VARIABILITY OF NEW SNOW DENSITY IN THE HIGHEST PART OF THE CARPATHIANS OVER THE LAST DECADES

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* Knowledge of new snow density (NSD) is importan in modelling, avalanche forecasting, transport, building construction, etc.

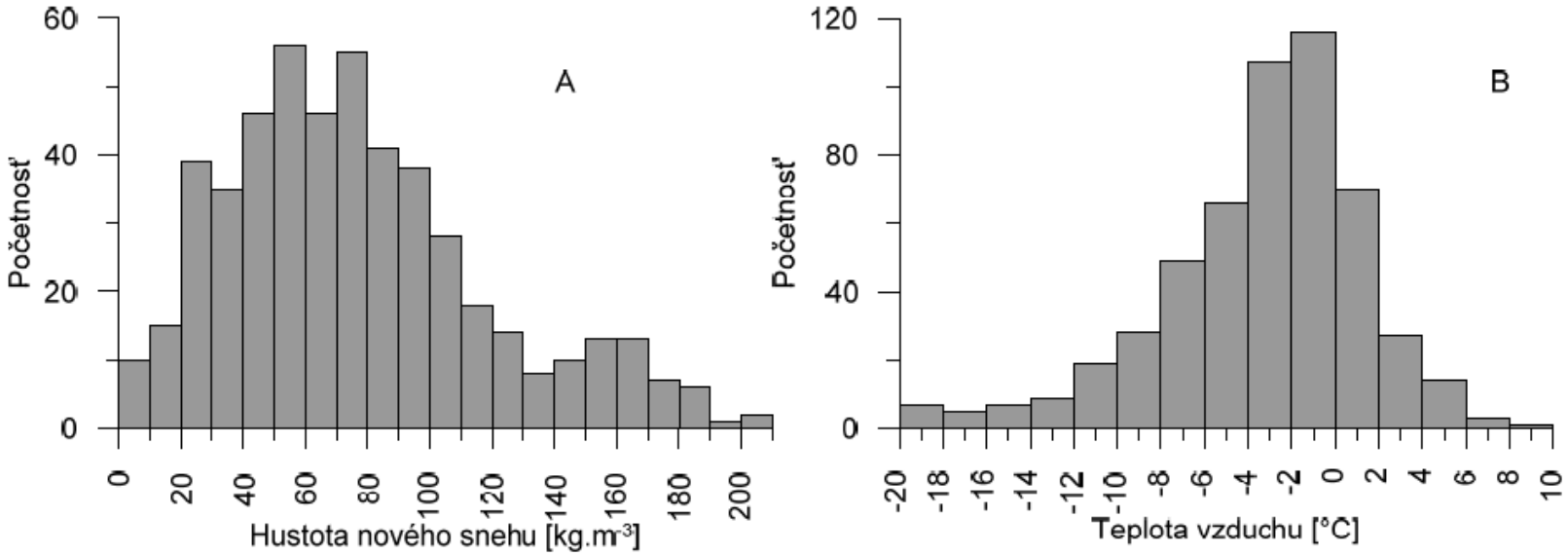
* Not much measured data at finer temporal resolution is presented
* Often, it is assumed that new snow density is around 100 kg.m^3
* What do measured data tell us?

Sources of data

* Density of new snow can be calculated from measured precipitation and depth of new snow
* These values are measured every morning by the observers at meteorological stations of SHMI (good spatial coverage, lower temporal resolution)

New snow density (left) and air temperature (right)

* 1989-2011, median 74 kg.m^{-3}, snowfall occurred mostly at air temperatures between 0°C and -4°C



Other sources of data

* Recently, data from automatic stations started to be applied – subdaily values (e.g. Helfricht et al., EGU 2017)
* The data have good temporal resolution but do not have long series of records

* However, there are also meteorological stations which measure precipitation and depth of new snow three times per day
* Slovakia has a dense network of precipitation and climatological stations
* But there are not so many of them at higher elevations which have an important influence on the hydrological cycle

Meteorological observatory at Skalnaté Pleso

* The highest „representative“ station in the Slovak Tatra Mountains (1778 m a.s.l.)
* Data available since the 1940’

Meteorological observatory at Skalnaté Pleso

* Professional observers
* Long data series
* Precipitation amount and snow depth are measured three times per day

Questions

* What are the sub-daily values of the new snow density?
* What is the influence of elevation?
* Can we see the influence of climate change?

Bad news:
The (old) data are not digitized

Mesiac: Apríl Rok: 2017 Deň: 16. mája

Meteorologická stanica v Skalnatom Plese

A. RIADNE POZOROVANIA TERMÍNOVÉ

Pozorovanie o hodine			6[39]	13[39]	20[39]	Pozn. o priebehu počasia o dobe trvania zrážok atď.
Tlak vzduchu	teplota na tlakomere		22,8	22,9	22,3	
	tlak zistený		609	611,3	611,2	
	tlak redukovaný na 0 °C		-2,4	+2,4	-2,3	
	tlak redukovaný na hl. m.		608,5	608,8	608,9	
	tend. baro-gr.	tvar krivky	811,3	811,7	813,1	
		počet desatín				
Teplota vzduchu	suchá		-3,6	+3,7	+6,1	
	vlhká		-5,0	+5,3	-6,2	
	najvyššia		0,1	0,1	0,2	
	najnižšia		-3,8	-6,8	-6,4	
Vlhkosť vzduchu	tlak pár		3,3	3,1	3,6	
	relat. podľa tabuľ.		70	67	72	
	relat. podľa hygrom.		70	68	90	
Oblačnosť – Mraky – vysoké	tvar					
	množstvo					
	ťah					
Mraky – stredné	tvar					
	množstvo					
	ťah					
Mraky – nízke	tvar		Sc	Sc	Ns	
	množstvo		9	10	10	
	ťah					
	výška v metroch		0	100	200	
	celková		9	10	10	
Poveternostné úkazy	pri pozorovaní					
	pred pozorovaním					
Dohľadnosť v km			0,4	3,8	6	
Vietor	smer		09	36	36	
	sila podľa Beauforta					
	rýchlosť v m za sekundu		8	4	2	
Spadnuté zrážky	množstvo		2,6	1,2	2,6	
	tvar		*	*	*	

