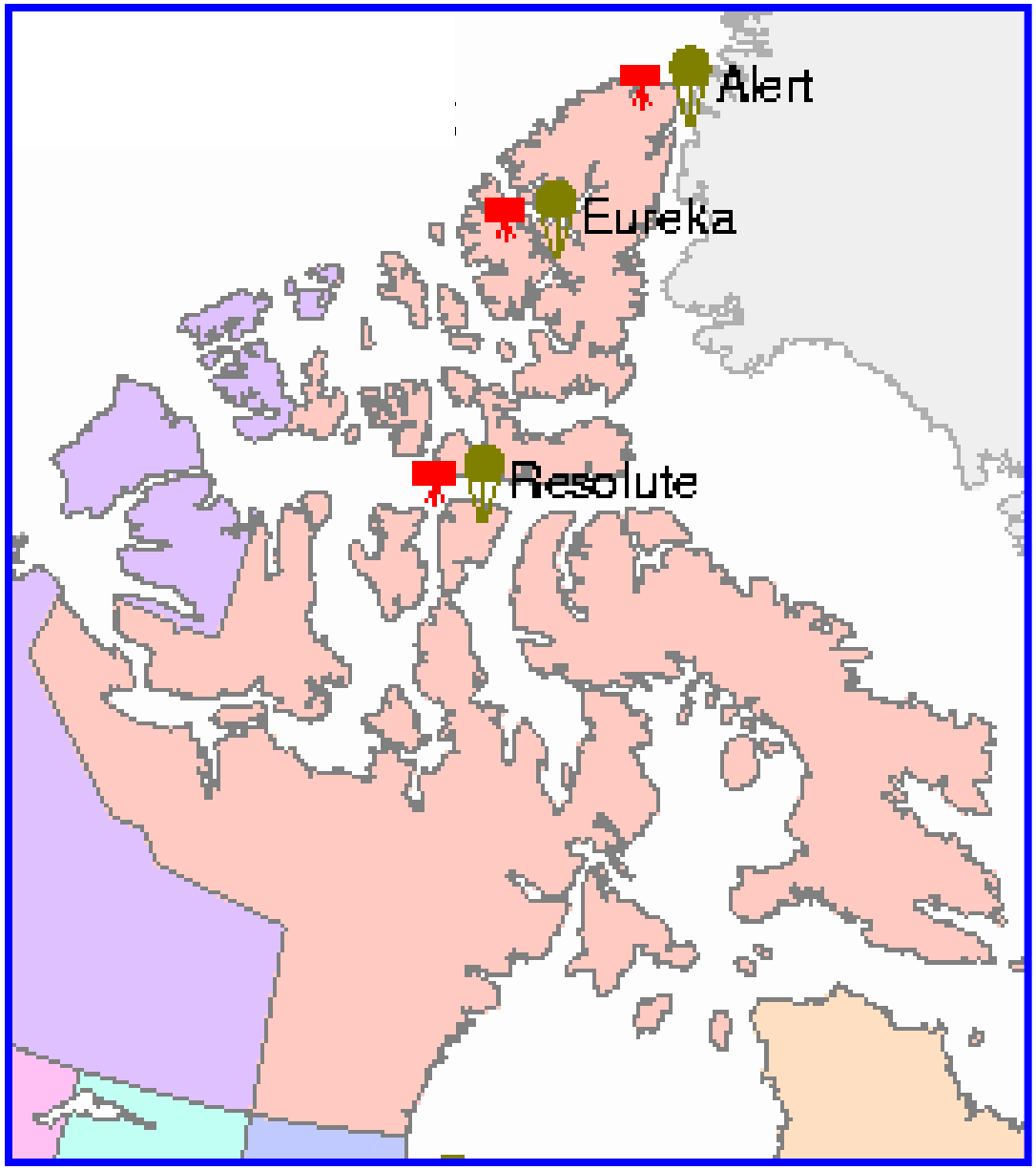
- Many animals including caribou, polar bears, Arctic wolves, Arctic hares, whales and seals live in Nunavut.

Polar bear photos courtesy of Andrea Moss

Arctic hare Photo courtesy of Pierre Fogal.

Wolf photos courtesy of Emily McCullough

Caribou Photo courtesy of Pierre Fogal.



http://exp-studies.tor.ec.gc.ca/e/ozone/ozonecanada.htm

- Eureka is located on Ellesmere Island in the High Arctic.
- It is the second-northernmost permanent research community in the world.
- Eureka experiences complete darkness from mid-October until late February and complete Sunlight from early April to late August.

Photo courtesy of Pierre Fogal

- Many CANDAC researchers operate their instruments from the Polar Environment Atmospheric Research Laboratory (PEARL) located in Eureka.
- Researchers typically travel to PEARL by airplane.

Photo courtesy of Pierre Fogal

CANDAC International Polar Year Legacy Project: Educational Resources

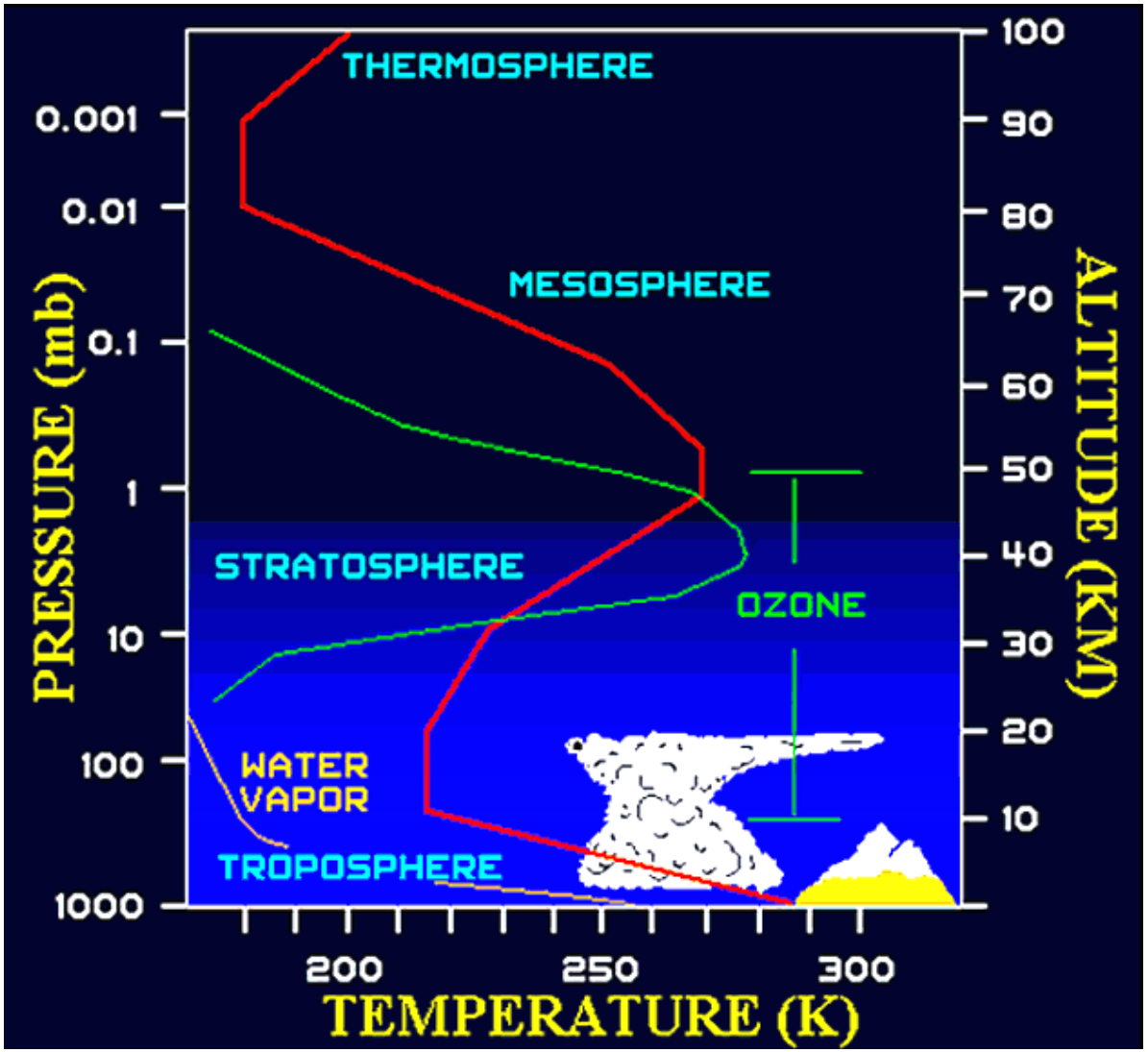
- As part of the International Polar Year (IPY) Legacy Project, CANDAC has created educational resources aimed at enhancing environmental science education in classes from kindergarten to grade 12.
- Educational materials can be found at: http://candac.ca/candac/Outreach/Outreach.php .
- This particular presentation is about:

