



# CCD IMAGING Earth's Atmosphere



# Earth's Atmosphere



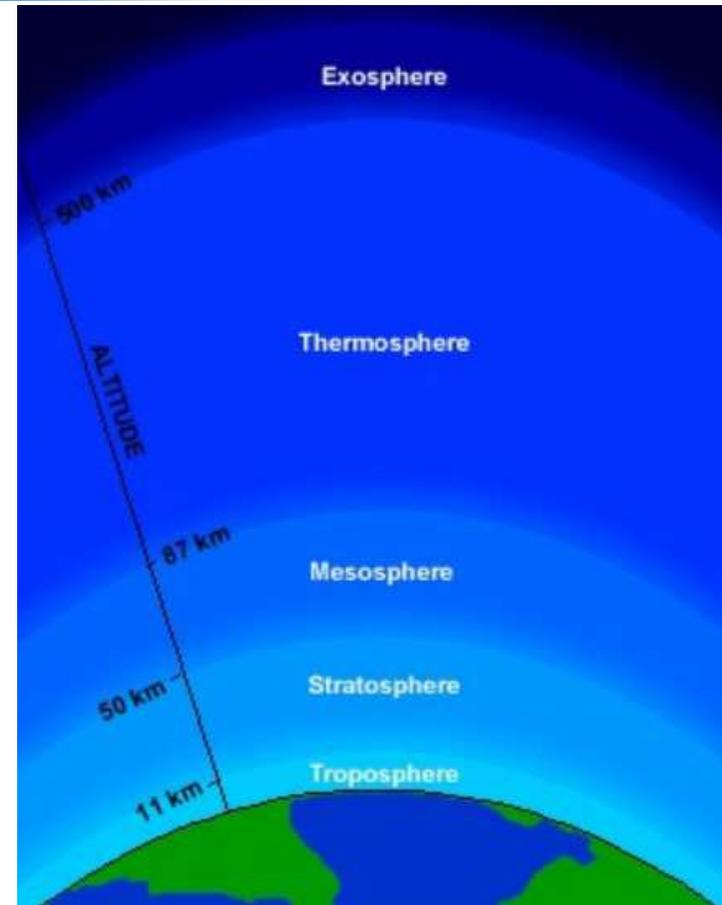
## Overview

While creating some beautiful effects, the Earth's Atmosphere is severely limiting from an Astronomical perspective. This lesson will outline some of those problem areas that must be considered.

Other related lessons: Seeing & Air Mass



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## Earth's Atmosphere

### The Earth's Atmosphere: Bane of the Astronomer

The Earth's atmosphere is beneficial to us as it provides beautiful vistas and shields us from harmful DNA-destroying things like x-rays and ultraviolet EMR and cosmic rays.

For ground based astronomers, these benefits create problems that we must deal with:

- Clouds
- Light Pollution & Sky Glow
- Electromagnetic limitations (Ex. UV)
- Turbulent atmosphere (Seeing, blurring of images)
- Atmospheric Extinction



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## Earth's Atmosphere

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### What is Extinction?

The impact of the Earth's Atmosphere causes an effect known as: Extinction - the dimming of a star's light caused by passing through the Earth's atmosphere. (NOTE: There is also interstellar extinction that will be mentioned later).

The effect is expressed in units of magnitudes that increase as the viewed object is further from the zenith and closer to the horizon. Extinction is not the same for all colors: red light is scattered less than blue light.

Deep red sunsets are pretty, but they can be bad news for photometry.





## Earth's Atmosphere

### Light Pollution & Sky Glow

The brightening of the night sky caused by street lights and other man-made sources, which has a disruptive effect on natural cycles and inhibits the observation of stars and planets.

Impacts astronomical imaging. Some Photometric techniques can overcome this impact.



