

# WMO Assessment 2022: Chapter 3 Summary

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# Update on Global Ozone: Past, Present, and Future

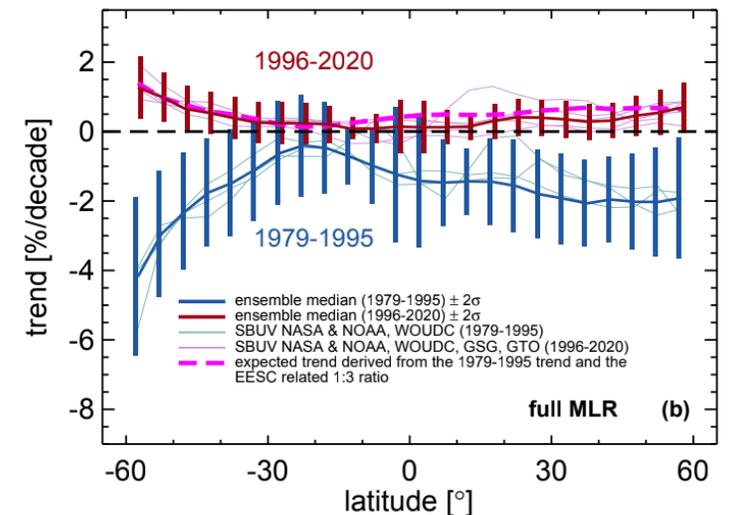
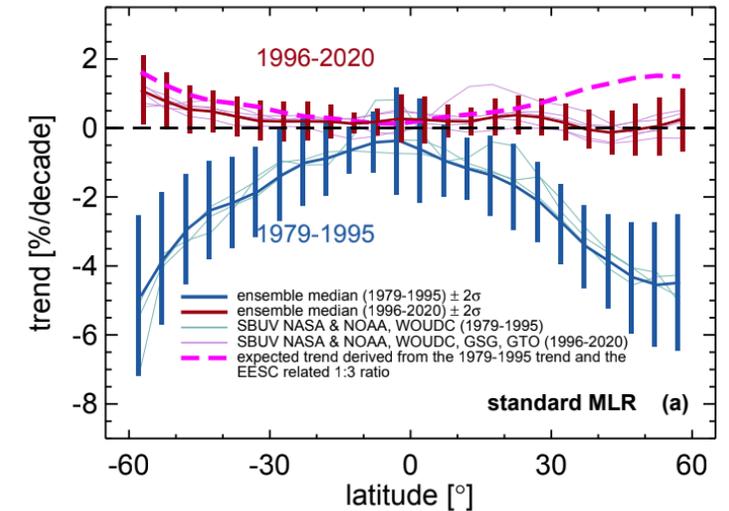
- Highlights and summarizes research since the last Assessment (2018)
- Primarily covers the stratosphere outside of the polar regions
- Discusses the state-of-the-art regarding analysis methodologies and complications
- Focuses on long-term trends and their uncertainties of total column and vertical profiles as well as modeling
- Chapter authors are currently finalizing third-order / final drafts

# What's new?

- Existing data sets and composites are improved and/or extended
- New instrument data (i.e., SAGE III/ISS and TROPOMI) for incorporation into existing and newly created data set composites
- Renewed focus on the role of natural variability in analyses and potential complications (e.g., QBO disruptions, large wildfires)
- Increased use of newer analysis techniques (e.g., DLM, ML, NN)
- Newer modeling simulations (e.g., CMIP6)

