Einführung hochaufgelöster numerischer Modelle in den operationellen Betrieb an der ZAMG: Erste Erfahrungen und zukünftige Planung

Florian Meier, Theresa Gorgas, Stefan Schneider, Florian Weidle, Yong Wang, Clemens Wastl, Christoph Wittmann, Xin Yan

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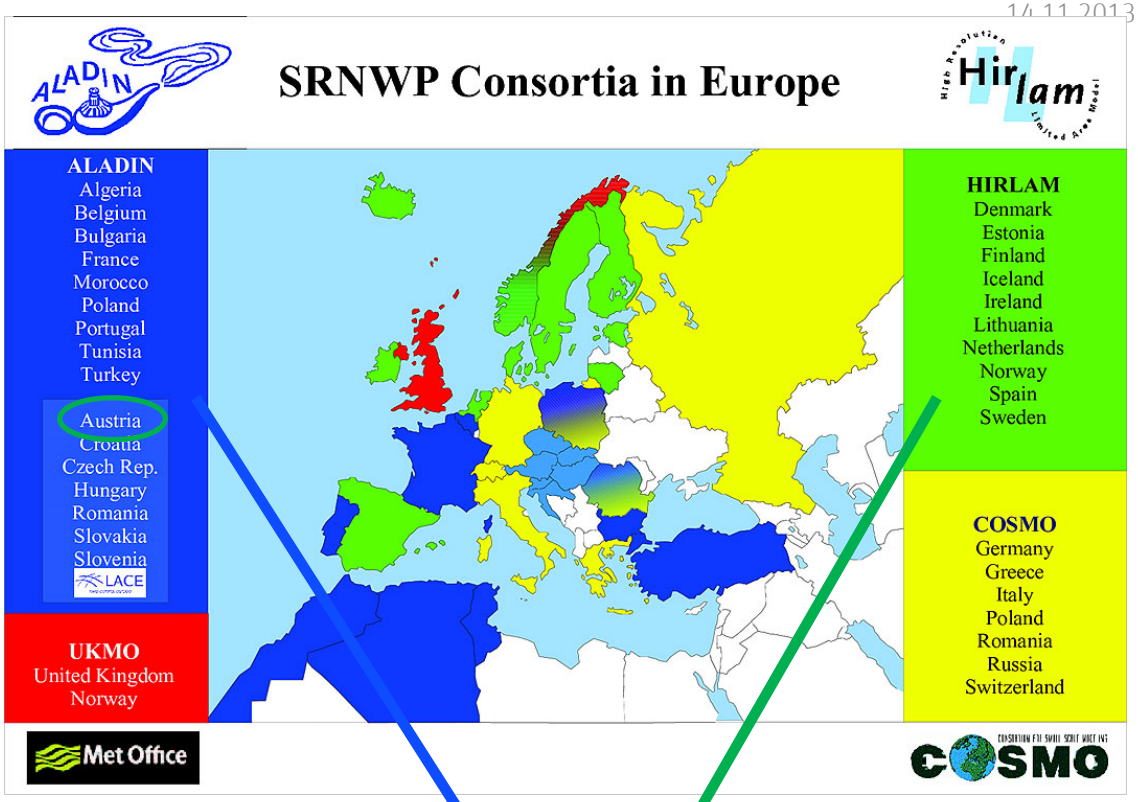
Was gab es bisher? Wie wurde es entwickelt?

Ausschnittsmodell ALARO:

- Maschenweite:4,8km/60L
- 4x täglich +72h
- Kopplung mit ECMWF-IFS
- Assimilation der Boden-feuchte/Temperatur
- Konvektion parametrisiert



ALARO-Ensemble: LAEF

2x täglich +60h -> +72h

18km Maschenweite/37L ->11km/45L

17 Member

AROME = HARMONIE

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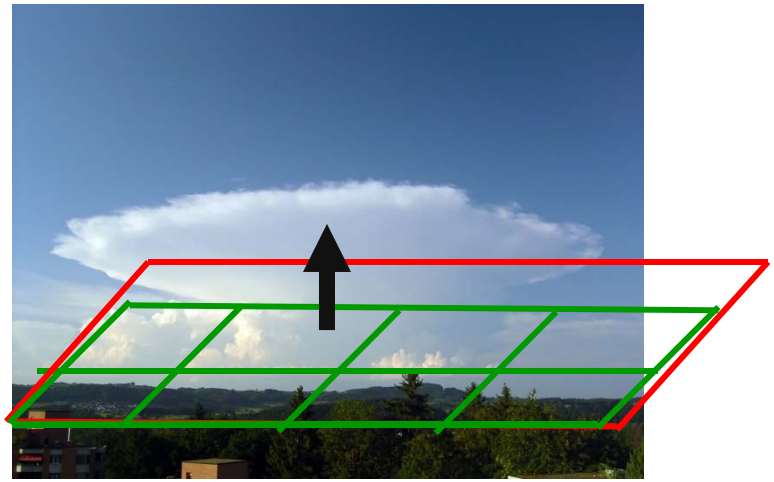
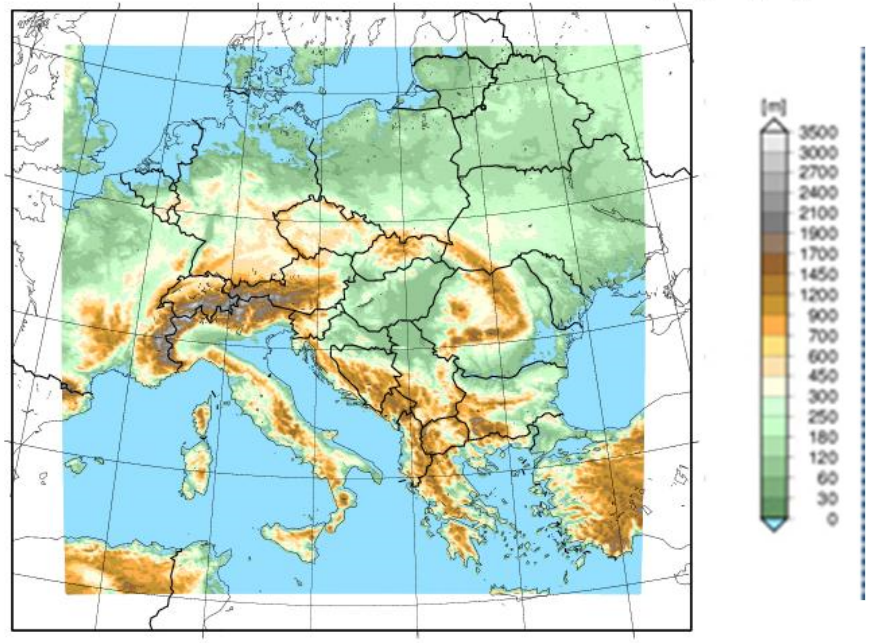
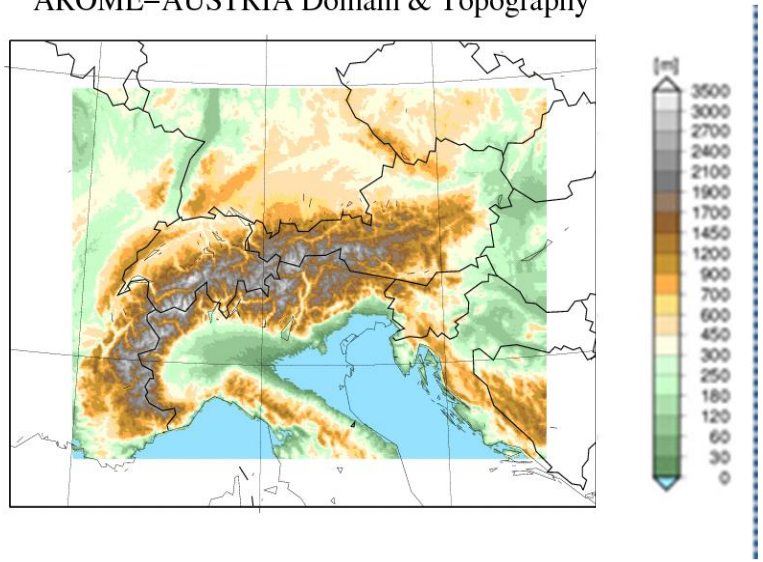
AROME: Modellierung mit expliziter hochreichender Konvektion

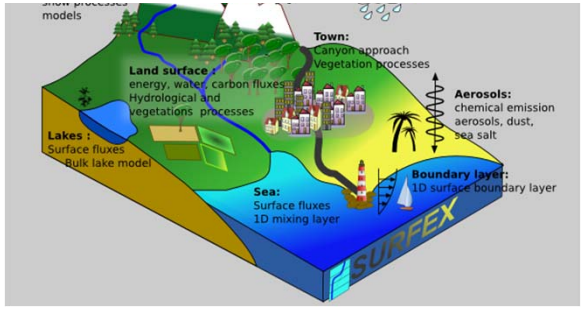


ALADIN–AUSTRIA 5km Domain & Topography



AROME–AUSTRIA Domain & Topography





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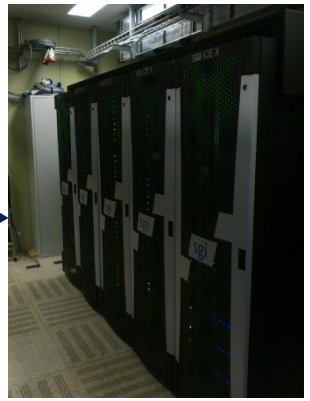
Neuerungen in AROME

	ALARO ->	AROME
Hochreichende Konvektion	parametrisiert	explizit
Dynamik	hydrostatisch	nicht-hydrostatisch
Initialisierung Atmosph.	Interpol. Globalmodell	Datenassimilation
Turbulent Kin. Energie	diagnostisch	prognostisch
Niederschlagsteilchen	Regen/Schnee	Regen/Schnee/Graupel
Bodenmodell	2-Schichten ISBA	3 Schichten SURFEX
Modellläufe	4x täglich +72h	8x täglich +30h (+48h)
Gittermaschenweite	5km/ 60 Schichten	2,5km/60->(1km/90)

2012: Neuer Hochleistungsrechner an derZAMG
ICE-X 4064 CPUs, 8 TB memory,
(theor.) peak perform.: 82 Tflops



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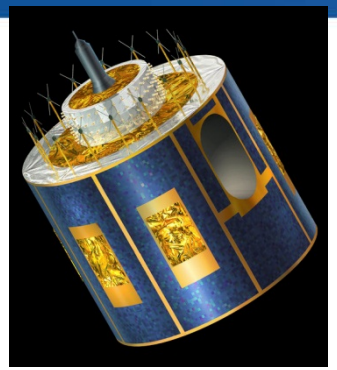
Datenassimilation: Inkrementelles 3D-Var + OI-Bodenassimilation

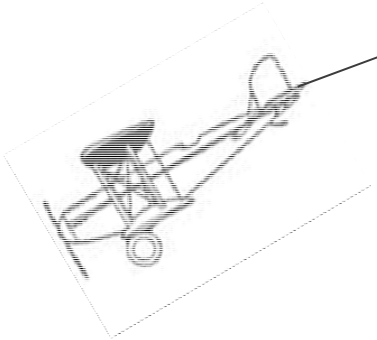
METEOSAT-MSG
AMV (Winde)
und Radianzen (SEVIRI Wasserdampfkanäle)



