Zentralanstalt für Meteorologie und Geodynamik

Experiences with ALARO in Austria

Christoph Wittmann, ZAMG

Content

- Implementations of ALARO at ZAMG
- Verification results ALARO-5km
  - Precipitation (SAL)
  - (near) surface parameters
  - Case (and sensitivity) study for 2m temperature
- Summary

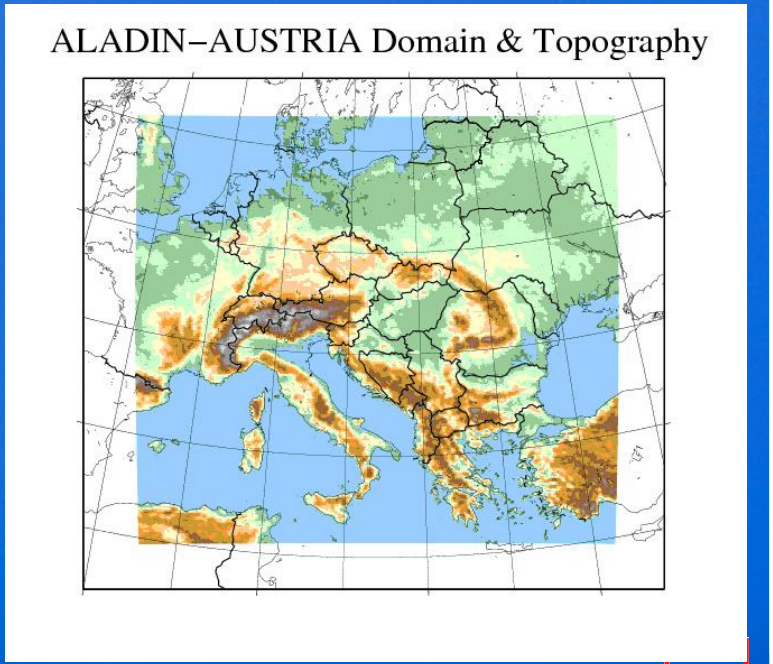
Implementation of ALARO-0 at ZAMG I

Short history:

- 09/2007 ALARO-0 (minus 3MT) operational (9.6km)
- 04/2009 full ALARO-0 operational (9.6km)
- 05/2009 start of daily ALARO-0 4.9km run (00 UTC)

Operational model (AL35T1):

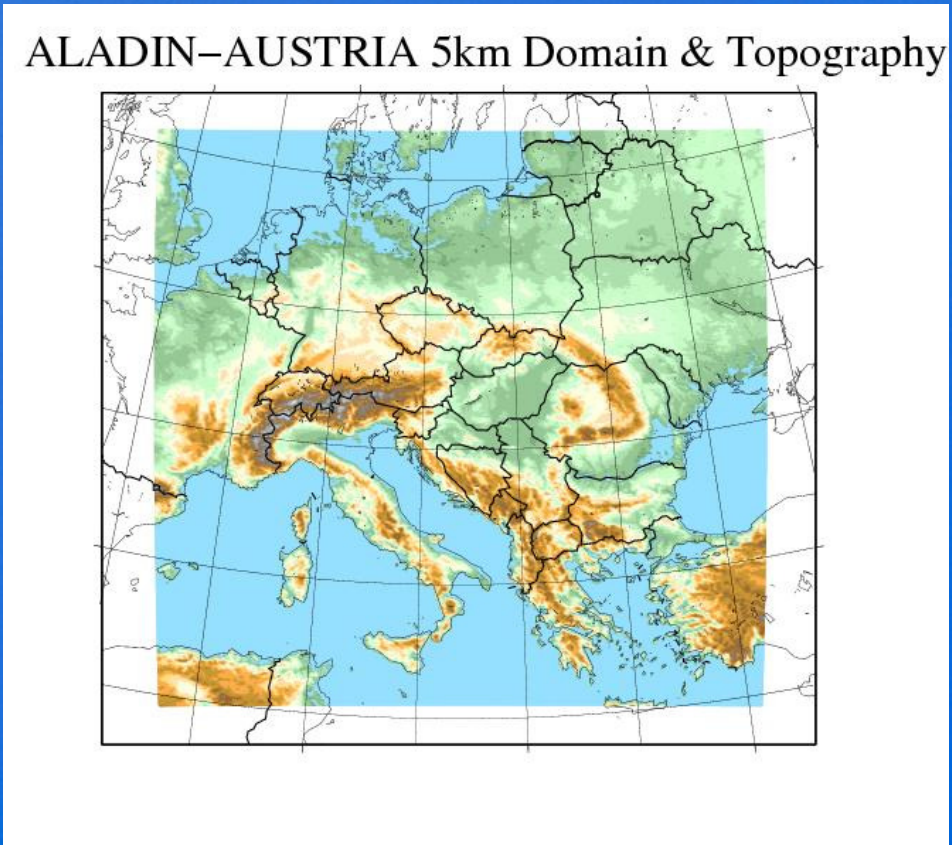
resolution:	9.6km / 60L
runs:	00/12 +72h, 06/18 +60
oro./grid:	envelope / quadratic
time step:	415s
init.+coupl:	ARPEGE
physics:	ALARO-0 + LACPANMX, ACNEBSK



Implementation of ALARO-0 at ZAMG II

ALARO 4.9km version:

resolution:	4.9km / 59L
runs:	00 +48h
oro./grid:	mean / linear
time step:	207s
init.:	ARPEGE
physics:	ALARO-0
dynamics:	NH (NDLNPR=1, LGVADW)



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Precipitation – Starting point

Main question to answer (forecasters, hydrologists, customers, …):

- Benefit from ALARO-5km in terms of precipitation forecasts?

Further question (myself):

- Benefit from NH dynamics on 5km resolutions (consuming more resources)?

Verification setup:

Period: 20090601 – 20090831 (convective period)

Observations: INCA precipitation analysis (radar+rain gauge)

Method: SAL (+ conventional grid point scores)

Precipitation - Models

	ALA-AUT	AROME	ALA5-NH	ALA5	ALA-EUR
timestep (s)	415	60	207	207	285
coupling model	ARPEGE	ALA-AUT	ARPEGE	ARPEGE	ECMWF
initialization	ARP (4DVAR)	ALA-AUT	ARP (4DVAR)	ARP (4DVAR)	ECMWF (4DVAR)
coupling frequency	3	1	3	3	3
horizontal resol. (km)	9,6	2,5	4,9	4,9	6,9
levels	60	60	59	59	45
forecast range	72	30	48	48	72
convect. param.	yes	no	yes	yes	yes
microphysics	ALARO-0 (3MT)	ICE3	ALARO-0 (3MT)	ALARO-0 (3MT)	ALARO-0 (3MT)
progn. hydrometeors	qv,ql,qi,qr,qs	qv,ql,qi,qr,qs,qg..	qv,ql,qi,qr,qs	qv,ql,qi,qr,qs	qv,ql,qi,qr,qs
kernel nh/h	hydrostatic	non-hydrostatic	non-hydrostatic	hydrostatic	hydrostatic
surface	ISBA	SURFEX	ISBA	ISBA	ISBA

+ ECMWF (T799)

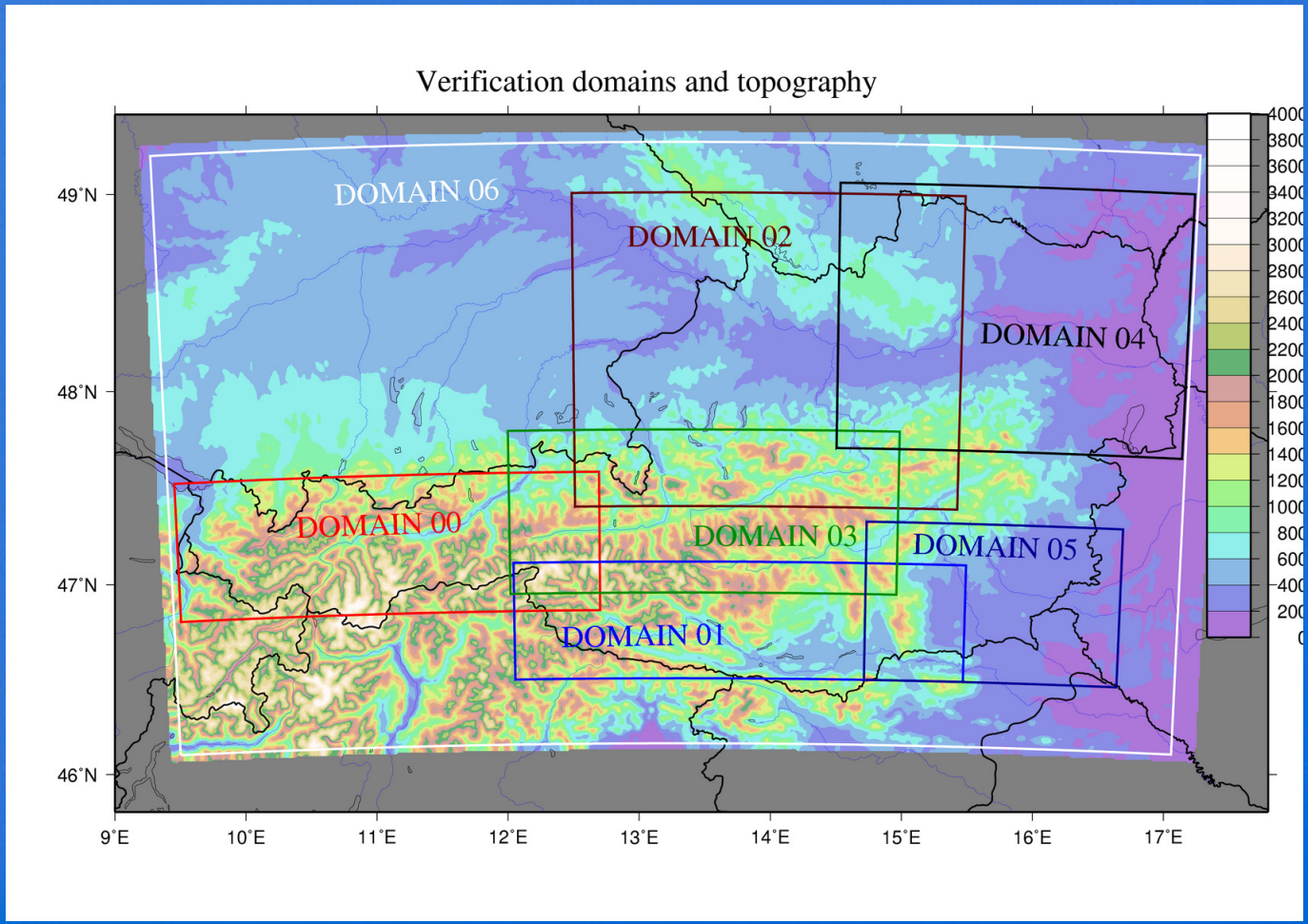
+ INCA (Nowcasting + optimized combination of ALA-AUT / ECMWF)

