

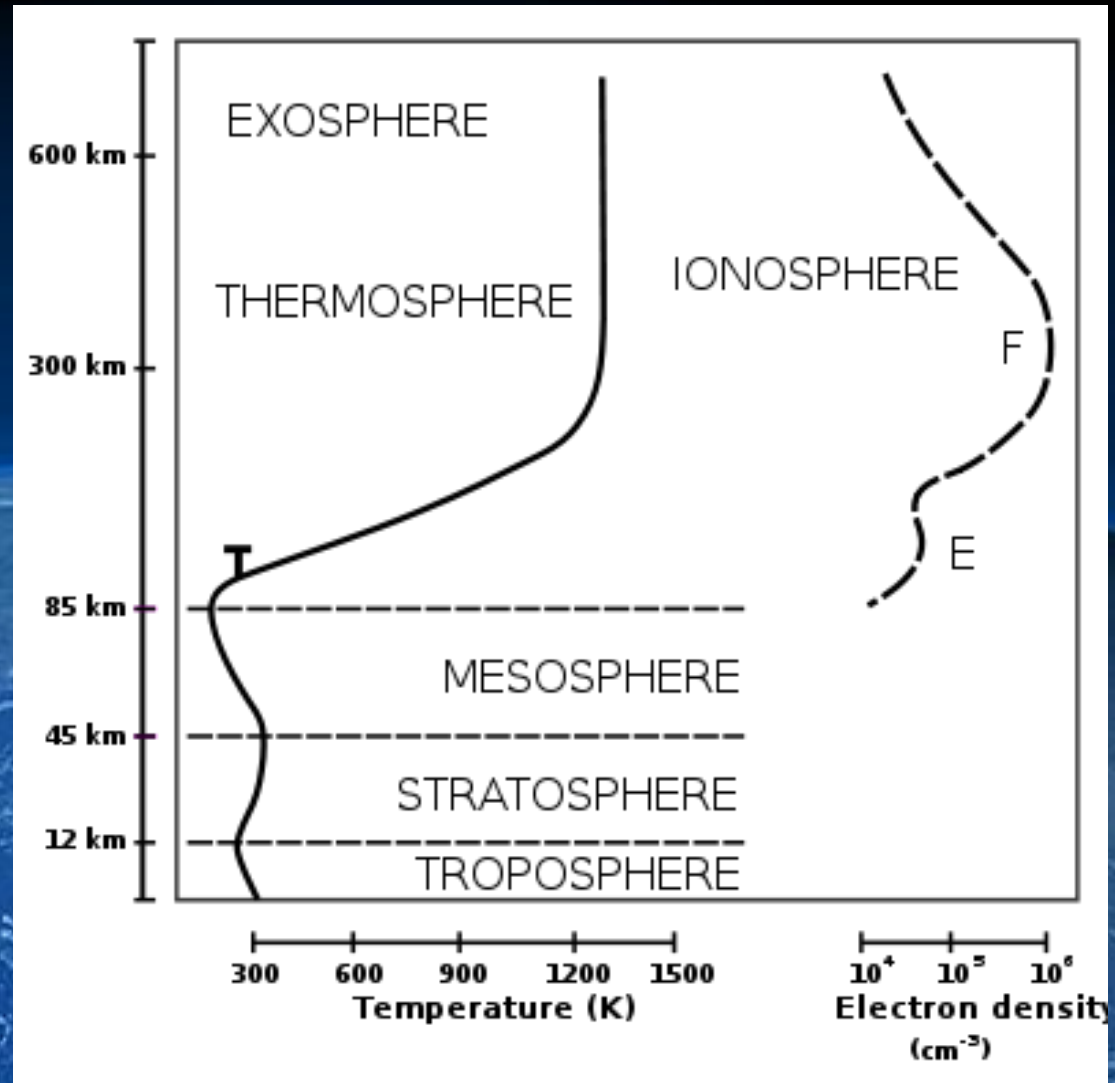
A satellite with a yellow body and solar panels is shown in orbit above the Earth's atmosphere. The Earth's surface is visible below, showing blue oceans and white clouds.

