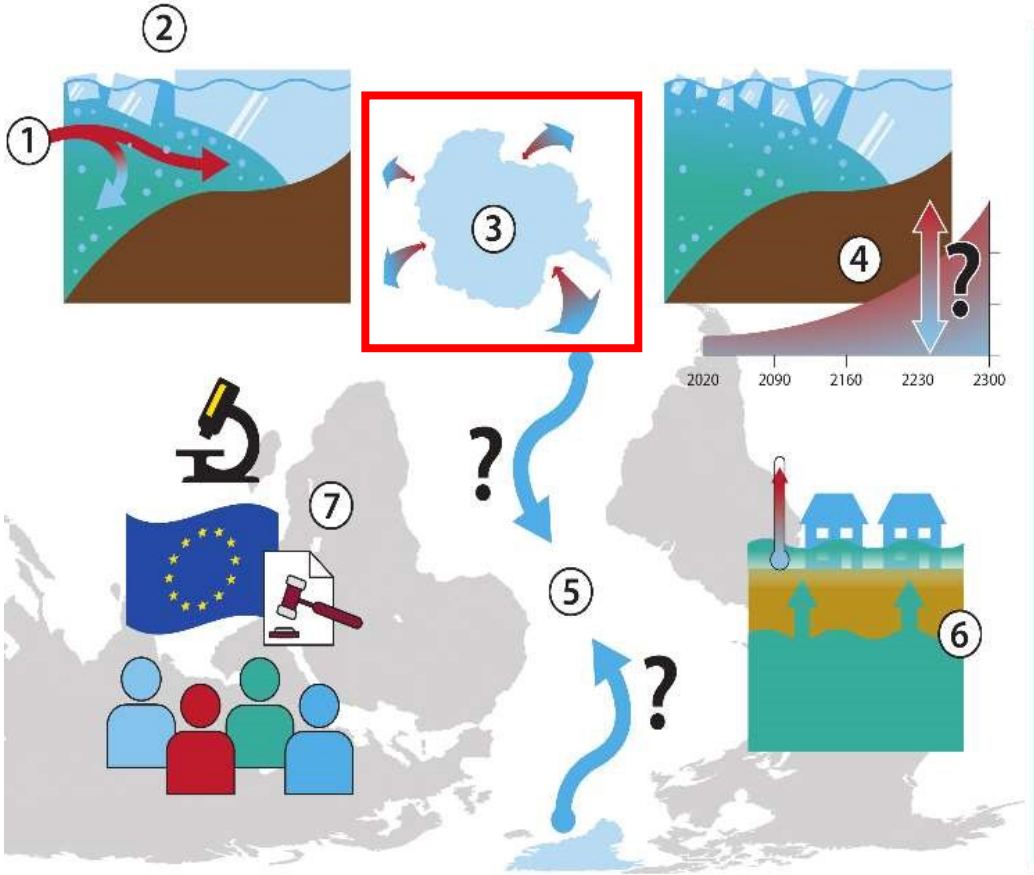
Work Package 3

ANTARCTIC ICE-SHEET MODELLING AND FRESHWATER FLUXES



1. Ocean processes around Antarctica (WP1)
2. Antarctic ice sheet-ocean interactions (WP2)
3. Antarctic ice sheet modelling and freshwater fluxes (WP3)
4. Future fluxes and stability of Antarctic ice sheet (WP4)
5. Ice sheet impact on global ocean circulation (WP5)
6. Ice sheet-ocean-climate impacts and tipping points (WP6)
7. Scientifically and socially relevant impacts and dissemination (WP7-9)

CNRS
DMI
UKRI-BAS
UNN
UU

Objectives: WP3

O3: Improve representation of AIS dynamics and integrate this knowledge into ice sheet and coupled ice sheet – climate models

Task 3.1 EO: contribution of continental scale ice dynamics processes to freshwater fluxes. Lead: CNRS (G.Durand, partners: UU (M.van den Broeke), UKRI-BAS (R. Arthern

Task 3.2 Contribution of surface mass budget and ice shelf processes
Lead: DMI (R.Mottram), partners: UU (M.van den Broeke).

Task 3.3 Subglacial fresh-water discharge from the AIS into the Southern Ocean.
Lead: UNN (H.Gudmundsson).

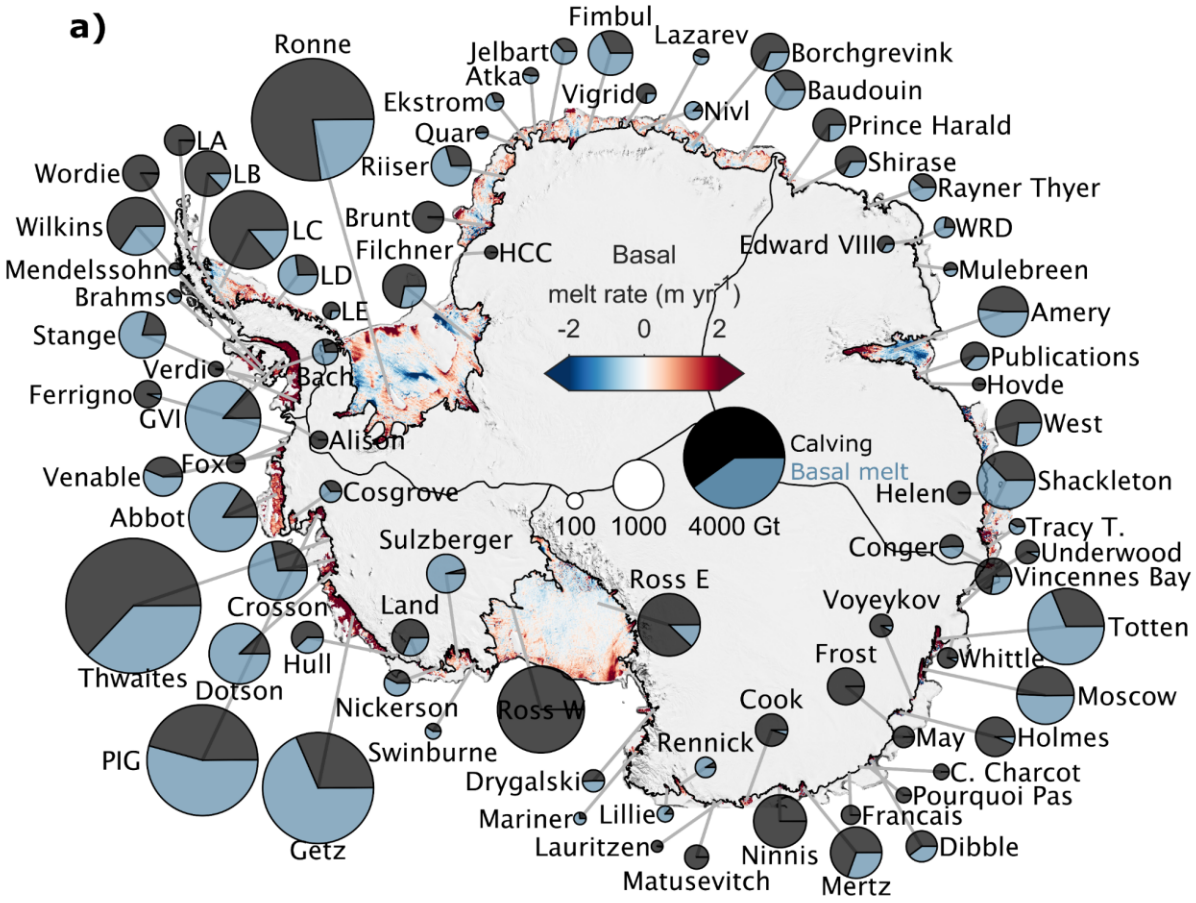
Task 3.4 Developing methodologies for hindcasting from ice-sheet models.
Lead: UKRI-BAS (R. Arthern).

