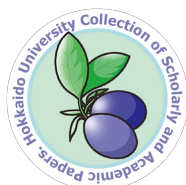




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Title	Decay of glaciers, ice caps and ice sheets
Author(s)	Ohmura, Atsumu
Relation	地球温暖化による劇変を解明する．平成20年6月24日．札幌市
Issue Date	2008-06-24
Doc URL	https://hdl.handle.net/2115/34392
Type	conference presentation
File Information	15-3.pdf



Decay of glaciers, ice caps and ice sheets

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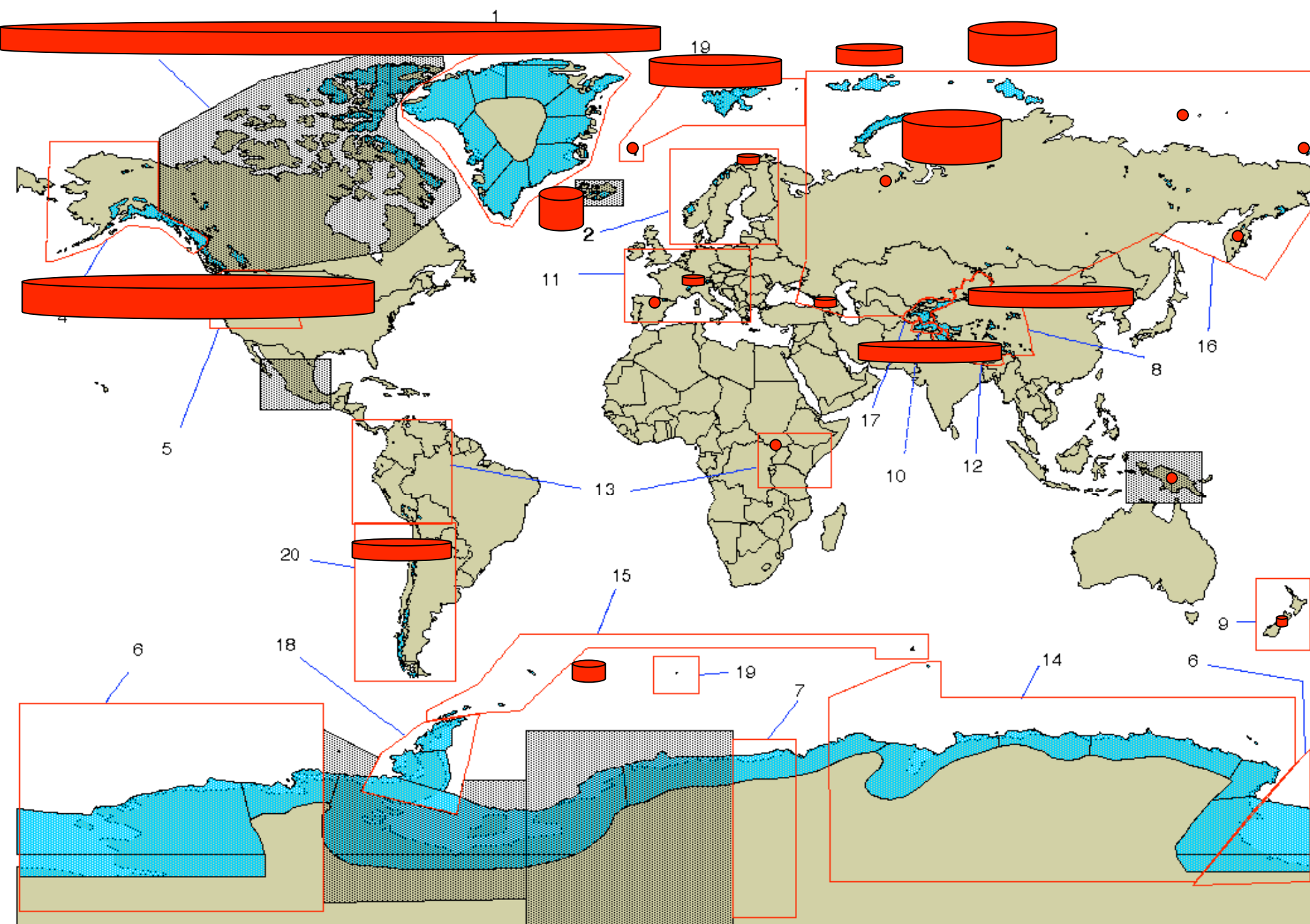
Global cryosphere area and volume (July, 2007)

Cryosphere

	Area in [10^6 km^2]	Volume
Seasonal snow cover	4 (19) ~ 46 (58)	$0.5 (1) \sim 5 (6) \times 10^3 \text{ km}^3$
Sea ice	15.0 ~ 21.5	$19 \sim 25 \times 10^3 \text{ km}^3$
Glaciers	15.9	$33.1 \times 10^6 \text{ km}^3$
Permafrost	23	$0.4 \times 10^6 \text{ km}^3 (11\text{-}35 \times 10^3 \text{ km}^3)$
Total	$58 \sim 78 \times 10^6 \text{ km}^2$	$33.5 \times 10^6 \text{ km}^3$

