

Sentinel-3A and -3B Tandem Phase (Preliminary) Evaluation of the Surface Topography Mission Sea State Products

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<https://s3tandem.eu/>



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SENTINEL-3A

Orbit Number: 11709
Time Since ANX: 5366.264
Lat: 40°S 40' 54"
Long: 4°W 55' 45"
Alt: 818.776 km

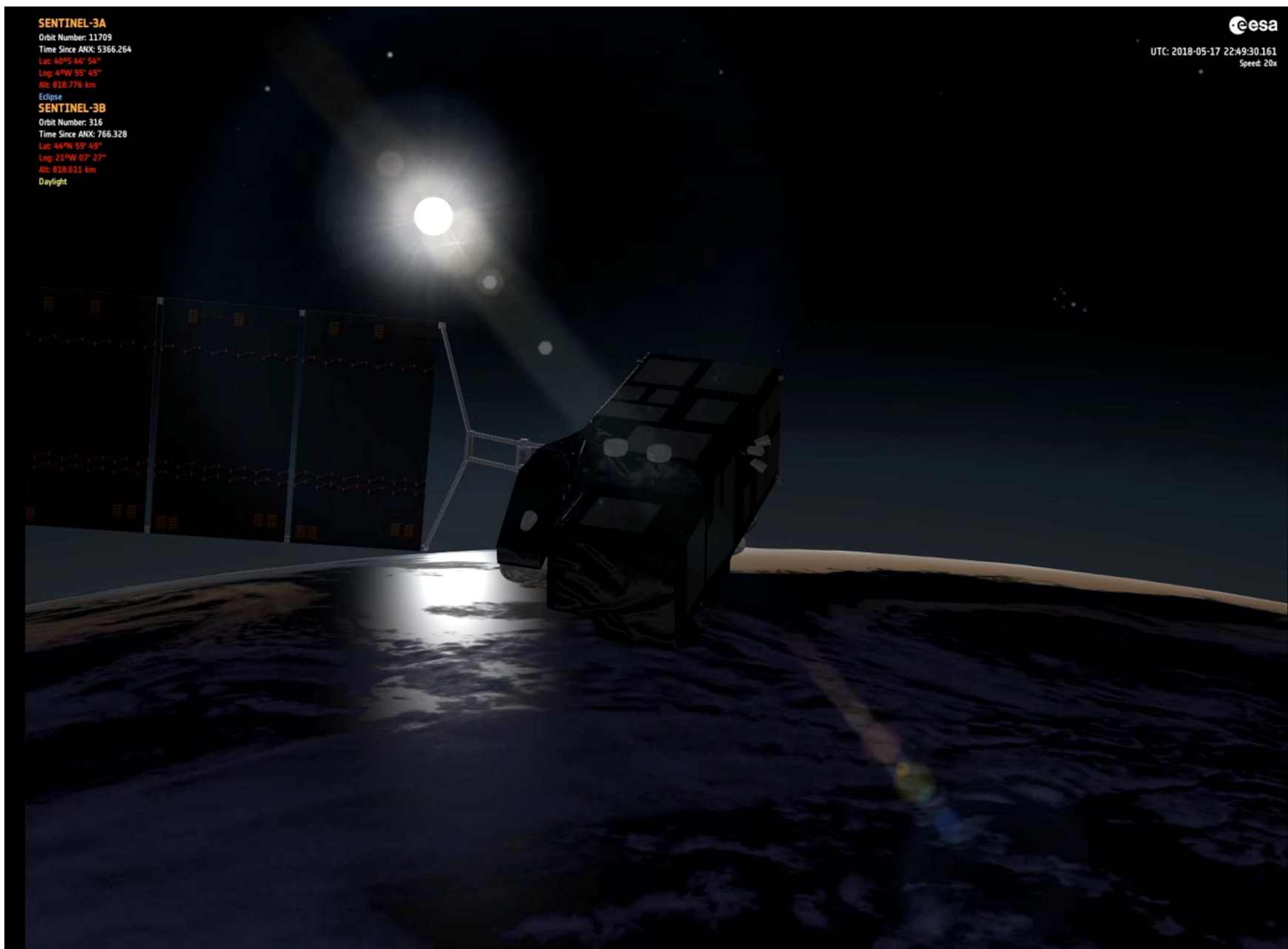
Eclipse

SENTINEL-3B

Orbit Number: 316
Time Since ANX: 766.328
Lat: 44°N 59' 49"
Long: 21°W 07' 27"
Alt: 818.611 km
Daylight



UTC: 2018-05-17 22:49:30.161
Speed: 20x



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Method

- **1 Hz data**
 - accessed via S3TC DIAS
- **8th June 2018 – 15th October 2018**
 - 14th June – 11th July 2018: S3B in LRM, S3A in SAR mode
- **Quality Control**
 - standard Ku-band ocean flags
 - samples contain at least 10 valid 20 Hz records
- **S3B Sigma0 corrected for 0.5 dB bias**
 - Re-compute wind speed (Abdalla et al., 2012)
- **Focus on open-ocean data away from poles**
 - ± 60 deg; > 50 km from land

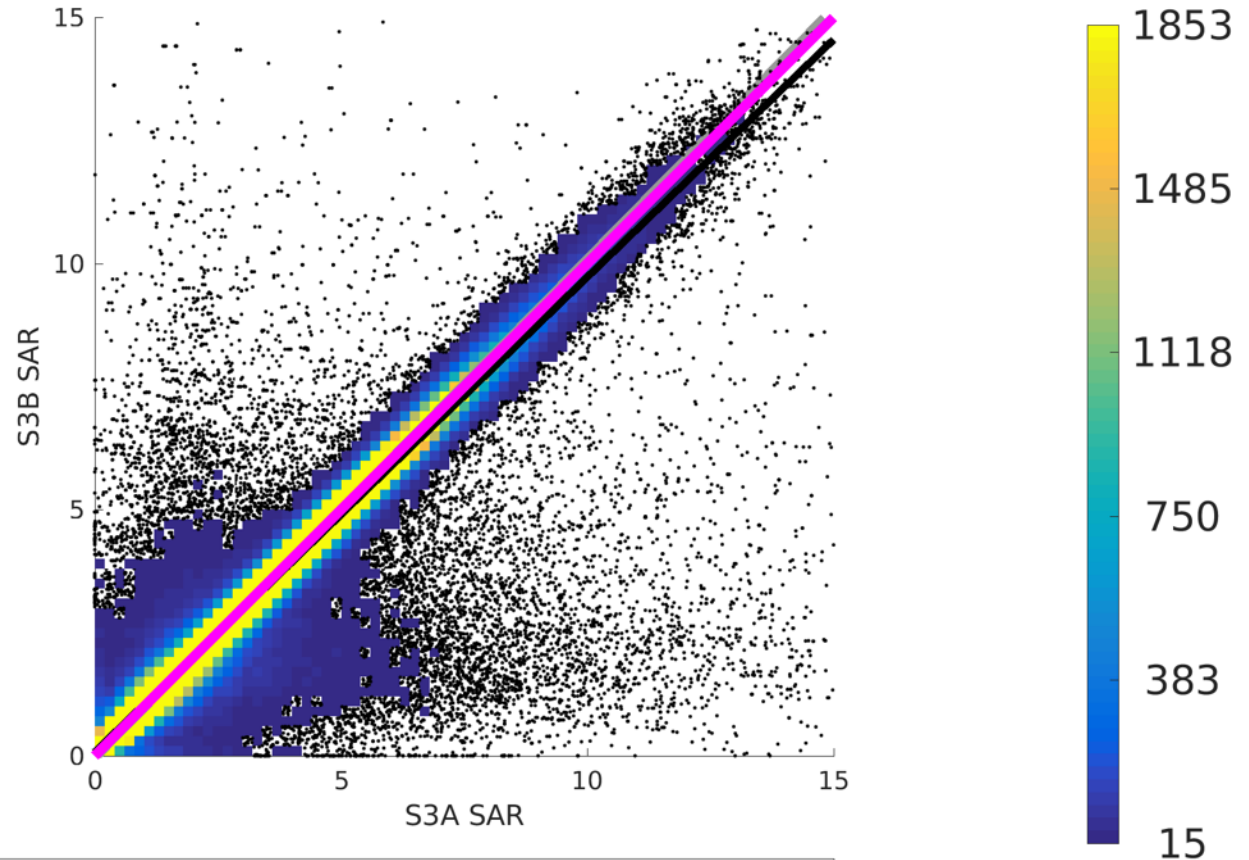
Method

- **Collocation around S3A SAR as fixed points**
 - S3B data within 30 seconds and 25 km (median)
- **Wave model data**
 - Hi-WW3* and ERA5
 - collocated to nearest grid point
- **Analyses for whole tandem period and by month (not shown)**
- **Analyses for global open ocean (± 60 deg) and by basin/hemisphere (not shown)**

