Snow and snow cover measurements in SHMI network and the use of data

Data acquiring

-Manual measurements – more than 660 stations

-Instalment of 75 automatic stations in 2015/16

-Limited satellite data use so far

Data use

-water balance calculation

-climatology of snowfall and snow cover

-NWP models

-traffic and sport and other social events information

Snow and snow cover measurements in SHMI network

-No special snow network

-All snow and snow cover measurements are the part of climatological and precipitation network

Snow and snow cover measurements
Symbols used for snow and snow cover

Snowfall

Snow with rain

Snow pellets

Drifting snow

Low drifting snow

High drifting snow

Snow cover c.

Snow cover u.

Snow and snow cover measurements in SHMI network

Snow parameters measured

Parameter	Characteristics recorded	Frequency	Instrument
Snowfall	Start, end, type, intensity	Daily	Visually (Disdrometer IH SAV - experimentally)
New snow cover Old snow cover	Height, (water content) Character, height, water content	Daily or 3x in a day Daily	Snow board Visually, snow-stake, snow tube, rain

Snow and snow cover measurements in SHMI network

- Precipitation stations – once a day at 7:00 a.m.:
  - Depth of new snow - over 24 h
  - Depth of total snow cover (SD)
  - Measurement of SWE (weekly on Monday if total snow cover > 0)

- Climatological station + 3x in a day at 07,14 and 21 LT
  - new snow

Snow and snow cover measurements in SHMI network

New snow – at 30x30cm wooden board in a wind protected position; reading on the ruler rounding to the whole cm

(after each measurement the snow from the board is emptied to the same place and the board is again placed on the surface of the snow layer)

Snow and snow cover measurements in SHMI network

Total snow cover measurements

- Using fixed or portable snow stick (pole) with marked ruler
- Preferably at various places (at least three) – averaged value

Snow and snow cover measurements in SHMI network

- It's a good idea to mark the location of your snow board with a flag or reflector

Snow and snow cover measurements in SHMI network

- SWE measurement – on Monday at 07 a.m.

  - using the gauge or weighing unit with cylinder

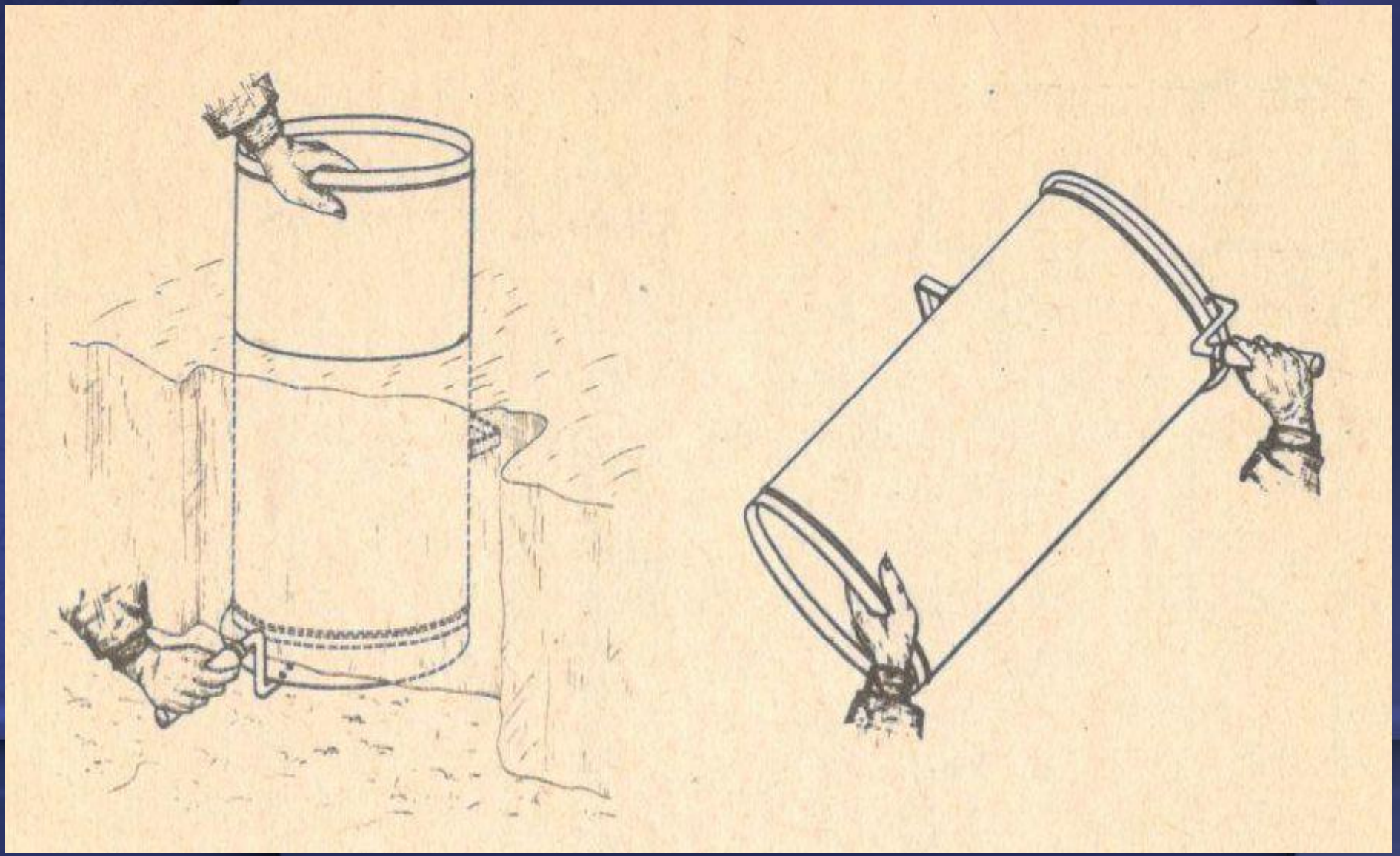
- the location should have not drifted, melted or blown clear
- we should take the core sample from an area where the depth of snow is the same as we determined the total snow depth (or make an average from several measurements)
- if using a weight the SWE is calculated by formula

$$SWE\ [mm] = 10*(P/q)$$

where P is sample weight [g]

q is cross-sectional area of the cylinder [cm^2]

Snow and snow cover measurements in SHMI network



Snow and snow cover measurements in SHMI network - automatization

- Started in 2004 with POVAPSYS-1 project –

7 stations with the ultrasonic snow depth sensors SwS-3 (by MPS Systém)

- outputs never in operational use – data often affected by other weather phenomena (temperature, wind, precipitation)
- nevertheless, a good experience for the future

Snow and snow cover measurements in SHMI network - automatization

- 2015 - 2nd phase of the POVAPSYS project – automatization of climatological network: 75 stations have been equipped by optical sensor for snow depth measurement

SHM 30 – laser snow depth sensor by Jenoptik (Germany)

