A prototype SAR altimeter retracker to assess the precision of SAR altimetry over the ocean

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Presentation Content

- Motivation : Sentinel-3 SRAL and Cryosat-2 SIRAL
- Introduction to SAR altimetry
- The ESA SAMOSA project
- A new capability to retrack SAR altimeter waveform over the ocean
- Conclusions & future work

The Sentinel-3 and Cryosat-2 SAR altimeters

S-3 Surface Topography Mission

- GMES Sentinel-3: Ocean and global land monitoring
- Payload includes ocean color, vegetation, sea/land surface temperature, altimetry
- Altimeter Payload:
  - Ku-/C-band Synthetic Aperture Radar Altimeter (SRAL)
  - Strong heritage from Cryosat-2 SIRAL
  - S3-STM will have 2 modes of operation (Ku-band)
    - Low-rate mode (LRM) – low PRF, conventional pulse-limited mode
    - SAR mode (SAR) – high PRF, single antenna along-track SAR
  - Both S3-STM operation modes may work in closed loop or open loop tracking mode

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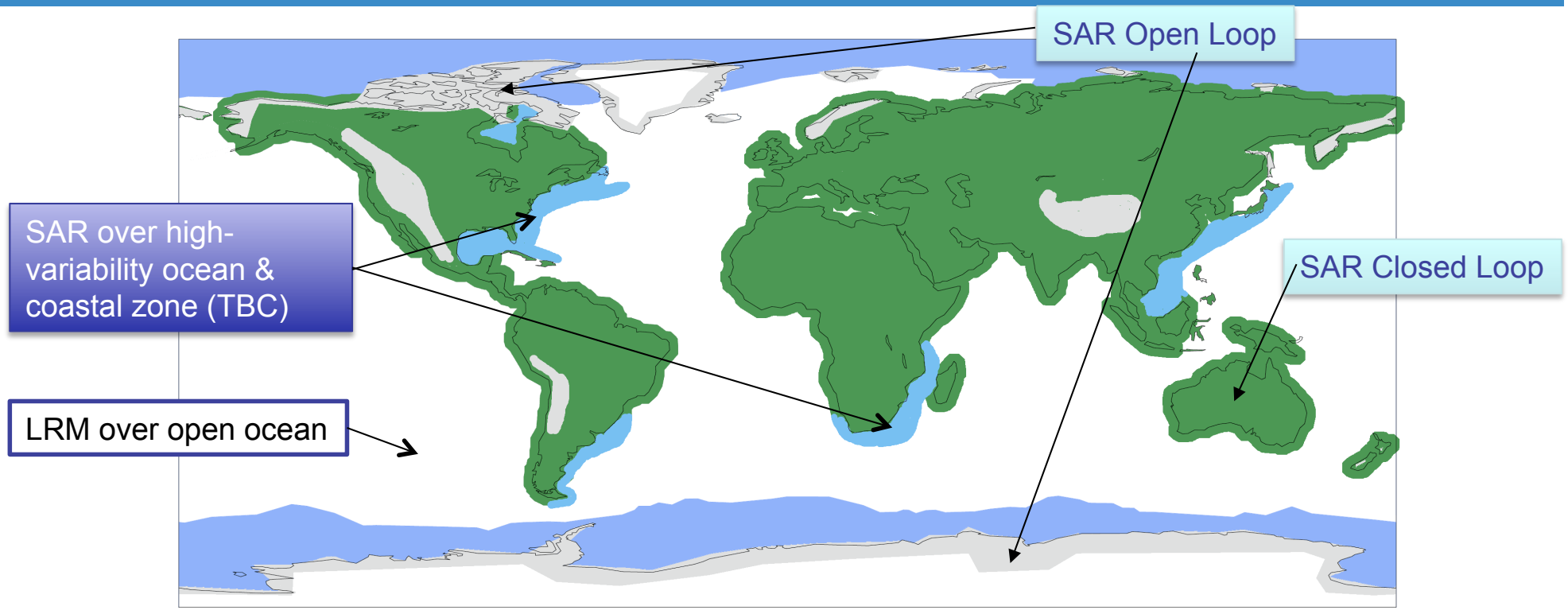
STM-S3 SAR Mode



- SAR Closed Loop (with switch to OL for rivers & lakes)
- SAR Open Loop
- SAR possible extensions

