

# STATISTICALLY CLASSIFYING THE PAN-ANTARCTIC MARGINAL ICE ZONE WITH CICE6

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IGS SYMPOSIUM ON SEA ICE  
ACROSS SPATIAL AND TEMPORAL SCALES  
BREMERHAVEN | GERMANY

# ANTARCTIC MARGINAL ICE ZONE (MIZ)

- The marginal ice zone is an interface between the open ocean and the consolidated inner pack
- Ocean surface waves can fracture ice floes 100s of km from the ice edge<sup>1</sup>, and contribute to the formation of pancake ice in the marginal ice zone<sup>2</sup>



<sup>1</sup> Kohout, A. *et al.*, Nature, (2014).

<sup>2</sup> Wadhams, P. *et al.*, JGR, (1987).

# MOTIVATION

- Traditionally, a 15-80% sea ice concentration range has been used to quantify the marginal ice zone
- However, this is not appropriate for the winter Antarctic MIZ, where large waves and pancake floes have been measured with SIC  $\approx 100\%$ <sup>3</sup>
- We use CICE with a floe size distribution (CICE6-FSTD) to model the variance of sea ice types

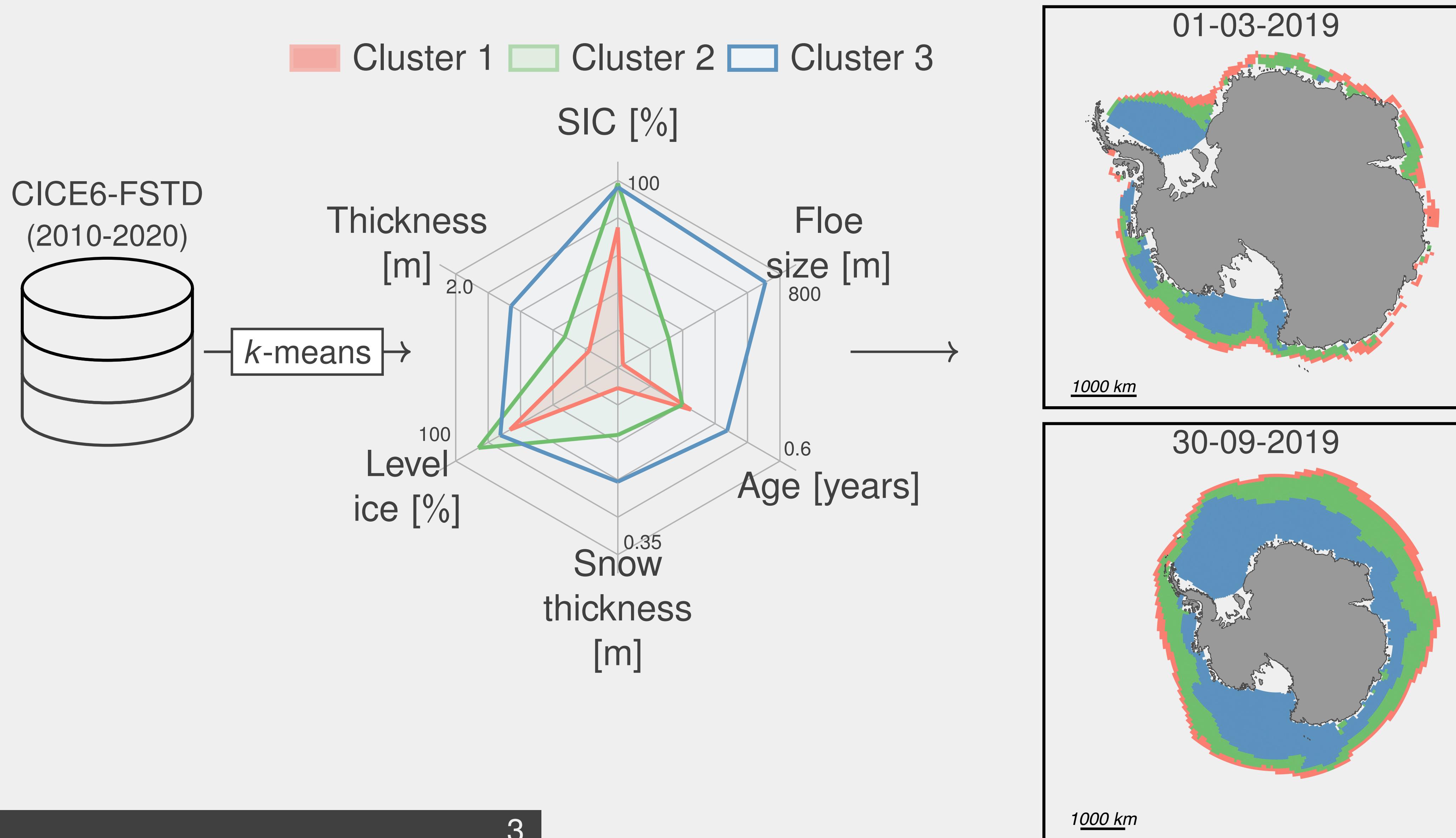


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<sup>3</sup> Alberello, A. *et al.*, Nature Comms., (2022).

