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

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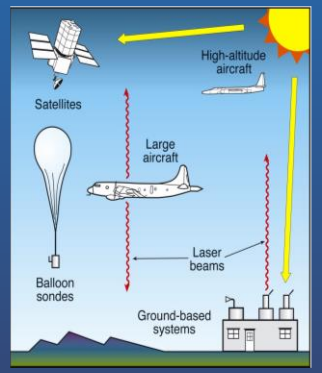


http://hegiftom.meteo.be/

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

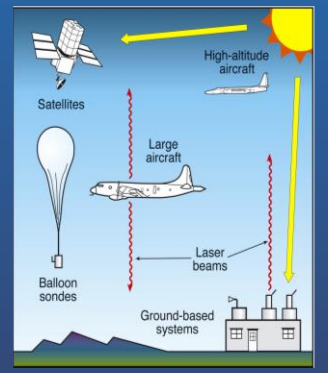

Ozonesondes


Brewer/Dobson Umkehr


FTIR


Lidar


MAX-DOAS & Pandora

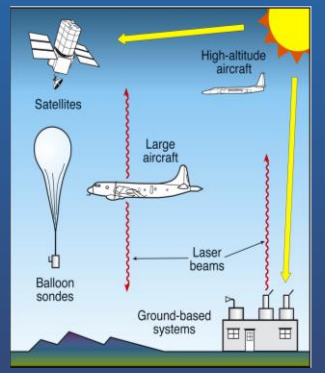


http://hegiftom.meteo.be/datasets

HEGIFTOM: work plan

Ground-based free-tropospheric ozone profile measuring instruments

- ***Homogenized time series*** of measured tropospheric ozone profiles with ***uncertainty estimates and quality flags*** included ***>>YEAR 1***
- ***Cross-comparisons for external consistency >> YEAR 2***
- ***Spatial and temporal representativeness, tropospheric ozone distribution and trends*** (in collaboration with reanalysis FWG) ***>> 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

