ARSO VREME

Snowpack modeling using the Crocus snowpack model at the Slovenian Environment Agency (ARSO)

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Outline

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- **Motivation**
  - Avalanche risk assessment tools
  - **CROSSRISK** project
- **Validation and model performance**
  - Gridded runs on **4 km Aladin** and **1 km Inca** grid
  - **Point** based runs
- **Operational implementation**
  - Daily **24h analysis** runs + **72h forecast**
- **Future Work**

CROSSRISK

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Public warnings – reducing rain and snowfall related risks

A project between many partner organizations from Slovenia and Austria

Goals:

- Improvement of forecast systems
- Unification of reports issued to the public
- ...

CROSSRISK

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Snowpack modeling:

Provide objective tools to forecasters

Comparison of different snowpack models

- 2D distributed simulations: Crocus (ARSO)
- Point simulations: Snowpack (ZAMG)

2D runs – Aladin domain

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- Aladin-ALARO used operationally at ARSO
- 4 km domain
- Output used to construct seasonal forcing files for SURFEX

Aladin domain

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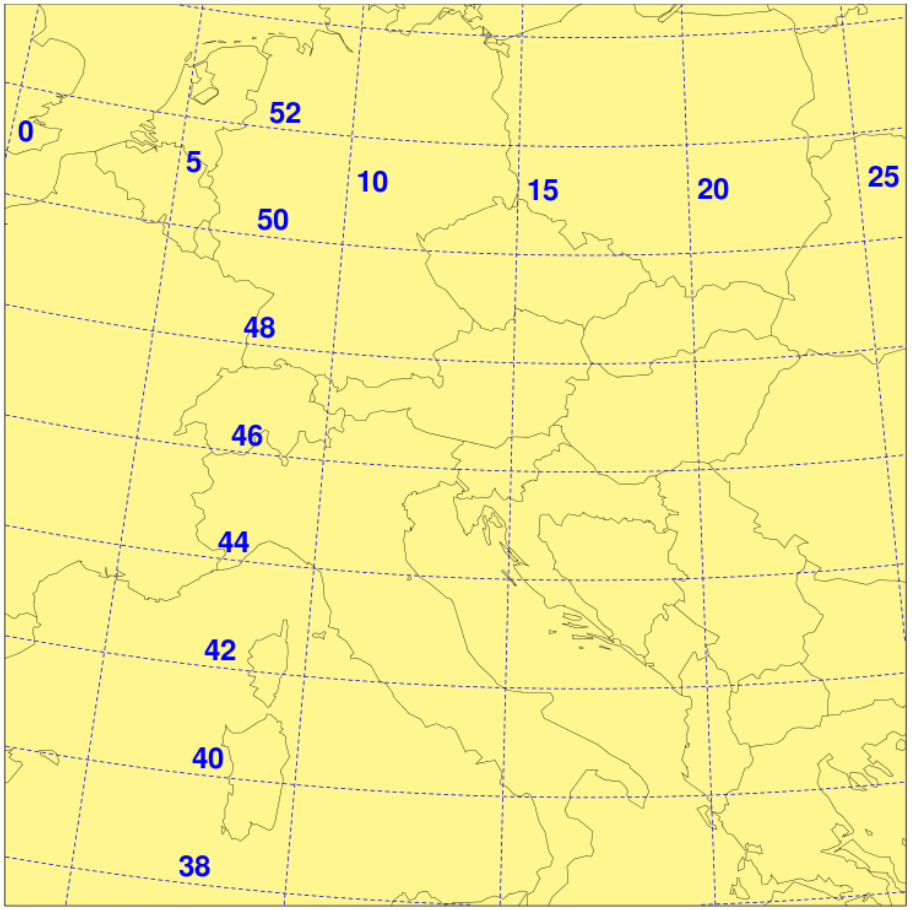
4km Aladin-SI Domain (421 by 421 ponts)



2D runs – Inca domain

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Inca-SI analysis

- **1km domain** centered at Slovenia
- Analyzed near surface quantities:
  - T2m
  - RH
  - Wind
  - Precipitation + precipitation type
- **SW** and **LW interpolated** from Aladin

Inca domain

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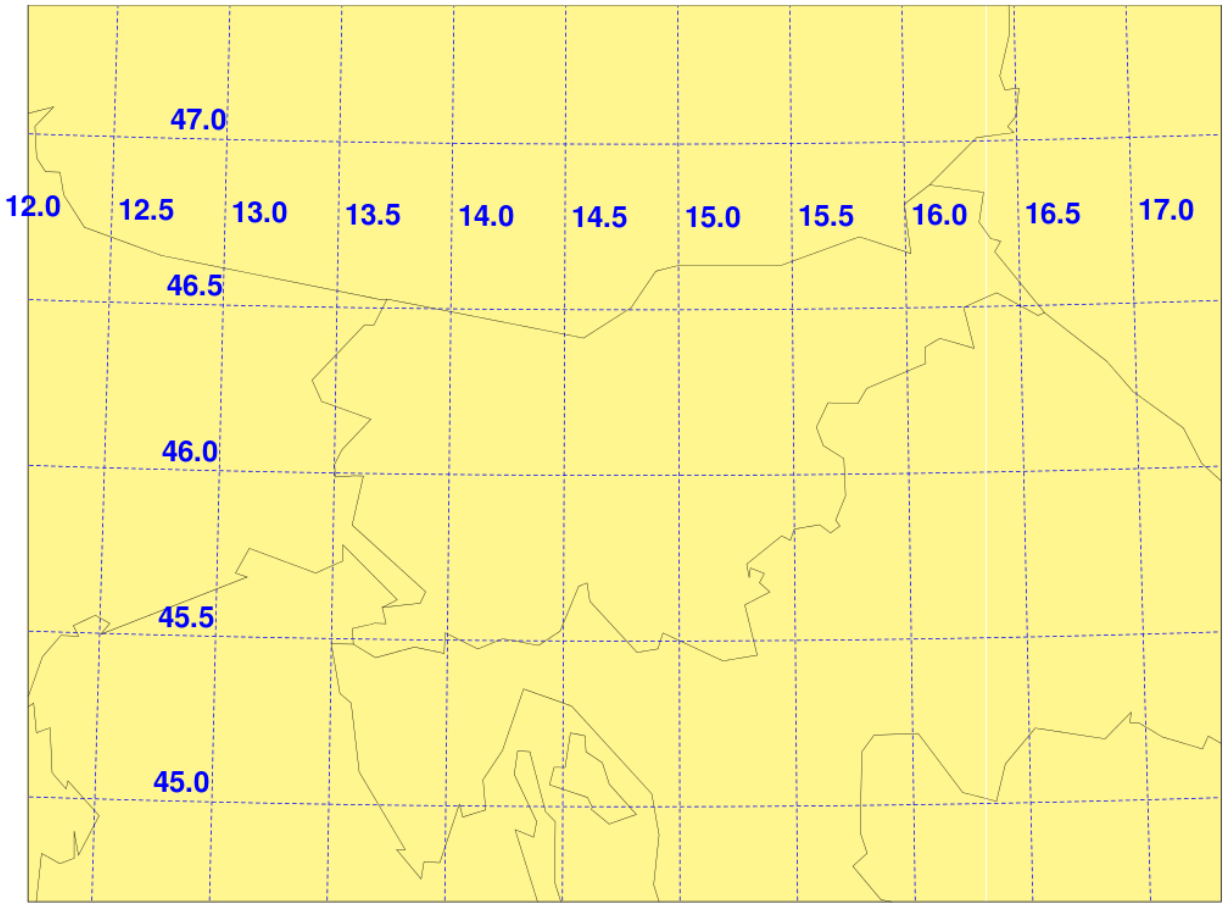

