climate change initiative

SEA STATE

The Sea State CCI dataset V1.1:
Towards a sea state Climate Data Record based on satellite observations

SEA STATE CCI TEAM
Laboratoire d'Océanographie Physique et Spatiale, Brest, France

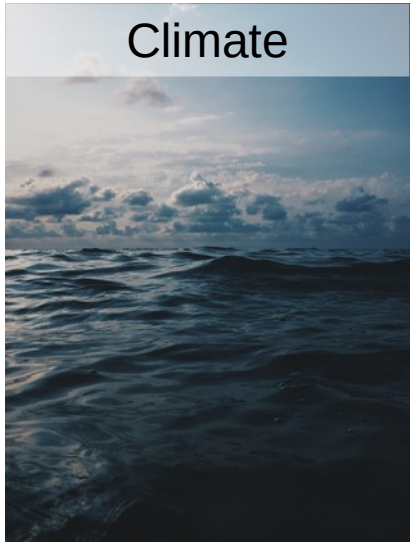
sea state cci

Ifremer

LOPS

Why do we need sea state observations ?

Climate



Marine safety

Coastal evolution

Offshore engineering

SEA STATES IMPACT

SSH measurements

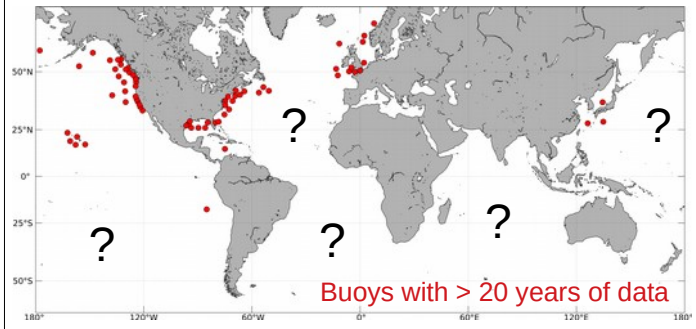
Coastal sea level

Marine energy

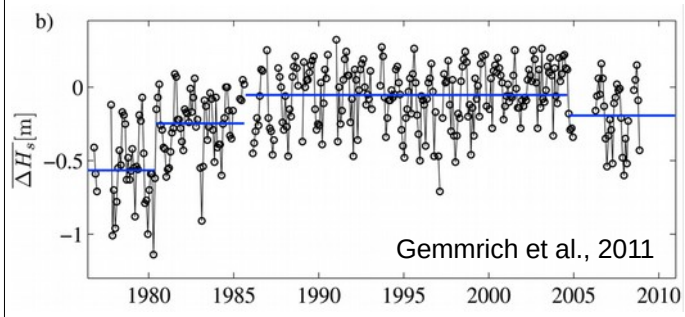
A Climate Data Record... what for?

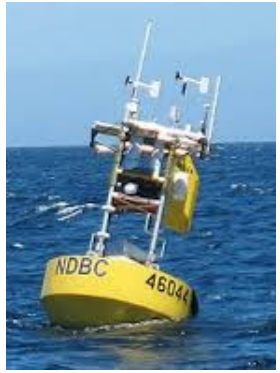
Climate Data Record :
A time series of measurements of sufficient length, consistency and continuity to determine climate variability and change (US NRC)

Long-term in-situ data are sparse...



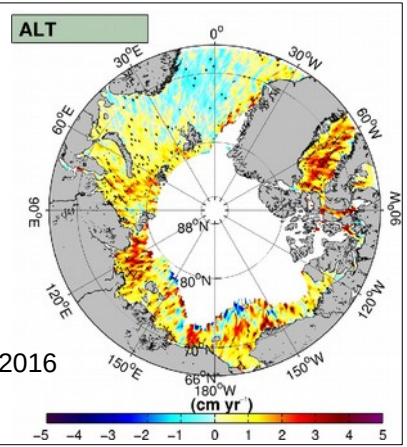
… and not always consistent



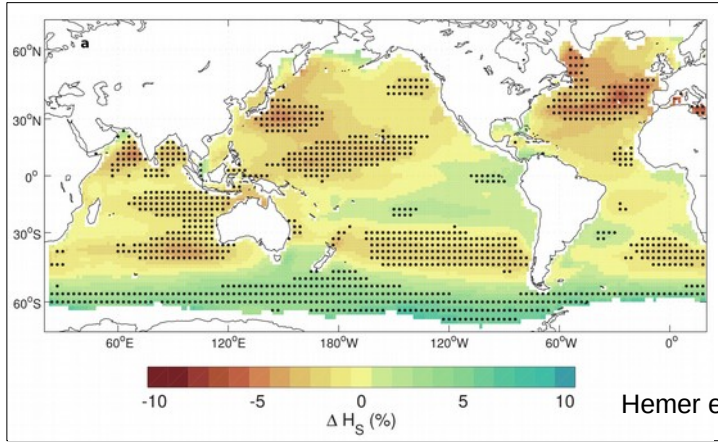


… due to changes in buoy hull and payloads

Rapid changes are observed (and projected) in the Arctic due to changes in sea ice extent and wind conditions



Stopa et al, 2016



Large uncertainties remain in past trends and projected changes

Hemer et al, 2013

Context

2007
- **IPCC AR4** : Ocean waves are identified as a key driver in the coastal zone, but little information was available on projected changes

2009
- **GlobWave** project initiated by ESA (EOEP-3 DUE) to improve the uptake of satellite wave data by the scientific, operational and commercial community

2010
- ESA launches the **Climate Change Initiative** to exploit EO archives and contribute to GCOS

2011
- The Coordinated Ocean Wave Climate Projections (**COWCLIP**) workshop initiates a collaborative effort to develop a coordinated approach to wave projection studies

