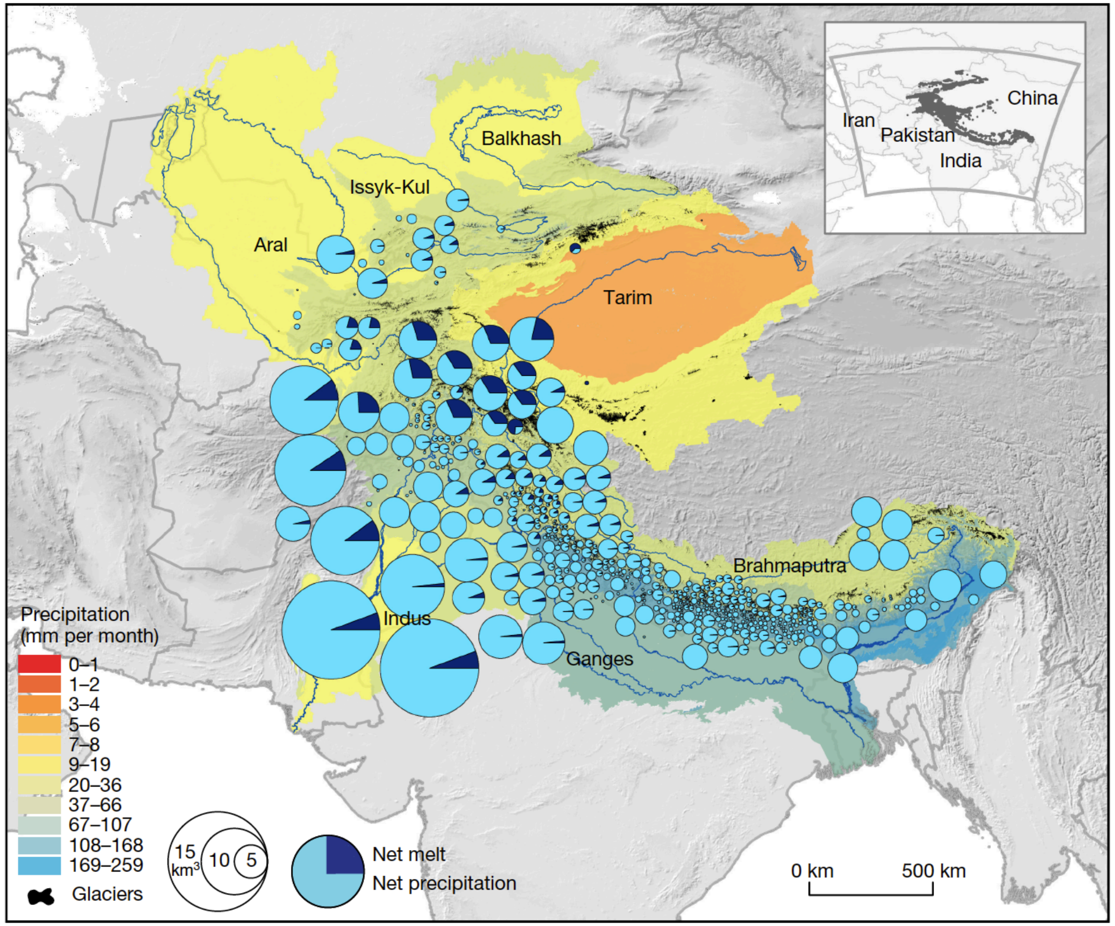
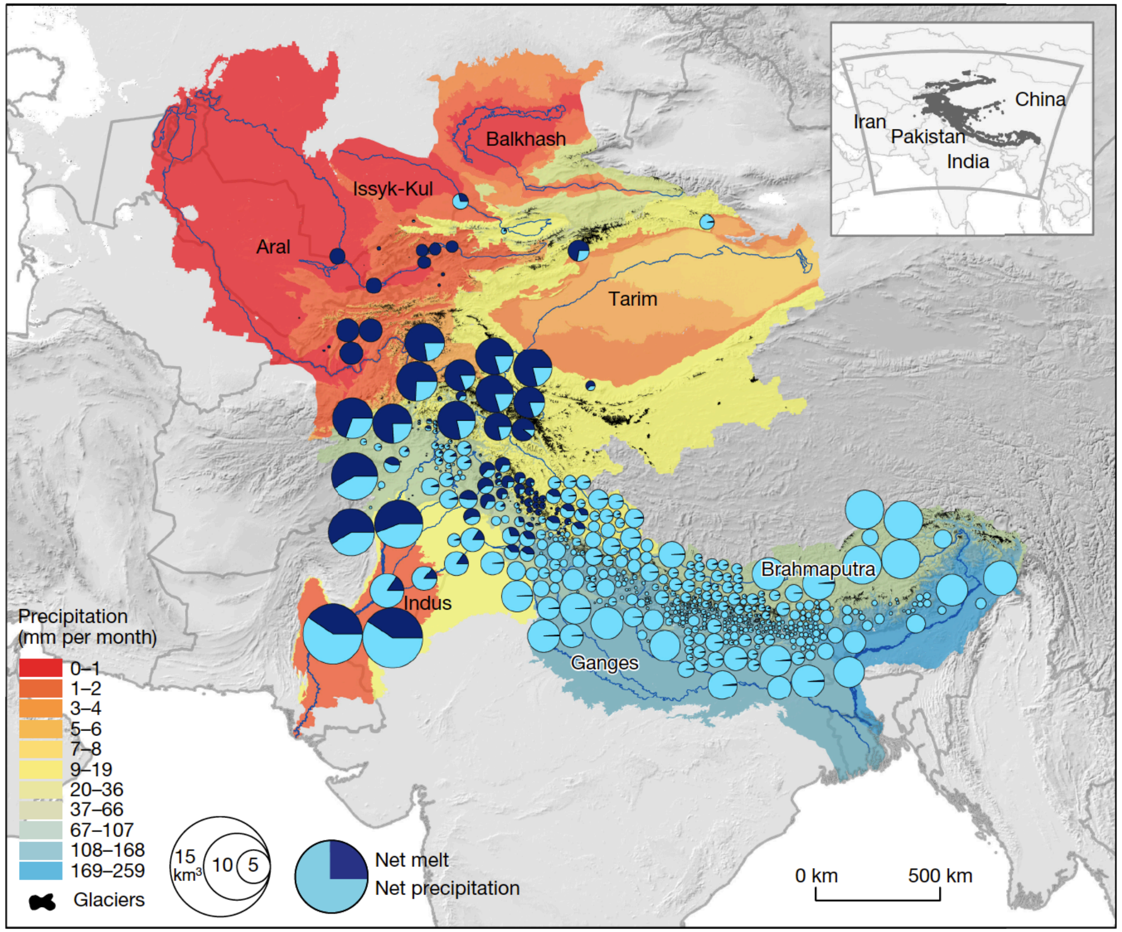
Glacier Hydrology

Glaciers are a regionally important buffer against drought (Pritchard et al., 2017).

