

Development of a limited area NWP model based nowcasting version for Austria

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ZAMG
Zentralanstalt für
Meteorologie und
Geodynamik

outline

- Setup of AROME-RUC
- Problems faced during setup definition
- Experiments:
 1. radar saturation
 2. FDDA-Nudging
 3. MODE-S-KNMI
 4. debugged B-Matrix

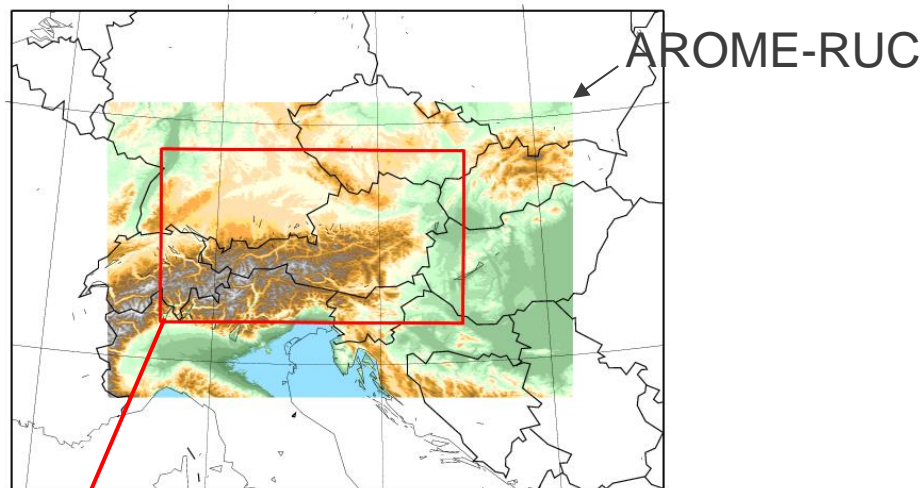
Technical setup of AROME-RUC for Nowcasting

Idea:

->fill gap between classical nowcasting systems and short range NWP
Hourly forecasts up to 12h with hourly 3D-Var analysis and 25 min cutoff time available within 1h

- 900x576x90 GP 1.2km LBC+ soil from AROME-OPER or own CANARI-OI-MAIN
- additional observations (radar reflectivity, Doppler winds, MODE-S aircraft, national SYNOP, AMDAR-Q, **national GNSS ZTD**)
- additional initialisation: latent heat nudging +35min (Stephan 2008), FDDA nudging (Liu et al. 2006) +30min (optional), (cloud analysis), IAU (Brousseau)

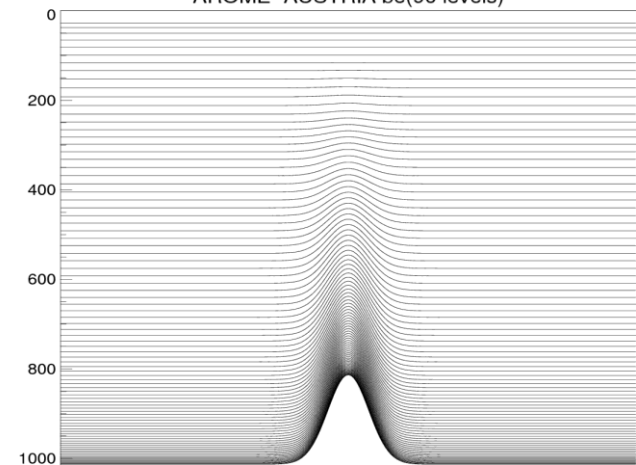
AROME-Nowcasting Domain & Topography



INCA-nowcasting

AROME-OPER 2.5kmL90

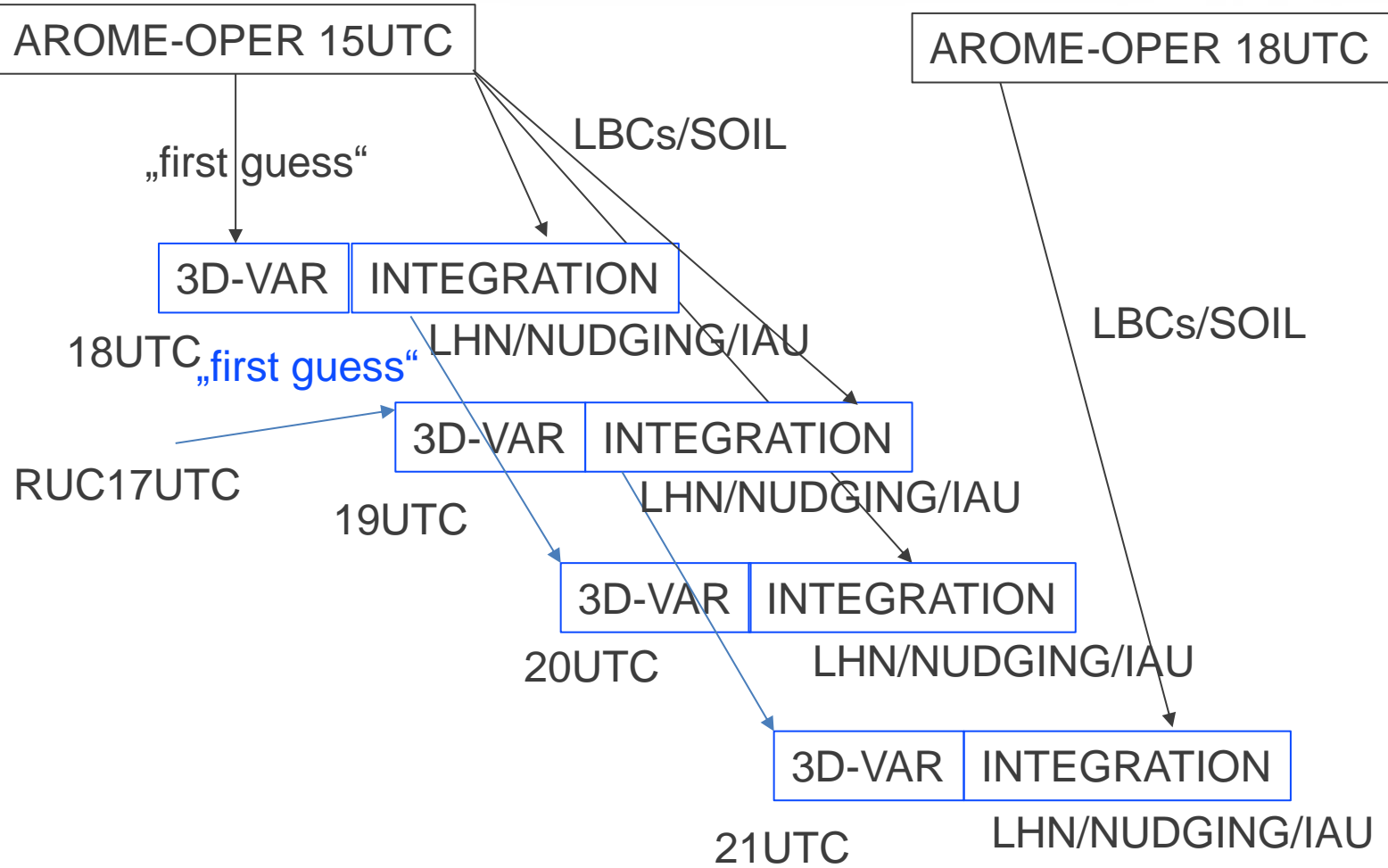
AROME-AUSTRIA be(90 levels)



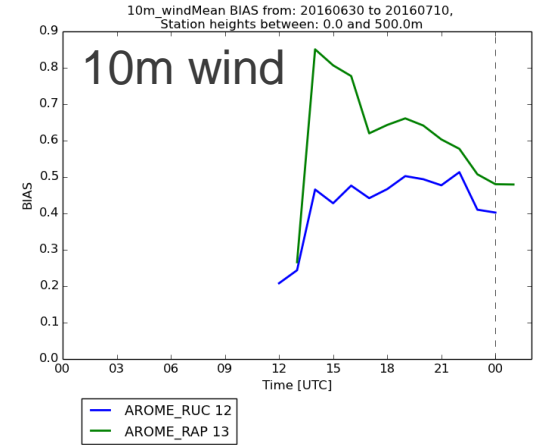
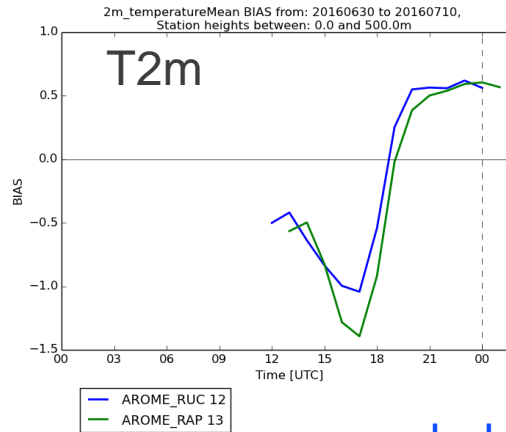
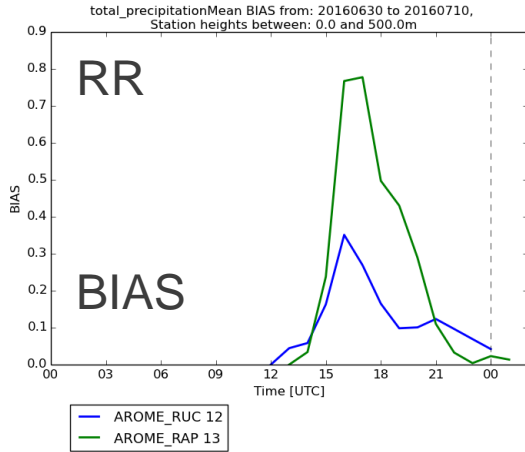
90 vertical layers

Technical setup of AROME-RUC for Nowcasting 2hourly cycle every hour

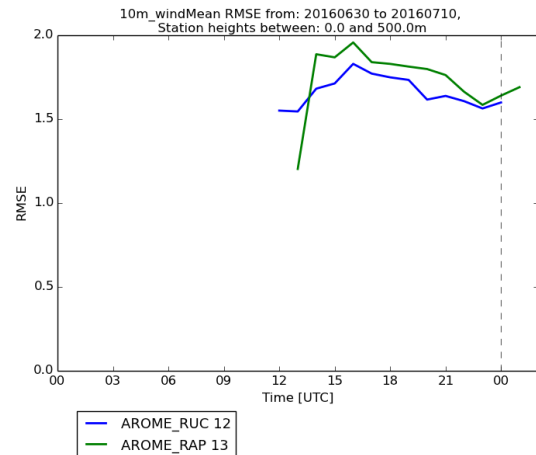
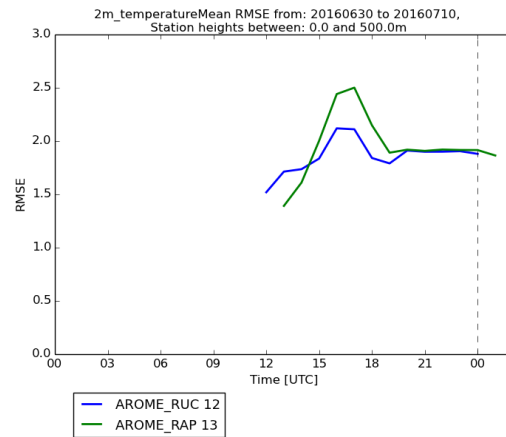
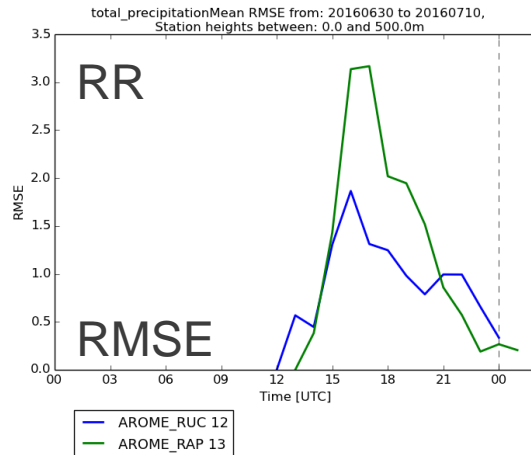
AROME
24.09.2018



1h cycle versus „open loop“ rapid refresh?



