UTILIZING JOINT TSX-PAZ ACQUISITIONS FOR IMAGING OF ANTARCTIC GLACIER GROUNDING LINES

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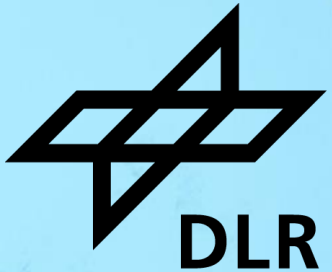
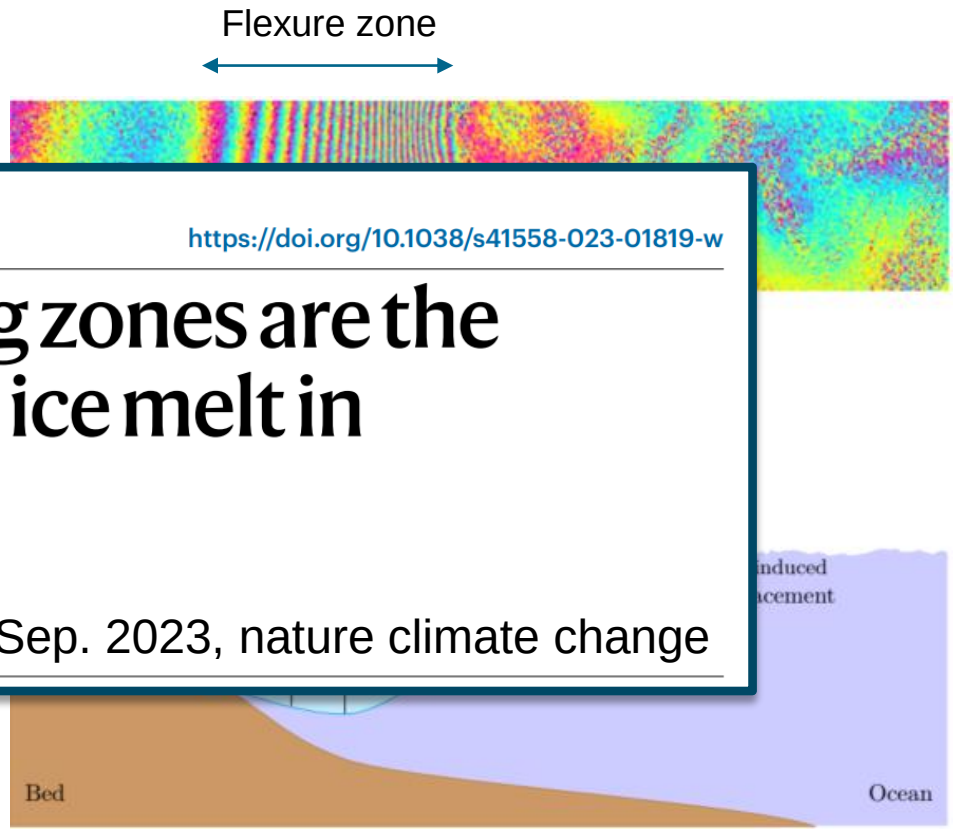


Glacier grounding lines

- Grounding lines have no visible surface feature
- The inte
  the land
- Observ
  play a k
  level rise
- Retreat of the grounding line is an indicator of ice shelf thinning



Grounding zone (position of G)
- Long term variations due to glacier thinning
- Short term variations with tidal state

