

Improved description of the mesoscale variability by combining four altimeter missions

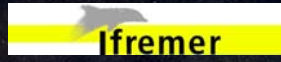
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1. Introduction

- ❖ Satellite altimetry is considered as one of the most important input datasets for operational applications.
- ❖ At least two altimeter missions are needed to resolve the main space and timescales of the ocean [Koblinsky et al, 1992].
- ❖ However, theoretical studies [e.g. Le Traon et al, 2002] have revealed that three or four altimeters should improve the mesoscale variability mapping.

Objectives of this work



1. To merge up to 4 altimeter missions [Jason-1, T/P, ERS-2/ENVISAT, GFO] and to evaluate the impact in the monitoring of mesoscale variability.
2. To validate the merged altimetric maps with independent altimetric, tide gauge and drifter data.
3. To estimate absolute surface currents by adding the mean currents and the Ekman component.

2. Data Sets

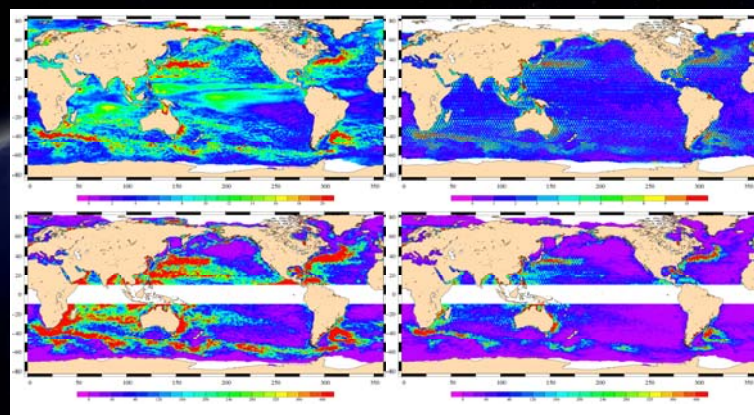
- Jason
- TP interlaced
- ERS/ENVISAT
- GFO



- Along-track data processing:
 - Usual geophys. corr. (IB, GOT-99)
- Objective analysis:
 - Long wavelength error corrected.
 - Variable space and temporal correlation radius.
 - Weekly maps, 1/3° mercator grid spatial resolution.
- Period: October 2002 – September 2003

(delayed time data)

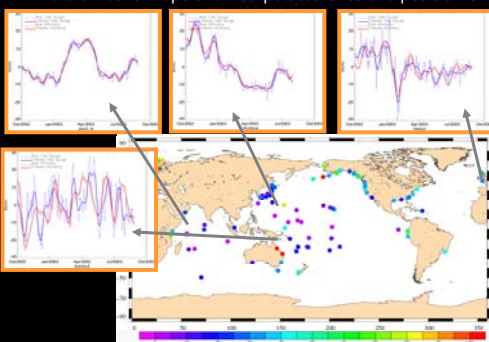
3. SLA and EKE variability



Upper panels: on the left, rms of sea level anomaly (SLA) estimated with 4 altimetric missions. On the right, rms of SLA differences between 4 and 2 satellites. Units are cm. Lower panels: as for the upper panels but for eddy kinetic energy (EKE). Units are cm²/s².

4. Comparison with tide gauge data

- 86 tide gauge (TG) stations from GLOSS/CLIVAR near-real time data.
- Processing: filtering of tides (Demerliac filter) and IB correction.
- The altimetric maps are interpolated onto the position of the TG stations.



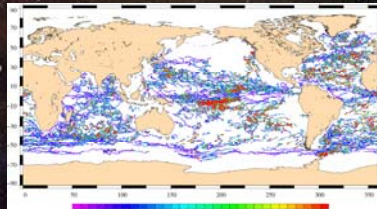
(bottom left) Mean square differences between TG and altimetry (4-sat) sea level. Units are % of TG variance. The largest errors are found in areas where the tidal model used for the altimetric data is not accurate enough (GOT-99).

2 missions	4 missions
46.7 %	35.3 %

Averaged error variance. Units are % of TG variance.