cycled
open loop

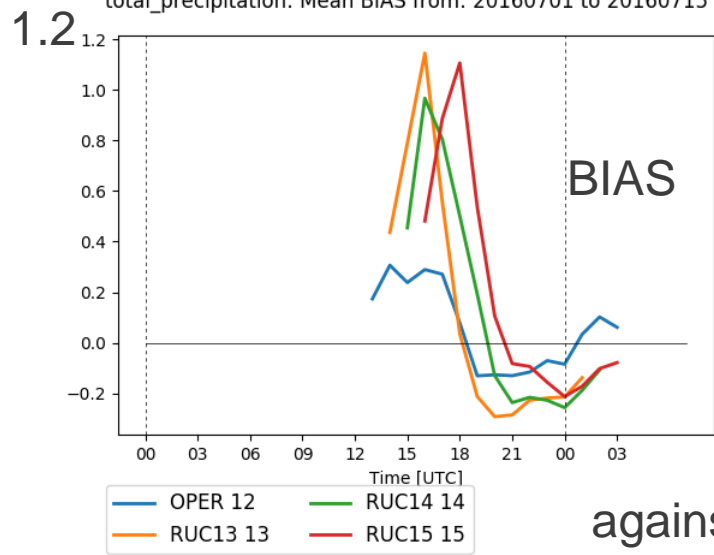


Based on old 2.5km version

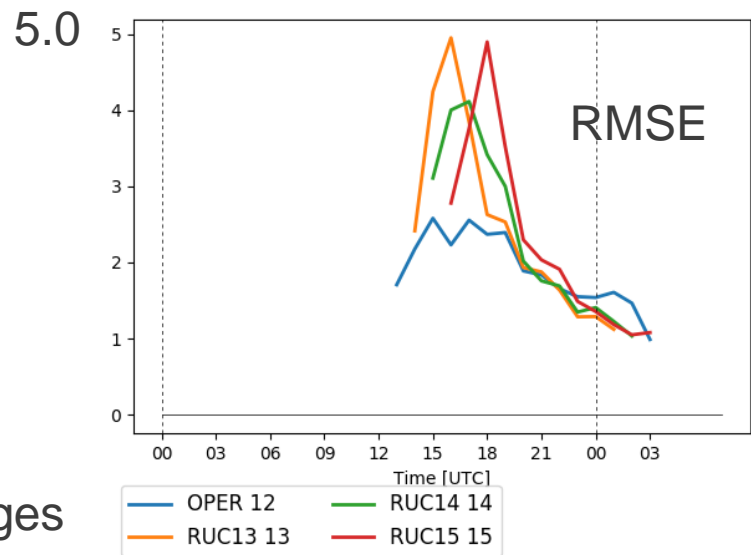
Validation July 2016: precipitation 1h vs 2h cycle



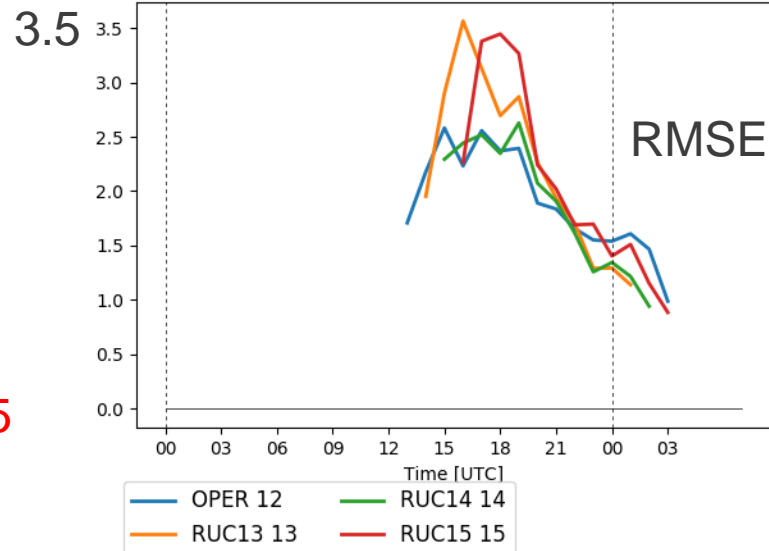
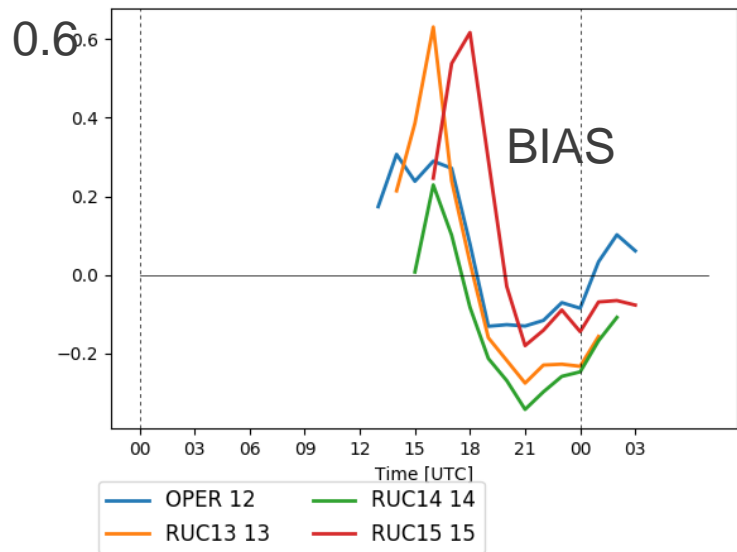
total_precipitation: Mean BIAS from: 20160701 to 20160715



total_precipitation: Mean RMSE from: 20160701 to 20160715



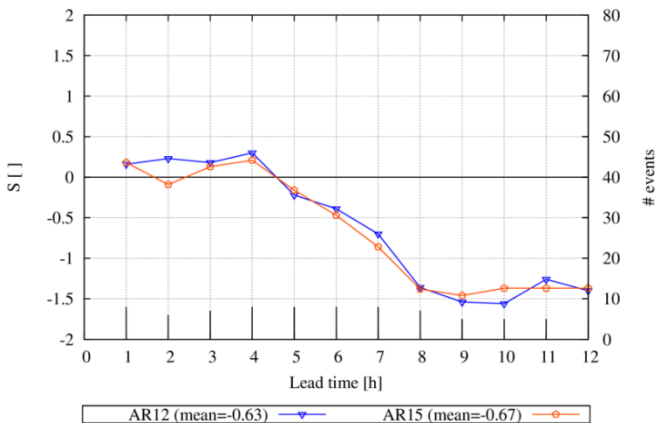
against 1h rain gauges



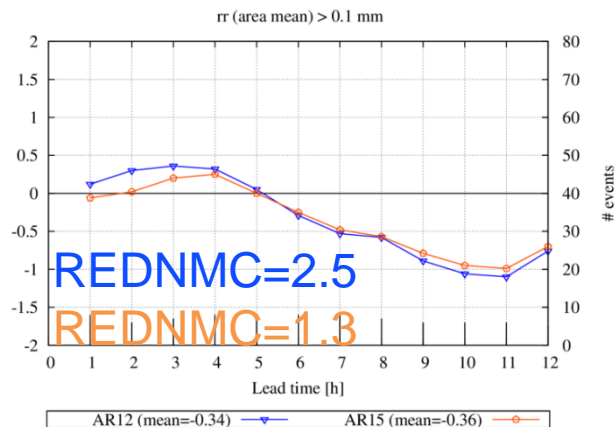
OPER 12
NWC 13
NWC 14/15

REDNMC=1.3 instead 2.5

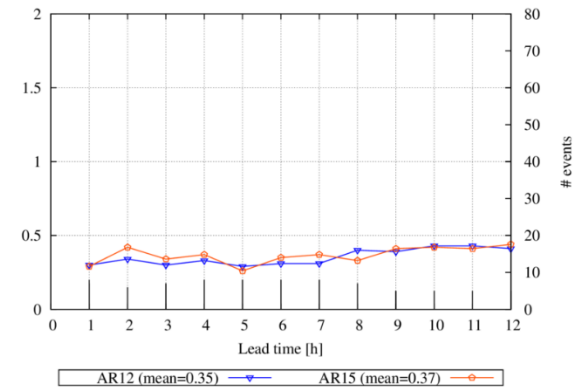
Structure Score [S] for domain 06 (OESTERREICH_GESAMT) at 02 km resolution
rr (area mean) > 0.1 mm



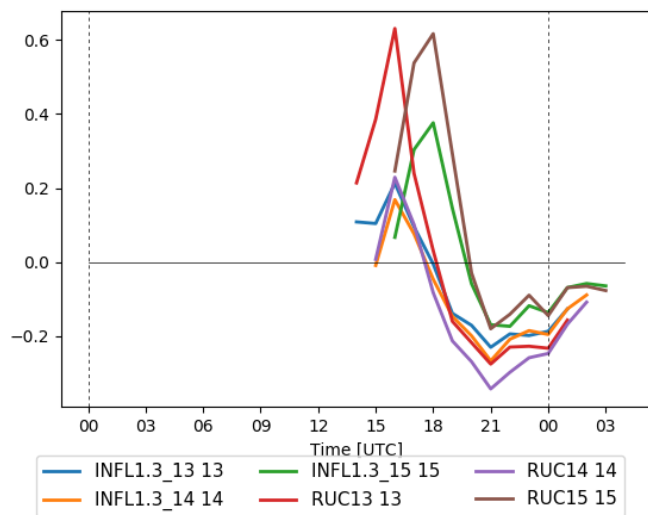
Amplitude Score [A] for domain 06 (OESTERREICH_GESAMT) at 02 km resolution
rr (area mean) > 0.1 mm



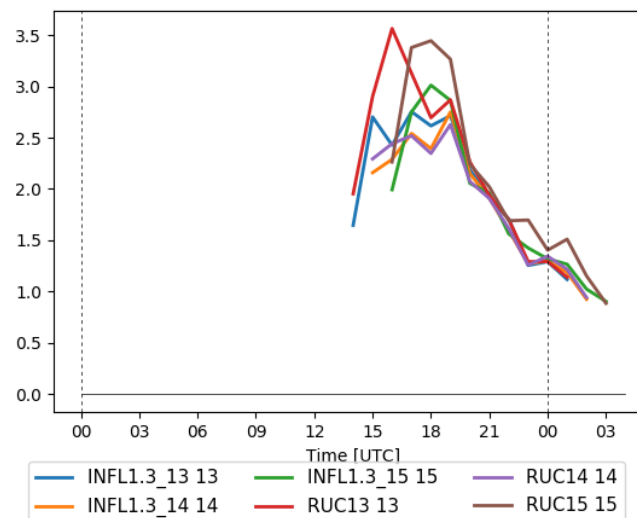
Location Score [L] for domain 06 (OESTERREICH_GESAMT) km resolution
rr (area mean) > 0.1 mm



total_precipitation: Mean BIAS from: 20160701 to 20160716



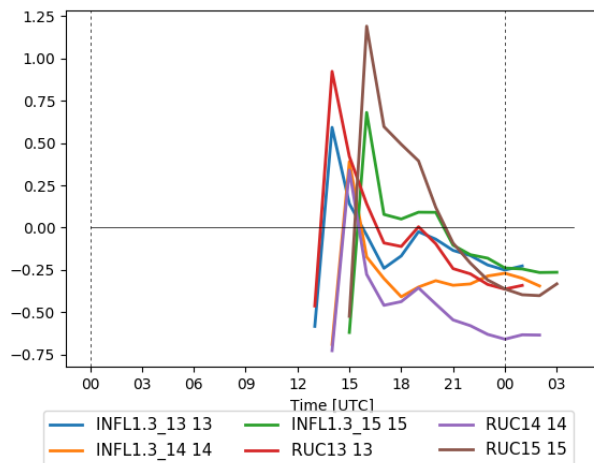
total_precipitation: Mean RMSE from: 20160701 to 20160716



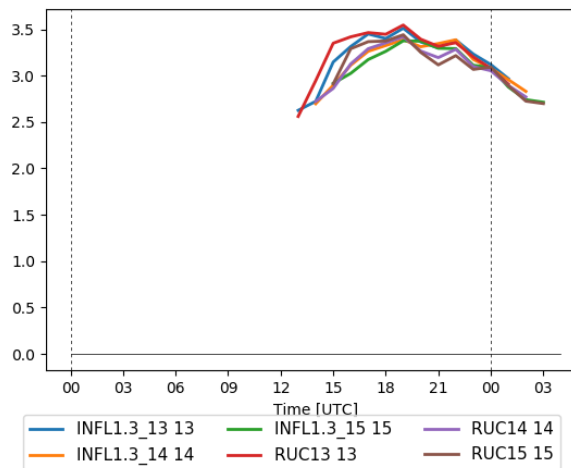
REDNMC=1.3 instead 2.5

AROME
24.09.2018

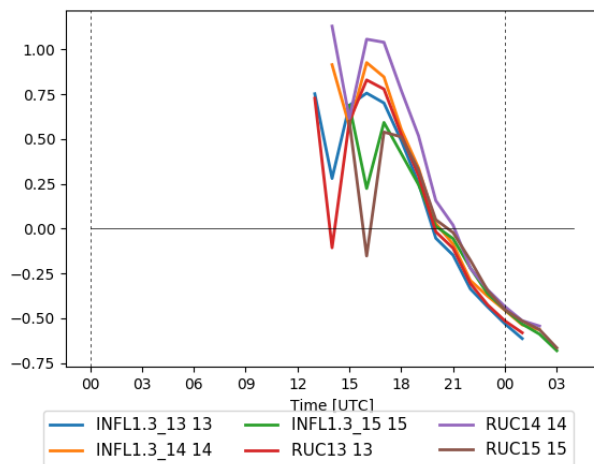
10m_gust: Mean BIAS from: 20160701 to 20160716



