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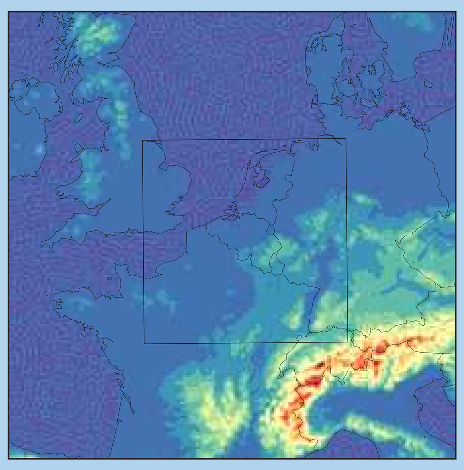
The operational ALADIN-Belgium model

1. Main features

- Model version: AL35t1 + ALARO-0 + 3MT
- 60 hour production forecasts four times a day (0, 6, 12 and 18 UTC).
- Lateral boundary conditions from Arpège global model.

2. The computer system



- SGI Altix 4700.
- 196 Itanium2 CPUs.

3. Model geometry

- 7 km horizontal resolution (240*240 points), 4 km resolution (192*192).
- 46 vertical levels.
- Linear spectral truncation.
- Lambert projection.

4. Forecast settings

- Digital filter initialization (DFI with LSPRT=.FALSE.).
- two time level semi-implicit semi-Lagrangian - SISL - advection scheme.
- Time step: 300s (7 km), 180s (4 km)
- Lateral boundary condition coupling at every 3 hours.
- Hourly post-processing (latitude-longitude and Lambert).

5. Operational suite/technical aspects

- Transfer of coupling file from Météo-France via Internet (primary channel) and the Regional Meteorological Data Communication Network (RMDCN, backup).
- Model integration on 40 processors (7 km), 20 processors (4 km).
- Post-processing on 8*1 processors.
- Continuous monitoring supported by a home-made Kornshell/Web interface.
- Monitoring with SMS (Supervisor Monitor Scheduler).

SURFEX behaviour within the BELGIAN NWP: ALADIN 7 km, ALARO 7 km, and ALARO 4 km

The purpose of this work is to compare the operational version of ALADIN/ALARO using the old ISBA surface scheme with a new version of the code (cy36t1_op2.03.tar) using SURFEX in-line.

The verification was made for a winter 2010/01 and summer 2010/07 period with a number of different configurations: (i) with the Geleyn radiation scheme (ACRANEB) and with the ECMWF radiation scheme (ACRADIN) because we must use this scheme if ones want to run ALADIN/ALARO with SURFEX, (ii) with and without SURFEX, and (iii) with the tuning used operationally in Toulouse (TLS), and the one used operationally in Brussels (BXL). The different simulations are:

- SIM1: ALADIN+ACRANEB+TUNING-BXL, this simulation must reproduce the ALADIN operational run.
- SIM2: ALADIN+RADIN+TUNING-TLS, compared to SIM1, this simulation represents the sensitivity of ALADIN to the radiation scheme.
- SIM3: ALADIN+RADIN+SURFEX+TUNING-TLS, compared to SIM2, this simulation represents the sensitivity of ALADIN to SURFEX and compared to SIM1, it represents the sensitivity to the combination of the ECMWF radiation scheme and SURFEX.
- SIM4: ALARO+ACRANEB+TUNING-BXL, this simulation must reproduce the ALARO operational run.
- SIM5: ALARO+RADIN+TUNING-BXL, compared to SIM4, this simulation represents the sensitivity of ALARO to the radiation scheme.
- SIM6: ALARO+RADIN+SURFEX+TUNING-BXL, compared to SIM5, this simulation represents the sensitivity of ALARO to SURFEX and compared to SIM4, the sensitivity to the combination of the ECMWF radiation scheme and SURFEX.
- SIM7: ALARO+RADIN+SURFEX+TUNING-TLS, compared to SIM6, this simulation represents the sensitivity to some tuning parameters used in Toulouse.
- SIM8: ALARO4+RADIN+SURFEX+TEB+TUNING-BXL, compared to SIM6, this simulation represents the sensitivity to the Town Energy Budget (TEB) at 4km resolution.

