Harmonization and Evaluation of Ground-based Instruments for Free Tropospheric Ozone Measurements by TOAR-II Focus Working Group "HEGIFTOM"

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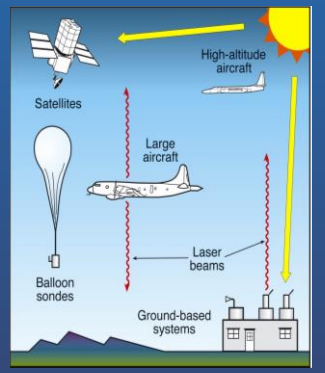


http://hegiftom.meteo.be/

Introduction to TOAR-II Focus Working Group: HEGIFTOM

Key Objective:
Evaluation and harmonization of the different free tropospheric ozone profiling datasets of the established measuring platforms (in-service aircraft, ozonesondes, Brewer/Dobson Umkehr, FTIR, Lidar).

Major Deliverable:
Quality assessed ozone data sets, whereby each measurement gets also an ***uncertainty*** and a ***quality flag***. Thereby, ***representativeness*** and ***instrumental drifts*** will be characterized and evaluated.

Including:
Testing ozone retrievals from new remote sensing techniques (MAX-DOAS, Pandora) against the established techniques.

IAGOS


Ozonesondes

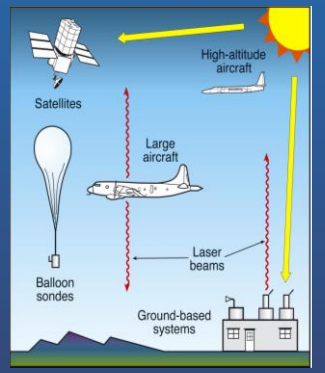

Brewer/Dobson Umkehr


FTIR


Lidar

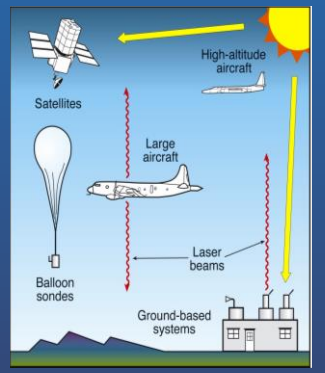

MAX-DOAS & Pandora

http://hegiftom.meteo.be/datasets



Introduction to TOAR-II Focus Working Group: HEGIFTOM

- ***Homogenized time series*** of measured tropospheric ozone with ***uncertainty estimates and quality flags*** included, traceable to a common standard for the different networks. ***>>YEAR 1***
- ***Characterization (+ representativeness) and eventual correction of instrumental drifts*** based on cross-comparisons between instruments at sites hosting different techniques or between instruments measuring identical air masses. ***>> YEAR 2***
- In collaboration with other TOAR-II focus working groups (i.e. Satellites, and Models: ***assessment of the tropospheric ozone distribution and trends*** of tropospheric ozone. ***>> YEAR 3***
- ***New explorative tropospheric ozone datasets*** from new UV-Vis instruments (Pandora & MAX-DOAS) *>> CONTINUOUS*



Internal Consistency within networks

Deliverable: Homogenized free tropospheric ozone profile data, described at HEGIFTOM website, with same template for each dataset:

Availability

location (ftp, data archive, website, doi, e-mail address contact person, etc.).

Data field description

Measured data fields (and their units), incl. auxiliary data fields, available metadata. Data format

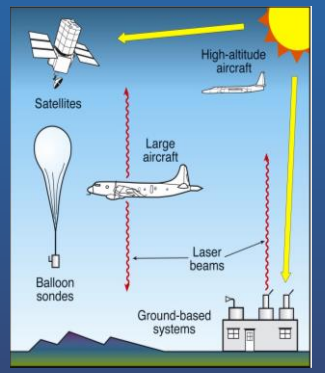
Description of homogenization procedure

short description of the steps taken to make the dataset (more) homogeneous within the network.

