



NCAR
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Local Arctic Ice Management

Evaluating Model Representations of Sea Ice
Flooding at Experimental Scales

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Edward Blanchard-Wrigglesworth²

Marika Holland¹

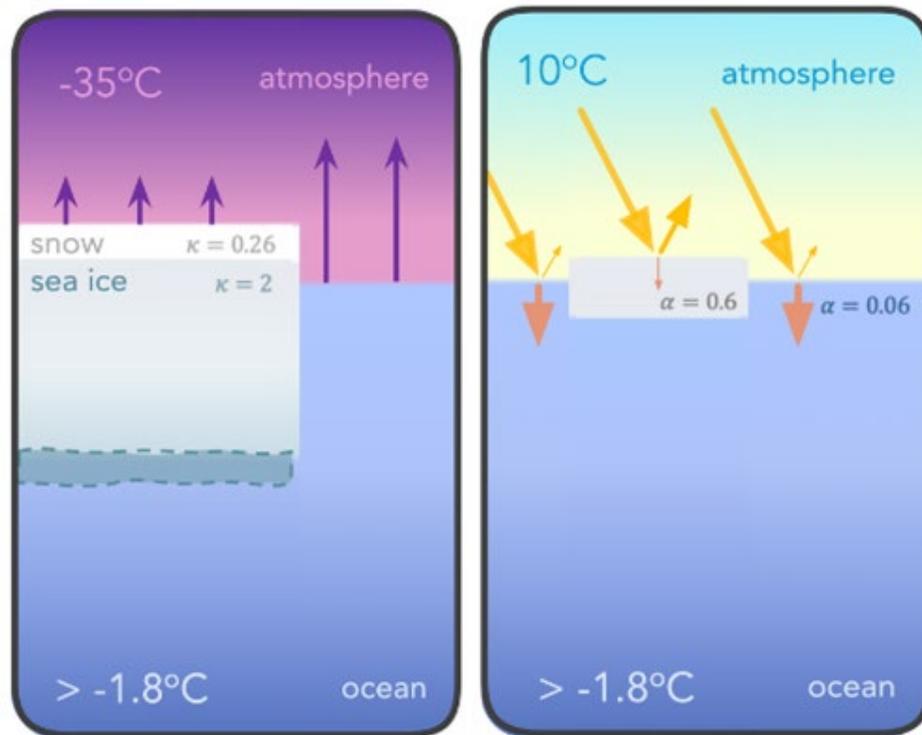
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²University of Washington, Seattle, WA

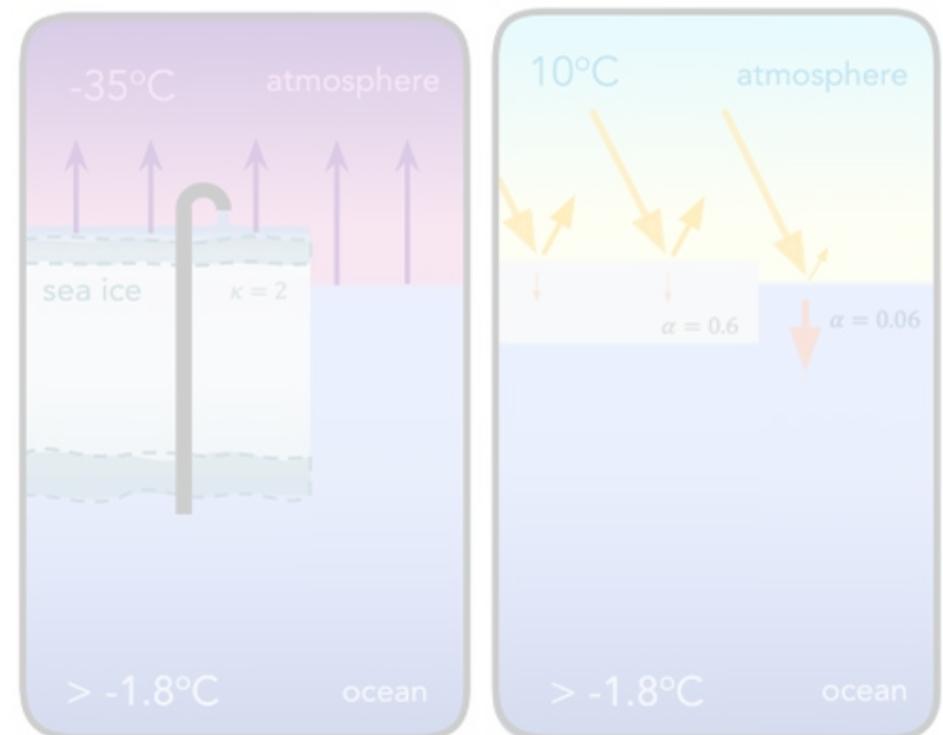
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Arctic Ice Management proposes to slow Arctic sea ice loss by intentional flooding

normal sea ice evolution

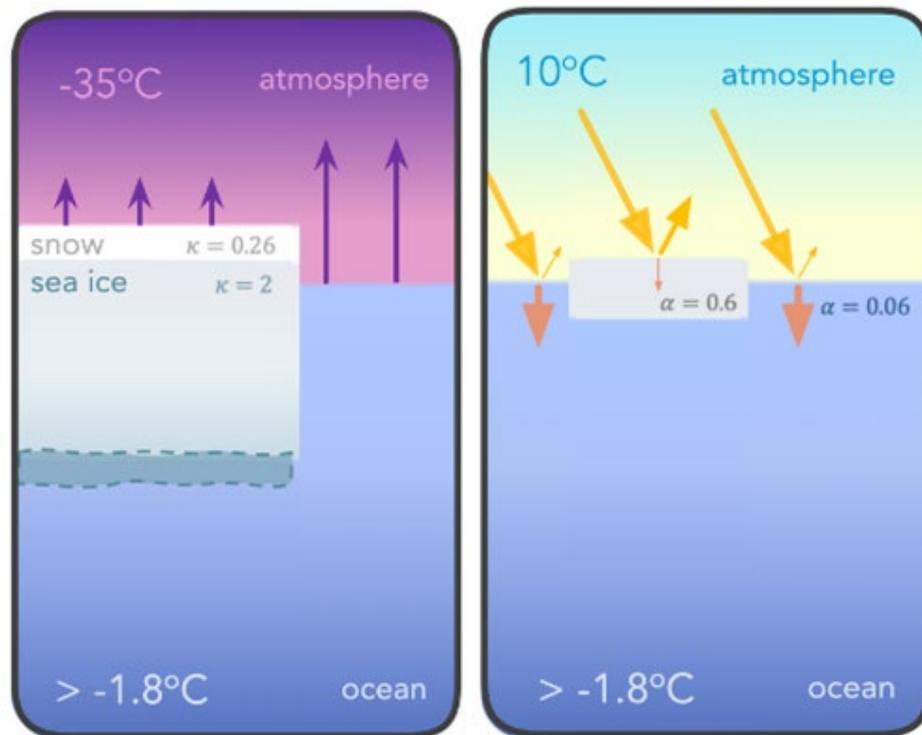


sea ice evolution with AIM

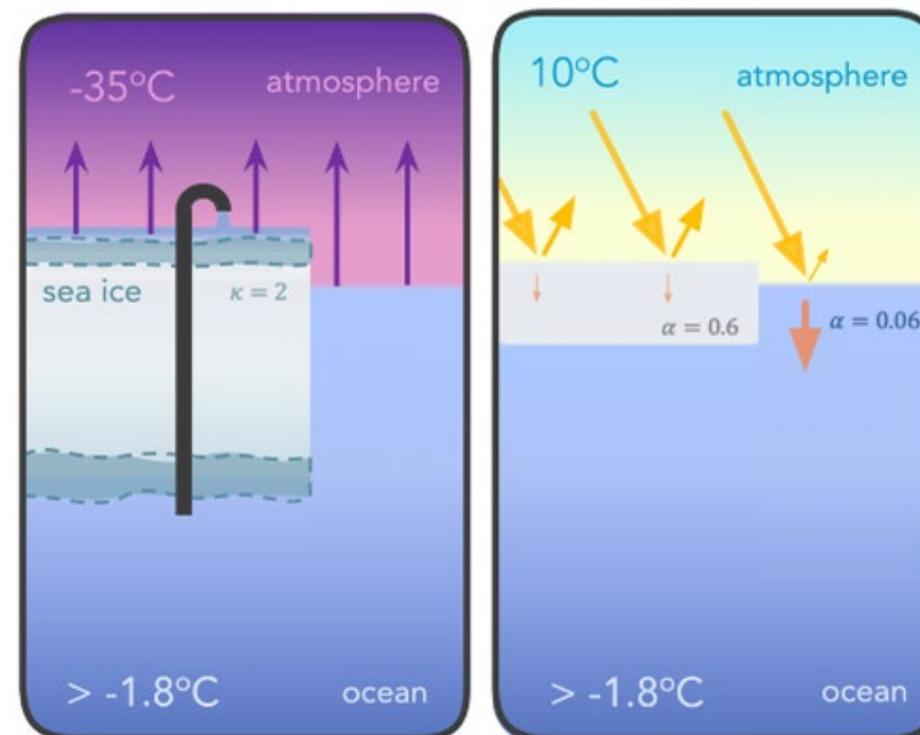


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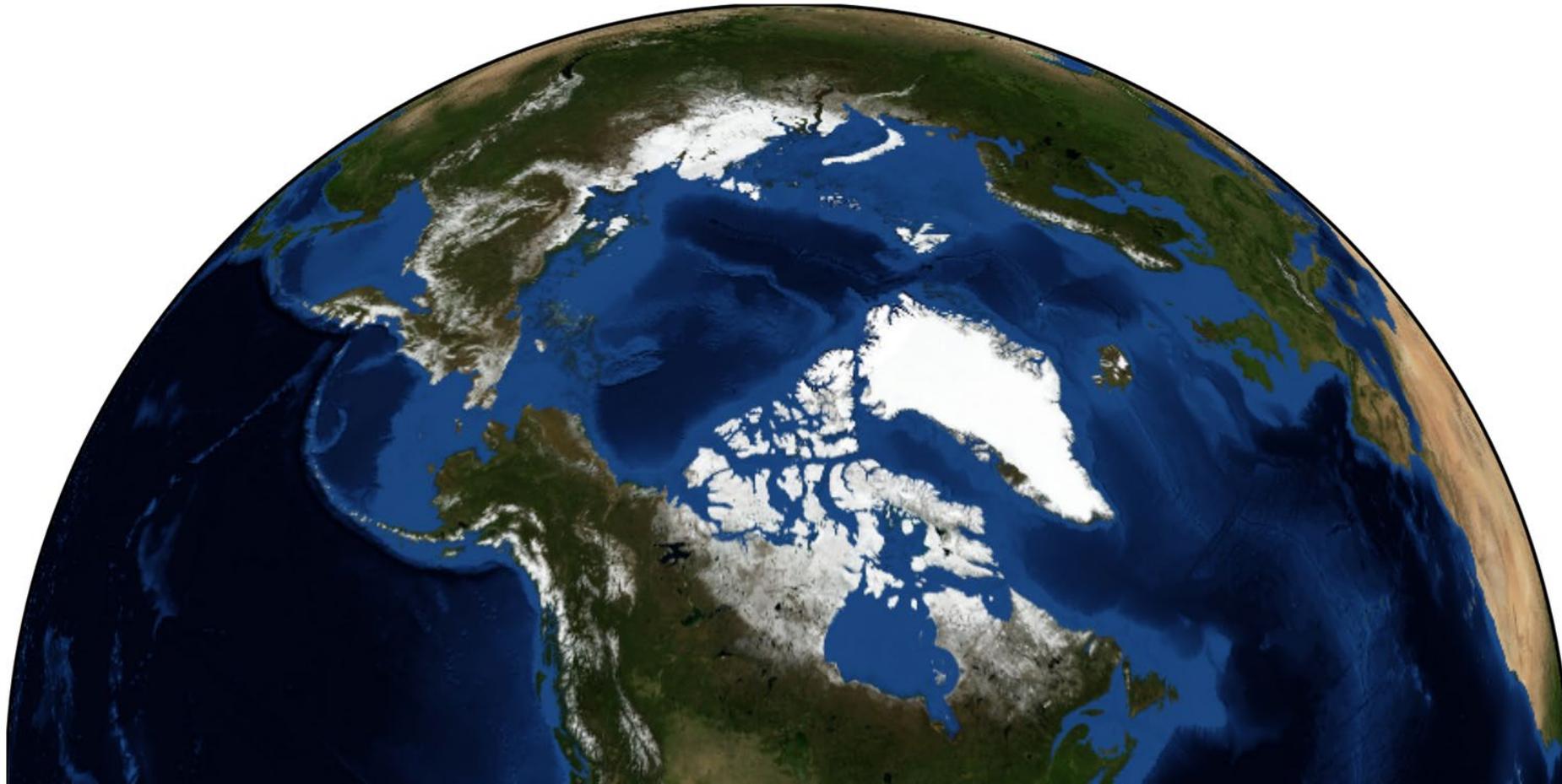


Privately and publicly funded field tests have emerged in the Arctic



Real Ice

UK-based, operating since ~2022



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Field tests

- Nome, AK (2023)



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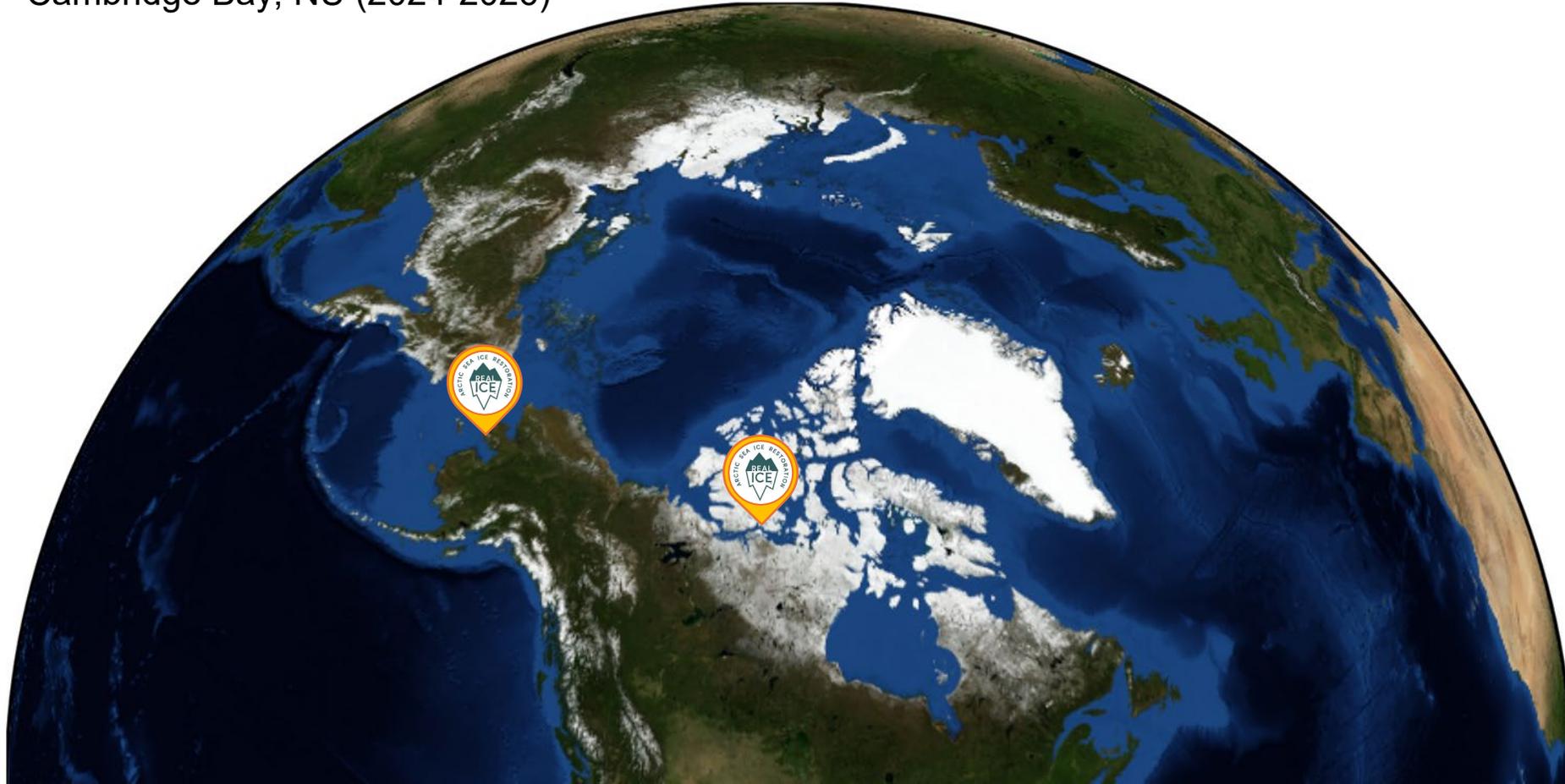


