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→ 4th COASTAL ALTIMETRY WORKSHOP

www.coastalaltimetry.org

14-15 October 2010

Porto, Portugal

4TH Coastal Altimetry Workshop
SUMMARY
Presented at OSTST 2010, Lisbon

M.J. Fernandes

Organising Committee Chair

With contribution from :

J. Benveniste, P. Berry, P. Cipollini, E. Coelho, F. Collard, X. Deng, W. Emery, L. Fegnolio-Marc, C. Gommenginger, K. Ichikawa, M. Saraceno, R. Scharroo, W. Smith, T. Strub, D. Vandermark, S. Vignudelli, J. Wilkin, P. Woodworth

Facts and Figures

A few figures

- 88 Abstracts (was 46 last year)
- 33 Posters (19)
- 34 Oral (28)
- 162 Registrations
- 126 participants (some authors no show) (86)
- From 17 countries
- 8 dedicated session (All with discussion time!!)

Argentina	1
USA	36
Canada	1
Portugal	30
Denmark	4
Italy	5
Great Britain	8
France	17
Spain	6
Germany	3
Russia	1
Greece	2
Cyprus	1
Australia	2
India	2
Japan	6

Facts and Figures

Several scientific communities together:

- Altimeter Experts
- Oceanography
- Marine Meteorology
- Land Hydrology
- Geodesy
- Modelling

Sessions

S1- Update and continued discussion on the technical issues in coastal altimetry

S2 - Recent progress on waveform retracking in coastal regions

S3 - Use of data from the various processing and/or reprocessing exercises: PISTACH, COASTALT, REAPER, ESA CCI

S4 - Methods to Inter-Compare Altimetry and Tide Gauge Data

S5 - Coastal currents and sea level variation

S6 - Wind and wave effects on Coastal altimetry

S7 - Assimilating satellite altimetry observations in simulations over coastal regions including moderate to strong tidal regimes –

S8 - Emerging applications

S1 – Update and continued discussion on the technical issues in coastal altimetry

- **Much progress made / being made, particularly in wet tropo and tidal modelling**

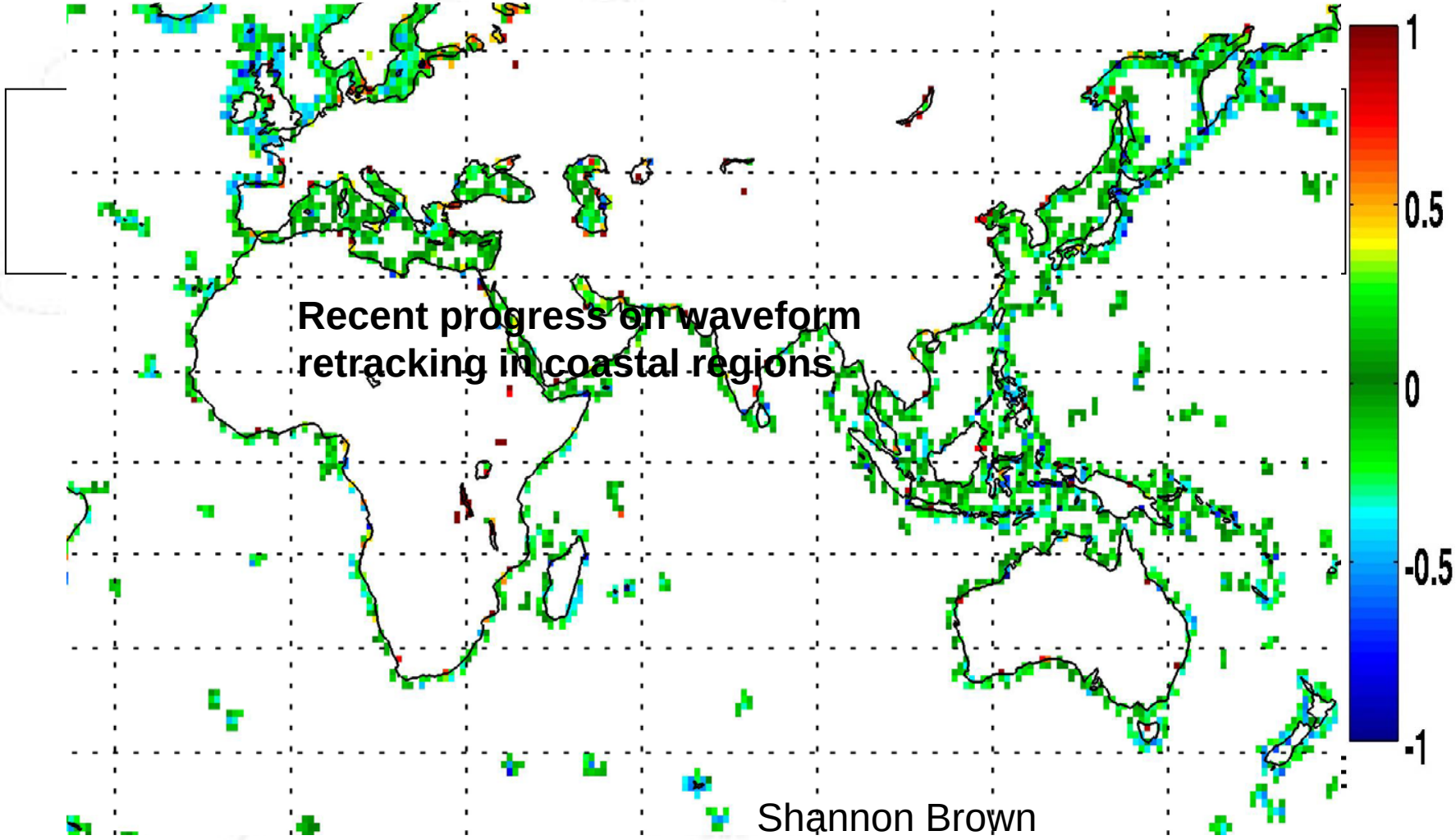
- **Progress made on tides**
  - COMAPI project develops regional tide models and regional and high-frequency (hourly) DAC
  - OSU develops competing tide models with aim of regional improvement
  - General interest in Arctic tides
  - Need for better coastal bathymetry is recognised (existing models usually too shallow)

S1 – Update and continued discussion on the technical issues in coastal altimetry

- **Progress made on the wet tropo (MPA)**
  - A JPL Enhanced JMR product provides more accurate and unbiased wet tropo near the coast, except in the tropics.
  - Similar product for AMR will be on GDR-C
  - Possible extension to Envisat.

