Challenging weather forecasting projects at medium ranges and possibly at more extended ranges

Contribution of the Royal Meteorological Institute (BELGIUM)
to the ECMWF Users' meeting
Reading – June 2014

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in co-operation with Dr. Fabian Debal, Pascal Mailier, Bert Van Schaeybroeck, Stéphane Vannitsem, Joris Van Den Bergh and Emmanuel Roulin at RMIB

Challenging projects in the forecasting area

I. Early warnings

A/ main objectives and general methodology
B/ methodology to exploit raw model data (ECMWF)
C/ methods to calibrate raw ECMWF model data (MOS tools / HEPS)
and to permit an operational exploitation of corrected data by forecasters
D/ methodology to implement a DECISION matrix
E/ iIllustration for early warnings; potential exploitation of current raw ECMWFdata

II. First tests on a new (complementary) clustering

III. Motivations and perspectives to exploit extended range forecasts

IV. Comments and discussions on these projects – more suggestions

A/ Early warnings – MAIN OBJECTIVES and general METHODOLOGY

Early warnings take advantage BOTH of HRES and mostly EPS-ECMWF models:
-raw forecast data are used for our areas and the next days
-from raw forecast fields a more likely weather scenario using « meteorological objects » (Conceptual Models) is built every for our areas and the next few days

Consistency between successive forecasts is very important for Early warnings in the next few days:
-more likely and reliable weather scenario elaborated by forecasters at synoptic scales exploits successive raw model data (e.g. D-1 and D0=TODAY runs)
-HRES and EPS data for ECMWF + also NCEP data from D+2
-« extreme » indices forecasts like EFI & SOT from EPS-ECMWF
-ALADIN and (soon) GLAMEPS will be checked for shorter ranges up to D+2

A « local » calibration relying on Model Output Statistics methods/tools is on the way to be proposed to forecasters. The main purpose is to exploit corrected forecasts (instead of current raw data forecasts) which are more tuned for a few weather parameters, Belgian locations, short and medium ranges.
-Kalman Filering technique (one dimensional) > *Pascal Mailier*
-Spread correction Member-By-Member method > *Bert Van Schaeybroeck & Stéphane Vannitsem*
-HEPS: Hydrological Ensemble Precipitation System post-processed for precipitation foracsts > *Emmanuel Roulin & Joris Van Den Bergh*

Corrected weather parameters data will be treated to help forecasters exploiting a « DECISION matrix » tailored for each type of Early warnings

Forecasters will be responsible to comment their DECISION on Early warnings relying BOTH on their more likely/reliable weather scenario and their estimation of the probability of high impact

B/ Early warnings – methodology to exploit raw model data (ECMWF)

- HIGH RESOLUTION data (16km): forecasted fields for successive lead times and a choice of upper air and surface parameters

- EPS data (32 km):

-probability charts for Belgium and surroundings areas built for a ***selection of weather parameters and high impact thresholds*** at different lead times

-EPSgrams and time series for belgian stations and different lead times (D10 every 6h AND D15 every day)

-« extreme forecasts » indices fields (EFI and SOT)

- Successive runs of model data for HRES and EPS data verifying on the same « time window » will be compared (consistency checking)

For example a current exploitation of raw ECMWF model data is illustrated in (E) helping to decide whether an Early warning must be issued or not

Selection of weather parameters for early warnings	**Selection of high impact Thresholds T - ΔT < threshold < T + Δ T (PROPOSAL)**
surface Wind: daily maximum gusts (km/h) NO (severe) convection	90 < max GUST < 110 km/h
Cold Spell: (mean) surface minimum & maximum Temperatures (°C)	Table: TN/TX – number of consecutive days (see slide on Cold spell « intensity »/duration)
Heat wave: (mean) surface minimum & maximum Temperatures (°C)	Table: TN/TX – number of consecutive days + ozone (Health Ministry criteria) (see slide on Heat wave « intensity »/duration)
daily Precipitation amount (RR/24h) NO (severe) convection	40 mm/24h < RR < 60 mm/24h + possibly THAW
Snow/ Ice/ freezing precipitations Estimated daily accumulation of snow (cm) Probable freezing rain/black ice events	2 cm/day < SNOW thickness < 5 cm/day Freezing rain / black ice occurrence (patchy or widespread but no thickness value)

C/ Early warnings – methodology to calibrate raw ECMWF model data and to treat these corrected data to the attention of forecasters

New Model Output Statistics tool(s) and an Hydrological Ensemble Prediction System (HEPS) developed in Belgium are presented hereafter to get a better use of raw ECMWF model data:

-Kalman filtering (1 dimension…) for surface temperatures **(Pascal Mailier)**

-a Member-By-Member (MBM) spread correction method to correct (calibrate) surface temperatures and winds (also gusts) forecasts **(Bert Van Schaeybroeck)**

