Coastal Altimetry with the Ka band

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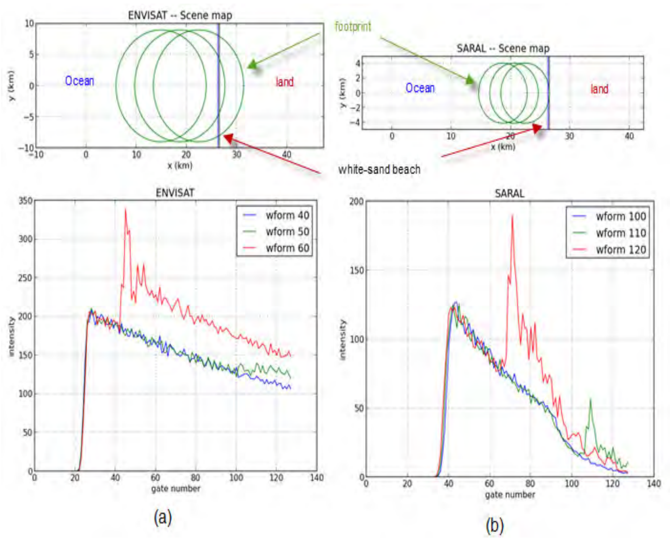
The Saral/AltiKa mission, launched in February 2013, is the first oceanographic altimeter using a Ka-band frequency. The use of the Ka-band is expected to supply more accurate measurements (better signal/noise ratio, improvement of the spatial and vertical resolution) enabling a better observation of ices, coastal areas, continental water bodies as well as the waves' height. We will revisit the problem of extending satellite altimetric products into the shelf and coastal seas with these new data, and consider three specific points:

- AltiKa/Saral SSH altimeter measurements, as compared with traditional Ku altimeter data;
- The characteristics of altimeter waveforms near the coast;
- Editing criteria for Ka-band altimetry.

Ka-band Altimetry in the Coastal Regions

Footprint

Because of the wavelength and altimeter design, the diameter of the footprint in AltiKa is about half that of Envisat. Numerical simulations let us explore the effect of different configurations on the observed waveforms. As a simple example, a sharp linear boundary between water and coast shows the effect of the observed waveforms for the different altimetrers. The approach to the coast shows deflection on the trailing edge (waveform number 50 and 110) and stronger with second peaks in the waveform 60 and 120 of Envisat and AltiKa respectively.