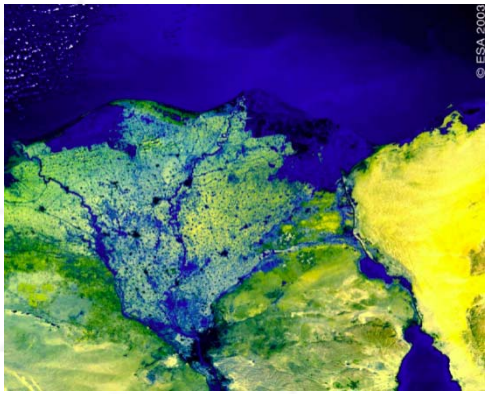
- **Progress made on the wet tropo (GPD)**
  - U Porto wet tropo from a combination of GNSS, valid MWR and NWM data is progressing towards global implementation.
  - So far has been implemented for Envisat, ERS-2 and Jason-2

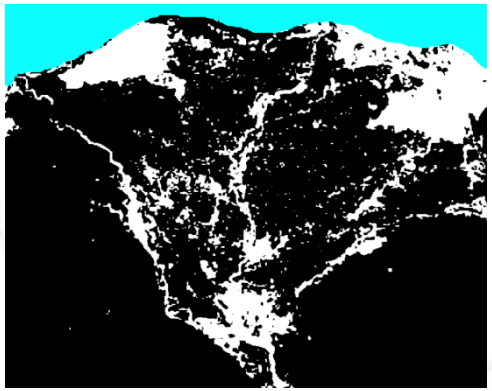
AMR-JMR MP Algorithm Bias 10-50km from Land

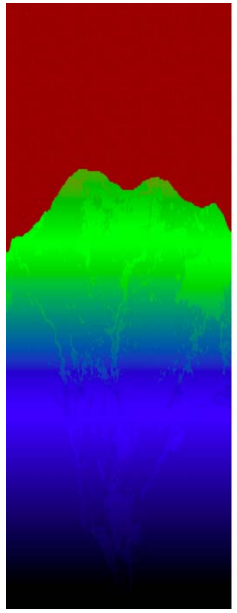


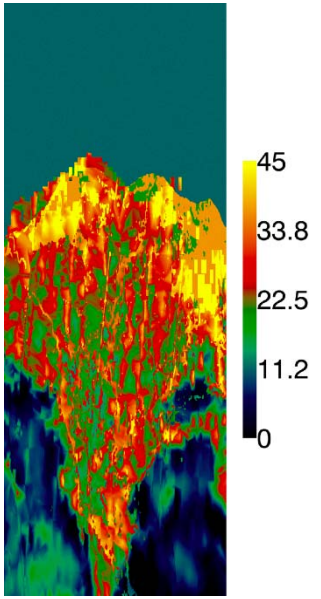
S2 – Recent progress on waveform retracking in coastal regions

