Altimetric precision of Delay Doppler Altimetry over the ocean with numerical simulations from the Cryosat mission performance simulator

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Content

- Context, aims and methodology
- The CRYMPS simulator & products
- CRYMPS scenarios over open water
- LRM & Brown ocean retracker
- SAR & SAR Altimeter ocean retracker
- Conclusions

ESA SAMOSA project

- Key aim of SAMOSA: to assess the improvement in range retrieval accuracy with SAR altimeters compared to conventional pulse-limited altimeters

- Previous talk by Martin-Puig et al. presented the **theoretical limit** for the range retrieval accuracy of an (MLE) SAR altimeter retracker

- In this talk, we focus on getting estimates based on **numerical simulations**
  - Analyses are based on simulated datasets from the Cryosat Mission Performance Simulator (CRYMPS)

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CRYMPS

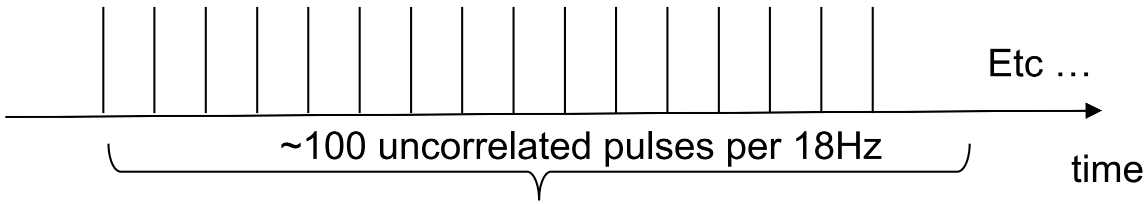
- CRYMPS = Cryosat Mission Performance Simulator
- CRYMPS developed & run at University College London/ MSSL, in collaboration with ESA/ESTEC
- Simulates the CryoSat platform orbit and instrument operation, generates official Cryosat products for Low Resolution Mode (LRM), SAR and SAR Interferometric (SARin) mode, for a given (explicit) 3D surface
- Simulator and surface descriptors were optimised for ice/sea ice surfaces
- Here, CRYMPS was applied to open ocean surfaces

Cryosat/CRYMPS LRM v SAR mode

LRM mode

PRF: 1970 Hz

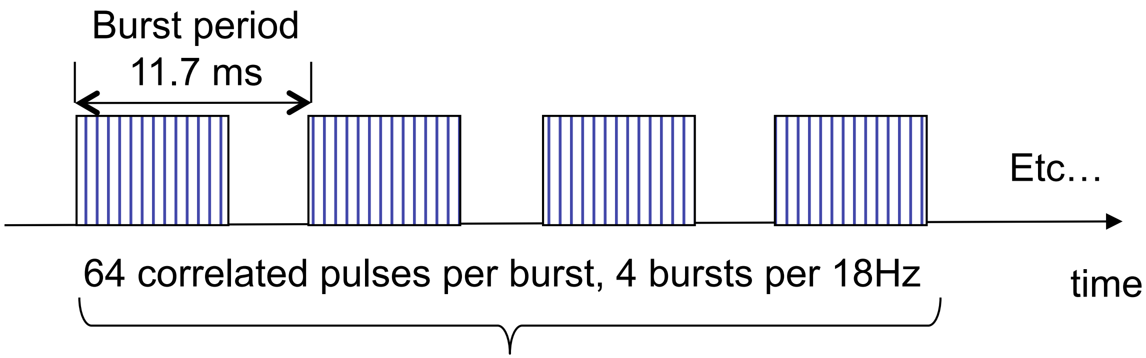
Continuous



SAR mode

PRF: 17.8 KHz

within bursts



LRM products

- L1B LRM 18Hz averaged waveforms
- L2 1Hz output

SAR products

- FBR SAR (I&Q)
- L1B SAR 18Hz averaged waveforms
- L2 1Hz output

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CRYMPS simulations over open ocean scenarios

