ROM SAF processing and new products:

A focus on the retrieval of planetary boundary layer height

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Outline

- ROM SAF product overview
  - NRT
  - Offline/NTC
  - Reprocessing (CDRs) – Climate Data Records
  - EPS-SG to come
- Recent additions to the product portfolio
  - Sentinel-6 NTC
  - Spire-EUM NRT
  - Spire-NOAA NRT
  - PlanetiQ-NOAA NRT
- ROMEX processing
- New ROM SAF product to come: Planetary boundary layer height

Current operational production chains

NRT production

- Metop NRT profile products
- Spire NRT profile products (based on EUMETSAT-procured data)
- Spire NRT profile products (based on NOAA-procured data)
- PlanetiQ NRT profile products (based on NOAA-procured data) – resumes soon

Offline production

- Metop Offline profile and gridded products
- Metop ICDR extending CDR v1.0 from Reprocessing #1 up to the present
- Sentinel-6 NTC profile and gridded products

Reprocessing activities

1st reprocessing done in 2018-2019:

- CDR v1.0 spanning RO data from 2001 - 2016 (~16 years)
- Interim CDR: CDR v1 series extending CDR v1.0
- Missions: Metop (EUM), CHAMP (UCAR), GRACE (UCAR), COSMIC-1 (UCAR)

2nd reprocessing being planned:

- CDR v2.0 will span 2001 - 2022 (~20 years)
- Interim CDR: ICDR v2 series will extend CDR v2.0
- New science:
  - Improved Level 1A input from EUMETSAT Secretariat
  - Kappa correction
  - 1D-Var based on R-matrix from 3CH analysis
  - PBLH parameters calculated with ROPP routines
- Missions: CDR v1.0 missions + TBD

EPS-SG products to come

Day 1 products (commitments in the EURD for EPS-SG):

- Products similar to current Metop NRT profile products
- Demonstration products to be produced during EPS-SG commissioning
- Operational production expected to start right after EPS-SG commissioning (12 months after the launch of the first EPS-SG satellite)

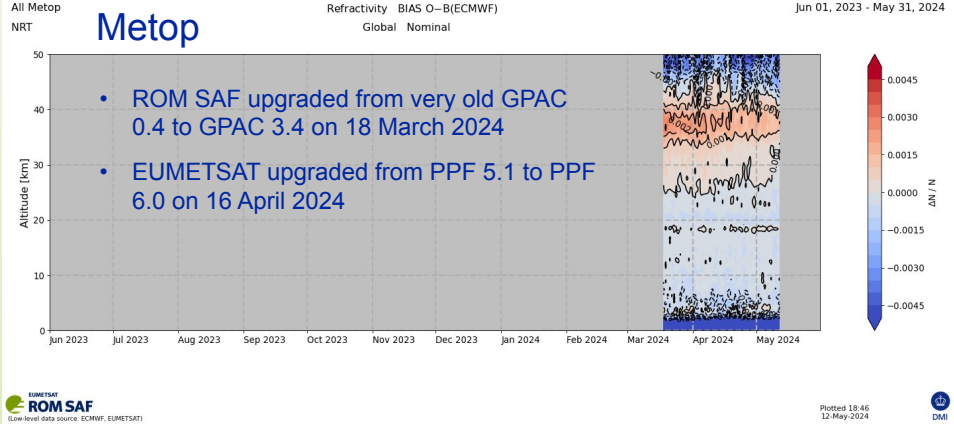
Day 2 products:

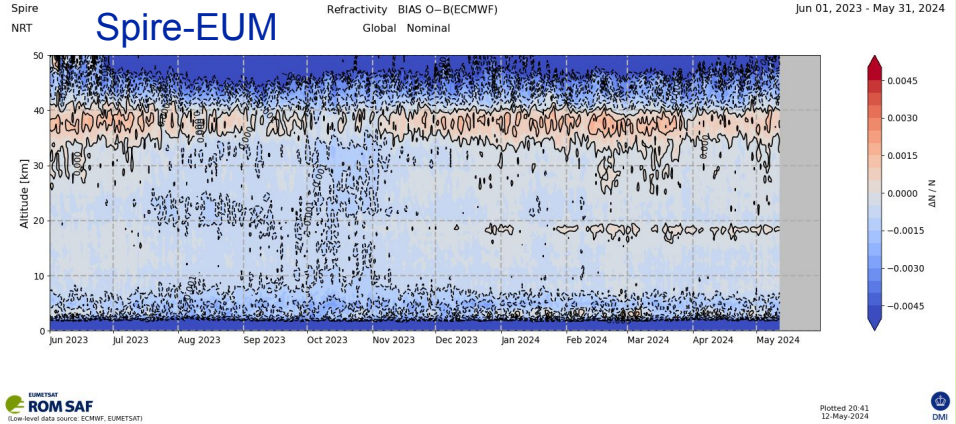
- Products similar to current Metop Offline and Gridded products
- Demonstration products to be produced during EPS-SG commissioning
- Operational production expected to start shortly after EPS-SG commissioning

