Radio occultation processing at the Wegener Center: Validation results and first long -term time series of rOPS

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Outline

Thank's to supporting partners

Great support from

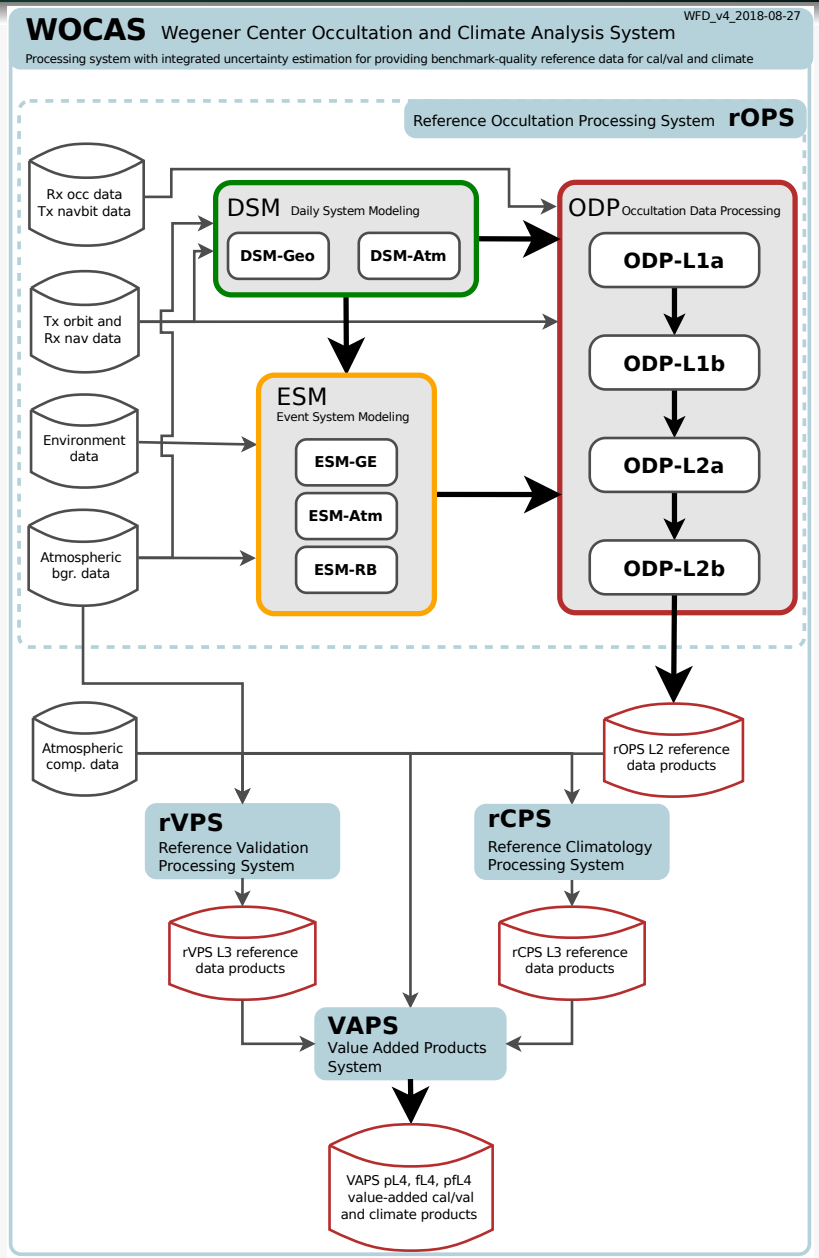
- EUMETSAT, Darmstadt
- UCAR, Boulder
- ROMSAF/DMI, Copenhagen
- ECMWF, Reading
- JPL, Pasadena
- AIUB, Berne
- NSSC Beijing
- others

Objective of presentation

Objectives

- overview of WEGC system
- current status of reprocessing
- example validation results

WOCAS Overview



Overview of the Wegener Center Occultation, Climate and Analysis System

FFG
Wegener Center
www.wegcenter.at

Processing steps (1)

Preparation of data sub-processes

- preparation of orbits and orbit uncertainties
- preparation of event location and environment data (for second order ionosphere correction) for all possible events
- preparation of FMO data for: QC, HAI, 1DMar, base-band approach
- statistical background data preparation
- statistical observation data preparation (for HAI)

Processing steps

Occultation data processing sub-processes

- raw/standard Level 1a data processing
- uncertainty and QC Level 1a data processing (needs FMO data)
- Level 1b data processing (GO/WO BA retr., merging, ionosphere correction)
- Level 2a data processing (HAI, RER, DAP)
- Level 2b data processing (physical parameter retrieval – combination of direct method and optimal estimation)

Development of rOPS over 2013 – 2019

Features changed with respect to OPSv5.6

- full chain from L0 to L2 (and follow on climate products)
- integral and differential operators have been implemented using the ”based-band approach”
- integrated uncertainty propagation from L0 to L2 which can later be used within the calculation of the climate products
- rigorous testing and coding utilizing CI tools
- full documentation containing also the derivation of the implemented algorithms

