Assessing New Altimeter Algorithms

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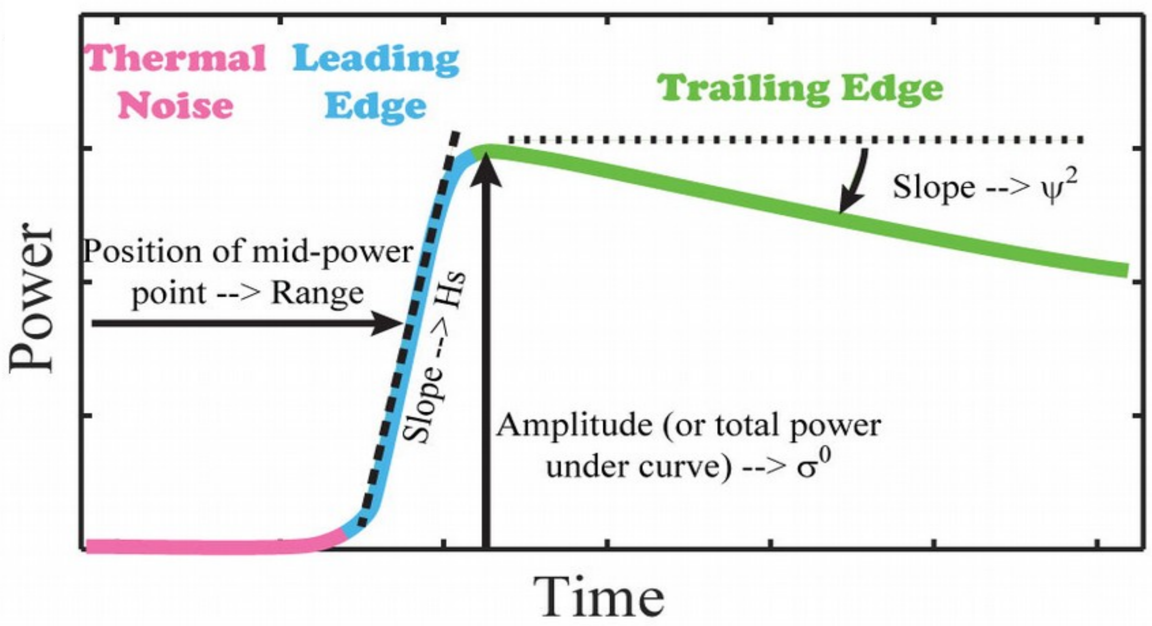
sea state cci

TUM

Altimeter Operation (LRM)



Altimeter Operation (SAR)

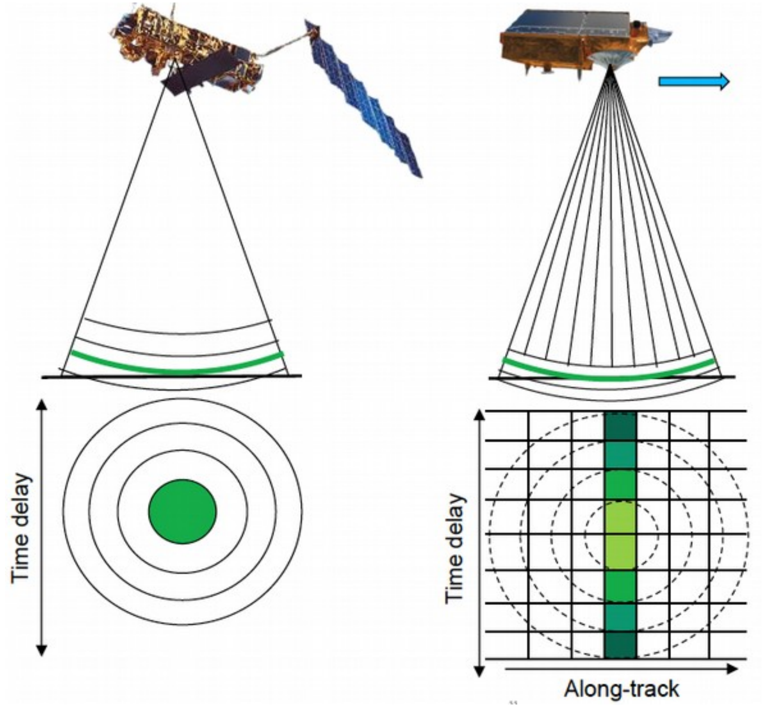


Image provided by F. Müller (based on Raney, 1998)

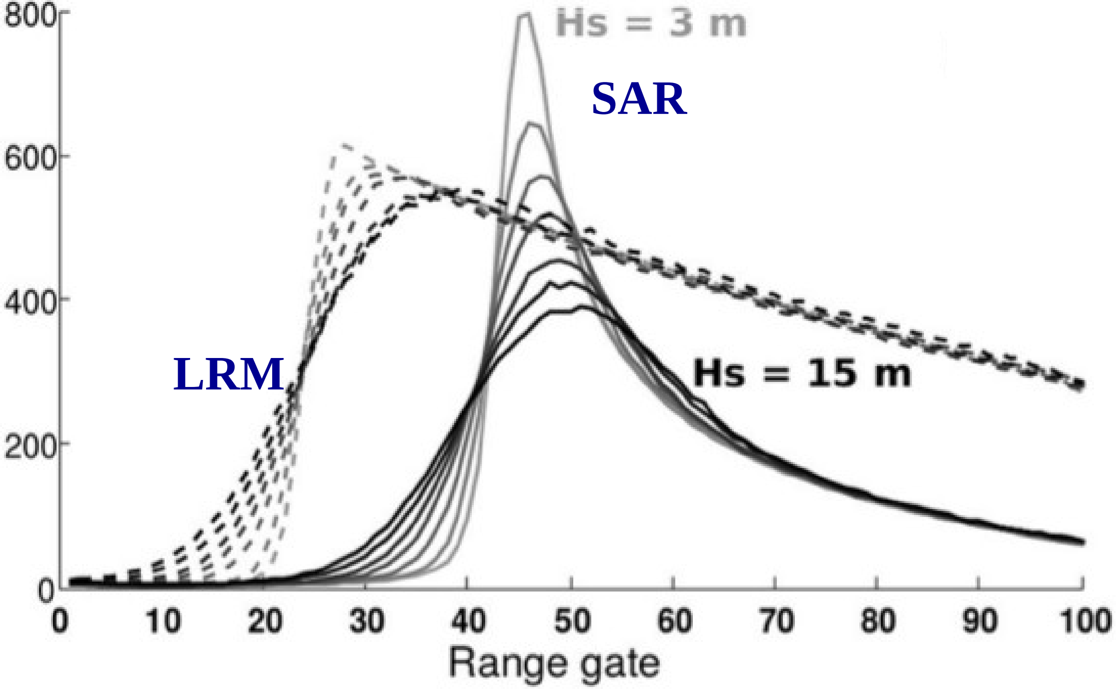


Image from Ardhuin et al (2019)