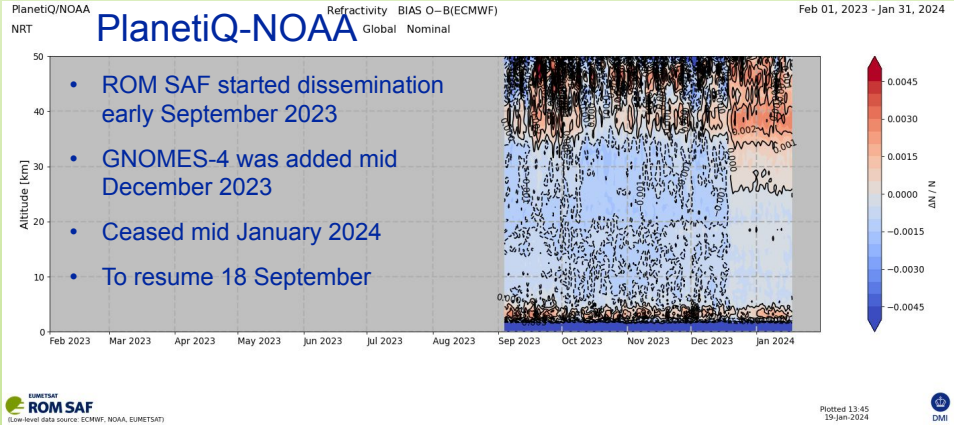
New Day 2 ionosphere products:

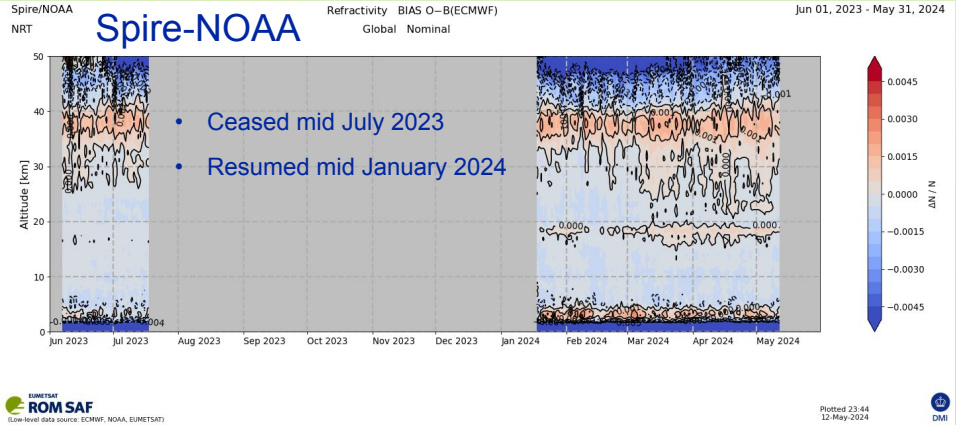
- Day 2 baseline products developed in CDOP 3
- Demonstration products to be produced during or after EPS-SG commissioning
- Production will start ~6 months after EPS-SG commissioning

NRT productions (refractivity)



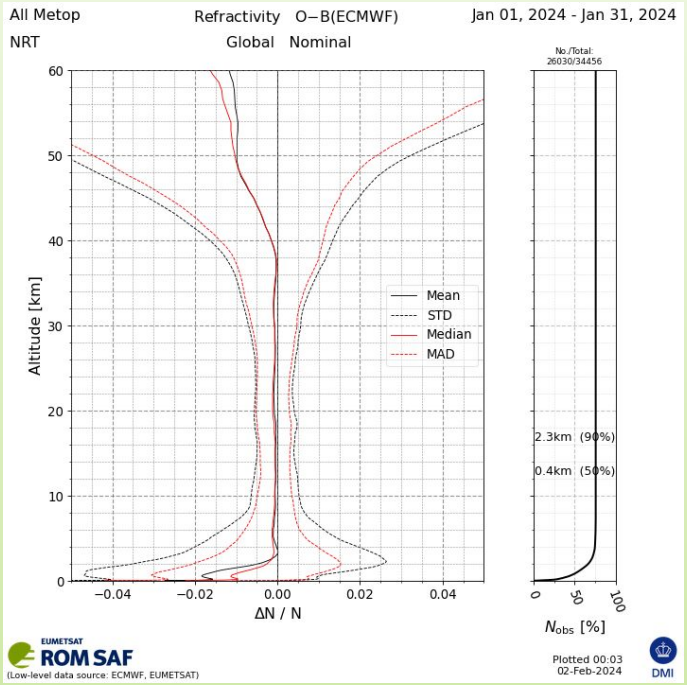




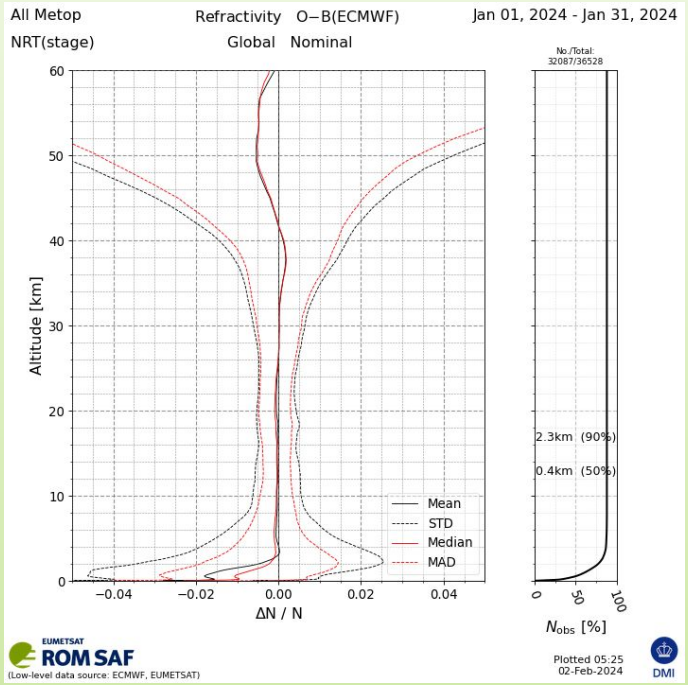


GPAC 3.4 vs GPAC 0.4 (refractivity)

