LOTUS Highlights on Ozone Trend Analyses and Phase 3

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What is LOTUS?

- Long-term Ozone Trends and Uncertainty in the Stratosphere
- SPARC Activity
- “The primary goal of the LOTUS effort is to foster collaboration between established and early career scientists around the world that have expertise in ozone and related trace gas observations, modeling, and trend analysis. This activity aims at interpreting atmospheric composition observations as a result of changes in ozone-depleting substances and climate. LOTUS meets the needs of the ozone trend community and provides vital contributions to the WMO Ozone Assessment in an organized and cohesive way.”
- Coordinators: R. Damadeo, I. Petropavlovskikh, S. Godin-Beekmann, D. Hubert, V. Sofieva, B. Hassler, M. Weber
- Website:
  - https://www.sparc-climate.org/activities/ozone-trends/
  - https://lotus.aeronomie.be/index.php

LOTUS 1st Phase (2016–2018)

- Inception at the 2016 Quadrennial Ozone Symposium
  - Discrepancy between results from 2014 WMO Ozone Assessment and SI2N Summary Paper
- Objectives
  - Reevaluate long-term trends and uncertainties in ozone profiles from satellite- and ground-based observations
  - Compare to CCMI ozone profile trends
  - Tackle challenges associated with trend analyses with wide community input and consensus (i.e., techniques)
- 2019 SPARC LOTUS Report
  - https://www.sparc-climate.org/publications/sparc-reports/sparc-report-no-9/
- Contribution to the 2018 WMO Ozone Assessment

Community Tools

- LOTUS Regression Model (MLR)
  - Created during Phase 1 and expanded/improved in Phase 2
  - Maintained at U. Saskatechewan and freely available at: https://arg.usask.ca/docs/lotus_regression/
  - Contains proxies for QBO, ENSO, solar, aerosol, and others
  - Can implement different trend models and seasonality of proxies/trends
- DLM Analysis Code
  - Written by Dr. J. Alsing (based on prior work of Laine, Latva-Pukkila, Kyrölä, 2014)
  - Available on GitHub (dlmmc)
  - https://doi.org/10.21105/joss.01157
  - Employs similar proxies and AR1 processes as MLR
  - Nonlinear trend models allows for non-prescribed long-term changes

LOTUS 2nd Phase (2018–2021)

- Focused on facilitating collaborative work to contribute to the 2022 WMO Ozone Assessment
  - Continue to improve/create data sets/composites (Ancellet et al., ACP, 2022; Petropavlovskikh et al., AMT, 2022; Sauvageat et al., ACP, 2022; Bognar et al., ACP, 2022)
  - Improve ground-based trends (Bernet et al., ACP, 2022; Maillard-Barras et al., ACP, 2022)
  - Seasonal trends (Szelag et al., ACP, 2020)
  - Regional trends (Sofieva et al., ACP, 2021; Coldewey-Egbers et al., ACP, 2022)
  - Update/extend total column ozone trends (Weber et al., ACP, 2022)
  - Update/extend vertical profile ozone trends (Godin-Beekmann et al., ACP, 2022)

Total Column Ozone Trends

- Global average TCO is ~2% lower than the 1964–1980 average
- TCO recovery trends are largely still statistically insignificant
- Using additional dynamical proxies can help isolate chemically driven trends