S2 - Coastal Zone Scenario

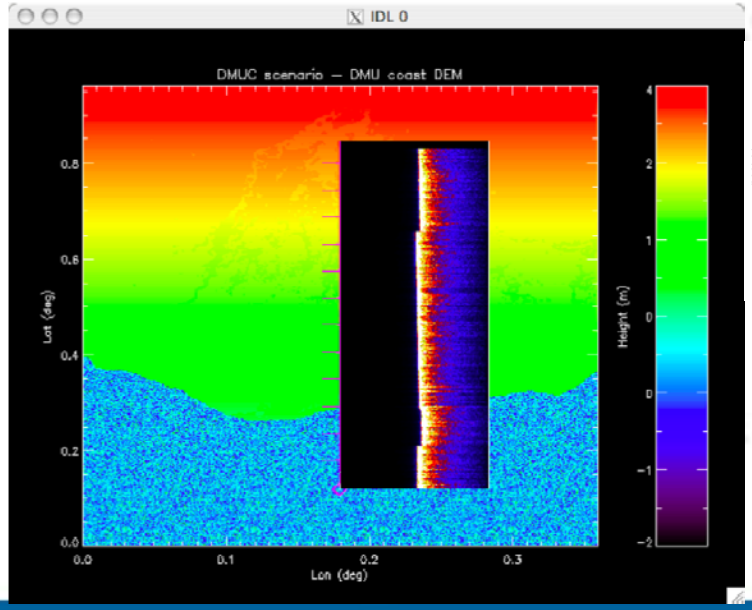


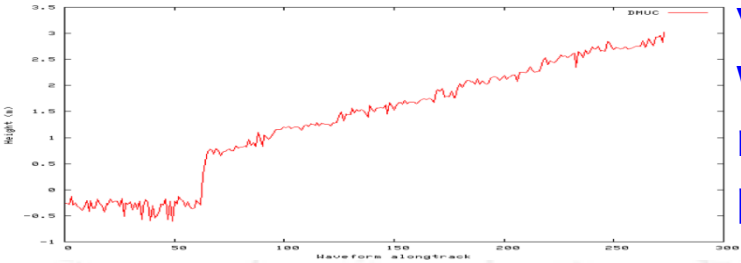


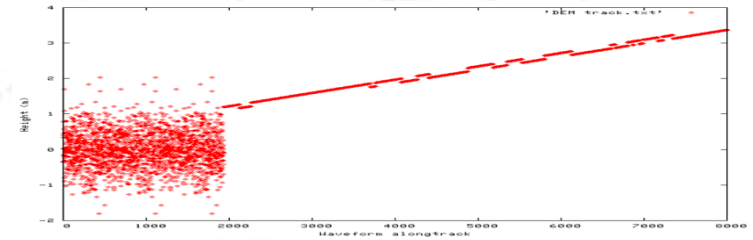




Nile delta synthesised with DEM and brightness



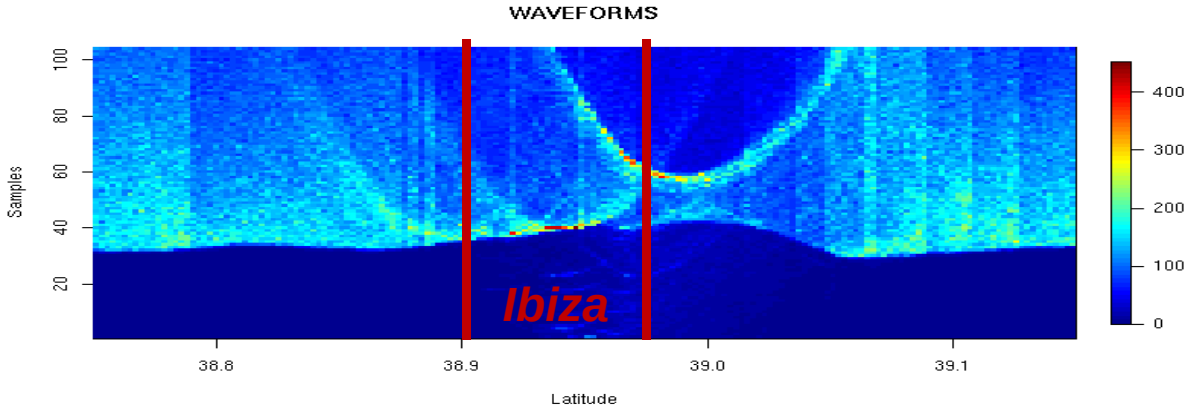




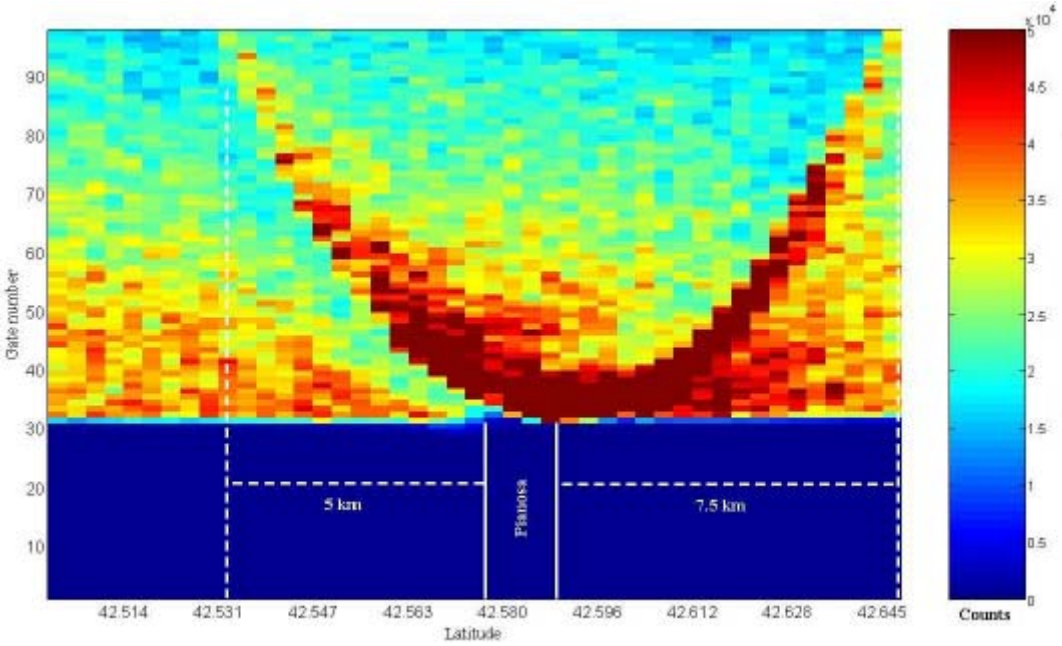
Very successful! Waveforms retracked and profile recovered.

S2 - Examples of observed waveforms

Jason-2, Cycle 8
Pass 187
(Med Sea, Ibiza Island)
Ku band



RA-2
Pianosa Island
Ku band
(Quartly, Seattle OSTST, 2009
Gomez-Enri, Coastal Meeting,
Rome, 2009)



S3 – Use of data from the various processing and/or reprocessing exercises: PISTACH, COASTALT, REAPER, ESA CCI

- **Usage increased** in the last year where they are freely accessible (e.g. PISTACH and CTOH -- COASTALT will be available soon);
- Different post-processing approaches: provided by experts or left to users;
- Availability of **clear documentation** helps to engage new users – we note a **progress** since last workshop;
- There are cases of **successful exploitation in scientific investigations**.

S3 – Use of data from the various processing and/or reprocessing exercises: PISTACH, COASTALT, REAPER, ESA CCI

RECOMMENDATIONS

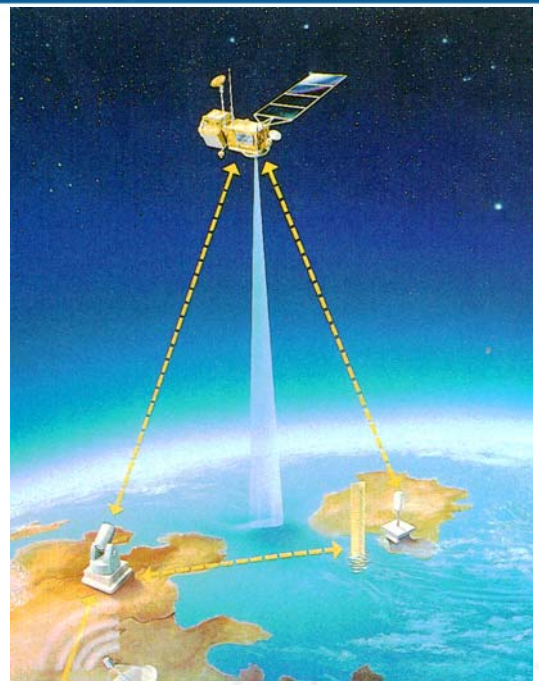
- Develop **summary descriptions** of all coastal altimetry products to inform on their **capabilities, advantages and disadvantages**;
- **Continuation** of projects and initiatives aiming at reprocessing and **produce coastal altimeter products**;
- **Continuation** of the **assessment** of the available coastal altimeter products, especially post-processing (which filtering, editing, co-location, etc.);
- **Publishing "champion user cases"** exploiting those products to **demonstrate the added value** of coastal altimetry in coastal studies.

