The GOME-type Ozone Profile Essential Climate Variable

GOP-ECV

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Melanie Coldewey-Egbers, 18 October 2024

ESA Climate Change Initiative+ ozone project

- **"Generation of multi-decadal time series of harmonized and consistent ozone data suitable to assess long-term changes in ozone and its vertical distribution"**

- Based on nadir- and limb-viewing sensors

- Single sensor as well as merged products

Input data and outline of merging approach

- **UVN satellite sensors**
    - GOME (1995-2011)
    - SCIAMACHY (2002-2012)
    - OMI (2004-today)
    - GOME-2A/B (2007-2021, 2013-today)

- **Ozone profile retrieval**
    - RAL scheme (Miles et al., 2015)
    - Surface – 80km, 19 layers
    - Optimal sensitivity to tropospheric ozone

- **Merging approach**
    - (1) Merge 5° x 5° level-3 ozone profiles (Sofieva et al., 2021)
    - (2) Apply clustering approach and derive Jacobians using a Neural Network approach
   - (3) Altitude-dependent scaling of merged profiles w.r.t. GTO-ECV total columns

Nearly the same series as for GTO-ECV (total columns)

Same approach for all sensors
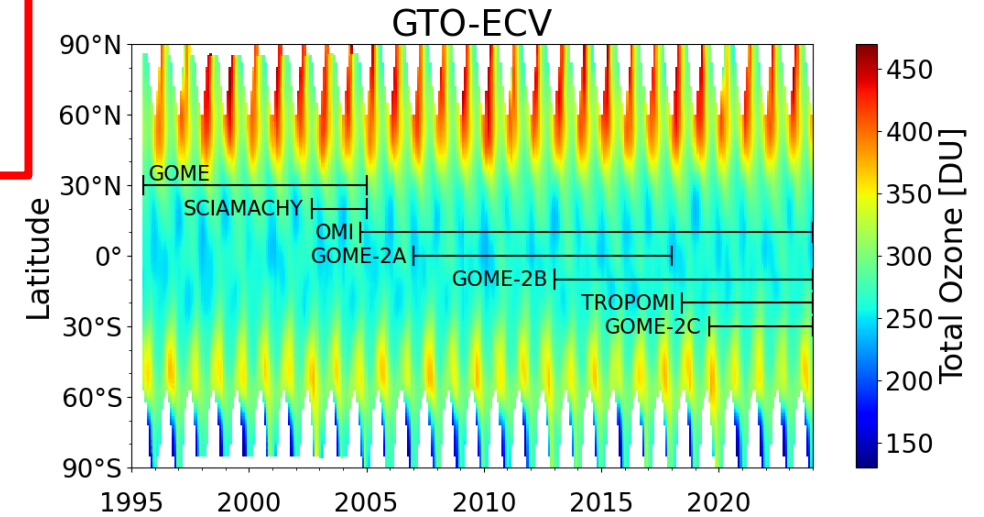
Coldewey-Egbers et al. (2014, 2015, 2020, 2022), Garane et al. (2018), Loyola and Coldewey-Egbers (2012), Loyola et al. (2009)
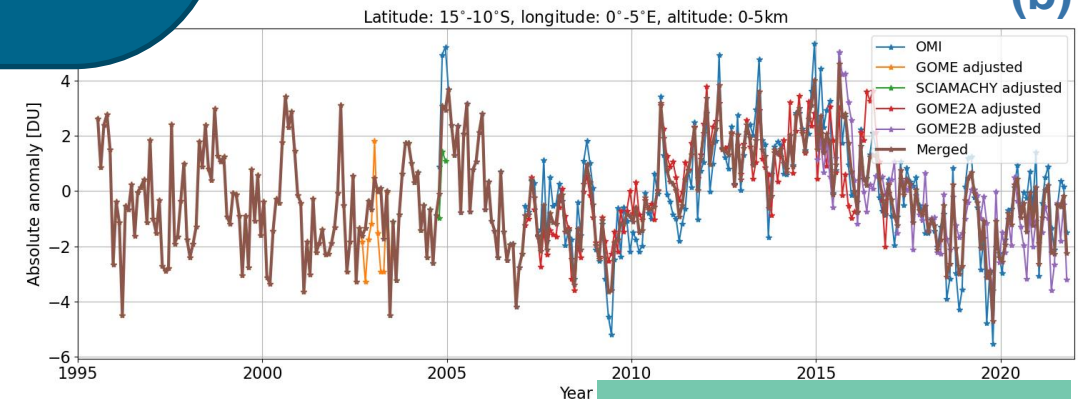
(1) Merging the profiles

