Homogenizing Metocean Data from Sentinel-3

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Motivation

To develop long-term climtologies of significant wave height (Hs) and sigma0 (-> wind speed), it is necessary to under-stand and remove all biases between different estimates.

This is necessary for different LRM sensors, but also for differences between SAR and (P)LRM-derived estimates from the same mission.

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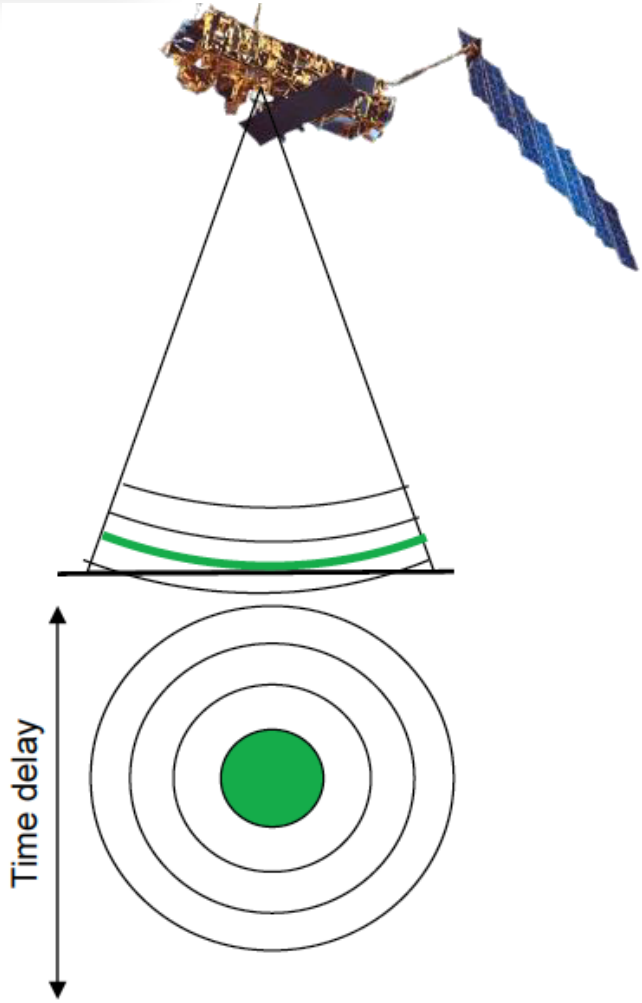
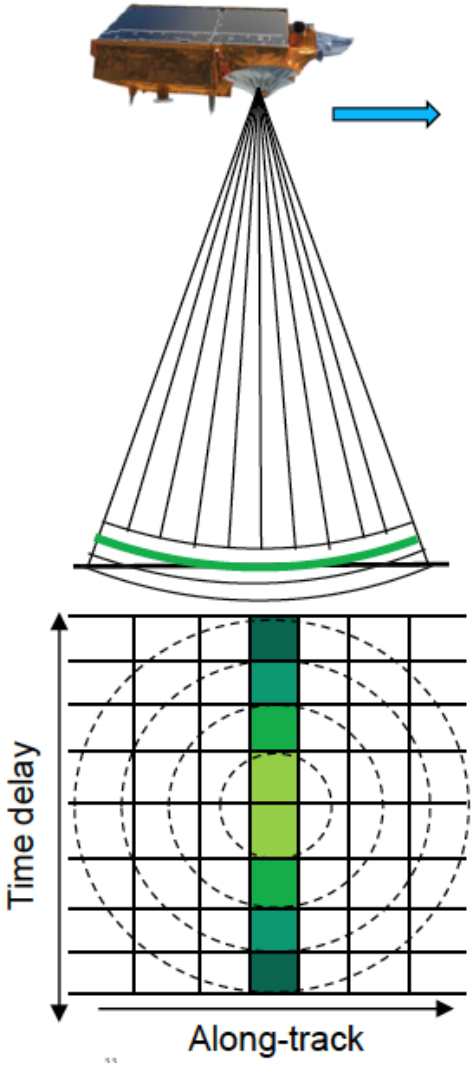
Footprints & Noise

