



Copernicus Sentinel-5 Precursor Data Product Validation

Validation Plans at BIRA-IASB

Jean-Christopher Lambert

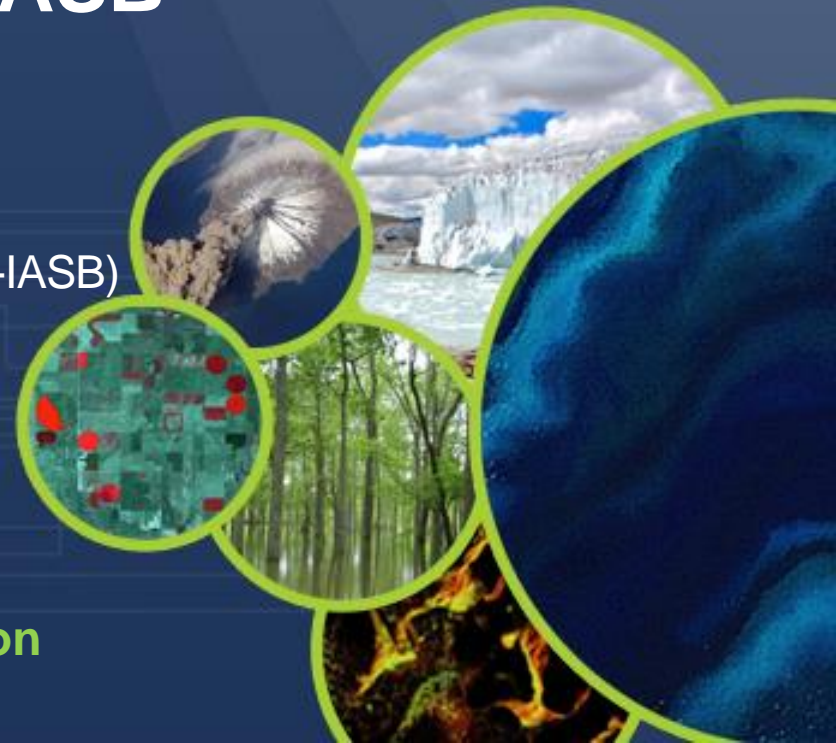
Royal Belgian Institute for Space Aeronomy (BIRA-IASB)

Session on Atmospheric Remote Sensing

WGCV Plenary #40

Canberra, March 14-18, 2016

Working Group on Calibration and Validation





Contributing Institutes

- Federal Scientific Institutes (FSIs) under BELSPO Authority
 - Royal Belgian Institute for Space Aeronomy, IASB-BIRA
 - Royal Meteorological Institute of Belgium, RMIB
- Regional Partners
 - Université de Liège, ULg
- International Partners
 - Instrument PIs and staff at stations affiliated with GAW/GO3OS, NDACC, SHADOZ, TCCON, AirCore project...



Overview of planned activities

- S5PVT AO projects: VALTOZ, CHEOPS-5p, NIDFORVAL, TCCON-4S5p, AirCore-S5p, MATRICS
- Campaigns: AROMAT (Romania, 2014/09, 2015/09, 2017), FRM4DOAS (CINDI-2, Cabauw, 2016/09), FRM4GHG (Sodankylä 2017)
- Mission Performance Centre / VDAF





Mandatory Sentinel-5 Precursor TROPOMI data products and their target uncertainties

Product Group	Data Product	Vertical Resolution	Bias	Random
Ozone	Ozone Profile	6 km	10-30%	10%
	Total Ozone	total column	6%	1.6%
	Tropospheric Ozone	trop column	25%	10%
NO ₂	Stratospheric NO ₂	strat column	<10%	0.5e15
	Tropospheric NO ₂	trop column	25-50%	0.7e15
SO ₂	SO ₂ enhanced	total column	30-50%	0.5 (0.2) DU
	Total SO ₂	total column	30-50%	0.5 (0.2) DU
CH ₂ O	Total CH ₂ O	total column	40-80%	1.2e16 (4e15)
CO	Total CO	total column	15%	<10%
CH ₄	Total CH ₄	total column	1%	1%
Aerosol	Aerosol Type	total column	~1 AAI	<0.1 AAI
	Aerosol Layer Height	total column	<100hPa	<50hPa
Cloud	Cloud Fraction	total column	20%	5%
	Cloud Height (Pressure)	total column	<0.5 km (100hPa)	<0.3 km (50hPa)
	Cloud Optical Thickness	total column	20%	5%