- Calculate de-seasonalized anomalies

- Reference sensor OMI (2005-2020)

- Align anomalies w.r.t. OMI

- Merge anomalies and approximate uncertainties

- Use OMI seasonal cycle to calculate back the absolute values

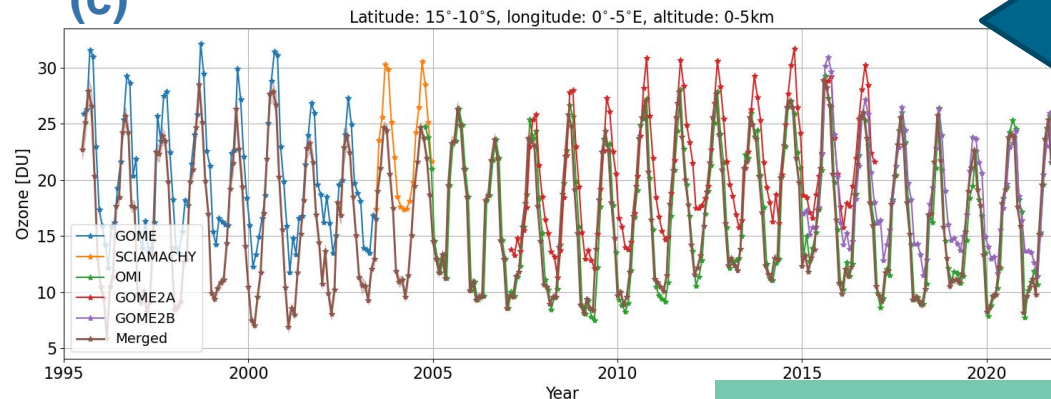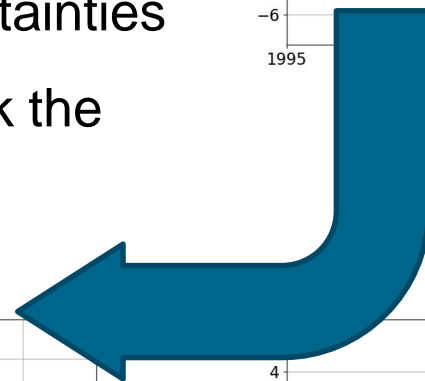**(a)**
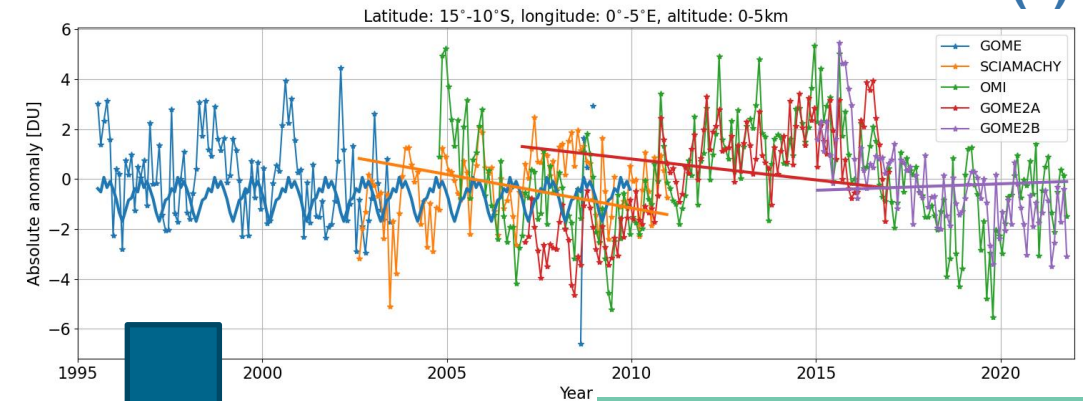
Alignment of anomalies
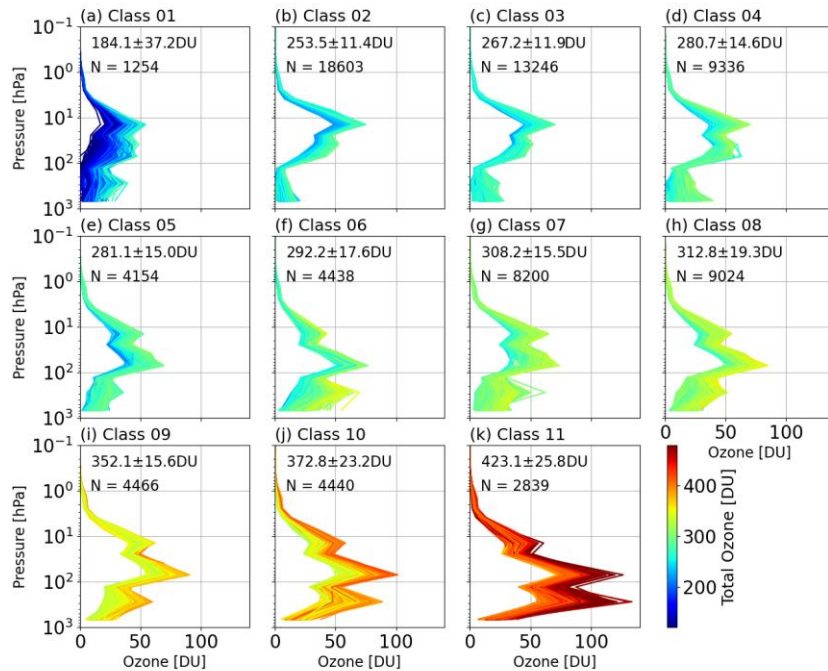
(c)

