Byrd Glacier: MCMC Driven Geostatistical Realizations of Subglacial Topography

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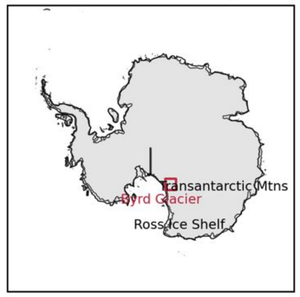
References: Shao, N., MacKie, E., Field, M., & McCormack, F. (2025). A Markov chain Monte Carlo approach for geostatistically simulating mass-conserving subglacial topography. Journal of Glaciology. EarthArXiv. https://doi.org/10.31223/X5SB2R

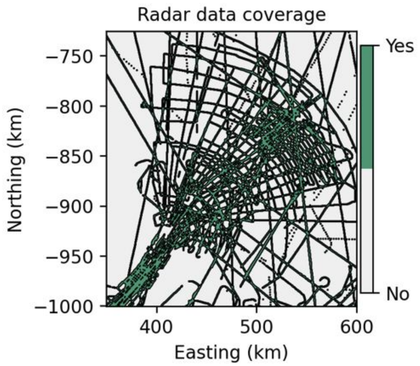
#1

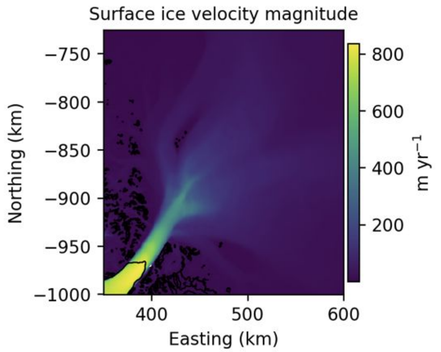
Introduction

Byrd Glacier is a fast, deep outlet cutting through the **Transantarctic Mountains** into the **Ross Ice Shelf**, but its bed is still poorly known and often smoothed in products like **BedMachine** (the main comparison in this analysis).

I use **Sequential Gaussian Simulation and Markov Chain Monte Carlo** to explore many possible bed geometries and select realizations that stay **rough and realistic** while minimizing mass-conservation residuals in the fast trunk.

