SAMOSA
Final Project Presentation

4. Development and assessment of new applications for SARM data over water

Project funded by ESA under the STSE programme:

STSE
Support To Science Element

SAMOSA

Session 4.1

- RDSAR: overview to theoretical basis, production of pseudo-LRM data from SARM FBR
- SAMOSA1 waveform model

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RDSAR

Motivation

CryoSat-2 → SIRAL first SAR altimeter on board a Satellite

The SIRAL modes are mutually exclusive

For the quantitative comparison of SARM and LRM data the SAMOSA team has been working on the reduction of SARM data such that it emulates conventional altimetry data

This allows for:

Quantitative comparison of the modes

Tracking SARM data with LRM techniques

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SIRAL data types

Low Resolution Mode - LRM

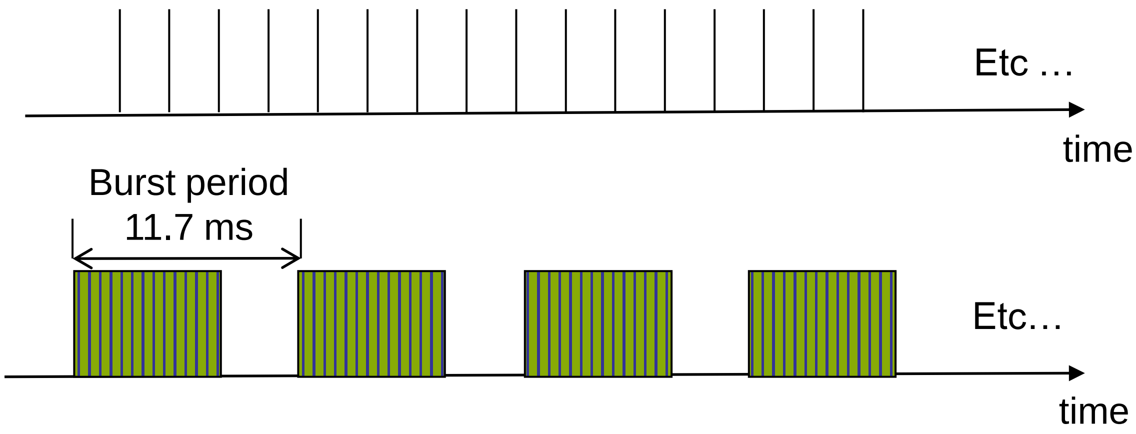
PRF_{LRM} = 1970 Hz

Decorrelated echoes

SAR Mode - SARM

PRF_{SAR} = 17.8 KHz

Correlated echoes



Full Bit Rate

LRM

L1 or Full Bit Rate Data and L1b or multi-look waveform data

Both correspond to multi-looked waveforms at a rate of approximately 20Hz

SARM

L1 or Full Bit Rate Data → consist of individual **complex echoes** (I,Q components)

and **L1b correspond to multi-looked waveforms** at a rate of approximately 20Hz

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Correlation / Decorrelation

★ Decorrelated adjacent waveform PRF upper bound (LRM)

- Is derived from the correlation of data between adjacent samples (Walsh, 1982). This calculation is based on the Van Cittert-Zernike theorem, which states that such decorrelation is achieved by:

$$PRF = \frac{V_s}{d\left(\frac{R_E + h}{R_E}\right)} \qquad d = \frac{0.305 / h}{r} \longrightarrow$$

Radius of a circle formed by the intersection of spherical waveform with MSL

★ Correlated waveforms - Nyquist sampling PRF lower bound (SARM)

- Determined by the Doppler bandwidth of the antenna pattern (15KHz for CryoSat-2)

Unequal number of pulses

$$m = \frac{\mathrm{PRF}_{SARM}}{\mathrm{PRF}_{LRM}} \longrightarrow$$

pseudo-LRM

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Conventional Altimetry processing blocks

- From EnviSat –RA2 we know that after samples are gathered:
  - They are hamming weighted and corrected for Rx-delay
  - Samples are IFFT
  - Samples are transformed to power and an amplitude fine correction is applied

