living planet symposium | BONN 23–27 May 2022

TAKING THE PULSE OF OUR PLANET FROM SPACE

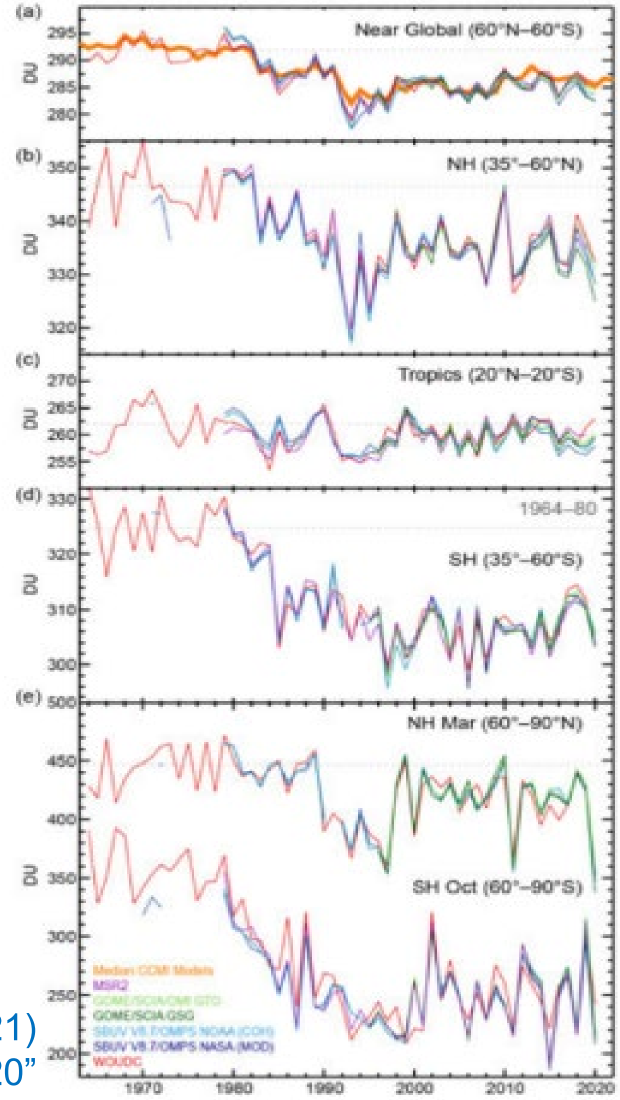
Global and regional ozone trends and their seasonal variation derived from the 1995-2021 ESA-CCI GTO-ECV data record

M. Coldewey-Egbers[1], D. Loyola[1], K.-P. Heue[1], C. Lerot[2], and M. Van Roozendael[2]
[1]DLR-IMF, Germany [2]BIRA-IASB, Belgium

24 May 2022

Motivation

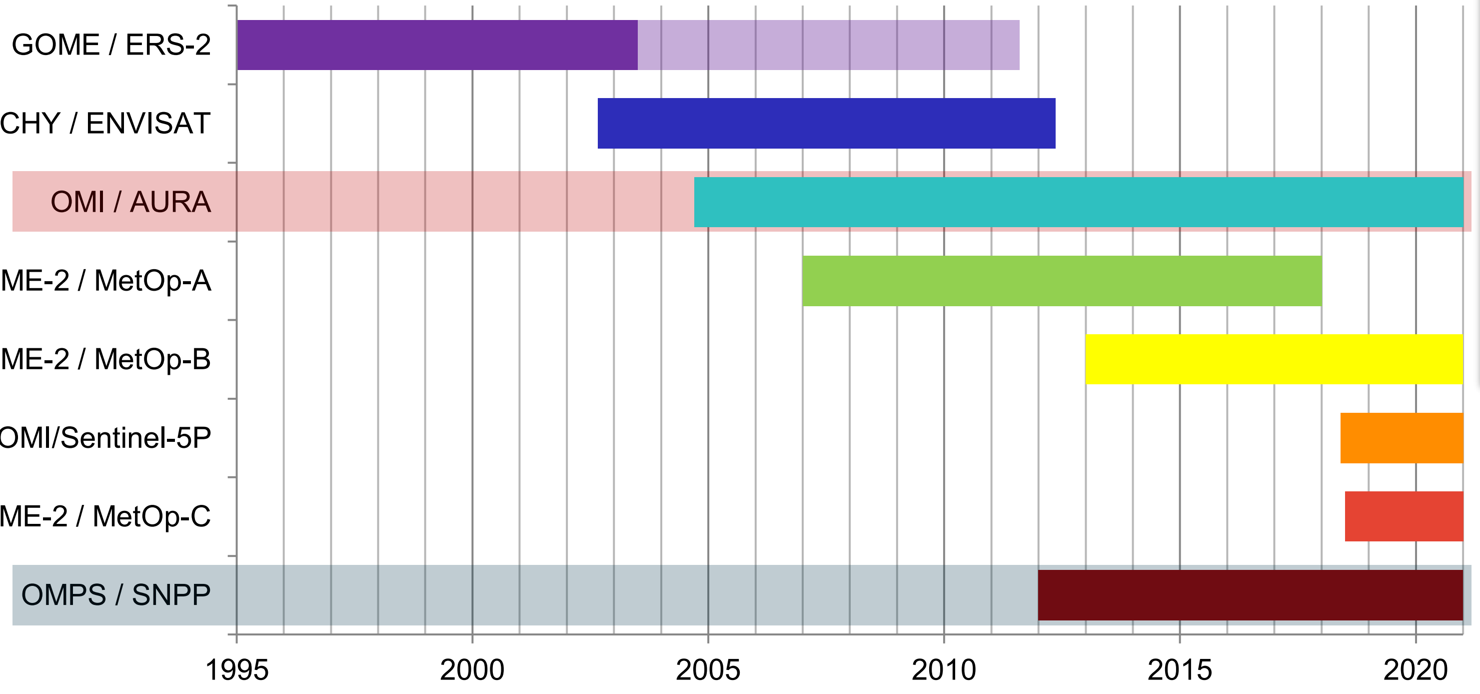
- Analyze changes in total ozone during the past 2.5 decades based on the GTO-ECV data record
- Weber et al. (2021), BAMS “State of the Climate”
  - Since the end of the ‘90s, total ozone remained stable - still below 1964-1980 mean – and with substantial year-to-year variability
  - In 2020 total ozone in middle and high latitudes were below the average of the past two decades
- Investigate possible longitudinal structures in trend patterns
- Analyze a possible seasonal dependence