Priemerný tlak denný redukovaný	na 0 °C	609,1	Absolútne denné extrémy teploty	max.	0,8	Priemerná denná teplota	4,9	Priemerný tlak pár	2,5
	na hlad. mora			min.	-6,4	Amplitúda teploty	7,2	Priemer. vlhkosť	76/76
Priemerná oblačnosť		9,7	Celkové zrážky za posledných 24 hod.	obyč.	3,8	Snehová pokrývka	nová 3	Teplomer prízemný	-4,1
Priemerná rých. vetra		4,7		nifer	***		celková 20	Doba slnečného svitu	1,5

Znenie podaných meteorologických depeší pravidelných: 99081 93227 05488 70003 70354 / 70000 97027 00254

02020

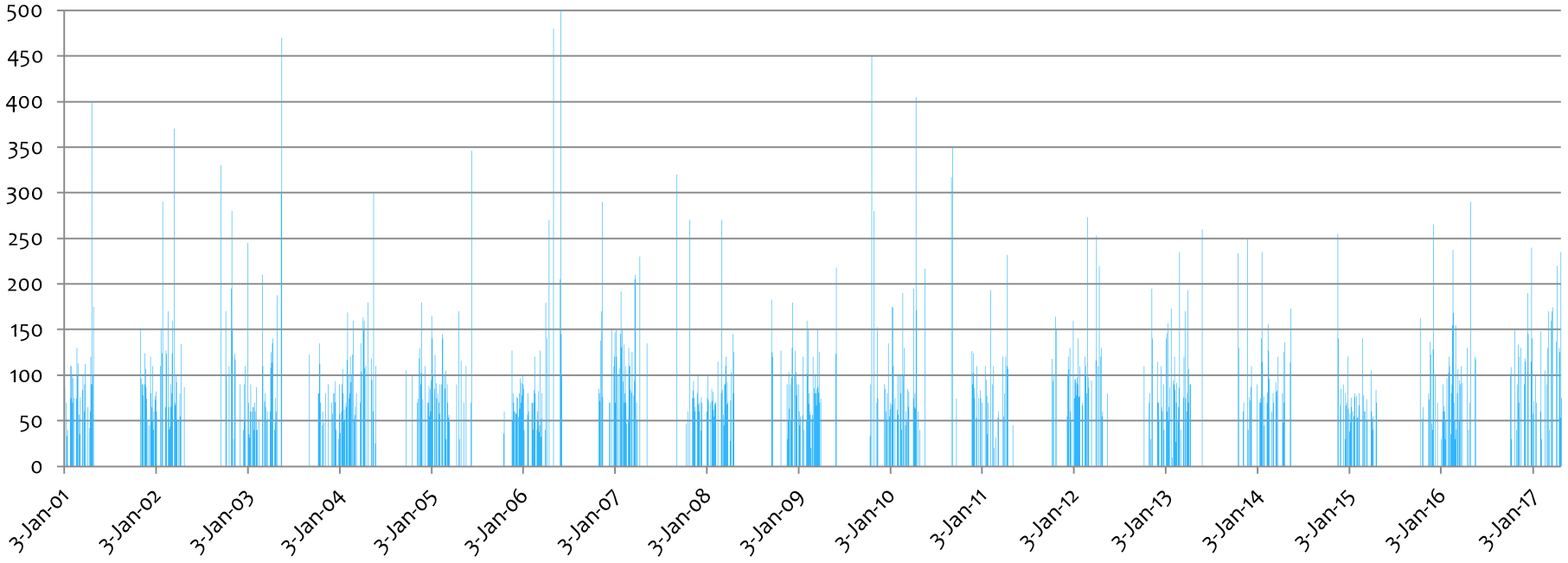
Poveternostný denník

Pozoroval

ZT 50 6362539/86/P-2377 K 161

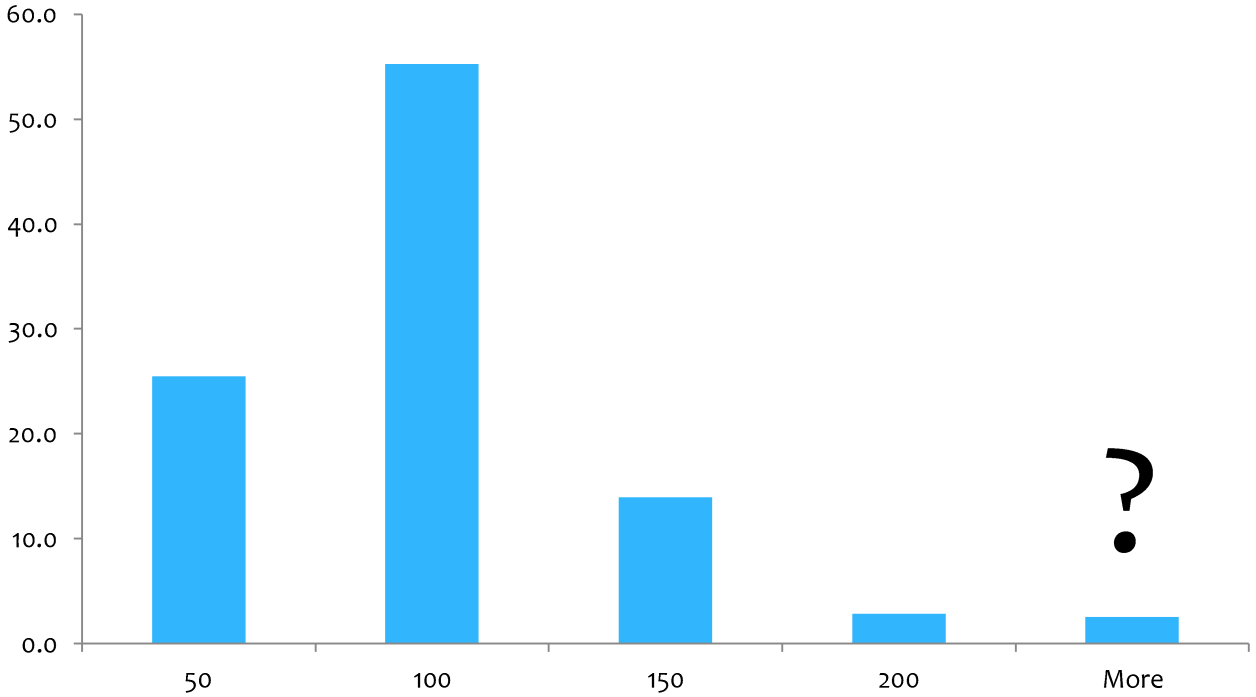
Preliminary results 2001-2017

* Raw data – several very high values



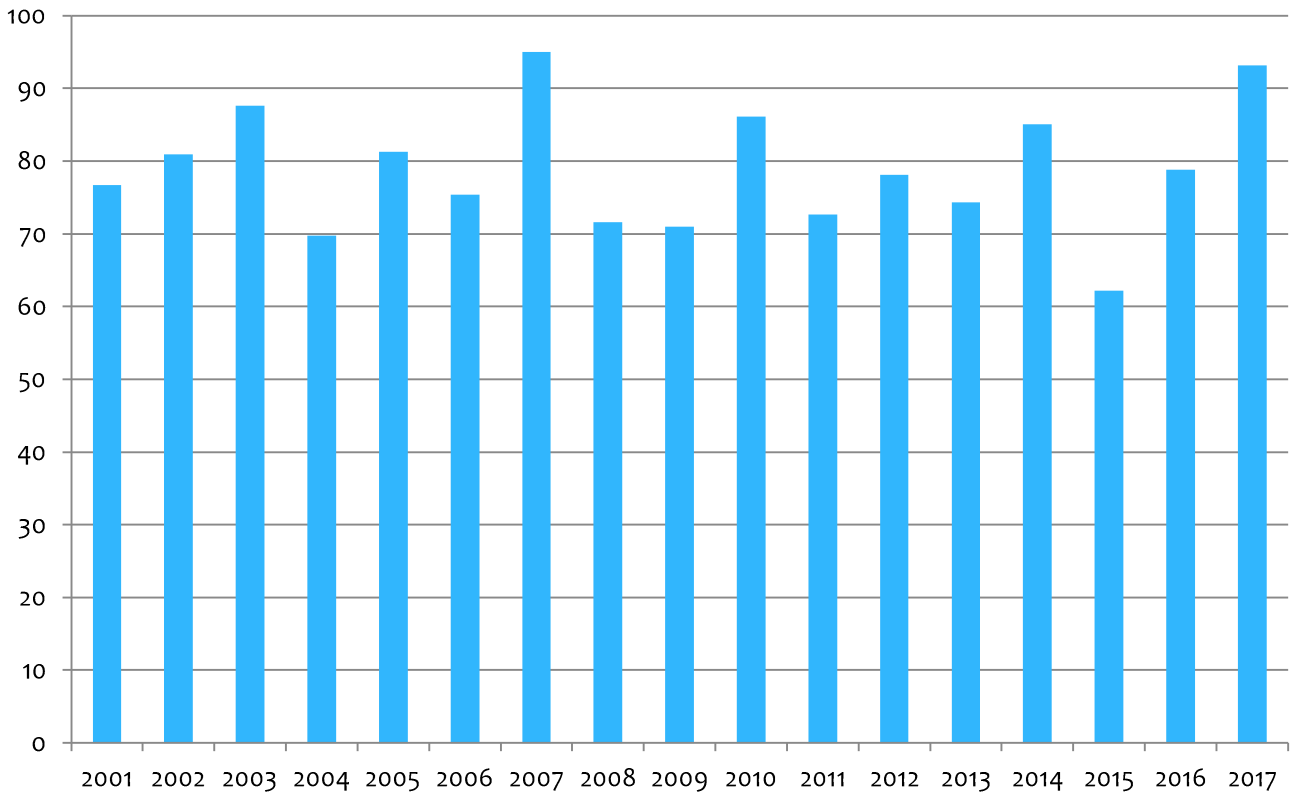
Preliminary results 2001-2017

* Median NSD 70 $kg.m^{-3}$
* NSD 50-100 $kg.m^{-3}$ are most frequent, but make up only about 55% of all measurements