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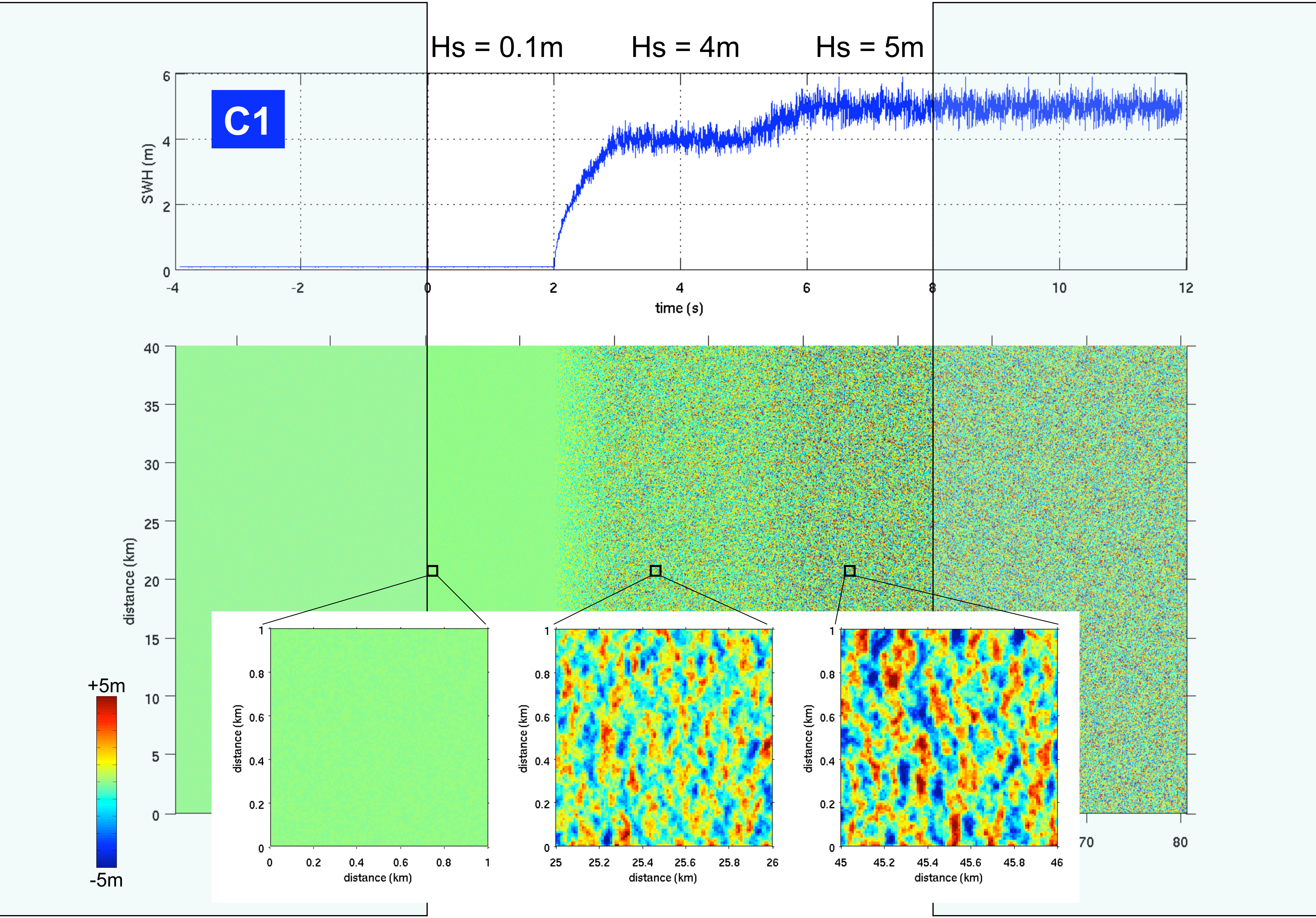
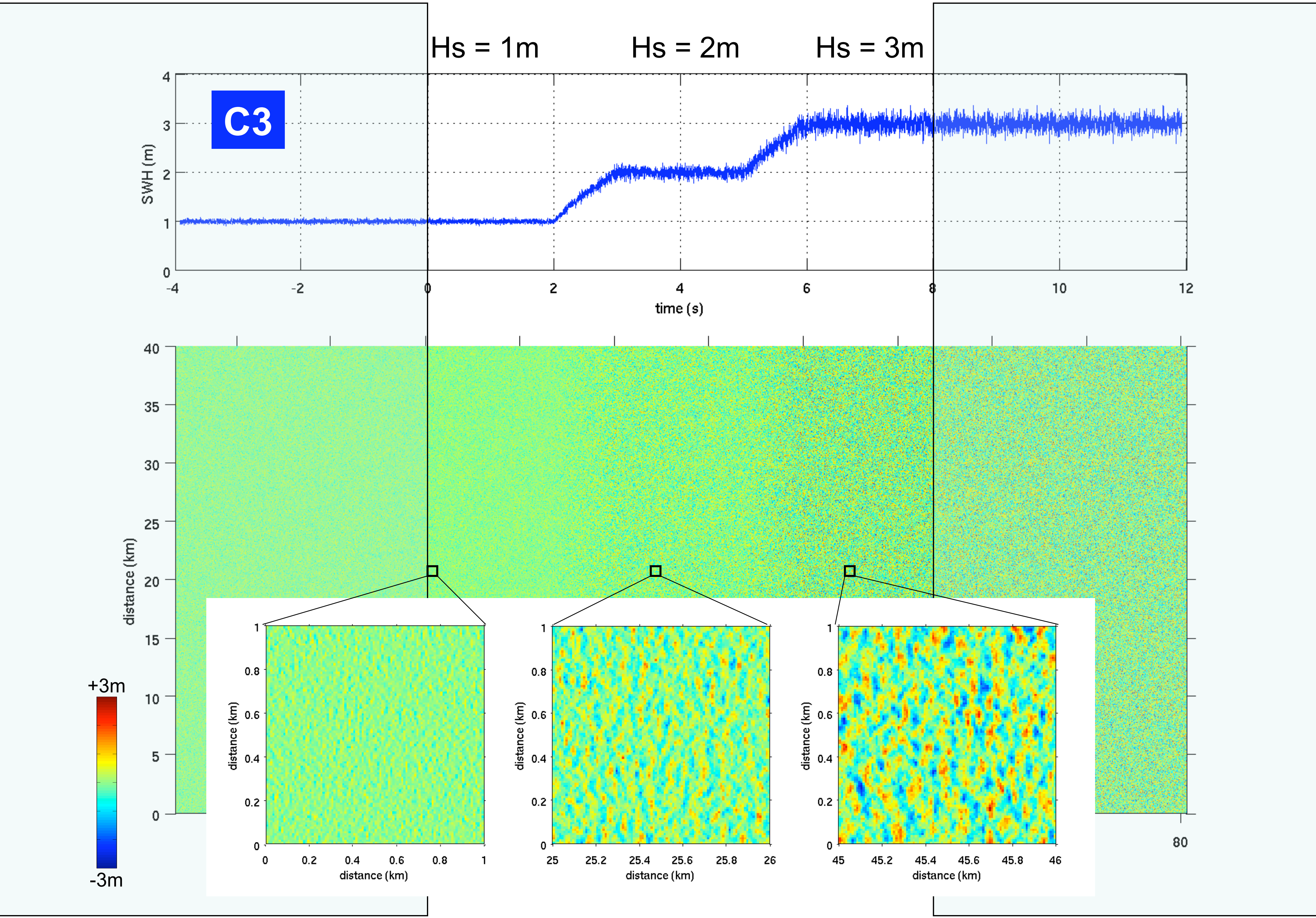
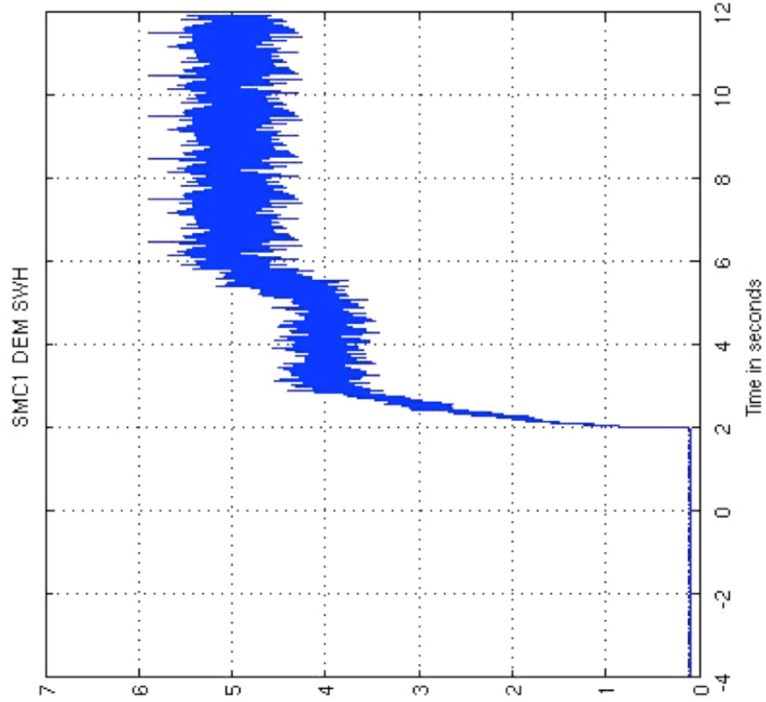