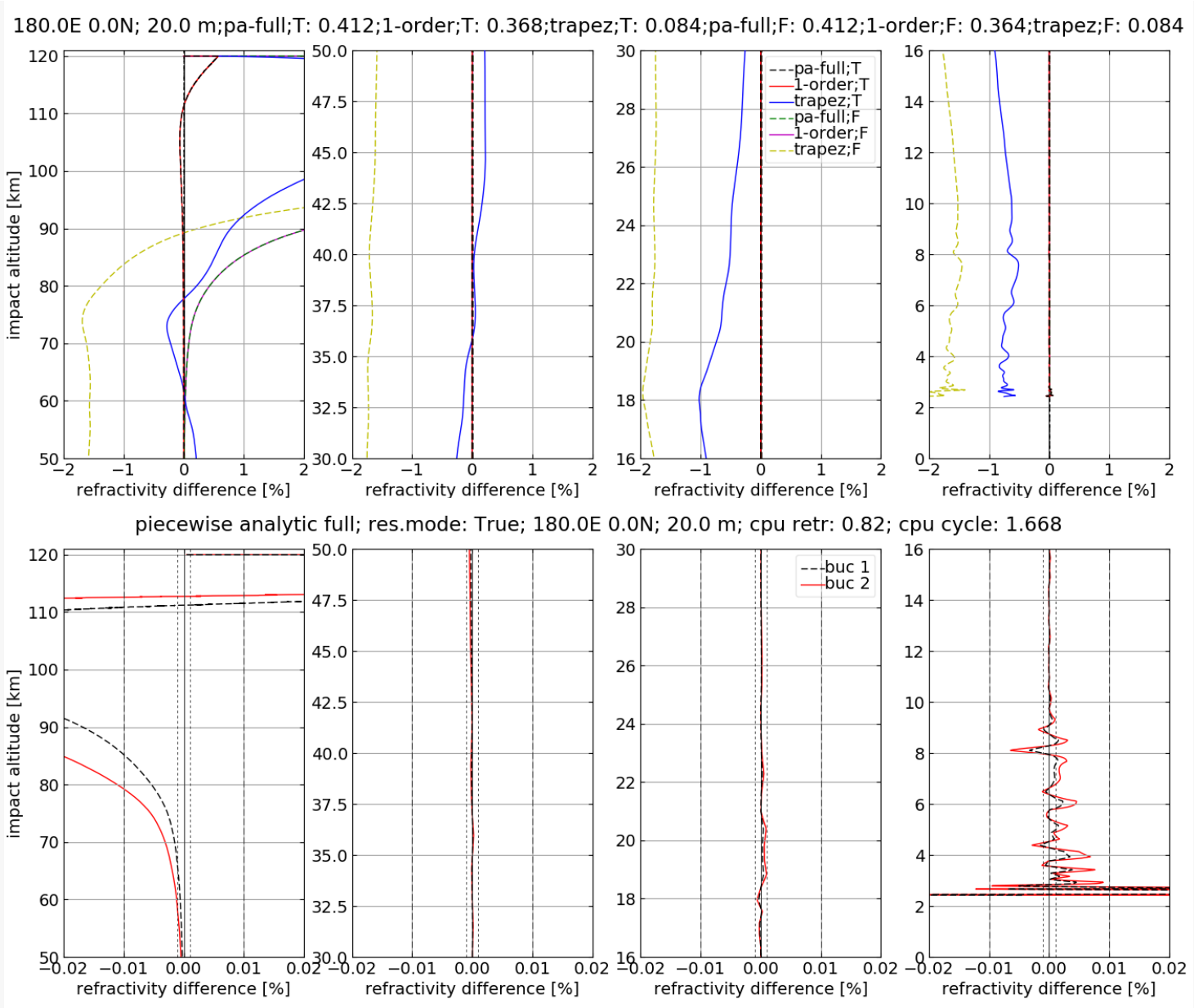
The "based-band approach"

So – what does this mean?

- subtracting an analytical part of the parameter to retrieve
- performing the retrieval on the residual part
- adding the retrieval of the analytical part to the retrieved residual

- if a parameter shows an error less than 10^{-4} in the BUC test then this can be used directly (e.g., doppler derivation)
- in case of integral operators (refractivity retrieval, hydrostatic integral) a log linear fit is performed for which the analytical integral can be easily performed.

Abel Integral – ”based-band approach”



Comparison and BUC results of the Abel Integral

Uncertainty Propagation

Random Uncertainty

done by standard error propagation:

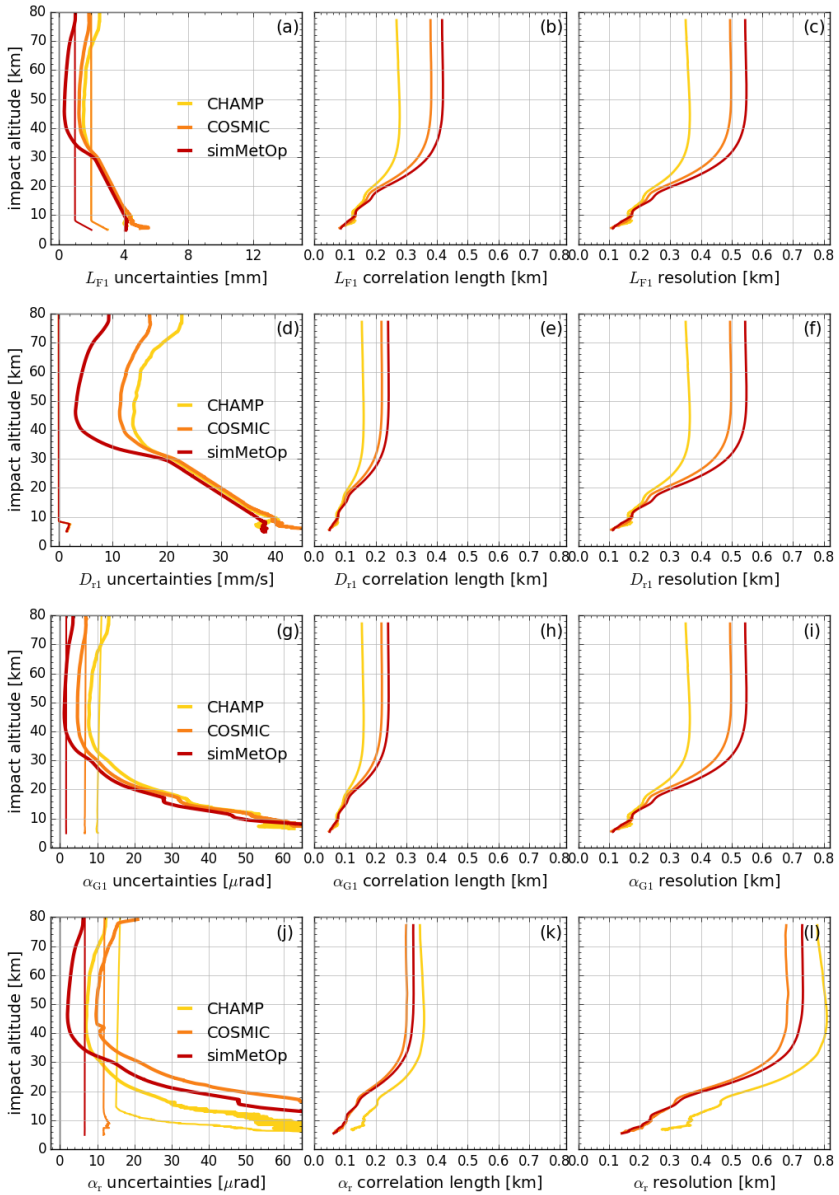
$$\Sigma_{prop} = \mathbf{A}\Sigma\mathbf{A}^T \tag{1}$$

