



Summary:

- ★ • Earth's interior and composition
- Probing the interior with seismic waves
- Earth's surface – imaging it with the Landsat satellites
- The atmosphere and the greenhouse effect
- The magnetosphere, Van Allen Belts, and the aurora

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<https://github.com/AstroDimitrios/Astronomy>



The Earth

and its wonders



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Recap



1. Kepler's first law was ...
2. Kepler's second law was ...
3. Kepler's third law was ...
4. What two things affect the gravitational field strength of a planet?



- 1: Orbits are elliptical with Sun at once focus
- 2: Equal areas in equal times
- 3: Ratio of the square of the orbital period and the cube of the semimajor axis is the same for all planets
- 4: Mass and distance



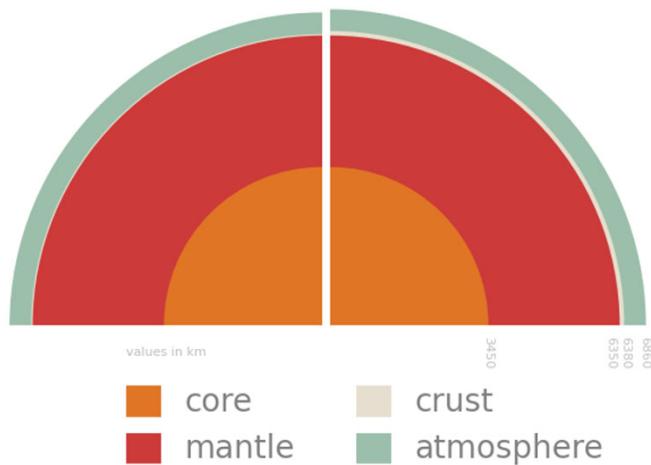
Full image has 1km per pixel

https://earthobservatory.nasa.gov/features/BlueMarble/BlueMarble_2002.php

Link has animations and other maps!

Internal Structure

Earth
compositional



Crust 5-70 km thick

Oceanic crust is denser and thinner made of basalt.

Continental is thicker and less dense and made of granite.

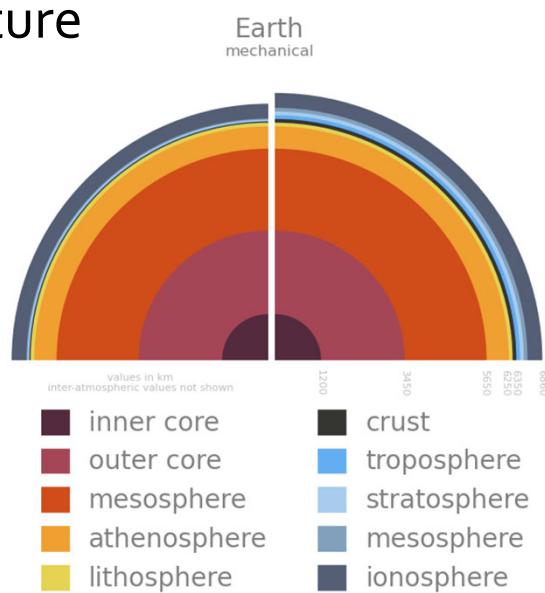
Compositional layers show changes in the main chemical components of the planet.

Core is iron + nickel and some impurities

Mantle is magnesium rich rock

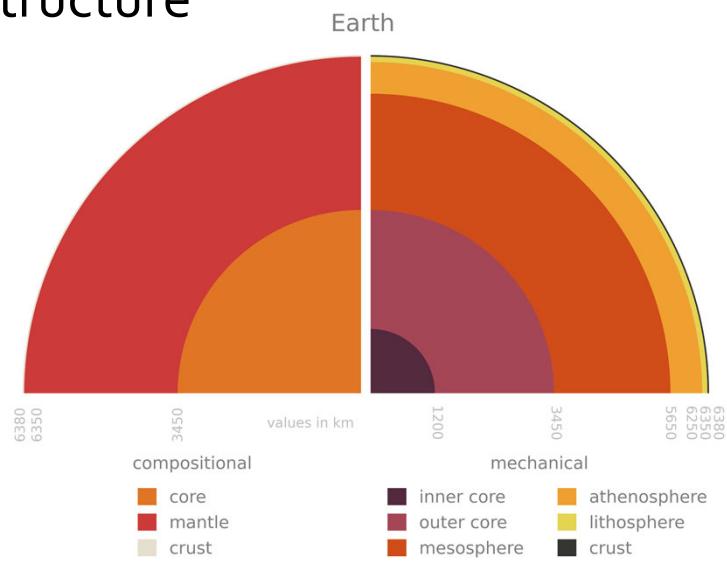
Atmosphere is mostly Nitrogen and Oxygen

Internal Structure

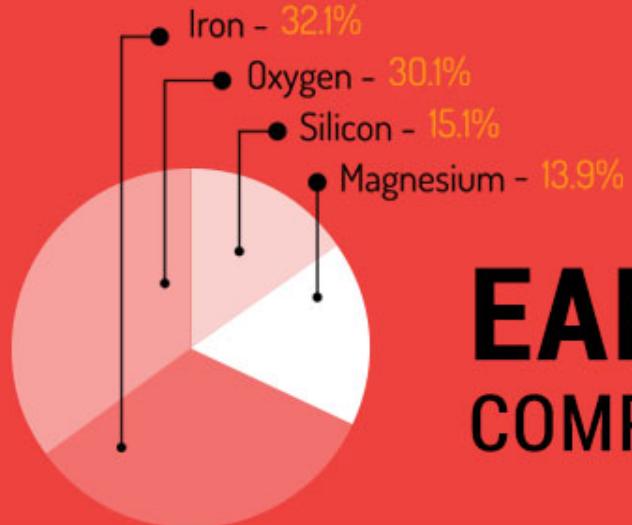


Mechanical layers denote changes in the physical properties of the material like the speed a wave travels through it.
Mainly strength and rigidity.