Milestones and Deliverables this year:

MS6 Joint EO workshop with ESA – Copenhagen, May 2023, report submitted, article in preparation for BAMS

MS5 – fast track delivery of ice dynamic fluxes

MS 7- up and coming: Basal melt fluxes



Task 3.2 Contribution of surface mass budget and ice shelf processes

- Ongoing work to set up and run models - final delivery due in 6 months

D3.2	Freshwater fluxes from surface mass budget and sub-shelf melt	WP3	1 - DMI	R — Document, report	PU - Public	18

Task 3.4
WP3 Ensemble Kalman Filter with WAVI

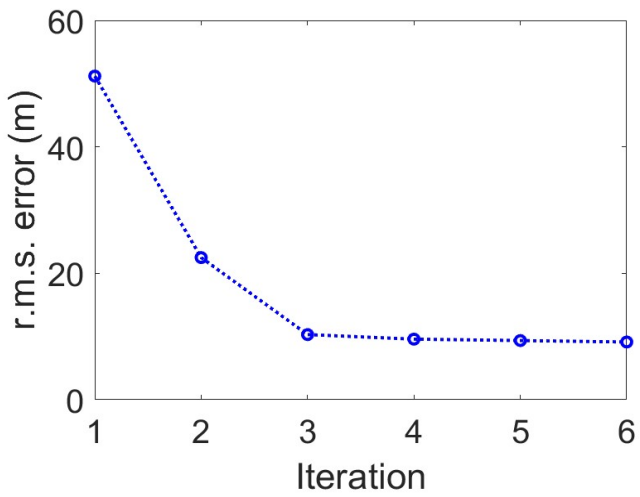
We combine

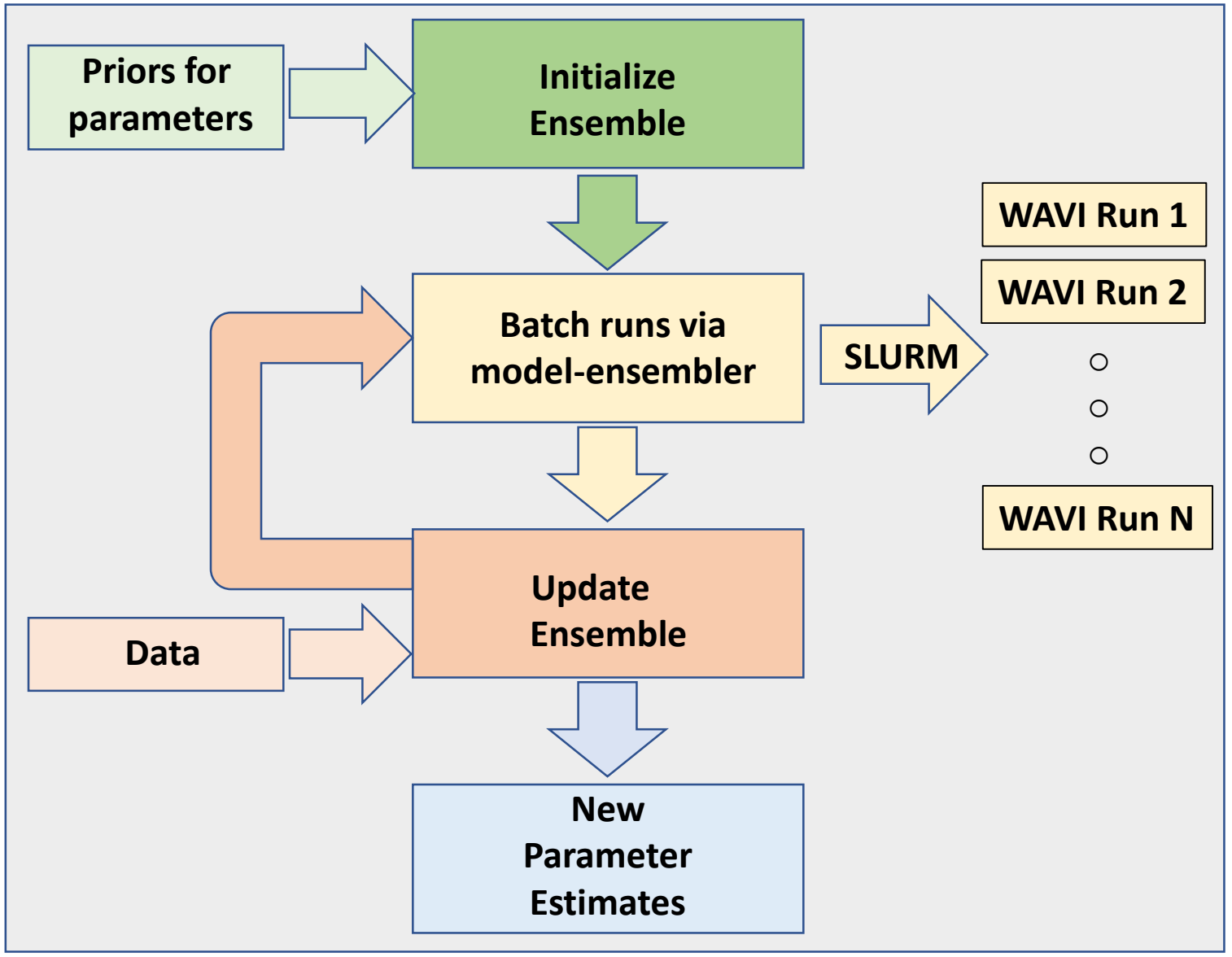
EnsembleKalmanProcesses.jl
A Julia package that implements the Ensemble Kalman Filter

model-ensembler
A tool for managing processes on a SLURM cluster

WAVI.jl
An ice sheet model

A si





Postdoc recruited. David Bett will work on Ocean:Ice following on from his work on PROTECT.

Questions?

