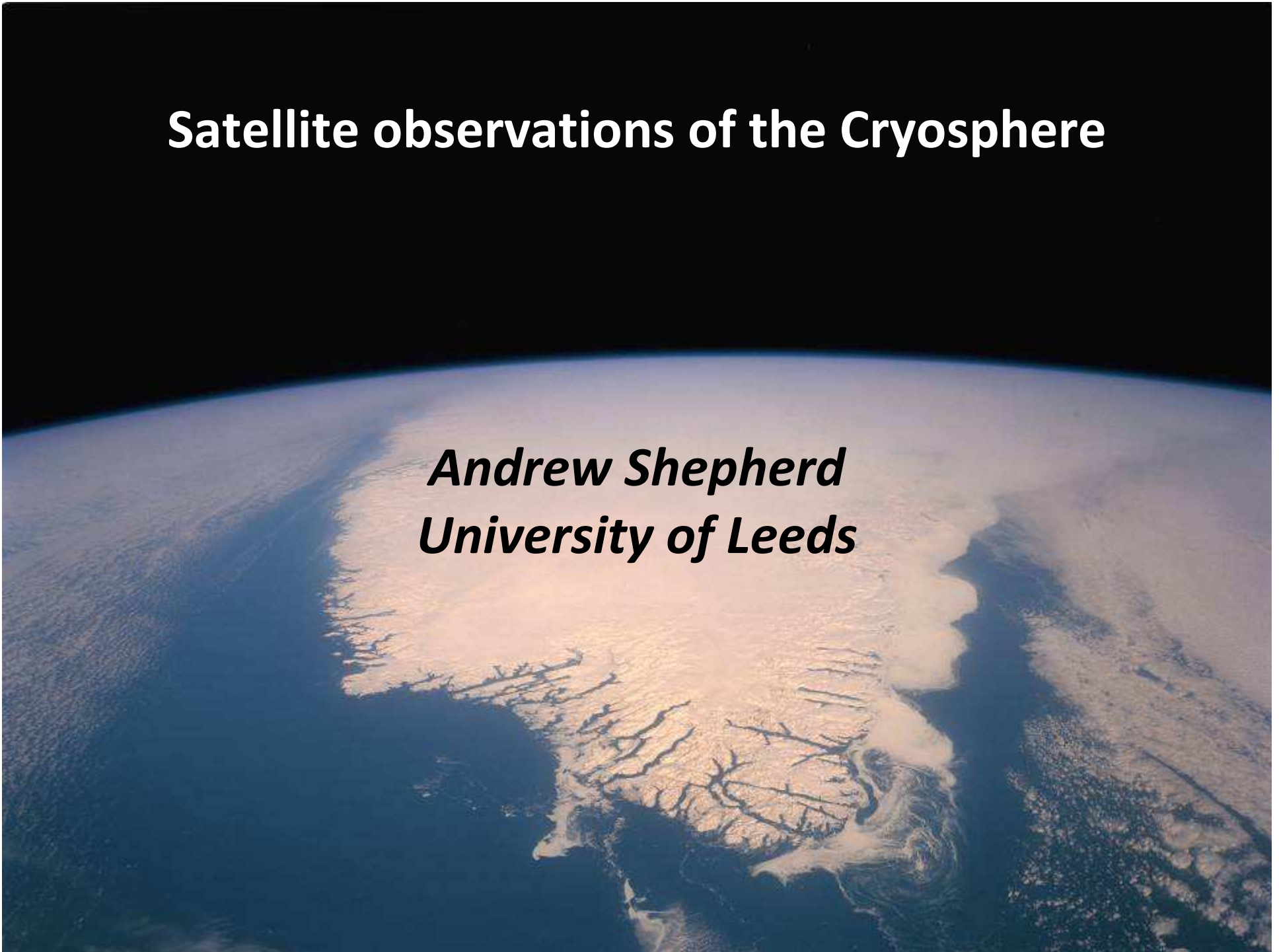


Satellite observations of the Cryosphere

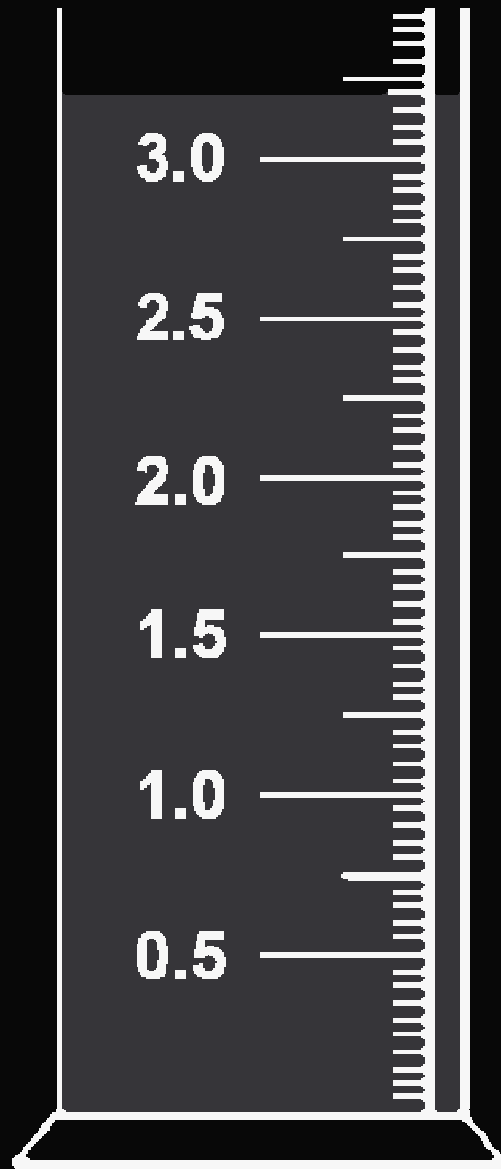
Andrew Shepherd
University of Leeds



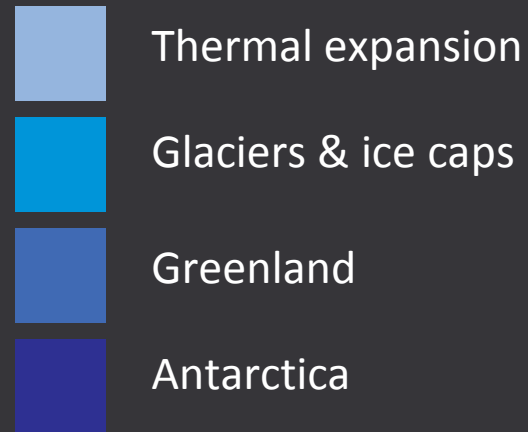
Outline

1. Cryosphere & climate
2. Mountain glaciers
3. Ice Sheets
4. Outlook

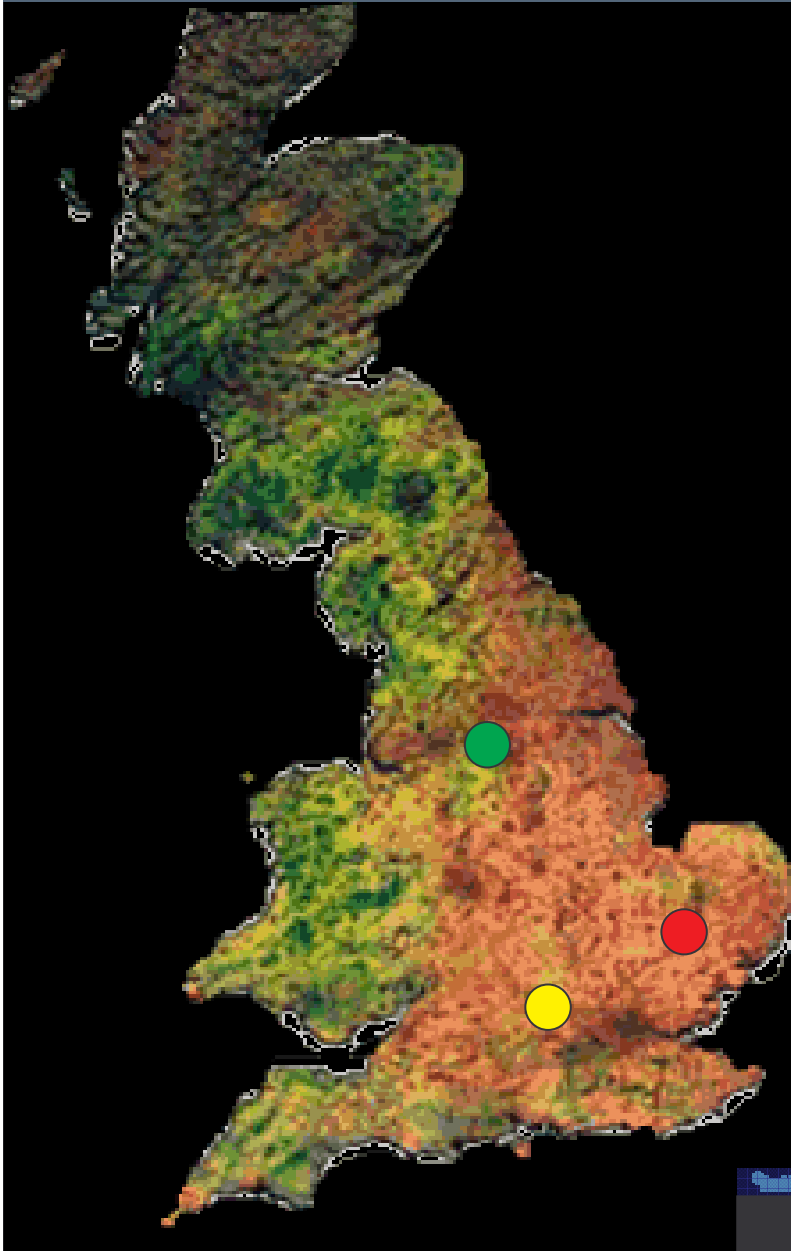
1. Cryosphere & Climate



Millimetres per year



1. Cryosphere & Climate



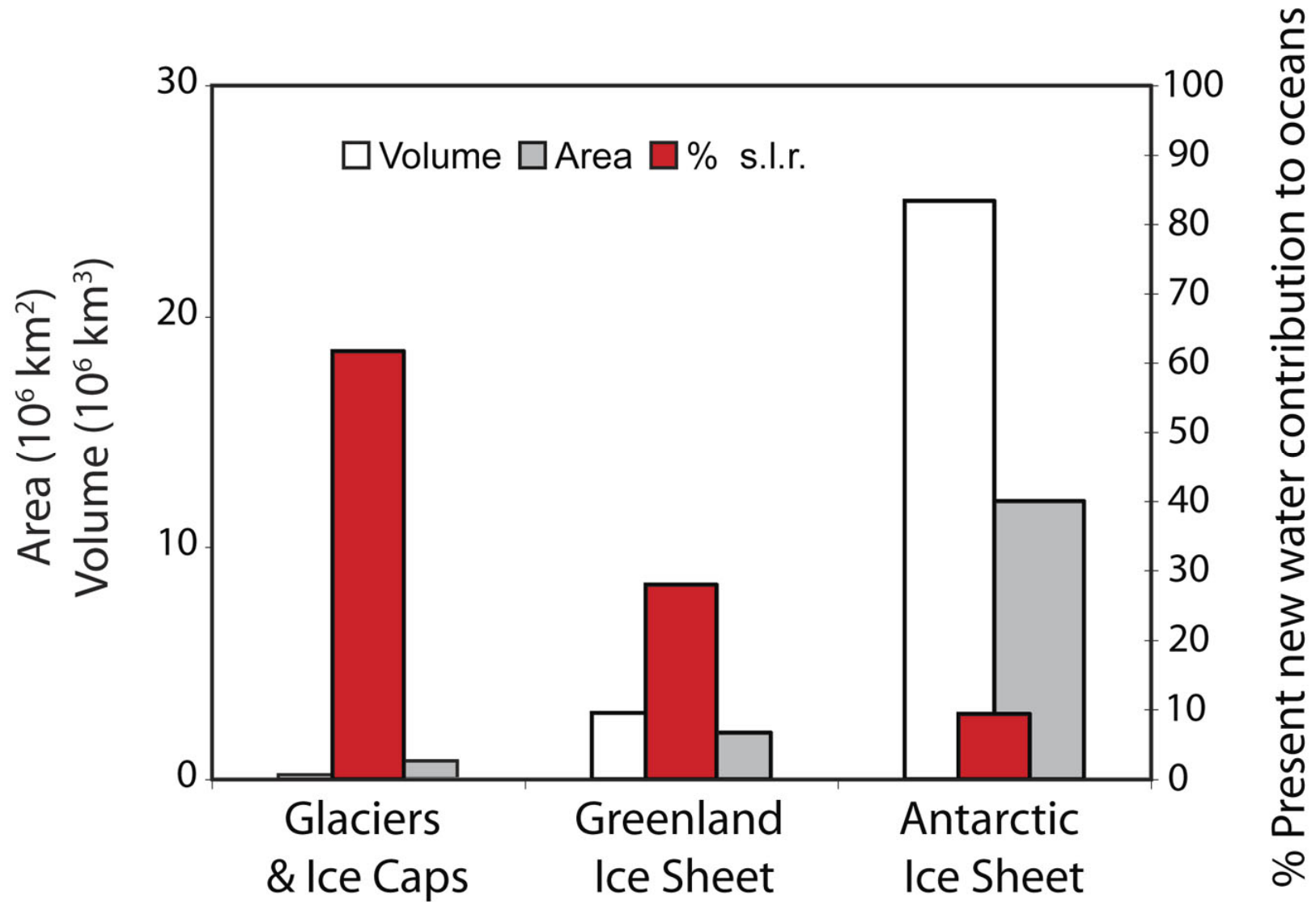
86 m.a.s.l.



48 m.a.s.l.