Hs = 0.1m
Hs = 4m
Hs = 5m
C1
SWH (m)
time (s)
distance (km)
+5m
-5m



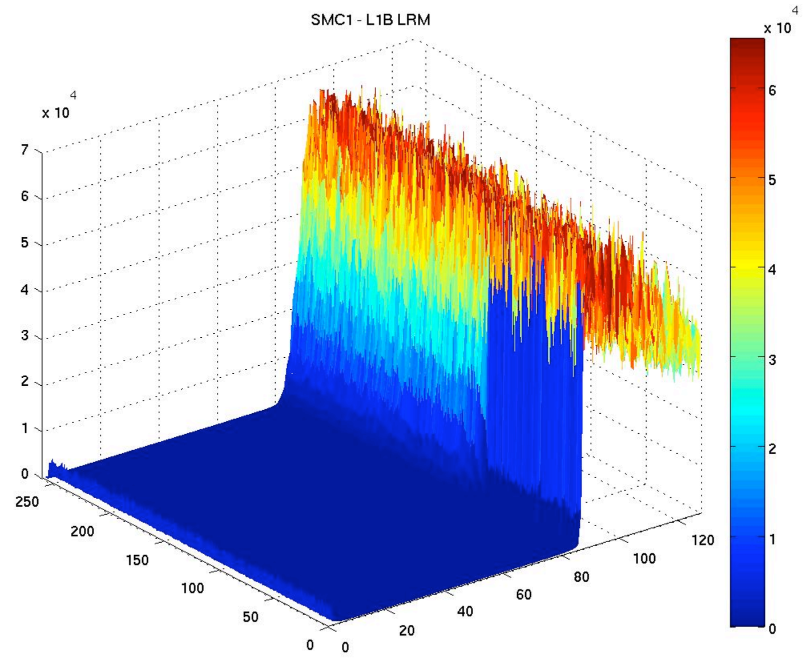
Hs = 1m
Hs = 2m
Hs = 3m
C3
SWH (m)
time (s)
distance (km)
+3m
-3m
80

