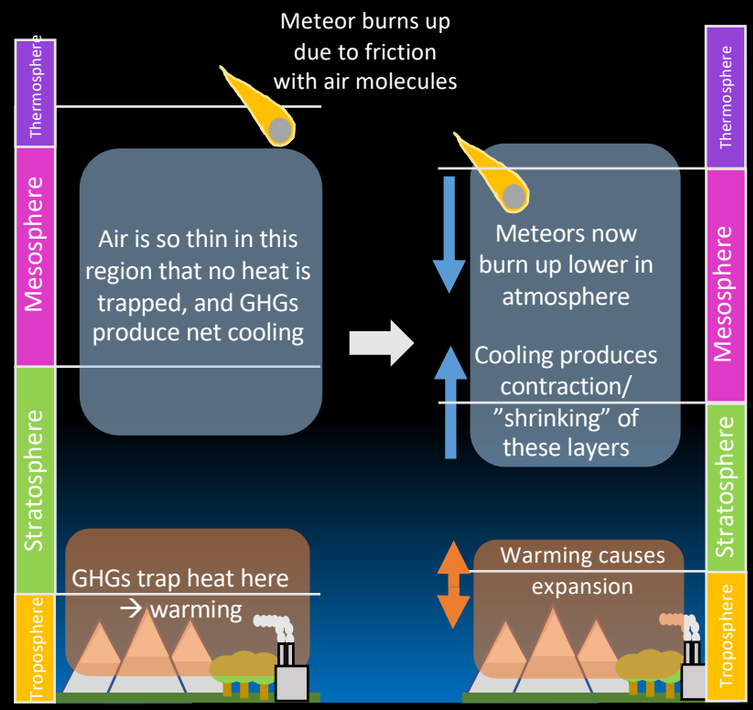
Using Meteors to Detect Changes in the Atmosphere Due to Greenhouse Gases

Meteoroids enter the atmosphere and burn up due to frictional heating with the air. This creates a trail of hot gas (what we call a “meteor”) that is detectable by ground-based radar. The altitude at which the meteoroid burns up is related to air density –the higher the density of air, the higher in the atmosphere the burning will start.

We analyzed long-term records of meteor altitudes (the majority of datasets comprise 15-22 years) and found that the altitudes the meteors were burning up has decreased over time. The height at which meteors burn up has been decreasing by ~400 meters per decade, globally averaged.

Increasing greenhouse gas emissions act as infrared warmers in the lower atmosphere. However, in the middle and upper atmosphere, where the air is much thinner, these same gases act as infrared coolers as re-emitted heat energy is simply lost to space. Contraction of these parts of the atmosphere is expected as a result of this cooling. We found linear decreases in detected meteor altitudes at all latitudes studied, which is consistent with a cooling and contracting middle and upper atmosphere.

These results indicate that our whole atmosphere is complex and interconnected, and it is important to better understand this coupling and how changes in the lower atmosphere may manifest in the middle and upper atmosphere, and vice-versa.



Erin C.M. Dawkins, et al.(2023), Solar cycle and Long-Term Trends in the Observed Meteor Altitude Distributions by Meteor Radars, *Geophysical Research Letters*, 50(2), e2022GL101953, doi:10.1029/2022GL101953