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Snow measurements for operational avalanche forecasting in Slovakia

M. Biskupič, F. Kyzek,

Avalanche Prevention Center

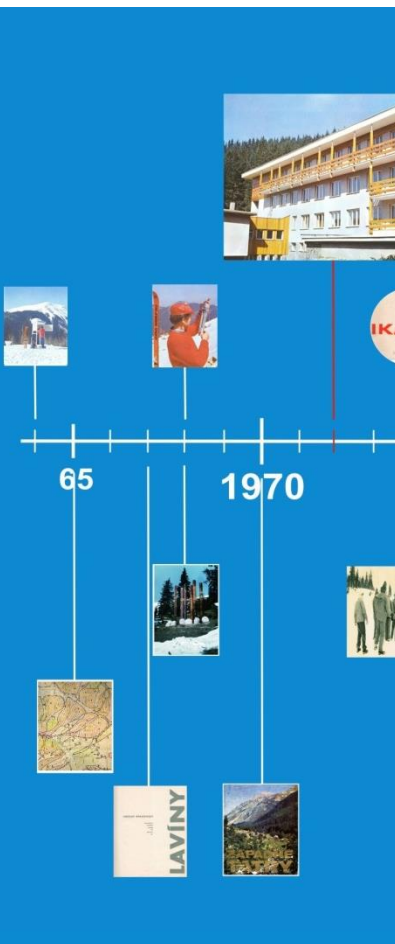
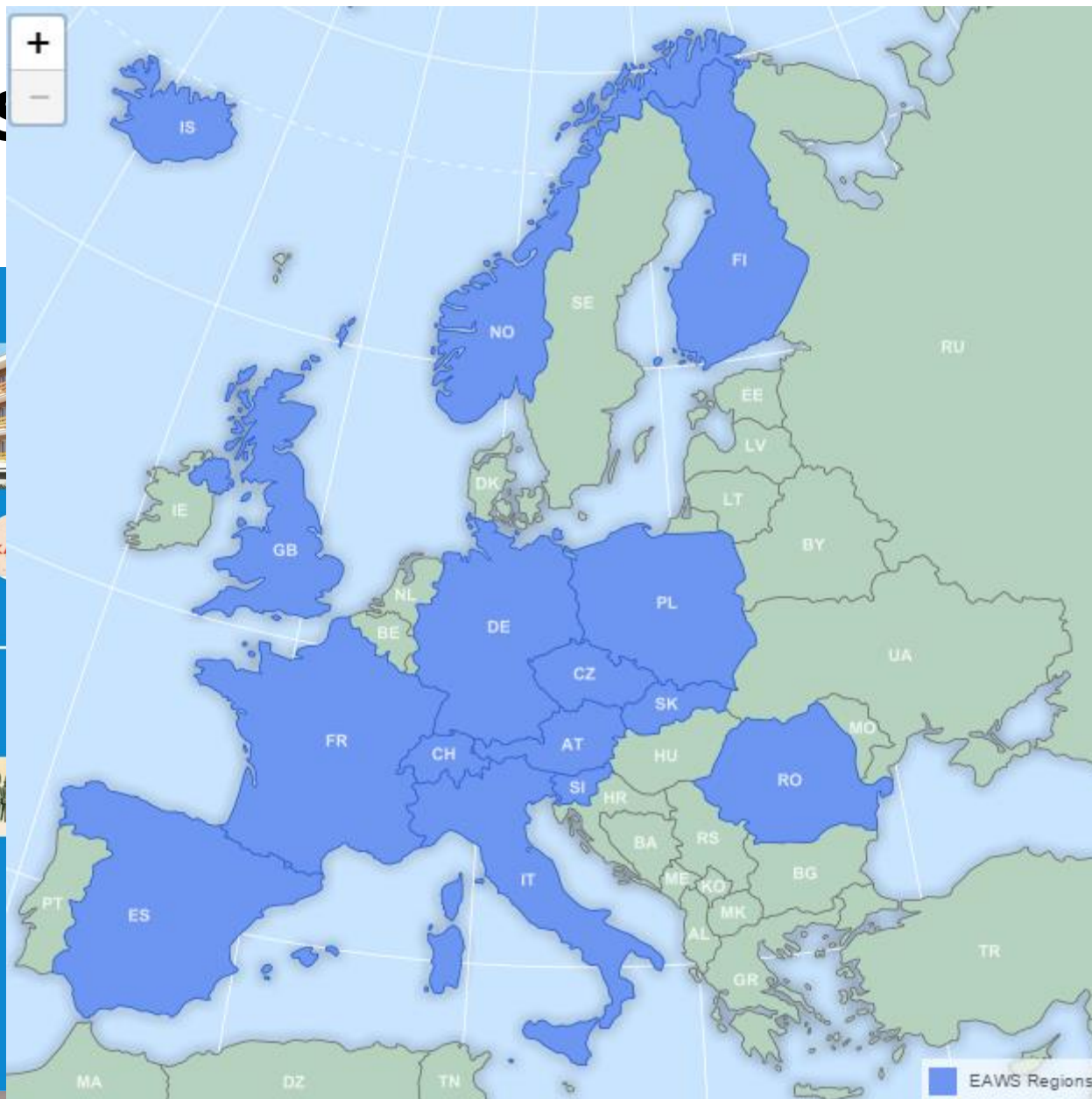
- Avalanche forecast /bulletin ✓
- Snow cover measurements ✓
- Avalanche mapping and observations ✗
- Mountain weather observations ✗
- Avalanche and mountain rescue ✗
- Snow stability observations and test ✓
- Artificial avalanche blasting ✓