Validation by independent means of S-5p data quality:

- over full range of measurand values
- over full range of influence quantities: temperature, cloudiness, SZA, VZA, ground albedo...
- for various key atmospheric states: background, polluted, rural, marine...
- with FRMs mimicking satellite measurements
- yielding statistically significant results
- research mode validation but also operational validation (Copernicus)

⇒ BIRA-IASB response: 7 AO proposals based on integrated use of :

- ground-based networks of Brewer, Dobson, FTIR, Lidar, (MAX-)DOAS and sonde stations
- measurements acquired during dedicated campaigns
- support provided by modelling tools
- research mode validation in AO projects + operational validation in MPC

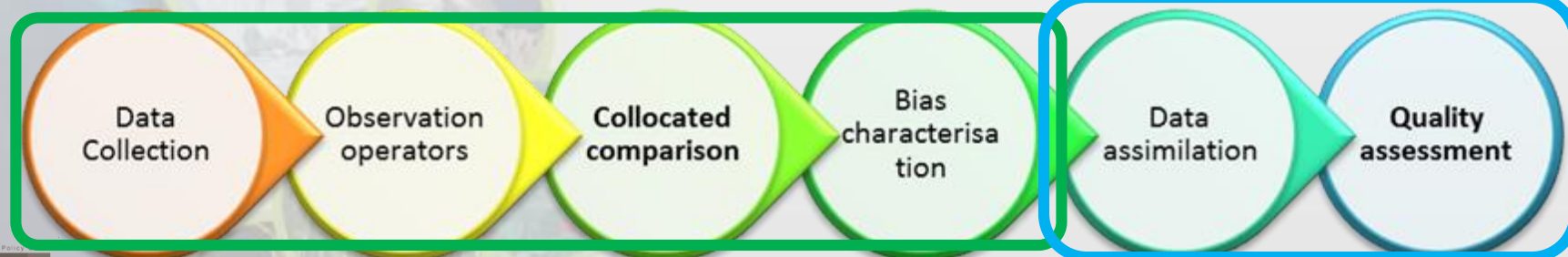
Sentinel-5p Validation Team

AO Proposals from BIRA-IASB



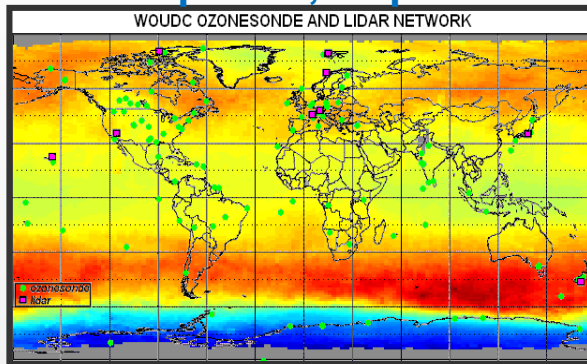
AO Proposal	Principal Investigator(s)	Target S-5P Products
VALTOZ	D. Balis (AUTH) and J.-C. Lambert	O ₃ column
CHEOPS-5p	J.-C. Lambert and A. Keppens	O ₃ profile, tropospheric O ₃
NIDFORVal	C. Vigouroux and G. Pinardi	NO ₂ , HCHO column
TCCON-4S5P	M.K. Sha	CO, CH ₄ column
TCCON-Comp	M. De Mazière	CO, CH ₄ column
AirCore-S5P	H. Chen (U. Groningen)	CO, CH ₄ column
MATRICS	J. Stavrakou	Tropospheric O ₃ , NO ₂ , HCHO, SO ₂ , CO

