Performances and benefits of a 1D-var approach to retrieve the wet tropospheric correction: recent achievements for S3A and S3B topography missions

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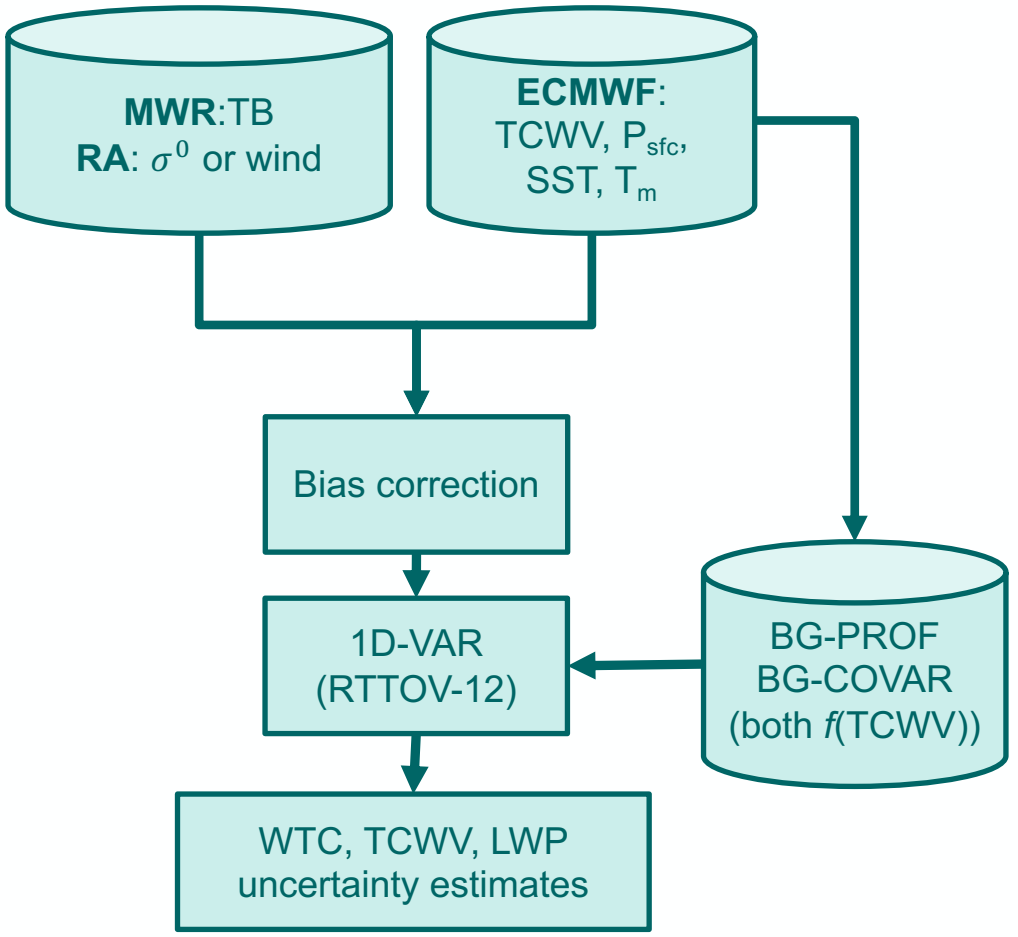
Study background

- **AMTROC / EUMETSAT (03/2019 - 12/2019)**
  - Implement 1D-VAR retrieval of TCWV and WTC above the ice-free open ocean from MWR observations onboard the S3 series
    - *Establish per-observation uncertainty*
    - *Provide per-observation quality flag*
    - *Apply to one year of S3-A data*
- **AMTROC CCN / EUMETSAT (03/2021 – 03/2022)**
  - Update and improve 1D-VAR retrieval scheme
    - *Process S3-A and S3-B full data records (from launch to 04/2021)*
    - *Evaluate against other operational/experimental products*
- **AMTROC + / EUMETSAT (09/2022 – 12/2023)**
  1. Updated background (ECMWF analysis)
  2. Synergetic use of MWR and SLSTR observations
  3. Proof of concept for Sentinel-6: 3-TBs and 6-TBs configurations

AMTROC 1D-VAR retrieval scheme



Input from S3:

MWR TBs, σ^0

Input from NWP:

SST, T, q profiles
and background error

Output:

TCWV + uncertainty
WTC + uncertainty
LWP + uncertainty

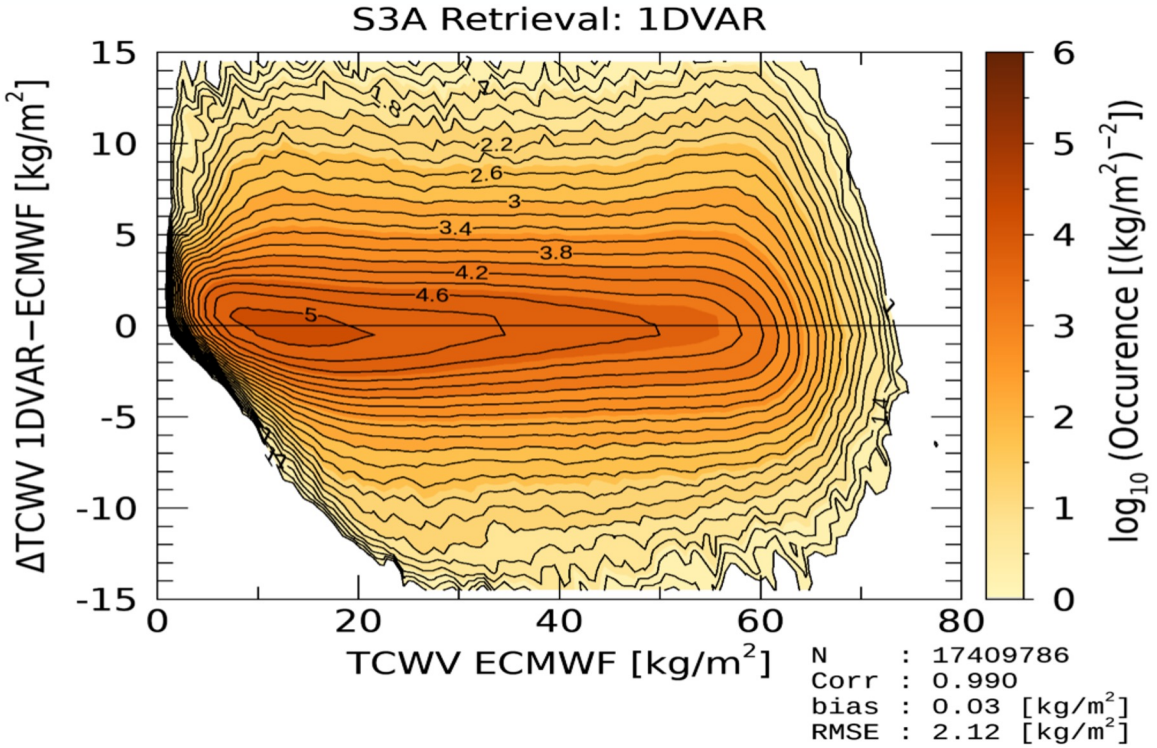
Validation

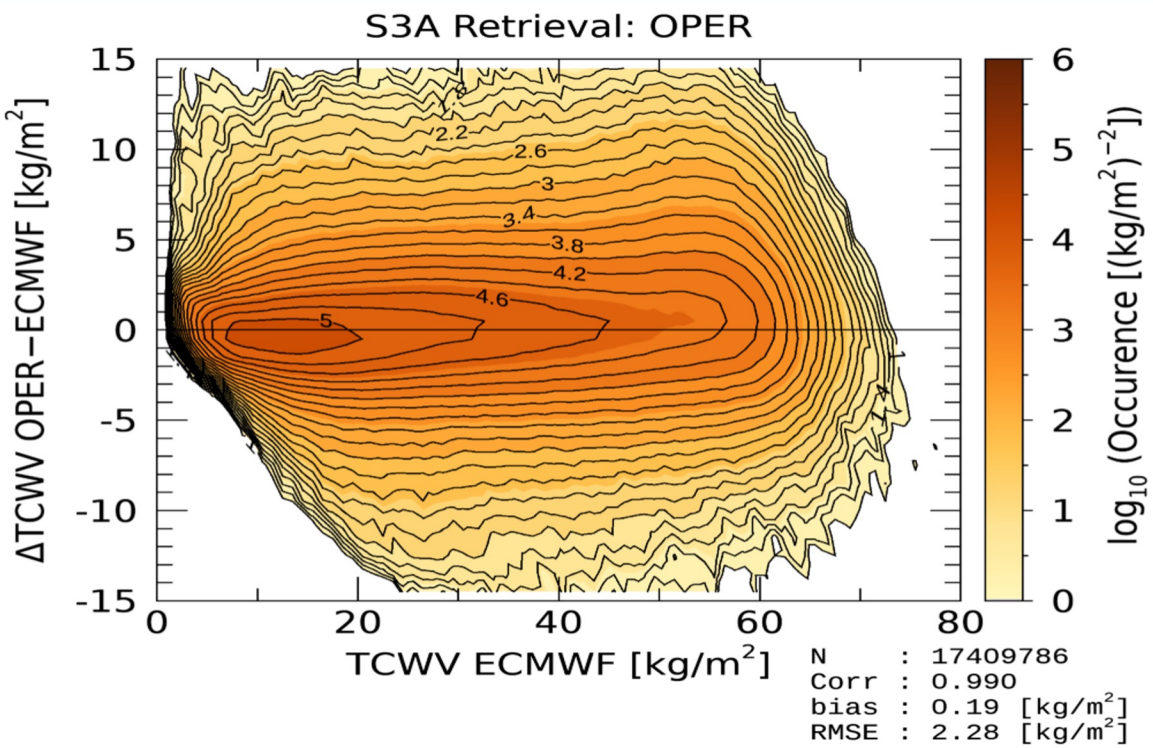
- Comparison with OPERA = S3 operational: CLS Neural Network solution:
  - Frery, M.-L., et al. (2020). Sentinel-3 Microwave Radiometers: Instrument Description, Calibration and Geophysical Products Performances. Remote Sensing, 12(16), 2590. https://doi.org/10.3390/rs12162590
  - Global semi-physical empirical approach
  - NN learning based on TB simulated from ECMWF analysis