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APC es



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History



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Avalanche prevention center



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Observational network

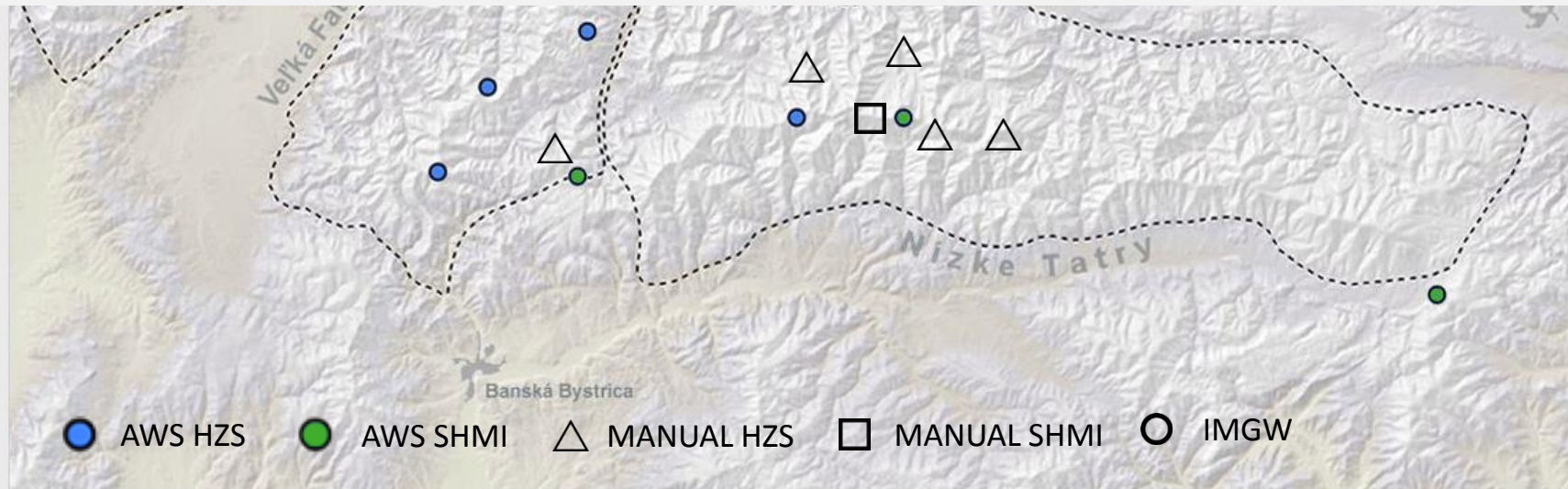
AWS HZS + SHMI: 10 min

Manual HZS: 24 hrs

Manual SHMI: INTER 24 hrs, SYNOP 1 hr,
INTER TATRY 24 hrs

IMGW: INTER PL: 12 hrs, SYNOP 1hr

Dúbrava - údolia
Chopok (SHMÚ)
Telgárt (SHMÚ)
Malá Fatra
Martinské hole
Snílovské sedlo
Žobrák
Veľká Fatra
Choč - poľana
Donovaly (SHMÚ)
Križna
Koniarky
Smrekovica
Prehľad AMS



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AWS

AWS	ELEVATION (m a. s. l.)
Žobrák	1215
Choč - poľana	1247
Žiarska chata	1285
Smrekovica	1339
Stará poľana	1380
Koniarky	1380
Martinské hole	1445
Snilovské sedlo	1492
Pod Klinom	1545
Krížna	1574
Biele pleso	1580
Salatín - dolina	1625
Ďurková - útulňa	1635
Sliezsky dom	1672
Pod Hrubou kopou	1800
Solisko - chata	1820
Vyššie Žabie pleso	2047
Ľadové pleso	2063
Zamrznuté pleso	2070



AWS



28/Dec/2015 08:58:30



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Sliezsky dom 1672 m n. m.

Vysoké Tatry

Biele pleso
Ladové pleso
Lomnický štít (SHMÚ)
Sliezsky dom
Solisko - chata
Štrbské pleso (SHMÚ)
Výšné Žabie pleso
Zamrznuté pleso
Stará poľana

Západné Tatry

Hrubá kopa - žľab
Pod Klinom
Salatín - dolina
Žiarska chata

Nízke Tatry

Ďurková - útulňa
Chopok (SHMÚ)
Telgárt (SHMÚ)

Malá Fatra

Martinské hole
Snilovské sedlo
Žobrák

Veľká Fatra

Choč - poľana
Donovaly (SHMÚ)
Krížna
Koniarky
Smrekovica

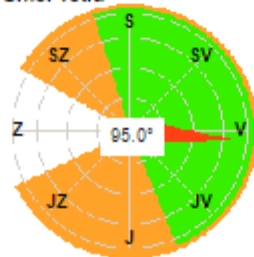
Prehľad AMS

Webkamera:



Teplota vzduchu -3.20 °C
Rýchlosť vetra 0.60 m/s
Nárazy vetra 1.40 m/s
Smer vetra V °
Výška snehu* 61.30 cm
Vlhkosť vzduchu 98.00 %
08:40 UTC* 16. 02. 2016

Smer vetra



Range	Min	Max
60 Minutes	342	158
180 Minutes	300	245

* Čas UTC koordinovaný svetový čas,
Stredoerópsky letný čas = UTC + 2h,
Stredoerópsky zimný čas = UTC + 1h.
** Výška snehu v zime, v lete výška trávy.

© 2015 HZS Všetky informácie, texty a elektronické obrázky, ktoré obsahujú

Teplota vzduchu [°C]