NOAA-16/18/19
MetOp –A/-B

AMSU-A,-B,MHS,
HIRS, IASI
ASCAT-Wind

AMDAR: Temperatur, Wind



Radiosonden:
U,V,T,Q,ϕ

SYNOP/TAWES/SHIP
10m Wind, 2m Temperatur und Feuchte, Druck

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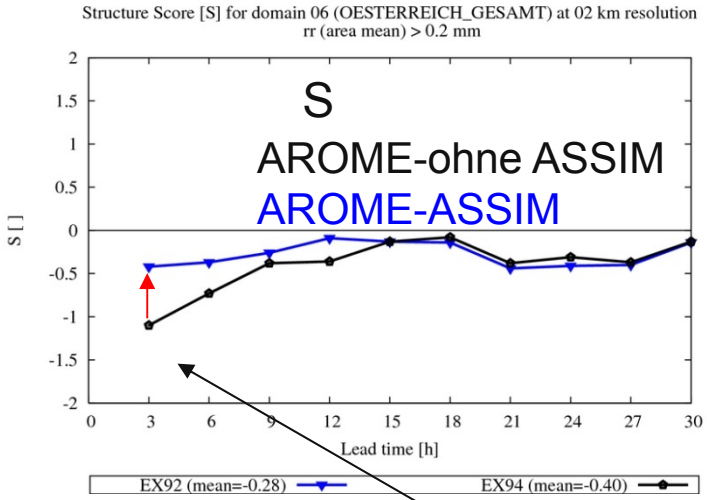
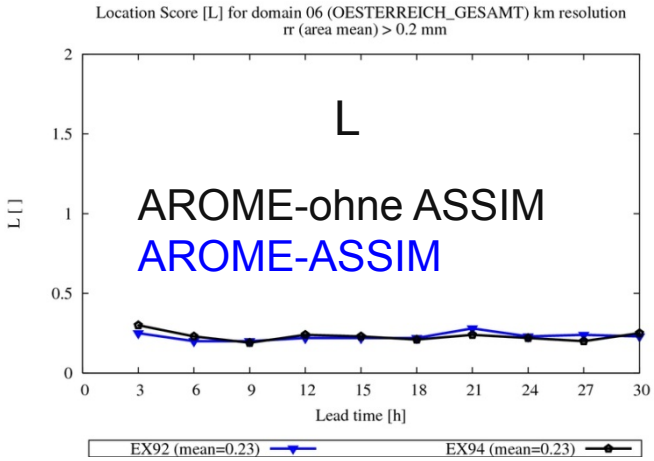
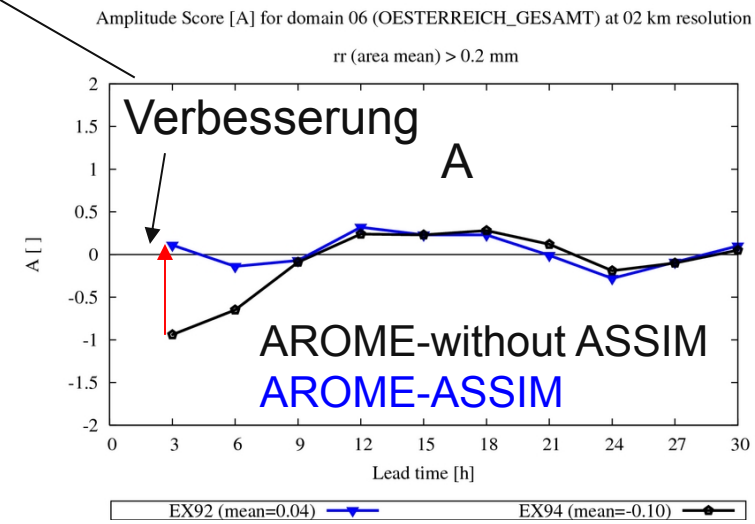
Evaluierung: Was bringt die Datenassimilation?





SAL-Score
Für ganz Österreich
Schwellwert: 0.2mm



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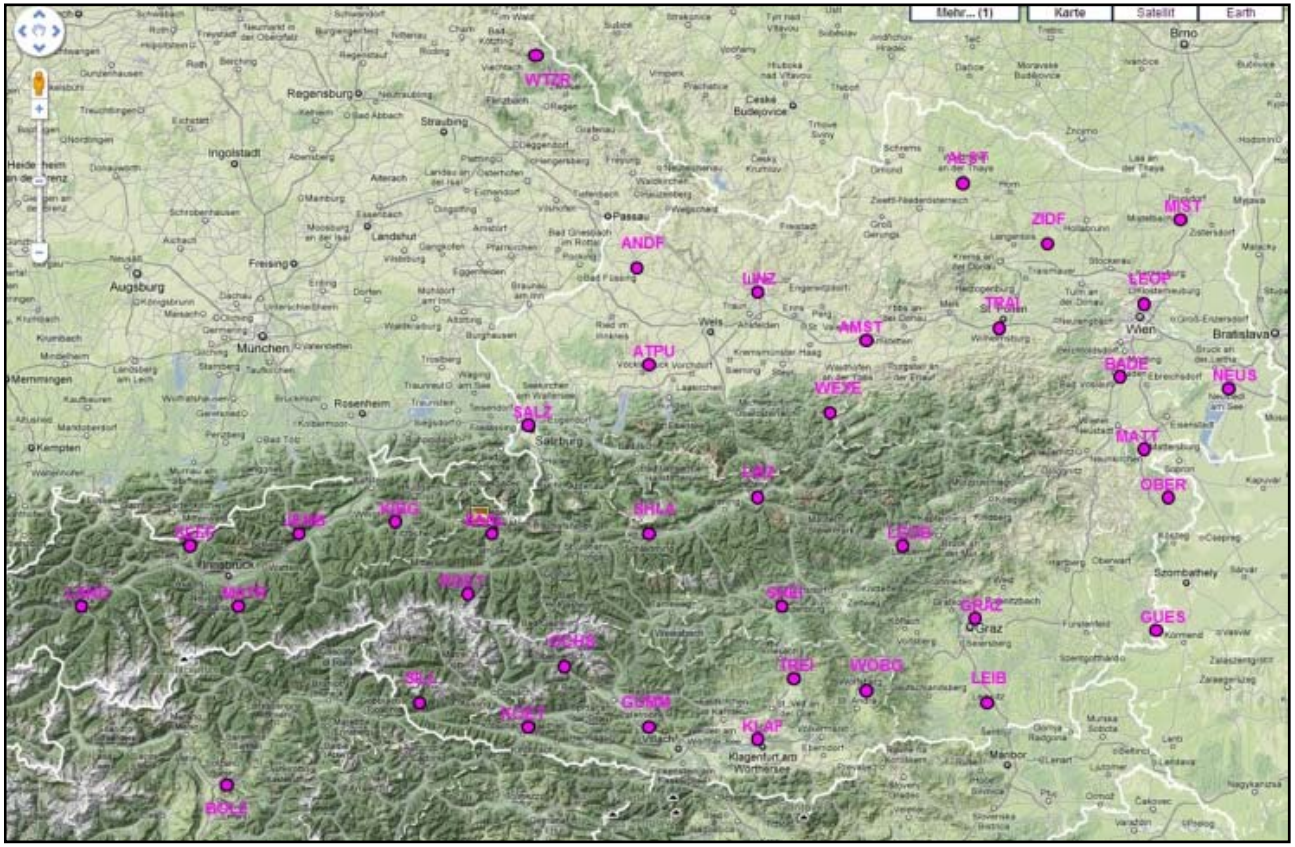
GPS-Stationsnetz in Österreich



- Daten von ca. 40 GPS Referenzstationen (TU Wien prozessiert Daten von Wien-Energie)
- statische Biaskorrektur

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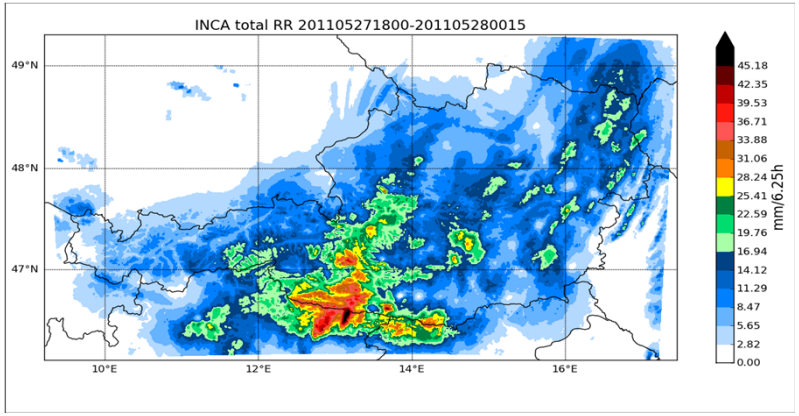
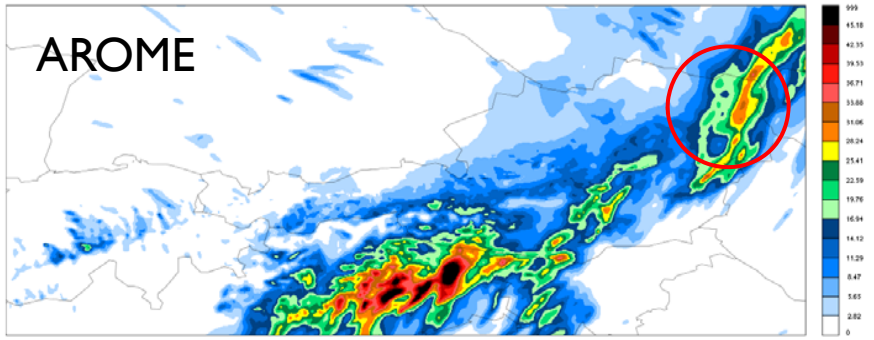
Assimilation österreichischer GPS-ZTD Daten

INCA

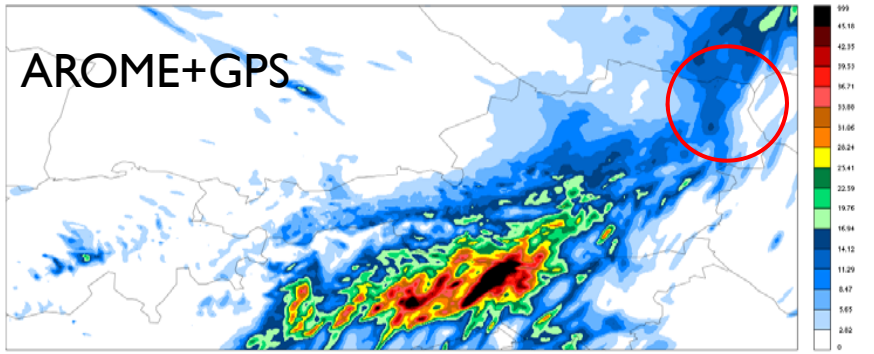


20110527l8-24UTC 6h accum

AROME



AROME+GPS



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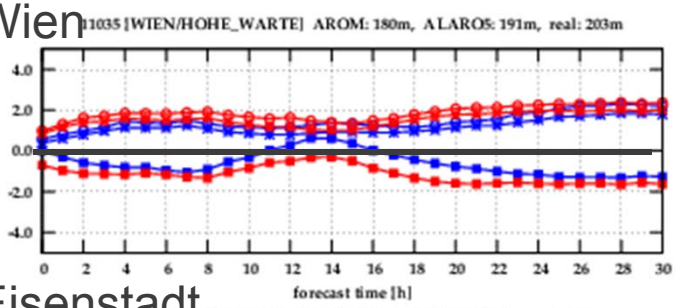
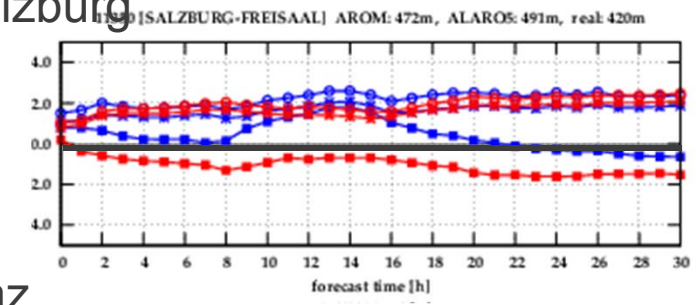
Verifikation T2m 12.11.12-31.1.13 00 UTC Läufe