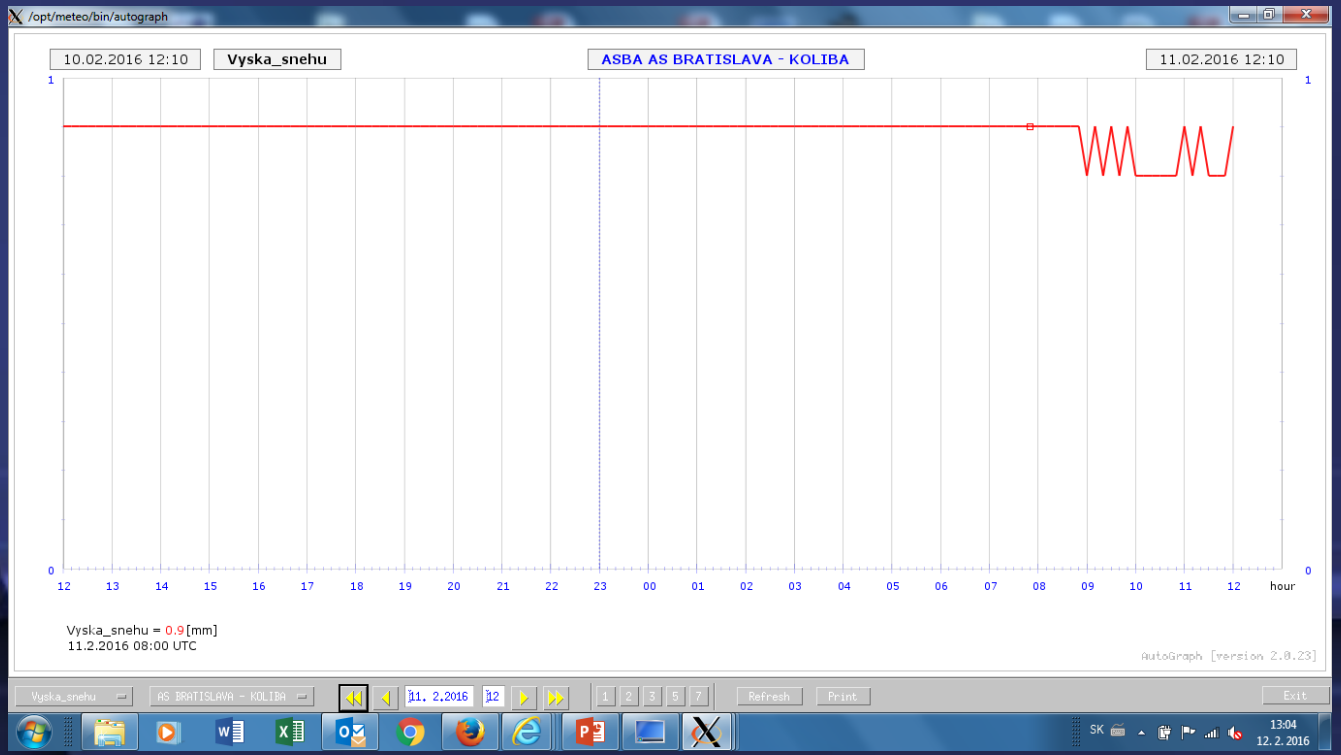
It emits modulated visible laser light and determines the distance to and object by comparing phase information.

Snow and snow cover measurements in SHMI network - automatization

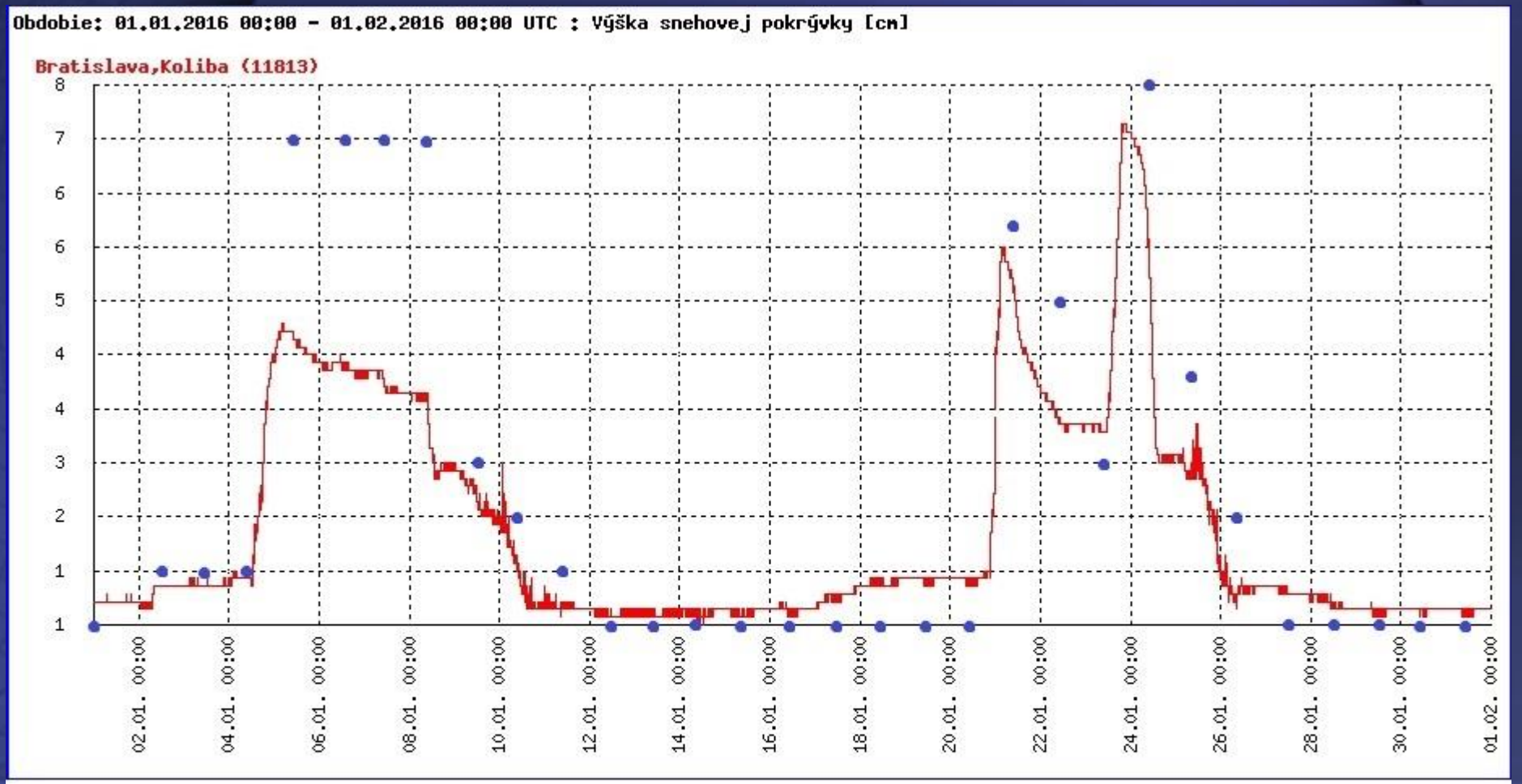
Snow and snow cover measurements in SHMI network - automatization

Snow and snow cover measurements in SHMI network - automatization

- To calculate snow depths is necessary to perform a zero level measurement, which is stored as offset value
- The „zero“ is advisable to check in time, fixed surface is the best solution

