Ocean Surface Topography Science Team Meeting, Chicago, 2019

Assessment of Sentinel-3A and Sentinel-3B Altimeter Data in the Coastal Zone

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NATURAL ENVIRONMENT RESEARCH COUNCIL

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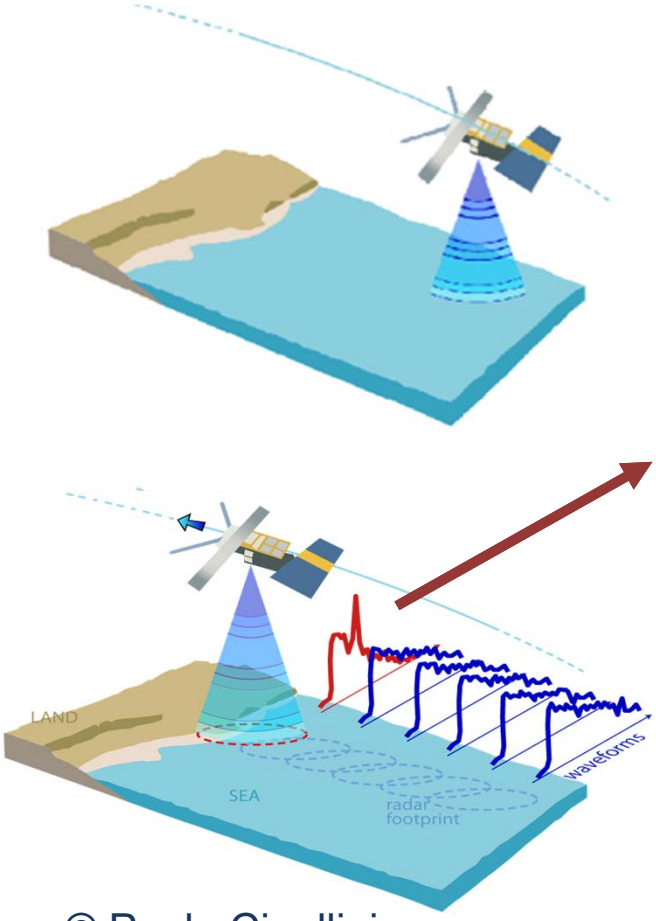
NERC SCIENCE OF THE ENVIRONMENT

Outline

- Altimetry challenges at the coast
  - Sub-waveform retracking (e.g. ALES)
- Performance in the coastal zone & the impact of SSB
  - Jason-3 Low Resolution Mode (LRM)
  - Sentinel-3A Pseudo-LRM and SAR mode
  - Sentinel-3B Pseudo-LRM and SAR mode
- Summary & Conclusions

Altimetry near the Coast: Retracking challenges



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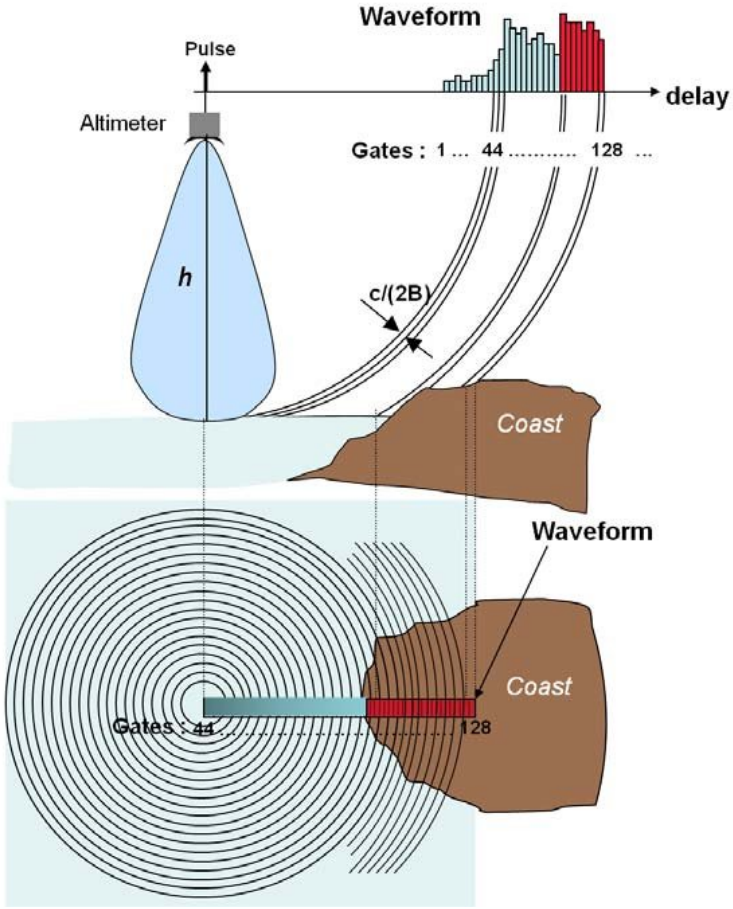
Anomalies in reflected echoes = Large error in fitting of Brown model = data flagged as "bad"

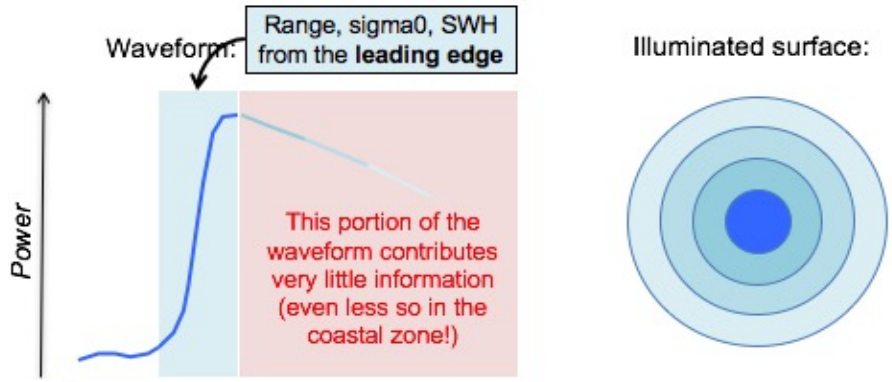


Gommenginger, Thibaut et al., 2011

Altimetry near the Coast: Other challenges

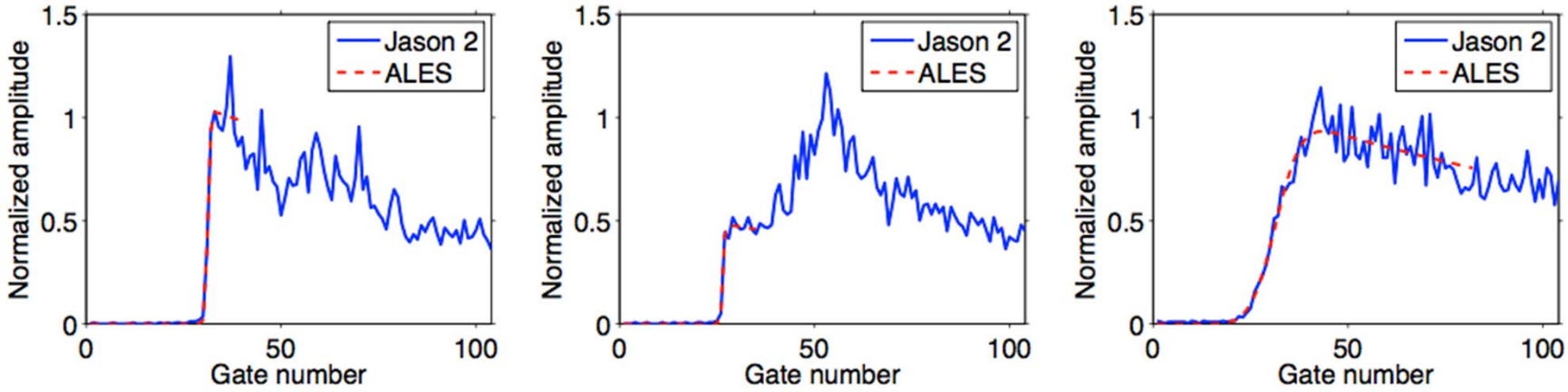
- Range corrections (wet troposphere, ionosphere)
- Geophysical corrections (coastal tide)
- Sea State Bias (SSB) correction
- Mean Sea Surface & Geoid

Sub-Waveform retracking



→ *use only part of the waveform, the one with the leading edge*
Adaptive Leading-Edge Subwaveform (ALES) retracker

ALES: Adaptive Leading-Edge Sub-waveform algorithm



- One algorithm for the coast and the open ocean without losing precision
- ALES improves the quality & quantity of data in the coastal zone

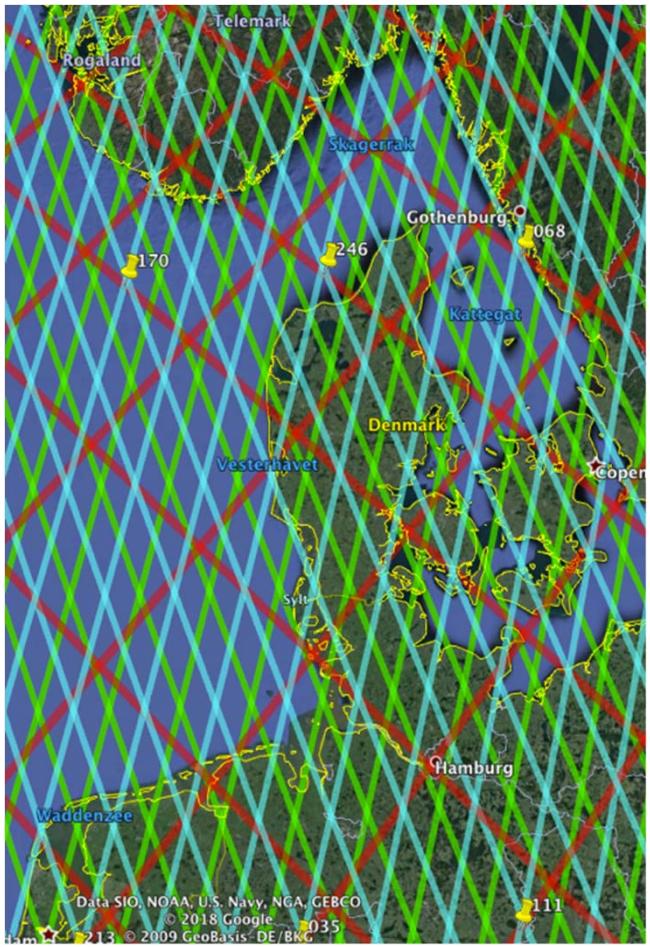
Passaro et al., 2014

NOC ALES

- Updated software implementation, some differences to Monte Carlo setup, different quality control criteria
- Applicable to all conventional Low-Resolution Mode (LRM) and pseudo-LRM (P-LRM) altimeter waveforms
- So far applied to:
  - **Jason-2**
  - **Envisat**
  - **Jason-3**
  - **SARAL/Altika**
  - **Sentinel-3A (PLRM)**
  - **Sentinel-3B (PLRM)**