* Pacific Islands Ocean Observing System (PacIOOS) at University of Hawaii
http://oos.soest.hawaii.edu/erddap/griddap/NWWIII_Global_Best.html

SWH S3A SAR vs. S3B SAR

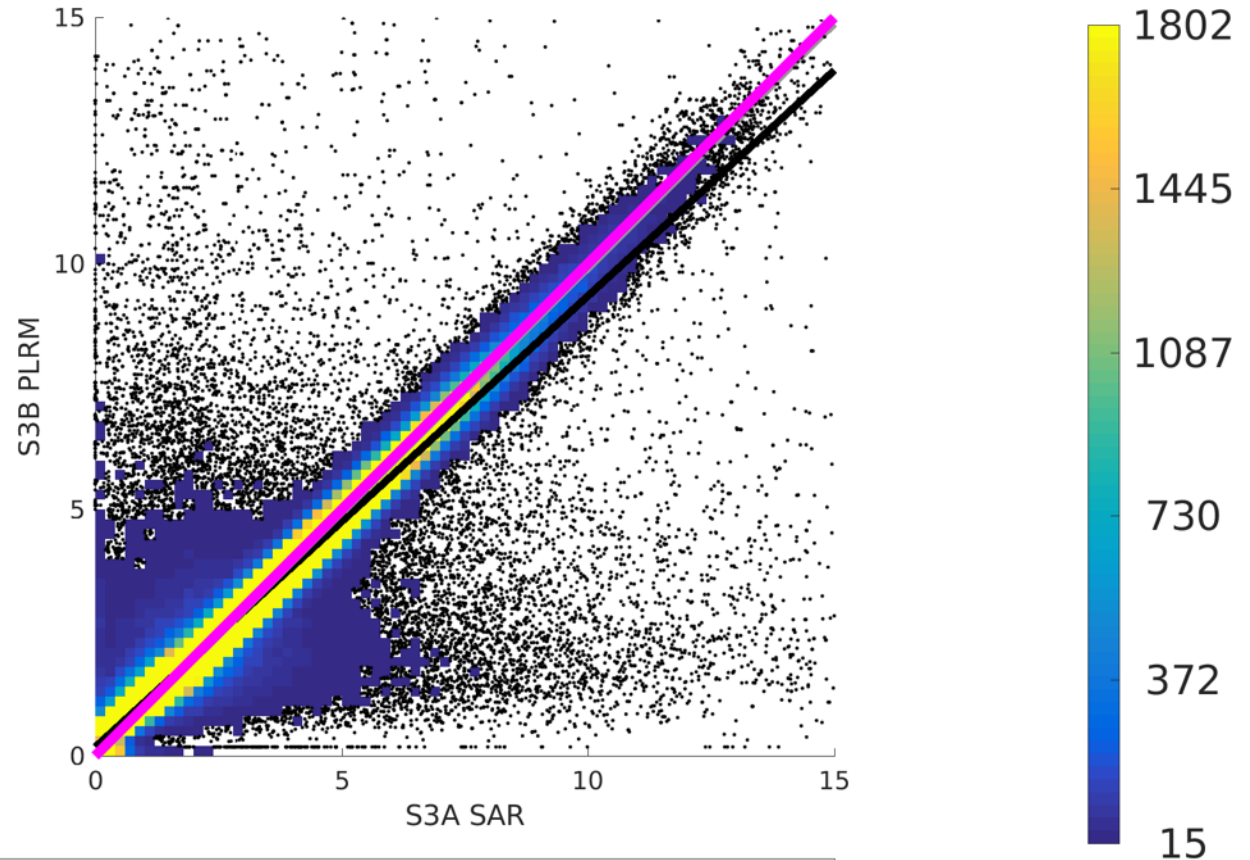
Median SWH (m) Correlation = 0.97 (N = 4038884). Bin size is 0.20



— S3B SAR = $0.96\text{S3A SAR} + 0.08$ (Mean S3B SAR is 2.65 ± 1.53)
— S3A SAR = $0.98\text{S3B SAR} + 0.07$ (Mean S3A SAR is 2.66 ± 1.54)
— Ref line ($y=x$)

SWH S3A SAR vs. S3B PLRM

Median SWH (m) Correlation = 0.96 (N = 4024826). Bin size is 0.20



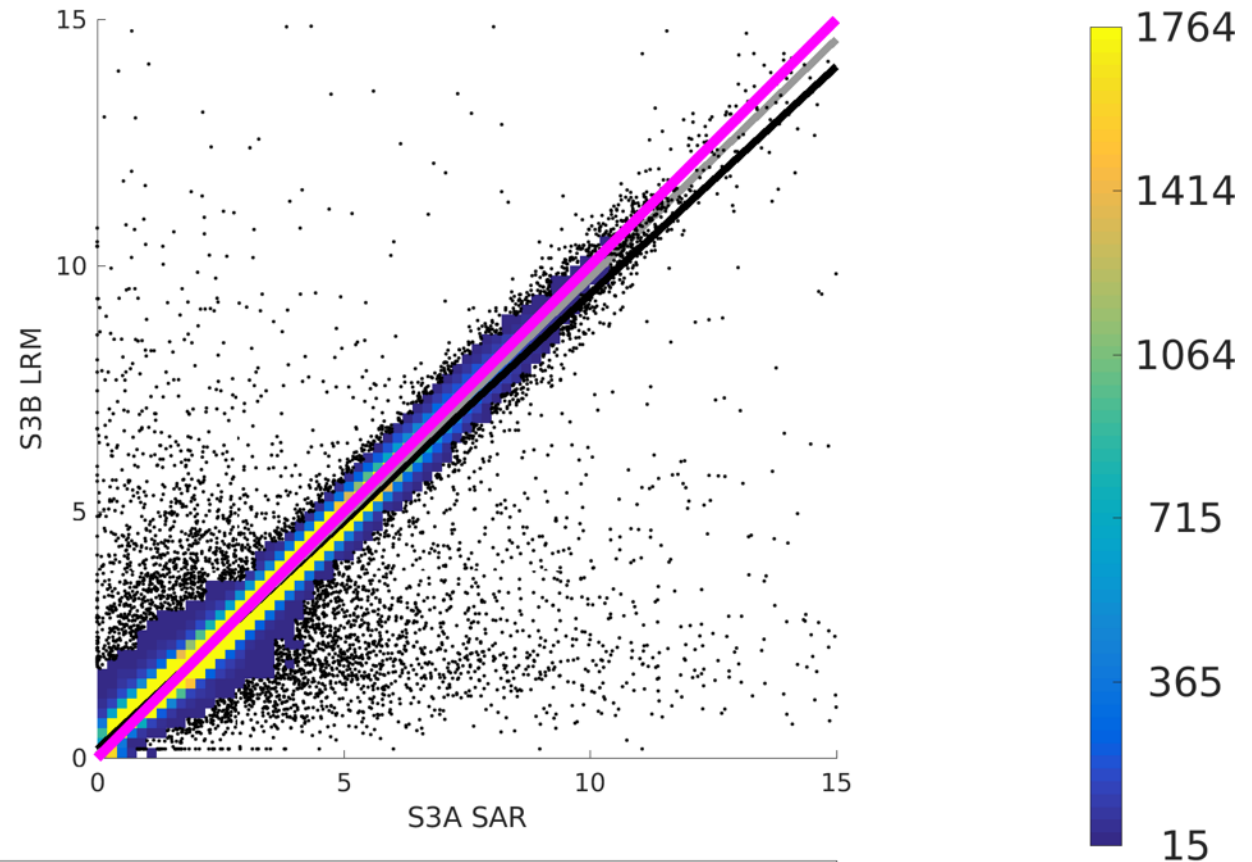
— $S3B\ PLRM = 0.92S3A\ SAR + 0.17$ (Mean S3B PLRM is 2.62 ± 1.47)
— $S3A\ SAR = 1.01S3B\ PLRM + 0.03$ (Mean S3A SAR is 2.67 ± 1.54)
— Ref line ($y=x$)