Website: https://ocean-ice.eu/

Twitter: https://twitter.com/OCEANICE_EU

Mastodon: oceaniceeu@fediscience.org

Facebook: https://www.facebook.com/OCEANICEEU

OCEAN:ICE is co-funded by the European Union, Horizon Europe Funding Programme for research and innovation under grant agreement Nr. 101060452 and by UK Research and Innovation

WP 3 Workshop

Ice shelf mass balance observations : toward a spatially and timely resolved dataset for modelling the future evolution of Antarctica

J.B Barré[1], R. Millan[1], F. Moncada[1,2], J. Bolibar[2], P. Mathiot[1], G. Durand[1], N. Jourdain[1]

1 - Université Grenoble Alpes, CNRS, IRD, INP, 38400, Grenoble, Isère, France
2 - TU Delft, 2600 AA Delft, The Netherlands

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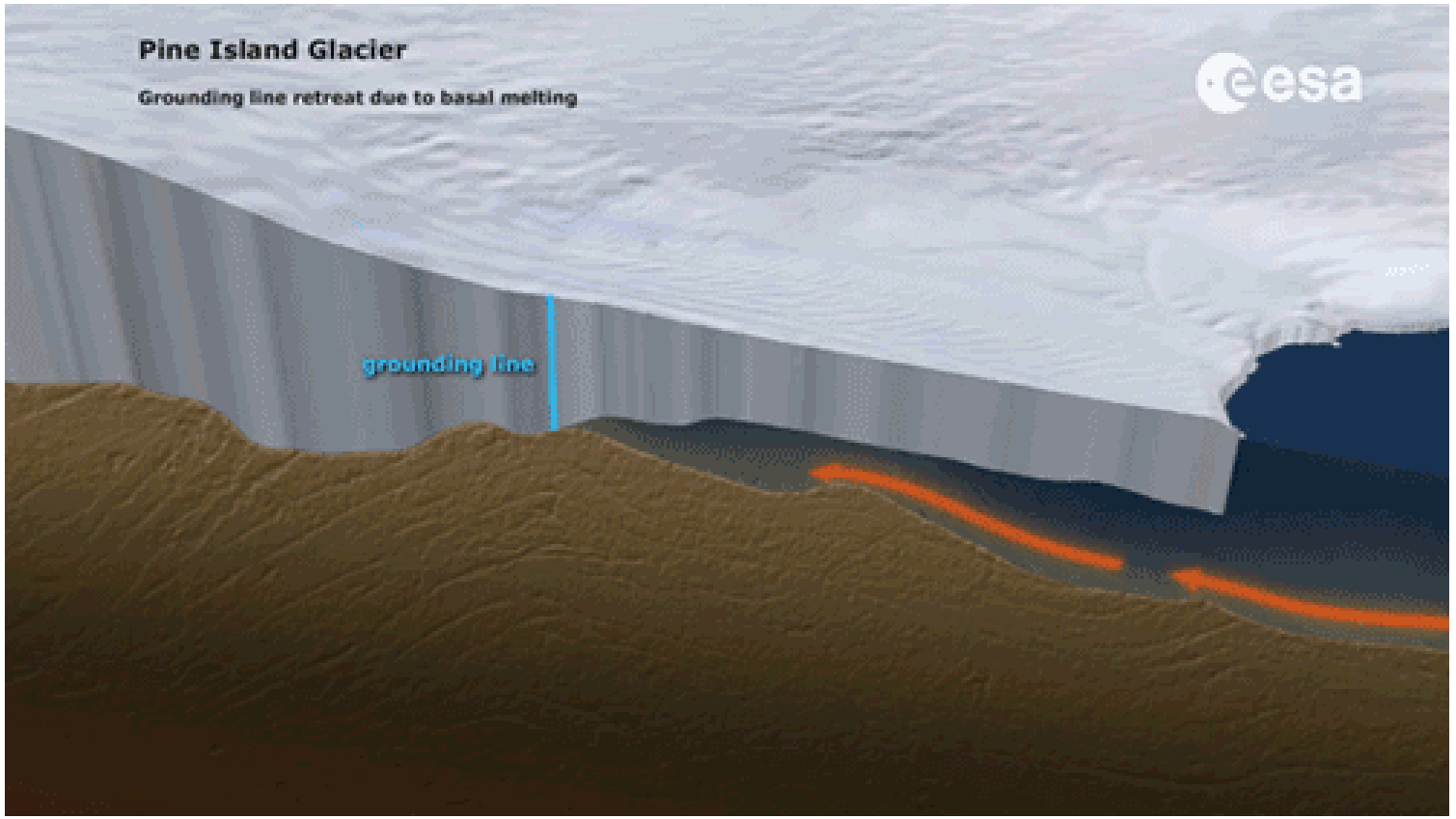
romain.millan@univ-genoble-alpes.fr

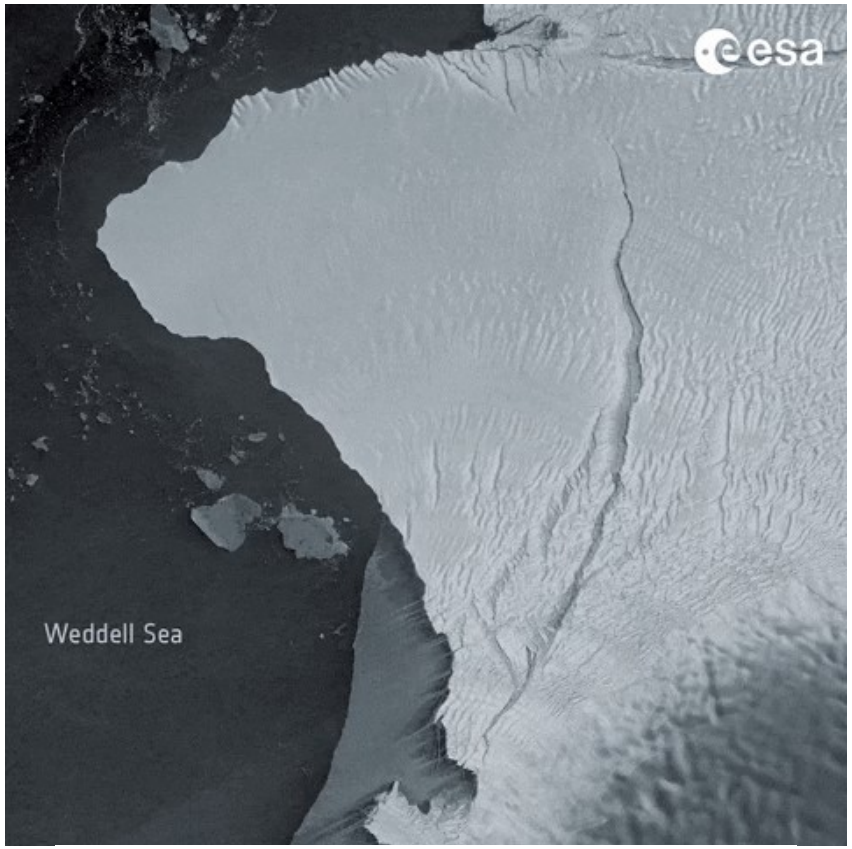
Copenhagen. 23 May 2023

Ice shelf dynamic mass losses

Ice Shelf Basal Melting



Ice Shelf Calving



A81 iceberg breaking away from the Brunt Ice Shelf.

