CONTRIBUTIONS TO THE IMPROVEMENT OF THE WET TROPOSPHERIC CORRECTION FOR SARAL/ALTIKA

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1. Aims of the study

Contribute to the assessment of the SARAL/AltiKa (SA) MWR-derived Wet Tropospheric Correction (WTC) and propose alternative corrections.

2. UPorto algorithms developed for the computation of alternative WTC

2.1 SARAL/AltiKa MWR data

- Latest solution available on RADS (Radar Altimeter Database System).
- Cycles 1 to 8, study period: 2013.

2.2 DComb (Data Combination) WTC [1]

- Combination, through Objective Analysis (OA), of wet path delays derived from:
  - SI-MWR (Scanning Imaging MWR) on-board RS missions, previously calibrated with respect to AMR (Jason-2);
  - GNSS data from coastal inland and island stations, reduced to sea level.
- In the absence of observations, ECMWF Operational model is used.
- Designed to compute a WTC for missions without an on-board MWR: substitutes the MWR-based correction.
- Continuous correction.
- Advantage: independent from the on-board MWR-based WTC, enables an independent evaluation of this correction.

2.3 GPD (GNSS-derived Path Delay) WTC [2]

- Estimates are calculated by OA from three different wet path delays:
  - GNSS-derived;
  - ERA Interim model;
  - valid MWR measurements.
- Primarily designed to compute an improved WTC on coastal areas.
- Based on the original MWR correction, estimates are calculated for invalid MWR measurements only, valid MWR measurements are kept unchanged.
- Continuous correction.

2.4 Examples of DComb and GPD corrections

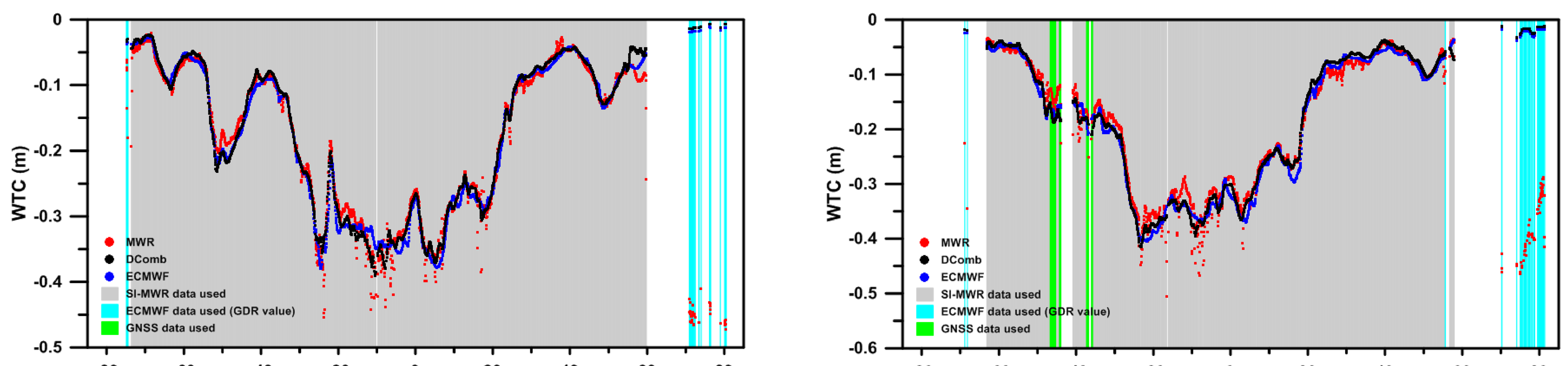

Fig. 1: Comparison of the DComb, MWR-based and ECMWF Operational model WTC; the DComb correction is calculated whenever observations (SI-MWR and/or GNSS) are available; otherwise, the DComb correction assumes the ECMWF WTC value + 5 mm). Examples are shown for SA Cycle 1, pass 15 (left) and pass 58 (right).

