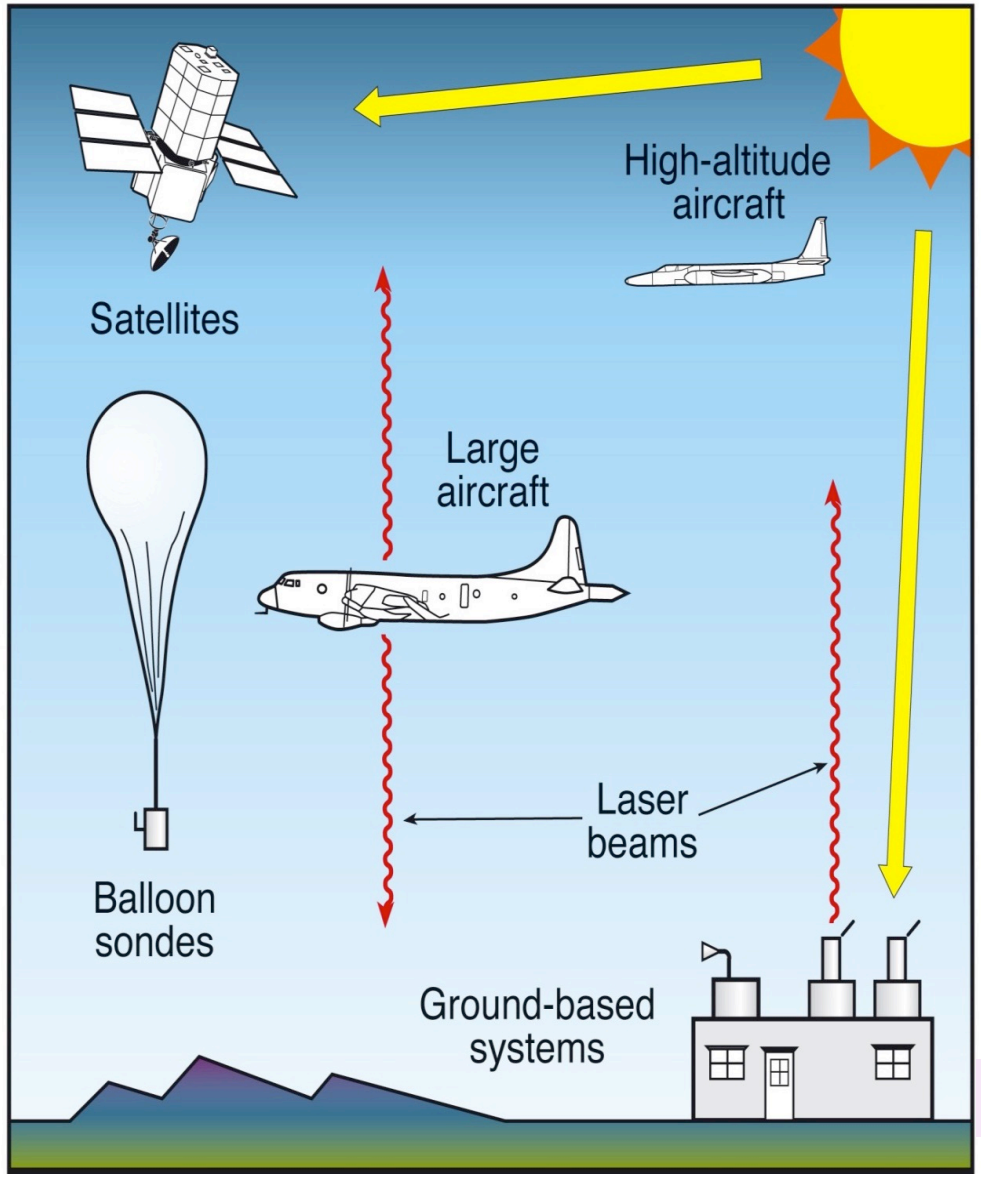

TOAR II: FWG-HEGIFTOM

2nd Focus Working Group Meeting (21 September 2021)

Harmonization and
Evaluation of
Ground-based
Instruments for
Free
Tropospheric
Ozone
Measurements