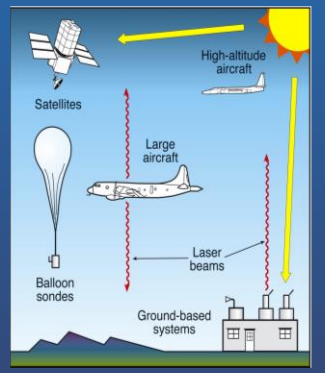
Description of homogenization procedure

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

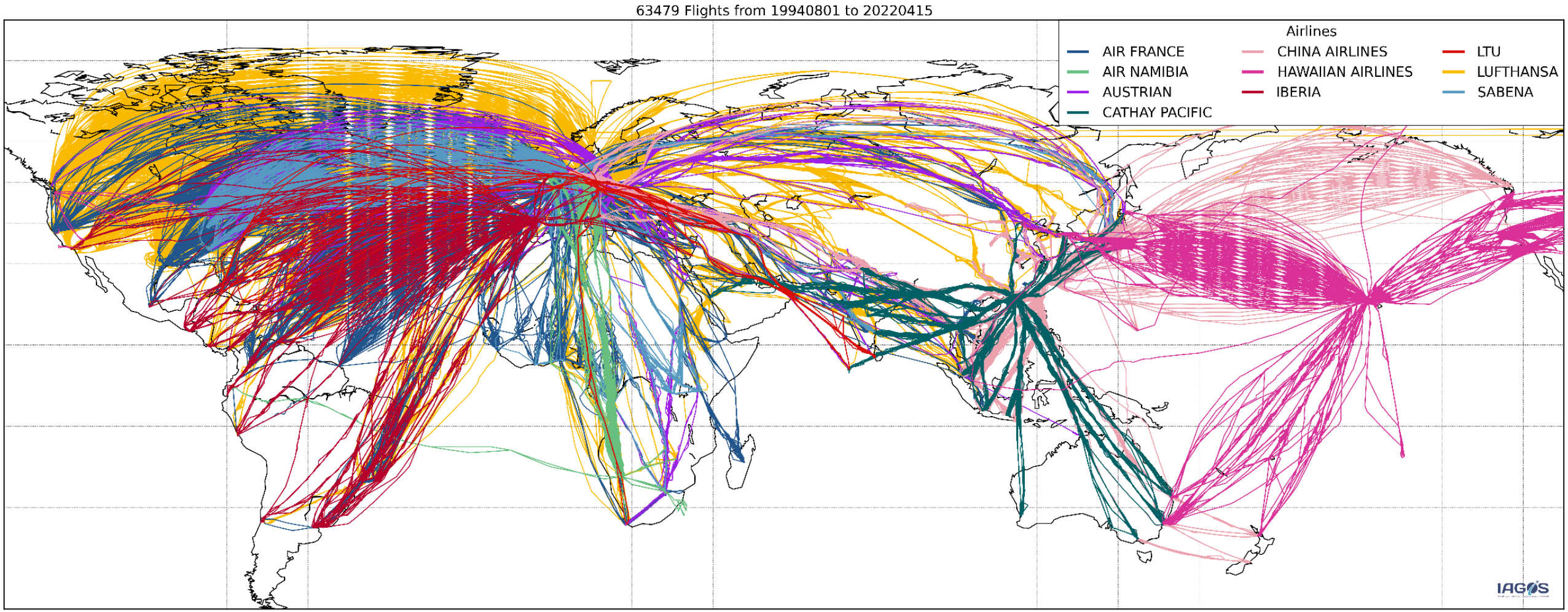
Data management

- *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



IAGOS

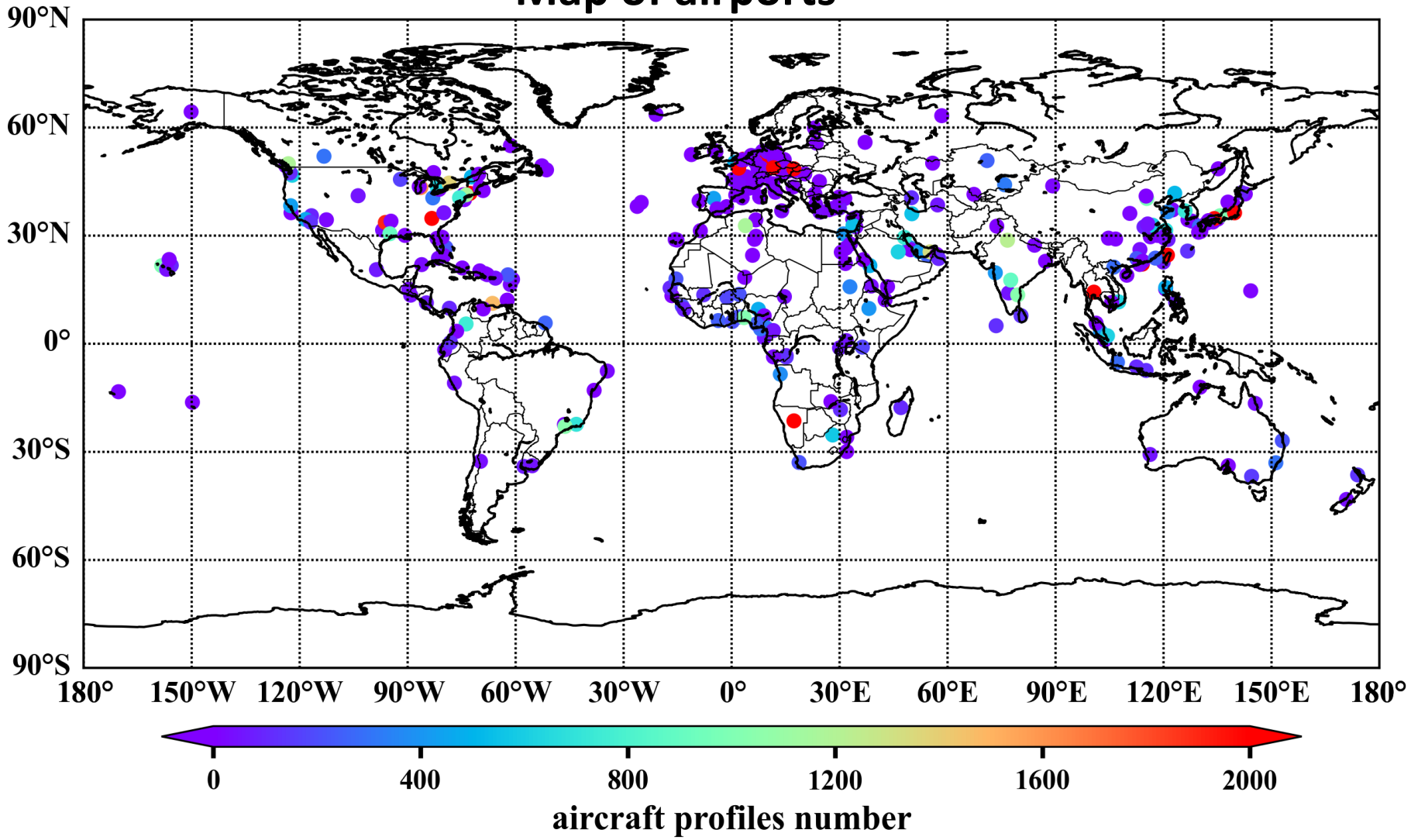


http://iagos-data.fr/#TimeseriesPlace

Contact: blot.romain@aero.obs-mip.fr

IAGOS

Map of airports

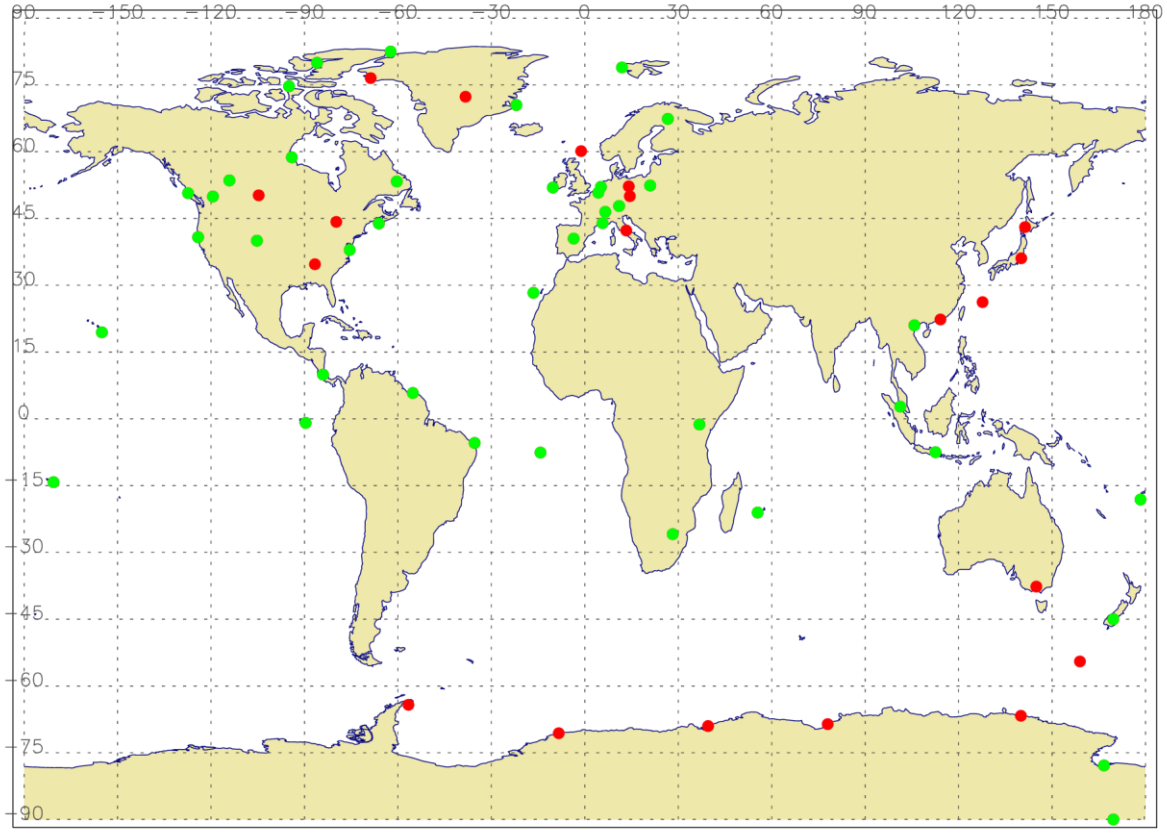


