Snow links to (numerical) weather forecasting and nowcasting at SHMU

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Outline

- Snow @ the Central Forecasting Office (CFO)
- Snow and NWP
  - nowcastning
  - short range forecasting
  - POVAPSYS project: upgrade of SHMU infrastructure
- links with COST ES1404, future plans

The Central Forecasting Office (1)

only items relevant to COST ES1404 are mentioned

duties:

- to issue weather forecasts and warnings for public/customers, several times/day
- to report to Civil Protection authorities if necessary
- to broadcast to media

based on:

- observations and measurements: SYNOP, AWS, local reports, radars, satellites, lightning system
- NWP models: ECMWF (det+EPS), GFS, ALADIN, LAEF, INCA...
- subjective/personal experience

The Central Forecasting Office (2)

Concerning snow information and snow-related forecast/warnings:

current state:

- SYNOP messages only from SK stations, 06 and 18UTC (333 section)
- INTER (local meteo messages at 7h local time) => maps of total snow and new snow/24h

forecasts:

amount of new snow according to precipitation water content predicted by NWP model => snow water equivalent estimated + empirical formula + personal/subjective experiences, e.g.

- if T ~ 0°C => 1mm ~ 1cm of new snow
- if T < -5°C => 1mm ~ 2-3cm of new snow
- windward/leeward effects considered

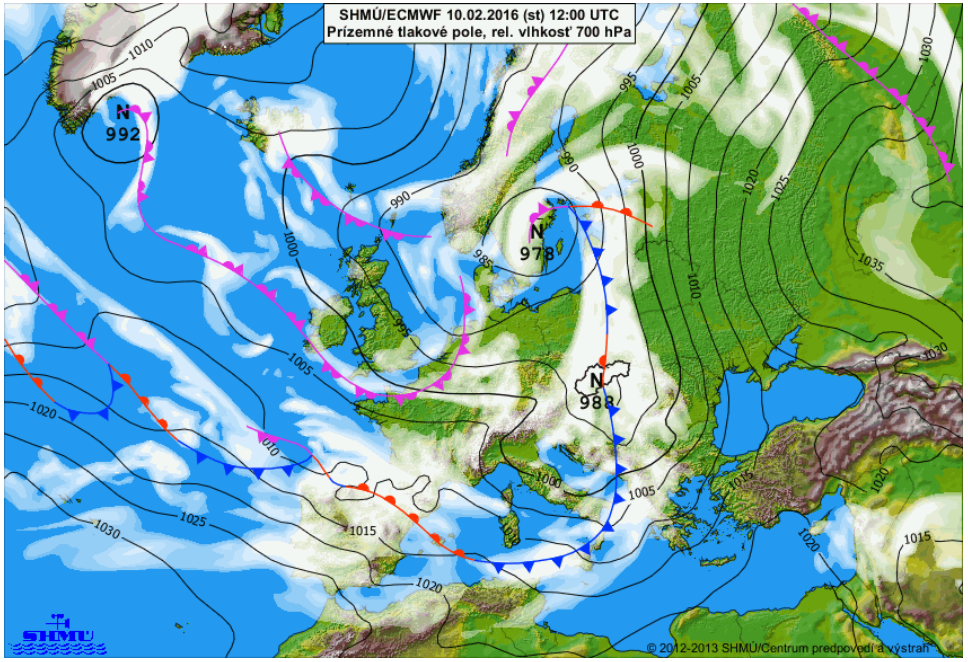
The Central Forecasting Office (3)

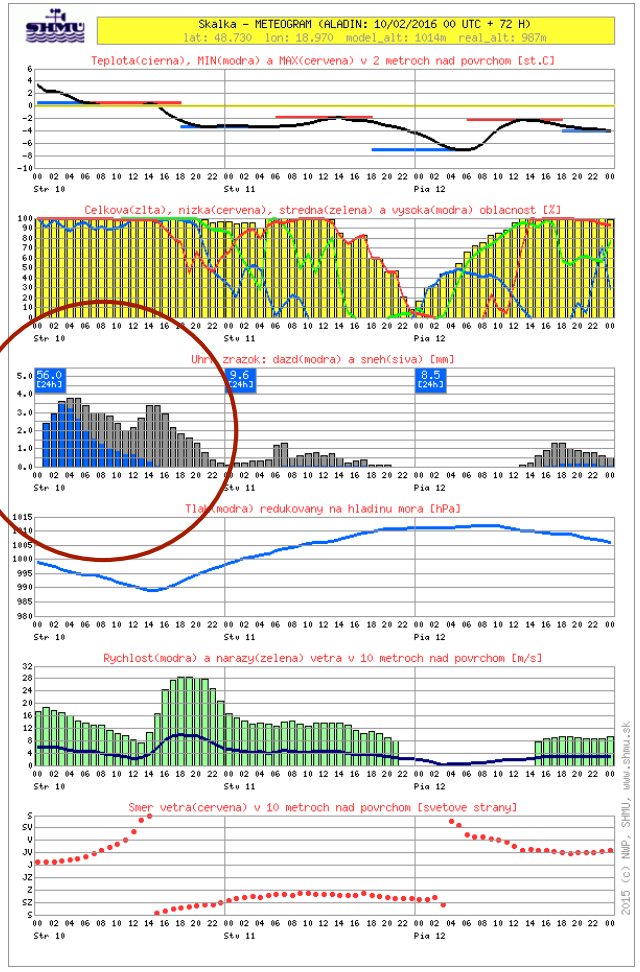
snow-related warnings: SHMU & Meteoalarm

		non-mountainous areas	mountain valleys
SNOW	1	new snow ≥ 10cm/12h or the first snowing in the season	new snow ≥ 20cm/12h
	2	new snow ≥ 20cm/12h	new snow ≥ 30cm/12h
	3	new snow ≥ 30cm/12h	new snow ≥ 40cm/12h
SNOW DRIFTS	1	moderate snowing or ground covered with snow cover max 4 days after last snowing & Tmax <1°C & wind speed > 5 m/s; or "blowing snow" reported	

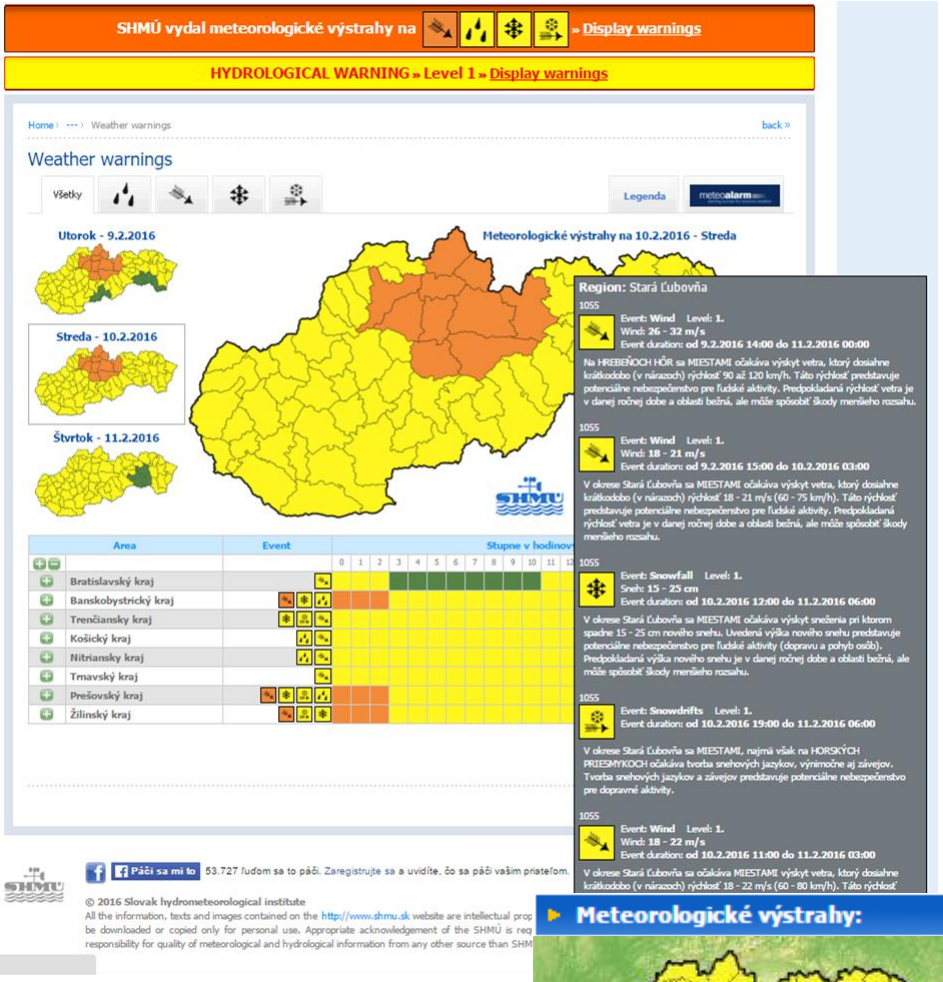
The Central Forecasting Office (4)

example of 10/02/2016 situation: cold front passing over Slovakia, 30-50mm/24h of precipitation => 25-50cm of snow predicted, strong wind => floods

