Deutsches Geodätisches Forschungsinstitut (DGFI-TUM)
Technische Universität München

Exploring Cryosat-2 stack data for nadir-lead detection in sea-ice regions

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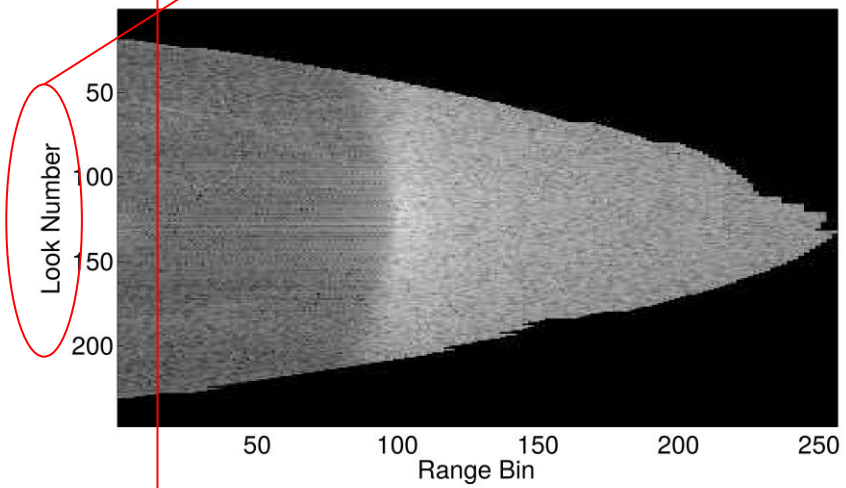
Objective and content

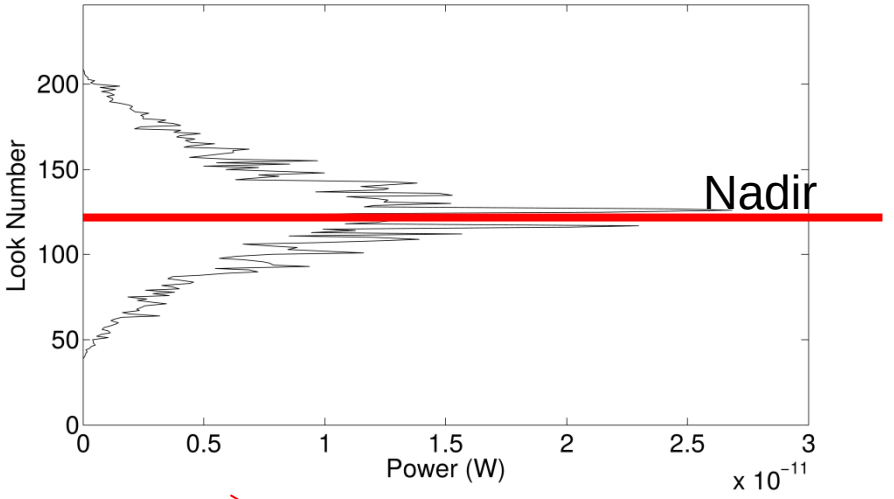
OBJECTIVE: Isolate leads in order to improve sea level records in sea-ice covered regions

- CS-2 full stack information
- A new parameter: the stack peakiness (SP)
- Visual Analysis against Sentinel-1 SAR
- Quantitative Analysis against Sentinel-1 SAR
- Maximum power as lead classifier?
- Conclusions