Internal Structure



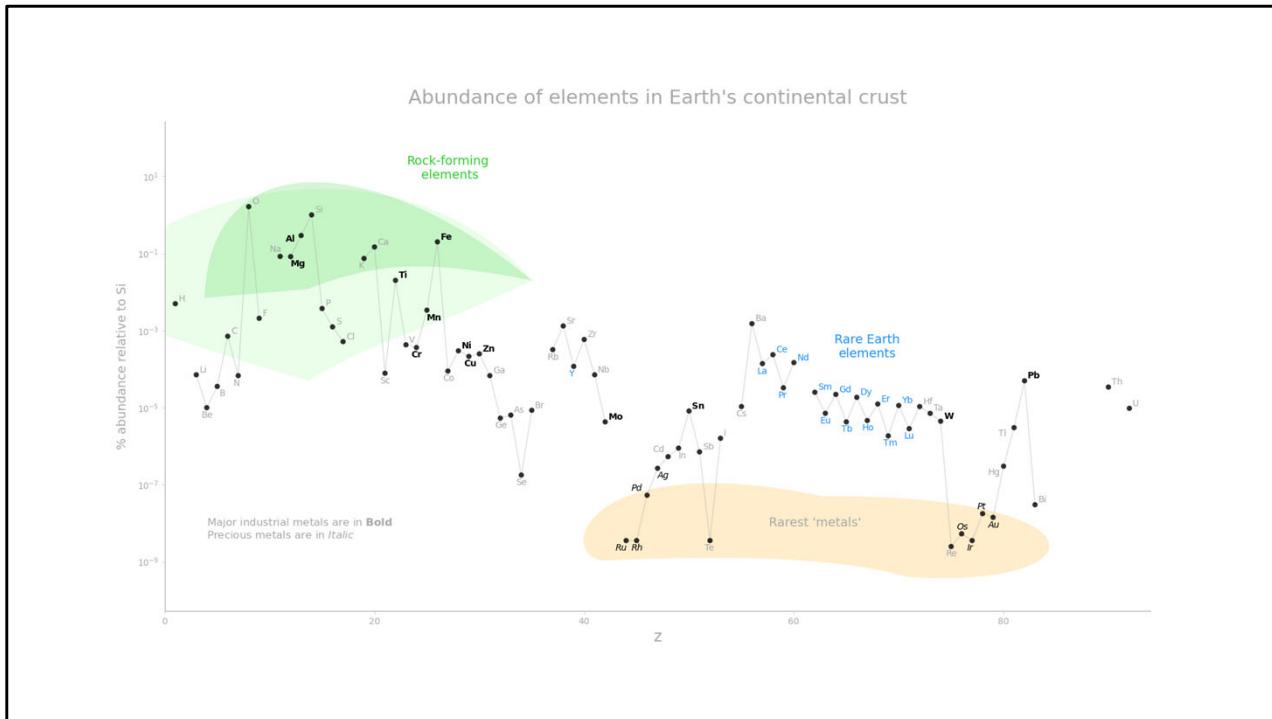
Comp vs mech layers



EARTH'S COMPOSITION

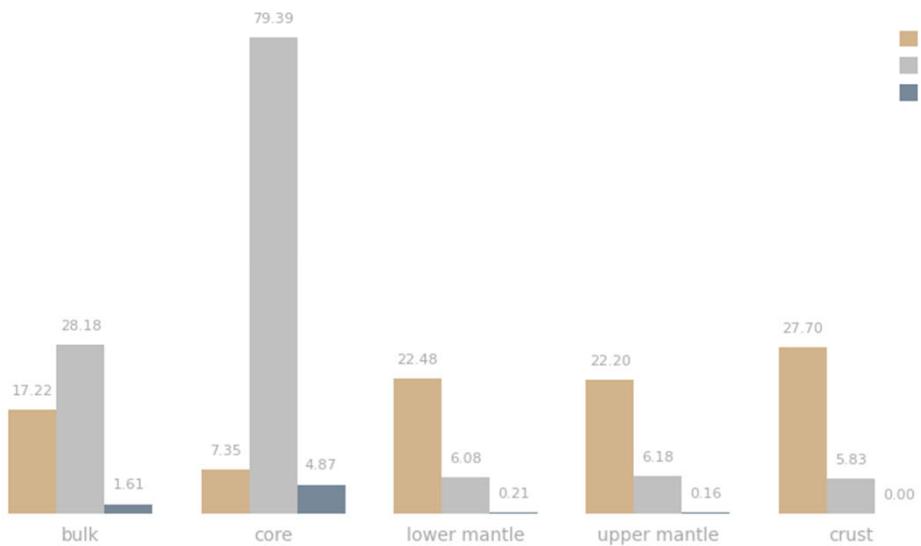
EARTHHOW

Overall composition.