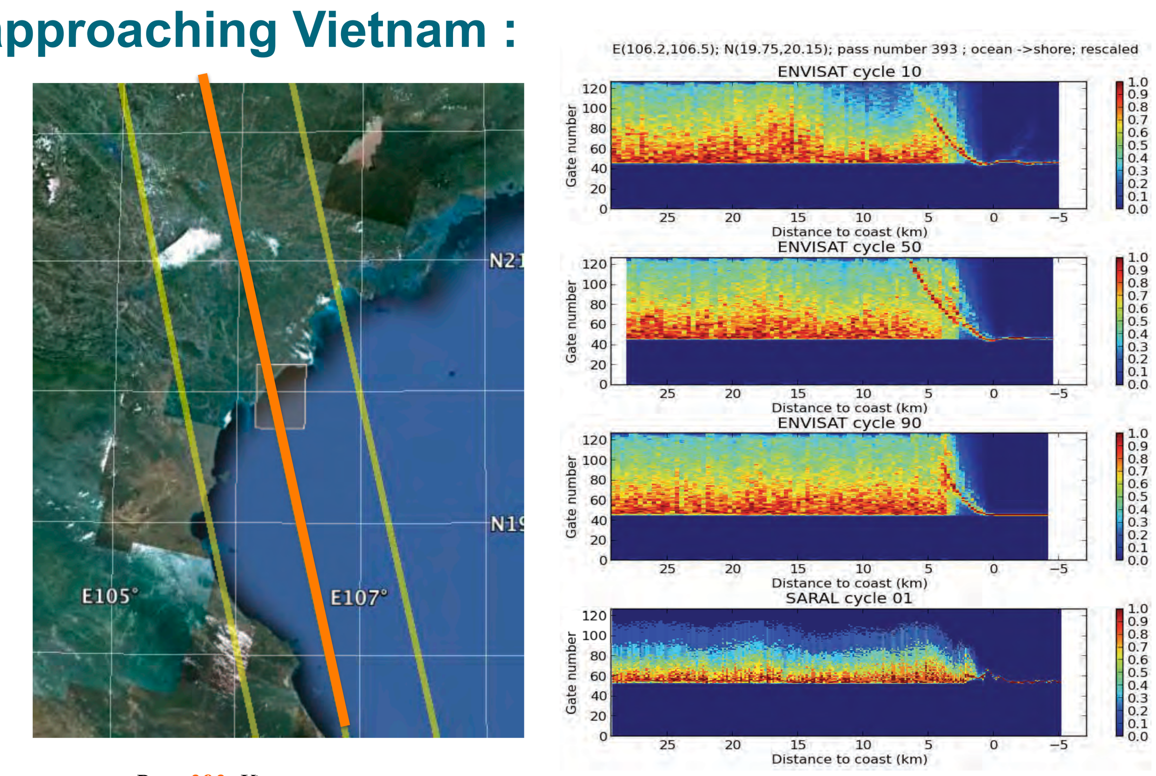


The footprints (upper panel) and the corresponding waveforms (lower panel) of Envisat and Saral in a simulation for a simple coastal region (step geometry)

Envisat and AltiKa approaching Vietnam :

Smooth sandy beach

The approach of a smooth sandy coast, as in pass 393 in Vietnam, Different waveforms of Envisat and AltiKa show the high reflectivy of the sandy beach on the Envisat data, for distances well@ over 6 km of the coast. Because of the smaller footprint, the effect of the beach is less evident



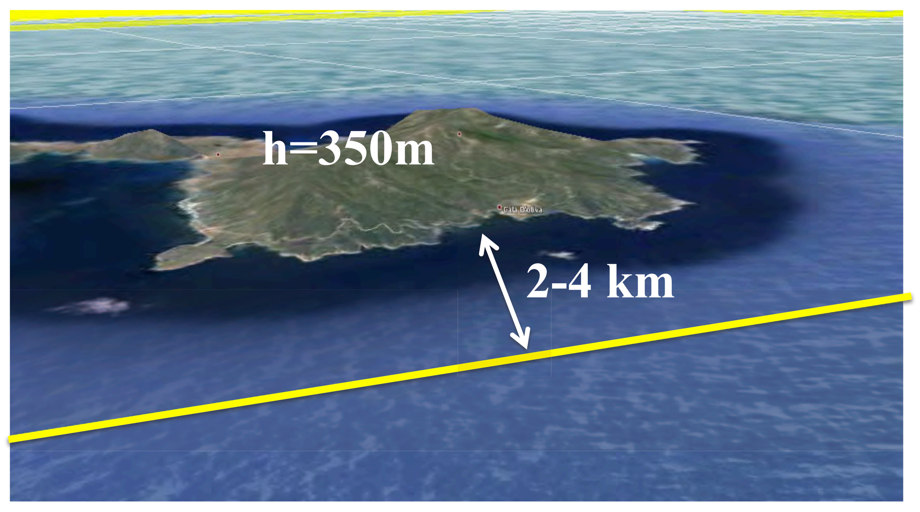
Pass 393, Vietnam

Envisat and Saral waveform showing specular reflections of sand as approachng the coast (over 8km for Envisat and 4 for AltiKa)