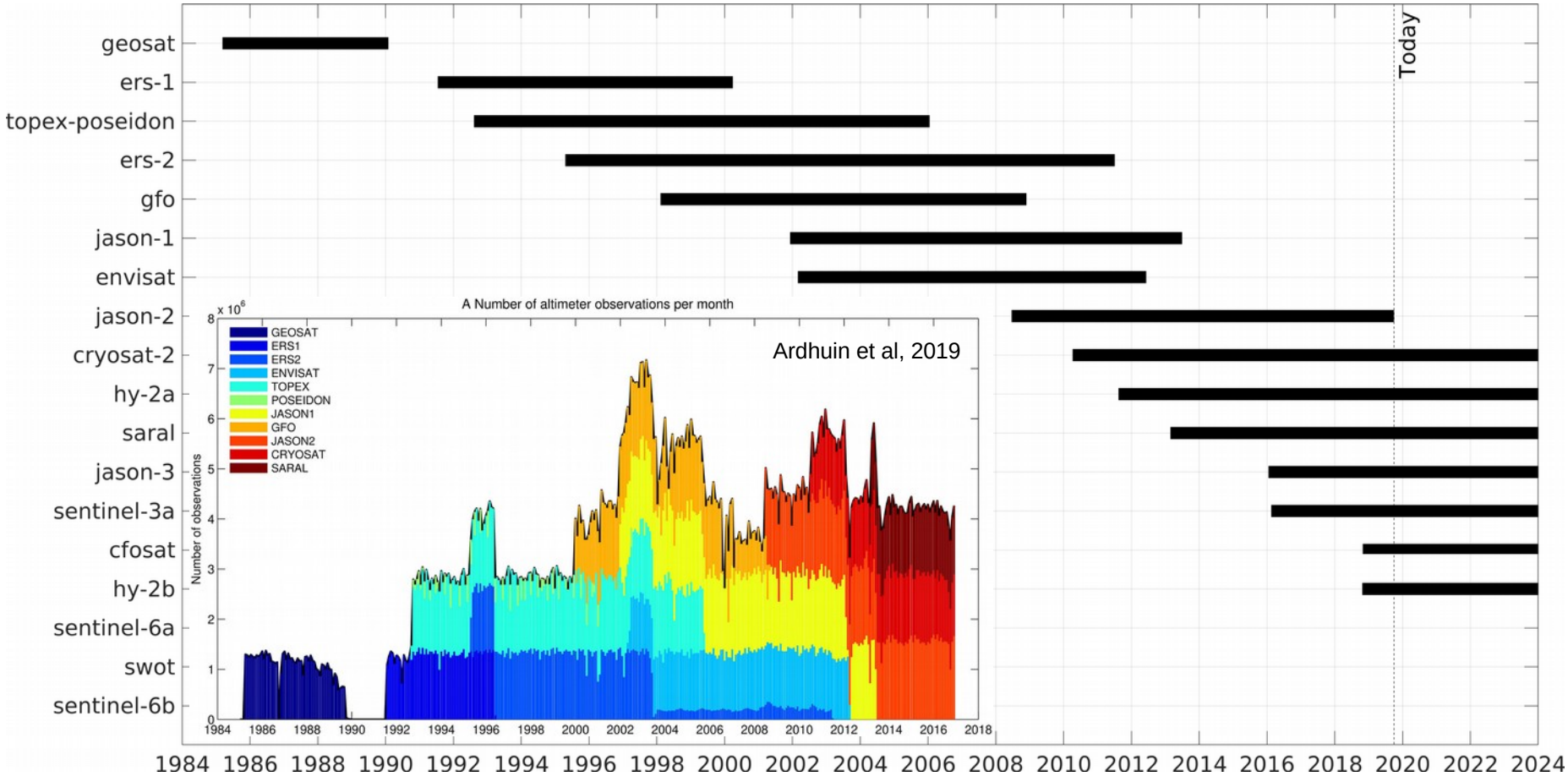
2014
- **IPCC AR5** : “Changes in Surface Wave” section (WG1 - Chapter 3)
  As the length of (altimeter) data set is short, it is not possible to determine whether their results reflect long-term SWH and wind speed trends, or are part of a multi-decadal oscillation.

2018
- **“Sea states” join the CCI+ program** (2018 - 2021) as a new ECV

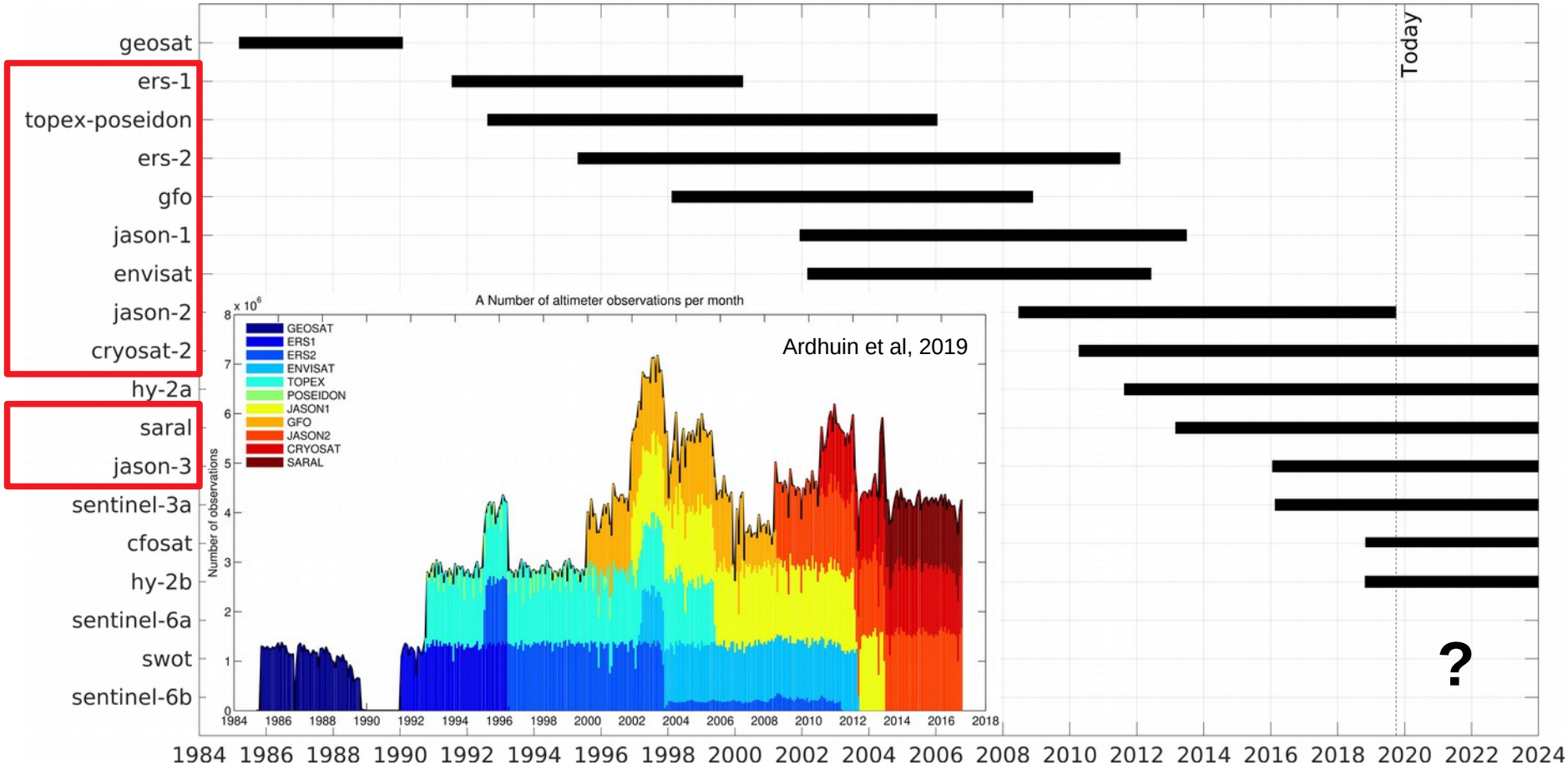
2019
- **IPCC SROCC** : “Waves and Extreme Sea Levels” section (Chapter 6.3)
  Extreme wave heights across the globe have increased by around 5% over the past three decades (medium confidence).

