

living planet symposium

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TAKING THE PULSE
OF OUR PLANET FROM SPACE



A record of surface meltwater ponding and slush on Antarctic ice shelves from 2013 to 2021 using Landsat 8

Neil Arnold, Ian Willis, Alison Banwell, Stef Lhermitte, Bert Wouters, Ruthie Halberstadt, Anna Maria Trofaier, Marcus Engdahl



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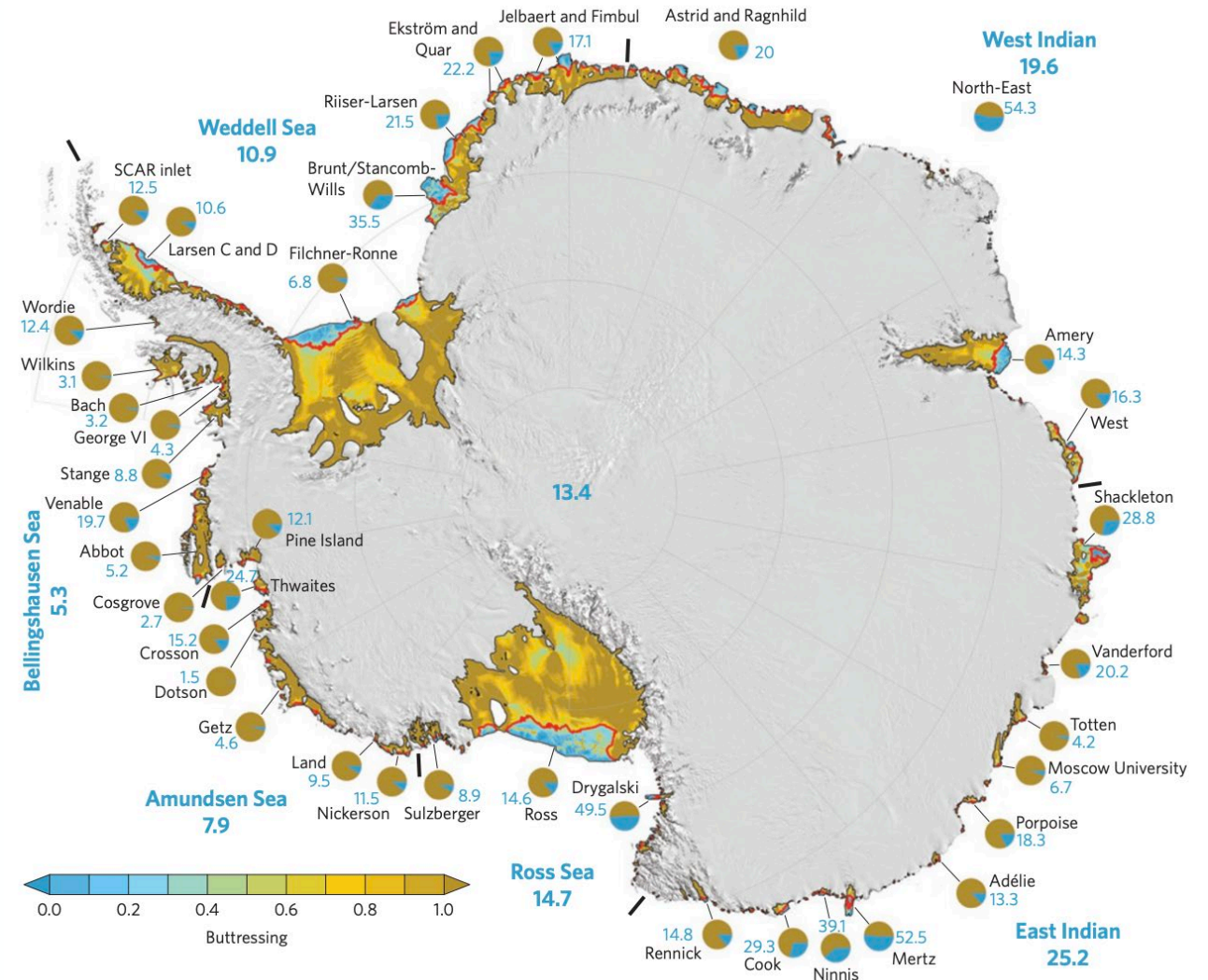
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26/05/22