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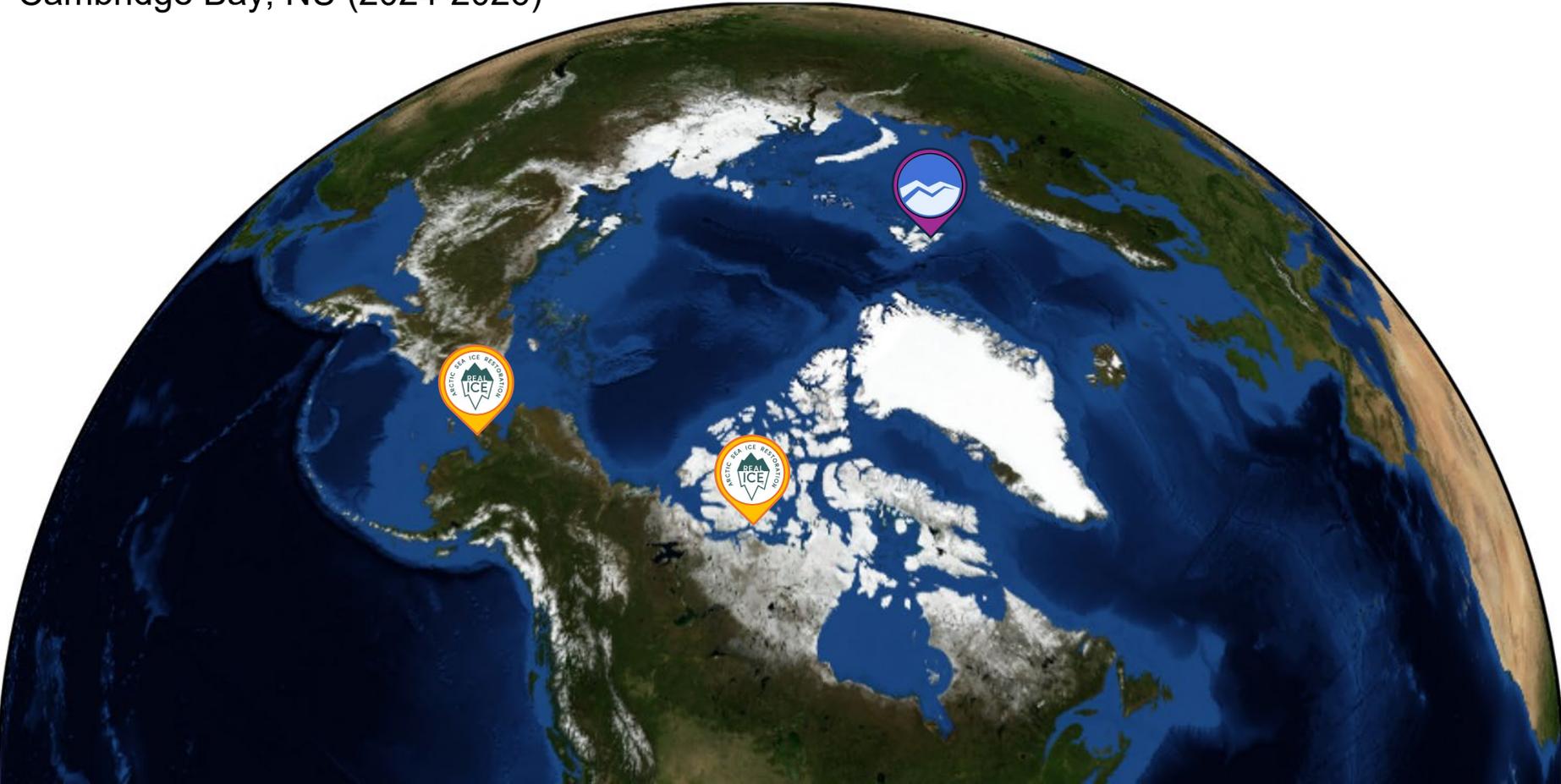
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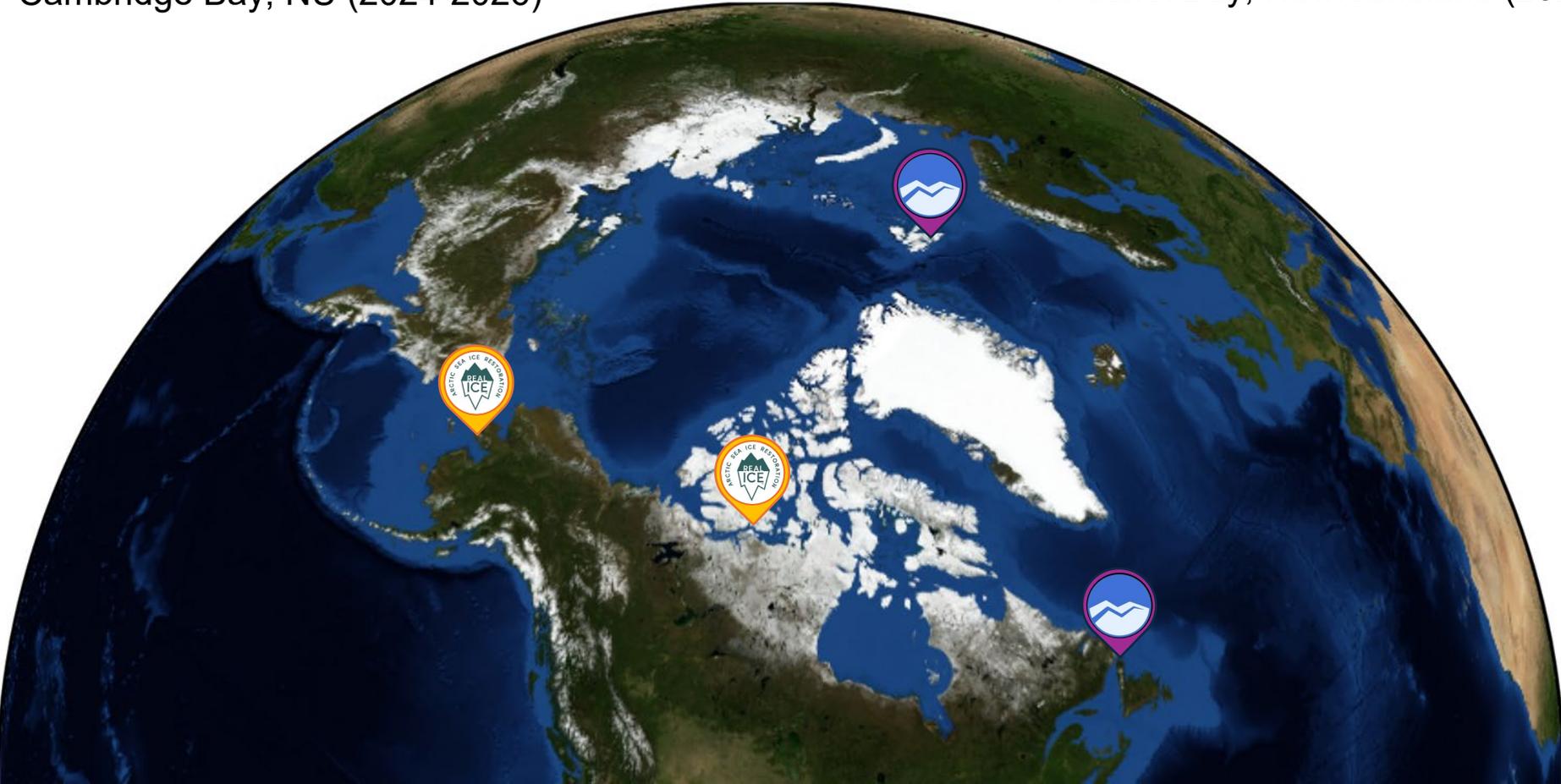
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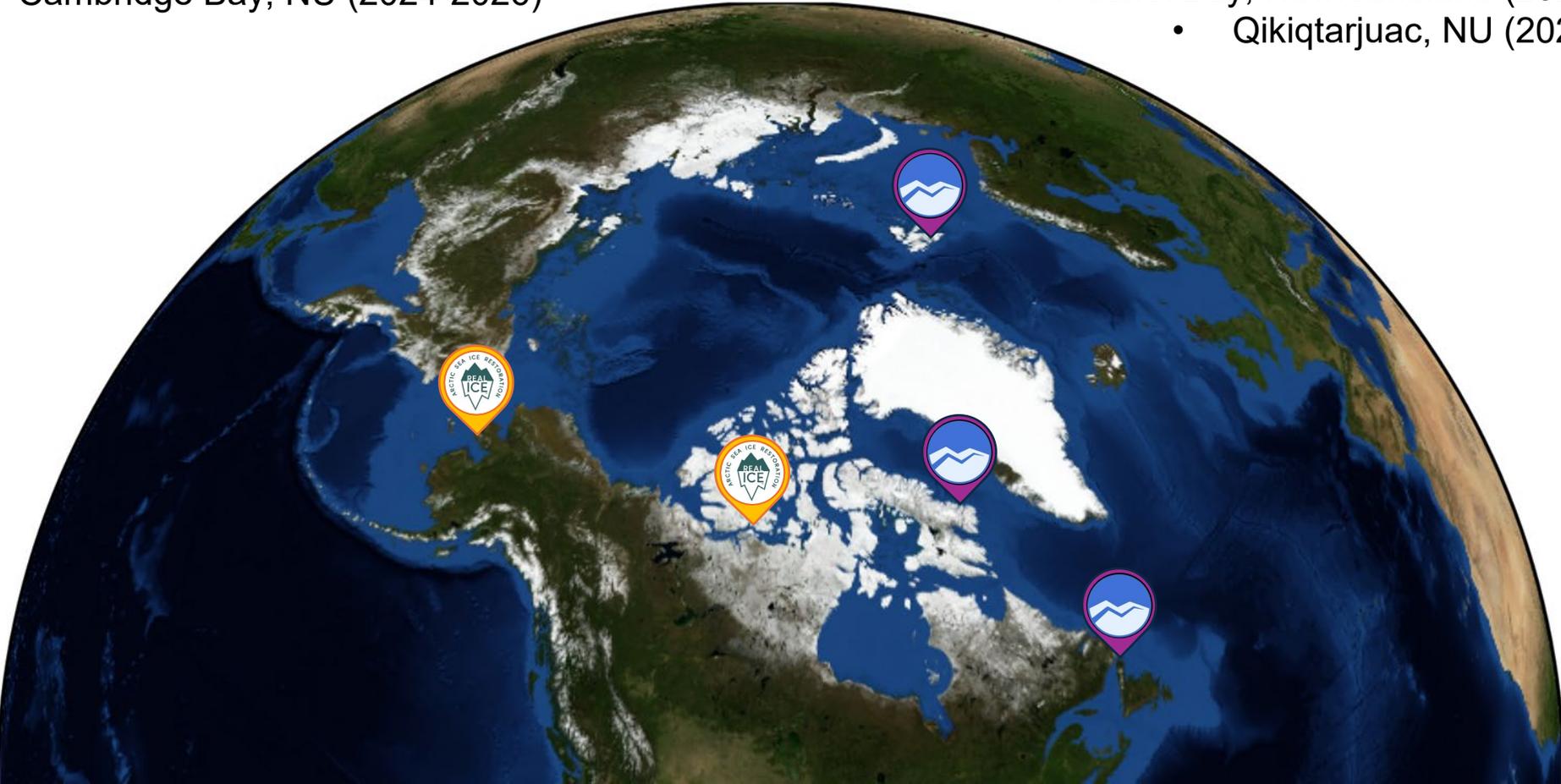
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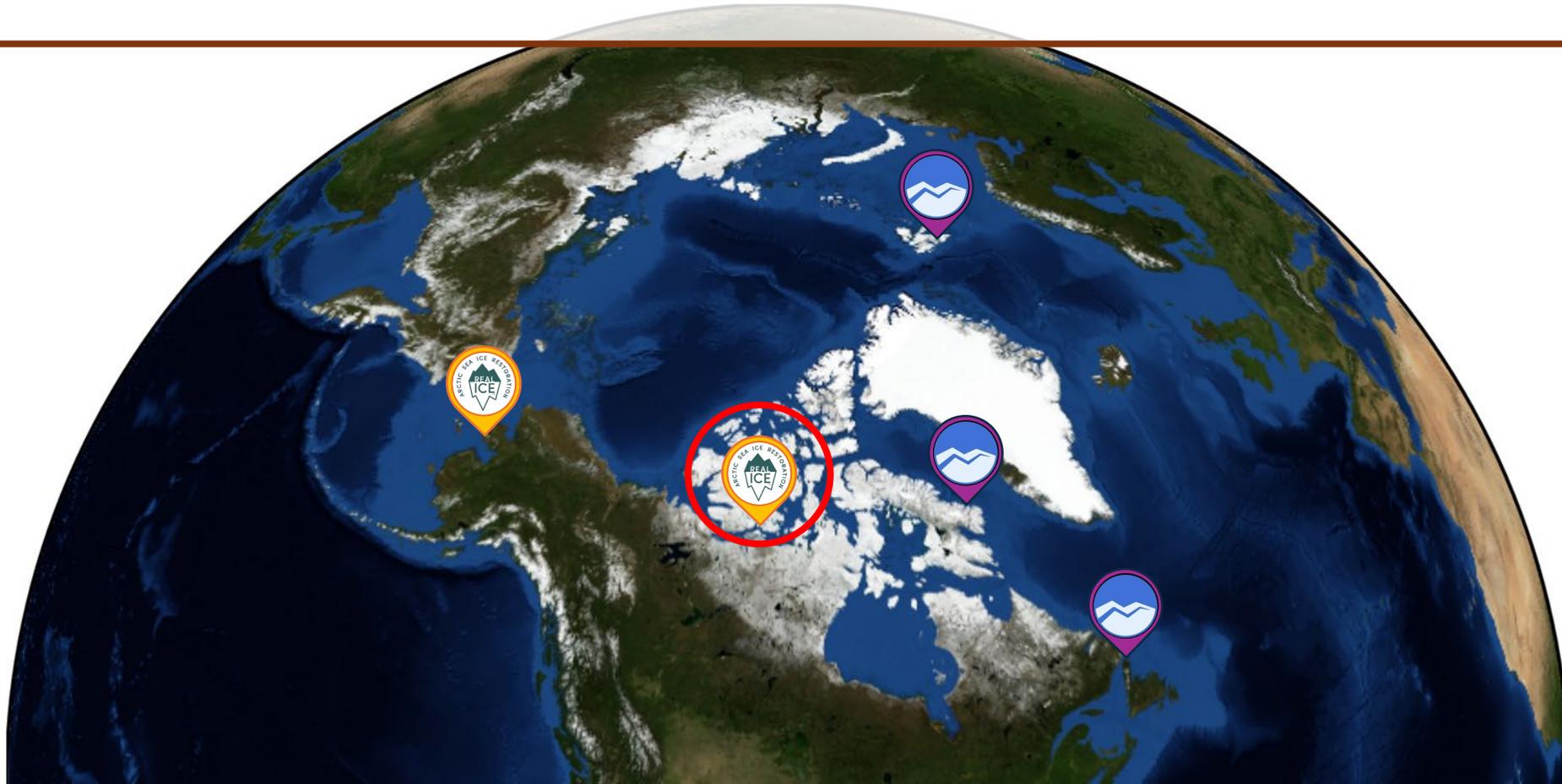
1) Is a sea ice component model fit - for - purpose ¹when studying AIM?

2) In what areas does the model fall short, if any?

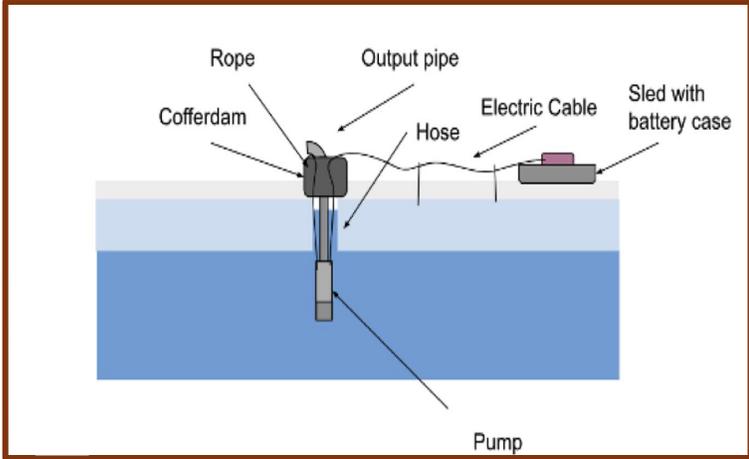
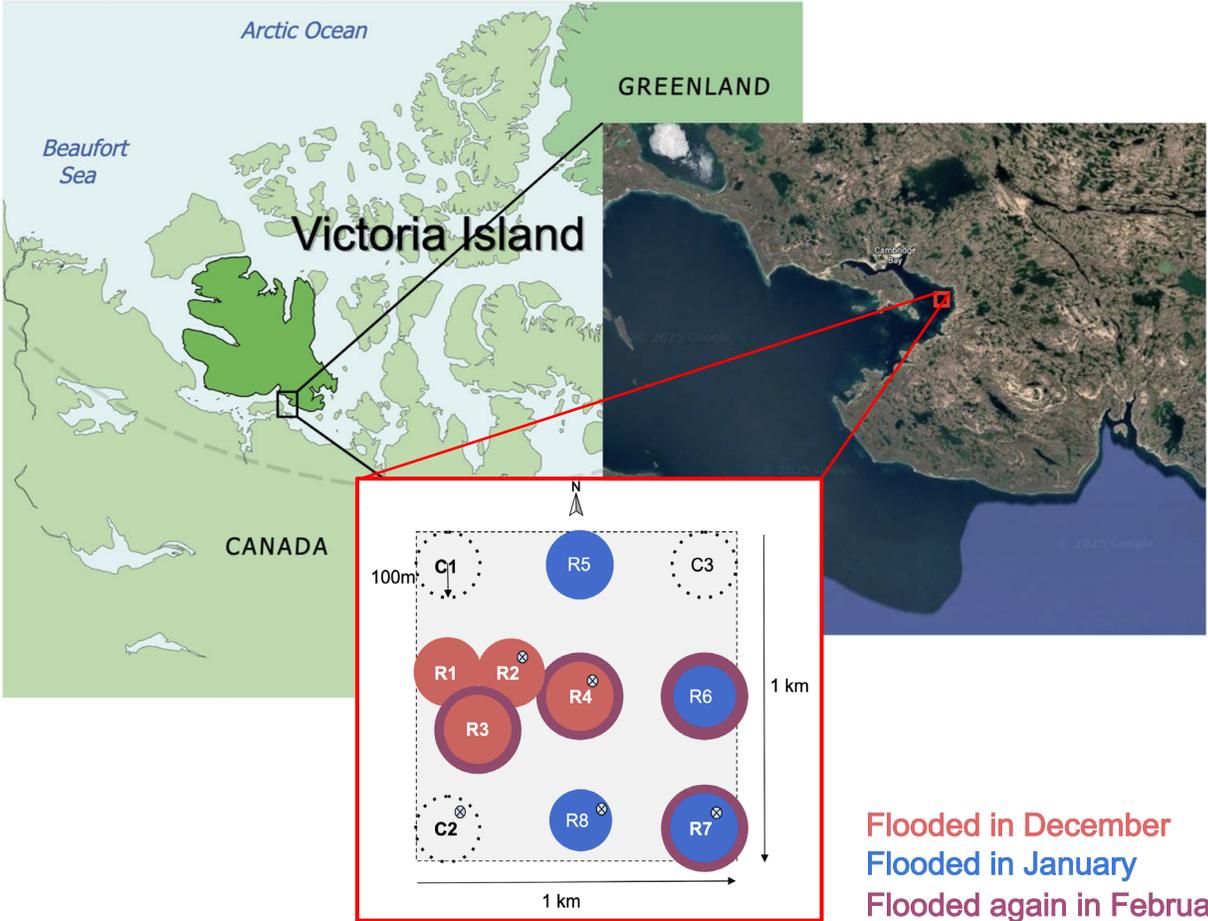
3) What do model simulations imply for field studies?

