Recent national activities, ALADIN-Belgium

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The operational ALADIN-Belgium model

1. Main features

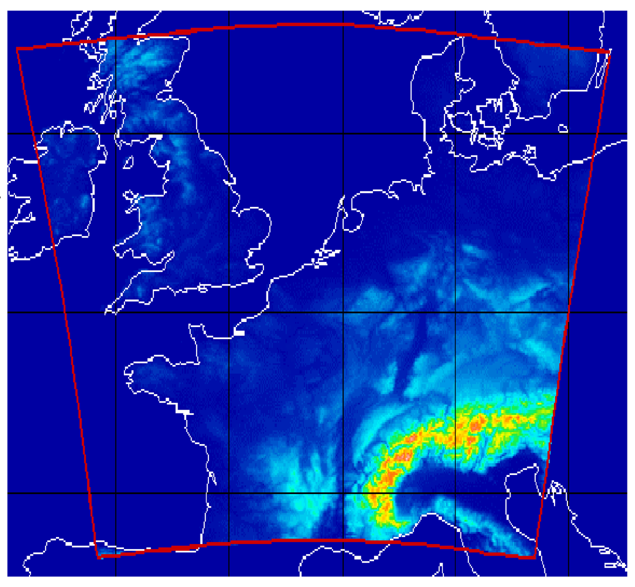
- Model version: AL29t2.
- 60 hour production forecasts four times a day (0, 6, 12 and 18 UTC).
- Lateral boundary conditions from ALADIN-France and Arpege global model.

2. The computer system

- SGI Altix 3700BX2.
- 56 Itanium2 1,5 Ghz 6Mbyte CPU's.
- Peak performance: 4.1 Gflop/processor.
- 104 Gbyte internal memory.

3. Model geometry

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



ALADIN-Belgium domain

4. Forecast settings

- Digital filter initialization (DFI).
- 300 s time step (two time level semi-implicit semi-Lagrangian - SISL - advection scheme.
- 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 16 processors.
- Post-processing on 8*1 processors.
- Continuous monitoring supported by a home-made Kornshell/Web interface.
- Monitoring with SMS (Supervisor Monitor Scheduler) will be made by October 2007.