with **A**: base-band state operator

Systematic uncertainty

propagated using the base-band state operators

Level 1b example ouput



L1b uncertainty propagation example (July 15, 2008)[Schwarz et al. 2018]

Reprocessing Summary

Satellites – base setup

- METOP-A/B
- CHAMP, GRACE

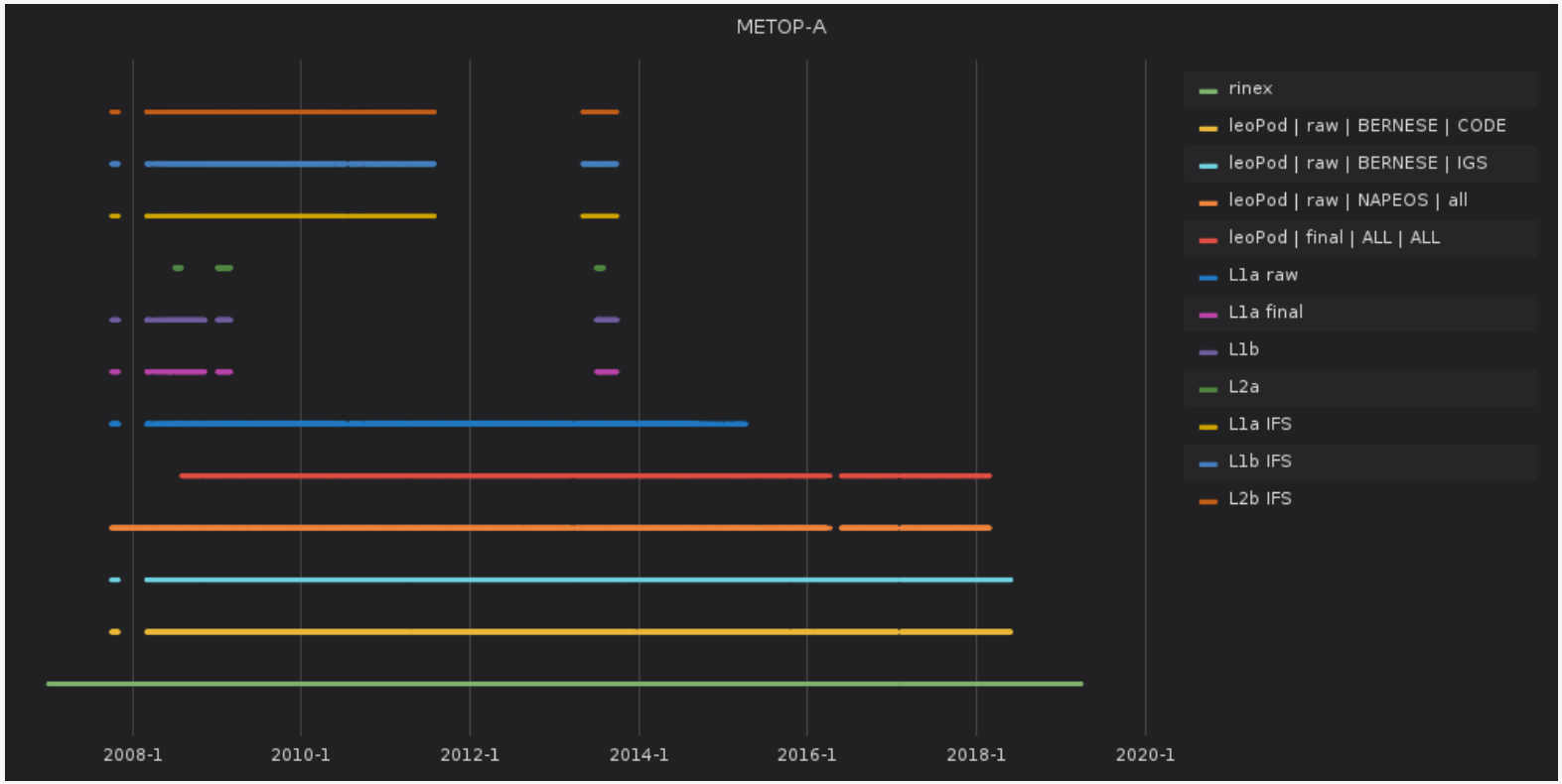
Satellites – follow on processing

- COSMIC (1–6)

