

The Role of Mountain Glaciers and Ice Caps in Sea Level Rise: Past, Present and Future

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AAAS * Sea Level Rise * CHICAGO * 090216



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Mountain Glaciers and Ice Caps

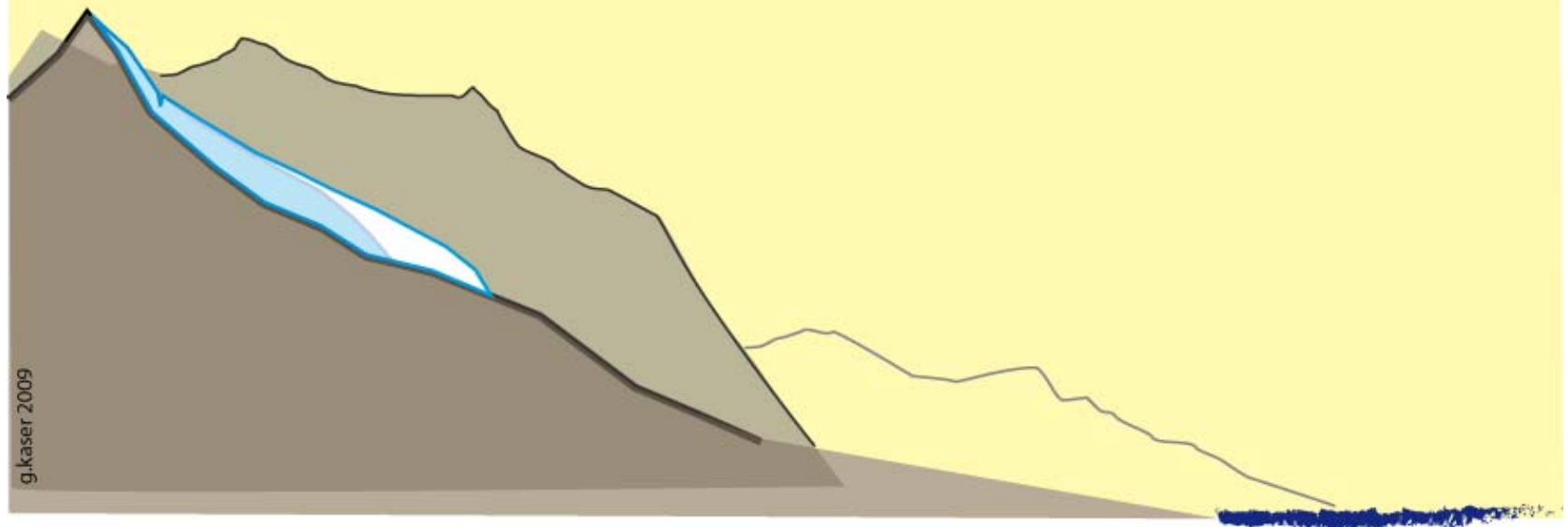


*Kibo, EIF, January 2009 (g*kaser)*

09*02*16 aads*sea level*chicago

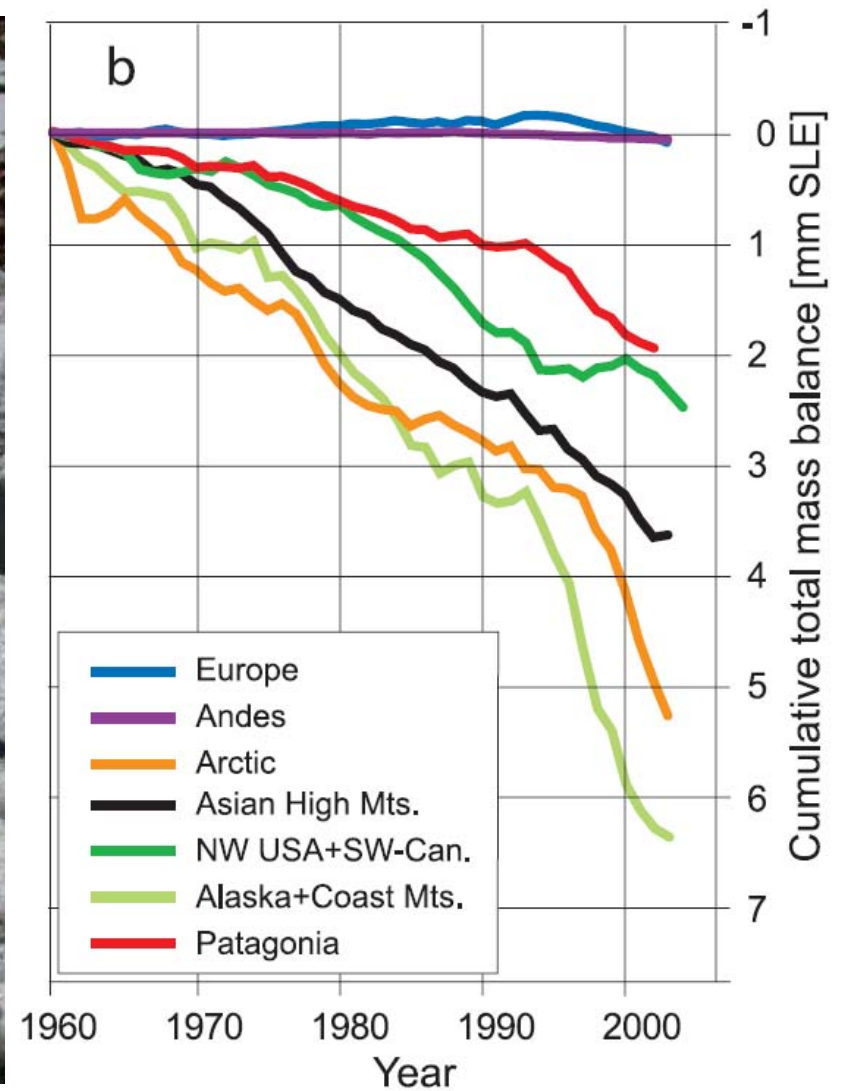
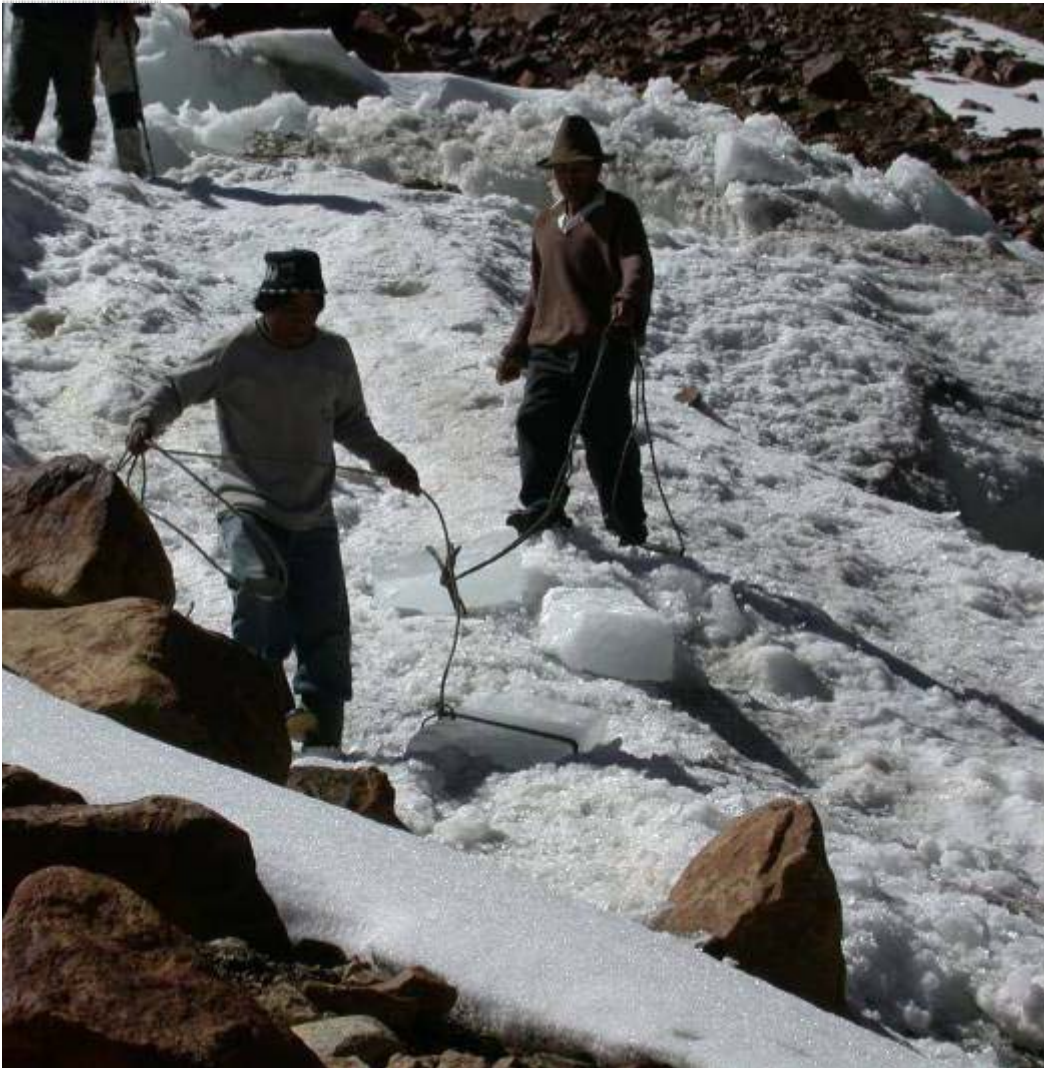


