On the accuracy of Jason-2 satellite sea surface data in a highly dynamical coastal environment

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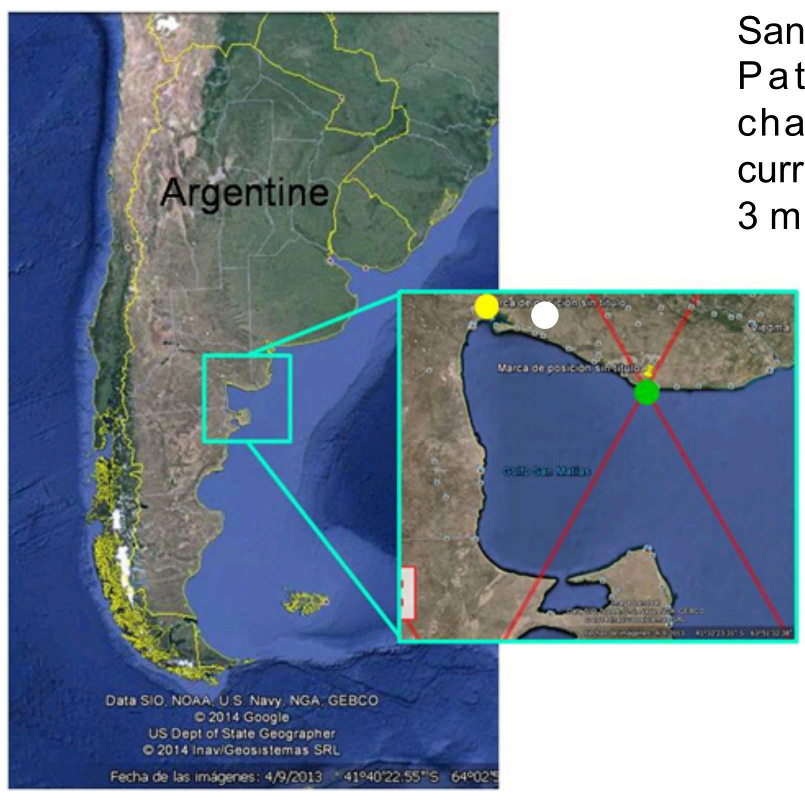
Over continental shelves and close to the coast the aliasing of unresolved high-frequency signals is a source of long-wavelength errors that must be corrected to make satellite altimetry measurements useful. Tides and atmospheric forcing are the main processes that generate high frequency signals closer to the coast and over continental shelves. Recent improvements in satellite altimetry data correction terms are encouraging studies of the remote sensed Sea Level Anomalies (SLA) progressively closer to the coast and over shallow continental shelves. In this work data from a bottom pressure recorder deployed during 7 months at 1 km from the coast in a highly dynamic (4m tidal amplitude) environment in the Patagonian Sea (Argentina) are compared with satellite altimetry data. Results show that uncorrected satellite data from Jason-2 correlate very well (0.98, 99% t-Student confidence level) and have a root-mean-square difference of 26 cm with in-situ data. Four tidal models and two model-derived sea-level pressure data are compared respectively with in-situ measured tide and sea-level pressure in order to study the accuracy of the main satellite-altimetry correction terms.

Region of study



San Matías Gulf is located in the Patagonian coast, which is characterized by intense tide currents and tide amplitudes (almost 3 m in the study point for M2).

To improve the accuracy of the corrections applied to satellite data, long time series of high-quality data are essential.

Figure 1: San Matias Gulf (www.google.es) in the argentinian coast.Green point : instrument location at a distance from the coast of 1.1 km and intersection between tracks 52 and 189. Yellow point: San Antonio Oeste meteorological station.White point: Caleta Los Loros meteorological station.

Data

SSH - in situ: Tide gauge SBE26plus. Record length: 7 months (April 2013 - October 2013).

SSH - satellite: Extracted from the intersection of Jason 2 tracks #52 and #189. Distance between the coast and the cross-track: 1.2 km.

T and S: CT sensor SBE37.

Atmospheric pressure: Local Meteorological Stations (Figure 1); NCEP; ERA-INTERIM.

Tidal models: Fes04 and Got47 are frequently cited, Fes2012 was developed recently.