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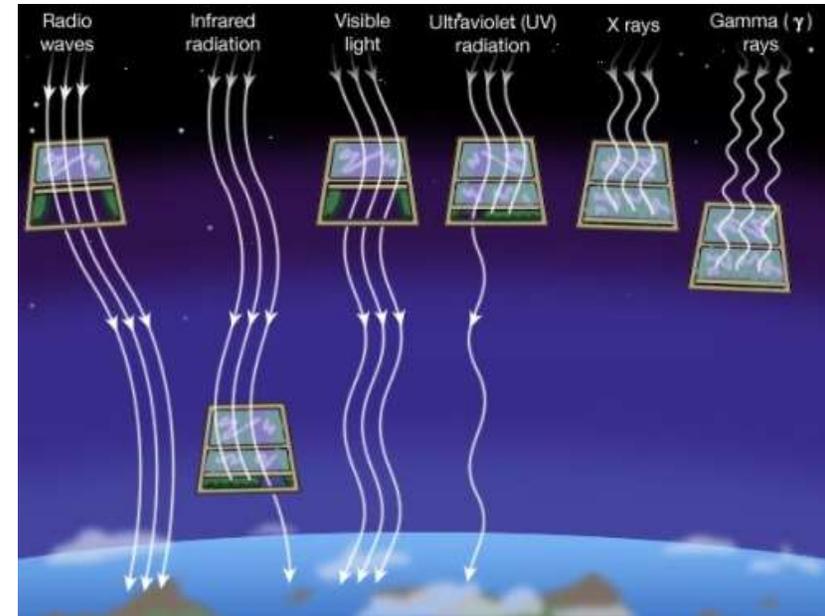
### Electromagnetic Limitations

The Earth's Atmosphere is only transparent to certain forms of light:

- Most radio light penetrates the atmosphere
- All visible light penetrates the atmosphere
- Some IR light passes through the atmosphere
- Most ultraviolet light (UV) and all X-rays and gamma-rays are blocked from reaching the surface of Earth

Therefore, the atmosphere has two main windows: Visible and Radio

IR can be better accomplished from higher elevations.





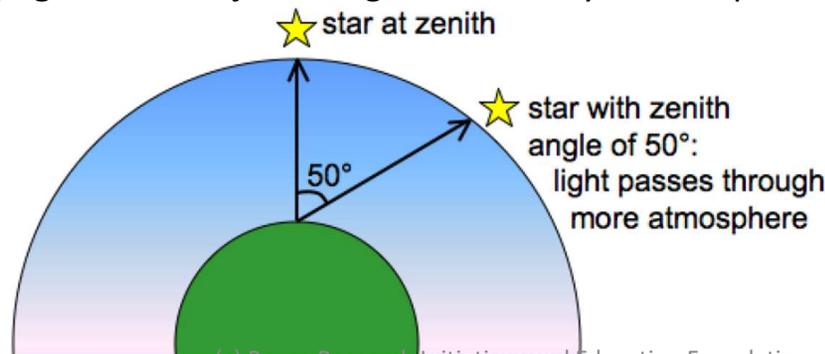
## Earth's Atmosphere

### Atmospheric Extinction

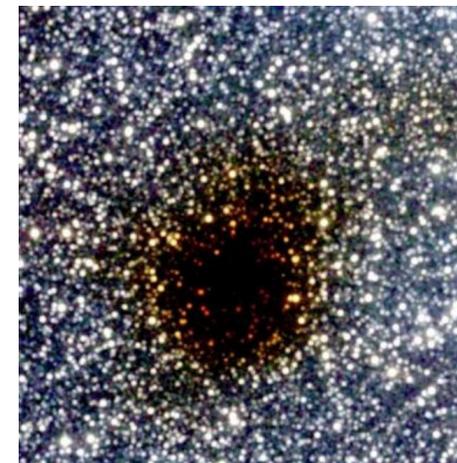
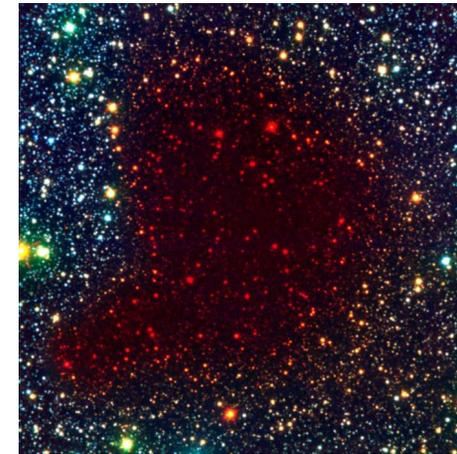
In reference to Astronomy, Extinction relates to the removal of light due to the blocking of certain wavelengths by interference from items such as: dust, water droplets, molecules, etc.

In space, this can be caused by molecular dust clouds. These cannot be mitigated but can be accounted for through post-processing practices that adjust the measured magnitudes for areas of known extinction.

On Earth, this is caused by the above items in the Earth's Atmosphere. This can be mitigated by delaying viewing/imaging until an object is higher in the sky....when possible.



