### Coastal wet tropospheric correction: GPD vs Composite

<table>
<thead>
<tr>
<th>Study variable</th>
<th>GPD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference variable</td>
<td>Composite</td>
</tr>
<tr>
<td>Missions</td>
<td>Envisat ((en))</td>
</tr>
<tr>
<td>Period</td>
<td>[19259, 22209]</td>
</tr>
</tbody>
</table>

Creation date: 2011/08/27

**Contents**

<table>
<thead>
<tr>
<th>A001</th>
<th>A002</th>
<th>A003</th>
<th>A004</th>
<th>A101</th>
<th>A102</th>
<th>A103</th>
<th>A104</th>
<th>A201</th>
<th>A202</th>
<th>A203</th>
<th>A204</th>
<th>A205</th>
<th>A206</th>
<th>A207</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>5</td>
<td>6</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td>13</td>
<td>18</td>
<td>20</td>
<td>23</td>
<td>25</td>
<td>27</td>
<td>30</td>
</tr>
</tbody>
</table>
Study overview

In this study, the wet tropospheric correction computed by the University of Porto, Faculty of science in the scope of the Sea level CCI project (WP2710) has been compared with the composite correction used in CNES/AVISO products to calculate the Envisat sea-level height (SSH).

The impact of using these wet tropospheric corrections on the SSH computation has been analyzed for Envisat mission from September 2002 (cycle 10) to October 2010 (Cycle 93).

The major aim of WP2710 is to provide a wet tropospheric correction for the coastal zone, applicable to all missions, fully compatible with respect to the microwave radiometer (MWR) based correction that shall be adopted in the open ocean, and ensuring its continuity and consistency in the open ocean/coastal transition zone. It has been produced by the university of Porto, Faculty of science (J. Fernandes).

This study has been performed on points where the studied correction is a valid estimate (GPD flag=1) and on non corrupted ocean points where it equals the radiometric correction (GPD flag=0).

For Envisat mission, the composite wet tropospheric correction is the reference: the radiometric wet tropospheric correction present in GDR products is used for coastal distances greater than 50 km while the ECMWF operational correction model is used for coastal distances lower than 50 km. The ECMWF operational correction is adjusted on the radiometric wet tropospheric correction to provide the continuity in the wet troposphere correction dataset.

All the validation diagnostics displayed in this report have been performed in agreement with the Sea-Level CCI Product Validation Plan (PVP).
**Diagnostic A001 (mission en)**

**Name:** Temporal evolution of differences between both altimetric components

**Input data:** Along-track altimetric components

**Description:** The temporal evolution of global statistics (mean, variance, slope) of differences between 2 different standards of a same altimetric component (sea surface height correction, altimeter parameter, orbit) are calculated from a cyclic way (altimeter repetivity, daily, weekly, monthly). These statistics are calculated from 1 Hz altimetric measurements after removing spurious sea level measurements.

![Graph of Mean of GPD - Composite](image1)

**Mean = 0.02564**  
**Slope = 0.00733 mm/yr**

![Graph of Standard deviation of GPD - Composite](image2)

**Mean = 0.6851**
Diagnostic A002 (mission en)

Name: Map of differences between both altimetric components over all the period

Input data: Along-track altimetric components

Description: The map of global statistics (mean, standard deviation) of differences between 2 different standards of a same altimetric component (sea surface height correction, altimeter parameter, orbit) are calculated over a given period which is the longer as possible to have obtain reliable statically results. These statistics are calculated from 1 Hz altimetric measurements after removing spurious sea level measurements.

Mean of GPD – Composite
Mission en, cycles 9 to 93

Mean (cm)
Standard deviation of GPD – Composite
Mission en, cycles 9 to 93

Standard deviation (cm)
Diagnostic A003_a (mission en)

**Name:** Periodogram derived from temporal evolution of altimetric component differences

**Input data:** Along-track altimetric components

**Description:** The periodogram derived from temporal and global altimetric component differences is calculated from cycle by cycle monitoring of altimetric component differences (derived from diagnostic A001). It is calculated from the mean or the variance differences. The Periodogram can be calculated for all the periods, but it can be focused on a dedicated period.
Name: Periodogram derived from temporal evolution of altimetric component differences

Input data: Along-track altimetric components

Description: The periodogram derived from temporal and global altimetric component differences is calculated from cycle by cycle monitoring of altimetric component differences (derived from diagnostic A001). It is calculated from the mean or variance differences. The Periodogram can be calculated for all the periods, but it can be focused on a dedicated period.
Diagnostic A004 (mission en)