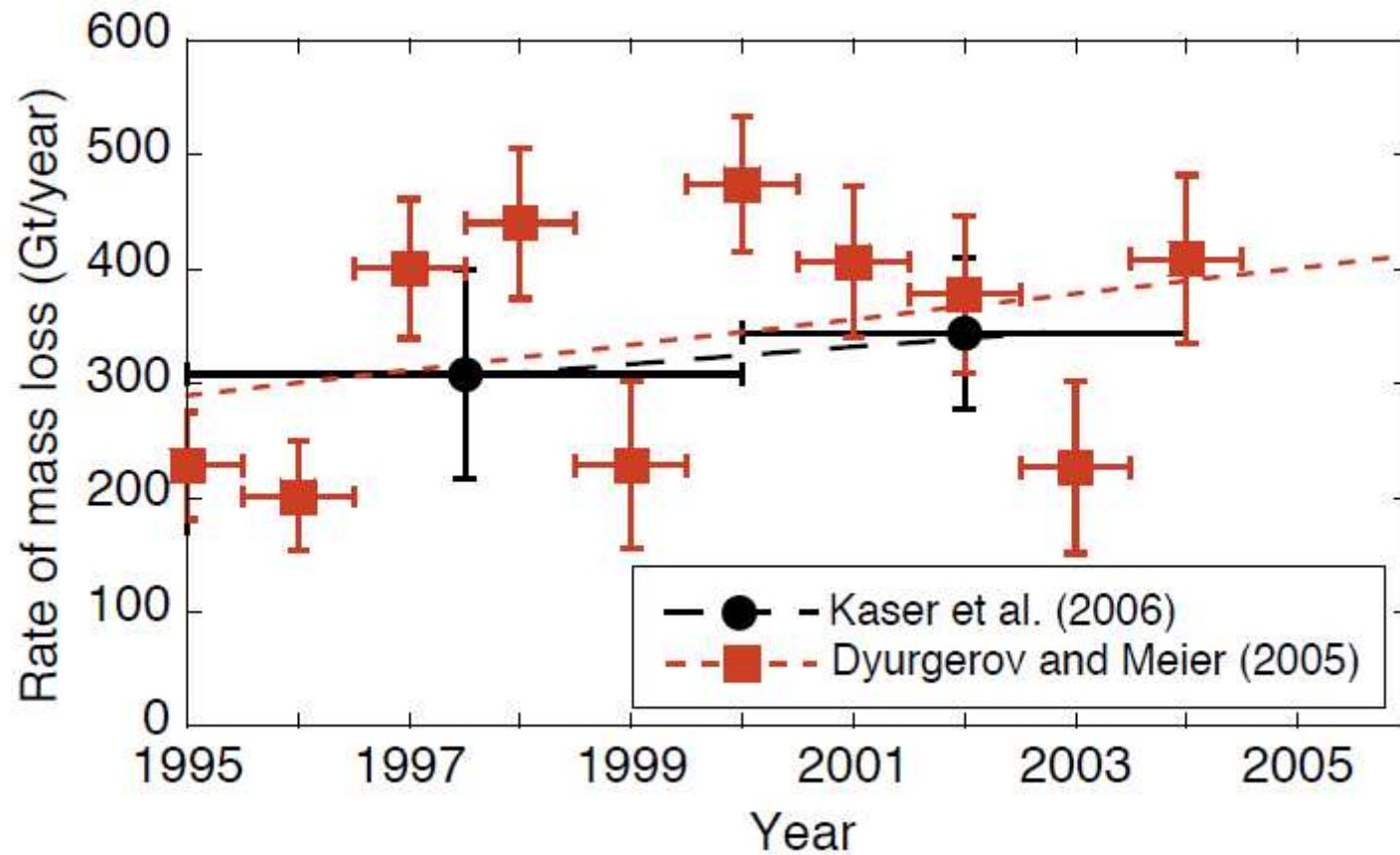


1. Cryosphere & Climate



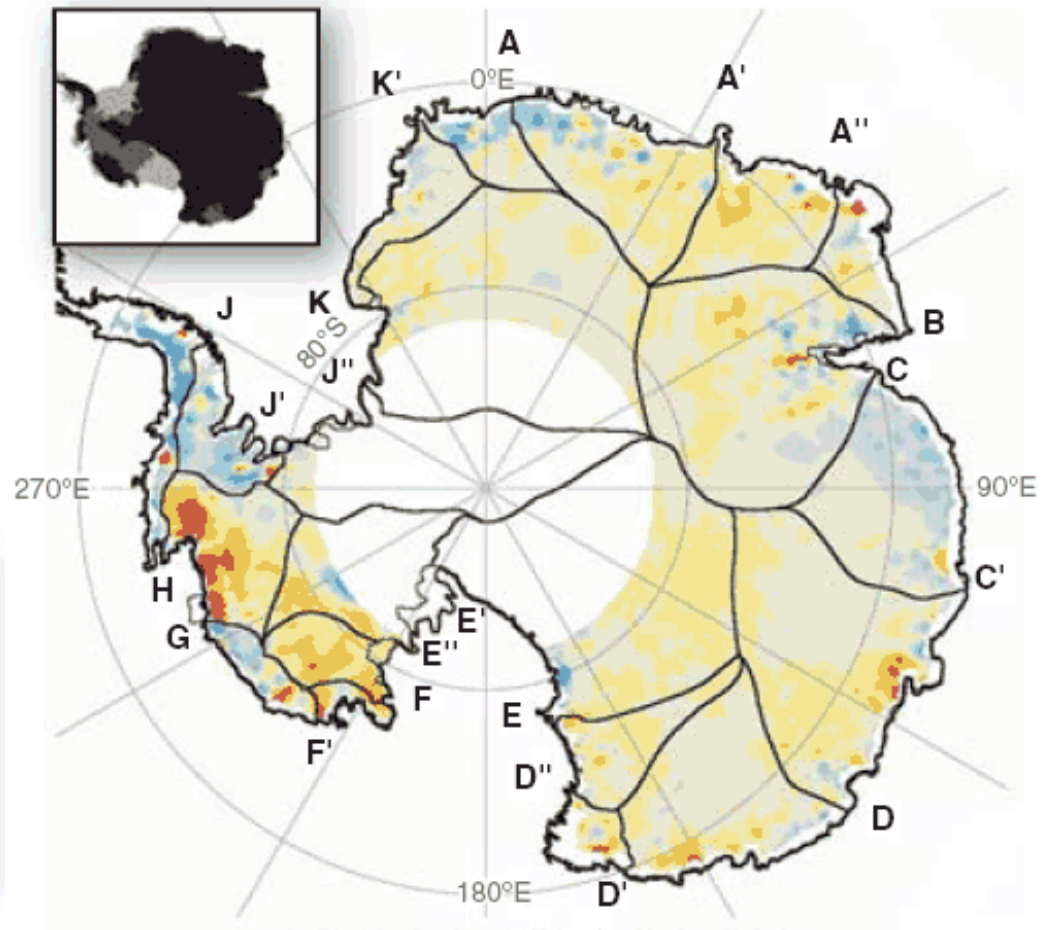
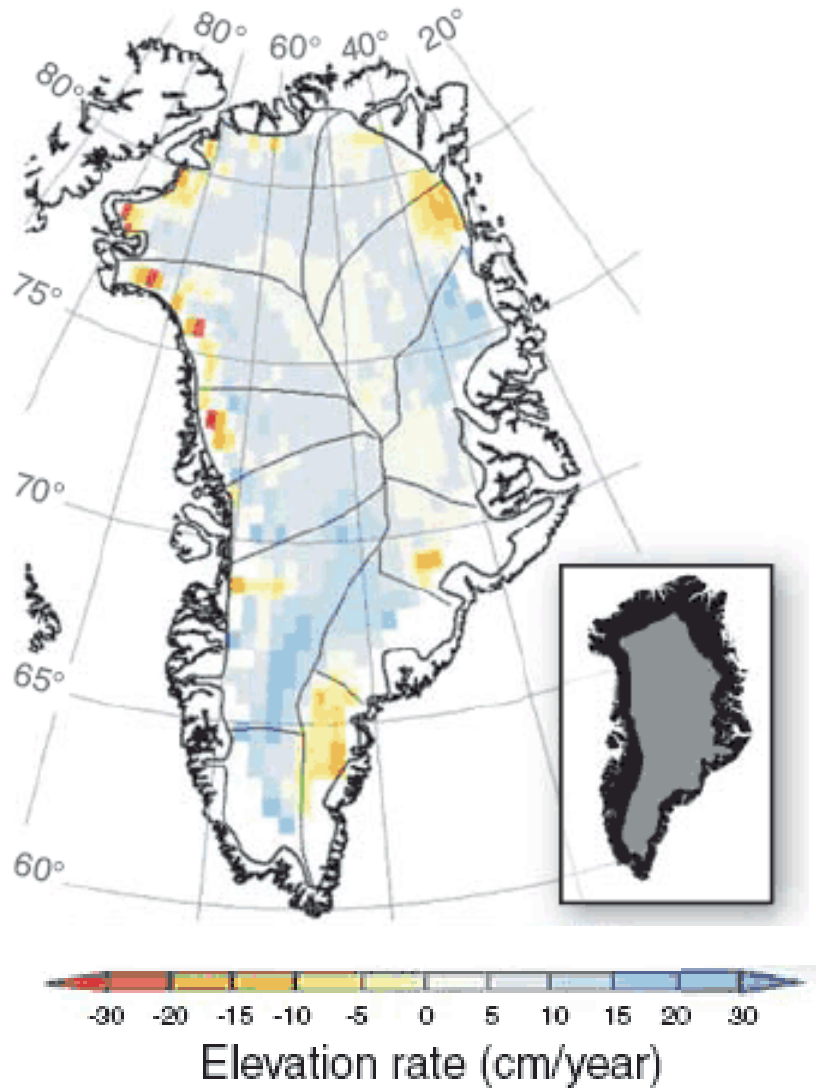
1. Cryosphere & Climate

- Glaciers & Ice Caps