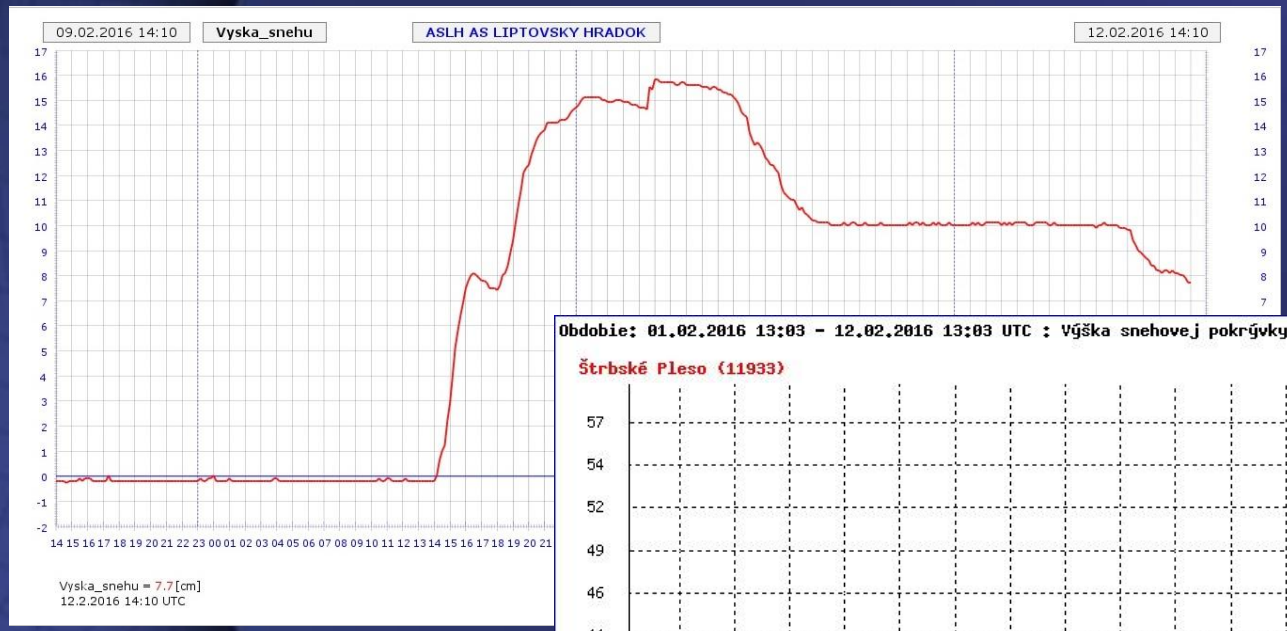


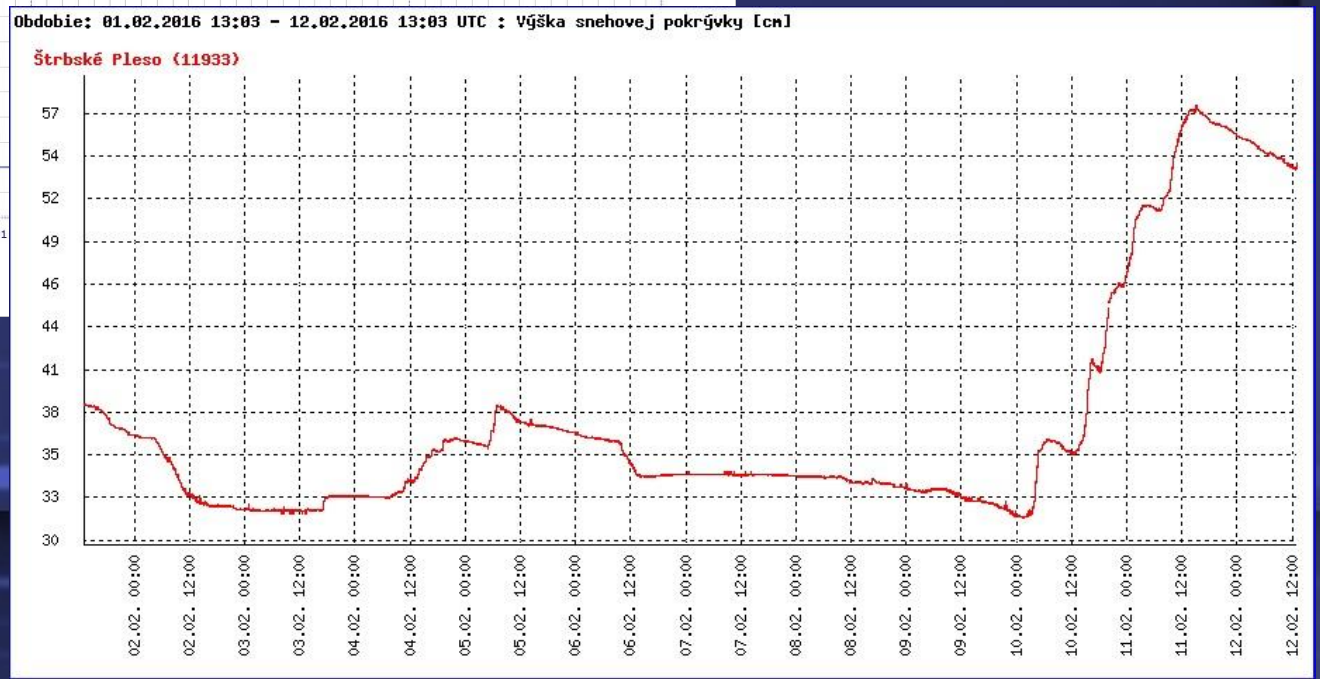
Snow and snow cover measurements in SHMI network - automatization



Snow and snow cover measurements in SHMI network - automatization

- Main advantage – real time outputs
- Main disadvantage – one-point measurement





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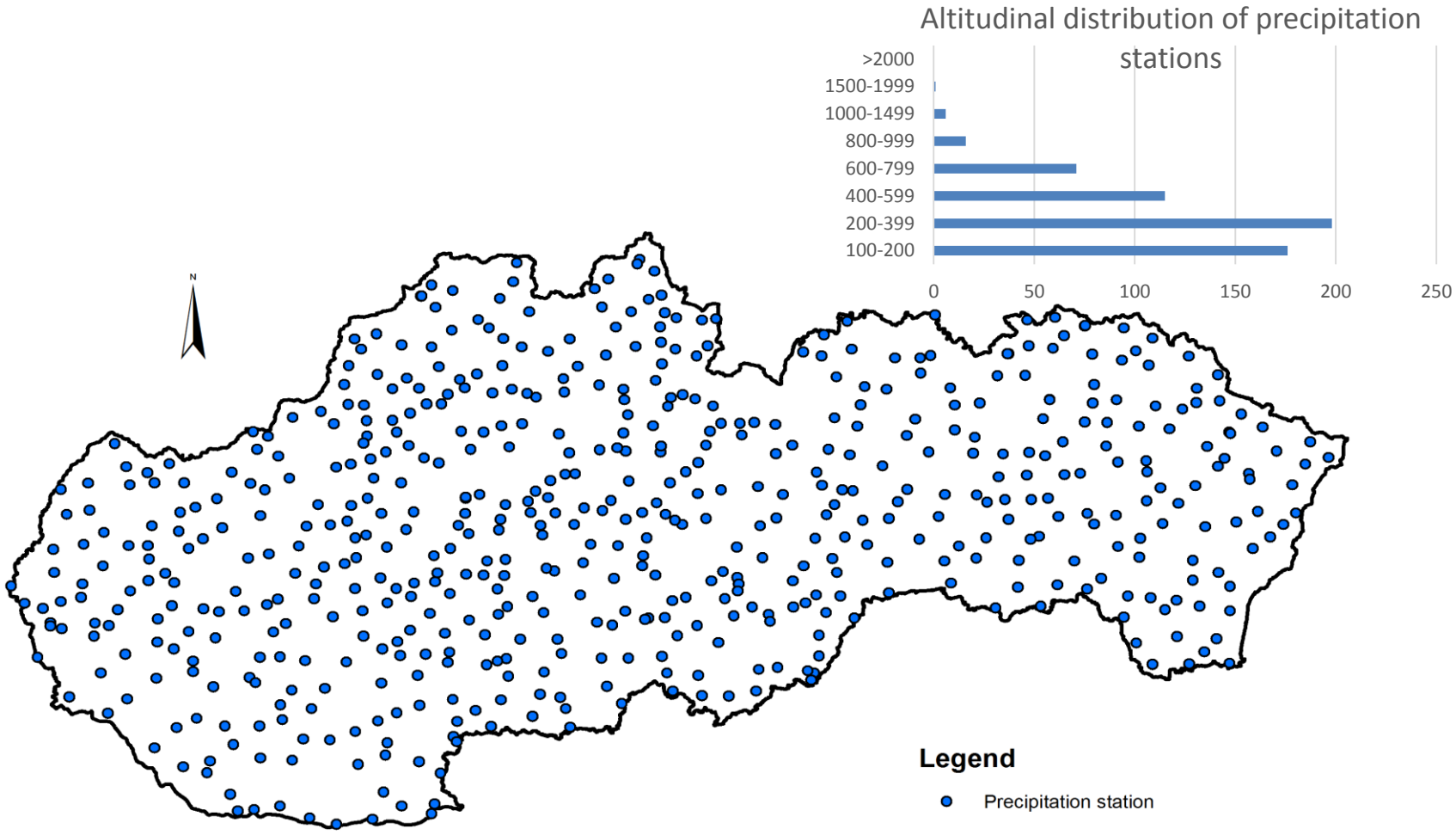