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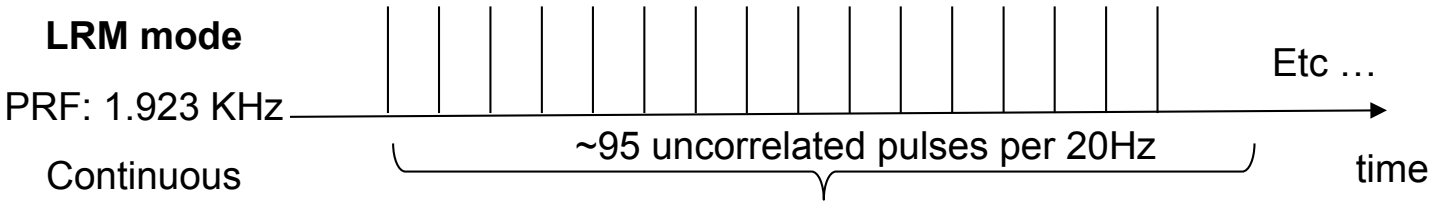
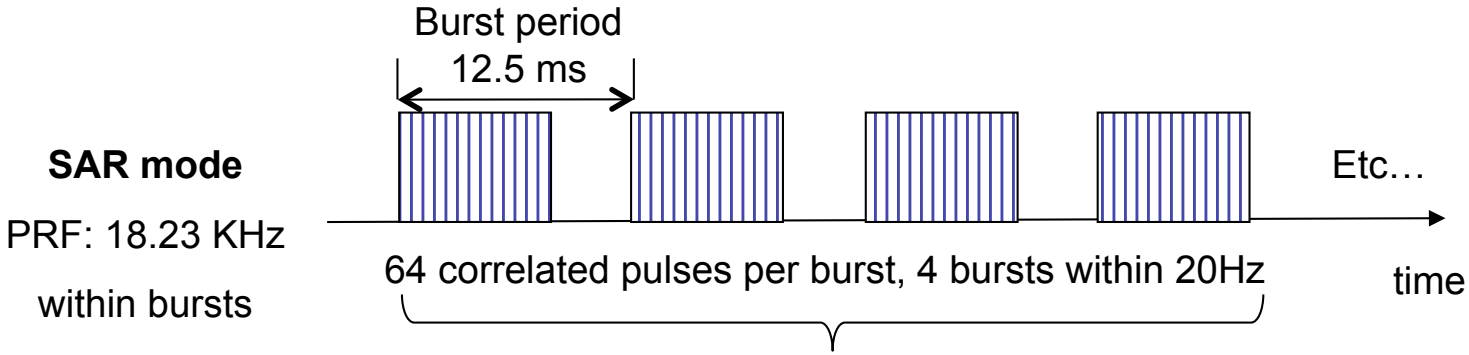
LRM v SAR mode