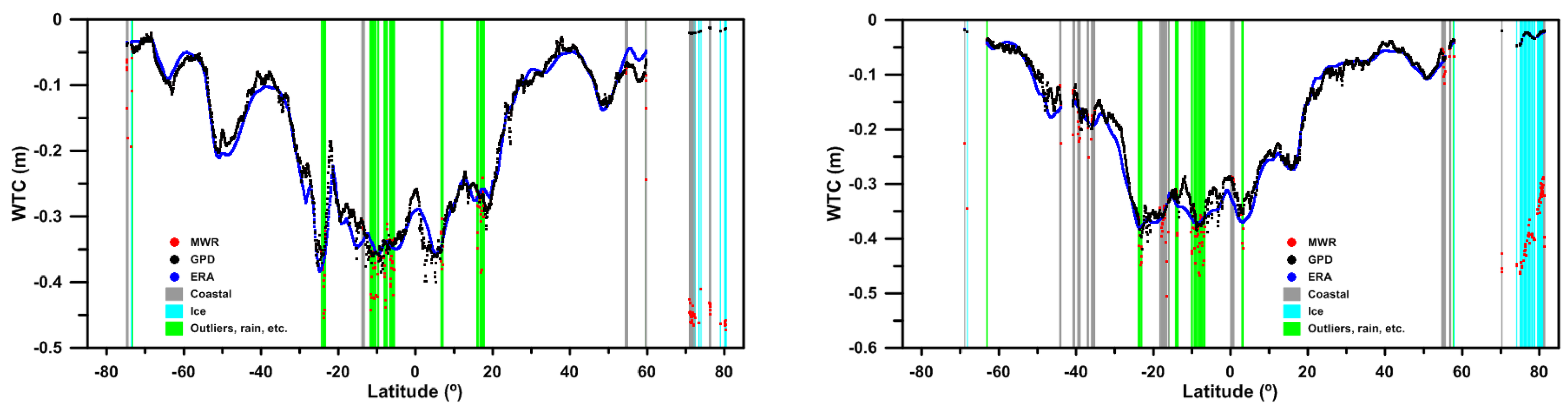

Fig. 2: Comparison of the GPD, MWR-based and ERA Interim WTC; the GPD correction is calculated whenever the MWR-based WTC is flagged as invalid (due to land, ice or rain contamination or instrument malfunction, see colour bars); otherwise, the GPD WTC assumes the values of the on-board MWR WTC. Examples are shown for SA Cycle 1, pass 15 (left) and pass 58 (right).

3. Assessment of the SA MWR-derived WTC: statistical diagnoses

- Difference in weighted variance (WV, weights function of latitude), for each cycle, of along-track Sea Level Anomaly (SLA) values computed using either DComb/GPD correction or MWR-based WTC.
- Difference in WV, for each cycle, of SLA differences at crossovers (XO) (provided that SLA values at XO do not differ more than 10 days, i.e., $\Delta T \leq 10$ days), with SLA values calculated using either DComb/GPD or MWR-based WTC.
- SLA variance difference, calculated using either DComb/GPD or MWR-based WTC, function of distance from coast, latitude and longitude.
- Differences in variance, for the whole period, of SLA differences at XO ($\Delta T \leq 10$ days), with SLA values calculated using either DComb/GPD or MWR-based WTC, mapped globally on a 4°×4° grid.