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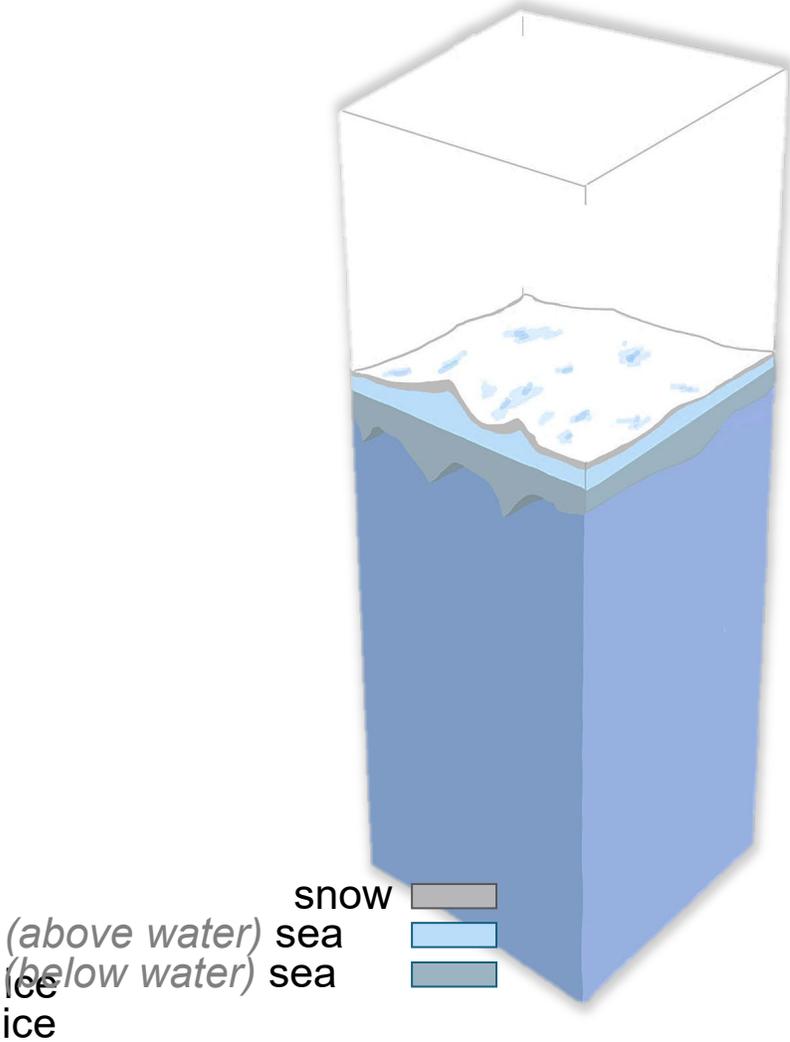
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Field test in Cambridge Bay: implementation and observations



Icepack: configuring a column thermodynamic sea ice model

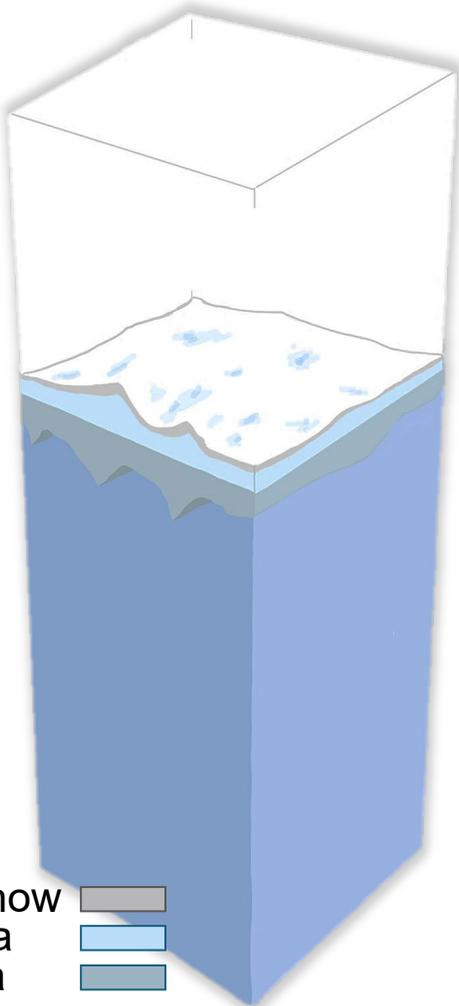


Icepack: configuring a column thermodynamic sea ice model



atmospheric forcing

- Cambridge Bay Shore Station
- CERES SYN- 1deg Ed. 4



ocean initial conditions

- Cambridge Bay Under-water Network
- ORAS5 Reanalysis



ice
ice
(below water) sea ice
(above water) sea ice
snow

ice	dark blue
ice	dark blue
(below water) sea ice	dark blue
(above water) sea ice	light blue
snow	grey

Icepack: configuring a column thermodynamic sea ice model



ice / snow initial conditions

- Real Ice *in situ* measurements
- Real Ice pumping rates and volumes/areas



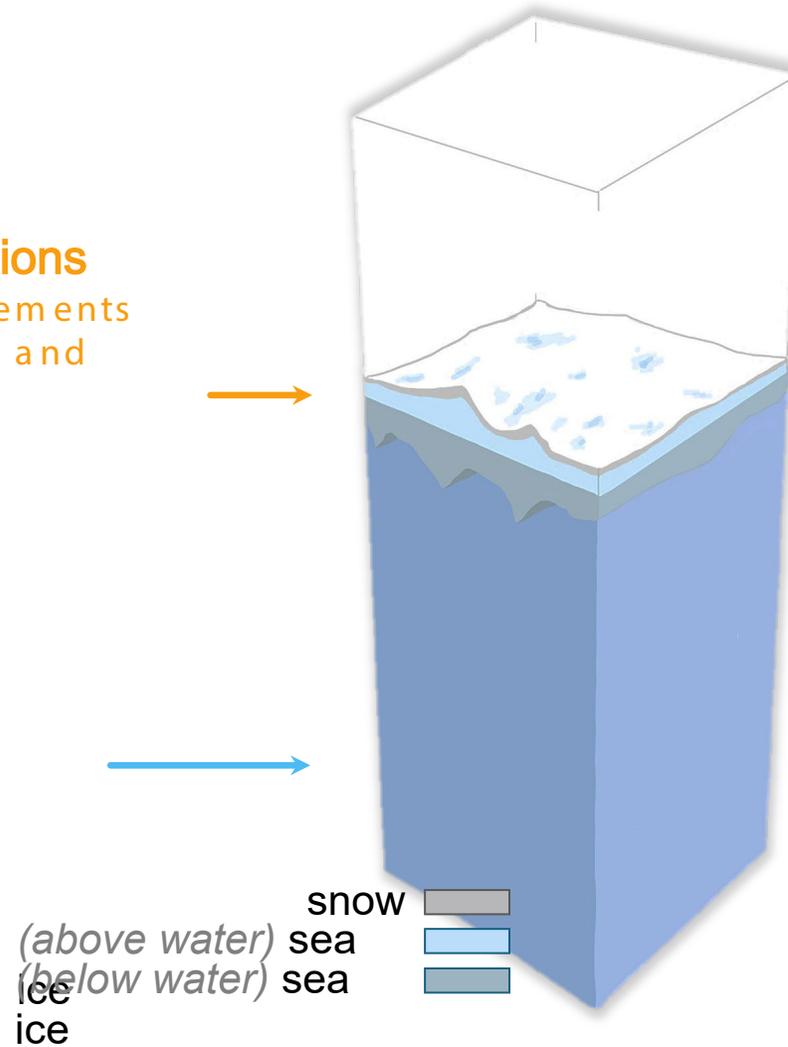
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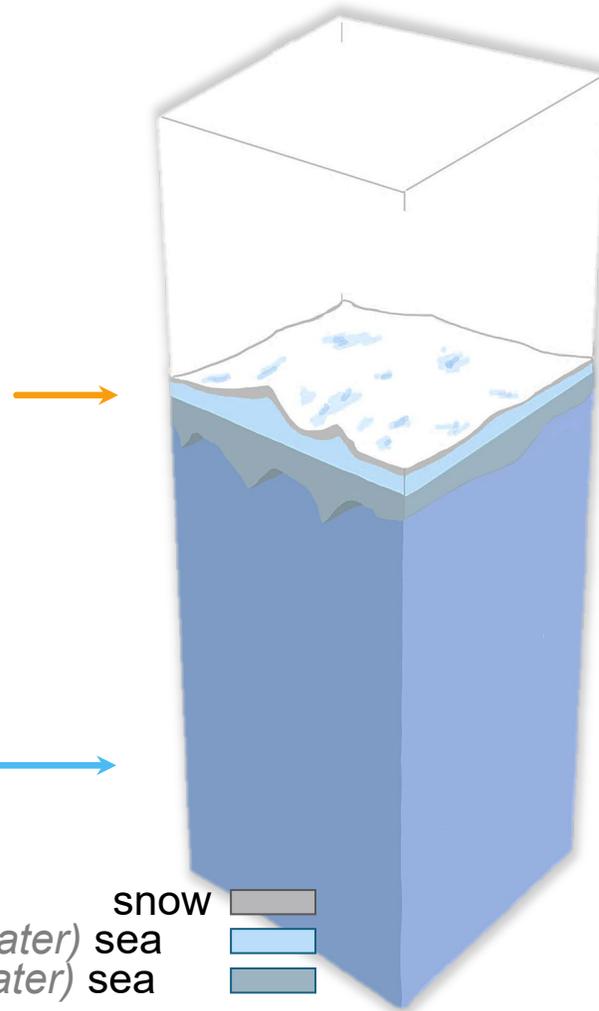
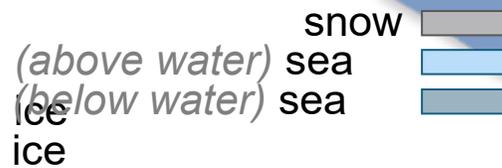
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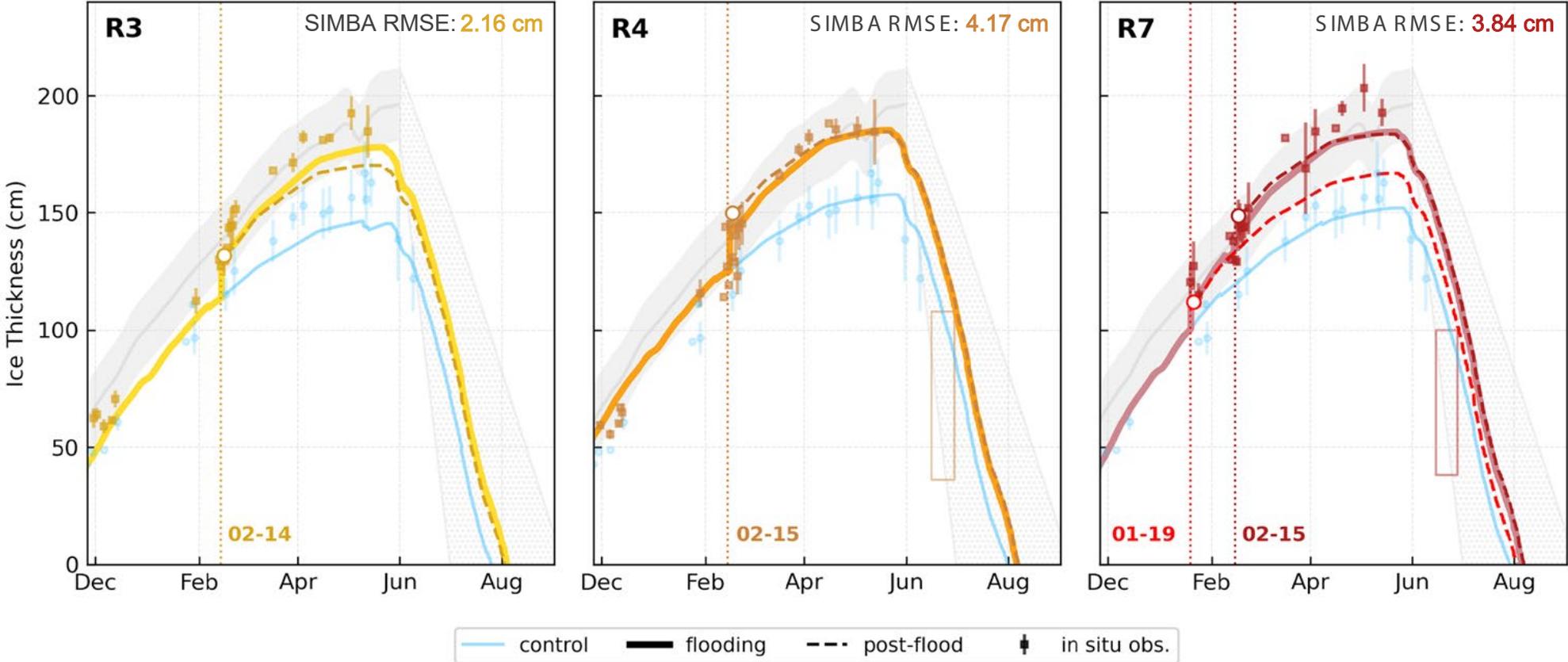
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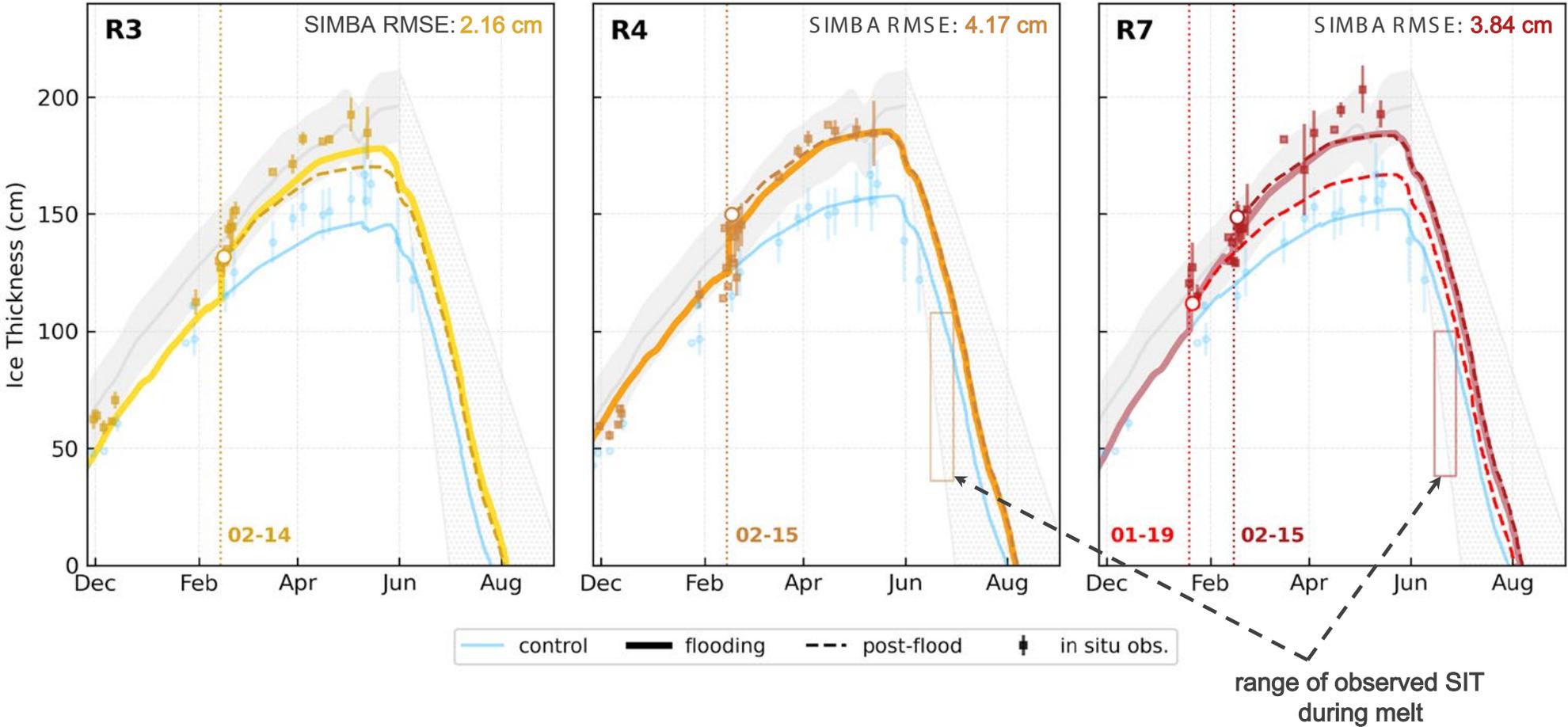
evaluation data

- (RI) Ice thickness, snow depth, and melt rates
- (RI) Drone-based luminance estimates
- Multi-decadal thickness measurements from Cambridge Bay

