Running and Tuning ALARO-1 at 1.3 km resolution
ALARO-1 Working Days, Prague

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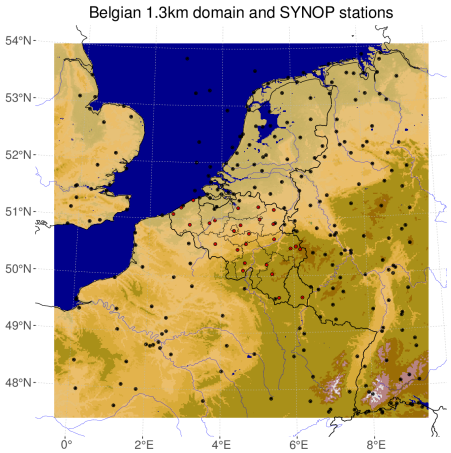
Context

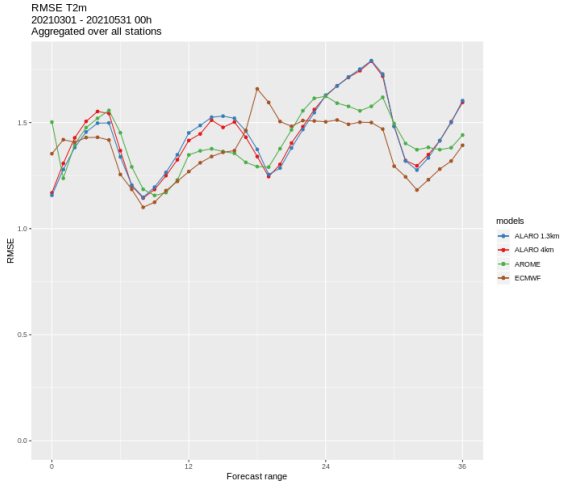
- Management strategy towards high resolution runs
- Focus on technical aspects and verification
- 1.3 km resolution ALARO(-1*) is operational since July 2017 (Pure downscaling)
- 1.3 km resolution AROME operational since September 2019 (Surface assimilation)

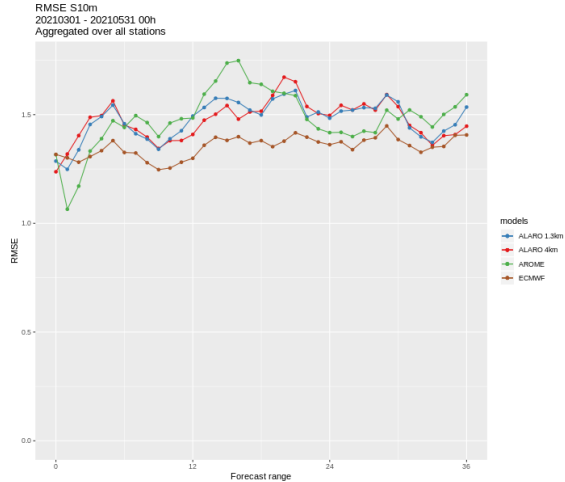
Technical specifications

- cy42t2 BF8 + local adaptations
- Runs 4 times a day (00, 06, 12, 18 UTC)
- 564 x 564 horizontal grid, 87 vertical levels
- timestep 45s
- forecast range: 36/48 hours
- hourly coupling to ARPEGE
- uses 769 cores / takes $\sim$ 1h

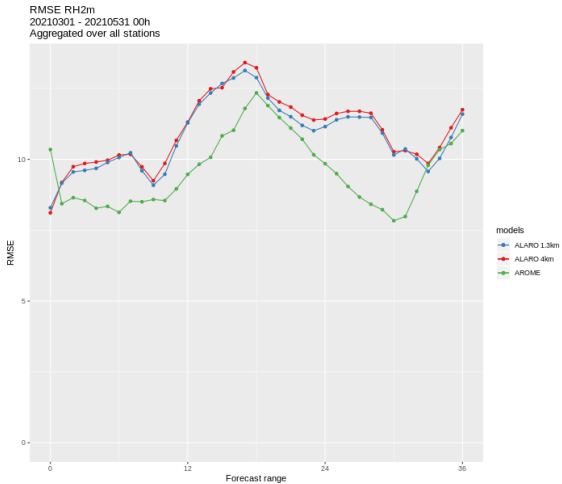


Some scores - T2m / S10m





Some scores - RH2m



Results / Consequences

- ALARO 1.3km no improvment over ALARO 4.0 km
- Better performance of AROME
- Forecasters lose confidence in ALARO
- No time for validation, quality control, tuning
- Troubled relationship with (some) forecasters

Improving ALARO 1.3 km

Sparked by Flatrate stay at CHMI (September 2020)

Draw from CHMI experience with their NH 2.3 km operational version

Steps towards improved 1.3 km ALARO version:

- Improve climfiles
- Improve tuning (Dynamics & Physics)
- Improve ALARO code (most recent modset)

Check impact on 1 winter month: Jan. 2020

STEP 1: Climate files (see also talk of Jan)

Known problem with roughness length fields for high resolution climate files.