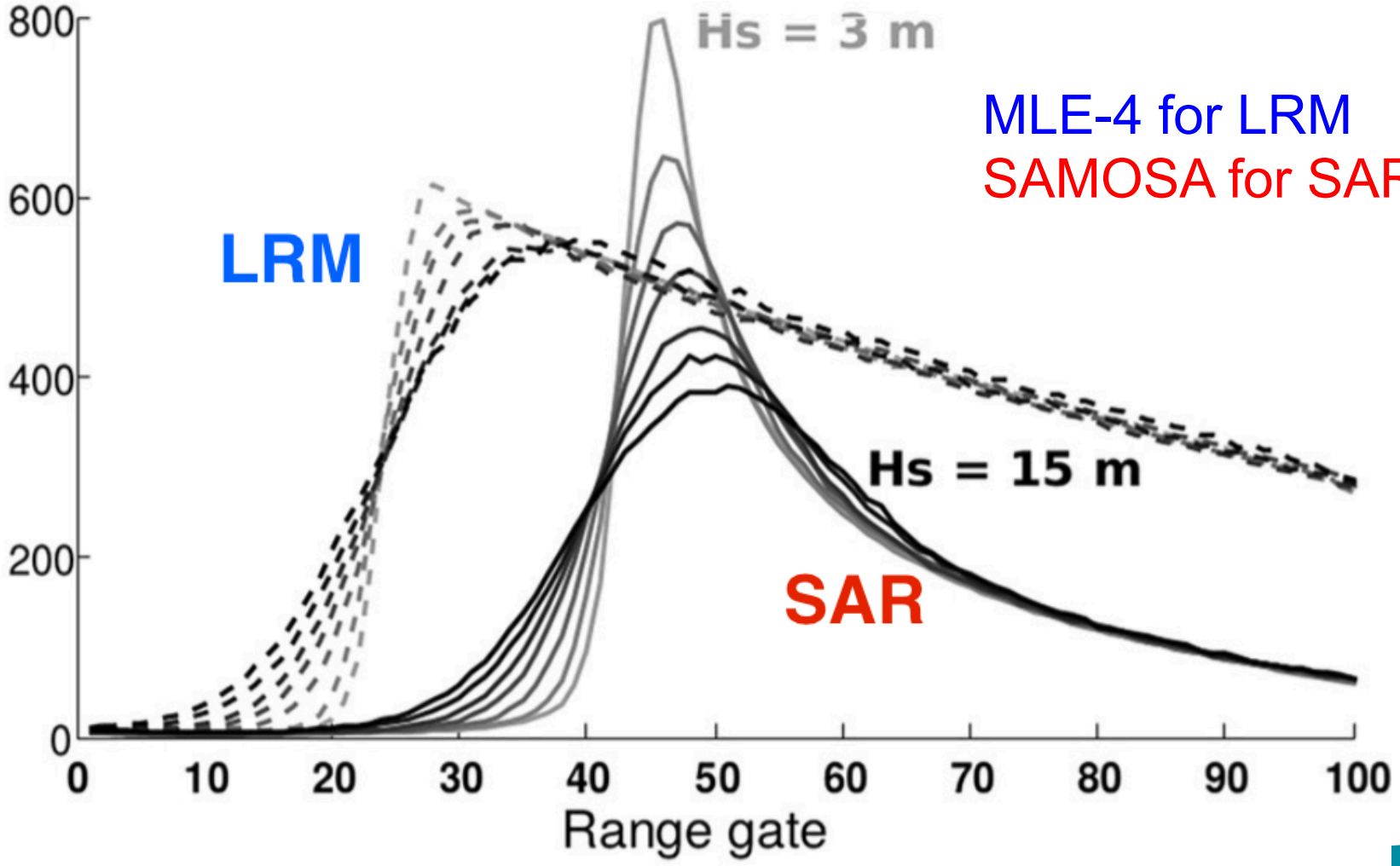




SAR processing permits finer along-track resolution and enables "multi-looking" to reduce measurement noise

Resultant waveforms

However these lead to different waveform shape ➔ need different algorithms



DATA Analysed

1 Hz data from S3A.
Full Mission Reprocessing in Jan 2020
(i.e. Baseline Collection 4)

Compare PLRM & SAR estimates

Empirical approach (rather than examining algorithms for MLE-4 and SAMOSA)