S4 – - Methods to Inter-Compare Altimetry and Tide Gauge Data

Topics

- Comparison of sea level variability from tide gauges, altimetry, models (Andersen – for storm surges, Dufau – for quality control and gauge and altimeter data)
- Comparison of sea level trends from altimetry, tide gauges and GPS (Woppelmann - Caribbean, Nurmaulia - Indonesia)
- Development of a reprocessing methodology for deriving improved quality altimeter SSHA data (Vandemark)
- Comparison of sea level variability from tide gauges, altimetry, models (Guoqi, Barbosa, Testut)
- Quality checking system for coastal altimetry and comparison to in-situ data (Vignudelli)
- Calibration system for altimetry (inter-mission comparisons, the use of tide gauges) (Leuliette)

Sea Level prediction



CAN WE WARN ABOUT INCREASED SEA LEVEL FROM ”STORM SURGES” WITH SATELLITE ALTIMETRY?

Main issues:

- ✓ **Sampling problems (fixed tracks, sampling 10, 17 or 35 days)**
- ✓ **Availability of ACCURATE REAL TIME data (1-6 hours)**
- ✓ **Can we capture the Surge by the altimeter (i.e. Accuracy of tide correction)?**
- ✓ **Can we Merge Tide gauge data and Altimetry (and observe the same signal)?**
- ✓ **Establish warning (tests with neural networks).**

ALL OF THESE ISSUES CAN BE ADDRESSED SUCCESSFULLY!!

TG Information cards

http://www.aviso.oceanobs.com/fr/calval/in-situ-global-statistics/index.html

- For the GLOSS/CLIVAR and SONEL networks
- Performed each week
- Distributed on AVISO website

Ongoing operational comparison of altimetry and tide gauge data to detect faults in both of the systems

S4- Discussion

- **Access to all required data for validating** coastal altimetry (tide gauge, coastal geoid, …)
- How to use data in **combination with models**
- Appreciation of subtle differences between data types (e.g. tidal loading, Vertical Land Movement)
- How best to **use coastal data for altimeter calibration** – need to know how best to apply the various corrections to each data type
- Also mentioned was possible loss of data due to **imprecise rain flags** (in GDR data)
- **Bottom pressure measurements** in coastal observatories (100s-1000s metres depth) are useful comparison data
- Also stressed was the need to **understand the main signals in the altimeter and tide gauge records** (fingerprints etc.) and also how aliasing in altimetry affects comparisons (Space/timescales of agreement of in-situ and altimeter data)

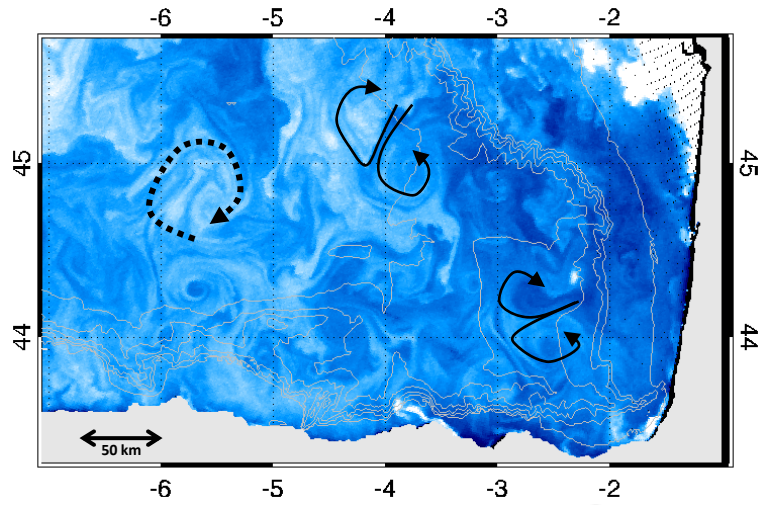
S5 – - Coastal currents and sea level variation

- In the coastal region, it is **still challenging to derive currents** from altimetry

- **Merging** several data (drifters, tide gauges, ADCP's etc) is **useful and necessary**
  - Along-track data provide higher spatial resolution
  - Data near land are important to estimate coastally-trapped currents
  - Specifically-processed Coastal altimetry data provide good correlation with SST and chlorophyll at seasonal scales

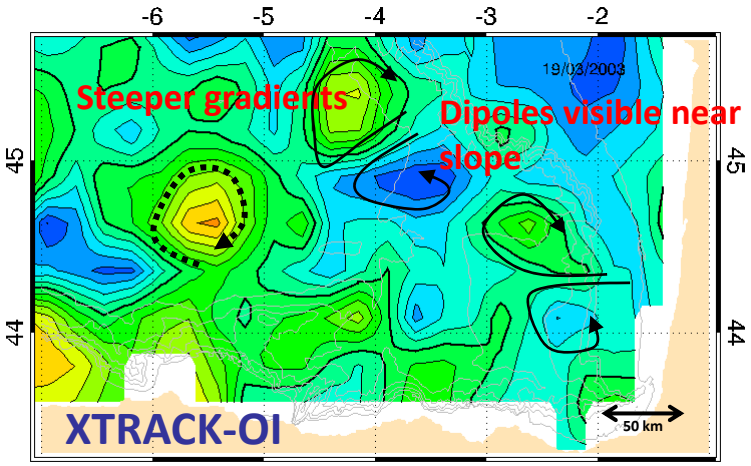
S5 – - Coastal currents and sea level variation