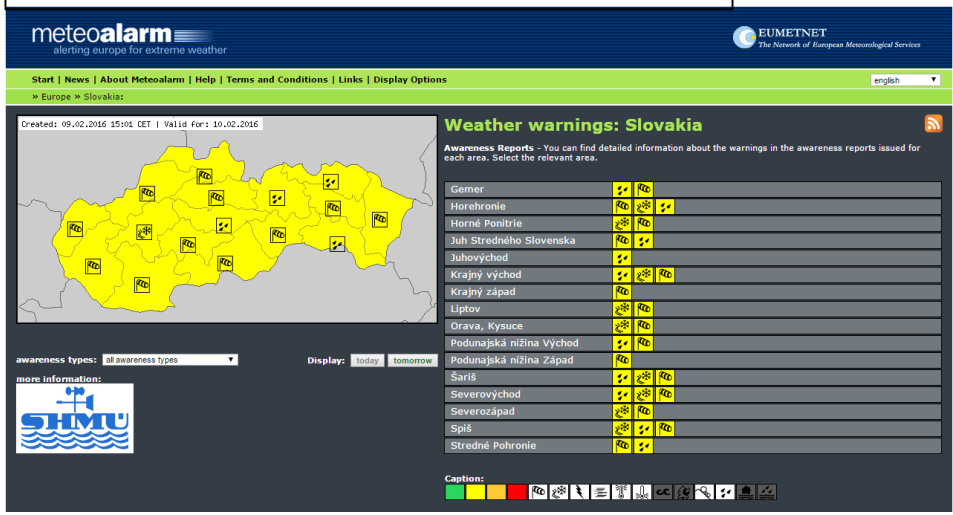




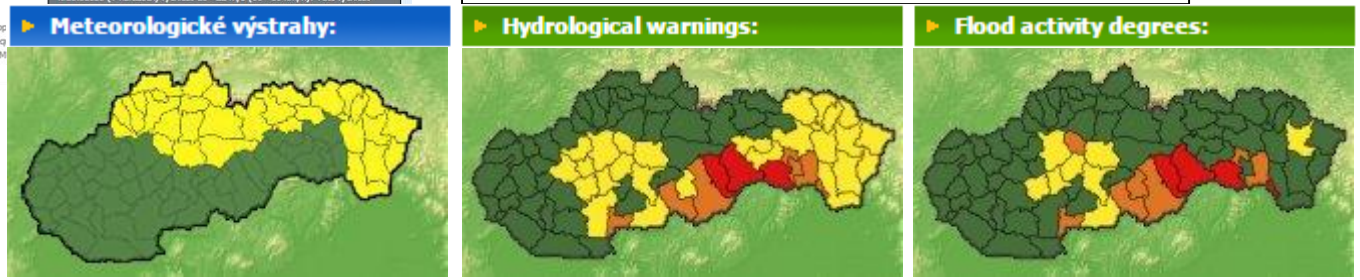
The Central Forecasting Office (5)



Meteoalarm (only 1st level?)

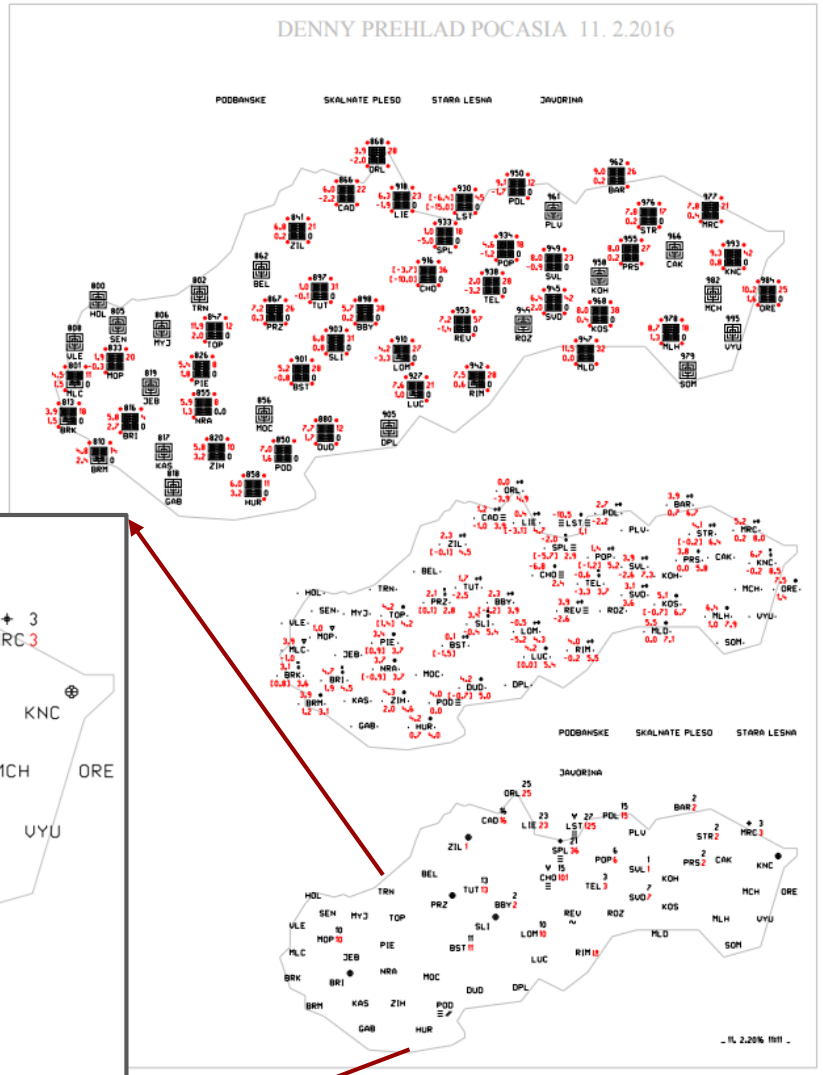


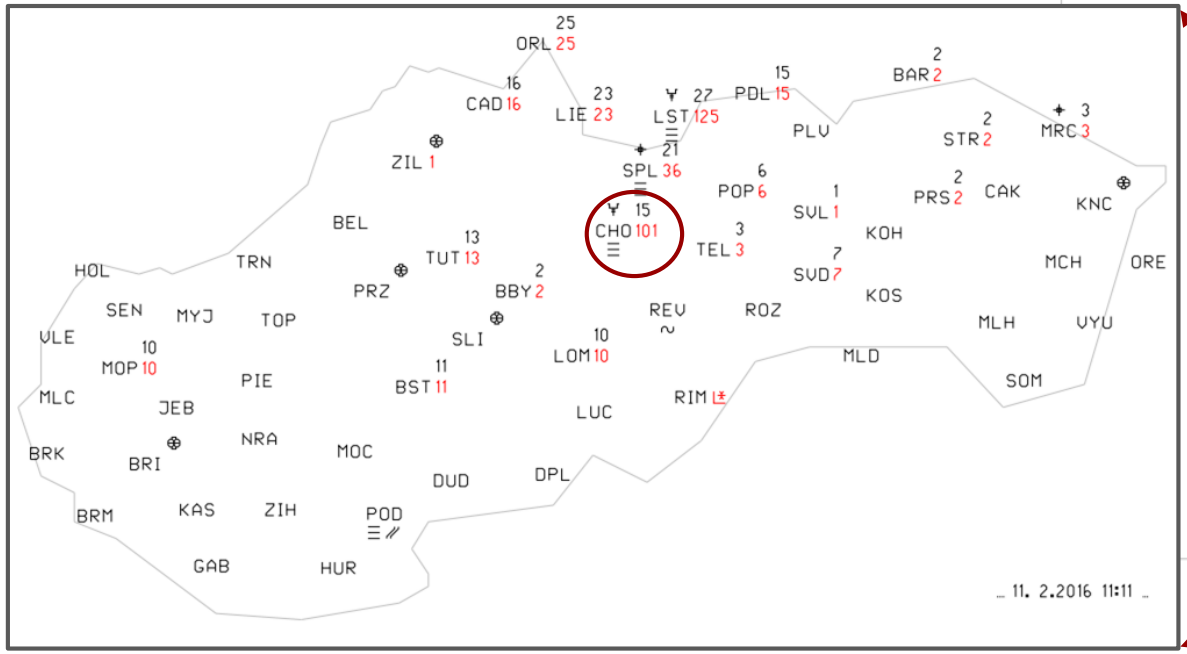
Flood warnings on the next day



The Central Forecasting Office (6)

example of the map based on the INTER local weather report from 11/02/2016 07:00 with zoom on snow measurements. Total snow in red, new snow/24h in black.

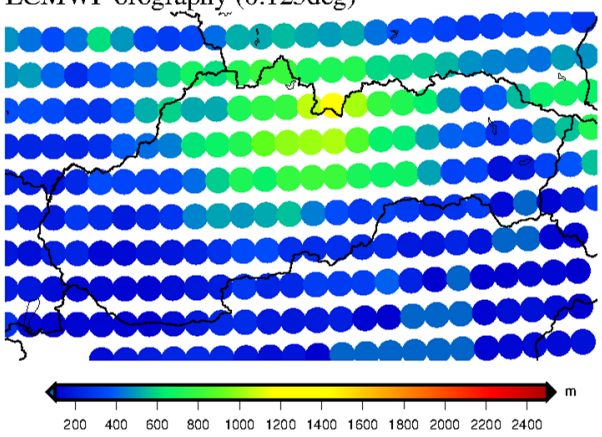




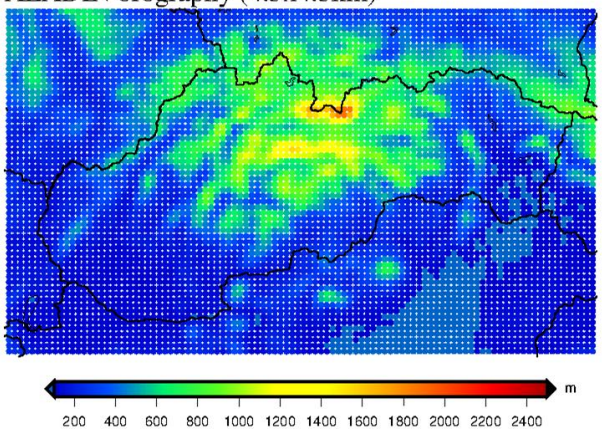
NWP models@SHMU: spatial and temporal scales

global	regional	local
ECMWF	ALADIN	INCA
temporal		
10 days (long range)	3 days (short range)	6-12hrs (nowcasting))
spatial deterministic		
0.125 ~16km	4.5/9km	1km
spatial probabilistic		
~33km	11.6km	-