1. Cryosphere & Climate

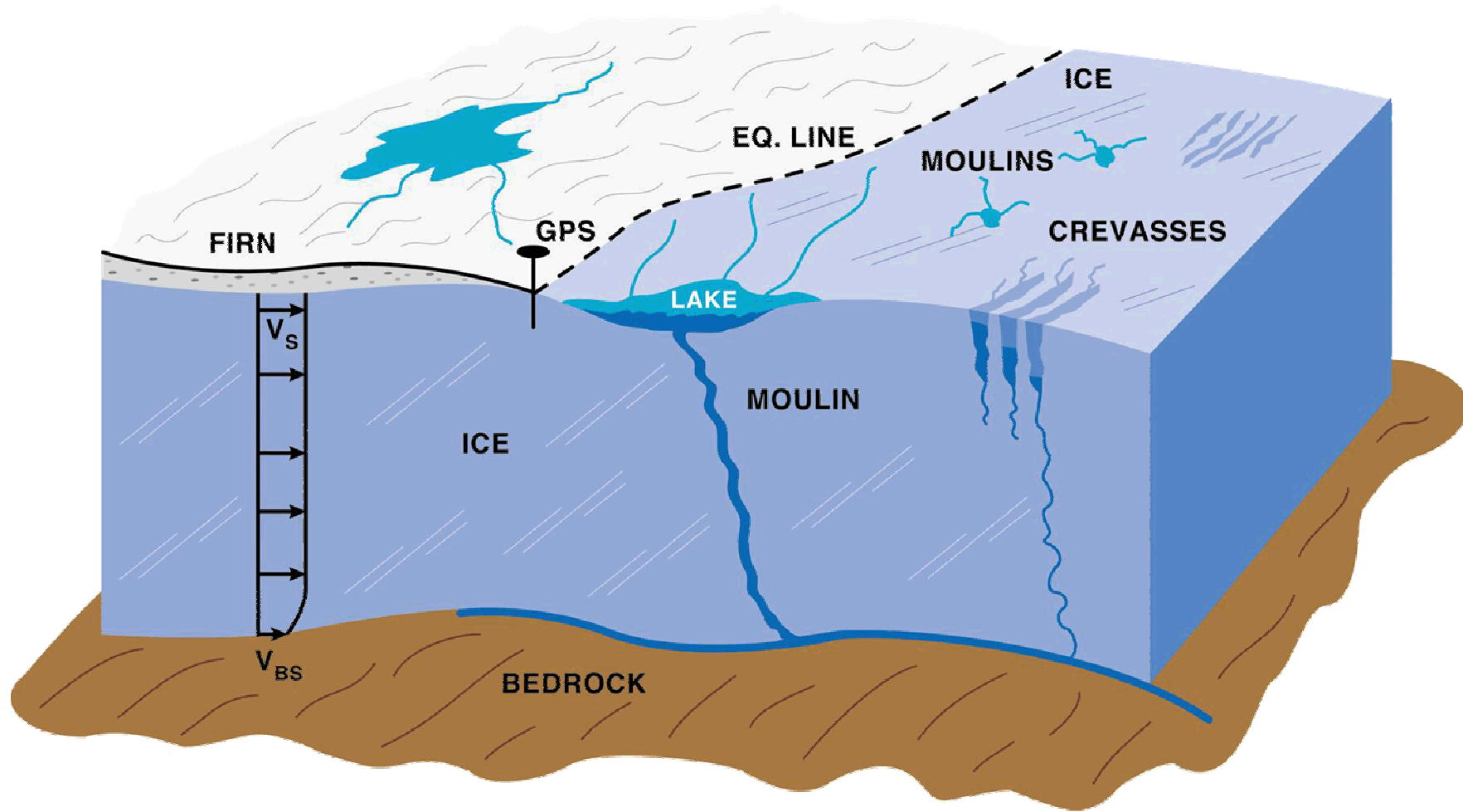
- Ice Sheets



Shepherd & Wingham, *Science*, 2007

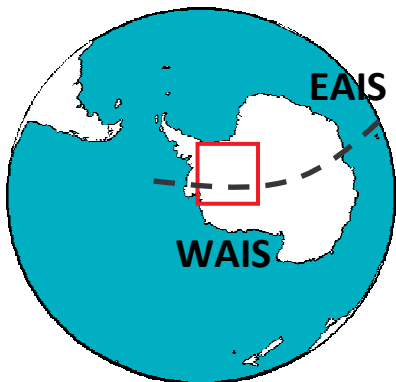
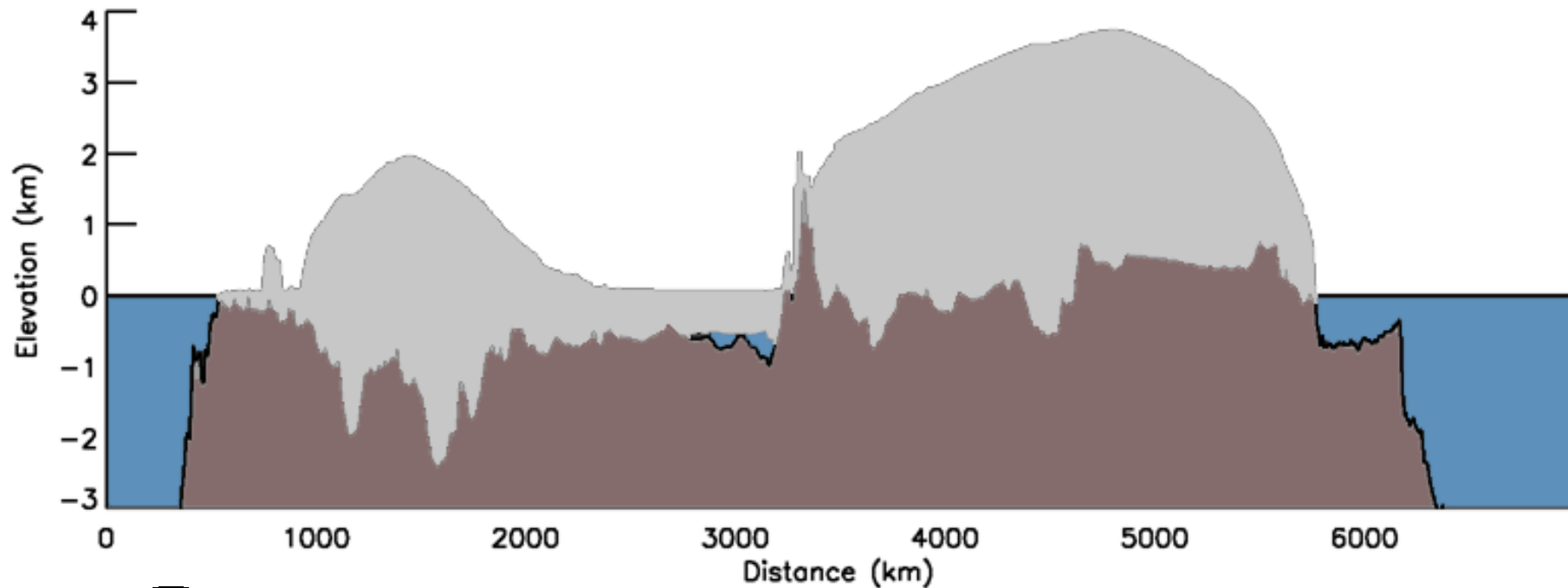
1. Cryosphere & Climate