https://doi.org/10.1038/s41558-023-01819-w

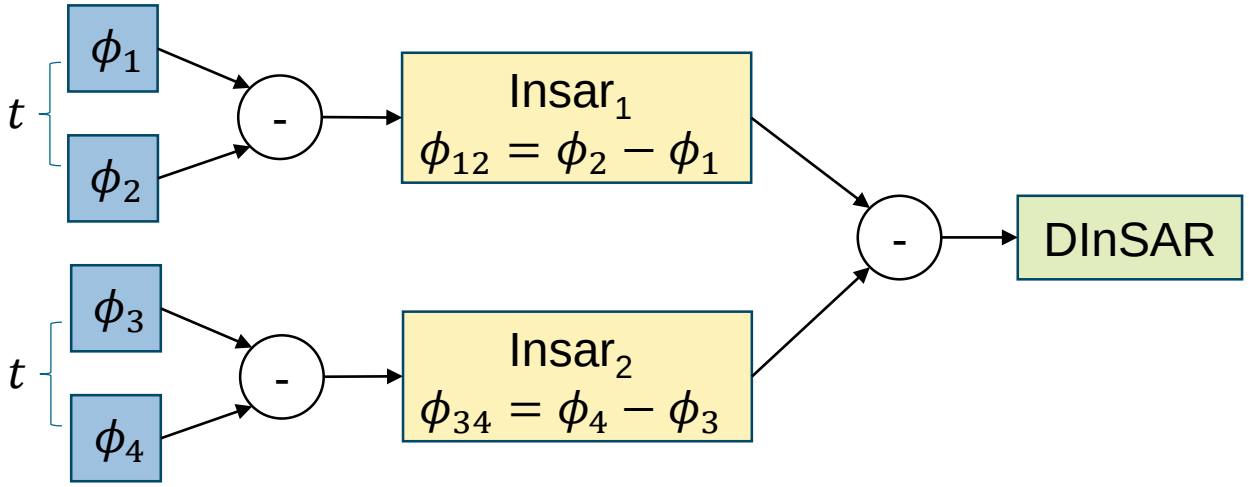
Observations of grounding zones are the missing key to understand ice melt in Antarctica

Eric Rignot

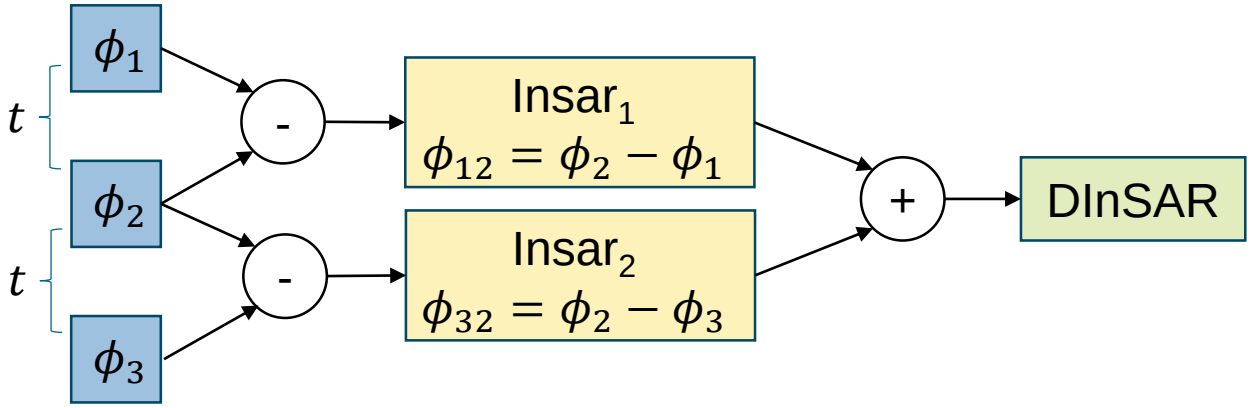
Sep. 2023, nature climate change

Double difference technique

Quadruplet case:



Triplet case:



$$\phi_{12} = \phi_{12,topo} + \phi_{12,ice\ velocity} + \phi_{12,tidal\ deformation} + \phi_{12,atmosphere} + \phi_{12,noise}$$

$$\phi_{32} = \phi_{32,topo} + \phi_{32,ice\ velocity} + \phi_{32\ tidal\ deformation} + \phi_{32,atmosphere} + \phi_{32,noise}$$