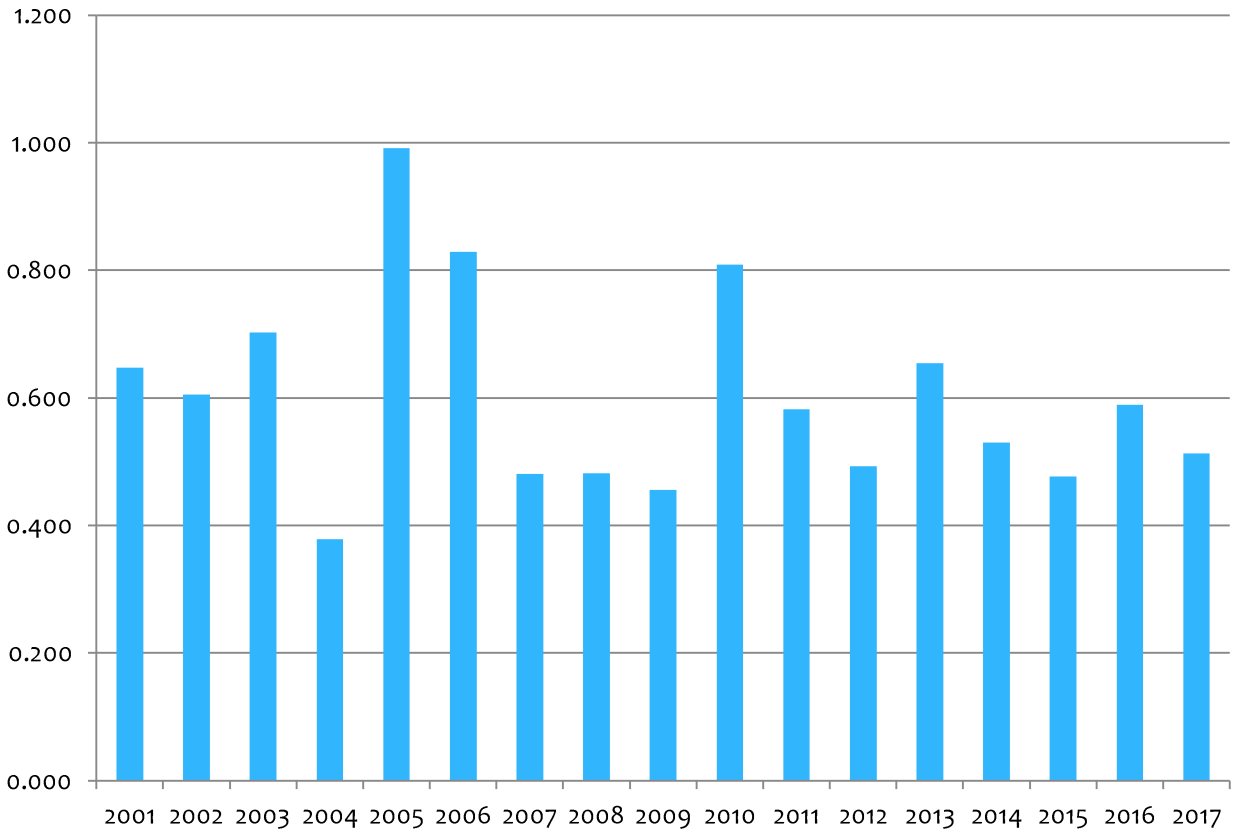
Preliminary results 2001-2017

* Mean annual NSD
* Interannual variability, but no trend (yet)



Preliminary results 2001-2017

* High intraannual variability (Cv)
* Smaller since 2007?