Tool (fa_sfx2clim) created by Jan Masek which imports diagnosed SURFEX roughness fields into climate file

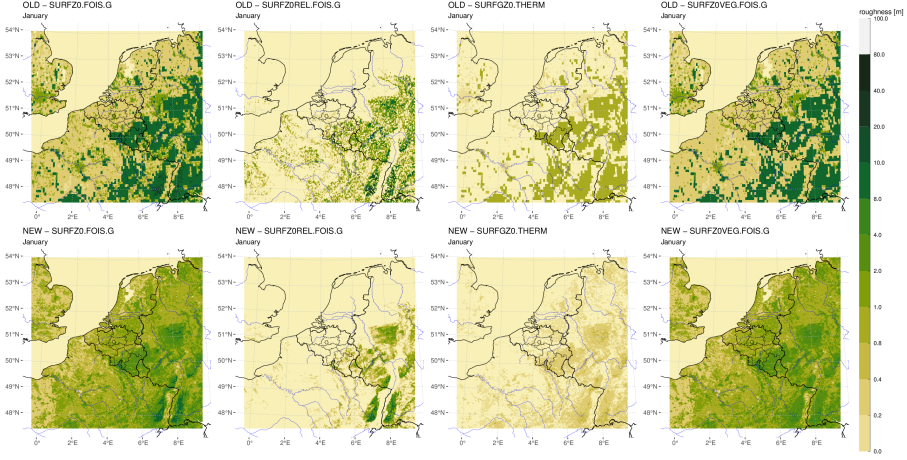
Old climate files

- Orography and land-sea mask from GMTED2010 - 7.5”
- standard orographic and vegetation roughness (from old E923 database)
- ECOCLIMAP I physiography

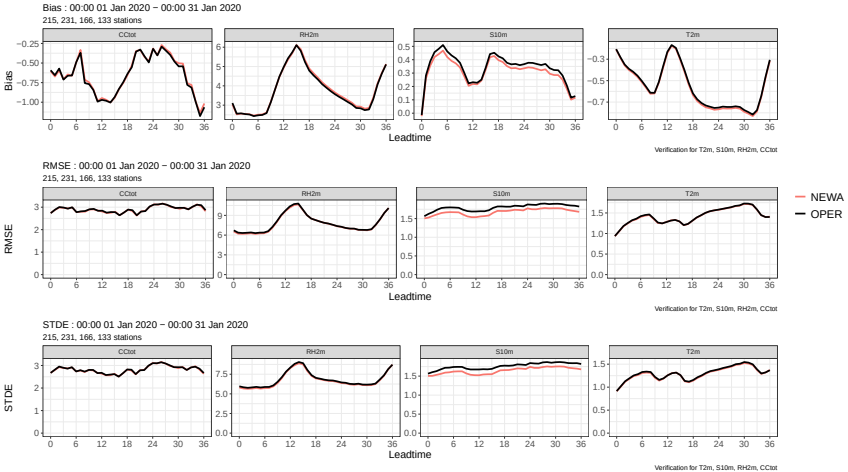
New climate files

- Orography and land-sea mask from GMTED2010 - 7.5”
- Orographic and vegetation roughness from SURFEX
- ECOCLIMAP II physiography

STEP 1: Difference in roughness lengths



STEP 1: Impact NEWA



STEP 2: Namelist tuning - Dynamics

Based on CHMI operational namelist

Old options

```
NITMP = 2
RDAMPDIV = 1.0
RDAMPQ = 0.0
RDAMPT = 1.0
RDAMPVD = 1.0
RDAMPVOR = 1.0
LAPRXPK=.T.
ND4SYS=2
```

New options

```
NITMP = 4
RDAMPDIV = 5,0
RDAMPQ = 20.
RDAMPT = 20.
RDAMPVD = 20.
RDAMPVOR = 5.0
LAPRXPK=.F.
ND4SYS=1
```

STEP 2: Namelist tuning - Physics

Based on CHMI operational namelist

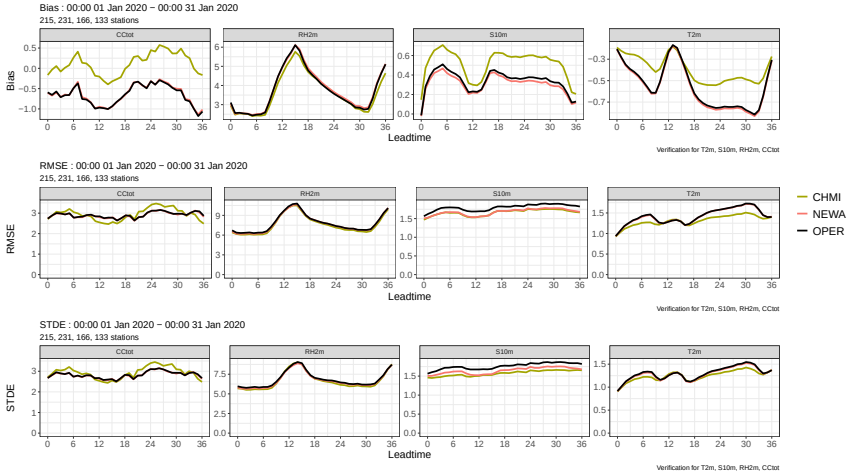
Old options

```
LGWD = .T.
LCDDEVPRO = .F.
LNSDO = .T.
LZ0HSREL=.F.
RMULACVG = -25.0
```