From Weber et al. (2021)
BAMS “State of the Climate in 2020”

GOME-type Total Ozone Essential Climate Variable

- Seven GOME-type nadir-viewing satellite sensors combined → 1st version generated at DLR with national funding and 2nd version generated as part of ESA-CCI/+ ozone projects
- July 1995 – December 2021 → regularly extended as part of EU Copernicus C3S/2 ozone projects
- 1°x1° monthly mean total ozone columns → analyze longitudinal structure of trends

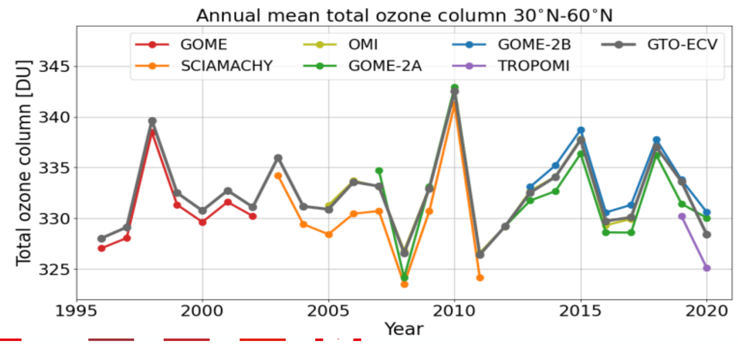


Excellent prerequisites for merging:

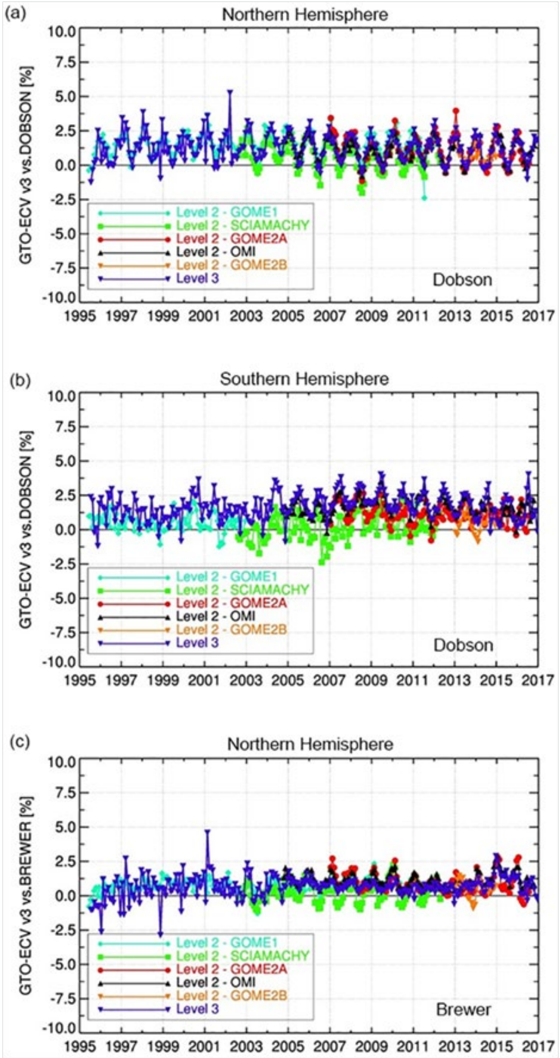
→ Long overlap periods with OMI

→ OMI measurements quite stable

→ Common total ozone retrieval algorithm GODFIT V4 (Lerot et al., 2014)