LRM products

L1B LRM 20Hz averaged waveforms



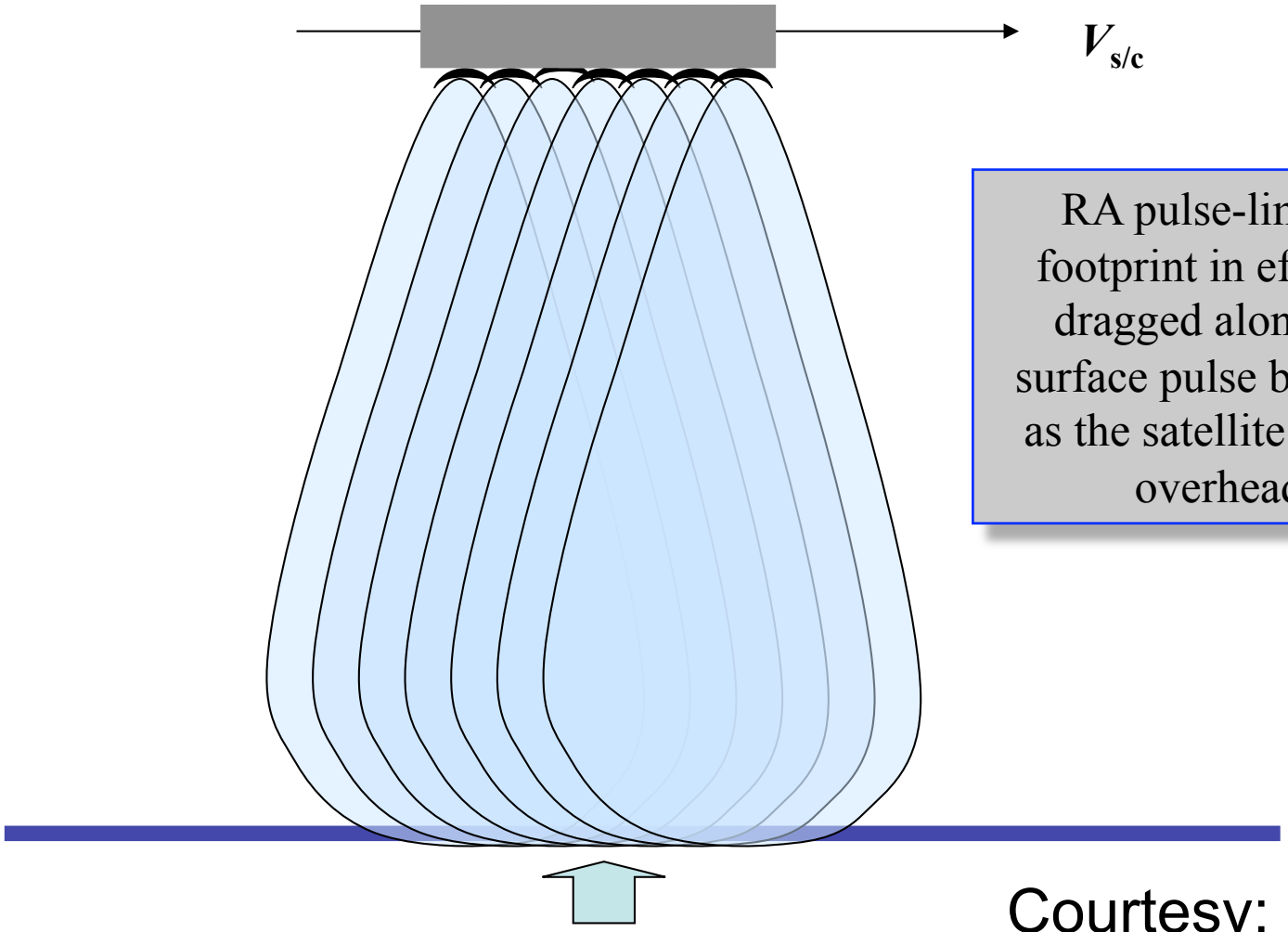
SAR products

L1B SAR 20Hz averaged waveforms

Delay-Doppler Altimetry

aka SAR altimetry

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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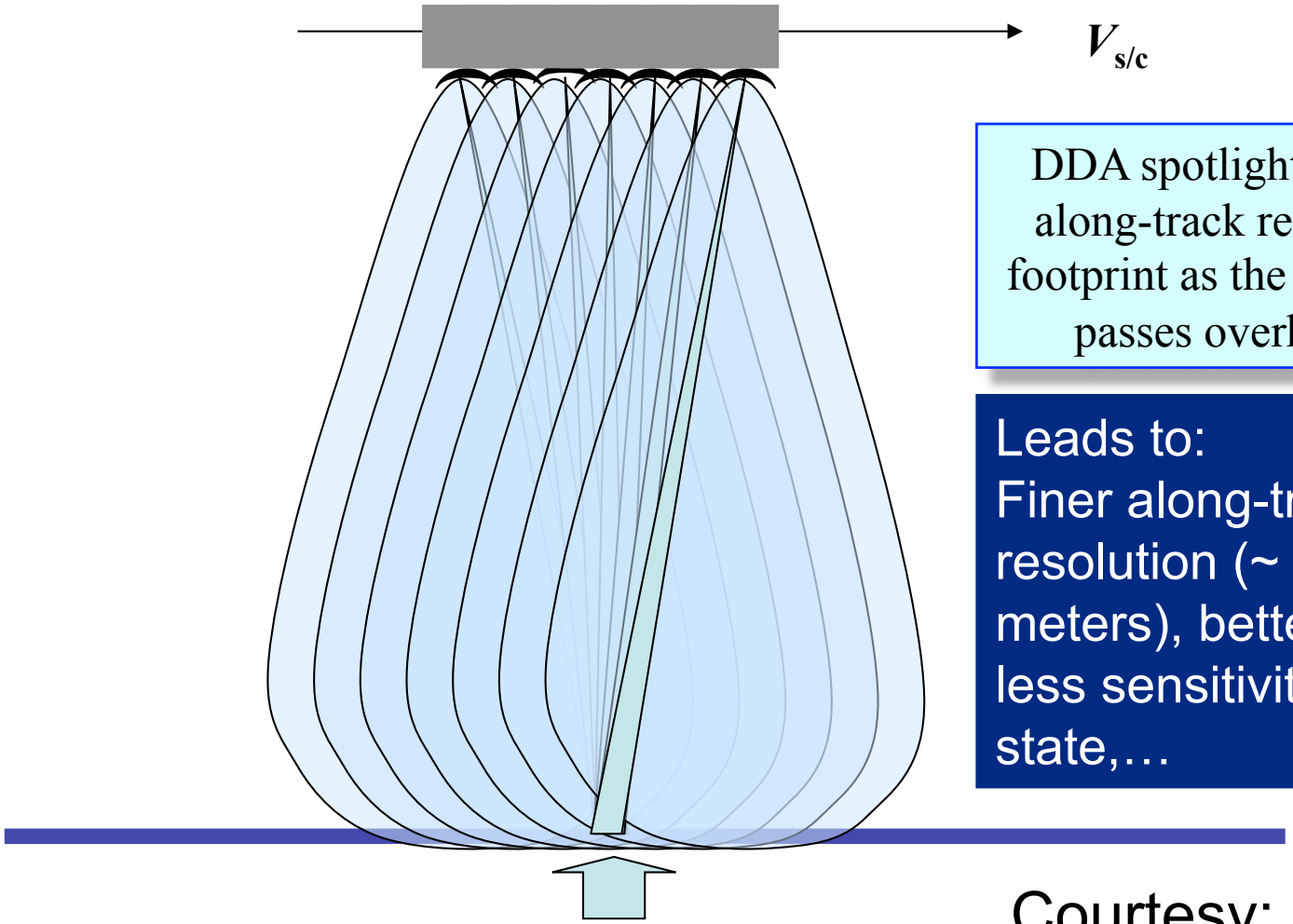
DDA: a fundamentally different method



