Integration of SIRGAS-CON data in the estimation of the Wet Tropospheric Correction for Latin America Coastal Altimetry

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Introduction

- The precise measurement of sea level from Satellite Altimetry requires a set of corrections with the same level of precision.
- The Wet Tropospheric Correction (WTC), mainly due to the atmospheric water vapour, is one of these corrections, which is determined from on-board Microwave Radiometers (MWR) observations.
- MWR-derived WTC algorithms, only tuned over open ocean, fail over coastal and inland waters, due to the land contamination.
- To recover the WTC over these regions, the University of Porto developed the GNSS-derived Path Delay Plus (GPD+) method (Fernandes and Lázaro, 2016).
- This method uses Zenith Tropospheric Delays (ZTD) from global and regional GNSS networks, combined with other sources of information.
- GPD+ provides a combined solution of WTC for all along-track altimeter points, continuous and valid, where the GNSS has a major contribution in coastal and inland waters, when available.
- To densify the current dataset used by GPD+, it is necessary to add new stations, mainly in the southern hemisphere, in regions such as South America, Africa and Oceania.
- SIRGAS-CON is a network available for this task in the Latin America.

Objective

Exploitation of the SIRGAS-CON ZTD (Mackern et al., 2020), from January 2014 to December 2020, aiming to use these data to densify the set of GNSS stations in Latin America used by GPD+ algorithm.

Data

- **SIRGAS-CON ZTD:** SINEX TRO files with 1-hour temporal resolution
- **IGS ZTD:** SINEX TRO files with 1-hour temporal resolution subsample
- **ERA5 (ECMWF):** Sea Level Pressure (SLP), Total Column Water Vapour (TCWV) and T2m (2 meter temperature)
- **Global Pressure and Temperature model (GPT2)**
- **Radiosondes (IGRA):** Precipitable Water (PW) data

Methods

- ZWD was calculated from the SIRGAS-CON ZTD, subtracting the ZHD calculated from ERA5.
- The accuracy and stability of this ZWD were evaluated by comparison with ZWD from IGS for common stations and ZWD from ERA5 for all stations.
- From this analysis, stations within the defined criteria were selected for use in GPD+.
  - From a total of 467 stations with available SIRGAS-CON ZTD
    - × 38 stations were rejected by the defined criteria;
    - × 63 were not considered in the selection (red in Fig. 1) because they are already included in GPD+ (IGS stations);
    - ✓ 366 stations were selected to be included in GPD+ (blue in Fig. 1).