4. Results for DComb WTC: comparison with MWR-based WTC

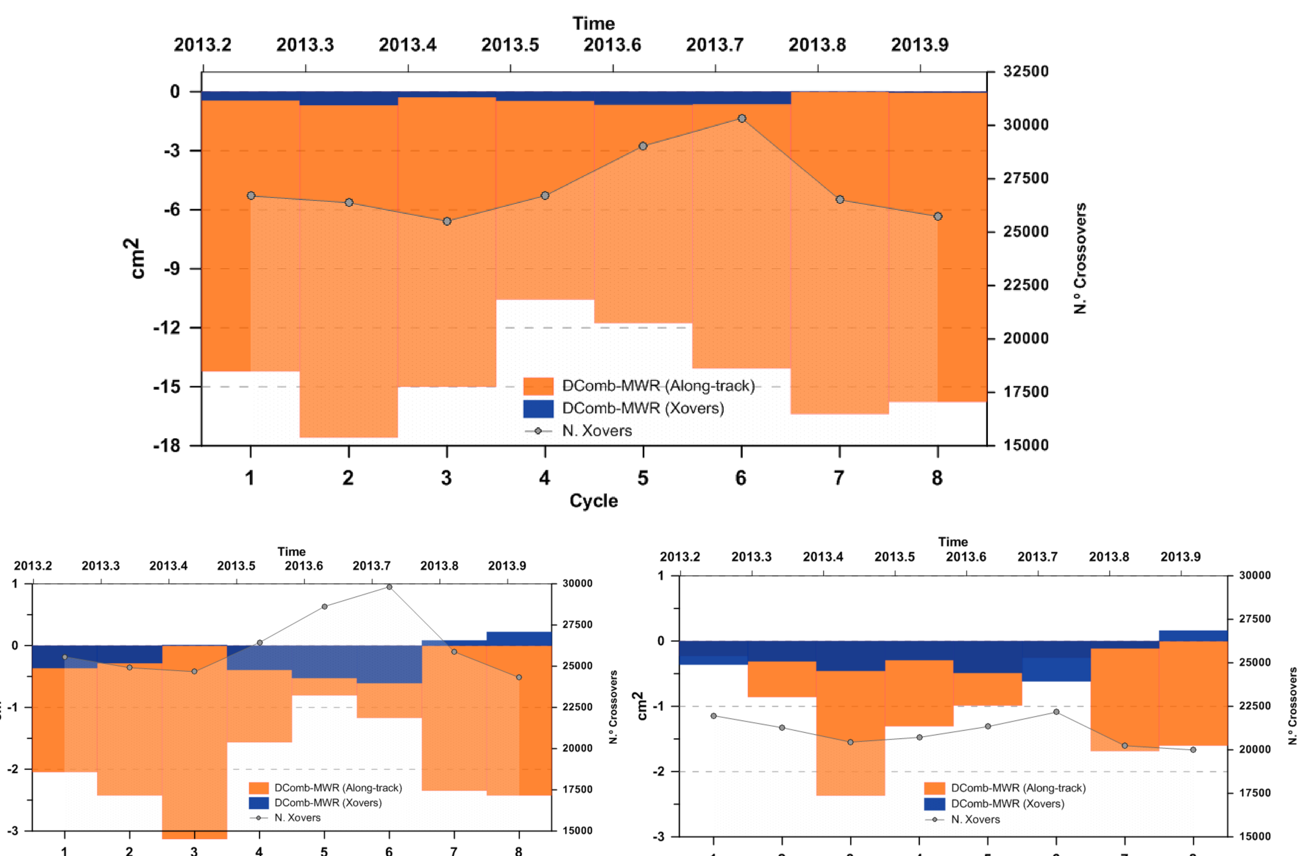

Fig. 3: Difference in weighted variance (cm²), for each cycle, of along-track SLA values (orange) and at XO (blue). The represented difference is DComb minus MWR: (top) all estimates are used; (bottom left): only estimates computed from observations (SI-MWR and/or GNSS) are used; (bottom right): only estimates over ocean (distance from coast > 100 km) and not contaminated are used.

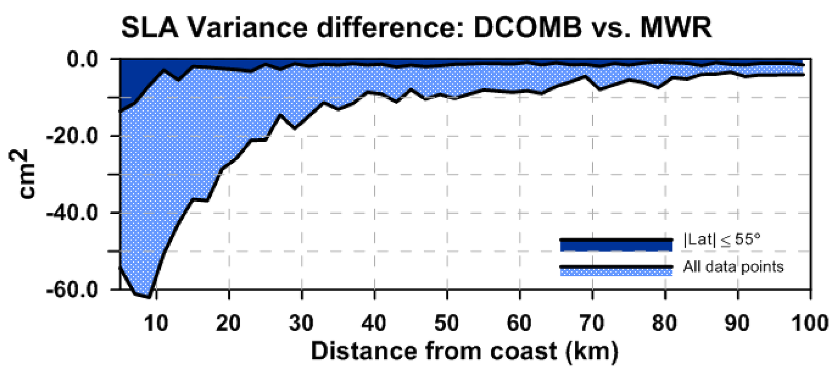

Fig. 4: SLA variance difference (cm²), function of distance from coast (using all data points and the selection of points with |latitudes|≤ 55°).