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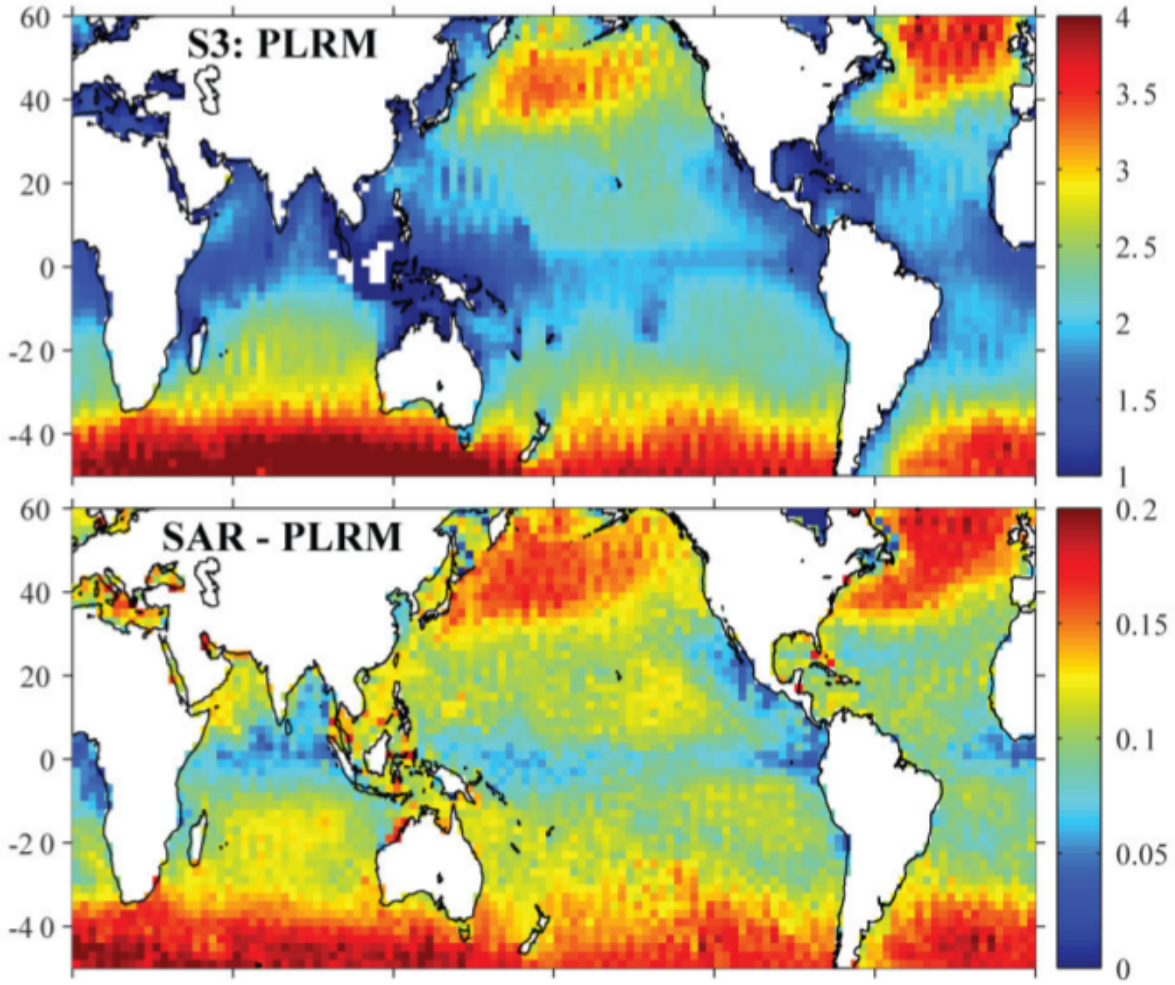
Significant Wave Height

From S3MPC Overview paper (Quartly et al., 2020)

