Regional Cooperation for
Limited Area Modeling in Central Europe

LACE
nwp central europe

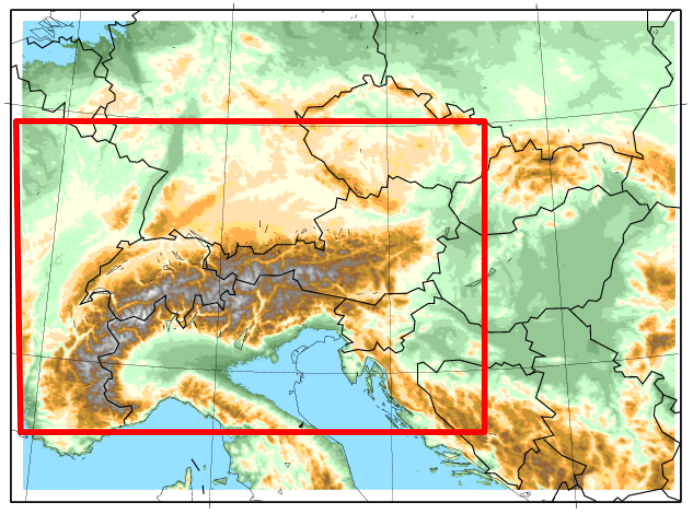
LACE RUC meeting - status in Austria

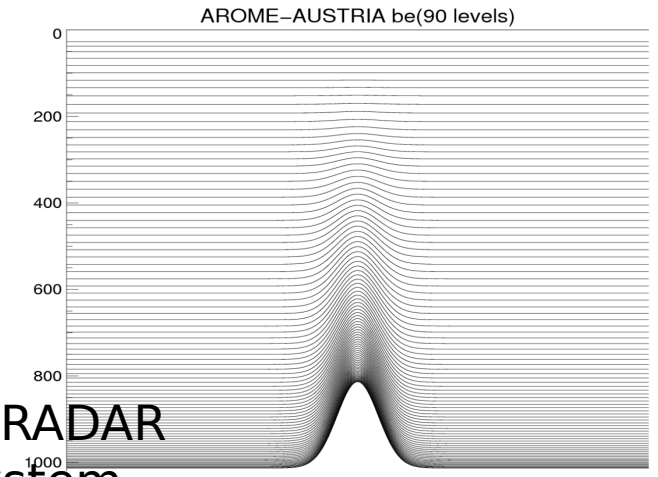
Florian Meier

DHMZ SHMU OMSZ ZAMG ROMANIA ANM

Operational model version:
AROME 2.5km L90
3h-cycling 3D-Var+OIMAIN +48h cy36t1/cy37t1op1

Observation Type	Parameter
SYNOP/TAWES	T2,RH2,Z,U10m,V10m
AMDAR	U,V,T
TEMP/PILOT	U,V,T,Q,Z
MSG AMV	U,V
NOAA16/18/19	AMSU-A,B,MHS,HIRS
METOP-A,-B	AMSU-A,B,MHS,HIRS
METOP-A	IASI radiances
METOP-A	ocean winds
MODIS	1km snow cover
MSG-SEVIRI	VW radiances



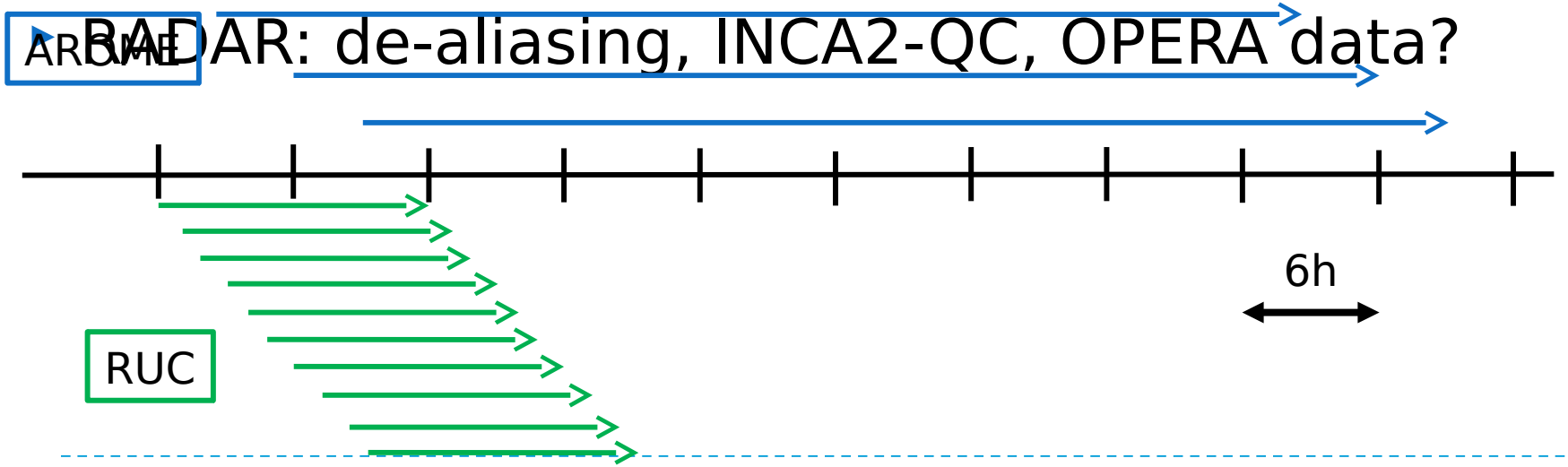


METOP-B IASI, windprofiler, national OPLACE,RADAR
technically working, but not in operational system

Austrian goals:

AROME 3/20/15

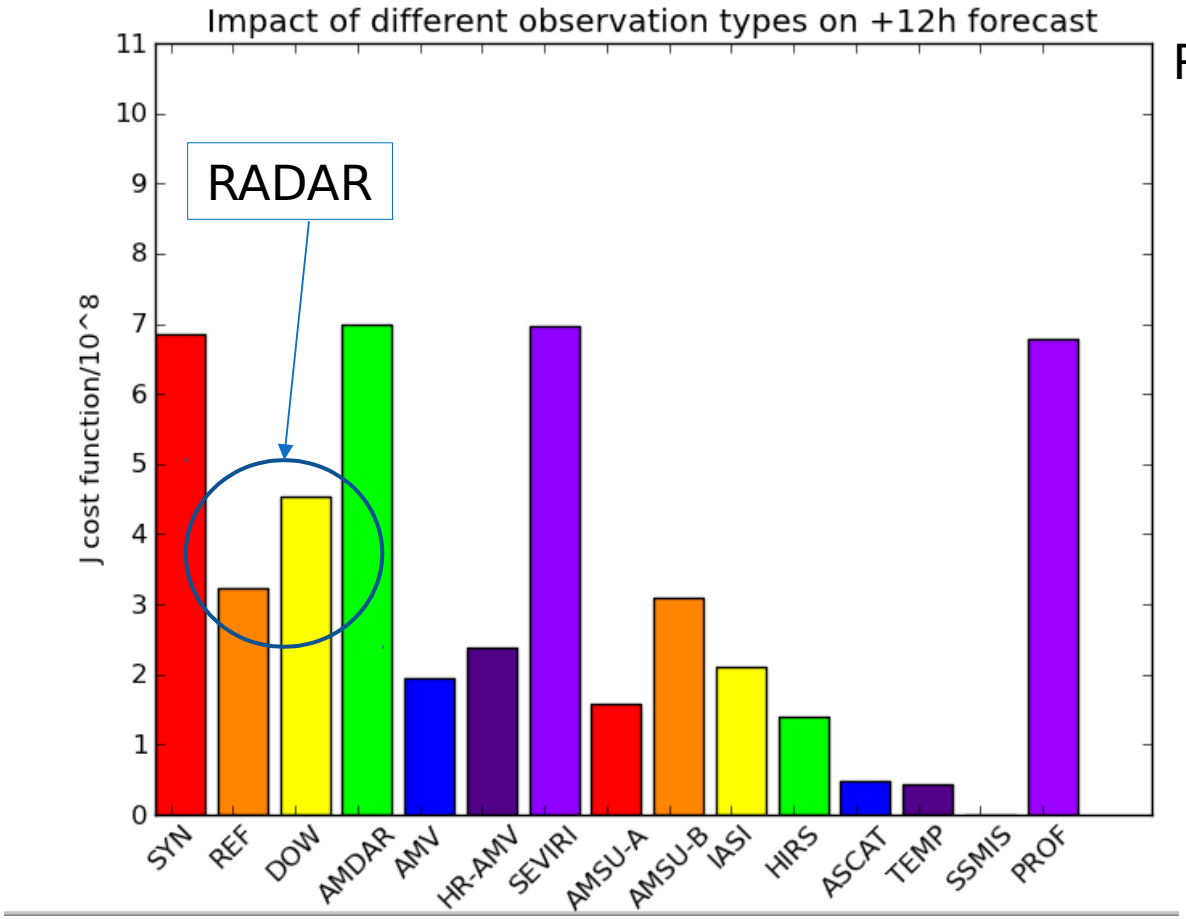
- AROME-RUC 2,5km 1hourly cycle +12h
- Assimilation of radar-data REF+DOW
- Possibly additional OBS SYNOP+AMDAR Mode-S?
- Work on spin-up (IDFI/IAU/Nudging?)
- RADAR: de-aliasing, INCA2-QC, OPERA data?



Challenges:

- Tight time schedule: AROME-OPER in Austria: 20min for integration, 16min 3D-Var, in total: 2h 7min per run, starting at +1:30h: Kornshell scripts and templates driven by watchdog/OKFILES ->Optimisation needed; smaller domain?
- Spin-up: DFI/IDFI/IAU/Nudging? Other? ECHKEVO diagnostics
- Observation selection: Safe time and make it simple, but use important observations
- New B-Matrix?

