Using IR Brightness Temperature Spectra to Disentangle the Effects of Ozone, Carbon Dioxide, and Water Vapor On Global Stratospheric Temperature Trends

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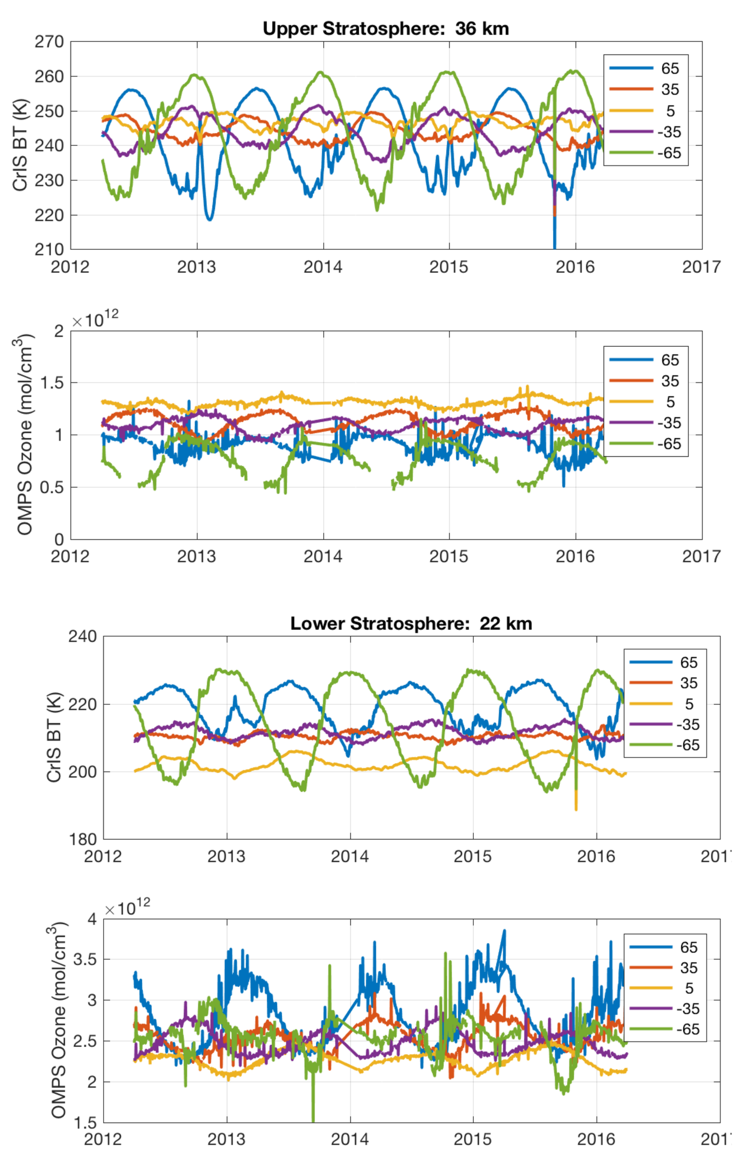
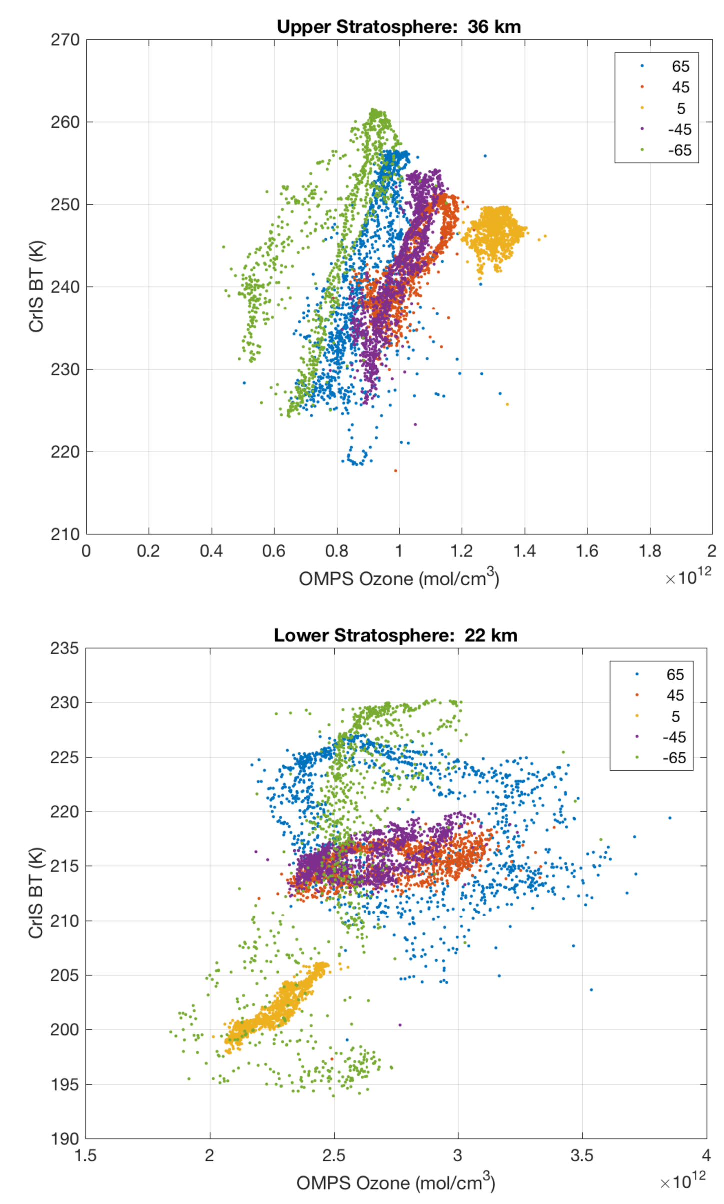
Zonal Mean CrIS BT and OMPS Ozone