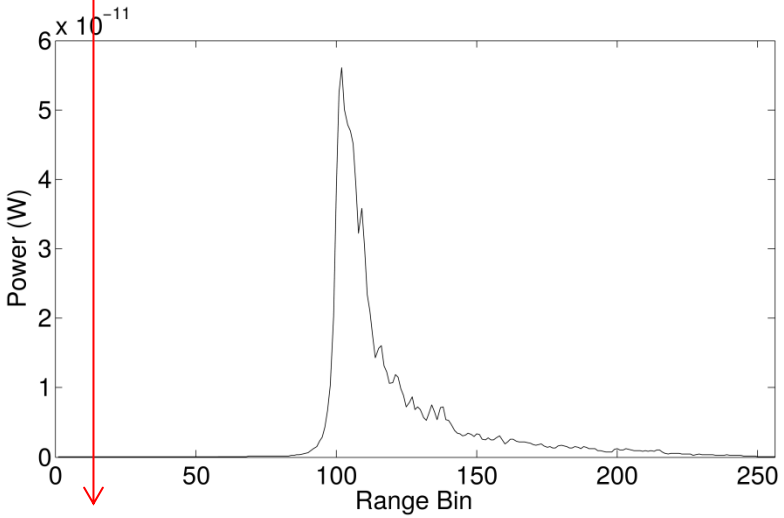
CS-2 full stack information

Illuminated area seen at different look angles





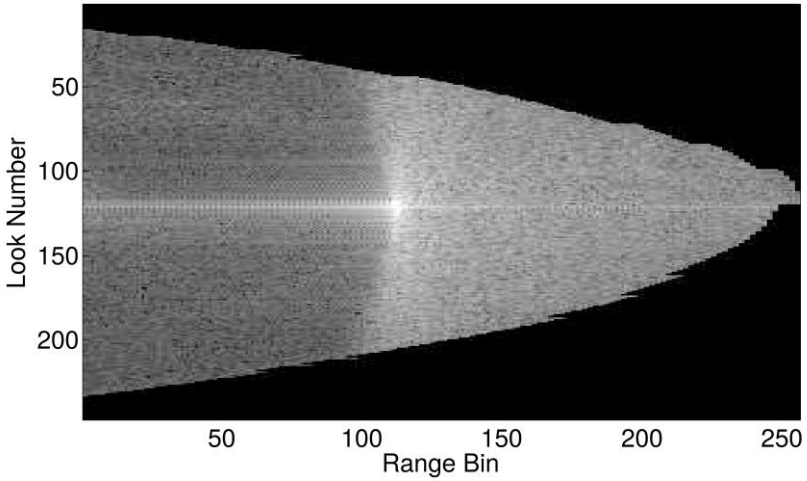
SUM -> Range Integrated Power

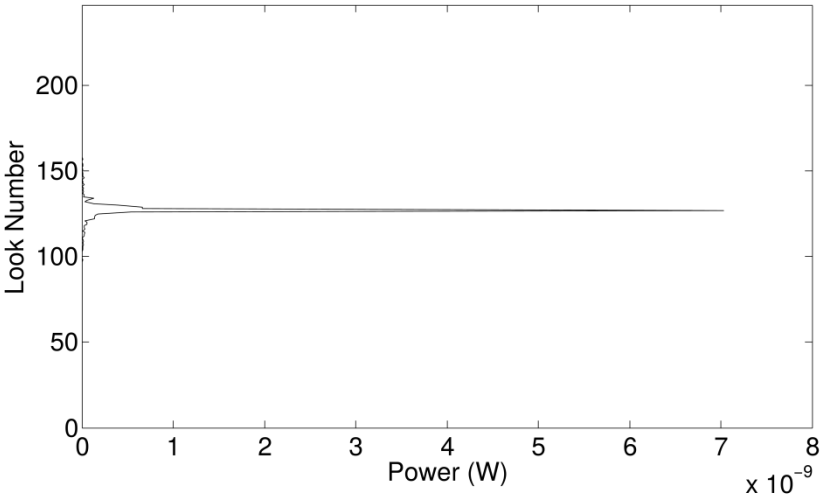


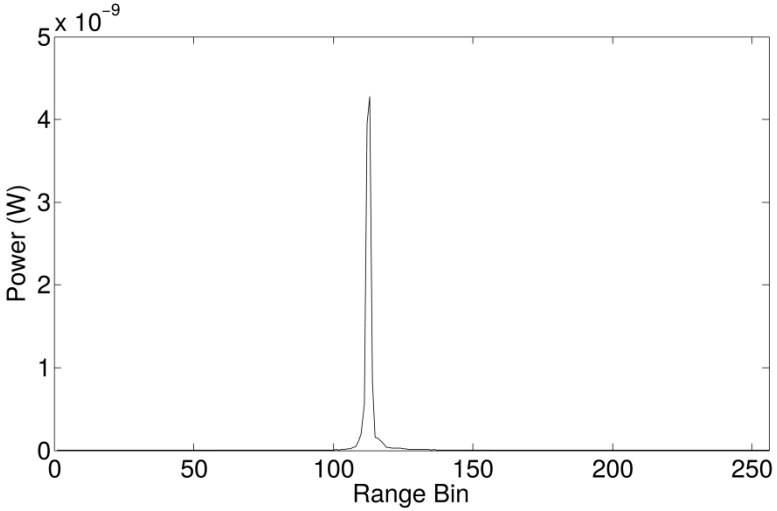
SUM -> Multi-looked waveform

ICE = diffuse backscattering

CS-2 full stack information







Lead = specular backscattering

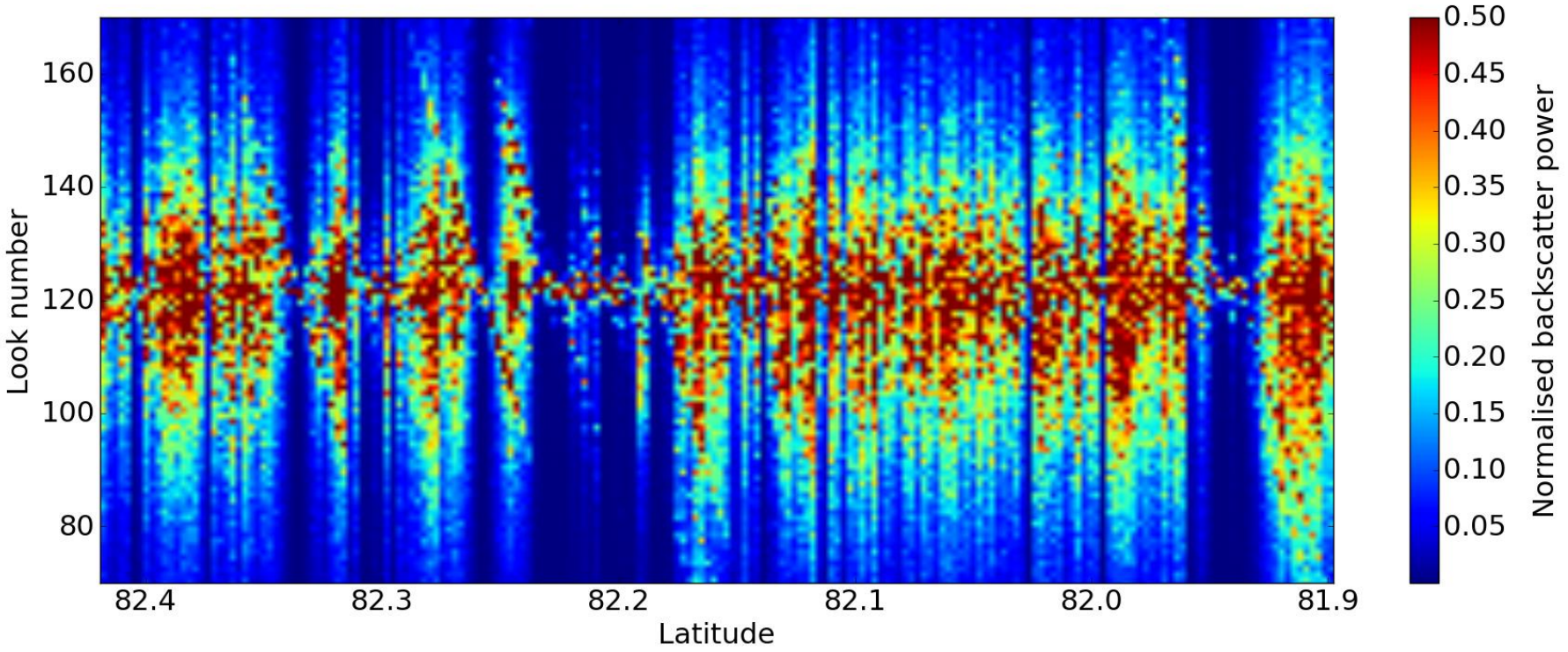
CS-2 full stack information

Previous CS-2 Exploitation:

- Ricker et al. : 6 indeces (Stack Standard Deviation, Stack Kurtosis + Waveform Right and Left Peakiness)

- Wernecke et al.: threshold on backscattered power

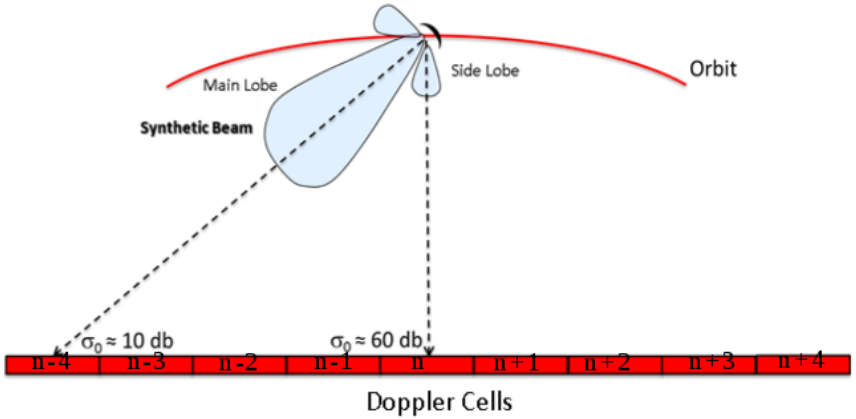
Stack data available from GPOD http://gpod.esa.int. Example: stack radargram over sea ice

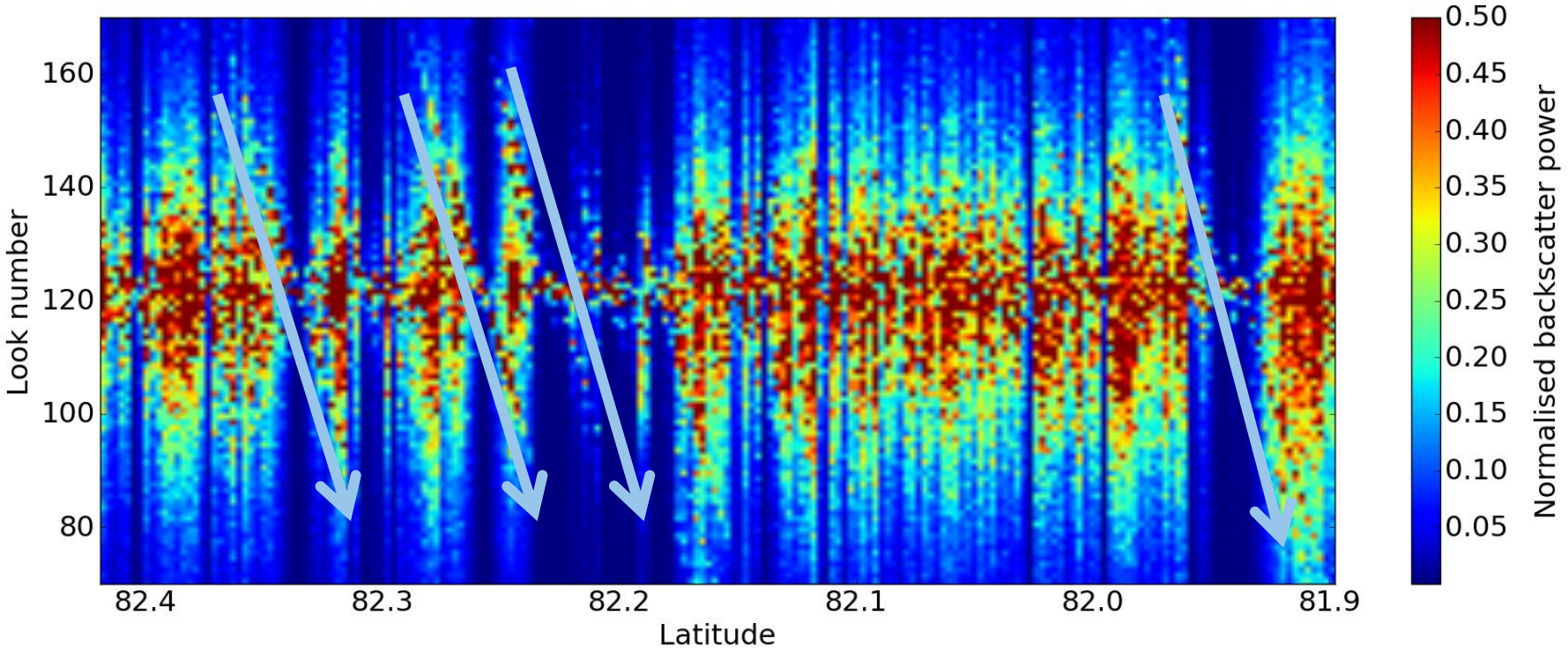


CS-2 full stack information

´Lead stripes´ due to side-lobe effect:

APPLY HAMMING WINDOW





CS-2 full stack information

´Lead stripes´ due to side-lobe effect:

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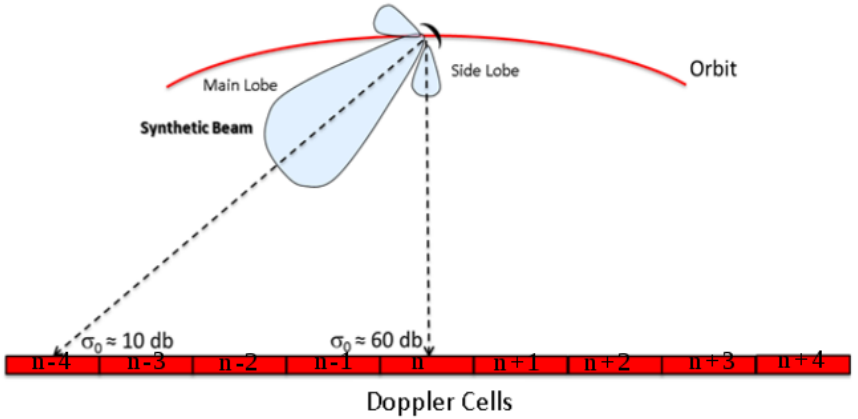
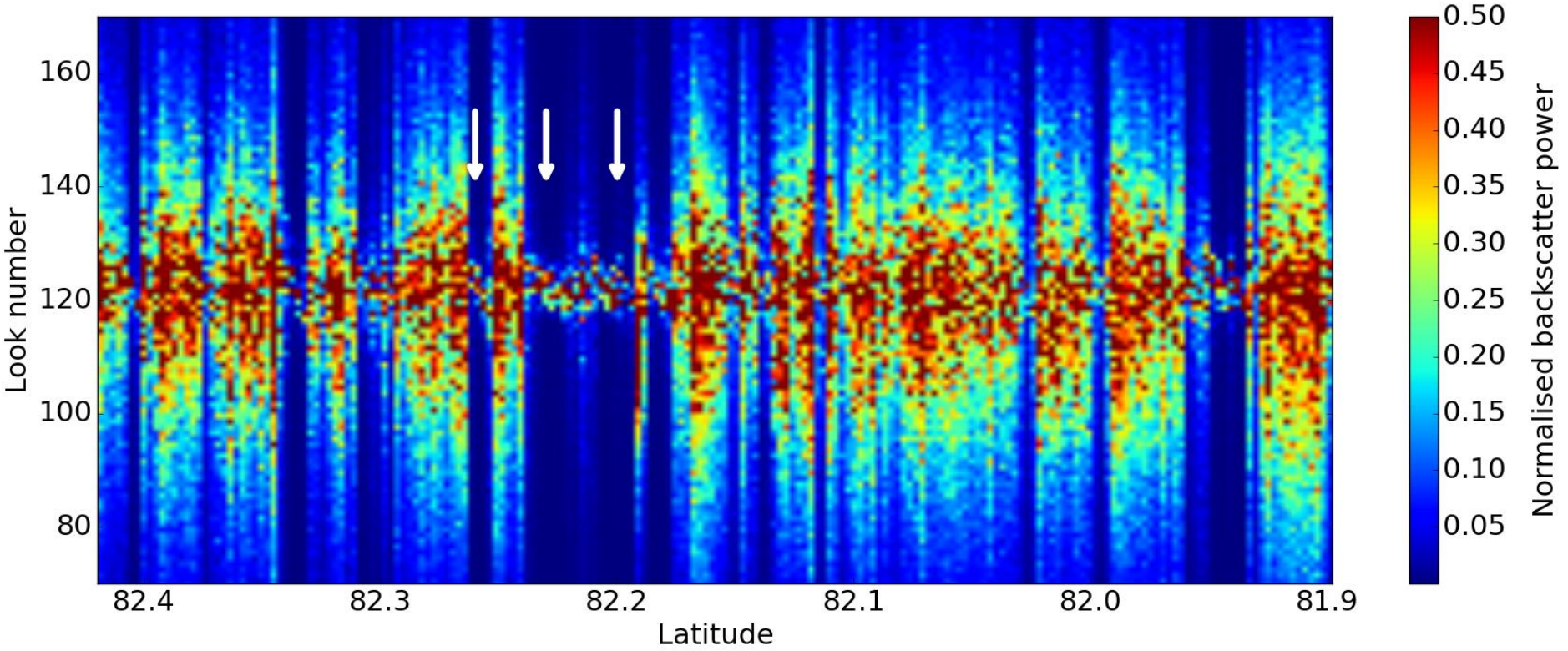
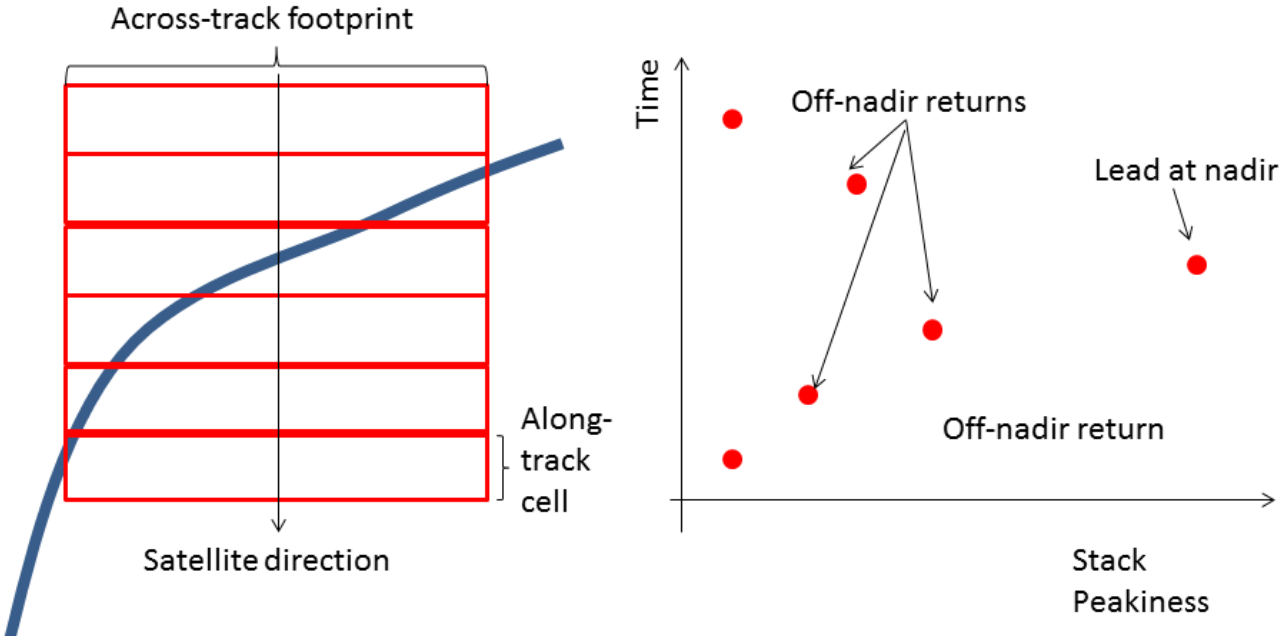
(residual effects still present)