Chairs:
Roeland Van Malderen (roeland.vanmalderen@meteo.be)
and Herman Smit (h.smit@fz-juelich.de)

https://igacproject.org/hegiftom-focus-working-group

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Essential workshop docs available at Google-Docs:

https://drive.google.com/drive/folders/1UfDkBevHgssWDt8-M2vg47HrBNE9tNN0

Agenda

1. **Introduction** to HEGIFTOM: workplan, and crossover to other FWG of TOAR-II (5')
2. **Internal Consistency**: Outcome of YEAR#1 (2021) incl. harmonized data sets; Deliverable: internal report on homogenized data sets from different data sets and their availability (10')
3. **External Consistency** /YEAR#2 : Intercomparisons and collaboration with Satellite and Re-analysis FWG (75')

   Presentations:

   •Homogenized ozonesonde time series: Improved agreement with independent data sets, *Ryan Stauffer* (10'+5')
   •Umkehr vs. Sondes, *Irina Petropavlovskikh* (5'+5')
   •Intercomparing data sets through their projection onto a model grid, *Yann Cohen* (10'+5')
   •Systematic use of NDACC data for monitoring the performance of the CAMS o-suite and reanalysis models, *Bavo Langerock* (10'+5')
   •Open Discussion (20')
4. **Representativeness** /YEAR#3 : Collaboration with TOAR-II FWG's on
   (i) Satellite Ozone
   (ii) Chemical Reanalysis (Scheduling a joint meeting in Jan/Feb 2022) (10')
5. **AOB: General Discussion + Outlook** (20')

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Introduction to TOAR-II Focus Working Group: HEGIFTOM

Key Objective:

Evaluation and harmonization of the different free tropospheric ozone datasets of the established measuring platforms.

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.

Included:

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

Detailed Workplan and Outcome of Year#1 at Google Docs:

https://drive.google.com/drive/folders/1UfDkBevHgssWDt8-M2vg47HrBNE9tNN0

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RECAP: HEGIFTOM's Expected Outcomes

- ***Homogenized time series*** of measured tropospheric ozone with ***uncertainty estimates and quality flags*** included. ***>>YEAR 1***
- ***Traceability to a common standard*** for the different ground-based networks. ***>> YEAR 1***
- ***Characterization 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*

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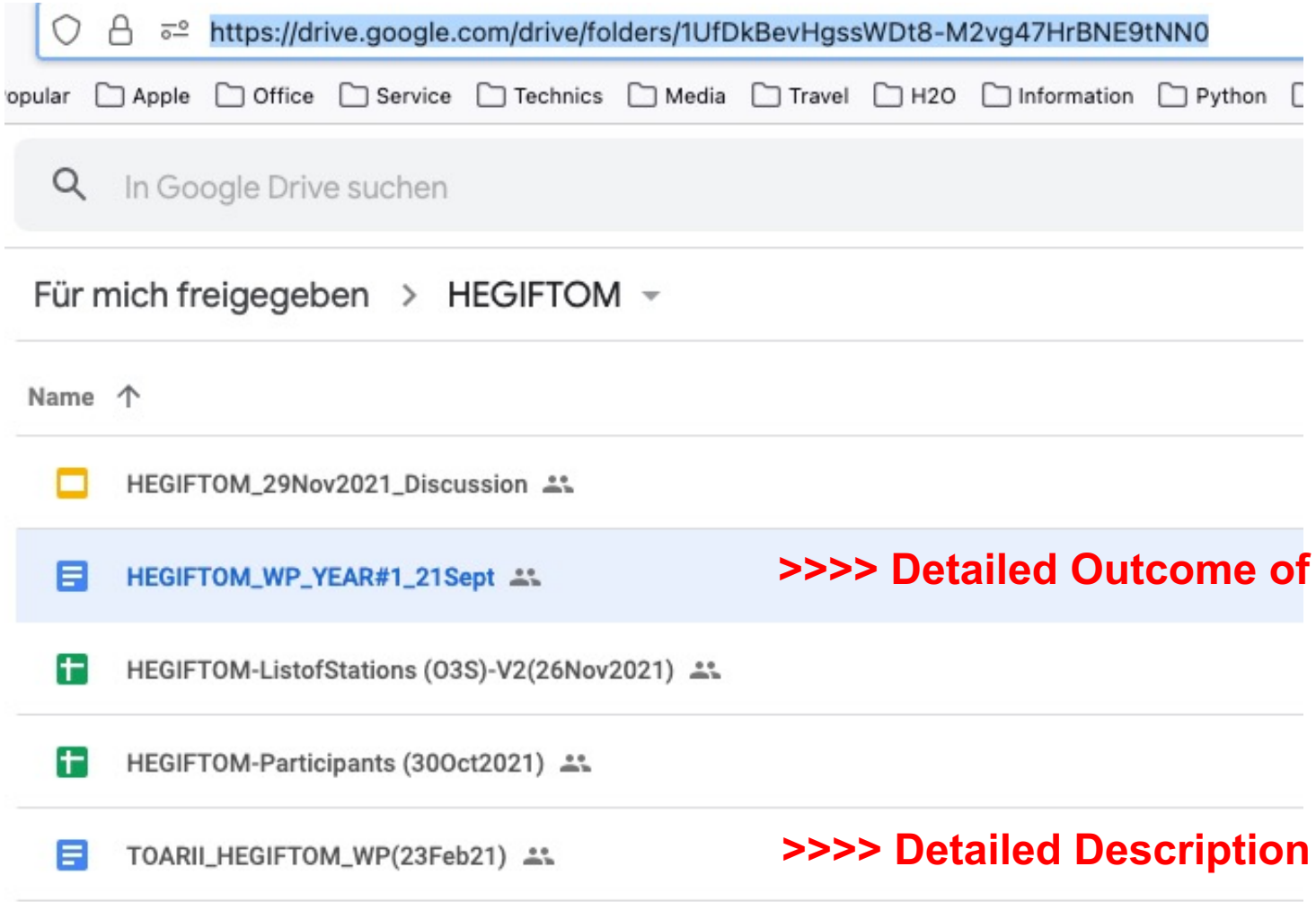
TOAR-II Focus Working Group: HEGIFTOM

