Climate Lab / Institute of Geography / University of Bremen / Germany
European Geoscience Union (EGU) – April 9th 2018 – Vienna
Session Cl4.17: Sea-Level rise: past, present & future

Source:
Maussion Fabien

Nicolas Champollion[1,*], Ben Marzeion[1], Georg Kaser[2] and Fabien Maussion[2]

[1] University of Bremen, Germany
[2] University of Innsbruck, Austria
[*] Visiting scientist at the "Institut des Géosciences de l'Environnement (IGE)", France

Limited Influence of Climate Change Mitigation on Short-Term Glacier Mass Loss

Universität Bremen

universität innsbruck

IGE

Introduction (1/3)

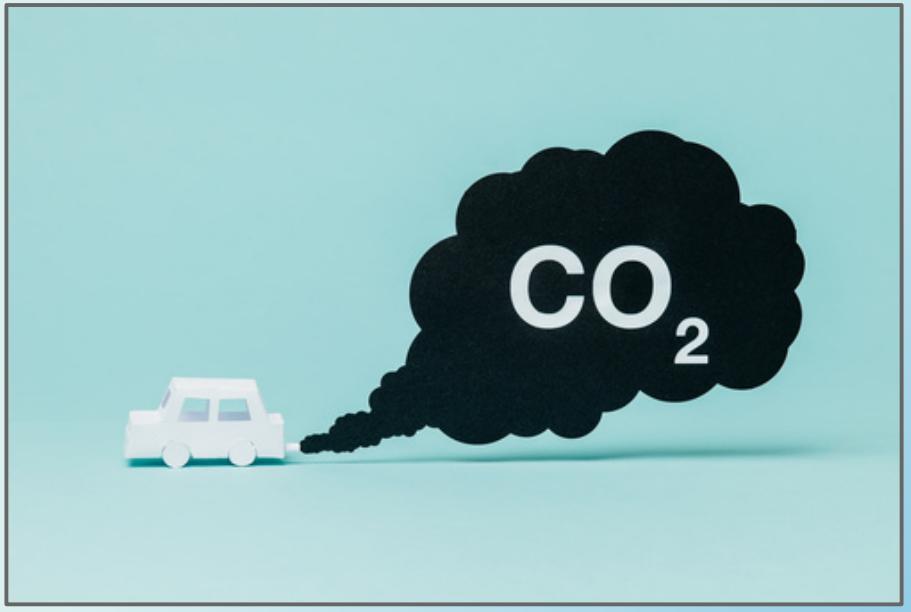
Universität Bremen*

Glaciers are in disequilibrium with the current climate:

→ long-term commitment of glacier mass loss !

→ but not yet realized ...

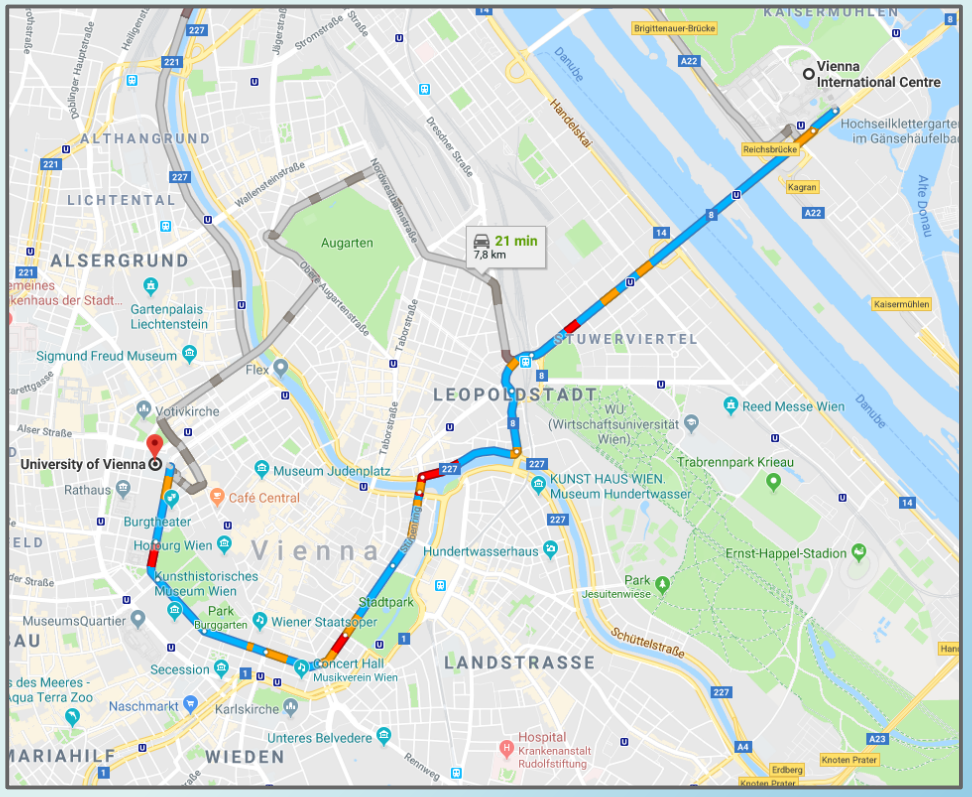
Source: Ecrins National Park, France



1 kg of CO_2 emitted

melting 15 kg of ice

Introduction (2/3)



≈ driving 5-10 km of a car

≈ melting 13 liquid water bottles

IN OTHER WORDS, EVERY DAY **WE** PARTICIPATE TO THE DISAPPEARANCE OF GLACIERS ...

Introduction (3/3)

We found that under present-day climate conditions, every emitted kg of CO_2 will eventually be responsible for a glacier mass loss of 14.8 +- 5 kg (**equilibirum experiments**).

