Ice shelves Basal Melting

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POLAR+ Ice Shelves

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SO-ICE

SO-ICE

Southern Ocean – Ice Shelf Interaction

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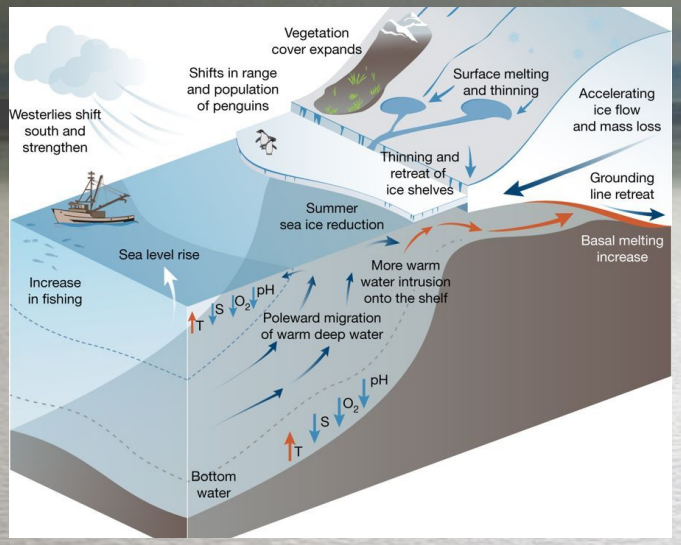
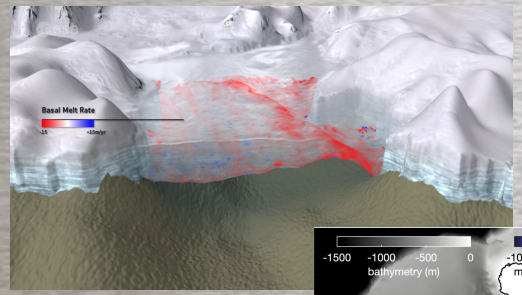
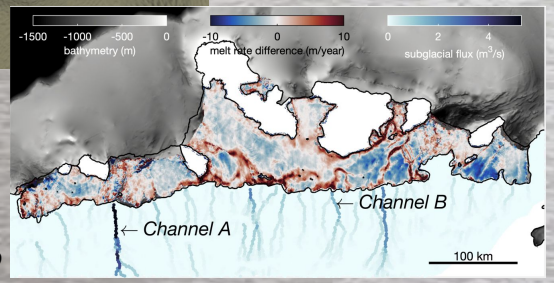
Ice shelves basal melting

Ice-ocean-atmosphere-sub-glacial interaction





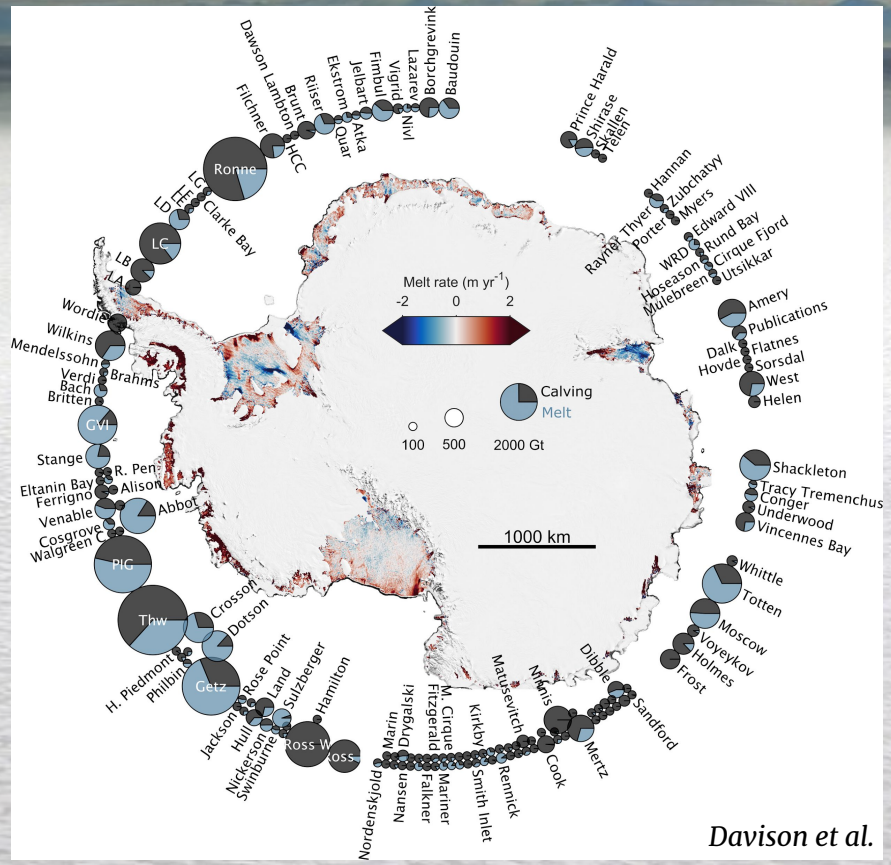
Basal melt rate "hotspots"



