

# Coastal wet tropospheric correction: GPD vs Composite

Study variable	<b>GPD</b>
Reference variable	<b>Composite</b>
Missions	Envisat ( <i>en</i> )
Period	[19259, 22209]

Creation date : 2011/08/27

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## 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).

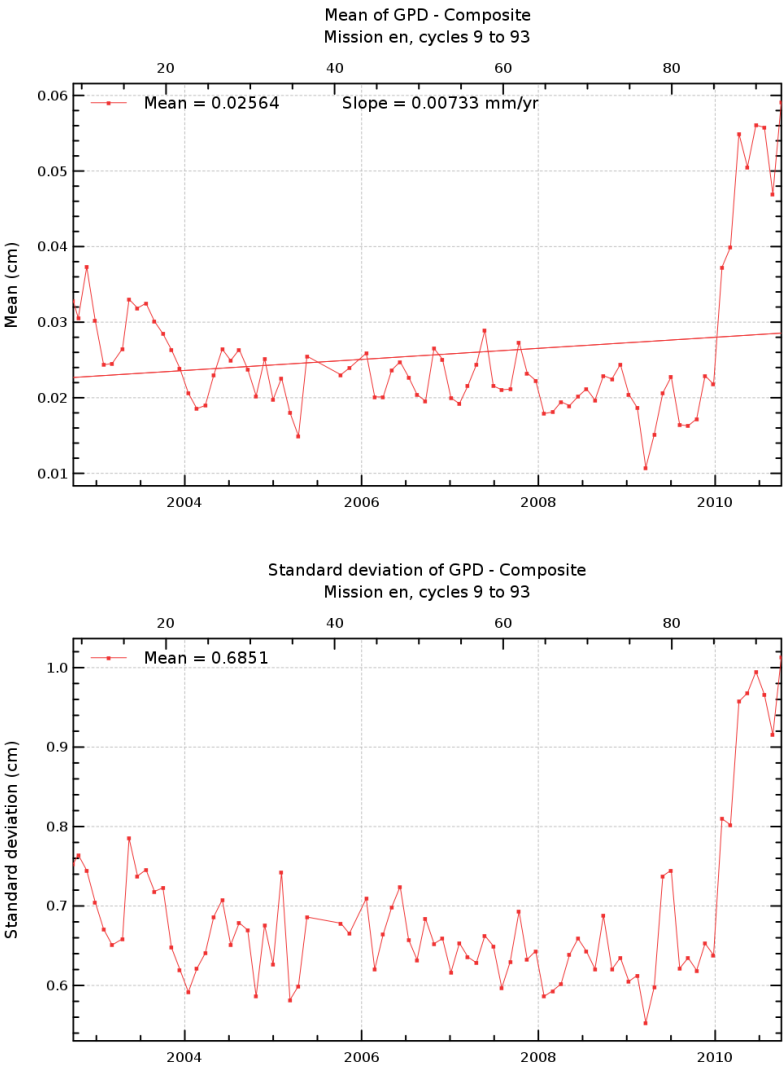
The major aim of WP2710 is to provide a wet tropospheric correction for the coastal zone, applicable to all missions, fully compatible with respect to the microwave radiometer (MWR) based correction that shall be adopted in the open ocean, and ensuring its continuity and consistency in the open ocean/coastal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

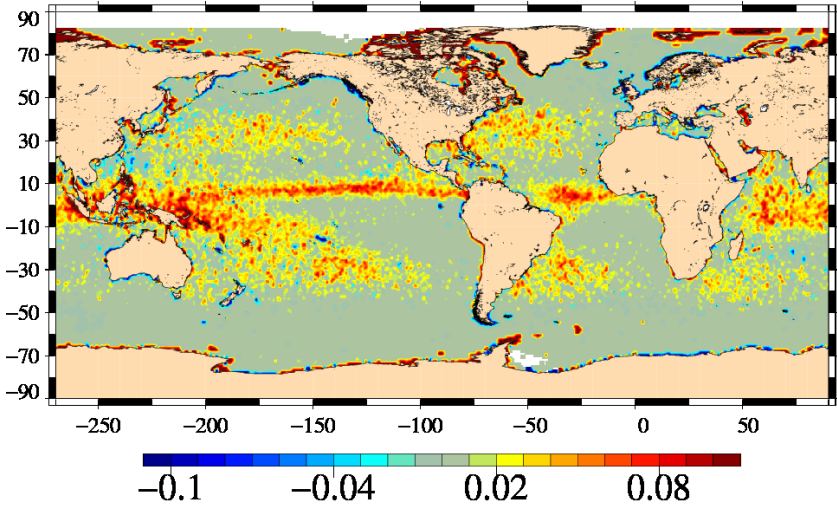
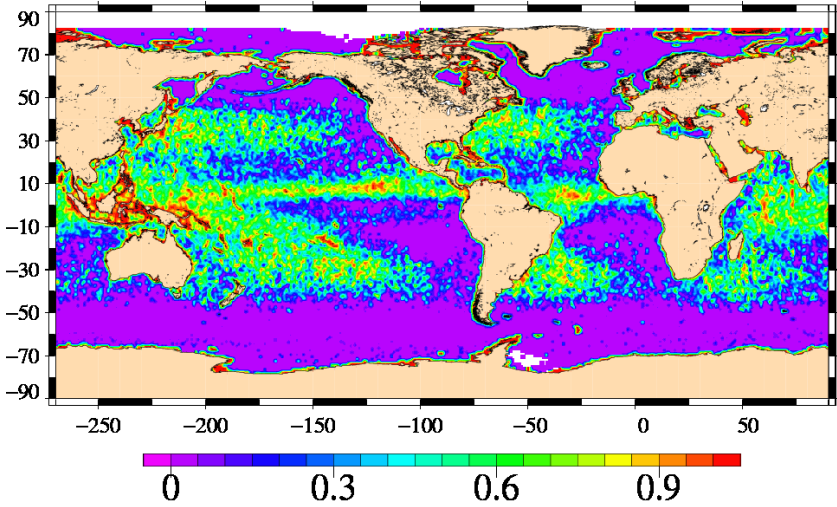
This study has been performed on points where the studied correction is a valid estimate (GPD flag=1) and on non corrupted ocean points where it equals the radiometric correction (GPD flag=0).

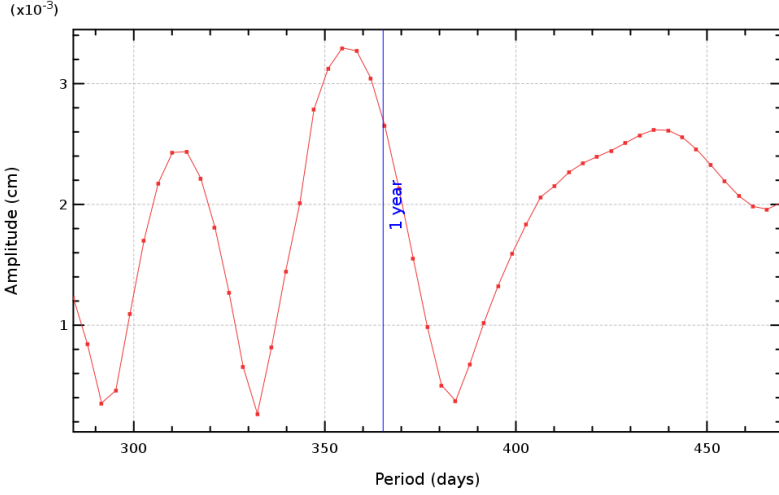
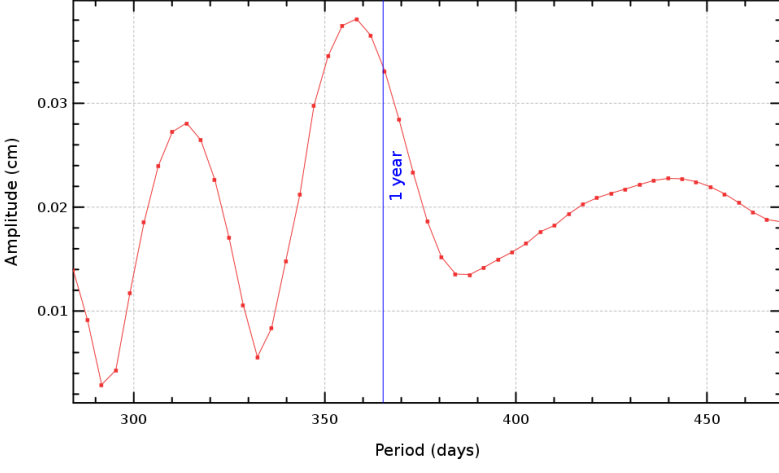
For Envisat mission, the composite wet tropospheric correction is the reference: the radiometric wet tropospheric correction present in GDR products is used for coastal distances greater than 50 km while the ECMWF operational correction model is used for coastal distances lower than 50 km. The ECMWF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



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.	
<div>Mean of GPD – Composite Mission en, cycles 9 to 93</div>  <div>Mean ( cm )</div> <div>Standard deviation of GPD – Composite Mission en, cycles 9 to 93</div>  <div>Standard deviation ( cm )</div>	

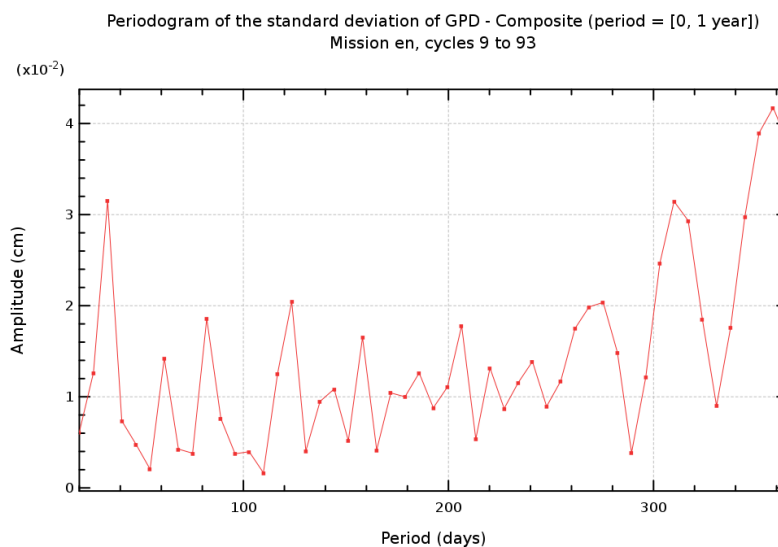
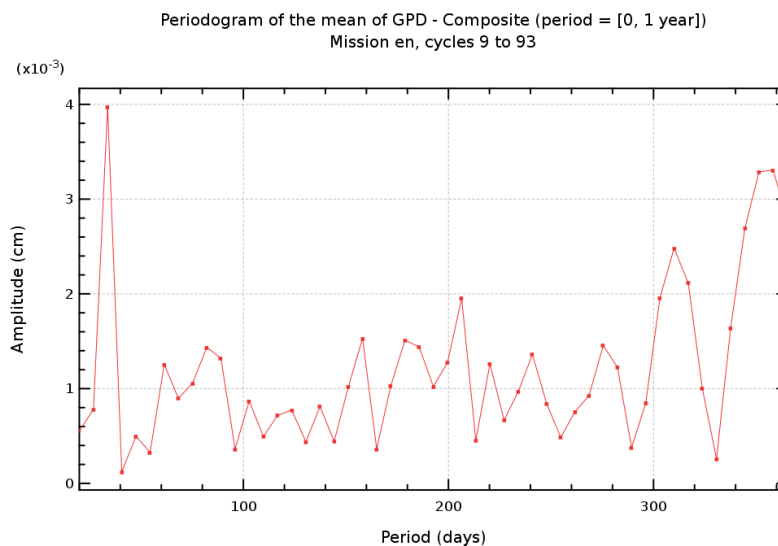
Diagnostic A003_a (mission en)	
Name : Periodogram derived from temporal evolution of altimetric component differences	
Input data : Along-track altimetric components	
<p><b>Description :</b> The periodogram derived from temporal and global altimetric component differences is calculated from cycle by 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.</p>	
<div><p>Periodogram of the mean of GPD - Composite (reference period = 1 year) Mission en, cycles 9 to 93</p><p>Periodogram of the standard deviation of GPD - Composite (reference period = 1 year) Mission en, cycles 9 to 93</p></div>	