16/Feb/2016 07:58:29

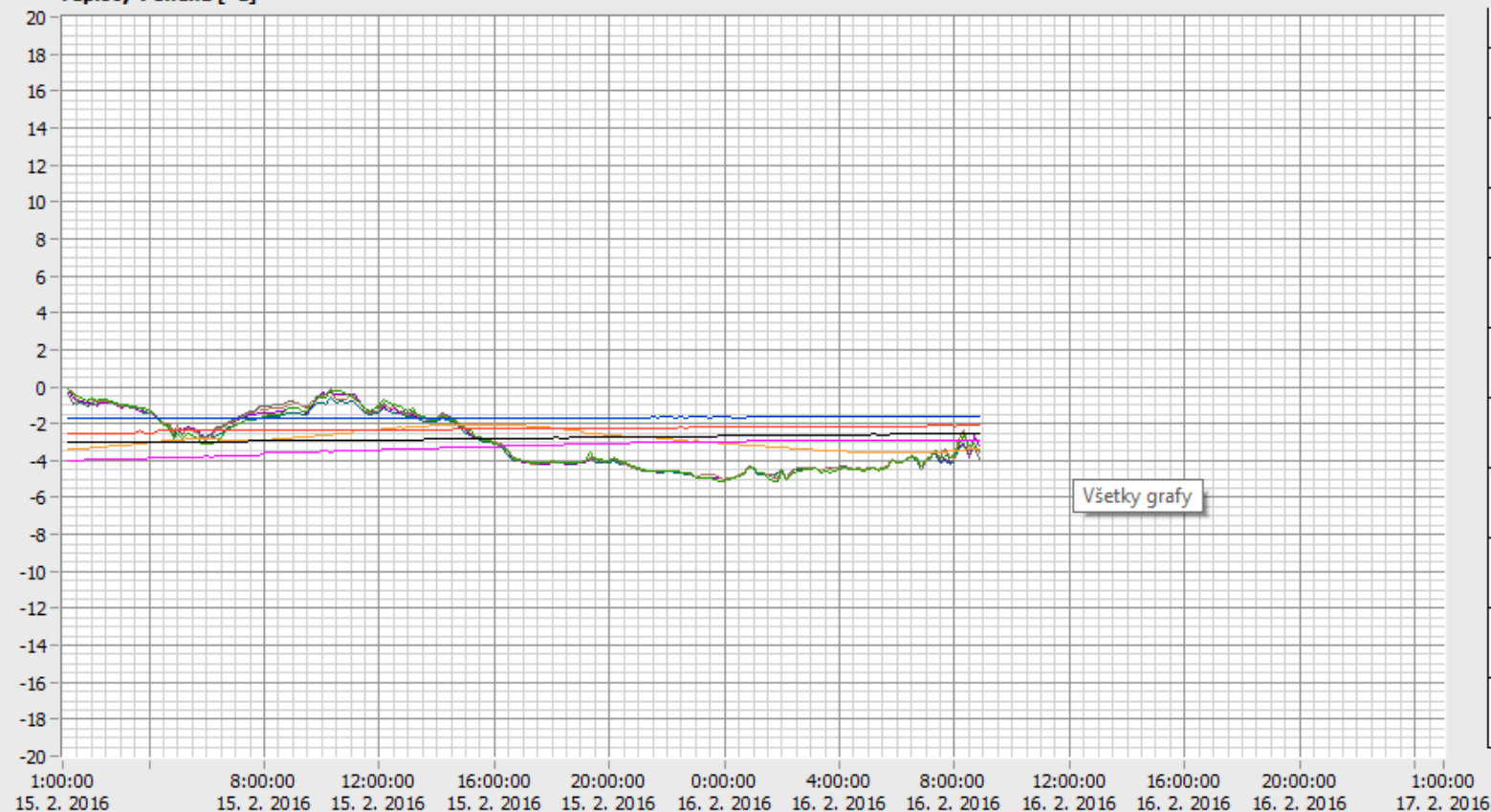


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Vysoké Tatry: Vysné Žabie pleso

Teploty v snehu [°C]



Čas: 8:50:0

Meranie	meranie
☒ Ts_0cm: Vyšné Žabie pleso	-1,600
☒ Ts_20cm: Vyšné Žabie pleso	-2,100
☒ Ts_40cm: Vyšné Žabie pleso	-2,500
☒ Ts_60cm: Vyšné Žabie pleso	-2,900
☒ Ts_80cm: Vyšné Žabie pleso	-3,400
☒ Ts_100cm: Vyšné Žabie pleso	-3,500
☒ Ts_120cm: Vyšné Žabie pleso	-3,600
☒ Ts_140cm: Vyšné Žabie pleso	-3,900
☒ Ts_160cm: Vyšné Žabie pleso	-3,200
☒ Ts_180cm: Vyšné Žabie pleso	-3,800

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Manual observations



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Manual observations – snow profiles



Manual observations – snow profiles

Záznam z vyhodnotenia ručného profilu snehovej pokrývky

Dátum, čas: 15.2.2015 12:17 Pozoroval:

Dolina: Luhá voda Oblasť HZS:

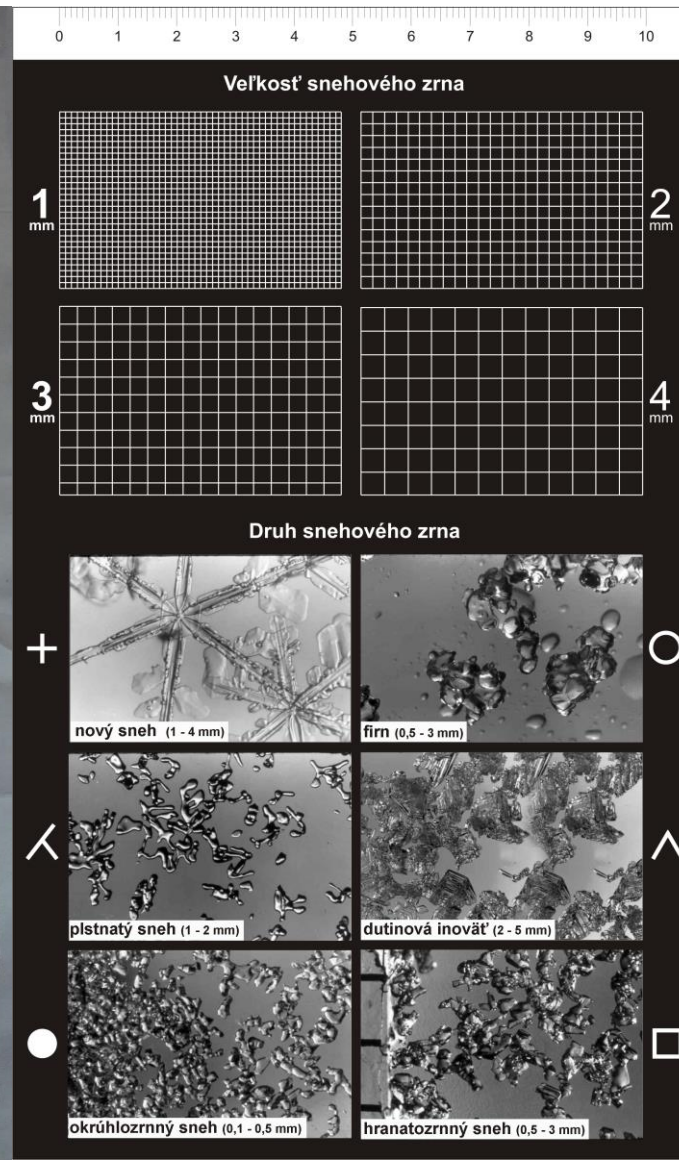
Lokalita: Čepčany pri Luhá vode Sklon svahu: 32