Gourmelen et al., 2017

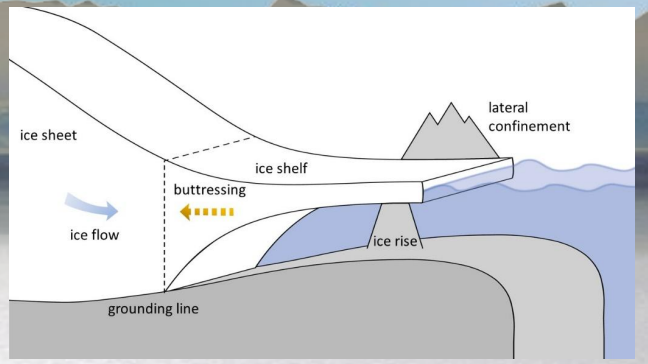
Wei et al., 2020

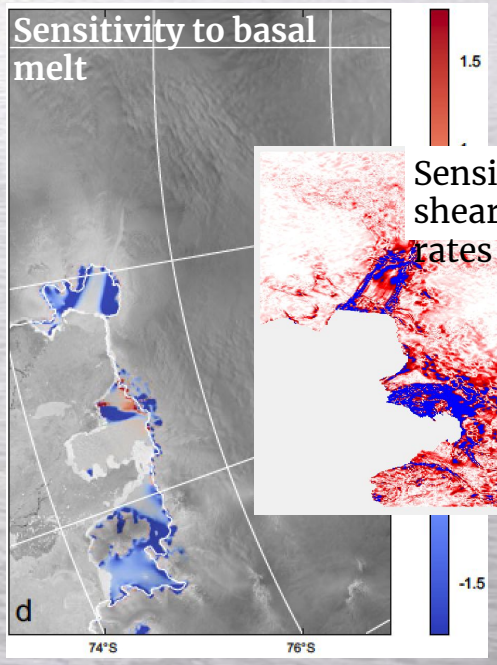
Ice shelves mass balance
Ice shelves fresh water budget



Davison et al.

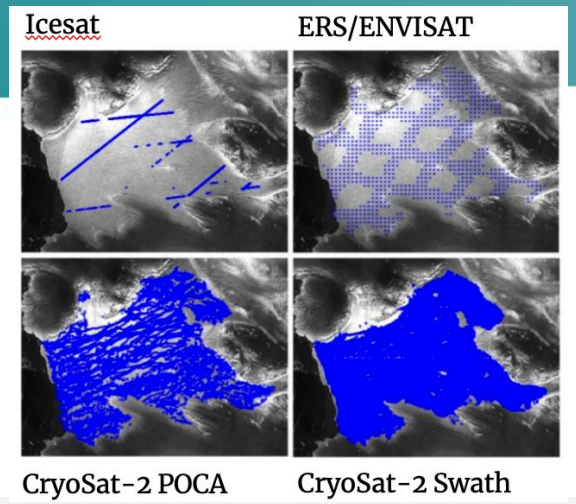
Impact on grounded ice





Morlighem et al., 2022

Datasets



Mass conservation:

$$\dot{m} = SMB - \left(\frac{dS}{dt} + \mathbf{u} \cdot \nabla S + S\nabla \cdot \mathbf{u}\right)$$

