

# Grounding Line Products of the Antarctic Ice Sheet Climate Change Initiative Project

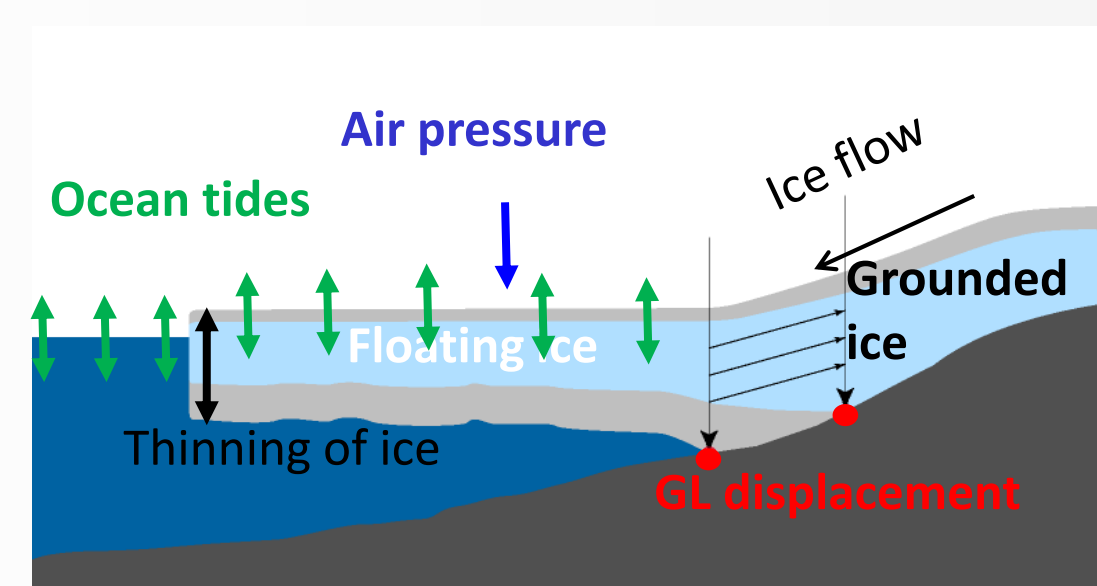
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## The grounding line location (GLL)

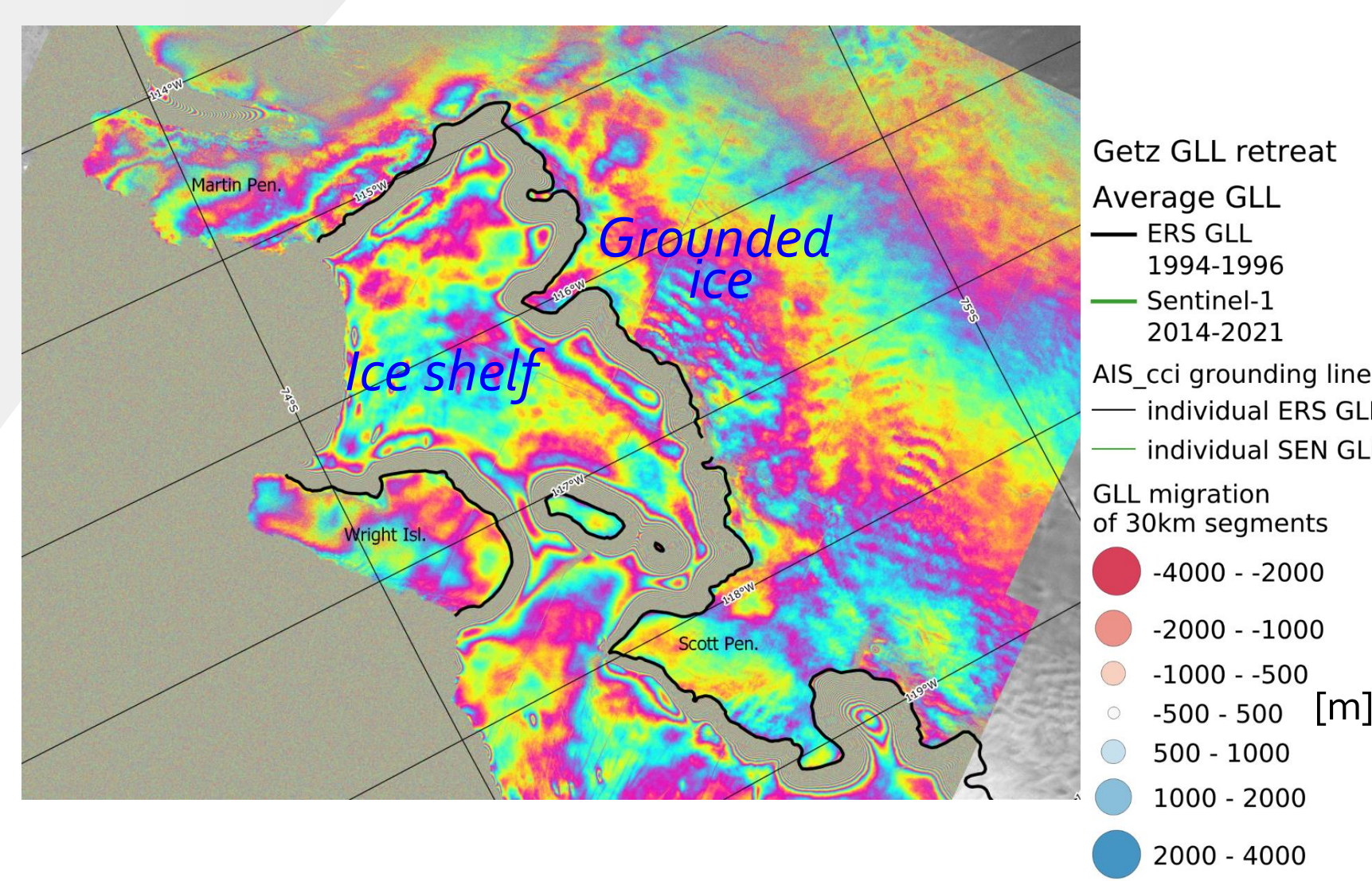
- a geophysical product of the Antarctic Ice Sheet Climate Change Initiative (AIS\_cci) ESA project.
- has been derived with InSAR over major ice streams and glaciers over the period 1994 – 2023 from ERS-1/2 era to Sentinel-1 A/B.
- AIS\_cci GLL product's metadata annotations include information about model-based ocean tide levels and air pressure at satellite acquisition times.

