



Committee on Earth Observation Satellites

Belgian Science Policy Office (BELSPO) / Federal Scientific Institutes (FSI)

I. Update on Cal/Val Activities

Jean-Christopher Lambert

Royal Belgian Institute for Space Aeronomy (IASB-BIRA)

Agency Reports

WGCV-47 Teleconference, July 14-17, 2020

Working Group on Calibration and Validation





Contributing institutes

Federal Scientific Institutes (FSI) under BELSPO authority

- Royal Belgian Institute for Space Aeronomy, BIRA-IASB
- Royal Institute of Natural Sciences of Belgium, RBINS
- Royal Meteorological Institute of Belgium, RMIB
- Royal Observatory of Belgium, ROB
- Belgian User Support and Operation Centre, B-USOC

Regional partners

- Belgian Interregional Environment Agency, IRCEL-CELINE
- Centre spatial de Liège, CSL
- Université de Liège, ULg
- Université libre de Bruxelles, ULB
- Universiteit Antwerpen, UA
- Vlaamse Instelling voor Technologisch Onderzoek, VITO

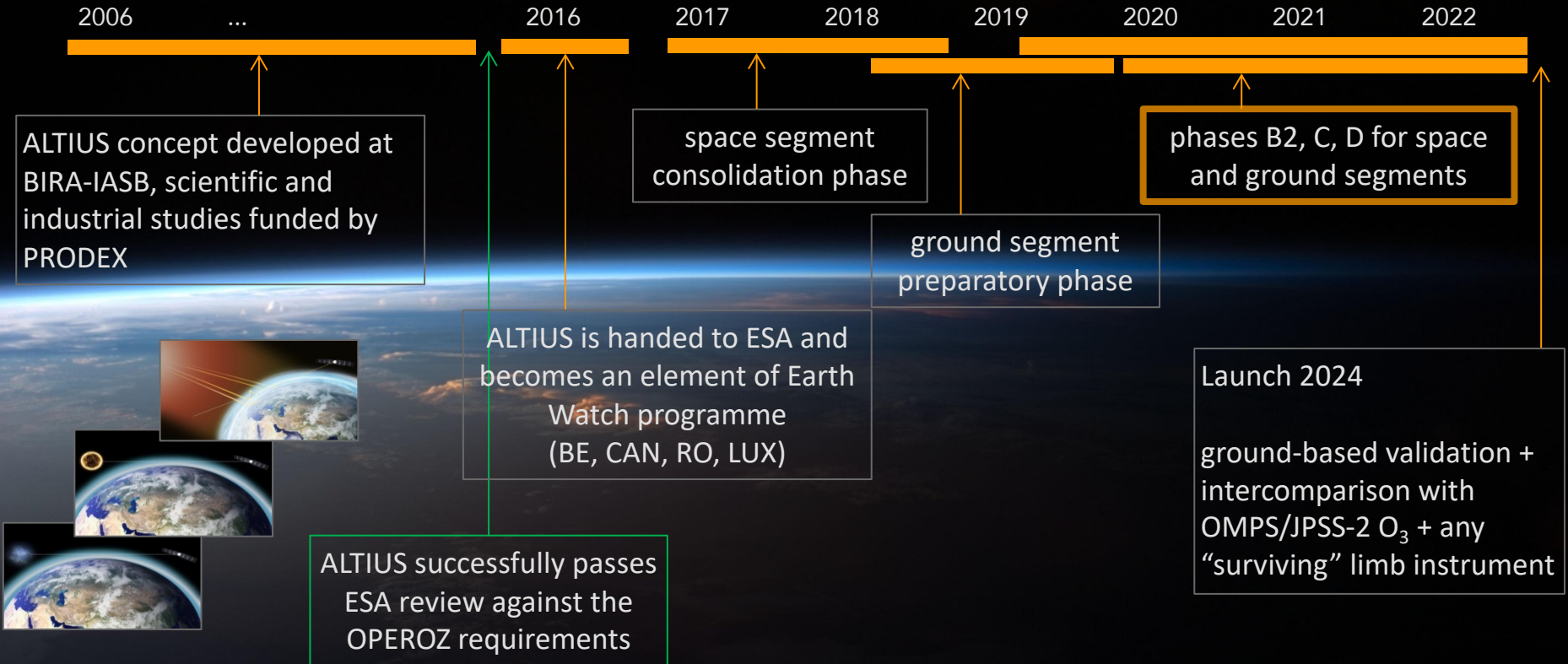


Brief update on:

1. EO missions
2. Validation data
3. Validation methods
4. Cross-domain Cal/Val
5. Validation systems
6. Validation reporting
7. Background information

ALTIUS - Atmospheric Limb Tracker for the Investigation of the Upcoming Stratosphere

Programmatics



Atmosphere: [\[various websites\]](#)

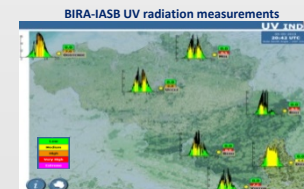
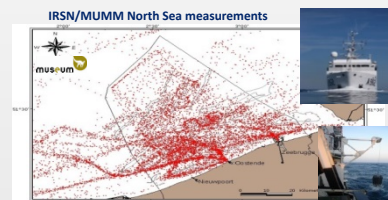
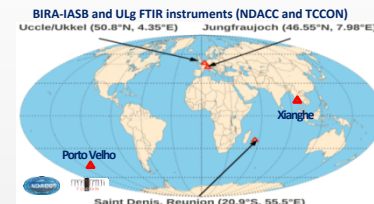
- AERONET, COCCON, EEA/EMEP, NDACC, PGN, TCCON, WMO/GAW stations
- Participation in EU Research Infrastructures ACTRIS and ICOS
- Data harmonization, reprocessing, error characterization: FTIR & MAXDOAS bilateral cooperation with China, GAIA-CLIM WP2, QA4ECV WP4, QA4EO
- FRM4DOAS central processing service (in progress)
- FRM4GHG, CO₂ retrieval strategy, AirCore+FTIRs campaigns (ongoing)
- UAV-, airplane- and car-based DOAS campaigns (CIP, S5PVAL-BE, BUMBA, SVANTE...)

Marine: <http://www.mumm.ac.be/datacentre>

- Belgian Maritime Data Centre (BMDC), SeaDataNet member
- Physical, chemical and meteorological parameters over North Sea
- Ship- and shore-based
- New WATERHYPERNET project for water (ocean, lake...) colour