Name: Altimetric component differences versus coastal distances

Input data: Along-track altimetric components

Description: Mean and standard deviation of the differences between 2 different standards of a same altimetric component (sea surface height correction, altimeter parameter, orbit) are computed and plotted in function of coastal distances between 0 and 100 km.
**Name** : Temporal evolution of SSH crossovers

**Input data** : Sea Surface Height (SSH) crossovers

**Description** : The temporal evolution of global statistics (mean, standard deviation) of SSH differences are calculated from a cyclic way (altimeter repetivity, daily, weekly, monthly) using successively both altimetric components in the SSH calculation. SSH crossovers are the differences between ascending and descending passes for time differences between both passes lower than 10 days (in order to reduce the effect of the oceanic variability).
Diagnostic A102 (mission en)

**Name**: Differences between temporal evolution of SSH crossovers

**Input data**: Sea Surface Height (SSH) crossovers

**Description**: The difference of temporal evolution between the global statistics (mean, standard deviation) of SSH differences are calculated using successively both altimetric components in the SSH calculation. SSH crossovers are the differences between ascending and descending passes for time differences between both passes lower than 10 days (in order to reduce the effect of the oceanic variability).

![Graph showing SSH crossovers: VAR(SSH with GPD) - VAR(SSH with Composite)](image)
**Diagnostic A103 (mission en)**

**Name**: Map of SSH crossovers

**Input data**: Sea Surface Height (SSH) crossovers

**Description**: The differences between maps of SSH crossovers differences (mean, variance) are calculated using successively both altimetric components in the SSH calculation. SSH crossovers are the differences between ascending and descending passes for time differences between both passes lower than 10 days (in order to reduce the effect of the oceanic variability).
**Diagnostic A104 (mission en)**

**Name** : Differences between maps of SSH crossovers

**Input data** : Sea Surface Height (SSH) crossovers

**Description** : The differences between maps of SSH crossovers (derived from diagnostic A103) are calculated from the SSH crossover differences (mean, standard deviation) using successively both altimetric components in the SSH calculation. SSH crossovers are the differences between ascending and descending passes for time differences between both passes lower than 10 days (in order to reduce the effect of the oceanic variability).

VAR(SSH with GPD) – VAR(SSH with Composite)

Mission en, cycles 9 to 93

SSH crossovers : difference of variances ( cm^2 )
Name: Temporal evolution of Sea Level Anomaly (SLA)

Input data: Along track SLA

Description: The temporal evolution of SLA statistics (mean, standard deviation) are calculated from a cyclic way (altimeter repetivity, daily, weekly, monthly) using successively both altimetric components in the SLA calculation. These statistics are calculated from 1 Hz altimetric measurements after removing spurious sea level measurements. They are calculated globally, but also separating ascending and descending passes (except for SLA Grids), or separating North and South hemispheres.

Global MSL
Mission en, cycles 9 to 93

- SLA with GPD: Slope = 0.421 mm/yr [L.S.R. = 0.12]
- SLA with Composite: Slope = 0.453 mm/yr [L.S.R. = 0.12]

Mean (cm)

Year: 2004 to 2010
**Name**: Temporal evolution of Sea Level Anomaly (SLA)

**Input data**: Along track SLA

**Description**: The temporal evolution of SLA statistics (mean, standard deviation) are calculated from a cyclic way (altimeter repetitivity, daily, weekly, monthly) using successively both altimetric components in the SLA calculation. These statistics are calculated from 1 Hz altimetric measurements after removing spurious sea level measurements. They are calculated globally, but also separating ascending and descending passes (except for SLA Grids), or separating North and South hemispheres.
**Name**: Temporal evolution of Sea Level Anomaly (SLA)

**Input data**: Along track SLA

**Description**: The temporal evolution of SLA statistics (mean, standard deviation) are calculated from a cyclic way (altimeter repetivity, daily, weekly, monthly) using successively both altimetric components in the SLA calculation. These statistics are calculated from 1 Hz altimetric measurements after removing spurious sea level measurements. They are calculated globally, but also separating ascending and descending passes (except for SLA Grids), or separating North and South hemispheres.
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Input data: Along track SLA

Description: The temporal evolution of SLA statistics (mean, standard deviation) are calculated from a cyclic way (altimeter repetivity, daily, weekly, monthly) using successively both altimetric components in the SLA calculation. These statistics are calculated from 1 Hz altimetric measurements after removing spurious sea level measurements. They are calculated globally, but also separating ascending and descending passes (except for SLA Grids), or separating North and South hemispheres.
Diagnostic A202_a (mission en)

