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Coastal Radar Altimetry: What can we learn from the Costa Concordia accident?

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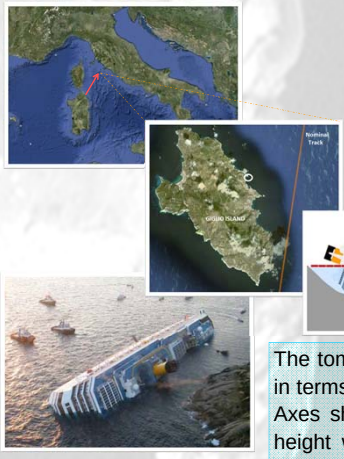
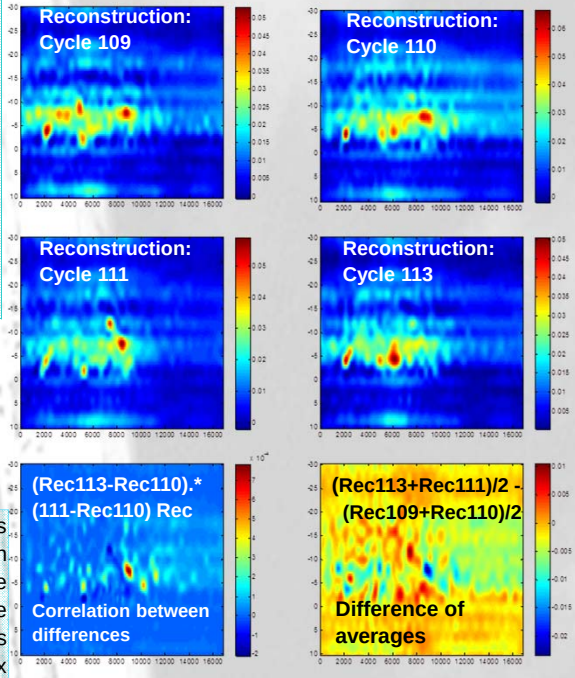
The retracking of radar waveforms is crucial in order to make satellite altimetry information reliable even in coastal zones, where particular targets (i.e. land, flat waters, ships) may act as signal contamination sources. On 13th of January 2012 the Costa Concordia cruise ship, with about 4200 passengers on-board, smashed its hull against the coast of Giglio Island, a tiny piece of land in the Tuscan Archipelago (Northwestern Mediterranean). Since then, the ship lies partly submerged in the water off the coast of the island. The dual-frequency radar altimeter (RA-2) on-board the ENVISAT satellite makes one descending pass (orbit 274) near Giglio Island, very close to the accident area (about 2Km), with a revisit time of 30 days. This particular condition represents a unique investigation opportunity, given by a steady and relatively large artificial target represented by the Concordia ship, being the orbit in the vicinity of a well-defined reflector, in addition to the pre-existing large structure represented by the island. We propose here to analyze the physical and electromagnetic effects associated with this particular feature on the RA-2 waveforms, using a recently experimented tomographic technique (Scozzari et al., 2012). This activity can provide additional information for the interpretation of "bright targets" phenomena in the framework of a wider research activity aimed at the extraction of the geophysical information from radar altimetry signals in contaminated contexts.

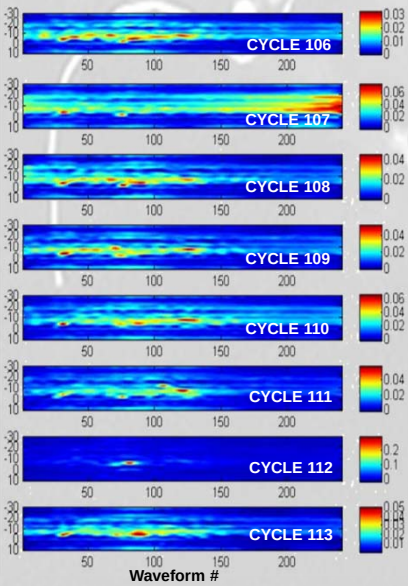


ENVISAT DATA

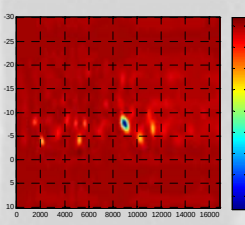
Five passages were analyzed before the accident (02/09/2011 (cycle 106); 02/10/2011 (cycle 107) 01/11/2011 (cycle 108; 01/12/2011 (cycle 109); and 31/12/2011 (cycle 110)) and three ones after (30/01/2012 (cycle 111); 29/02/2012 (cycle 112); 30/03/2012 (cycle 113).

The tomographic reconstructions are given in terms of modulus of the contrast function. Axes show the along-track positioning and height with respect to the nominal air-sea interface (in meters).





Most of tomographic images reveal the presence of a pattern that extends for some distance along track. The small-scale disturbance due to the ship is probably hidden in the complex reflection scenario due to island scattering.
Therefore, the simple tomographic reconstructions are not able to reveal any easily detectable change.



Element-wise product of the two matrices represented in the pictures above.

By combining the tomographic images before and after the accident to obtain anomalies, the situation is clearly improved. The post-processed image is now less affected by artefacts and a clear signature emerges in the area where the ship is located. This signature is compatible with the ship, while the background parts are filtered out by the simple change detection technique experimented.

CONCLUDING REMARKS

A signature in the Envisat waveforms due to the presence of the Concordia ship is revealed by the tomographic analysis enhanced by a simple post-processing step. This is a further proof that small targets emerging from the sea can be detected by satellite altimetry, as already shown in the case of icebergs (see Tournadre et al. 2012). The tomographic technique is a promising tool to provide a proof of their evidence and would help to make a mapping of targets at sea. On the other hand, the presence of small targets can disturb re-trackers. Their identification and removal would permit to clean waveforms data, which are after treated for the usual altimetry purpose.

REFERENCES

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