- How much water is presently released from MG&IC? 3
- How much of it reaches the Ocean? 1
- How much water is stored in MG&IC? 2





The underway loss



Lemke et al. (2007) - IPCC 2007 - AR4 WG I, Ch. 4



The total extent of MG&IC

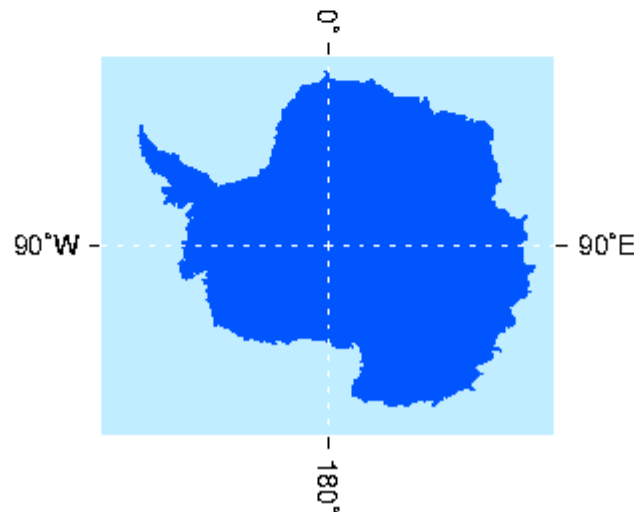
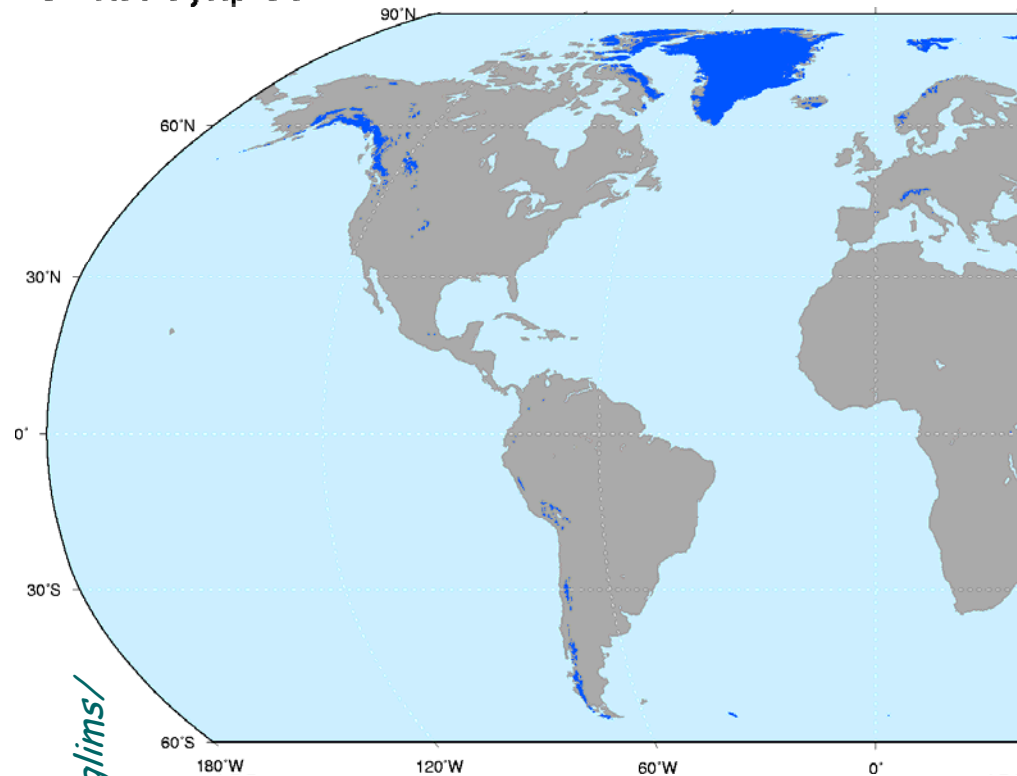
Reference	Area (10^3 km^2)	Volume (10^3 km^3)	SLE ^f (m)
Raper and Braithwaite, 2005 ^{a,c}	522 ± 42	87 ± 10	0.24 ± 0.03
Ohmura, 2004 ^{a,d}	512	51	0.15
Dyurgerov and Meier, 2005 ^{a,e}	546 ± 30	133 ± 20	0.37 ± 0.06
Dyurgerov and Meier, 2005 ^{b,e}	785 ± 100	260 ± 65	0.72 ± 0.2
IPCC, 2001 ^b	680	180 ± 40	0.50 ± 0.1

