D4.1 Algorithm Theoretical Baseline Document

(one ATBD per sub-theme or one single document, to be agreed between the Agency & team)

1. INTRODUCTION

The objective of this task is to generate a regional tidal correction in the North East Atlantic, over the Cryosat-2 tracks and for the whole period of the mission.

2. OVERVIEW

The COMAPI regional tidal atlas was developed in 2010 in the frame of a CNES project. It is based on a hydrodynamic solution and benefits from the assimilation of altimetry and tide gauge observations. It was validated at that time against the concurrent global models and it proved to bring much improvement in the coastal zones of the North East Atlantic Ocean [Cancet et al, 2010].

3. ALGORITHM DESCRIPTION

The tidal atlases are generally provided in the form of harmonic constituent maps (amplitude and phase) for the main tidal waves. At a given point and at a given date, the total elevation of the ocean tide is considered to be the sum of the contribution of all these tidal waves.

$$\eta(x,y,t)=i\,Aix,y\cos(\omega it+\varphi ix,y)$$

Where

- η is the total tide elevation at the geographical point defined by the position x,y at the t date ;
- i is the index of the tidal wave ;
- $Ai(x,y)$ is the amplitude of the tidal wave at the considered location ;
- $\varphi i(x,y)$ is the phase of the tidal wave at the considered location ;
- ωi is the pulsation of the tidal wave.

The ocean tide correction used to correct the tidal signal in the altimetry measurements is computed following the equation above, using some tide prediction software.

The spectra of the global tidal atlases and of the COMAPI regional tidal atlas are composed of the following waves:

Models	**Main components**	**Long-period tides**	**Non-linear components**
FES2004	M2, S2, K1, O1, N2, K2, P1, Q1, S1, 2N2, Ssa	Mf, Mm, MSqm, Mtm	M4
TPXO7.2	M2, S2, K1, O1, N2, K2, P1, Q1	Mf, Mm	M4, MS4, MN4
GOT4.8	M2, S2, K1, O1, N2, K2, P1, Q1, S1	/	M4
DTU10	M2, S2, K1, O1, N2, K2, P1, Q1 + S1 from GOT4.7	/	M4 from GOT4.7
EOT10a	M2, S2, K1, O1, N2, K2, P1, Q1, S1, 2N2	Mf, Mm	M4
FES2012	M2, S2, K1, O1, N2, K2, P1, Q1, S1, 2N2, Ssa + **Minor components:** E2, J1, L2, La2, Mu2, Nu2, R2, T2	Mf, Mm, MSf, Mtm	M3, M4, M6, M8, N4, MS4, MN4, S4, MKS2
COMAPI	M2, S2, K1, O1, N2, K2, P1, Q1, 2N2	Mf, Mm, MSqm, Mtm	M4, MS4, MN4, S4, M6, MK4, SN4,

regional atlas	+ **Minor components:** E2, J1, L2, La2, Mu2, Nu2, R2, Ro1, Sig1, T2		SK4, 2Q1, MP1, 2MK6, 2MN6, 2MS6, 2SM2, 2SM6, KJ2, MK3, MKS2, MO3, MSK6, MSN2, MSN6

Table 1: Available spectra of some recent global models and the COMAPI regional model

An important point concerns the S1 wave. The S1 wave has a dual origin, both gravitational and radiational. The second origin is predominant and is an effect of the atmospheric forcing on the sea surface height. It should logically be included in the DAC, but for years the choice has been made to filter it out in the SSALTO processing chain of the DAC and to consider it at an ocean tidal wave.

As the S1 tidal wave is not available in the COMAPI regional atlas (cf. Table 1), the prediction for this wave will be done using the S1 solution from the FES2012 atlas [Carrère et al., 2012], which is the most recent global tidal atlas compatible with the COMAPI atlas. This S1 solution was computed with the forcing of a mean atmospheric pressure field in order to obtain both the gravitational and the radiational parts of the wave.

4. ASSUMPTIONS, CONSTRAINTS, AND LIMITATIONS

a. Practical Considerations

i. Input Data

- Location and date of the Cryosat along-track data in the North-East Atlantic ocean ;
- Maps of amplitude and phase of the tidal constituents: COMAPI regional tide atlas and FES2012 global atlas (S1 wave).

ii. Output

Ocean tidal elevation at the location and date of each Cryosat measurement in the North-East Atlantic Ocean.

All these tidal elevations are compatible with the FES2004 loading tide and with the dynamic atmospheric correction provided by SSALTO.

b. Quality Control

The Noveltis prediction software was validated by comparing its outputs with the outputs of other prediction tools including the CLS own prediction software, in the frame of the FES2012 project.

5. REFERENCES

Cancet, M., Lux, M., Pénard, C., et al. (2010). COMAPI: New regional tide atlases and high frequency dynamical atmospheric correction, presented at the Ocean Surface Topography Science Team meeting, Lisbon, Portugal

Carrère, L., Lyard, F., Cancet, M., Guillot, A., & Roblou, L. (2012). FES2012: A new global tidal model taking advantage of nearly twenty years of altimetry, Proceeding of the 20 Years of Progress in Radar Altimetry Symposium, Venice, Italy