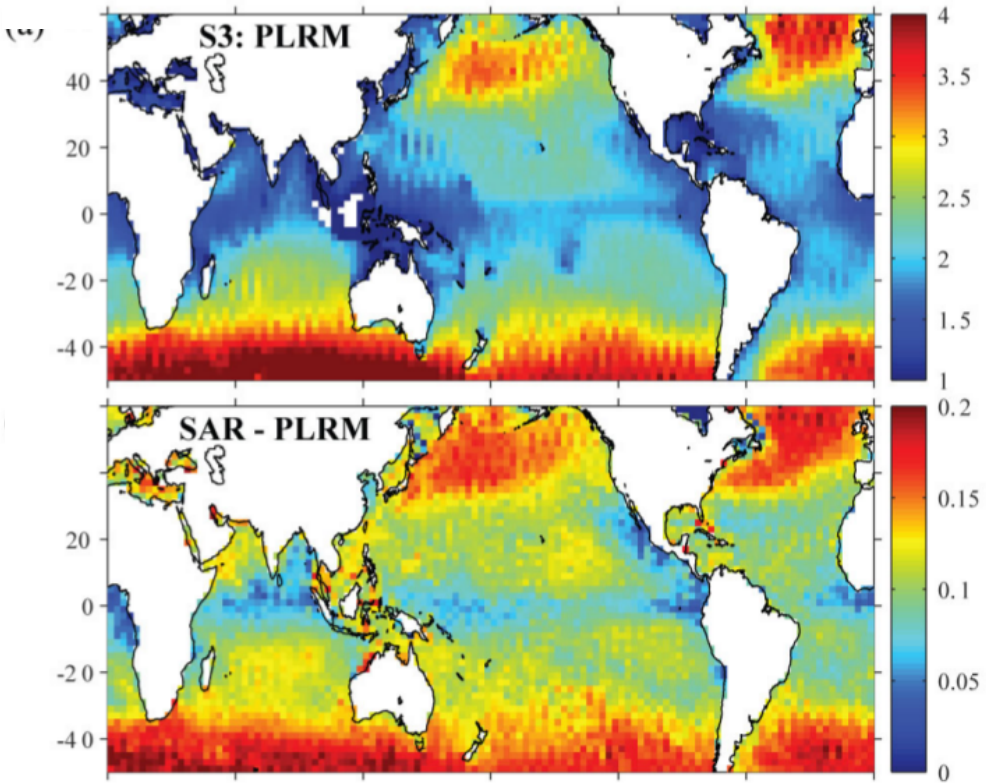


Top: Average Hs for 2019 from PLRM

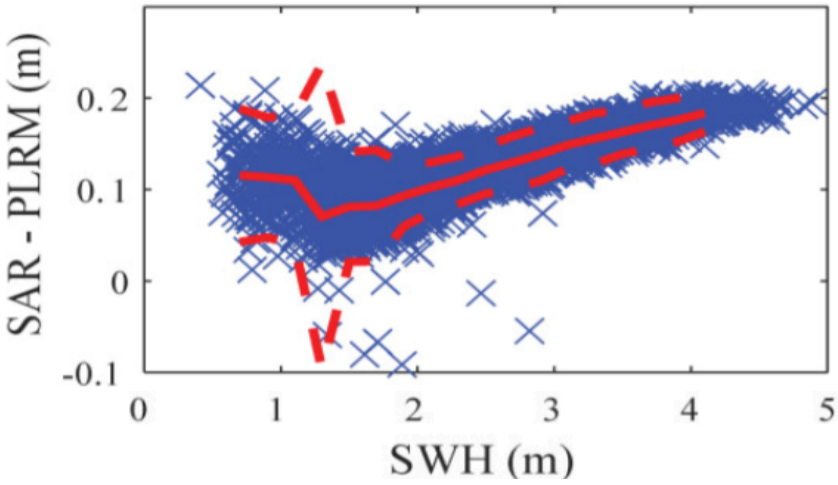
Bottom: Average difference in Hs for SAR - PLRM

Significant Wave Height

From S3MPC Overview paper (Quartly et al., 2020)



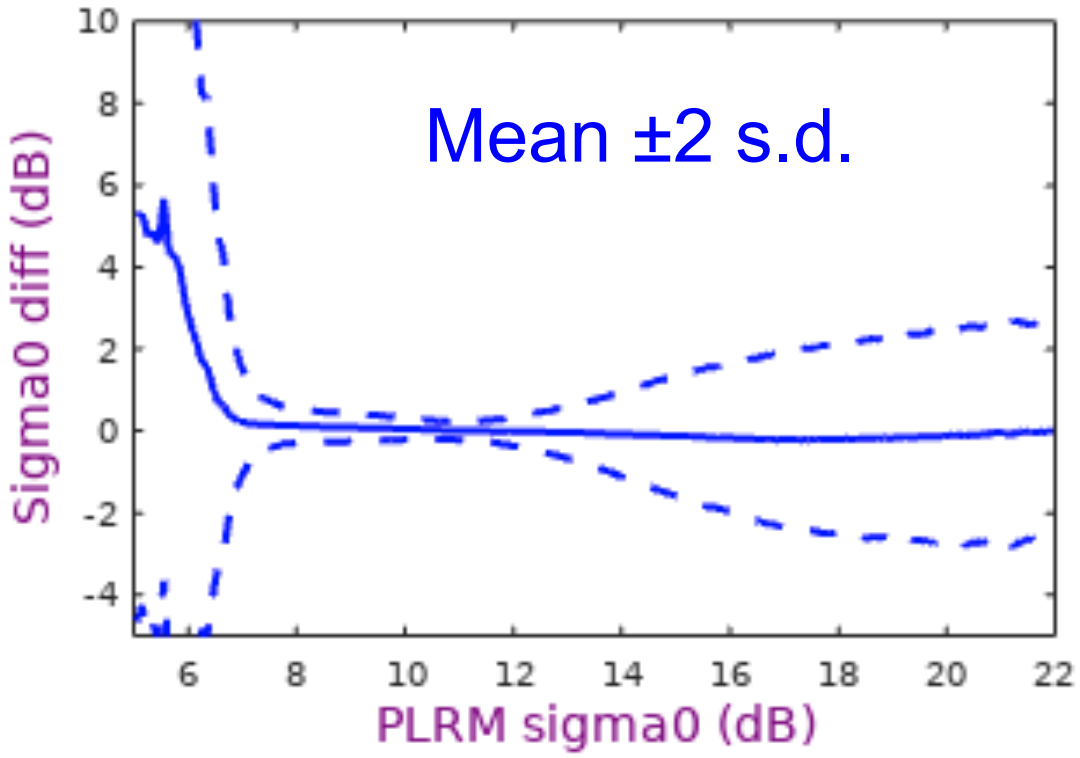
SAR reads higher at high Hs



Note PLRM record is unbiased w.r.t. Jason-3

Sigma0

We now look at the difference between SAR and PLRM-derived estimates of sigma0, σ^0