Upper Stratosphere

Lower Stratosphere



Correlation of CrIS BT and OMPS Ozone

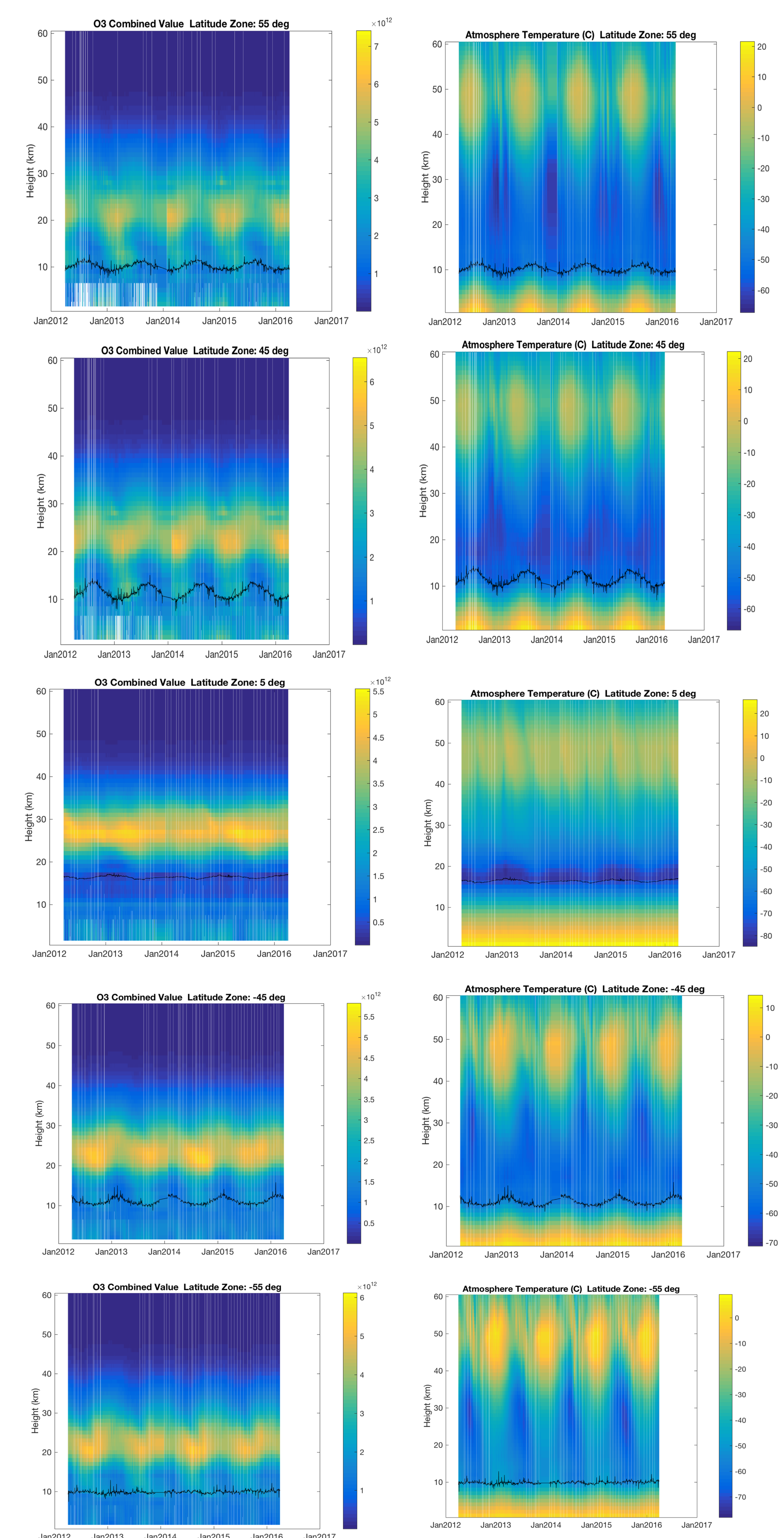


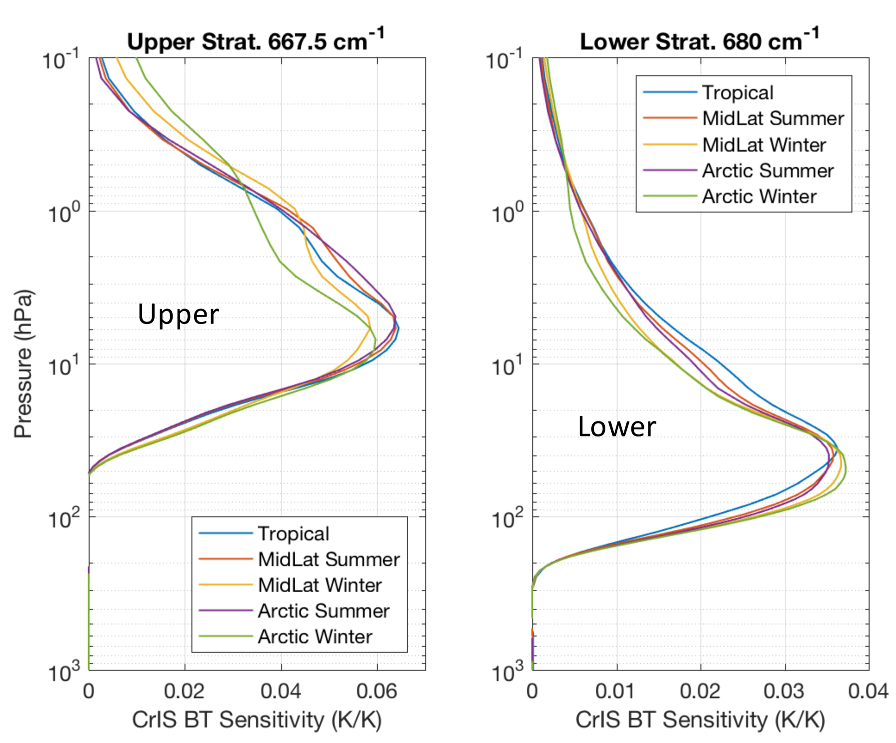
Ozone and Atmospheric Temperature

