



# Towards AROME rapid update cycle: Usage of satellite and radar data in Austria

*Florian Meier with contribution of Lukas Tüchler*



**ZAMG**  
Zentralanstalt für  
Meteorologie und  
Geodynamik

# Outline

- Observation impact in AROME 3h
- Usage of SAF HR-AMVs
- recent developments in radar assimilation in Austria
- future plans for AROME-1h RUC

SATIN project



Austrian Space Applications Programme



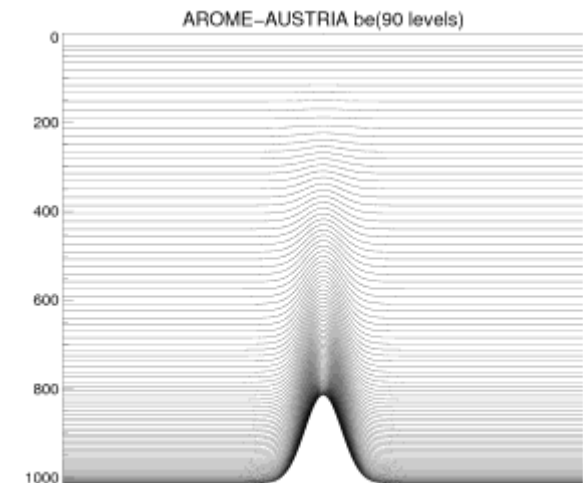
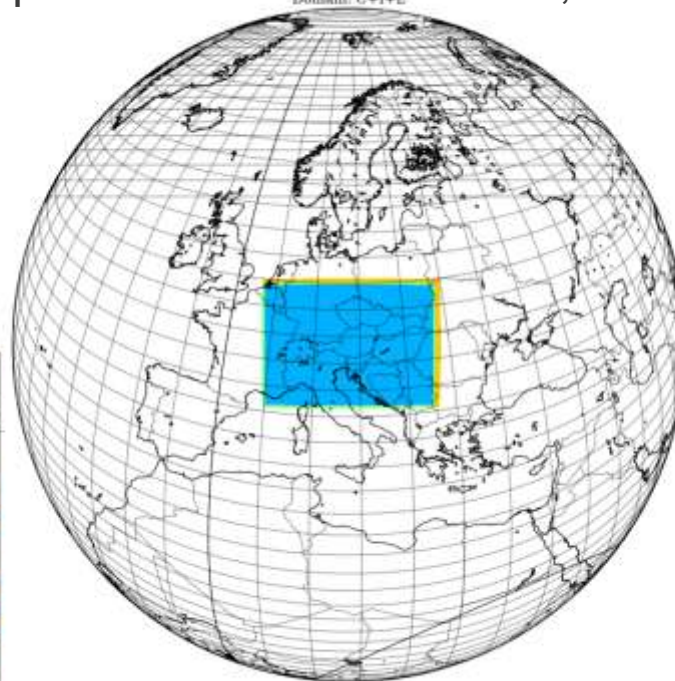
FFG

# Operational AROME system: 2.5km 90L: 3D-Var + CANARI/OIMAIN

AROME

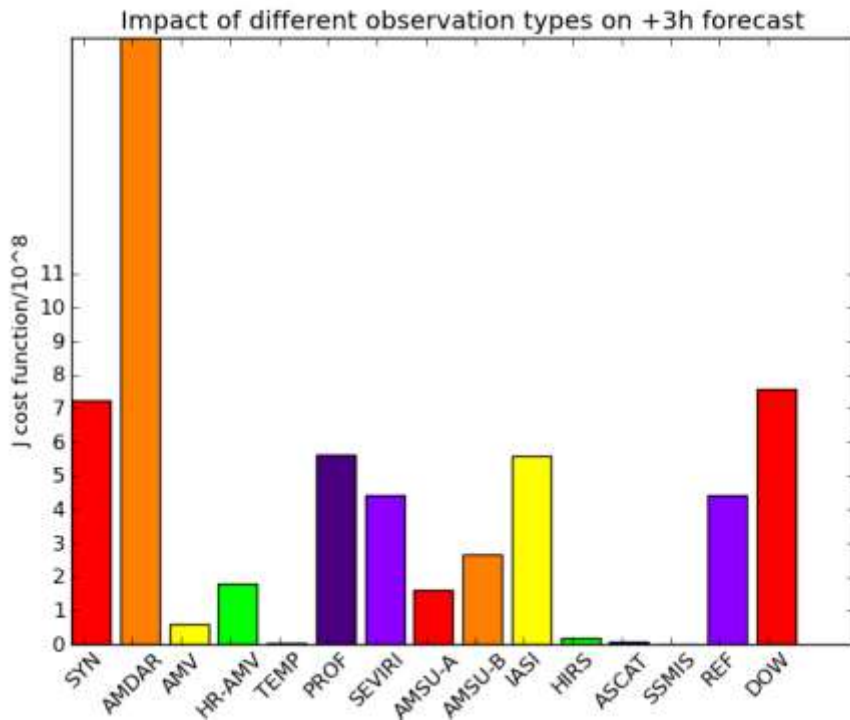
22.04.2015

- 8x day +48h ; 3h-assimilation cycle; cy36t1 export bf09 (OIMAIN cy36t1op2)
- B-Matrix: Ensemble method (downscaled ALADIN LAEF differences 20130621-20130704 16 member 100 diffs)
- LBC: IFS-lagged (6h/9h) 3 hourly
- model top (~20 hPa): predictor 5/6 switched off; AMSUA-A ch12 & ch13 blacklisted

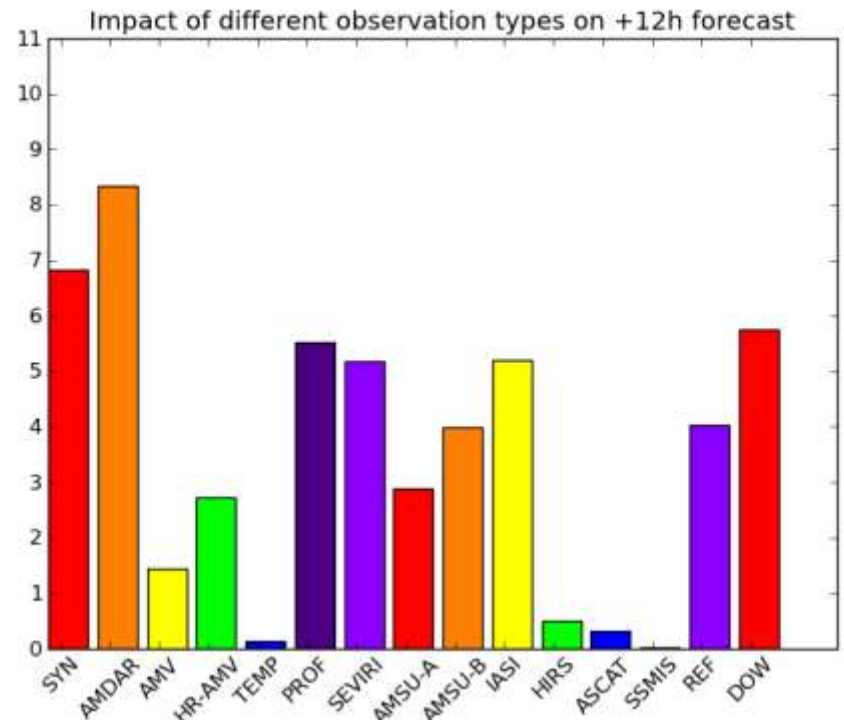


change 08/2014  
new domain, L60->L90,+30h->+48h

# Observation impact – moist total energy norm method (Storto and Randriamampianina) 09 and 21 UTC runs



+3h



+12h

$$\langle x^i - x^{ctr}, x^i - x^{ctr} \rangle = \int_{\eta_0}^{\eta_1} \int_D \left( u^2 + v^2 + \frac{c_p}{T_r} T^2 + \frac{RT_r}{p_r^2} p^2 + \frac{L^2}{c_p T_r} q^2 \right) \frac{\partial p_r}{\partial \eta} d\eta dD$$

