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Regional comparison of sea level time series from altimetry and tide gauges in the Northwestern Mediterranean Sea

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SUMMARY

Both tide gauges and satellite altimeters observe the sea level variability. However, tide gauge observations are restricted to the coastlines and altimetry provides information in the open sea. Indeed, the use of altimetric data near the coasts is challenging, due to technical problems and uncertainties in the corrective terms.

The main objective of this study is to analyze, at different regional and temporal scales, the degree of coherence between tide gauge and altimetry observations in the area of interest. Our comparison analysis includes different statistics. The results are mainly driven by the seasonal signal but also reflect local conditions affecting coastal sea level.

1. SCIENTIFIC ISSUE

The Northwestern Mediterranean Sea :

- Cyclonic circulation: The Liguro-Provençal Current:
  - ➢ Strong seasonal variation + interannual modulation (Millot, 1990)
  - ➢ Meanders and instabilities generate mesoscale activity
- Strong continental winds: Tramontane (Northwestern wind) and Mistral (Northern wind)

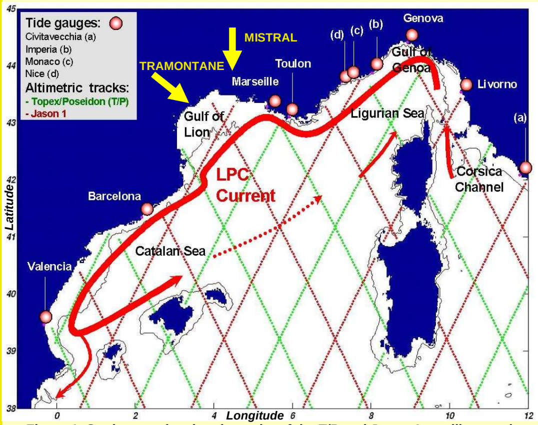

Figure 1: Study area showing the paths of the T/P and Jason-1 satellites, and positions of the tide gauges

Satellite versus tide gauge sea level observations:

Altimetric data :

- Synoptic observation every 10 days
- Lack of data in the coastal areas (decreased accuracy of the corrective terms + technical problems)

Tide gauge data :

- Local observation (measures coastal sea level)
- High temporal resolution (more adapted to the study of coastal dynamics)

→ Complementary roles

2. DATA PROCESSING AND VALIDATION

ALTIMETRIC DATA PROCESSING (CTOH DATASET)

T/P and Jason-1 data (Figure 1) during the 3-year tandem mission, from October 2002 to October 2005

- Data editing strategy (Roblou et al., 2007):
  - ➢ Editing criteria re-defined with special care for the shelf/coastal seas
  - ➢ Reconstruction of the missing corrections with a Bezier polynomial technique
  - ➢ Extrapolation of the radiometer information near the coast
- De-aliasing corrections (response to atmospheric forcing, tides) from the global MOG2D and FES2004 models
- Projection onto a nominal ground track every 6-7 km
- Low pass Loess filter applied along track with a 20 km wavelength cut off

TIGE GAUGE DATA

10 stations (Figure 1) ; hourly data from Oct. 2002 to Oct. 2005

- De-aliasing corrections from the global MOG2D model (response to atmospheric forcing) and from an harmonic analysis (tides)
- Post-processing : 36-hour-filtering to eliminate the very high frequency signal (inertial oscillations, …) + 6-hour data resampling

ALTIMETRIC DATA VALIDATION

Standard deviations of the differences and correlations between altimetric and tide gauge sea level anomalies have been computed.

Normalized Taylor diagrams:

Reference: Tide gauge (TG) data

Tested data: Altimetric data within a 100-km radius of the TG station

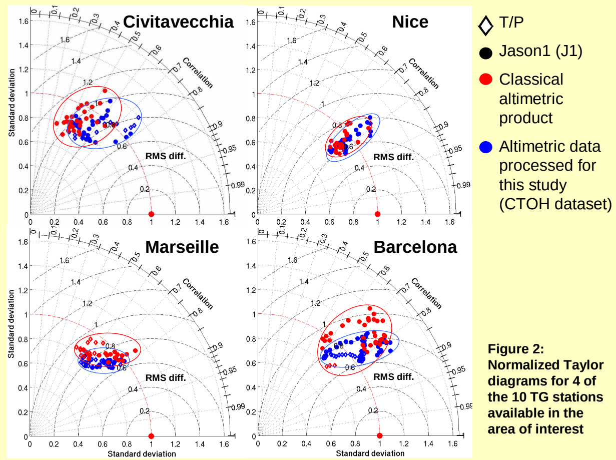

Figure 2: Normalized Taylor diagrams for 4 of the 10 TG stations available in the area of interest