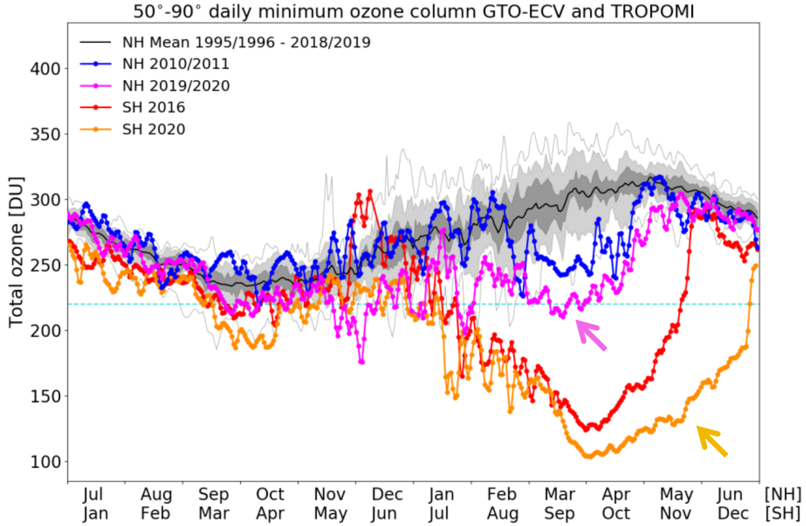


GOME-type Total Ozone Essential Climate Variable



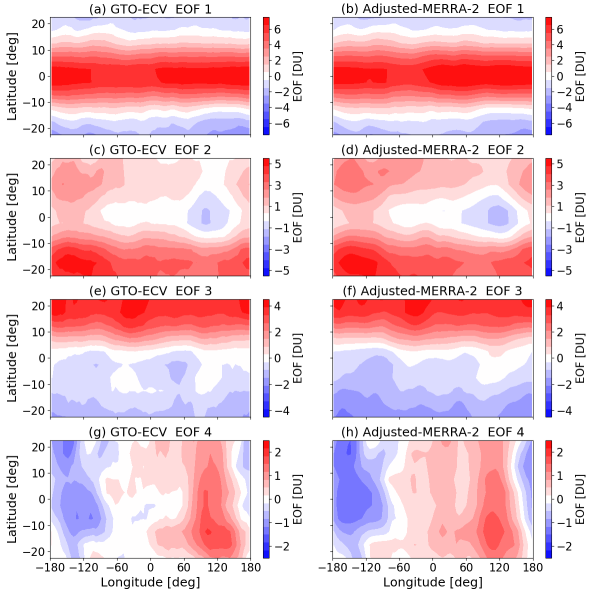
- Details in Coldewey-Egbers et al., AMT, 2015
- Validation results in Garane et al., AMT, 2018

- Analysis of 50°-90° daily minimum ozone in Dameris et al., ACP, 2021

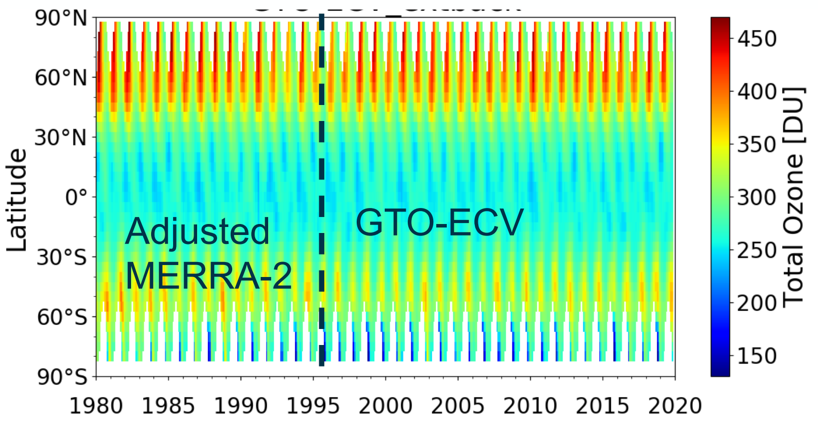


➢ 2020 Arctic: record low ozone values below 220DU

➢ 2020 Antarctic: longest-lasting and one of largest hole



- Comparison with adj. MERRA-2 (Coldewey-Egbers et al., AMT, 2020)
- Combined record 1980-2021