MG&IC excluding those in GL and AA: 0.15 - 0.43 m SLE
MG&IC including those in GL and AA: 0.49 - 0.74 m SLE

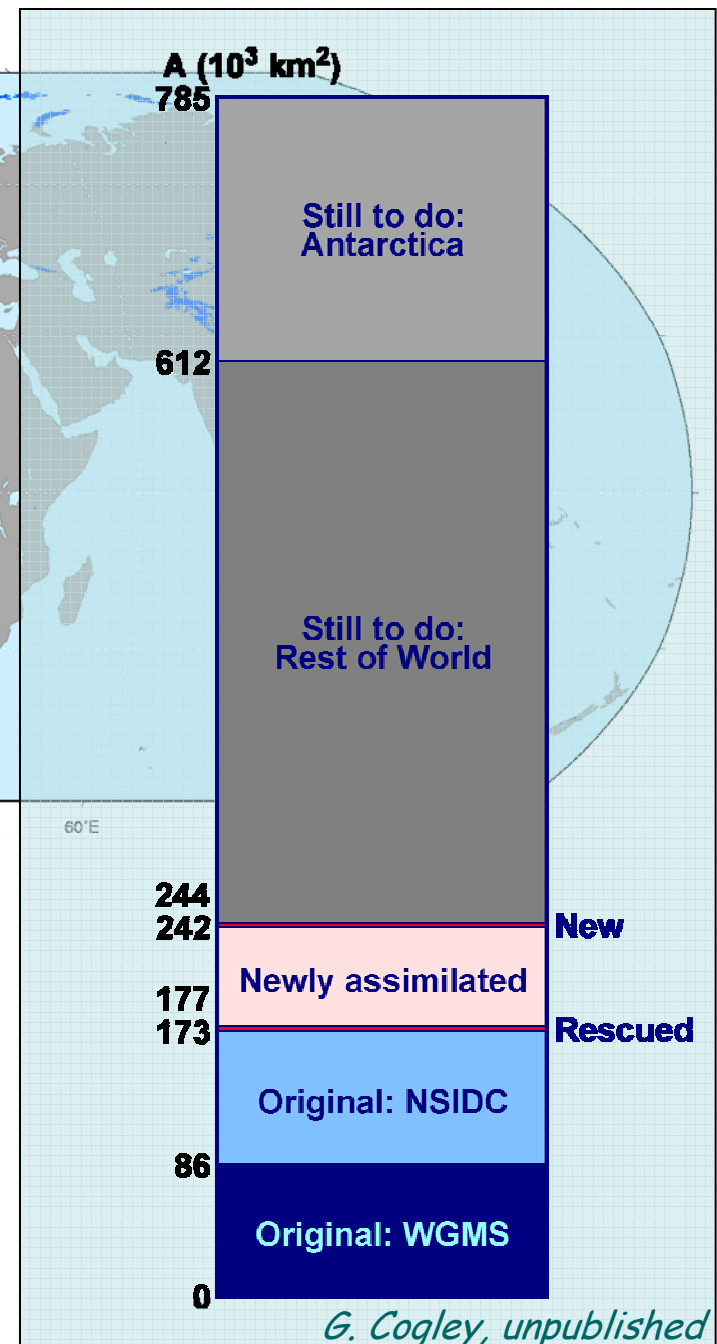
Inventories



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NSIDC * <http://nsidc.org/glims/>

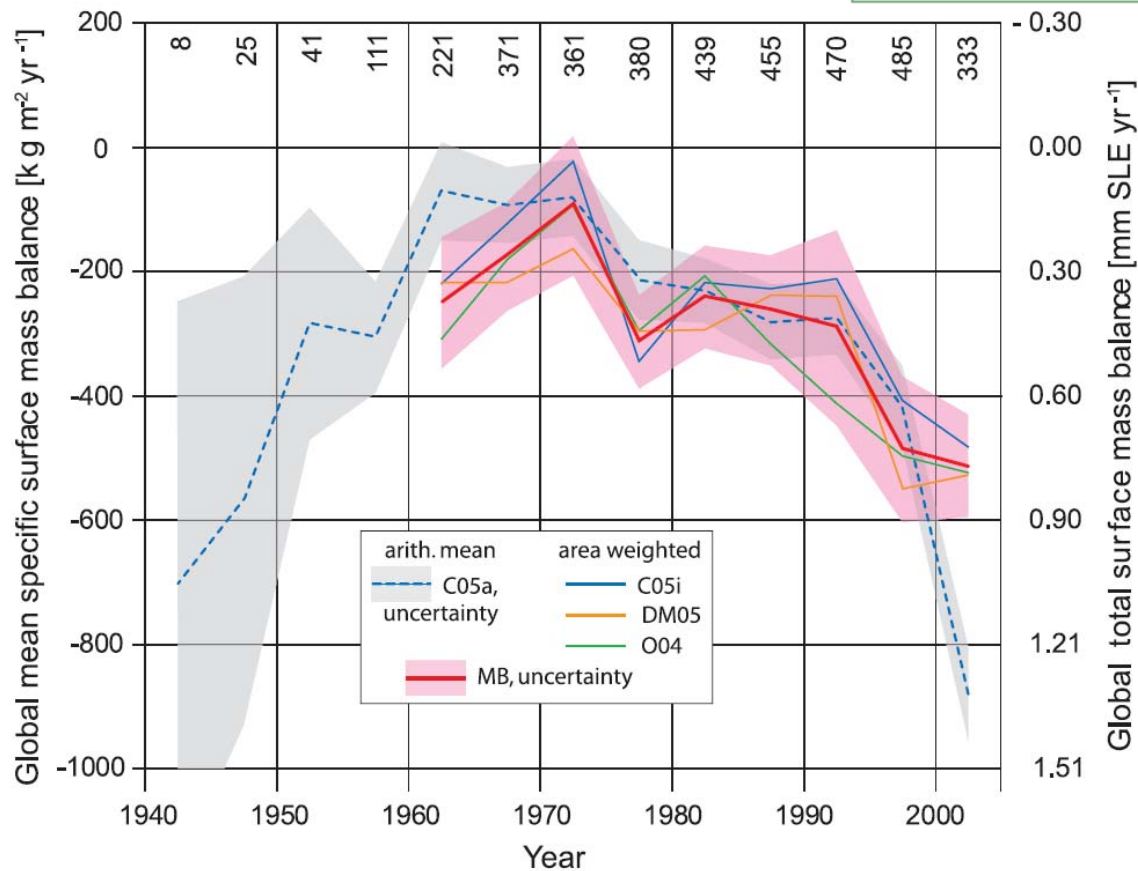


G. Cogley, unpublished



Mass losses

Period	Sea Level Equivalent ^b (mm yr ⁻¹)
1960/1961–2003/2004	0.50 ± 0.18
1960/1961–1989/1990	0.37 ± 0.16
1990/1991–2003/2004	0.77 ± 0.22

