A comparison of mesoscale analysis and dynamic adaptation methods for initial conditions for ALADIN over Slovenia

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Introduction

- accurate initial conditions cruical for successful forecast
- comparison of two operationally used strategies of initial conditions for LAMs
  - dynamic adaptation (e.g. Slovenia)
    - interpolation of global model analysis (ARPEGE)
    - assumption: processes on mesoscale mainly a result of adjustment to surface characteristics
  - mesoscale analysis (e.g. Hungary)
    - observations enter directly into the mesoscale model through data assimilation - higher resolution of observations
- comparison between model outputs and against observations
- we are interested in key differences and some cases

Assimilation sistems and models

- 4D-VAR analysis in ARPEGE
- upper-air 3D-VAR mesoscale analysis for ALADIN-HU
- NMC-type construction of **B** matrix
- no additional observation types in mesoscale assimilation but higher resolution (weaker thinning)
- soil analysis for ALADIN-HU taken from ARPEGE
- some differences between ALADIN models
  - ALADIN-SI: 9.5 km grid, 37 levels
  - ALADIN-HU: 8.0 km grid, 49 levels
- some configuration differences - model outputs (forecasts) not directly comparable

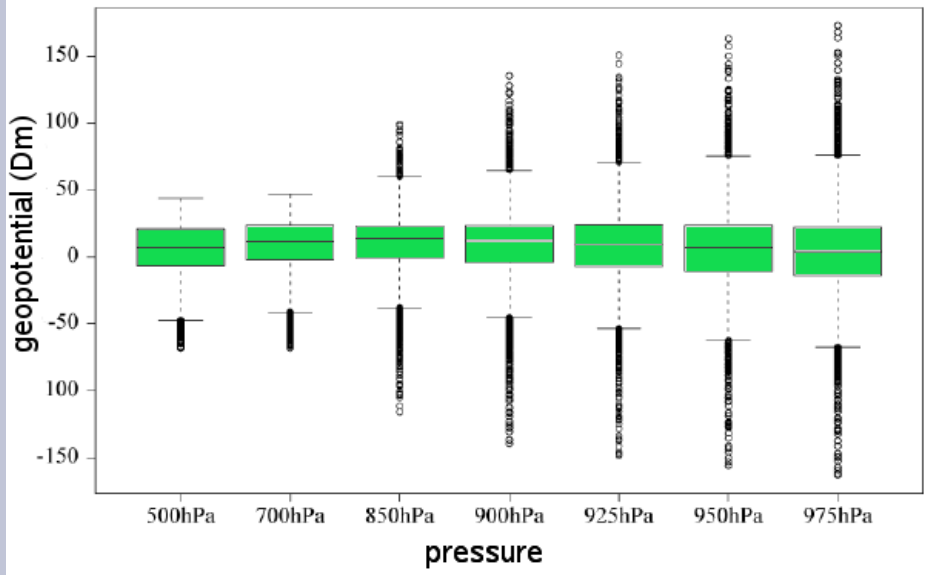
Data set and methodology

- 00 UTC analyses and 24h forecasts for the period of June 2006
- mesoscale analyses and forecasts provided by HMS
- post-processing to ALPS domain (covering the whole Alps and Slovenia) using *FullPos*
- horizontal resolution of 10 km, interpolation on pressure levels for easier interpretation
- gridpoint difference statistics for main fields

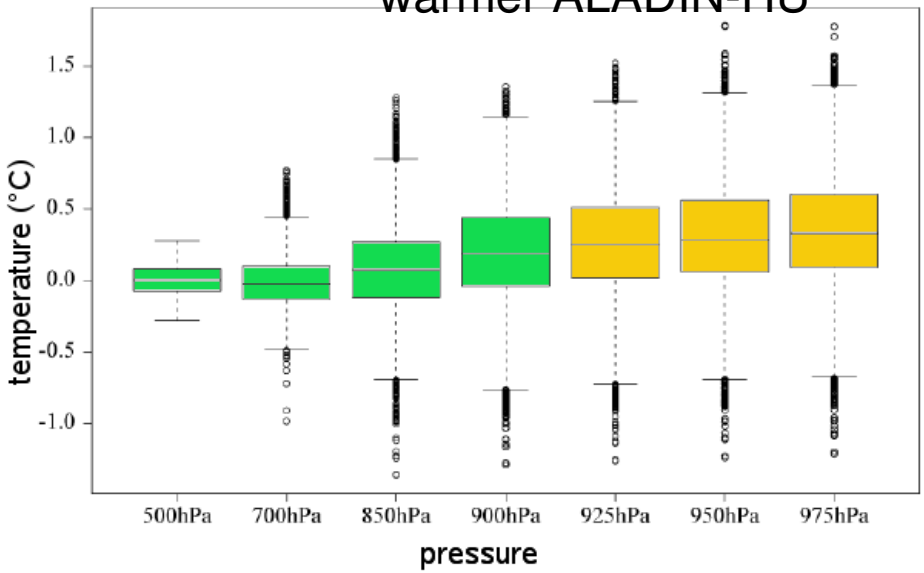
domain ALPS (in colors)