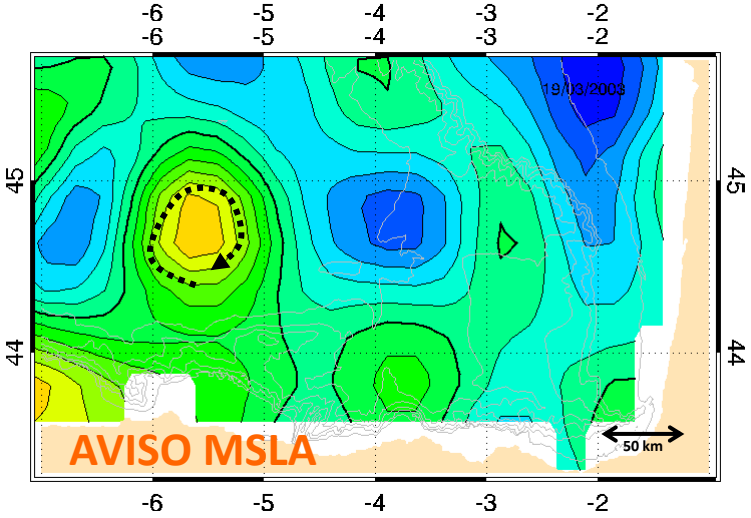
Use of 4 satellite missions and high-frequency along-track information was able to reproduce submesoscale features that was missed in AVISO



MODIS Aqua Pseudo-color image - 18/03/2003

- Satellite imagery may provide punctual information on fine scale dynamics





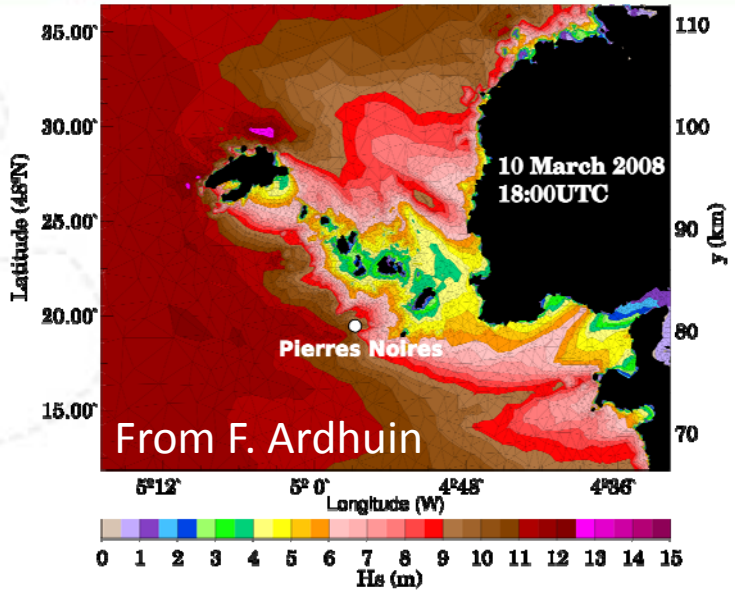
S5 – - Coastal currents and sea level variation

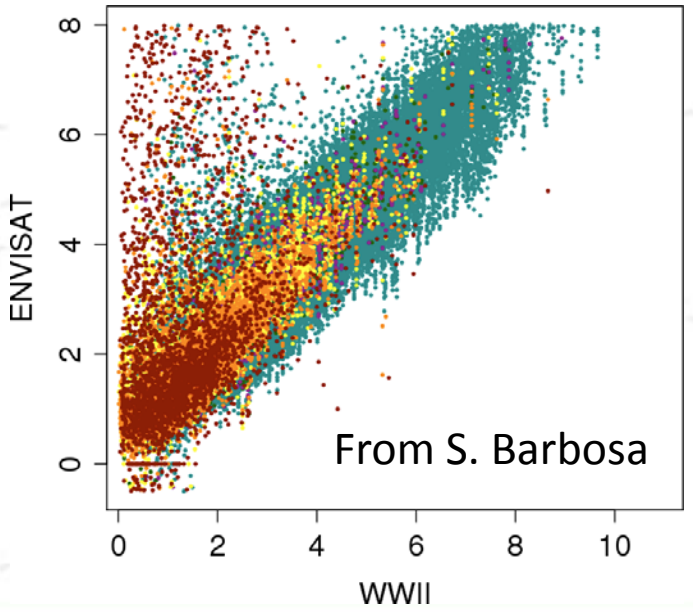
Suggestions

- Sea level and currents close to the coast should be examined carefully with ***in situ*** **data**
- As the temporal and spatial scales become smaller in the coastal area, availability of surrounding altimetry **data from all missions** should be considered
- Methods to estimate **wind-driven and tidal currents** should be further studied to **complement interpretation of the geostrophic currents** in the coastal regions
  - For combined use with *in situ* velocity data (e.g. Lagrangian drifters, snapshot ADCP obs)
  - For upwelling studies etc.