## Diagnostic A003\_b (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.



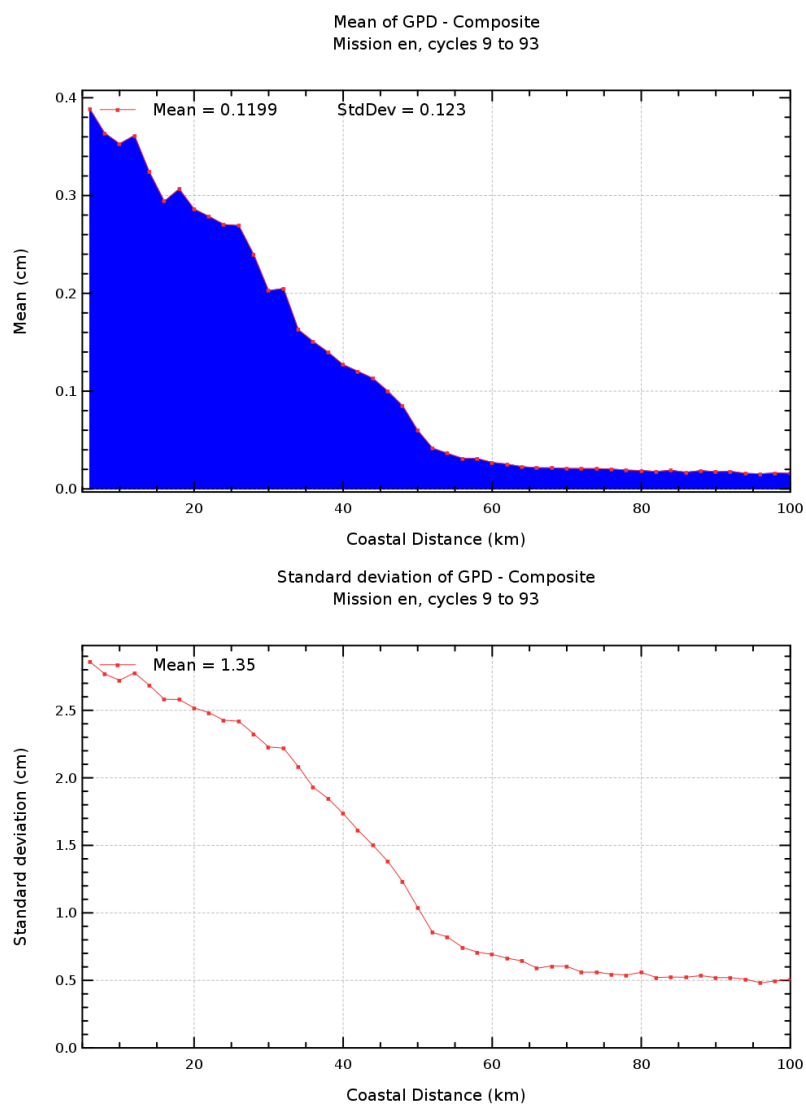
**Diagnostic A004 (mission en)**

**Name :** Altimetric component differences versus coastal distances

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

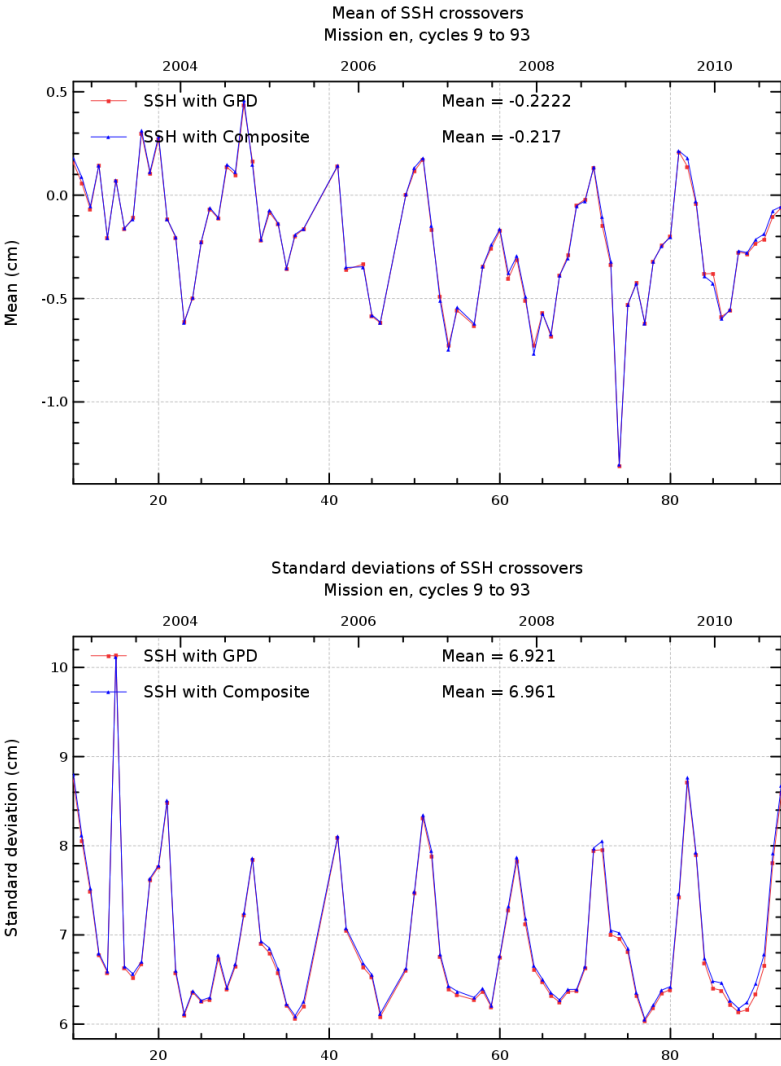
**Description :** Mean and standard deviation of the differences between 2 different standards of a same altimetric component (sea surface height correction, altimeter parameter, orbit) are computed and plotted in function of coastal distances between 0 and 100 km.

Diagnostic type : Global internal analyses





Diagnostic A101 (mission en)	
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).	



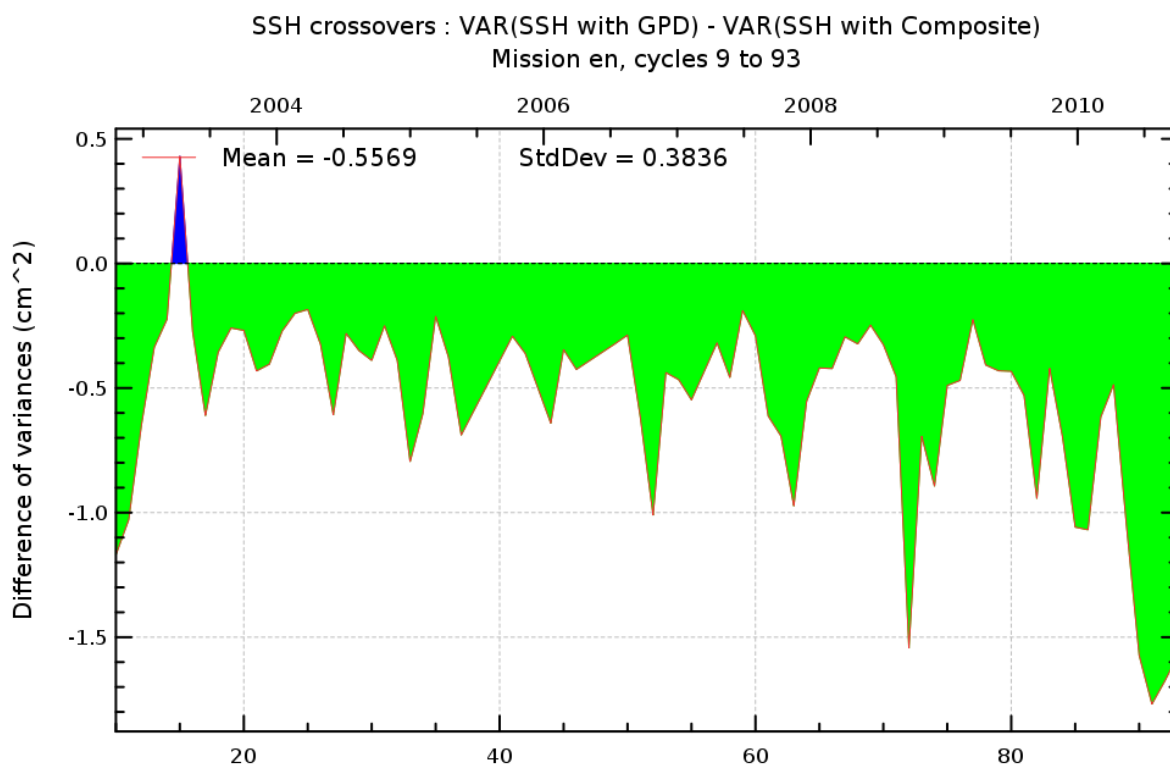
**Diagnostic A102 (mission en)**

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

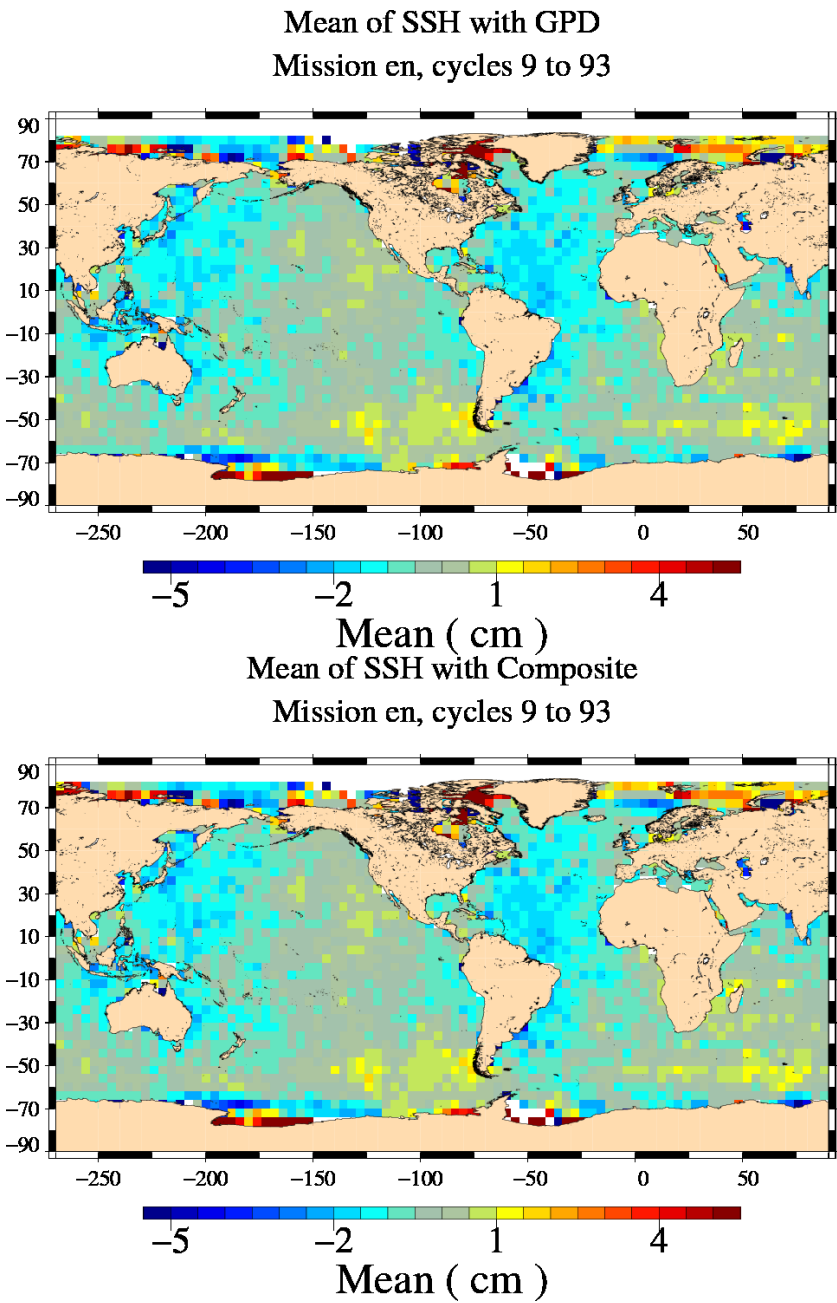
**Input data :** Sea Surface Height (SSH) crossovers