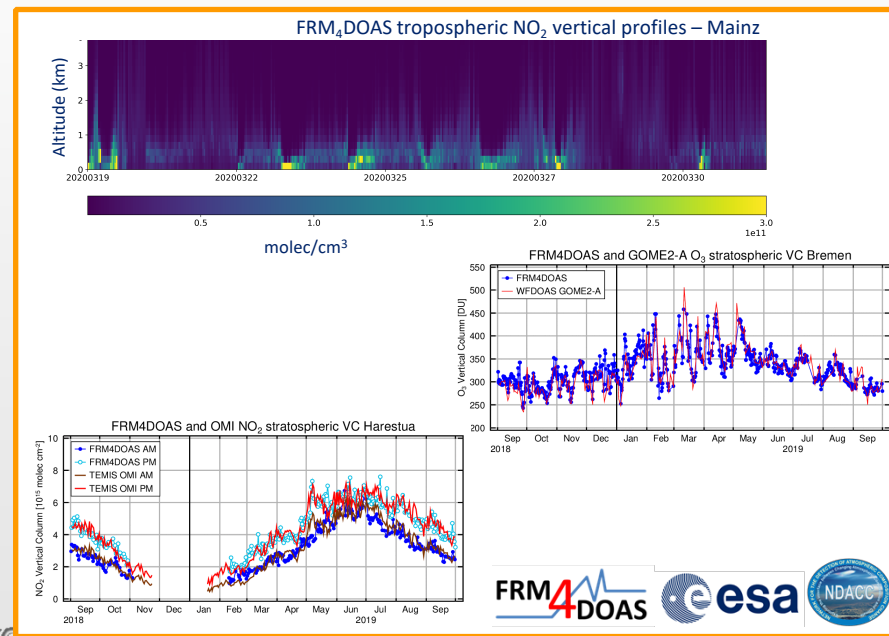
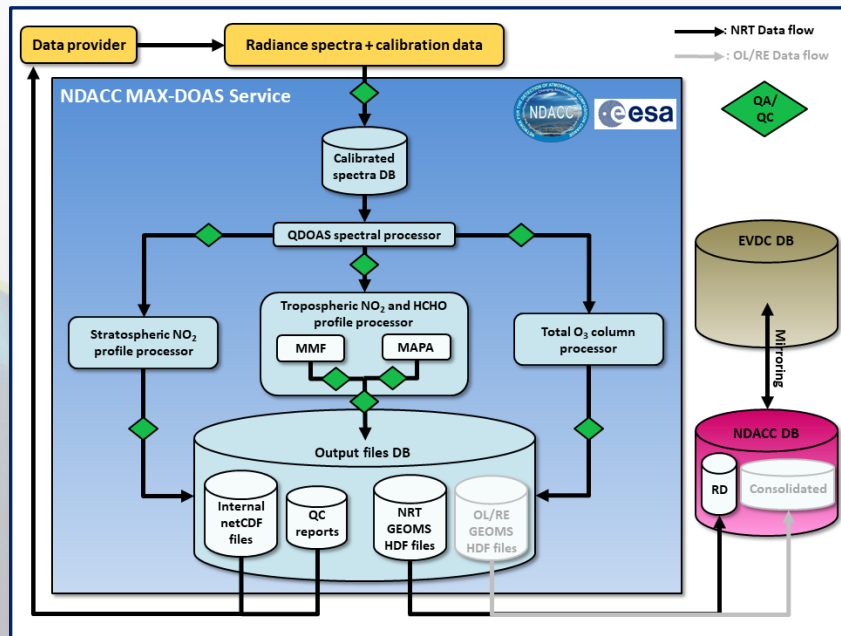
Solar: <http://uvindex.aeronomie.be>

- Solar UV-Visible Irradiance Monitoring Network (7 RT stations in Belgium + Belgian Antarctic Base), centralised calibration centre in Uccle
- Spectral irradiance 280-600 nm, broadband, clouds, sunshine duration...





- ✓ Aim: Development of a near-real-time (24h latency) **MAX-DOAS Central Processing System** to be operated within NDACC in support of satellite validation: Sentinels -5p, -4 and -5, GEMS, TEMPO, CO2M...
- ✓ Status: Phase 1 completed, demonstration service under implementation at NDACC/EVDC (operational at 11 sites)
- ✓ Target products: total O_3 , tropospheric and stratospheric NO_2 , tropospheric $HCHO$



S5P Campaigns

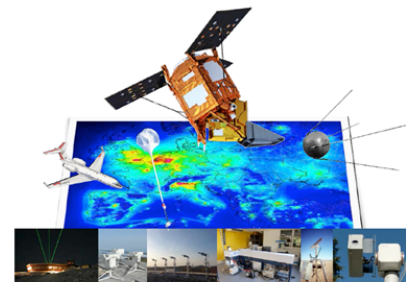


■ ESA funded S5P cal/val campaign activities

- Focus on gaps and activities complementary to routine measurements
- Key activities are defined in the S5P Campaign Implementation plan (S5P CIP 2018)
- Coordinated S5P validation based on all campaign data will be performed at BIRA
- Campaign website under construction: <https://s5pcampaigns.aeronomie.be/>

■ Key activities: ESA QA4EO and SVANTE projects (2019-2022)