Preliminary results 2001-2017

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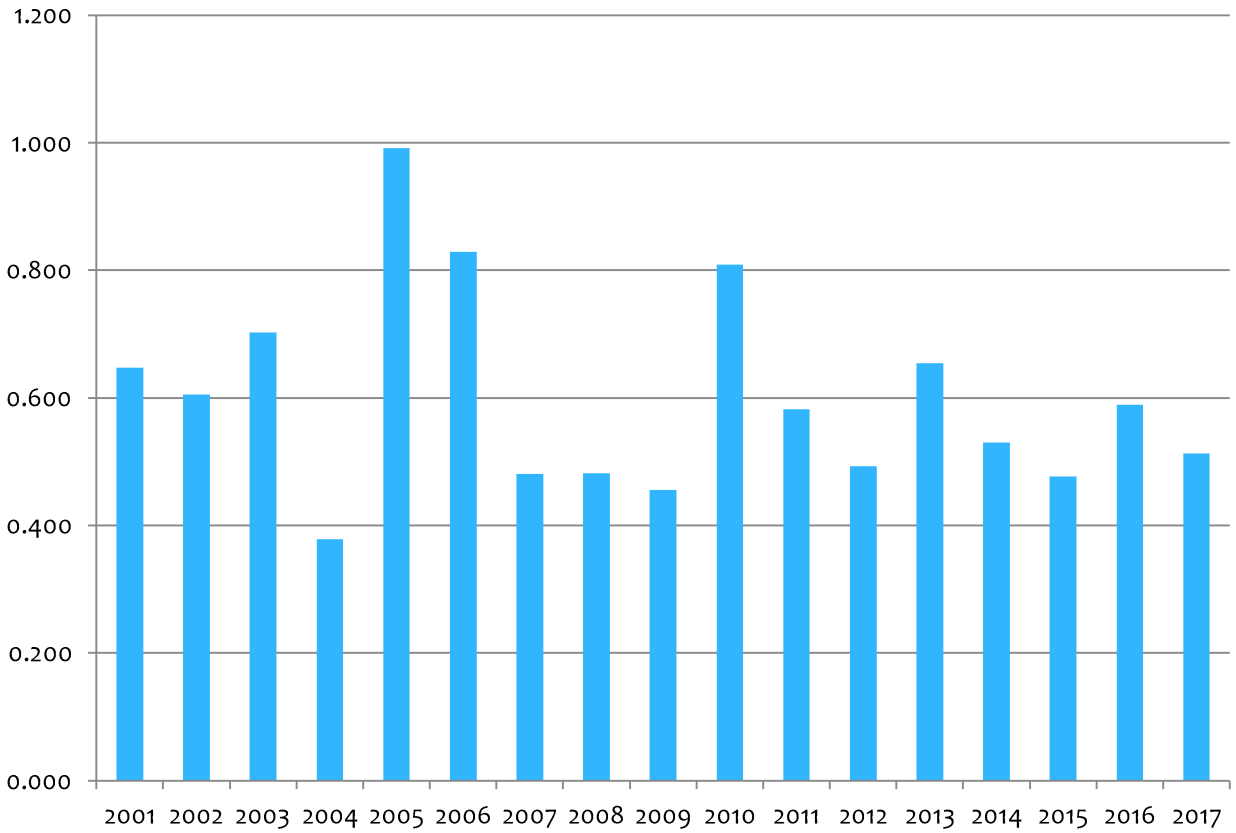
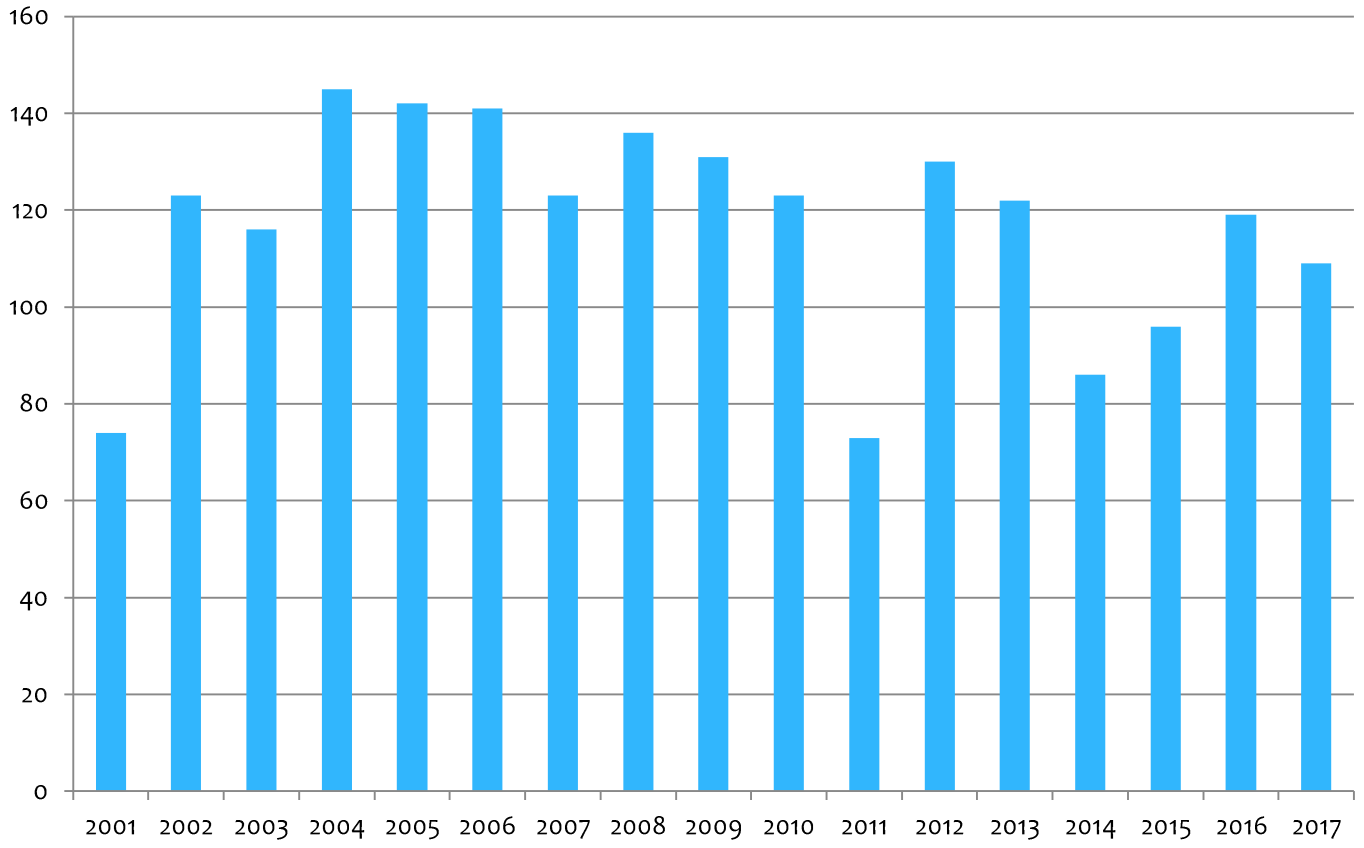


Preliminary results 2001-2017

* “Number of snowfalls”



Preliminary results 2001-2017

* NSD at low elevation was significantly smaller (but very few data digitized yet)

Disdrometer – supplementary information for snow-related studies

* Instruments measuring size and speed of falling particles - type of precipitation (drizzle, rain, snow, hail, etc.)