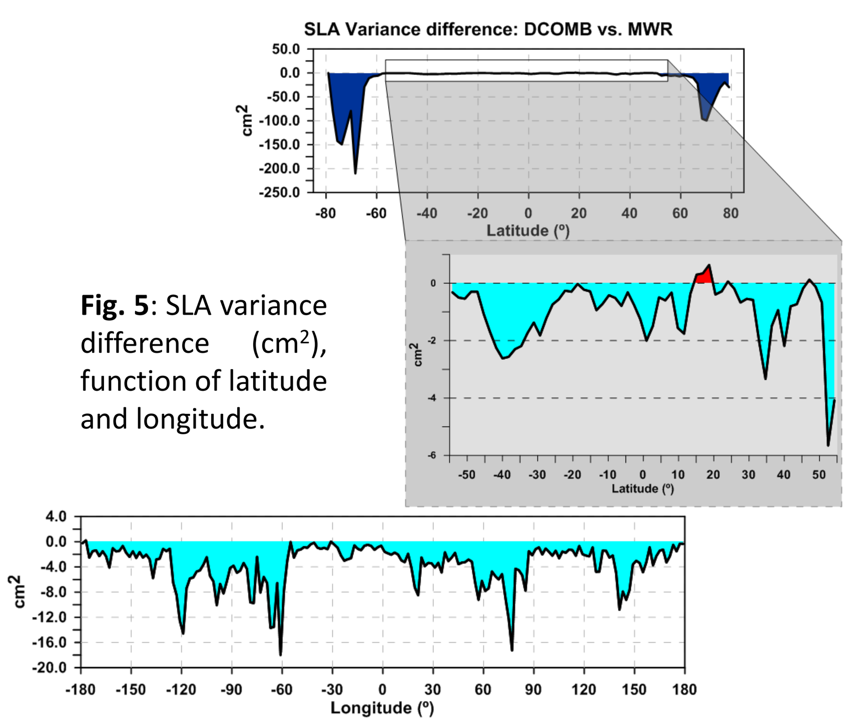

Fig. 5: SLA variance difference (cm²), function of latitude and longitude.