Ehrendorfer et al. 1999

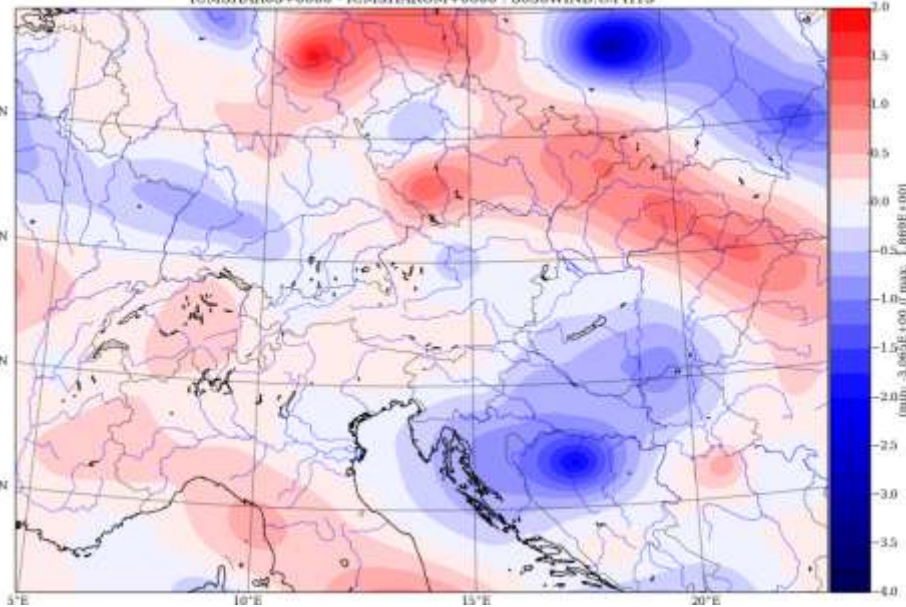


# Using SAF HR atmospheric motion vectors in 3D-Var

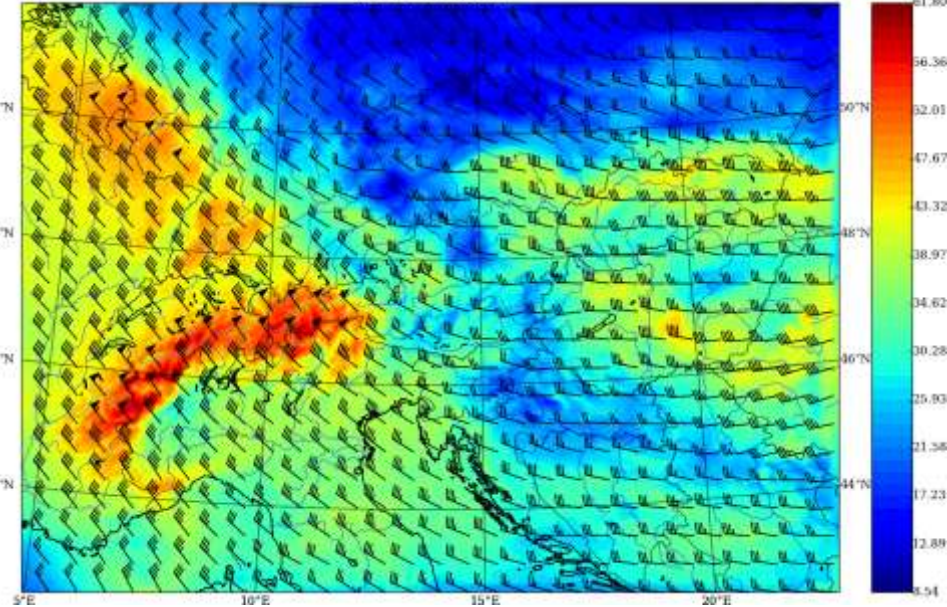
AROME  
22.04.2015

- HR-AMV in ECMWF format not SAF format (proposed by CZ,HU)
- HR-AMV (V4.0, 2013)
- New sub-base geowind2 in bator: decodebufr/init/(lecture only cy36t1)-  
case 'geowind' ->case 'geowind,geowind2'
- Adaptation of scripts param.cfg and blacklists mf\_black.mb/LISTE\_LOC

ICMSHAR03+0000 - ICMCHAROM+0000 : S030WIND.U.PHYS



S030WIND.PHYS  
2015-04-01 06:00:00



U wind AROME+HR-AMV-AROME-REF  
20150401 06 UTC +0h S050=520hPa

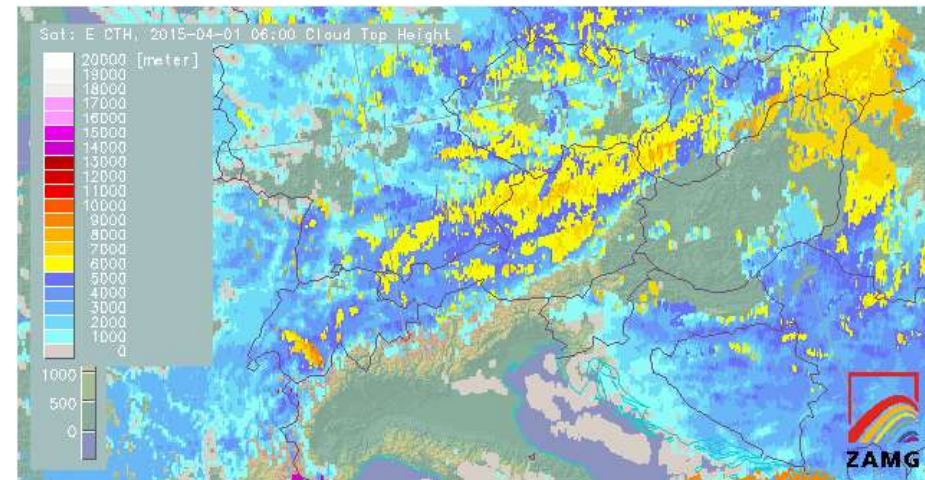
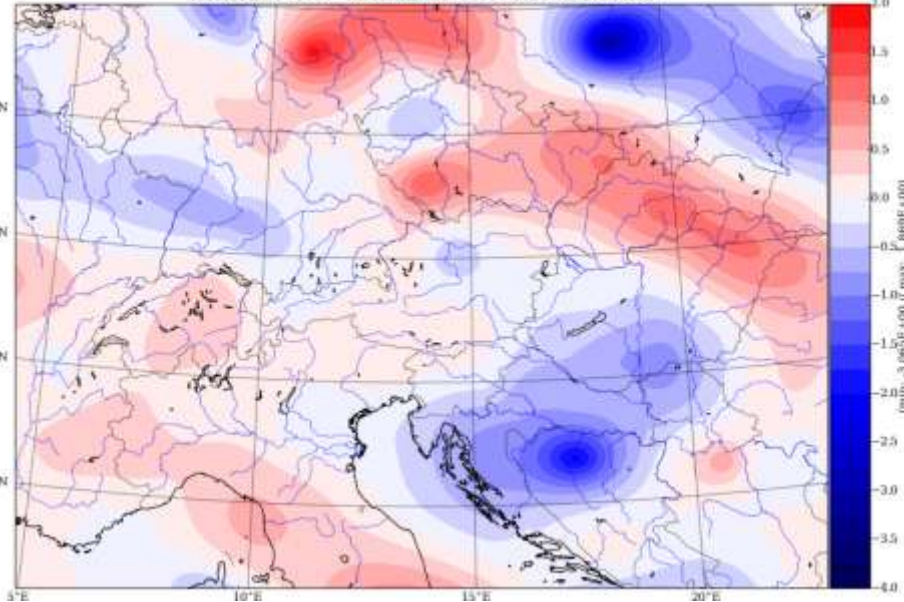
AROME-REF

# Using SAF HR atmospheric motion vectors in 3D-Var

AROME  
22.04.2015

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ICMSHAR03+0000 - ICMCHAROM+0000 : S030WIND.U.PHYS