5. Comparison with drifter data

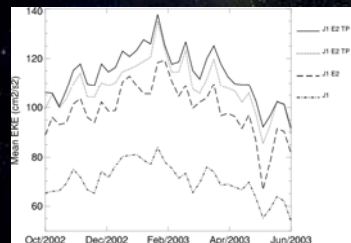
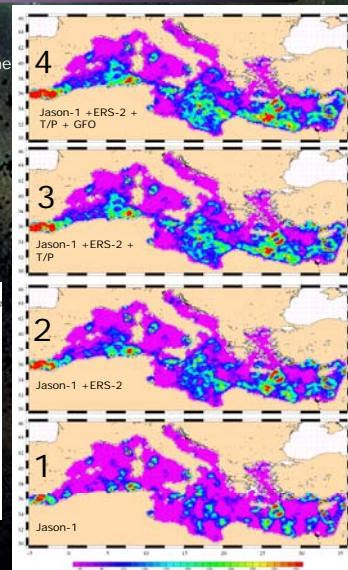
- We have computed absolute currents by adding to the geostrophic anomaly velocities, the mean currents, and an Ekman component.
- Absolute currents maps have been compared with lagrangian drifter data (total of 673,000 measures).



(left) Number of drifting buoy 6 hourly observations into 1/2° boxes. (right) Trajectory of a drifting buoy in the Brazil-Malvinas Confluence Region super-imposed over velocity vectors and sea surface height derived from altimetry. In average, in the open ocean, the velocity misfits for the 4 mission scenario for U and V are 24.3% and 28.4%, which implies a correction, from two to four missions, of about 9% and 15%, respectively.

6. A zoom in the Mediterranean Sea

- (right) Mean Eddy Kinetic Energy (EKE) in the Mediterranean Sea. Units are cm²/s².
- The combination of four altimeters reveals important differences from the reference 2-satellite configuration.
- The variability of western Alboran gyre and the continuity of the Atlantic Ionian Stream, crossing the Ionian Basin are better reproduced with 4 altimeters.
- (bottom) Temporal evolution of mean EKE averaged over the Mediterranean Sea.



J1E2TPG2	113 cm ² /s ²
J1E2TP	109 cm ² /s ²
J1E2	99 cm ² /s ²
J1	70 cm ² /s ²

(+15% J1E2)

7. Conclusions

- Successfully merged four altimetric missions to produce global sea level anomaly maps.
- In **areas of intense variability**, the rms differences between a classical configuration of only two altimeters and the scenario merging four missions can reach up to 10 cm and 400 cm²/s², in SLA and EKE, respectively, which represents an important percentage of signal variance.
- In **areas of moderate activity** (e.g. Mediterranean Sea) the combination of Jason-1 + ERS-2/ENVISAT fails to reproduce some relevant mesoscale signals. On the contrary, when T/P and GFO are added, these features are well recovered and the EKE does not show significant discontinuities due to sampling effects. The merged Jason-1 + ERS-2/ENVISAT + T/P + GFO maps yield EKE levels 15% higher than Jason-1 + ERS-2/ENVISAT.
- In **coastal areas**, there is an important improvement (~25%) in the estimation of sea level, as revealed by the comparison with tide gauge data.
- An external validation with **surface drifters** covering the global ocean is carried out, and it is shown that the four altimeter scenario resolves better some mesoscale structures that are not properly recovered with Jason-1 + ERS-2/ENVISAT.
- A comparison with **86 tide gauges** reveals an improvement of about 25% in the estimation of sea level in coastal areas with 4 satellites compared to the errors obtained with 2 altimeters.
- In **operational applications**, using real time data, the impact of 4 altimeters is even more critical because there are less available data to construct the maps (only past data). See poster: 'On the quality of real-time altimeter gridded fields: comparison with in situ data' by Pascual et al.

Details in: Pascual, A., Y. Faugere, G. Larnicol, and P.-Y. Le Traon (2006), Geophys. Res. Lett., 33, L02611.

Pascual, A., M-I Pujol, G. Larnicol, P-Y Le Traon, M-H Rio (2007) Mesoscale Mapping Capabilities of Multisatellite Altimeter Missions: First Results with Real Data in the Mediterranean Sea. J. Mar. Sys. 65, 190-211.