Three stations are selected: (Uccle, WMO number 6447) representing a flat suburban area, Saint-Hubert (WMO number 6476) a rural area with higher topography, and Koksijde (WMO number 6400) at the coast.

ALR7		Winter		Summer	
		Day	Night	Day	Night
T2m	Flat	0	0	+++	+++
	High	---	+	+++	+++
	Coast	0	0	0	+++
W10m	Flat	0	0	0	0
	High	+++	+++	+++	+++
	Coast	---	---	0	0
RH2m	Flat	++	++	--	++

Rgrib2: an R package for GRIB decoding and encoding

The Rgrib2 package, developed at RMI, is an add-on library for the open source statistical software R. It is linked to ECMWF's GRIB_API library. With this package, it is possible to read and write GRIB files interactively, analyse the contents and visualise gridded data in various ways.

The package is used for verification and scientific analysis. It is also at the core of the post-processing module of the forthcoming GLAMEPS suite. In that last context, it

- reads member data,
- produces probability maps,
- produces probability forecasts in GRIB-2 format.

Other capabilities are interpolation to (some) different projections & grids, extraction of point data and vertical profiles.

Unsaturated downdraft: a different approach of moist downdraft parameterization

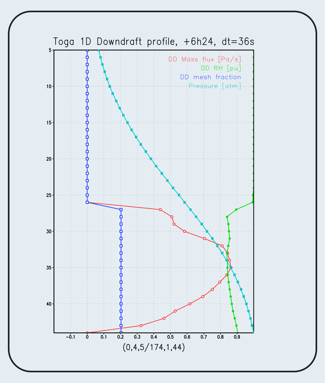
The new non-saturated downdraft parameterization is derived from ideas of Betts and Silva Dias (JAS 36, 1979) and from Sud and Walker (MWR 121, 1993).

The downdrafts start around the level of minimum θ_e close to 650 hPa. They are powered by the evaporation of precipitation, which requires an exchange between the air in the downdraft and the precipitation flux. When the downdraft velocity increases, the exchange is reduced and the downdraft air cannot reach saturation, entraining a reduction of the negative buoyancy of the downdraft.

We assume that the downdraft follows a curve of constant θ_e, remaining unsaturated. The water vapour contents follows

$$\frac{dq}{dp} = \frac{q_w - q}{\Pi_E} + \text{mixing}$$
$$\Pi_E = \rho g \frac{w_D}{4\pi DF}$$

and a similar relation for θ_e. q_w is the saturated descent reference, Π_E is a pressure scale for evaporation, ρ the density, w_D the downdraft velocity, D is a diffusion coefficient, F depends on the precipitation intensity and assumptions on the distribution of droplets.



Profile extracted from a single column model test. The downdraft mass flux starts around 650hPa, the relative humidity first decreases significantly, and increases again towards the surface, with the slowing down of the downdraft.

The downdraft properties (θ, q) are computed level by level together with the prognostic downdraft velocity.

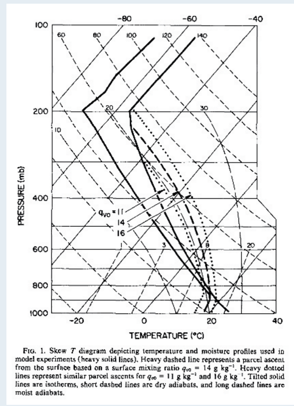
We use a diagnostic scheme closure, stating that the downdraft area represents around one third of the total precipitation area.

New concepts for the deep convection parameterization scheme

The Alaro-1 deep convective updraft scheme presently under test integrates a set of high resolution-specific features:

- Evolution over several time steps of the updraft velocity and mesh fraction, but also gradual elevation of the cloud top.
- Perturbation approach (CSU: Complementary Subgrid Updraft) where the subgrid scheme does not represent a real updraft but a complementary contribution to the resolved scheme.
- Updraft profile built from an Updraft Source Layer as in the Kain-Fritsch scheme, allowing a better control of triggering.
- CAPE closure, for the steady state, complemented with a prognostic evolution towards it.

The scheme is presently being tested using an academic setup (Weisman & Klemp, MWR 110, 1982).