Data management

- *Flagging*
- *Uncertainties*
- *Traceability*
- *Internal consistency*
- *External consistency*
- *Data quality indicators*
- *List of homogenized sites (name, geographical location, period of observations)´*

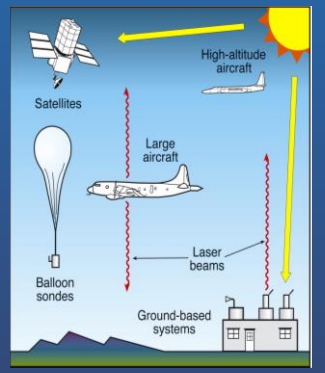
https://hegiftom.meteo.be/datasets



Internal Consistency within networks

Achievements and updates:

- **IAGOS**:
  - internal consistency paper published in AMT (Blot et al., https://doi.org/10.5194/amt-14-3935-2021),
  - simulation chamber comparison of IAGOS-CORE UV-photometer and reference photometer for ozonesondes
- **Lidar**: TMF data has been updated with new data processor, OHP will follow
- **FTIR:** flagging applied to the NDACC data
- **Brewer/Dobson Umkehr**:
  - 5 Dobson Umkehr sites have been homogenized (Petropavlovskikh et al., https://doi.org/10.5194/amt-15-1849-2022), 1 to go.
  - Updated uncertainty estimation of the retrievals.
- **ozonesondes**:
  - 10 more sites homogenized, e.g. OHP: Ancellet et al., https://doi.org/10.5194/amt-15-3105-2022 (±10/50 remaining),
  - WMO-GAW report on Ozonesonde Measurement Principles and Best Operational Practices (https://library.wmo.int/doc_num.php?explnum_id=10884)



Internal Consistency within networks

Achievements and updates:

- **ozonesondes**:

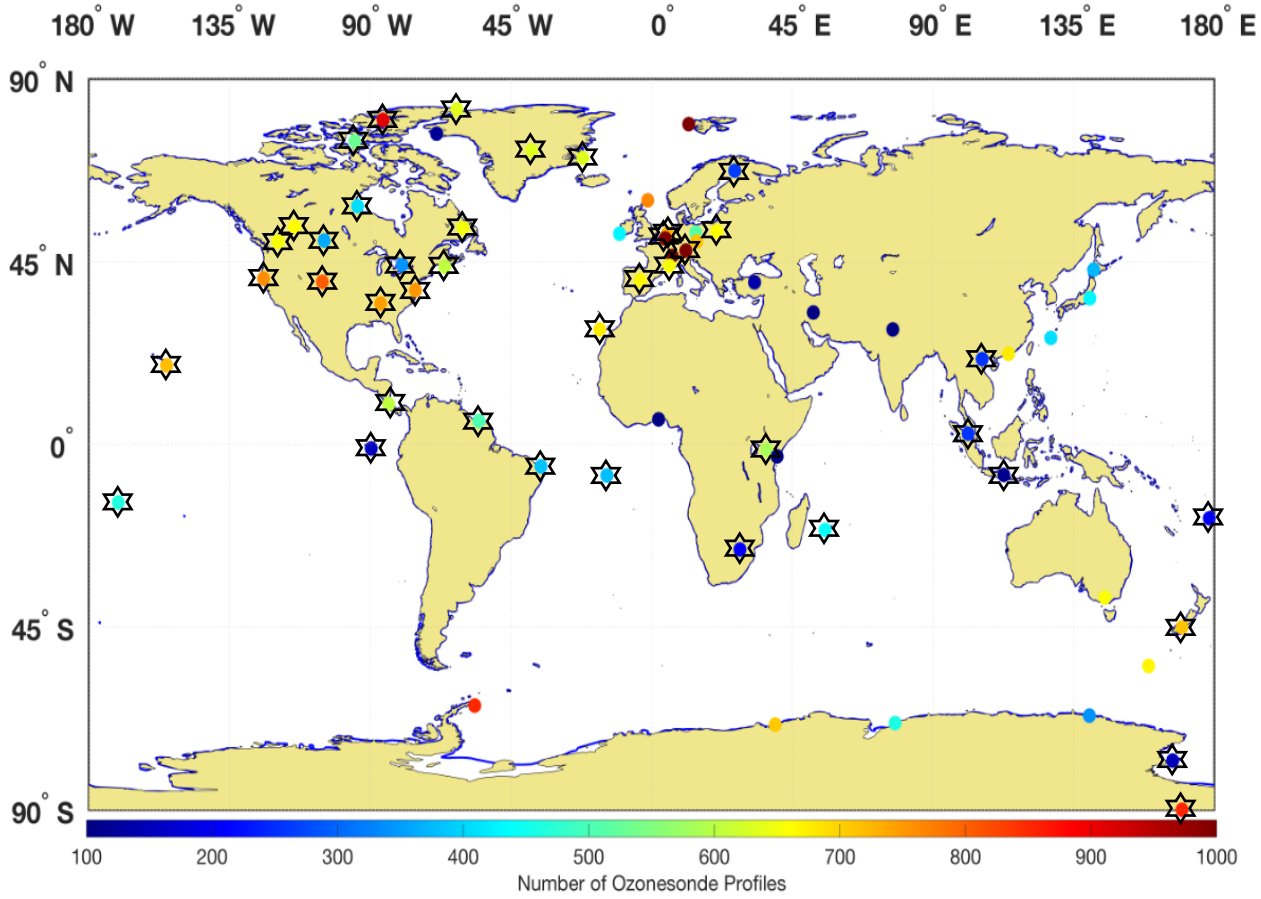


Figure 1-2: Global ECC ozonesonde station locations with the number of ozonesonde profiles from 2005-2019 (Aura satellite era) indicated by the colormap.

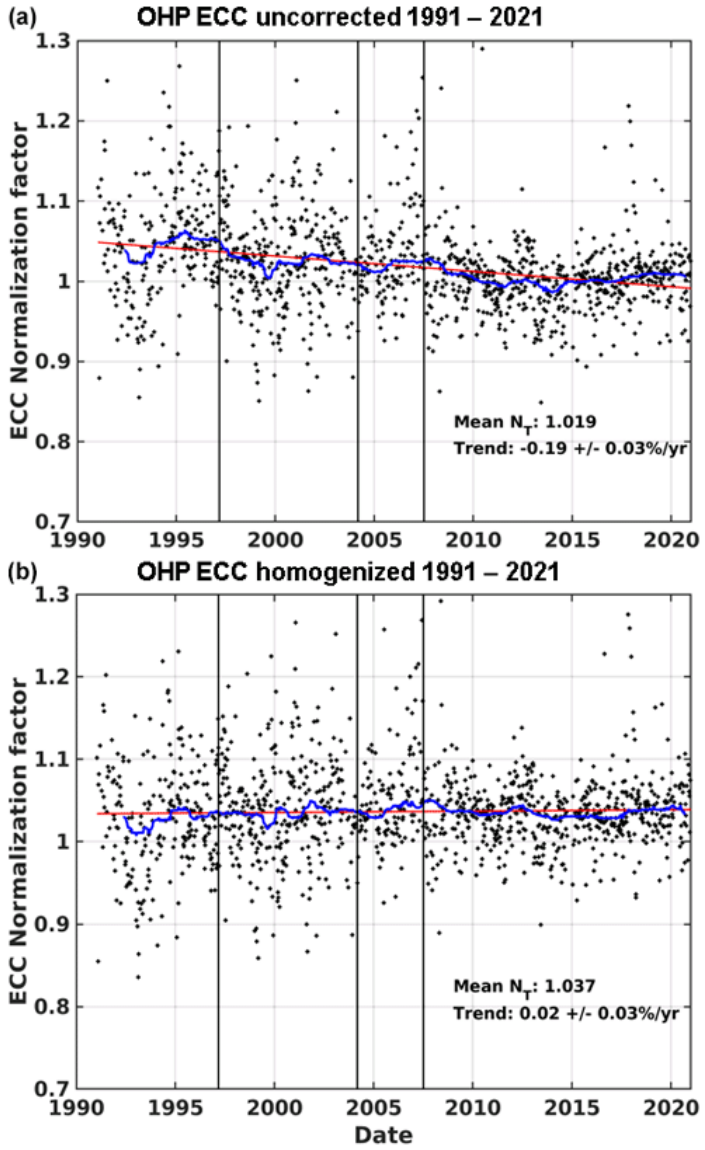
- 42 from around 60 “active” sites homogenized (stars)
- remaining: Japanese, Asian, Australian, some EU and Antarctic sites.
- all homogenized data (and only homogenized data!) are available on a ftp-server, together with general description and link to github Python code on HEGIFTOM website:

https://hegiftom.meteo.be/datasets/ozonesondes

Internal Consistency within networks

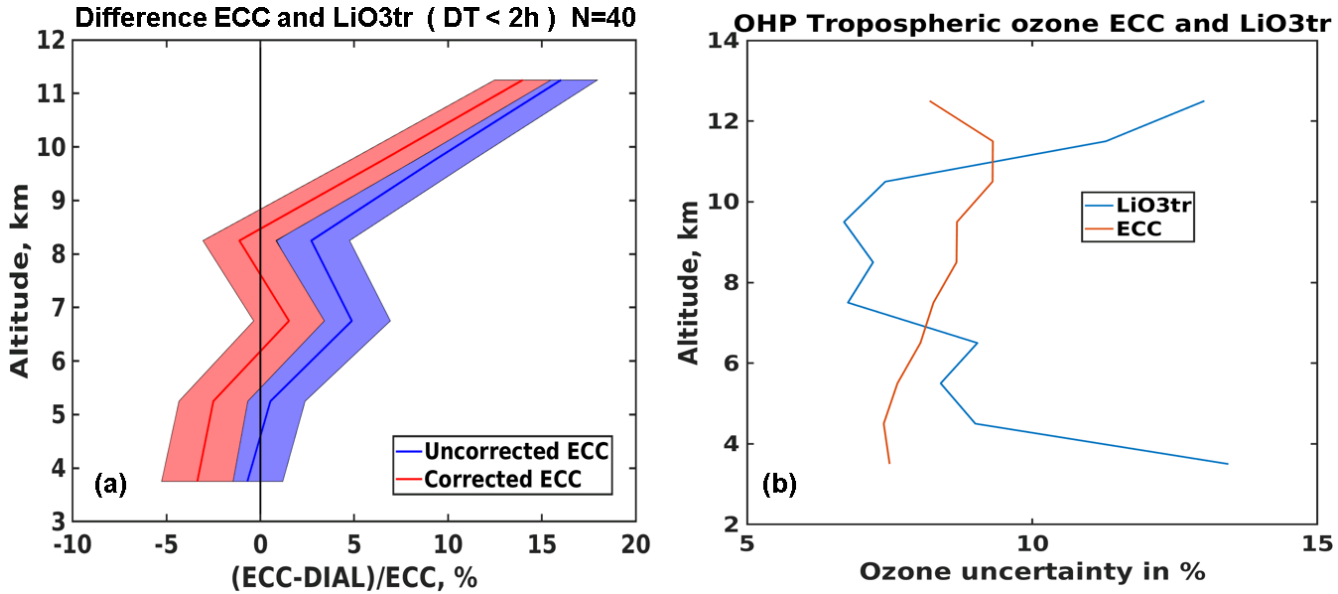
Achievements and updates: OHP ozonesondes

Total ozone



Tropospheric ozone profile

(Lidar)



Ancellet et al., 2022

- smaller drift (TCO)
- smaller relative biases

External Consistency: intercomparisons

Deliverable: TOAR-II Intercomparison Guidelines for Observations of Tropospheric Column Ozone and Tropospheric Ozone Profiles (https://igacproject.org/sites/default/files/2022-03/TOAR-II_Guidelines_for_TCO_and_Profile_Intercomparisons.pdf)

- For coordinate conversions (ozone number densities → ozone partial pressures, altitude grids → pressure grids):
  - ✓ ERA-Interim
  - ✓ MERRA-2