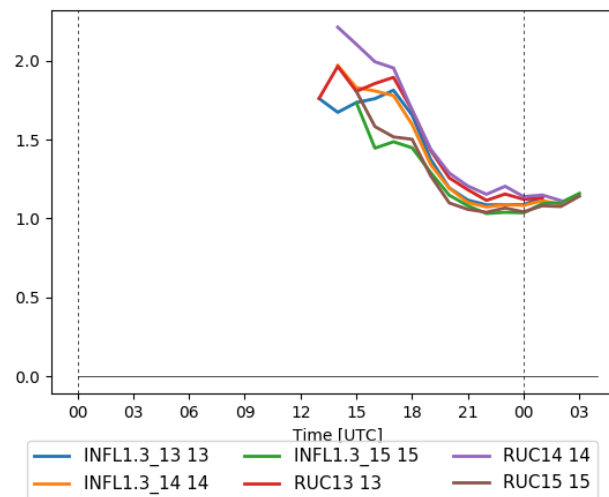
10m_gust: Mean RMSE from: 20160701 to 20160716



mssl_pressure: Mean BIAS from: 20160701 to 20160716



mssl_pressure: Mean RMSE from: 20160701 to 20160716



Crashes without abort in minimization - NaN cost function

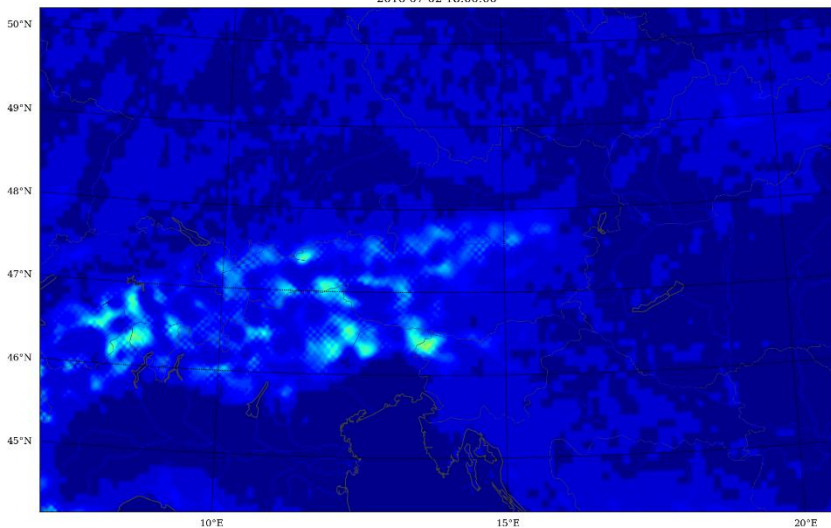
AROME

4.09.2018

- GOM arrays NaN (simulated synop observations) due to negative exchange coefficients PCH/PCD(5) in achmttl.F90/acntclstl.F90
- Most crashes avoidable, if synop stations Leiser Berge, Ptuj and Kostelní Myslová blacklisted
- MF-Solution (P. Brousseau) NFPCLI =3 in 927 for old ISBA fields else NFPCLI =1
- old ISBA surface fields (ADDSURF) are still used (roughness, vegetation, emissivity?)!
- Idea: exchange fields with SURFEX values \rightarrow all crashes avoided so far

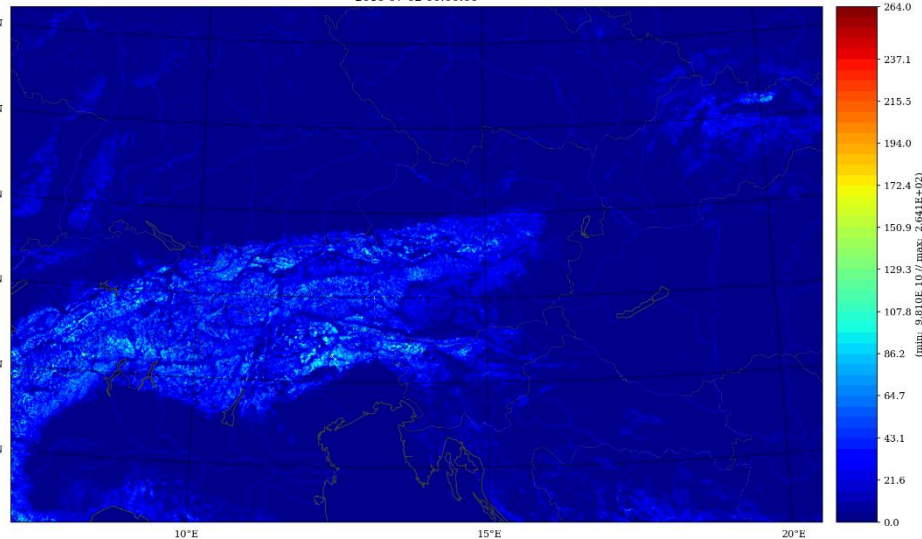
ISBA-OLD

SURFZO.FOIS.G
2016-07-02 18:00:00



SURFEX: SPXZOREL.G

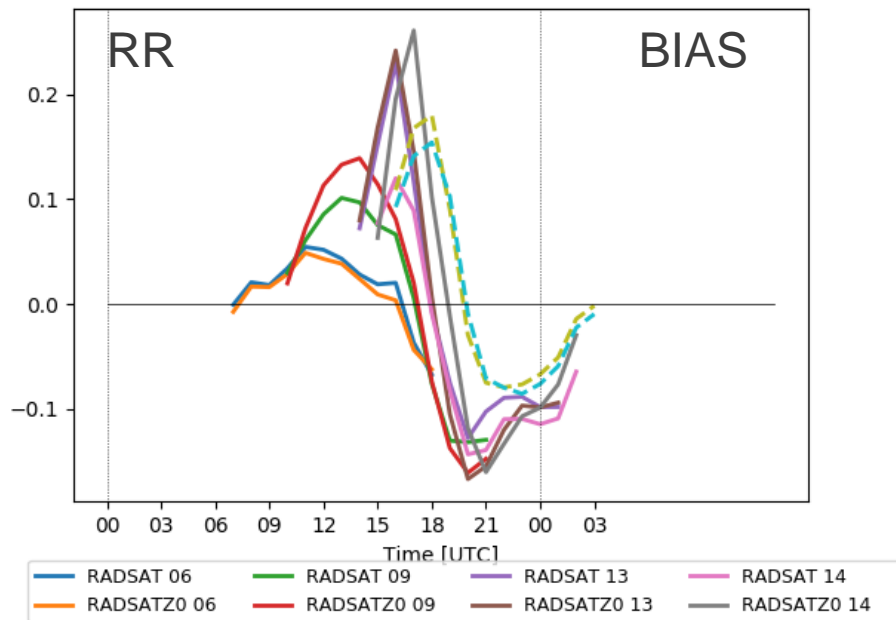
SURFZO.FOIS.G
2016-07-02 00:00:00



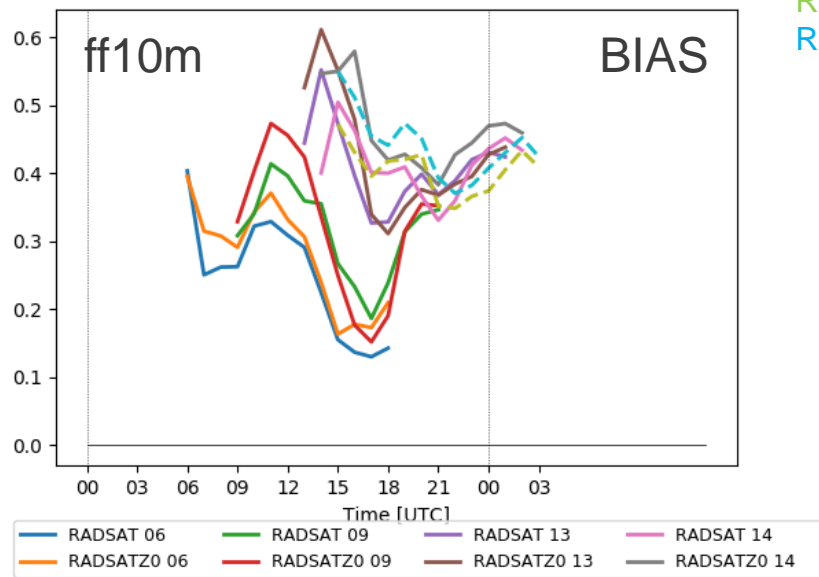
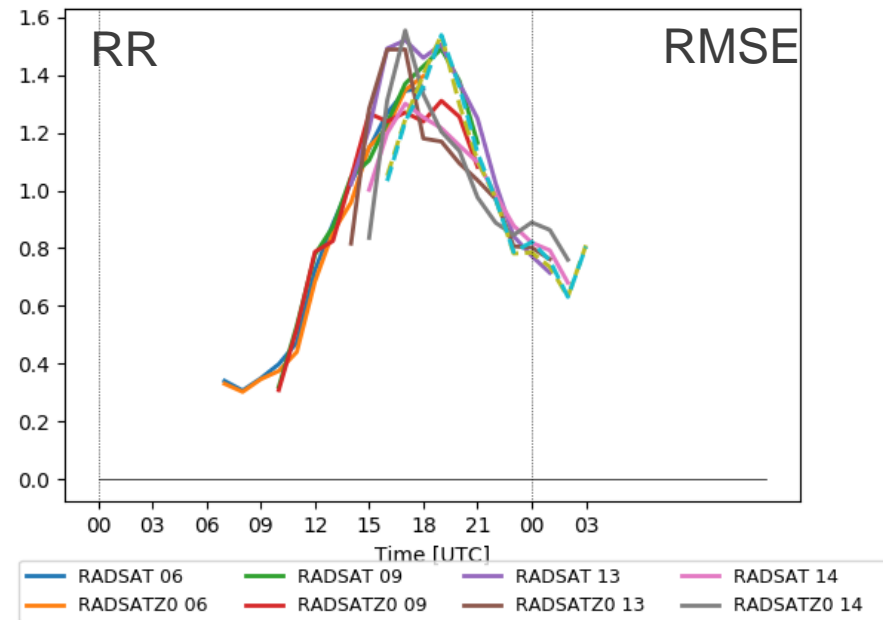
αεουγπαπκ

Impact on the performance

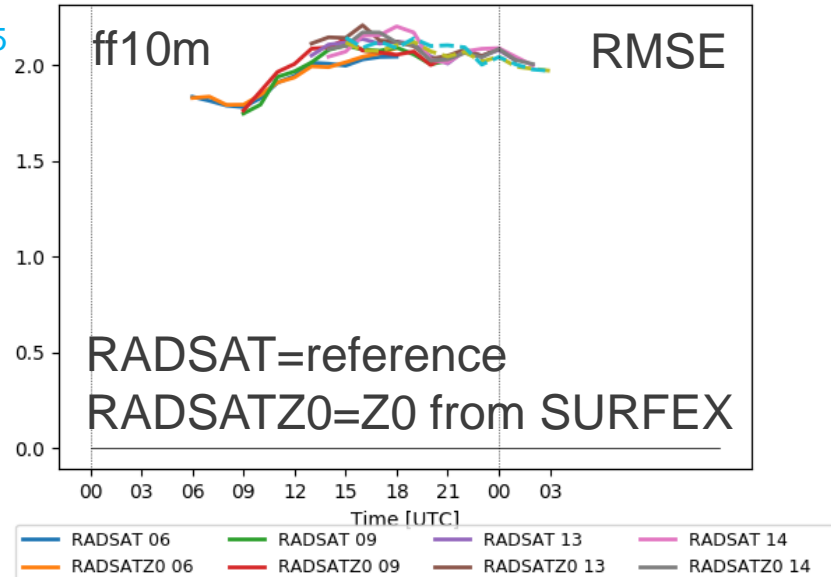
total_precipitation_area: Mean BIAS from: 20160701 to 20160716