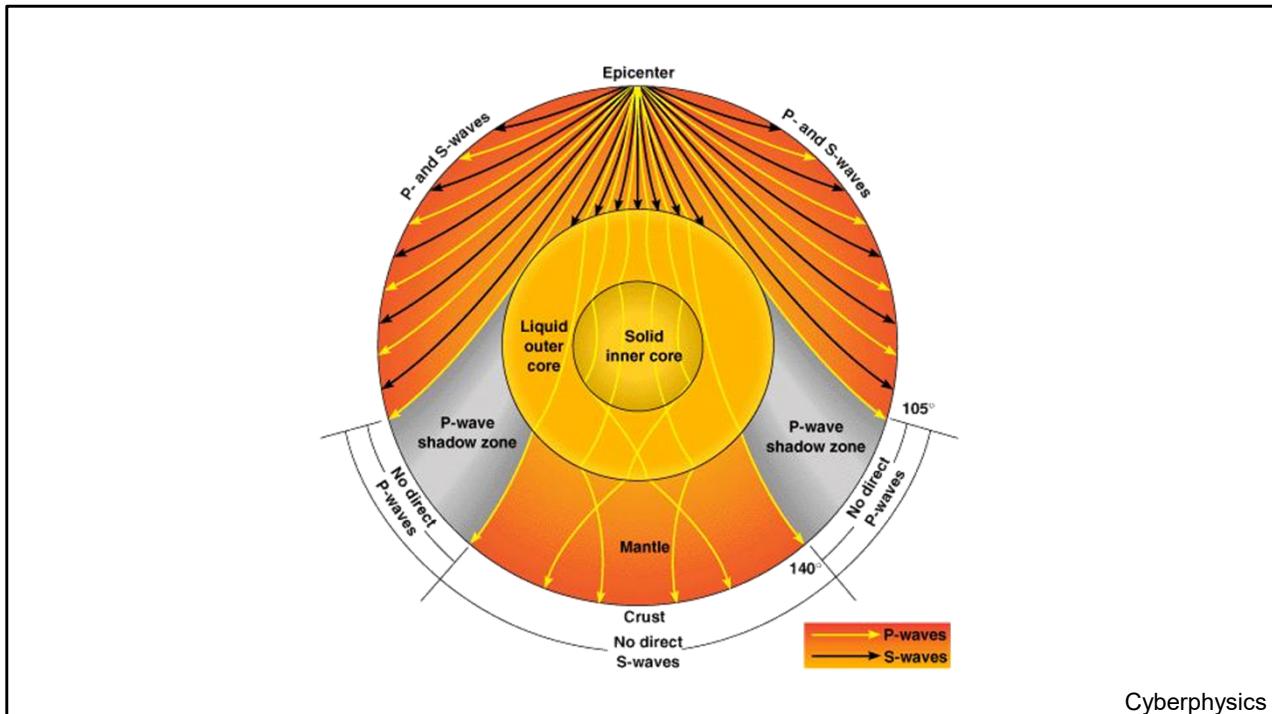


Composition of the crust only – note the log scale and the large amount of Oxygen.

Percentage of total composition for elements Si, Fe, and Ni in different layers of the Earth



Slightly older data but shows the difference between the compositional layers well.



Cyberphysics

Transverse s waves can't travel through the outer core so it must be a liquid.

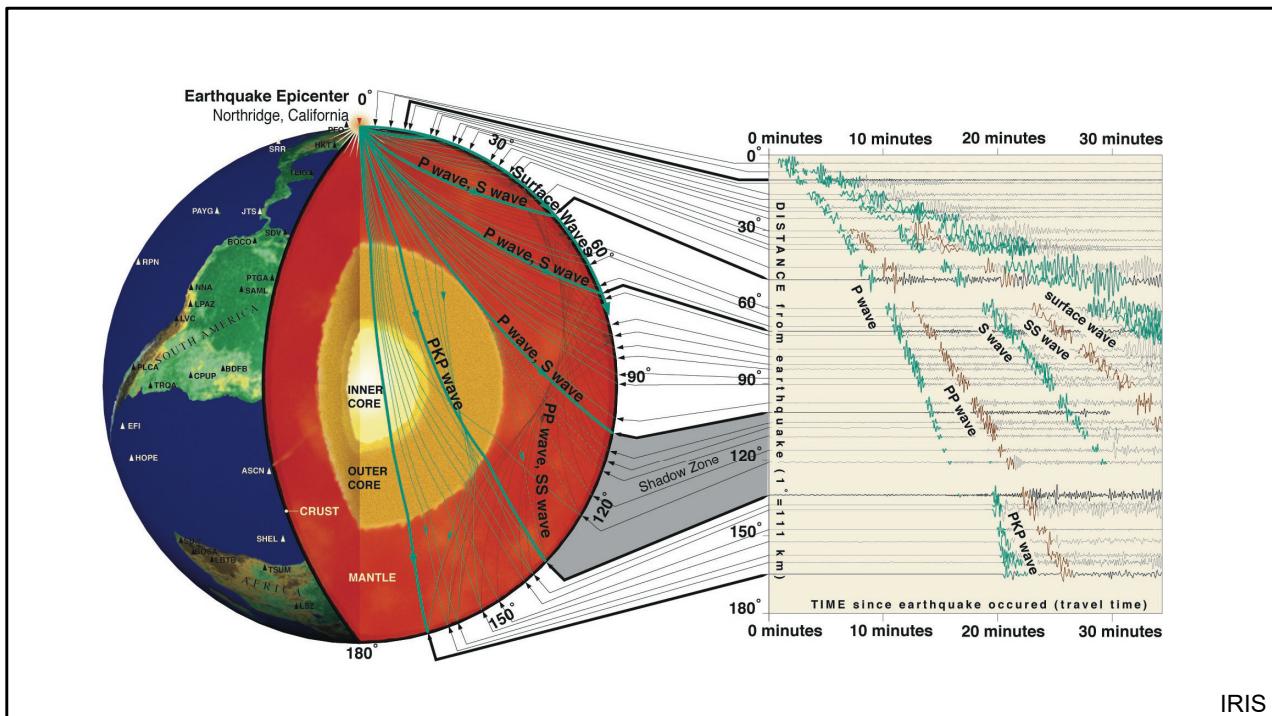


Image from:

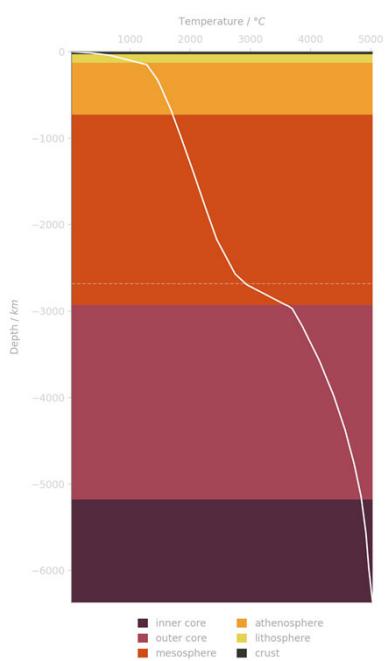
https://www.iris.edu/hq/inclass/lesson/imaging_earths_interior_with_seismic_waves/in_the_ppt

PKP is just a wave that has travelled through the outer core. PP and SS have bounced off the surface.

Internal Temperature

Based off models and known phase changes of certain materials.

Thought to reach anywhere from 5500 to 6500 degrees Celsius at the centre of the core.



Theoretical! We can't drill down to see. Kola Superdeep borehole 12.2km

Recap



1. What is the difference between the continental and oceanic crust?
2. What is the difference between a compositional and mechanical layer?
3. What is the inner core made out of?
4. What temperature is the Earth's inner core?



Earth's Surface

71% water

97% of that is in the ocean

2% is frozen

<1% is fresh water

An even smaller amount is
water vapour in the air



NASA/MODIS

Earth's Surface

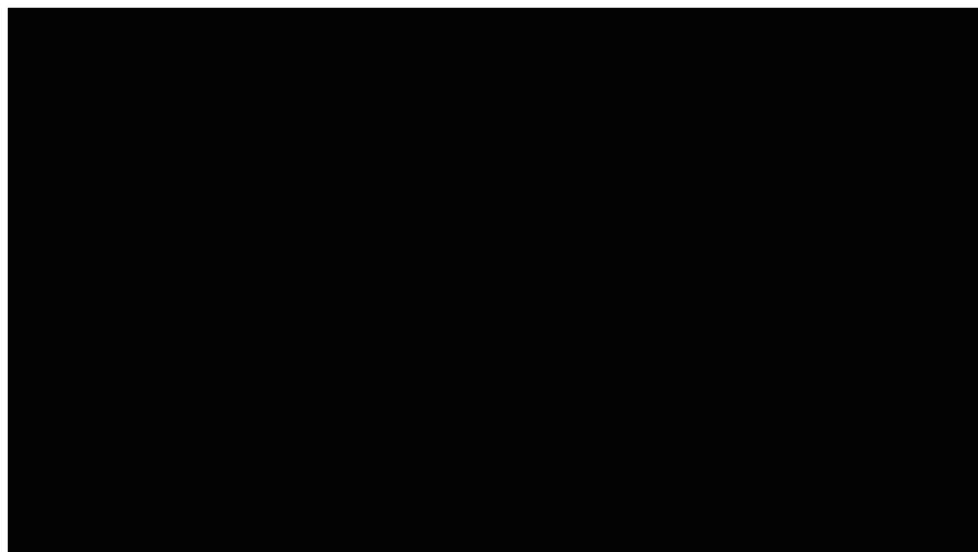


NASA/Landsat

[Emaprlab.users.earthengine.app/view/lt-gee-time-series-animator](https://emaprlab.users.earthengine.app/view/lt-gee-time-series-animator)

Let's you make a gif over time of you favourite places!

Earth's Surface



NASA/Landsat

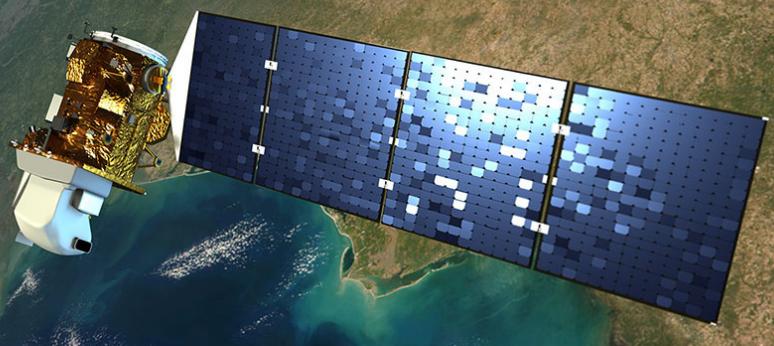
Gif shows the evolution of the Landsat program by NASA/USGS which images the Earth.