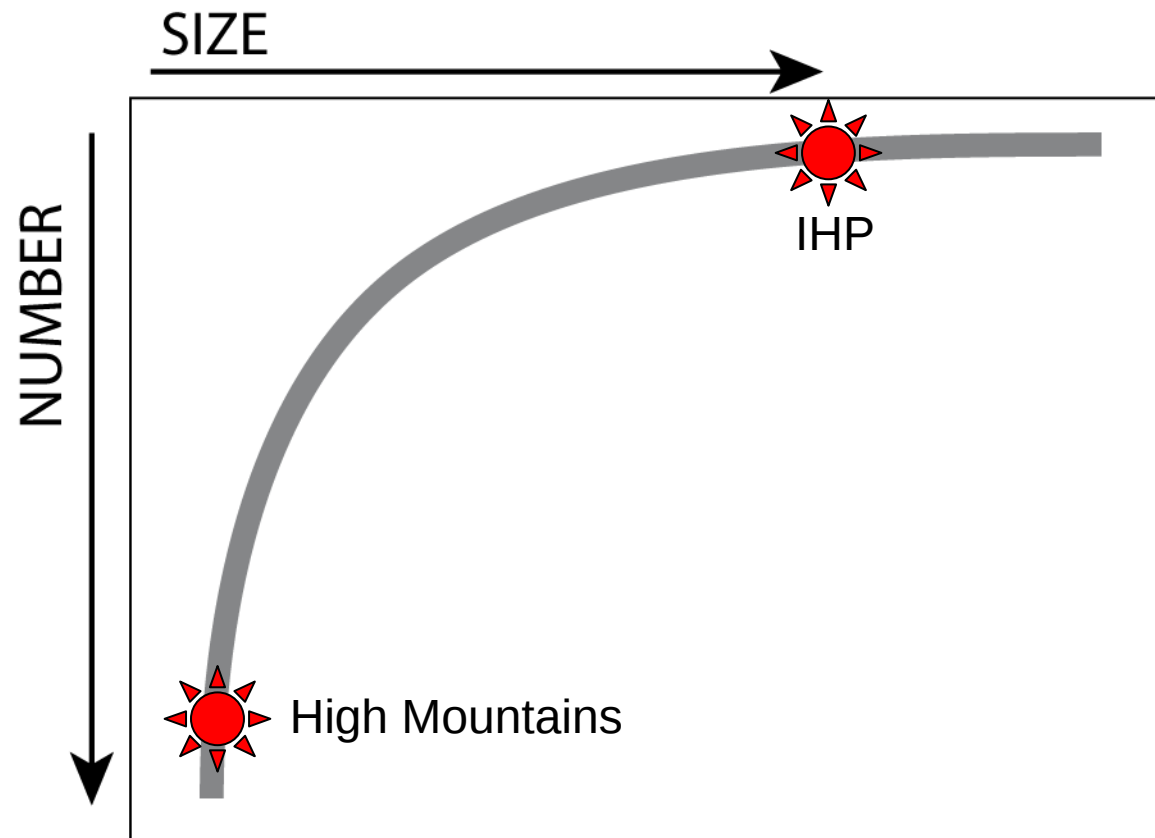


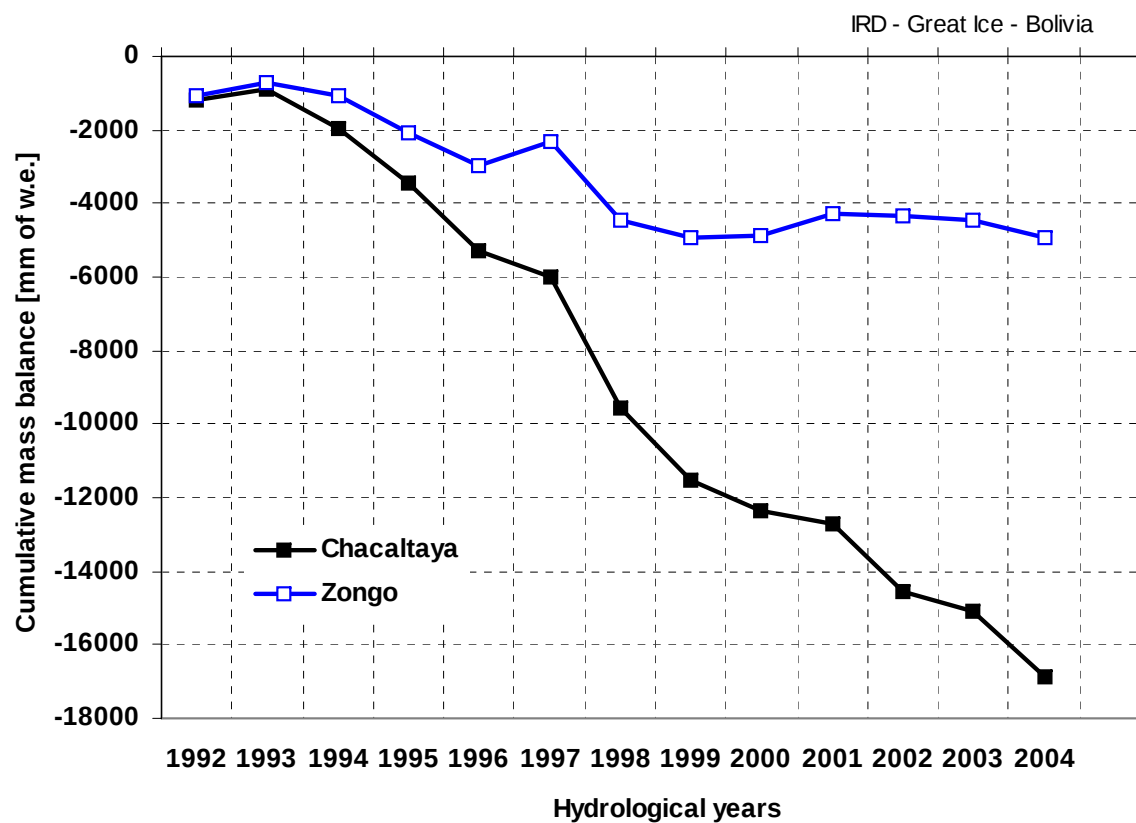
~0.8 mm SLE yr⁻¹

Lemke et al. (2007)