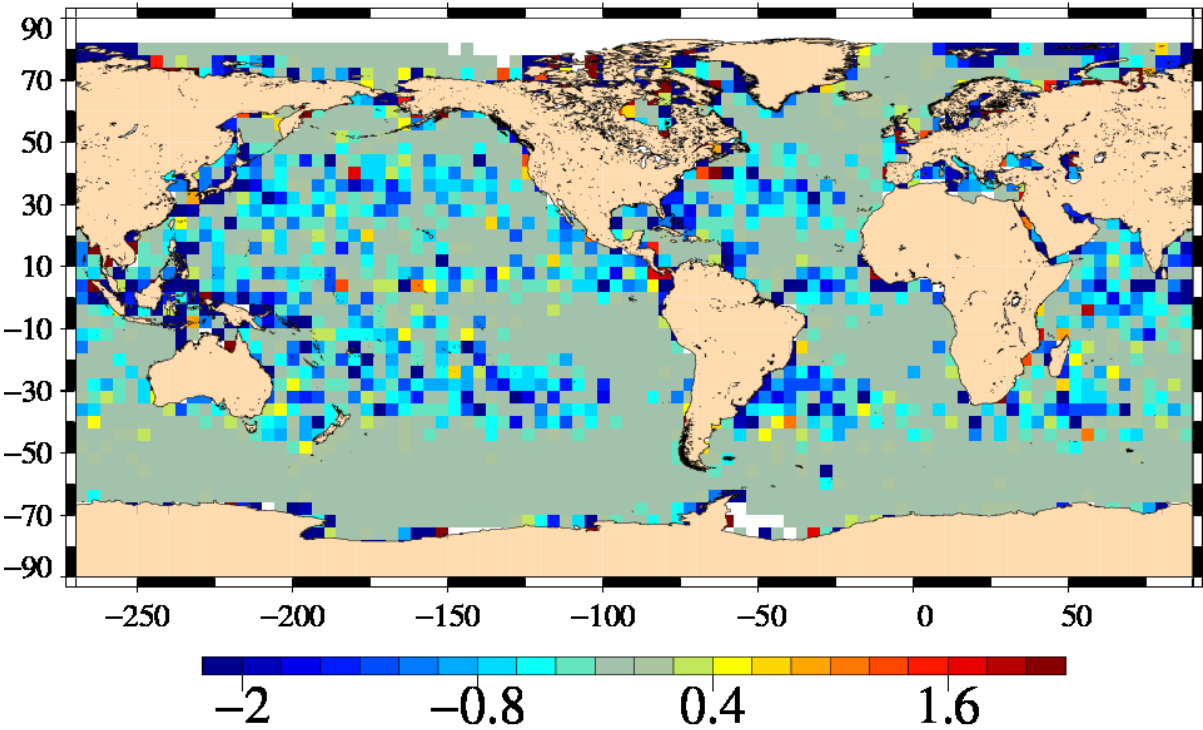
**Description :** The difference of temporal evolution between the global statistics (mean, standard deviation) of SSH differences are calculated using successively both altimetric components in the SSH calculation. SSH crossovers are the differences between ascending and descending passes for time differences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

Diagnostic type : Global internal analyses



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 type : Global internal analyses	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).
	<div>VAR(SSH with GPD) – VAR(SSH with Composite) Mission en, cycles 9 to 93</div>  <p>SSH crossovers : difference of variances ( cm<sup>2</sup> )</p>

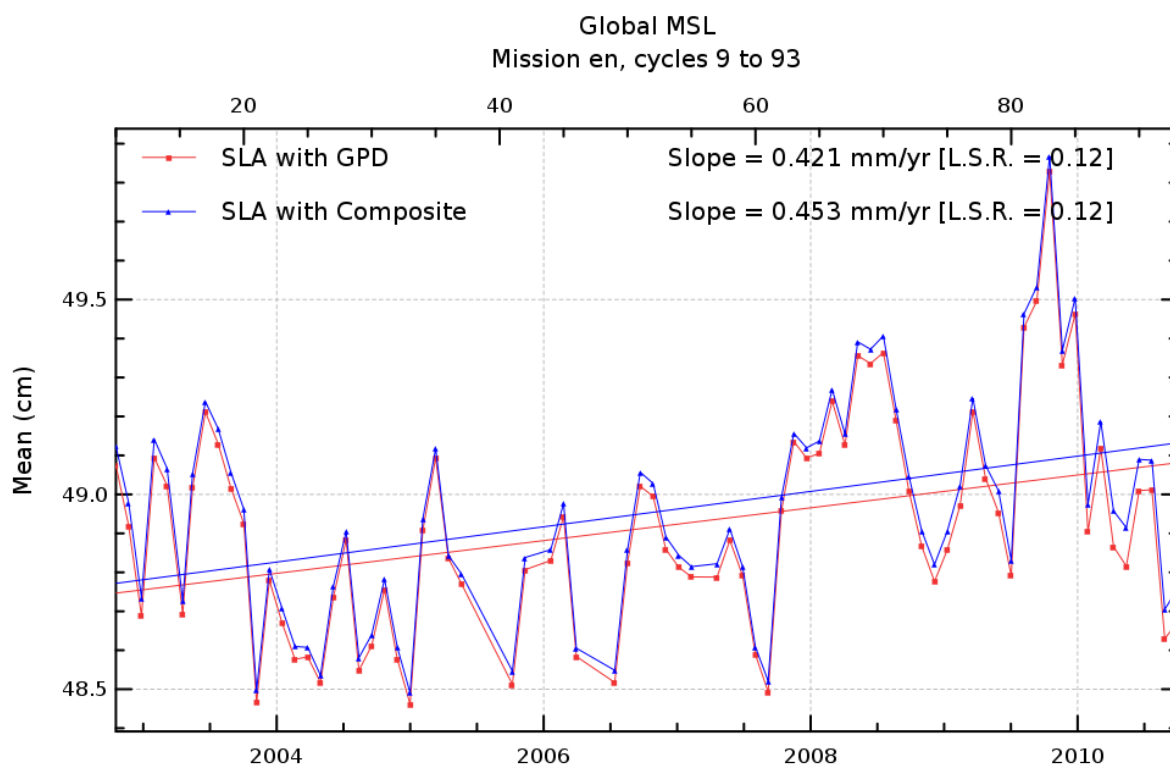
## Diagnostic A201 a (mission en)

**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.

Diagnostic type : Global internal analyses



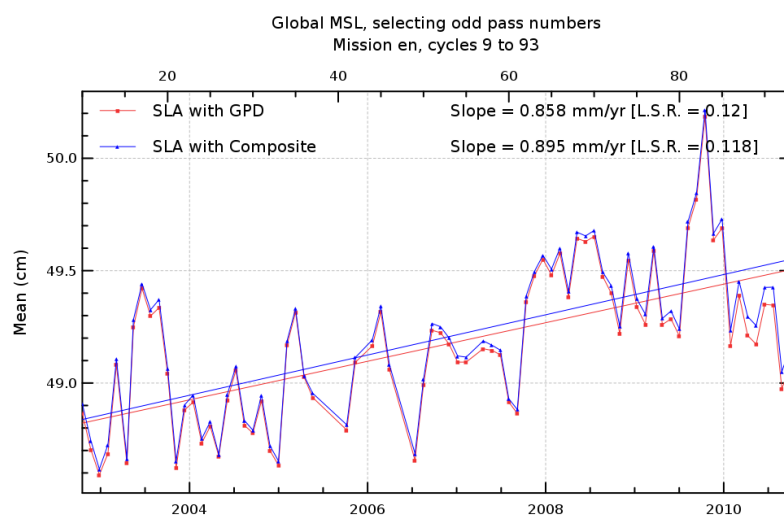
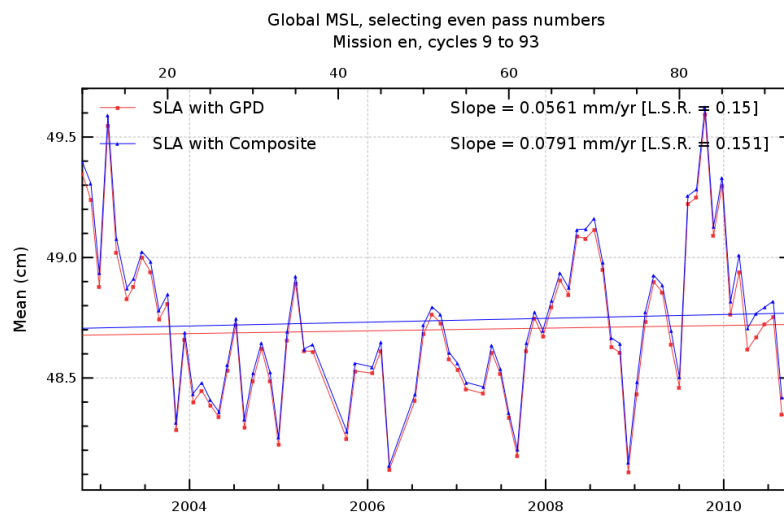
## Diagnostic A201\_b (mission en)

**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.

Diagnostic type : Global internal analyses



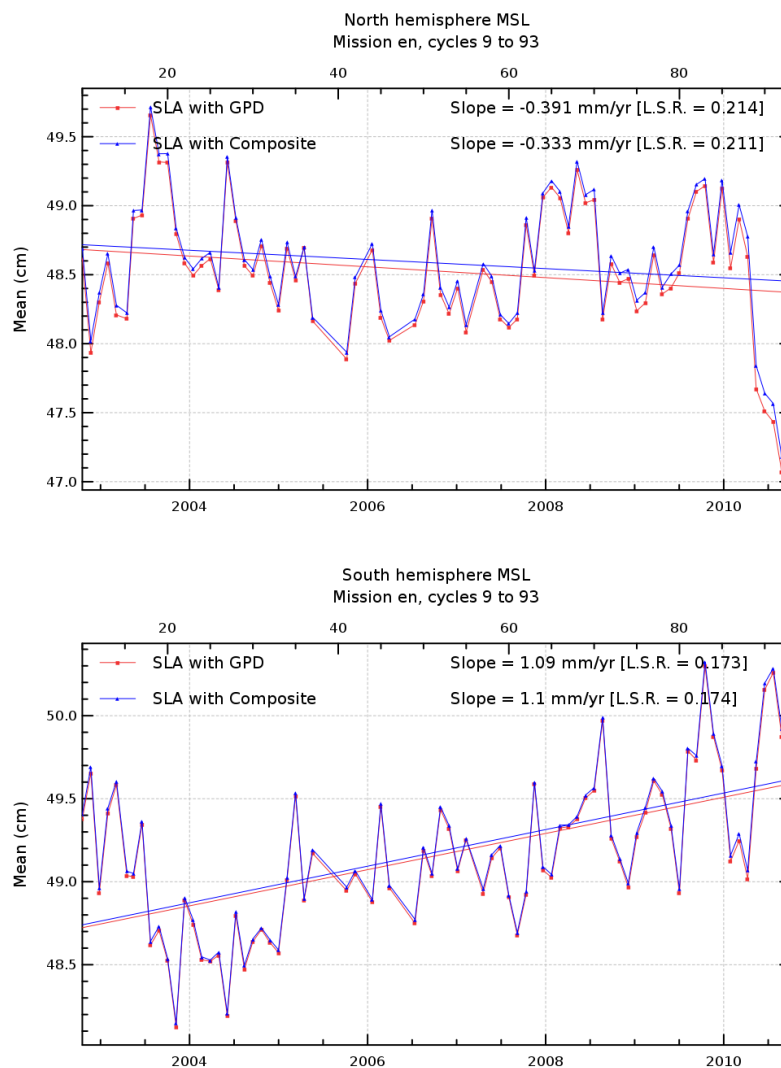
## Diagnostic A201\_c (mission en)