- NO₂ and HCHO
 - S5PVAL-DE → Airborne and GB tropo NO₂ measurements in Ruhr, Germany
 - S5PVAL-DE₂ → Airborne and GB tropo NO₂ and HCHO recurrent measurements in Berlin, Germany
 - S5PVAL-RO → Airborne and GB tropo NO₂ and HCHO recurrent measurements in Bucharest, Romania
 - S5PVAL-BE → Airborne and GB tropo NO₂ measurements in Brussels, Antwerp, Belgium
- CO and CH₄
 - COCCON → deployment of EM27/SUN FTIR in several high/low albedo, polluted/background sites (Brazil, India, Mexico, Namibia, Alaska, New Zealand, ...)
 - Contributions to MAGIC, ACCLIP and HyTES campaigns
- ALH → Aerosol Layer Height validation study based on LIDAR and Ceilometer networks





Status of NDACC, TCCON and COCCON data quality/readiness for GHG satellite validation

See WGCV-47 ACSG Highlights / GHG Roadmap

Material provided by M.K. Sha (mahesh.sha@aeronomie.be),

B. Langerock (bavo.langerock@aeronomie.be) and

M. De Mazière (martine.demaziere@aeronomie.be)

Royal Belgian Institute for Space Aeronomy, Brussels (BIRA-IASB)



NASA (G. Labow *et al.*)

- The Great Tropospheric Ozone Cook-Off @CEOS AC-VC-15
- Intercomparison of monthly/daily gridded satellite data records
 - Spatial structure of the bias



DLR (K.-P. Heue, M. Coldewey-Egbers, D. Loyola *et al.*)

- Harmonisation, multi-satellite trends
- Intercomparison CCD S5P, GOME-2, OMI and S5P/BASCOE
 - Spatial & temporal structure of the bias
 - Trends
 - Validation with ozonesondes and lidars at RMIB (A. Delcloo)



BIRA-IASB (D. Hubert, A. Keppens, J.-C. Lambert, C. Vigouroux)

- National project BERTOLDT with ULB (P.F. Coheur, C. Wespes) and RMIB (R. Van Malderen)
- Characterise & understand differences between satellite tropospheric O₃ using ground-based comparisons (ozonesondes, NDACC FTIR)
 - Global distribution and trends
 - Tropospheric content and profile
 - Vertical sensitivity & smoothing
 - Geophysical features: zonal wave one, NAO, QBO, MJO...



Other activities/groups welcome

- Cooperation with other ongoing activities at ESA, NASA, NOAA...
- IAGOS aircraft data ?
- Coordination with TOAR-II Satellite Ozone WG