Essential docs available at Google-Docs:

https://drive.google.com/drive/folders/1UfDkBevHgssWDt8-M2vg47HrBNE9tNN0



>>>> Detailed Outcome of HEGIFTOM Year 1

>>>> Detailed Description of HEGIFTOM-Work Plan

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Topic 2: Data Storage of Homogenized Time Series

Instrument	Data available at…	Harmonized data available at… (version number, uncertaities	HEGIFTOM Analysis Data: Consistency & Representativeness
Ozonesondes	WOUDC, NDACC, SHADOZ	HEGIFTOM-ftp-server at KMI/Uccle	HEGIFTOM ftp-server
IAGOS	http://iagos-data.fr/	http://iagos-data.fr/	HEGIFTOM ftp-server
FTIR	NDACC	???	HEGIFTOM ftp-server
LIDAR	NDACC, TOLNet	???	HEGIFTOM ftp-server
Brewer/Dobson Umkehr	WOUDC, NOAA	Level2 : https://woudc.org/data/explore.php NOAA (5 stations) ftp://aftp.cmdl.noaa.gov/ozwv/Dobson/Umkehr	HEGIFTOM ftp-server
MAX-DOAS		TBD	TBD
Pandora	http://data.pandonia-global-network.org/	TBD	TBD

Milestones by January 2022:

1. Homogenized (Harmonized) Data made available on identified data server for internal use
2. Documentation on specifications of the homogenized data set, traceability incl. uncertainty budget, and optional: version number, data reliability flag.
3. Description of data format and meta data with an example.

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HEGIFTOM: Ground-based Free Tropospheric Ozone Measuring Platforms