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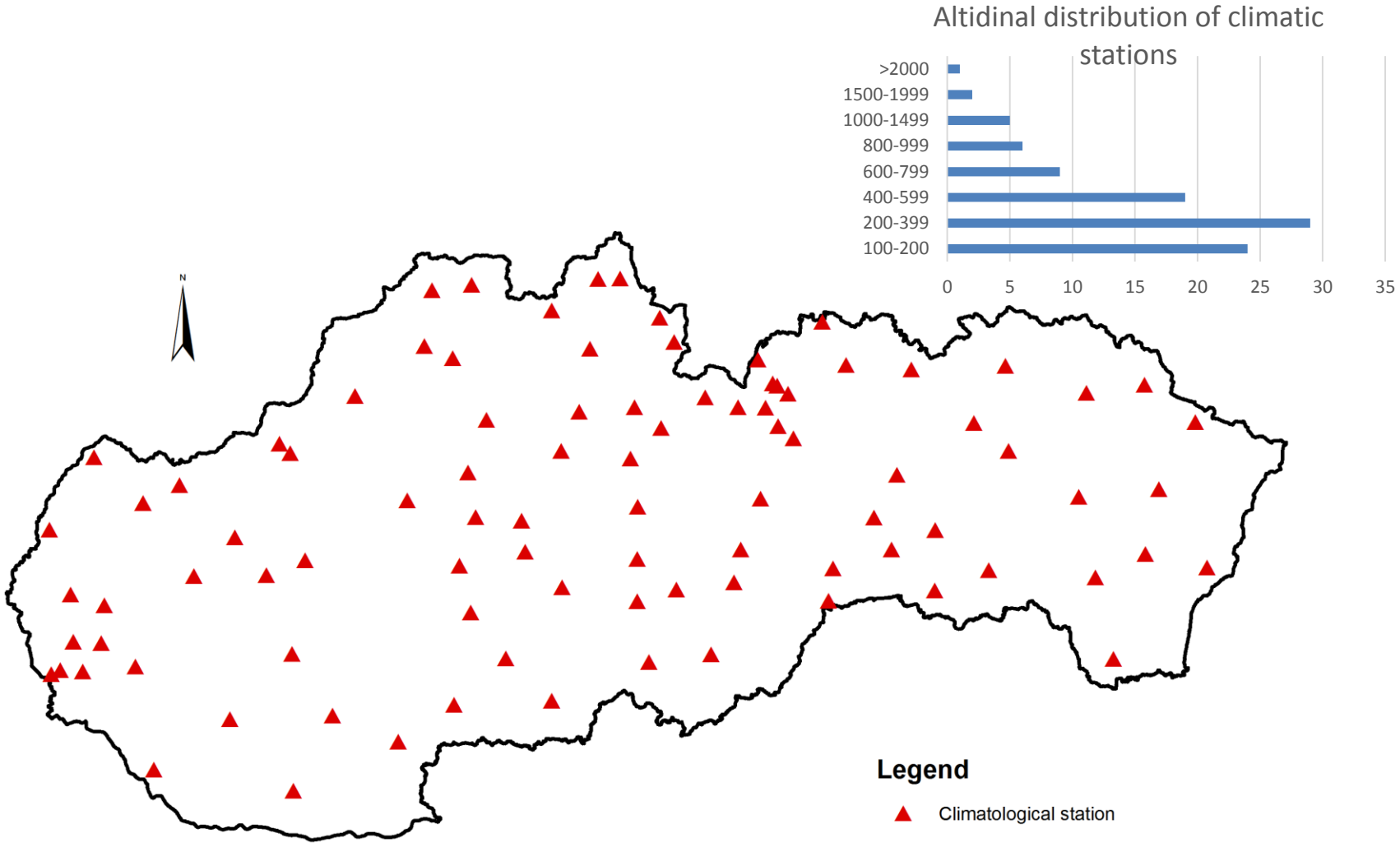

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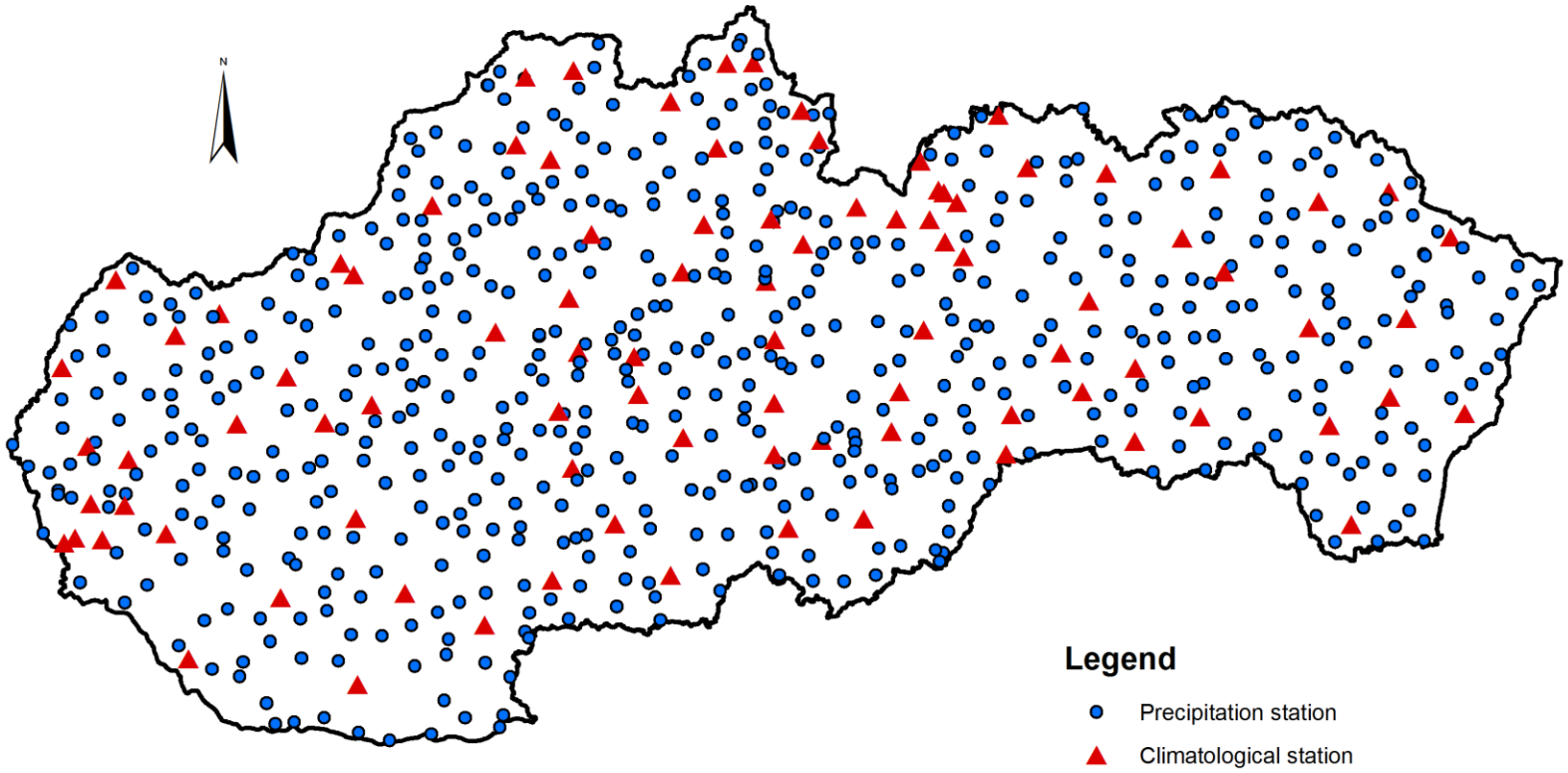

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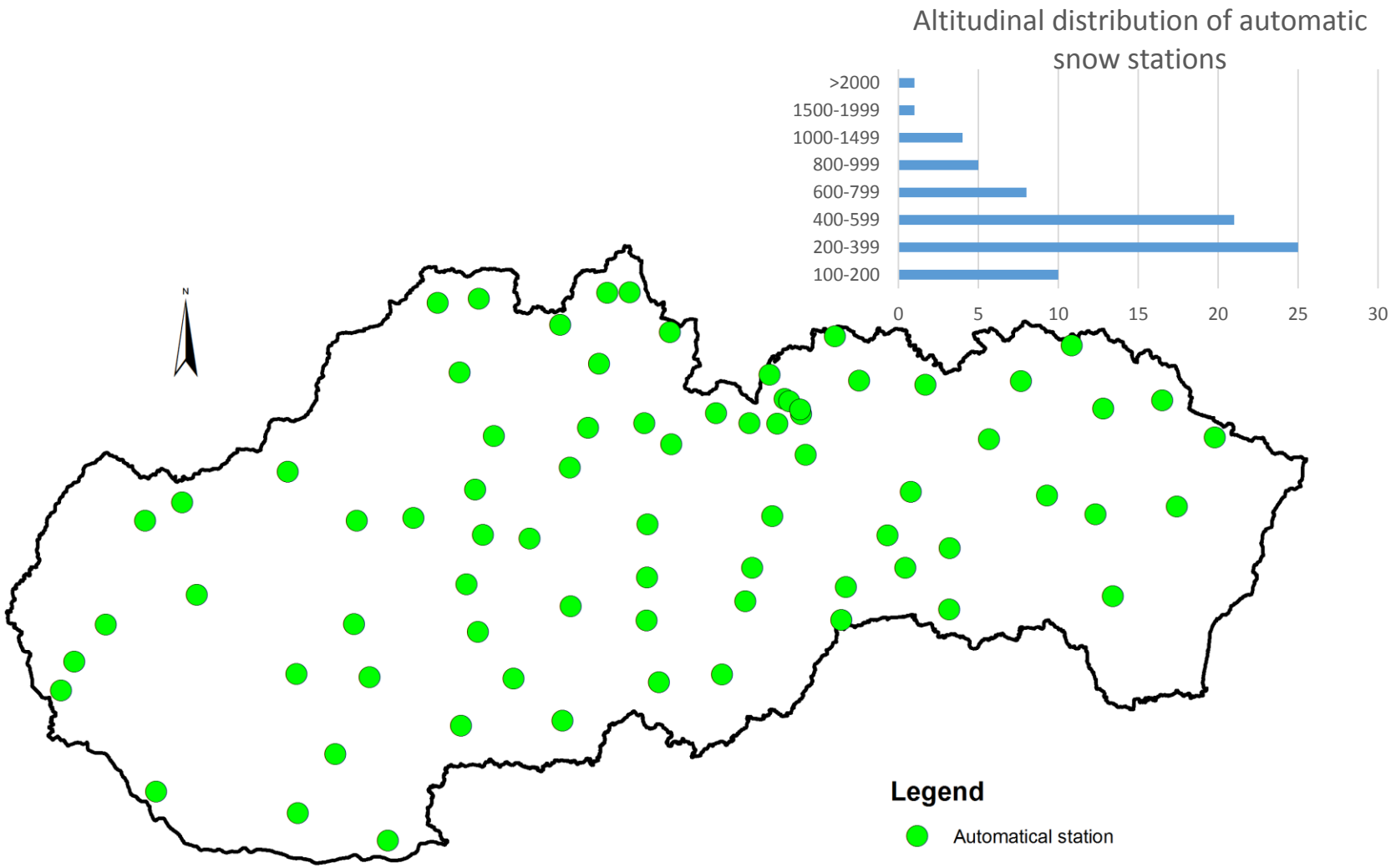

