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# Measurement of snow characteristics in the mountains

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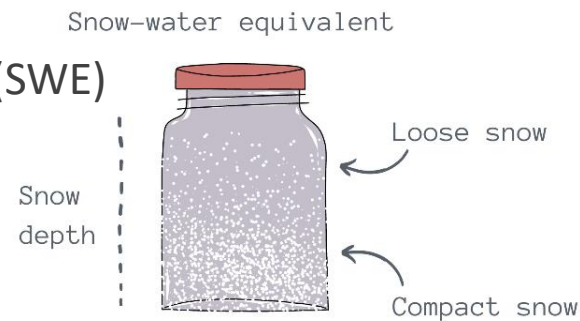
# Introduction

Climate change - increasing role of the water in environment for the society

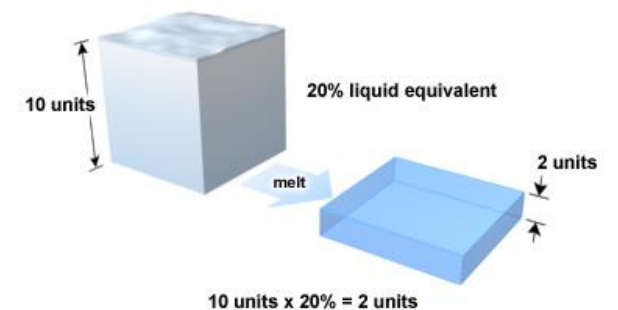
- increasing role of numerical models in weather, climate and hydrological forecasts
- need for reliable data including the data on the evolution of the water in snow
- terrestrial observations higher relevance

Monitored parameters of snow:

- commonly: snow depth, snow water equivalent (SWE)



Example of Water Yield from a Volume of Snow



- other: density, the depth of new snow (on wooden board), stratification, snow temperature, snowmelt etc.



- **Manual** measurement of snow properties: physicaly and time-consuming – increases costs - burdened by low, inflexible time resolution