Dynamic Atmospheric Correction: Mog2D (http://ctoh.legos. obs-mip.fr)

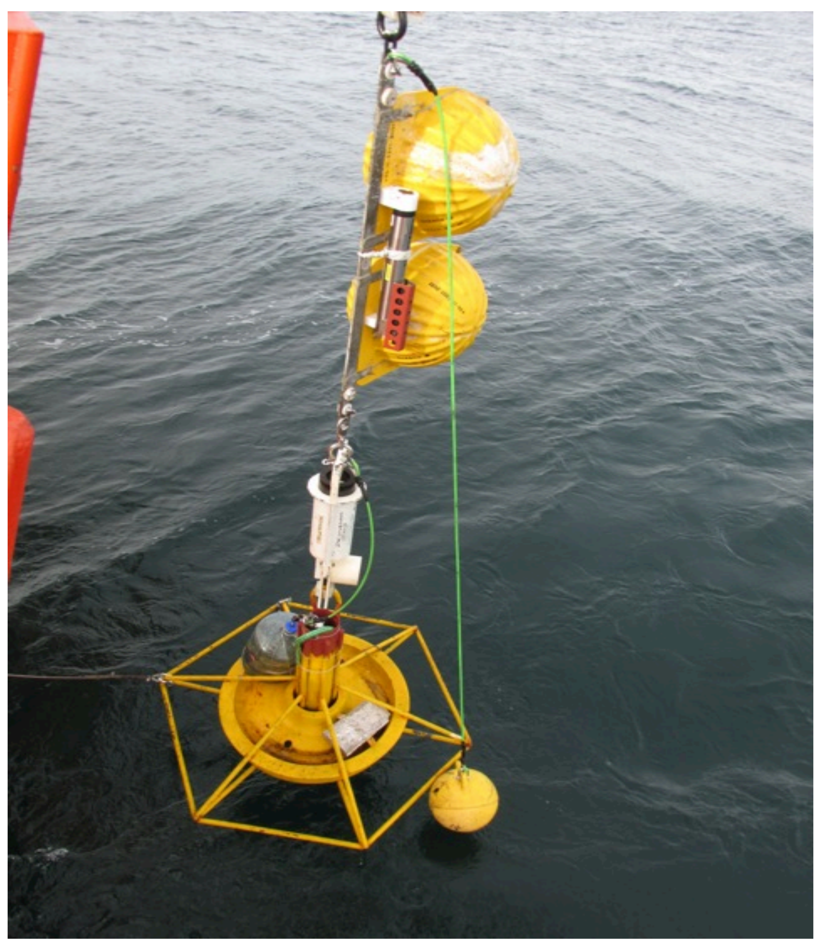


Figure 2: Moored instruments.