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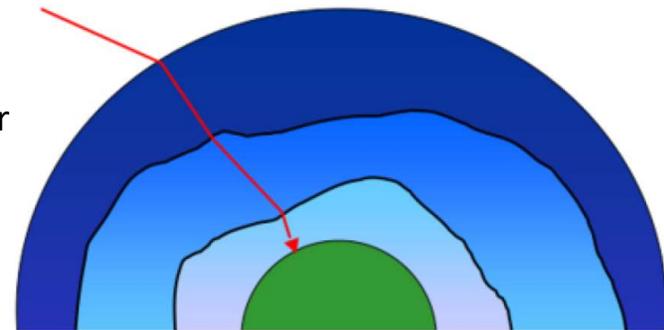
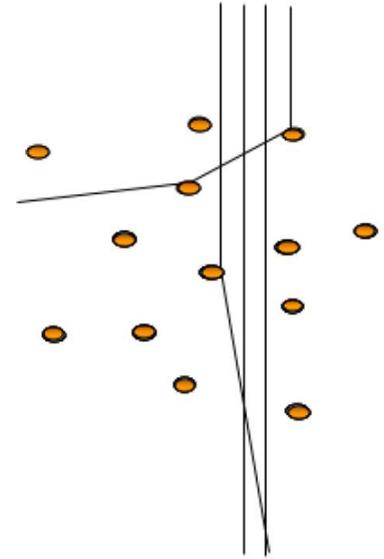
## Earth's Atmosphere

### Turbulent Atmosphere

When starlight enters the Earth's atmosphere, the photon paths can be altered in two main ways:

- Scattering Light Rays – When photons scatter off of particles in the atmosphere such as dust.
- Refracting of Light Rays – Variations in air pressure and temperature cause the bending (refraction) of light rays. Varying temps and pressure will cause this refraction to be inconsistent. Motion can be as much as a few arcseconds.

Significant changes in humidity, smoke or haze, dust, and many other sources can affect the impact of atmospheric extinction.



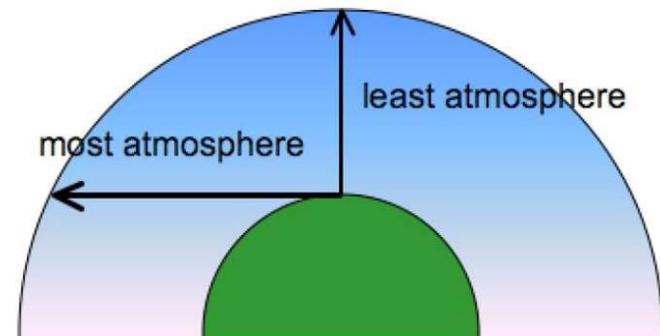
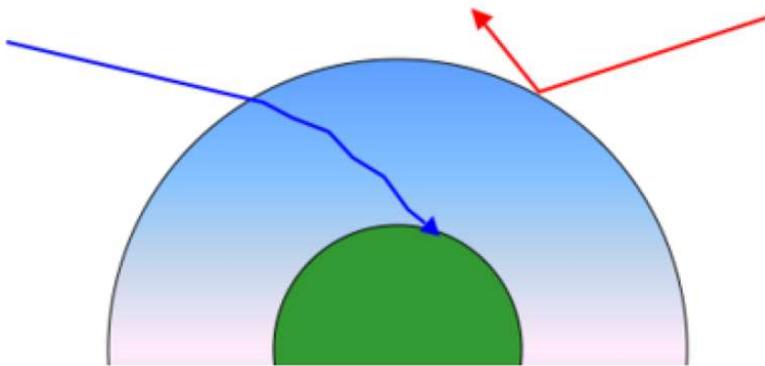


## Limiting Atmospheric Effects

Some of the factors discussed above can be mitigated by astronomers:

- Clouds
- Light Pollution & Sky Glow
- Electromagnetic limitations (Ex. UV)
- Turbulent atmosphere
- Atmospheric Extinction

Wait until the clouds move  
Differential Photometry, Filters, Post-Processing, Standard Stars  
Space based telescope????  
Image on different nights, increase image Binning  
View at lower Air Masses (closer to Zenith)





## Earth's Atmosphere

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### Summary

This lesson was provided to outline some of the considerations for how the Earth's Atmosphere impacts astronomical imaging and science.

Some of these can be mitigated from the Earth's surface while others cannot (ex. Gamma Rays).

For more on the effects of Seeing and Air Mass considerations in your imaging and science, refer to those lessons.



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***Questions?***