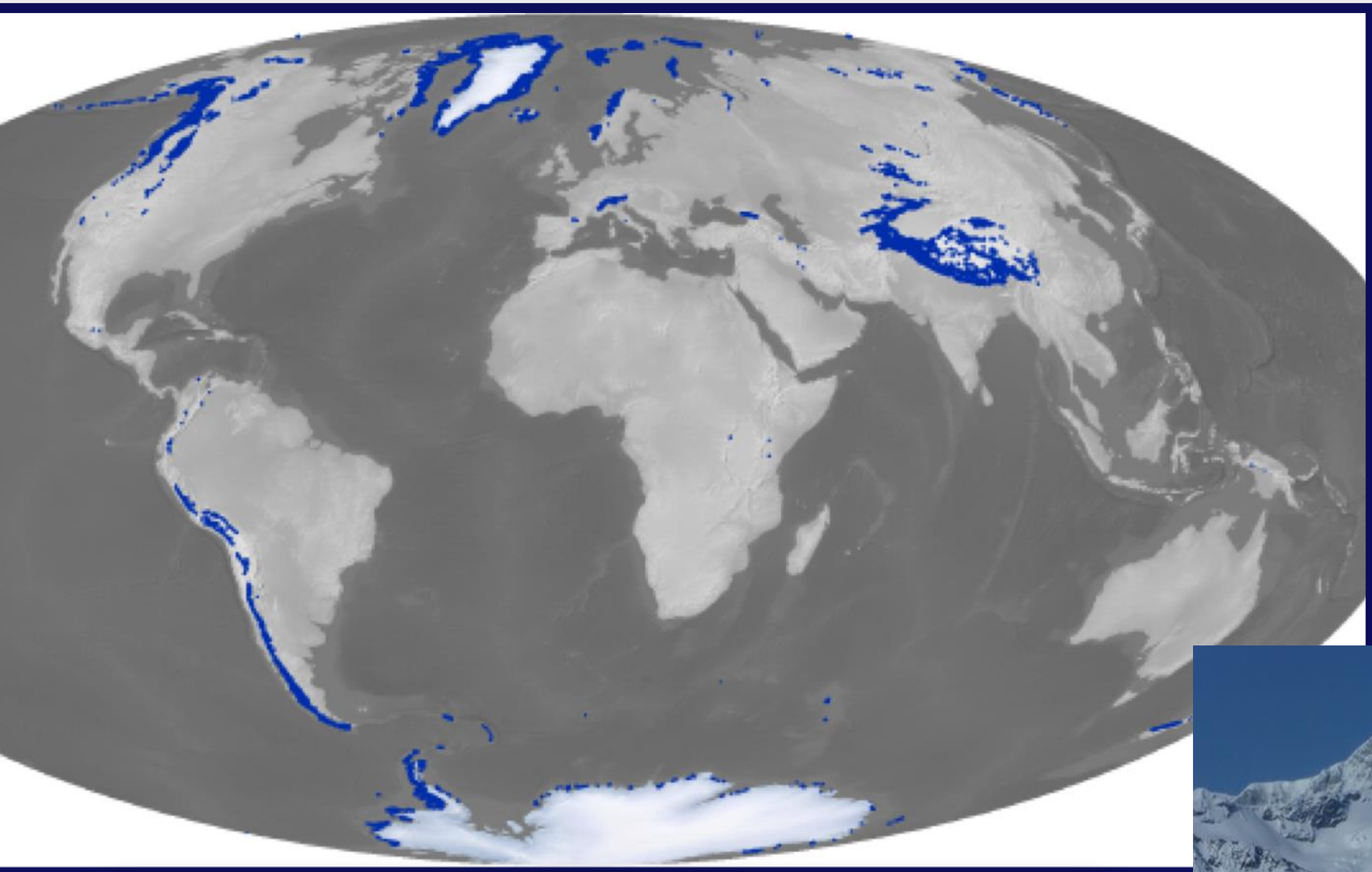
Global glacier meltdown
Every increase in temperature matters !

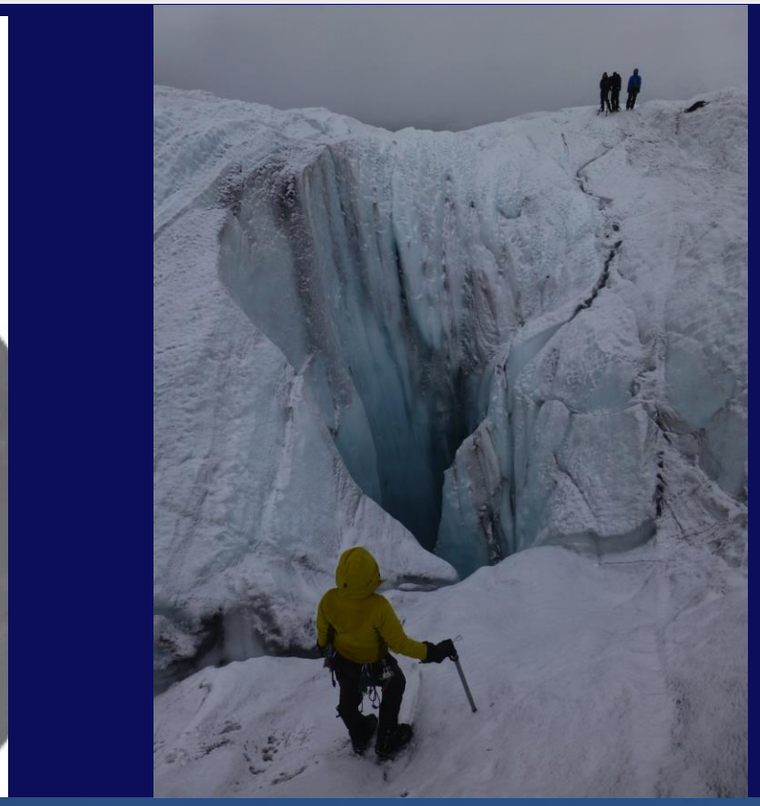
Regine Hock (Thomas V Schuler)

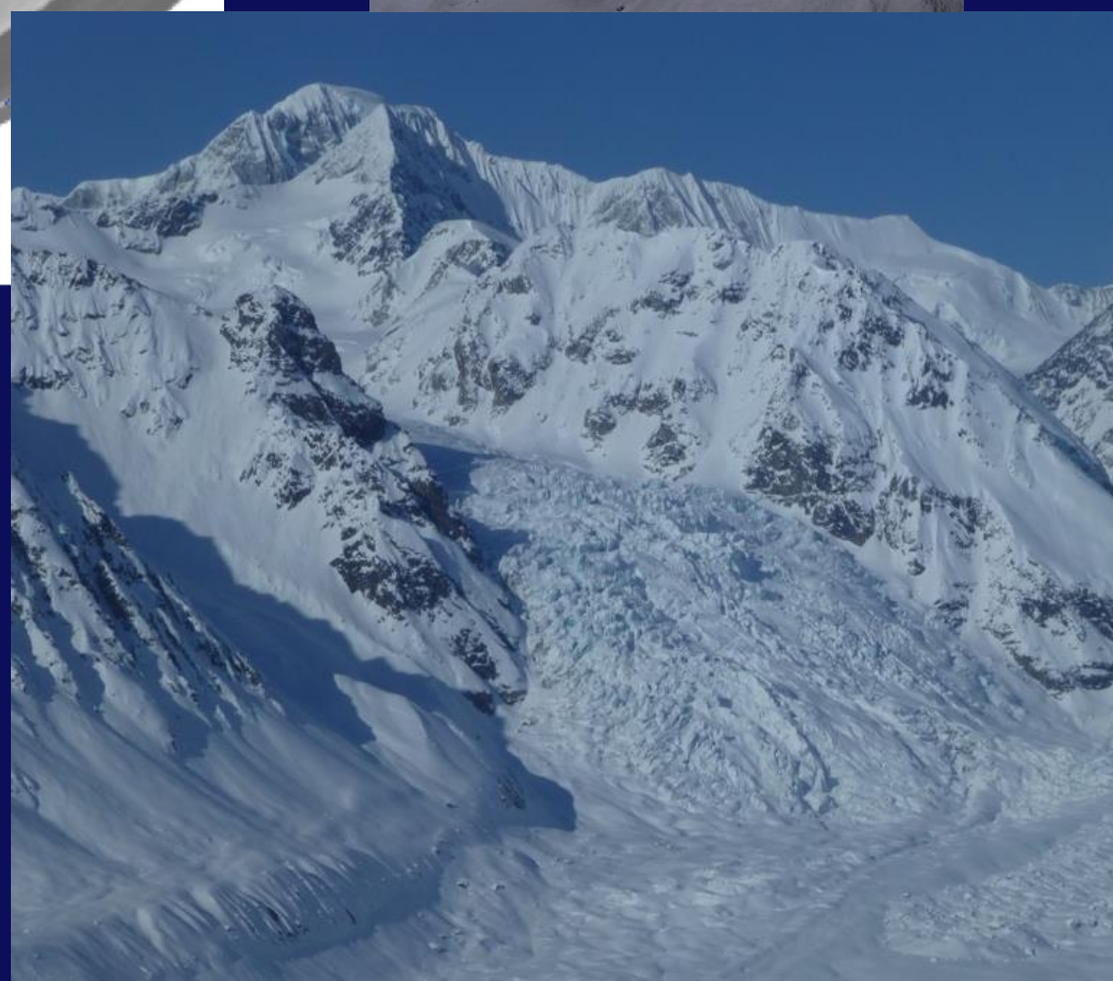
Department of Geosciences, Univ. of Oslo, Norway