Human Impacts on the Atmosphere

Big questions about our atmosphere

- How is the Ozone Layer changing?
- How is the Earth's climate changing?
- How is air pollution changing our atmosphere?

Structure of the Atmosphere

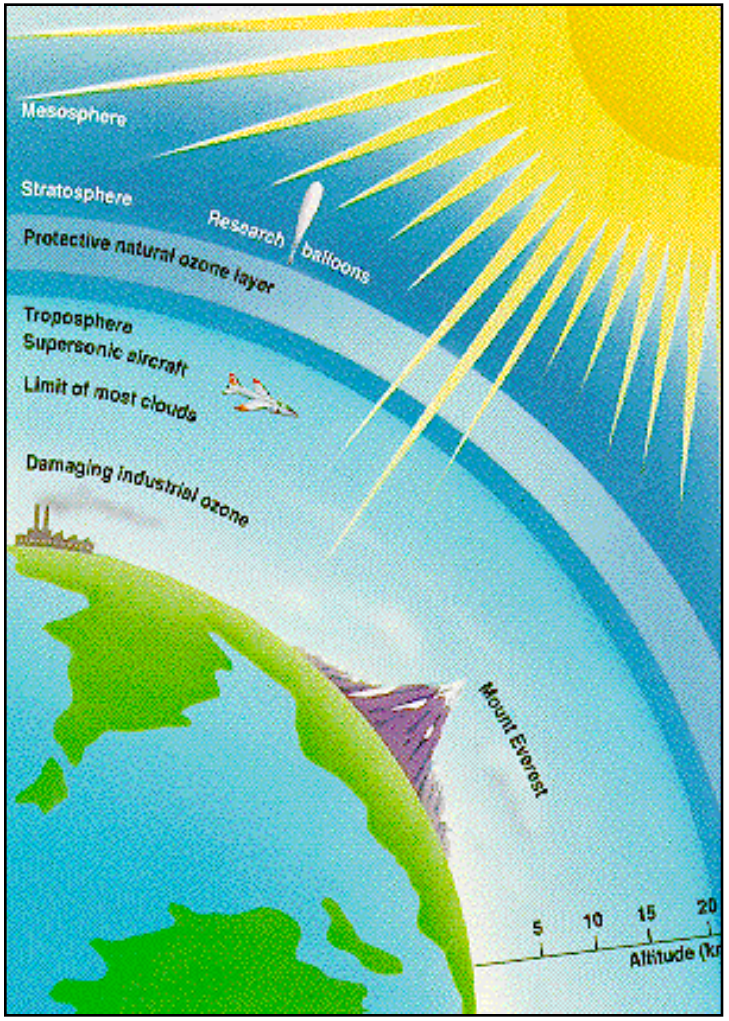


http://www.astronoo.com/articles/globalWarming-en.html

The Ozone Layer

Ozone in the Atmosphere

- Ozone is a molecule made up of three oxygen atoms.
- The oxygen that we breathe is a molecule made up of two oxygen atoms.
- Ozone protects the Earth by blocking harmful UV light from the Sun.



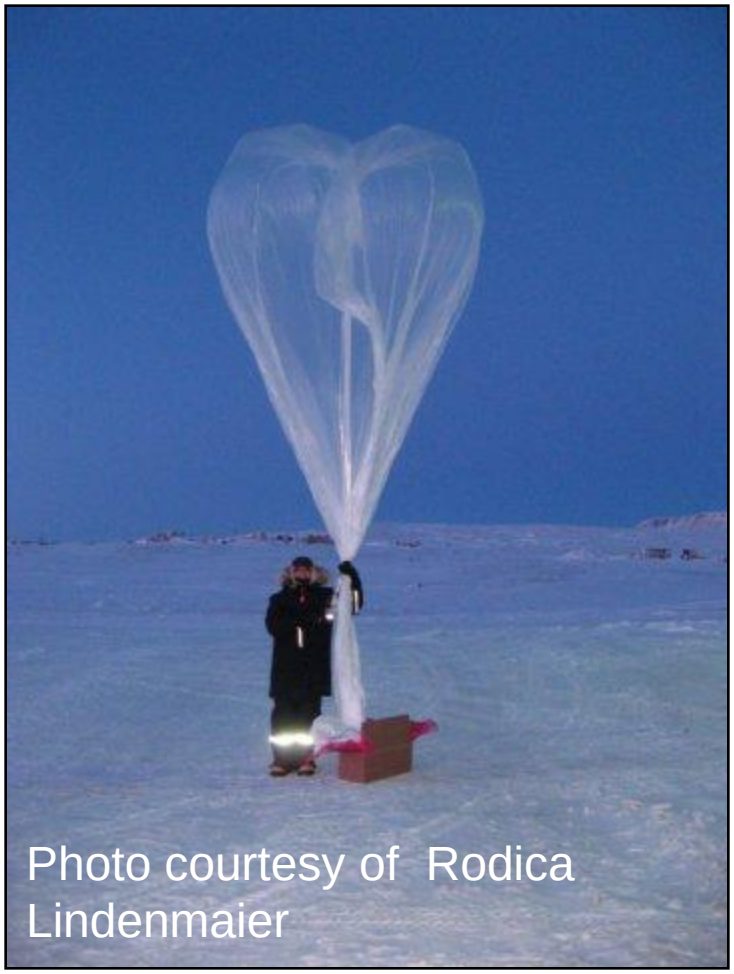
http://www.ec.gc.ca/ozone/DOCS/KIDZONE/EN/ozoneupthere.cfm

Why is there less ozone?