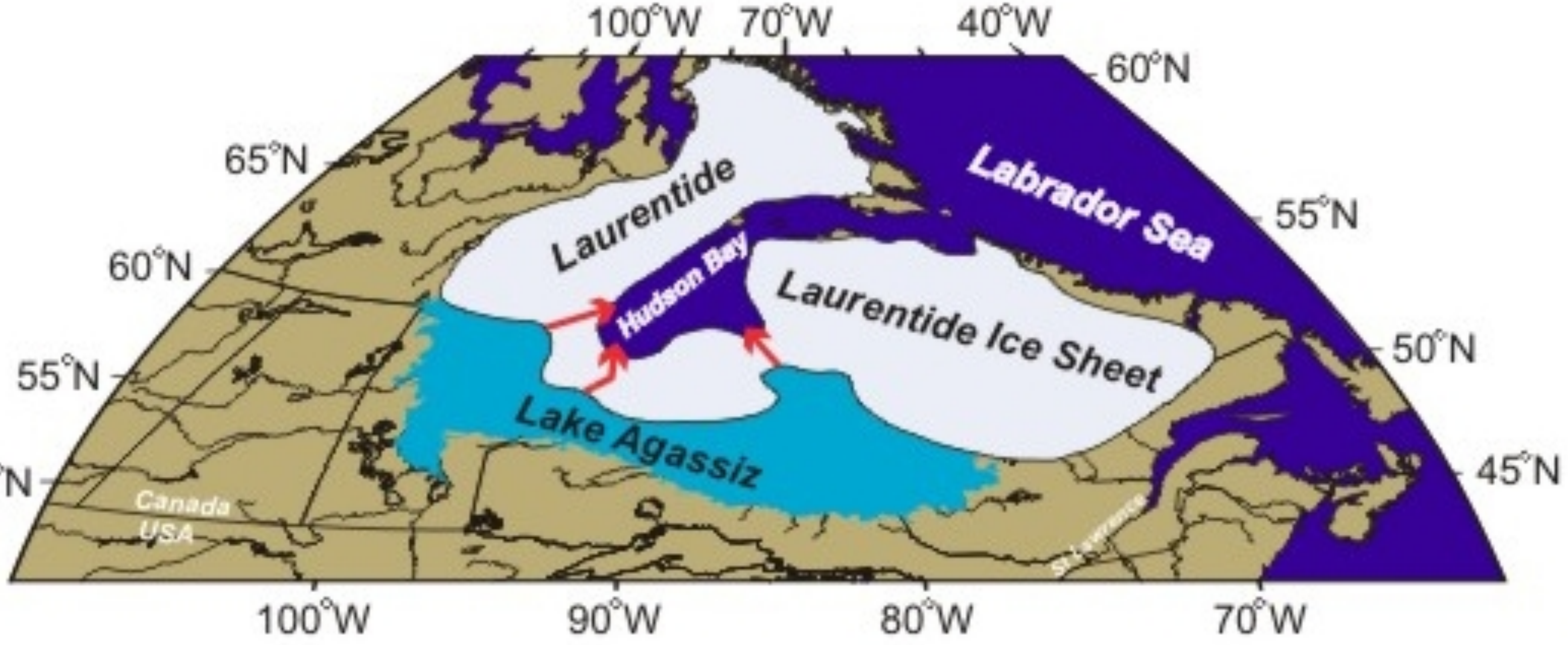




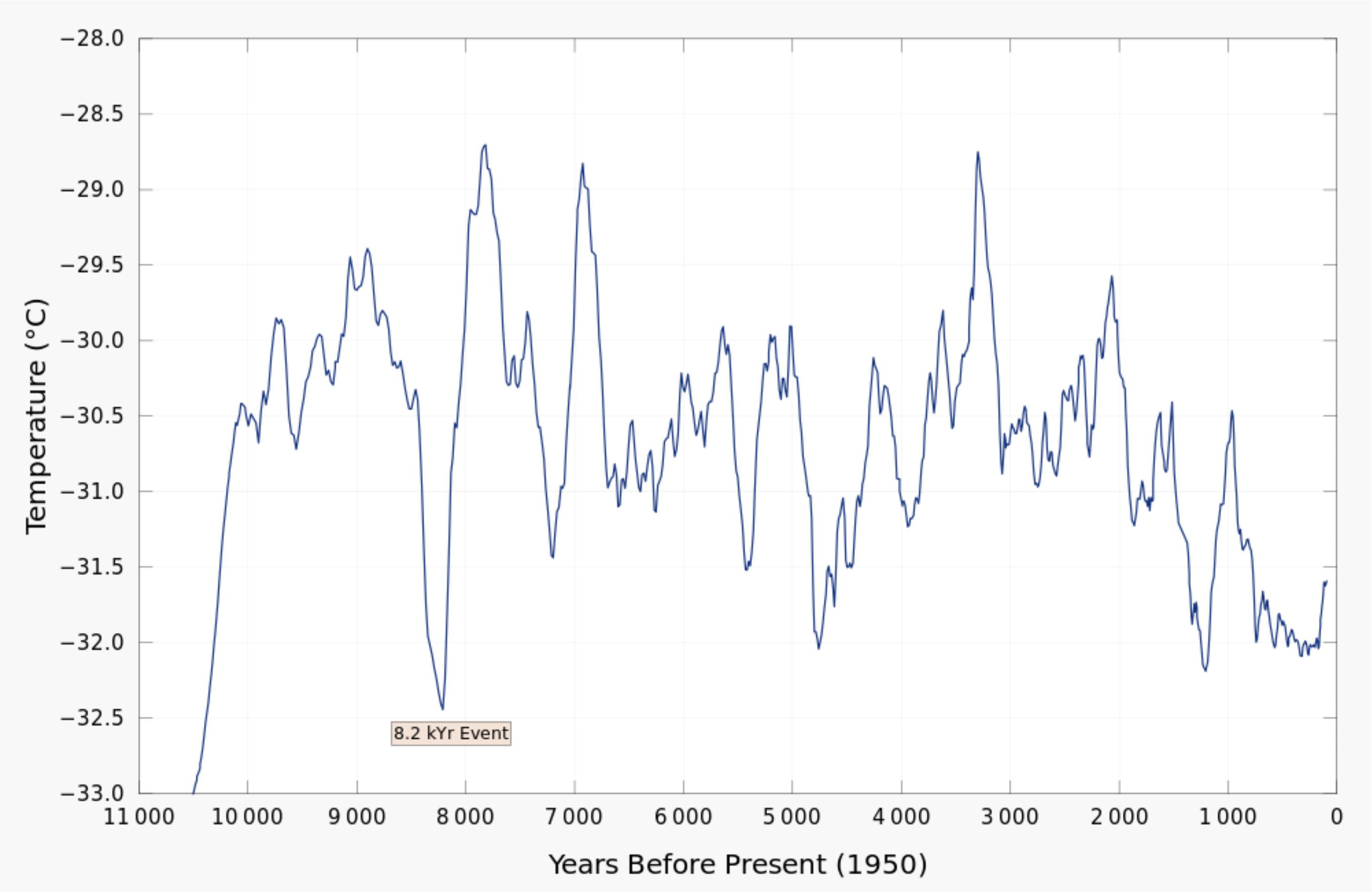
Glaciers and hydropower

Swisseduc.ch

Climatic impacts of glacial lake draiange



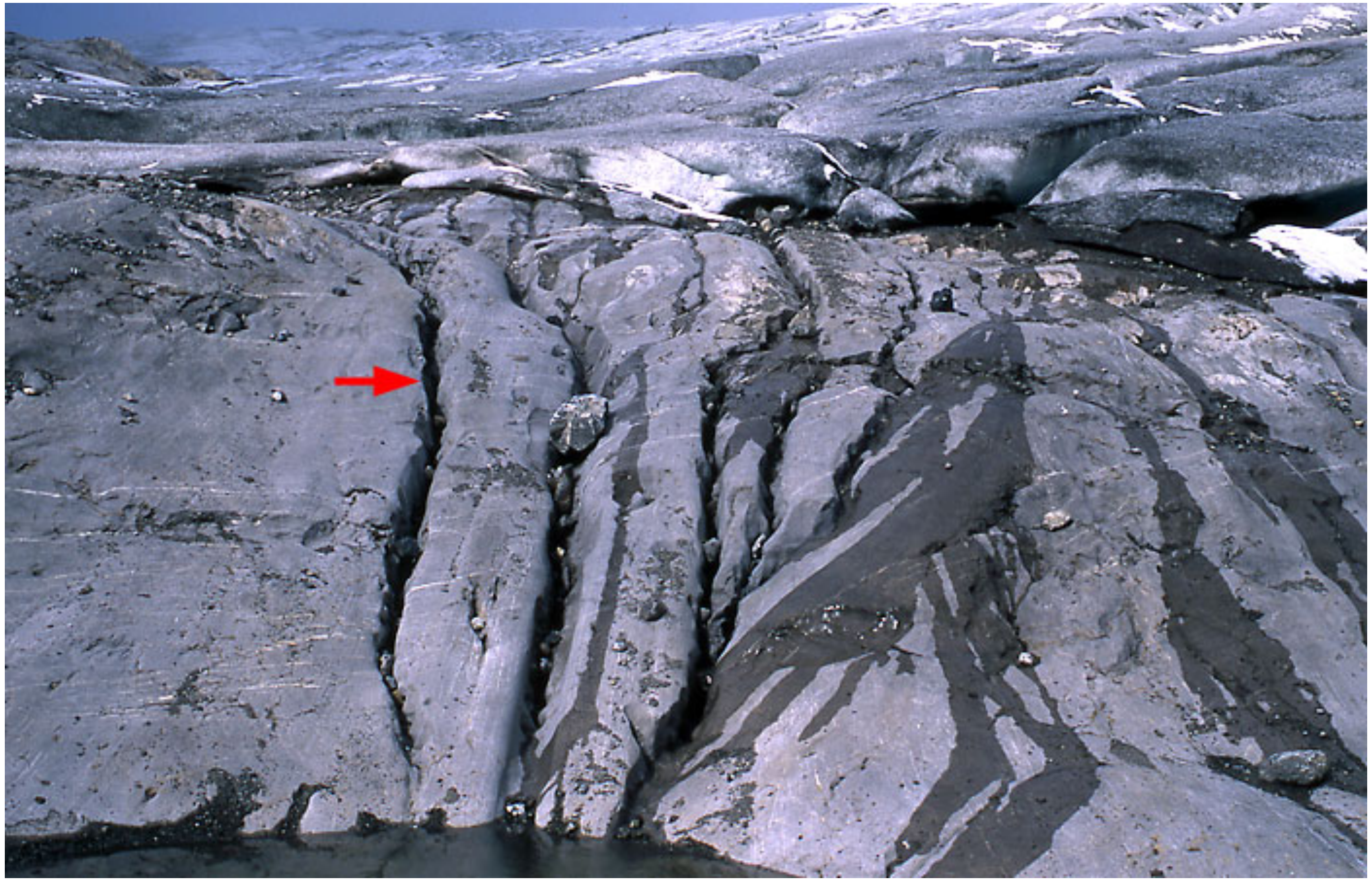
Paleo-lake drainage events were climatically important (Clarke 2002).



