

## Postdoc Research

# Ocean Color Remote Sensing of Sea Surface Glacial Meltwater on the Antarctic Peninsula Shelf

Author: **B. Jack Pan**, JPL Postdoctoral Fellow (329F Water & Ecosystems)

Advisor: **Michelle M. Gierach** (329F Water & Ecosystems)

Collaborators: Michael P. Meredith, Rick A. Reynolds, Oscar Schofield, Alexander J. Orona

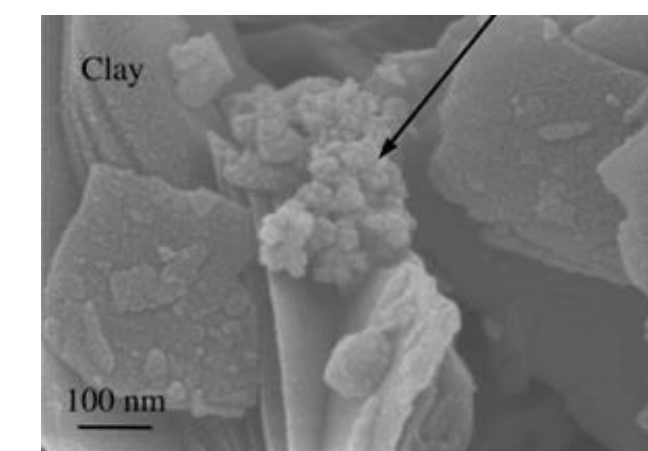
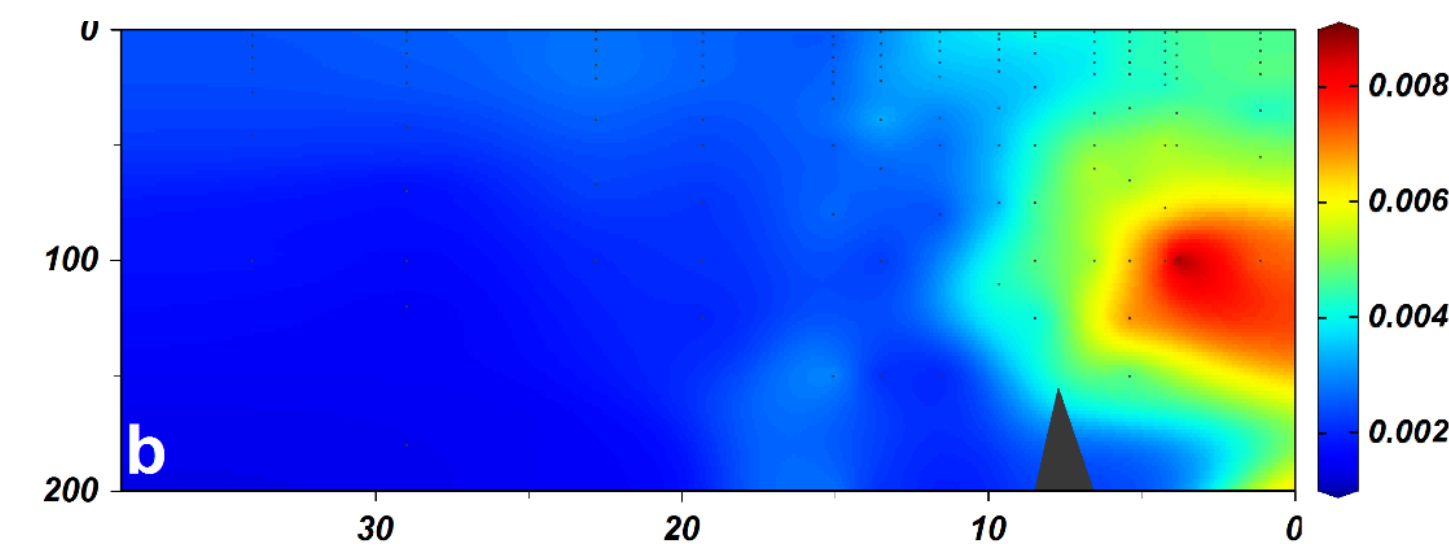
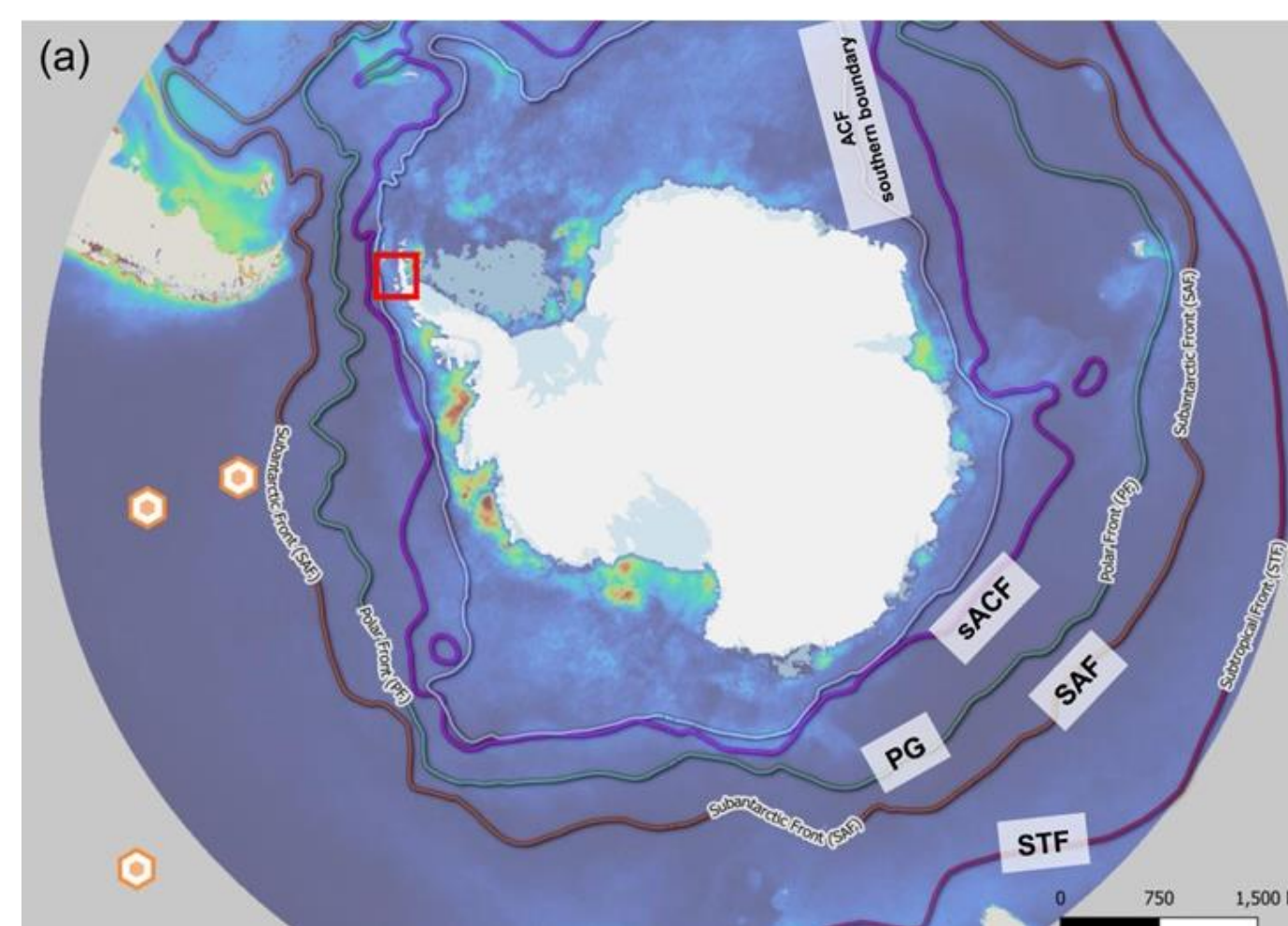
## Background