Candidate Algorithms

LRM

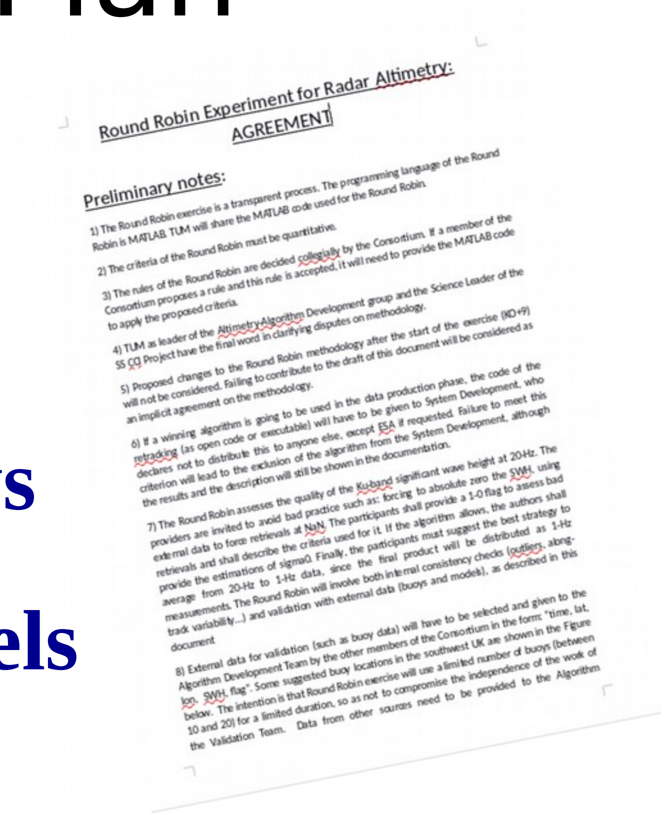
MLE-3
MLE-4
WHALES
WHALES_adj
WHALES_PTR
WHALES_PTR_adj
TALES
STARv2
Adaptive
Brown-Peaky

SAR

SAMOSA
WHALES
TALES
STARv2
LR-RMC
ACDC

Assessment Plan

1. **Invalid observations**
2. **Noise level**
3. **Comparison with buoys**
4. **Comparison with models**
5. **Processing Time**


Round Robin Experiment for Radar Altimetry:
AGREEMENT

Preliminary notes:

1) The Round Robin exercise is a transparent process. The programming language of the Round Robin is MATLAB. TUM will share the MATLAB code used for the Round Robin.

2) The criteria of the Round Robin must be quantitative.

3) The rules of the Round Robin are decided collegially by the Consortium. If a member of the Consortium proposes a rule and this rule is accepted, it will need to provide the MATLAB code to apply the proposed criteria.

4) TUM as leader of the Altimetry Algorithm Development group and the Science Leader of the SS CCI Project have the final word in clarifying disputes on methodology.

5) Proposed changes to the Round Robin methodology after the start of the exercise (KO+9) will not be considered. Failing to contribute to the draft of this document will be considered as an implicit agreement on the methodology.

6) If a winning algorithm is going to be used in the data production phase, the code of the retracking (as open code or executable) will have to be given to System Development, who declares not to distribute this to anyone else, except ESA if requested. Failure to meet this criterion will lead to the exclusion of the algorithm from the System Development, although the results and the description will still be shown in the documentation.

7) The Round Robin assesses the quality of the Ku-band significant wave height at 20-Hz. The providers are invited to avoid bad practice such as: forcing to absolute zero the SWH, using external data to force retrievals at NaN. The participants shall provide a 1-0 flag to assess bad retrievals and shall describe the criteria used for it. If the algorithm allows, the authors shall provide the estimations of sigma0. Finally, the participants must suggest the best strategy to average from 20-Hz to 1-Hz data, since the final product will be distributed as 1-Hz measurements. The Round Robin will involve both internal consistency checks (outliers, along-track variability...) and validation with external data (buoys and models), as described in this document

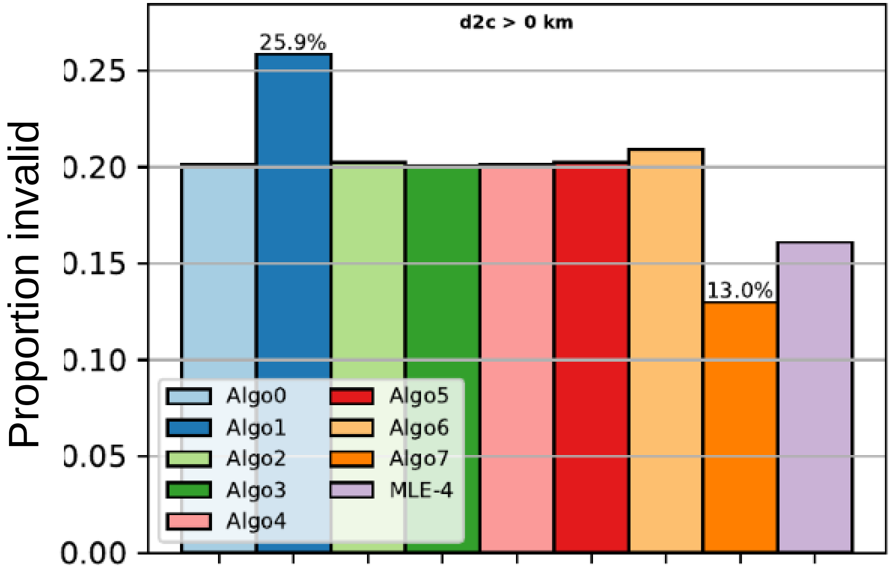
8) External data for validation (such as buoy data) will have to be selected and given to the Algorithm Development Team by the other members of the Consortium in the form: "time, lat, lon, SWH, flag". Some suggested buoy locations in the southwest UK are shown in the Figure below. The intention is that Round Robin exercise will use a limited number of buoys (between 10 and 20) for a limited duration, so as not to compromise the independence of the work of the Validation Team. Data from other sources need to be provided to the Algorithm