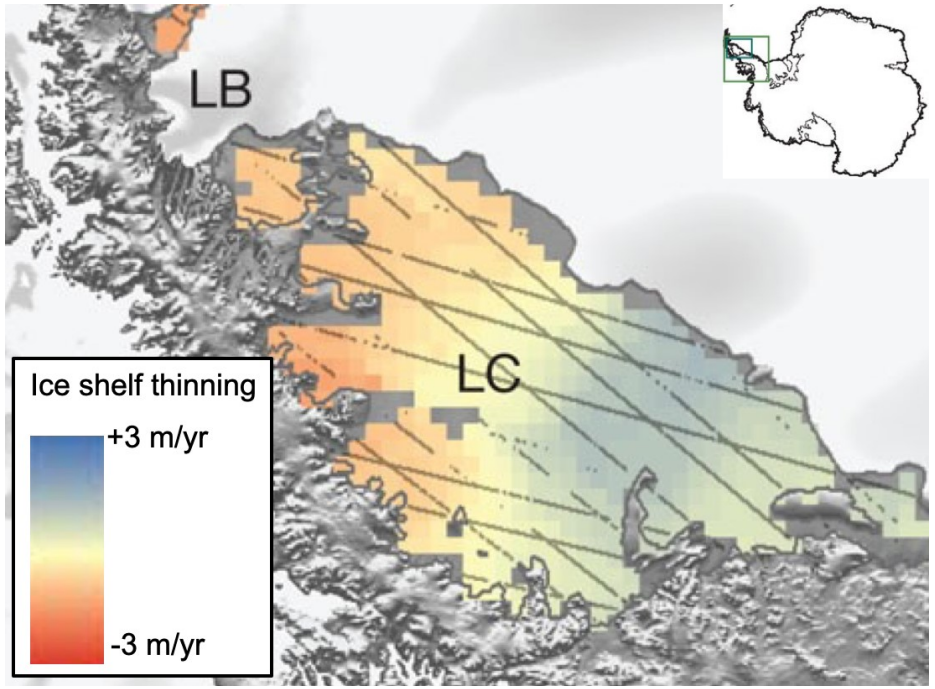
January 2023 - Copernicus Sentinel data (2021-23), processed by ESA

Ice shelf basal melting: Methods

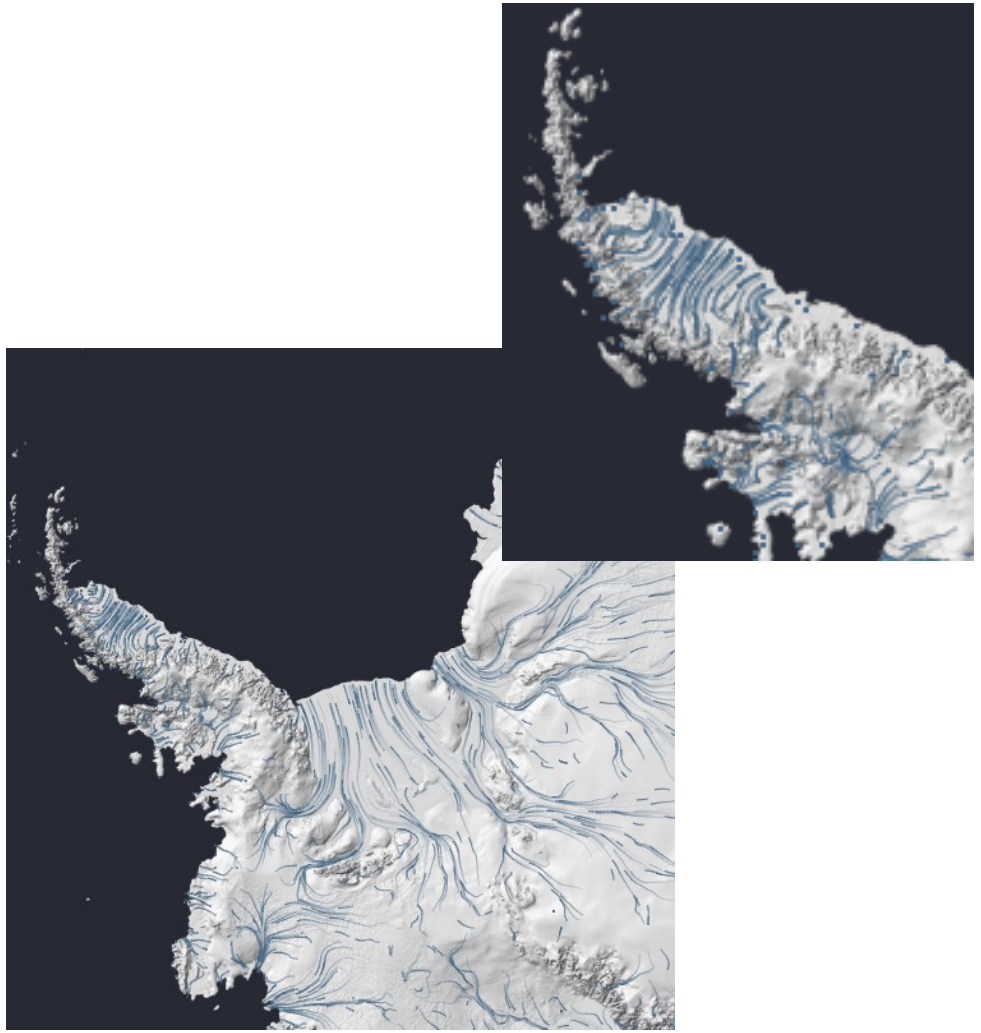
Ice flux divergence Firn air content

$$\frac{Dh}{Dt} = \frac{(\rho_w - \rho_i)}{\rho_w}\left(\frac{M_s}{\rho_i} - H_i \nabla . v - w_b\right) + \frac{Dh_{air}}{Dt}$$

