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Adaptive threshold retracking for Arctic summer sea ice freeboard

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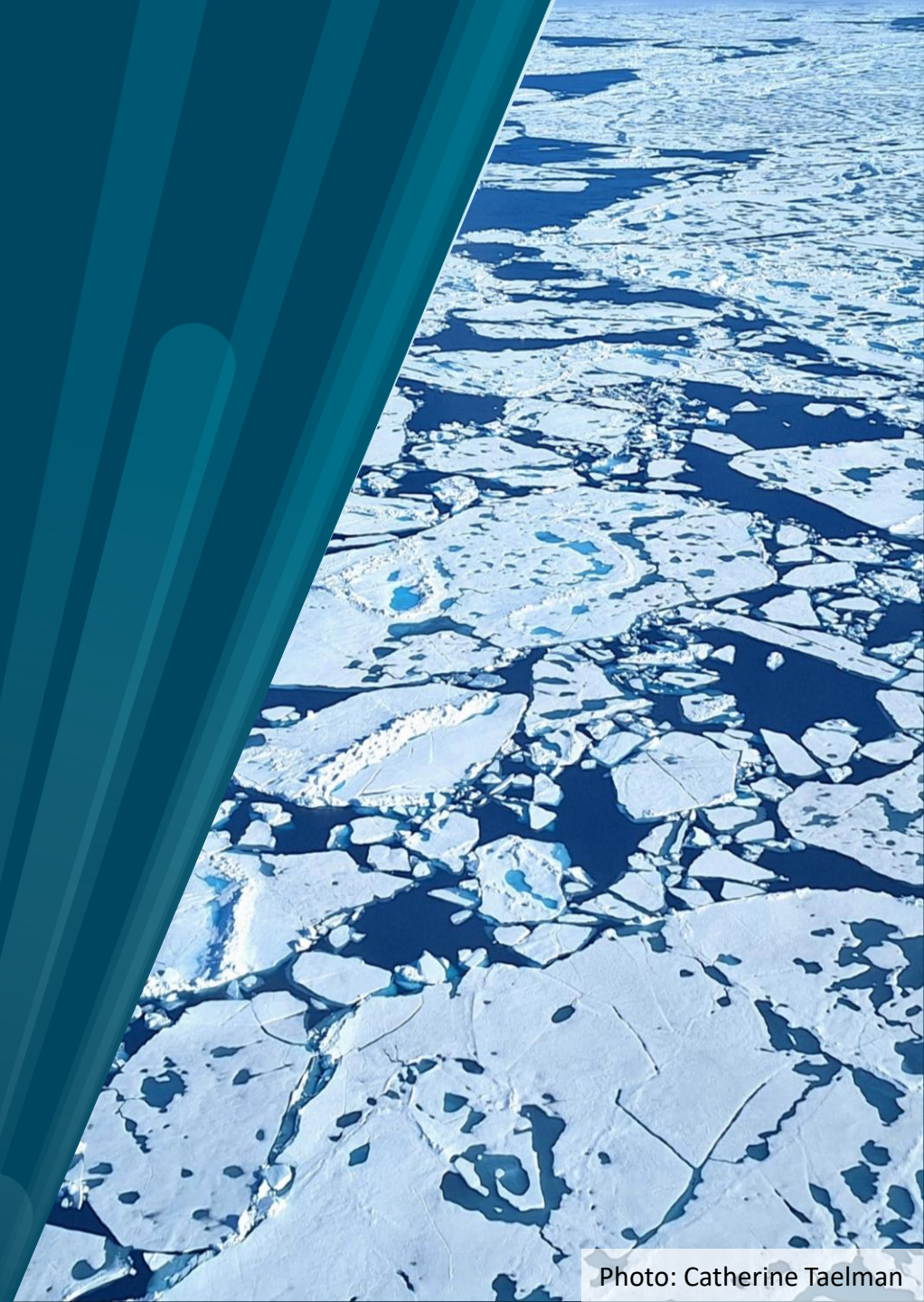


Photo: Catherine Taelman

Importance of summer data

- Sea ice thickness determines overall sea ice volume, stability of the sea ice and biological growth under the ice (most in summer!)
- Essential variable for shipping (most in summer!)
- Summer sea ice thickness very valuable for predictions