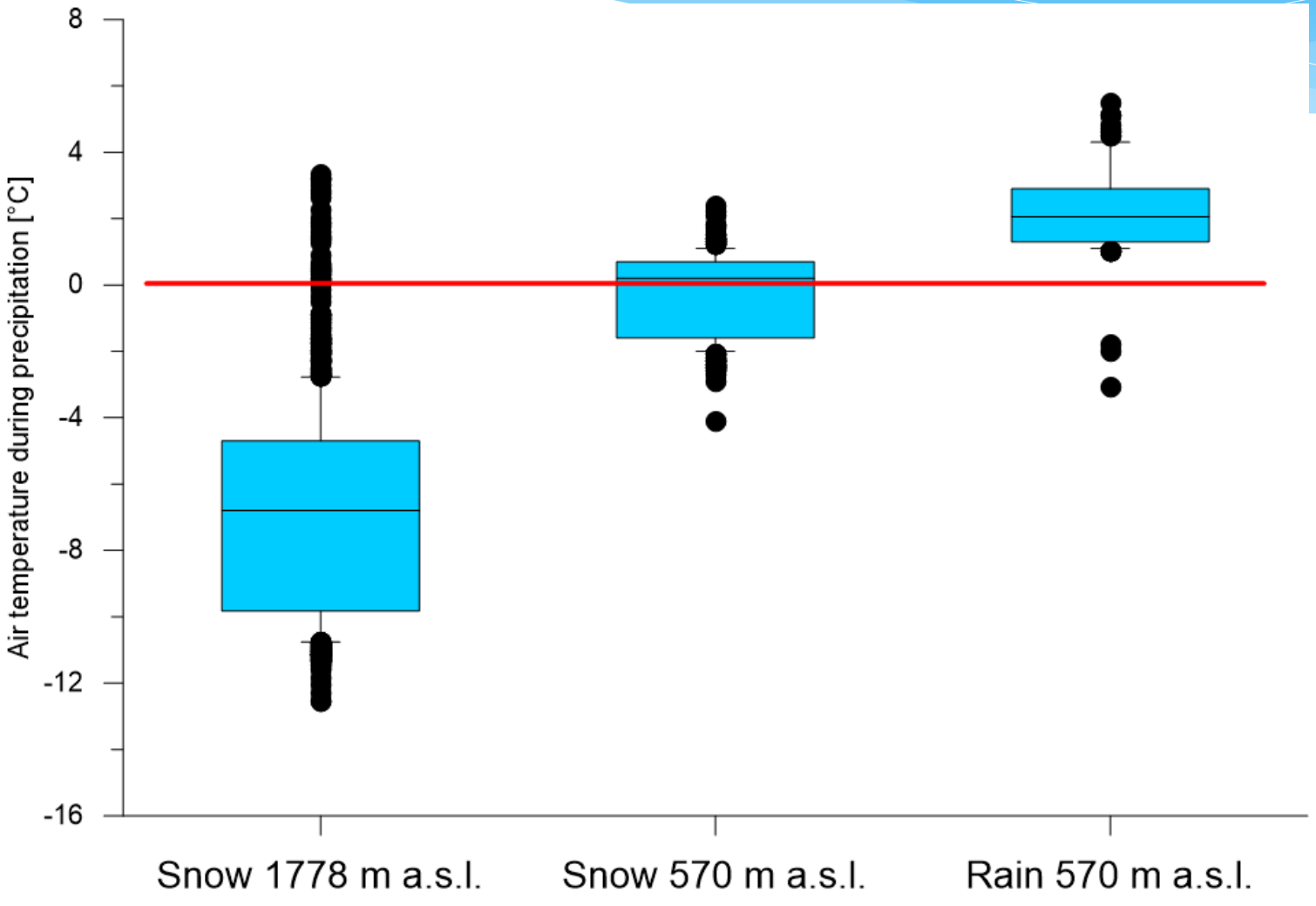
Disdrometer – supplementary information for snow-related studies

* Most snow models use air temperature to determine solid and liquid precipitation
* Usually, this threshold temperature is calibrated
* Whenever possible the models should use measured parameters
* What do measurements (disdrometer data) say about the snow-rain threshold temperatures ?