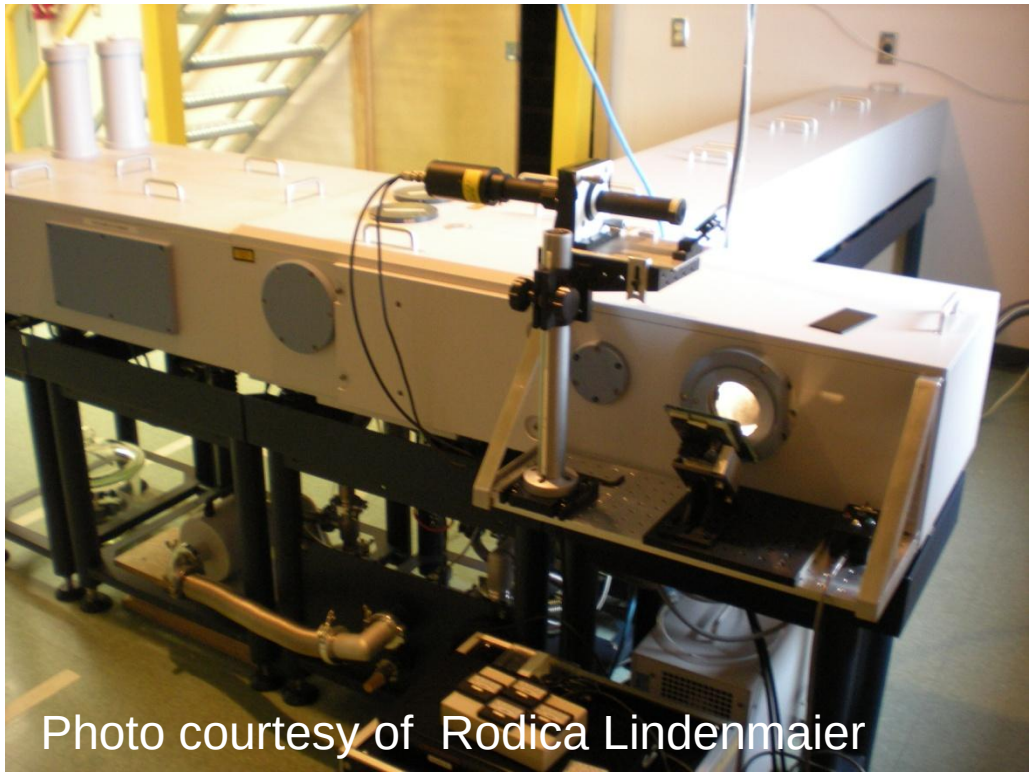
- The ozone layer has gotten thinner because humans have emitted chemicals into the atmosphere.
  - For example, for many years, humans emitted Chloroflourocarbons (CFCs) into the air which damaged the ozone layer.
- Scientists need to measure and monitor ozone in order to better understand what is happening.

How do we measure ozone?

Ozonesondes launched on balloons

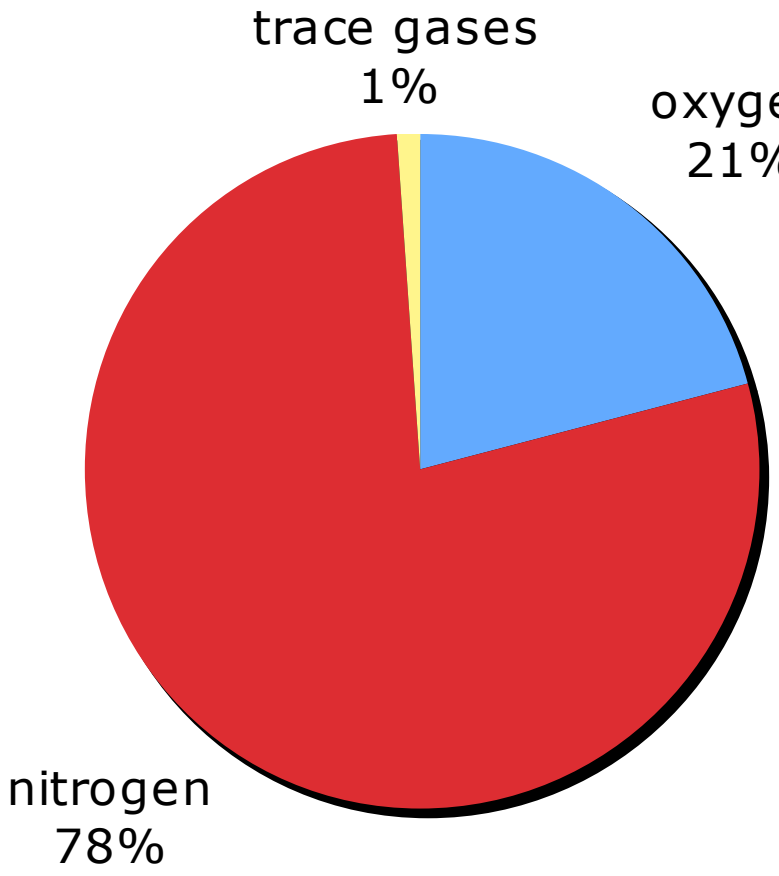


Ground-based instruments such as a spectrometer



Atmospheric Pollution

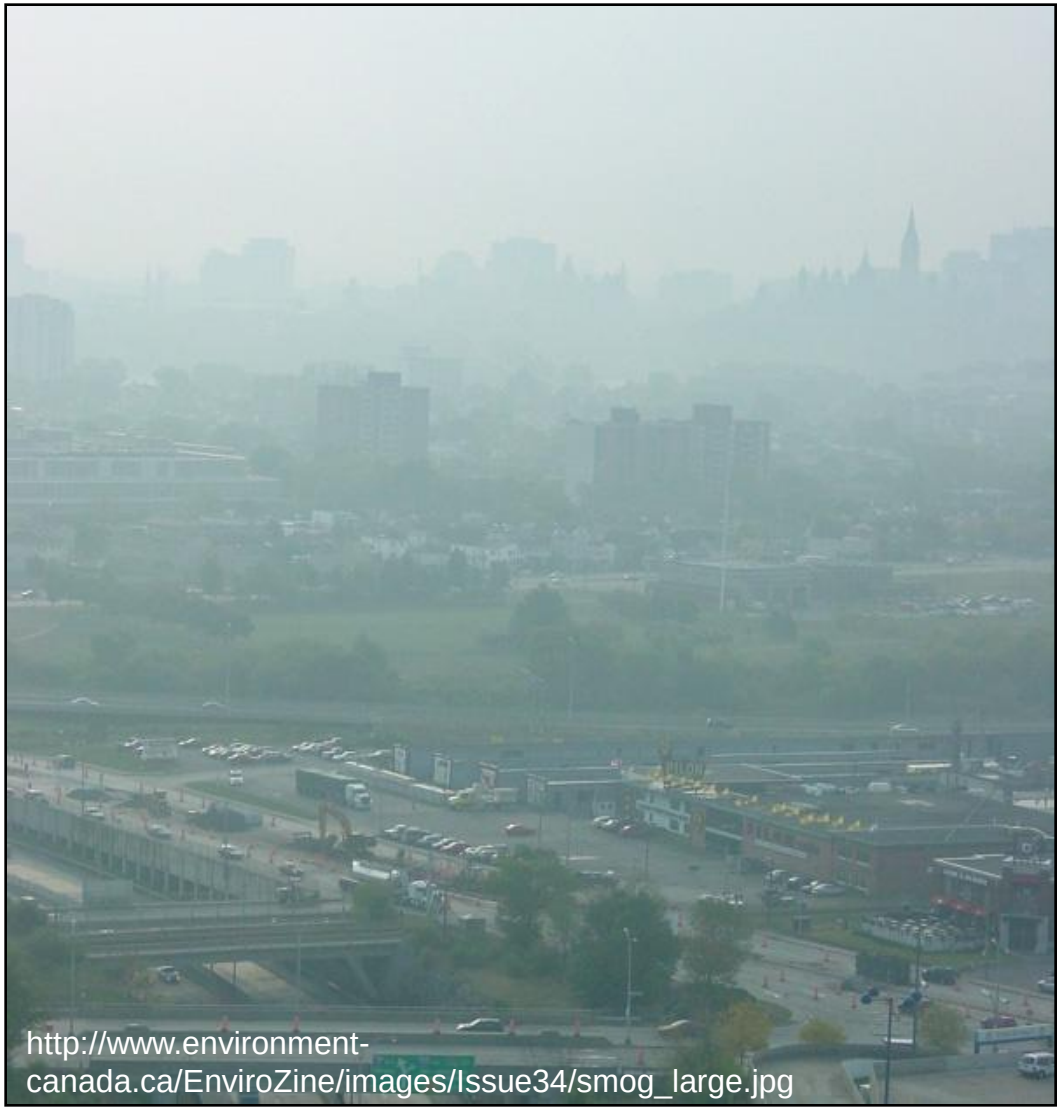
What is in the air?



Trace Gases include:

- Argon
- Water vapour
- Carbon dioxide
- Methane
- Nitrous oxide
- Ozone
- Many many more…

What else is in the air?



http://www.environment-canada.ca/EnviroZine/images/Issue34/smog_large.jpg

What is air pollution?