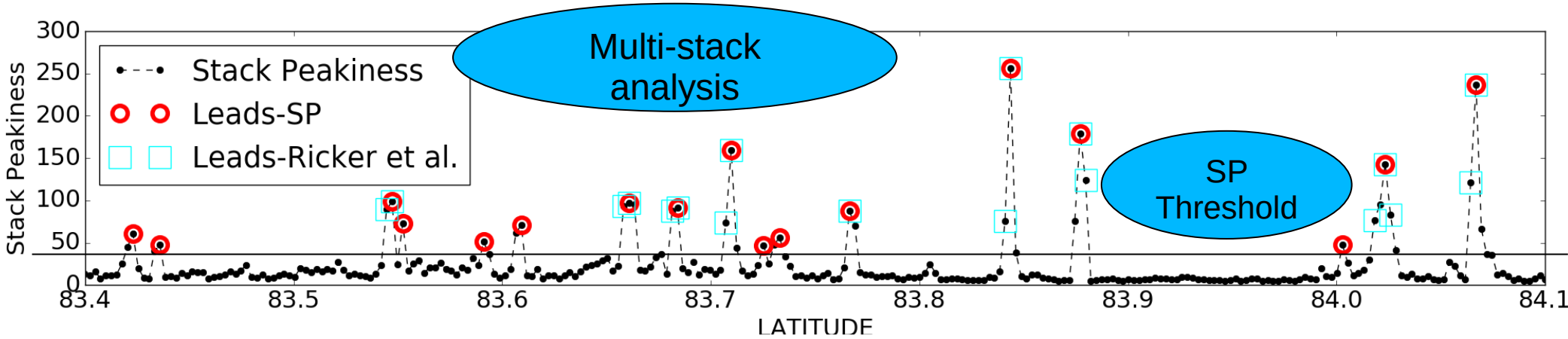




A new parameter: the stack peakiness (SP)

$$\mathrm{SP} = \frac{1}{\overline{P_{l,r}}}\ , \text{with } \overline{P_{l,r}} = \frac{\sum_{i=1}^{N} P(i)_{l,r}}{N}\ , P = single\ look$$





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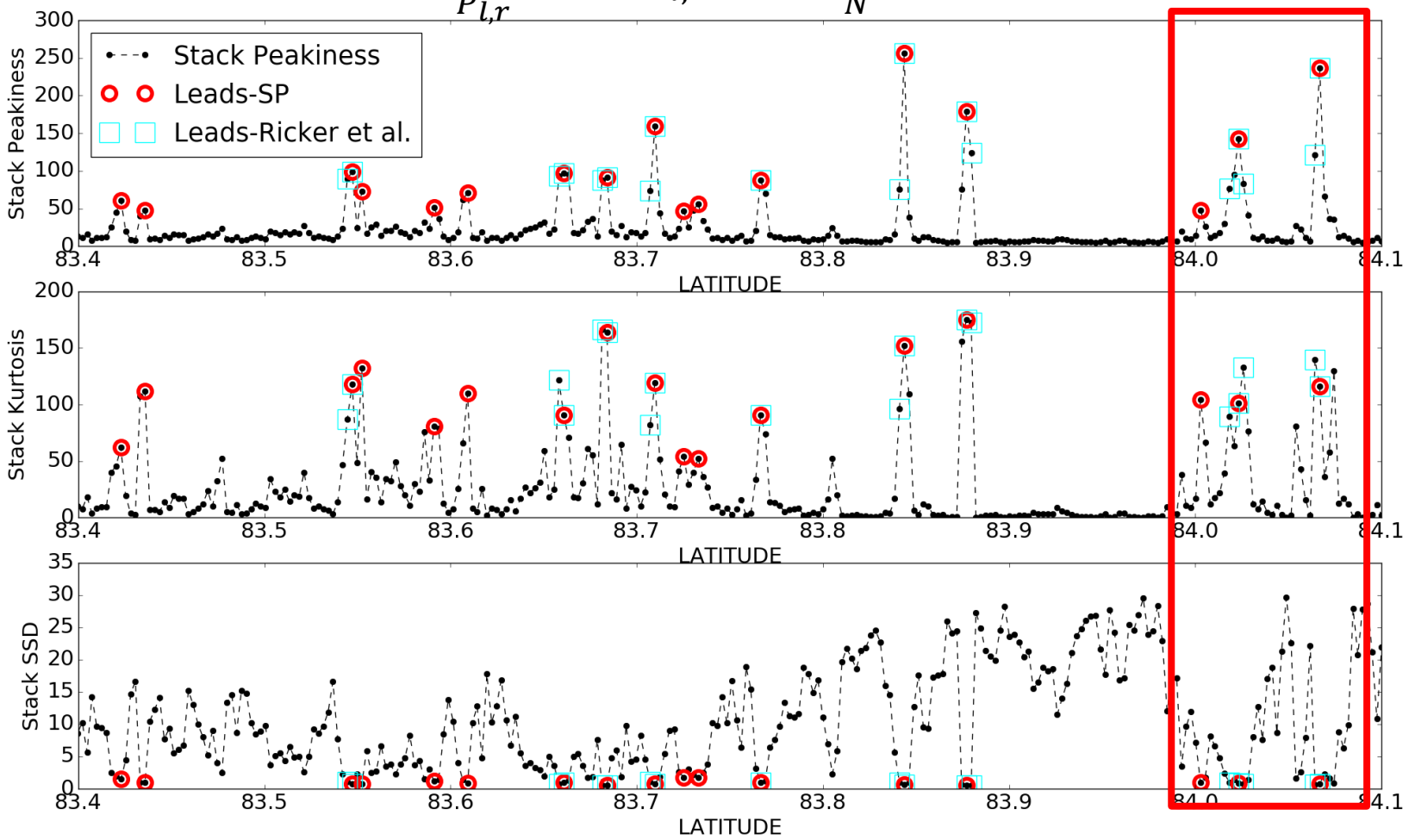

SK: influenced by remaining side-lobe effects

$$SK = \frac{\sum_{i=1}^{N} (P_i - \bar{P})^4 / N}{std^4}$$

SSD: based on Gaussian fitting (not good for peaky returns)

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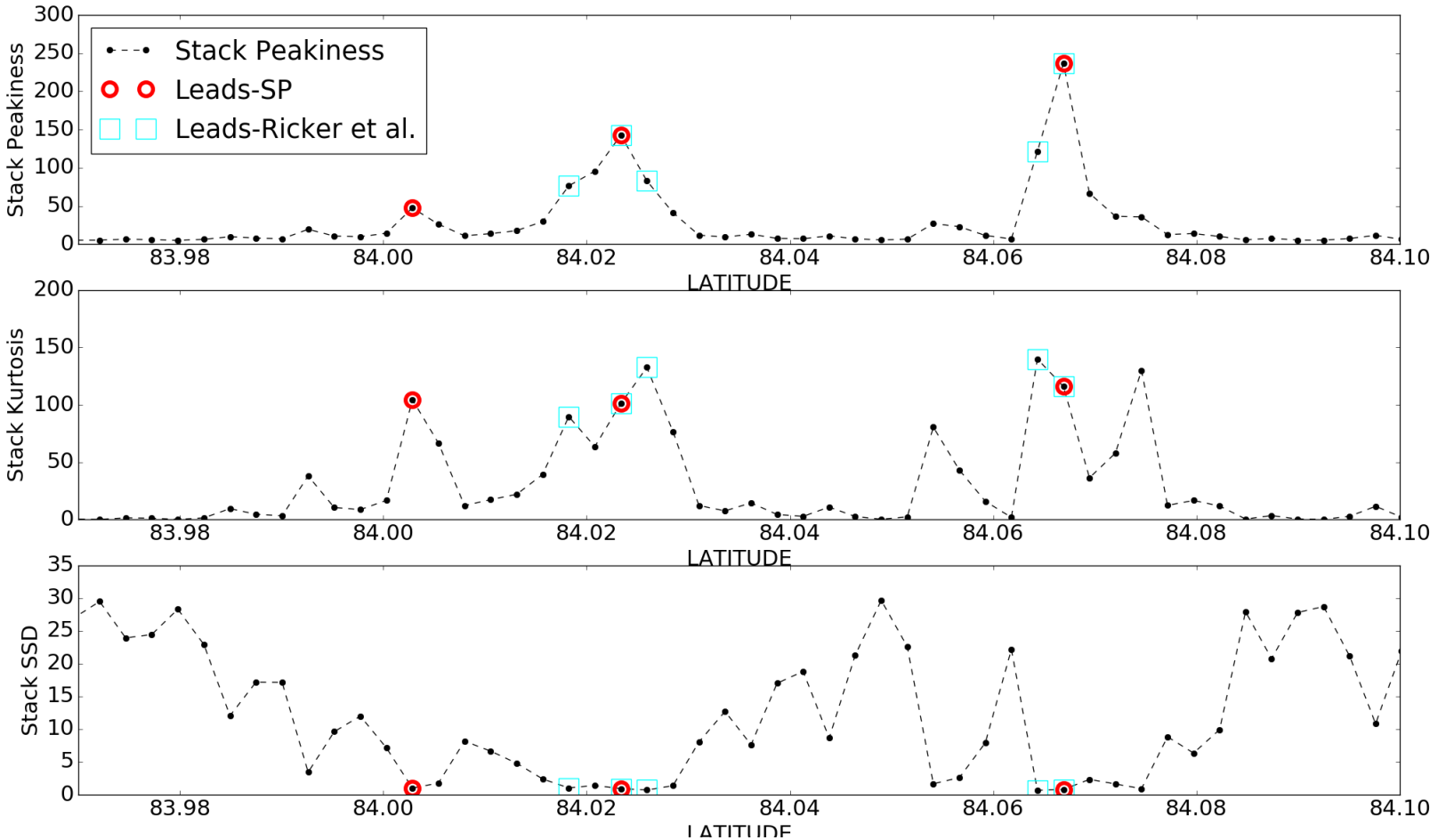