Validation

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- Comparison of **snowdepth** between **SURFEX** runs on **4 km** (**crocus04**), **1 km** (**crocus01**) domain and **Aladin model (aos)**

- Automatic **snowdepth** measurements available for **66 stations**

Validation

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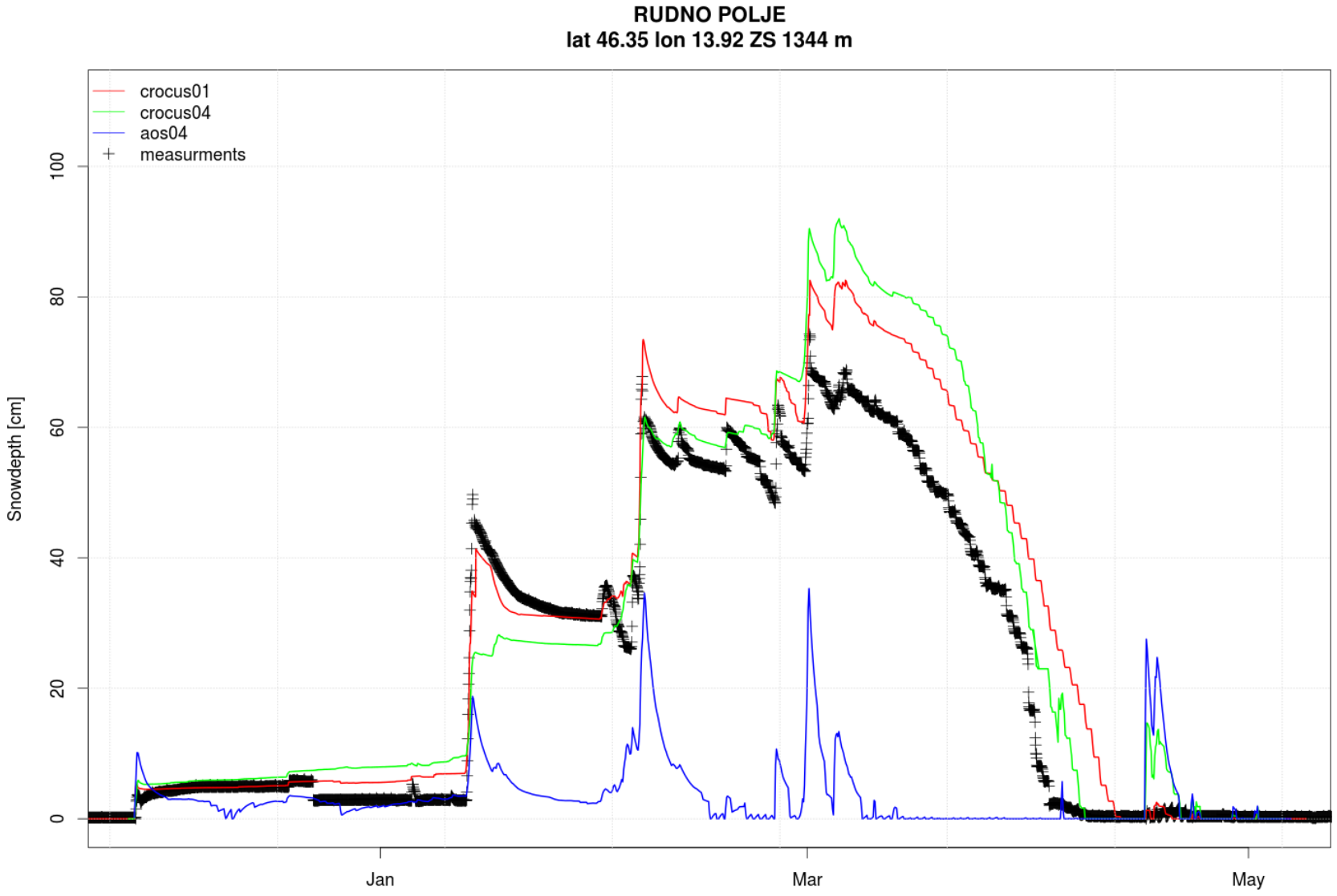