Ice Shelf Buttressing



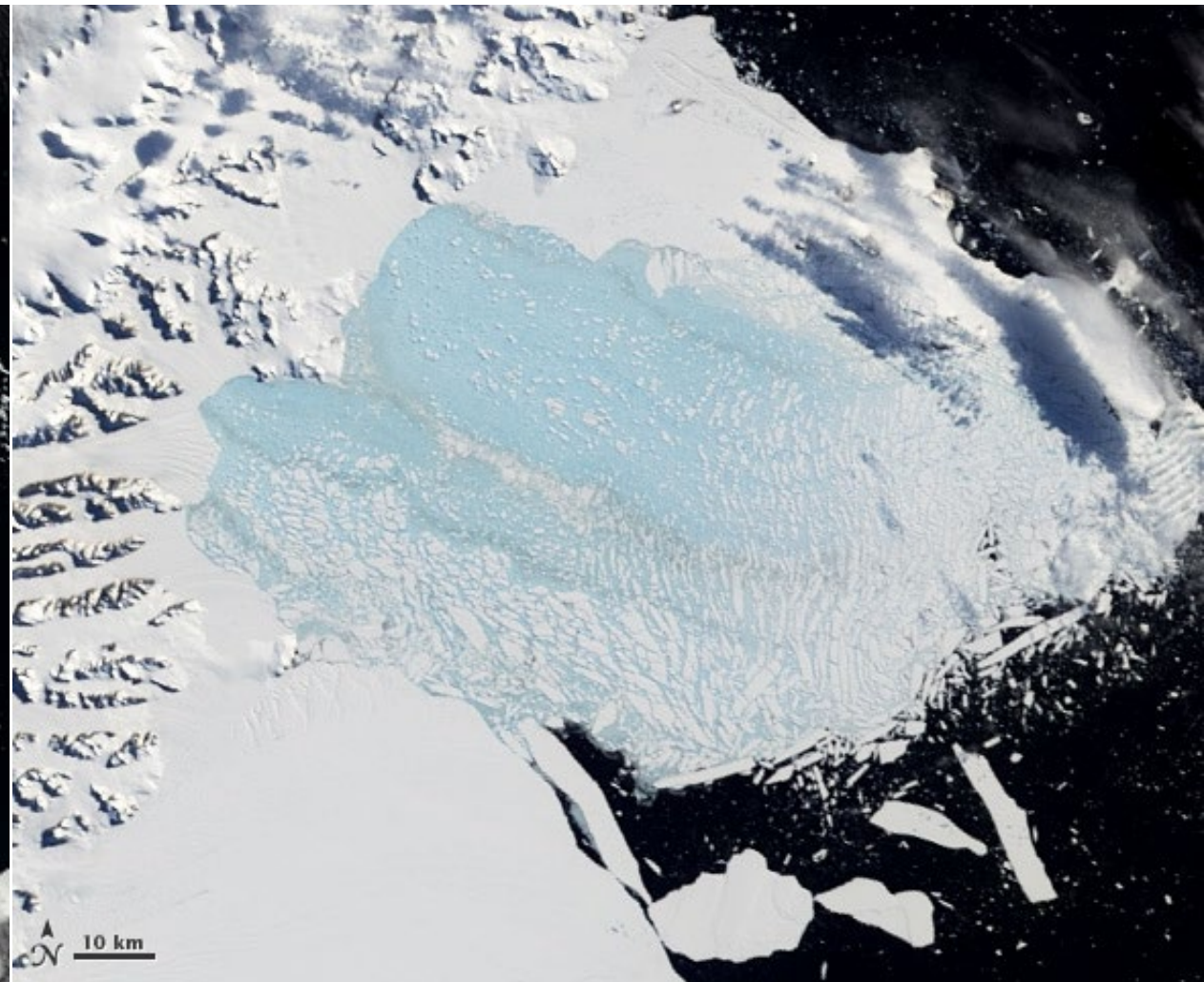
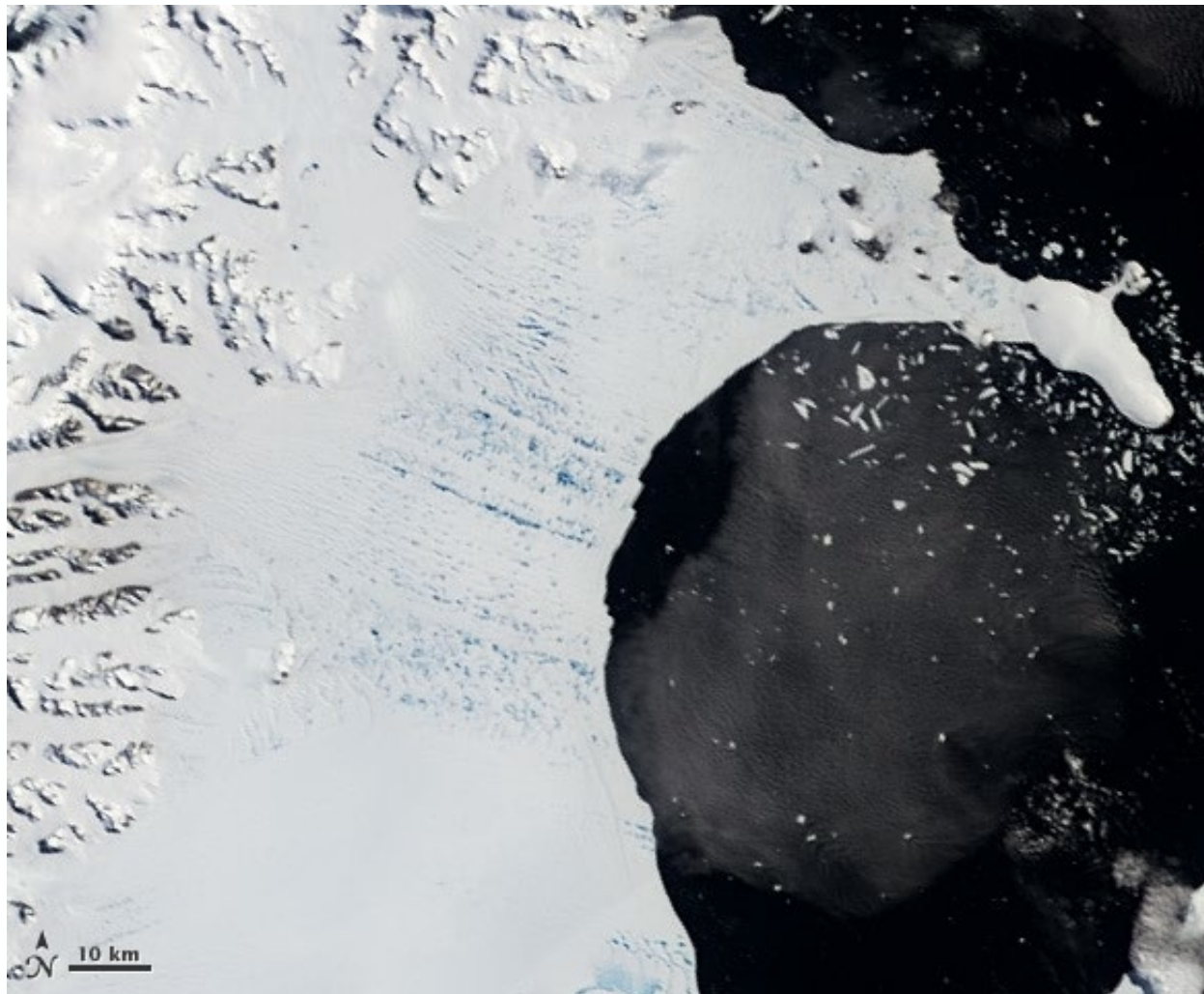
- Ice shelves border ~ 75% of Antarctica
- Furst et al. (2016) determined which parts of each shelf are passive shelf ice vs. active shelf ice.
- The Bellingshausen Sea has the lowest regional percentage of Passive Shelf Ice (i.e., it is actively buttressing much of the upstream grounded ice).



Furst et al. (2016)



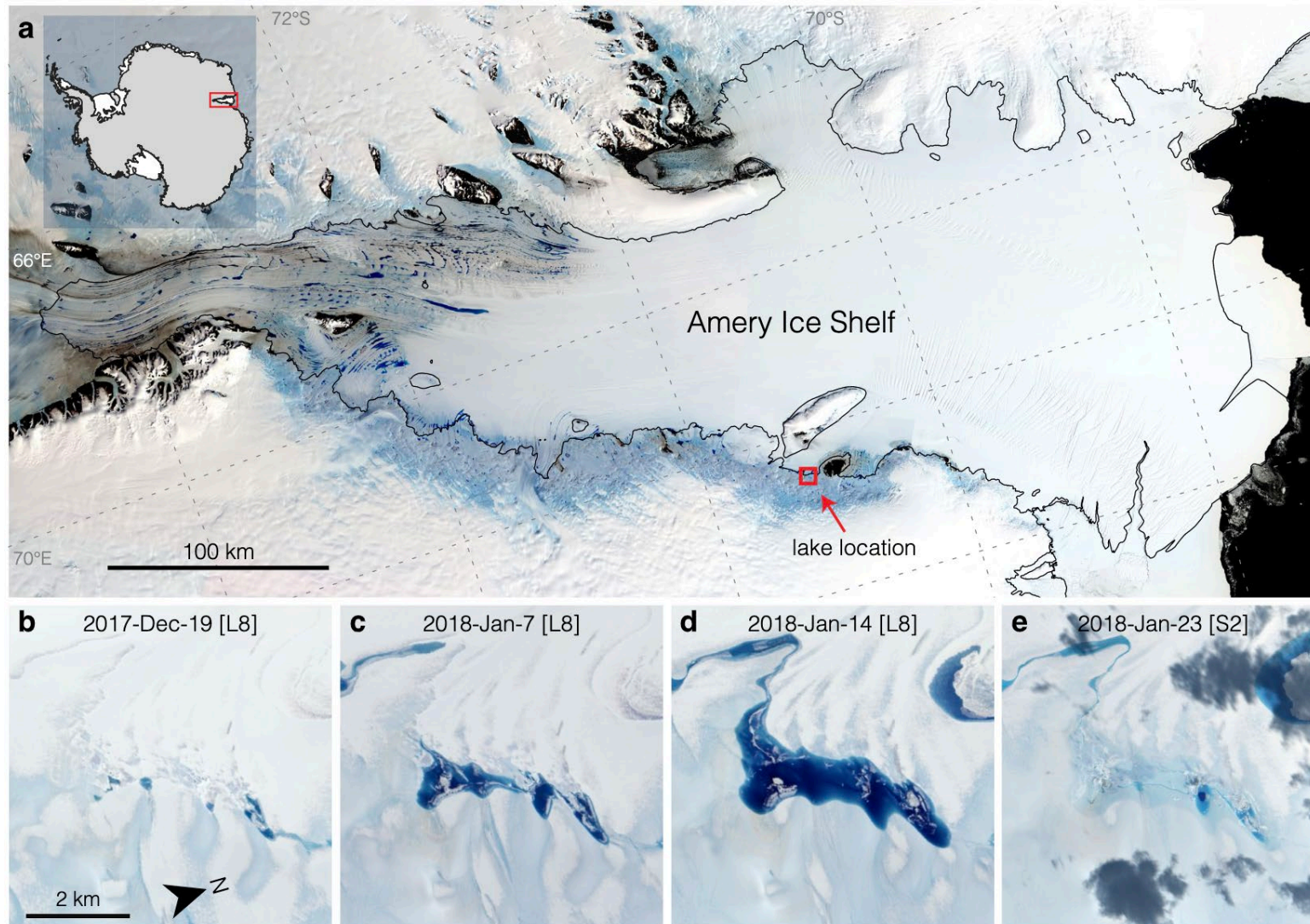
How Dangerous is Meltwater?