SWH S3A SAR vs. S3B LRM

Median SWH (m) Correlation = 0.98 (N = 1050428). Bin size is 0.20

Smaller number of
collocated samples during
the 4-week S3A SAR/S3B
LRM phase

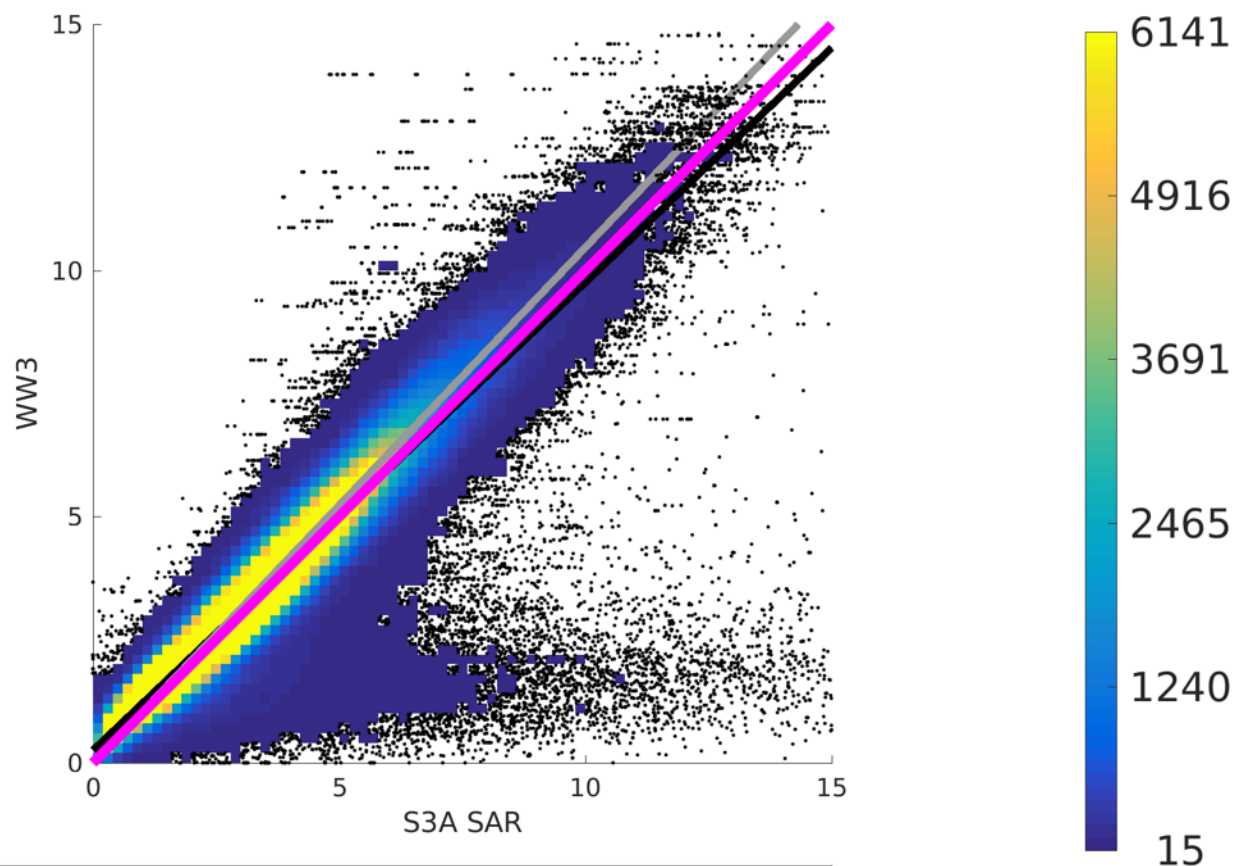
But still sufficient (> 1M)
to confirm excellent
agreement between SAR
and LRM SWH



— S3B LRM = $0.92S3A \text{ SAR} + 0.17$ (Mean S3B LRM is 2.67 ± 1.42)
— S3A SAR = $1.03S3B \text{ LRM} - 0.05$ (Mean S3A SAR is 2.71 ± 1.50)
— Ref line ($y=x$)

SWH S3A SAR vs. Hi-WW3

Median SWH (m) Correlation = 0.95 (N = 5582800). Bin size is 0.20



— WW3 = $0.95 \text{S3A SAR} + 0.25$ (Mean WW3 is 2.83 ± 1.53)
— S3A SAR = $0.95 \text{WW3} + 0.01$ (Mean S3A SAR is 2.71 ± 1.53)
— Ref line ($y=x$)



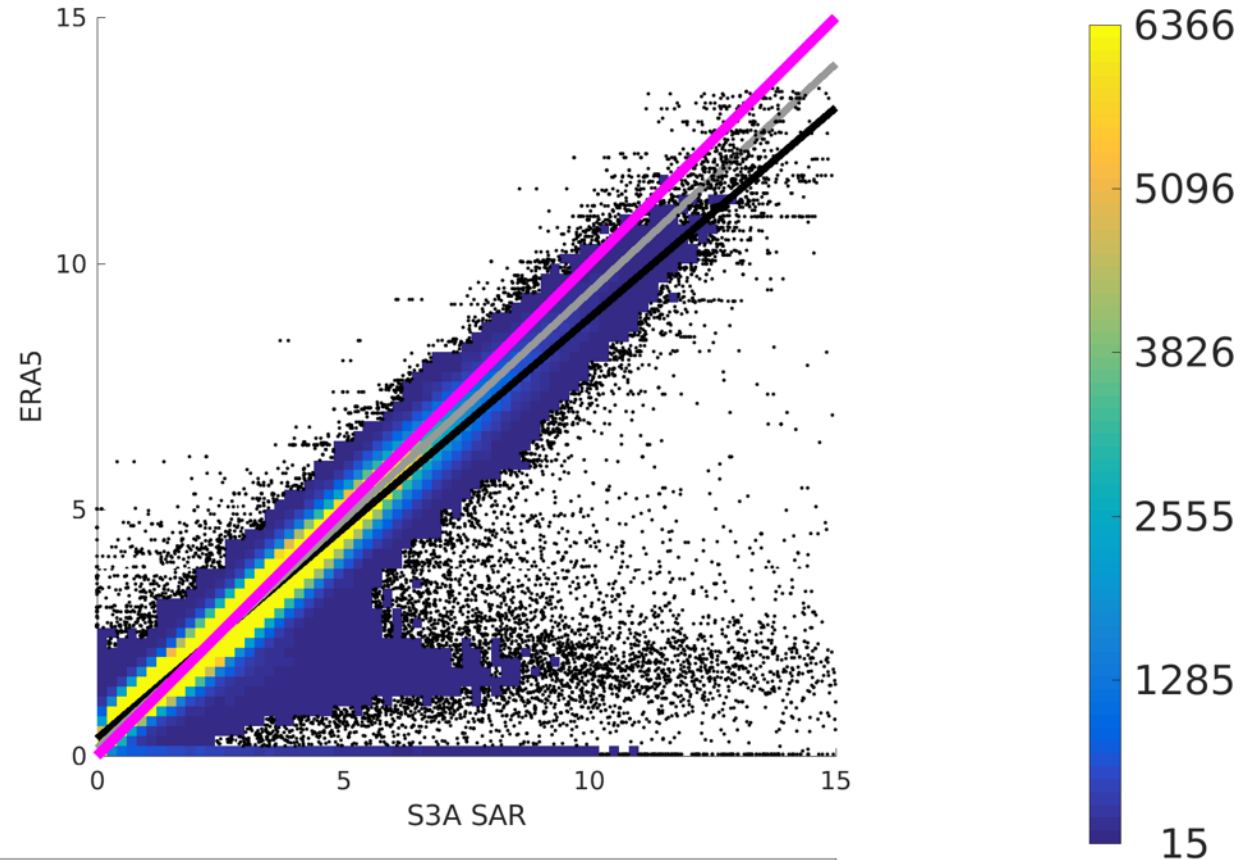
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SWH S3A SAR vs. ERA5

Median SWH (m) Correlation = 0.96 (N = 5662939). Bin size is 0.20



— ERA5 = $0.85S3A\ SAR + 0.35$ (Mean ERA5 is 2.64 ± 1.38)
— S3A SAR = $1.08ERA5 - 0.16$ (Mean S3A SAR is 2.69 ± 1.55)
— Ref line ($y=x$)

