Exploiting the high spatial resolution of AIRWAVE TCWV data to retrieve the WTC for coastal altimetry in view to its application to Sentinel-3

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Outline

- Motivation, objective and study area
- GPD+ algorithm and WPD datasets
- AIRWAVE WTC dataset assessment
- GPD+ WTC with AIRWAVE for ENVISAT
- Overall summary and future work

Motivation and objective

- **Research funded by IDEAS+ project**

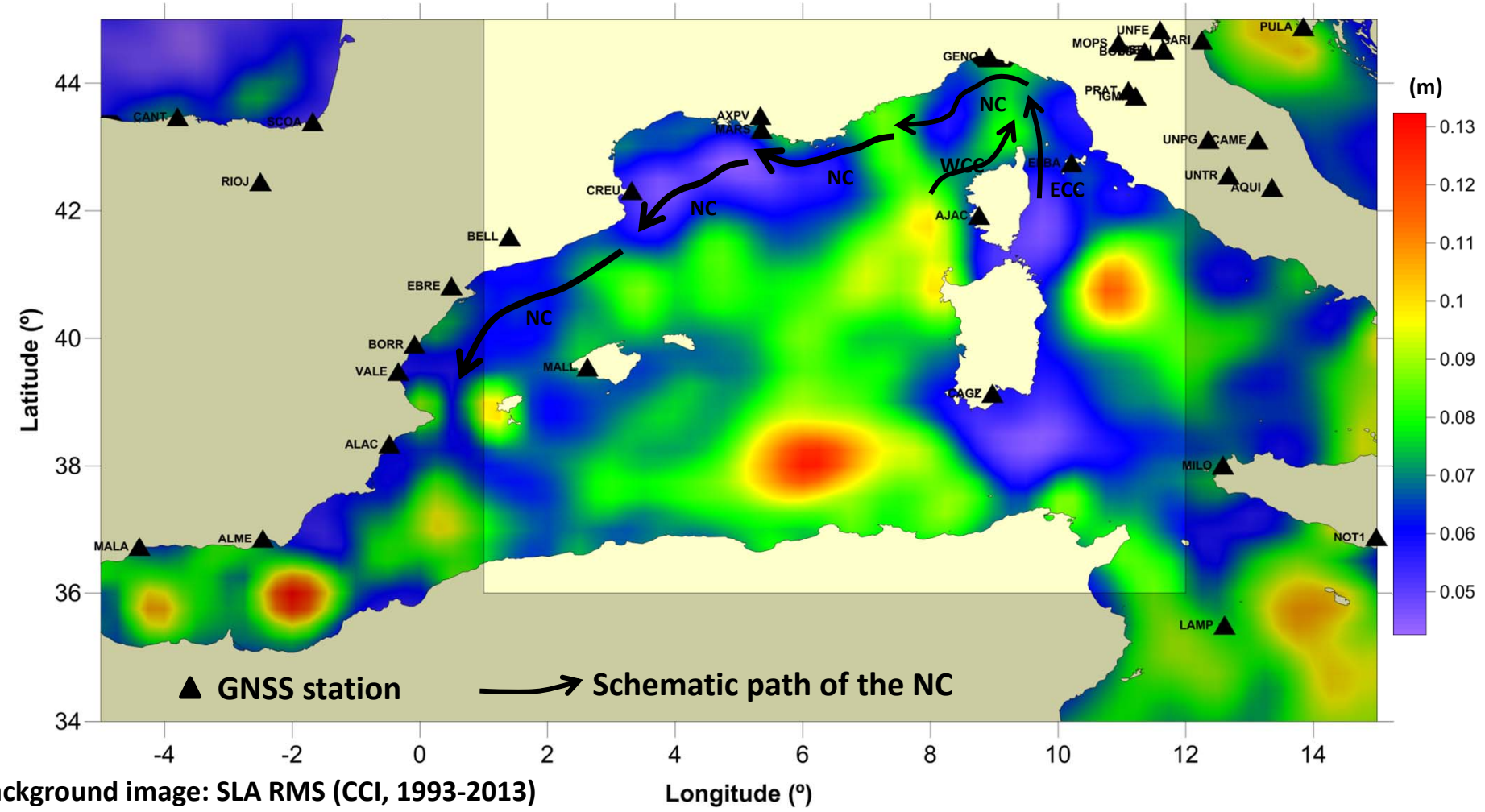
- **Motivation**

  - Are AIRWAVE (Advanced InfraRed WAter Vapor Estimator) TCWV data useful for coastal altimetry applications?

- **Objective**

  - To develop, analyze and validate a GPD+ Wet Tropospheric Correction (WTC) computed with AIRWAVE data.

Study region



Background image: SLA RMS (CCI, 1993-2013)

GPD+ algorithm and WPD datasets: GPD+

- Optimal interpolation (OI) of all available wet path delay observations to estimate the WTC for those along-track points with an invalid MWR-derived correction.

- Applies improved criteria to detect invalid MWR measurements.

