

Range retrieval performance in LRM, SAR and pseudo- LRM mode:

Results from computer simulated products
and Cryosat2

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Content

- Range retrieval in LRM, SAR and pseudo-LRM mode from computer simulated products
 - Simulated data from Cryosat Mission Performance Simulator (CRYMPS) for open-ocean scenarios
 - SAMOSA1 SAR ocean retracker
- Application of SAMOSA1 SAR retracker to Cryosat2 SAR
- Extension of SAMOSA1 model in low wave height conditions
- Range retrieval from Cryosat2 data with the SAMOSA1 SAR retracker



Range retrieval accuracy in LRM, SAR and pseudo-LRM mode

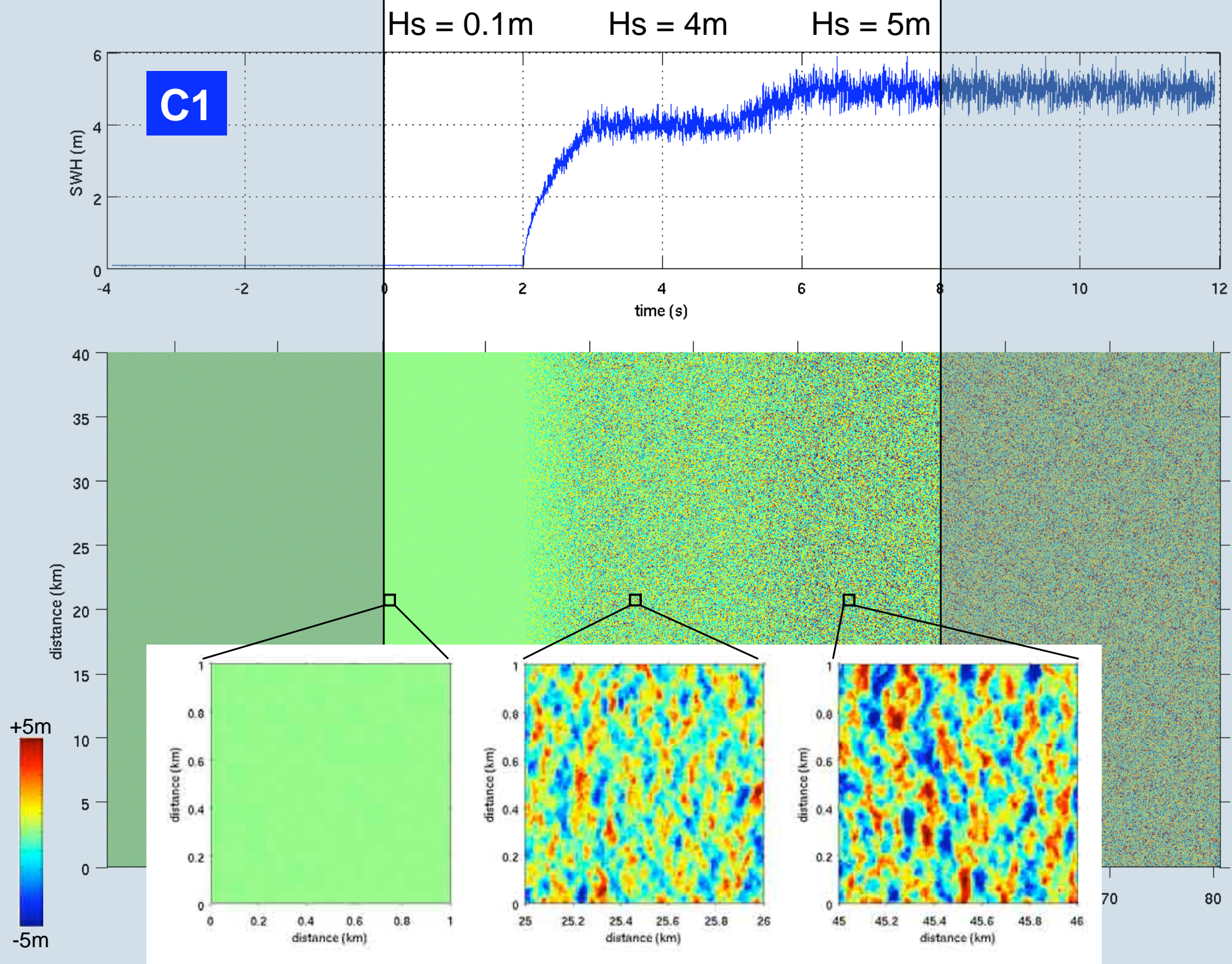
Simulated LRM and SAR L1B data



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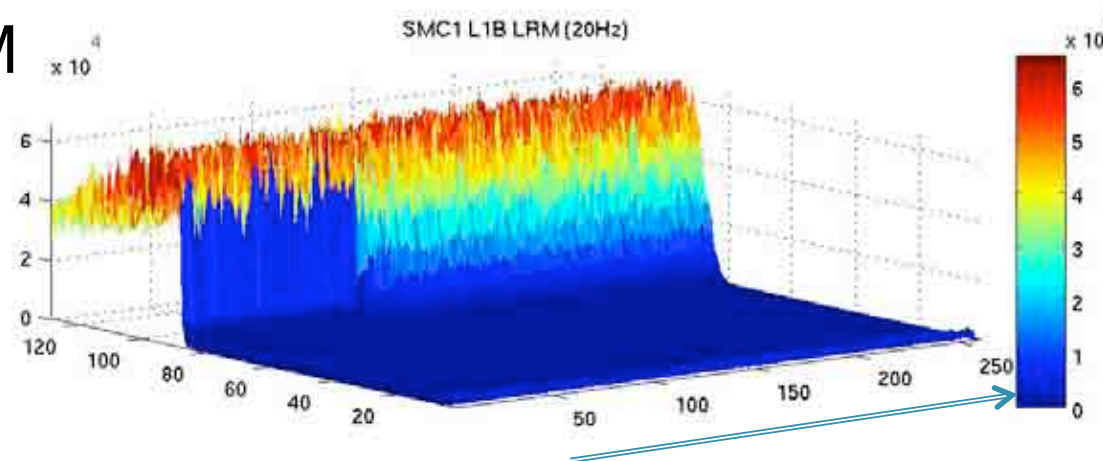
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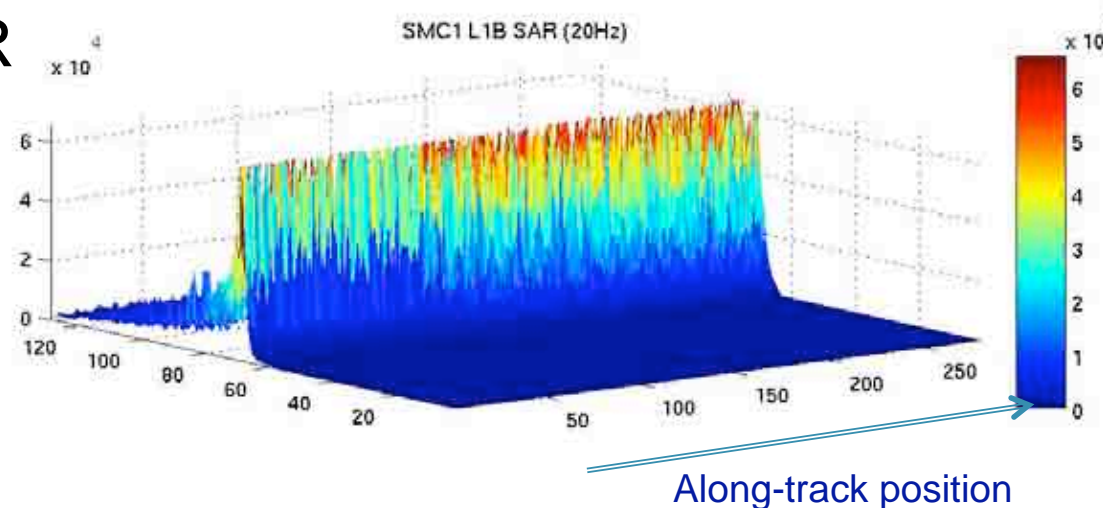


Simulated LRM and SAR L1B waveforms

LRM



SAR



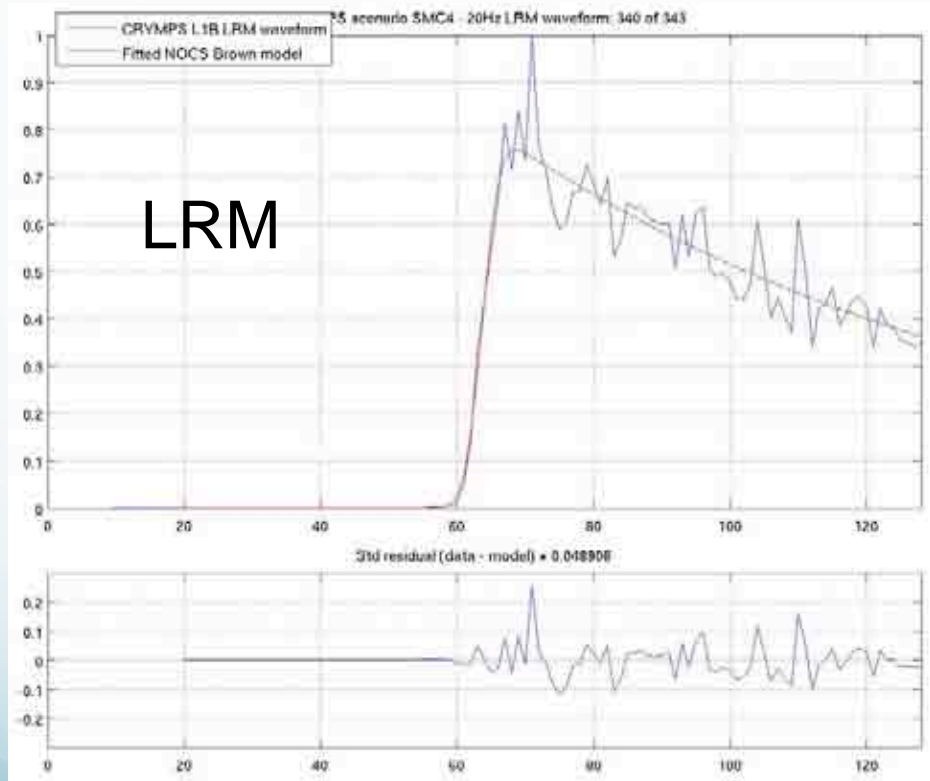
- Significant wave height changes from 0.1 -> 4 -> 5 meters
- Both LRM and SAR waveforms broaden as wave height increases
- SAR waveforms much peakier than LRM



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Simulated and fitted LRM and SAR waveforms



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RDSAR processing of simulated SAR data

- Starlab RDSAR software applied to SAR Full-Bit-Rate products produced by the Cryosat simulator for various scenarios
- N_p , the number of pulses in each burst to incoherently average prior to incoherent summing can vary between 1 and 8
- Computations done for $N_p = 1, 4$ and 8
- Results are similar for the three cases
 - we show results for $N_p = 8$ only



Range retrieval accuracy as a function of SWH

Three open ocean
simulations for
SWH ranging
0.1m to 5 m

SWH = 0.1m

SWH = 1

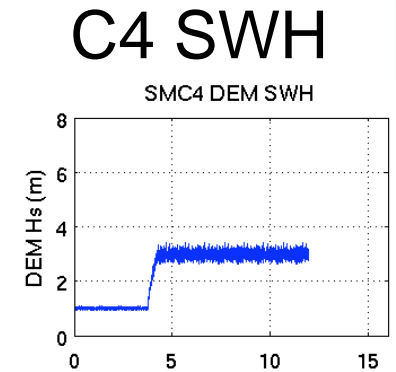
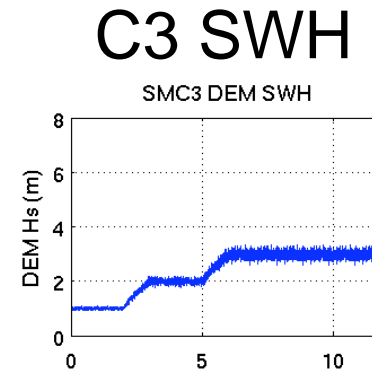
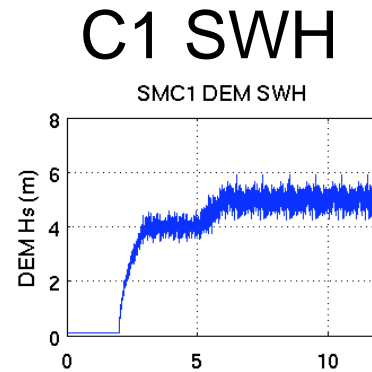
SWH = 2