Jason-3, Sentinel-3A & Sentinel-3B in test region

German Bight/Danish Strait



- Jason-3 (red) 12 Feb 2016 – 21 Feb 2019
  - LRM
- Sentinel-3A (Cyan) 7 Dec 2018 – 16 June 2019
- Sentinel-3B (Green) 17 Dec 2018 – 17 June 2019
  - Pseudo-LRM
  - SAR

German Bight/Danish: Jason-3

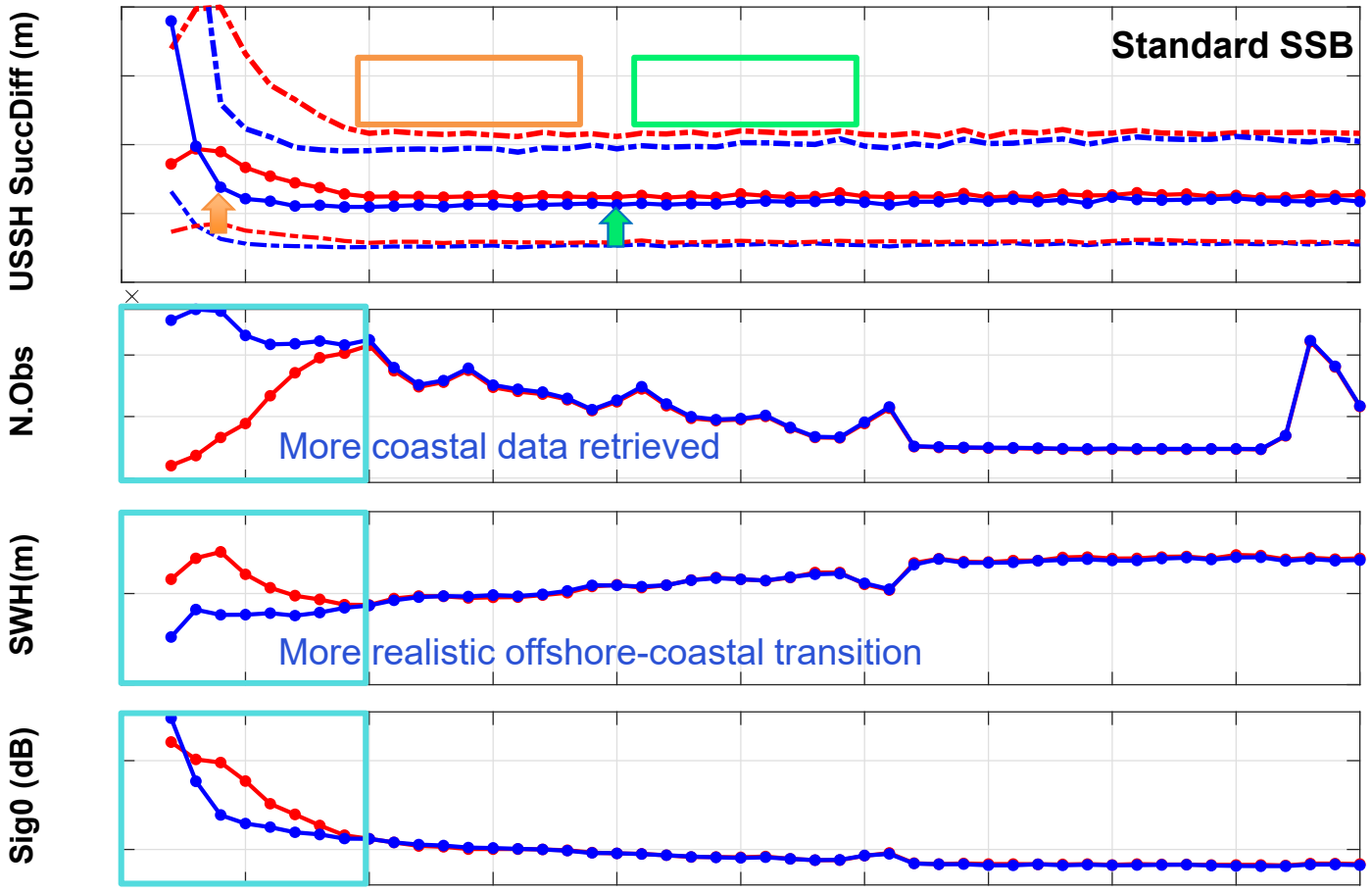
SGDR LRM

ALES LRM

With Sea State Bias correction applied

SSB ALES: Jason-2 Tran'2012 with **20Hz** ALES Hs & U10 input

SSB SGDR: Jason-2 Tran'2012 with **1Hz** SSB interpolated to 20Hz