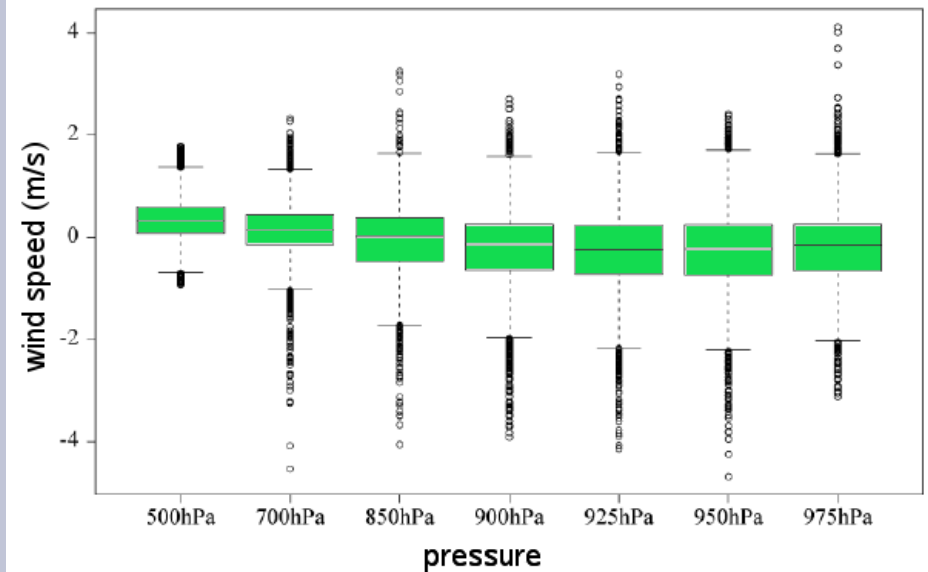
104 X 68 gridpoints, Δx = 10 km

Analysis: ALADIN-HU – ARPEGE

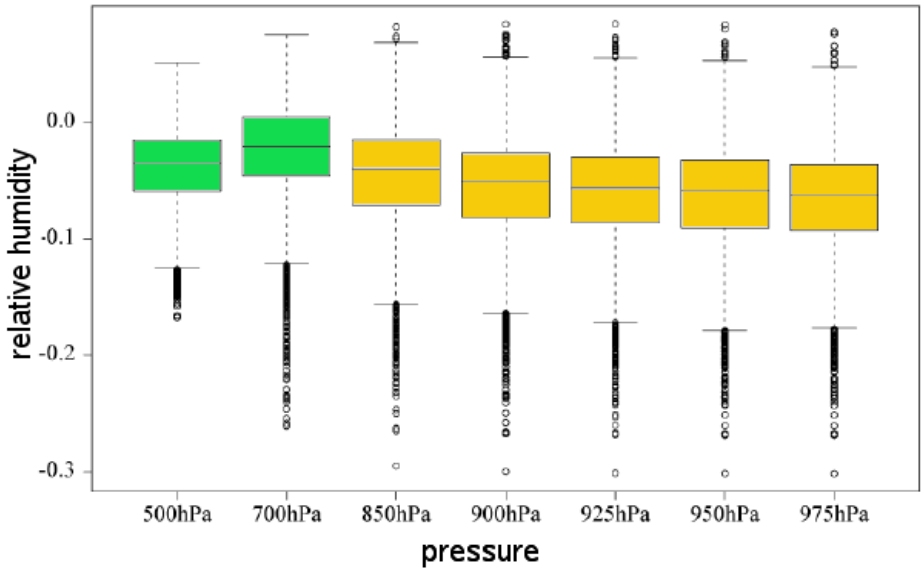


warmer ALADIN-HU



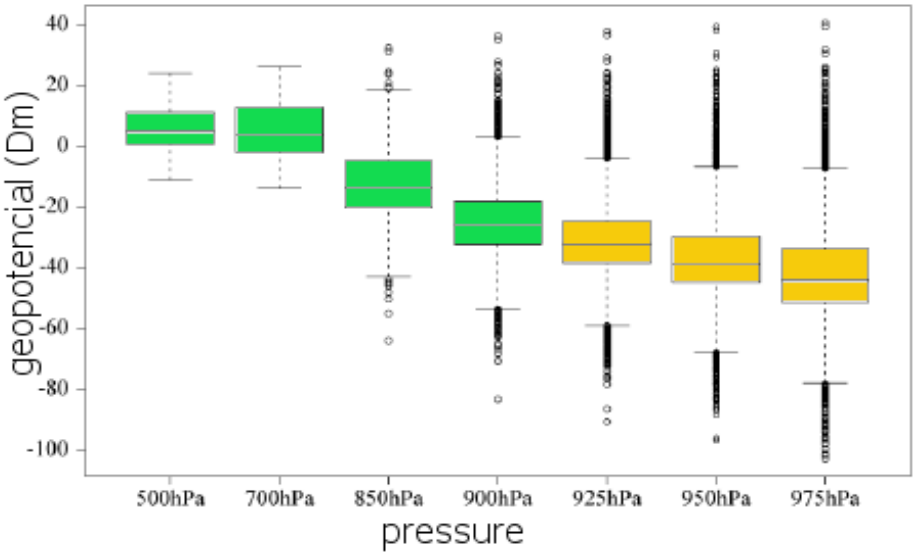


more humid ALADIN-SI

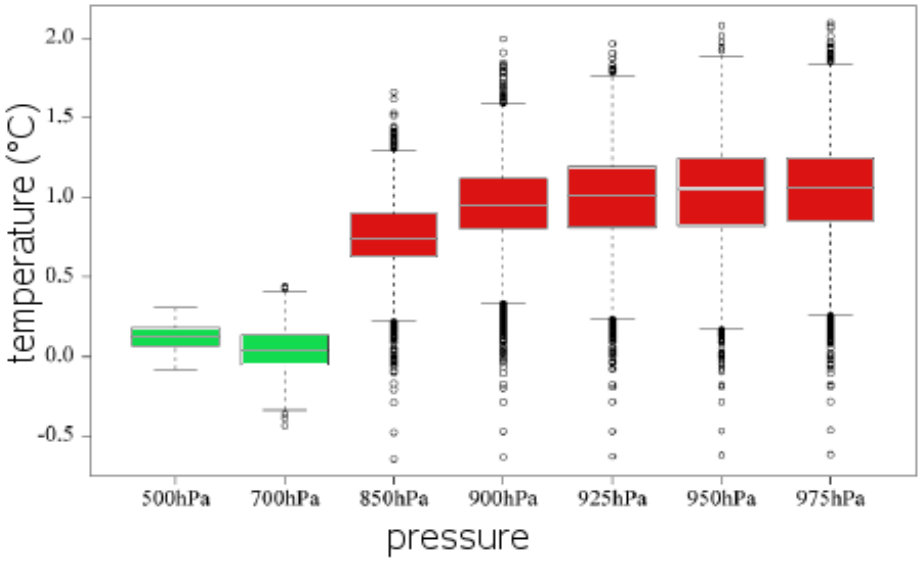


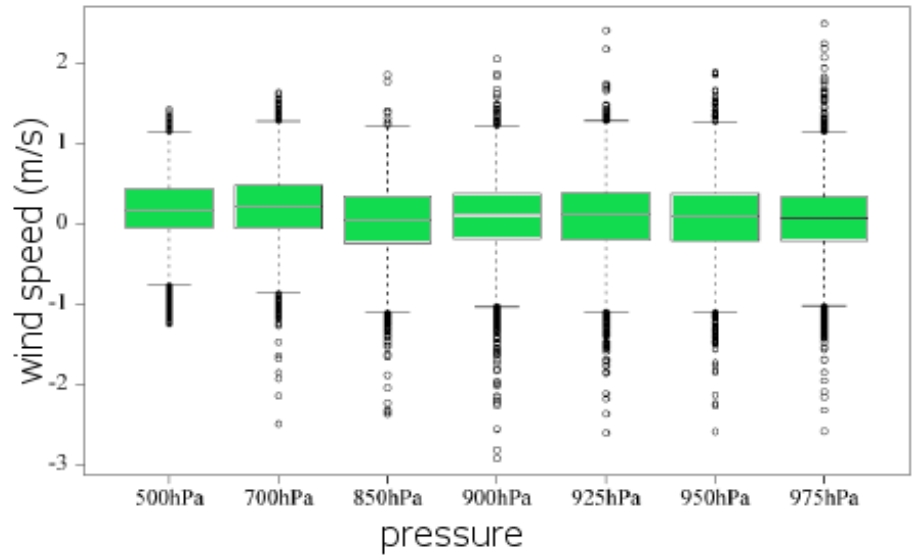
24-hour forecasts: ALADIN-HU – ALADIN-SI

