SAR Altimetry numerical simulations over water surfaces

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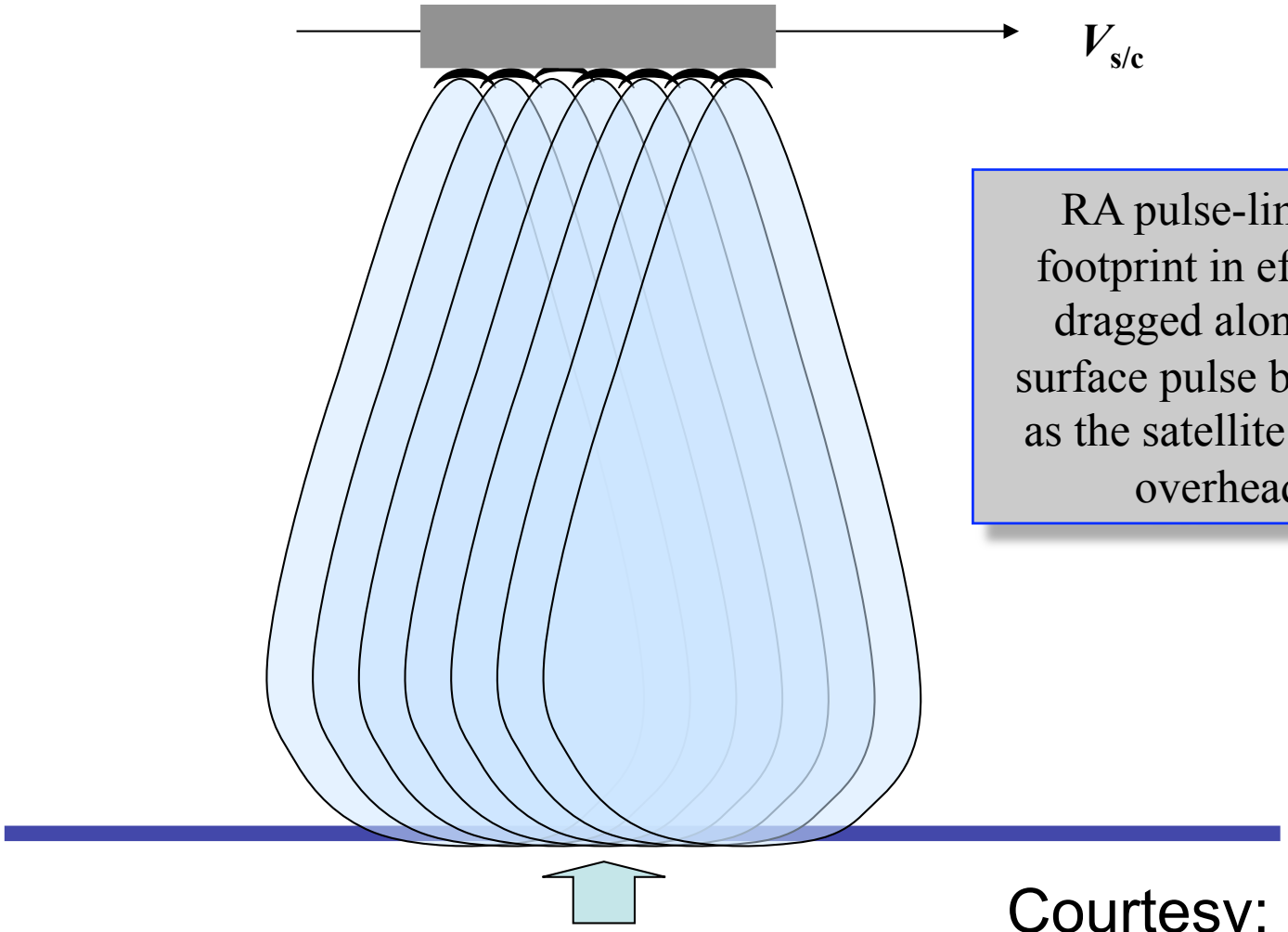
Presentation Content

- What is Delay-Doppler Altimetry (DDA)?
- The ESA SAMOSA project
- Motivation and methodology
- CRYMPS DDA simulations over water
- First results
- Conclusions

What is Delay-Doppler Altimetry (SAR) ?

Conventional ALT footprint scan



RA pulse-limited footprint in effect is dragged along the surface pulse by pulse as the satellite passes overhead

Courtesy: K.Raney

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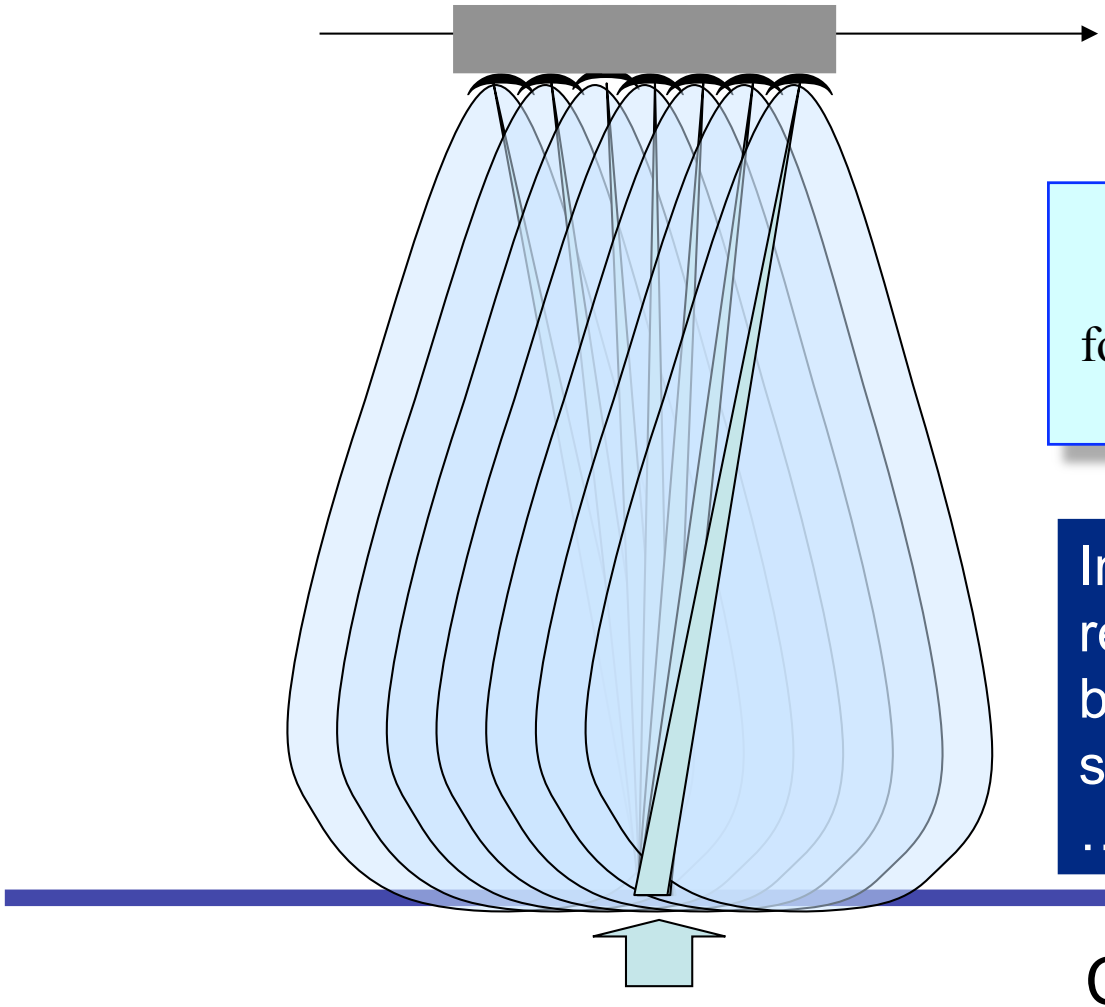
DDA: a fundamentally different method



