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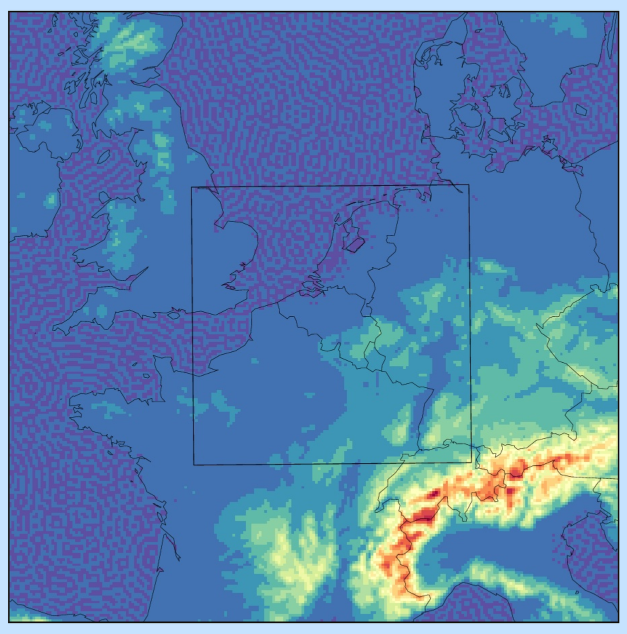
The operational ALADIN-Belgium model

1. Main features

- Model version: AL38t1 + 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).

Unsaturated downdrafts, downbursts and the Pukkelpop storm case

(Pieter De Meutter, Luc Gerard)

Downbursts are very strong downward air motions. They can occur in severe convective systems and are often accompanied by very strong surface wind gusts. On 18 August 2011, a bow echo formed over Belgium. The bow echo hit the popular music festival Pukkelpop, where a 100m wide downburst occurred during a few minutes. Festival tents and light towers were knocked down, causing five casualties.

Unfortunately it is impossible to resolve downbursts with current operational numerical weather prediction models having kilometric resolutions, due to the small spatial and temporal scales of downbursts. We tested whether a new parameterisation scheme for unsaturated downdrafts could be used to better predict such very strong downdrafts or downburst.

We used the Alaro model, operational at the Royal Meteorological Institute of Belgium, at 4 km horizontal grid spacings with the deep convective scheme 3MT (Gerard et al., 2009) and added the unsaturated downdraft parameterisation. The sub-grid scale downward mass flux is used as a proxy for downbursts. The results were validated with a 1 km horizontal grid spacing forecast without deep convection parameterisation, and with the documented case of 14 July 2010 (Hamid, 2012) where multiple downbursts occurred.

An example of the use of our downburst proxy for the Pukkelpop case is given in Fig. 1. The precipitation cells in the east show downburst potential, while the cells in the west, which were less convective, show no downburst potential.

References

- Gerard, L., J.-M. Piriou, R. Brozkova, J.-F. Geleyn, and D. Banciu, 2009: *Cloud and precipitation parametrization in a meso-gamma-scale operational weather prediction model*. Mon. Wea. Rev., 137 (11), 3960–3977.
- Hamid, K., 2012: *Investigation of the passage of a derecho in Belgium*. Atmos. Res., 107,86–105.