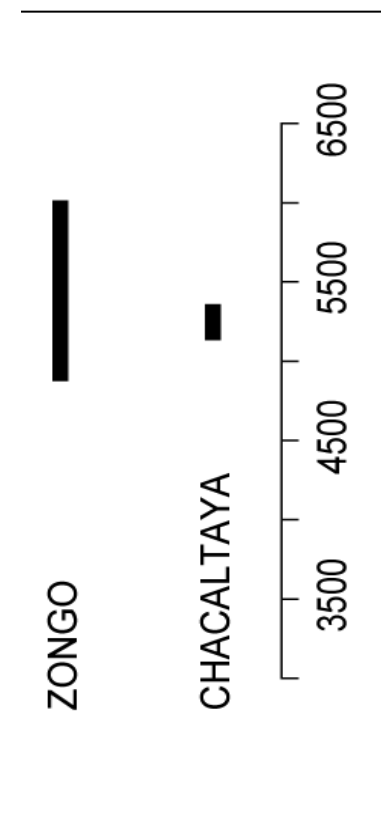


„Mass Budget' Glaciers

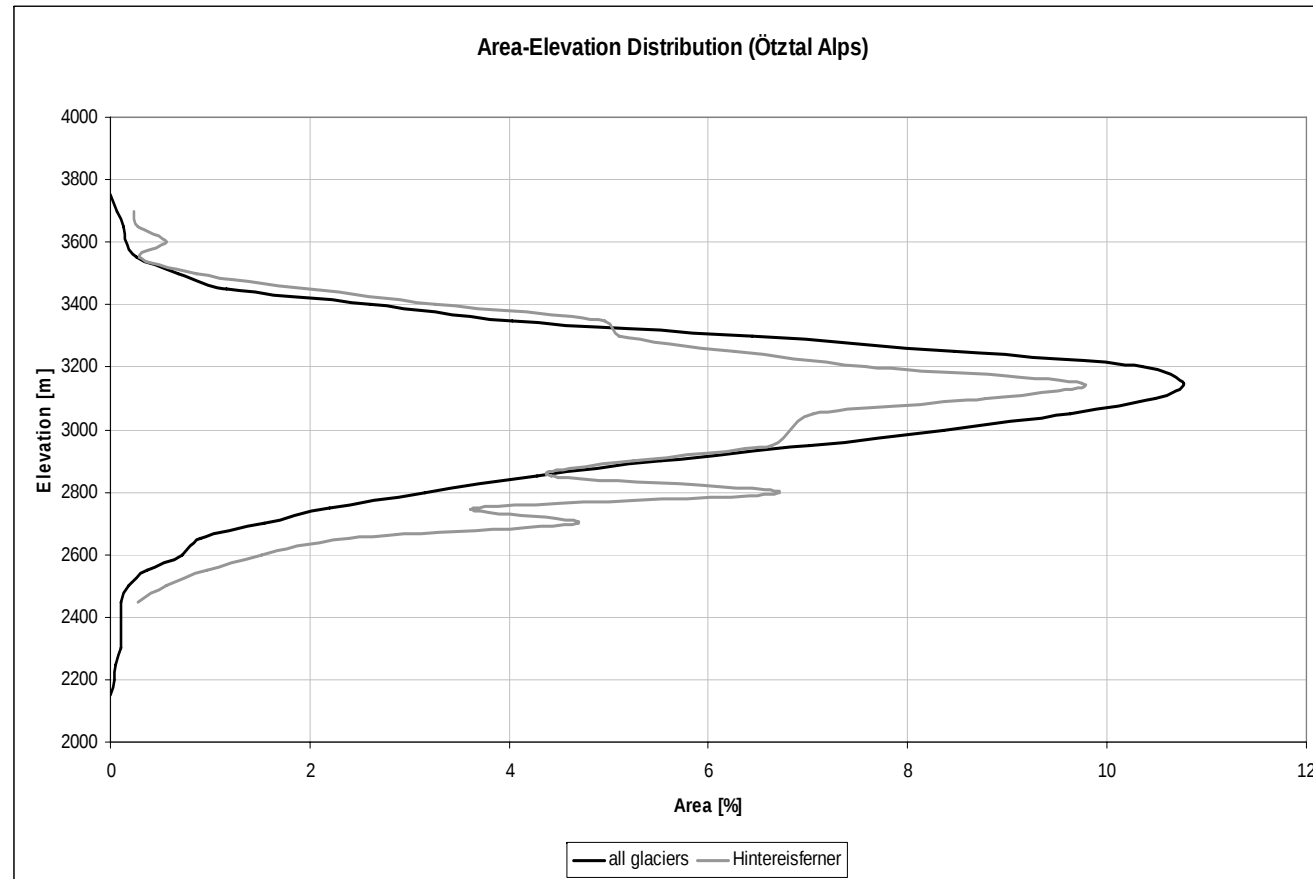




Francou et al. MRI, 2005



Juen Uibk, 2006



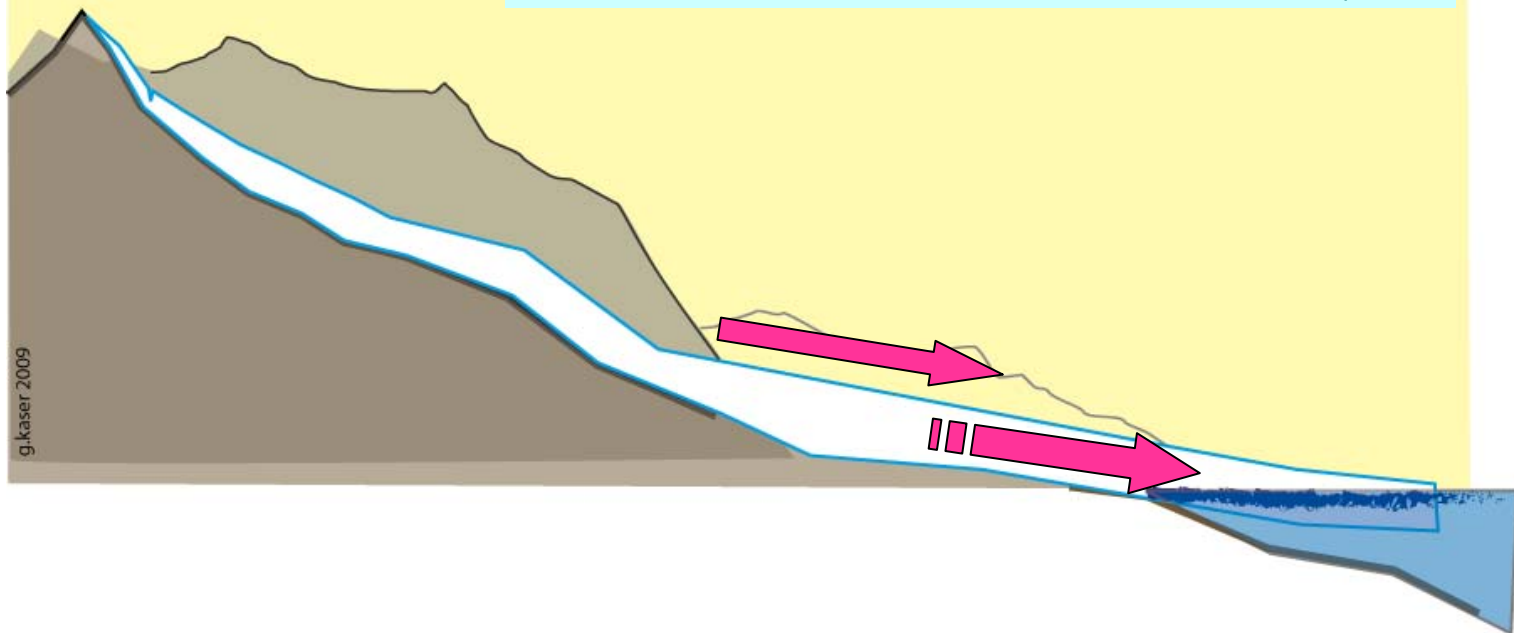
	1997	2003	2004	2005
Extrapolation $b_{\text{mean}}/b(Z)$ [kg m ⁻²]:	48%	19%	50%	27%