Bolivia

All glaciers outside the ice sheets

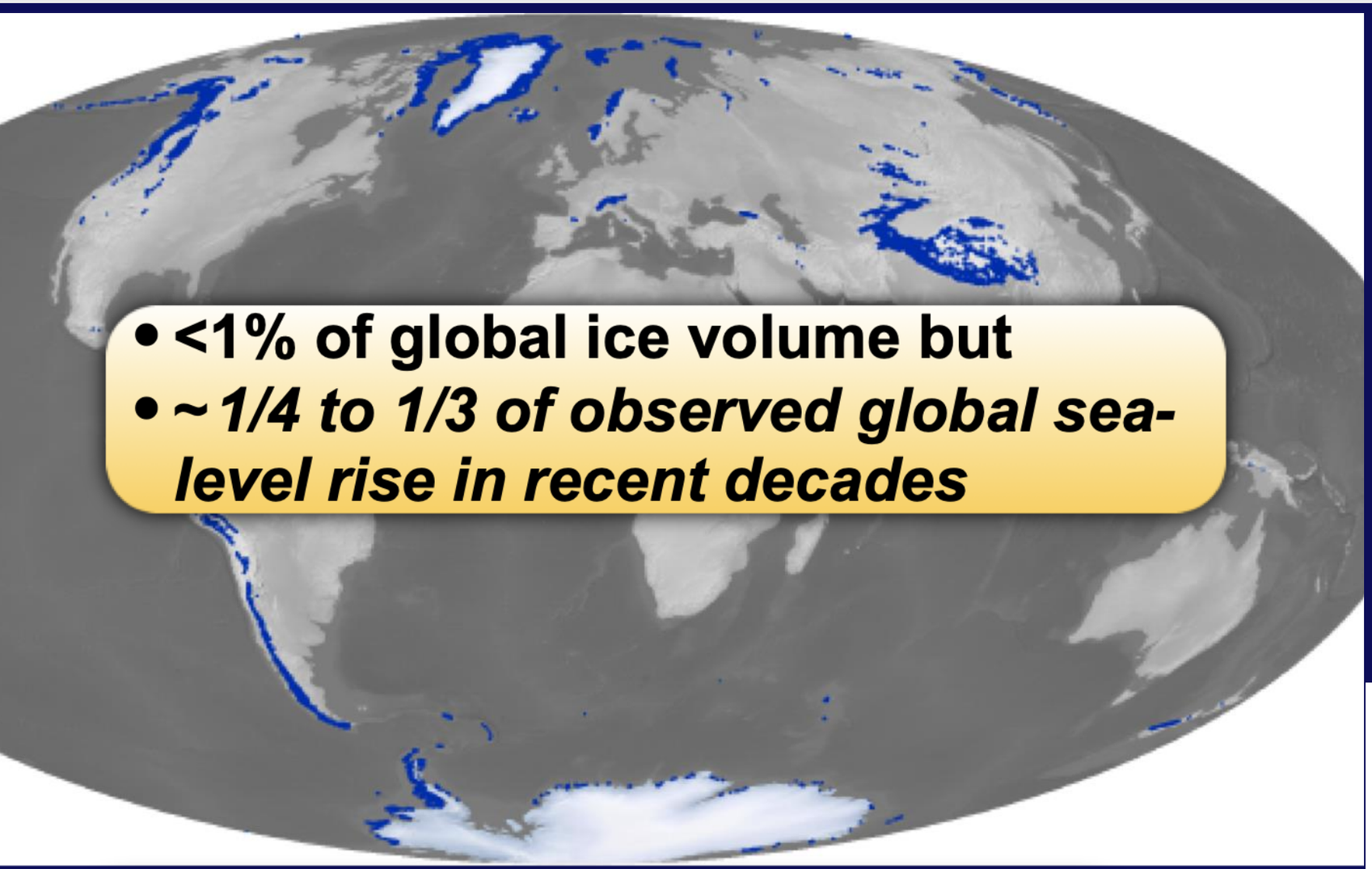




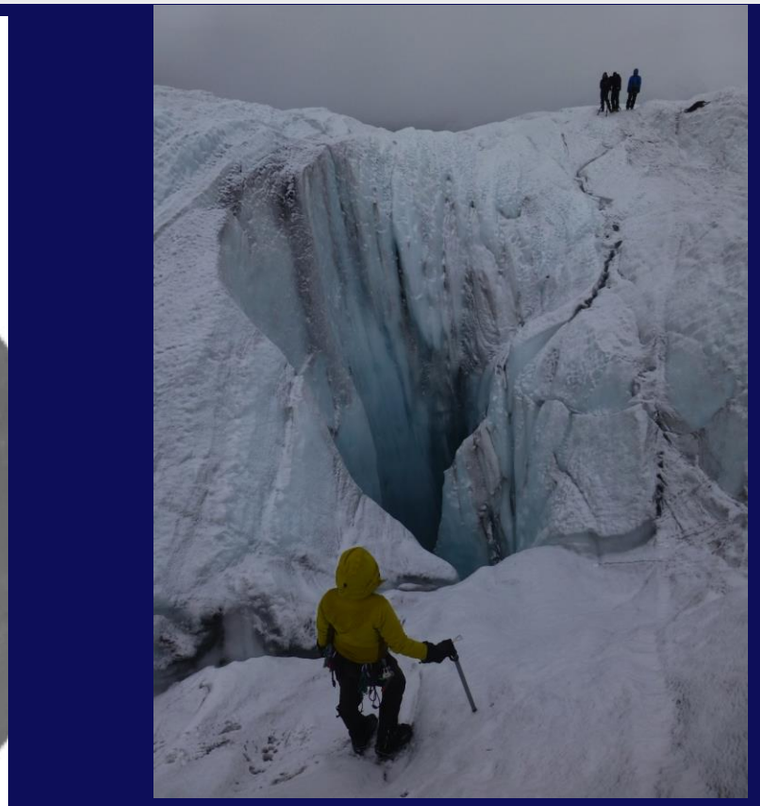


- >270,000 glaciers
- ~707,000 km²
  (incl. glaciers in the Greenland & Antarctic periphery)
- Sea-level equivalent
  <0.4 m

All glaciers outside the ice sheets



- **<1% of global ice volume but**
- ***~1/4 to 1/3 of observed global sea-level rise in recent decades***



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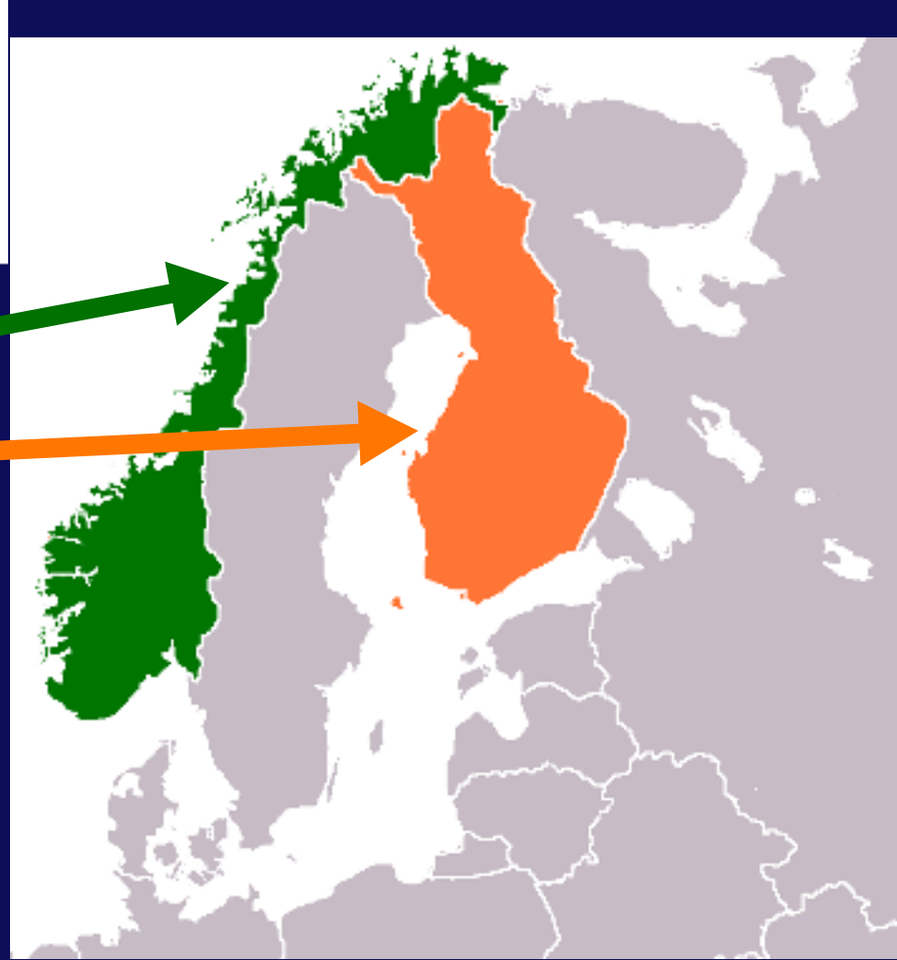


