EGU General Assembly 2022

This presentation participates in OSPP

Outstanding Student & PhD candidate Presentation contest

Reconstruction of the Patagonian Ice Sheet during the Last Glacial Maximum using numerical modelling and geological constraints

Franco Retamal-Ramírez[1,2,3], Andrés Castillo[4,5], Jorge Bernales[4,6], Irina Rogozhina[5,7]

[1]Departamento de Geofísica, Universidad de Concepción, Concepción, Chile
[2]Center for Climate and Resilience Research (CR)2, Chile
[3]Centro de Investigación Gaia Antártica, Universidad de Magallanes, Punta Arenas, Chile
[4]MARUM - Center for Marine Environmental Science and Faculty of Geosciences, University of Bremen, Bremen, Germany
[5]Department of Geography, Norwegian University of Science and Technology, Trondheim, Norway
[6]Institute for Marine and Atmospheric Research Utrecht, Utrecht University, Utrecht, Netherlands
[7]Departamento de Ciencias de la Tierra, Universidad de Concepción, Concepción, Chile

Universidad de Concepción

Universidad de Magallanes, Chile

marum Center for Marine Environmental Sciences

Universiteit Utrecht

NTNU Norwegian University of Science and Technology

Introduction

Global Last Glacial Maximum between 23,000 to 19,000 thousand years (ka) before present

Patagonian Ice Sheet (PIS) located in southern South America (38 °S - 56 °S)