Absolute values

(b)

Merging the anomalies

(2) Clustering of profiles and estimation of Jacobians
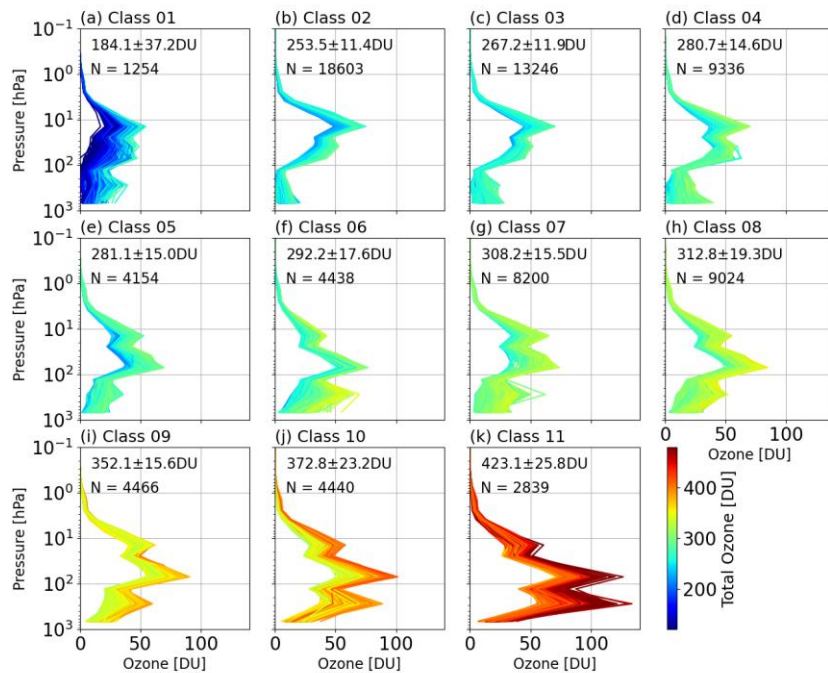
(a) Clustering:

- Use subset of 80,000 profiles
- *k*-means clustering procedure
- 11 clusters (Xu et al., 2017)