Test processing

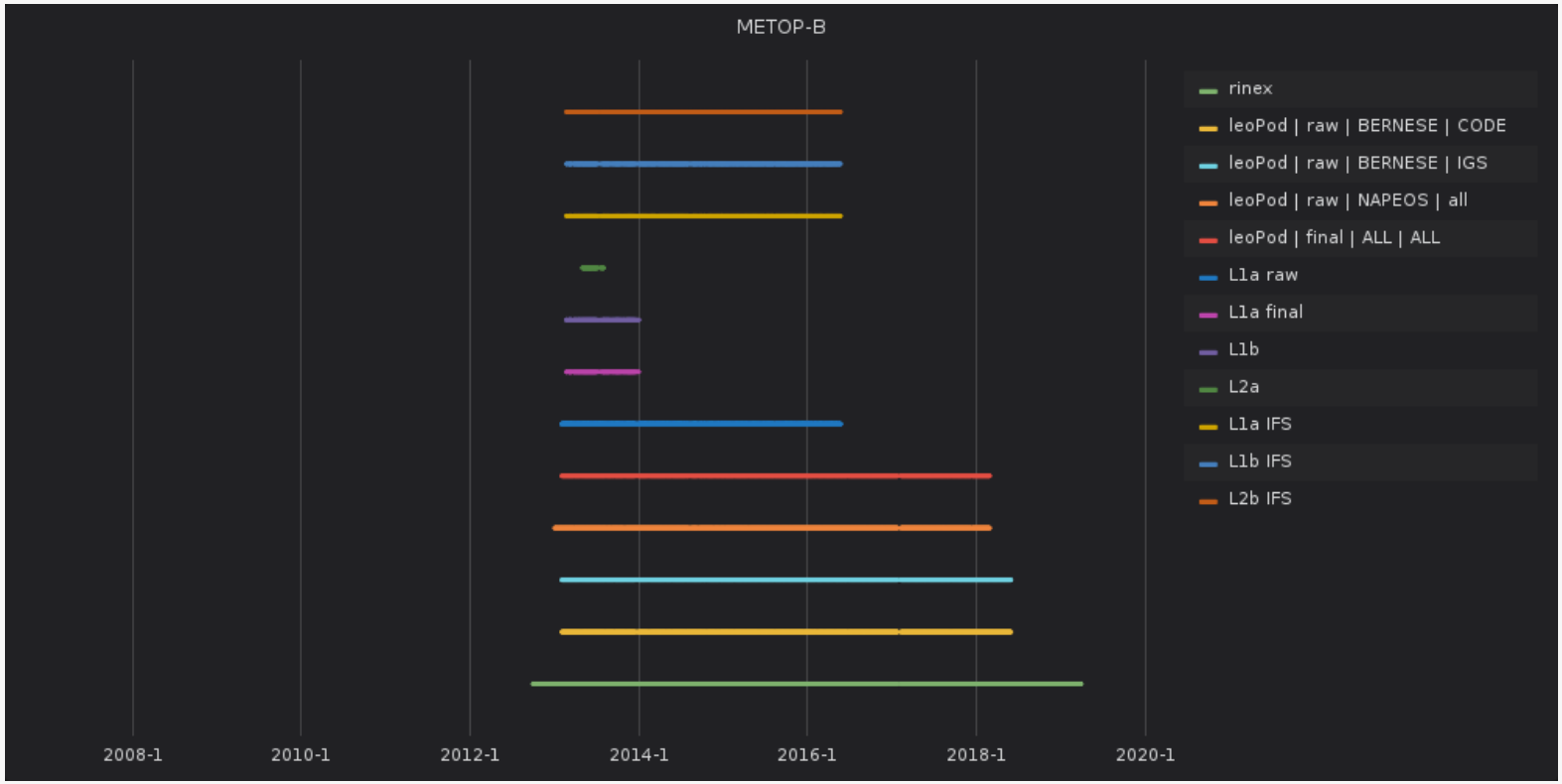
- SPIRE, FY3C

Reprocessing METOP-A – status



METOP-A processing status

Reprocessing METOP-B – status

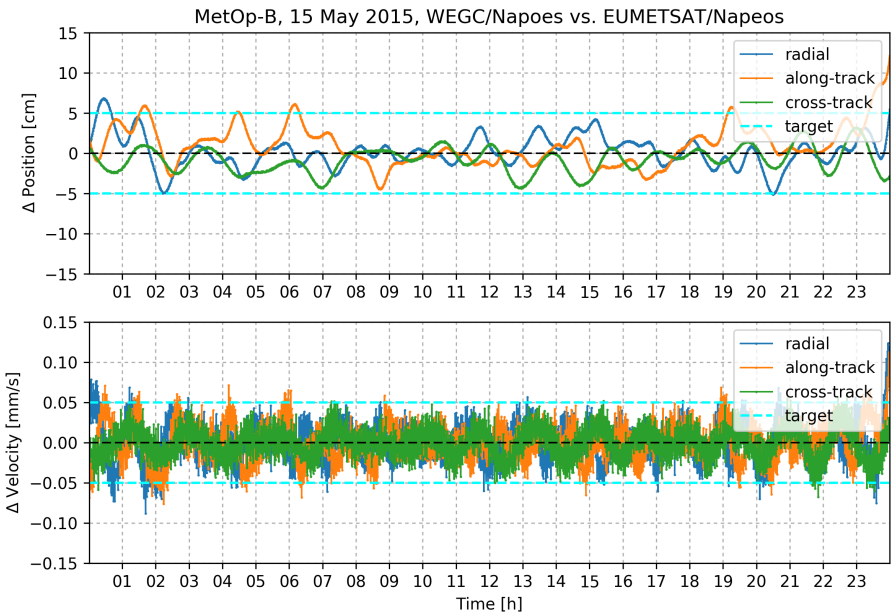