- Air pollution affects many people in the world.
  - Smog is one example of air pollution. It can cause breathing problems and irritation for asthmatics.
- Most of these gases and particles are produced by human activity.
  - Vehicles, factories, power plants and homes produce the majority of these pollutants.
- Some contributions come from natural sources.
  - Forest fires, trees and volcanoes emit pollutants; however, these are much smaller than those emitted by humans.

How do we measure air pollution?

- From the ground
  - Ground-based instruments are stationed all over the world including PEARL.
- From balloons
  - Balloons are launched from various locations around the globe including PEARL.
- From space
  - Satellites can carry scientific instruments that measure gases related to atmospheric pollution. This allows us to see all parts of the globe and help understand how pollution is transported.

AHSR (Arctic High Spectral Resolution) LIDAR (Light Detection And Ranging)

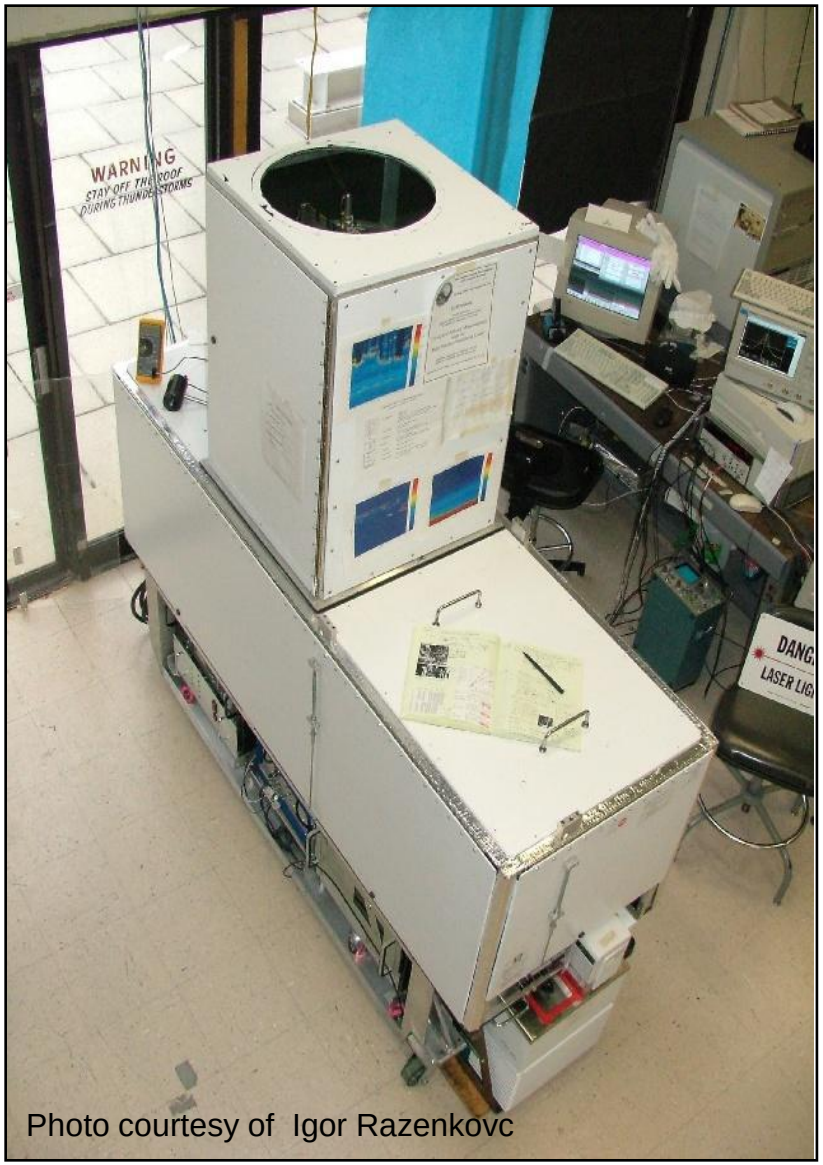


Photo courtesy of Igor Razenkovc

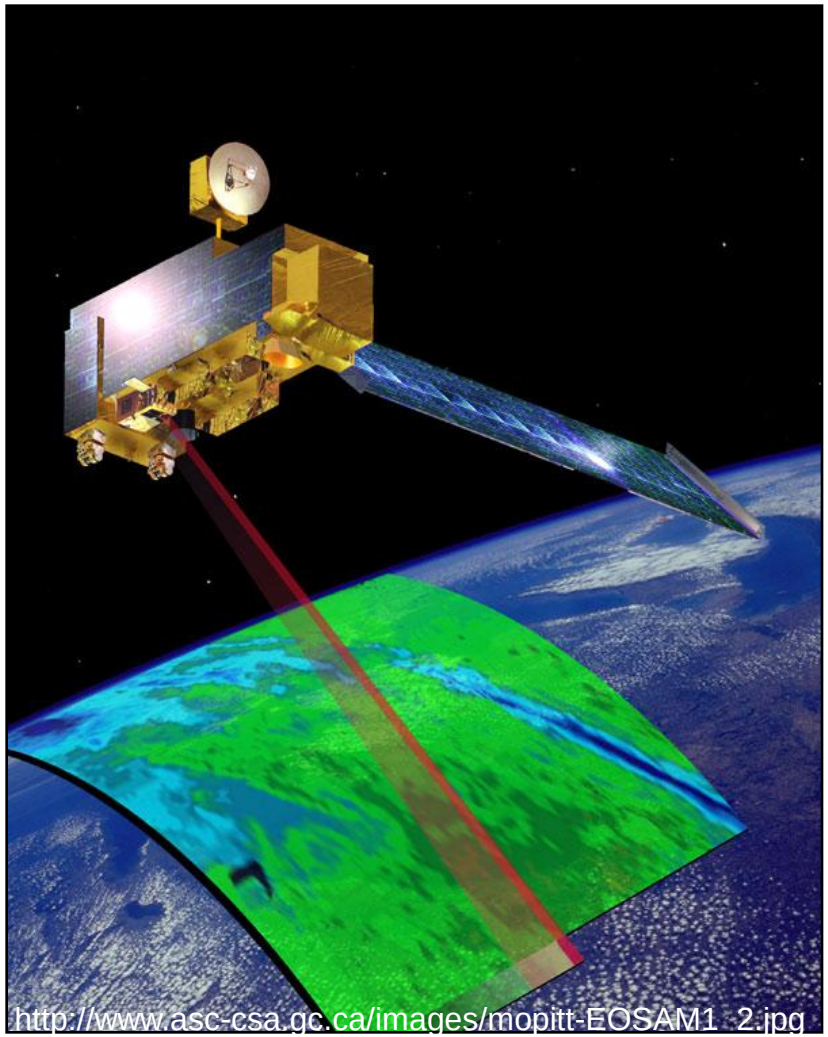
MANTRA Balloon (Middle Atmosphere Nitrogen Trend Assessment)

Photo courtesy of
http://www.atmosp.physics.utoronto.ca/MANTRA/

MOPITT

(Measurements Of Pollution In The Troposphere)

- MOPITT was successfully launched on December 18 1999, onboard the NASA Terra satellite.
- It was Canada's first major instrument to measure pollution from space (carbon monoxide).