NASA
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How Dangerous is Meltwater?



Trusel et al. (2022)

How Dangerous is Meltwater?



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Bell et al. (2017)



Image modified from NASA Earth Observatory (Lauren Dauphin)

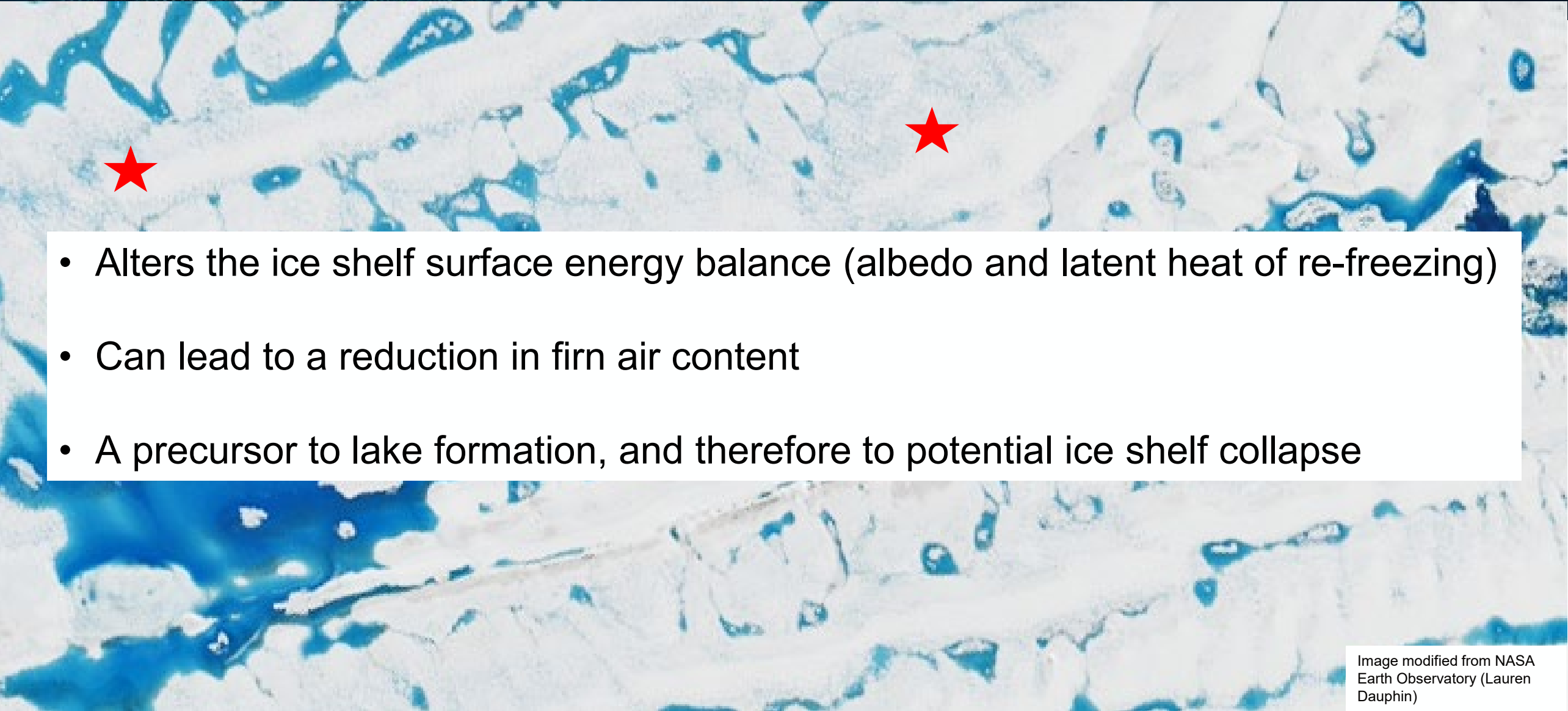
- 
- Alters the ice shelf surface energy balance (albedo and latent heat of re-freezing)
 - Can lead to a reduction in firn air content
 - A precursor to lake formation, and therefore to potential ice shelf collapse

Image modified from NASA
Earth Observatory (Lauren
Dauphin)

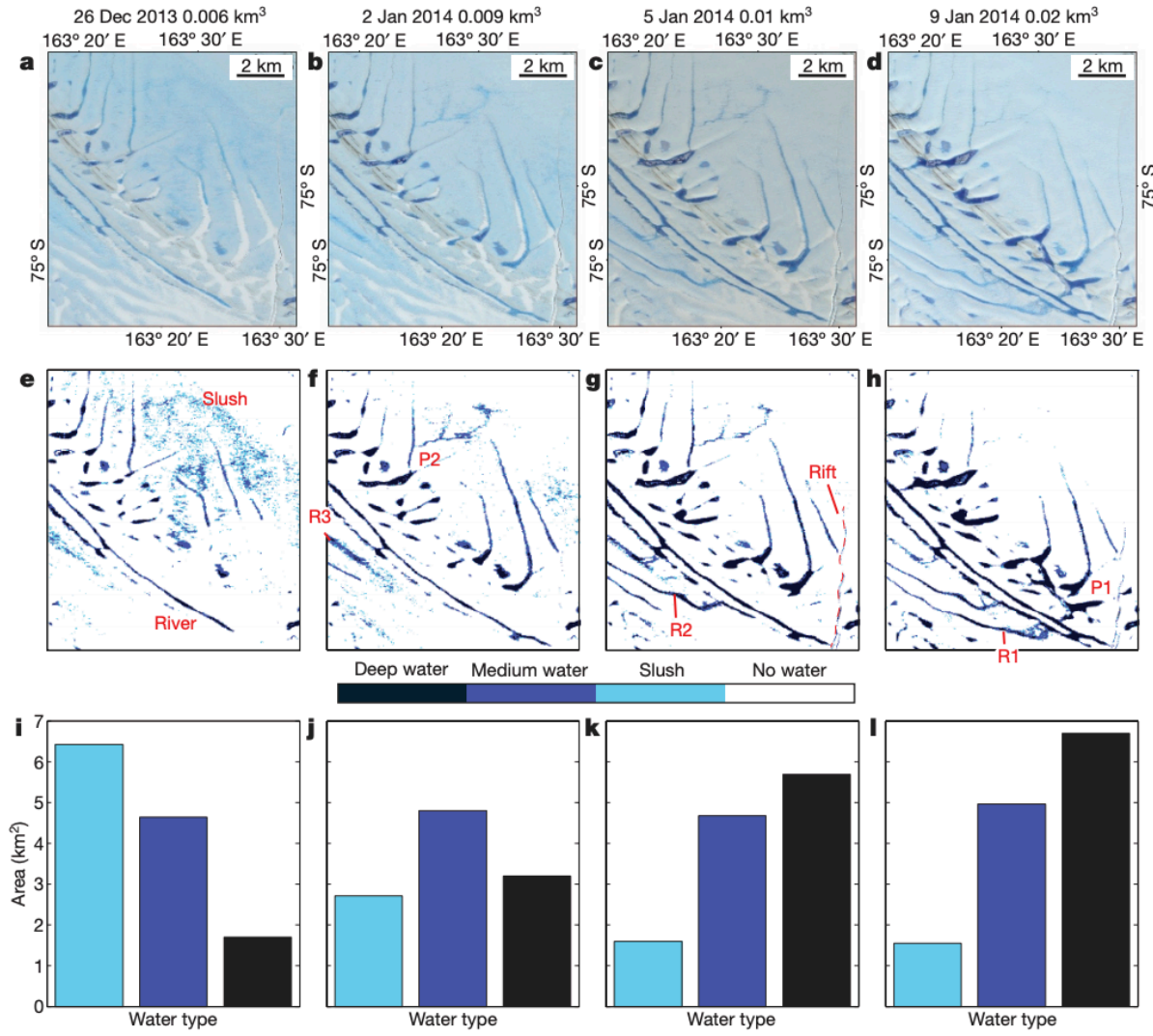
AIM

Develop a continent-wide dataset of surface meltwater extent on ice shelves (2000's-present day)

