SPECIAL PROJECT PROGRESS REPORT

Progress Reports should be 2 to 10 pages in length, depending on importance of the project. All the following mandatory information needs to be provided.

Reporting year	2016……………………………………………….……
Project Title:	Multiphysics and stochastic perturbations for high-resolution LAMEPS…………………………….……
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Computer Project Account:	SPBETERM…………………………………….……
Principal Investigator(s):	Piet Termonia…………………………………….……
	……………………………………………………….……
Affiliation:	Royal Meteorological Institute, Belgium……………
Name of ECMWF scientist(s) collaborating to the project (if applicable)	……………………………………………………….……
	……………………………………………………….……
Start date of the project:	1/1/2015……………………………………….……
Expected end date:	31/12/2017…………………………………….……

Computer resources allocated/used for the current year and the previous one

(if applicable)

Please answer for all project resources

		Previous year		Current year	
		Allocated	Used	Allocated	Used
High Performance Computing Facility	(units)	130000	402895	130000	8793 (29/06/2016)
Data storage capacity	(Gbytes)	800	26	800	8.9 (29/06/2016)

Summary of project objectives
(10 lines max)

This project aims to study the sensitivities of convection-permitting (EPS) systems to various aspects:

- use of different physics configurations (e.g. in turbulence, deep convection, microphysics)
- stochastic perturbations (e.g. SPPT)
- influence of surface error/uncertainty (e.g. on triggering of deep convection)
- influence of initial and lateral boundary conditions

As in the predecessor project SPFRCOUP, the intention of this project is to allow scientists from selected (Cooperating and Non-Member) States access to resources on the HPCF to (1) develop and maintain a unified software environment for experimentation and preparing boundary conditions, and (2) perform boundary condition file preparation at ECMWF before sending it to their own sites for running the LAM(EPS)s.

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Summary of problems encountered (if any)
(20 lines max)

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Summary of results of the current year (from July of previous year to June of current year)
This section should comprise 1 to 8 pages and can be replaced by a short summary plus an existing scientific report on the project

RMI-Belgium activities

As discussed in the previous progress report, last year we started investigating the Pentecost storms of 2014 with a simplified version of the HarmonEPS system, consisting of one ALARO member and one AROME member, both at 2.5km horizontal resolution, coupled to the ECMWF deterministic model. As planned, we tested a full-fledged version of HarmonEPS this year, consisting of 10+1 ALARO members and 10+1 AROME members, again at 2.5km, using the ECMWF-EPS for initial perturbations (IC) and lateral boundary conditions (LBC). This is meant to be a prototype convection-permitting EPS system for Belgium, and hereafter referred to as RMI-EPS.

Tests with the RMI-EPS were done for the Pentecost storms of 2014 and a several thunderstorm cases in August 2015. For the hail event of Saturday 7 June (Pentecost weekend), which was missed by all our operational models and the simplified HarmonEPS system, as discussed in the previous progress report, a negative result was also obtained with the RMI-EPS. Thus, coupling to the ECMWF-EPS instead of the deterministic ECMWF model, did not improve the forecast in this case. Whether this was due to a deficiency in the LBC's or some missing physics in the model (or insufficient horizontal resolution), is still unclear, but could perhaps be tested by coupling to the ECMWF analysis.

More positive results were obtained with the prototype RMI-EPS during a series of thunderstorm events over Belgium occurring in August 2015. We will discuss here a thunderstorm event on 13 August 2015, and some statistical comparison with GLAMEPS and ECMWF-EPS (referred to as ECEPS). The case of 13 August 2015 was interesting as our operational deterministic LAM model gave very little precipitation over Belgium (figure 1), while our forecasters nevertheless gave a 'code orange' warning for the west of the country. As it turned out, the largest amount of precipitation was actually observed in the east of the country, and this was in fact nicely predicted by the RMI-EPS, as shown by the regional probabilities in figure 2. Note that in contrast to the more customary gridpoint probability maps (figure 3), where each gridpoint has an exceedance probability, the regional probability maps (figure 2) only have one exceedance probability per region (Belgian province). This is often more useful and user-friendly.