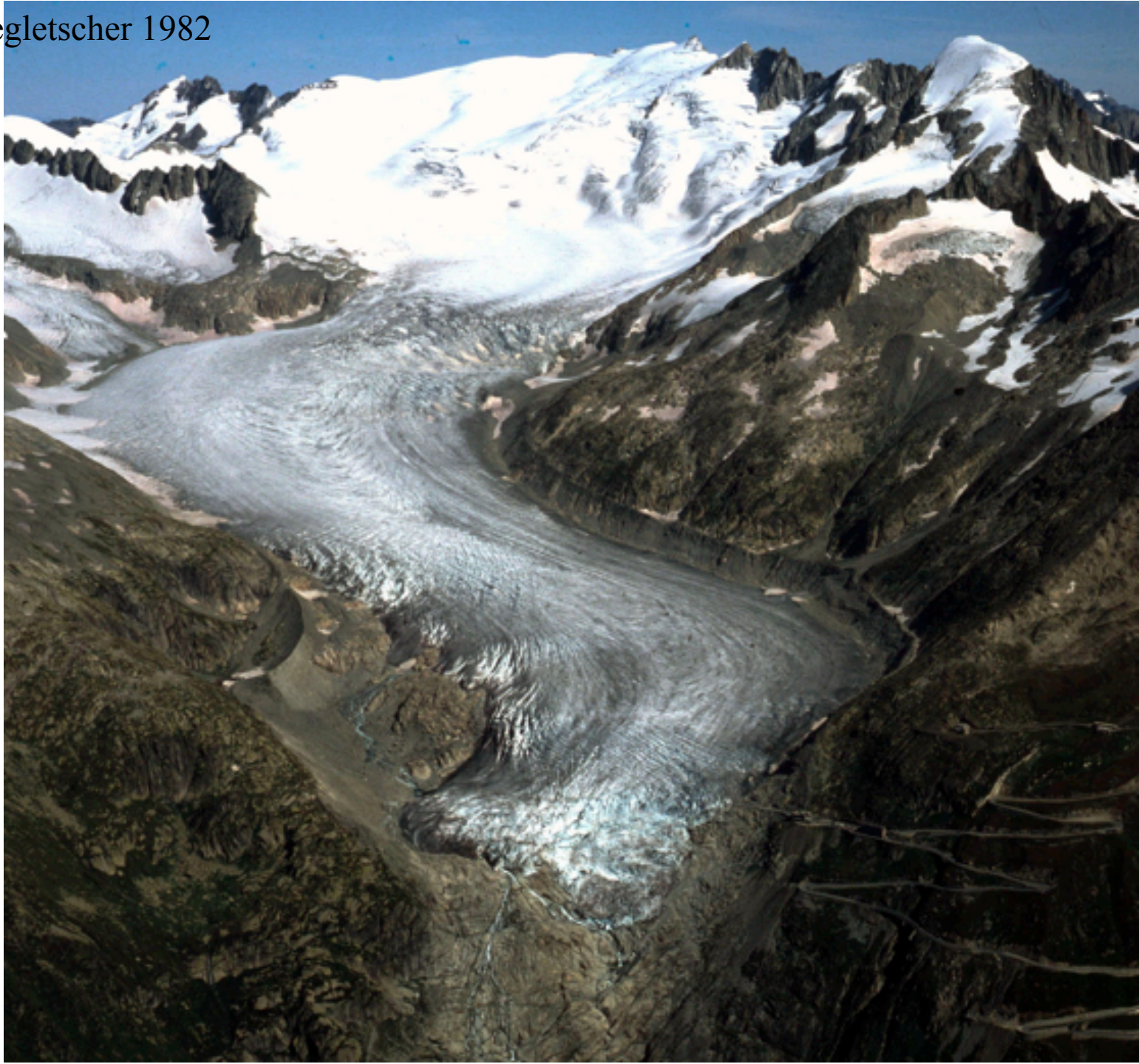
Glacier ice distribution

	[10^6 km^2]	[10^6 km^3]
Antarctic	13.59 (86 %)	30.11 (90.9 %)
Greenland	1.75 (11 %)	2.93 (8.8 %)
Others (Mountain glaciers and ice caps)	0.55 (3 %)	0.10 (0.3 %)
Total	$15.89 \times 10^6 \text{ km}^2$	$33.14 \times 10^6 \text{ km}^3$