Results

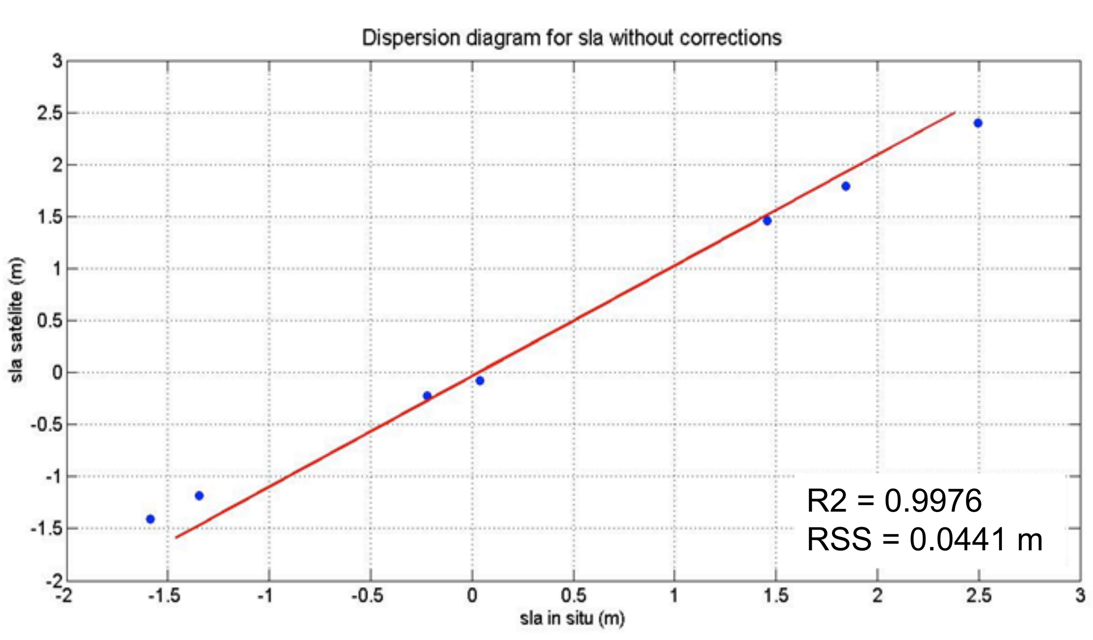


Figure 3: Dispersion diagram of SLA from satellite information (CTOH) and in situ data without corrections of tide and atmospheric pressure.

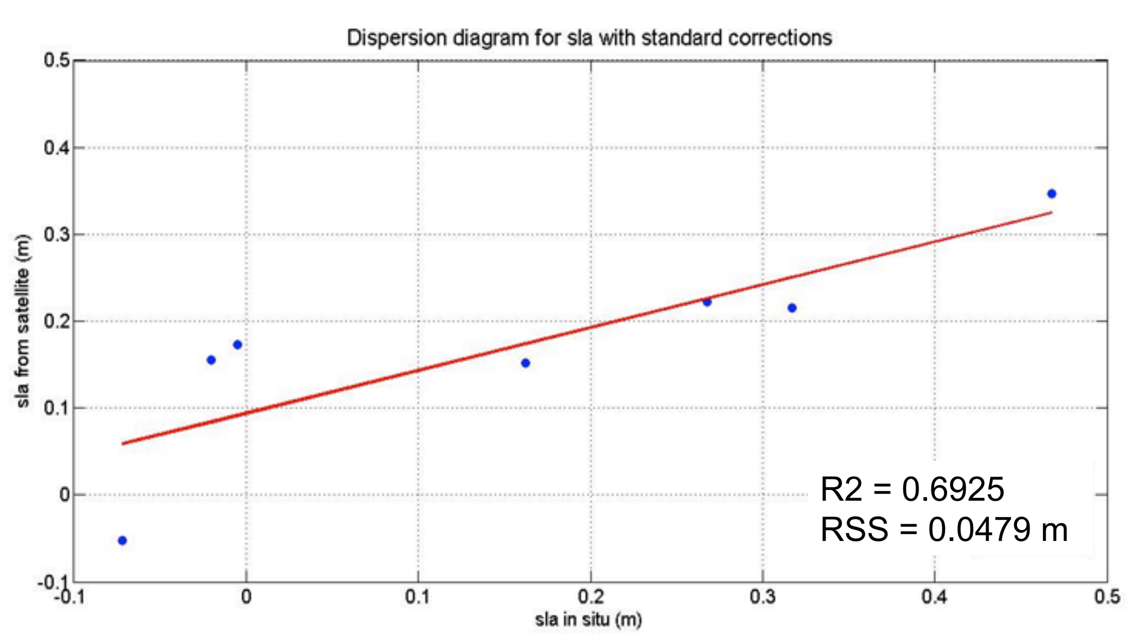


Figure 4: Dispersion diagram of SLA from satellite information (CTOH) and in situ data with standard corrections of tide (fes2012) and atmospheric pressure (DAC).

Satellite and in situ data show an excellent agreement (figures 3 and 4). Nevertheless, it is essential to expand in situ data series in order to obtain a more robust adjustment. Dispersion diagram for SLA with standard corrections (figure 4) shows lower agreement than without corrections (figure 3).

