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Impact of Different Wet Tropospheric Corrections on Sea Level Change in the Indonesia Region

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Abstract

This study addresses the impacts of various wet tropospheric corrections (WTC) in the determination of sea level change in Indonesia. The various WTC (Microwave Radiometer, ERA interim model, and GNSS-derived path delay (GPD) and DComb algorithms) have been applied to derive Sea level Anomaly (SLA). To improve the local solution for GPD and DComb, Zenith Total delay (ZTD) computed using 29 local GNSS stations around Indonesia region were used.

Introduction

For more than 20 years, satellite altimetry has been observing sea level variability over the world. The study of sea level variation in Indonesia region using satellite altimetry is a challenging topic due to the coastal effects present in altimeter data, which need to be addressed. Amongst these effects, the wet tropospheric correction (WTC) is of particular relevance due to its large spatio-temporal variation.

The aim of this research is to assess the impacts of various WTC in the determination of sea level change in Indonesia.

Various Wet Tropospheric Corrections

Several wet tropospheric corrections have been applied to satellite altimetry data in the Indonesia region to build a continuous set of sea level anomalies (SLA) for the period 1992 - 2013, for eight different satellite altimetry missions: ERS-1, ERS-2, Envisat, CryoSat-2, SARAL/AltiKa, TOPEX/Poseidon, Jason-1 and Jason-2.

The WTC data sets used are: those available in the Radar Altimetry Database System (RADS), in particular those from the on-board Microwave Radiometer (MWR) and from the ERA Interim model, and WTC developed at the University of Porto using the GNSS-derived path delay (GPD) algorithm (for all missions except CryoSat-2 and SARAL) (Fernandes, 2010, Fernandes, 2013a) and from the Data Combination (DComb) WTC. In addition to global sets of zenith total delays from the IGS, EUREF and Suominet networks, a set of wet path delays from GNSS stations in Indonesia were used. For this purpose, a dataset of zenith total delays was computed for 29 local GNSS stations using Precise Point Positioning (Zumberge, 1997) on the GIPSY software. (Fig.1)