DDA spotlights each along-track resolved footprint as the satellite passes overhead

Improved along-track resolution, higher PRF, better S/N, less sensitivity to sea state, …

Courtesy: K.Raney

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ESA SAMOSA project

- SAMOSA - Development of SAR Altimetry Mode Studies and Applications over Ocean, Coastal Zones and Inland Water
- Project management: David Cotton, SatOC
- Consortium members: NOCS, Starlab, De Montfort University, Danish National Space Centre
- Tasks:
  1. Review state of the art (Starlab)
  2. Quantify improved range error in different sea states (NOCS)
  3. Assess recovery of short scale surface slope signals (DNSC)
  4. Develop theoretical model for DDA waveforms (Starlab)
  5. Assess capability in coastal zone and inland waters (DMU)
  6. Application to RA-2 individual echoes (NOCS)
  7. Validation with ASIRAS data (DNSC)

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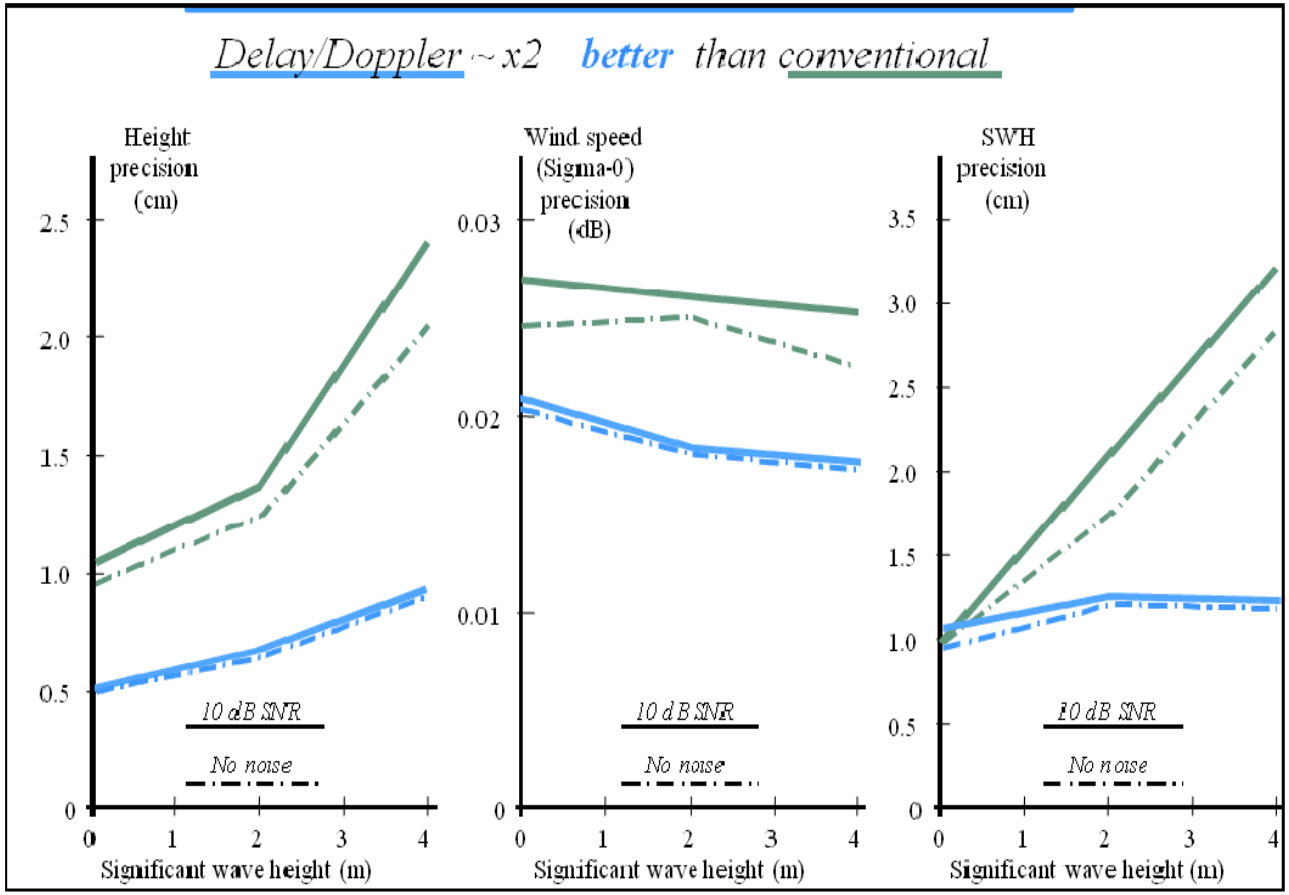
Motivation

- Task 2: to independently validate Jensen & Raney (1998) on improved sea level retrieval with DDA against sea state