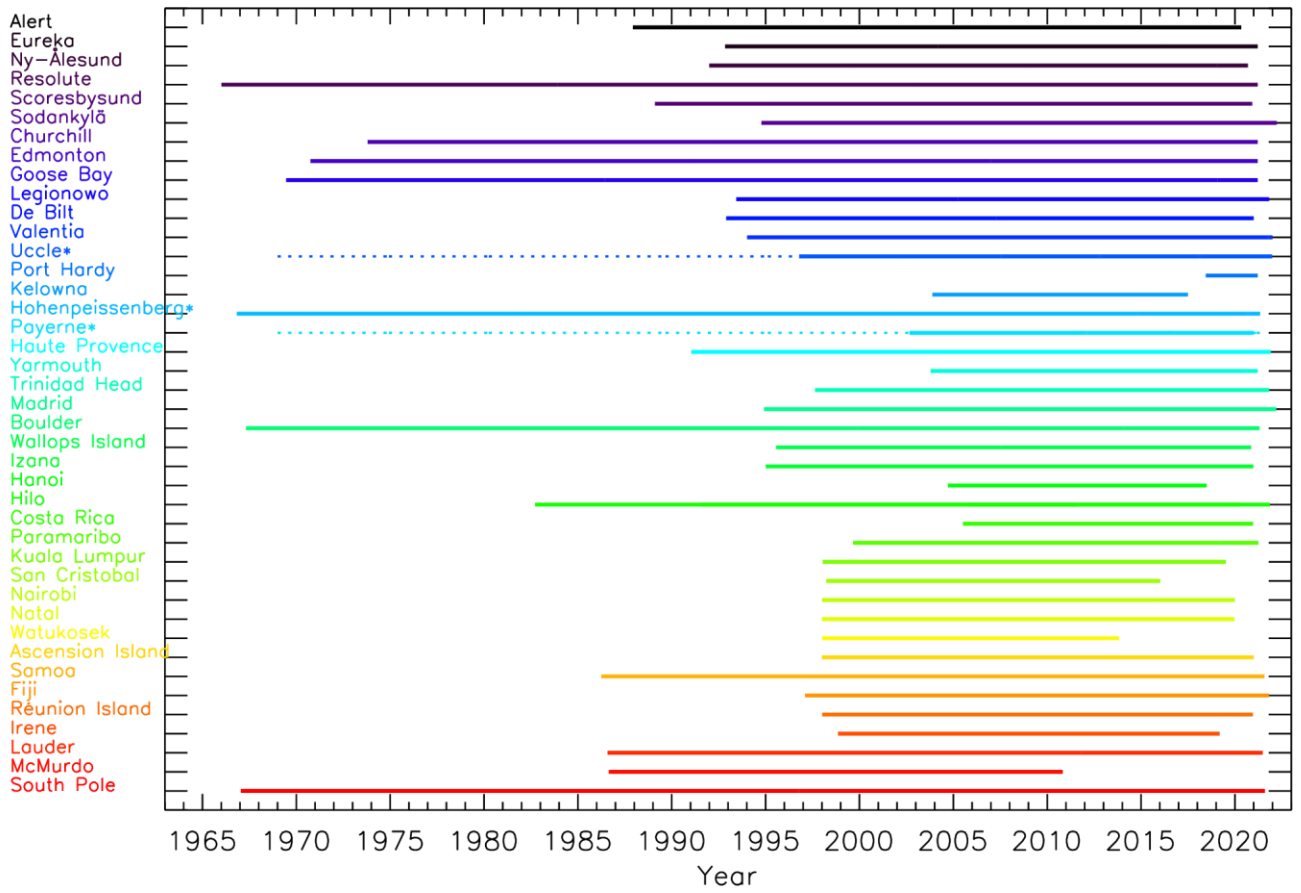
1994/08 to 2021/03
310 stations
122574 profiles

http://iagos-data.fr/#TimeseriesPlace

Contact: blot.romain@aero.obs-mip.fr

Ozonesondes





- ±40 sites (green dots) with homogenized ozone profile data
- profile data available at ftp-server
- tropospheric ozone column data (TOAR-II compliant) can be provided

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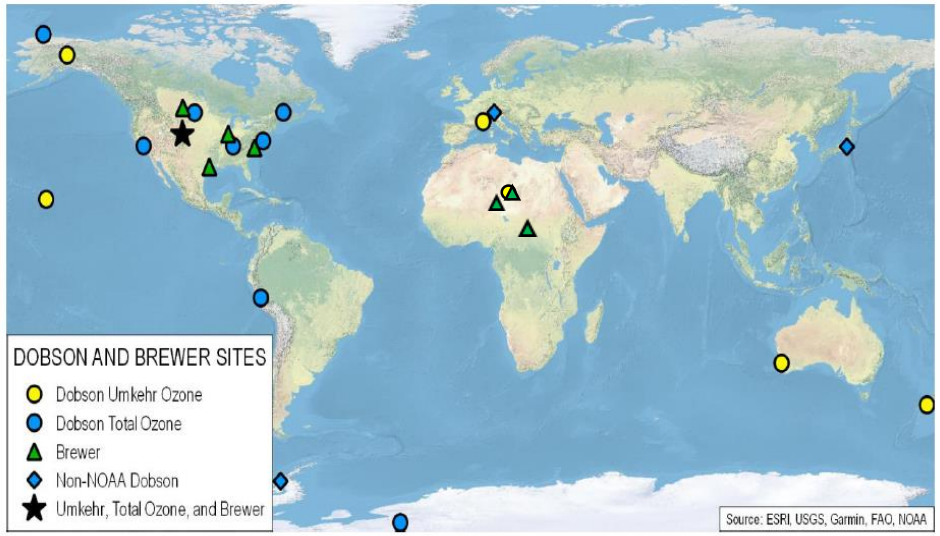
Brewer/Dobson Umkehr