total_precipitation_area: Mean RMSE from: 20160701 to 20160716

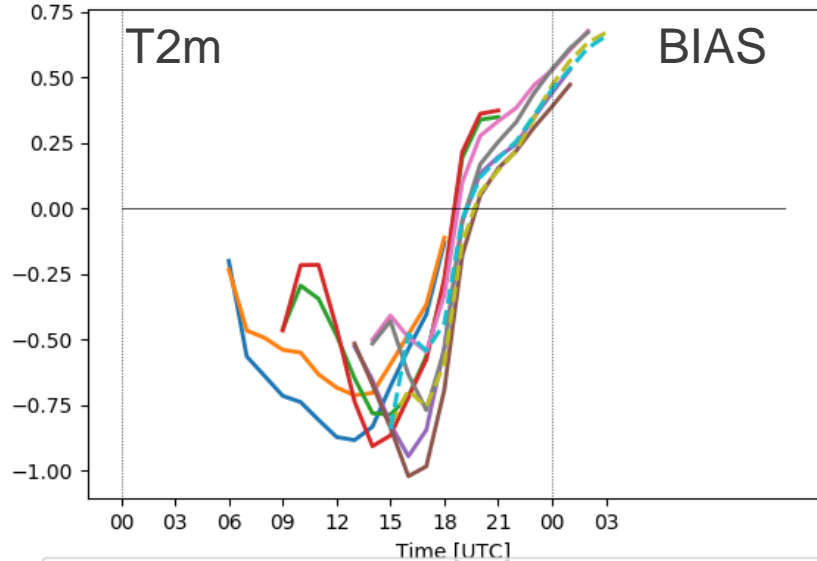


RADSAT15
RADSATZ015



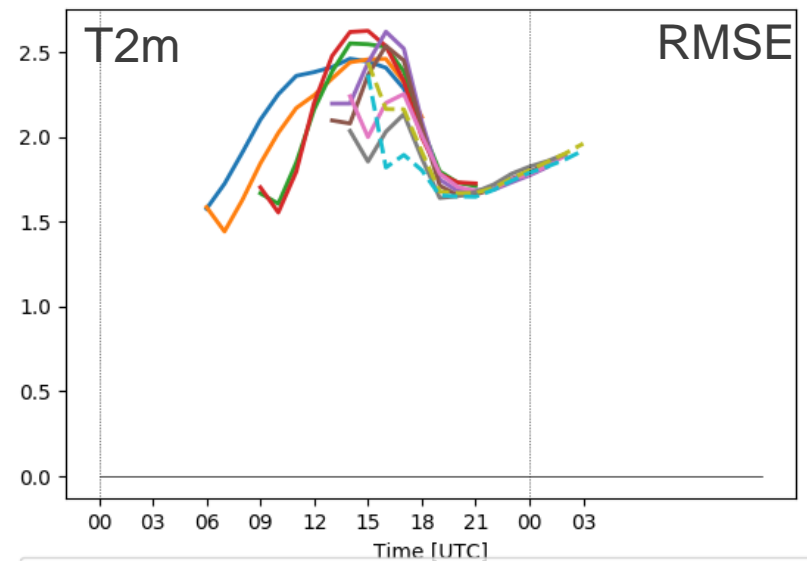
Impact on the performance

2m_temperature: Mean BIAS from: 20160701 to 20160716

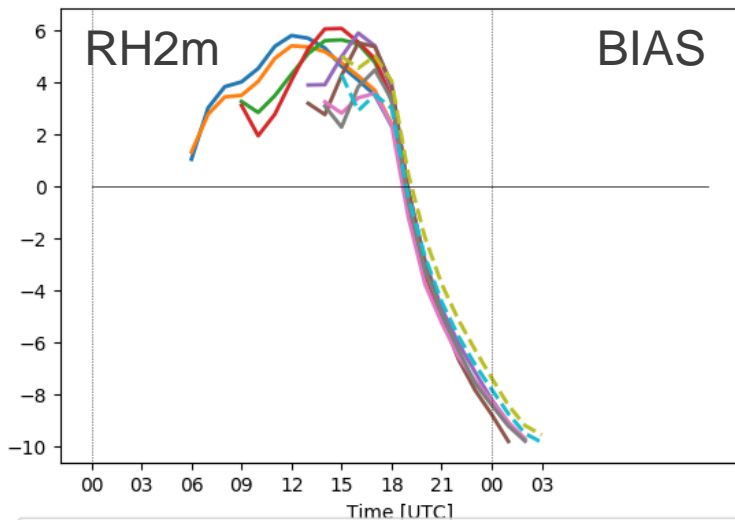


— RADSAT 06 — RADSAT 09 — RADSAT 13 — RADSAT 14
— RADSATZ0 06 — RADSATZ0 09 — RADSATZ0 13 — RADSATZ0 14

2m_temperature: Mean RMSE from: 20160701 to 20160716

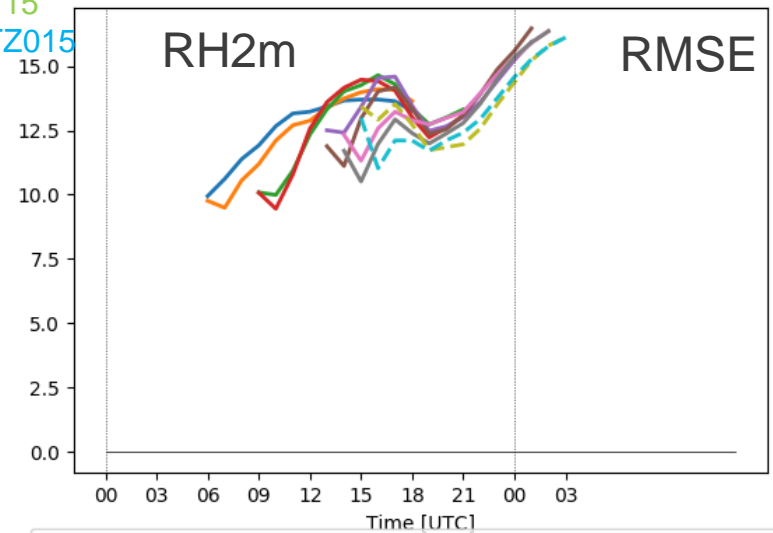


— RADSAT 06 — RADSAT 09 — RADSAT 13 — RADSAT 14
— RADSATZ0 06 — RADSATZ0 09 — RADSATZ0 13 — RADSATZ0 14



— RADSAT 06 — RADSAT 09 — RADSAT 13 — RADSAT 14
— RADSATZ0 06 — RADSATZ0 09 — RADSATZ0 13 — RADSATZ0 14

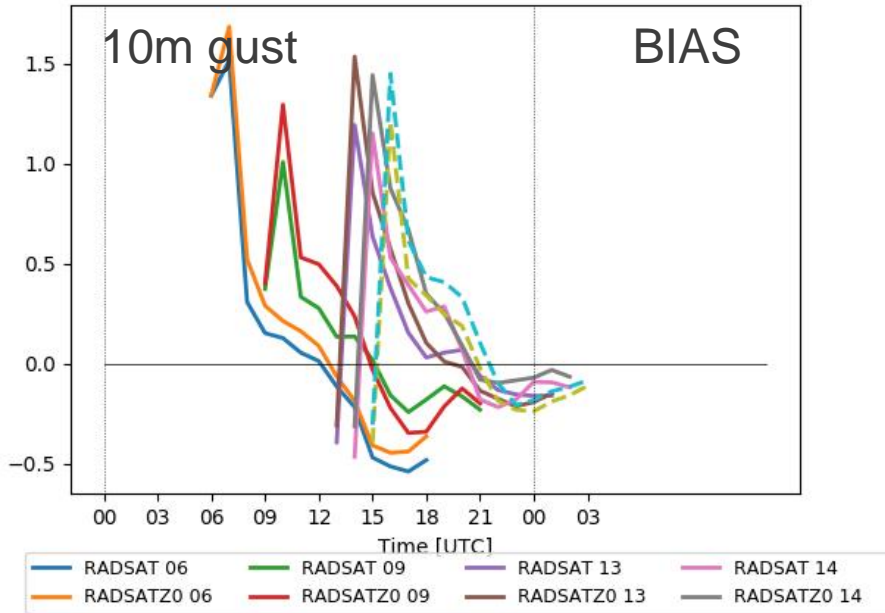
RADSAT15
RADSATZ015



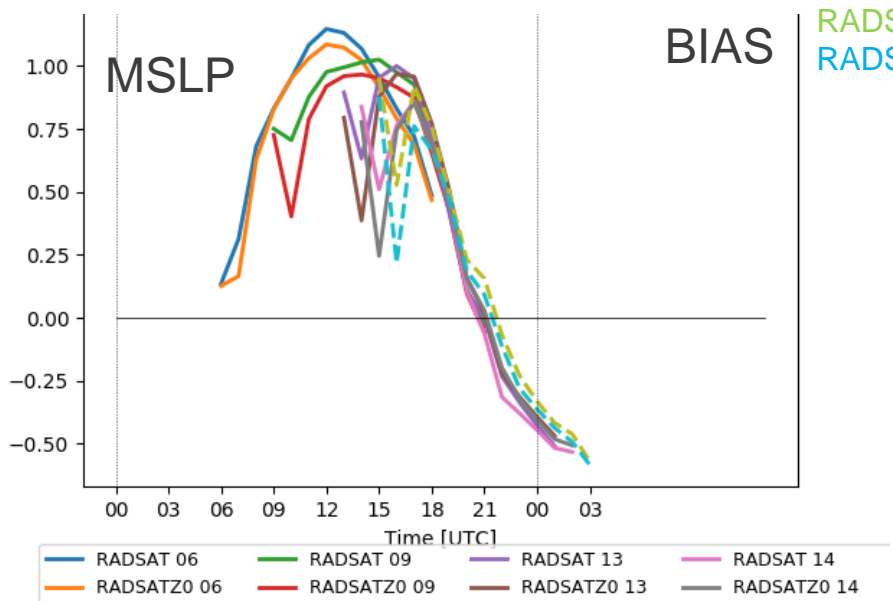
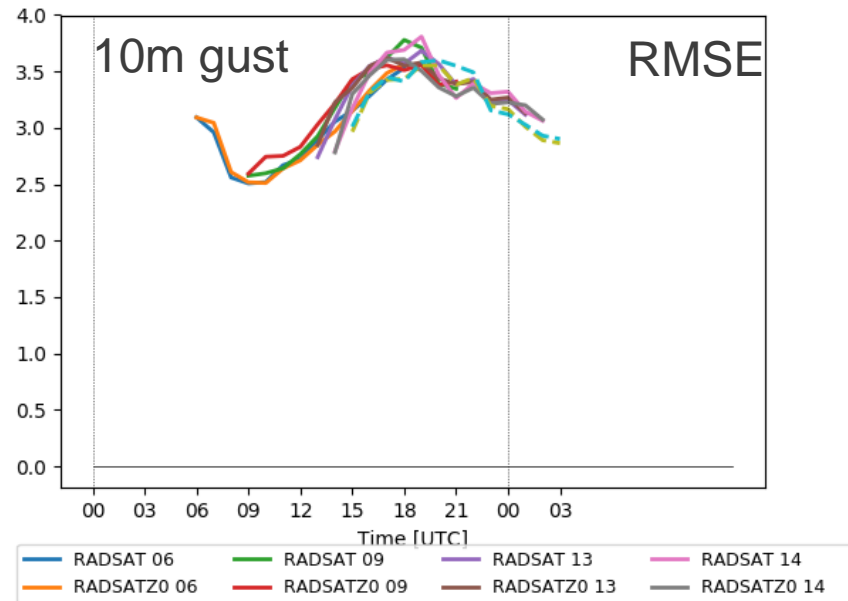
— RADSAT 06 — RADSAT 09 — RADSAT 13 — RADSAT 14
— RADSATZ0 06 — RADSATZ0 09 — RADSATZ0 13 — RADSATZ0 14

Impact on the performance

10m_gust: Mean BIAS from: 20160701 to 20160716

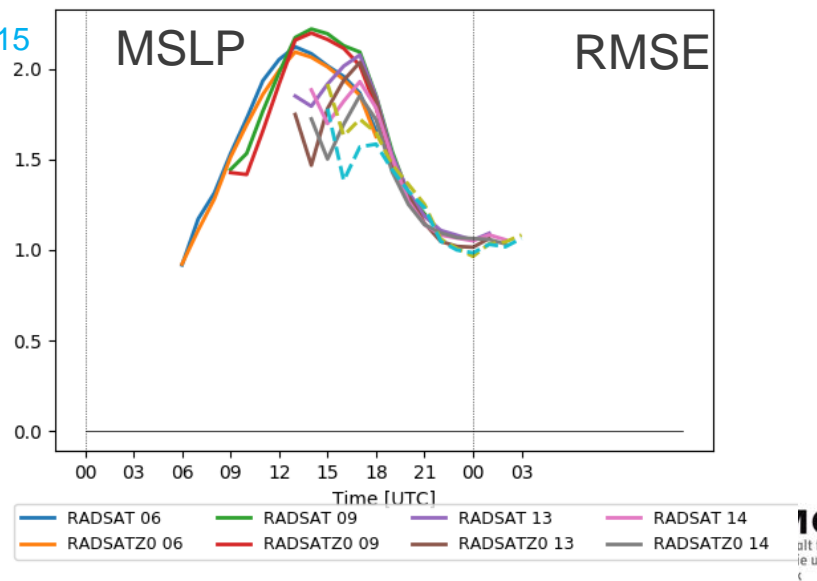


10m_gust: Mean RMSE from: 20160701 to 20160716



RADSAT15
RADSATZ015

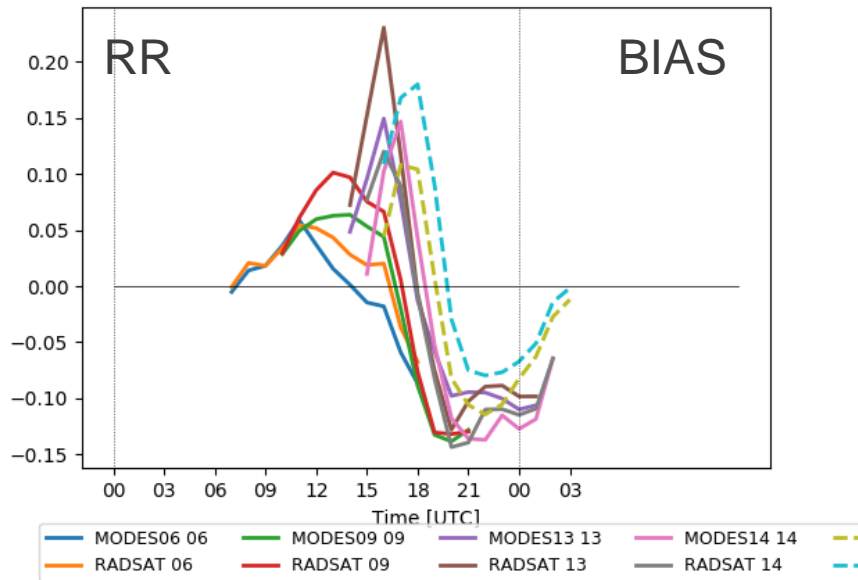
msl_pressure: Mean RMSE from: 20160701 to 20160716