Validation

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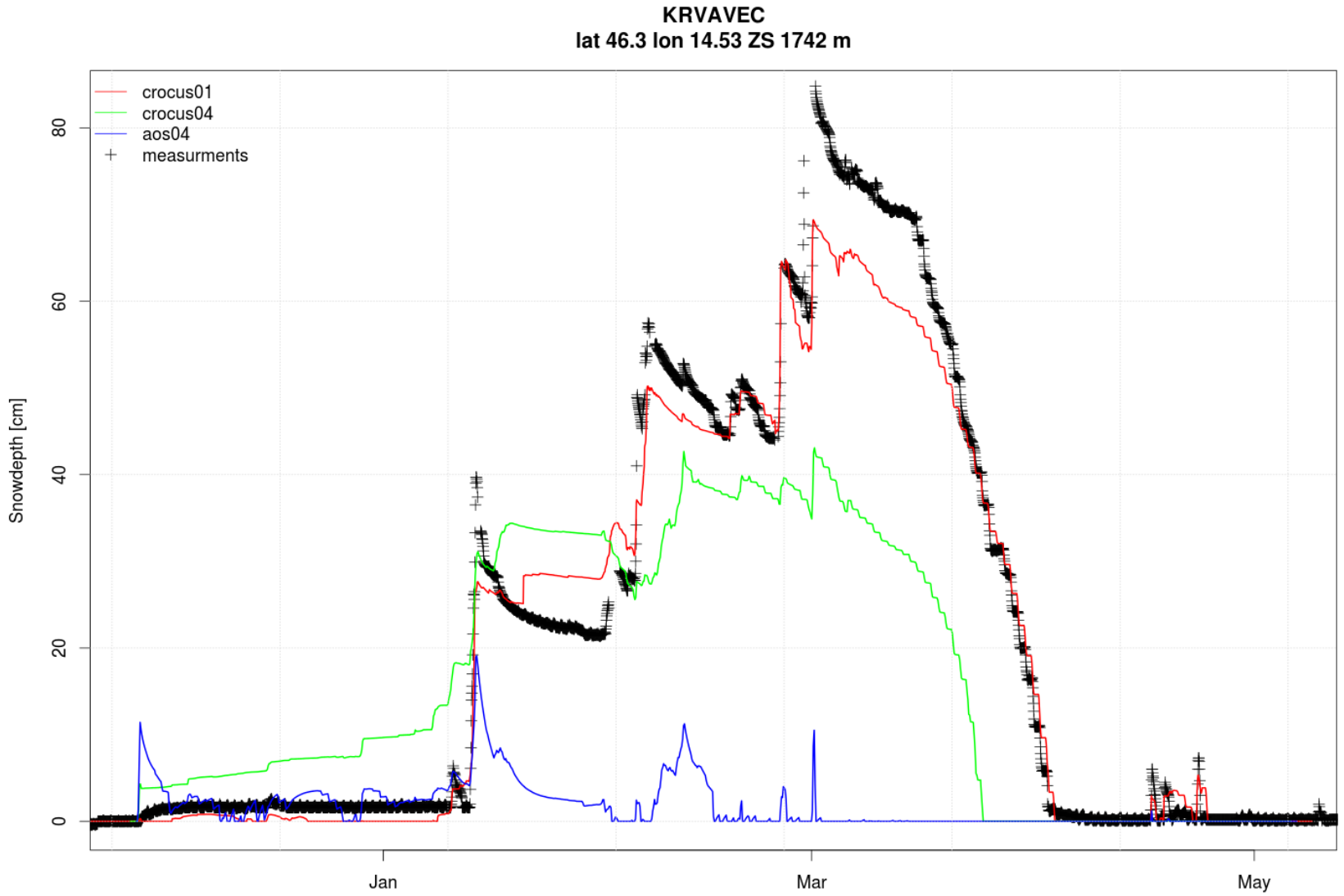

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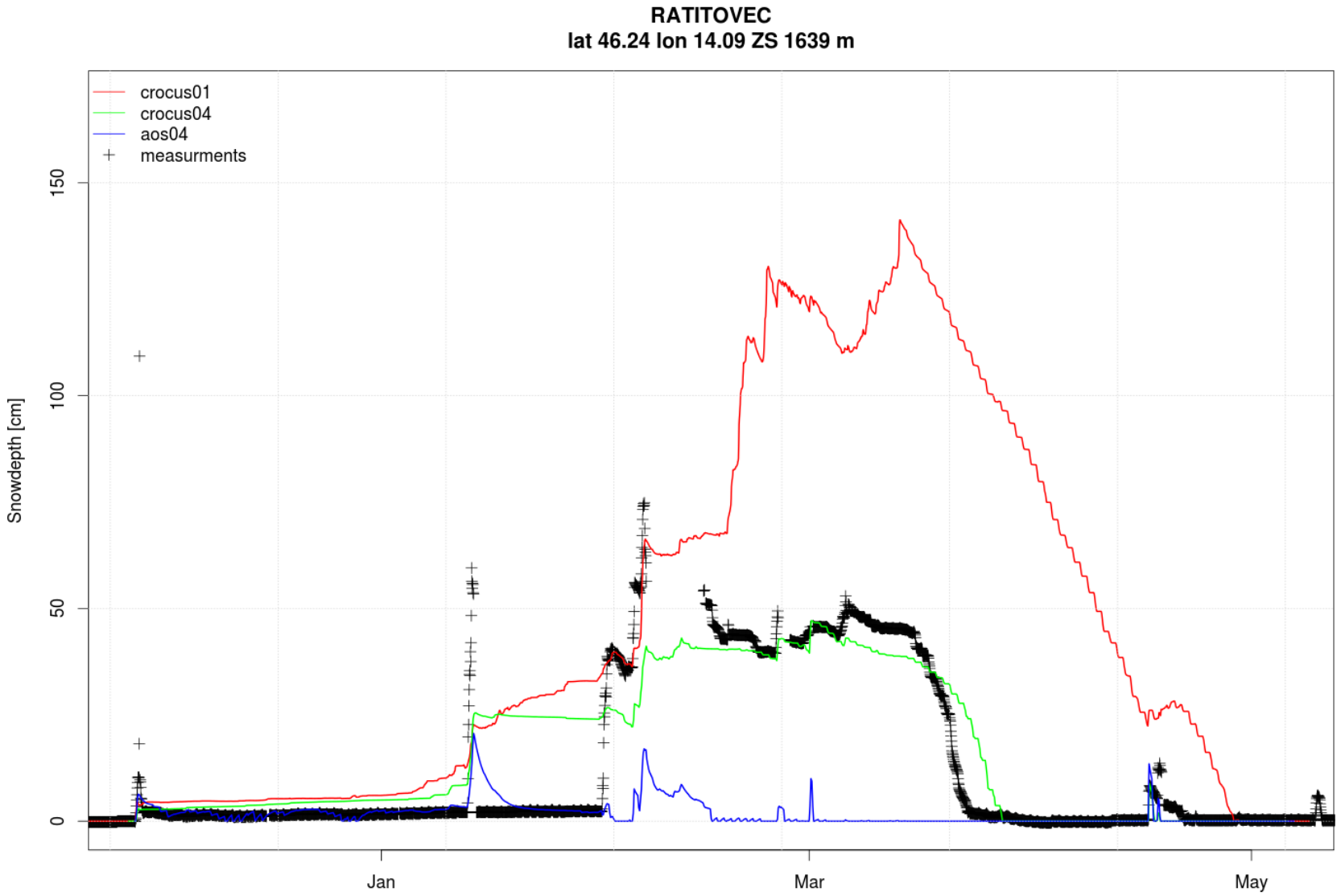