http://www.asc-csa.gc.ca/images/mopitt-EOSAM1_2.jpg

Weather vs. Climate

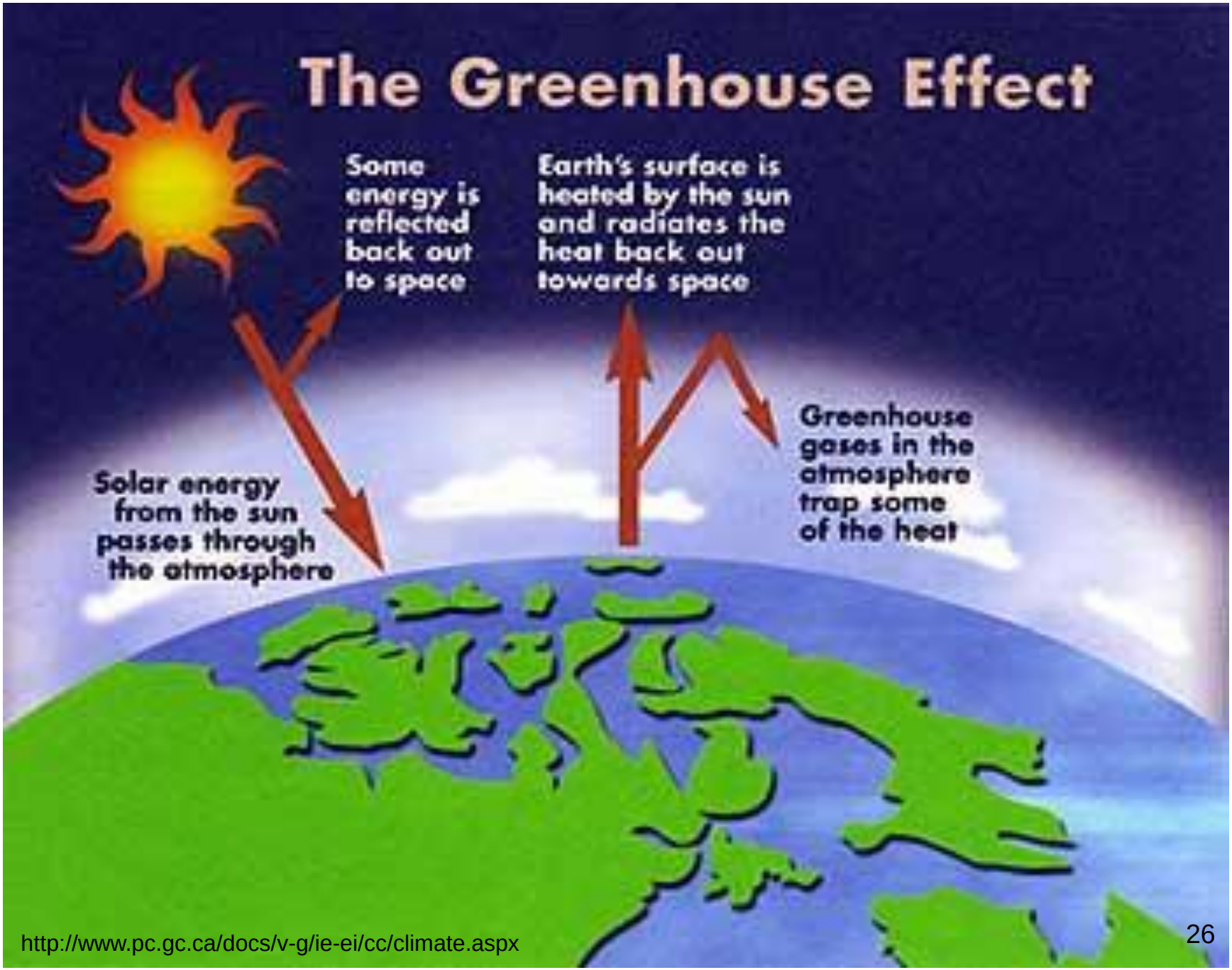
Weather

- Weather is the current condition of the atmosphere in a specific location.
- The weather in one area changes daily and sometimes hourly.
- The weather on any one date cannot be predicted from the weather on that date in previous years.

Climate

- By taking weather information from several years, we can describe the climate in a specific location.
- Climate describes the typical weather you can expect in a region.
- For example, using precipitation and temperature as a guide:
  - Vancouver has a lot of rain (typical Coastal climate).
  - Halifax has a lot of fog (typical Maritime climate).

Atmospheric Change



http://www.pc.gc.ca/docs/v-g/ie-ei/cc/climate.aspx

The Greenhouse Effect

- Without our atmosphere, based on the Earth's distance from the Sun, the average temperature on Earth would be about -18°C instead of +14°C.
- There are 4 main greenhouse gases (GHGs) that contribute to the Greenhouse Effect:
  - Water Vapour (H_2O) → most influential GHG
  - Carbon Dioxide (CO_2)
  - Methane (CH_4)
  - Nitrous Oxide (N_2O)

Where do they come from?

- Sources of GHGs can be either natural or human-made (anthropogenic).
  - Some natural GHG sources include plants, animals, soil and oceans.
  - Some anthropogenic GHG sources include burning fossil fuels, farming and industry.
- Human activities are increasing GHG emissions, and thus enhancing the greenhouse effect.
- There is a concern that GHGs are causing the global climate to change.

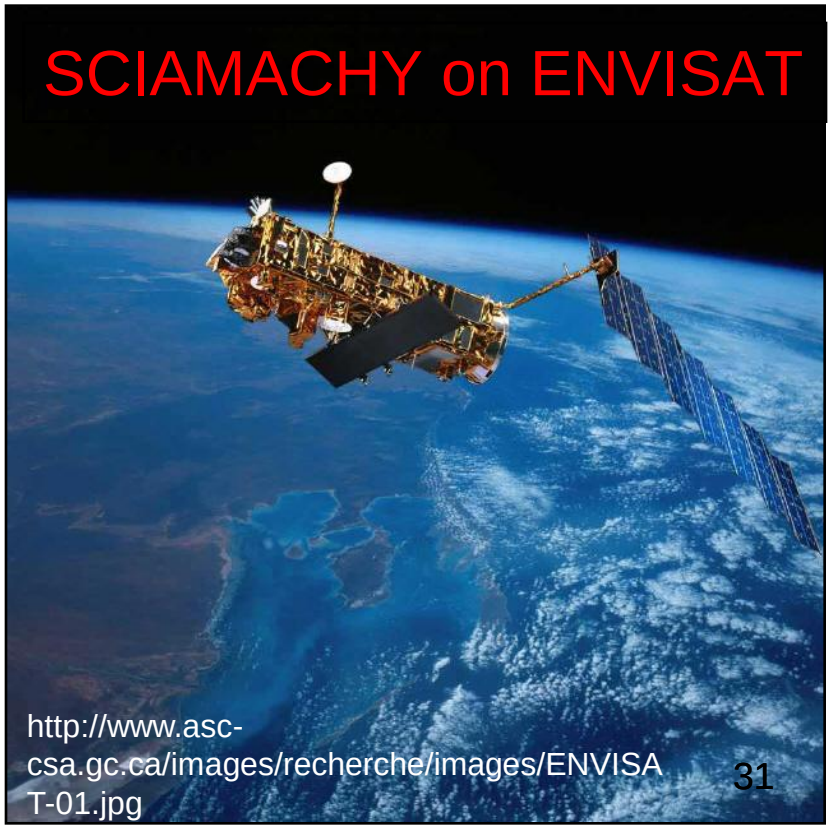
What is climate change?

- According to the Government of Canada, “Climate change is a long-term shift in climate measured by changes in temperature, precipitation, winds, and other indicators. Climate change can involve both changes in average conditions and changes in variability, including, for example, changes in extreme conditions.”
  - Government of Canada: Canada’s Action on Climate Change, http://www.climatechange.gc.ca/default.asp?lang=En&n=F2DB1FBE-1

How can we monitor GHGs?

- We can learn about the Earth's climate in past centuries a few different ways.
  - Paleoclimatology is the study of climate using natural sources such as tree rings, ice cores, corals, and ocean and lake sediments.
- We can also study the present state of the atmosphere a few different ways.
  - Climatology is the study of the climate using measurements from satellites, balloons and the ground.

- Measurements can be made from satellites, balloons and the ground.



Spectrometers and Spectroscopes

Spectrometers

- Spectrometers are a common way to measure greenhouse gases and other gases in the atmosphere.