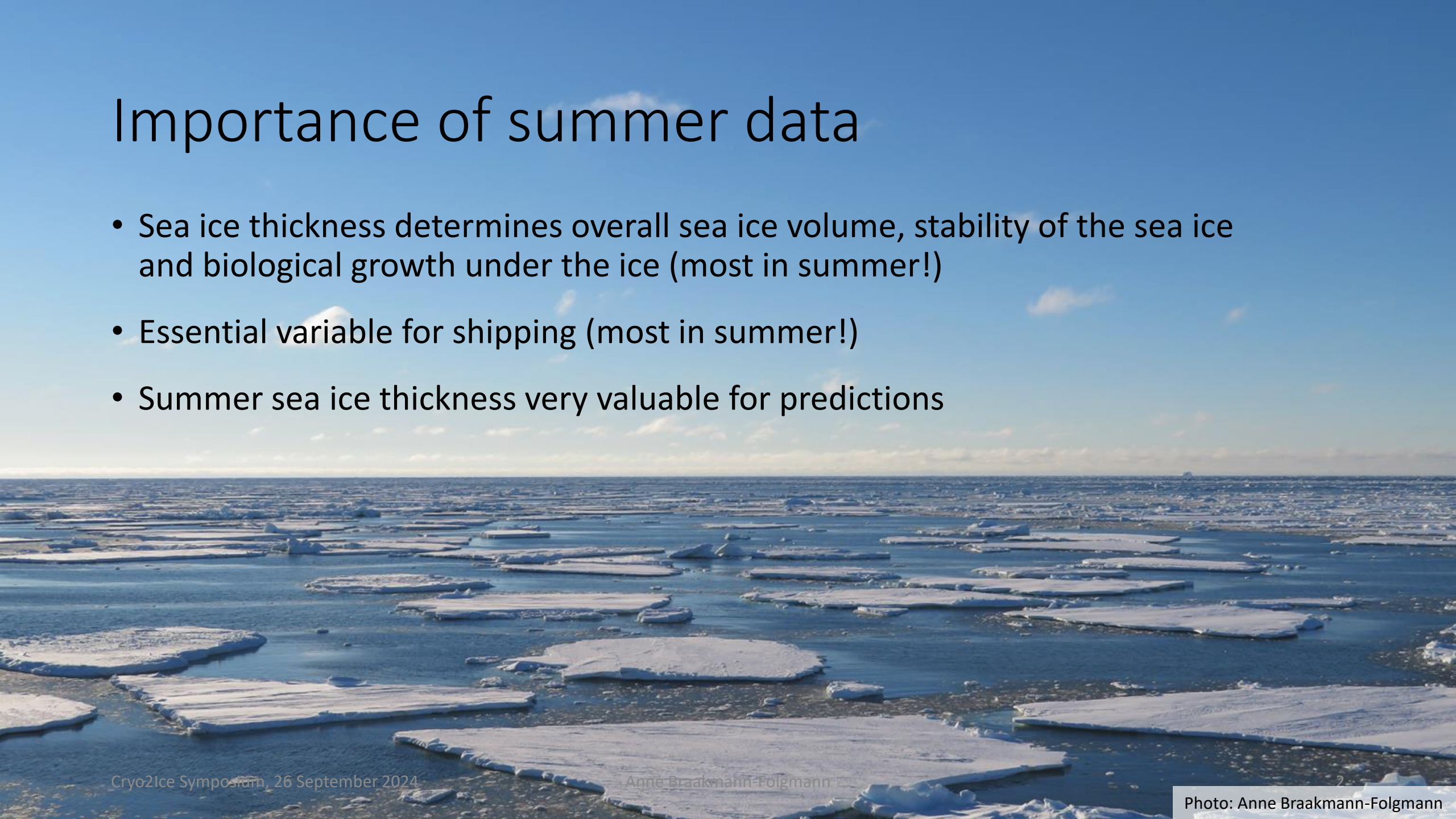
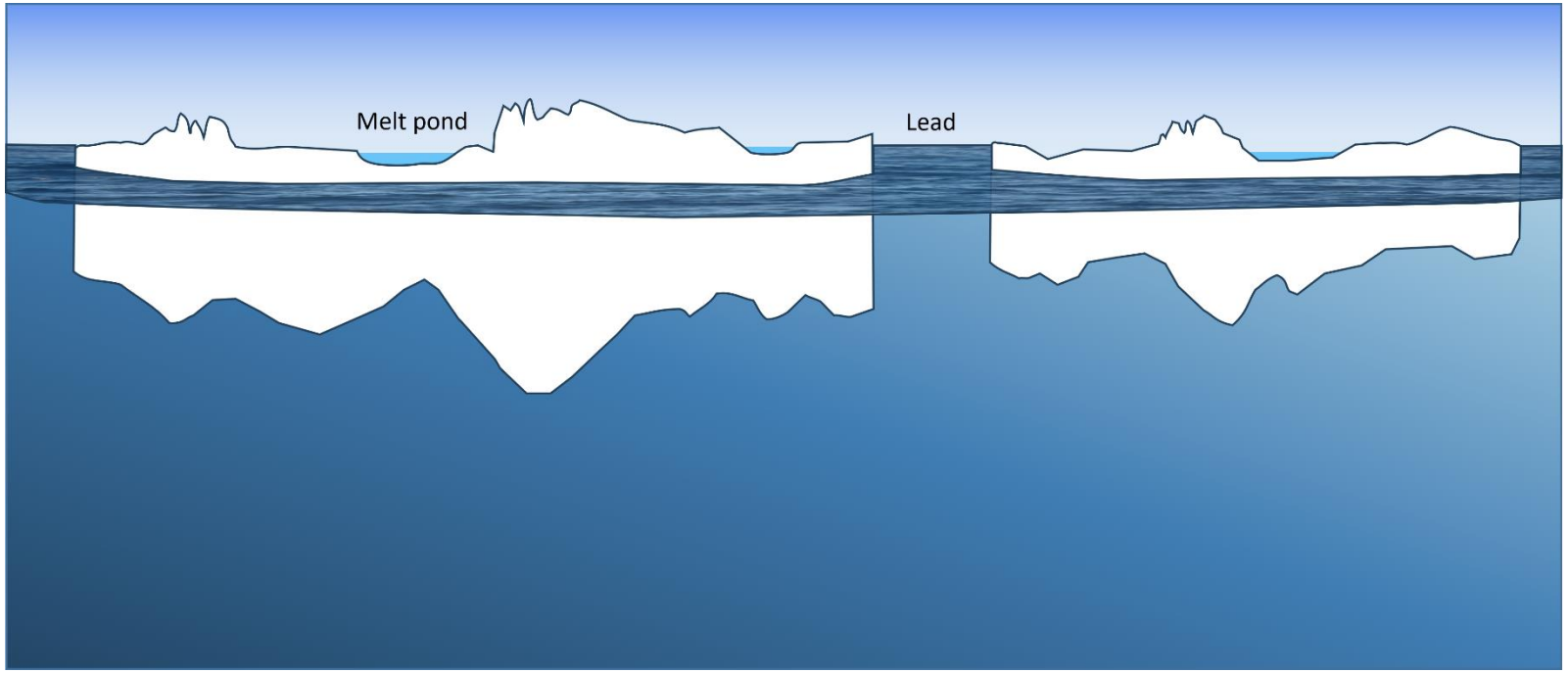