Wien



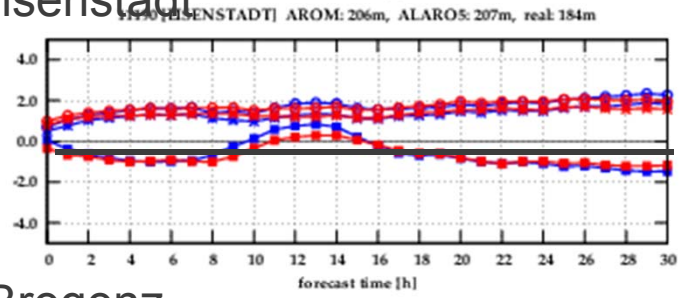
Salzburg



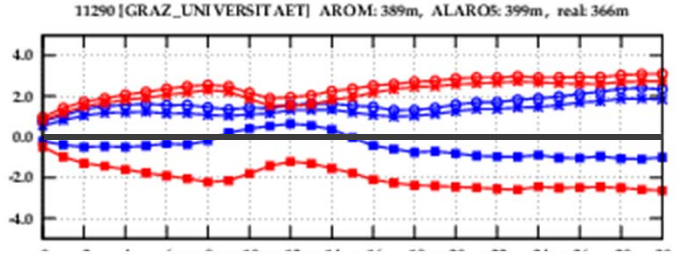
AROME

ALARO

Eisenstadt



Graz

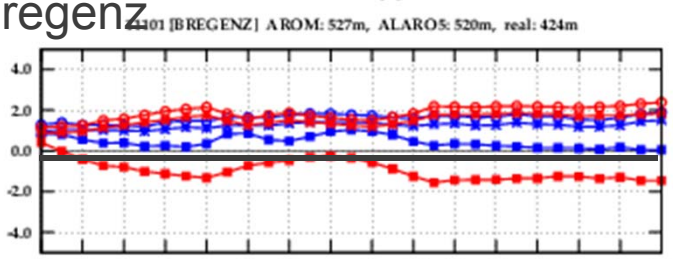


MAE

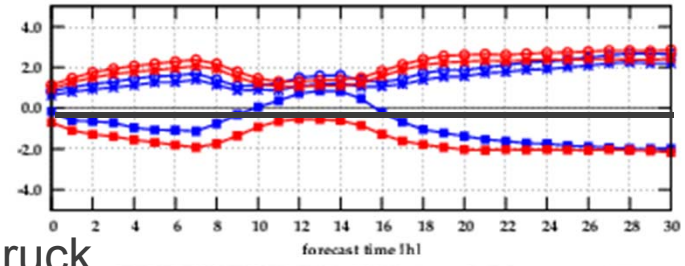
RMSE

BIAS

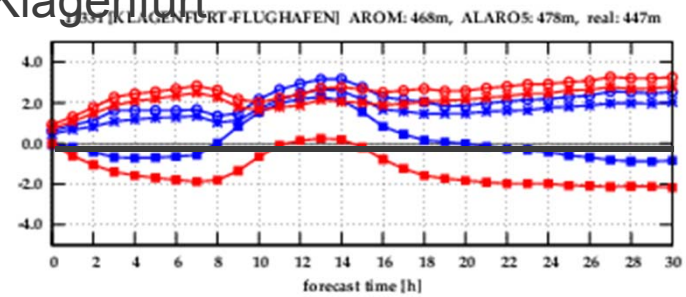
Bregenz



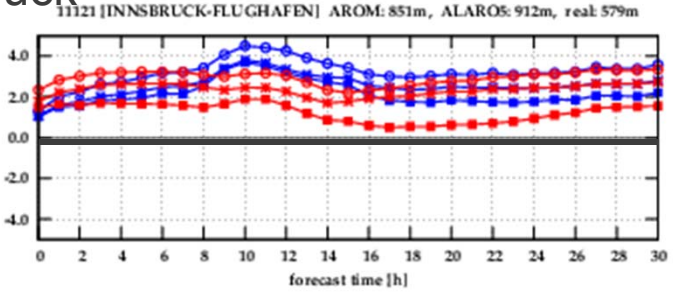
Linz



Klagenfurt



Innsbruck



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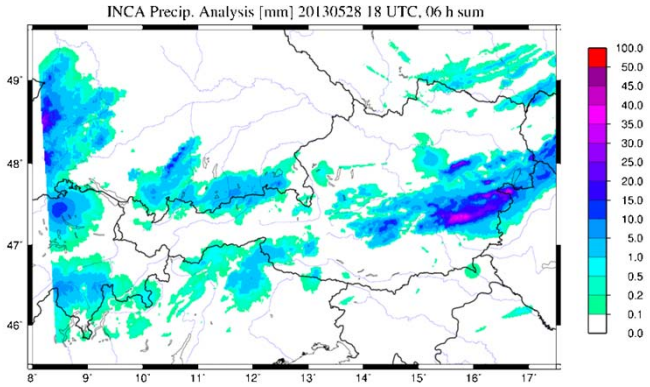
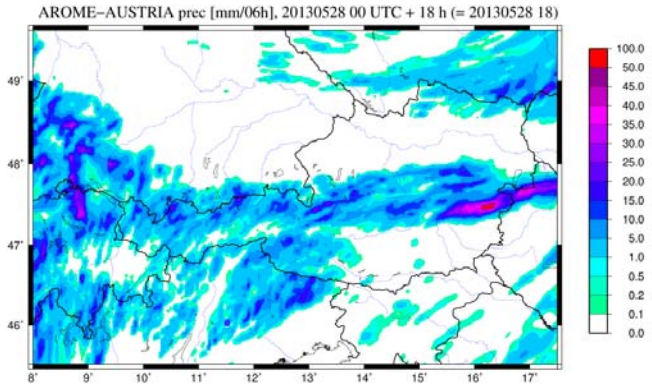
Anwendung: Konvektion im Bereich Wechsel/Südburgenland

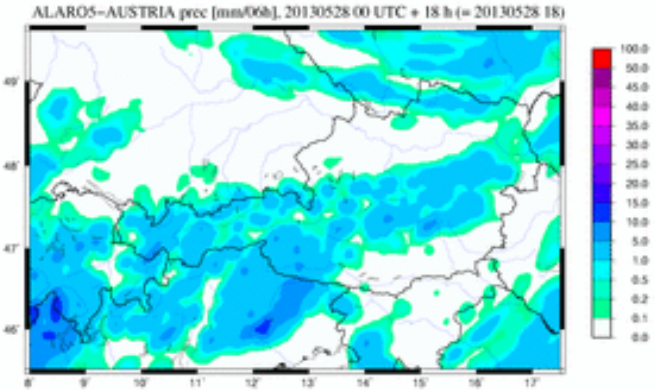
28.5.2013 00 UTC +18h RR/6h



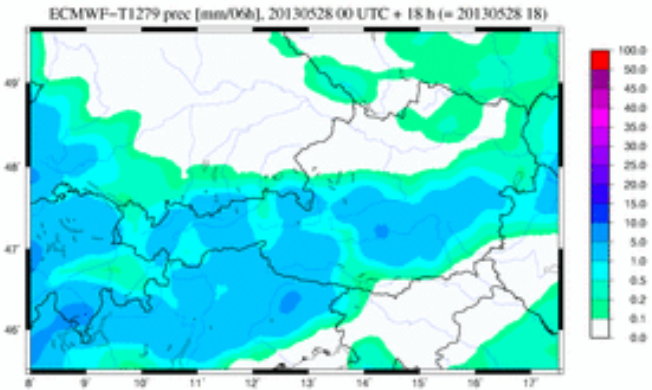
INCA Analysen



AROME



ALARO



Globalmodell-IFS

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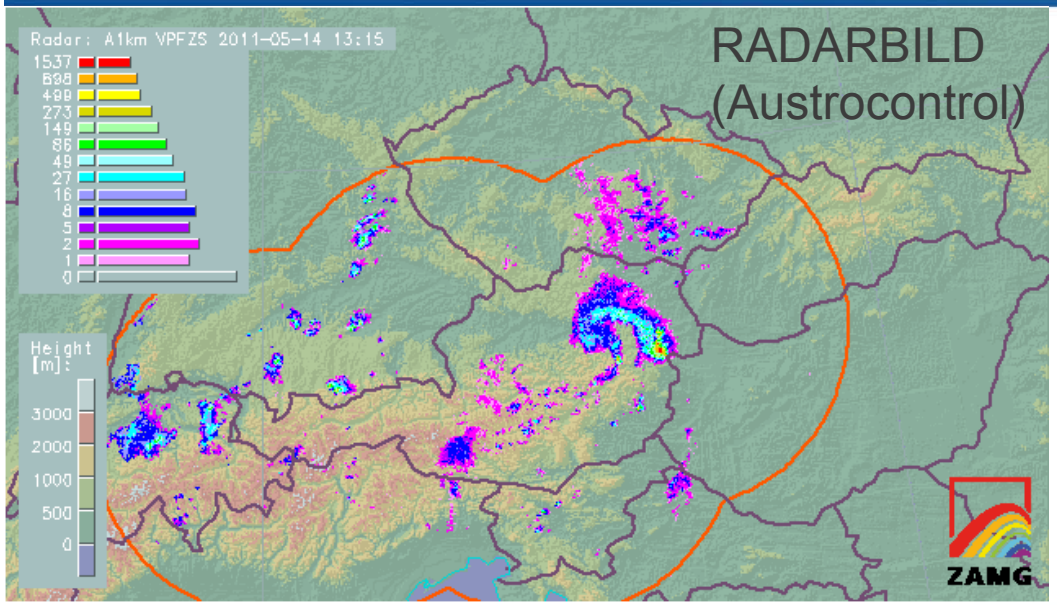
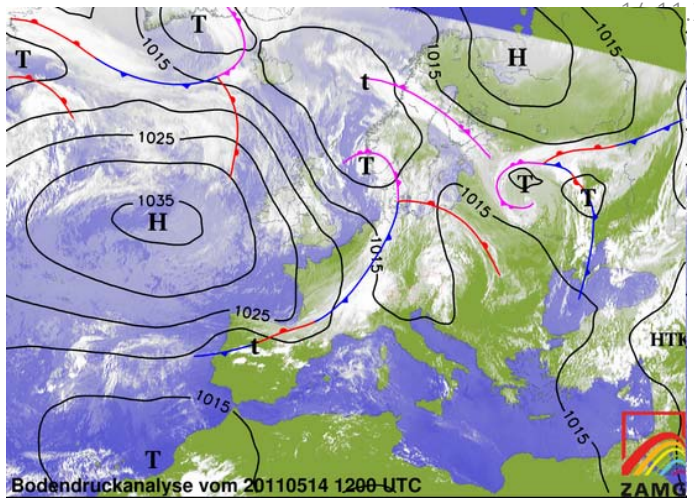
Hagelgewitter im Burgenland 14.5.2011

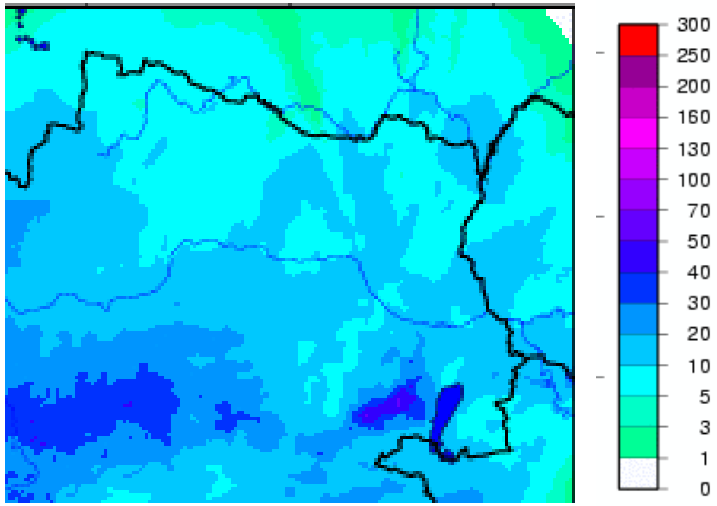


RADARBILD
(Austrocontrol)

AROME
14.11.2013



INCA-Analyse
12UTC+24h



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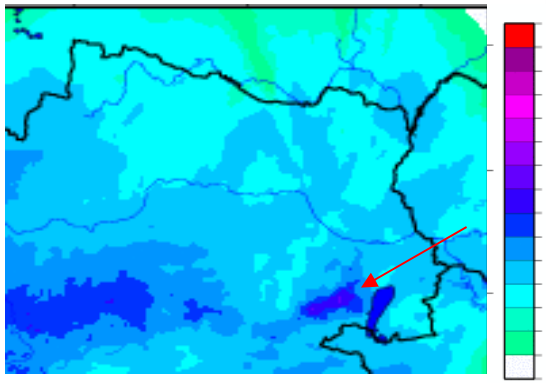
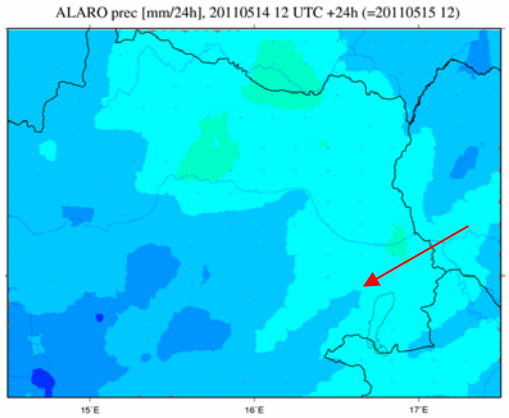
Hagelgewitter 14.5.2011 12UTC+24h Niederschlag