Expozícia svahu: -SV Výška: m'n.m.

Počasie: Teplota vzduchu: -0,3 °C

V	W	F	D	K	Test stability	Kritická vrstva
Výška vrstvy	Vlhkosť	Druh	Veľkosť	Tvrdosť		
1 - suchý		+ nový	0,1 - 0,5	1 = pásť	ZB - zosuvný blok	0 - 9
2 - slabó vlhký		^ plstnatý	0,5 - 1,0	2 = 4 prsty	KT - kompres. test	
3 - vlhký		• okrúhlozrný	1,0 - 2,0	3 = 1 prst	NM - nórska met.	
4 - mokrý		□ hranatozrný	2,0 - 4,0	4 = ceruzka		
5 - veľmi mokrý		^ dutin. inovät	4,0 a viac	5 = nôž	(vysvetlivky na druhej strane)	
		○ firn, iné		6 = fad		

V	W	F	D	K	Test stability	Kritická vrstva	Teplota snehu
							výška °C
212							
210	3	A	1-2	1			
208	3	0	1	5			
205	3	AX	1-2	1			
182	3	28	0,5-1	3			
167	2	AX	0,5-1	3/4			
154	1	XL	0,5-1	3			
150	1	•	0,5-0,5	4			
112	1	•	0,5-1	3/4			
104	1	•	0,5	2/3			
25							
60	1	X	0,5-1	3			



Manual observations – snow profiles

www.lawis.at/profile/index.php?profile_lang=en&header=1



EAWS - SnoProfiler

[en] ▼



Stations

Profiles



Incidents

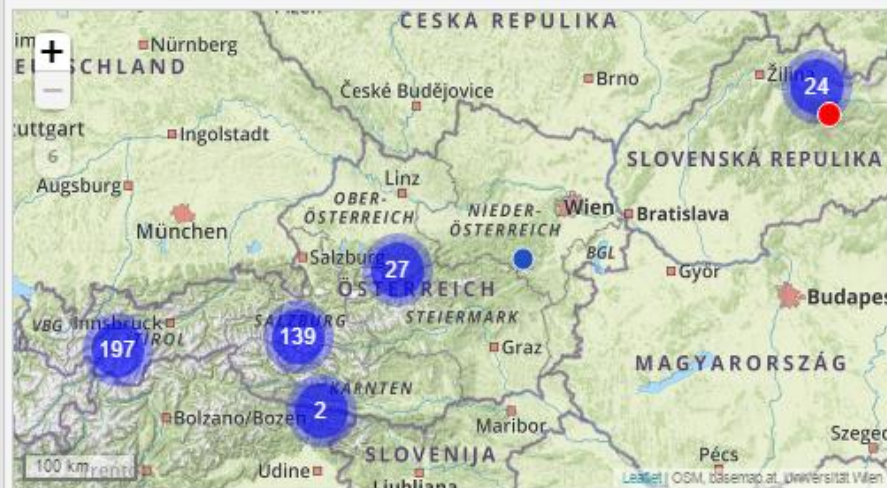
Login

1 month

all regions

all aspects

all altitude ranges

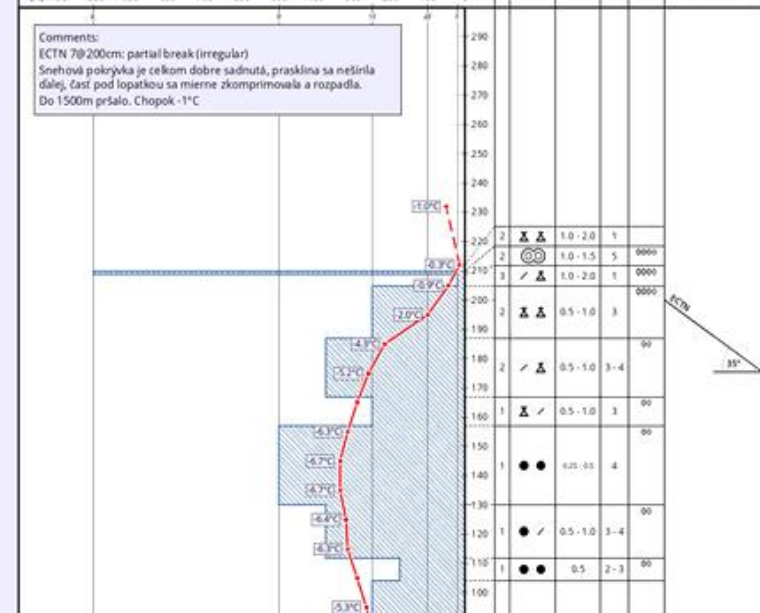


Date	Country	Region	Altitude (m)	Aspect	Slope (°)	Profile
2016-04-09 10:29	Austria	Kärnten	3130	E	35	
2016-02-16 12:30	Spain	Val d'Aran	2130	N	20	
2016-02-15 15:10	Spain	Aragón	2100	N	18	
2016-02-15 14:45	Spain	Aragón	1950	SE	32	
2016-02-15 14:10	Austria	Kärnten	1916	NE	35	
2016-02-15 13:30	Austria	Tirol	1670	NE	35	
2016-02-15 13:20	Czech Republic	Ceská Republika	1205	S	19	
2016-02-15 13:00	Slovakia	Slovensko	2016	NE	35	