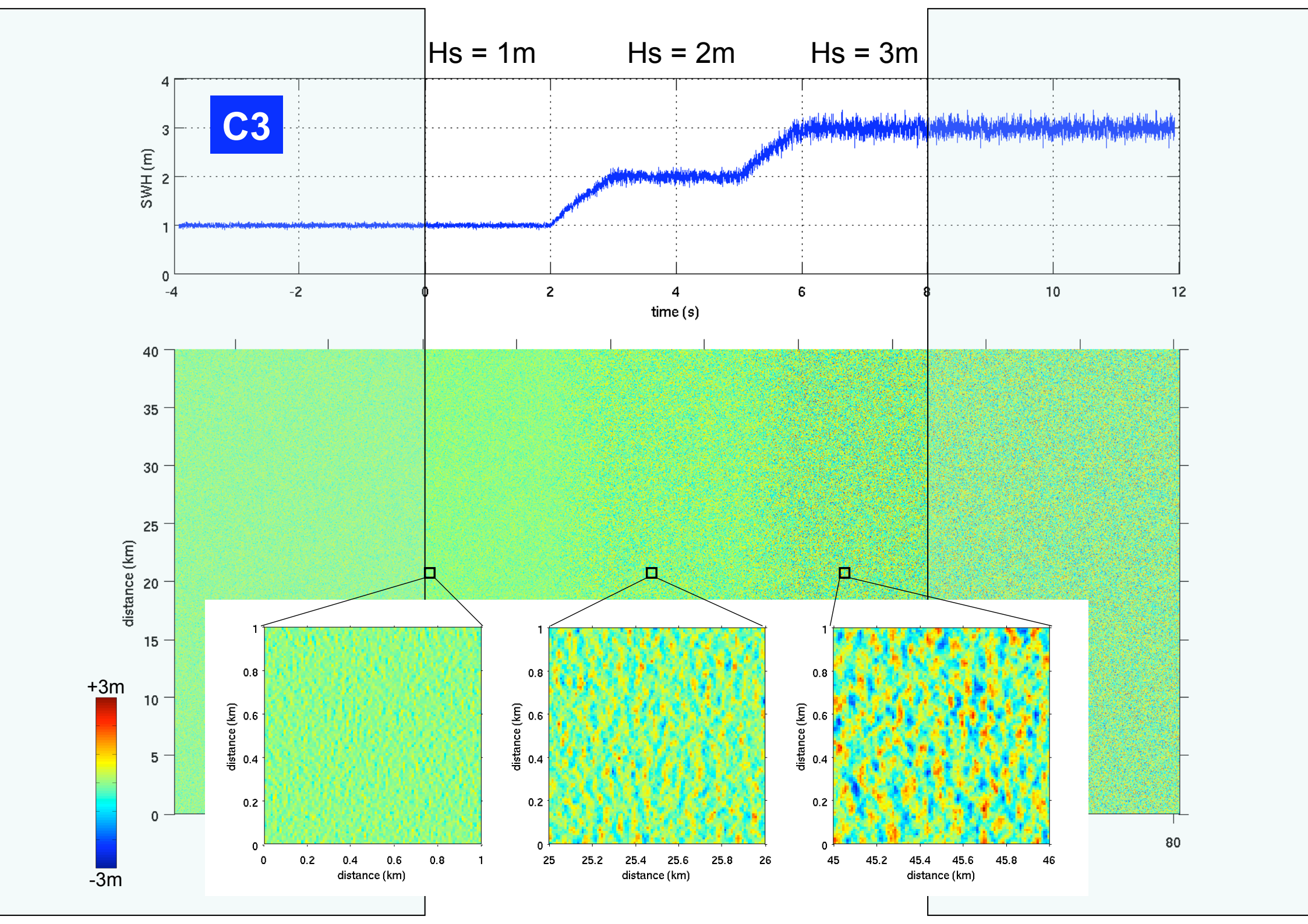


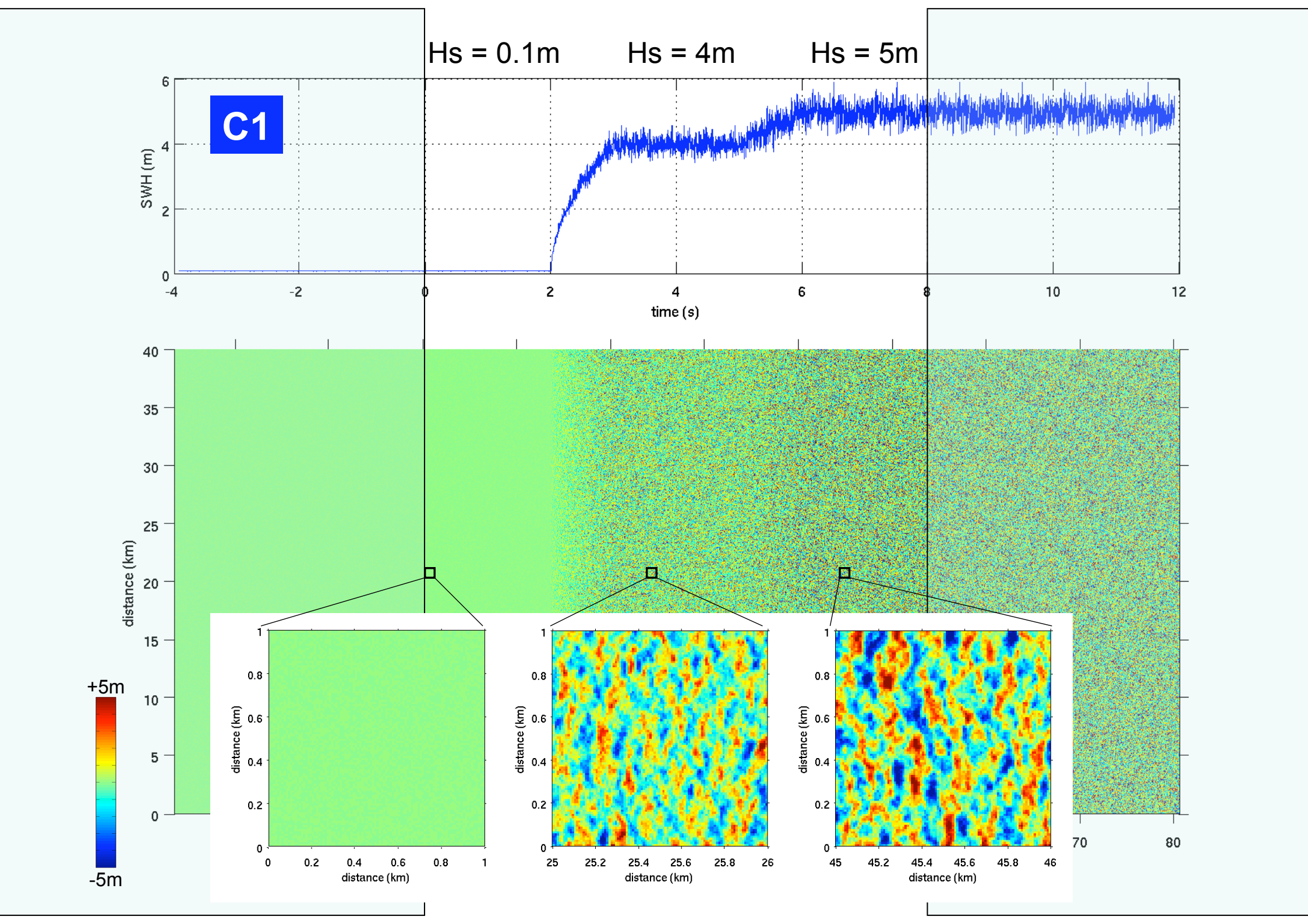
Methodology

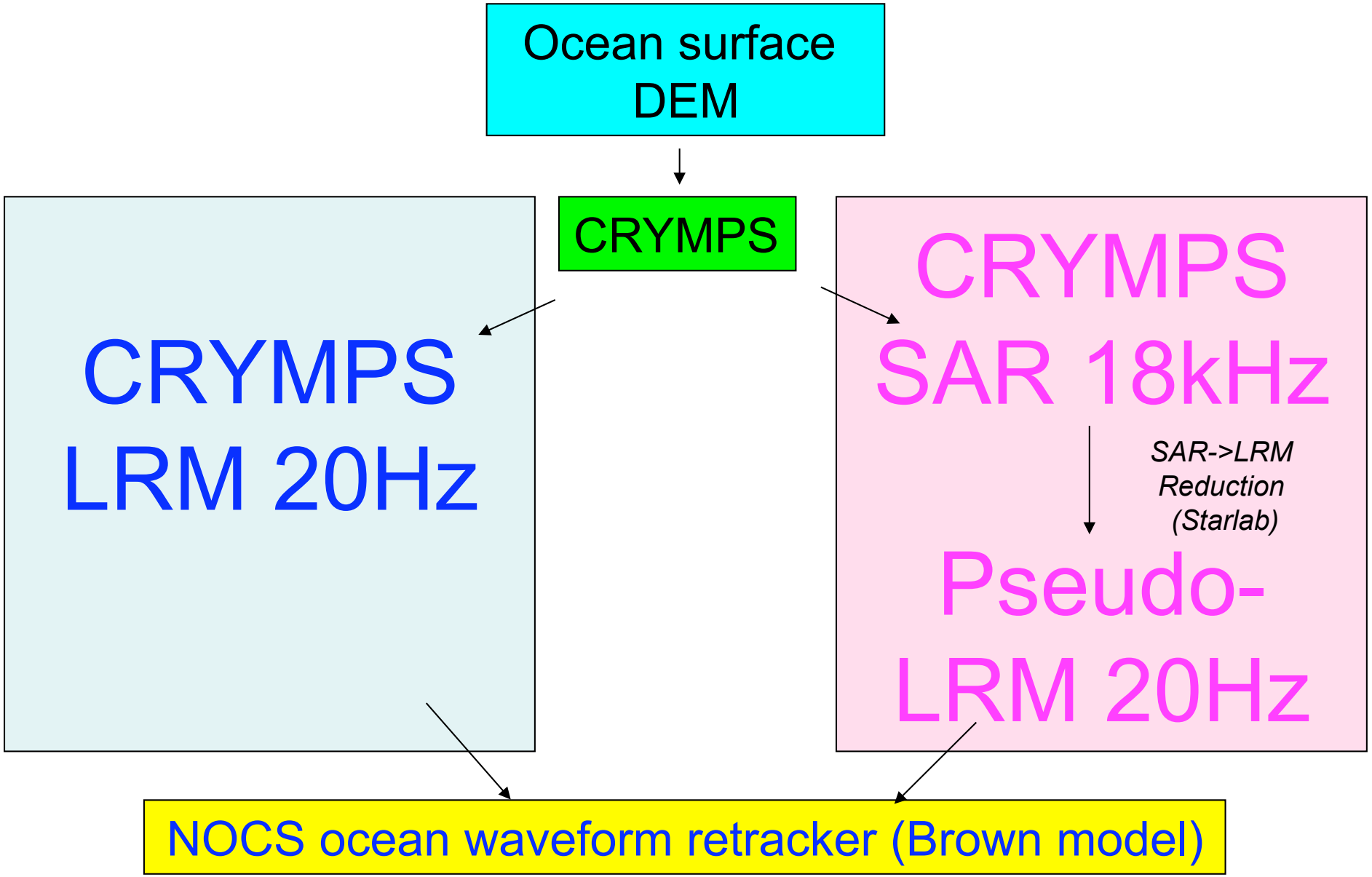
- CRYMPS: Cryosat Mission Performance Simulator
- CRYMPS developed & run at University College London/MSSL, in collaboration with ESA/ESTEC
- Simulates the CryoSat platform orbit and instrument operation, generates official Cryosat products for LRM, SAR and SARIn mode, for a given (explicit) surface
- Simulator and surface descriptors optimised for ice/sea ice surfaces
- Here, CRYMPS is applied to ocean surfaces

CRYMPS runs over open ocean

Code	Description	SWH	Swell Amplitude	Swell wavelength	PDF s.d.
F13	F1: CRYOVEX 2006, 02/05/2006 F3: CRYOVEX 2006, 30/04/2006	1.41m 0.71m	1.0 m 0.5 m	100 m 50 m	4 cm 4 cm
F24	F2: moderate sea state F4: high sea state	4.23 m 14.1 m	3.0 m 10 m	150 m 200 m	10 cm 10 cm
C3	Realistic ocean wave spectrum (Elfouhaily et al., 1997)	1/2/3 m	N/A	N/A	10 cm
C1	Realistic ocean wave spectrum (Elfouhaily et al., 1997)	0.1/4/5 m	N/A	N/A	10 cm
FT1	Sea Floor Topography 1, variations in sea surface height, low swh, short wavelength	1.41 m	1.0 m	100 m	4 cm


Hs = 1m
Hs = 2m
Hs = 3m
C3
SWH (m)
time (s)
distance (km)
+3m
-3m
distance (km)
distance (km)
distance (km)


Hs = 0.1m
Hs = 4m
Hs = 5m
C1
SWH (m)
time (s)
distance (km)
+5m
-5m
distance (km)
distance (km)
distance (km)