- Do this using classification algorithms in Google Earth Engine
 - Ultimately want to classify two classes: **Ponded Water and Slush**

Image modified from NASA Earth Observatory (Lauren Dauphin)

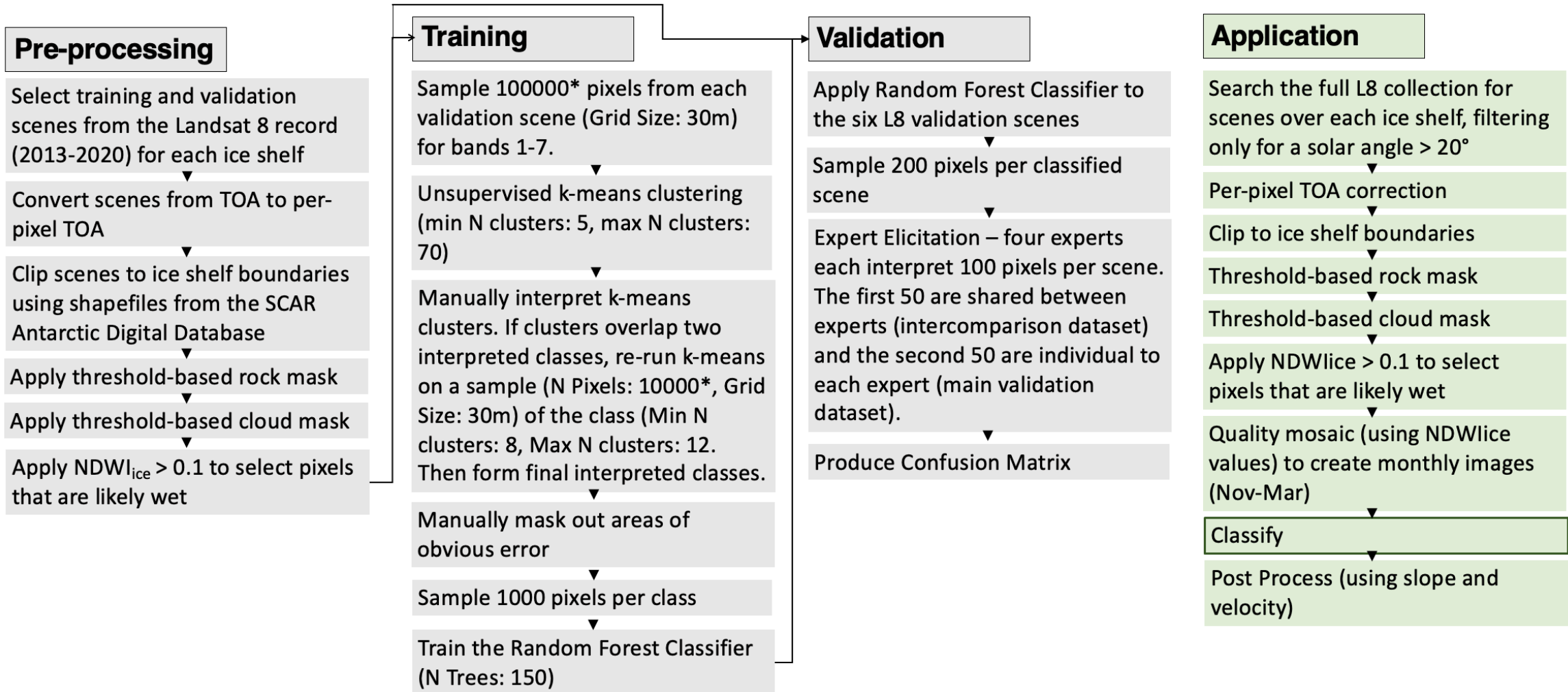
Mapping Slush: Threshold Base Approach



Bell et al. (2017)