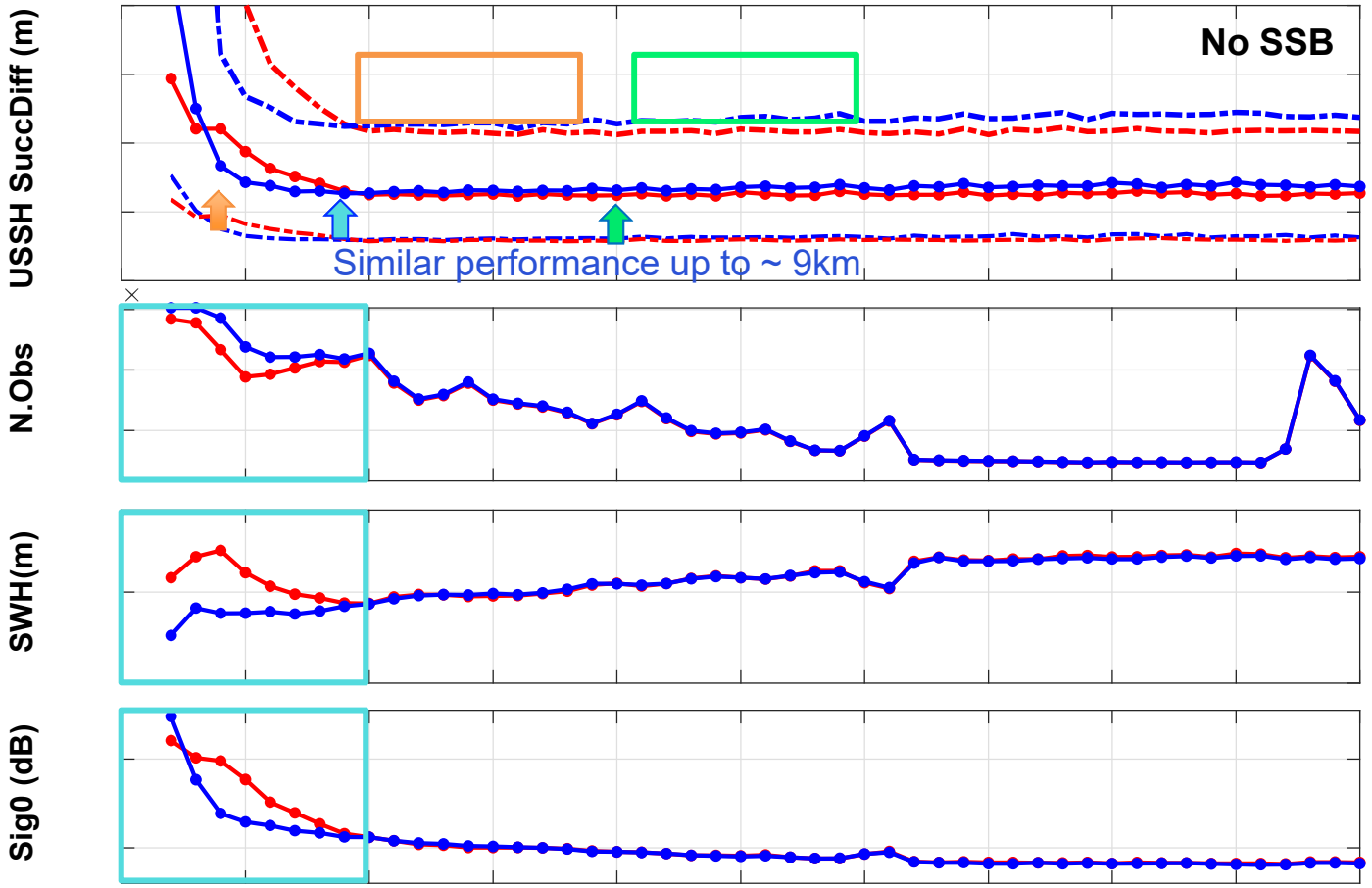


German Bight/Danish: Jason-3

SGDR LRM

ALES LRM

No Sea State Bias correction applied



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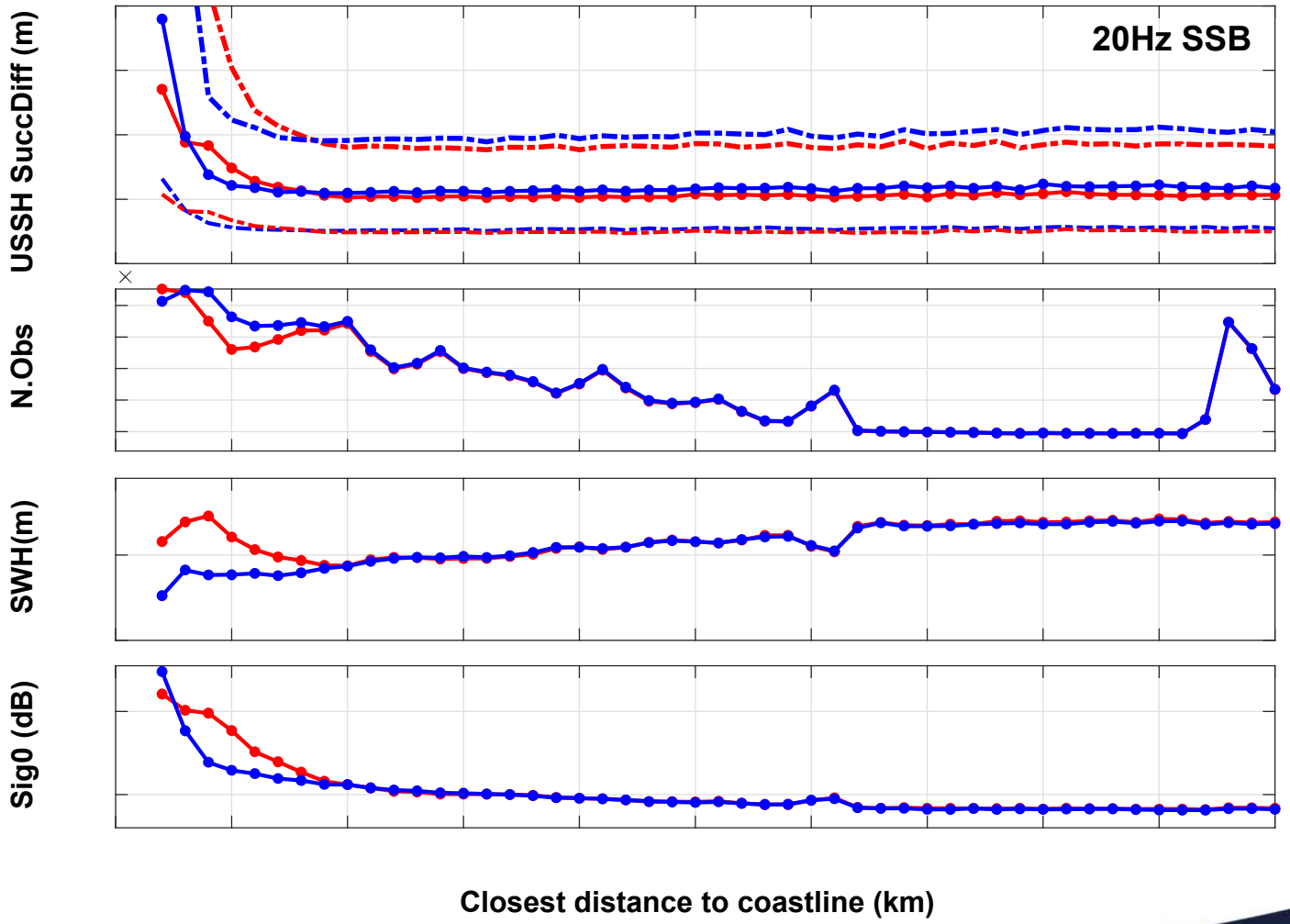
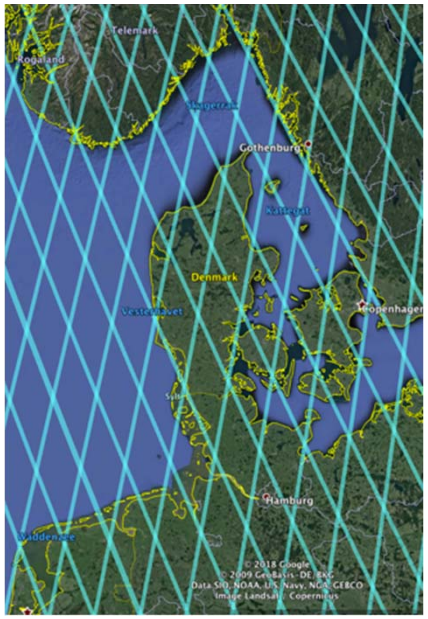


German Bight/Danish: Sentinel-3A PLRM



SGDR PLRM

ALES PLRM

With Sea State Bias correction applied

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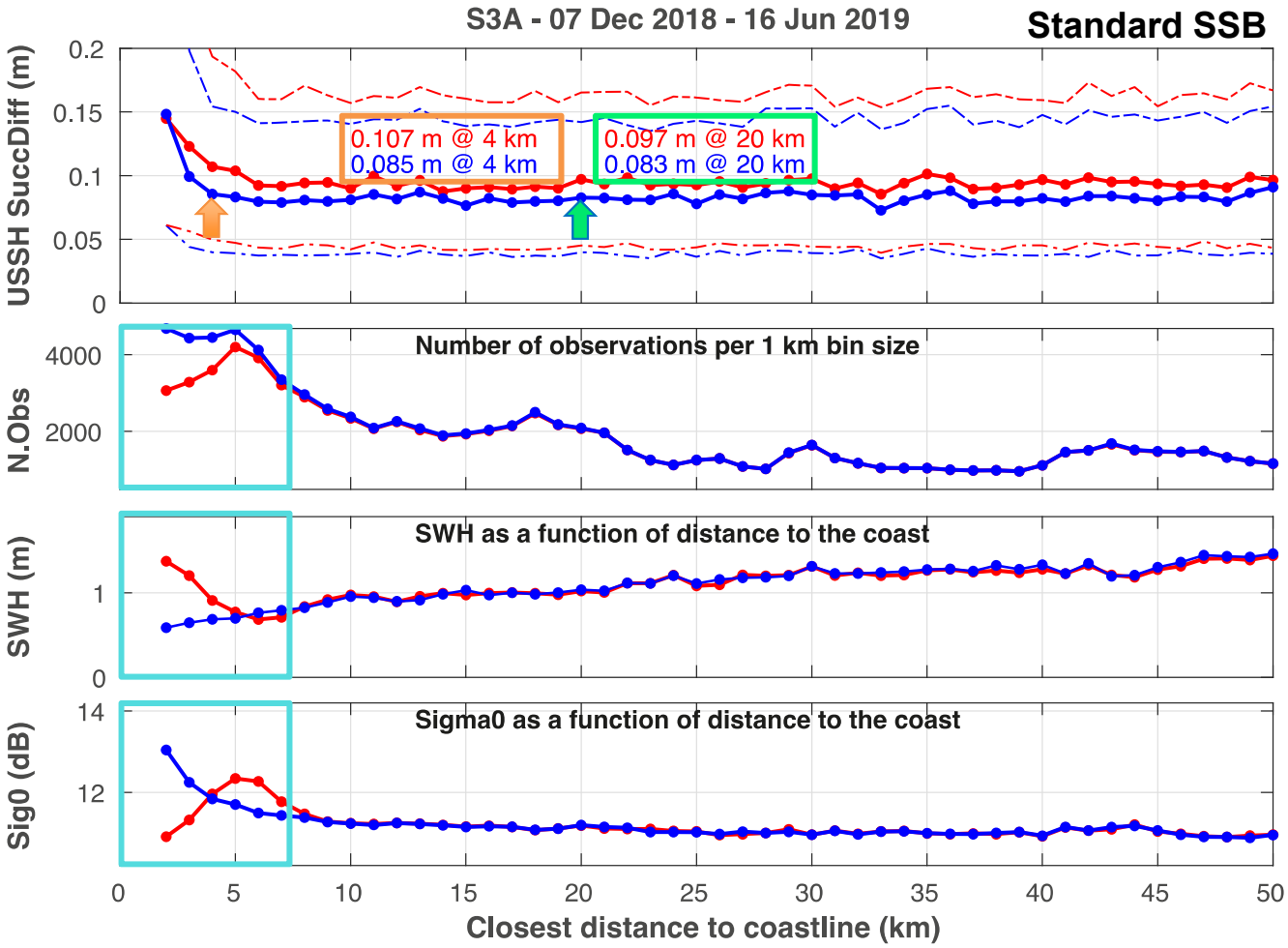