Outlines of GLIMS Regions.
As of 1999-04-23

Rhonegletscher 1982



Rhonegletscher 2006



Triftgletscher
2002



Triftgletscher 2005



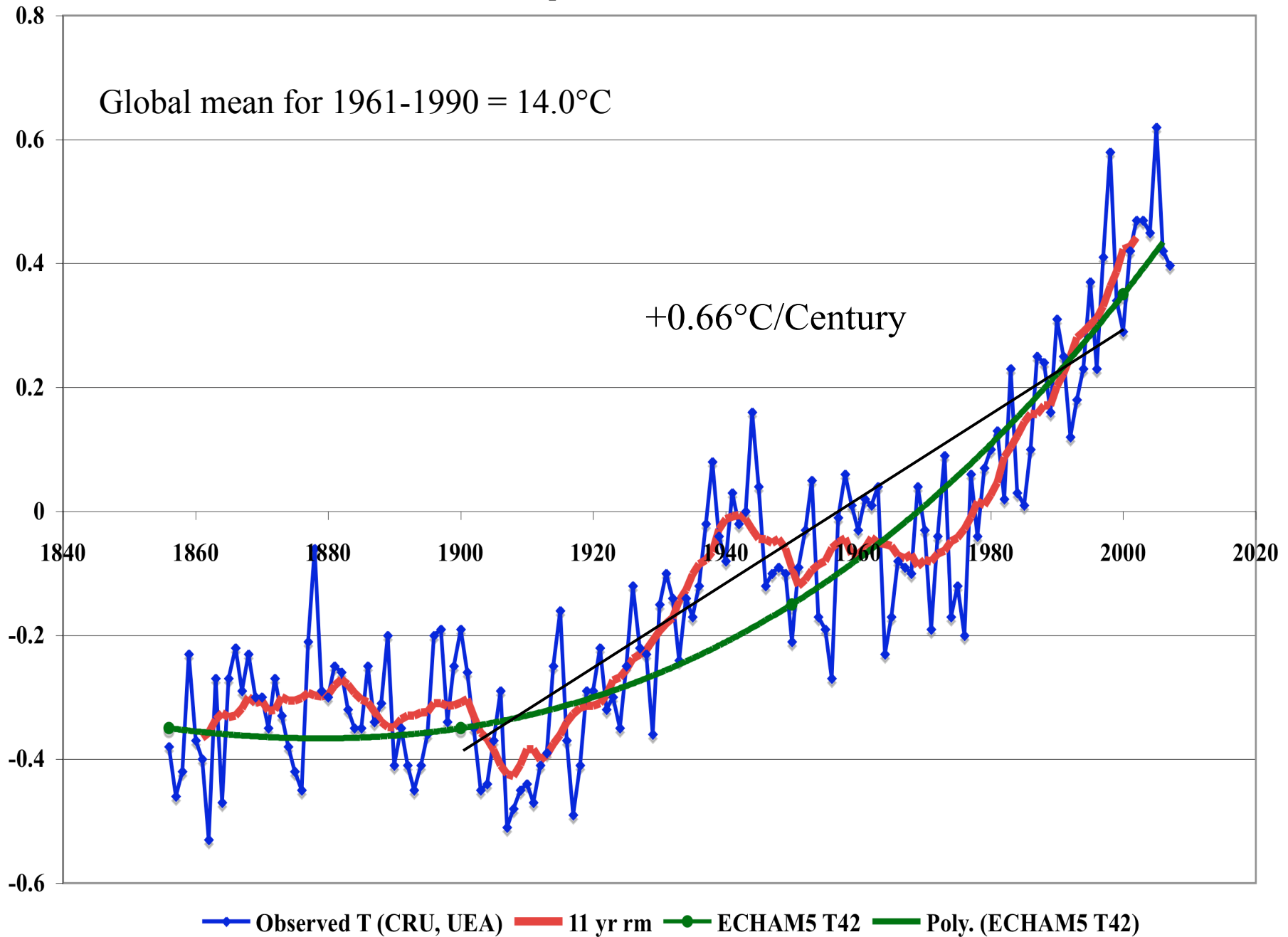
30.6.2005

Global mean air temperature, observed and simulated

