AIRWAVE-SLSTR: The AIRWAVE algorithm extension to Sentinel 3 SLSTR measurement and the quality of the Water Vapor Columns retrieved over water surfaces

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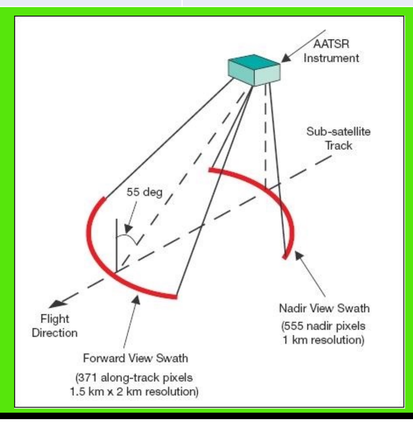
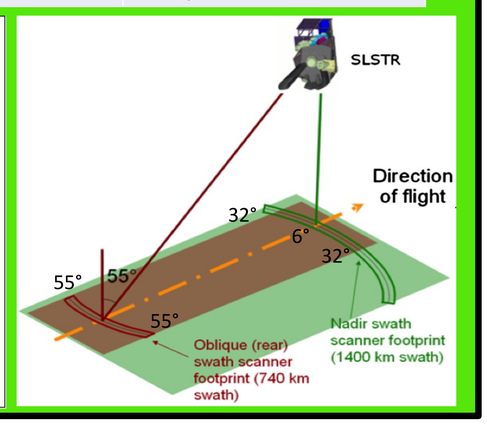
Abstract

The Advanced Infra-Red WAter Vapor Estimator (AIRWAVE) is an algorithm designed to obtain the Total Column of Water Vapor (TCWV) from the satellite measurements of the Along Track Scanning Radiometer (ATSR) instrument series. In the frame of EUMETSAT project AIRWAVE-SLSTR (https://www.eumetsat.int/AIRWAVE-SLSTR), the AIRWAVE algorithm has been extended to the measurements of Sea and Land Surface Temperature Radiometer (SLSTR), an advanced version of ATSR which is on board the Copernicus Sentinel 3 satellite. AIRWAVE has the unique capability to retrieve TCWV over water surfaces for cloud-free scenarios using the SLSTR TIR channels, and therefore in both day and night-time, covering all the water surfaces of the Earth. The Application of AIRWAVE to SLSTR, together with the TCWV data obtained from (A)ATSR measurements will create a long time series of TCWV data derived with the same algorithm. Here we will show both the new implementation and the performances of the AIRWAVE algorithm applied to SLSTR measurements using the results of the validation performed with independent products measured by space borne sensors Special Sensor Microwave-Imager/Sounder (SSMI/S) and Micro-Wave Radiometer (MWR) and in situ measurements from Integrated Global Radiosonde Archive (IGRA database).

Observation geometry

	ATSR	SLSTR
Viewing geometries	nadir/forward	nadir/oblique
Across track positions	512 both nadir and forward	1500 nadir; 900 oblique



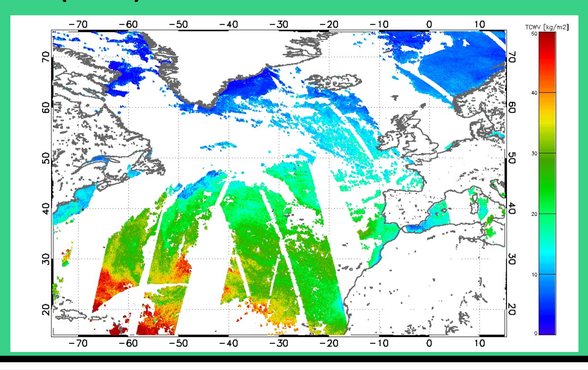


AIRWAVE-SLSTR ALGORITHM

New pre-computed parameters for the retrieval:

- New CO_2 and CFCs climatology, accounting for their trends over the years.
- New viewing geometry of SLSTR with respect ATSR.
- New Spectral Response Functions (SRF).