Removed by DEM

Cancels in DInSAR

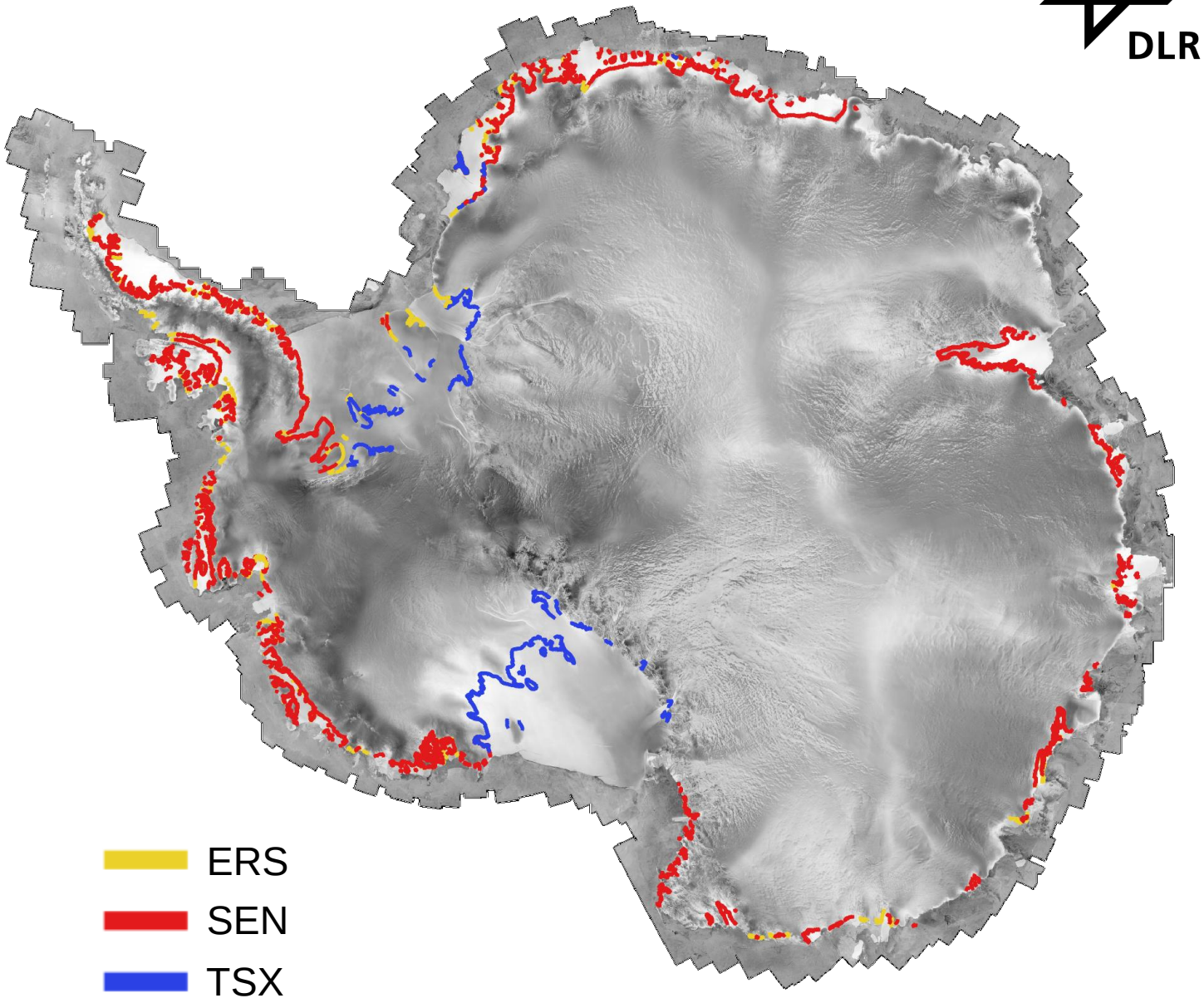
Causes fringe belt

Low frequency

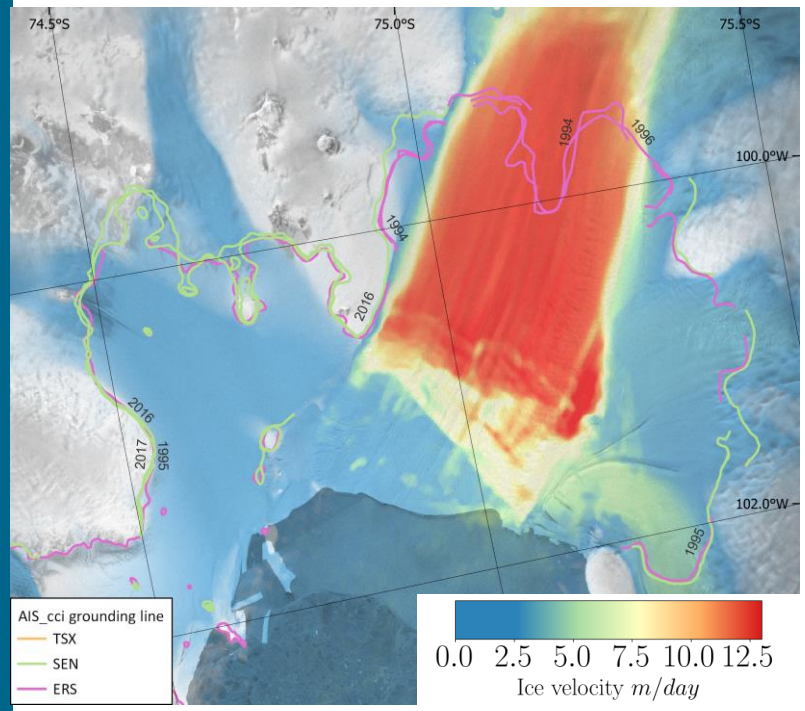
Dominates with long temporal baselines

Existing grounding line products