Thickness changes Changes in SMB Basal melting rates

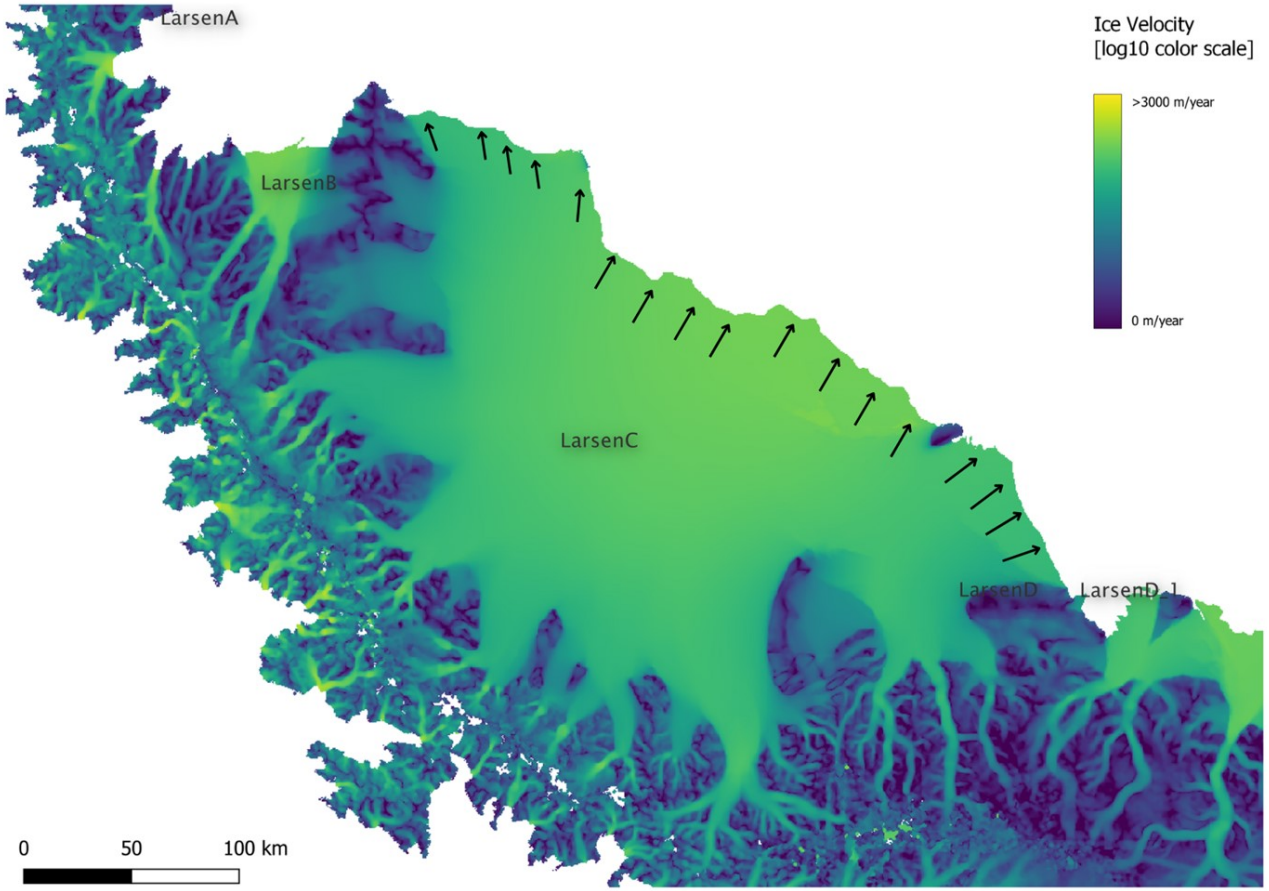


Pritchard et al., 2012



ige-vis.univ-grenoble-alpes.fr/antarctica/index.html

Ice shelf calving: Methods



MEaSUREs InSAR-Based Antarctica Ice Velocity Map, Version 2

Mass budget equation

Basal melt — Grounding line flux

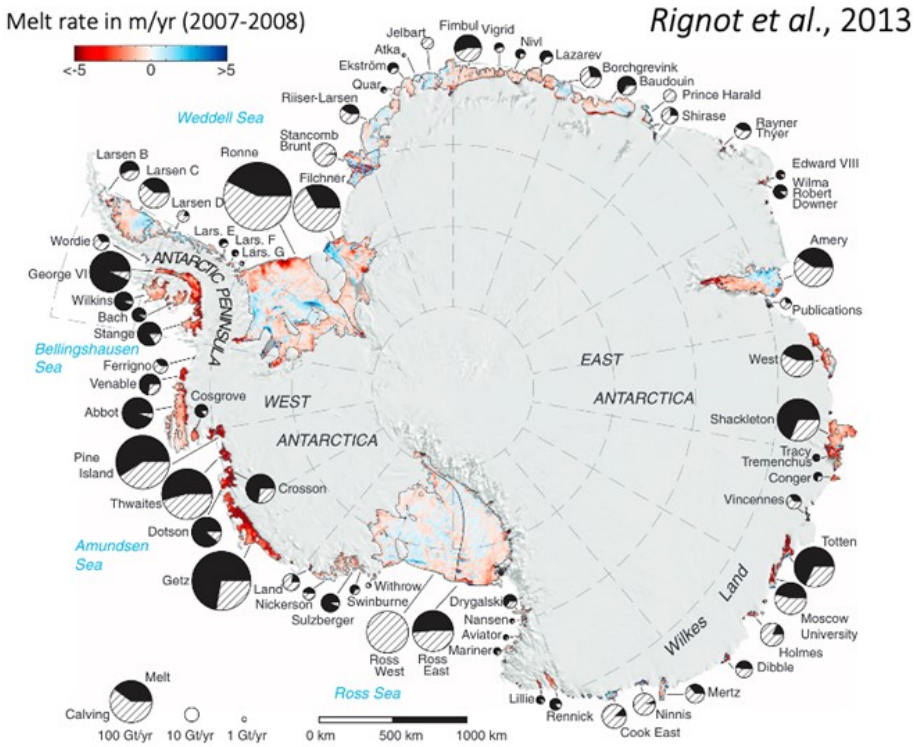
$$dV = BMB + SMB + GLF - CF$$

Volume change — Surface mass balance — Calving flux

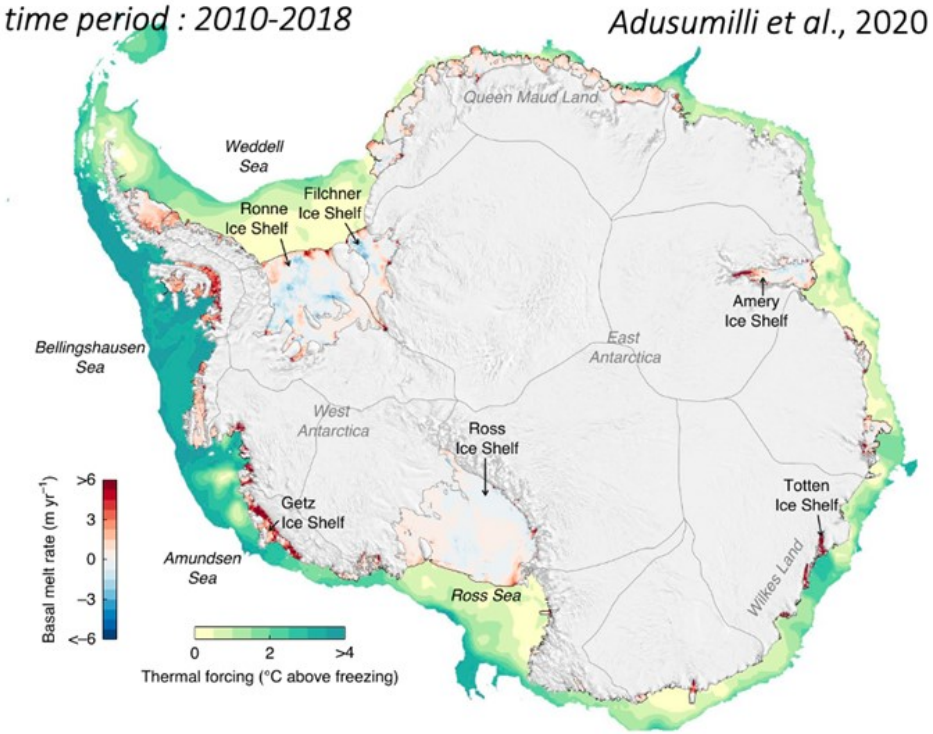
Front line gate

(ice thickness, surface flow velocity)