SWH = 3

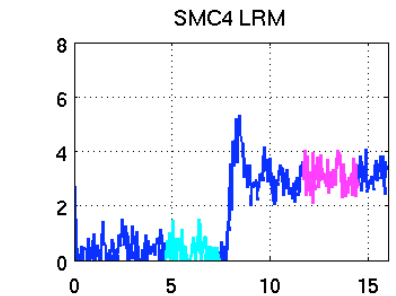
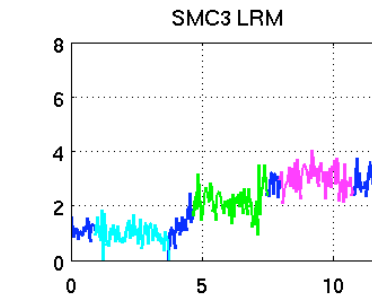
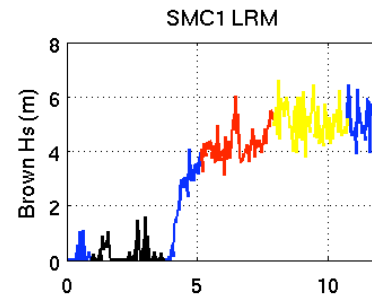
SWH = 4

SWH = 5

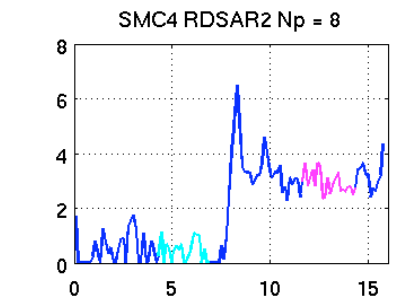
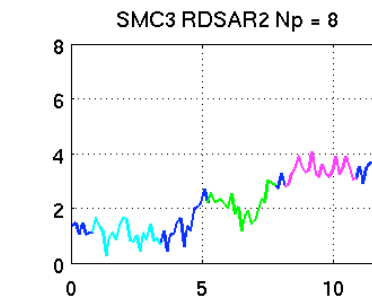
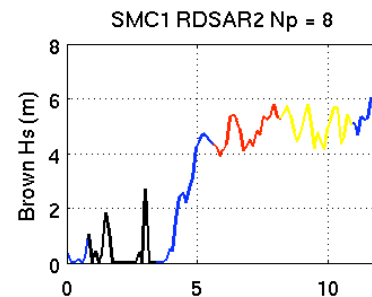
DEM



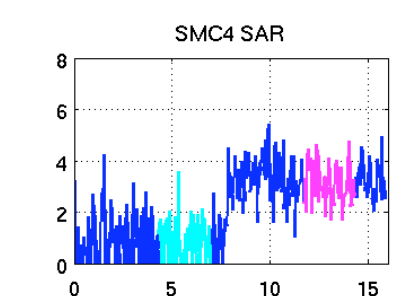
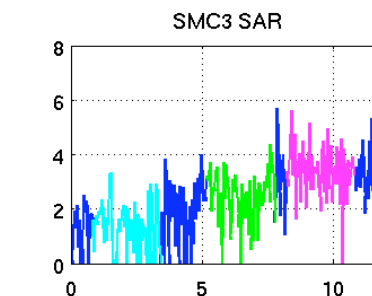
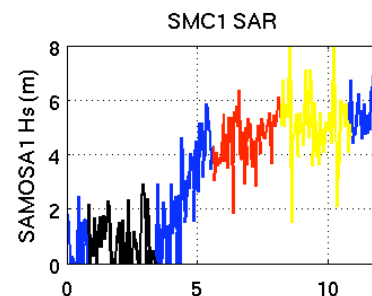
LRM



RDSAR



SAR

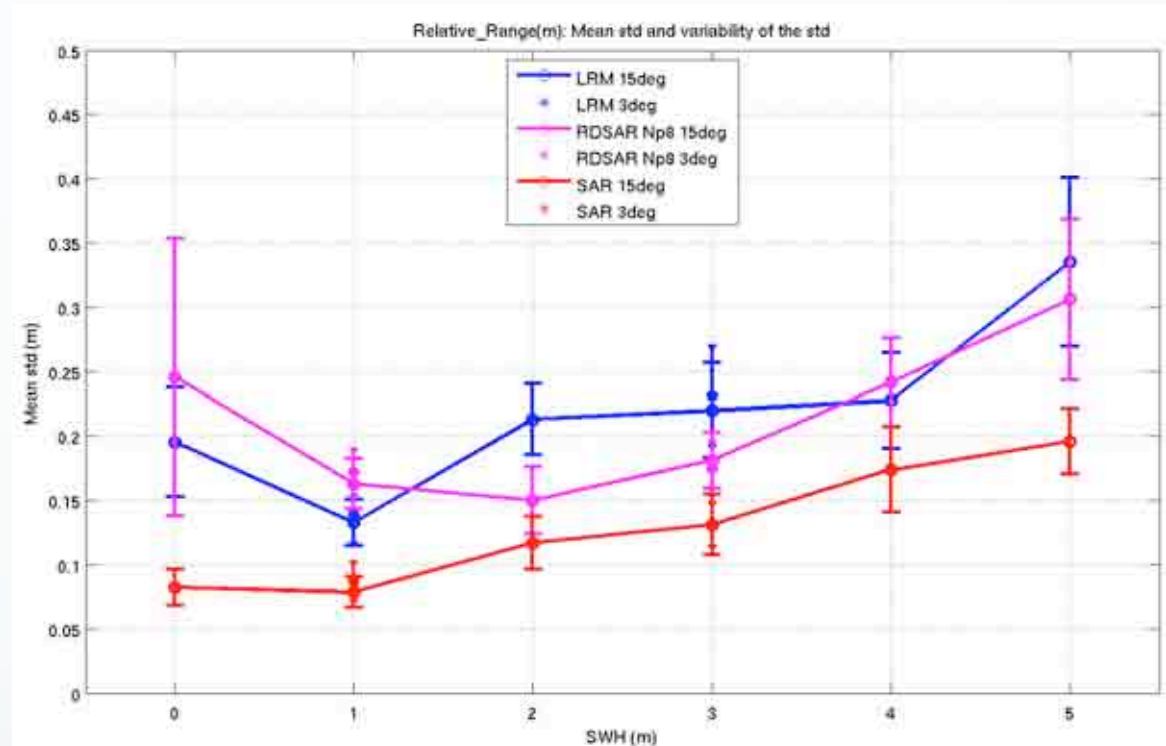


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Range retrieval accuracy in LRM, SAR and pseudo-LRM

- Relative range (std)
 - LRM (blue)
 - SAR (red)
 - RDSAR (magenta)
- Key findings:
 - RDSAR retrieval accuracy similar to LRM
 - SAR range accuracy improved by ~ factor 2 compared to LRM
 - But according to these results, the retrieved SWH is much noisier for SAR than LRM



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Application of SAMOSA1 SAR retracker to Cryosat2 SAR