differences also in Φ

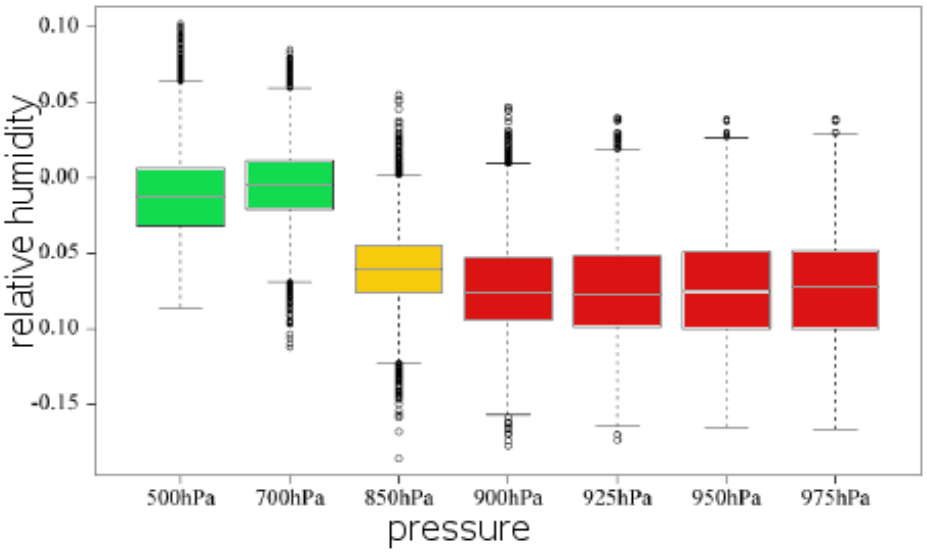


even warmer





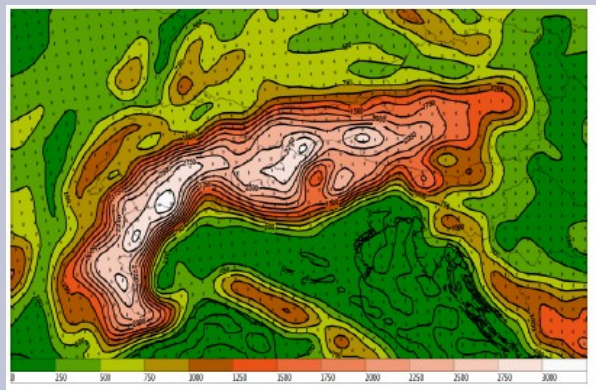
even more humid



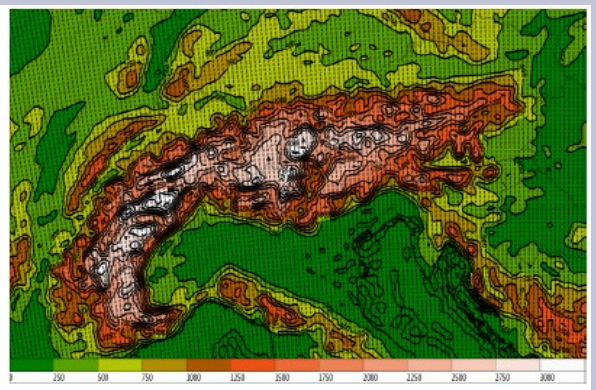
Relief representation of the analysis

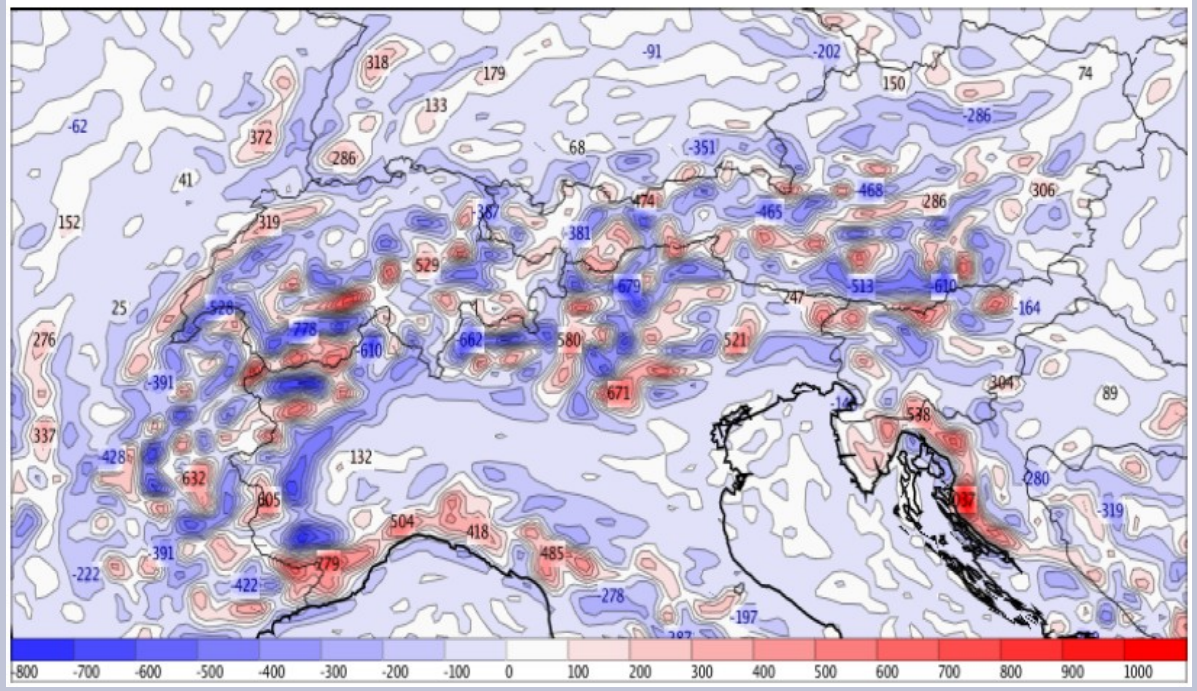
- quite many large differences in orography representation
- greatest differences:
  - on sharp mountain ridges
  - in the valleys and basins inside mountaineous regions