MSG cloud top high

U wind AROME+HR-AMV-AROME-REF  
20150401 06 UTC +0h S050=520hPa

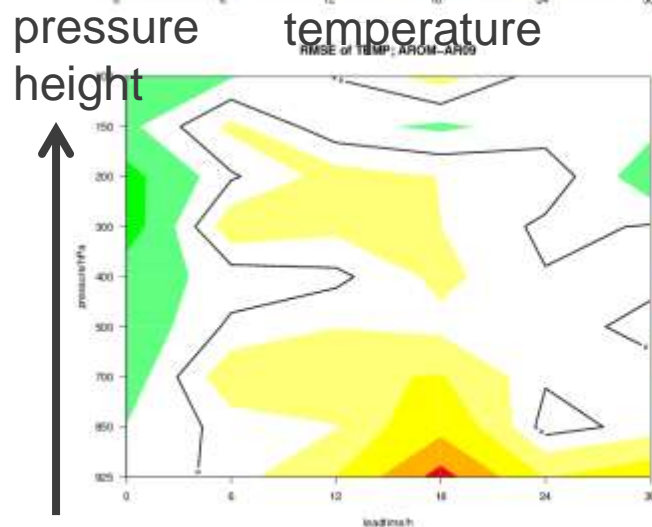
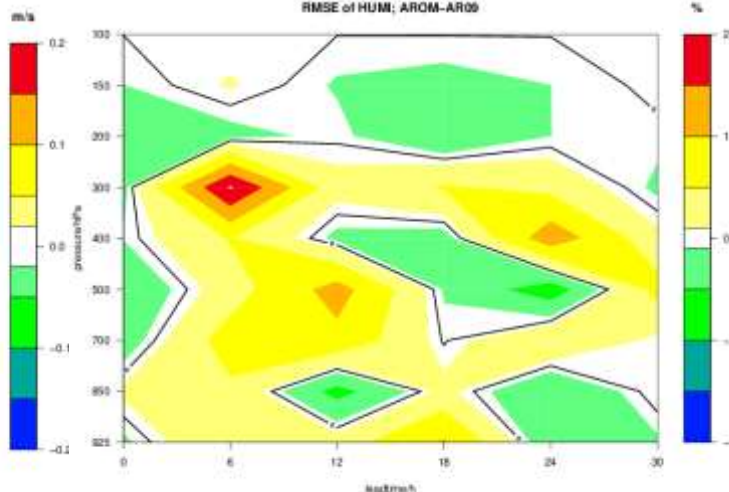
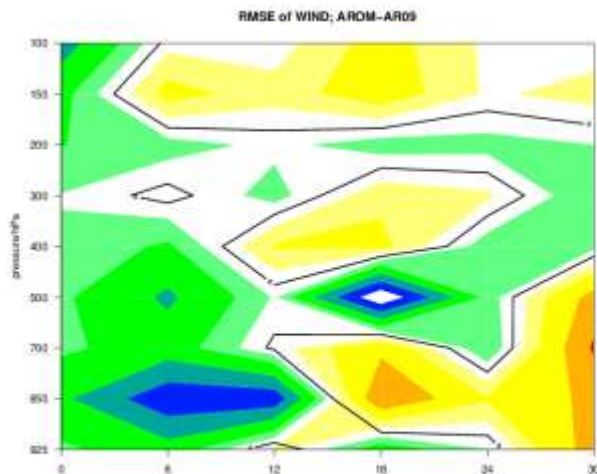


# Verification of HR-AMV impact 20150119-20150225 00UTC

AROME  
22.04.2015

## windspeed

## relative humidity



RMSE compared to radio soundings;  
difference REF-experiment

- mostly neutral
- Small improvement around 300hPa in RH
- degradation of low level wind

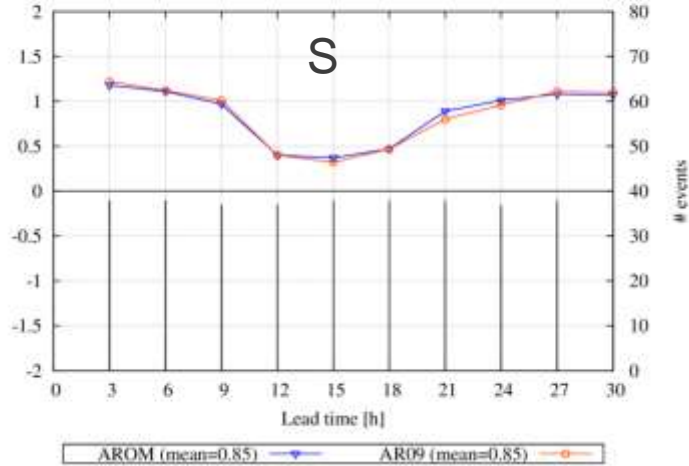
pressure height ↑

leadtime →

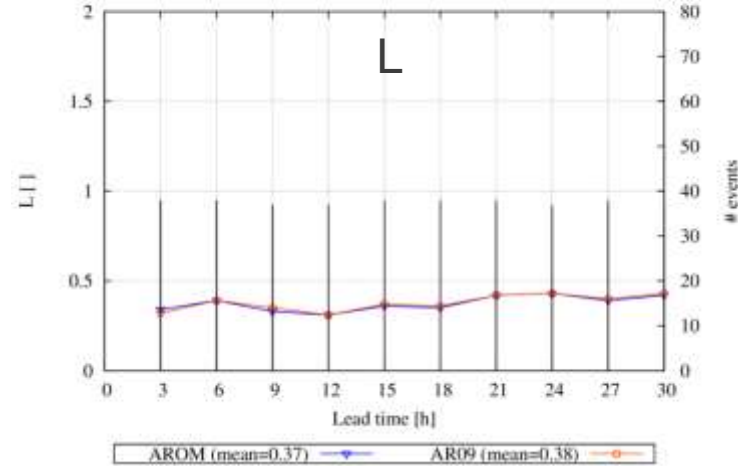
# Verification of HR-AMV impact 20150119-20150225 00UTC – precipitation and screen level parameters

AROME  
22.04.2015

Structure Score [S] for domain 06 (OESTERREICH\_GESAMT) at 02 km resolution  
rr (area mean) > 0.0 mm

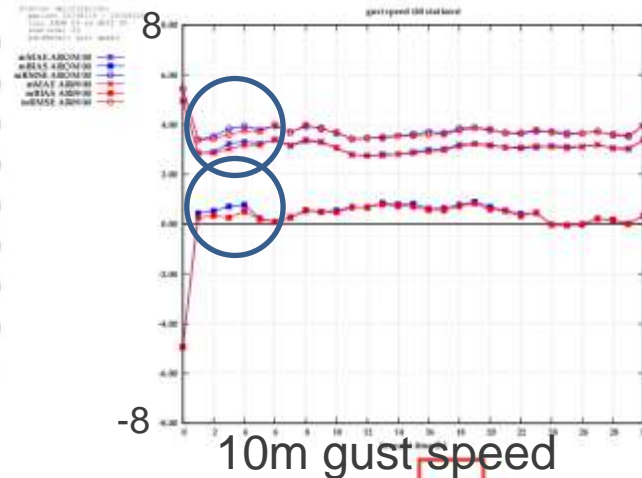
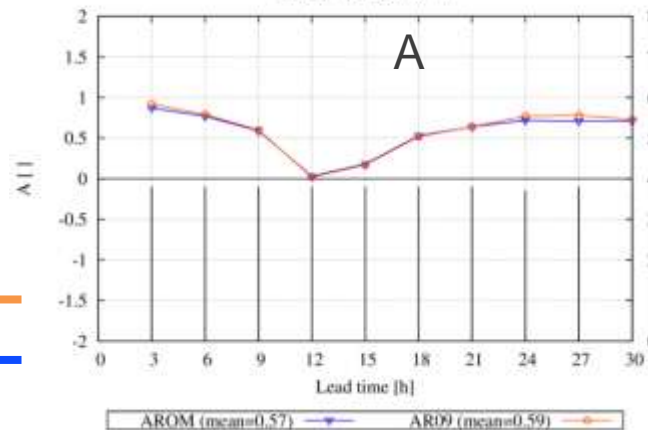


Location Score [L] for domain 06 (OESTERREICH\_GESAMT) km resolution  
rr (area mean) > 0.0 mm



Neutral!