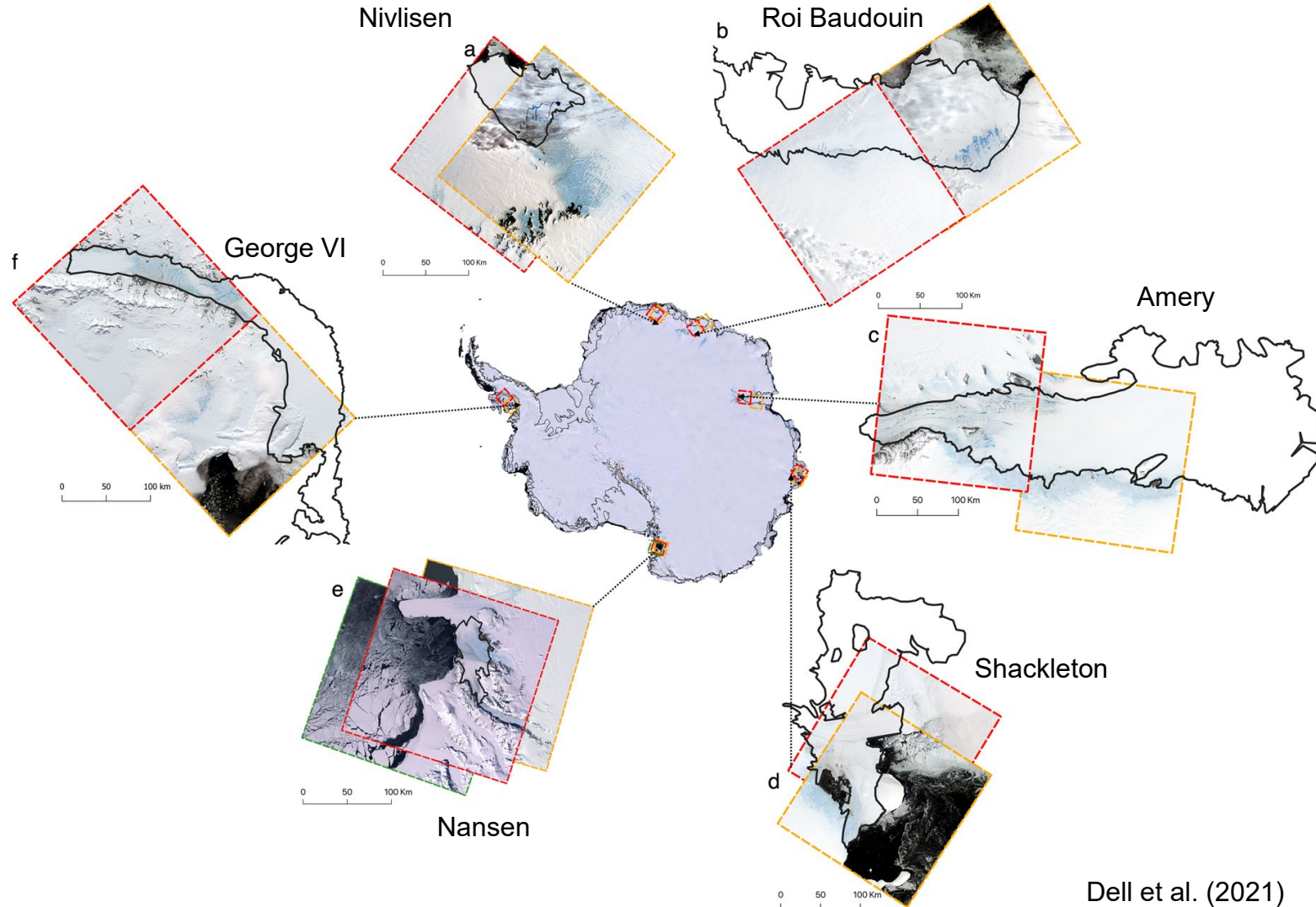


Mapping Slush: Random Forest Approach



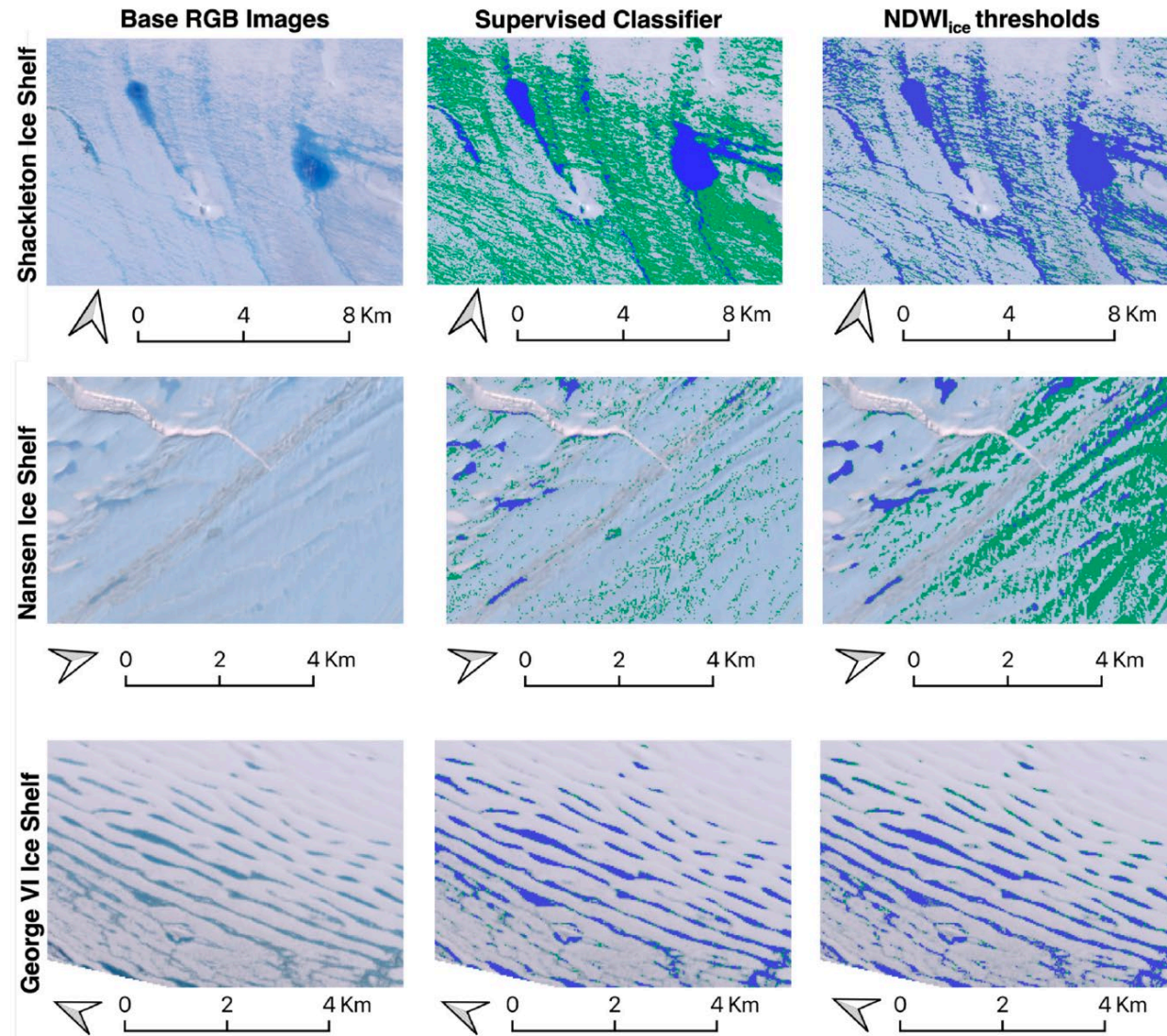
Modified from Dell et al. (2022) ¹⁰

Mapping Slush: Random Forest Approach



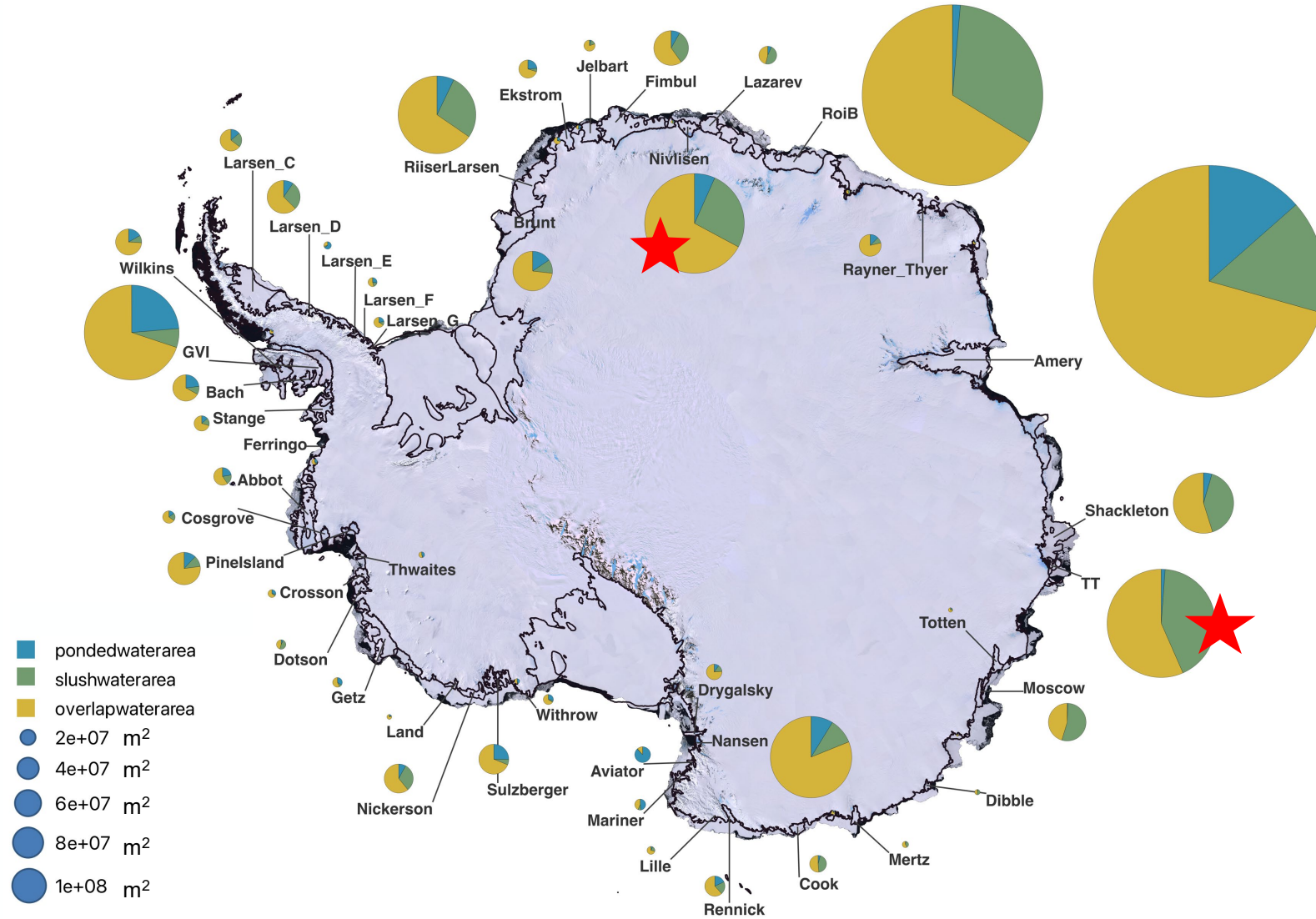
Dell et al. (2021)