just 00 UTC runs, up +30h forecast range , 3h intervals

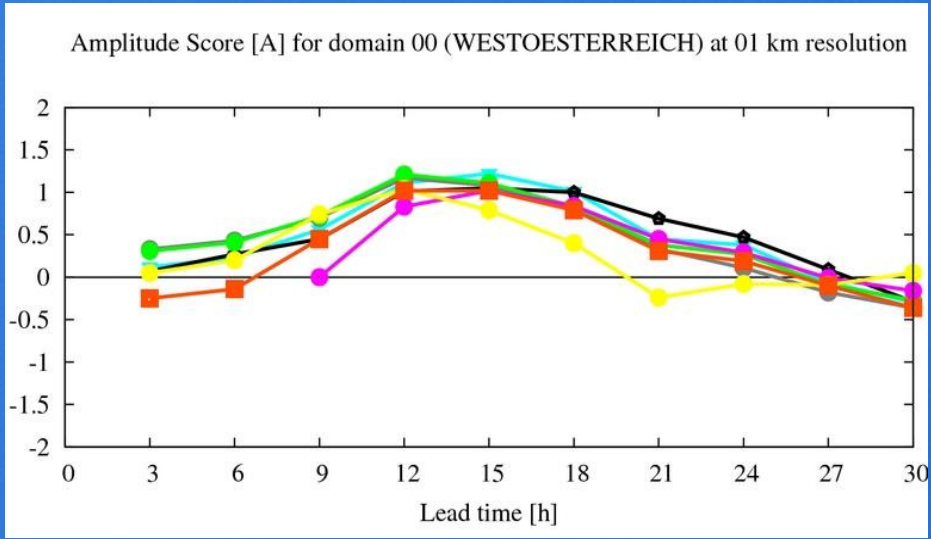
Precipitation - SAL

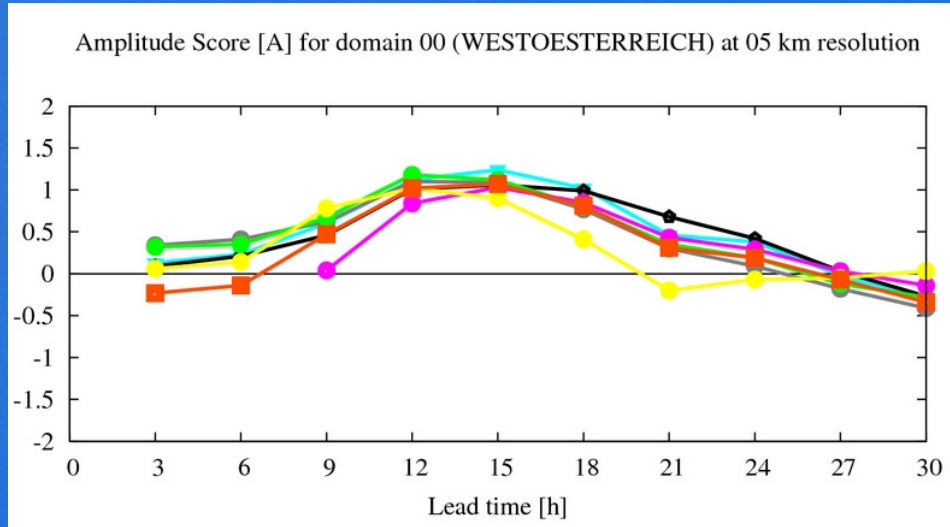
- **Amplitude A**
  - Areal mean
  - A … [-2….+2]
  - A<0: underestimation, 0 perfect, A>0 overestimation
- **Structure S**
  - Comparing scaled volumina of precipitation objects
  - S … [-2 … +2]
  - S<0 objects too small/intense, S>0 too big/flat
- **Location L**
  - Comparing mass center and mean distance of objects from mass center
  - … [0 …+2]
  - L=0 perfect forecast

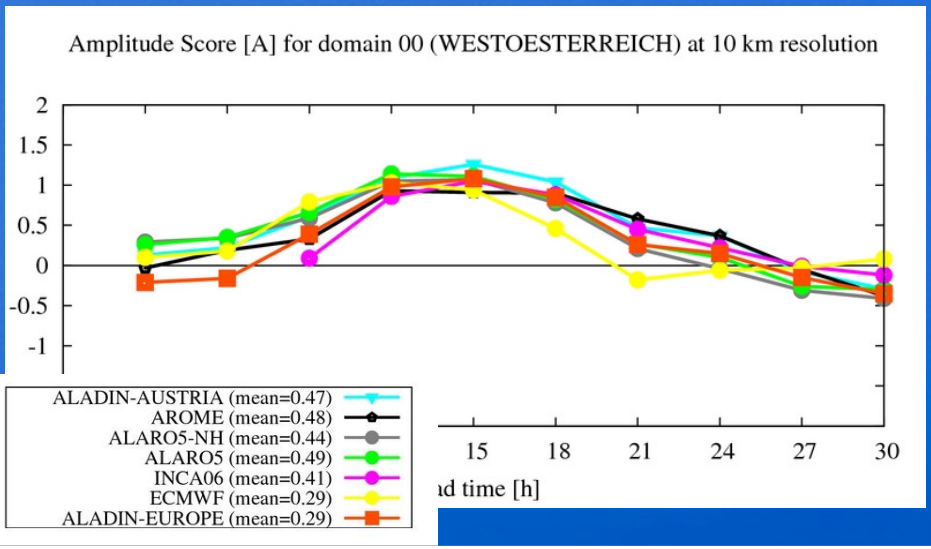
Precipitation - Domains



Precipitation – Results "Alpine domain"