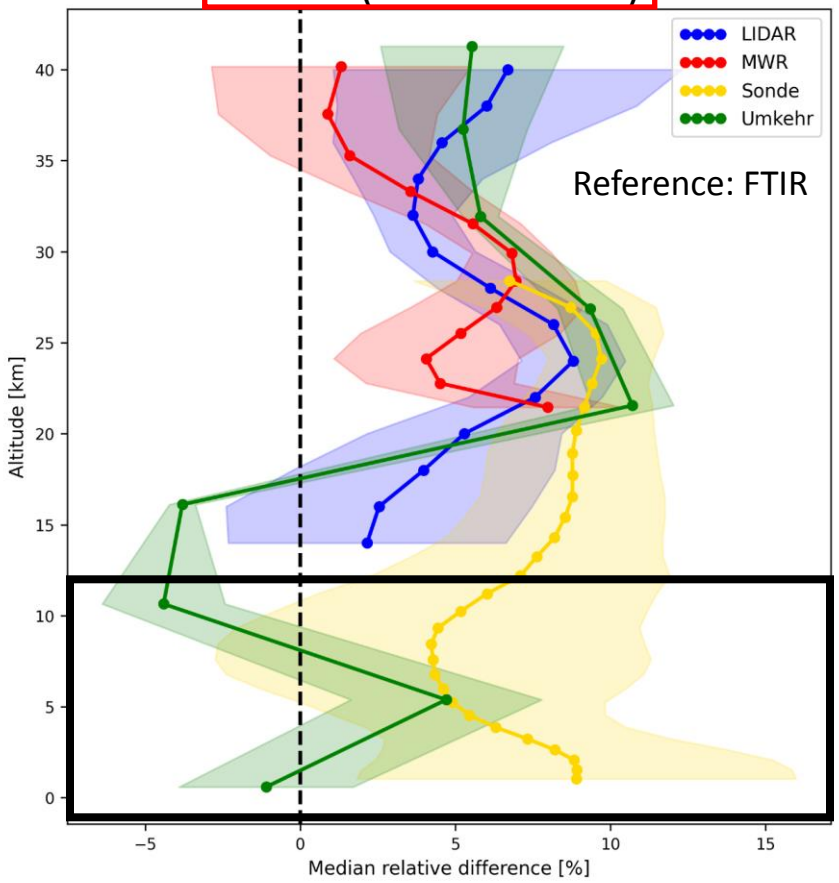
- Tropospheric column ozone:
  - ✓ Fixed pressure levels:
    - ground – 150 hPa in tropics
    - ground – 200 hPa in subtropics (15°-30°)
    - ground – 300 hPa in midlatitudes (30°-60°)
    - ground – 400 hPa in polar regions
  - ✓ ground – thermal tropopause (WMO definition, from ERA-Interim or MERRA-2)

- For comparing tropospheric ozone profiles between different techniques: apply the averaging kernels (AKs), e.g. satellite, Umkehr, or FTIR AKs, to smooth the observed ozonesonde, lidar, and reanalysis ozone profiles

External Consistency: intercomparisons

Intercomparisons: comparison of (tropospheric) ozone retrievals from different ground-based instruments at dedicated sites