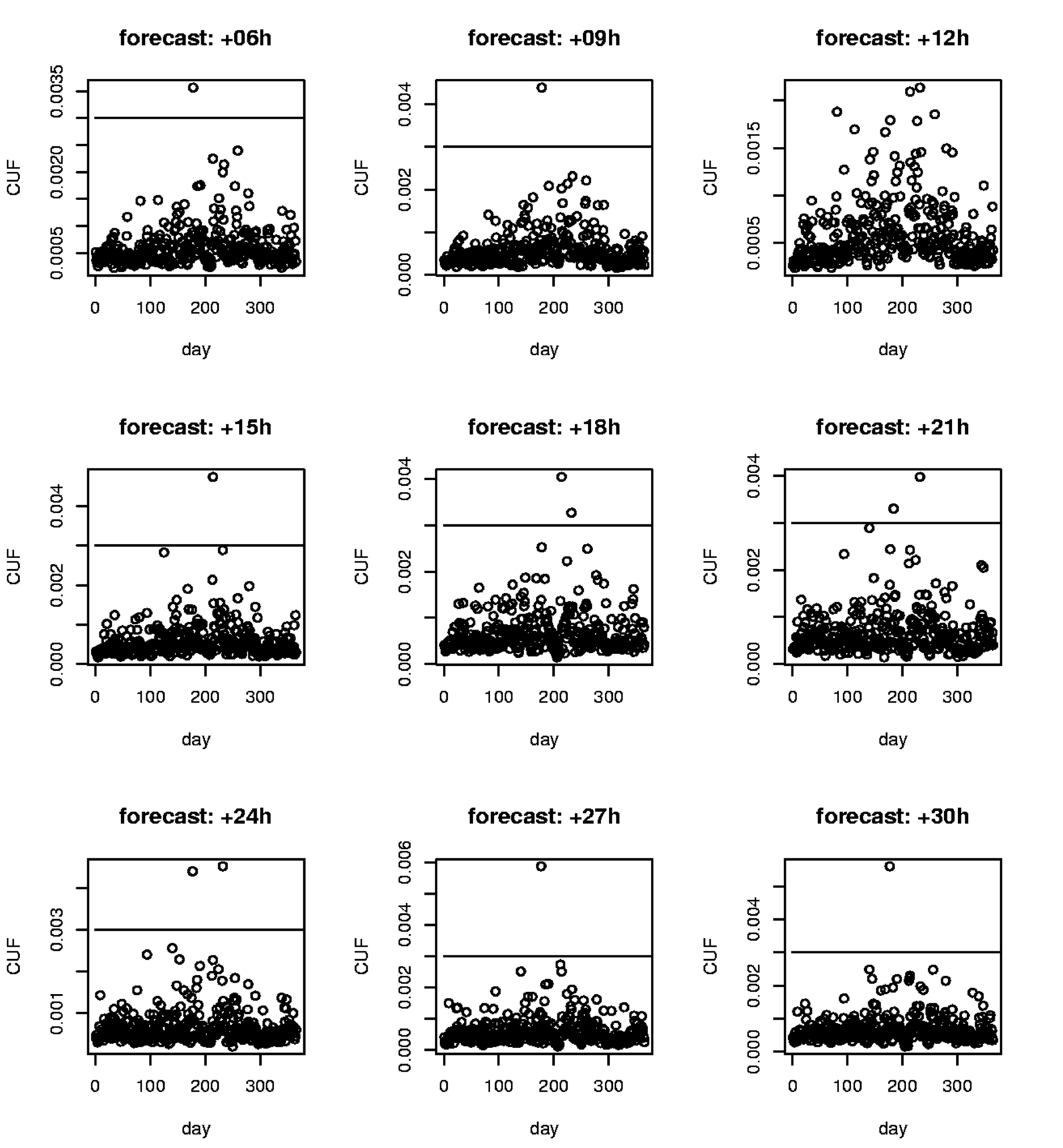
Olivier Latinne

Monitoring the Coupling-Update Frequency (CUF)

When a fast moving storm system crosses the border of a limited area model, the coupling frequency may be too low to capture this event adequately. Therefore, an index was developed (Termonia 2004) to monitor the data loss due to the coupling.

The coupling files for ALADIN/Belgium contain the field CUF1PRESSURE since 21/02/2006. A high value for this index indicates that there is a potentially significant difference between the linear interpolation of 2 successive coupling files, and the actual value in the original (e.g. global) model.

The figure summarizes the value of the index for the period 21/02/2006-31/08/2007 (only the forecasts at 00h). In this time, the warning threshold value of 0.003 was reached on 5 occasions:
- 24/11/2006 : a storm entering the domain
- 25/11/2006 : the same
- 01/12/2006 : a system that only touched the coupling zone
- 31/12/2006 : a system that only touched the coupling zone
- 18/01/2007 : a storm system that developed inside the domain, but gives a signal when passing through the coupling zone.



In 4 of these cases, re-initializing the forecast doesn't make a difference. For the storm passing through on 25/11/2006, restarting the forecast with the storm inside the domain increases the wind speeds in the first hours (though only when turning the DFI off).

Piet Termonia & Alex Deckmyn

Ref:

Hamdi, R. and Masson, V.: Inclusion of a drag approach in the Town Energy Balance (TEB) scheme: 1-D offline validation in a street canyon. Accepted in *Journal of Appl. Meteorol.*

Termonia, P., 2004: Monitoring the coupling-update frequency of a limited-area model by means of a recursive digital filter. *Mon. Wea. Rev.* 132, 2130-2141.