A Changing Thermosphere

By Tyler Blake

Thermosphere “Heat Sphere”

- Temperature increases with height
- ~80km to ~600km
- Includes Ionosphere
- Affected by solar radiation
- A Reducing Environment



Thermosphere Cooling?

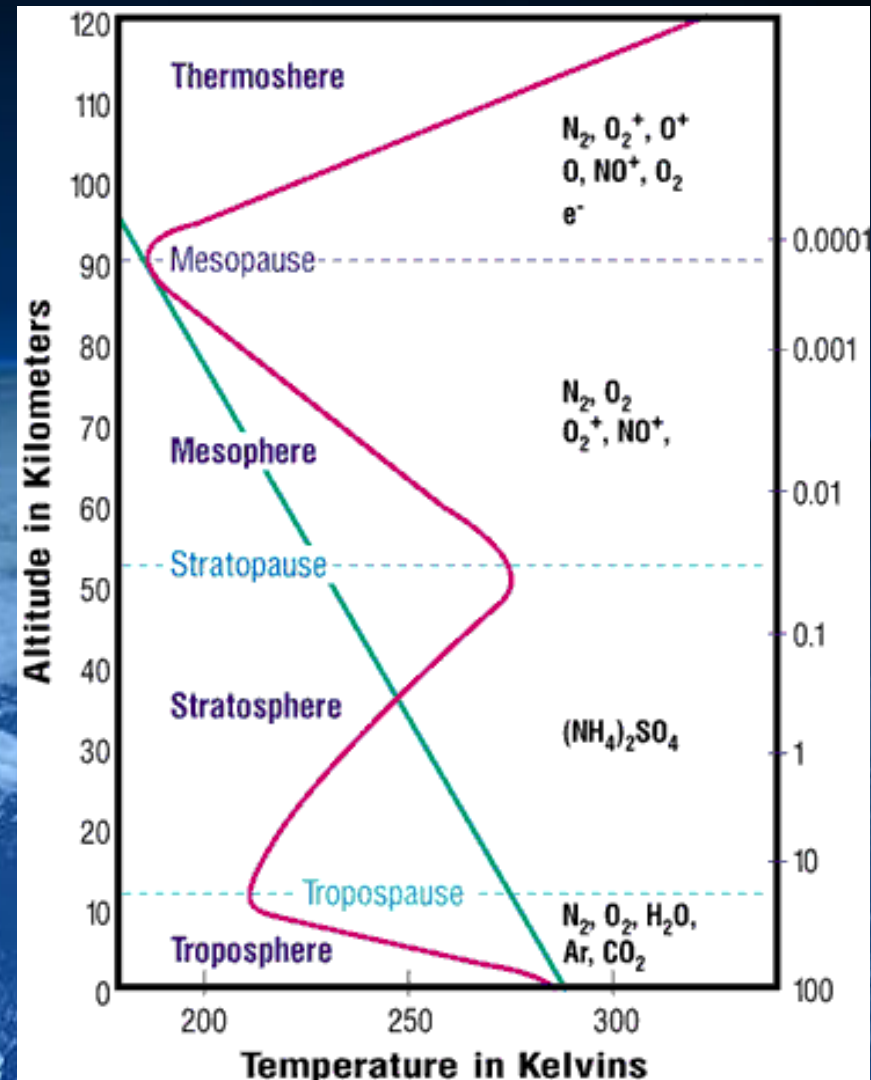
- Thermosphere thins with height
- Lower density = fewer collisions
- Fewer collisions = less energy radiated back to Earth, and thus cooling
- Density has decreased by 10% in the last 35 years

Increasing amounts of greenhouse gases work in the opposite way in the thermosphere, they radiate heat back to space

- As this happens, thermosphere condenses, each layer moves down, creating smaller differences between the layers
- Example is Venus, extremely hot troposphere and an extremely cold thermosphere

Chemistry

- Three body collisions aren't common due to low pressures
- Atomic Oxygen = main constituent
- High temperatures drive oxidation reactions in the reverse direction
- Photodissociation of Oxygen



