Automatic delineation of the grounding line of Antarctica in DInSAR interferograms

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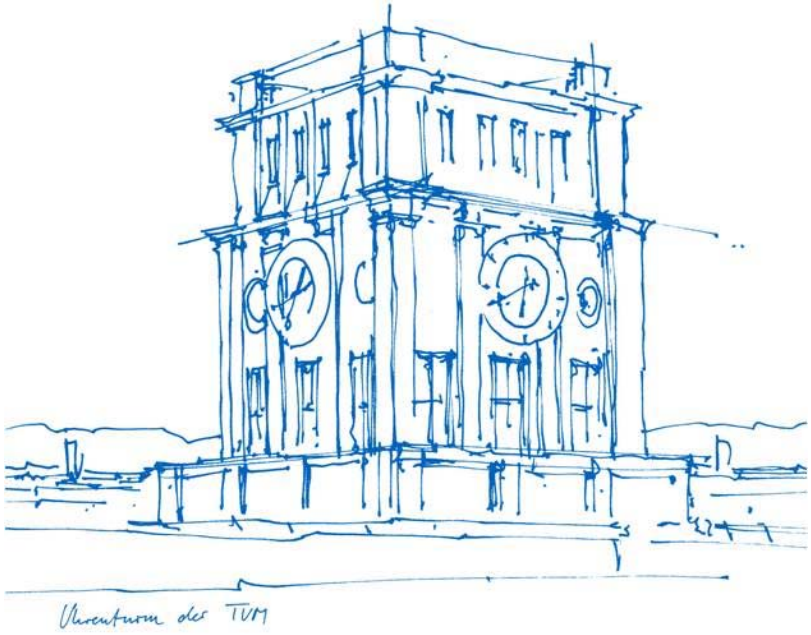


Motivation

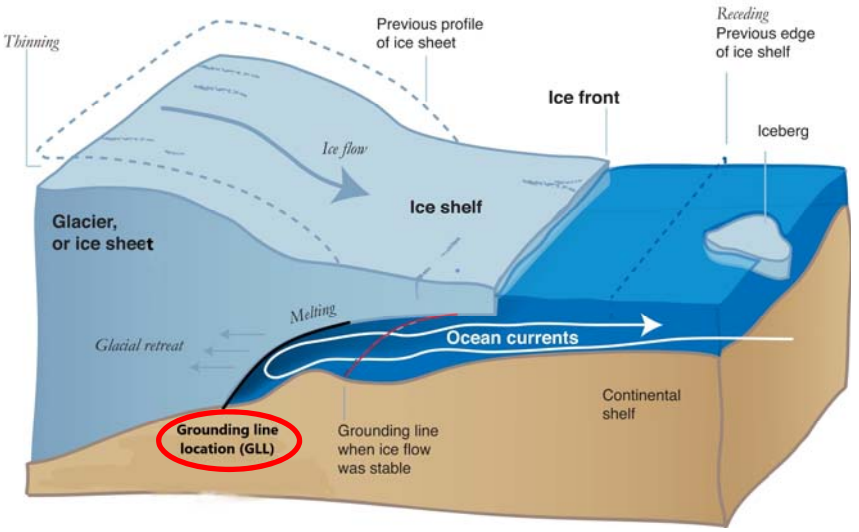
The grounding line marks the boundary where an outlet glacier no longer lies on bedrock but starts to float over open water (e.g. ocean)

Significance:

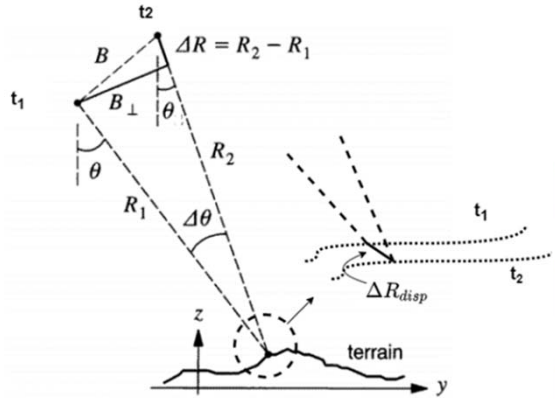
- Ice mass transported out of ice sheets is estimated at the grounding line
- Site of basal melting, indicator of ice sheet stability