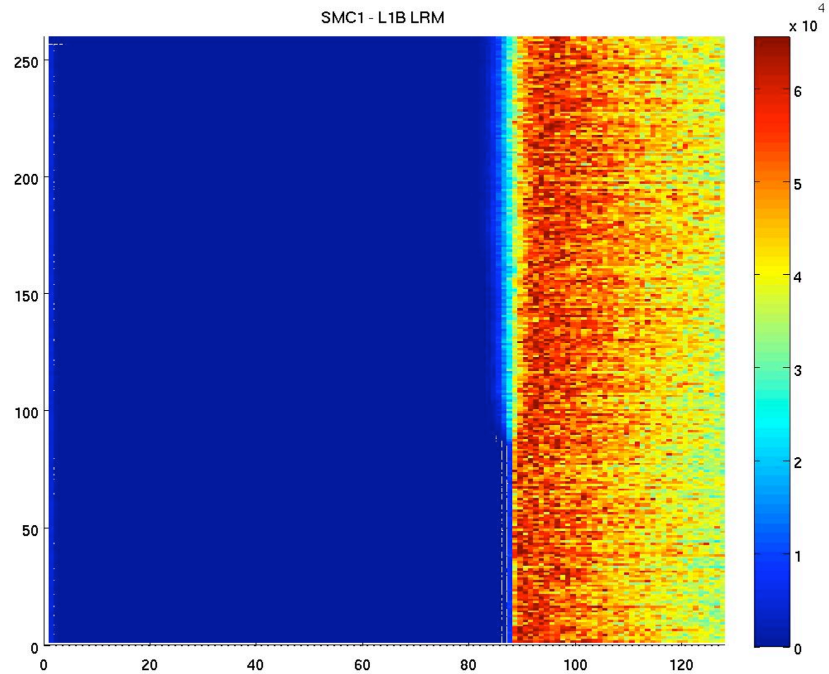
CRYMPS LRM
& Brown ocean retracker

CRYMPS LRM Scenario C1



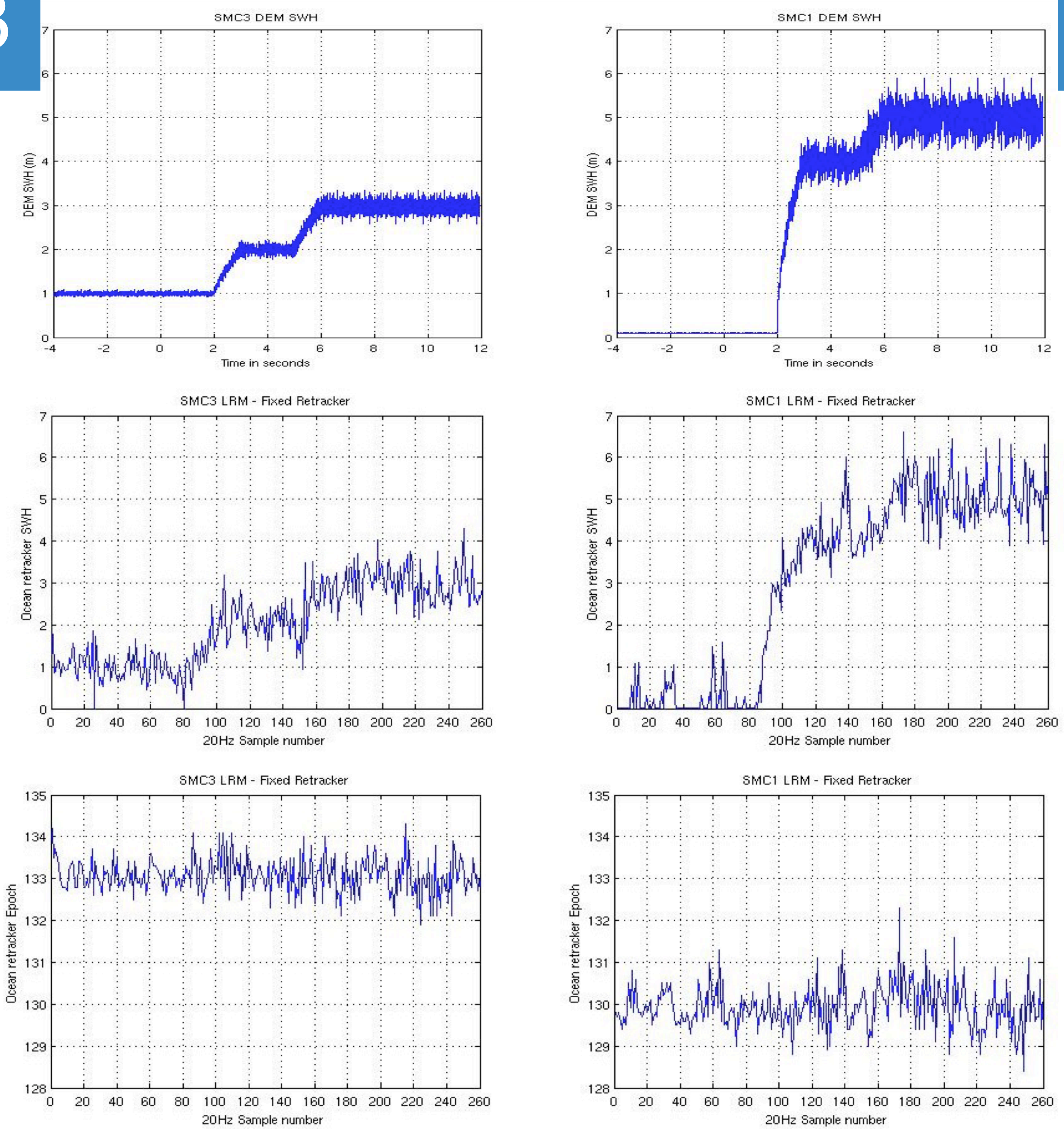
← DEM SWH





C3

C1



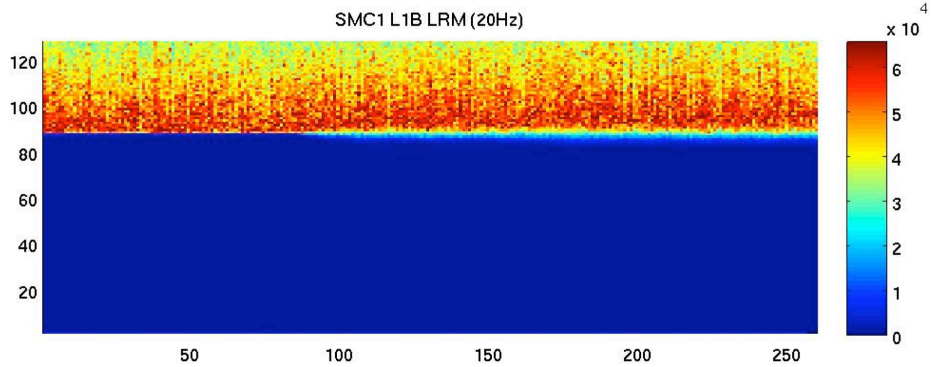
DEM SWH

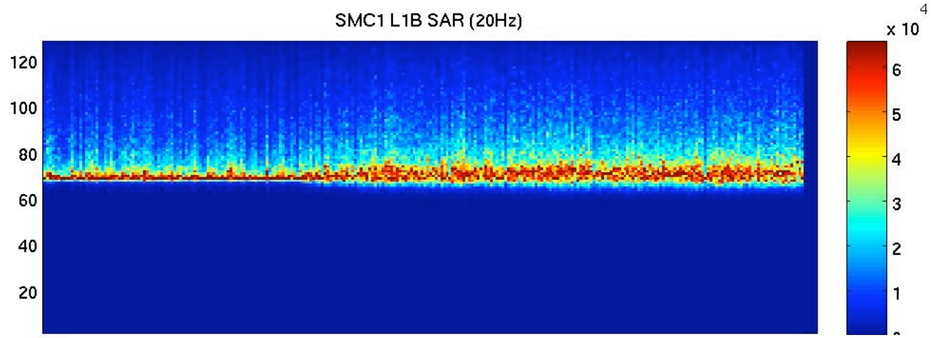
Retracked SWH (Brown model)

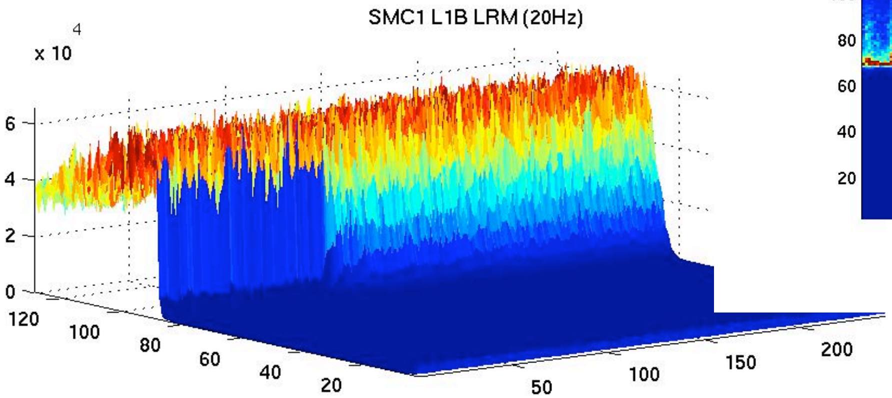
Retracked Epoch (Brown model)

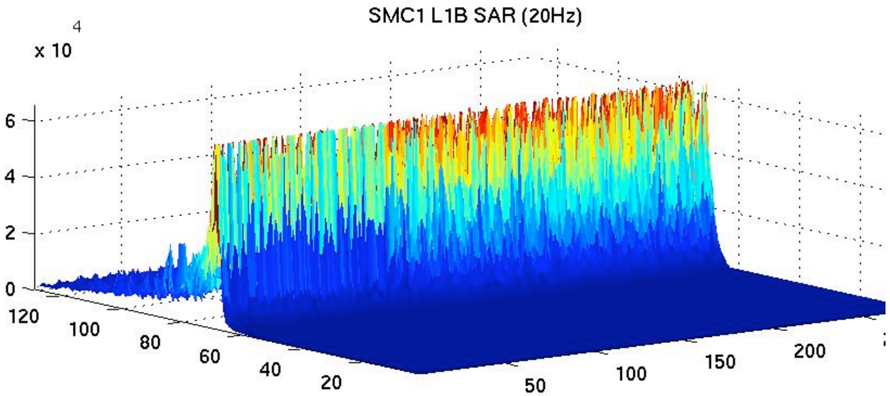
CRYMPS SAR
& SAR Altimeter ocean retracker