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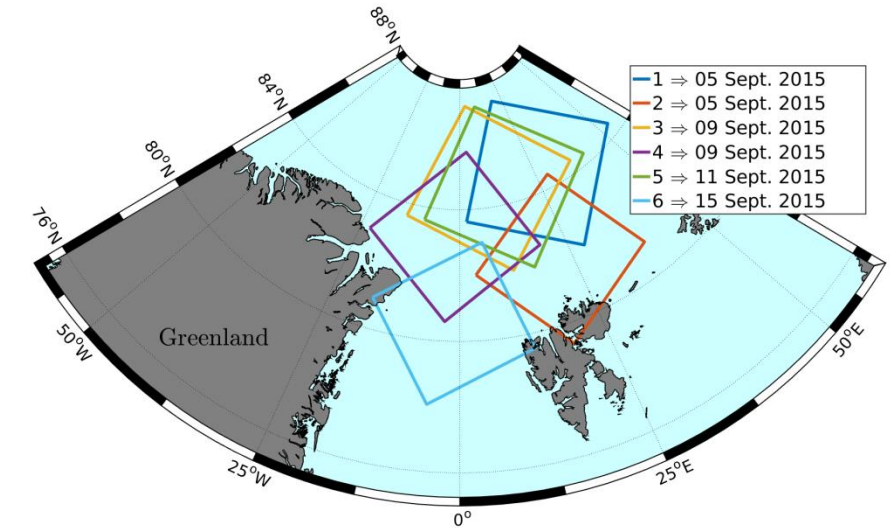
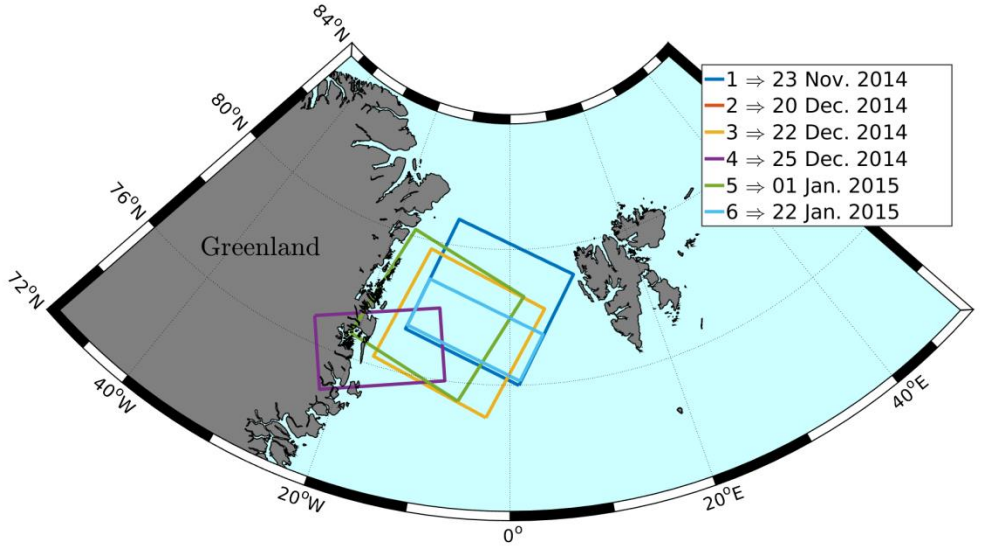
Analysis against Sentinel-1 SAR



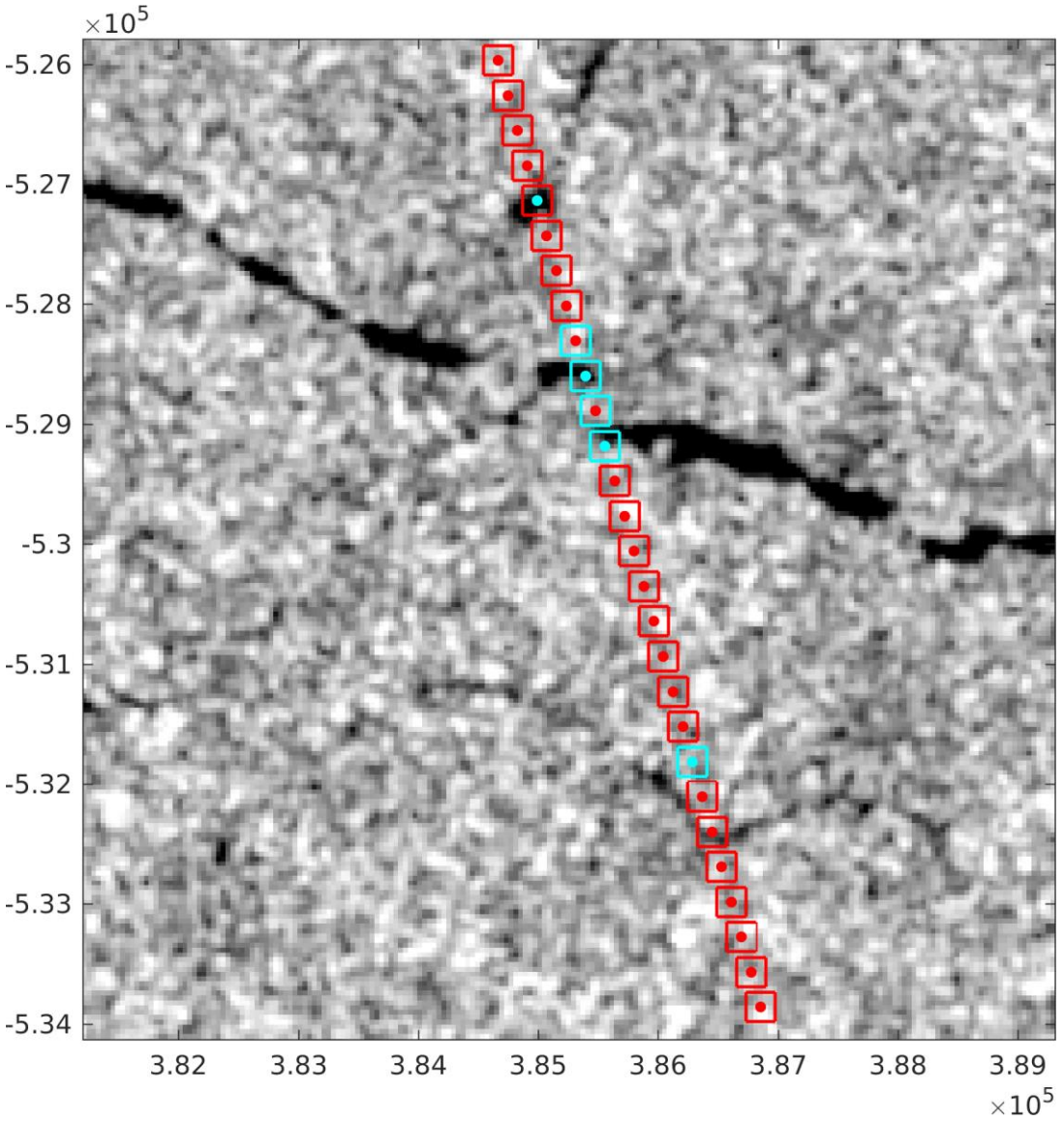


SAR pixel resolution = 40x40 m (then filtered to decrease random noise)