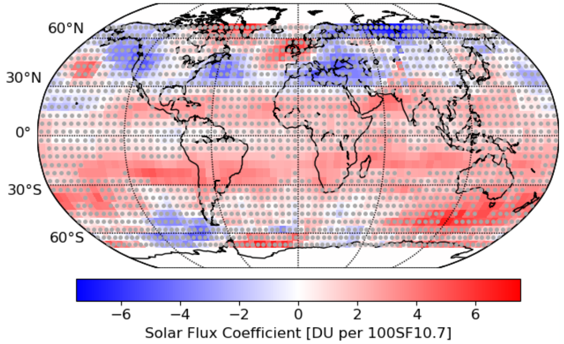


Total ozone trend analysis

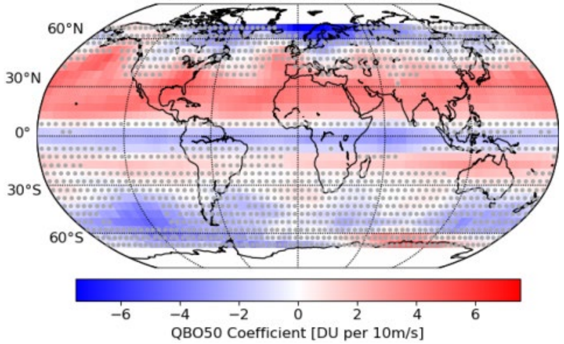
esa

- Update of Coldewey-Egbers et al., GRL, 2014
- Coldewey-Egbers et al., ACP, accepted
- $O_3(m) = A + B \cdot m + C \cdot SF(m) + D \cdot QBO30(m) + E \cdot QBO50(m) + F \cdot MEI(m) + G \cdot (A)AO(m) + X$