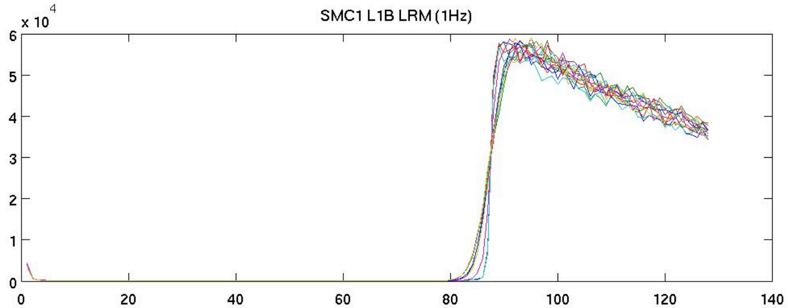
LRM & SAR L1B Scenario C1

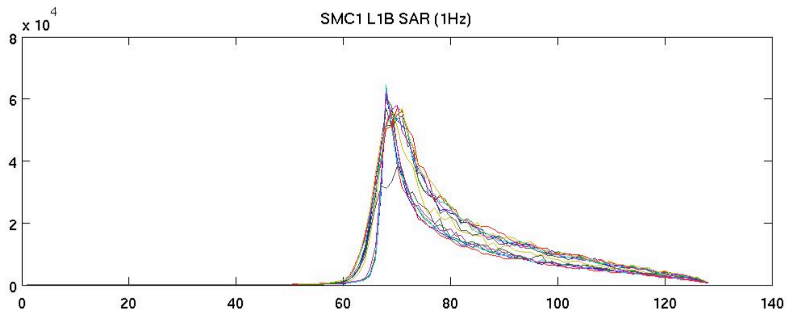






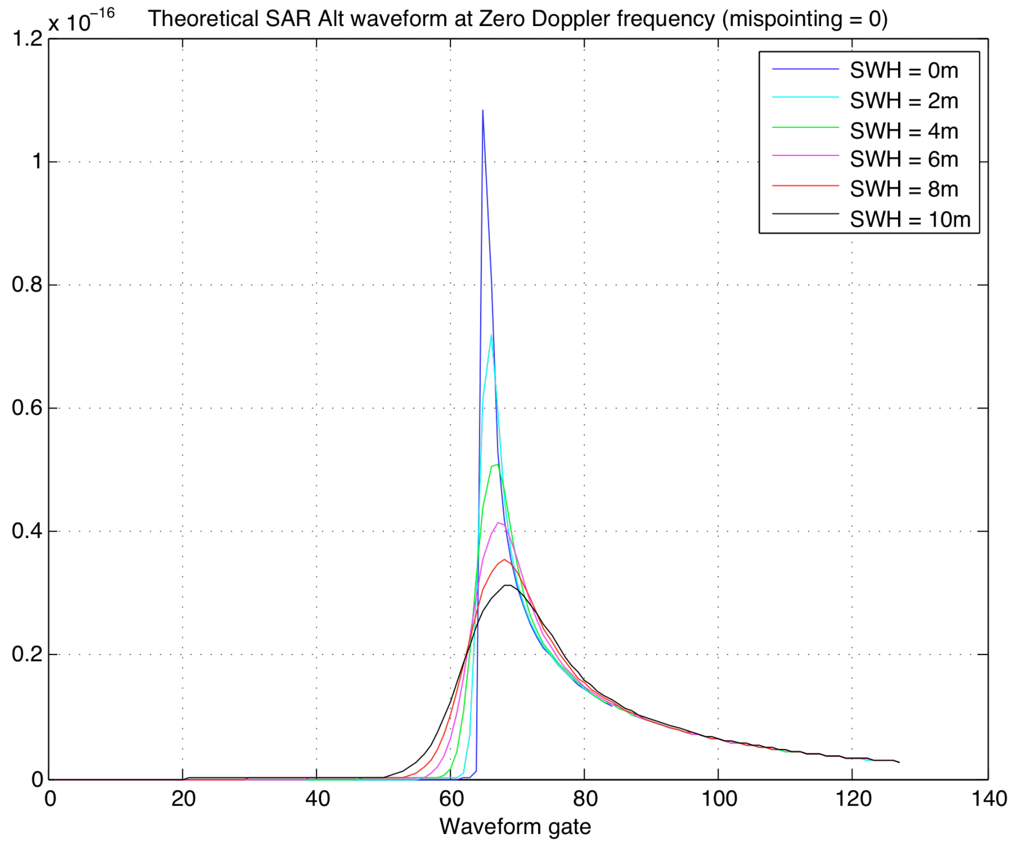






New SAR Alt Theoretical model

- New theoretical model developed by Starlab within SAMOSA
- Provides numerical and analytical solutions for SAR Altimeter Delay Doppler Maps for single burst.
- Model depends on Epoch, SWH, along-track mispointing, Sigma0



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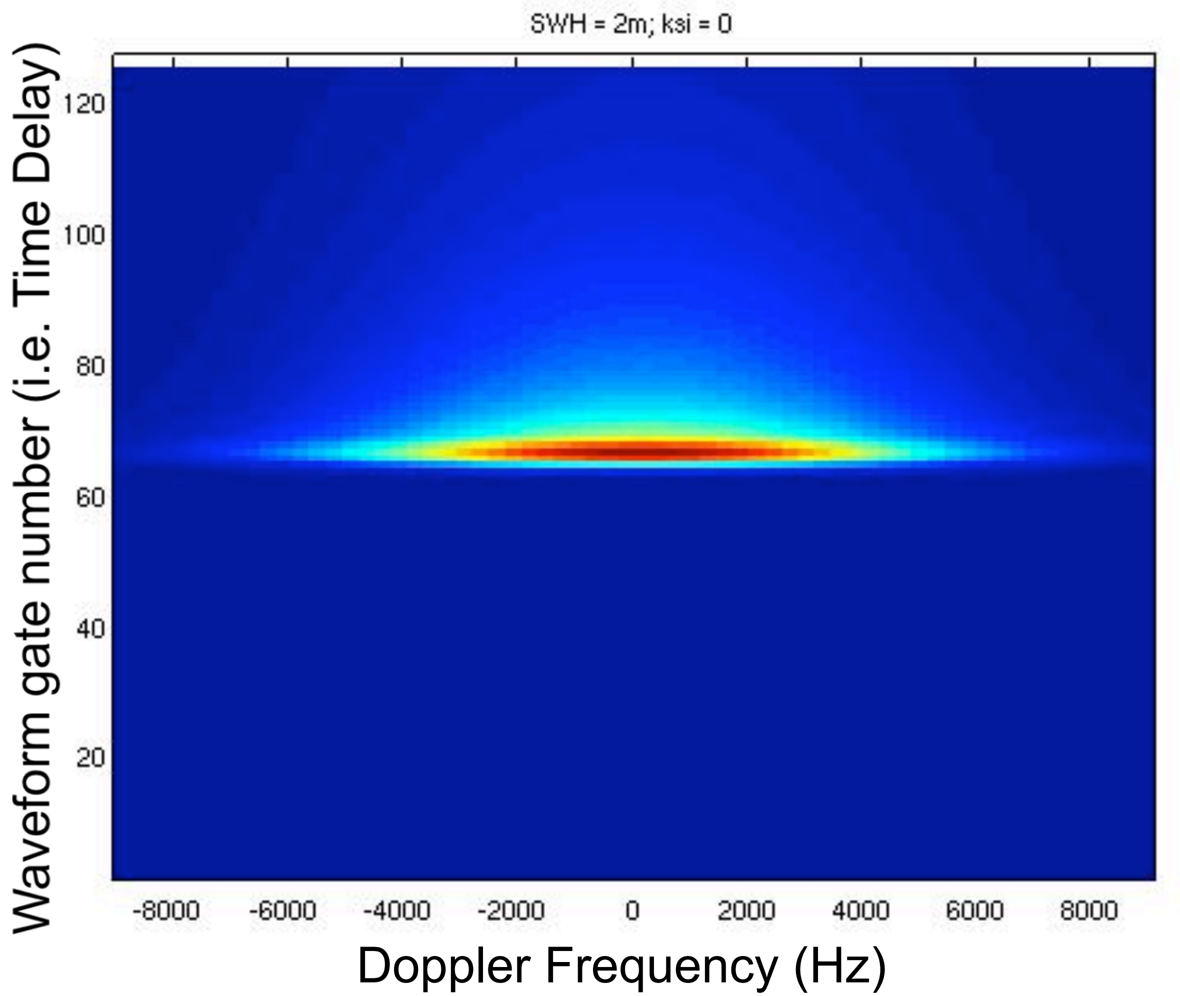
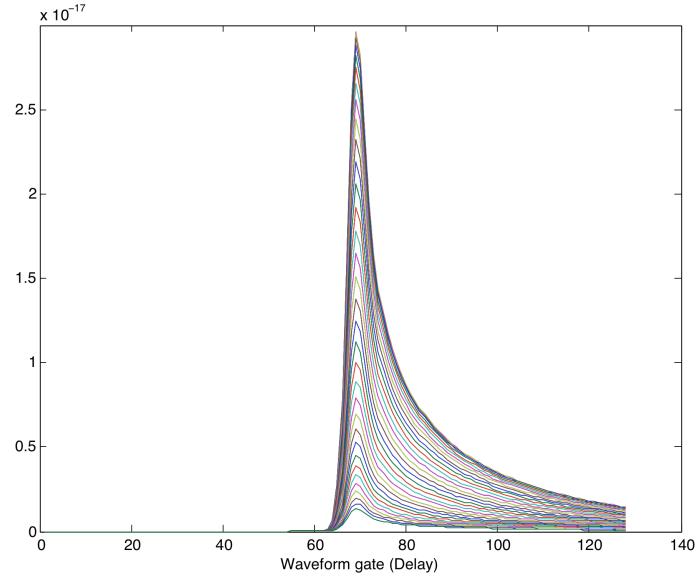
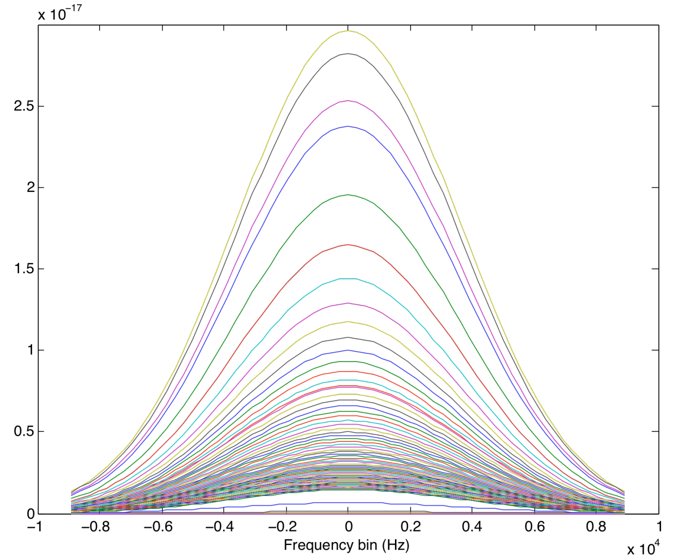
Example SAR Alt Delay-Doppler Map