Amplitude Score [A] for domain 06 (OESTERREICH\_GESAMT) at 02 km resolution  
rr (area mean) > 0.0 mm



SAL-SCORE  
(Wernli et al. 2008)  
Perfect: S=A=L=0

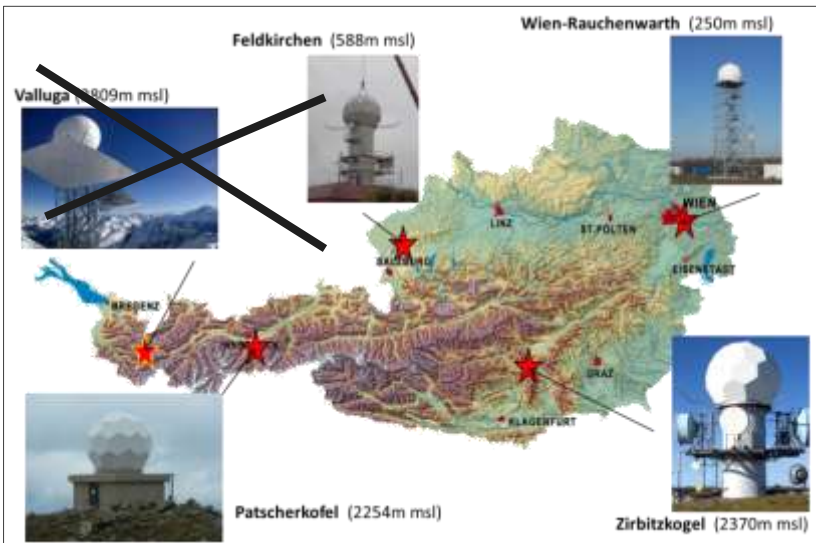
AROME+HR-AMV ——— (orange line)  
AROME-REF ——— (blue line)

T2m, RH2m, 10m windspeed and MSLP also neutral



# RADAR-Assimilation in AROME in Austria

AROME  
22.04.2015



(From Kaltenböck 2012)



- test data of 4 Austrian dual pol. RADARS (EEC) available (DOW+REF) ,HDF5
- 16 elevations each
- Parallel run on operational domain (3hourly)
- de-aliasing (CINRAD method of He et al. WAF 2012)->change to BALTRAD-dealias?
- Blacklisting of elevations  $<1.5^\circ$
- If  $<7$  dBZ->no data/undetected
- CONRAD-RC
- AROME 2.5km cy36t1 export
- No quality control - INCA2 flags in preparation
- Assimilation standard AROME method 1D+3D-Var

# Schematic scheme of RADAR assimilation at ZAMG

AROME  
22.04.2015

Raw data HDF5 "OPERA style"

INCA2-QC

HDF5+qc flags

de-aliasing

blacklisting

HDF5

Adapted CONRAD

(Jann/Kovacic)

REF MF-bufr

DOW MF-bufr

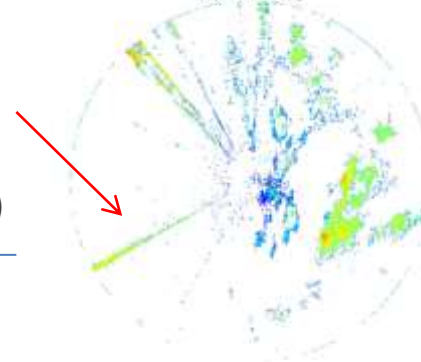
BATOR

SCREENING/Bayes

MINIMIZATION

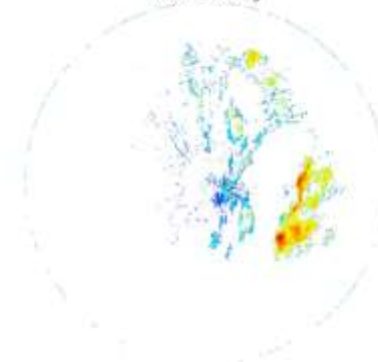
Depending on thresholds and flags  
-> set to "no data"

t\_arch/aladin/ASSIM/RADAR/DEALIASING/PARA01\_LOWM\_201405150000.hdf  
DBZH - 0.5deg



Raw reflectivity

t\_arch/aladin/ASSIM/RADAR/DEALIASING/PARA01\_LOWM\_201405150000.hdf  
DBZH - 0.5deg

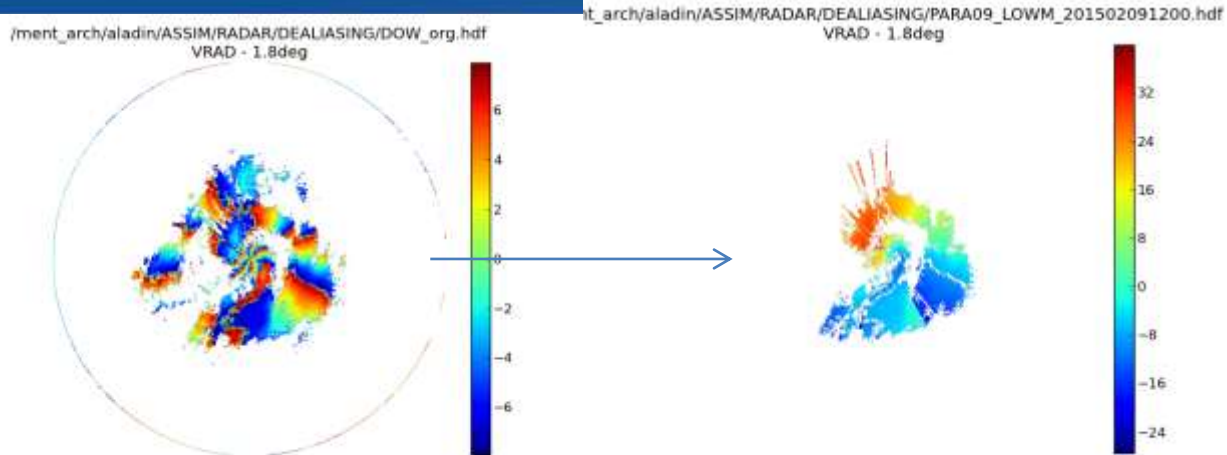


After using QC flags

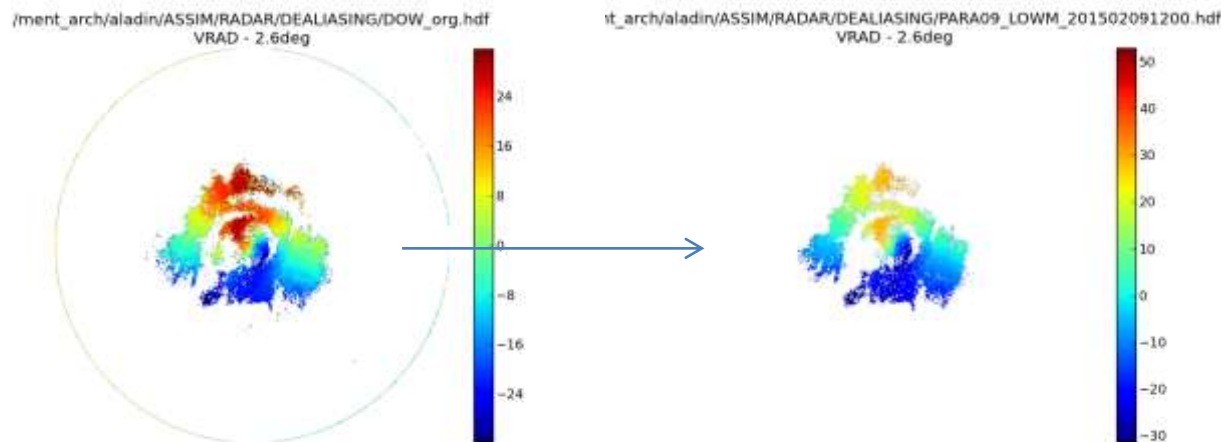
# RADAR-Vienna de-aliasing doppler wind 9<sup>th</sup> February 2015 12 UTC