TCWV retrieved by AIRWAVE between 12:00 and 23:59 UTC of 03/10/2020



AIRWAVE vs IGRA STATIONS

Maximum allowed distance (between IGRA station and SLSTR measurement) is **100 km.**

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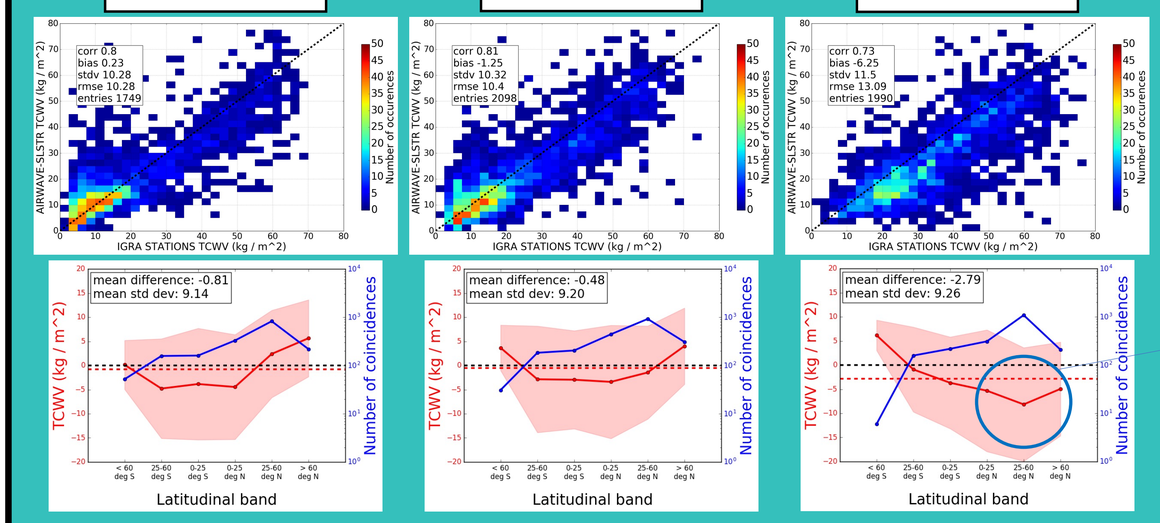

Worst agreement in July at the mid-latitudes of the NH

General good agreement between AIRWAVE and IGRA stations.

AIRWAVE vs SSMI/S

We used SSMI/S F17 satellite products because they properly cover the entire S3 SLSTR mission period.

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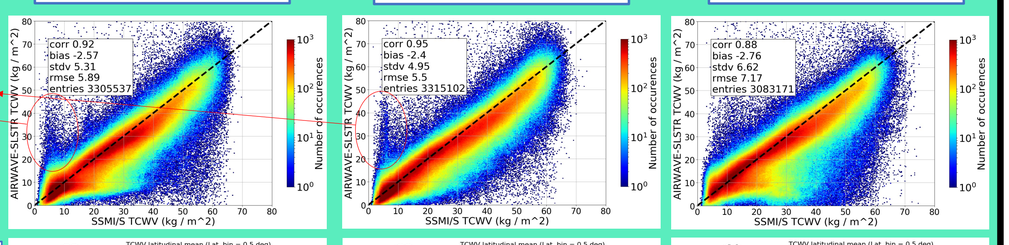
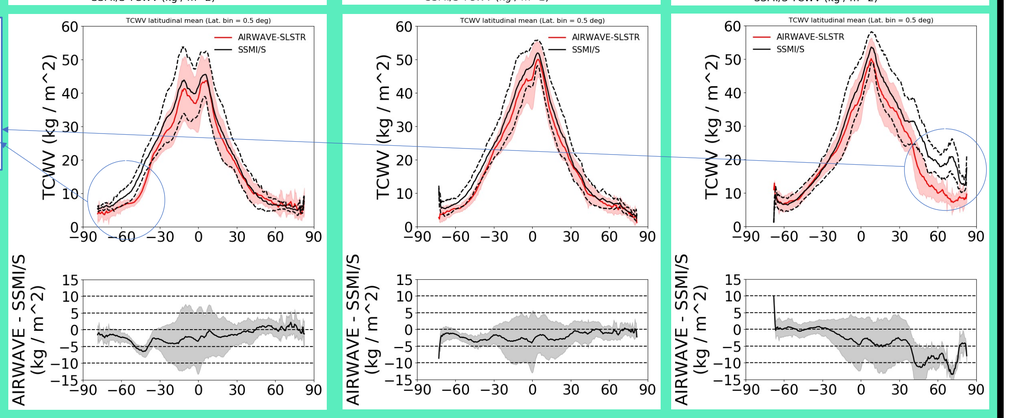
Not perfect cloud filtering



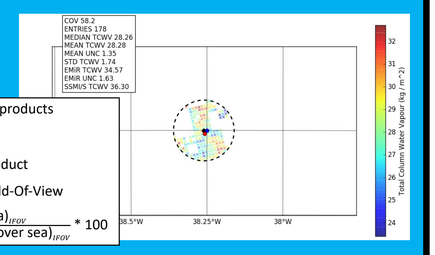
Worst agreement in the summer hemispheres



AIRWAVE-SLSTR TCWV is highly correlated with SSMI/S product, reproducing accurately the TCWV latitudinal variability.