Main results:

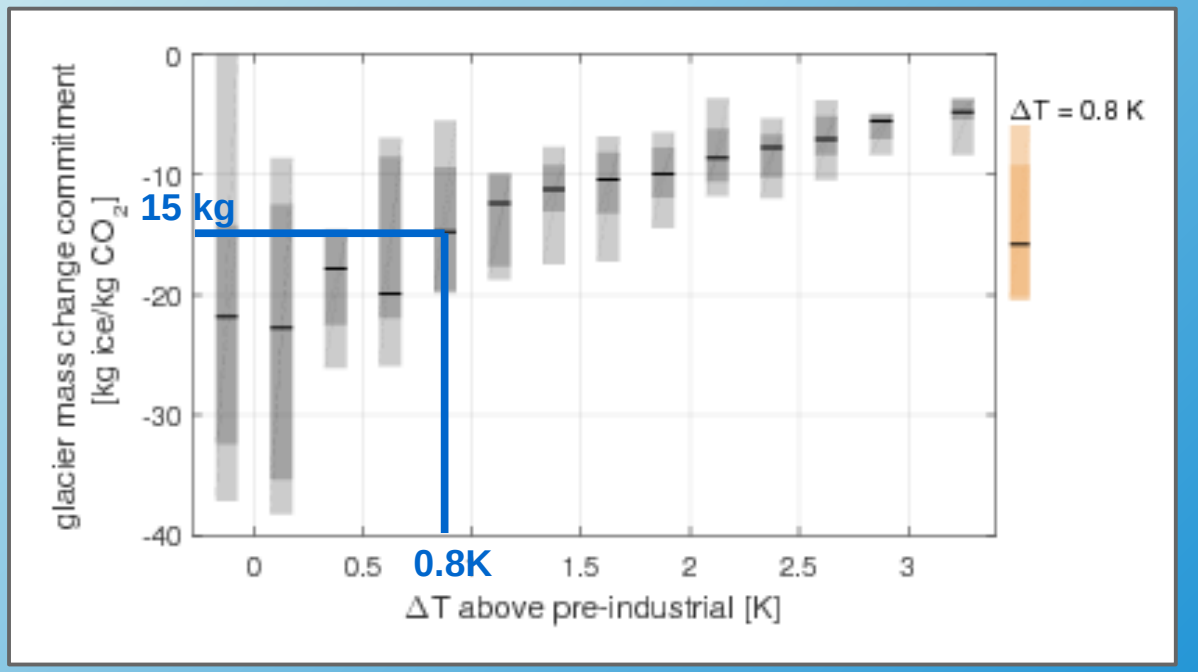
A. mass loss commitment is not already realized

B. relationship between CO_2 emission and glacier mass loss decreases with time:

- global glacier mass decreases with time
- mass balance / elevation feedback

C. mass loss commitment is additive

D. previous mass loss commitment is omitted



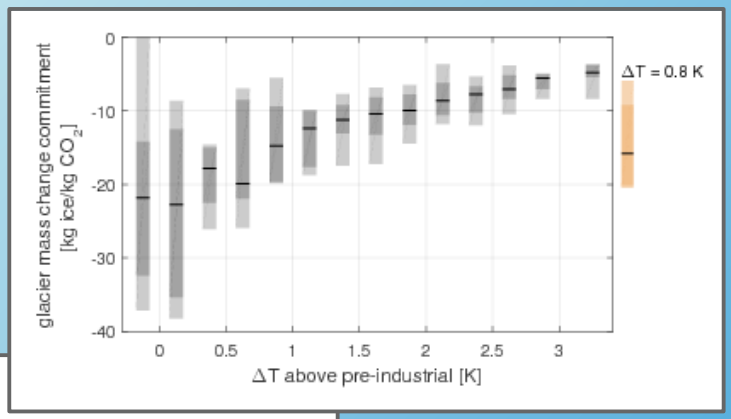
Source: Marzeion et al., 2018. © Nature Climate Change, no commercial reuse permitted

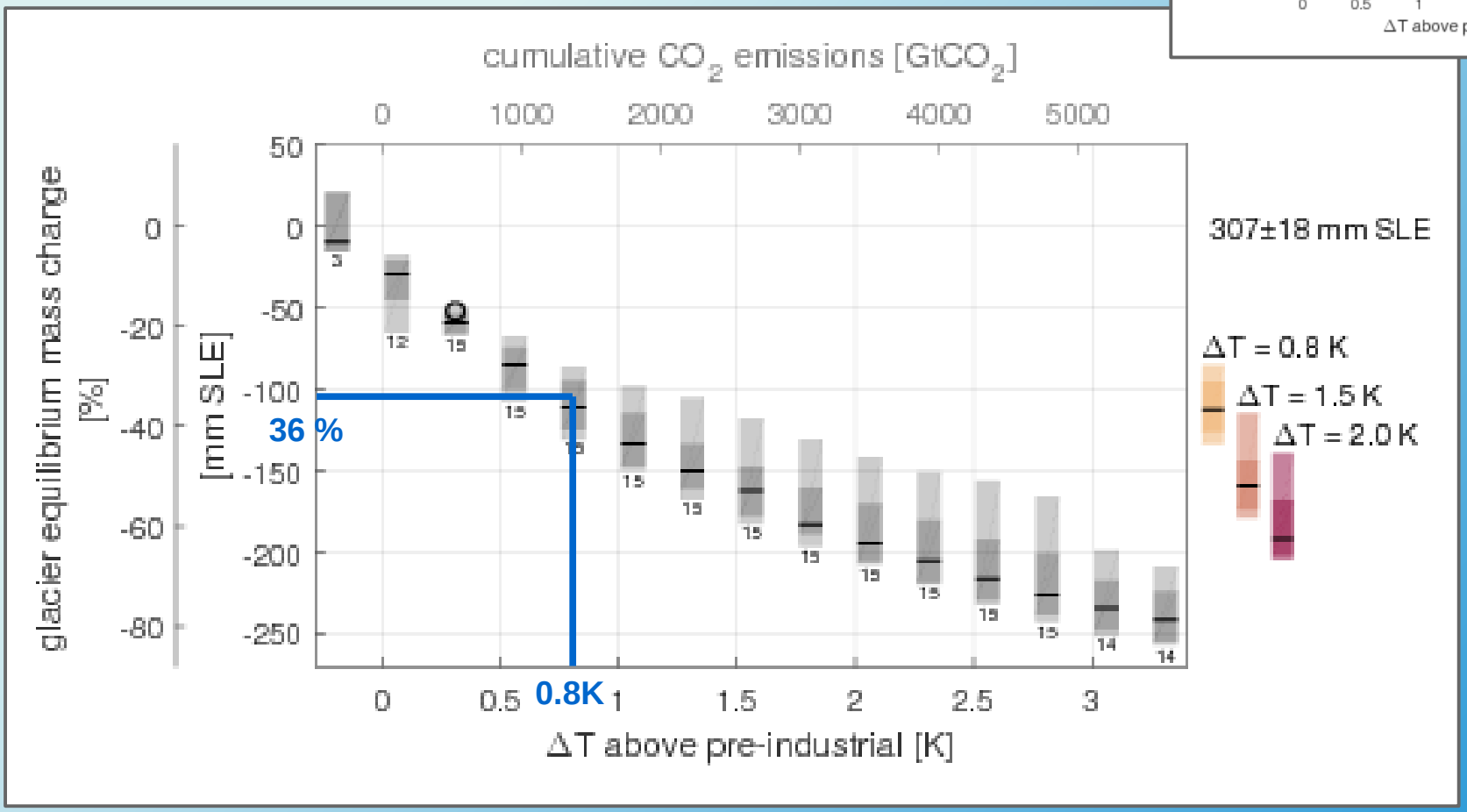
Glacier Mass Loss Commitment (1/3)