Ice shelf basal melting and calving: state of the art



- Grid resolution 10x10 km
- Time period 2007-2008



- Average basal melting 2010-2018 in Lagrangian approach (500x500 m)
- Time series 1994-2018 (Eulerian) with grid size 10x10 km

Others: *Depoorter et al.*, 2013; *Pritchard et al.*, 2012

Ice shelf basal melting and calving : new datasets

Article

Antarctic calving loss rivals ice-shelf thinning

https://doi.org/10.1038/s41586-022-05037-w Chad A. Greene[1✉], Alex S. Gardner[1], Nicole-Jeanne Schlegel[1] & Alexander D. Fraser[2]

https://doi.org/10.5194/egusphere-2022-1128
Preprint. Discussion started: 1 November 2022

EGUsphere

Widespread slowdown in thinning rates of West Antarctic Ice Shelves

Fernando S. Paolo[1], Alex S. Gardner[1], Chad A. Greene[1], Johan N. Nilsson[1], Michael P. Schodlok[1], Nicole-Jeanne Schlegel[1], Helen A. Fricker[2]

	Calving flux Greene et al., 2022	**Basal melt** Paolo et al., 2022 (submitted)
Grid Resolution	240 m (frontline) or integrated mass changes	2 x 2 km
Time series	1997, 2000 to 2021(yearly)	1992 to 2017 (bi-yearly)
Extent	Antarctica 181 ice shelves	Antarctica 181 ice shelves
Data	open access (MIT licence) https://github.com/chadagreene/ice-shelf-geometry	open-access https://its-live.jpl.nasa.gov

Ice shelf basal melting and calving : new datasets


Article

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	https://github.com/chadagreene/ice-shelf-geometry	https://its-live.jpl.nasa.gov

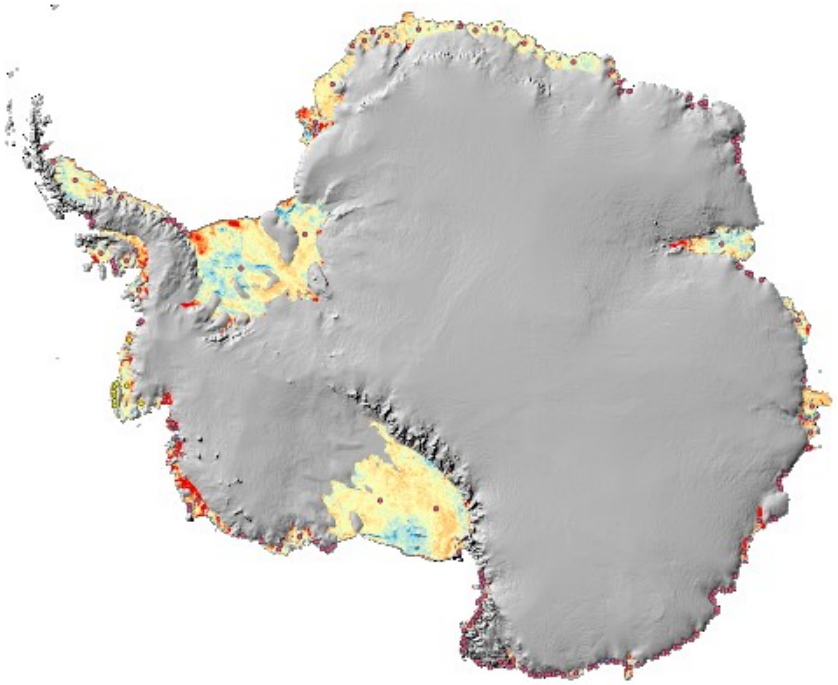
Goal

Provide latest freshwater fluxes estimates from iceberg calving and basal melting

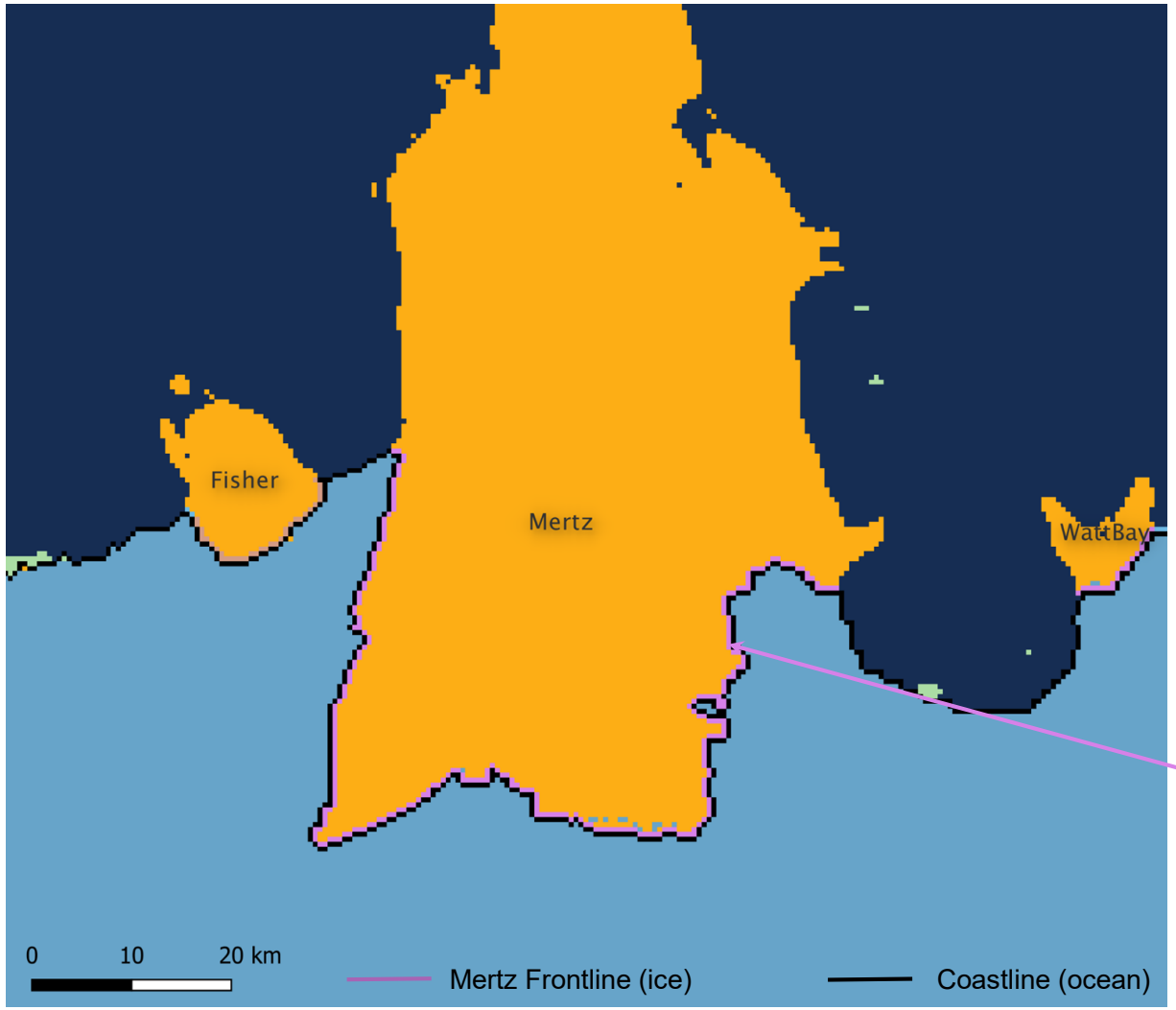
Goal: provide latest freshwater fluxes estimates from basal melting