2021
- **IPCC AR6** : Sea State CCI contribution on sea state observed changes

Altimetry missions from 1984 onwards

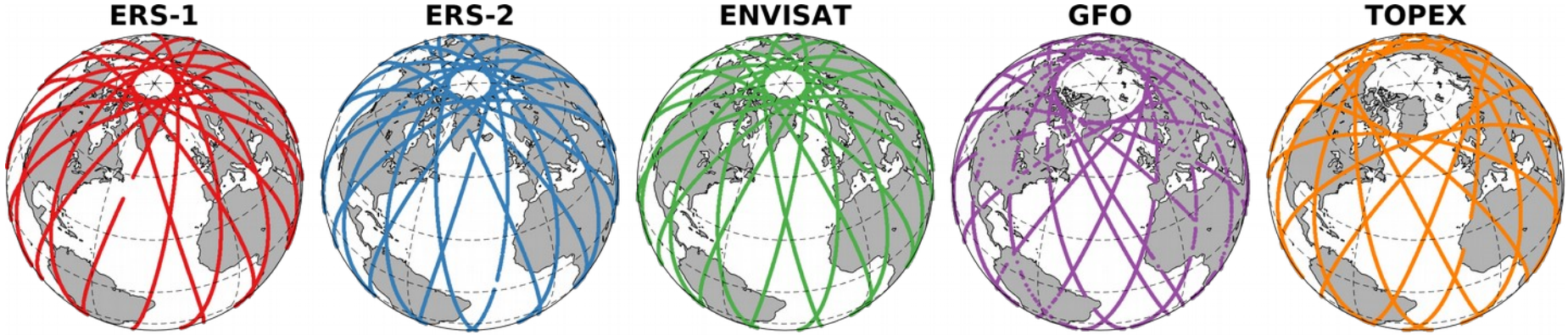


Altimetry missions from 1984 onwards

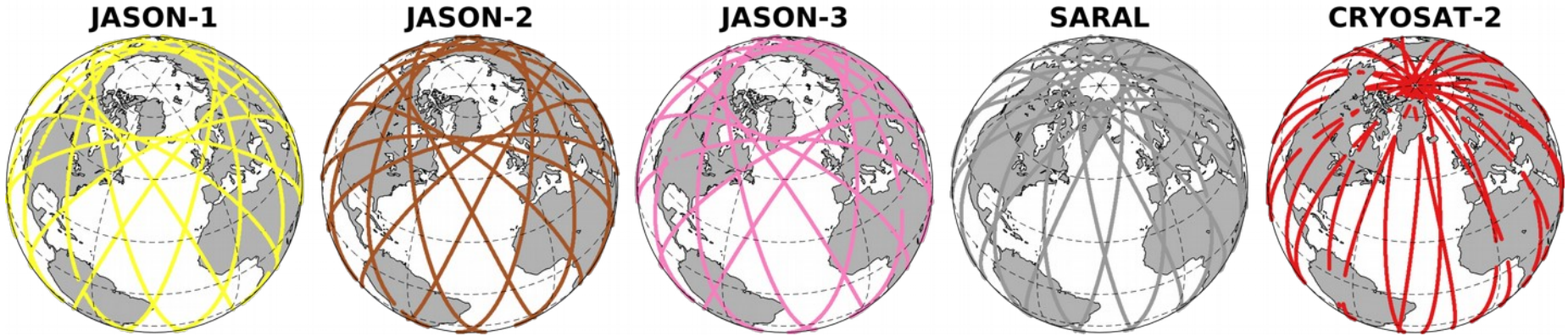


Satellite orbits

DAILY GROUND TRACK



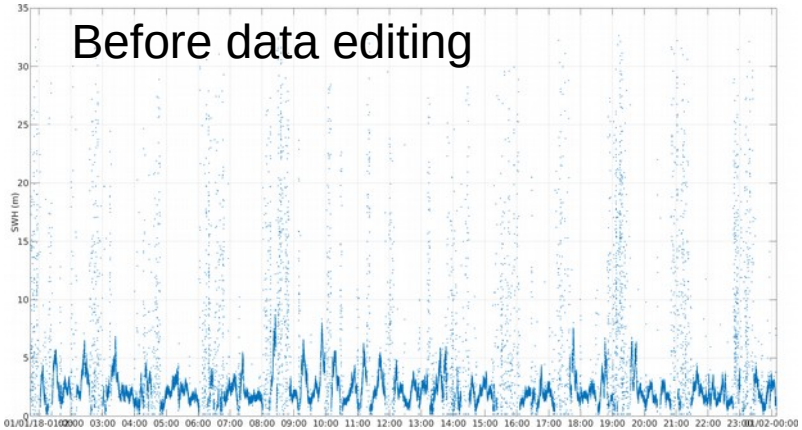
Difference in spatial sampling, revisit time, instruments, retracking algorithm, formats...