The position of the grounding line changes in time:

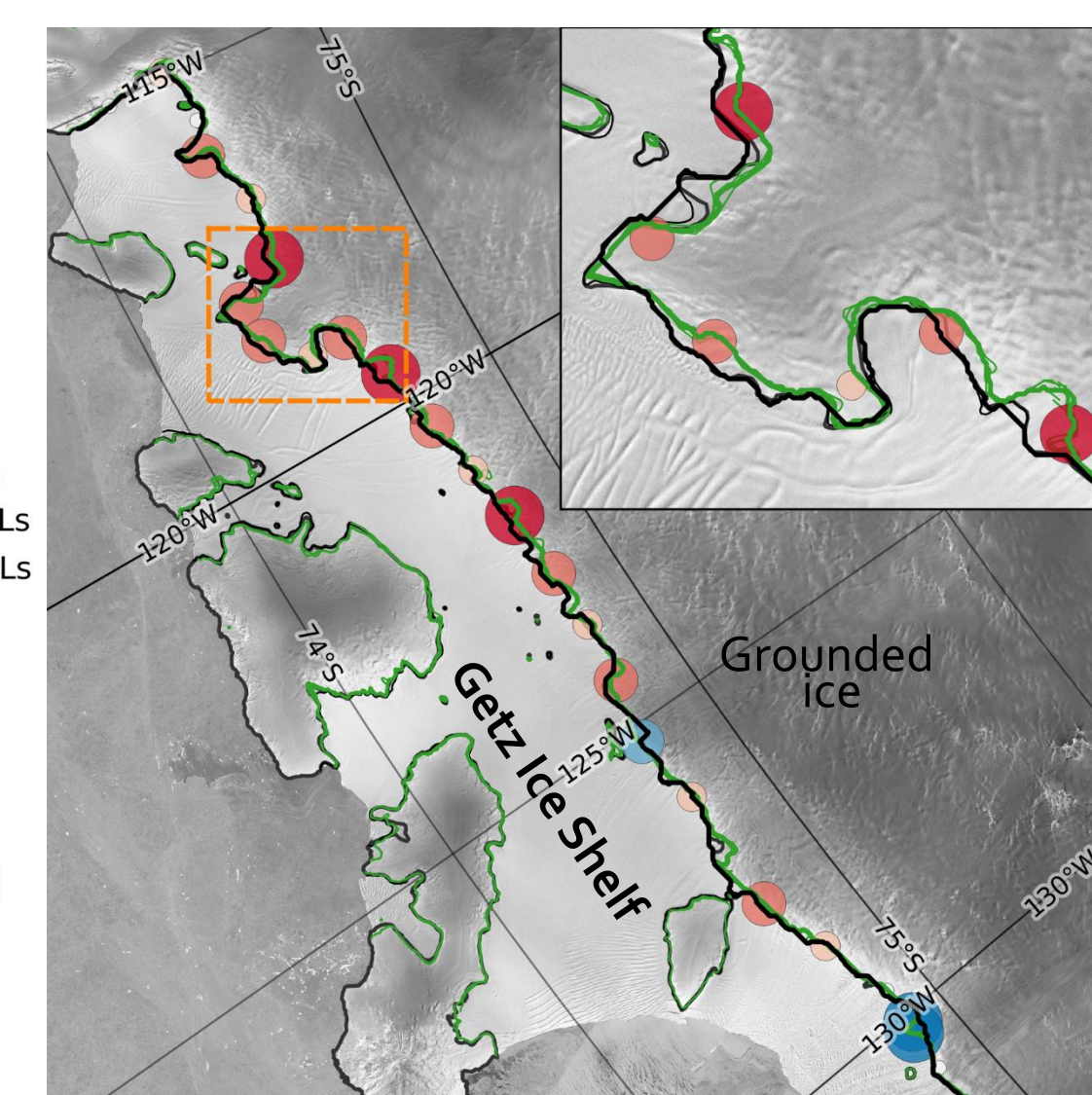
- at short time scale GLL moves back and forth with the vertical movement of the floating ice induced by ocean tides.
- at long term scale GLL migration in one direction can occur. Usually, it is expected to observe a retreat of GLL due to ice thinning. This phenomenon is a climate change indicator.