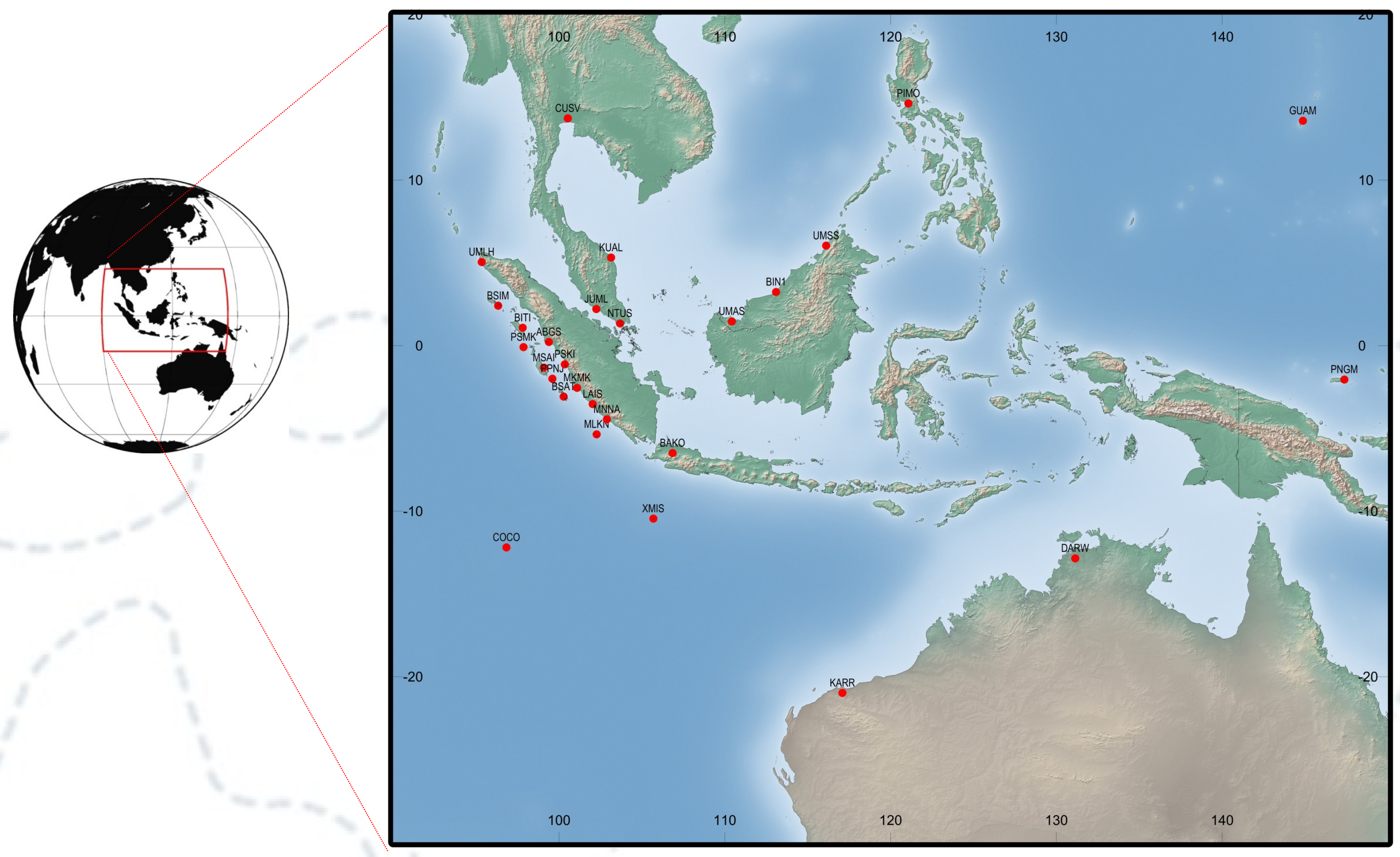

Fig. 1 Indonesia Region.
Red dots represent GNSS station used in the estimation of GPD and DComb corrections.

Assessment of SLA

In order to assess the quality of various WTC on altimeter data, analyses of SLA variance, derived from different datasets, has been performed.

The SLA datasets have been computed using DTU10 MSS, and the following set of range and geophysical corrections: ERA Interim dry, various wet troposphere, smoothed dual-frequency ionosphere (when available, JPL GIM otherwise), MOG2D dynamic atmospheric correction, CLS sea state bias, solid earth tides and GOT 4.8 ocean and load tides.

$SLA_{ERA} = SSH_{raw} - MSS - (dry_{ERA} + wet_{ERA} + iono_{DF} + ssb_{CLS} + tides + tides_{GOT4.8} + invbar_{MOG2D})$

$SLA_{MWR} = SLA_{ERA} + wet_{ERA} - wet_{MWR}$

$SLA_{GPD} = SLA_{ERA} + wet_{ERA} - wet_{GPD}$

For Cyrosat-2 (C2) and SARAL/Altika (SA), instead of the GPD the Dcomb correction has been used:

$SLA_{DCOMB} = SLA_{ERA+} + wet_{ERA} - wet_{DCOMB}$

Figures 2 shows how the different WTC affect SLA variance function of distance from coast.

Using these data-sets, 4 SLA time series (period 1992 – 2014) have been computed, two for the set of satellites ERS-1, ERS-2, Envisat, CryoSat-2 and SARAL/AltiKa and two for the set TOPEX/Poseidon, Jason-1 and Jason-2. For each satellite set a time series was computed using the WTC from ERA Interim and another using the WTC from GPD/Dcomb. The trend and seasonal signal effects were modelled using a Seasonal-Trend Decomposition Procedure based on Loess (STL) . It can be observed that these series are significantly different from the global one.