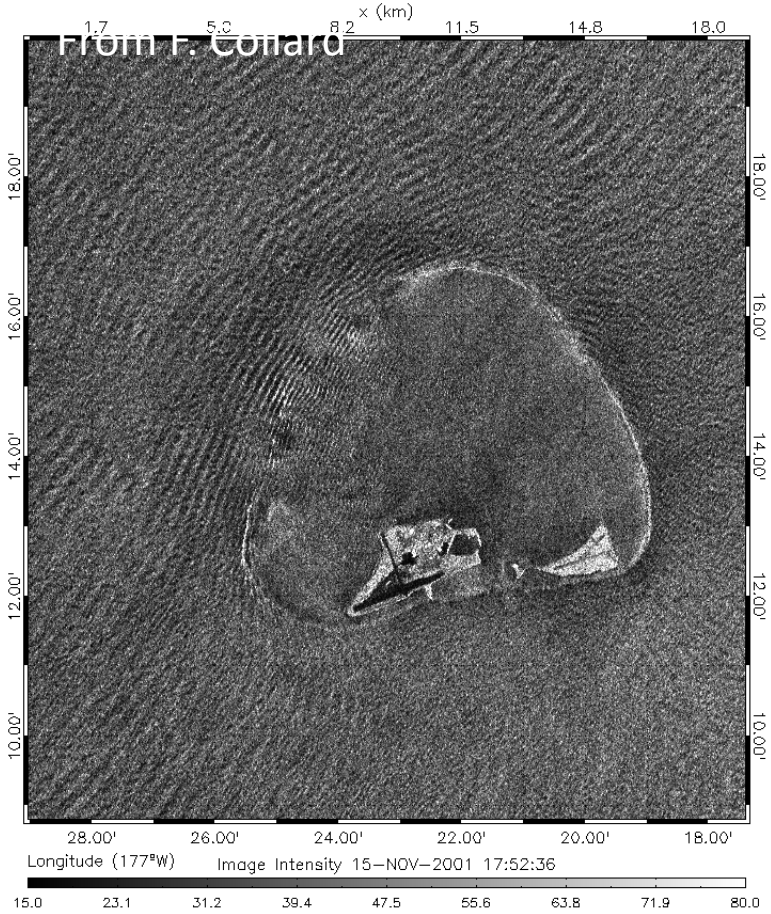
S6 – Wind and wave effects on Coastal altimetry

- Two talks on state-of-the-art wave modeling (F. Ardhuin, S. Barbosa)
- Highlighted important processes specific to the coastal zone
  - Effect of infra-gravity waves on sea level
  - Poorer quality winds in-shore, effect of strong currents (e.g. tidal) on waves, etc…





- One talk about satellite SAR to provide high-resolution data on wind and waves (F. Collard)
  - Improved winds in coastal zone with SAR compared to scatterometers
  - observed transformation of waves in shallow water



- Poster by Putrasahan et al., on SST/ wind stress coupling using high resolution circulation model
- No contribution looking directly at effect of wind and waves on altimetry

Seed questions and Issues

- What way forward for SSB in the coastal zone ?
  - Open ocean SSB models not valid in coastal regions; may need new parametrisations to capture increased non-linearity of waves.
  - Need combined use of altimetry, SAR and wave models to develop new approach for coastal SSB corrections
- SSB intimately linked to waveform retracking
  - E.g. coastal wind sheltering will cause specular waveforms that affect retracking performance
  - Coastal altimetry should follow the example of OSTST and have joint “SSB and Retracking” sessions.

S7 - Assimilating satellite altimetry observations

• We need to improve how to handle high frequency phenomena in coastal areas in order for multi-scale data assimilation to fully use coastal altimetry data

• We can use coastal high resolution baroclinic models in conjunction with other coastal observing system data (CODAR, gliders, …) to compute background fields (e.g. shelf and slope MDT, merged multi-satellite SST) for altimetry and other remote sensing data processing

• There is active development of the multi-variate assimilation methods and covariance models required to combine multiple observational data sets (e.g. gliders, HF radars, vessel ADCP, moorings, etc) with altimetry into integrated analysis products that could be used in oceanographic analysis.

• Coastal forecast systems are already exploiting coastal altimetry for operational applications.