Mapping Slush: RF vs. NDWI



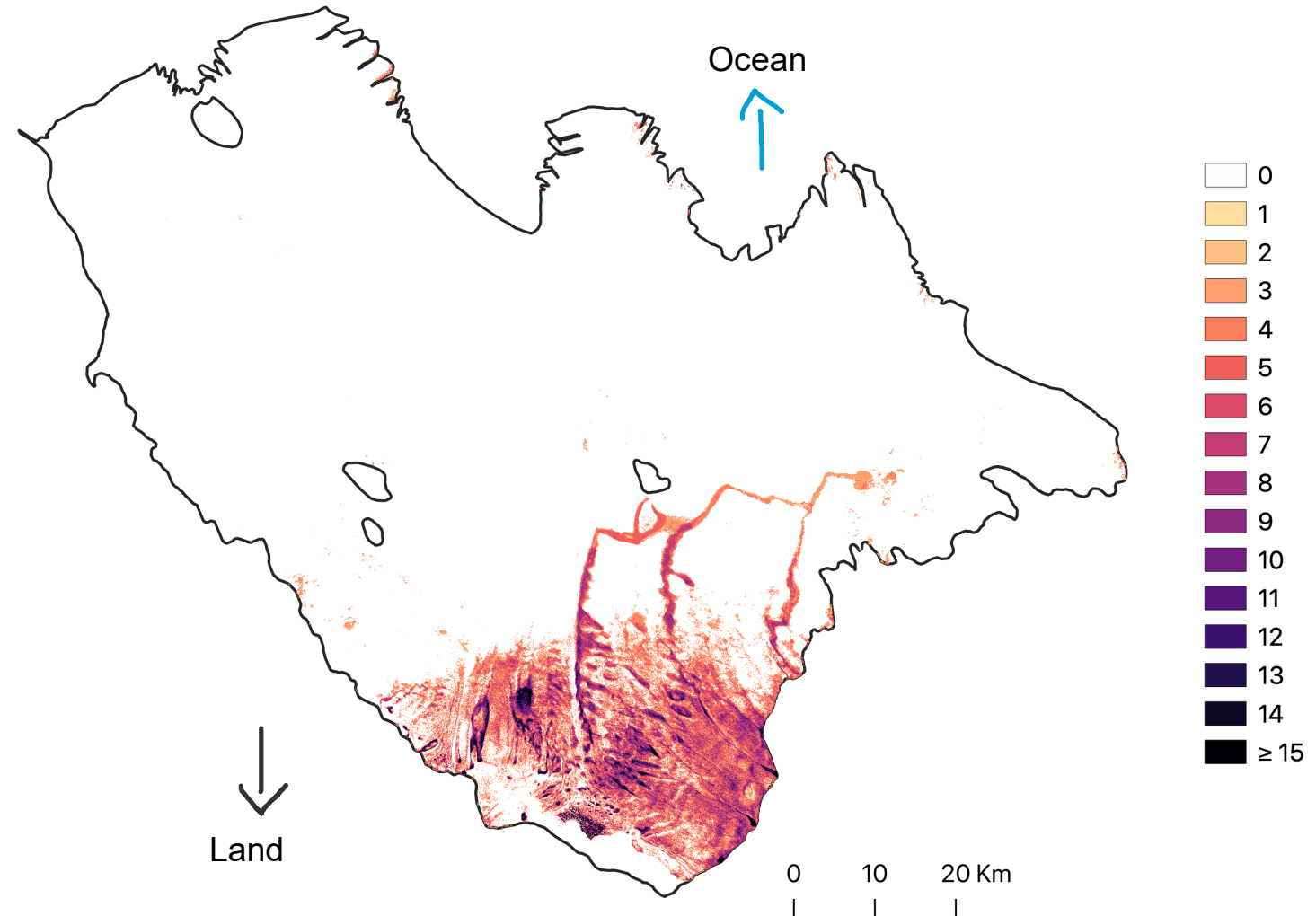
■ Ponded Water ■ Slush

Dell et al. (2021)