Working Group on Calibration and Validation

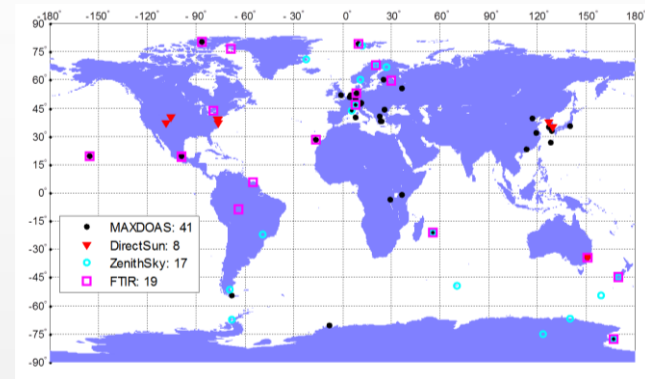


Integrated use of network-based measurements

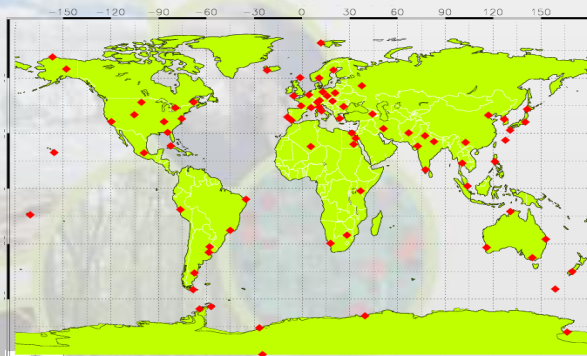
CHEOPS-5p

O₃ profile, trop. O₃

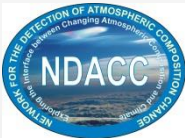
NIDFORVAL

NO₂, HCHO columns

VALTOZ

O₃ column

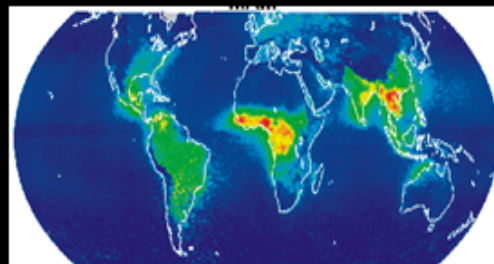
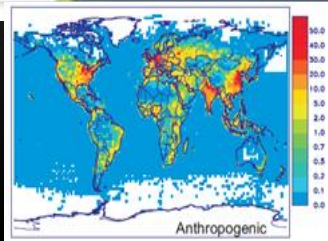
TCCON-4S5p