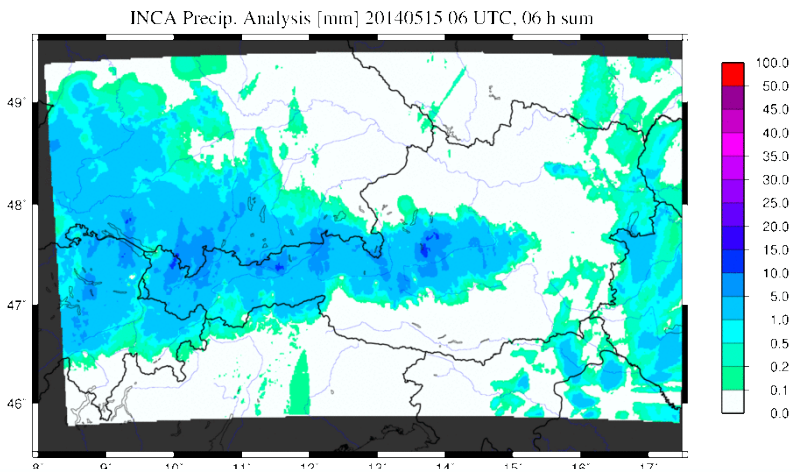
Which observations? AROME3h 21/09 UTC runs MTEN+12h



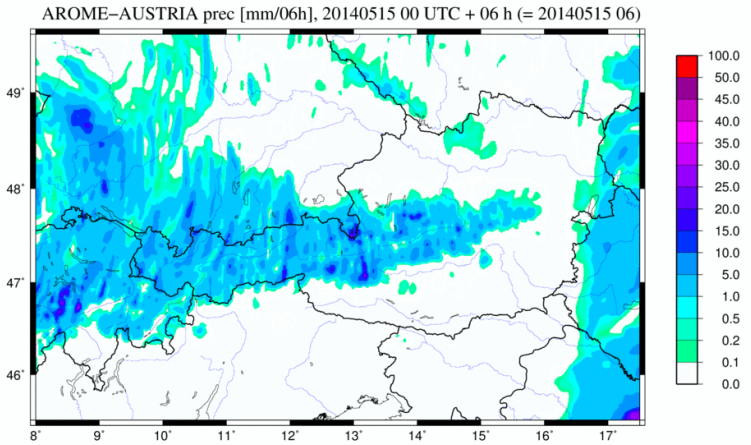
Roger's Tool

SATIN project

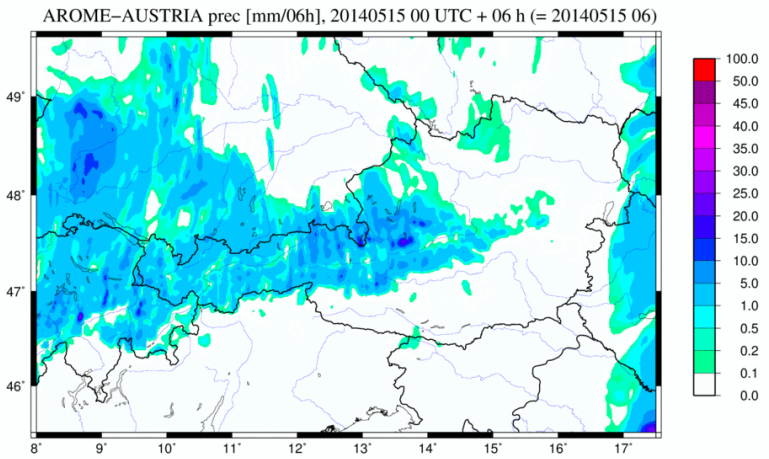
Example: widespread rain on 15th May 2014 00 UTC+6h 6hourly precipitation



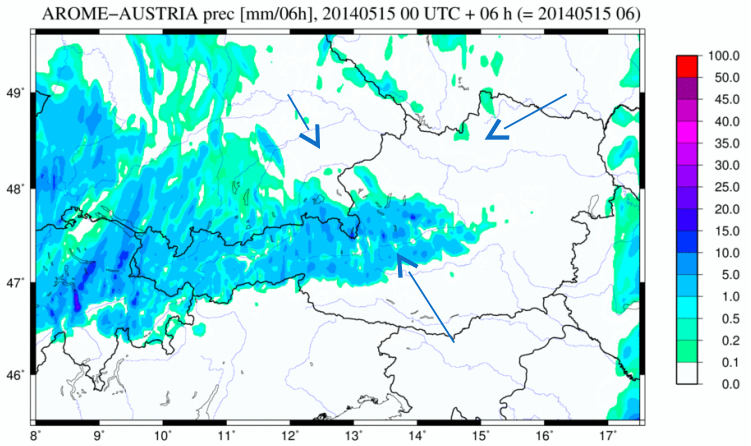
INCA reference



AROME-OPER

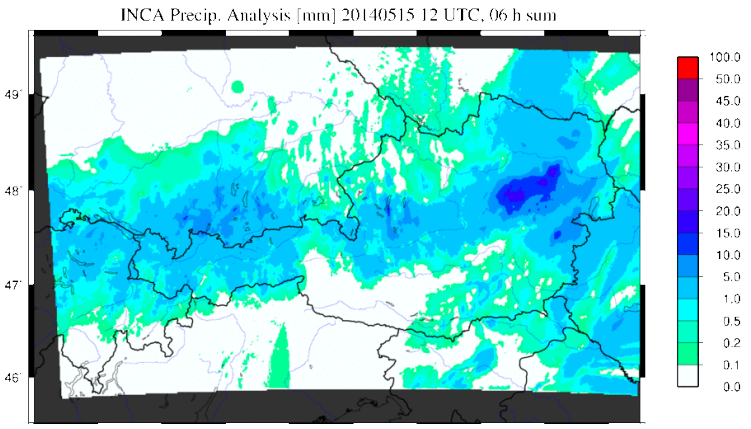


AROME+RADAR

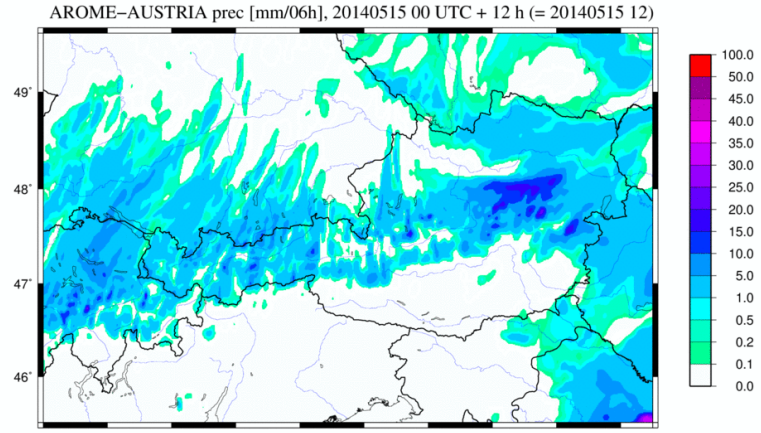


AROME+RADAR+RUC

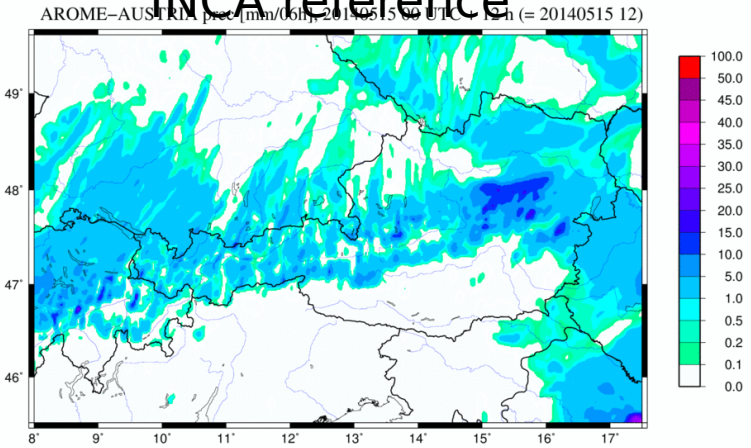
Example: widespread rain on 15th May 2014 00 UTC+12h 6hourly precipitation



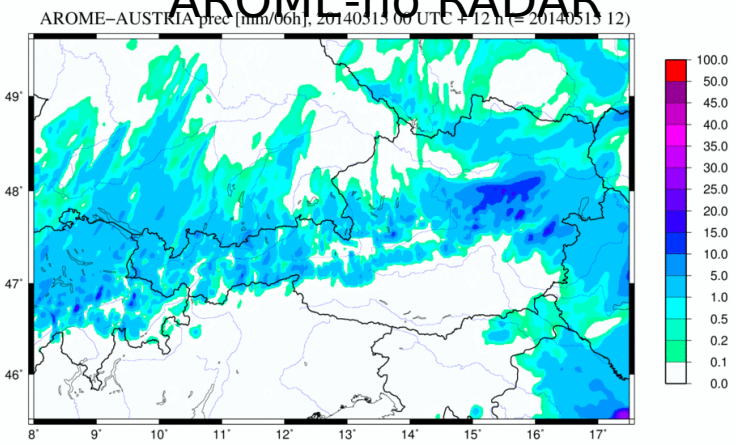
INCA reference



AROME-no RADAR



AROME+RADAR



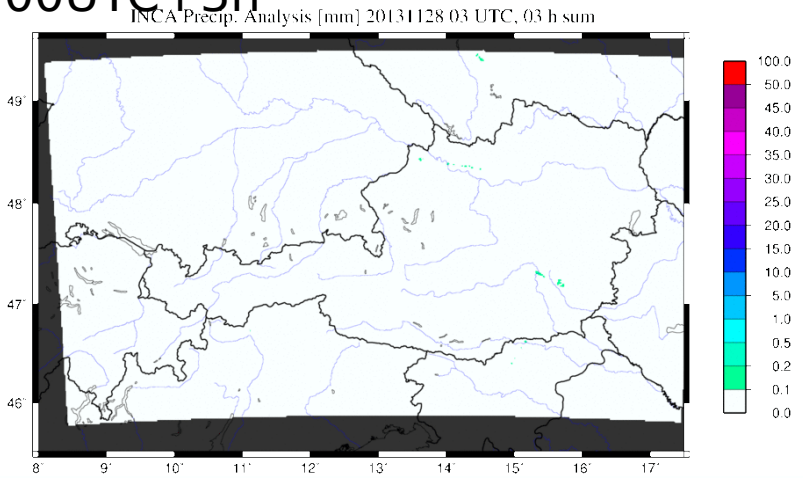
AROME+RADAR+RUC

IDFI: computational costly, crashes in elascaw.F90 (cy37t1op1)

!!IFLVM2=KFLEV-2 ***F. Meier 200150204 BUG?

IFLVM2=(~~KFLEV+~~KSLEV-1)-2 elascaw L407

28th November 2013 precipitation 00UTC+3h



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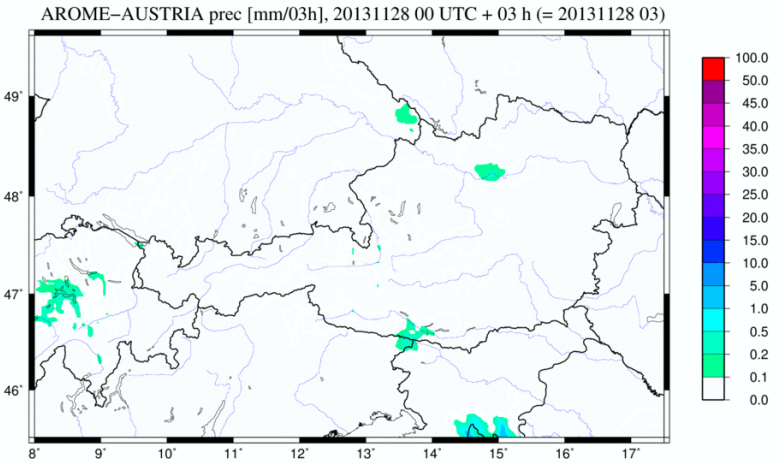
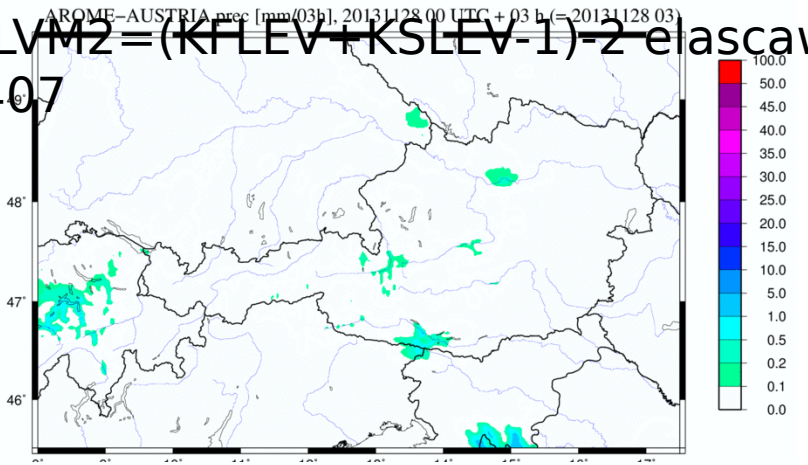
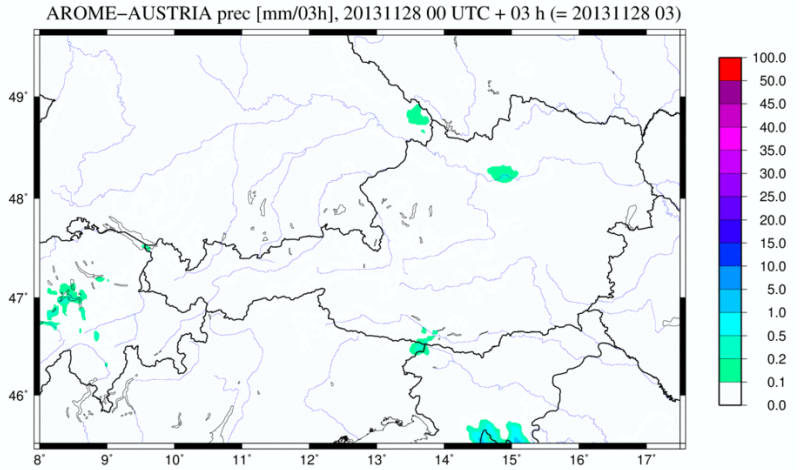