- RDSAR – processing done to the pseudo-LRM sequence
  - Window delay correction
  - Samples are IFFT
  - Samples are transformed to power and gain compensation is applied

Still unequal number of pulses

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Methodologies

- **Methodology 1:**
  - Coherent summation of in between pulses → peaky waveforms
- **Methodology 2:**
  - F.T of the data in azimuth, across the data at a constant range over each burst → this would re-distribute the samples by Doppler bin. → peaky waveforms
- **Methodology 3:**
  - One every "m" waveforms:
    - For a constant sea state scenario it can be proved that in order to reduce SARM FBR data to an equivalent of 1s of LRM data and preserve equal number of pulses we need to reduce 3 seconds of SARM FBR data.

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Results and Conclusions

– **Methodology 3:**

- Statistical equivalence has shown to be preserved between the pseudo-LRM sequence and its equivalent LRM for a constant sea state scenario
- In addition, we tried to incoherently combine the in between pulses
  – For such additional summation statistical equivalence has shown to also be preserved
  – In addition **incoherent summations** has resulted in a SNR improvement of the trailing edge since the results have shown that the coherence in the return complex SARM FBR Echoes trailing edge is less predominant than in the leading edge.

– **Methodolgy implemented in RDSAR**

– **Results with simulated data:**

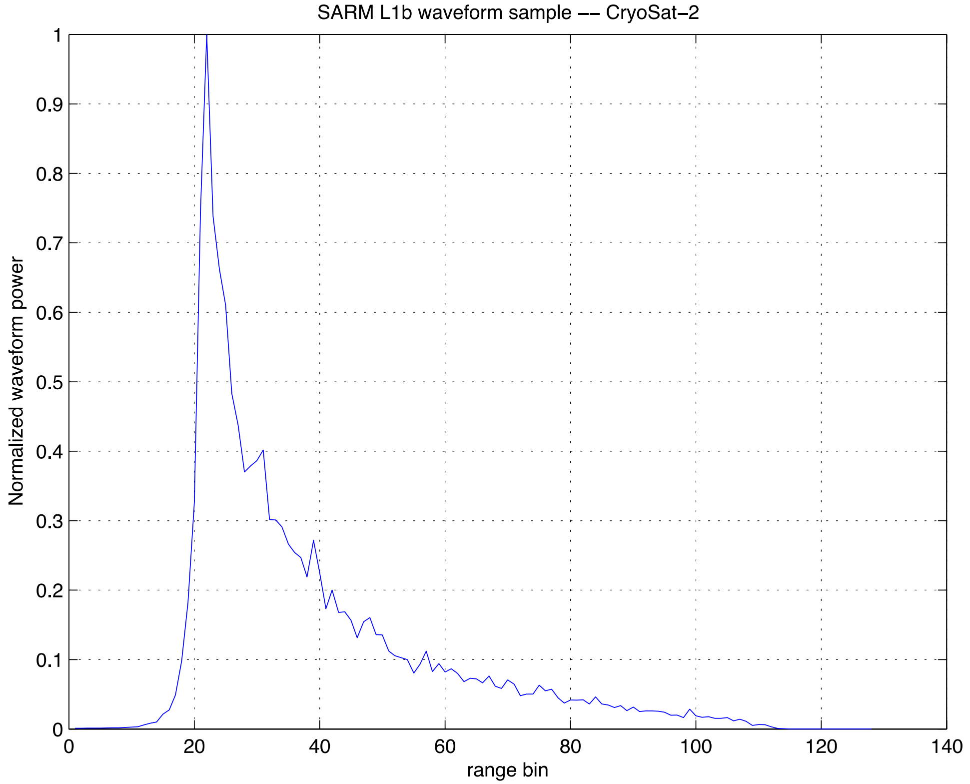
– RDSAR vs LRM

– RDSAR vs SARM for quantitative comparison

SAMOSA1 waveform model

Motivation

– The shape of a SARM return echo is different from a “Brown-style” waveform, and so a re-tracker designed for a conventional altimeter cannot be expected to work on SARM data.