Universität Bremen*

Using historical runs and RCP scenarios to force a temperature-index mass balance model and volume-area / volume-length scaling …

Ice volume changes are small after 300 years → equlibrium.

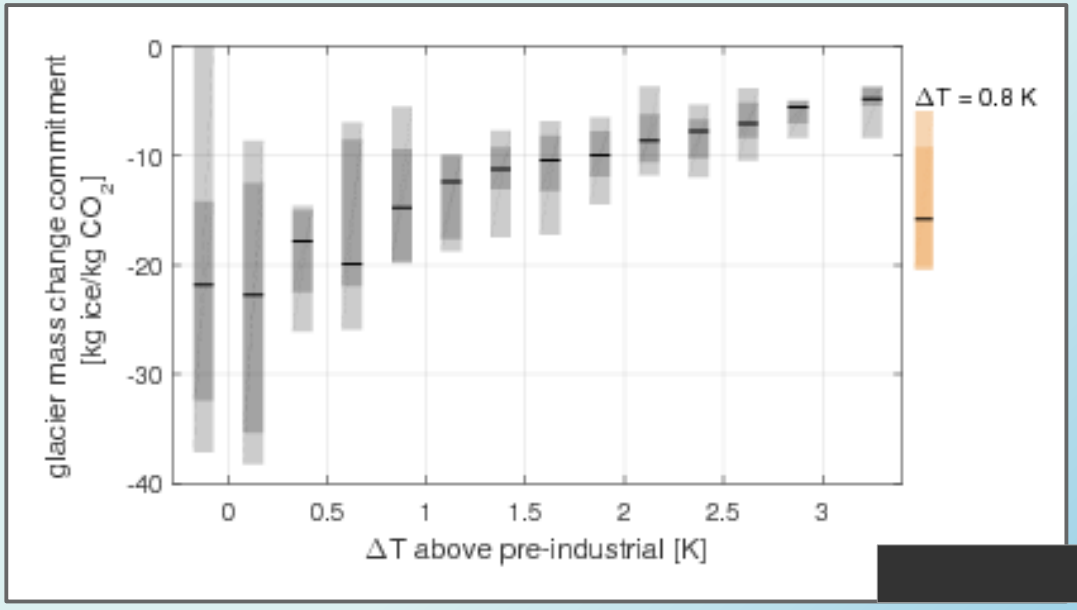




Source: Marzeion et al., 2018. © Nature Climate Change, no commercial reuse permitted

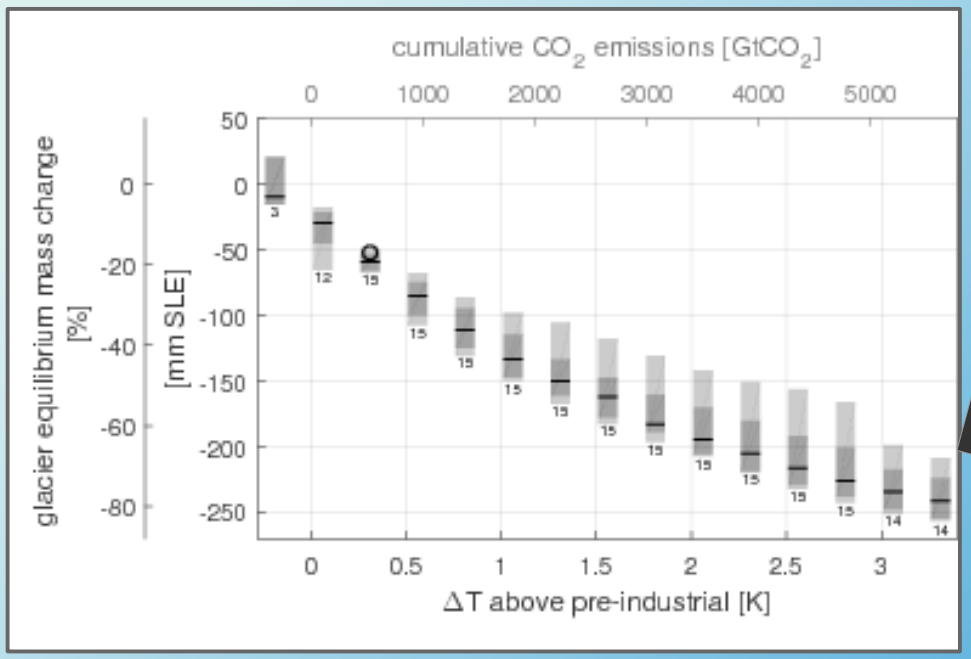
Glacier Mass Loss Commitment (2/3)