CS-2 along-track resolution = 305 m
…after Hamming-windowing = 400 m
(Scagliola, 2013)

BUT a lead dominates altimeter echo for over a km (Armitage and Davidson 2014)

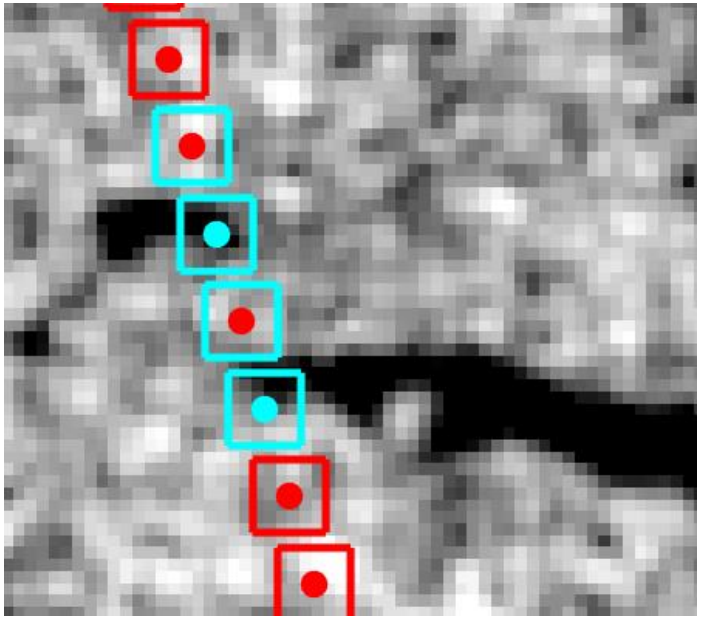
Visual Analysis against Sentinel-1 SAR



CYAN = LEADS

SQUARES = Ricker et al.

POINTS = SP classification



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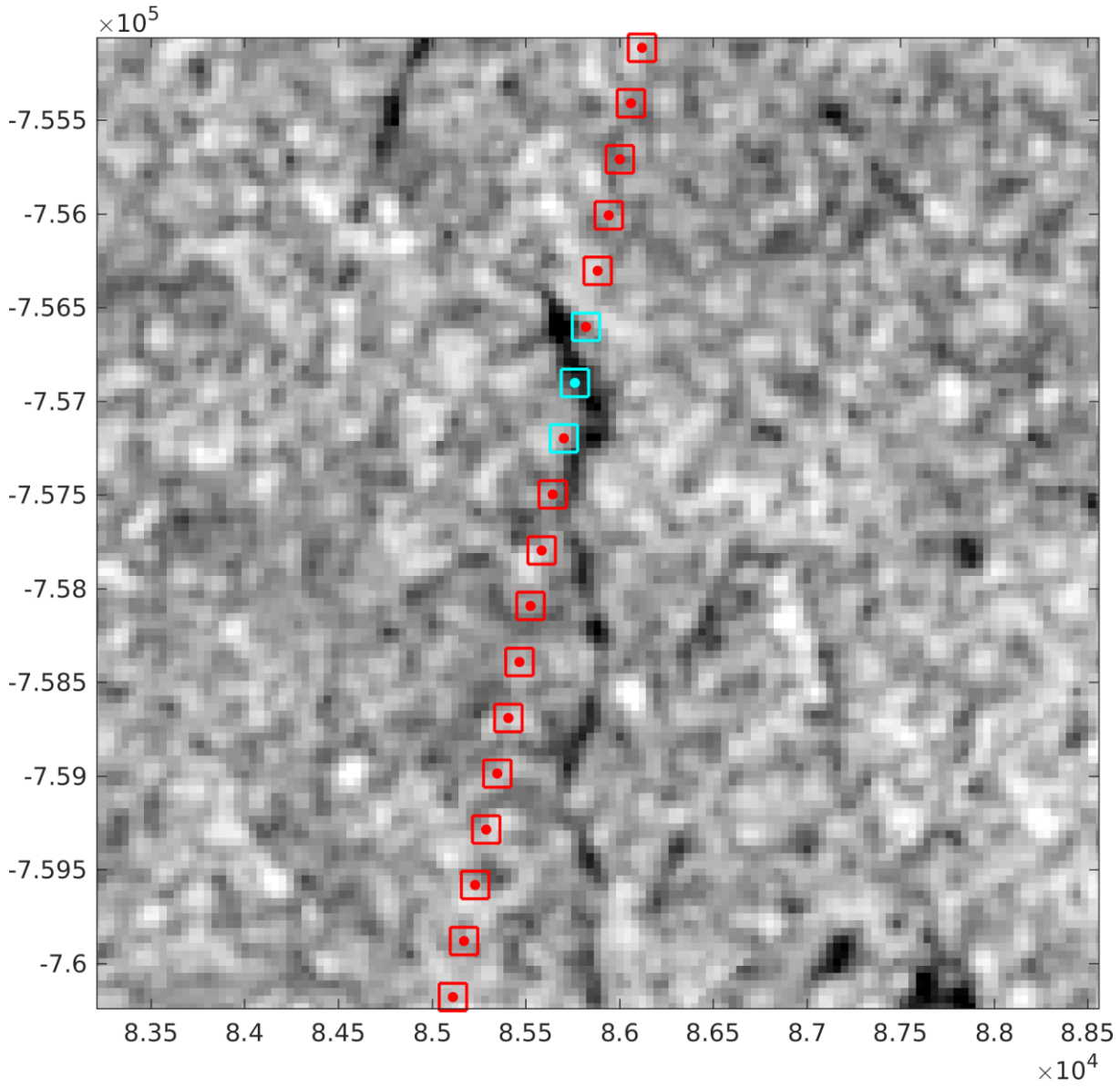

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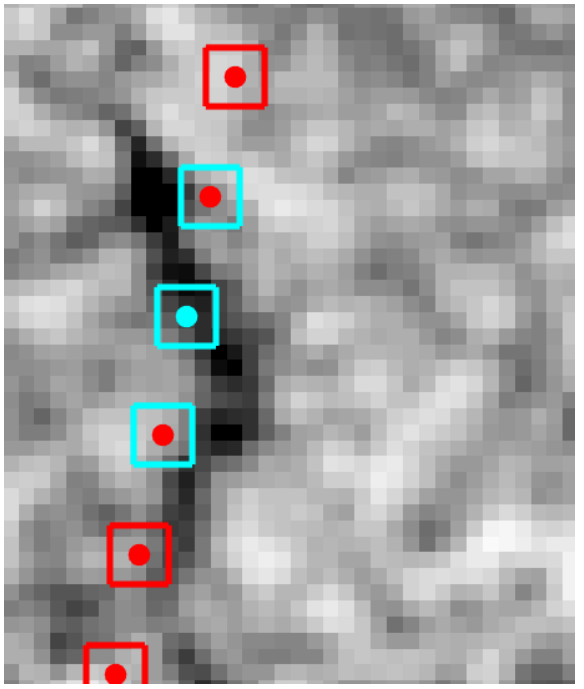

Quantitative Analysis against Sentinel-1 SAR

Lead Detection	SAR leads spotted by CS-2 (´true leads´)	CS-2 leads not confirmed in SAR (´false leads´)	Ratio
Stack Peakiness	64%	56%	1.1
Ricker et al.(2015)	55%	47%	1.1

STACK PEAKINESS equals a 6-parameter classification

NADIR IMPROVEMENT not seen in the quantitative comparison with SAR. Why?