ARPEGE

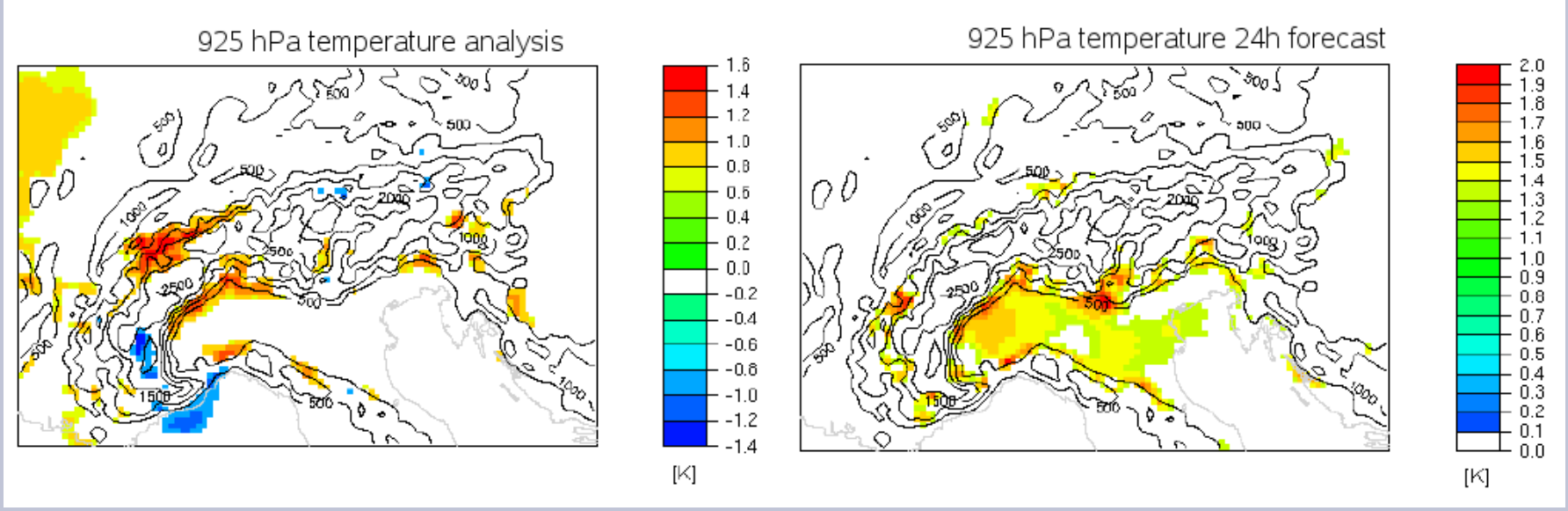


ALADIN-HU





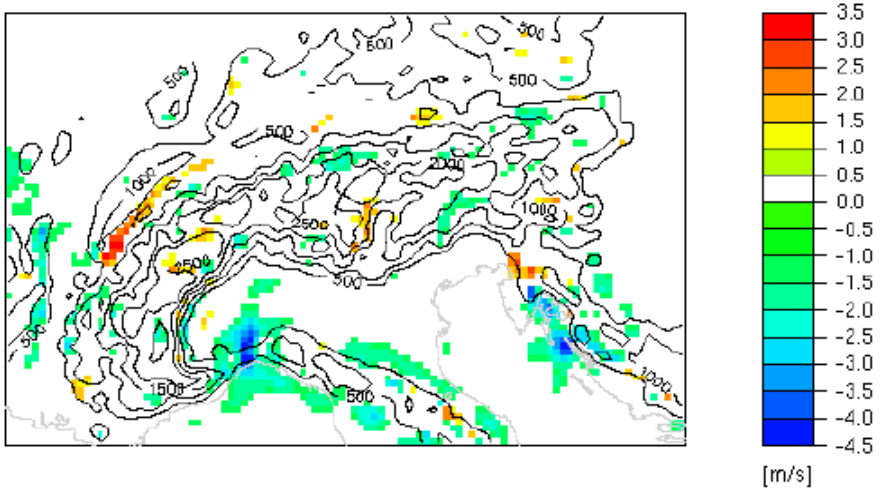
Spatial distribution of significant differences



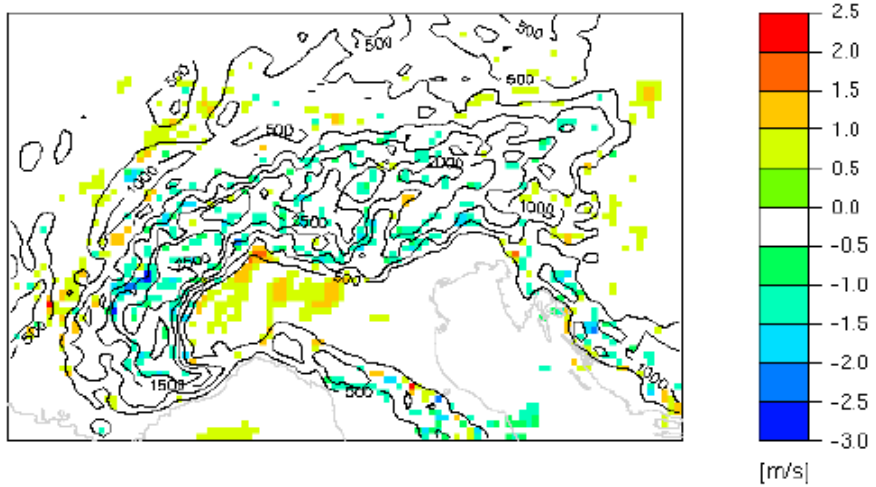
- interesting results under 700 hPa (1/10 greatest are shown)
  - geopotencial: observable differences in hilly regions
  - temperature: warmer ALADIN-HU, Po basin
  - wind: differences are random (rare soundings)
  - moisture: more moist ALADIN-SI, differences in analysis connected with orography differences