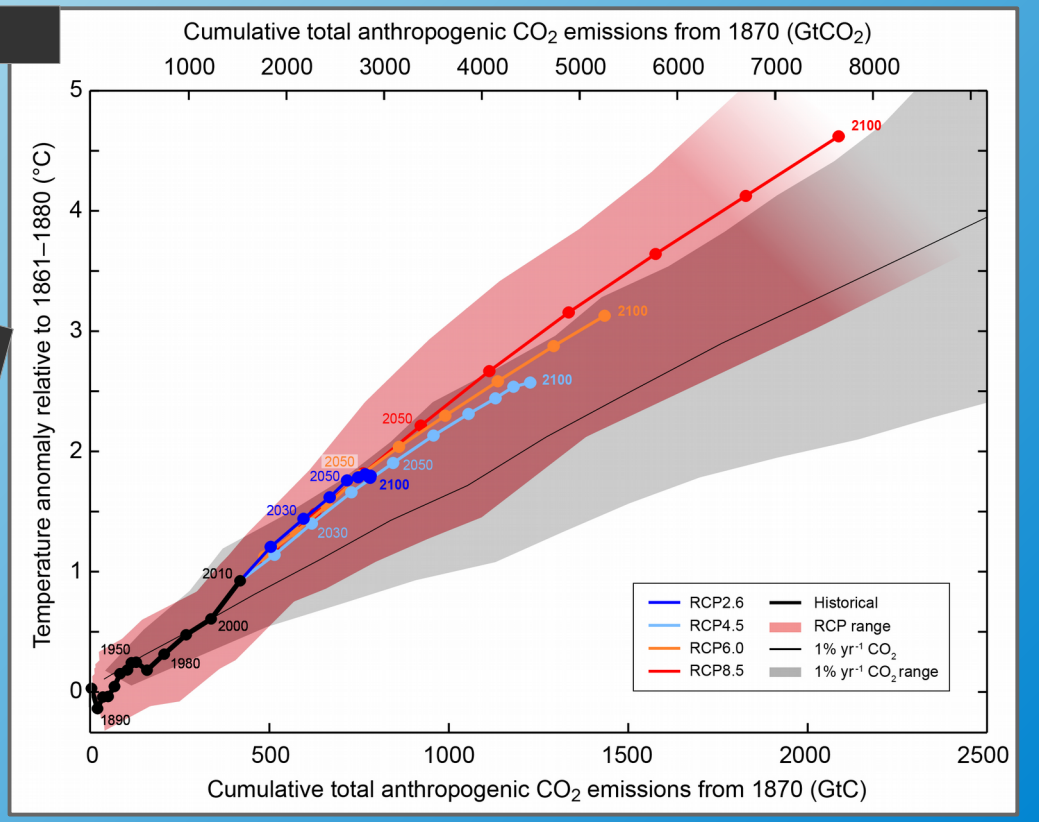
Universität Bremen*



Relationship between cumulative total anthropogenic CO_2 emissions from 1870 and global mean air temperature anomaly relative to 1861-1880 is linear !

Source: IPCC, AR5, 2013.



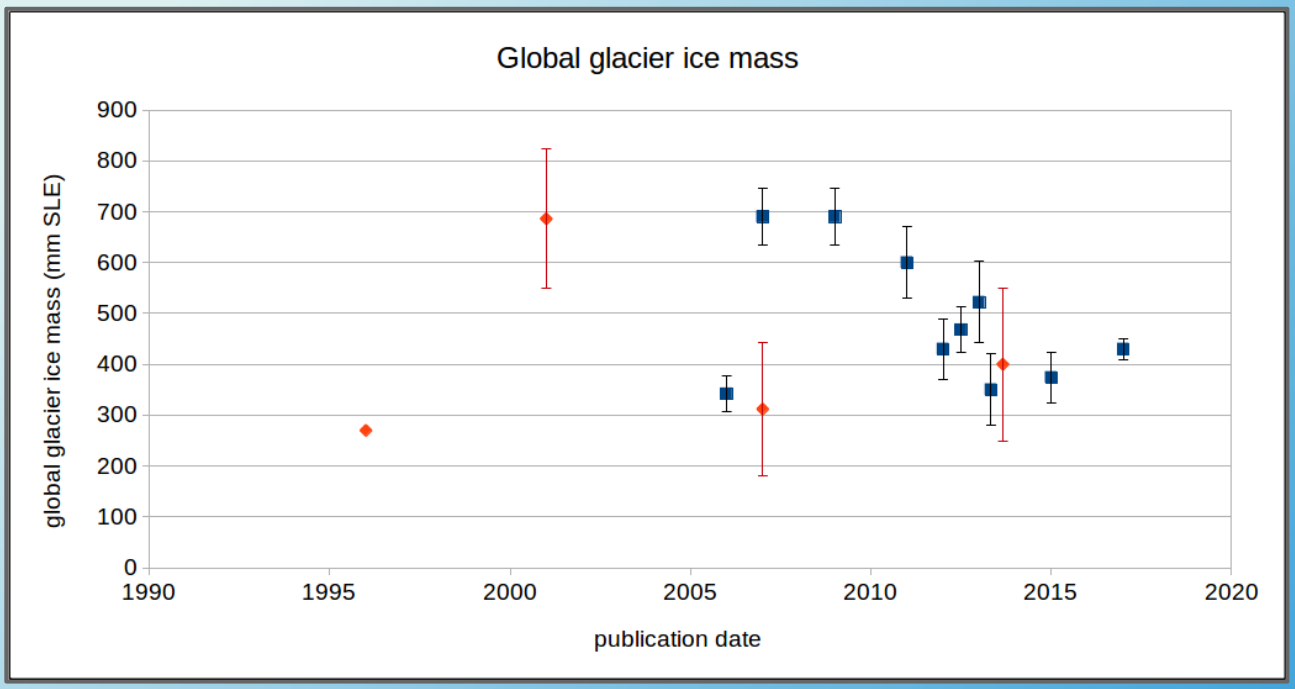


Glacier Mass Loss Commitment (3/3)