Basal melt rate | Thickness change | Advection | Divergence

Linear changes

- Linear changes over CryoSat-2 period (~11 years)
- Maps of ~1km pixels

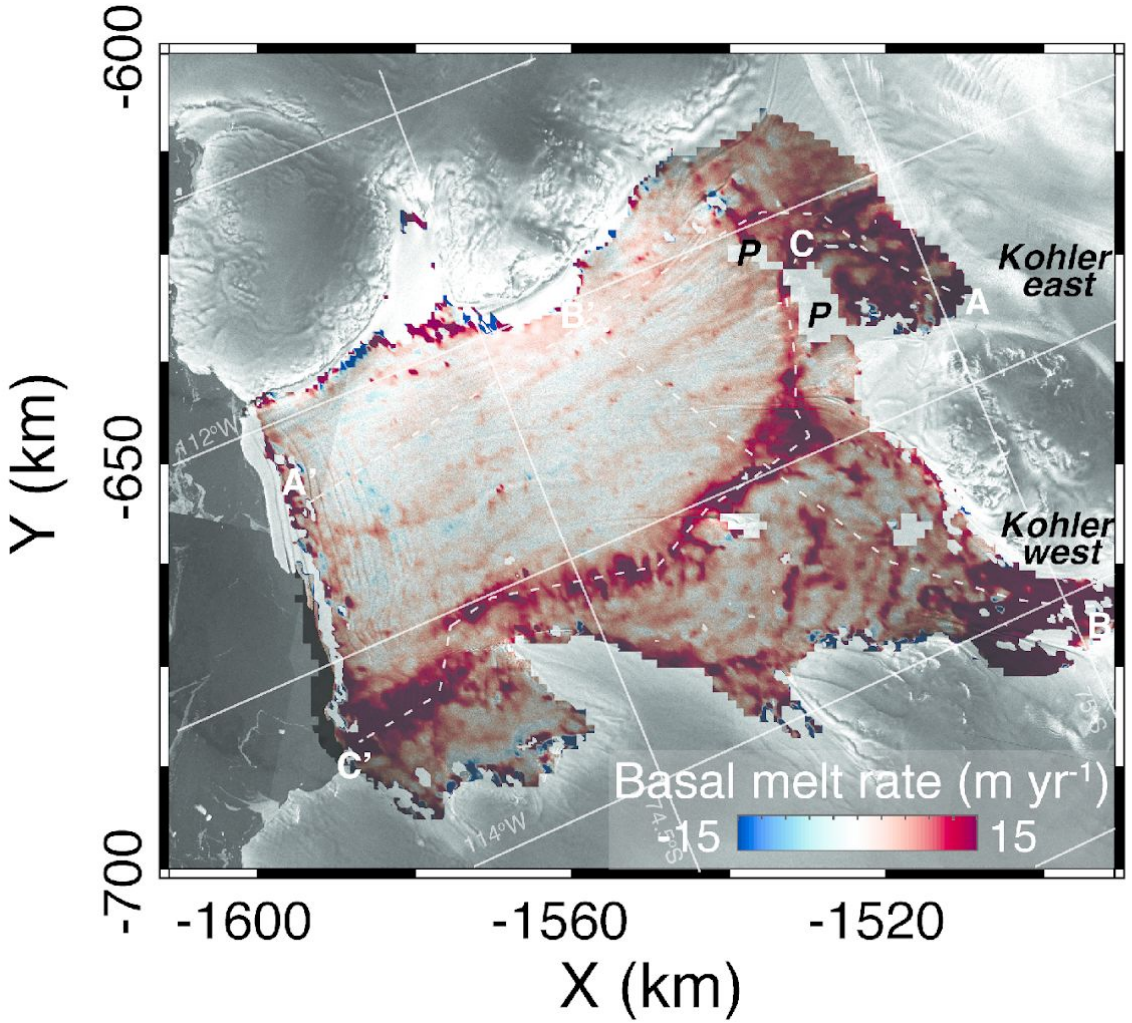
Time series

- 30 days temporal resolution
- Nominal ~1km spatial grid

Basal melting

$$\dot{m} = SMB - \left(\frac{dS_{\text{Lag}}}{dt} + S\nabla \cdot \mathbf{u}\right)$$