AROME+IDFI: NSTDFI=11; TAUS=1,5h



AROME-OPER

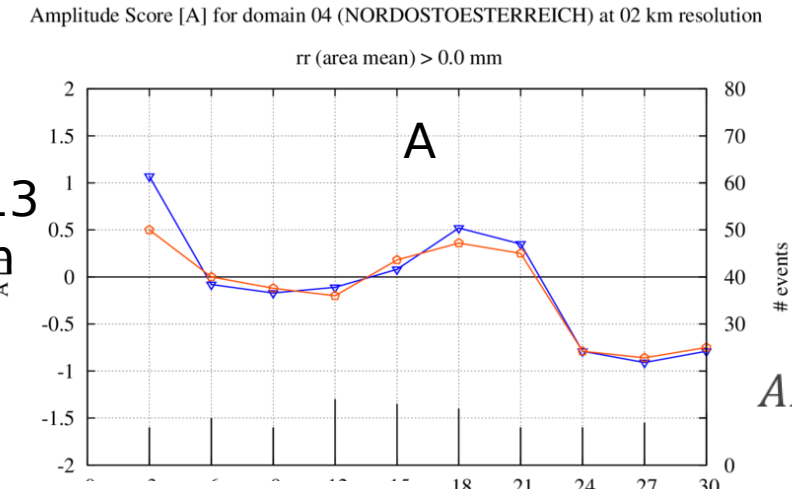


AROME+IDFI: NSTDFI=22; TAUS=1h

IDFI:

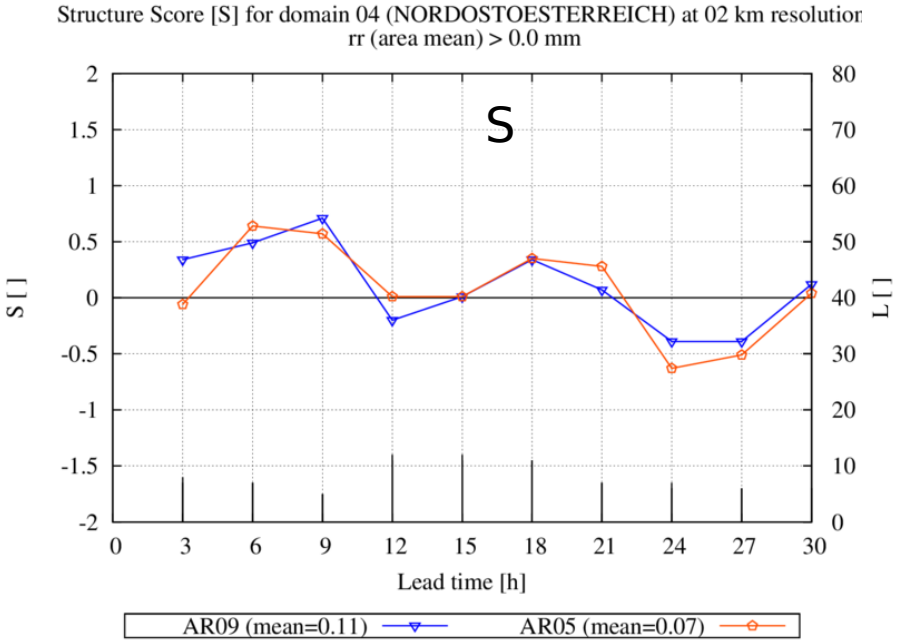
AROME 3/20/15

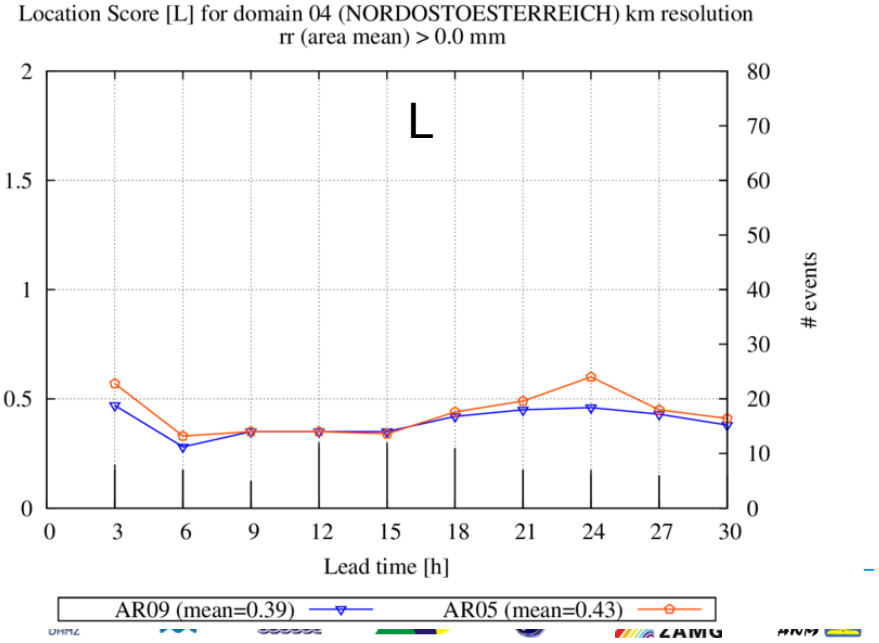
SAL- score
10th-30th July 2013
threshold: 0.0mm
NE-Austria



AROME-OPER
AROME-IDFI

$$ANA_{IDFI} = FG + \overline{ANA} - \overline{FG}$$





Spin-up diagnostics ECHKEVO

Namelist NAMCHK in 001->Special: FA-Output->ASCII-Output->GNUPLOT visualisation

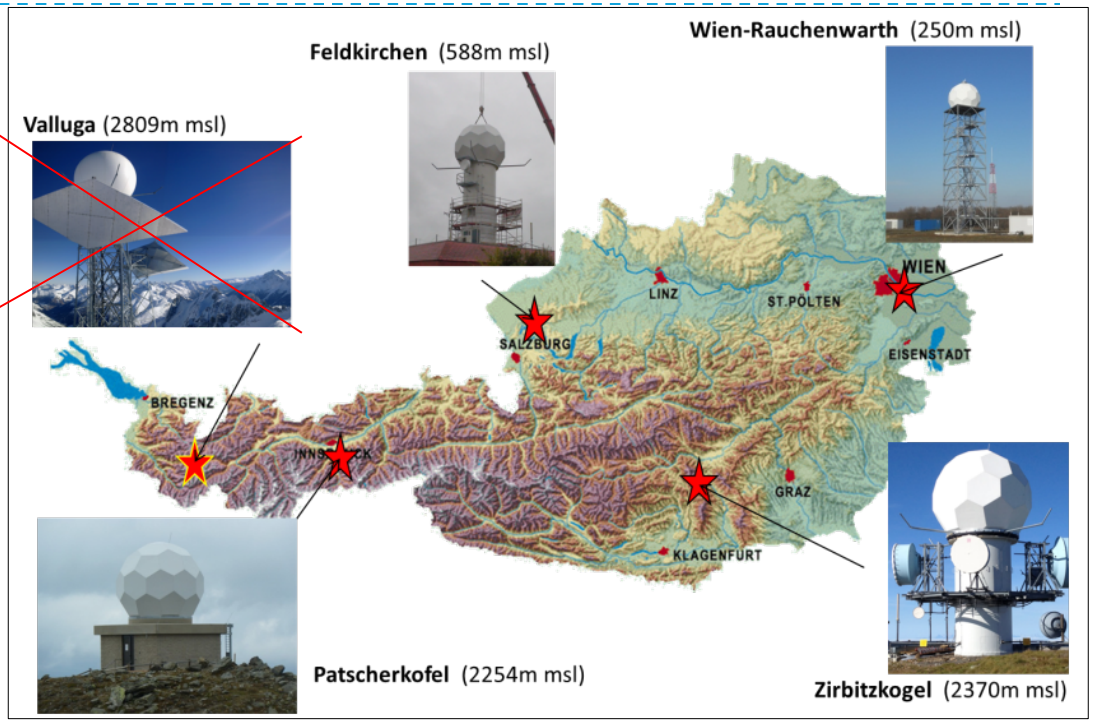
cy36t1 ok; cy37/cy38t1-> „points lost“ abort! ->code chkevo.F90 changed significantly-> debugging needed?

```
&NAMCHK
  LECHKEVO=.TRUE.,  -> switch on diagnostics
  LECHKTND=.FALSE., -> if true global diagnostics
  LECHKPS=.FALSE.,   diagnostics of lnPS, if .TRUE. PS instead
  !! NFRQCHK=2, -> frequency of diagnostics in timesteps  default every timestep
  NFLDCHK=6,        number of fields
  NNFCHK(1)=3,      3d : =(n-1)*NFLEVG+k    k=level n=1:Vorticity, n=2 divergence ,n=3:U, n=4:V  ... NFLEVG=90->Vorticity level 3
  NNFCHK(2)=85,   Vorticity level 85
  NNFCHK(3)=175,  divergence level 85
  NNFCHK(4)=265,
  NNFCHK(5)=355,
  NNFCHK(6)=356,
  NGPCHK=2,         number of grid points
  NXCHK(1)=50,      indices of grid points for diagnostics  1 <= NYCHK(i) <= NDGLG 1 <= NXCHK(i) <= NLOEN(NYCHK(i))
  NYCHK(1)=60,
  NXCHK(2)=200,
  NYCHK(2)=210,
/
```