Old GPAC 0.4



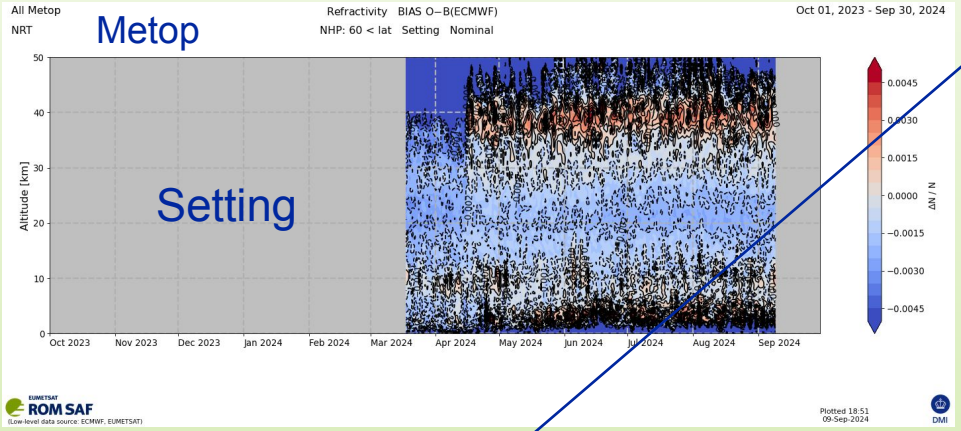
New GPAC 3.4

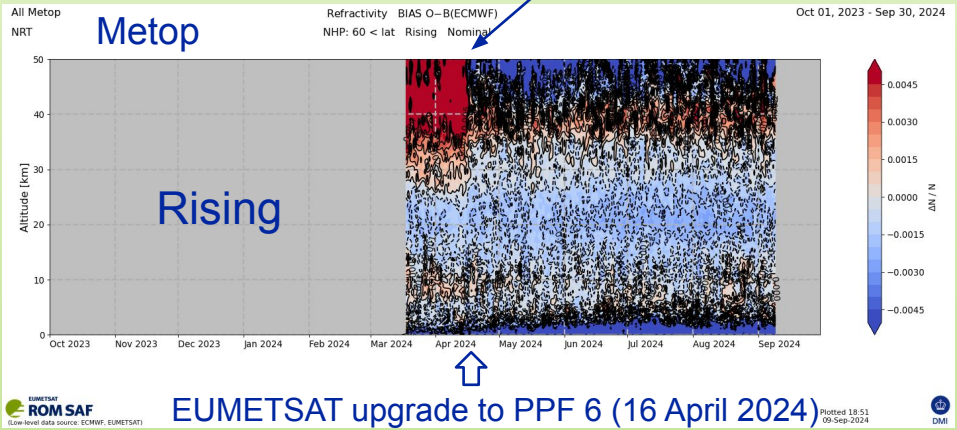


GPAC 3.4:

- Improvement to the statistical optimization in the refractivity retrieval (using ROPP/BAROCLIM)
- Significant increase in the number of nominal occultations (due to changed QC at the ROM SAF)
- Slightly larger standard deviation (a consequence of the larger number of nominal occultations)

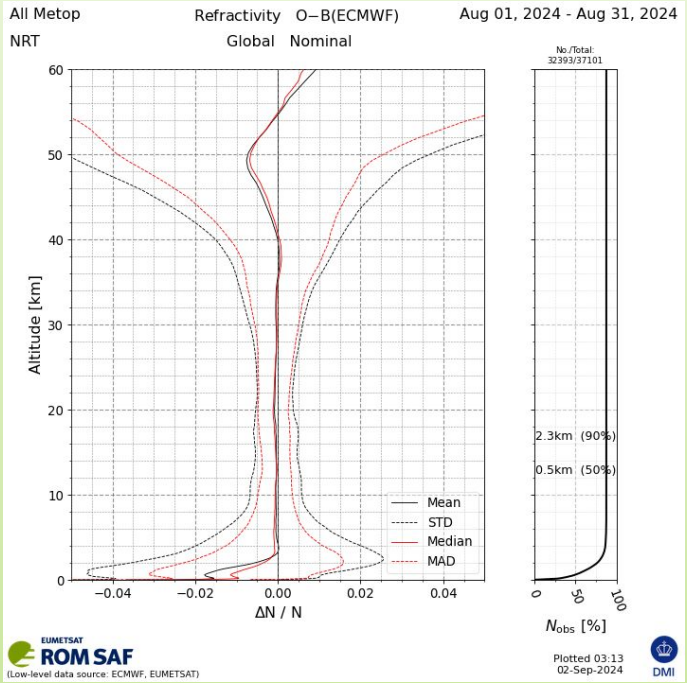
PPF 6 vs PPF 5 (refractivity)