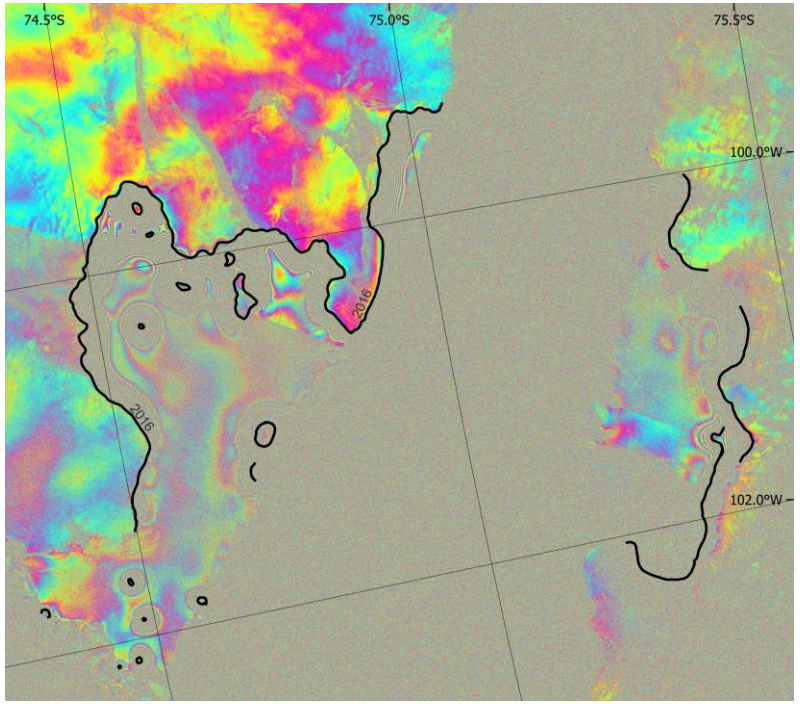
- ESA‘s Antarctic climate change initiative
  - ERS – Sentinel-1 – TSX
- MEaSUREs program
  - ERS – ALOS – Radarsat – (CSK)
- Dedicated individual efforts targeting single glaciers with other constellations