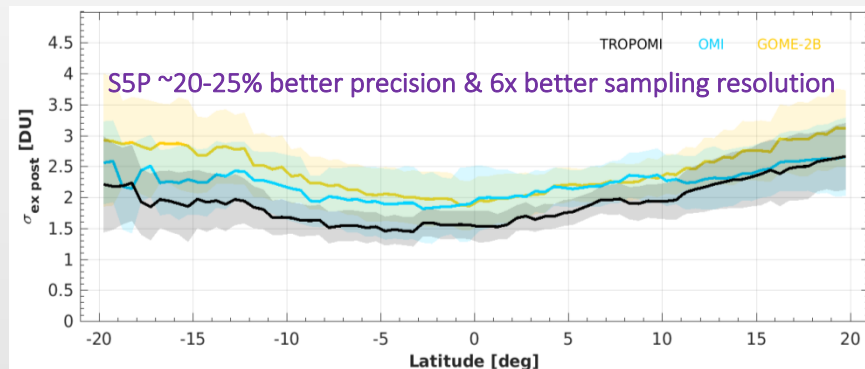
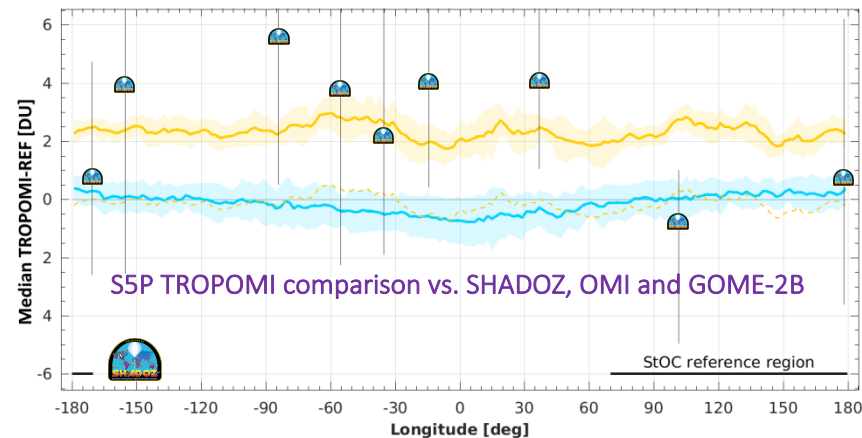
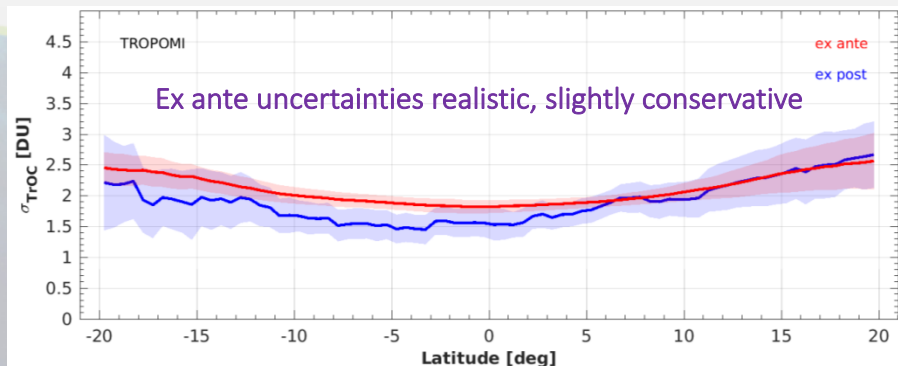
<https://doi.org/10.5194/amt-2020-123>
Preprint. Discussion started: 1 July 2020
© Author(s) 2020. CC BY 4.0 License.

Atmospheric
Measurement
Techniques
Discussions
EGU

Hubert *et al.*, AMTD 2020

TROPOMI tropospheric ozone column data : Geophysical assessment and comparison to ozonesondes, GOME-2B and OMI