- Elevation change
- Ice thickness
- Ice velocity
- Surface Mass Balance and firn air content
- Hydrostatic equilibrium assumption



Time series of basal melt

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Basal melt anomalies:

Anomalies are relative to the 2010–2021 mean

Basal melt anomaly

SMB anomaly

Ice and ocean density

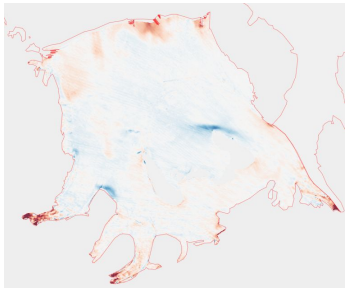
Elevation change anomaly

Firn air content anomaly

$$w_{b,anom}(t) = \frac{M_{s,anom}}{\rho_i} - \frac{\rho_w}{\rho_w - \rho_i}\left(\frac{dh_{anom}}{dt} - \frac{dh_{air,anom}}{dt}\right)$$

Basal melt time series:

Rates from basal melt map



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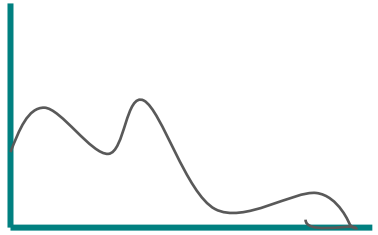
Basal melt anomaly



