Nitrate Release from a Melting Snowpack in Alptal

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Introduction

Chemical species in precipitation and snow fall are a relevant source of sparse nutrients for the vegetation.

The spatial and temporal variation of the release of these nutrients from the snowcover during melt influences e.g. the uptake of them by plants.

Johannessen and Henrikson (1978) and others showed, that the ionic concentration in the first portion of melt can be elevated compared to the snow pack (Fig. 1) - an effect, which is often called **ionic fractionation** and explained by restricted integration of ions into the crystalline lattice of ice during snow metamorphism (Fig. 2), and was found to be enforced by melt-freeze cycles.

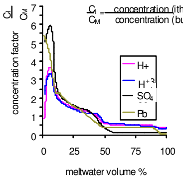

Fig. 1: Ionic pulses in melt water from a snow lysimeter experiments found by Johannessen and Henrikson (1978).

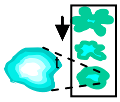

Fig. 2: Ionic fractionation: Schematic of the ion redistribution during regular snow metamorphism.

Objectives

- Characterize spatial variability of melt water and ion release from snow
- investigate the persistence of the release pattern
- determine the magnitude of ionic fractionation for a Subalpine snow pack.

Methods

In winter 1998/1999, we sampled the melt water released from a snow pack on a open field in Alptal (Central Switzerland):

- subalpine zone
- 1200 m a.s.l.
- sloped towards SW (10-15%)
- rather impermeable underground.

The Alptal area has a long tradition of field experiments concerning catchment hydrology and nutrient budgets (Burch 1994; Schleppi, 1999).

The meltwater was sampled at the soil surface with network of 32 small basins and stored in sample bottles. Melt water was periodically collected from the samplers and snow pit sampling was performed. Samples were analysed for concentrations of nitrate by ion chromatography. At about 20 cm above soil surface, liquid water content was continuously monitored with time domain reflectometry probes (TDR).

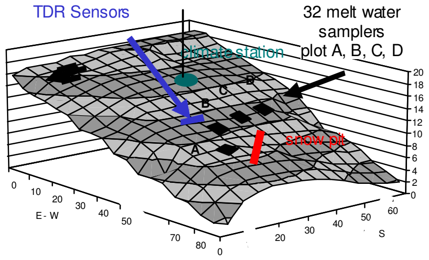

Fig. 3: Experimental setup. The installations on each of the plots A, B, C, and D are shown in Fig. 3..

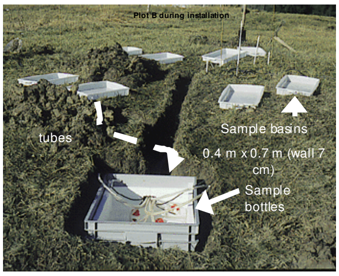

Fig. 4: Plot B: on each of the plots 8 small basins (0.4 x 0.7 m) were put on the soil surface to collect the melt water released from the snow cover.

Results and Discussion

The water release from the strongly layered snow pack showed a large spatial variability and the release pattern was temporally changing (Fig. 5).

We identified three flow types:

(I) percolation of surface melt
(II) base melt
(III) saturated lateral flow in basal snow layer

Melt water release tended to be higher in local depressions than on local hills. It is likely that this tendency results from lateral flow inside the snow pack along layer boundaries, due to capillary effects.

The ratio between the nitrate concentration in the melt water and the mean concentration in the snow pack was in the range between 0.7 and 1.4. These values are low compared to values up to 12 found in laboratory experiments. The nitrate concentrations in the snow, which were typical for the subalpine zone on the Northern Swiss Alps, were close to their solubility in ice and this explains the low ionic fractionation effect (Eichler, 2000).

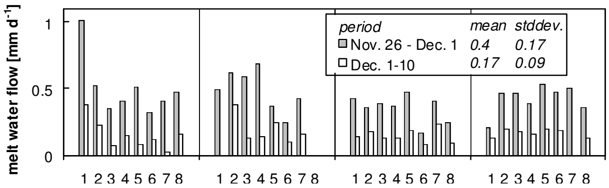

Fig. 5: Melt water sampled with the samplers on the four plots in two periods in early winter.

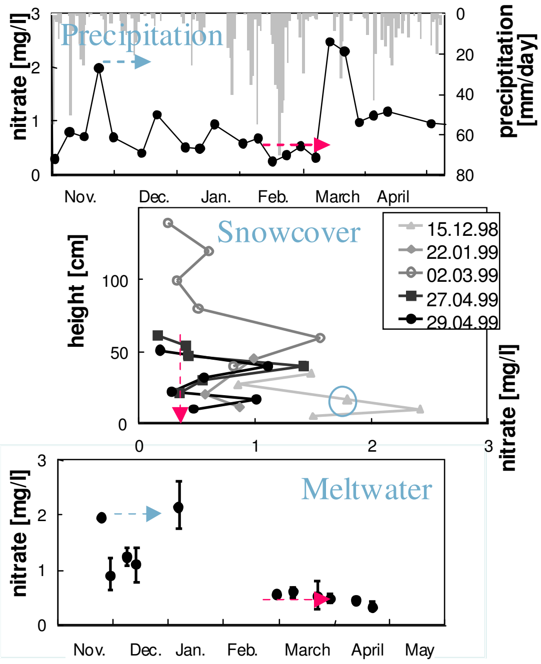

Fig. 6: Nitrate concentrations in precipitation, snow cover, and melt release.

Conclusions

- The spatial variability of water and nitrate release from a subalpine snow cover is large
- Ionic fractionation of nitrate is of minor importance, the concentration is mainly determined by flow paths within the snow cover.
- The spatial release pattern is temporally changing.

References

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Publication

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