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

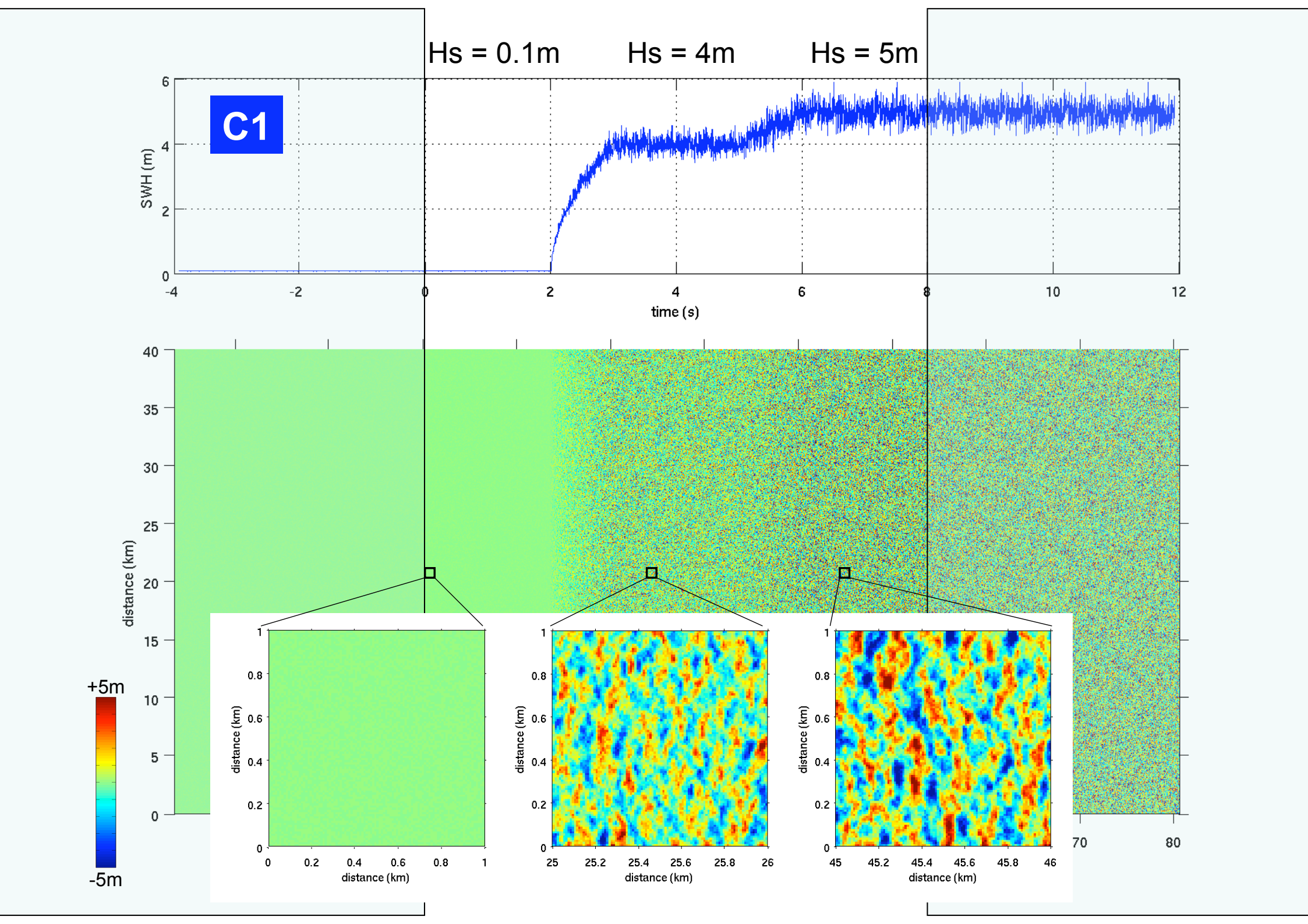
Leads to:
Finer along-track resolution (~ 250 meters), better S/N, less sensitivity to sea state,…