(For the next series of plots we consider the bias and scatter as a function of a variable, and portray that by solid line for mean relationship and dashed lines giving ±2 s.d.

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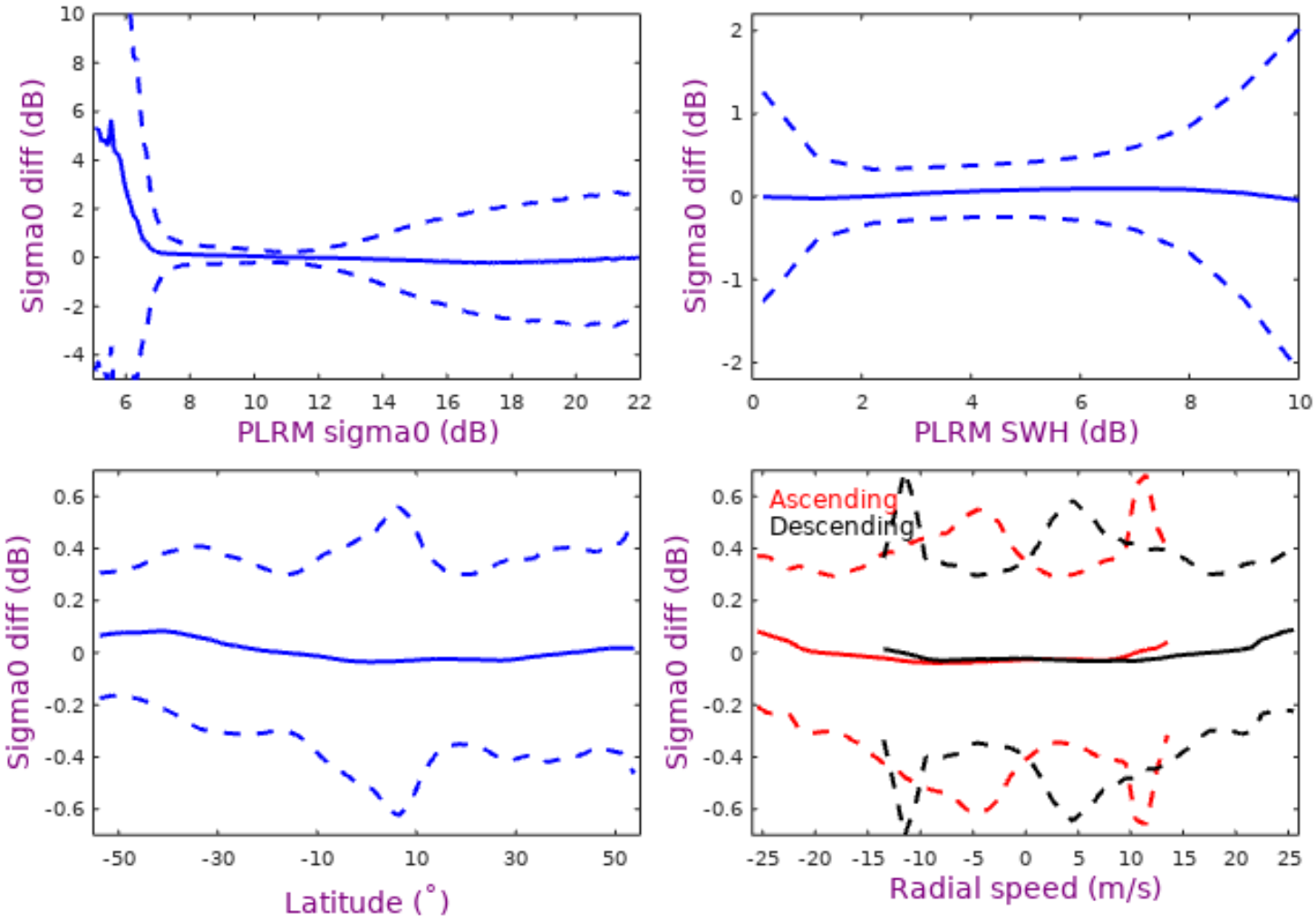
Sigma0 bias (SAR-PLRM) I