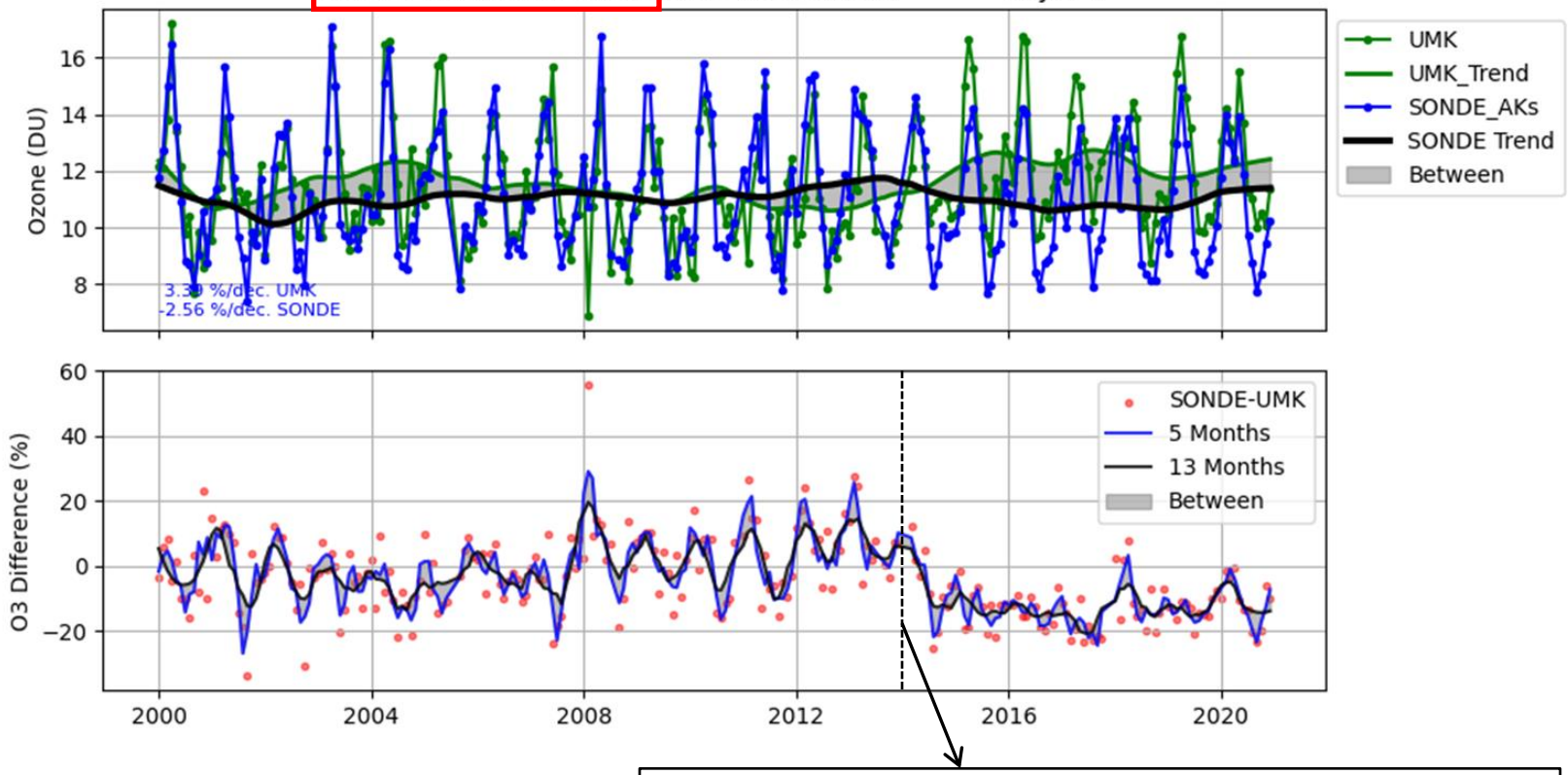
Lauder (New Zealand)



Björklund et al.

Mauna Loa (MLO) Hawaii (19.5 N, 155.6 W)

Layer 1 : 1000 – 250 hPa



drop in tropospheric ozone content in ozonesonde in 2014

Effertz et al.

External Consistency: intercomparisons

Instrument	Ozonesondes	MOZAIC/ IAGOS	FTIR	Lidar	Umkehr
Ozonesondes		Tarasick; Cohen, Vigouroux, Blot	Vigouroux, Björklund	Ancellet	Petropavlovskikh, Effertz, Hannigan
MOZAIC/ IAGOS			Cohen, Vigouroux, Blot		
FTIR					Petropavlovskikh, Effertz, Hannigan, Vigouroux, Björklund
Lidar					
Umkehr					Dobson/Brewer Umkehr at Arosa, Boulder
MAX-DOAS/ Pandora					
Surface			Garcia		
Satellite	Keppens, Hubert, Lambert; 9?	9?	Virolainen, 9?	9?	9?
Models	(Keppens, Hubert, Lambert); Miyazaki; 9?	9?	9?	9?	9?

9: Irina Petropavlovskikh + Bavo Langerock + others: reanalyses vs GB vs satellite overpass tropospheric ozone, spatial and temporal inhomogeneities in GB comparisons

Outlook (2022-2023)

- continue intercomparison studies
- study the **spatial and temporal representativeness** of ground-based free tropospheric measurements, in collaboration with TOAR-II satellite and reanalysis focus groups
- **development** of free-tropospheric ozone retrieval algorithm with MAX-DOAS & Pandora at and comparison with other ground-based free tropospheric ozone data
- support TOAR-II satellite ozone focus working group to determine drifts and biases between satellite ozone retrievals
- assessment of the tropospheric ozone distribution and trends of tropospheric ozone.
- more information: http://hegiftom.meteo.be