- Surface melting induced imbalance



1. Cryosphere & Climate

- Ocean melting induced imbalance



2. Mountain glaciers



2. Mountain glaciers

The Guardian | Thursday 21 January 2010

National

11

Climate change

Glaciergate: claims were man-made and could be load of hot air, says UN scientist

IPCC report said Himalaya ice would vanish by 2035

Panel head apologises for unsubstantiated assertion

Fred Pearce

One paragraph, buried in 3,000 pages of reports and published almost three years ago, has humbled the head of the UN's

Targets

UN chief softens Copenhagen

The offending paragraph, in the panel's fourth assessment report on the impacts

2035 The date by which the glaciers of the Himalayas were very likely to have disappeared, according to the discredited claims

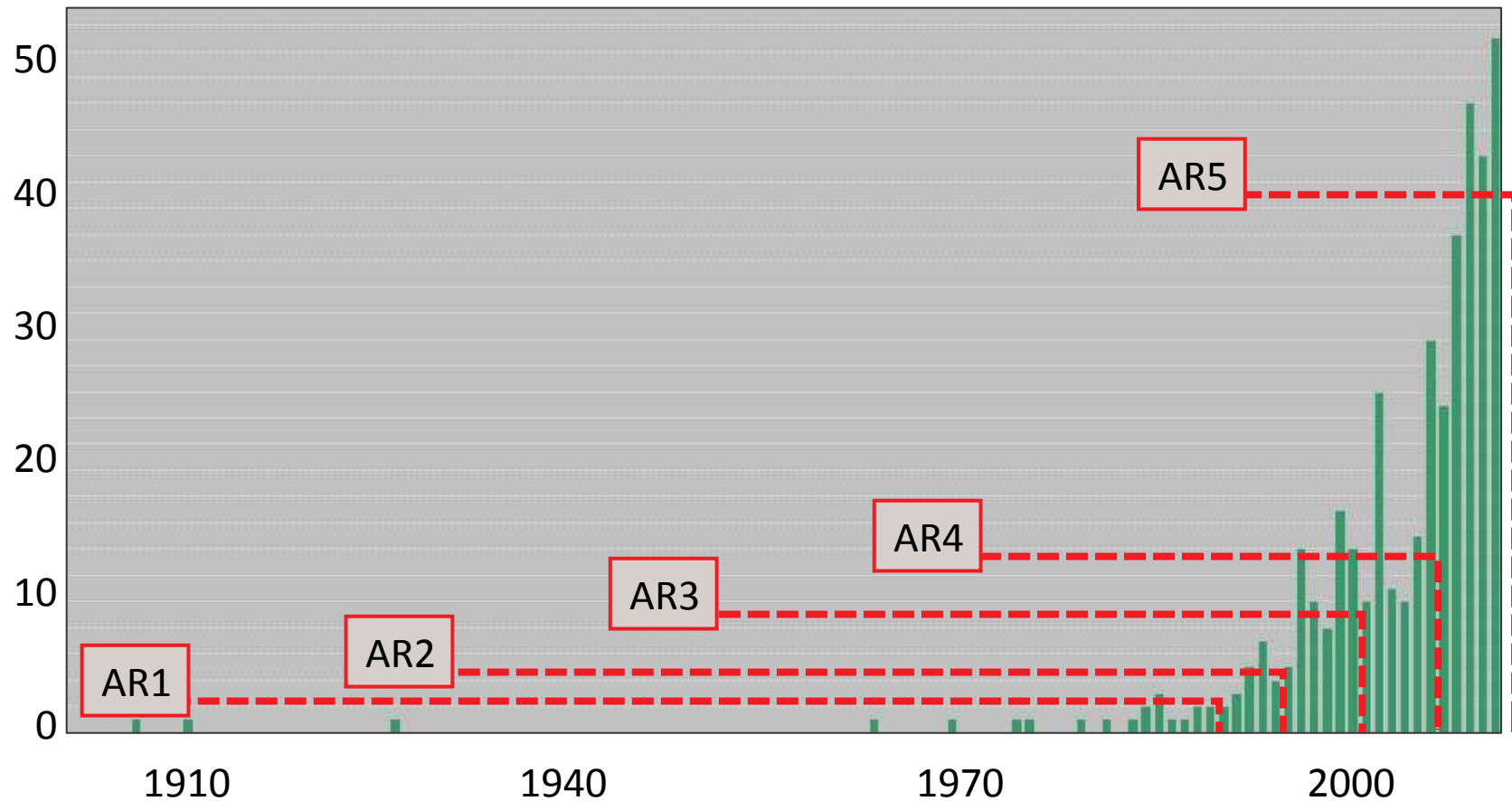
Defence melts away

A UN climate change panel's report said there was a 90% possibility of the Himalayan glaciers vanishing by 2035 - a claim it now accepts was 'poorly substantiated' Photograph: George F Mobley/National

conference in Bonn. "It's a soft deadline." The deadline was intended to be the first

2. Mountain glaciers

Papers published each year on Himalayan Glaciers




2. Mountain glaciers

theguardian
News | Sport | Comment | Culture | Business
Environment > Glaciers

Thinning glaciers driving p satellite survey finds

Satellite survey of Greenland and Antarctic ic extensive network of rapidly thinning glaciers loss in the regions

Ian Sample, science correspondent
guardian.co.uk, Wednesday 23 September 2009 18.05 BST




theguardian
News | Sport | Comment | Culture | Business | Money | London 2011
Environment > Glaciers

The Himalayas and nearby peaks have lost no ice in past 10 years,

Meltwater from Asia's peaks is much less th estimated, but lead scientist says the loss o glaciers around the world remains a serious

- Live Q&A: What does the Himalaya glacie climate change?
- In pictures: the best images of the Earth fr

Damian Carrington
guardian.co.uk, Wednesday 8 February 2012 18.10 GMT




theguardian
News | Sport | Comment | Culture | Business | Money | London 2011
Environment > Glaciers

Karakoram glaciers have g last decade, new research s

3D altitude maps captured by satellites sho the greater Himalaya range are bucking the continued ice loss

Damian Carrington
guardian.co.uk, Sunday 15 April 2012 18.00 BST




theguardian
News | Sport | Comment | Culture | Business | Money | London 2012
Environment > Glaciers

The glaciers are still shrinking – and rapidly

A couple of glaciers shrinking more slowly than expected does not change the irrefutable fact that most are melting rapidly

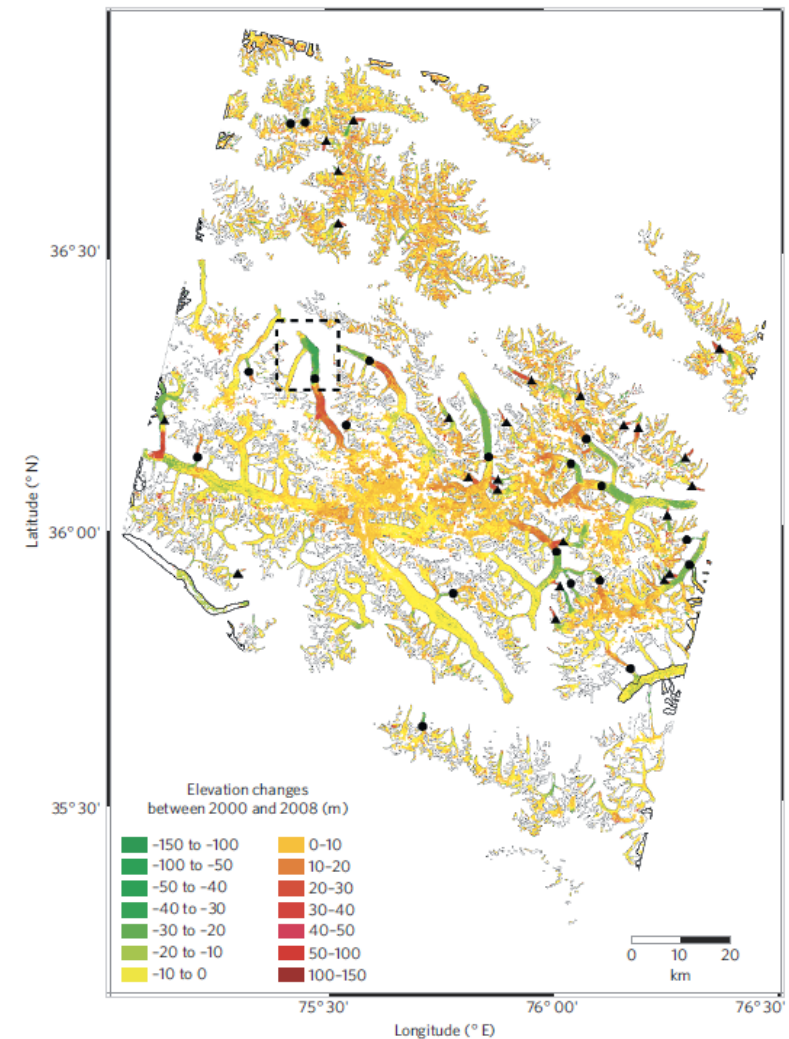
Jonathan Bamber
guardian.co.uk, Sunday 15 April 2012 18.00 BST
Comments (332)