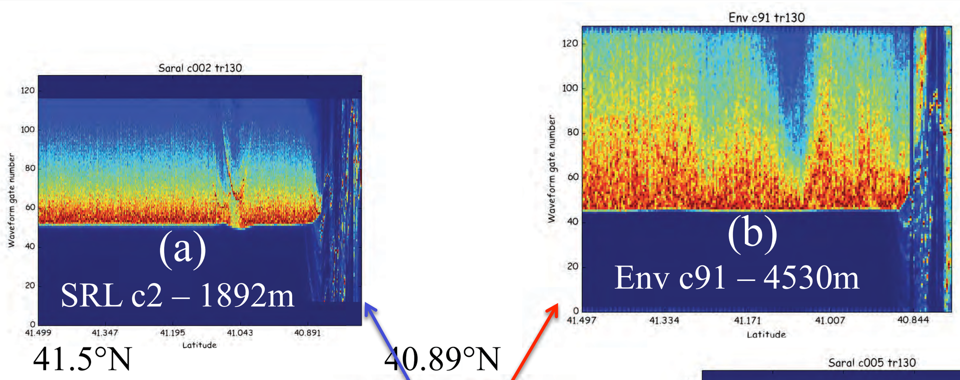
Approaching topography – Asinara Island (North Sardinia)

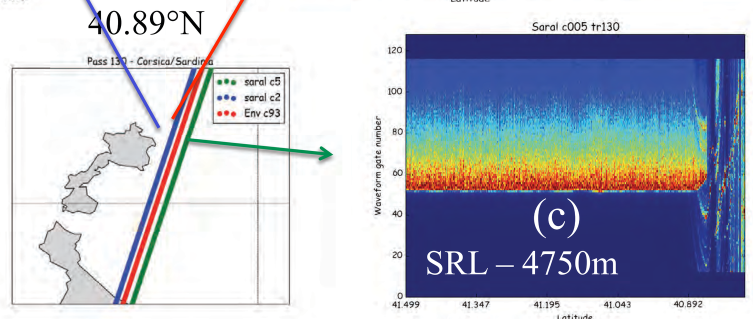
The effect of topography is much more dramatic; because of the footprint, the altimeter can detect high topography (as the 350m-high Elighe Mannu forest shown right). Orbital manouvers make AltiKas ground path go from the west of envisat track 130 in cycle 2, to its east on cycle 5. On figure (a) Altika waveforms show clearly the reflection of topography between 41.19°N and 41.043°N, that is between 12 and 2 km from the island.

For Envisat, the effect is visible starting at 41.293°N, or 22 km from the coast of the island.



Geometrical configuration of the ground path along Asinara Island





Three different paths (cycles 2 and 5 Saral, 91 for envisat) showing the difference in waveforms near the coast.

An objective approach for SLA editing

First step – identify relevant parameters

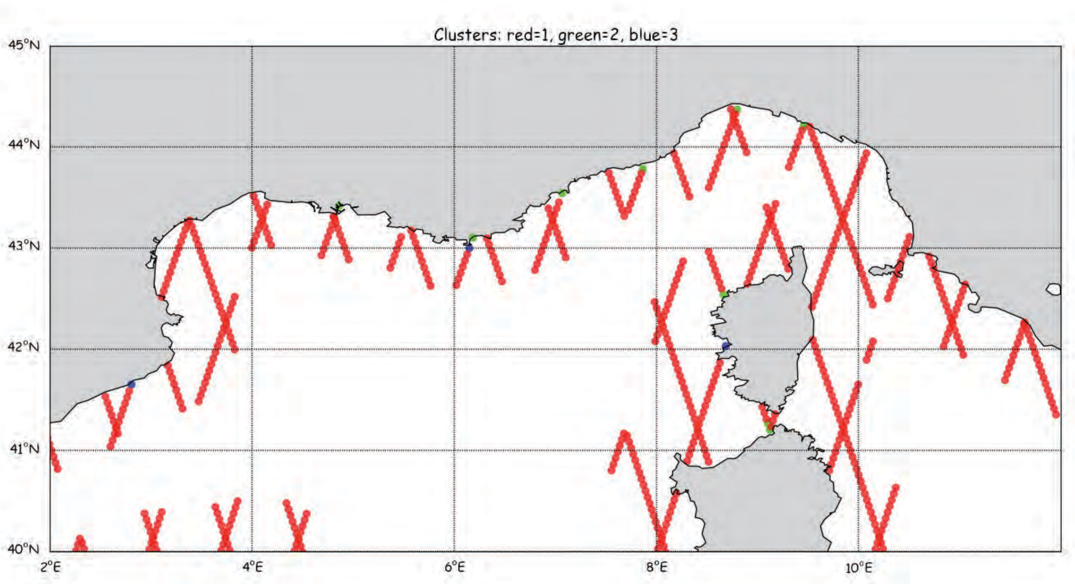
- Use *N* parameters as (non-independent) coordinates of phase space (**all** of them, except latitude, longitude and SLA);
- Calculate EOF of the SLA-space after normalisation (by standard deviation).
- The eigenvectors indicate the most relevant parameters.
- The number of modes to use depend on how much variance is explained by the modes.