INCA



ALARO



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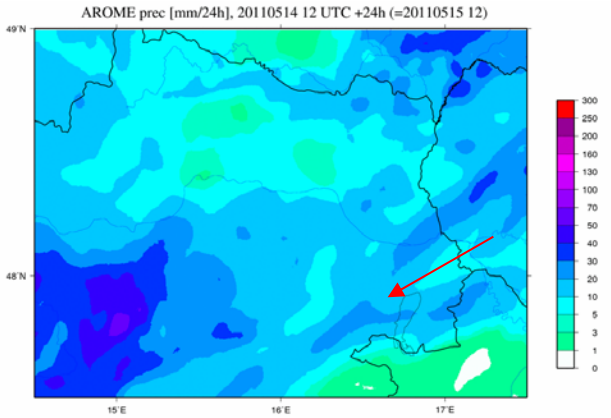
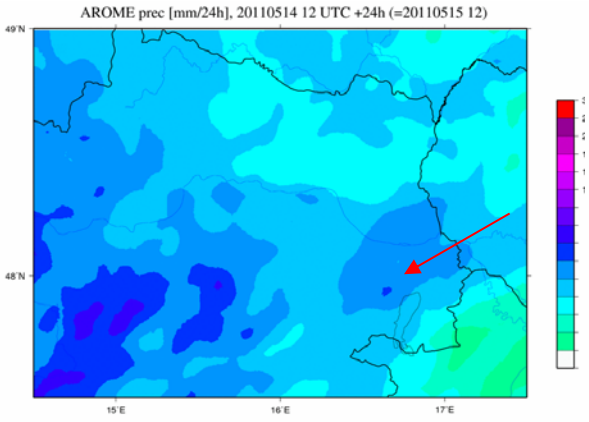
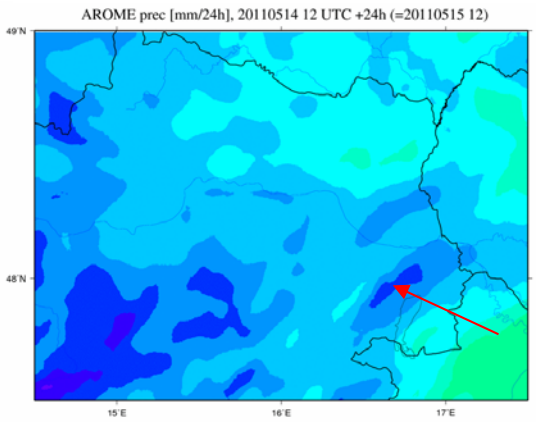


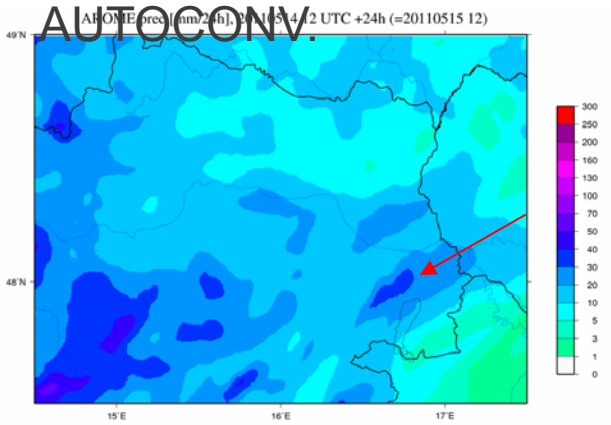
AROME+ASSIM



AROME+ASSIM+PILOT



AROME+ASSIM+PILOT+ AUTOCONV



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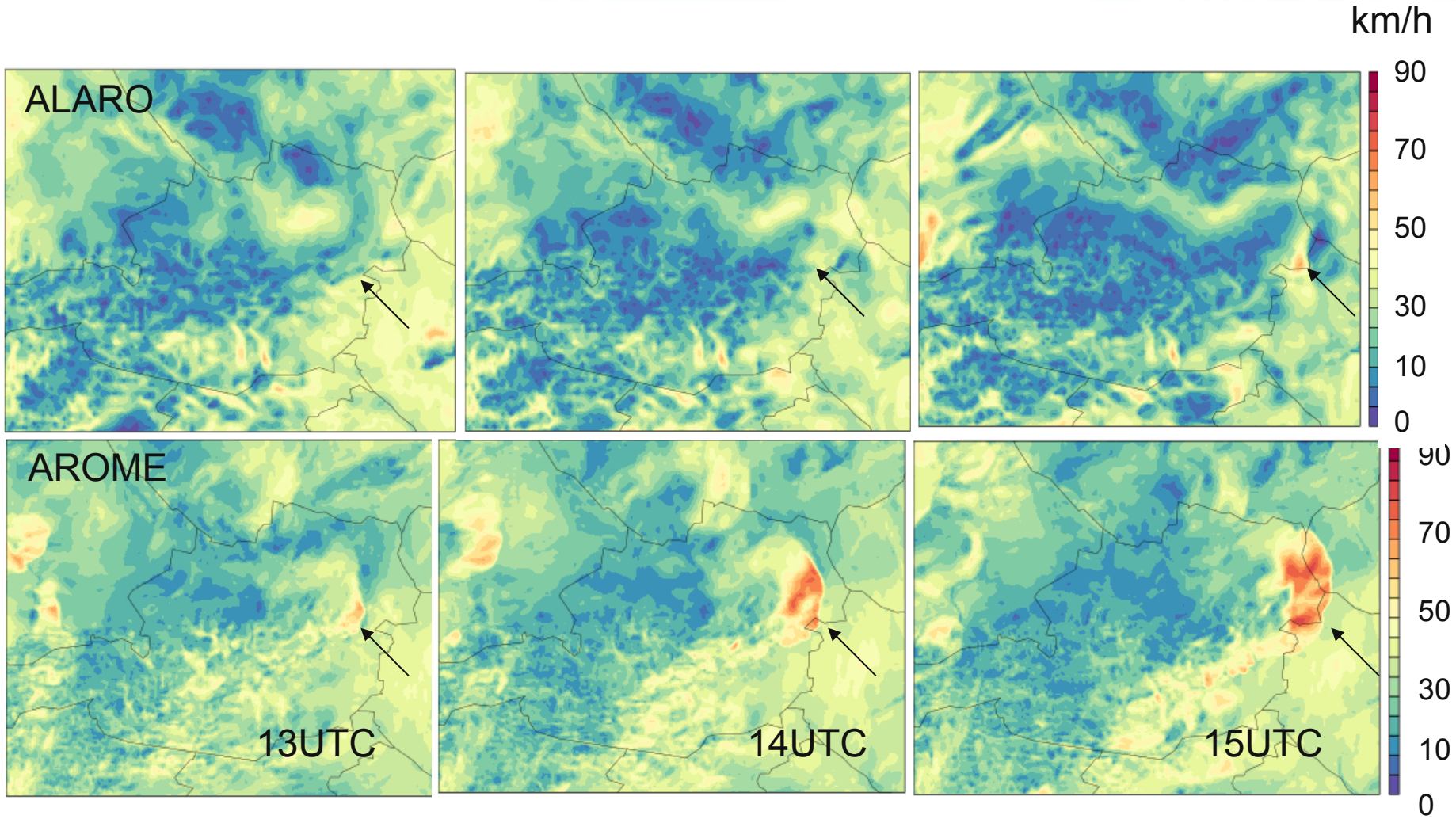
1h-Böen am 14.5.2011



Eisenstadt: 13:27 111,6km/h, Neusiedl 13:58 79,2 km/h, Bruckneudorf 14:07 75,6 km/h

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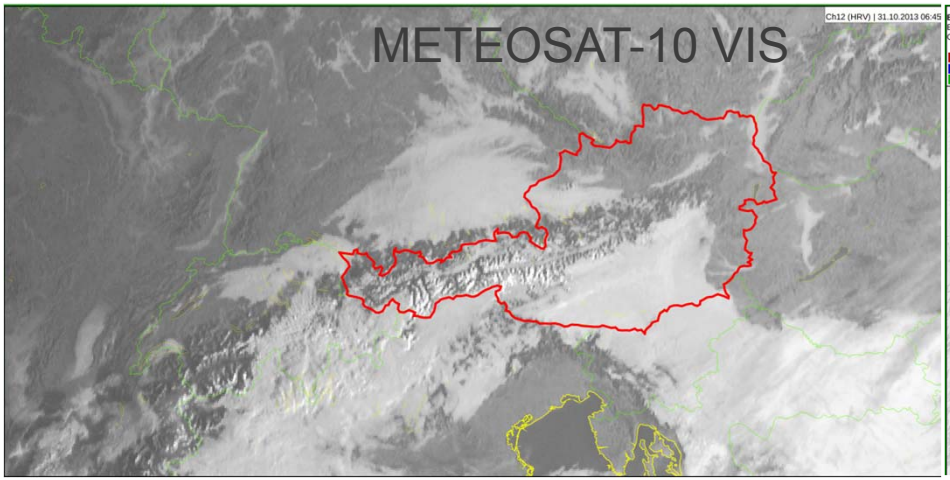
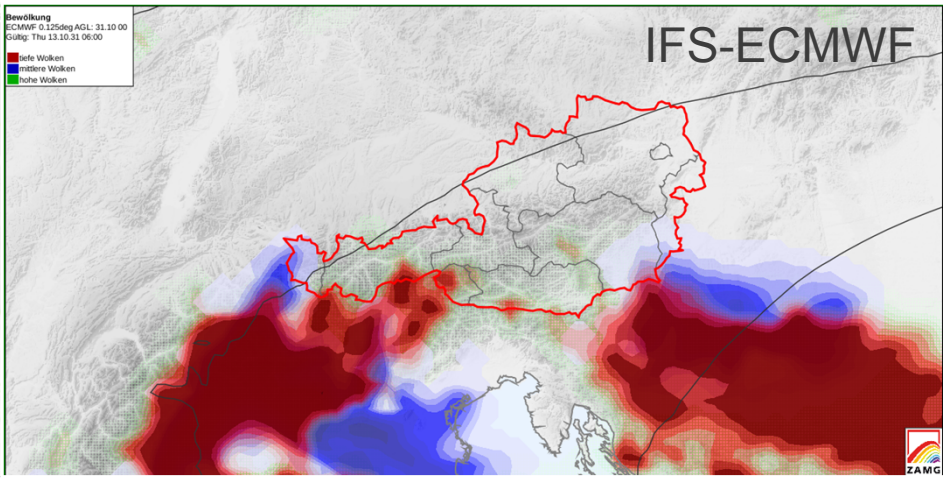
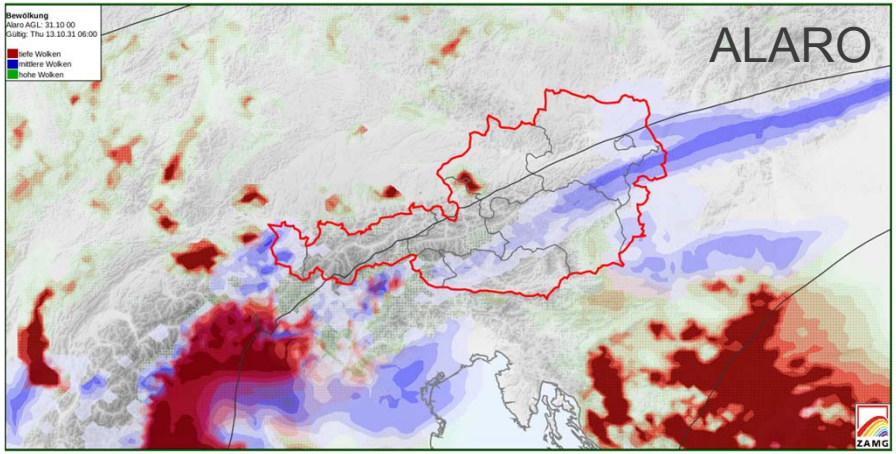
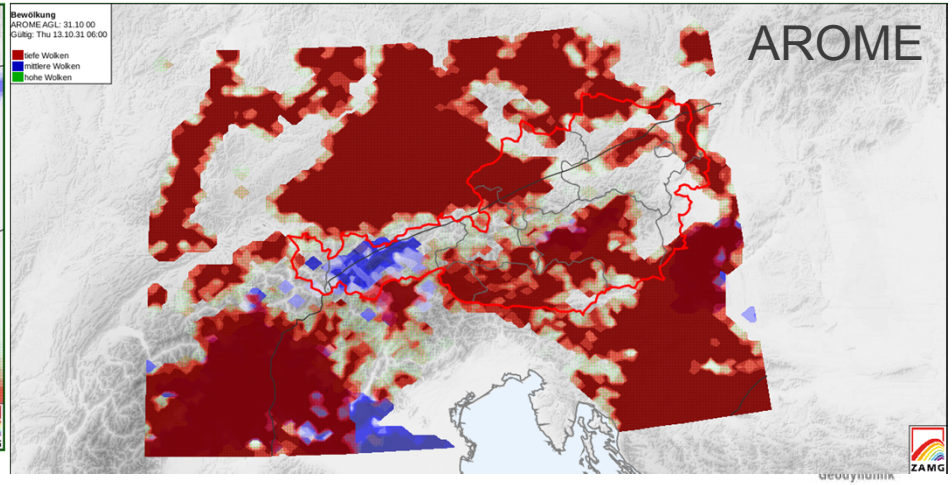
Hochnebel-/Nebelvorhersage: 31.10.2013 00 UTC +6h