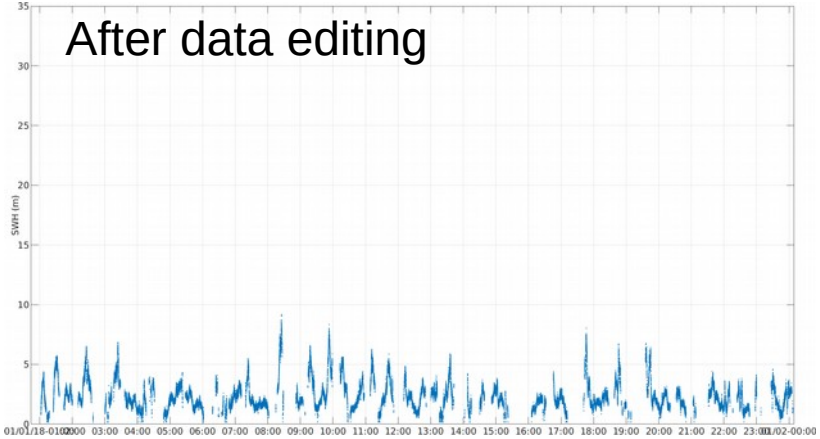


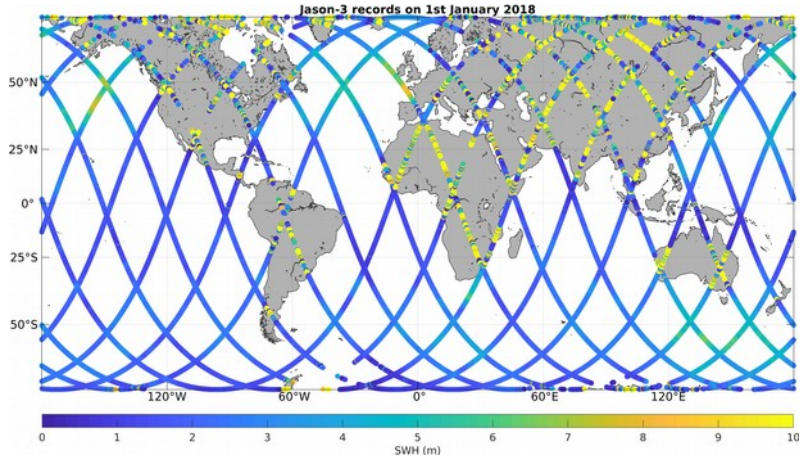
Processing steps

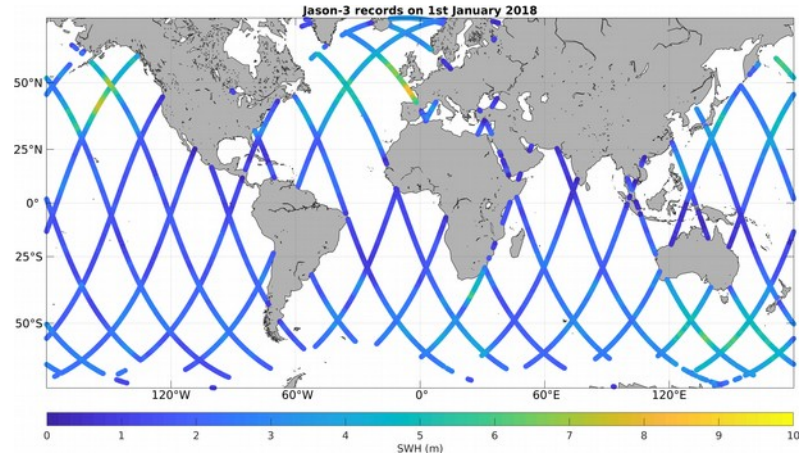
- Data editing
- Inter-calibration
- Denoising
- Validation

Data editing





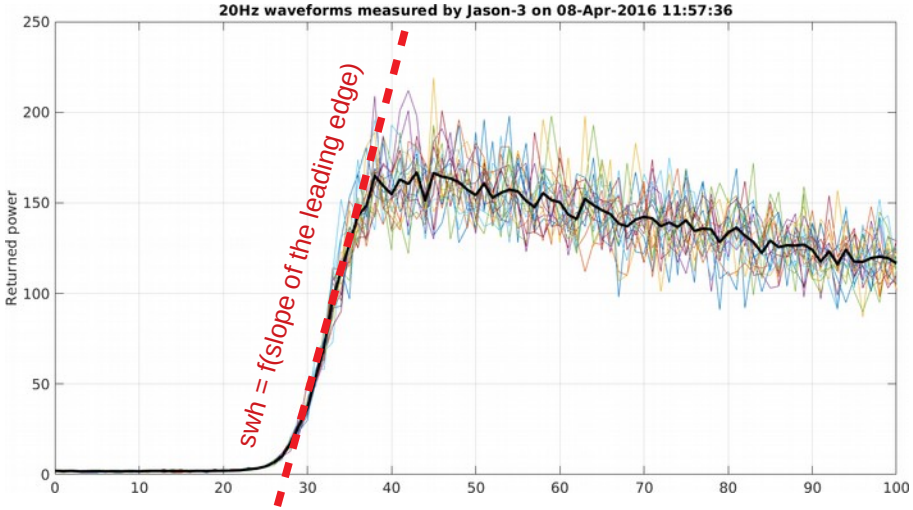


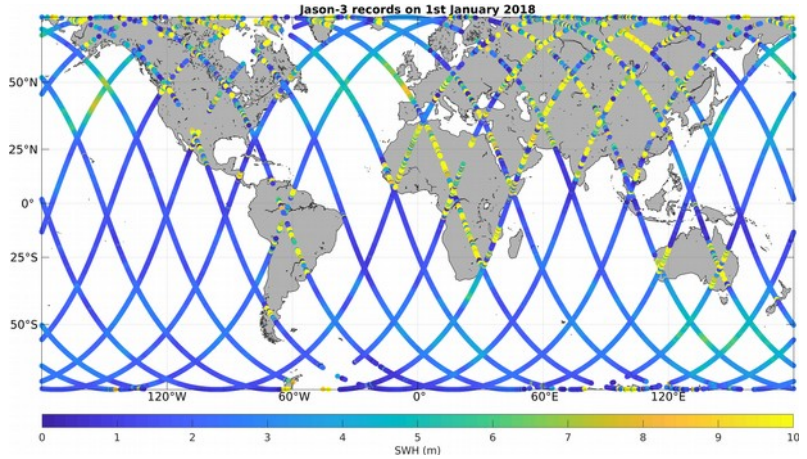


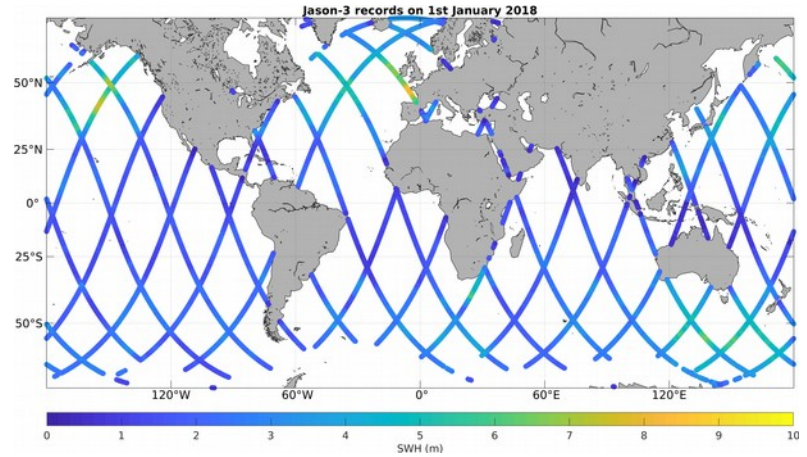
Data editing

A 1-Hz swh record is rejected in case of :