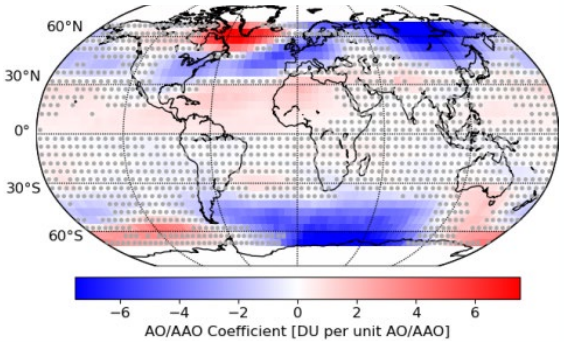
Solar Flux



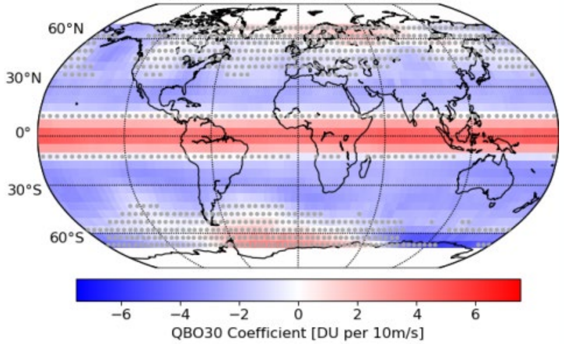
QBO50



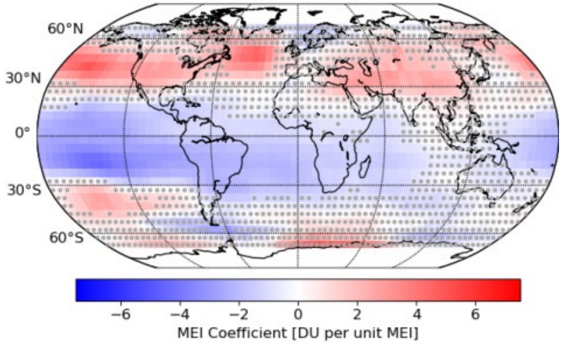
(A)AO index



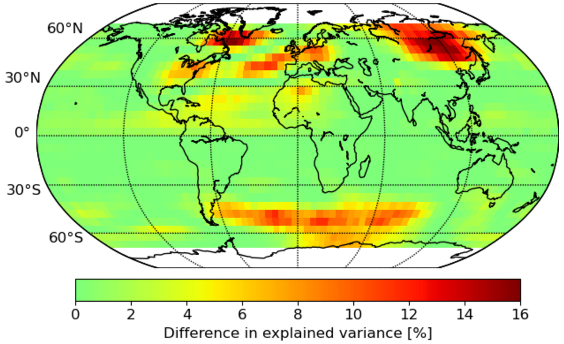
QBO30



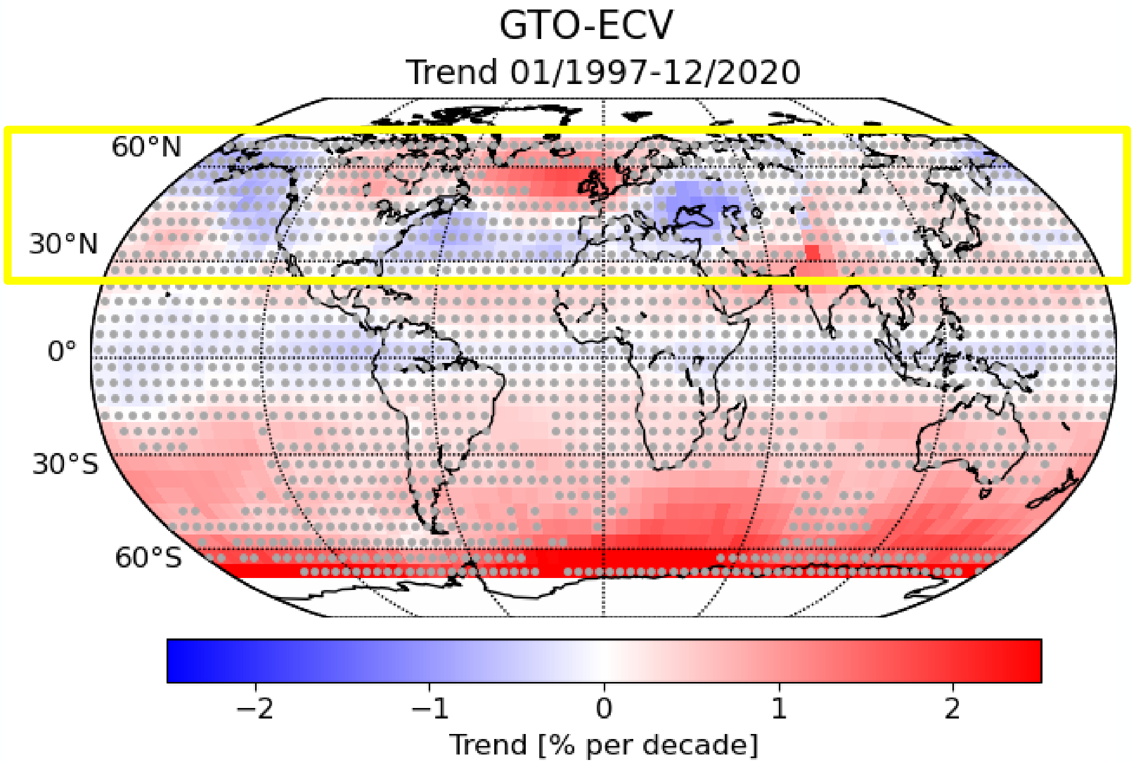
MEI

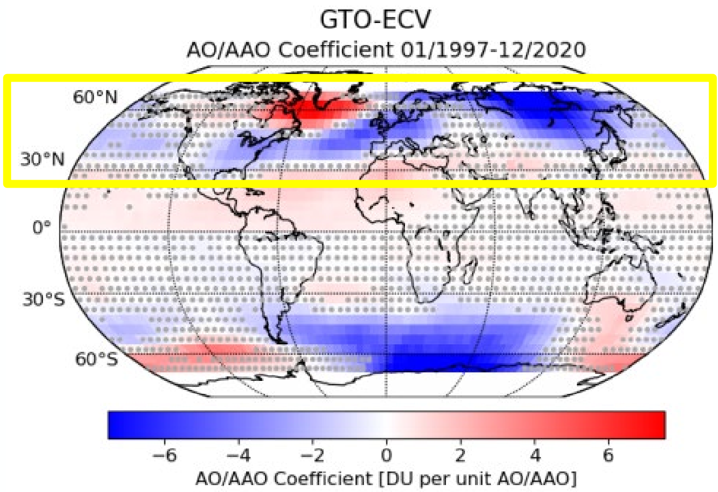


Difference in explained variance

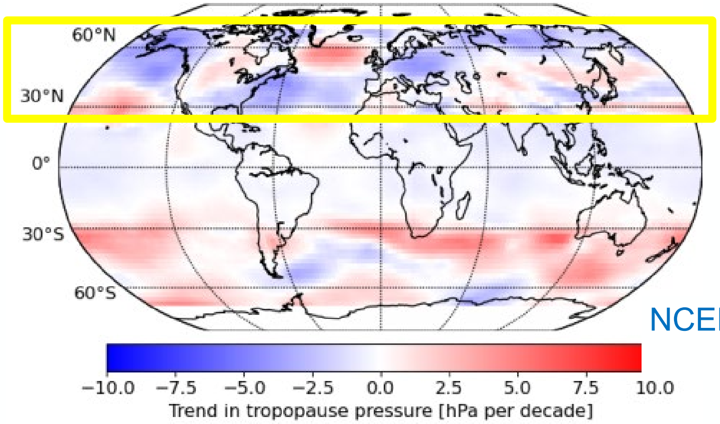


Regional total ozone trends





Linear trend in tropopause pressure