Photo: Anne Braakmann-Folgmann

Challenges in summer: melt ponds!

1. Hard to distinguish ponds and leads
2. Melt ponds sit lower than average floe height (EM bias)

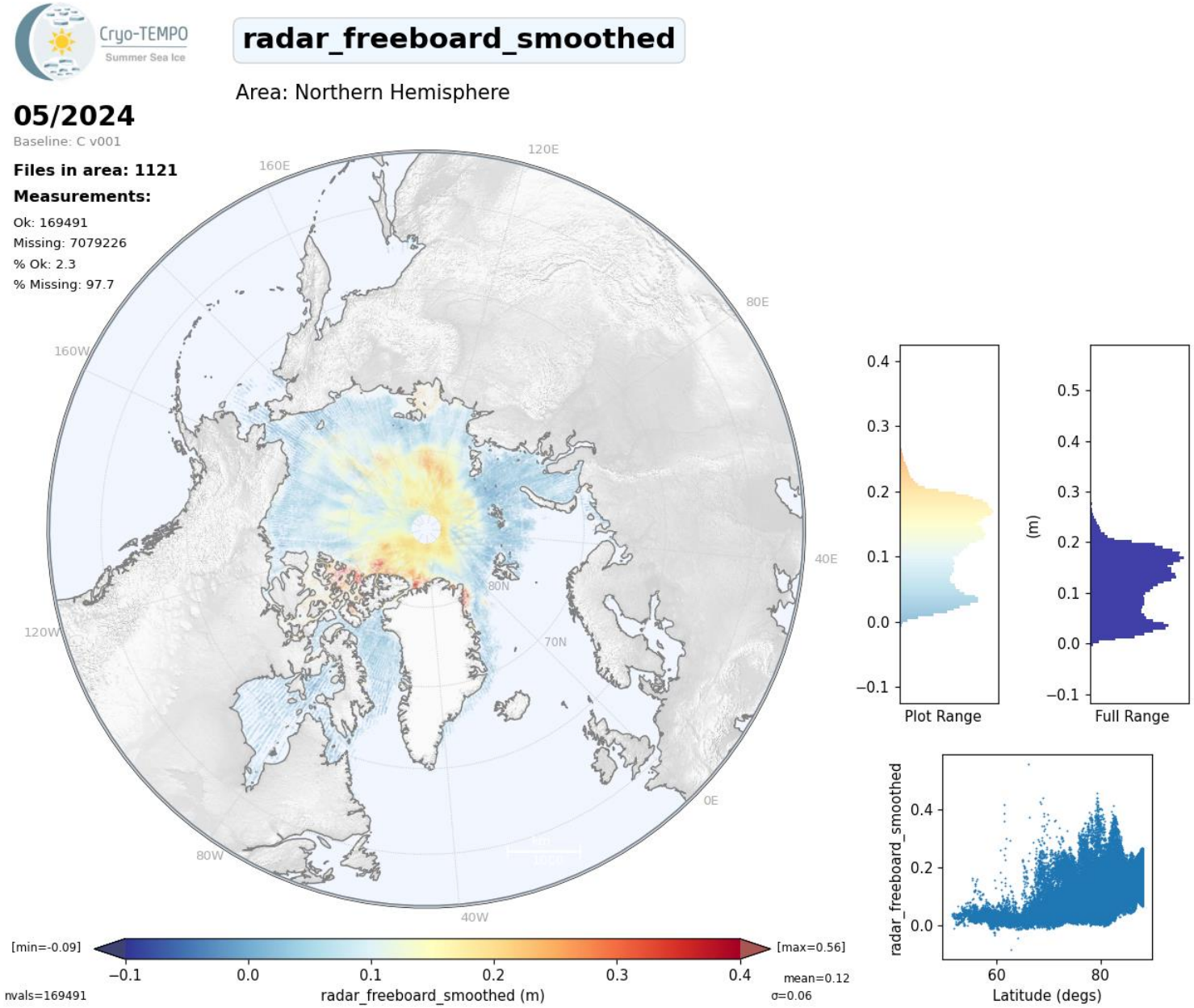


CryoTEMPO summer sea ice

