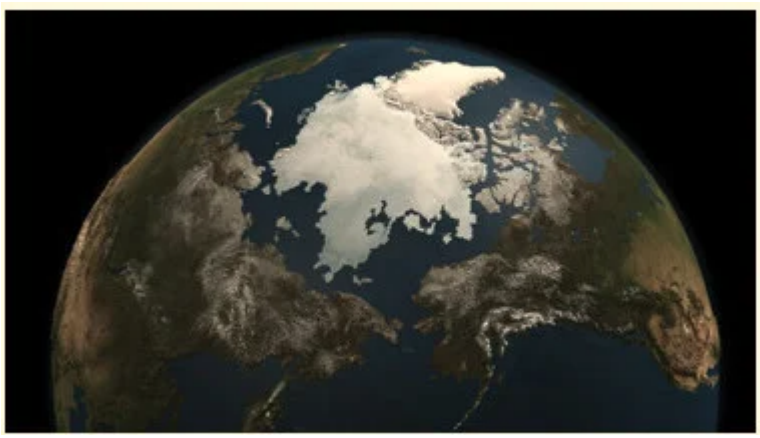
IPCC 2021 – Changing Polar Climate

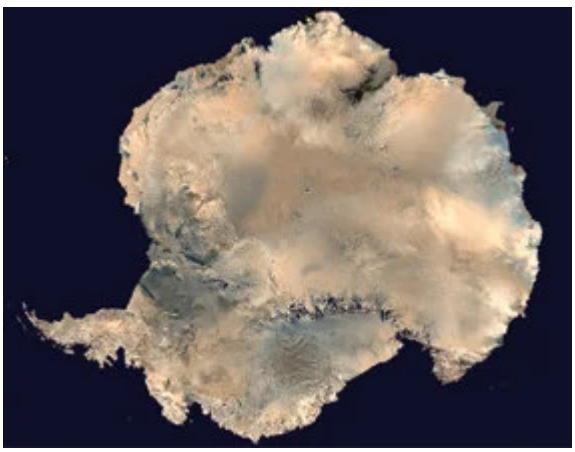
According to the IPCC report for Policymakers "*Human influence is very likely the main driver of the global retreat of glaciers since the 1990s and the decrease in Arctic sea ice area between 1979–1988 and 2010–2019 (about 40% in September and about 10% in March). There has been no significant trend in Antarctic sea ice area from 1979 to 2020 due to regionally opposing trends and large internal variability. Human influence very likely contributed to the decrease in Northern Hemisphere spring snow cover since 1950. It is very likely that human influence has contributed to the observed surface melting of the Greenland Ice Sheet over the past two decades, but there is only limited evidence, with medium agreement, of human influence on the Antarctic Ice Sheet mass loss.*"[1]



NASA **https://www.nasa.gov/topics/earth/features/ice-min-approach.html < https://www.nasa.gov/topics/earth/features/ice-min-approach.html>**

The Arctic is largely sea ice with some parts of countries intruding

Sea ice typically covers about 14 to 16 million km^2 in late winter in the Arctic



https://www.nasa.gov/audience/forstudents/k-4/stories/nasa-knows/what-is-antarctica-k4.html

Antarctica is a CONTINENT with land mass under the ice, mountains, and volcanoes.

Antarctica is 14 million km^2 PLUS 17 to 20 million km^2 of sea ice in the Antarctic Southern Ocean in winter.

Below are some of the common regional changes in the Polar regions[2]

Annual mean surface air temperatures and precipitation will continue to increase during the 21st century under all assessed emissions scenarios in both Polar regions.

There is *high confidence* that mean precipitation and precipitation intensity will increase, the Arctic is projected to be dominated by rainfall and in Antarctica rainfall will increase over the coastal regions.

There is *high confidence* that glaciers have lost mass in all polar regions since 2000 and will continue to lose mass at least for several decades, even if global temperature is stabilized.