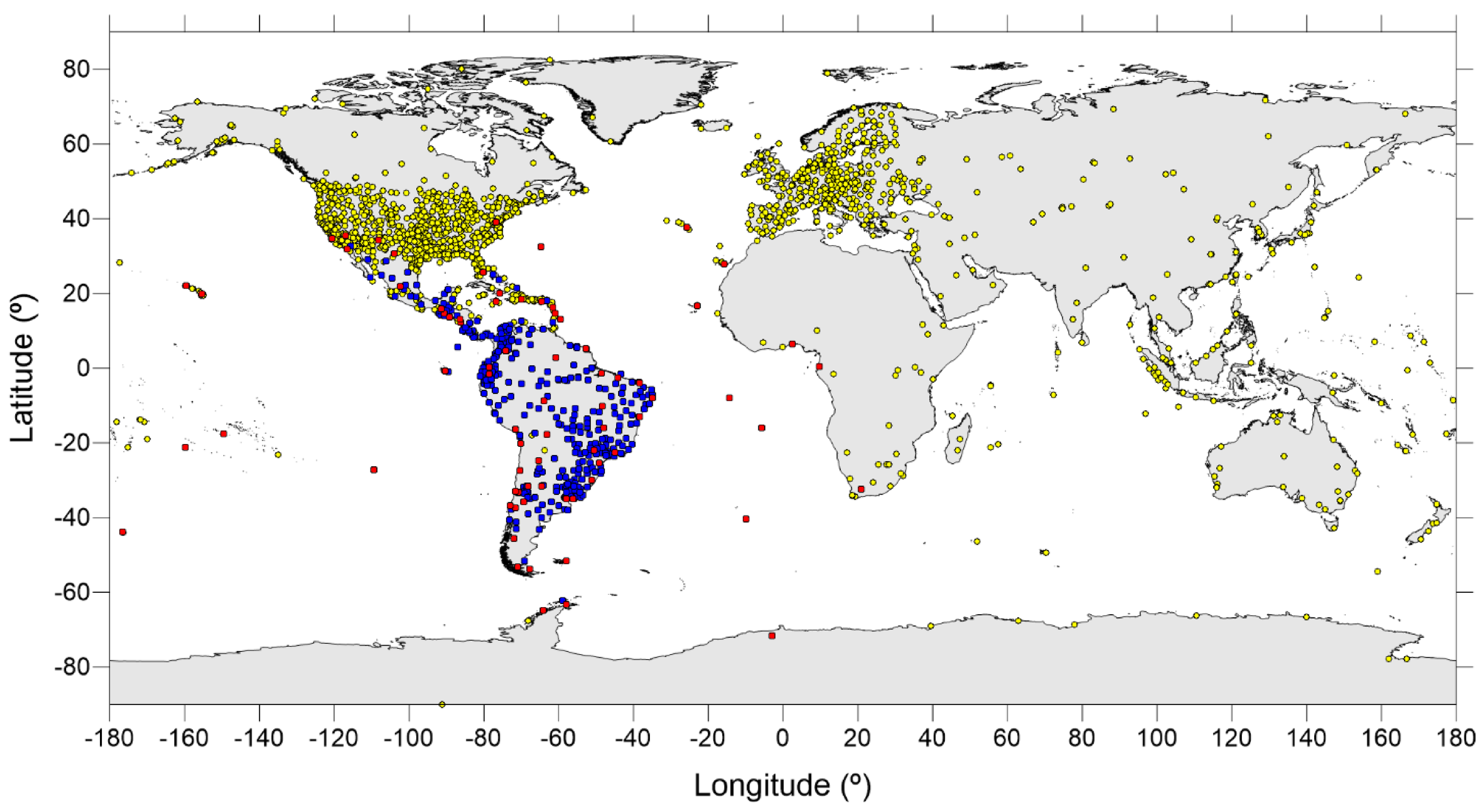
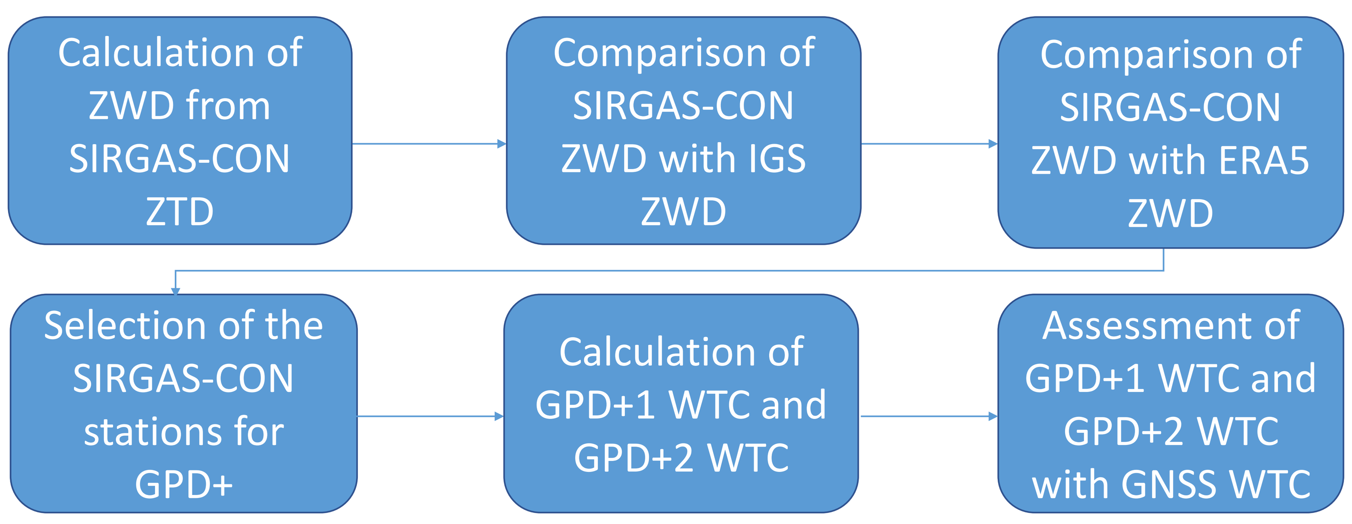


Fig 1. GPD+ network densification with SIRGAS-CON. Current GPD+ stations are in yellow, SIRGAS-CON stations are in blue and common stations are in red.