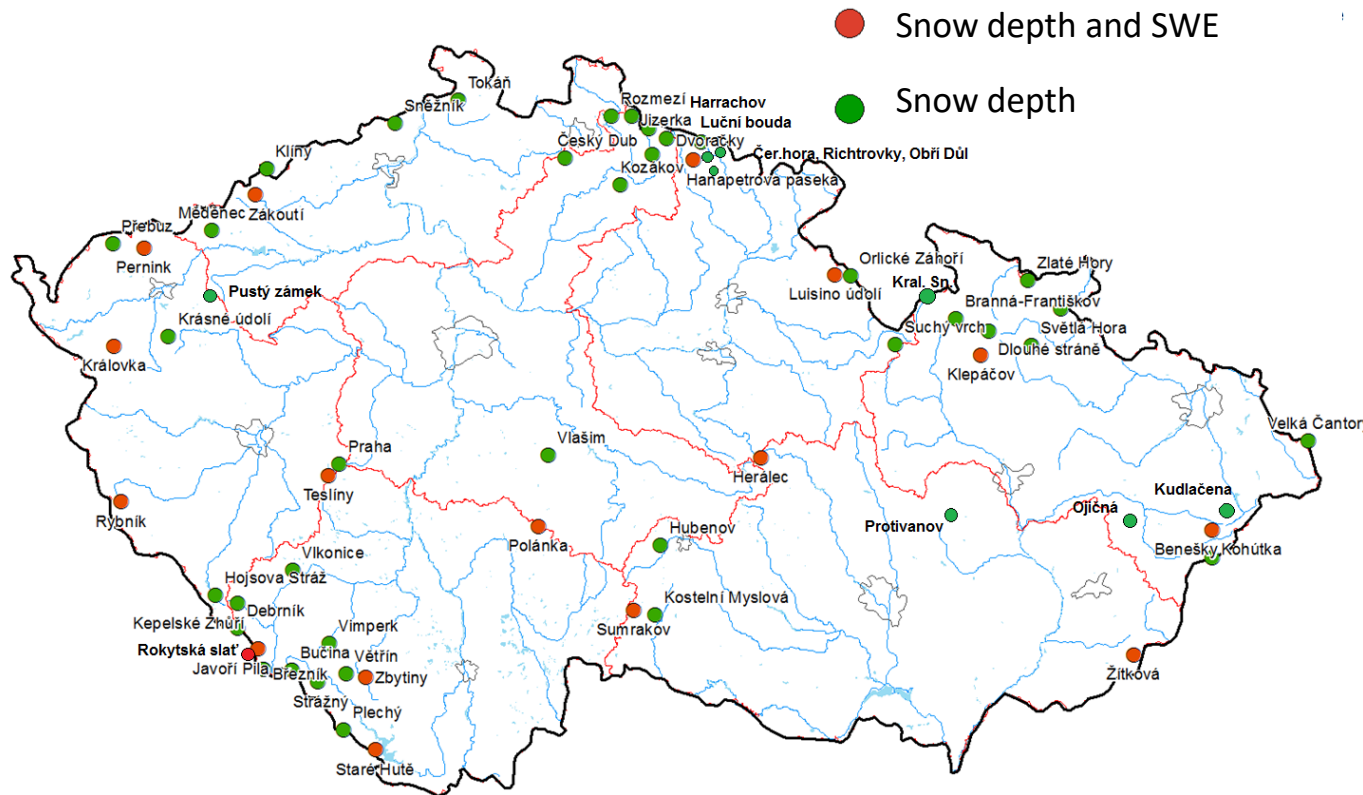


- **Automatic** snow measurement - number of methods tested - however, due to the complicated physical properties of the snow profile (water in three states - gaseous/liquid/solid, variability of snow and eis crystals, snowbridging...), each of them has its weaknesses
- reviews of the techniques:
  - LUNDBERG A., HALLDIN S. 2001. Snow measurement techniques for landsurface-atmosphere exchange studies in boreal landscapes. Theoretical and Applied Climatology, 70: 215-230
  - ŠPULÁK O., SOUČEK J., ČERNOHOUS V. 2012: Pozemní metody a technologie měření vodní hodnoty sněhu: review / Ground-based methods and techniques of snow water equivalent measurement: review. Zprávy lesnického výzkumu, 57 (4): 304-313



# Snow monitoring in the Czech Republic: provided by the Czech Hydrometeorological Institute (CHMI)

- o network of manual measurements: with a daily step of monitoring (414 pieces); and with a weekly measurement step (Monday) - throughout the country
- o network of automatic snow stations: 17 snow gauge type stations (SWE and snow depth) and 48 snow depth stations - mostly in higher and mountainous locations; aim to increase numbers



# Developed device

## - Research project (2012 – 2014)

- in cooperation of Forestry and Game Management Research Institute (Opočno Research Station), Research Institute of Water Management and the company Ing. Libor Daneš

## - The device named LDSMS2014

- SWE on principle of scale (weighted 2x2 m), snow depth by ultrasound sensors (laser more reliable, but costly)
- snowmelt seepage, temperature
- possible to measure also all other meteorological data



**High accuracy of measurement**  
resolution 0.1 mm of SWE,  
accuracy of the weight sensors 0.2 % FS



**Preventing of snow bridging**  
reliable prevents  
formation of snow bridges



**Simplicity**  
simple installation in any landscape,  
simple and quick user operation



**GSM/GPRS**  
integrated GSM/GPRS module enabling  
online access to data



**Low power consumption**  
due to integration of modern technologies in the processors - SLEEP mode



**Environmentally friendly**  
minimal risk of of environmental pollution  
(without pillows filled with antifreeze liquids)



**Increased resistance**  
robust design ensures extremely long  
service life, high resistancex of the entire  
device against overvoltage and noise