Termonia, P. and Voitus, F.: Externalizing the lateral-boundary conditions from the dynamical core in semi-implicit semi-Lagrangian models. Accepted *in Tellus.*

Downscaling of the ERA-40 reanalysis

Belgian activities up to now were focused on the dynamical downscaling of the ERA-40 re-analysis. As a first approach, we opted for a **double nesting** strategy, with domain resolutions at 40 km and 10 km. A third nesting at 2 km was also introduced, but this consisted only of a dynamical adaptation run (30' and limited physics) for a more detailed wind field (Zagar & Rakovec, 1999). This work is part of the ECMWF special project SPFRCOUP.

Nesting strategy

- The first stage, at 40 km resolution, consists of runs starting at 00h and lasting 48 hours. They are coupled every 6 hours to interpolated ERA-40 data. The first 12 hours are taken as spin-up.
- The second stage consists of 36 hour runs at 10 km resolution, coupled every 3 hours to the 40 km data set. After a 12 hour spin-up, this leaves 24 hours of data.
- The 10 km output is used (with constant boundary conditions) for a dynamical adaptation run at 2.1 km.
- Only the interpolation of ERA-40 data to the 40 km domain was run at ECMWF. All other steps were run locally at RMIB.

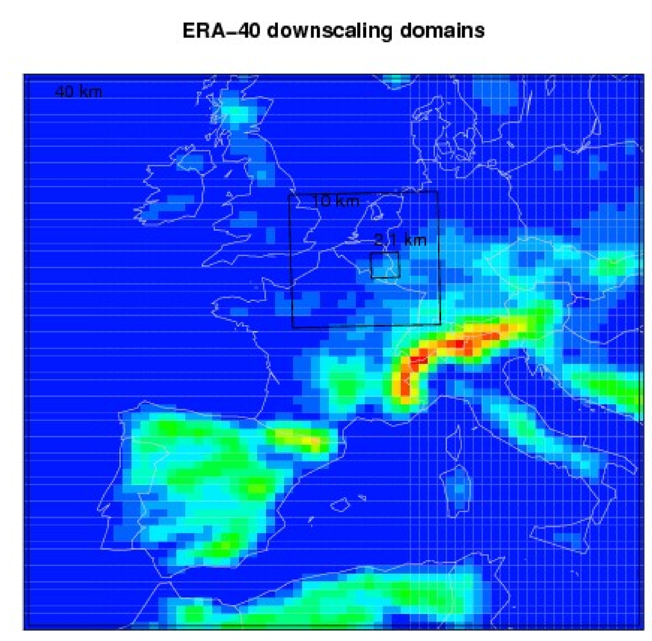


Illustration 1: ERA-40 Downscaling: nested domains for Belgium

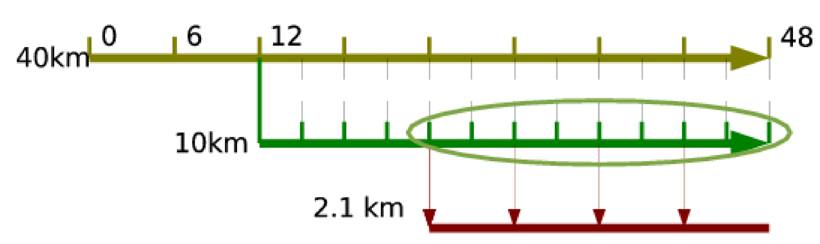
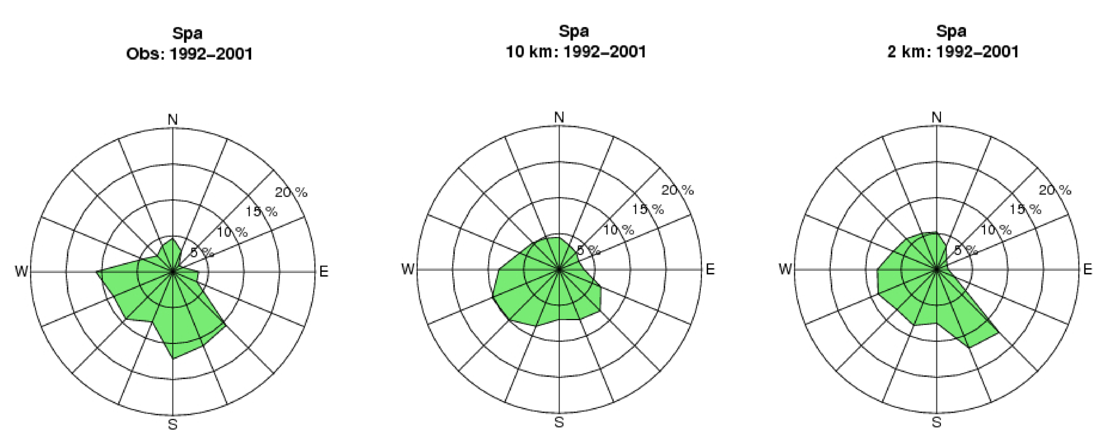