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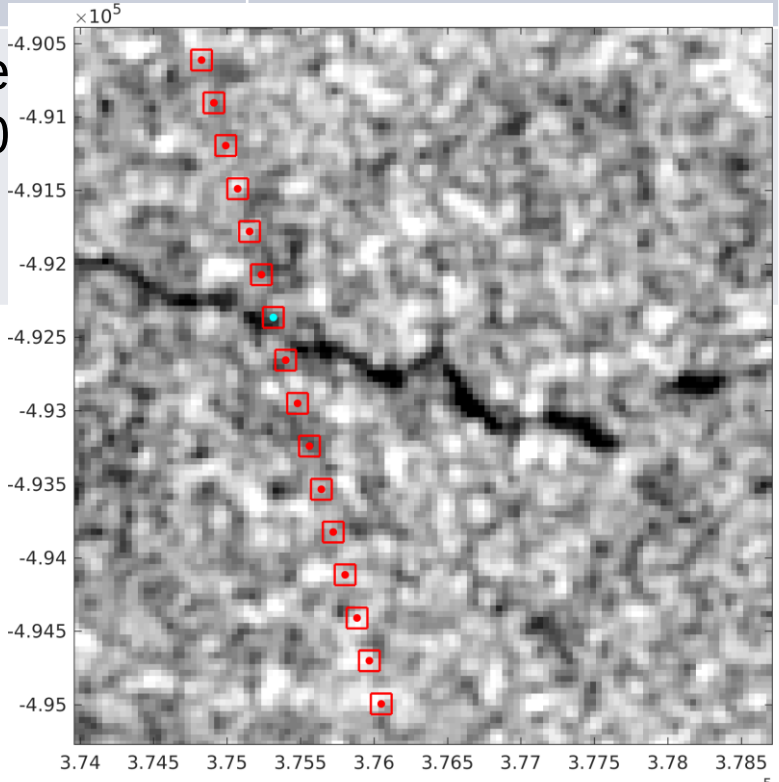

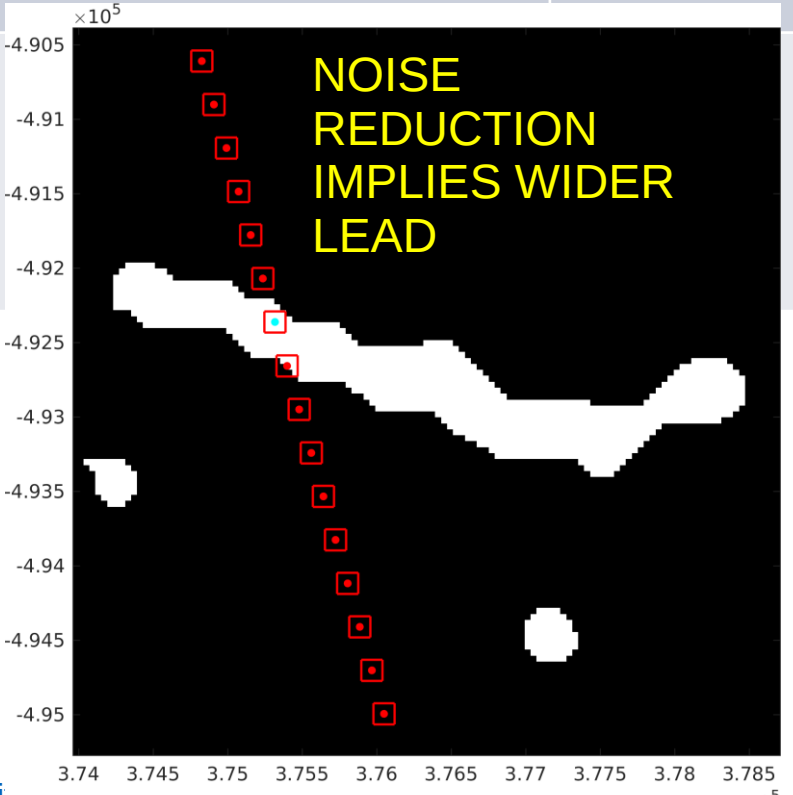

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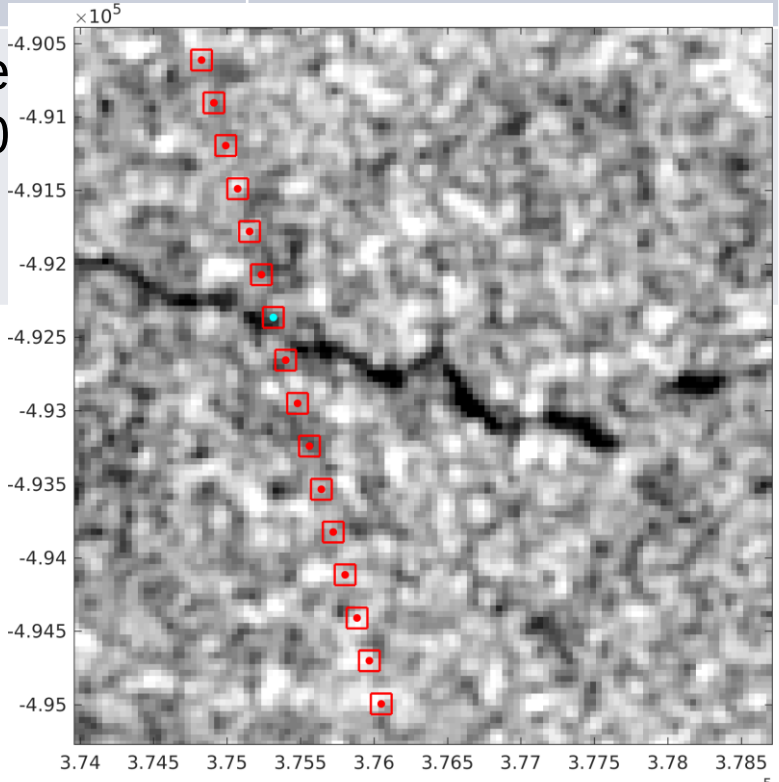
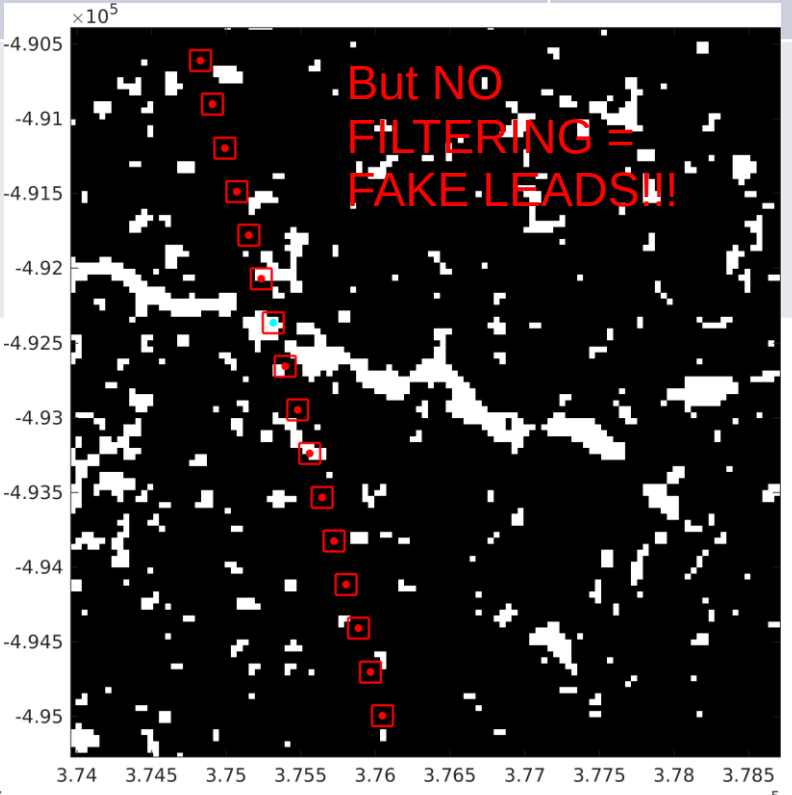
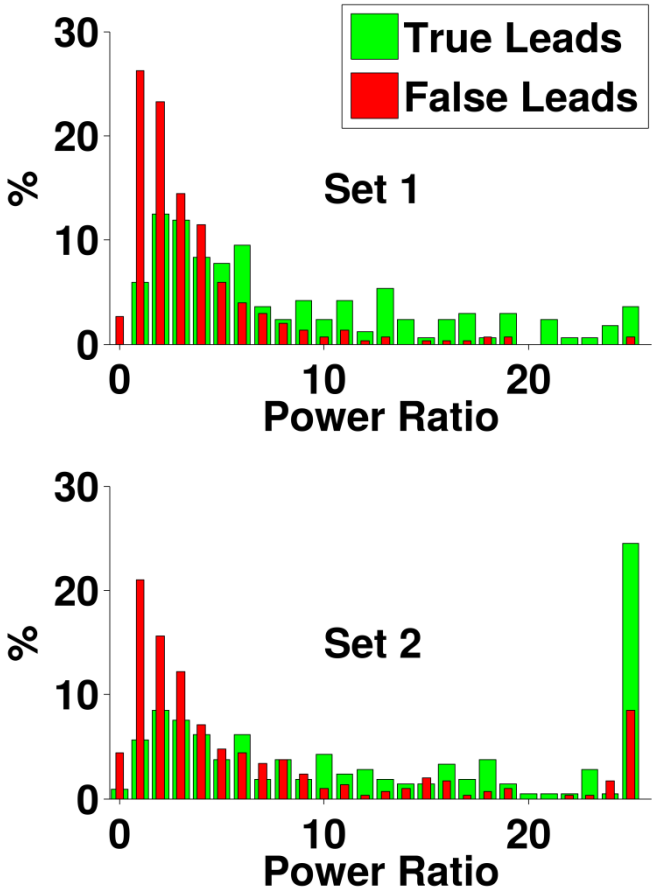