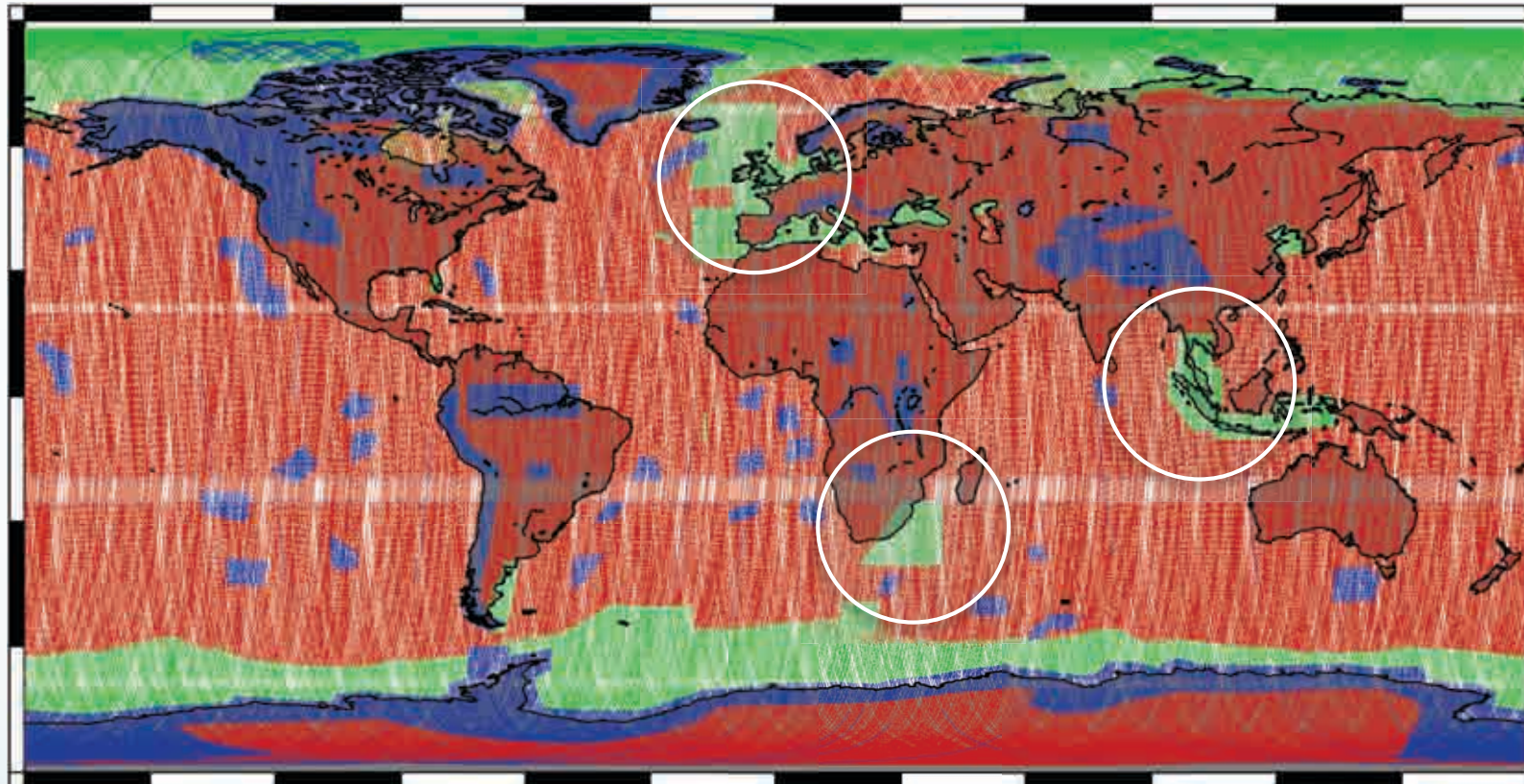


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Cryosat-2 L1B SAR data



SAR
LRM
SARIn

Courtesy Lars Stenseng, DTU
Based on 3 months of Cryosat2 data
July-Oct 2010



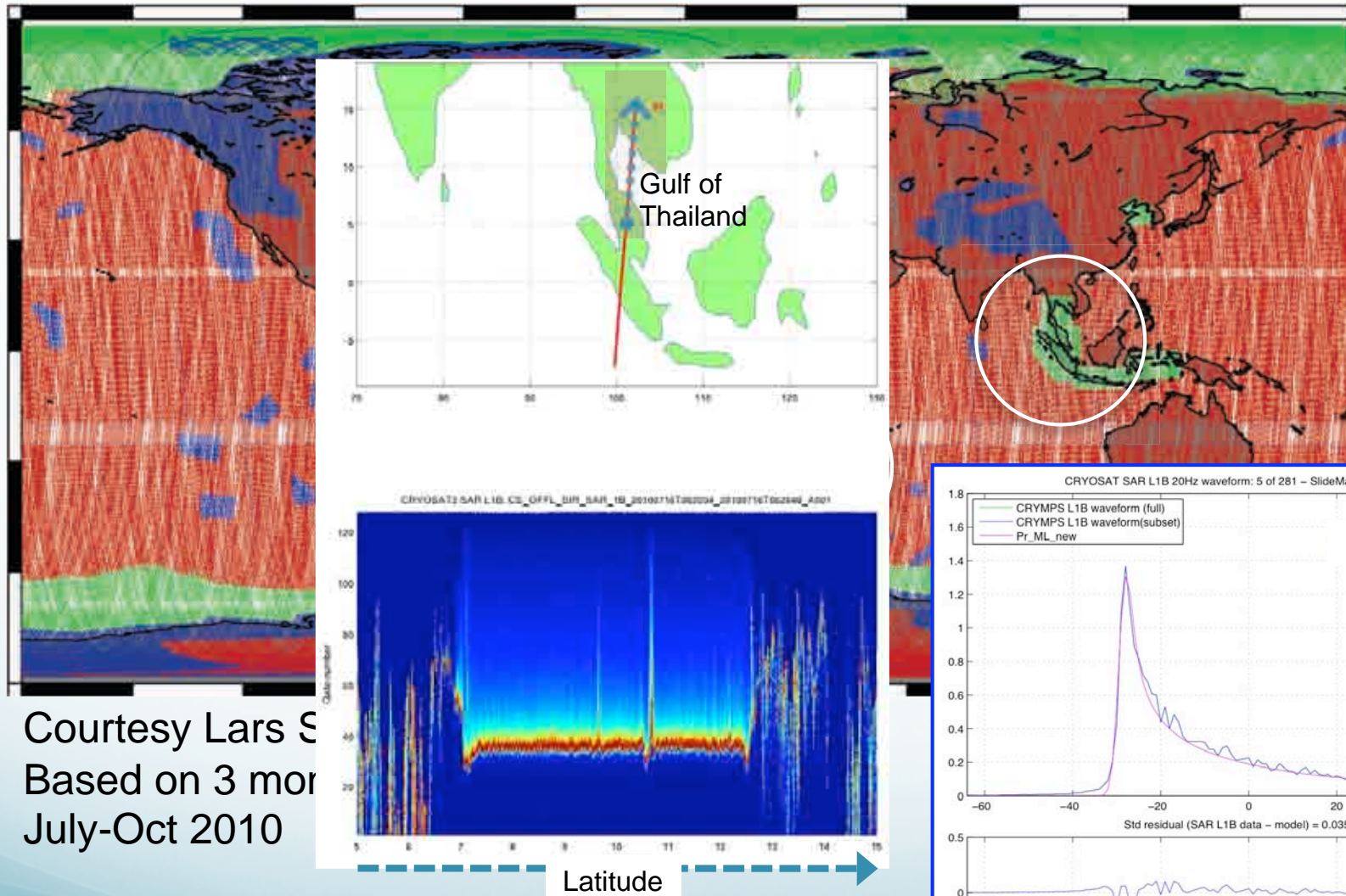
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Cryosat-2 L1B SAR data

SAR
LRM
SARIn



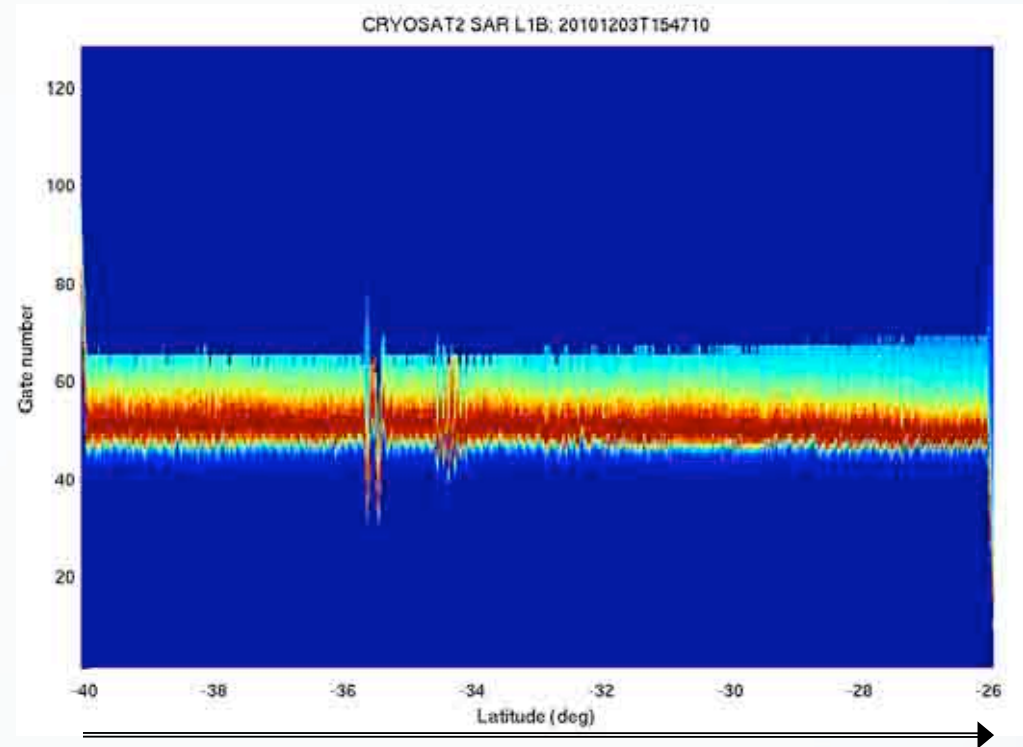
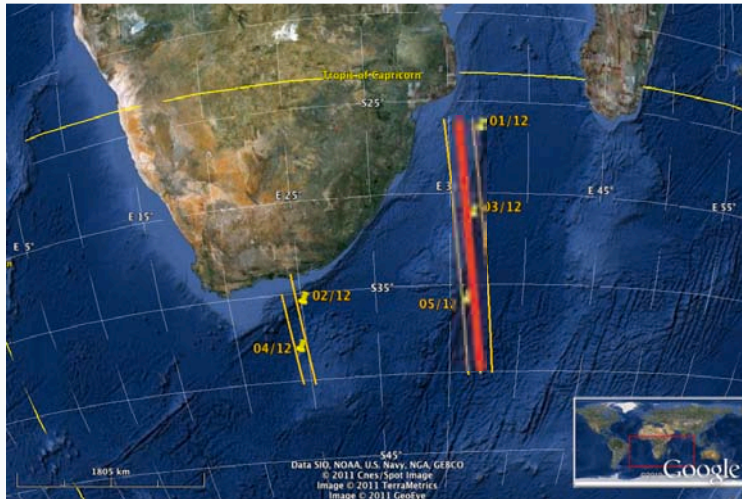
Courtesy Lars S
Based on 3 mor
July-Oct 2010



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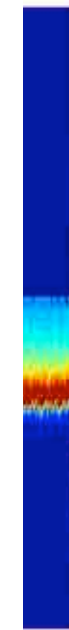
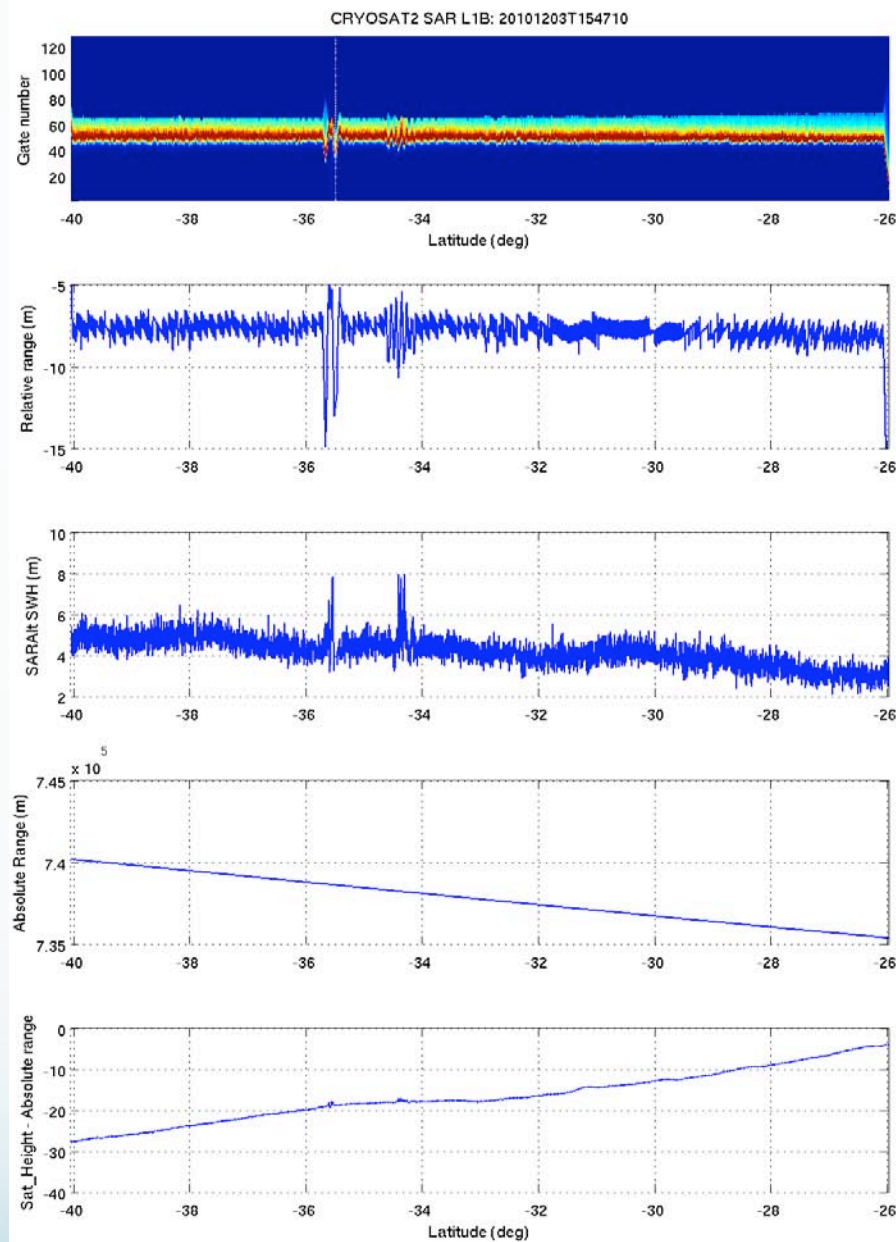
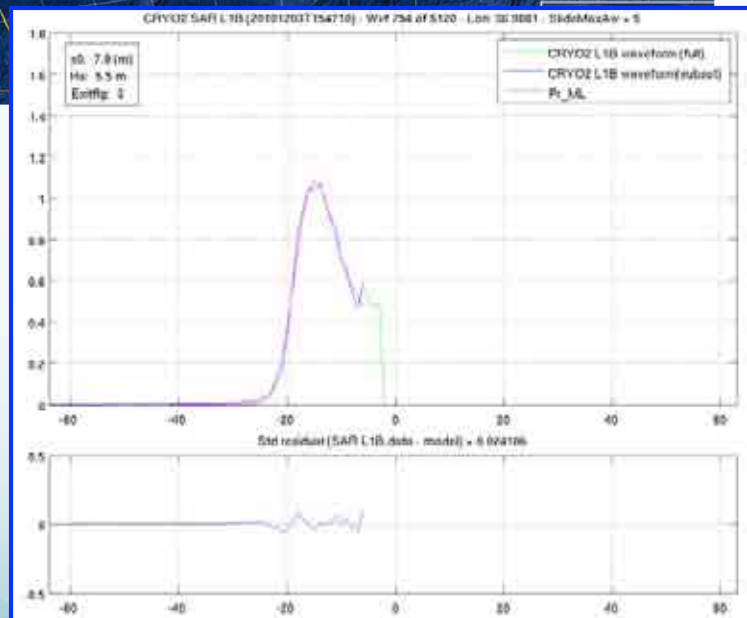
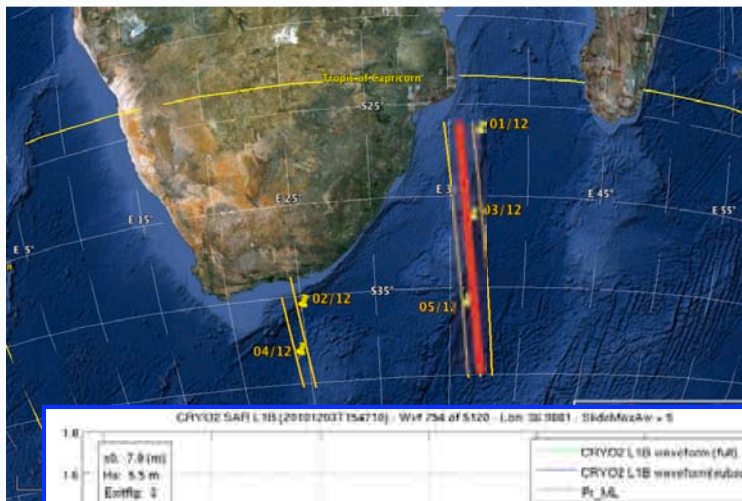