Earth's Surface

Monitors:

Wildlife
Human Activity
Climate Change
Fires
Weather

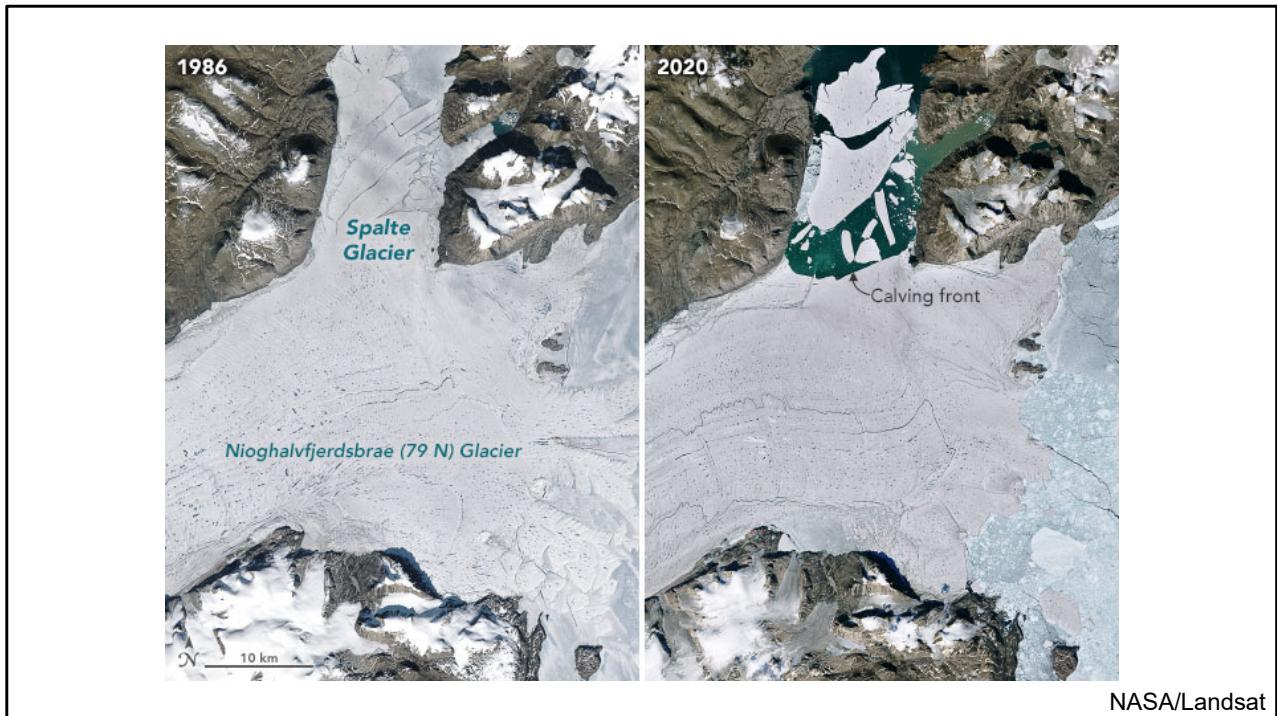
Images in visible and
IR wavelengths of light



NASA/Landsat

Landsat 9!

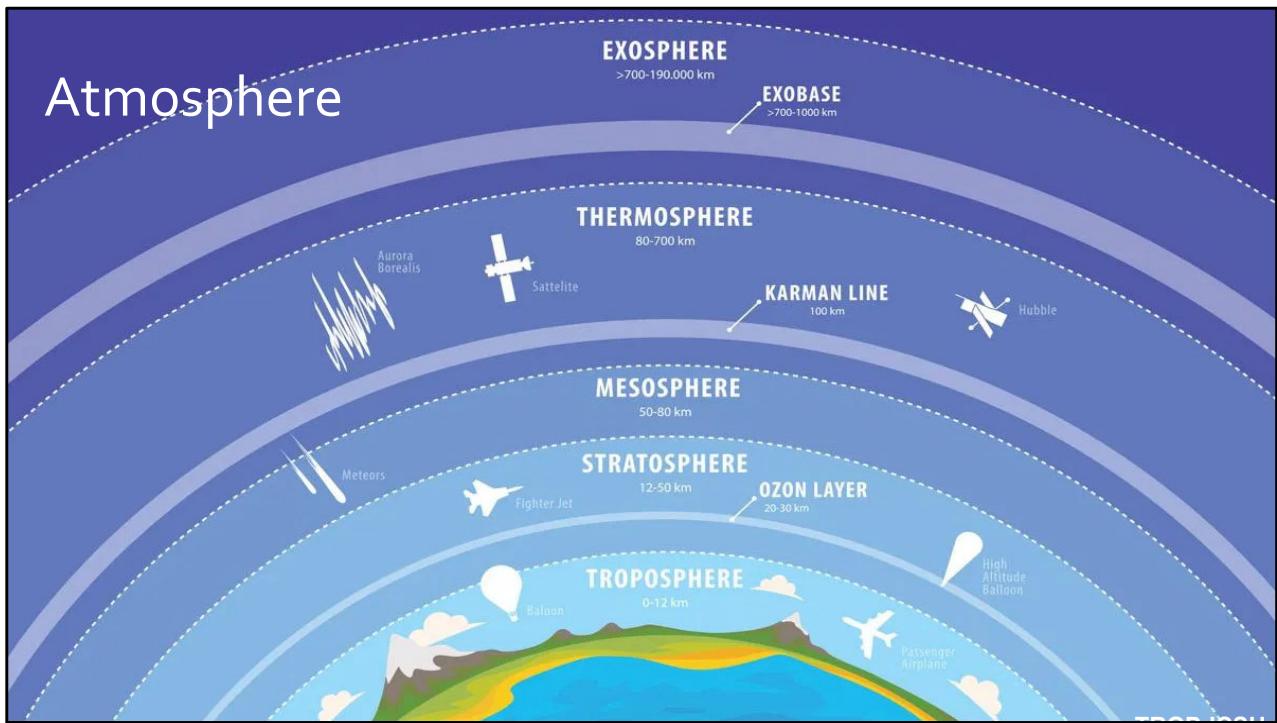
<https://landsat.visibleearth.nasa.gov/index.php?p=1>



NASA/Landsat

Glacier in Greenland showing calving and retreat.