Courtesy: K.Raney

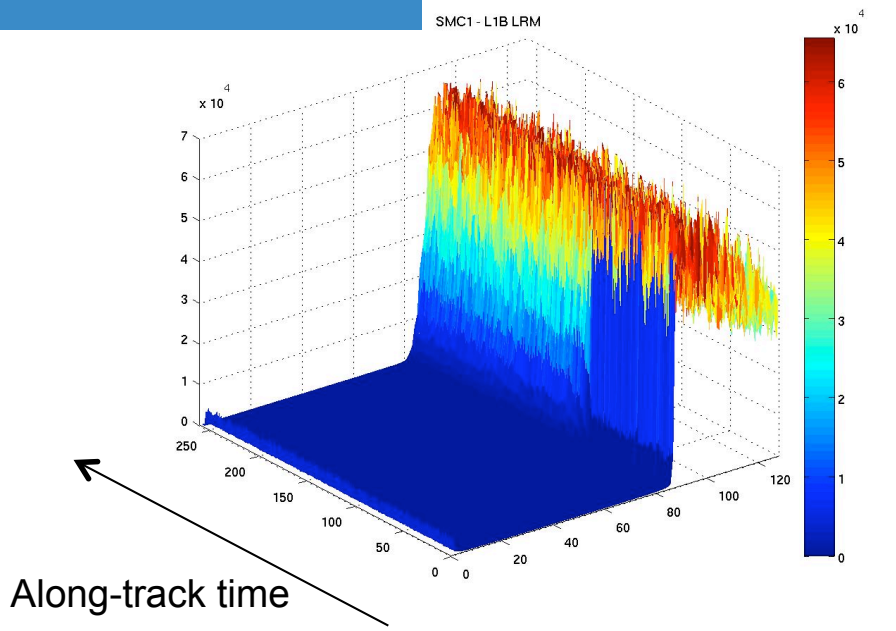
The ESA SAMOSA project

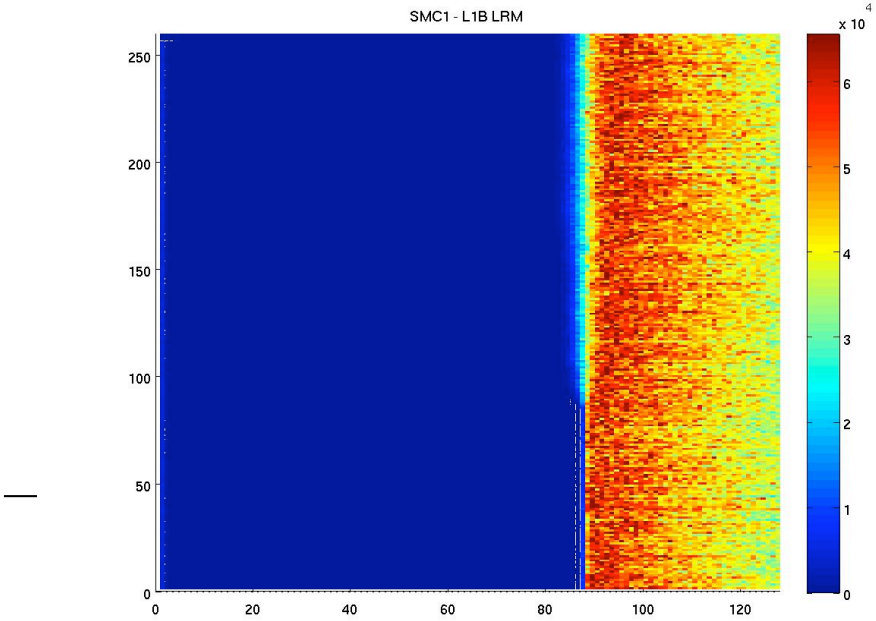
ESA SAMOSA project

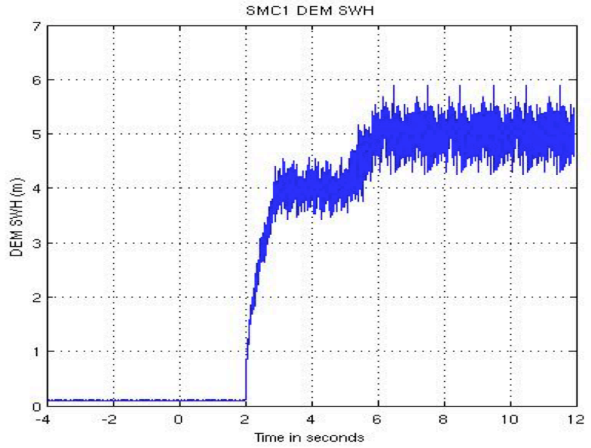
- Project led by David Cotton (SatOC) with NOCS, Starlab, De Montfort University, Danish National Space Centre
  - Support from R. Keith Raney (JHU/APL)
- Key aims of SAMOSA:
  - range retrieval accuracy between LRM and SAR mode
  - performance of SAR over small scale ocean topography features (e.g. sea mounds) and for coastal altimetry
- Approach:
  - LRM and SAR simulated waveforms from the Cryosat Mission Performance Simulator (CRYMPS)
  - new theoretical model for SAR waveforms over ocean
  - new prototype SAR waveform retracker applied to CRYMPS data