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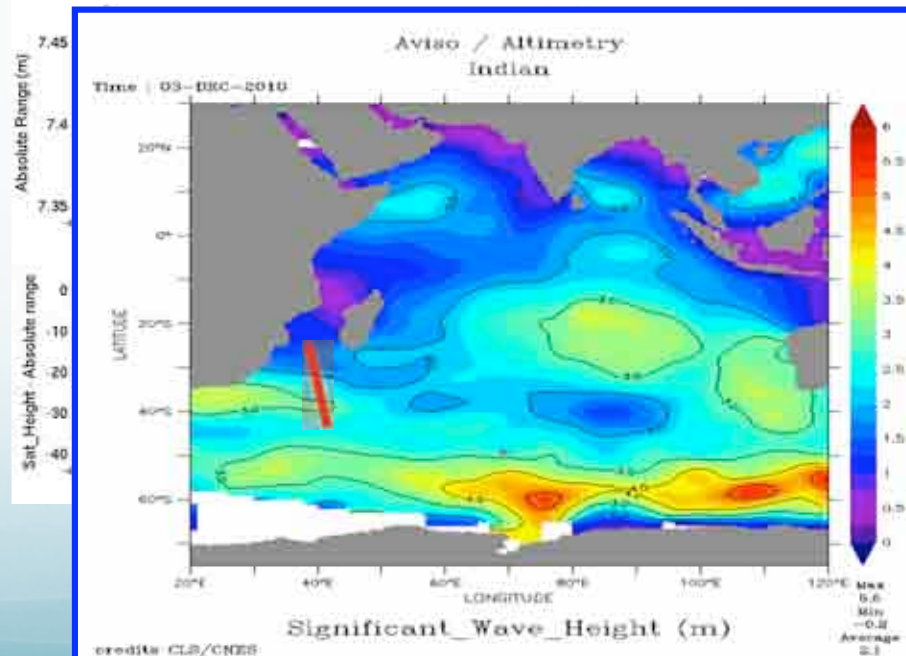
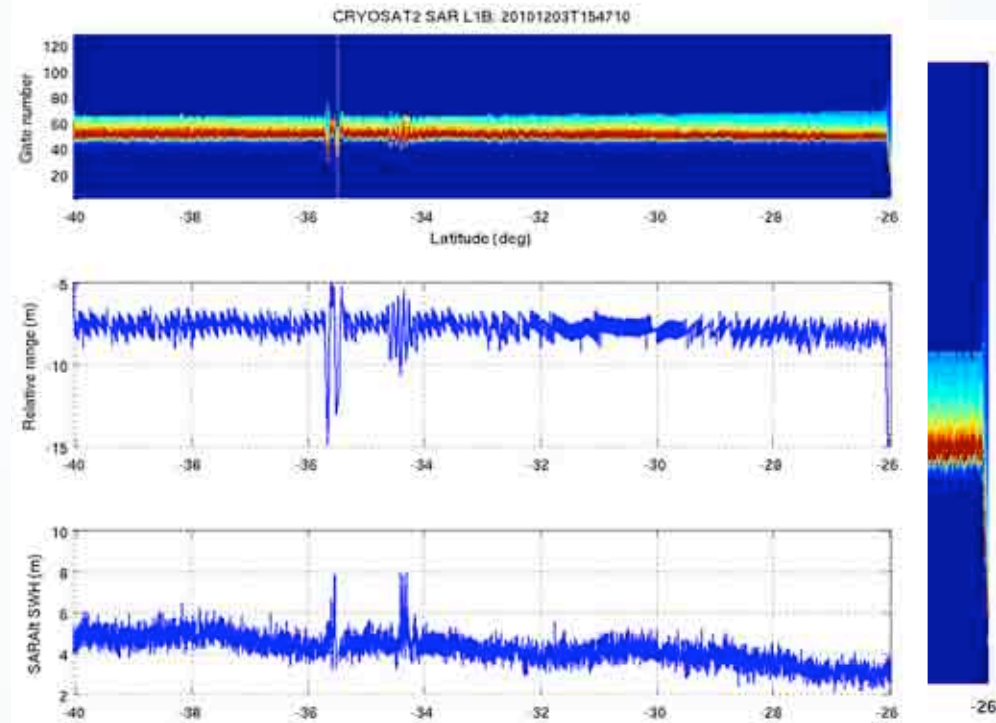
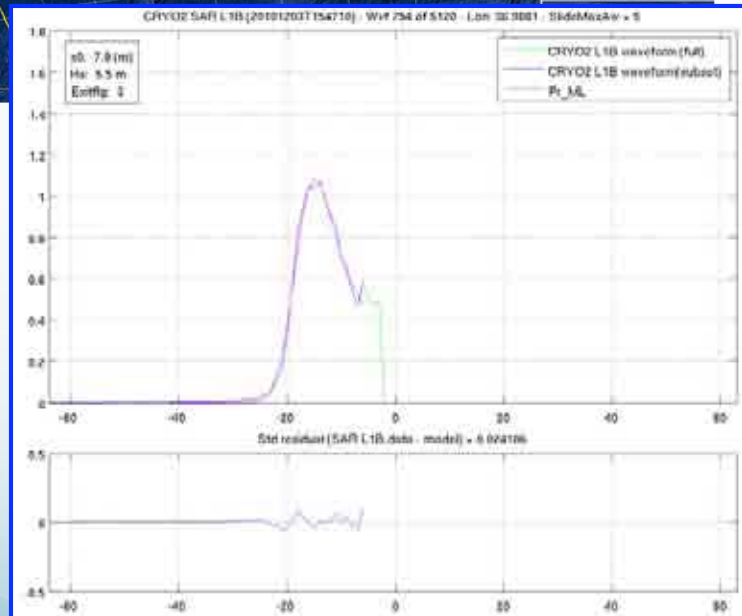
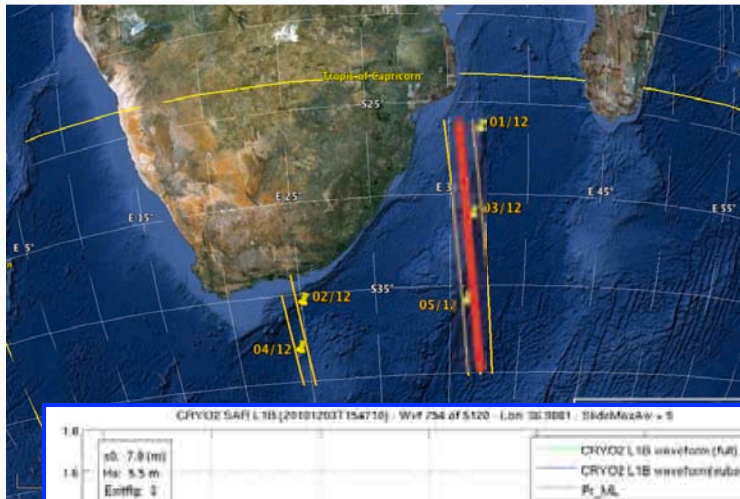
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2011

Extension of SAMOSA1 SAR model in low wave height conditions

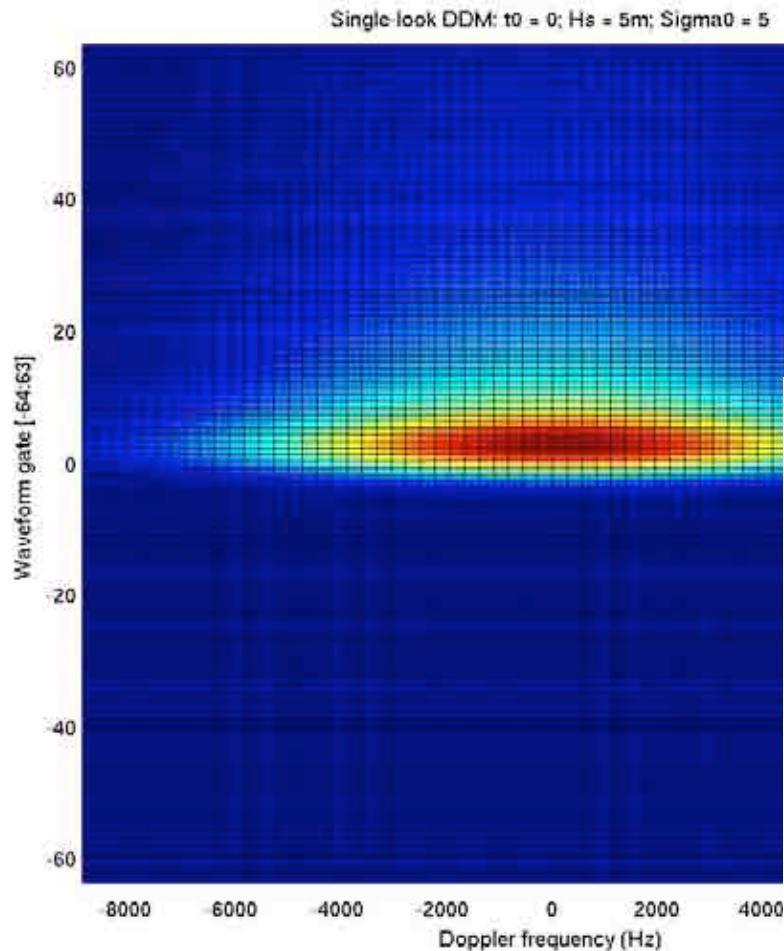


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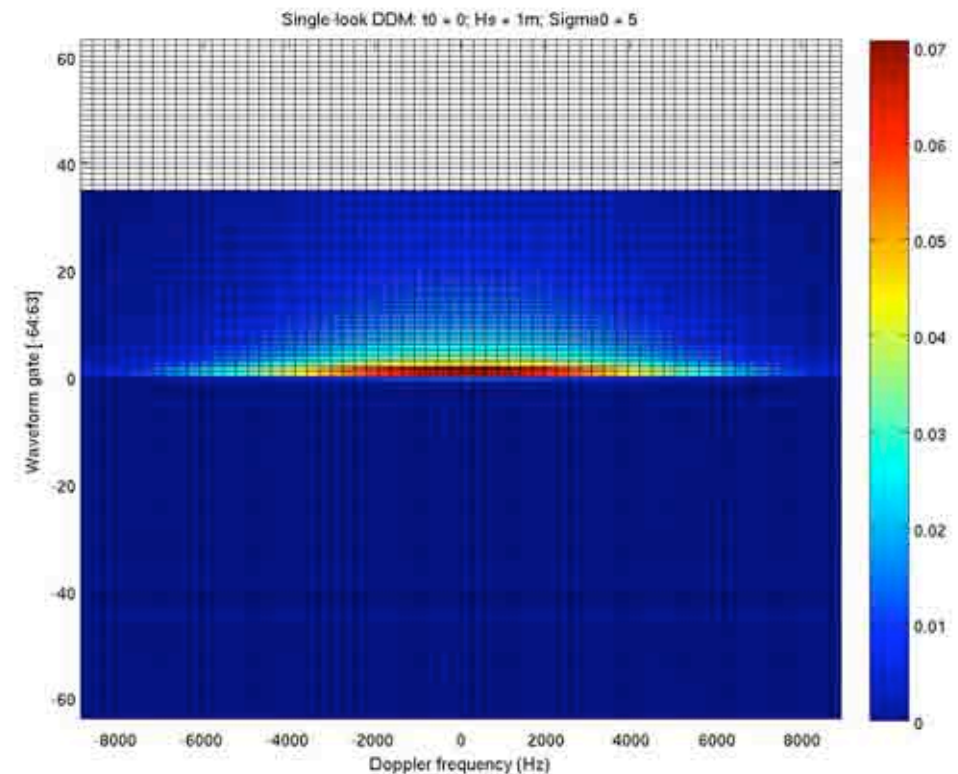
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The problem



$$\tau_0 = 0, \xi = 0$$
$$H_s = 1\text{m}$$
$$\sigma^0(0) = 5 \text{ } (\sim 7\text{dB})$$



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The problem/The solution

- Numerical singularity in the trailing edge in low wave height conditions linked to the modified Bessel functions
- An new mathematical formulation was developed and implemented to address this problem and extend the SAMOSA1 SAR model in these conditions
 - SAMOSA1 Extended model