Hoinkes, S., in progress



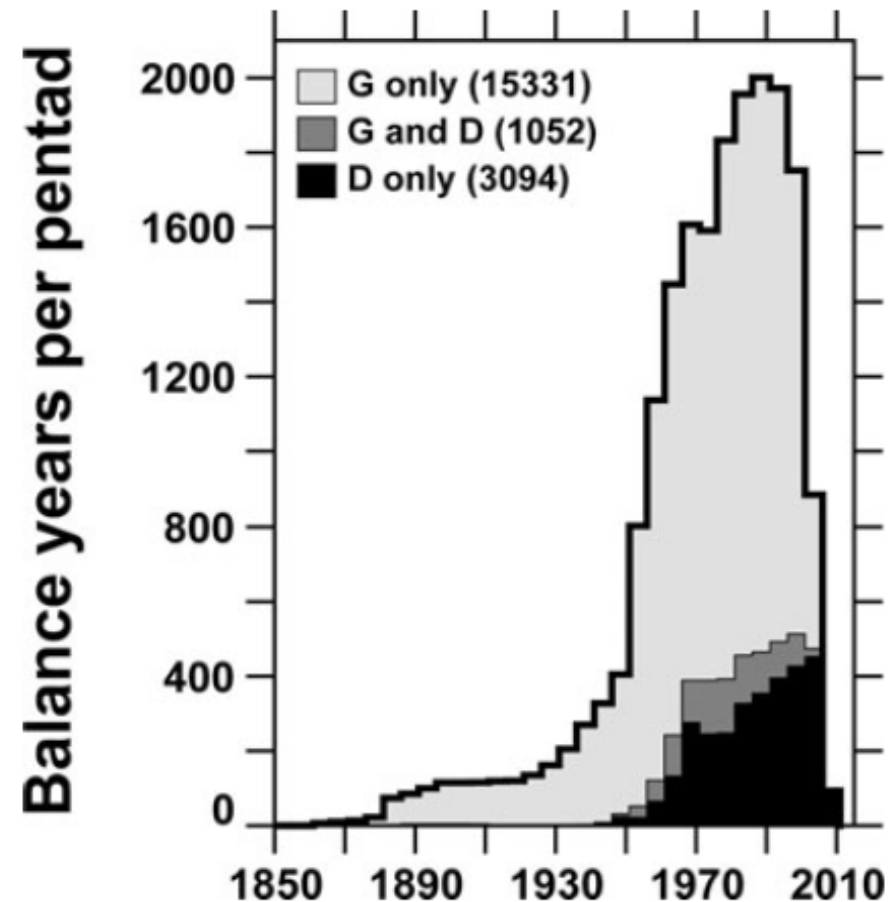
Melt water from surface
Ice discharge

Meier et al. Science (2007):
2006: 1.4 ± 0.24 mm SLE yr^{-1}





Directly and geodetically measured data



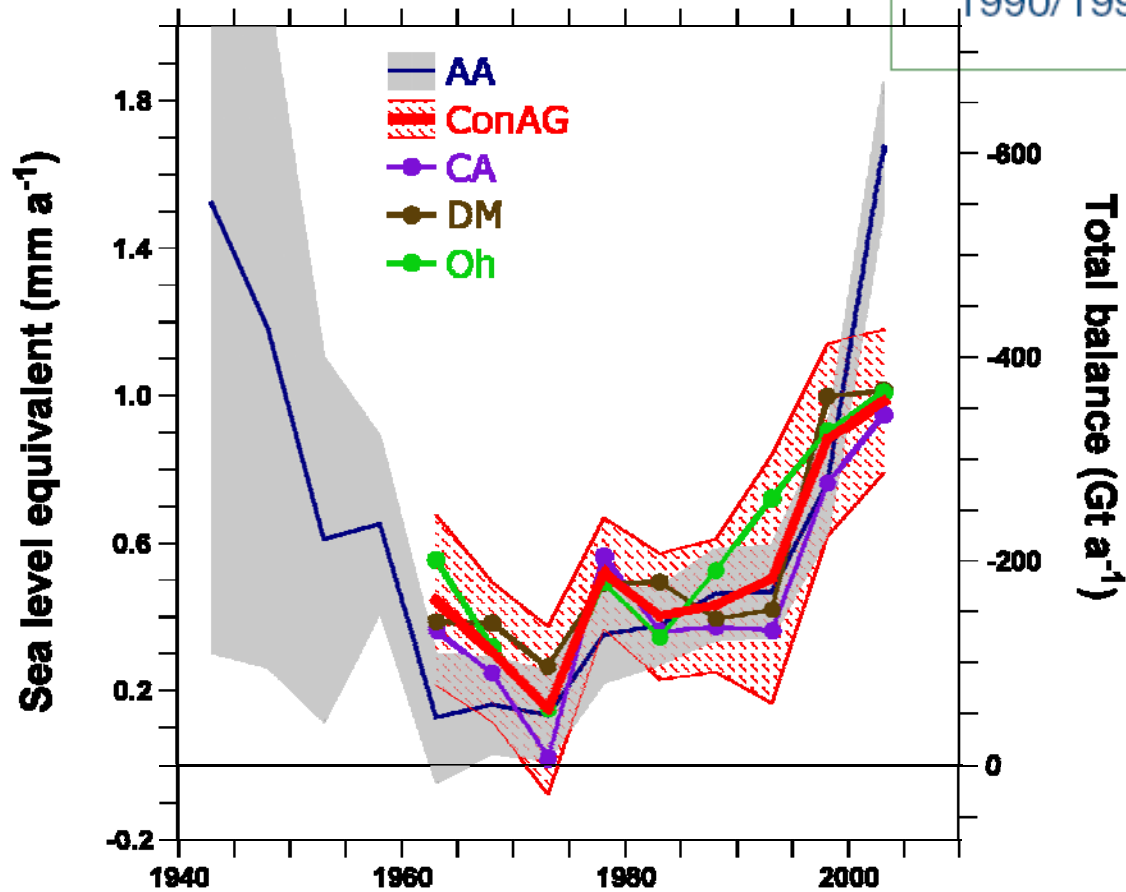
Marine calving glaciers: from 3 to 16%
Lake calving glaciers: from 4 to 16%