Paleo-lake drainage events were climatically important (Clarke 2002).

Oberaletschgletscher,
Bernese Alps, Switzerland.
Photo J. Alean, 2005.

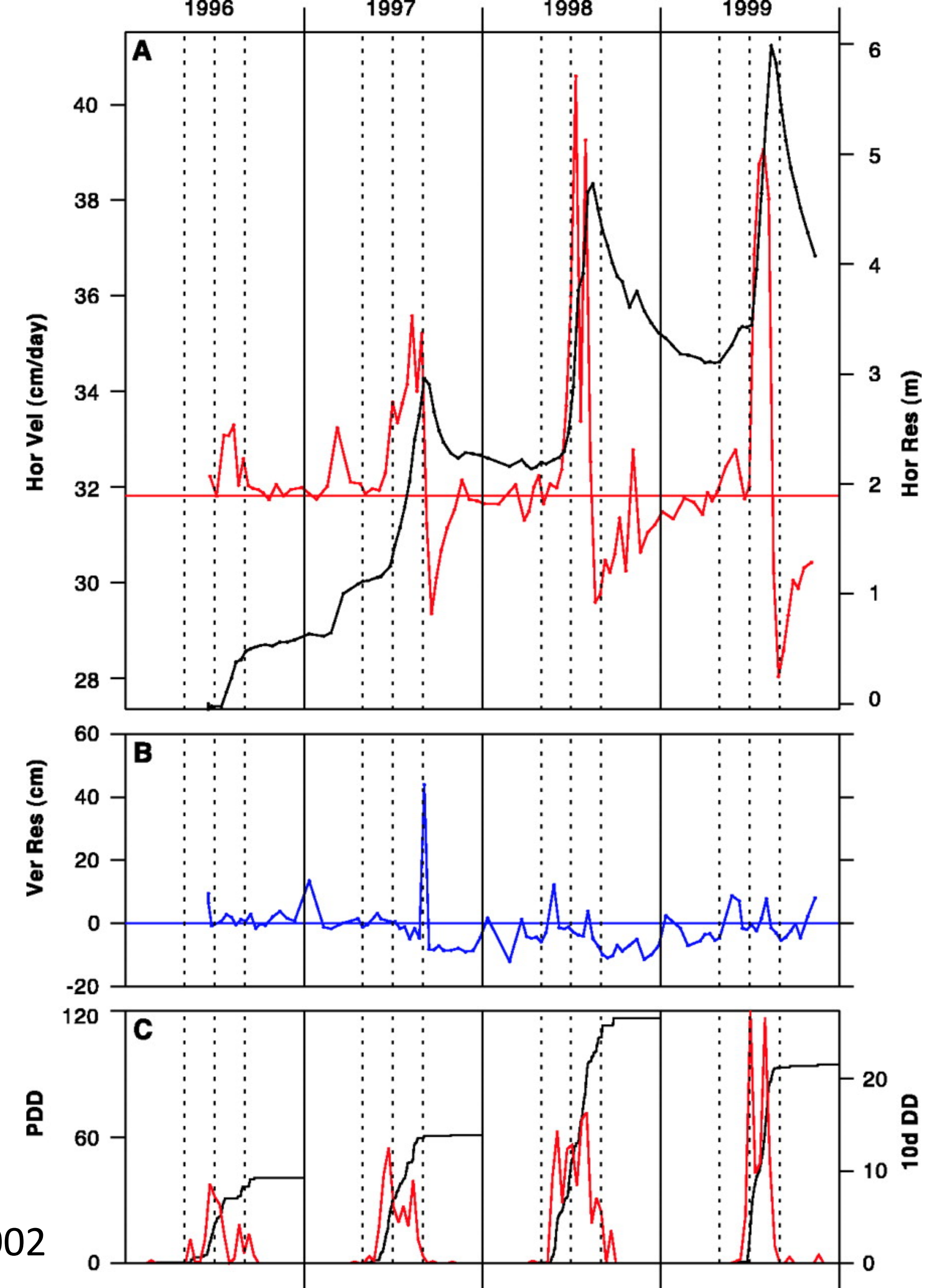
Glacier de Tsanfleuron,
Valais, Switzerland.
Photo J. Alean, 2005.