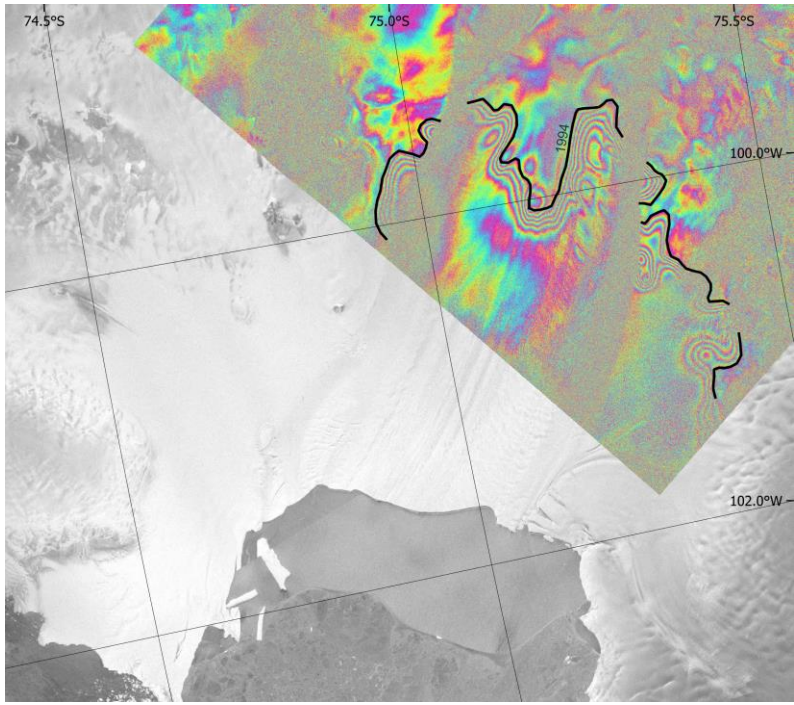
Pine island glacier – existing grounding line products