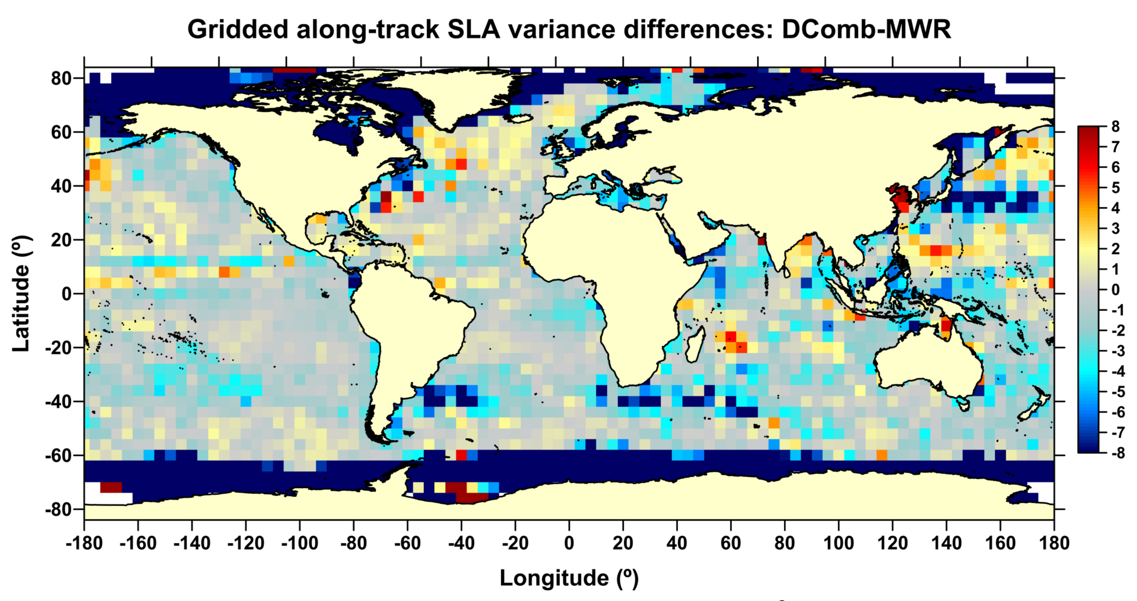

Fig. 6: Map of along-track SLA variance difference (cm²) from collinear analysis. Pixels values are mean values within each 4°×4° region; pixels with no data values are represented in white.

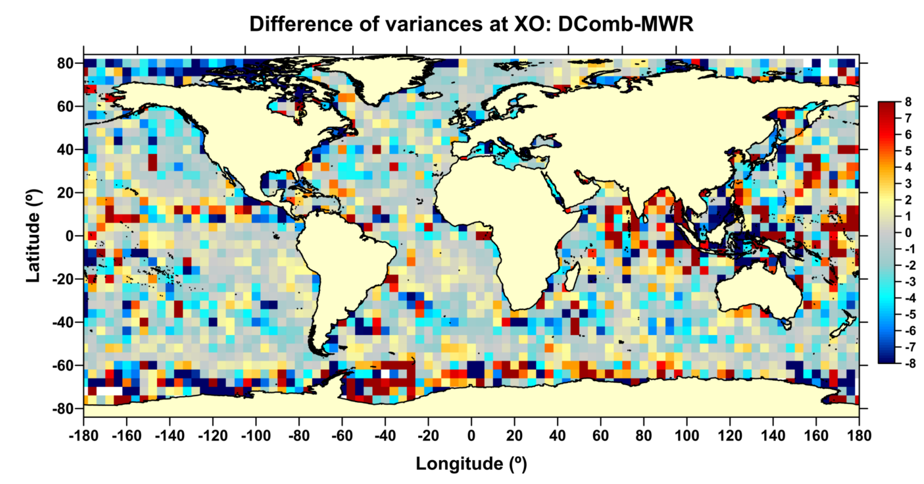

Fig. 7: Map of SLA variance differences (cm²) at XO. Pixels with no data values are represented in white.

