CP40 WP4000

SAR over open & coastal ocean

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WP4 Objectives & Approach

- Objectives
  - analyse Cryosat-2 Level 2 SAR retracked parameters for various L2 processing choices
  - evaluate the Cryosat-2 Level 2 SAR retracked parameters against independent measurements from in situ sources and other satellites
- Approach
  - Cryosat-2 SAR L2 data:
    - CNES and ESRIN SAR retrackers applied to CNES CPP L1B waveforms
    - ESRIN SAR retracker applied to ESRIN L1B waveforms (from FBR)
  - Compare Cryosat-2 SAR L2 products against measurements from buoys, tide gauges and other satellites.
    - focus on Sea Surface Height (SSH), Significant Wave Height (SWH) and Received Power (Pu)

WP4 Development choices & Trade-offs

Run reference	C2 L1B product	L2 SAR retracker model	Alpha_p LUT	Peel effect applied	Motivation
CNES	CPP	Numerical retracker	N/A	N/A	N/A
ESRIN R1	CPP	ESRIN SAM2	Yes	Yes	Full SAMOSA analytical model (Gaussian waves statistics)
NOC R2	CPP	NOC SAM3	No	No	Consistent with S3 DPM except for treatment of Thermal Noise. Only small dataset available for benchmarking.
ESRIN R3	CPP	ESRIN SAM3	Yes	Yes	To quantify impact on retrieval of omitting f1 term in SAMOSA3
ESRIN R4	CPP	ESRIN SAM3	Yes	No	Consistent with S3 DPM but with inclusion of alpha_p LUT
ESRIN R6	CPP	ESRIN SAM3	No	No	Consistent with S3 DPM baseline
ESRIN R5	ESRIN FBR	ESRIN SAM2	Yes	Yes	To explore impact at L2 of L1B processing choices

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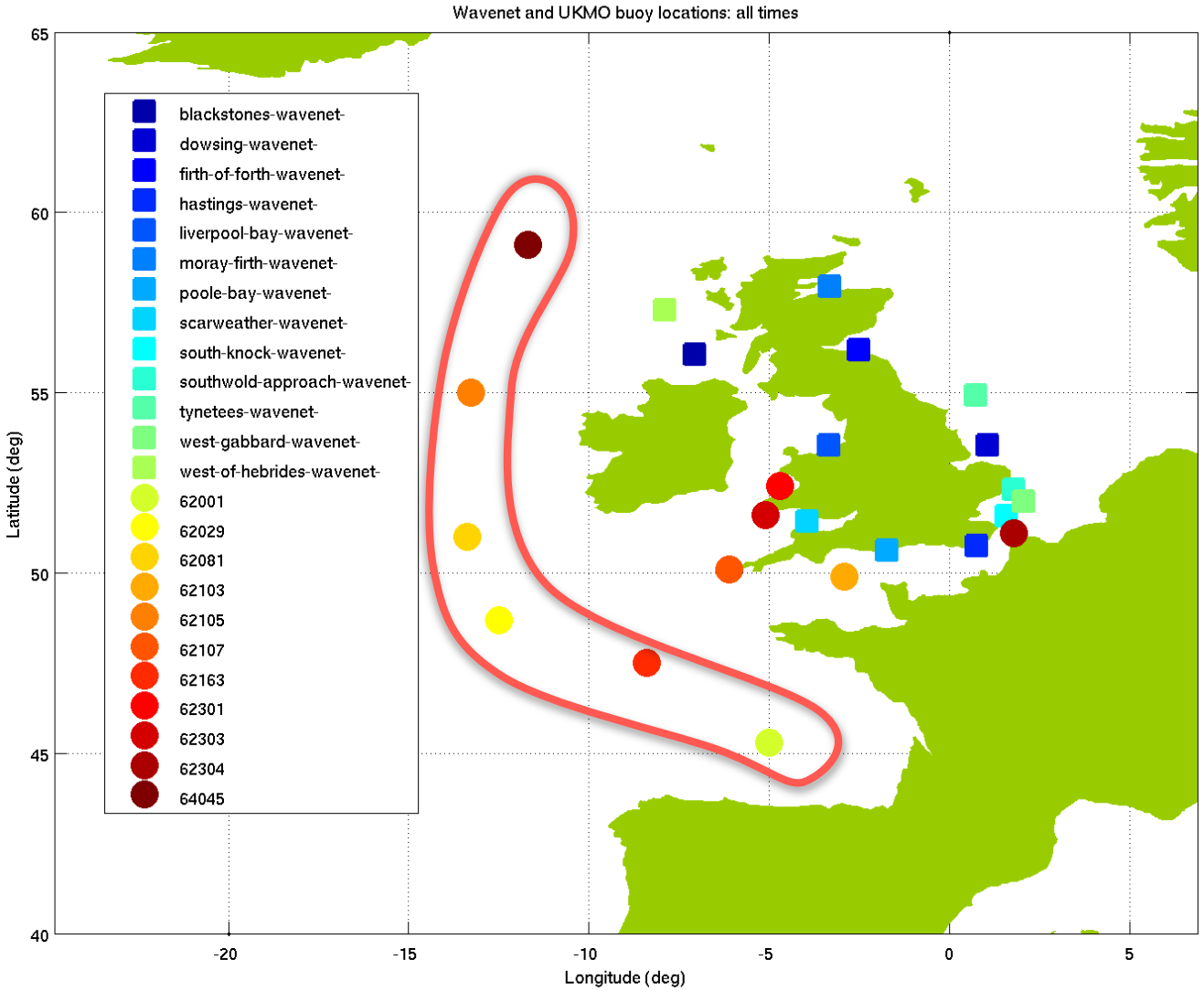
CPP SAR data North-East Atlantic

- July 2012 & Jan 2013
- Validation around the UK
- Diagnostics
  - Inter-comparison of different SAR L2 products
  - Validation of SAR SWH against buoys in the open ocean and offshore
  - SSH/SWH noise against other satellites (Jason-2)
    - No ENVISAT, no Alti-Ka over those two months



- Open ocean buoys
- Offshore buoys
- Coastal buoys (not shown)