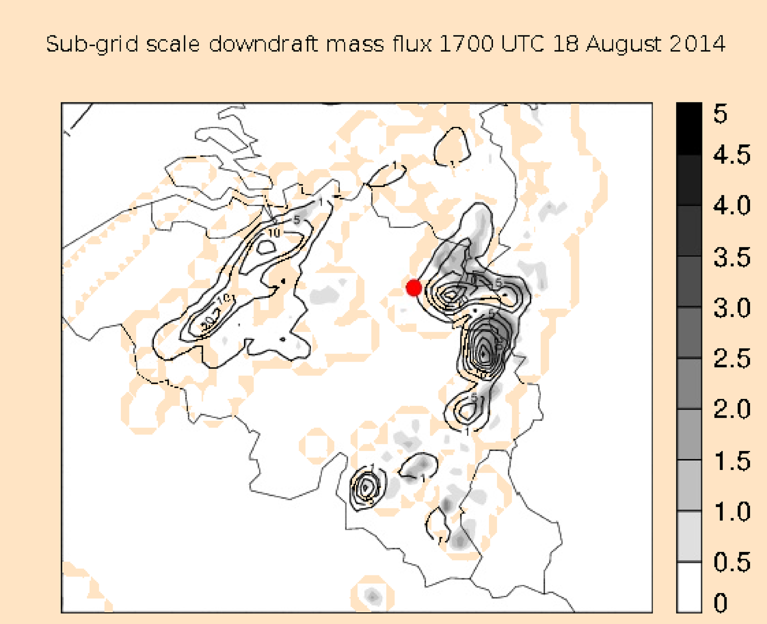


FIG 1: Sub-grid scale downdraft mass flux (units: kg/m²s) as forecasted by Alaro with the unsaturated downdraft scheme for 1700 UTC, 18 August 2011. Rain rate is shown by black contours (lines for 1, 5, 10, 20, 30, 40 and 50 mm/h). The location of the Pukkelpop festival is shown with a red dot. The downburst at the Pukkelpop festival occurred at 1615 UTC.

Study of the Jacobian of an Extended Kalman Filter for soil analysis in SURFEX

(Annelies Duerinckx & Rafiq Hamdi)

Experimental setup

- ALARO (4km resolution, 46 vertical levels, v36t1) + SURFEX (two-layer version)
- surface assimilation (6h cycle) with an Extended Kalman Filter
- screenlevel observations (T_{2m} and RH_{2m})
- soil prognostic variables used in EKF: superficial and deep soil temperature (T_s,T_2), superficial and root zone soil moisture (W_g,W_2)

The EKF

The equation for the Extended Kalman Filter (EKF):

$$\mathbf{x}_i^a = \vec{x}_i^b + \mathbf{BH}^T(\mathbf{HBH}^T + \mathbf{R})^{-1}[\vec{y}_i^o - \mathcal{H}(\vec{x}_o^b)]$$

with x^a the analysis model state, x^b the background model state, y - H (x^b) the observation departure and $\mathbf{BH}^T(\mathbf{HBH}^T + \mathbf{R})^{-1}$ the Kalman gain matrix. t is the time step indicator, **B** is the covariance matrix of background errors, **R** is the covariance matrix of observation errors and y is the observation vector.

H is the Jacobian matrix of the observation operator H and is calculated with a finite differences approach:

$$H_{ij} = \frac{\delta y_i^t}{\delta x_j^{to}} = \frac{y_i^t\left(x_j^{to} + \delta x_j\right) - y_i^t\left(x_j^{to}\right)}{\delta x_j}$$

The calculation of the Jacobian with finite differences assumes a linear response of the land-surface evaporation to a small soil moisture variation. In general this hypothesis is well satisfied, although some noise may still enter the Jacobian matrix under certain meteorological conditions. This leads to oscillatory model trajectories for the screen-level variables and introduces noise in the Jacobian matrix.

Figure 1 shows how an oscillation sets in when the Richardson number becomes positive. This oscillation is reflected in the T_{2m} evolution and the corresponding δT_{2m} / δW_2 Jacobian value. These are artificial 2Δt oscillations that dissappear again after a short time. We propose a temporal filter to remove the oscillations in T_{2m} and RH_{2m} before calculating the Jacobians. Figure 2 shows that the filter improves the forecast scores, specifically for relative humidity.