New options

```
LGWD = .F.
LCDDEVPRO = .T.
LNSDO = .F.
LZ0HSREL = .T.
RMULACVG = 55.0
```

STEP 2: Impact CHMI



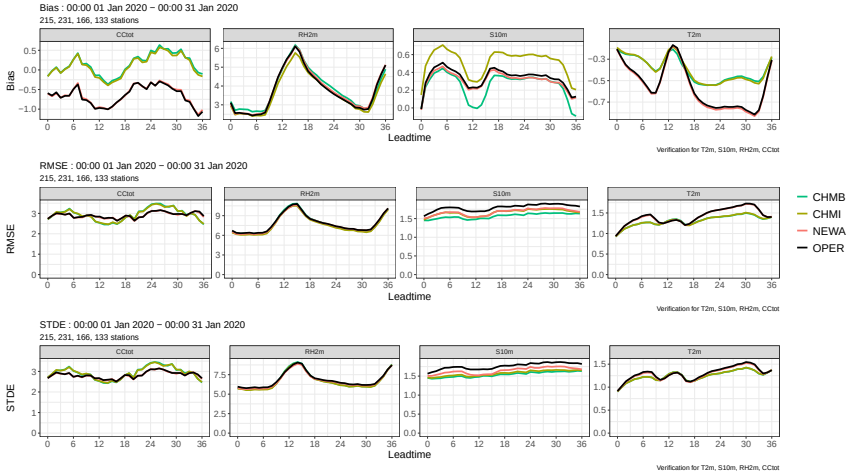
STEP 2b: Retune tree height

Solution found by Jan Masek (suggested by Meteo-France)

- rescale the SURFEX tree height by $\times 1.5$

New climate files (NEWB) + CHMI tuning = CHMB

STEP 2: Impact CHMB



STEP 3: New modset

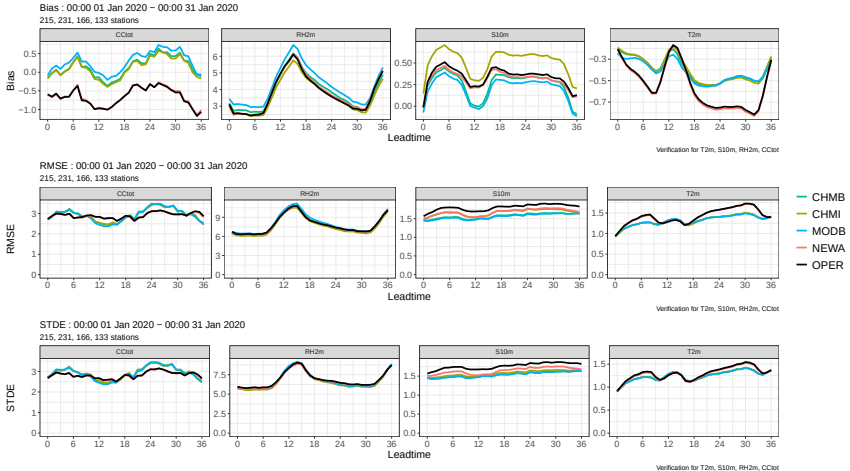
Modifications & Improvements on top of cy43t2 bf9 provided by CHMI
Most important changes:

- added option for NDIFFNEB=3 (diffusion of conservative variables)
- fix of the computation ZALPHA1 (Betts temperature is used for the computation of solid and liquid phase)
- new implementation of mixing length EL1, removed experimental options EL2-EL5 (not active)
- improved protections and removed sign bug in calculation of Rif(TKE, TTE)
- treatment of oscillations when prognostic TTE is used

Some nice extras:

- new visibility diagnostics
- precipitation type diagnostics

STEP 3: Impact MODB

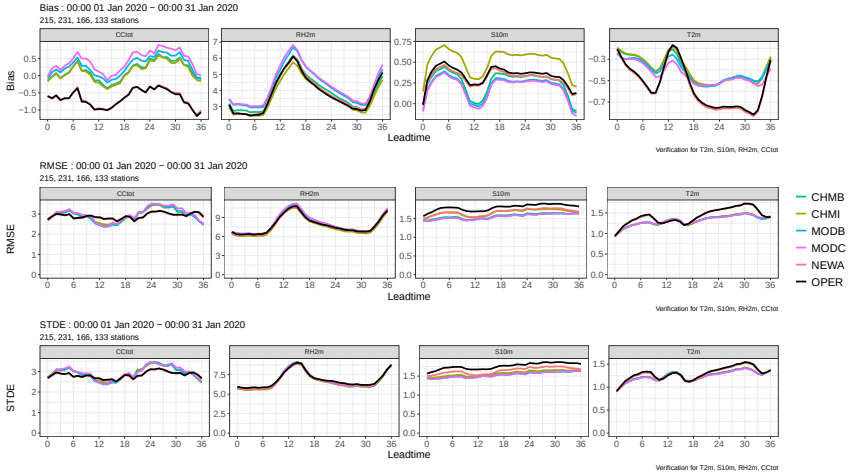


STEP 3b: Minor retuning

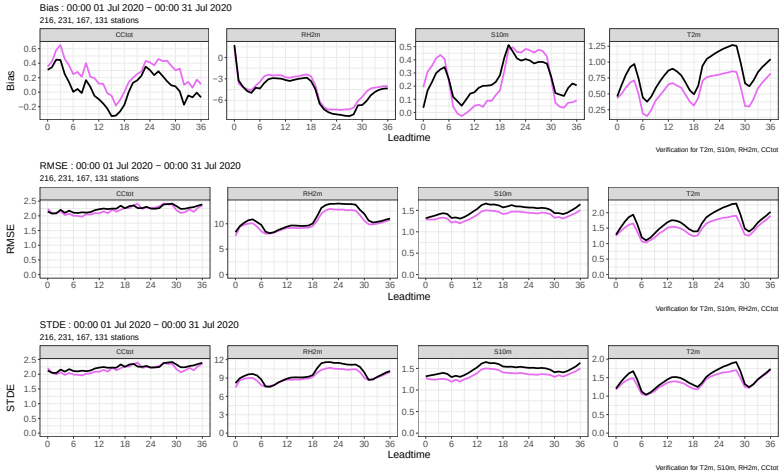
More implicit treatment of the TKE/TTE solver:

$$\texttt{ETKE\_DELTA} = 0.0 \longrightarrow \texttt{ETKE\_DELTA} = 0.3$$

STEP 3b: Impact MODC

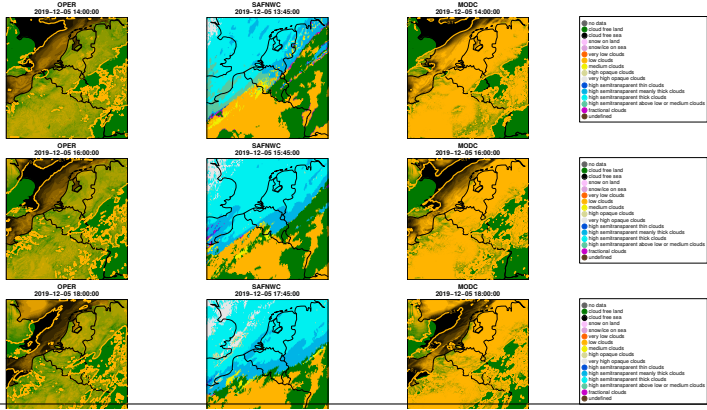


Impact MODC on summer month



Impact MODC on CClow

Rerun of 5 December 2019: Inversion with low clouds/fog that was missed by the model



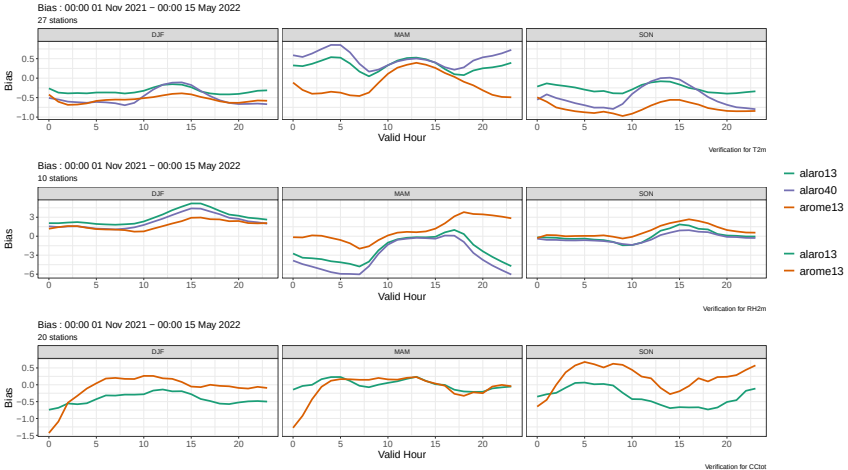
Conclusions after 2 month test

- New roughness-length positive impact on 10m wind
- Largest improvements due to retuning of dynamics & physics
- New TTE/TKE turbulence solver improves low level cloudiness