Glaciers lose mass and retreat world-wide

Muir Glacier, Alaska

Photo courtesy: W Field and B. Molnia, National Snow and Ice Data Center

Findelengletscher, Switzerland 2010-2018

R. Delaloye, Fribourg University

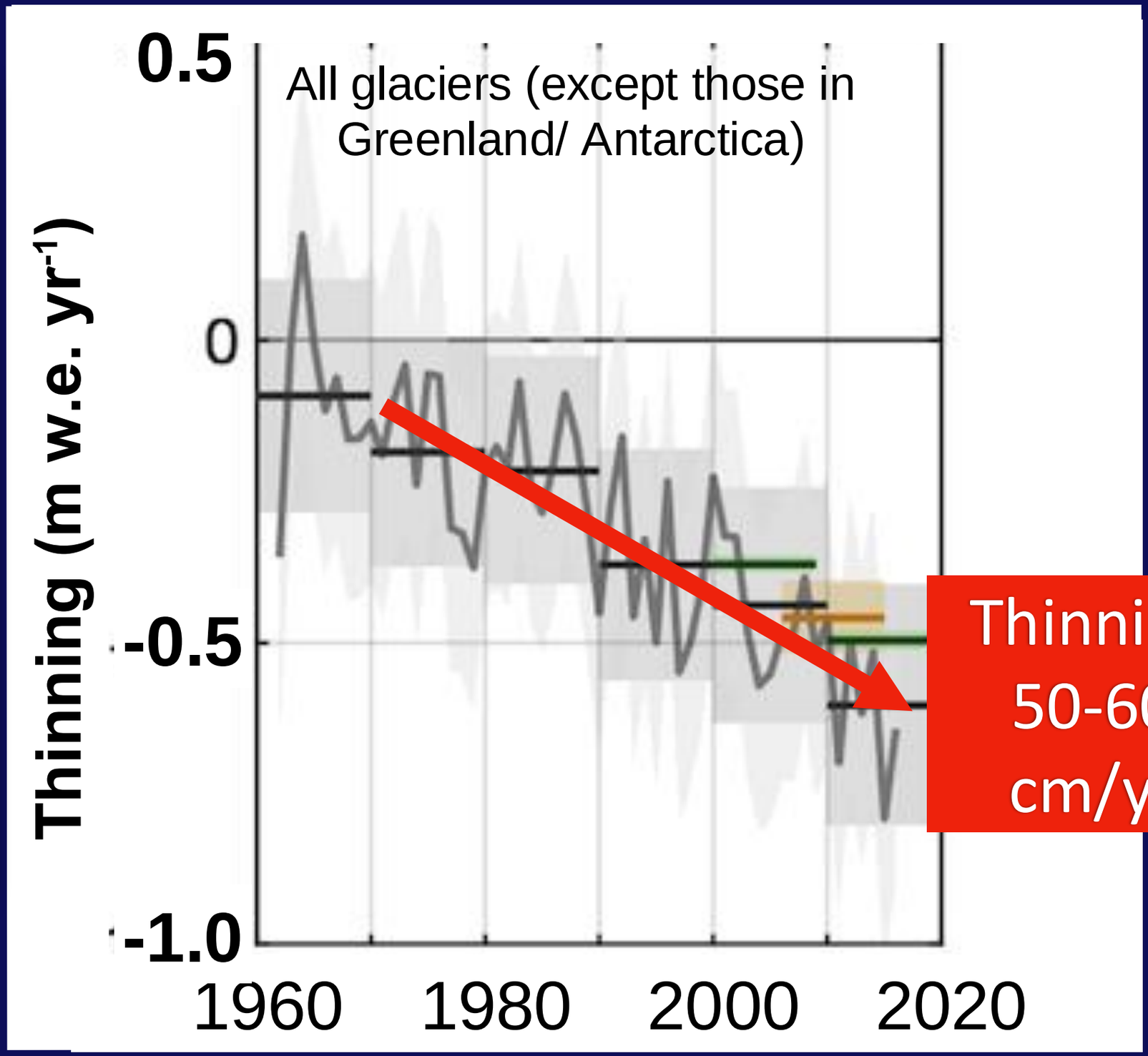
ALPINE CRYOSPHERE AND GEOMORPHOLOGY

Courtesy M. Huss

Global glacier mass changes 1960-2019

- *Increased glacier mass loss rate*
- *Mass loss is **18%** larger loss from **Greenland Ice Sheet** and more than twice that from **Antarctic Ice Sheet**.*
- *Since 2000 glaciers have lost **5%** of their volume*
  (14% in Scandinavia
  40% in European Alps)

GLAMBIE, 2025, Science

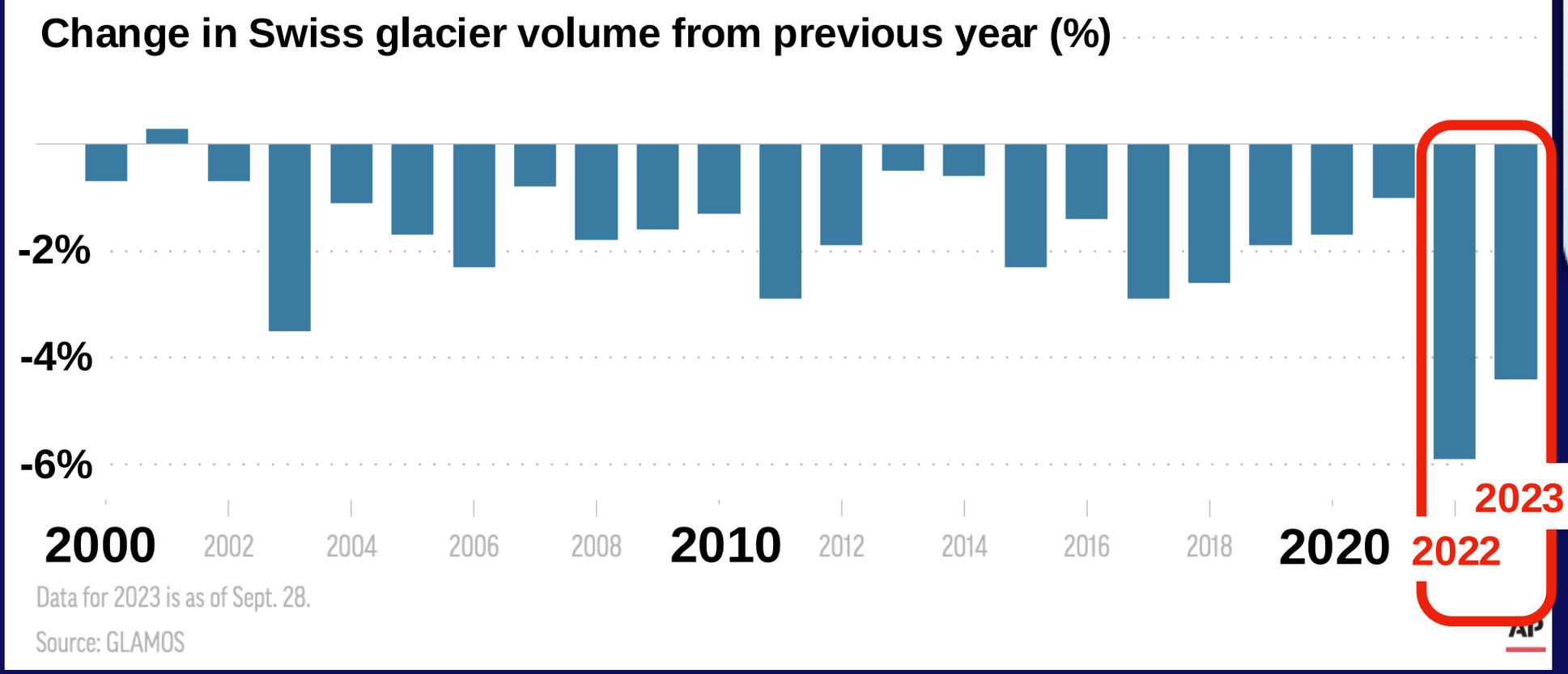


Fox-Kemper et al. 2021, IPCC AR6, Chapter 9
based on Hugonnet et al., 2021, and other studies

Record glacier melt in European Alps in 2022/2023

Swiss glacier melt accelerates

The last time Swiss glaciers added ice was more than a generation ago. Low winter snowfall and high summer heat over the last two years has contributed to accelerated glacier melt.