Both major ice sheets – Greenland and Antarctica – have been losing mass since at least 1990, with the highest loss rate during 2010–2019 (*high confidence*), and they are projected to continue to lose mass.

1. Using your knowledge of global warming explain why the four changes described above have occurred.

Summary of change	Reason for the change
1. Annual mean surface air temperatures and precipitation will continue to increase during the 21st century in both Polar regions.	
2. Mean precipitation and precipitation intensity will increase, the Arctic is projected to be dominated by rainfall and in Antarctica rainfall will increase over the coastal regions.	
3. Glaciers have lost mass in all polar regions since 2000 and will continue to lose mass at least for several decades, even if global temperature is stabilized.	
4. Both major ice sheets – Greenland and Antarctica – have been losing mass* since at least 1990, with the highest loss rate during 2010–2019 (*high confidence*), and they are projected to continue to lose mass.	

*Losing mass – this means that more ice melts than is gained via snowfall in a given year.

2. **Change two** above suggests that there will be more precipitation (snowfall and rainfall) in Arctic and Antarctic regions. Complete the futures exercise below to consider what this change could mean for those regions.

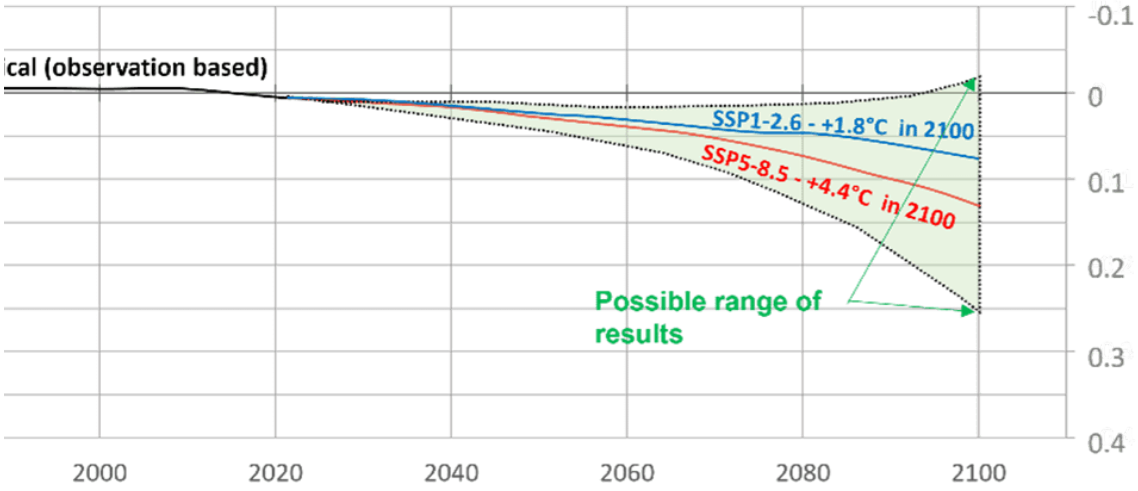
   - What **possible** futures are there for the Arctic and Antarctic with increased precipitation?_____
   - What **probable** futures are there for the Arctic and Antarctic with increased precipitation?_____
   - What **preferable** futures exist for these regions? Here you might want to consider the key role these regions play in regulating our global climate._____

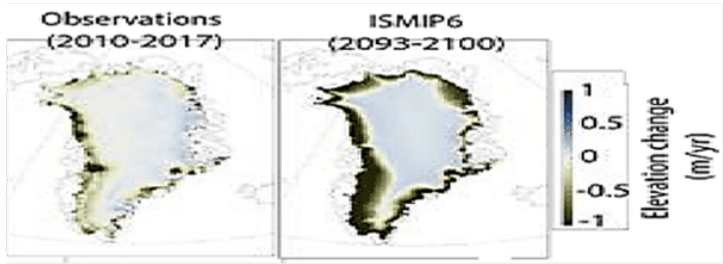
Changes to the Greenland and Antarctic ice sheet.