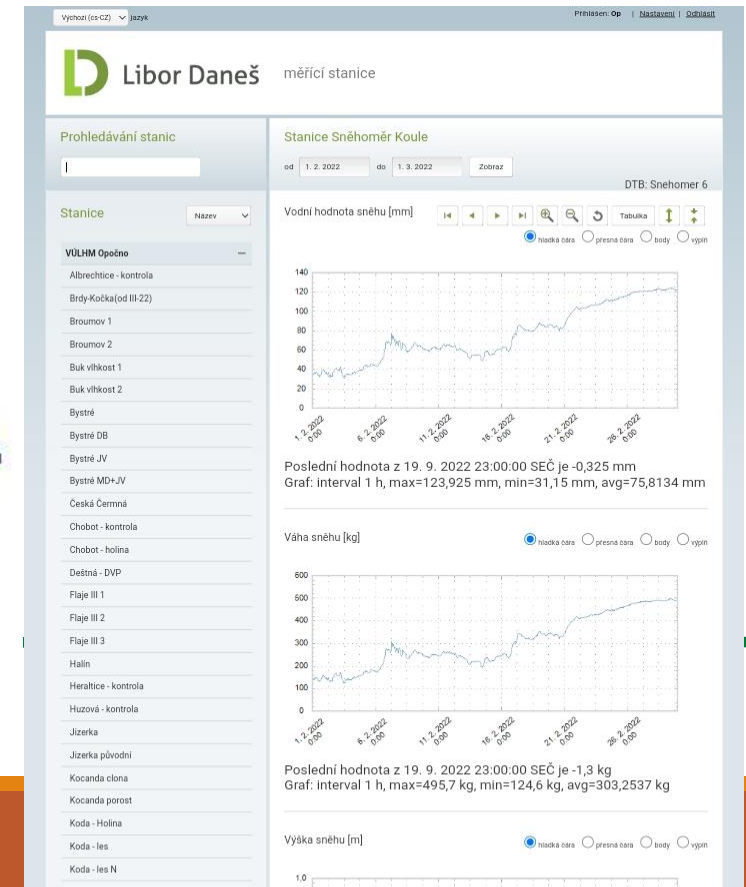
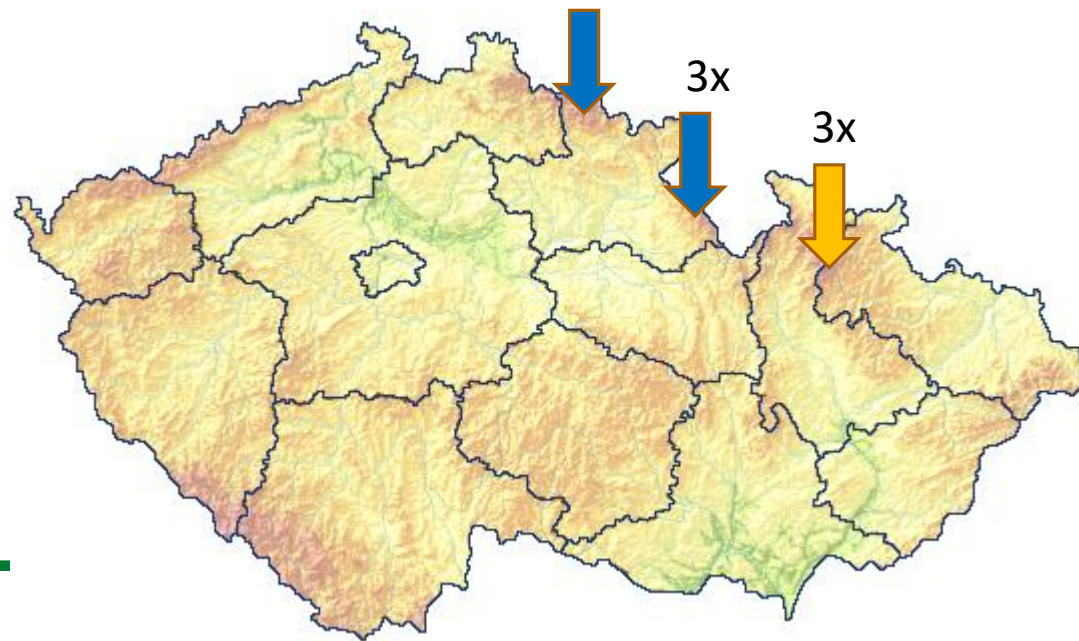


**Sensors and probes**  
facility to connect plenty of other sensors  
including snowmelt seepage measurement,  
high data logger modularity





- tested on 7 localities; not included into CHMI network; less snowy winters
- nowadays at three localities in the Orlické Mountains and at one locality in the Giant Mountains,
- preparing the installation of 3 snow measuring devices LDSMS2014 in small research basins in Hrubý Jeseník Mountains