Snowprofile: Chopok - centrálny žľab

Name: Kyzek, Biskupič	e-mail: slp@hzs.sk	Date: 15. Feb. 2016 12:15
Location: Chopok - centrálny žľab	Elevation: 1990 m	Air temperature: -1.0°C
Subregion: Slovensko	Incline: 35°	Precipitation: Graupel
Region: Slovensko	Aspect: NE	Intensity: Light
Country: Slovensko	Wind speed: Gentle (< 20 km/h)	Sky condition: Fog
Lat. / Long.: 48.9437° / 19.5925°	Wind direction: N	Profile-class: 4

+	Precip. particles	●	Rounded grains	A	Depth hoar	○	Melt forms	⊠	Faceted, rounded	☉	Melt-freeze crust
/	Decomp. / fragm.	□	Faceted crystals	V	Surface hoar	■	Ice formations	⊠	Graupel		



Manual observations – stability tests



Manual observations – stability test



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Manual observations – stability test



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Manual observations – stability test



Manual observations – stability test



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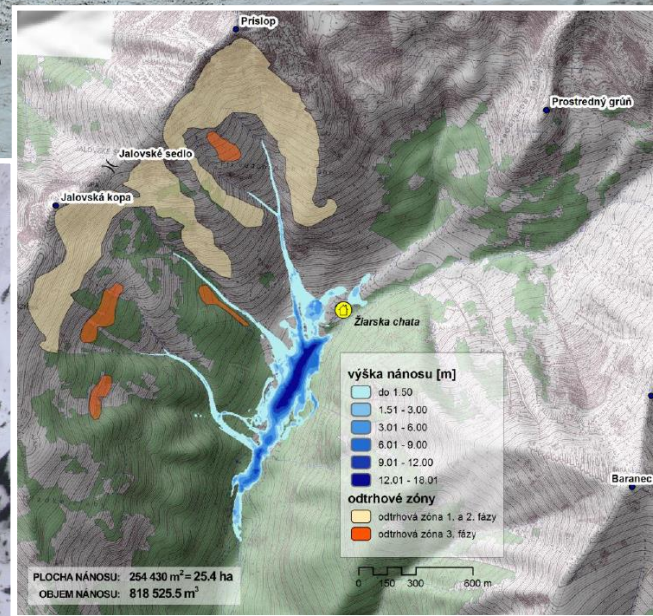
INTRODUCTION

- During the season of 2008/2009 several catastrophic avalanches caused large damages on forest, road and infrastructure.



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INTRODUCTION

- Permanent real time monitoring of avalanche prone slopes is necessary due to the possible evacuations



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Monitoring system

- The temperature loggers were installed on the Príslop (1967 & 1727 m a. s. l.) to measure the air temperature and temperature at snow/ground interface in 10 minutes interval
- Experimental meteo station was installed on the top of the Príslop (2 142 m a. s. l.) to measure air temperature, wind direction and wind speed

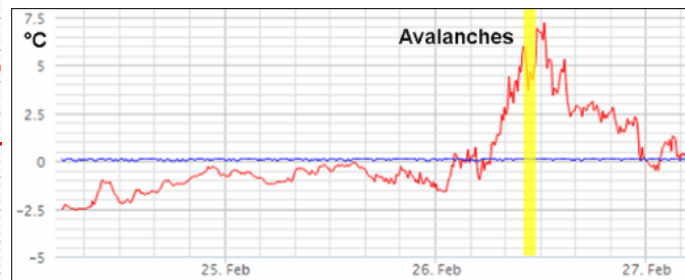
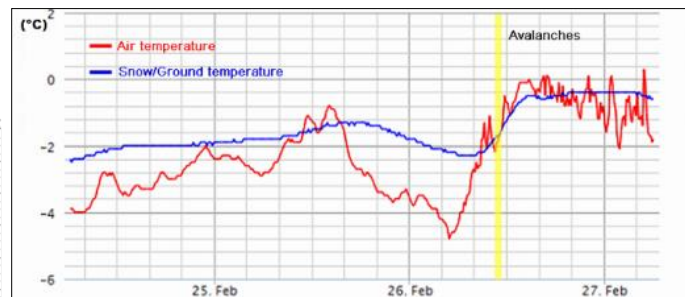
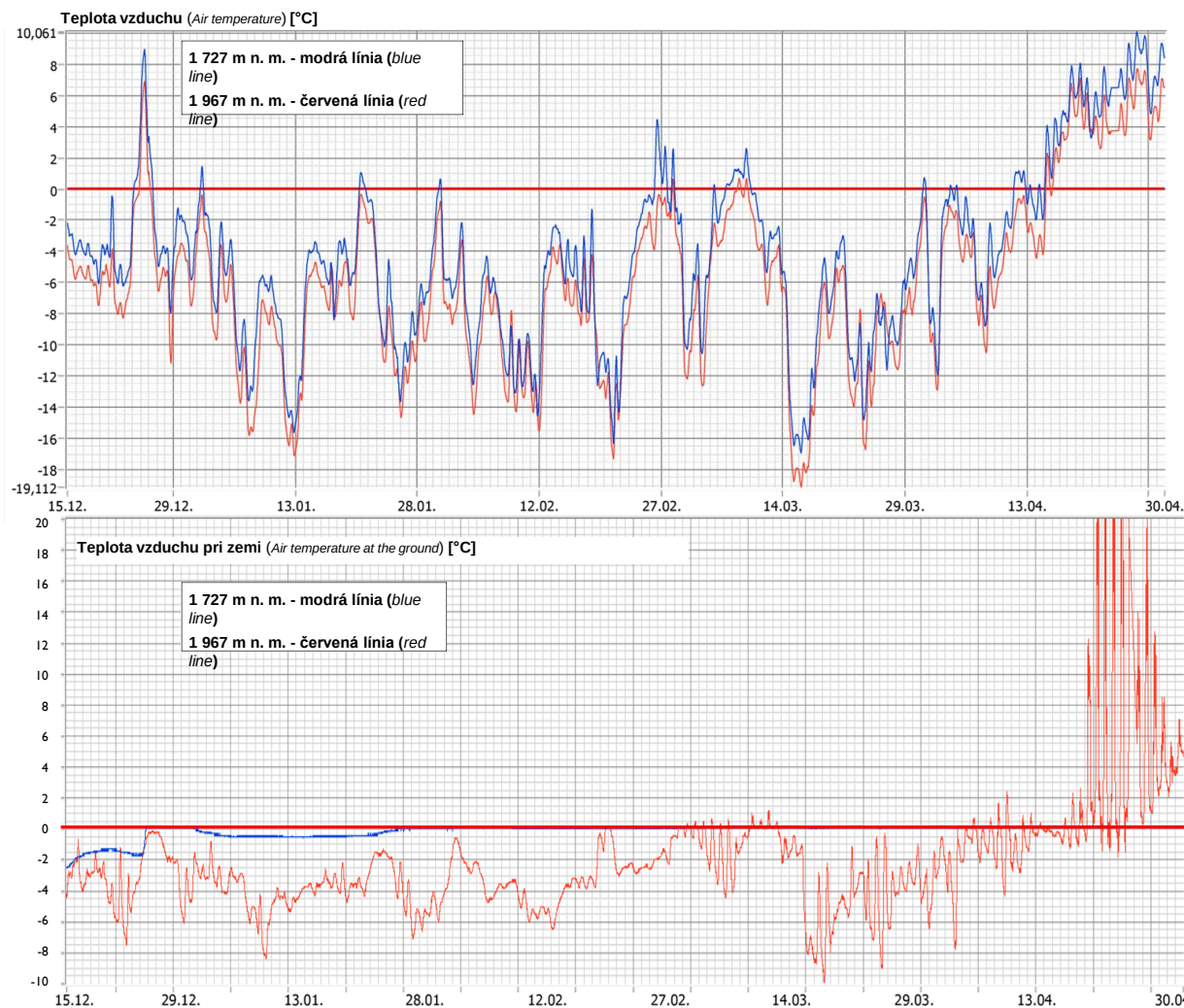


