

Wave measurements in the Antarctic marginal ice zone and in the Southern Ocean using LainePoiss type buoys

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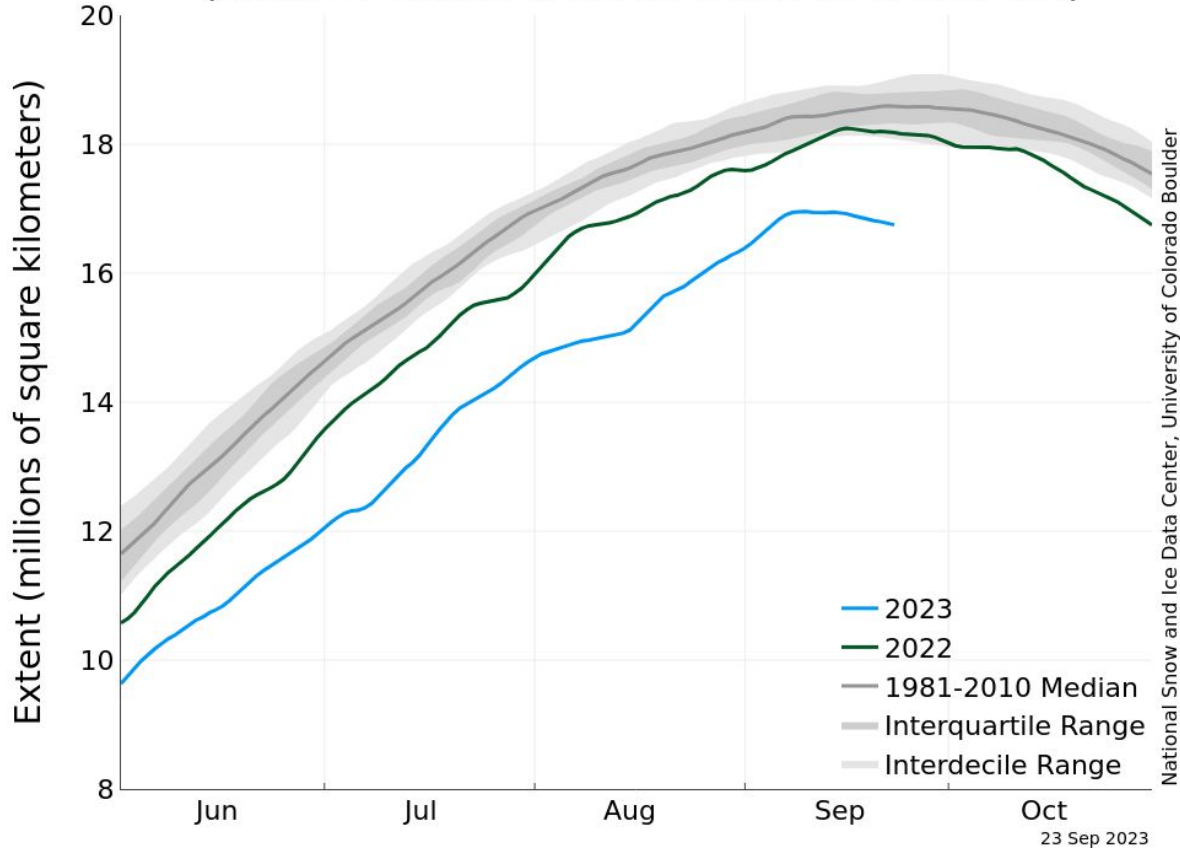
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Antarctic Sea Ice Extent (Area of ocean with at least 15% sea ice)



The big picture:

Antarctic sea ice extent
ca **1.5 million km²** lower
in 2023 than the
long-term observations.

This could lead to more
wave energy propagating
into pack ice...

Which in turn could affect
the disintegration process of
ice-shelves...

Which could accelerate
glacier mass loss...

Outline

What is a “LainePoiss” type buoy?

Why and how did some of them end up in the Southern Ocean AND in the MIZ of Antarctica?

How did the buoys perform?

What is a “LainePoiss” type buoy?