High ice velocity causes fast decorrelation



Incoherent Sentinel-1 6 day DInSAR combination

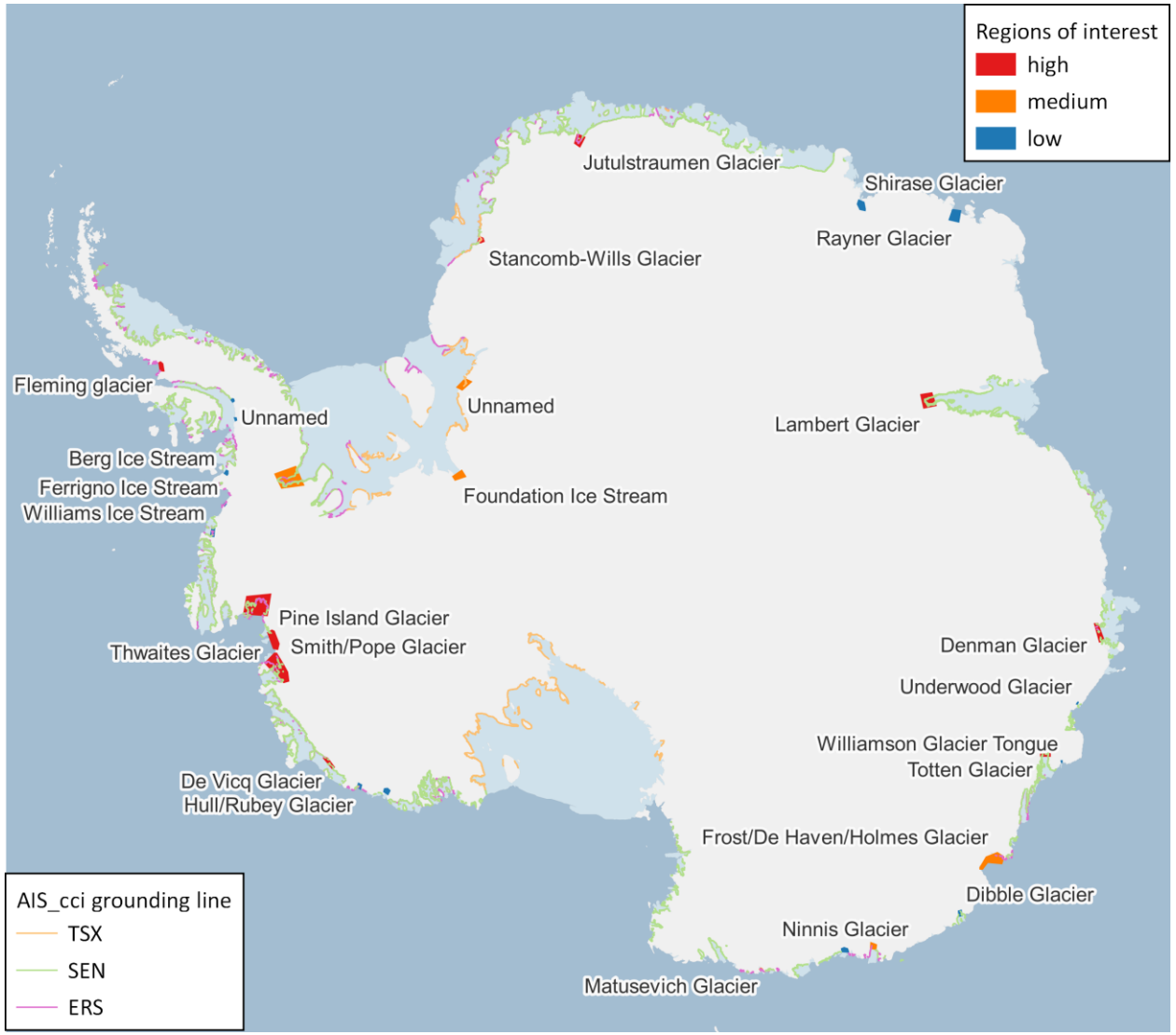


Coherent ERS 3-day DInSAR combination

Especially for some of the faster glaciers, the only available InSAR observations of the grounding line have been acquired during the ERS Tandem phases (1991/92, 1994 and 1995/96).

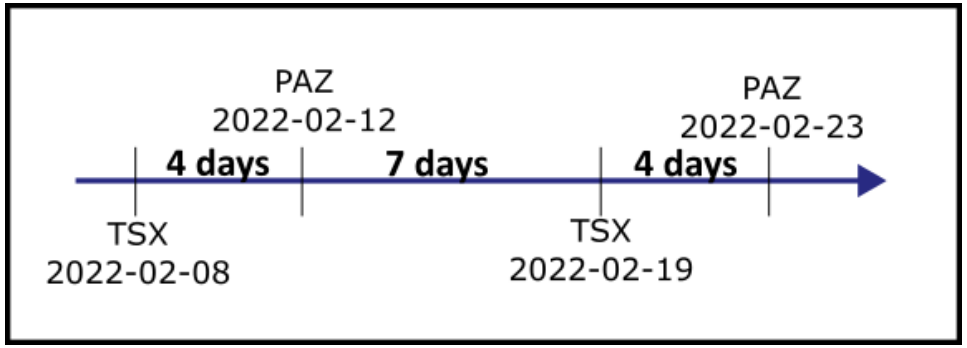
Regions of interest

- Especially the fastest glaciers are difficult targets with current constellations
- The fastest glaciers are scientifically most interesting and potentially contribute to rapid sea level rise
- Problems are:
  temporal decorrelation (deformation)
  located in S1 pole hole (need for left looking capabilities)



TSX/PAZ constellation

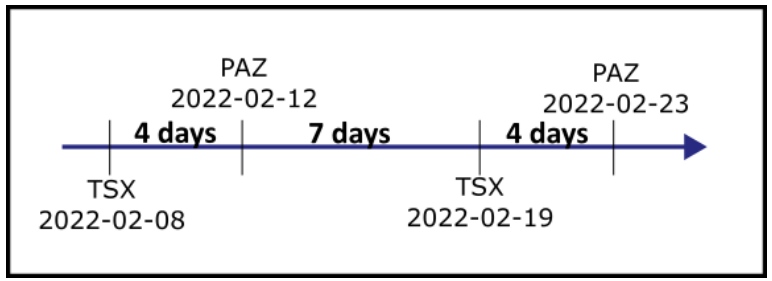
- In May 2021, a joint AO of DLR and the Spanish National Institute of Aerospace Technology (INTA) was released
- Temporal baseline reduced to 4 days