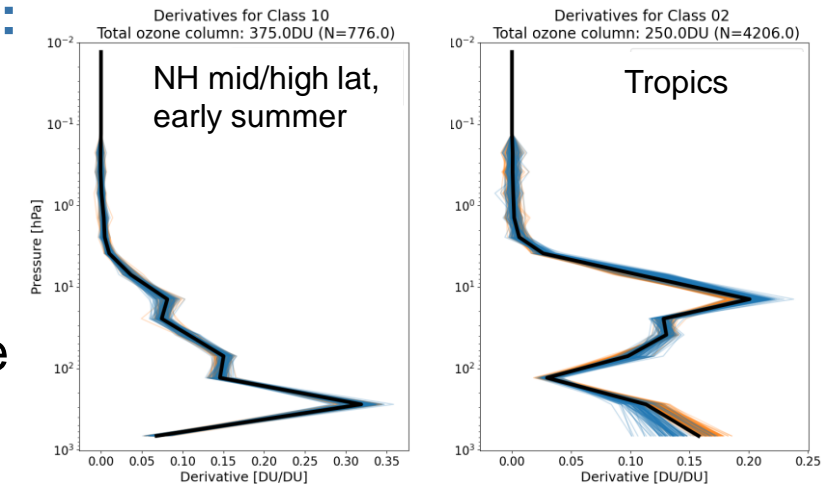# (2) Clustering of profiles and estimation of Jacobians

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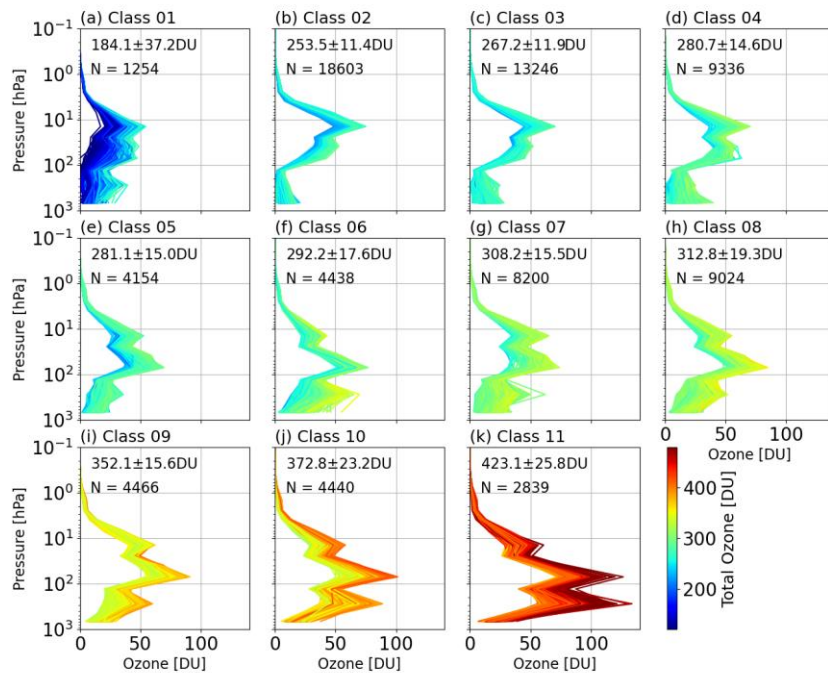

(b) NN training & Jacobians:

- One ensemble (242NNs) for each class
- Output: partial columns
- Calculate median derivative w.r.t. total ozone
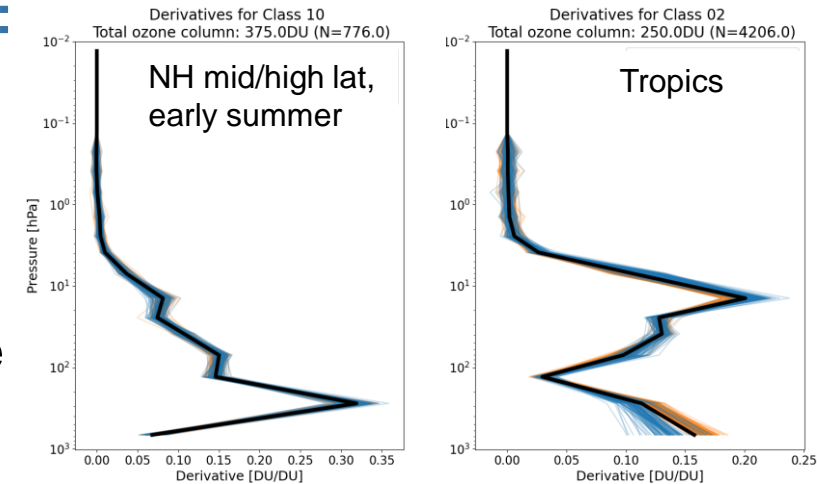
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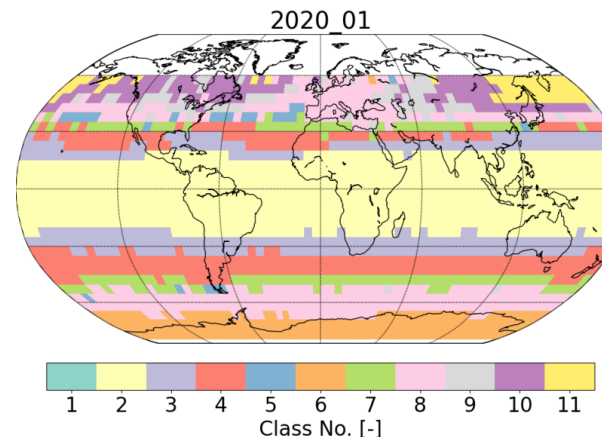- 11 clusters (Xu et al., 2017)