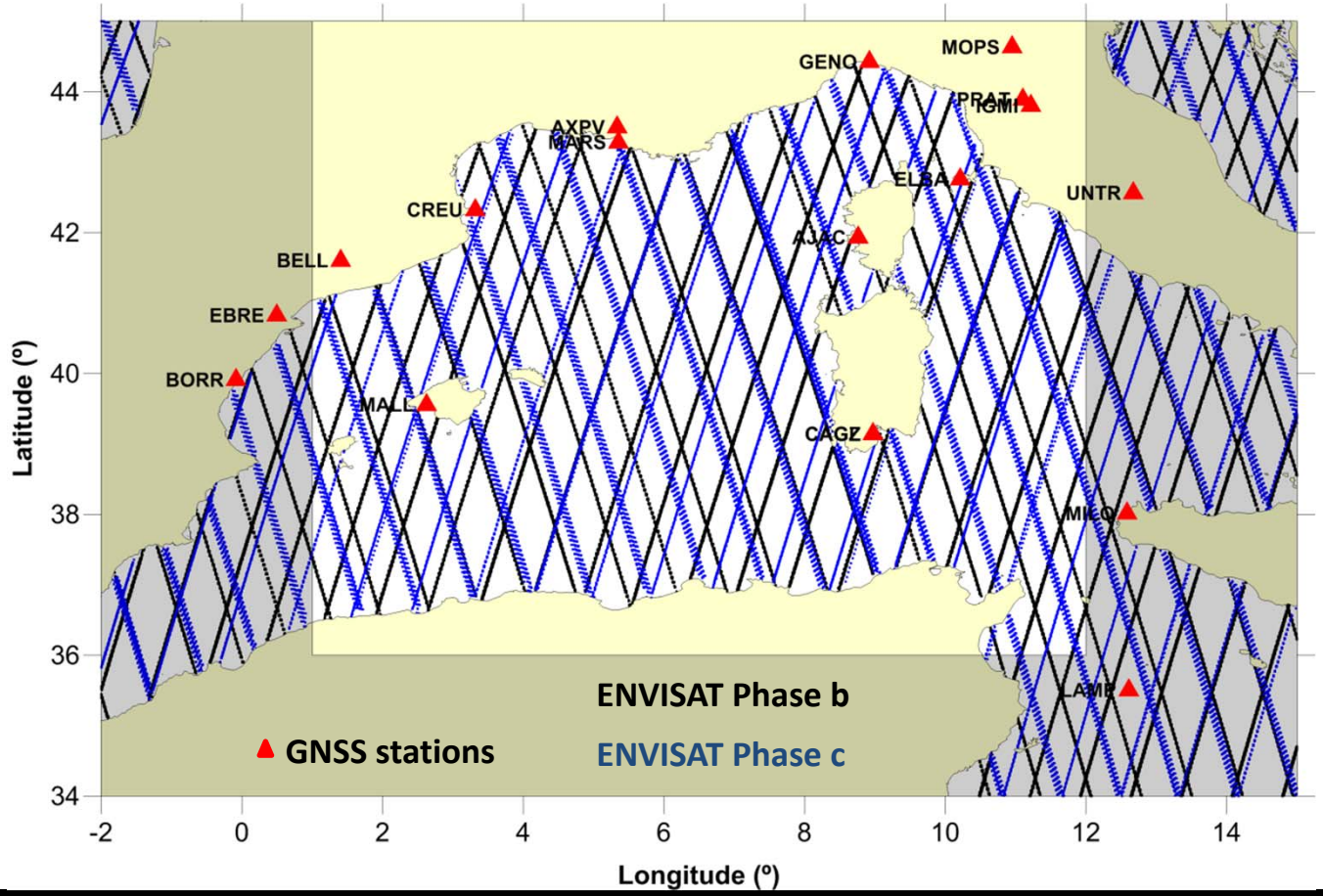
- Assigns different white noise to each dataset.

- The GPD+ WTC is:
  - a new WTC estimate from OI for those points with invalid MWR measurements, when observations are available;
  - the first guess (WTC from a NWM) for those points with invalid MWR measurements, in the absence of observations;
  - the MWR-derived WTC whenever it exists and is valid.

- GPD+ can estimate the WTC for all along-track points using all or just a selected set of available data sets (e.g., only AIRWAVE) → comparison with co-located MWR valid measurements.

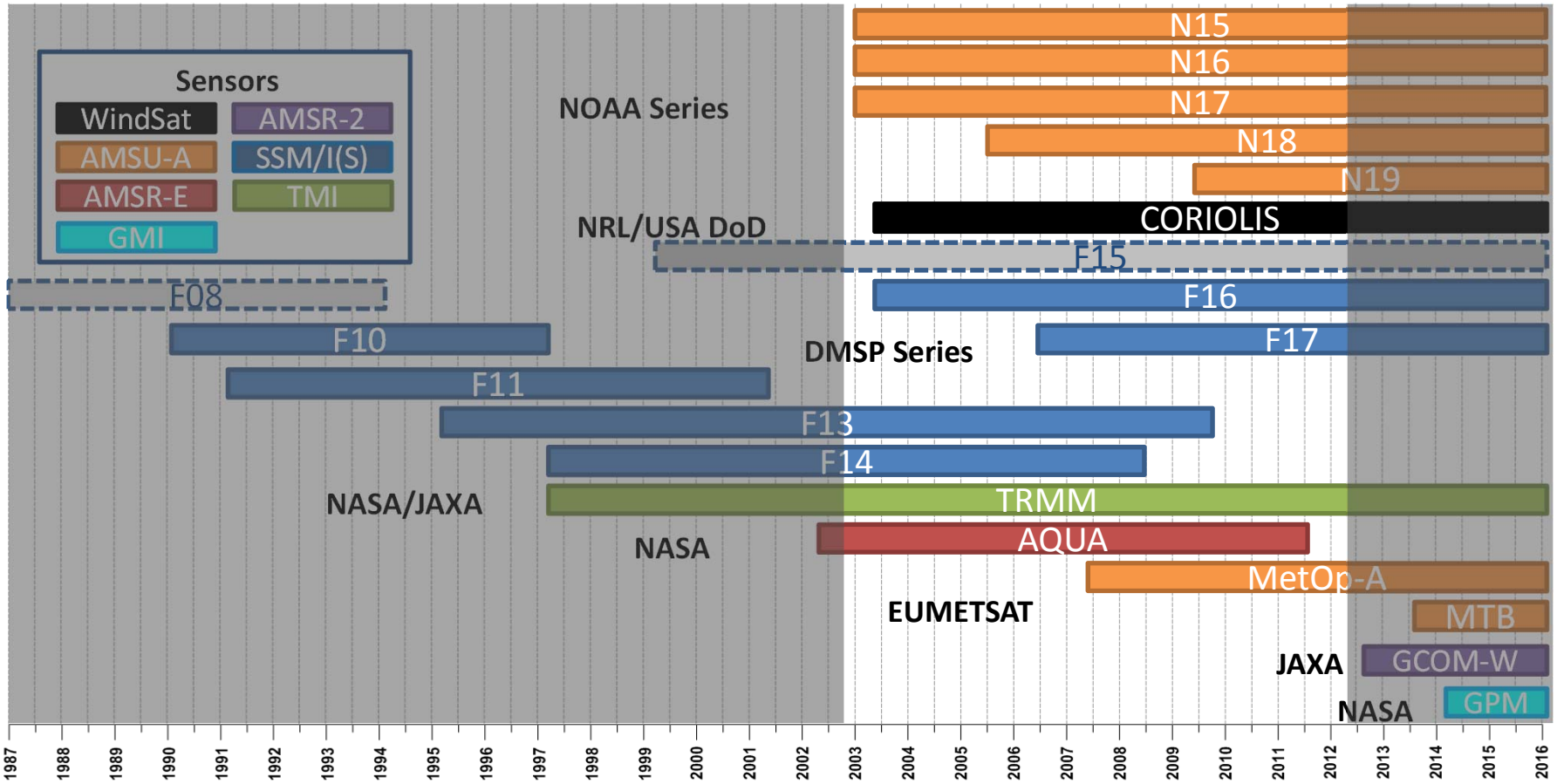
GPD+ algorithm and WPD datasets: MWR and GNSS