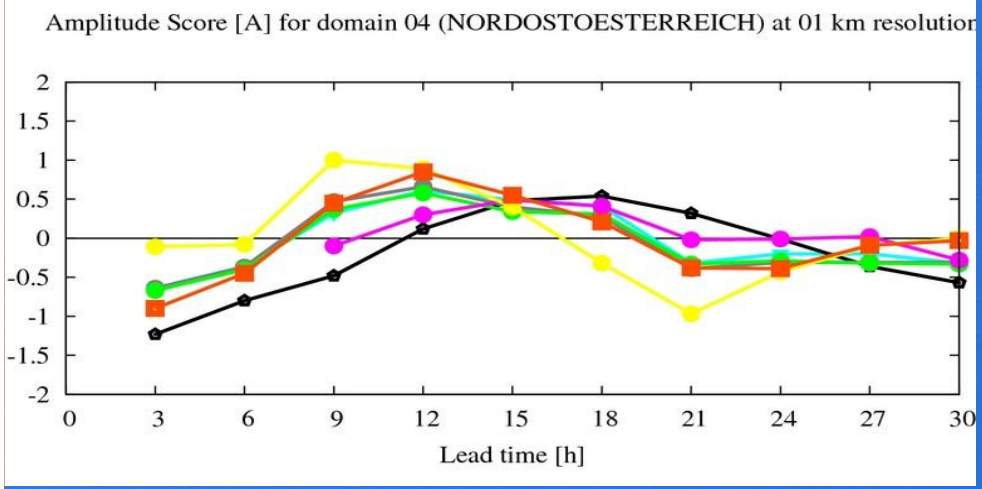


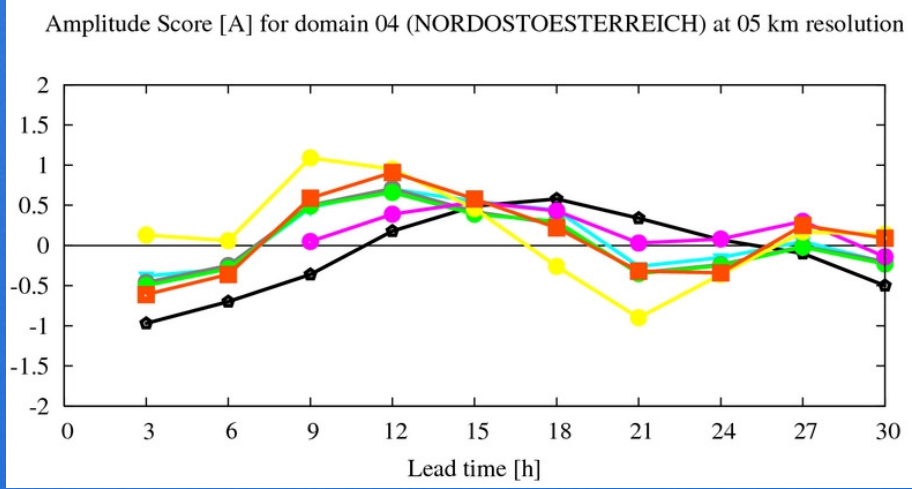


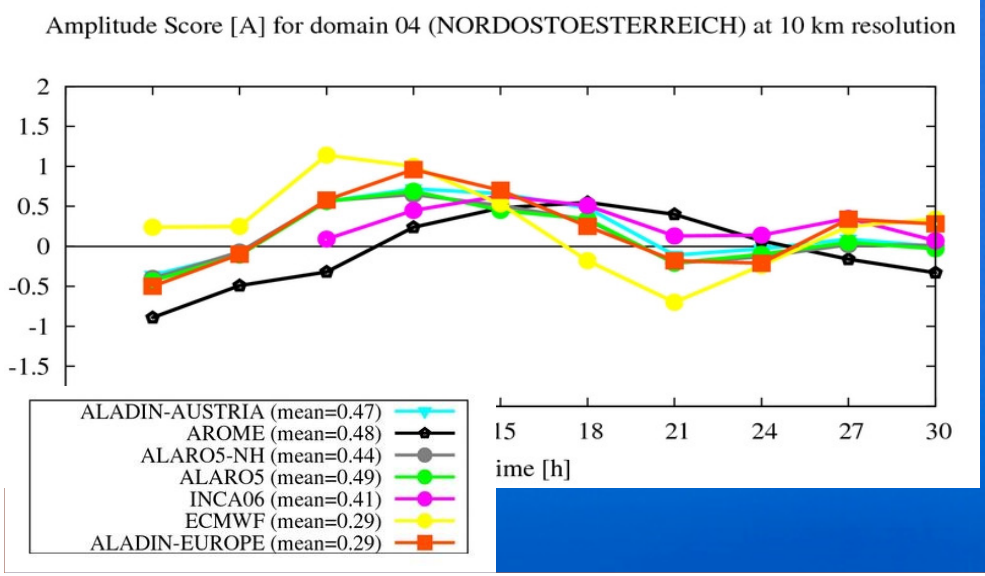


- all models overestimating convective diurnal cycle
- (very) little less overestimation during afternoon/evening for 5km versions (with respect to 9.6km OPER)
- no noticeable differences for 5km NH vs. 5km H
- no change for different resolution (of verification grid)
- high resolution? for what ? BUT: lot of events with OBS=0 MODEL~0 -> Score A=2

Precipitation – Results "Flatland domain"

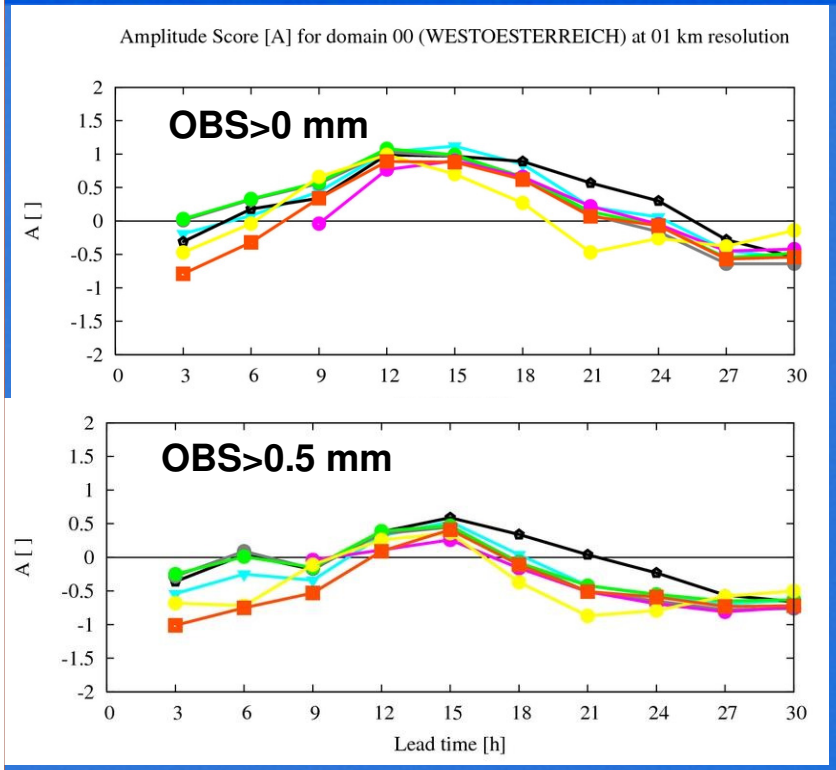


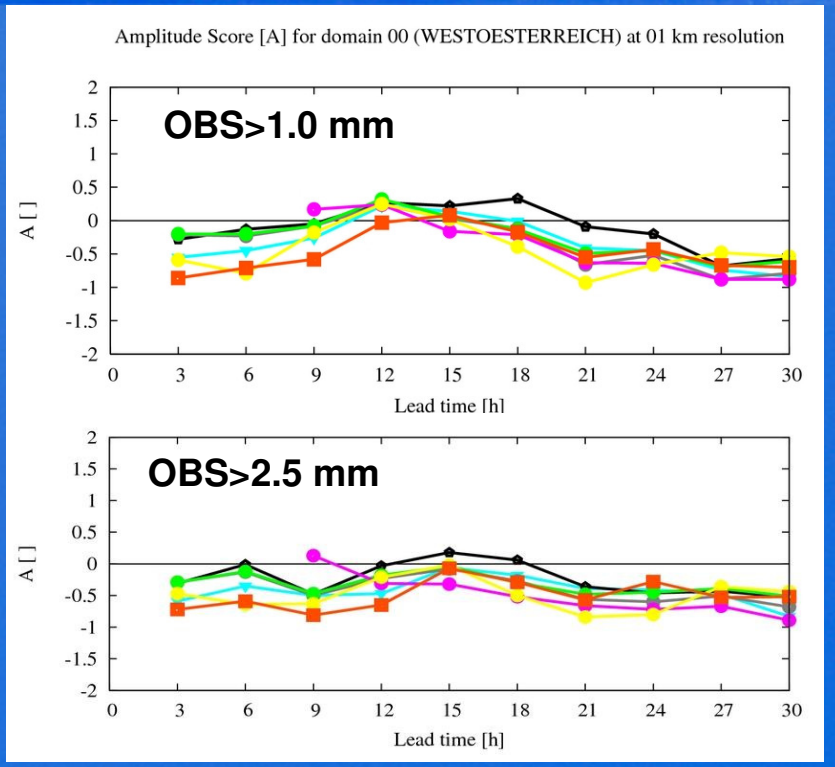




- **all models underestimating precipitation in the morning**
- **phase shift of convective diurnal cycle (ECMWF – ALADIN/ALARO – AROME), less overestimation for high resolution models (simulation of detachment from alpine area??)**
- **no noticeable differences for 5km NH vs. 5km H**
- **hardly changes for different resolution (verification domains)**
- **AGAIN: lot of events with OBS=0 MODEL~0 -> Score A=2**

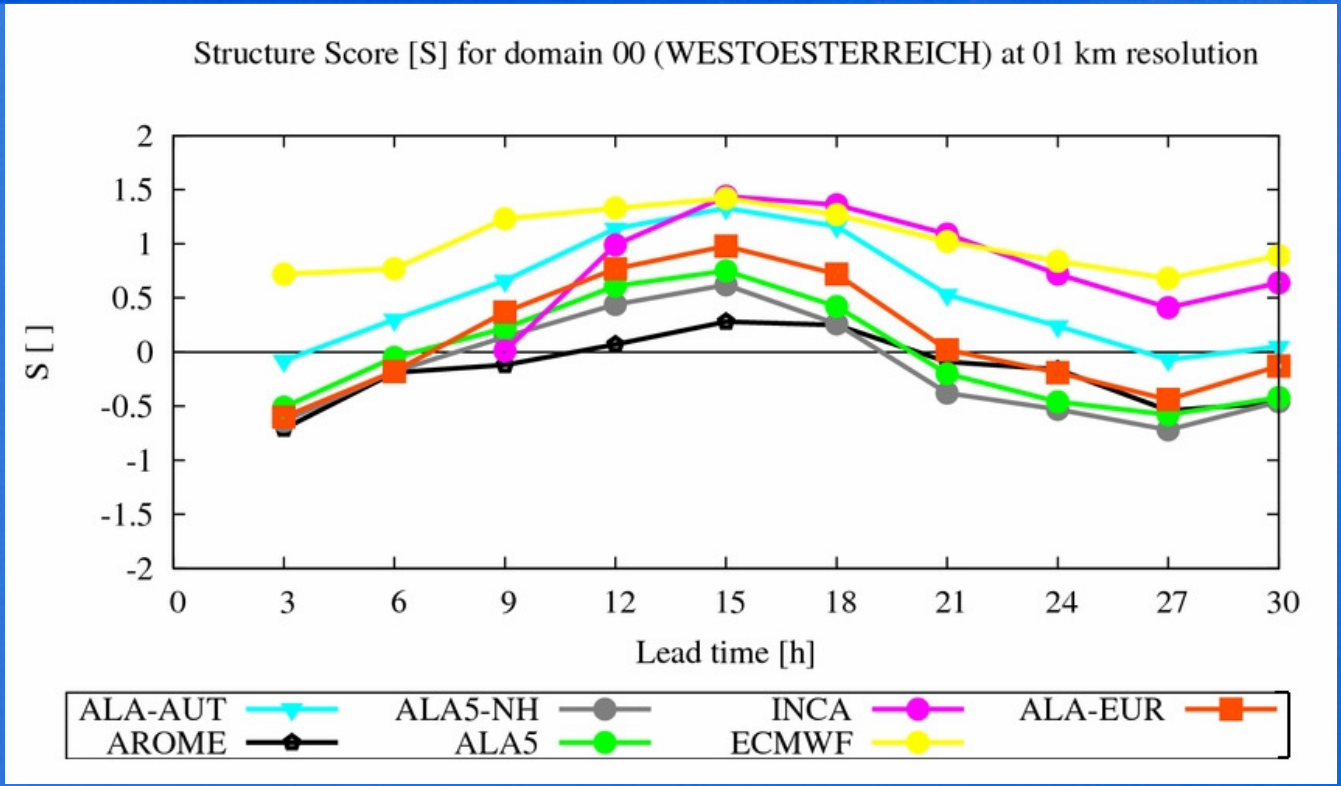
Precipitation – Results "Alpine domain" II