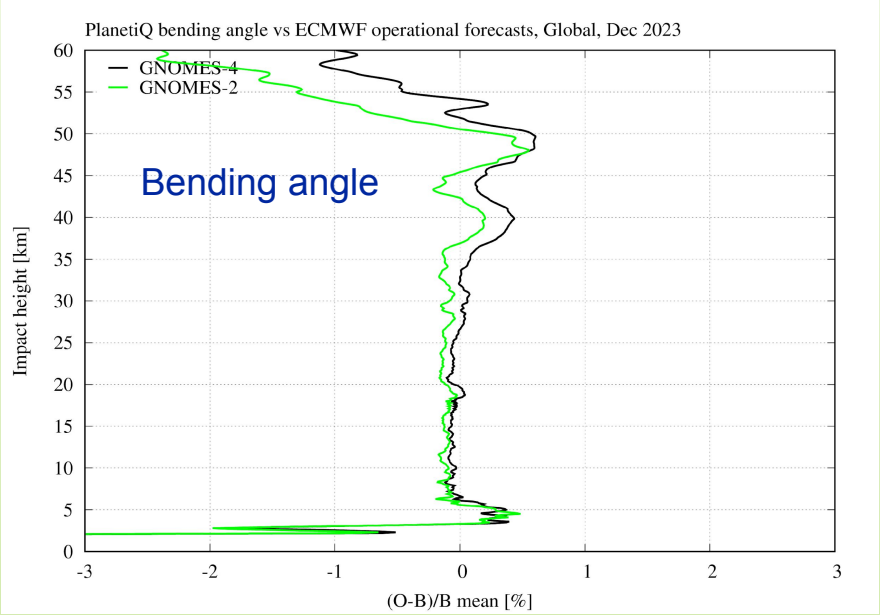


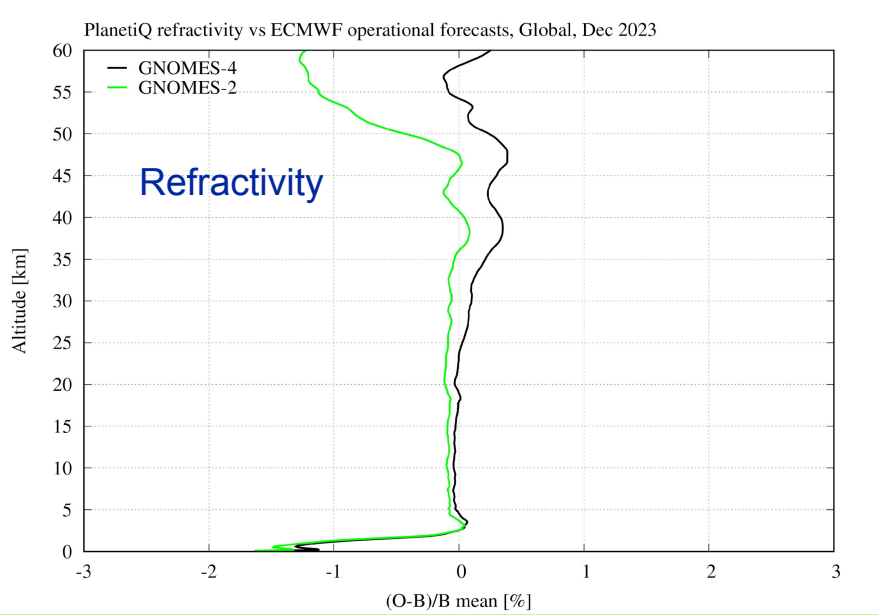
EUMETSAT upgrade to PPF 6 (16 April 2024)