Illustration 2: Nesting strategy

Validation of wind downscaling

The downscaling of the wind field at 10 km and 2.1 km resolution has been compared to observed 10m winds at the station of Spa, which has significant orographic effects. The test period was 1992-2001. At 10km, the downscaled wind field (at the grid point closest to the station) does not accurately reproduce the local orographic effects, but at 2.1 km the SE wind component is very clearly visible.



When comparing the wind speed distribution, it can be seen that the downscaled climatology tends to underestimate wind speed for this location. But it should be noted that this is a very local effect. In the 2.1 km dynamical adaptation the wind speed distribution is much closer to the observations.

Alex Deckmyn

Including atmospheric layers in vegetation and urban offline surface schemes

A formulation to include prognostic atmospheric layers in offline surface schemes is derived from atmospheric equations. While multi-layer surface schemes developed previously need a complex coupling between atmospheric models levels and surface scheme levels, the coupling proposed here remains simple, respecting the ALMA formulation. This is possible because the atmospheric layers interacting with the surface scheme are independent of the atmospheric model that could be coupled above (Masson and Seity, 2008). The Surface Boundary Layer (SBL) (both inside and just above the canopy) is resolved prognostically, taking into account large-scale forcing, turbulence and, if any, drag and canopy forces and surfaces fluxes.

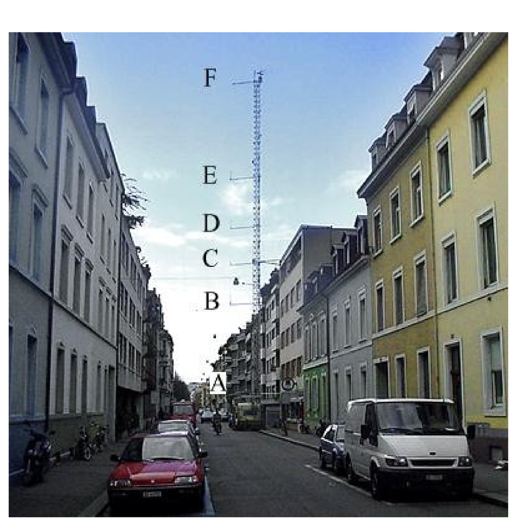
1. Validation with the ISBA scheme:

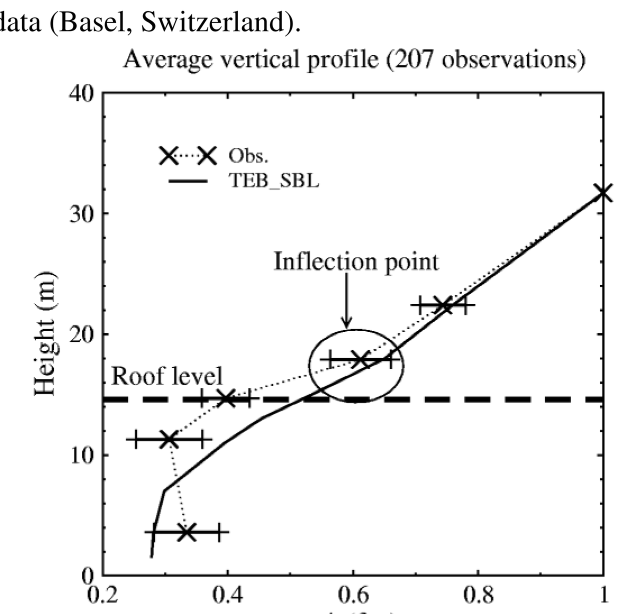
The SBL implemented in the ISBA (Noilhan and Mahfouf, 1989) scheme allows to retrieve the logarithmic law in neutral conditions and is able to retrieve the 2m variables accurately, without any use of analytical extrapolation (as the Paulson laws 'REF'). In this Table are displayed the scores (bias and root mean square error -RMS-) on the surface radiative temperature, 2m temperature and 2m specific humidity for a flat terrain, low vegetation site, not far from Roissy airport (France) (Masson and Seity 2008):

	Ts		T2m		q2m	
	BAIS	RMS	BAIS	RMS	BAIS	RMS
REF (3 years, overall scores)	-0.39	1.76	0.05	0.69	-0.10	0.59
SBL (3 years, overall scores)	0.09	1.67	-0.36	0.71	0.06	0.62
REF (3 years, daytime scores)	-0.46	2.32	-0.28	0.62	-0.05	0.68
SBL (3 years, daytime scores)	-0.25	2.39	-0.30	0.64	-0.01	0.70
REF (3 years, nighttime scores)	-0.55	1.58	0.32	0.86	-0.13	0.53
SBL (3 years, nighttime scores)	0.13	1.26	-0.40	0.78	0.12	0.54

2. Validation with the TEB scheme:

The inclusion of the SBL into the urban Town Energy Balance (TEB) (Masson, 2000) scheme is also presented (Hamdi and Masson, 2008), where the ability of the method to simulate both the profiles of both mean and turbulent quantities from above the building down to the road surface is shown using the BUBBLE experiment data (Basel, Switzerland).





Rafiq Hamdi

New approach to Lateral Boundary condition's

1

New approach to LBC's

- Some alternative ideas for the Davies scheme exist where one imposes the characteristic values at the inflow LBC's and extrapolates (by upstream time differencing) the outgoing characteristics
- The work of Aidan McDonald (2000; 2003; 2005; 2006) has led to a formulation for the semi-implicit semi-Lagrangian scheme in the HIRLAM model which leads to a quality that is comparable to the Davies scheme.

2

New approach to LBC's

- This is done by adapting the dynamical equations at the boundaries, i.e. in *distinct* points only.
- In order to have a stable scheme as a net result, this adaptation should be done in the implicit part of the semi-implicit scheme, in practice being the Helmholtz equation.
- In spectral models this equation is solved in spectral space where the value of a field can not be changed in distinct points!

3

Extrinsic LBC's

- Termonia and Voitus propose an approach where the LBC's are computed with a numerical finite-difference scheme that is different than the SI SL scheme of the dynamical core.
- This is called *extrinsic* LBC's. This can be applied in a gridpoint model but much more interestingly, it may allow to solve the problem of LBC's in spectral models ...