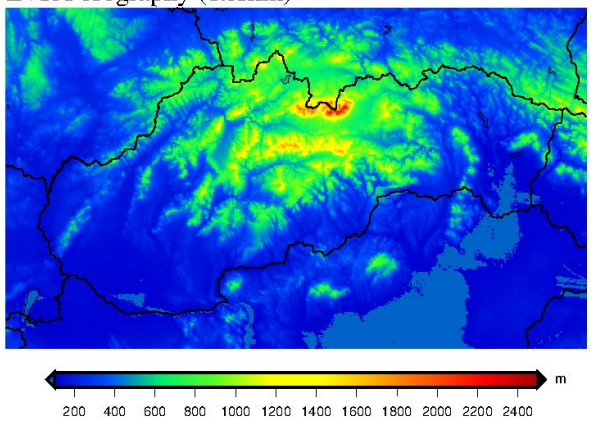
ECMWF orography (0.125deg)



ALADIN orography (4.5x4.5km)



INCA orography (1x1km)



INCA nowcasting system (1)

nowcasting = very short forecast (0-6/12h) aiming to predict high impact phenomena => high spatial and temporal resolution

INCA-CE project (www.inca-ce.eu) INCA-CE Nowcasting for Central Europe

INCA corrects the NWP model (ALADIN) forecasts with real-time observations applying:

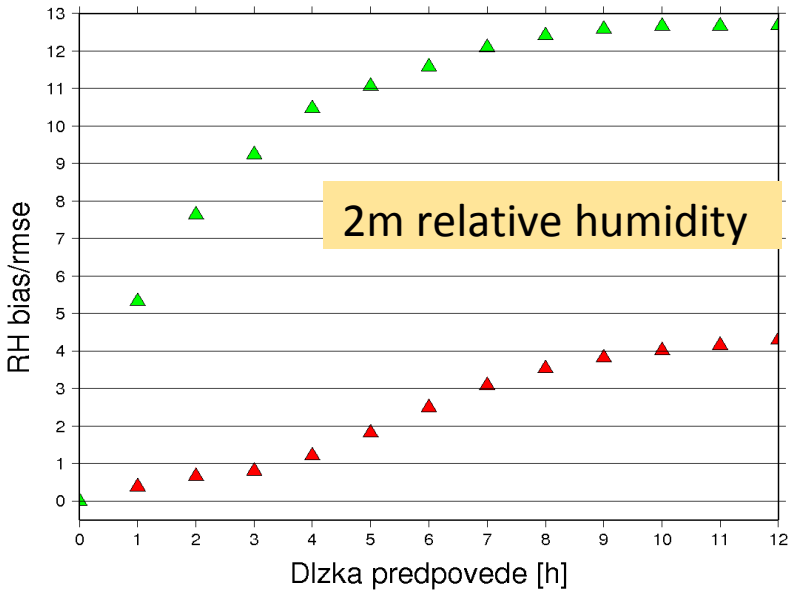
- objective analysis
- statistical extrapolation in time
- empirical corrections of forecasted fields

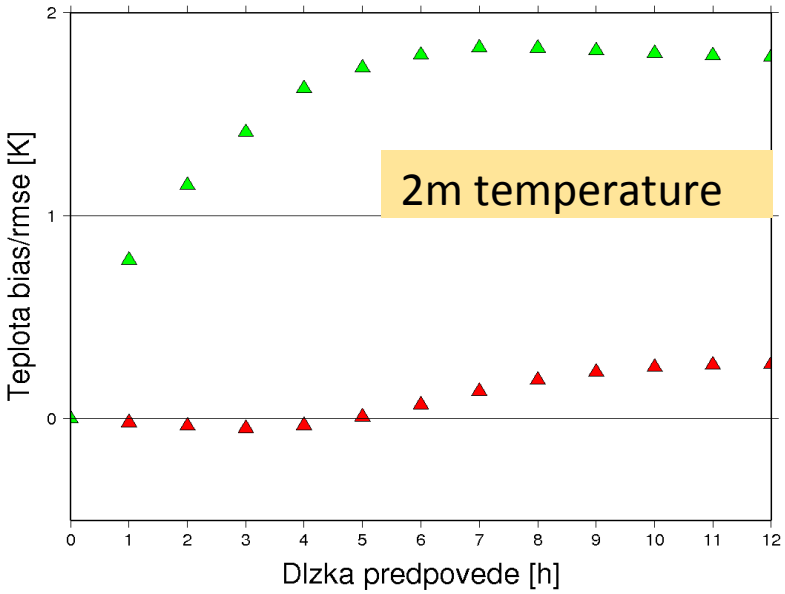
resolution:

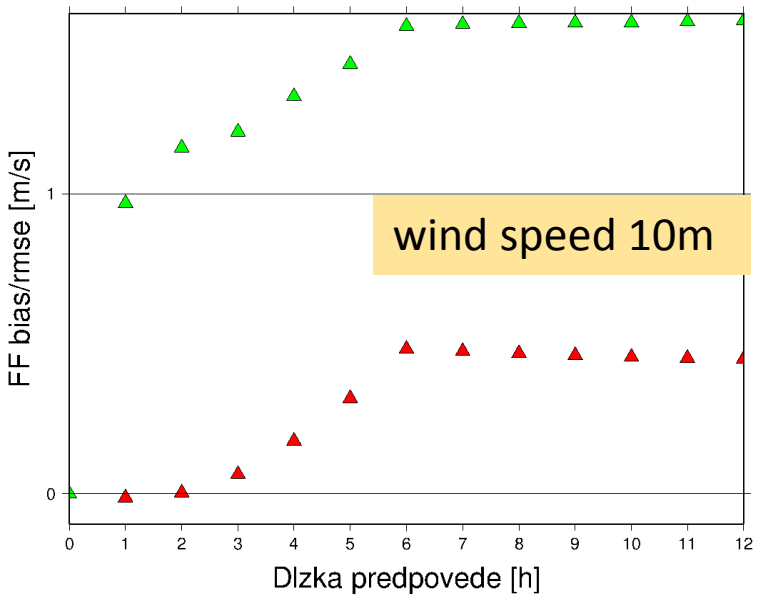
- horizontal: 1x1km
- vertical: 21 levels with resolution of 200m (T, q) and 125 (wind)
- temporal:

INCA nowcasting system (2)

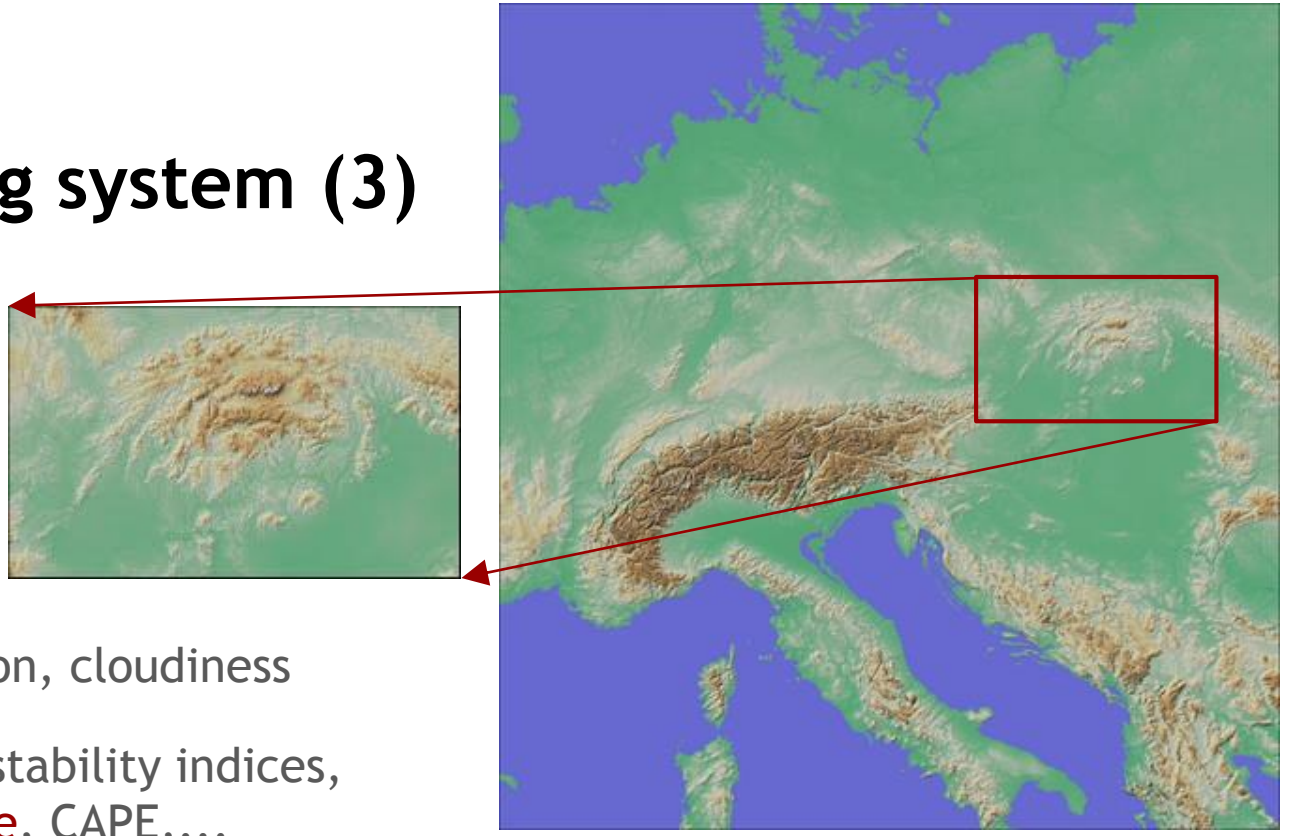
scores wrt observations (BIAS) and (RMSE); note the relaxation to NWP driving model after ~6h