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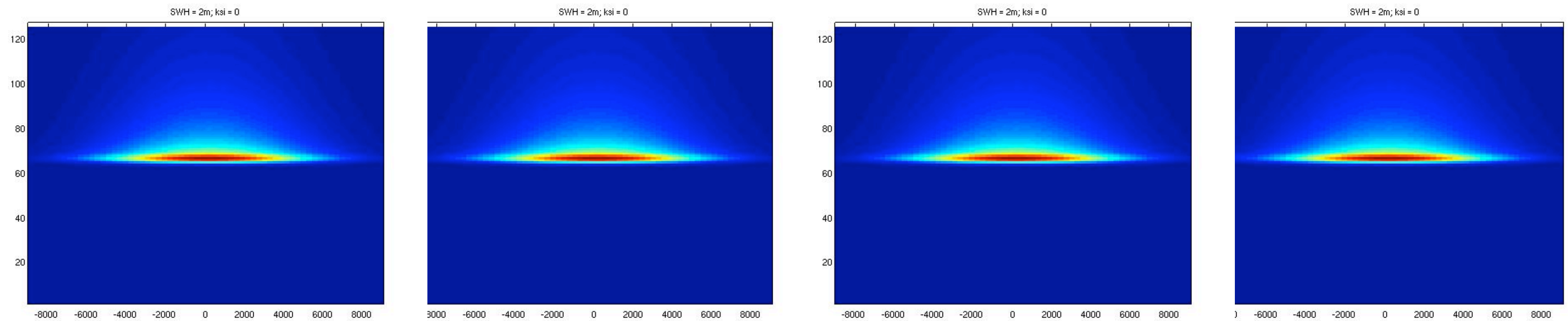
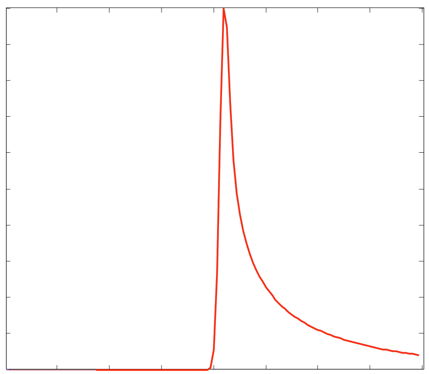
Multi-looking