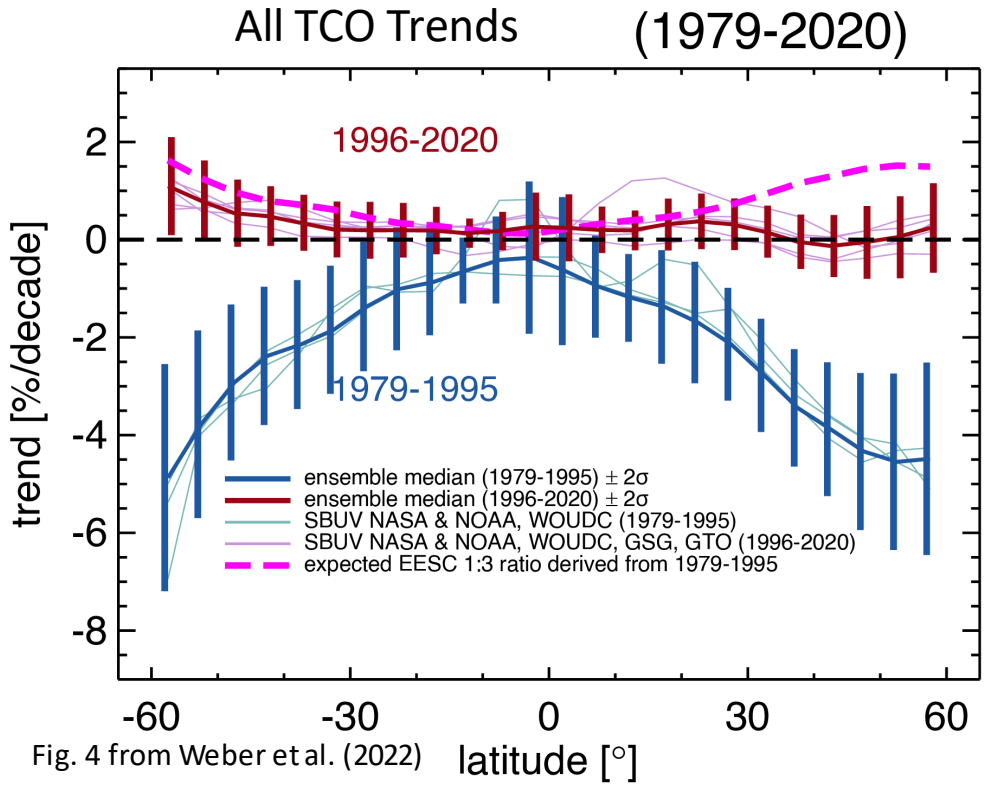

Fig. 4 from Weber et al. (2022)

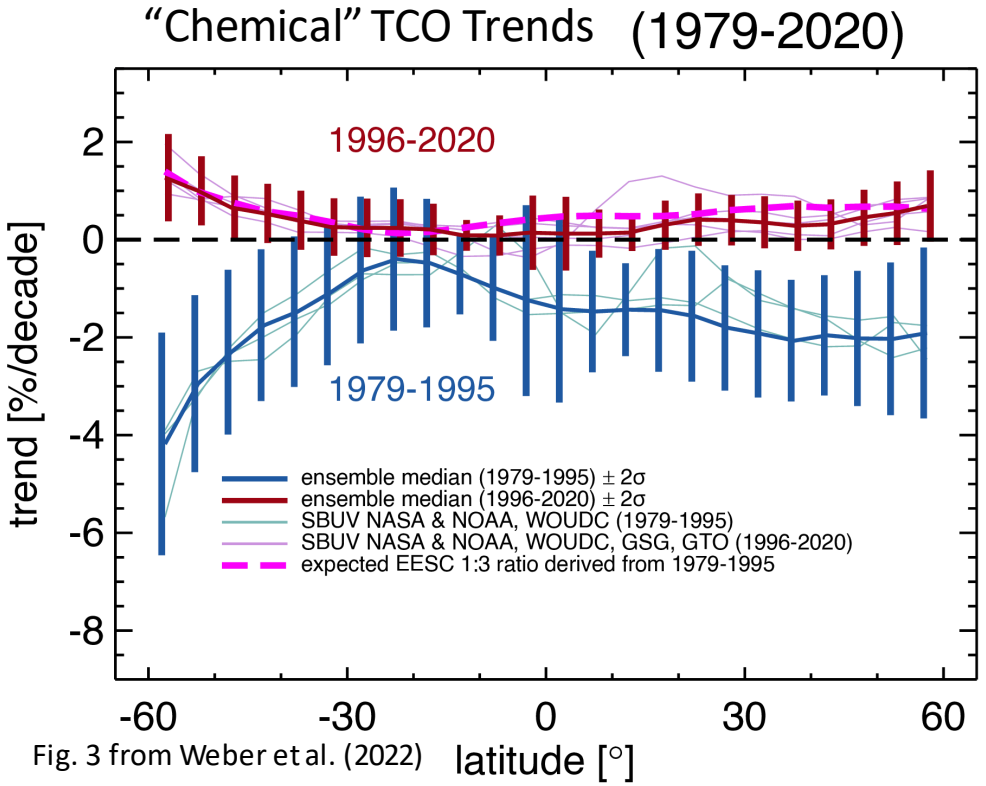

Fig. 3 from Weber et al. (2022)