Radar network Austria owned by aviation weather service Austrocontrol

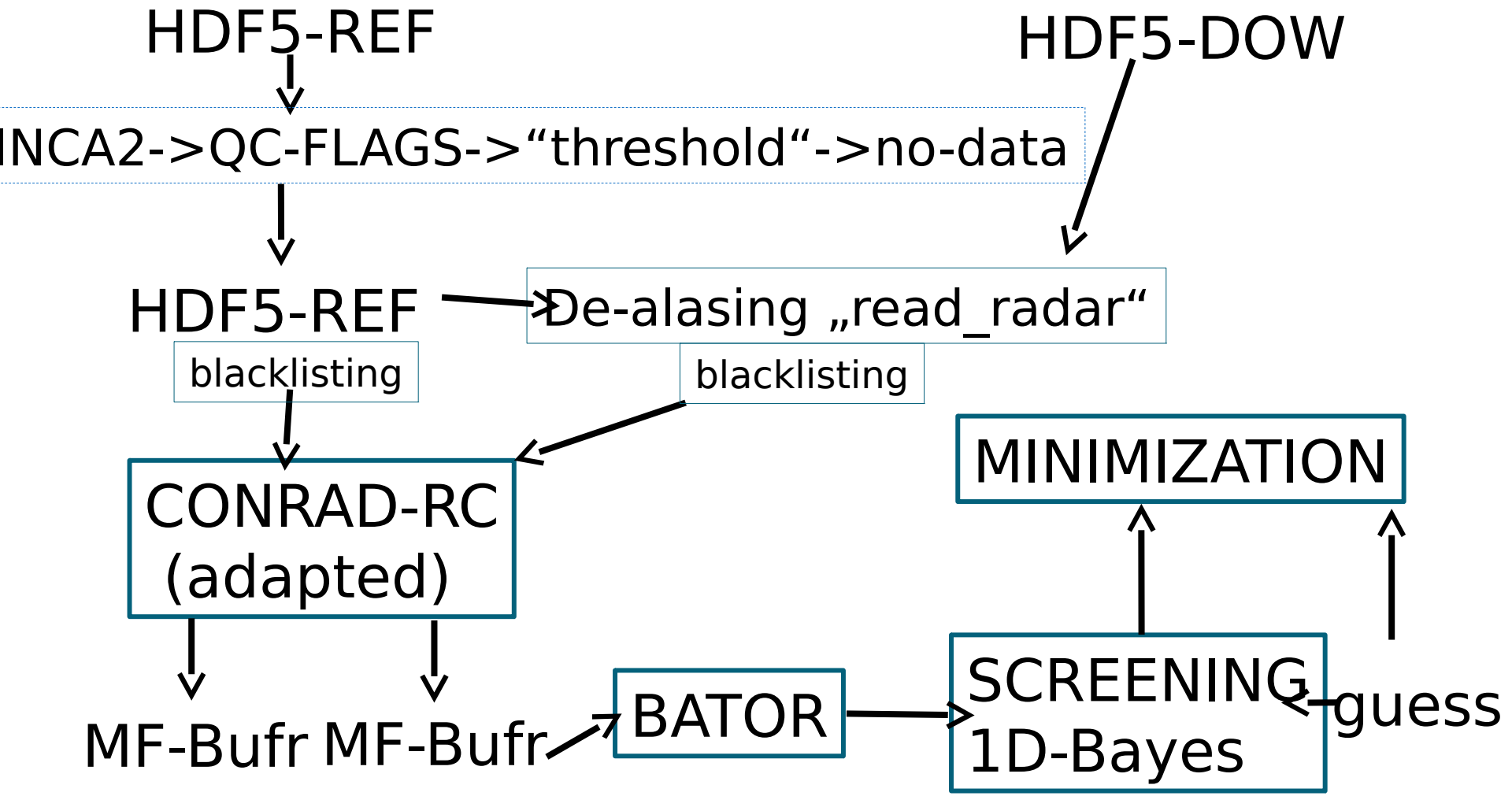
- 5 radar station
- All dual pol. /doppler
- Moments: **DBZH**, ΦDP,ρHV, TH, **VRAD**,WRAD, ZDR, (VIL)

From new moments you can derive size Distribution and kind of hydrometeors

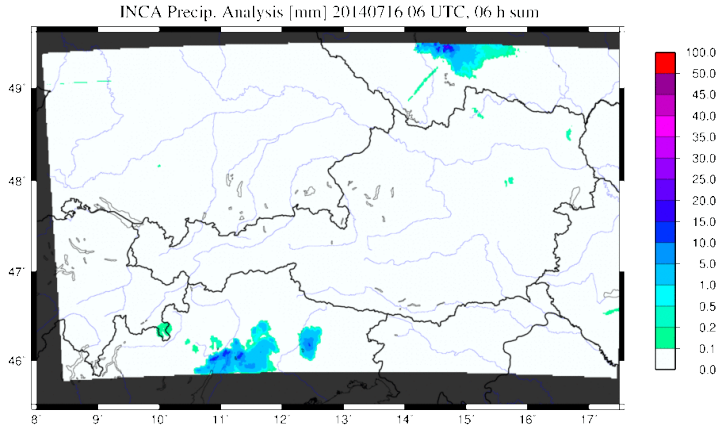


- We get test data of 4 stations since March 2014 (constant quality since July 2014) every 5 minutes 16 elevations each
- HDF5 one file per moment and station
- Calibration issues

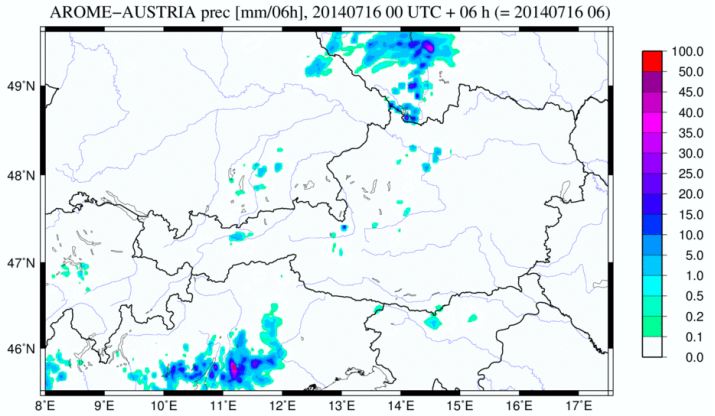
3D-Var RADAR-Cycle:



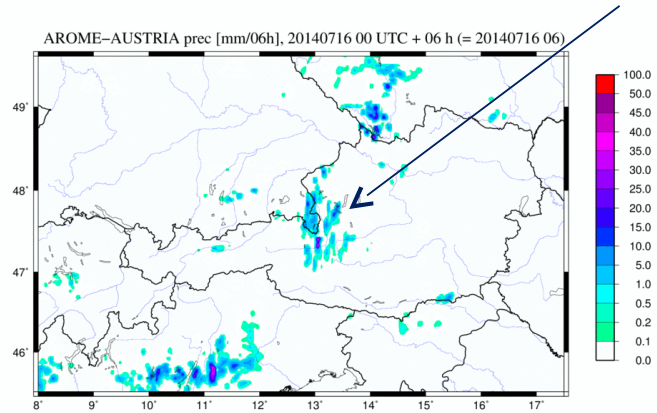
Case study: 16th July 2014 00-06 UTC



INCA

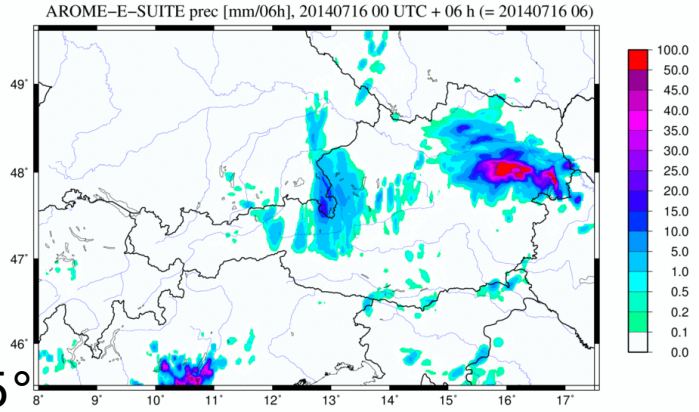


Still QC (INCA2?) necessary!!



AROME-RADAR+blacklisting <1.5°

AROME-OPER

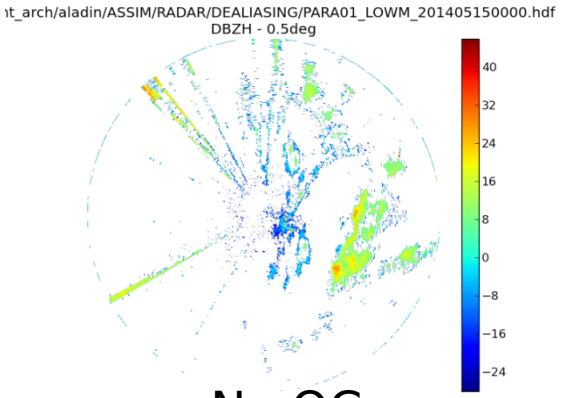


AROME-RADAR

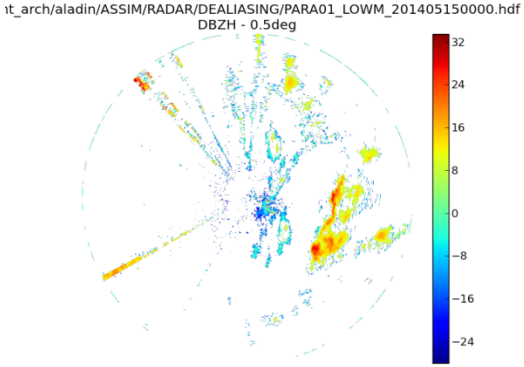
INCA2-QC: Case study at ZAMG

- Hdf5 files with quality flags: Laplace, WIFI, Attenuation, beam blockage, q5=q1*q2*q3*q4*q-distance, q6=product of q1-q4
- (SAF satellite flag not implemented yet, RADAR climate flag ongoing work)
- First choice: if q5≤0.3, set reflectivity to no data
- this has also consequence for DOW assimilation, because DOW is not used if DBZH below 7.0dBz

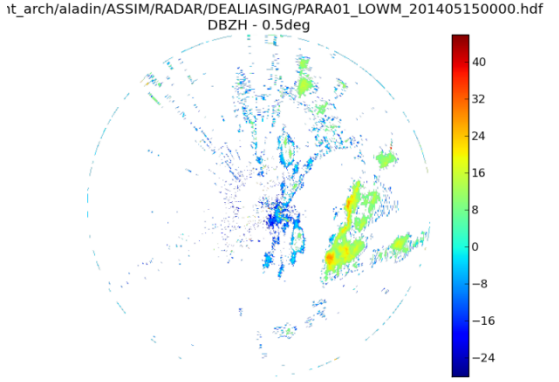
INCA2 Flags: Case study 20140515 00 UTC RADAR Vienna