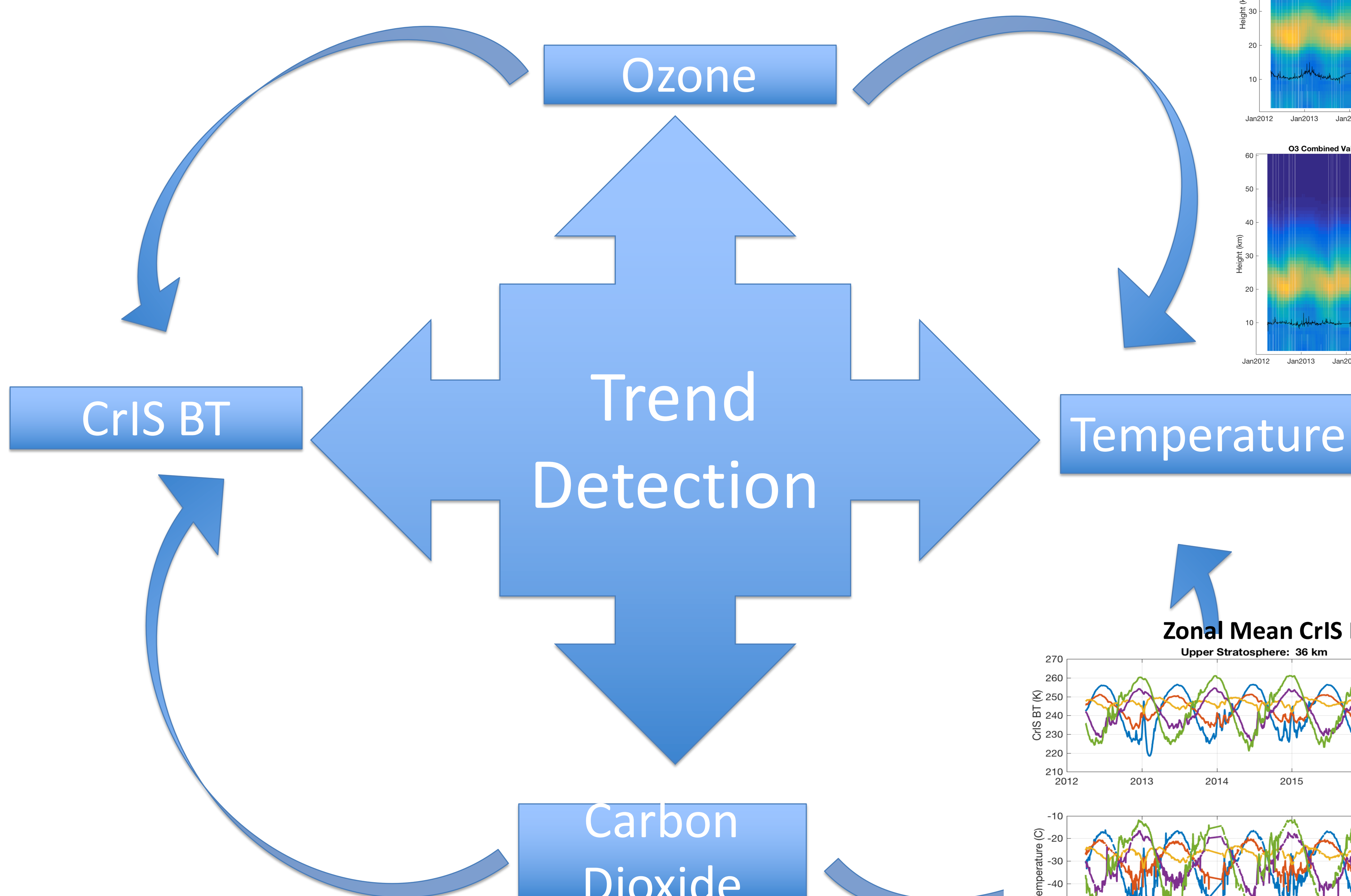
The figures on the right depict the combined ozone value over a time series of ~4 years, as well as the atmospheric temperature over the same time period.