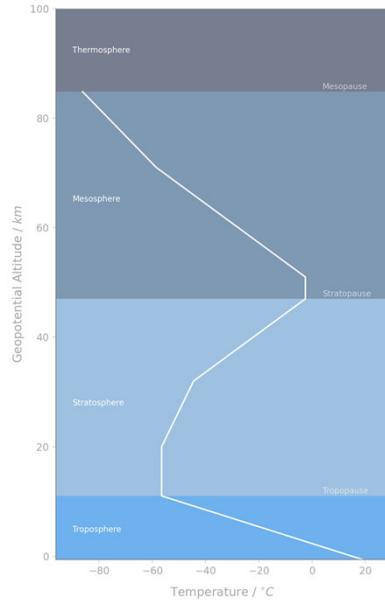
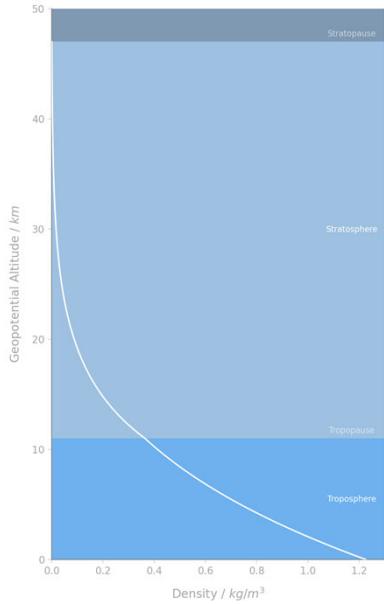
<https://landsat.visibleearth.nasa.gov/view.php?id=147350>



Exobase is where the edge of the atmosphere is after that the particles are free to escape into space.

The exosphere is warm because it's being bombarded with solar radiation.

Atmosphere

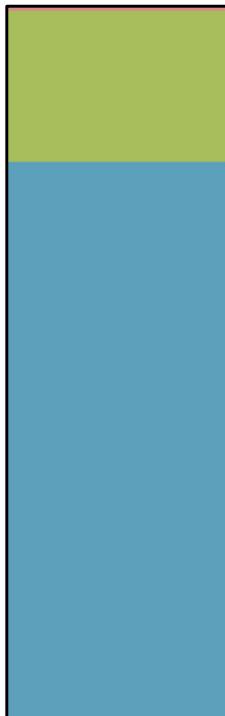


Layers are bottom to top.

The images are for the International Standard Atmosphere since our atmosphere varies.

Above where the graphs stop the density continues to decrease but the temp sharply increases to 1500 deg C in the exosphere at

Atmospheric Composition



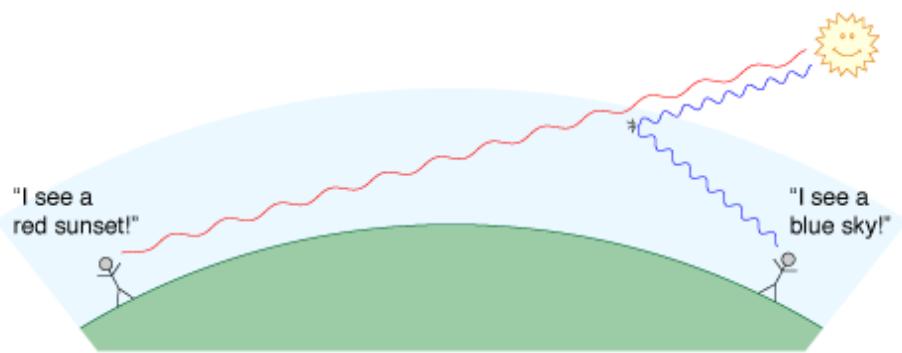
Mostly Nitrogen and Oxygen

Carbon Dioxide is the most abundant greenhouse gas

All other gases such as methane are present in smaller trace amounts

Why is the sky blue?

Shorter blue wavelengths of light are scattered by air particles.