- Compare observations for entire two-year time period against operational ECMWF analysis

➢ Stay away from land (>200 km)
➢ Stay away from sea ice (within ±55 deg)
➢ Compare 1DVAR as well as OPERA

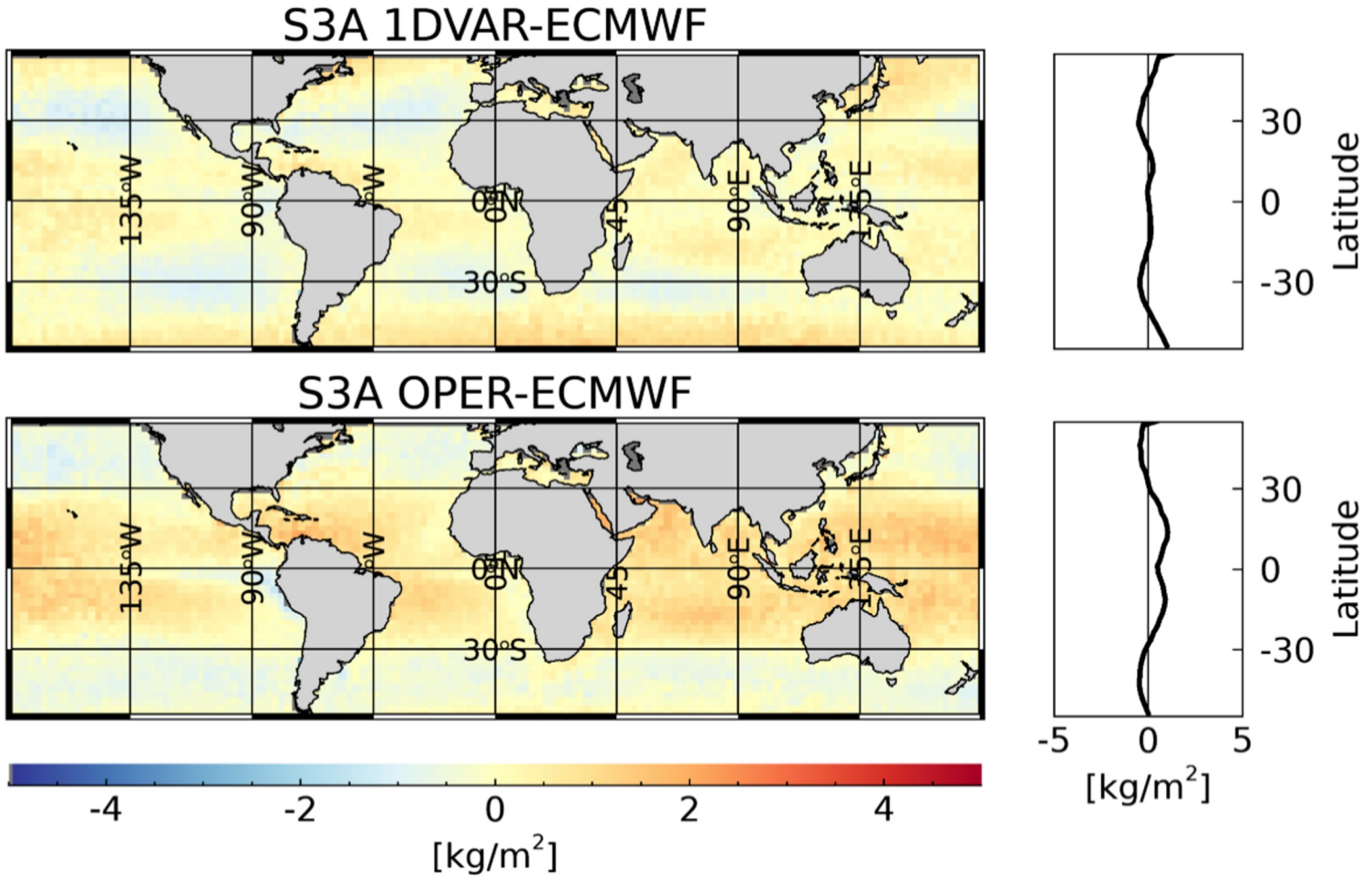
Retrieval accuracy against operational ECMWF analysis