2. Mountain glaciers

Slight mass gain of Karakoram glaciers in the early twenty-first century

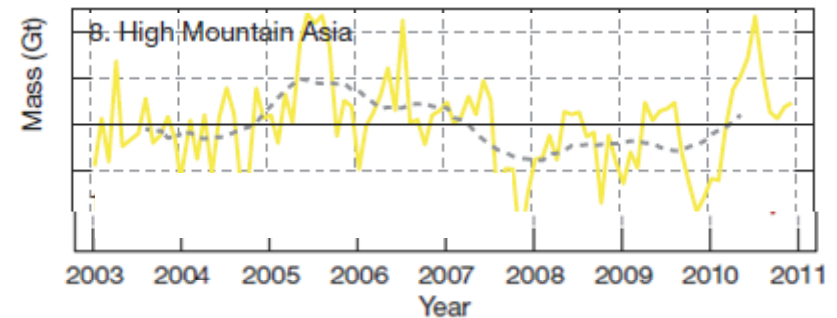
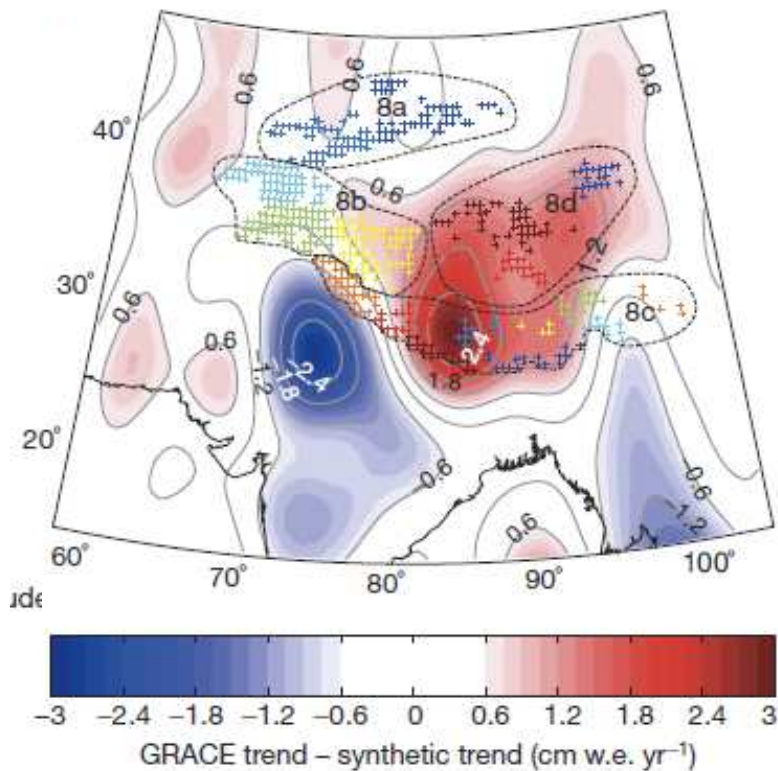
Julie Gardelle^{1*}, Etienne Berthier² and Yves Arnaud³



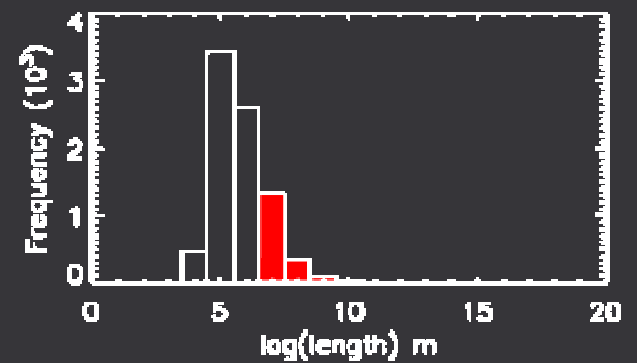
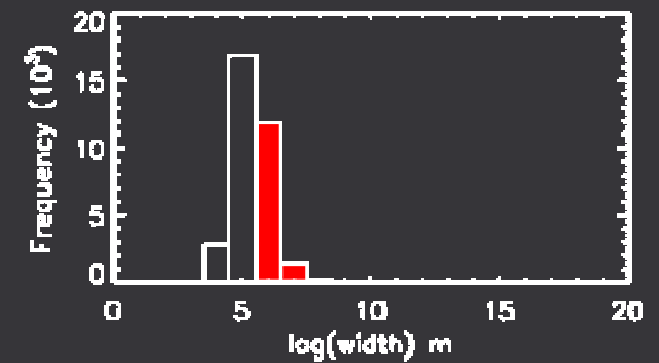
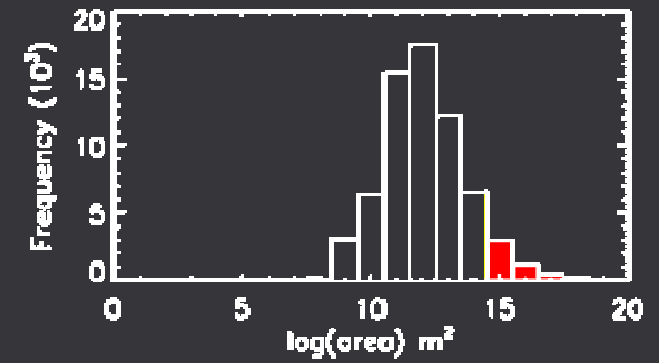
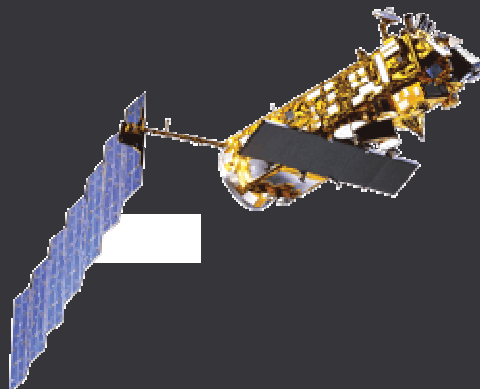
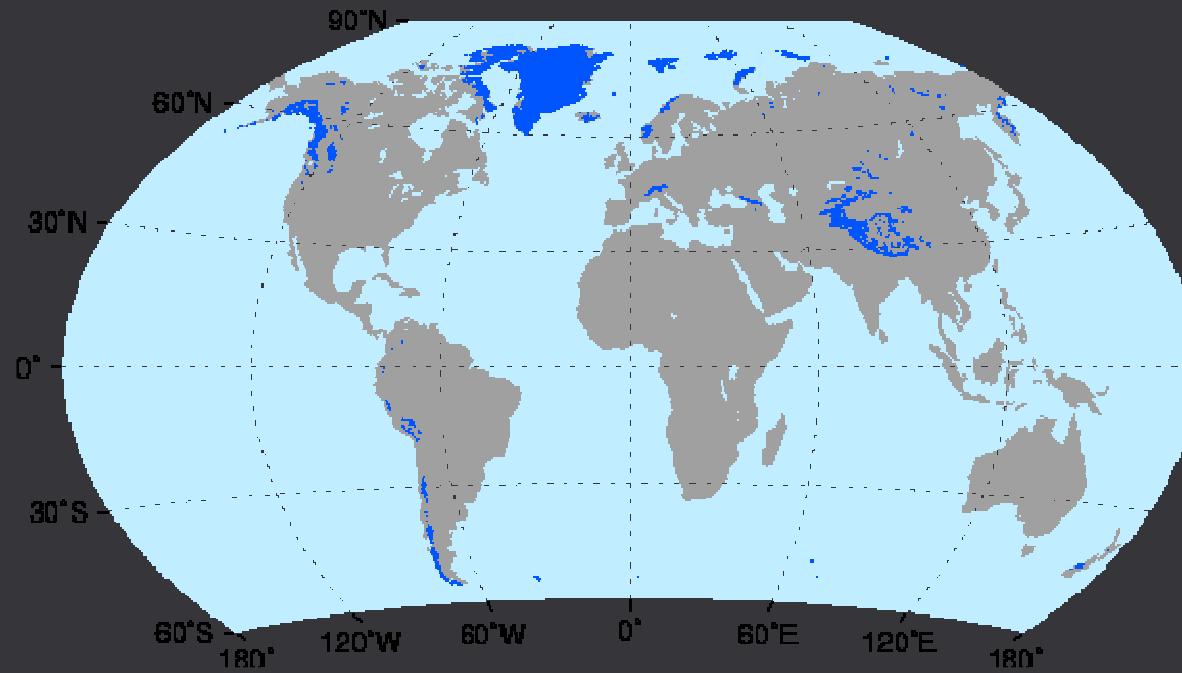
2. Mountain glaciers