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(c) Classification:

- Assign a class to each individual profile
- *k*-neighbors approach
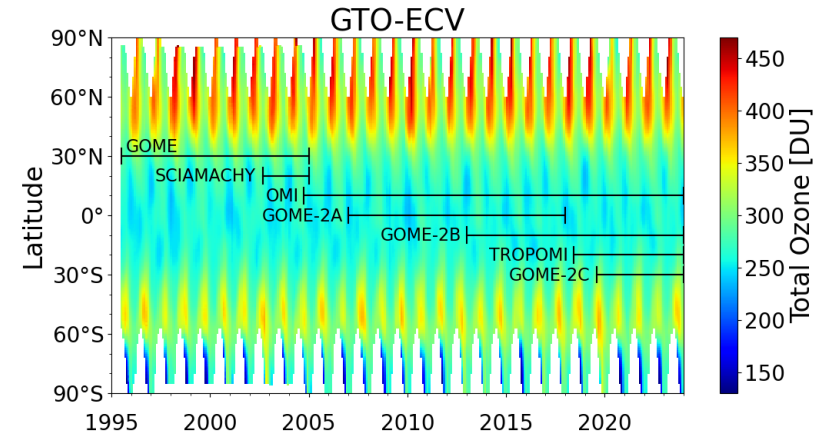
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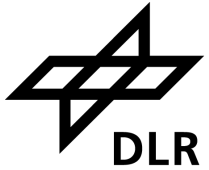# (3) Scaling the profiles w.r.t. GTO-ECV

GOME-type Total Ozone Essential Climate Variable

- GOME, SCIAMACHY, OMI, GOME-2A/B/C, TROPOMI

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

- Merging approach: reference sensor OMI

- Merged time series: 07/1995 – 12/2023; 1°x1° monthly means

- Climate applications: trend analysis and CCM evaluation

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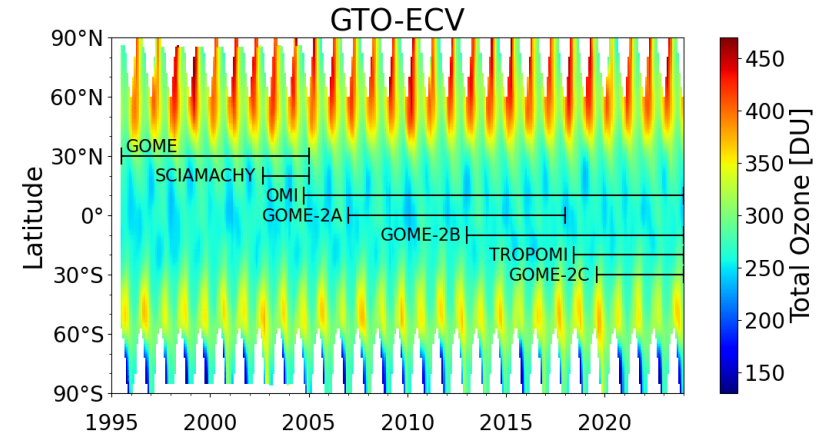
ΔTOZ = GTO-ECV - MERGED