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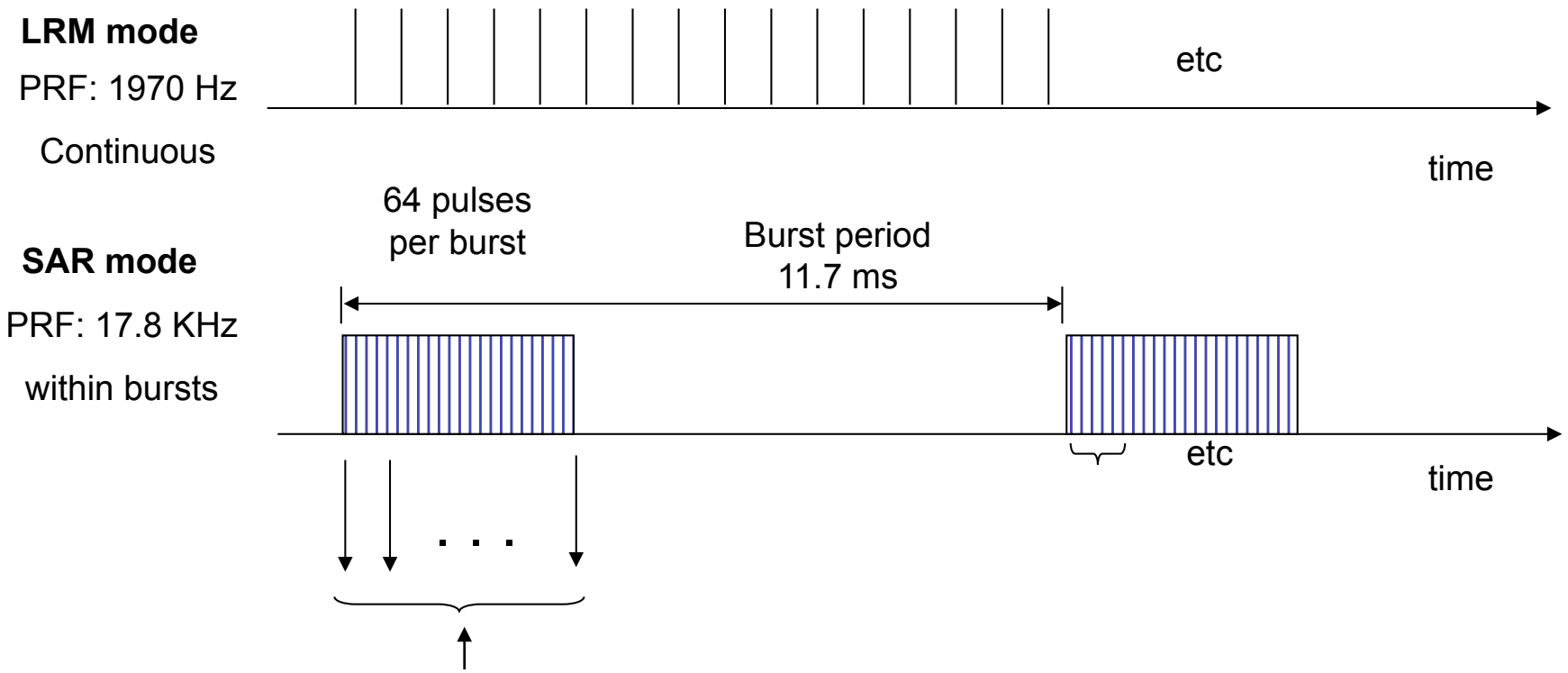
SAR -> pseudo-LRM reduction ?



$$n = \frac{PRF_{SAR}}{PRF_{LRM}} = 9$$

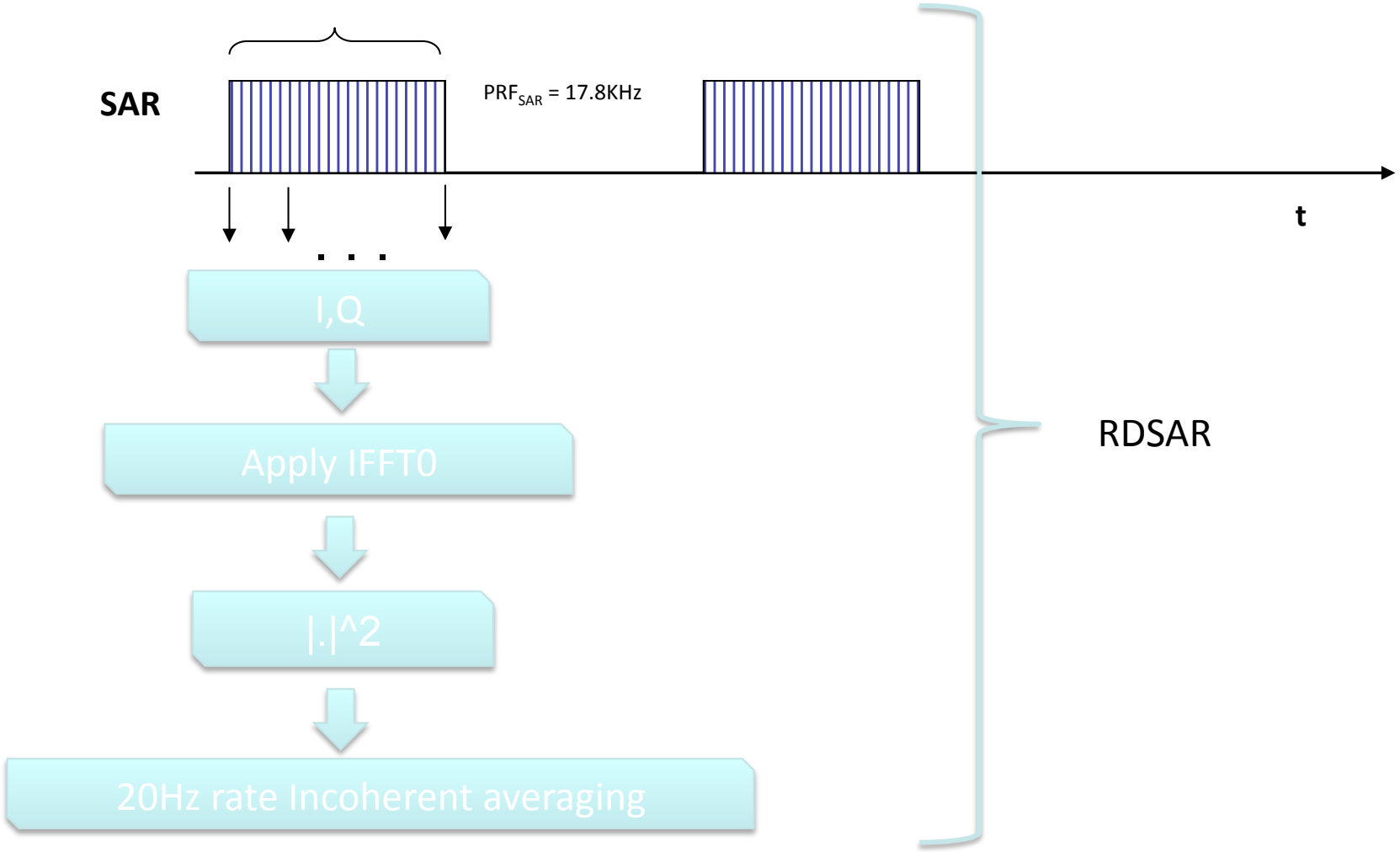
Extract 1 in every 9 waveforms

We get 8 waveforms per burst:
Wf1+wf10+wf19+wf28+wf37+wf46+wf55+wf64

Work in Progress !