Vertical Profile Ozone Trends

- Statistically significant recovery trends across the upper stratosphere in good agreement with models (i.e., ODS-driven)
- Large uncertainties in the lower stratosphere
- Negative trends in the tropical UTLS in agreement with models (i.e., dynamically driven)
- Disagreement between observations (negative) and models (positive) in the UTLS at mid-latitudes

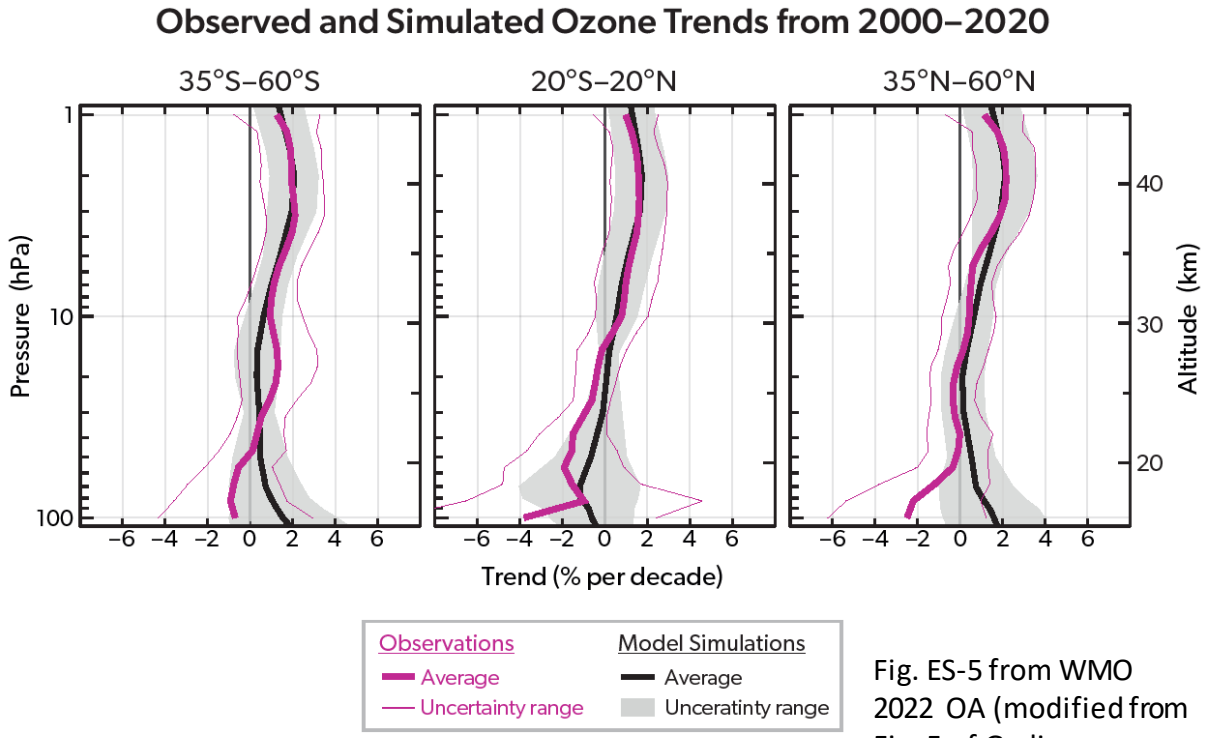

Fig. ES-5 from WMO 2022 OA (modified from Fig. 5 of Godin-Beekmann et al. (2022))

LOTUS 3rd Phase (2022–2025)

- Objective: Address questions and knowledge gaps outlined in the upcoming 2022 WMO Ozone Assessment in time for the 2026 Assessment
- LOTUS, in collaboration with other SPARC Activities (e.g., CCMI, OCTAV-UTLS, ATC, TUNER), will meet these needs outlined in six topics:
  1) Analysis Techniques
  2) Partial Column Trends
  3) Trends in the UTLS with OCTAV-UTLS
  4) Data Consistency between Satellite- and Ground-based Observations
  5) Trends in the Polar Regions
  6) Interconnections with Temperature and GHGs
- Interested in collaborating/participating? Visit https://lotus.aeronomie.be/ and contact us!