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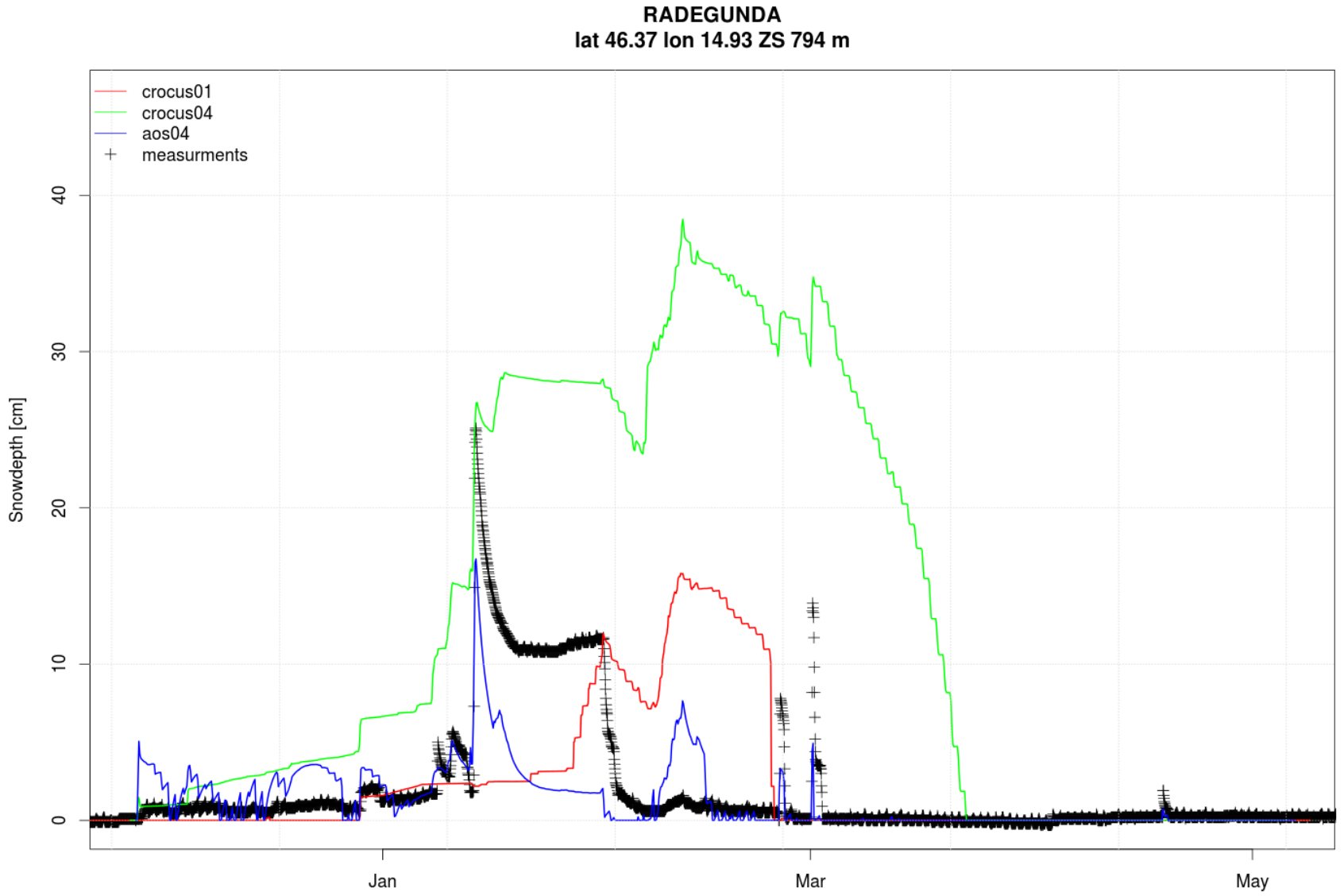

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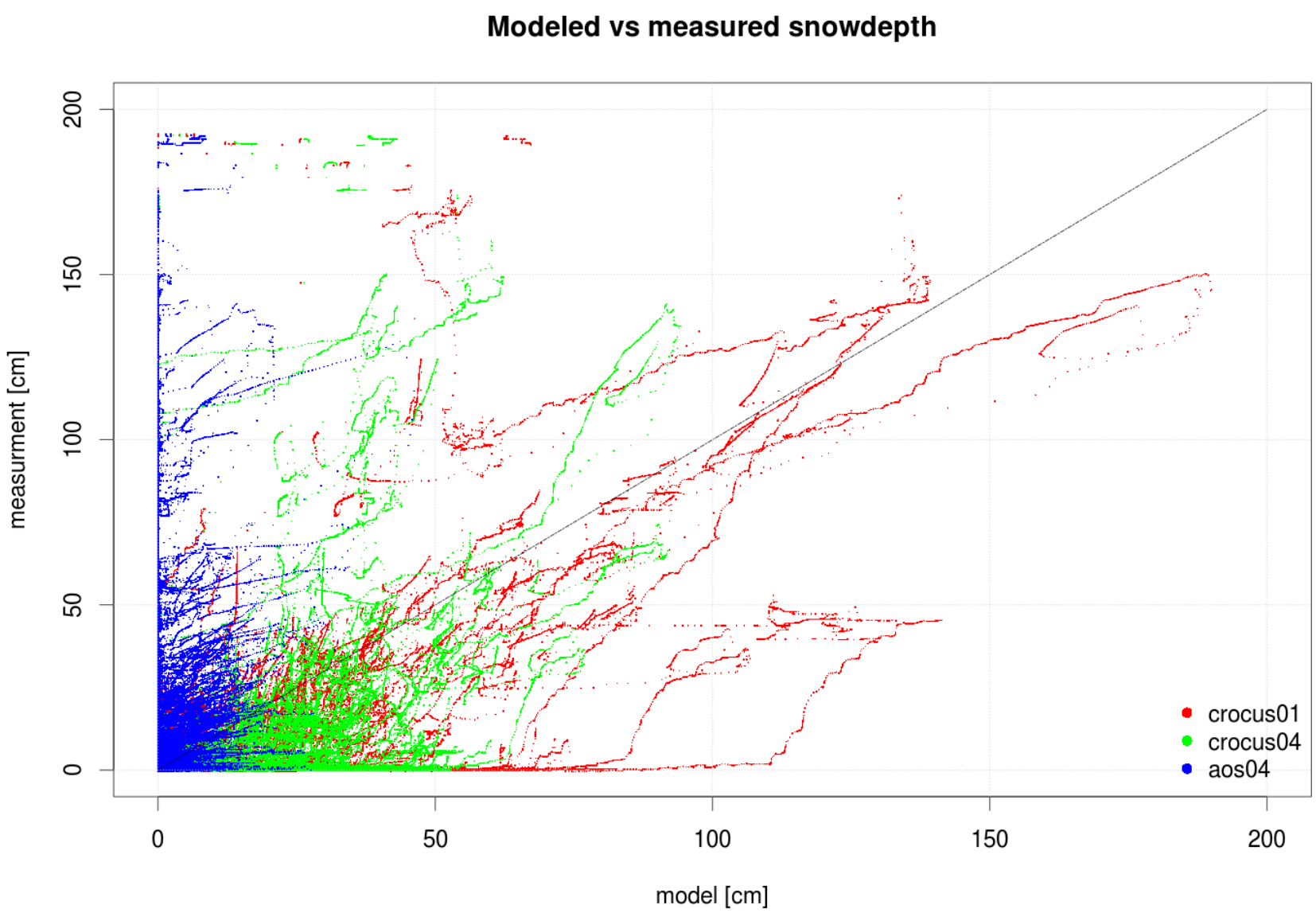