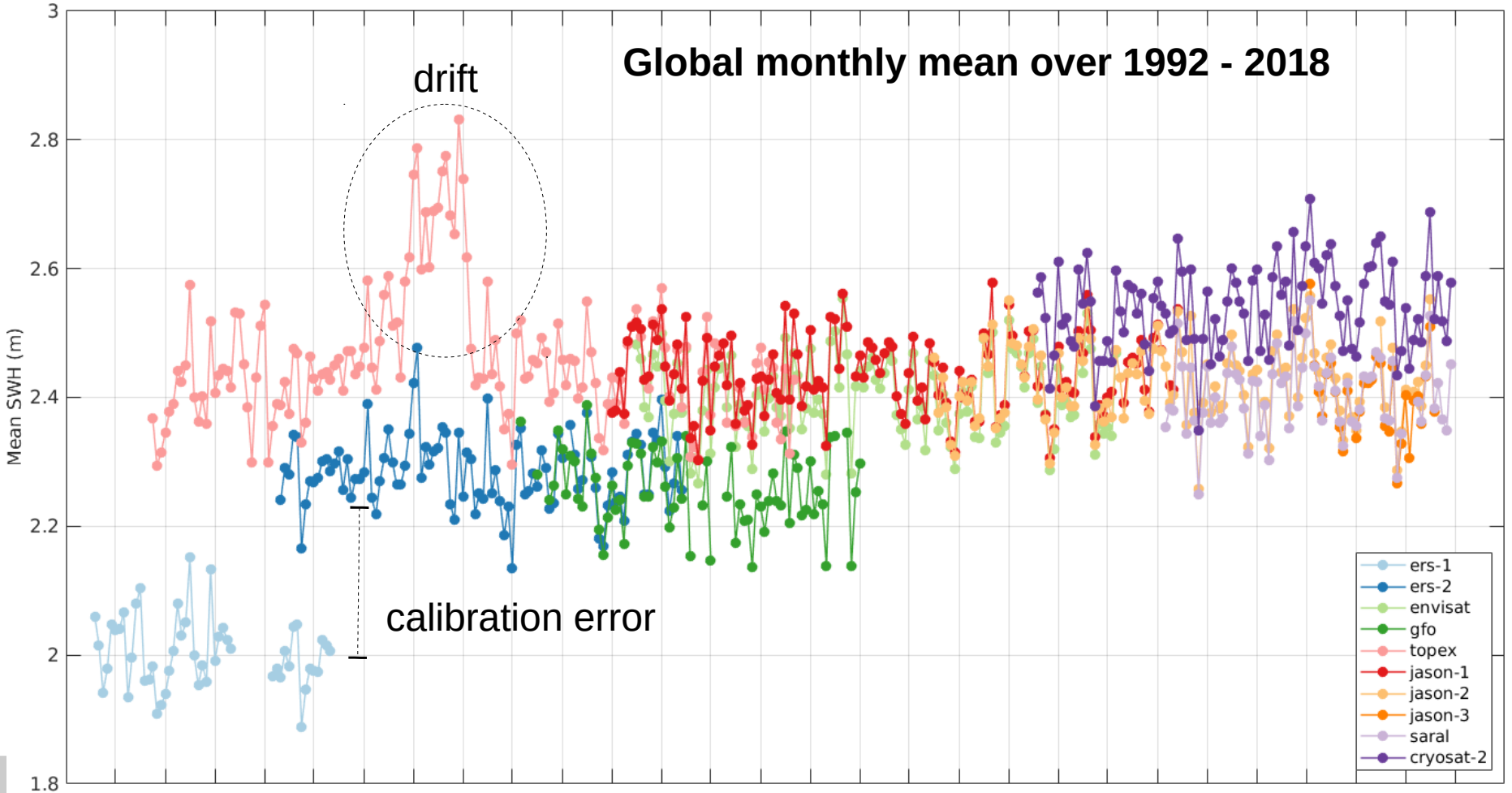
- Land or ice contamination (ice mask from Sea Ice CCI)
- Undefined or negative sigma0, ssh and swh values
- Unrealistic swh gradient
- Insufficient number of valid 20-Hz waveforms
- Large RMS deviation from the mean swh



