The Antarctic Ice Sheet

Global distribution of glaciers
Significance of the Antarctic glaciers
Topography, ice thickness and sub-ice maps
Flow rates: ice-streams, ice divides
Floating ice shelves
Sub-glacial lakes
Climate change and melting in Antarctica
Significance of the Antarctic Glaciers

Antarctica: 90% of world’s ice volume (~10 x greater than Greenland). If it all melts sea level will rise by 60 to 70 m.

The ice sheet is much thicker than Greenland’s. It is considerably colder on Antarctica, with lower snow-fall rates.

The Antarctic ice sheet is divided into eastern and western components. The eastern ice sheet is several times larger than the western one, and about twice as thick.
Land surface above and below sea level, and areas of exposed rock (yellow)
Topography of the sub-ice surface. With ice Antarctica is easily the most elevated continent. But even without ice there are large parts of it that are very high.
Topography after melting and isostatic rebound
Exaggerated topography and ice thickness
(The thickest ice is over 4000 m)
There are many orders of magnitude of difference in the rate of flow of Antarctic ice, from less than 1.5 m/y along the ice divides, to over 1000 m/y in some of the ice-stream areas and on the ice shelves.

Some ice streams are situated over areas of soft sedimentary rock, the postulated connection being that the ice can slide faster if the underlying material will deform.
Ice shelves

• Antarctica has extensive floating ice shelves on almost all of its coasts
• The largest (Ross) is about ½ the size of British Columbia
• The shelves range in thickness from a few tens of m to around 750 m
1. **Stable glacier and ice shelf**

Glacier flow driven by gravity.

Buoyant (hydrostatic) force at ice shelf front partially supports ice shelf mass.

Water Level

Grounding Line

2. **Two effects of warmer temperatures**

a) Melt water percolates through glacier; glacier speeds up (summer only)

b) Water-filled fractures carve through ice shelf; shelf disintegrates.

Water Level

Grounding Line

3. **Unstable glacier front after ice shelf collapse**

As shelf retreats past grounding line buoyant support decreases at front but glacier flow continues and glacier front calves rapidly.

Water Level

Grounding Line

4. **Glacier acceleration**

Old Surface

New Surface

Lower part of glacier steepens, accelerates, and loses mass.

Calved Icebergs
Locations of approx. 150 subglacial lakes in Antarctica
Three projects to collect samples from subglacial lakes:

- Ellesmere (UK)
- Vostok (Russia)
- Whillans (USA)
Climate change in Antarctica

Temperature change per decade (degrees Celsius)