SAMOSA1 waveform model

Model Description

– We demonstrated that the model can be expressed as a three fold convolution:

$$W(tau, Doppler_{bin}) = P_{FS}(tau, Doppler_{bin}) * S_R(tau, Doppler_{bin}) * (\frac{c}{2}) P_z(\frac{ctau}{2})$$

– Model 1 assumes:

- Ocean-Gaussian statistics
- Gaussian antenna pattern
- no-curvature effects across track, only along-track are considered
- mispointing angle effects along-track
  - ✓ Doppler shift
- radial velocity effects are neglected

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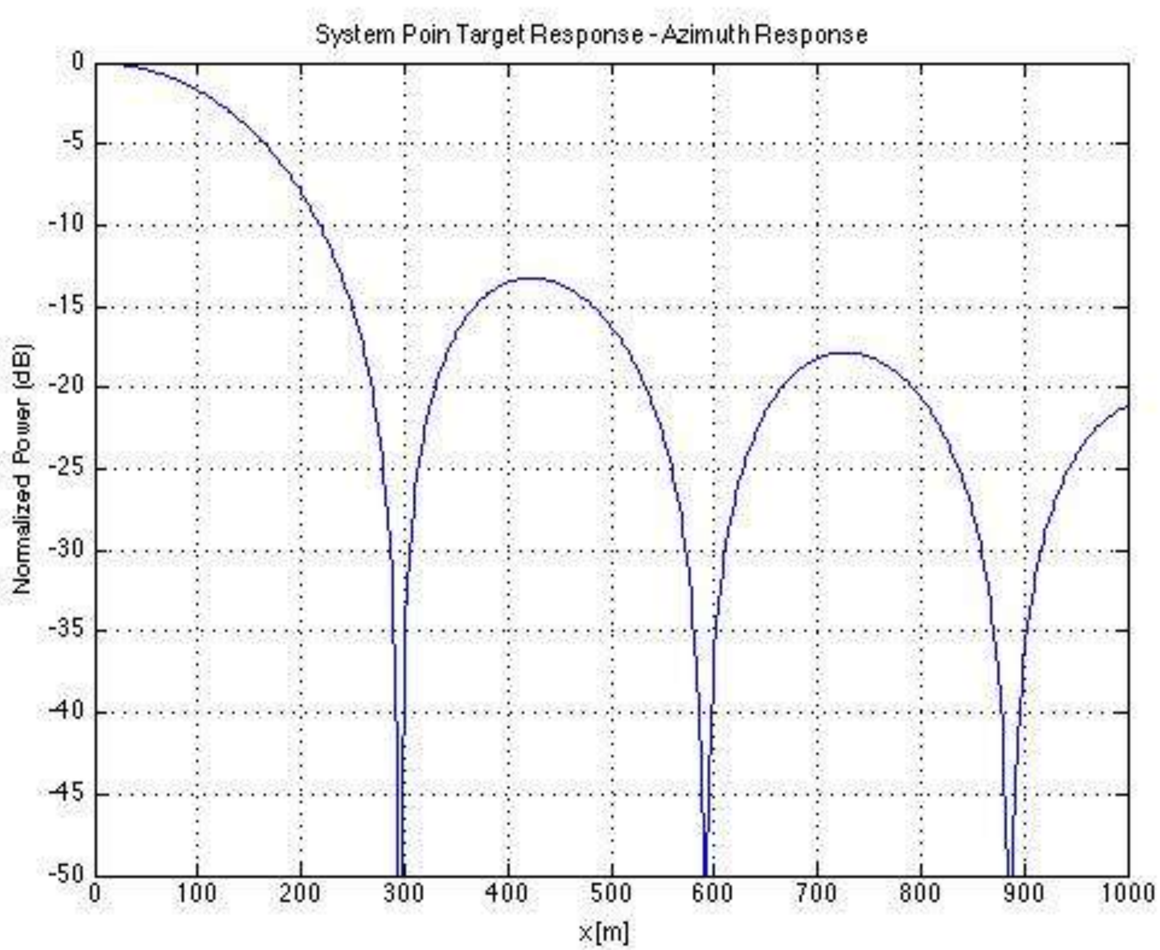
SAMOSA1 waveform model