- **smaller amplitude for stronger events (domain average, 20.000 grid points)**
- **better overall performance for high resolution models for stronger events (?)**

Precipitation – Results for Structure



- higher resolution -> better structure
- significant difference 5km NH – 5km H in Alpine domain
- L component: usable for case studies

Precipitation – Starting point

Main question to answer (forecasters, hydrologists, customers, …):

- Benefit from ALARO-5km in terms of precipitation forecasts?

Benefit gets visible for high impact weather and when considering structure of precipitation fields.

Further question (myself):

- Benefit from NH dynamics on 5km resolutions (consuming more resources)?

Opportunity to save resources more attractive than better structure of precipitation objects in Alpine areas.

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Near surface parameters

Question: Benefit from ALARO-5km model for

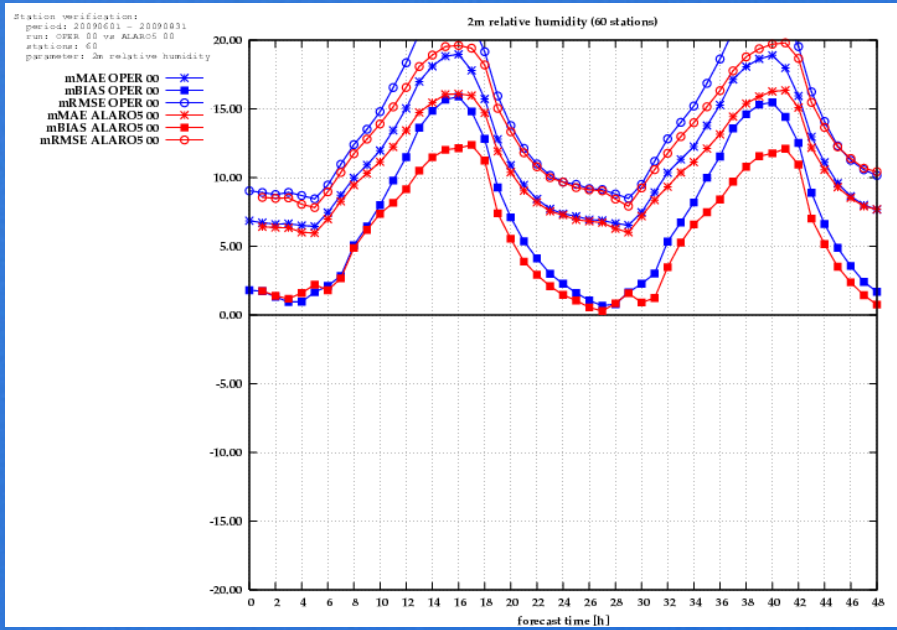
- 2m temperature?
- 2m (relative) humidity?
- 10m wind speed / direction?
- 10m wind gusts?
- pressure?
- total cloudiness ?
- …

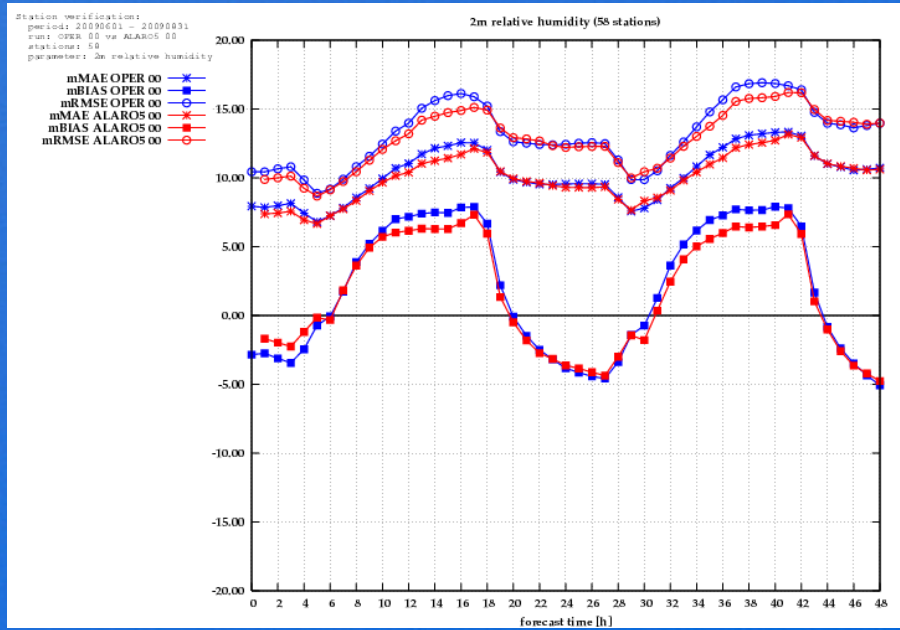
A priori one might expect better/more realistic representation in mountainous area

Verification – Point forecasts

- Period: 20090601 – 20090831, just 00 UTC runs
- Point forecasts vs. station observations
- Stations assigned to height intervals:
  - 0 – 500m
  - 500m – 1000m
  - 1000m – 1500m
  - > 1500m (mountain stations)

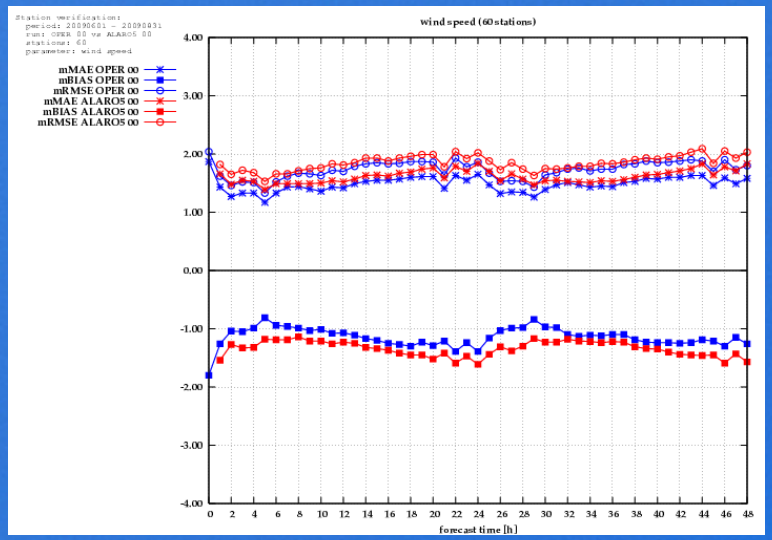
2m relative humidity & MSLP

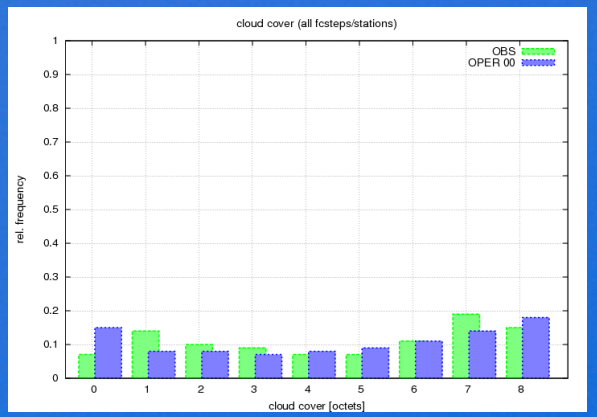


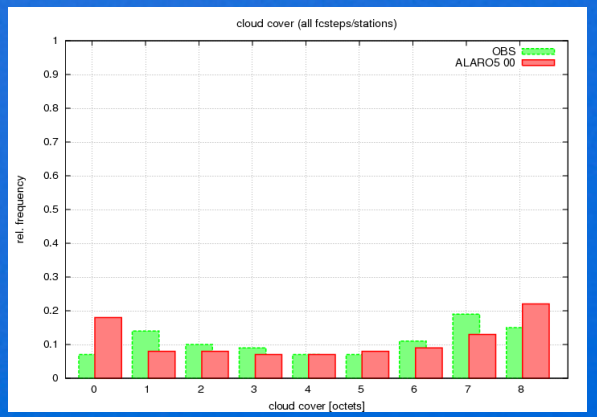


- clear benefit for all height intervals
- bigger improvement for stations in mountainous areas
- bad near surface (relative) humidity forecast (connected to surface/evaporation?)
- same valid for pressure (mslp)

