GC11K-1112: Terra Trends: A Global Slowdown in Decreasing Atmospheric CO and the Regional Interpretation Using AOD

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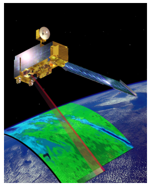
Introduction

Atmospheric carbon monoxide (CO) has been decreasing globally for the last two decades. Building on previous studies, we update global and regional estimates of the CO trend. Recently, positive trends in wildfires in Northern Hemisphere boreal regions may have contributed to slowing down the decreasing CO. Additionally, time-varying air quality policies will have different impacts on atmospheric composition and related trends. Aerosols are co-emitted with CO from both fires and anthropogenic sources. Consequently, a combined trend analysis of CO and aerosol optical depth (AOD) measurements from space can help elucidate the drivers of regional differences in the CO trend.

Long-term CO and AOD measurements from the Terra satellite

MOPITT (Measurements of Pollution In The Troposphere) CO

- CO molecules absorb infrared (IR) radiation.
- Gas filter correlation radiometer; first light in 2000 [2].
- Optimal estimation inverts the IR signal into CO amount.
- Version 8, TIR-only, daytime retrievals [1].
- Converted to column average VMR using retrieved dry air column.



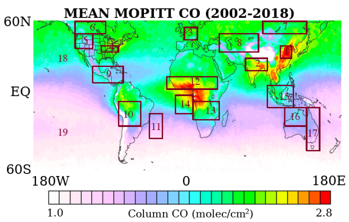
[Image: NASA]

MODIS (Moderate Resolution Imaging Spectroradiometer) AOD

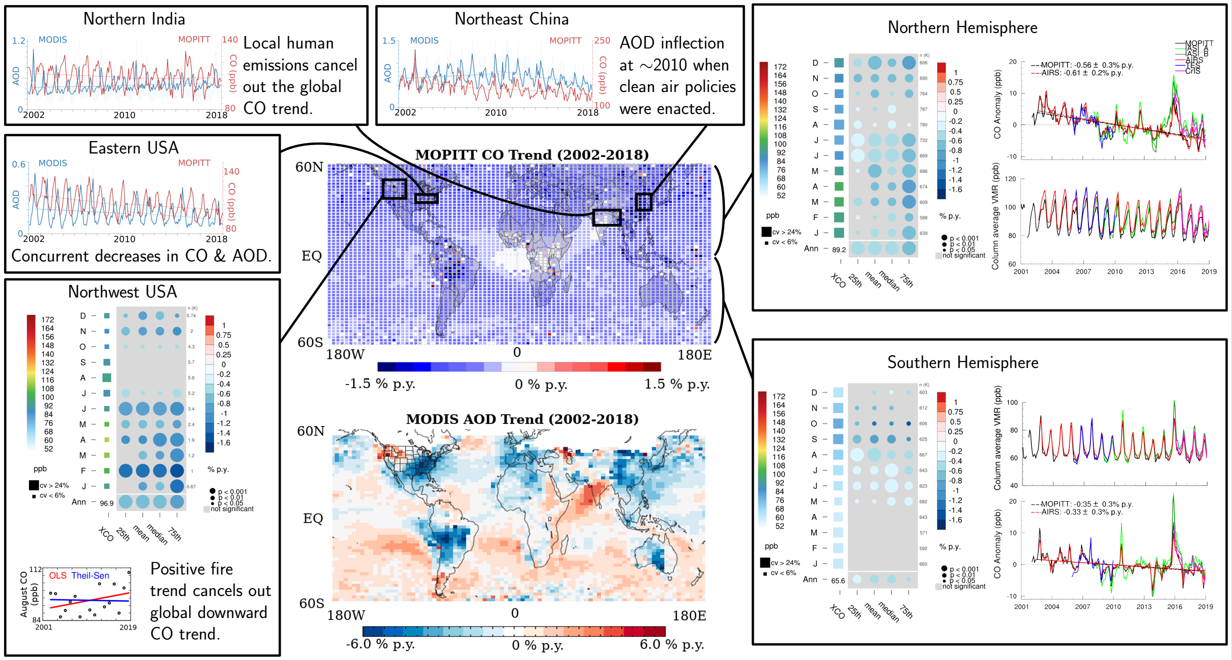
- Passive imaging radiometer: reflected solar and thermal radiation [3].
- DTDB algorithm retrieves over vegetation, oceans and deserts [3].
- Collection 6.1, Level-3, MOD08_M3 [4, 5].

Trend analysis methodology

- Timeseries of month average values determined within regions (right).
- Remove seasonal cycle.
- Use Weighted Least Squares (WLS) weighted by σ to calculate trends for 2002-2018 and for two sub-periods: 2002-2010, 2010-2018.
- Also calculate Theil-Sen trends in CO percentile values separated by month for 2002-2018.

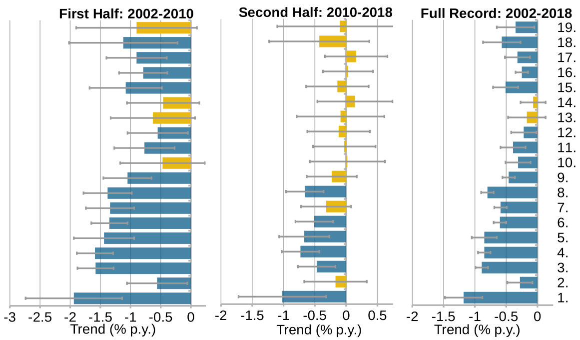


Timeseries analysis



Buchholz, R. R. et al, Air pollution trends measured from Terra: CO and AOD over industrial, fire-prone and background regions, to be submitted 2019 to the Terra Mission - 20 Years of Science collection in Remote Sensing of Environment.

Regional Weighted-Least-Squares Trends



Negative trend significant outside 1σ

Trend not significant

- CO declines faster in the first half of the record compared to the second half or the full records.
- Northeast China (region 1) has the strongest trend in any period.
- Stronger trends in NH (regions 1-9, 12 and 18) compared to SH (regions 10-11, 13-17 and 19) shows a combination of the global reduction in fire with anthropogenic emission reductions.

Summary

We calculate global and regional trends in MOPITT CO and use MODIS AOD to interpret CO variability.

- CO decreases globally at -0.50 ($\pm$0.3) % per year from 2002 to 2018. This is a deceleration compared to CO trends from earlier studies over shorter periods.
- Regional analysis: Areas with common fire sources and where air quality measures have been implemented, such as Eastern USA and more recently, Northeast China show similar behavior in CO and AOD.
- Climate-driven positive fire trend in the NH boreal fire-prone regions, such as Northwest USA, locally counteracts the global downward CO trend in summer.
- Analyses of trends by percentile and month indicate that strongest (most negative) trends occur in the 75th percentile for the NH and that late summertime CO trends (when CO lifetime is lowest) are the least substantial, in both hemispheres.

Overall, local changes in biomass burning and air quality can counteract the global downward trend in CO.

References

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