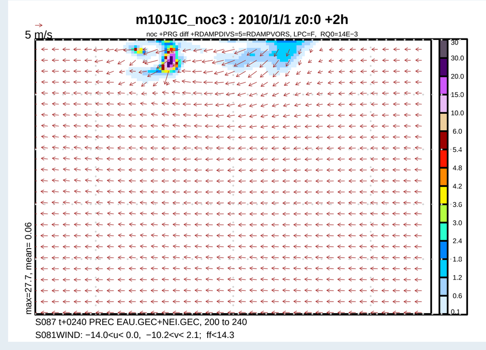
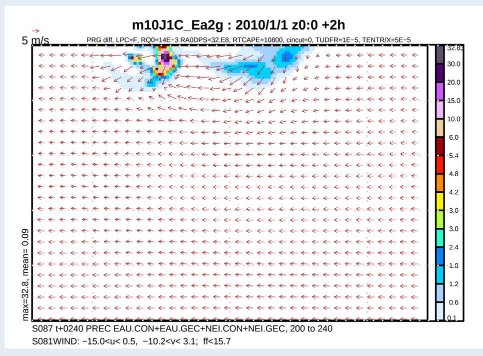
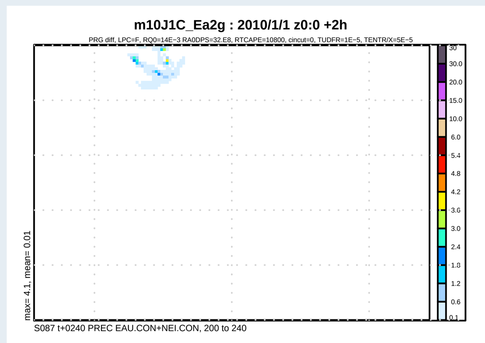
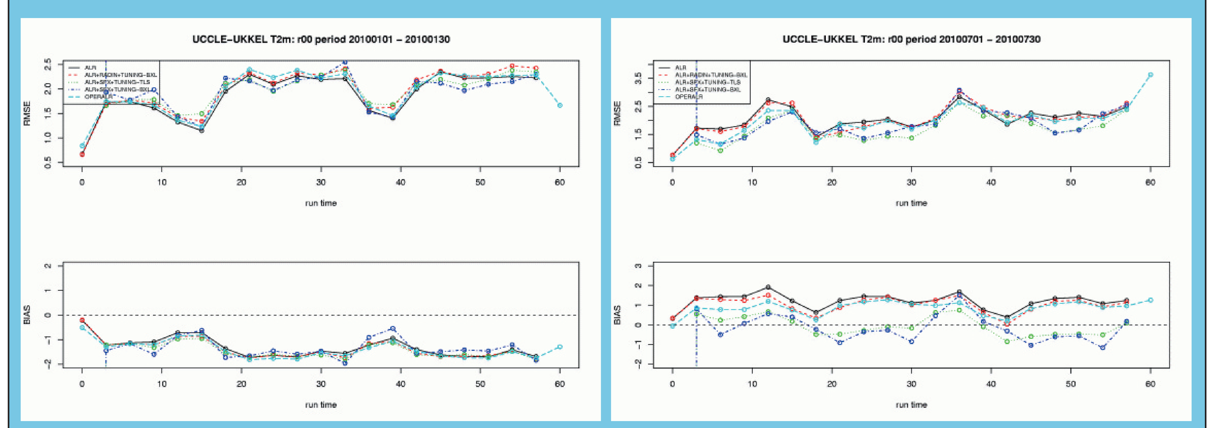


Fig 2: Weisman and Klemp academic experiment. A single profile (a) and a sheared zonal wind profile are used over the entire flat domain. The initial perturbation is a bubble of horizontal radius 10km, vertical radius 1400m, at 1400m above the surface, with a maximum theta anomaly of 2K at its center. (b-d) 20-minutes accumulated surface precipitation in the academic run at resolution 1km, 87 vertical levels, 2 hours integration. without convection parameterization (b), with parameterization (total (c) vs convective (d) parts).