The graphic below shows Greenland Ice Sheet cumulative mass changes in gigatonnes (recently observed and projected by models under SSP1-2.6 and SSP5-8.5 scenarios) and equivalent sea level change (in metres). Maps show recent elevation changes (metres/year).

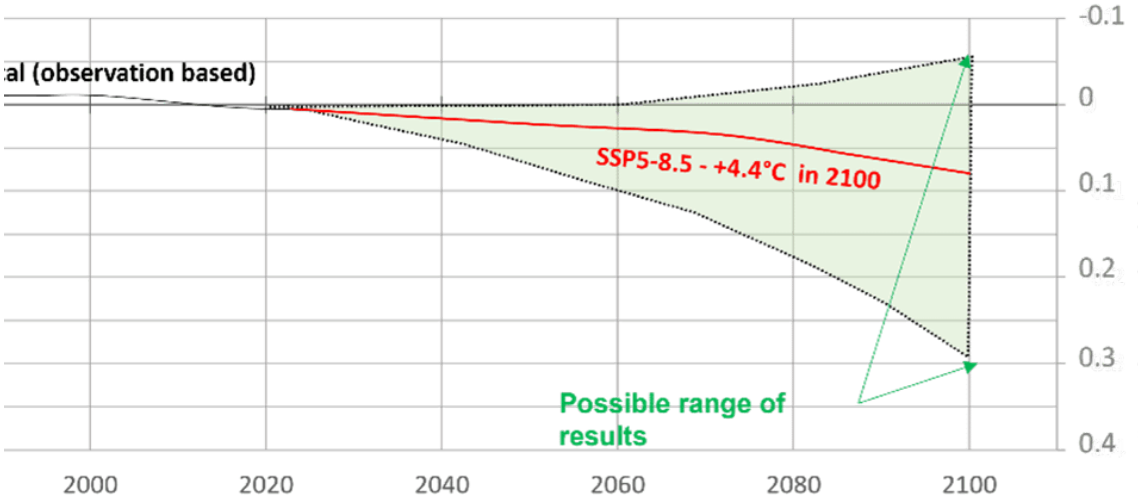
- SSP1-2.6: Global CO_2 emissions are cut severely, but not as fast, reaching net-zero after 2050. Temperatures stabilize around 1.8°C higher by the end of the century.
- SSP5-8.5: Current CO_2 emissions levels roughly double by 2050. The global economy grows quickly, but this growth is fuelled by exploiting fossil fuels and energy-intensive lifestyles. By 2100, the average global temperature is a scorching 4.4°C higher.

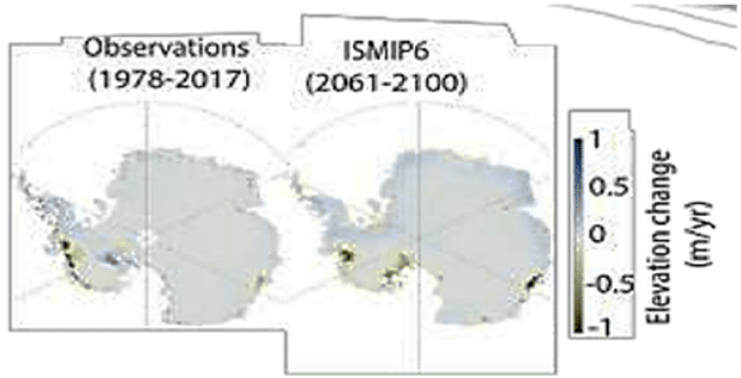
Ice mass change and equivalent sea level change - Greenland