Wind & total cloudiness



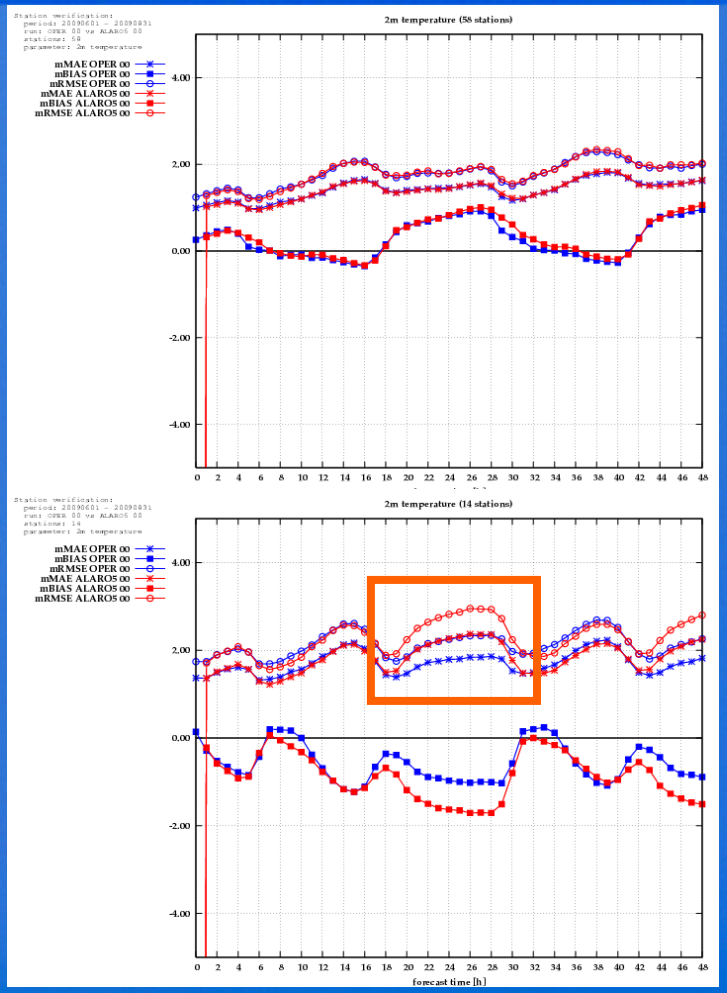




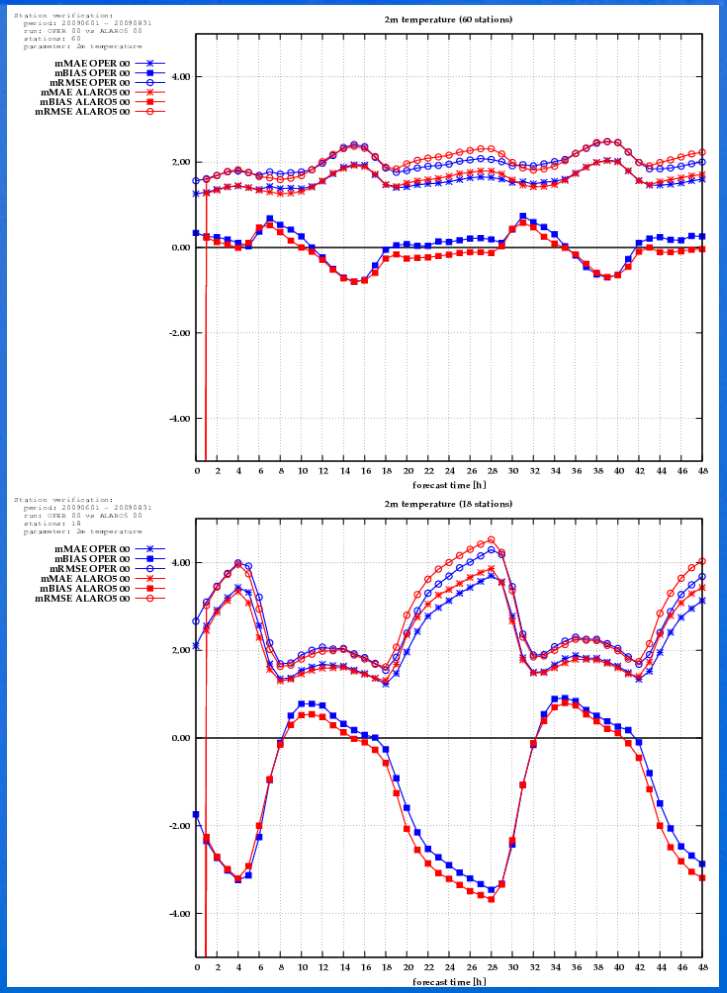
- wind: neutral for mountain tops, slightly worse for stations < 1500m
- neutral impact on cloudiness; climatology shows more binary character; BUT: verification “questionable” (SYNOP vs. 9.6km gridbox vs. 4.9km gridbox)

2m Temperature

0 – 500m



500 – 1000m

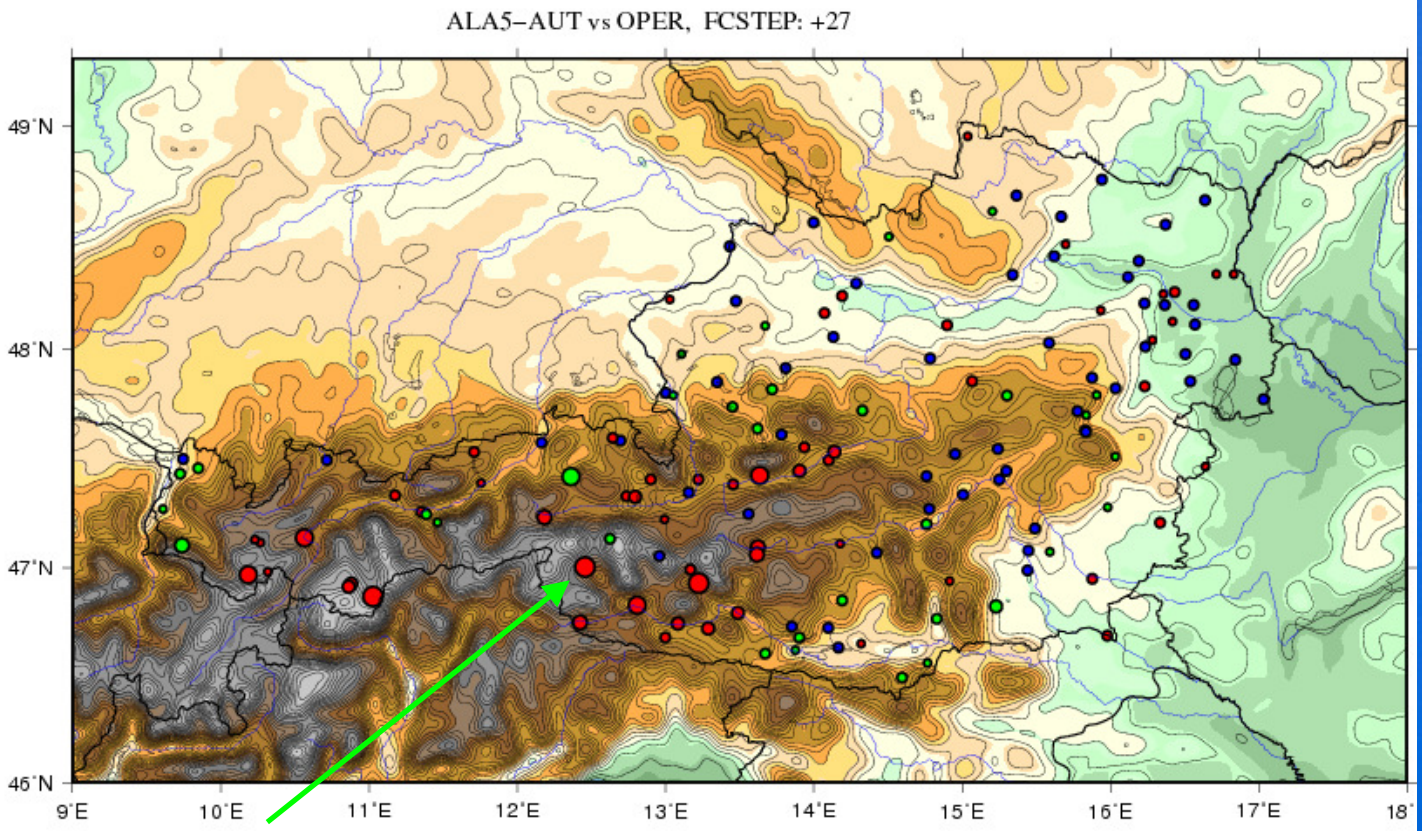


1000 – 1500m

> 1500m

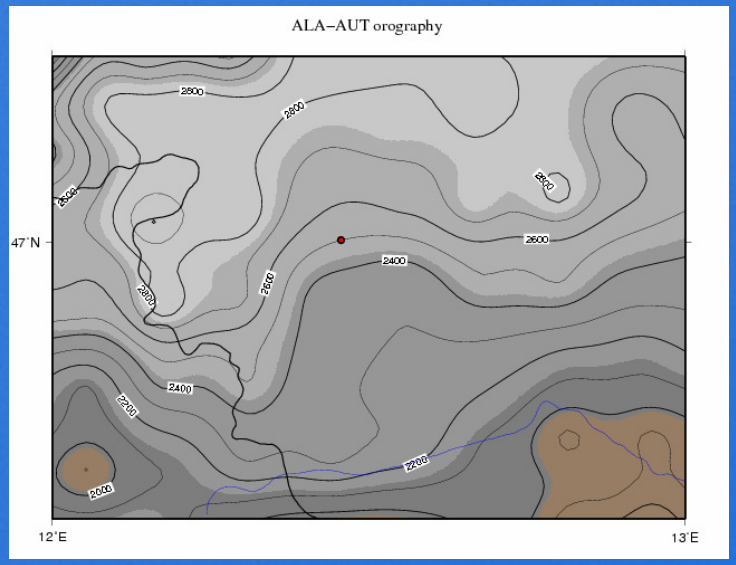
simple height correction applied!!!

