Assignment: How does the SMB in your model respond to climate change?

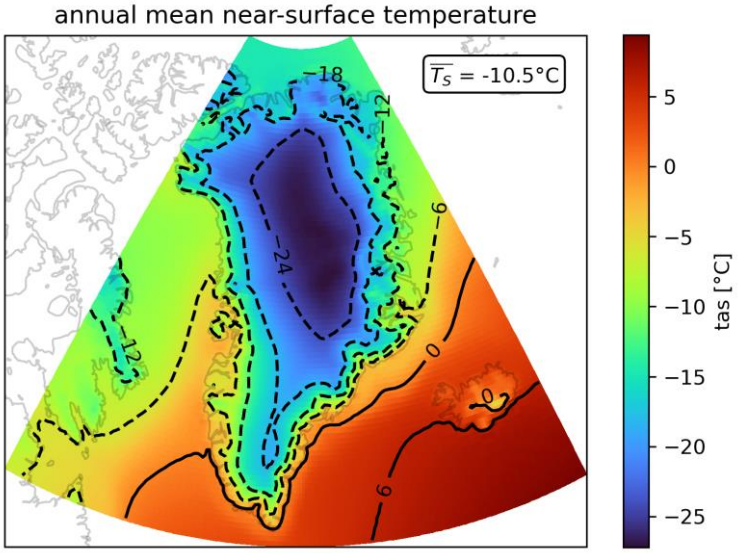
Robert Wright, 19/02/2024

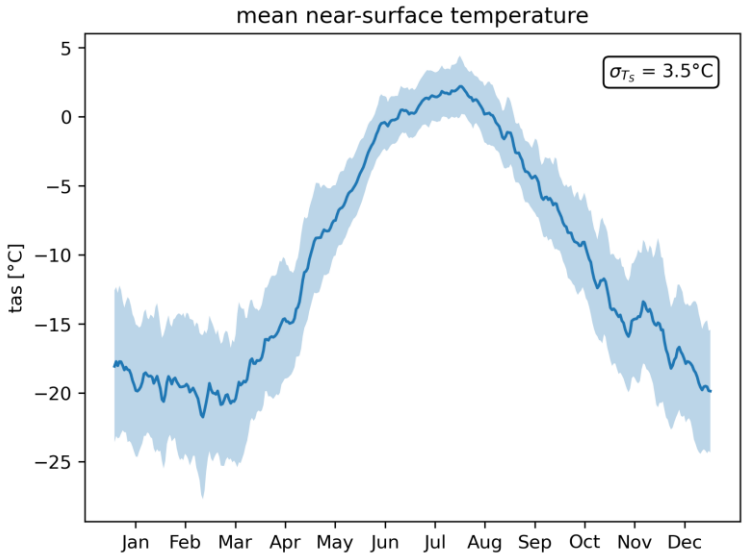
PDD Model Parameters

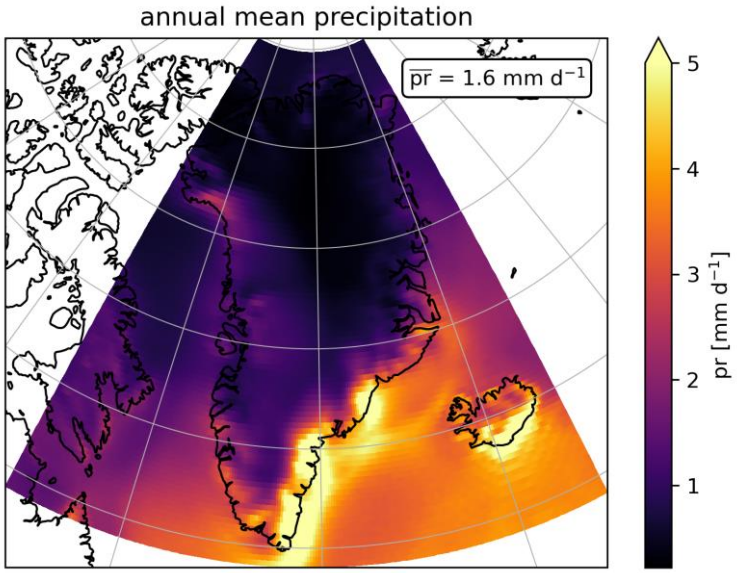
I used the following influences to scale the temperature and precipitation field, respectively:

Variable	Mechanisms	Value
Temperature	Latitudinal gradient	Linear gradient, North-South difference: 15°C
	Elevation	Lapse rate: 0.65°C/100m
	Seasonality	Cosine-function, winter-summer difference: 20°C
	Weather	Normal distribution with standard deviation of 3.5°C
Precipitation	Latitudinal gradient	Linear gradient, North-South difference: 4 mm/d
	Distance to coastline	Euclidian distance scaled by 0.1

I derived an estimate of the above values for the different scaling methods from reanalysis data. I used ERA5 data from 2010 to 2019 to create multi-year plots of the annual mean temperature and precipitation in Greenland:







PDD Model Simulation

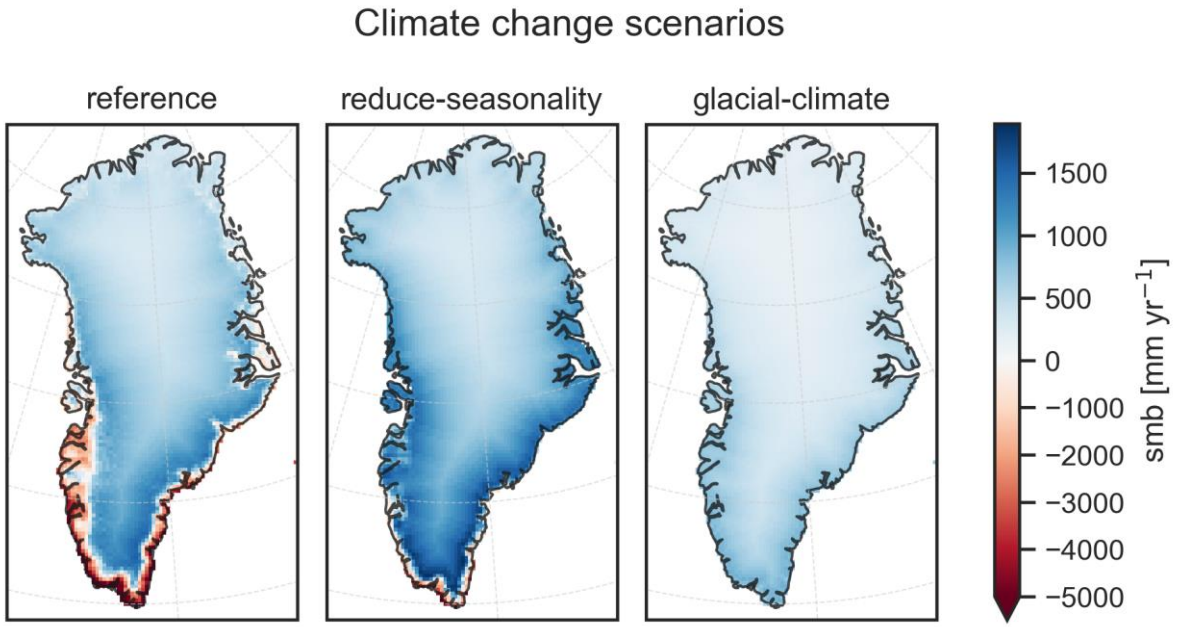
Then, I implemented the formulas for melting/ablation and accumulation. I chose beta = 5 mm/d/°C as this is within the interval of the *ice* and *snow* melting factor chosen in Seguinot, 2017. This original setup is referred to as the *reference* in the following.

Climate Change Scenarios

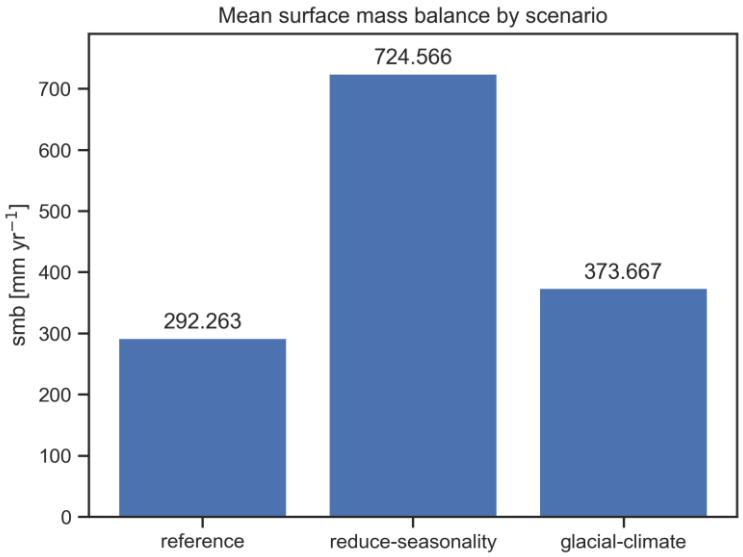
I simulated two different scenarios:

1. *Reduce-seasonality*: Here, the absolute summer-winter difference of the seasonal cycle is reduced to 2°C.

2. *Glacial-climate*: The atmosphere is colder and dryer. Hence, the initial values for filling the temperature and precipitation fields are lowered to -10°C and 3 mm/d, respectively.



Please note that the colorbar uses a different scaling for positive and negative values. While decreasing the magnitude of the seasonal cycle leads to pronounced positive mass balances, a glacial climate, although not matching such high positive values, results in a growth of the ice sheet reaching all the way to the coastline. The mean surface mass balance is in both cases higher if compared to the *reference* simulation.



Code Availability

I'm uploading the improved pdd-model source code as well as the python files to generate all the figures of this report. The project can also be found in an online repository.