PPF 6 solved a high altitude bias between setting and rising occultations



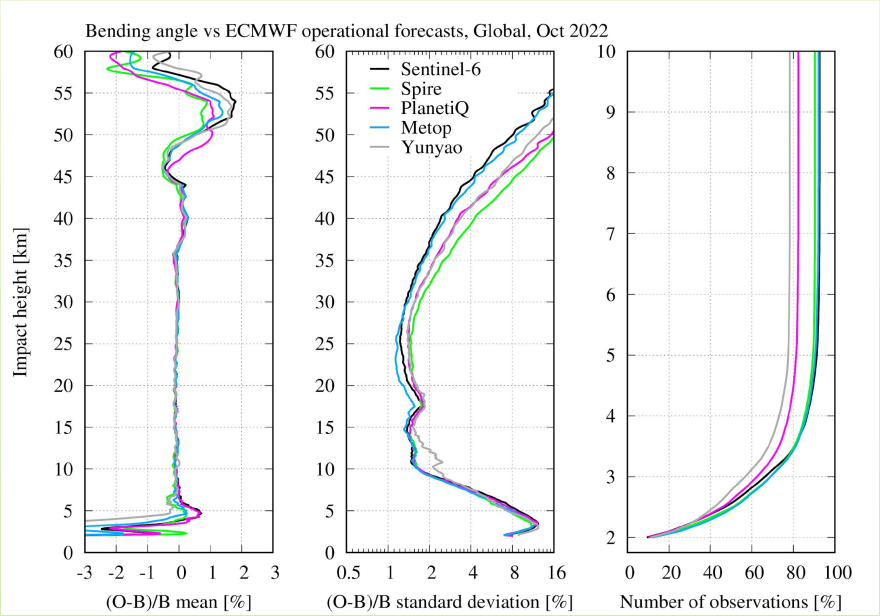
PlanetiQ-NOAA GNOMES-2/GNOMES-4

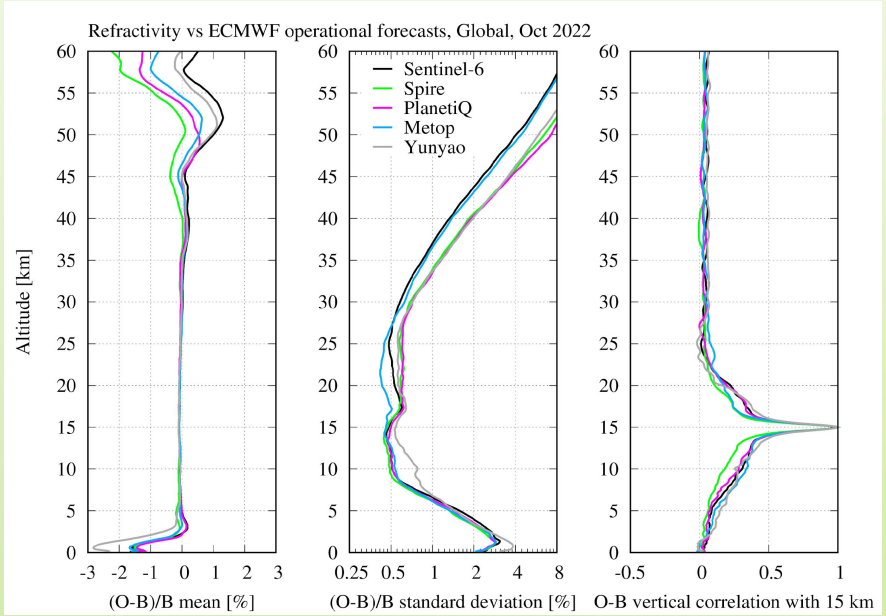




- Statistics for 10 days (20th to 29th) in December 2023
- 0.1% – 0.2% difference in biases in core region (5 km – 35 km) – which one is more right?
- The processing of PlanetiQ NRT data (NOAA-procured on EUMETCast) to resume on 18 September or shortly thereafter
- EUMETSAT Secretariat process to bending angle and ROM SAF process to refractivity (and 1D-var products)

ROMEX





- Five missions with bending angle provided by EUMETSAT, processed to refractivity at the ROM SAF
- Statistics for about 14000 occs/mission; 18 days (Sentinel-6), 12 days (Metop), 5 days (PlanetiQ), 1.4 day (Yunyao), 1 day (Spire)
- BUFR made available to NWP centers at the ROM SAF website

Upcoming ROM SAF product: Planetary boundary layer height

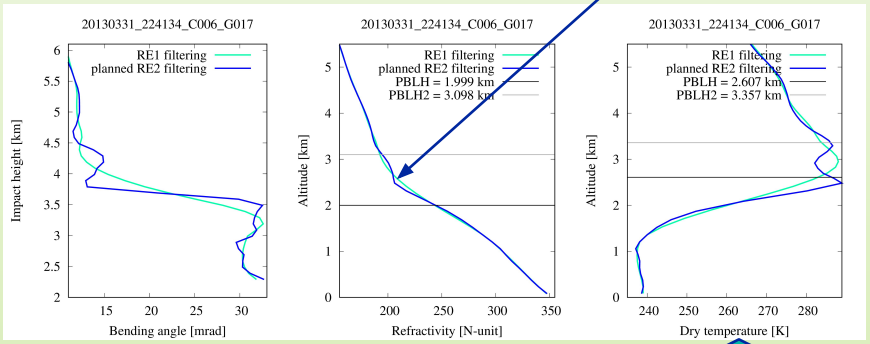
- We plan to generate planetary boundary layer height (PBLH) as part of reprocessing #2
- Later: Metop-SG and all other ROM SAF missions
- The Radio Occultation Processing Package (ROPP) has algorithms to derive the PBLH based on sharpest vertical gradients (though this may not always be the PBLH)
- Many previous RO studies base the PBLH on the maximum (negative) vertical refractivity gradient
- ROPP also provides PBLH based on bending angle and dry temperature gradients

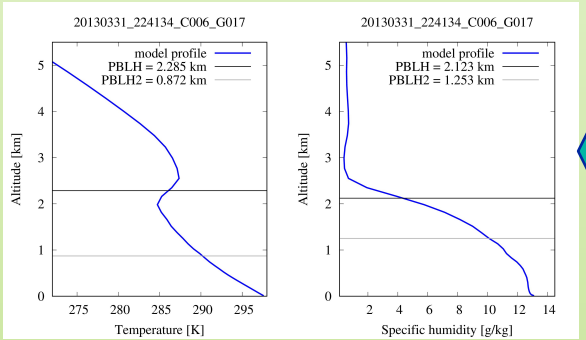
In this work (work in progress):

- Using COSMIC-1 data from April 2013 – comparing to derived PBLH from ERA-5 using the same algorithms
- Modified the algorithms in ROPP slightly (inspired by ROM SAF reports by Feiqin Xie and Ian Culverwell):
    - Raised threshold of lowest height from 300 m to 4 km (increased the finding of a valid PBLH from about 50% to about 95%, without affecting statistics too much)
    - For dry temperature: using the lowest of two Tdry local maxima (not the gradients)

Upcoming ROM SAF product: Planetary boundary layer height

Finding the maximum of Tdry: Roughly corresponds to finding the 'breakpoint' in the refractivity profile (Sokolovskiy et al. 2006)