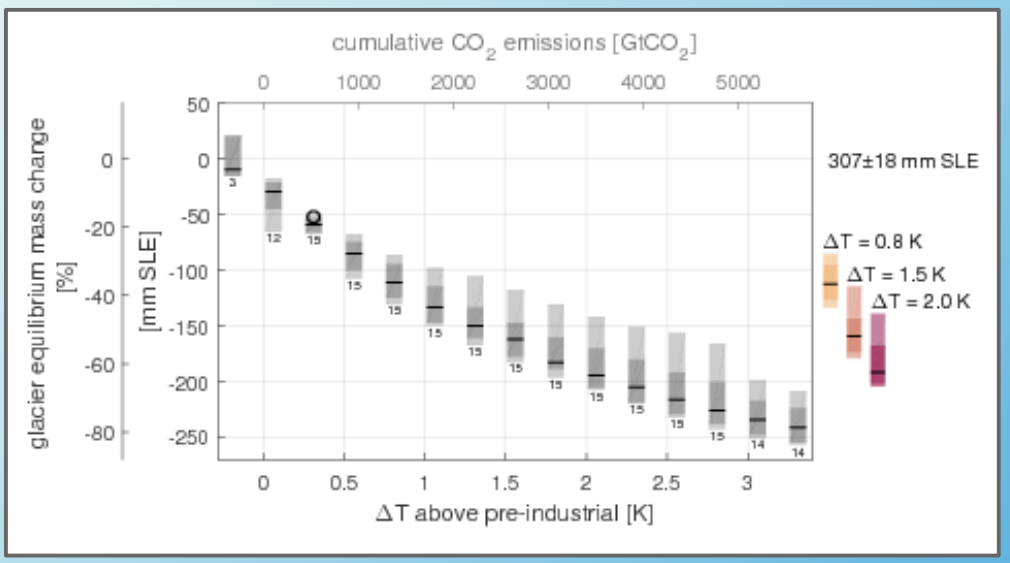
Universität Bremen*

Current climate: around 36% of the total glacier ice mass is commited to melt.

Paris agreement (1.5 & 2K): 50 to 60% of the total glacier ice mass is commited to melt.



Source: Champollion, pers. comm.

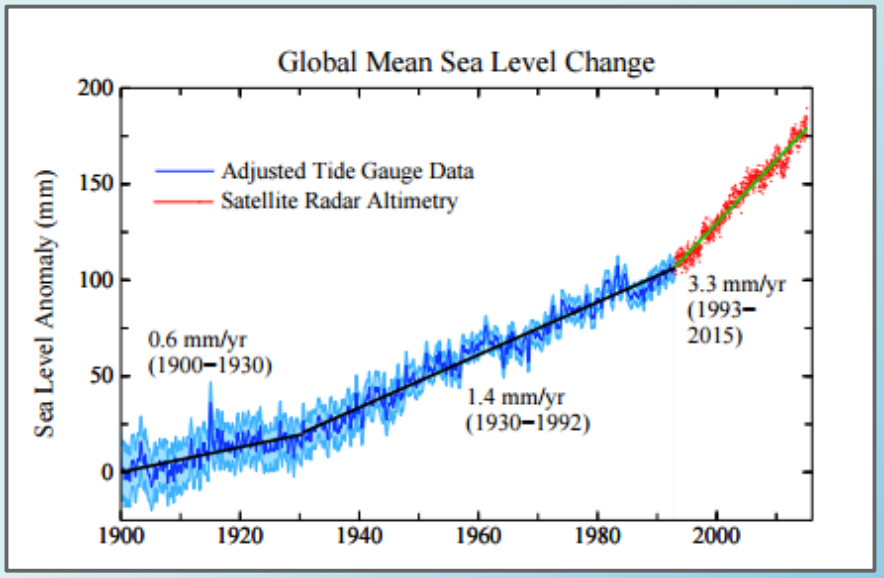


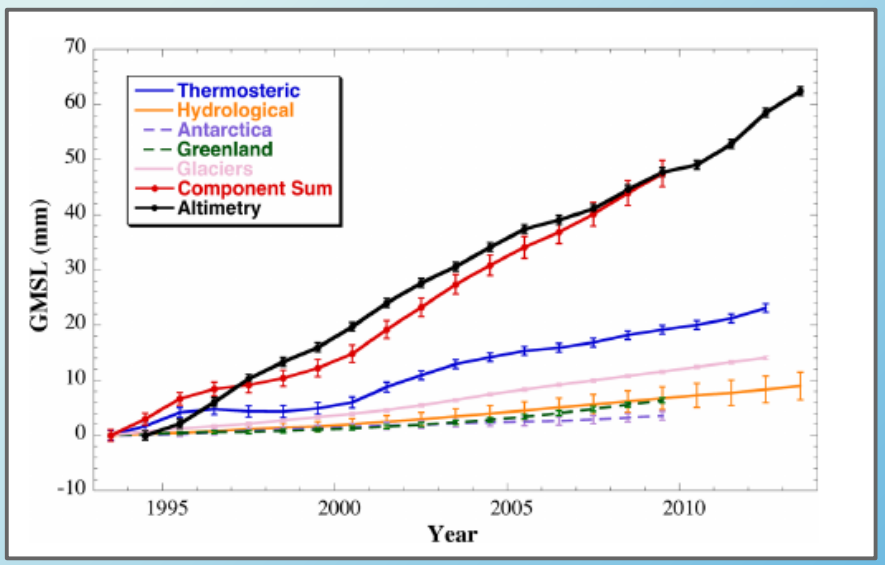
Antarctica & Greenland peripheral glaciers are not included – Global glacier ice mass is uncertain.