Recent contributions of glaciers and ice caps to sea level rise

Thomas Jacob^{1†}, John Wahr¹, W. Tad Pfeffer^{2,3} & Sean Swenson⁴



2. Mountain glaciers



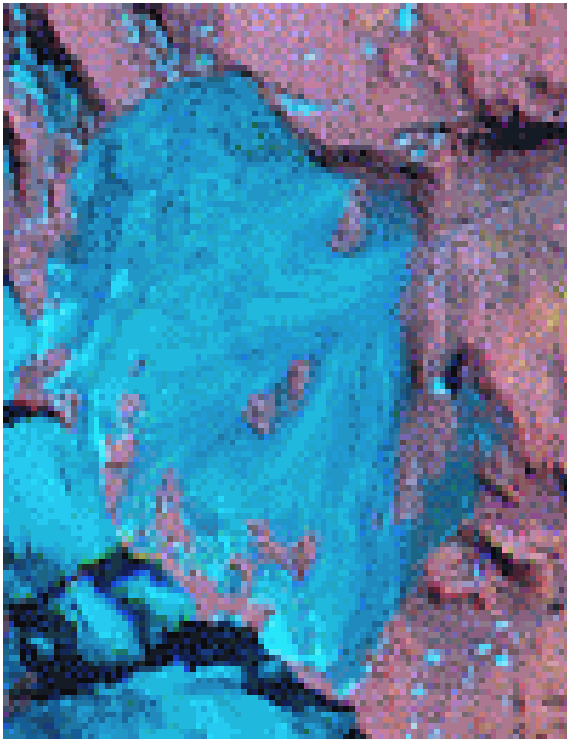
2. Mountain glaciers

Glacier disintegration Andes: 1985-2000-2011

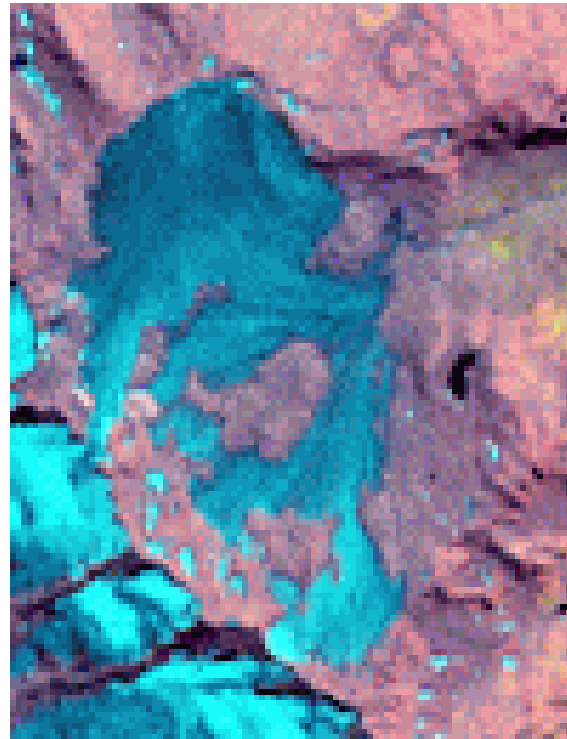


2. Mountain glaciers

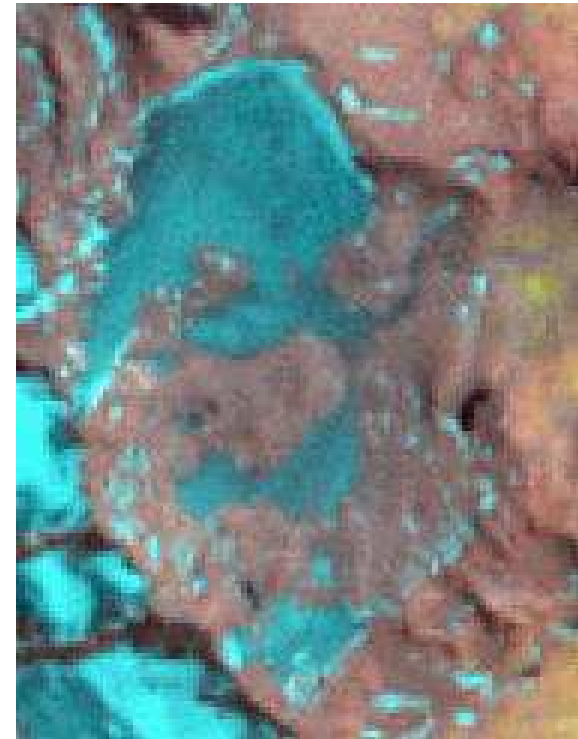
Disintegration of Careser Glacier (Italy)



TM 1985

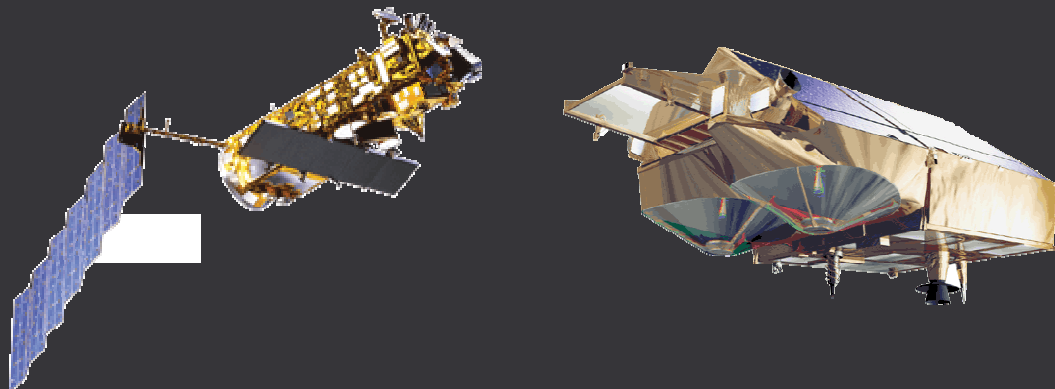
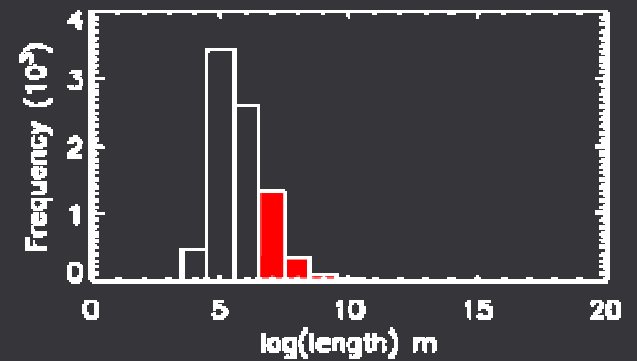
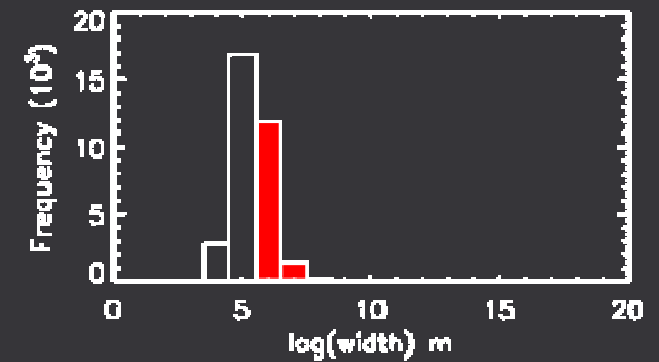
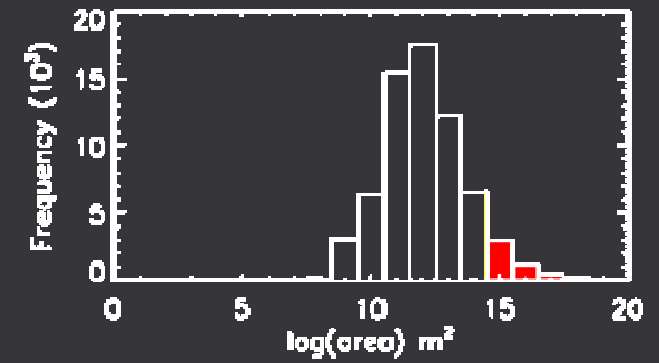
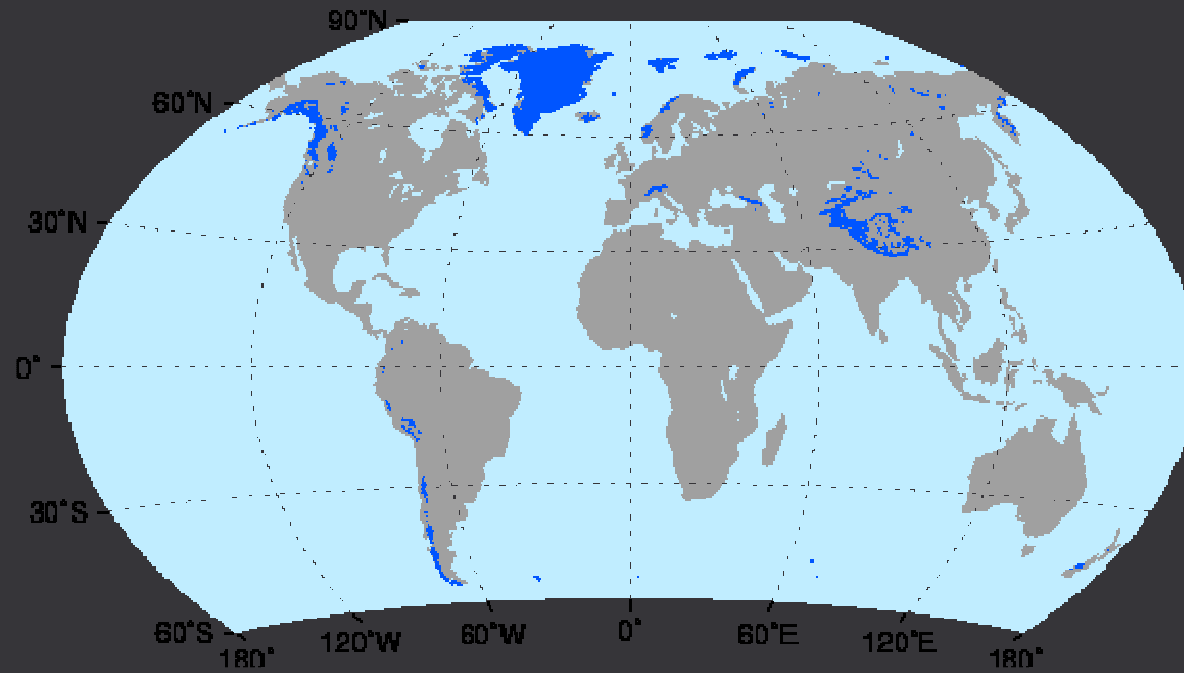