GTO-ECV – MERGED_SCALED
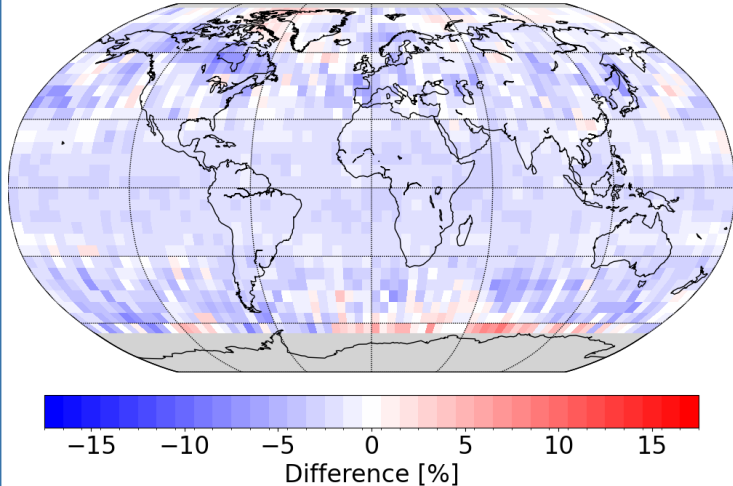
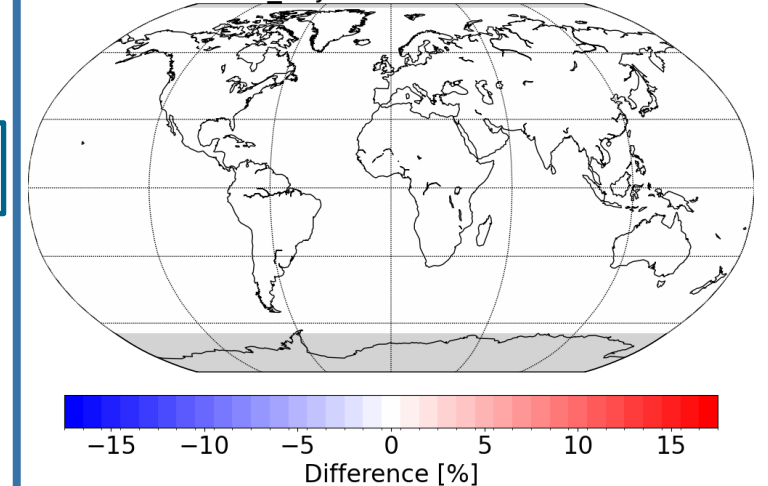Scaling:

$$\text{GOP-ECV}(z) = \text{MERGED}(z) + \Delta TOZ * d/dtoz$$

Total ozone difference

Derivative
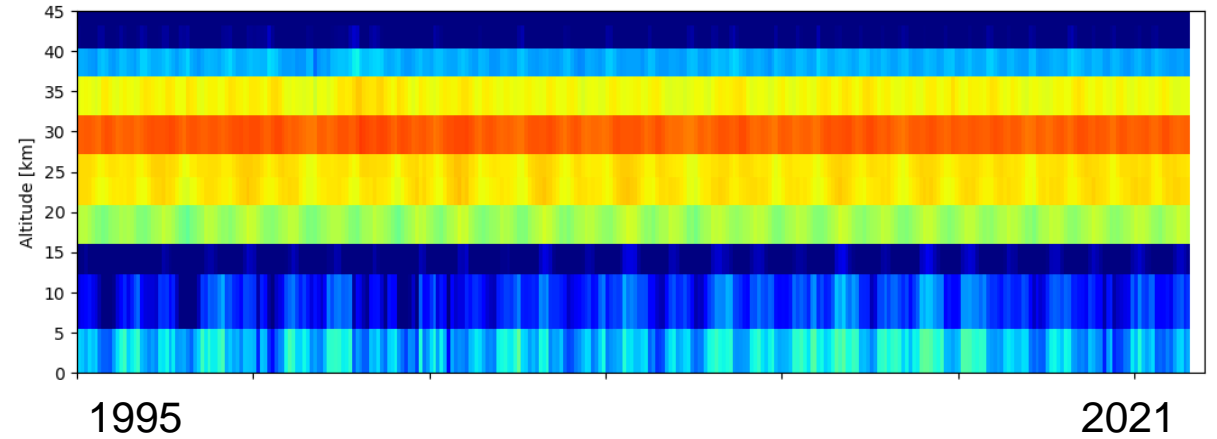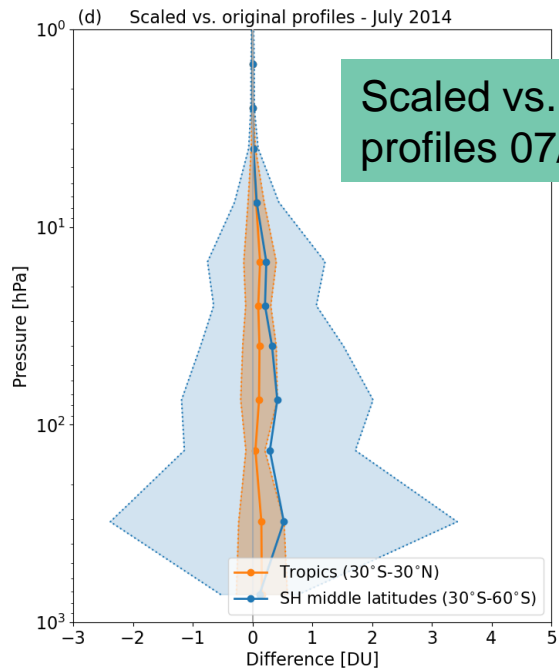
Final GOP-ECV data record
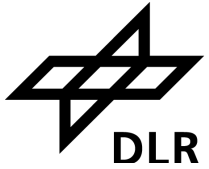
- 5° x 5° monthly mean partial columns