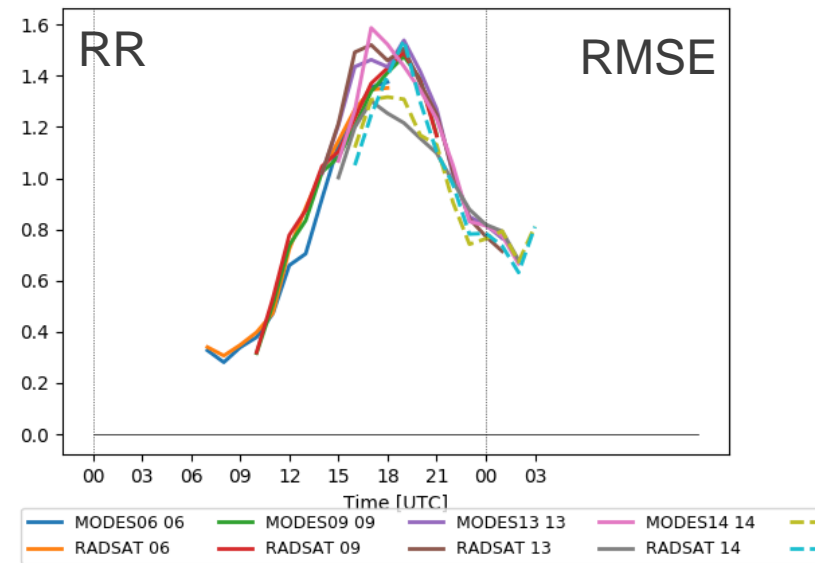
Radar saturation: standard reflectivity assimilation cannot do anything if model simulates nothing in the surrounding area (radius: 100km/200km)

Saturate pseudo profile, if reflectivity exceeds threshold (idea of E. Wattrelot)
Reduce QC check in inv_refl1dstat.F90

total_precipitation_area: Mean BIAS from: 20160701 to 20160716



total_precipitation_area: Mean RMSE from: 20160701 to 20160716



Higher positive Bias except 14UTC; RMSE mixed

change cy40t1->cy43t1: zdist=100km->200km in radar_profs.F90;
NOBSPROFS(13)=81->225 (in SCREENING namelist don't use it in minimization!)
More memory in screening needed if NOBSPROFS=225

FDDA nudging in AROME (TAWES observations; Liu et al. 2006)

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24.09.2018

$$DISTANCE' = DISTANCE + R \frac{|z_{OBS} - z_{GP}|}{dz_{thres} = 300m}$$

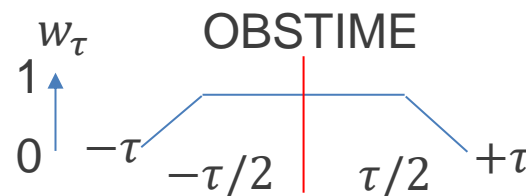
$$w_{xy} = \frac{R^2 0.75^2 - DISTANCE'^2}{R^2 0.75^2 + DISTANCE'^2} \left(\frac{p_{SGP}}{500hPa} + 1 \right)$$

$$\frac{\partial x}{\partial t} = \frac{\partial x}{\partial t_{phys}} + G \frac{\sum_i w_{xyi}^2 (y_{iobs} - x_{model})}{\sum_i w_{xyi}}$$

$$\frac{\partial x}{\partial t} = \frac{\partial x}{\partial t_{phys}} + G \frac{\sum_i w_{xyi}^2 y_{iobs}}{\sum_i w_{xyi}} - G \frac{\sum_i w_{xyi} x_{model}}{\sum_i w_{xyi}}$$

R=20km
G_C=0.00433
τ=6
(namelist switches)

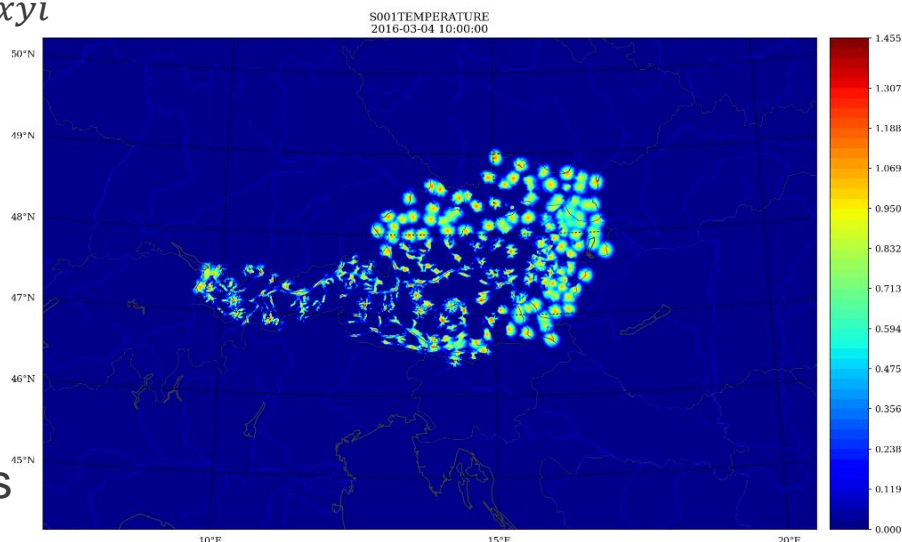
$$G = G_C * w_\tau$$



Observations at: +10 / 20 / 30min

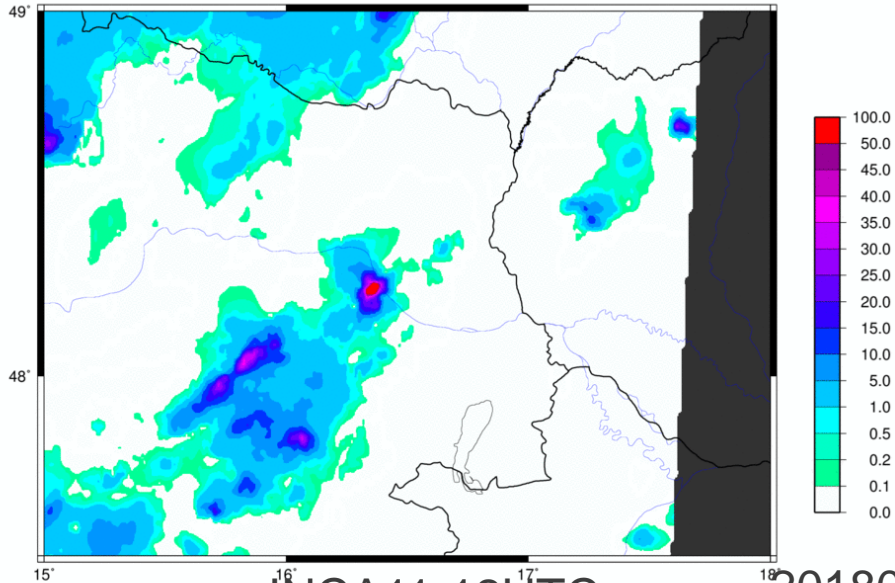
x=T2m/RH2m/U10m

called from apl_arome.F90 after microphysics

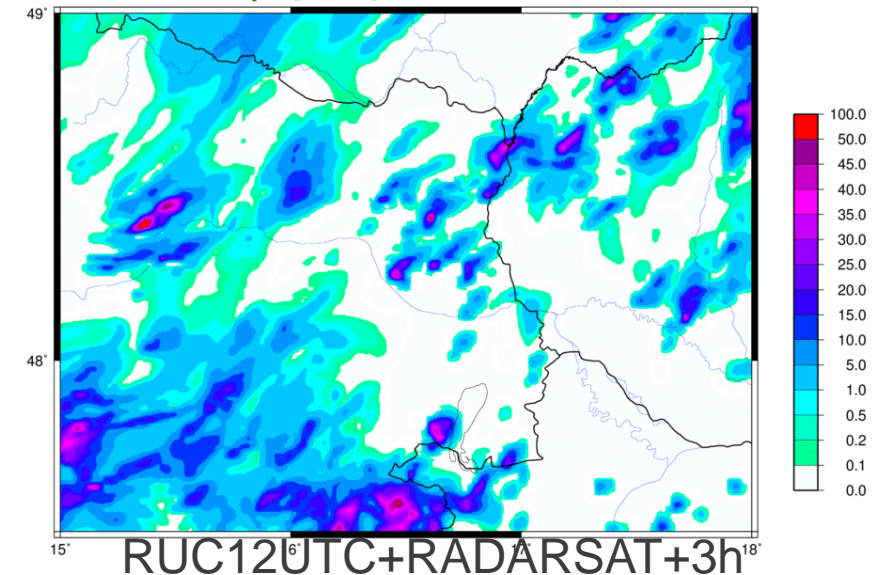
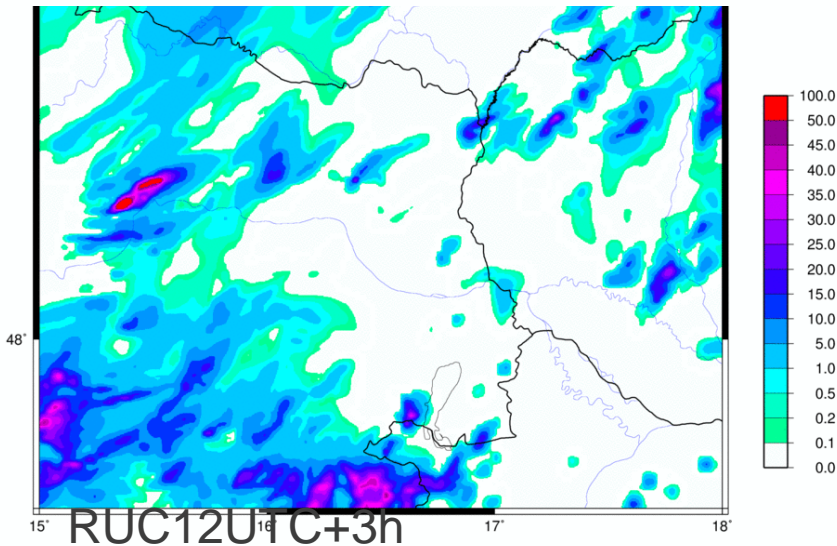
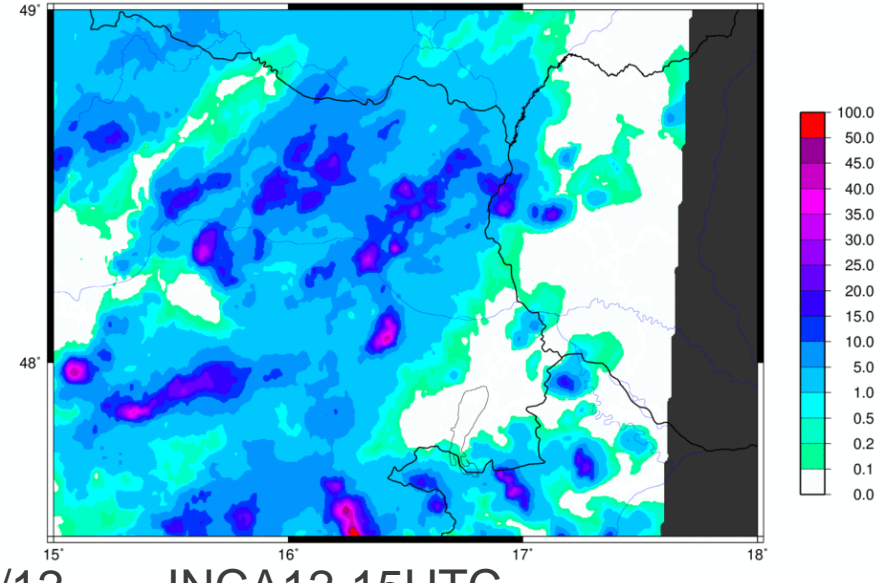