**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.

Diagnostic type : Global internal analyses



## Diagnostic A201\_d (mission en)

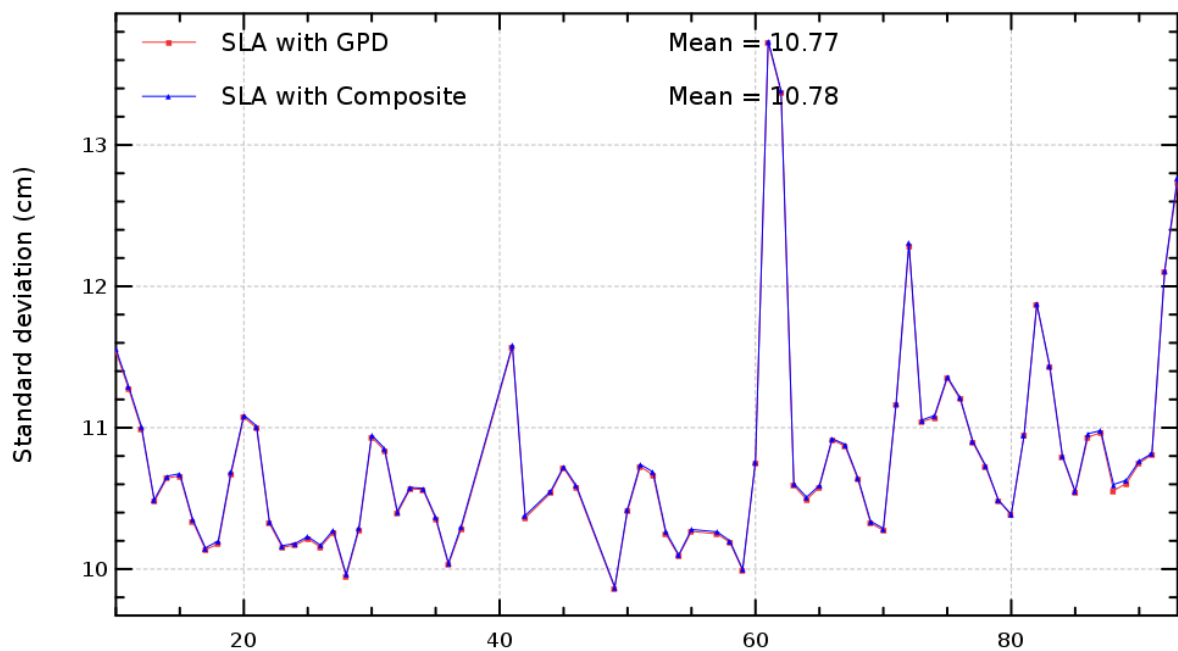
**Name :** Temporal evolution of Sea Level Anomaly (SLA)

**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.

Diagnostic type : Global internal analyses

Global MSL  
Mission en, cycles 9 to 93





## Diagnostic A201\_e (mission en)

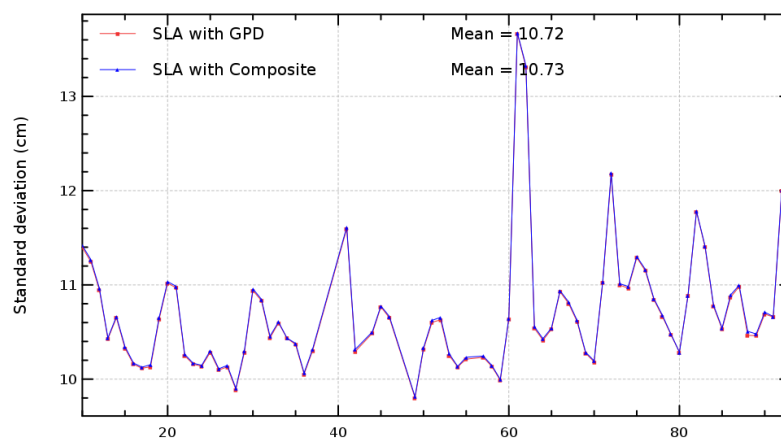
**Name :** Temporal evolution of Sea Level Anomaly (SLA)

**Input data :** Along track SLA

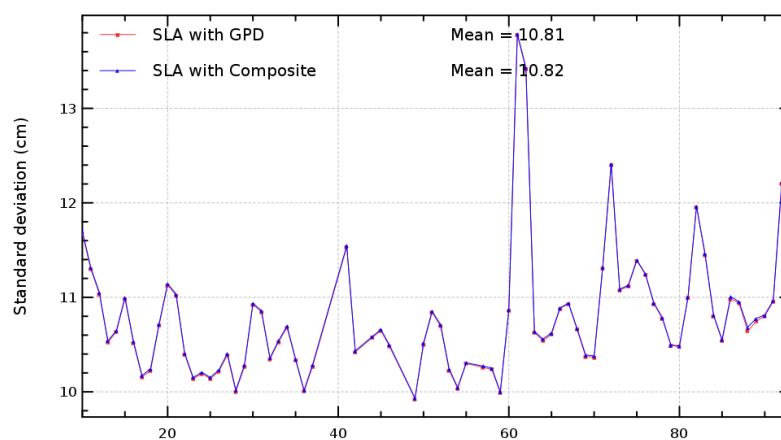
**Description :** The temporal evolution of SLA statistics (mean, standard deviation) are calculated from a cyclic way (altimeter repetivity, daily, weekly, monthly) using successively both altimetric components in the SLA calculation. These statistics are calculated from 1 Hz altimetric measurements 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.

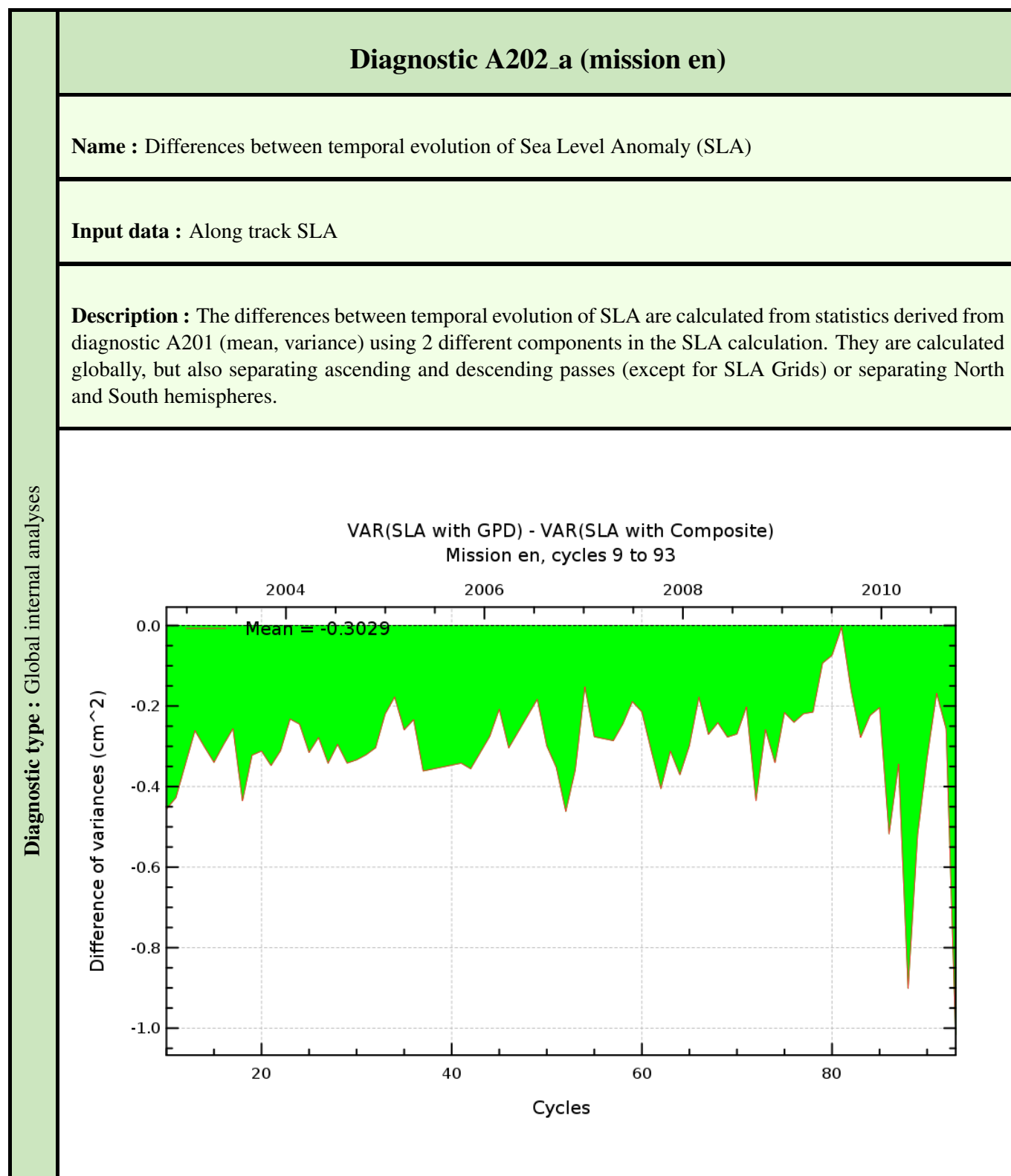
Diagnostic type : Global internal analyses

Global MSL, selecting even pass numbers  
Mission en, cycles 9 to 93



Global MSL, selecting odd pass numbers  
Mission en, cycles 9 to 93





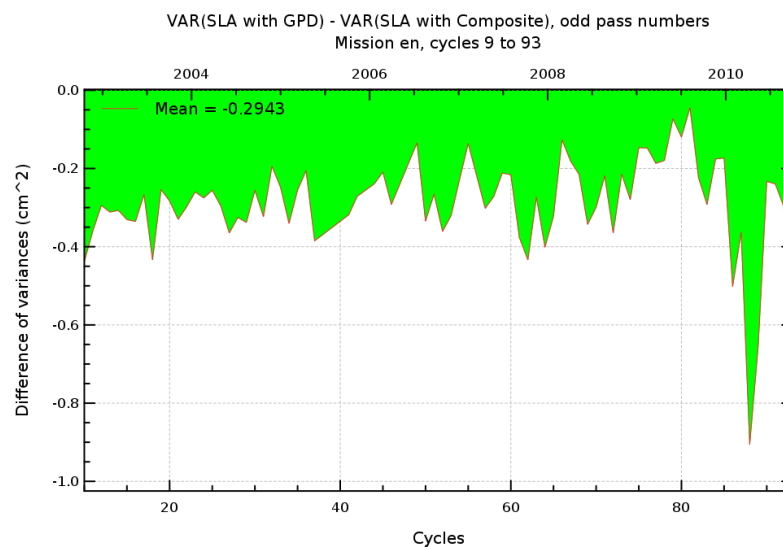
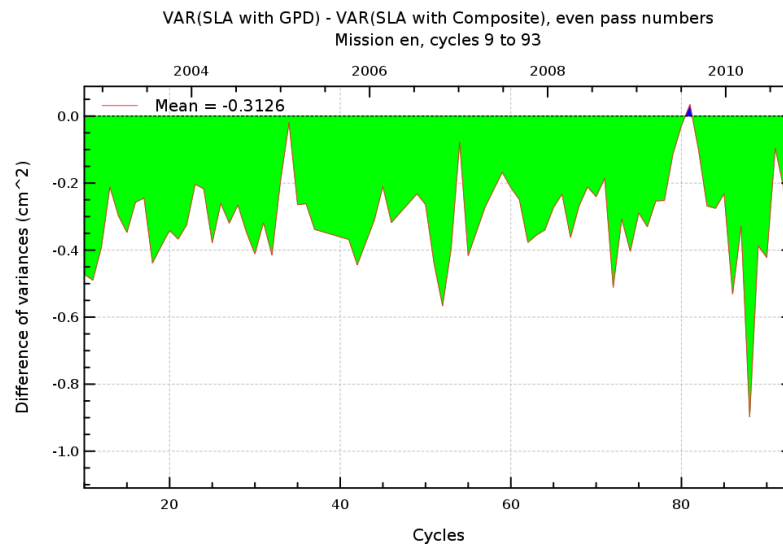
## Diagnostic A202\_b (mission en)