- Error estimates (Sofieva et al., 2021)

- 19 layers from surface to 80km
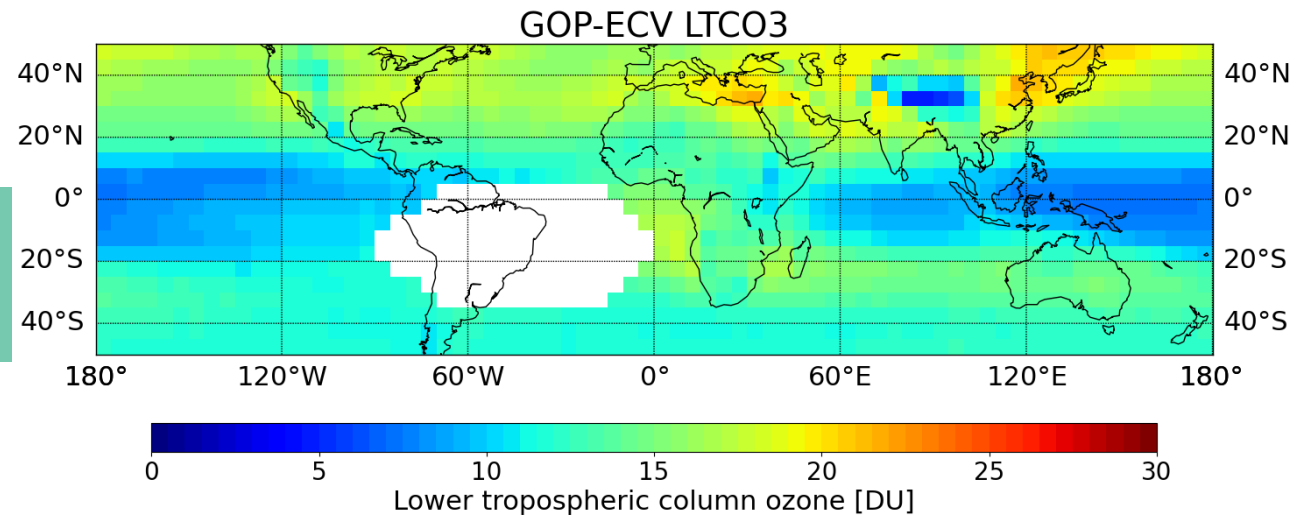
- Time period: 07/1995 – 10/2021

1995   2021

Partial ozone columns in tropics 1995-2021

Ozone partial column [DU]

(d) Scaled vs. original profiles - July 2014

Scaled vs. original profiles 07/2014

Tropics (30°S-30°N)
SH middle latitudes (30°S-60°S)

Lower tropospheric (surface-450hPa) ozone columns

GOP-ECV LTCO3

Lower tropospheric column ozone [DU]

Outlook

- Validation using ground-based data ongoing

  - BIRA: validation of profiles (check consistency with L2 data)

  - AUTH: validation of total columns (check consistency with GTO-ECV data record)

- Comparison with similar data records

  - Partial columns: merged SBUV records (NASA & NOAA)

  - Tropospheric columns