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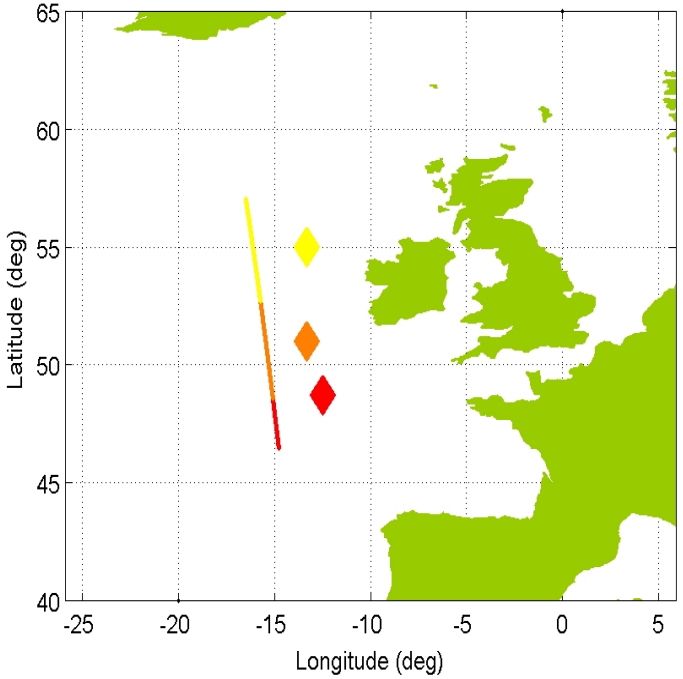

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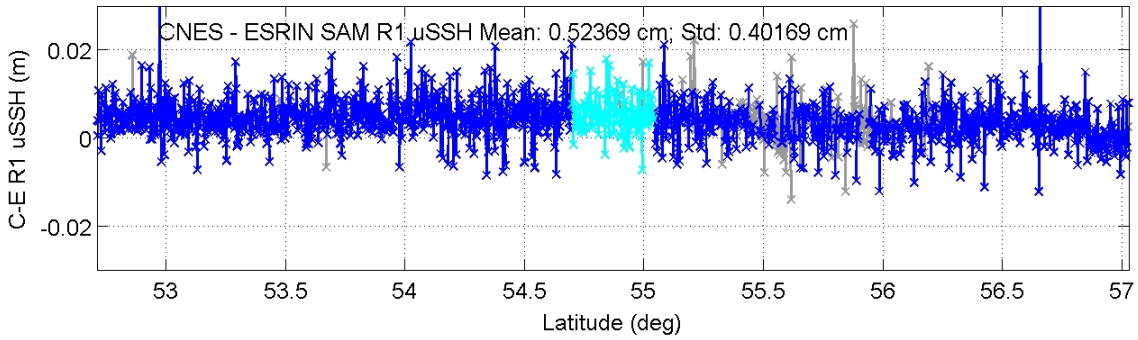