INCA nowcasting system (3)



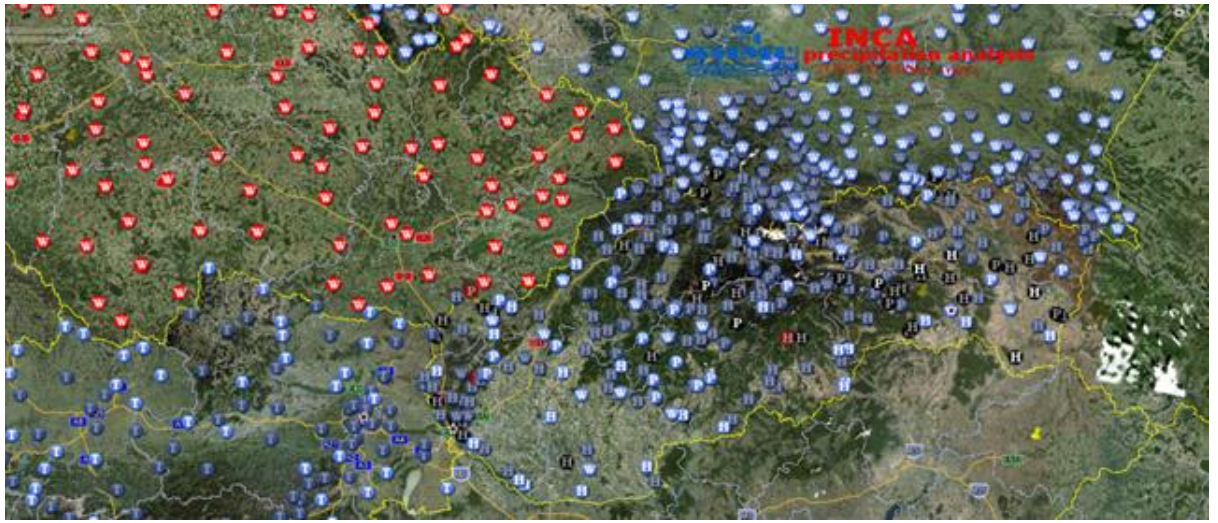
Domains: EU and SK

Fields:

- 3D: T, RH, wind
- 2D: total precipitation, cloudiness
- derived: wind gust, stability indices, 0-isotherm, snow line, CAPE,...

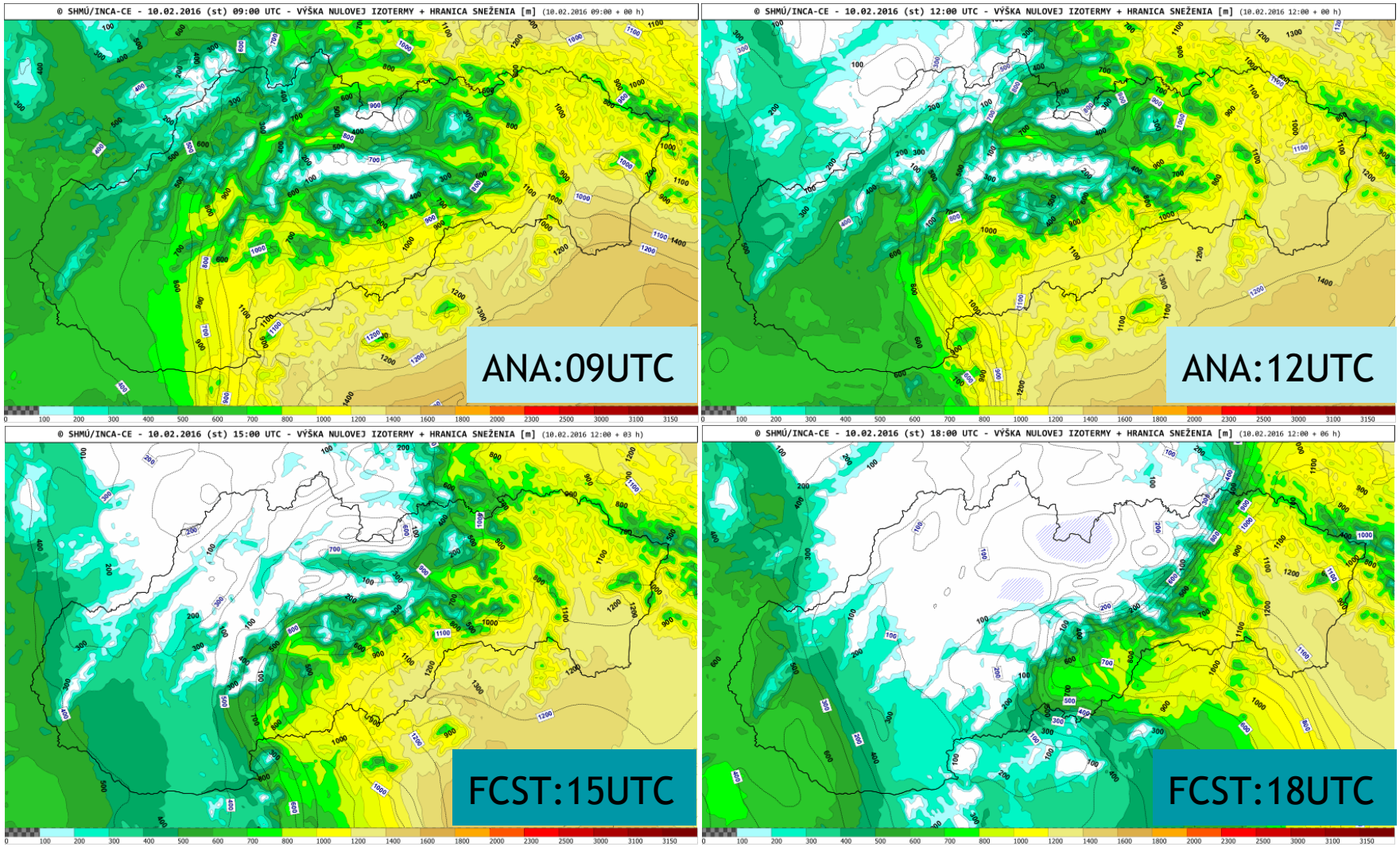
Observations:

- SYNOP, AWS, APS, AHS,
- TEMP, radar, satellites (NWCSAF)
- NWP data
- international data exchange within INCA-CE project



INCA: example of snow-related quantities

0 isotherm above terrain (color) and snow line height (lines): example of 10/02/2016

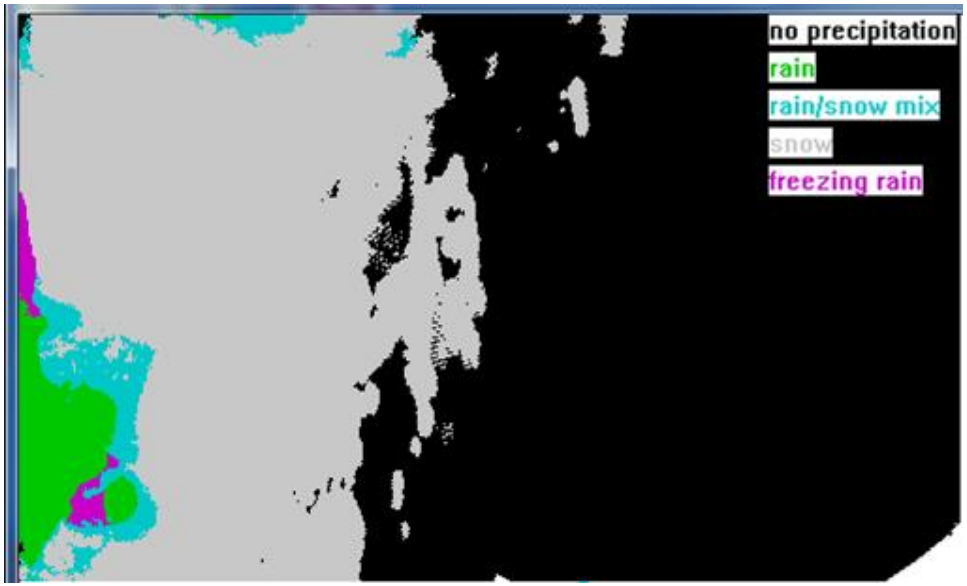


INCA:new development

distinction of precipitation types according to the wet bulb temperature

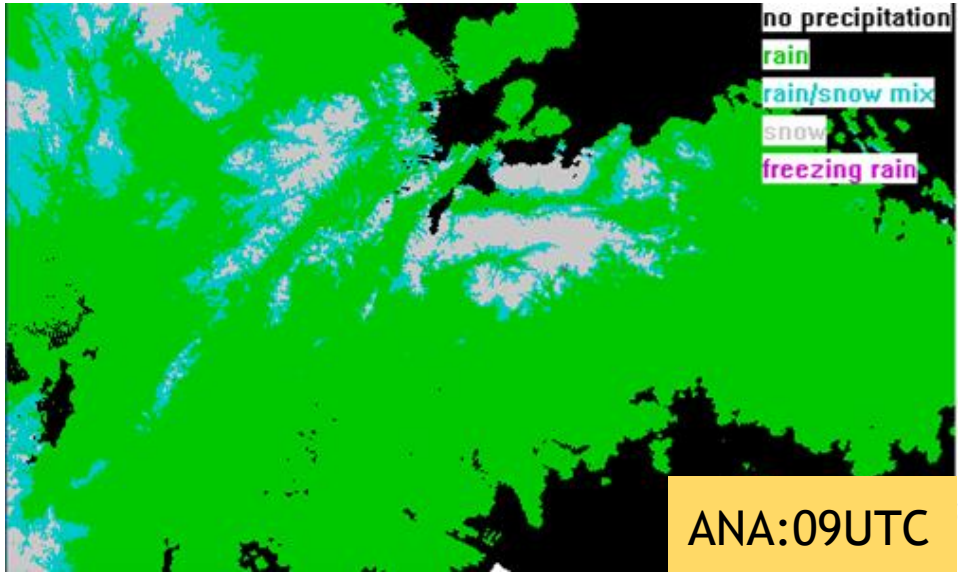
5 categories (2D array):