AIRWAVE vs EMiR-MWR

Triple co-location between AIRWAVE-SLSTR, EMiR-MWR and SSMI/S



- **Red dot**: Barycentre of the geographical distribution of the products
- **Black dot**: Centre of the MWR Instantaneous Field-Of-View
- **Blue dot**: Grid point (0.25 deg x 0.25 deg) of the SSMI/S product
- **Dashed line**: Approximation of the MWR Instantaneous Field-Of-View
- $\mathbf{COV_{IFOV}} = \frac{(\text{N of clear-sky AIRWAVE products over sea})_{IFOV}}{(\text{Sum of cloudy and clear-sky AIRWAVE products over sea})_{IFOV}} * 100$

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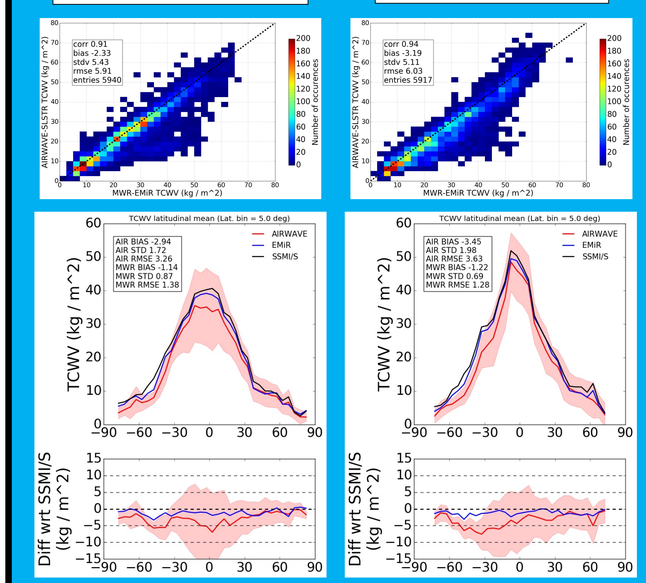
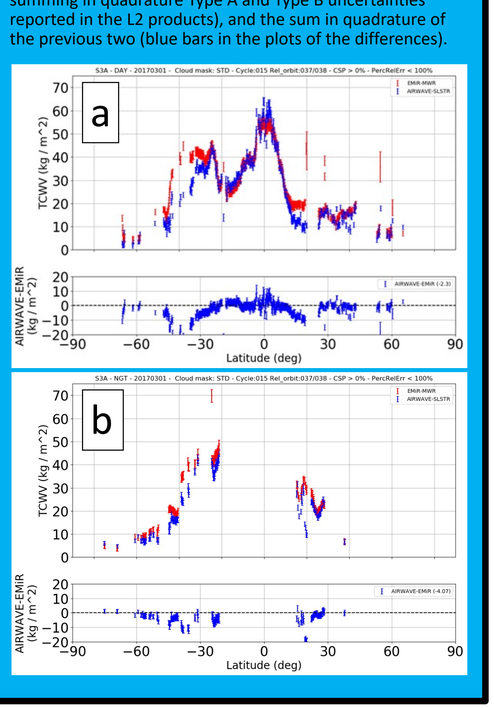


Example of the inter-comparison between AIRWAVE-SLSTR (blue line) and EMiR-MWR (red line) TCWV products for day-time (a, over Atlantic ocean) and night-time part (b, over Pacific ocean) of the orbit 015_037/038 (1st March 2017). The error bars represent the EMiR-MWR uncertainty reported in the L2 products (blue bars), the mean of the AIRWAVE-SLSTR products uncertainties within the MWR IFOV (red bars) (the uncertainty for the single AIRWAVE product is calculated summing in quadrature Type A and Type B uncertainties reported in the L2 products), and the sum in quadrature of the previous two (blue bars in the plots of the differences).



Conclusions

- General good agreement between AIRWAVE and SSMI/S, IGRA and Emir-MWR.
- AIRWAVE-SLSTR correctly reproduces the features of the TCWV latitudinal distribution.
- On average, presence of dry bias between the AIRWAVE-SLSTR and SSMI/S (mean bias of -2.4 kg/m^2), EMiR – MWR (-2.7 kg/m^2) and IGRA (-2.3 kg/m^2).
- Dry bias is larger in the Summer hemispheres but can be cured with parameters computed using a new climatology estimated only over water surfaces.
- We attribute part of the average bias to the different atmospheric penetration of the TIR channels wrt MW. Investigation on other causes is ongoing.
- Application of AIRWAVE-SLSTR on the full SLSTR-A and B is ongoing.