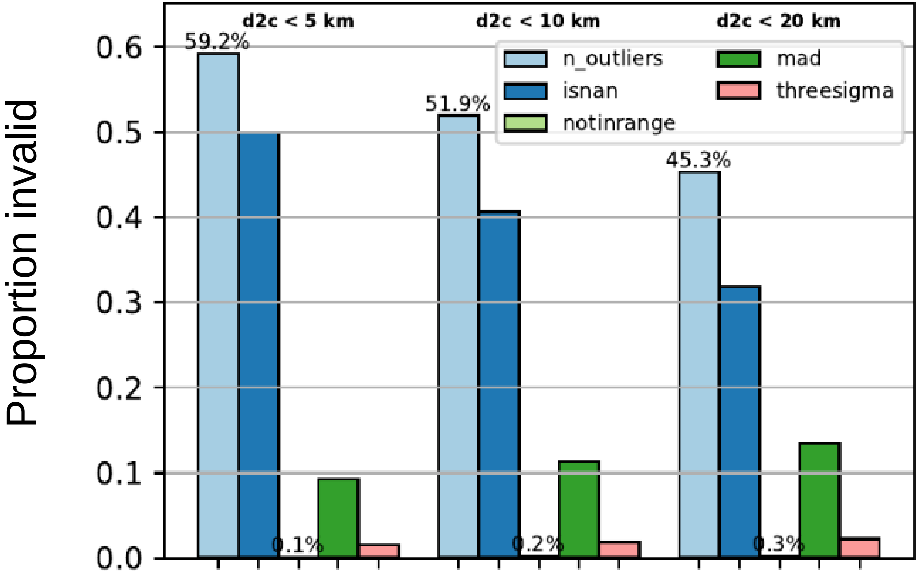
1. Invalid Observations

1.1 NaNs (Unspecified values)

1.2 Hs>25m OR Hs<-0.25m (Physically unreasonable values)

1.3 > N x Median Absolute Deviation (Spurious outliers)





~20% of data are invalid

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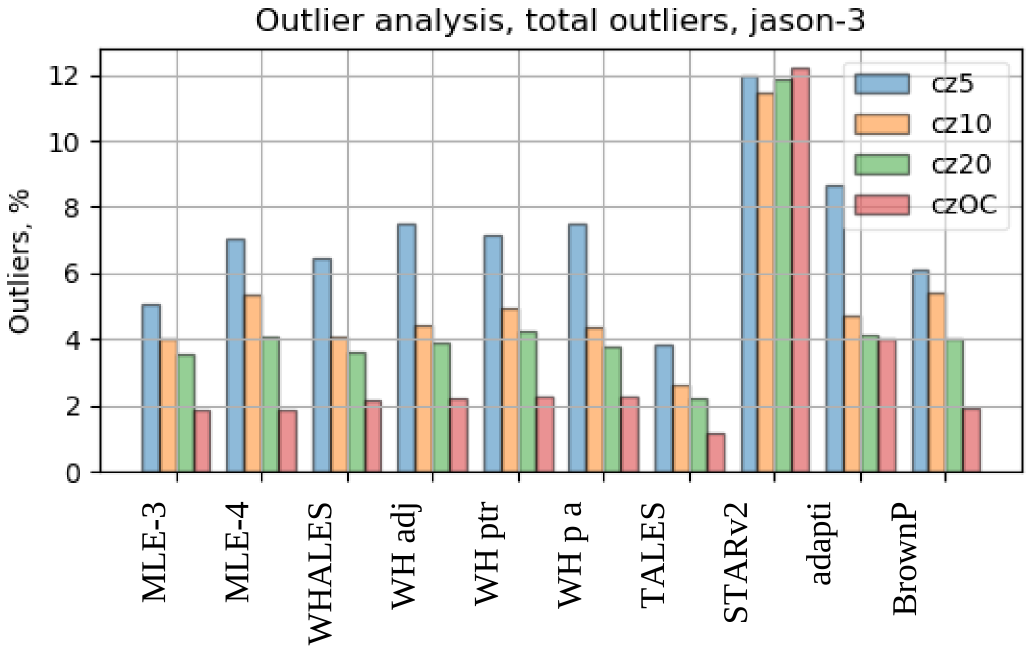
1.3 Occurrence of Outliers

Alternatively, we can use 3x1.48 x Median Absolute Deviation

(eqv to 3 S.D.)