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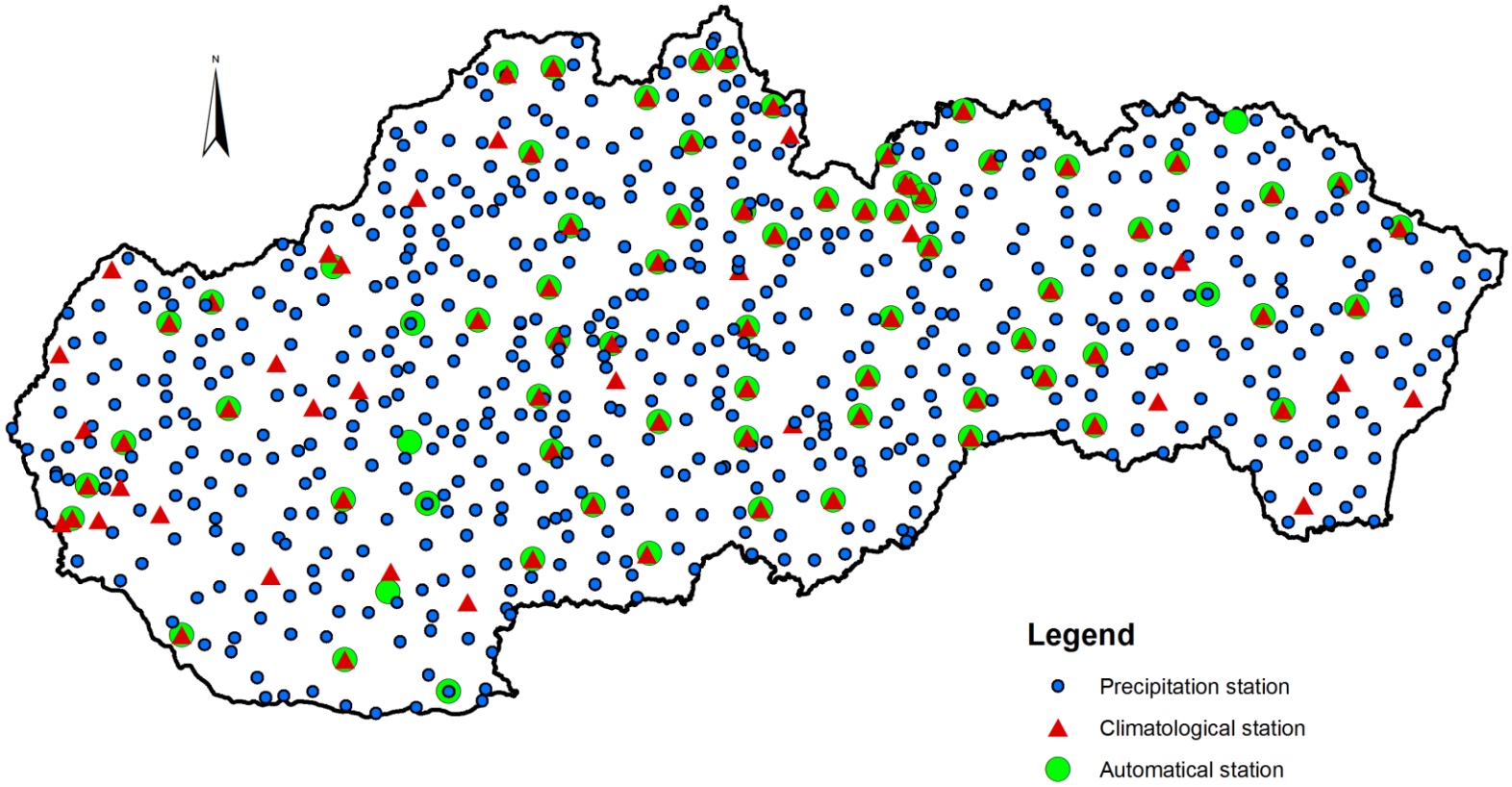


Snow and snow cover measurements in SHMI network

- basic input for processing of basin's snow water supply – **Snow Depth** (SD) and **Snow Water Equivalent** (SWE)
- on Mondays, from December to March/April, *real time* data from 238 gauges (volunteers – phone call)
  - manual measurements using standard rain gauge or weighing snow gage (SWE) and graduated snow stakes (SD)
- **95% gauges up to 1000 m – question relating to** representativeness of network (availability in mountain terrain)
- Data from snow cover network is supplemented by the data from ***snow courses expedition*** regularly performed in mountain terrain (altitudes above 1000 m)
- **Snow water supply info**: http://www.shmu.sk/sk/?page=1&id=mim_sneh

Snow and snow cover measurements in SHMI network – data use

Snow-melt runoff plays important role in runoff regime of Slovakian rivers.

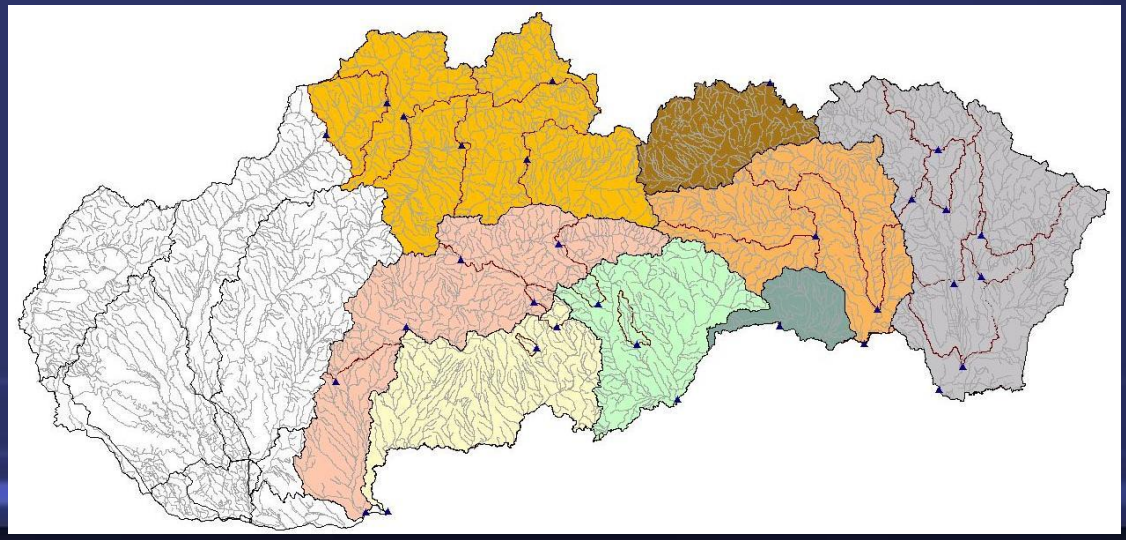
Although only 20-30 % (in average) of yearly precipitation totals accumulate in snow cover, more than 40 % of yearly runoff creates snow-melt runoff.

