Findings & Recommendations

of the First Coastal Altimetry Workshop

Silver Spring, February 2008

Objectives of 1st Workshop

- Develop a new error budget specifically for the coastal ocean for the alongtrack signals.
- Identify specific problems where progress can be made in improving the alongtrack estimates of range and “corrections” in the region next to the coast.
- Form partnerships and collaborations to work on these. How do we do this? Through the new OST Science Teams? Through the various Europeans initiatives?
- In doing this, provide information and recommendations to the agencies and programs which will be reprocessing the historical data for better coastal coverage.

Recommendation 1

The study groups from this workshop continue to collaborate with the goal of reporting progress at the Coastal Altimetry workshop in Pisa Italy on November 5 to 7, 2008.

Recommendation 2

Coastal Zone altimetry is a secondary mission objective, after open ocean, for the currently planned altimeter missions.

Coastal experts and coastal user needs should be more involved in pre-launch design and post-launch cal/val of missions.

Future mission design should take advantage of technologies and enhancements that will further coastal applications.

Recommendation 3

In order to fulfill the need for long-term altimeter records a **global coastal ocean data set** shall be produced containing all historical along-track and auxiliary data and meta-data. Ideally, this will be

- in a common data format
- processed for multi-satellite consistency
- at the highest resolution possible (10, 18, 20 Hz)
- seamless between coastal and open ocean
- use best-available regional models to the extent possible.

Recommendation 4

The large footprint of water vapor radiometers is a major part of the error budget for coastal altimetry. Future missions should consider ways to improve the resolution, for example by adding higher frequency radiometers.

Recommendation 5

We need further studies that integrate altimetry with in situ data and models in the coastal zone, in order to

better understand coastal processes

and

demonstrate the value of altimetry in coastal observing systems.

Findings, tracking

We expect “standard” (Brown model) retracking to be adequate seaward of 20 km from the coast.

90% of waveforms are Brown-like seaward of 10 km from the coast.

Constrained retracking can reduce noise.

Adaptive (non-Brown model) retracking can recover data closer to the coast, however, intercalibration of the track point and wind- and wave-dependent biases will need to be studied.

Findings, wet troposphere, 1

Atmospheric “rivers”~200 km wide increase IWV near the coast.

0.5˚, 6-hourly models lack structure with ± 2 cm Ku-delay and less than 100 km half-wavelength

High-resolution coastal models show model gradients of 5 to 6 cm of delay per 100 km.

WVR can be used > 50 km from coast; at closer distances, land emissivity causes several cm of error.

SSMI land contamination begins 200 km from the coast.

Findings, wet troposphere, 2

Two parallel mitigation strategies are in development.

1, based on correction of brightness temperatures for fraction of land contamination

2, filling holes with model data, possibly adjusted for a bias or bias and slope.

Future missions may consider the use of higher-frequency channels.

Findings, tides

Tides are strongly dependent on bathymetry.

Compound tides (e.g., M4) have significant amplitude in shallow water and may contribute 6.6 cm to the global RMS misfit of models to gauges.

RMS errors in models are around 2.4 cm in deep water and ~12 cm in shallow water, but this value is highly dependent on locality.

The wavelength of the tide error will depend on depth.

The best approach may be to merge local and global models, but this is resource and labor intensive.

Findings, IB

The ocean's response to pressure forcing at shorter than 20 day periods is not as simple as an inverted barometer.

The MOG2D/DAC model shows a big (how big?) improvement over simple IB, especially at coastal and high-latitude areas.

(What length scale is the error that is improved?)

The S1/S2 atmospheric tides need further investigation.

Local models should be developed.

Findings, Sea State Bias

SSB is EM, skewness and tracker-dependent.

To first order, SSB is 1 to 5 (typically 3) % of SWH.

Present models adjust SSB based on SWH and U10.

New, three-parameter models (SWH, U10, age) differ from two-parameter models by 2 cm in shallow water and at SWH < 1.5 m.