Additionally, a preliminary statistical verification over 15 forecasts around several thunderstorm episodes in August 2015 was done, with encouraging results. Figure 4 shows RMSE and ensemble spread for 6h accumulated precipitation, with scores being averages over 10 standard WMO weather stations spread over the whole of Belgium. The RMSE of RMI-EPS is comparable with those of GLAMEPS and ECEPS, while the ensemble spread is clearly larger and closer to the RMSE.
For 2-meter temperature, results are shown in figure 5. Here, the RMSE is somewhat smaller than GLAMEPS and ECEPS in the first 24h, and somewhat larger thereafter. The ensemble spread on the other hand is clearly worse than GLAMEPS, but still much better than ECEPS. The larger and better ensemble spread for 2-meter temperature in GLAMEPS is likely due to the addition of more perturbations in the surface, which is something that can still be improved greatly in the current (prototype) version of RMI-EPS. However, at the moment our main focus is on physics at convection-permitting scales and the improvement of thunderstorm forecasting.
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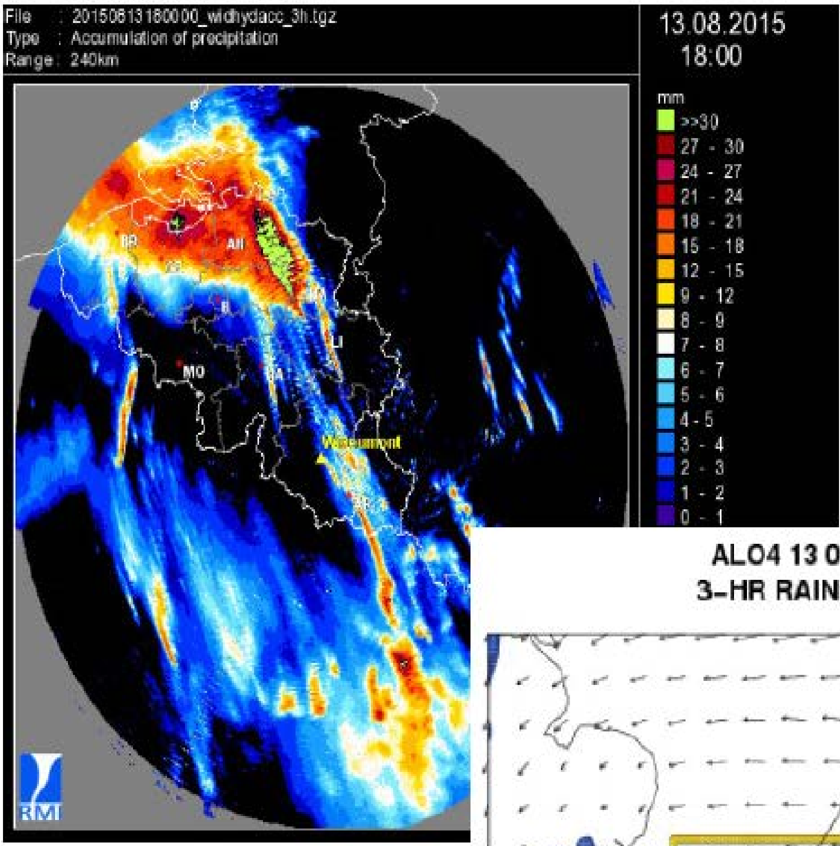

The radar image shows the very active line of thunderstorms in the north of Flanders. Remark the large amounts of rain over Limburg, east Vlaams-Brabant. Alaro did not expect any thunderstorm activity over Belgium at that time.

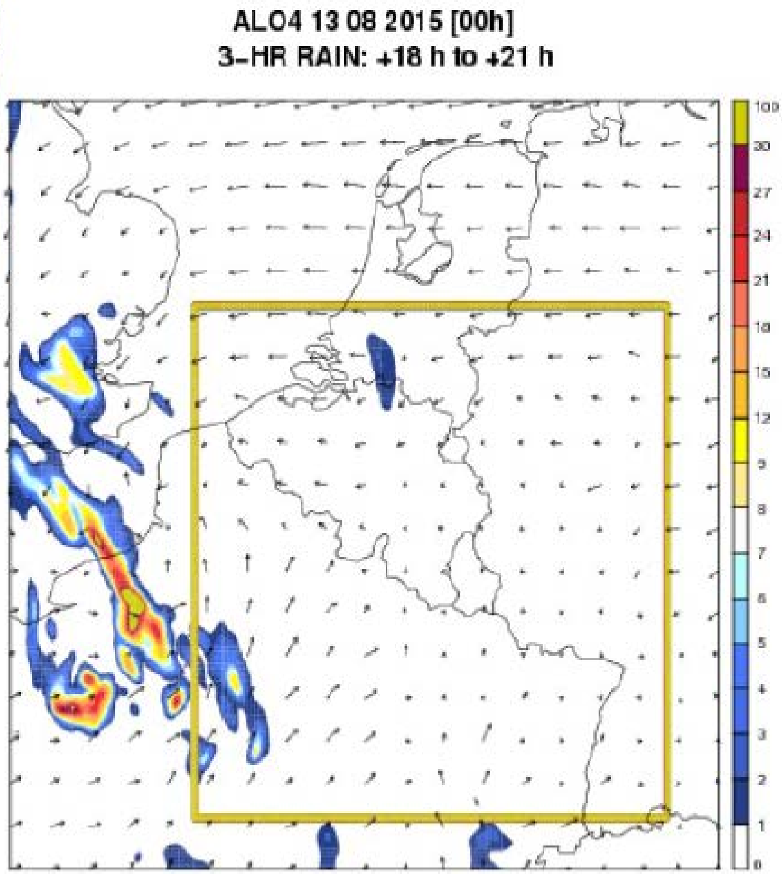

Figure 1 : Thunderstorm event over Belgium on 13 August 2015. Radar Image (top) and deterministic ALARO4 model forecast (bottom) for 3h accumulated precipitation from 18h tot 21h UTC.