Spatial distribution of significant differences

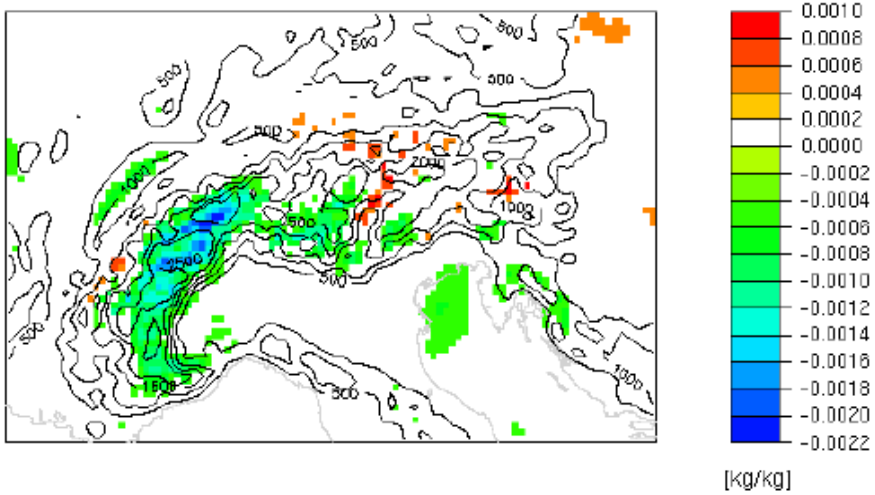
925 hPa wind speed analysis



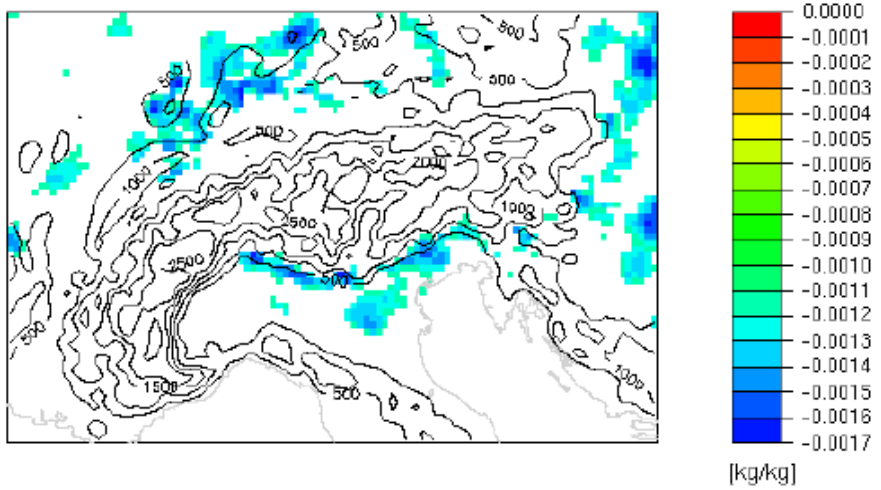
925 hPa wind speed 24h forecast



925 hPa absolute humidity analysis

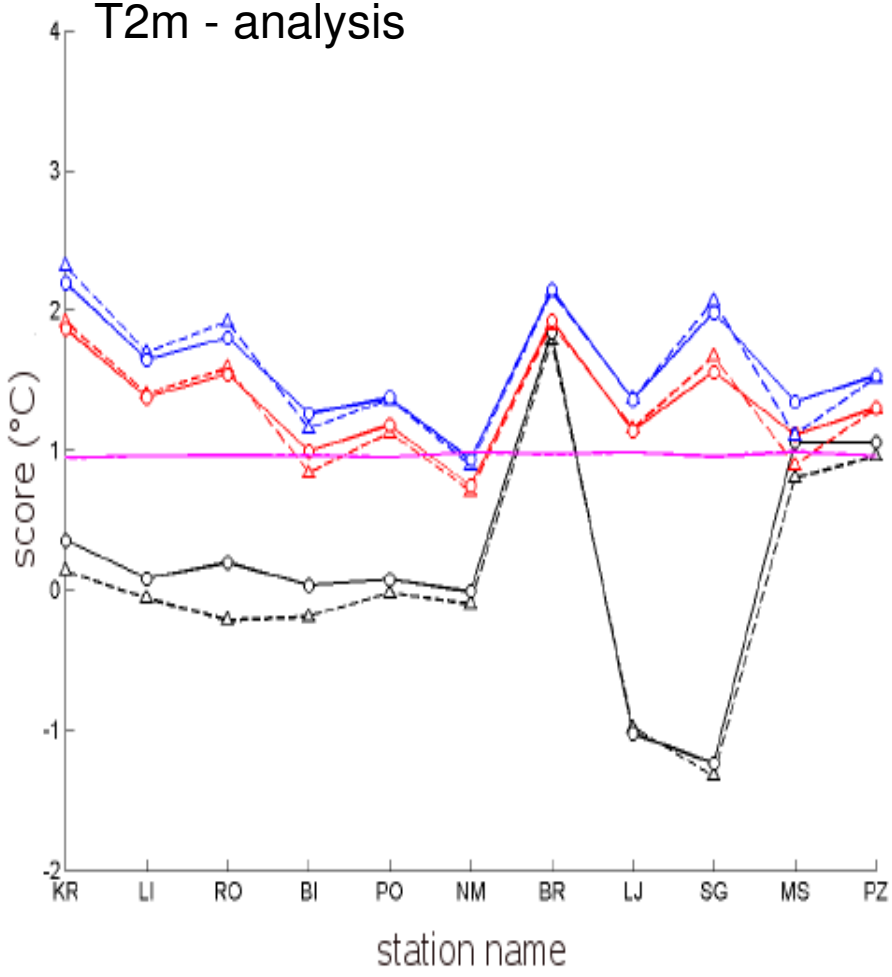


925 hPa absolute humidity 24h forecast

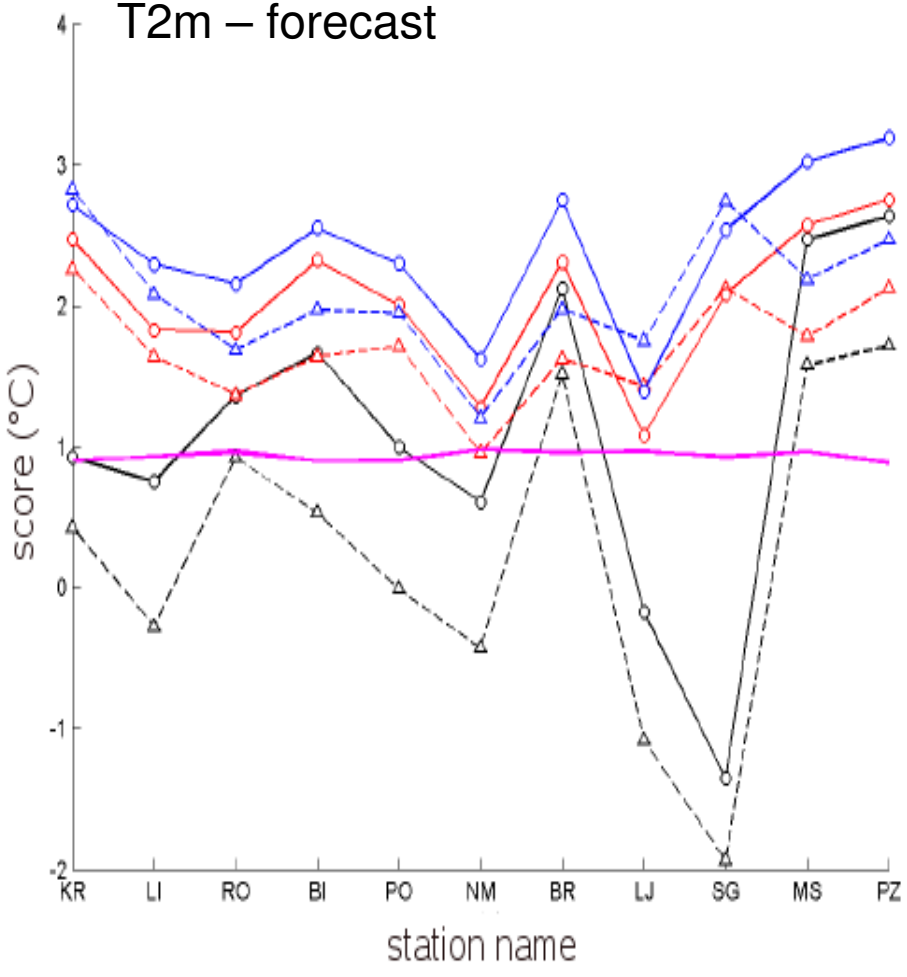


Verification - 2 m temperature

T2m - analysis



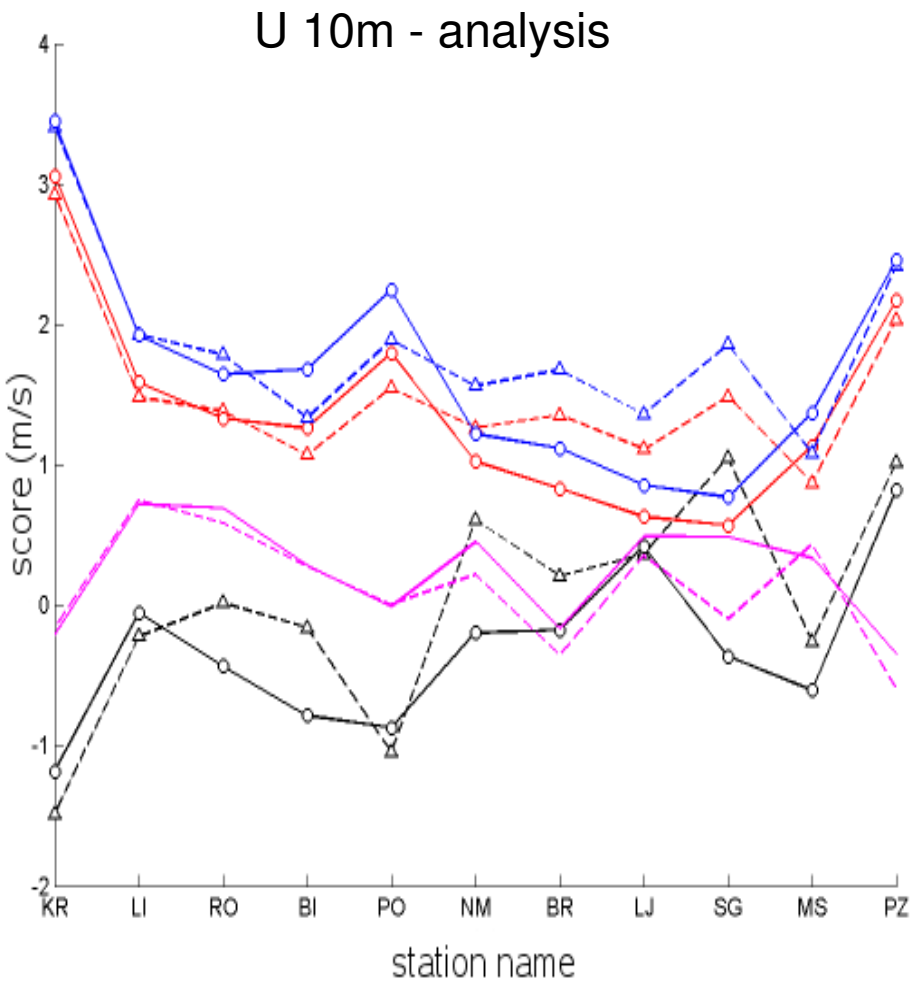
T2m – forecast

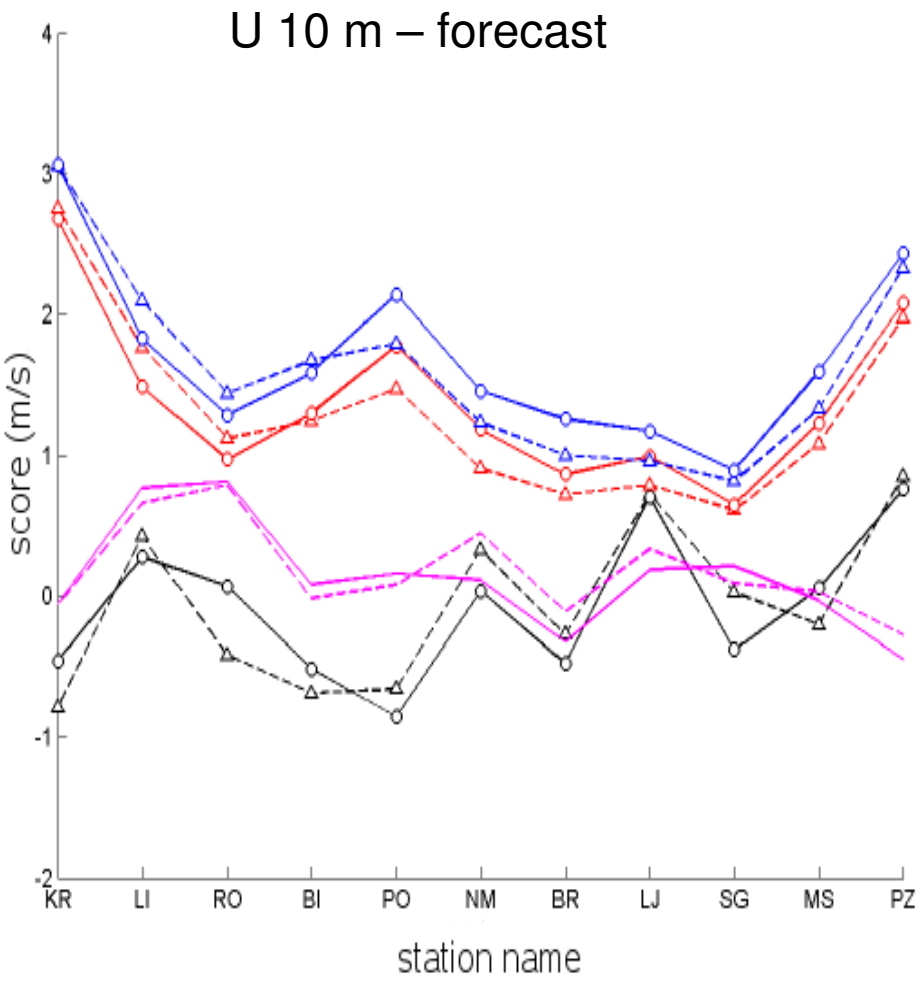


MAE RMSE bias AC

solid line: ALADIN-HU, dashed line: ARPEGE/ALADIN-SI

Verification - 10 m wind