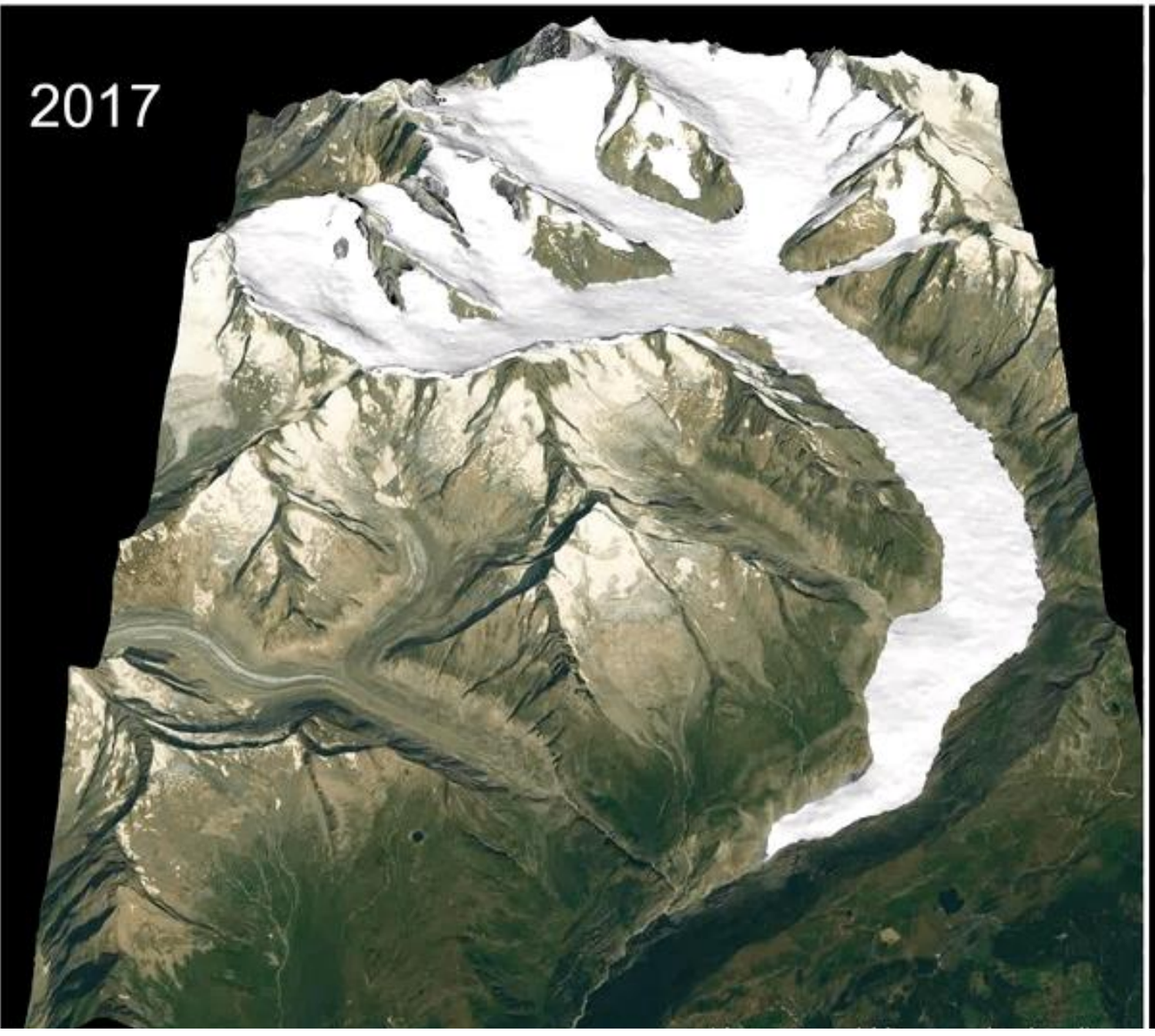


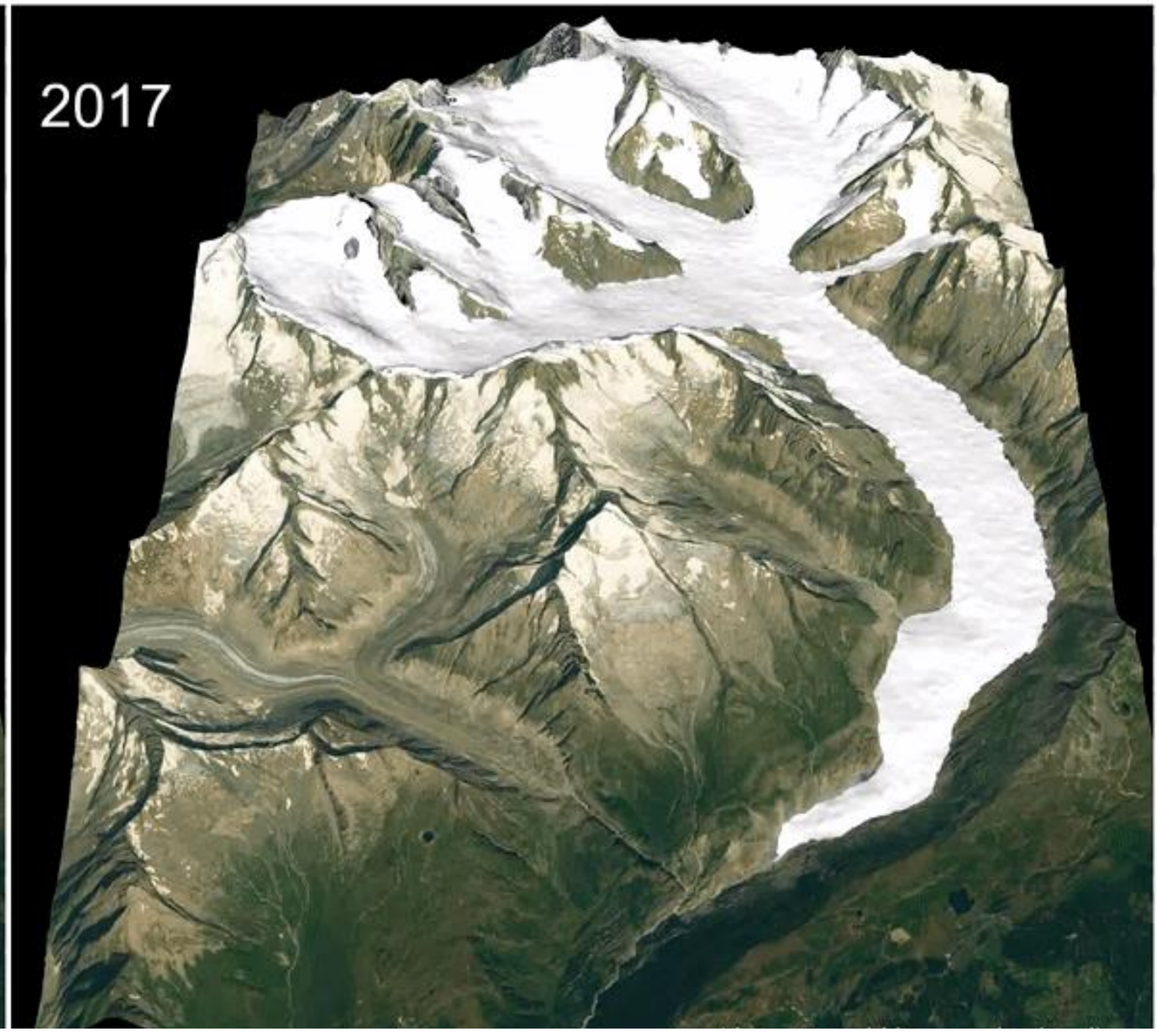
10 % of total glacier volume melted in 2 years (2022 and 2023)

www.gletschervergleiche.ch, Simon Oberli
Courtesy M. Huss

How will glaciers change in the future?

Aletschgletscher, Switzerland, 2017 - 2100





High emission scenario (RCP8.5)

Low emission scenario (RCP2.6)

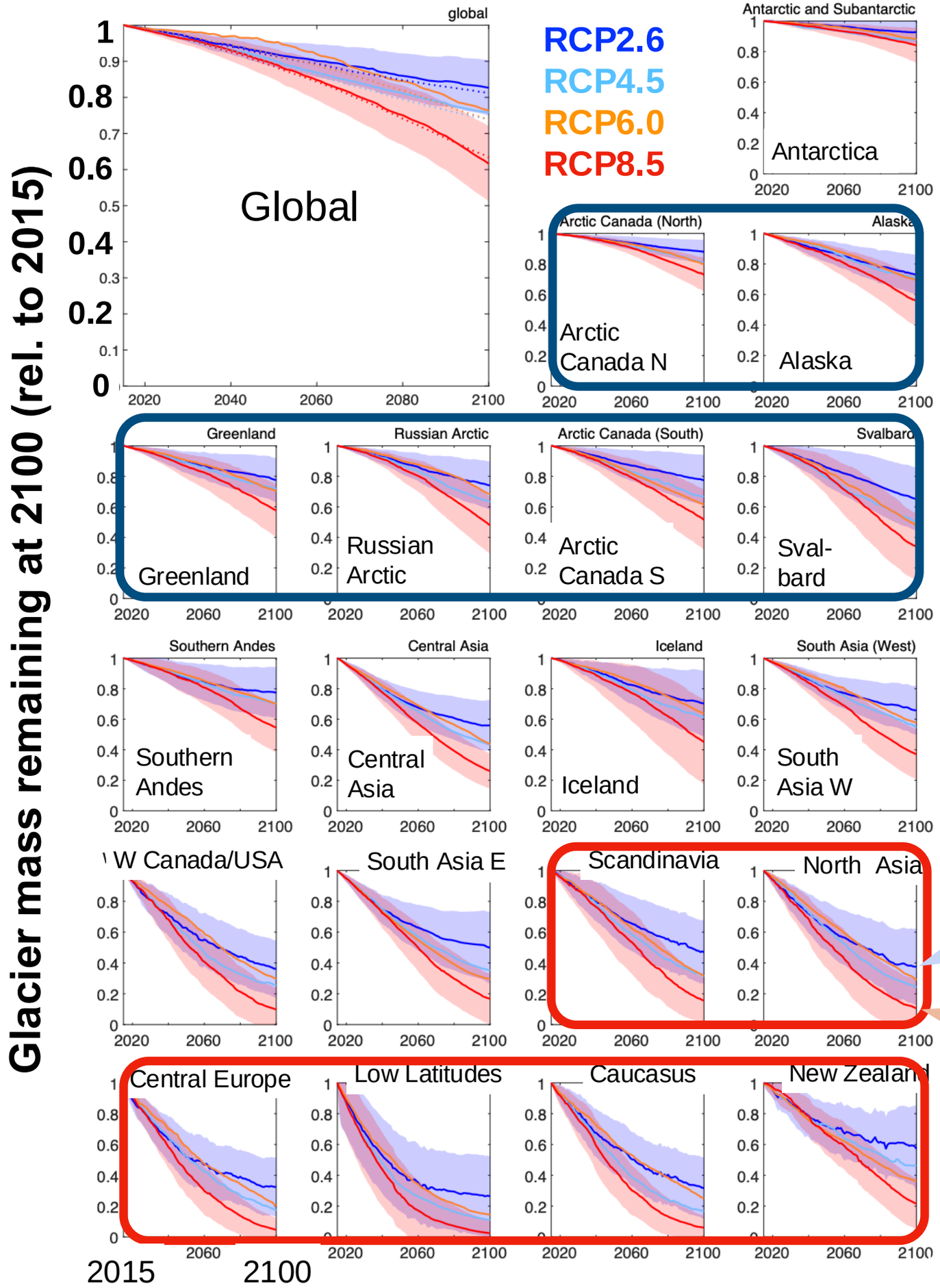
Largest glacier in the European Alps

(23 km long)

Courtesy of Matthias Huss

Jouvet & Huss, 2019, J. Glaciol.

Regional glacier projections 2015 - 2100



Global mass losses

~20 % (RCP 2.6)

~40 % (RCP 8.5)

Sea-level equivalent

~8 *mm* (RCP 2.6)

~17 *mm* (RCP 8.5)

Low emission scenario (RCP2.6)

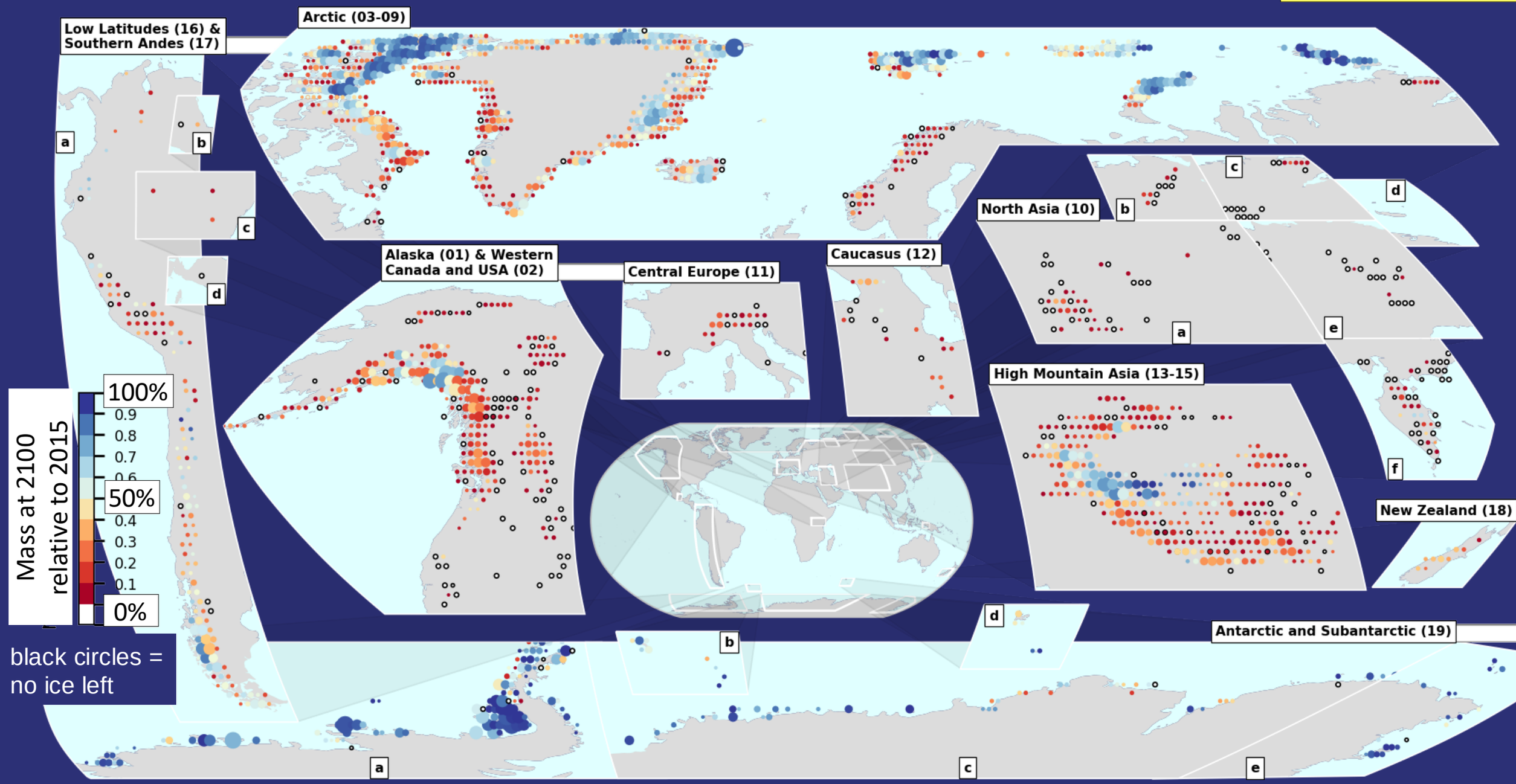
High emission scenario (RCP8.5)

egions are sorted
y relative mass
sses

Marzeion et al 2020

How much glacier mass will remain in 2100 relative to 2015 ?

