Royal Holloway
Geography for Schools
Lecture Series

Changing glaciers: glacier mass balance summary

Author: Dr Bethan Davies

A-Level Syllabus:

- AQA Glacial Systems and Landscapes, glaciers as natural systems, glacial budgets, recent and prospective impact of climate change.
- OCR Glaciated Landscapes: systems and glacier mass balance; influence of climate on glaciated landscape; specific skills in mass balance calculations.

How do we build a glacier? We start with a snowflake. Snow falls in cold regions, like the tops of mountains or in high-latitude, polar regions. If that snow remains over the summer, it will gradually build up into layers. Snow that is one year old and survived one melt season is called *firn.* Eventually, enough snow will remain that the lowermost layers are compressed into ice.

The weight of the overlying snow increases as year after year, successive accumulation layers are built up. Firn becomes ice once the interconnecting air passageways between the grains are sealed off. Once the density has reached 830 kg m^{-3}, it is defined as *glacier ice.* Over time, if the snowpack continues to build up, a glacier will be born.

The key input to a glacier system is therefore *precipitation* (snow, hail, freezing rain and rain). Glaciers may also gain snow from wind-blown snow, avalanching and hoar frost. These inputs together make up the *surface accumulation* on a glacier.

Glaciers lose mass by melting (surface melt, and underwater melt if it ends in a lake or the sea), calving off blocks of ice as icebergs, and sublimation. This is called *ablation.*

In general, glaciers receive more mass in their upper reaches and lose more mass in their lower parts. This is because it is colder at the top of the mountain, and warmer as we move down the mountain, due to temperature lapse rates.

The part of the glacier that, over the course of one year, receives more snow than it loses mass from ablation, is the *accumulation zone*. The part of the glacier that loses more mass than it gains is the *ablation zone*.

Each year, the glacier flows downslope under the force of gravity. You can think of glacier ice as a sticky, thick, slow-moving, viscous fluid. Ice flows from the accumulation zone to the ablation zone. If the glacier is in equilibrium with the climate, the terminus or snout of the glacier will remain at the same location, and build a moraine. It will continuously flow downslope, bringing material down to the moraine.

If the glacier loses more mass than it gains, perhaps because air temperatures increase, it will start to shrink. It may well keep flowing downslope, but it will melt more at the terminus, and so will become smaller each year. These glaciers are receding. Worldwide, almost all glaciers are shrinking and receding, causing issues with sea level rise, risks of water shortages, and hazards from outburst floods and ice avalanches.

For more information about Geography at Royal Holloway visit:
www.royalholloway.ac.uk/research-and-teaching/departments-and-schools/geography/

Follow us: @RHULGeography

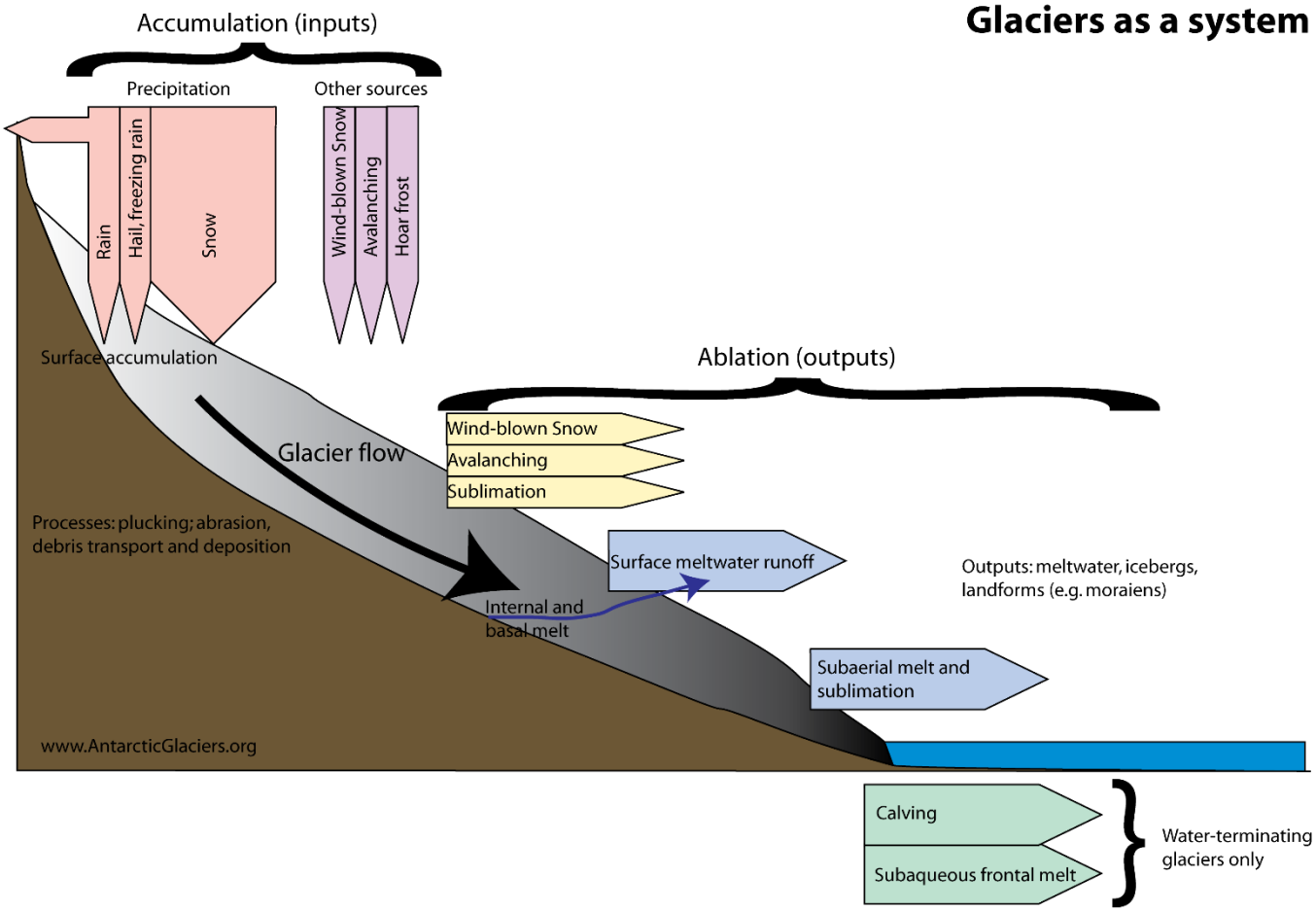

Figure 1. Glaciers as a system. Accumulation and Ablation across a simple glacier. From www.AntarcticGlaciers.org (Bethan Davies)

Further reading

- **Glacier mass balance: http://www.antarcticglaciers.org/glacier-processes/mass-balance/**
- **Glacier mass balance on climate.gov: https://www.climate.gov/news-features/understanding-climate/climate-change-glacier-mass-balance**
- **World Glacier Mass Balance browser: https://wgms.ch/fogbrowser/**

For more information about Geography at Royal Holloway visit: www.royalholloway.ac.uk/research-and-teaching/departments-and-schools/geography/

Follow us: @RHULGeography