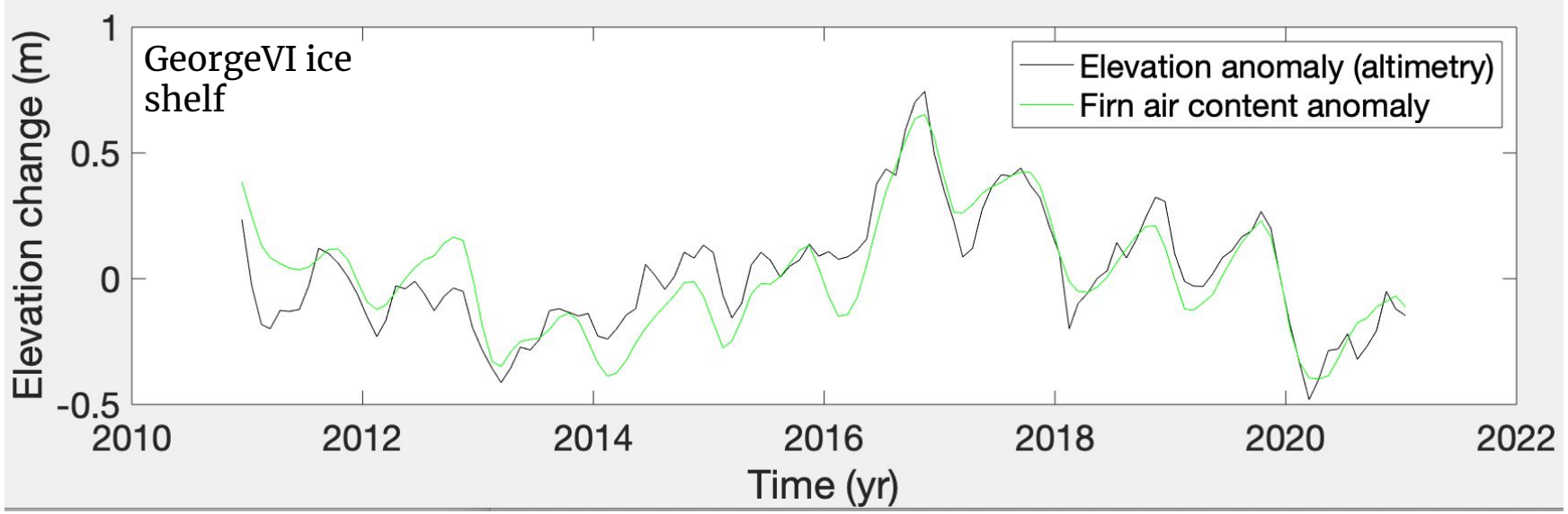
Time series of basal melt

Basal melt anomalies:

Anomalies are relative to the 2010–2021 mean

Basal melt anomaly | SMB anomaly | Ice and ocean density | Elevation change anomaly | Firn air content anomaly

$$w_{b,anom}(t) = \frac{M_{s,anom}}{\rho_i} - \frac{\rho_w}{\rho_w - \rho_i}\left(\frac{dh_{anom}}{dt} - \frac{dh_{air,anom}}{dt}\right)$$



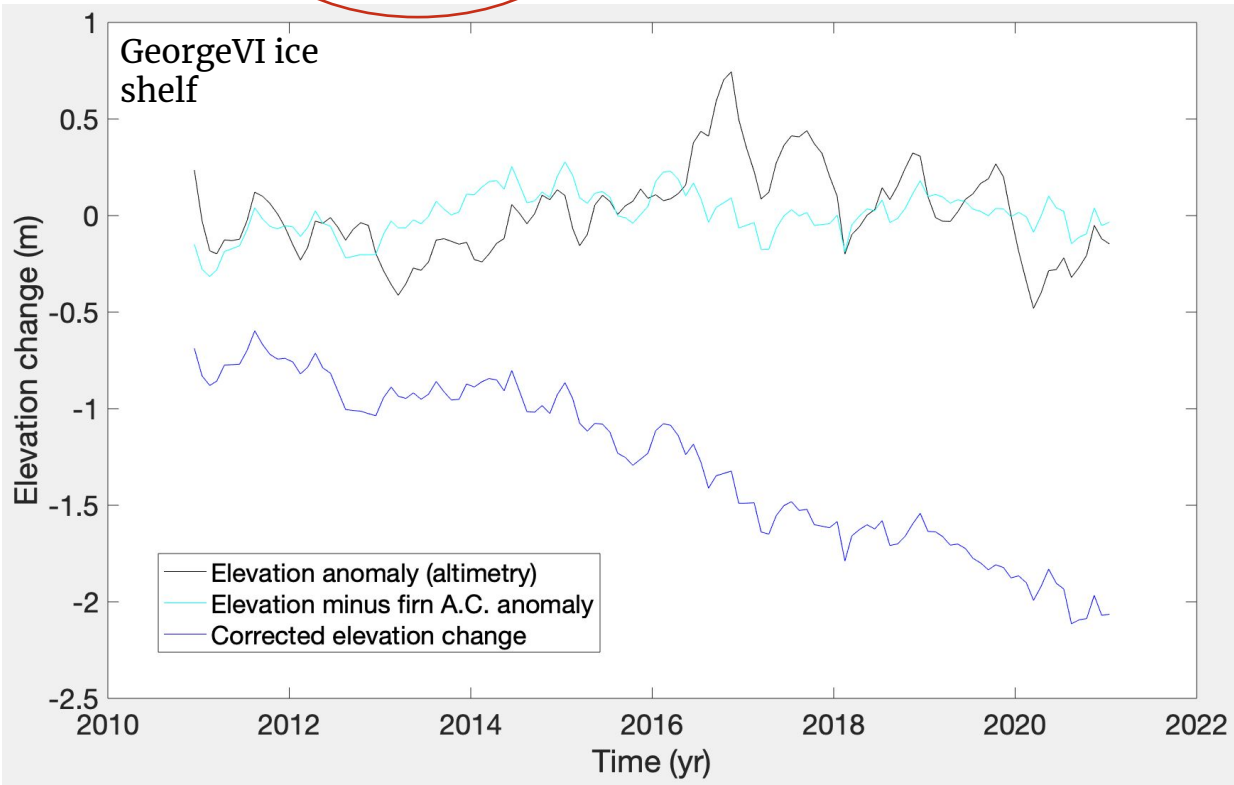
Time series of basal melt

Basal melt anomalies:

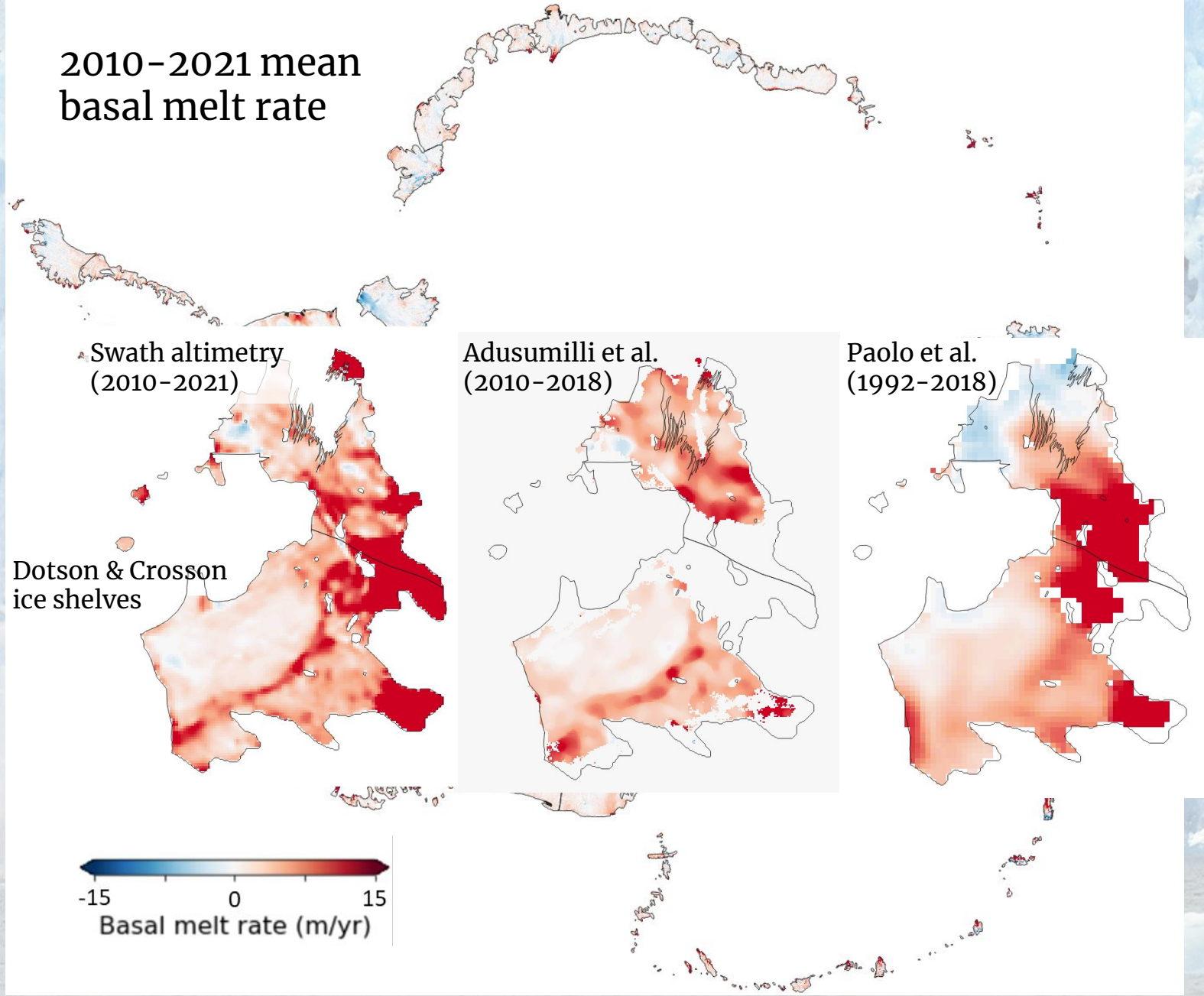
Anomalies are relative to the 2010–2021 mean