Instrument/Platform	Time period	Coverage/Network	Groups in HEGIFTOM
Ozonesondes	1965 - present	**> 50 Sites** worldwide (GAW/WOUDC, NDACC, SHADOZ)	RMI (Belgium), FZJ (Germany), ECCC (Canada), NOAA (USA), NIWA (NZ), NASA (USA)
MOZAIC/IAGOS	1994 - present	Cruise altitude (10-12 km) & Airports worldwide **(100-250 Airports)**	CNRS (France) & KIT (Germany
FTIR	1995 - present	NDACC, **13-15** sites having more than 10 years of data	BIRA (Belgium), NCAR (USA), AEMET (Spain)
Lidar		NDACC, TOLNET **(9-10 Sites)**	NASA (USA), LATMOS (France), UAH (USA)
Umkehr (Dobson & Brewer)	1956 - present	WOUDC (> Sites), NEUBrew, EUBrew **(14 Sites)**	NOAA (USA), MeteoSwiss (Switzerland), BoM (Australia), NIWA (New Zealand), OHP (France), AEMET (Spain), Univ. Thessaloniki (Greece)
MAX-DOAS	2010-present	**5-10 Sites** NDACC and associated sites	BIRA (Belgium)
Pandora	2012 - present	**> 40 sites** at 2020, Pandonia Global Network (PGN)	NASA (USA), VTU (USA), LuftBlick (Austria)

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Topic 2: Description Homogenized Free Tropospheric Ozone Profile Data Template under evaluation by PI's

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)´***

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Topic 2: HEGIFTOM- Strategy On Data Repository (Status March 2021)

Preamble

TOAR-II will not create a data base for free tropospheric observations or new data products. Only surface data of TOAR-I are in a common integrated data base (JOIN at FZJ: PI = Martin Schultz)

HEGIFTOM Policy on Data Storage:

- HEGIFTOM will provide a password protected FTP-data server (limited capacity) to store processed data.
- Original data primarily stored at the native data base of each measuring platform
- HEGIFTOM will provide for each groundbased platform the entry point for the data base of the original data.
- New, harmonised data can be stored on HEGIFTOM-ftp data server
- Results from external consistency and eventual representativeness studies can be stored on HEGIFTOM-ftp data server or by another entry point if required
- However, HEGIFTOM will be flexible and open for other practical solutions. BUT: keep things simple and manageable within the limited resources that are available

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Topic 3: Planning of inter-comparison activities

Instrument/ Platform	Ozone-sondes	MOZAIC/ IAGOS	FTIR	LIDAR	Umkehr (Dobson & Brewer)
Ozone-sondes		23 sites + trajectories Blot, Smit, Van Malderen	11 sites Vigouroux et al.	3 sites	9 sites
MOZAIC/ IAGOS			7 sites	2 sites	9 sites
FTIR				1 site	5 sites Vigouroux & Irina
Lidar					1 site
Umkehr (Dobson & Brewer)					
MAX-DOAS	Development of a tropospheric data product				
Pandora	Development of a tropospheric data product				