TIDE CORRECTION

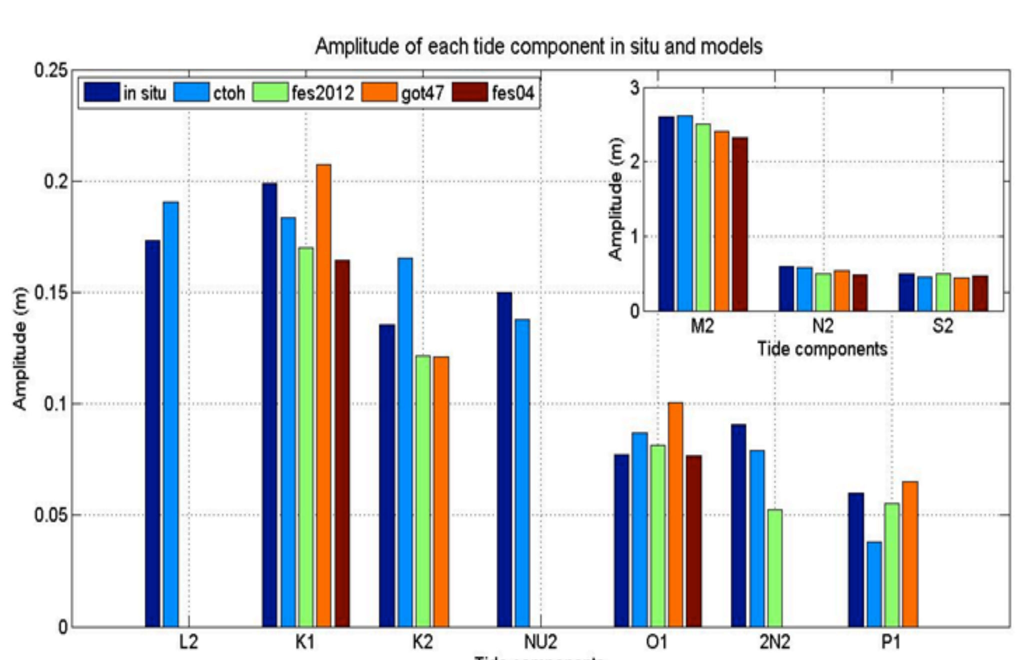


Figure 5: Comparison of in situ and model amplitudes for each tide component.

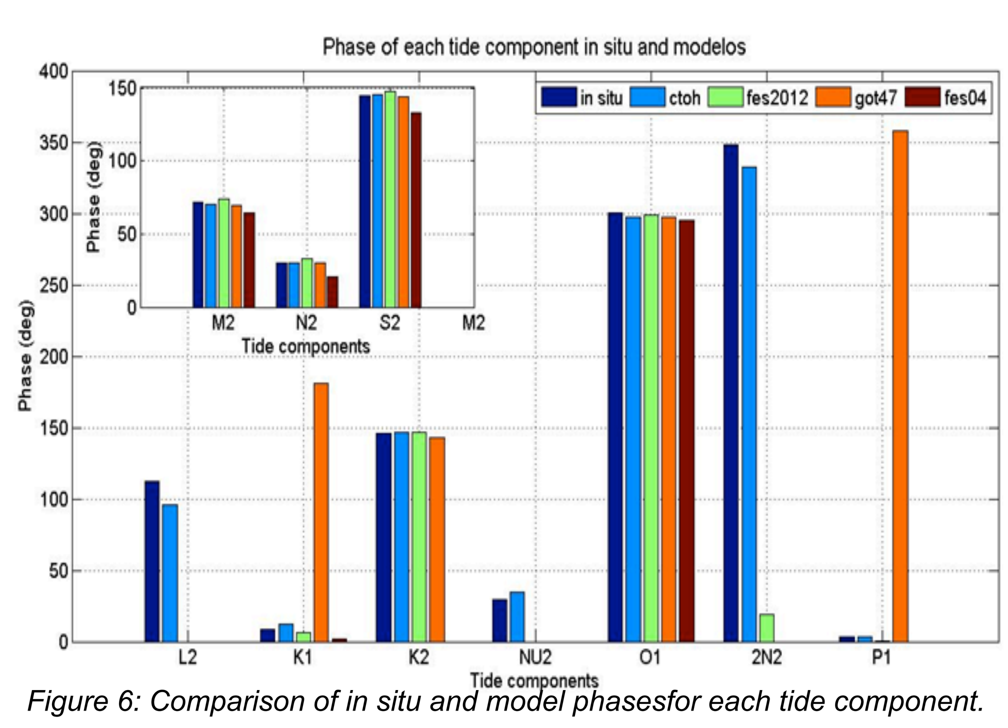


Figure 6: Comparison of in situ and model phasesfor each tide component.