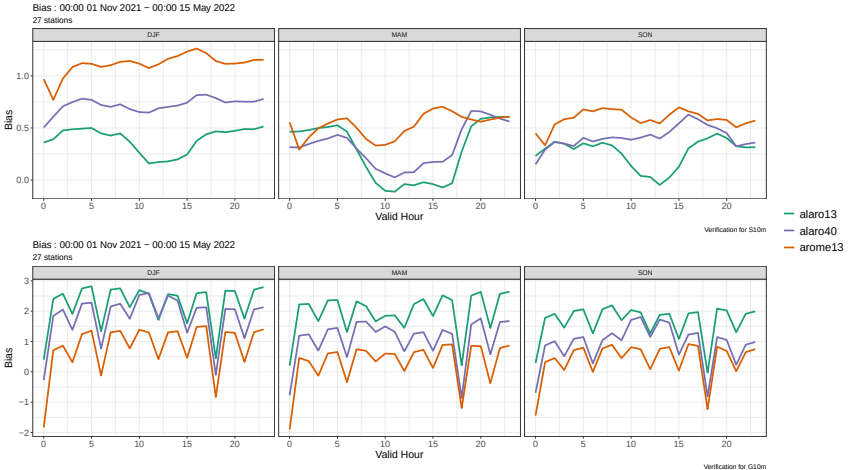
$\longrightarrow$ MODC pre-operational (1 run/day) in Summer of 2021 with feedback from head-forecaster

$\longrightarrow$ MODC became operational in November 2021, together with new ecFlow-based scripting system (NodeRunner)

After 7 months in operation: BIAS in diurnal cycle



After 7 months in operation: BIAS in diurnal cycle

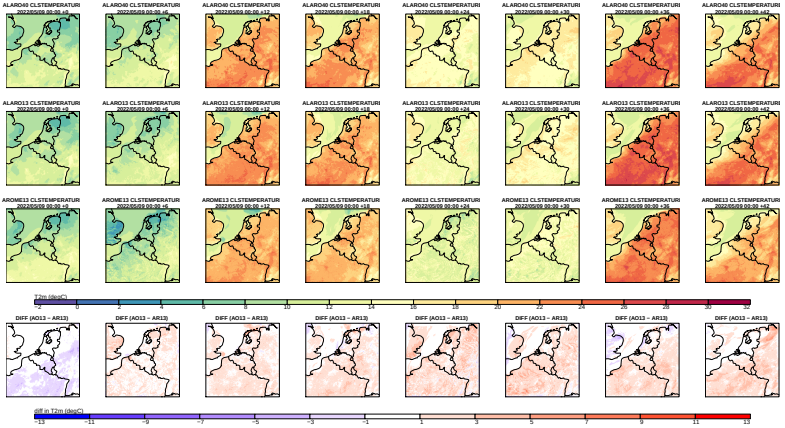


After 7 months in operation: temporal overview

Some Case-studies

Warm BIAS mid-end May 2022

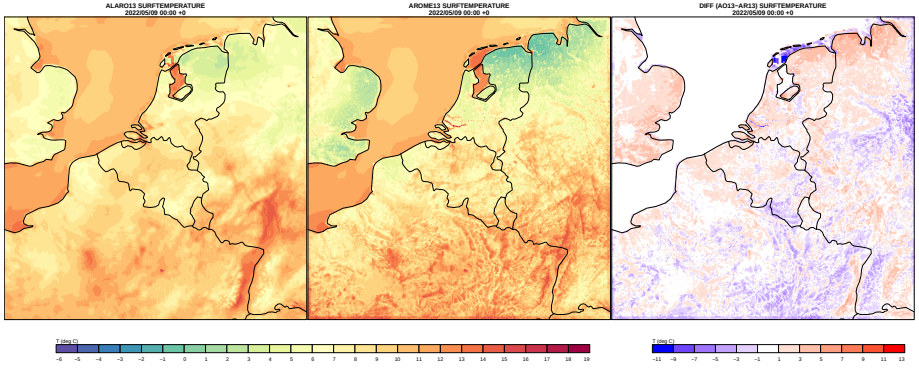
ALARO up to 3 degrees warmer than other models



What about the surface? (Thanks Radmila)

ALARO (pure dynamical downscaling) $\longleftrightarrow$ AROME (surface assimilation)

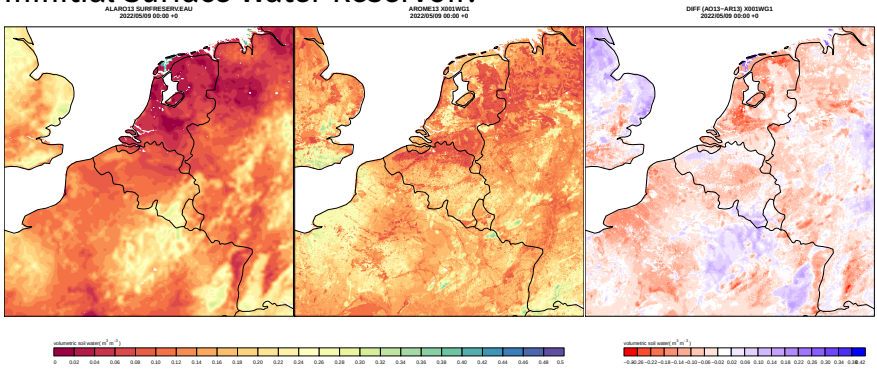
Initial Surface Temperature:



What about the surface? (Thanks Radmila)

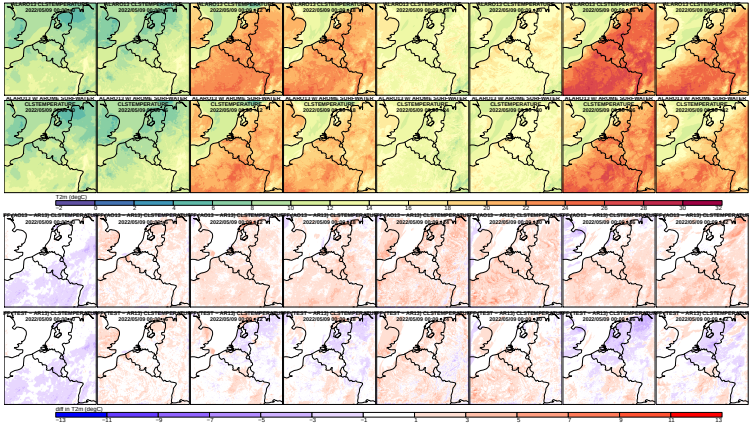
ALARO (pure dynamical downscaling) $\longleftrightarrow$ AROME (surface assimilation)

Ininitial Surface Water Reservoir:



Combine initial states

Replaced ALARO surface water by AROME surface water in initial state



Warm BIAS mid-end May 2022 - conclusions

During long dry period the surface in the initial conditions becomes too dry

Why:

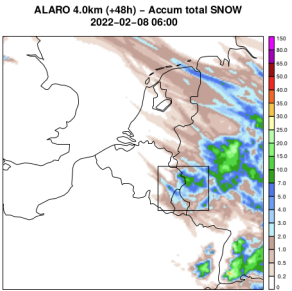
- ARPEGE: 3 layer SURFEX
- LBCs: 2 layer ISBA
- BIAS introduced in conversion or ARPEGE just too dry?

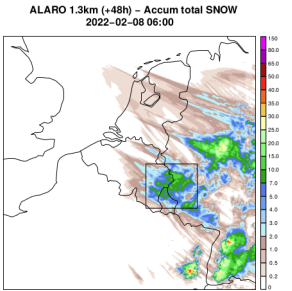
Solutions:

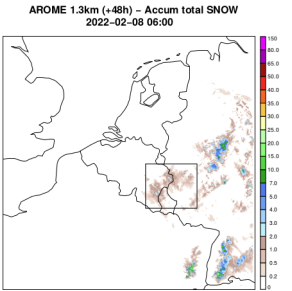
- ALARO + surface assimilation
- ALARO + SURFEX
- all of the above

Snowfall on 6-7 February 2022

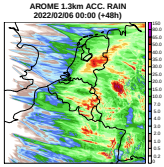
ALARO (both 4 km and 1.3 km) overestimated snowfall

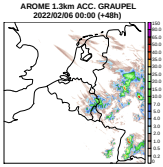


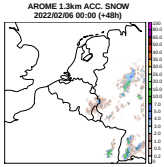


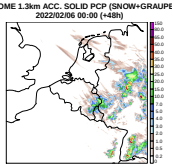


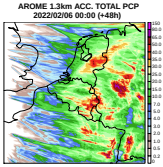
Snowfall on 6-7 February 2022

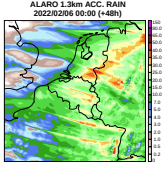


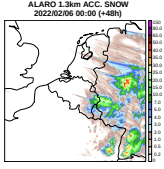


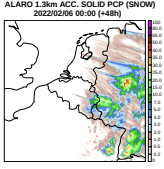


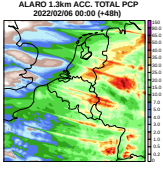


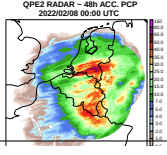












Snowfall on 6-7 February 2022

- Total precipitation amounts are very similar between ALARO and AROME (also spatial patterns)
- Most of the ALARO snow is GRAUPEL in AROME
- Looking forward to testing prognostic graupel in ALARO