Photodissociation

Oxygen

- $O_2 + h\nu \rightarrow O + O$
- Gravity separates molecules (Nitrogen at bottom, Oxygen in middle, H and He at top)
- Doesn't occur at any other part of the atmosphere

Nitrogen

- $N_2 + h\nu \rightarrow N + N$
- Photodissociation of N_2 only occurs at high altitudes



Recombination

Oxygen

- $O + O \rightarrow O_2$
- $O + N + [M] \rightarrow NO$
- Cyclical Process

Nitrogen

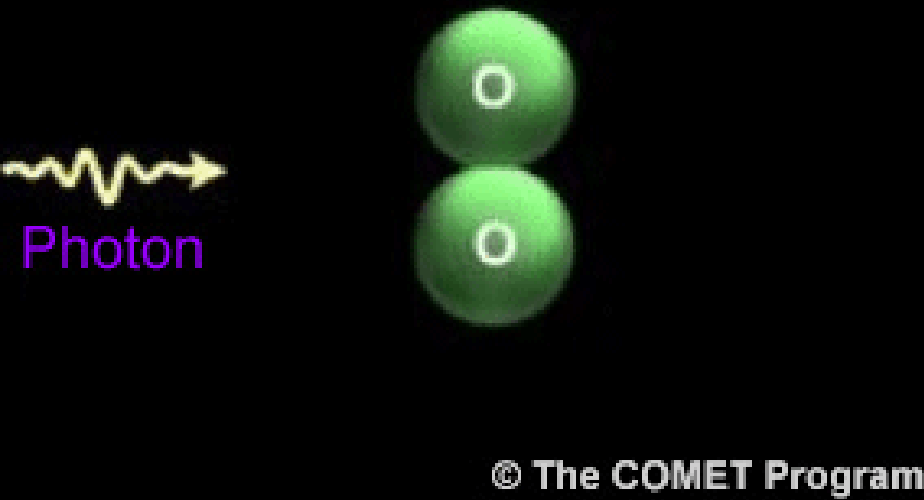
- $N + NO \rightarrow N_2 + O$
- $N + O_2 \rightarrow NO + O$



Thermosphere Reactions

Photodissociation

Photodissociation of Oxygen (O_2)



Recombination



Ionosphere



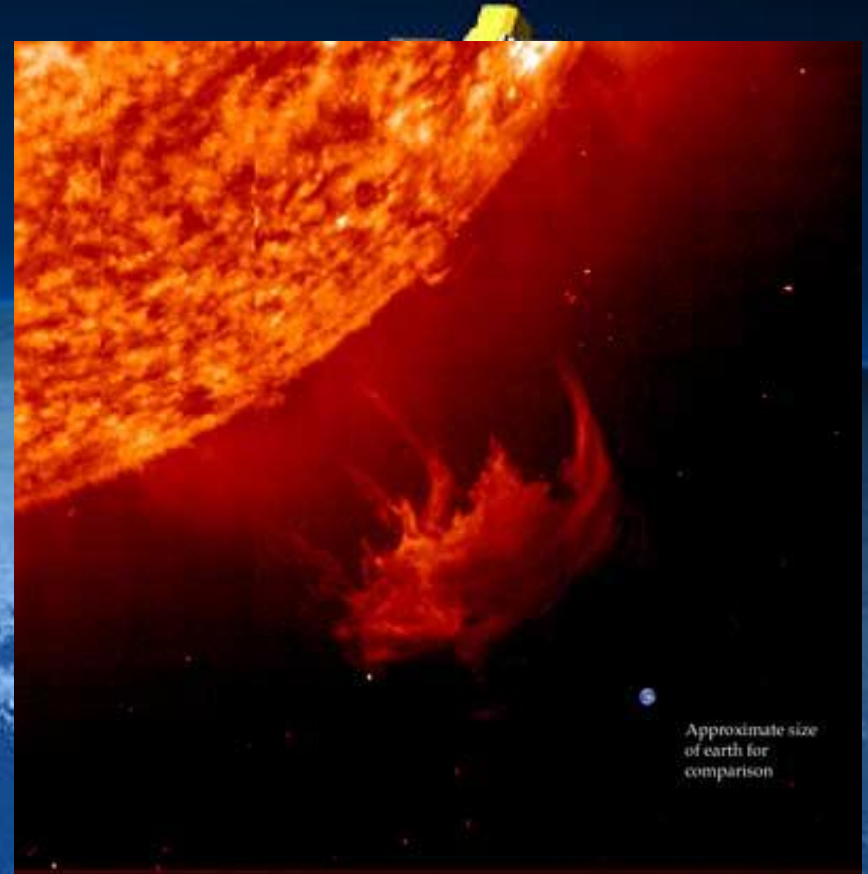
- Shell of electrons and electrically charged atoms and molecules
- UV, X-Rays, and short wavelengths of solar radiation are ionizing
- Dependent on the sun and its' solar activity
- Auroras occur here due to solar wind, collisions between ions and atoms become more frequent, causing them to release energy in the visible wavelength