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

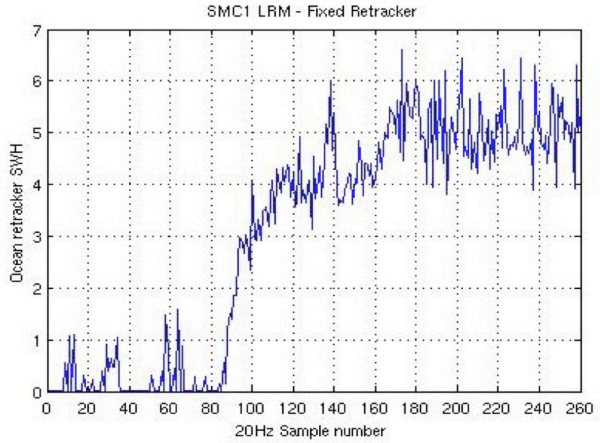
C1 LRM



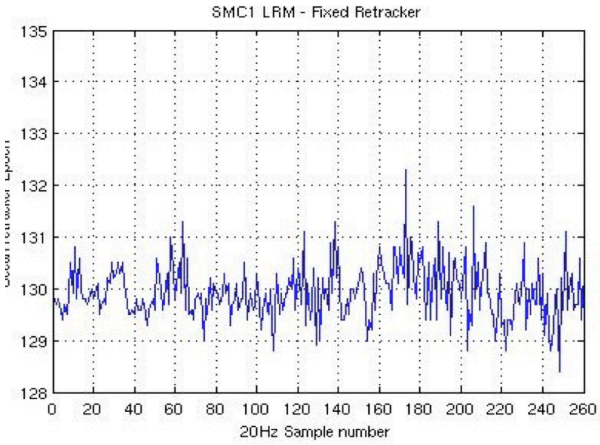




DEM SWH



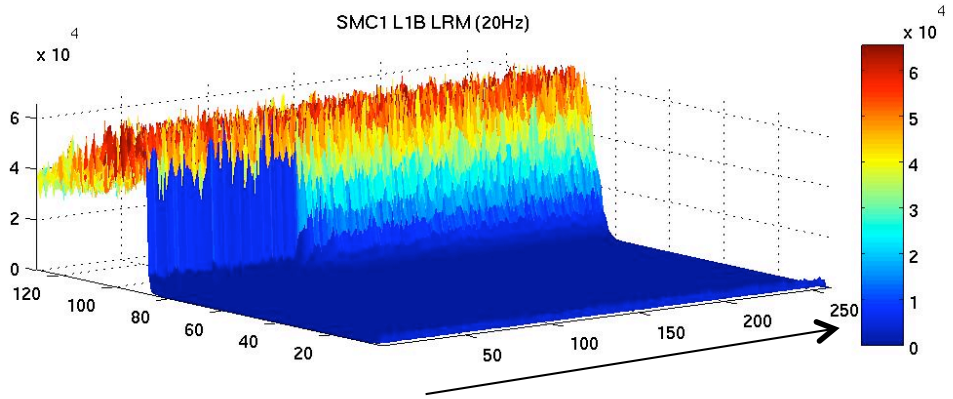
Retracked SWH (Brown model)

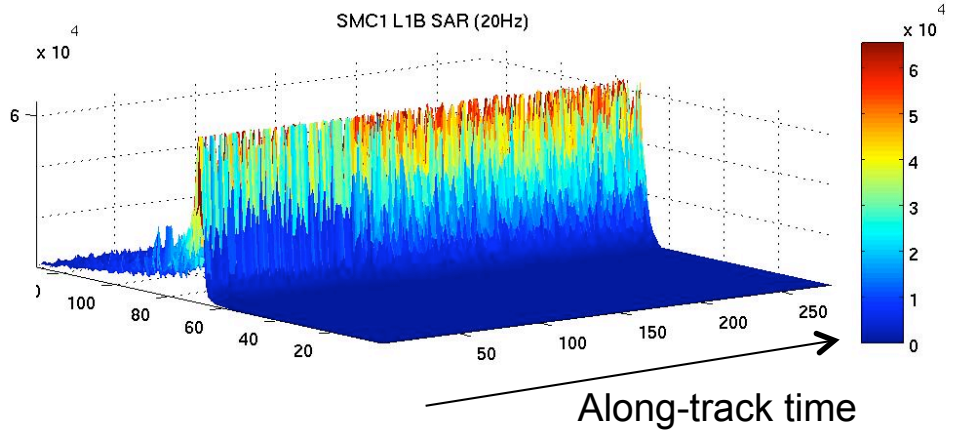


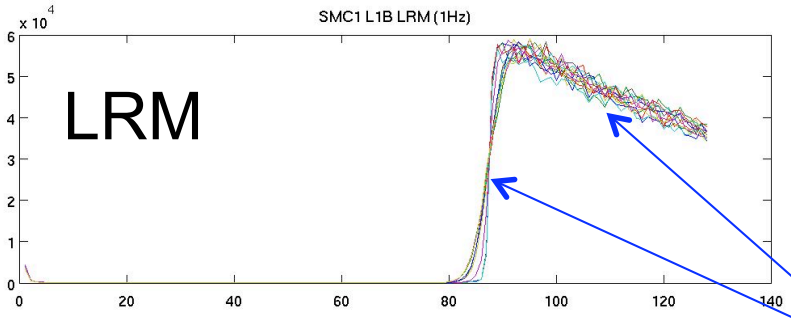
Retracked Epoch (Brown model)

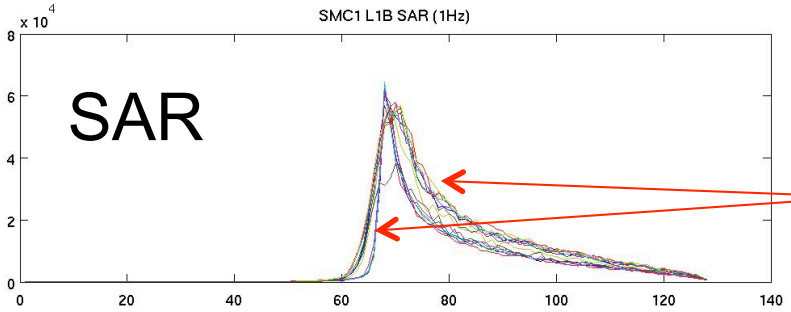
CRYMPS SAR & SAR Altimeter ocean retracker