Basal melt anomaly | SMB anomaly | Ice and ocean density | Elevation change anomaly | Firn air content anomaly

$$w_{b,anom}(t) = \frac{M_{s,anom}}{\rho_i} - \frac{\rho_w}{\rho_w - \rho_i}\left(\frac{dh_{anom}}{dt} - \frac{dh_{air,anom}}{dt}\right)$$



2010–2021 mean basal melt rate



- Subglacial discharge
- Antarctic peripheral glaciers

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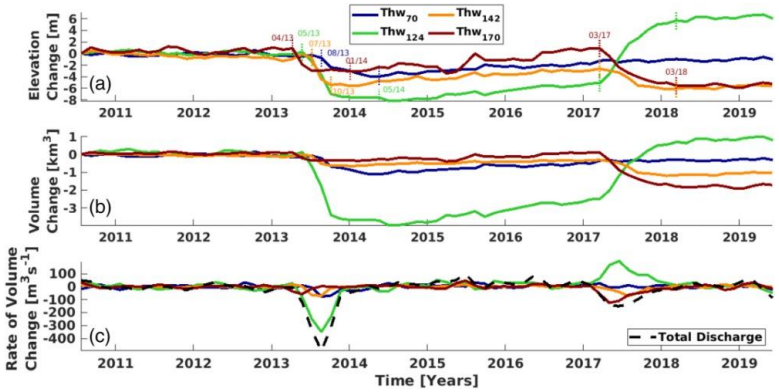
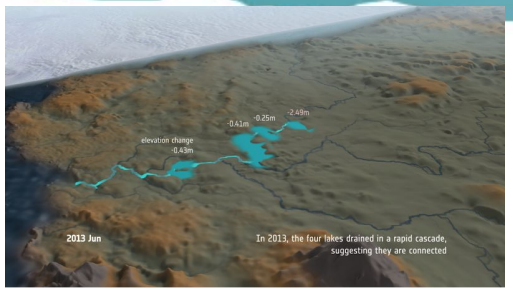
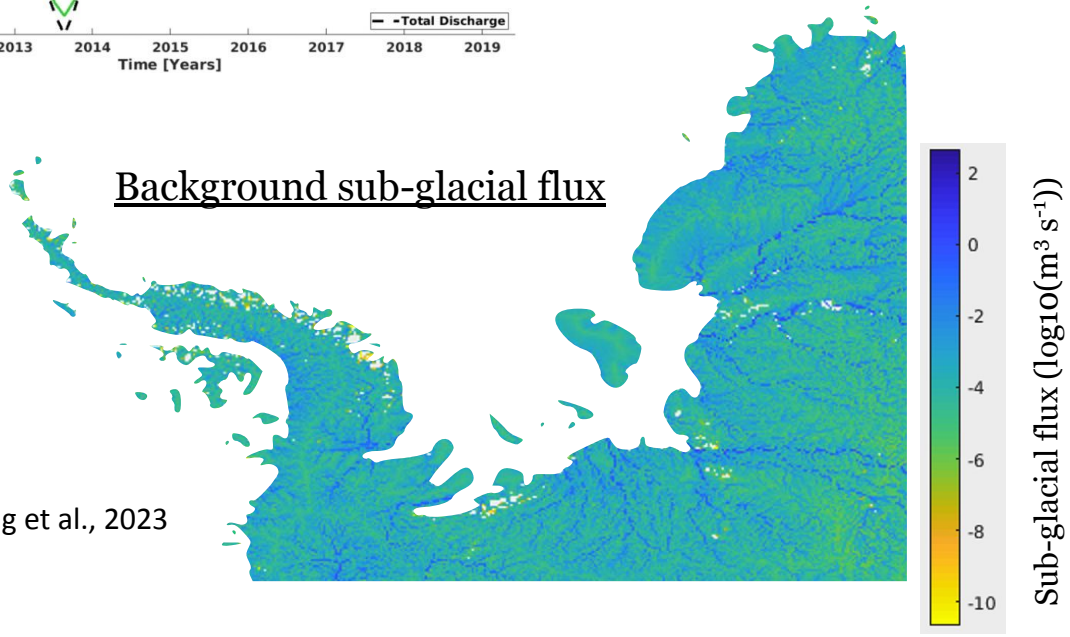
Transient sub-glacial flux