- WPD from the MWR on board ENVISAT: cycles 10 to 113 (SL_cci, Reproc. V3.0)
- WPD from 18 GNSS stations



GPD+ algorithm and WPD datasets: SI-MWR

- WPD from TCWV dataset of 14 Scanning Imaging MWR (SI-MWR
- All radiometers calibrated w.r.t. SSMI/SSMI(S)



GPD+ algorithm and WPD datasets: AIRWAVE

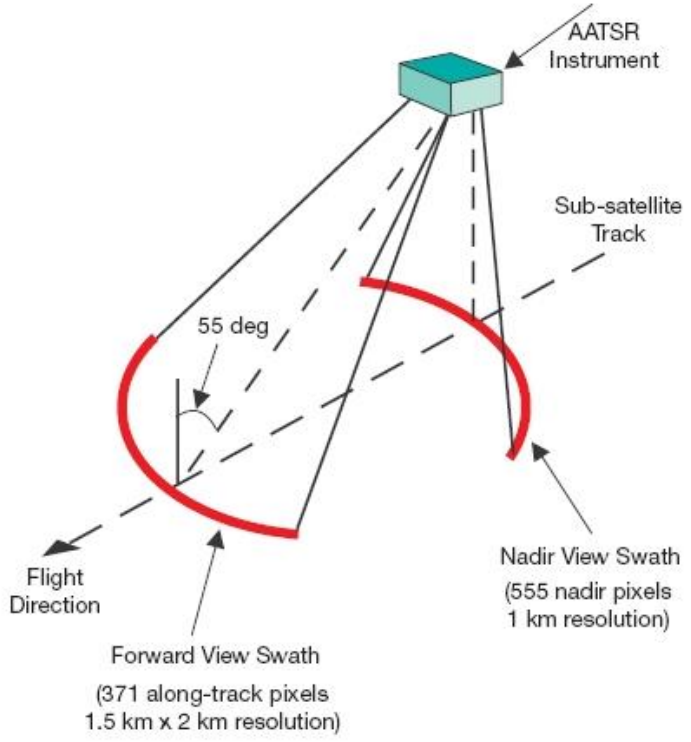
• **WPD from the AIRWAVE TCWV V2 dataset retrieved from the Along-Track Scanning Radiometer (ATSR) on board ERS-1/2 and ENVISAT.**

Pros

- Dual view capability (0° and 55°)
- Stable orbit tracks (ANX 10:00pm, 10:30pm)
- TIR channels calibrated on-board (BB)
- **High spatial resolution: 1x1 km²**
- **Data available up to the coast and acquired along the ENVISAT tracks**

Cons

- **Small swath (500 km across track)**
- Only 10.8 and 12 µm BTs always available (day and night)



- **Advanced InfraRed WAter Vapor Estimator (AIRWAVE) retrieval scheme:**

  - uses the instrument physical characteristics (slit (filter) functions), in combination with advanced radiative transfer models (RTM) and a spectral sea surface emissivity database;

  - exploits the ATSR dual view capabilities.

- **AIRWAVE uses a set of tabulated retrieval parameters:**

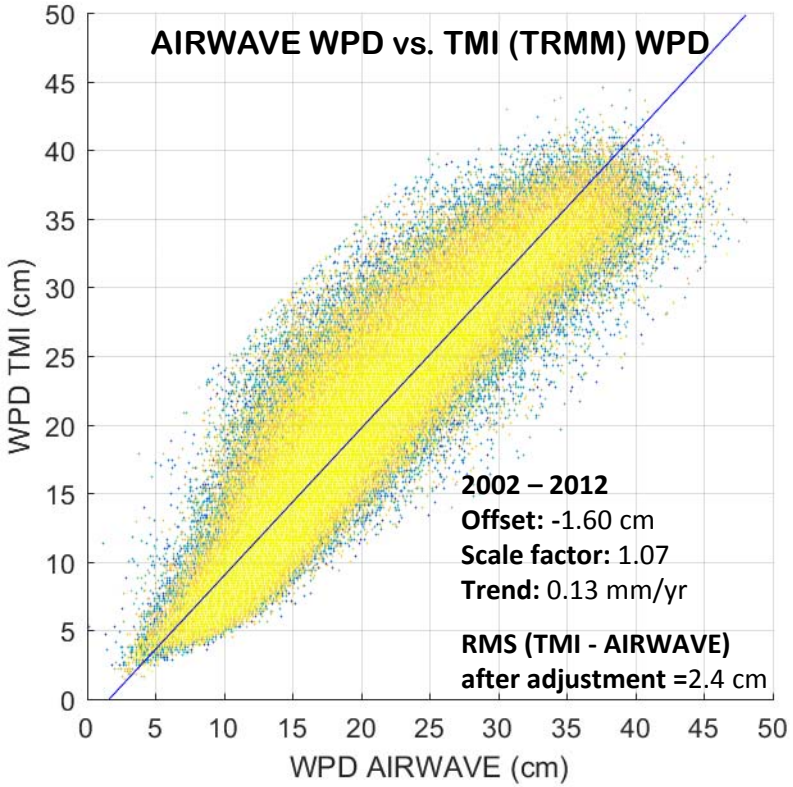
  - in V1, retrieval parameters are time independent and fixed for the whole globe;