S7 - Assimilating satellite altimetry observations

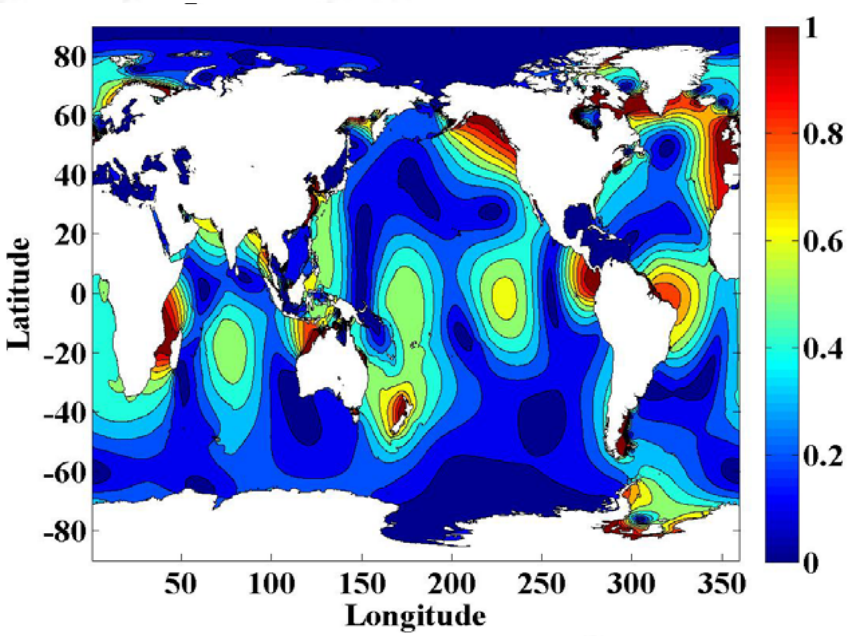
TIDES

WILL BE INCLUDED IN THE NEXT GENERATION

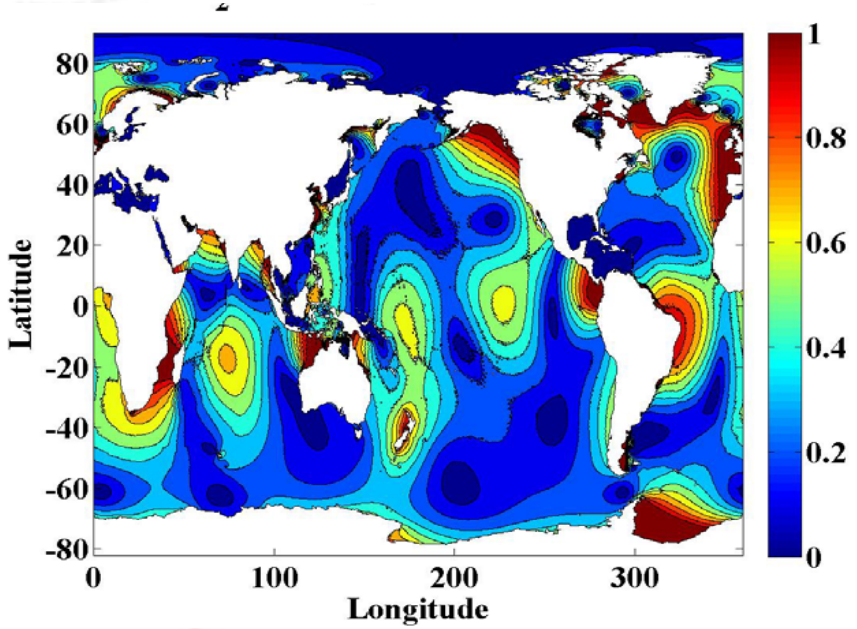
OF THE MODELS ASSIMILATING ALTIMETRY

Comparison of M_2 tide from Altimetric Assimilation Model (TPXO7.2) and HYCOM – Internal Tides are an important signal also (Richman et al.)

TPXO7.2 M_2 Tidal Model



HYCOM M_2 Tide

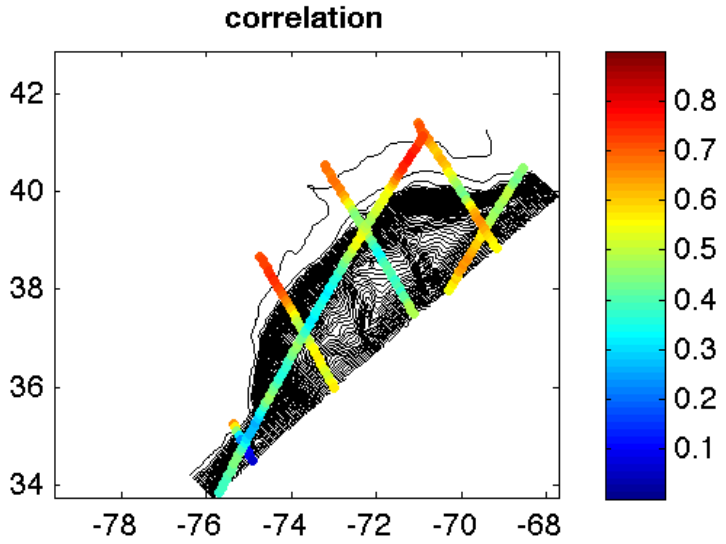


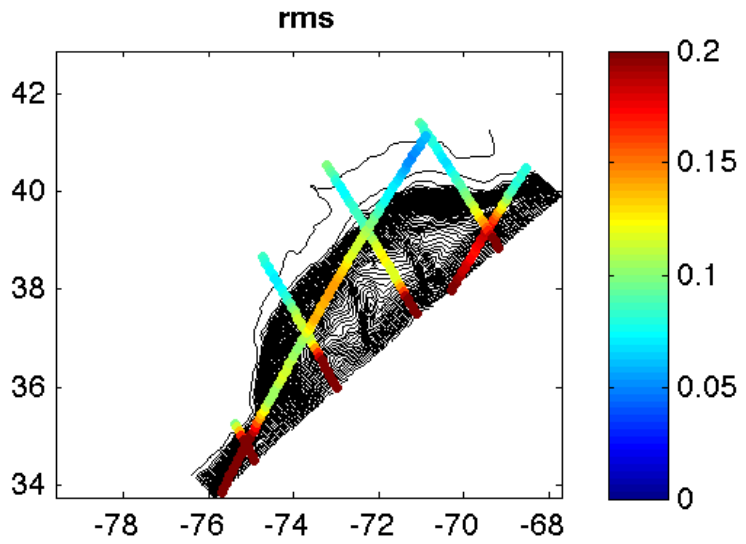
Difference with 102 pelagic tide gauges 7.8 cm rms

Difference with TPXO7.2 model 5.4 cm rms

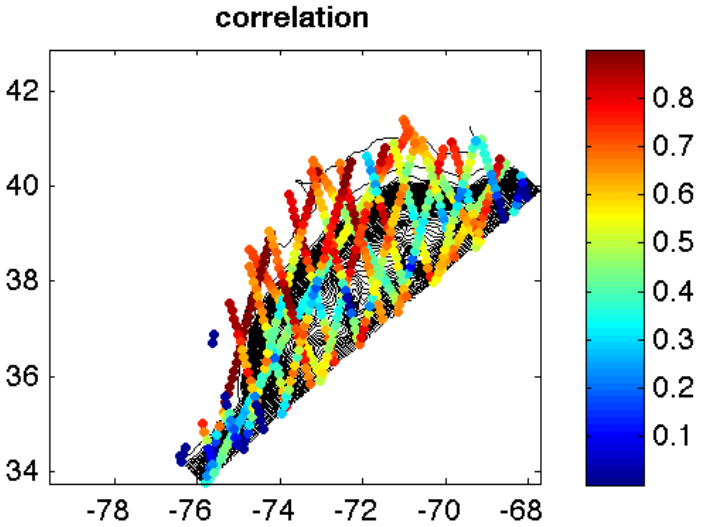
Regional-Local Models that assimilate SSH improve the full 3D state of the ocean