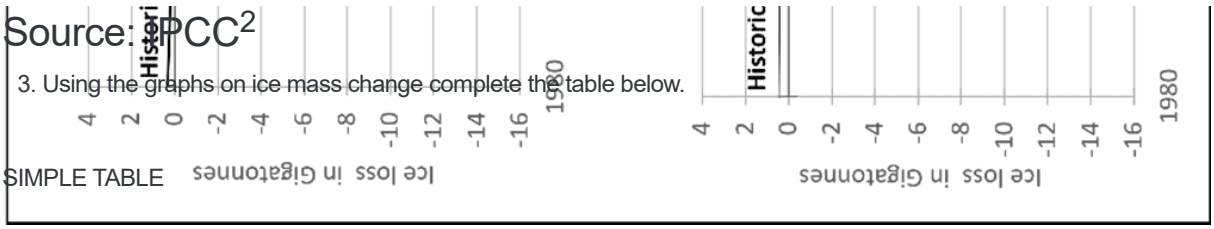
Ice mass change and equivalent sea level change - Antarctica





Source: IPCC[2]

3. Using the graphs on ice mass change complete the table below.



SIMPLE TABLE

	IPCC scenario	Temperature rise by 2100	CO_2 emissions	Mean loss of ice mass in 10,000 gigatons	Mean Sea level change	Description of what happens to the ice sheet on the maps
Greenland	**SSP1 – 2.6**	1.8°C higher	CO_2 emissions are cut severely, but not as fast, reaching net-zero after 2050			
Greenland	**SSP5 – 8.5**	4.4°C higher	Current CO_2 emissions levels roughly double by 2050			
Antarctica	**SSP1 – 2.6**	1.8°C higher	CO_2 emissions are cut severely, but not as fast, reaching net-zero after 2050			
Antarctica	**SSP5 – 8.5**	4.4°C higher	Current CO_2 emissions levels roughly double by 2050			

A gigaton is a billion tonnes. It is roughly equivalent to the mass all of the living mammals other than humans on earth.

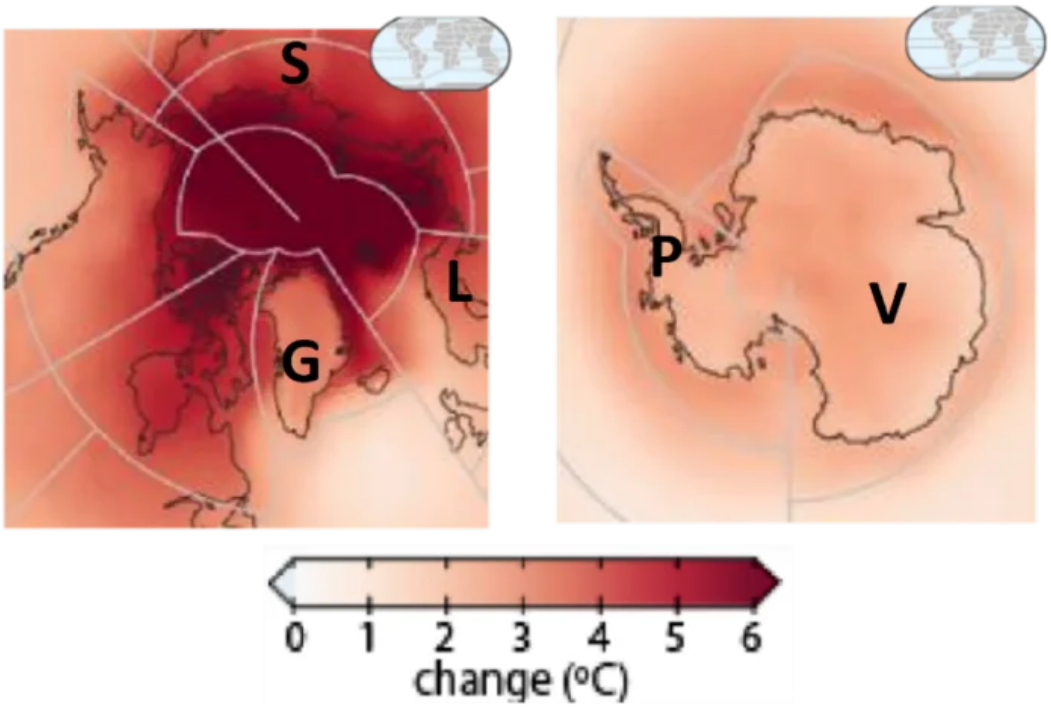
4. Which of the two areas, Greenland or Antarctica, will be most affected by climate change in 2100? Use data from the two graphs and maps to justify your view._____