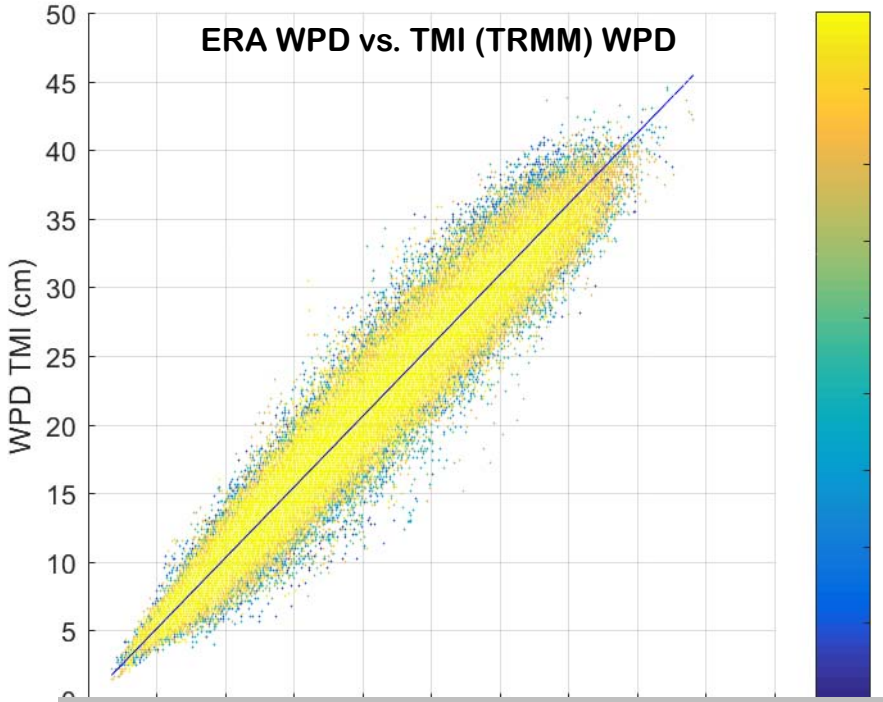
  - in V2, these parameters are calculated accounting for different scenarios using LUTs and multi-linear interpolation (space and time);

  - LUTs are estimated from a climatological dataset, making **AIRWAVE TCWV totally independent from any other TCWV products**.

AIRWAVE WTC dataset assessment

- **Match points between TMI and AIRWAVE data:**
  - **Global analysis;**
  - **Only points with a $\Delta T < 45$ min and $\Delta D < 50$ km were considered;**





→ **No calibration was applied to AIRWAVE data.**
→ **AATSR stable over the period of analysis.**

GPD+ with AIRWAVE for ENVISAT

- **GPD+ solutions:**
  - AIRWAVE only (all along-track points);
  - MWR + GNSS + SI-MWR + AIRWAVE;
  - MWR + GNSS+ SI-MWR (reference solution, previously validated, e.g. SL_cci).

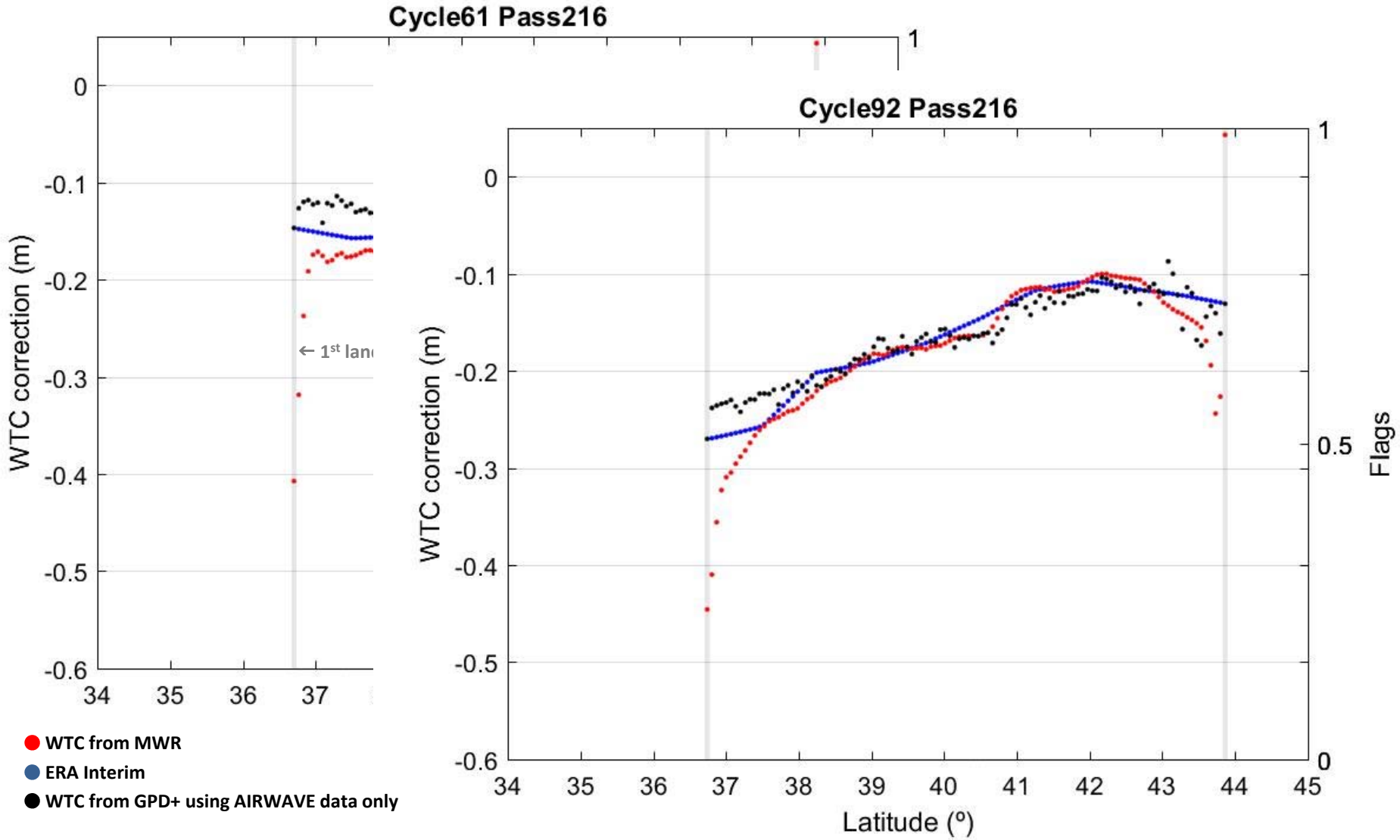
- **Remarks:**

- AIRWAVE data selected in a buffer of 40 km centred at the ENVISAT tracks;
- White noise of AIRWAVE WTC: 1 cm.
- SI-MWR used for distances to coast > 30 km (same criterion as the one used to generate the reference solution).