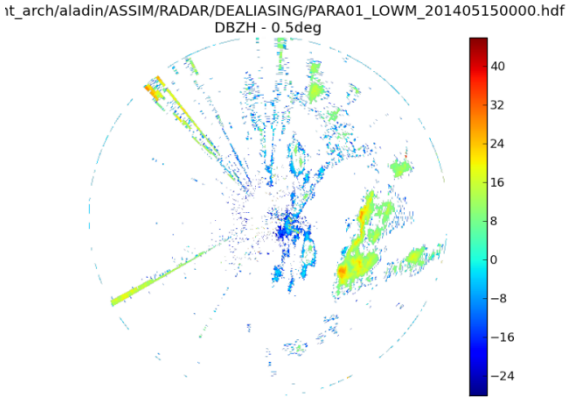
No QC



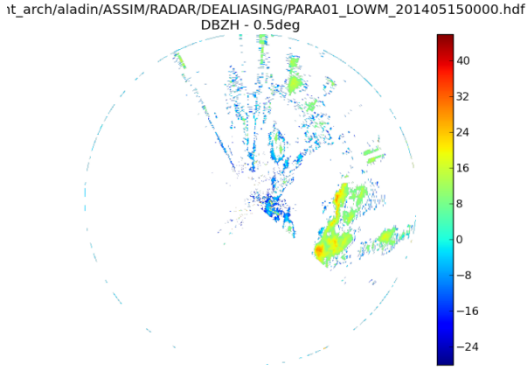
Q-LAPLACE>0.75



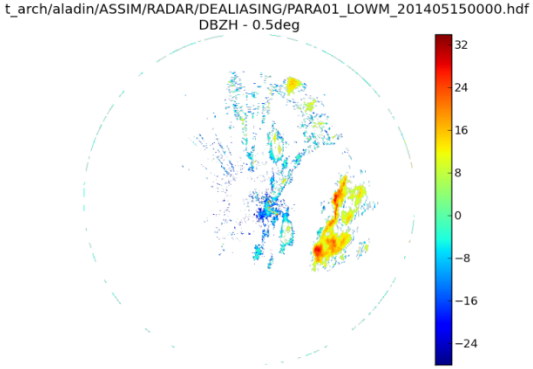
Q-WIFI>0.75



Q-ATTEN>0.75



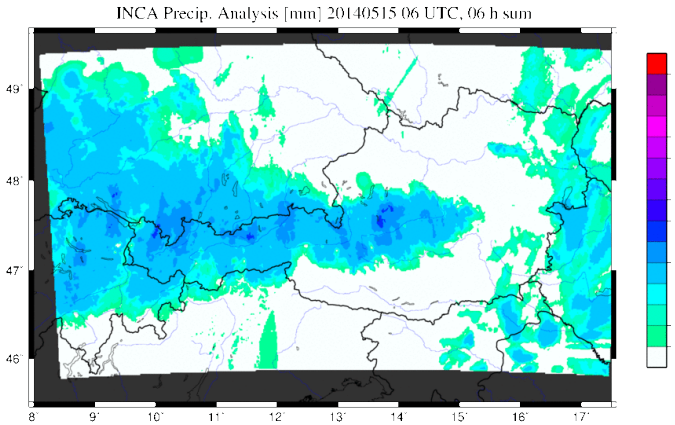
Q-Block>0.75



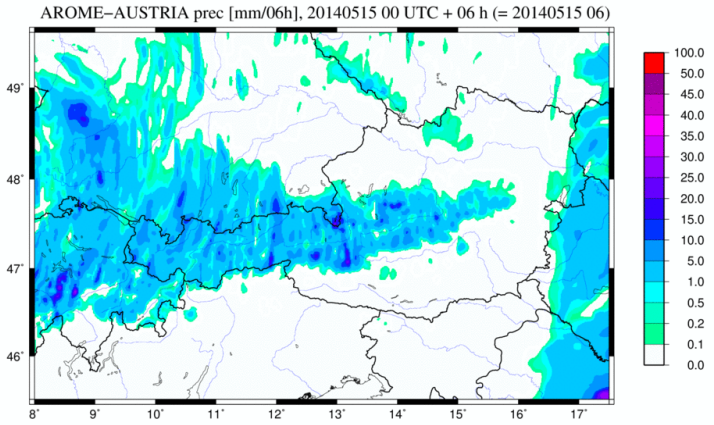
Q-combined+DIST>0.3

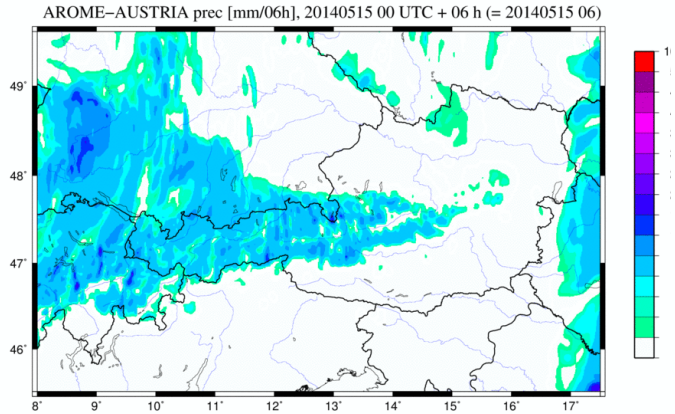
Case study 20140515 00 UTC+6h

INCA reference

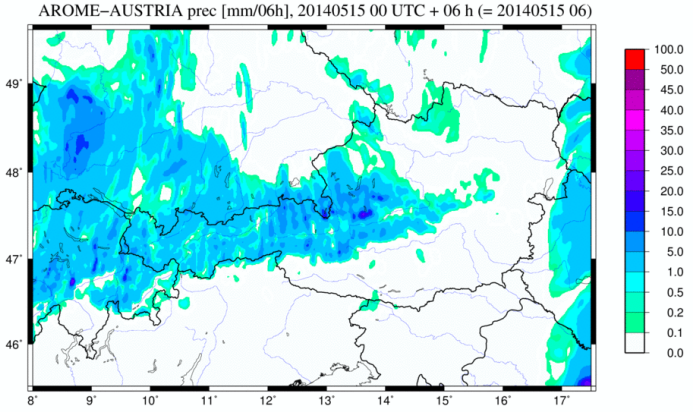


AROME no RADAR





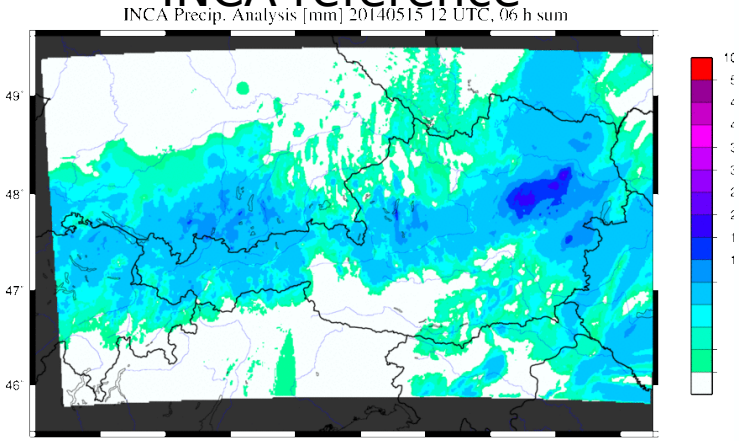
AROME +RADAR+blacklisting



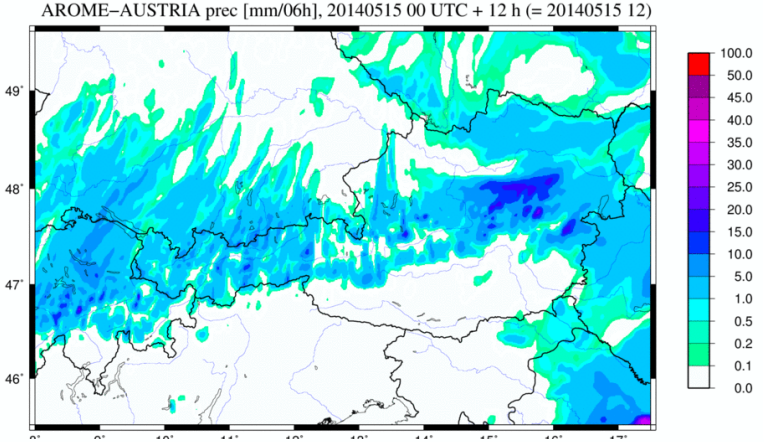
AROME +INCA2

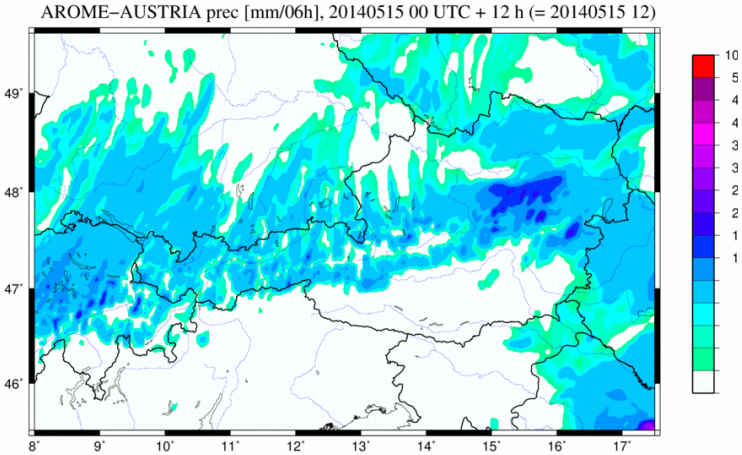
Case study 20140515 00 UTC+12h

INCA reference

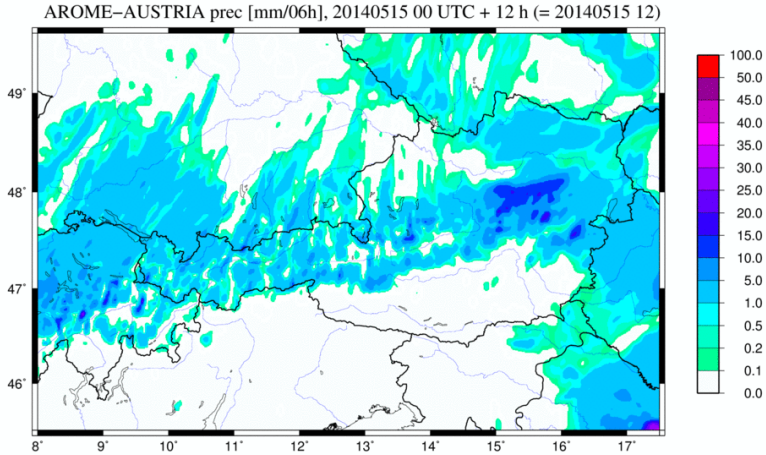


AROME no RADAR





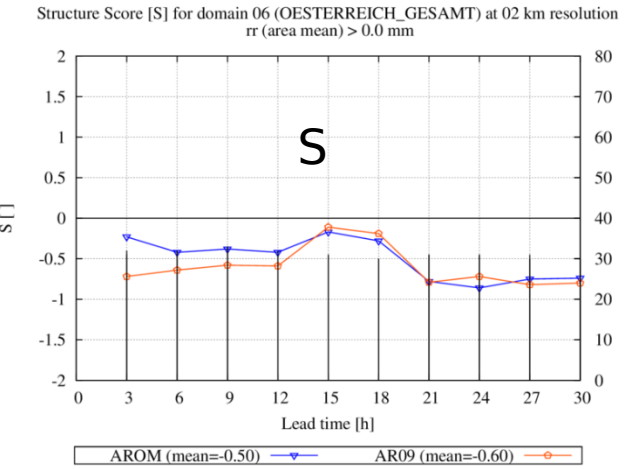
AROME +RADAR+blacklisting

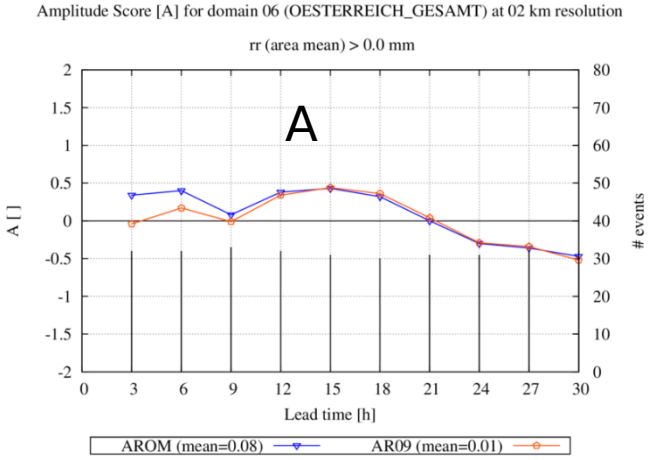