Projected climate changes in the Polar regions

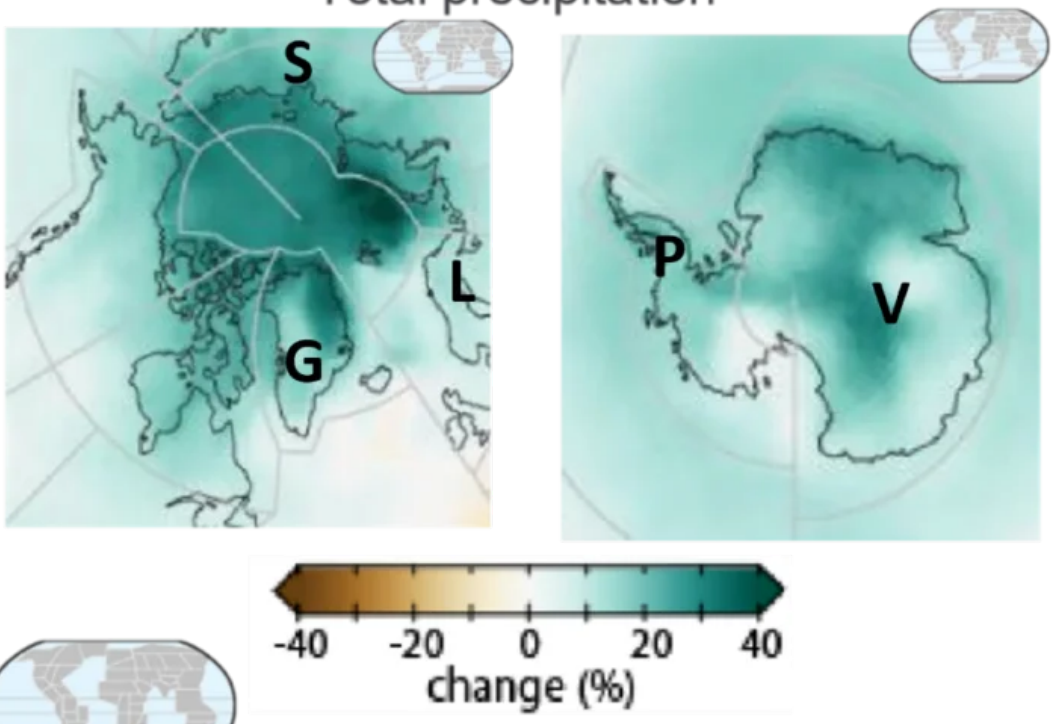
Look carefully at the graphic below, it shows projected changes in the future (SSP5-8.5 scenario) in mean annual temperature and total precipitation at 2°C global warming compared to 1850–1900 for the Arctic (left) and Antarctic (right).

Answer the questions below:

Projected changes (SSP5-8.5 scenario) in mean



Total precipitation



Temperature

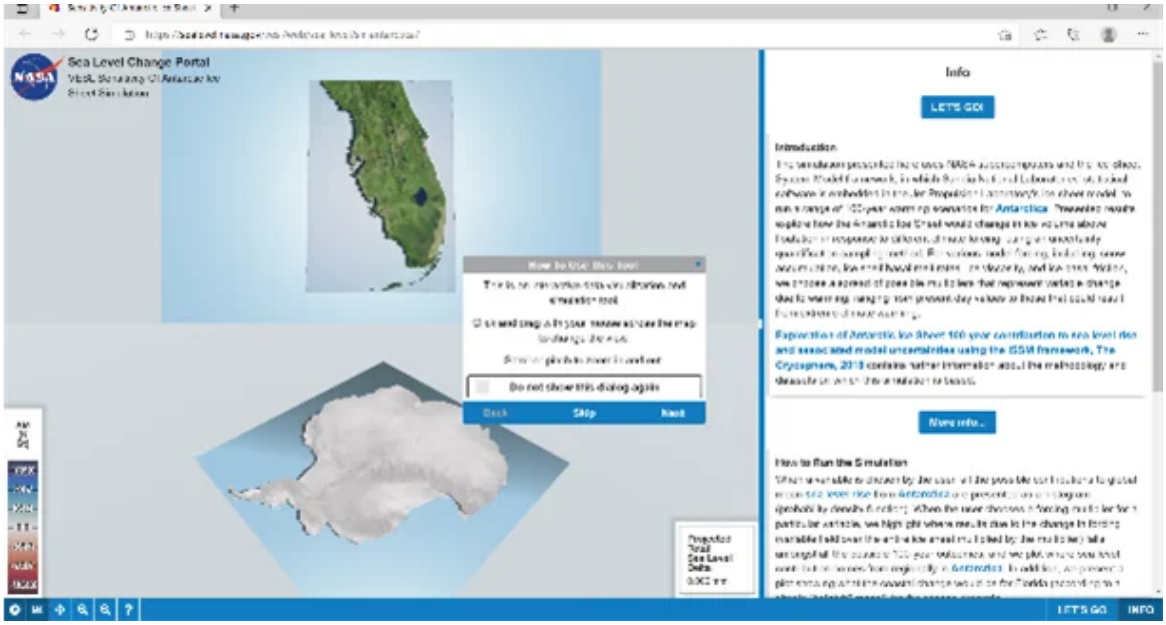
5. What is the projected change for Greenland (G)?
6. What is the projected change for Lapland (L)?
7. What is the projected change for Siberia (S)?
8. Which parts of the Arctic will suffer the most from temperature changes under the IPCC's most extreme climate change scenario?_____
9. What is the projected temperature change for the Antarctic Peninsula (P)?_____
10. What is the projected temperature change at Vostok (V)?_____

Precipitation

11. What is the projected change for Greenland?
12. What is the projected change for Lapland?
13. What is the projected change for Siberia?
14. Which parts of the Arctic will suffer the most from precipitation changes under the IPCC's most extreme climate change scenario?_____
15. What is the projected precipitation change for the Antarctic peninsula?_____
16. What is the projected precipitation change at Vostok? _____
17. Which areas are likely to suffer the most change, the oceans or the land masses?_____
18. Conduct research online, why is it significant for ice melting that the oceans warm? (e.g. https://www.worldwildlife.org/pages/why-are-glaciers-and-sea-ice-melting) _____

Extension

Geographic Information Systems (GIS) – run the simulation at this website **https://sealevel.nasa.gov/vesl/web/sea-level/slr-antarctica/ < https://sealevel.nasa.gov/vesl/web/sea-level/slr-antarctica/>** .
Describe the changes that take place to try to explain them._____



Sources

- IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press. In Press. P.10. Accessed 28th November 2021 at **Sixth Assessment Report (ipcc.ch) < https://www.ipcc.ch/report/ar6/wg1/>**
- ch. 2021. *Regional fact sheet – Polar Regions.* [online] Available at: **https://www.ipcc.ch/report/ar6/wg1/downloads/factsheets/IPCC_AR6_WGI_Regional_Fact_Sheet_Polar_regions.pdf < https://www.ipcc.ch/report/ar6/wg1/downloads/factsheets/IPCC_AR6_WGI_Regional_Fact_Sheet_Polar_regions.pdf>** [Accessed 28 November 2021].

Other resources based on the 2021 IPCC report
< https://www.metlink.org/ipcc-2021-resources/>