discard the blue circles that represent Dobson total ozone only

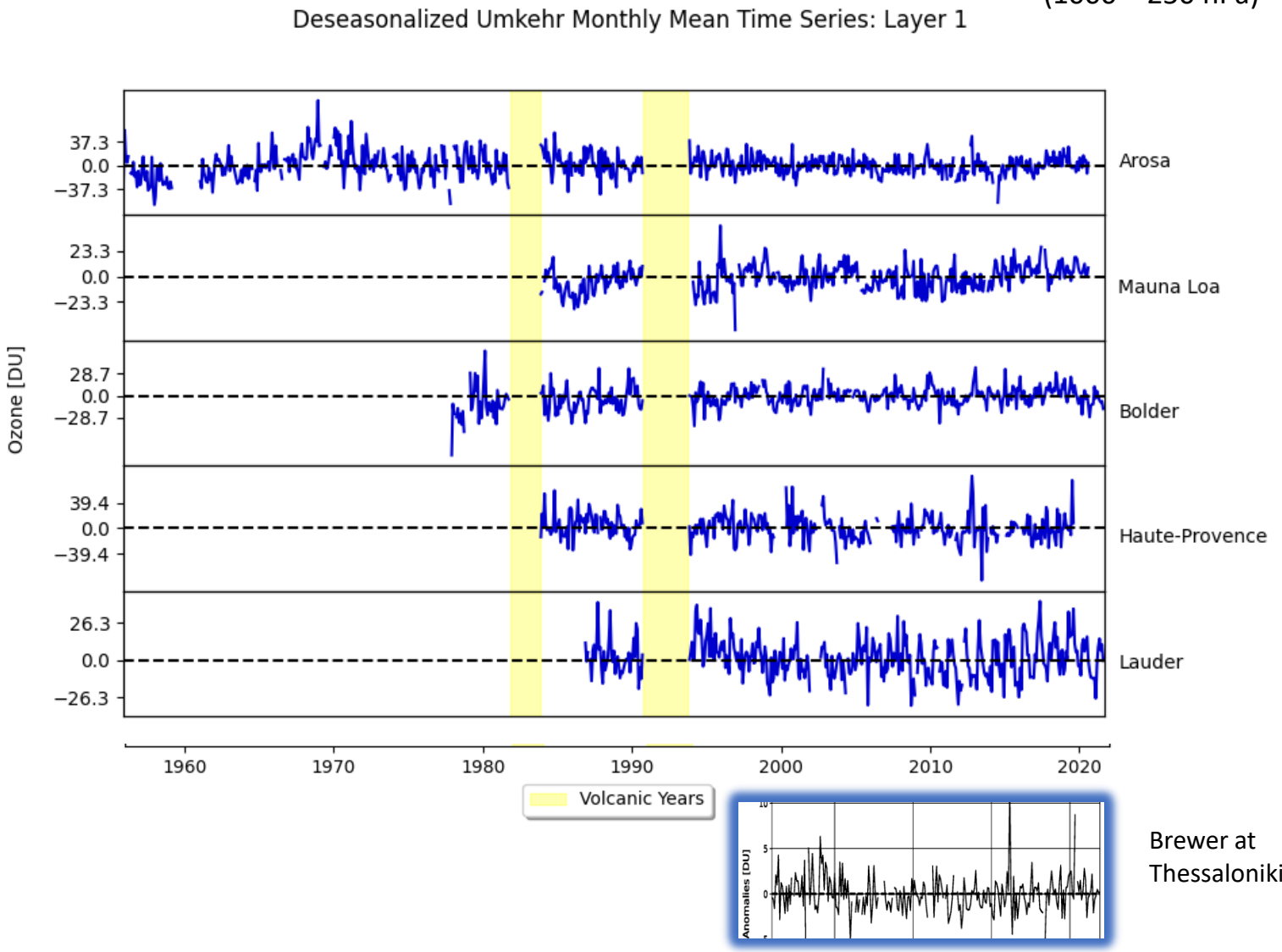
Not plotted Brewer Umkehr time series

- Hradec Kralove, 2005-2022
- Marambio base, 2010-2020 (stopped)
- Arosa/Davos, 1998-2022
- Belsk, 2010-2022

Dobson Umkehr

- Belsk, 1963-2022
- Perth, 1985-2016, 2023-

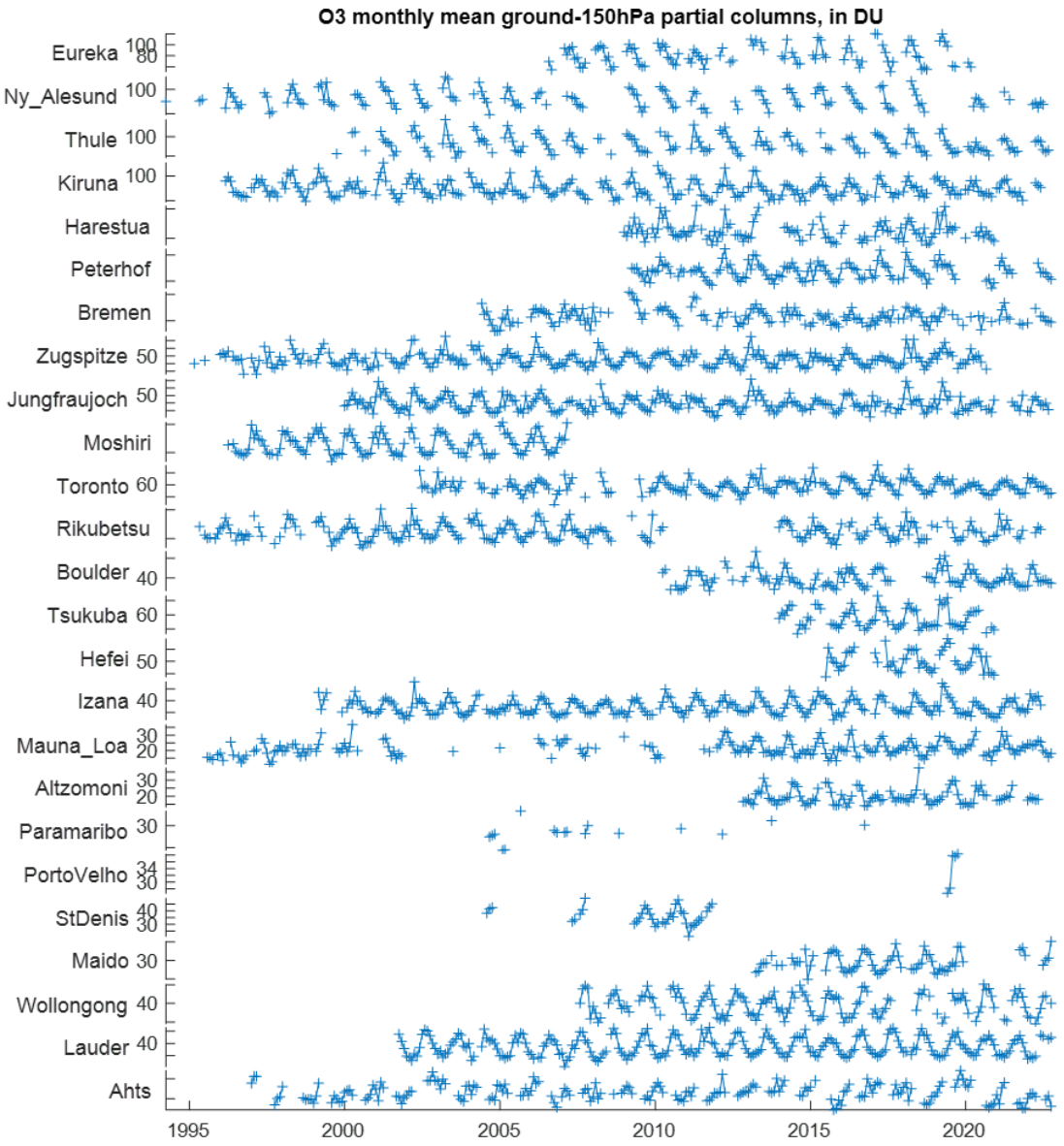
(1000 – 250 hPa)