Alari, V., Björkqvist, J.V., Kaldvee, V., Mölder, K., Rikka, S., Kask-Korb, A., Vahter, K., Pärt, S., Vidjajev, N. and Tõnisson, H., 2022. **LainePoiss[®]—A Lightweight and Ice-Resistant Wave Buoy.** *Journal of Atmospheric and Oceanic Technology*, 39(5), pp.573-594.

www.lainepoiss.eu



Mass 5.5 kg
Diameter 0.36 m
Height 0.23 m

Inertial measurement unit
(MEMS)

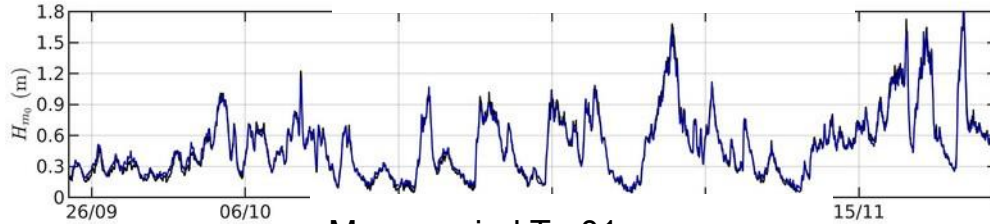
High frequency cut-off
1.28 Hz

Cellular LTE and/or satellite
Iridium communication

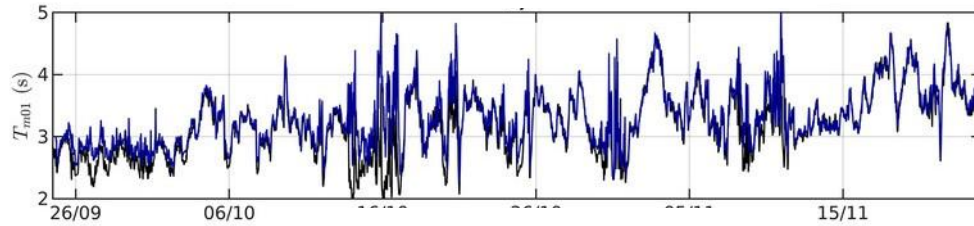
Rechargeable battery
 ≥ 4 months
Primary battery
 ≥ 10 months

Why Southern Ocean?

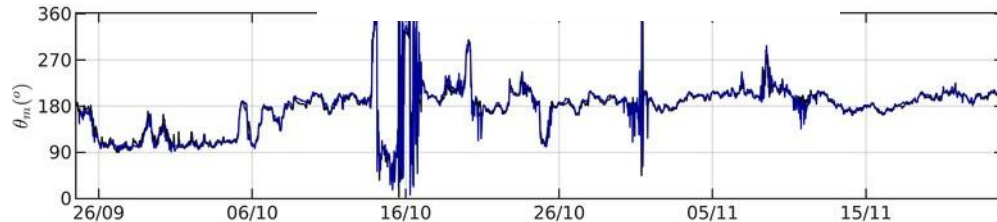
Significant wave height



Mean period T_{m01}



Wave direction

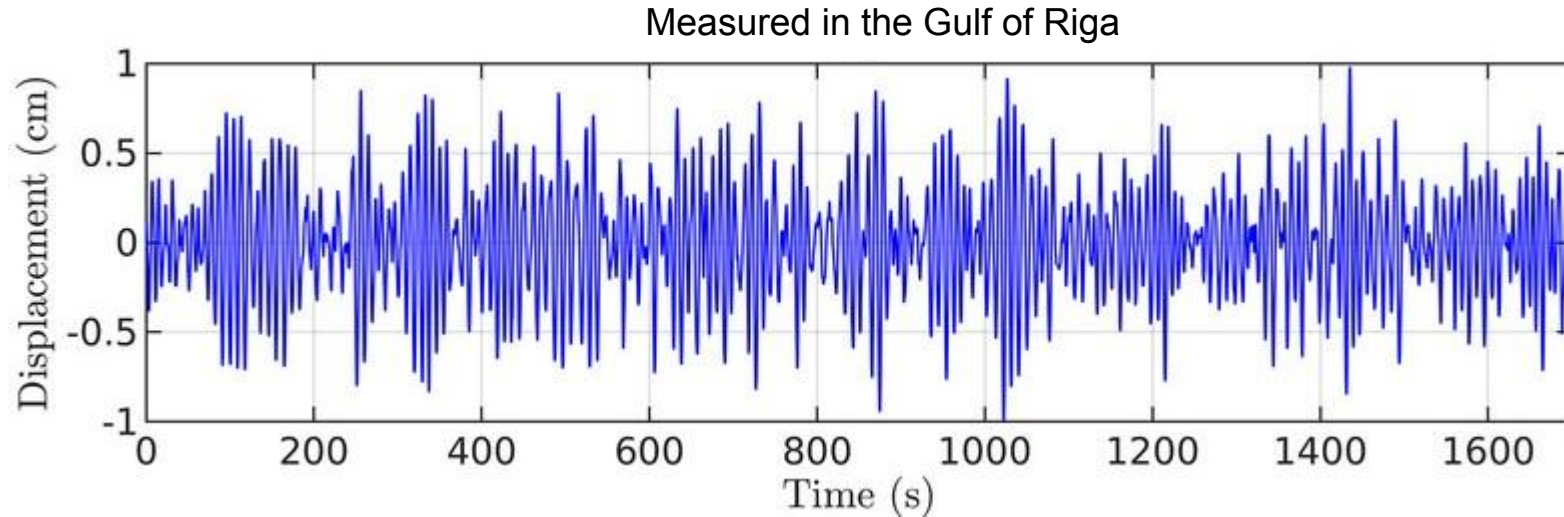


Comparison in the Baltic Sea between LainePoiss and DWR show reasonable agreement.