Vadret da Morteratsch,
Grisons, Switzerland.
Swisseduc.ch

Greenland supraglacial hydrology

Relationship between basal water and sliding



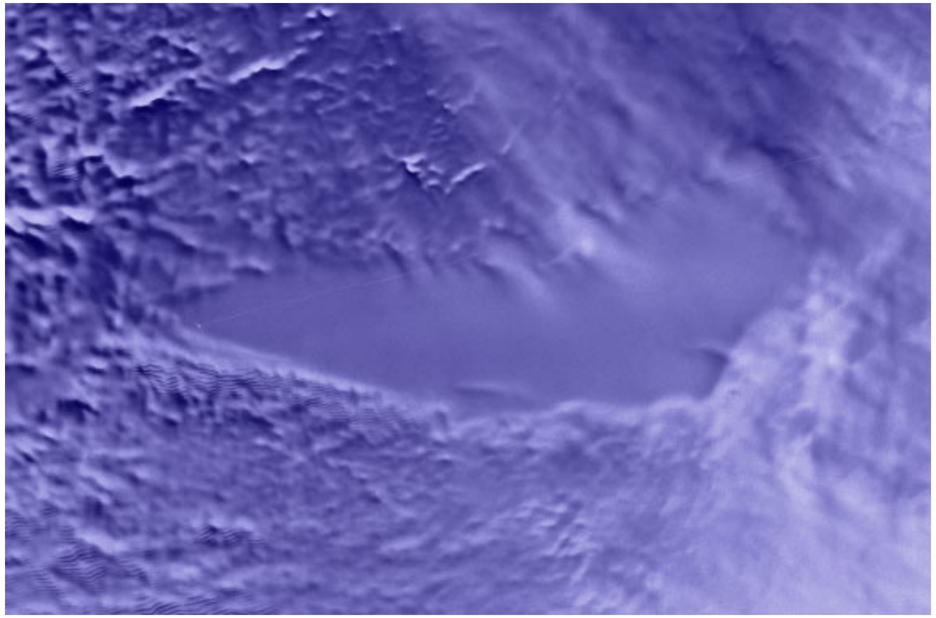
Zwally et al 2002

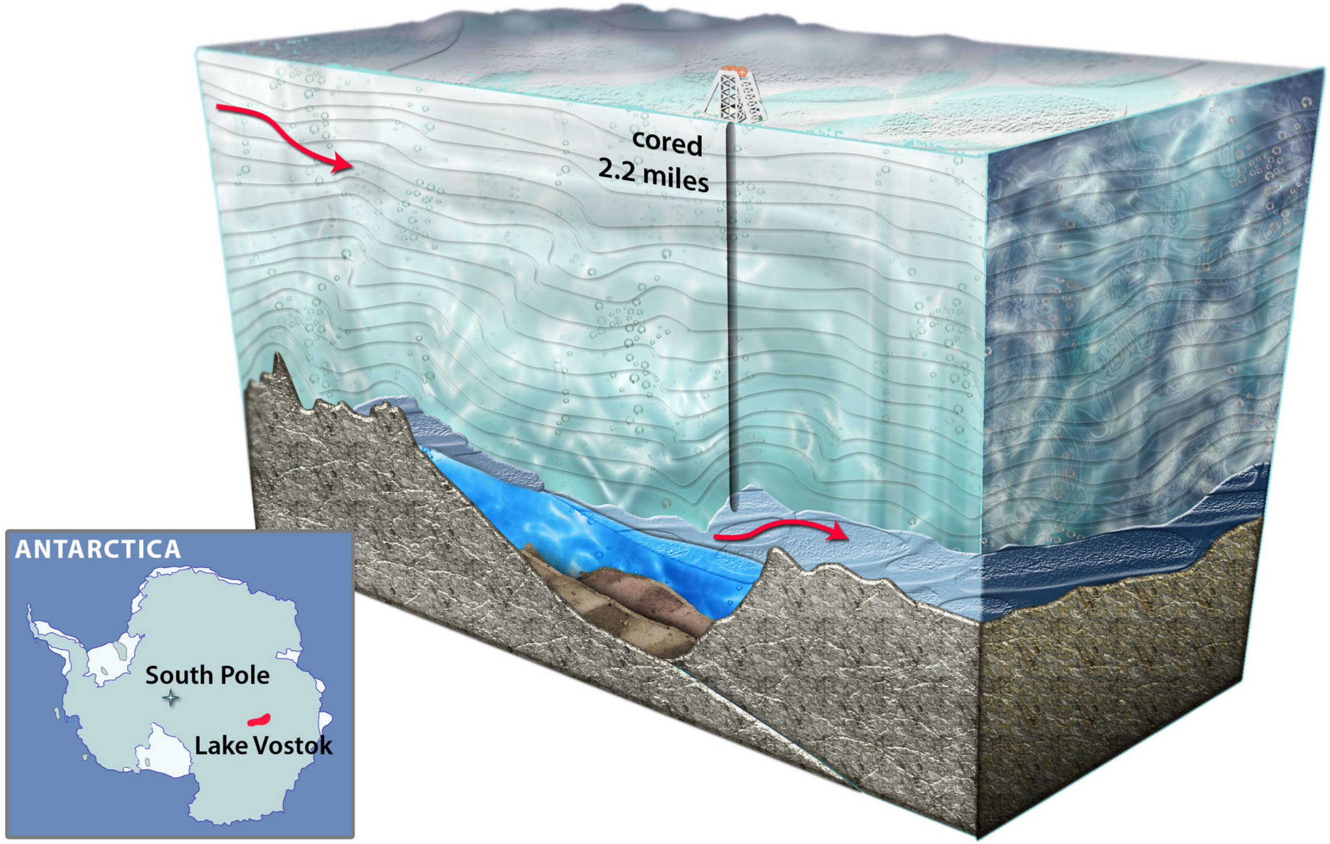
Large and Rapid Melt-Induced Velocity Changes in the Ablation Zone of the Greenland Ice Sheet