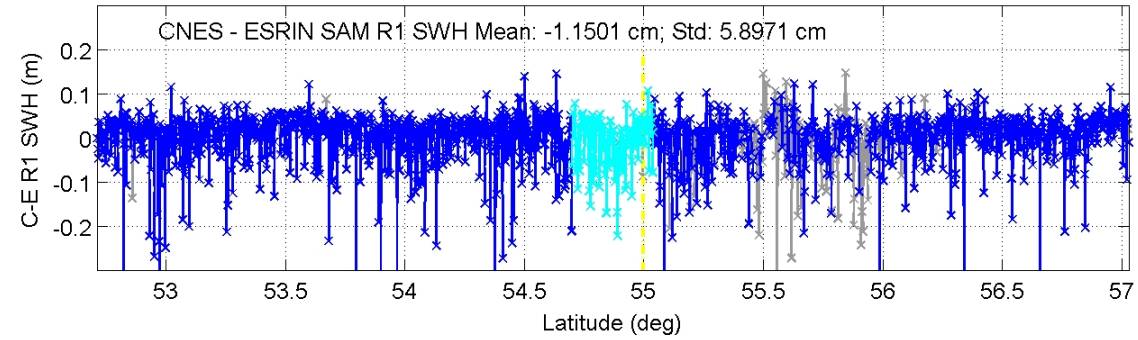

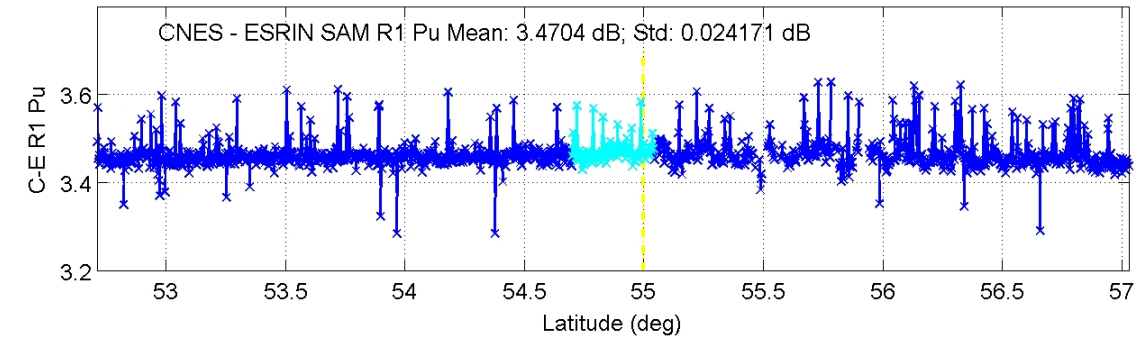

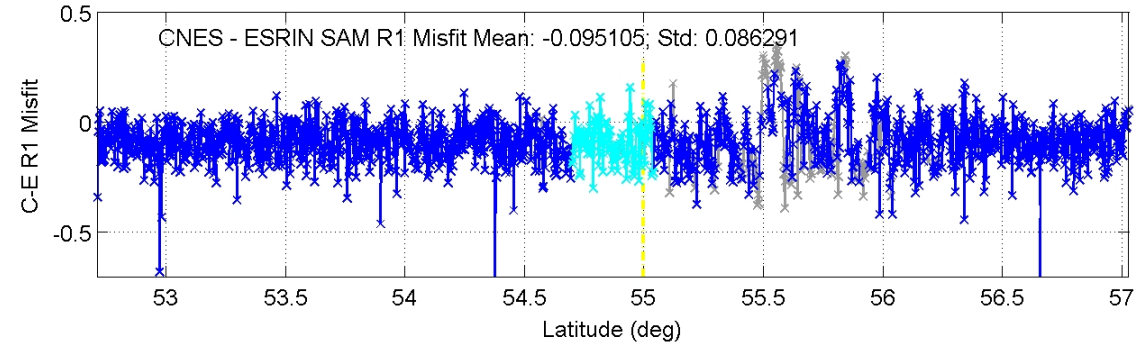

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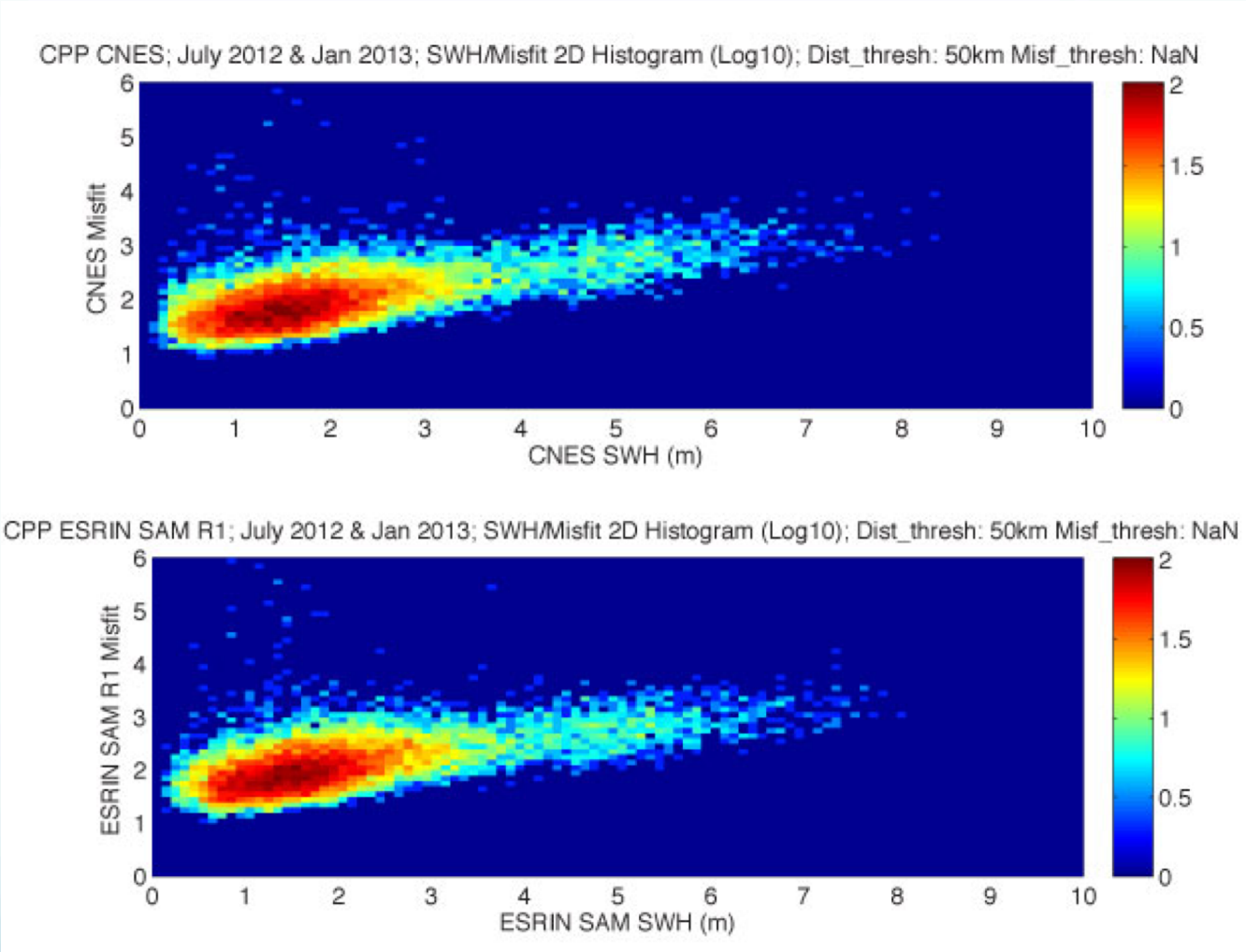
Misfit v SWH



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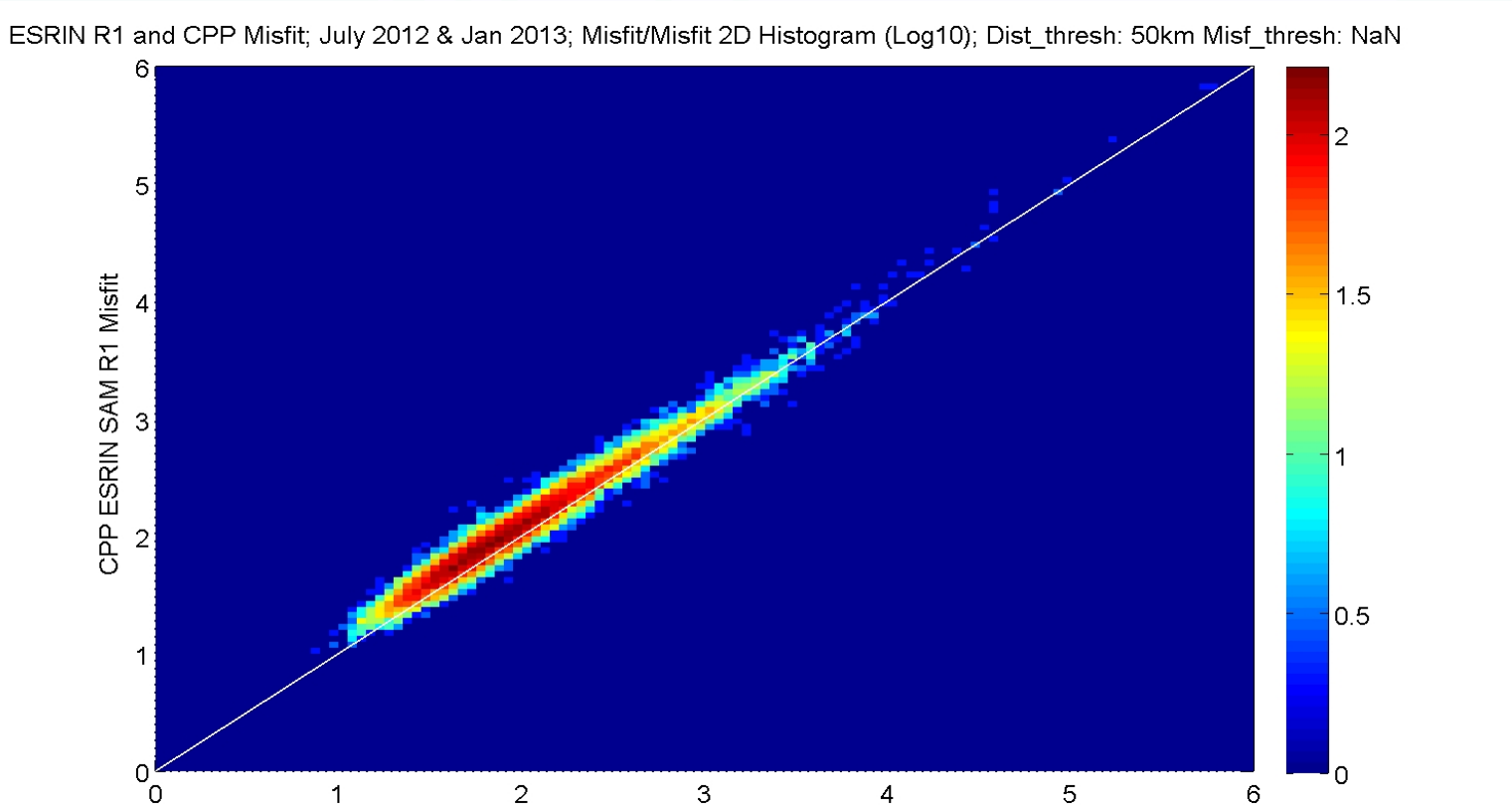
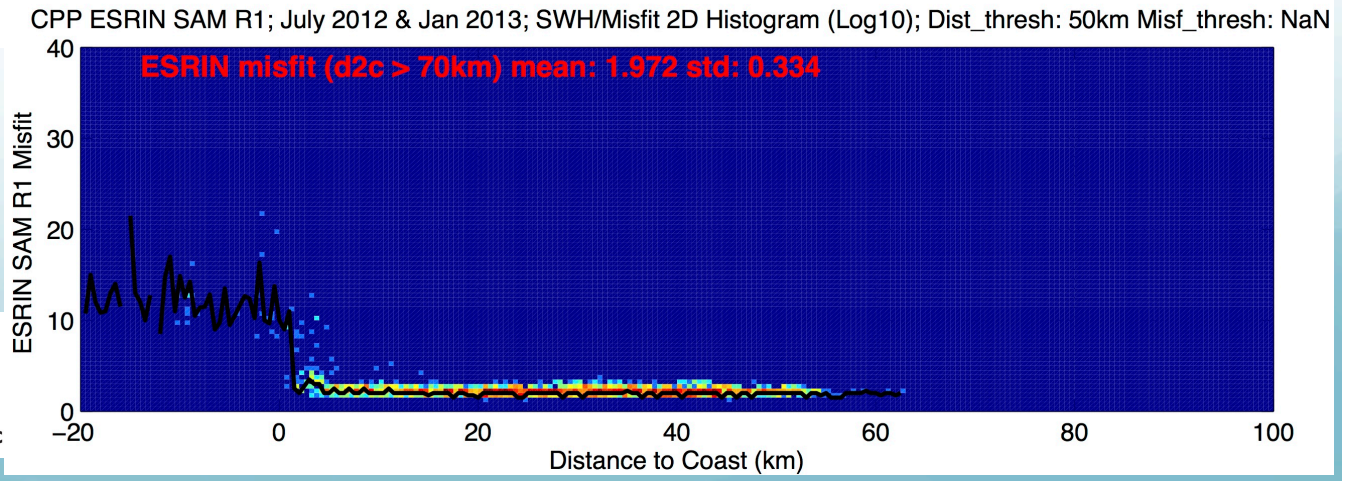
Misfit