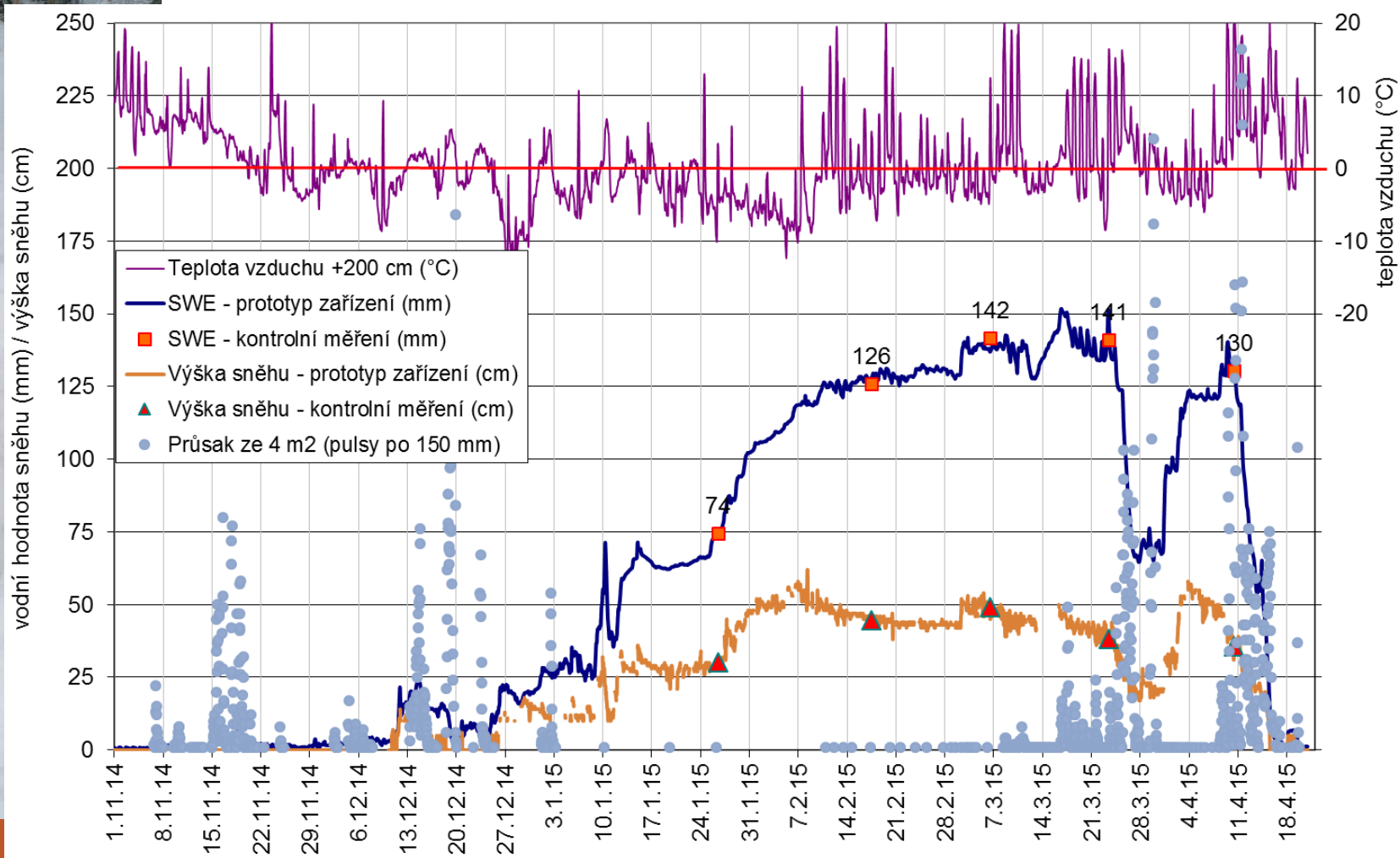
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# Results of data analyses

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## Testing of the developed device:

- an hourly interval for collecting SWE data may not be sufficient for accurate description of snow cover trends and for tracking winter hydrology during rain-on-snow events
  - the device did not prevent snow bridging fully
  - snowmelt at each device was accelerated by up to one day comparing to surrounding environment
  - the calculated evaporation from snow in tested winters ranged between 3.9% and 8.3% and increased with decreasing altitude
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- ŠPULÁK O., KACÁLEK D., ČERNOHOUS V. 2020: Snow cover accumulation and melting measurements taken using new automated loggers at three study locations. *Agricultural and Forest Meteorology*: 285-286



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You will see...

Thank you for your attention.



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