R. S. W. van de Wal,* W. Boot, M. R. van den Broeke, C. J. P. P. Smeets, C. H. Reijmer, J. J. A. Donker, J. Oerlemans

Continuous Global Positioning System observations reveal rapid and large ice velocity fluctuations in the western ablation zone of the Greenland Ice Sheet. Within days, ice velocity reacts to increased meltwater production and increases by a factor of 4. Such a response is much stronger and much faster than previously reported. Over a longer period of 17 years, annual ice velocities have decreased slightly, which suggests that the englacial hydraulic system adjusts constantly to the variable meltwater input, which results in a more or less constant ice flux over the years. The positive-feedback mechanism between melt rate and ice velocity appears to be a seasonal process that may have only a limited effect on the response of the ice sheet to climate warming over the next decades.

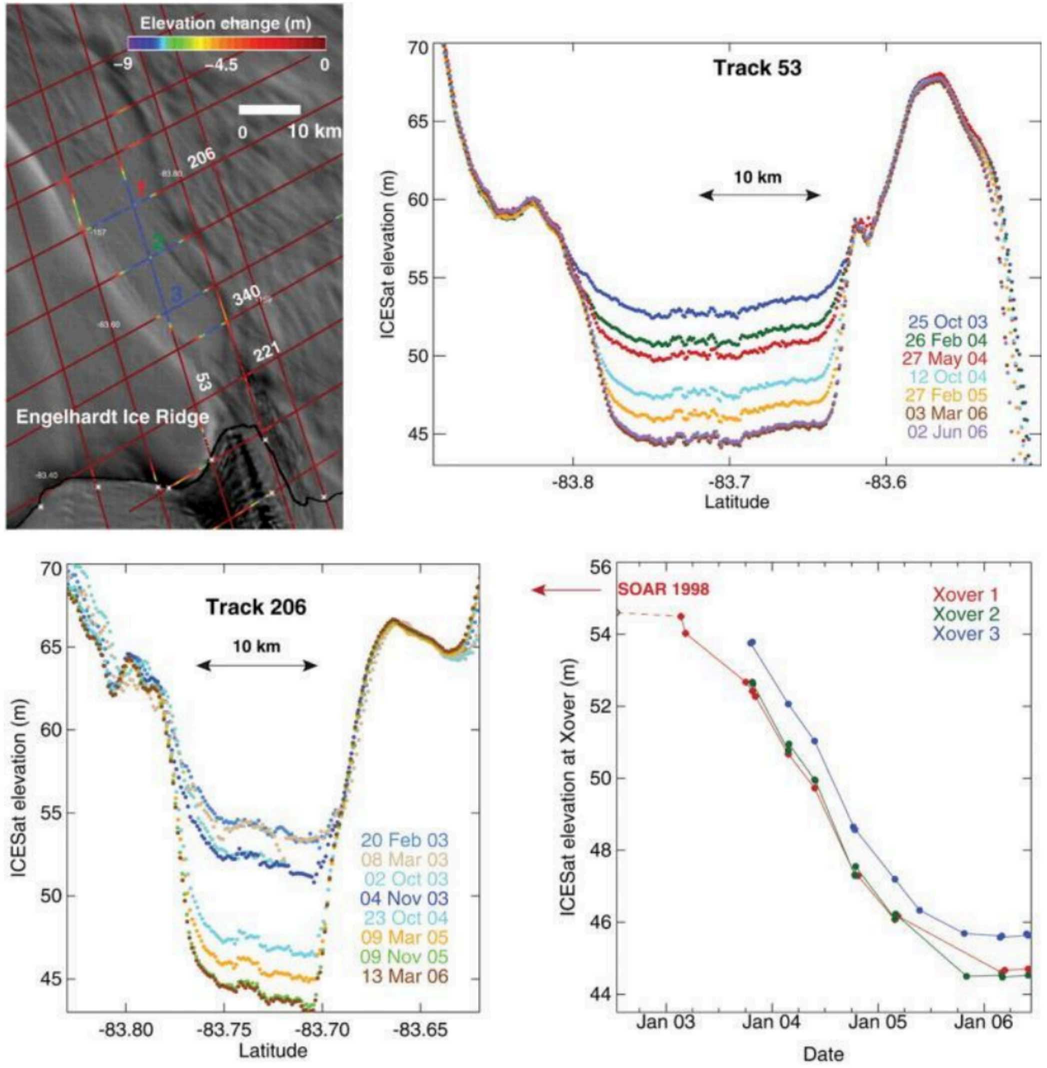
Antarctic subglacial lakes





[Antarctic Glaciers]