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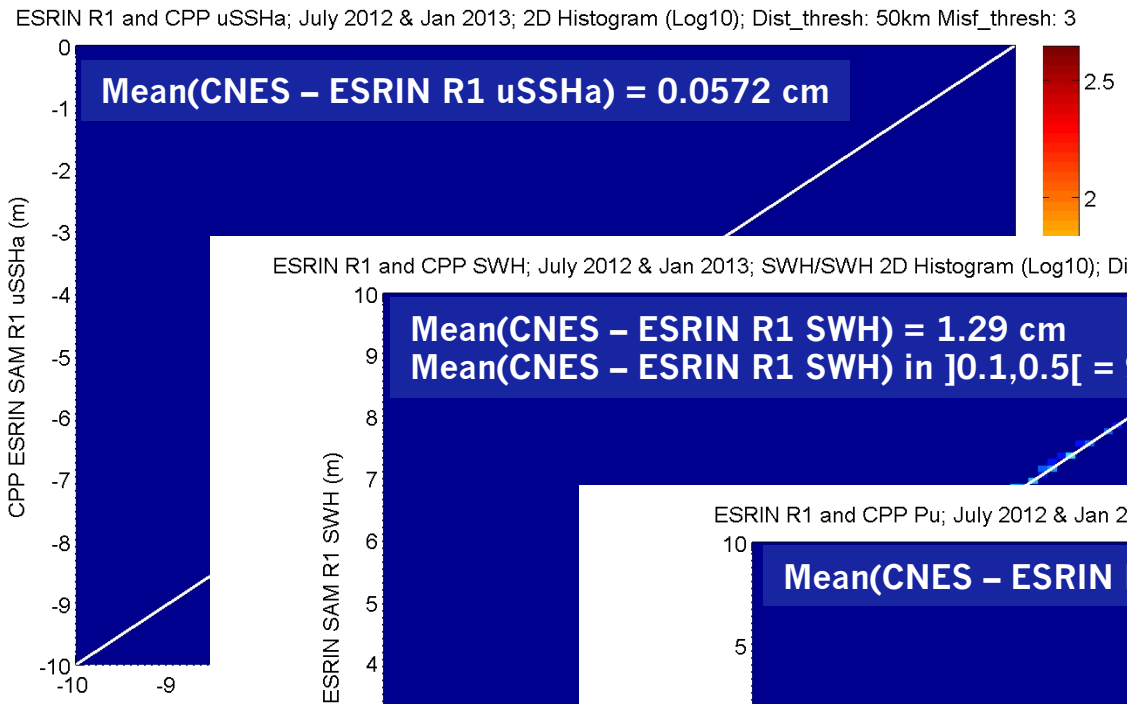
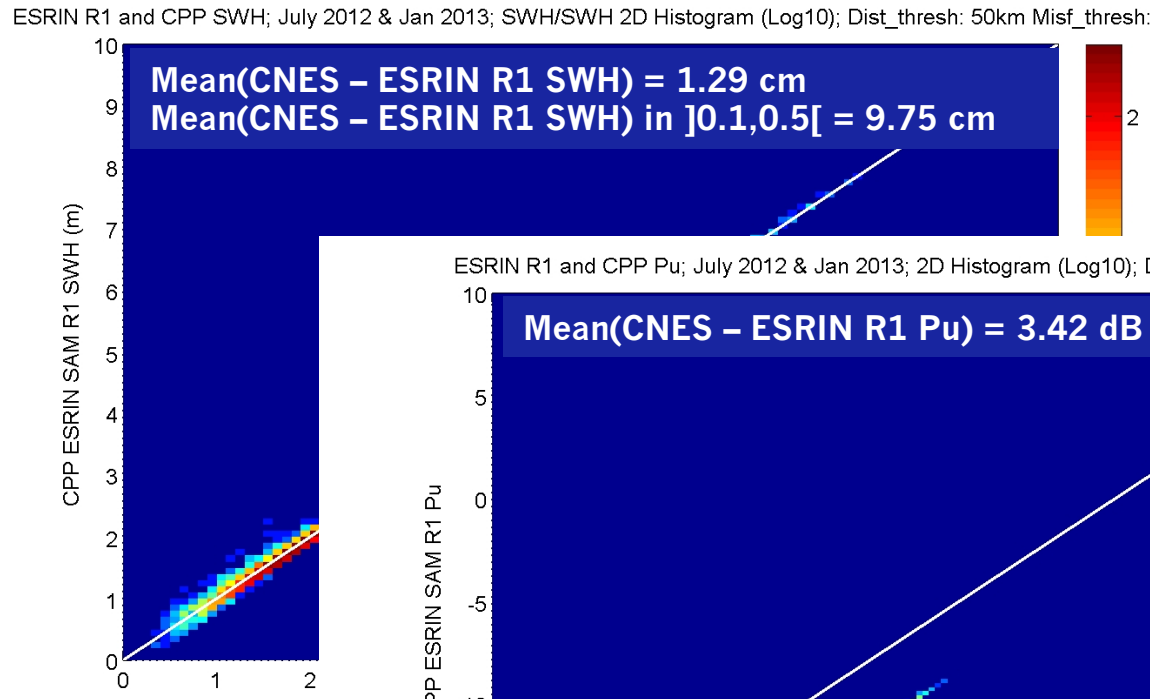
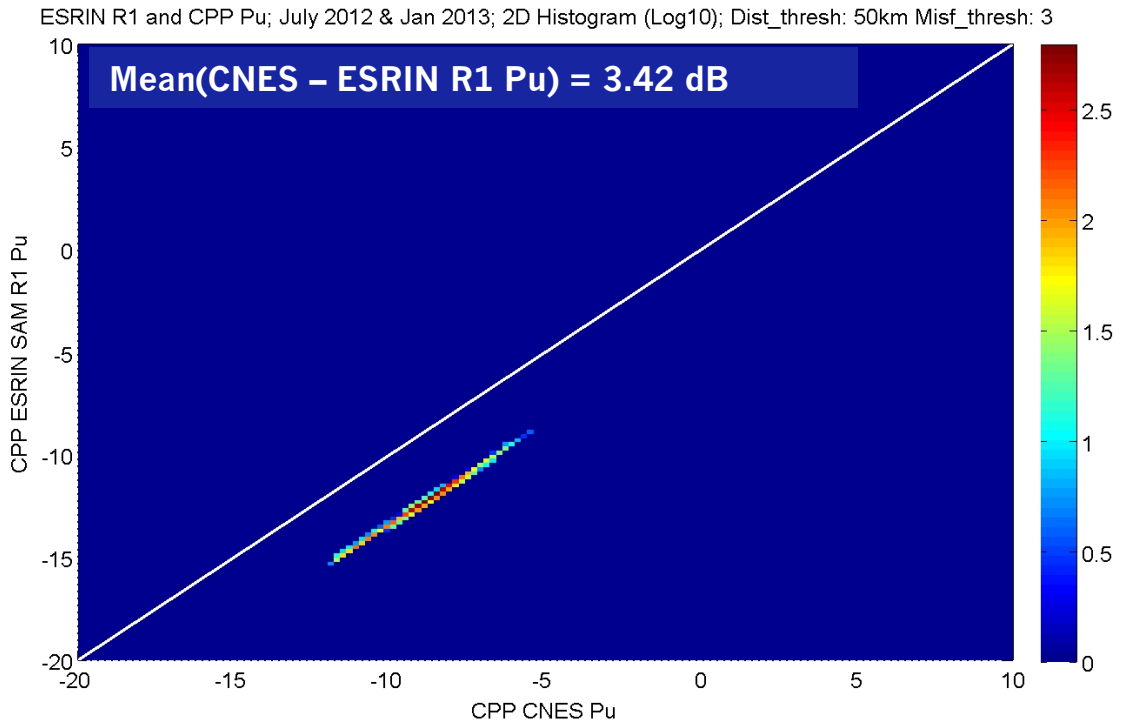
uSSHa, SWH and Pu