Basal melt rates

- Use of the Paolo et al., 2023 paper based on altimetry data and Eulerian framework
- Calculation of yearly averages over the entire period of study
- Resampling on the BedMachine grid size and polar stereographic projection
- Calculation of integrated basal melting rates for each ice shelves (correct for pixel deformation in PS projection)



Goal: provide latest freshwater fluxes estimates from iceberg calving



Dataset

- Greene *et al.*,2022 : Integrated value of mass losses for each one of the 181 ice shelves.

Constraint

- frontlines need to be fixed for ocean models.

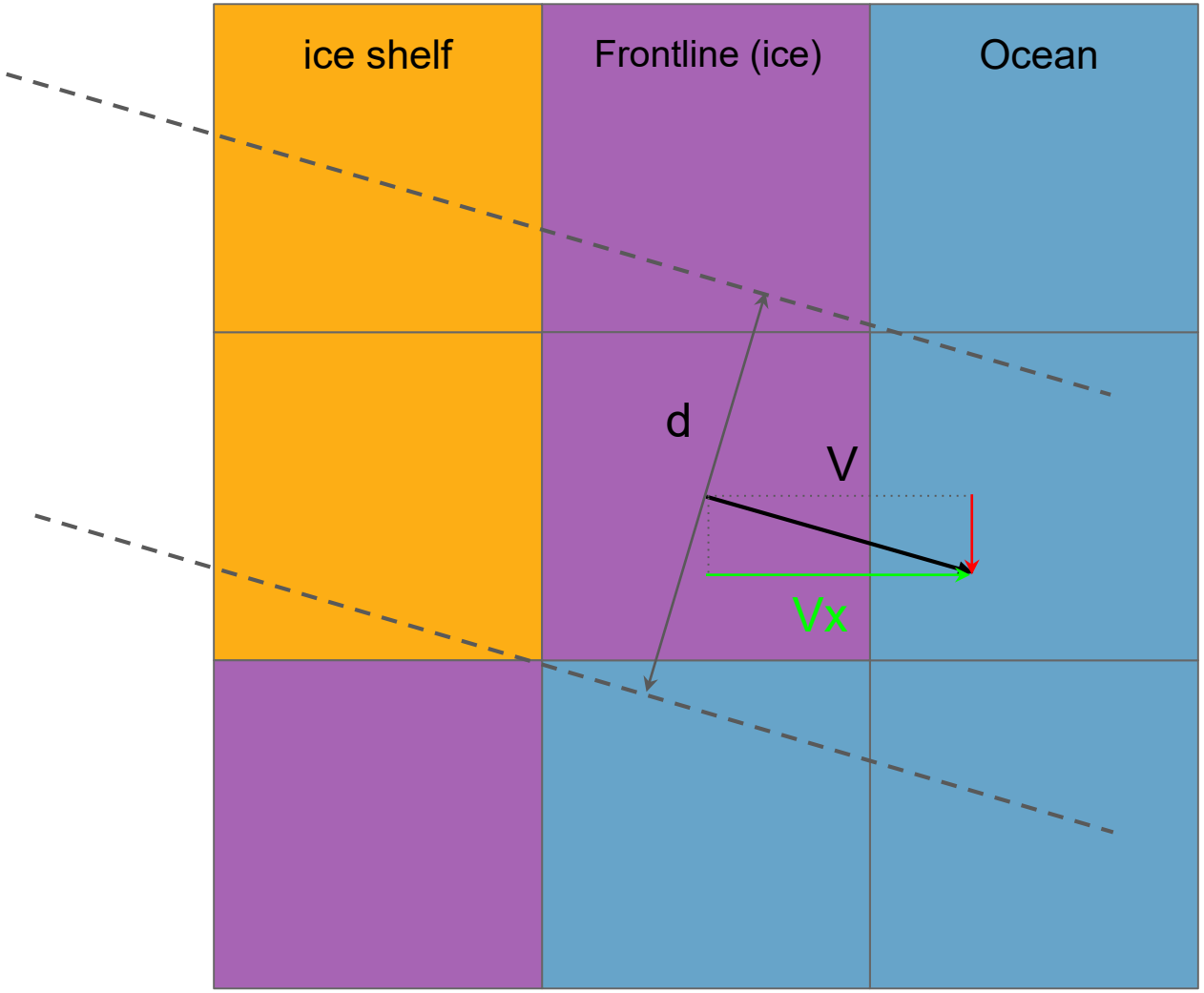
Frontlines database

- Delineate each front independently of the others using Bedmachine mask V3.