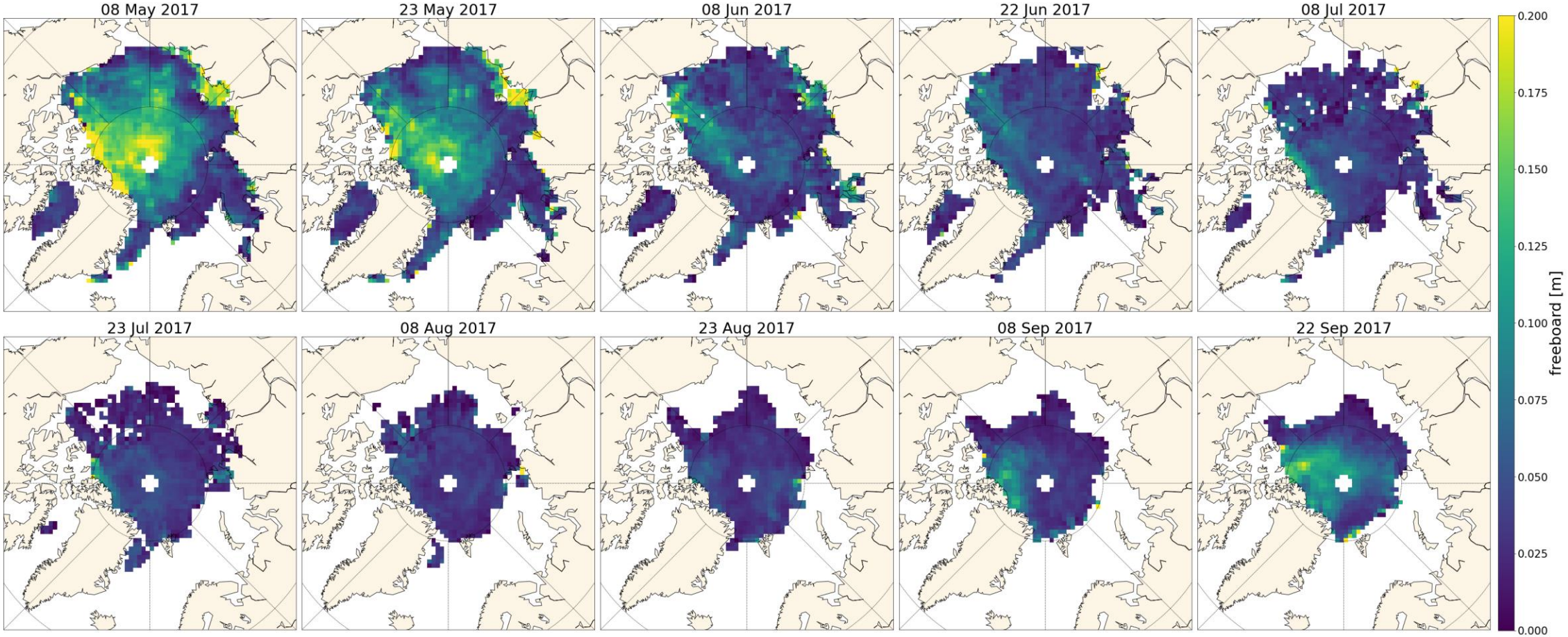
- Operational production of along-track radar freeboard since this year

+ Reprocessing since 2010

- Available from ESA CryoSat FTP server
- Improvements will be implemented each year