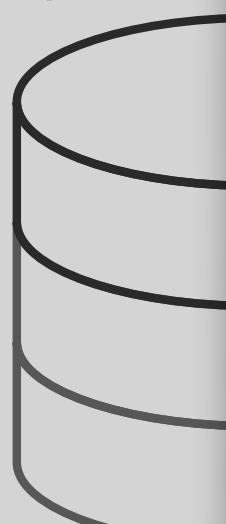
Credit: Sandra Zicus.

# UNSUPERVISED CLASSIFICATION OF SEA ICE DATA

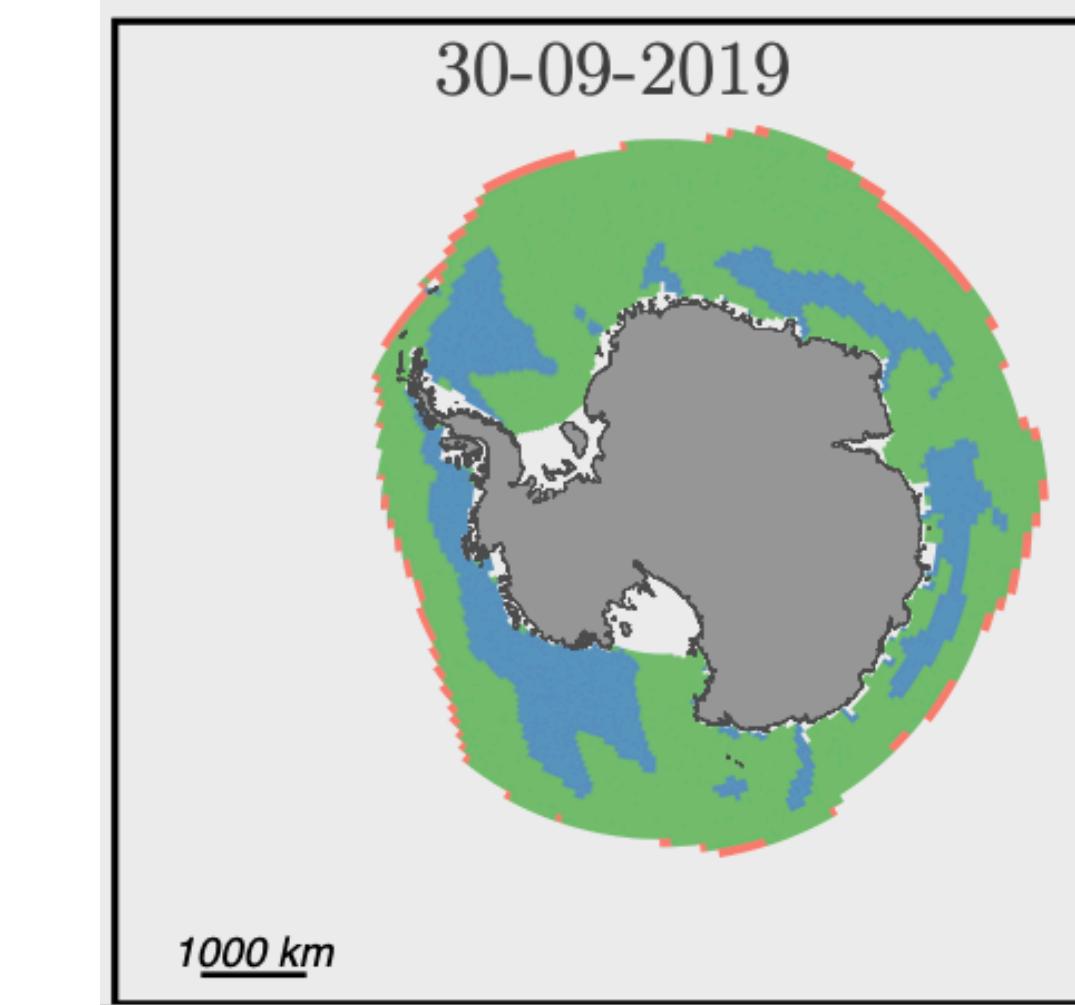
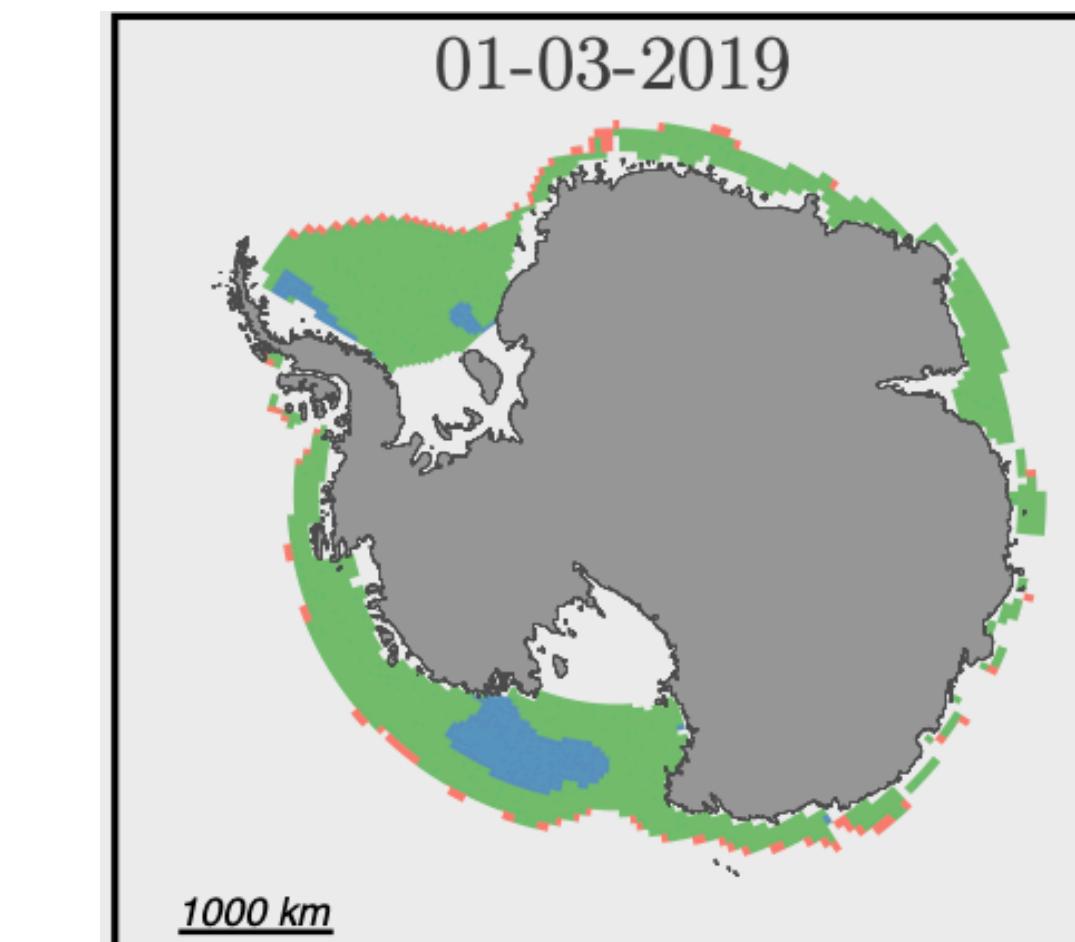
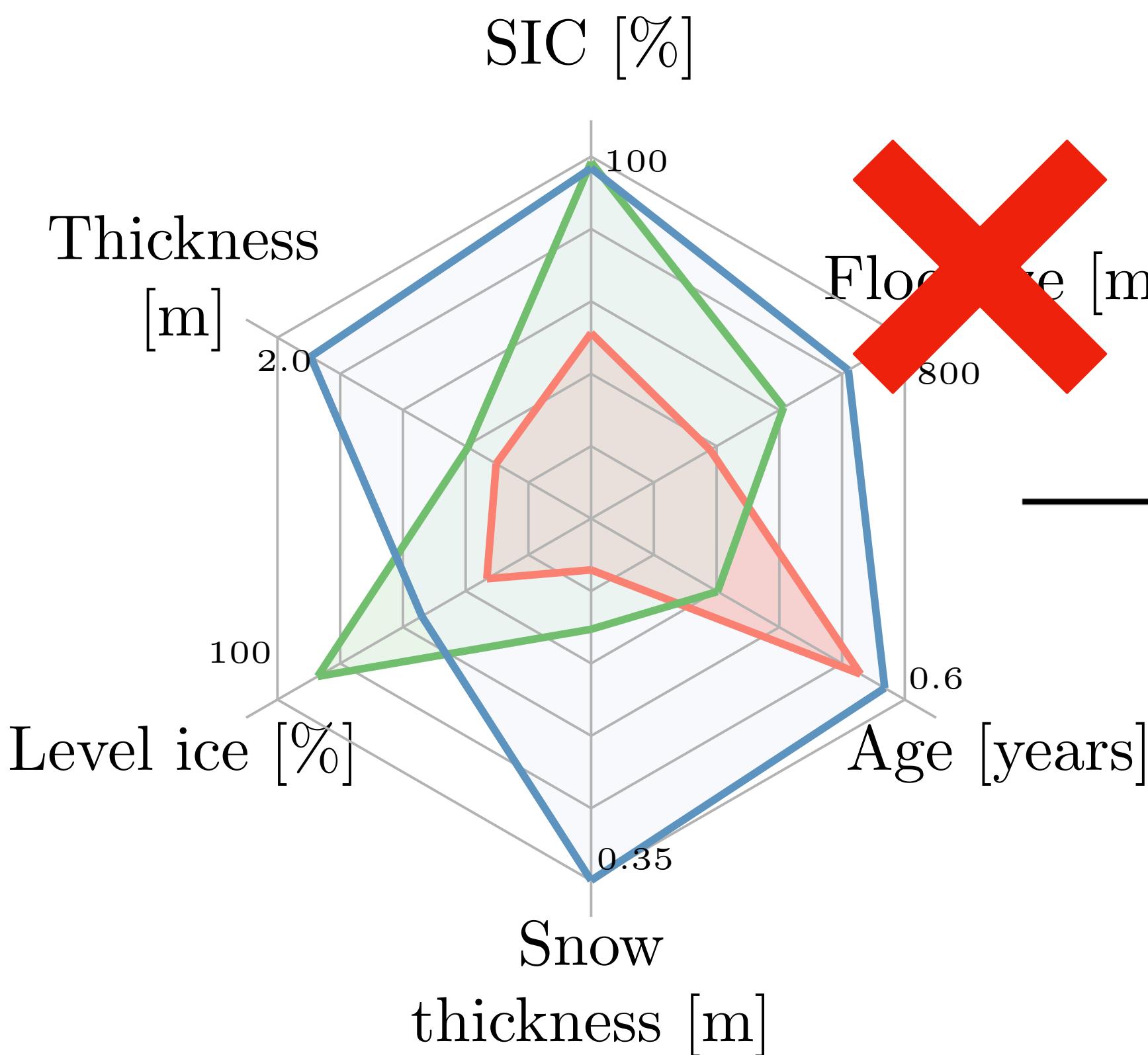