Cogley *Ann. Glac.*, 2009



Directly and geodetically measured data

Period	Sea Level Equivalent ^b (mm yr ⁻¹)
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1960/1961–1989/1990	0.37 ± 0.16
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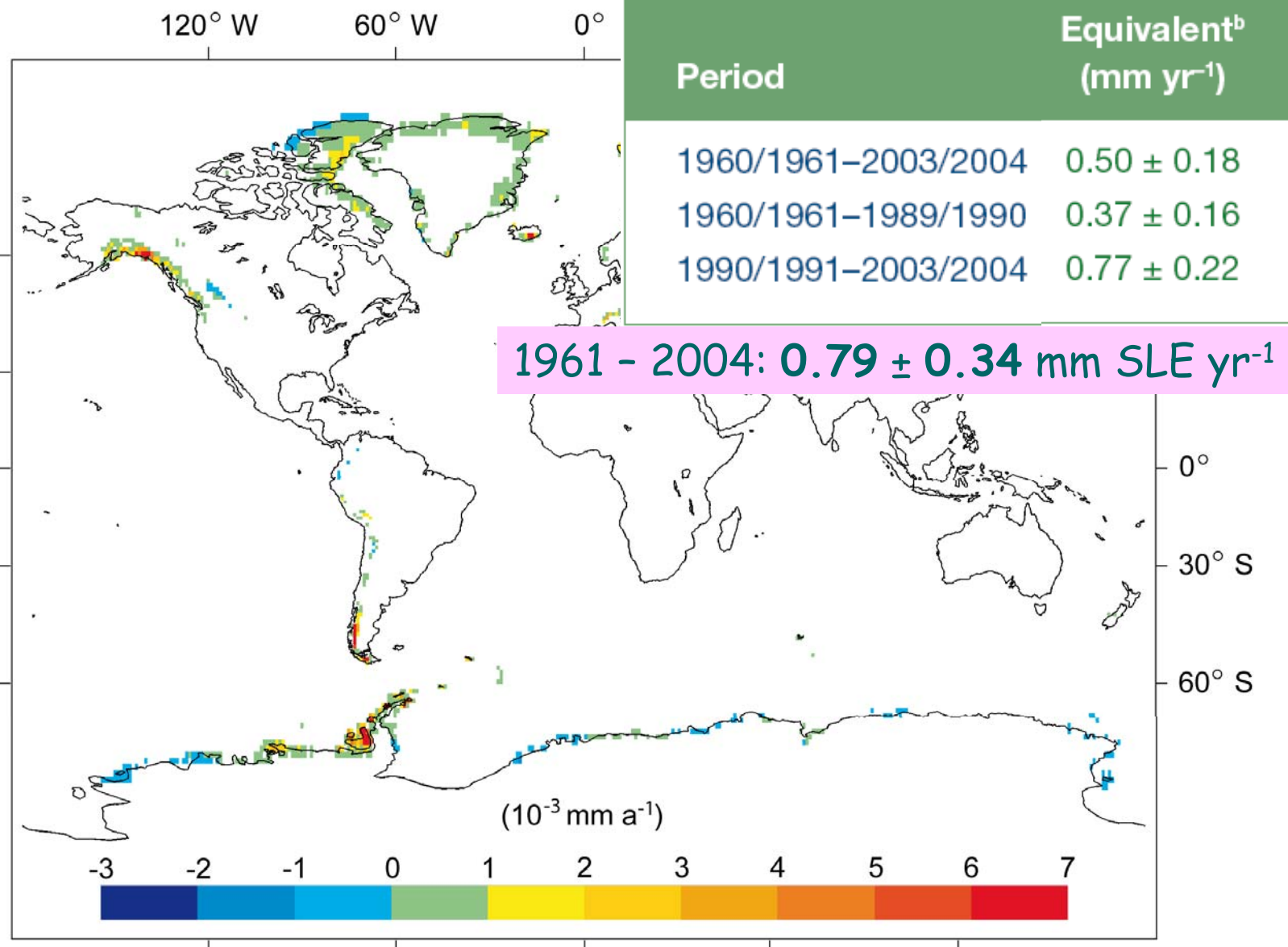
1.1 mm SLE yr⁻¹

Cogley, Ann. Glac. (2009)