Radar saturation 20180710 12UTC

INCA Precip. Analysis [mm] 20180710 12 UTC, 01 h sum

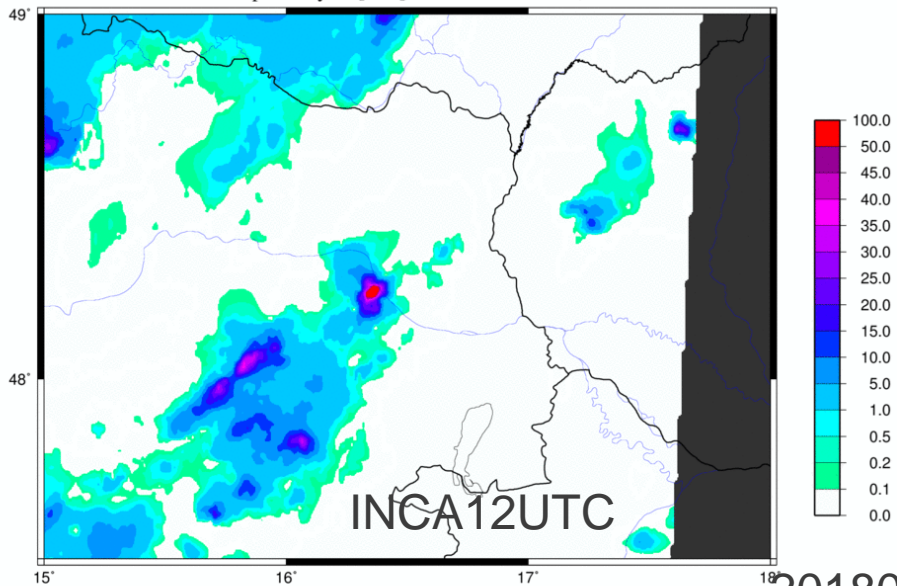


INCA Precip. Analysis [mm] 20180710 15 UTC, 03 h sum

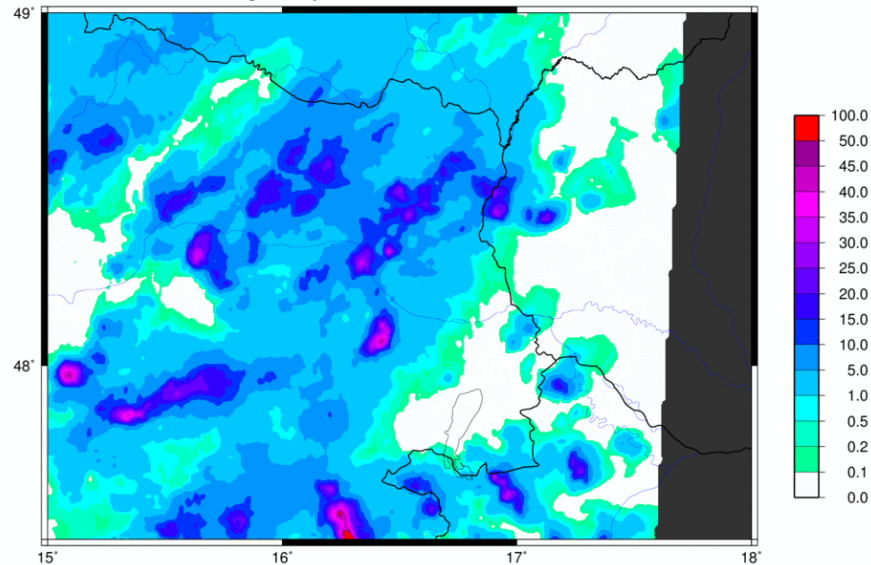


NUDGING 20180710 12UTC

INCA Precip. Analysis [mm] 20180710 12 UTC, 01 h sum



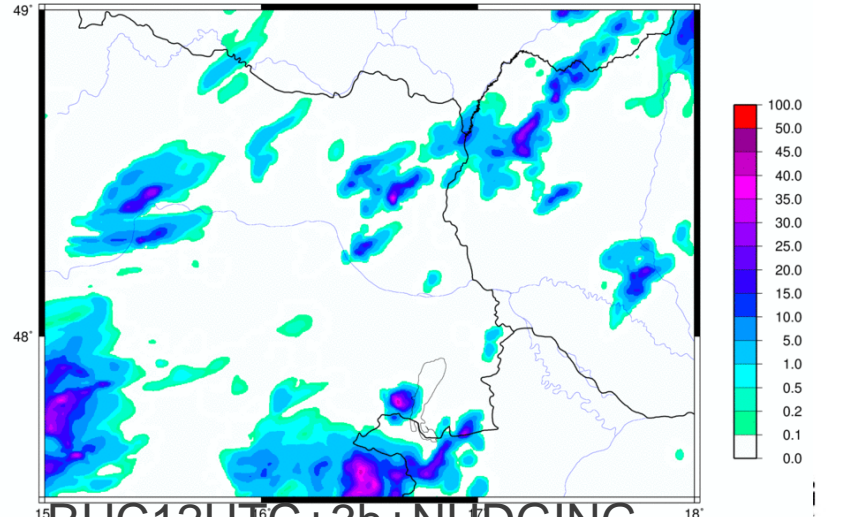
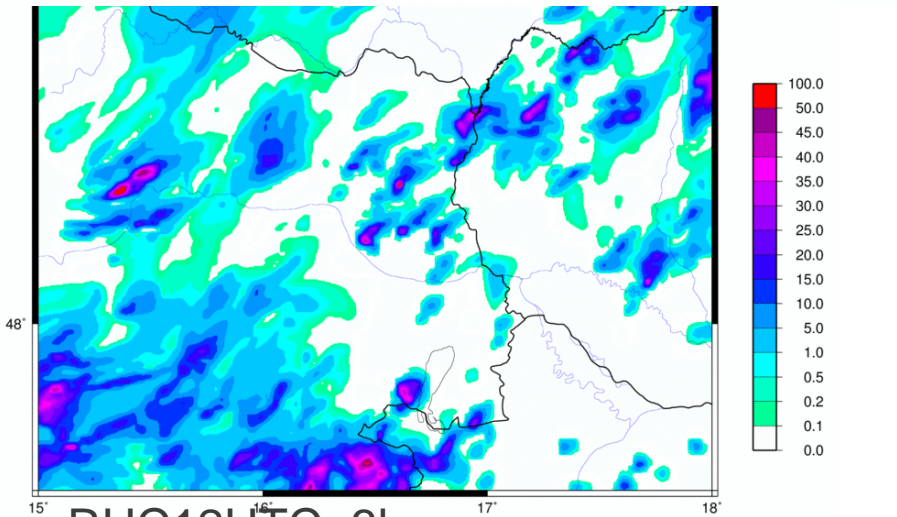
INCA Precip. Analysis [mm] 20180710 15 UTC, 03 h sum



20180710/12

INCA12-15UTC

AROME-AUSTRIA prec [mm/01h], 20180/10 12 UTC + 03 h (= 20180/10 15)

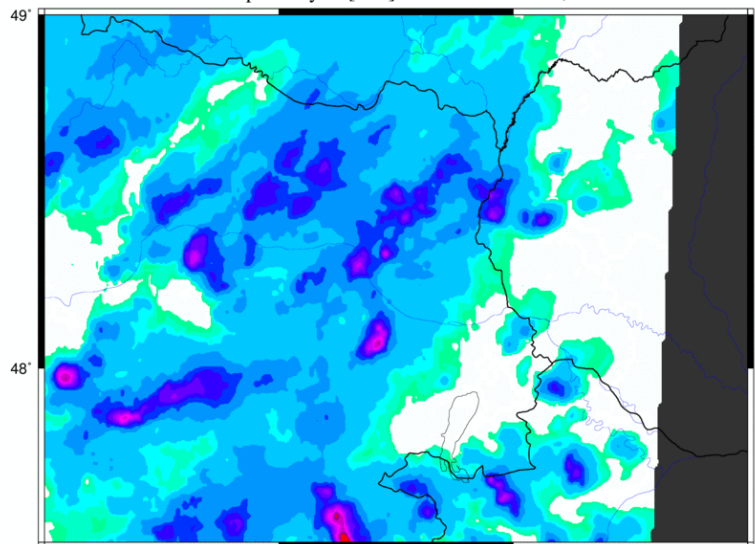


RUC12UTC+3h

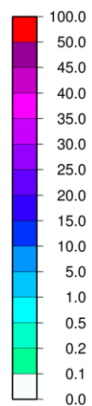
RUC12UTC+3h+NUDGING

Radar saturation 20180710 12UTC

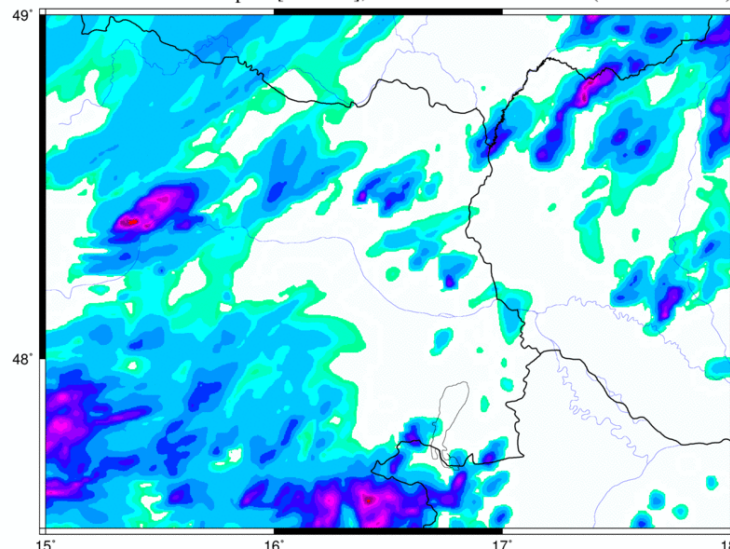
INCA Precip. Analysis [mm] 20180710 15 UTC, 03 h sum



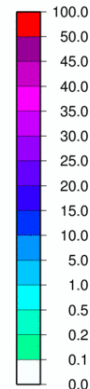
INCA12-15UTC



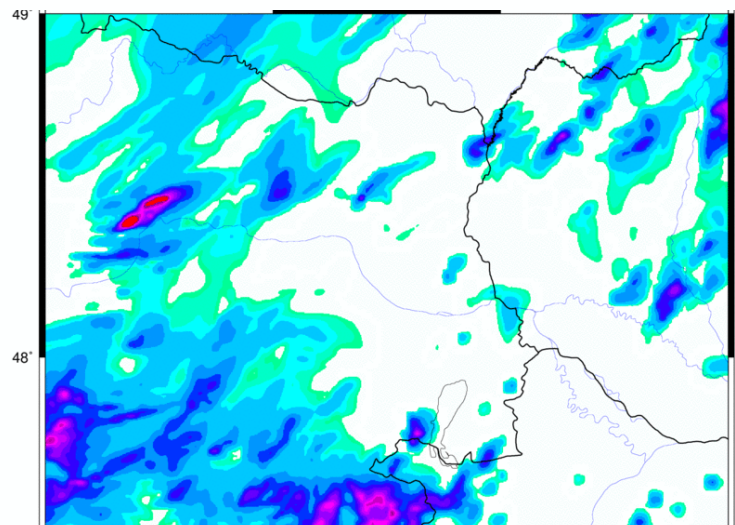
AROME-AUSTRIA prec [mm/03h], 20180710 12 UTC + 03 h (= 20180710 15)



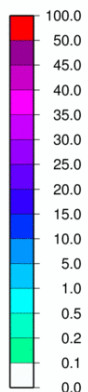
RUC12UTC+LHN+3h



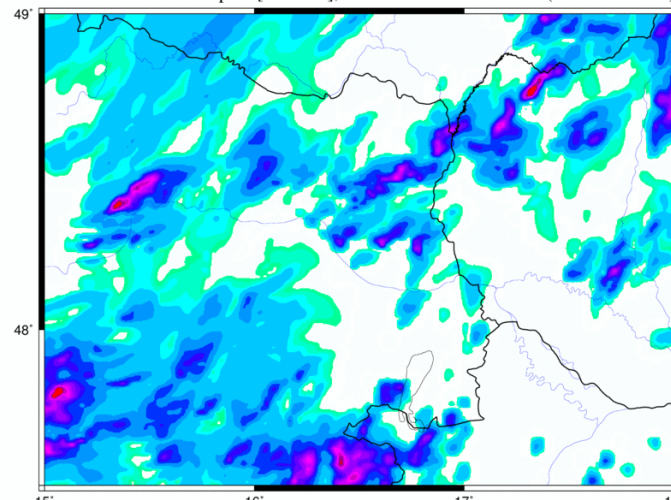
20180710/12



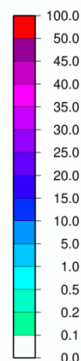
RUC12UTC+3h



AROME-AUSTRIA prec [mm/03h], 20180710 12 UTC + 03 h (= 20180710 15)