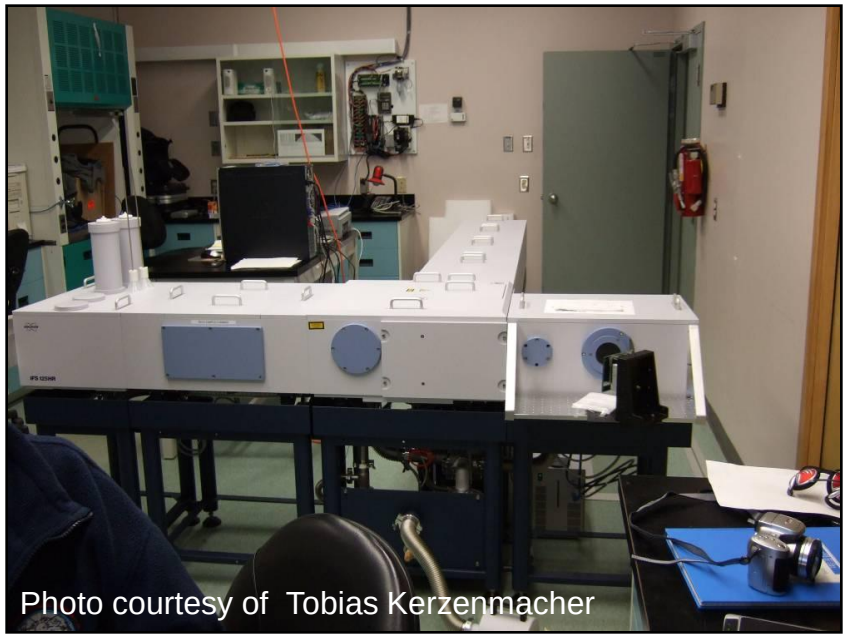


Photo courtesy of Tobias Kerzenmacher

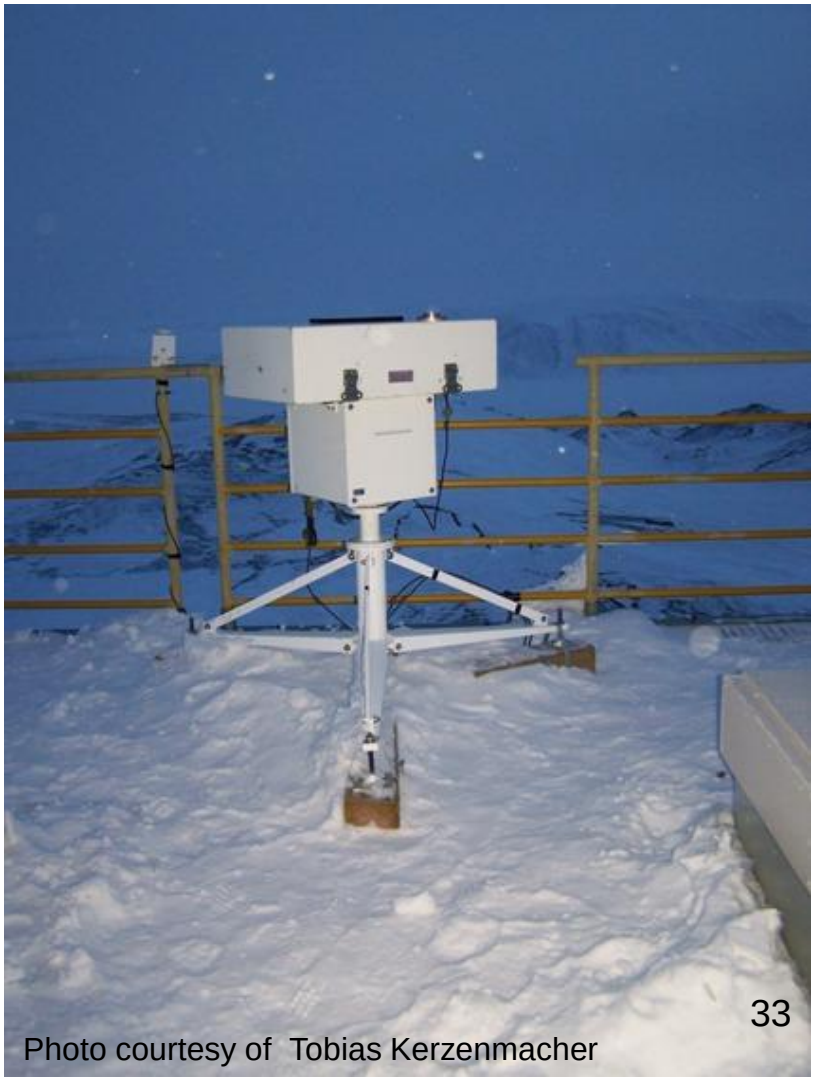
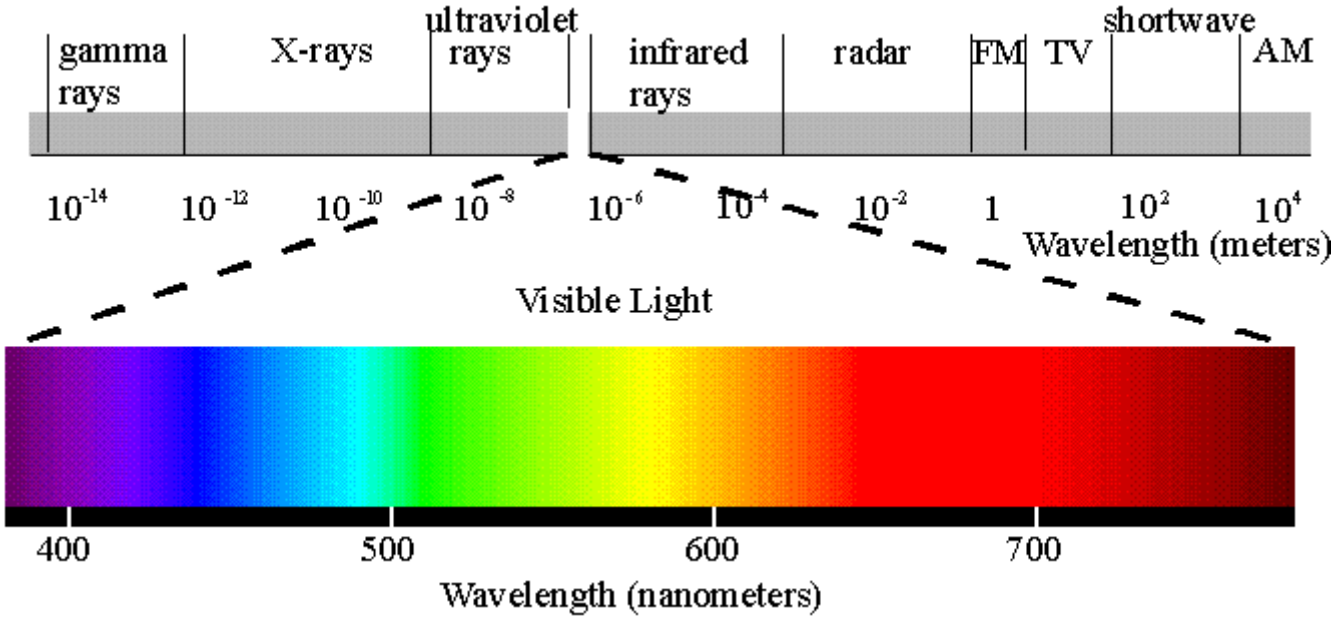