Indeed the sigma0 bias and spread seem to vary with many parameters



Sigma0 bias (SAR-PLRM) II

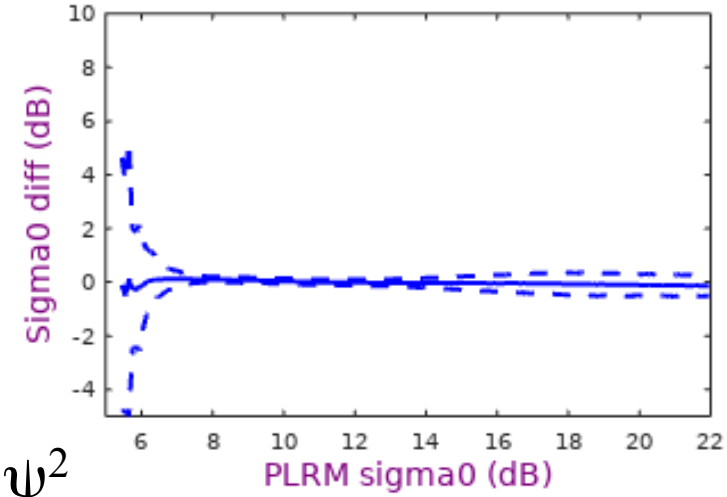
First, we correct σ^0 for mispointing (both for PLRM and SAR)

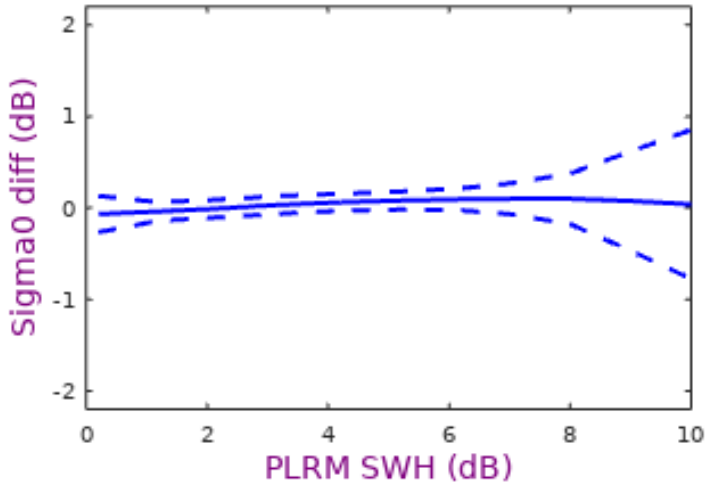
Sigma0 adjustment

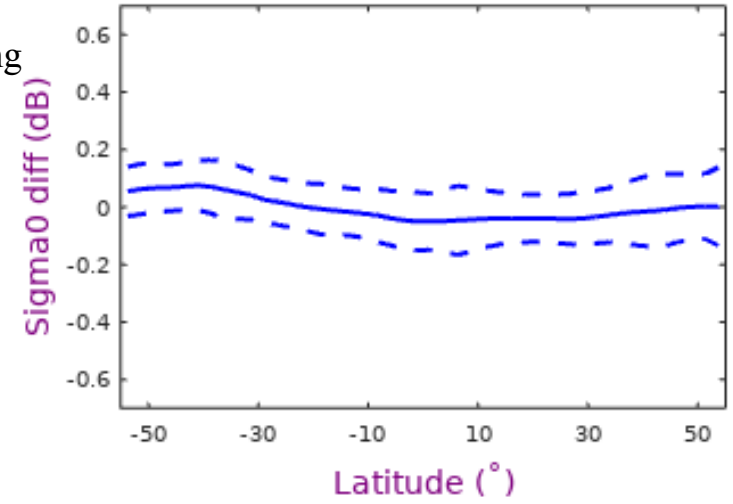
$$\sigma^0_{adj} = \sigma^0 - \alpha\,\psi^2$$