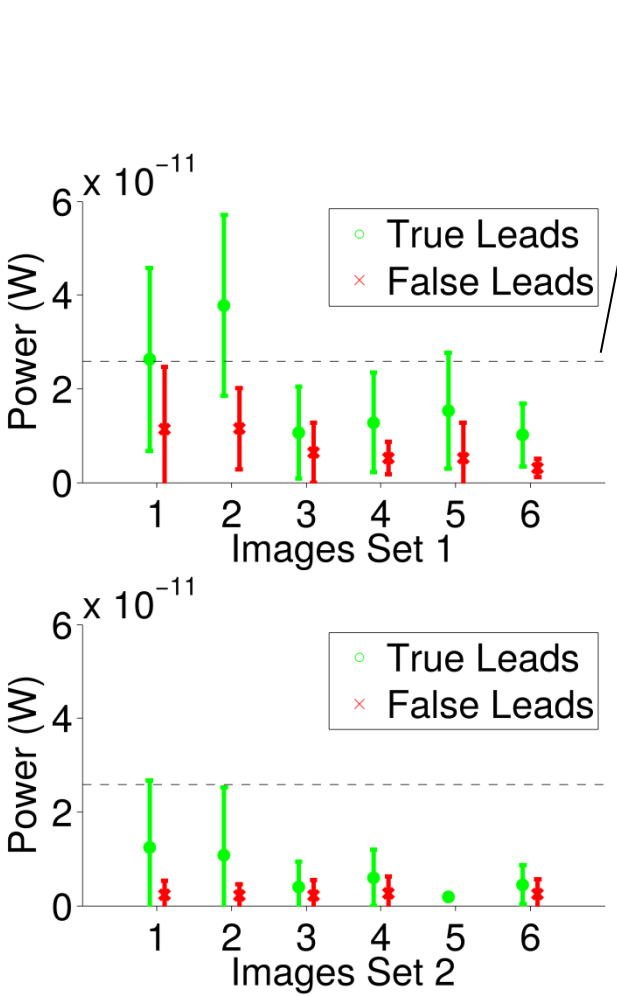


Maximum power as lead classifier?



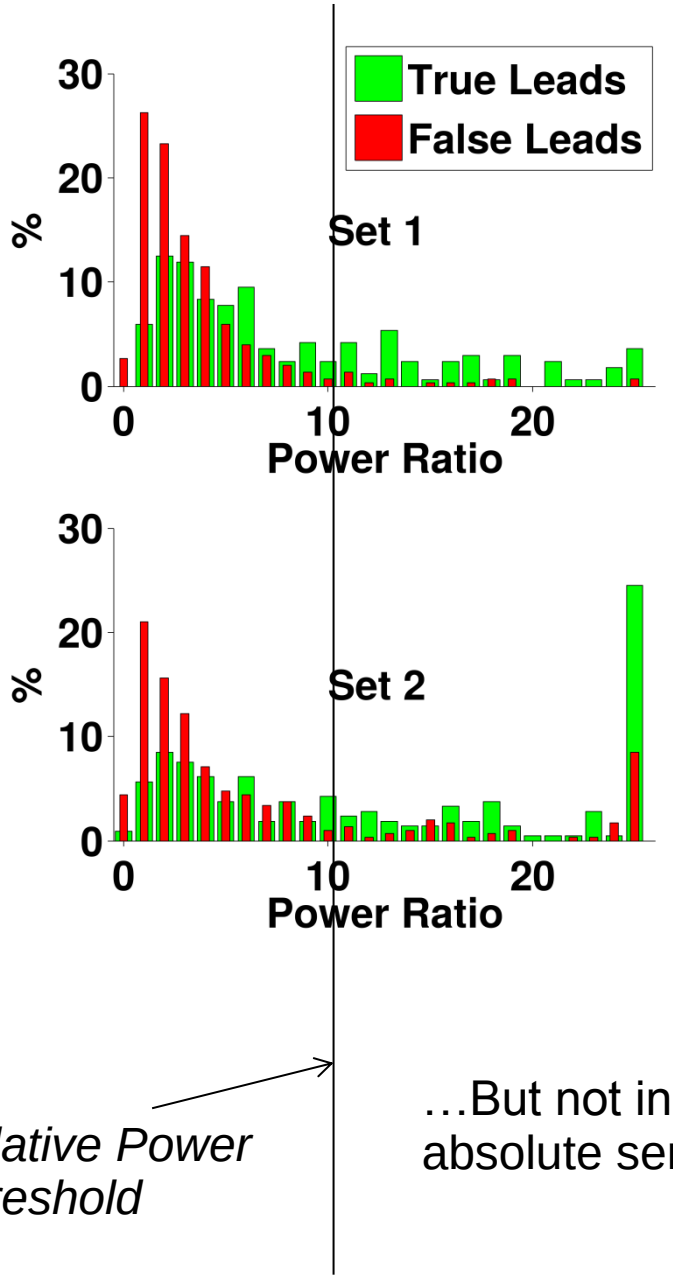
A posteriori analysis:
´False leads´ on average scatter less power back…

Threshold from Wernecke et al.



…But not in an absolute sense!

Maximum power as lead classifier?



A posteriori analysis:
´False leads´ on average scatter less power back…

Lead Detection	(´true leads´)	(´false leads´)	Ratio
Relative Power Threshold	41%	29%	1.4

Conclusions

- Stack data are important. We need them easily available (thanks GPOD)

- We propose the introduction of Stack Peakiness as standard stack parameter
    - SP classification is at least as good as multi-parameter classification
    - SP and multi-stack analysis are a promising tool for nadir lead detection

- Absolute power is probably not a reliable nadir-lead classifier. Relative power might be.

We have developed an automatic SAR image processing for lead detection -> See Felix Müller‘s OSTST Poster **IPM_014**

CHECK OUT: Discussion paper in “The Cryosphere”: Lead Detection using CS-2 Delay Doppler processing and Sentinel-1 SAR images

OSTST POSTER SESSION
Session : Instrument Processing: Measurement and retracking (SAR and LRM)
Room(s) with show times :
Grande Halle: 03.11.2016 - 11:00 - 03.11.2016 - 18:00

Poster Number: IPM_014 “Unsupervised classification of multi-mission altimetry data for open water detection in the Greenland Sea” Felix Müller et al.

Acknowledgements:

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Cryosat 2: https://gpod.eo.esa.int/
Sentinel 1: Sentinels Scientific Data Hub and Sentinel 1 Toolbox

https://www.nasa.gov/sites/default/files/726745main_seaice10_thul6_083.jpg