Name : Differences between temporal evolution of Sea Level Anomaly (SLA)

Input data : Along track SLA

Description : The differences between temporal evolution of SLA are calculated from statistics derived from diagnostic A201 (mean, variance) using 2 different components in the SLA calculation. They are calculated globally, but also separating ascending and descending passes (except for SLA Grids) or separating North and South hemispheres.
Diagnostic A202_b (mission en)

Name: Differences between temporal evolution of Sea Level Anomaly (SLA)

Input data: Along track SLA

Description: The differences between temporal evolution of SLA are calculated from statistics derived from diagnostic A201 (mean, variance) using 2 different components in the SLA calculation. They are calculated globally, but also separating ascending and descending passes (except for SLA Grids) or separating North and South hemispheres.
Diagnostic A203.a (mission en)

Name: Map of Sea Level Anomaly (SLA) over all the period

Input data: Along track SLA

Description: The map of global statistics (mean, standard deviation) of SLA are calculated using successively both altimetric components in the SLA calculation over a large period. These statistics are calculated from 1 Hz altimetric measurements after removing spurious sea level measurements.
**Diagnostic A203_b (mission en)**

**Name:** Map of Sea Level Anomaly (SLA) over all the period

**Input data:** Along track SLA

**Description:** The map of global statistics (mean, standard deviation) of SLA are calculated using successively both altimetric components in the SLA calculation over a large period. These statistics are calculated from 1 Hz altimetric measurements after removing spurious sea level measurements.

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**SLA with GPD trends:** even pass numbers

Mission en, cycles 9 to 93

<table>
<thead>
<tr>
<th>Trends (mm/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-20.29394</td>
</tr>
<tr>
<td>-8.24106</td>
</tr>
<tr>
<td>3.81181</td>
</tr>
<tr>
<td>15.86469</td>
</tr>
</tbody>
</table>

**SLA with Composite trends:** even pass numbers

Mission en, cycles 9 to 93

<table>
<thead>
<tr>
<th>Trends (mm/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-20.38429</td>
</tr>
<tr>
<td>-8.27946</td>
</tr>
<tr>
<td>3.82538</td>
</tr>
<tr>
<td>15.93021</td>
</tr>
</tbody>
</table>
**Diagnostic A203_c (mission en)**

**Name**: Map of Sea Level Anomaly (SLA) over all the period

**Input data**: Along track SLA

**Description**: The map of global statistics (mean, standard deviation) of SLA are calculated using successively both altimetric components in the SLA calculation over a large period. These statistics are calculated from 1 Hz altimetric measurements after removing spurious sea level measurements.
Name: Differences between maps of SLA

Input data: Along track SLA

Description: The difference of SLA maps (mean, standard deviation, slope) is calculated from maps derived from diagnostic A203 using successively both altimetric components in the SLA calculation over a given period. This can be done globally, or separating in ascending and descending passes (except for SLA Grids).
Diagnostic A204_b (mission en)

Name: Differences between maps of SLA

Input data: Along track SLA

Description: The difference of SLA maps (mean, standard deviation, slope) is calculated from maps derived from diagnostic A203 using successively both altimetric components in the SLA calculation over a given period. This can be done globally, or separating in ascending and descending passes (except for SLA Grids).
Diagnostic A205.a (mission en)

**Name**: Differences between maps of SLA (2)

**Input data**: Along track SLA

**Description**: The difference of SLA maps (mean, standard deviation, slope) is calculated from maps derived from diagnostic A203 using successively both altimetric components in the SLA calculation over a given period. This can be done globally, or separating in ascending and descending passes (except for SLA Grids).

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**SLA with GPD amplitude – SLA with Composite amplitude**: annual signal
  **Mission en, cycles 9 to 93**

**Amplitude (cm)**
-0.05 -0.02 0.01 0.04

**Phase (degree)**
-180 -72 36 144
Name: Differences between maps of SLA (2)

Input data: Along track SLA

Description: The difference of SLA maps (mean, standard deviation, slope) is calculated from maps derived from diagnostic A203 using successively both altimetric components in the SLA calculation over a given period. This can be done globally, or separating in ascending and descending passes (except for SLA Grids).
Diagnostic A206.a (mission en)

Name: Periodogram derived from temporal evolution of Sea Level Anomaly (SLA)