CO, CH₄ column

AO Project MATRICS: L2 issues affecting Inverse Modeling/Assimilation

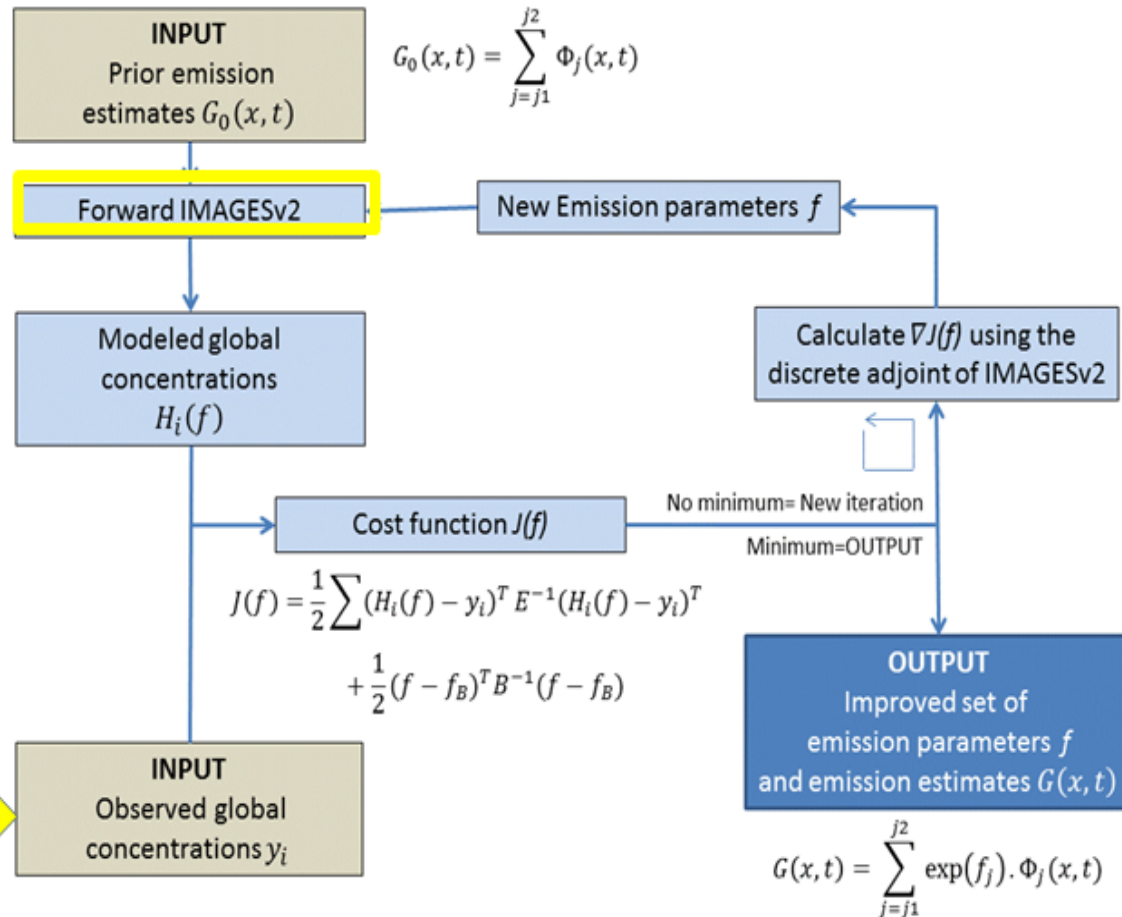


A priori emissions



De Smedt et al. 2008, 2010, 2012

OMI HCHO



Muller et al. 2005, Stavrou et al. 2006, 2008, 2009, 2011, 2012, 2013

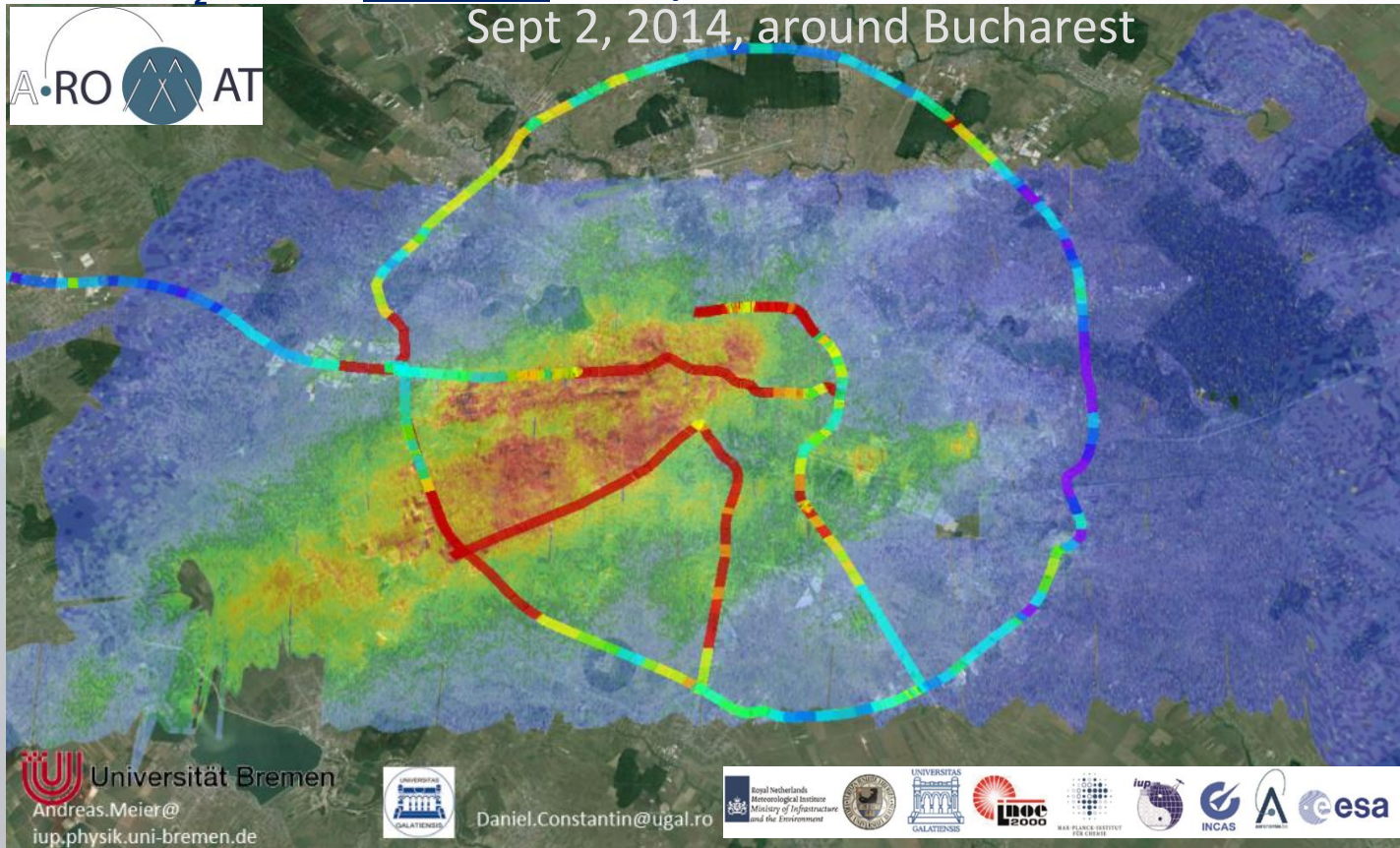
Contribution to High Resolution AQ Campaigns AROMAT