# UNSUPERVISED CLASSIFICATION OF SEA ICE DATA

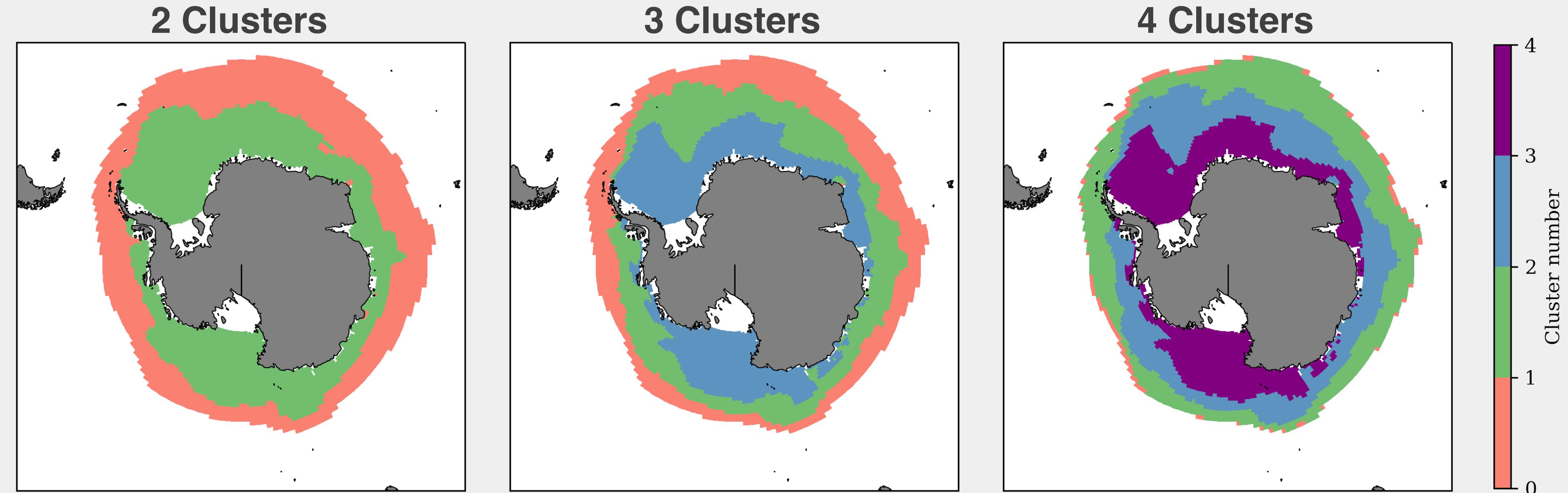
CICE6  
(2010)