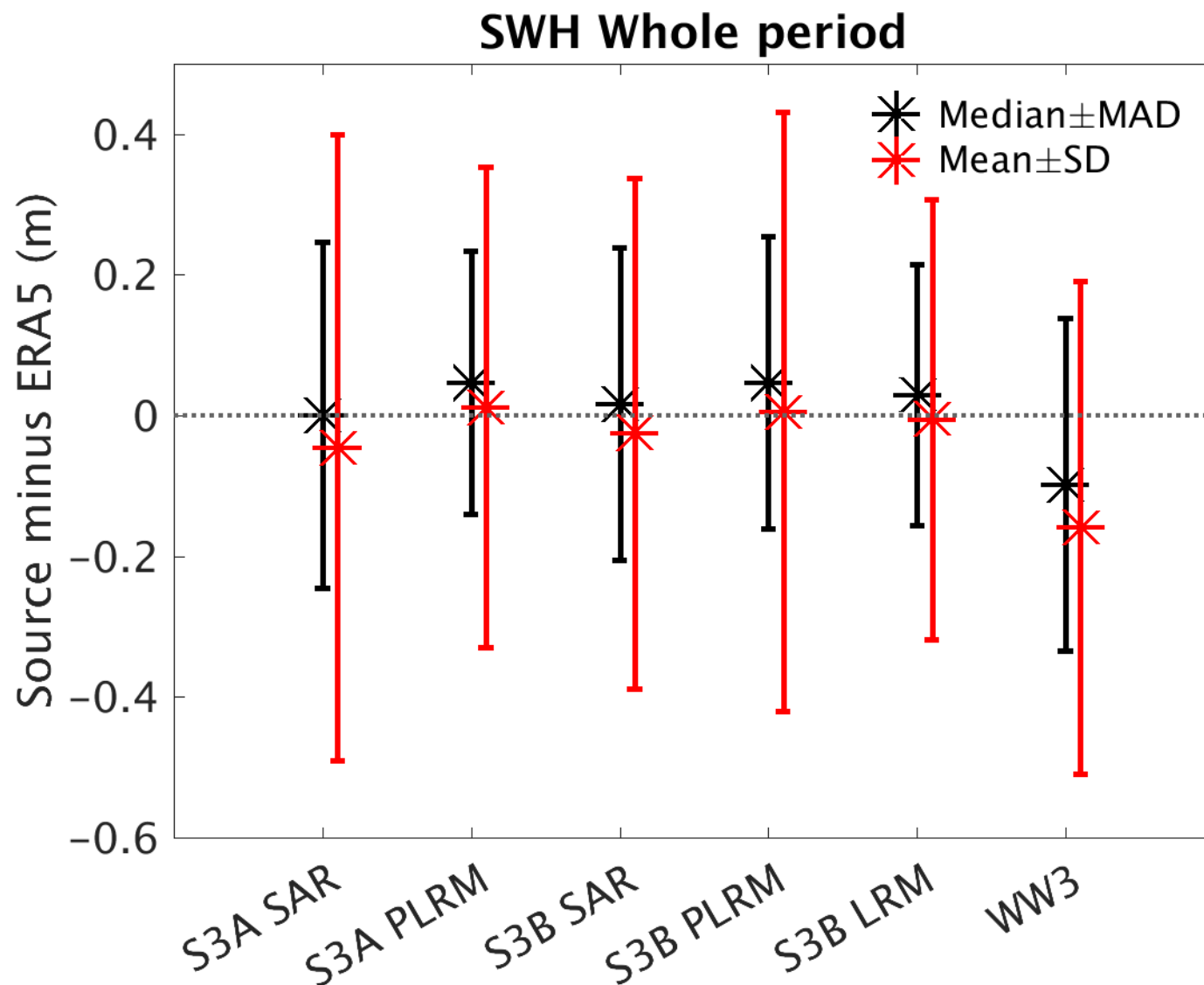


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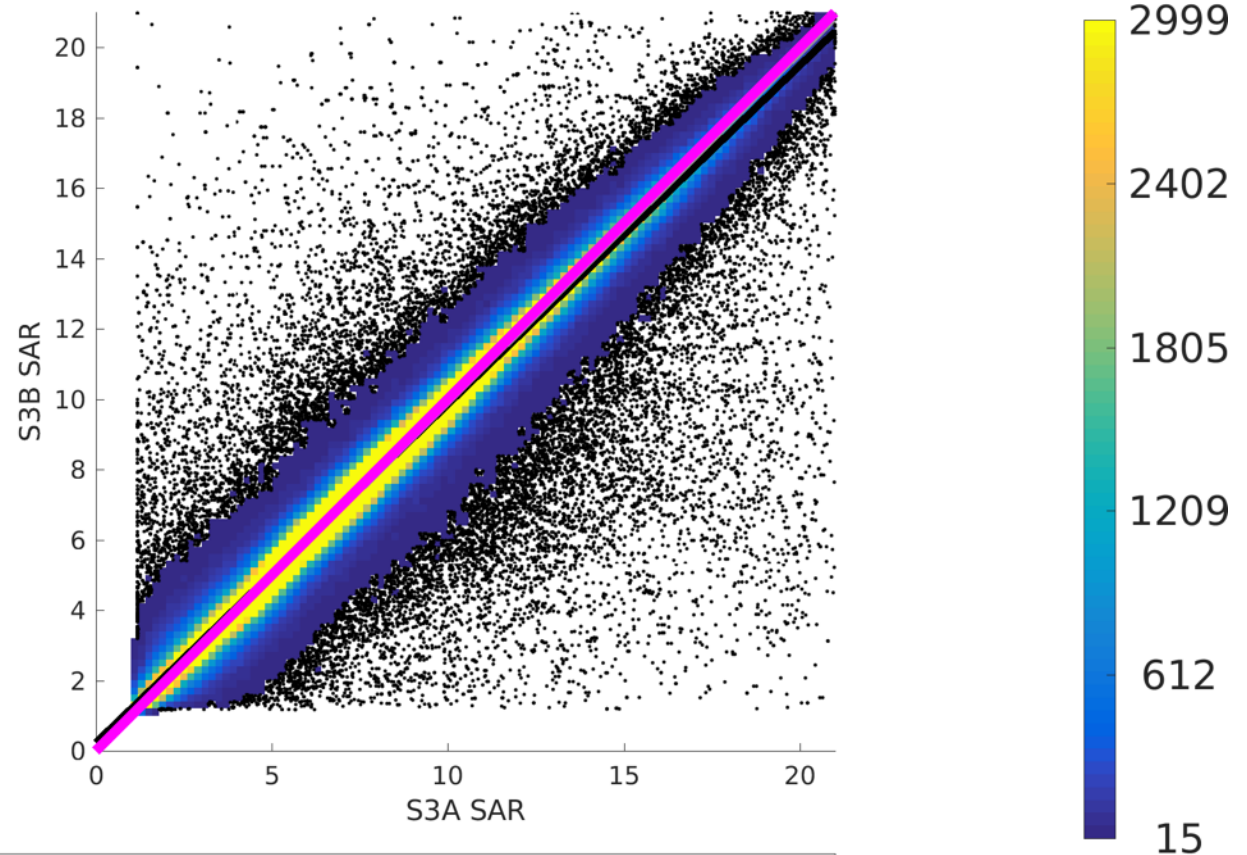
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ERA5 SWH Differences



Wind speed S3A SAR vs. S3B SAR

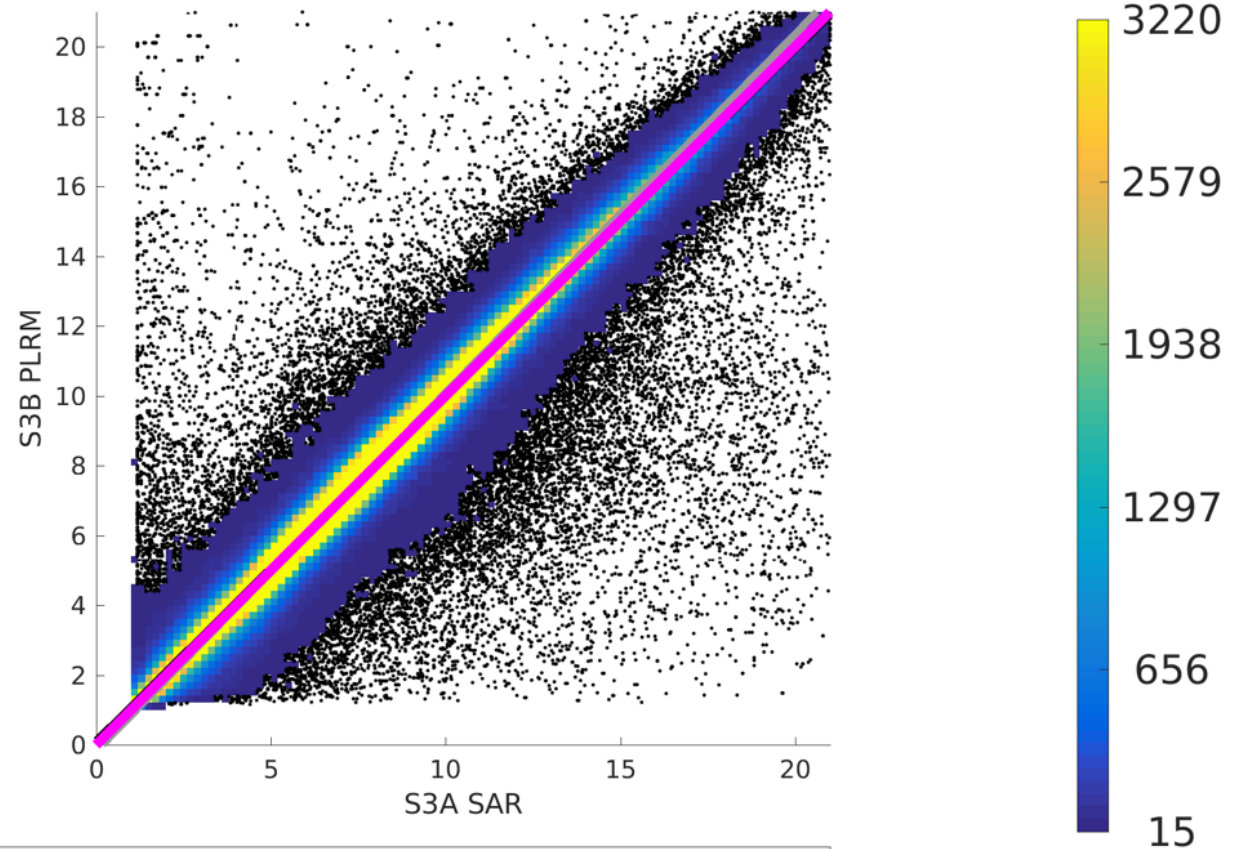
Median windspeed (m/s) Correlation = 0.98 (N = 3980318). Bin size is 0.20