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First results

- The temperature loggers were installed on the Príslop (1967 & 1727 m a. s. l.) to measure the air temperature and temperature at snow/ground interface in 10 minutes interval



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Remote sensing

Normalized Difference Snow Index

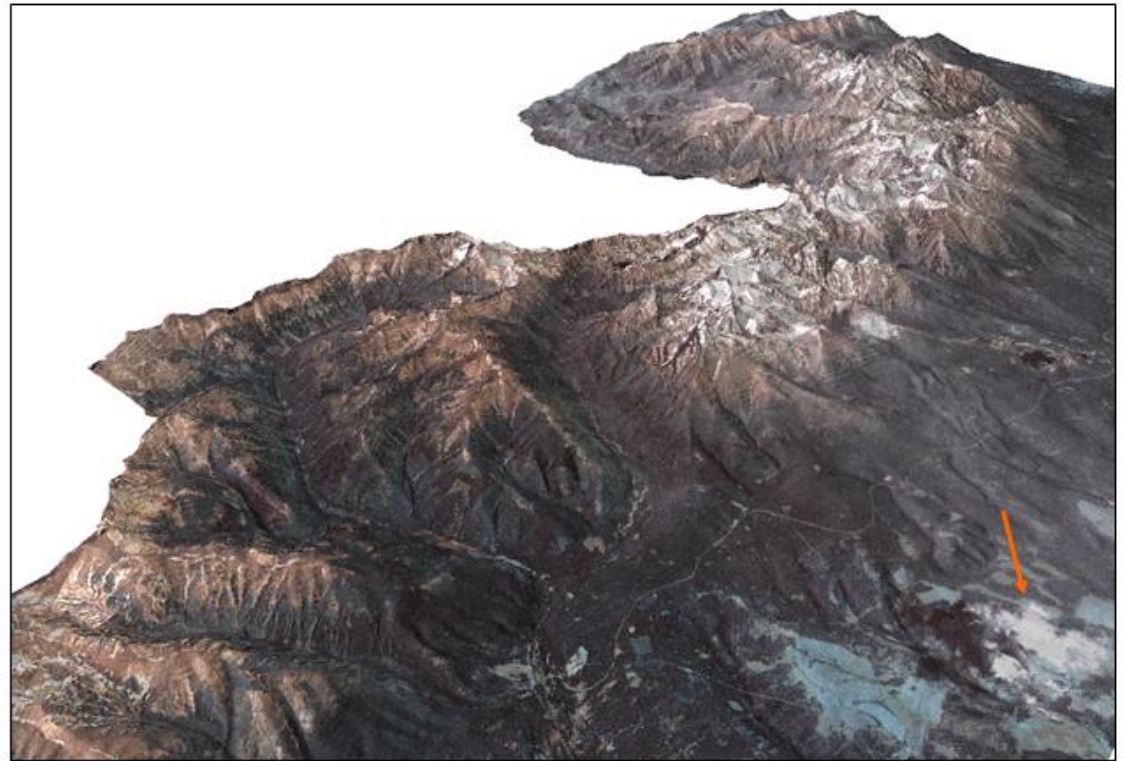
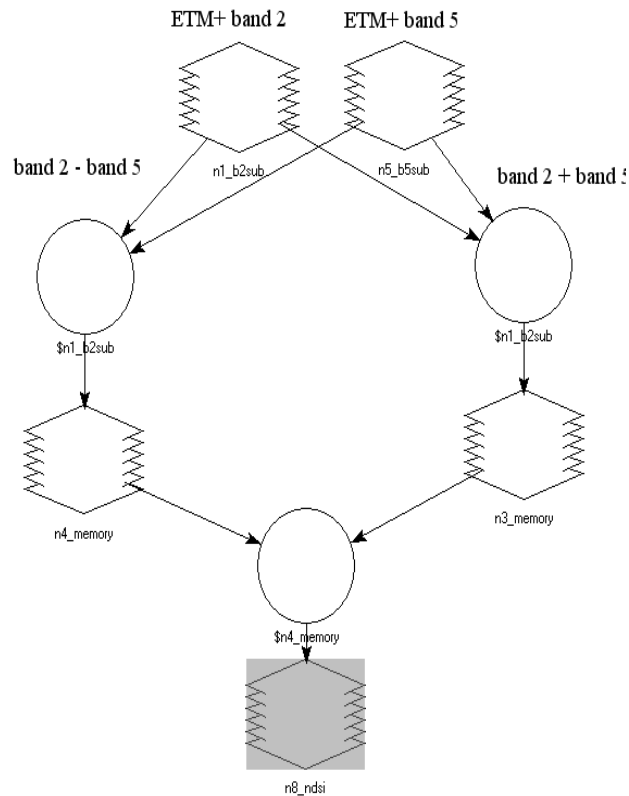