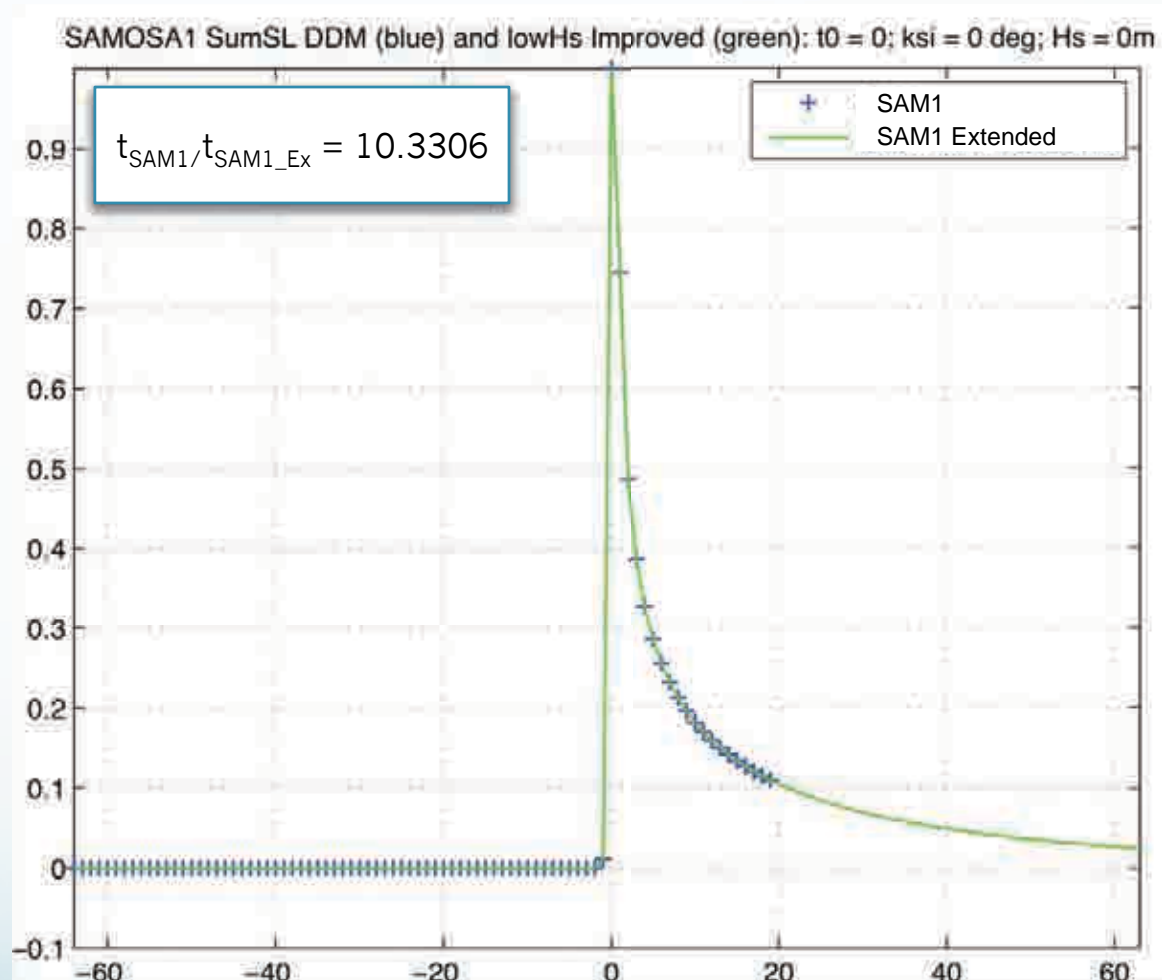
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Performance of SAMOSA1 Extended model

- Perfect fit to original SAMOSA1 model
- No drop-out in trailing edge, even for $H_s = 0$ m
- Extended model is ten-fold faster

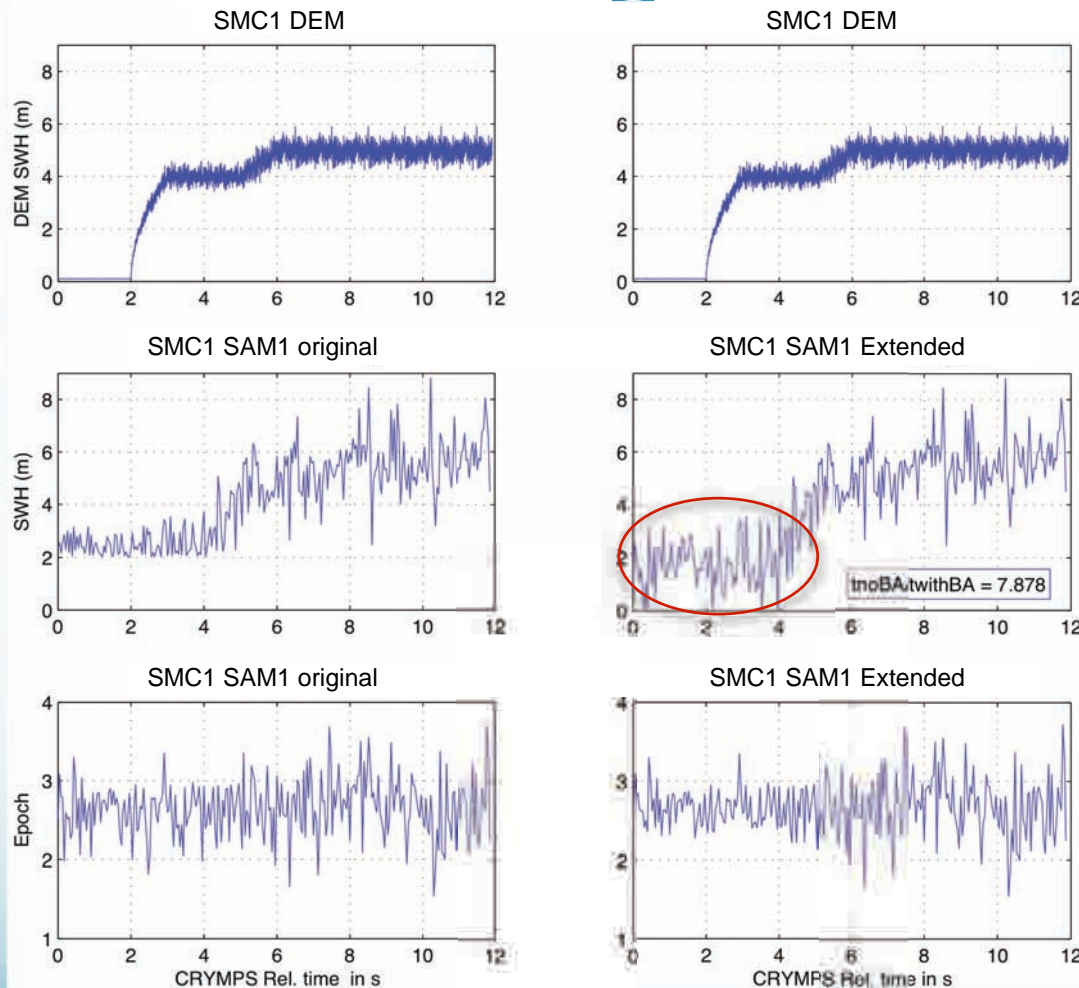


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Application to simulated data in low wave height conditions (SMC1)



- Better retrieval in low wave height
- Faster retracking (x 10)
- SAMOSA1 SAR model can now use full gate range
- Not currently included in DPM



Range retrieval accuracy from Cryosat2 data

SAMOSA1 Extended model



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Methodology

- Aim: to estimate the range retrieval accuracy of SAR mode in different sea states from Cryosat-2 data
- Lots of Cryosat-2 data in LRM and SAR mode, but not collocated (exclusive modes)
- Comparison of Cryosat2 SAR with Jason2 LRM



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Methodology

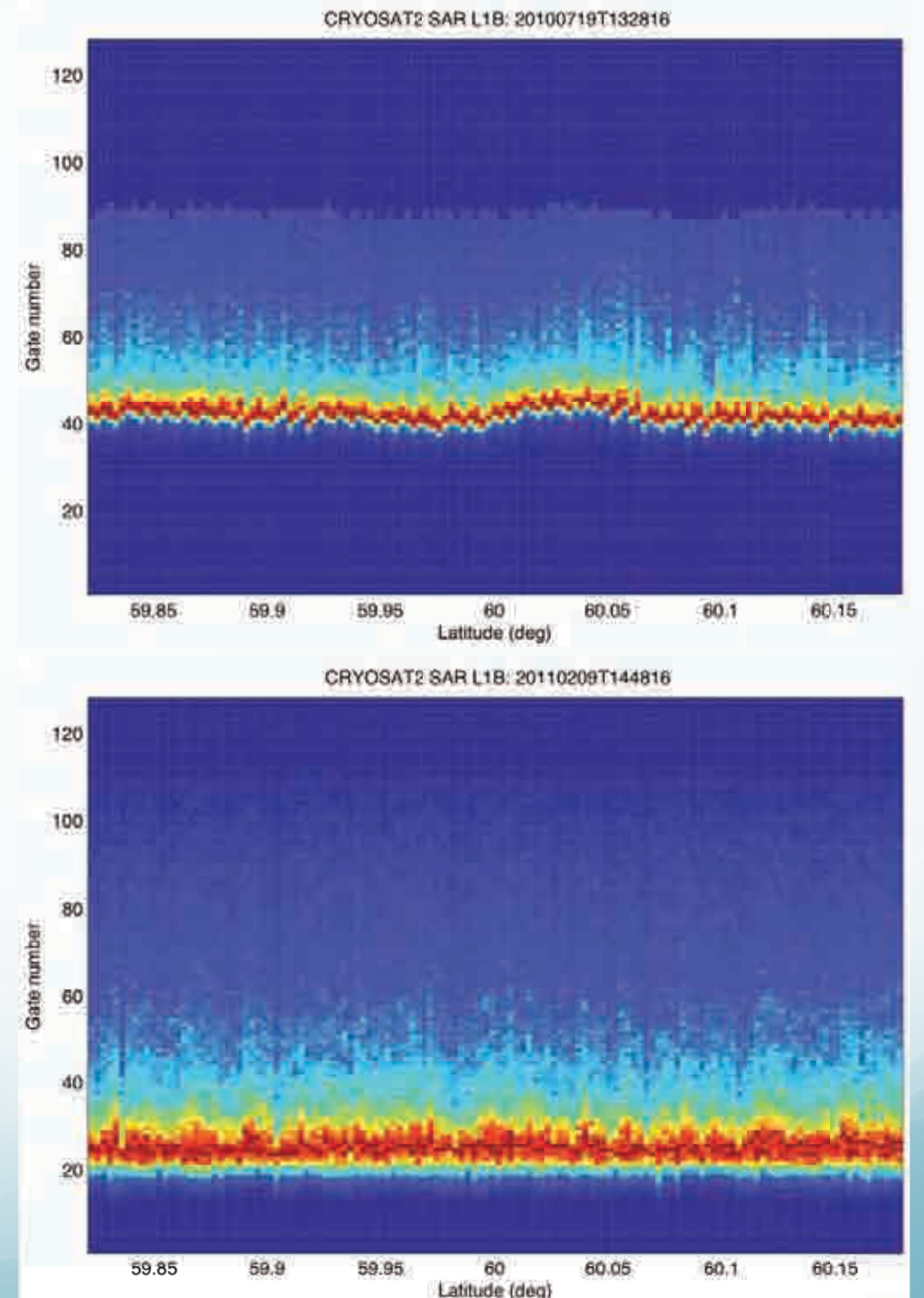
- Aim: to estimate the range retrieval accuracy of SAR mode in different sea states from Cryosat-2 data
- Lots of Cryosat-2 data in collocated (exclusive mode)
- Comparison of Cryosat2 S
- Focus on Norwegian Sea
- July 2010 – March 2011
 - Wide range of sea states



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Cryosat-2 SAR in Norwegian Sea