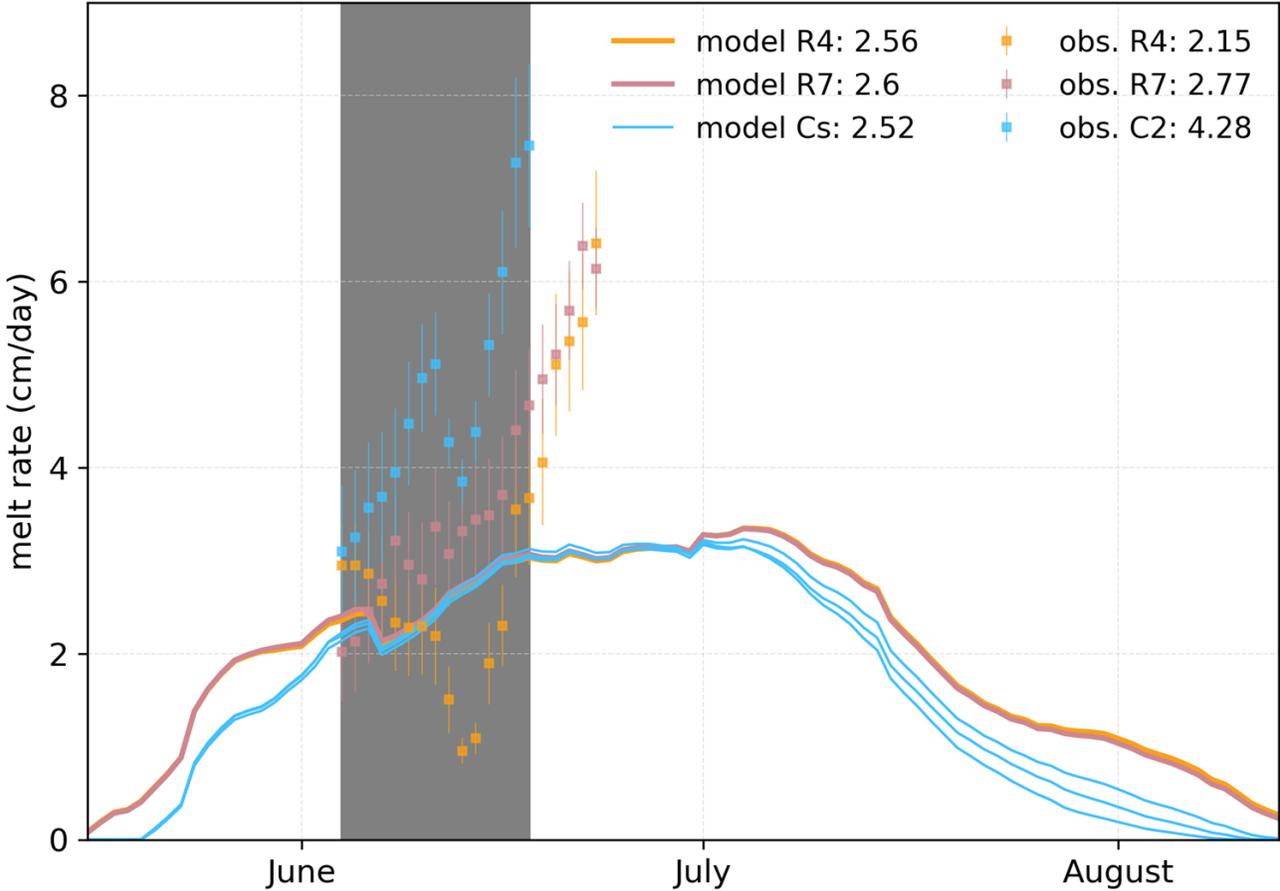
Fitness - for - purpose: ice thickness evolution and flooding representation



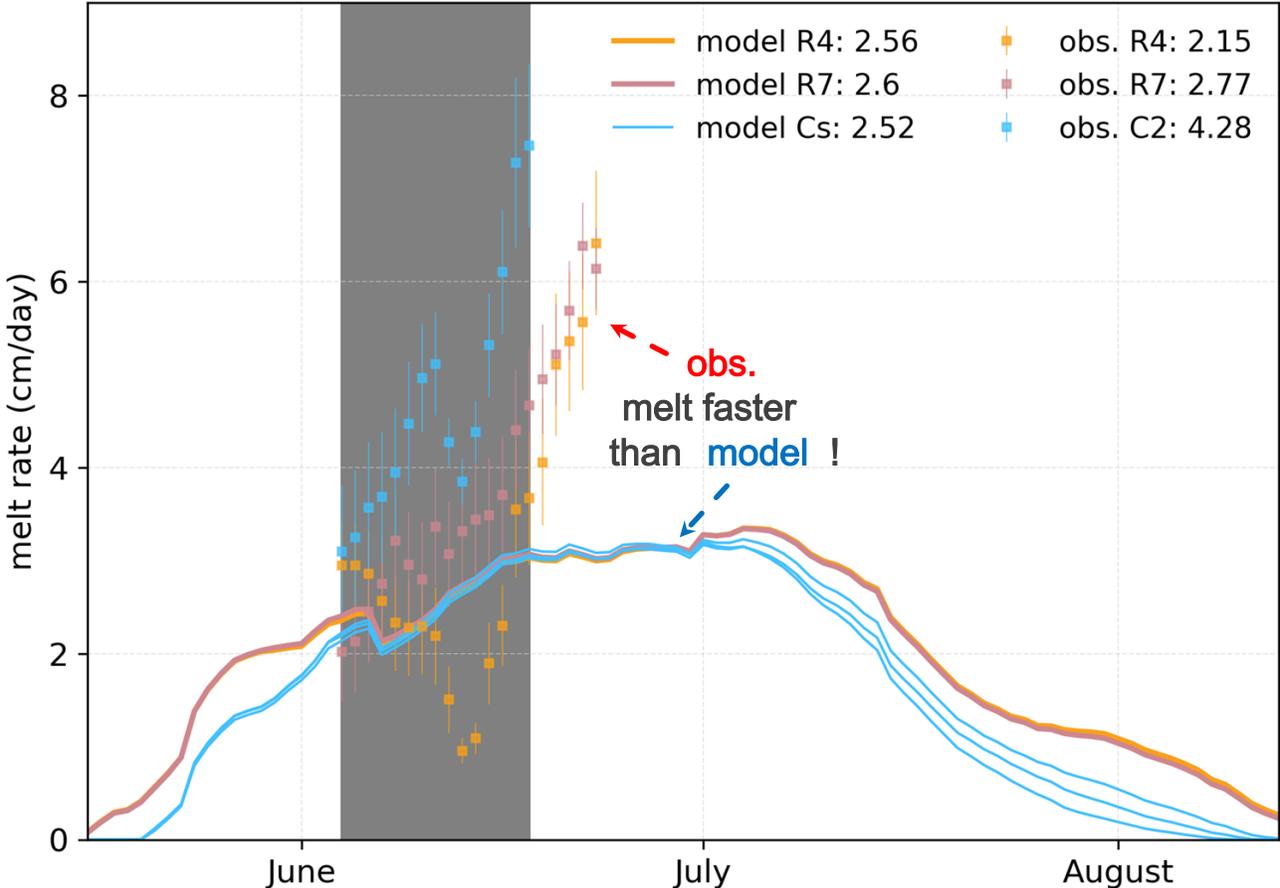
Fitness - for - purpose: melt season timing



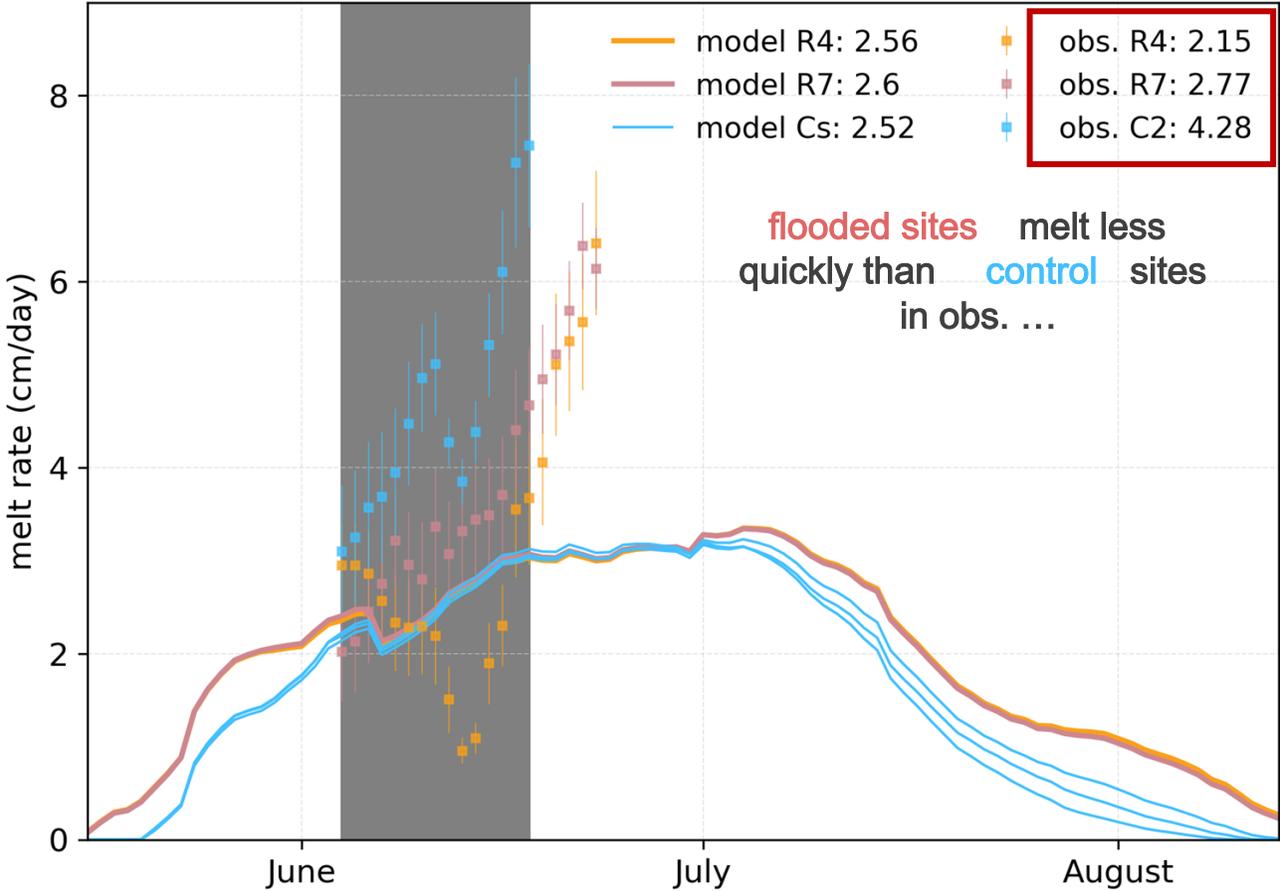
Process implications: melt rate relationship differs between obs. and models



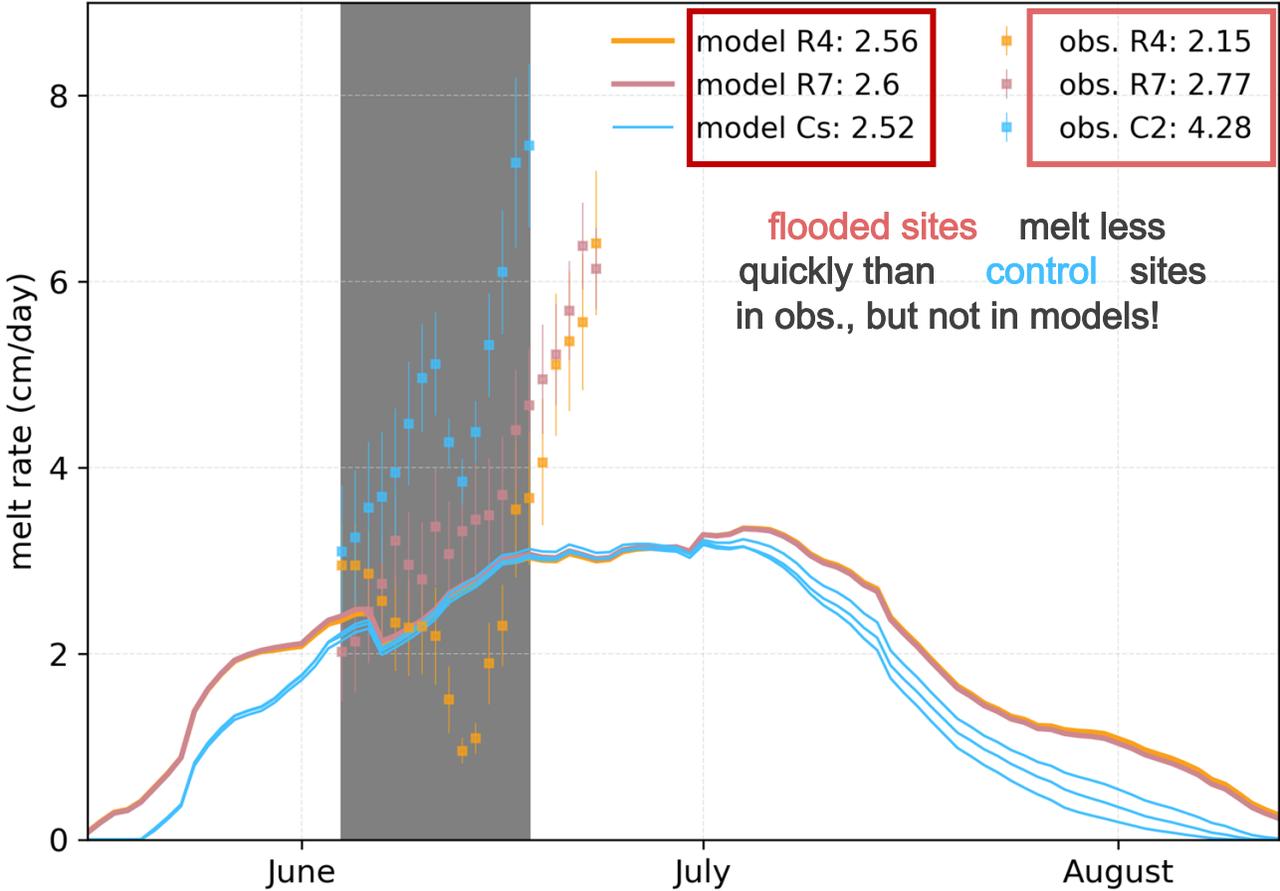
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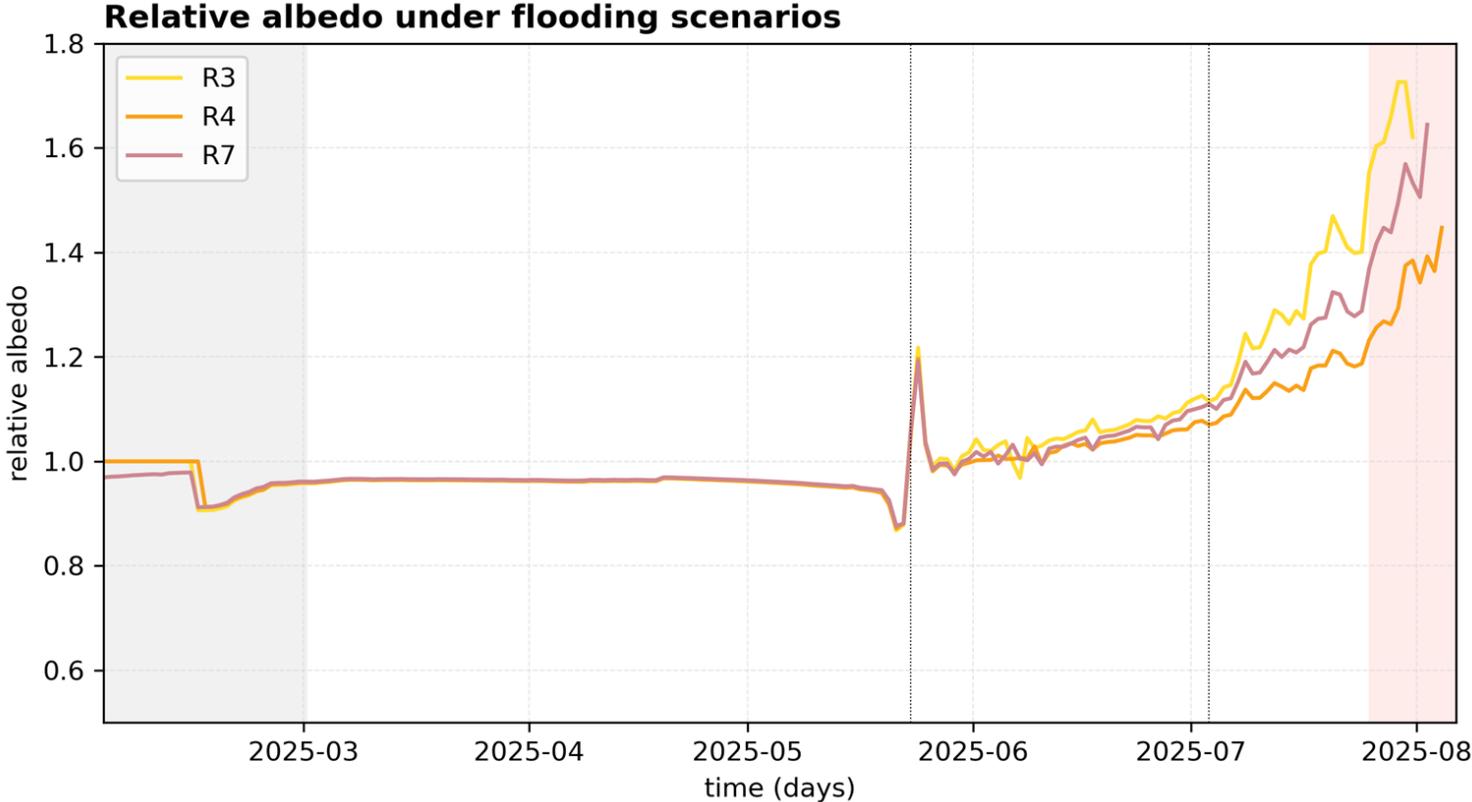