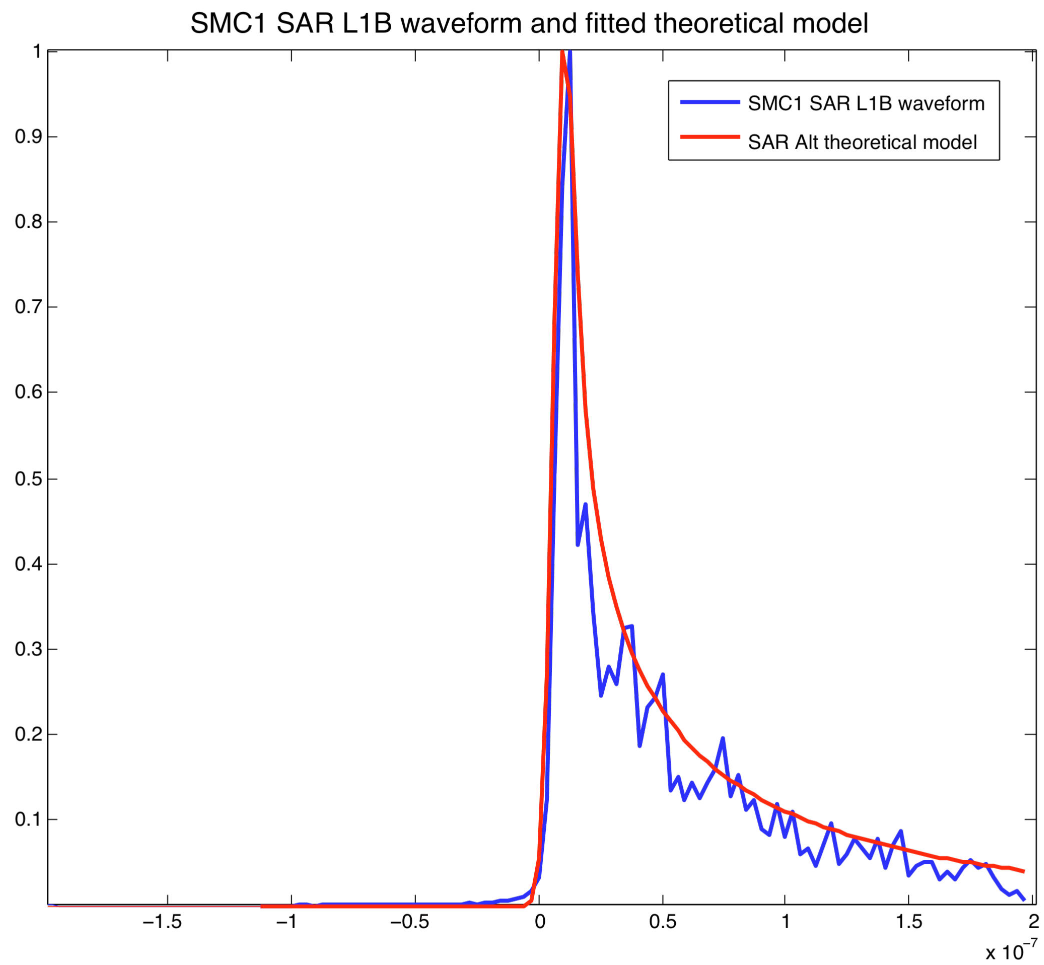


Incoherent averaging



SAR L1B
18Hz averages

First SAR Alt retracker result



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Conclusions

- SAMOSA aims to quantify the improved range retrieval performance of SAR altimeters, compared to pulse-limited altimetry, over the ocean
  - This work contributes to preparations for Sentinel-3, which will feature a SAR altimeter similar to Cryosat-2/SIRAL, to be operated in SAR mode over (parts of) the ocean.
- LRM and SAR waveforms have been successfully generated with CRYMPS for ocean surfaces, and retracked with a Brown ocean retracker and a new SAR altimeter ocean retracker
  - The methodology to retrack SAR altimeter waveforms over ocean has been established & demonstrated for CRYMPS data.
  - Final results due end of July'09

Thank You !

(also for staying 'til the end)

For questions or info, contact:

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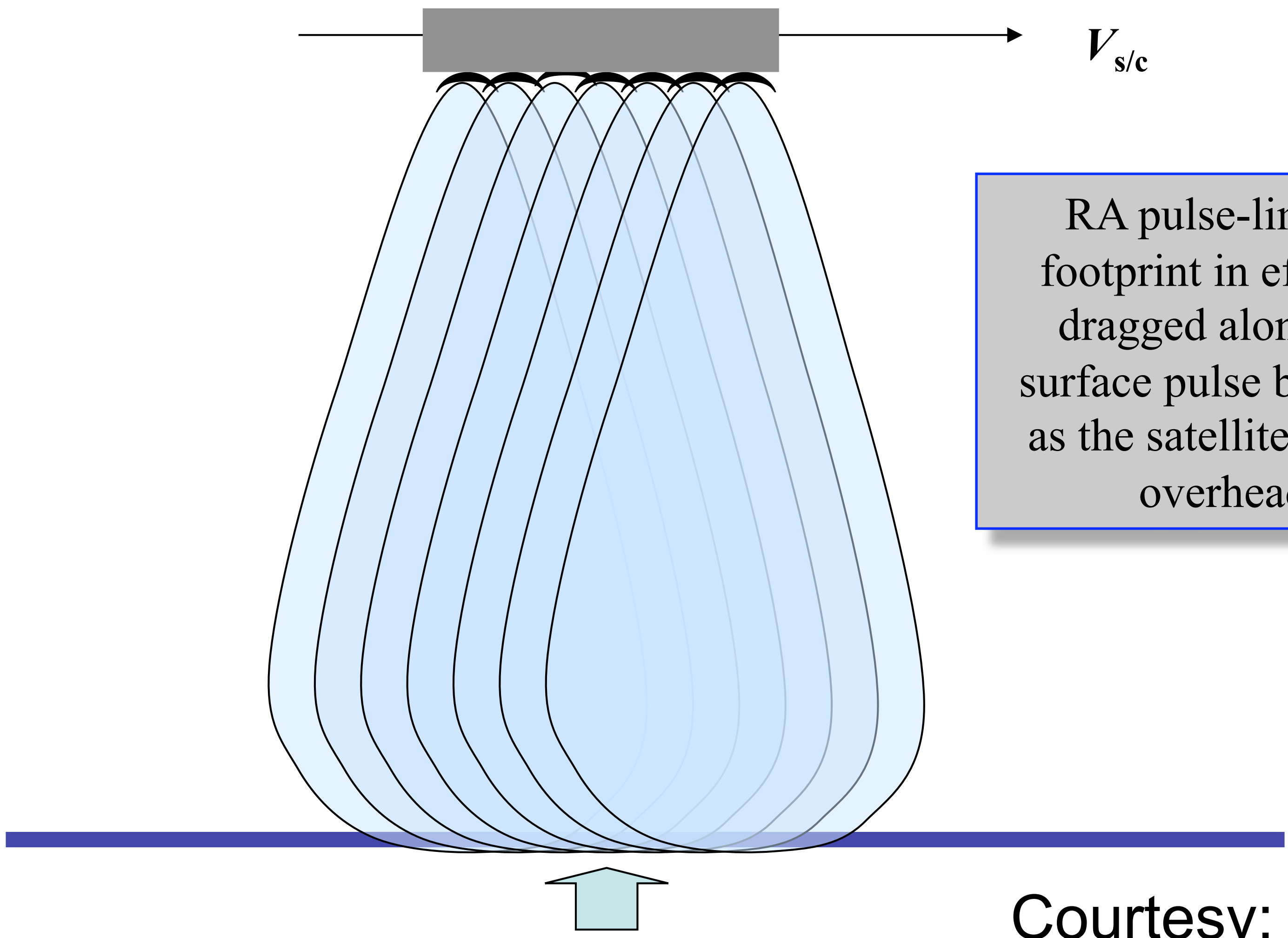
Supplementary slides