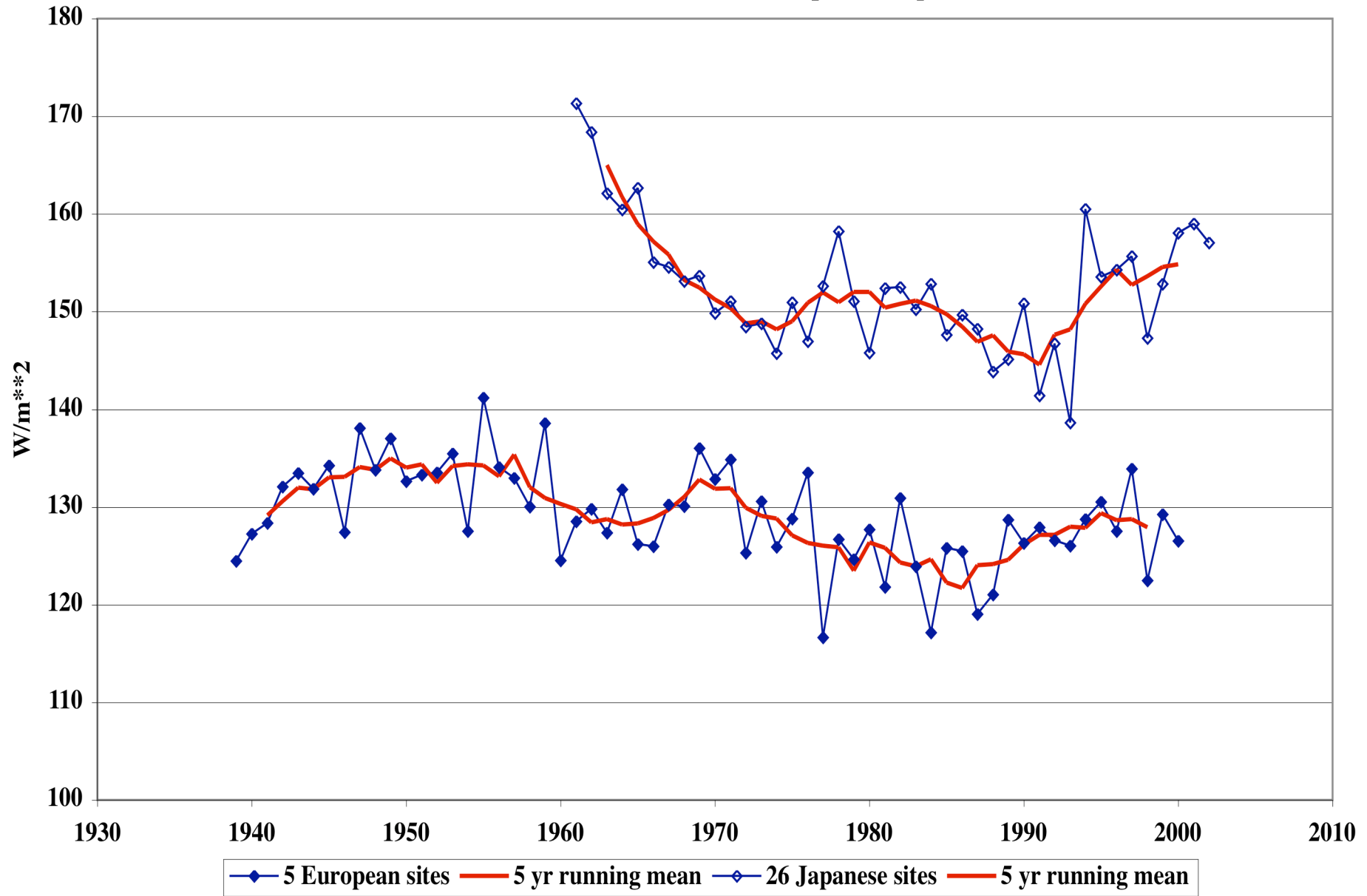
Global mean for 1961-1990 = 14.0°C

+0.66°C/Century

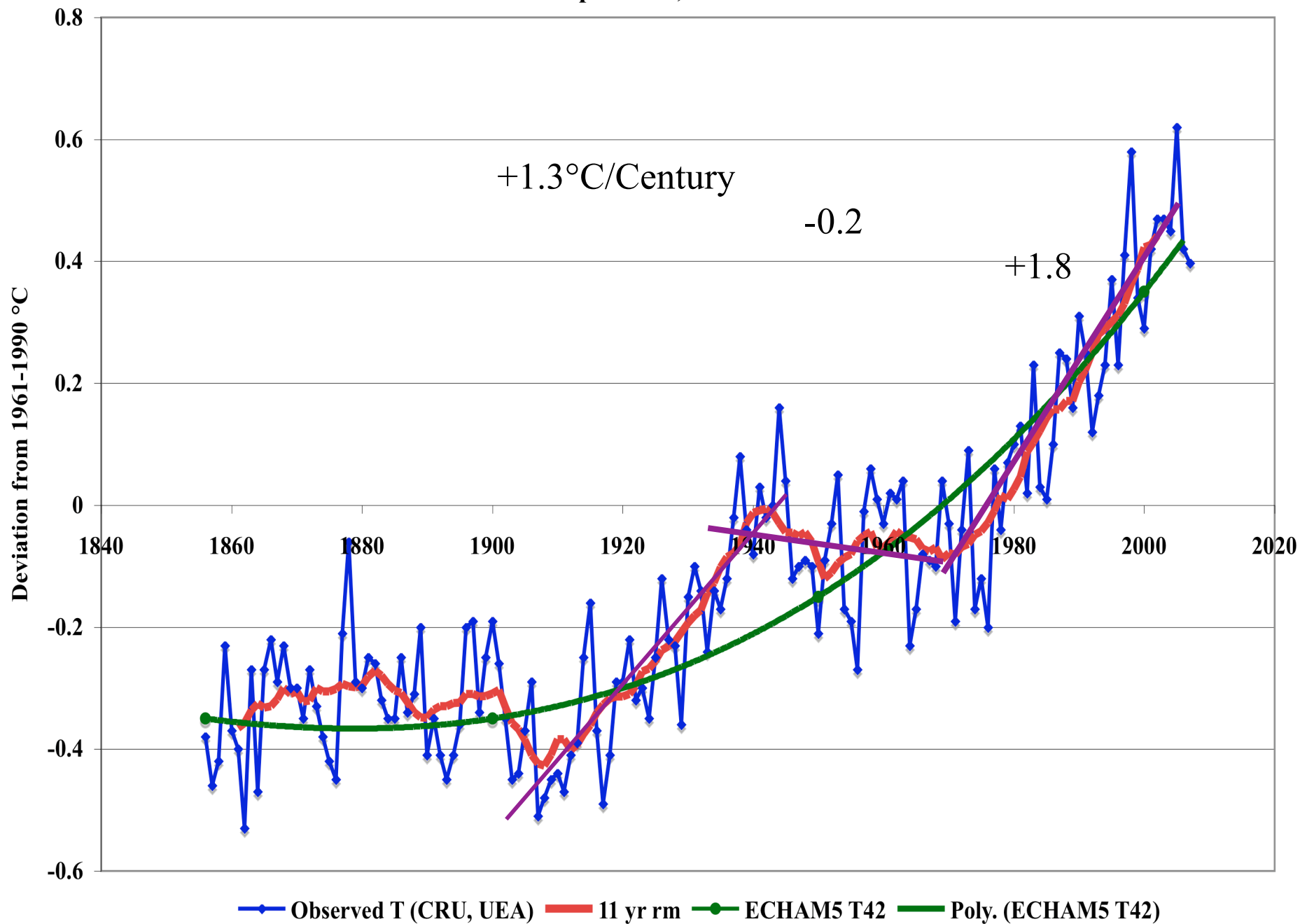
Deviation from 1961-1990 °C



Annual mean solar radiation in Europe and Japan