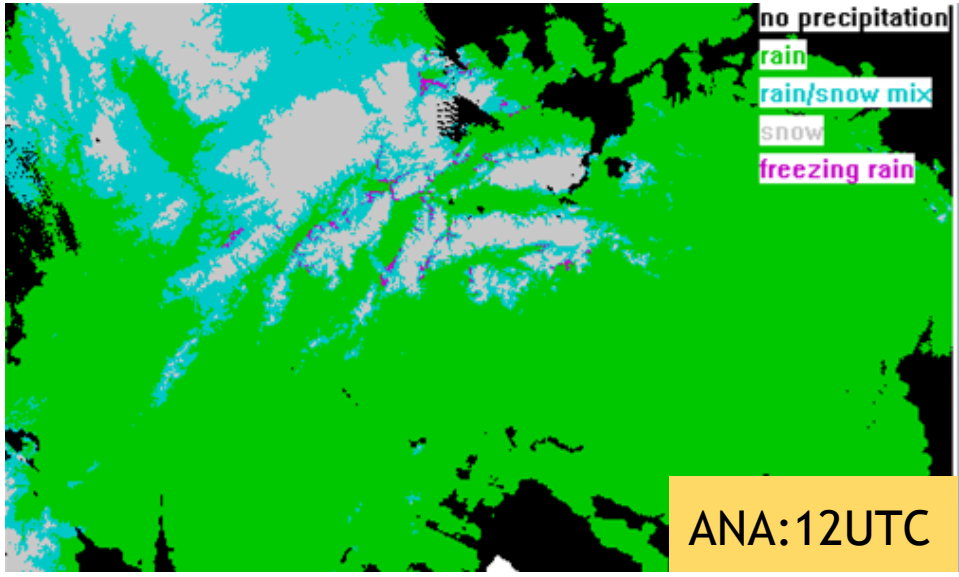
- no precipitation
- rain
- rain/snow mix
- snow
- freezing rain

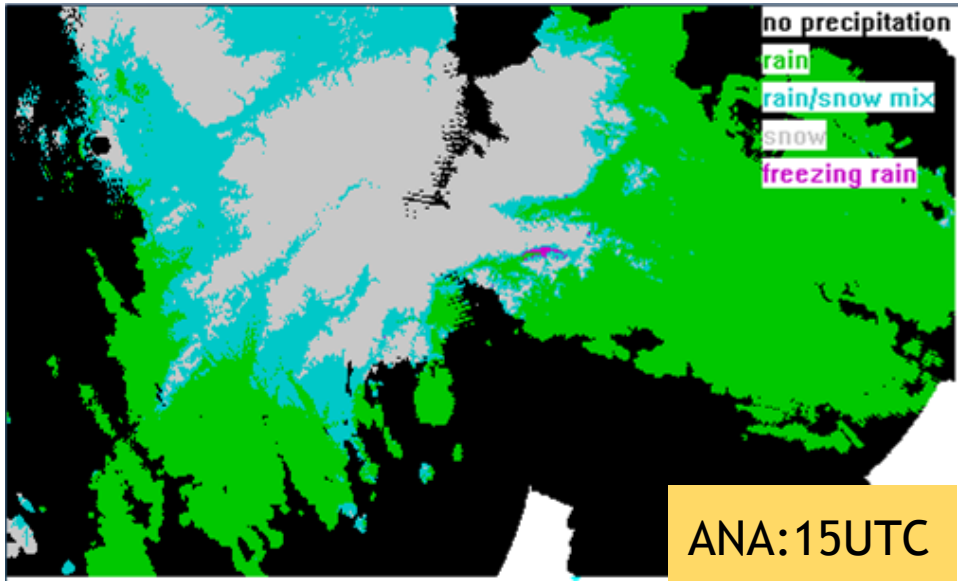


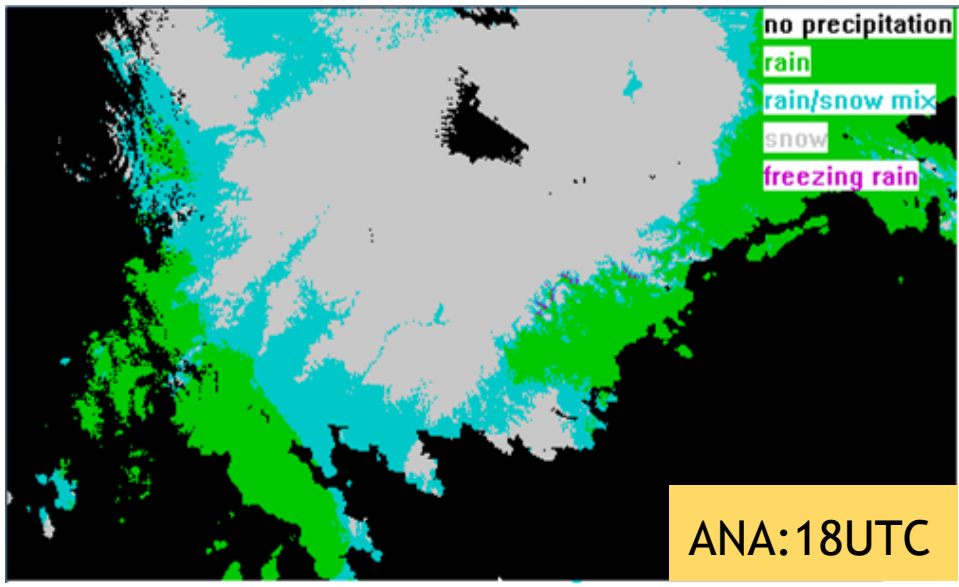
T_ω<2°C	$z_s - z < -1.5\Delta z_{melt}$	snow
	$1.5\Delta z_{melt} < z_s - z < -0.5\Delta z_{melt}$	mix rain/snow
	$z_s - z < 0.5\Delta z_{melt}$	rain
$T_\omega \geq 2°C$		rain
T_{ground}<0°C and T < 2°C or T<0°C		freezing rain

INCA precip distinction for 10/02/2016 situation









Numerical Weather prediction

NWP model **ALADIN**

operationally exploited 4x/day (00, 06, 12, 18UTC) up to +72hours with hourly model outputs

coupled to global model Arpege

hydrostatic dynamics, ALARO-0 physics, ISBA surface scheme

Assimilation

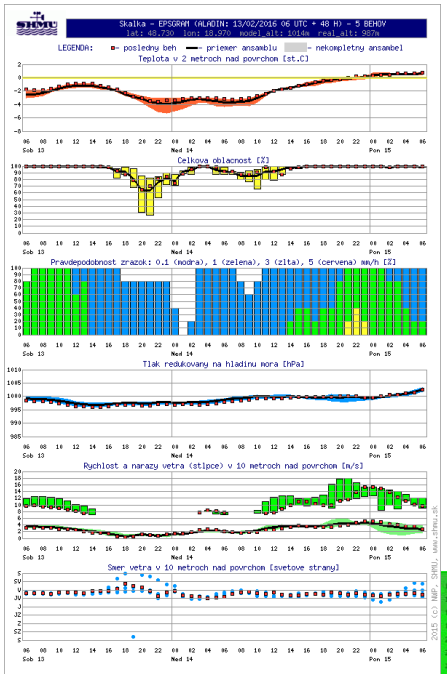
pseudo-assimilation (no data) spectral blending by DFI for upper-air;

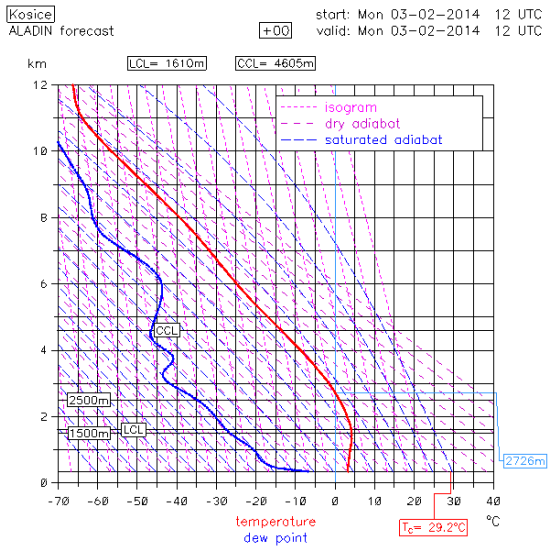
CANARI scheme based on optimal interpolation for surface analysis: SYNOP 2m T and 2m RH measurements used to analyze T_{surf} and RH_{surf}