SPTR - azimuth



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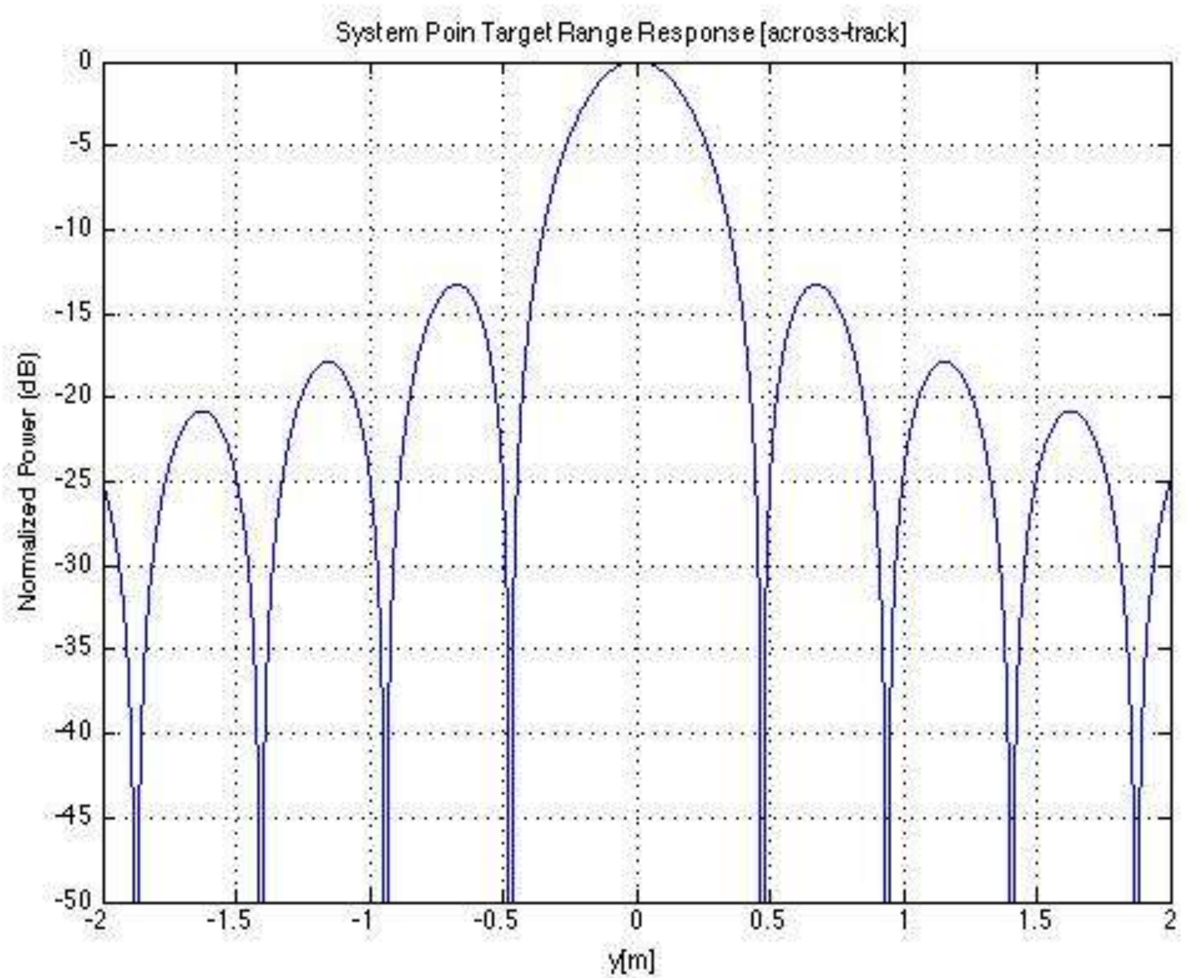
SAMOSA1 waveform model