For successful snow-melt runoff forecasting the info. about snow water storage over the basin is necessary.

Snow and snow cover measurements in SHMI network – data use

The Act No 666/2004 Collection of Articles about flood protection:

- SHMU has obligation to provide the information about the water content in the snow cover to state authorities and administrators of river basins
- snow water content is regularly calculated for 35 profiles in river basins of Váh, Hron, Ipeľ, Slaná, Poprad, Hornád, Bodva and Bodrog



Climatology of snow and snow cover in Tatra mountains – data use

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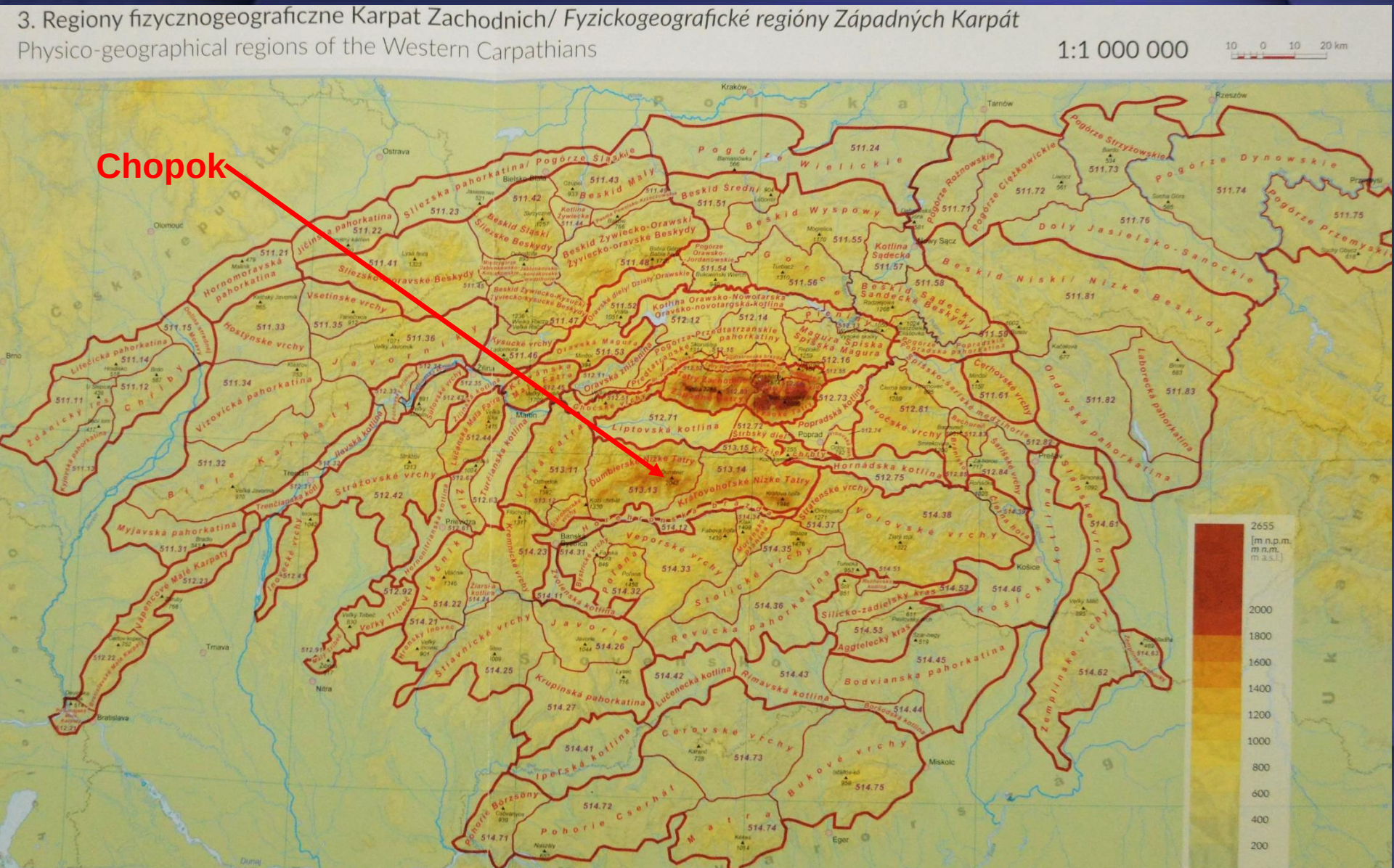