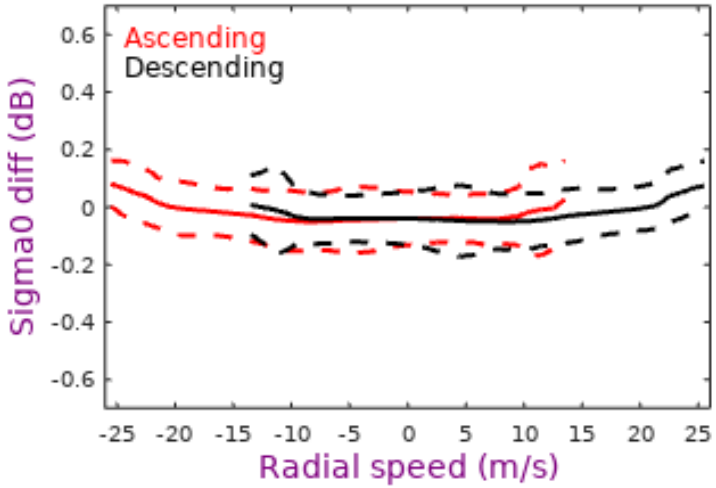
where ψ^2 = mispointing

this reduces r.m.s. spread from 0.453 to 0.144 dB









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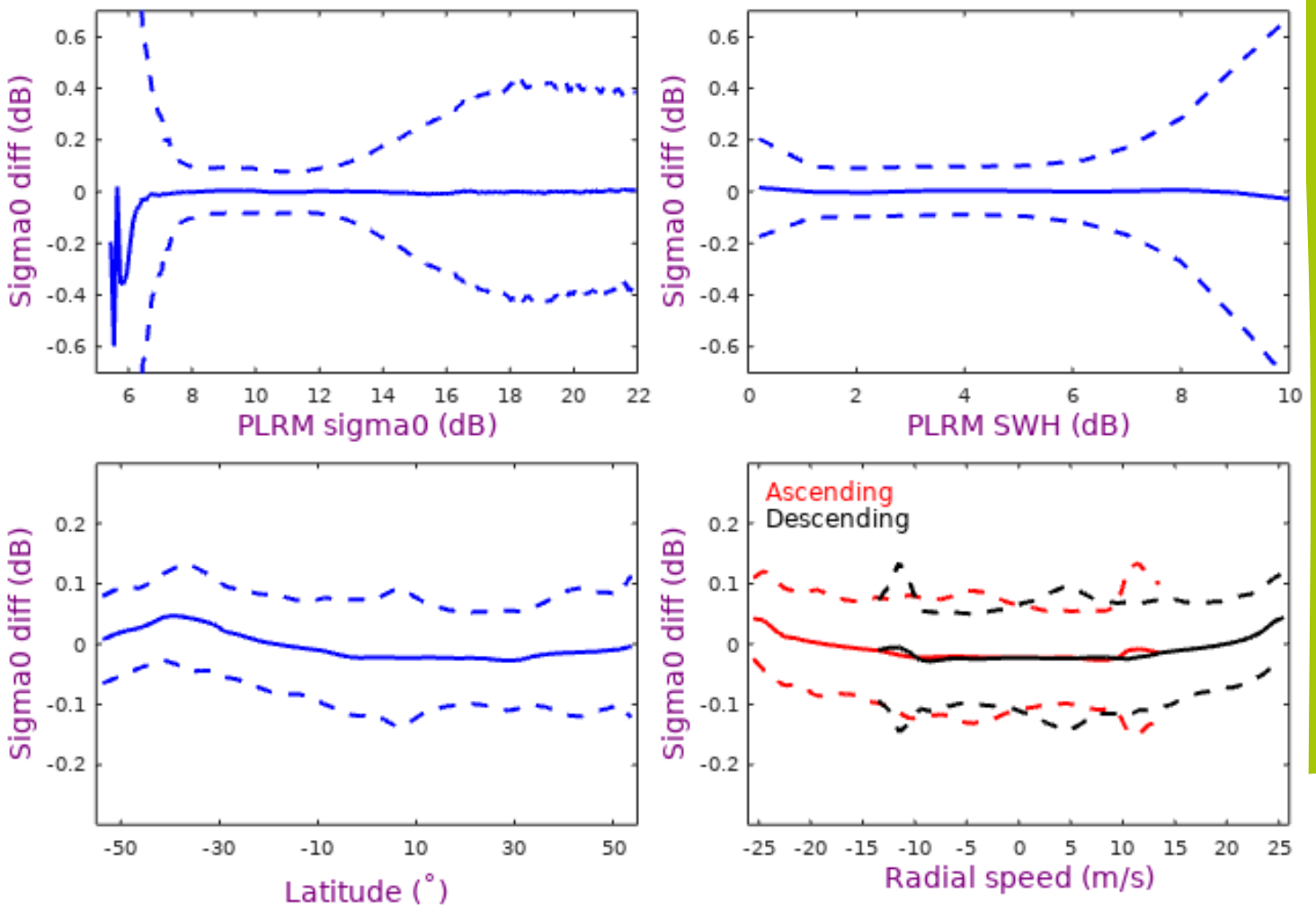
Sigma0 bias (SAR-PLRM) III