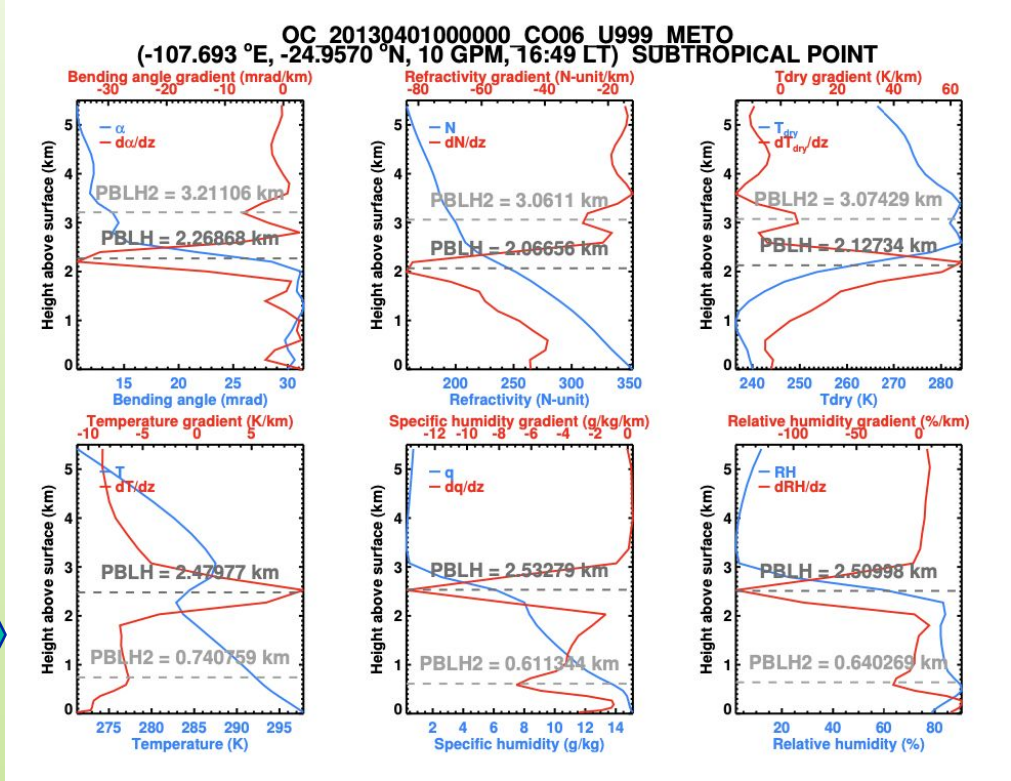


Tdry experiment

ERA5

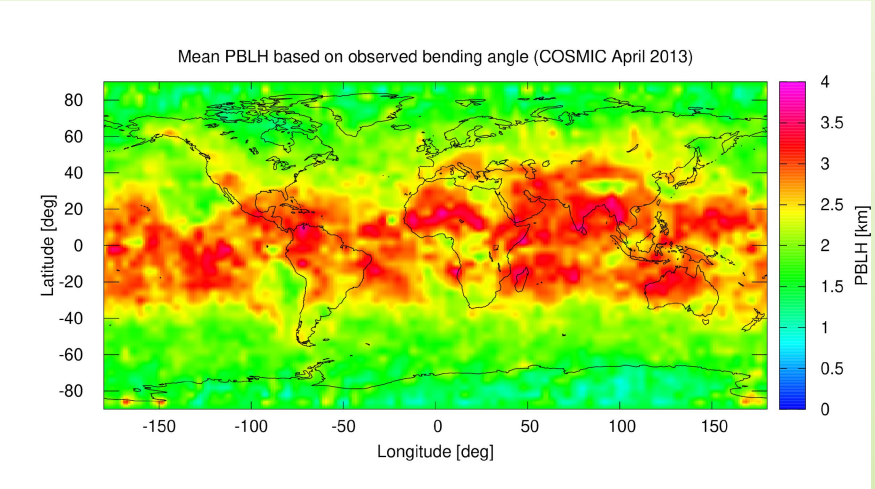
Met Office

From ROM SAF report #24 by Ian Culverwell (2016)



Mean PBLH from bending angle vertical gradients

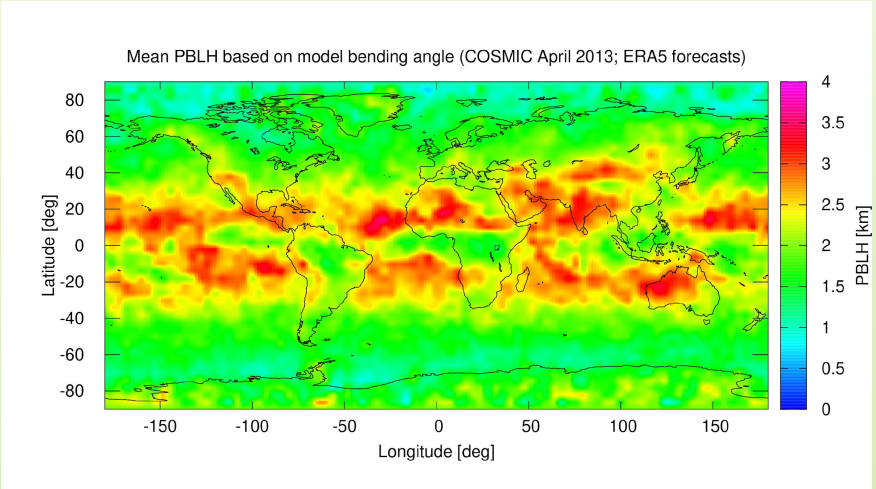
Observations



Height above surface (from ERA5 model)

Based on ROPP processing of UCAR atmPhs files

Model



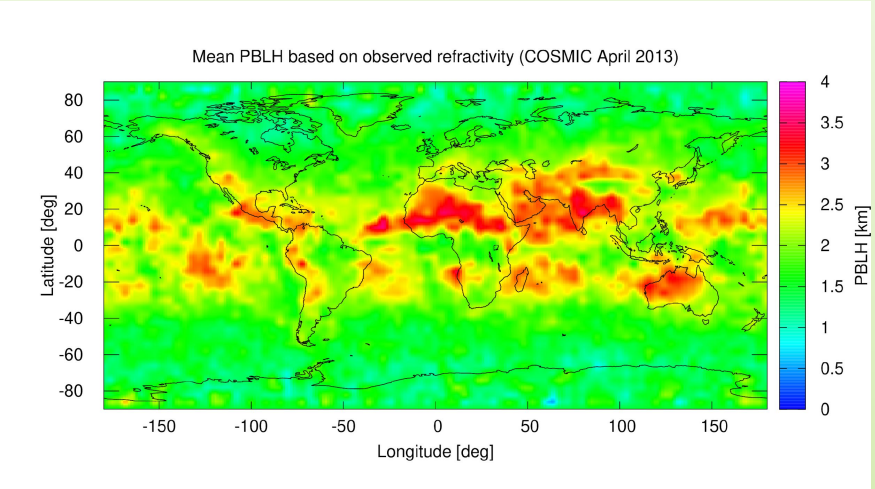
Height above surface (from ERA5 model)

