Recent radio occultation reprocessing at the Wegener Center: Profile and climatology data validation including uncertainty evaluation

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EUMETSAT ROM SAF
FFG
Wegener Center
UNI GRAZ

Thank's to supporting partners

Great support from

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

Objective of presentation

Objectives

- motivation
- overview on processing at WEGC
- overview on rOPS
- validation and climatologies

Motivation

WEGC as part of ROM SAF

- rOPS data is/will be used as validation data for the GPAC data products
- rOPS is used as the R & D system of ROM SAF

General – not less important

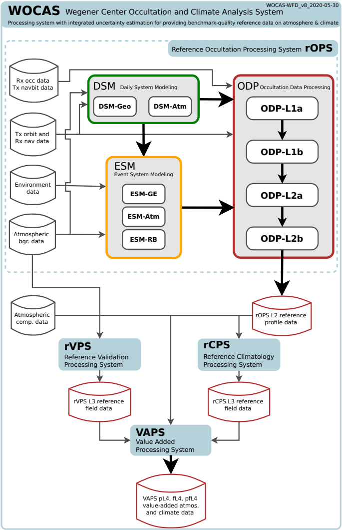
- produce a dataset (utilizing the uncertainty of rOPS) which can show the power/consistency of the RO method
- produce a dataset which can be part of a various RO datasets for the next IPCC assessment report

rOPS

Features of the new system

- processing of the data from raw measurement data (L0 data including orbit data processing) onward
- implementation using base band (minimize potential biases)
- provide an integrated uncertainty processing from:
  - raw orbit and measurement uncertainty input
  - and some assumptions for unknown raw uncertainties
- uncertainty propagation of these input uncertainties down to dry- and physical parameter
- get a new clean code base
- testing based on CI tools
- planned phase only QC had to be extended by an additional bending angle part

WOCAS overview



Overview of the Wegener Center Occultation and Climate Analysis System

rOPS intention

probably remember – time frame expectations

- 3 years (Gottfried) to 10 years (Uli)
- definitely much overestimated by Uli since we only needed 9 years

Processing setup

Satellites – base setup

- METOP-A/B/C and CHAMP
- output of:
  - excess phase data
  - bending angle data
  - dry parameter (refractivity, T_d, p_d, etc.)
  - physical parameter (T, p, q, etc.)
  - uncertainties for all these atmospheric species.

Test processing

- COSMIC-1, GRACE, COSMIC-2, SPIRE, FY3

Validation and comparison datasets

Validation dataset

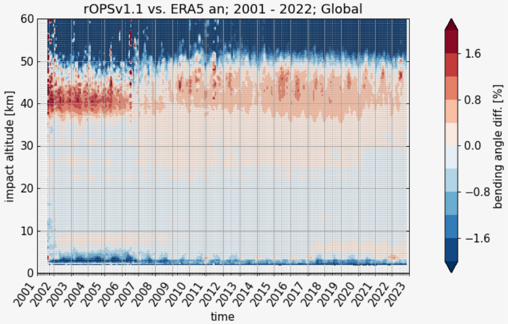
- ERA5 analysis (interpolated to RO locations)

Comparison datasets

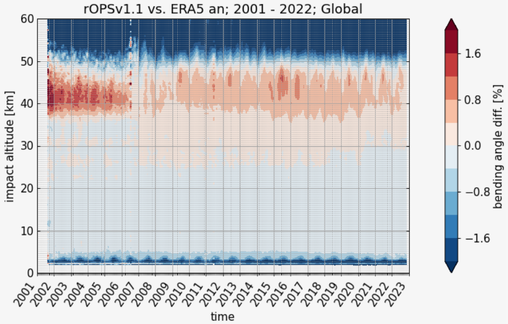
- GPAC CDR/ICDR data
- old CDAAC RO-Trends data

