Part 1
Glaciers on Spitsbergen
What is a glacier?

- A glacier consists of ice and snow.
- It has survived at least 2 melting seasons.
- It deforms under its own weight, the ice flows!
How do glaciers form?

Glaciers form where:

• Summer temperatures are not high enough to melt all the snow accumulated during the previous winter.

• In winter fresh snow accumulates, year after year, on top of the snow that survived summer.

• When the ice gets 10s of meters thick it begins to flow out- and downwards to areas with higher temperature. Here the ice melts or calves into the sea.
Equilibrium line

accumulation area

ablation area

Illustration: K. Bælum
The ice flows down hill to lower lying areas.
Deformation of the ice equilibrium line

Velocity

Depth

Sliding on the bed

Deformation of the ice

equilibrium line

Illustration: K. Bælum
The ice flows faster near the surface of the glacier than along the bottom.
The ice flows faster in the middle of the glacier than along the sides.
Snow + ice in = melting and calving

=> Glacier in balance

Illustration: K. Bælum
Snow + ice in < melting and calving

=> Glacier is **shrinking**
Snow + ice in > melting and calving

=> Glacier is growing

Illustration: K. Bælum
Speed of glacier < balance speed

=> Glacier is **growing** in the top, **retreating** in the front
equilibrium line

Illustration: K. Bælum
equilibrium line

Illustration: K. Bælum
SURGE!!!!

Illustration: K. Bælum
What is a surge?

- A response to an imbalance in the glacier geometry caused by insufficient mass transport from accumulation to ablation area (In Svalbard probably linked to permafrost).

- A sudden increase in speed (often from 10s of meters/year to 1000s of meters/year)

- The buildup period between surges in Spitsbergen is typically 50-500 years

- The surge typically lasts from 2 to 10 years
What is a surge?

- Often, but not always, the terminus (tip) of the glacier advances several kilometers.

- The surface of the glacier becomes heavily crevassed (fractured) as a result of the increased speed.

- It takes from 10-20 years for the newly formed crevasses to close up.

- Estimates of Svalbard glaciers that surge lie between 30% and 90%
Surges occur both in water-terminating and terrestrial glaciers.
Example of surge - Freemannbreen

1936

Norwegian Polar Institute

1956

Norwegian Polar Institute
Example of surge - Skobreen

Photo M. Sund
Example of surge - Skobreen

Photo: L. Kristensen
Surging glaciers

Photo: M. Sund
Persei-/Vindeggbreen

Currently not surging glaciers

Surging glaciers
Glaciers in Svalbard - Today

- 60% of Spitsbergen is covered by glaciers
Glaciers in Svalbard - Today

- 60% of Spitsbergen is covered by glaciers
- Austfonna; The world's 3rd biggest ice cube
- The largest glaciers are on the east coast and in the northern parts due to more precipitation
Glaciers in Svalbard - Today

- Longyearbyen: 300 mm/year, an arctic desert
- Mean annual temperature -5°C
- For glaciers the summer temperature is more important than the winter temperature
Glaciers in Svalbard - Past

- 18,000 BC: Ice age, most of Spitsbergen covered by ice.
- 10,000 BC: Holocene optimum. Relatively warm with few glaciers.
- 5500 BC: Colder again, climate similar to today.
- 1000 BC: Milder than today, Vikings were growing grain on Greenland.
Glaciers in Svalbard - Past

• 500 BC: Little Ice Age begins. The mean annual temperature sinks considerably and the glaciers are growing.

• 1920 -1925 Little Ice Age ends on Spitsbergen Mean annual temperature rises several degrees.

• 1925-2000: Mean annual temperature -5°C. The glaciers are too large for today's climate and are therefore shrinking.
Glaciers in Svalbard - Past

http://folk.uio.no/olehum/SvalbardOutline.html
Glaciers on Spitsbergen - Future

• Glaciers will return to their pre little ice age size.

• If temperatures rise, models indicate that the precipitation might increase as well.

• The surge frequency for glaciers might change.

• The velocity and calving rates might change as well.