- **SLA variance difference analyses (GPD-ERA & GPD-MWR):**

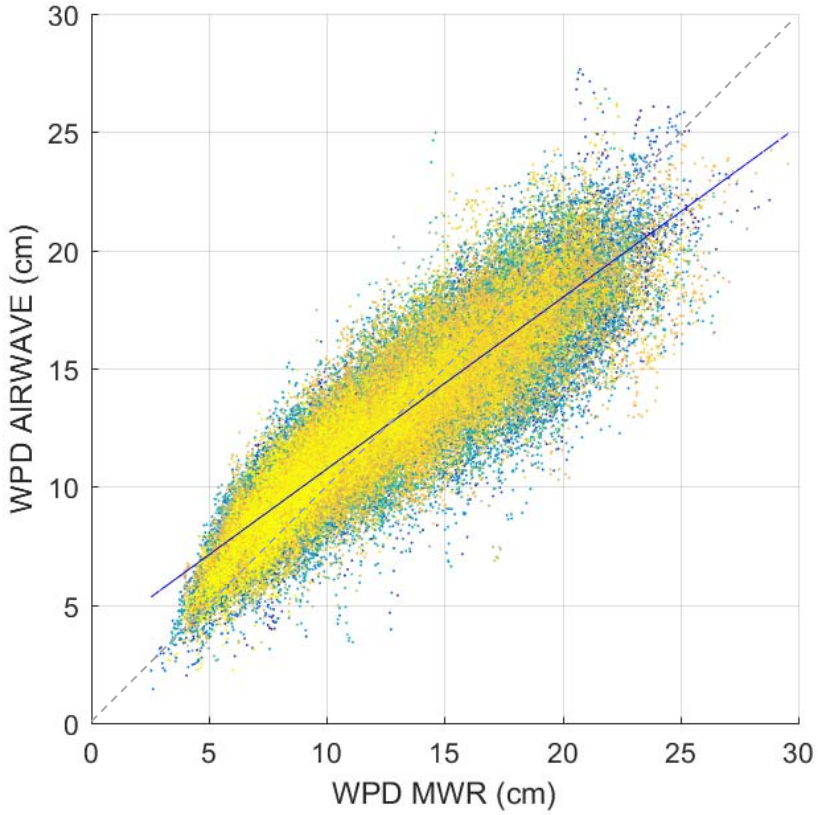
- cycle by cycle;
- spatial analysis;
- function of the distance from coast.

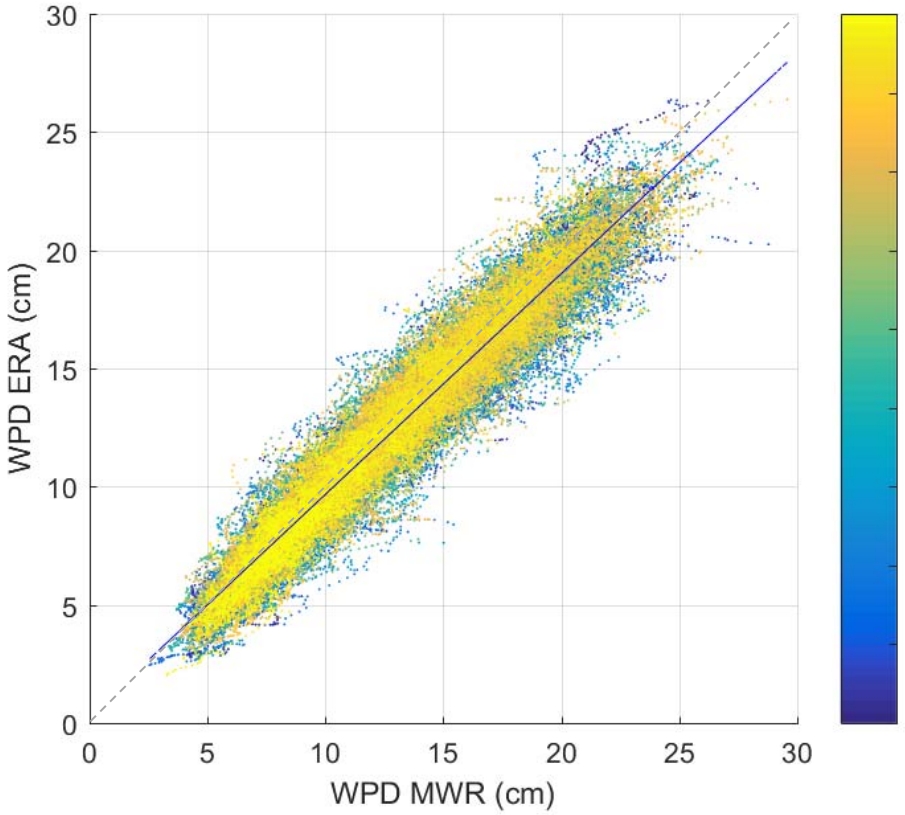
- **GPD+ WTC with AIRWAVE data only: examples of the correction**