GLL on DInSAR Sentinel-1A/B interferogramm

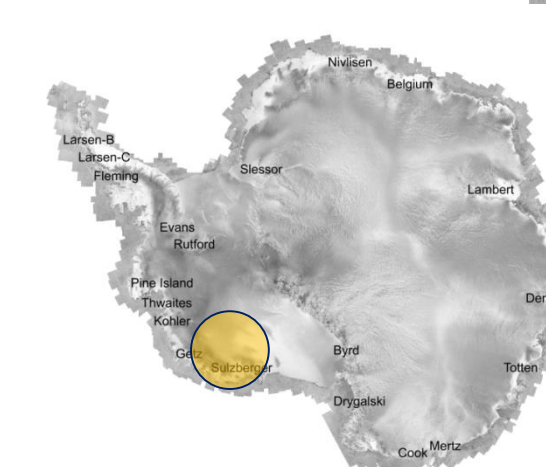


GLL time series and migration from 1994/96 to 2014/21



- S-1 constellation with 12 / 6-days repeat cycle (IW mode) offer unique opportunity to obtain coherent DInSARs and map dense time series of GLLs since 2014/2017

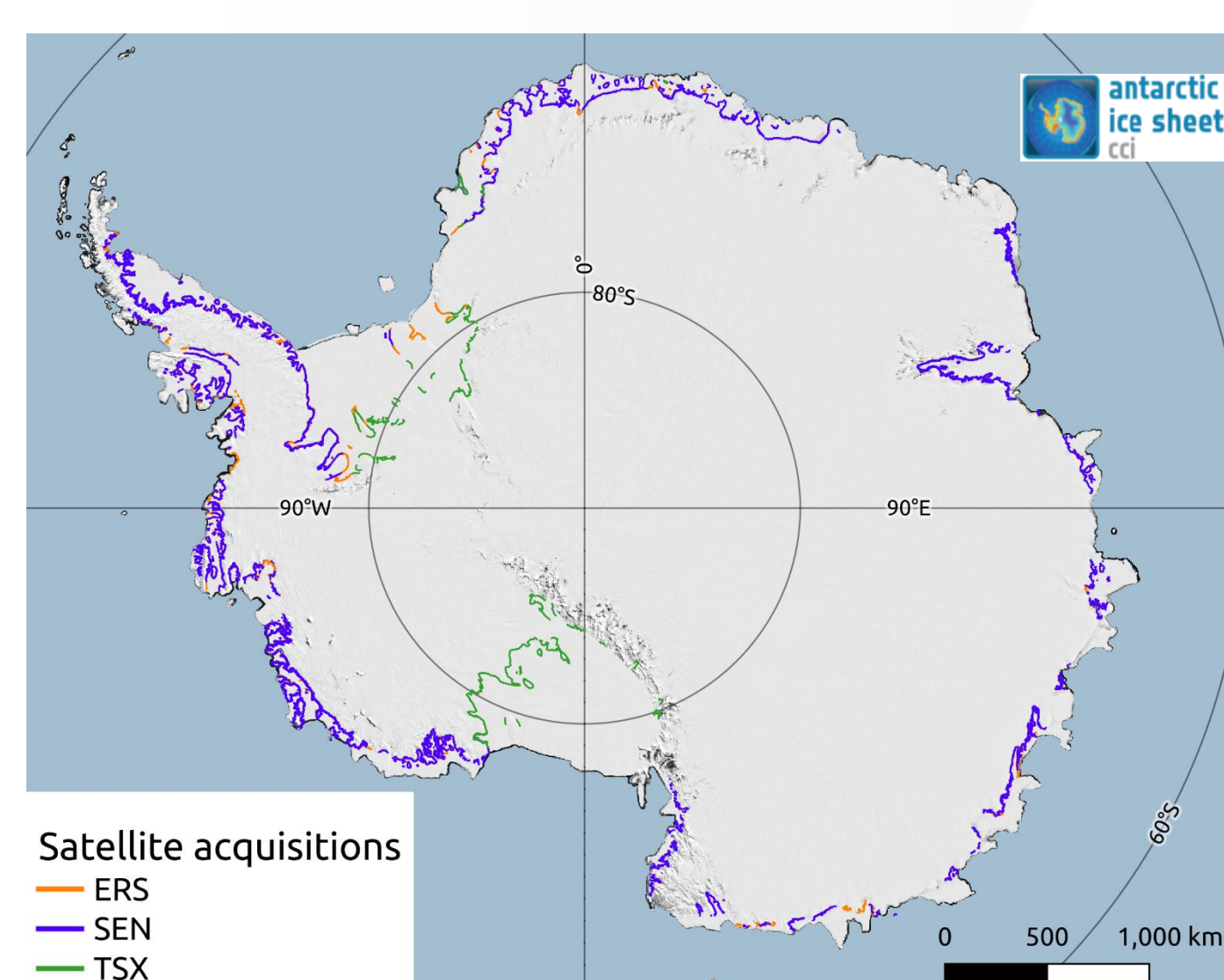
- continuous GLL could be delineated in both epochs
- consistent delineation for dense long time series needed