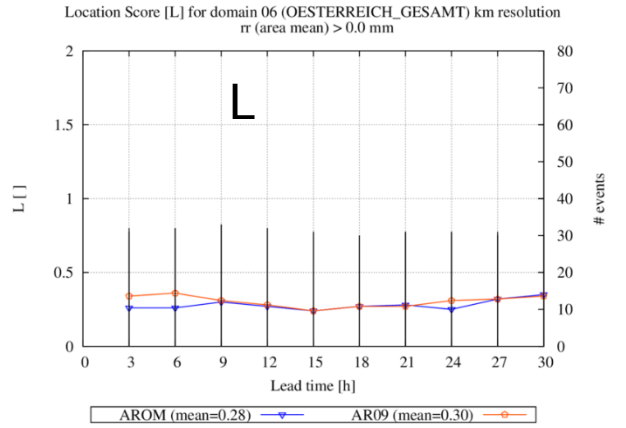
AROME +INCA2

Scores: SAL 20140717-20140818

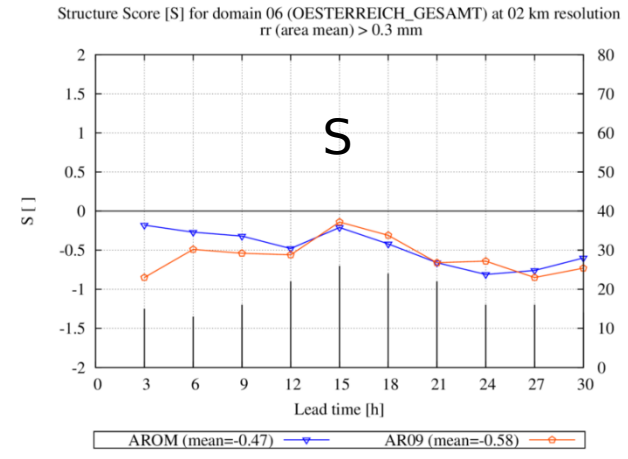
AROMEOPER
AROMERADAR

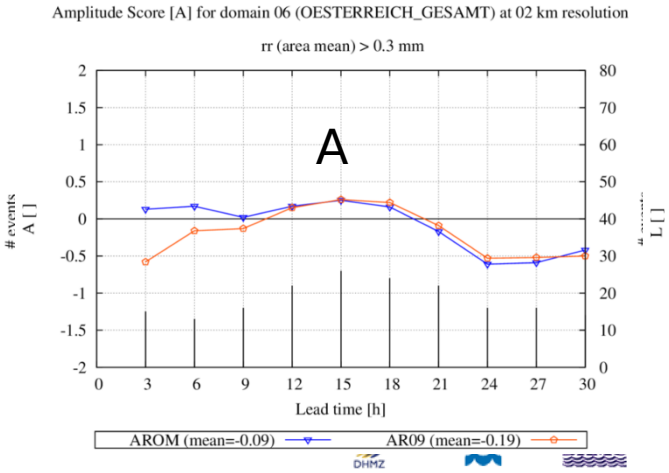


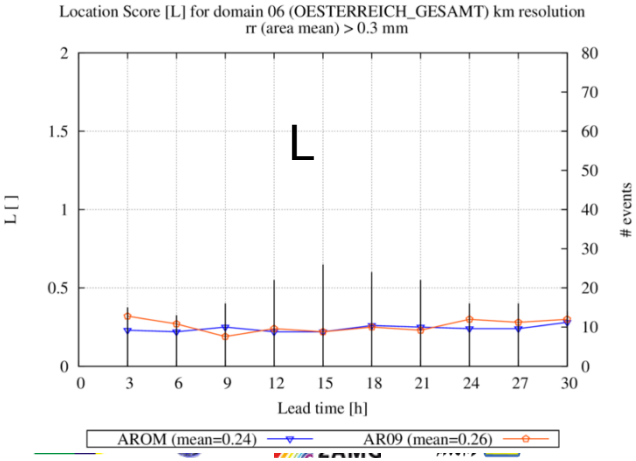




SAL-all Austria >0.0mm (top) >0.3 (bottom)







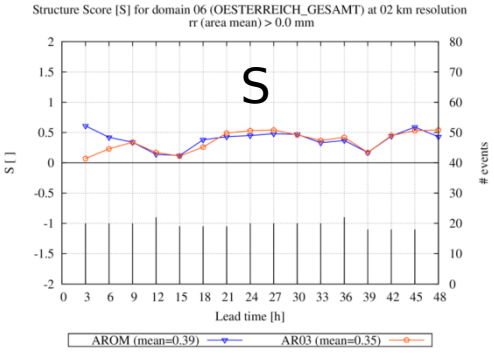
SAL –verification RADAR 10th November-1st December2014

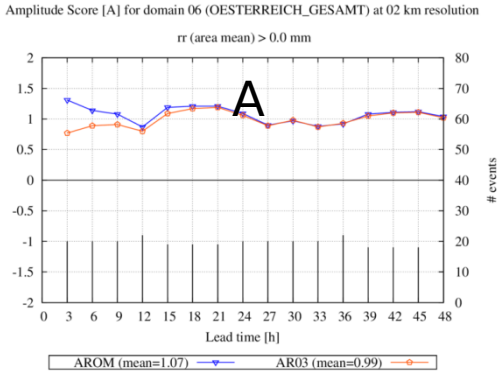
Regional Cooperation for Limited Area Modeling in Central Europe

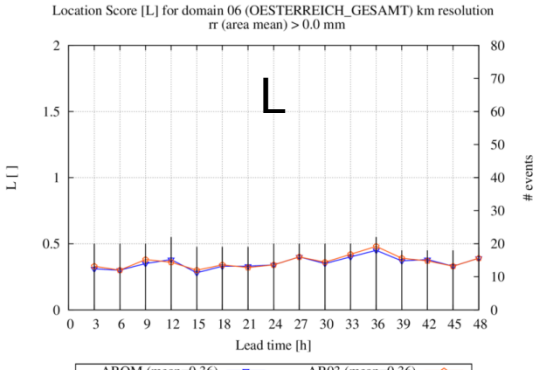
LACE nwp central europe

No QC; elevations below 1.5° blacklisted

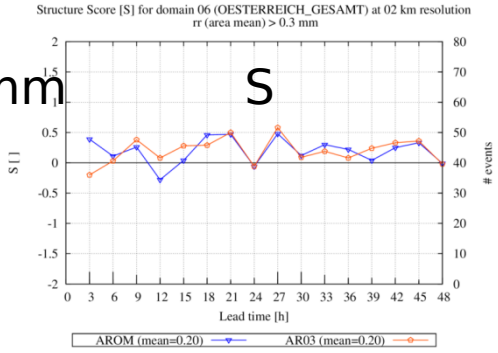
all

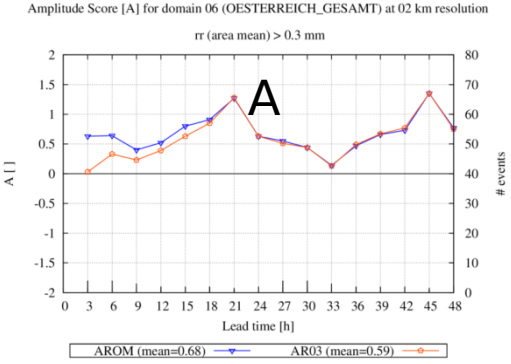


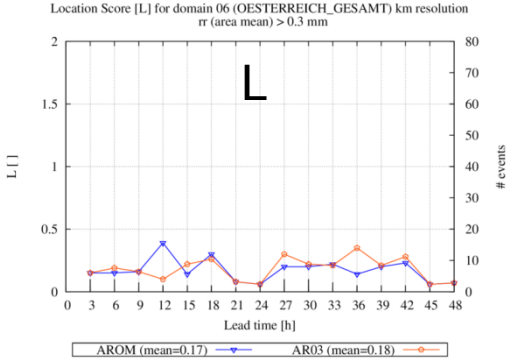




>0.3mm







AROME-OPER

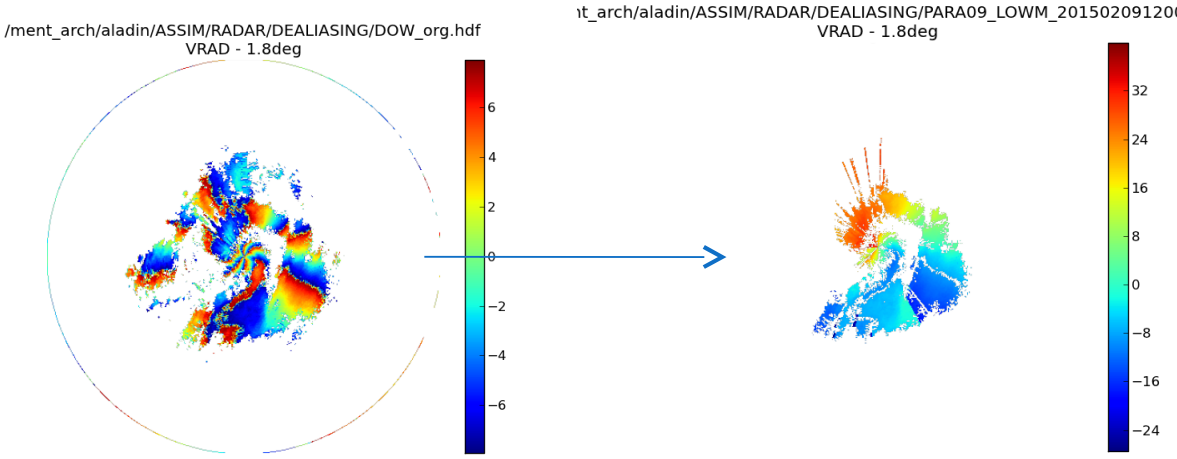
AROME+RADAR still degrading in Western Austria

Dealiasing:

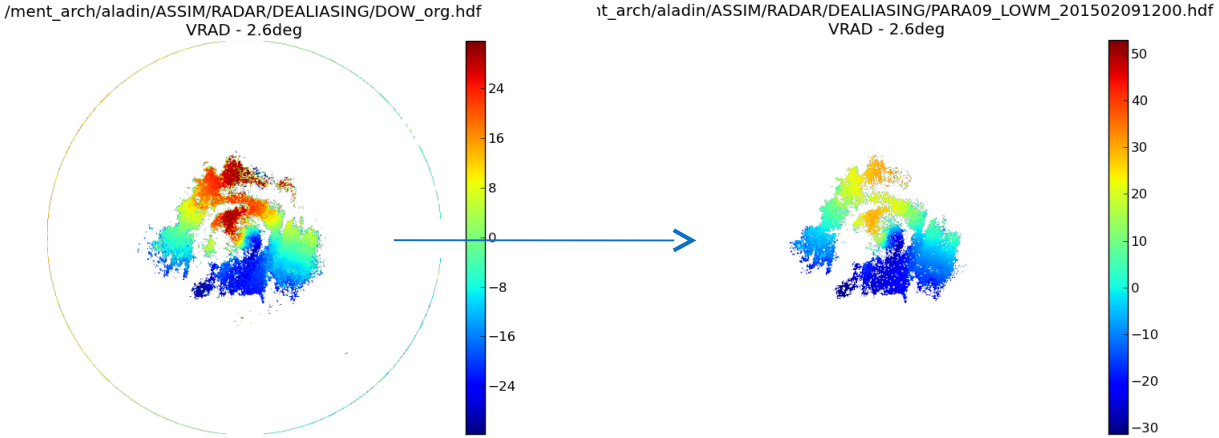
- Vrad unambigous only as long as |V|<Vmax=PRF*λ/4
- Otherwise: V=Vo ± 2n*Vmax; n=0,1,2,3...
- No algorithm available at ZAMG -> own C-Routine/bash-script combination based on CINRAD algorithm (He et al. WAF, 27, 2012); needs hdf5 library+ C-compiler
- Independent for each elevation no other observations used
- Fast (some seconds per radar station), but not without mistakes -> some filters included in BATOR
- If REF< 7dBZ -> DOW=no data

Radar de-aliasing: Vienna-Airport 201502091200 UTC

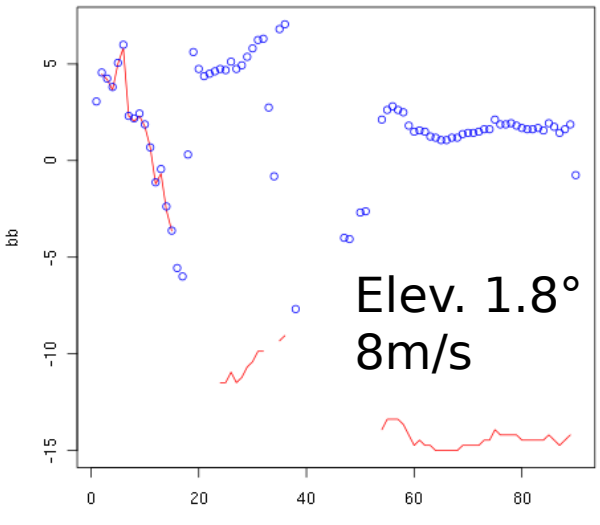
Elev. 1.8°
Vmax=8m/s

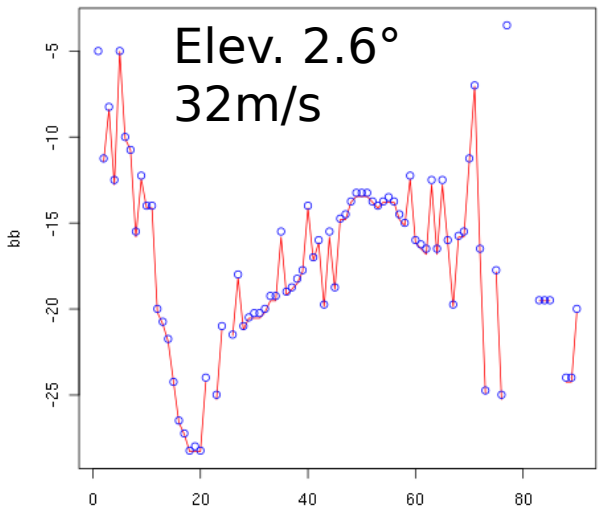


Elev. 2.6°
Vmax=32m/s



Radar de-aliasing: Vienna-Airport 201502091200 UTC

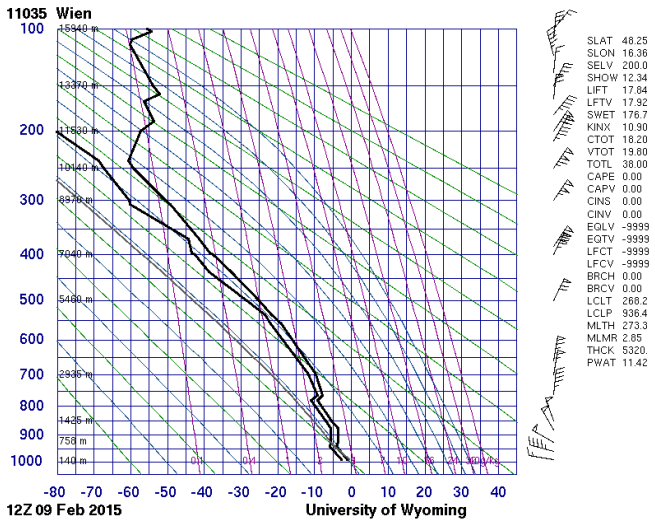




ray 150°

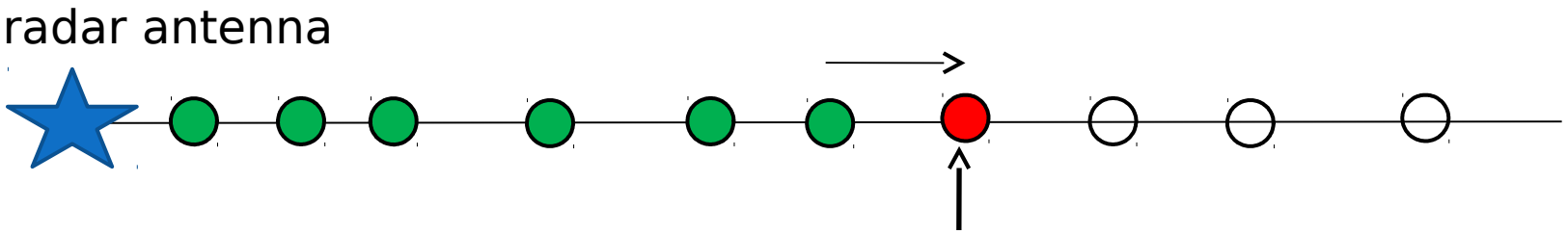
raw

de-aliased



De-aliasing

- Look for beam with minimum DOW (should be almost de-aliased) – this is first de-aliased

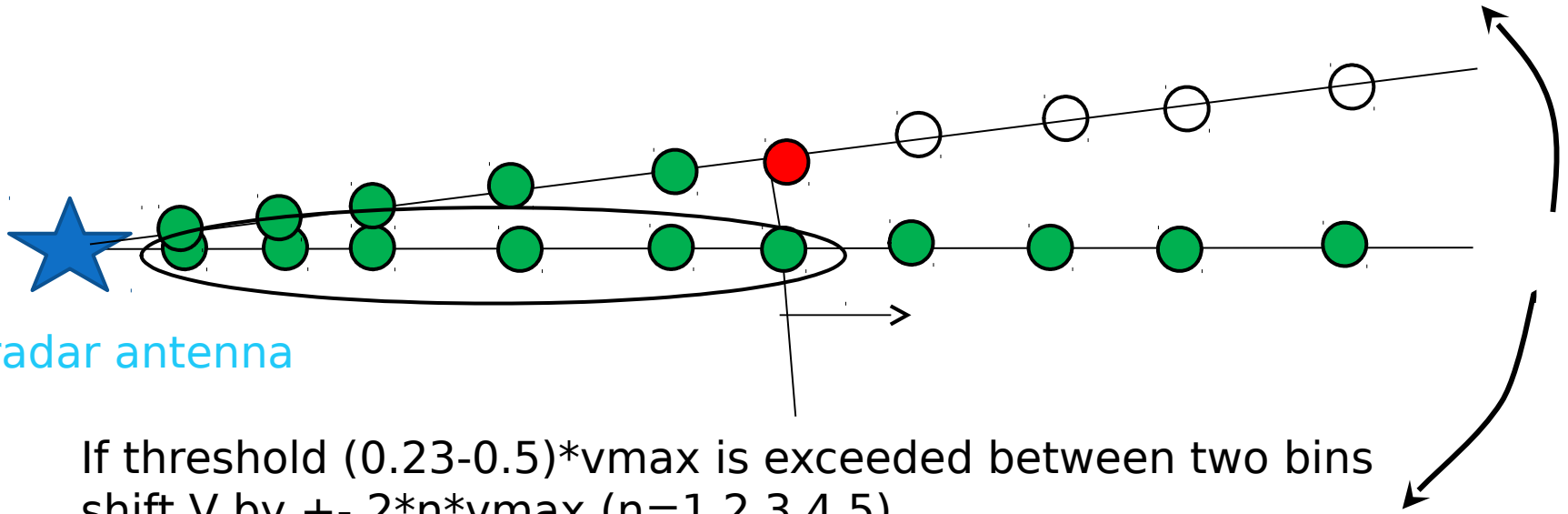


- Starting from this beam de-alias the neighbored ones

If threshold (0.23-0.5)*vmax is exceeded between two bins
shift V by +- 2*n*vmax (n=1,2,3,4,5)
If within threshold, set to de-aliased

De-aliasing

1st step

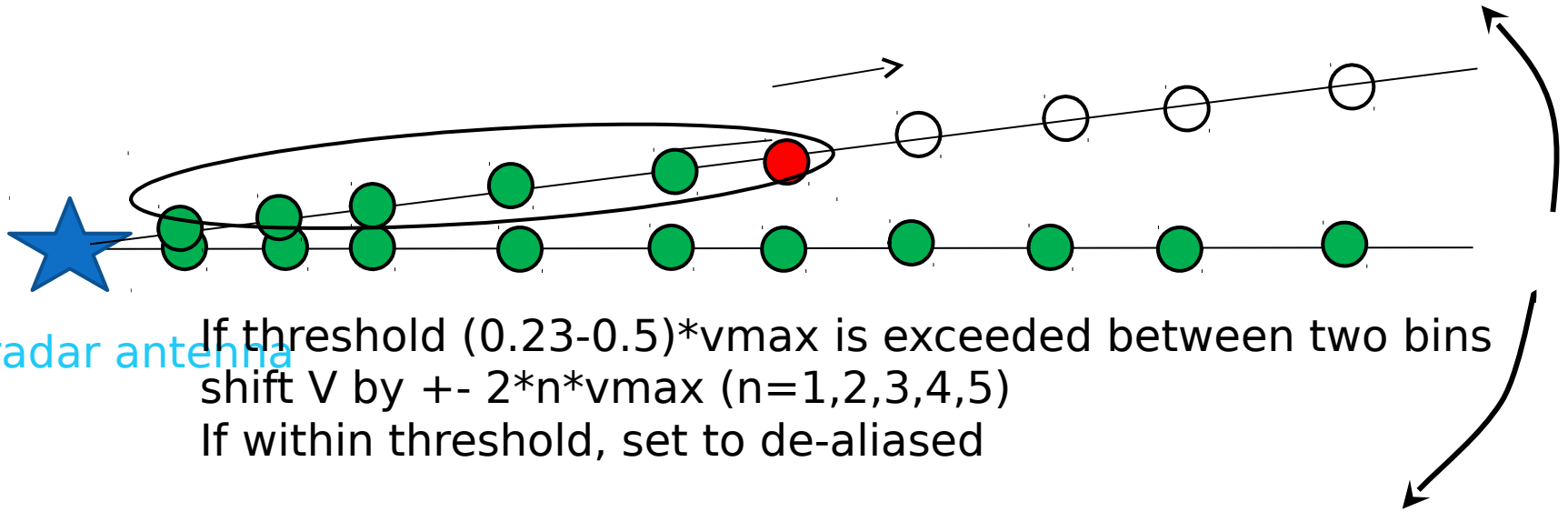


If threshold (0.23-0.5)*vmax is exceeded between two bins
shift V by +- 2*n*vmax (n=1,2,3,4,5)
If within threshold, set to de-aliased

f all these gates are not de-aliased, the red one is set to “not de-aliased”