Elev. 1.8°  
Vmax=8m/s



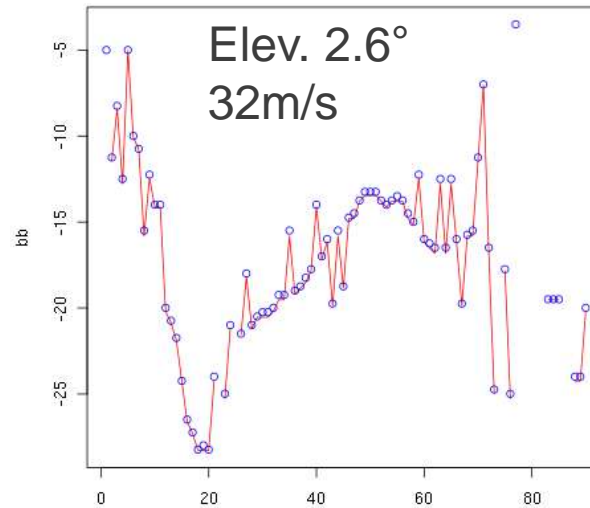
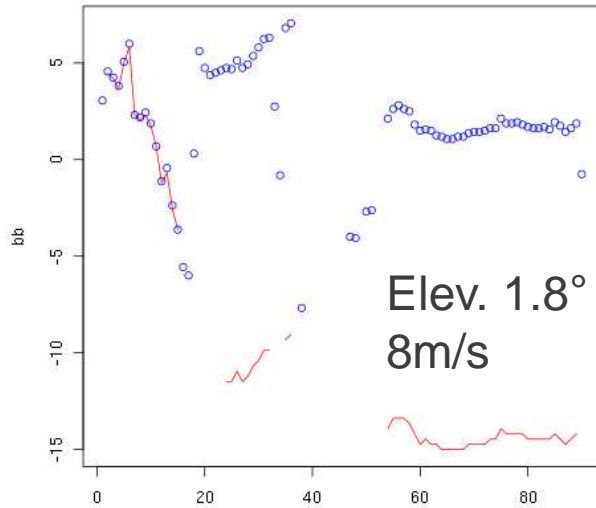
Elev. 2.6°  
Vmax=32m/s



Vrad unambiguous only as long as  $|V| < V_{max} = \text{pulse repetition freq.} * \lambda / 4$   
Otherwise:  $V = V_0 \pm 2n * V_{max}$ ;  $n = 0, 1, 2, 3, \dots$

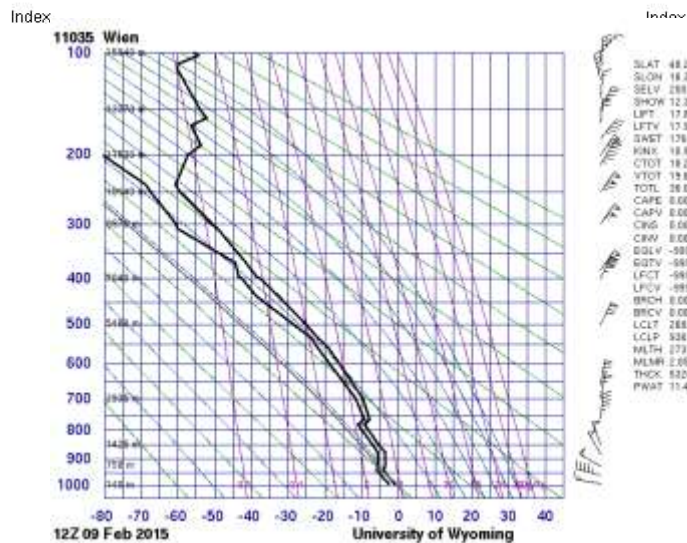


# RADAR-Vienna de-aliasing 9<sup>th</sup> February 2015 12 UTC

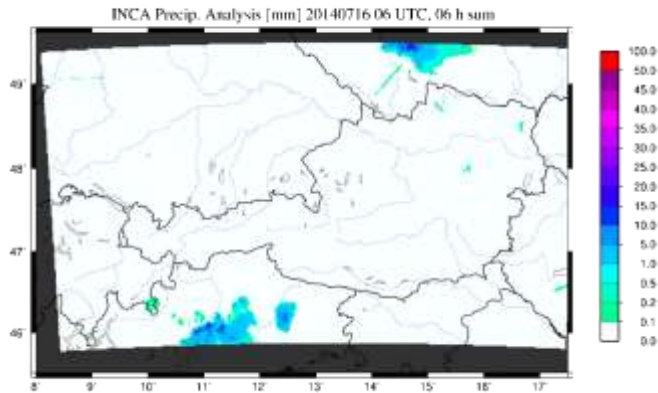


beam 150°

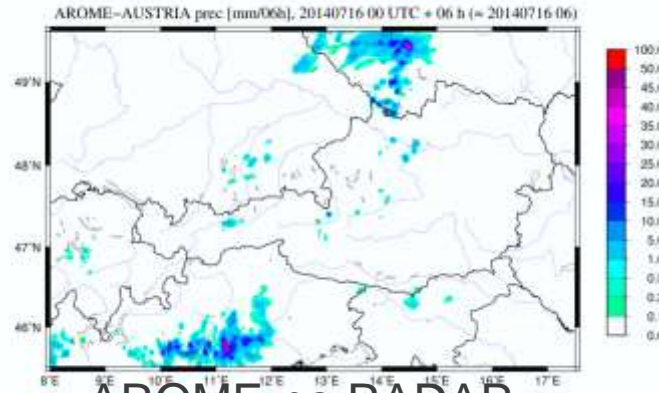
raw  
de-aliased



# Case study: 16<sup>th</sup> July 2014 00-06 UTC

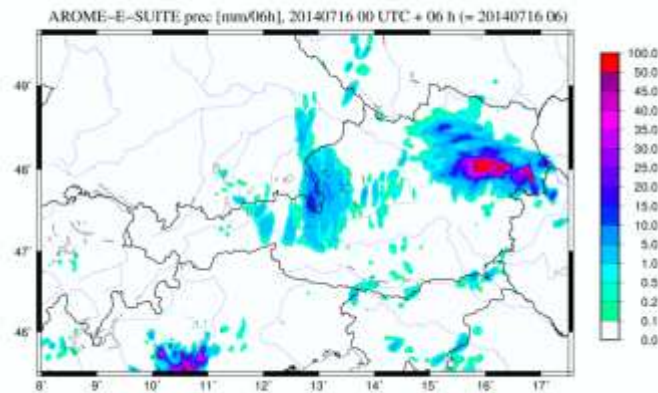


INCA reference



AROME-no RADAR

Still QC necessary!!

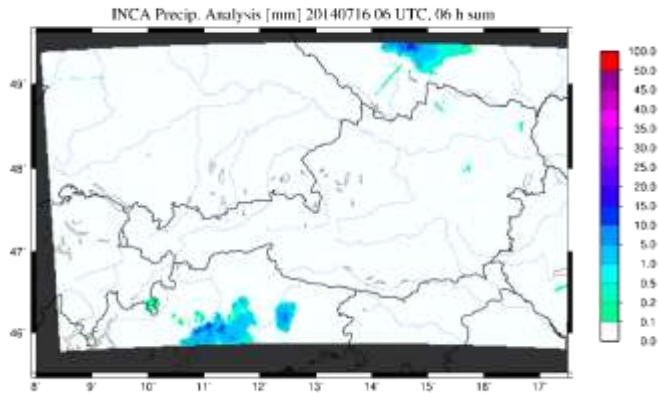


AROME-RADAR raw

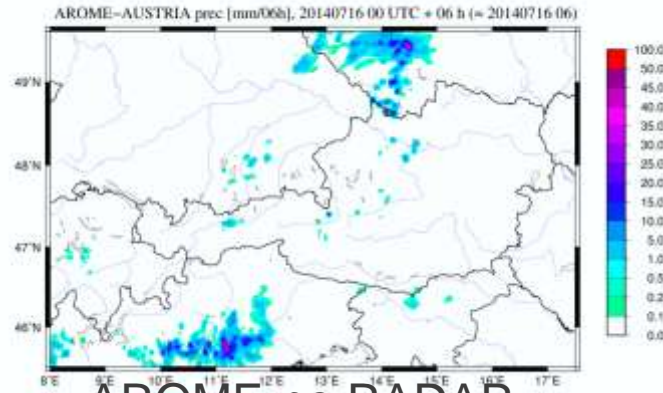


AROME-RADAR+de-alias+  
blacklisting <1.5°

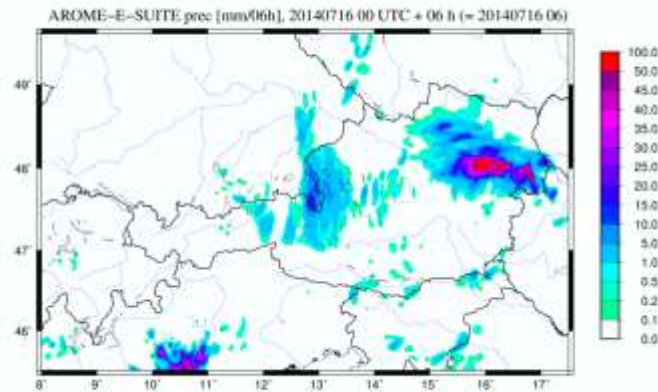
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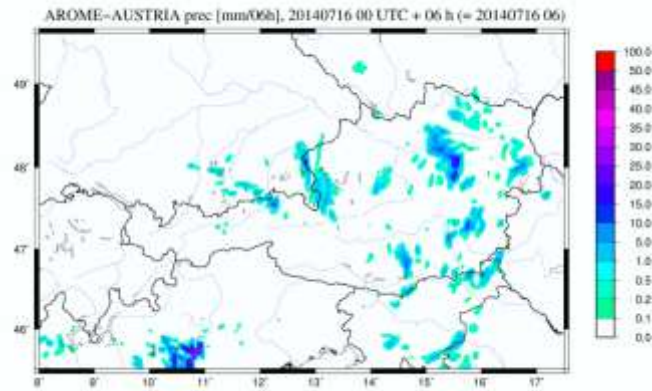
INCA reference