Final remarks

RMI

Conclusions

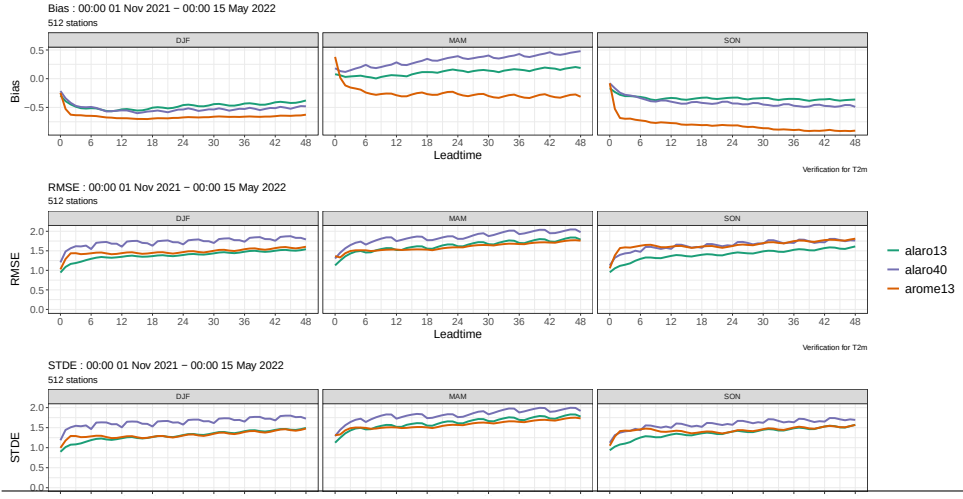
- New ALARO-1 configuration + New Climate files in operation since November 2021
- Forecasters very happy about wind and low cloud improvements
- Contact with forecasters has much improved
- Flat-rate stays can be very fruitful

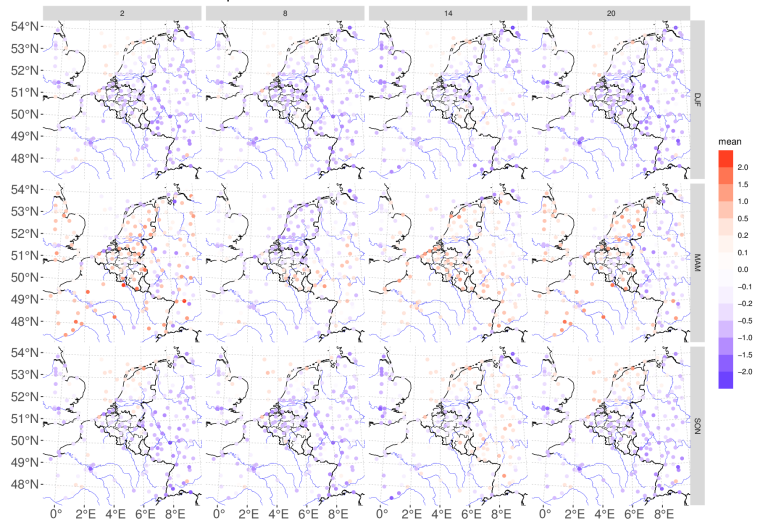
Outlook

- More in-depth validation of precipitation
- Run tests with prognostic graupel
- ALARO with SURFEX