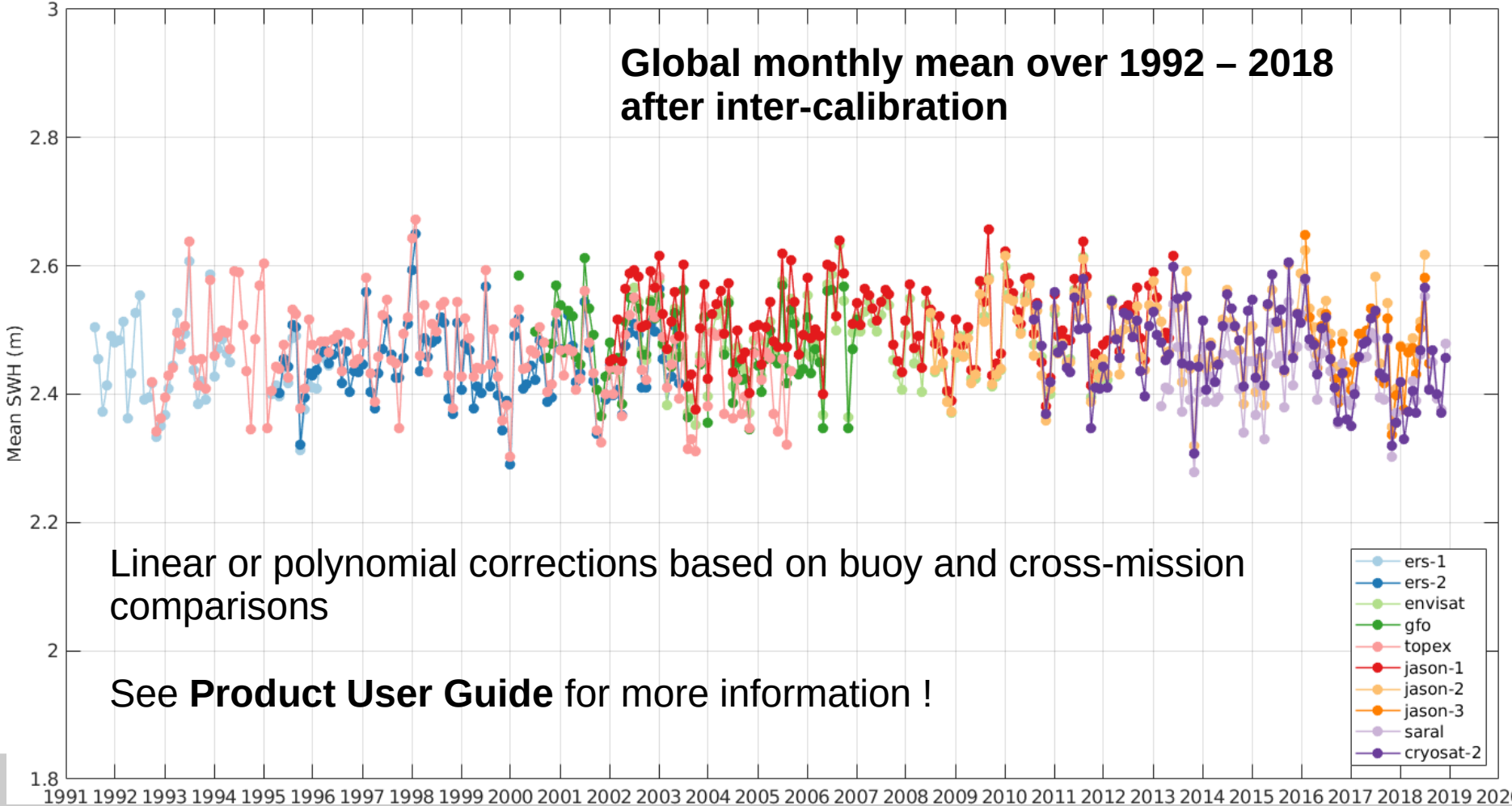




Inter-calibration



Inter calibration

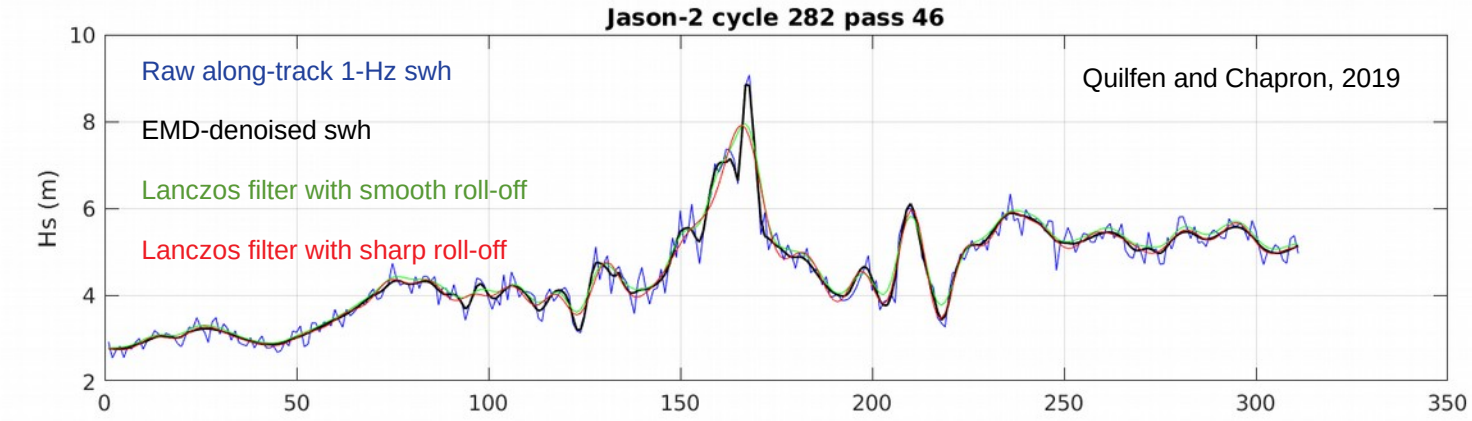


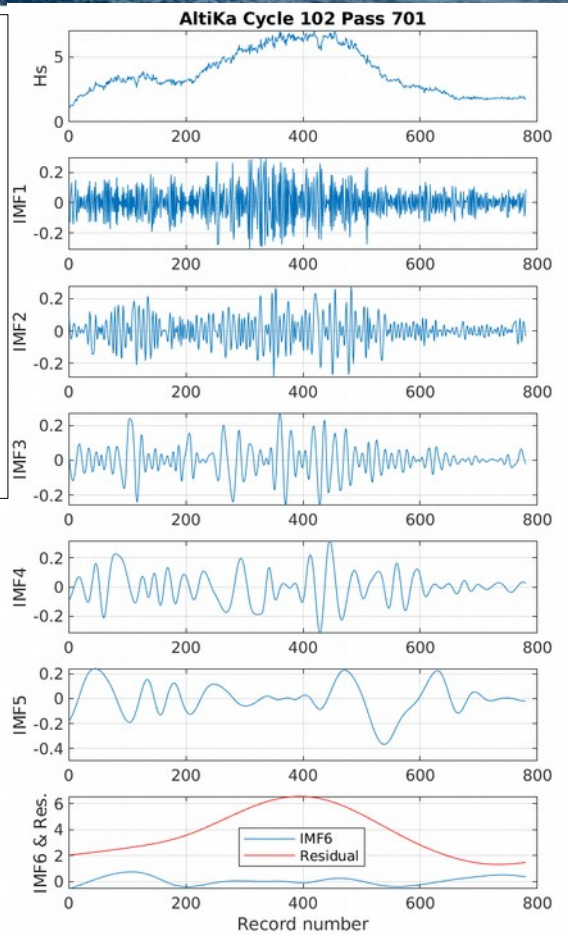
Linear or polynomial corrections based on buoy and cross-mission comparisons

See **Product User Guide** for more information !

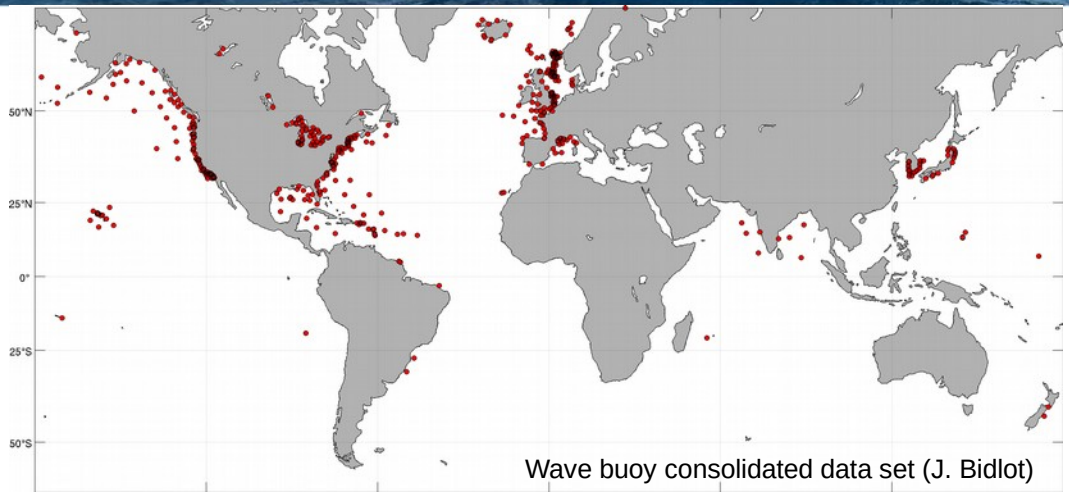
SWH denoising

- At **scale < 100km**, swh signal characterized by **low SNR**
- Signal denoising based on **EMD** and **wavelet thresholding**
- **Adaptive** method suited for **non-linear** and **non-stationary** processes
- **Improved mapping of strong gradients and extreme values**
- See presentation from **Bertrand Chapron at 4:10pm** !