Snow profiles

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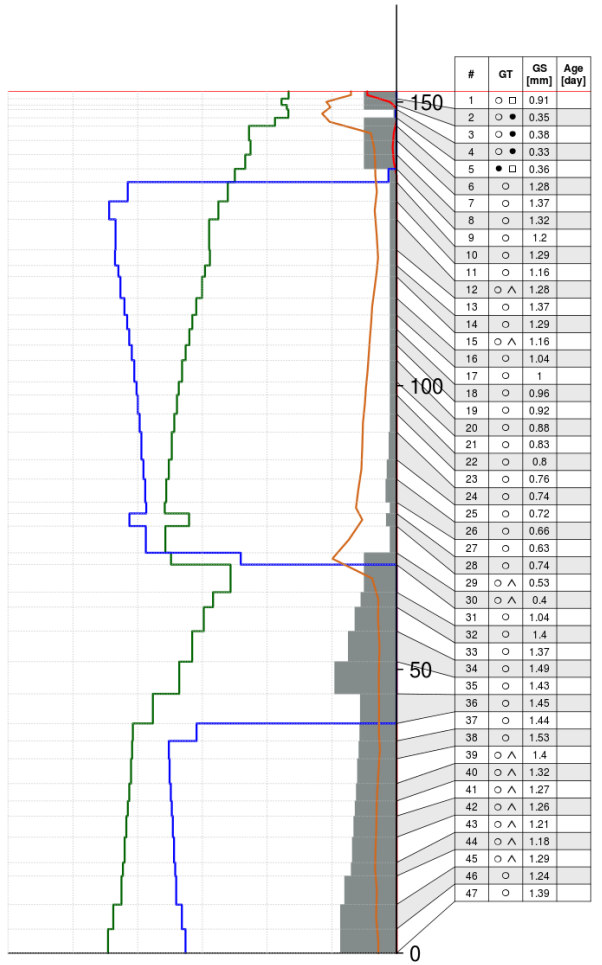
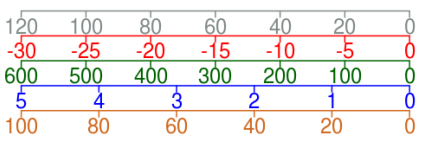
Vrsic, 46.433° N, 13.752° E
2018-01-14 12:00:00

Snow Depth: 152 cm
Snow LWE: 510 kg/m²



#	GT	GS [mm]	Age [day]
1	○ □	0.91	
2	○ ●	0.35	
3	○ ●	0.38	
4	○ ●	0.33	
5	● □	0.36	
6	○	1.28	
7	○	1.37	
8	○	1.32	
9	○	1.2	
10	○	1.29	
11	○	1.16	
12	○ ∧	1.28	
13	○	1.37	
14	○	1.29	
15	○ ∧	1.16	
16	○	1.04	
17	○	1	
18	○	0.96	
19	○	0.92	
20	○	0.88	
21	○	0.83	
22	○	0.8	
23	○	0.76	
24	○	0.74	
25	○	0.72	
26	○	0.66	
27	○	0.63	
28	○	0.74	
29	○ ∧	0.53	
30	○ ∧	0.4	
31	○	1.04	
32	○	1.4	
33	○	1.37	
34	○	1.49	
35	○	1.43	
36	○	1.45	
37	○	1.44	
38	○	1.53	
39	○ ∧	1.4	
40	○ ∧	1.32	
41	○ ∧	1.27	
42	○ ∧	1.26	
43	○ ∧	1.21	
44	○ ∧	1.18	
45	○ ∧	1.29	
46	○	1.24	
47	○	1.39	



Ram Resist. [daN]
Temp [°C]
Rho [kg/m3]
LWC [%]
SSA [m2/kg]