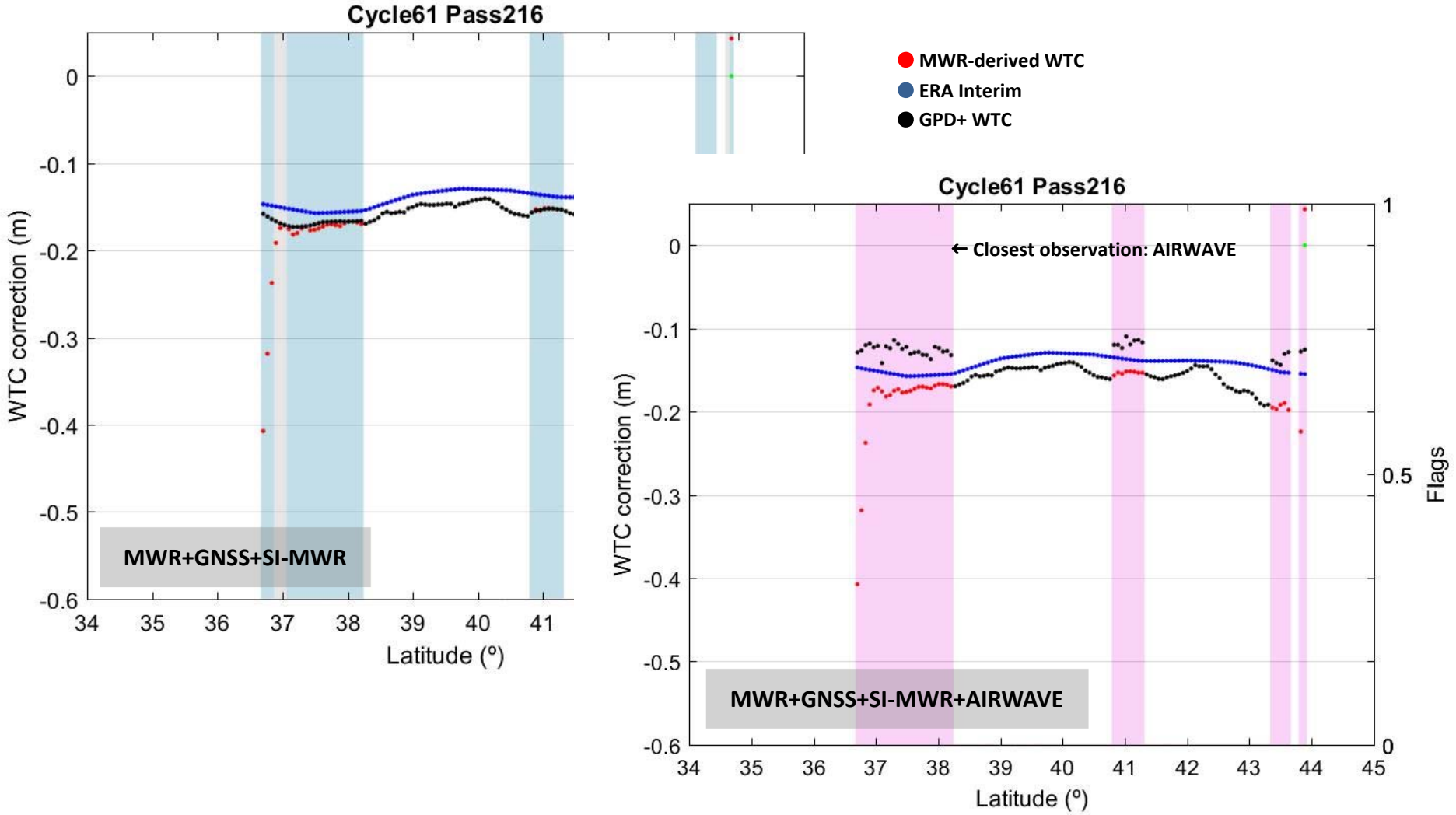
• **GPD+ with AIRWAVE data only: Comparison AIRWAVE WTC - MWR/ERA WTC for ENVISAT cycles 10-113**

→ Only for along-track points (124092) with an estimated GPD+ WPD and valid MWR-derived WPD