LRM & SAR L1B Scenario C1









LRM: slow decaying trailing edge & increased tilt of leading edge for high SWH

SAR: peaky waveforms, fast decaying trailing edge, peak broadening at high SWH

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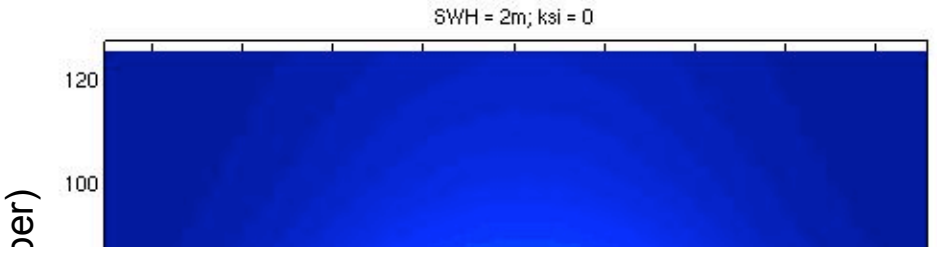
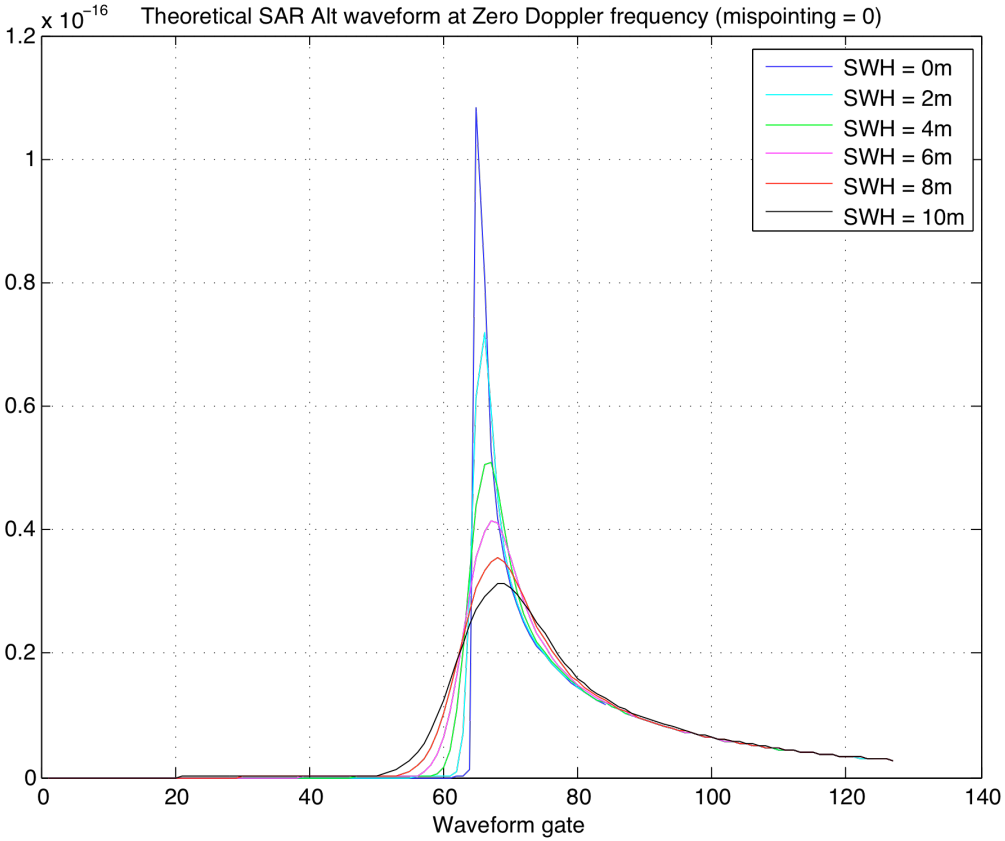
Single-look SAR Alt Delay-Doppler Map

- 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 range, SWH, along-track mispointing, Sigma0





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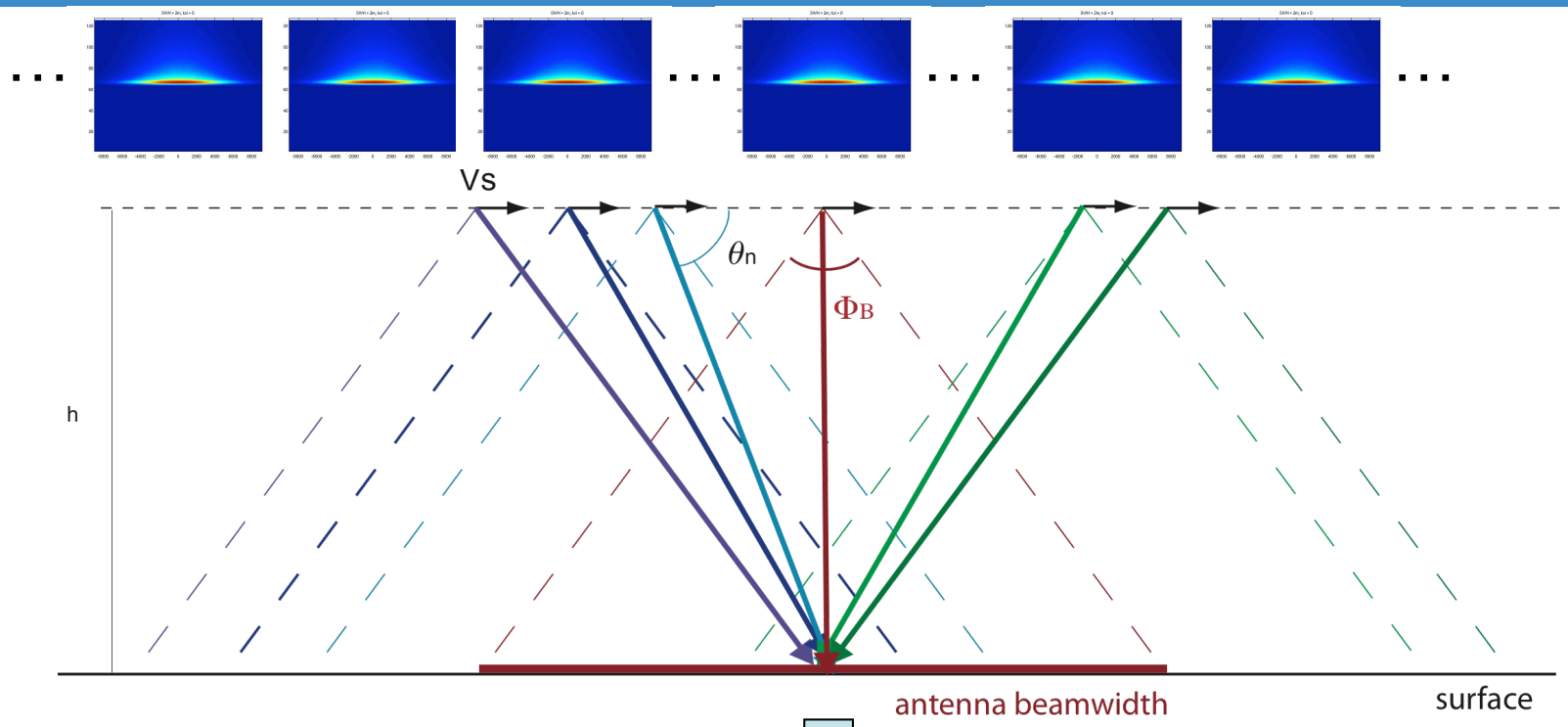
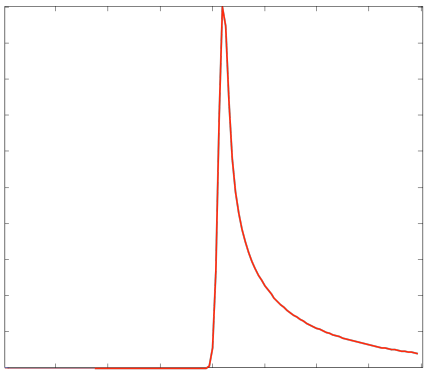
Multi-looking