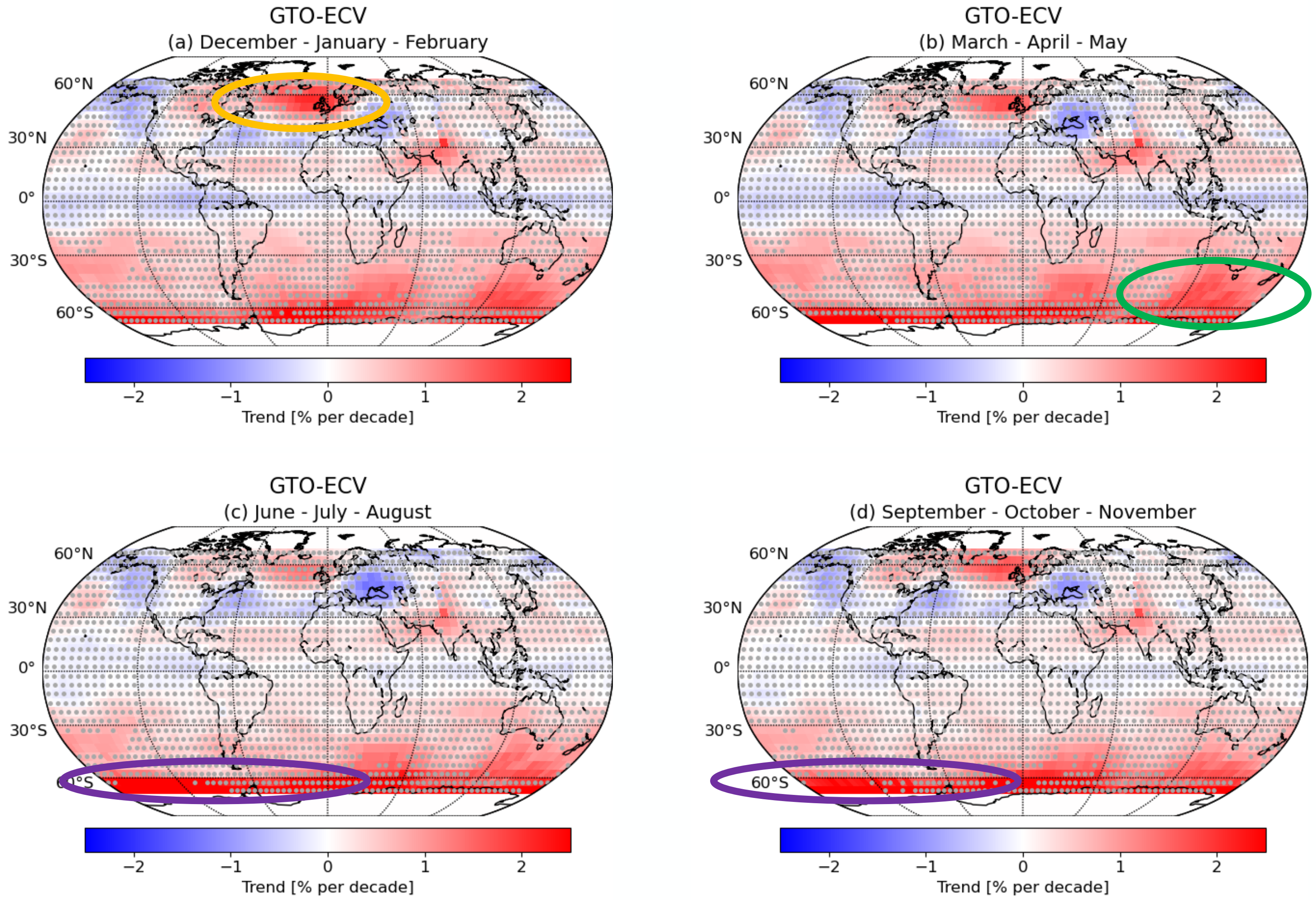


NCEP/NCAR reanalysis
Kalnay et al., 1996

- SH: significant positive trends → **0.6±0.5%/dec** (subtropics) and **2.8±2.6%/dec** (60°-70°S)
- NH: longitudinal structures → positive trends over the North Atlantic & barely significant negative over eastern Europe

Seasonal dependence of ozone trends (i)

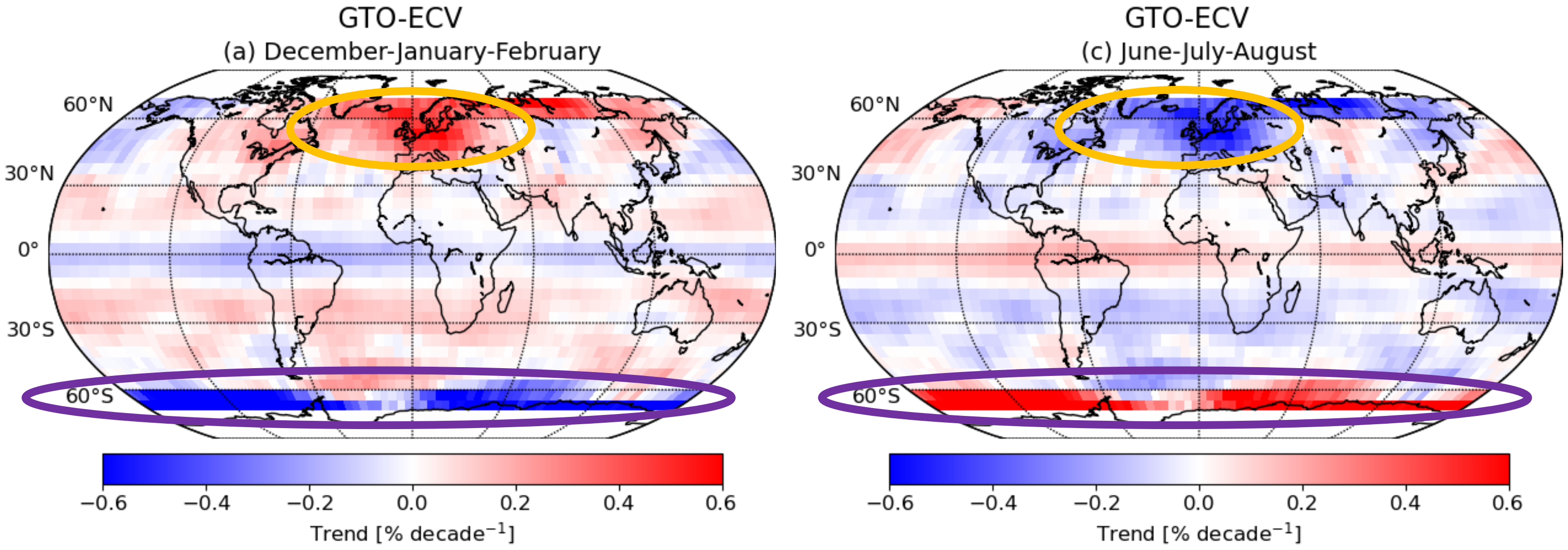
Positive trends in North Atlantic region most pronounced in boreal winter (Dec-Jan-Feb)