- **Sea surface glacial meltwater (SSGM)** is important to polar ecology due to buoyancy-induced stratification, creating optimal light condition for phytoplankton growth. SSGM is a proxy for upwelled nutrient-rich deep water, and SSGM itself is also a source of dissolved iron
- SSGM has been found to have an optical signal due to its embedded nanoparticles
- SSGM is a prominent physical feature in the **Western Antarctic Peninsula (WAP)** surface ocean – one of the most productive polar regions
- WAP and the broader Western Antarctica host several important polar fisheries and tourism industries (attracted by megafauna) which rely on primary production
- However, SSGM measurement is limited and mostly restricted to shipboard sampling, with stable oxygen isotope ( $\delta^{18}\text{O}$ ) measurement as one of the most cost-effective methods

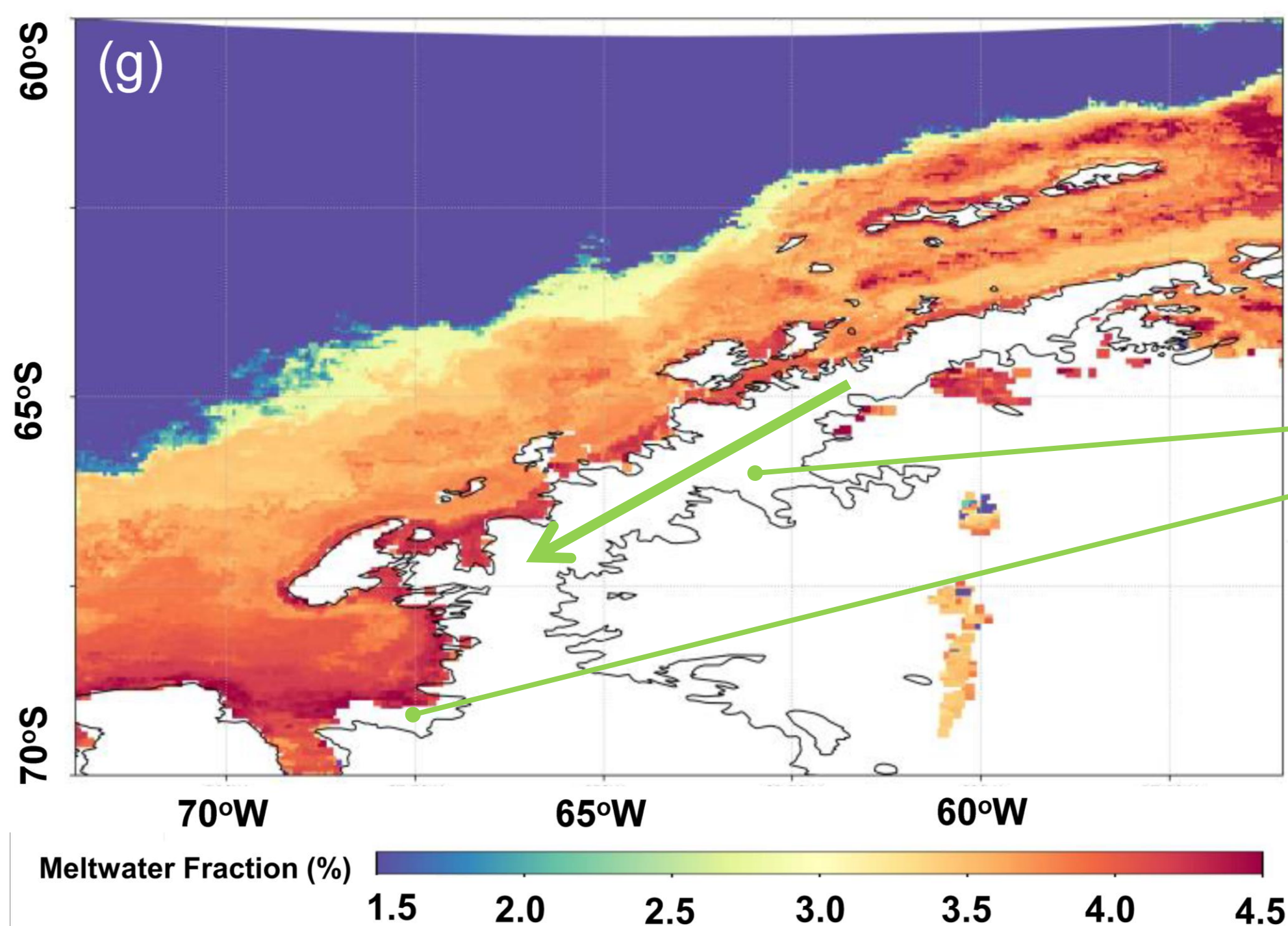
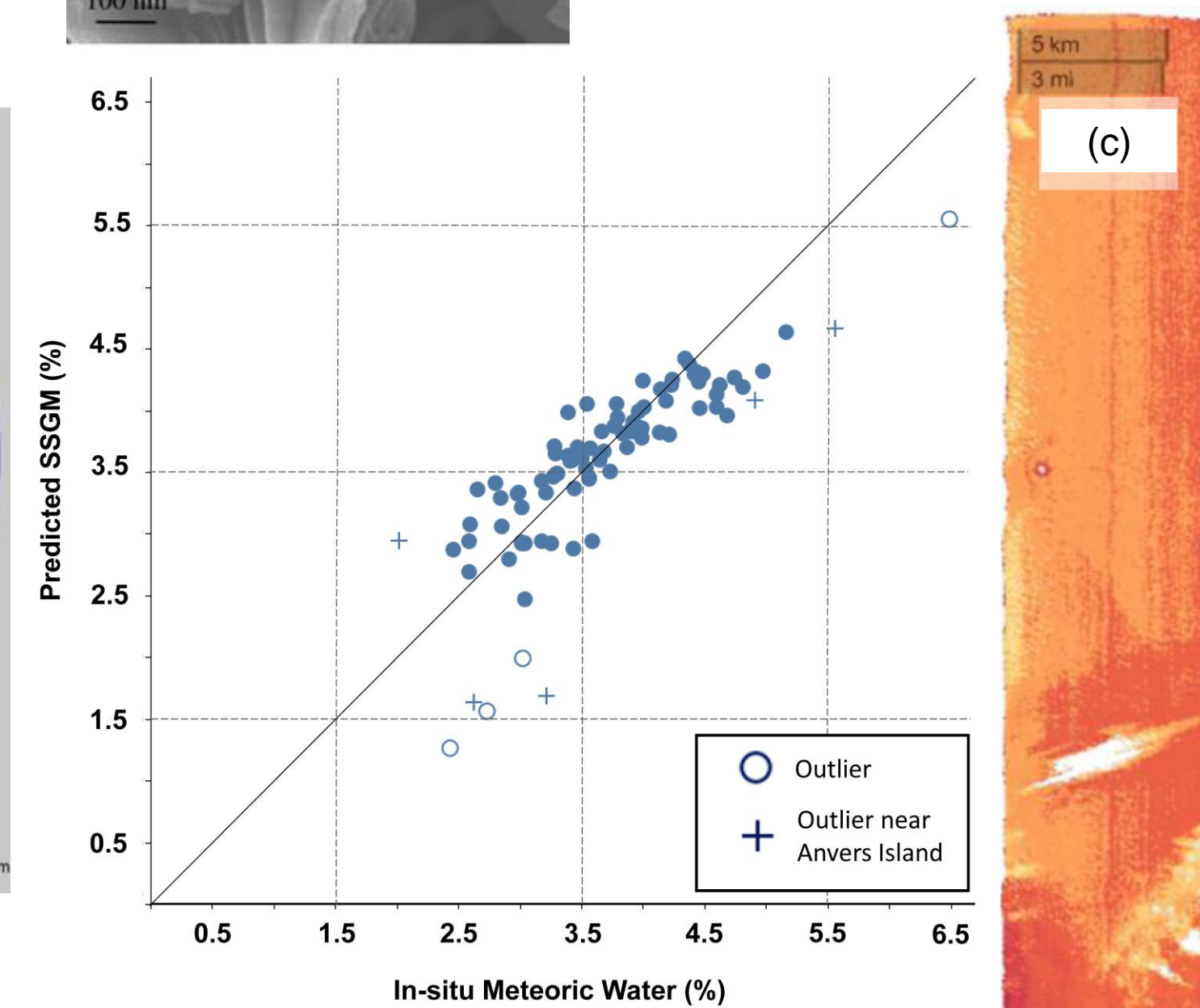
## Objectives