Brewer at Thessaloniki

Contact: irina.petro@noaa.gov

FTIR

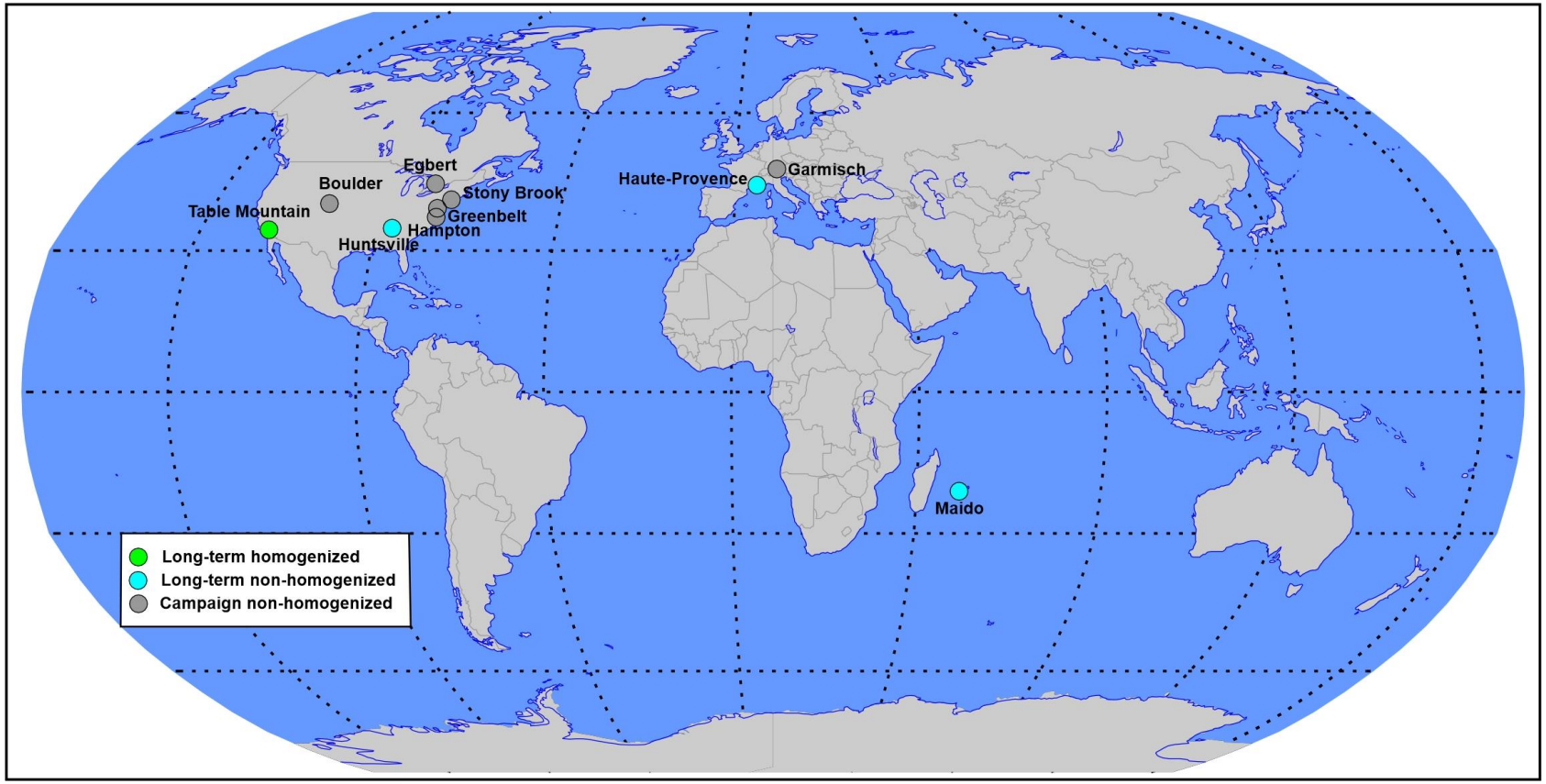


- 25 sites (22 active in O_3) providing O_3 data. See NDACC Infrared WG: https://www2.acom.ucar.edu/irwg
- oldest date back to the mid 90s, most since mid 2000s
- those sites also provide CO/HCHO

Contact: corinne.vigouroux@aeronomie.be

Lidar

Tropospheric Ozone Lidar Sites



- 3 long-term (Haute Provence, Table Mountain, Huntsville)
- 1 homogenized (at HEGIFTOM ftp-server)
- campaign data, mostly at USA

Contact: thierry.leblanc@jpl.nasa.gov

Lidar

Long-term Tropospheric Ozone Lidar Data Availability, by decade (for each decade, stations are sorted by Latitude from NP to SP)

As of Oct 31, 2022

Homogenized
Non homogenized

Station	Network	POC	Format	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Observatoire de Haute Provence, France (43.9N, 5.7E)	NDACC	G. Ancellet (CNRS)	ASCII Ames										
Huntsville, USA (34.7N, 86.6W)	NDACC, TOLNet	M. Newchurch (UAH)	ASCII Ames										
Table Mountain, USA (34.4N, 117.7W)	NDACC, TOLNet	T. Leblanc (JPL)	HDF										
Reunion Island, Maido, France (21.1S, 55.4E)	NDACC	V. Duflot (LACy)	ASCII Ames										
				2021	2022	2023	2024	2025	2026	2027	2028	2029	2030

Station	Network	POC	Format	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Observatoire de Haute Provence, France (43.9N, 5.7E)	NDACC	G. Ancellet (CNRS)	ASCII Ames										
Huntsville, USA (34.7N, 86.6W)	NDACC, TOLNet	M. Newchurch (UAH)	ASCII Ames										
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				2011	2012	2013	2014	2015	2016	2017	2018	2019	2020

Station	Network	POC	Format	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Observatoire de Haute Provence, France (43.9N, 5.7E)	NDACC	G. Ancellet (CNRS)	ASCII Ames										
Table Mountain, USA (34.4N, 117.7W)	NDACC	T. Leblanc (JPL)	ASCII Ames										
Table Mountain, USA (34.4N, 117.7W)	NDACC, TOLNet	T. Leblanc (JPL)	HDF										
				2001	2002	2003	2004	2005	2006	2007	2008	2009	2010