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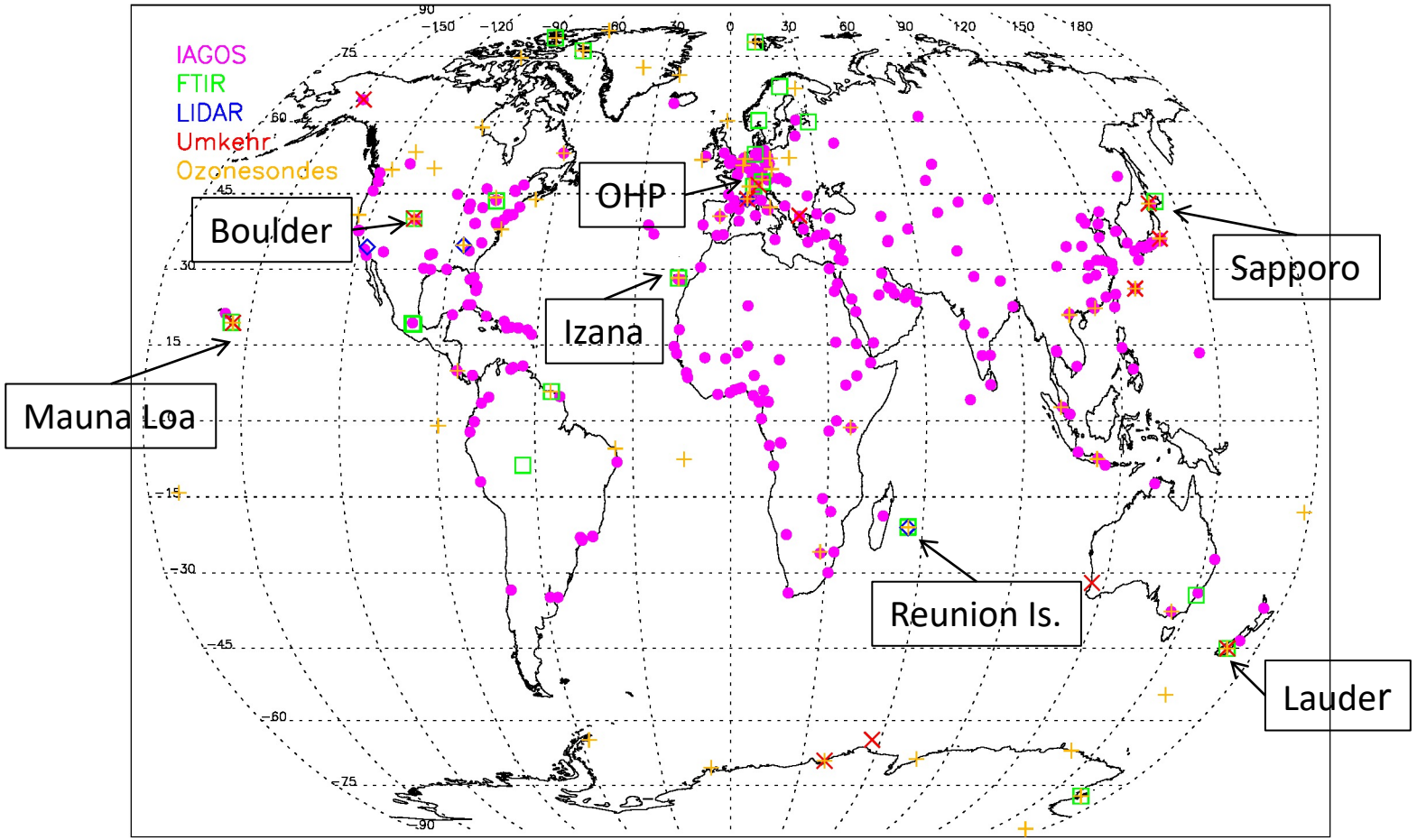
Topic 3: HEGIFTOM: External consistency



"Supersites"

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HEGIFTOM Workshop
29 Nov 2021

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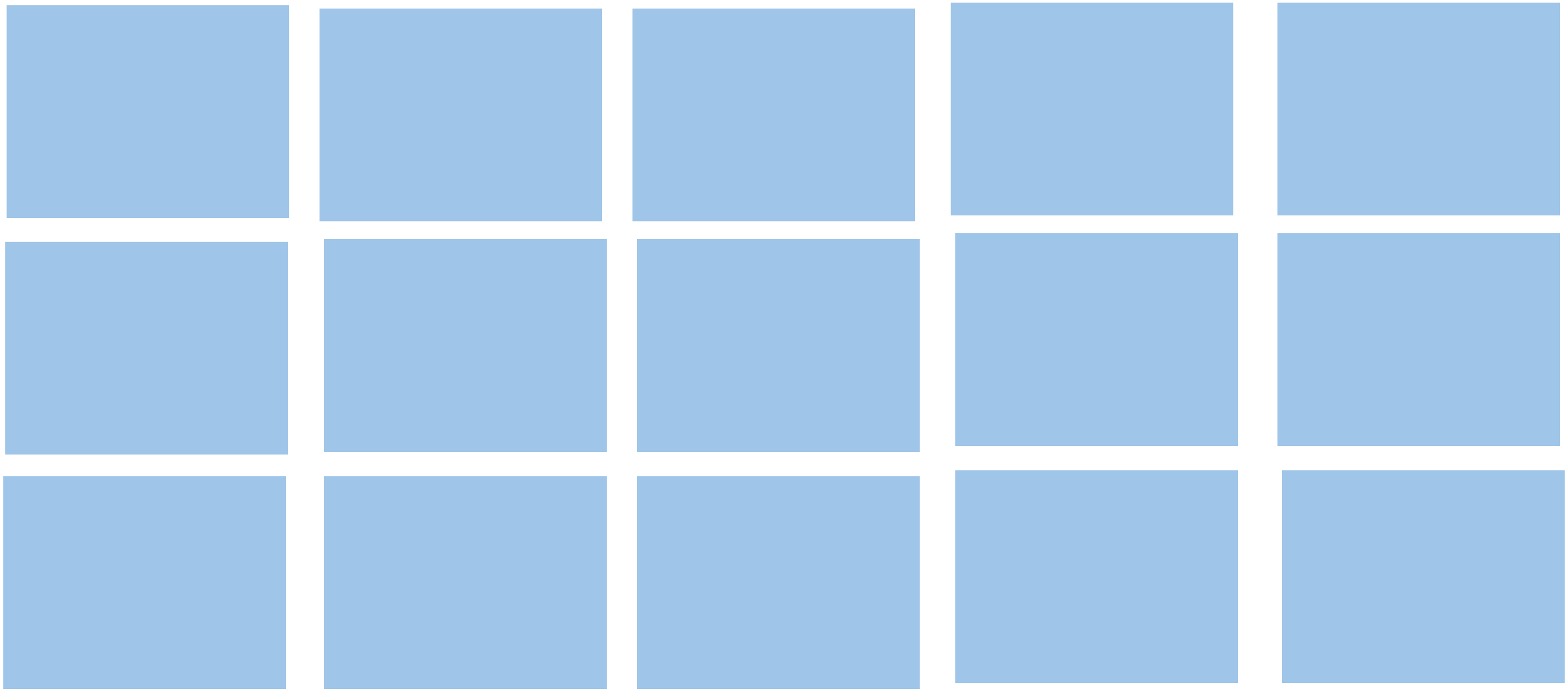
Group Discussion Slides