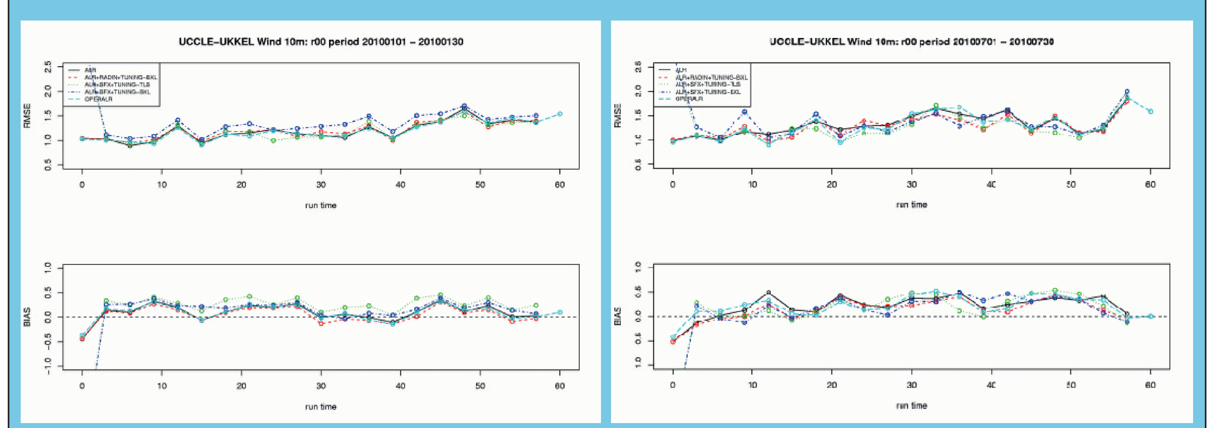




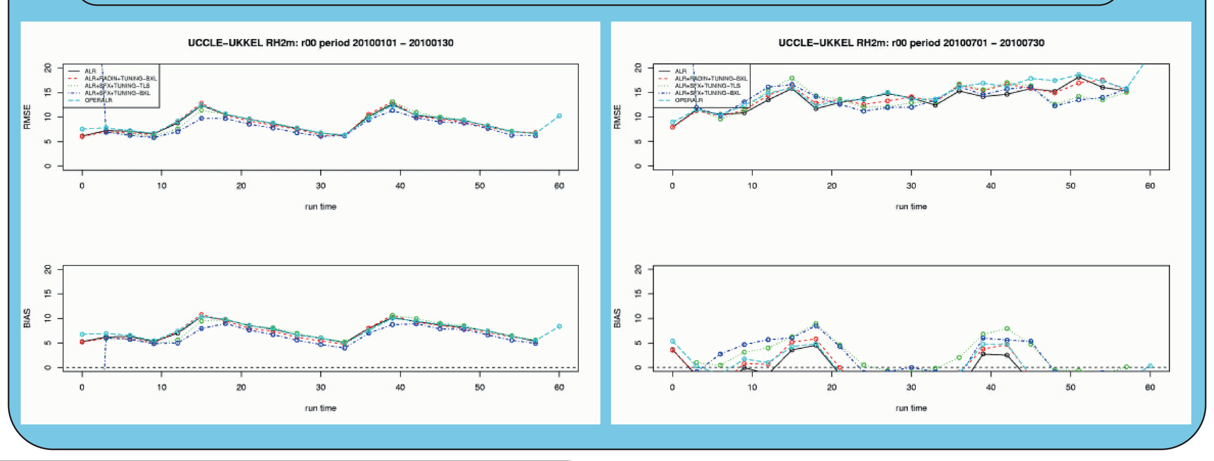
2m Temperature (flat suburban area)



10m Wind speed (flat suburban area)



2m Relative humidity (flat suburban area)



Application of Boyd's periodization method in NWP

- ALADIN is a spectral LAM, which requires model fields to be periodized
- Until now, the periodization has been done with splines
- J.P. Boyd (2005) has proposed an alternative method based on windowing
- Application of Boyd's method in the ALADIN model shows its superiority in comparison to the spline-based method, especially when a strong signal enters the domain.