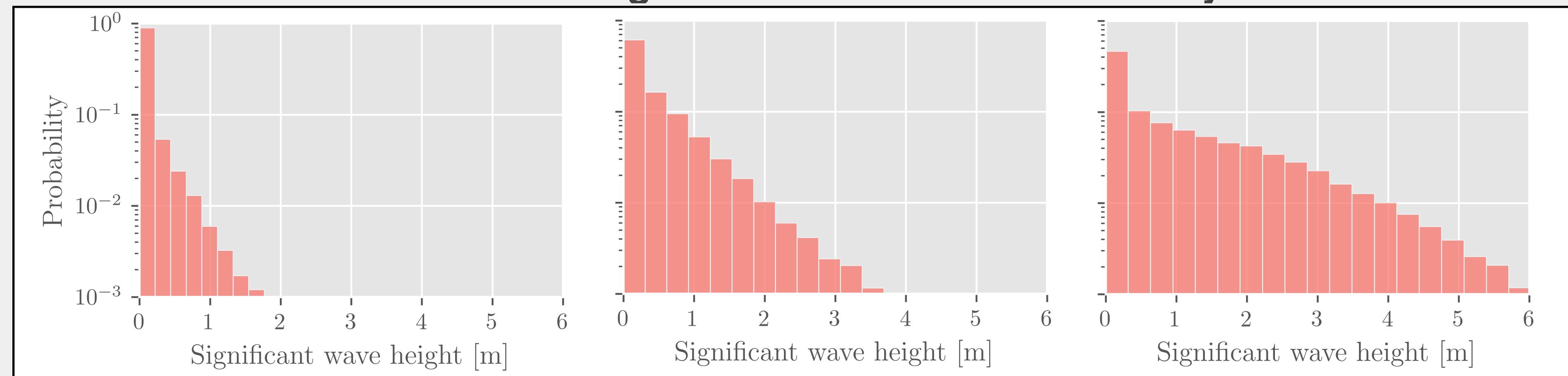
Cluster 1 Cluster 2 Cluster 3



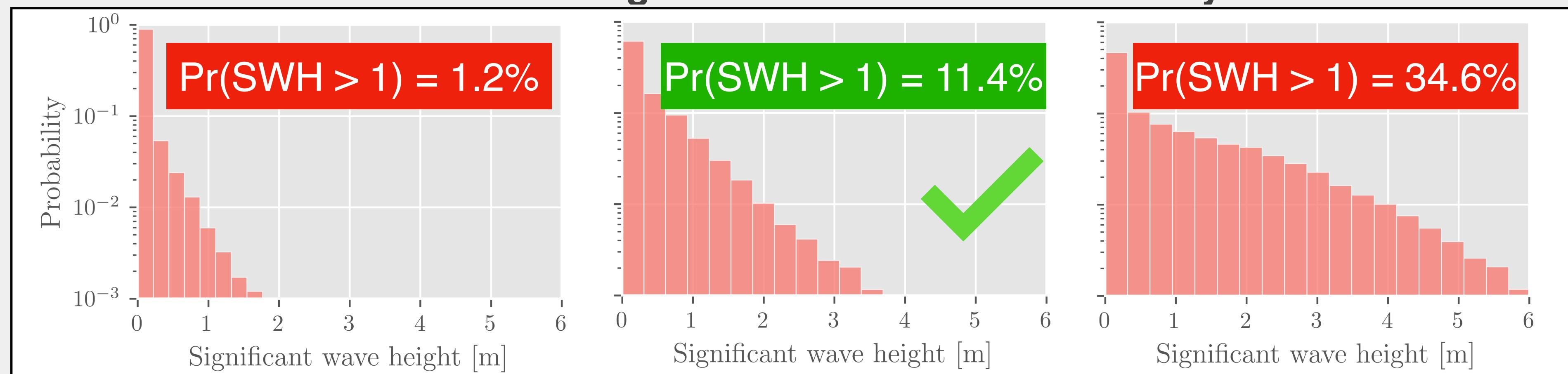
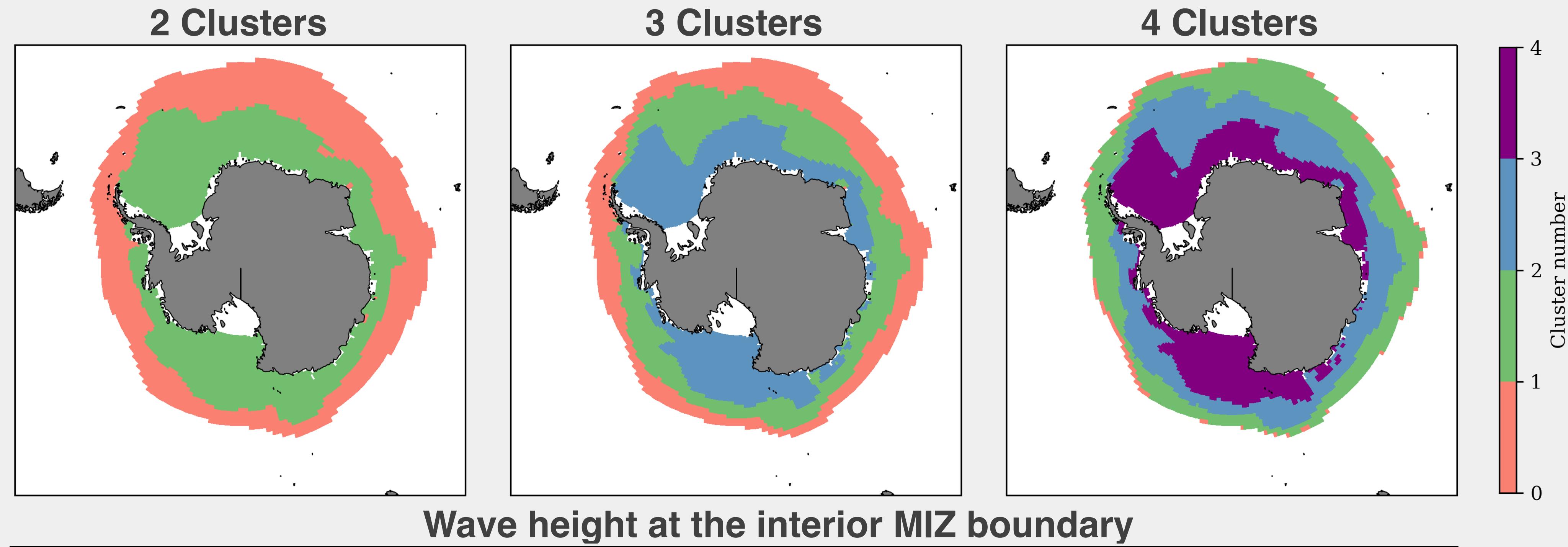
# CLUSTER NUMBER SELECTION