Disdrometer – supplementary information for snow-related studies

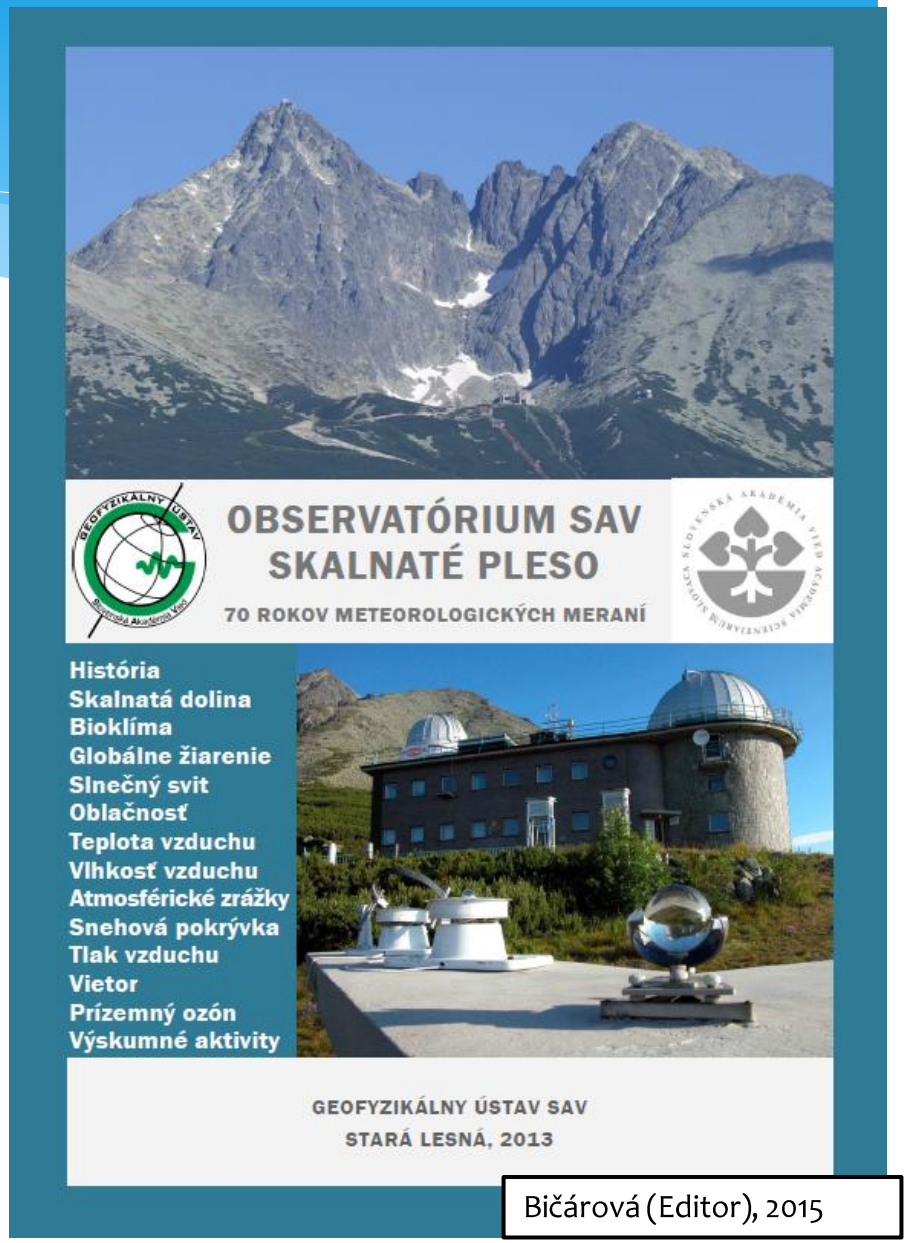
* Installed in June 2014 at 570 m a.s.l.
* In September 2016 at 1778 m a.s.l. (Skalnaté Pleso)