Models --------------------- Components	Ctoh	Fes2012	Got47	Fes04
M2	1,75E-4	1,16E-2	2,27E-2	8,67E-2
N2	4,95E-05	4,58E-3	1,67E-3	1,01E-2
S2	4,38E-4	4,13E-4	1,31E-3	5,00E-3
L2	1,53E-3	-----	-----	-----
K1	1,91E-4	4,45E-4	8,20E-2	7,85E-4
K2	4,52E-4	9,82E-05	1,24E-4	-----
NU2	1,77E-4	-----	-----	-----
O1	5,65E-05	1,23E-05	2,89E-4	2,72E-05
2N2	3,44E-4	1,43E-05	-----	-----
P1	2,39E-4	1,40E-3	2,84E-05	-----
RSS	**2,46E-3**	**1,25E-2**	**8,51E-2**	**8,74E-2**

Table 1: Root mean square error (RMSE) of each tide components between model and in situ.; and root sum square (RSS)

Results show that amplitudes and phases obtained by harmonic analysis of the satellite altimetry CTOH data set is the one that better represents the in-situ tidal components. Among global models analyzed, FES2012 get the best results.

ATMOSPHERIC CORRECTIONS

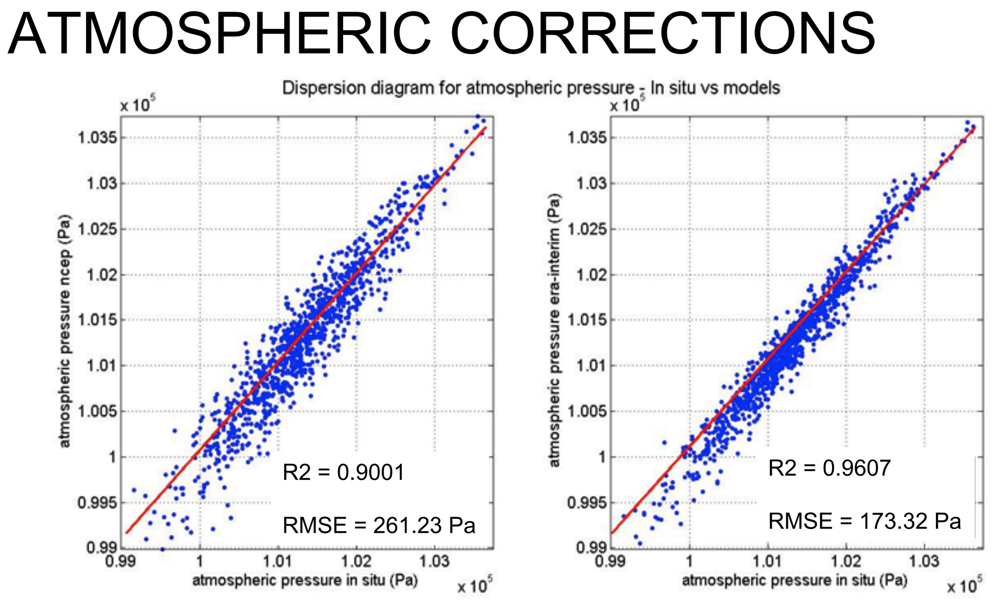


Figure 7: Dispersion diagram of atmospheric pressure in situ vs ncep model (left) and vs era-interim model (right).