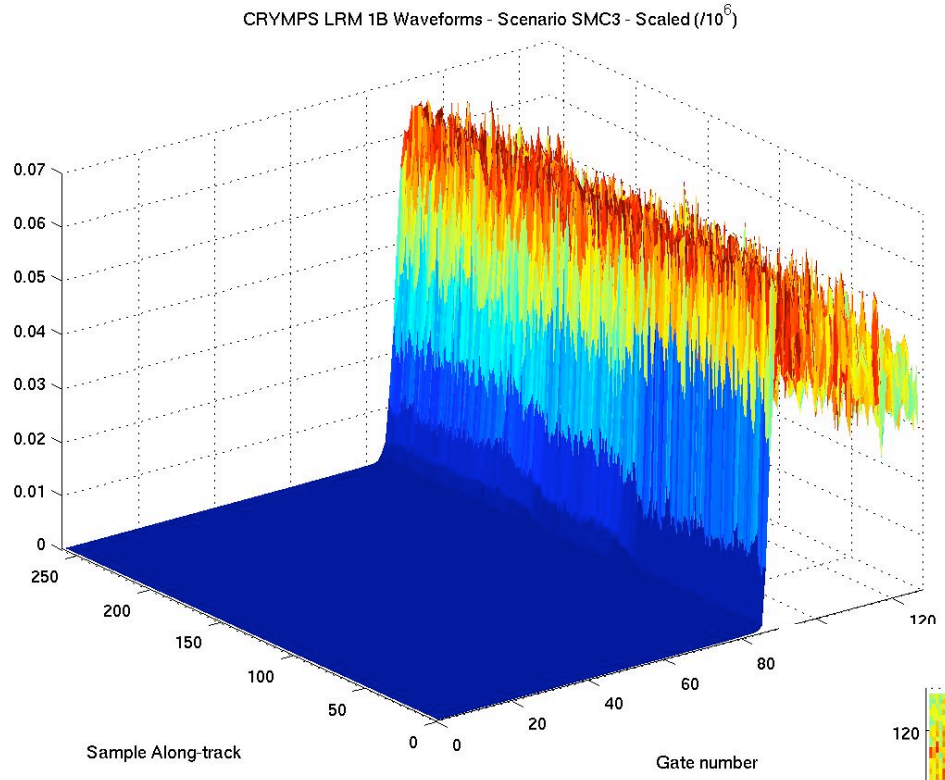
Courtesy: K.Raney & C. Martin-Puig

20Hz pseudo-LRM

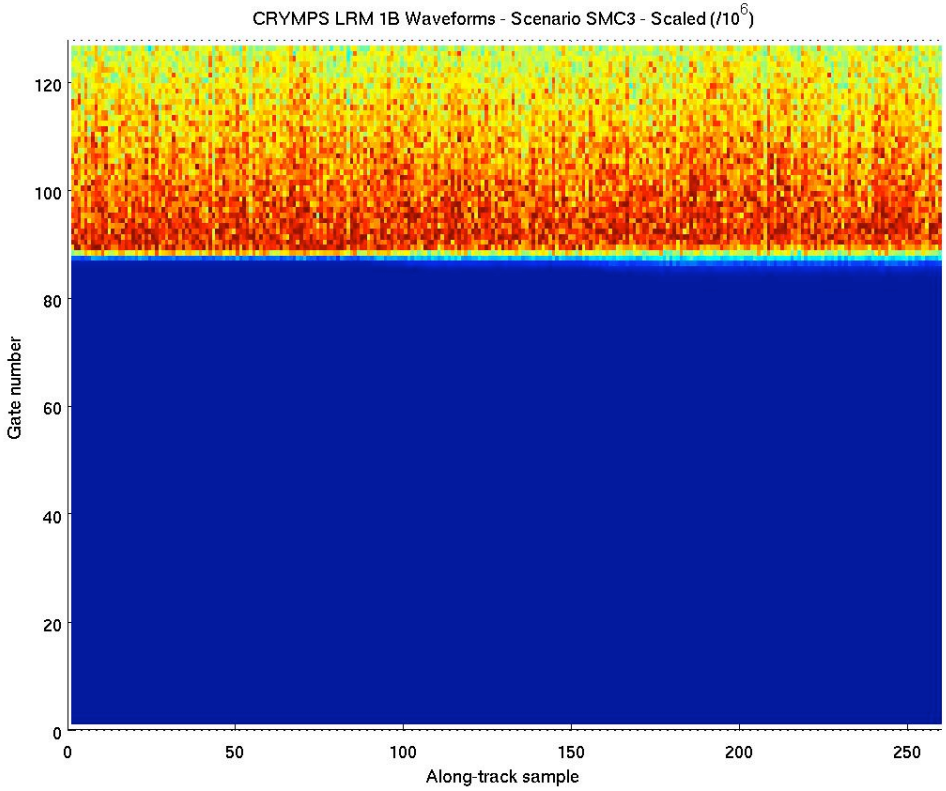


First results

C3 LRM
Hs: 0.1→4→5m

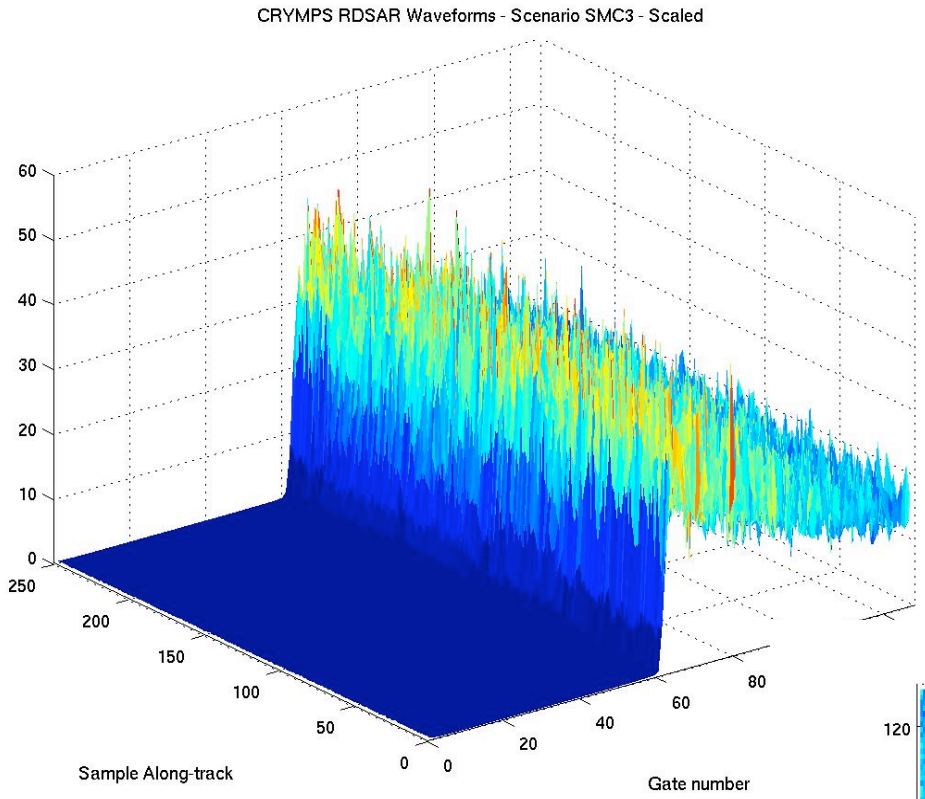