Global temperature increase by 2100 above pre-industrial **+1.5°C**



Rounce et al, 2023, Science

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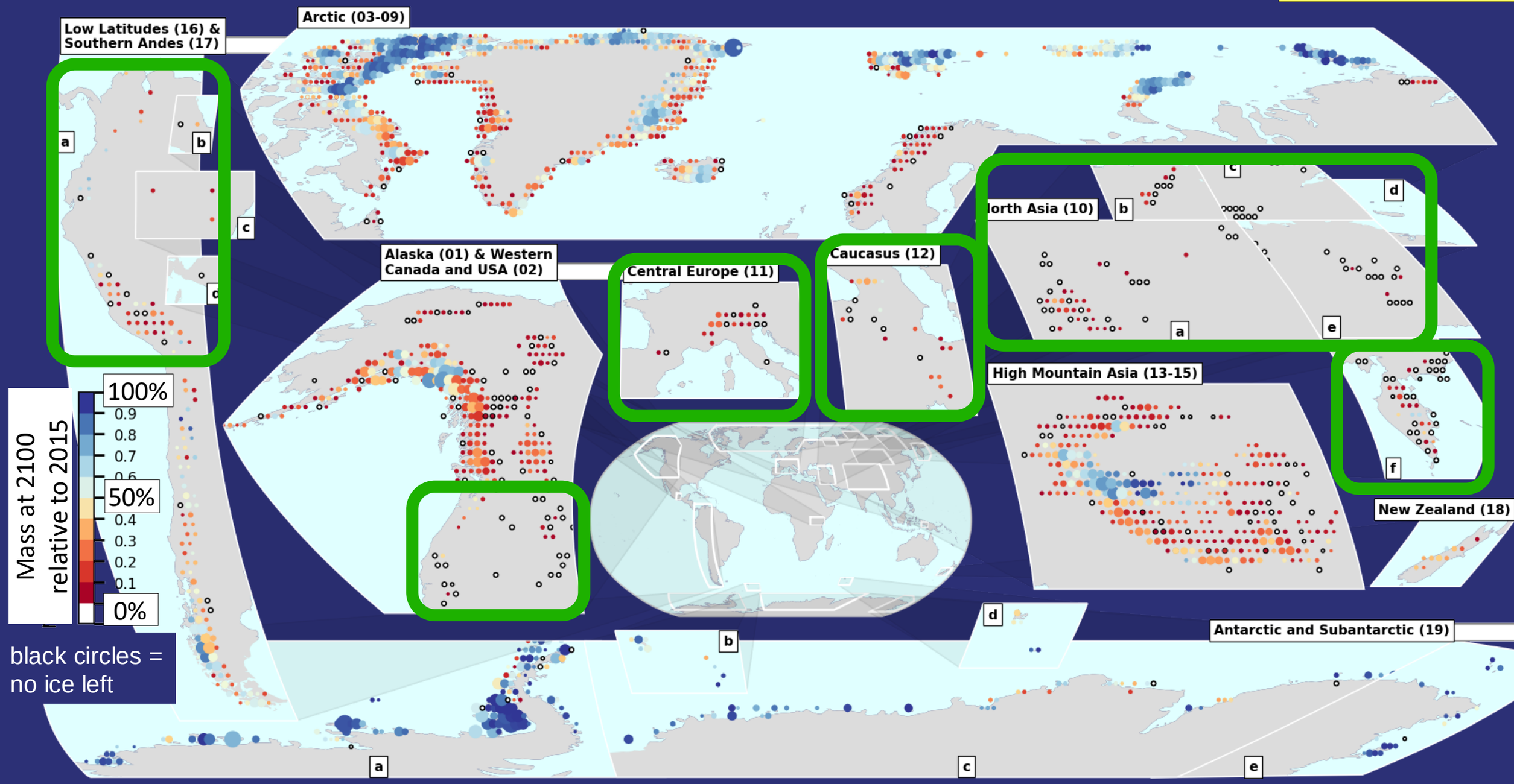
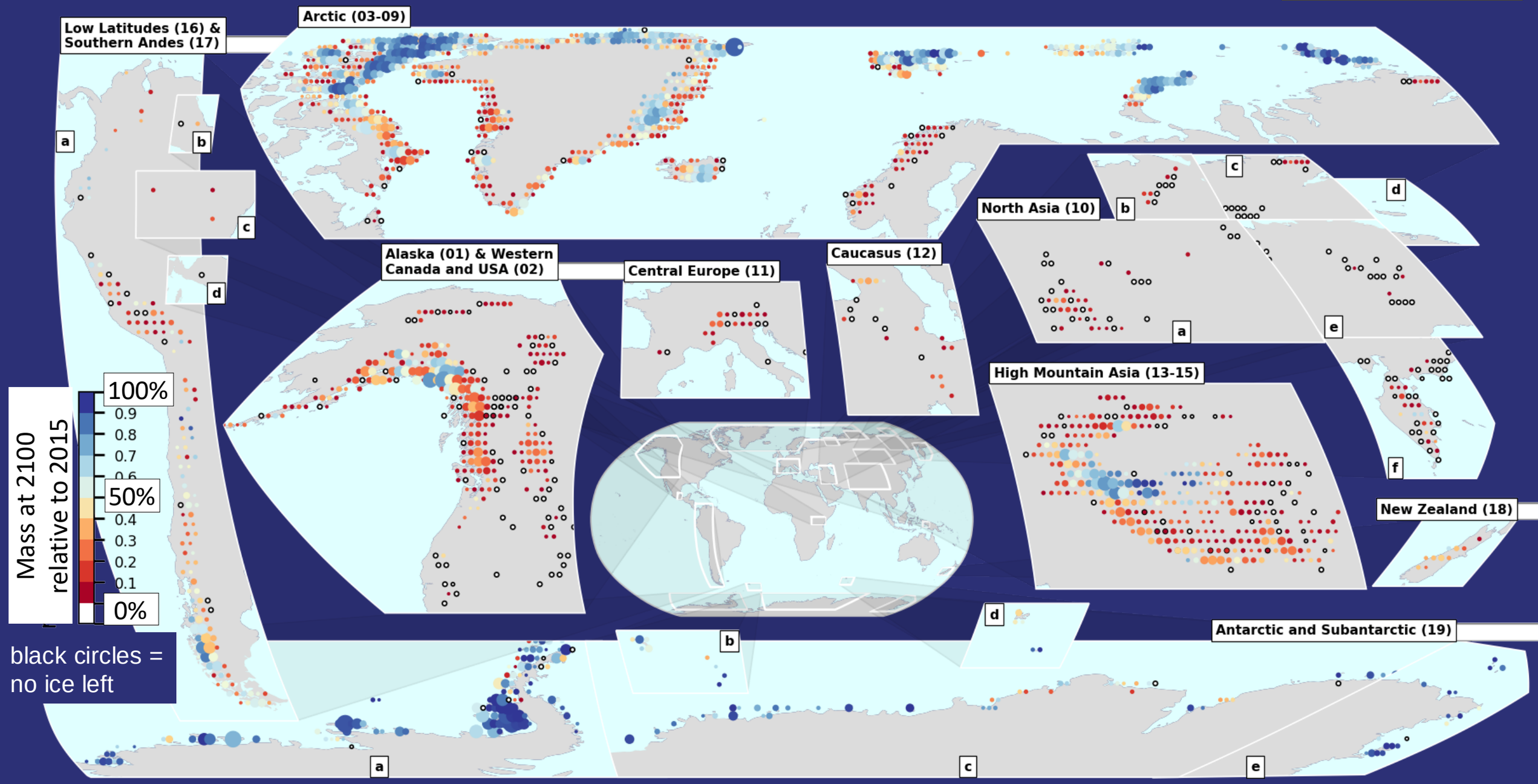


Almost complete deglaciation for +1.5°C in many regions

How much glacier mass will remain in 2100 relative to 2015 ?