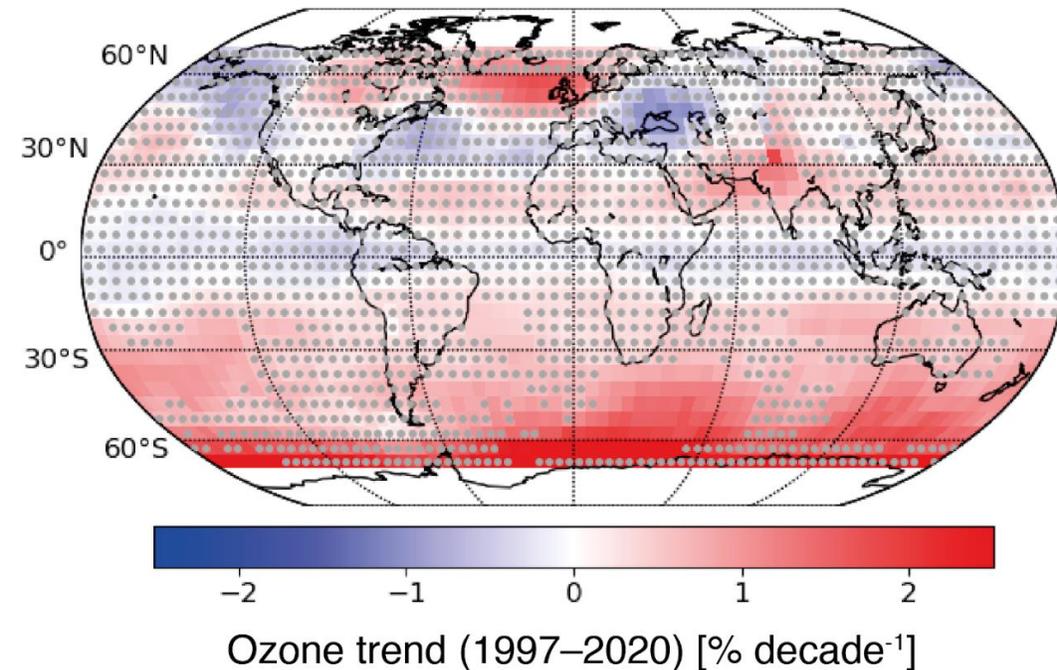
# Total Column Ozone Trends

- First statistically significant semi-global trends in the post-1996 era ( $0.4 \pm 0.2\%/dec$ )
- Small positive, but statistically insignificant trends at SH mid-latitudes and negligible trends at NH mid-latitudes
- Attempts at isolating just chemically driven trends shows small positive trends in both hemispheres at mid-latitudes with mixed significance
- Tropical trends remain small and insignificant in either case



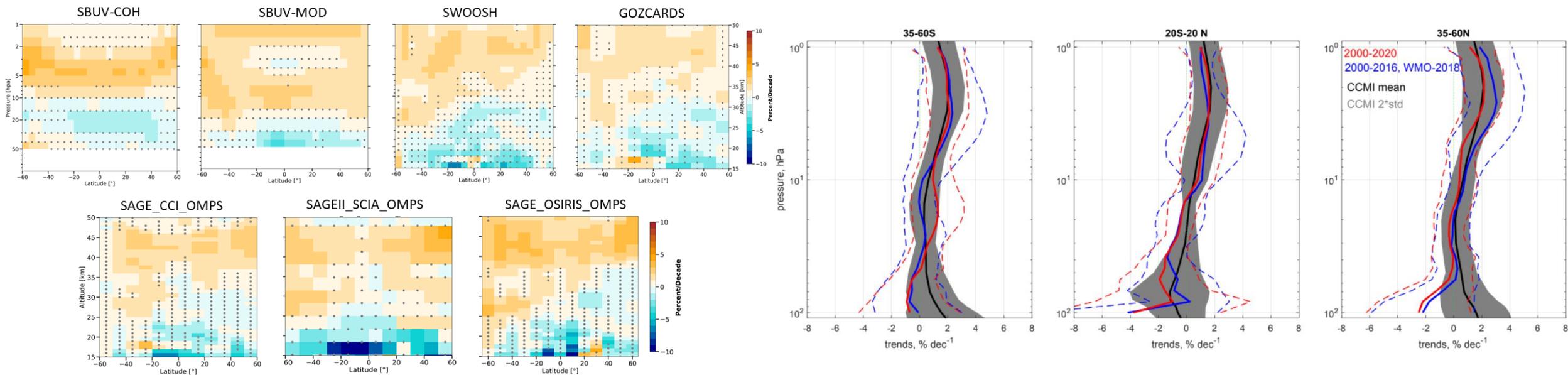
# Total Column Ozone Trends

- New analyses looking at finer temporal and spatial resolutions
- Trends show longitudinal variation at northern mid-latitudes
- Statistical significance is small due to less data at higher resolution
- Despite reduced statistical significance, these spatially resolved trends also show some minor seasonality