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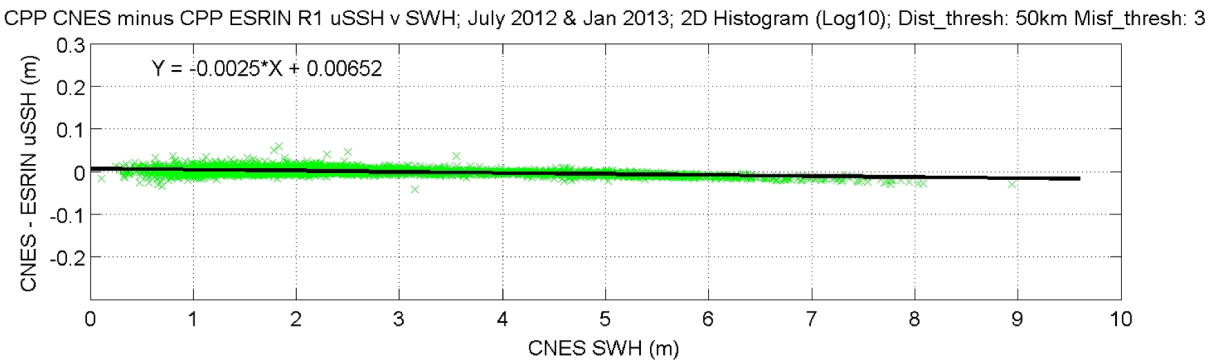
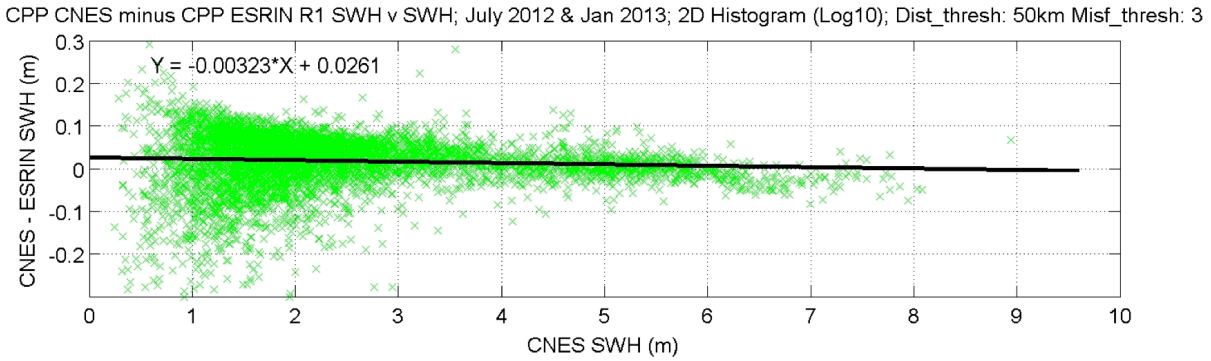
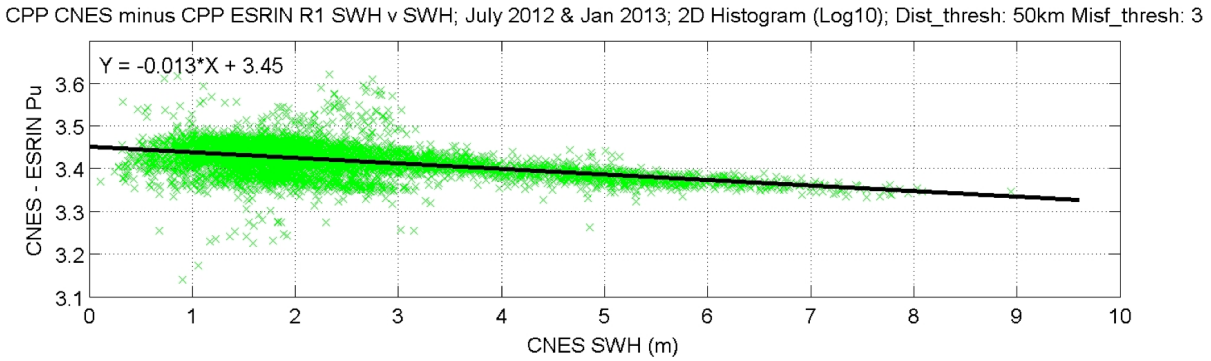
CNES- ESRIN trends