— S3B SAR = $0.96\text{S3A SAR} + 0.23$ (Mean S3B SAR is 7.88 ± 3.47)
— S3A SAR = $1.01\text{S3B SAR} + 0.03$ (Mean S3A SAR is 7.95 ± 3.55)
— Ref line ($y=x$)

Wind speed S3A SAR vs. S3B PLRM

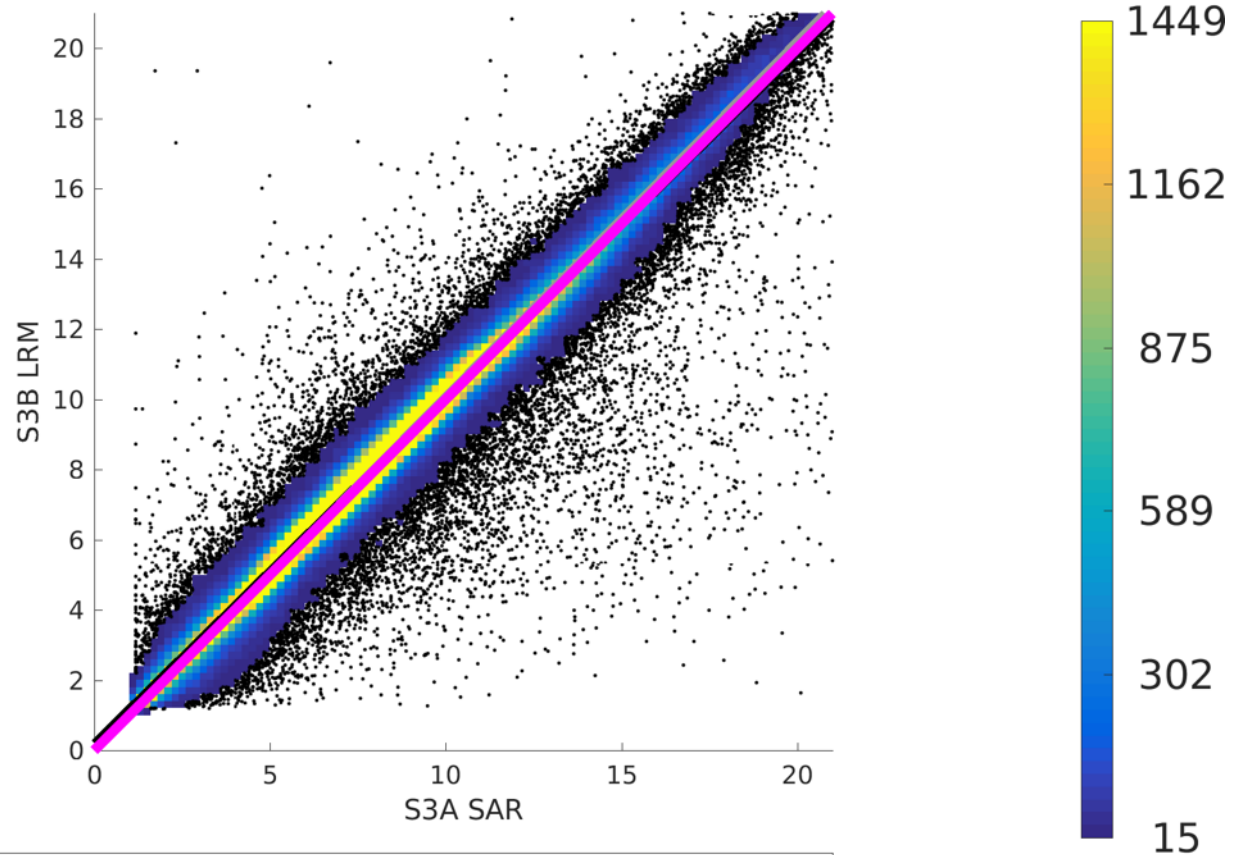
Median windspeed (m/s) Correlation = 0.98 (N = 3987368). Bin size is 0.20



— S3B PLRM = $0.99\text{S3A SAR} + 0.11$ (Mean S3B PLRM is 7.98 ± 3.59)
— S3A SAR = $0.97\text{S3B PLRM} + 0.18$ (Mean S3A SAR is 7.94 ± 3.56)
— Ref line ($y=x$)

Wind speed S3A SAR vs. S3B LRM

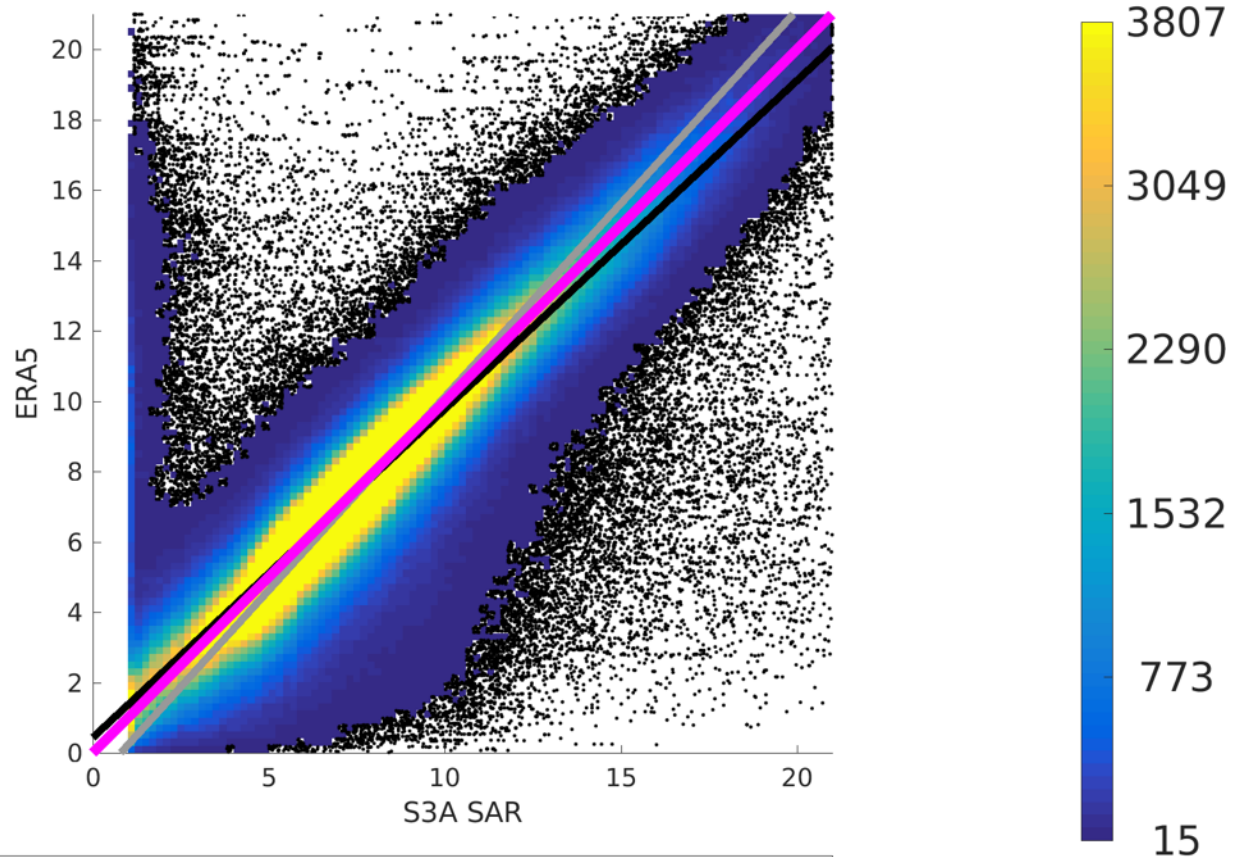
Median windspeed (m/s) Correlation = 0.99 (N = 1041771). Bin size is 0.20