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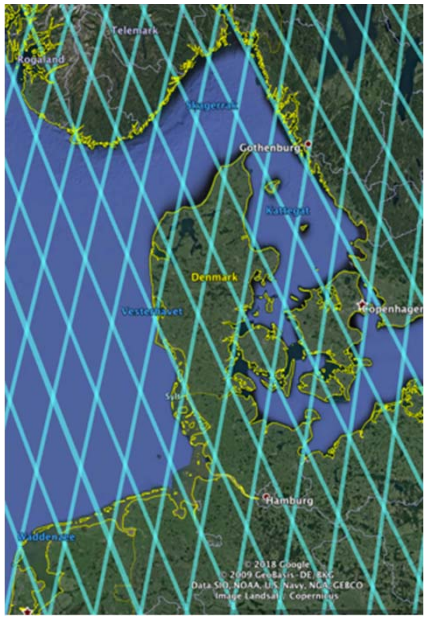
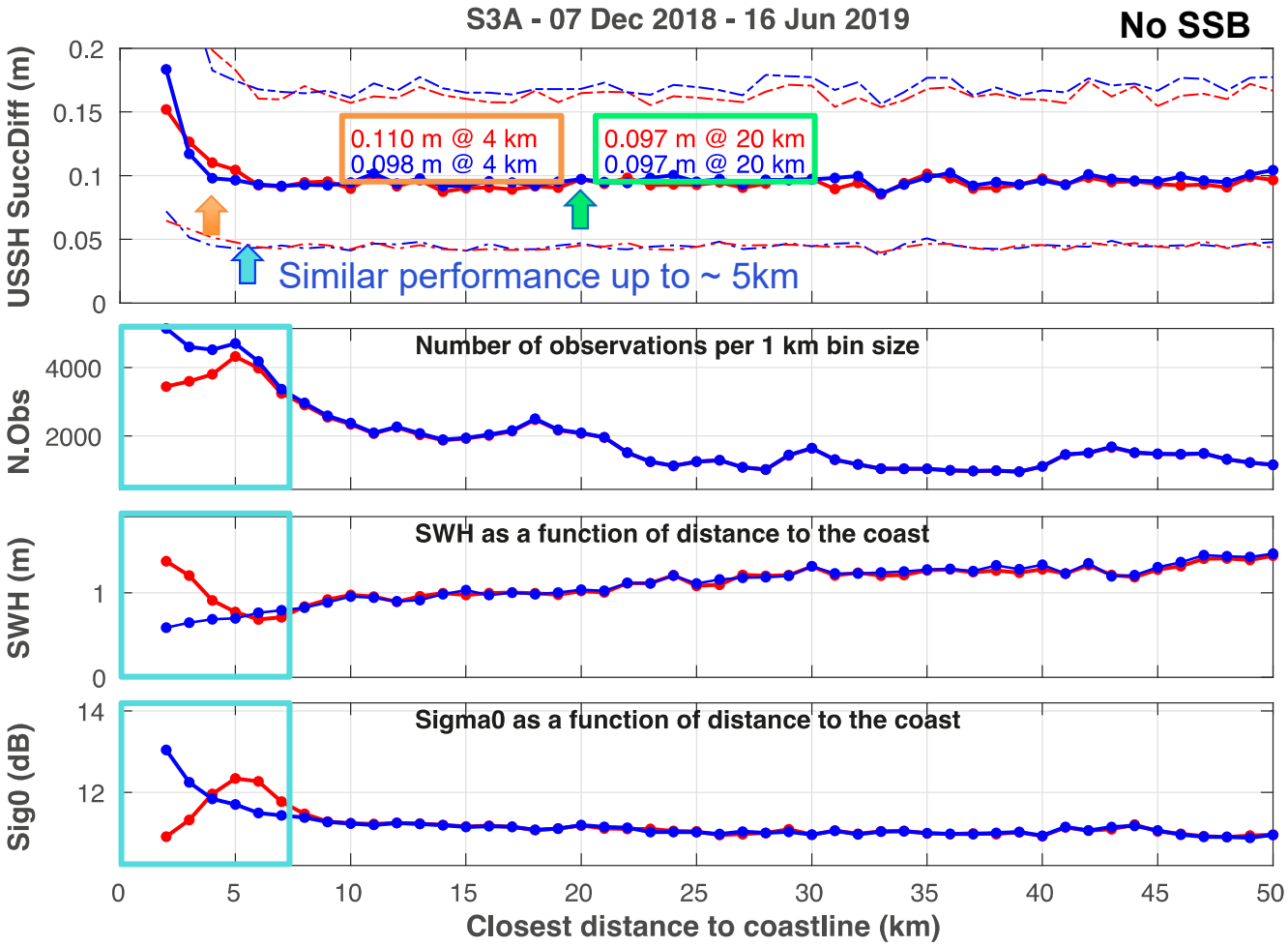


SGDR PLRM

ALES PLRM

No Sea State Bias correction applied



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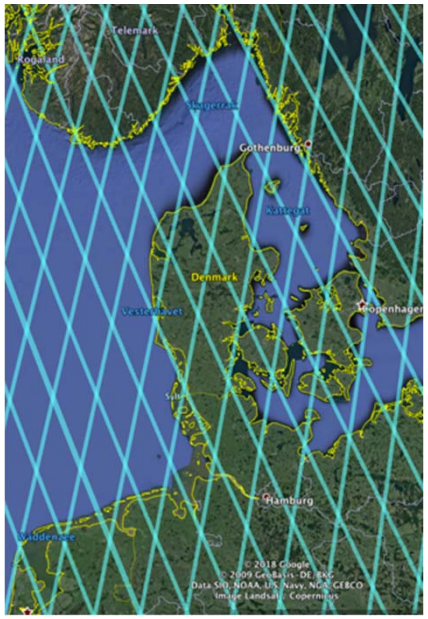


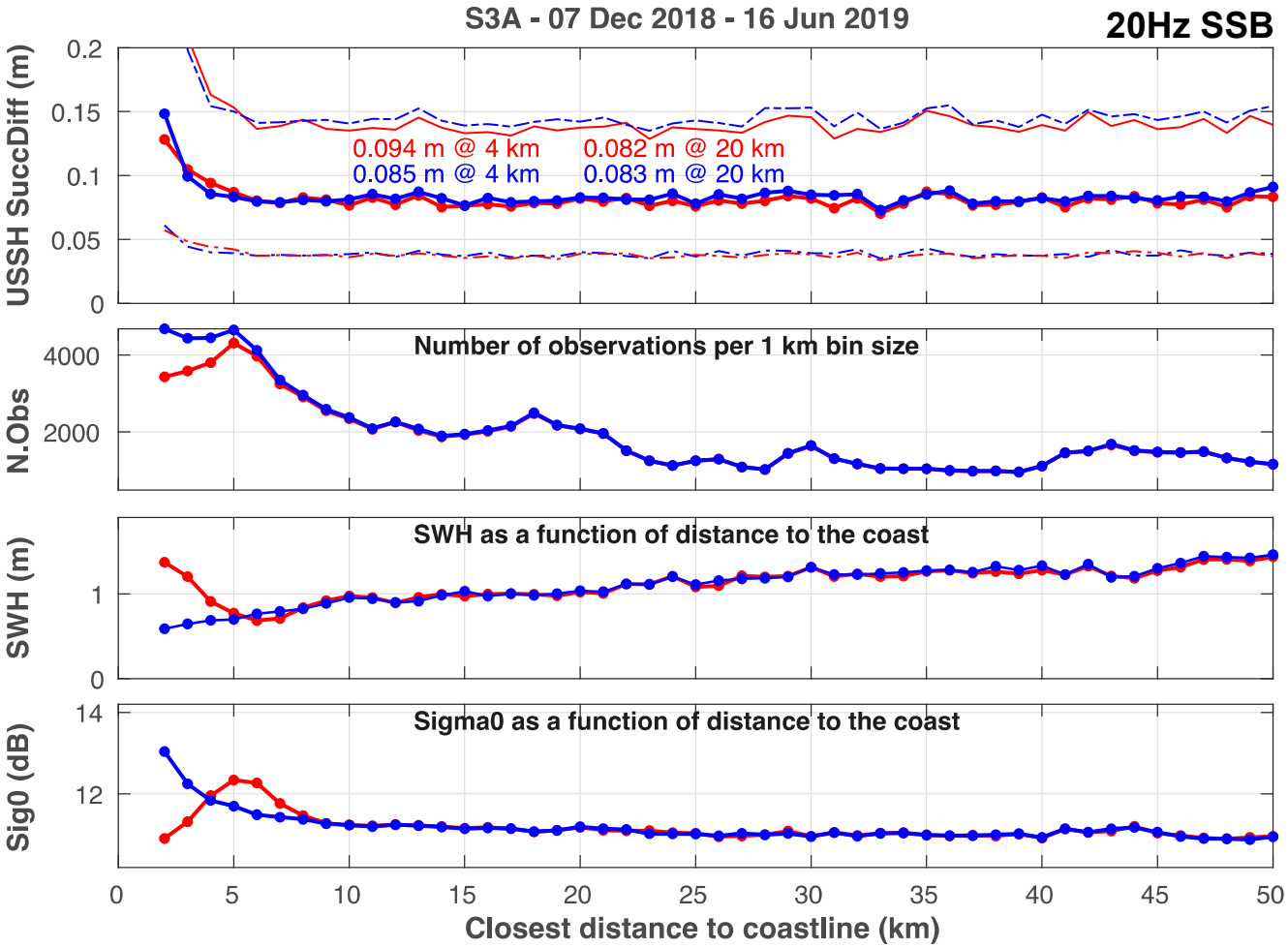
SGDR PLRM

ALES PLRM

With Sea State Bias correction applied

SSB ALES: Jason-2 Tran'2012 with **20Hz** ALES Hs & U10 input

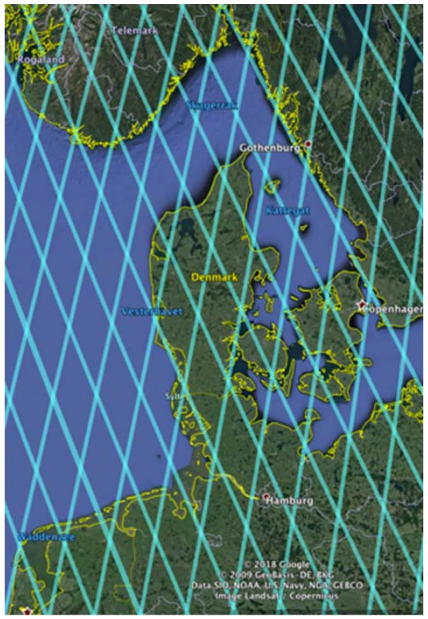
SSB SGDR: Jason-2 Tran'2012 with **20Hz** SGDR Hs & U10 input



Summary LRM/PLRM: USSH noise at 4 km & 20 km

	4km		20km	
Jason-3	**LRM SGDR**	**LRM ALES**	**LRM SGDR**	**LRM ALES**
No SSB			0.062	0.066
SSB 1Hz			0.062	-
SSB 20Hz			0.051	0.056
Sentinel-3A			**PLRM SGDR**	**PLRM ALES**
No SSB			0.097	0.097
SSB 1Hz			0.097	-
SSB 20Hz			0.082	0.083
Sentinel3-B			**PLRM SGDR**	**PLRM ALES**
No SSB			0.096	0.096
SSB 1Hz			0.097	-
SSB 20Hz			0.083	0.083