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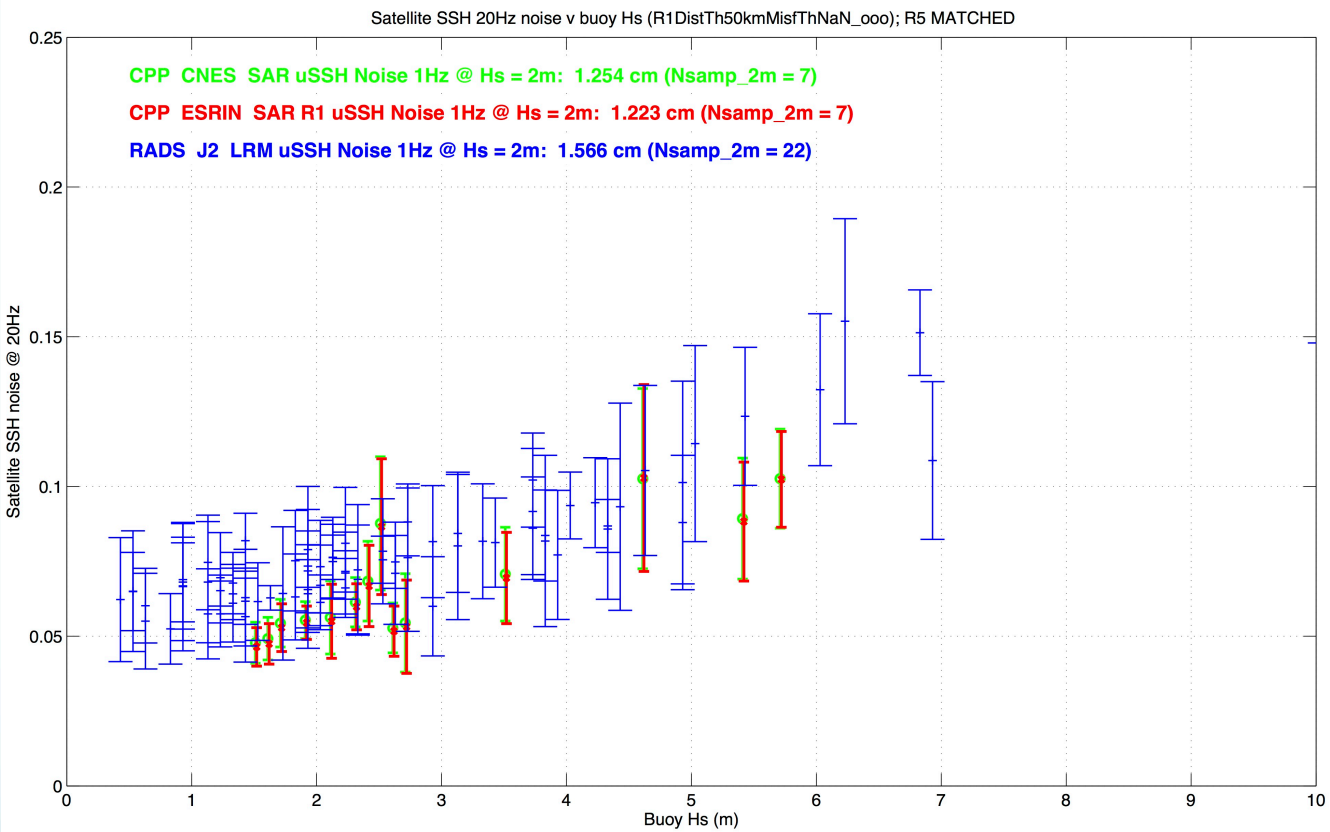
SSH Noise v SWH



- Exact match in outlier removal
- Exact match in make-up of collocated dataset for all runs including R5/FBR