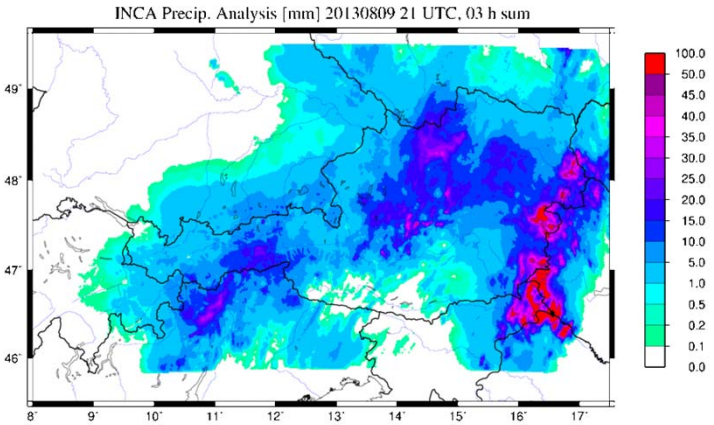




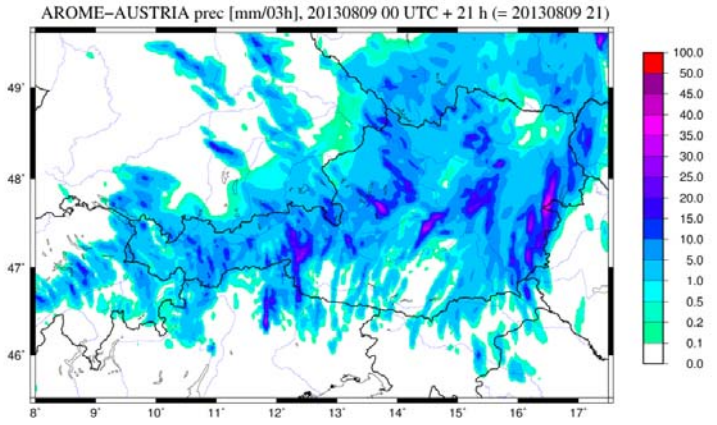


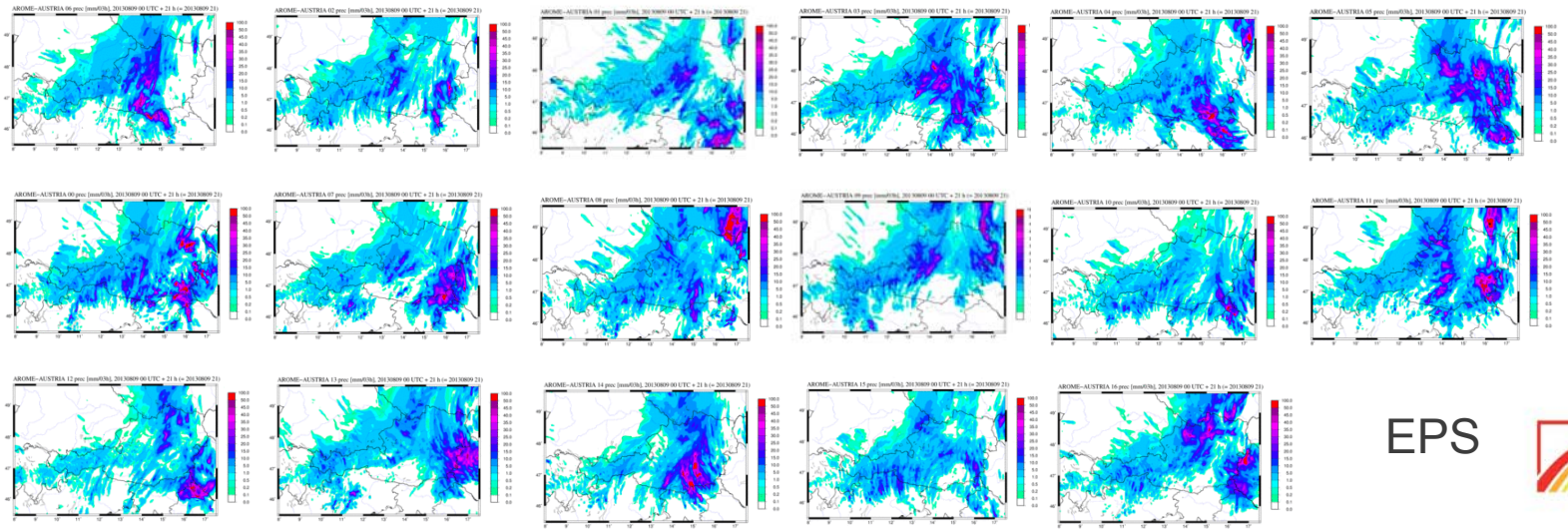
Zukunft: AROME-Ensemble – “downscaling” von LAEF

INCA-ANALYSE



AROME OPER





EPS

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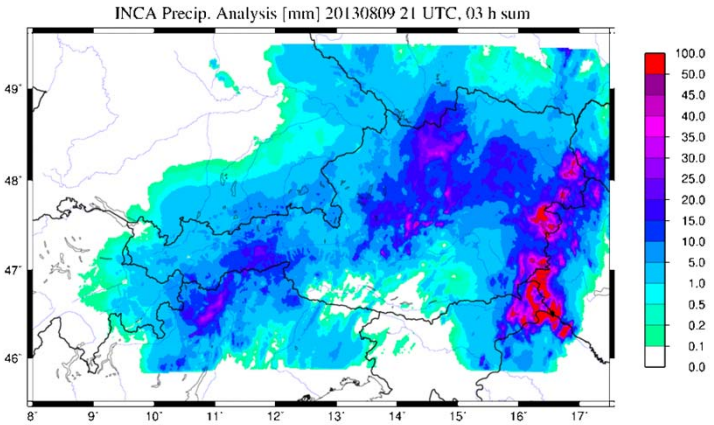
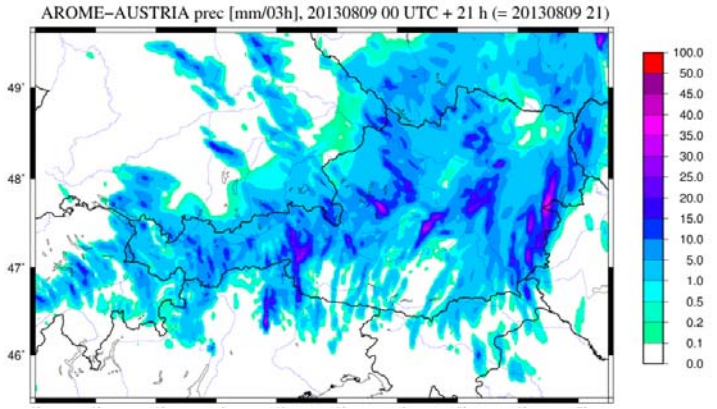
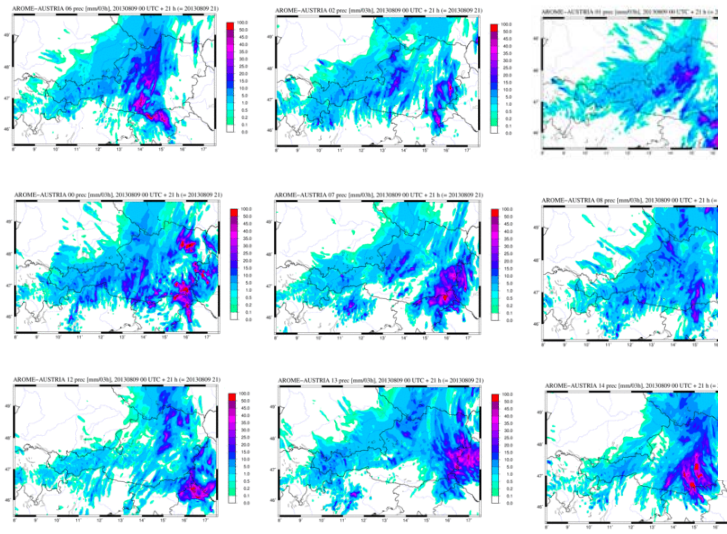
Zukunft: AROME-Ensemble – “downscaling” von LAEF

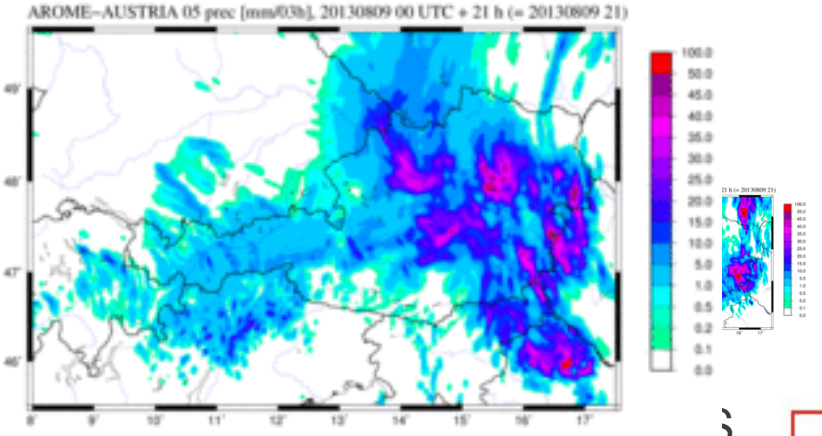
INCA-ANALYSE



AROME OPER







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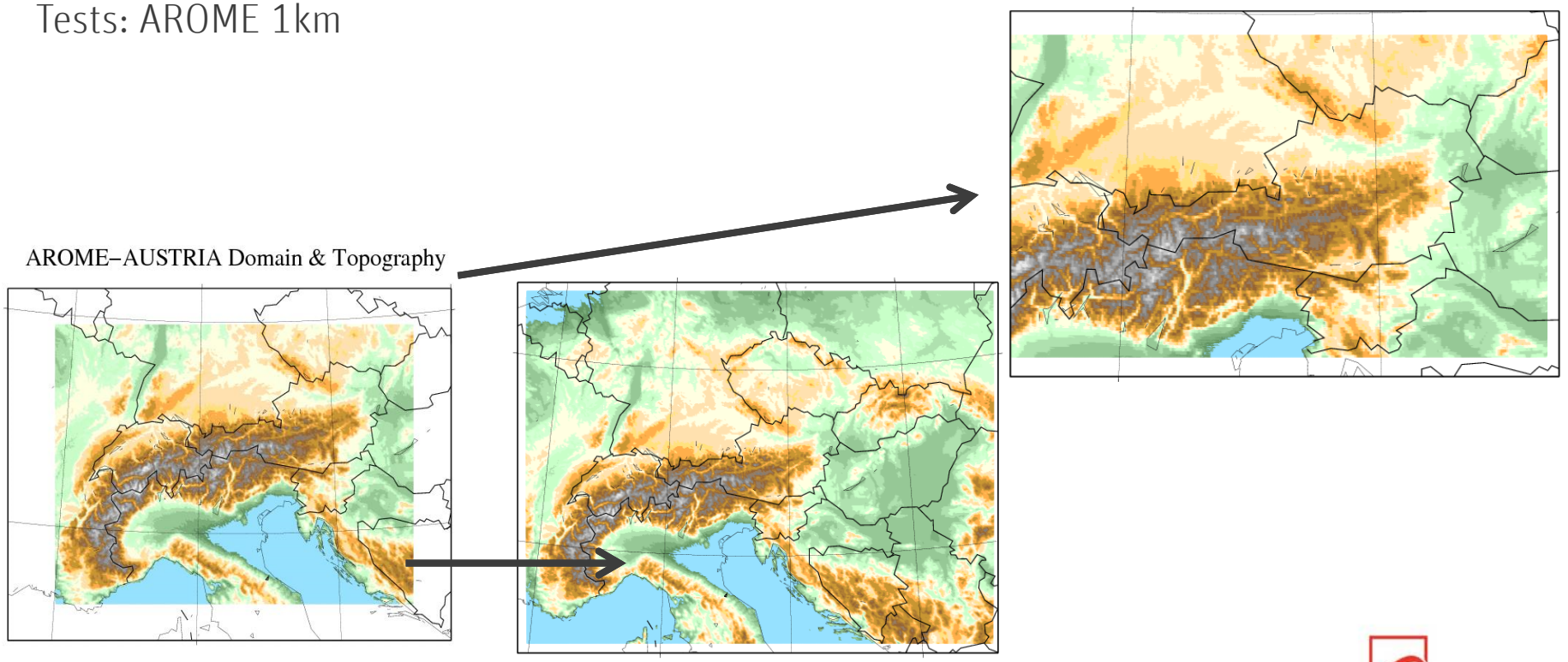
Ausblick

- Weiterentwicklung Modellcode
- neue Beobachtungen in der DA: GPS, RADAR, IASI, HR-Satellitenwinde
- Größere Domain 90L +48h
- Tests zu AROME-Ensemble ->EDA
- Tests: AROME 1km