HEGIFTOM: Intercomparison studies

- **Plans for intercomparison studies?**
- **Are common approaches/tools/guidelines needed for such intercomparison studies? If yes, which?**

HEGIFTOM: Intercomparison studies



HEGIFTOM: External consistency: to be answered

- **Consistency in the use of meteo data to convert instrument's "natural" coordinates to common coordinates:** which model is used by satellite ozone working group?
- **Common tropopause height definition:** difficult to achieve; alternative is fixed pressure levels
- **Identical air masses (e.g. IAGOS vs. ozonesondes):** tools (e.g. trajectories)?
- **Common tropospheric ozone column extent vs. averaging kernels:** satellite ozone working group topic?
- **Vertical smoothing of ground-based measurements when compared to satellite retrievals:** satellite ozone working group topic?

HEGIFTOM: External consistency discussion

In terms of harmonization, Is HEGIFTOM focus WG expecting to provide a common code or algorithm to determine the tropopause from ozonesondes?

BL heights: Can Luis produce a BL height similarly to his other met proxies with JETPAC?

What is the definition of the boundary layer height?

Topic 4: HEGIFTOM: Representativeness

- Can we define/determine any metrics for “representativeness”?
- How can we derive representativeness for a single station/an ensemble of stations (region)?
- What are the typical “correlation” lengths (i.e times) of ozone at different altitudes (chemical and dynamical) in order to be able to separate between atmospheric and instrumental variability during intercomparisons.
- How temporally representative are sites for estimating trends in tropospheric ozone?
- Gridded satellite ozone datasets vs. ground-based measurements. How?

➢ Workplan of satellites and chemical reanalysis modelling group is covering these questions to a large extent → collaboration!

➢ **Joint meeting of HEGIFTOM with Satellites & Chemical Reanalysis FWG in beginning of 2022**