Local empirical coastal models differ from global-average models by ± 3 cm.

Wave-current interactions are not yet accounted for.

Findings, SWH

Altimeter data are a very useful source of SWH profiles in the deep ocean.

Deep ocean SWH data are typically averaged for six seconds for comparability with large-scale wave models.

Correlation scales appear to fit the Monaldo model.

In coastal areas, SWH correlation scales can be as short as the wavelength.

Satellite orbit sampling issues show up as differences in apparent wave height climatologies.

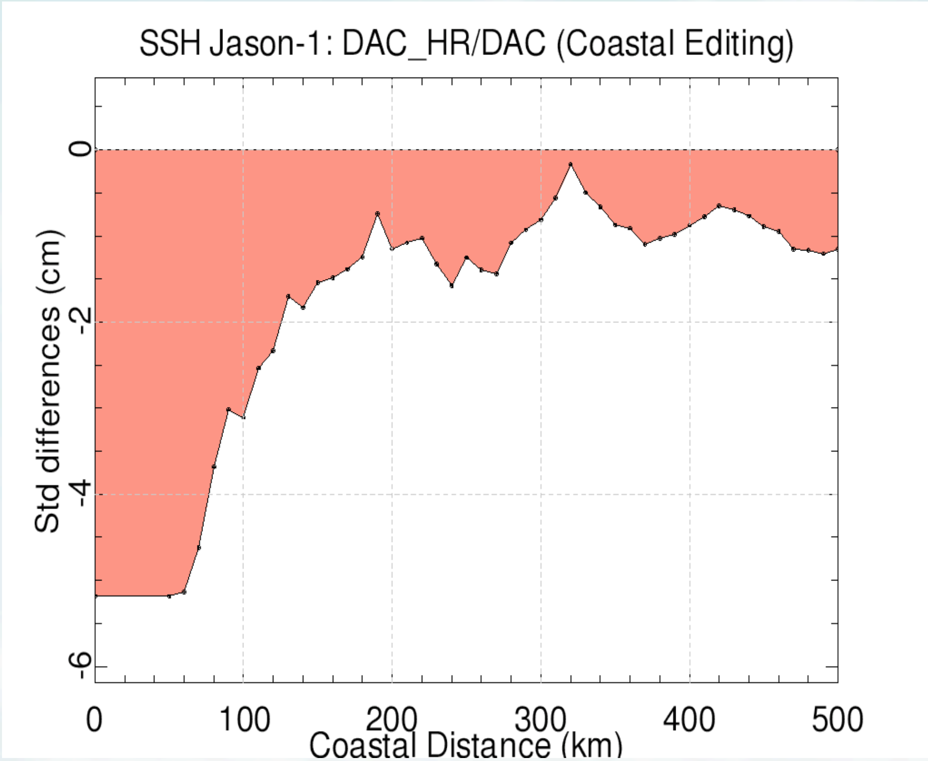
Findings, Programs

Currently, agencies treat coastal altimetry data acquisition as one of a group of secondary objectives, of lower priority than open oceans.

Coastal experts and coastal user needs should be more involved in pre-launch design and post-launch cal/val.

Source	Proximity, km	Horizontal scale, km	height error, cm	slope err, μrad
wet 0.5 deg, 6 hr model		100	2	0.2
wet ssmi	200			
wet wvr	> 50		< 1 cm	
wet wvr	20 - 50		< 3 cm	
tide model	locality-dependent	depth-dependent	12 cm	> 1
IB	l.-d. (shelf depth)	60 -120 km	1 - 5 cm	~0.5 ?
SSB, precision	20 km	(from SWH estimate)	2 cm	
SSB, accuracy	l.-d.	long	3 cm bias	