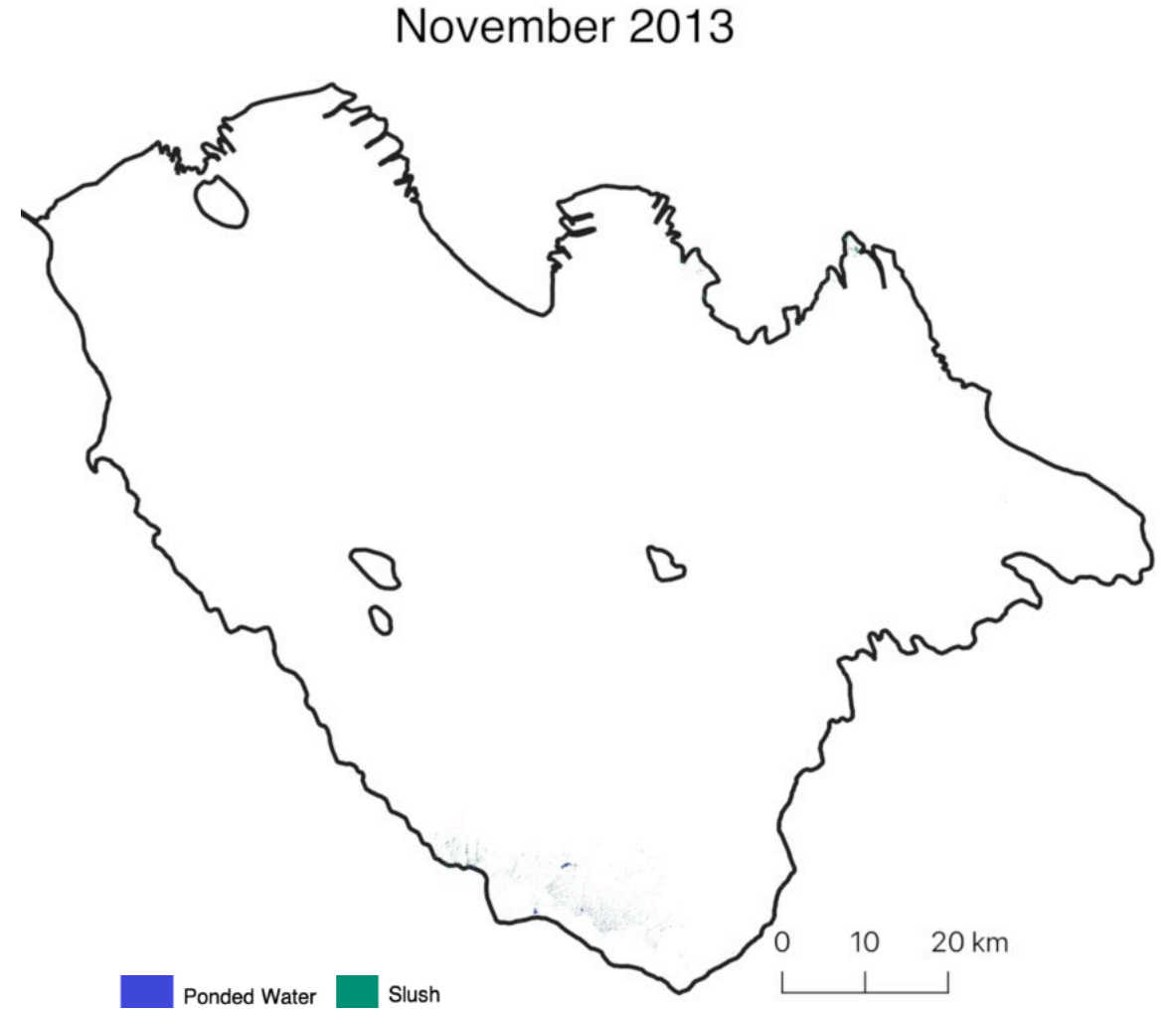
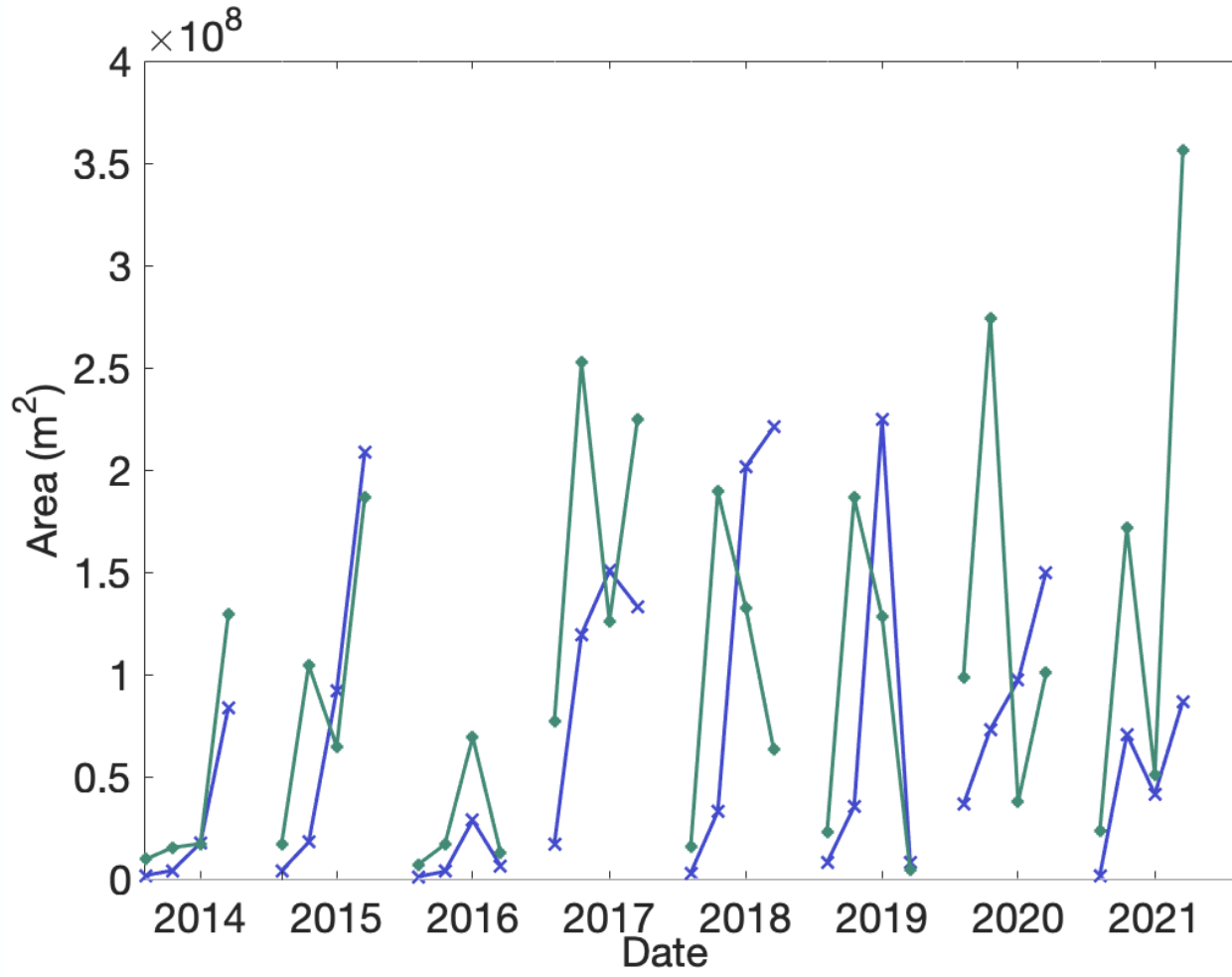


Nivlisen Ice Shelf

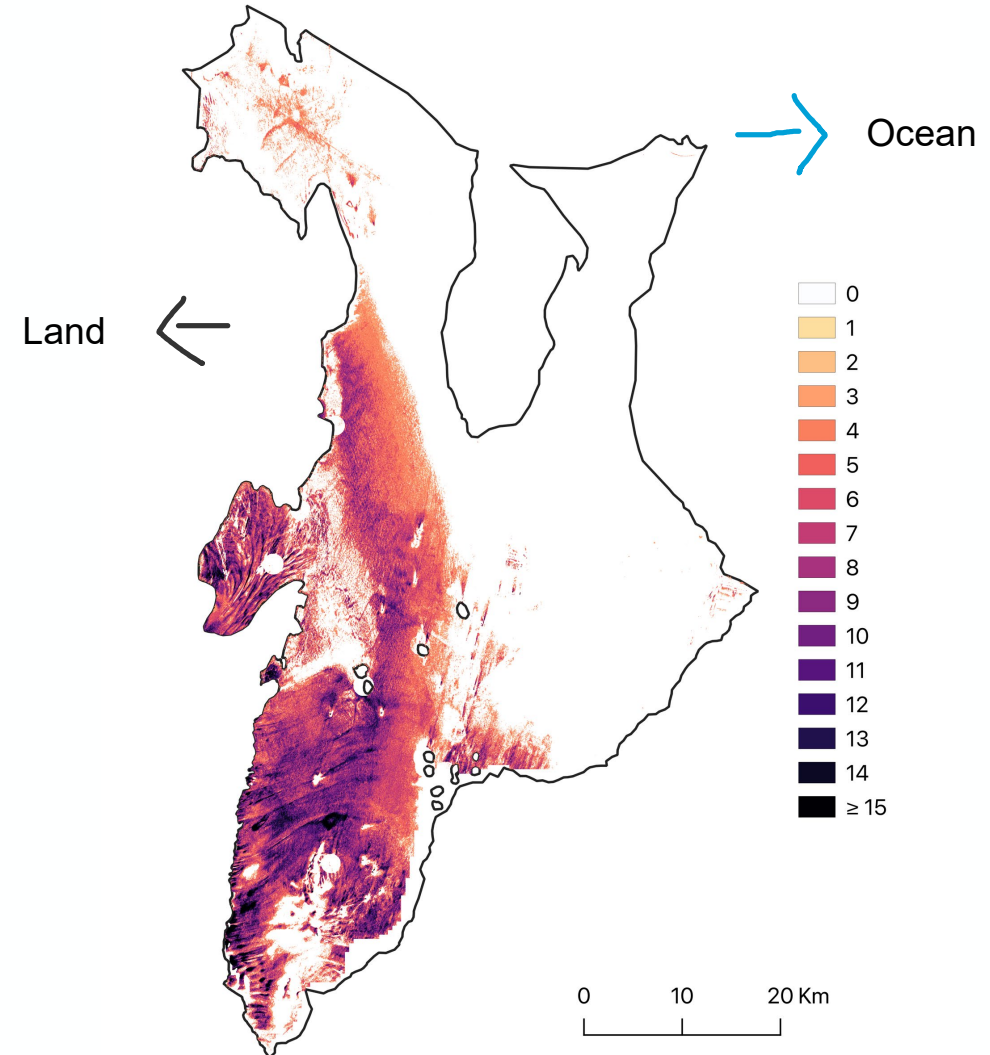
- From 2013-2021
 - 900 km² of surface meltwater (slush and ponded).
 - 7% **ponded water** only
 - 27% **slush** only
 - 66% **both** slush and ponded water.
- Maximum melt extent covers 12% of the total ice shelf area.