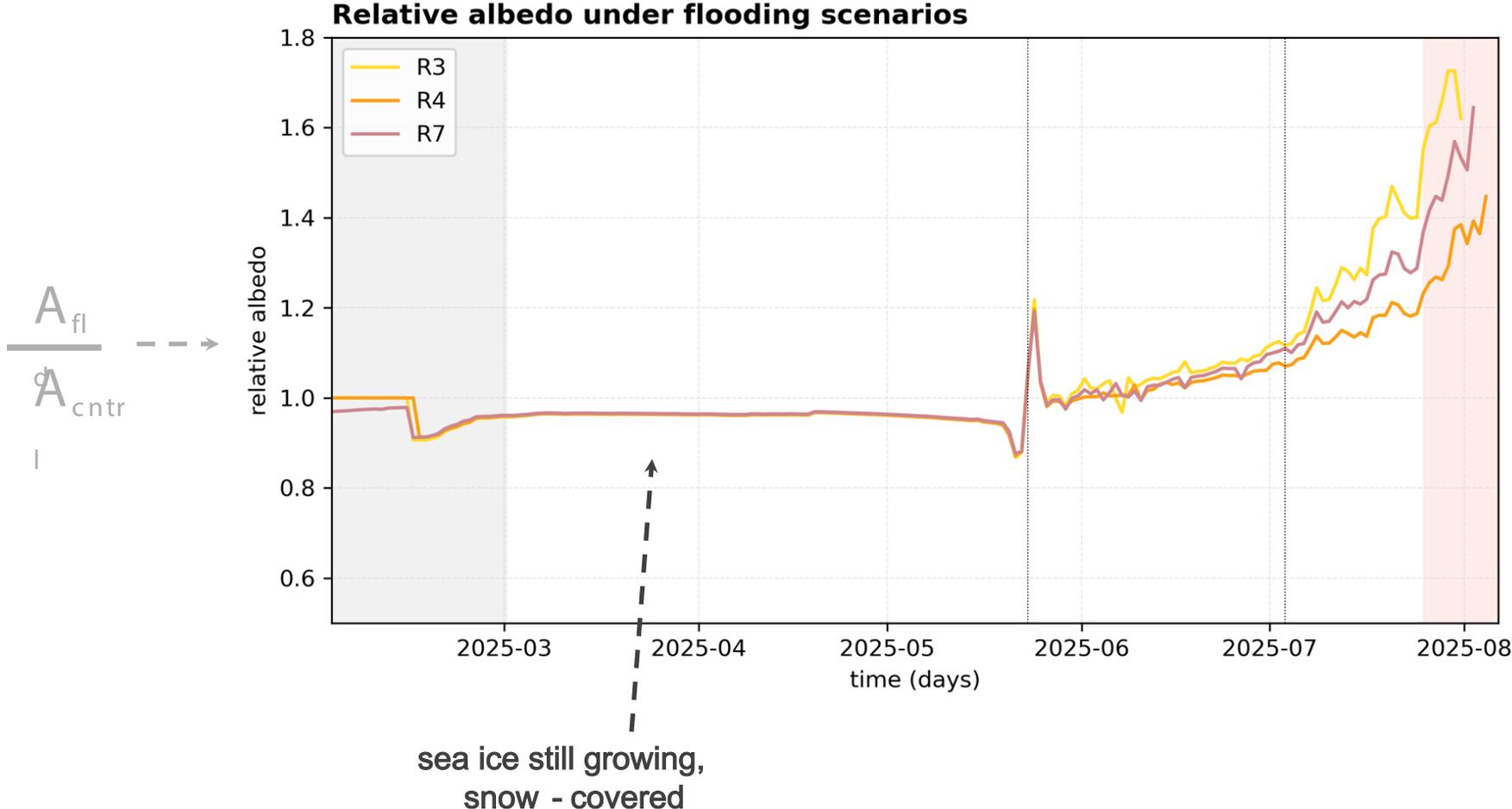
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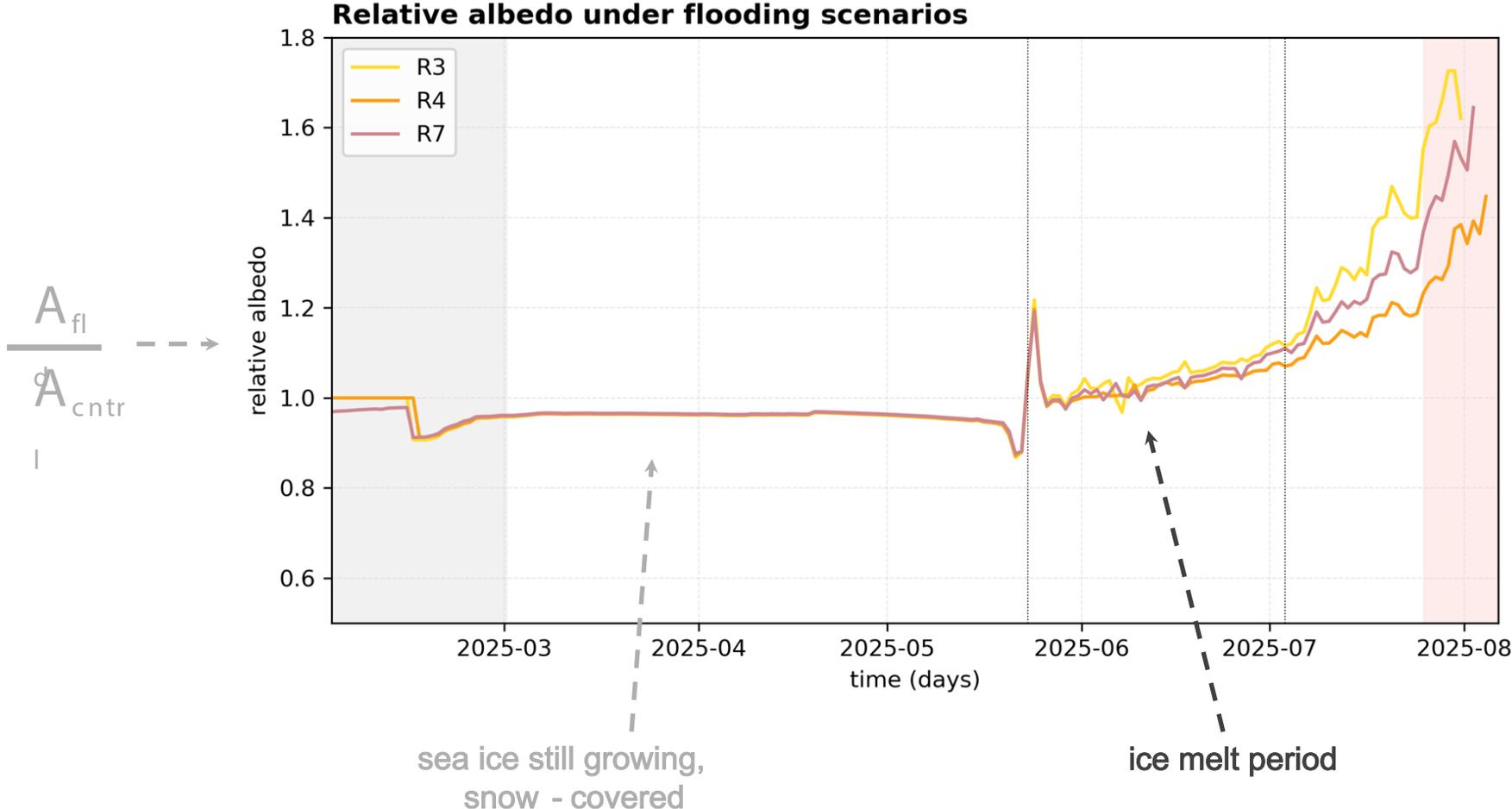


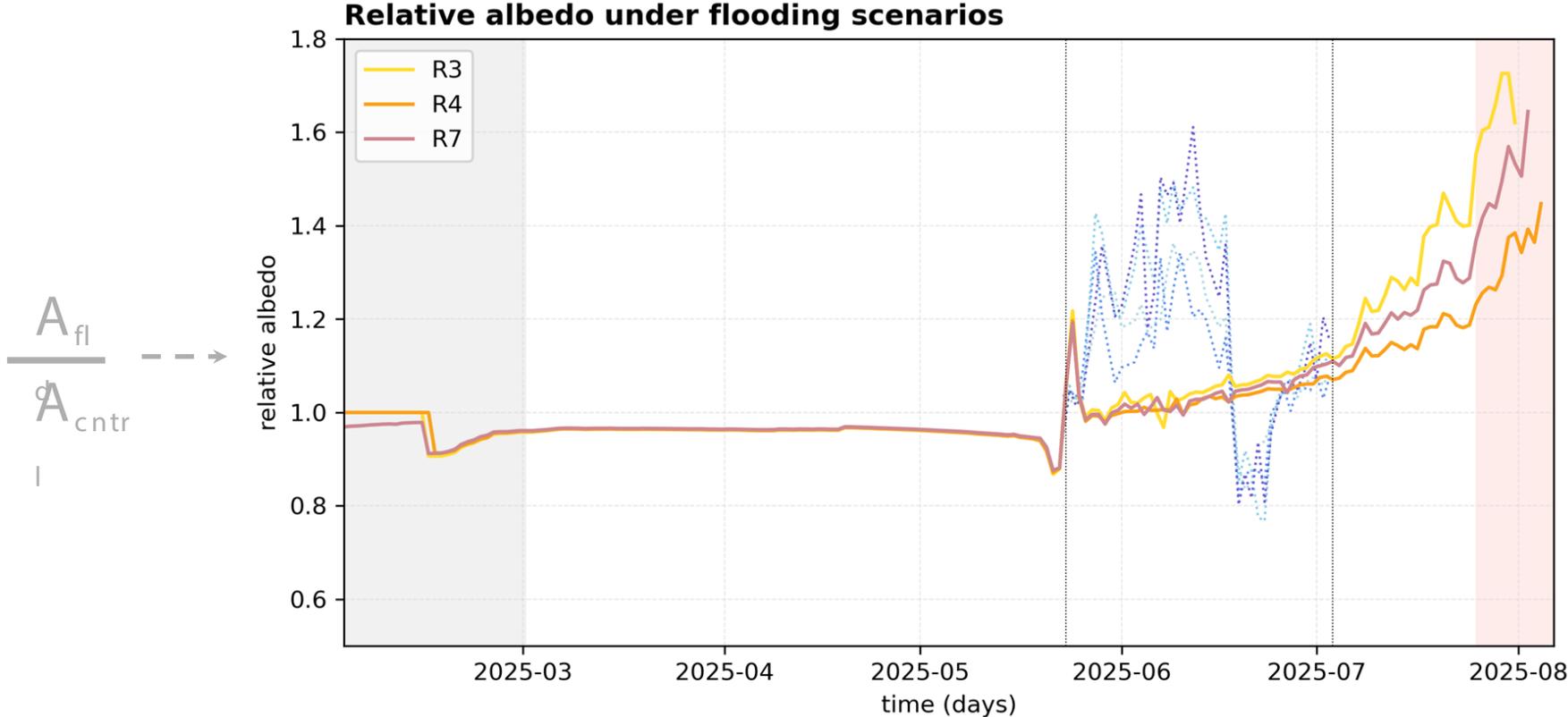
$$\frac{A_{fl}}{A_{cntr}}$$

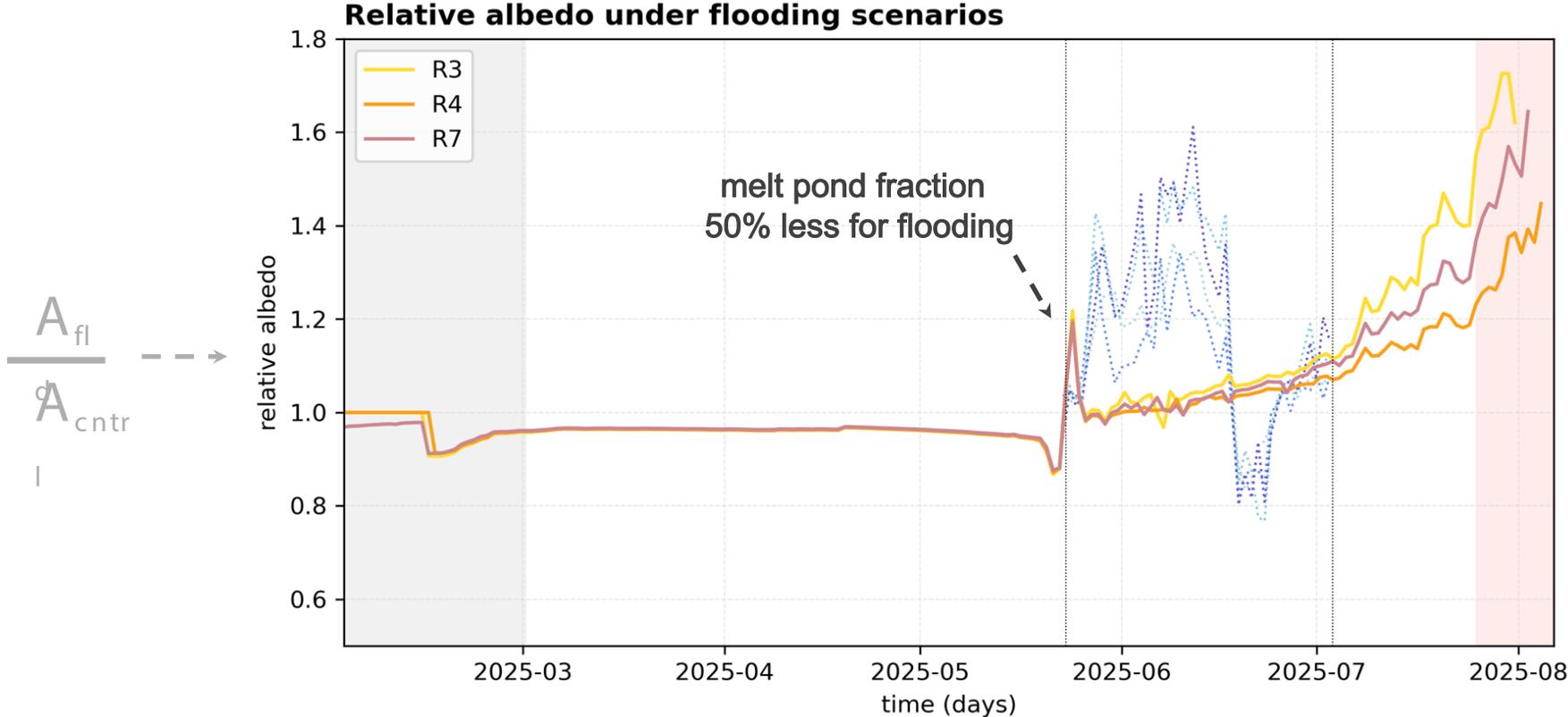
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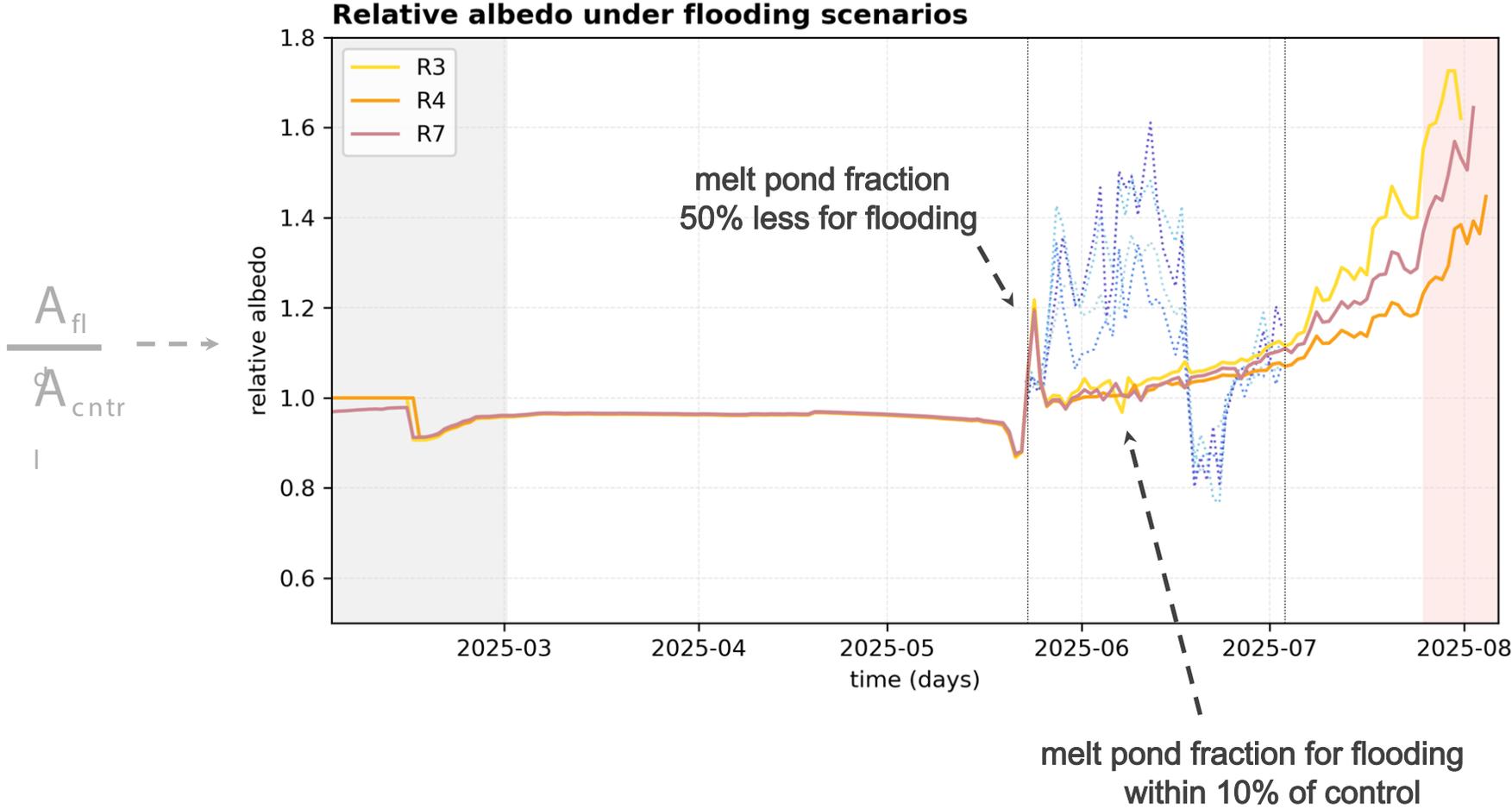