Wave height at the interior MIZ boundary

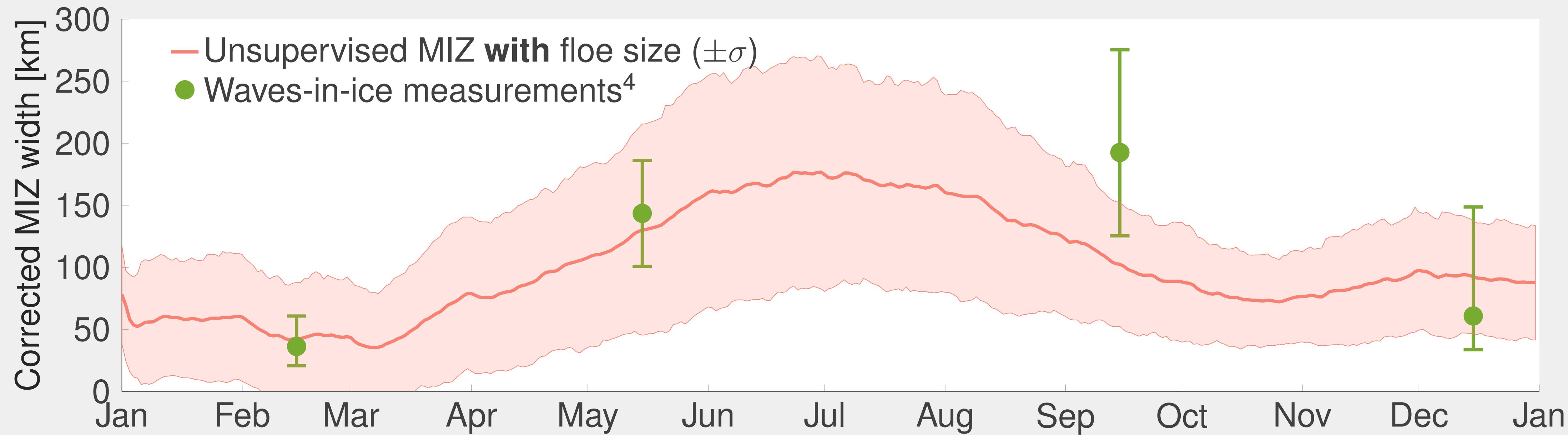


# CLUSTER NUMBER SELECTION



# MARGINAL ICE ZONE WIDTH

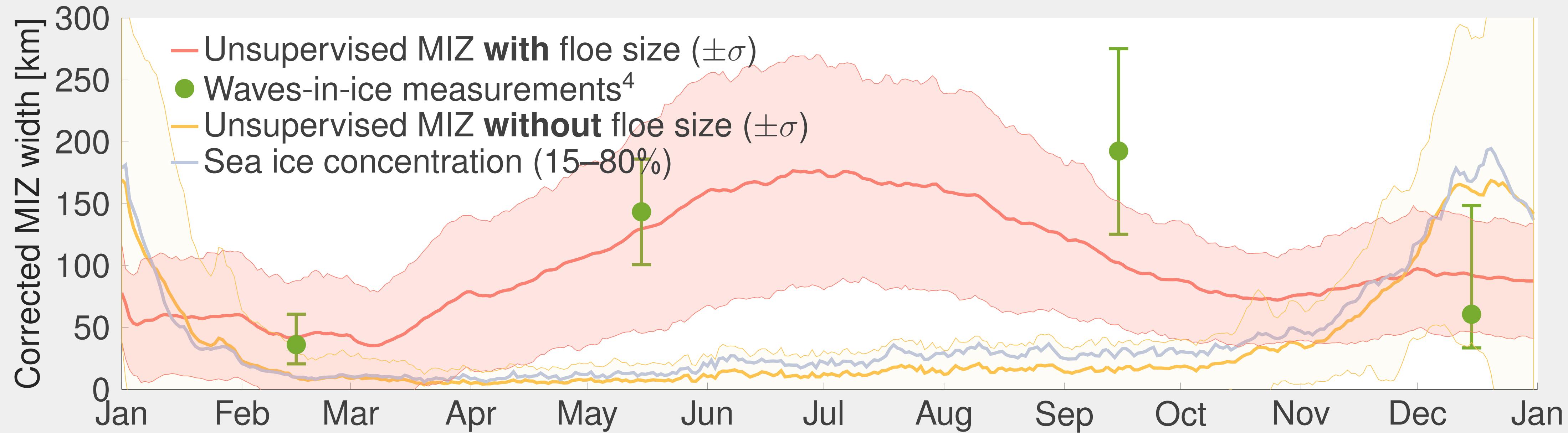
- The extent of the **unsupervised MIZ** is validated with altimetric observations of significant wave heights in sea ice<sup>4</sup>
- Floe size data allows us to capture the high-concentration wave affected regions



<sup>4</sup>Brouwer, J. et al., *The Cryosphere*, (2022).