MAE RMSE bias AC

solid line: ALADIN-HU, dashed line: ARPEGE/ALADIN-SI

Verification of precipitation

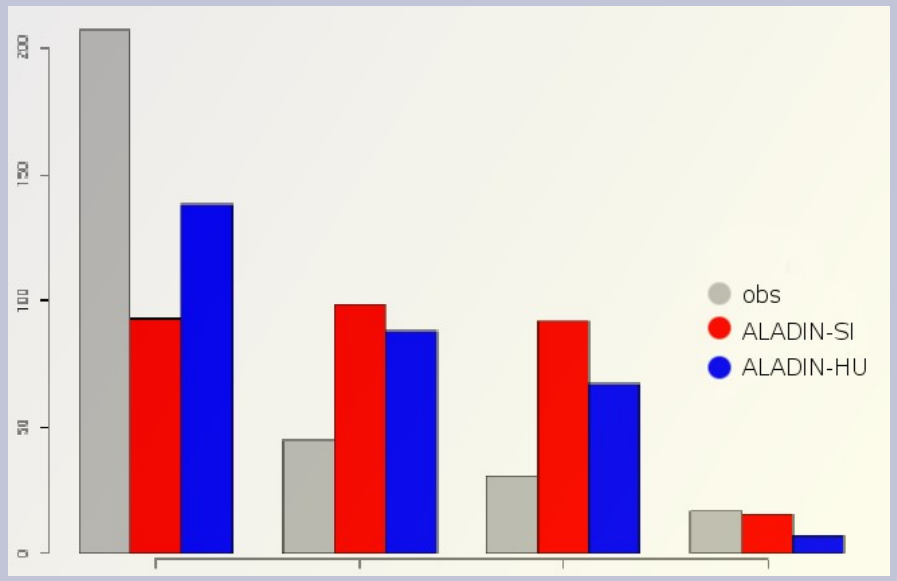
- multi-category verification
  - 11 slovenian automatic stations
  - 4 X 4 contingency tables - 4 standard classes
  - columns: observations
  - rows: forecasts

ALADIN-SI

forecast/observed	<=0.1 mm	>0.1 mm	>2 mm	>10 mm
<=0.1 mm	84	6	1	2
>0.1 mm	68	19	10	2
>2 mm	52	17	16	7
>10 mm	3	3	4	6

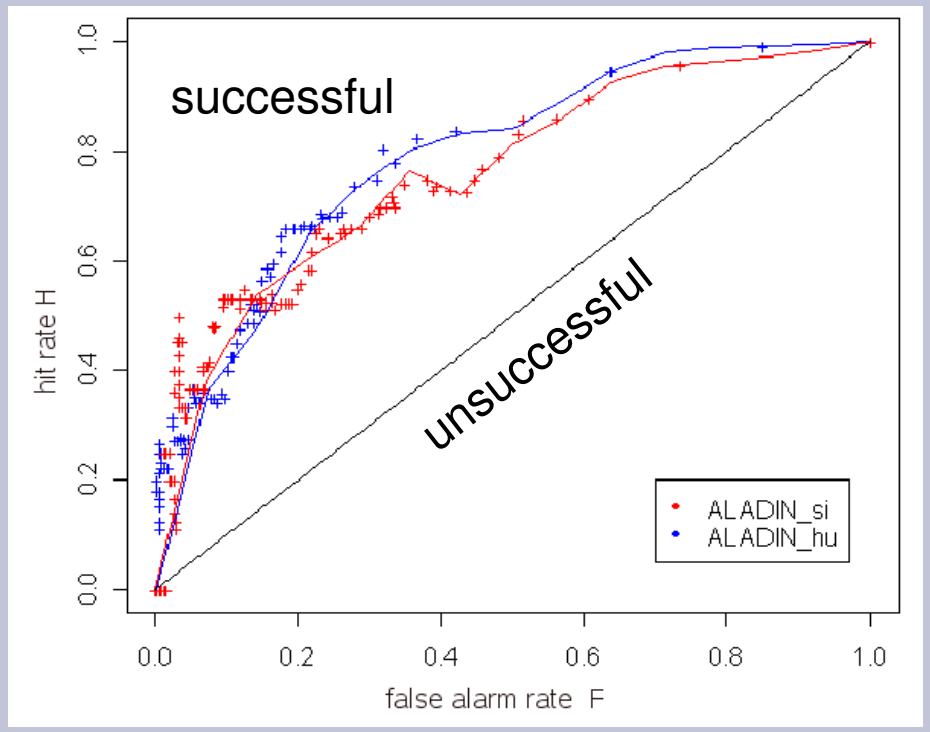
ALADIN-HU

forecast/observed	<=0.1mm	>0.1mm	>2mm	>10mm
<=0.1mm	123	8	6	1
>0.1mm	55	22	8	3
>2mm	29	14	15	9
>10mm	0	1	2	4