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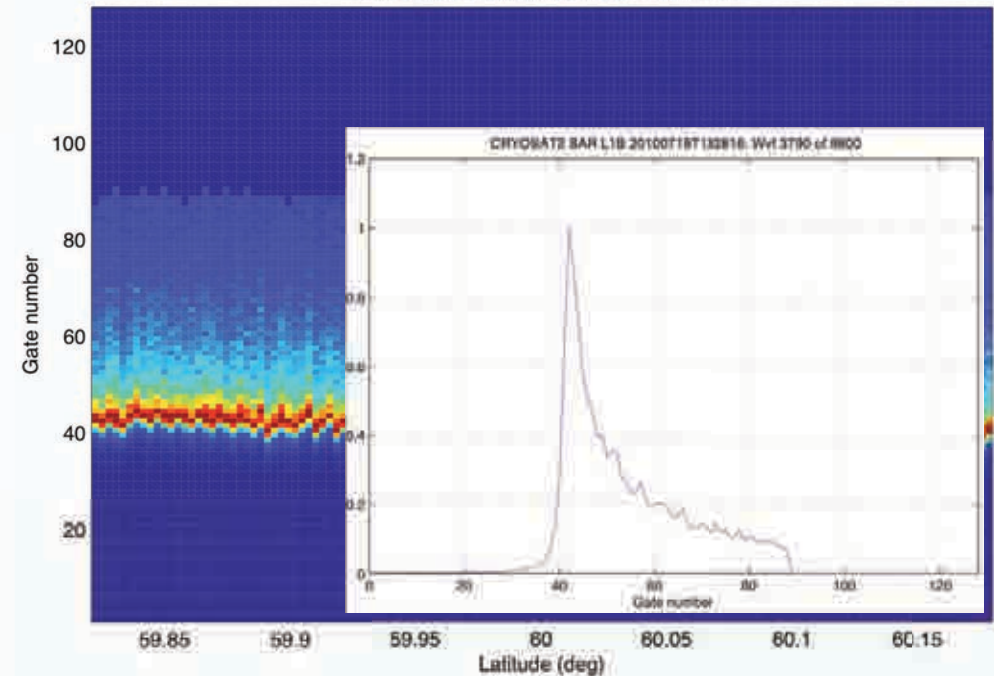
Cryosat-2 SAR in Norwegian Sea



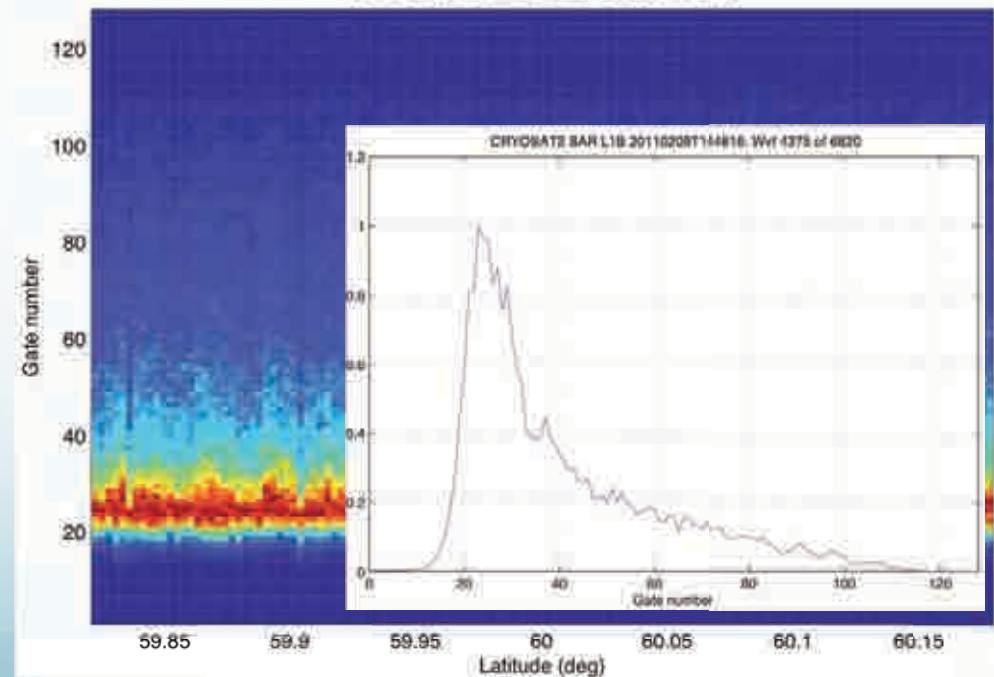
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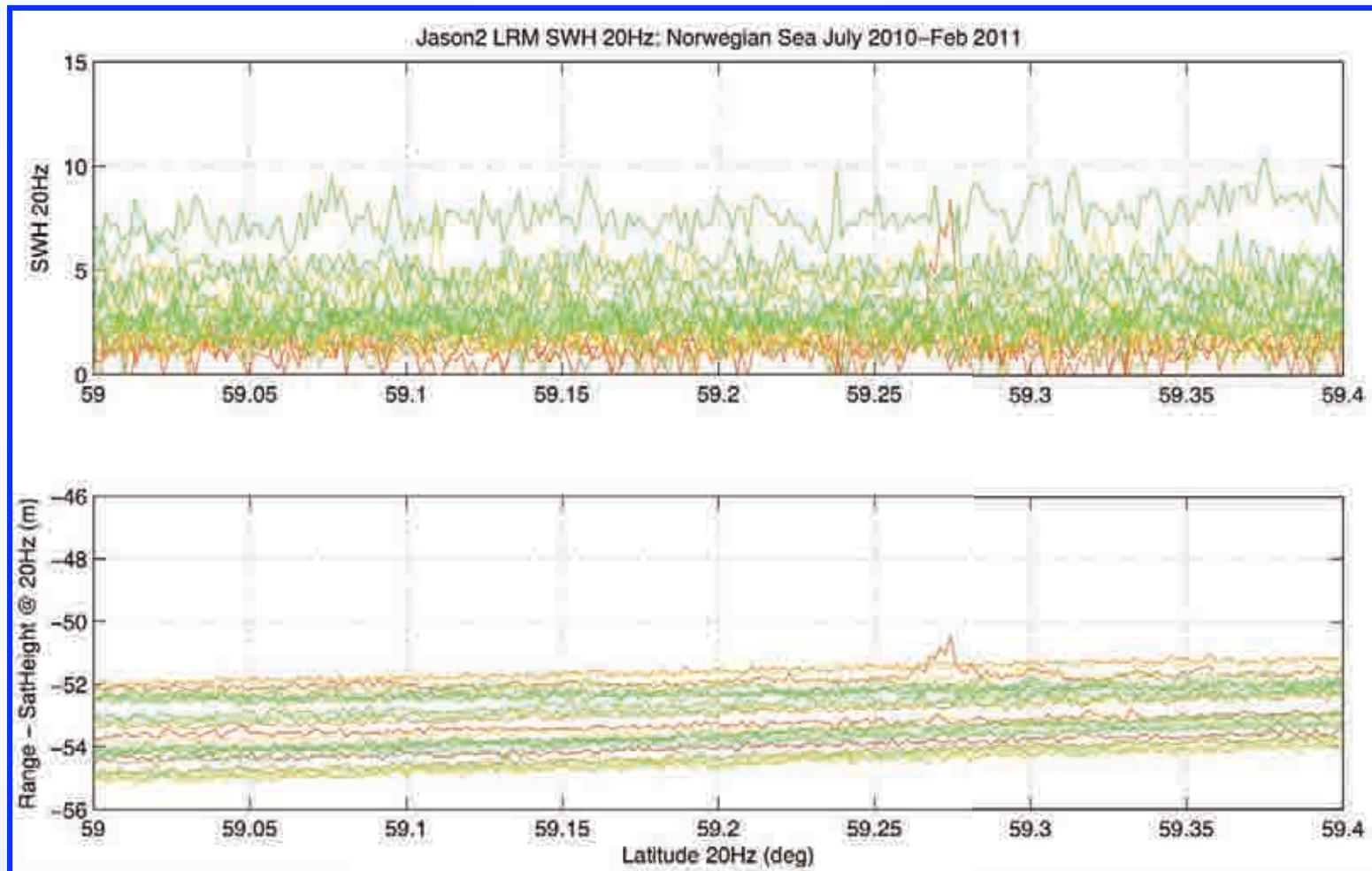
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CRYOSAT2 SAR L1B: 20100719T132816



CRYOSAT2 SAR L1B: 20110209T144816

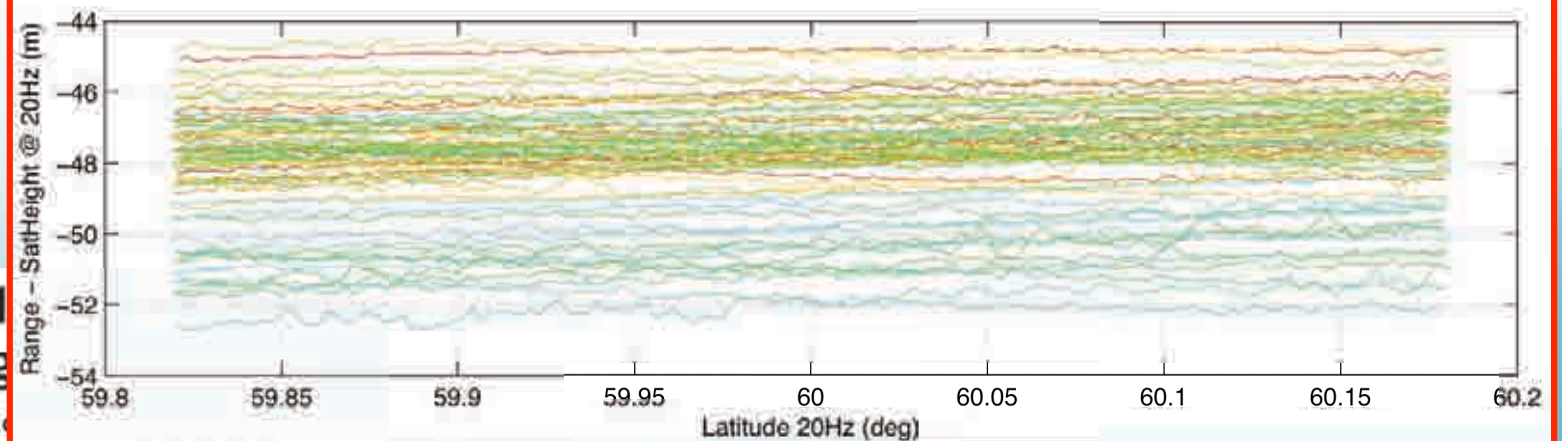
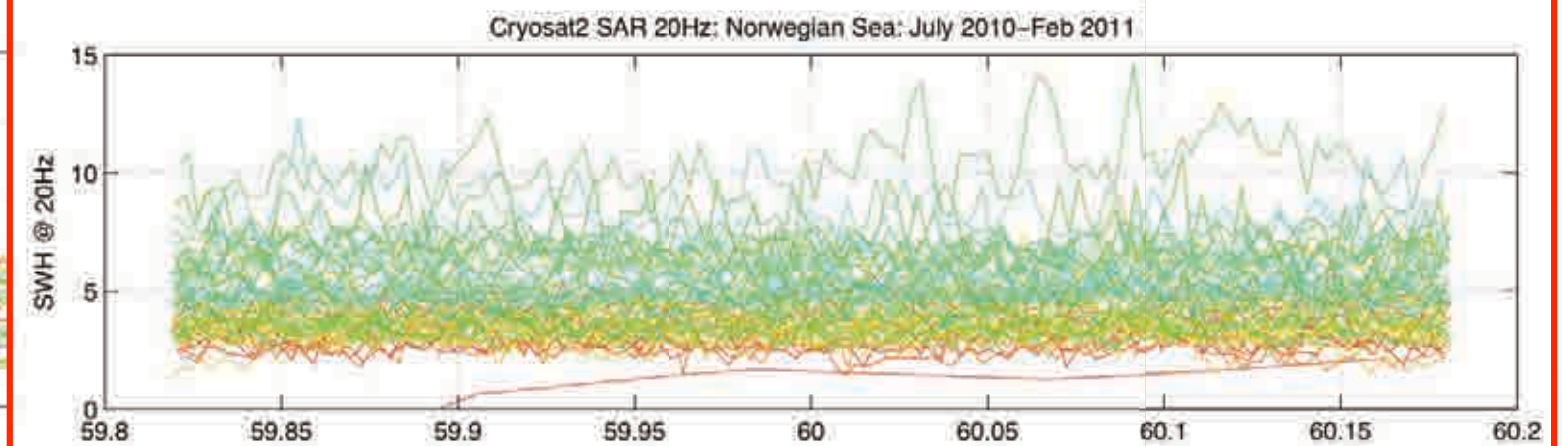
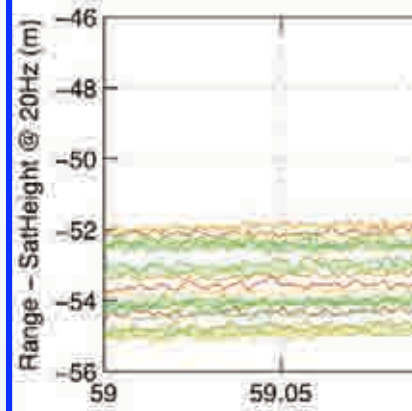
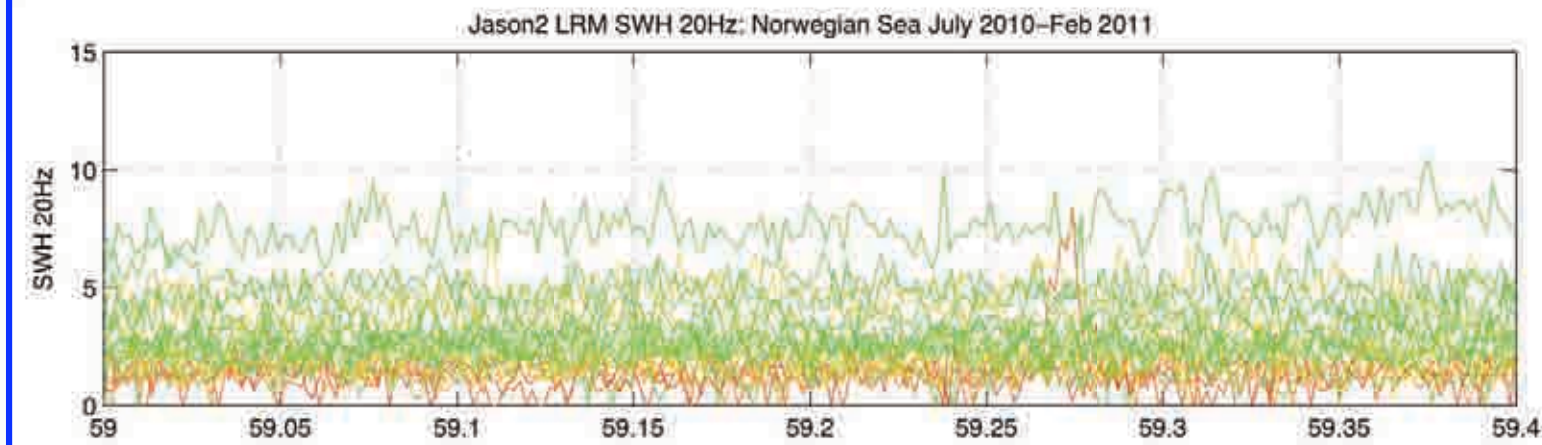