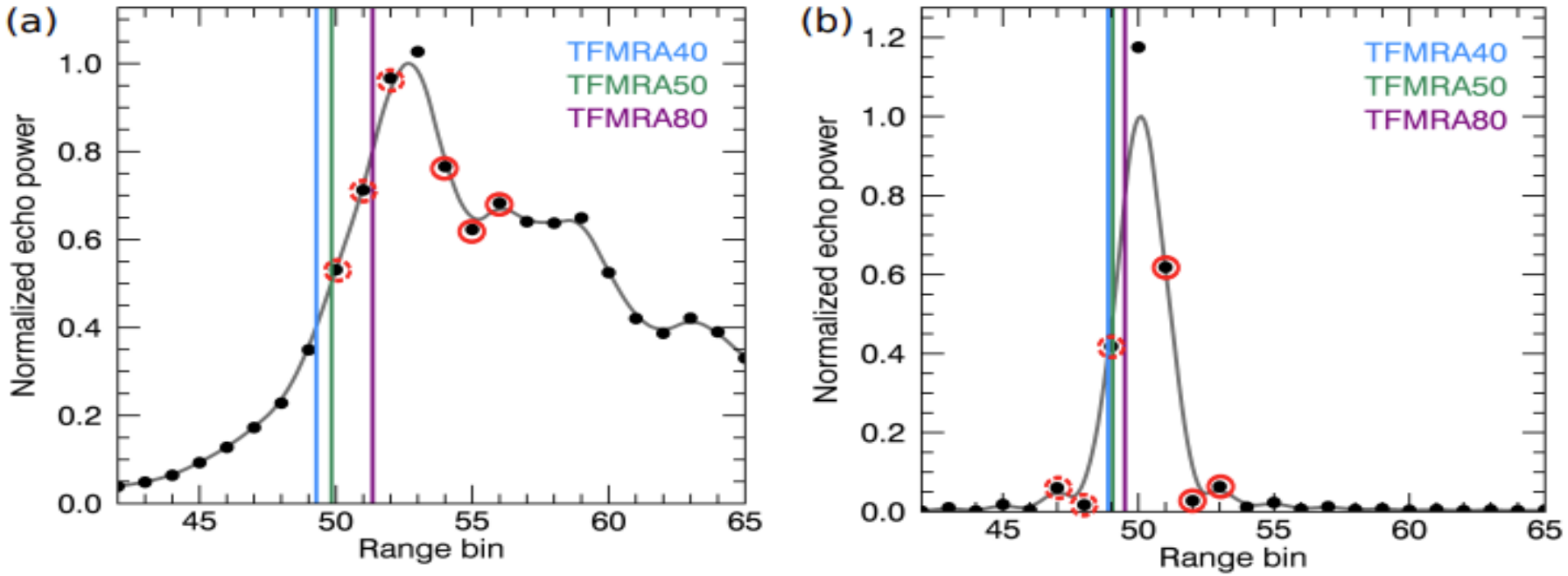
Spatial and temporal evolution



→ Overall realistic spatial and temporal patterns, but rougher MYI areas are underestimated

Varying the retracking threshold

- So far: TFMRA50 (Threshold first-maximum retracker algorithm at 50% threshold)
- **<u>Idea:</u> Adjust threshold to summer conditions**, rather than apply correction to fb



Typical sea ice (a) and lead (b) waveforms retracked at different thresholds by Ricker et al. (2014)

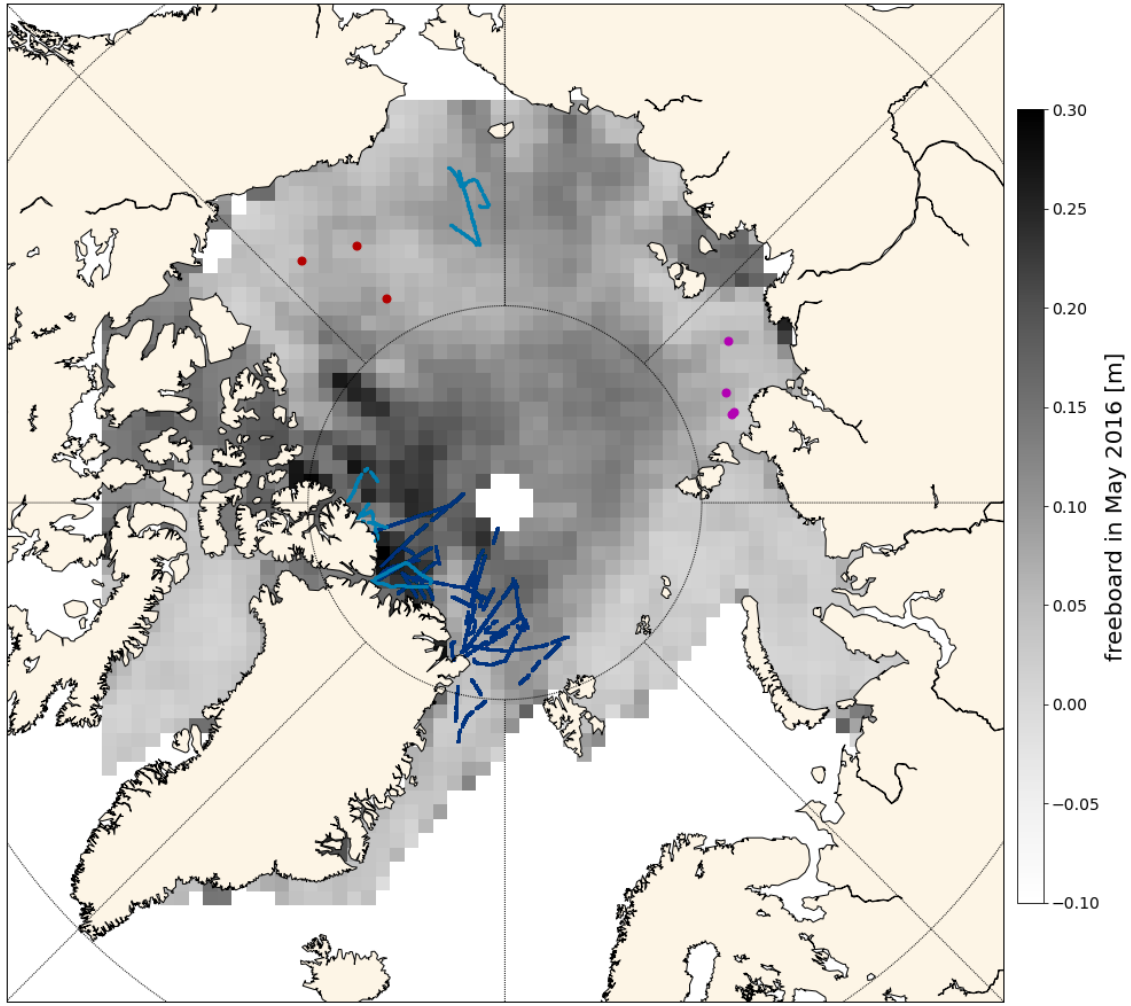
Validation data

- How do we find the optimal threshold?