- CTOH dataset vs. classical product:
  - ➢ lower dispersion
  - ➢ higher correlations
  - ➢ more data available
  - ➢ weaker RMS difference
- CTOH dataset vs. tide gauge:
  - ➢ high coherence

→ Good confidence in CTOH altimetric dataset

3. ALTIMETRIC AND TIDE GAUGE DATA COMPARISON

REGIONAL CORRELATIONS BETWEEN TIDE GAUGE AND ALTIMETRIC DATA

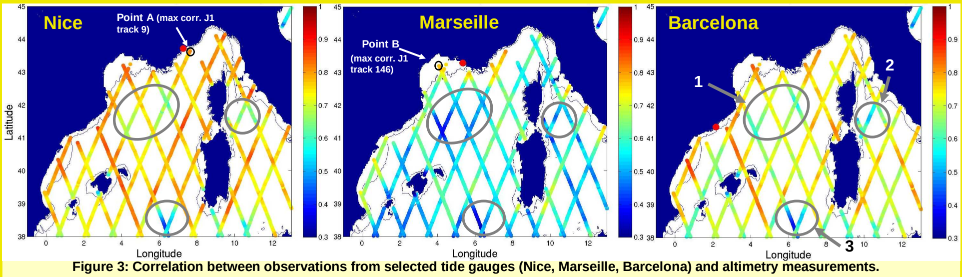

Figure 3: Correlation between observations from selected tide gauges (Nice, Marseille, Barcelona) and altimetry measurements.

- **Nice and Barcelona:** High correlations between satellite and TG observations everywhere, except in zones 1 to 3
- **Marseille:** correlation pattern reflecting coastal sea level variability
  - ➢ Covariability driven by the seasonal signal for all stations, except for Marseille
  - ➢ Regional correlations reflect local conditions affecting sea level

1. Deep Water formation region
2. Bonifacio gyre
3. Mesoscale eddies generated by the Algerian Current

COASTAL SEA LEVEL ANALYSIS

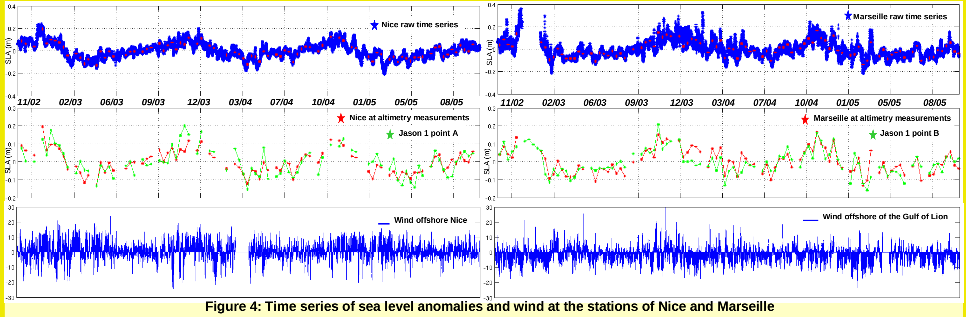

Figure 4: Time series of sea level anomalies and wind at the stations of Nice and Marseille

- Good agreement between tide gauges and altimetric sea level anomalies near the coast for:
  - ➢ the seasonal cycle
  - ➢ the high frequency signal
- High frequency oscillations are much more important in data located in the Gulf of Lion
  - ➢ partly correlated with local events: Tramontane and/or Mistral wind bursts
  - ➢ partly associated with coastal processes

4. CONCLUSIONS AND PERSPECTIVES

- The altimetric data processing used in this study improves the accuracy of altimetric data near the coasts.
- Coherence between tide gauge and altimetry observations not only appears at seasonal and regional scales (expected) but also at much higher frequencies and at coastal scales.
- Further analysis will be carried out to assess the relationship between the sea level observations and climate variables: sea surface temperature, atmospheric observations.

REFERENCES

Millot C., 1990, The Gulf of Lions' hydrodynamics. In *Continental Shelf Research*, Vol. 10, No. 9-11, pp. 885-894.
Roblou L., F. Lyard, M. Le Hénaff and C. Maraldi, X-TRACK, A new processing tool for altimetry in coastal oceans, Proc. ENVISAT Symposium, Montreux, Switzerland, 2007.

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