Since the Baltic Sea is fetch limited, only a certain spectrum range can be compared.

We would like to cover the range of ocean wave energy.

Why Antarctic MIZ?



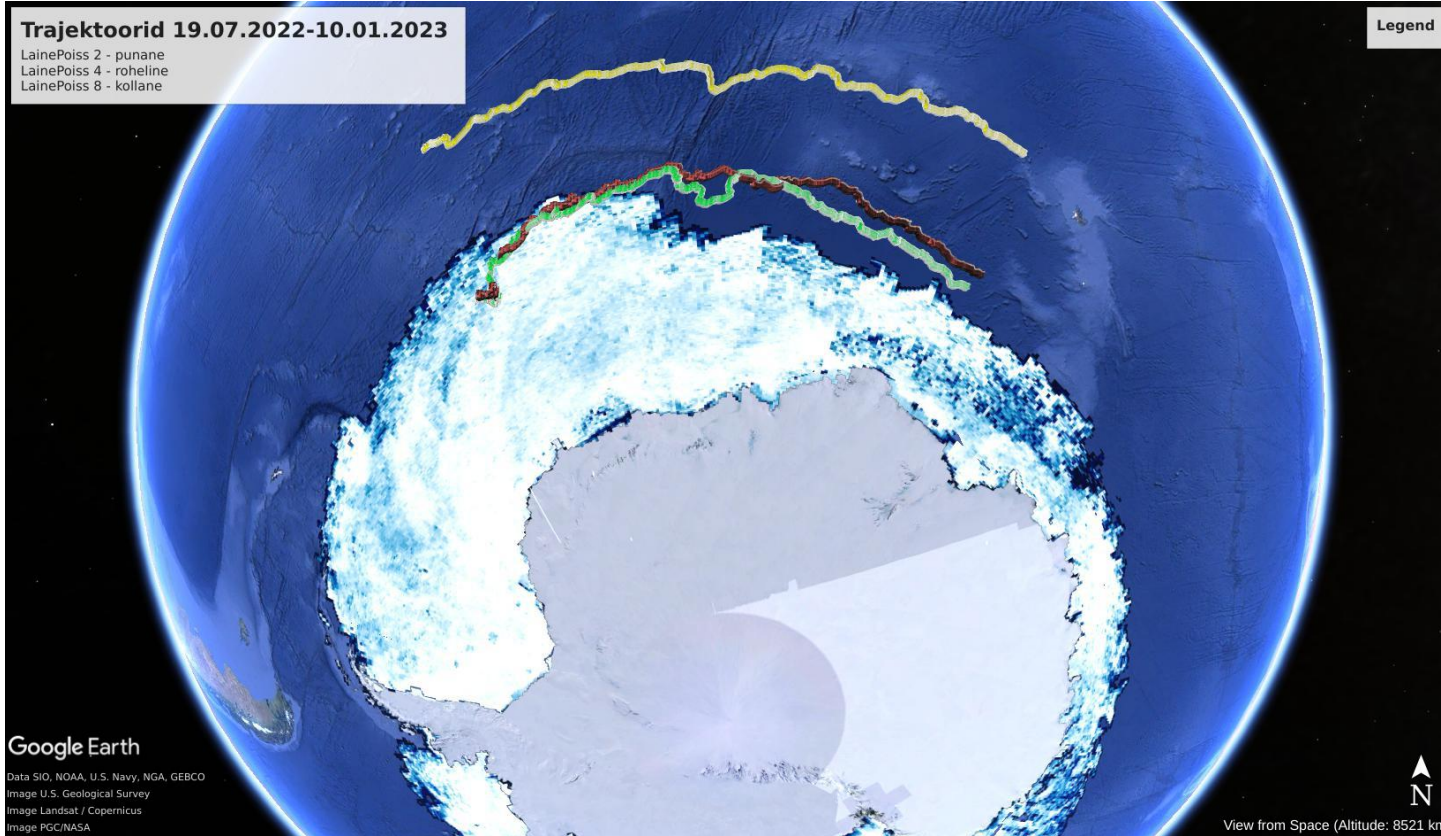
We have measured waves-in-ice in the seasonal ice-cover of the Baltic Sea. But, are LainePoiss buoys usable in the Polar Regions?