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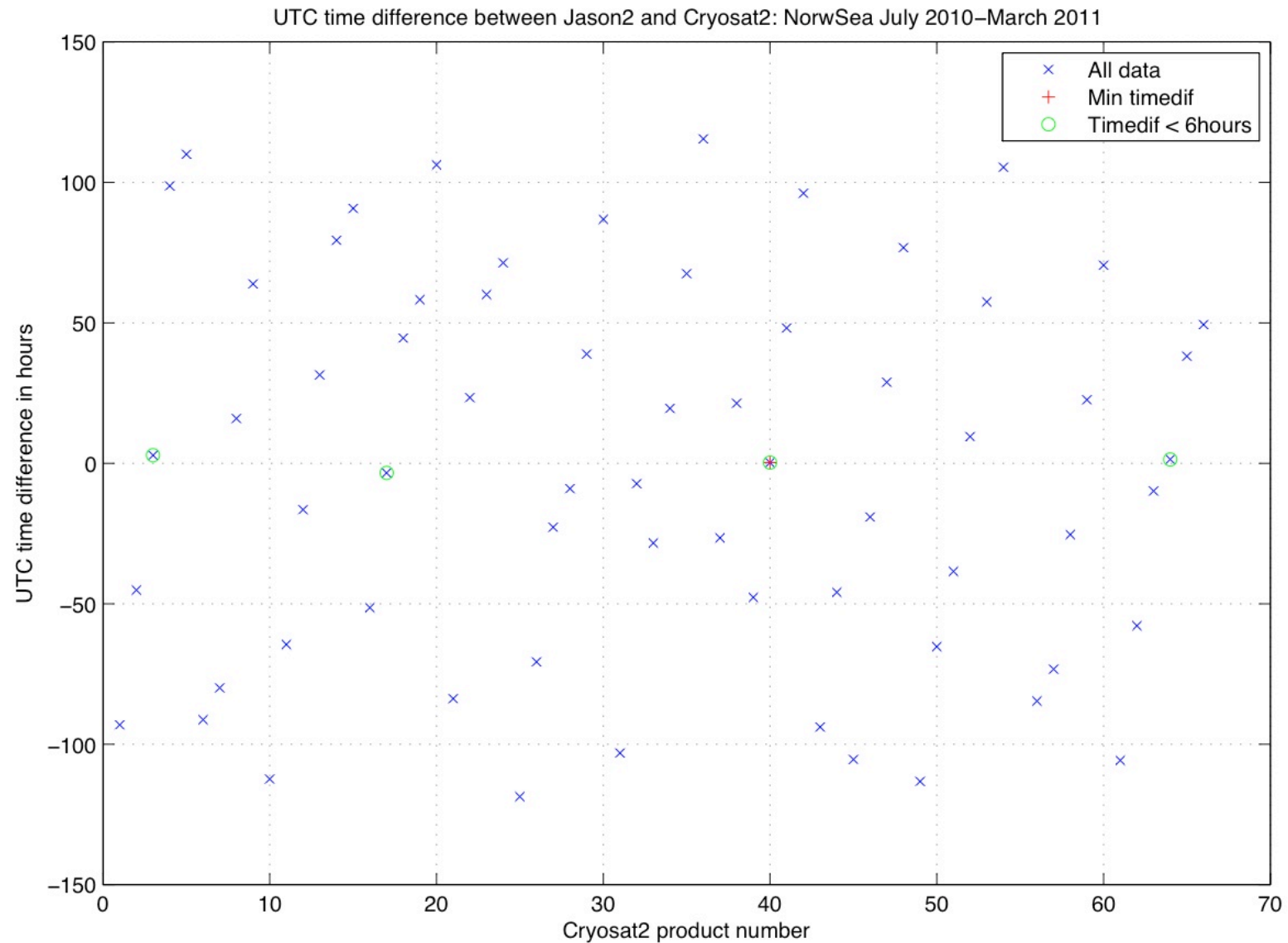
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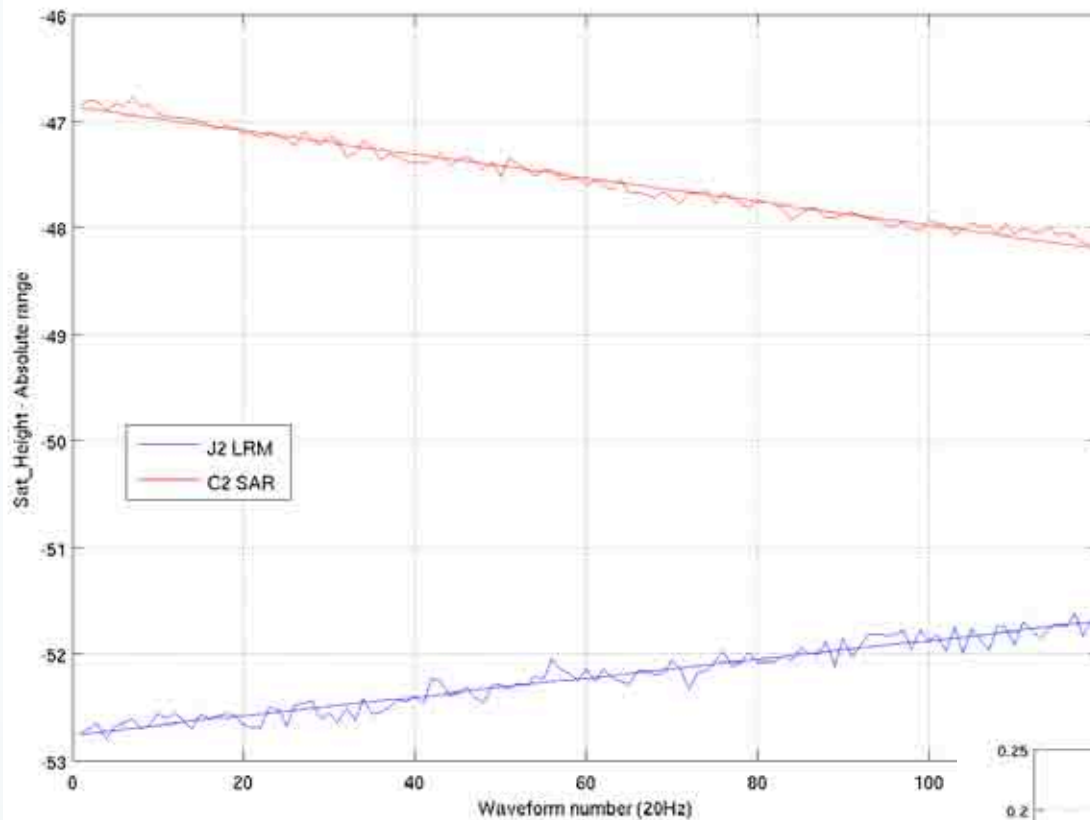


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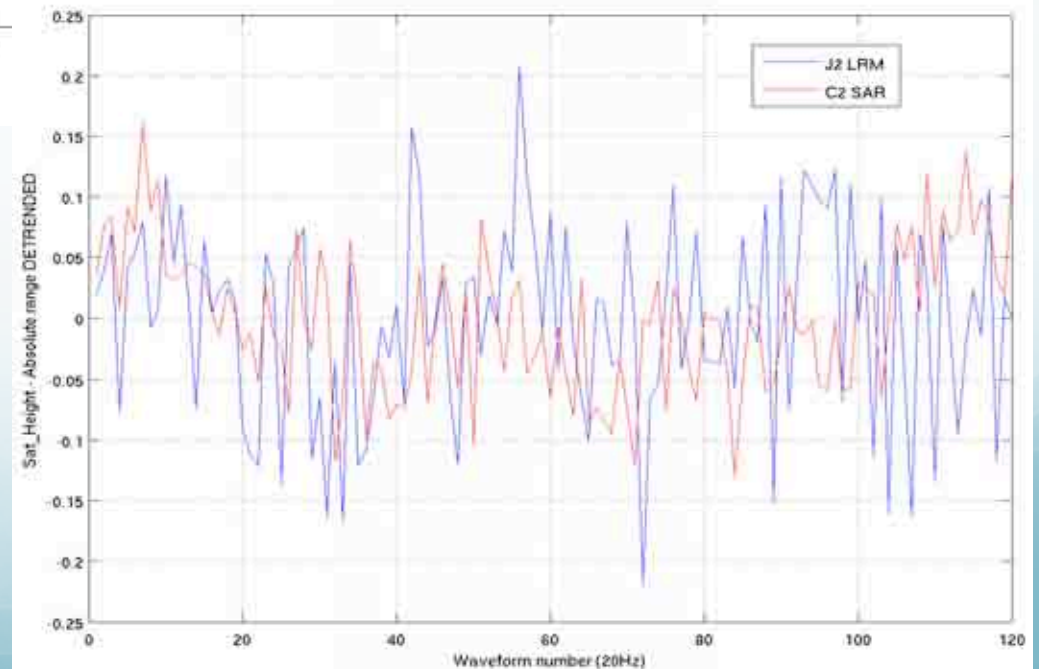
Few C2/J2 collocations in time