Fig3: True color Landsat composite sharpened with panchromatic band 8 draped over DEM of Slovak part of High Tatras national park. Orange arrow shows the clouds which were correctly classified as a no snow area by estimating the threshold value to 0.4.

Remote sensing

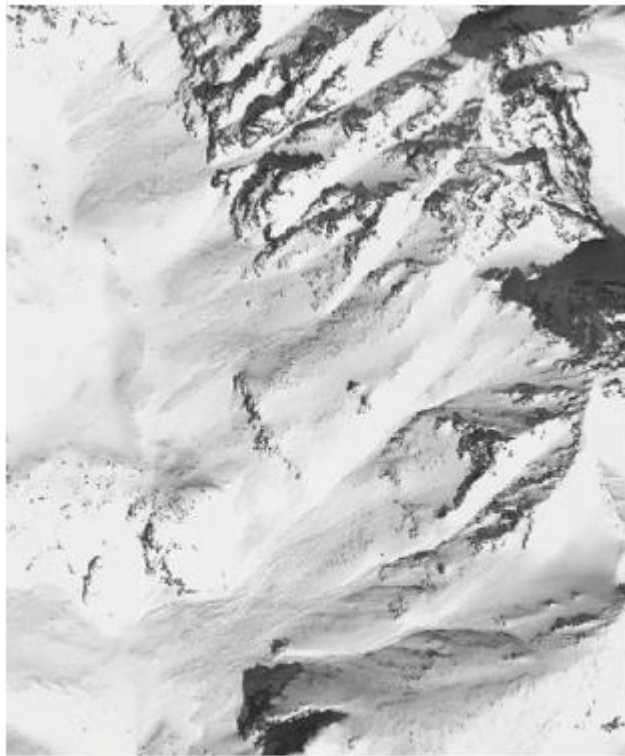


Figure 7a: Qualitative comparison between expert mapping and algorithm performance: Raw image. (Satellite image: Copyright © DigitalGlobe/WorldView-1)

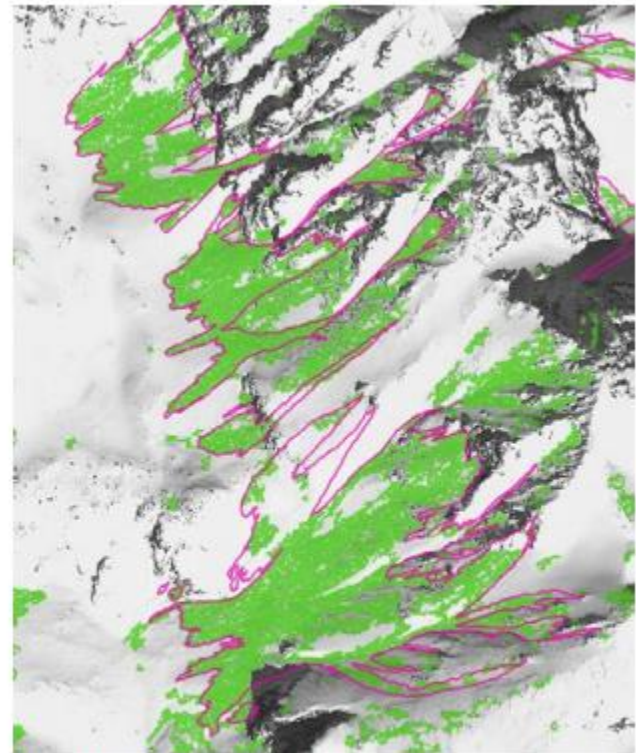
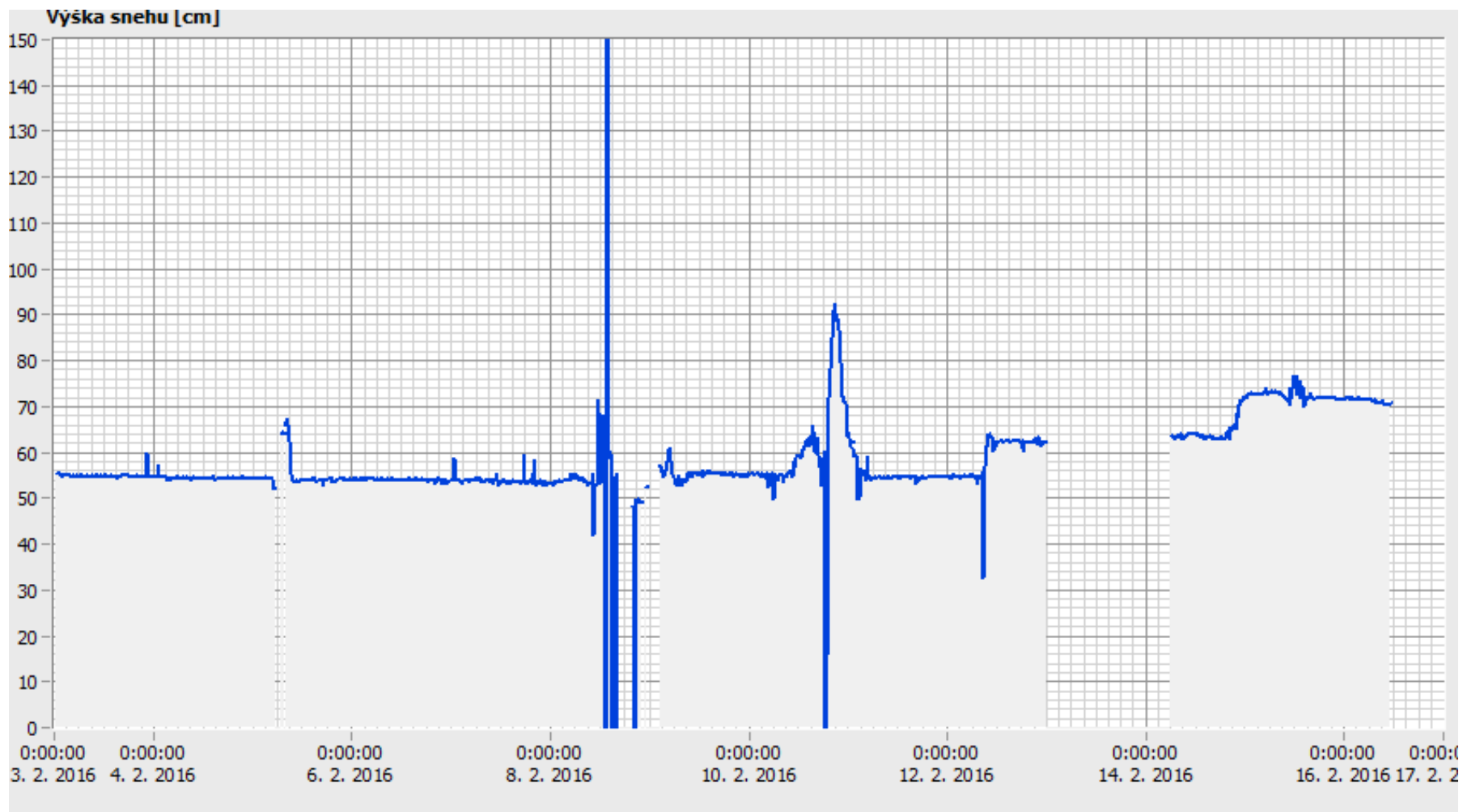