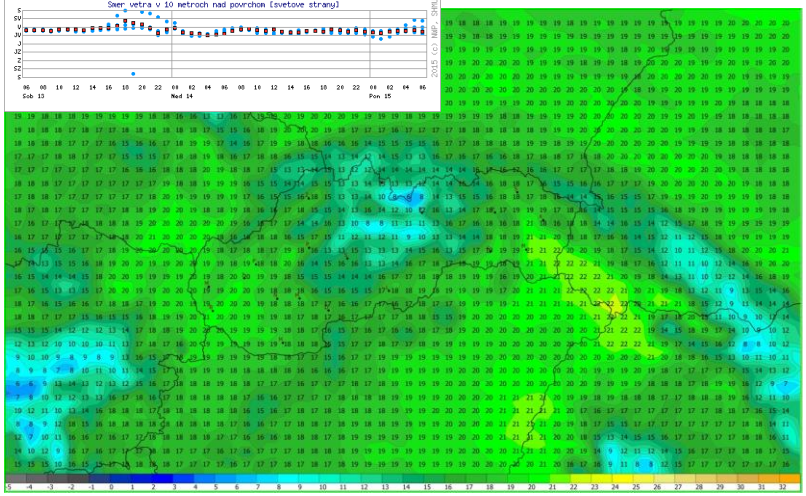
Output

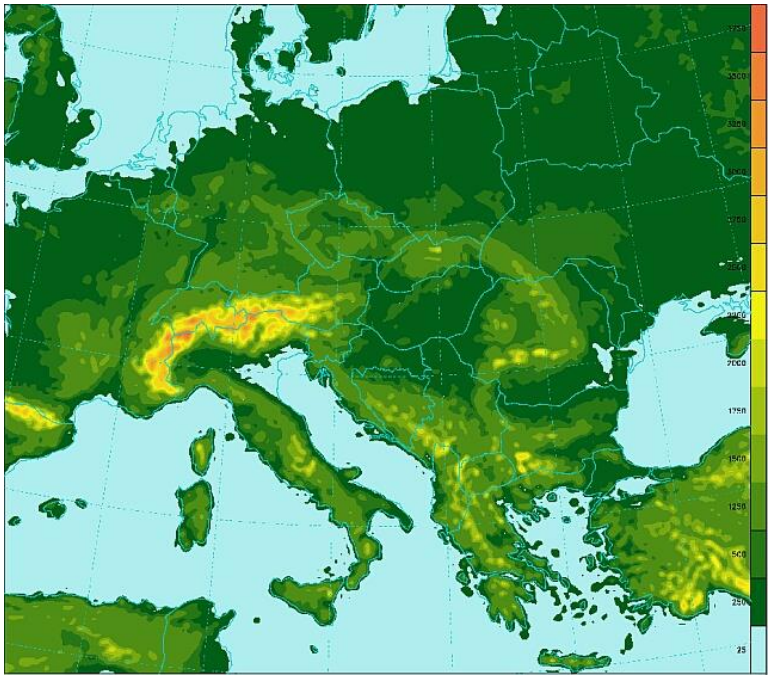
3D/2D prognostic & diagnostic parameters: T, RH, U,V, p_s, precipitation, TKE, cloudiness...

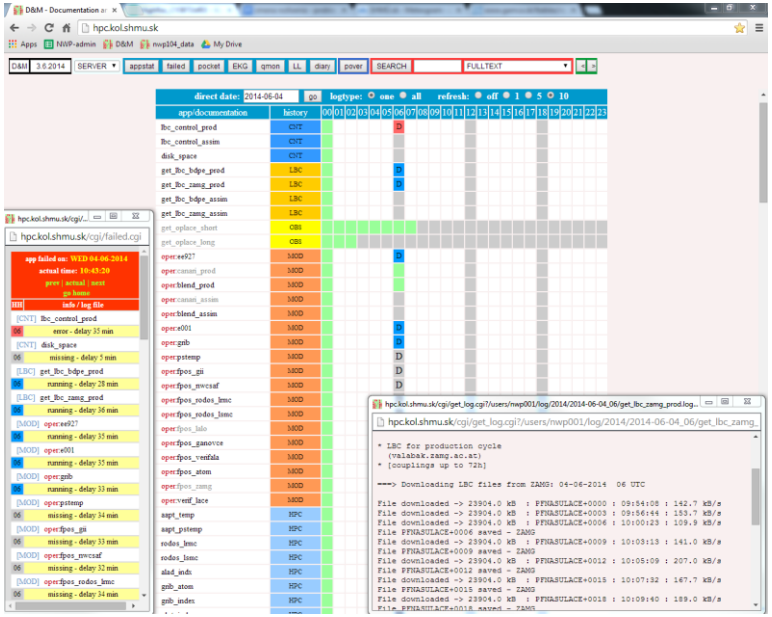
NWP system ALADIN











ALADIN operational & e-suite

	OPER	E-SUITE
resolution	9x9km (320 x 288pts)	4.5x4.5km (625 x 576 pts)
spectral trunc & grid	106x95 quadratic	312x287 linear
vertical levels	37	63
orography	envelope orography	mean orography (old Z0)
cycle	CY36T1 (3MT, SLHD)	CY38T1_bf03_export
physics	ALARO 3MT, SLHD	ALARO-0/1 baseline
assimilation/initialization	upper air spectral blending with CANARI surface assimilation, no initialization	
coupling model	ARPEGE (long- & short cut off), 3h frequency	

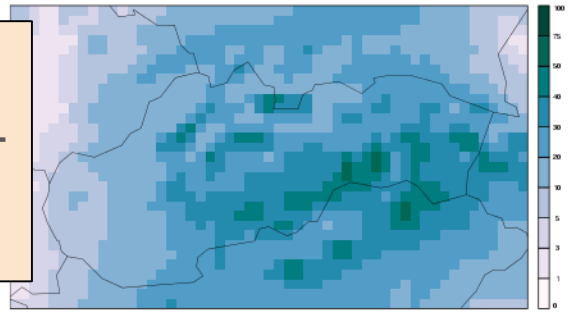
10/02/2016 situation: 24h precipitation/snow

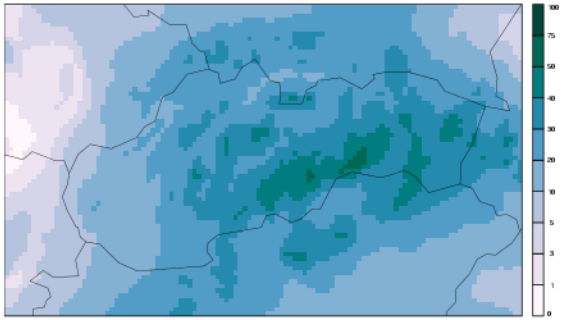
operational

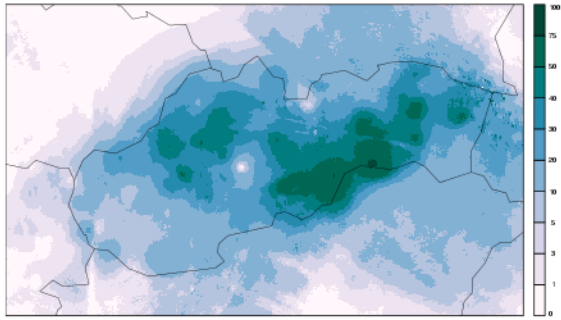
e-suite

INCA analysis

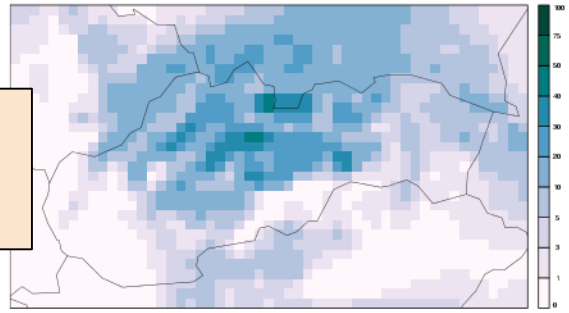
total prec

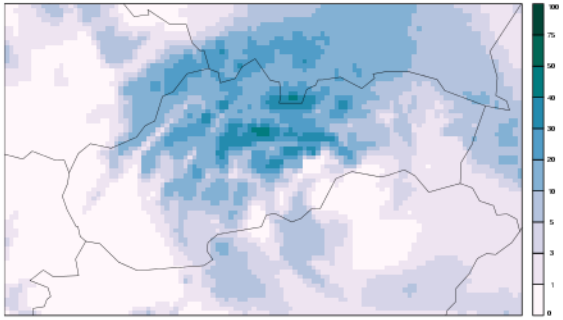






snow





Motivation (1)

Winter 2013/14: long-lasting negative temperature BIAS on almost all SK stations was observed, probably due to unrealistic snow cover in ALADIN.

Not observed during winter 2012/13 (neither during 2014/15) despite no change in the operational setup.

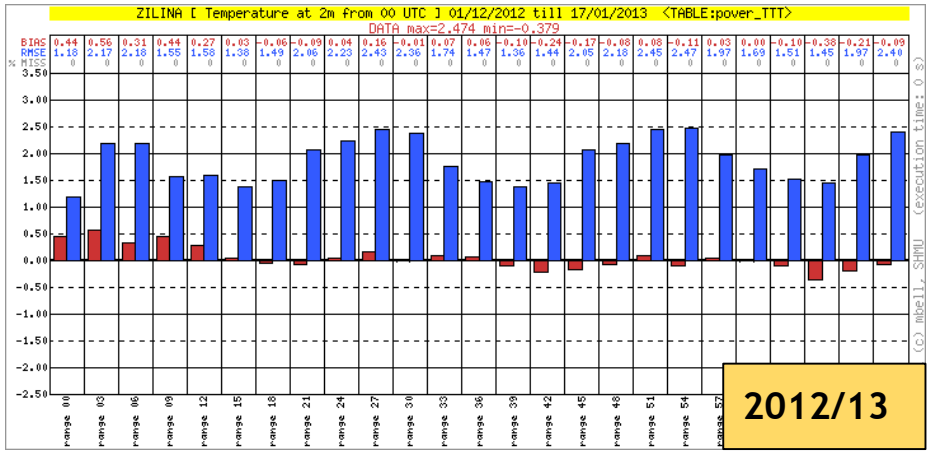
In reality there was NO SNOW in January 2014 over whole Slovak territory except highest mountains.