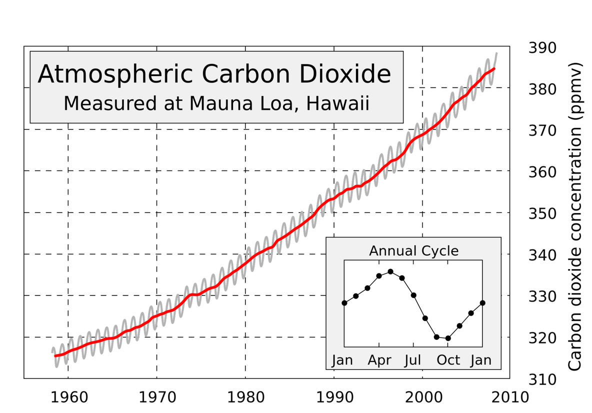
In the summer months, when the temperature is hotter, the tropopause altitude (black line) increases in height noticeably in the mid latitude zones due to the hot air rising. There is no variability in the tropopause altitude in the tropical zones due to the fact that the sun is shining on that area year round. There is also little to no variability at -55 degrees due to the fact that there are no large land masses present in that area.

As the tropopause altitude increases, it is observed that the ozone concentration in the lower stratosphere decreases. This is seen predominantly in the mid latitude zones during the summer months.