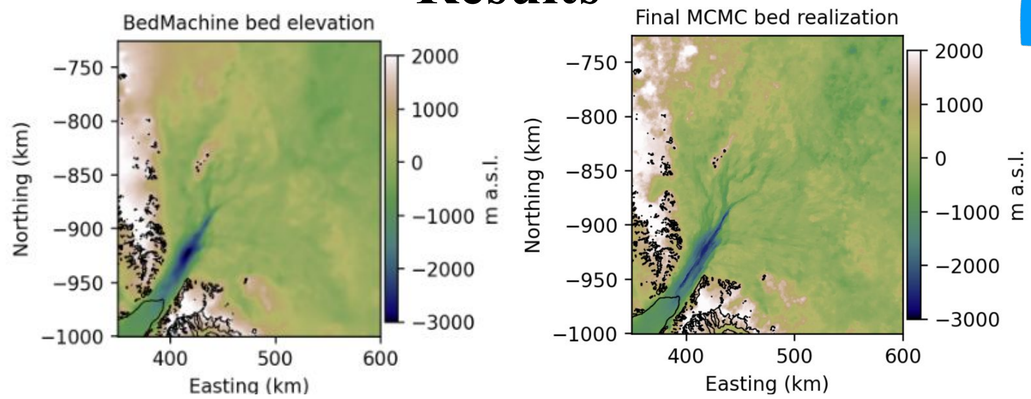


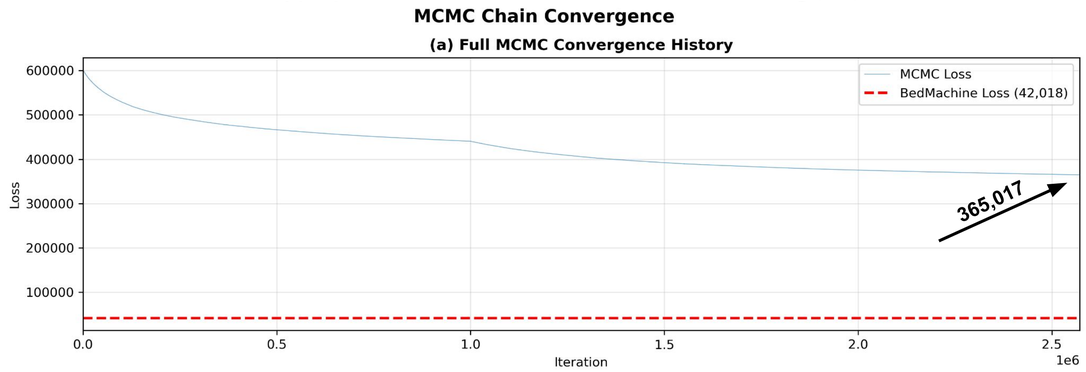


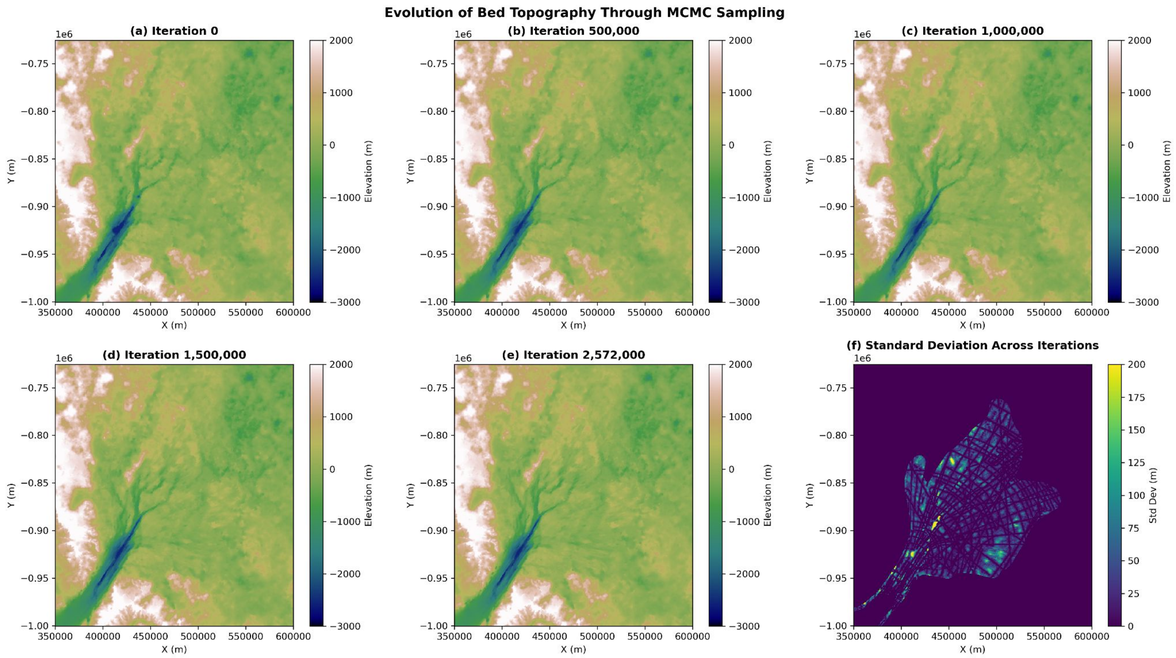


#3

Results







#2

Methods

Ran **≈2.6 million large-scale MCMC iterations** and a **20,000-step small-scale** SGS refinement, perturbing blocks only inside the high-velocity trunk and accepting/rejecting with a mass-conservation loss (velocity, SMB, dh/dt) in the grounded fast-flow region.

Mass-flux loss **dropped from 601,122** (initial SGS bed) **to 365,017**, and extreme **residuals in the trunk became smaller** and less widespread.

BedMachine v3 still has a much lower loss (42,018), so my inversion does not yet beat that reference, but *relative to the initial bed it clearly moves the geostatistical prior toward a more realistic configuration. MCMC works!*

Further tuning of parameters and longer chains should keep lowering mass-flux residuals and shrinking the gap with BedMachine.