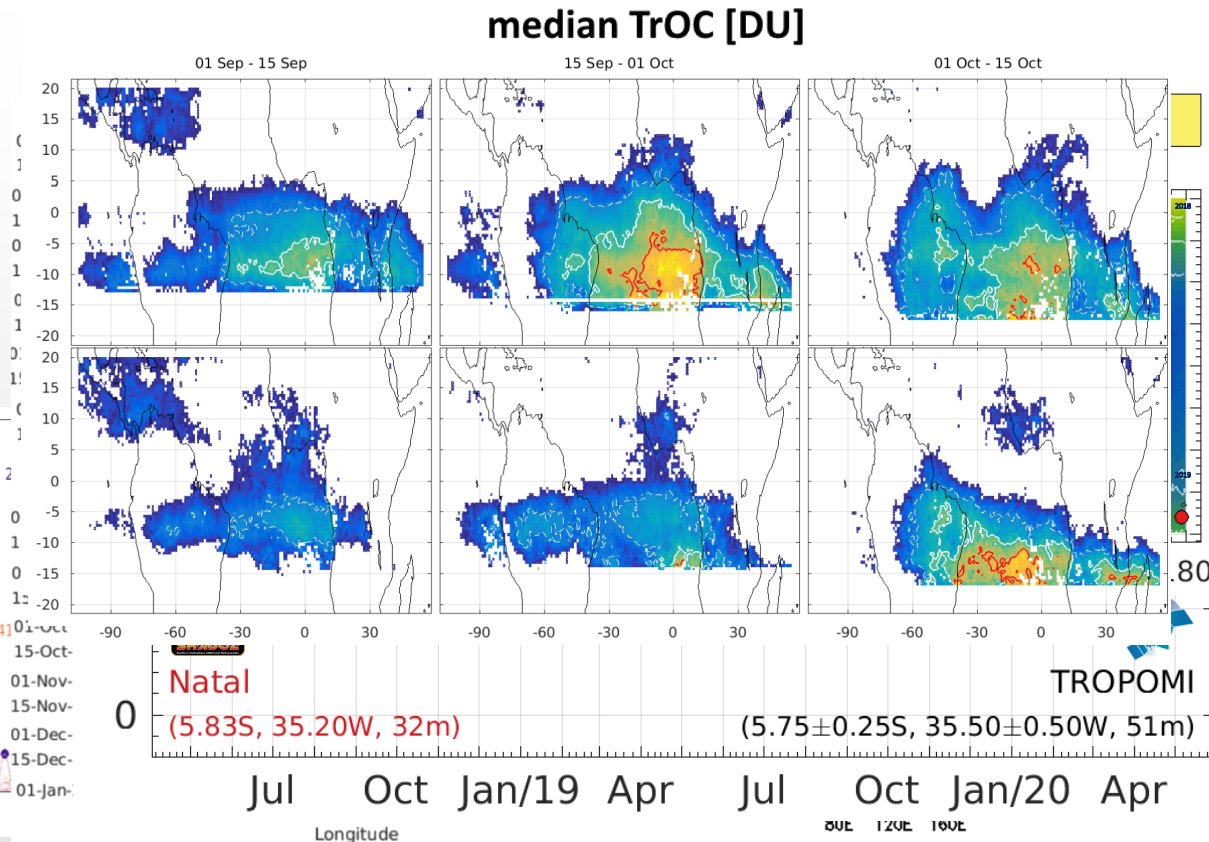
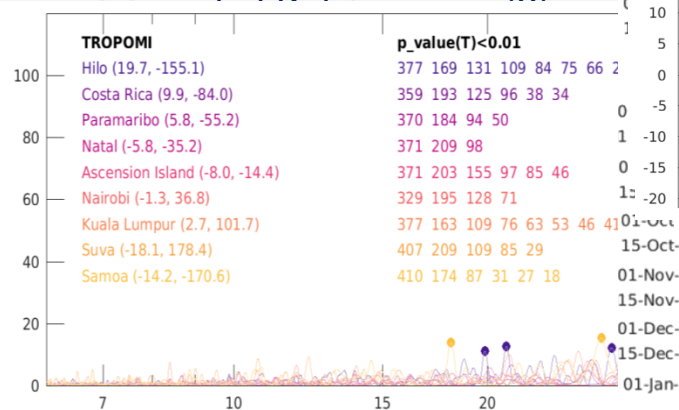
Daan Hubert¹, Klaus-Peter Heue^{2,3}, Jean-Christophe Lambert¹, Tijl Verhoelst¹, Marc Allaart⁴, Steven Compennolle¹, Patrick D. Cullis⁵, Angelika Dehn⁶, Christian Félix⁷, Bryan J. Johnson⁸, Arno Keppens¹, Debra E. Kollonige^{8,9}, Christophe Lerot¹, Diego Loyola², Matakite Maata¹⁰, Sahmud Mawit¹¹, Mohammed Mekouar¹², Ashia Dittus⁴, Fabian Remeke², Hans D. S. B. B. 9.13