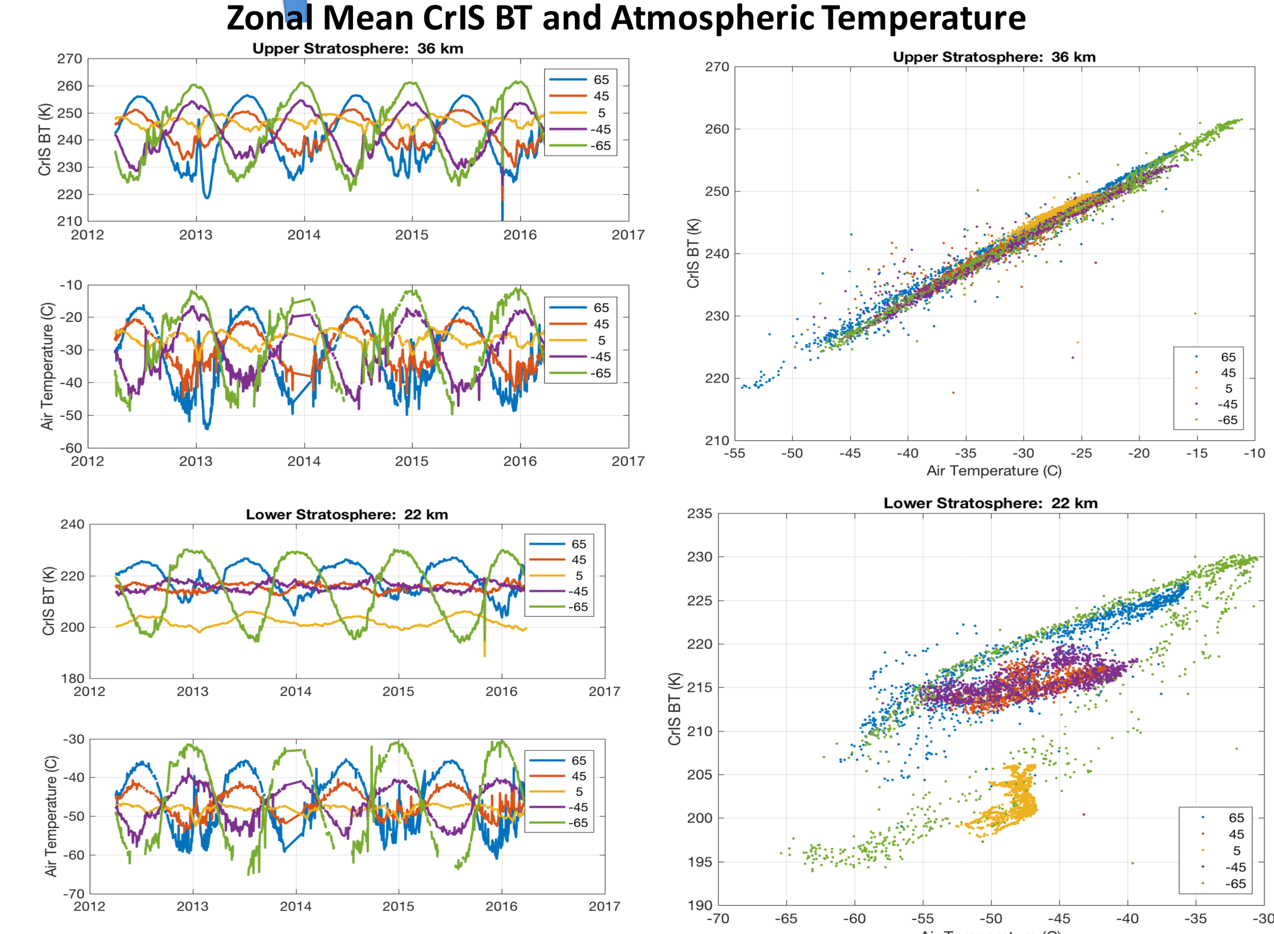


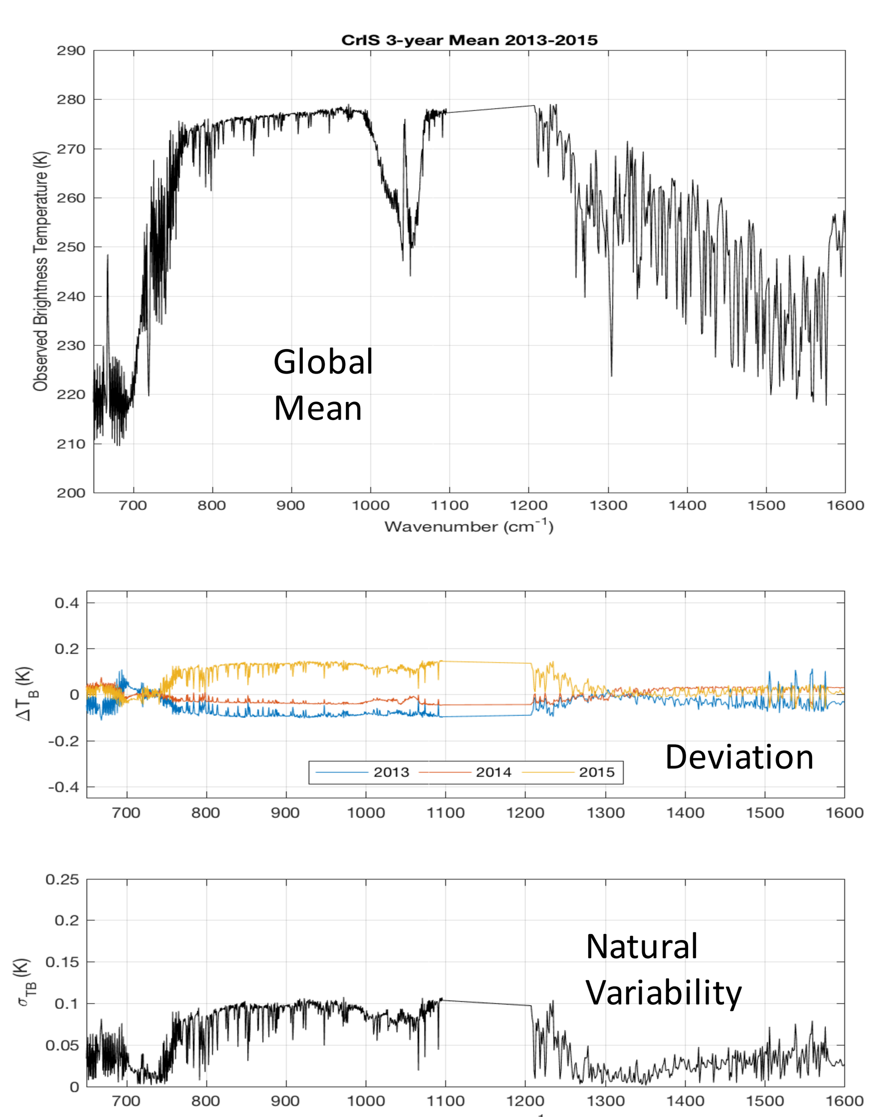






Zonal Mean CrIS BT and Atmospheric Temperature





Data and Method

- Cross-track InfraRed Sounder (CrIS) radiance spectra were obtained from a NOAA special processing at UW
- Ozone Mapping Profiler Suite (OMPS) profile data was obtained from NASA archive
- Computed daily zonal mean Nadir CrIS brightness temperature (BT) spectra
- Extracted upper and lower stratospheric peaking BT
- Computed daily zonal mean OMPS ozone profiles
- Weighted OMPS profile using CrIS vertical sensitivity
- Computed correlation of CrIS BT and OMPS ozone density for ten degree latitude zones
- Calculated multi-year mean and standard deviation of CrIS BT for area weighted global average
- Estimated time to detect trend in stratospheric observed BT using natural variability < 0.1 K