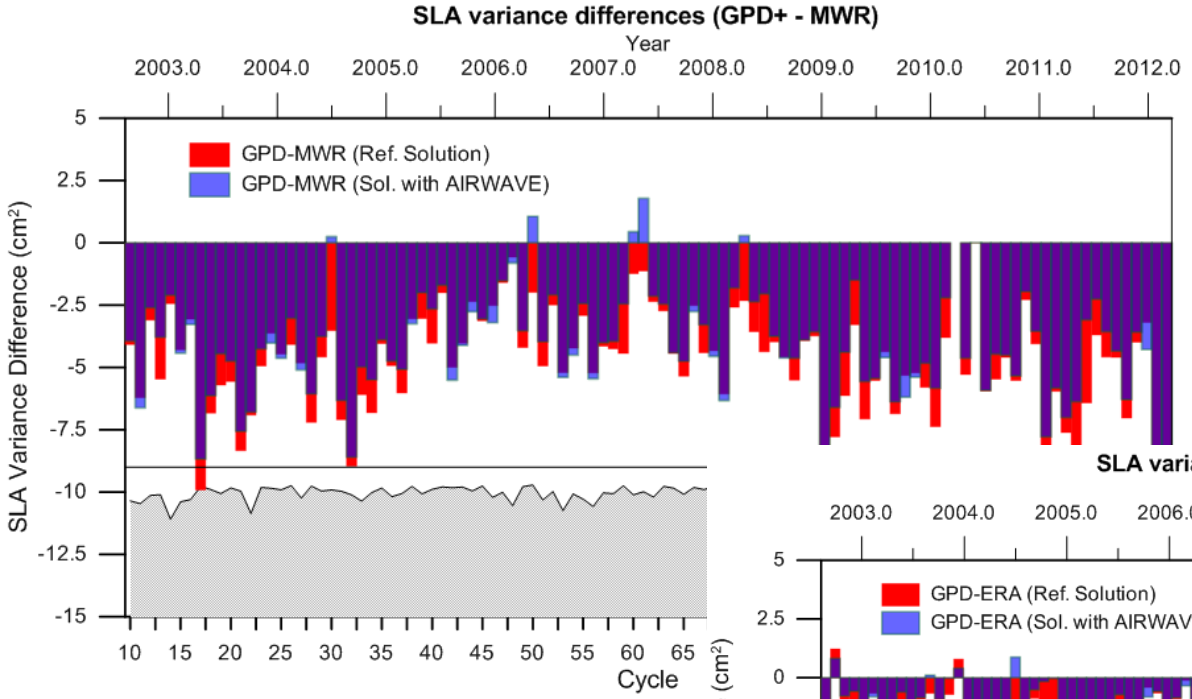




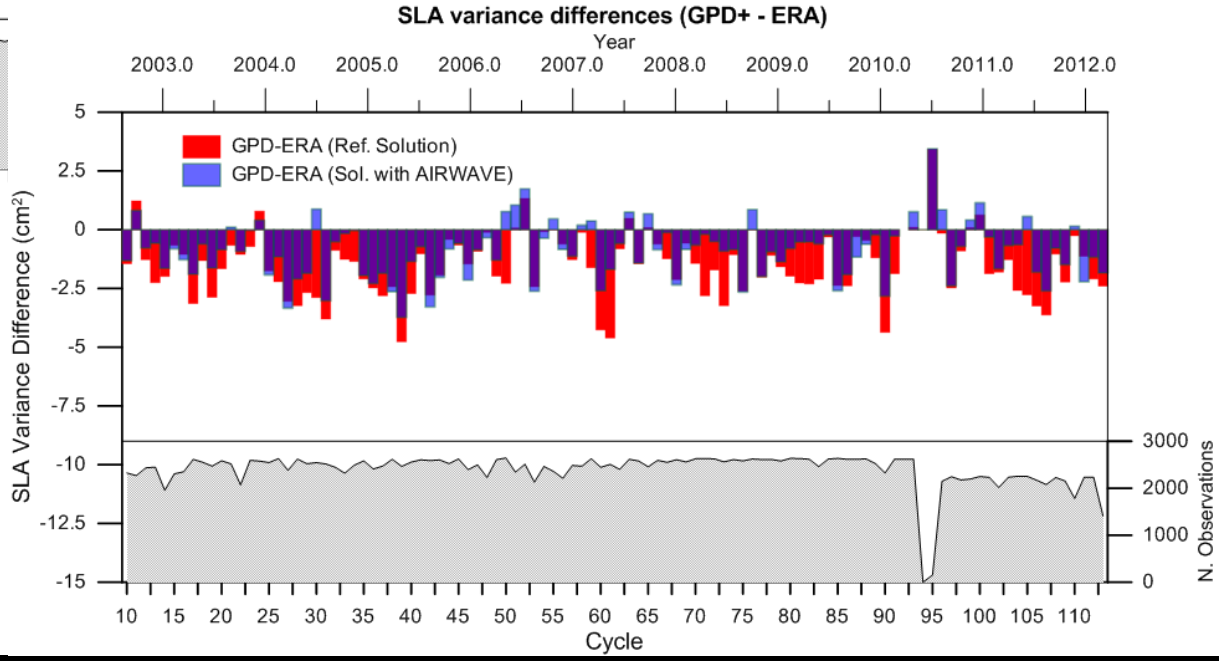
- **GPD+ WTC with all data sources: MWR + GNSS+ SI-MWR + AIRWAVE: comparison with the GPD+ reference solution (SL_cci, no AIRWAVE data)**



• **SLA variance differences (cm^2), temporal evolution: GPD+ with AIRWAVE vs. GPD+ Reference Solution.**



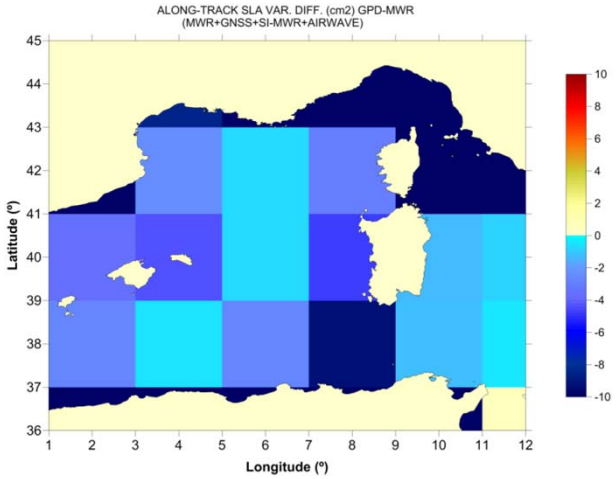
→ **Points for which the MWR measurement is outside the WTC limits excluded**

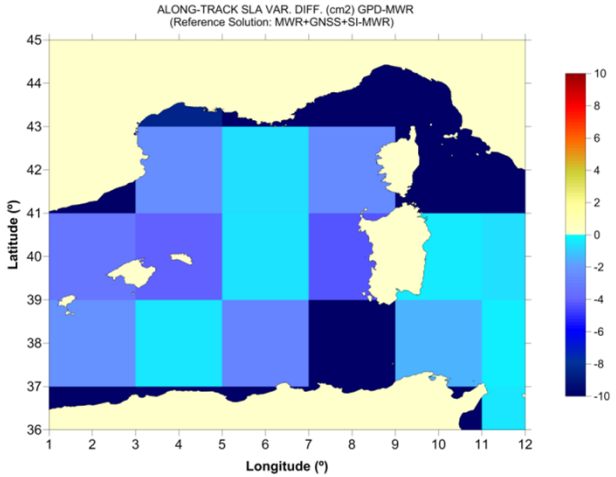


- **SLA variance differences (cm^2), spatial analysis: GPD+ with AIRWAVE vs. GPD+ Reference Solution**

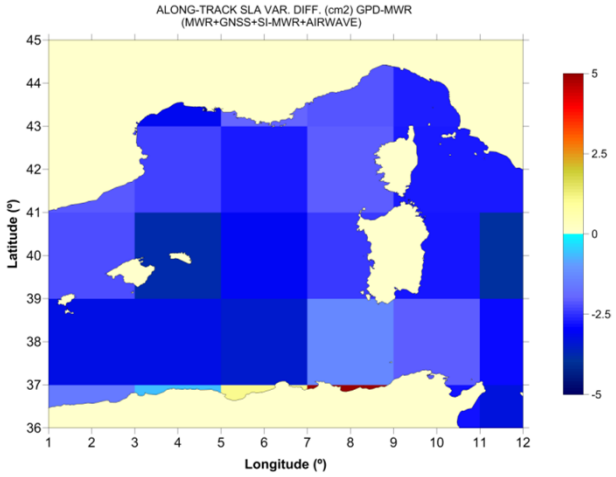
→ Points for which the MWR measurement is outside the WTC limits excluded