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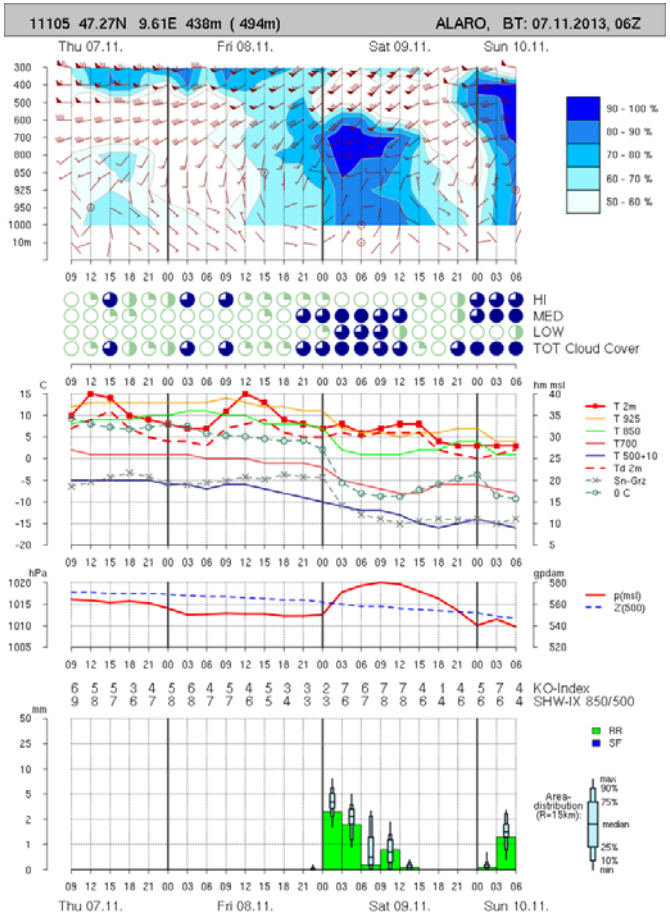

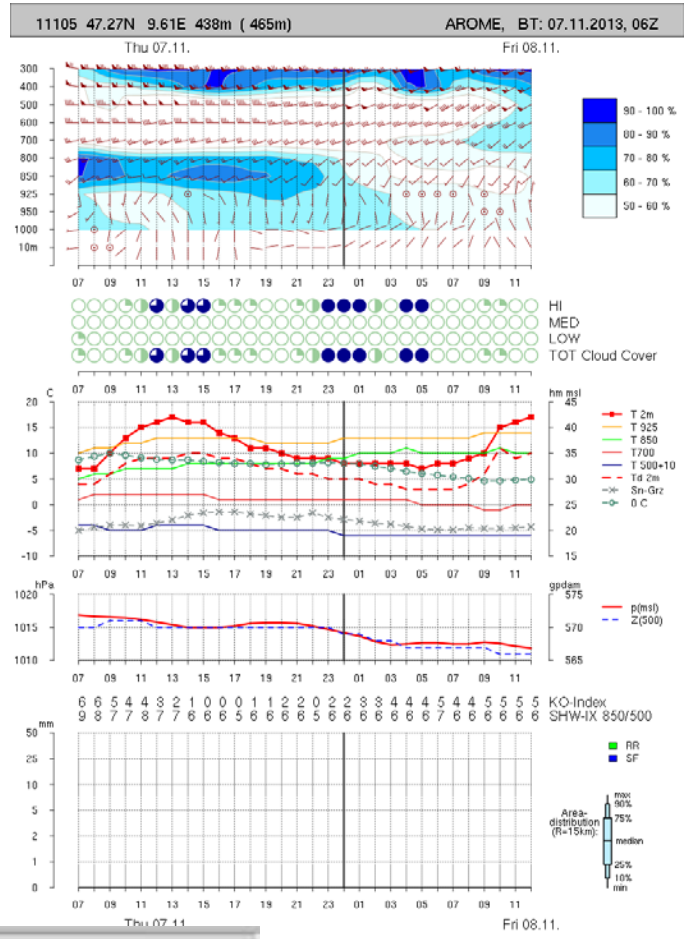

austro CONTROL

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AROME

14.11.2013

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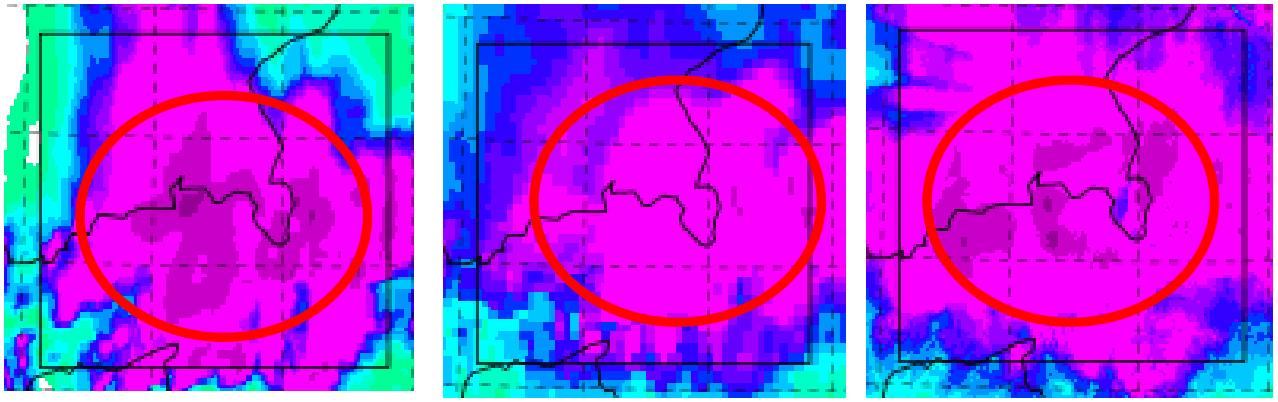
Frohnleichnamshochwasser: ALARO vs. AROME

Modell	24h Niederschlagssummen [mm] für Ausgangslage		
	31.5. 00UTC – 1.6. 00UTC	1.6. 00UTC – 2.6. 00UTC	2.6. 00UTC – 3.6. 00UTC
INCA Analyse	33.7	44.5	68.6
AROME	30.5	42.1	63.9
ALARO	23.9	36.8	50.9
SAL (AROME)	0.02/-0.10/0.06	0.17/-0.06/0.01	-0.11/-0.07/0.02
SAL (ALARO)	0.24/-0.34/0.07	0.32/-0.19/0.01	0.25/-0.30/0.03

AROME für alle 3 Ausgangslagen mit besserer Vorhersage (Flächenniederschlag) und besseren Scores für Amplitude, Struktur und Ort



AROME **ALARO** **INCA An.**

AROME mit deutlich höheren lokalen Niederschlagsspitzen (> 150mm / 24h)

Vorhersage für 02.06.2013 00 UTC – 03.06.2013 00 UTC

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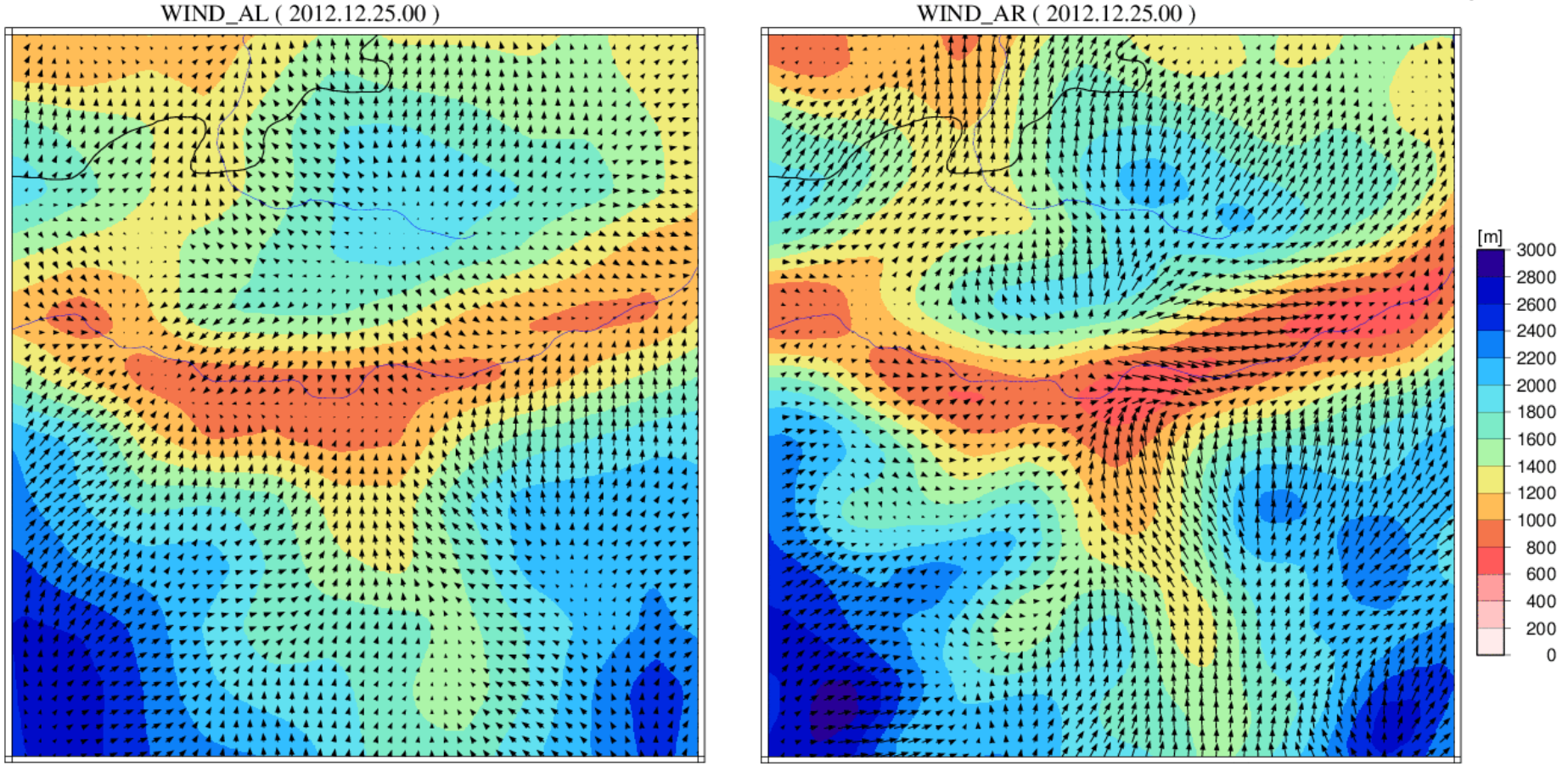
Föhn am 25.12.2012

AROME



ALARO

AROME

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Assimilation österreichischer GPS-ZTD Daten (Xin Yan)

P, T, q->e (AROME Variablen)

H-Operator

Thayer (1974), Bevis et.al (1994)

Integration im Modell

$$ZTD_1 = 10^{-6}\sum_{k_b}^{k_{top}}(k_1\frac{p(k)}{T_v(k)}(z(k-1)-z(k))+10^{-6}\sum_{k_b}^{k_{top}}(k_2'\frac{e(k)}{T(k)}+k_3\frac{e(k)}{T(k)^2})(z(k-1)-z(k))$$