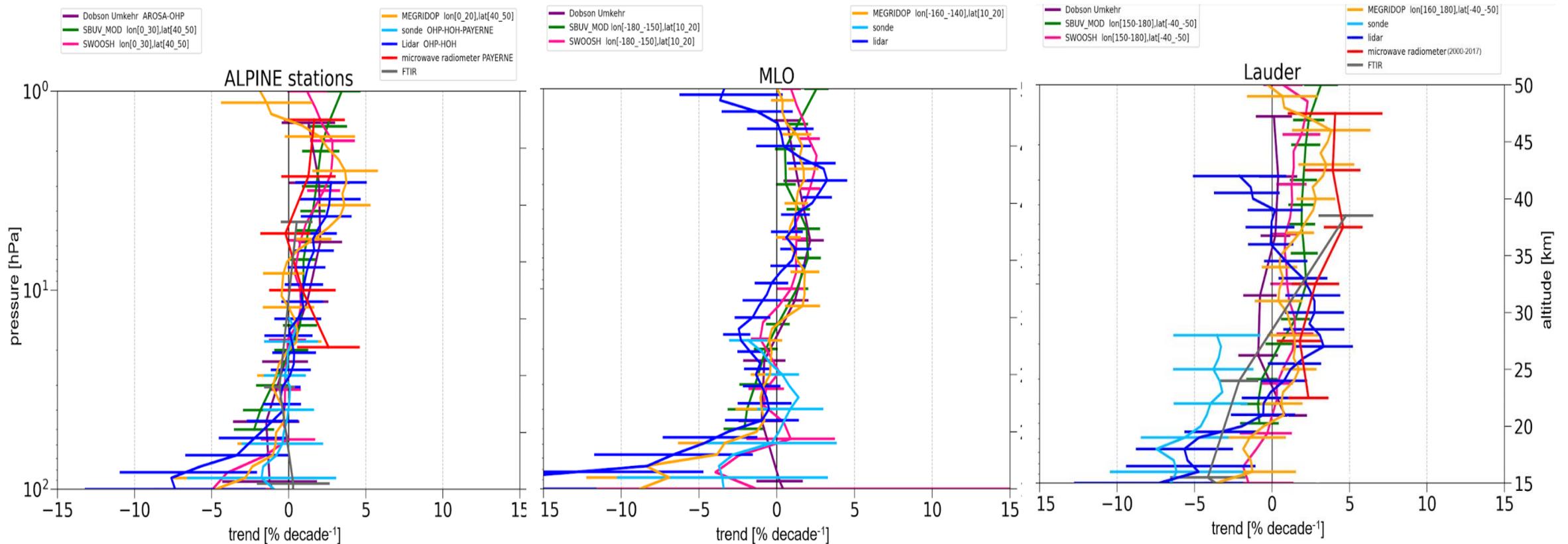
# Vertical Profile Trends

- Statistically significant positive trends in the upper stratosphere, with reduced uncertainties since the last Assessment
- Still appears to be statistically insignificant negative trends in the lower stratosphere (not robust across all data sets)