AROME-no RADAR



AROME-RADAR raw



AROME-RADAR+de-alias+  
INCA2-QC; SAF and climate  
flag not used yet



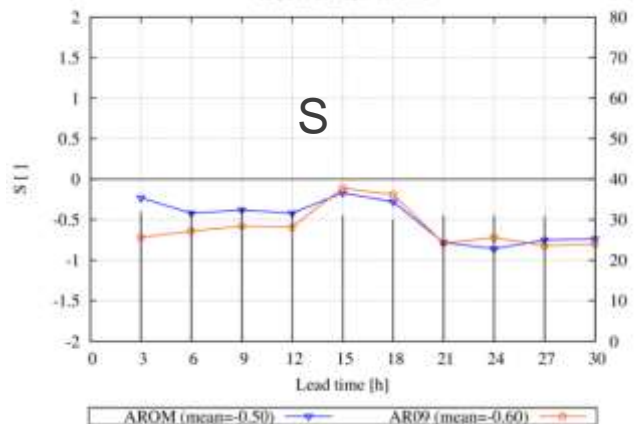
# Validation of RADAR DA: SAL 20140717-20140818

AROMEOPER  
AROME+RADAR

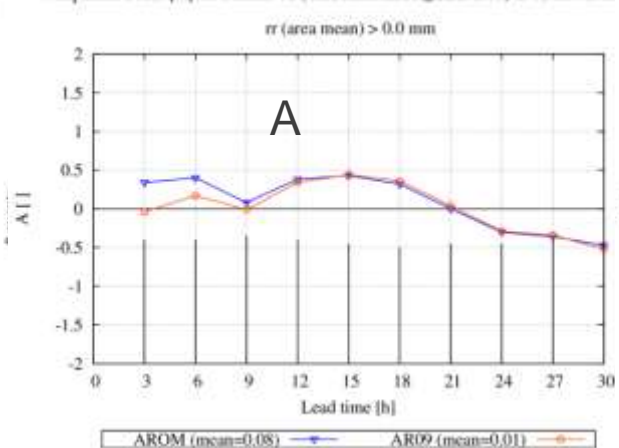
20140717-20140818

<1.5° blacklisted

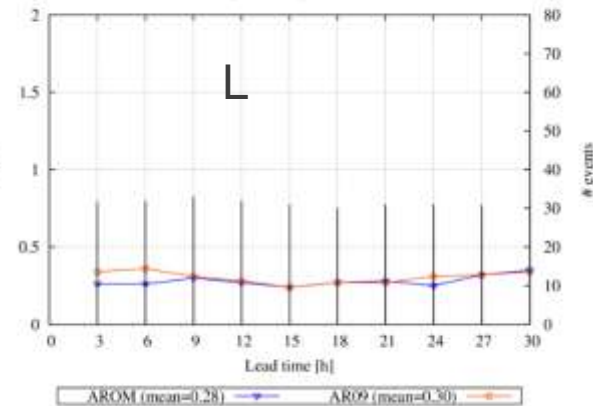
Structure Score [S] for domain 06 (OESTERREICH\_GESAMT) at 02 km resolution  
rr (area mean) > 0.0 mm



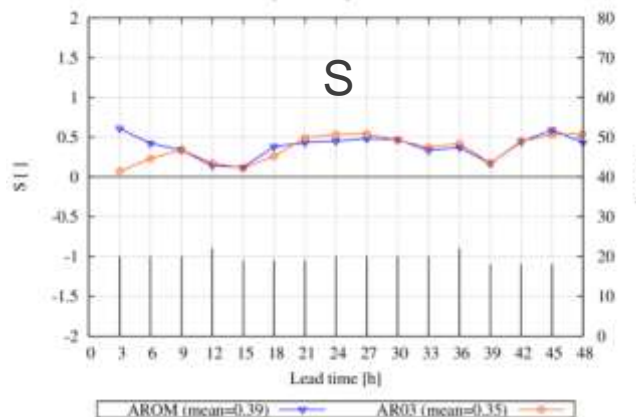
Amplitude Score [A] for domain 06 (OESTERREICH\_GESAMT) at 02 km resolution



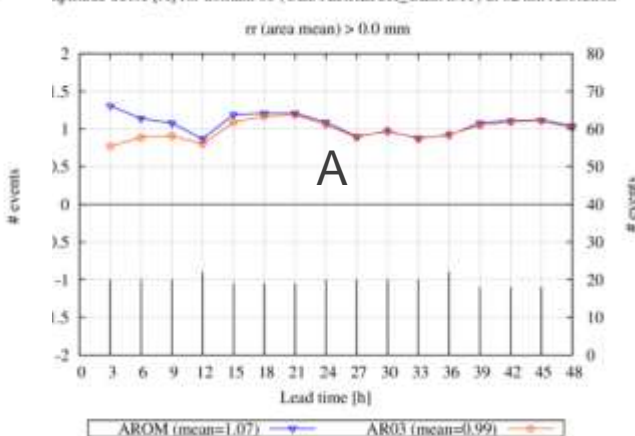
Location Score [L] for domain 06 (OESTERREICH\_GESAMT) km resolution  
rr (area mean) > 0.0 mm



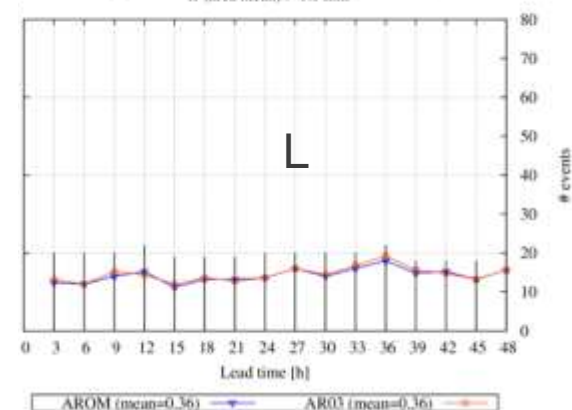
Structure Score [S] for domain 06 (OESTERREICH\_GESAMT) at 02 km resolution  
rr (area mean) > 0.0 mm



Amplitude Score [A] for domain 06 (OESTERREICH\_GESAMT) at 02 km resolution



Location Score [L] for domain 06 (OESTERREICH\_GESAMT) km resolution  
rr (area mean) > 0.0 mm