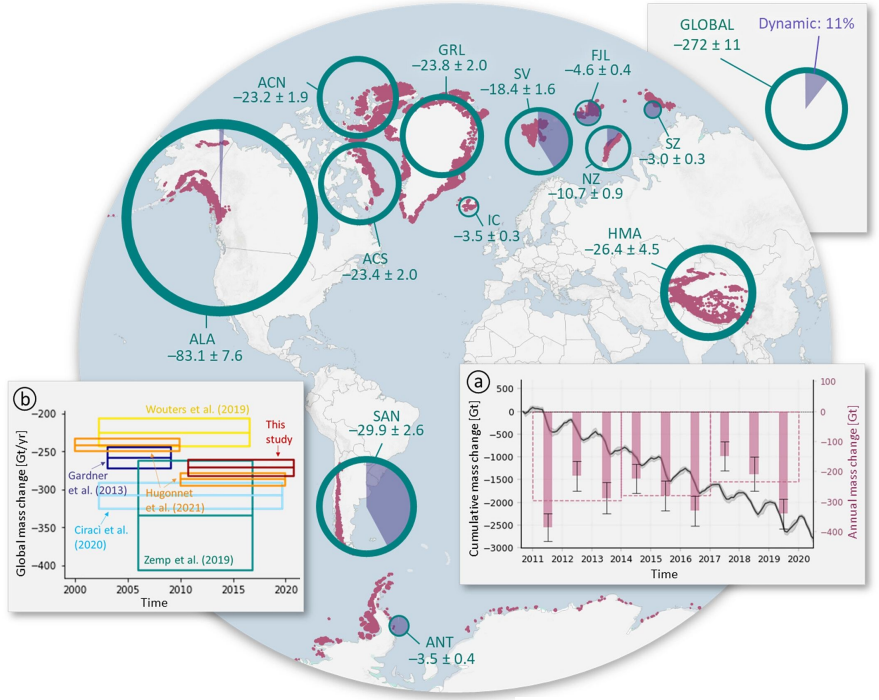


Malczyk et al., 2020

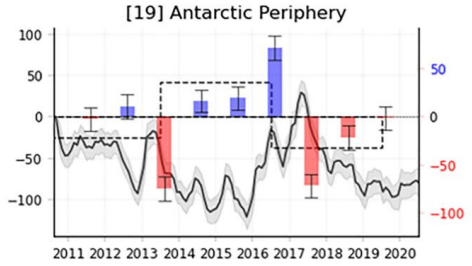
Background sub-glacial flux



Wearing et al., 2023

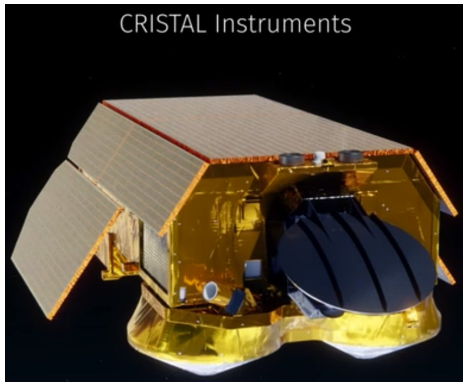


Jakob & Gourmelen, 2023



Looking ahead

Swath as operational mode/product



CRISTAL: part of Copernicus expansion programme –

Future Sentinel 9
Launch in 2027/28