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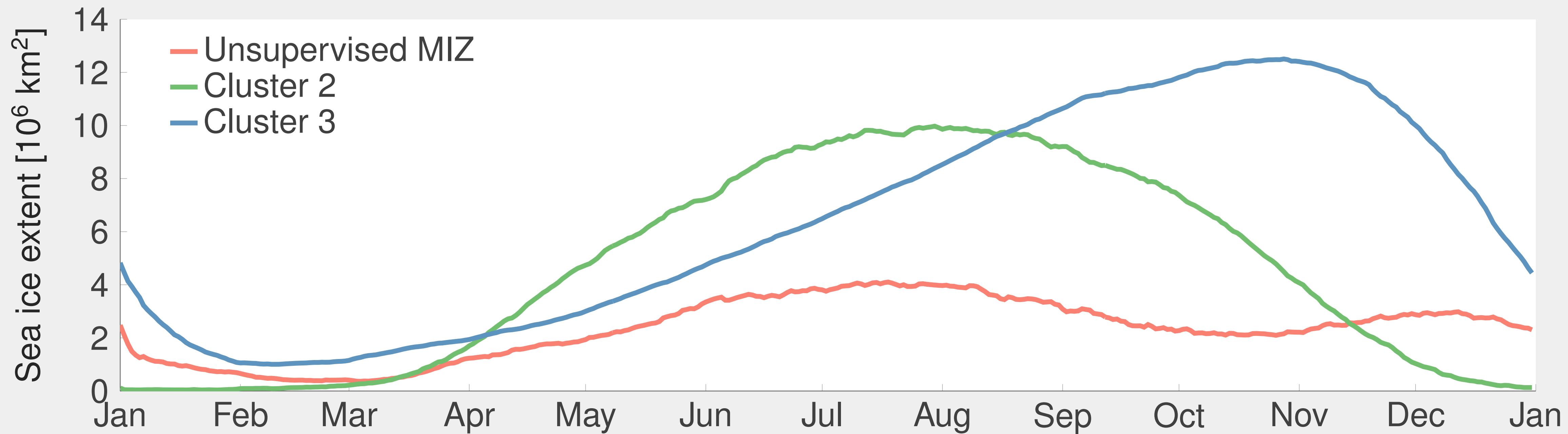
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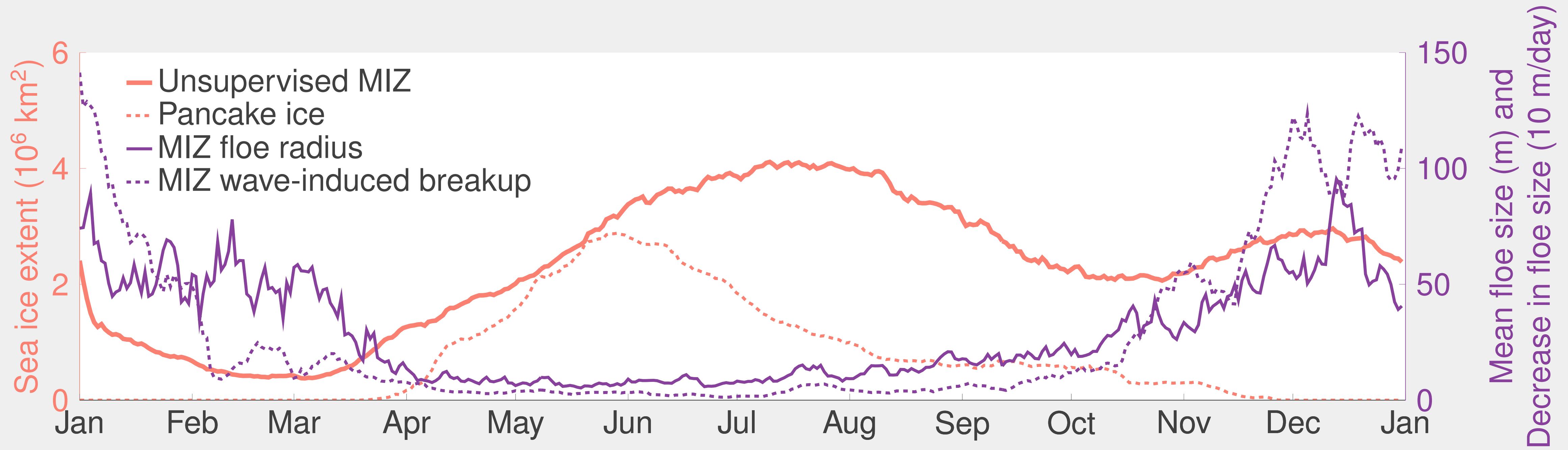
# SEASONALITY OF THE SEA ICE CLUSTERS