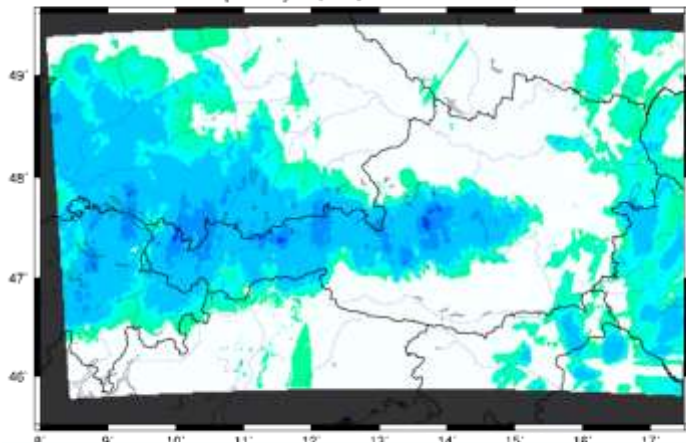


# widespread rain on 15<sup>th</sup> May 2014

## 00 UTC+6h 6hourly precipitation

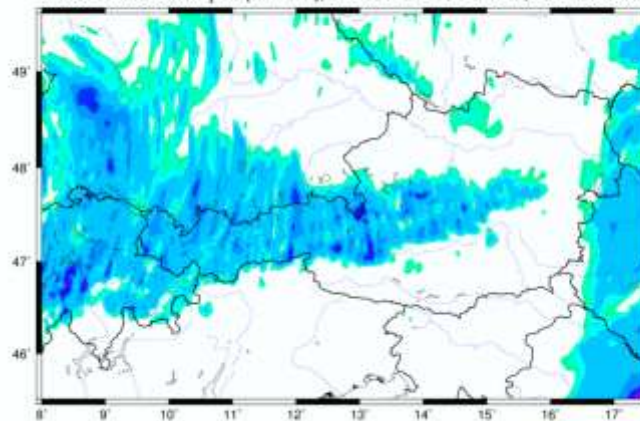


INCA Precip. Analysis [mm] 20140515 06 UTC, 06 h sum



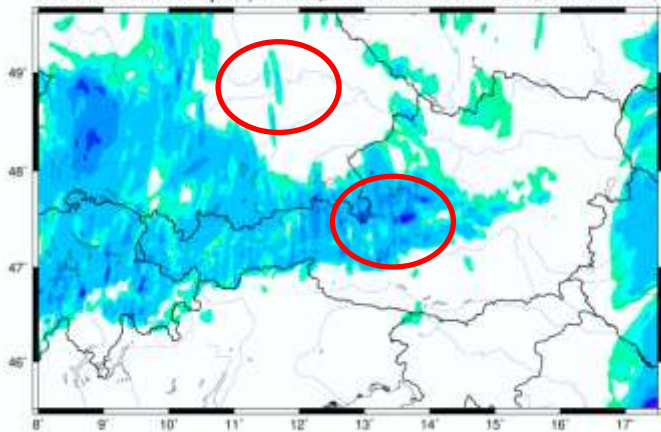
INCA reference

AROME-AUSTRIA prec [mm/06h], 20140515 00 UTC + 06 h (= 20140515 06)



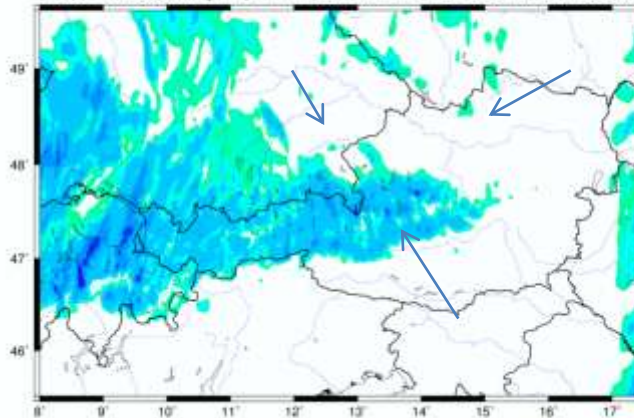
AROME-no RADAR

AROME-AUSTRIA prec [mm/06h], 20140515 00 UTC + 06 h (= 20140515 06)



AROME+RADAR+IDFI

AROME-AUSTRIA prec [mm/06h], 20140515 00 UTC + 06 h (= 20140515 06)



AROME+RADAR+1h-RUC+IDFI

- Better QC essential for RADAR data assimilation
- De-aliasing needs further evaluation maybe switch to other method
- HR-AMV results: neutral impact
- Tests with 1hourly AROME-RUC with conventional obs.+RADAR and +0-+12h forecast coupled to AROME-OPER planned for second half of 2015 -> input for nowcasting
- Optimisation of IASI usage planned for 2015

## Questions on 1h RUC development:

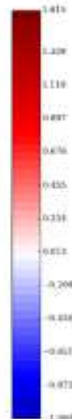
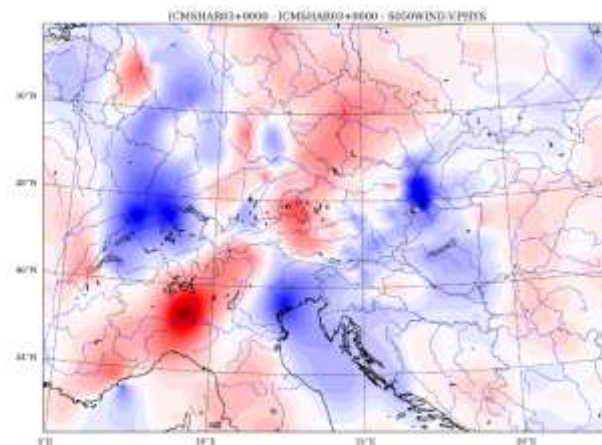
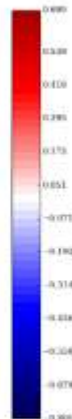
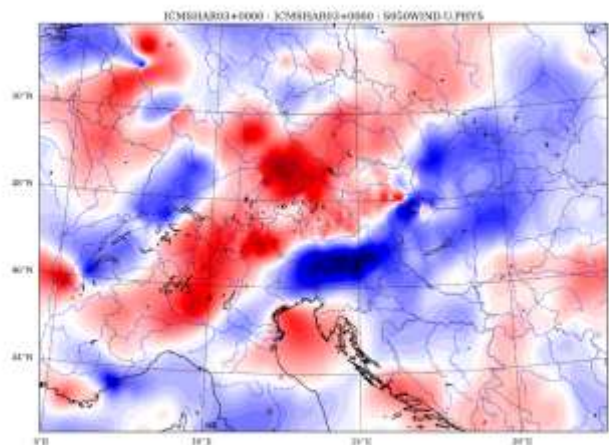
- Evaluation and treatment of spin-up in hourly assimilation
- Need for new B-Matrix?
- Need for quicker additional method like nudging?
- Should RADAR-QC flags be fed into BATOR/SCREENING?





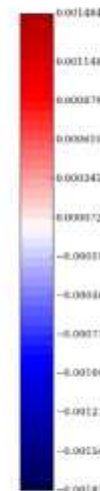
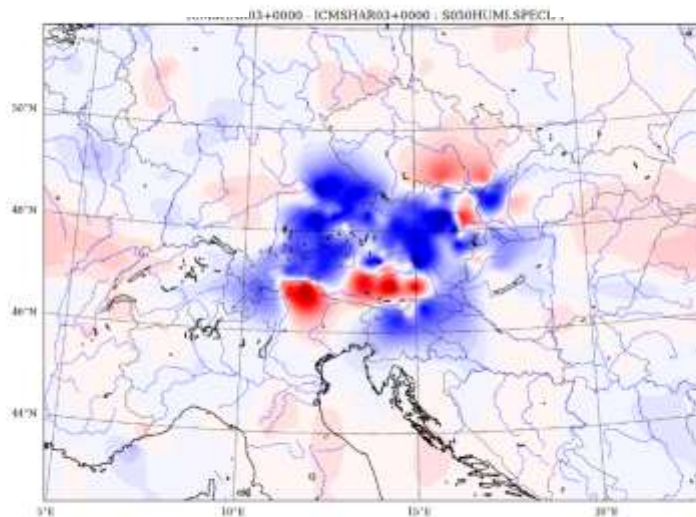
AROME  
22.04.2015