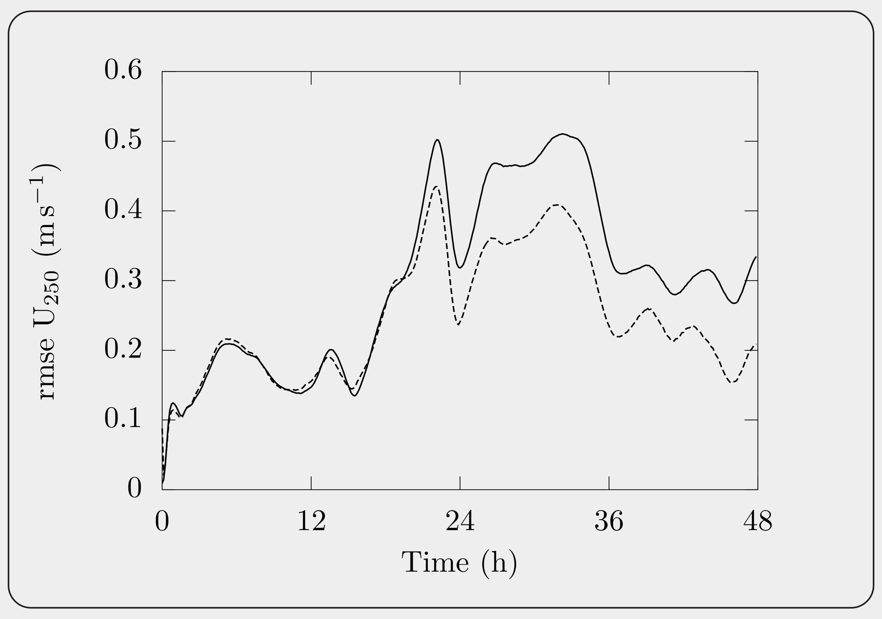
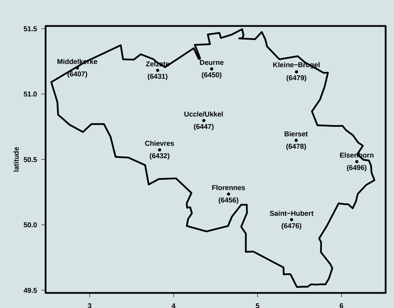


Figure: Error on 250hPa wind with spline-based method (solid line) and Boyd's method (dashed line). A depression enters the domain after 20h.

Verification of GLAMEPS over Belgium

Introduction



We compare GLAMEPS with ECEPS (EPS of ECMWF) and ALARO7 (deterministic LAM) for Belgium.

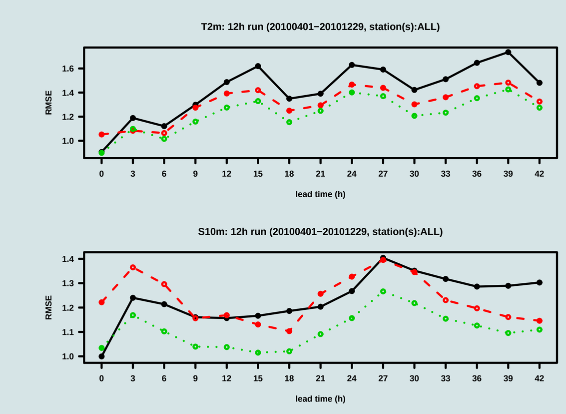
- Scores are averaged over 10 standard stations in Belgium.
- Verification period: 01/03/2010 - 29/12/2010 (forecast dates).
- Only T2m (2m temperature) and S10m (10m wind speed) for now.

The bias corrected data was constructed from the raw data by subtracting for each forecast the bias over the previous 28 days, i.e a simple sliding bias correction. This removes the bias almost completely. The verification period of the bias corrected data is 01/04/2010 - 29/12/2010 (with observation data from 01/04/2010 to 31/12/2010).