Opazovalec: grs_mojstrana-rlotric

SNEG	nov	1	do:		cm	
	ves	140	do:	150	cm	

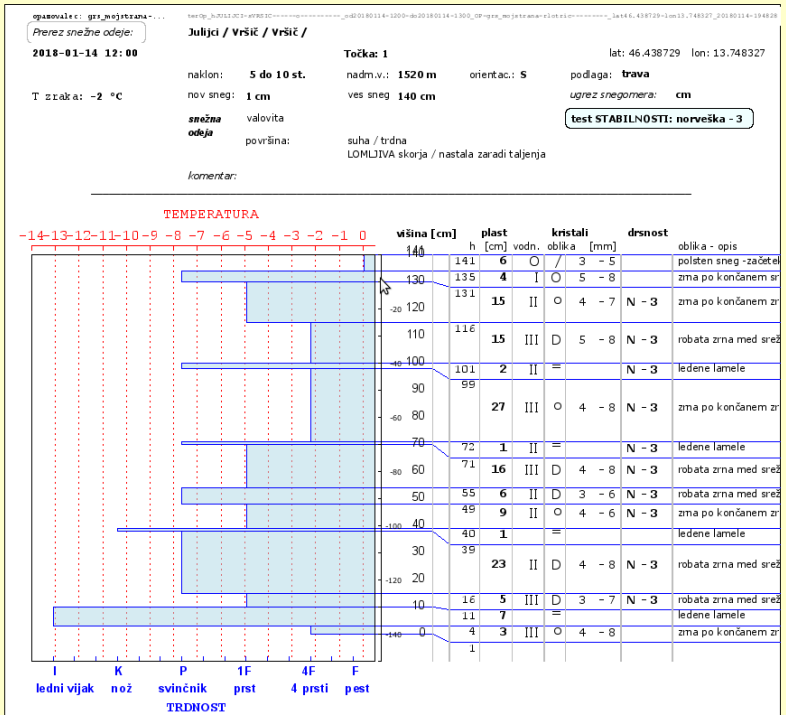
PLAZOVI	vrsta	pobočja	višina napok	obleteli v zadnjih 24h	velikost	ocenjena NEVARNOST
	plazov ni bilo	- - - - - - - -		ni bilo plazu (ni bil opažen)		zmerna

POJAVI			
	KLOŽE	N_NE_E_SE_S_-_-_-	med 1500 in 2000 m
	OPASTI	N_NE_E_SE_-_-_-_-	med 1500 in 2000 m
	GREBENI	spihani/ledeni	
komentar	S smucmi smo se povzpeli s sedla na vrh Vrsic. Na trdi podlagi je bilo do 20 cm suhega nesprijetega snega, mestoma mehka kloza v manjsem obsegu. Na grebenu manjse opasti.		

TOČKA: 1. ____ ČAS začetka opazovanja: 2018-01-14 12:00

LOKACIJA	nadm. viš. [m]	naklon pobočja	orientac. pobočja	podlaga	lat	lon
	1520	5 do 10 st.	južno	trava	46.438729	13.748327
Sneg	nov sneg [cm]	ves sneg [cm]	*temp. zraka [st.]*	*veter SMER*	*veter MOČ*	
	1	140	-2	brezvetrje		

Snežna odeja	oblika	stanje			ugrez snegomera [cm]	Stabilnost - metoda	Stabilnost - stopnja
	valovita	suha	trdna	LOMLJIVA skorja	nastala zaradi taljenja	norveška	3



Point simulations

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All required forcing parameters are measured at 3 mountain stations

Point simulations

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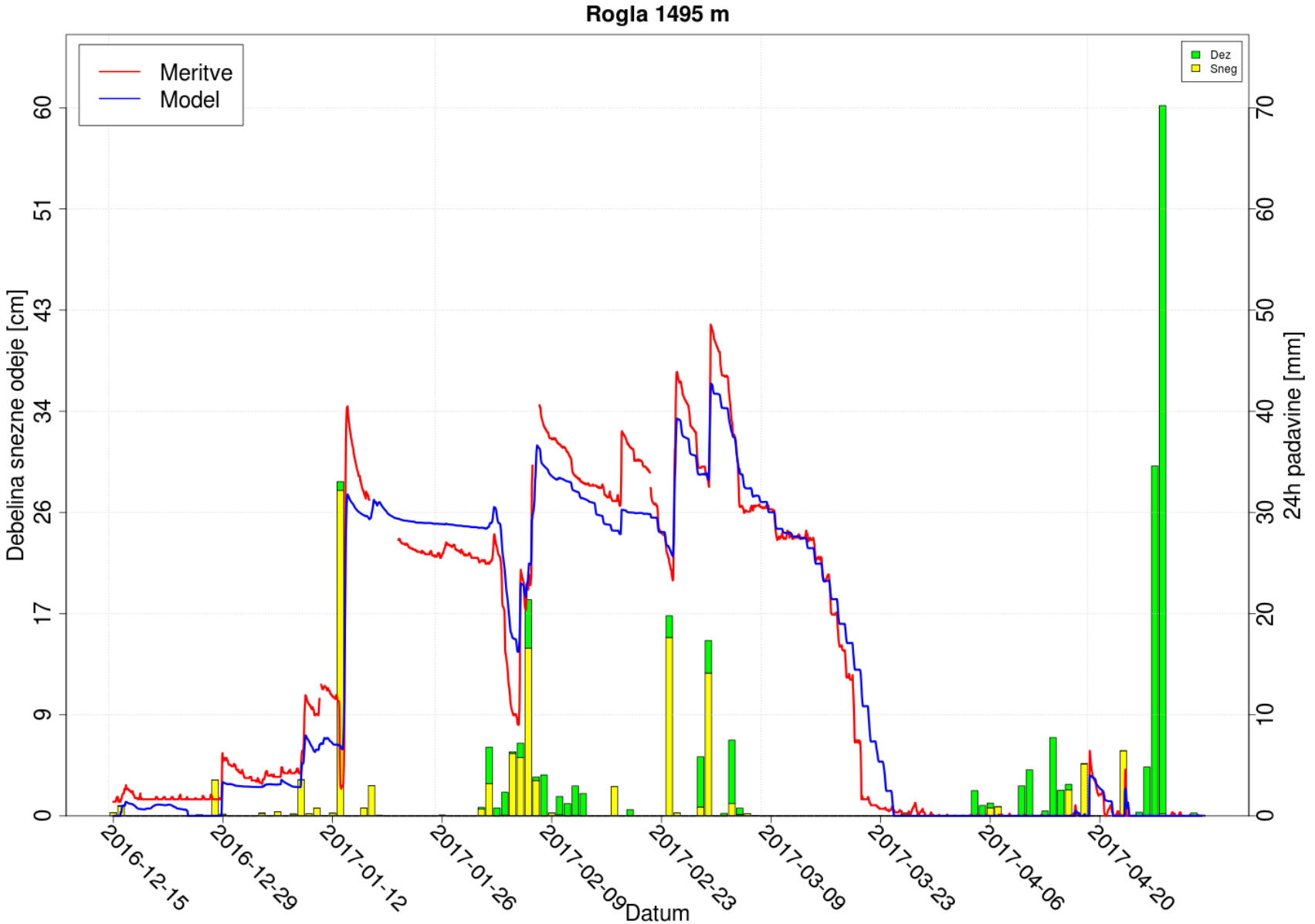