- both models predict too little dry days (precipitation amount <= 0.1 mm)
- both models predict too many rain events in categories 2 and 3
- ALADIN-HU more sucessful, except for cases with more than 10 mm precipitation

- binary verification: occurence or non-occurence of the event (given by threshold)
- 2 X 2 contingency tables, various scores, ROC

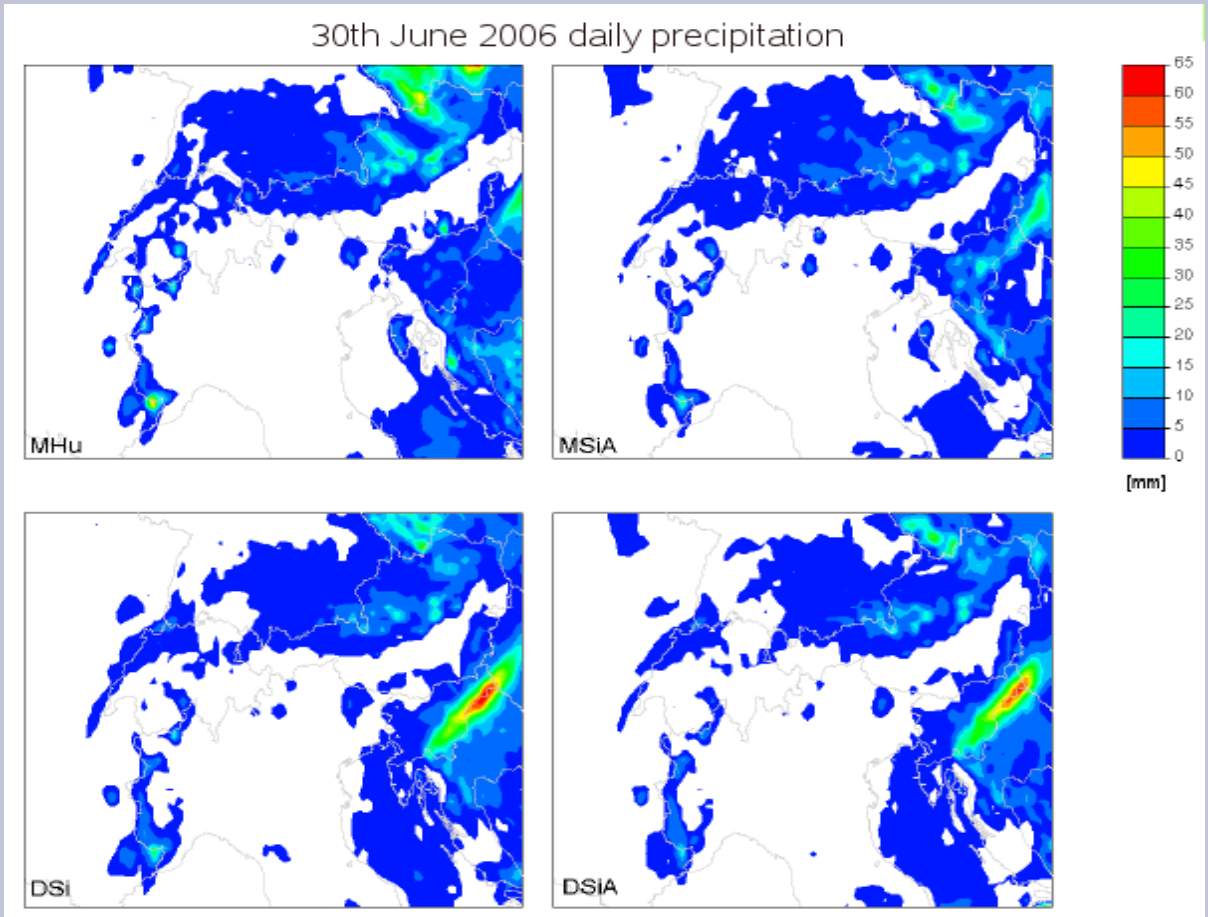


forecast/observed	yes	no
yes	a (hit)	b (false alarm)
no	c (miss)	d (correct rejection)

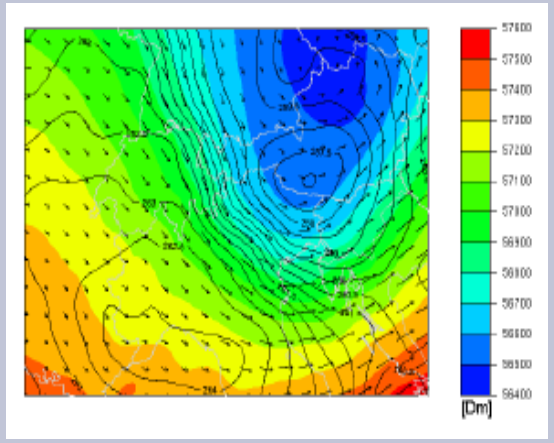
symbol	*name*	*definition*	ALADIN-SI		ALADIN-HU	
threshold			1 mm	10 mm	1 mm	10 mm
H	hit rate	$\frac{a}{a+c}$	0.73	0.38	0.69	0.25
F	false alarm rate	$\frac{b}{b+d}$	0.39	0.04	0.23	0.01
PC	proportion correct	$\frac{a+d}{n}$	0.63	0.93	0.75	0.95
$BIAS$	bias	$\frac{a+b}{a+c}$	2.28	1.00	1.61	0.44
HSS	Heidke skill score	$\frac{PC-E}{1-E}$	0.23	0.34	0.37	0.33
PSS	Pierce skill score	$\frac{ad-bc}{(a+c)(b+d)}$	0.34	0.34	0.45	0.24
CSI	critical success index	$\frac{a}{a+b+c}$	0.29	0.23	0.36	0.21

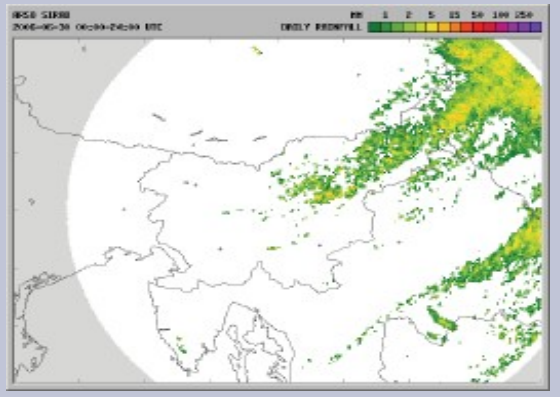
Case study

- 30th June 2006: passage of a weak front associated with some thunderstorms in the early morning
- simulations repeated on ALPS domain using ALADIN-SI
- better forecast provided by mesoscale analysis