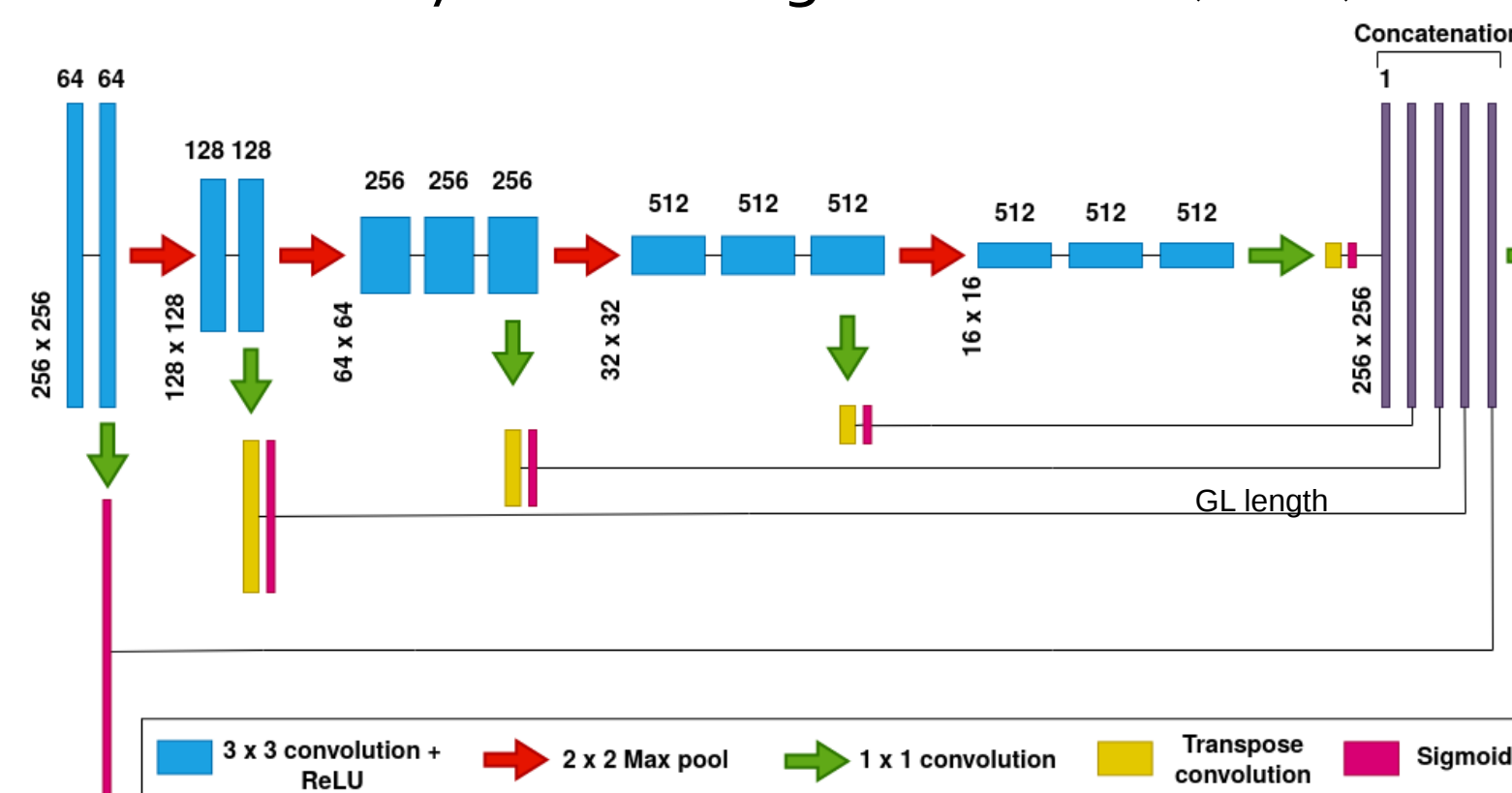
## GLL automatic delineation [1]

train **machine learning** network → automatic delineation → **consistent gapless**,  
**temporal extended time series** of AIS\_cci GLLs

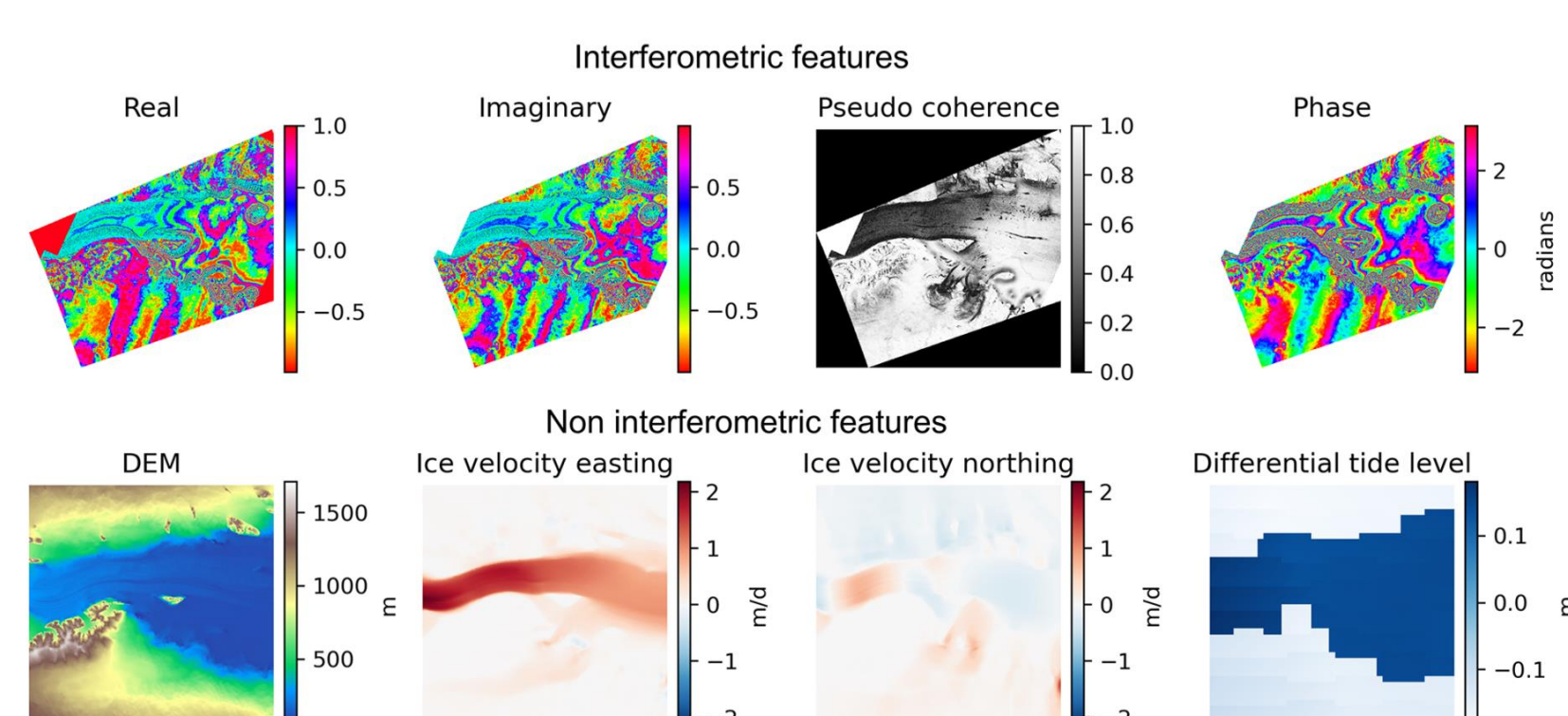
AIS\_cci GLLs through manual delineations of S-1, ERS-1/2 and TSX interferograms