Active subglacial lakes in Antarctica

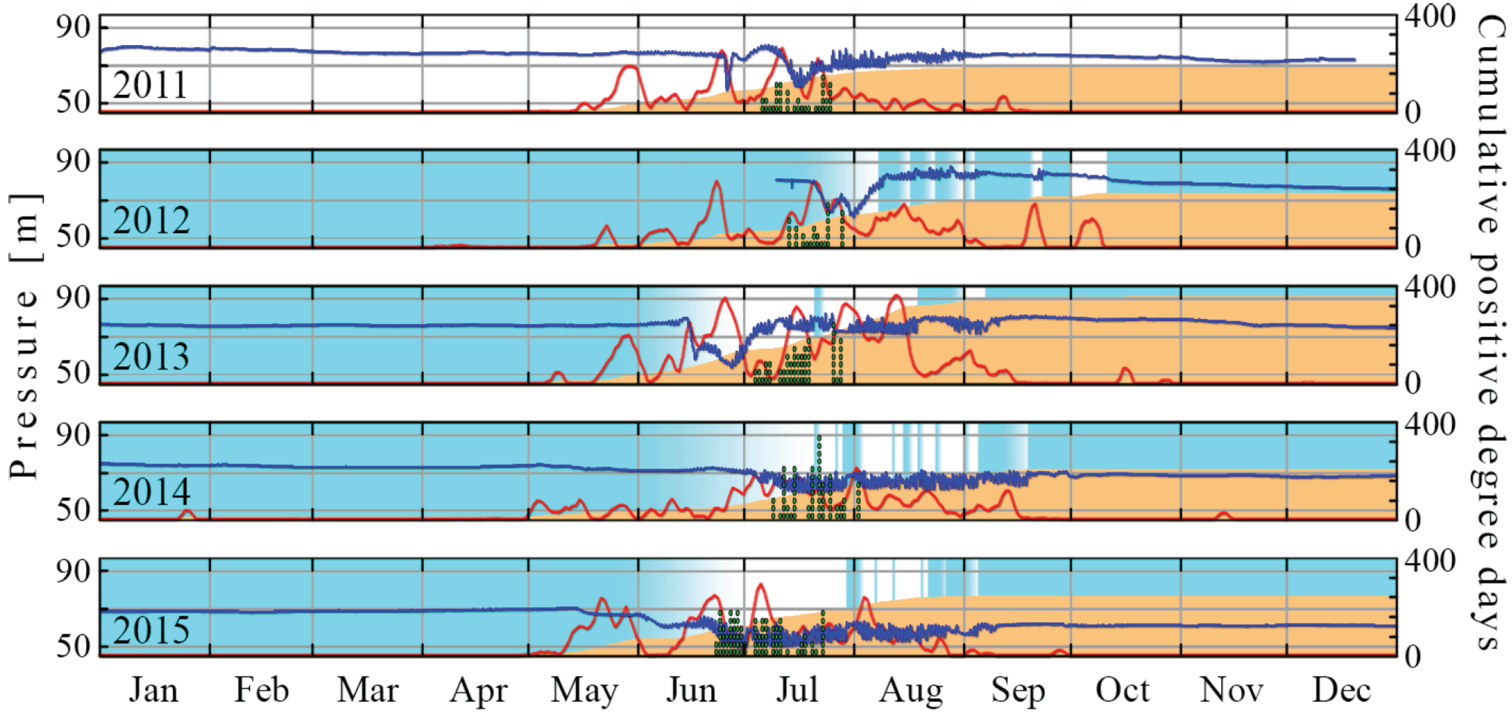


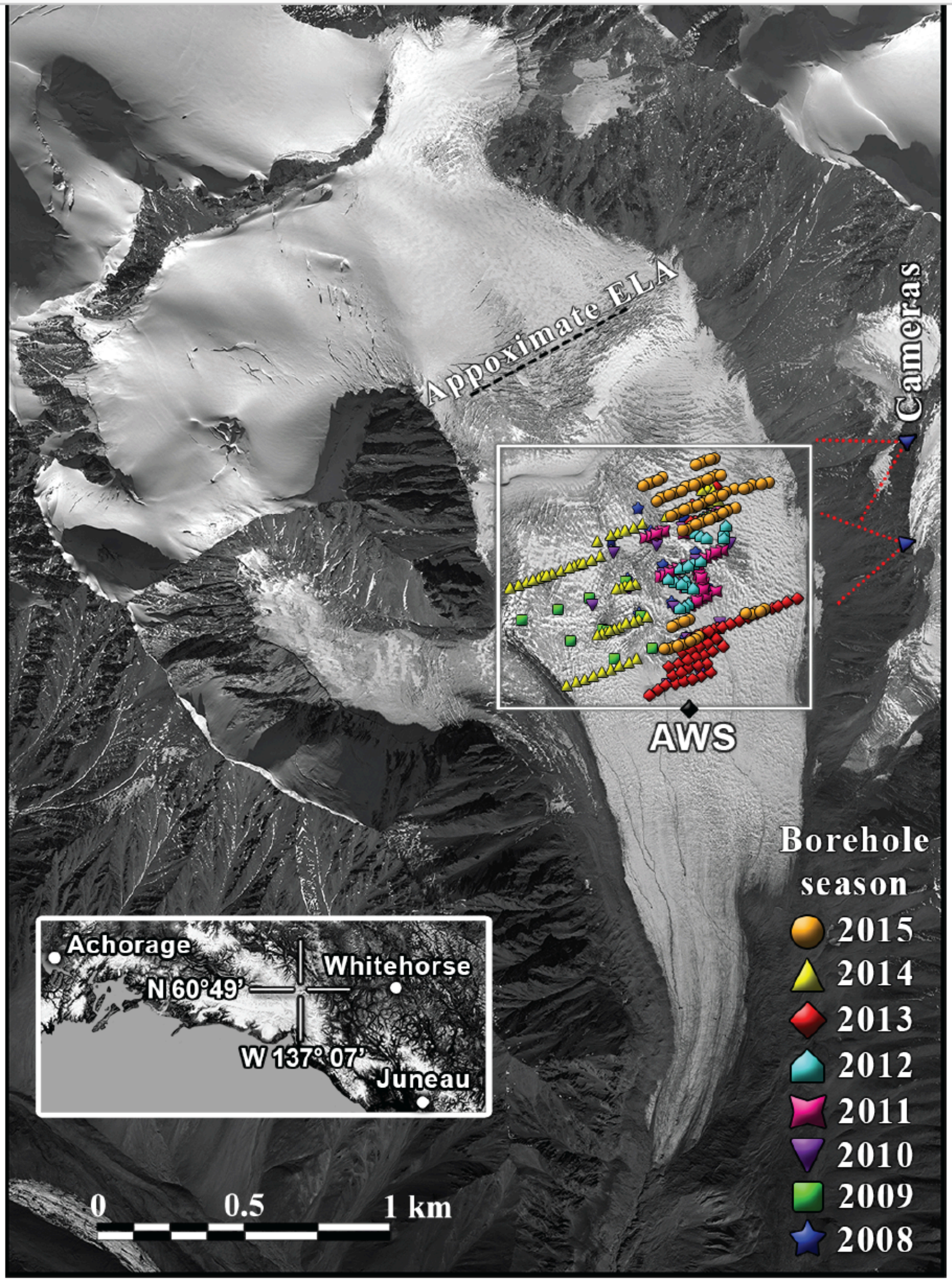
H A Fricker et al. Science 2007;315:1544-1548