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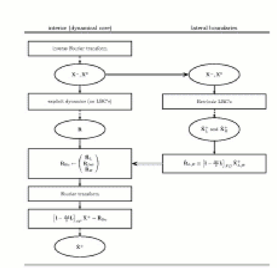
Extrinsic LBC's

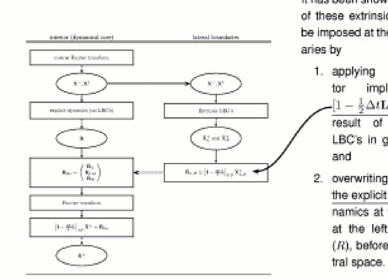


It has been shown that the result of these extrinsic schemes can be imposed at the lateral boundaries by

1. applying the operator implicit operator $[1-\frac{1}{2}\Delta t\mathbf{L}]_{FD}$ to the result of the extrinsic LBC's in gridpoint space, and
2. overwriting the result of the explicit part $\mathbf{R}$ of dynamics at the boundaries at the left (L) and right (R), before going to spectral space.

5

Extrinsic LBC's



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6

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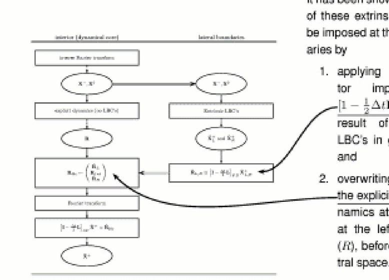

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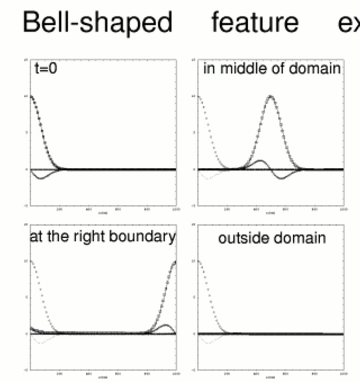
Tests in 1D shallow water

Bell-shaped feature existing the domain



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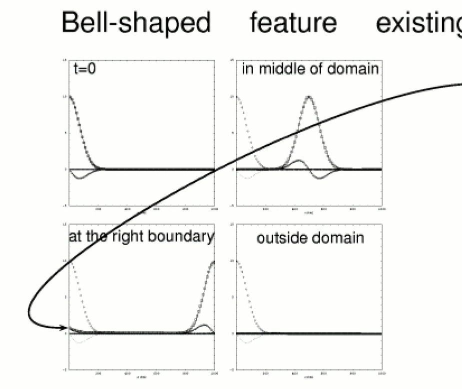
Tests in 1D shallow water

Bell-shaped feature existing the domain



Inaccuracy due to inconsistency between the operator $[1-\frac{1}{2}\Delta t\mathbf{L}]_{FD}$ in gridpoint space and the one in spectral space $[1-\frac{1}{2}\Delta t\mathbf{L}]_{SP}$.

Boyd (2005) proposes a better periodic extension yielding more accurate derivatives than the one in ALADIN, and used here. We expect this to improve.

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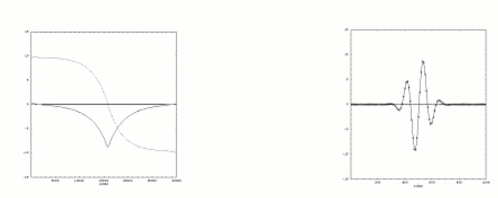
Tests in 1D shallow water

Some tests as they have also been done by McDonald in the shallow-water model, but here in the spectral model.



The adjustment experiment. The gravity waves are leaving the domain correctly without leaving reflections. The final state (see Gill 1982) is correctly reproduced.

A radiation experiment. The initial state is radiated away through the boundaries to infinity.

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Outlook

- Extrinsic LBC's allow to use Shoukri's (2006) approach for the LBC's while the dynamical core as it is, i.e. still SI SL Eulerian in the meteorological variables.
  At the boundaries, the equations are written in terms of the characteristic variables and solved in this form. This has 2 advantages:
  - easier to impose the characteristic values in this form
  - they are stable!

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Discussion and conclusions

- We are also testing some iterative approach. Some common action is planned with HIRLAM (A. McDonald) on this.
- Renewed optimism to find alternatives for the Davies scheme in spectral models.

Piet Termonia