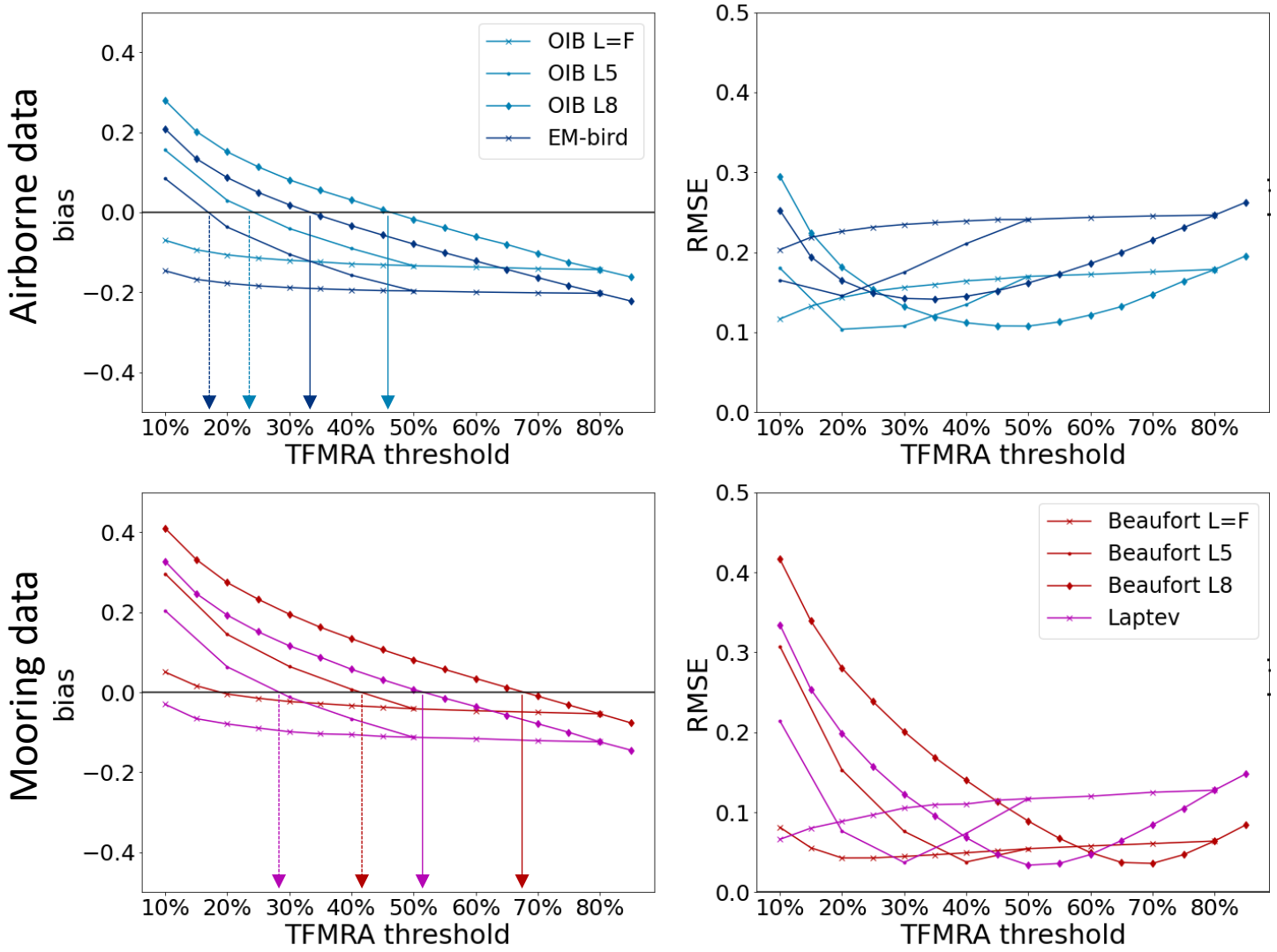
→ Compare to validation data:

- Mooring data:
  - Beaufort Sea: 3 moorings 2016 – 2018
  - Laptev Sea: 4 moorings 2015-2016
- Airborne data:
  - Operation Ice Bridge data 2016-2017
  - AWI EM-bird data 2016-2018

- All data are converted to freeboard and downsampled to 60 km and 15 days for even coverage and better comparability to CryoSat