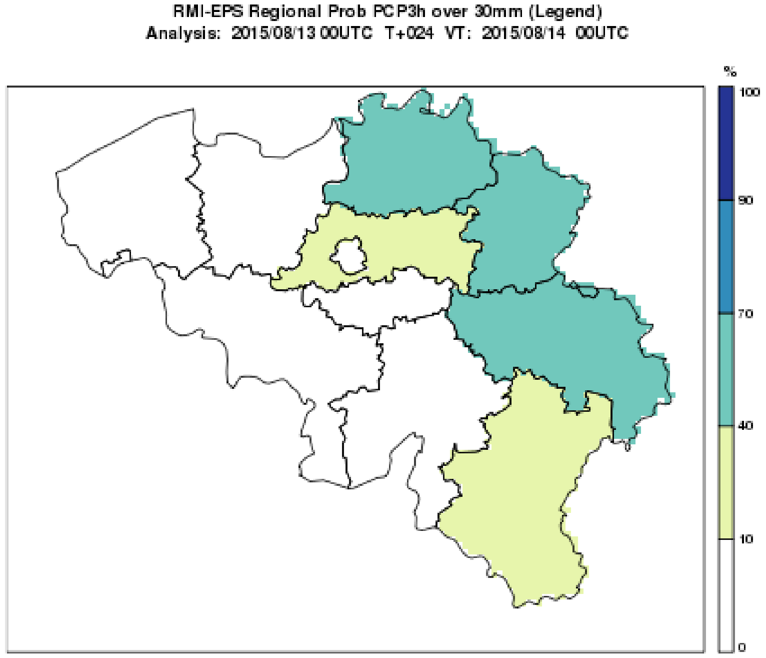

Figure 2: Regional probability map RMI-EPS: 3h accumulated precipitation (> 30mm), forecast of 20150813 (00h UTC) + 24h.

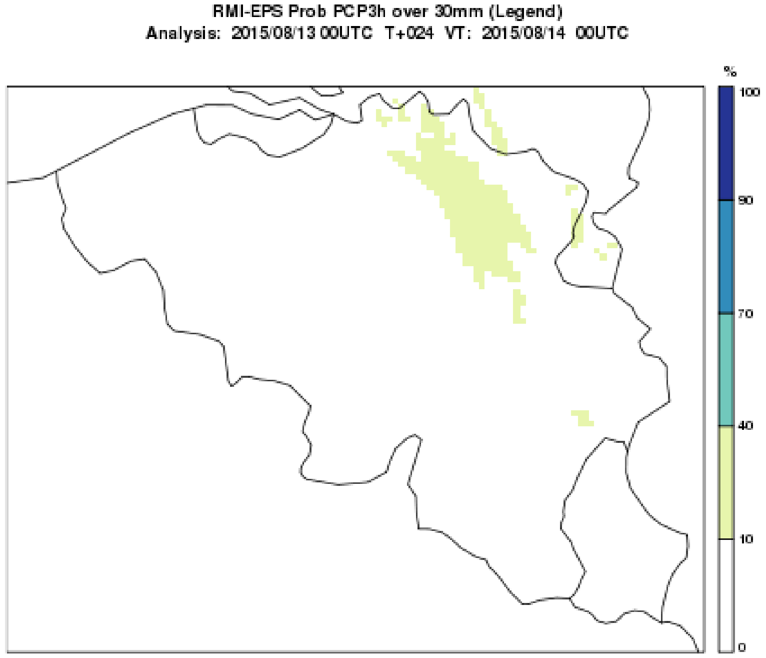

Figure 3: Probability map RMI-EPS: 3h accumulated precipitation (> 30mm), forecast of 20150813 (00h UTC) + 24h.