Validation vs. ERA5

Bending angle mean/median – time series

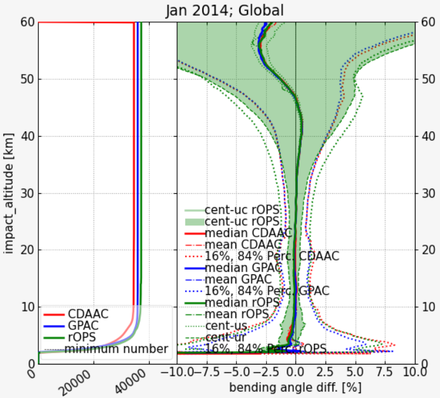


BA mean – vs. ERA5

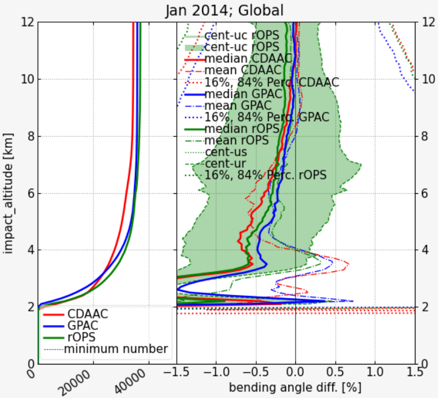


BA median – vs. ERA5

Bending angle – example month

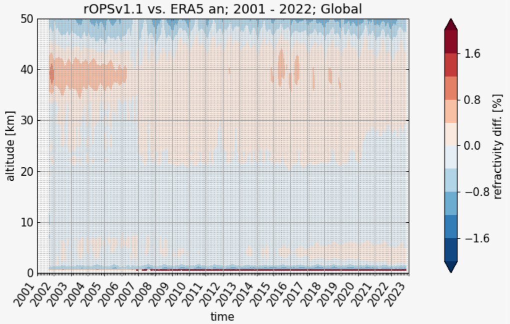


BA full range – vs. ERA5

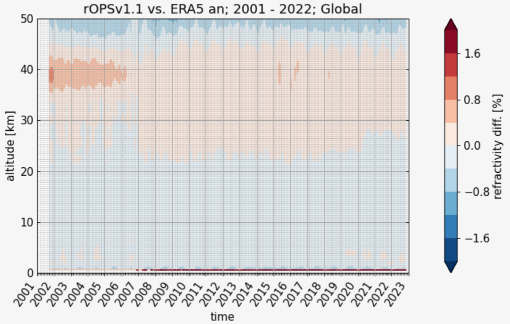


BA troposphere – vs. ERA5

Refractivity mean/median – time series

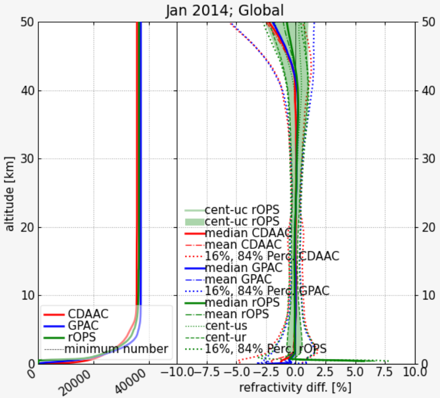


refractivity mean – vs. ERA5

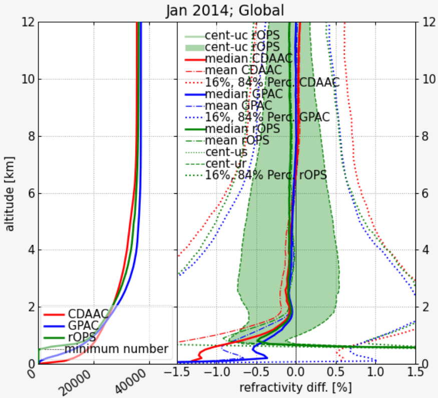


refractivity median – vs. ERA5

Refractivity – example month

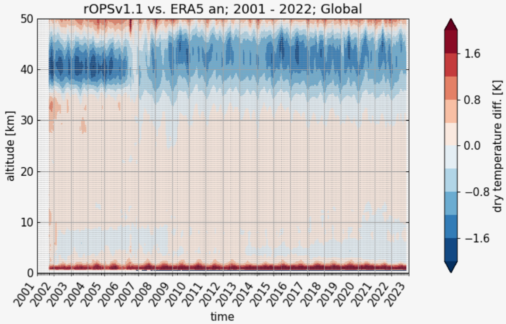


refractivity full range – vs. ERA5

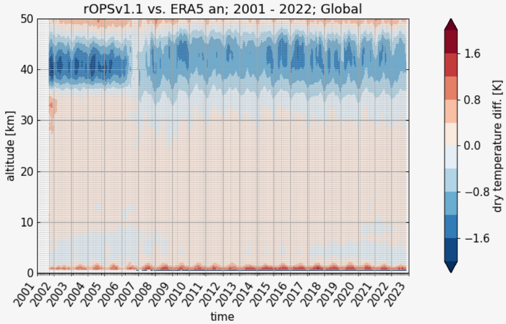


refractivity troposphere – vs. ERA5

Dry temperature mean/median – time series

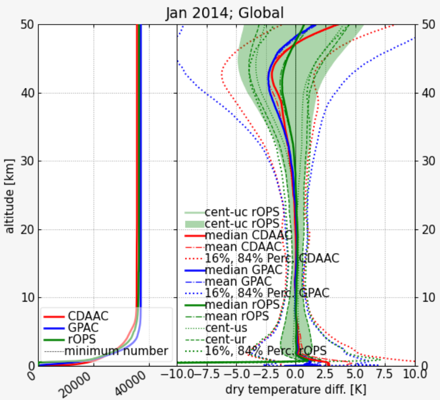


dry temperature mean – vs. ERA5

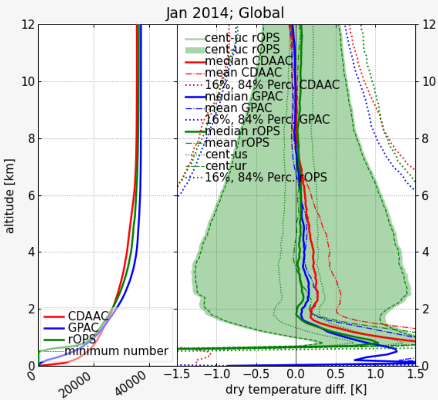


dry temperature median – vs. ERA5

Dry temperature – example month

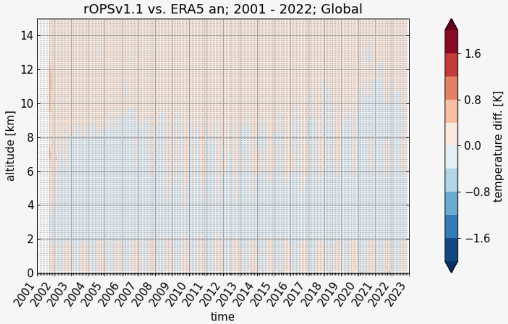


dry temperature full range – vs. ERA5