Floods at Vatnajokull, Iceland

USGS

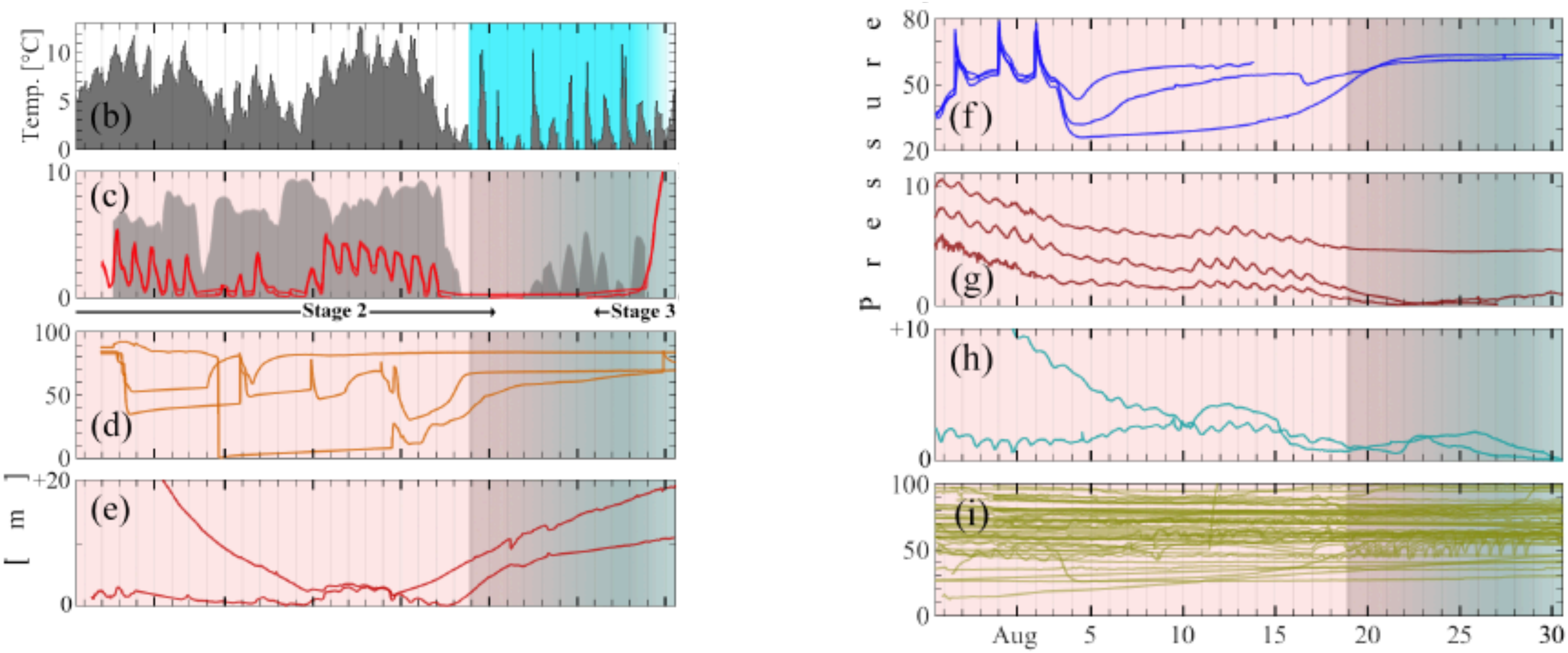
State-of-the-art observations





Rada and Schoof 2018

State-of-the-art observations



Terminology

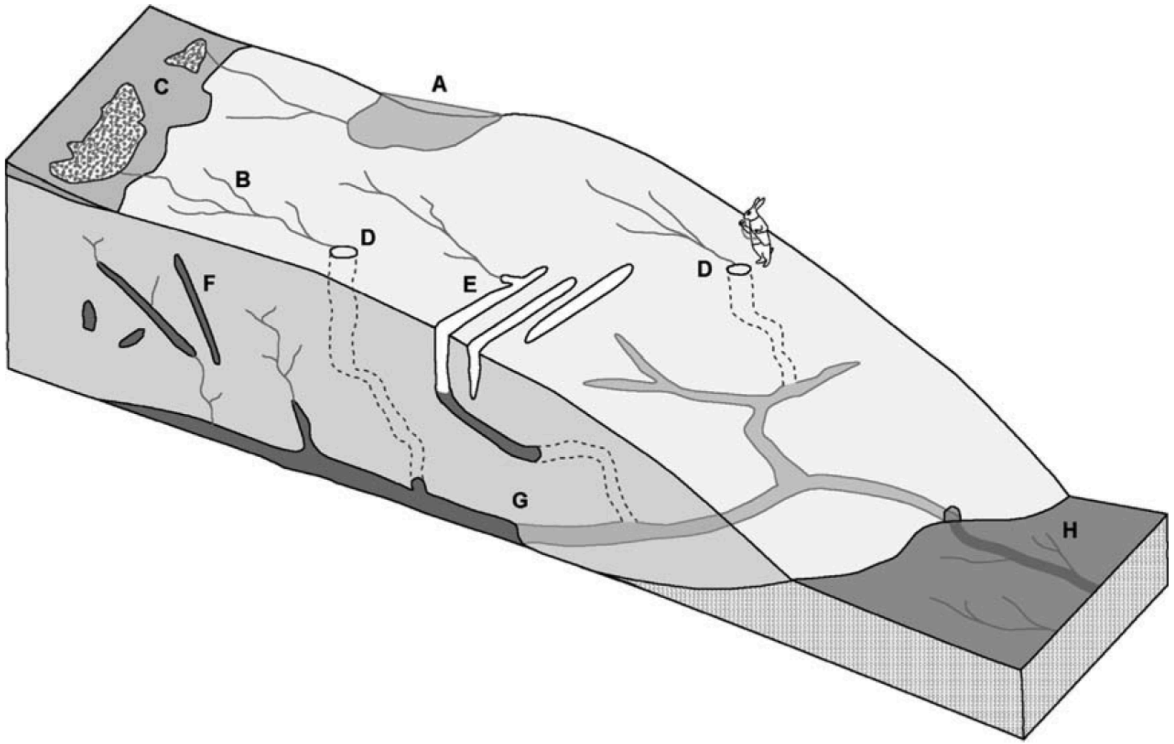
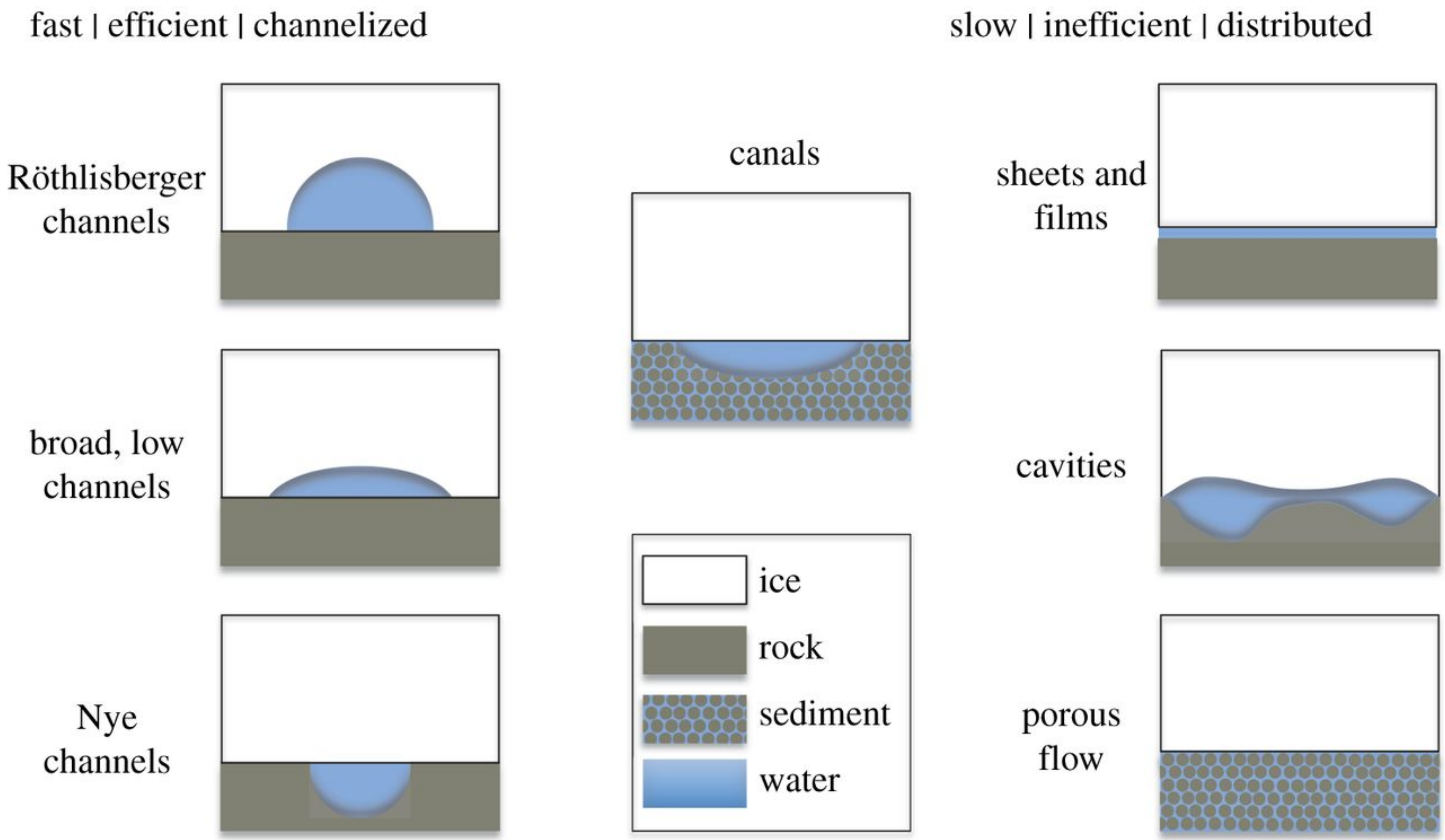