Impact of different retracking thresholds



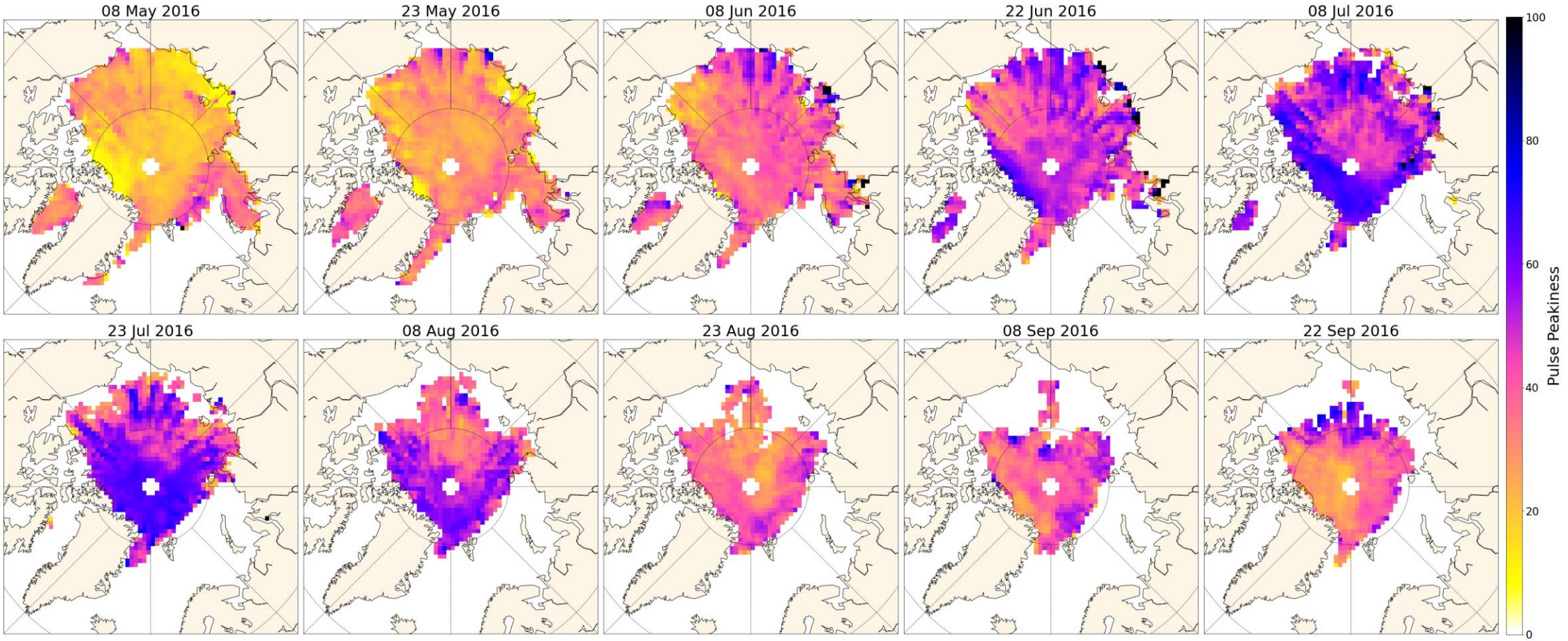
L=F.. Same threshold for leads and floes
L5 .. Lead threshold 50%
L8 .. Lead threshold 80%

→Varying the thresholds has a large impact on the agreement with *in situ* data

→Different thresholds work best in different conditions

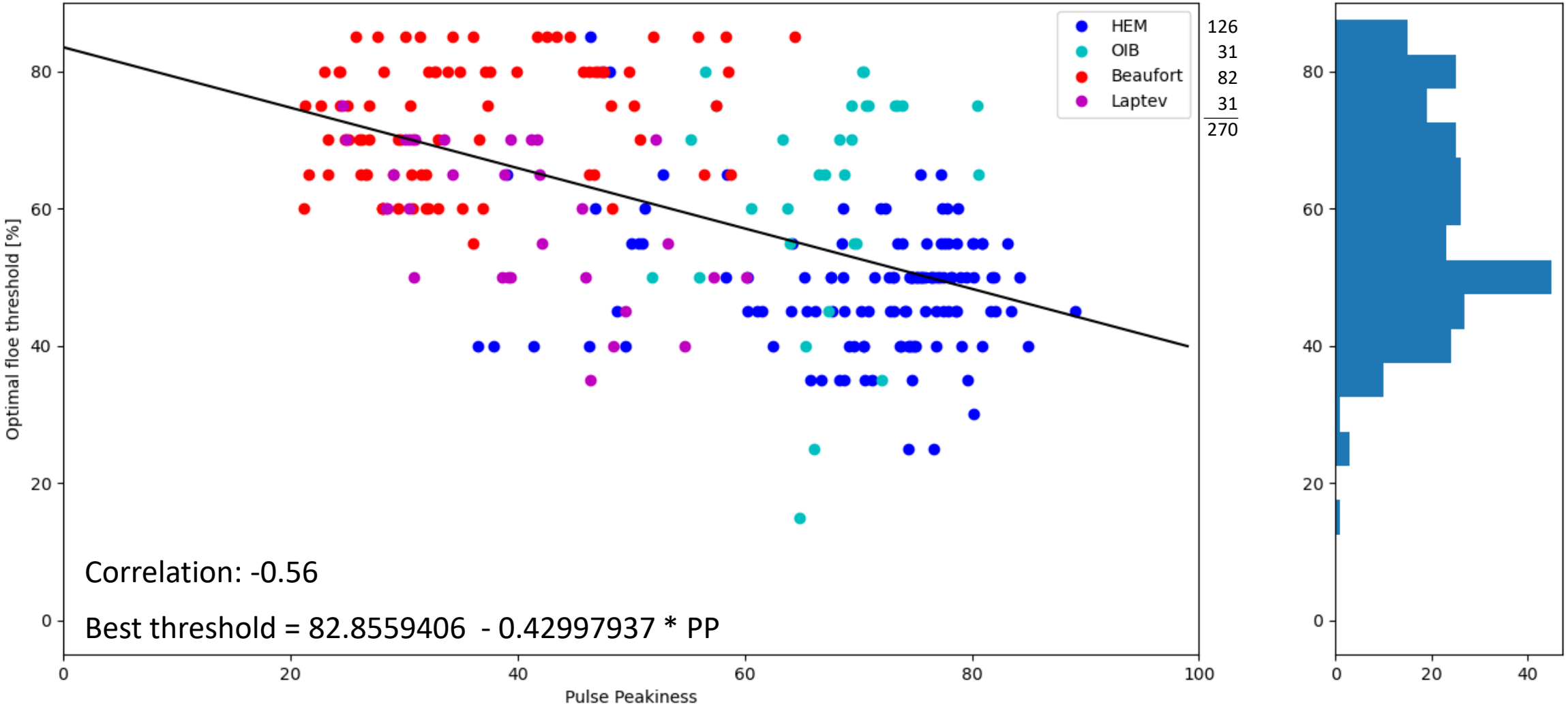
→Find a way to vary the floe threshold based on waveform parameters