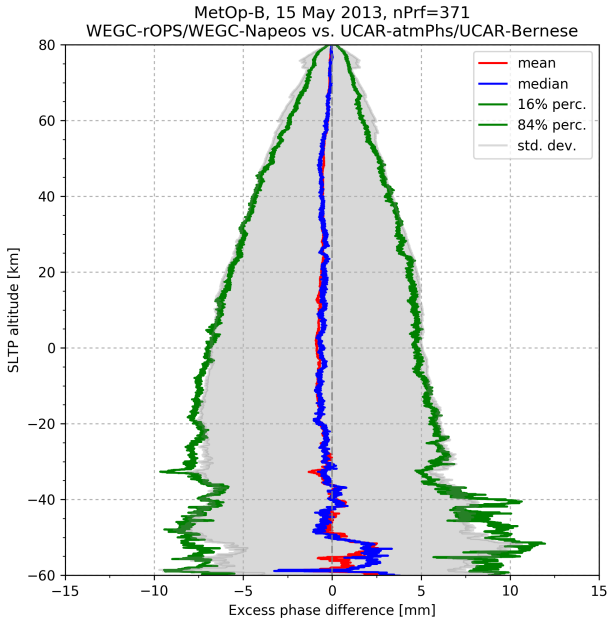
METOP-B processing status

Orbits and phases – L1a

Talk by Josef Innerkofler; Tuesday, 17:10

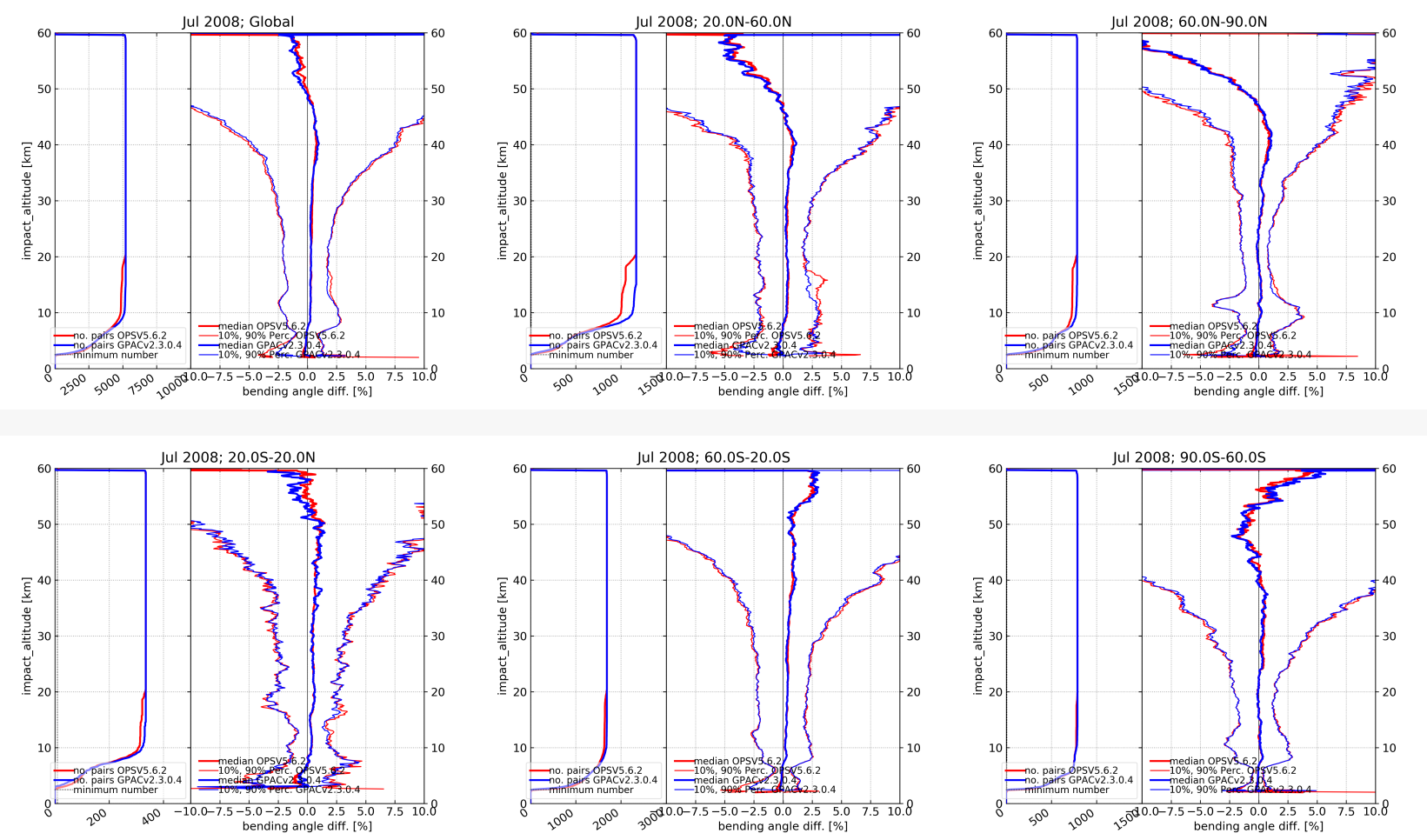
- multi-satellite POD
- multi-satellite L1a