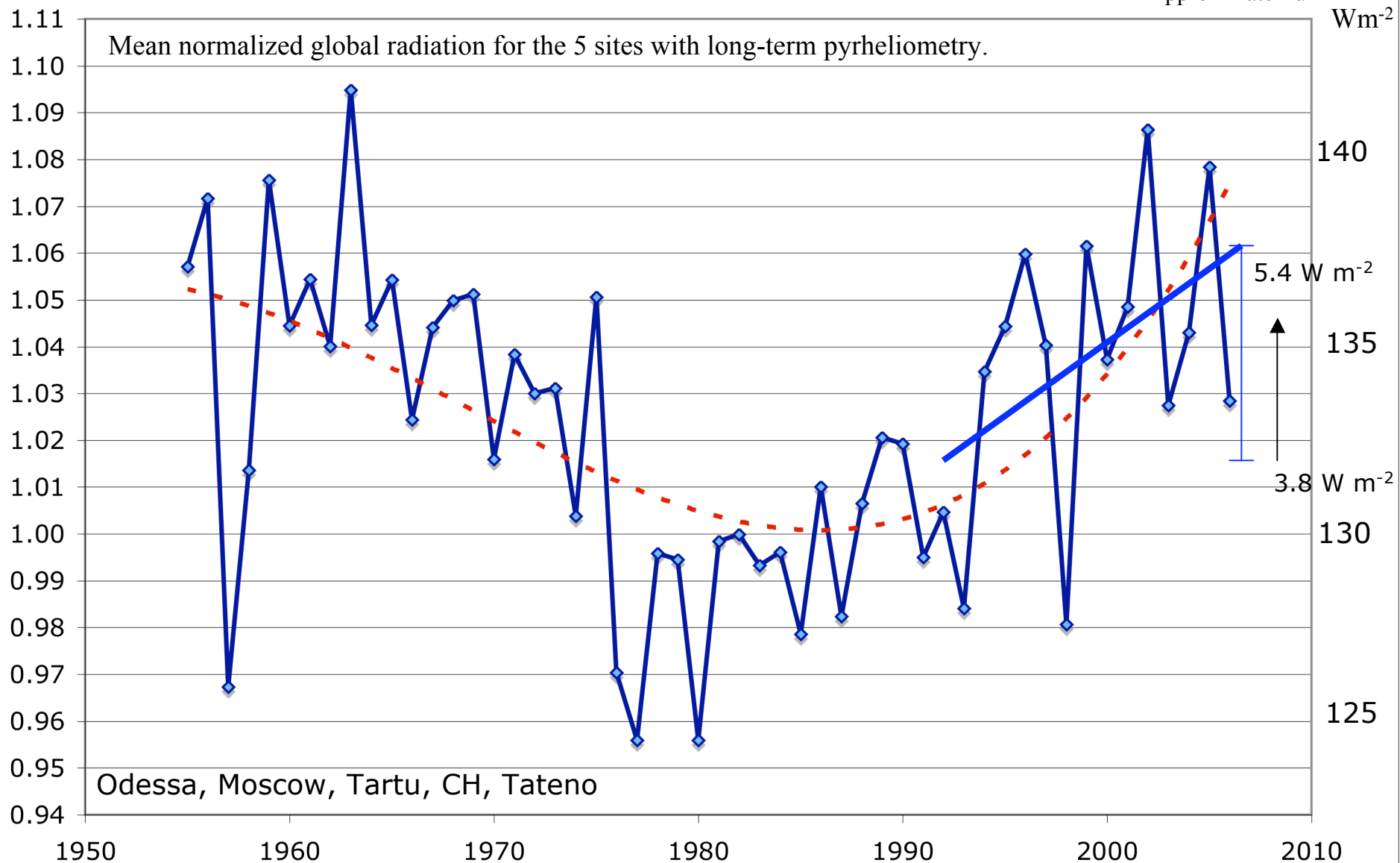


Global mean air temperature, observed and simulated



Approximate flux
 Wm^{-2}

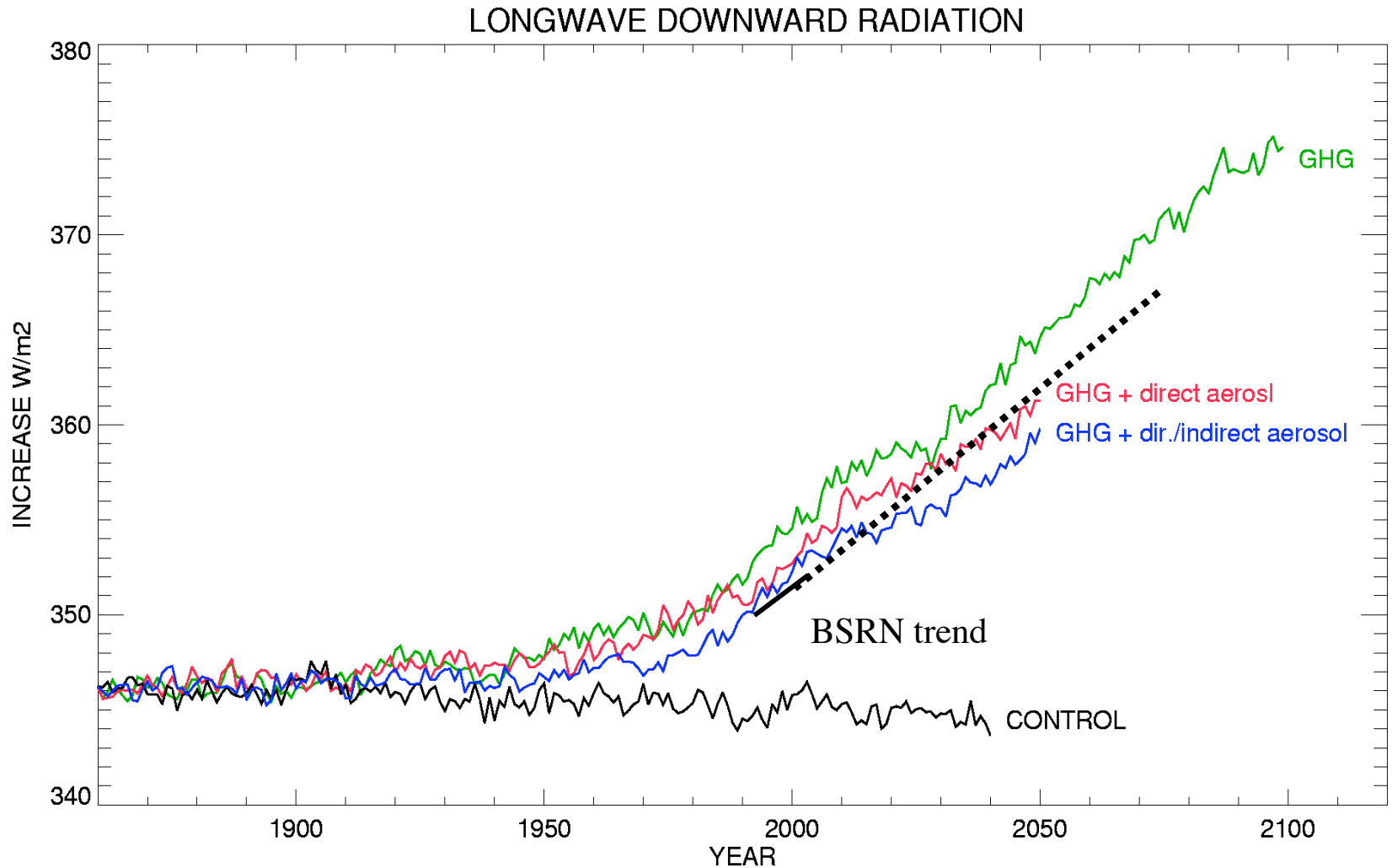
Mean normalized global radiation for the 5 sites with long-term pyrheliometry.