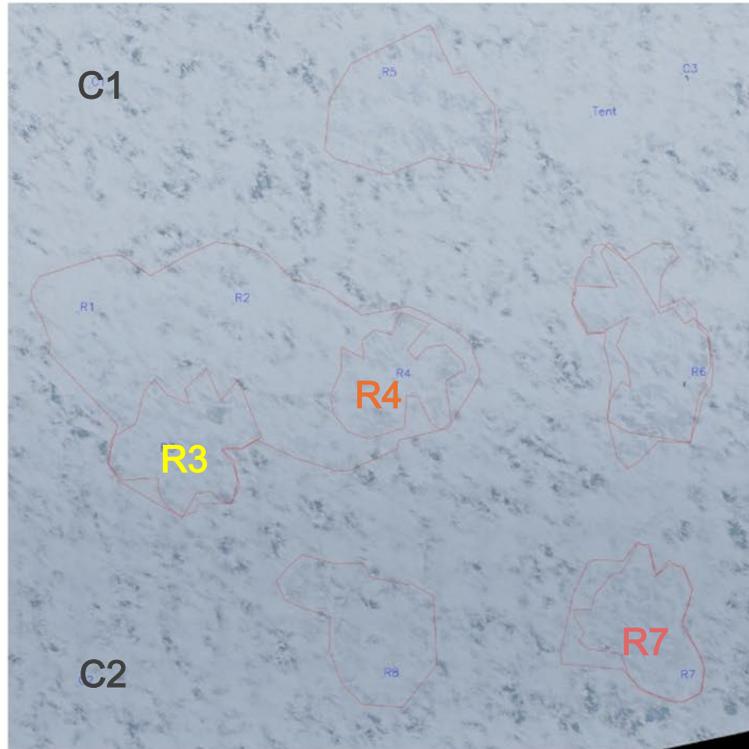




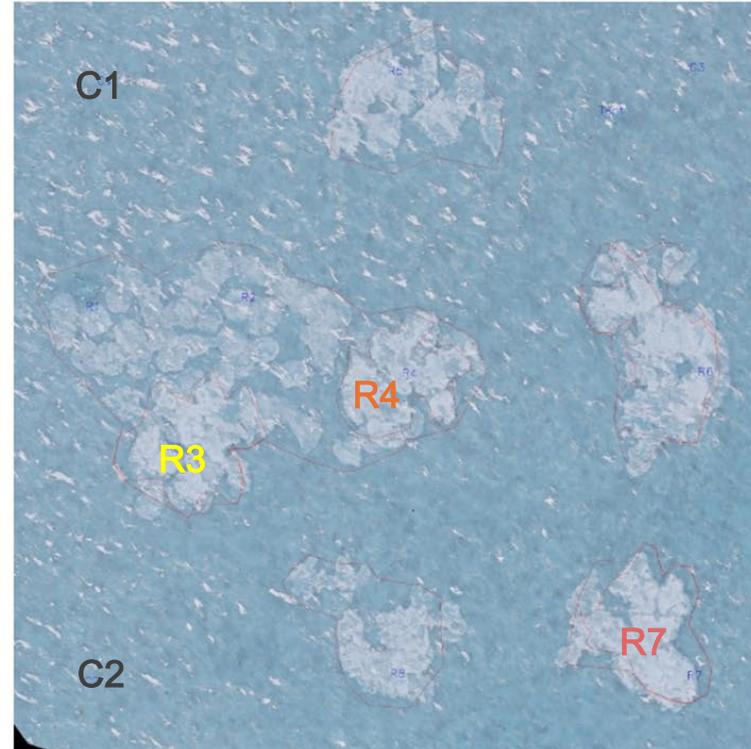




A) May 23, 2025

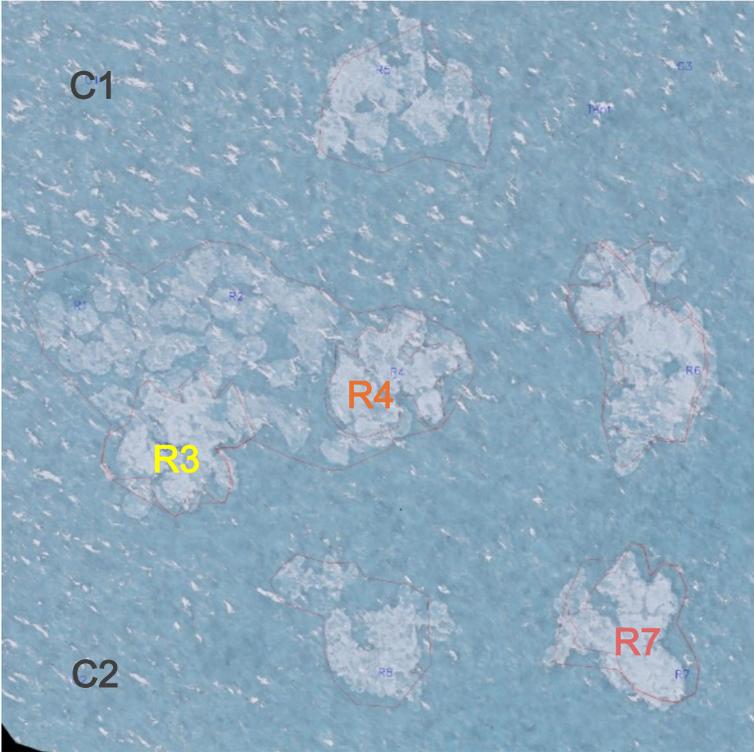


B) May 29, 2025

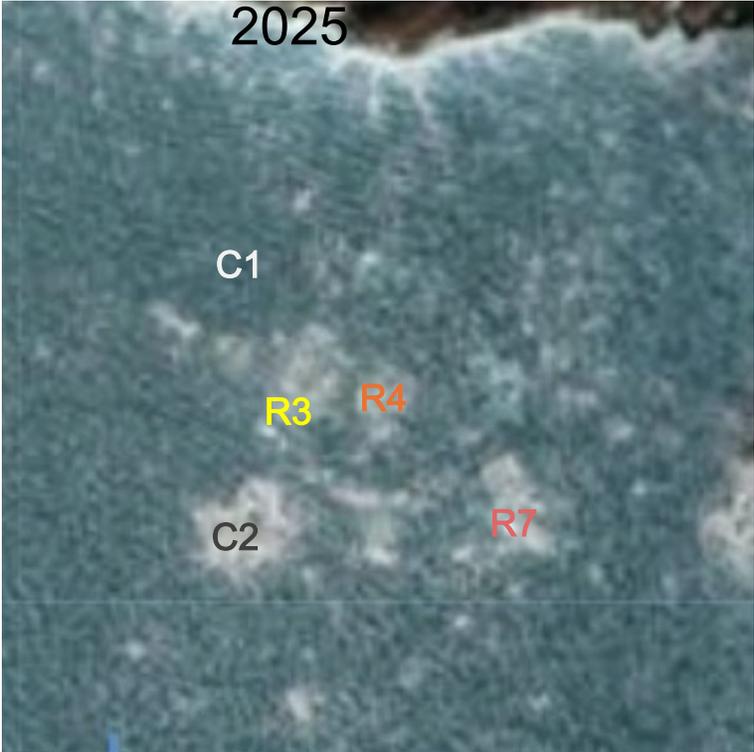


flooded sites appear to have **much smaller** melt pond fraction!

B) May 29, 2025



June 30, 2025



ESA Sentinel image

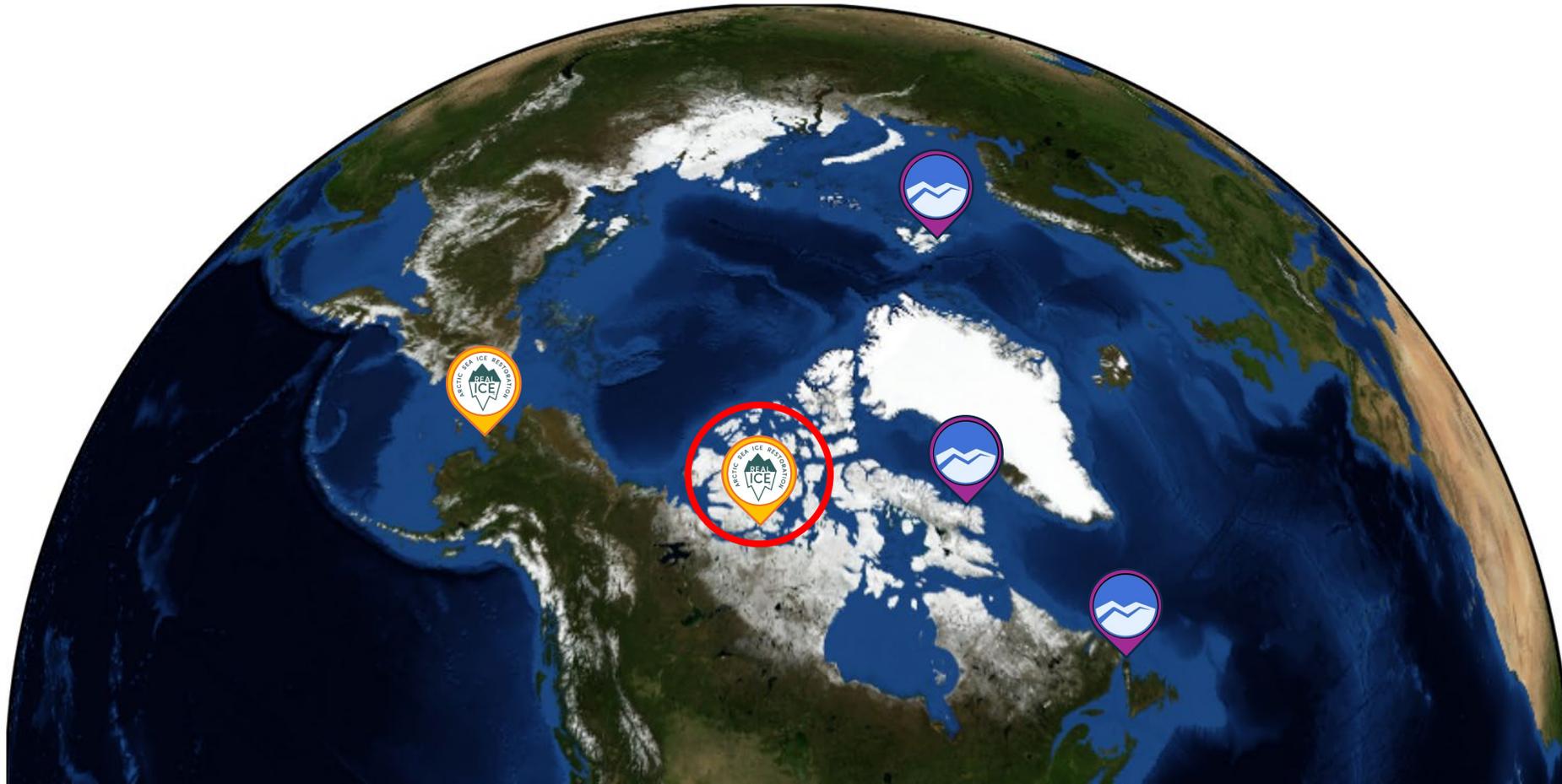
flooded sites appear to have **much smaller** melt pond fraction!

Current takeaways

1. Icepack is **fit - for - purpose** for predicting ice evolution during the growth season under intentional flooding
1. Icepack **may not be fit - for - purpose** for estimating the flooding influence on the **ice - free date**.
1. Model representation of **albedo differs** from the observations when comparing flooded sites to controls; this may be related to **melt pond evolution** .
1. Recommend improvements/additions to field observations to adequately evaluate fitness- for- purpose beyond surface- level metrics
 - Direct albedo and surface radiative measurements
 - Melt pond evolution observations (area and depth)

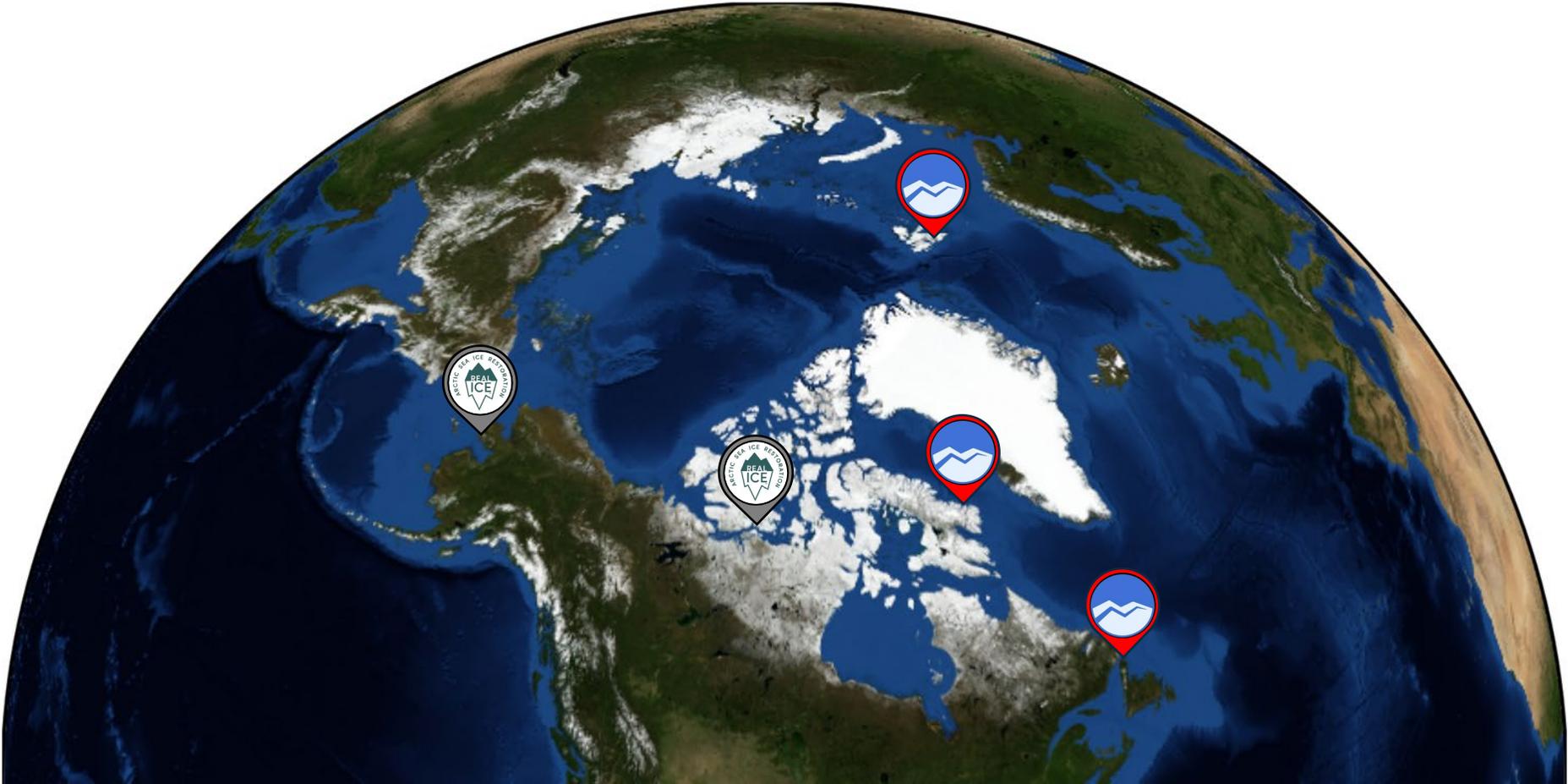
Next directions...

We've been considering fitness-for-purpose for one localized instance.



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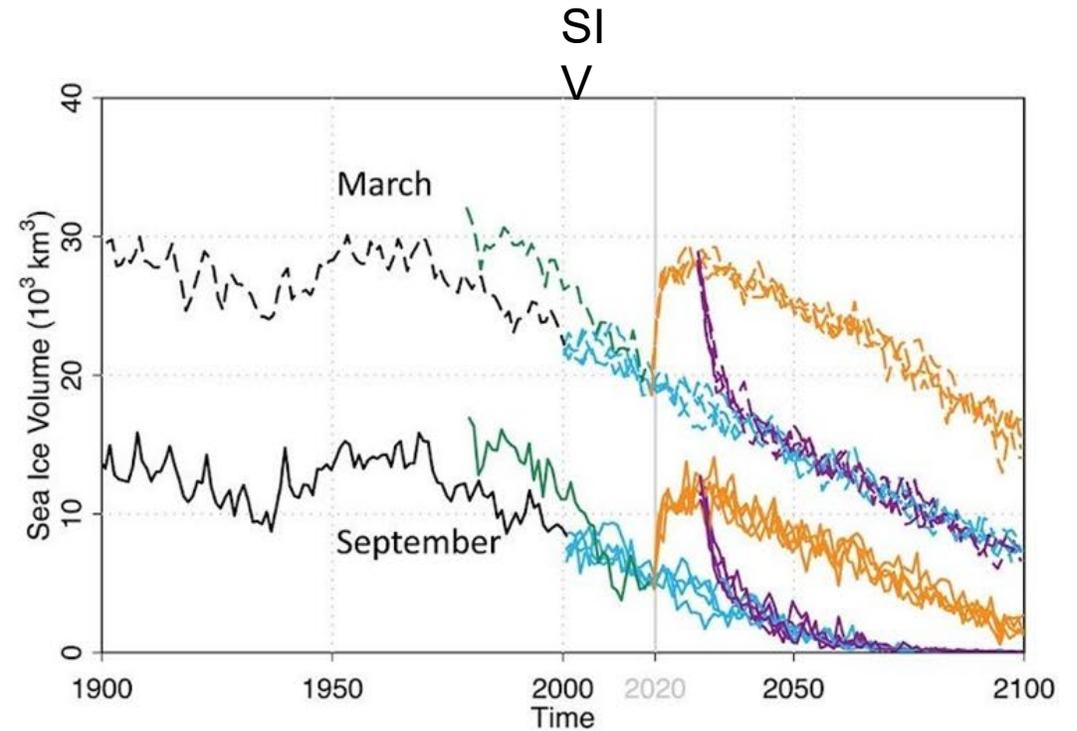
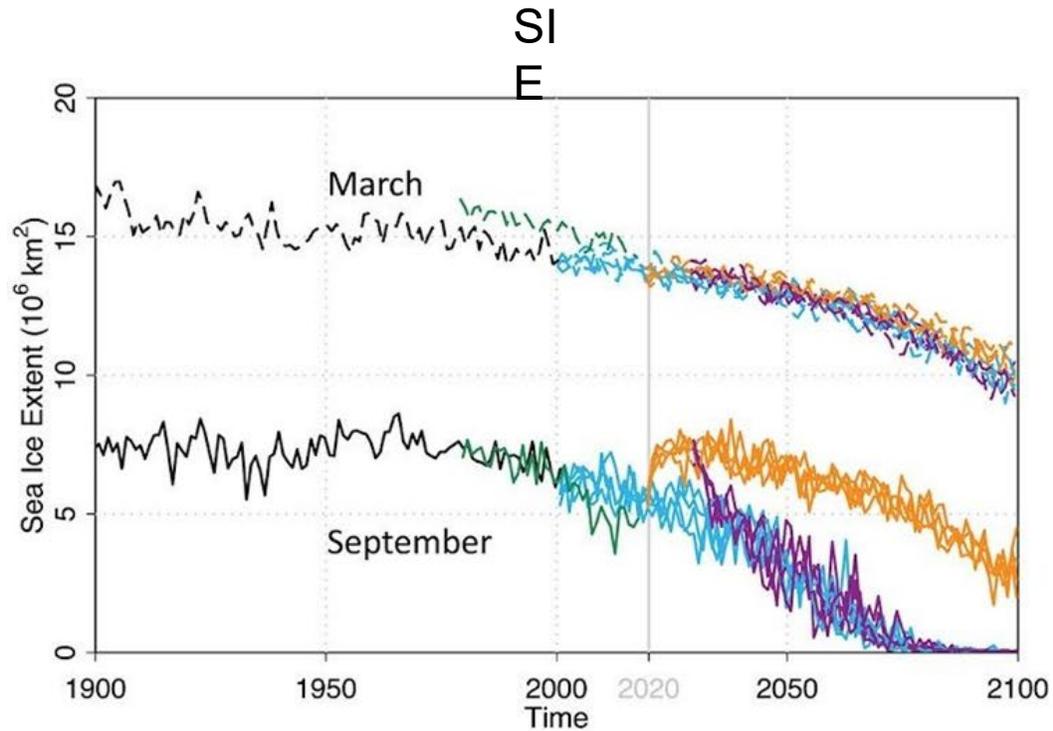
We've been considering fitness-for-purpose for one localized incident
What is the **contextual fitness for purpose** ? ☐ apply to the Arctic Reflections sites