Doppler-beam selection & incoherent integration over multiple bursts



Multi-looked SAR L1B Waveform at 18Hz

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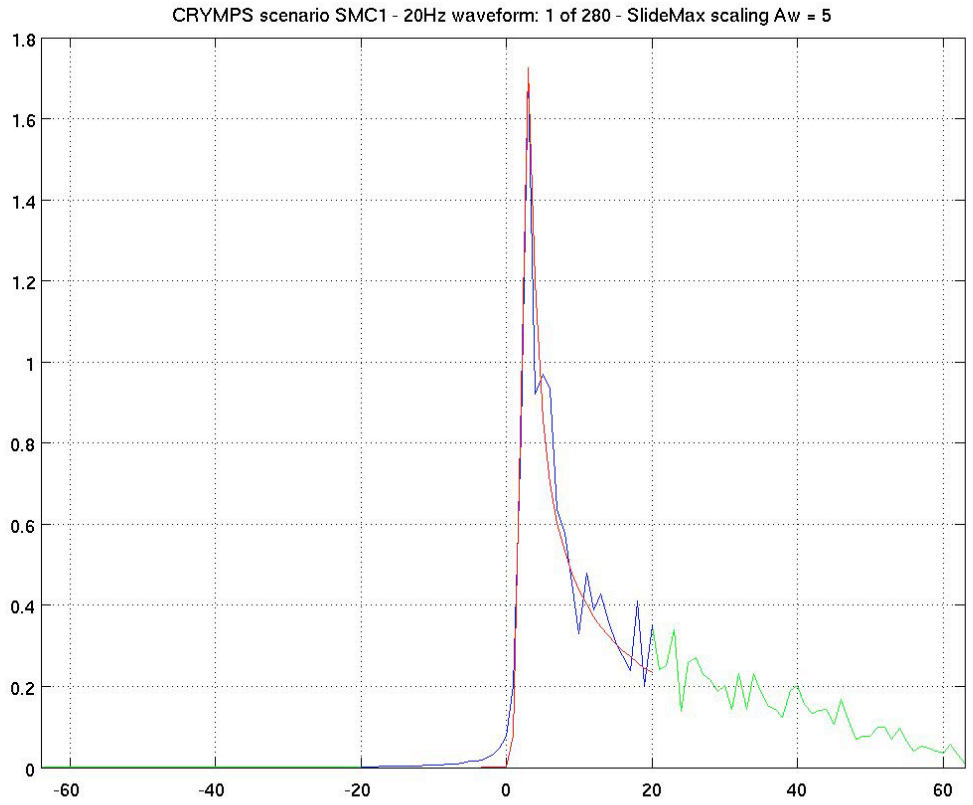
Prototype SAR Alt ocean retracker

- Single-look DDA model and multi-looking implemented at NOCS as prototype SAR Alt ocean retracker
- Applied to CRYMPS
- Good fit between theoretical and CRYMPS waveforms
- Multi-looking & noise being optimised



Conclusions & Future work

- SAMOSA aims to quantify the improvement in performance of SAR altimeters compared to pulse-limited altimeters over ocean surfaces and the coastal zone
- The Cryosat Mission Performance Simulator (CRYMPS) successfully generated simulated LRM and SAR L1B waveforms for ocean surfaces with realistic wave fields
- A new theoretical model and prototype SAR ocean retracker were developed and applied to CRYMPS data over ocean. Good agreement was found between theoretical & numerical SAR waveforms, but the multi-looking methodology is still being optimised
- Next, we will compare the range & SWH retrieval accuracy in LRM and SAR mode in the open ocean. Other CRYMPS datasets over ocean topography and in coastal regions will determine the capability of SAR altimeters for those applications.

Thank You !

Any questions ?

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