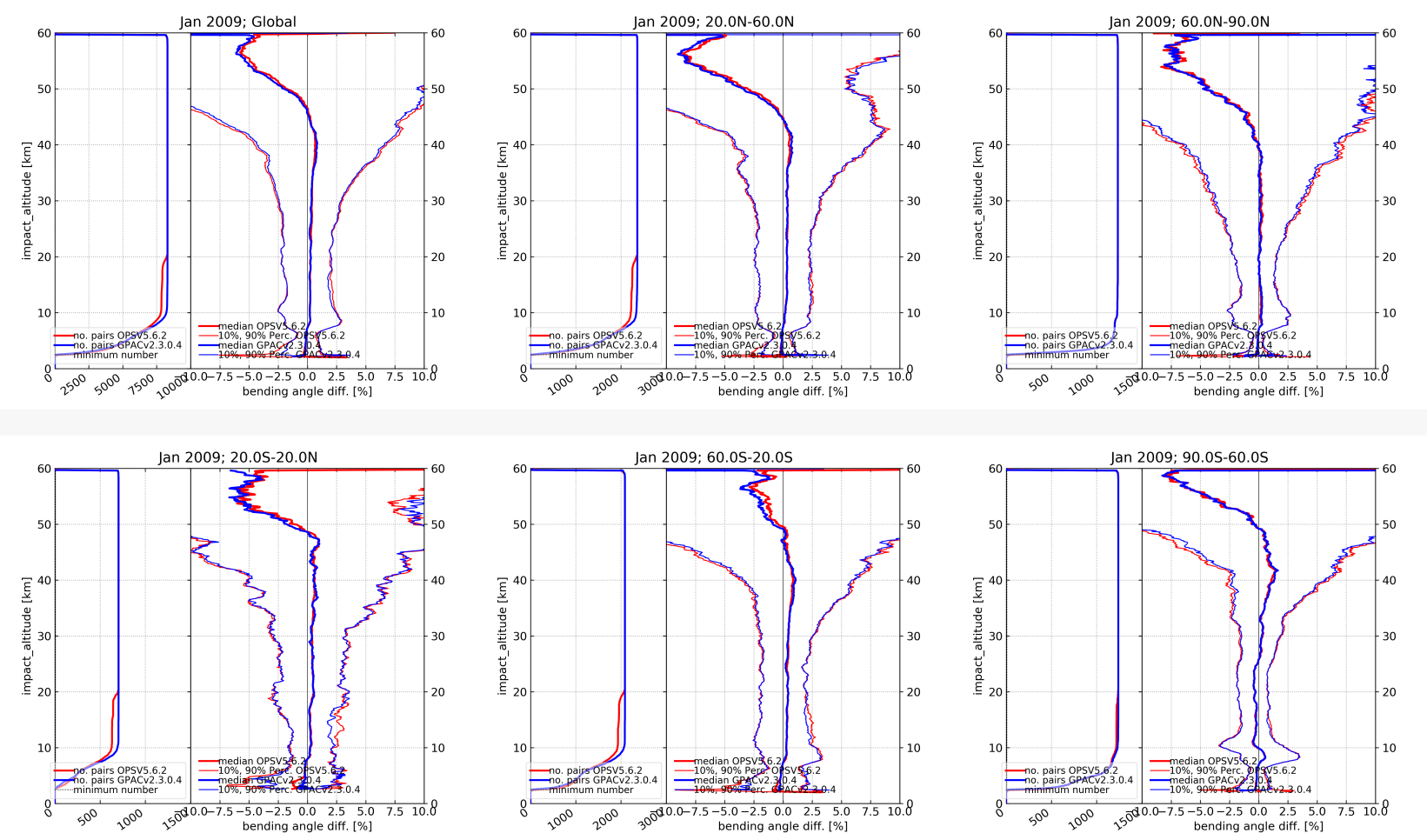
Orbit and Phase data comparison for METOP-B for May 15, 2013