German Bight/Danish: Sentinel-3A SAR

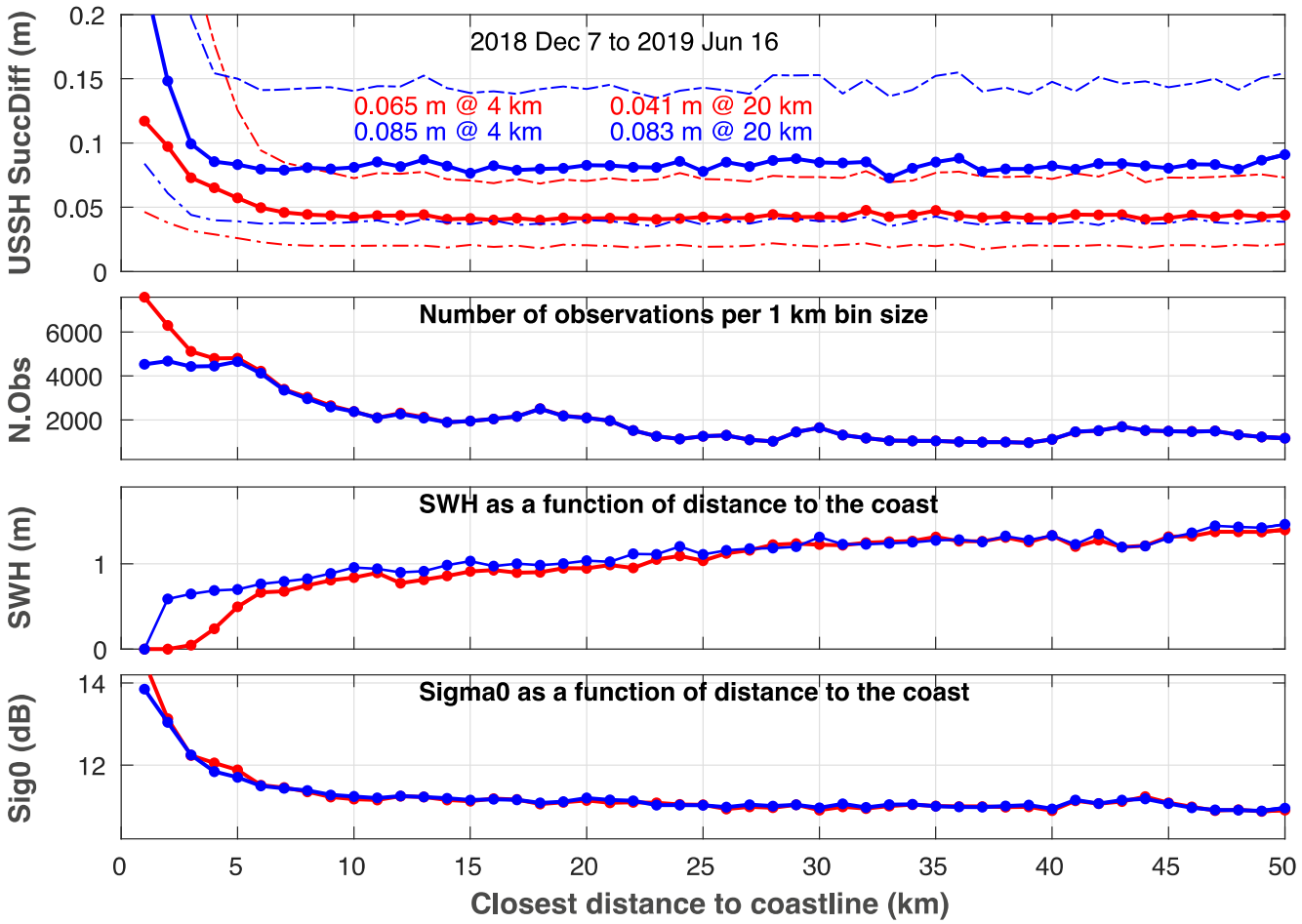


SGDR SAR ALES PLRM

With Sea State Bias correction applied

SSB ALES: Jason-2 Tran'2012 with **20Hz** ALES Hs & U10 input

SSB SGDR: CNES empirical Jason-2 GDR-C **1Hz** SSB interpolated to 20Hz



Summary LRM/SAR: USSH noise at 4 km & 20 km

	4km		20km	
Jason-3	**LRM SGDR**	**LRM ALES**	**LRM SGDR**	**LRM ALES**
No SSB	0.110	0.084	0.062	0.066
SSB 1Hz	0.095	-	0.062	-
SSB 20Hz	0.092	0.069	0.051	0.056
Sentinel-3A	**SAR SGDR**	**PLRM ALES**	**SAR SGDR**	**PLRM ALES**
No SSB	0.065	0.098	0.042	0.097
SSB 1Hz	0.065	-	0.041	-
SSB 20Hz	0.061	0.085	0.039	0.083
Sentinel3-B	**SAR SGDR**	**PLRM ALES**	**SAR SGDR**	**PLRM ALES**
No SSB	0.053	0.094	0.041	0.096
SSB 1Hz	0.053	-	0.041	-
SSB 20Hz	0.050	0.084	0.038	0.083

Summary

- Dedicated coastal sub-waveform retracking (ALES) brings a range of benefits for Jason-3 LRM and Sentinel-3A and Sentinel-3B P-LRM
  - Increased number of valid data in coastal zone
  - More realistic transition of wave and wind from offshore to nearshore
  - Reduced range noise
  - Better correlation with in situ (not shown)
- ALES range noise reduction in open ocean comes mainly from applying SSB at 20Hz!
  - 20Hz SSB also improves range noise for SGDR LRM and SGDR PLRM
  - But 20Hz SSB benefits for SAR noise are much less pronounced
  - Reasons for this impact on LRM/PLRM is currently not clear
- S3 SGDR SAR shows significant better performance in coastal zone
  - compared to S3 P-LRM and Jason-3 LRM
  - even compared to ALES!
  - But sub-waveform approach could have benefits for SAR in last 1-2 km (not shown)

THANK YOU

Contact: chris.banks@noc.ac.uk or nayoub@noc.ac.uk

How does ALES Work?

Step-1

Estimating the leading-edge, initial estimate of SWH

SWH

Width of the sub-waveform is defined in ALES based on SWH (relationship from Monte Carlo simulations)

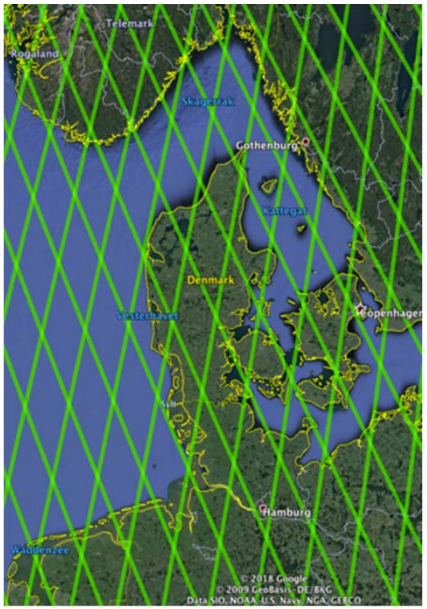
Step-2

Re-tracking the sub-waveform (Brown Model)

Range, SWH, Sigma0

- Analyses repeated for S3B PLRM
  - plots not shown here

German Bight/Danish: Sentinel-3B



SGDR PLRM

ALES PLRM

With Sea State Bias correction applied

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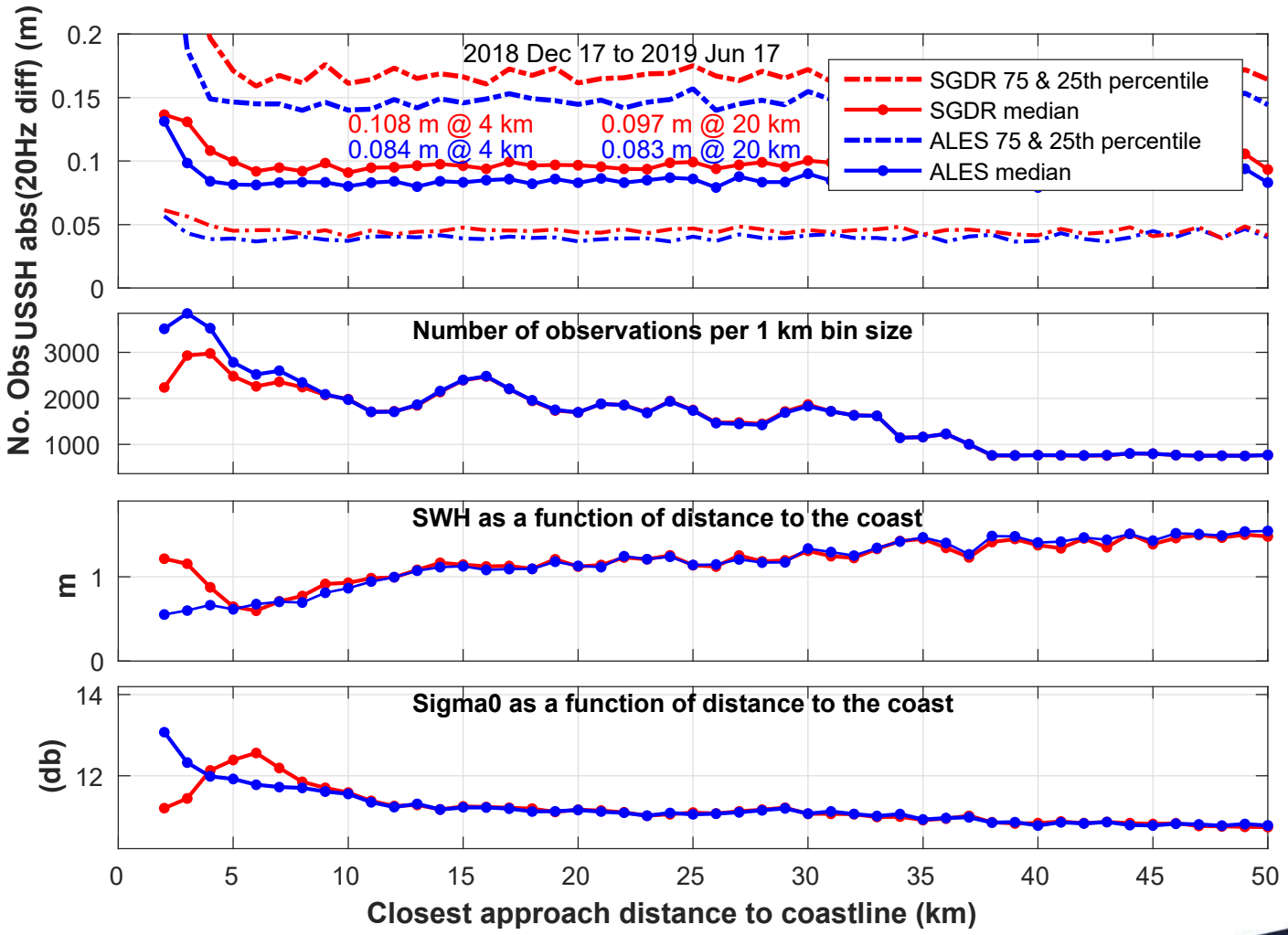
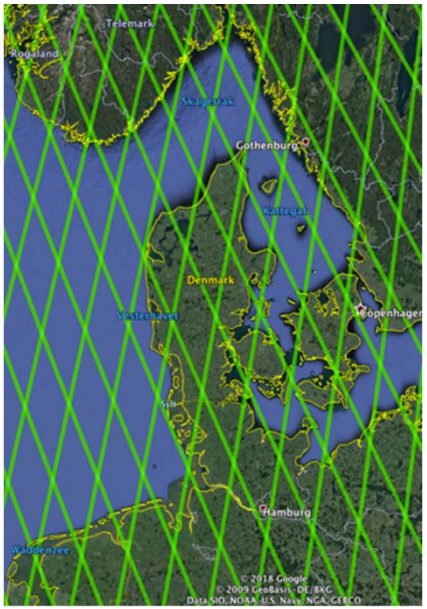