Global Mean Sea Level

The past, present and future contribution of glaciers to sea-level rise are 30 - 35% of the total sea-level rise.

Source: Hansen et al., 2016

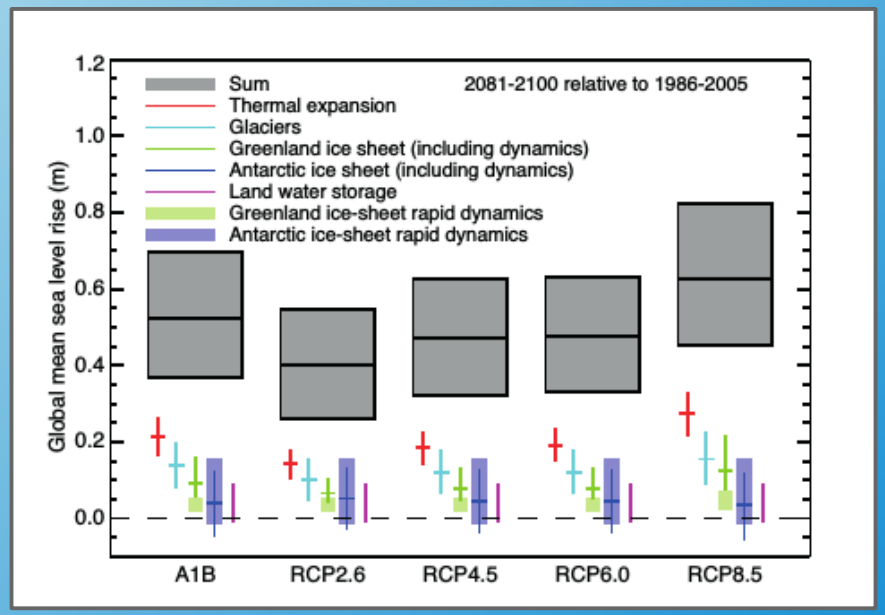




Source: Chambers et al., 2017

Glacier contribution:

- **1901-1990**: 54 mm SLE → 0.6 mm SLE yr^{-1}
- **1993-2013**: 15 mm SLE → 0.8 mm SLE yr^{-1}
- **21st century**: 110-180 mm SLE → 1.1 to 1.8 mm SLE yr^{-1}



Source: Church et al., 2013

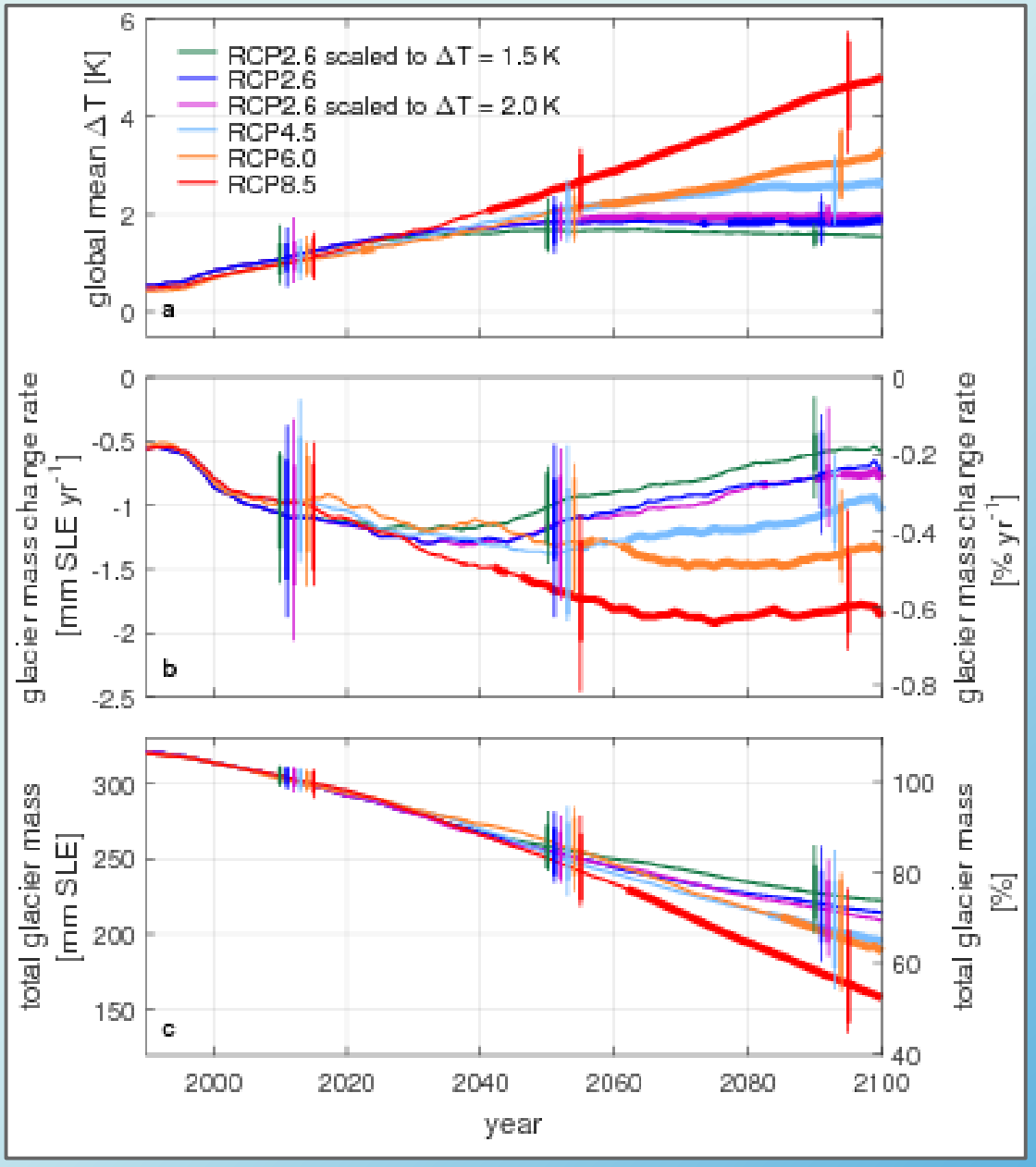
21ST Century Glacier Evolution (1/3)