Challenges

- GLLs are subsurface features
- GLLs move:
  - short term – tidal bending of ice shelves
  - long term – changes in ice thickness



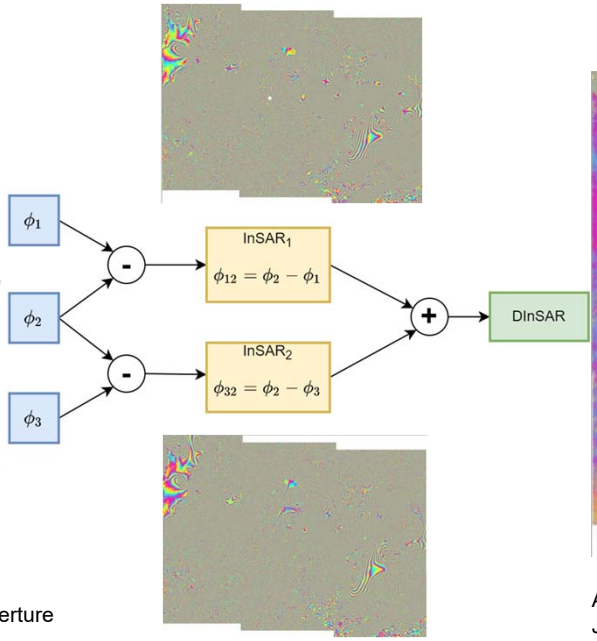
Differential InSAR based grounding line detection



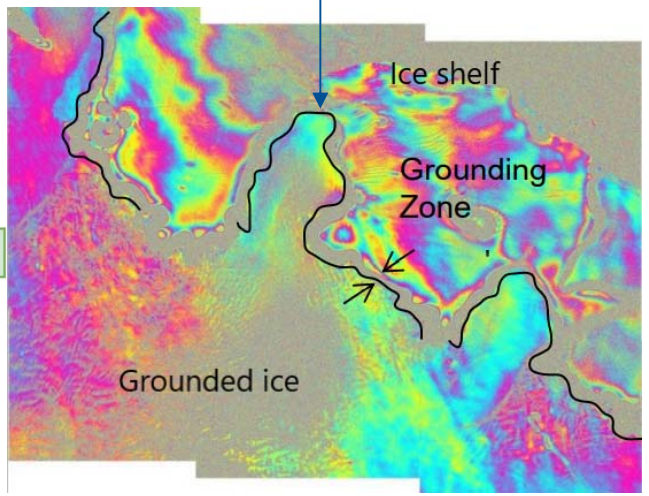
$$\Delta\phi = \Delta\phi_{topo} + \Delta\phi_{flat\ earth} + \Delta\phi_{disp} + \Delta\phi_{atmos}$$

$$\Delta\phi_{disp} = \frac{4\pi}{\lambda}\Delta R_{disp}$$

Adapted from Bamler, R., & Hartl, P. (1998). Synthetic aperture radar interferometry. *Inverse problems*, *14*(4), R1.