2m Temperature – MAE characteristics

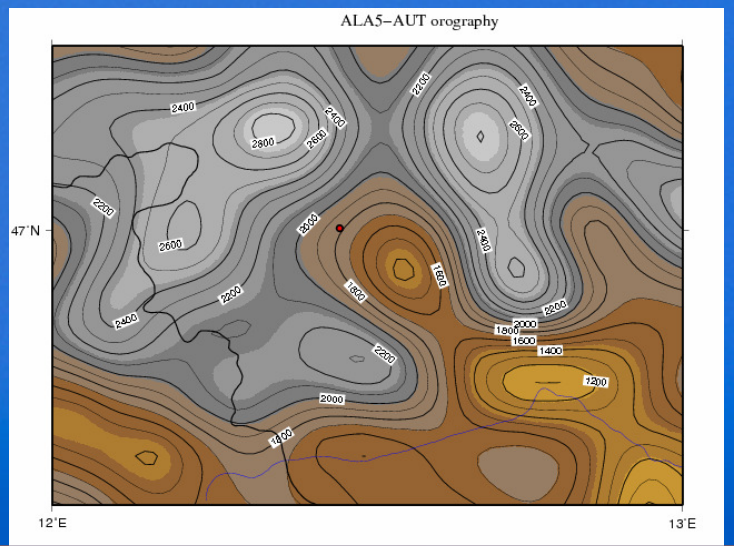


2m Temperature - Virgen

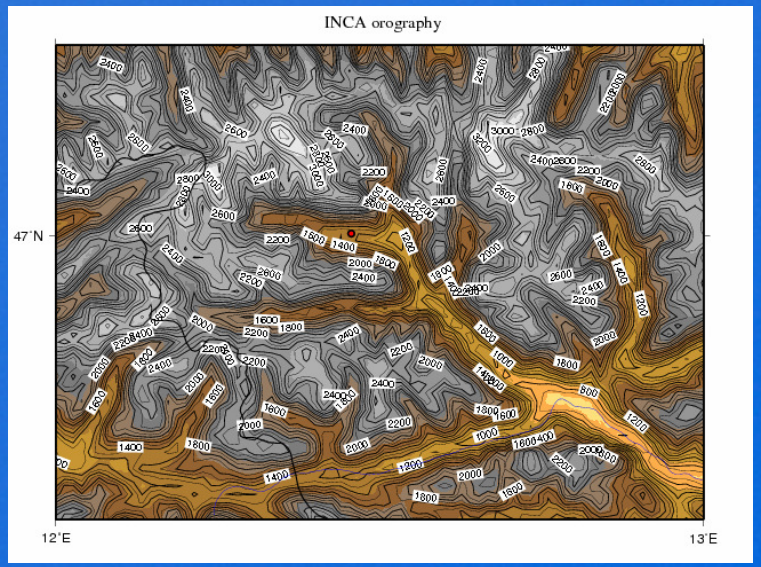
OPER



ALA5

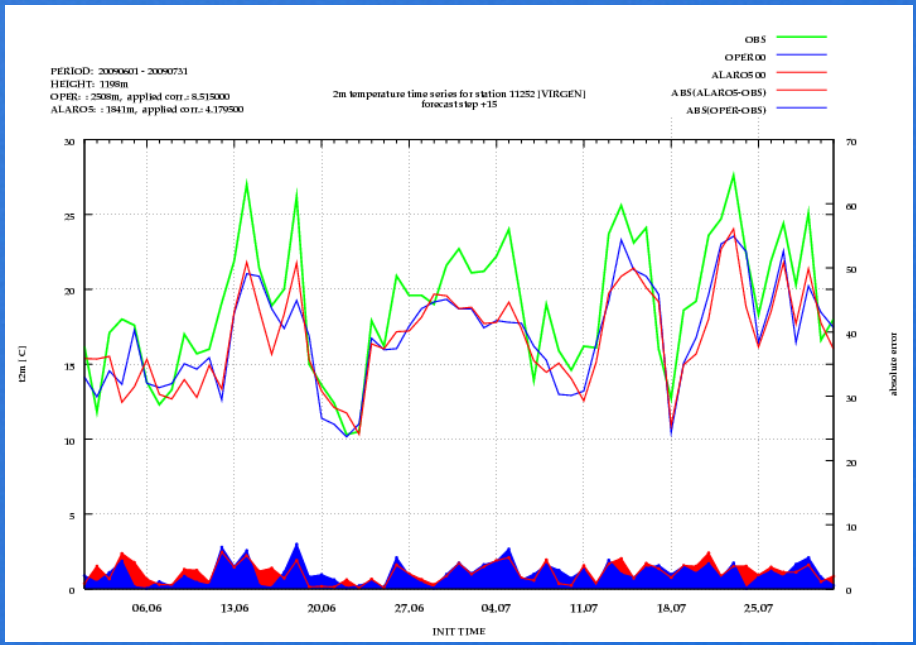


INCA

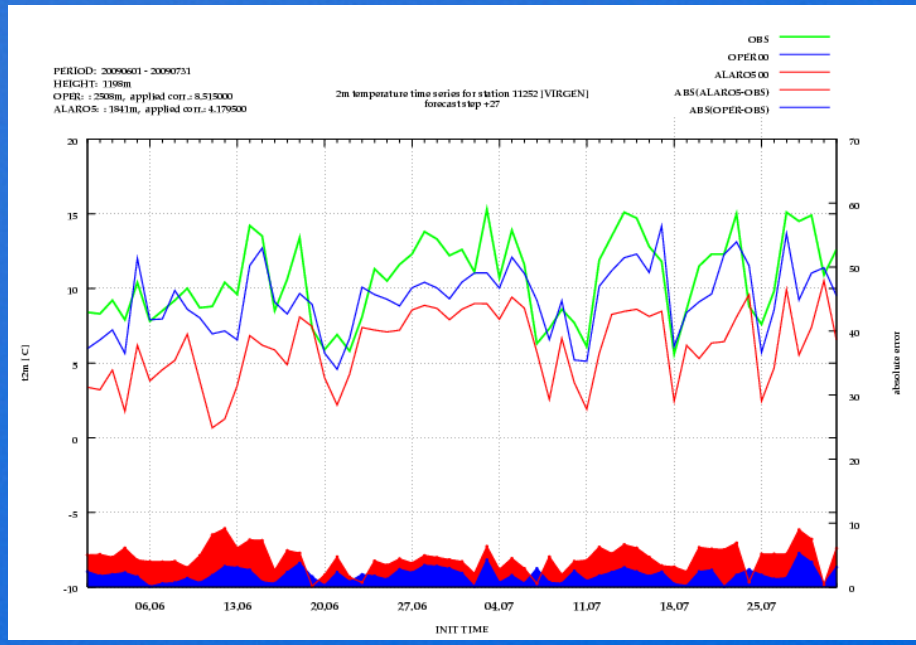


2m Temperature – Virgen time series

Time series 20090601 – 20090731, 00 + 27h

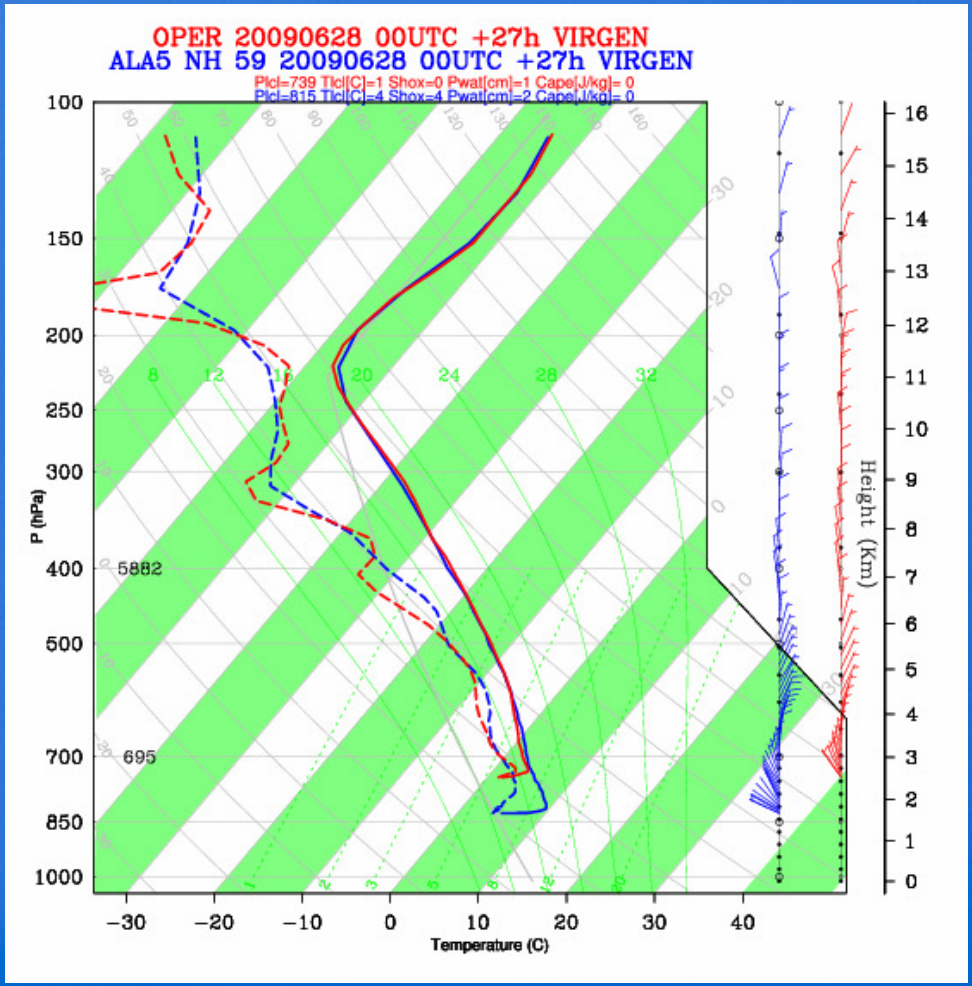


no height correction applied



simple height correction applied

2m Temperature – Virgen pseudotemp

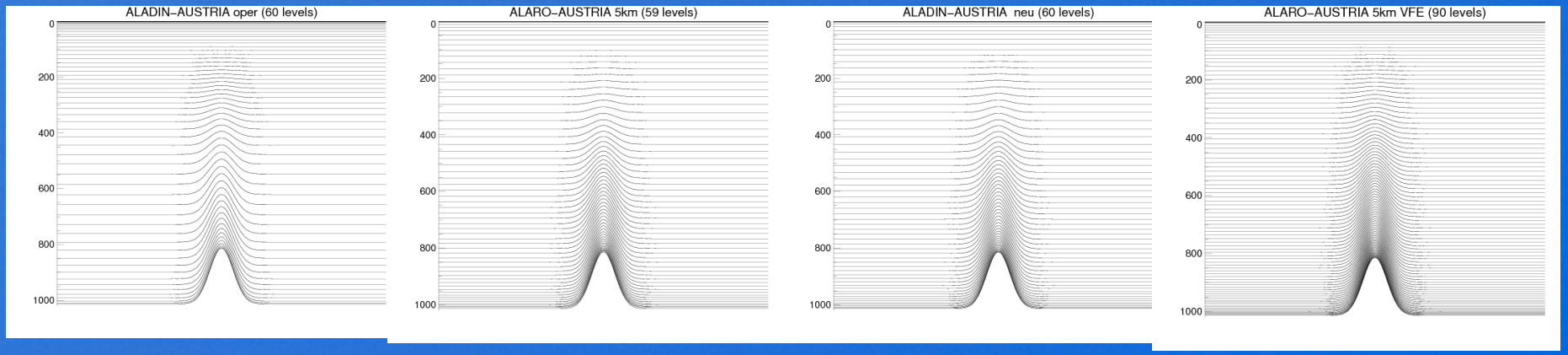


Pseudotemp for VIRGEN:
20090628 00 UTC +27h

Sensitivity to vertical resolution

Sensitivity of near surface inversion to vertical resolution?