Odessa, Moscow, Tartu, CH, Tateno

Detection of important changes in radiation

1. Global dimming & brightening
2. Possible increase in long-wave incoming radiation



Decadal global change in radiation

Change in terrestrial irradiance

1950-1990 +1.0 Wm⁻²/Decade

1991-2007 +2.5

Change in solar irradiance

1950-1990 -4.5 Wm⁻²/Decade

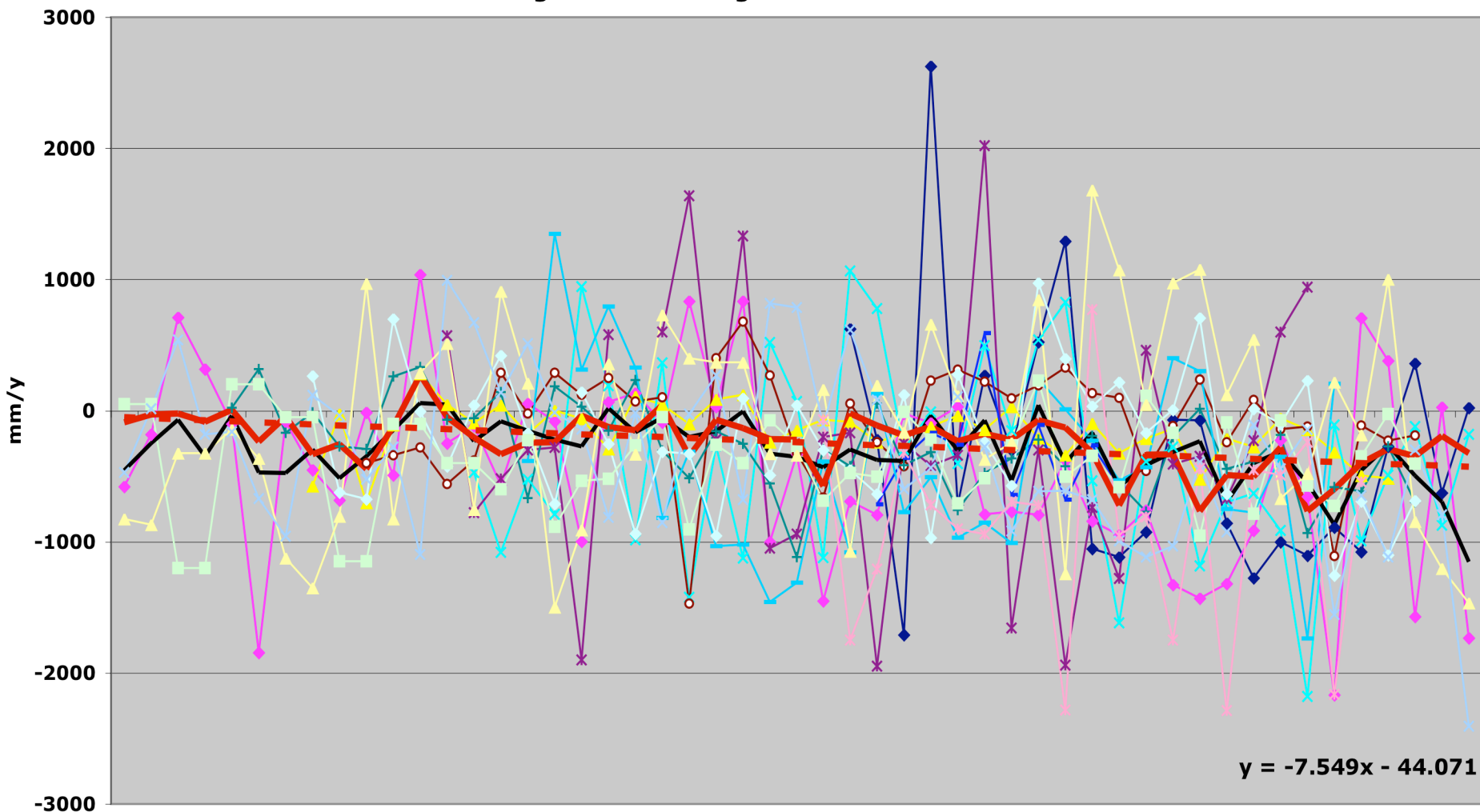
1991-2007 +4.1

Change in Total irradiance

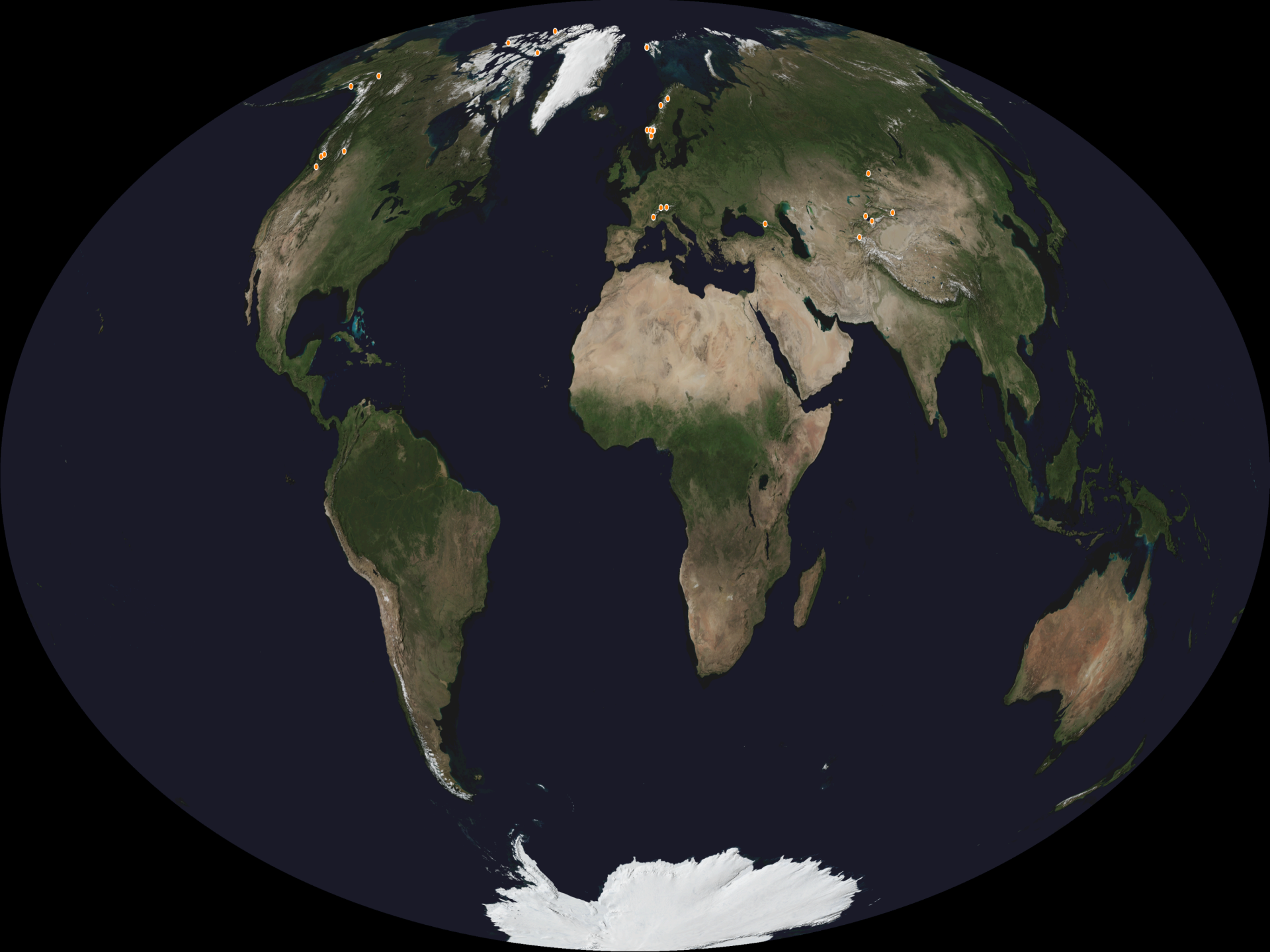
1950-1990 -3.0 Wm⁻²/Decade

1991-2007 +6.6

Global and Regional area-weighted annual net mass balance



- | | | | |
|-------------------------------|--------------------|----------------------|----------------------|
| ◆ Andes | ◆ Rockies, Coastal | ▲ CND Arctic | ✕ Alaska |
| ✕ Kamchatka | ○ Altai | ✕ Tenshan, Dzungaria | ◆ Himalayas |
| ✕ Pamir | ◆ Caucasus | ■ Svalbard | ▲ Scandinavia |
| ✕ Alps | ✕ Equatorial | — Arithmetic mean | — Area-weighted mean |
| ■ Linear (Area-weighted mean) | | | |





Austre Brøggerbreen

Midre Lovénbreen

Storglaciären

Engabreen

Storbreen

Ålfotbreen

Gråsubreen

Hellstungubreen

Nigårdsbreen

Rembesdalsskåla

Claridenfirn

Vernagtferner

Glacier de Sarennes



Leviy Aktru
Maliy Aktru
No.125 (Vodopadniy)