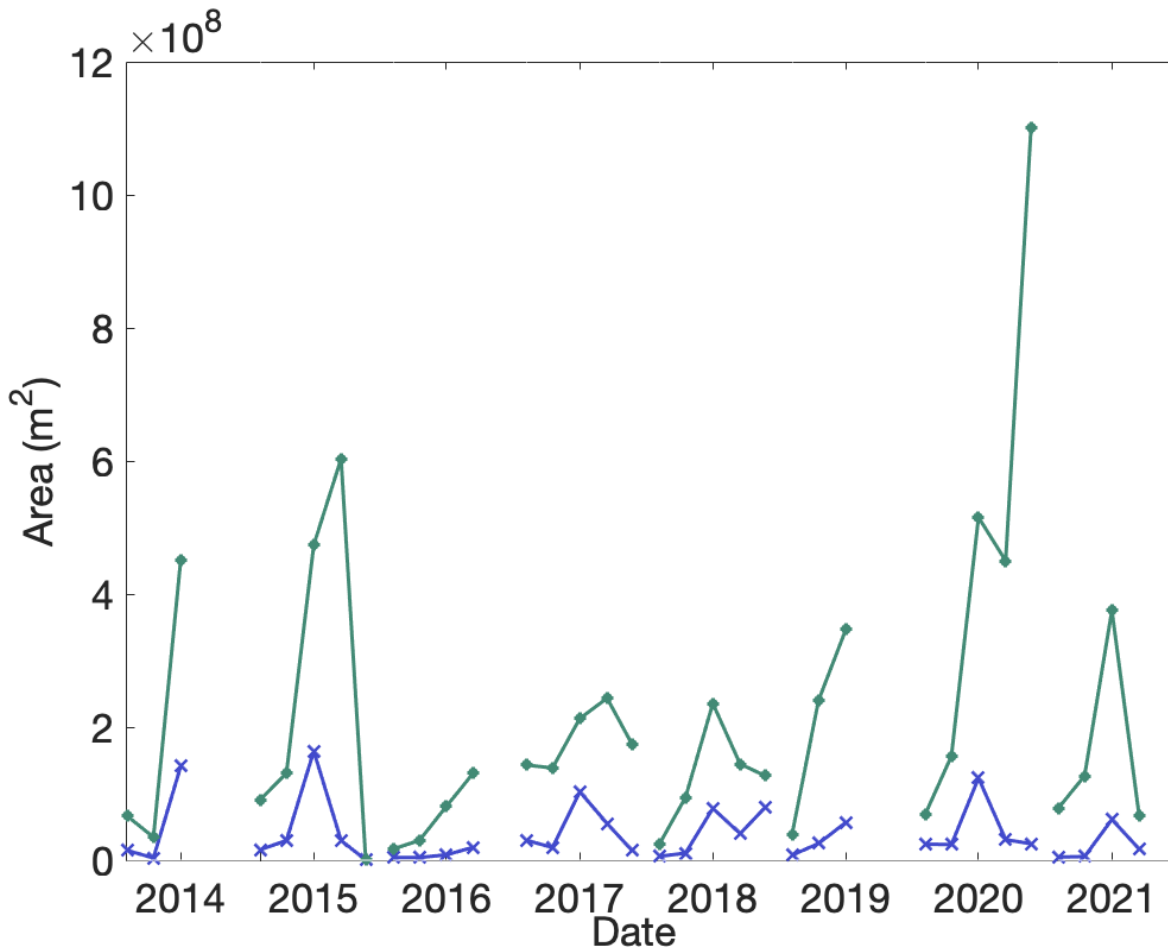


Nivlisen Ice Shelf



- 40% of the size of Nivlisen
- From 2013-2021
 - 1000 km² of surface meltwater (slush and ponded).
 - 1% **ponded water** only.
 - 42% **slush** only
 - 57% **both** slush and ponded water.
- Maximum melt extent covers 35% of the total ice shelf area.

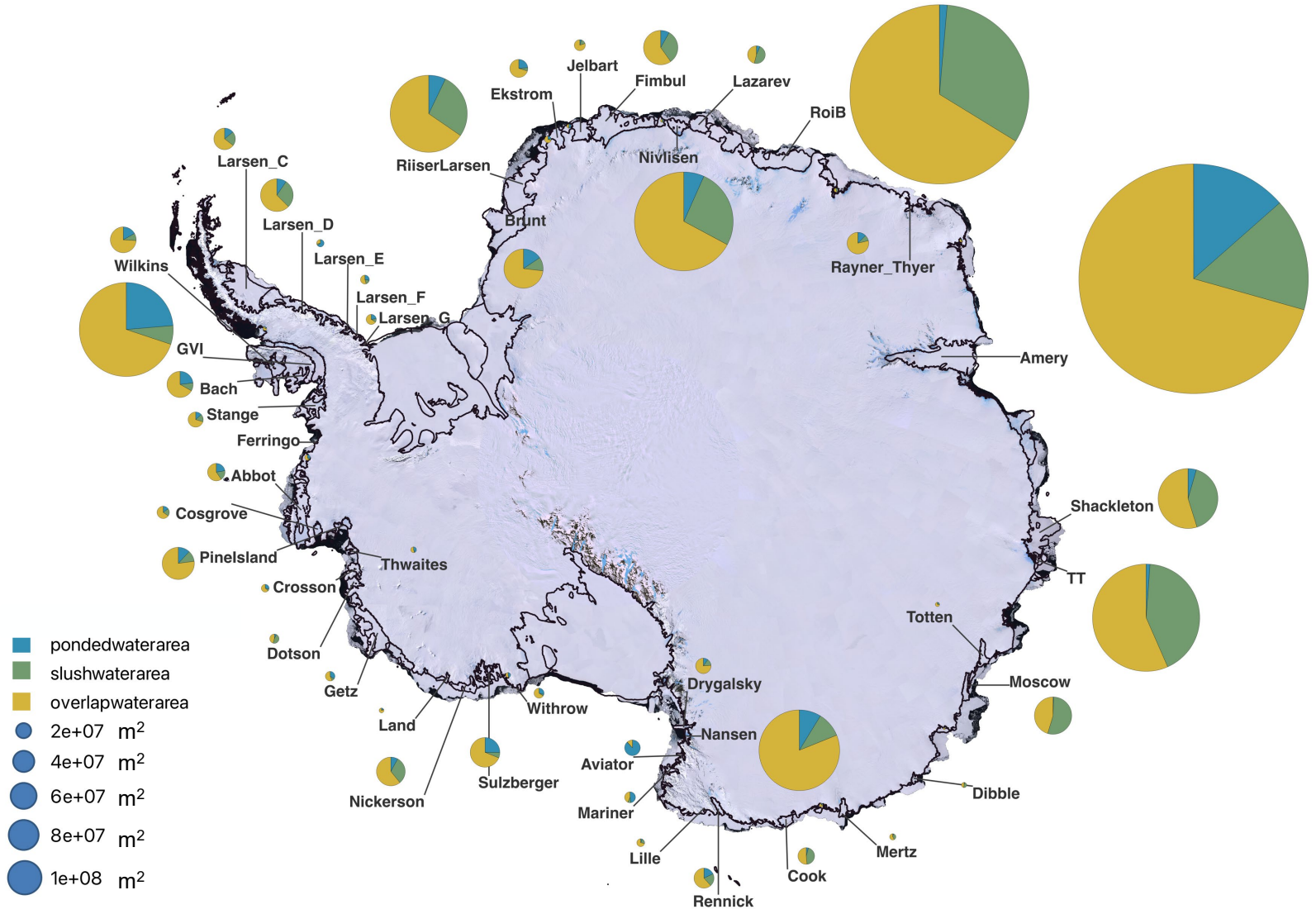




Legend: ■ Pondered Water ■ Slush

Conclusions

- We have an established method to map all surface meltwater (slush and ponded water) on a pan-Antarctic scale.
- This has been applied to the full Landsat 8 record
- Future work will extend the dataset to include Landsat 7 scenes, extending our record back to 2000.
- & trends on individual and regional scales will be investigated.



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