TM 2003

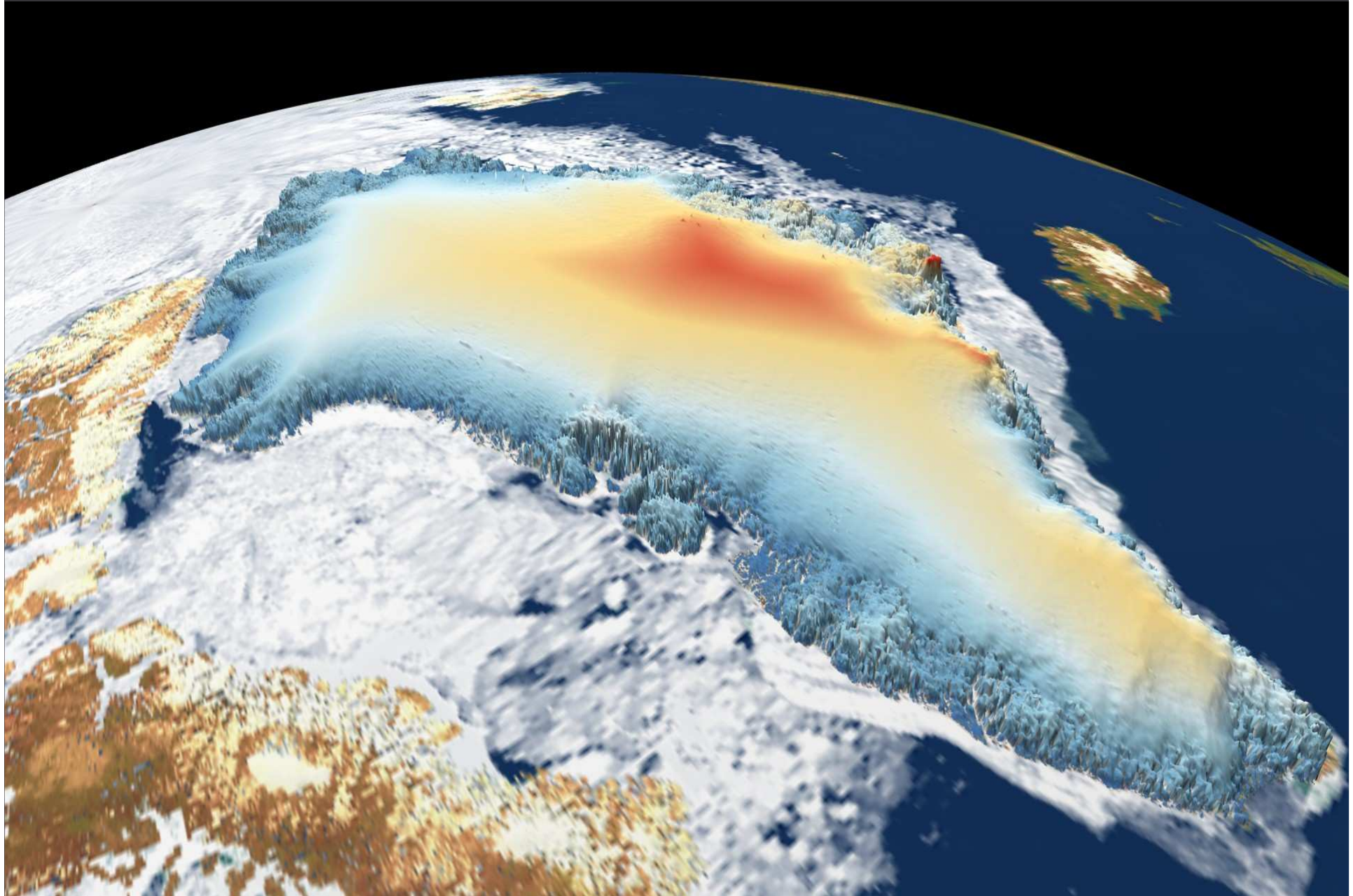


TM 2009

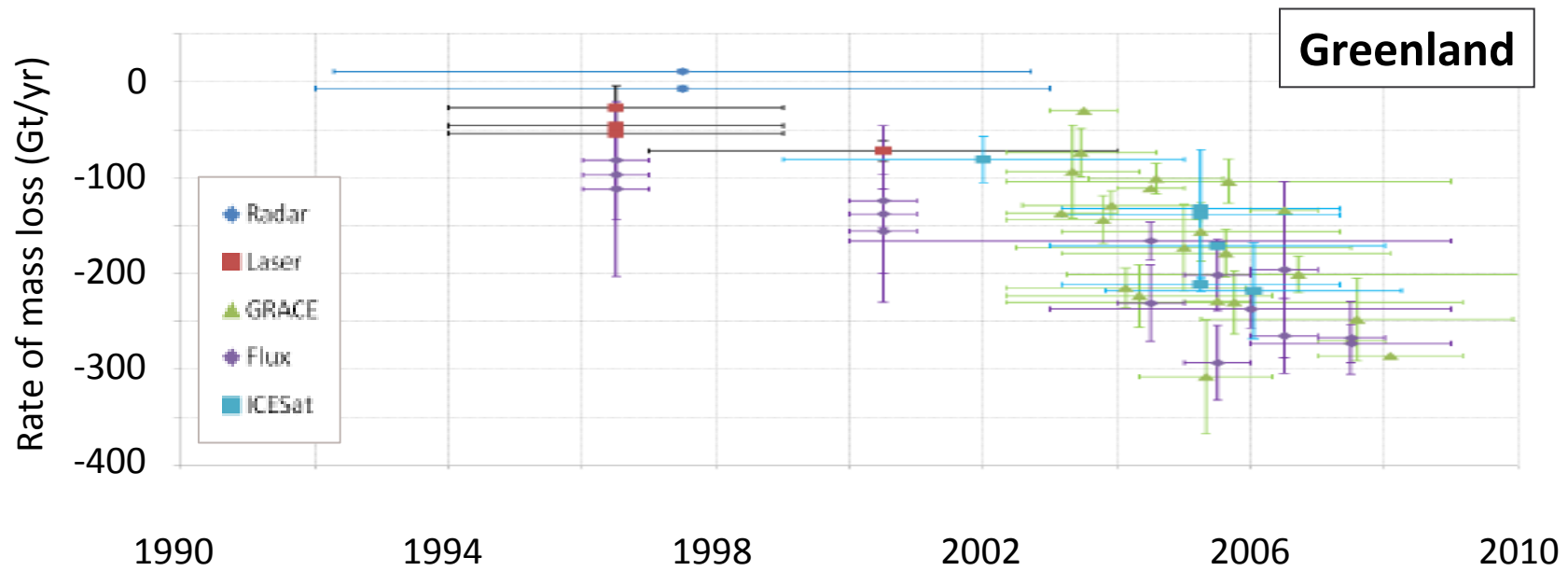
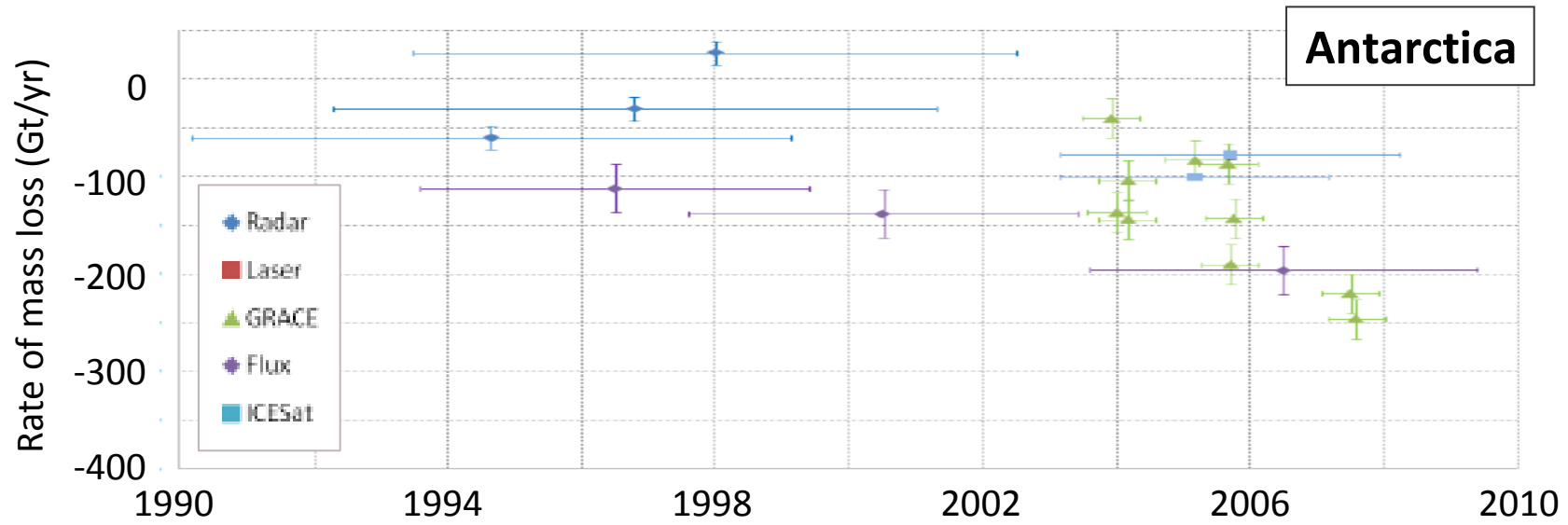
2. Mountain glaciers



3. Ice Sheets



3. Ice Sheets



3. Ice Sheets

- There remains poor agreement between estimates of ice sheet mass balance (and the consequent global sea level contribution) as determined using the three satellite geodetic techniques of altimetry, interferometry, and gravimetry.
- The IPCC have expressed concern that progress will not be made in the run up to the fifth assessment report
- Disagreement is highlighted as a primary emerging topic and the value of inter-comparison projects was explicitly noted.

Origins of differences are:

- Sampling differences in time and space
- Uncertainties of geodetic techniques and ancillary data
- Differing processing techniques

imbie

Ice Sheet Mass Balance Inter-comparison Exercise

- ESA and NASA supported
 - Contribution to AR5
- Time limited exercise (Aug 2011- Jul 2012)
- Aim is to reconcile satellite estimates of ice sheet mass balance