Local LGM reached at ~ 35 ka with sea level equivalent of ~1.5 m

Dissimilar response with Northern Hemisphere ice sheets

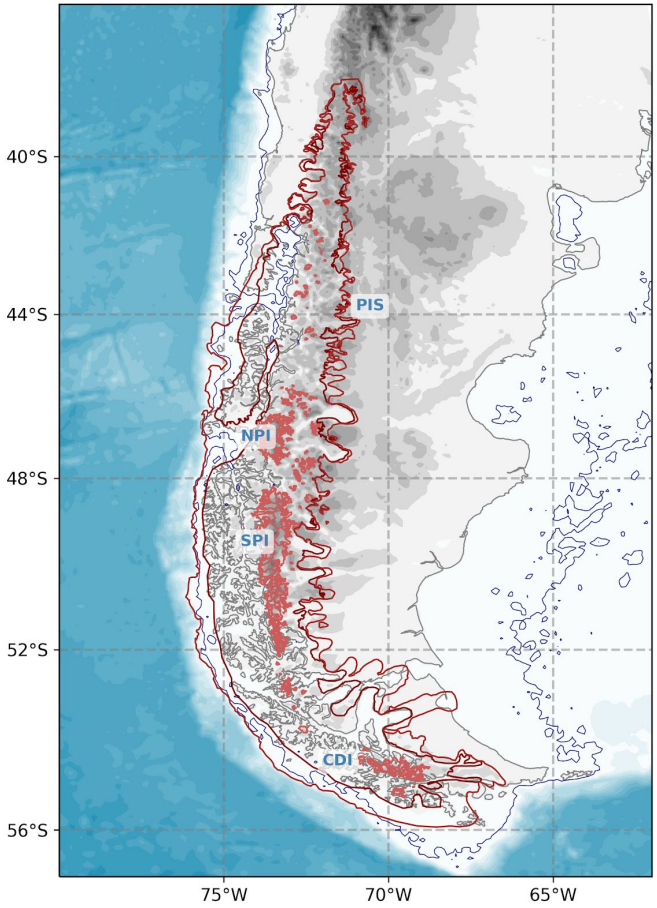
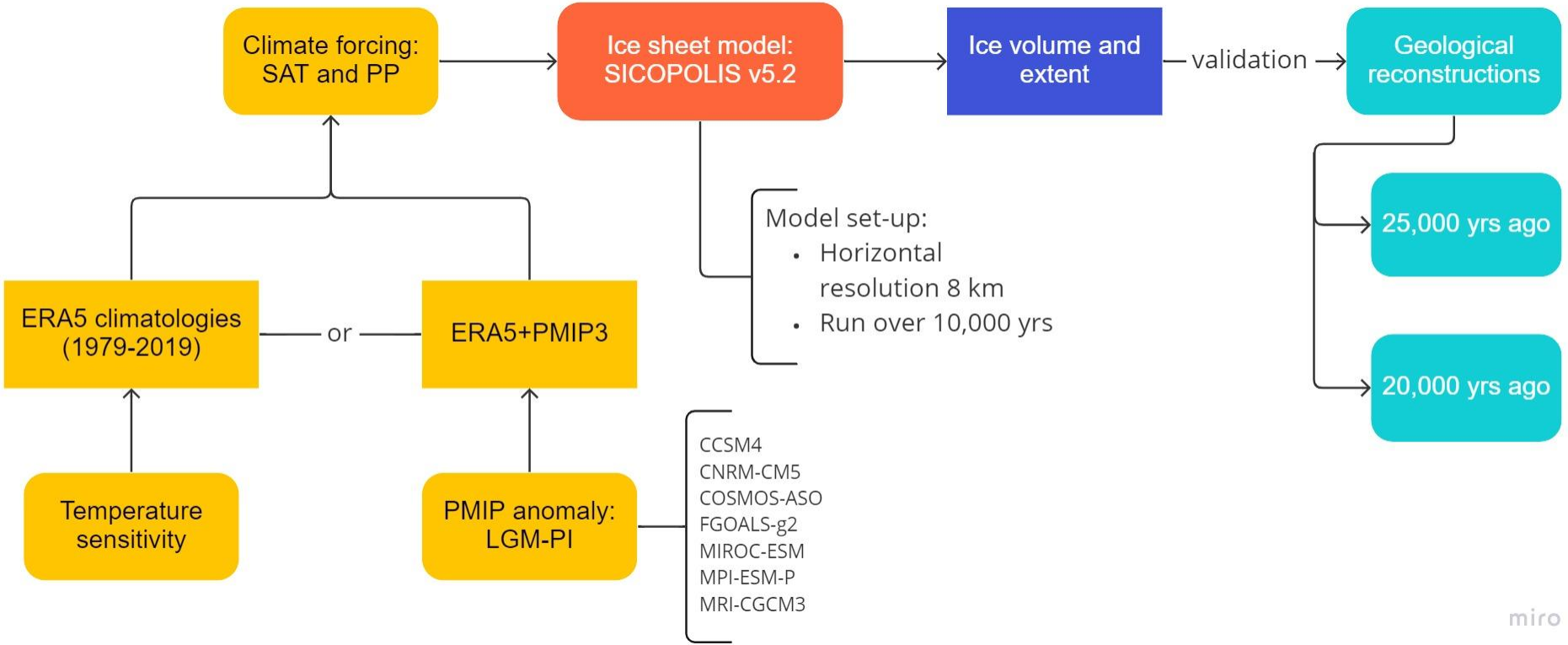


Figure 1: Topographic map of Patagonia using ETOPO1, contours every 400 m. Present day ice fields based on Davies and Glasser (2012). PIS reconstruction from Davis et al. (2020) for 35 and 20 ka BP. Last glacial maximum sea level (-120 m) is shown in blue contour.

Methods



Results

ERA5 climatologies

Decrease of constant temperature over all the domain (between 0 and -9 °C)

Table 1: Approximate estimation of area and volume at each time slice from Davies et al. (2020)

Time	Ice volume (km^3)	Ice extent (km^2)
35 ka	590,000	490,000
25 ka	550,000	465,000
20 ka	400,000	360,000