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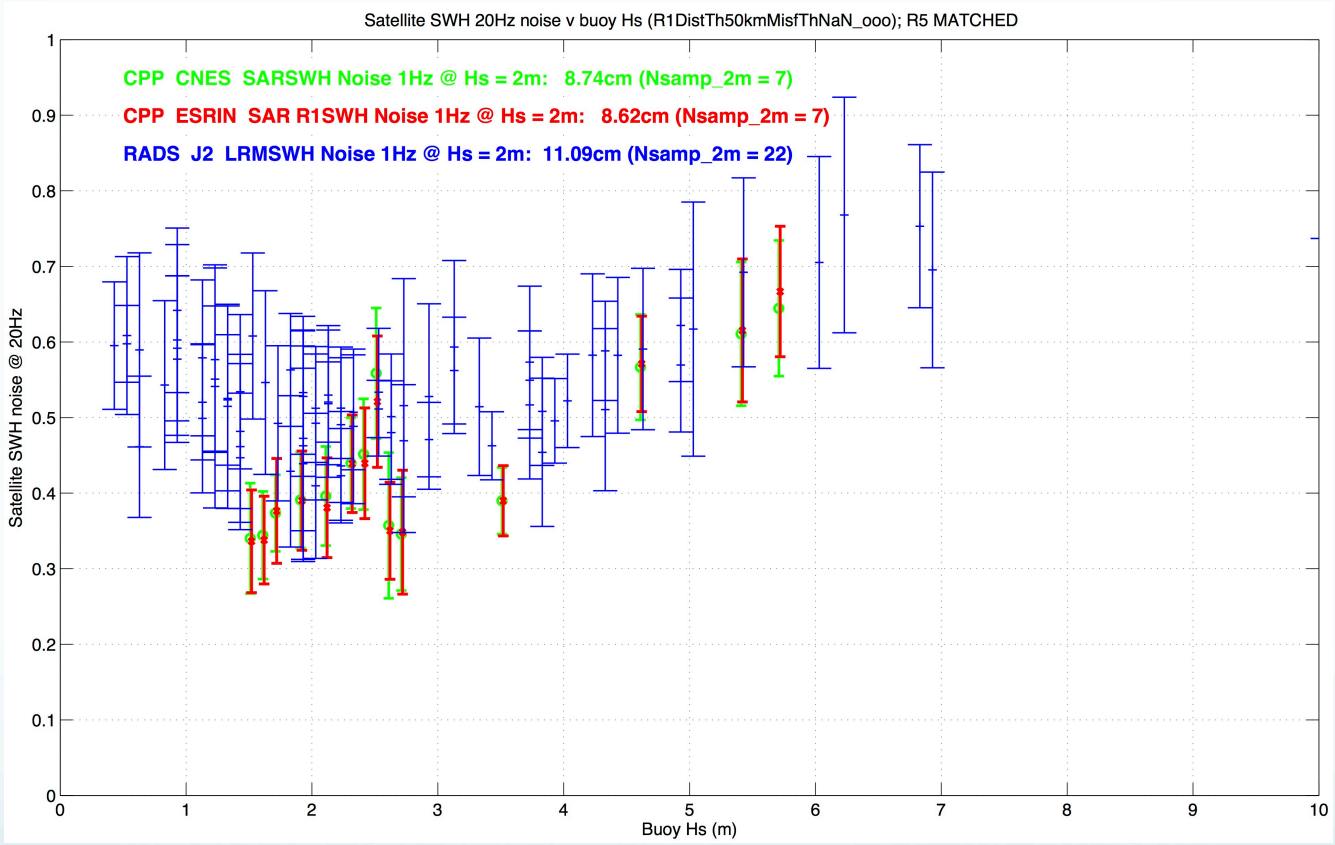
SWH Noise v SWH



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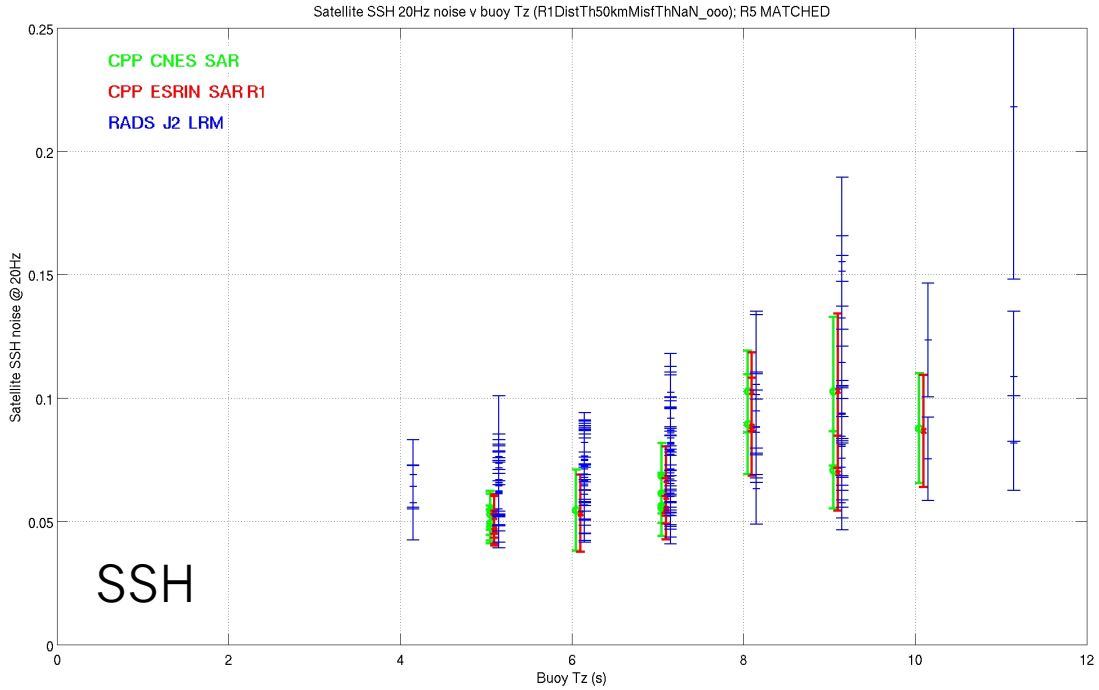