— S3B LRM = $0.98S3A\ SAR + 0.21$ (Mean S3B LRM is 8.12 ± 3.50)
— S3A SAR = $0.99S3B\ LRM + 0.02$ (Mean S3A SAR is 8.05 ± 3.51)
— Ref line ($y=x$)

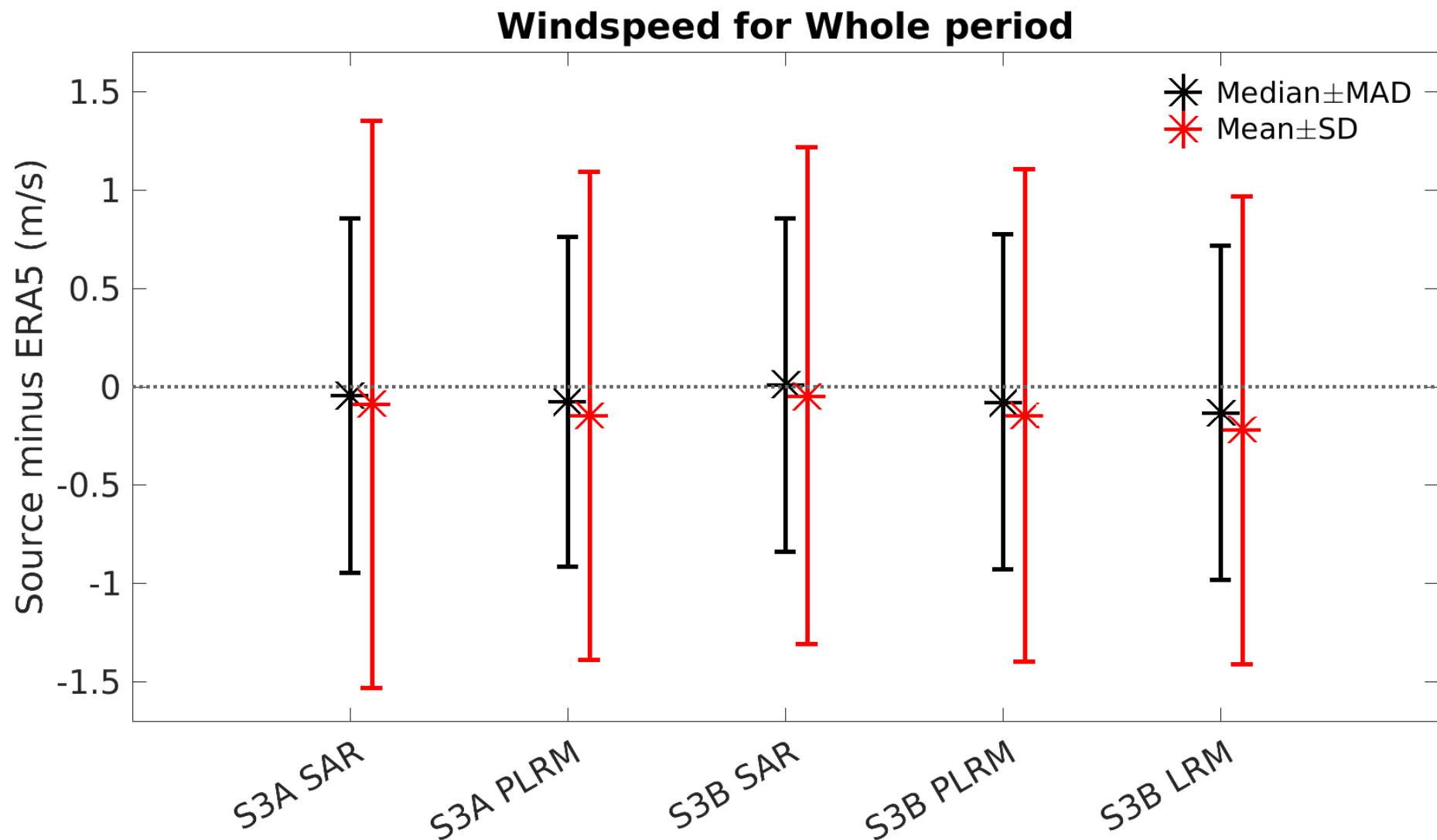
Wind speed S3A SAR vs. ERA5

Median windspeed (m/s) Correlation = 0.92 (N = 5662939). Bin size is 0.20



— ERA5 = $0.93\text{S3A SAR} + 0.43$ (Mean ERA5 is 7.79 ± 3.67)
— S3A SAR = $0.91\text{ERA5} + 0.79$ (Mean S3A SAR is 7.88 ± 3.62)
— Ref line ($y=x$)

ERA5 Wind speed Differences



Summary

- **Sentinel-3 Tandem phase reveals excellent agreement between altimeters on S3A and S3B for SWH and wind speed**
 - difficult to assess to this level of detail by other means
- **Very good agreement between SAR and P-LRM for both S3A and S3B**
 - SAR SWH still occasionally biased high in low sea states
- **Special S3A SAR/S3B LRM dataset especially useful and encouraging**
 - Further work to study SAR/LRM in different sea states
- **Comparisons with models (Hi-WW3, ERA5) reveal various issues with wave model data**
 - Tandem phase provides critical means to ensure consistency between successive missions



Next steps

- **Refine analyses by oceanic basin and by month/seasons**
- **Collocate with buoys for validation and error estimation**
 - Including triple collocation
- **Characterise SAR/LRM/P-LRM differences in terms of spatial distribution and wave climate**



- **Thanks to members of Sentinel 3 Tandem for Climate project team**

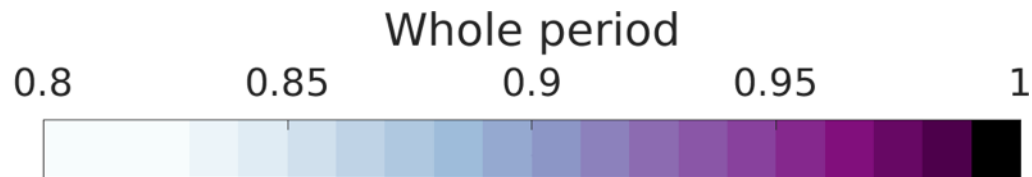
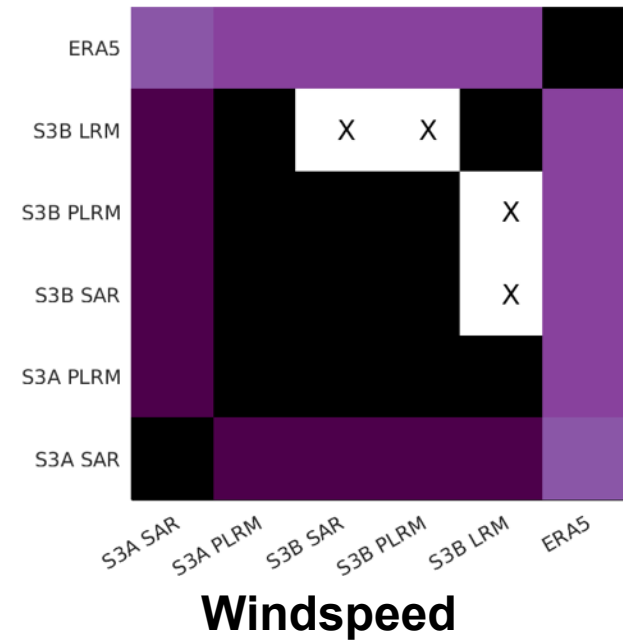
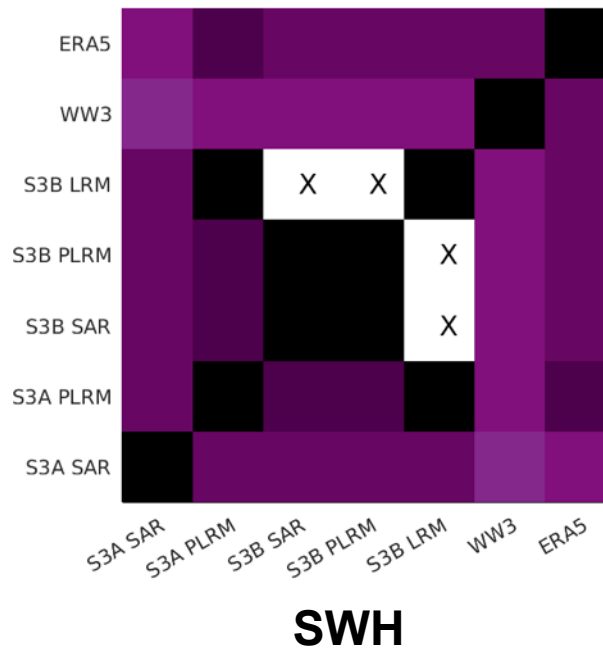
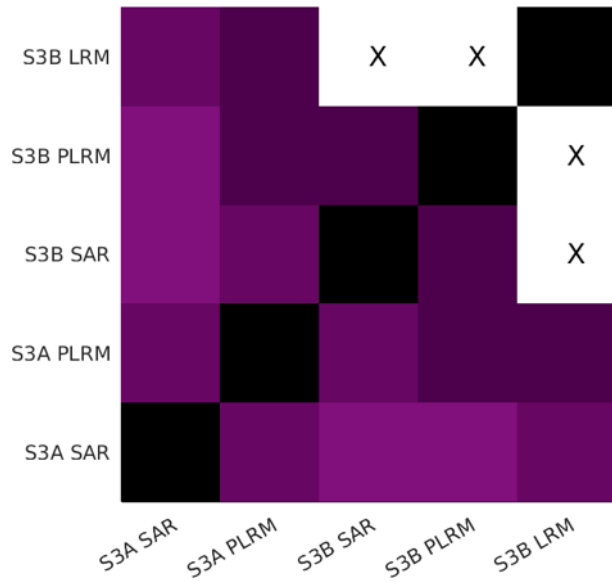