- 4 different vertical level distributions
- 3 horizontal resolutions (9.6km, 4.9km, 2.5km)



OPER 60	ALA5 59	TEST60	TEST90
H(60)=17m	H(59)=12m	H(60)=10m	H(90)=10m

Sensitivity to vertical resolution II

Results:

- Near surface inversion more sensitive to horizontal resolution (topography) than to vertical resolution:

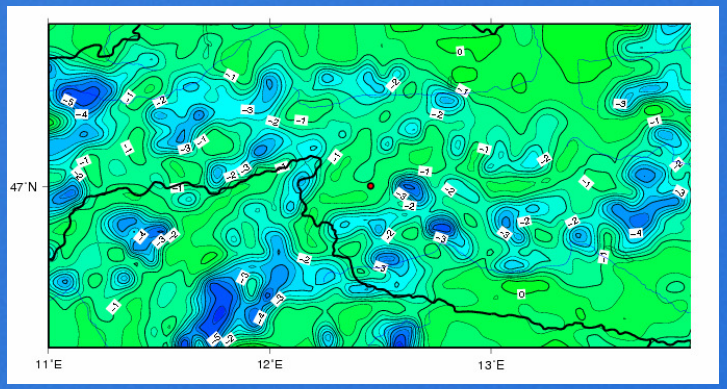
9.6km: 2.6 K
4.9km: 4.2 K
2.5km: 5.0 K

ALA5 (60 OPER)
ALA5 (59)
ALA5 (TEST 60)
ALA5 (TEST 90)

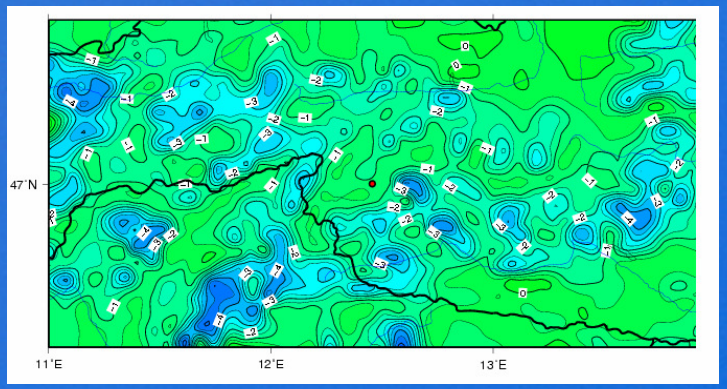
→ 4.2 K +/- 0.2 K

Modified interpolation formula for screening level

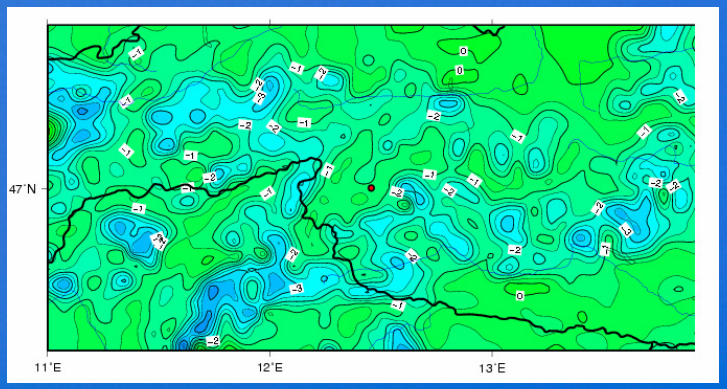
T2m – T(NLEV) for different ZAH (Kullmann 2009) for 20090628 00 UTC + 27h