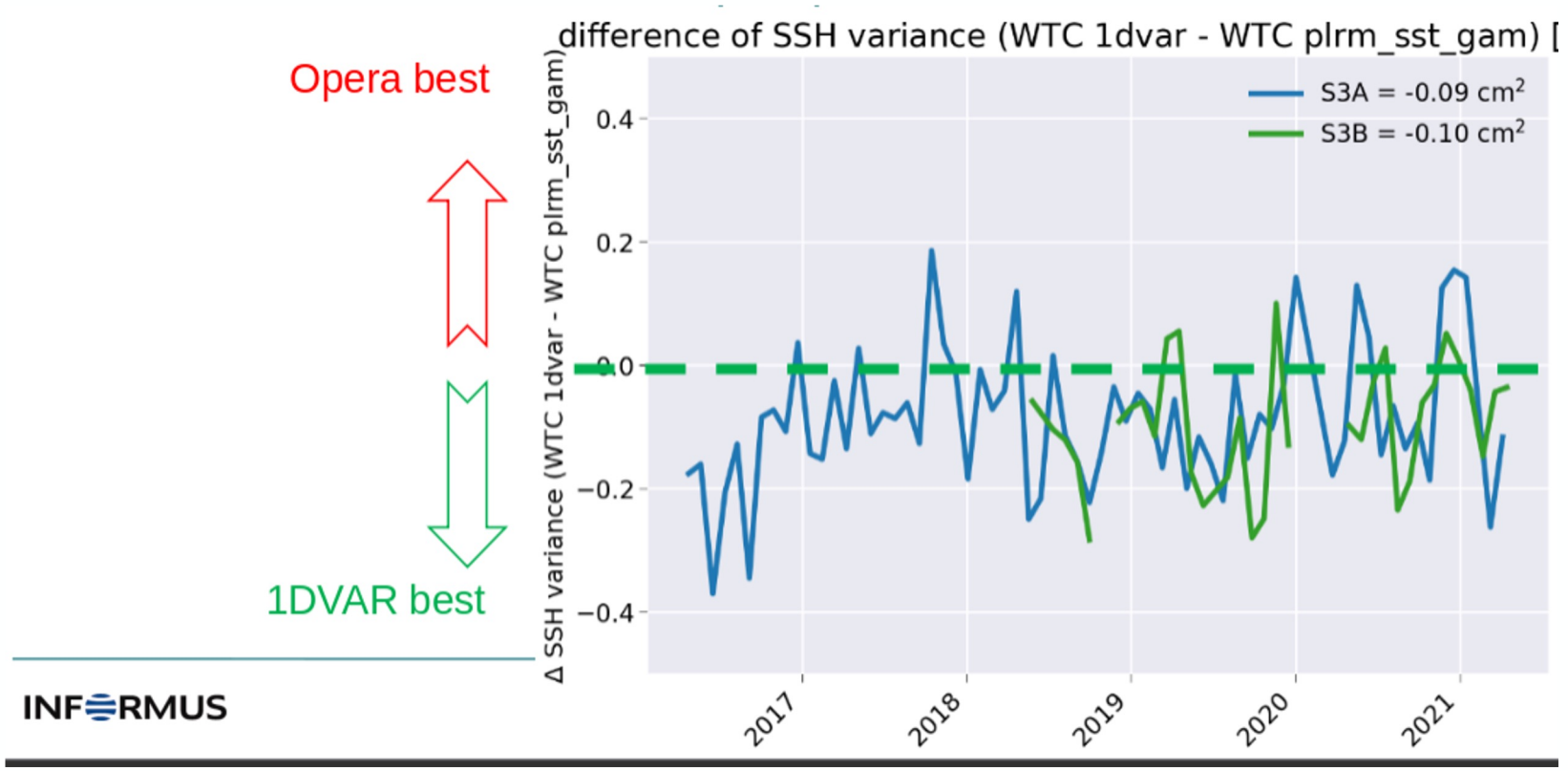
The difference between 1DVAR and ECMWF shows similar results than for OPERA and ECMWF with a slightly larger dependence on TCWV for small values and smaller dependence on the TCWV at larger values.