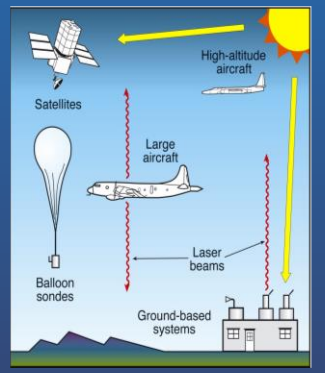
Station	Network	POC	Format	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Observatoire de Haute Provence, France (43.9N, 5.7E)	NDACC	G. Ancellet (CNRS)	ASCII Ames										
Table Mountain, USA (34.4N, 117.7W)	NDACC	T. Leblanc (JPL)	ASCII Ames										
Table Mountain, USA (34.4N, 117.7W)	NDACC, TOLNet	T. Leblanc (JPL)	HDF										
				1991	1992	1993	1994	1995	1996	1997	1998	1999	2000

Station	Network	POC	Format	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Observatoire de Haute Provence, France (43.9N, 5.7E)	NDACC	G. Ancellet (CNRS)	ASCII Ames										
				1981	1982	1983	1984	1985	1986	1987	1988	1989	1990

Contact: thierry.leblanc@jpl.nasa.gov

External Consistency: intercomparisons

Instrument	Ozonesondes	MOZAIC/ IAGOS	FTIR	Lidar	Umkehr
Ozonesondes		Tarasick; Cohen, Blot	Vigouroux, Björklund; Hannigan, Ortega	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		Virolainen		
Models	(Keppens, Hubert, Lambert); Miyazaki				



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

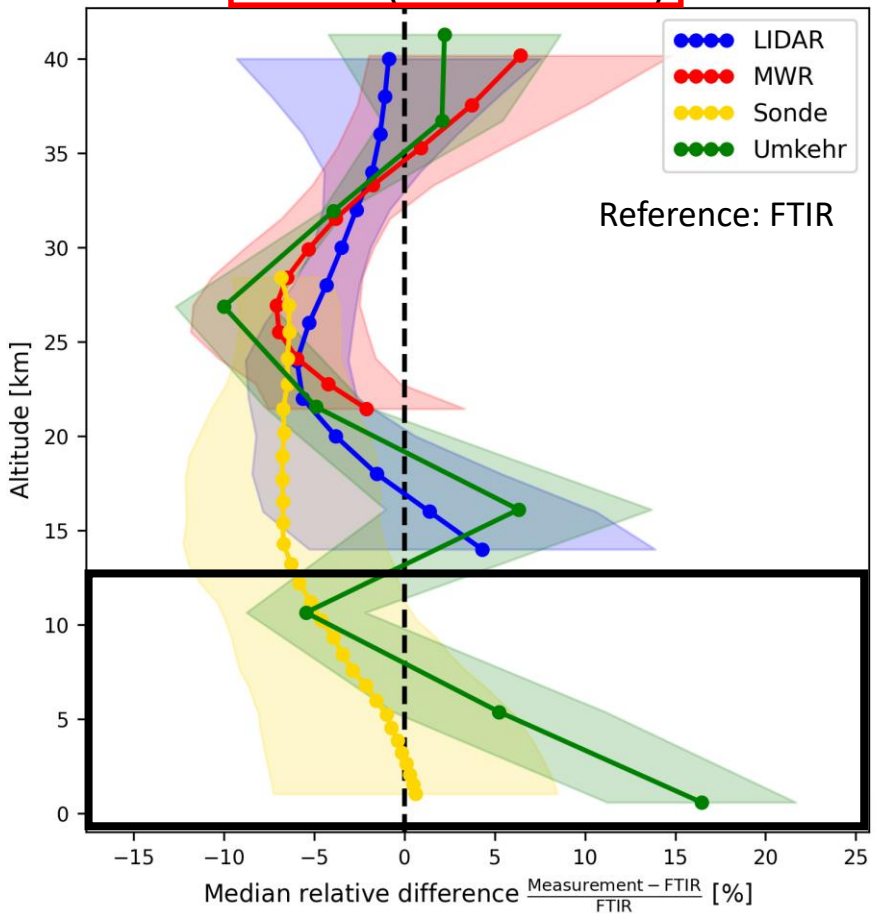
- Tropospheric column ozone:
  - ✓ Fixed pressure levels:
    - ground – 150 hPa in tropics
    - ground – 200 hPa in subtropics (15°-30°)
    - ground – 300 hPa in midlatitudes (30°-60°)
    - ground – 400 hPa in polar regions
  - ✓ ground – thermal tropopause (WMO definition, from ERA-Interim or MERRA-2)