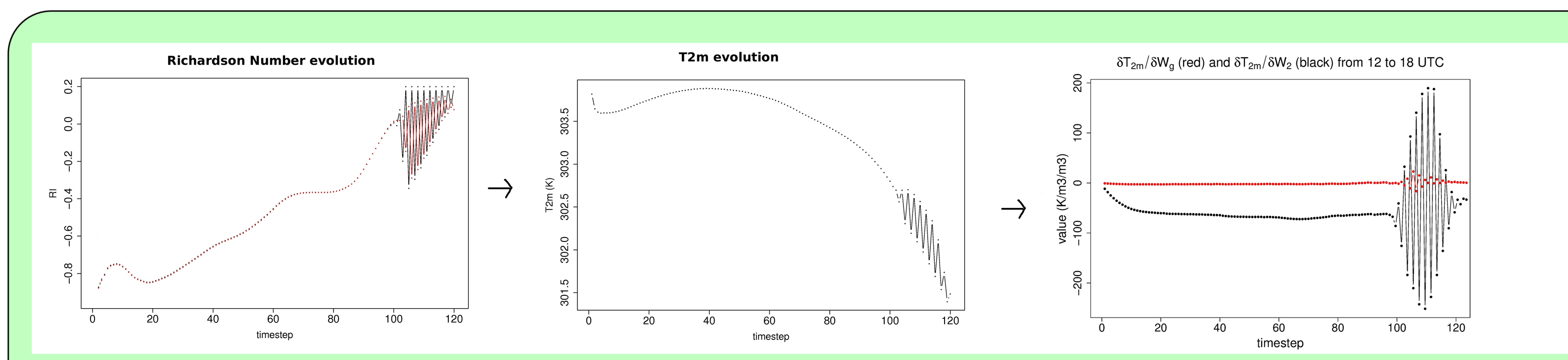


Figure 1: a) Evolution of the Richardson Number (RI) with a small oscillation starting when RI>0. b) Evolution of T_{2m} with the same small oscillation visible. c) δT_{2m} / δW_2 Jacobian evolution with a resulting large oscillation. Belgian domain (output plotted every timestep). Perturbation size for the initial perturbed states is 10-4.

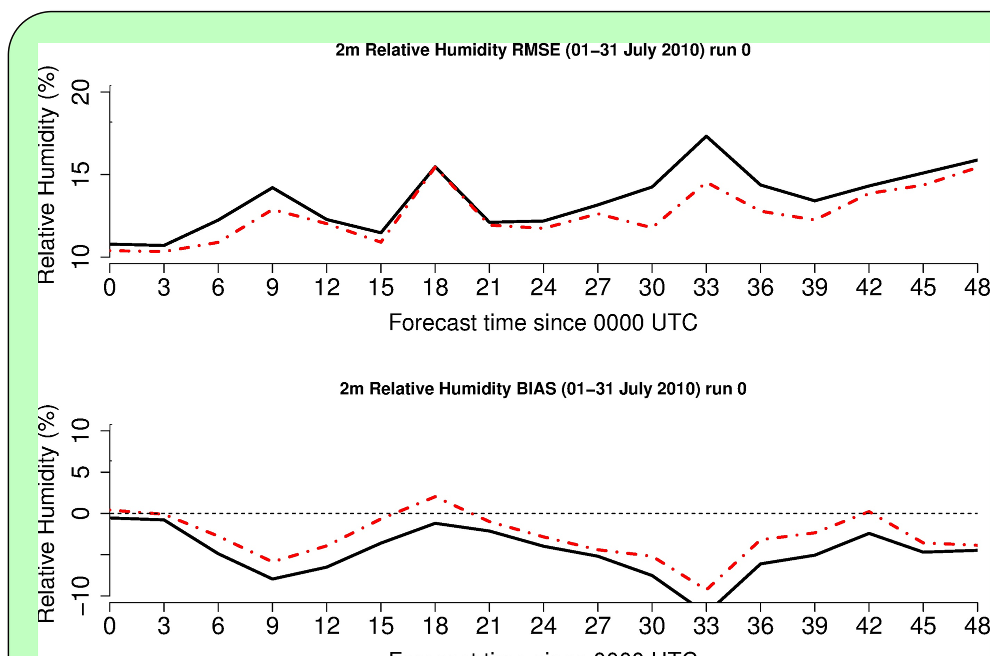


Figure 2:Forecast scores (BIAS and RMSE) for RH_{2m} for the station of Beitem (Belgium) averaged over July 2010 for the reference run (black) and the filtered run (red).

CORDEX participation

(Olivier Giot, Rozemien De Troch, Rafiq Hamdi, Steven Caluwaerts)

The Coordinated Regional Climate Downscaling Experiment [1] is an international effort to gain insight in climate processes at the local scale.

In April the RMI decided to contribute to this prestigious project with its local area model ALARO-0. Since then evaluation of the model using ERA-INTERIM as perfect boundary conditions has been performed on the high resolution (12.5km) EURO-CORDEX grid for the period 1979-2010. Preliminary results show that for 2-meter temperature ALARO-0 performs in a comparable manner to other models and excels in predicting precipitation amounts [2]. The figure shows the mean 2-meter temperature bias over the period 1989-2008 with respect to the E-OBS data set. Clearly, some large biases arise (e.g. Eastern Europe and Scandinavia) and these will be the subject of further study.

References

[1] Giorgi F, Jones C, Asrar G (2009) *Addressing climate information needs at the regional level: the CORDEX framework*. WMO Bull 58: 175–18

[2] Kotlarski et al.: *Regional climate modeling on European scales: a joint standard evaluation of the EURO-CORDEX RCM ensemble*, Geosci. Model Dev., 7, 1297-1333, doi:10.5194/gmd-7-1297-2014, 2014.