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Correlation



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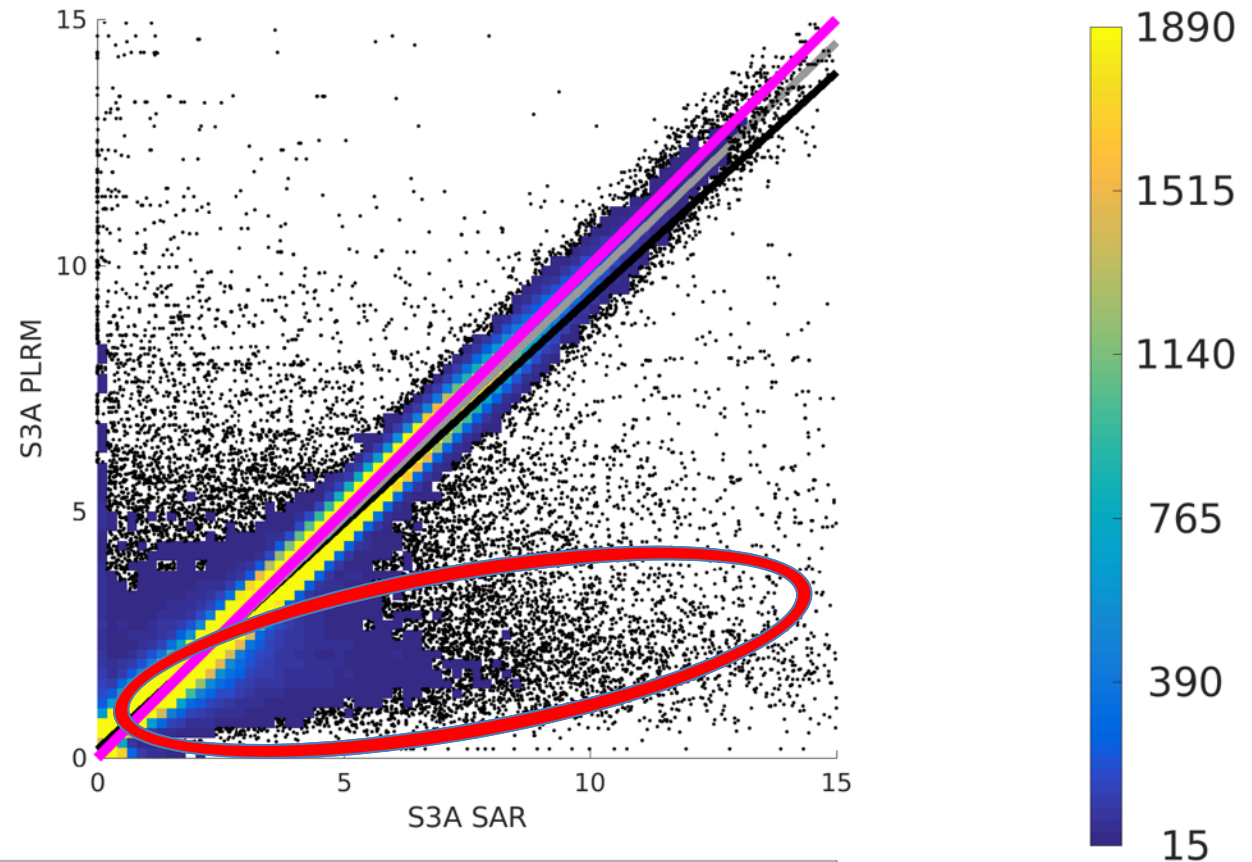
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SWH S3A SAR vs. S3A PLRM

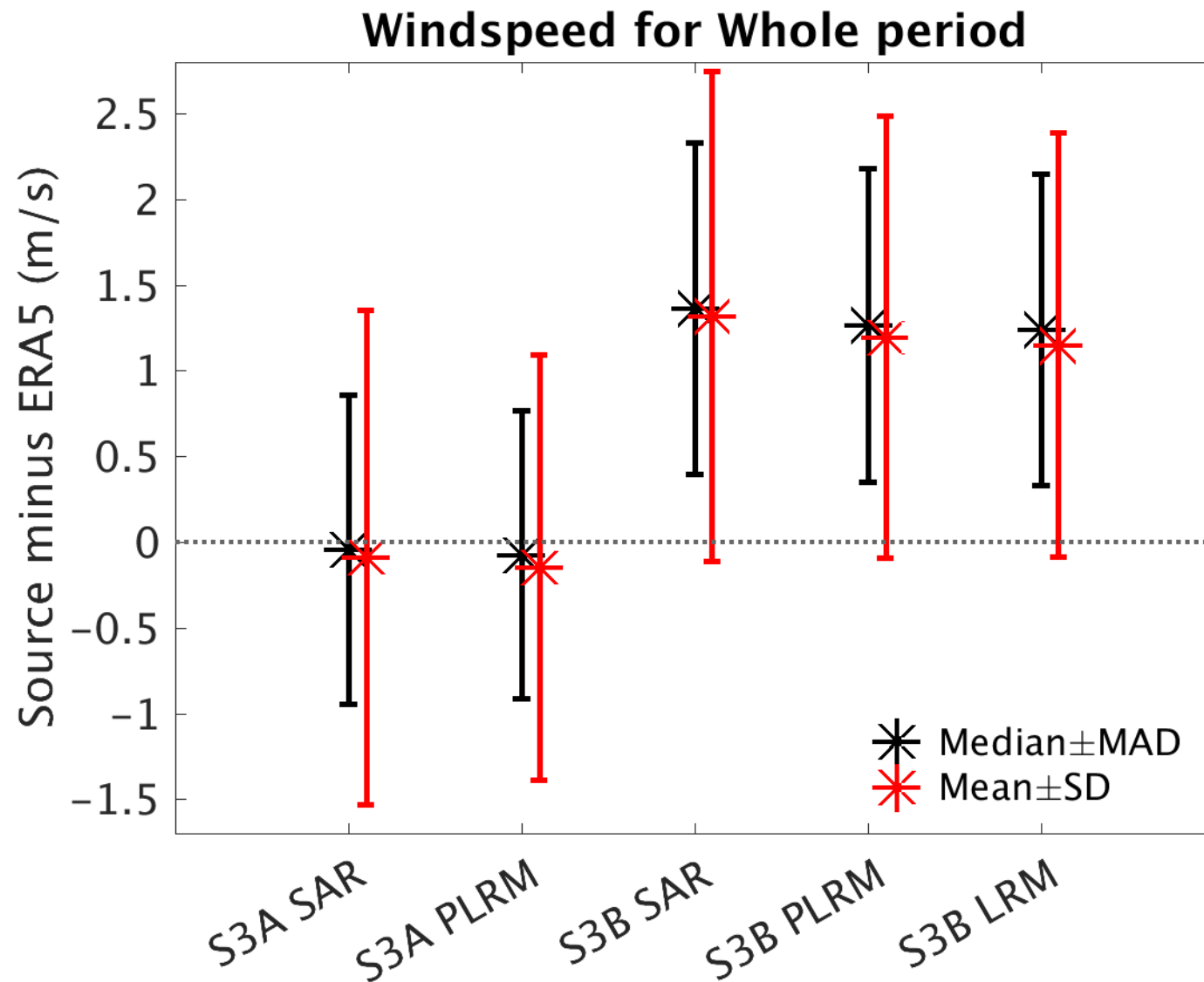
Median SWH (m) Correlation = 0.97 (N = 5646332). Bin size is 0.20

Chris, I don't think you should show this. S3A SAR v S3A PLRM has been shown many times before and is not relevant in this talk about the Tandem phase. Stick to S3A v S3B, it will make it a lot easier for people to follow the next few slides.