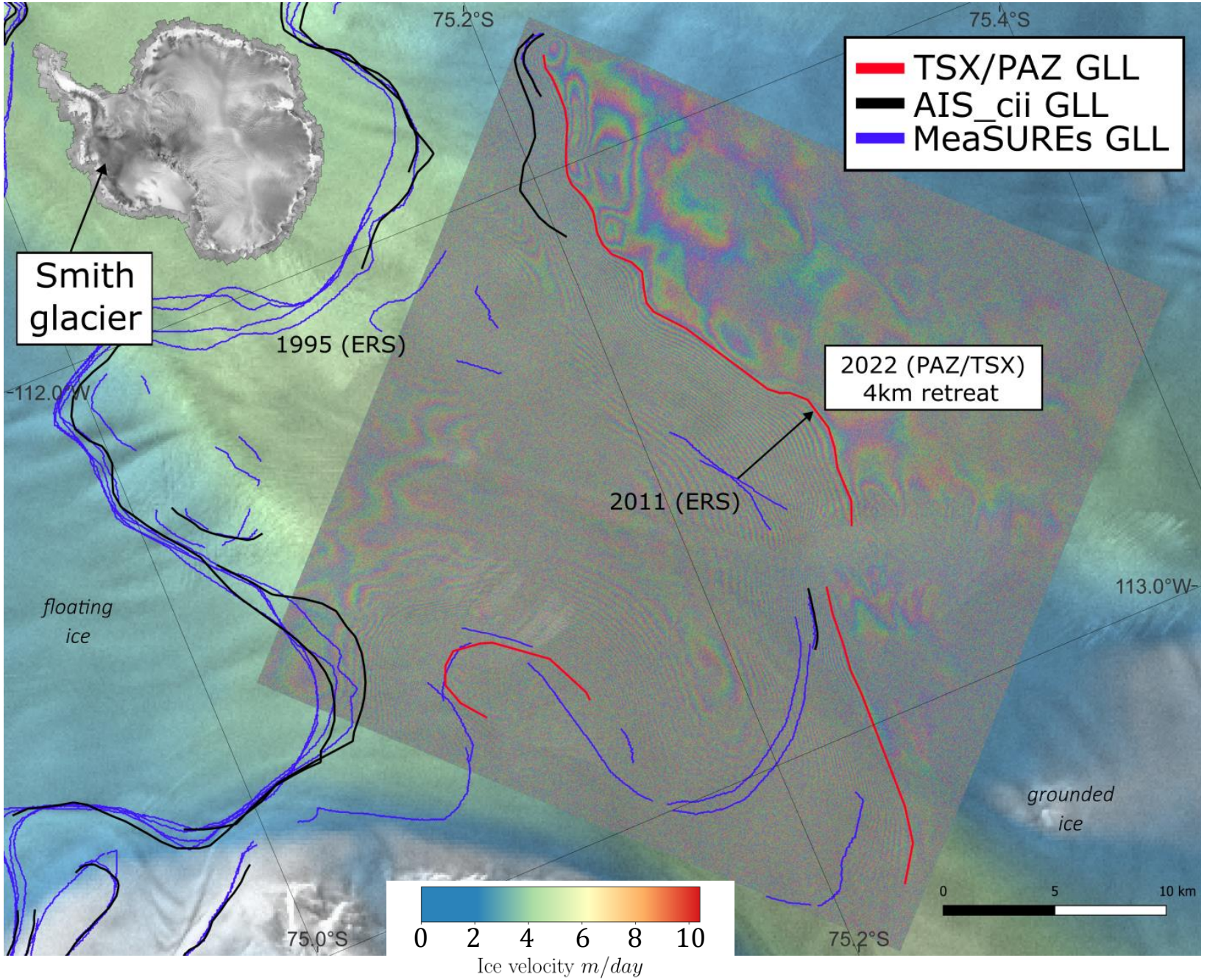
Constellation	Repeat pass time interval [days]	Resolution [m]	Band
Sentinel-1	6/12	5m x 20m	C-band
TerraSAR-X (TSX)	11	3m x 3m	X-band
ERS	3/1	8m x 4m	C-band
TSX/PAZ	**4/7**	**3m x 3m**	**X-band**
COSMO-SkyMed	1	3m x 3m	X-band
Radarsat-2	24	12m x 5m	C-band