Retrieval accuracy against operational ECMWF analysis



The geographical distribution of the difference shows the 1DVAR is closer to the model than OPERA over sub-tropical regions but shows a larger bias at high latitudes

SSH Xover Analysis



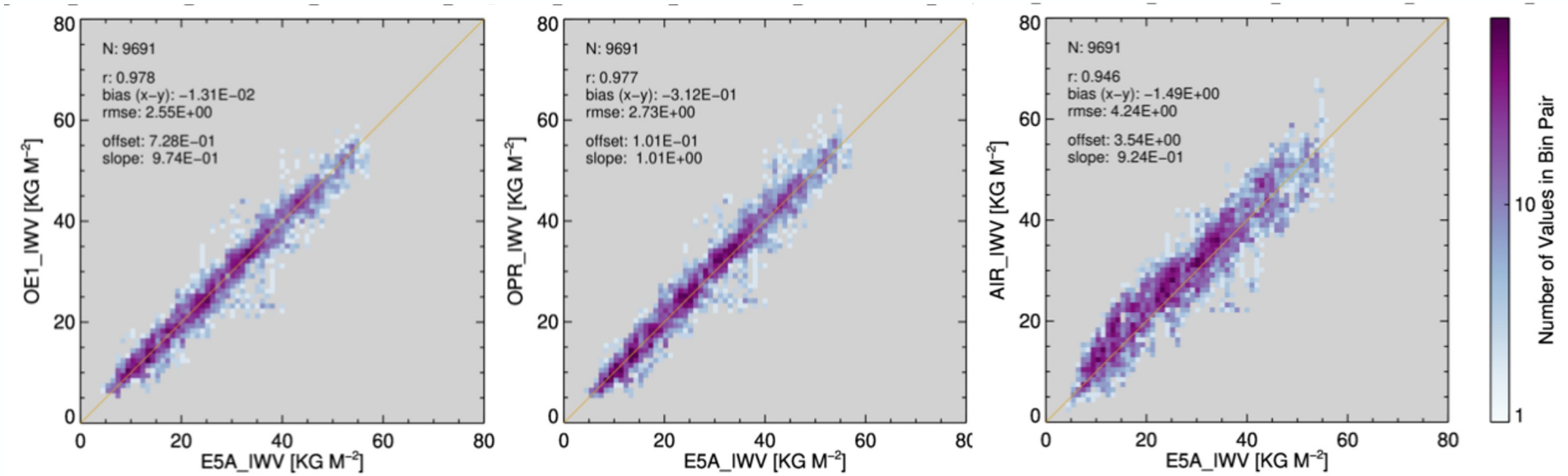
Slightly better global performance using 1DVAR

Synergetic use of MWR and SLSTR observations

- AIRWAVE (https://www.eumetsat.int/AIRWAVE-SLSTR)
- The AIRWAVE algorithm has been designed to obtain the TCWV from the measurements of the Along Track Scanning Radiometer (ATSR) instrument series (Casadio et al., Castelli et al.).
- The algorithm, independent from external constrains, makes use of a set of tabulated parameters, calculated off-line using a Radiative Transfer Model (RTM) specifically developed to simulate the ATSR radiances.
- The approach exploits the clear sky Brightness Temperature measured over the sea in forward and nadir directions in the TIR channels.

Synergetic use of MWR and SLSTR observations

- Analyses over open ocean: comparison to ERA5



Statistics summary for 13 [14] November 2020. N = 9691.