- We present the development of a first-generation model to map SSGM
- Applying the model to visualize SSGM fraction in the broader WAP region

Left: (a) An overview of the Southern Ocean and major currents and fronts. Background color indicates chl-a climatology (2002-2016); Right: MODIS-derived SSGM vs. in-situ values based on  $\delta^{18}\text{O}$  samples.



Top: particular backscattering coefficient at 420nm near glaciers in an Antarctic fjord  
Left: electron microscopy of nanoparticles from glacial meltwater



## Approach and Results

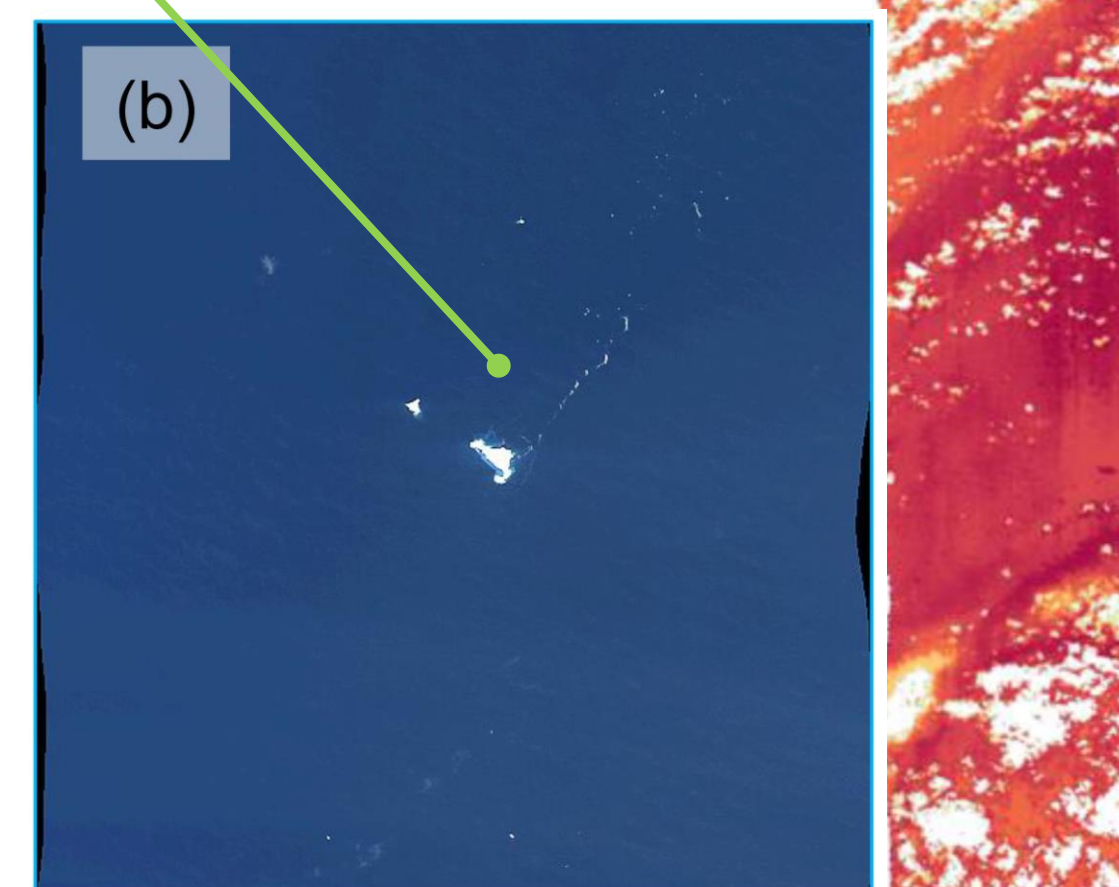
- We describe a machine learning methodology used to develop this SSGM algorithm using MODIS-Aqua data
- Confirmation with existing field data from diverse field campaigns in the WAP covering a range of spatial and temporal scales

### MODIS-A, February Climatology 2010-2020

- Southward flow of the Antarctic Peninsula Coastal Current
- Accumulation of meltwater in Marguerite Bay + glacial drainage near Alexander Island

### PRISM Airborne Ocean Color, 01/25/2016

- Icebergs observed in both enhanced RGB and derived glacial meltwater fraction. Right: entire scene average SSGM: 3.94%;  
Left: areas around the icebergs: 6.49%.



## Significance of Results/Benefits to NASA/JPL

- Provide a novel method to observe sea surface glacial meltwater which is significant to polar ecosystems
- Indicate appropriate spatial scale and residence time for future missions and field campaigns to observe SSGM
- Highly relevant to future NASA ocean color missions such as PACE and SBG and expand these missions' potential use cases for polar remote sensing

## Future Work

- Applying this novel data product to study the impact of glacial meltwater on ecosystem dynamics over extended spatial and temporal scales that were not available previously
- Second-generation algorithm for circumpolar applications

## Publications and Acknowledgements:

Pan, B.J., Gierach, M.M., Meredith, M.P., Reynolds, R.A., Schofield, O. and Orona, A.J., 2023. Remote sensing of sea surface glacial meltwater on the Antarctic Peninsula shelf. *Frontiers in Marine Science*, 10.

## Author Contact Information:

+1 (626) 679-0806 | [jackpan@jpl.nasa.gov](mailto:jackpan@jpl.nasa.gov)