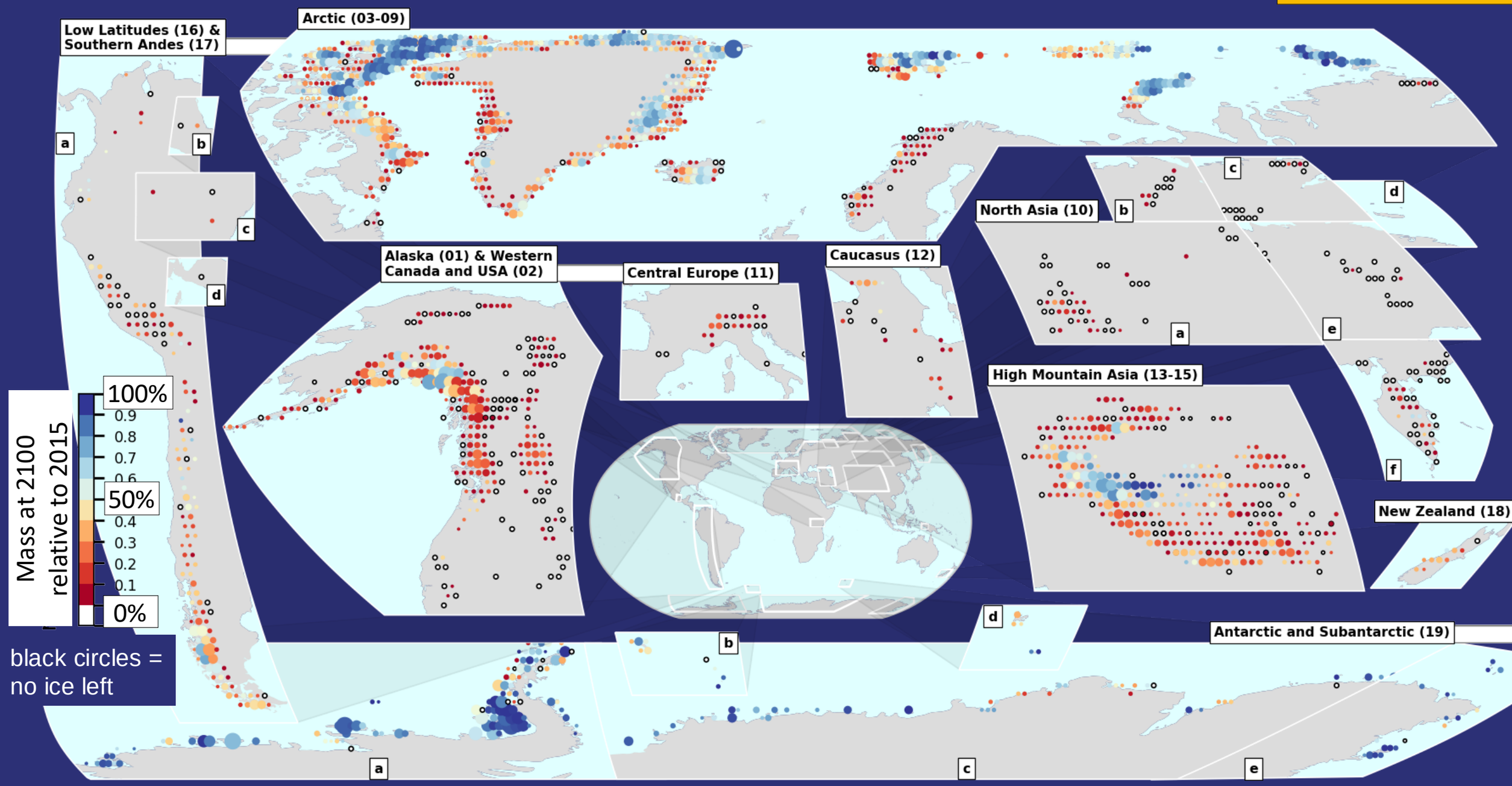
Global temperature increase by 2100 above pre-industrial **+2°C**



Rounce et al, 2023, Science

How much glacier mass will remain in 2100 relative to 2015 ?

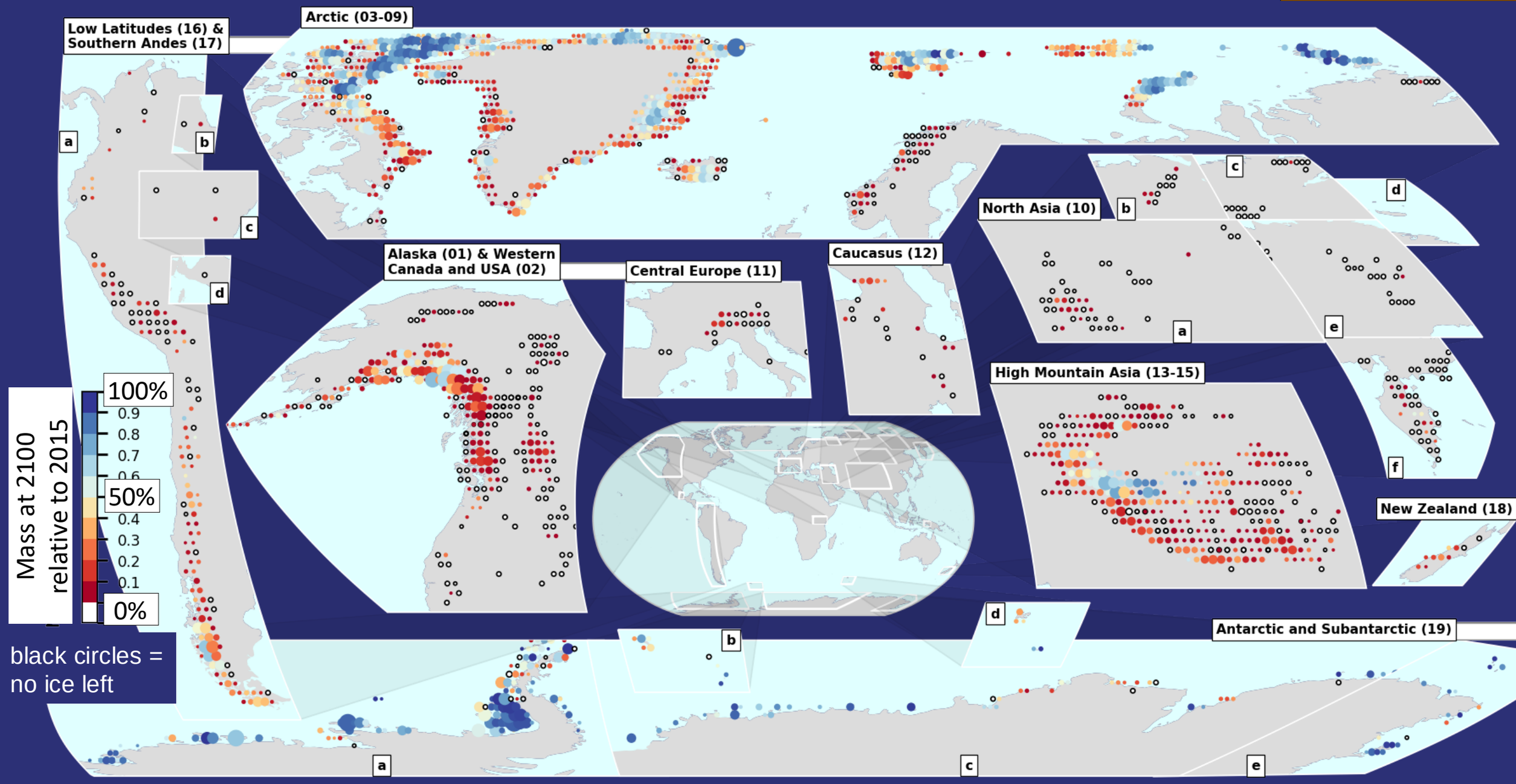
Global temperature increase by 2100 above pre-industrial **+3°C**



Rounce et al, 2023, Science

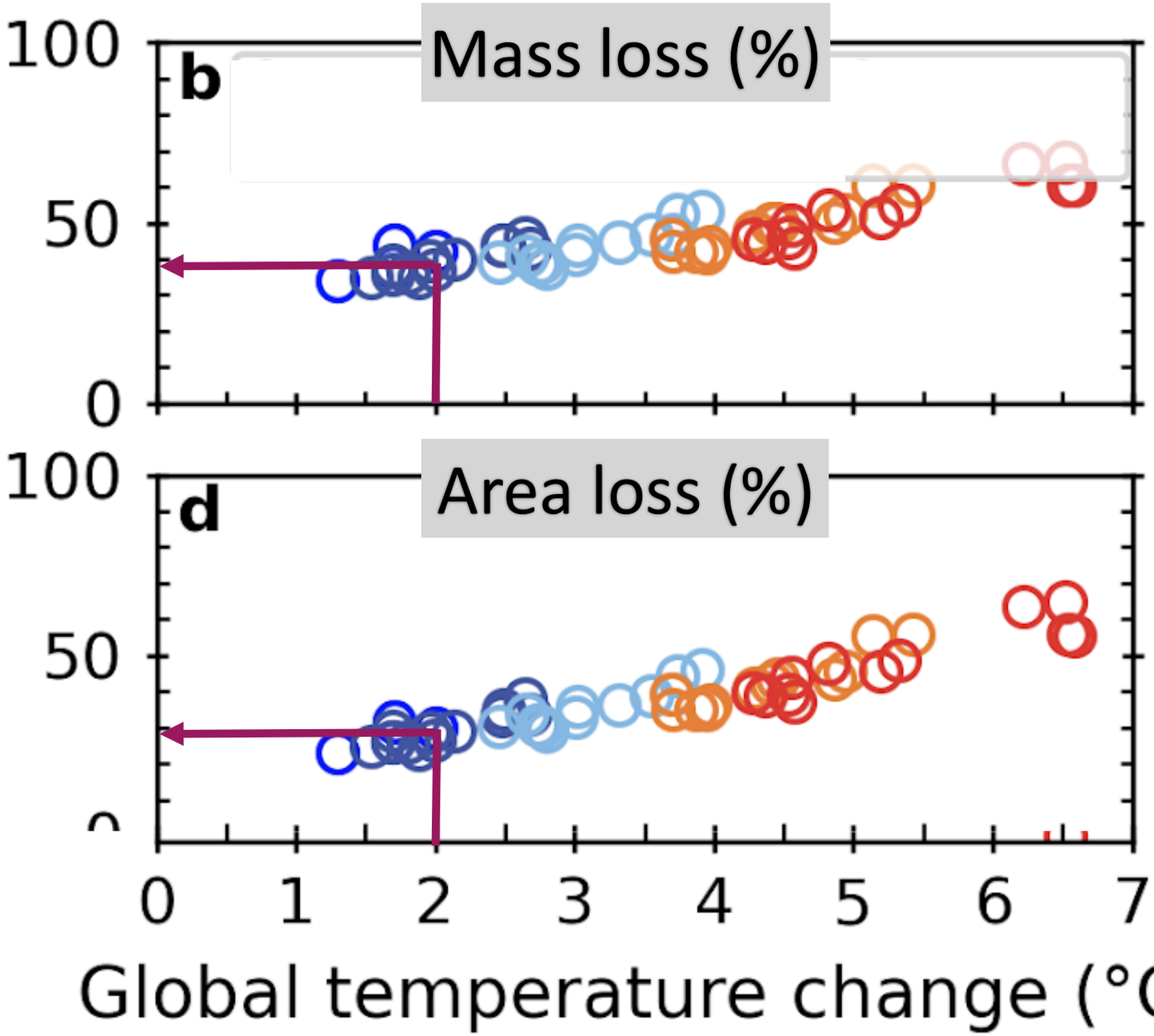
How much glacier mass will remain in 2100 relative to 2015 ?