NISAR	12	3-10m	L-band
ICEYE	1	3m x 3m	X-band
RCM	4	16mx16m	C-band

First results – Smith glacier



- A dense fringe belt is characterizing the flexure zone
- The grounding line has retreated compared to previous ERS measurements
- Key to imaging the grounding line maintaining coherence



Conclusions

- Interferometric capability of the sensors TSX and PAZ has been demonstrated
- On Smith glacier the grounding line has retreated approx. 4km since it has last been imaged with ERS in 2011
- The TSX/PAZ constellation provides a unique opportunity to regularly image the grounding line with short temporal baselines
- The temporal baseline is reduced to 4 days which remains a rare opportunity in current constellations
- On some fast glaciers the last InSAR observations date back to the ERS tandem phase

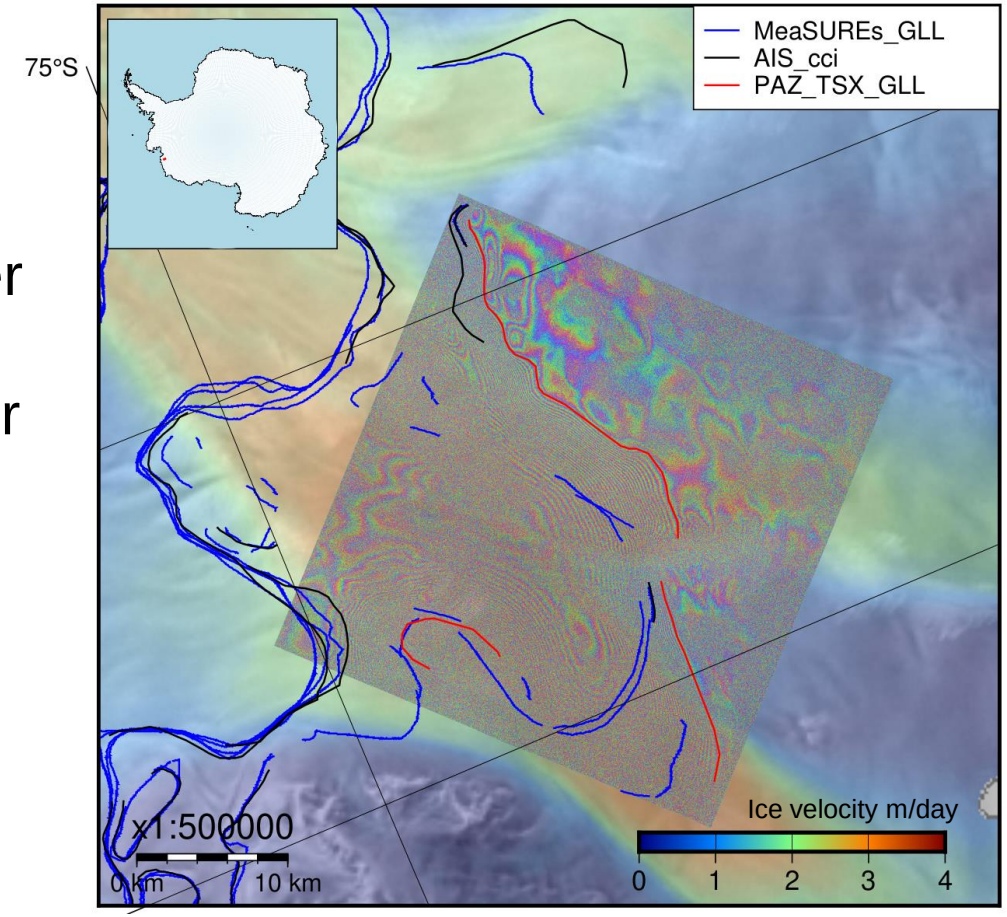
Outlook & Recommendations

Future acquisition plan

- Exploit the scientific capabilities of the TSX/PAZ constellation and image the glacier grounding line for all fast glaciers
- Start a targeted & coordinated effort to cover the grounding zone

Open science questions:

- Analyse seasonal coherence variations in the regions of interest to inform a possible future campaigns
- Comparison of coincident grounding line observations with Sentinel-1 or TSX/PAZ on slower glaciers



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