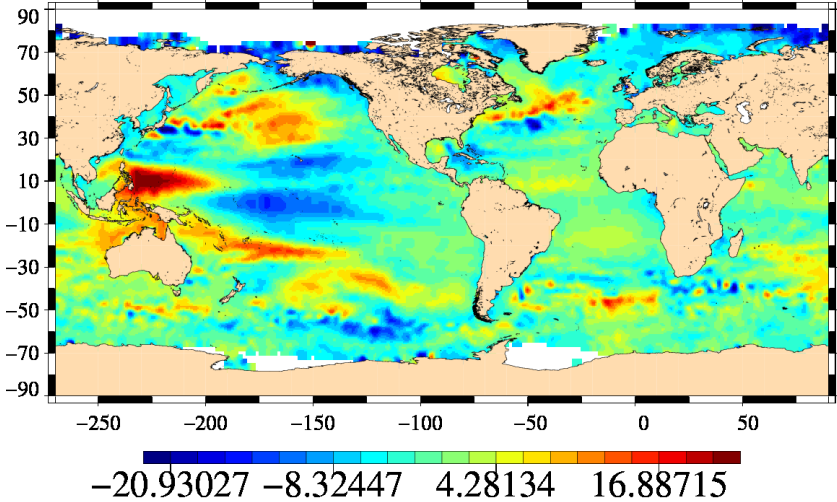
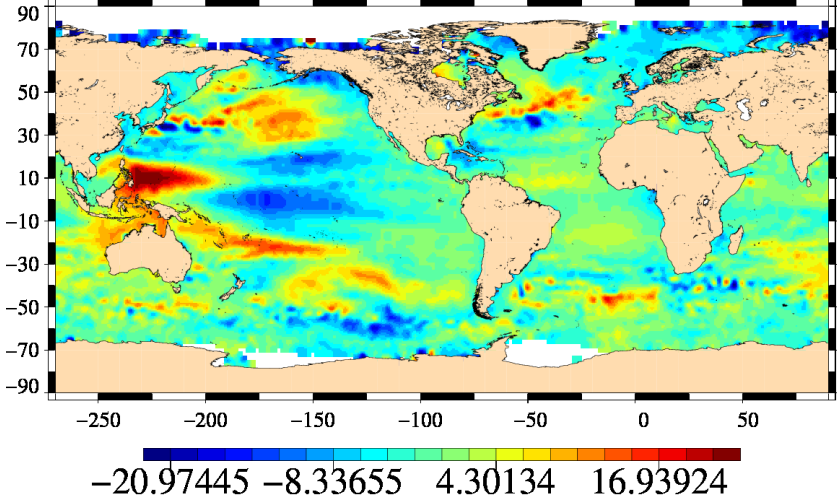
**Name :** Differences between temporal evolution of Sea Level Anomaly (SLA)

**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 type : Global internal analyses



Diagnostic type : Global internal analyses	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.	
	<div>SLA with GPD trends</div> <div>Mission en, cycles 9 to 93</div>  <div>-20.93027 -8.32447 4.28134 16.88715</div> <div>Trends (mm/yr)</div> <div>SLA with Composite trends</div> <div>Mission en, cycles 9 to 93</div>  <div>-20.97445 -8.33655 4.30134 16.93924</div> <div>Trends (mm/yr)</div>	

## Diagnostic A203\_b (mission en)

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

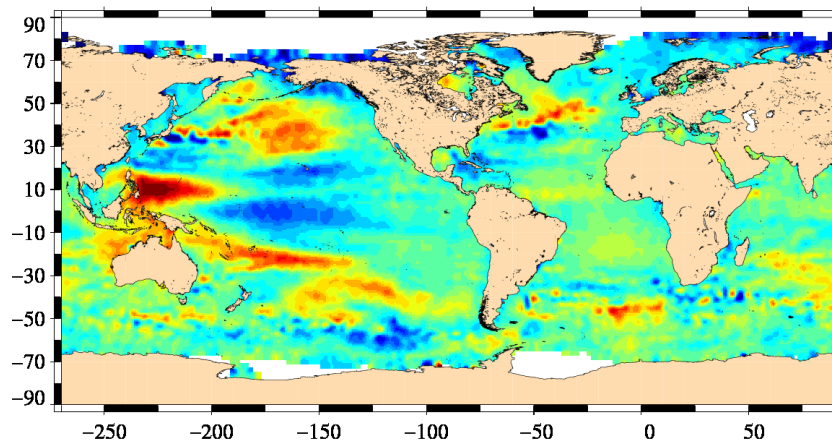
**Input data :** Along track SLA

**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.

Diagnostic type : Global internal analyses

SLA with GPD trends : even pass numbers

Mission en, cycles 9 to 93

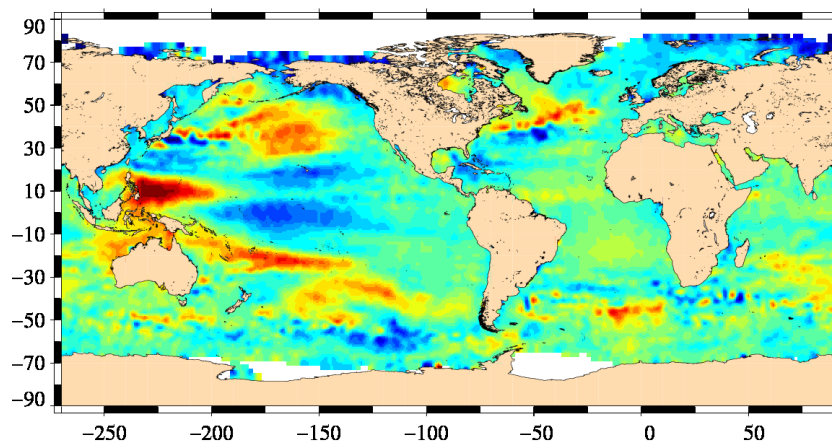


-20.29394 -8.24106 3.81181 15.86469

Trends (mm/yr)

SLA with Composite trends : even pass numbers

Mission en, cycles 9 to 93



-20.38429 -8.27946 3.82538 15.93021

Trends (mm/yr)

## Diagnostic A203\_c (mission en)

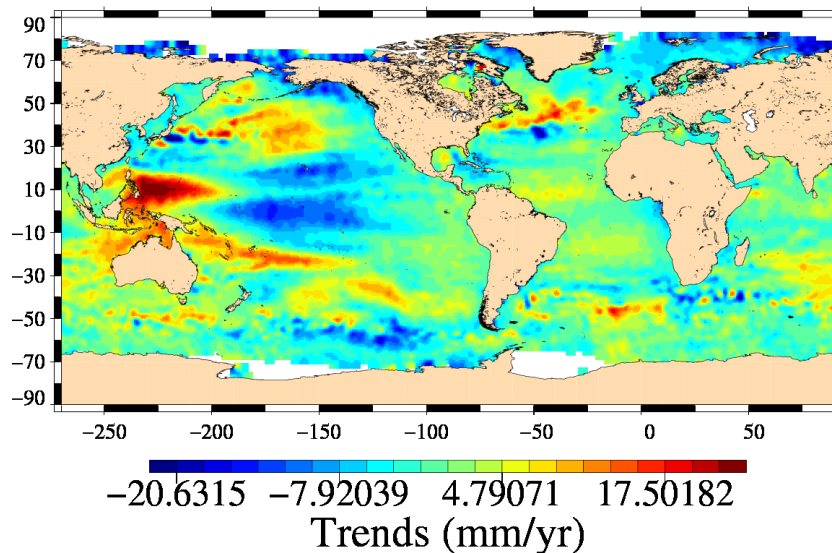
**Name :** Map of Sea Level Anomaly (SLA) over all the period

**Input data :** Along track SLA

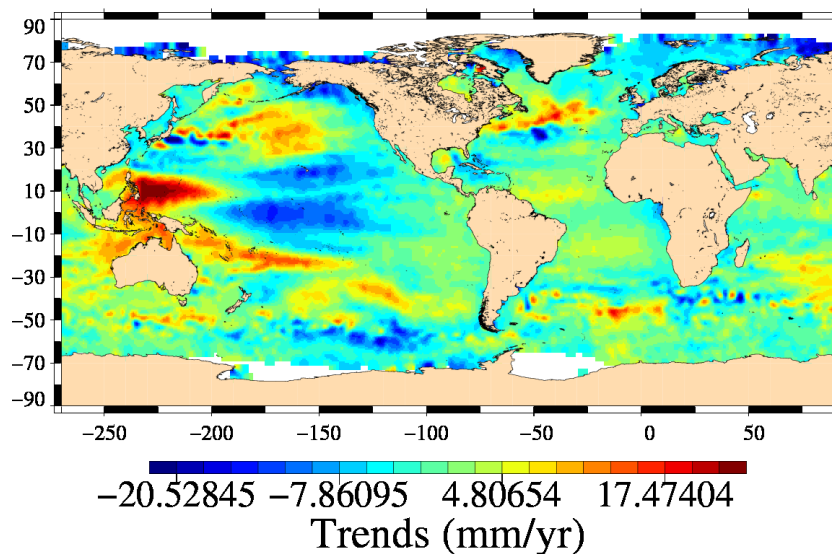
**Description :** The map of global statistics (mean, standard deviation) of SLA are calculated using successively both altimetric components in the SLA calculation over a large period. These statistics are calculated from 1 Hz altimetric measurements after removing spurious sea level measurements.