Universität Bremen*

But not all the glacier mass loss commitment is going to happen, at least for the 21st century, and if humans are doing something !

What does it represent transitory ?

21ST CENTURY GLACIER EVOLUTION (2/3)

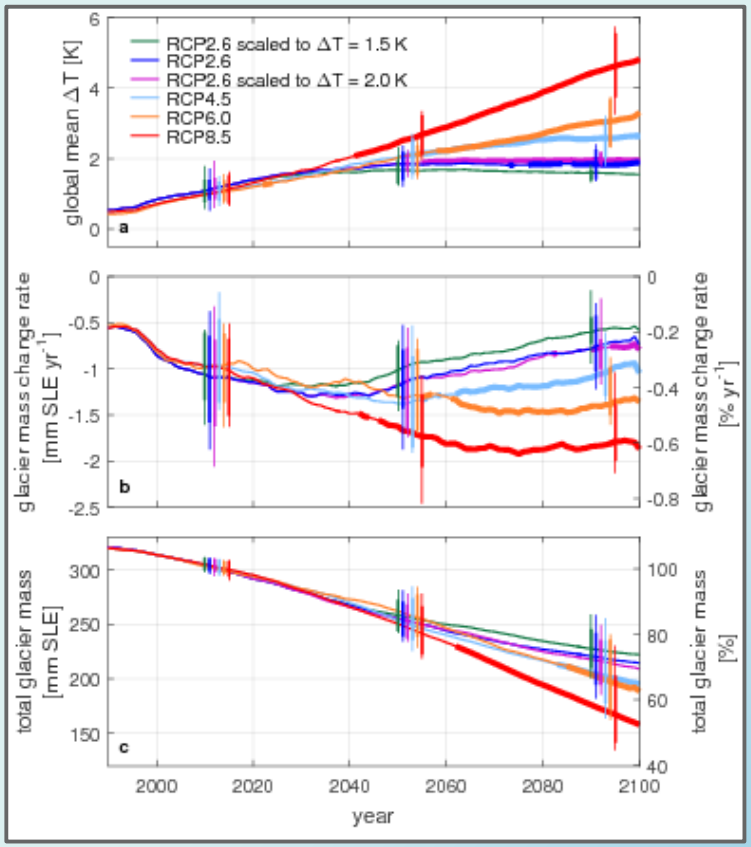


Using RCP scenarios to force temperature-index mass balance model and volume-area / volume-length scaling …

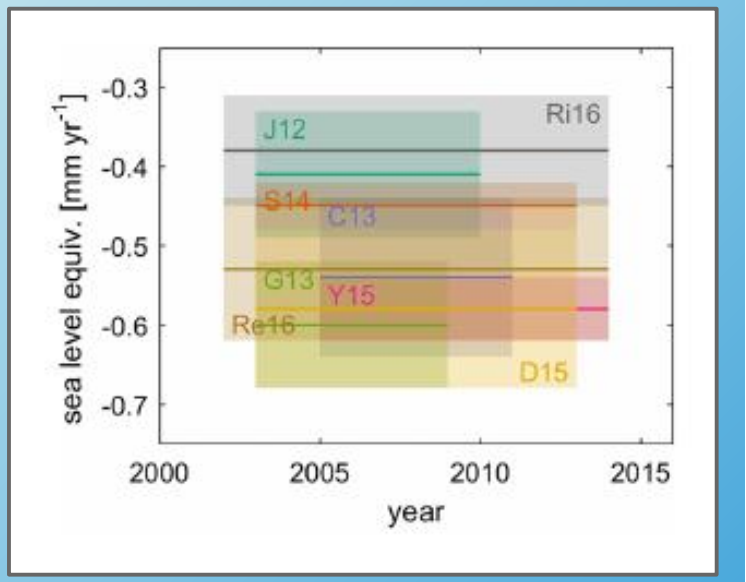
→ **transient experiments**

Source: Marzeion et al., 2018.
© Nature Climate Change, no commercial reuse permitted

21ST CENTURY GLACIER EVOLUTION (3/3)



Comparison with previous studies ...