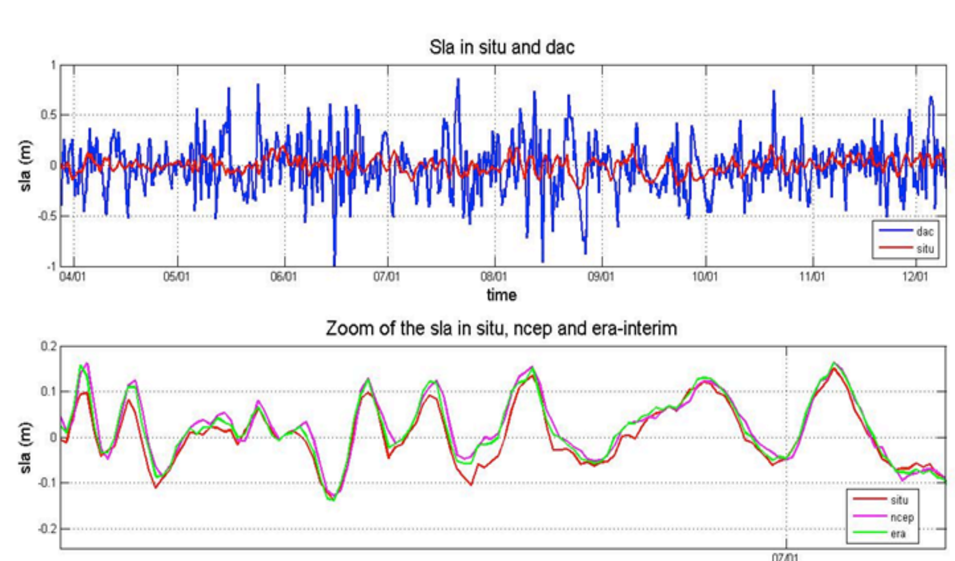


Figure 8: Time series for DAC and inverted barometer corresponding to in situ data (up). Time series for inverted barometer corresponding to in situ data, ncep model and era-interim model (down).

	RMS (m)	RMS (m) with 20-day low pass filter
SLA with tide corrections (CTOH)	0.2892	0.1112
SLA with tide (CTOH) and dac corrections	0.1339	0.0884
SLA with tide (CTOH) and NCEP corrections	0.2928	0.0919
h with tide (CTOH) and ERA-INTERIM corrections	0.2991	0.0961

Table 2: Root mean square (RMS) for SLA with several corrections.

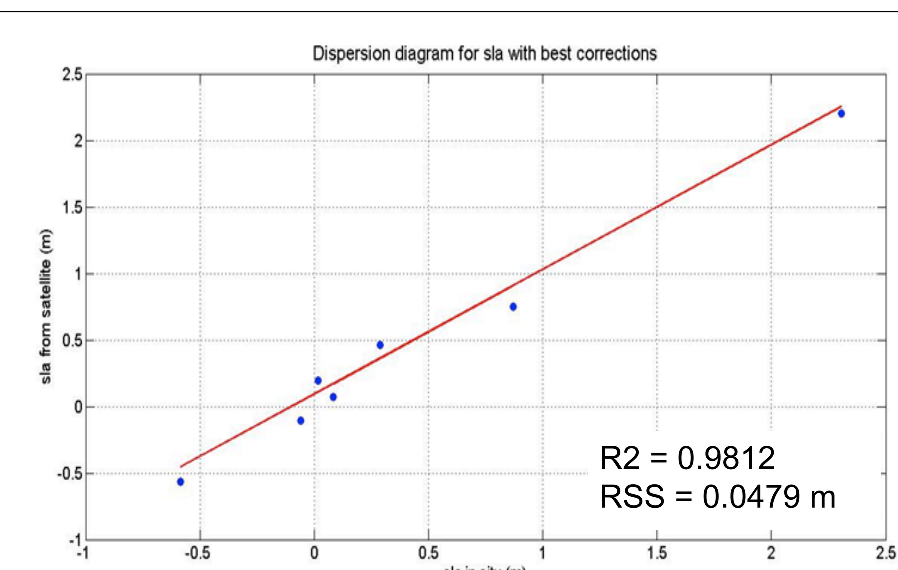
In-situ atmospheric pressure shows a better adjustment with ERA-INTERIM model than with NCEP model (figure 7).

DAC presents a wider range of values than in-situ inverted barometer (IB) data; in-situ IB, NCEP and ERA-INTERIM models have similar patterns (figure 8). DAC adjusts better to in situ data than IB (Table 2).

Conclusion

In-situ data allowed confirm that in this complex area:

- Despite the vicinity of the coast, satellite altimetry data are very accurate.
- Tides are represented reasonably well by modern tide models (FES2012) .
- Tidal altimetry derived components by CTOH are very accurate
- Simple IB correction largely underestimates SLA variability due to atmospheric forcing.
- DAC as obtained by Mog2D is a much more adequate correction than IB alone.
- Using DAC and CTOH the adjustment improves.



(CTOH) and in situ data with best corrections of tide (CTOH) and atmospheric pressure (DAC).

Acknowledgements

This study is a contribution to the CNES-CNRS UMI-IFAECI -1, PICT 2012 0467, PIO 133 20130100242 and IAI SGP 2076 Projects. LRE received partial grant to attend the meeting from ESA.

Satellite along-track data used in this study were developed, validated, and distributed by CTOH/LEGOS. Dynamic atmospheric Corrections are produced by CLS Space Oceanography Division using the Mog2D model from Legos and distributed by Aviso, with support from Cnes (http://www.aviso.altimetry.fr/)