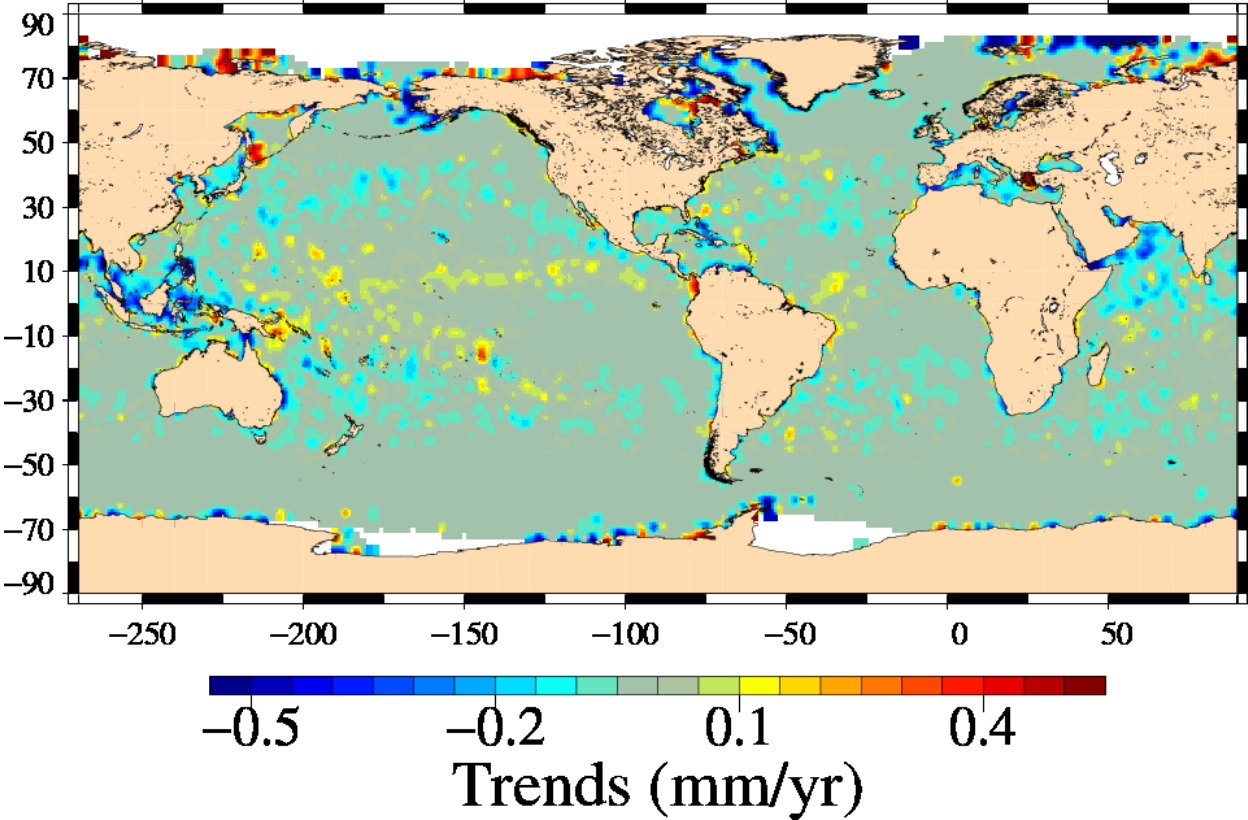
Diagnostic type : Global internal analyses

SLA with GPD trends : odd pass numbers  
Mission en, cycles 9 to 93



SLA with Composite trends : odd pass numbers  
Mission en, cycles 9 to 93



Diagnostic type : Global internal analyses	Diagnostic A204_a (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).	
	<div>SLA with GPD trends – SLA with Composite trends</div> <div>Mission en, cycles 9 to 93</div> 	



## Diagnostic A204\_b (mission en)

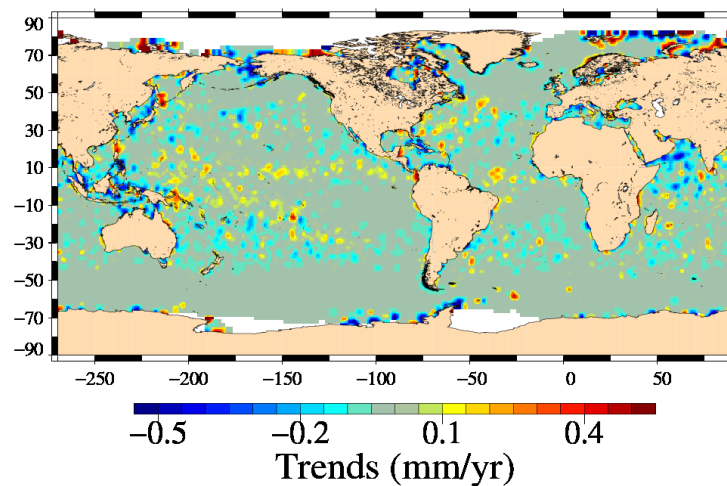
**Name :** Differences between maps of SLA

**Input data :** Along track SLA

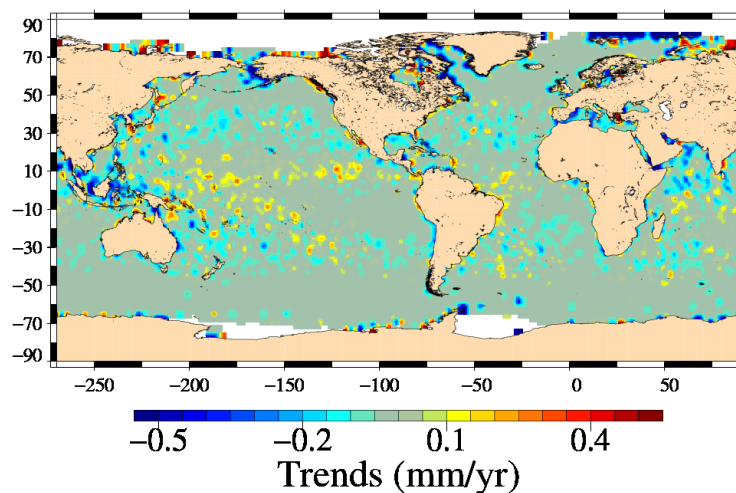
**Description :** The difference of SLA maps (mean, standard deviation, slope) is calculated from maps derived from diagnostic A203 using successively both altimetric components in the SLA calculation over a given period. This can be done globally, or separating in ascending and descending passes (except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

Diagnostic type : Global internal analyses

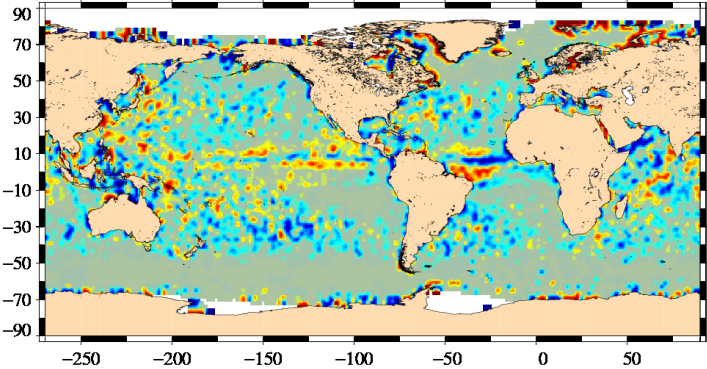
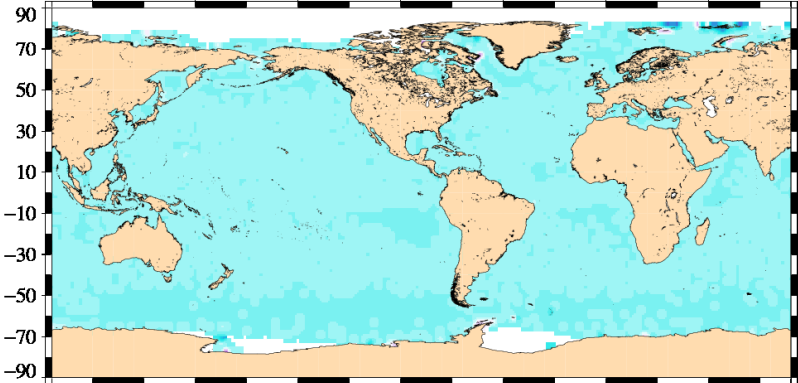
SLA with GPD trends – SLA with Composite trends : even pass numbers  
Mission en, cycles 9 to 93



SLA with GPD trends – SLA with Composite trends : odd pass numbers  
Mission en, cycles 9 to 93





Diagnostic type : Global internal analyses	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).	
	<div>SLA with GPD amplitude – SLA with Composite amplitude : annual signal Mission en, cycles 9 to 93</div> <div><p>A global map showing the difference in SLA amplitude between GPD and composite data. The map covers latitudes from -90 to 90 and longitudes from -250 to 50. A color scale at the bottom indicates amplitude in cm, ranging from -0.05 (dark blue) to 0.04 (dark red), with intermediate values at -0.02, 0.01, and 0. The map shows significant spatial variability, with higher positive differences (red/orange) in the central and eastern Pacific and lower differences (blue) in the Indian Ocean and parts of the Atlantic.</p></div> <div>SLA with GPD phase – SLA with Composite phase : annual signal Mission en, cycles 9 to 93</div> <div><p>A global map showing the difference in SLA phase between GPD and composite data. The map covers latitudes from -90 to 90 and longitudes from -250 to 50. A color scale at the bottom indicates phase in degrees, ranging from -180 (dark purple) to 144 (dark blue), with intermediate values at -72, 36, and 90. The map shows a more uniform distribution of phase differences compared to the amplitude map, with most values falling between -72 and 36 degrees.</p></div>	

## Diagnostic A205\_b (mission en)

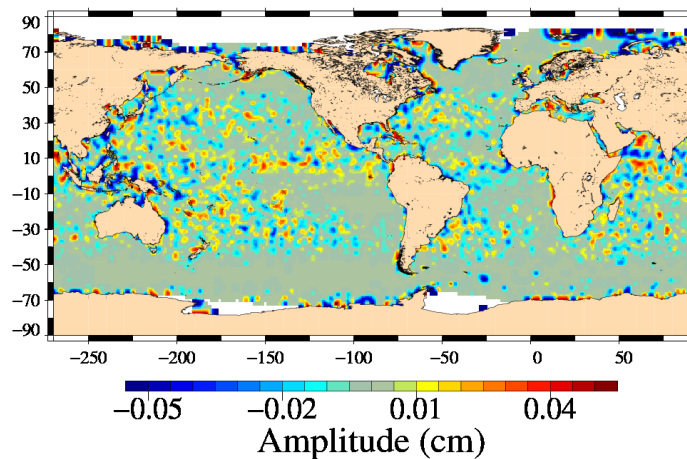
**Name :** Differences between maps of SLA (2)

**Input data :** Along track SLA

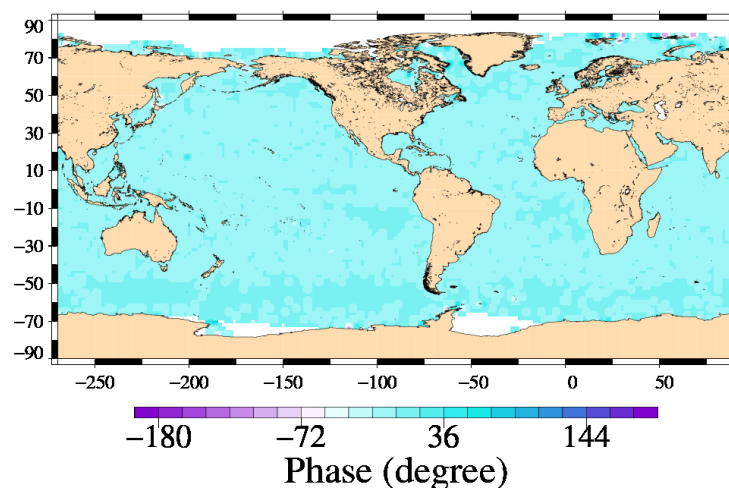
**Description :** The difference of SLA maps (mean, standard deviation, slope) is calculated from maps derived from diagnostic A203 using successively both altimetric components in the SLA calculation over a given period. This can be done globally, or separating in ascending and descending passes (except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

Diagnostic type : Global internal analyses

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



SLA with GPD phase – SLA with Composite phase : semi-annual signal  
Mission en, cycles 9 to 93



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.	
<div>Periodogram of SLA (reference period = 1 year) Mission en, cycles 9 to 93</div> <p>This plot shows the amplitude of SLA in centimeters versus the period in days. The x-axis ranges from 300 to 450 days, and the y-axis ranges from 0.0 to 0.6 cm. Two data series are shown: 'SLA with GPD' (red line with square markers) and 'SLA with Composite' (blue line with triangle markers). Both series show a prominent peak at approximately 365 days, which is marked by a vertical green line labeled '1 year'. The amplitude at this peak is about 0.7 cm. There is a smaller peak around 450 days with an amplitude of about 0.15 cm. The two series are nearly identical.</p> <div>Periodogram of SLA (period = [0, 1 year]) Mission en, cycles 9 to 93</div> <p>This plot shows the amplitude of SLA in centimeters versus the period in days. The x-axis ranges from 0 to 350 days, and the y-axis ranges from 0.0 to 0.6 cm. Two data series are shown: 'SLA with GPD' (red line with square markers) and 'SLA with Composite' (blue line with triangle markers). The plot shows several small peaks, with the most significant one at approximately 350 days, reaching an amplitude of about 0.7 cm. The two series are nearly identical.</p>	