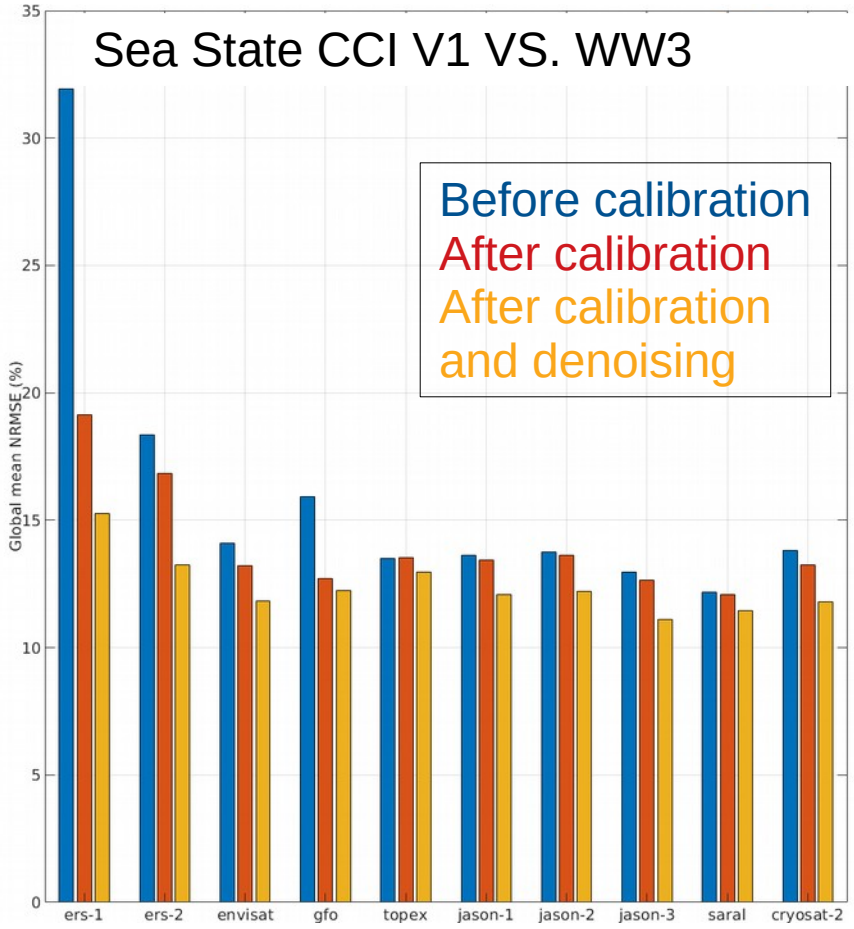


Validation against in-situ data and model outputs



Wave buoy consolidated data set (J. Bidlot)

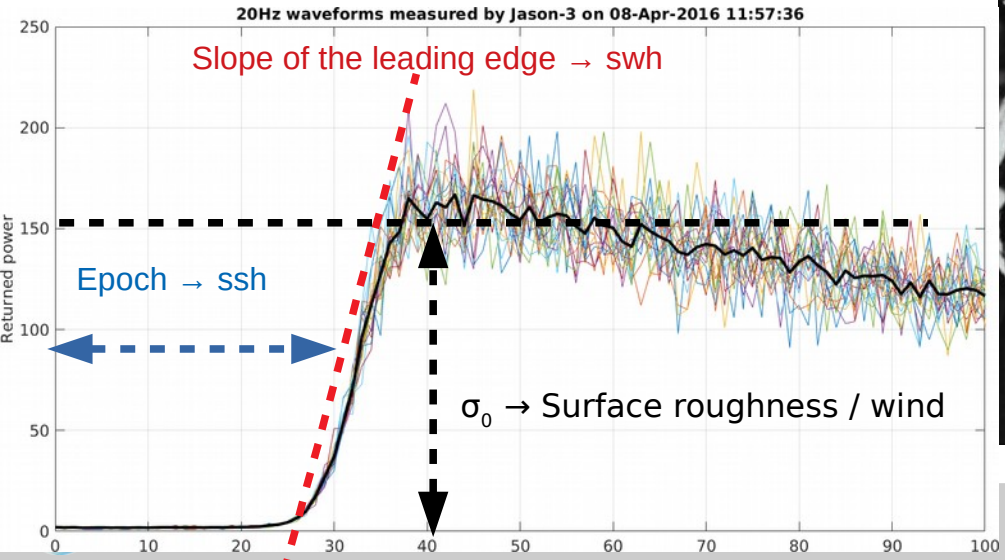
MISSION	NYEAR	NCOLOC	BIAS (M)	RMSE (M)	NRMSE (%)	SI (%)
ers-1	3	1018	-0.072	0.26	9.95	8.41
ers-2	17	9207	0.014	0.24	10.41	8.96
envisat	11	8286	0.044	0.23	10.05	8.58
gfo	9	5221	0.026	0.26	10.91	9.46
topex	12	7797	0.014	0.24	9.74	8.39
jason-1	12	11094	0.010	0.22	9.58	8.31
jason-2	11	14395	0.069	0.21	9.67	7.86
jason-3	3	4181	0.097	0.21	9.95	7.48
saral	6	7876	0.088	0.21	10.14	7.96
cryosat	9	7913	0.048	0.19	9.00	7.57
AVERAGE	**9.3**	**7698.8**	**0.034**	**0.23**	**9.94**	**8.30**



Next step : finding the optimal retracker !

CCI Round-Robin “tournament”