- Two runs of the algorithm were carried out to calculate the WTC; one with the current operational networks (GPD+1) and another one adding SIRGAS-CON (GPD+2).



Results

- To assess the impact of SIRGAS on the algorithm, a comparison between both GPD+ WTC with GNSS-derived WTC has been performed for Sentinel-3A (S3A) and Sentinel-3B (S3B), from the beginning of each mission until December 2020, and for CryoSat-2 (CS2) from January 2014 to December 2020.
- Fig. 2 shows a decrease in the RMS of the differences between GNSS and **GPD+2** when compared to the differences with **GPD+1,** for the three missions.
- This decrease is greater close to the coast, where the MWR fails and GPD+ extends up to 25 km from the coast for S3A and S3B, while for CS2 this impact is up to 70 km from the coast, since this satellite has no on-board MWR.
- An assessment with radiosondes was also carried out. Fig. 3 shows radiosondes with RMS improvement (green diamonds), with no RMS change (blue diamonds) and with RMS degradation (red diamond) for GPD+2 WTC w.r.t. GPD+1 WTC, for CS2.
- The same analysis was performed for S3A and S3B. Overall, when compared with radiosondes, the decrease can reach 0.5 cm in the RMS after the inclusion of SIRGAS-CON stations.
- Both assessments reveal the same result: locally, SIRGAS-CON stations improve the GPD+ WTC.