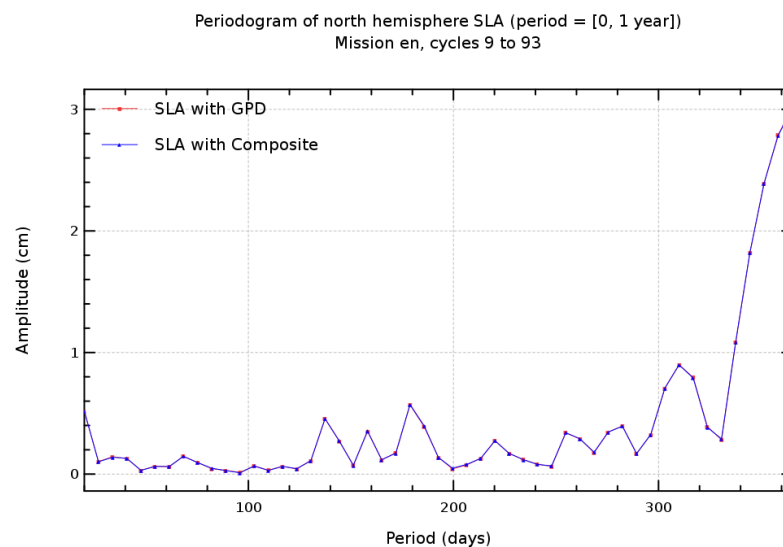
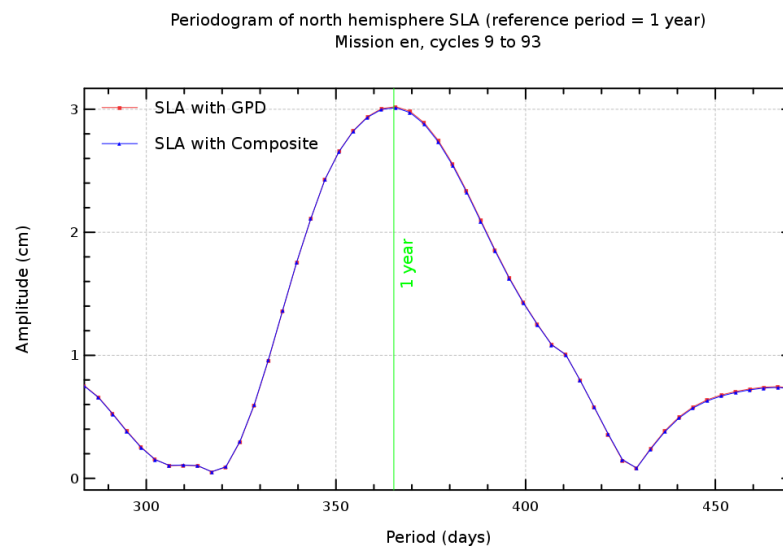
## Diagnostic A206\_b (mission en)

**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.

Diagnostic type : Global internal analyses



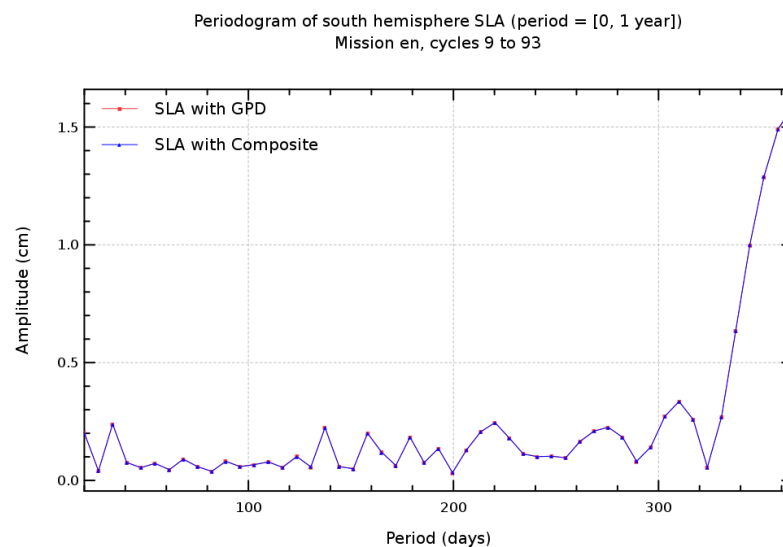
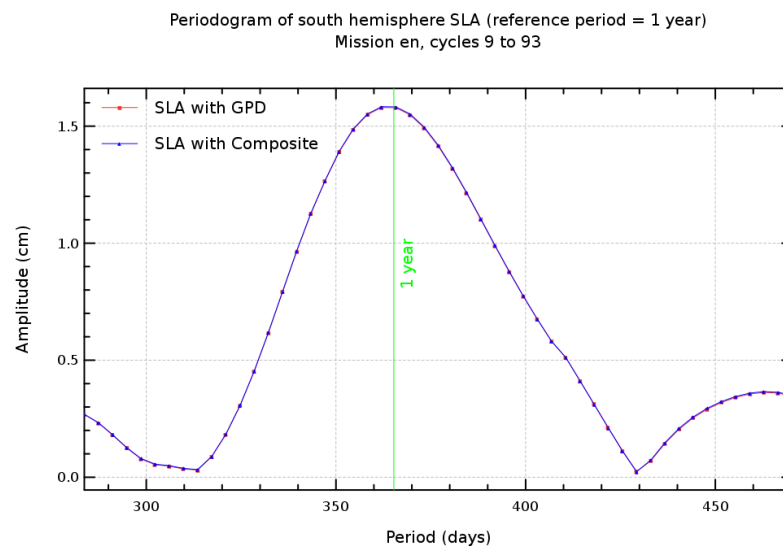
## Diagnostic A206\_c (mission en)

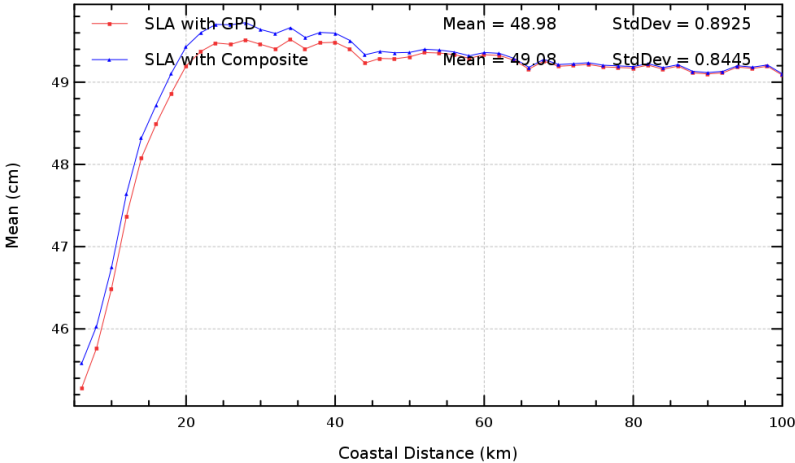
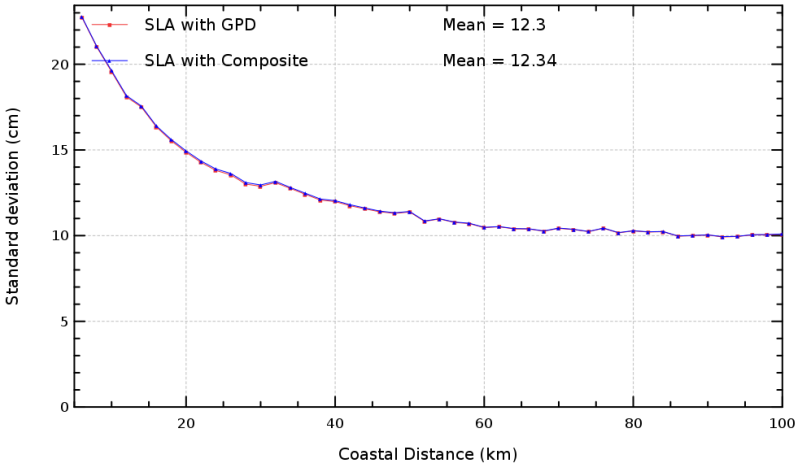
**Name :** Periodogram derived from temporal evolution of Sea Level Anomaly (SLA)