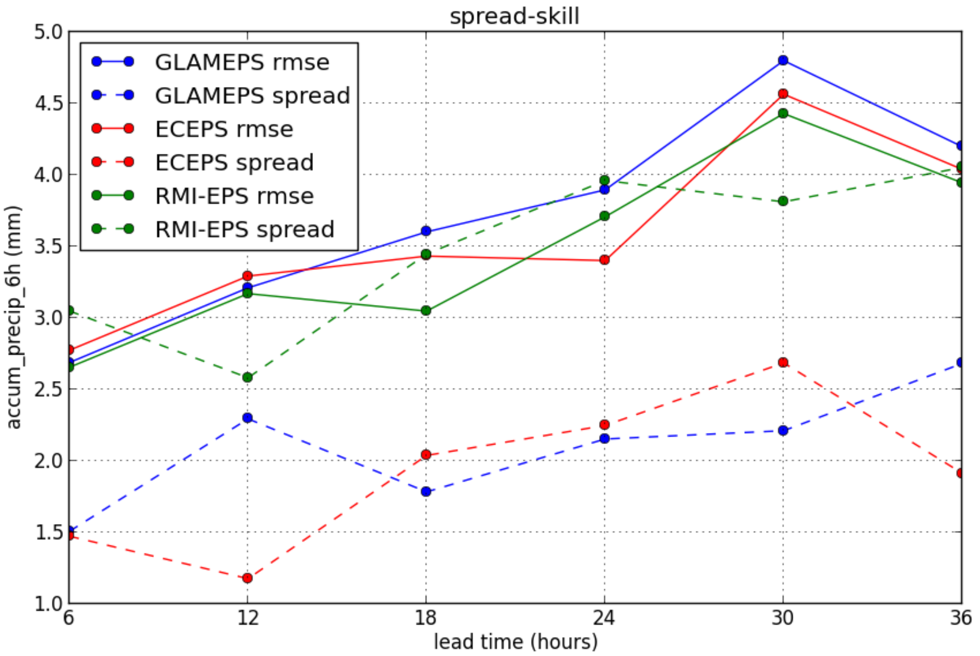

Figure 4: RMSE and spread for 6h accumulated precipitation: thunderstorm cases of august 2015 (averages over 10 standard stations in Belgium). Comparison of RMI-EPS with GLAMEPS and ECEPS.

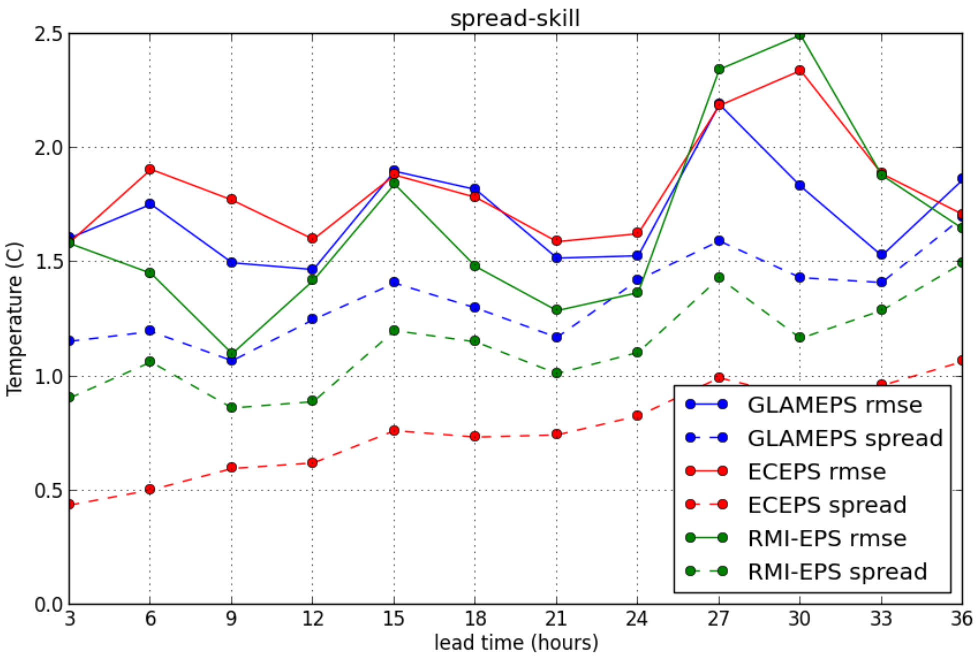

Figure 5: RMSE and spread for 2-meter temperature: thunderstorm cases of august 2015 (averages over 10 standard stations in Belgium). Comparison of RMI-EPS with GLAMEPS and ECEPS.

List of publications/reports from the project with complete references

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Summary of plans for the continuation of the project

(10 lines max)

The SBUs of this project (SPBETERM) will be used to generate boundaries for convection-permitting LAM-EPS experiments, e.g.:

- Coupling ALARO-1 to ECMWF (deterministic) and to ECMWF-EPS
- HarmonEPS experiments with archived ECMWF-EPS boundaries
- Perturbing physics in ALARO

Several ongoing thunderstorm case studies will be continued, and combined with statistical verification over longer time periods.

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