Daniel V. Schroeder

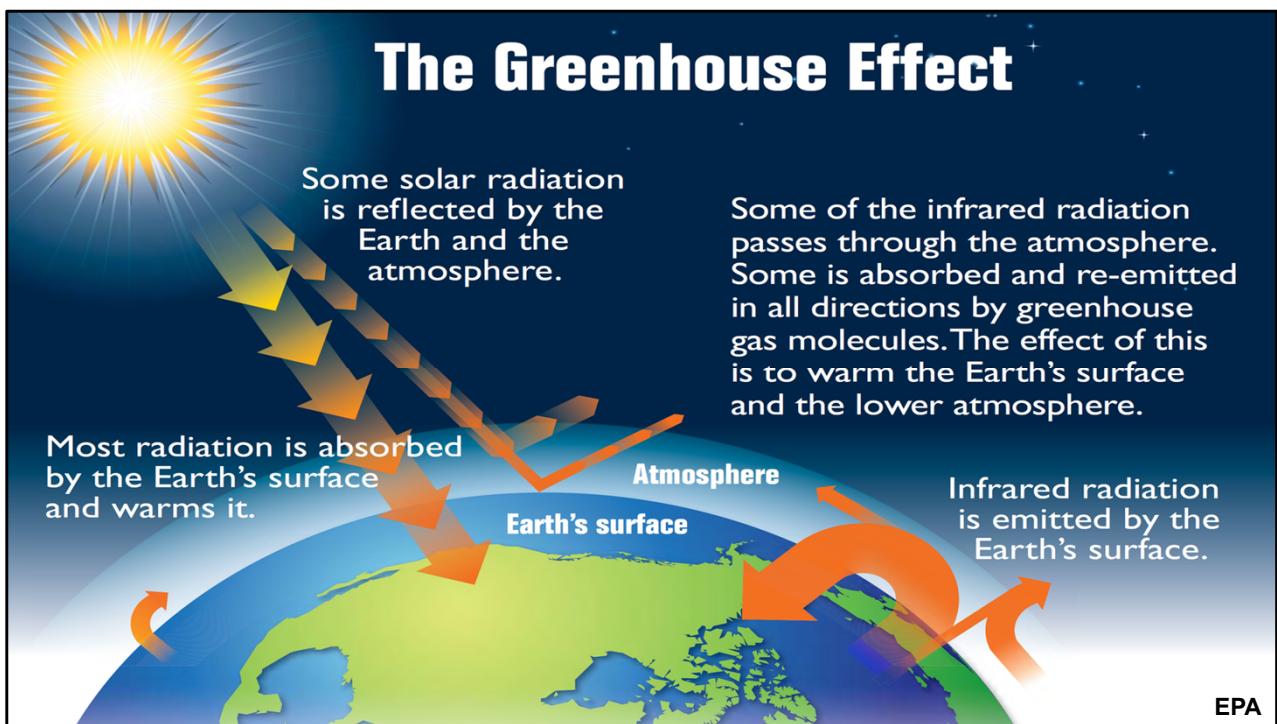
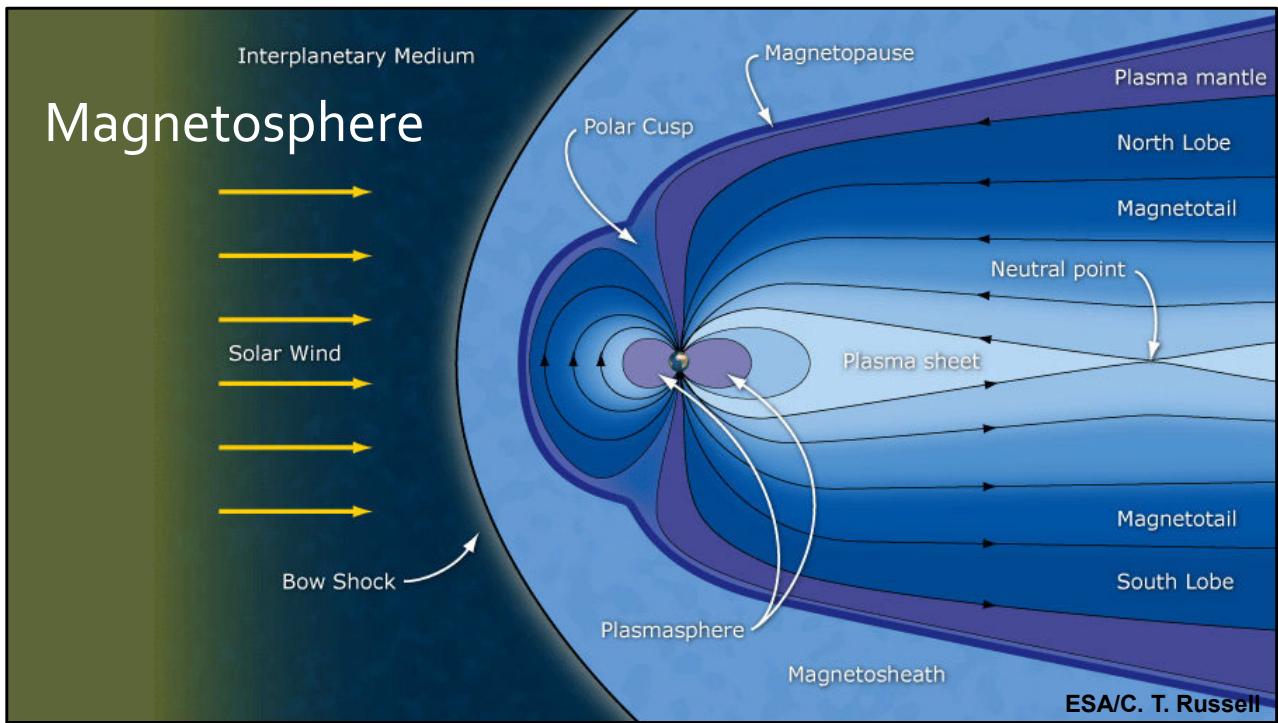


Image by the Environmental Protection Agency via Wikimedia commons



Caused by rotating/moving fluid in the outer core

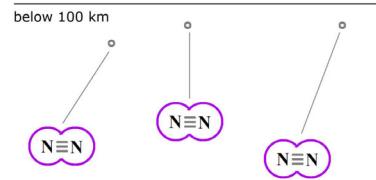
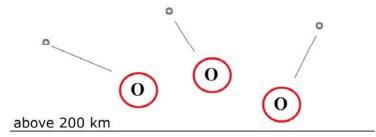