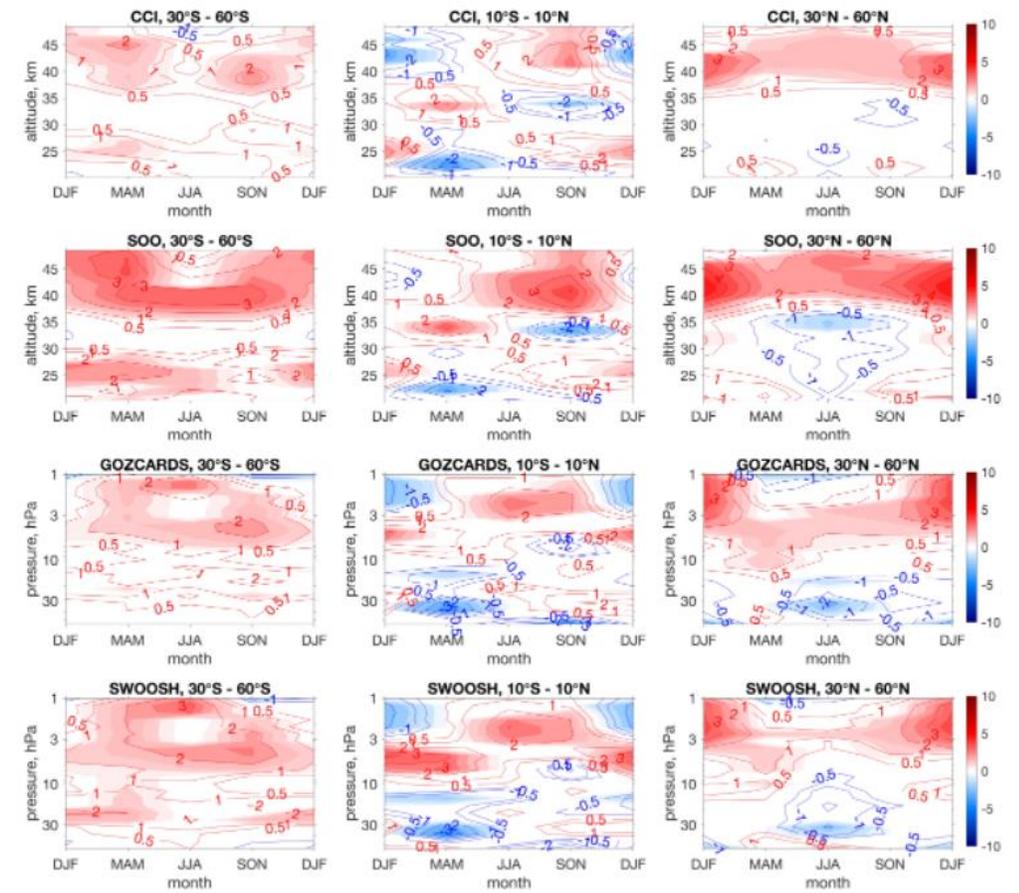
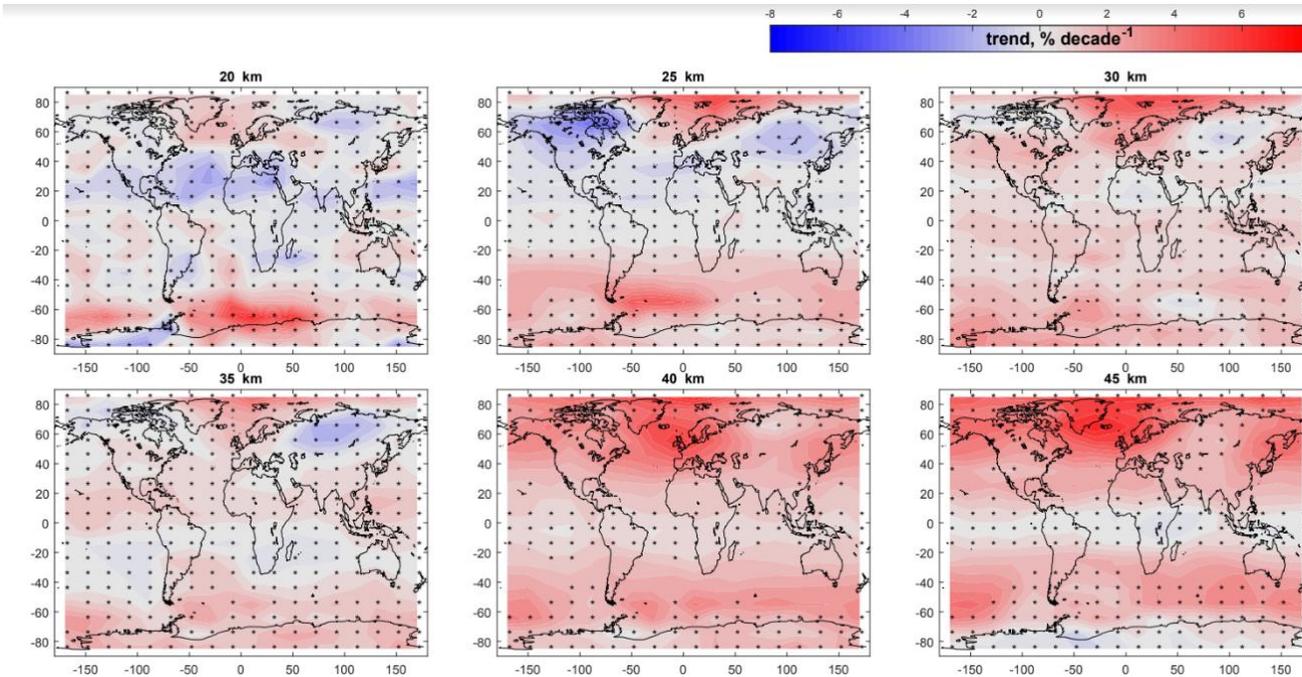
# Vertical Profile Trends

