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Outstanding Student Poster Contest

Antarctic subglacial conditions inferred from combined interferometric velocity data and ice sheet modeling

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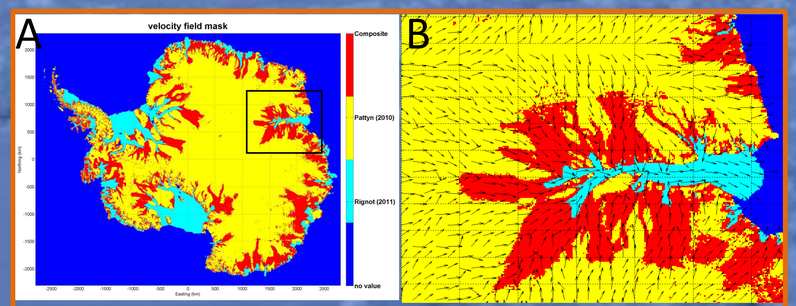
I. Abstract and Motivation

- Antarctic subglacial conditions can be elucidated through several techniques. However, since direct measurements are only limited to a few deep drillings to the bed, there is always a substantial amount of ice sheet and thermodynamical modeling involved. This can either be done based on a fully coupled thermomechanical ice sheet model, or a thermodynamical model coupled with present-day ice sheet geometry and environmental conditions.
- Based on the method of Pattyn (2010), we present an update of the basal temperate conditions using new data of bedrock elevation, ice thickness (Le Brocq et al. 2010), observed surface velocities obtained from interferometric analysis (Rignot et al. 2011) and a new lakes inventory (Fig. 1c From Wright et al., under review).

II. Methods

- ✓ Calculation of a new surface velocity field (Fig. 1A) and incorporation of new data sets.
- ✓ Calculation of temperature *T* and calibration of model (velocity *v*, temperature, …)
- ✓ $$\frac{\partial T}{\partial t} = \nabla\left(\frac{k}{\rho c}\nabla T\right) - v\cdot\nabla T - \frac{2}{\rho c}\varepsilon\sigma$$
- ✓ New estimates are compared to the initial basal temperature calculation (Fig. 4)



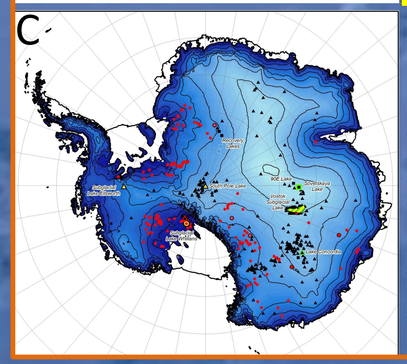


Fig 1. [A] Mask of the different velocity data. In yellow: from a hybrid ice sheet/ice shelf model (Pattyn 2010), in light blue: obtained from interferometric analysis (Rignot et al. 2011), in red obtained by mixing these two data. [B] Zoom on the Lambert glacier and Amery Ice Shelf, arrays indicate ice flow direction. [C] Location of all lakes included in the inventory (from Wright at al., under review). Colours/shapes indicate the type of investigations undertaken at each site: Black/triangle = RES, yellow = seismic sounding, green = gravitational field mapping, red/circle = surface height change measurement, square = shape identified from ice surface feature. Lake Vostok is shown in outline.

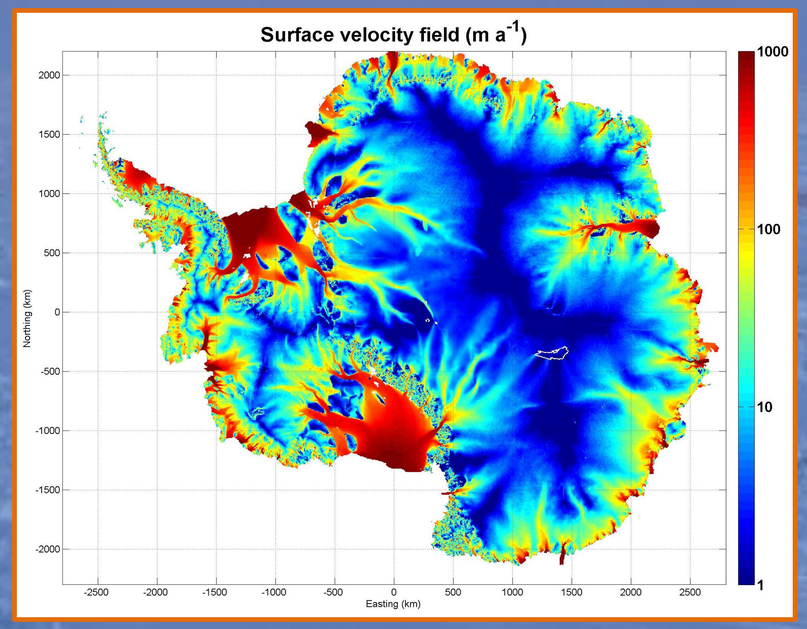


Fig 2. Antarctic ice velocity field derived from Rignot et al. (2011) and Pattyn (2010) truncated at 1000 m a^{-1}. The white line indicates the Vostok Lake.