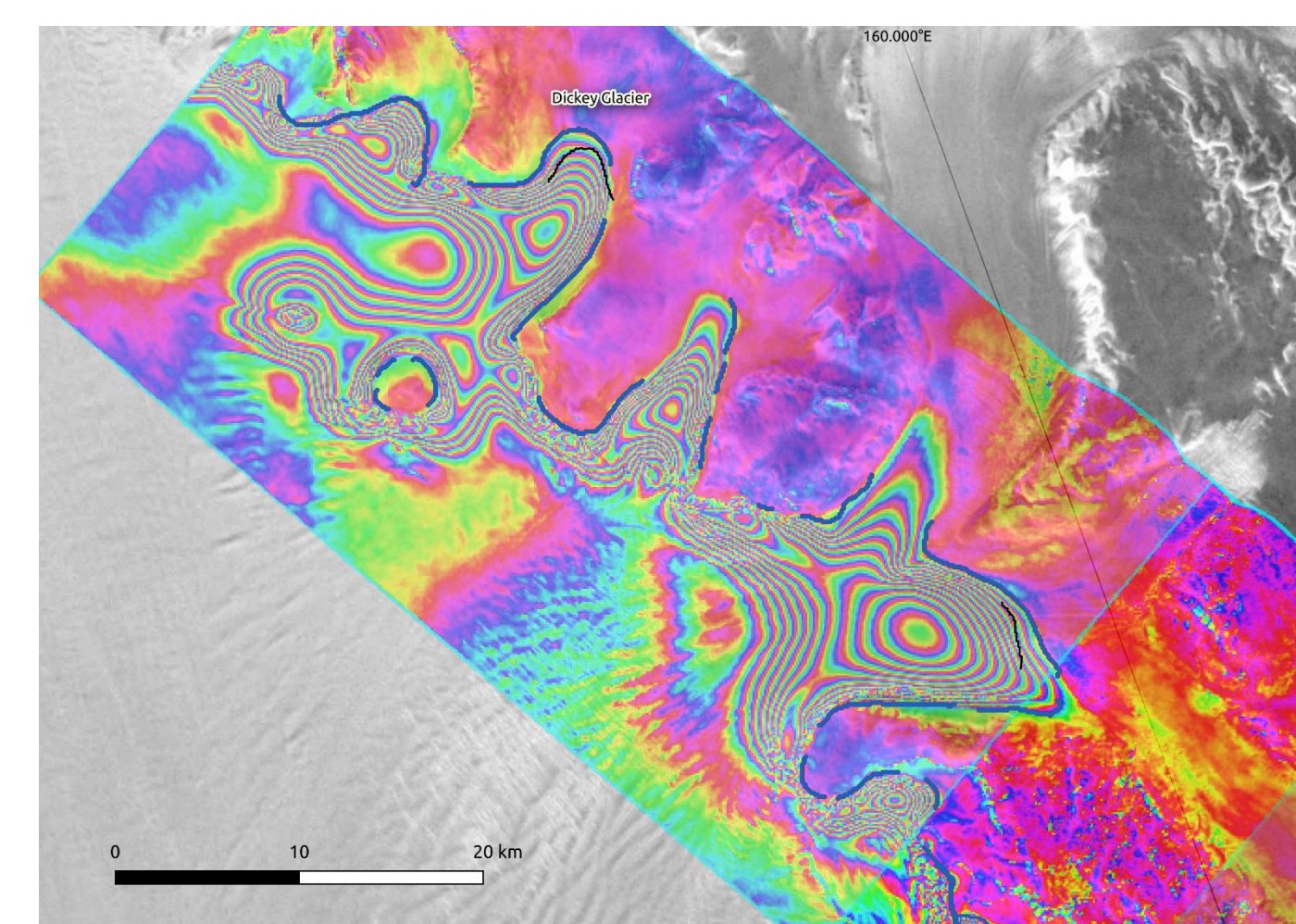
### Holistically Nested Edge Detection (HED)