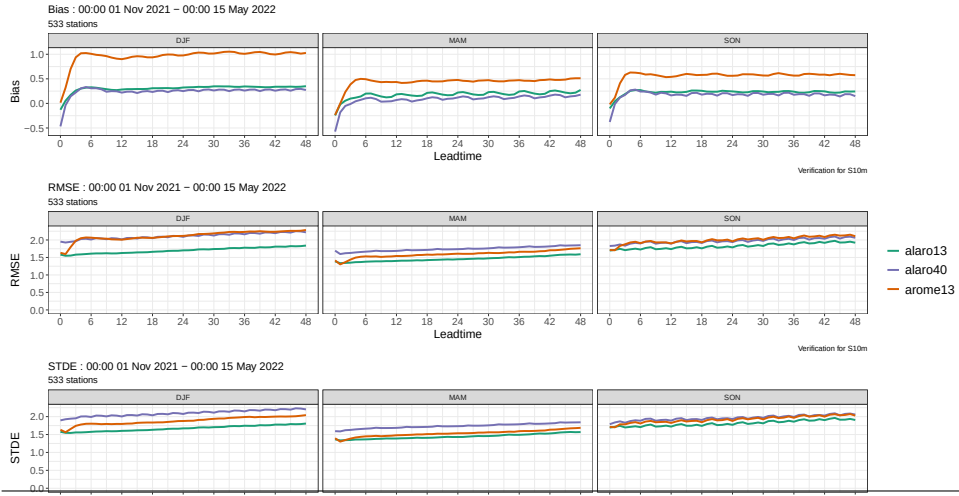
Backup Slides

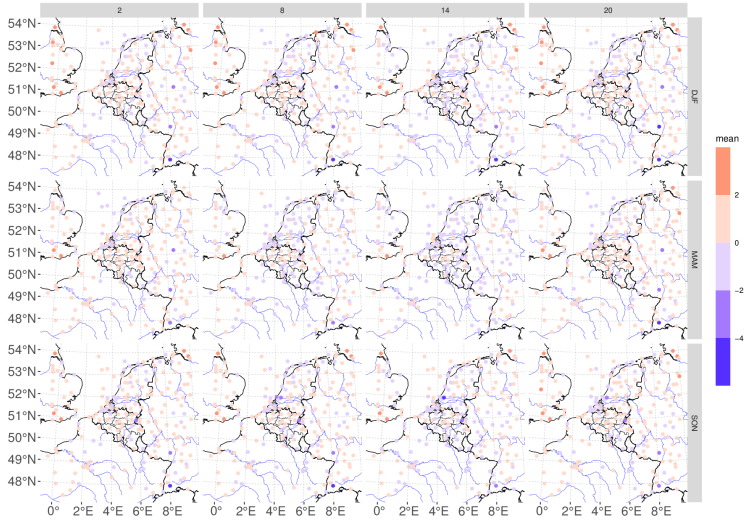
T2m


Bias : 00:00 01 Nov 2021 − 00:00 15 May 2022
512 stations
DJF
MAM
SON
Bias
Leadtime
Verification for T2m
RMSE : 00:00 01 Nov 2021 − 00:00 15 May 2022
512 stations
RMSE
Leadtime
Verification for T2m
STDE : 00:00 01 Nov 2021 − 00:00 15 May 2022
512 stations
STDE
alaro13
alaro40
arome13


Spatial overview of the alaro13 T2m bias
2
8
14
20
DJF
MAM
SON
54°N
53°N
52°N
51°N
50°N
49°N
48°N
0°
2°E
4°E
6°E
8°E
mean
2.0
1.5
1.0
0.5
0.2
0.1
0.0
−0.1
−0.2
−0.5
−1.0
−1.5
−2.0

S10m


Bias : 00:00 01 Nov 2021 − 00:00 15 May 2022
533 stations
DJF
MAM
SON
Bias
Leadtime
Verification for S10m
RMSE : 00:00 01 Nov 2021 − 00:00 15 May 2022
533 stations
RMSE
Leadtime
Verification for S10m
STDE : 00:00 01 Nov 2021 − 00:00 15 May 2022
533 stations
STDE
alaro13
alaro40
arome13


Spatial overview of the alaro13 S10m bias
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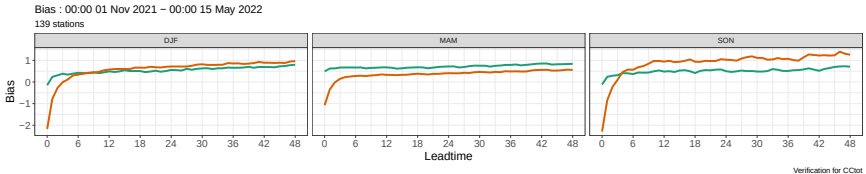
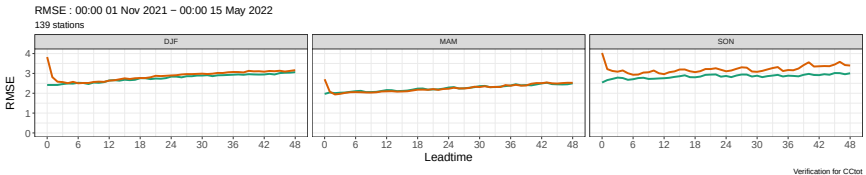
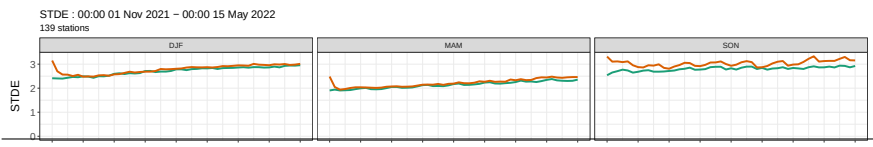
53°N
52°N
51°N
50°N
49°N
48°N
0°
2°E
4°E
6°E
8°E
mean
2
0
−2
−4

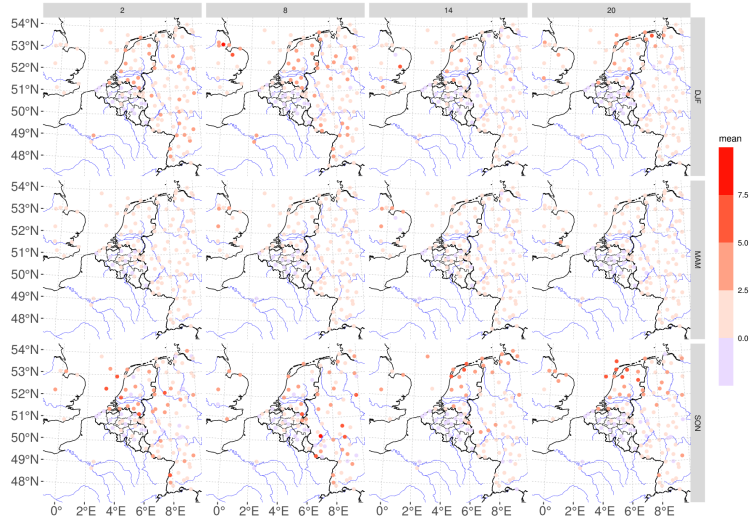
CCtot







alaro13
arome13


Spatial overview of the alaro13 CCtot bias
2
8
14
20
DJF
MAM
SON
54°N
53°N
52°N
51°N
50°N
49°N
48°N
0°
2°E
4°E
6°E
8°E
mean
7.5
5.0
2.5
0.0