ESA/NASA

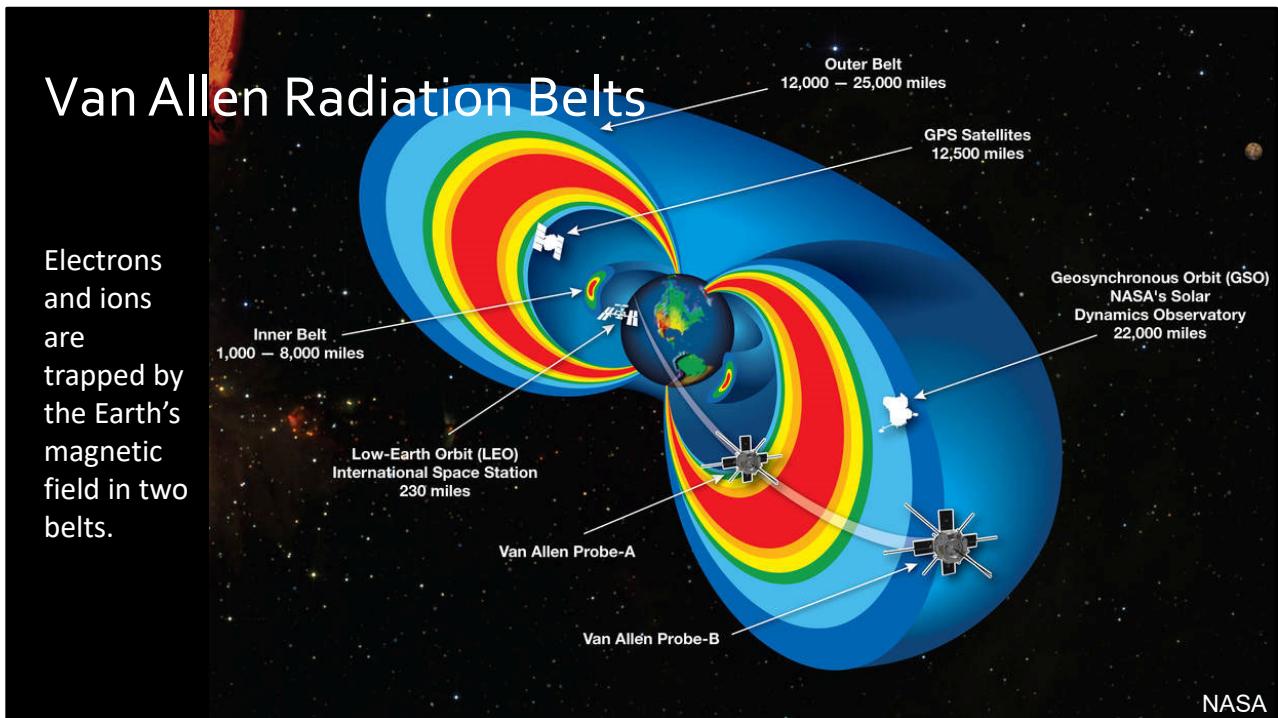
<https://www.nasa.gov/image-feature/aurora-and-the-pacific-northwest>

Charged particles enter the polar cusps and ionise the particles in the atmosphere.

Aurora colors explained



Sun Viewer Twitter



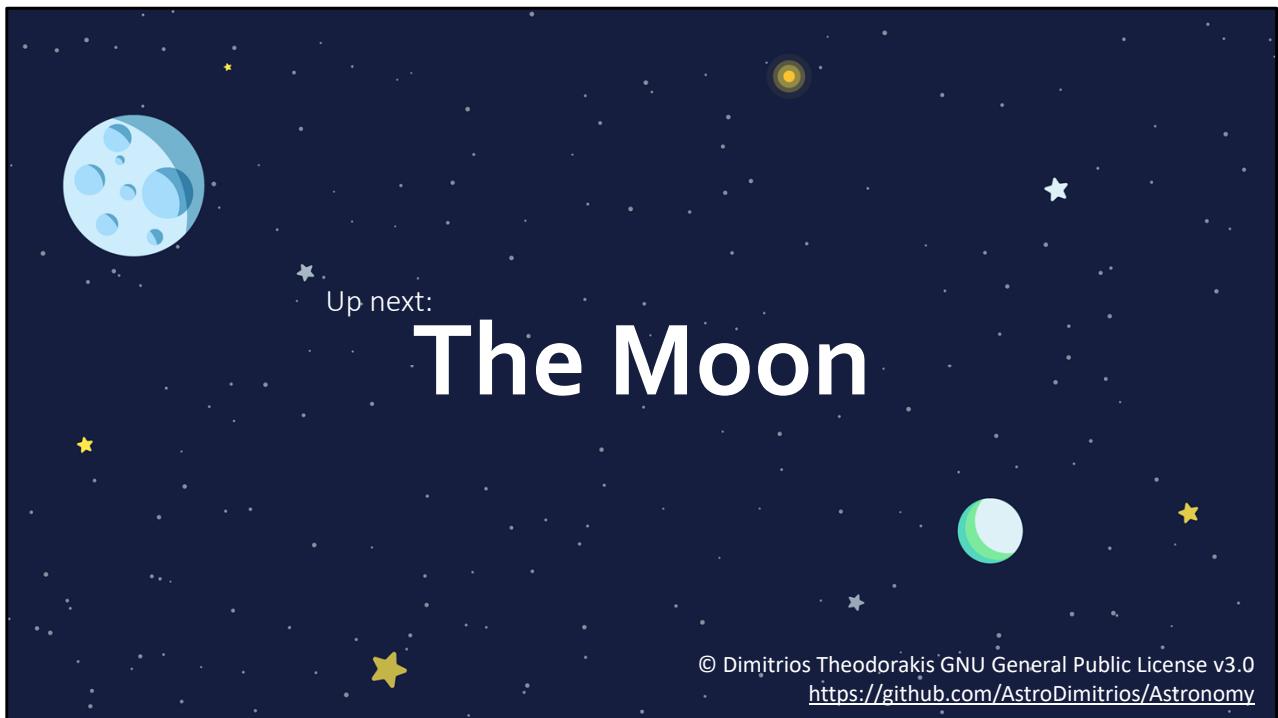
https://www.nasa.gov/mission_pages/sunearth/news/gallery/20130228-radiationbelts.html

Recap



1. How much CO₂ is there in the atmosphere? *
2. Why do we observe the Earth in IR wavelengths?
3. What produces the Earth's magnetic field?
4. What makes the different colours of the Aurora?





Up next:

The Moon

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