

### Introduction

Rain-on-snow (ROS) events are associated with major flood events in many regions worldwide. Understanding the process of water movement behaviour in the snowpack during rain can therefore be a key knowledge of avoiding tremendous losses of human lives and property. Water sprinkled on the snowpack provides an opportunity to simulate such a process. We analysed the outflow composition from the snowpack during and after an artificial ROS event. Deuterium ( $\delta^2$ H) was used to track and separate rain water from the total outflow. Tracking the rainwater gave us an additional information about the ratio of rainwater and non-rain water and therefore how much rainwater is held in the snowpack.



## Materials and methods

- The experiment was conducted 18.3.2015 in Davos, Sertig 1860 m.
- A snow cube was isolated by styrofoam from the surrounding snow.
- A metal plate was placed on the bottom of the snow cube.
- The ROS event was simulated by 4 rain periods during 3.5 hours. Each period lasted 30 min and separated by 30 min break.
- In total 42.8  $\pm$  1.8 L of water enriched by deuterium was sprinkled  $[\delta^2 H = -23.1 \ (\% V-SMOW)].$
- Thermometers were employed to monitor temperature changes (snow, water, air)
- Snow characteristics were investigated before and after experiment, as well as outflow isotopic changes.
- The snow cube was prepared one day before. The snow analyses were done one day after the sprinkling.





# Hydrograph separation during artificial rain-on-snow event using deuterium

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	1		2		3		4	
Time lag rain - runoff [min]	11.00		5.00		5.00		5.00	
	Rain	Total	Rain	Total	Rain	Total	Rain	Total
Time lag rain - max flow rate [min]	34.00	28.00	25.00	26.00	21.00	21.00	25.00	25.00
Max flow rate [L.h <sup>-1</sup> ]	2.30	18.00	11.94	20.00	12.64	18.00	12.62	16.67

## **Deuterium** Hydrogen 2 Oxygen O<sub>16</sub>

#### Conclusions

- During an artificial ROS event 42.8  $\pm$  1.8 L was sprinkled, which caused 44.0  $\pm$  1 L of total outflow.
- Isotopic hydrograph separation showed that the total outflow consisted of 25  $\pm$  1 L of rain water.
- Approximately 40 % of input rain water (17.8  $\pm$  2.8 L) was held in the snowpack 21 hours after the experiment.
- During the first rain period most of the pre-event liquid water content was released (5.6 L).
- Wave front speed of the rain water during the first period was 5 cm.min<sup>-1</sup>.
- The ratio of rain water volume to the total outflow volume during the periods rised, rain water volume during last three periods remained almost the same.

![](_page_0_Picture_39.jpeg)

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![](_page_0_Picture_43.jpeg)