Parameters for cycle 2 of Med. Sea modes 1, 2 and 3

swh_rms	doppler_corr	dist_to_coast_leuliette
signal_to_noise_ratio	model_wet_tropo_corr	tracker_40hz
swh	width_leading_edge_40hz	ice2_slope1_40hz
tb_k	ice2_sig0_40hz	ice1_range_40hz
amplitude_40hz	range_used_40hz	iono_corr_gim
agc_40hz	ice2_le_sig0_40hz	ice1_qual_flag_40hz
tb_ka	ice2_epoch_40hz	range_40hz
alt_40hz	seaice_amplitude_40hz	ice1_sig0_40hz
swh_numval	sig0_used_40hz	number_of_iterations
	ice2_sigmal_40hz	agc_rms

Second step – Cluster relevant parameters

- Project the data onto the chosen parameter subspace.
- Use K-means clustering to group data points and separate them into 3 groups.



Colors showing cluster number for cycle 2 of AltiKa
« Normal » points are red

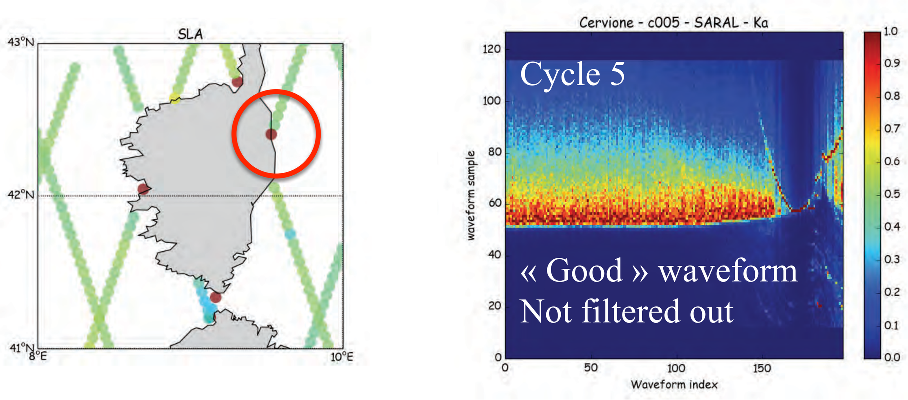
Final step - Filter the data

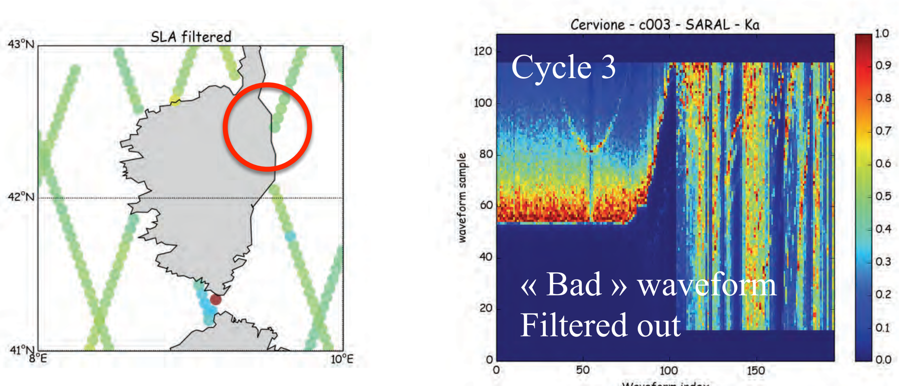
- Two choices are possible:

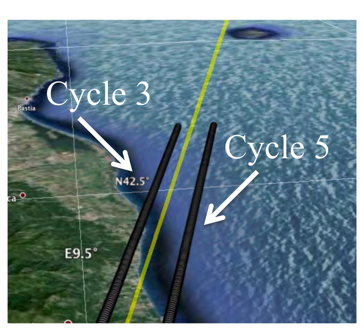
1) Use the cluster number of each point as editing criterion and filter out the data belonging to the smallest size clusters (minimum size = 30).