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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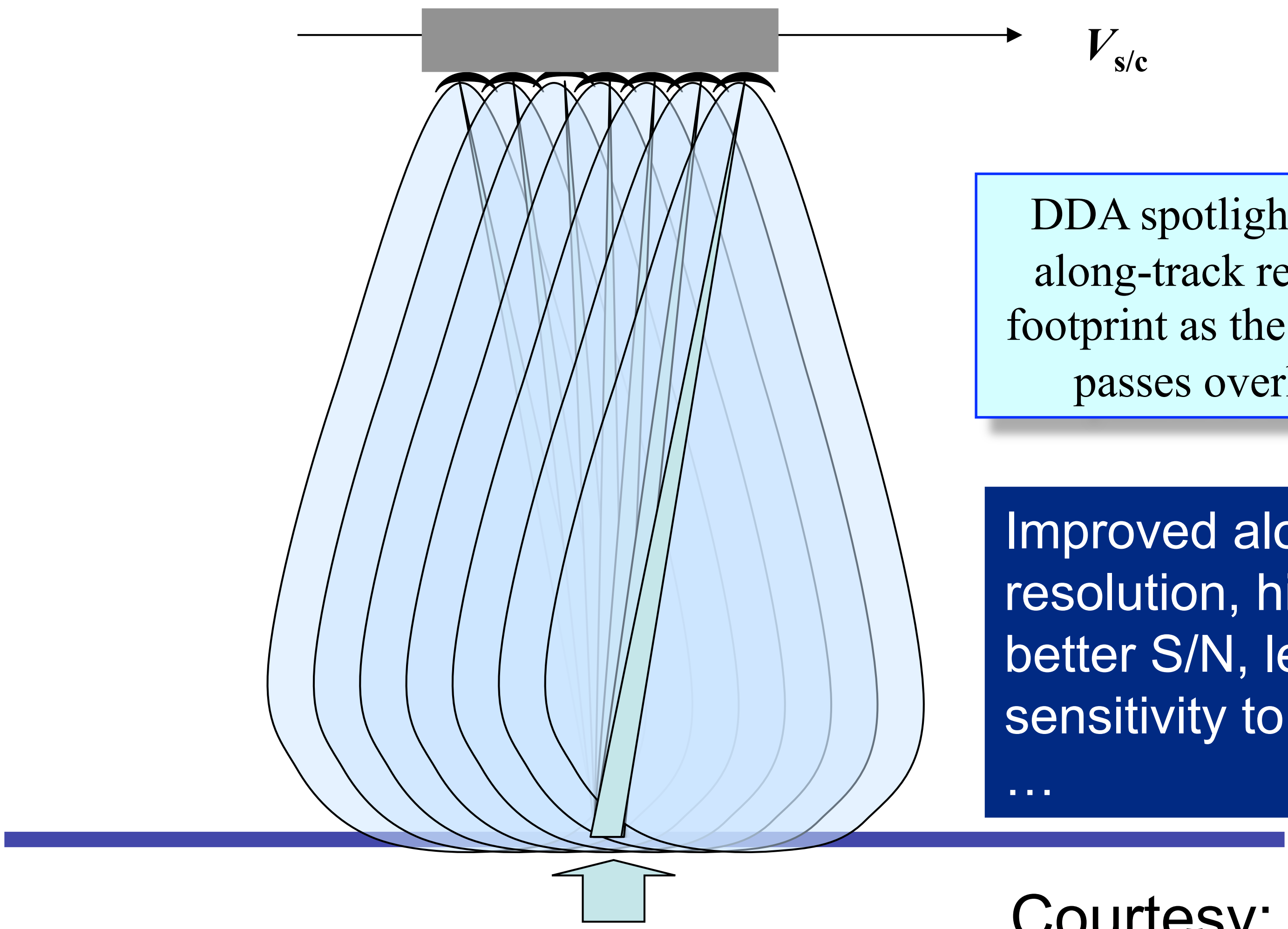
DDA: a fundamentally different method

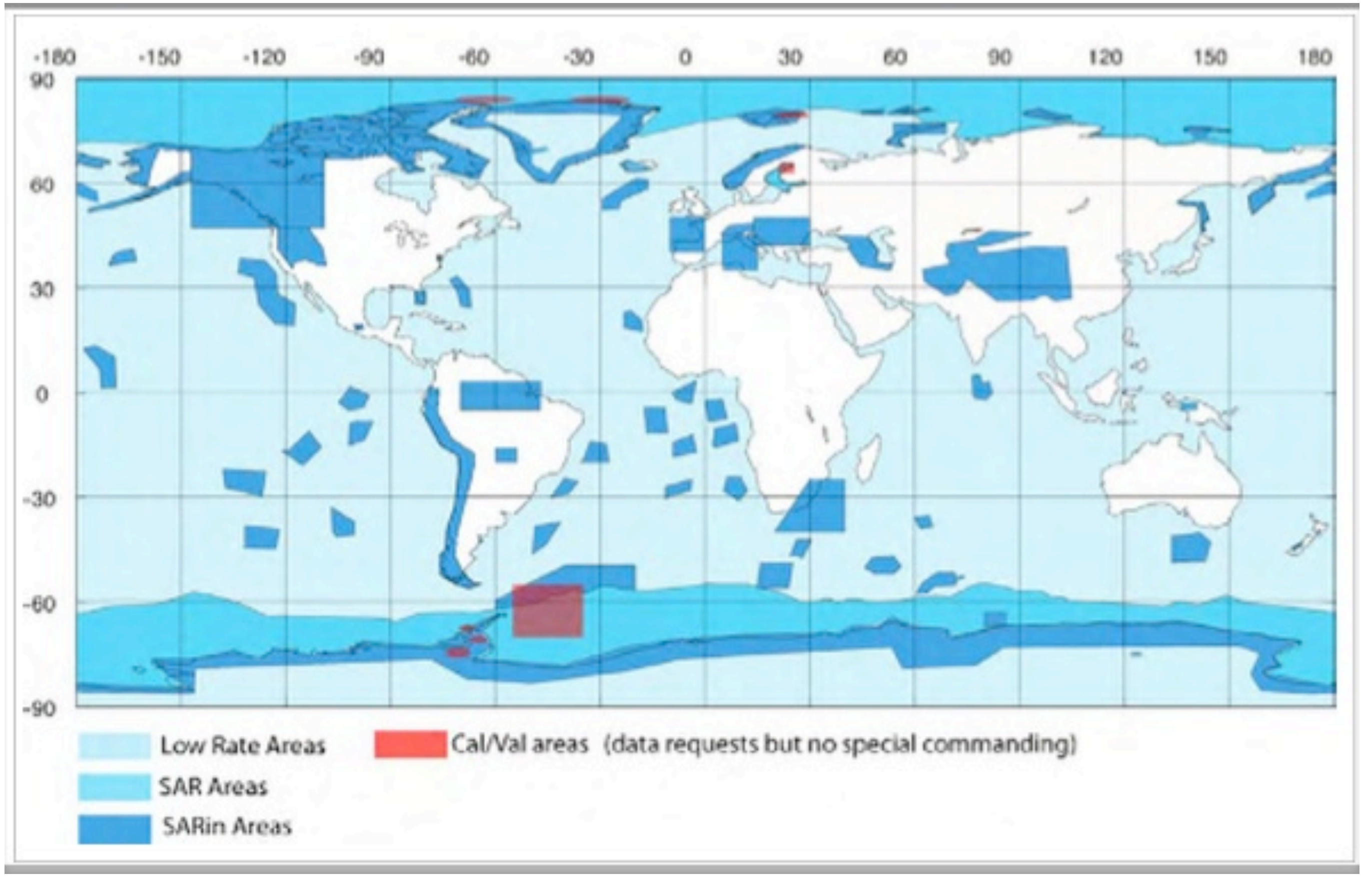


DDA spotlights each along-track resolved footprint as the satellite passes overhead

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

Courtesy: K.Raney

Cryosat-2 & Sentinel-3 acquisition modes



Cryosat-2

- Land ice: SARIn
- Sea ice: SAR
- Ocean: LRM

Sentinel-3

- Ocean: LRM & SAR over W. Boundary currents & coastal (?)

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