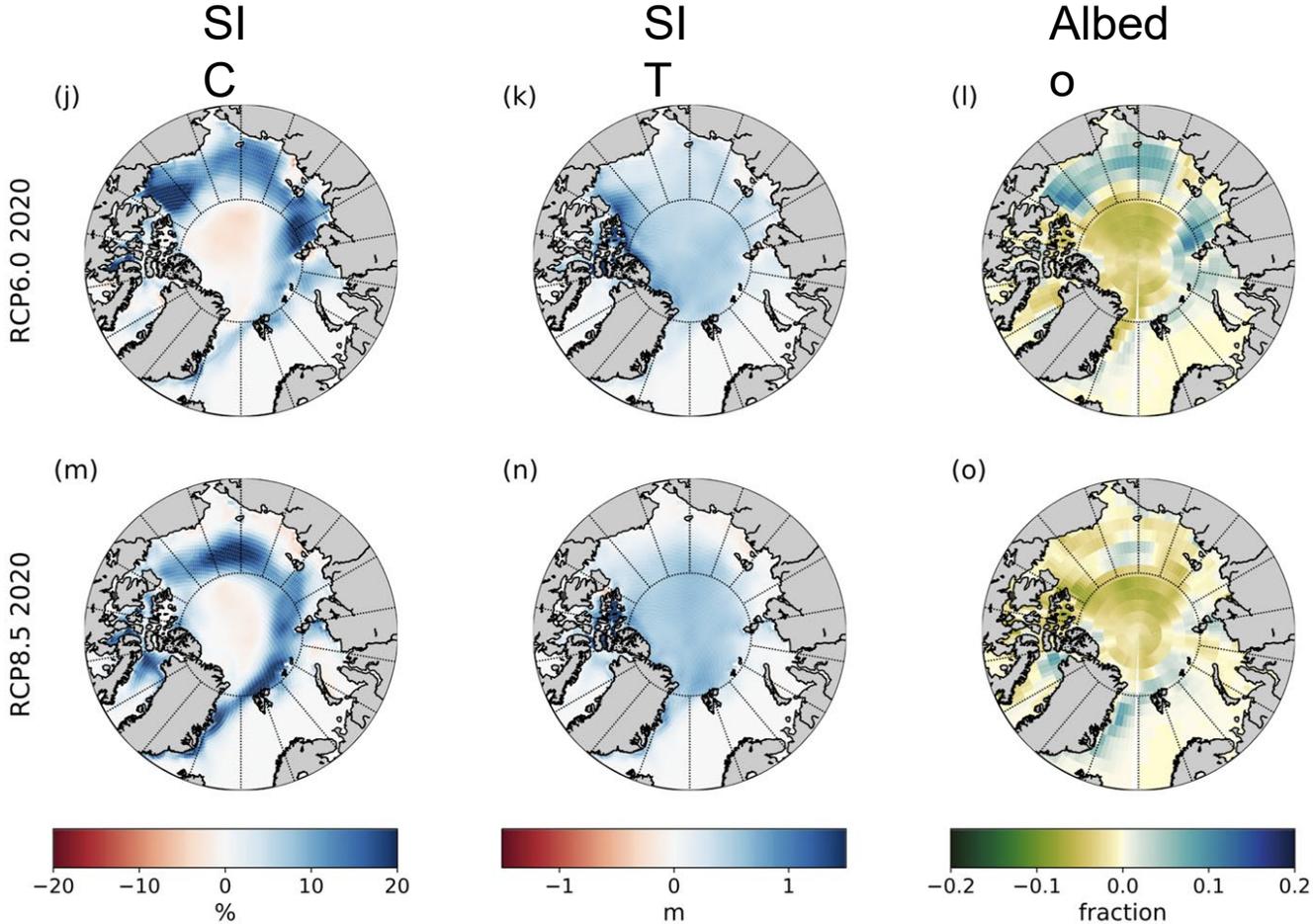
Thanks!
Questions?



Annual Arctic sea ice evolution in **continuous flooding** and **short-term flooding** scenarios compared to **controls**



Average September sea ice response to 20 years of intentional flooding (compared to control)



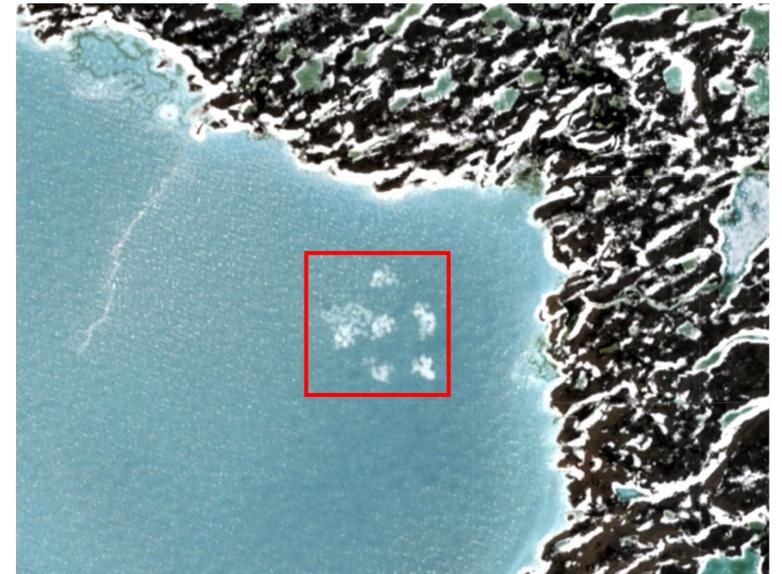
Field setup in Cambridge Bay



O(10m
)

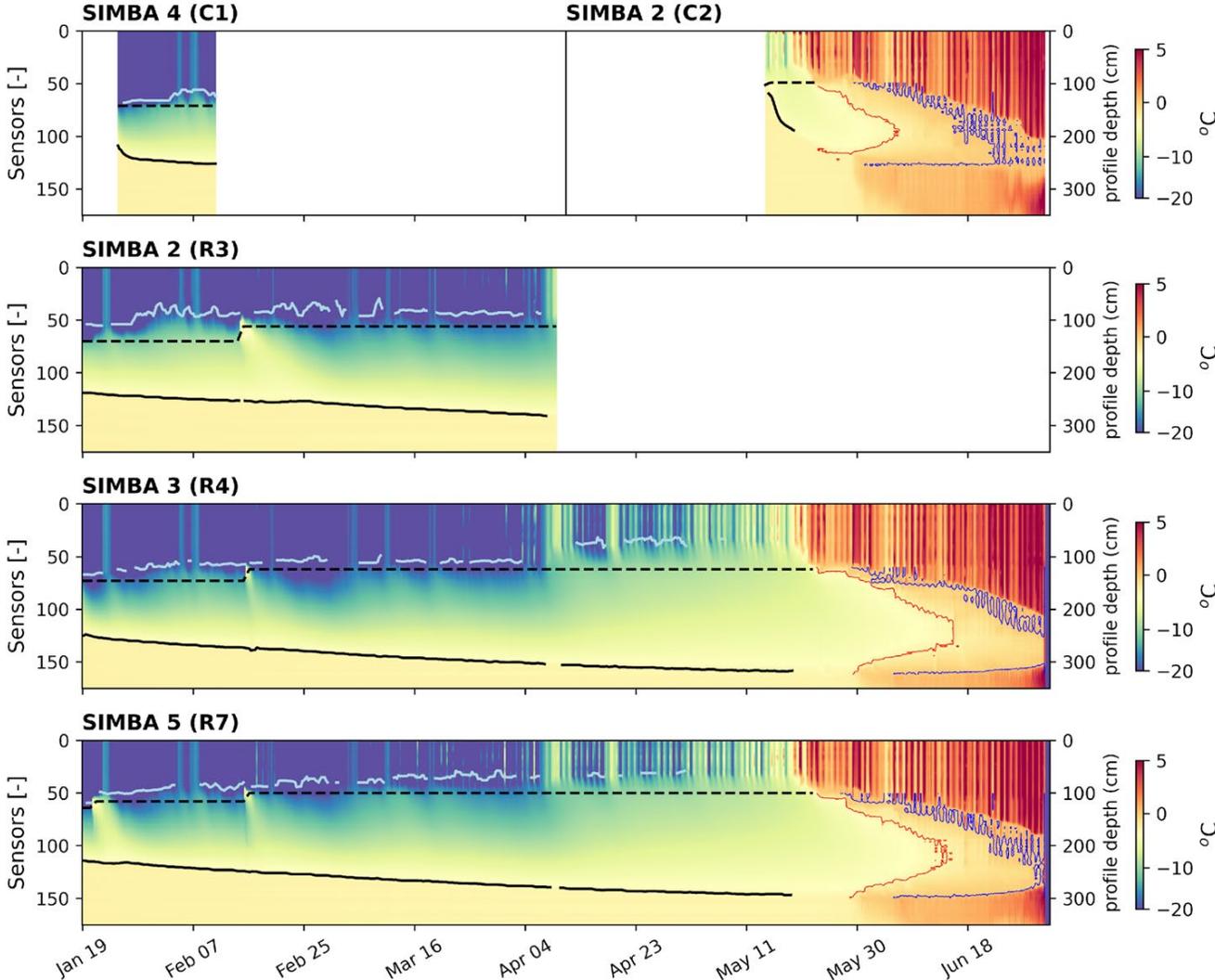


O(100m
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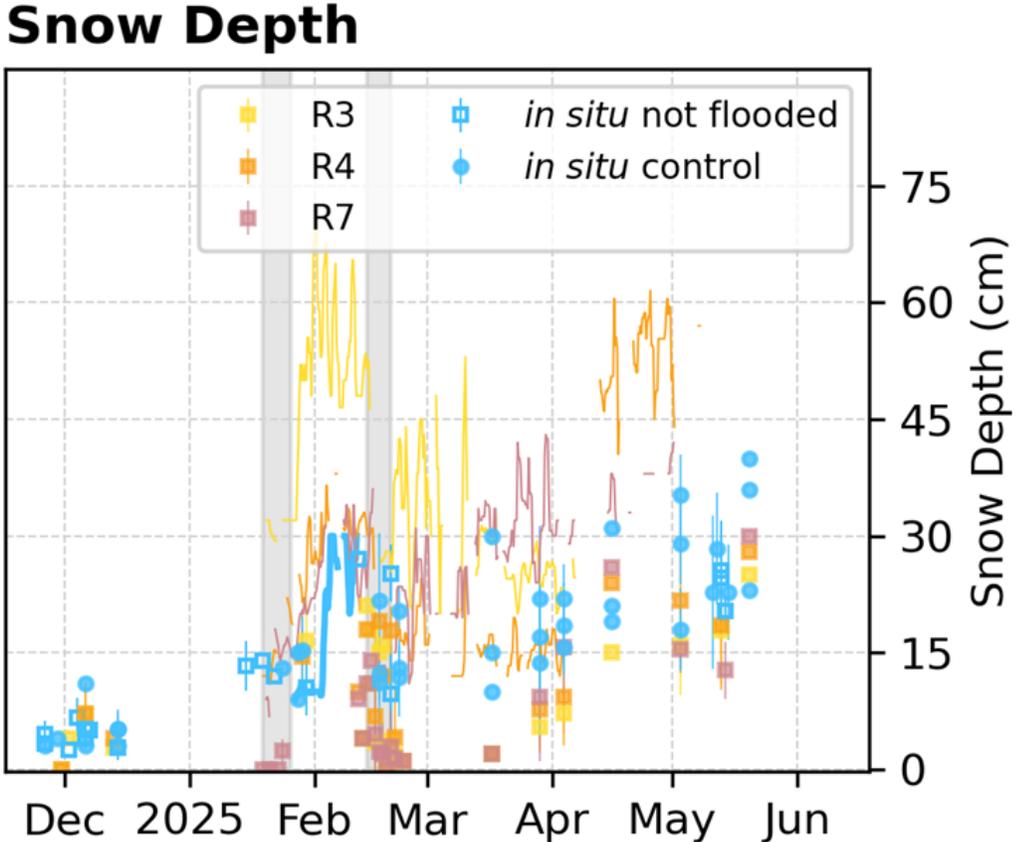
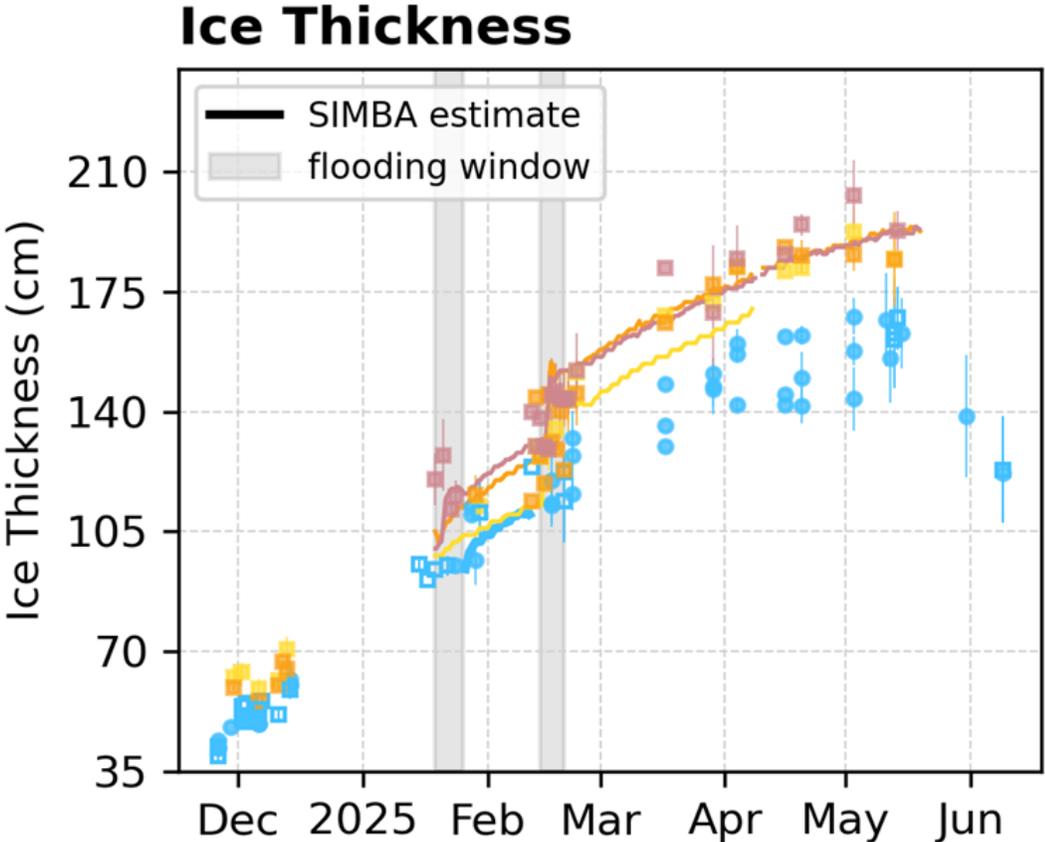


O(1000m
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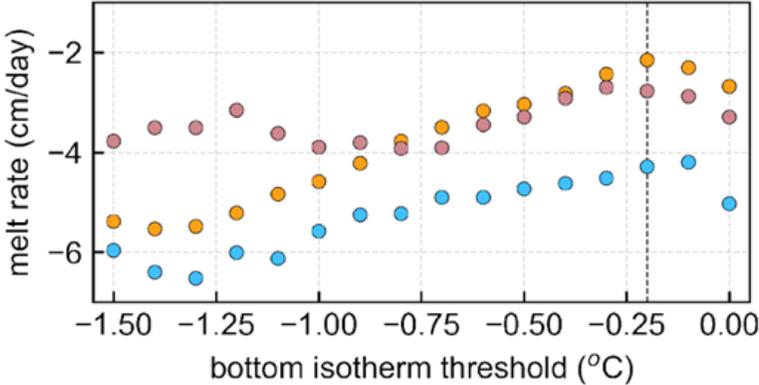
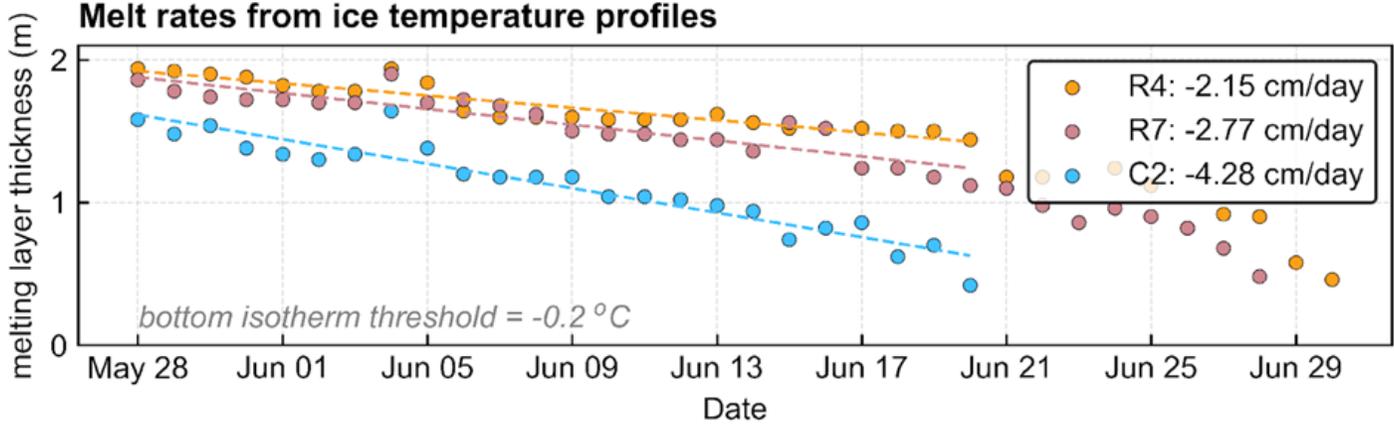
SIMBA temperature measurements provide a continuous picture of ice evolution