Djankuat

Tsentralniy Tuyuksuyskiy

Urmuqihe No.1

Abramov

Kara Batkak



Meighen Ice Cap

Melville South Ice Cap

Devon Ice Cap

Gulkana

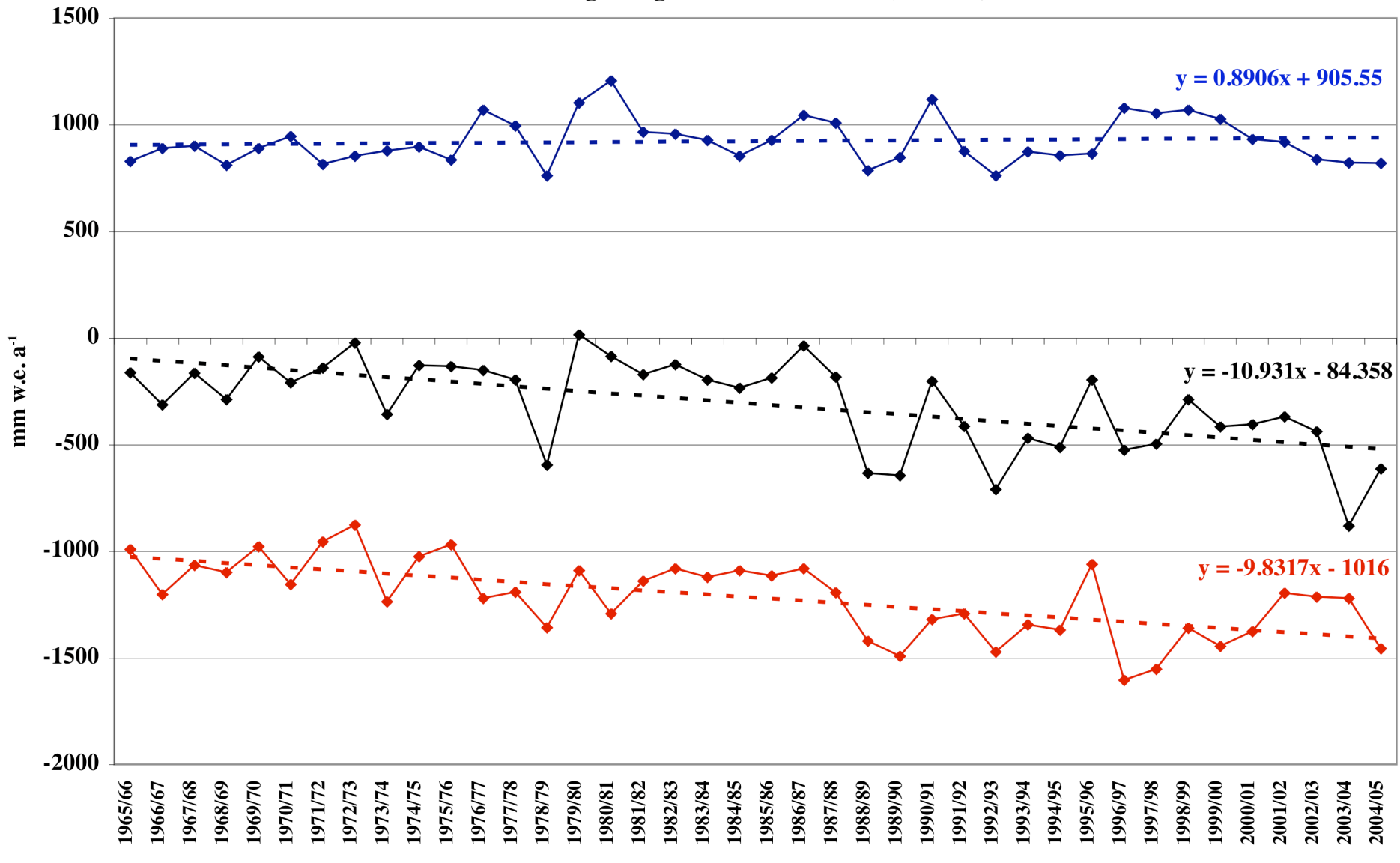
Wolverine

Place
Helm

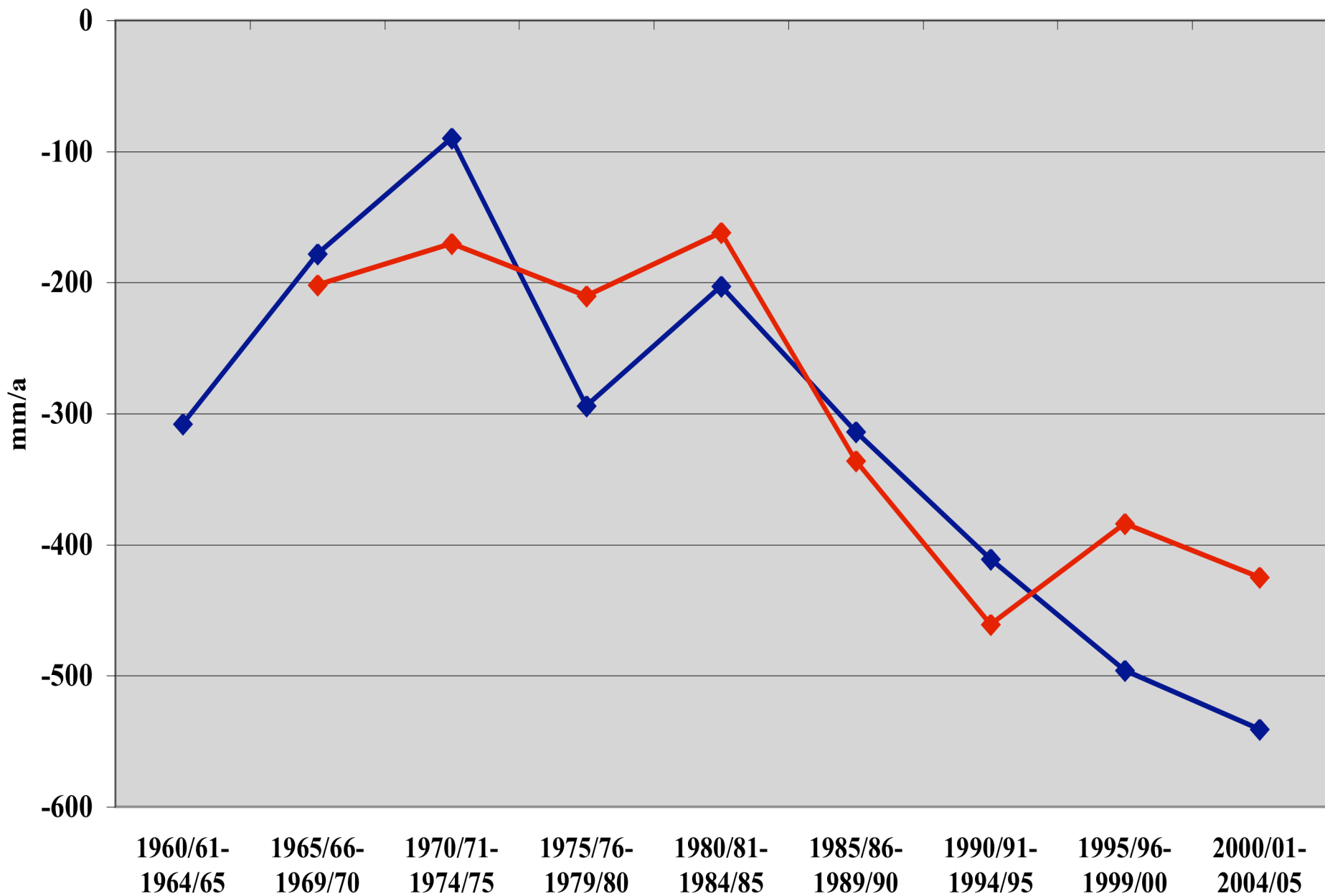
Peyto

South Cascade

Global area-weighted glacier mass balance (Revised)