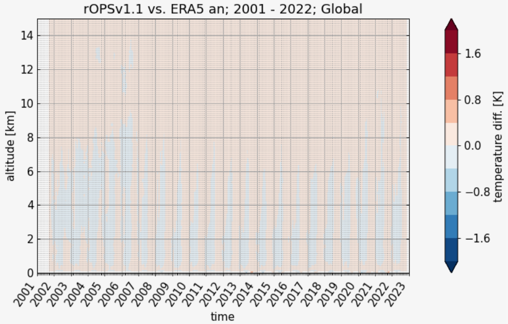


dry temperature troposphere – vs. ERA5

Temperature mean/median – time series

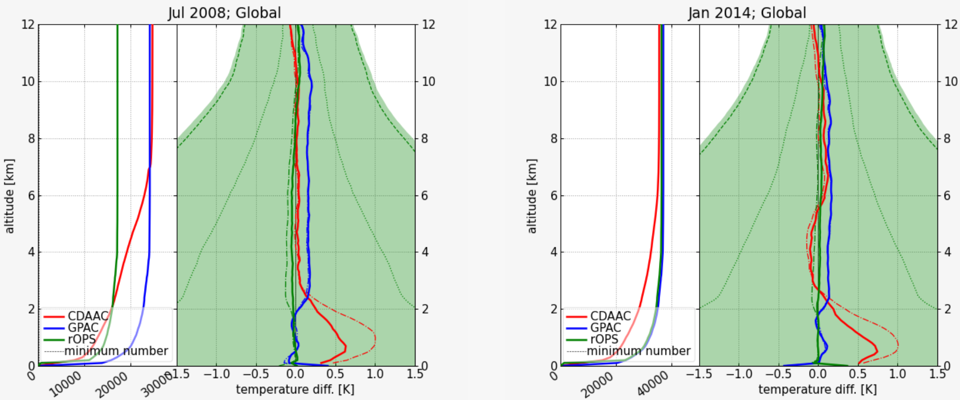


temperature mean – vs. ERA5



temperature median – vs. ERA5

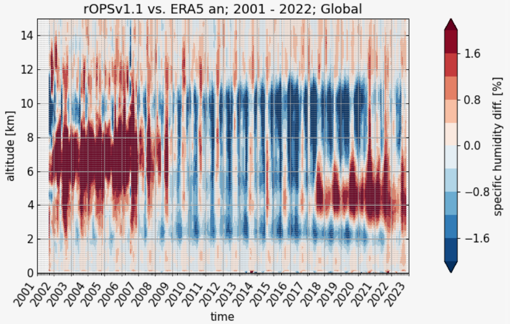
Temperature – example months



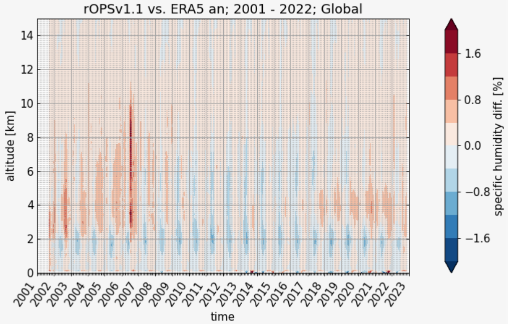
temperature; July 2008 – vs. ERA5

temperature; January 2014 – vs. ERA5

Specific humidity mean/median – time series

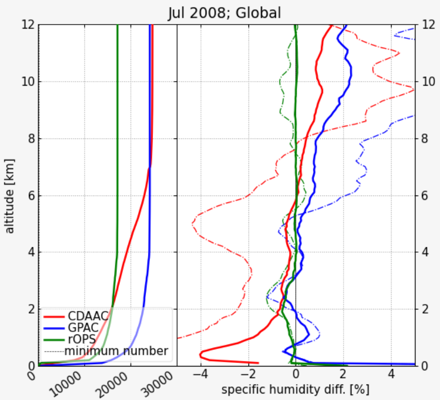


specific humidity mean – vs. ERA5

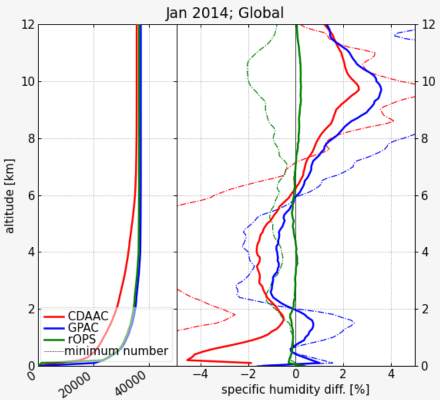


specific humidity median – vs. ERA5

Specific humidity – example months

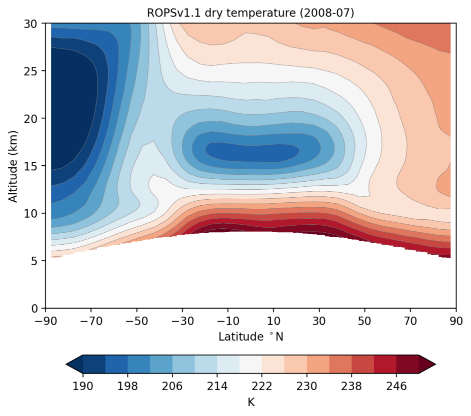


specific humidity; July 2008 – vs. ERA5

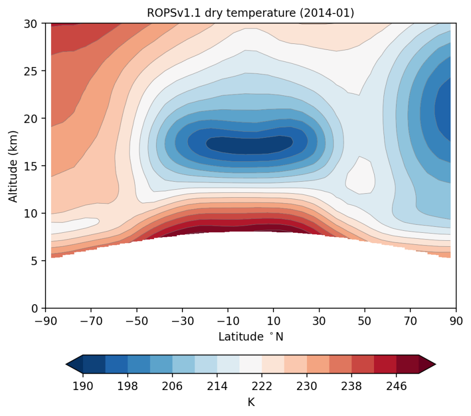


specific humidity; January 2014 – vs. ERA5

Example climatologies – dry temperature



dry temperature climatology; July 2008



dry temperature climatology; January 2014

Usage of climatologies

Talk of Andrea on Tuesday

Processing Summary

rOPS

- base reprocessing using METOP and CHAMP looks mature
- bending angle data: very consistent to GPAC and CDAAC data – well within the rOPS uncertainty bounds
- refractivity: very consistent up to about 42 km – above within uncertainty bounds
- dry temperature: very consistent up to about 30 km – above within uncertainty bounds
- temparature: almost no bias with respect to ERA5 in median statistics, very small bias ($<$0.1 K) in mean statistics
- specific humidity: almost no bias with respect to ERA5 in median statistics down to about 3 km, below $<$0.5 %; mean statistics: bias $<$2 %

Outlook

Todo

- include other missions (COSMIC-1, GRACE, COSMIC-2, Spire, etc.)
- perform detailed validation including external non-RO datasets and different analysis and forecast fields
- use in a range of RO & Climate scientific studies (within ROM SAF context, IPCC AR7, etc.)

Literature

G. Kirchengast, M. Schwärz, B. Angerer, J. Schwarz, J. Innerkofler, V. Proschek, J. Ramsauer, J. Fritzer, B. Scherllin-Pirscher, and T. Rieckh
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That's it!