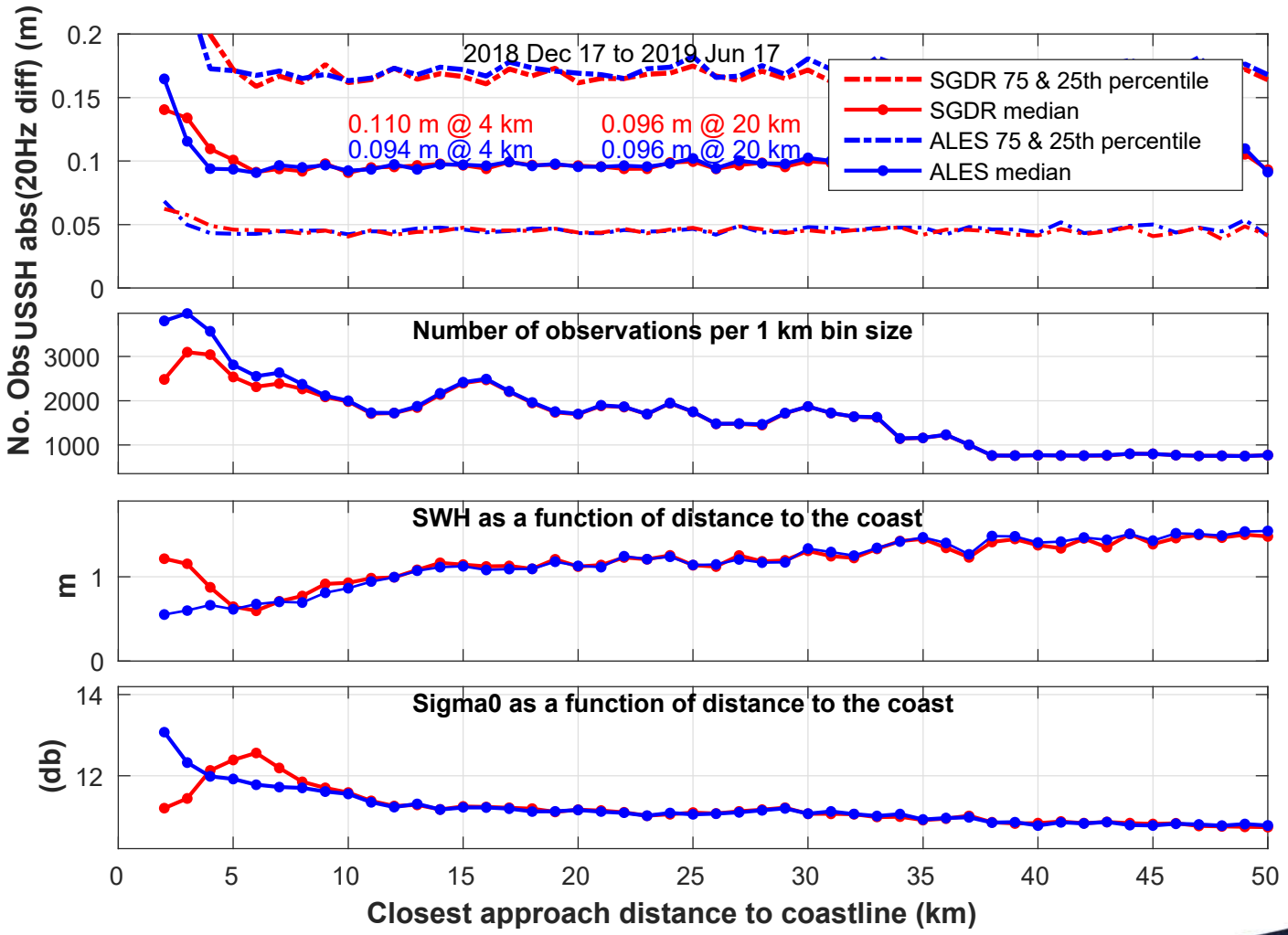
German Bight/Danish: Sentinel-3B



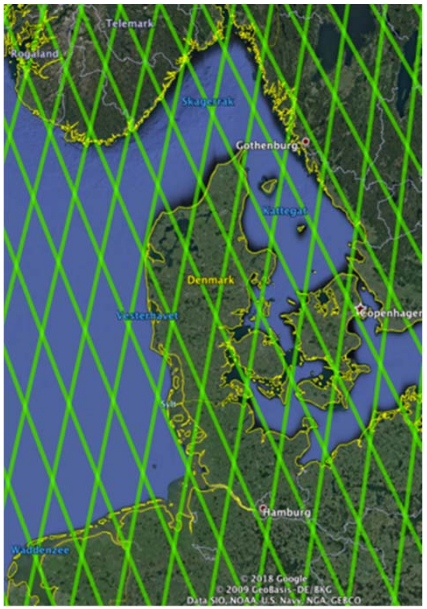
SGDR PLRM

ALES PLRM

No Sea State Bias correction applied



German Bight/Danish: Sentinel-3B



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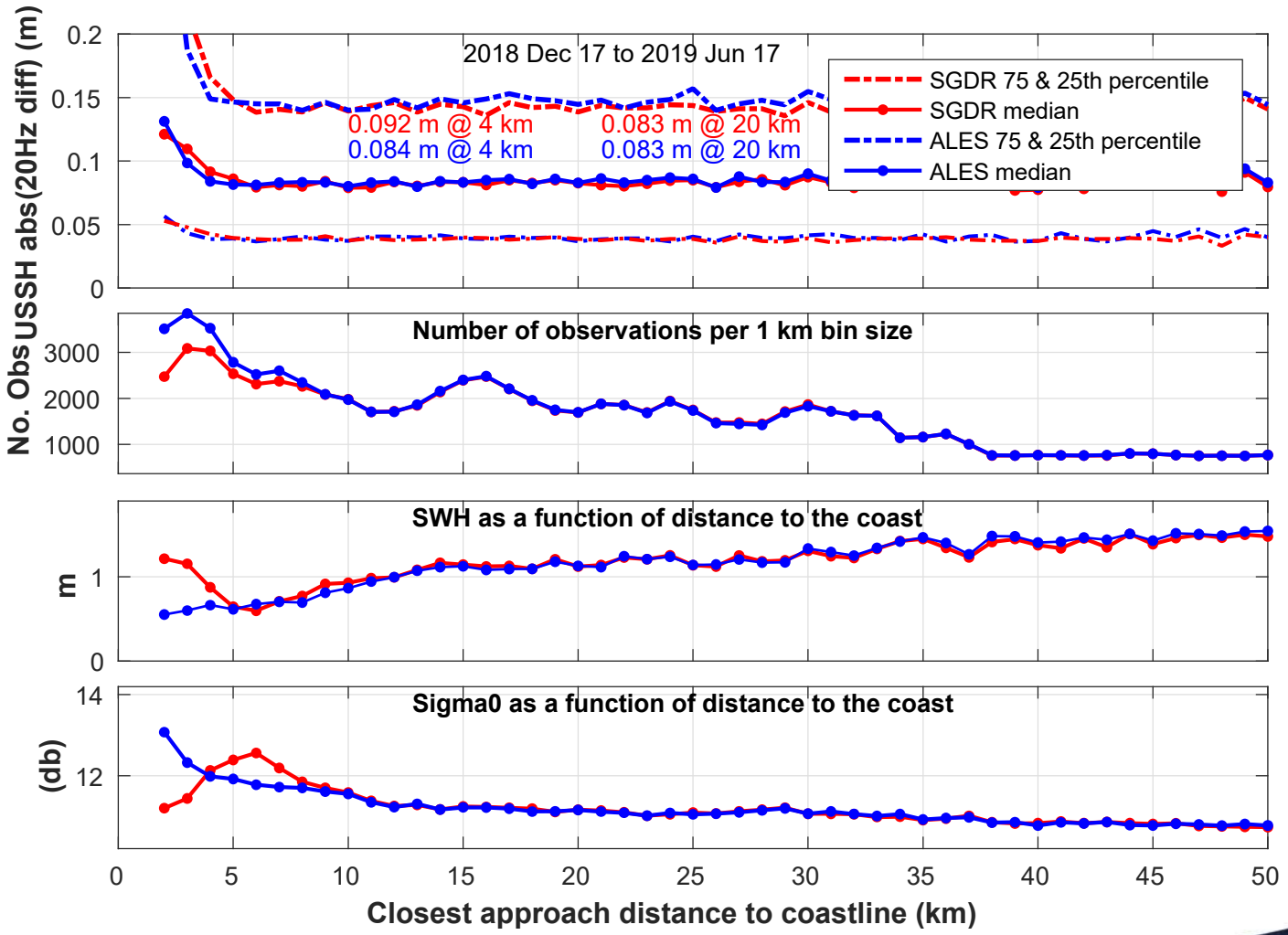
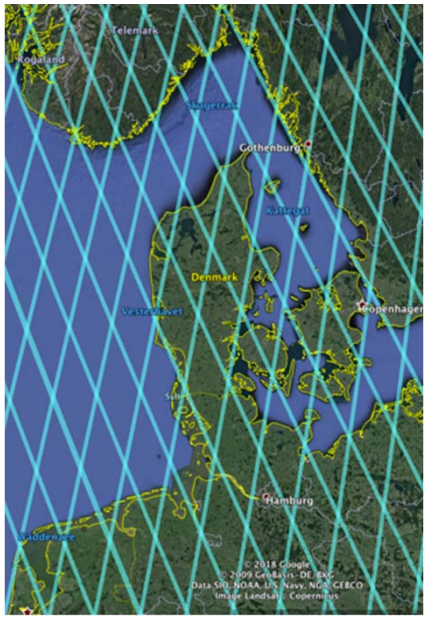