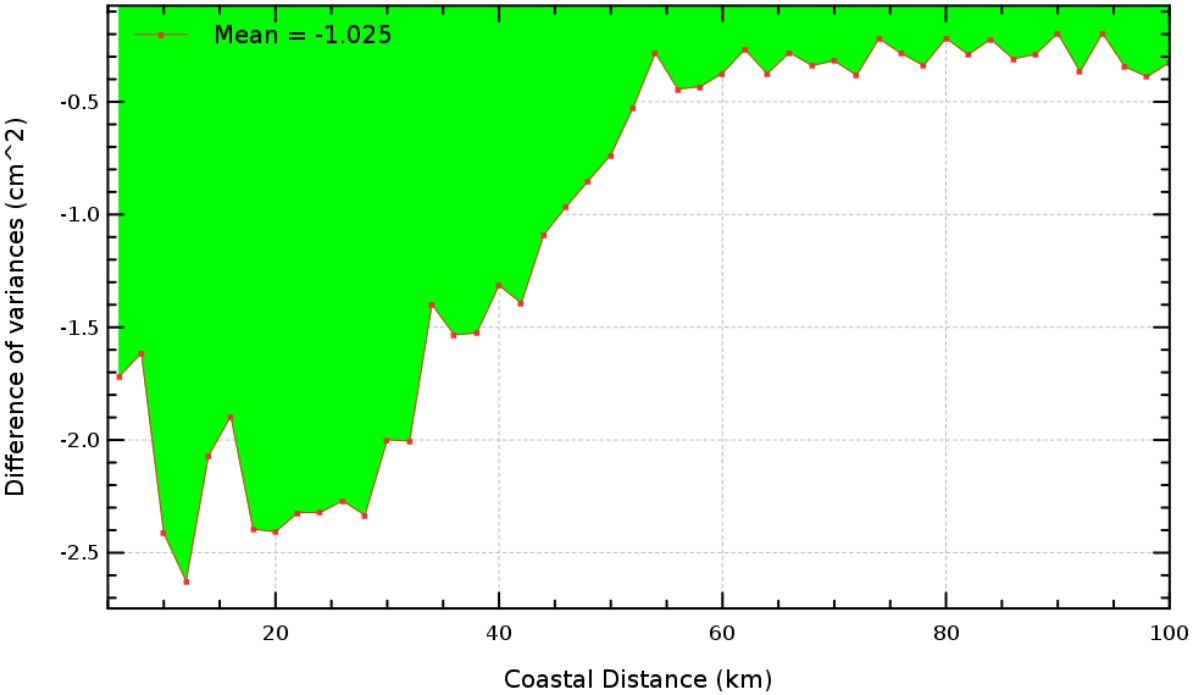
**Input data :** Along track SLA

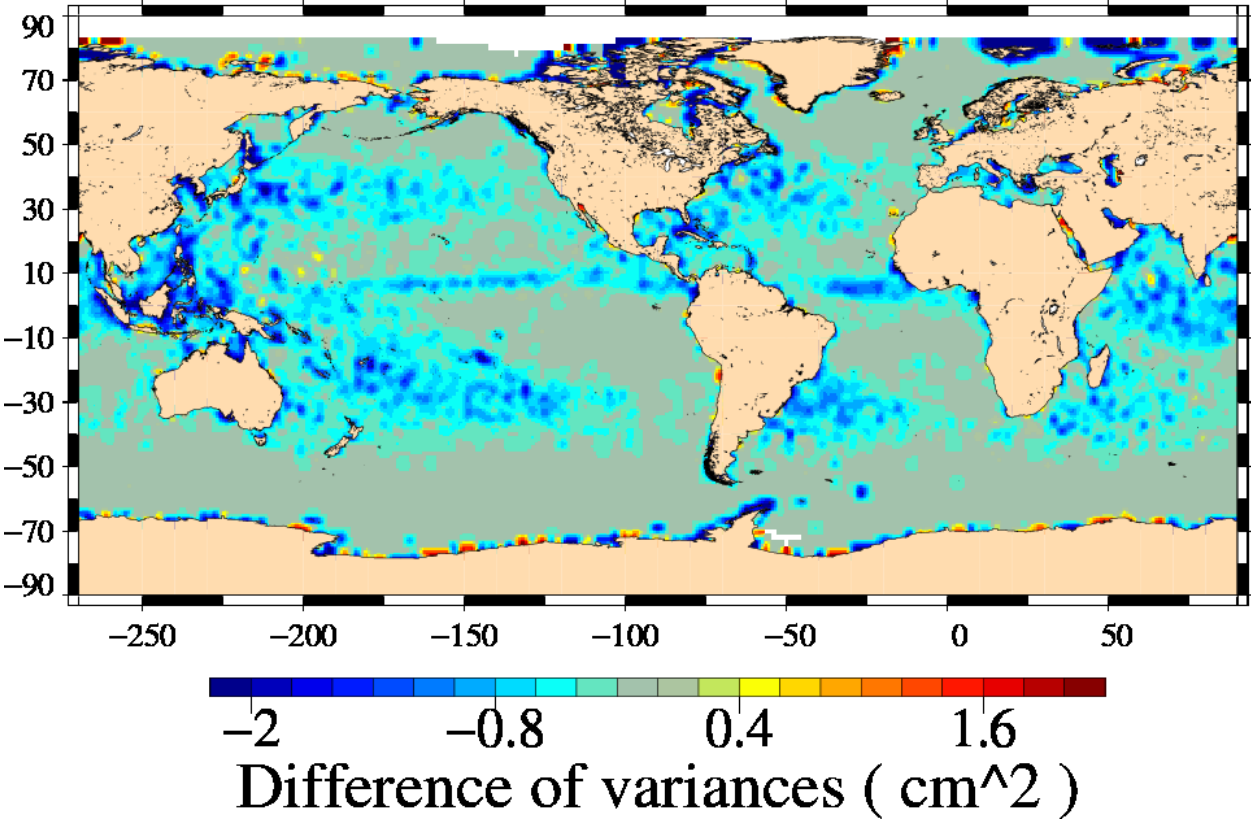
**Description :** The periodogram derived from temporal evolution of SLA (global, northern or southern hemisphere) can be done over all periods or focusing on particular periods, such as annual, semi annual or 60 day signal. Therefore mean of SLA differences are computed (every day or cycle), and time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

Diagnostic type : Global internal analyses



Diagnostic type : Global internal analyses	Diagnostic A207 (mission en)	
	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.	
	<div>Global MSL Mission en, cycles 9 to 93</div>  <div>Global MSL Mission en, cycles 9 to 93</div> 	

Diagnostic type : Global internal analyses	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.
	<div>VAR(SLA with GPD) - VAR(SLA with Composite) Mission en, cycles 9 to 93</div> 

Diagnostic type : Global internal analyses	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.	
	<div>VAR(SLA with GPD) – VAR(SLA with Composite)</div> <div>Mission en, cycles 9 to 93</div> 	



**Diagnostic C001 (mission en)**

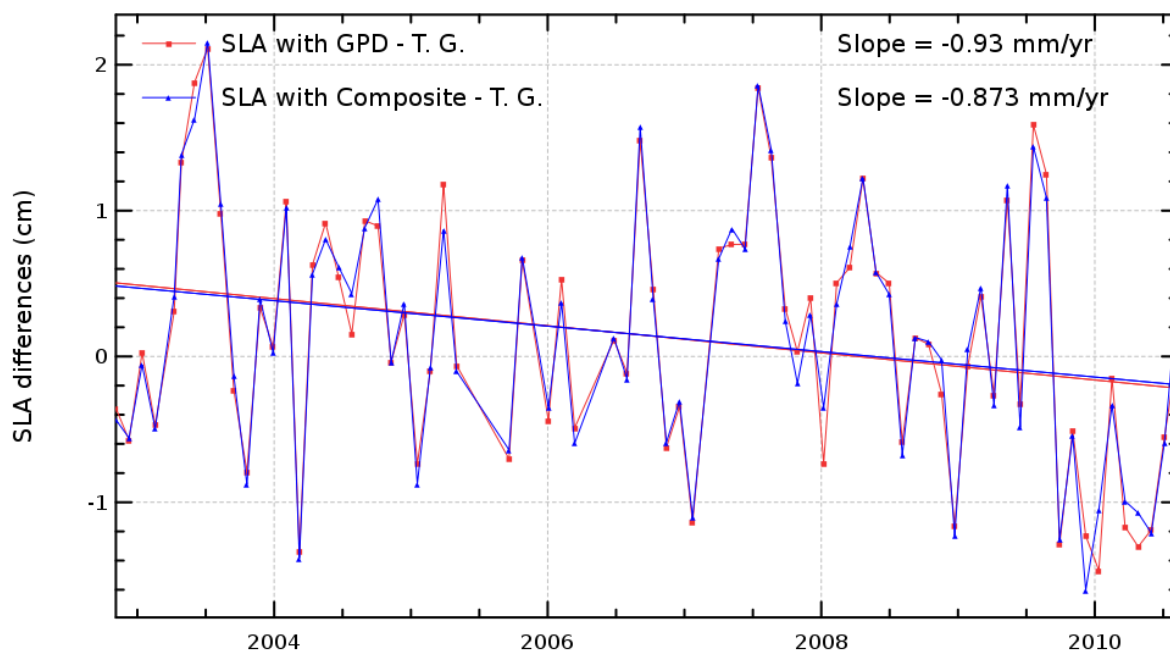
**Name :** Temporal evolution of SSH differences between tide gauges and altimetry measurements

**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 repetitivity) 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 type : Altimetry and in-situ data comparison

SLA differences : altimetry measurements - tide gauges  
Mission en, cycles 9 to 93



**Diagnostic C002 (mission en)**

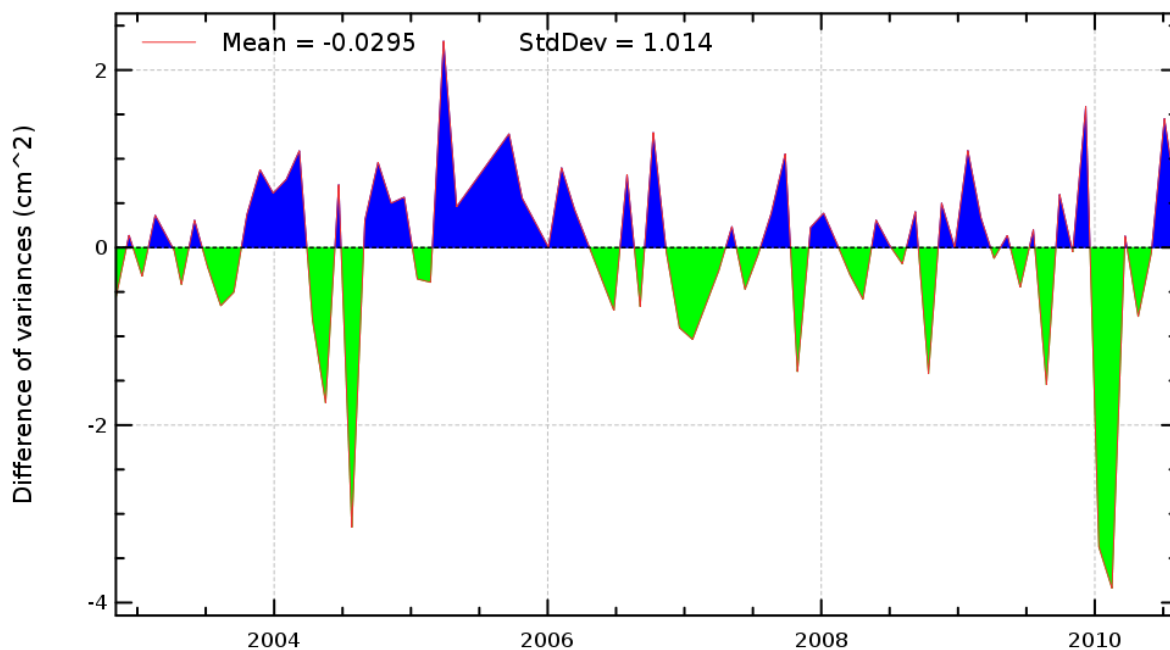
**Name :** Differences of temporal evolution of SSH differences between tide gauges and altimetry measurements

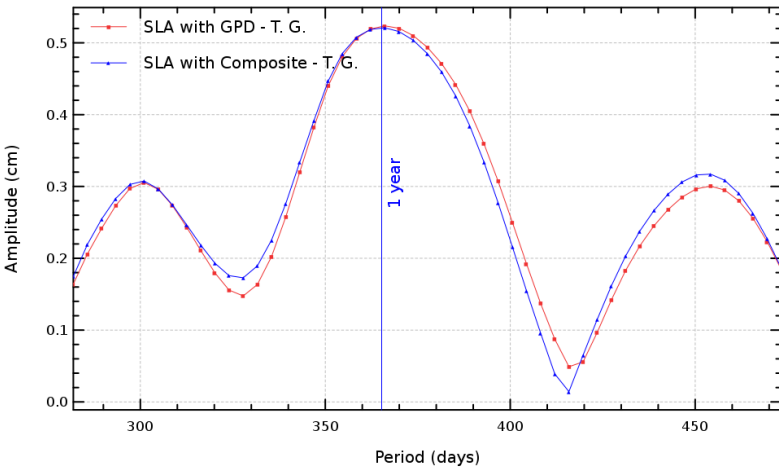
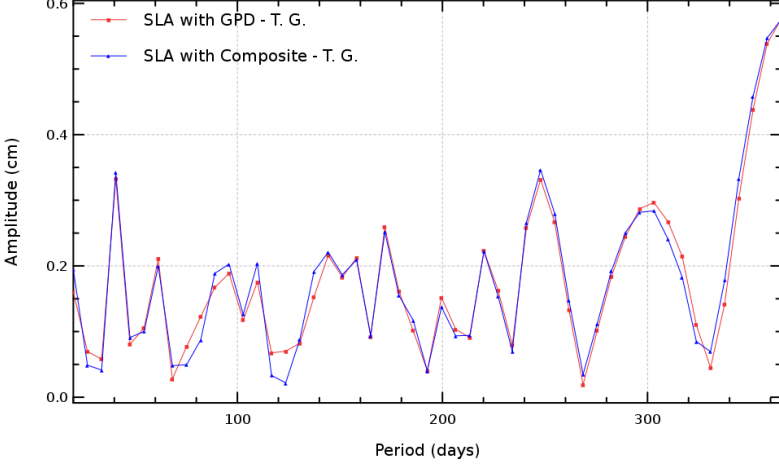
**Input data :** Tide gauges SSH measurements

**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 type : Altimetry and in-situ data comparison

Difference of variances :  $\text{VAR}(\text{SLA with GPD} - \text{T. G.}) - \text{VAR}(\text{SLA with Composite} - \text{T. G.})$   
Mission en, cycles 9 to 93



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	
<div>Periodogram of SLA differences : altimetry measurements - tide gauges (ref. period = 1 year) Mission en, cycles 9 to 93</div>  <div>Periodogram of SLA differences : altimetry measurements - tide gauges (period = [0, 1 year]) Mission en, cycles 9 to 93</div> 	

**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.

Diagnostic type : Altimetry and in-situ data comparison

Histogram of the difference of variances :  $\text{VAR}(\text{SLA with GPD} - \text{T. G.}) - \text{VAR}(\text{SLA with Composite} - \text{T. C.})$   
Mission en, cycles 9 to 93