- 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

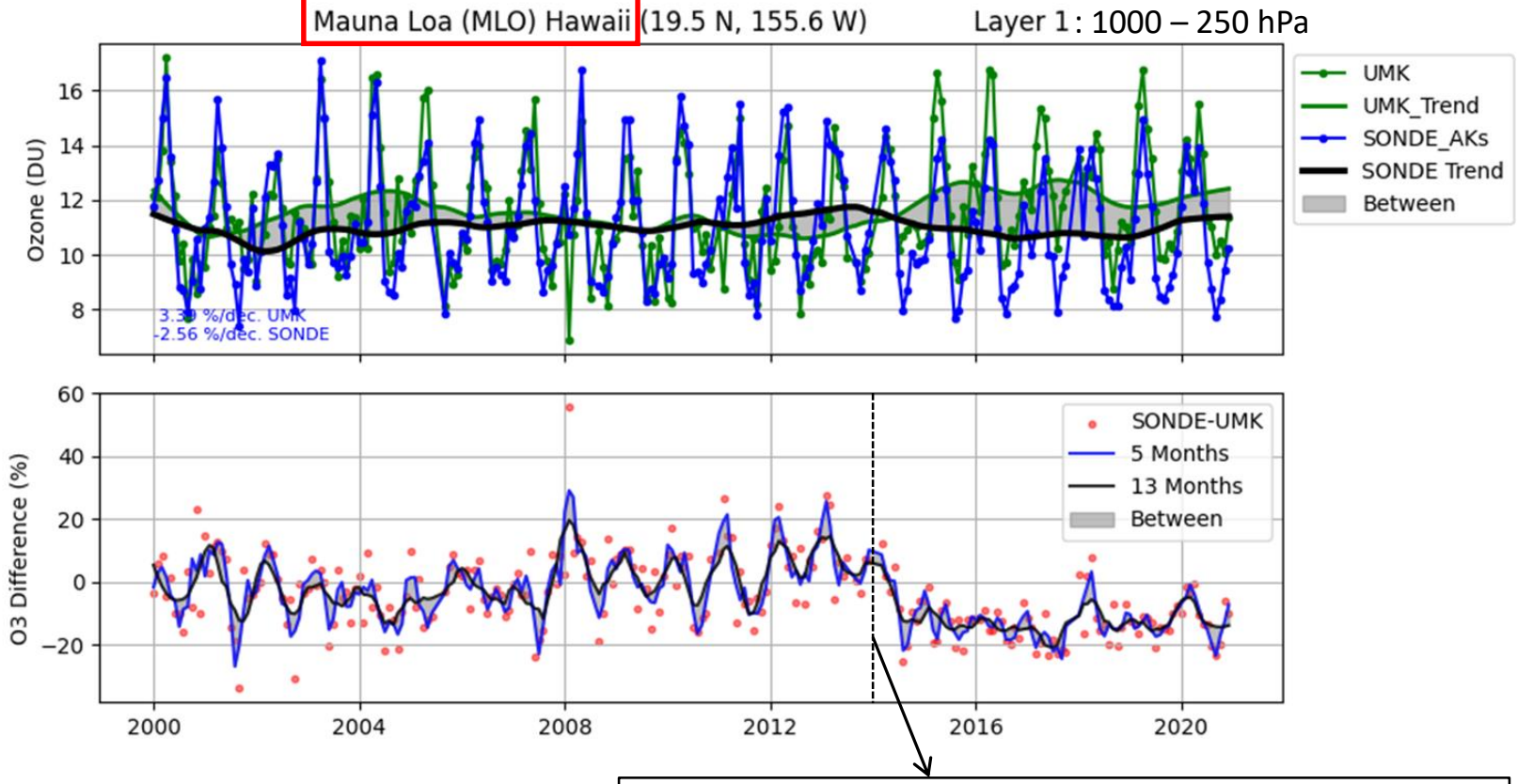
Intercomparisons: comparison of (tropospheric) ozone retrievals from different ground-based instruments at dedicated sites

Lauder (New Zealand)



Björklund et al.

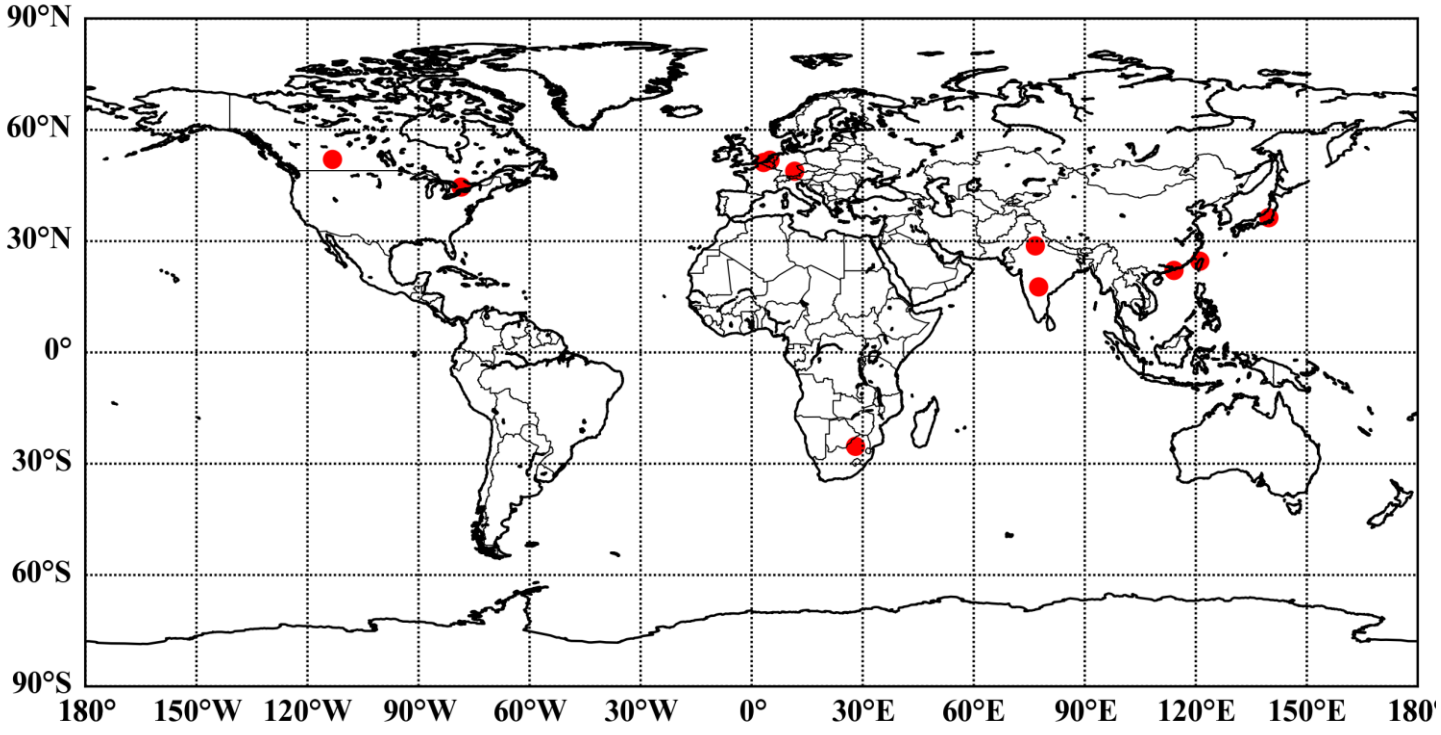
Mauna Loa (MLO) Hawaii (19.5 N, 155.6 W)