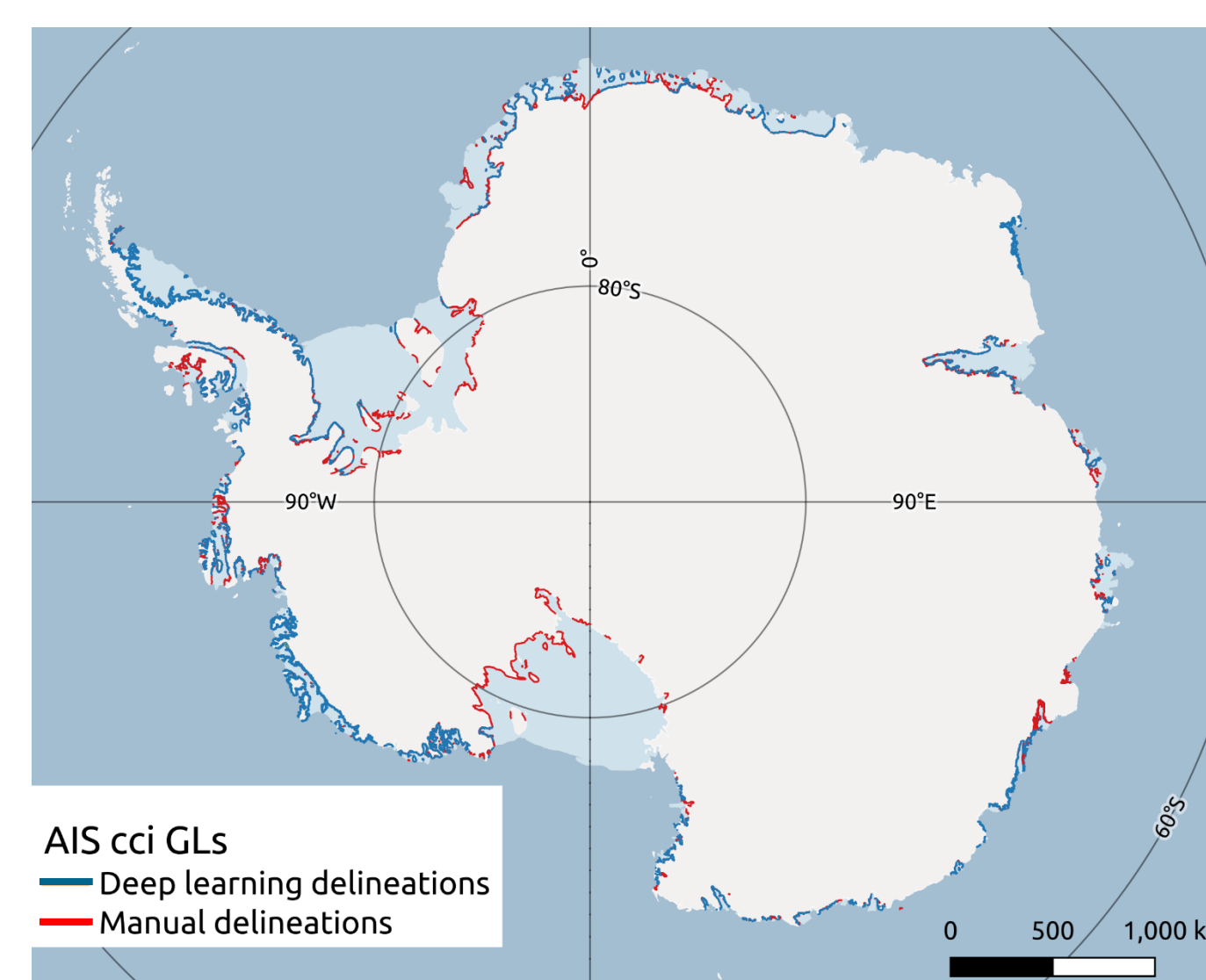
### Training dataset: input features



HED grounding line from TerraSAR-X DInSAR



Combined manual and ML-delineations to fill GLL gaps