- Comparisons with ground supersites (i.e., multiple measurement systems) show general agreement with gridded satellite-based trends



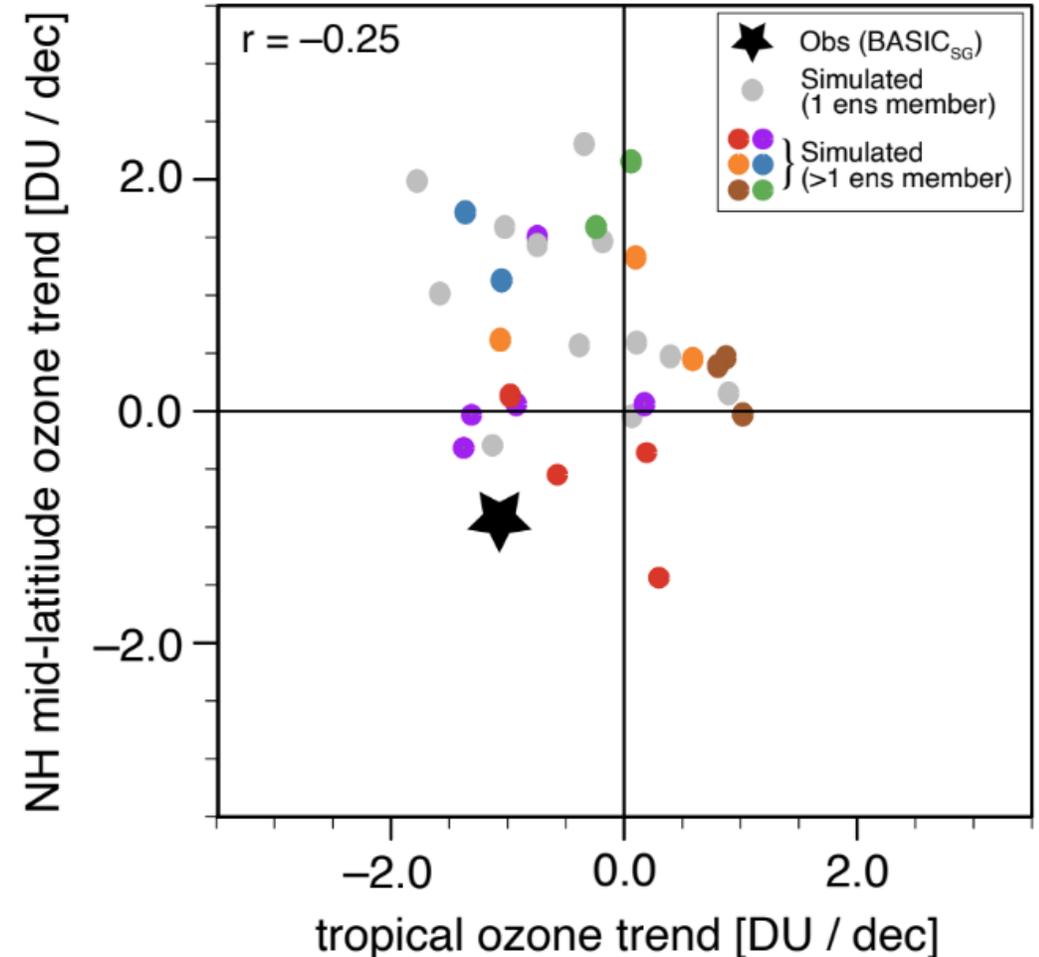
# Vertical Profile Trends

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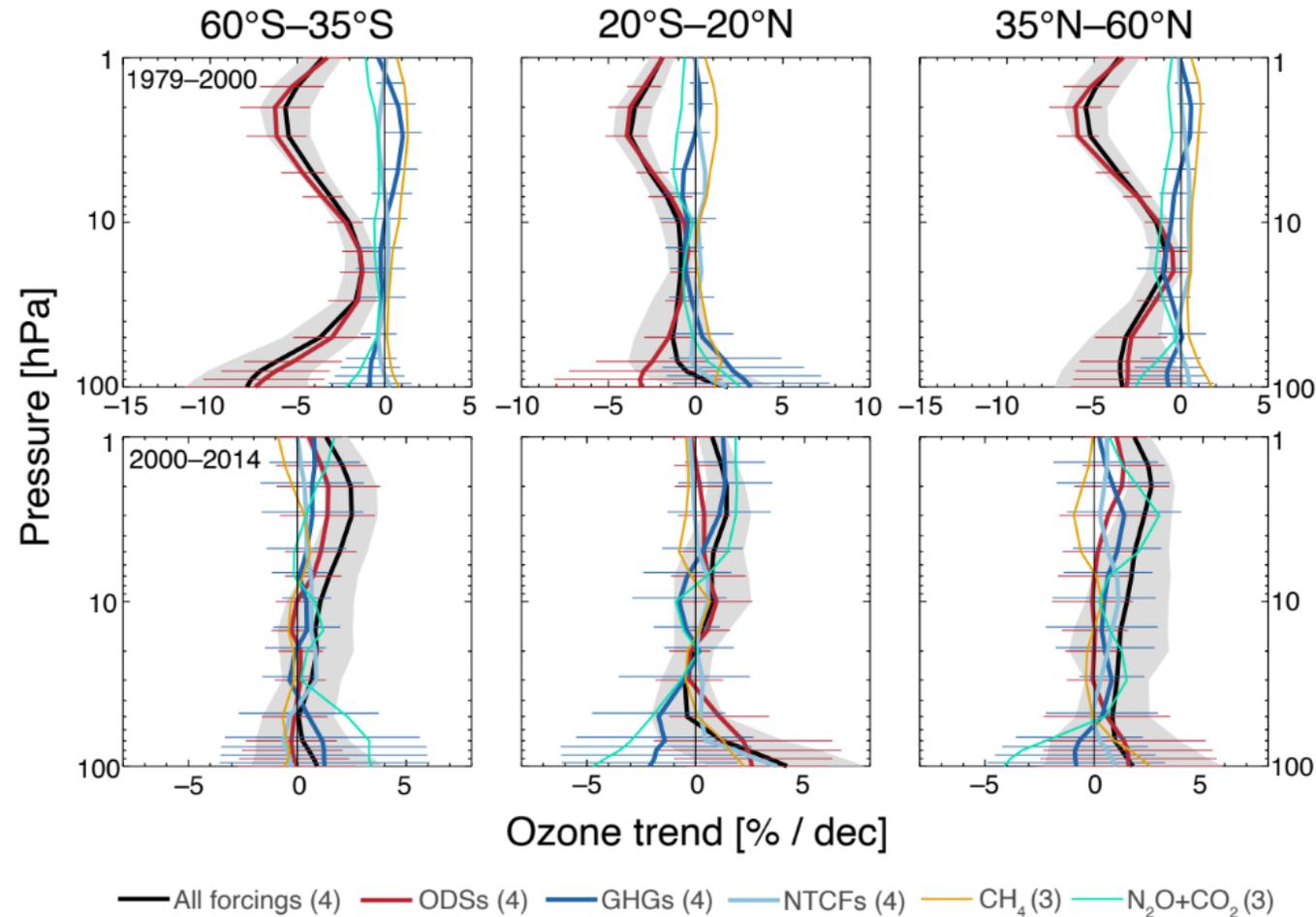
# Focus on the UTLS

- Observations are in general agreement showing negative trends in the lower stratosphere both in the tropics and at mid-latitudes
- Free-running model simulations, however, continue to suggest there should be positive trends at mid-latitudes and that observational results are an outlier
- Natural variability and data quality continue to complicate results



# Modeled Attribution of Changes

- Dominant drivers of upper stratospheric ozone trends are still decreasing ODSs and increasing GHGs
- Lower stratospheric changes are more complicated as changes in tropospheric ozone and dynamics also play a role



# Modeled Future Changes

- Expected future recovery is heavily dependent on GHGs and tropospheric O<sub>3</sub> precursors
- Changes in tropospheric column can potentially have a significant impact on future total column changes
- Unexpected recent CFC emissions are not expected to impact recovery, though they may delay it