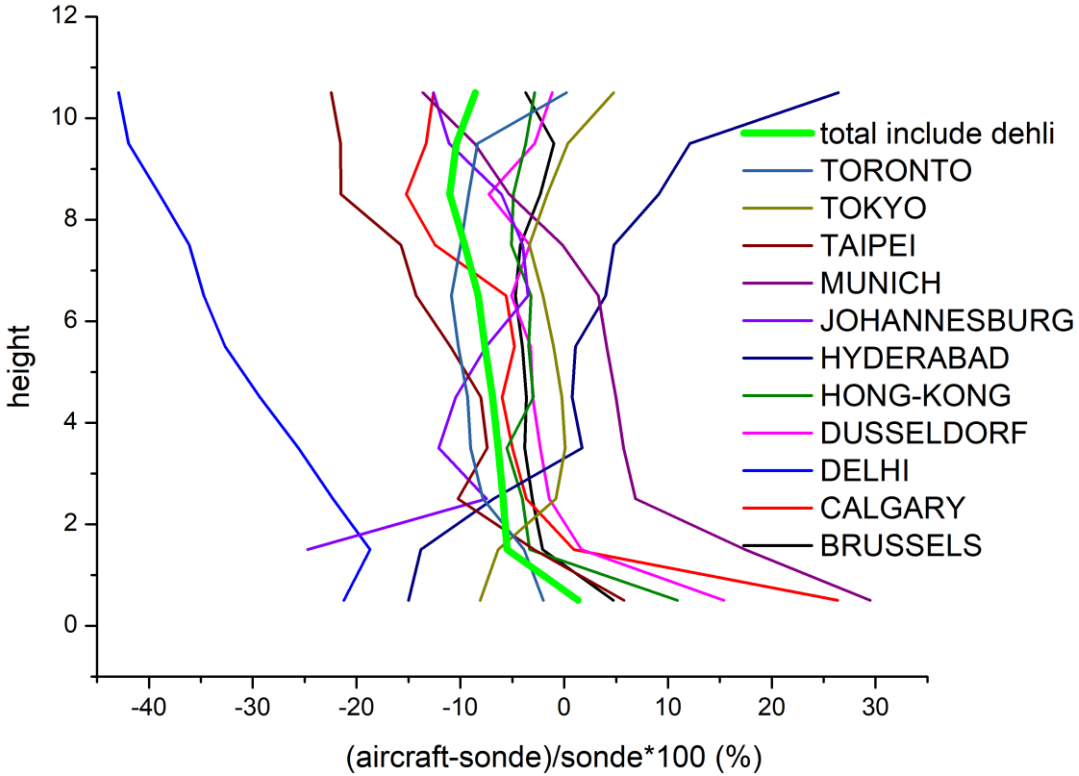


Effertz et al.

External Consistency: intercomparisons

IAGOS vs. sondes at 11 stations

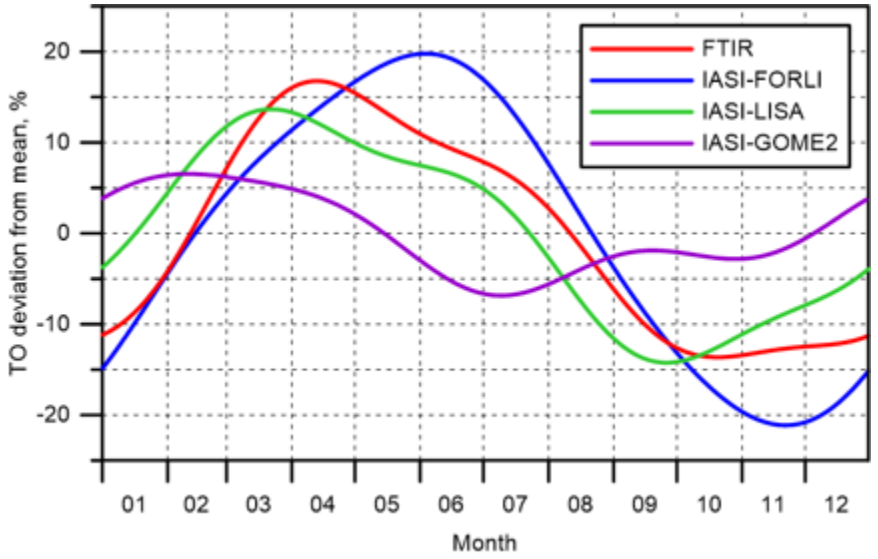




Wang & Tarasick

External Consistency: intercomparisons

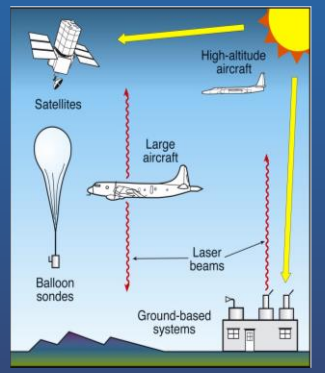
FTIR vs. IASI @ St-Petersburg



Virolainen et al.

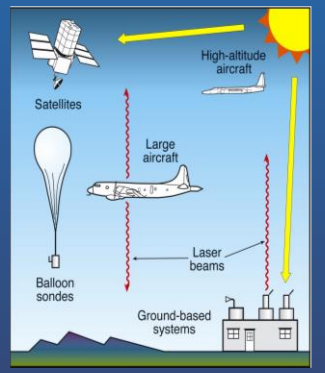
Outlook (2023)

- continue intercomparison studies
- study the **spatial and temporal representativeness** of ground-based free tropospheric measurements, in collaboration with TOAR-II 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
- calculate tropospheric ozone trends from our datasets (e.g. Vigouroux et al. for FTIR)
- submit papers for the TOAR-II Special Issue
- more information: http://hegiftom.meteo.be



Discussion

- What data/products do the TOAR-II participants expect from us?
- How to increase the number of intercomparison studies?
- Spatial/temporal representativeness → regional tropospheric ozone distribution?
- HEGIFTOM common activity on calculation trends of our datasets?
- Ideas for TOAR-II Special Issue papers linked with HEGIFTOM?



Publications

Paper Title or topic	Lead Author	Co-Authors	Assigned
Homogenized EU ozonesonde dataset	Van Malderen/Poyraz	Smit, EU O3S PIs	Yes
Internal and external consistency of homogenized LIDAR datasets	Leblanc		Yes
Intercomparison paper: Umkehr/FTIR/sondes/lidar	Björklund	Vigouroux, Petropavlovskikh + all instrument Pis	Yes
Intercomparison paper: FTIR/sondes	Hannigan	Ortega et al.	Possibly.
Intercomparison paper: IAGOS/sondes	Wang	Tarasick, Van Malderen, Smit	Yes, what about Cohen, Blot et al.???
Intercomparison paper: GB(sondes+???)/satellites	FWG-Satellites	HEGIFTOM + Satellite FWG	To be checked with Hubert, Keppens, Lambert
Overview HEGIFTOM and Outcome (stability and drift)	Van Malderen/ Smit	HEGIFTOM	Depending on commonalities between (i) homogenization principles in the different networks, (ii) intercomparison results at different sites/in different studies
Representativeness of GB techniques	Miyazaki	HEGIFTOM	Yes