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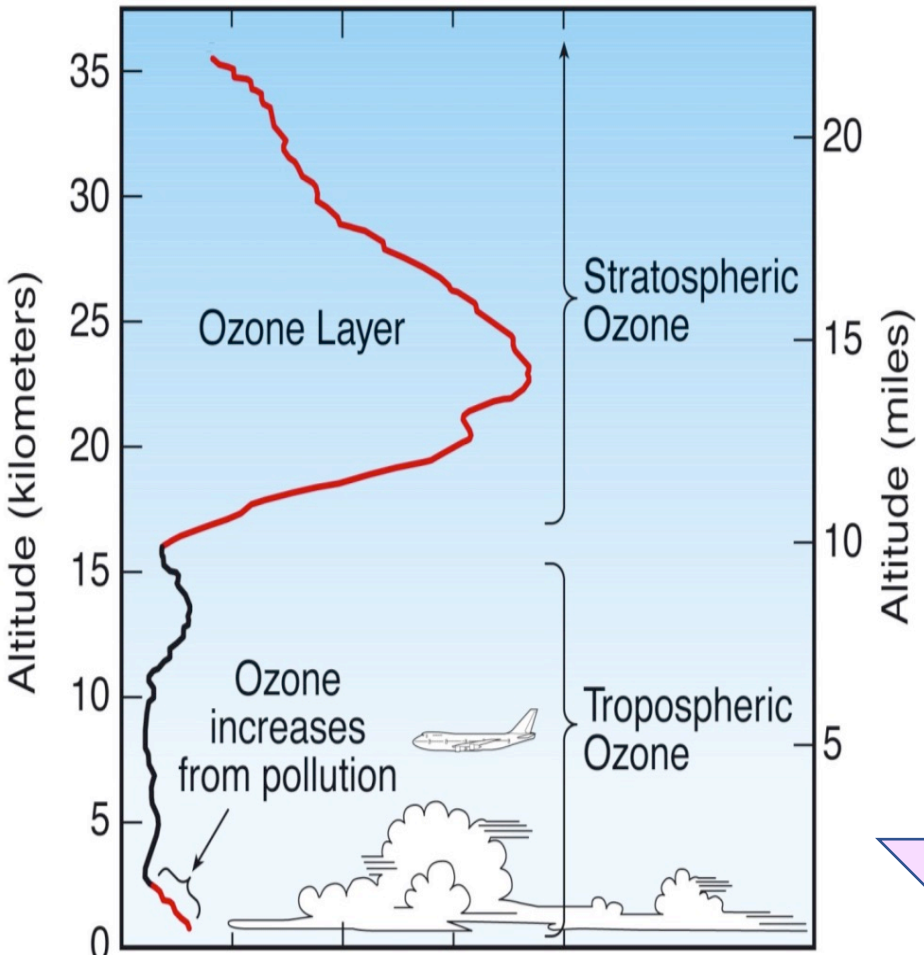
Topic 4: **Representativeness of Ozone Data in Time and Space: Ozone Chemistry versus Transport**



Very Slow (months): Quasi Steady State:

Time Scale of Ozone Chemistry

Stratosphere:

- Global scale: slow ozone chemistry and vertical stability

Slow (weeks)

Upper Troposphere/Lower Startosphere

- Large scale: slow ozone chemistry

Lower/Middle Troposphere LT/MT:

- Regional: Fast to slower ozone chemistry

Near Surface (PBL):

- Local: Fast ozone chemistry

Fast (hours)

Representativeness Ground Based O3 Observations:
Chemical Reanalysis or CTM's could help to deliver the typical time scales of ozone as a function of altitude, geographical location and time of the season!!!

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Topic 5: HEGIFTOM: AOB

1. HEGIFTOM Website: to be done January 2022, to be hosted by KMI/Uccle
2. Next HEGIFTOM PI-Meeting: Jan. 2022
3. Next HEGIFTOM Workshops:
   I. Representativeness: Joint meeting of HEGIFTOM with Satellites & Chemical Reanalysis FWG in beginning of 2022 (Jan/Feb)
   II. 3rd FWG Meeting (on-line): March/April 2022
4. Publications planned.

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Paper Title or topic	Lead Author	Co-Authors	Assigned
Intercomparison paper: Umkehr/FTIR	Petropavlovskikh	Vigouroux et al.	Yes
Intercomparison paper: FTIR/sondes	Hannigan	Ortega et al.	Yes
Intercomparison paper: IAGOS/sondes	Blot	Smit, Van Malderen et al.	No?
Intercomparison paper: GB(sondes+???)/satellites	FWG-Satellites	HEGIFTOM + Satellite FWG	Yes/No?
Overview HEGIFTOM and Outcome (stability and drift)	Van Malderen/ Smit		Yes
Representativeness of GB techniques	Miyazaki		Yes/No?

Lidar versus Sondes/FTIR or IAGOS ??			