Modellierte ZTD

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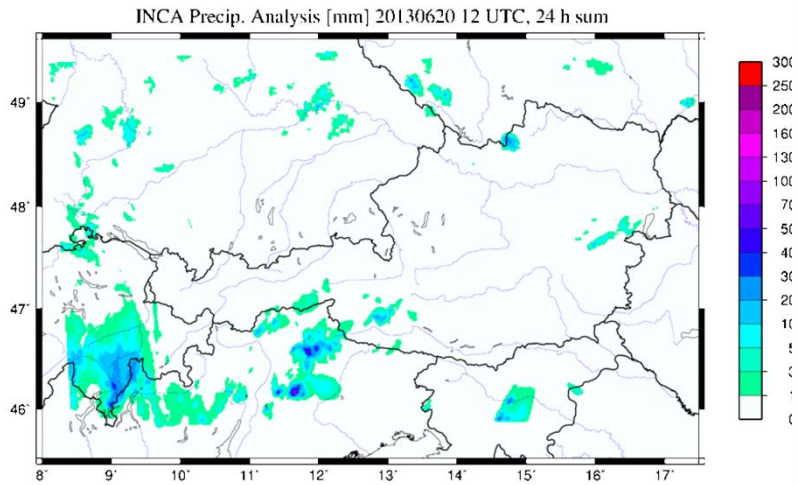
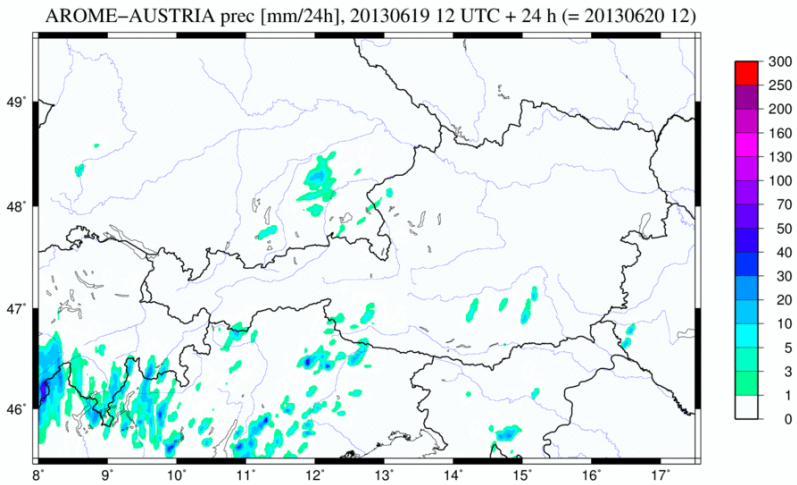
19th June 2013 12 UTC +24h precipitation forecast problem
AROME-Vorhersageproblem

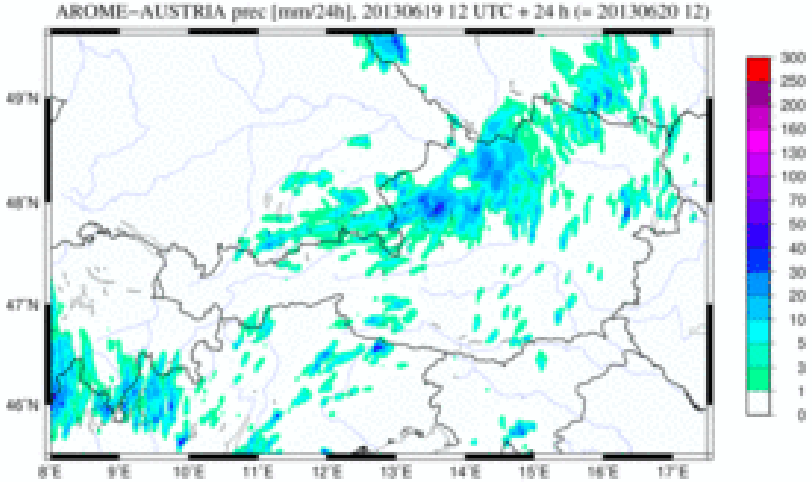
INCA



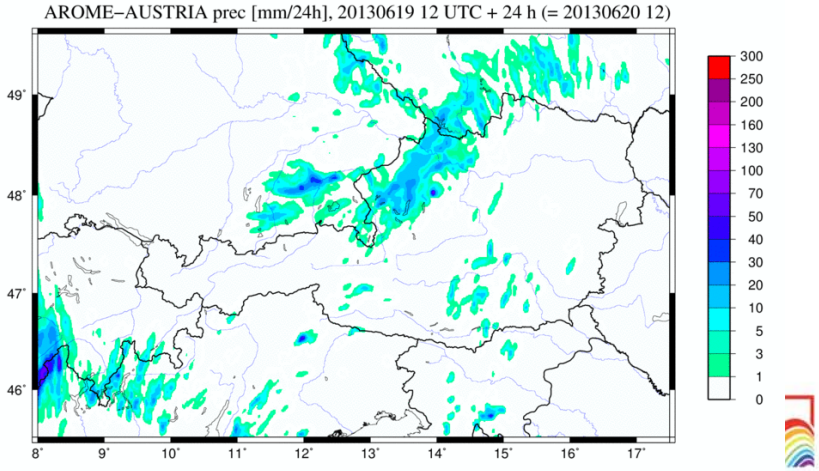
AROME ohne Assimilation T2m in 3D-Var



AROME-OPER



AROME weniger SYNOP



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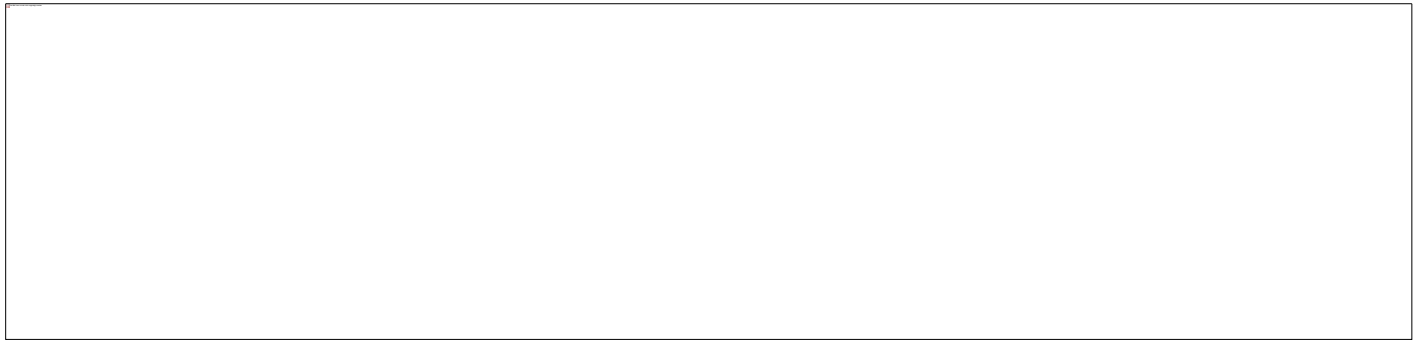
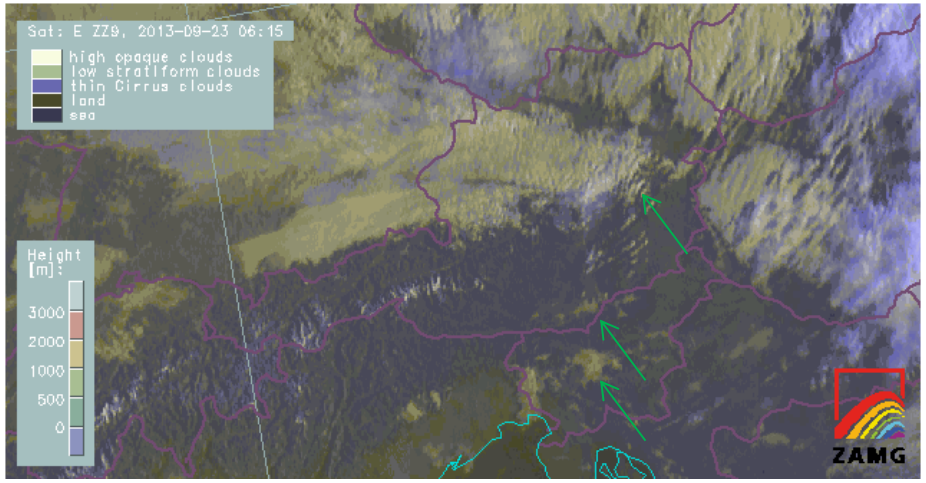


Variationelle Biaskorrektur:

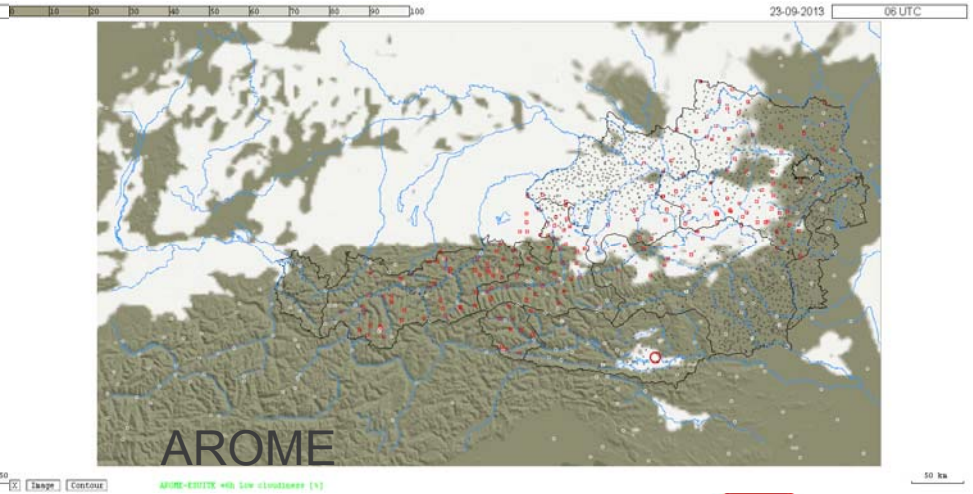
$H(x,\beta) = H(x) + \Sigma\beta i.Pi(x)$

Hochnebelvorhersage 23. September 00UTC +6h

AROME
14.11.2013



MSG-METEOSAT



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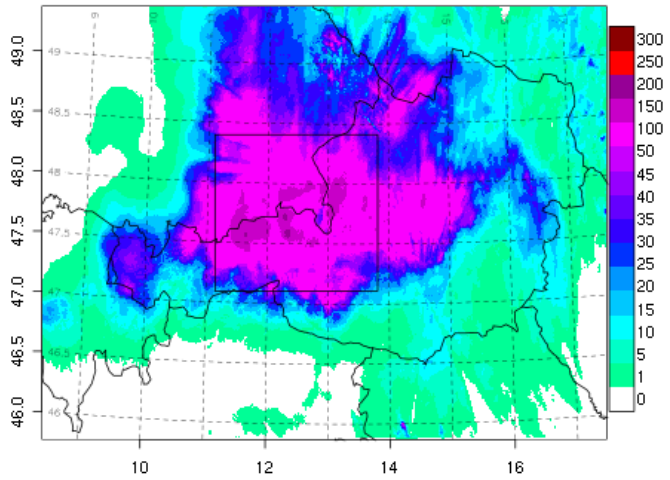
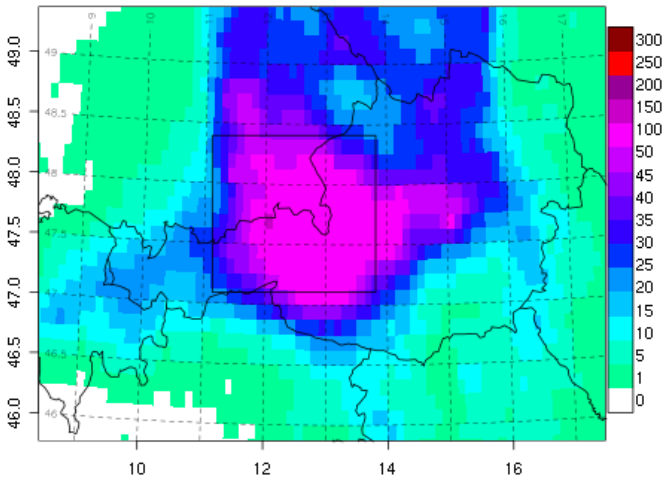
AROME
14.11.2013