- Atmospheric temperature data was extracted from the OMPS data files (from the NASA GMAO GEOS-5).

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Conclusions

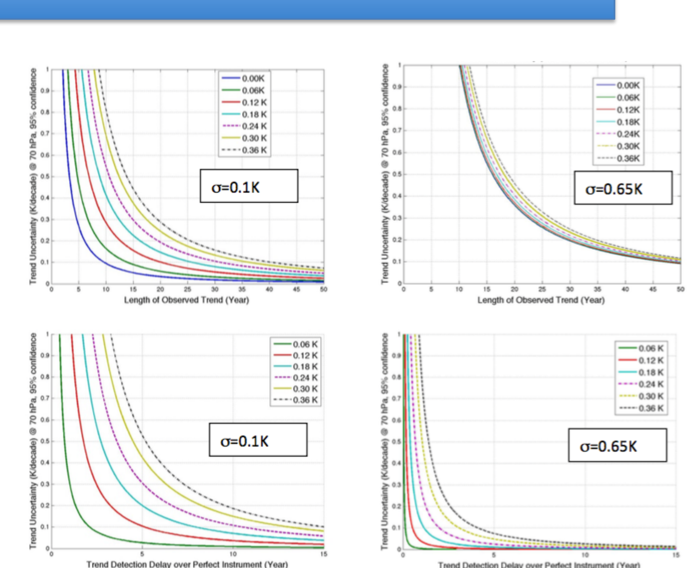
Analysis of coincident CrIS and OMPS data shows a higher correlation of BT and ozone for the upper stratosphere(excluding the tropics). Little correlation was seen in the lower stratosphere.

Analysis of coincident CrIS BT and atmospheric temperature shows a high correlation for the upper stratosphere. Less correlation is seen in the lower stratosphere.

Additional investigation is required to obtain a complete understanding of the role of ozone and carbon dioxide in regards to future trends in stratospheric temperature.

Objective

The objective of this study is to correlate the infrared brightness temperature spectra from Earth orbiting satellites with time and space coincident vertical profiles of atmospheric temperature and ozone concentration. Mean and standard deviation vertical profiles will be computed from the north pole and south pole. Corresponding brightness temperature mean spectra will be correlated with the temperature and ozone vertical profiles.



Anthropogenic increases of carbon dioxide are predicted to lead to warming trends in the troposphere and cooling trends in the stratosphere. Ozone recovery following the Montreal protocol which banned ozone destroying chemicals, is expected to lead to a warming of the stratosphere. CrIS observed BT are proposed for monitoring stratospheric temperature trends. The global natural variability is less than 0.1 K, which implies a time to detect of about 10 years.

References

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