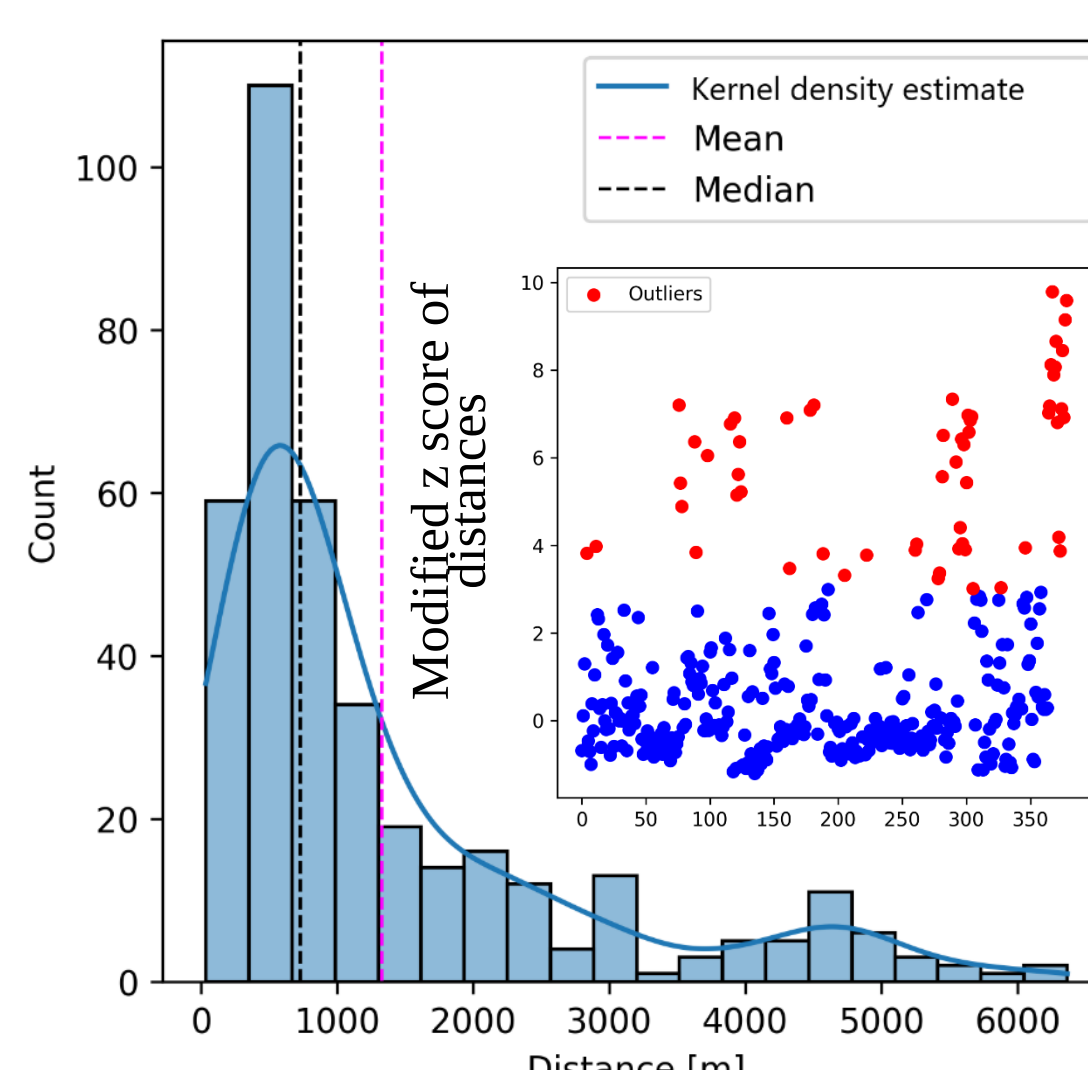
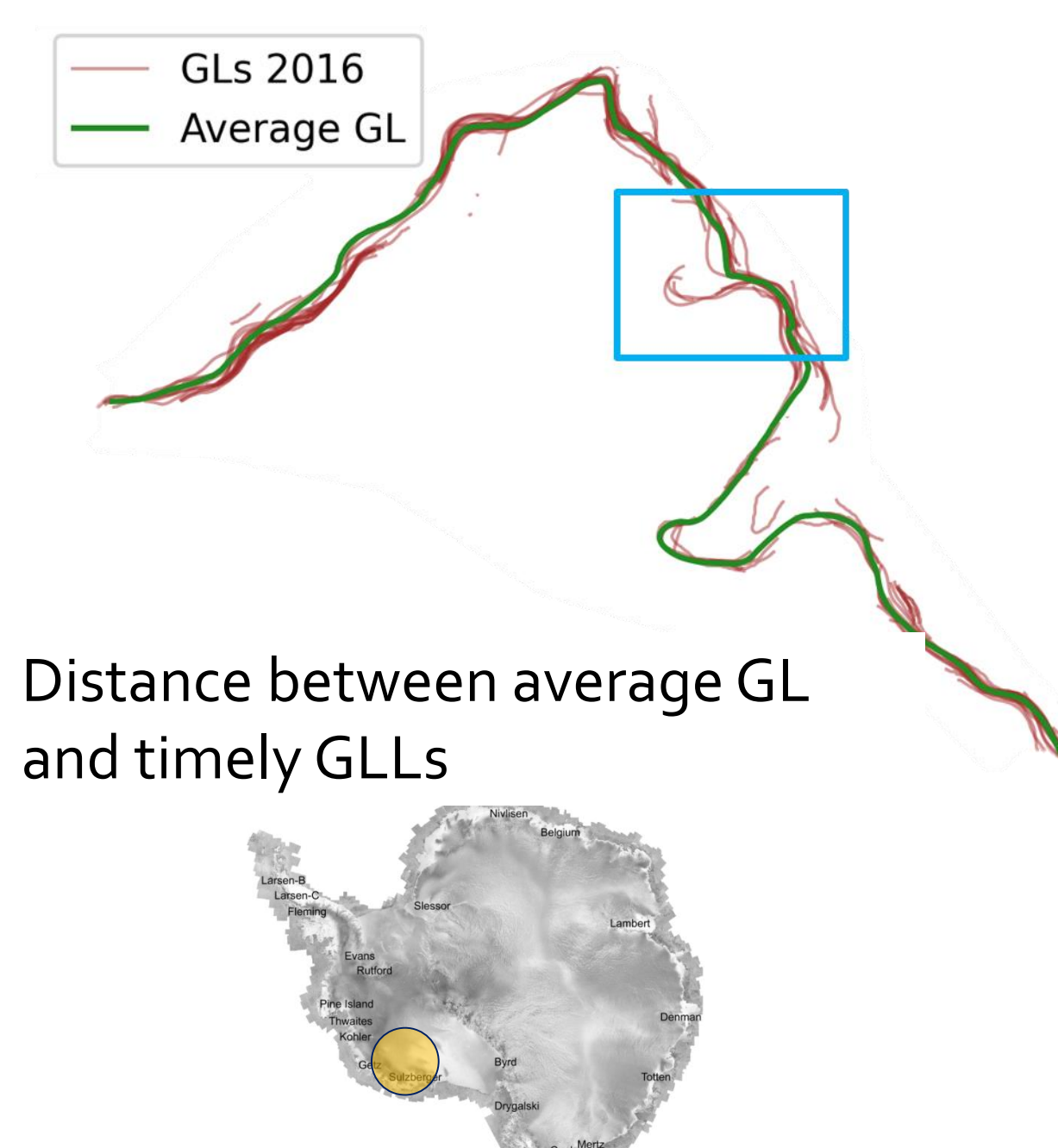
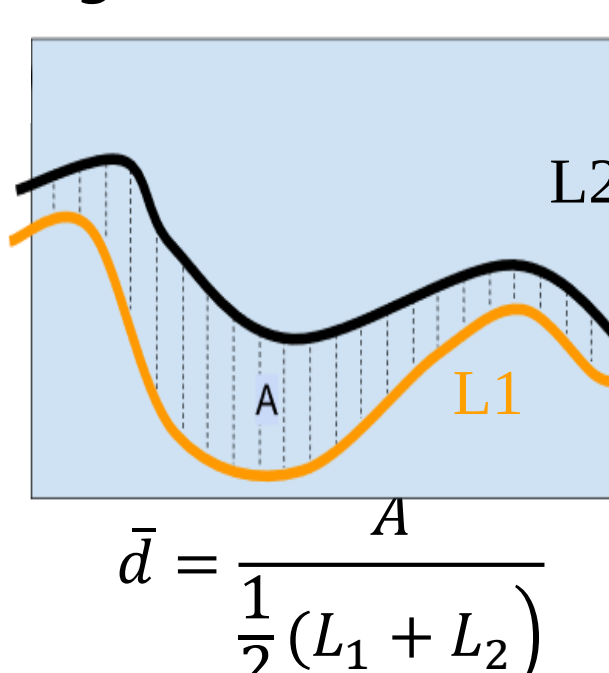
## Grounding Line Migration (GLM) - new parameter of AIS\_cci (in development)