Auroras

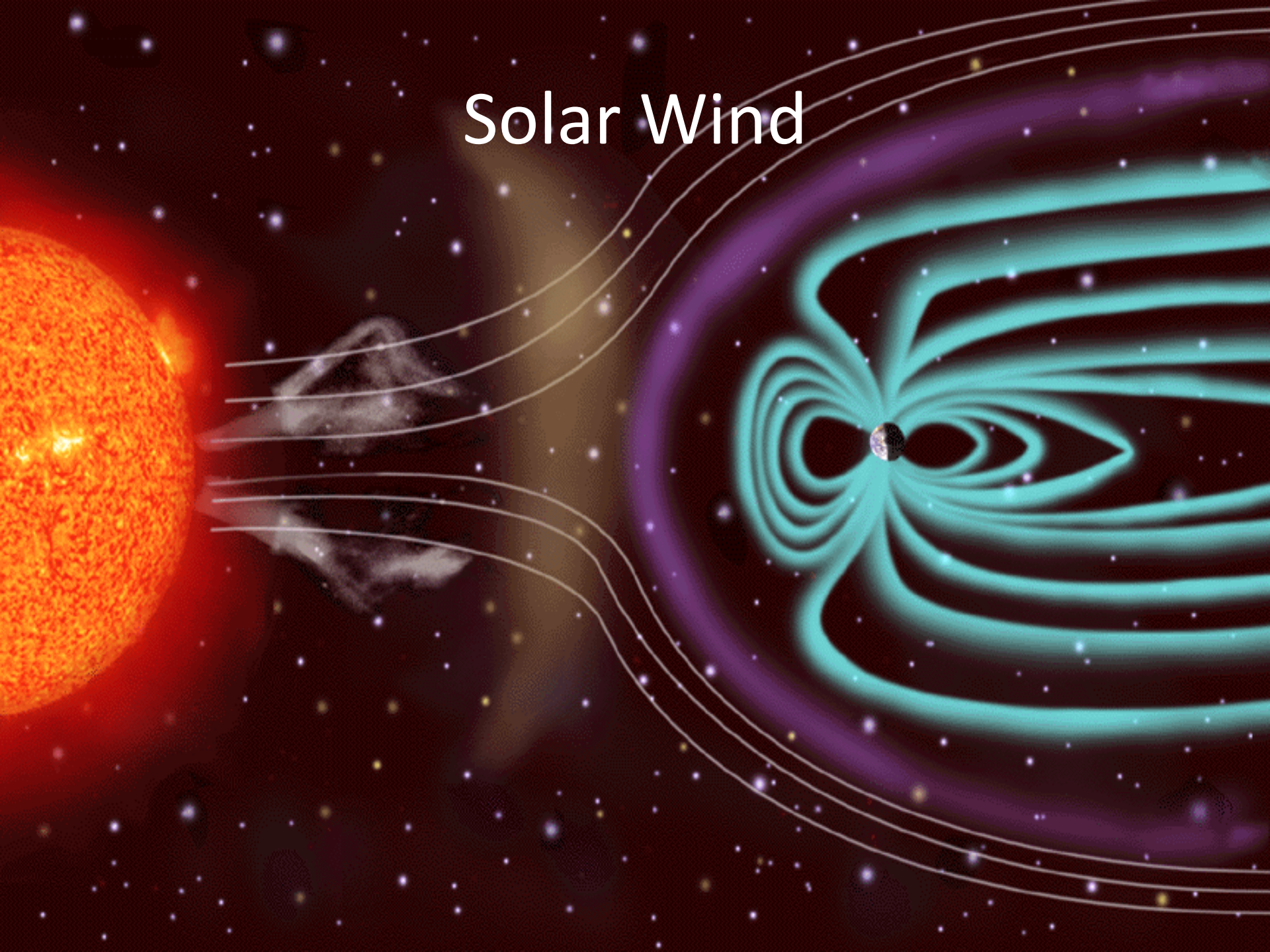


Solar Wind

- Solar wind: flux of electrons and protons
- Usually deflected by magnetic field
- During intense sunspot events, flux can reach as low as 150km
- High ion densities increases the conductivity of the atmosphere
- This disrupts power distribution and communication systems.