Point simulations

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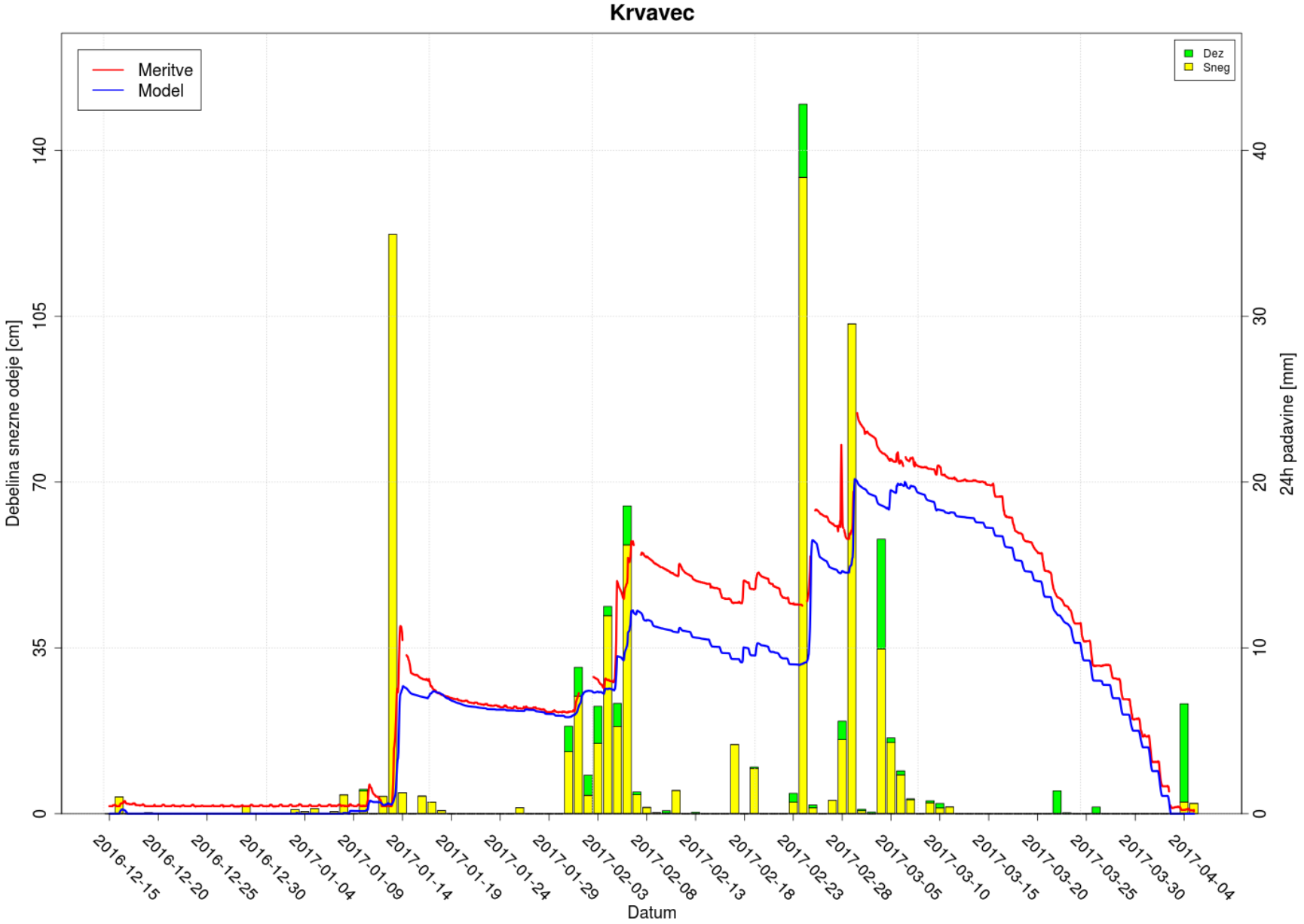