Ice shelves frontlines identified with BedMachine V3

Morlighem, M. (2022). MEaSUREs BedMachine Antarctica, Version 3

Goal: provide latest freshwater fluxes estimates from iceberg calving



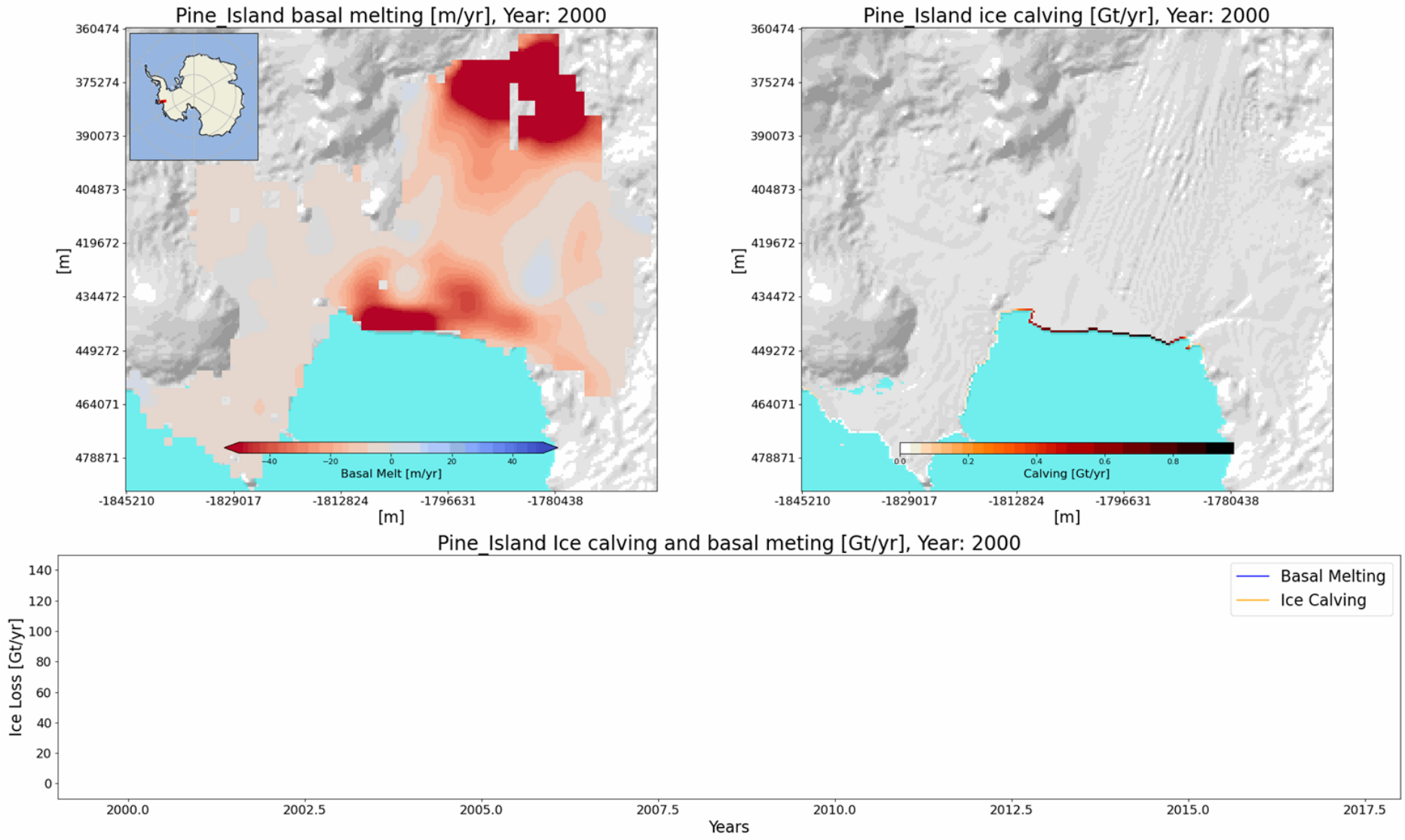
Frontline pixel surrounded by two ocean pixels

Spatialization of the calving fluxes along the frontlines

- For each pixel of the frontline:
  - spatialization coefficient [0,1] based on surface flow velocities,
  - applied this coefficient to the integrated yearly mass loss
- Consider only negative mass losses, *i.e.* calving events.

Results

Comparison of calving vs melting over the entire time period (2000 - 2017)



Results

Comparison of results over similar time periods and same ice shelves groups.

Period 2007-2008	**Rignot et al.,2013**	**Greene et al. ,2022**
Ice Calving [Gt/y]	1081±126	1032±37

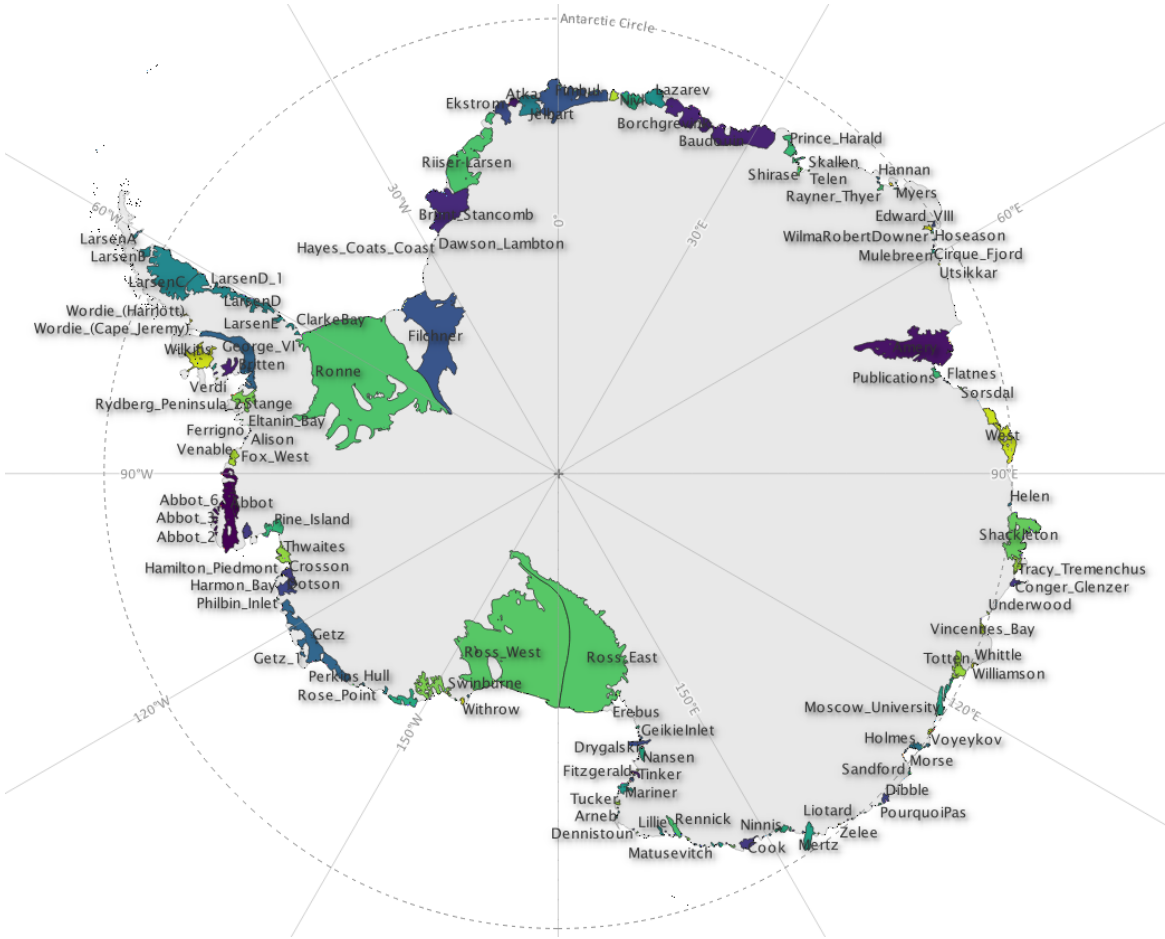
Period 2007-2008	**Rignot et al.,2013**	**Paulo et al., *review***
Basal Melting [Gt/y]	1310±418	1292±388

Period 1994-2017	**Adusumilli et al.,2020**	**Paulo et al., *review***
Basal Melting [Gt/y]	1250±150	968±290

Data products

- **Ice shelves vector file**:
  ice shelves layer (MEaSUREs) and calving data (Greene et al. 2022) merged into a file in *shp/gpkg* format.

- **Integrated basal melt/calving** over the same time period in *csv* format,
- **Spatialized basal melting and calving** in *netcdf* format.



Mouginot et al. (2017). **MEaSUREs Antarctic Boundaries** for IPY 2007-2009 from Satellite Radar, Version 2. Boulder, Colorado USA. NASA NSIDC

Calving front of the Astrolabe Glacier, 2007. B. Jourdain

Thank you for your attention