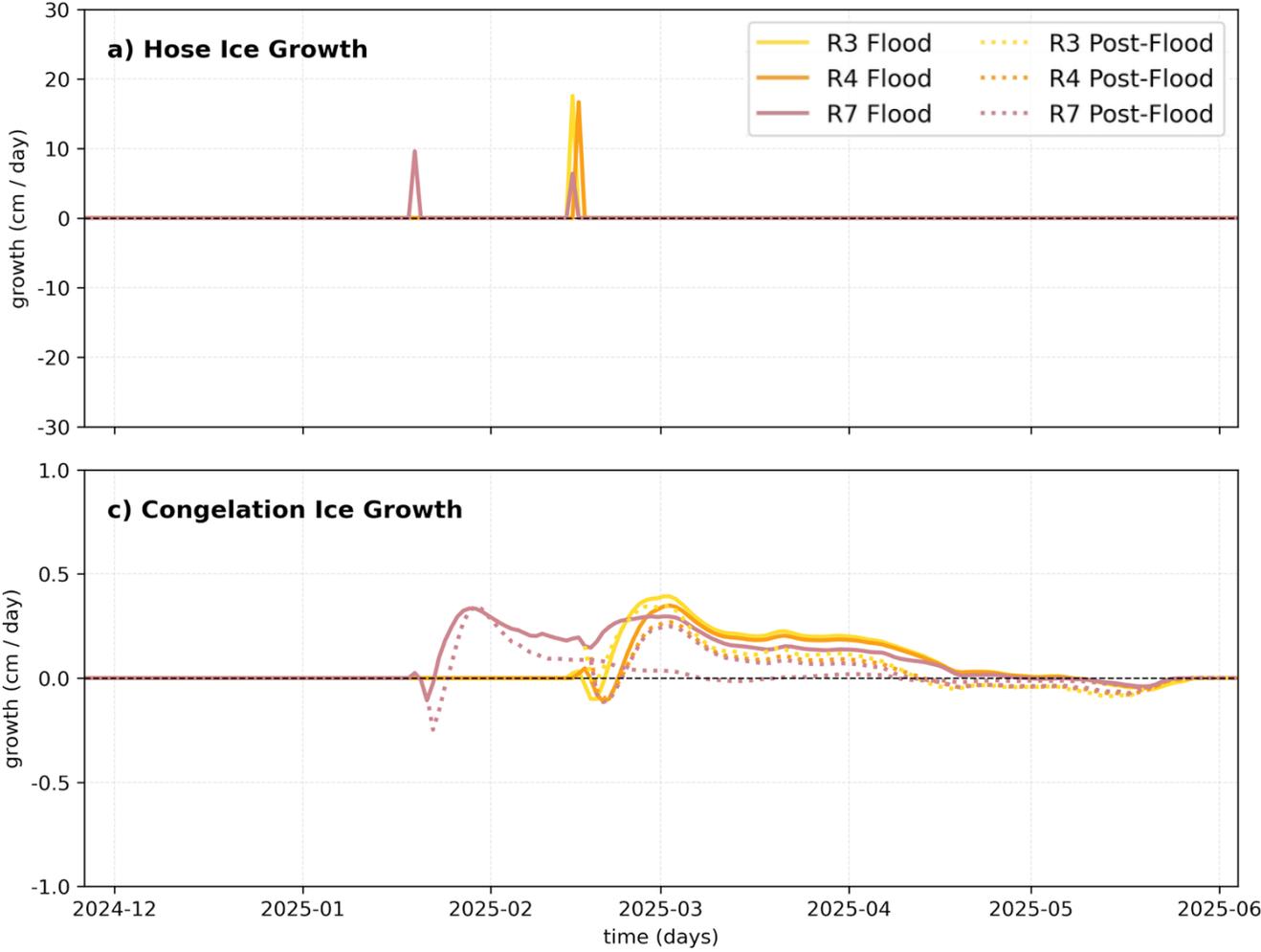
SIMBAs validated by *in situ* observations



SIMBA- estimated melt rates



Process implications from the model: sea ice growth in FLOOD cases



Direct effect from flooding

17.53 cm

16.64 cm

15.96 cm

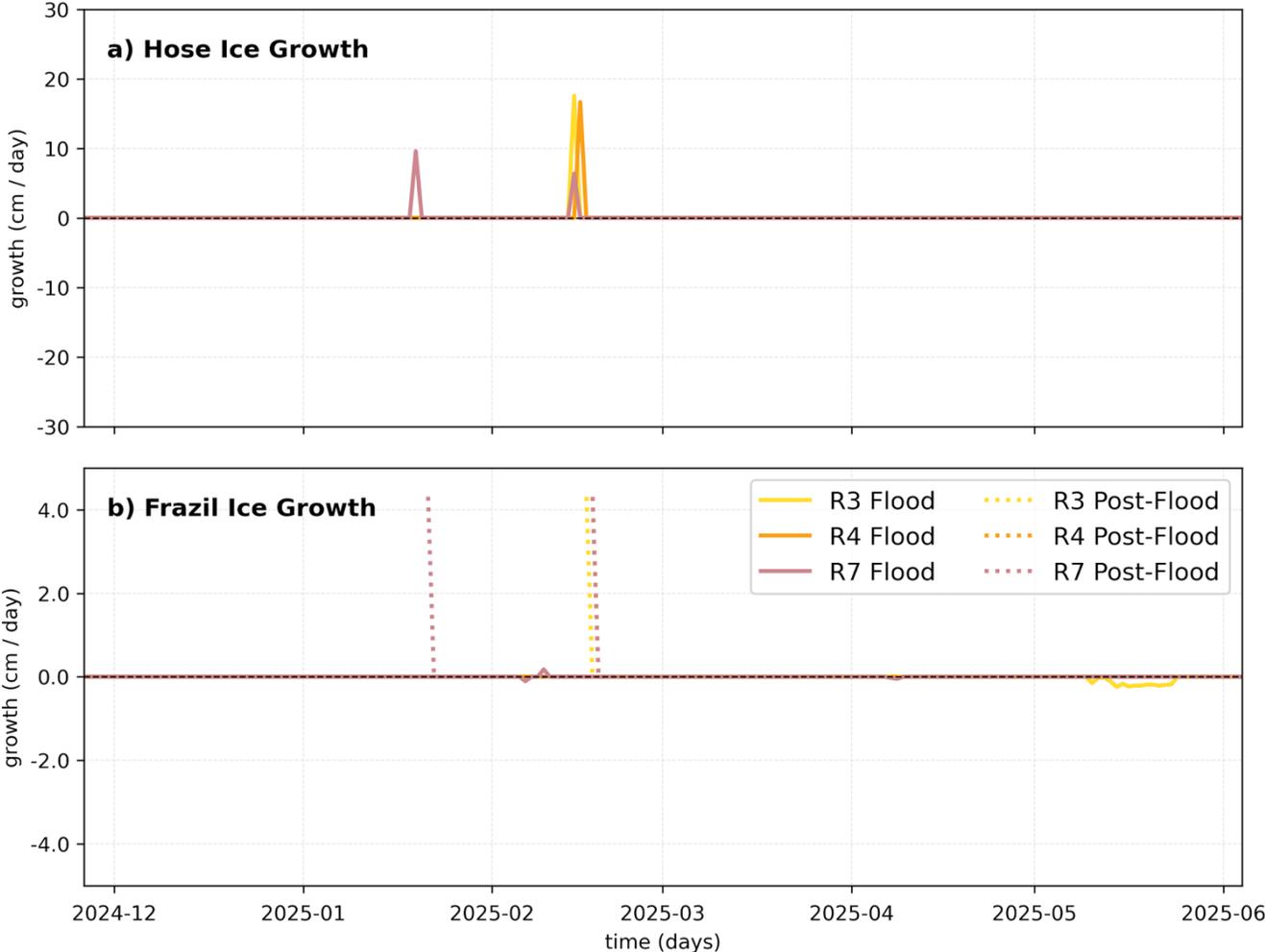
Secondary effect (congelation)

12.01 cm

10.40 cm

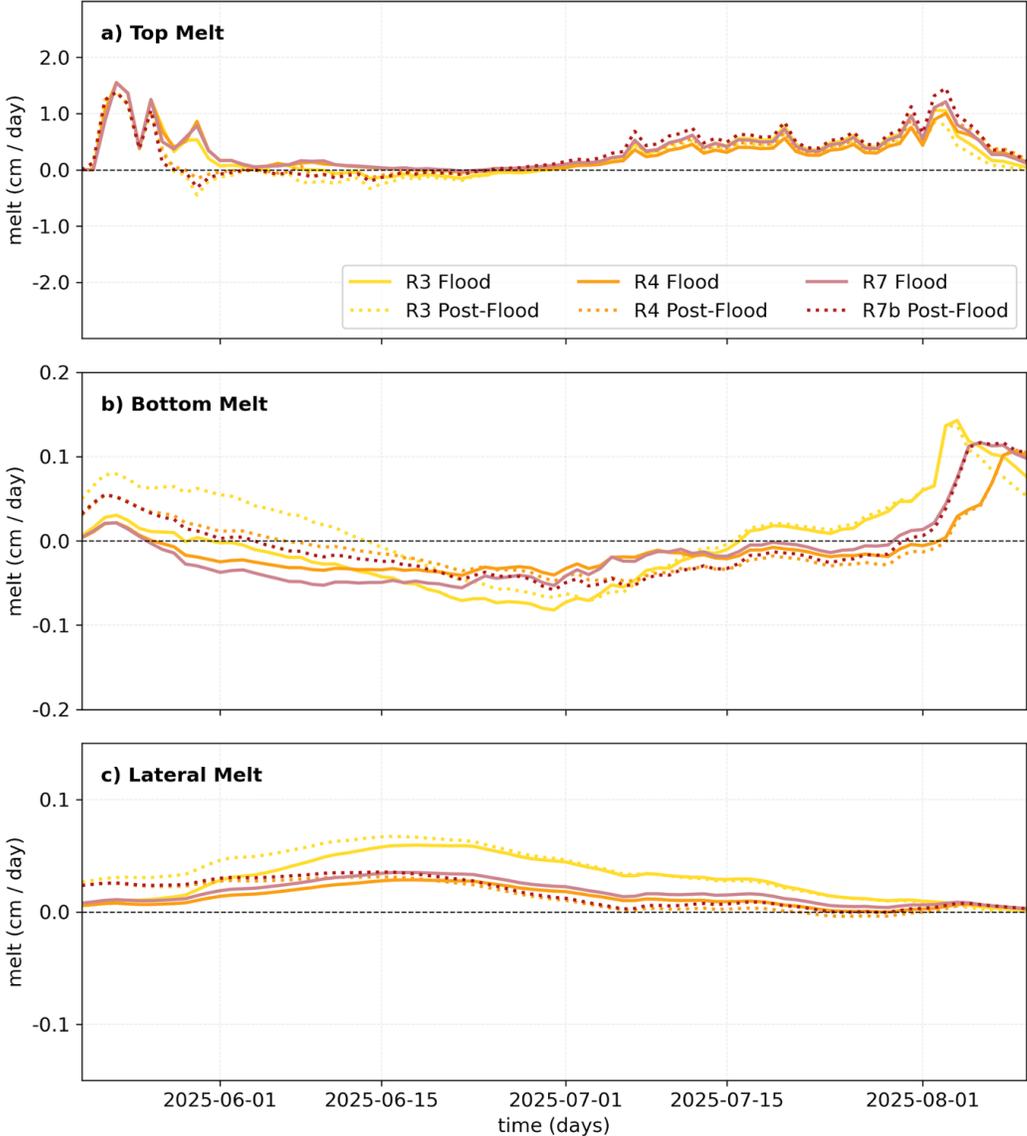
15.82 cm

Process implications from the model: sea ice growth in POSTFLOOD cases

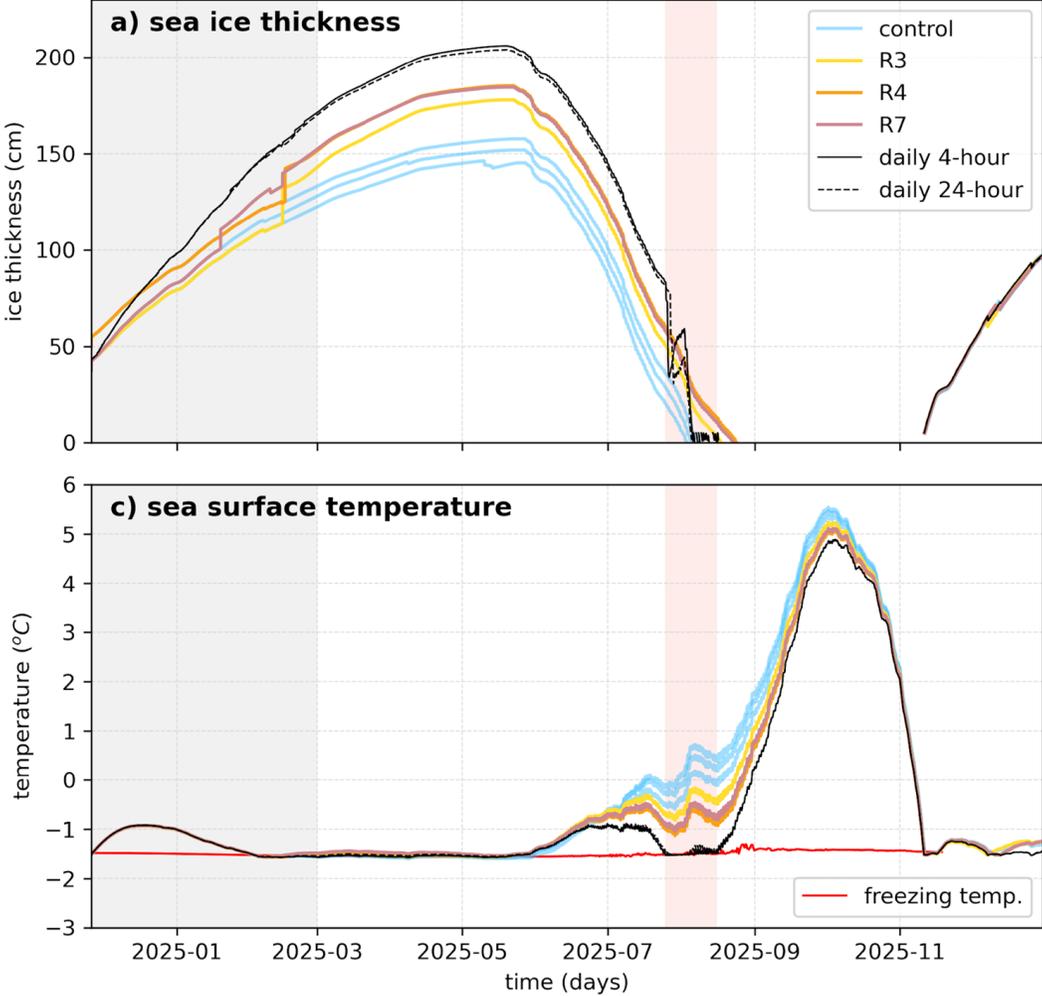


Process implications from the model: sea ice melt

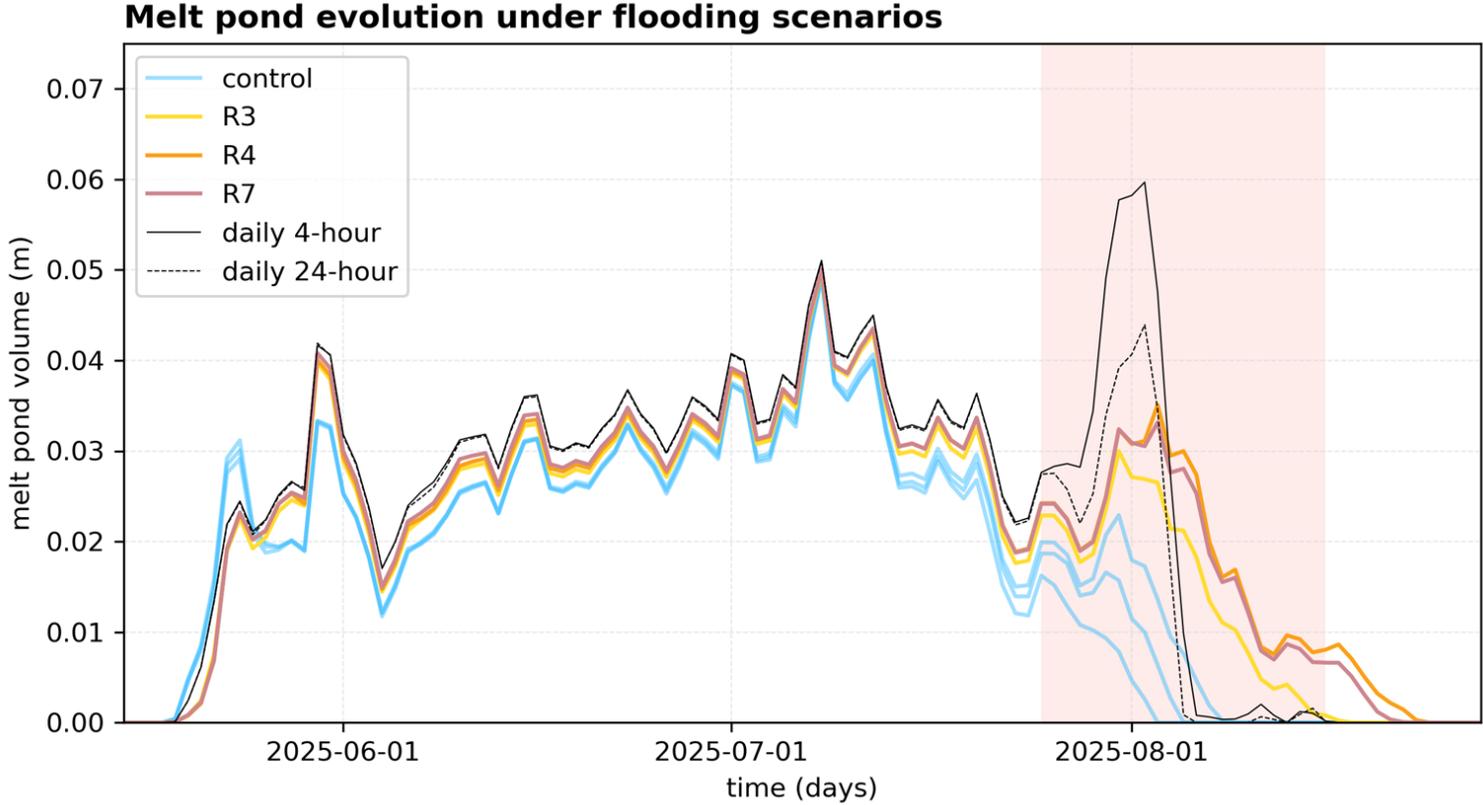
Ice melt season



Implementation strategy matters: idealizations overestimate impact



Melt ponds under intentional flooding



Salinity profile comparison with ice core data