Bending Angle – L1b; July 2008



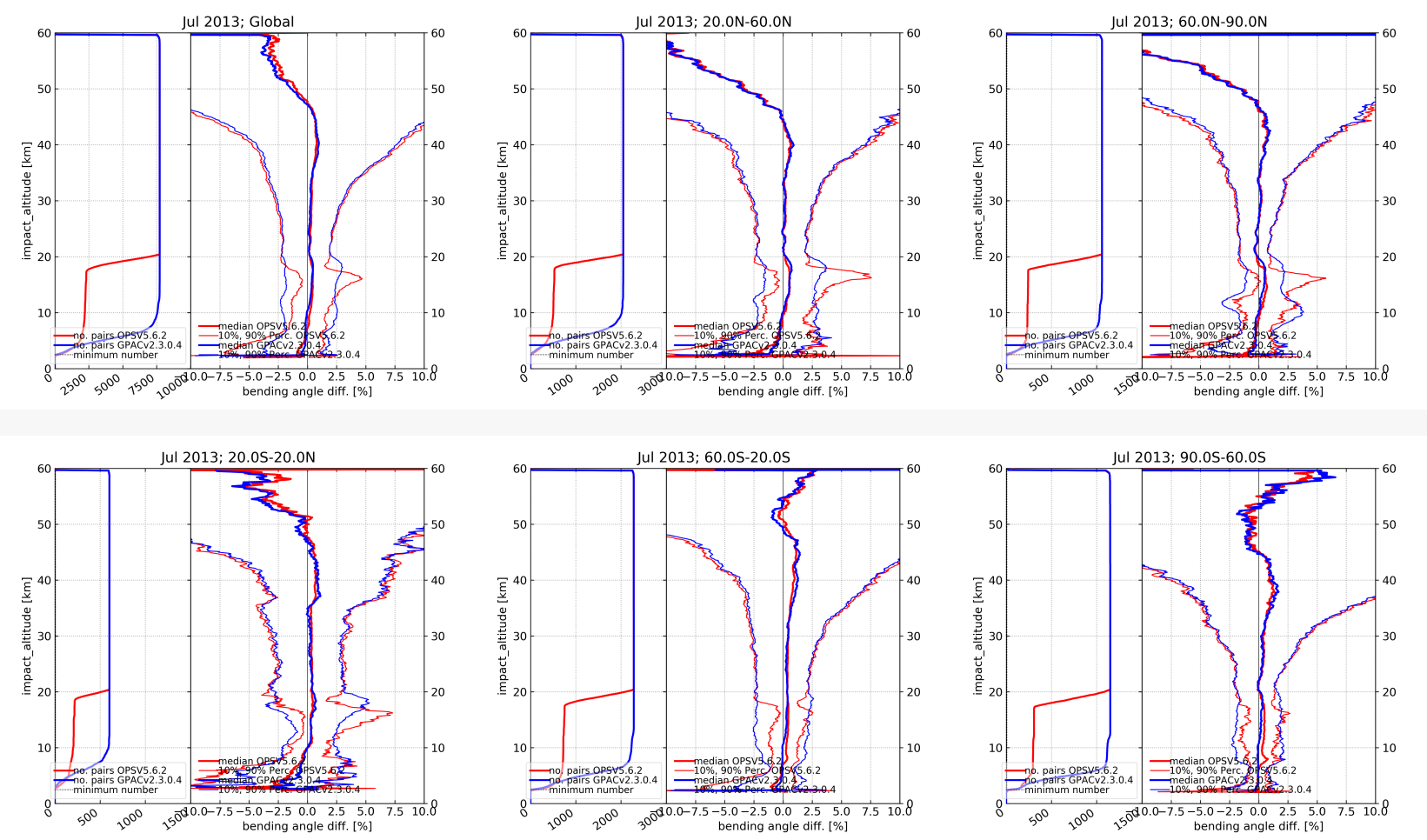
rOPS vs. OPSv5.6 and GPACv2.3.0; bending angle; July 2008

Bending Angle – L1b; January 2009



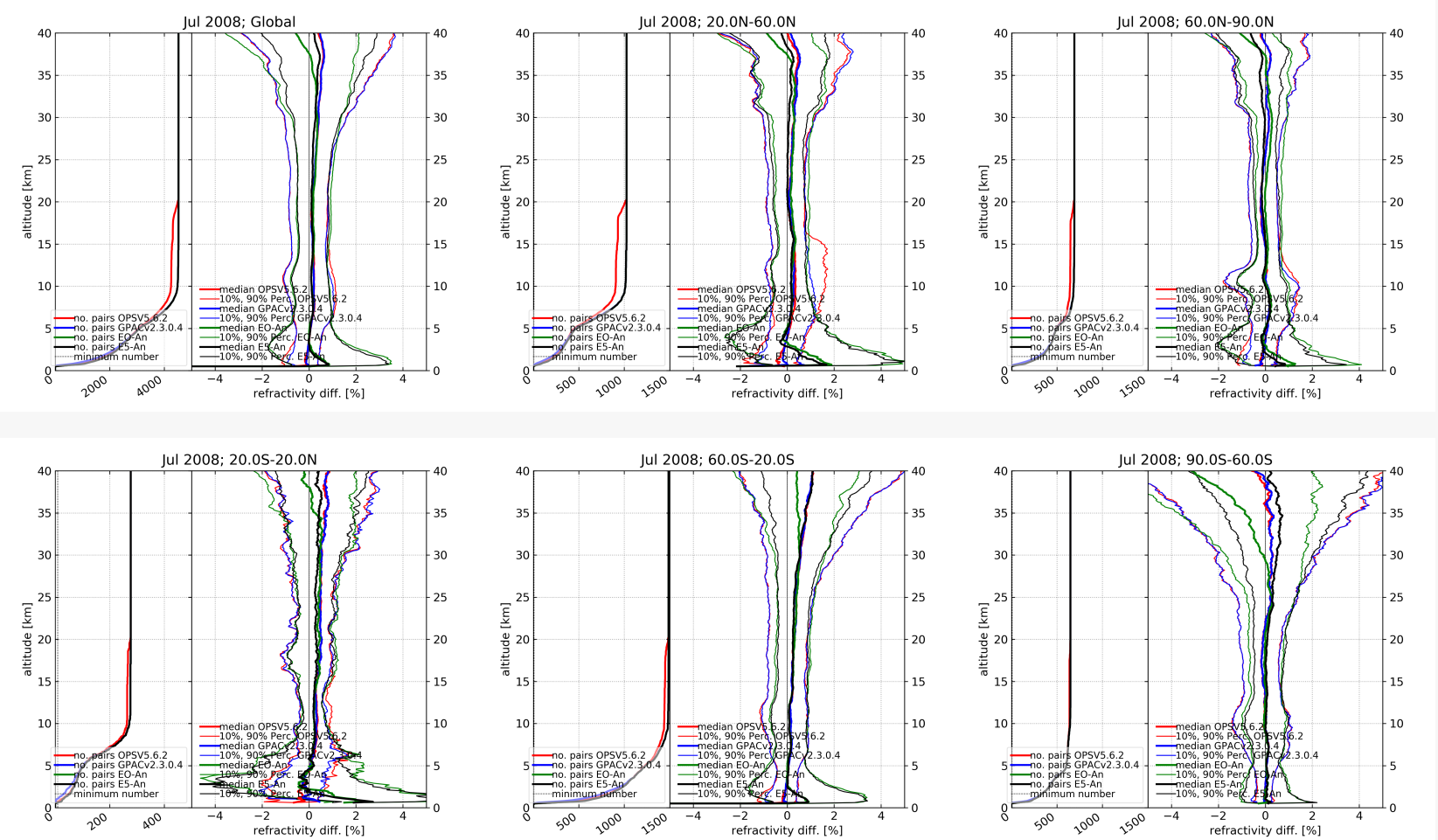
rOPS vs. OPSv5.6 and GPACv2.3.0; bending angle; January 2009

