Impact of climate upon the hydrolgy of a small polar glacier basin (Austre Lovénbre (79°N, Svalbard)

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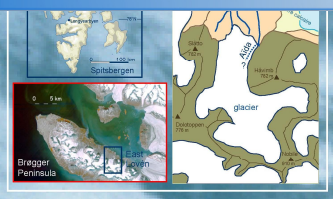


The Lovén FLOWS program will be conducted over a 4-years period including IPY. The objective is to set up a real scale hydrological observatory of a representative polar glacier basin of Spitsbergen, by a survey in continuous of both (i) the fluxes and their spatial and temporal dynamics and (ii) some meteorological parameters (T°C, Pmm). One of the originality of this project is the setting up of a real in situ sensing system based on digital cameras to survey the basin.

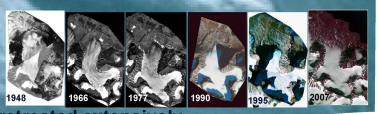
Study area

The AustreLovén glacier basin(10 km2) has been selected to be an observatory of streamflow dynamics in western Spitsbergen. The selection is based upon 4 criteria:

1. It is representative of the small continental glaciers of western Spitsbergen;

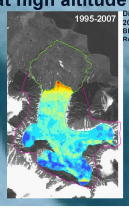
2. The outflows of the basin are concentrated into two well-defined rivers crossing a calcareous bar in twocanyons. This situation exceptional in polar regions allows the measurement of the total outflows;

3. The glacier displays a rapid response to recent climatic changes.



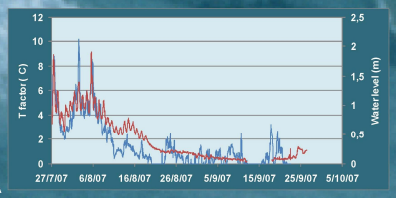
The Loven East glacier has retreated extensively, especially during the last sixty years due to global warming.

4. The glacier shows a high decrease in thickness in its lower part while its thickness displays few variation at high altitude

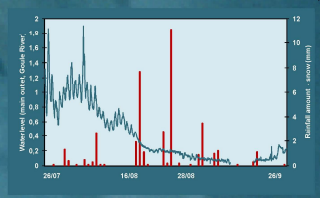


Hydrological data

The water level of the outlet of the Austre Loven glacier catchment is more dependant upon air temperature conditions (A) than upon rainfall or snow fall amount (B)



A



B

However the water level curve differs to that of air temperature (T factor is an indicated of air T integrated over the whole basin)

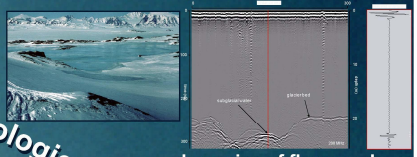
Hydrological dynamics

Previous studies have shown a very important fluvioglacial dynamics, characterised by a high discontinuity of runoff in space and time.

The in situ sensing is helpful to follow the fluvio-glacial dynamics in space and time, at different scales (km2, m2, dm2):

– organisation of the runoff,

– constitution and evolution of the icing and the subglacial flow,



– dynamics of flows and hydro-morphologic evolution in the moraine
  – front retreat,
  – closing up of the subglacial channel,
  – snow distibution

The monitoring system

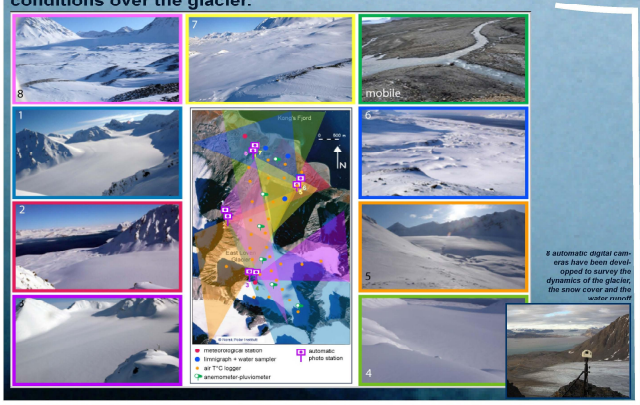
The water budget and the glacier mass balance is studied by 2 approaches :

• the hydrological way (rainfall, snow, flow rates)

• the glaciological way (snow thickness, ice elevation coupled to GPS measurements)

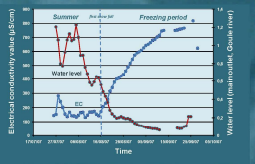
The daily water level (sum of hourly data) is in agreement with air daily T over the glacier basin.

In addition 2 meteorological stations and 25 T°C loggers (Hobo) survey the climatic conditions over the glacier.



8 automatic digital cameras have been developped to survey the dynamics of the glacier, the snow cover and the water runoff

Chemical and isotopic data

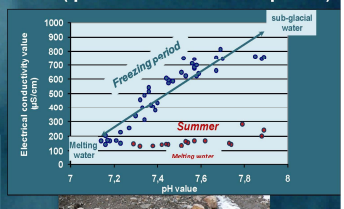


The runoff water during summer is rather diluted due to a high proportion of melting water.

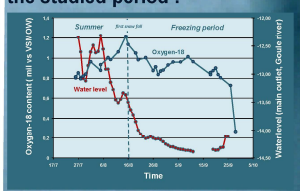
At the beginning of winter, the mineralisation of water increases progressively independantly of T or P.

During the summer, the runoff water gets low mineralisation (less than 200 µS/cm) with variable pH values (7-8).

During the beginning of winter (freezing period), the chemical composition of water evolves progressively between 2 end-members : (1) melting water and (2) sub-glacial water (pH of 8 and EC of 800 µS/cm).



The isotopic composition of runoff water varies during the studied period :



Summer : the enrichment in O-18 indicates that the type of melting water changes through the thawiung period (snow/ice, altitude)
Winter : the increasing proportion of sub-glacial water explains the depletion in O-18 of water.