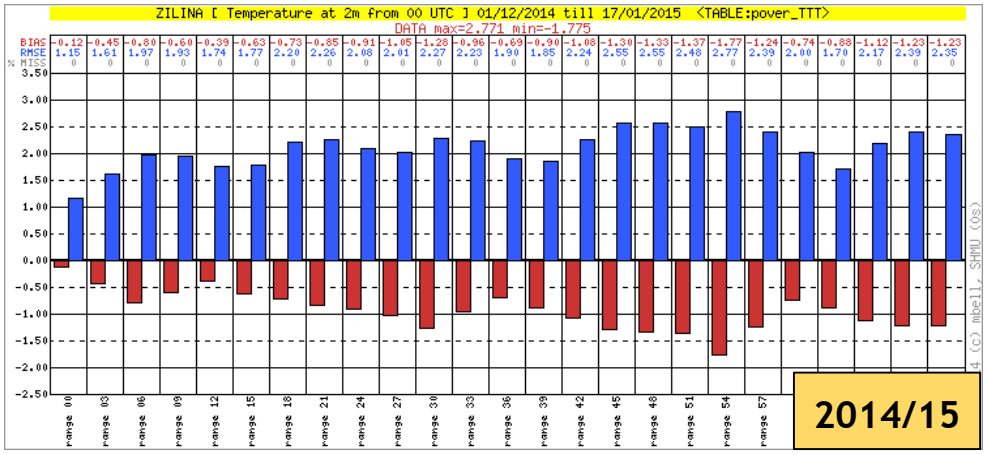
Snow cover is not analyzed in CANARI, but it is cycled from the guess.

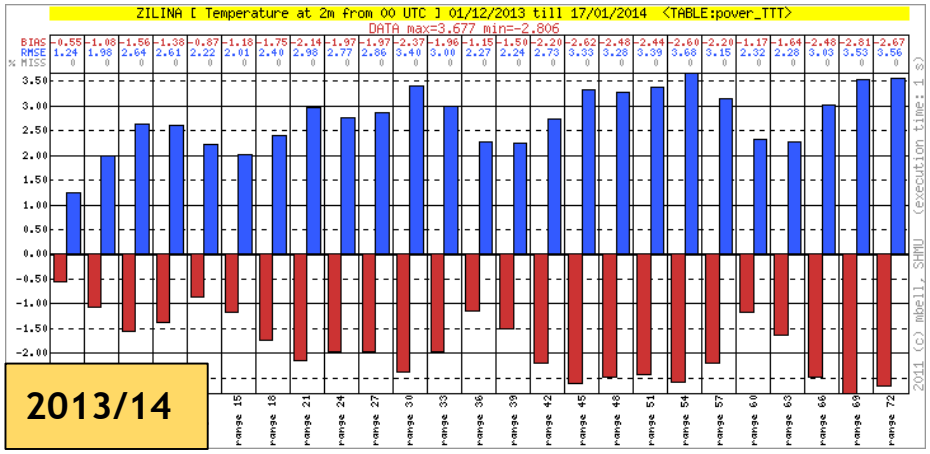
There was much less snow in Arpege (in LBC), but its amount was changing forecast to forecast!

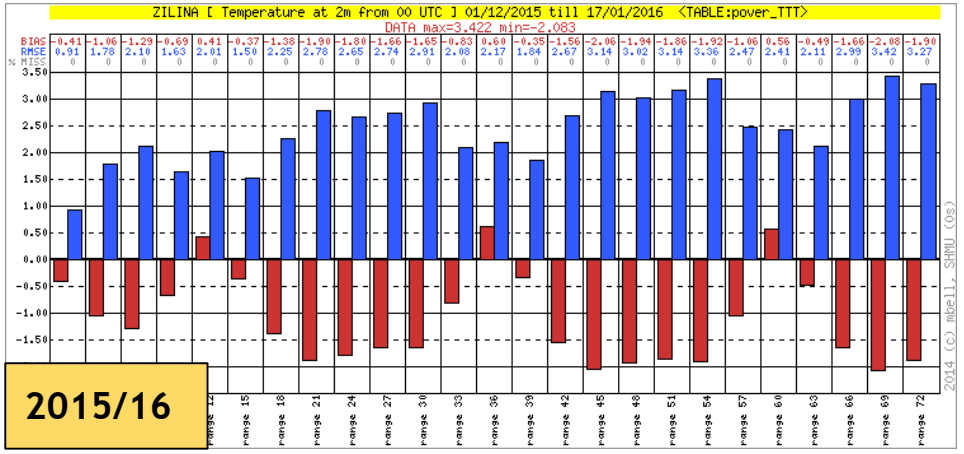
Motivation (2)

2mT scores for Zilina, 01/12-17/01: Cold 2m temperature BIAS (red) in winter 2013/14 (and 2015/16) despite no change of operational setup





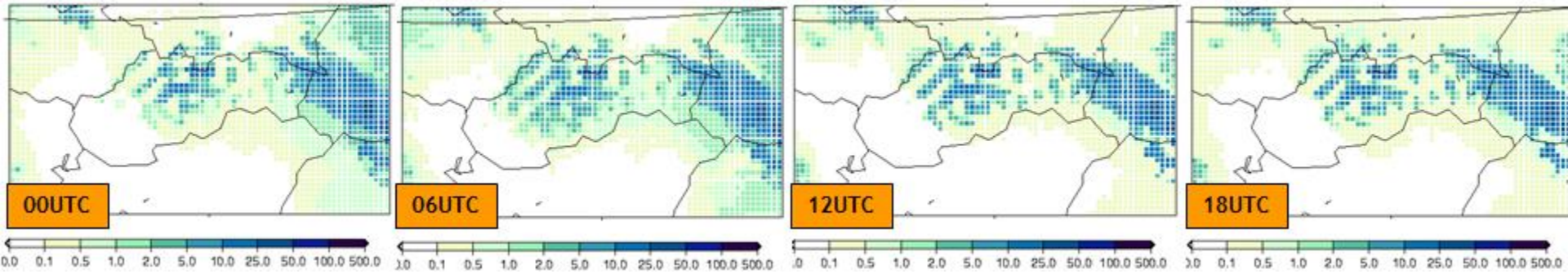




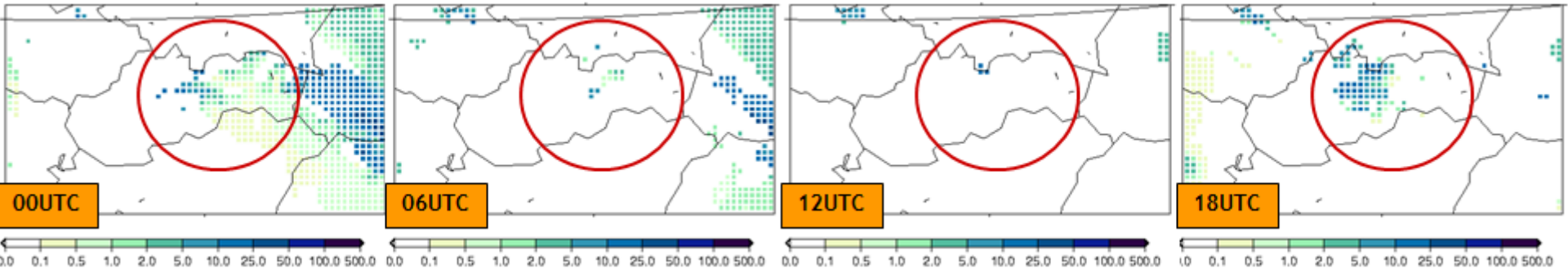
Motivation (3)

example of the snow reservoir on 15/01/2014 in assimilation files (+0000) - no snow fall that day

ALADIN: completely unrealistic (there was no snow at all), but consistent from NT to NT



ARPEGE: more reasonable, but changing with network times (this is generally observed feature)



Motivation (4)

No assimilation of snow quantities @ ALADIN/SHMU

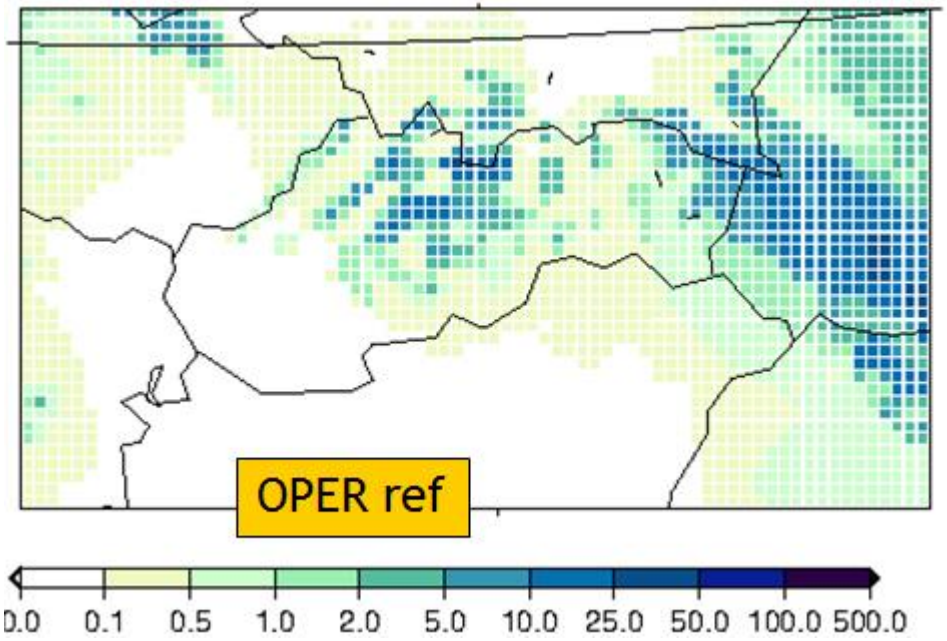
Snow comes from guess, and only new precipitation and melting taken into account