Solar Wind



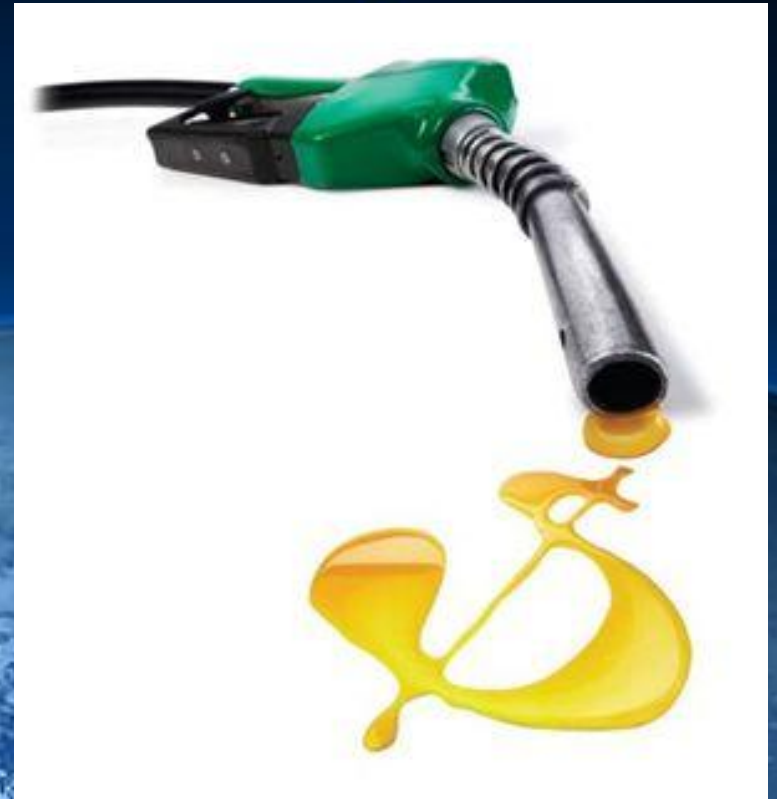
Effects on Satellites

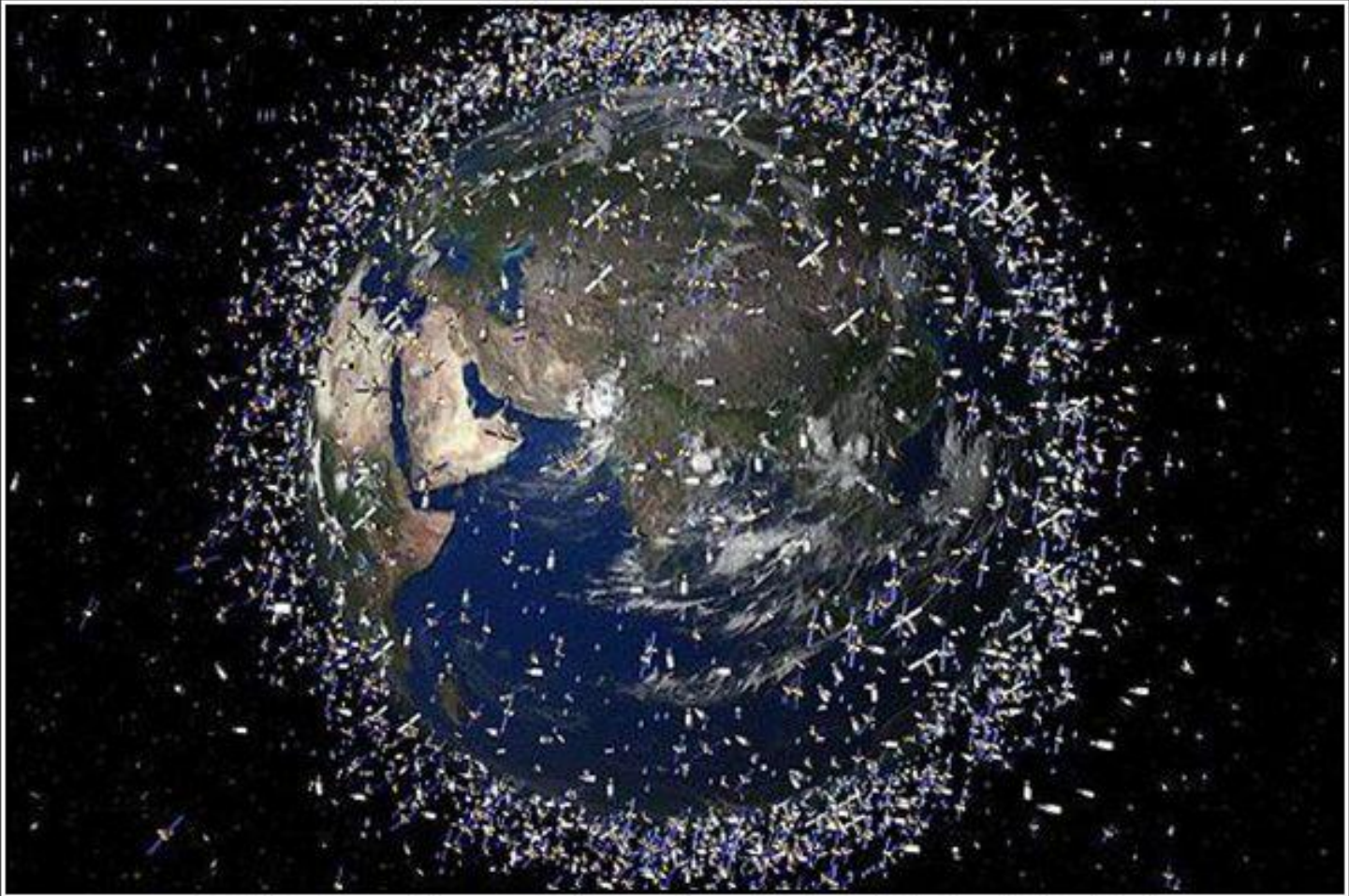
- Dependent on density of the thermosphere
- Extra heating from solar fluxes causes the outer atmosphere to expand, causing more drag on satellites
- Satellites enter lower regions of the atmosphere, and disintegrate
- Damaging CO₂ caused by fossil fuel burning
- Condensing atmosphere causes more space junk to be suspended



Economy

- Satellites orbit in the Thermosphere
- Lower density means less drag by the atmosphere
- Lower fuel costs
- Projected millions of \$ of fuel costs saved





SPACE JUNK

It's like dodging bullets up there

Dangers of Space Junk

- 4 million lbs of junk, some traveling at speeds of up to 17,500mph
- Any contact could destroy a satellite or spacecraft
- Usually are pulled down by gravity and disintegrate
- Since the atmosphere is becoming less dense, the junk is suspended for longer periods of time
- “For the first time, junk is the single biggest risk factor to equipment in some orbits” (Fred Guteri, Newsweek)



Conclusion

- Thermospheric cooling
- Our GHG emissions are condensing our upper atmosphere



References

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Questions?