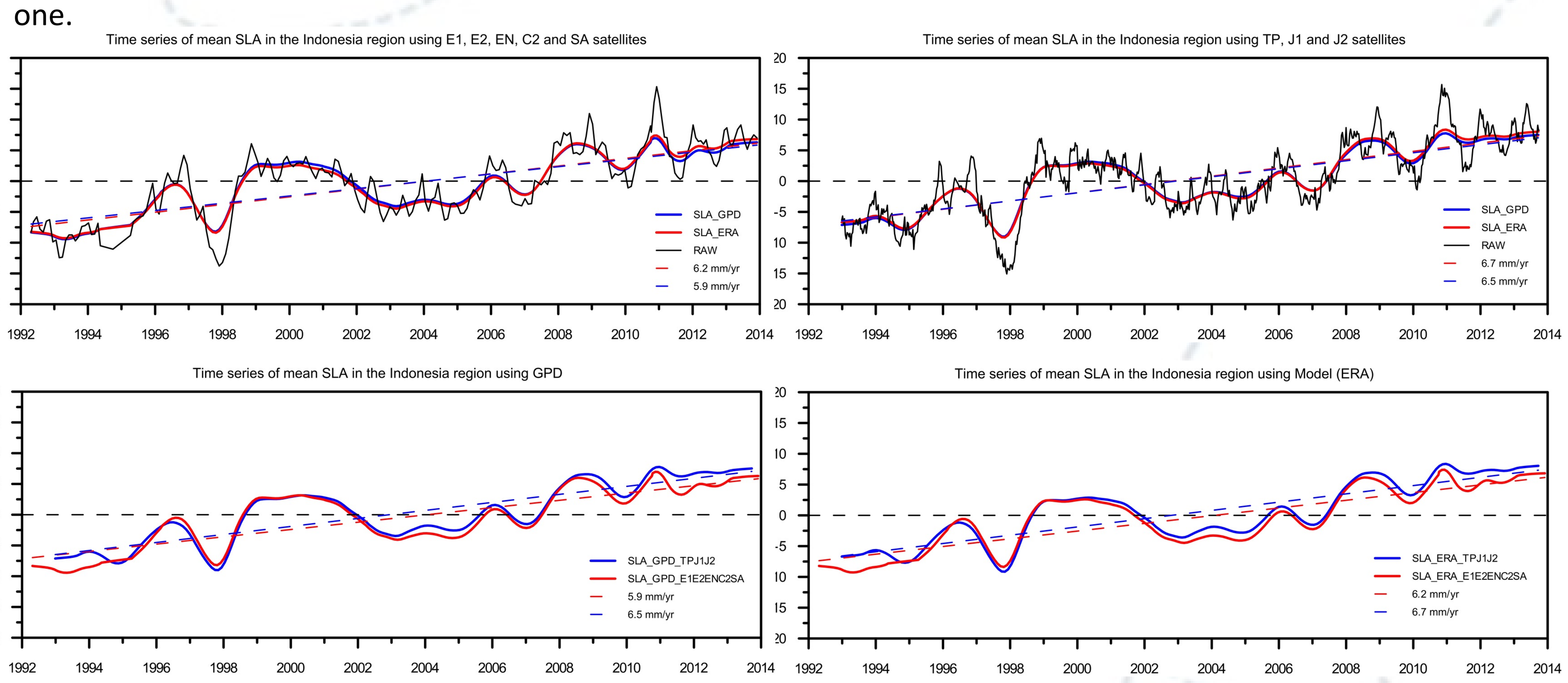

Fig. 3 Time series of mean SLA in the Indonesia region for ERS-1, ERS-2, Envisat, CryoSat-2 and SARAL/AltiKa (left - above) and for TOPEX/Poseidon, Jason-1 and Jason-2 (right - above). (mean SLA in centimeter)