Seasonal dependence of ozone trends (ii)

Deviation from annual mean trend

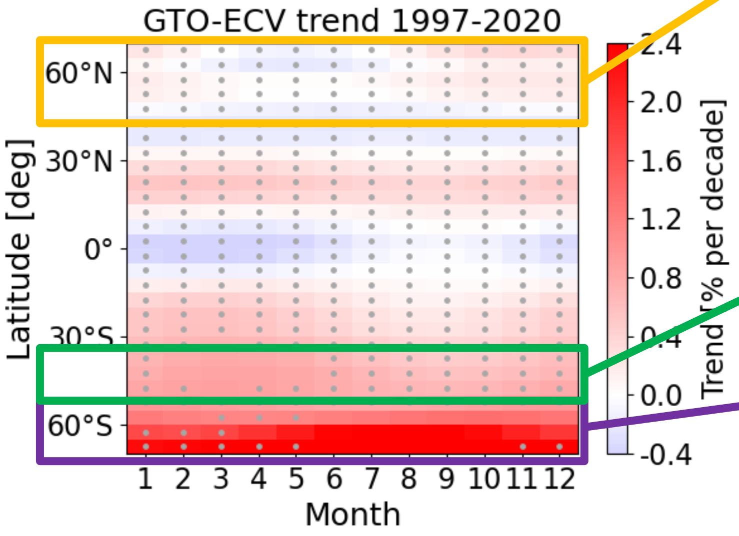
Trends in North Atlantic region and Europe most pronounced in boreal winter (Dec-Jan-Feb)

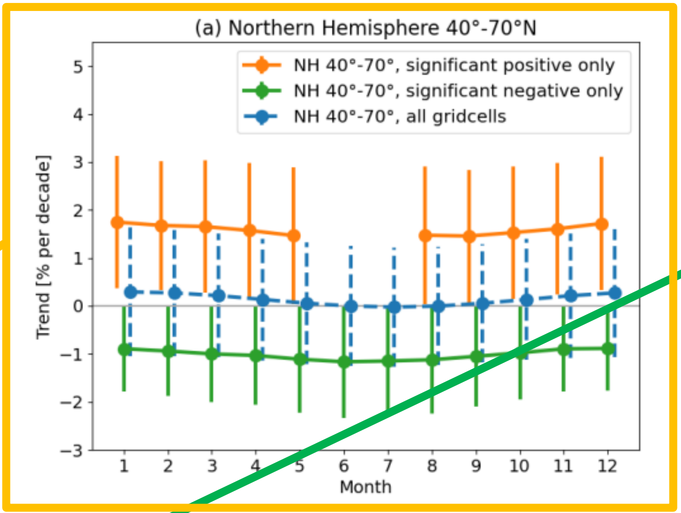


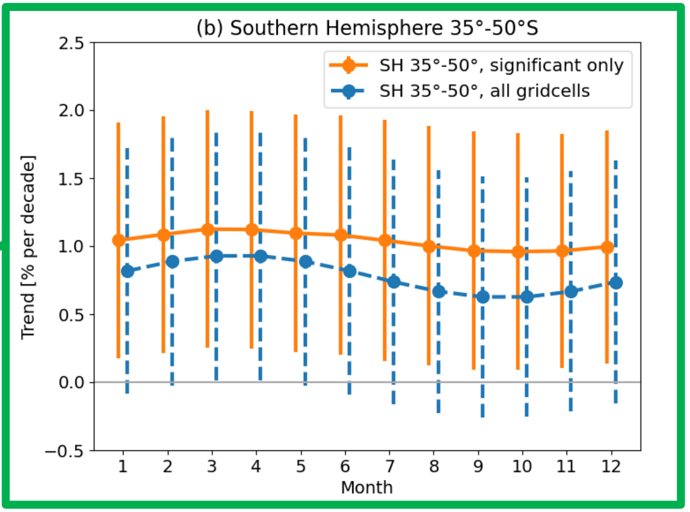
Positive trends in SH high latitudes maximum in austral winter and spring (Jun-Jul-Aug)