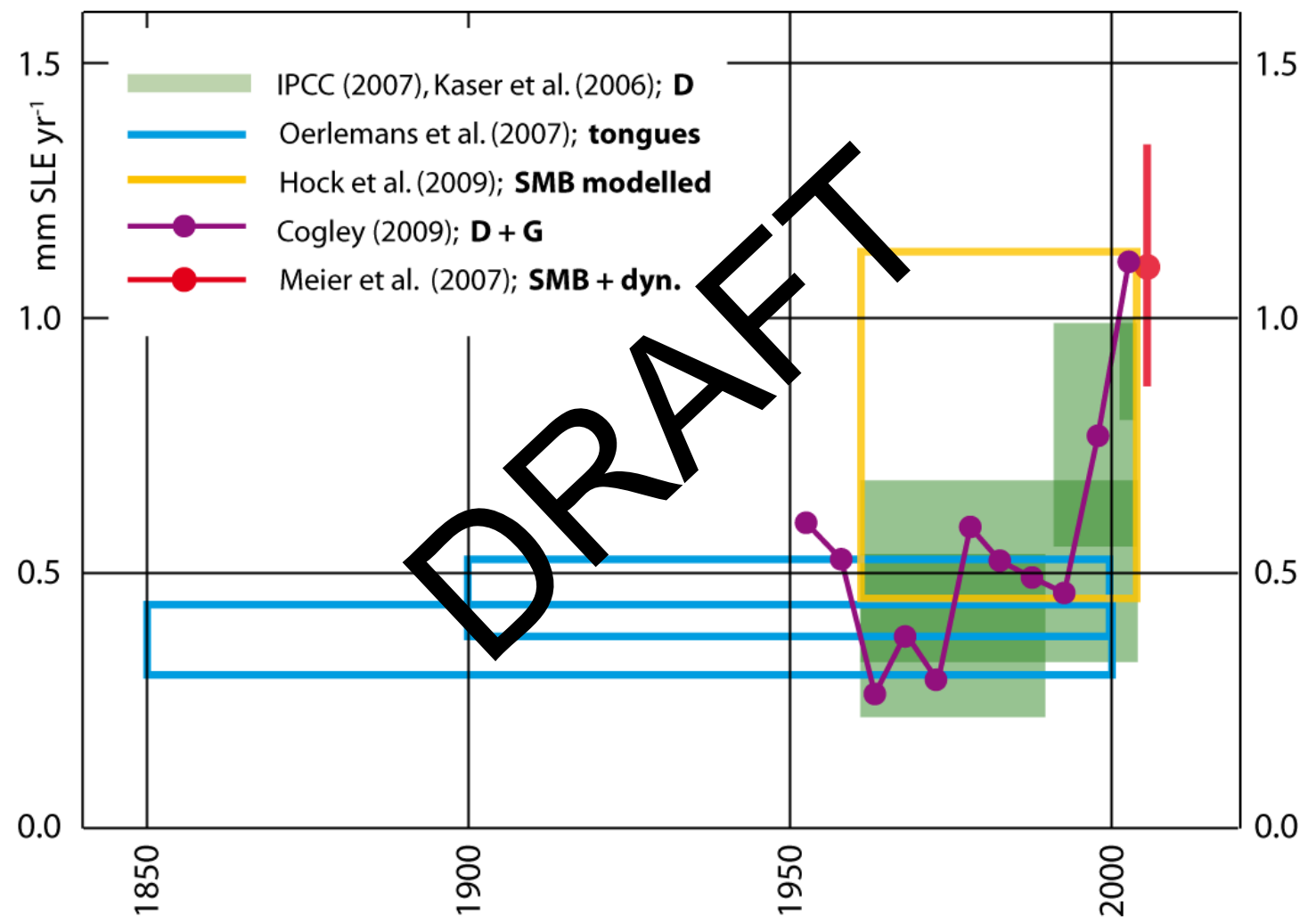
Modelling from atmospheric RA

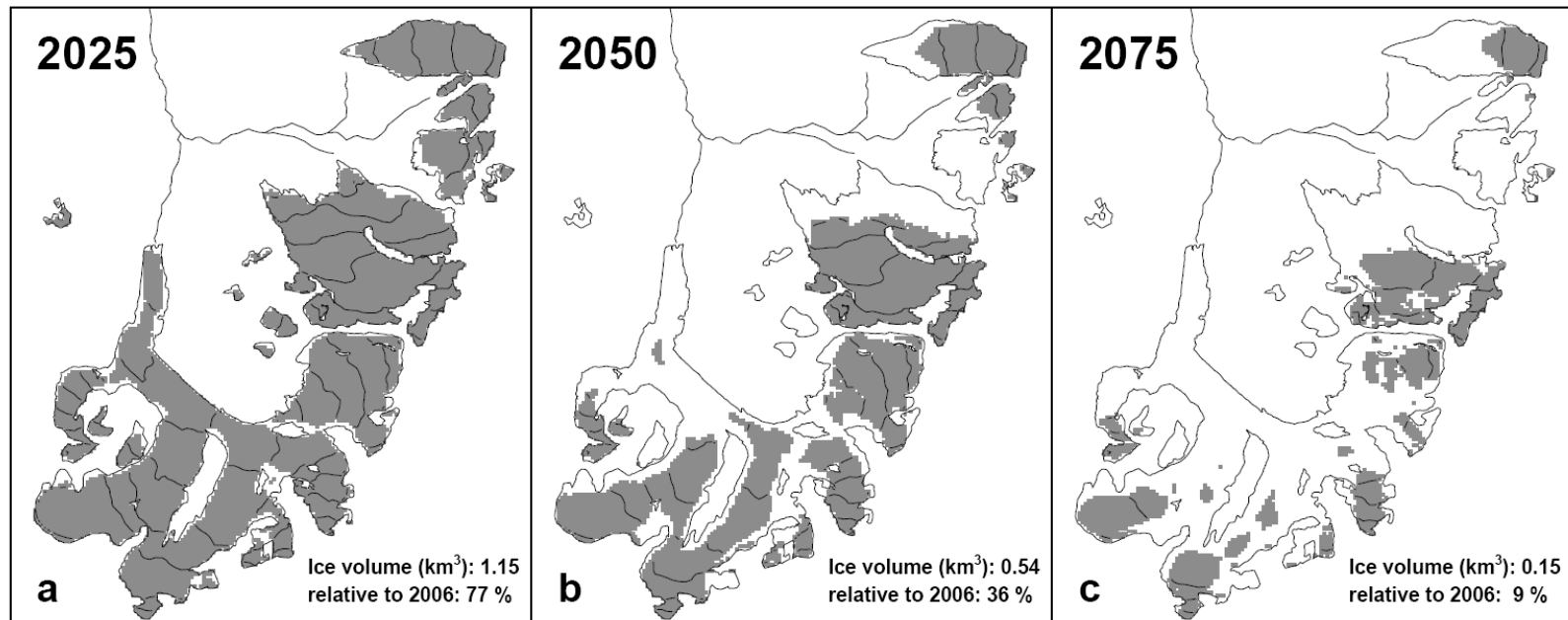


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Hock et al. *GRL* (in press)





Huss et al., Hydr.Process. (2008)

Meier et al. Science (2007):

until 2050: **0.040 – 0.124 m SLR**

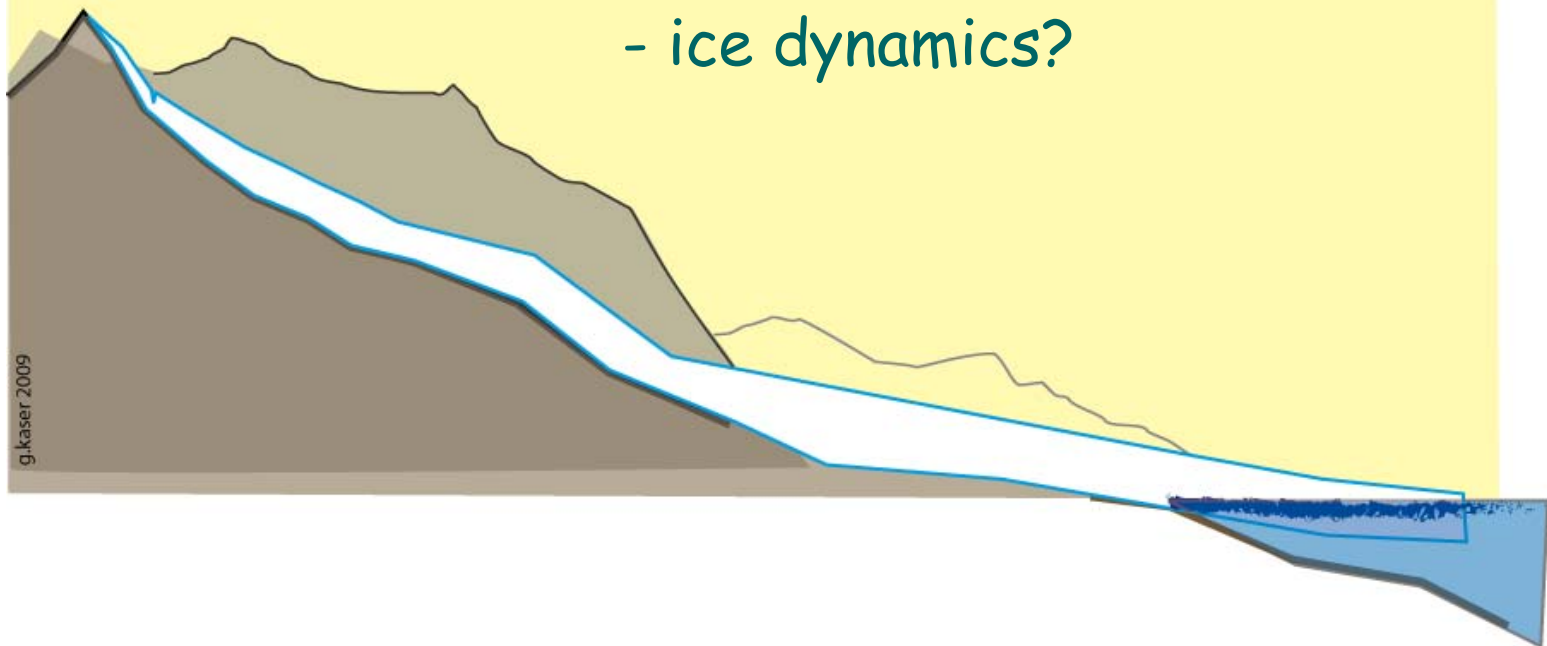
until 2100: **0.080 – 0.368 m SLR**

MG&IC including those in GL and AA: 0.49 – 0.74 m SLE

Lemke et al. (2007) - IPCC 2007 - AR4 WG I, Ch. 4



- Total: 0.49 – 0.74 m SLE
- Loss: around 1.1 mm SLE yr⁻¹
- Uncertainties:
 - lack of data: are & volume
 - lack of data: mass budgets
 - extrapolation methods
 - ice dynamics?





Thank you

*Kibo, NIF, January 2009 (g*kaser)*