Abstract

In the current frame of debates on future altimetry constellation design, the need for a decision-making tool has been highlighted by CNES and realised through the development of an end-to-end altimeter mission simulator. This simple, flexible and evolutive tool at accessible cost simulates the learning configurations and discriminate among them. The present study describes the first prototype of the end-to-end Jason-1/Jason-2 tandem mission simulator. Based on a simplified version of the recently published Ensemble Twin Experiments methodology (Moure et al., 2000), the simulator aims at quantifying the potential of an altimeter observing system by estimating its ability to reduce the statistical error of a storm surge model of the Bay of Biscay. Relative performance scores help discriminate the various observing scenarios (number of satellites, orbit/interval type, ...). Some validation and application case results are presented. Especially, the phasing between the orbits of Jason-1 and Jason-2 after switching into a scientific/application phase of the tandem mission is analysed with an end-to-end mission simulator.

1. Methodology

Satellite tracks generation

The altimeter configuration is set up by the user, given a set of simple orbit parameters to specify:

- Inclination, altitude, number of revolutions per cycle, number of Earth rotations with respect to its orbit plane, initial longitudinal/latitude, instrumental noise level

As a prior requirement, CNES NOVELTIS has implemented a multi-satellite configuration. In this prototype tool, the user can thus choose either mono- and/or wide swath altimeters. In a wide swath altimeter configuration, one can also tune the cross-track (track resolution and the cross-track number of cells).

Pseudo-observation generation

The simulator computes the spacecraft positions of the user-built altimetry constellation over the whole study period. It computes pseudo-observations generated by extracting the model process (from the reference simulation, $f(t)$) at the space-time altimetry properties. These pseudo-observations are then modelled following a gaussian noise of zero mean and standard deviation specified by the instrumental noise level (user given).

2. Observation scenarios

In the specific configuration of oceanic response to uncertainties in atmospheric forcing:

- homogeneous distribution of SLA errors (Fig.4 (a))
- max. error structures in EC, rover in East of Bay of Biscay (Fig. 4 (a))
- errors are variable in time (Fig. 4 (b) and space (for instance Fig. 5)

3. Characterization of model errors

In the specific configuration of oceanic response to uncertainties in atmospheric forcing:

- SLA ensemble variance reduction for the complete period.
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4. Analysis diagnostics

a) Observation error budget

b) Observation error budget

c) Observation error budget

5. Satellite systems performances

Jason-1

Jason-1 + Topex

Jason-1 + Envisat - Topex

Jason-1 + Envisat - Topex - GFO

First scientific validation results

Jason-1 + Topex

Jason-1 + Envisat - Topex

Jason-1 + Envisat - Topex - GFO

Topex + Jason-1

Jason-1 + Jason-2

Better performance of the new tandem mission orbit Jason-1+Jason-2 for data assimilation in storm surge model (probably due to a better temporal sampling).

Conclusions / Perspectives

In the specific modelling framework presented here:

- The simulator is confirmed as an efficient tool to estimate the performances of various altimetry configurations. Its ability to discriminate among such configurations has been validated against the efficiency of various assimilation methodologies implementing a 2D-model and a complex analysis system assimilating real observations (Pujol et al., 2008).
- Based on the simulator’s results, orbit re-configurations (phase, interleaved orbits) can be proposed for in a wide swath constellation observation system designed by extracting the model process (from the reference simulation, $f(t)$) at the space-time altimetry properties. These pseudo-observations are then modelled following a gaussian noise of zero mean and standard deviation specified by the instrumental noise level (user given).

In a close future, further developments of the simulator should be achieved in close collaboration with NOVELTIS and POC, for instance:

- extending the period of simulation of the "storm-surge" simulator in order to refine the statistical coherence and reliability of the results;
- enhancing the capability of the simulator by considering other oceanic processes, such as tides (involving important questions such as the impact of tides aliasing in observation).