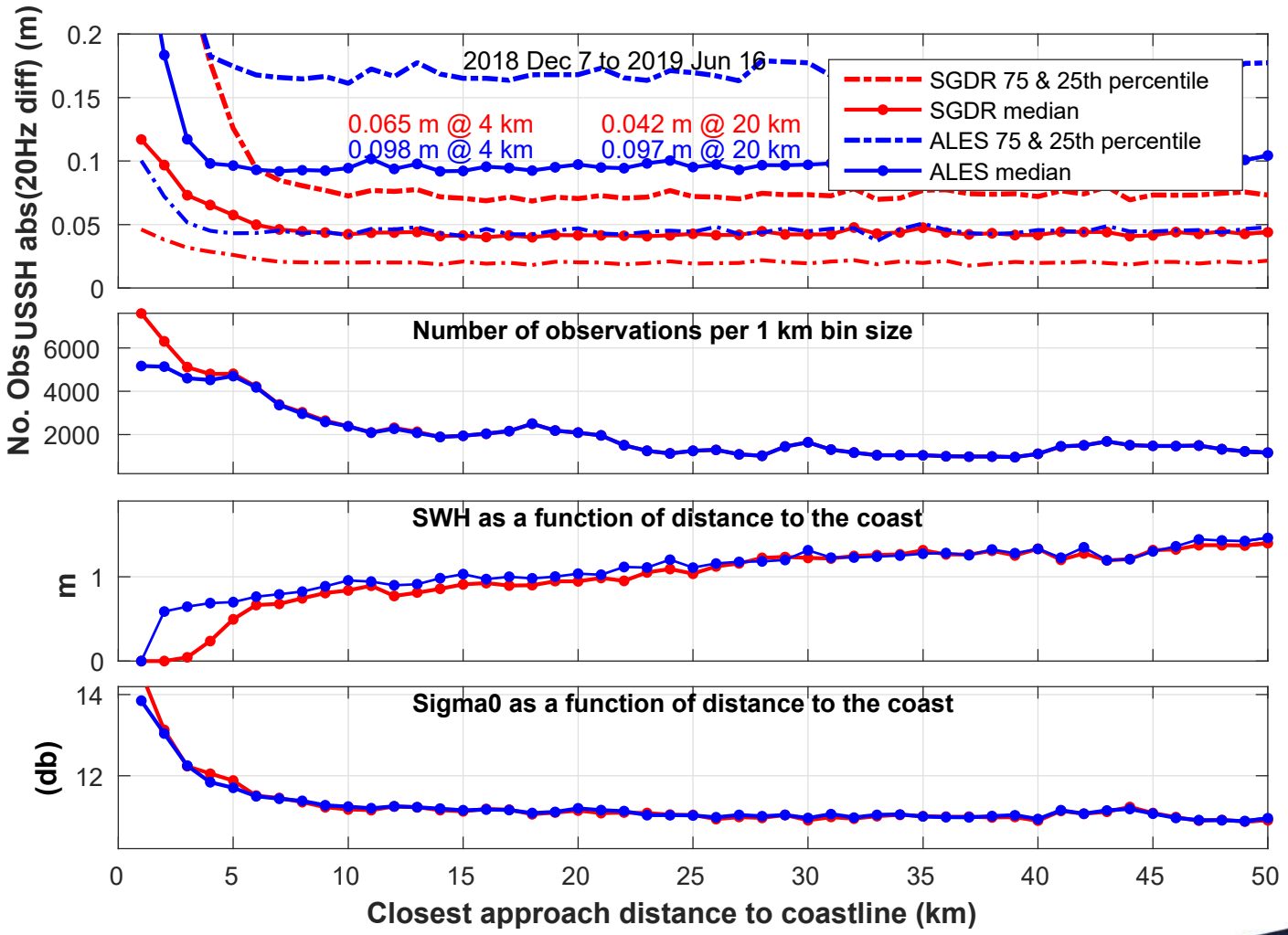


German Bight/Danish: Sentinel-3A

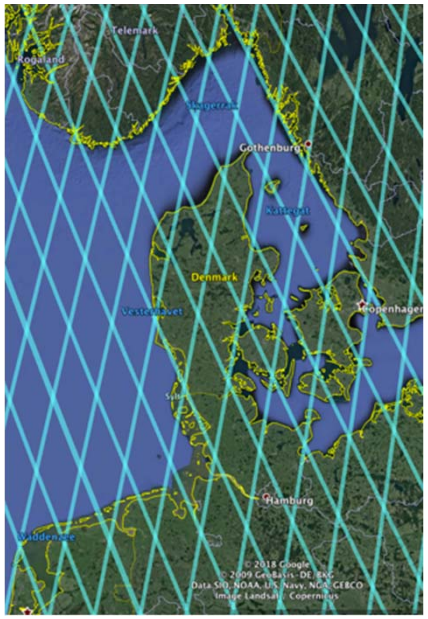
SGDR SAR

ALES PLRM

No Sea State Bias correction applied



German Bight/Danish: Sentinel-3A



SGDR SAR
ALES PLRM

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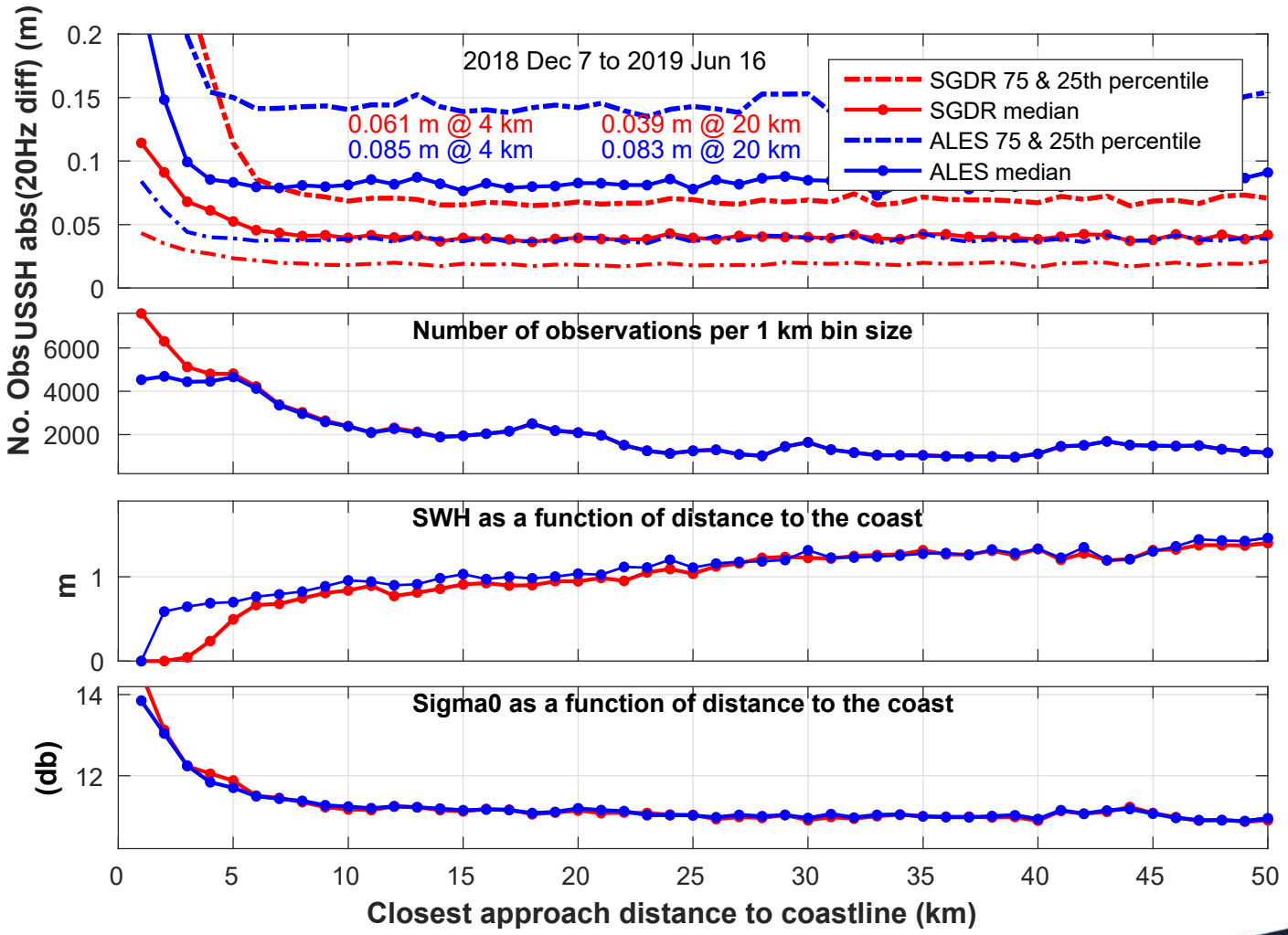