SPTR – range



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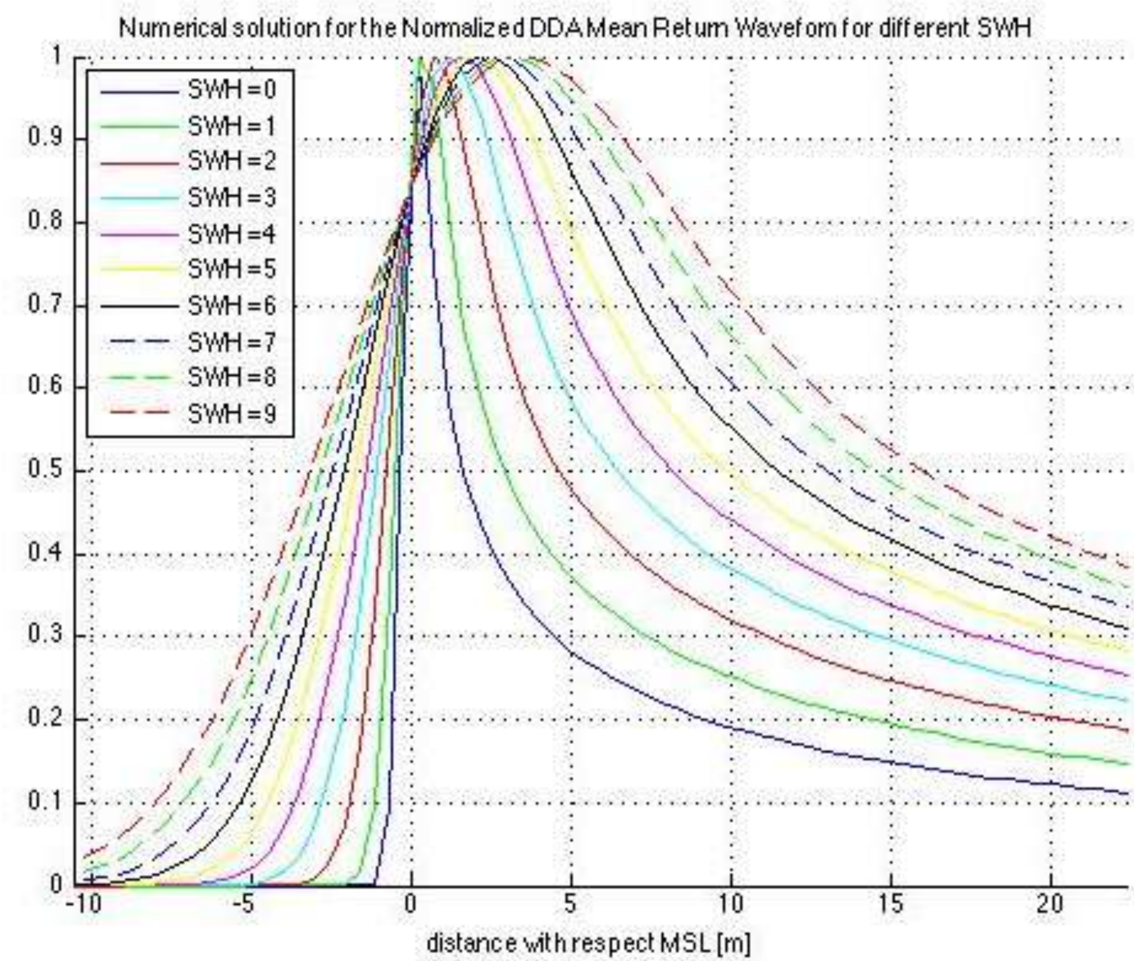
SAMOSA1 waveform model

SAMOSA WM1 for different SWH conditions and Doppler zero



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Thanks for your attention!

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