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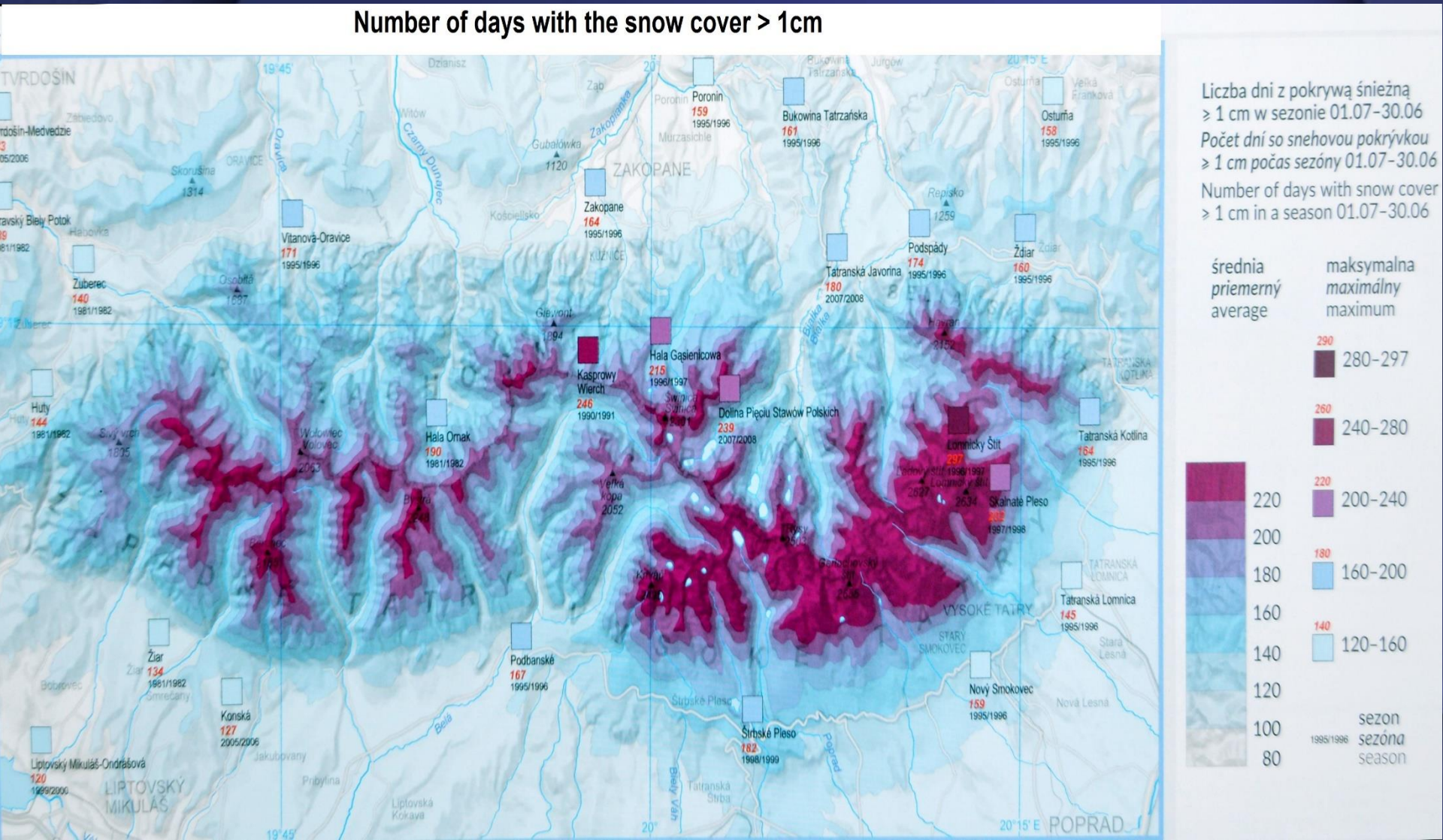
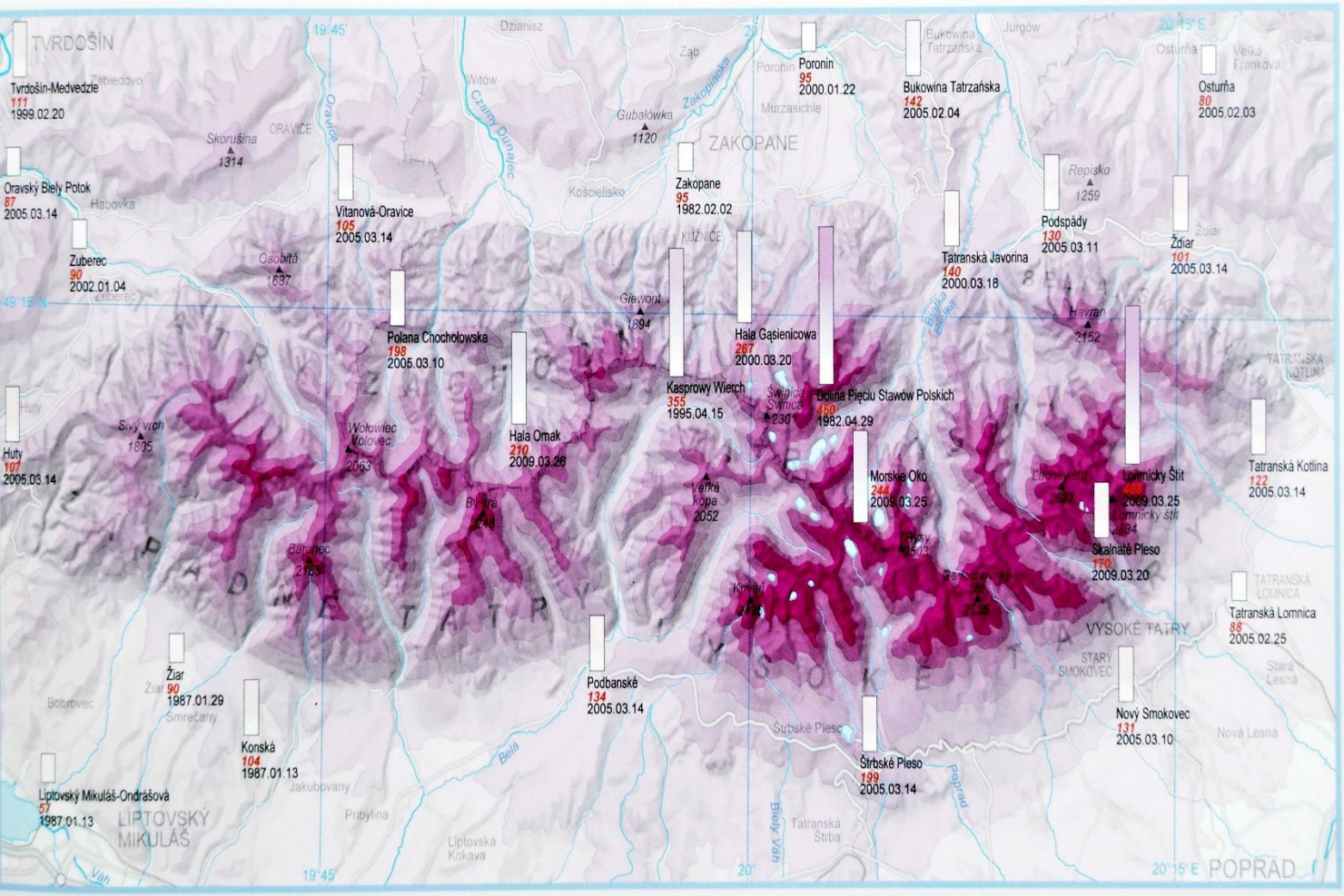


Climatology of snow and snow cover in Tatra mountains – data use

Maximum snow cover depth and mean seasonal fresh snow accumulation during the season



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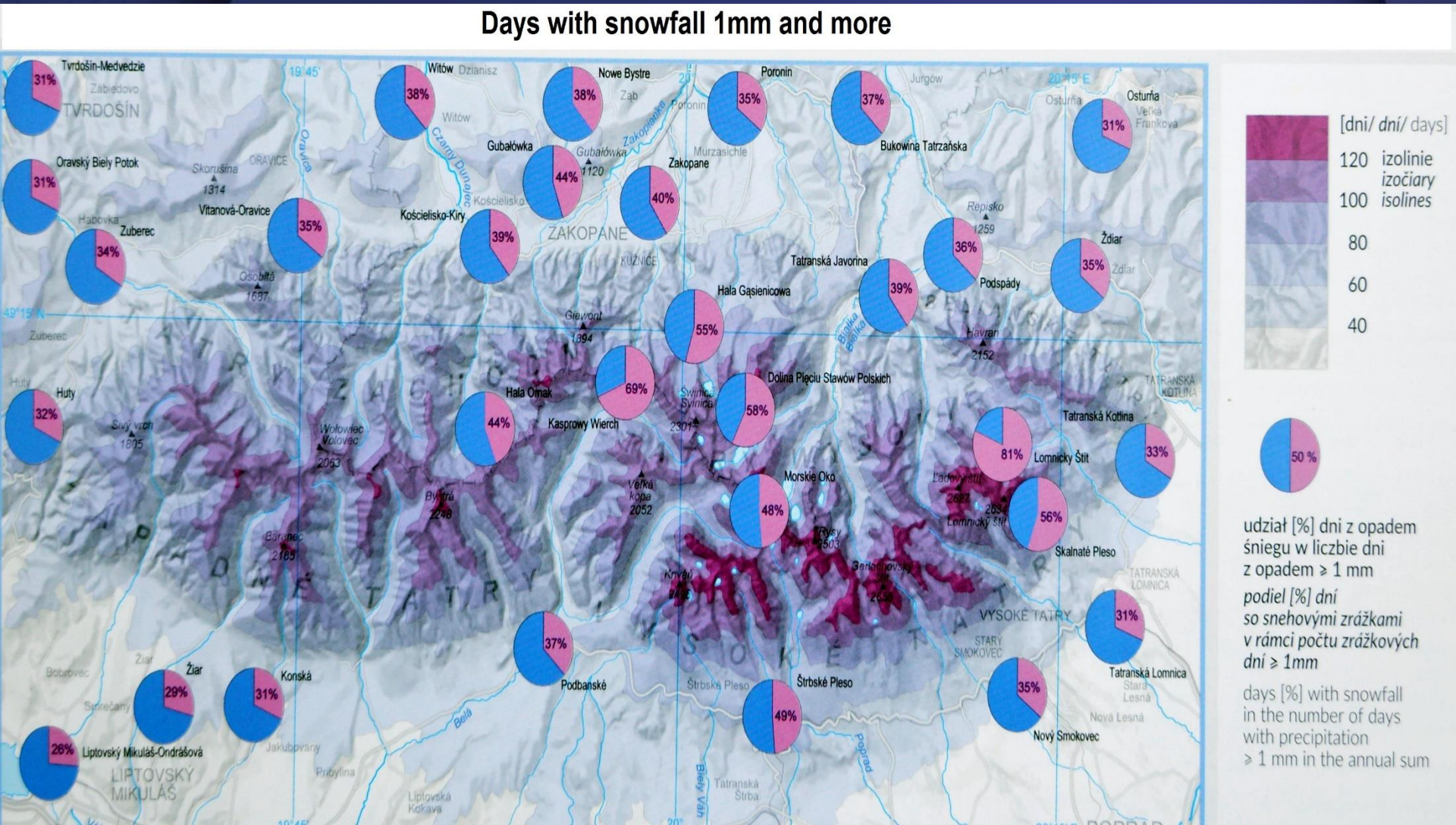
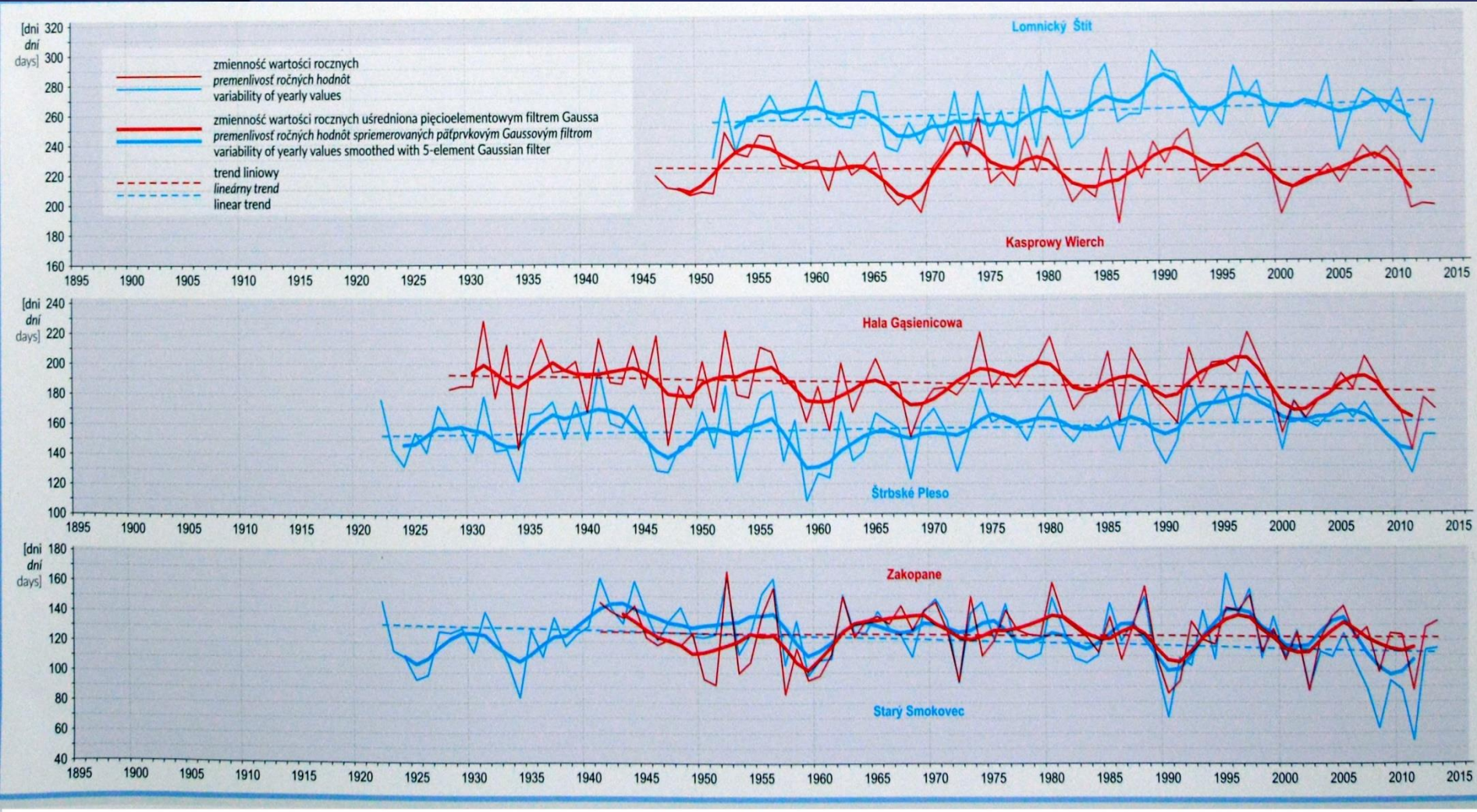