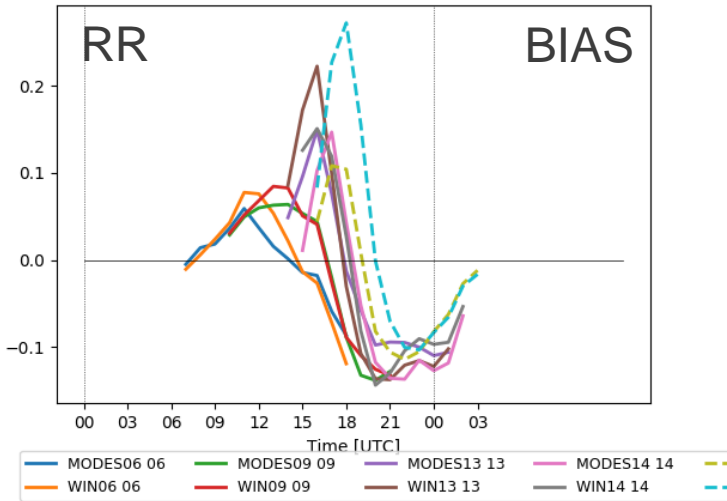
RUC12UTC+RADARSAT+NUDG+LHN+3h



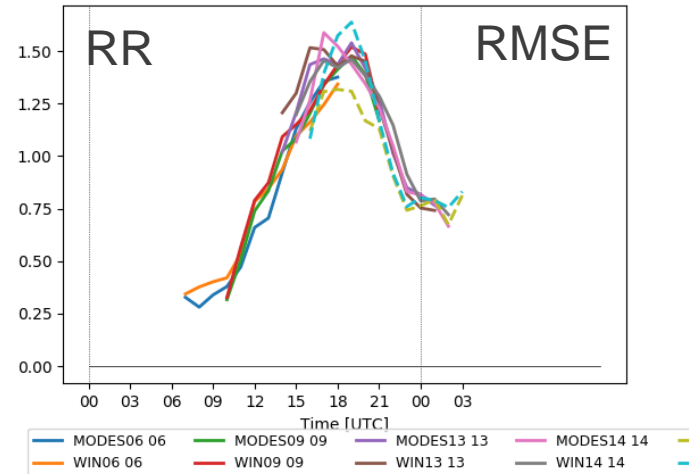
Impact MODE_S KNMI

AROME
24.09.2018

total_precipitation_area: Mean BIAS from: 20160701 to 20160716

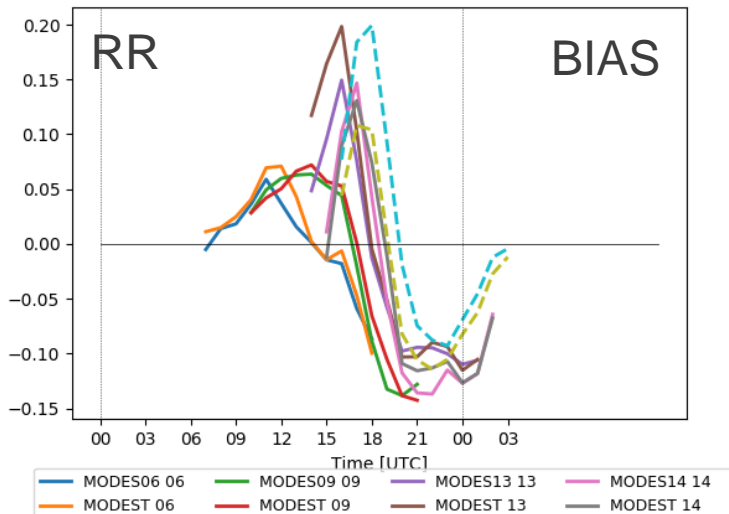


total_precipitation_area: Mean RMSE from: 20160701 to 20160716

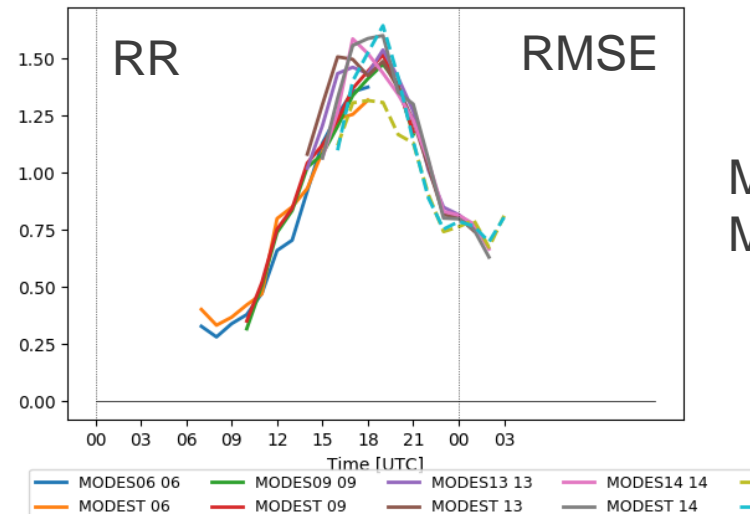


MODE-S U/V/T
reference

total_precipitation_area: Mean BIAS from: 20160701 to 20160716



total_precipitation_area: Mean RMSE from: 20160701 to 20160716

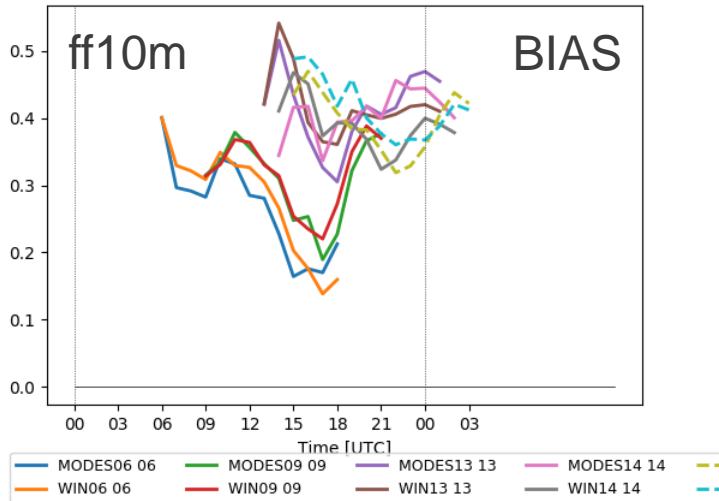


MODE-S U/V/T
MODE-S Tonly

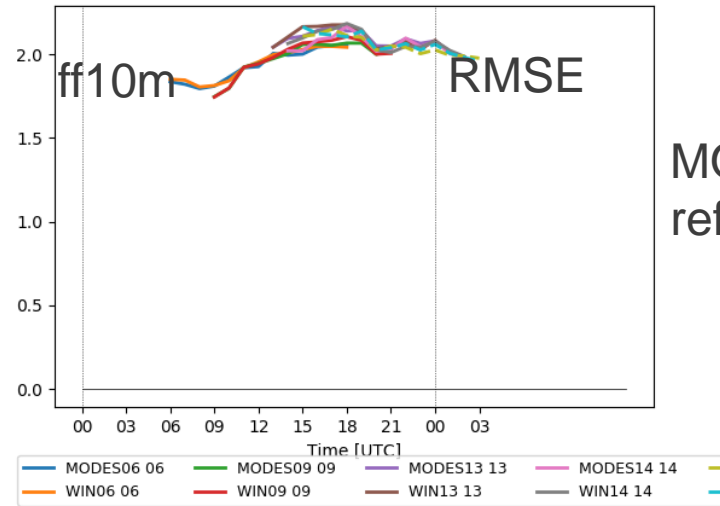
Impact MODE_S KNMI

AROME
24.09.2018

10m_wind: Mean BIAS from: 20160701 to 20160716

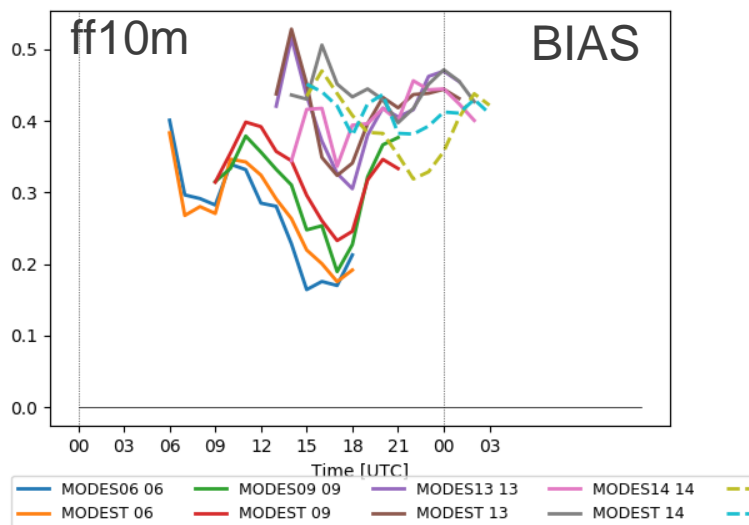


10m_wind: Mean RMSE from: 20160701 to 20160716

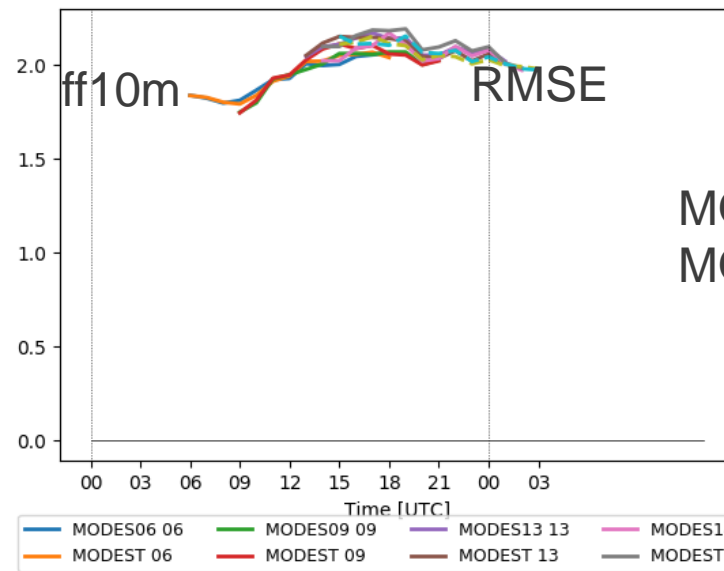


MODE-S U/V/T
reference

10m_wind: Mean BIAS from: 20160701 to 20160716



10m_wind: Mean RMSE from: 20160701 to 20160716



MODE-S U/V/T
MODE-S Tonly

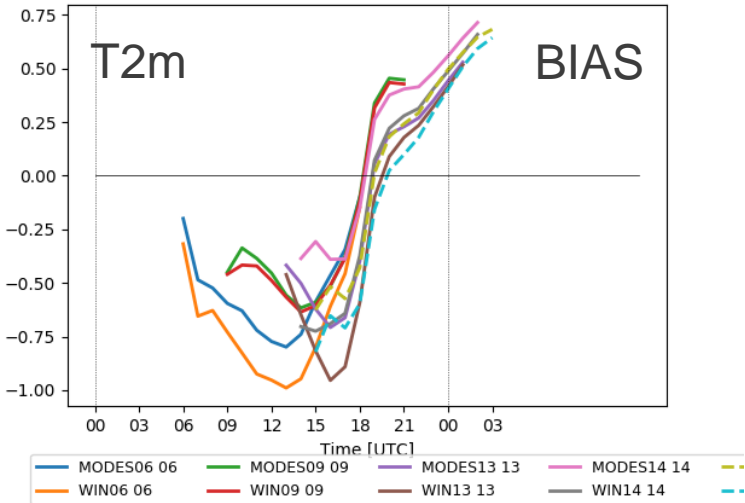
Impact MODE_S KNMI

-> impact positive mostly from winds, but also T

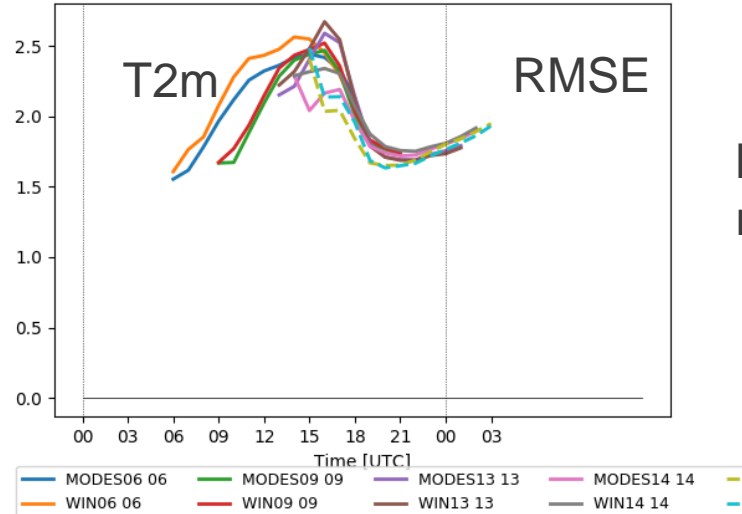


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2m_temperature: Mean BIAS from: 20160701 to 20160716