Input data: Along track SLA

Description: The periodogram derived from temporal evolution of SLA (global, northern or southern hemisphere) can be done over all periods or focusing on particular periods, such as annual, semi annual or 60 day signal. Therefore mean of SLA differences are computed (every day or cycle), and time data series are plotted as a periodogram.
Name: Periodogram derived from temporal evolution of Sea Level Anomaly (SLA)

Input data: Along track SLA

Description: The periodogram derived from temporal evolution of SLA (global, northern or southern hemisphere) can be done over all periods or focusing on particular periods, such as annual, semi annual or 60 day signal. Therefore mean of SLA differences are computed (every day or cycle), and time data series are plotted as a periodogram.
**Name**: Periodogram derived from temporal evolution of Sea Level Anomaly (SLA)

**Input data**: Along track SLA

**Description**: The periodogram derived from temporal evolution of SLA (global, northern or southern hemisphere) can be done over all periods or focusing on particular periods, such as annual, semi annual or 60 day signal. Therefore mean of SLA differences are computed (every day or cycle), and time data series are plotted as a periodogram.
Name: Sea Level Anomaly (SLA) versus coastal distance

Input data: Along track SLA

Description: Mean and standard deviation of SLA - computed by using successively both altimetric components - are plotted in function of coastal distances between 0 and 100 km.
Diagnostic A208 (mission en)

Name: Sea Level Anomaly (SLA) differences versus coastal distance

Input data: Along track SLA

Description: The differences of SLA variances - computed by using successively both altimetric components - are plotted in function of coastal distances between 0 and 100 km.

\[
\text{VAR(SLA with GPD)} - \text{VAR(SLA with Composite)}
\]
Mission en, cycles 9 to 93

- Mean = -1.025

Difference of variances (cm^2)

Coastal Distance (km)
Diagnostic A209 (mission en)

Name: Differences between maps of SLA (3)

Input data: Along track SLA

Description: The differences between maps of SLA are calculated from the SLA differences (mean, standard deviation) using successively both altimetric components in the SLA calculation.

VAR(SLA with GPD) – VAR(SLA with Composite)
Mission en, cycles 9 to 93

Difference of variances (cm^2)
Name: Temporal evolution of SSH differences between tide gauges and altimetry measurements

Input data: Tide gauges SSH measurements

Description: The temporal evolution of global statistics (mean, variance, slope) of SSH differences between tide gauges and altimeter measurements are calculated from a cyclic way (altimeter repetivity) using successively both altimetric components in SSH calculation. The altimetric and tide gauges data are colocated with criteria of maximum of correlation, and tide gauges used are derived from global networks (GLOSS/CLIVAR, REFMAR).
Diagnostic C002 (mission en)

Name: Differences of temporal evolution of SSH differences between tide gauges and altimetry measurements

Input data: Tide gauges SSH measurements

Description: The difference between temporal evolution of global statistics of differences between tide gauge and altimeter data differences are calculated from a cyclic way (altimeter repetivity, daily, weekly, monthly) using successively both altimetric components in altimetric SSH calculation. The altimetric and tide gauges data are collocated with criteria of maximum of correlation, and tide gauges used are derived from global networks as GLOSS/CLIVAR.
Diagnostic C003 (mission en)

**Name:** Periodogram derived from temporal evolution of SSH differences between tide gauges and altimetry

**Input data:** Tide gauges SSH measurements

**Description:** The periodogram derived from temporal evolution of altimetric and tide gauges SSH differences is calculated using successively both altimetric components in the altimetric SSH. The periodogram is calculated from the mean or variance statistics and it can be displayed for all the whole time period or a dedicated one.

![Periodogram of SLA differences: altimetry mesurements - tide gaugues (ref. period = 1 year)](image1)

Periodogram of SLA differences: altimetry mesurements - tide gaugues (period = [0, 1 year])

Mission en, cycles 9 to 93

![Periodogram of SLA differences: altimetry mesurements - tide gaugues (period = 1 year)](image2)
Diagnostic C004 (mission en)

**Name:** Histograms of differences between tide gauges and altimeter SSH differences

**Input data:** Tide gauges SSH measurements

**Description:** The difference of histograms between altimeter and tide gauge SSH differences is computed from the elementary statistics (mean, variance) at each tide gauge using successively both altimetric components in the altimetry SSH.

Histogram of the difference of variances: \( \text{VAR(SLA with GPD - T. G.)} - \text{VAR(SLA with Composite - T. C.)} \)

Mission en, cycles 9 to 93

- Nbr = 146
- Mean = 0.001795
- StdDev = 0.01155

Number of tide gauges vs Differences of variances (cm^2)