Pulse peakiness

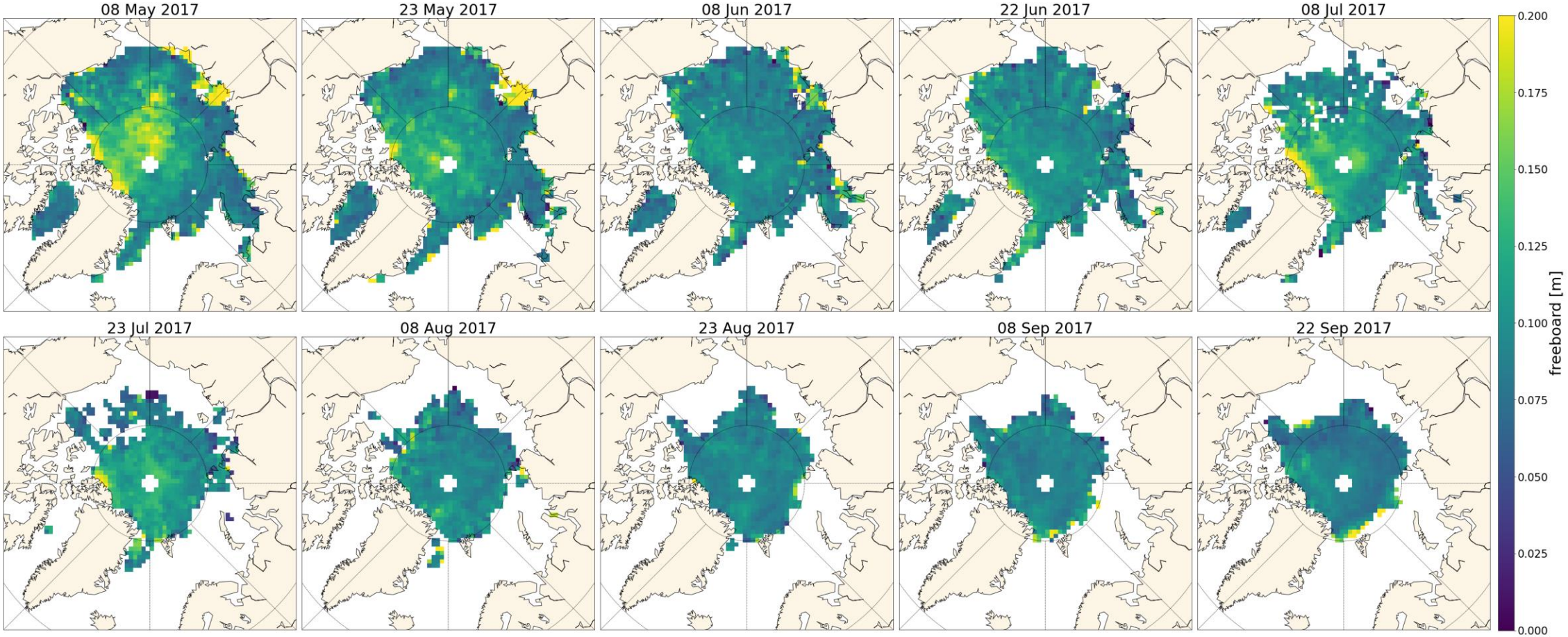


→ Shows obvious spatial and temporal patterns linked to melt

Optimal floe threshold as a function of PP



Resulting freeboard maps



Validation against *in situ* data

	TFMRA 50			Leads: TFMRA 80, Floes: TFMRA (PP)		
	Bias [m]	RMSE [m]	correlation	Bias [m]	RMSE [m]	correlation
OIB 2016	-0.06	0.09	-0.15	-0.01	0.06	-0.03
OIB 2017	-0.18	0.21	0.35	-0.12	0.16	0.30
HEM 2016	-0.19	0.22	0.13	-0.11	0.16	0.30
HEM 2017	-0.17	0.20	0.43	-0.11	0.15	-0.13
HEM 2018	-0.20	0.26	0.10	-0.13	0.21	0.00
Beaufort	-0.04	0.05	0.40	0.00	0.05	-0.04
Laptev	-0.07	0.08	-0.29	-0.01	0.05	-0.28

Conclusions

- Operational summer sea ice freeboard product available since May
- Overall patterns and anomalies captured already

- Changing the retracking threshold has large impact on final product
- Different thresholds are ideal in different conditions

- First attempt for adaptive retracking threshold improves agreement with *in situ* data, but diminishes seasonal and spatial signals

Photo: Catherine Taelman