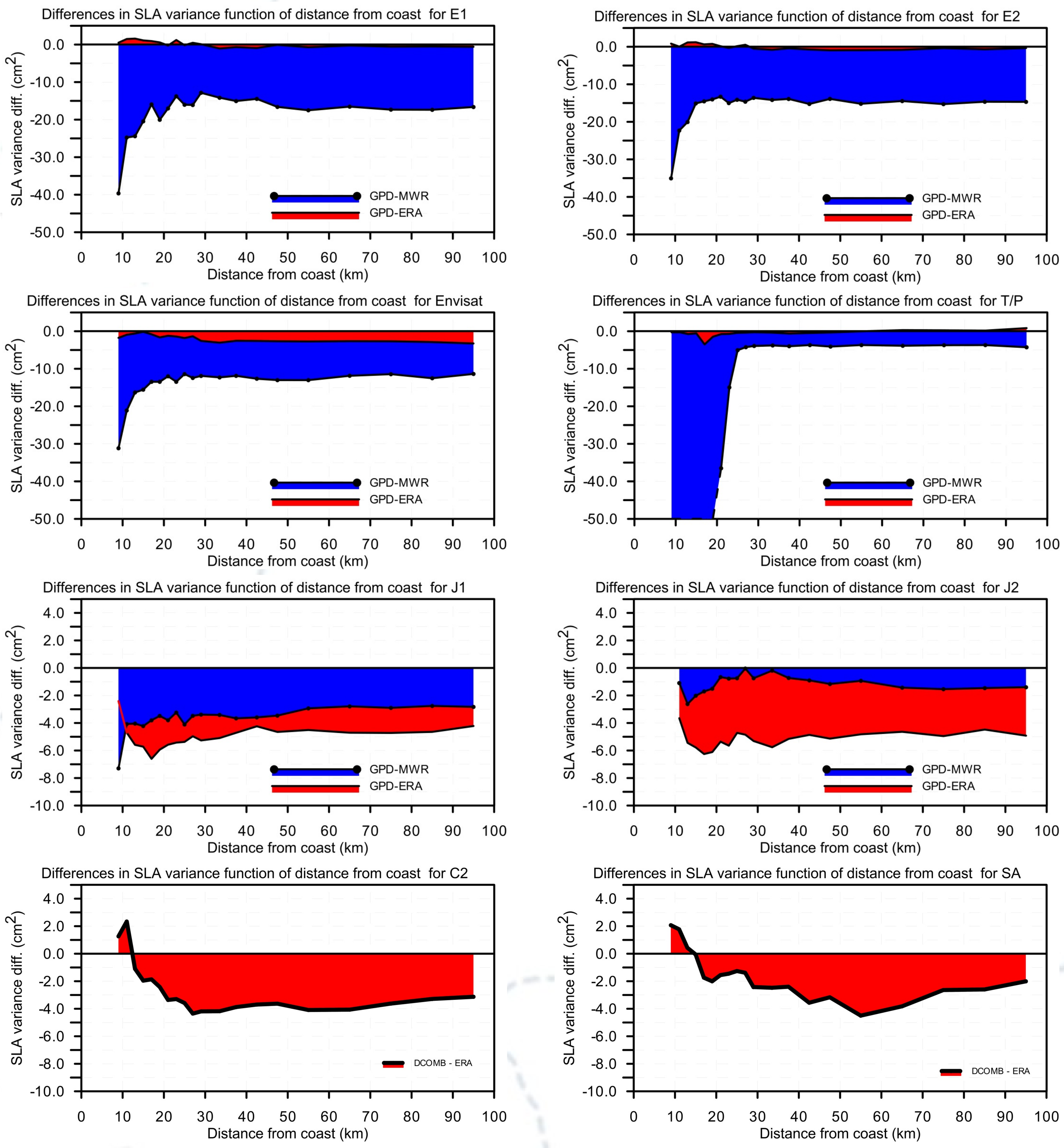

Fig. 2 Differences of SLA variance function of distance from coast

The assessment of the various of WTC is performed using SLA variance analysis function of distance from the coast. These figures in fig.2 show the differences of SLA variance function of distance from the coast between GPD/Dcomb – On board microwave radiometer (**blue**) and GPD/Dcomb – ERA interim model (**red**).

Conclusions and future work

- For most of Satellite altimetry missions, the GPD corrections reduce the SLA variance when compared to Microwave Radiometer (MWR), particularly in the coastal zone.
- For E1 and E2, GPD does not reduce significantly the SLA variance with respect to the ERA Interim model, probably due to small quantity of GPS stations available in those periods.
- For C2 and SA, DComb significantly reduce SLA variance with respect to ERA interim model in the coastal zone, except for the shortest distances. Dcomb also reduces the variance with respect to the SA on-board MWR
- Results show the effect of using different WTC in the computation of mean sea level time series. For the SLA time series derived of E1, E2, EN, C2, and SA missions the mean sea level trend is 6.2 mm/yr (ERA) and 5.9 mm/yr (GPD/Dcomb). For the SLA time series derived of T/P, J1, J2 missions, the mean sea level trend is 6.7 mm/yr (ERA) and 6.5 mm/yr (GPD) respectively. From the figures it can be observed that the effects at decadal scales are much larger.
- Future work includes the following main topics: the analysis of the space-time variations of sea level in Indonesia and comparison with tide gauge data.

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