Estimating retrieval accuracy



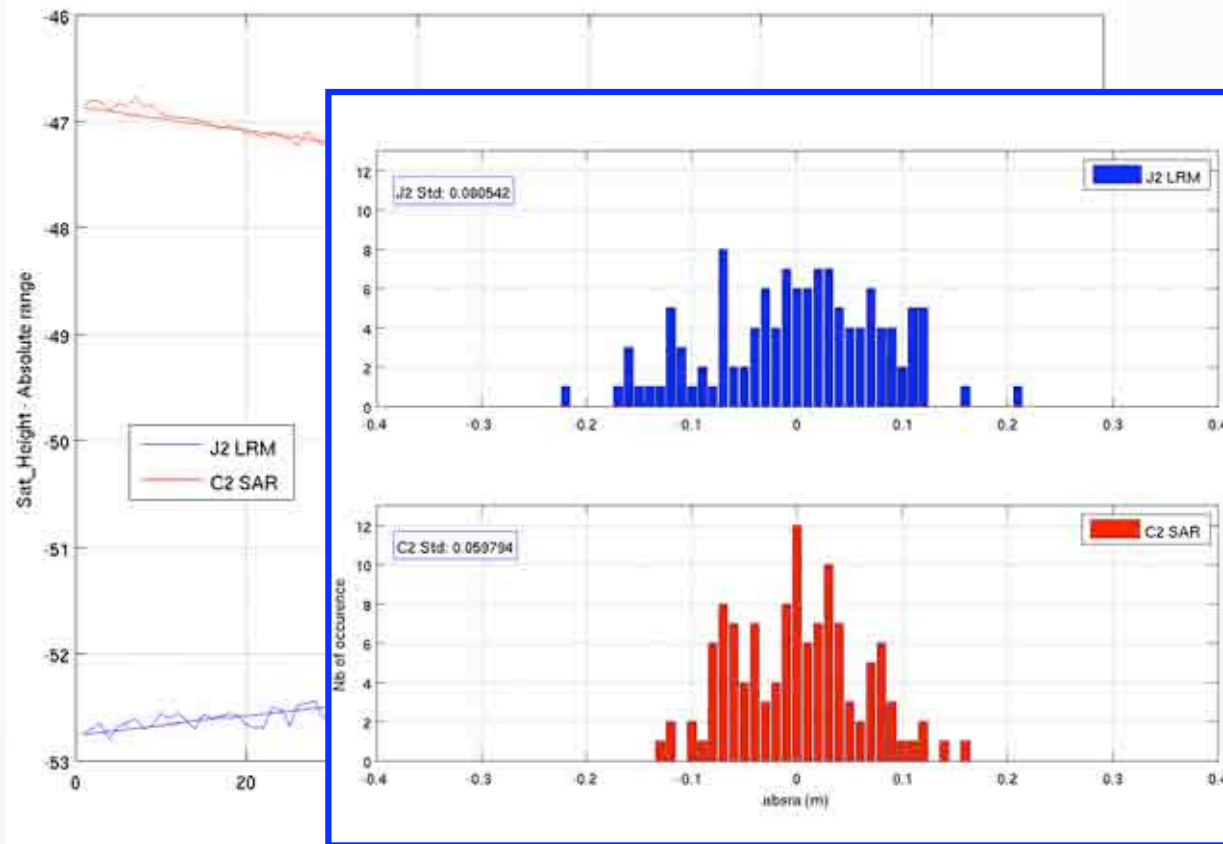
- C2/J2 within 6 hrs
- 6 seconds of data
- De-mean & de-trend



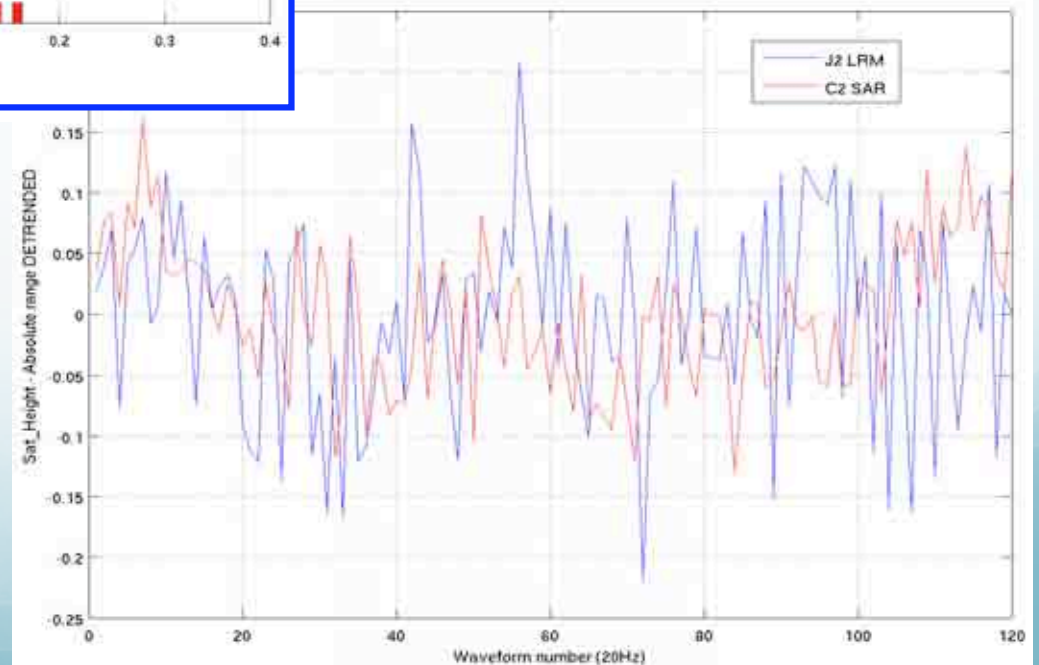
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Estimating retrieval accuracy

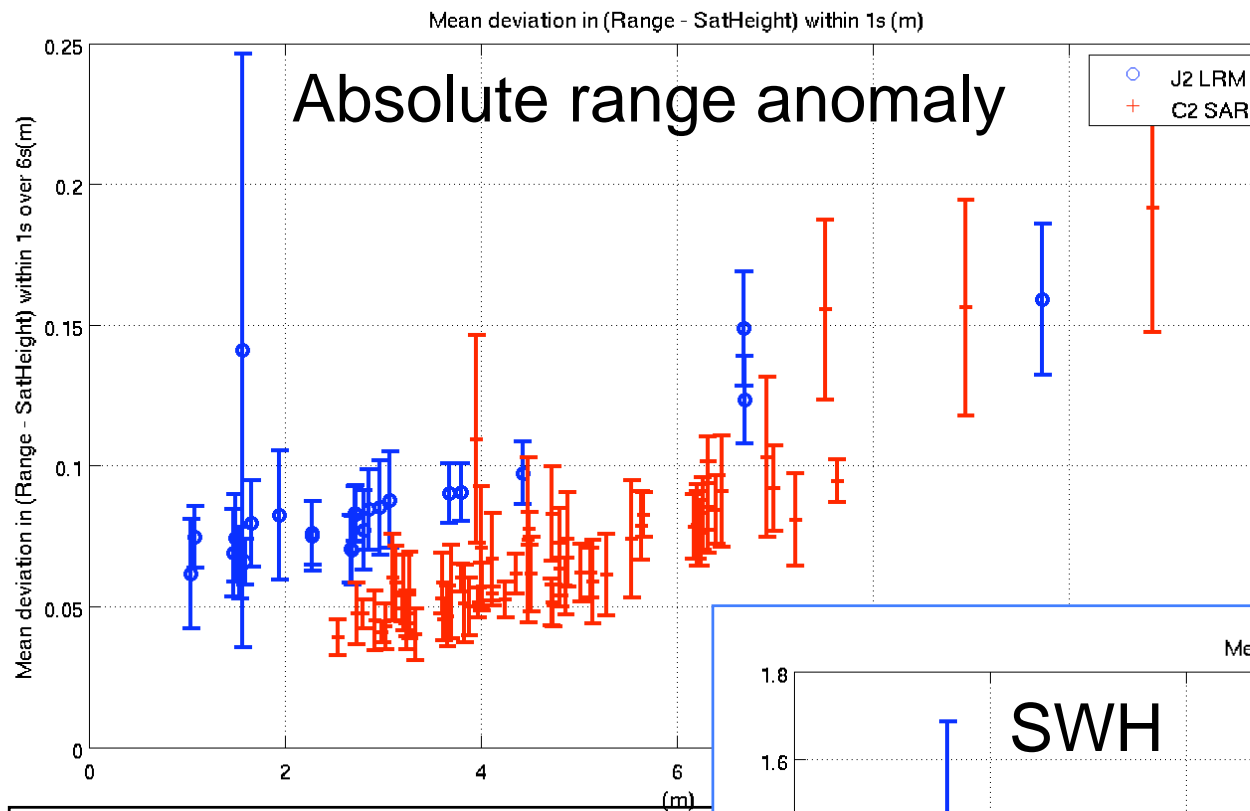


- C2/J2 within 6 hrs
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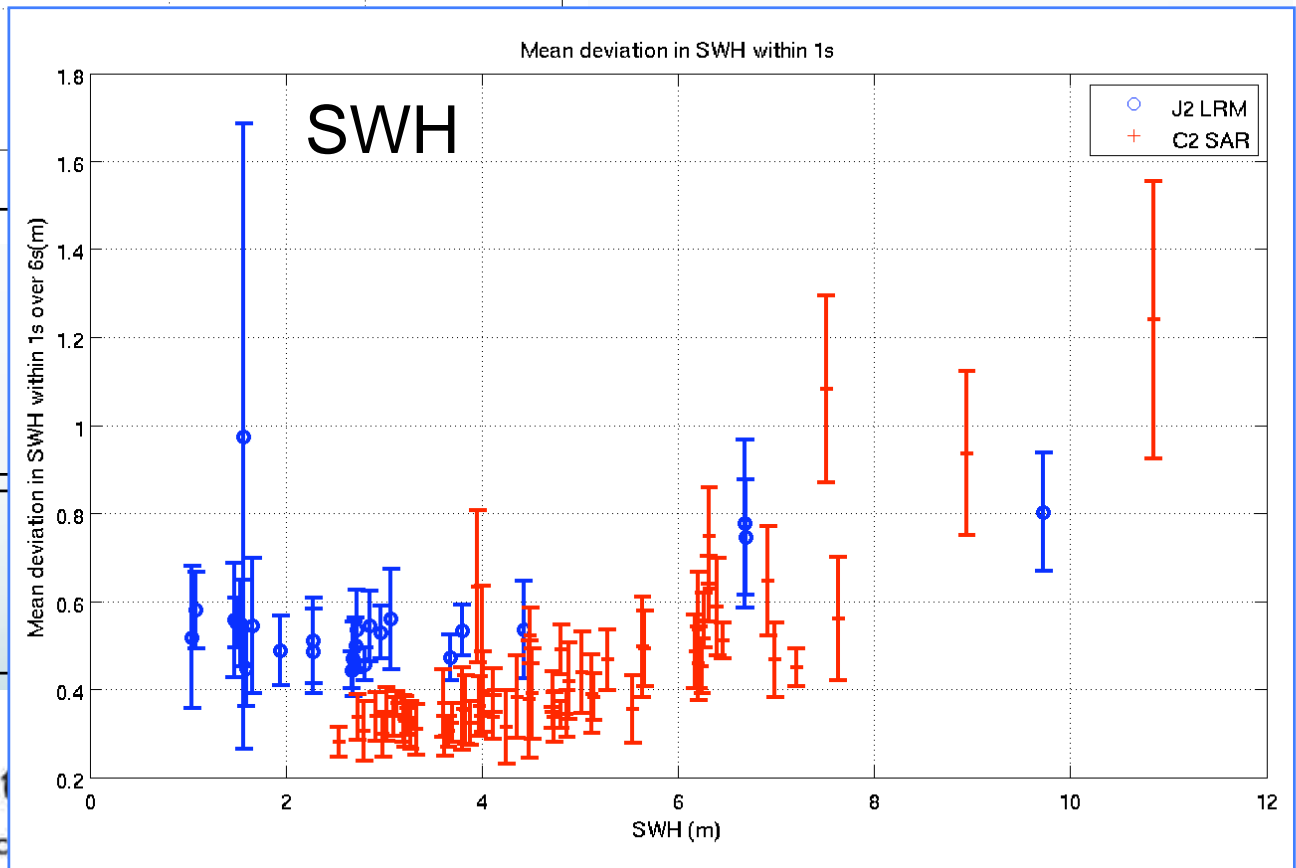


Retrieval
accuracy @
20Hz

For $H_s = 1$ to 7m:

- Jason2 LRM: 7-14 cm
- Cryosat2 SAR: 4-10 cm

- Jason2 LRM: 0.5-0.75 m
- Cryosat2 SAR: 0.3-0.6 m



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Conclusions (1)

- Retrieval performance were obtained for range and SWH in LRM, SAR and pseudo-LRM mode based on simulated LRM and SAR L1B data over open ocean
- Key findings:
 - Range retrieval accuracy improved by factor ~ 2 in SAR mode compared to LRM
 - From the simulated results, SAR SWH retrieval is poorer than in LRM mode
- SAMOSA1 SAR retracker was applied to Cryosat-2 data over various regions and found to give good fit
 - Although SWH may be slightly overestimated



Conclusions (2)

- Range and SWH retrieval accuracy was estimated for Cryosat SAR and Jason2 LRM data
- Range retrieval accuracy for Hs between 1 to 7 m:
 - Jason2 LRM: 7-14 cm Cryosat2 SAR: 4-10 cm
- Cryosat2 data suggest that SAR SWH has similar or slightly better accuracy than LRM
- Retrieved SAR SWH > 2 m with SAMOSA1 extended model
 - Insufficient collocations in time with J2 to validate C2 SAR SWH obtained with SAMOSA1 SAR retracker