- S3A PLRM = $0.92S3A\ SAR + 0.17$ (Mean S3A PLRM is 2.64 ± 1.45)
- S3A SAR = $1.03S3A\ PLRM - 0.04$ (Mean S3A SAR is 2.69 ± 1.54)
- Ref line ($y=x$)

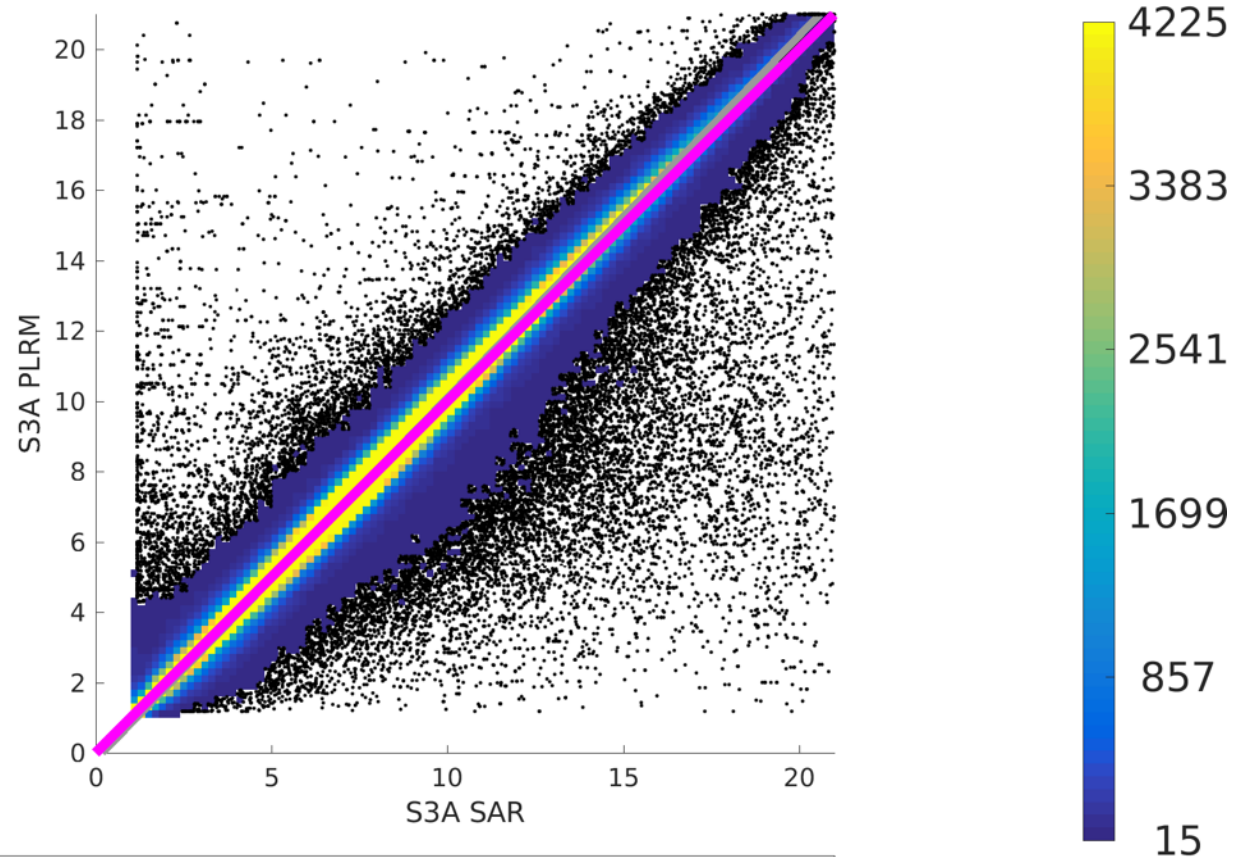
ERA5 Wind speed Differences - OLD



Wind speed S3A SAR vs. S3A PLRM

Median windspeed (m/s) Correlation = 0.99 (N = 5646334). Bin size is 0.20

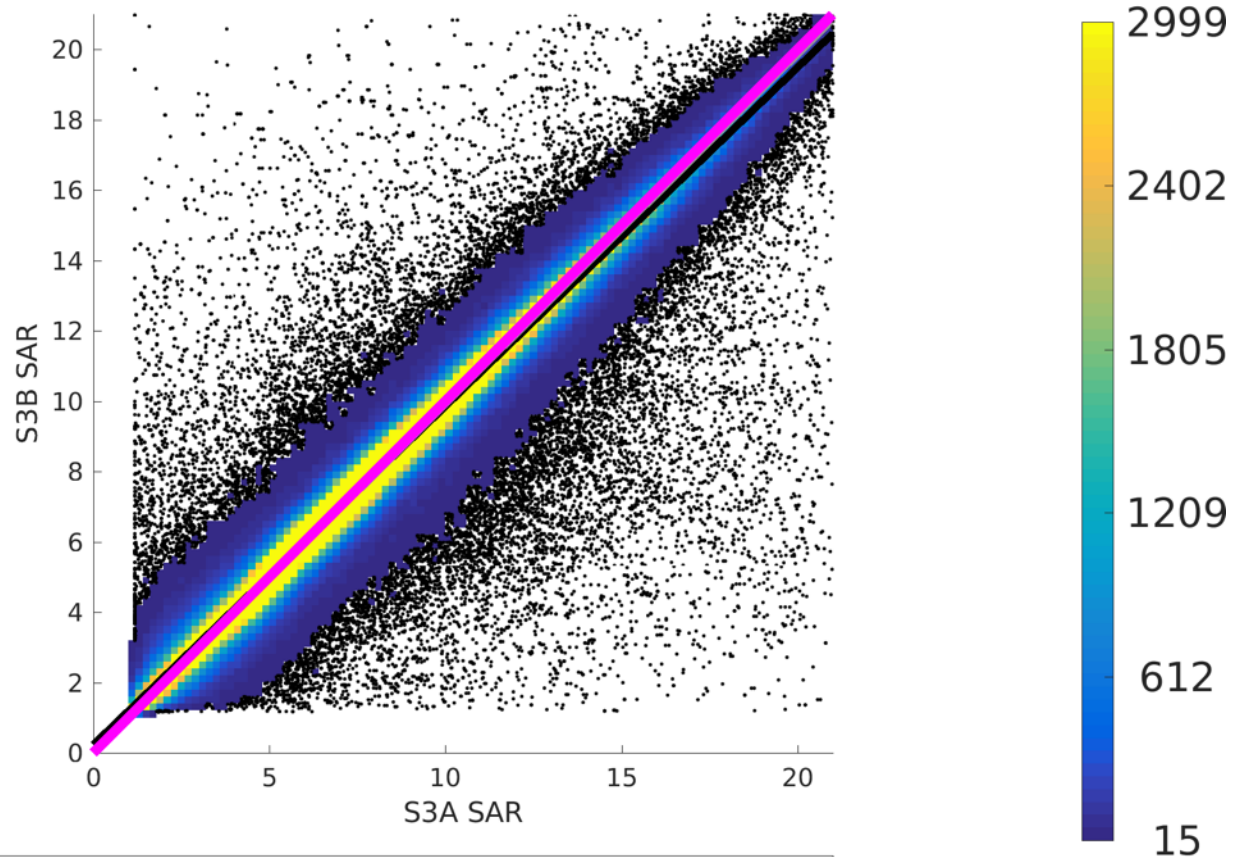
Chris, same comment as
Slide 5 I.e. do not show
S3A v S3A results in
Tandem phase talk



— $S3A\ PLRM = 1.00S3A\ SAR + 0.01$ (Mean S3A PLRM is 7.93 ± 3.66)
- - $S3A\ SAR = 0.97S3A\ PLRM + 0.19$ (Mean S3A SAR is 7.90 ± 3.61)
— Ref line ($y=x$)

Sigma0 S3A SAR vs. S3B SAR

Median windspeed (m/s) Correlation = 0.98 (N = 3980318). Bin size is 0.20



— $S3B\ SAR = 0.96S3A\ SAR + 0.23$ (Mean S3B SAR is 7.88 ± 3.47)
— $S3A\ SAR = 1.01S3B\ SAR + 0.03$ (Mean S3A SAR is 7.95 ± 3.55)
— Ref line ($y=x$)