# AROME+reflectivity-AROME no RADAR 20150401 06+0h



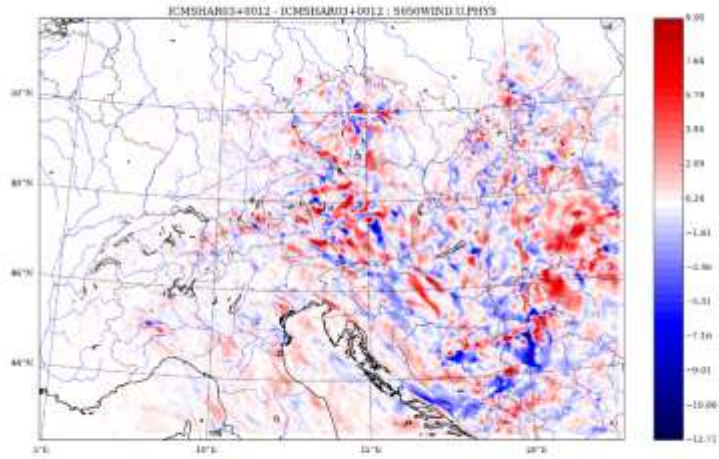
Q

U



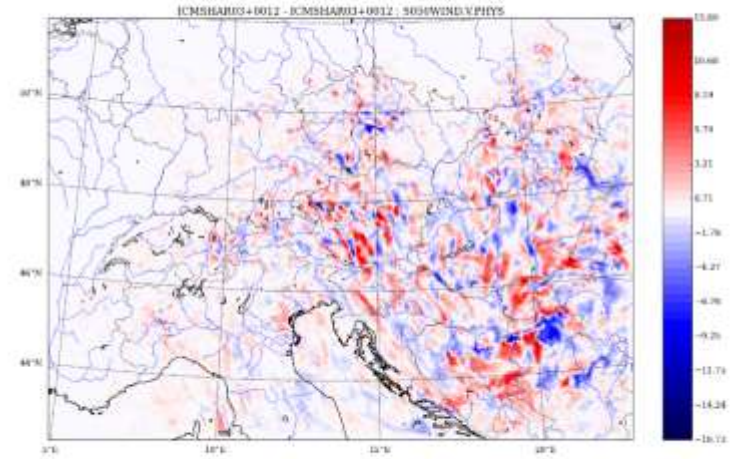
V

# AROME+reflectivity-AROME no RADAR 20150401 06+12h

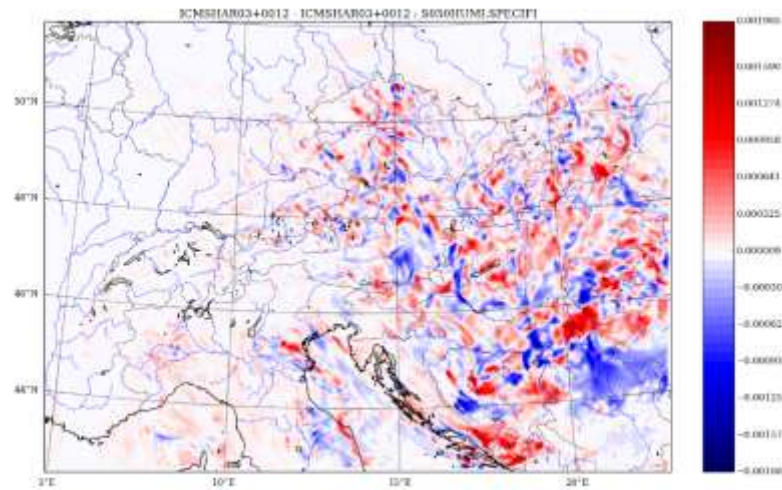


U

Q



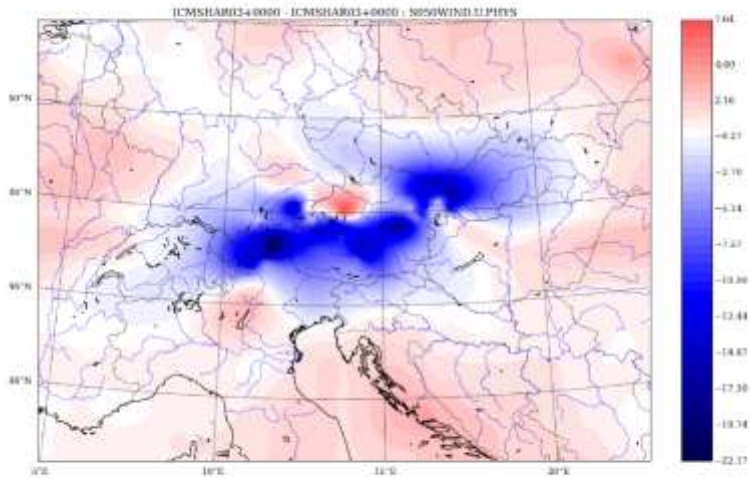
V





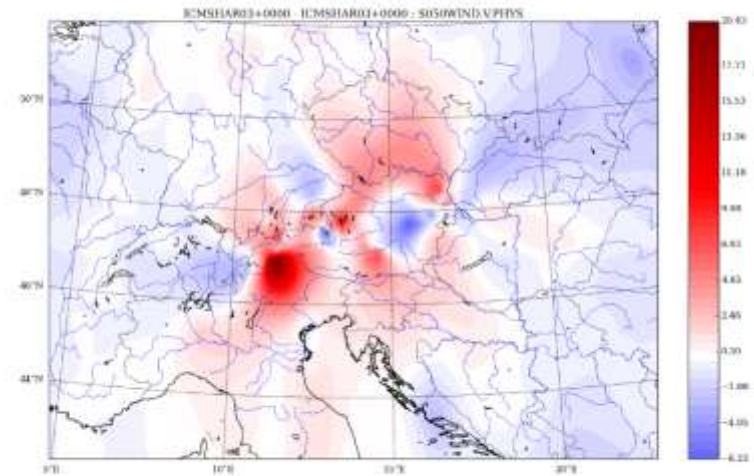
# AROME+Doppler wind-AROME no RADAR 20150401 06+0h

AROME

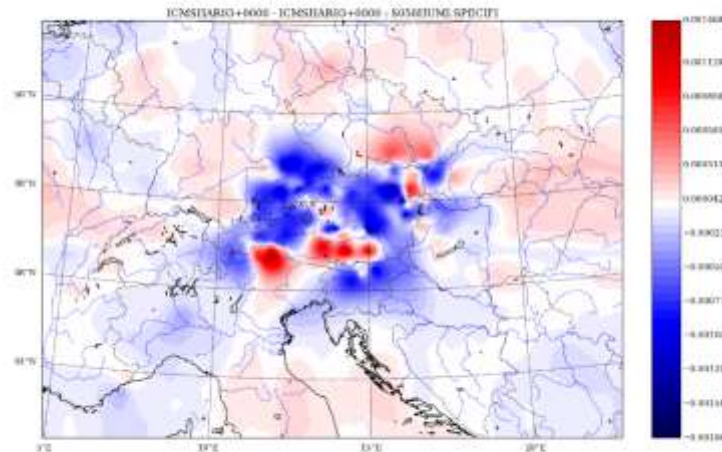


U

Q

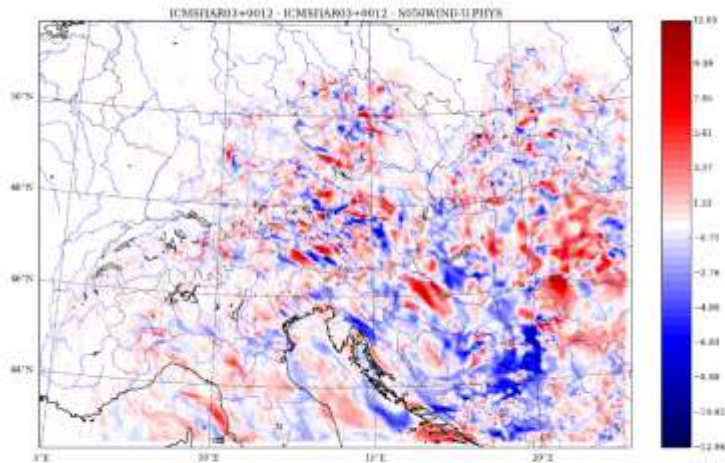


V



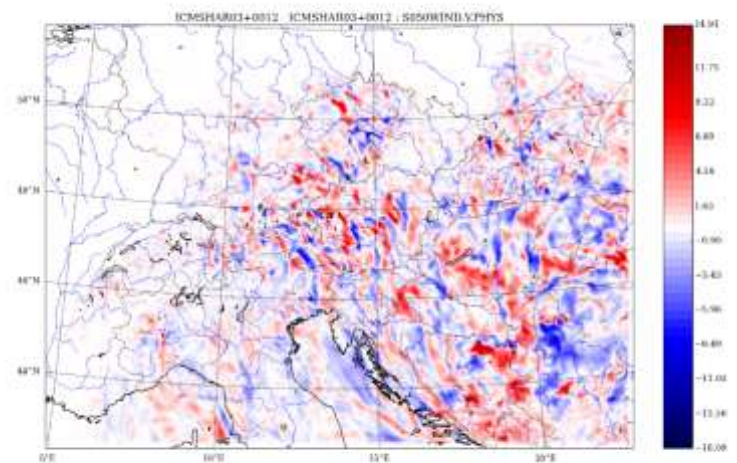


# AROME+Doppler wind-AROME no RADAR 20150401 06+12h



U

Q



V