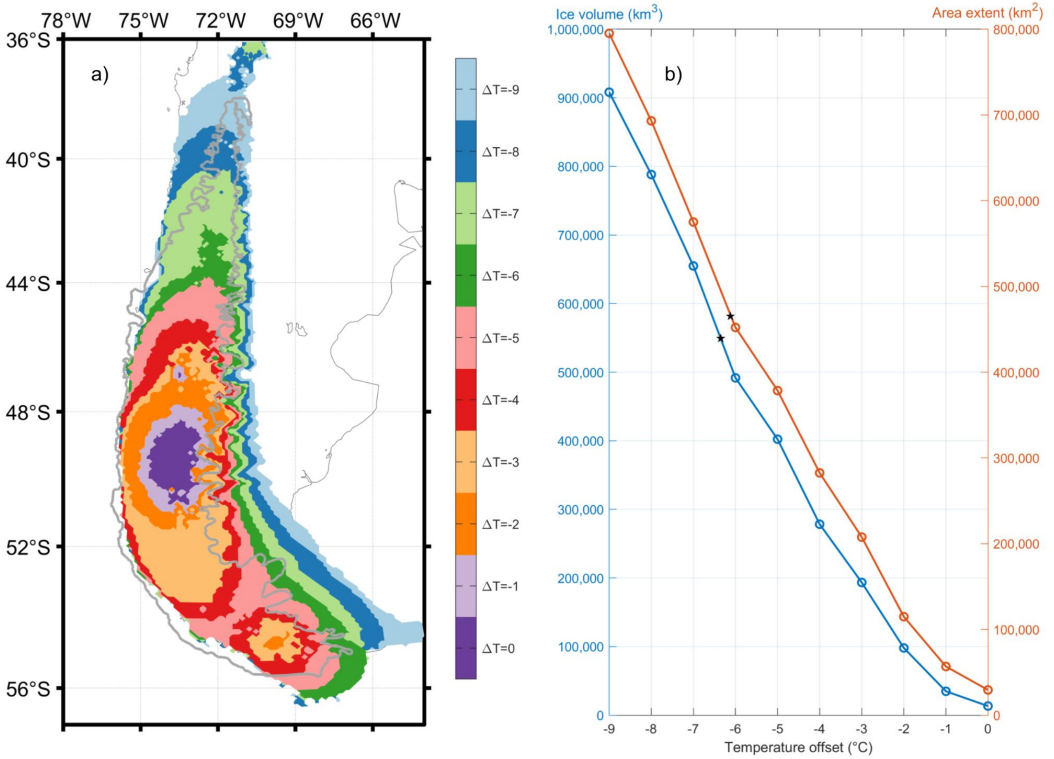


Figure 2: (a) Ice cover derived using precipitation and near-surface temperature from ERA5 and uniform temperature anomalies. (b) Show the final ice volume modelled relative to the temperature offset applied. Black stars represent the ice volume and extent estimated by Davies et al. (2020) at 25 ka BP

Results

PMIP experiments

None of the experiments are able to build-up ice in northern Patagonia (38-41 °S)

CNRM-CM5 reach the greater extension to the north

CNRM-CM5 experiment reach an ice volume of 450,000 km^3 and extension of 426,000 km^2