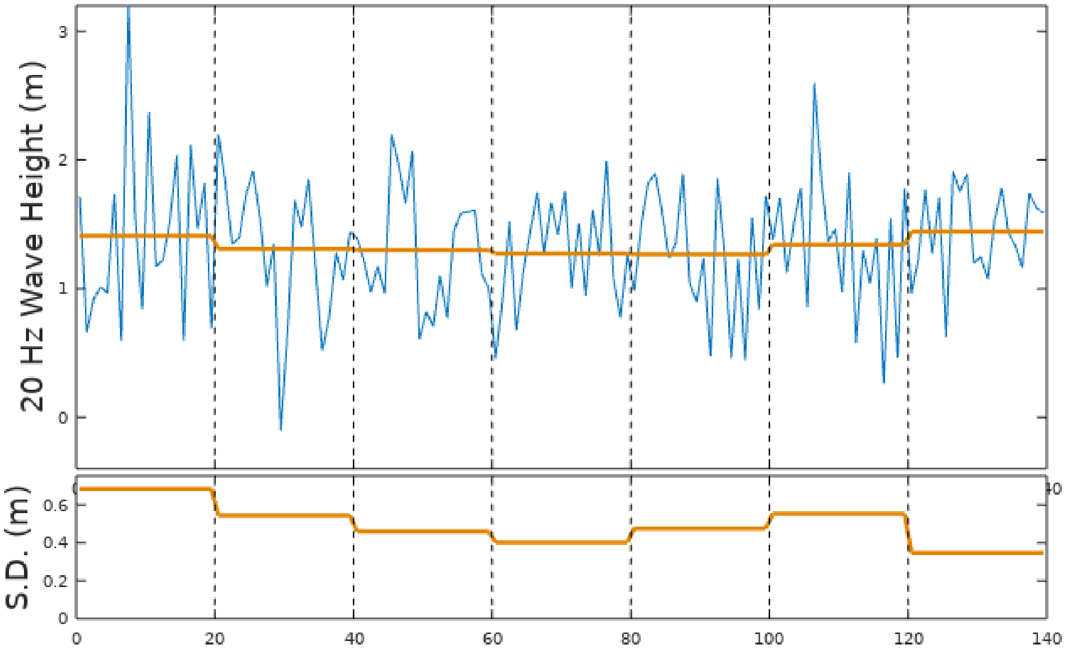
~2% of data are outliers

2. Measures of "Noise"

2.1 Along-track difference

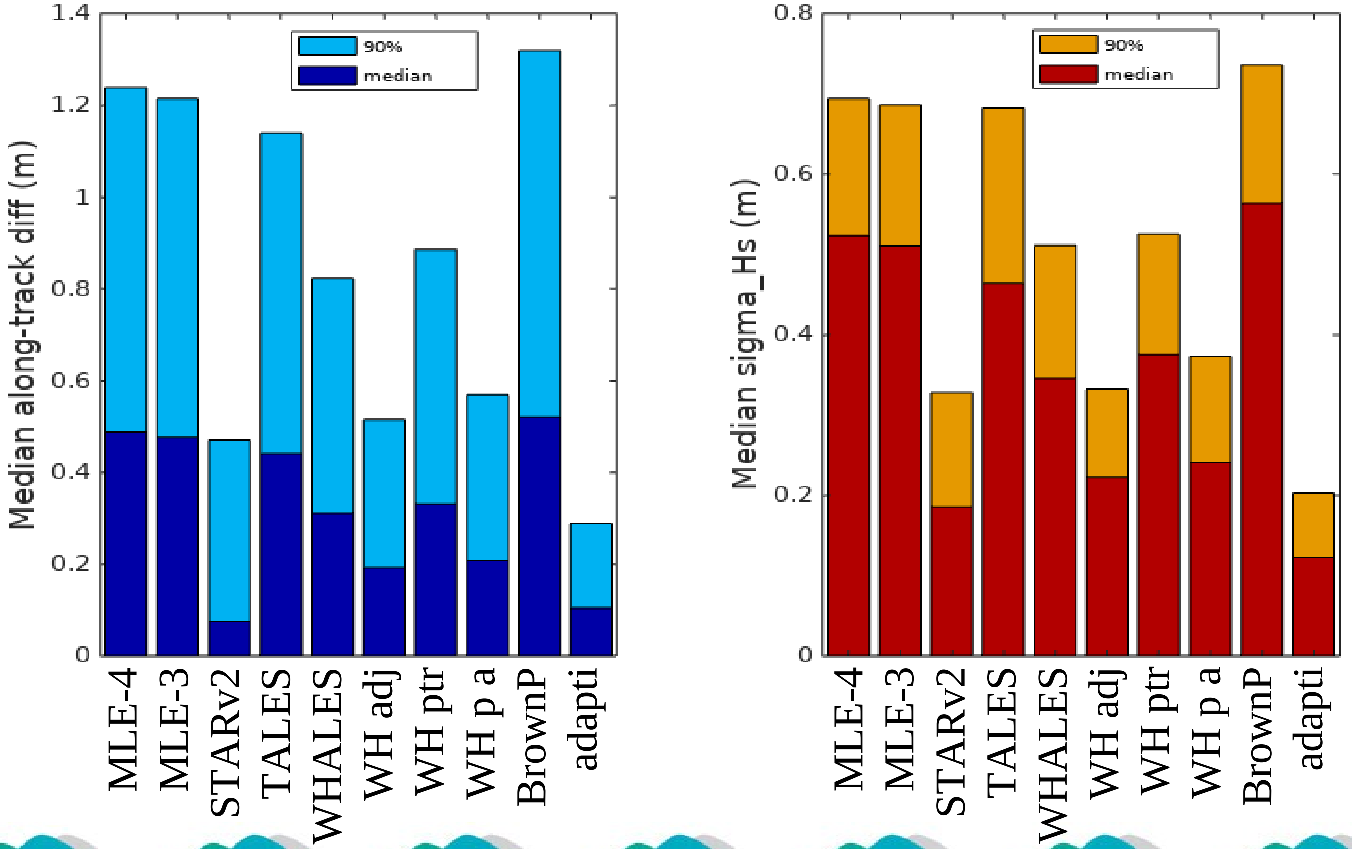
2.2 σ_{Hs} (S.D. of 20 records in 1-second)