Half of snow at low altitude was falling at air temperatures higher than 0°C

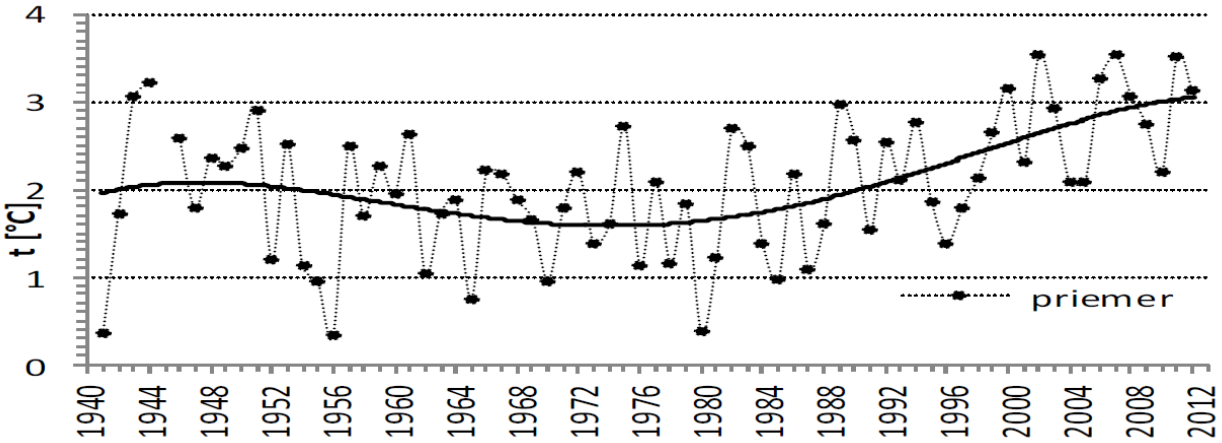


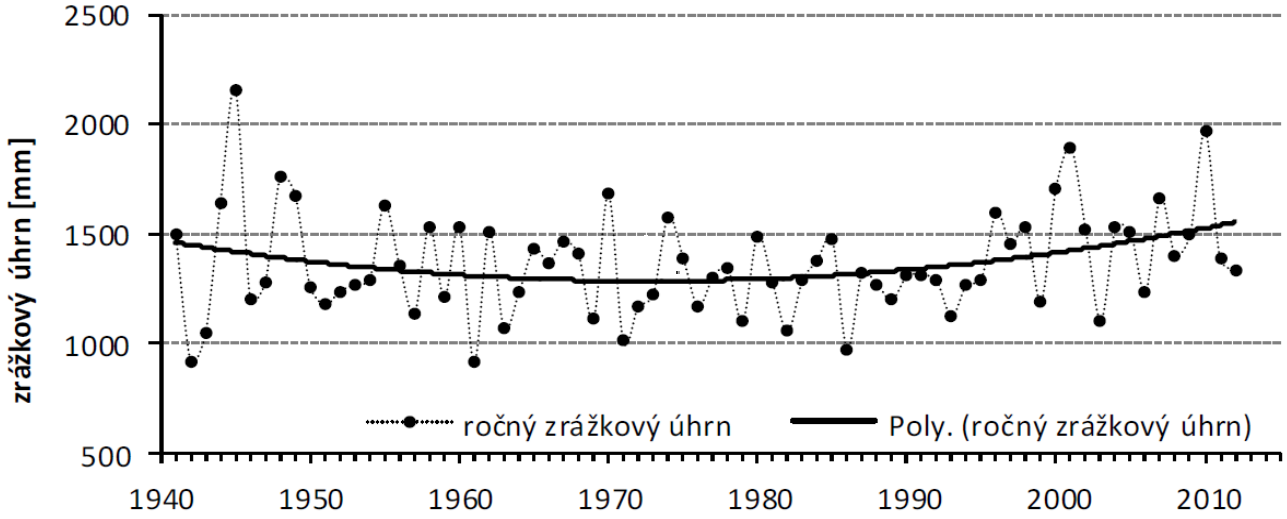
Thank you for your attention

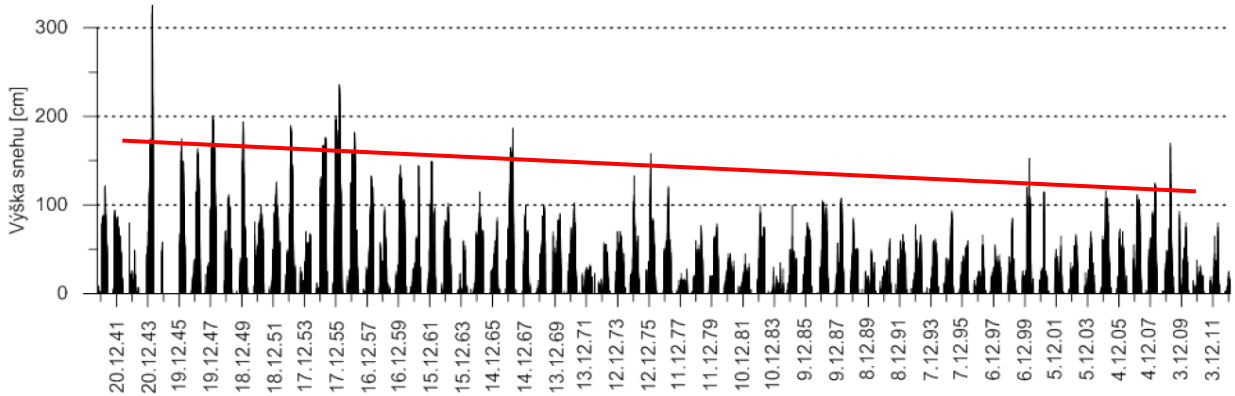
Meteorological observatory at Skalnaté Pleso

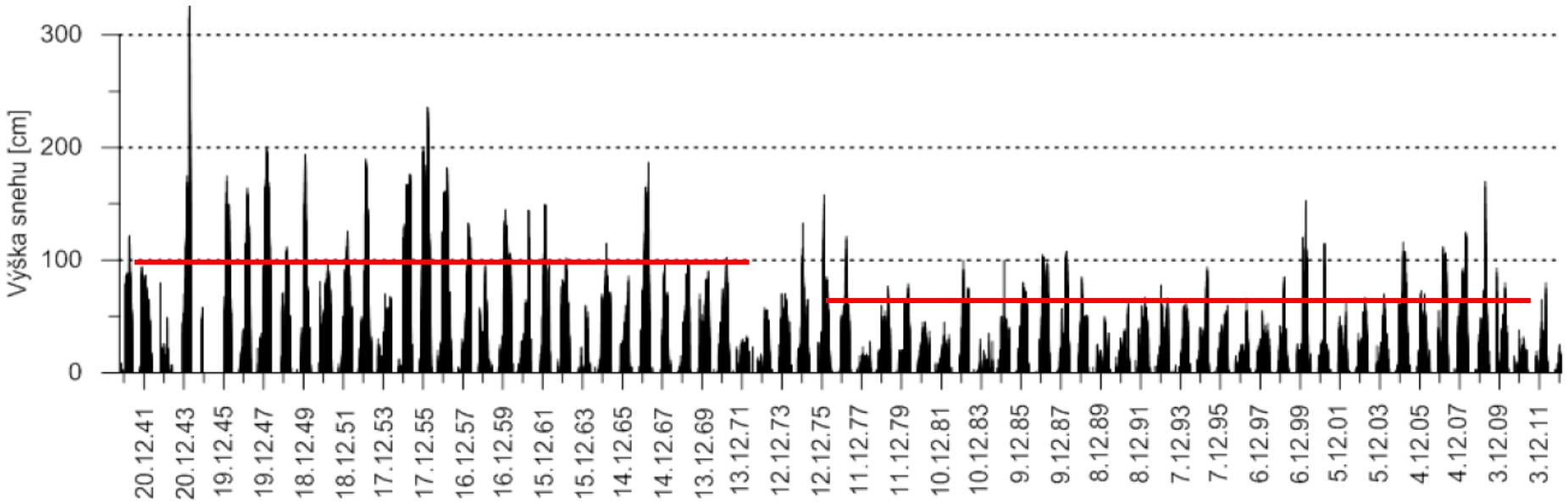


Bičárová (Editor), 2015


t [°C]
priemer


zrážkový úhrn [mm]
ročný zrážkový úhrn
Poly. (ročný zrážkový úhrn)


Výška snehu [cm]


Výška snehu [cm]
300
200
100
0
20.12.41
20.12.43
19.12.45
19.12.47
18.12.49
18.12.51
17.12.53
17.12.55
16.12.57
16.12.59
15.12.61
15.12.63
14.12.65
14.12.67
13.12.69
13.12.71
12.12.73
12.12.75
11.12.77
11.12.79
10.12.81
10.12.83
9.12.85
9.12.87
8.12.89
8.12.91
7.12.93
7.12.95
6.12.97
6.12.99
5.12.01
5.12.03
4.12.05
4.12.07
3.12.09
3.12.11