Deployments in the SO and Antarctic MIZ



During the SCALE-WIN22 (Southern Ocean seasonal Experiment, Winter 2022) expedition two LainePoiss buoys were deployed in the MIZ of the Weddell Sea and one in the open water in the vicinity of the ice edge.

LainePoiss tracks in the Southern Ocean and MIZ

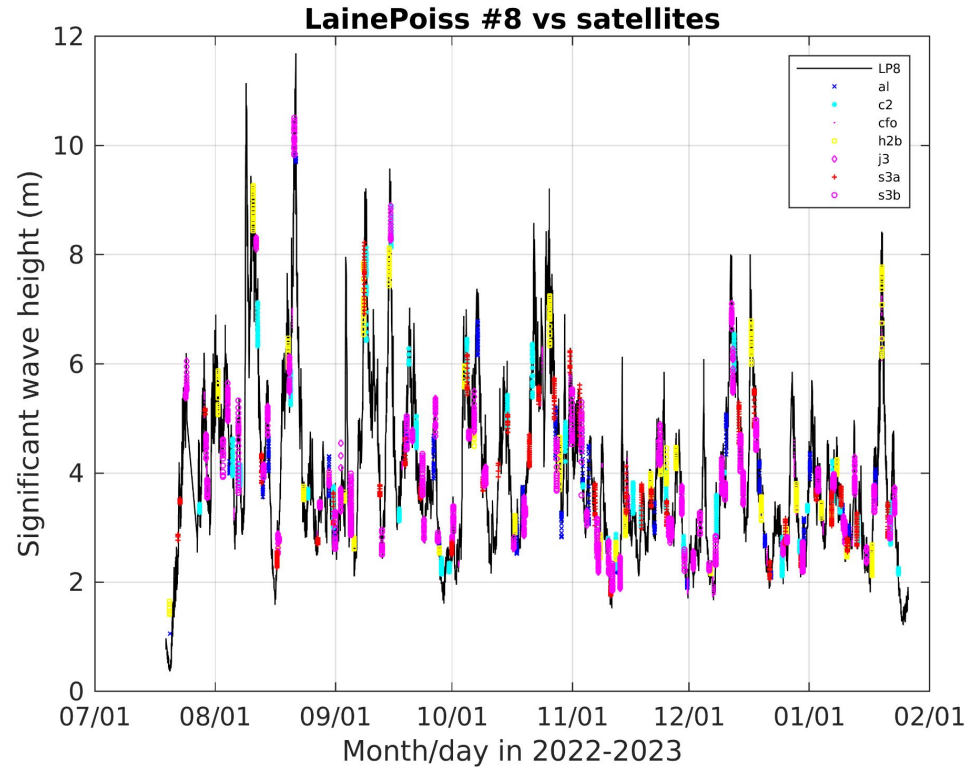


YELLOW -
open ocean

RED - in the
MIZ for two
months

GREEN - in the
MIZ for two
months

Validation in the Southern Ocean



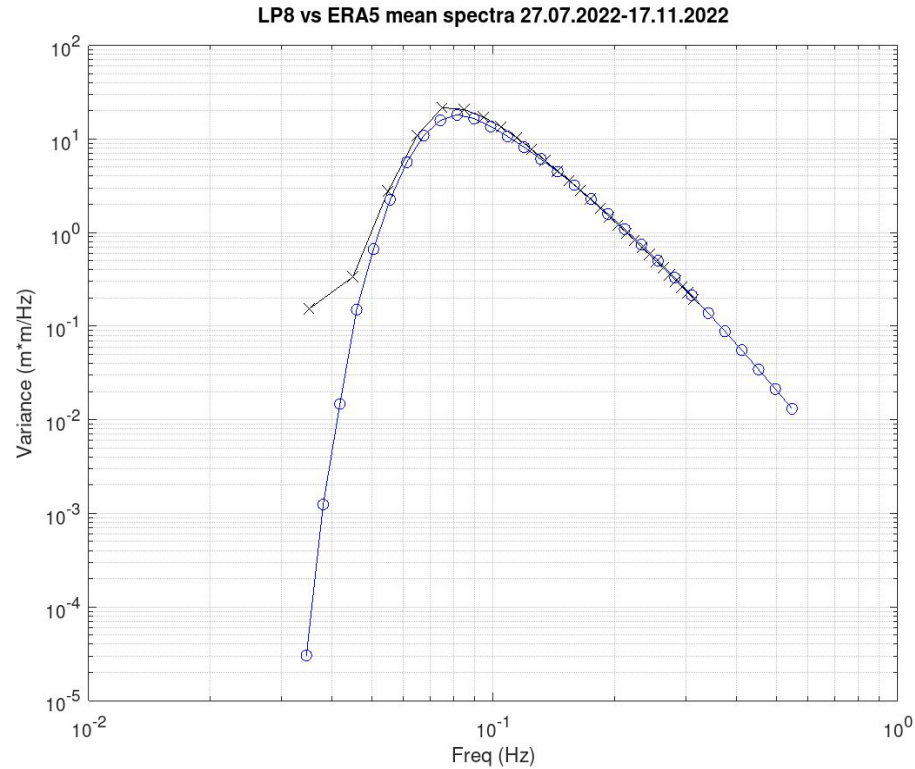
Validation metrics for significant wave height