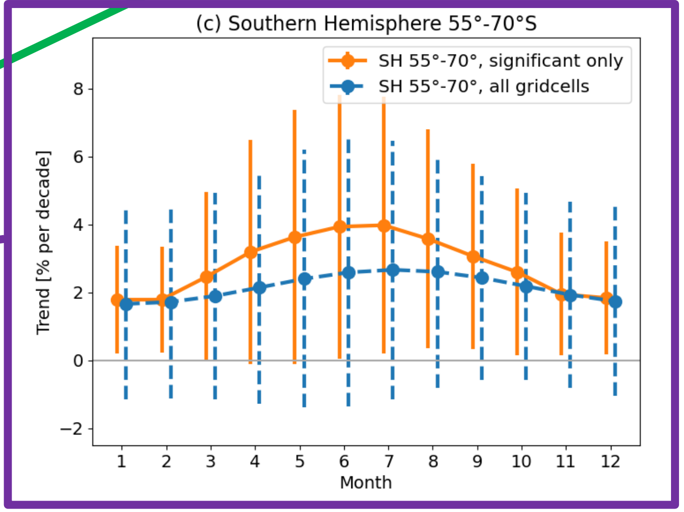
Seasonal dependence of ozone trends (iii)

Seasoneal dependence of zonal mean trends

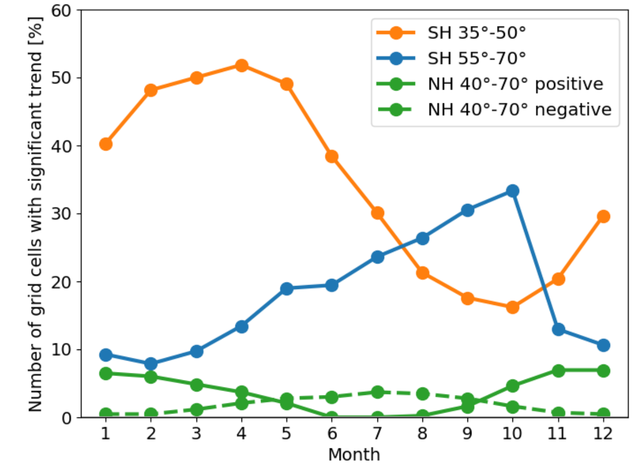








Number of grid cells with significant trends



Summary

- Significant **positive trends mainly in SH**, but strong inter-annual variability in NH
- Total ozone trends indicate **longitudinal structures** in particular in NH
- Trends indicate a **small seasonal dependence** which changes with latitude
- GTO-ECV data record included in relevant reports: BAMS (since 2014), WMO (since 2010), **IPCC 2021 (new)**
- See also Weber et al. "Global ozone recovery trends in total ozone derived from observations and chemical-climate modelling" (next but one presentation)

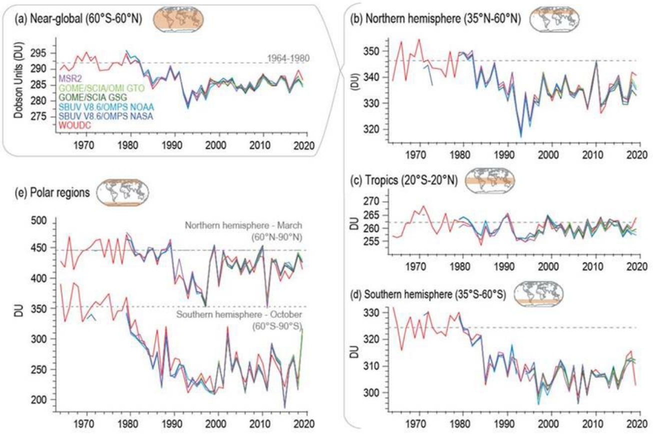
https://doi.org/10.5194/acp-2021-1047
Preprint. Discussion started: 17 January 2022

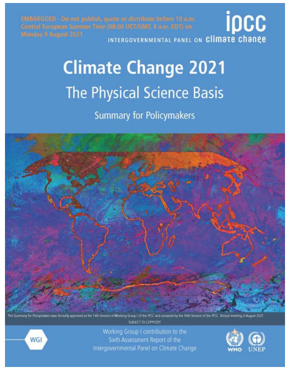
Atmospheric Chemistry and Physics
Discussions
Open Access

Global, regional and seasonal analysis of total ozone trends derived from the 1995–2020 GTO-ECV climate data record

Melanie Coldewey-Egbers[1], Diego G. Loyola[1], Christophe Lerot[2], and Michel van Roozendael[2]
[1]Deutsches Zentrum für Luft- und Raumfahrt (DLR), Institut für Methodik der Fernerkundung, Oberpfaffenhofen, Germany
[2]Royal Belgian Institute for Space Aeronomy (BIRA-IASB), Brussels, Belgium
Correspondence: Melanie Coldewey-Egbers (Melanie.Coldewey-Egbers@dlr.de)

Mean total column ozone in six regions





Outlook

- ESA-CCI+ ozone project: Generation of a **merged ozone profile** data record **GOP-ECV** based on same satellite sensors

- **Input:** ozone profiles retrieved with RAL scheme (Miles et al., 2015)

- **Merging approach:** based on de-seasonalized anomalies

- **Harmonization** w.r.t. GTO-ECV total columns: altitude dependent adjustment of the profiles (based on derivatives) in order to match the total columns