Global temperature increase by 2100 above pre-industrial **+4°C**



Rounce et al, 2023, Science

Projected global glacier change by 2100 per degree global warming above pre-industrial



Rounce et al, 2023, Science

Temp increase of 2°C:

45% mass loss

35 % area loss

- Each degree makes a difference !

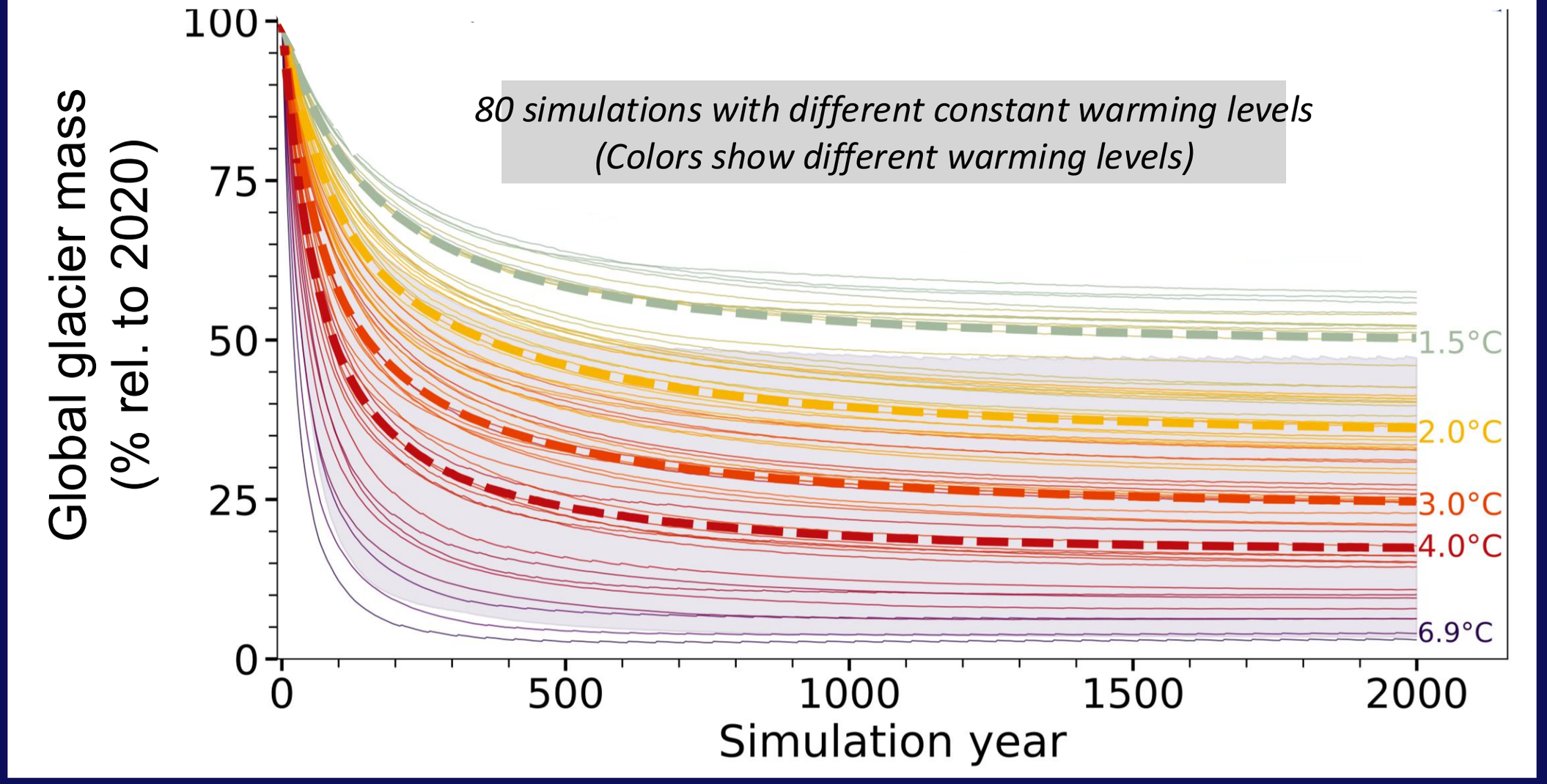
- +1.5°C scenario: ~ 50% (>100,000 glaciers) projected to disappear by 2100
- Most glaciers projected to disappear are < 1 km²

How much ice could be preserved if we stabilized the climate?

- How much ice would remain if global mean air temperatures were to stabilize at present-day and policy-relevant levels above pre-industrial (e.g., Paris Agreement targets +1.5°C, +2°C) ?

- **80 constant climate scenarios** derived from global climate models (—> 0.1 - 6.9° C above pre-industrial)
- **20-year periods repeated for 2000 - 5000 years**

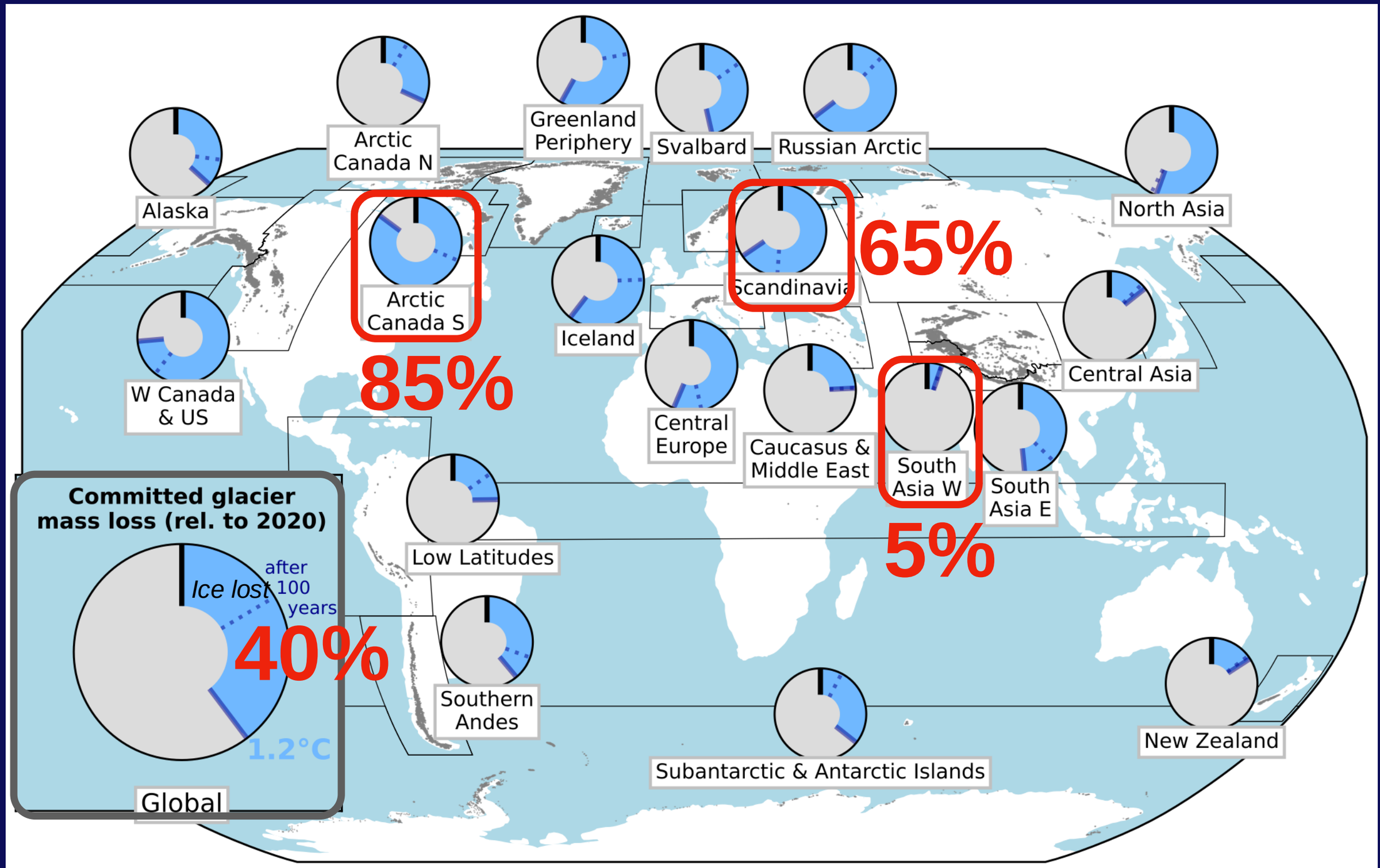
Glacier simulations under constant climate



- **Initial strong glacier mass losses within 100-200 years even if climate does not change anymore**
- **Then glaciers gradually reach “steady state” (new equilibrium) as they retreat to higher (colder elevations)**