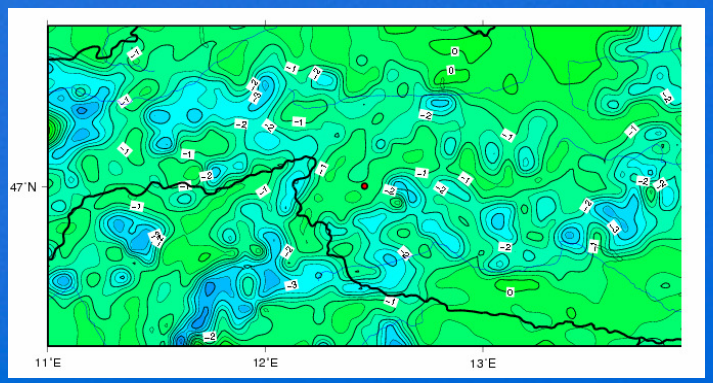
ZAH -> inf



ZAH = 35



ZAH = 15

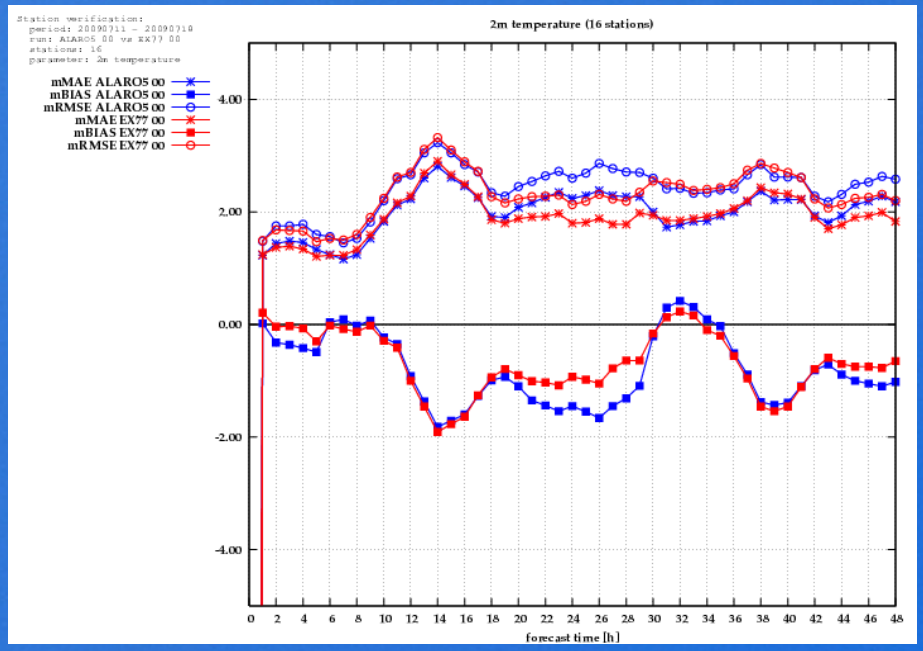


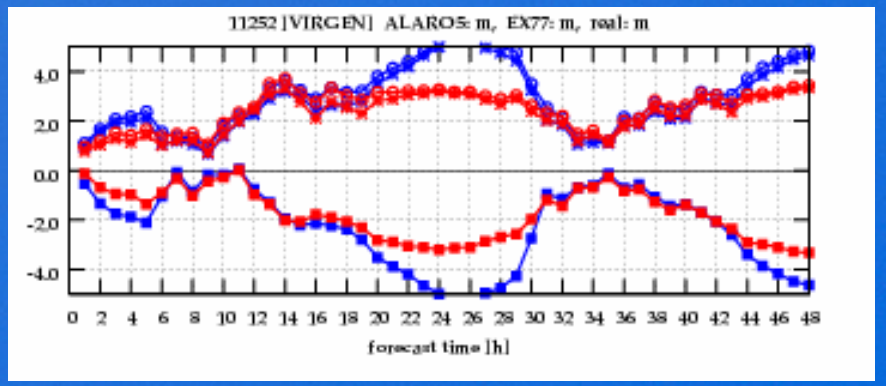
ZAH = 05

No change for Virgen in this case, BUT …

Modified interpolation formula for screening level II

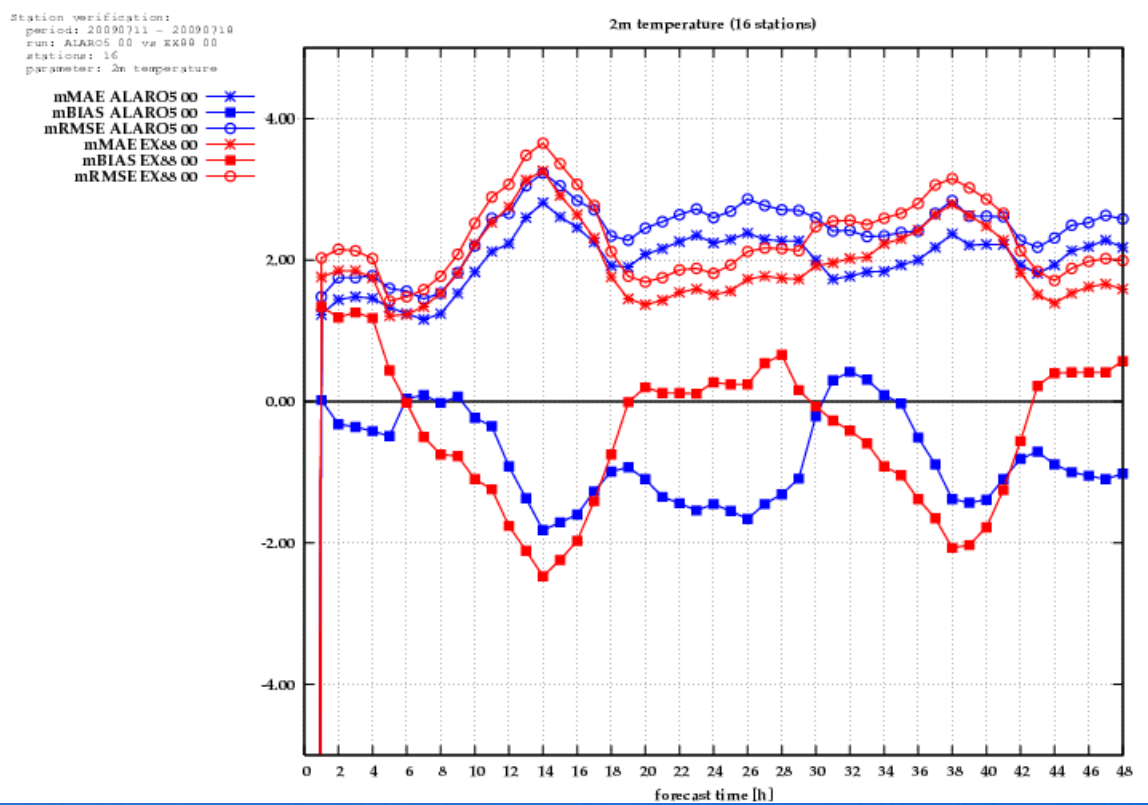
1 week period: 20090711 – 20090718 with ZAH=35





significant reduction of BIAS, but is it enough to touch this problem from point of interpolation? BIAS reduced but still there! -> long-term tests and …?

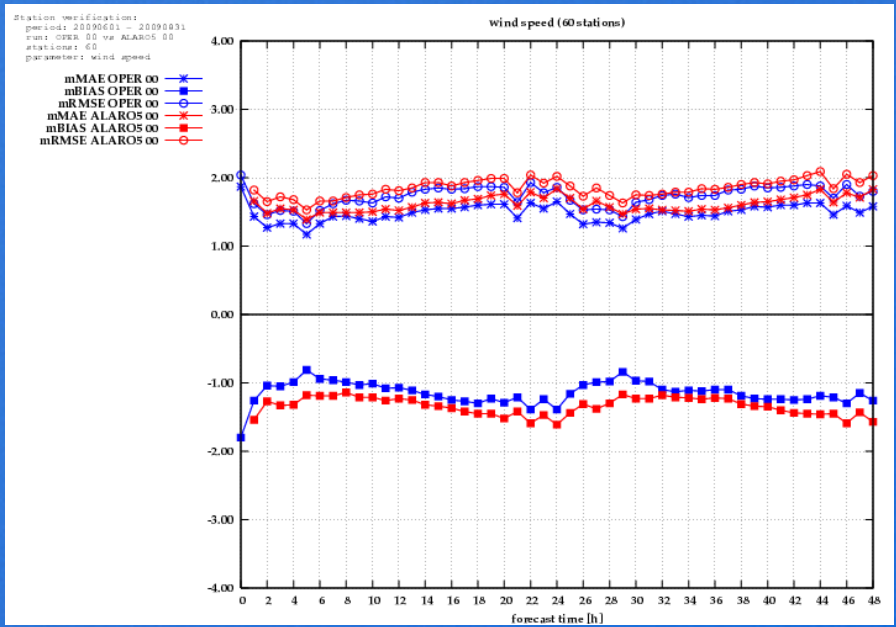
What about skipping interpolation?



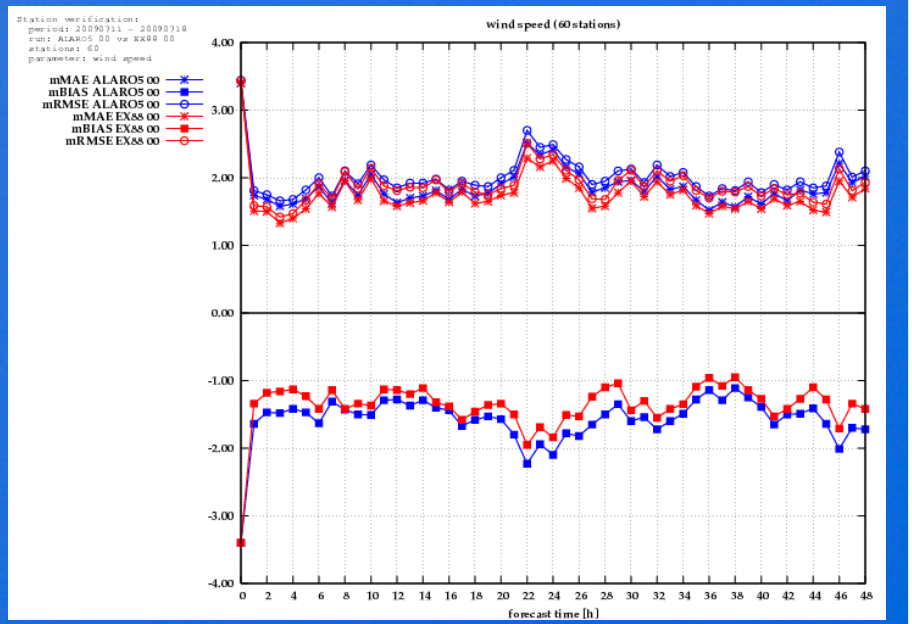
BIAS completely removed during night, but stronger one introduced during day ;-(

Wind speed

Skip interpolation to 10m? (lowest level is already around 10m)



OPER (red) vs. ALA5
20090601 - 20090731



ALA5 (red) no int. vs. ALA5 (blue)
20090711 - 20090718

Near surface parameters

Question: Benefit from ALARO-5km model for:

- 2m temperature?
- 2m (relative) humidity?
- 10m wind speed / direction?
- 10m wind gusts?
- pressure?
- (total cloudiness) ?
- …

Open points (forecasters):

- low stratus in valleys/bassins (now better represented by topography)
- Föhn

Summary

- For certain parameters ALARO-5km performs better than operational 9.6km version (RH2m, mslp)
- Precipitation patterns have better structure, quality of quantitative forecasts very similar to 9.6km (hydrological point of view)
- 2m temperature with problems especially during night in mountainous areas (better topography leads to worse results?!)
- Wind forecasts disappointing, neutral to worse (again in alpine region). Interpolation to 10m still needed?
- Modified screening level interpolation gets much more important on higher resolution
- Further analysis and improvement needed for near surface humidity and temperature (where to start? surface scheme?)?

C. Wittmann, 2010: *Evaluation of ALARO-5km near surface parameters over Austria with special emphasis on 2m temperature. Soon available from www.rclace.eu*

C. Wittmann et. al, 2009: *Evaluating multi-scale precipitation forecasts using high resolution analysis, subm. to Advances in Science and Research*

C. Wittmann, 2009: *Evaluation of ALARO-5km over Madeira, ALADIN FR/ LACE stay report. Available from www.rclace.eu*