5. Results for GPD WTC: comparison with MWR-based WTC

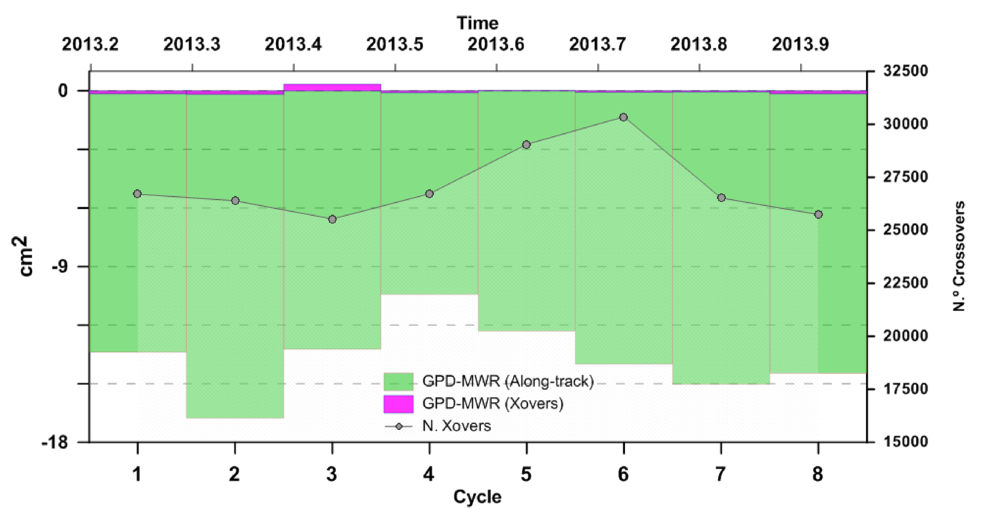

Fig. 8: Difference in weighted variance (cm²), for each cycle, of along-track SLA values (green) and at XO (magenta). The represented difference is GPD minus MWR.

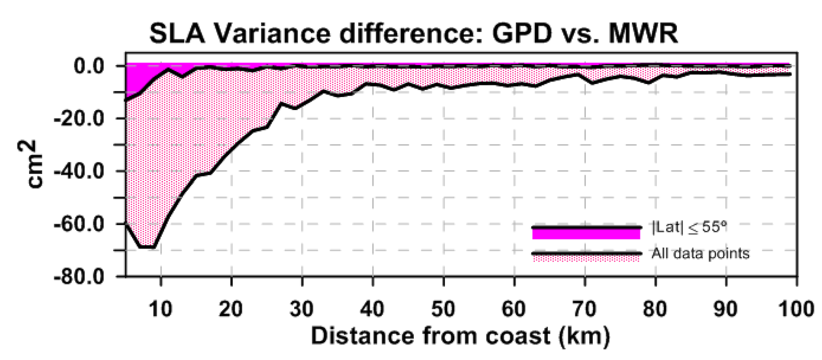

Fig. 9: Difference in variance (cm²) of SLA data sets computed using either GPD or MWR WTC, function of distance from coast (using all data points and the selection of points with |latitudes|≤ 55°).

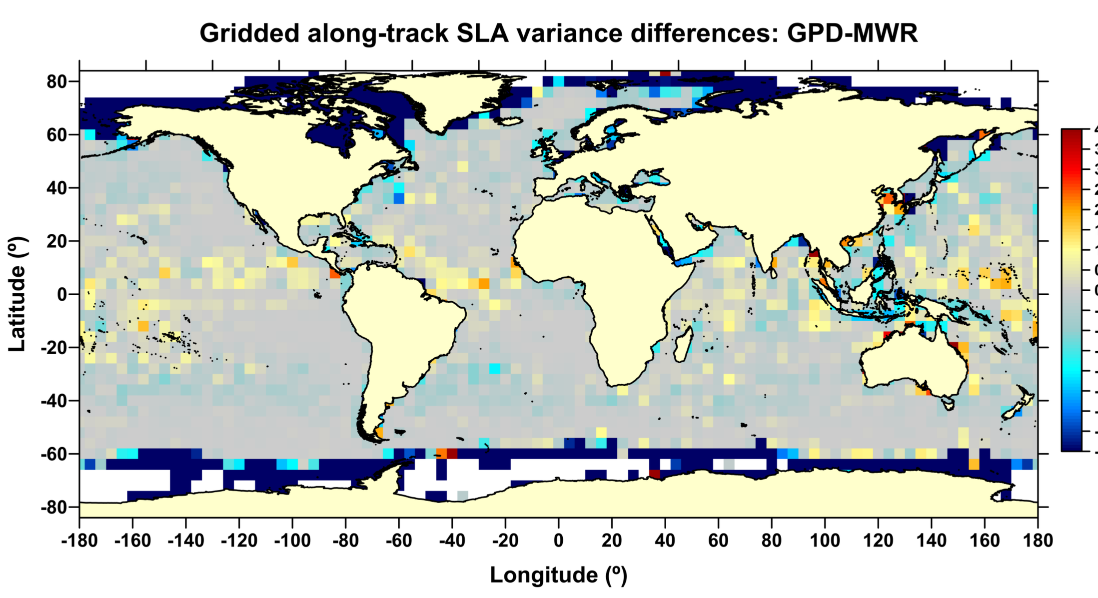

Fig. 10: Map of along-track SLA variance difference (cm²) from collinear analysis. Pixels values are mean values within each 4°×4° region; pixels with no data values are represented in white.