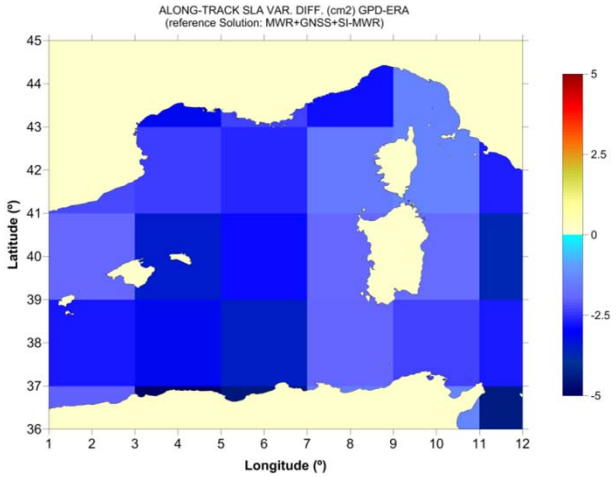
GPD+ - MWR





GPD+ - ERA



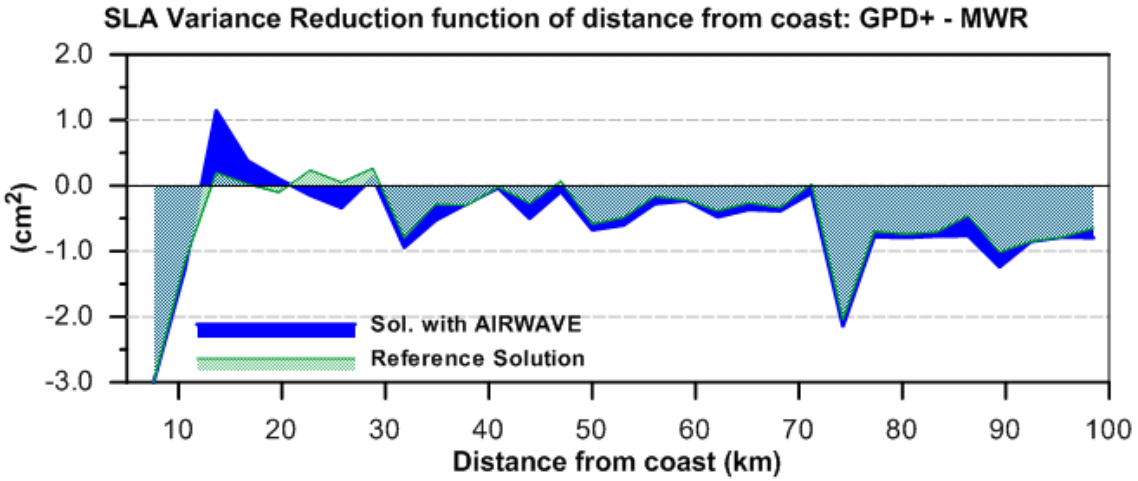


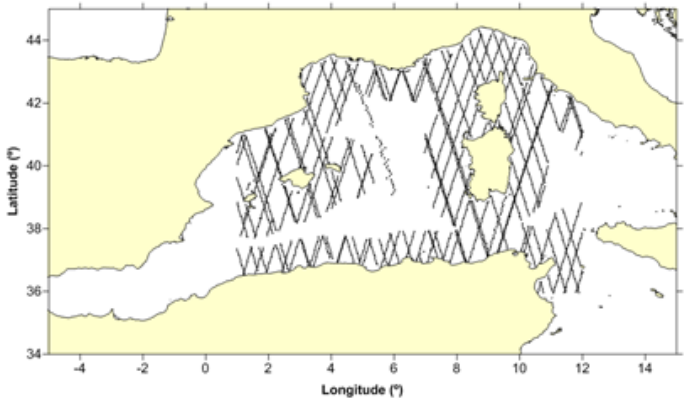
GPD+ Solution with AIRWAVE

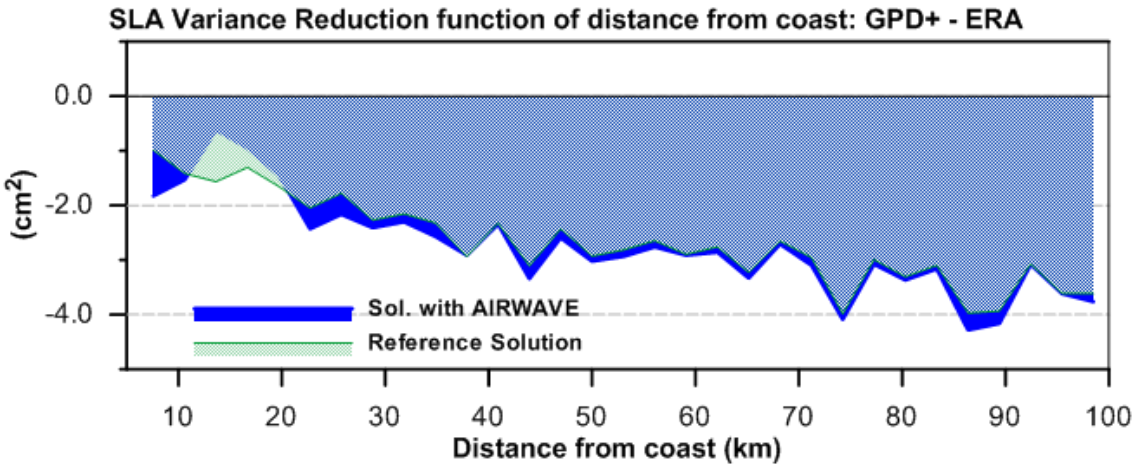
Reference Solution

- **SLA variance differences function of distance from coast**

→ Points for which the MWR measurement is outside the WTC limits excluded







Overall summary and future work

- **AIRWAVE WTC advantages:**
  - high spatial resolution;
  - data available up to the coast;
  - captures small scale variability.

- **AIRWAVE WTC assessed using TMI:**
  - AIRWAVE data show large dispersion
  - RMS(TMI-AIRWAVE) = 2.4 cm (larger than for other SI-MWR ~1 cm)
  - White noise for AIRWAVE = 1 cm

- **AIRWAVE WTC assessed using SLA variance analyses:**

  - Function of distance from coast: GPD+ with AIRWAVE performs better than GPD+ Reference solution except for distances 10 – 20 km off the coast.

  - At present, the best WTC is still the GPD+ reference solution (without AIRWAVE), however results indicate that the high spatial resolution of AIRWAVE should be better exploited in coastal regions, using an a priori data editing/filtering for noise removal.

- **Issues to be addressed:**
  - Spatial filtering of the AIRWAVE WTC;
  - Proper inter-calibration with respect to SI-MWR;
  - Global analysis.