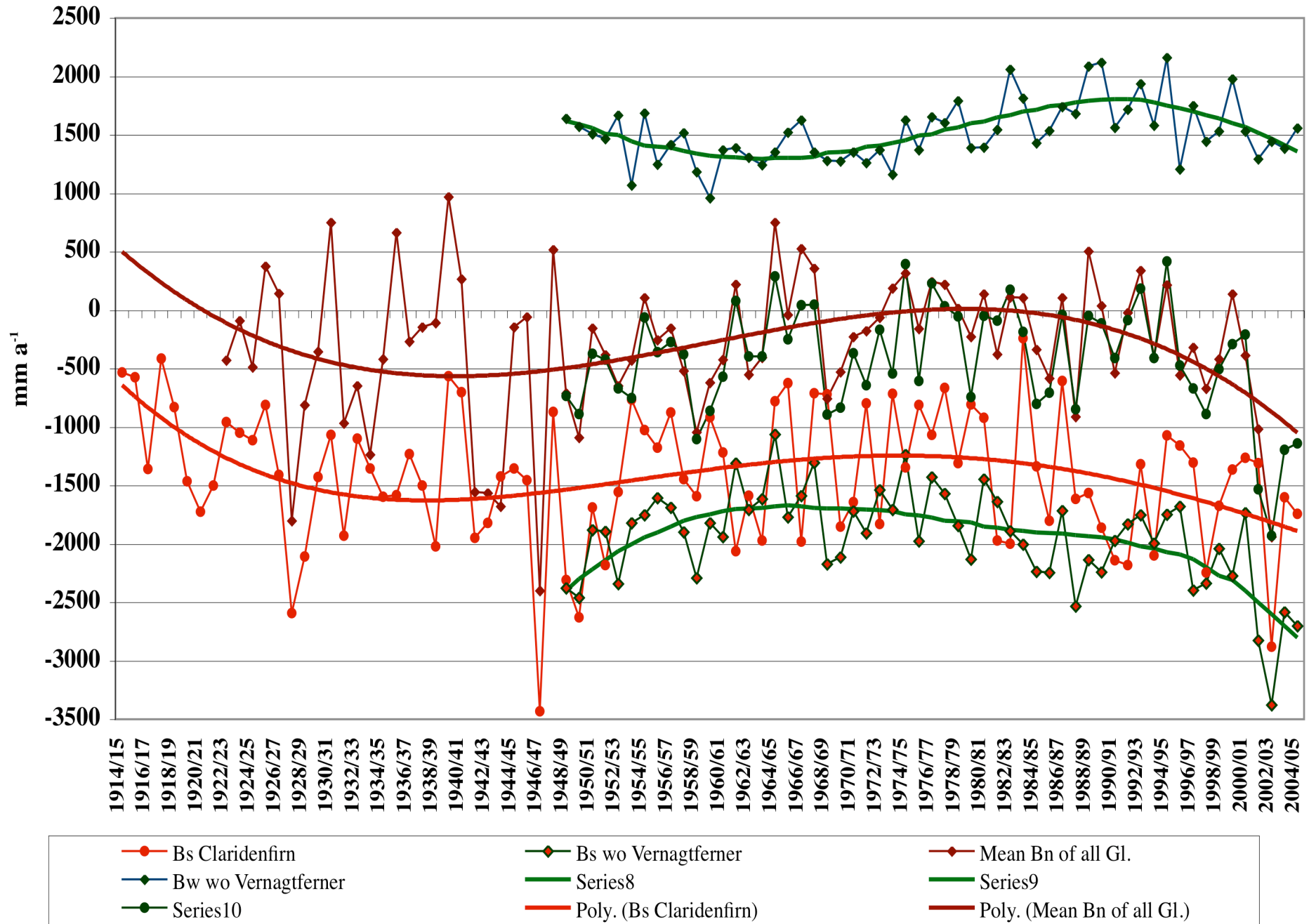
Pentade global mass balance

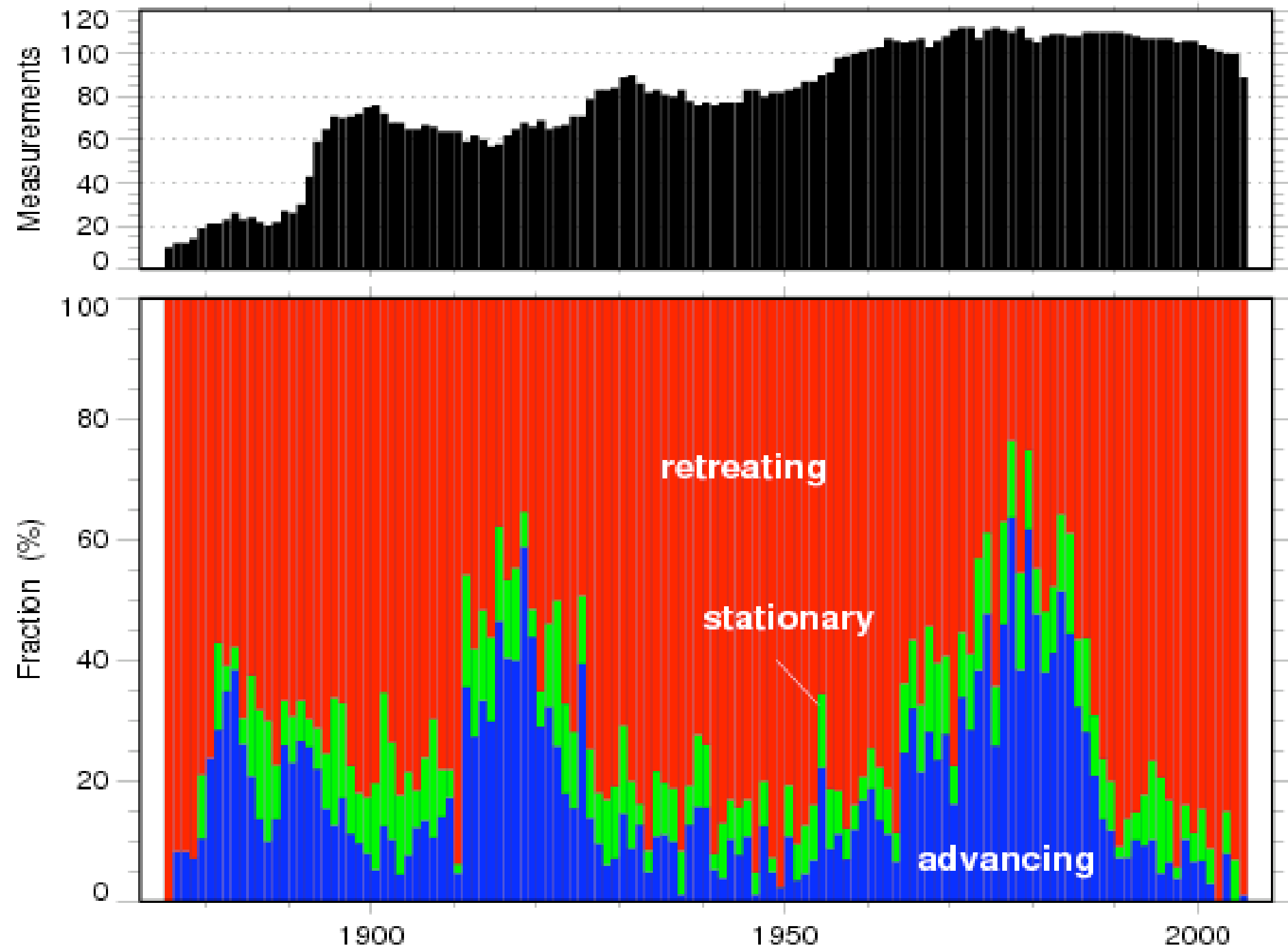


Global mean pentade annual net mass balance

Pentade period	ms mass b.	Sea-level
	mm/a	mm/5 a
1960/61-1964/65	-308	2.4
1965/66-1969/70	-178	1.4
1970/71-1974/75	-90	0.7
1975/76-1979/80	-294	2.2
1980/81-1984/85	-203	1.5
1985/86-1989/90	-314	2.4
1990/91-1994/95	-411	3.1
1995/96-1999/00	-496	3.8
2000/01-2004/05	-541	4.1
Total over 45 years	-14,175 mm	21.6 mm

Mean mass balance of glaciers in Europe





Estimate of the mass balance of the Greenland ice sheet

Surface area: 1,756 x 10³ km²

	Total ice volume km³ W.E. y¹	Mean specific balance mm W.E. y¹	Source
Annual precipitation on Greenland	753	346	Ohmura et al. (1999)
Annual precipitation on tundra	163	379	ditto
Annual precipitation on ice-covered area	590	340	ditto
Loss through evaporation/sublimation	61	35	ditto
Loss by run-off as liquid precipitation	13	8	ditto
Annual accumulation	516	297	ditto
Melt	297	169	This work
Calving	316	180	Reeh (1994), E. Rignot (PC)
Rate of storage	-91	-52	This work

Sea-level influence during the 20th century

1. Small glaciers and ice caps	4.7 cm
2. Greenland	2.5
3. Antarctic	10 ?
4. Thermal expansion of ocean	2
5. Other sources	?

Gauge	17 cm
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