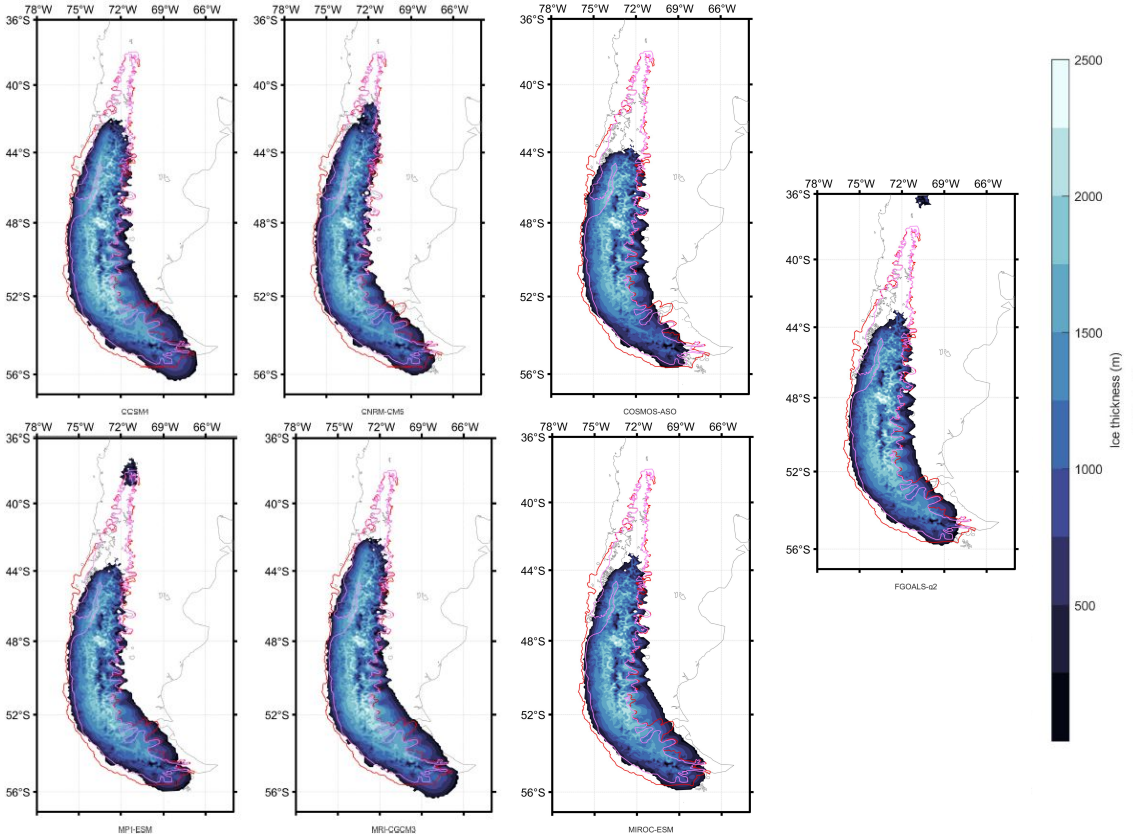


Figure 4: Modelled ice thickness after 10 ka. Geological reconstruction of PIS for 25 and 20 ka based on Davies et al. (2020) are shown for comparison.

Summary

None of the PMIP experiments is able to reconstruct the PIS extension during the LGM

Strong dependence of the surface air temperature in the PIS extent

CNRM-CM5 show the greater extension with lower overestimation

CNRM-CM5 experiment reach an ice volume and extension between the reconstructions for 25 and 20 ka of Davies et al. (2020)

Future work

Andrés Castillo presentation GM7.3 room G2 on Monday, 23 May 2022, 17:50 CEST

References

- Davies, B. J., Darvill, C. M., Lovell, H., Bendle, J. M., Dowdeswell, J. A., Fabel, D., Garc´ıa, J.-L., Geiger,A., Glasser, N. F., Gheorghiu, D. M., et al. (2020). The evolution of the patagonian ice sheet from 35 ka to the present day (PATICE).Earth-Science Reviews, page 103152
- Garreaud, R., Lopez, P., Minvielle, M., & Rojas, M. (2013). Large-scale control on the Patagonian climate. Journal of Climate, 26(1), 215-230.
- Greve, R. (1997). Application of a polythermal three-dimensional ice sheet model to the greenland ice sheet:response to steady-state and transient climate scenarios.Journal of Climate, 10(5):901–918
- Greve, R. and Hutter, K. (1995). Polythermal three-dimensional modelling of the greenland ice sheet withvaried geothermal heat flux.Annals of Glaciology, 21:8–12.
- Hulton, N. R., Purves, R., McCulloch, R., Sugden, D. E., and Bentley, M. J. (2002). The last glacial maximum and deglaciation in southern south america.Quaternary Science Reviews, 21(1-3):233–241.
- Moreno, P. I., Lowell, T. V., Jacobson Jr, G. L., & Denton, G. H. (1999). Abrupt vegetation and climate changes during the last glacial maximumand last termination in the chilean lake district: a case study from canal de la puntilla (41 s). Geografiska Annaler: Series A, Physical Geography, 81(2), 285-311.
- Thorndycraft, V. R., Bendle, J. M., Benito, G., Davies, B. J., Sancho, C., Palmer, A. P., ... & Martin, J. R. (2019). Glacial lake evolution and Atlantic-Pacific drainage reversals during deglaciation of the Patagonian Ice Sheet. *Quaternary Science Reviews*, *203*, 102-127.