- 16 seconds along-track
- 260 LRM samples along-track



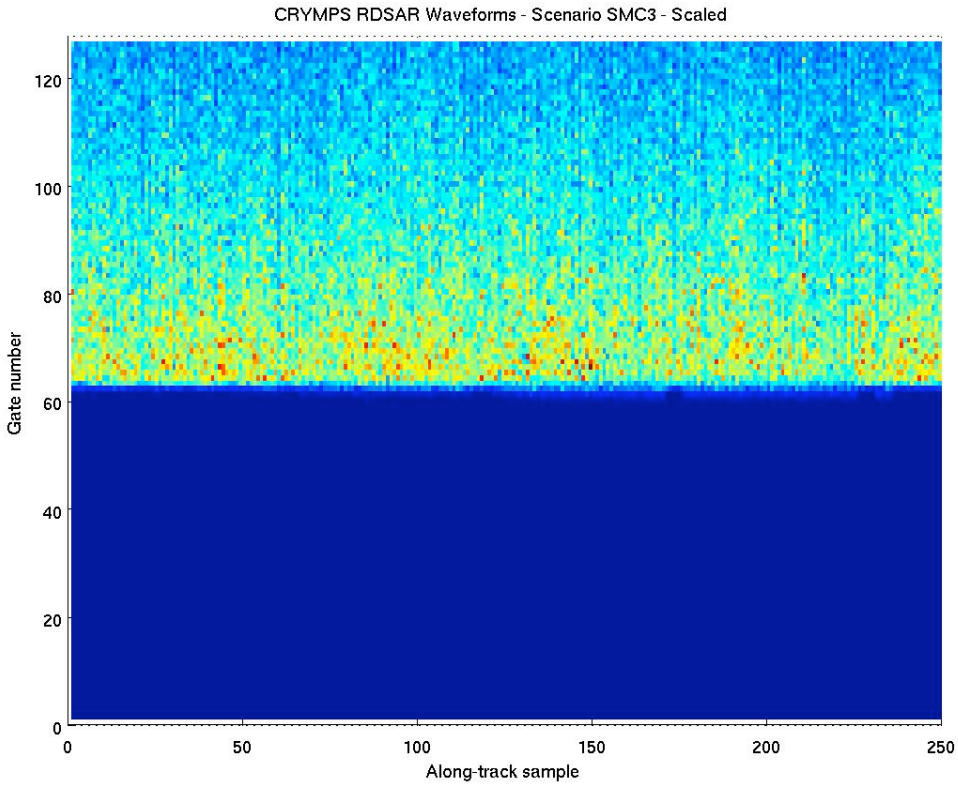
- No Power Scaling applied
  - No along-track variability in peak amplitude
  - No Sigma0 info
- Amplitude scaled by 10^{-6}