Climatology of snow and snow cover in Tatra mountains



Long-term variability of annual number of snow cover >1cm

Method of snow water content processing

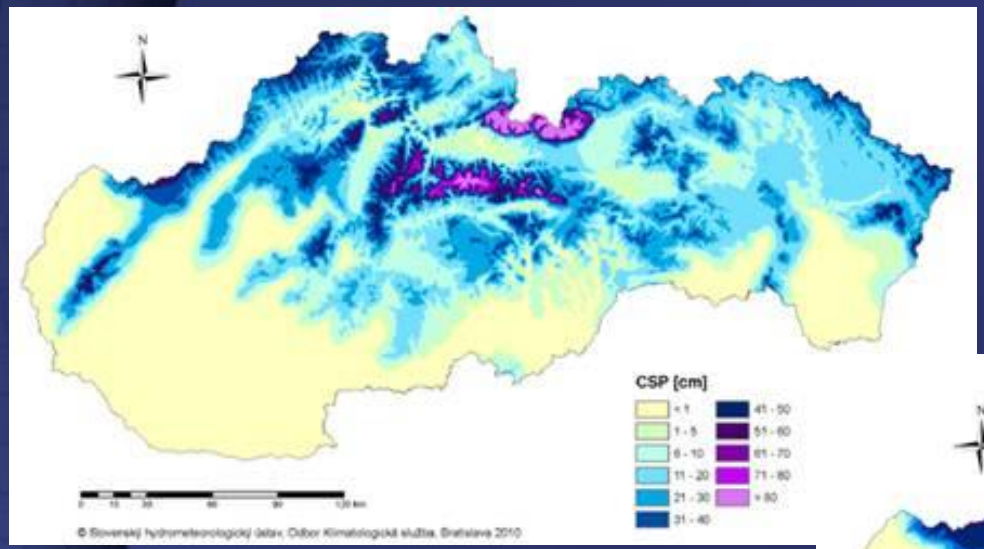
- Simple linear relationship between SWE and altitude of stations:
  - Basin is devided into elevation zones.
  - Mean SWE for each zone is calculated from regression equation.
  - Amount of water stored in snow calculated as the weighted average. The weight is given by ratio of the area of particular zone to catchment area
- Measurements in each elevation zone is not necessary

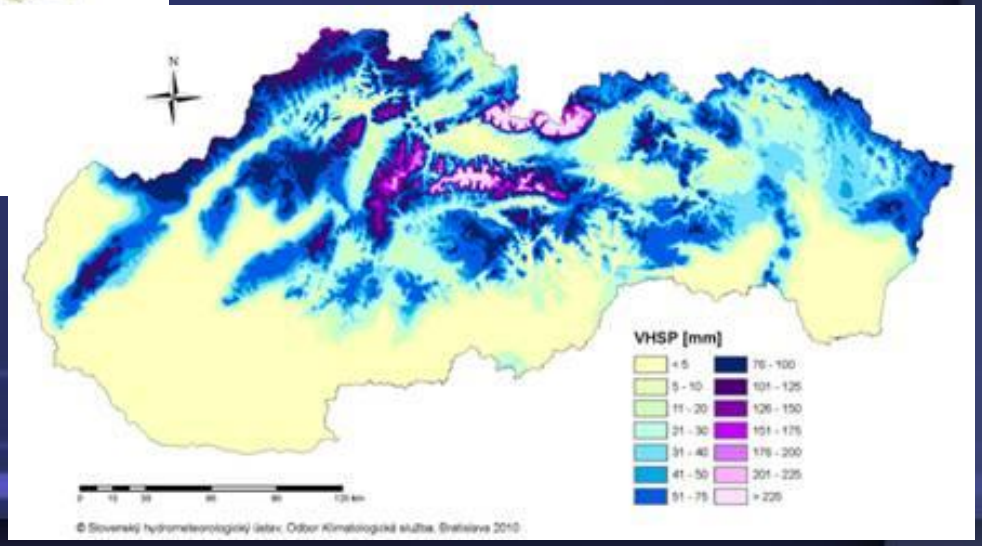
Weekly maps of SD and SWE

- created by Division of climatology
- processing of snow cover characteristics in GIS gives info about distribution in time and space
- data from network of snow gage stations (238) + virtual stations (>100, in mountain regions, values are determined by regression model or expertise estimation)
- method: 3D interpolation with influence of topography – regularized spline with tension (GIS environment - GRASS)
- ***operational hydrology calculates <u>snow water supply</u> from maps of SWE using map algebra in GIS***

Example of maps of SD and SWE 22.2.2010

http://www.shmu.sk/sk/?page=1&id=klimat_tyzdennemapy&produkt_id=0





Hydrological modelling

- For study purposes or creating snow-melt runoff scenarios we use conceptual rainfall-runoff model HBV – simulation processes of snow accumulation and snow-melt runoff

POVAPSYS and snow hydrology

- snow-melt runoff forecasting using rainfall-runoff models
- automatization of climatological stations – radar sensor to SD evaluation

Some photos from snow courses expedition

Thank you!