2) Use the min/max values of the cluster data to filter out other points (as in the handbook criteria given for AltiKa open ocean applications).

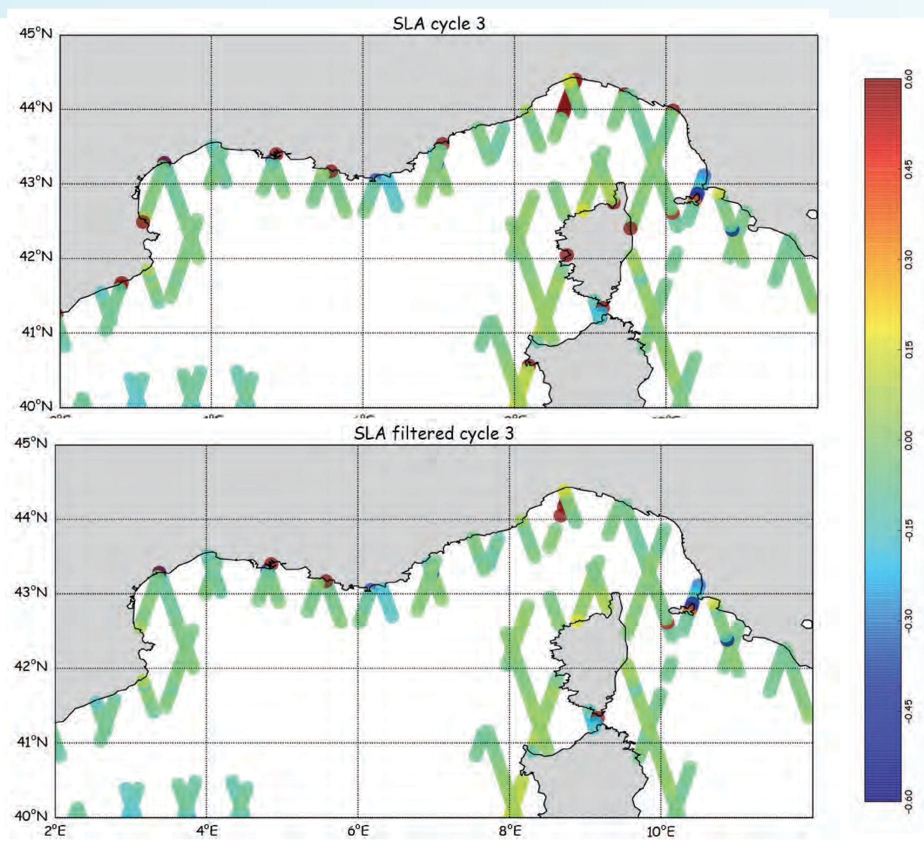
In the figure at right, most of the bad points were removed, 1.9% of all points at a distance less than 50km of the coast.







The example of pass 588 in Corsica (Cervione) is interesting; the clustering does not filter out well-shaped waveforms (cycle 5, on top) parallel to but off the coast, but does filter out erratic waveforms very near the coast (cycle 3).



Original and filtered SLA map for cycle 3 of AltiKa
2.7% of all data points have been edited

Conclusions and perspectives

We have shown work in progress for an objective methodology to coastal altimetry high-frequency editing criteria.

We choose the parameter set which will be the basis for editing in terms of EOFs analysis;; a classical *k-means* clustering algorithm is used to group data, and this group indicates if it is filtered or not. Looking at individual points of problematic zones, we find that the presence of topography alters the behaviour of the altimeter, giving spurious signals or losing the tracker altogether.

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