C3 RDSAR
Hs: 0.1→4→5m



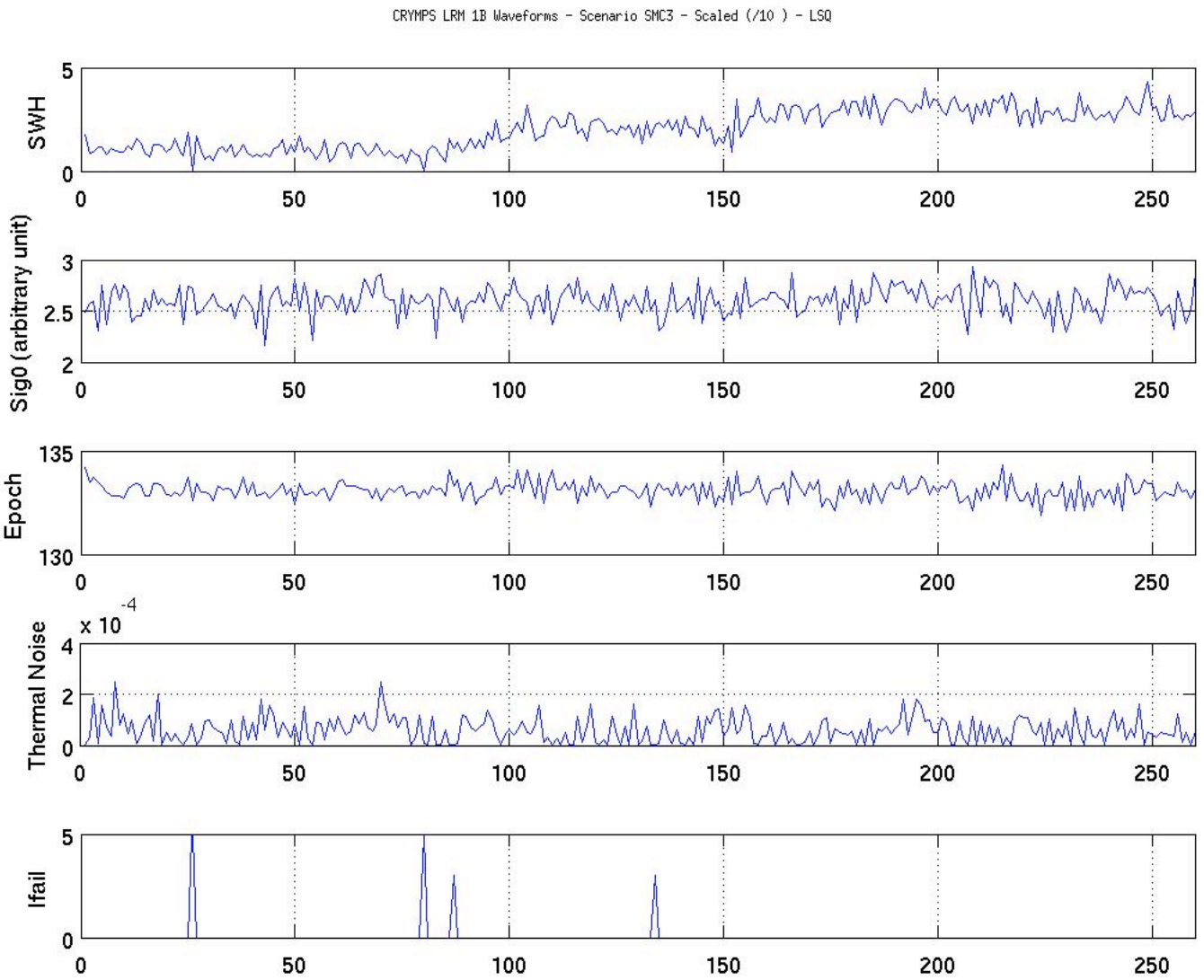
- 16 seconds scenarios
- 250 samples along-track

- No Power Scaling applied



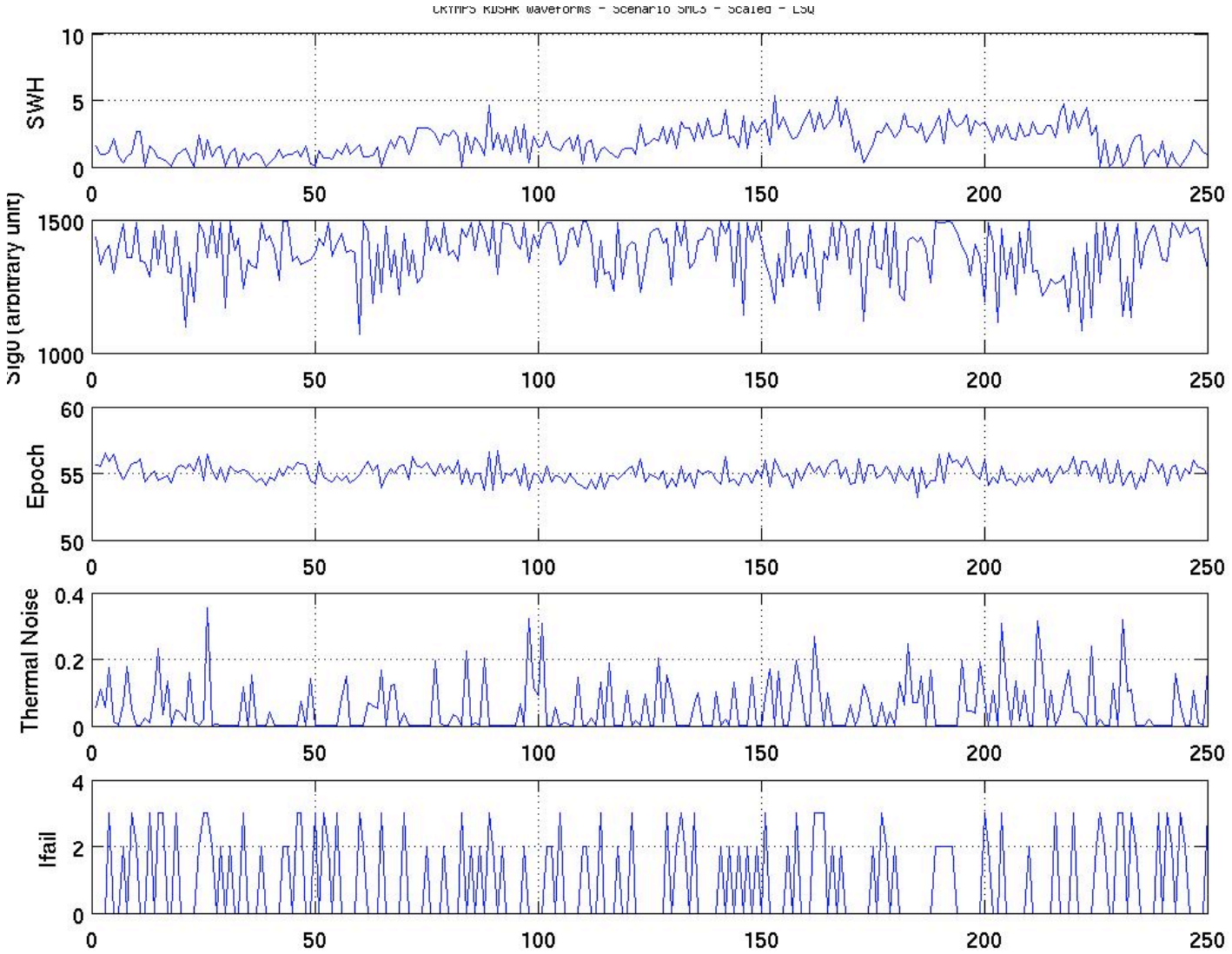
Ocean retracker results

C3 LRM



Ocean retracker results

C3 RDSAR



Conclusions

- SAMOSA will assess the improved performance of DDA w.r.t. pulse-limited altimetry to:
  - Retrieve higher-accuracy ocean range, detect short-scale surface slope, extend altimetry to the coastal zone,…
- Methodology is based on Cryosat-type SAR and LRM data from the CRYMPS simulator applied to ocean surfaces
- Reduction of SAR -> pseudo-LRM still debated
- First results show that:
  - CRYMPS produces realistic LRM and DDA waveforms
  - the CRYMPS waveforms were successfully retracked with the NOCS ocean retracker, both LRM and RDSAR

SAR Altimetry numerical simulations over water surfaces

Thank You !

For further info, contact Christine Gommenginger

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