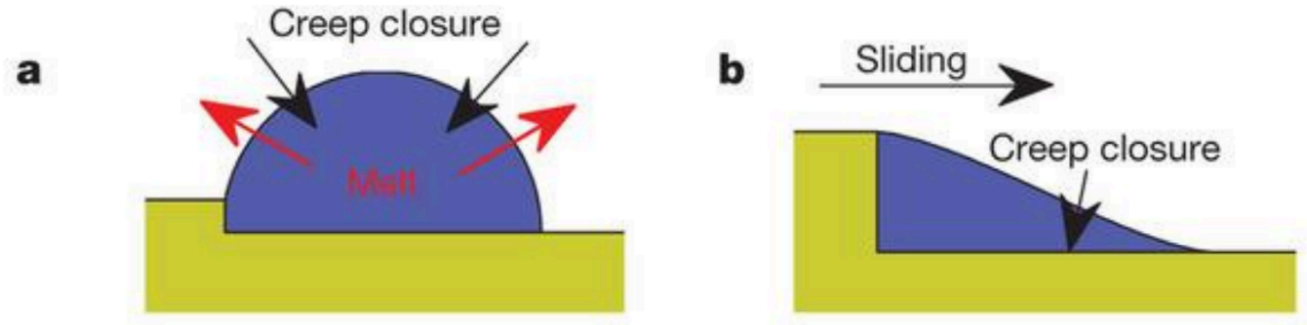
Figure 6.1: Some elements of the glacier water system: (A) Supraglacial lake. (B) Surface streams. (C) Swamp zones near the edge of the firn. (D) Moulins, draining into subglacial tunnels (for scale, white rabbit is about 10 m tall). (E) Crevasses receiving water. (F) Water-filled fractures. (G) Subglacial tunnels, which coalesce and emerge at the front. (H) Runoff in the glacier foreland, originating from tunnels and also from upwelling groundwater. Though not depicted here, water is also widely distributed on the bed in cavities, films, and sediment layers. Sediment and bedrock beneath the glacier contain groundwater. (Refer to the insert for a color version of this figure)

Models



Flowers, 2015

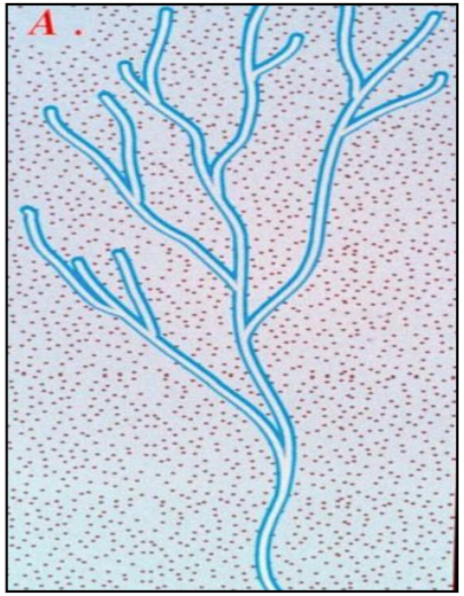
Theory

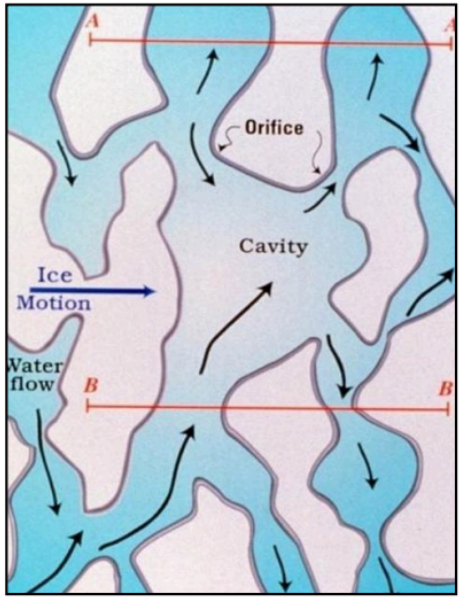


$$\frac{dp_w}{dx} = \frac{C\,(p_i - p_w)^{24/11}}{Q^{2/11}}$$

$$\frac{dp_w}{dx} = C\,\frac{Q^2(p_i - p_w)}{h^{\frac{13}{3}}\,u}$$

Channel flow is concentrated into larger channels, which are at **lower** pressure.





Cavity flow isconcentrated into larger cavities, which are at **higher** pressure.

Andrew Fowler after Schoof and others