III. Results and outlook

- More than 50 % of the grounded part of the Antarctic ice sheet is at pressure melting point (Fig. 3).
- The differences of temperature between this study and the result of Pattyn (2010) are minor (Fig. 4). Except: - on the edges of the ice sheet caused by a greater difference in velocity field.
  - in West Antarctica due to a significant change of ice thickness.
- The incorporation of lakes plays a role as well but on a very small scale.
- New data from AGAP (Antarctica's Gamburtsev Province) program could improve the basal conditions for this area.

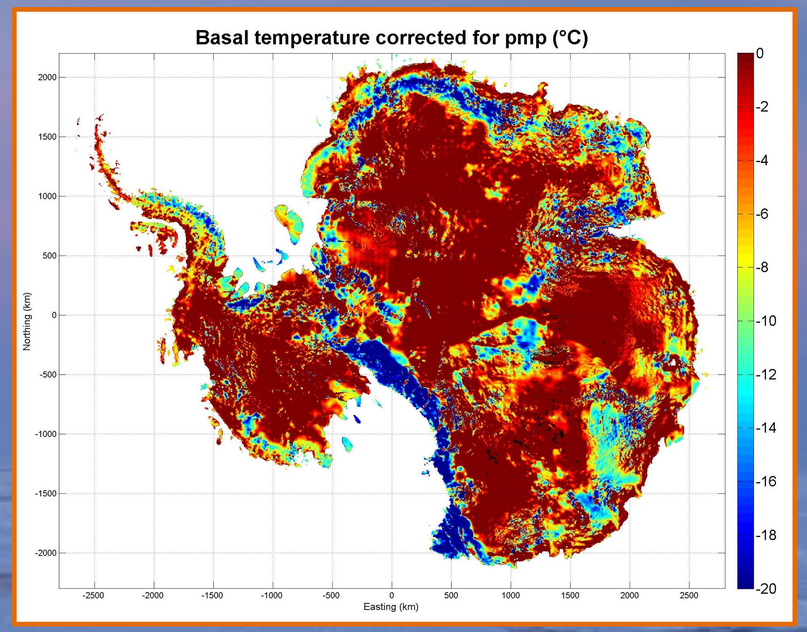


Fig 3. Basal temperature corrected for pressure melting (°C)

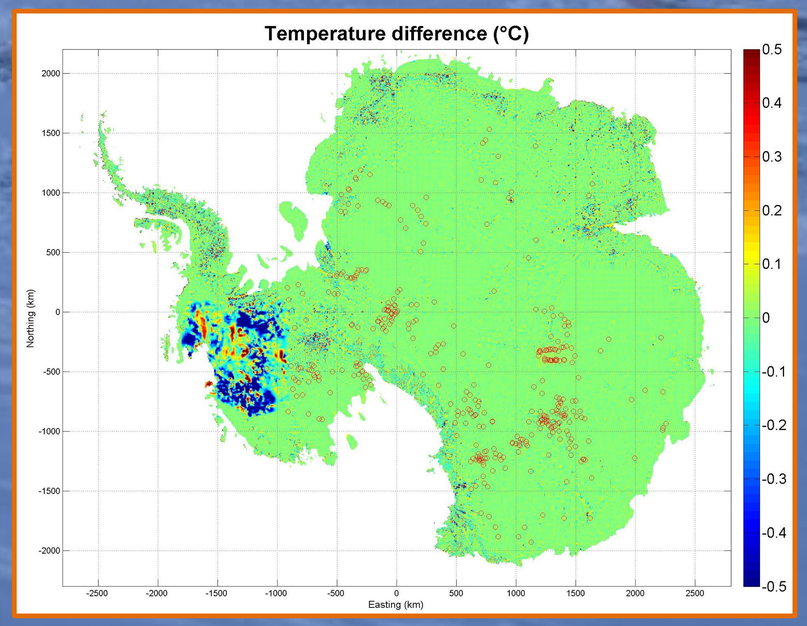


Fig 4. Basal temperature difference (°C) truncated at -0.5 and 0.5. Positive values indicate that our temperature calculations are higher than Pattyn's (2010). Lakes used to constrain the model are noticed by red circles.

IV. Take home message

- **Ice thickness and velocities influence most the basal temperature but the incorporation of new data doesn't change the modeled basal conditions a lot.**

References

1. Le Brocq, A., Payne, A., Vieli, A., 2010. An improved Antarctic dataset for high resolution numerical ice sheet models (ALBMAP V1), Earth Syst. Sci. Data Discuss. 3, 195-230.
2. Pattyn, F., 2010. Antarctic subglacial conditions inferred from a hybrid ice sheet/ice stream model, Earth Planet. Sci. Lett. 295, 451-461.
3. Rignot, E., Mouginot, J., Scheuchl, B., 2011. Ice Flow of the Antarctic Ice Sheet, Science 333, 1427-1429.
4. Wright, A., Siegert, M., The Identification and Physiographical Setting of Antarctic Subglacial Lakes: An Update Based on Recent Discoveries (under review).

Image Credit: NASA