Based on ROPP forward modelling at locations of occultation events using extracts from ERA5 GRIB files

- Generally larger PBLH estimates from observations than from the model, except in Antarctica

Mean PBLH from refractivity vertical gradients

Observations



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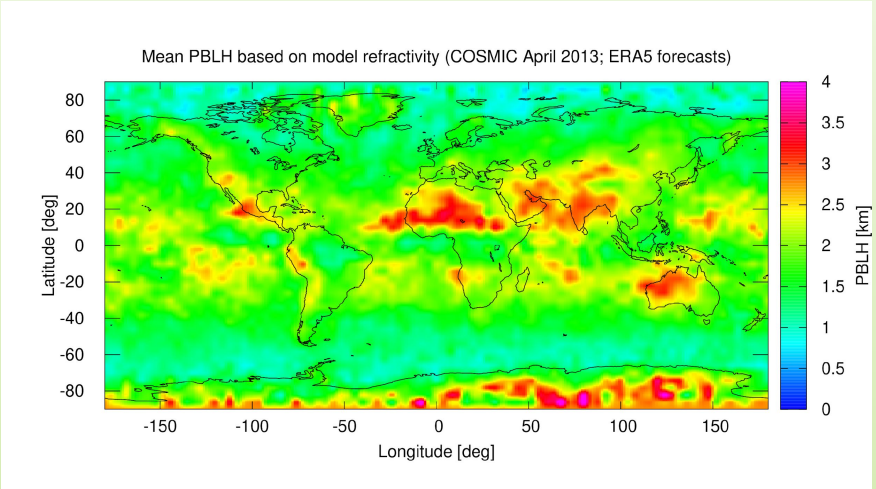


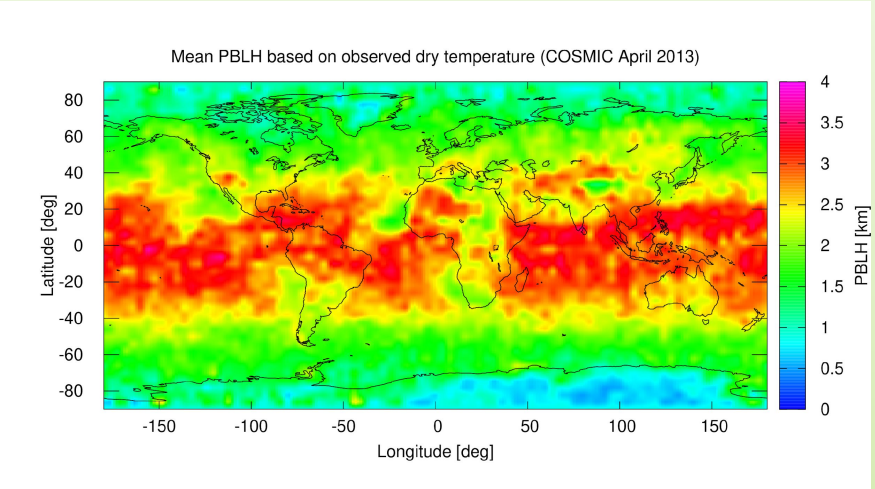
Height above surface (from ERA5 model)

Based on ROPP forward modelling at locations of occultation events using extracts from ERA5 GRIB files

- Smaller PBLH estimates using refractivity than using bending angle
- PBLH estimates from observations more similar to those from the model, except in the arctic regions

Mean PBLH from dry temperature (not using gradients)

Observations



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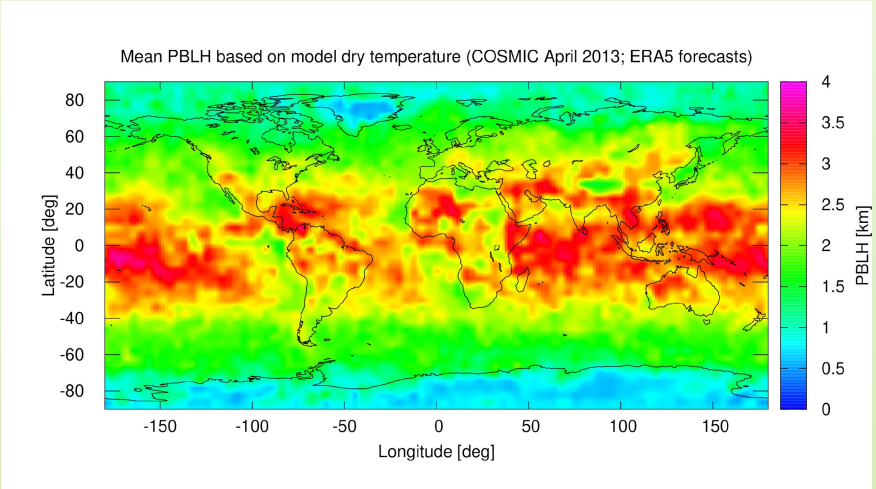
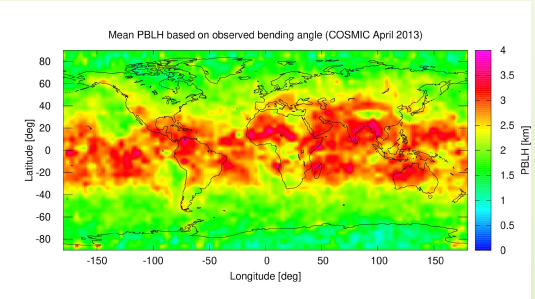