Source: Marzeion et al., 2017

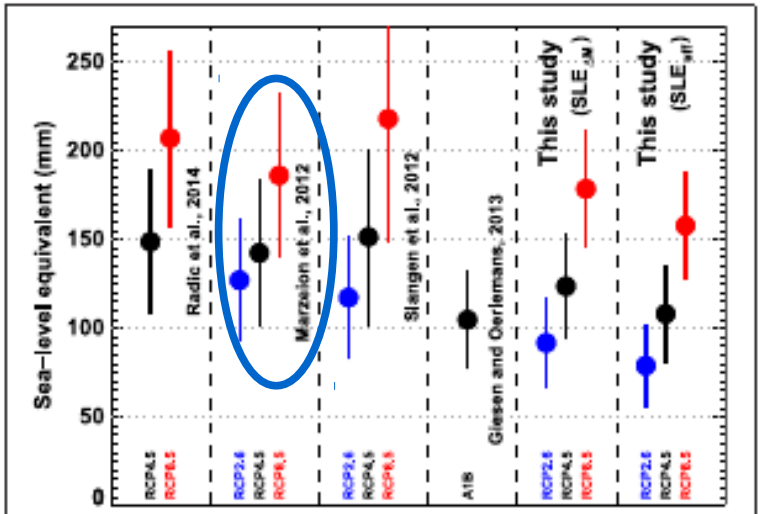


FIGURE 13 | Comparison of modeled twenty-first century sea-level equivalent from glacier mass loss based on previous assessments included in IPCC (2013) with results from this study. Circles refer to multi-model means from 8 to 15 GCMs and bars indicate ±1σ. Previous results are recomputed to refer to the period 2010–2100 -by assuming their average rates to be constant in time. Results of this study are given both as $SLE_{\Delta M}$ and SLE_{eff} while the results from previous studies denote $SLE_{\Delta M}$.

Source: Huss and Hock, 2015

With our glacier model, we showed the low influence of climate change mitigation on glaciers due to the current climate glacier mass loss commitment !

Source: Alex Tingle, NASA & Google

Ongoing Activities & Future Works (1/2)

Universität Bremen

OGGM Open Global Glacier Model

Marzeion et al., 2012 – Maussion et al., 2018, submitted –
http://oggm.org/ → **explicit ice dynamic**
& much more other advantages :-)
(see poster OGGM, Champollion, N. et al.,
Wednesday 11 April 17:30-19:00 in Hall X5, session CR1.2/CL4.19)

GlacierMIP → **glacier model intercomparison** (WCRP/CLIC,
http://www.climate-cryosphere.org/activities/targeted/glaciermip)

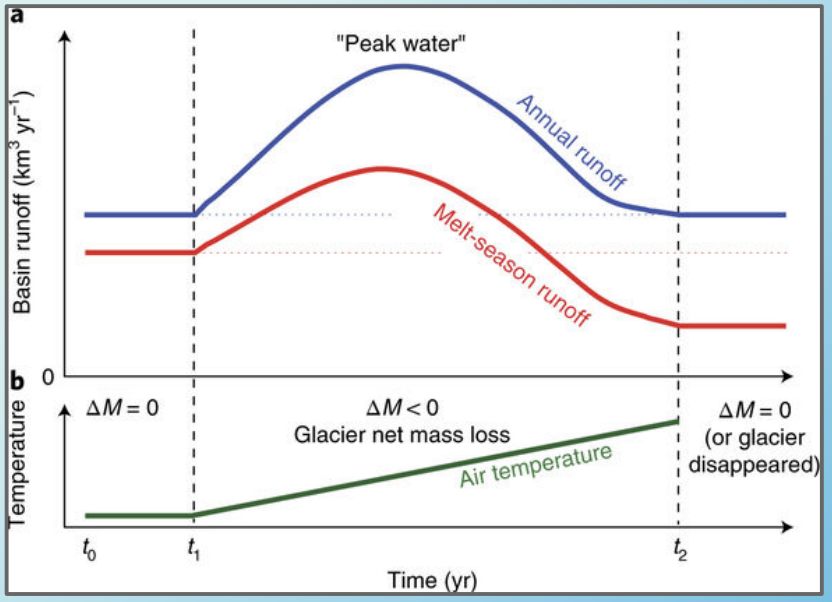
ITMIX (IACS) → **ice thickness intercomparison**

IACS International Association of Cryospheric Sciences

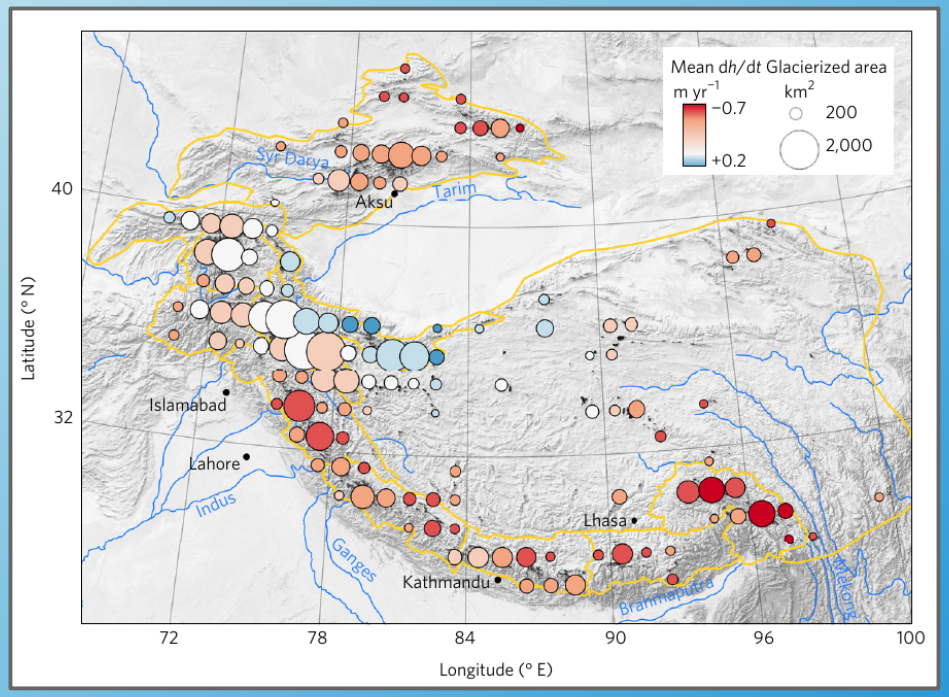
Ongoing Activities & Future Works (2/2)

Universität Bremen*

A. regional evolution of glacier mass loss
B. implication for hydrology
C. historical mass balance reconstruction
...



Source: Huss et al., 2018



Source: Brun et al., 2017


THANK YOU FOR
YOUR ATTENTION