Point simulations

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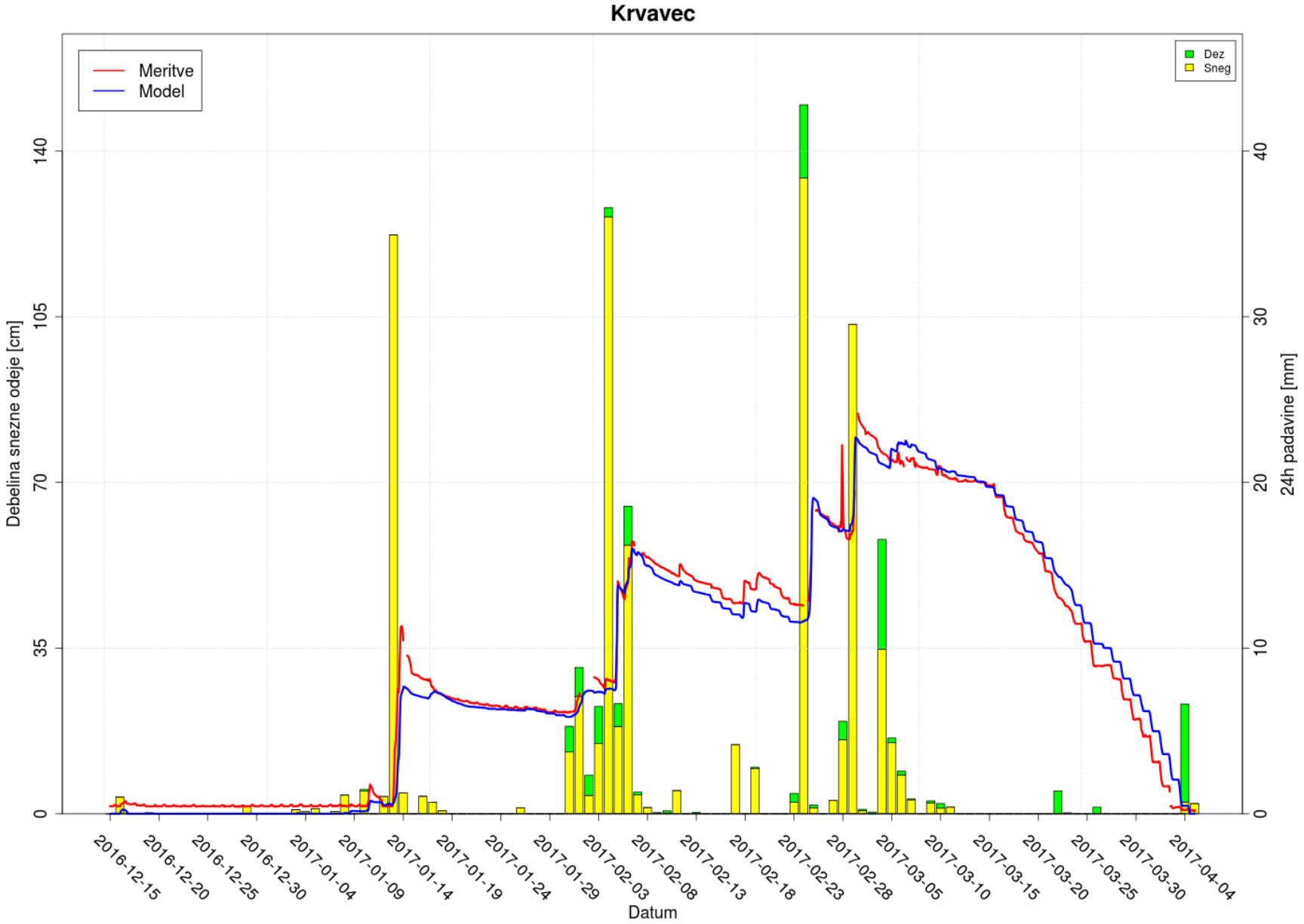
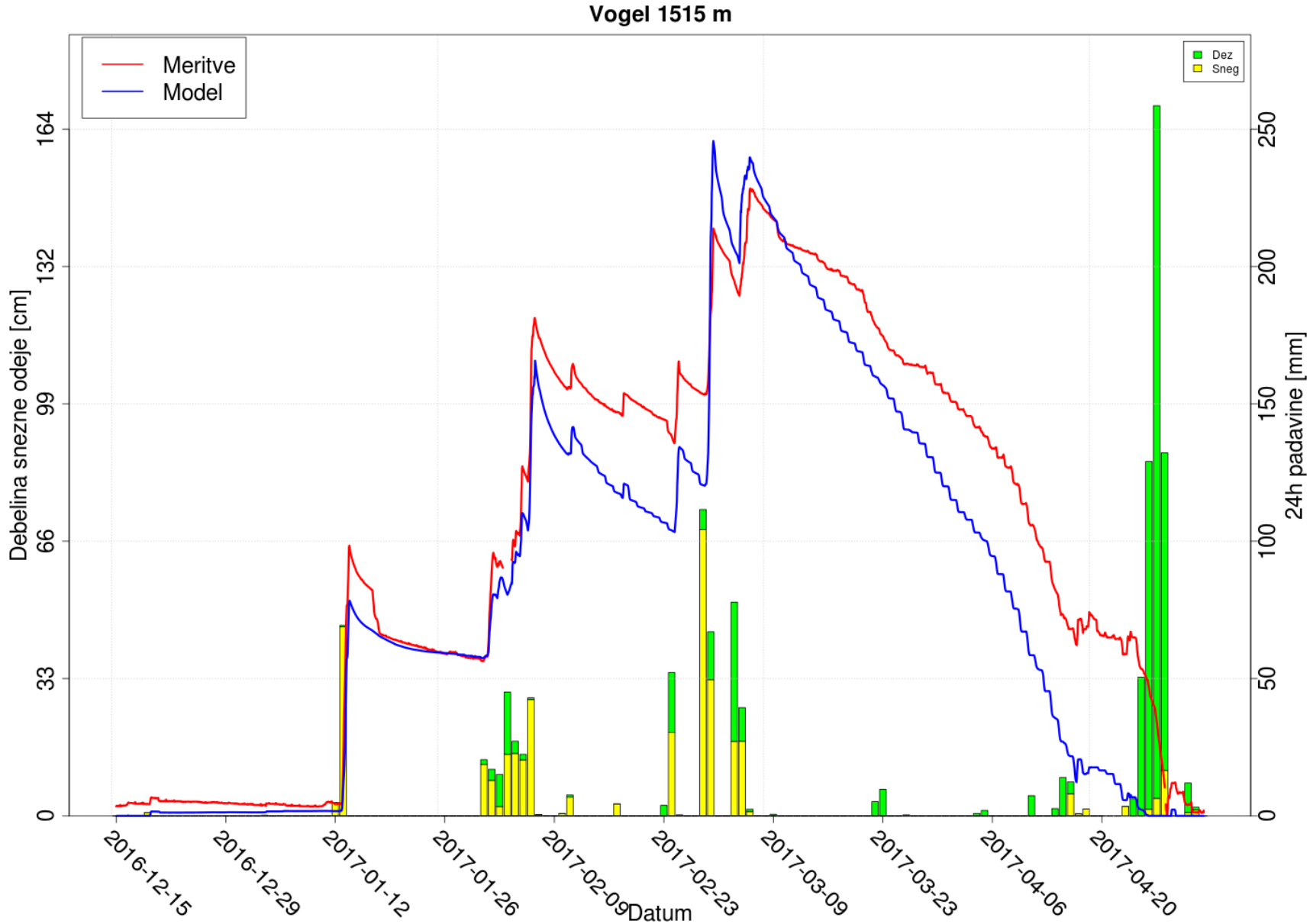


Point simulations

ARSO VREME



Operational implementation

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Analysis

- **Daily 24h** runs based on **Inca_SI analysis**
- **LW** is obtained from **Aladin** (bias corrected)
- A **restart file** is generated at the end of each day, which is used as the **initial state** for the next simulation

Forecast

- **72h** forecast based on **Aladin 00 run** forecast
- Aladin data is **interpolated** onto Inca domain

Restart file from **analysis** is used as the **initial state**

Future work

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- Operational suite on Inca-AT domain
- Usage of Crocus for hydrological modeling purposes
- Optimization of the operational suite

End

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Thank you for the attention!