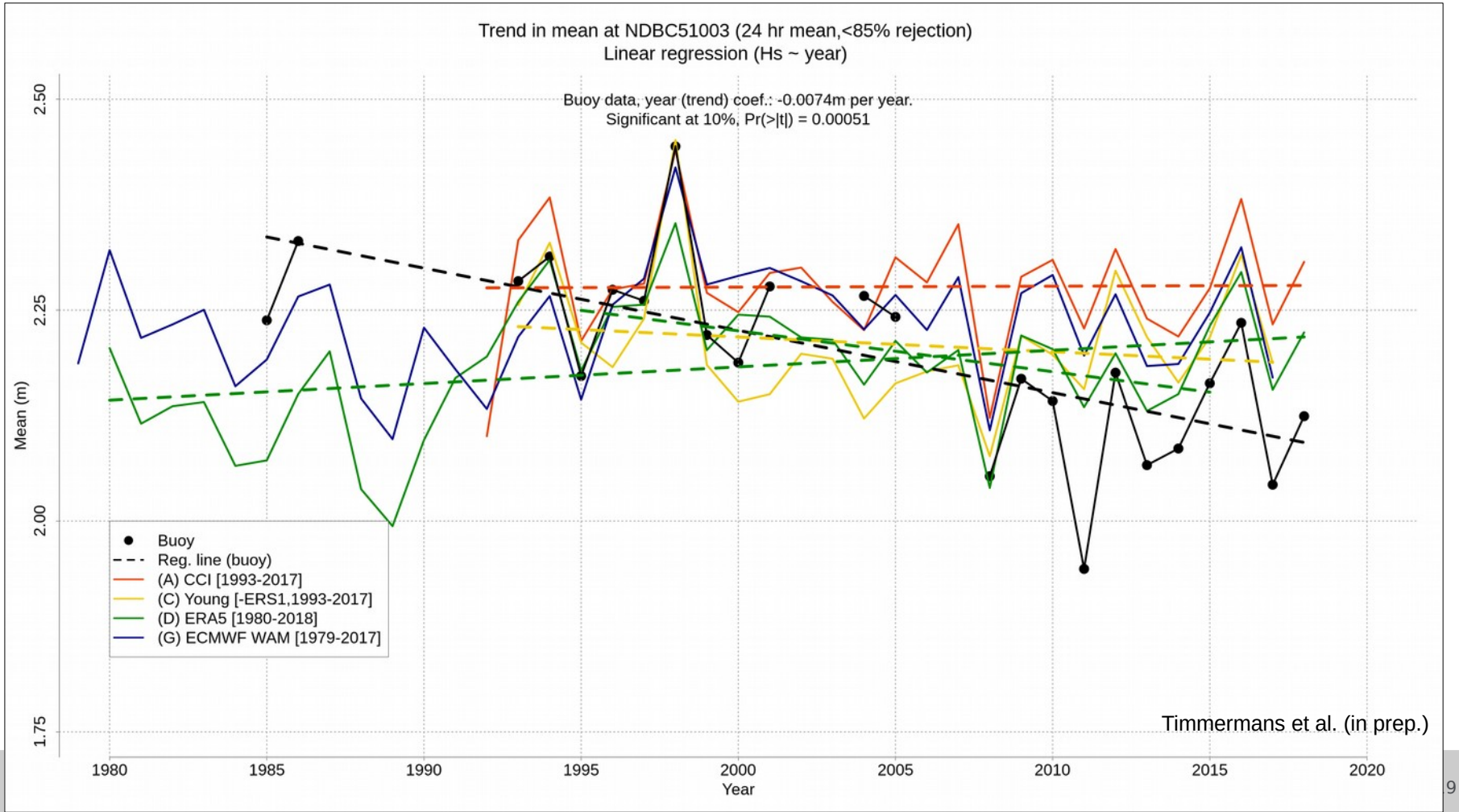
- Retracking algorithm for altimeter waveforms have been initially designed for ssh estimation (range)
- Dedicated retrackers are necessary for swh
- Sea state CCI is doing a comparative study to select an optimal retracking algorithm for swh
- More information at 15:50 with Graham Quartly (PML)



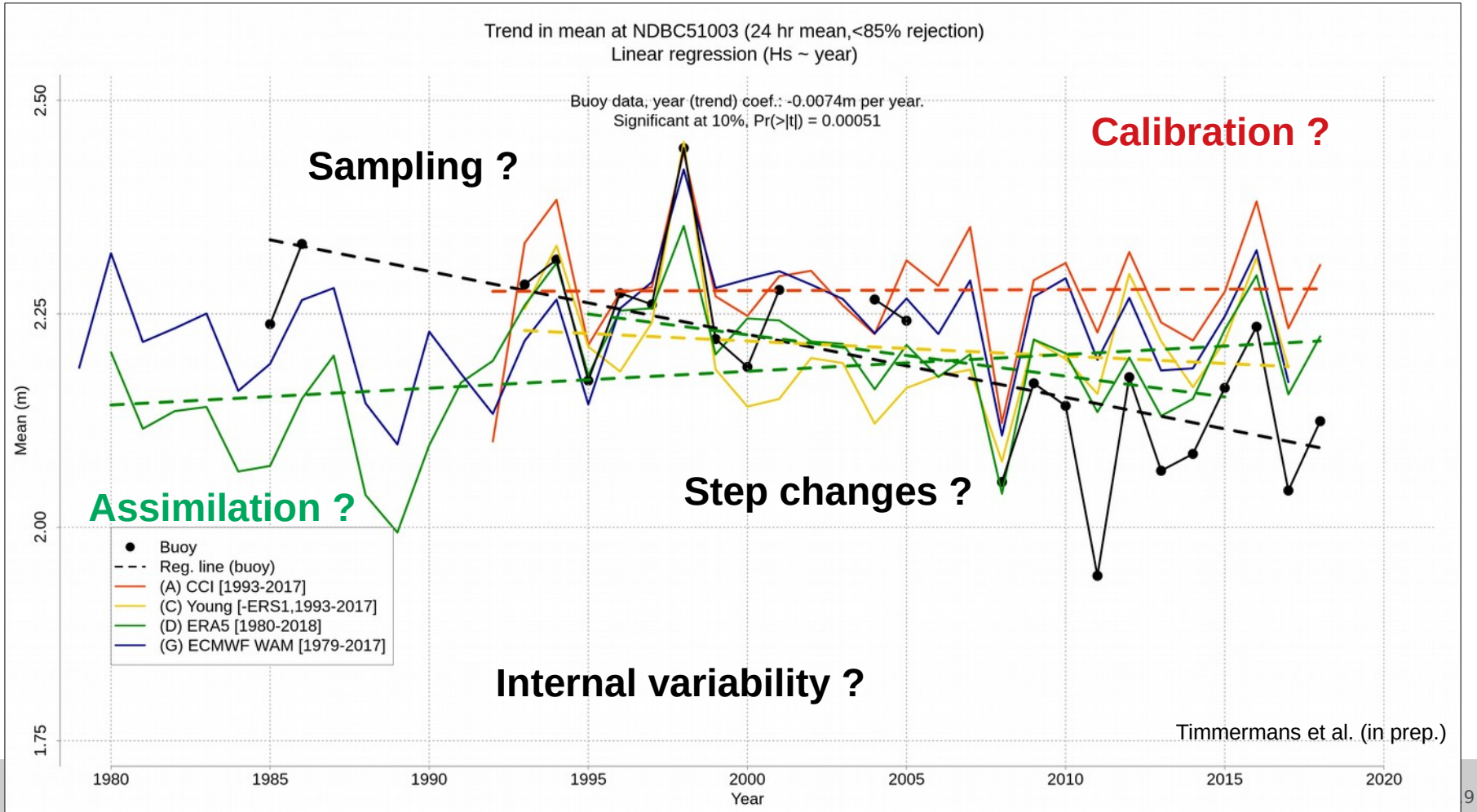
MLE-3 WHALES TALES Adaptive

MLE-4 STAR Brown Peaky

Climate trends... what can we say?



Climate trends... what can we say?



Summary

Your feedback is critical to:

- Improve the currently available CCI sea state dataset (user feedback to CCI)
- Shape the future of sea state global observations (CCI feedback to GCOS)

Enjoy the Sea State CCI dataset V1

- it’s easy to access (if not please tell us!)
- it will keep improving, and remain stable and available over long-term
- it’s designed for investigating long-term trends, extremes, small-scale variability, interactions with other components of the Earth system (CCI ECV)

Future releases will include :

- full reprocessing with dedicated retrackers
- new missions
- improved editing and calibration
- detailed uncertainty information
- new (spectral) parameters