Hubert et al., AMTD 2020

Daan Hubert¹, Klaus-Peter Heue^{2,3}, Jean-Christopher Lambert¹, Tijl Verhoelst¹, Marc Allaart⁴, Steven Compemolle¹, Patrick D. Cullis⁵, Angelika Dehn⁶, Christian Félix⁷, Bryan J. Johnson⁵, Arno Keppens¹, Debra E. Kollonig⁸, Christophe Lerot¹, Diego Loyola², Matakaki Maata¹⁰, Schmilg E. Pearl¹¹, M. Sreenivasulu Reddy¹², André-Denis Fiegler Boyce², Hans-D. Schulz⁹

- ✓ Zonal wave one
- ✓ Biomass burning
- ✓ Annual & semi-annual cycles
- ✓ Madden-Julian Oscillation
- Higher-frequency signals





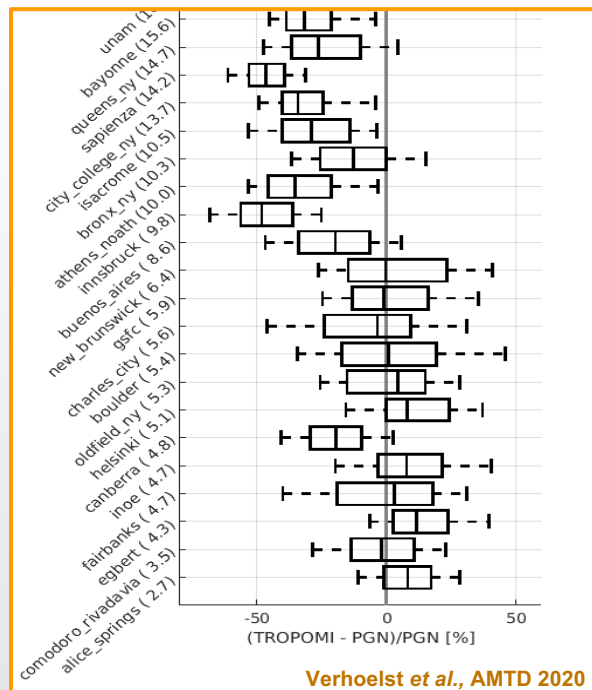
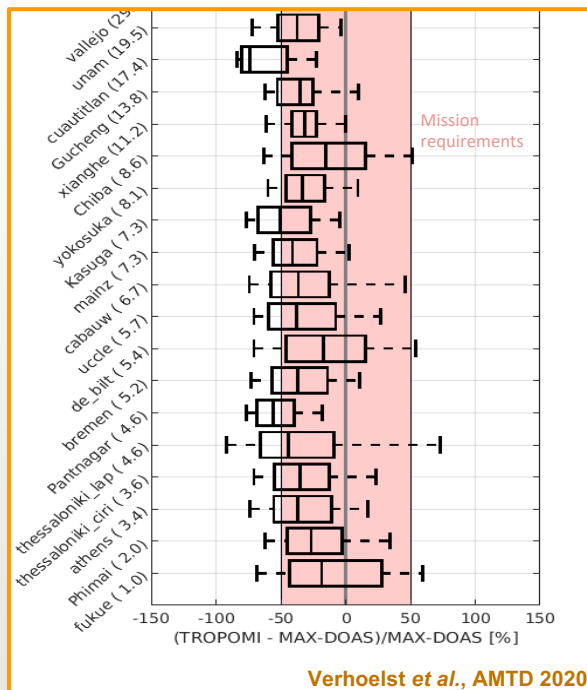
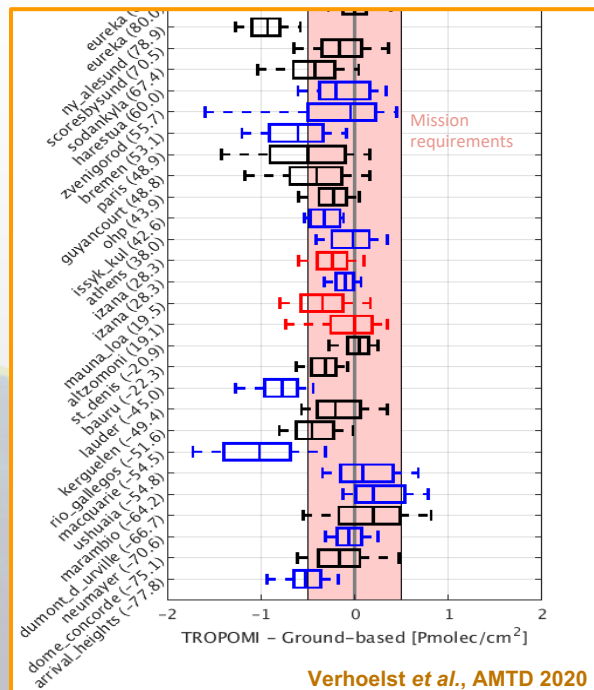
Synergistic validation of S5P TROPOMI NO₂ vs. complementary ground-based monitoring networks:

NDACC ZSL-DOAS,

NDACC MAX-DOAS

and

Pandonia Global Network (PGN)





- Clouds modify the radiance measured by atmospheric composition sounders and influence the L2 retrieval of trace gases by masking and by modified sensitivity.
- Effective – and not geometric – cloud fraction, cloud top height and/or cloud optical thickness are retrieved in the NIR (O_2-A) or VIS (O_2-O_2) with several key assumptions: e.g., clouds as reflecting boundaries (CRB) or as layers (CAL).
- Intercomparison study published: ground-based validation (vs. Cloudnet and ARM) of all S5P TROPOMI cloud processors + OMI O_2-O_2 , MODIS and S-NPP VIIRS
- In parallel, impact studies of cloud retrievals on TROPOMI L2 trace gas retrievals, coordinated by IUP/UB
- Switch to improved S5P UPAS processor at DLR tomorrow
- Further cloud intercomparisons ongoing, with inspiration from ACIX and CMIX

<https://doi.org/10.5194/amt-2020-122>
Preprint. Discussion started: 29 June 2020
© Author(s) 2020. CC BY 4.0 License.



Atmospheric
Measurement
Techniques
Discussions
EGU

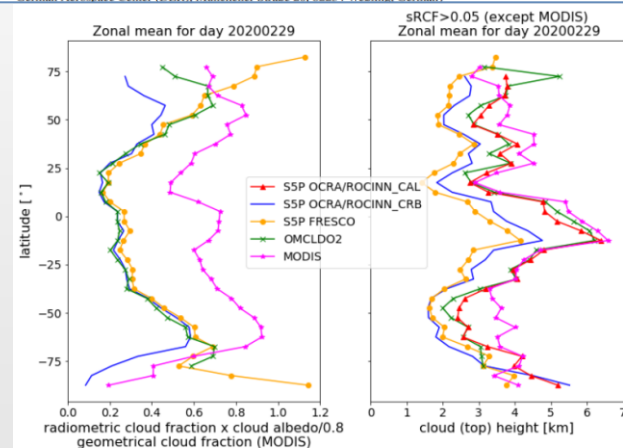
Validation of the Sentinel-5 Precursor TROPOMI cloud data with Cloudnet, Aura OMI O_2-O_2 , MODIS and Suomi-NPP VIIRS

Steven Compornolle¹, Athina Argyrouli^{2,3}, Ronny Lutz³, Maarten Sneep⁴, Jean-Christopher Lambert¹, Ann Mari Fjæraa⁵, Daan Hubert¹, Arno Keppens¹, Diego Loyola³, Ewan O'Connor^{6,7}, Fabian Romahn³, Piet Stammes⁴, Tijl Verhoelst¹, and Ping Wang⁴

¹Royal Belgian Institute for Space Aeronomy (BIRA-IASB), Ringlaan 3, 1180 Uccle (Brussels), Belgium

²Technical University of Munich, TUM Department of Civil, Geo and Environmental Engineering, Chair of Remote Sensing Technology, Munich, Germany

³German Aerospace Center (DLR), Münchener Straße 20, 82234 Weßling, Germany





Thank you for your attention!