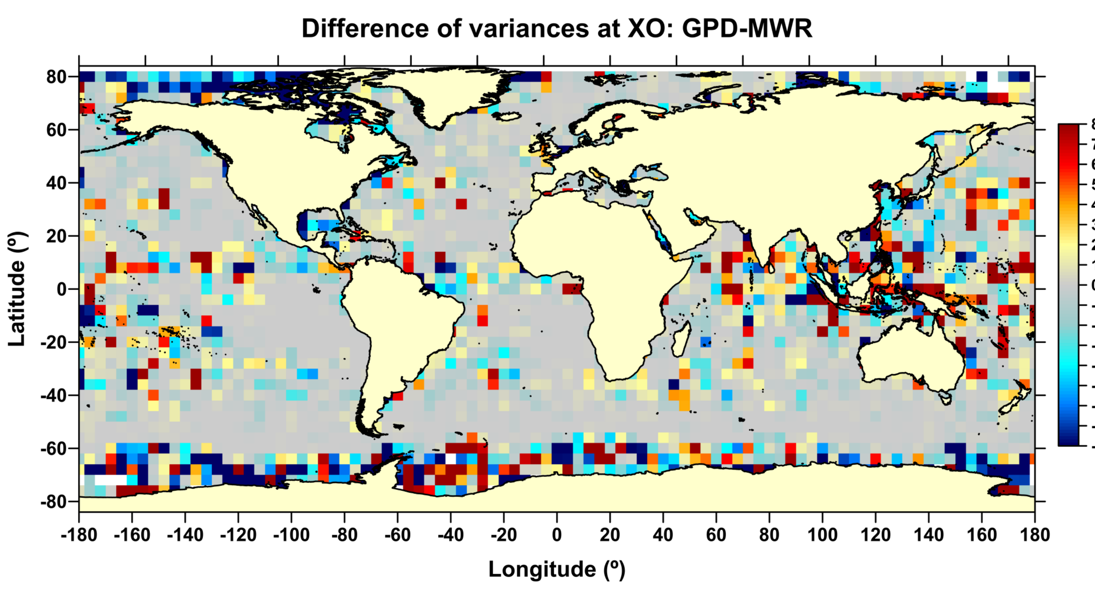

Fig. 11: Map of SLA variance differences (cm²) at XO. Pixels with no data values are represented in white.

6. Summary

- Results confirm that the improvement of the SA MWR WTC retrieval algorithm is still needed, particularly in coastal and polar regions.
- Statistical diagnoses have shown that DComb WTC correction performs better than the current MWR-based correction, this result being more evident in the latter regions; in open ocean regions, differences in along-track SLA values, using either the DComb or MWR, are generally lower than 2 cm².
- GPD WTC, being dependent on the MWR-based WTC, is worse than DComb WTC. Contaminated MWR values are still present (see Fig. 2, left plot); GPD algorithm mainly improves the SA WTC in coastal and polar regions.
- Results show that the contamination present in the SA on-board MWR WTC is well depicted in the analyses of SLA variance, while the variance at crossovers does not capture these localised effects.

References

1. Fernandes, M.J., A.L. Nunes, C. Lázaro (2013), Analysis and inter-calibration of wet path delay datasets to compute the wet tropospheric correction for CryoSat-2 over ocean. *Remote Sens.*, vol. 5, 4977-5005; doi:10.3390/rs5104977.
2. Fernandes M.J., C. Lázaro, A.L. Nunes, N. Pires, L. Bastos, V. B. Mendes (2010), GNSS-derived Path Delay: an approach to compute the wet tropospheric correction for coastal altimetry. *IEEE Geosci. Rem. Sens Lett.*, vol. 7, no. 3, 596–600.

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