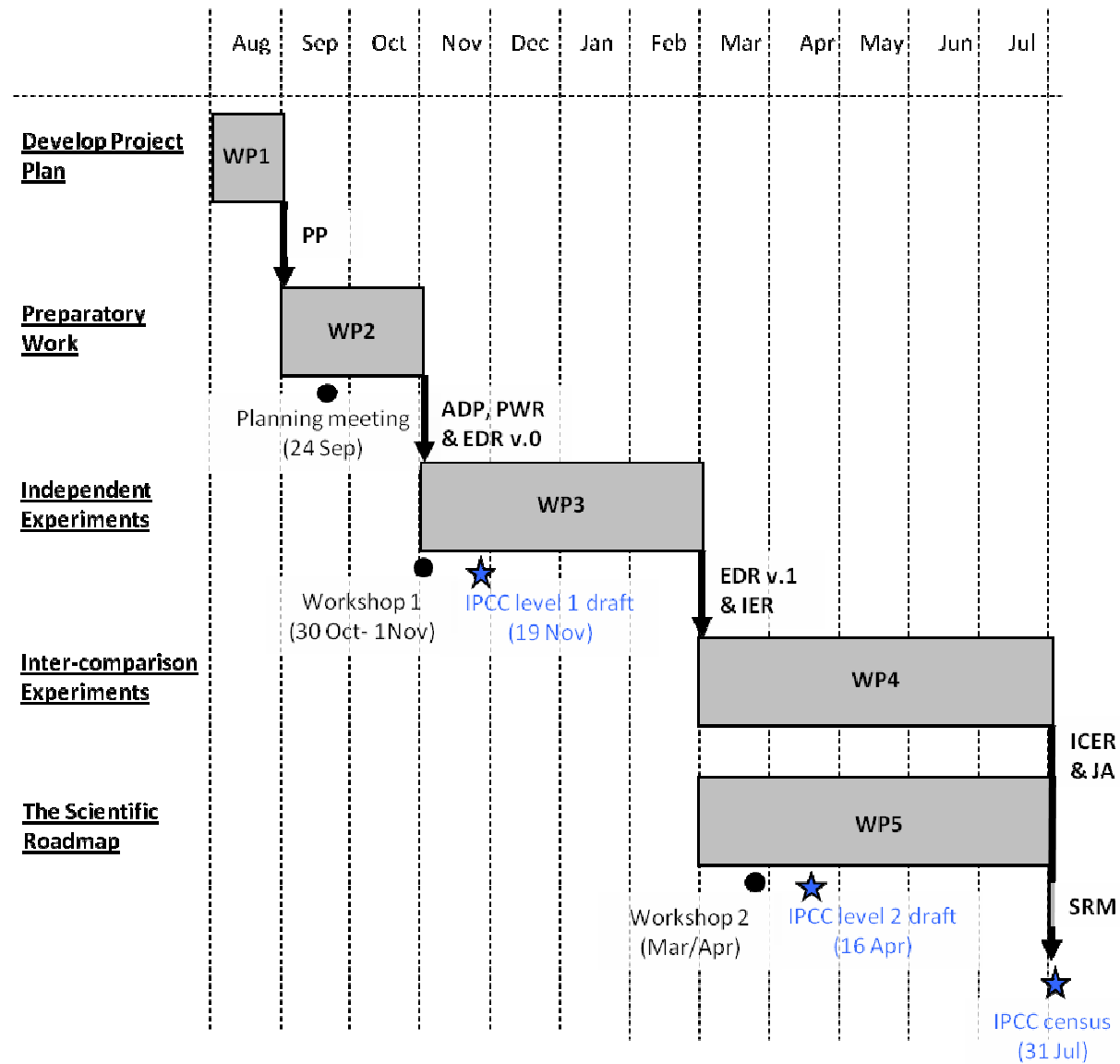
imbie experiments

- AIM is to reconcile geodetic estimates of ice sheet mass balance
- OBJECTIVES are to
 - (i) establish causes for differences in ice sheet mass balance
 - (ii) refine current methods

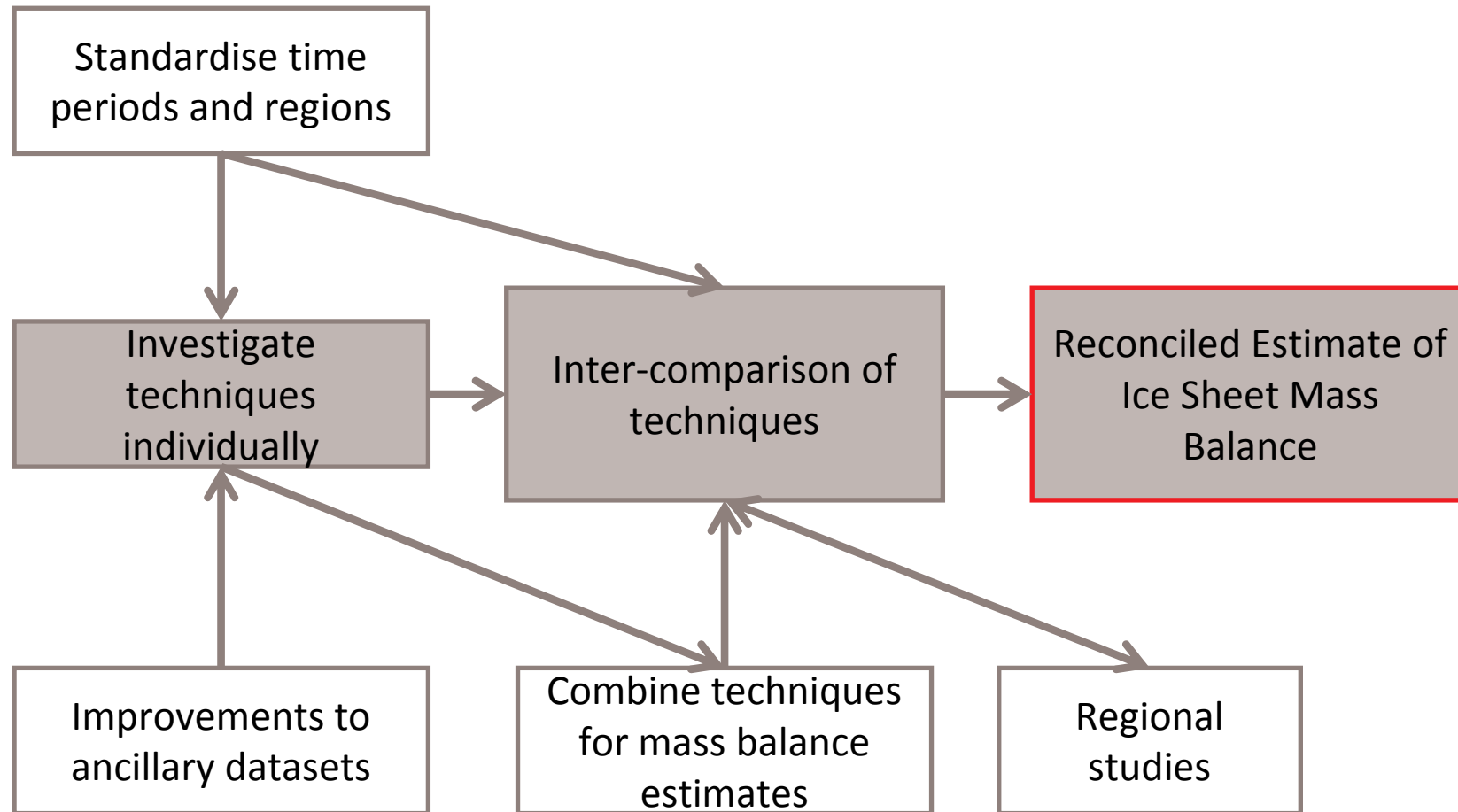
imbie partners

Altimetry	Gravimetry	Mass Budget	Surface Mass Balance (SMB)	Post Glacial Rebound (PGR)	Independent
Rene Forsberg	Srinivas Bettadpur	Eric Rignot	Michiel van den Broeke	Erik Ivins	Tony Payne
Hamish Pritchard	Scott Luthcke	Andrew Shepherd	David Bromwich	Glenn Milne	Ted Scambos
Ben Smith	Ernst Schrama	Adrian Luckman		Pippa Whitehouse	David Vaughan
Duncan Wingham	Isabella Velicogna	Ian Joughin		Dick Peltier	Stan Jacobs
Jay Zwally	John Wahr	Helmut Rott			
	Martin Horwarth				

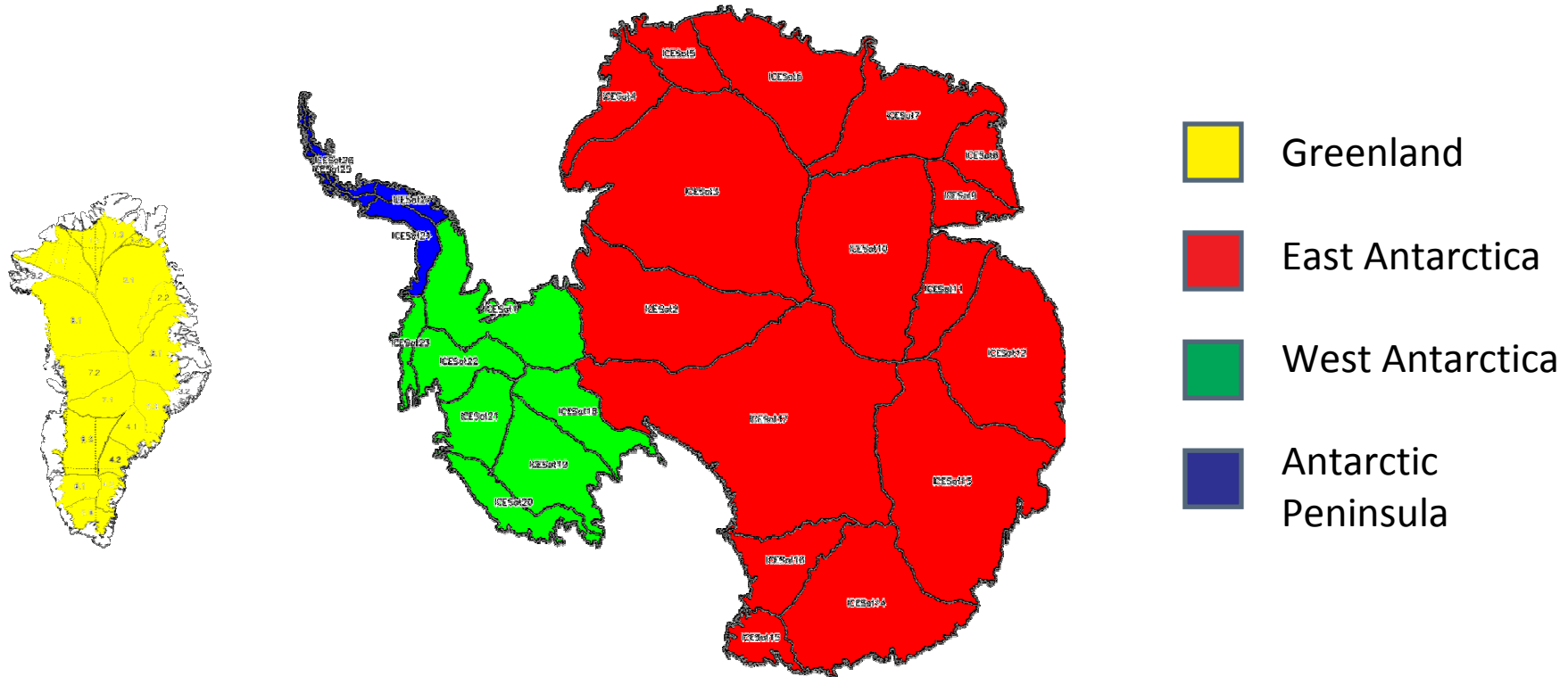
imbie schedule



imbie experiments



imbie regions



imbie epochs