Bending Angle – L1b; July 2013



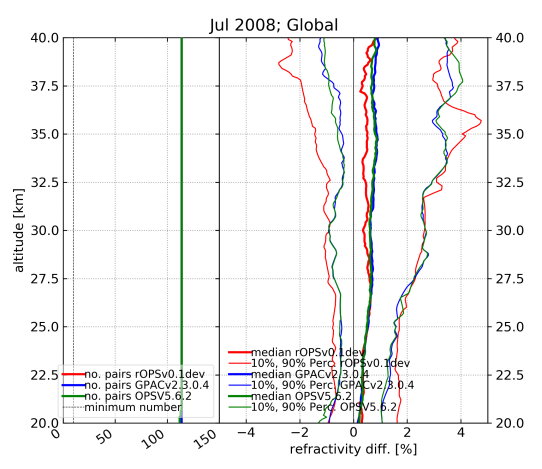
rOPS vs. OPSv5.6 and GPACv2.3.0; bending angle; July 2013

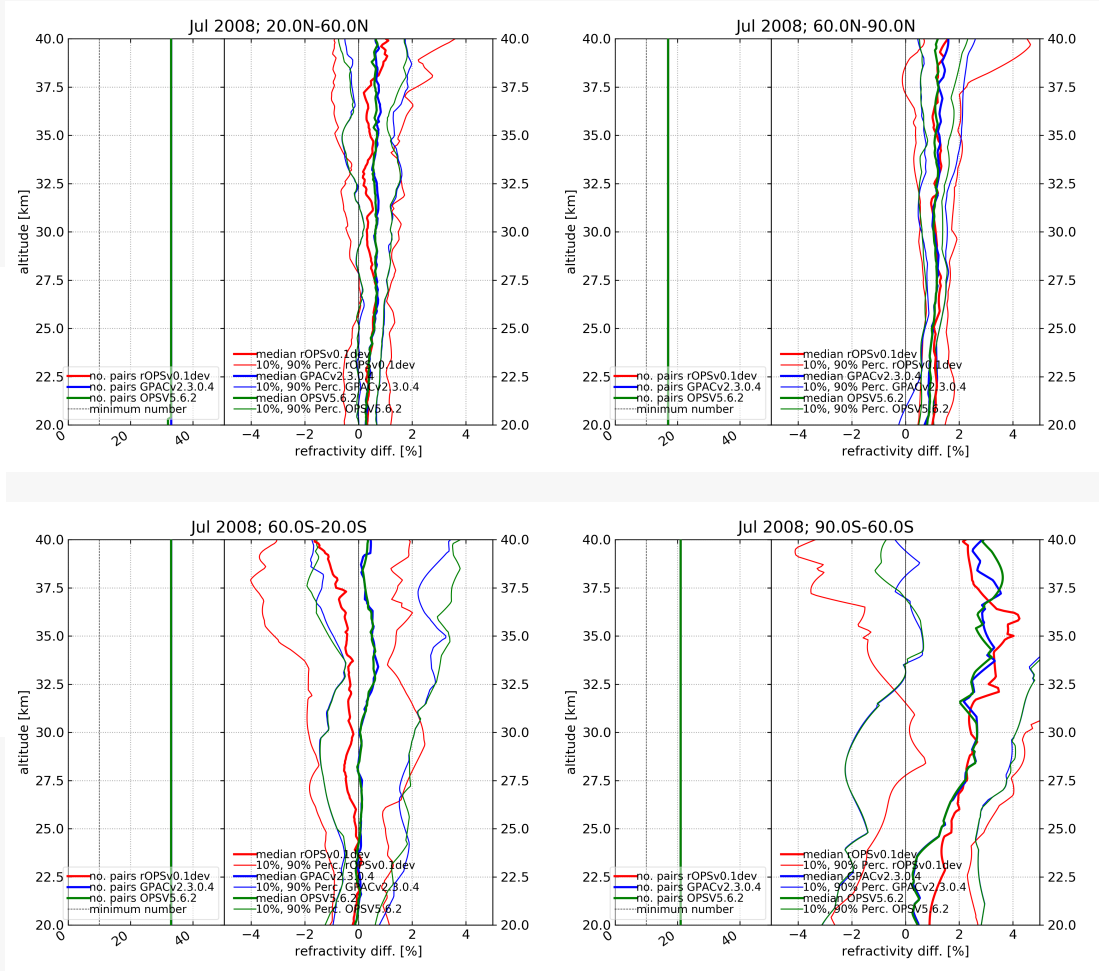
Refractivity – L2a; July 2008



rOPS vs. OPSv5.6 and GPACv2.3.0; refractivity; July 2008

Refractivity – L2a; July 2008; vs. MIPAS





rOPS, OPSv5.6, and GPACv2.3.0 vs. MIPAS-MA; refractivity; July 2008

Summary

Done

- rOPS re-implementation has been finished down to L2a
- rOPS reprocessing has been started;
  - METOP-A, METOP-B up to L1a almost ready
  - L1b to L2b first validation processing
- first validation results show consistency to other RO datasets and analysis data (ERA-5, EC-Op)
- but: biases detected; under investigation;
- after resolving of these problems: continuing of reprocessing

That's it!