500 hPa cold core

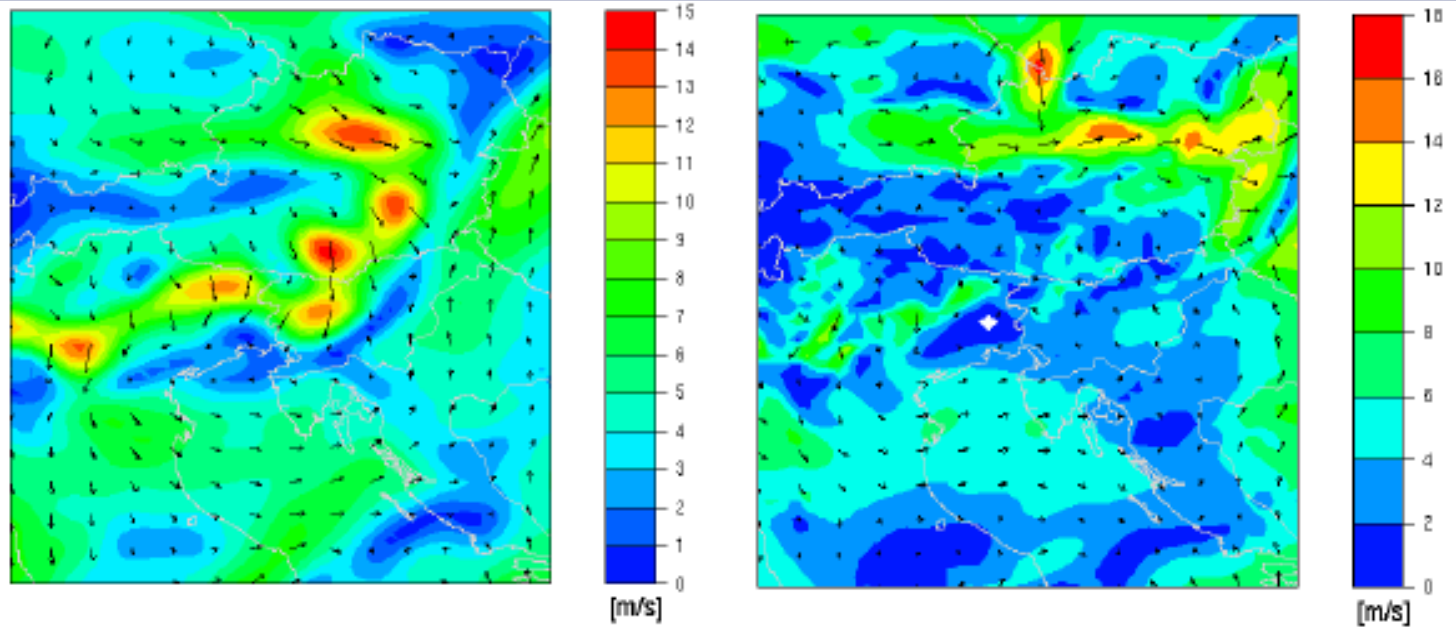




Case study

- convective part of precipitation similar in all forecasts, differences in stratiform (resolved) part
- more low-level moisture in ARPEGE analysis
- convergence zone more pronounced in ARPEGE analysis (field too smooth)

wind 850 hPa

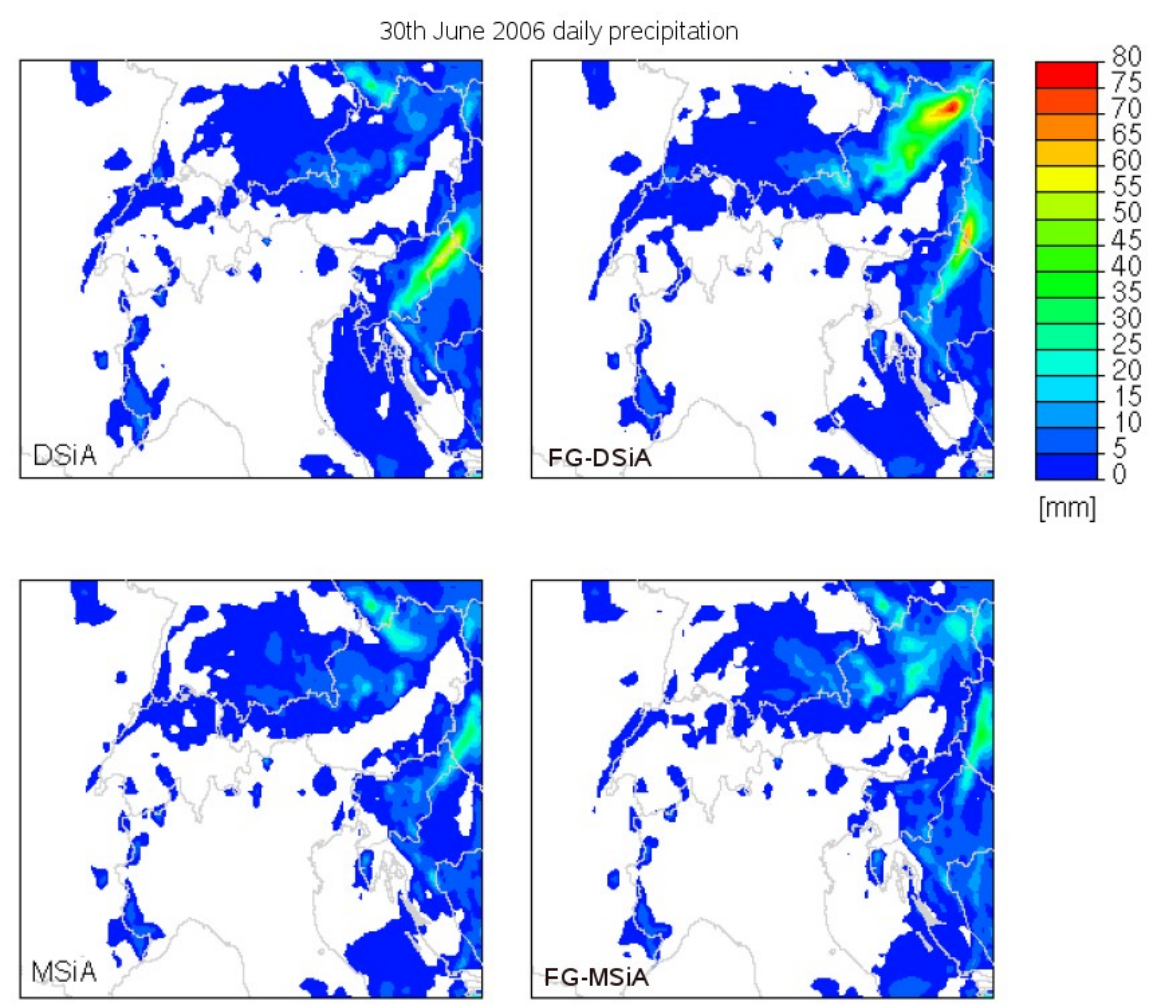


ARPEGE analysis

ALADIN-HU analysis

Case study

- impact of observations in 2006/06/30/00 UTC analysis?
- additional simulations using first guesses (2006/06/29/18 UTC analysis)
- observations tend to lower the precipitation amounts – too little observations in the area
- precise first guess was important



Conclusions

- there are some differences between dynamic adaptation and mesoscale analysis in June 2006 over Slovenia
  - differences pronounced in mountaineous regions in temperature and moisture fields
- the overall success of both strategies approximately equal
  - 3 x higher resolution of mesoscale analysis, but poorer assimilation method
  - neutral impact on wind, degradations in temperature, better precipitation forecast (more balanced structures)
- the benefits of mesoscale analysis can be found in special cases – also indicated by some other studies
- the sample relatively small, for more reliable comparison longer time period and use of the same model would be needed
- significant improvements expected with more high-resolution observations and better asimilation algorithms

Thank you for your attention!

Questions, comments?