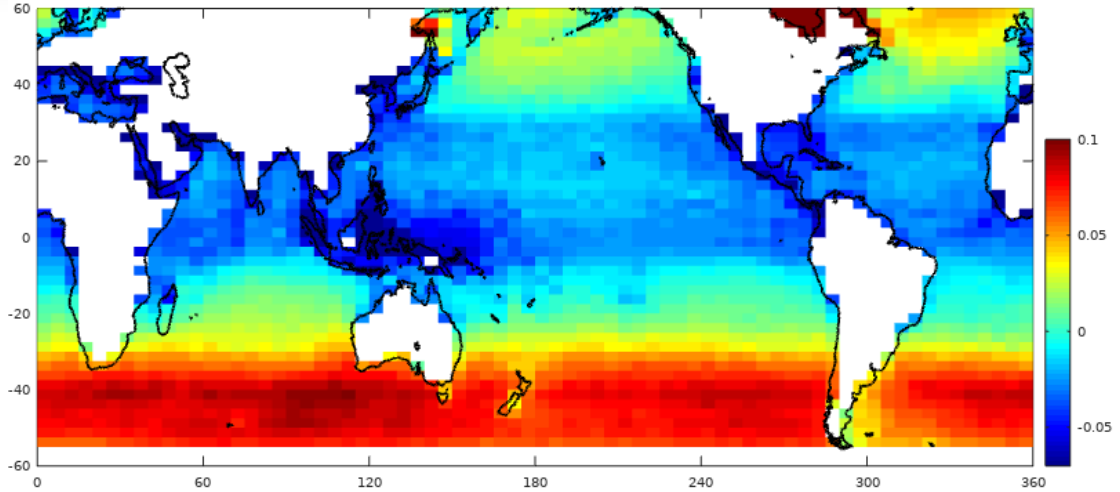
The bias in σ^0 is then characterised as a function of σ^0 and Hs and this mean bias is removed from all.

(These plots have narrower axis ranges than previous plots, so as to show the variations.)

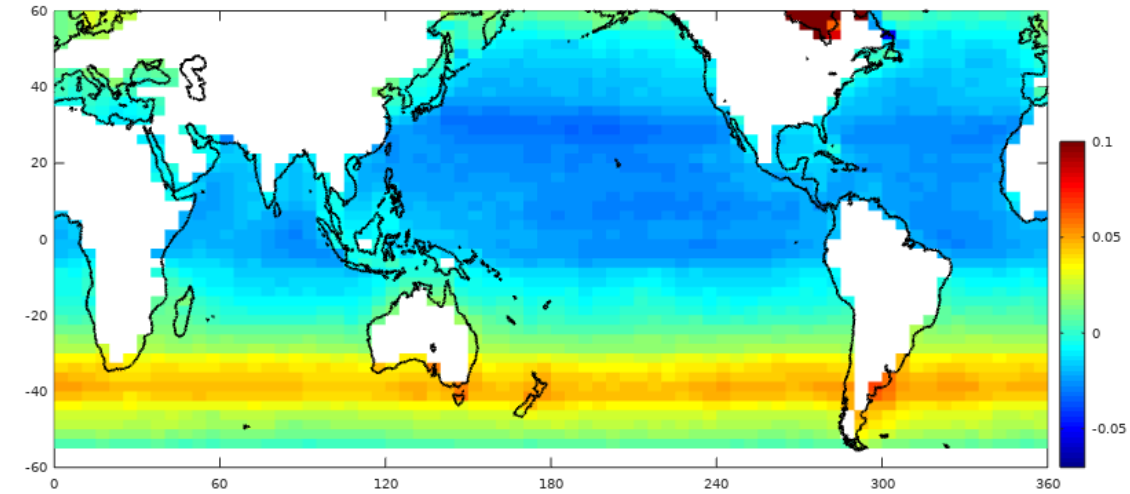


Residual bias : $\sigma^0_{SAR} - \sigma^0_{PLRM}$ (dB)

Original



After adjustments



Maps of mean difference for period show banded structure, but the adjustment, f(σ^0,Hs) has reduced intensity from [-0.05,0.08] to [-0.03, 0.05].

This is likely associated with the radial velocity, as this affects positioning of waveform within the window.

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Summary

Hs & σ^0 are two key parameters derived from altimeter data. Together they lead to many metocean parameters (Wave height, Wave power, Wind speed, Wave period, Air-sea gas transfer velocity, ...).

To achieve multi-satellite climatologies of all these we need SAR retrievals to be unbiased w.r.t. LRM

Correction of σ^0 using ψ^2 still very effective

Further adjustments f(σ^0,Hs) also needed

Residual bias in σ^0 appears to be related to radial velocity

"The Caveat"

Thanks for reading this far!

In case you might think I am offering opinions on EU trade policy, health measures or infrastructure plans, they ask you to read this:

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