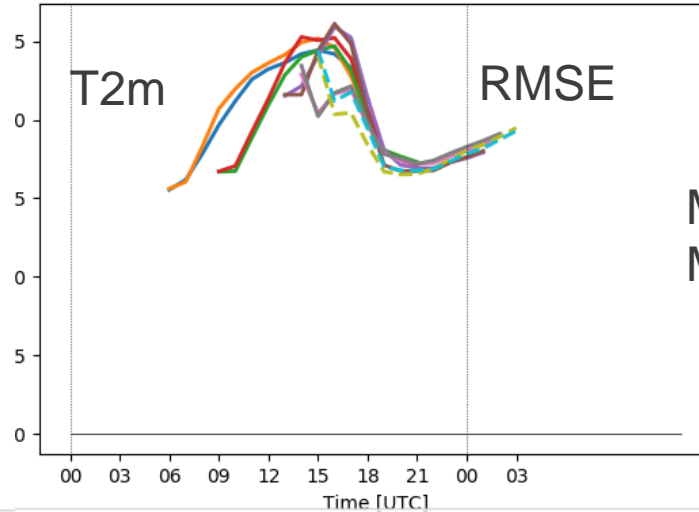
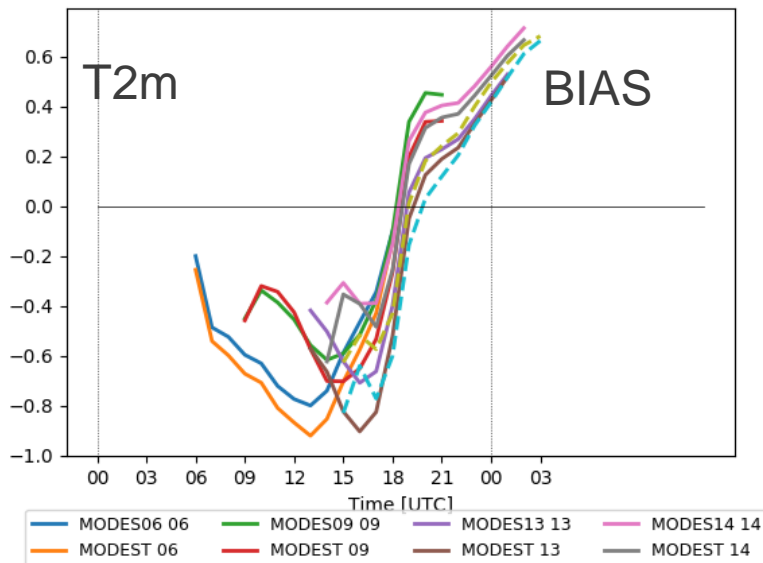


2m_temperature: Mean RMSE from: 20160701 to 20160716



MODE-S U/V/T
reference

2m_temperature: Mean BIAS from: 20160701 to 20160716

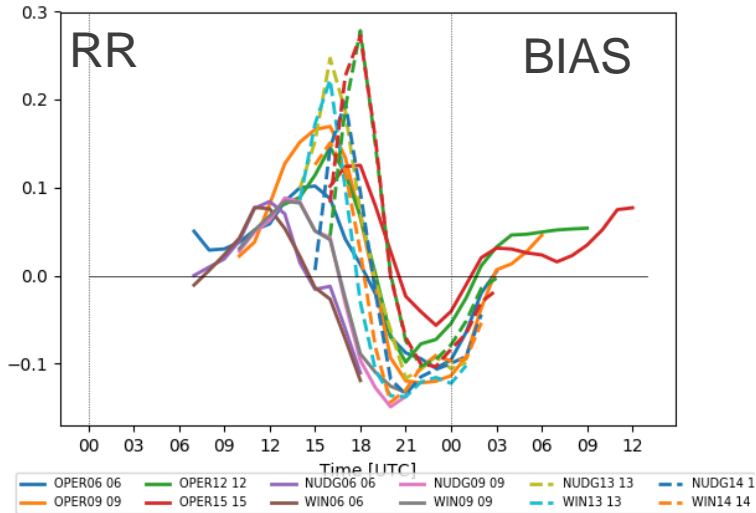


MODE-S U/V/T
MODE-S Tonly

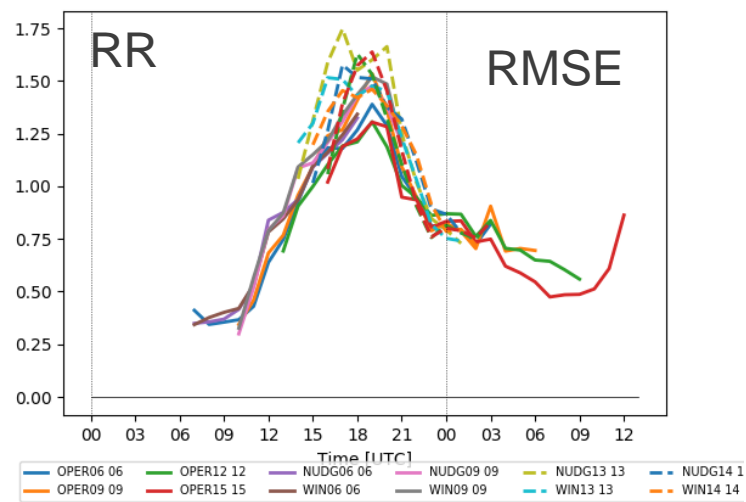
Extended assimilation window -90-+30min instead -30-+30min -> mixed results

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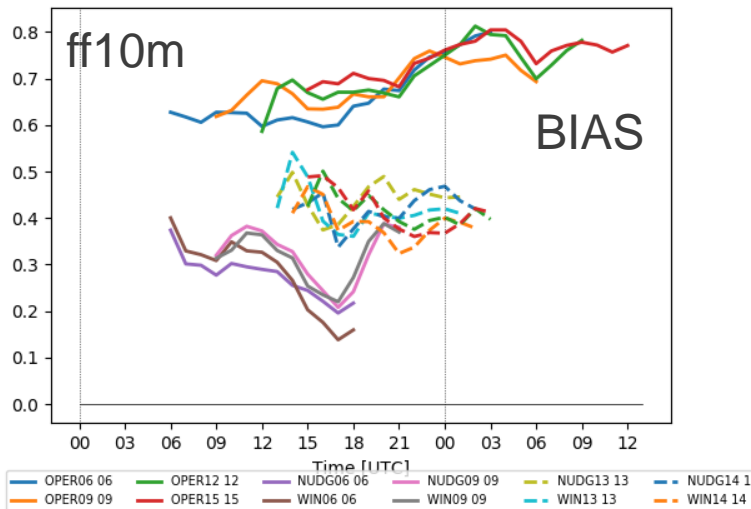
total_precipitation_area: Mean BIAS from: 20160701 to 20160716



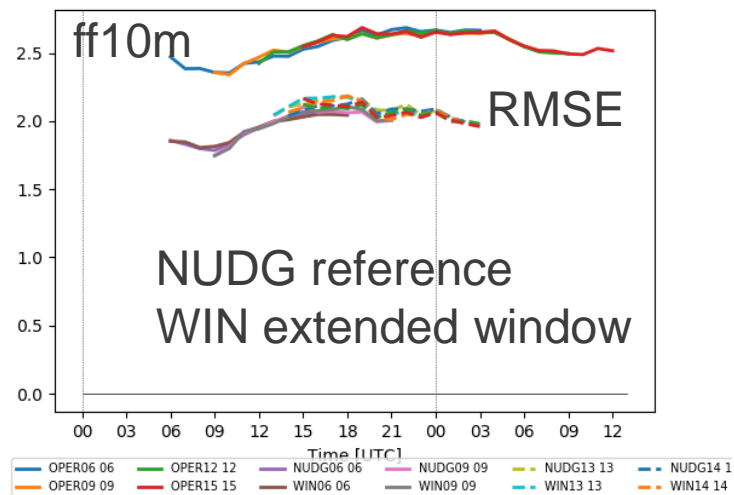
total_precipitation_area: Mean RMSE from: 20160701 to 20160716



10m_wind: Mean BIAS from: 20160701 to 20160716



10m_wind: Mean RMSE from: 20160701 to 20160716



BUG in FESTAT cy40t1 use cy43t1 instead (report on LACE forum)

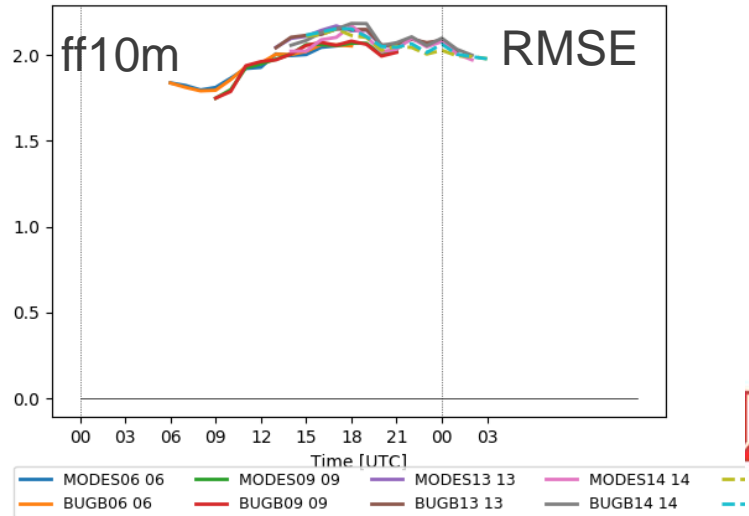
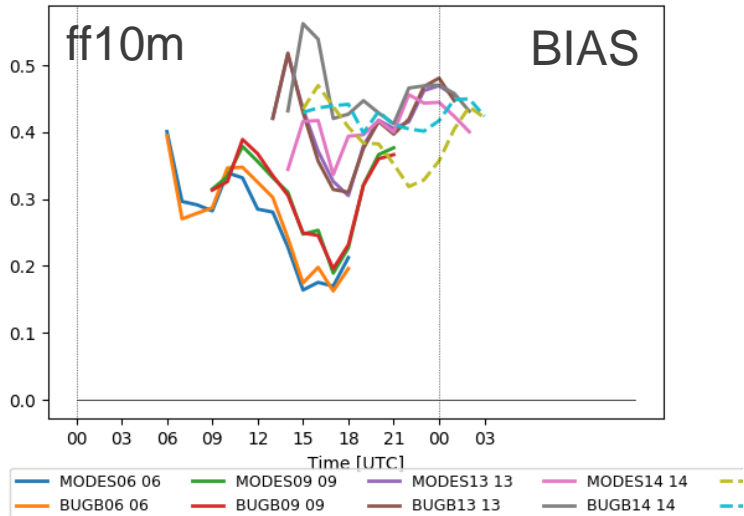
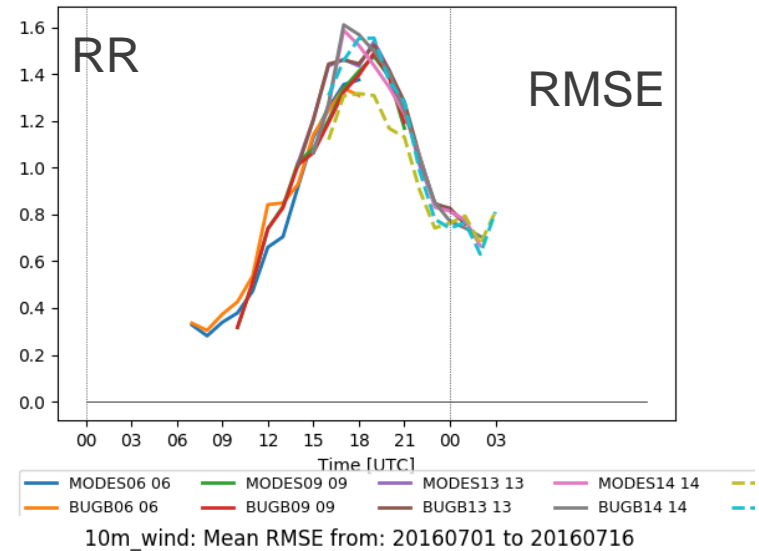
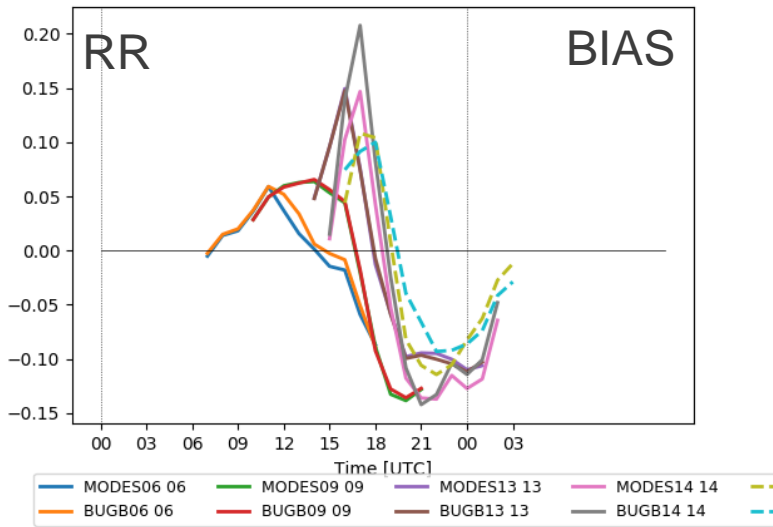


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T2m/RH2m/MSLP mostly neutral impact

total_precipitation_area: Mean BIAS from: 20160701 to 20160716

total_precipitation_area: Mean RMSE from: 20160701 to 20160716



Conclusions

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- Switch to 2h cycle and reduced REDNMC significantly improved results
- RUC improves so far mostly wind forecast
- MODE-S-KNMI has slight positive impact
- Roughness length and other old ISBA fields should be reconsidered for DA
 - >long term; avoid NFPCLI=1 for ISBA interpolation
- Switch from bugged FESTAT cy40t1 to cy43t1 slightly improved the results
- Own surface assimilation for AROME-RUC leads to slight degradation of scores, but „cheaper“ due to slow PREP offline

Finalisation of two test months planned till end of 2018

Nudging, LHN and cloud initialisation need some more investigation