	Sentinel-3A	Sentinel-3 B	CryoSat- 2	Jason-3	SARAL	CFOSAT	HY-2B
CC	0.97	0.96	0.98	0.97	0.98	0.98	0.98
RMSD (m)	0.33	0.35	0.36	0.35	0.42	0.38	0.44
Bias (m)	-0.03	0.03	0.11	0.01	0.04	0.10	0.03
SI (%)	8.59	9.30	8.39	8.32	11.75	8.59	10.48
Mean LP8 (m)	3.85	3.72	4.09	4.24	3.55	4.23	4.17
Mean SAT (m)	3.88	3.69	3.98	4.23	3.52	4.13	4.14
N	43	41	43	51	36	37	45

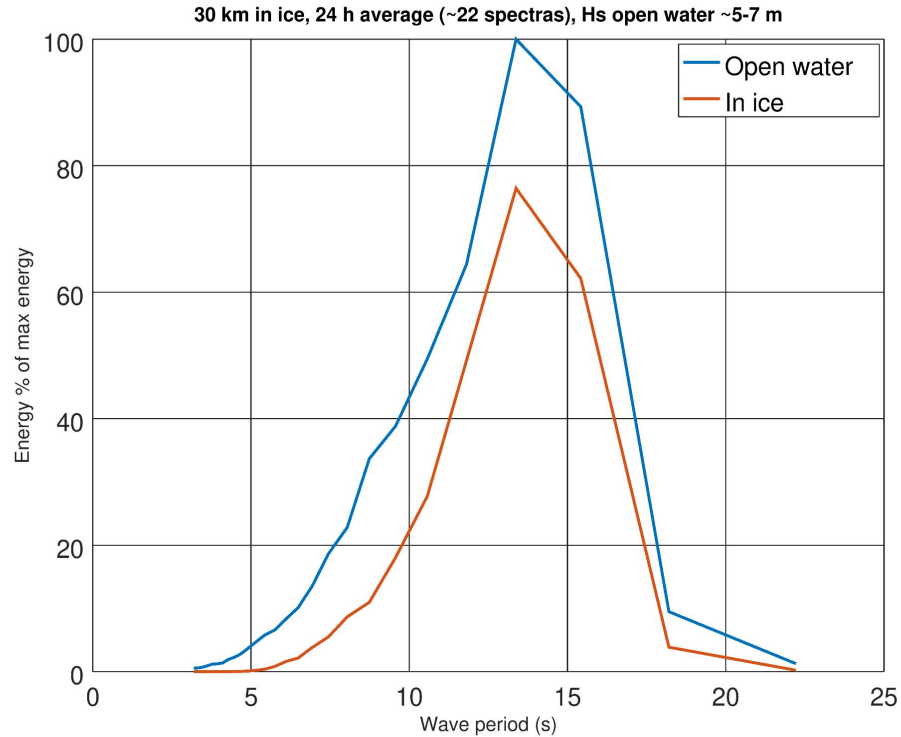
Validation metrics for peak period

	CFOSAT
CC	0.80
RMSD (s)	1.21
Bias (s)	-0.03
SI (%)	11.00
Mean LP8 (s)	11.01
Mean SAT (s)	11.04
N	63

Comparison to ERA5



Wave damping in ice in the Antarctic MIZ



Conclusions

LainePoiss buoys in the Antarctic MIZ captured the well known frequency dependent wave damping.

LainePoiss compared to several altimeter products shows very reasonable agreement (correlation between 0.94-0.99 with most of the time scatter index less than 10 %) in all measured significant wave height ranges from 2 m to 11 m.

LainePoiss a suitable sea-state detector also in oceanic (icy) conditions.

Thank you for your attention!

Q&A now, during Workshop and victor.alari@taltech.ee