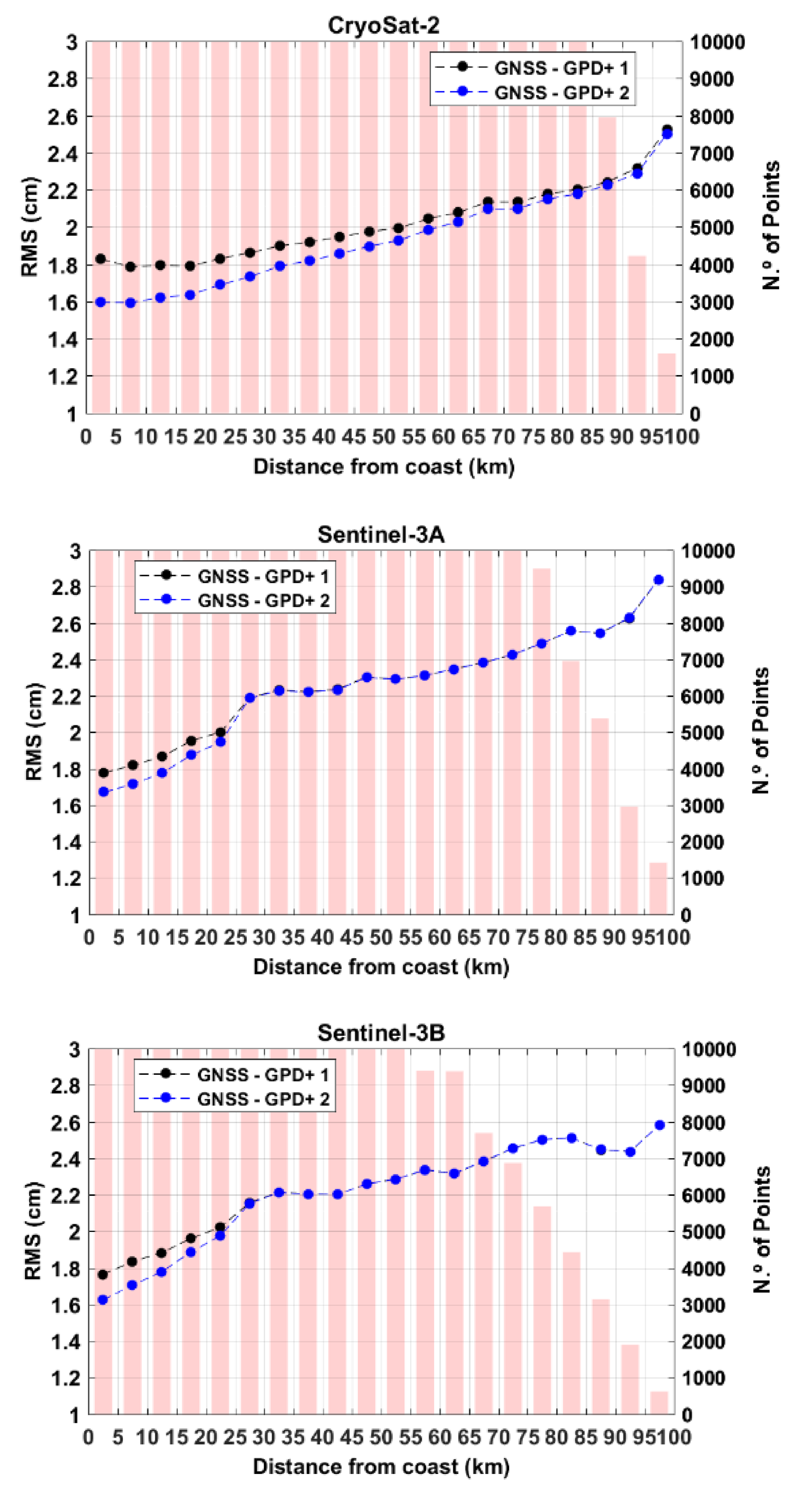


Fig. 2. RMS of differences between GNSS-derived WTC and GPD+1 (black) and GPD+2 (blue) WTC for CS2 (top), S3A (middle) and S3B (bottom).

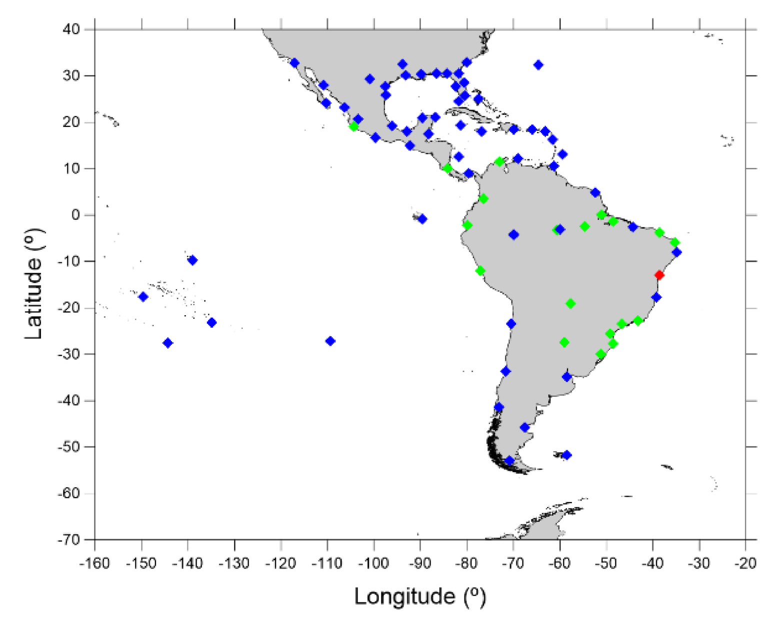


Fig. 3. Radiosondes with RMS improvement (green diamonds), with no RMS change (blue diamonds) and with RMS degradation (red diamond) for GPD+2 WTC w.r.t. GPD+1 WTC, for CS2.

Conclusions

- Results show a decrease in the RMS of the differences between GNSS-derived WTC and the GPD+ solution after the addition of the SIRGAS-CON stations when compared to the differences with the solution of the current GPD+ version, for the three analysed satellites.
- The assessment with radiosondes also shows a decrease in the RMS after adding the new network and reinforces the conclusion that SIRGAS-CON stations improve the GPD+ WTC.
- The objective is to continue the exploitation of other regional networks to improve the GPD+ over regions that still lack GNSS data. The Southeast Asia, Japan and Oceania are regions characterized by the presence of many islands, prone to MWR failure and still have few stations in the current GPD+, needing a densification to improve WTC in their coastal zones.