High Resolution DAC / Low Resolution DAC

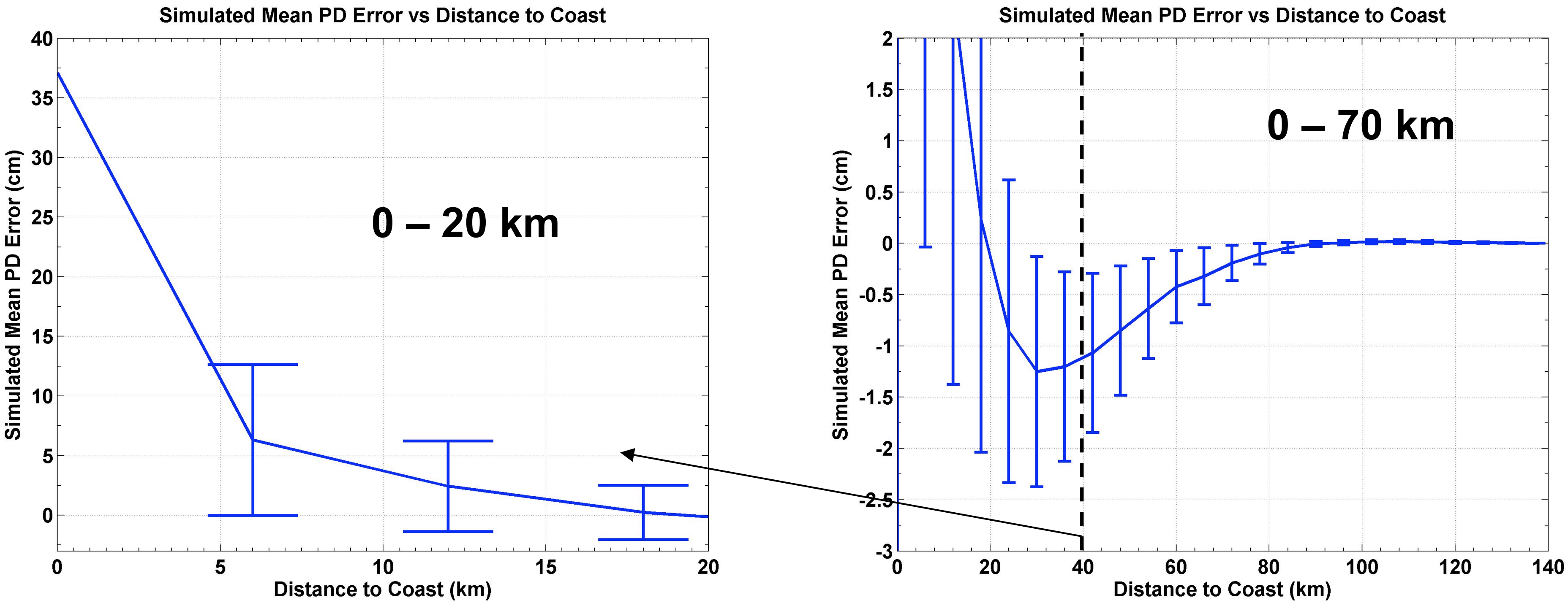


Preliminary results from the PISTACH coastal altimetry project:

- **dedicated editing applied to coastal regions**
- **gain in variance of HR DAC relative to LR DAC, as a function of distance to shore**

Radiometer Wet Path Delay Errors Near Land

- Error varies as a function of distance to land, land geometry and land brightness variations
- Typical Errors for JMR/TMR without correction
  - > 50 km from coast errors due to land < 0.5 cm
  - 20 – 50 km from coast error due to land < 3 cm
  - 0 – 20 km from coast error due to land up to 30 cm



Developing Land Correction Algorithms

- Land contamination of radiometer brightness temperature measurements can be removed provided that the following are all known perfectly
  - Antenna pattern
  - Land surface emissivity
  - Land Surface Temperature
- Sensitivity to errors in these three quantities increases with distance to land
- Correction algorithms can likely reduce errors to <1 cm to 20 km, but not likely perform well inside of 20 km from land