Dealiasing

2nd step



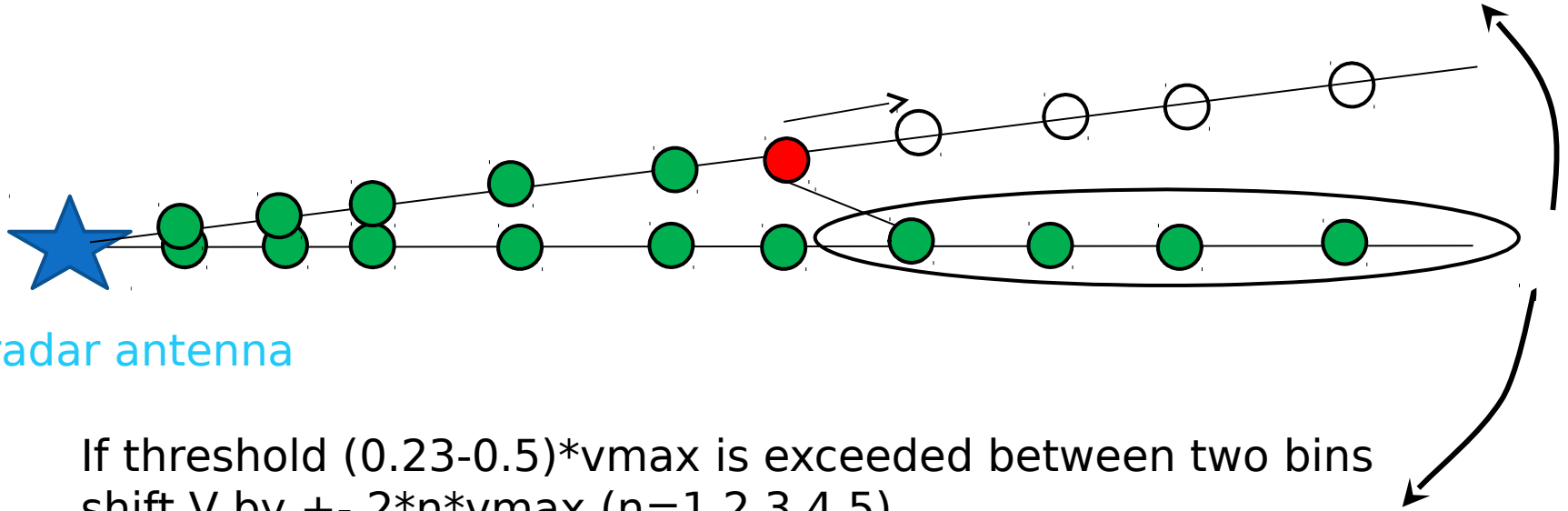
radar antenna

If threshold (0.23-0.5)*vmax is exceeded between two bins
shift V by +- 2*n*vmax (n=1,2,3,4,5)
If within threshold, set to de-aliased

f all these gates are not de-aliased, the red one is set to “not de-aliased”

Dealiasing

3rd step



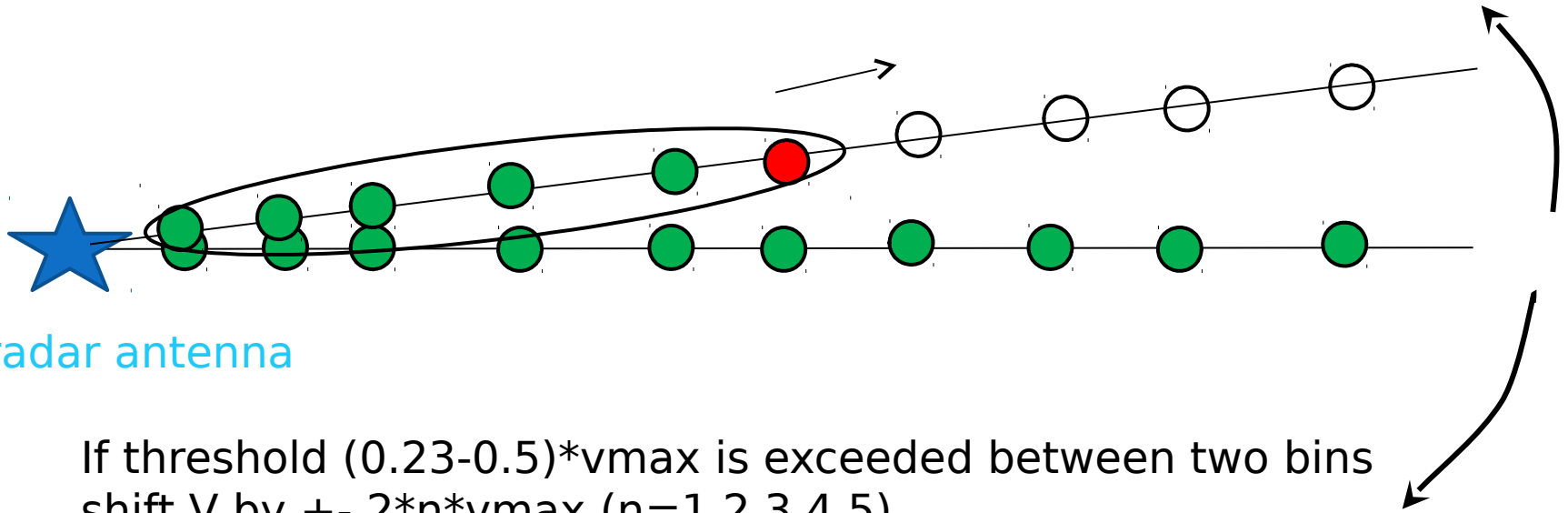
radar antenna

If threshold (0.23-0.5)*vmax is exceeded between two bins
shift V by +- 2*n*vmax (n=1,2,3,4,5)
If within threshold, set to de-aliased

f all these gates are not de-aliased, the red one is set to “not de-aliased”

Dealiasing

4th step



radar antenna

If threshold (0.23-0.5)*vmax is exceeded between two bins
shift V by +- 2*n*vmax (n=1,2,3,4,5)
If within threshold, set to de-aliased

all these gates are not de-aliased, the red one is set to “not de-aliased”

extreme Jumps, elevations <1,5°, gates with reflectivity<3dBz -> no data

RADAR nudging – Newton relaxation

- Fast and computationally cheap
- During integration
- No observation errors, no error statistics („perfect OBS“)
- All based on 2D rain rate product (obs) on model grid, which is converted to 3D-model variable tendency -> INCA/OPERA?
- Methods: Latent heat nudging (Jones & Macpherson 1997: UM, Stephan et al. 2008: COSMO, Cedilnik 2005: ALADIN)

Divergence nudging(Korsholm et al. 2014: HIRLAM)

Specific humidity nudging (Davolio & Buzzi 2004)

Nudging

$$\frac{\partial}{\partial t}x = x_{advection} + \frac{\partial}{\partial t}x_{physics} + \frac{x - x_o}{\tau}$$

- Vertical weighting function empirically derived or dependence on physics tendency (LHN)
- τ: Tunable time constant limited by model timestep
- 2D rain rate depends on 3D microphysics activivity in the past – not an instantanous process. Which is the best 2D rain rate?
- Nudging of Doppler winds? Interpolation, tangential/vertical wind components?

Different kinds of RADAR nudging

Latent heat nudging (Jones and Macpherson): $\Delta\theta_{LHN}=\frac{\Delta RR}{RR_{fg}}\Delta\theta_{physics}$

Divergence nudging Korsholm et al.:

$$F(p)=\frac{\Delta D(p)}{\alpha}$$

$$F(p)=\begin{cases}\dfrac{p-ps}{pb-ps}-1 & : pm\le p\le ps\\ \dfrac{pm-pb}{pb-ps}\left(1-\dfrac{p-pm}{pt-pm}\right) & : pt\le p\le pm\end{cases}$$

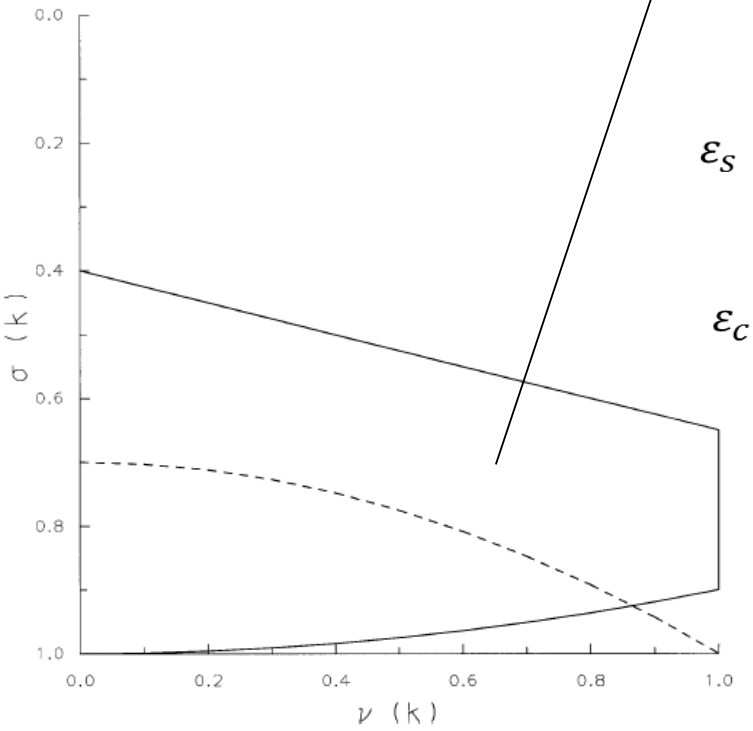
$$\int_{ps}^{pt}\Delta D(p)dp=0\rightarrow pb$$

$$\int_{ps}^{pt}q(p)F(p)dp=\frac{\Delta RR}{\alpha}\rightarrow\alpha$$

Different kinds of RADAR nudging

- Moisture nudging Davolio and Buzzi (2004):

$$\frac{\partial q(k)}{\partial t} = -\frac{v_{s,c}}{\tau}\left[q(k) - \varepsilon_{s,c} q(k)^{sat}\right]$$



$\varepsilon_s = 0.8 \; or \; 1.1 \; ; \; depending \; if \; \Delta RR > 0 \; or < 0$

$\varepsilon_c = 0.1 \; or \; 0.9 \; ; \; depending \; if \; \Delta RR > 0 \; or < 0$

Davolio and Buzzi (2004)