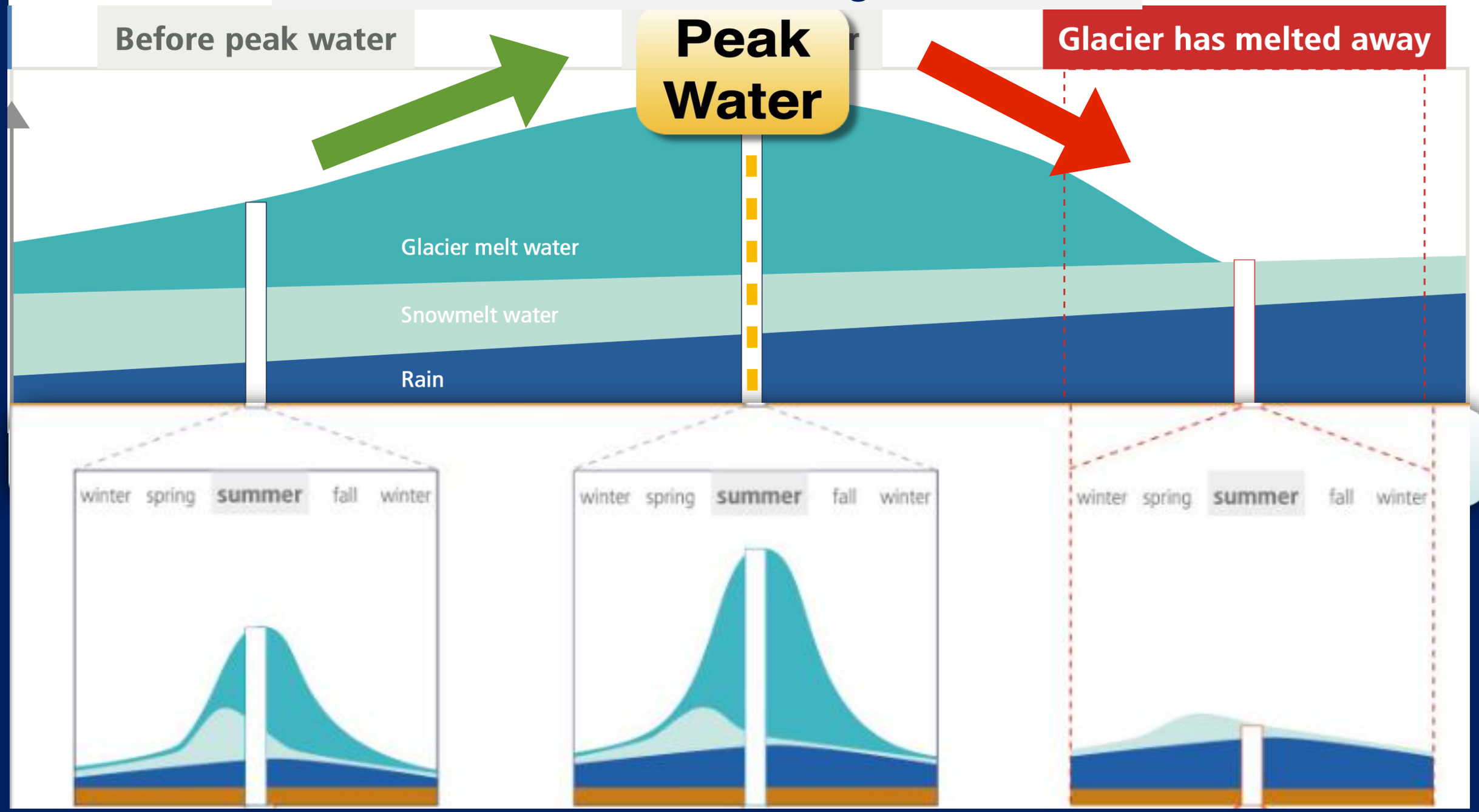
Zekollari & Schuster et al, in review, Science

Committed regional mass losses (present-day climate)



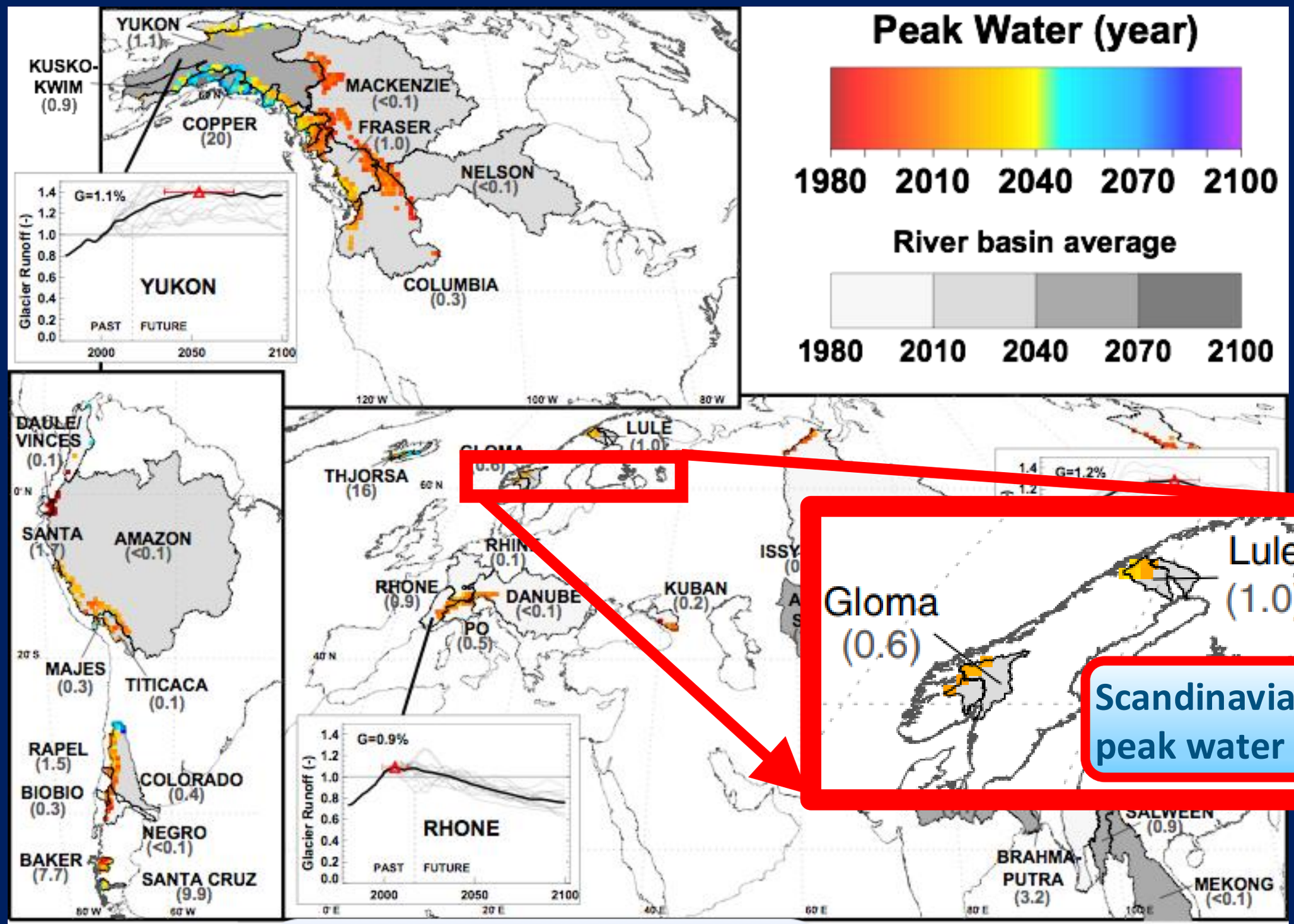
Zekollari & Schuster et al, in review, Science

Continued ice mass loss → glacier retreat



Hock et al. 2019, IPCC SROCC

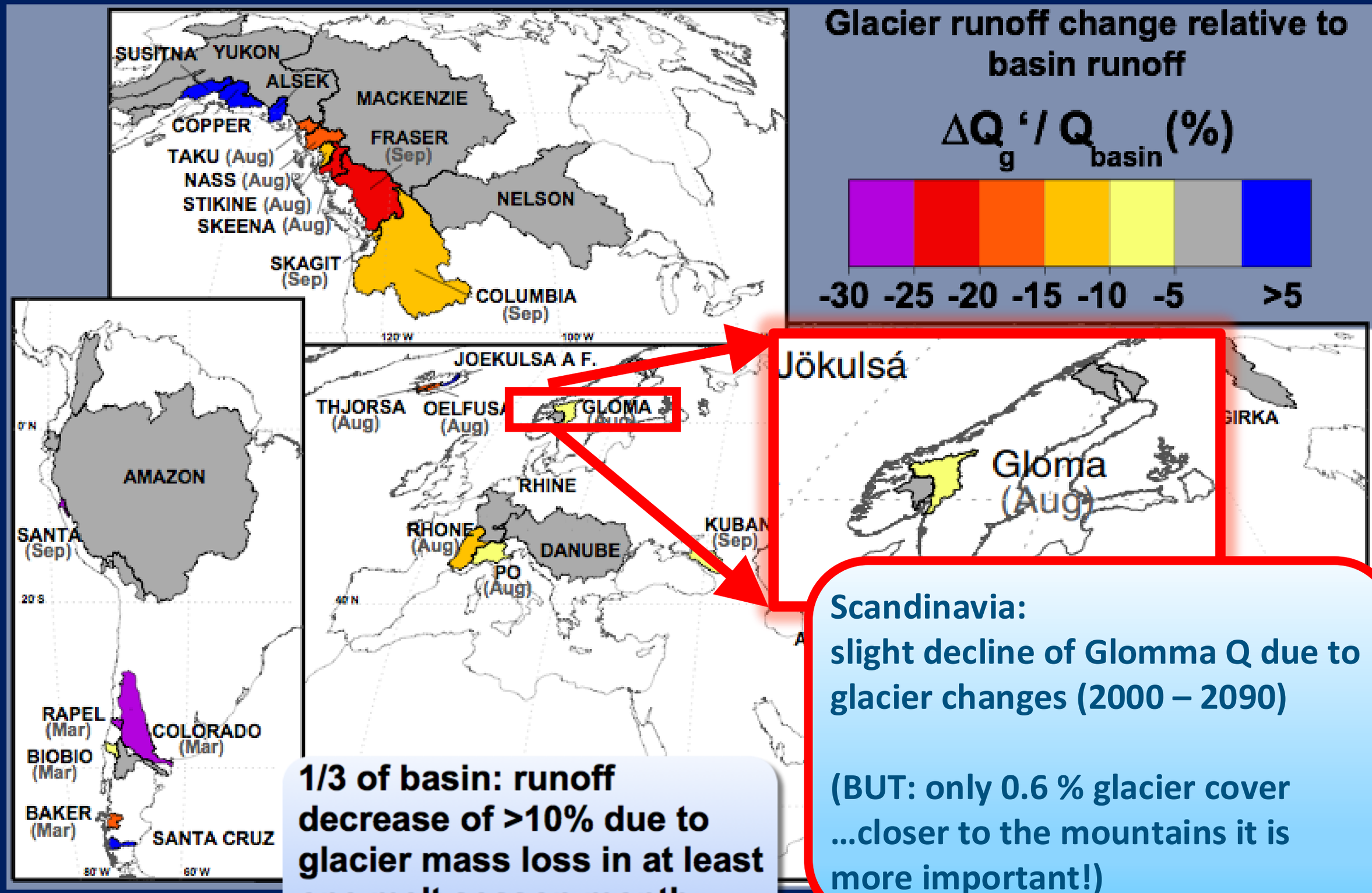
RCP 4.5: when will Peak Water occur?



later peak water in basin with larger glaciers/ice cover %

Huss & Hock, 2018, Nature Climate Change

Where do glacier runoff changes (2000 – 2100) matter?



1/3 of basin: runoff decrease of >10% due to glacier mass loss in at least one melt season month

Scandinavia:
slight decline of Glomma Q due to glacier changes (2000 – 2090)

(BUT: only 0.6 % glacier cover …closer to the mountains it is more important!)

Huss & Hock, 2018, Nature Climate Change

Key messages

40% → Committed global mass loss under **present-day** climate conditions

64% → +2°C warming level

Every increase in temperature matters for glacier preservation

Thank you

McCall Glacier, Alaska