The comparison to ERA5 shows very similar results for 1DVAR and OPERA
Biases and RMSE are larger for AIRWAVE

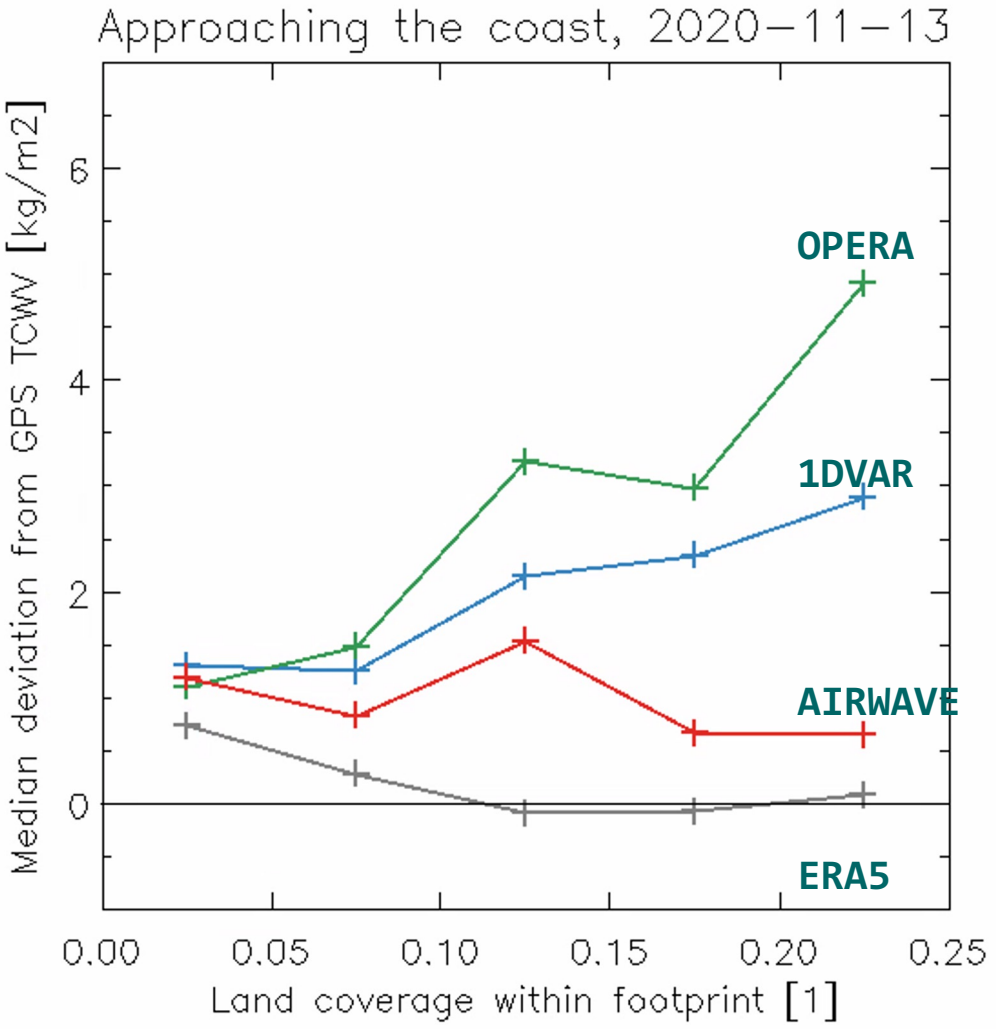
Synergetic use of MWR and SLSTR observations

Coastal area

ERA-5, AIRWAVE:
Not affected by land contamination

1DVAR, OPERA:
Significant land contamination
above ca. 5-10 % land coverage

Limited sample
(esp. AIRWAVE)



Conclusion

- An updated version of the 1dvar solution based on ECMWF analysis proved to be slightly better than the previous version
  - still slightly better than the operational product at global scale
  - but the global scale hides contrasted regions where OPERA or 1dvar alternatively performs better
- A user friendly reprocessing-ready code has been delivered to EUMETSAT
- Synergetic use of MWR and SLSTR observations
  - a collocation software is developed and validation over 1 day of data
  - synergetic use could help (clear sky condition)
    - SLSTR validation and future development
    - MWR retrievals improvement over coastal areas
- On-going activity:
  proof of concept of the benefit of 1DVAR over the 3-TB configuration of Sentinel-6.

Meteosat-8, 15 January 2006, 15:30 UTC
Channel 05 (WV6.2)
Source: EUMETSAT

Thank you for your attention

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