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Topic 5: Timeline TOAR-II

TOAR-II Status and roadmap

2020

Selection of new steering committee

Planning of objectives and roadmap

Development of enhanced data infrastructure

2021

First TOAR-II workshops

Formation of working groups (WGs)

Beginning of new data collection

Bring data infrastructure online

2022

WGs: Preparation of analyses and planning of manuscripts

Develop new metrics and populate database

2023

Finalize data

Perform new and updated analyses

Draft manuscripts, submit by Sept. 1

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Reserve Slides

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HEGIFTOM: Workplan + Timeline

YEAR#01=2021 (M01-M12):Internal consistency within each network+ Preparation of Year#02

- March 2021: Kick-Off Meeting
- Summer 2021: Inventory of operation procedures, practices, and data correction algorithms that are presently in use at the different sites/instruments within each network
- Winter 2021/2022: Concept (strategy) for cross intercomparison among different networks (incl. inventory of sites with co-located techniques and identification of identical air masses for in-situ measurements) >>>>> HEGIFTOM Meeting in 29 Nov. 2021
- Dec. 2021: harmonized and documented datasets as input of the cross-comparison between different ground-based techniques and focus working groups of satellites, models, statistics and other interests >>>> Brief documentation on different homogenized data sets.

YEAR#02=2022 (M13-M24):External consistency among the networks through intercomparisons

- Cross intercomparison among different networks
- Characterization and evaluation of instrumental drifts among the different datasets.
- Representativeness ground based free tropospheric observation platforms/stations

YEAR#03=2023 (M25-M33): Exploitation of data sets with other TOAR-II WG's & Preparation of publications

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Topic 1: Progress in homogenization activities so far

- LIDAR
  - TMF: homogenized (GLASS) for 1999-2004 (NDACC, TBD) & since 2018 (NDACC, HDF); other years: ongoing, few more weeks needed to ensure QA/QC.
  - OHP: GLASS processing + new French-based data processor, both TBD
- Ozonesondes
  - ASOPOS report ready by end of the year (SOPs, Uncertainty calculation, Metadata and Quality indicators, Homogenization guidelines)
  - Homogenized: SHADOZ + NOAA + Canadian + Uccle + De Bilt + Mc. Murdo + Payerne, OHP, Izana, Madrid, Sodankyla, Lauder, Legionowo
  - Homogenized data available on ftp-server
- IAGOS
- FTIR
- Brewer/Dobson Umkehr
- Pandora/MAX-DOAS

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Topic 2: HEGIFTOM: Internal consistency discussion

Uncertainties

- **How can we harmonize the different uncertainty estimates between the platforms?**
- **Can the TUNER methodology be applied to ground-based networks?**
- **Can we distinguish between random and systematic errors?**

Data archiving

- **Where will the "harmonized" data of the different platforms be made available? (NDACC/ftp-server? Versioning? Natural coordinates!)?**

Data flagging

- **Can we make recommendations for data flagging (each measurement point vs. each data file)?**

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HEGIFTOM: Internal Consistency

- ***Homogenization/harmonization activities within each network (incl. reporting of random or systematic uncertainties) is on the responsibility of the PI of each platform***
- ***No HEGIFTOM prescriptions,*** but comparing those activities enables the different platforms to learn from each other:
  - *Commonalities when meaningful for a platform*
  - *Differences between platforms allowed*
- ***Primary deliverable to TOAR-II:*** internal consistent free-tropospheric ozone measurements for different ground-based platforms, in their natural coordinates plus the documentation of the the external consistency among the different platforms

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Ground-based Free Tropospheric Ozone Measuring Platforms:
Homogenisation-Uncertainty (Random-Systematic)-Data Flagging-Internal Consistency

Instrument/ Platform	Homogeni -sation	Uncertainty: Random	Uncertainty: Systematic	Data Flagging	Internal Consistency
Ozone-sondes	Dec. 2021	Yes	No	Yes	Dec.2021
MOZAIC/ IAGOS	Done	Yes	No	Yes	Yes *(Blot et., AMT, 2020)*
FTIR	Done (2021)	Per Station	Under Investigation	No	2021
Lidar	Done (2021)	Yes	Yes	No	2021
Umkehr (Dobson & Brewer)	2021	Under Investigation	Under Investigations	No	2021
MAX-DOAS	Development of a tropospheric data product				
Pandora	Development of a tropospheric data product				

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