AirMAP: IUP-Bremen pushbroom imager, resolution 100m, on Uni. Berlin Cessna (Schönhardt et al., 2014)

Mobile DOAS systems: compact uv-vis spectrometers on cars (MPIC, **IASB-BIRA**, Uni. Galati) Ref: Wagner et al., 2010; Merlaud, 2013; Constantin et al., 2013

+ KNMI NO_2 sonde + **IASB-BIRA SWING/UAV** + on site instrumentation

Sept 2, 2014, around Bucharest



Working Group on Calibration and Validation

Universität Bremen
Andreas.Meier@iup.physik.uni-bremen.de



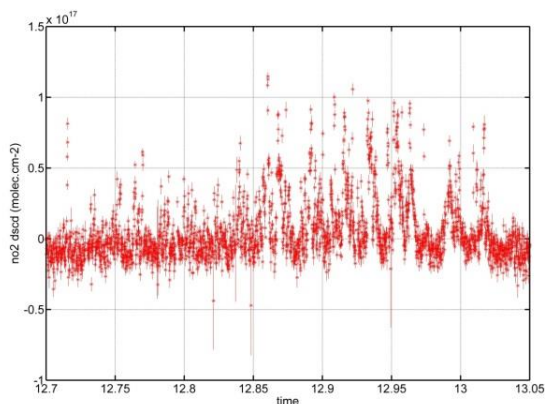
Daniel.Constantin@ugal.ro



Contribution to High Resolution AQ Campaigns AROMAT

Campaigns: AROMAT-1 Sep. 2014, AROMAT-2 Aug./Sep. 2015, Bucharest 2017

IASB-BIRA_SWING/UAV Ref: Merlaud et al., 2013





Project

- Coordinator: P. Veefkind, KNMI
- Partners from Netherlands, Belgium, Germany, UK
- Co-funding ESA + national agencies
- Kick-off May 2016
- Coordinating activities + calibration + algorithm evolution + data validation
- Copernicus mission \Rightarrow research + operational aspects

MPC Validation Data Analysis Facility (VDAF)

- Goal: Operational validation flow with (semi-)automated reporting
- Centralised at BIRA-IASB as part of MPC/Coordination Centre
- International collaboration for good practices, independent VDAF verification, interpretation of TROPOMI validation results, feedback to/from algorithms...
- Synthesis of EU CAMS/NORS, ESA Multi-TASTE, ESA CCI, EU QA4ECV AVS and EUMETSAT O3M-SAF facilities



Thank you!