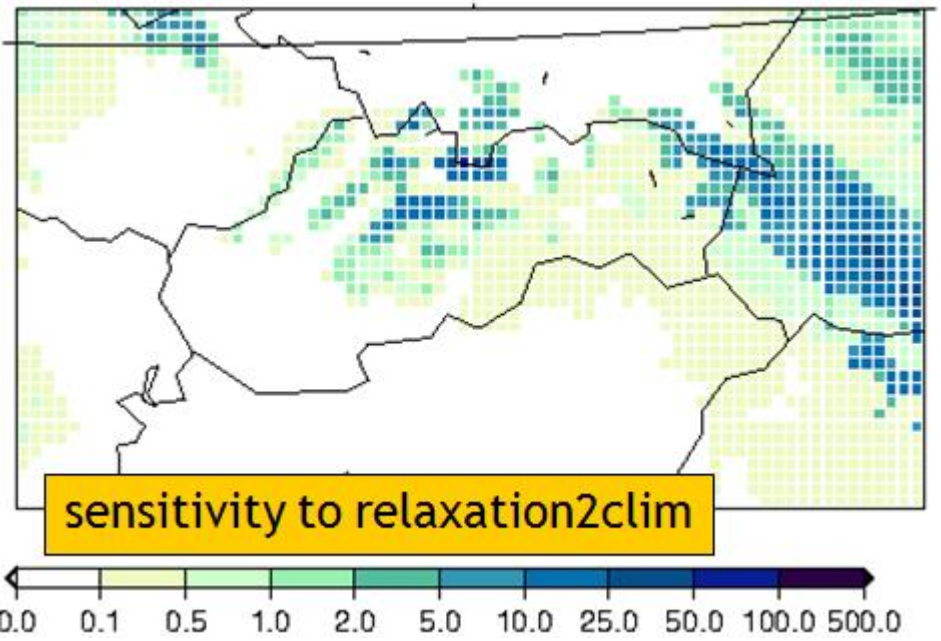
Few experiments with tuning of relaxation to climatology parameter and with additional snow melting parameter performed – no big improvement

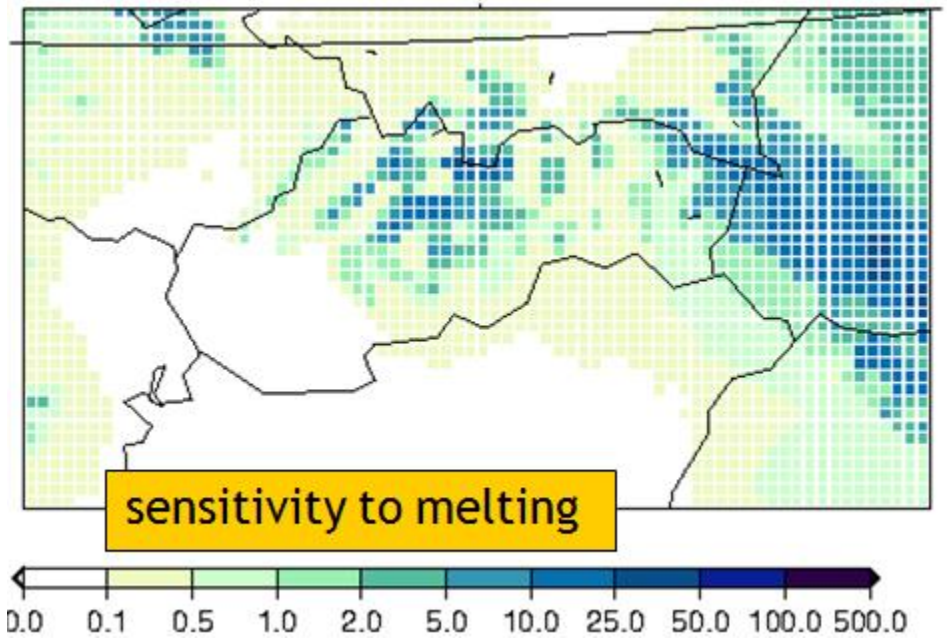
Need of snow analysis => Let's have a look what measurements are available and how our European colleagues do?

Motivation (5)

Snow cover in analysis after 6weeks of assimilation: 15/01/2014 00UTC sensitivity to relaxation 2 clim is weak, sensitivity to melting is negligible



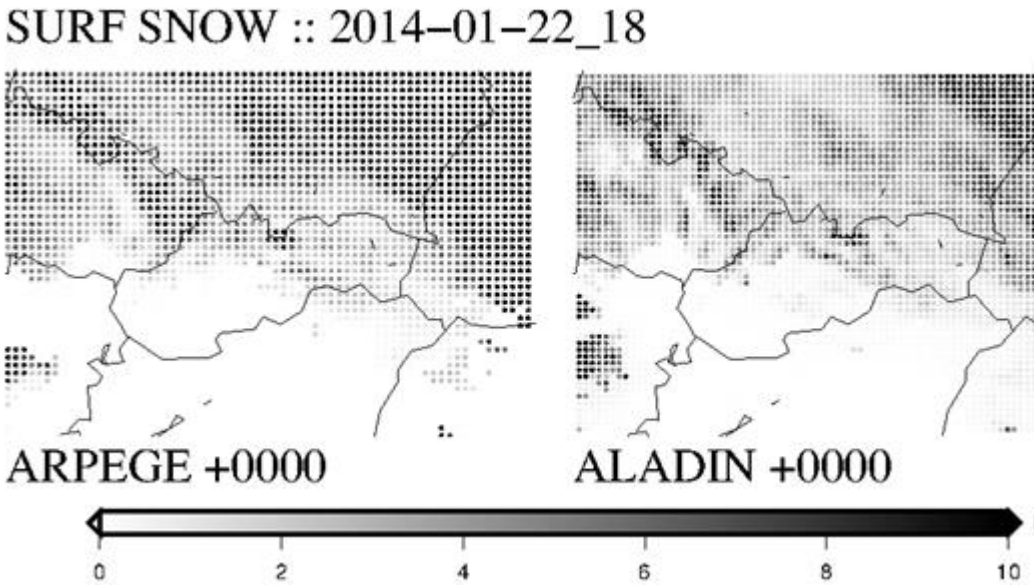


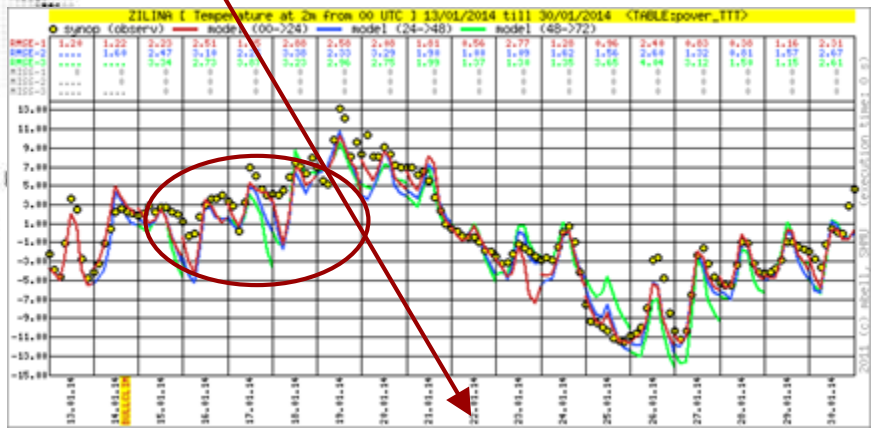


Motivation (6)

Solution: it was snowing on 22/01/2014 in Slovakia => snow cover => T2m BIAS “under control”

Stop joking: there is a need to work on snow analysis





Plans relevant wrt COST ES1404 WG3

new supercomputer with upgraded ALADIN version

Improve operational forecasts

SURFEX (CROCUS snow model), 3DVAR, AROME

project with MRS in preparation

Check what observations & measurements are available

(European snow DB? - yes, restricted access)

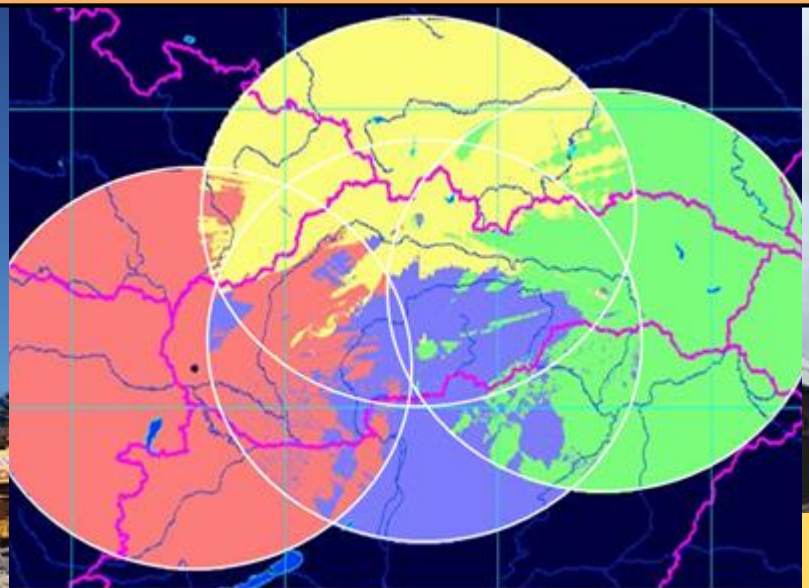
Learn what other Partners do

Contribute with work/R&D results to COST ES1404 WG3

POVAPSYS: Upgrade of the SHMU infrastructure (1)

automatic station network upgrade:70->137 APS, 32->91 AWS

Radar network: 2 upgraded + 2 new will be installed



POVAPSYS: Upgrade of the SHMU infrastructure (2)

current HPC	new HPC(~1.26x)
IBM p755	IBM Flex System p460
4x Power7 8core CPUs (3.6 GHz), 256 GB RAM	4x Power7+ 8core CPUs (3.6 GHz), 256 GB RAM
10 nodes	12 nodes
AIX 6 SE OS	Red Hat Enterprise Linux