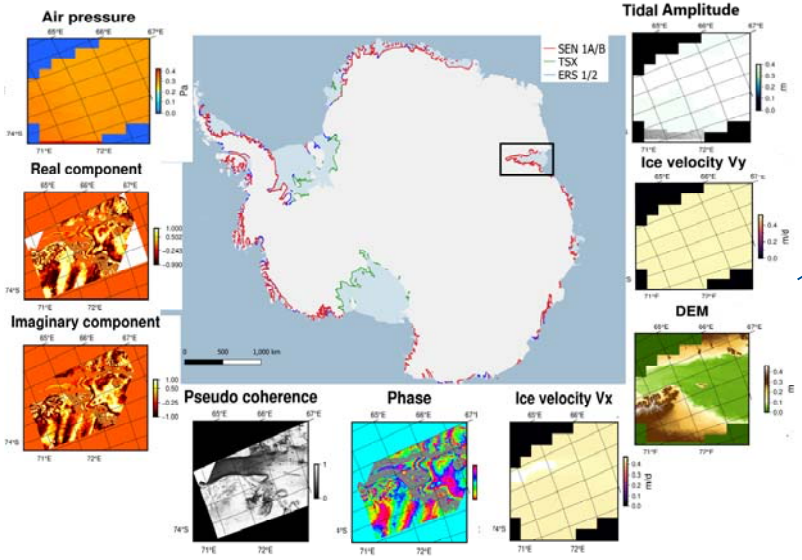


Manually delineated grounding line

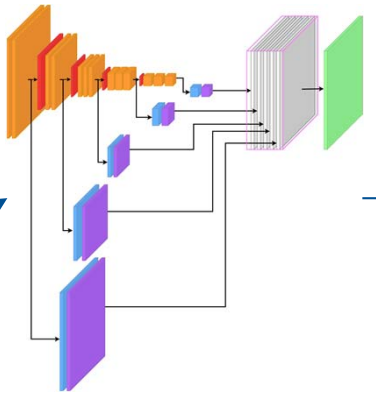


Adapted from Chowdhury, T. A., Floricioiu, D., Parizzi, A., Wuite, J., & Nagler, T. (2017). Grounding Line Derivation Over Antarctic Ice Sheet from Sentinel-1, TerraSAR-X and ERS-1/2.

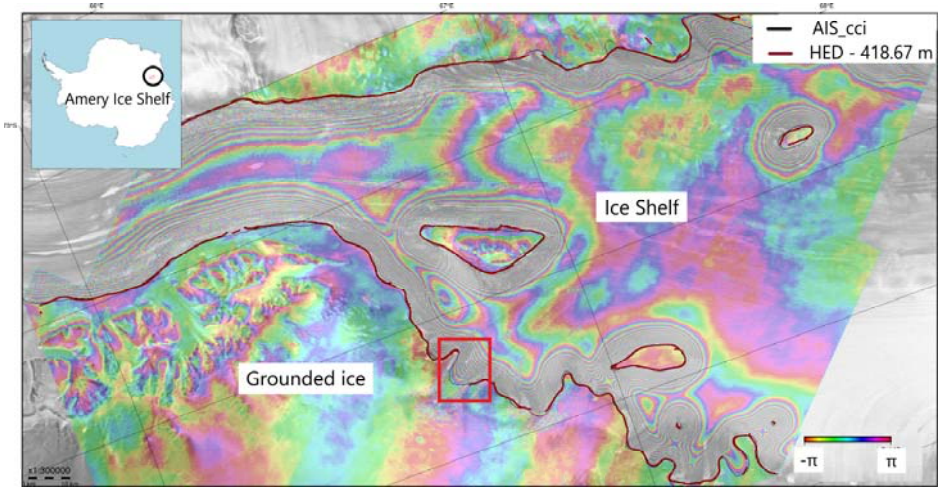
Deep learning based GLL delineation



Tarekere, S. R. (2022). Mapping the grounding line of Antarctica in SAR interferograms with machine learning techniques.(Master thesis)



Xie, S., & Tu, Z. (2015). Holistically-nested edge detection. In *Proceedings of the IEEE international conference on computer vision* (pp. 1395-1403).



Conclusion

- The best perfoming model has an overall deviation of **209 m** from ground truth
- DEM, ice velocity, tidal amplitude and air pressure do not significantly contribute to the network delineations
- Potential first approximation of GLL → could save some manual effort

Future scope:

- Physics aware deep learning based GLL delineation
- Generation of monthly or half yearly GLLs → useful for studying migration patterns
- Integration into numerical ice sheet model

Thank you for your attention!