Figure 7b: Qualitative comparison between expert mapping and algorithm performance: manually digitized avalanche outlines (in pink) superimposed on the automatically classified avalanches (in green). (Satellite image: Copyright ©



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Problems & issues



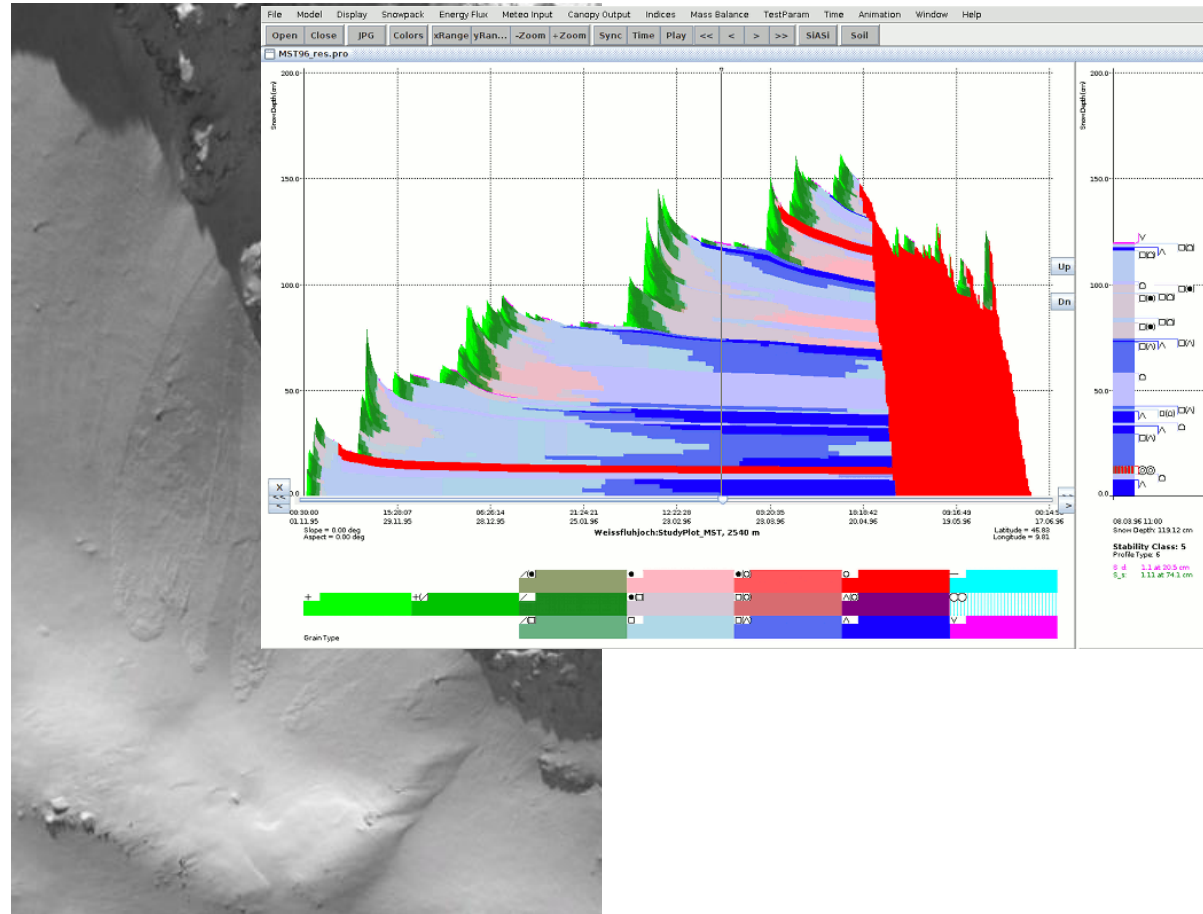
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Problems & issues



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