2.3 Spectra of Hs variation



2. Noise Level

Along-track difference

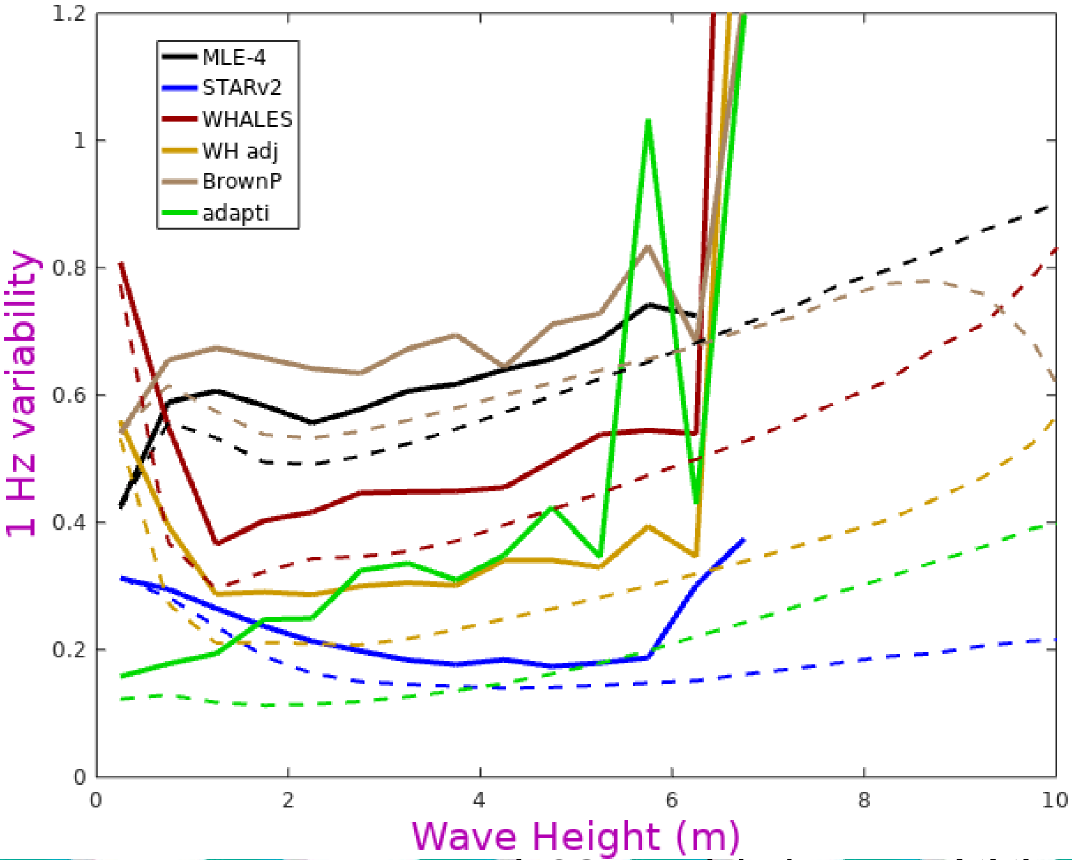


S.D.

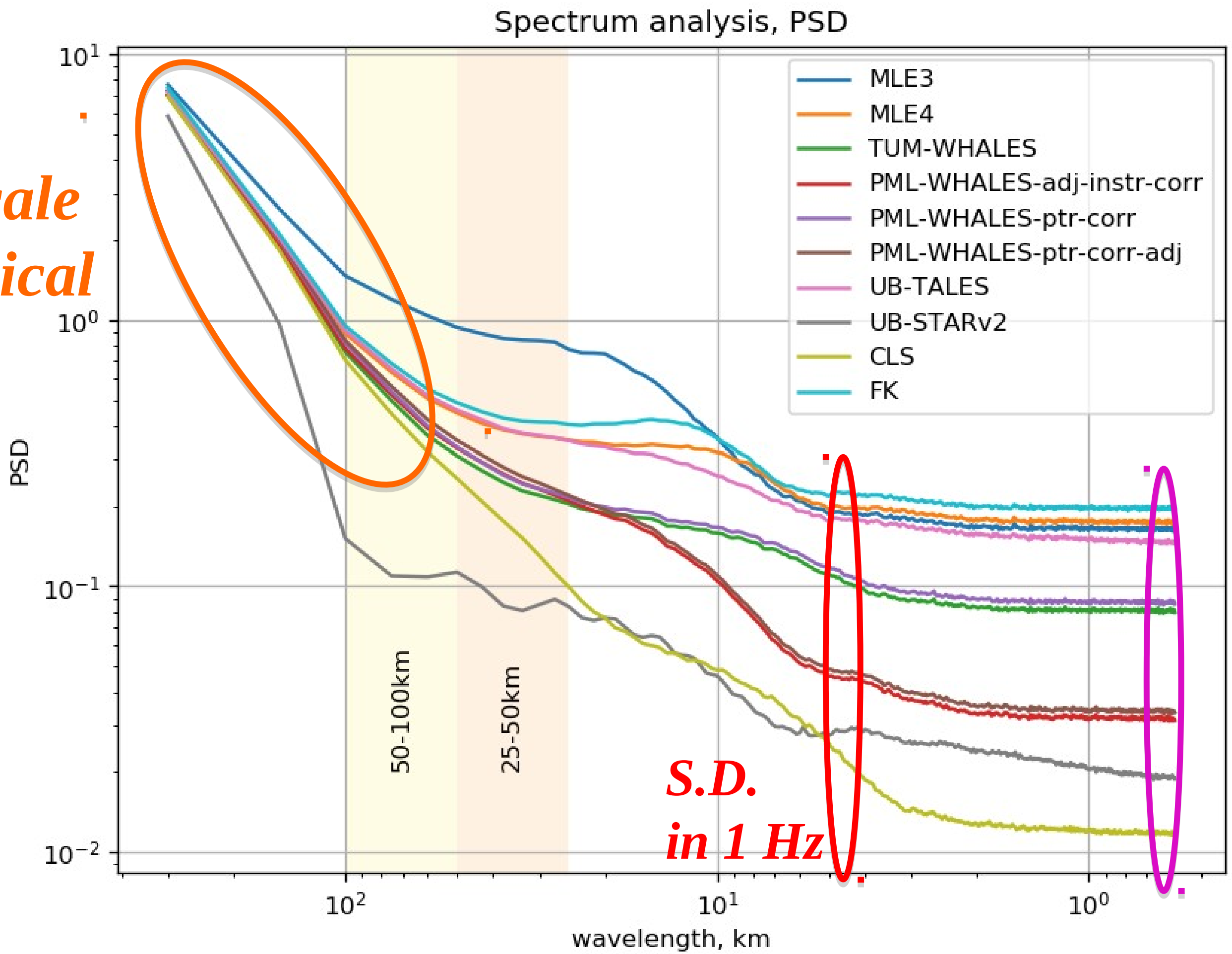
σ_{Hs}

2. Noise Level: sigma Hs

σ_{Hs} —
Variability of the 20 observations in a 1 Hz record



Large-scale Geophysical signal



S.D. in 1 Hz

Along-track difference

PM

CCI

3. Comparison with Buoys

Jason-3 repeats tracks every 10 days

Consider 51 obs. points (~17 km) nearest to buoy & calculate median:

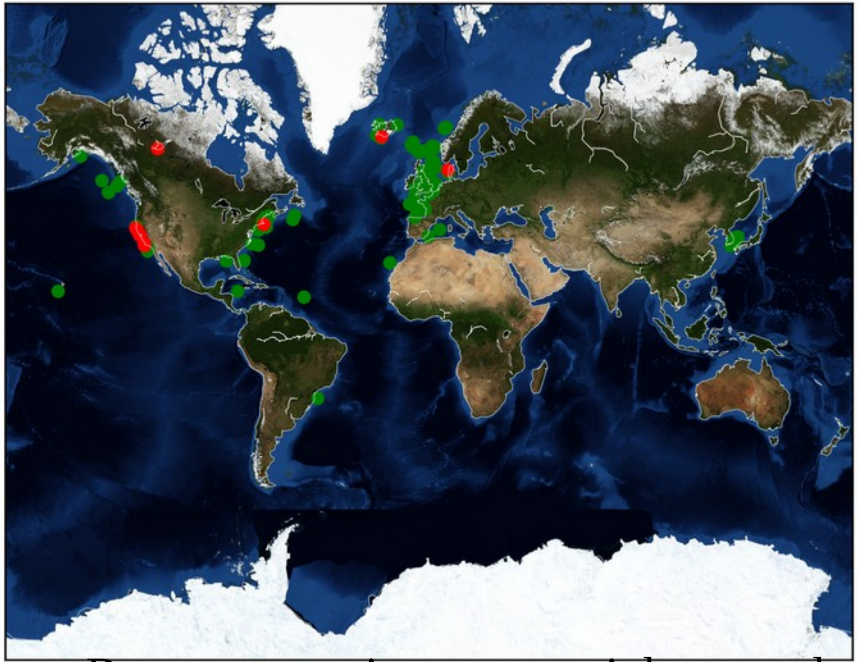
Compare with hourly buoy records

Interpolated to overpass time

Consider 2 Years data

(~73 overflights) of 125 buoys

Some subsequent editing



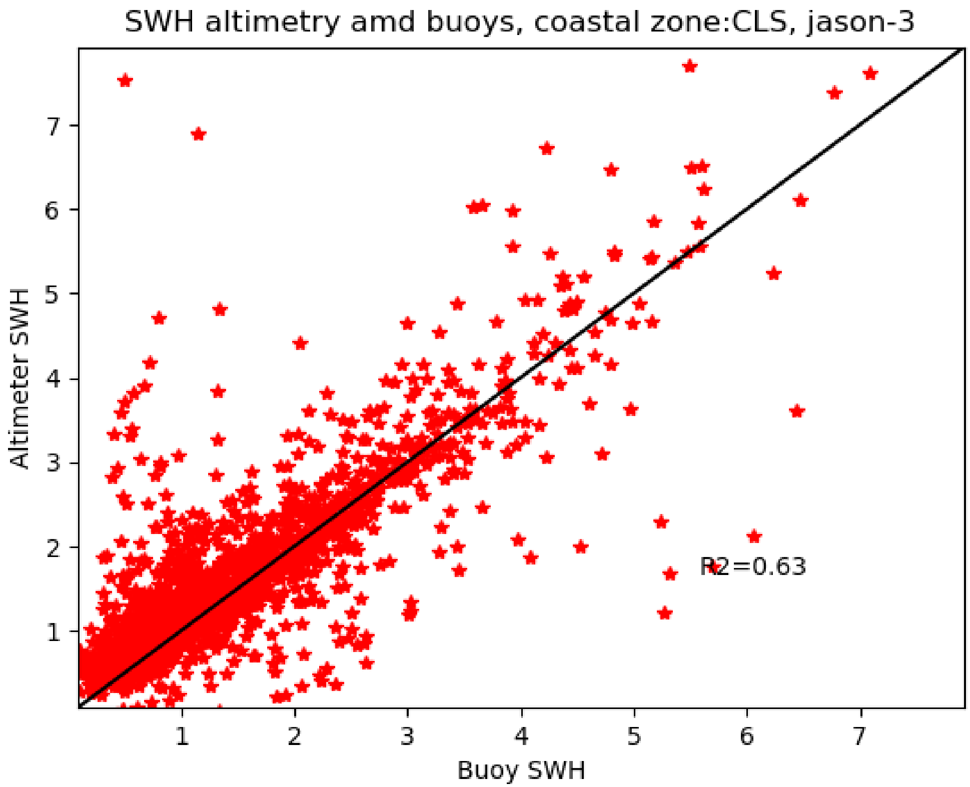
Buoys comparisons are mainly coastal; some enclosed or short-fetch

3. Comparison with Buoys

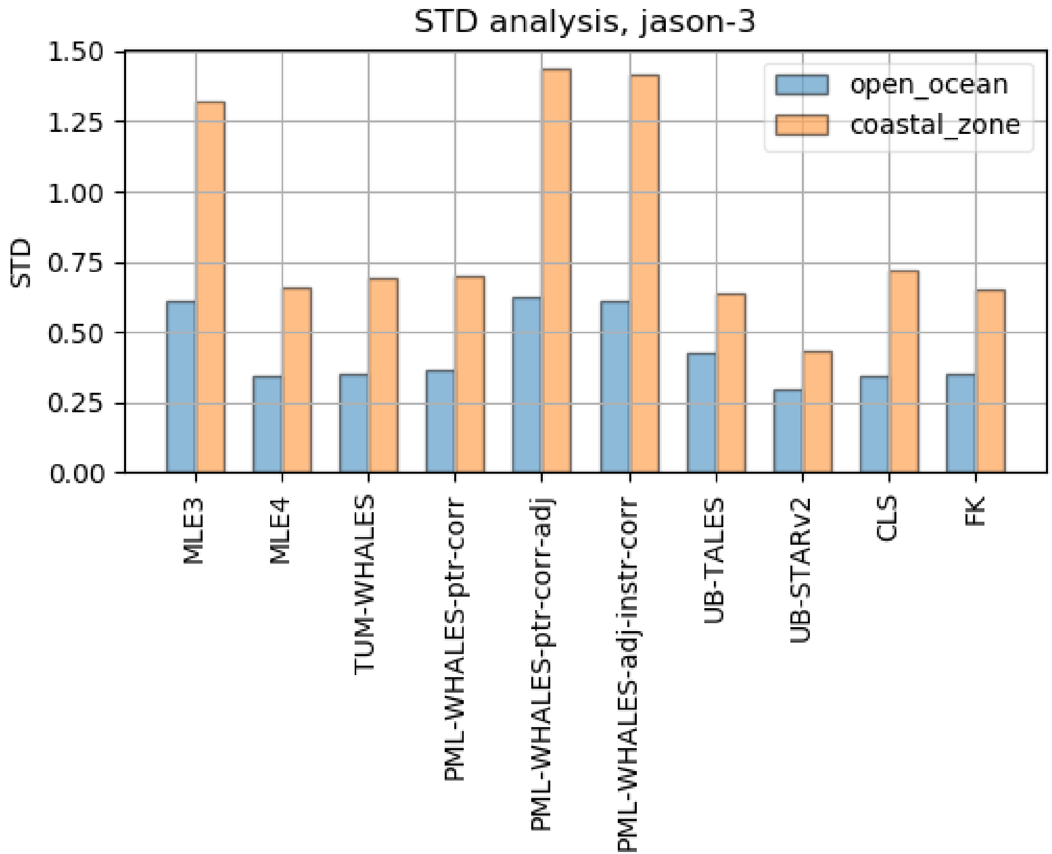
Scatterplot for buoys

Used to derive:

- Median bias
- Correlation, r^2
- Std. Dev.



3. Comparison with Buoys



4. Comparison with Models

Two models used: ERA5 WAM and CY46R1

Similar results, so only ERA shown here

Two years of data (spanning all seasons), interpolated to 1 Hz altimetry points

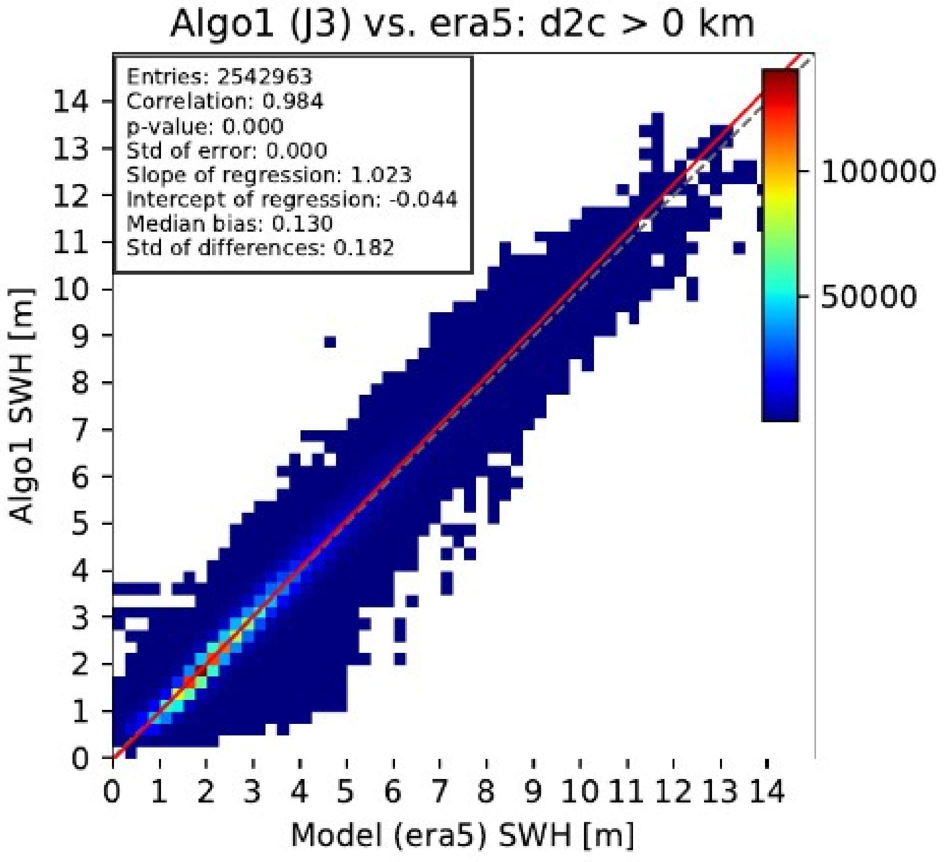
Evaluate 1 Hz data points

4. Comparison with Models

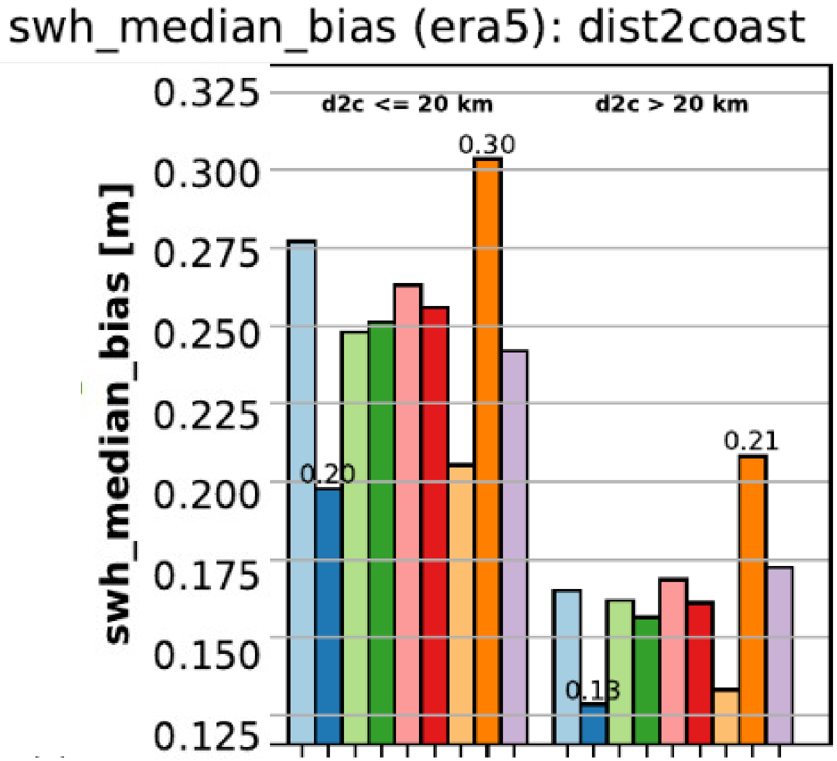
Scatterplot for models

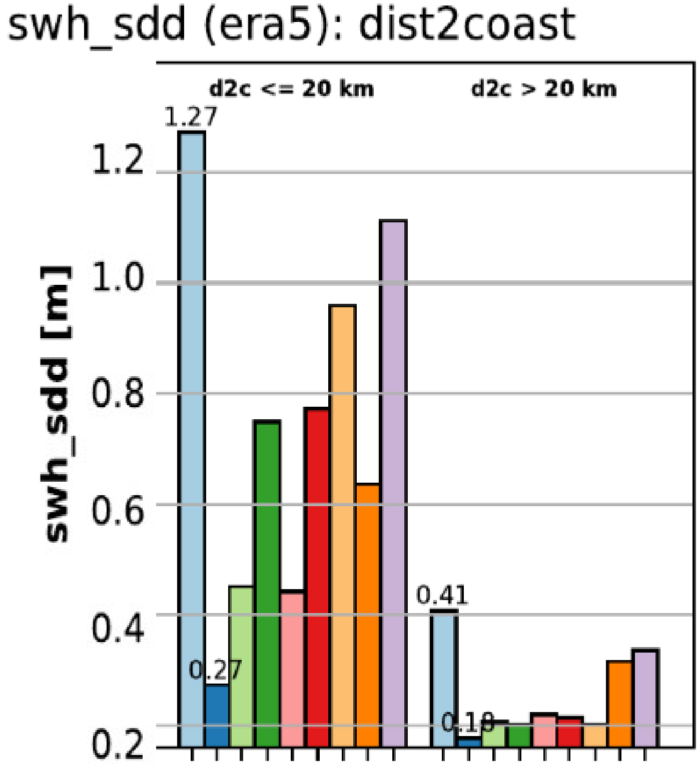
Used to derive:

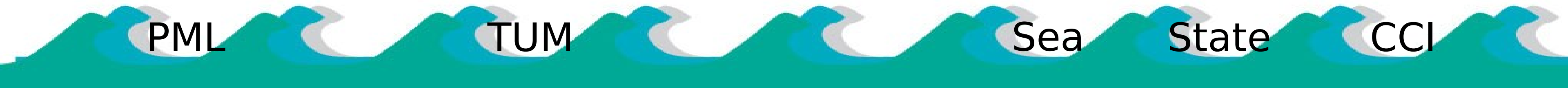
- Median bias
- Correlation, r^2
- Std. Dev.



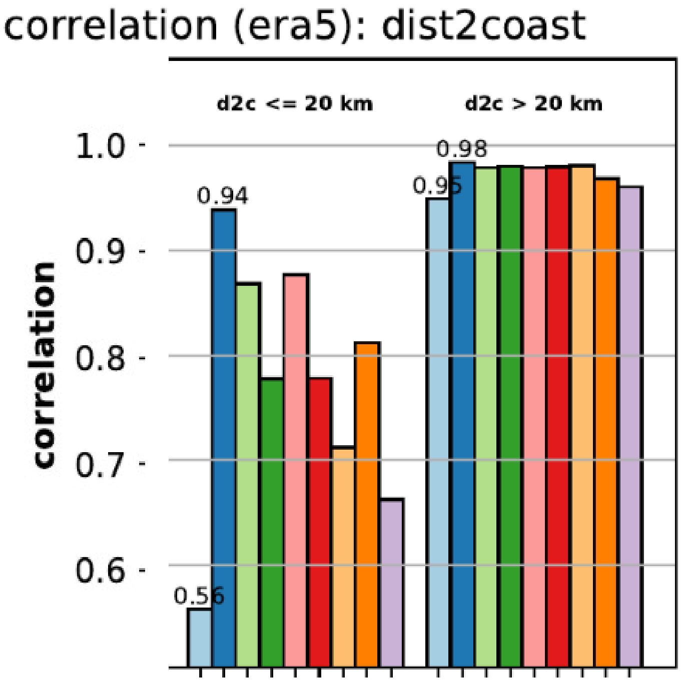
4. Comparison with Models

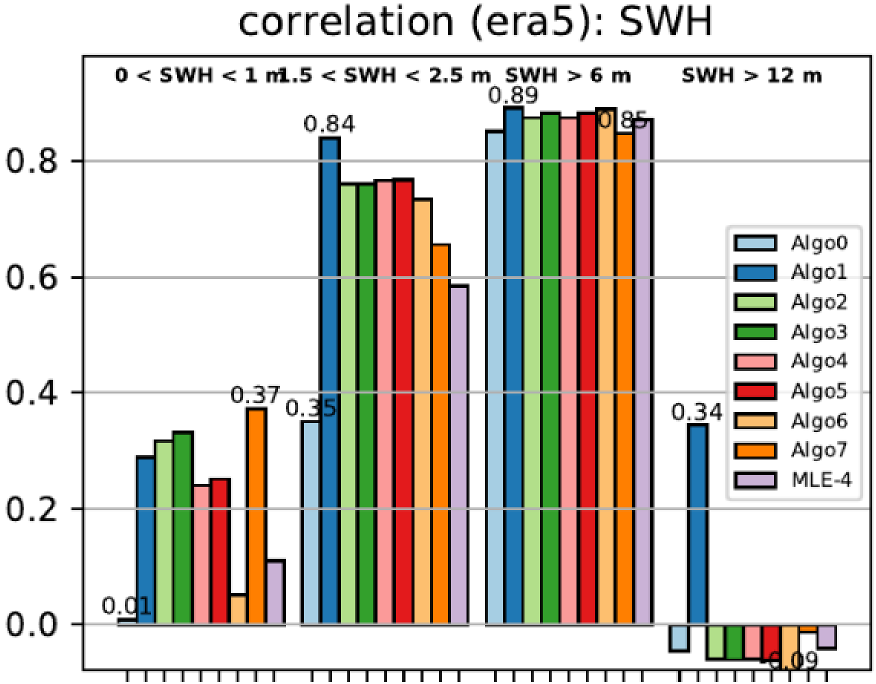






4. Correlation with ERA5





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Choices / Compromise

We are nearing the end of a statistical evaluation of many state-of-the-art algorithms for deriving SWH from Jason-3 and Sentinel-3 (not shown).

Ideally, we would implement one that outperforms traditional inversions in terms of:

1. Coverage (fewer bad data points or outliers) especially in coastal zone
2. Noise level / uncertainty
3. Comparison with coastal buoys (minimal bias, low S.D., high correlation)
4. Comparison with global models (minimal bias, low S.D., high correlation)

   Consistency between missions

   Processing time

You can Influence the Decision