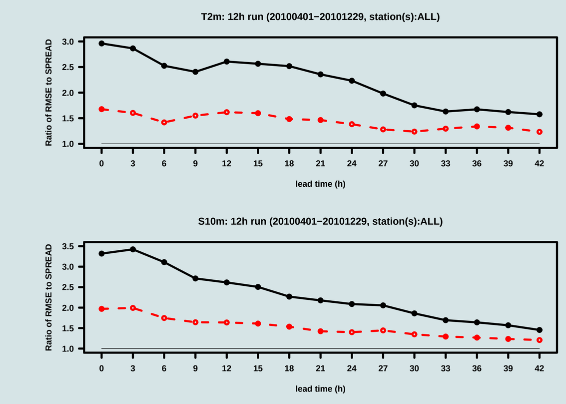
Conclusions

- GLAMEPS scores are considerably better than those of ECEPS at most lead times, both for T2m and S10m.
- The ensemble mean of GLAMEPS has a lower RMSE than the ensemble mean of ECEPS and the ALARO7 deterministic model.
- GLAMEPS has a much better RMSE to SPREAD ratio.
- GLAMEPS has a lower CRPS than ECEPS. The reliability component of CRPS is much better for GLAMEPS. The plots of potential CRPS show that the better CRPS of GLAMEPS is mostly (but not completely) due to a better reliability.

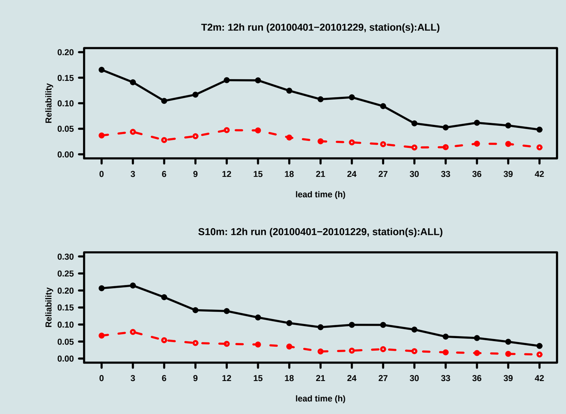
We show some scores for the bias corrected forecasts of the 12h run. Results of the 0h run are very similar.



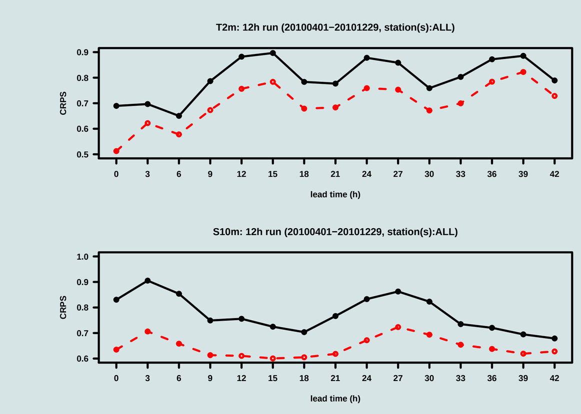
RMSE of ALARO7 (black full line), ensemble mean ECEPS (red big dashed line) and ensemble mean GLAMEPS (green small dashed line) for bias corrected T2m (top) and S10m (bottom) (run=12h)



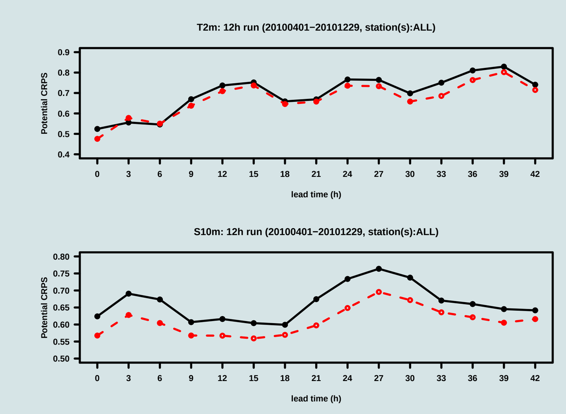
Ratio of RMSE to SPREAD of ECEPS (black full line) and GLAMEPS (red dashed line) for bias corrected T2m (top) and S10m (bottom) (run=12h).



Reliability component of CRPS of ECEPS (black full line) and GLAMEPS (red dashed line) for bias corrected T2m (top) and S10m (bottom) (run=12h).



CRPS of ECEPS (black full line) and GLAMEPS (red dashed line) for bias corrected T2m (top) and S10m (bottom) (run=12h).



Potential CRPS of ECEPS (black full line) and GLAMEPS (red dashed line) for bias corrected T2m (top) and S10m (bottom) (run=12h).