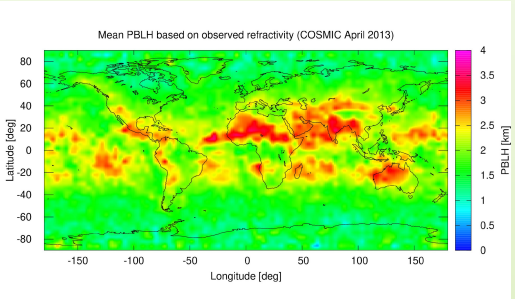
Height above surface (from ERA5 model)

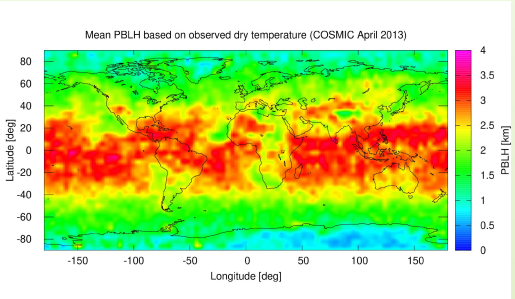
Based on ROPP forward modelling at locations of occultation events using extracts from ERA5 GRIB files

- Generally larger PBLH estimates at mid and low latitudes using dry temperature than using refractivity, but smaller in the arctic regions, especially over the ice sheets
- PBLH estimates from observations more similar to those from the model

Overview – PBLH observations vs model







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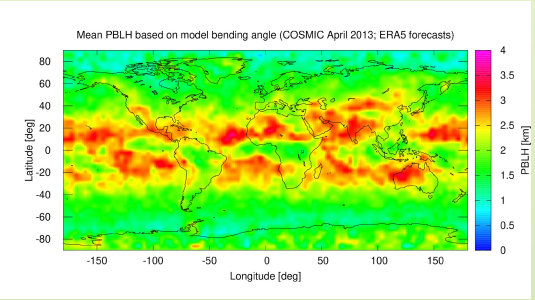

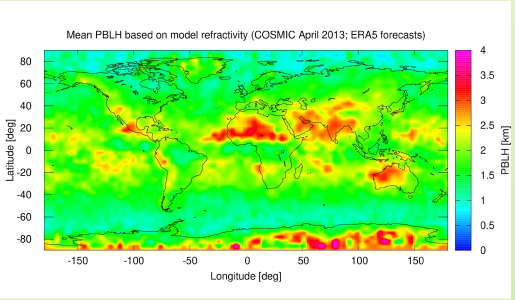

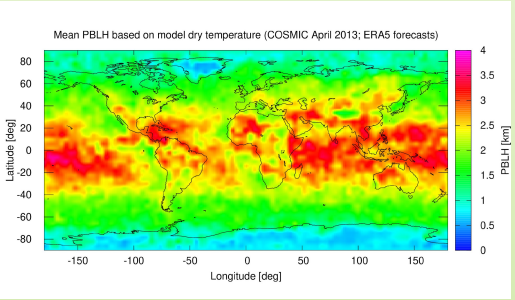

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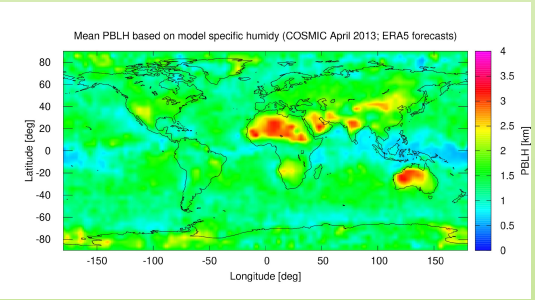

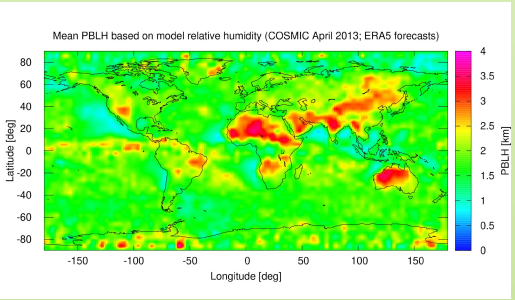

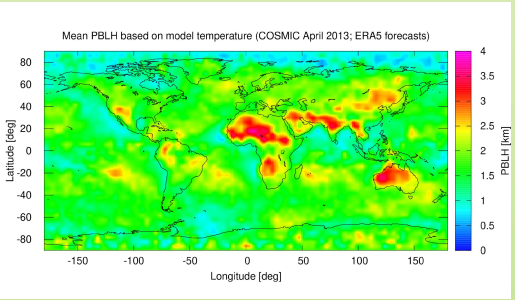

More model

Summary and conclusions

ROM SAF processing status and plans

- Metop NRT
  - ROM SAF upgraded from old GPAC 0.4 to GPAC 3.4 (and more recently to 3.6)
  - EUMETSAT upgraded from PPF 5 to PPF 6 which solved biases between rising and setting
- Commercial NRT:
  - PlanetiQ (NOAA-procured) to resume 18 September
  - Spire (NOAA-procured and EUMETSAT-procured) continues
- Also running Metop OFL/ICDR (also recently upgraded to 3.6) and Sentinel-6 NTC
  - Includes level 3 gridded products
- Planning for Reprocessing #2 with improvements and new science added
- EPS-SG to come (first launch scheduled for late 2025)

Planetary boundary layer height product

- Experimenting with using dry temperature (not using gradients)
  - Gives more similar results between observations and model (no gradient noise?)
  - Generally larger PBLH estimates at mid and low latitudes, but smaller over the arctic ice sheets
- Still in the plans: Compare to PBLH from ERA5, which is based on the bulk Richardson number