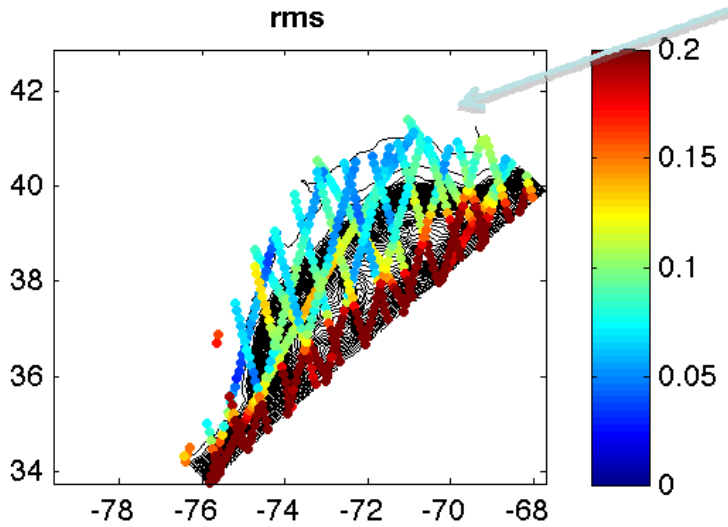
Skill in hindcasting along-track SSHA by the assimilation system





Correlation and RMS error of model SSH and Jason-1 SSH assimilated





Envisat SSH (not assimilated) is hindcast well by assimilation system

GENERAL SEED QUESTIONS:

•Do we need to improve how to handle high frequency phenomena in coastal areas and multi-scale data assimilation before we can fully use coastal altimetry data?

•Can we use (or do we need to use) coastal high resolution baroclinic models and other observations in computing background fields for altimetry and other remote sensing data processing?

•What are the most adequate solutions to combine multiple observational data sets (e.g. gliders, HF radars, etc) with altimetry into integrated observations data sets that could be used in model analysis and assimilation?

PROCESSING APPROACH QUESTION:
IN COASTAL REGIONS WHAT ARE THE CHALLENGES FOR ALTIMETRY AS:

1. **A STANDALONE PRODUCT TO DELIVER SSH ANOMALIES SNAPSHOTS ,**

2. **A COMPONENT INCLUDED IN A WIDER OBSERVATION-MONITORING NETWORK DELIVERING MAPS OF SSH ANOMALIES ALONG WITH OTHER PARAMETERS**

S8- Emerging applications

- **How to combine altimetric techniques with gliders in order to monitor 3D coastal mesoscale ?**
  - New methodologies have been developped and tested to **improve the altimetry-glider consistency** by partially solving the Reference Level issue for glider and using 20Hz data for altimetry
- **Monitoring Coastal Erosion Using Satellite Altimetry, GPS, and Terrestrial Laser Scanning on Galveston Island, Texas**
- **Altimeter as a High Resolution Imager of the Surface Roughness for coastal application**
  - High resolution altimeter waveforms; good imager of the surface backscatter at high resolution
  - Possibility to define a new operational product in particular to analyse surface slicks and to help the analysis on inland waters.

Conclusions / Recommendations

- Much progress reported…
  - First time we have “Emerging Applications”
- A growing archive to exploit
  - Current missions = nearly 19 years
  - Take a look soon at new CryoSat data
  - Forthcoming (improved!) missions
    - Sentinel-3, SARAL/AltiKa (india), HY-2 (china)

Conclusions / Recommendations

- Is the next question?

"Can Coastal Altimetry contribute to the Regional Sea Level Rise monitoring?"

Coastal Altimetry Book

Coming soon!

Published by Springer

Editors: Vignudelli (CNR, IT), Kostianoy (SIO, RU),
Cipollini (NOCS, UK), Benveniste (ESA)

http://www.alticore.eu/book

Stefano Vignudelli · Andrey Kostianoy · Paolo Cipollini
Jérôme Benveniste (Eds.)
Coastal Altimetry

Radar altimetry over the oceans represents a success story for satellite-based Earth Observation. However there is an important marine domain where altimetry has remained underexploited until recently: the coastal zone. Data in that region have been usually discarded due to problems with the altimeter radar echoes and to the lack of those corrections needed for an accurate estimation of sea level. Several scientists around the world have set out to fill this gap in knowledge and *push altimetry closer to the coast* by means of new/better corrections and dedicated reprocessing of the data. The importance of the new topic of Coastal Altimetry has now been recognised by the major space agencies like ESA and CNES. The last few years have seen the coalescence of a lively Coastal Altimetry Community, holding regular international workshops. This book summarises the promising advances in the topic, with the twofold aim to form a handy reference for the latest technical improvements and to present a number of case studies illustrating the value of altimetry data for coastal studies. The 20 chapters represent the work of a great number of research groups around the world, making the book an authoritative account of the state of the art in this novel topic.

Stefano Vignudelli is a researcher at the Consiglio Nazionale delle Ricerche in Pisa, Italy. His areas of expertise include satellite remote sensing of the marine environment, particularly the development of radar altimetry in the coastal zone through new methods for data processing, validation studies and oceanographic applications.

Andrey G. Kostianoy is a Chief Scientist at the P.P. Shirshov Institute of Oceanology, Russian Academy of Sciences, in Moscow, Russia. He is a specialist in physical oceanography. His research has focused on satellite monitoring, oceanography of coastal zones, regional climate change and environmental problems of the Black, Caspian and Aral seas.

Paolo Cipollini is a Senior Research Fellow at the National Oceanography Centre, Southampton, U.K. He is a specialist in satellite oceanography with focus on observations of planetary waves, satellite data processing and coastal altimetry. He is the manager of the ESA initiative for Coastal Altimetry research and development (COASTALT).

Jérôme Benveniste is a Senior Advisor at the European Space Agency, Esrin, Italy. He is a specialist in physical oceanography and applications of radar altimetry, developing new altimetry products, algorithms and validation. He has recently launched the ESA initiative for Coastal Altimetry research and development.

ISBN 978-3-642-12795-3

springer.com

Vignudelli · Kostianoy
Cipollini · Benveniste (Eds.)

Coastal Altimetry

S. Vignudelli
A. Kostianoy
P. Cipollini
J. Benveniste
(Eds.)

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Coastal Altimetry

Springer

Next Coastal Altimetry Workshop?

- Just before next OSTST !

CA Workshop Proceedings

- Posters and presentations will be made available on the web as PDF files

www.coastalt.eu

- We will publish the Workshop Summary on EOS or SRT

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