Noise v Tz

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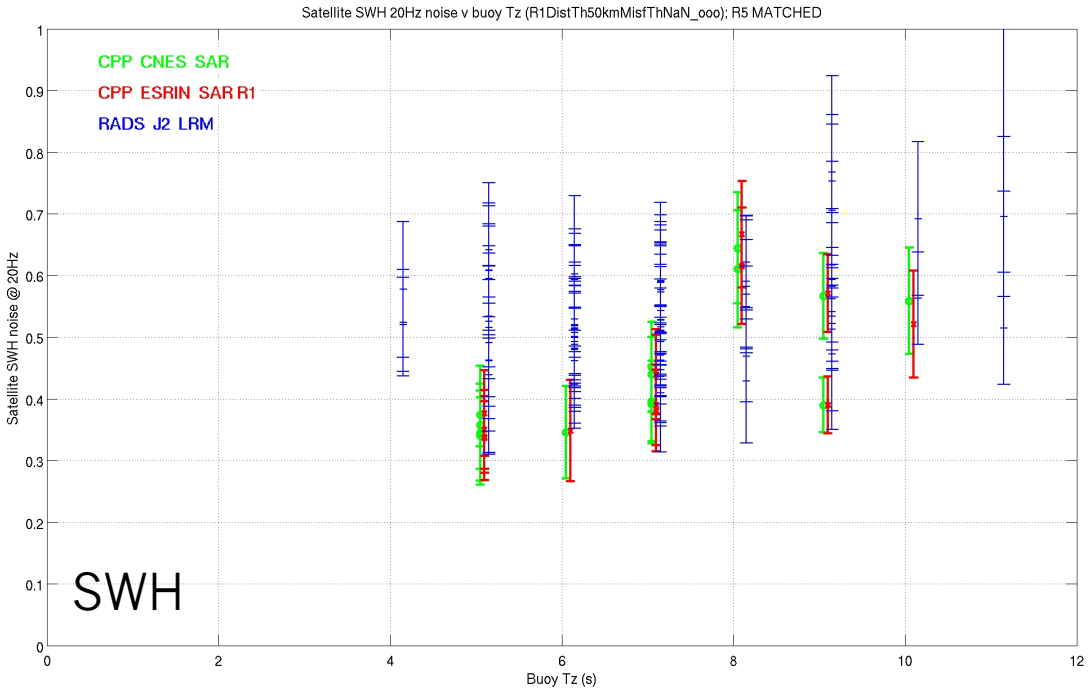
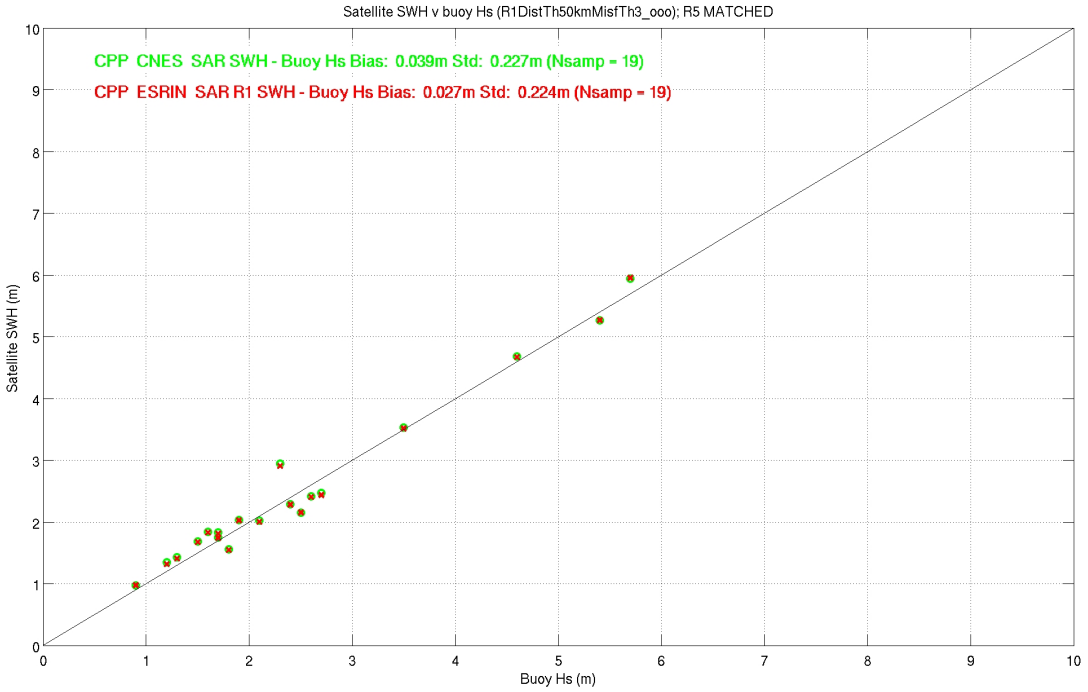


SAR SWH v Buoy Hs



- Exact match in outlier removal
- Exact match in make-up of collocated dataset for all runs including R5/FBR

- All offshore buoys & misfit threshold = 3
  - Bias ~ 0.2 m
- Open ocean buoys only & no misfit threshold
  - Bias ~ 0.05 m
- Open ocean buoys only & misfit threshold = 3
  - Bias ~ 0.03-0.04 m

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Overall results: all runs

Run reference	1Hz Noise @ 2m		SWH v buoy Hs		CNES – ESRIN difference			CNES – ESRIN against SWH (trend)		
	SSH (cm)	SWH (cm)	Bias (cm)	Std (cm)	SSH (cm)	SWH (cm)	Pu	SSH (cm/m)	SWH (cm/m)	Pu (units/m)
CNES	1.254	8.74	6.3	22.8	-	-	-	-	-	-
ESRIN R1	1.223	8.62	5.1	22.5	-0.0	1.2	3.42	-0.28	0.39	-0.013
ESRIN R3	1.246	8.58	5.0	22.5	1.7	1.2	-14.1	1.05	-0.22	-0.011
ESRIN R4	1.246	8.52	-15.8	22.2	-0.3	22.4	-13.9	0.11	2.81	-0.001
ESRIN R6	1.250	9.25	-10.9	25.4	-0.3	17.4	-13.9	0.11	-4.76	0.002
ESRIN R5	1.218	8.42	5.2	22.7	N/A	N/A	N/A	N/A	N/A	N/A
Jason-2	1.566	11.09	7.9	32.1	N/A	N/A	N/A	N/A	N/A	N/A
Notes	Open-ocean No misfit threshold		Open-ocean No misfit threshold		Open-ocean No misfit threshold			Open-ocean No misfit threshold		

- Exact match in outlier removal
- Exact match in make-up of collocated dataset for all runs including R5/FBR

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WP4000 Summary & Conclusions

- Excellent agreement between SAMOSA SAR retrackers and CNES numerical retracker
  - ESRIN R1, R3 and R5 show particularly strong agreement, occasionally exceeding the performance of CNES SAR numerical retracker
- ESRIN R4 and R6 show marked differences from the CNES results
  - Highlights the need for the L2 SAR retracking to account for processing applied to L1B waveforms (e.g. post RCM-migration “peel”)
- Results for SAR noise as a function of Hs confirm previous findings about SAR altimetry delivering reduced noise for SSH and SWH compared to Jason-2 LRM
- SAR noise for SSH and SWH increase with wave period (i.e. in presence of long waves)
- SAR SWH shows no bias against wave buoys in the open ocean
  - Validation against buoys closer to land leads to biases estimates, even with application of misfit threshold

WP4000 Issues & Future work

- Exact matching of outlier removal and collocated buoy datasets across all runs lead to very small number of samples
  - Analyses of larger datasets are required to obtain more robust statistical results and estimates of the uncertainty.
- The use of misfit for data editing should be further explored.
- The origin of spikes observed in the difference plots between the ESRIN and CNES results need to be explored
  - could be responsible for large data loss observed when computing noise statistics.

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Thank you for your attention

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