- Thin sheets of ice form rapidly over the winter before becoming either thicker and larger, or risk becoming broken by waves (MIZ)



# SEASONALITY OF THE MARGINAL ICE ZONE

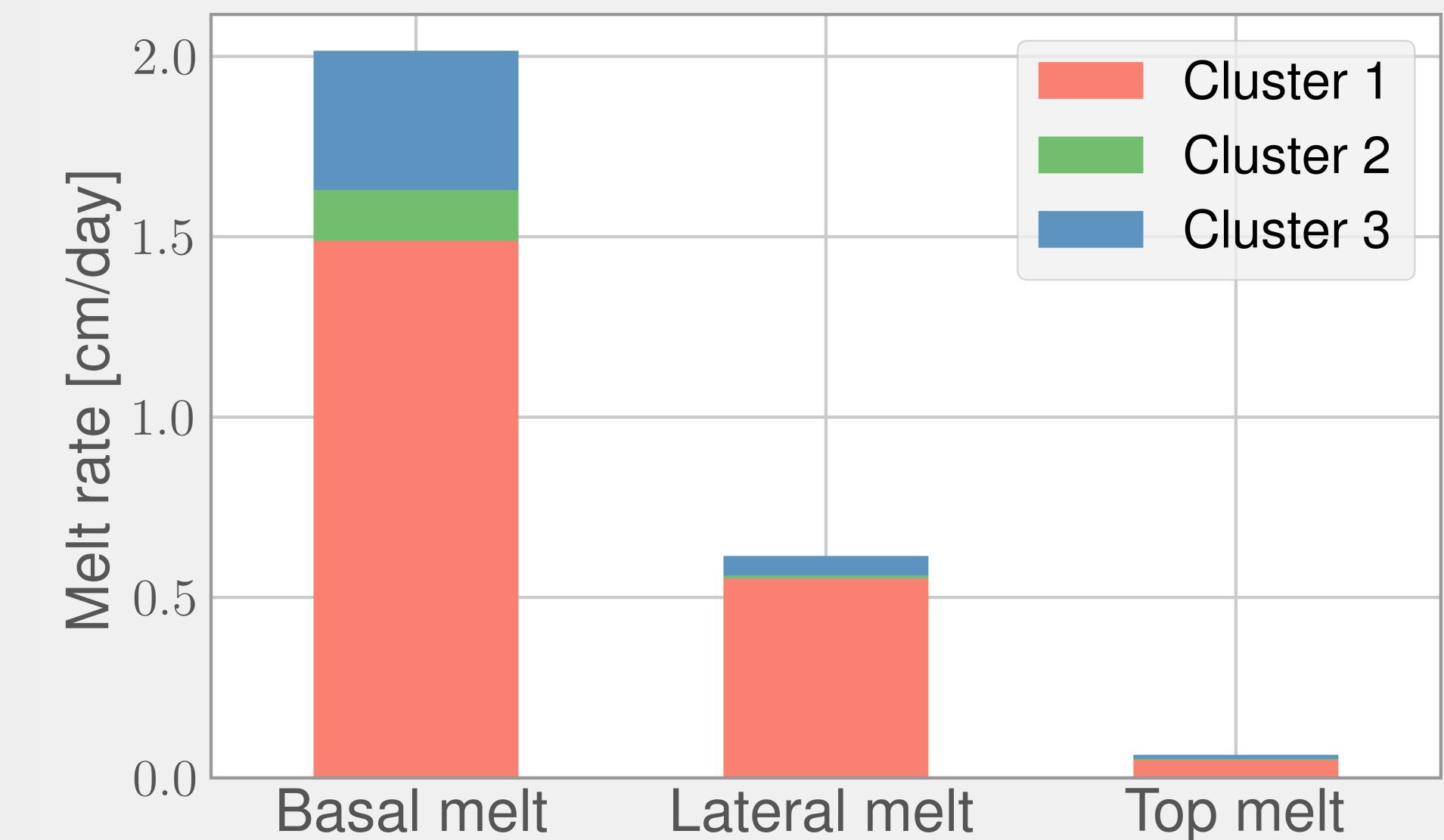
- Unlike with a threshold, the **floe size** of the **unsupervised MIZ** is allowed to change over the season
- This captures both the pancake ice formation in the winter and broken floes in the summer



# HOW DOES THE MIZ EVOLVE?

Although our definition is informed only by the ‘ice appearance’, MIZ dynamics are still identified

- The MIZ dominates the rate of wave-induced breakup and melting of floes
- Meanwhile, the rate of welding and large floe formation occur mostly in the interior regions (clusters 2 and 3)



# CONCLUSIONS

- An unsupervised algorithm (*k*-means) has quantified the Antarctic wave affected marginal ice zone from simulated sea ice data
- The extent of this region agrees with satellite derived waves-in-ice measurements
- This further validates the importance of floe size for identifying areas of wave affected ice

# THANKS FOR LISTENING!

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