Photo courtesy of Tobias Kerzenmacher

The Electromagnetic Spectrum



http://www.yorku.ca/eye/spectru.htm

Inside a UV-Visible Spectrometer

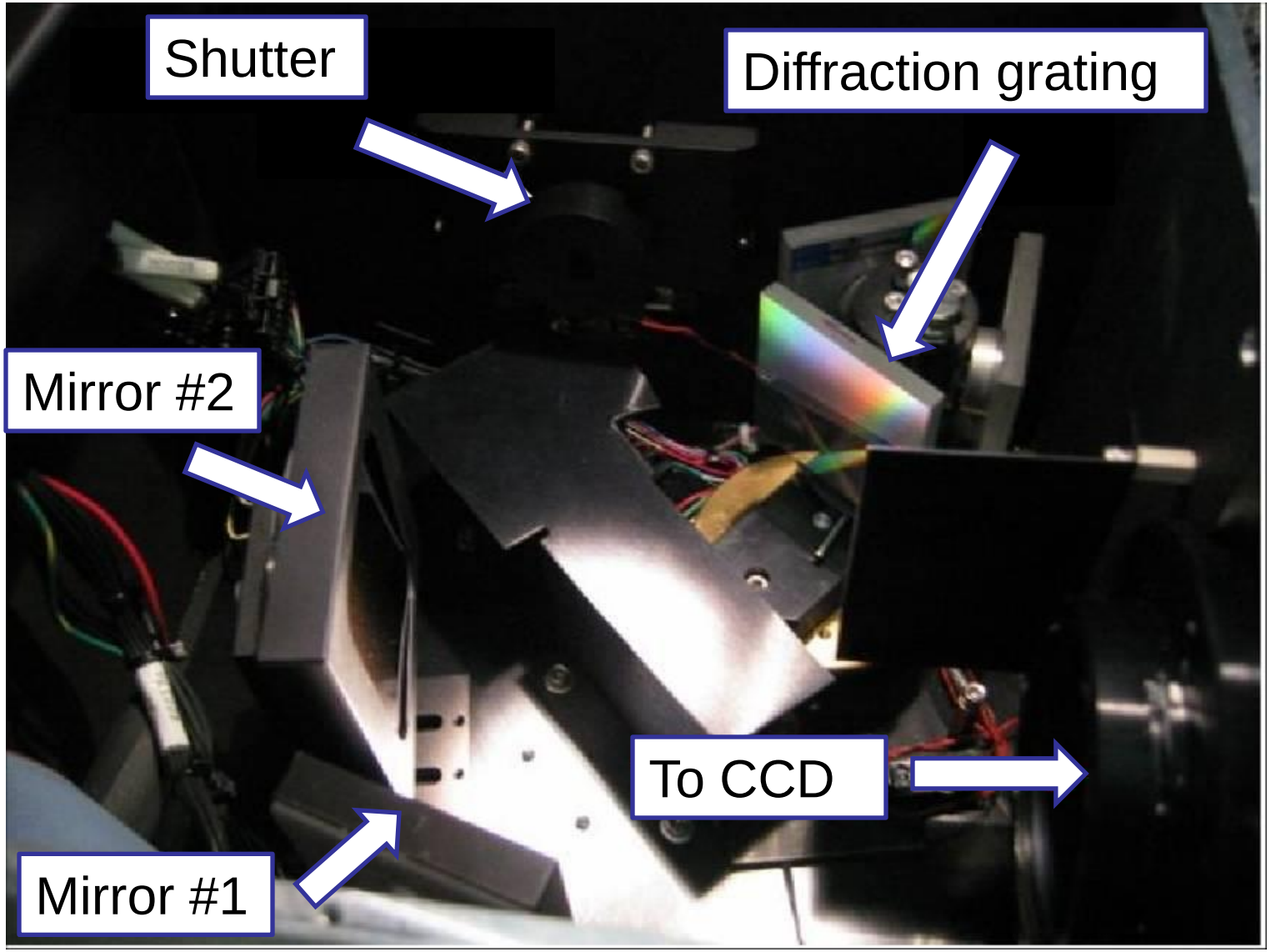


Photo courtesy of Paul Loewen

Inside a UV-Visible Spectrometer

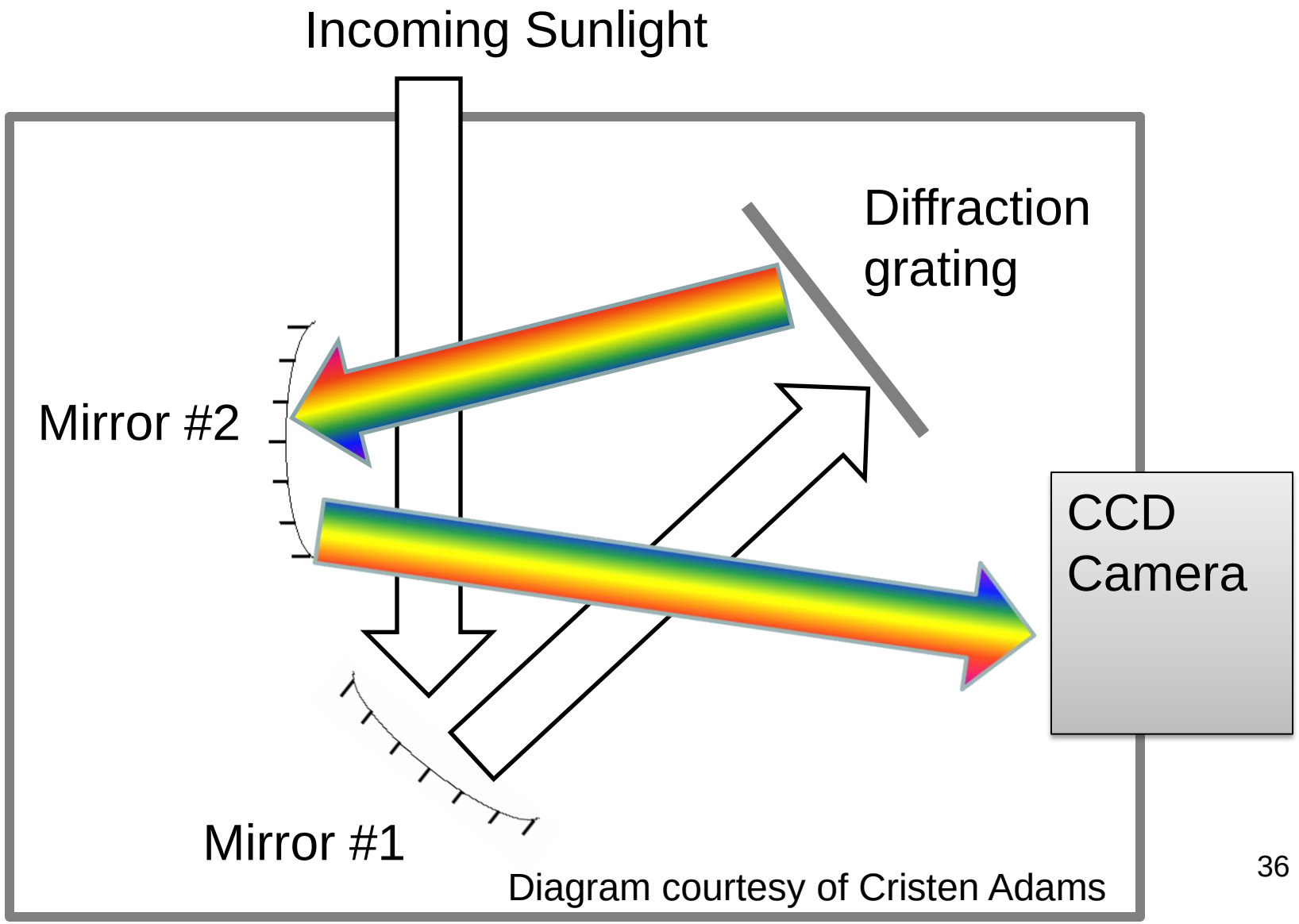
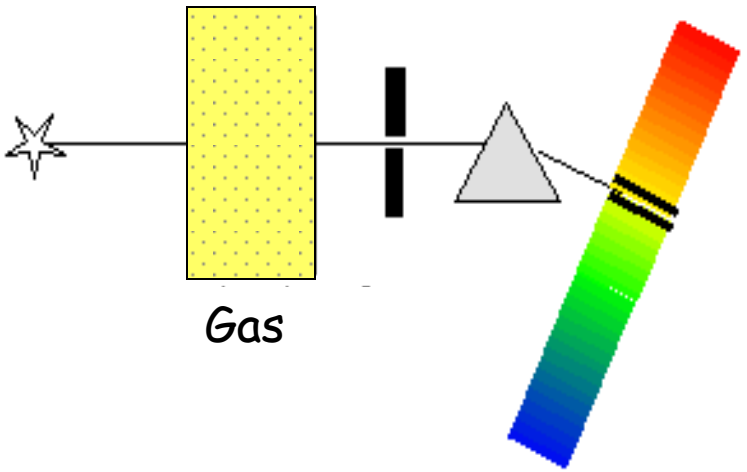
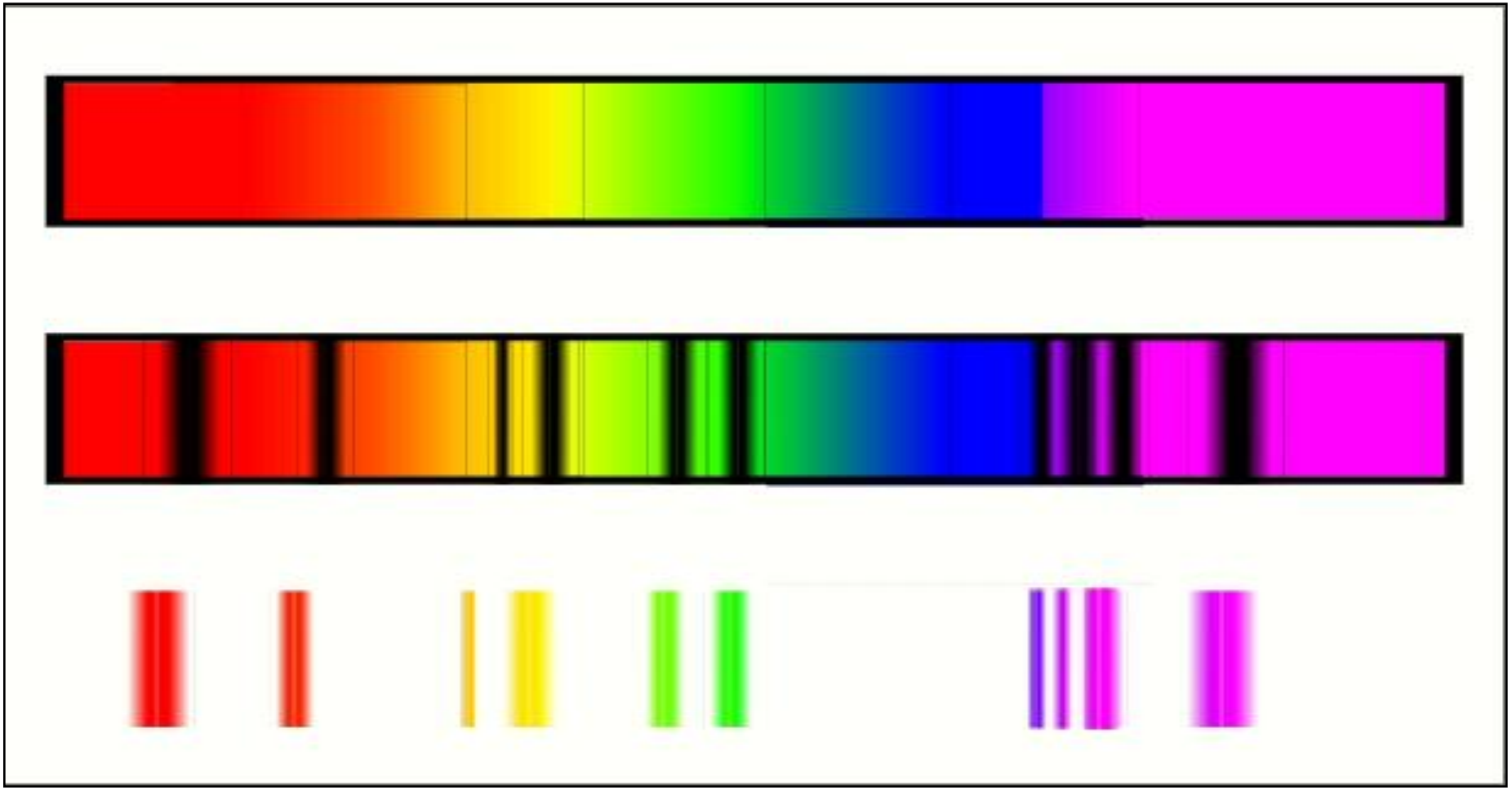


Diagram courtesy of Cristen Adams

‘Fingerprints’

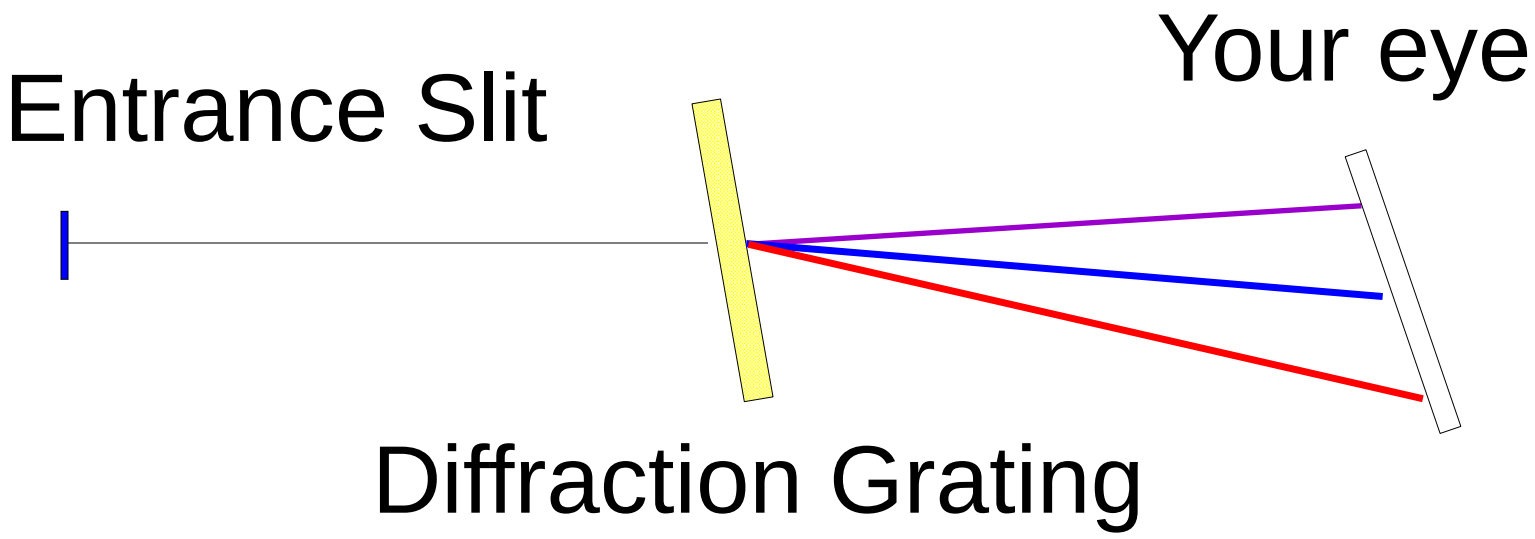
- Each person has their own set of fingerprints, and so too do gases in the atmosphere.
- A particular gas or molecule absorbs a unique pattern of colours.
- When the light reaches the spectrometer, the spectrum will be missing pieces where the light has been absorbed by the gases in the atmosphere.





http://www.asc-csa.gc.ca/images/edu_scisat_grade9-spectra-trans_spectrum_type1.jpg

A Simple Spectroscope



Build a Spectroscope

For instructions visit:
http://jchemed.chem.wisc.edu/HS/Journal/Issues/2006/Jan/clicSubscriber/V83N01/p56.pdf