Will provide short-term temporal variations within the grounding zone and separate this short-term position change from a long-term climatic-induced relocation of the grounding zone.

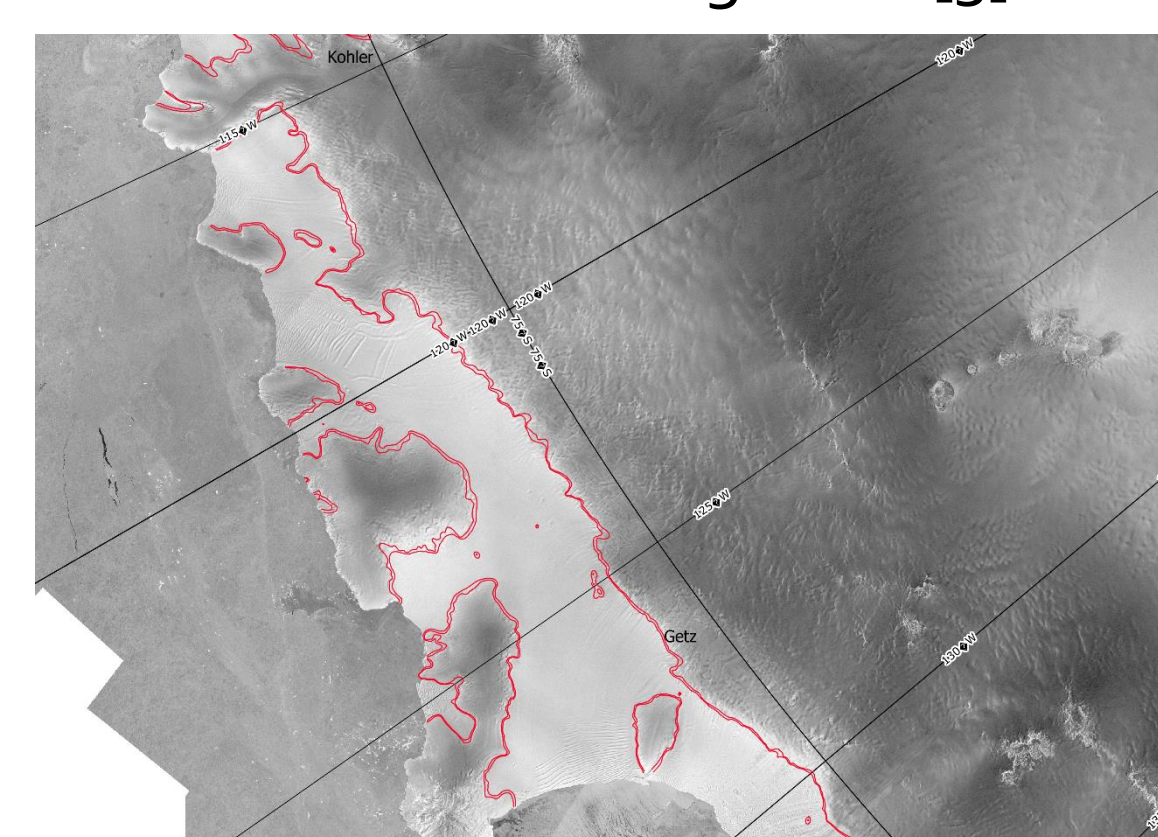
Algorithm development:

- quantify the distance between GLLs
- statistical analysis DInSAR-derived GLLs and calculate nominal Grounding Zone width

'Box-method': Area averaged grounding line change measurement [2]



MEaSURES Grounding Zone [3]\*



Short-term zone of migration of the GL  
1 Jan. 2018 - 31 Dec. 2020

\*Example of data source for validation

### References:

- Ramanath, S. et al (2025). Automatic grounding line delineation of DInSAR interferograms using deep learning, The Cryosphere, 19, 2431–2455, <https://doi.org/10.5194/tc-19-2431-2025>, 2025.
- Moon, Twila and Ian R. Joughin. „Changes in Ice Front Position on Greenland's Outlet Glaciers from 1992 to 2007". Journal of Geophysical Research: Earth Surface 113, Nr. F2 (2008). <https://doi.org/10.1029/2007JF009927>.
- Rignot, E., Mouginot, J. & Scheuchl, B. (2023). MEaSURES Grounding Zone of the Antarctic Ice Sheet. (NSIDC-0778, Version 1). Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. <https://doi.org/10.5067/HGLT8XB480E4>. Date Accessed 11-11-2024.

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