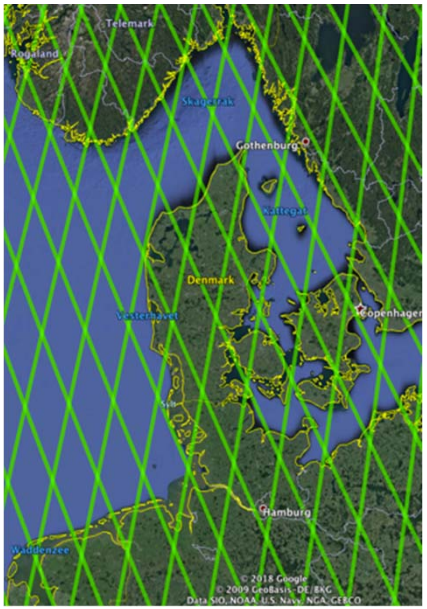

German Bight/Danish: Sentinel-3B

SGDR SAR

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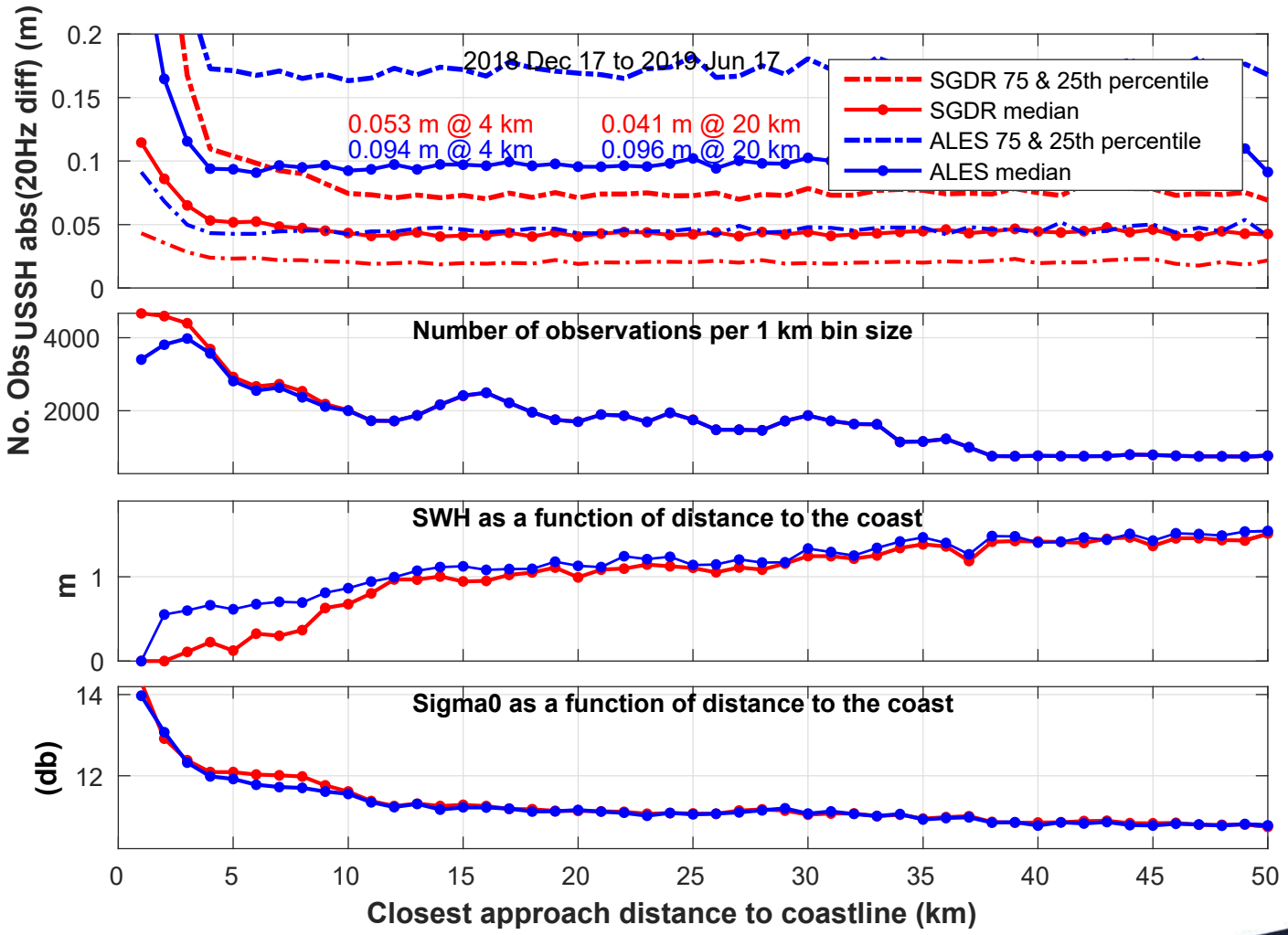

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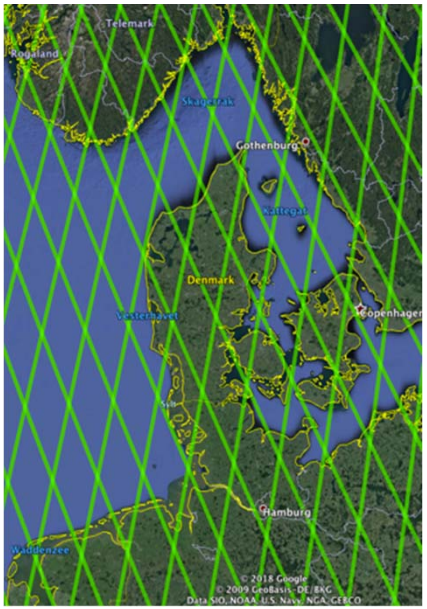

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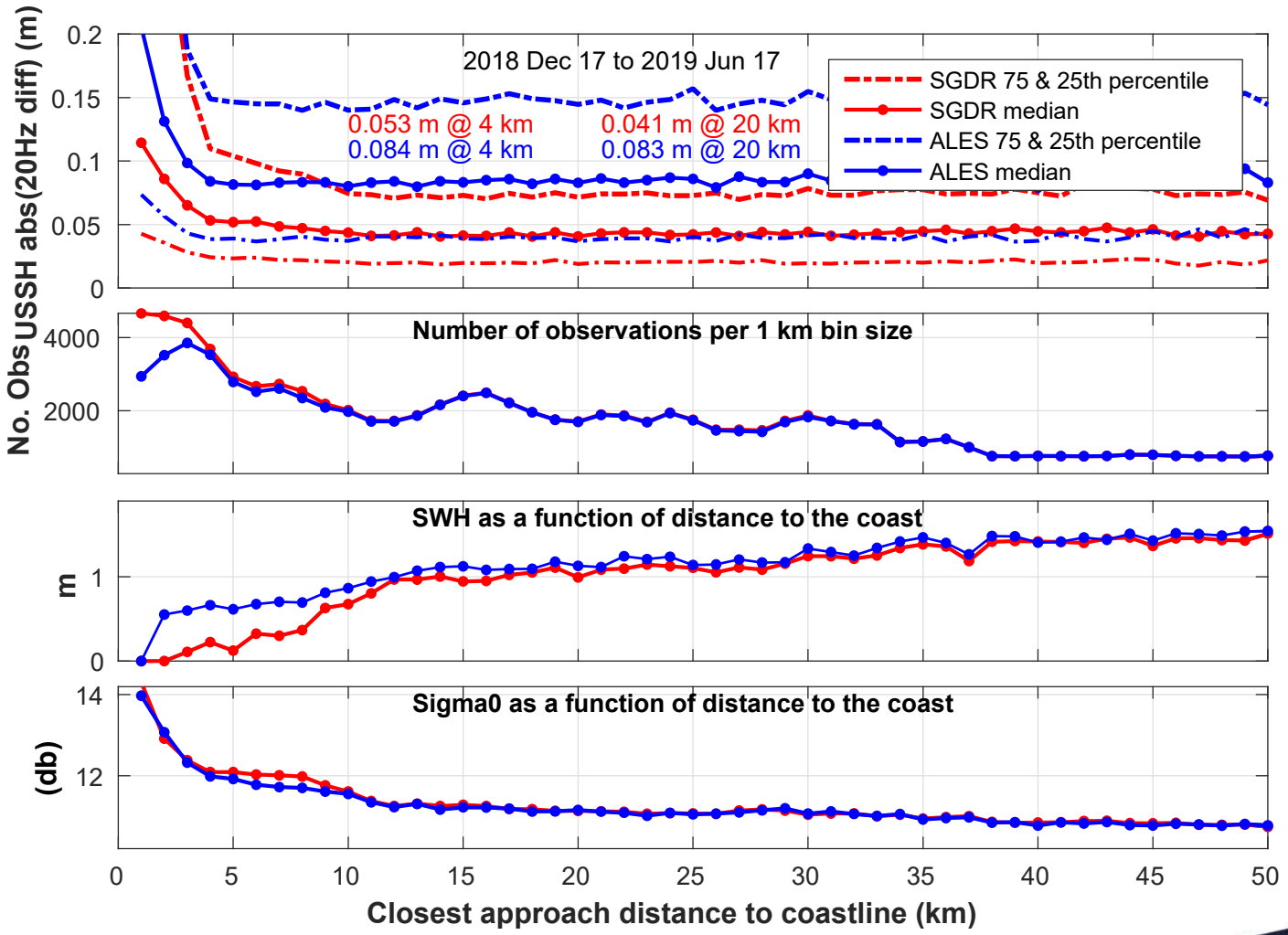

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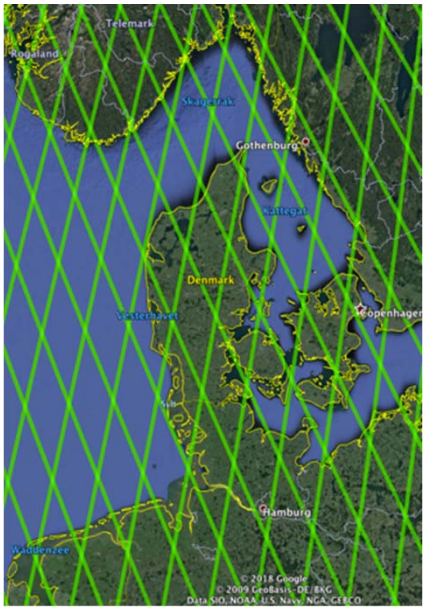

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