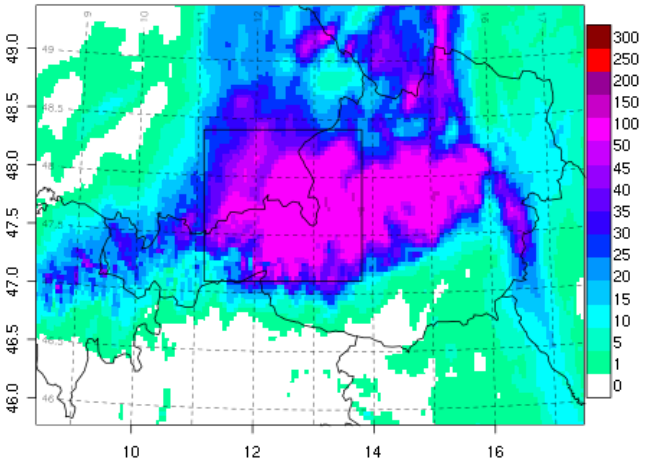
24h precip. INCA 2013060300



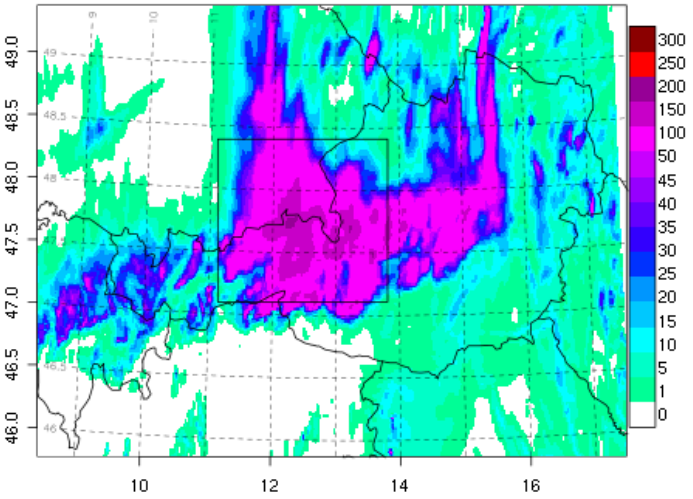
24h precip. ECMWF 2013060200+24



24h precip. ALARO5 2013060200+24



24h precip. AROME 2013060200+24



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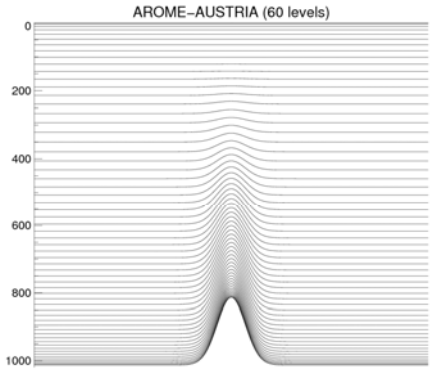
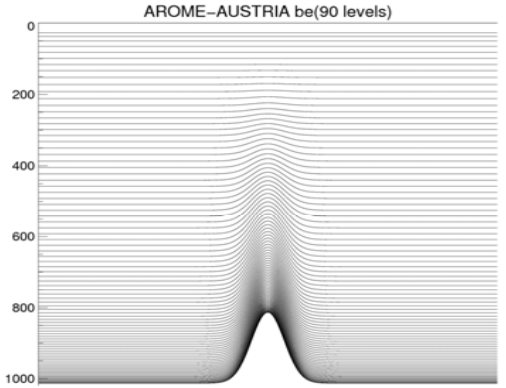
AROME at ZAMG: pre-operational and test versions

Pre-operational:
432x320 GP L60 2,5km

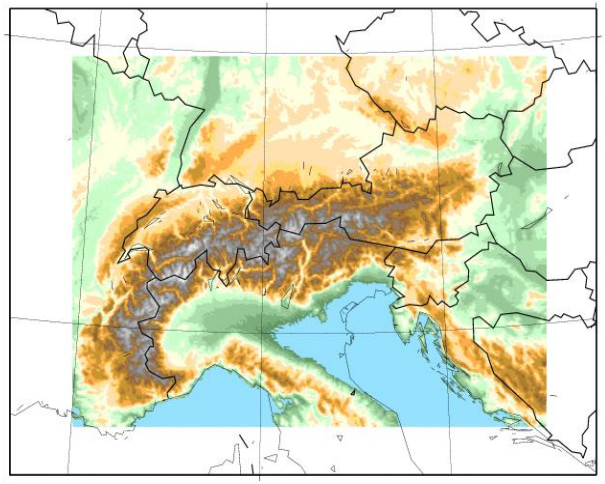


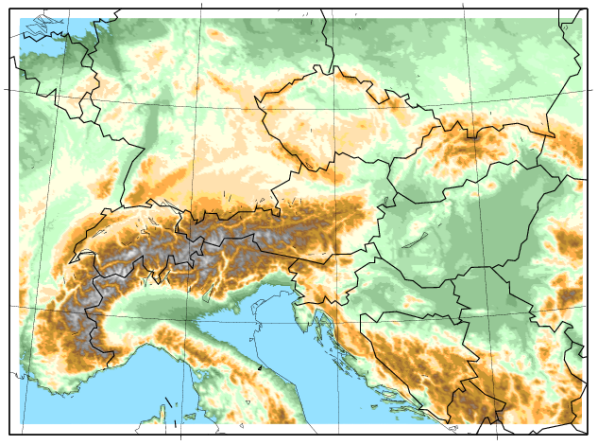
Test version: 600x432GP
L90 2,5km



Levels like
MF-be

AROME–AUSTRIA Domain & Topography





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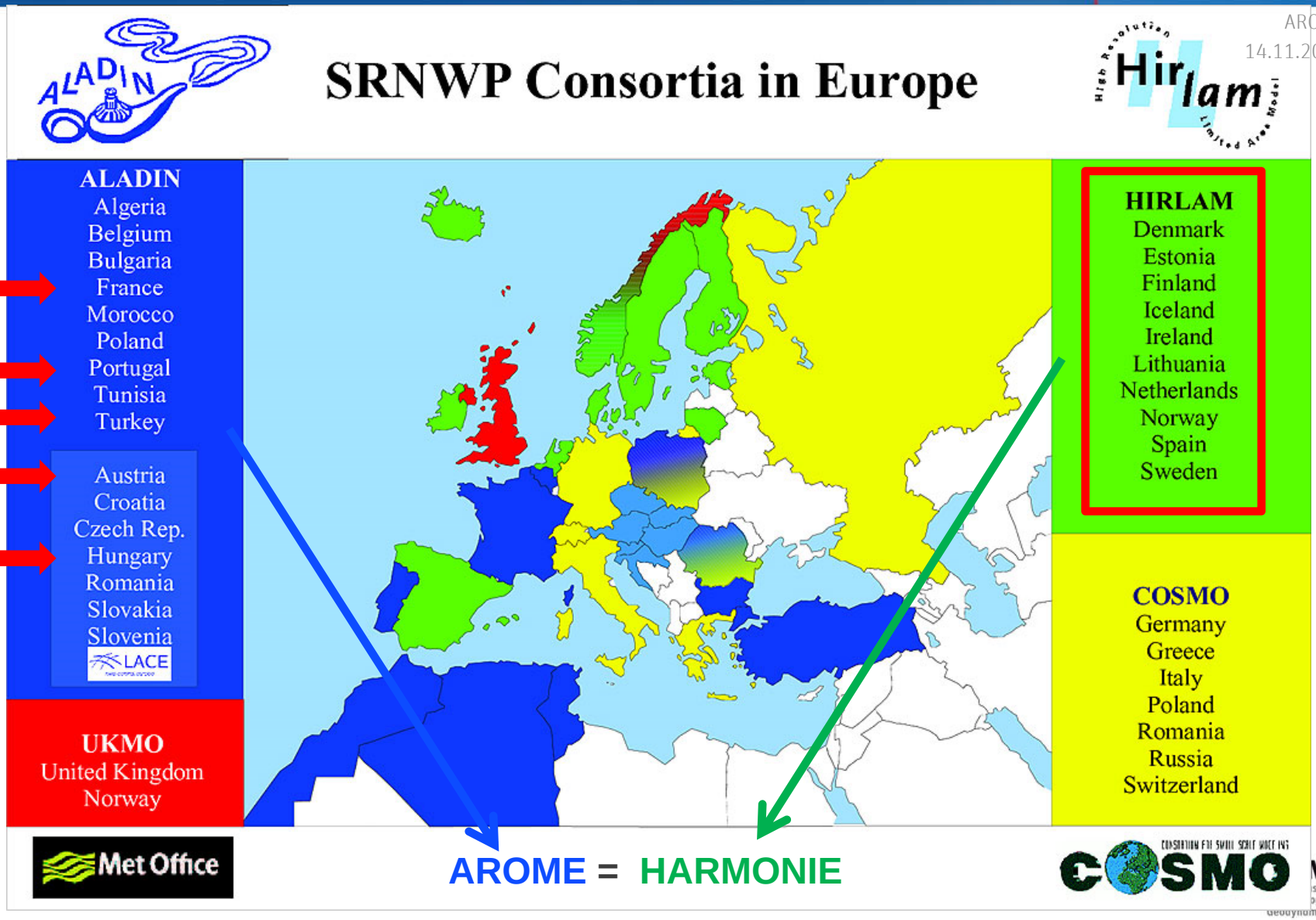
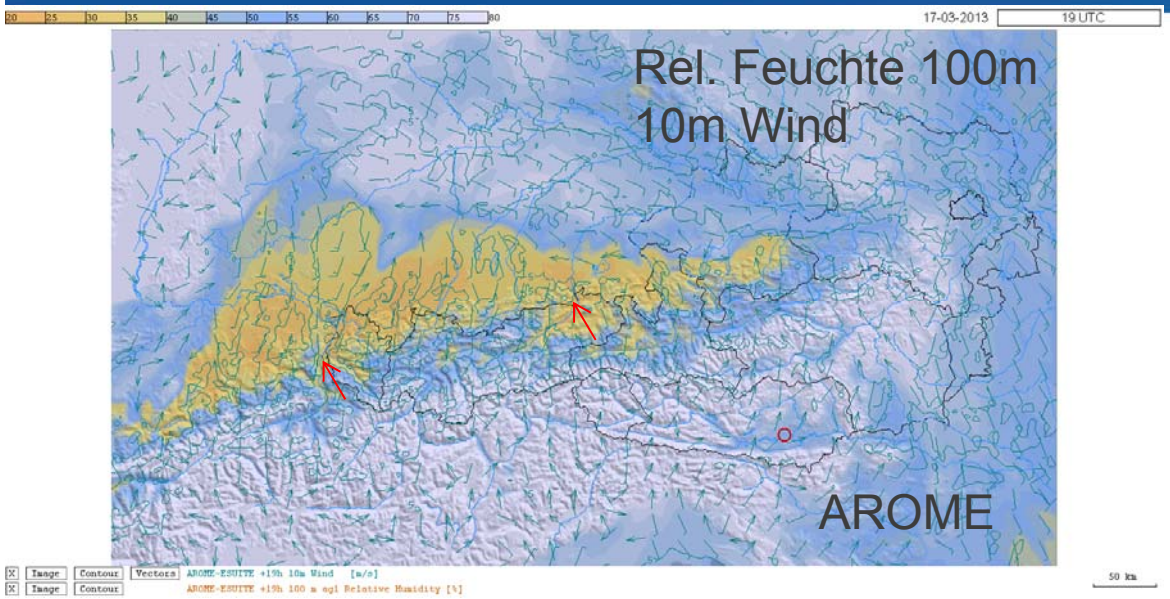
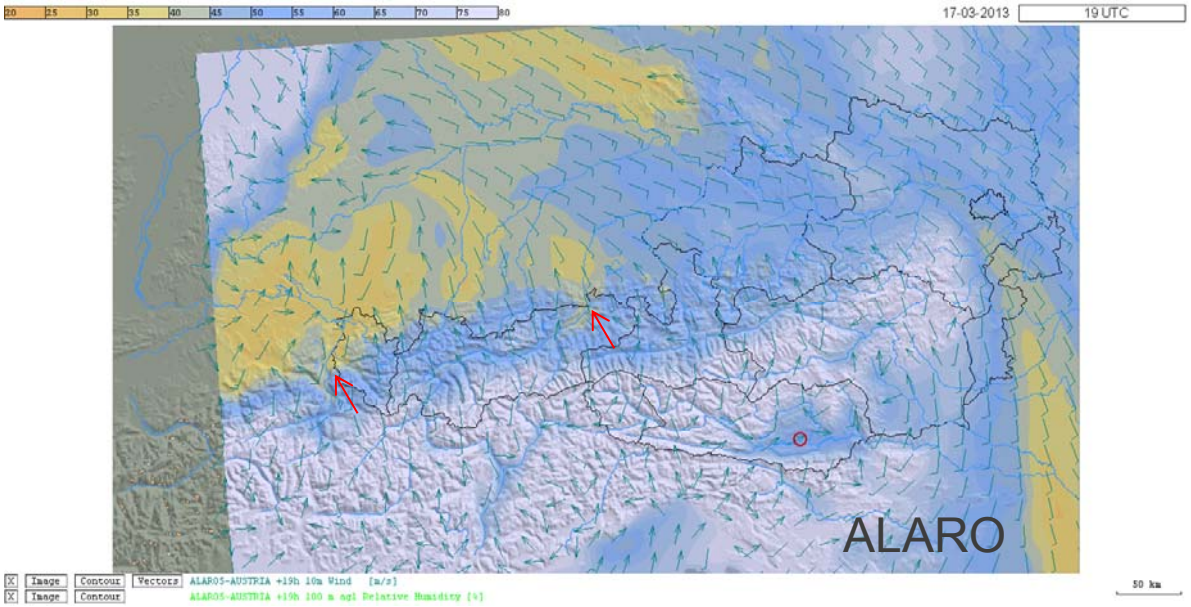
Wer verwendet / entwickelt AROME?



Föhn am 17.3.2013 19 UTC



SYNOP Vaduz: 8,7m/s RF=27%
AROME: 9,5m/s RF=36,1%
ALARO: 10,6m/s RF=42,5%



Kufstein: 2,9m/s RF=39%
AROME: 3,2m/s RF=37%
ALARO: 3,1m/s RF=52%

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