-an HEP System **(Joris Van Den Bergh & Emmanuel Roulin)** to exploit precipitation forecasts with a a post-processing

Treatment of corrected data for Belgium to the attention of forecasters:

These (corrected) MOS data for a selection of « representative » belgian stations (5) and lead times will be exploited to get PRE-FILLED TABLES for forecasters - with a choice of weather parameters – given Percentiles [like P15, P50 and P85 to sample the distribution of forecasts] and the date of the run:

- Daily TN table from D+2 to D+14 for a 12- hour period (18h00 – 06h00 Z)
- Daily TX table from D+2 to D+14 for a 12- hour period (06h00 – 18h00 Z)
- Daily maximum of surface (wind) gusts (period 00h00- 24h00 Z)
- daily amounts of precipitations (period 00h00 – 24h00 Z)

These corrected MOS data can also be displayed on plumes (with « trajectories » drawn for a given Percentile corresponding to pre-filled (uncorrected AND corrected) tables [using P15 – P50 – P85]
-other representations like time series … can be helpful (suggestions are welcome)
-no interpolated fields over Belgium: MOS regressions are usually calculated for stations and not all grid points which implies no extrapolation)

1D Kalman Filtering method

$X_k = K_k \,.\, Z_k + (1 - K_k) \,.\, X_{k-1}$ a linear combination

X_k is an estimator of the bias at step k (error made for the last forecast)

X_{k-1} is an estimator of the bias at the step k-1 (recursive correction from previous forecasts)

Z_k is a measure of the bias at step k

K_k is the Kalman gain parameter which is taken as a constant value for all lead times at a given date

Questions

-Kalman Filtering = a deterministic approach (Ensemble-mean shifted)
-results highly expected to compare the quality of corrected forecasts using separately Kalman Filtering and Spread Method (Pascal)
-smoothing « action » of Kalman Filtering not appropriated to « abrupt » weather Changes in the « weather regimes »
-impact of a « no spread » correction on the probability forecast
-short time of computation
-adaptation for a new model version

MBM Spread correction method tested to calibrate raw EPS forecasts using hindcasts (BVS may 2014)

Based on **ECMWF HINDCASTS data** set for medium-range forecast.
Operational implementation of method that corrects:

- Bias
- Ensemble mean
- Ensemble spread

Verification on one year 2011-2012 of 51-member EPS in operational setting against observations of 17 Belgian stations.

Regression coefficients (α, β, γ) are adjusted in the following relation:
$X_{C,n}^{m}$ = corrected forecast for the parameter X and the member m of the ensemble index n (corresponding to the observation n)

$$\mathbf{X_{C,n}^{m} = \alpha + \Sigma_{p=1}^{P} \beta_p \langle V \rangle_{p,n} + \tau_n \varepsilon_n^{m}}$$

α = a bias adjustment parameter
β_p = an ensemble-mean scale parameter (a vector with p predictors)

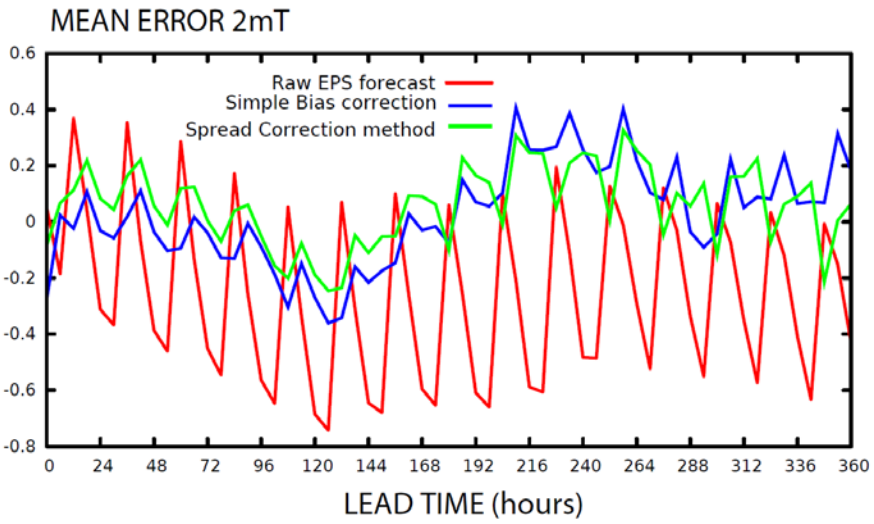
$T_n^{2} = \gamma_1^{2} + \gamma_2^{2} . \sigma_{\varepsilon,n}^{-2}$ = a spread adjustment parameter

$\varepsilon_n^{m} = V_{1,n}^{m} - \langle V \rangle_{1,n}$ = deviation of member m from the ensemble mean <V> for the ensemble index n

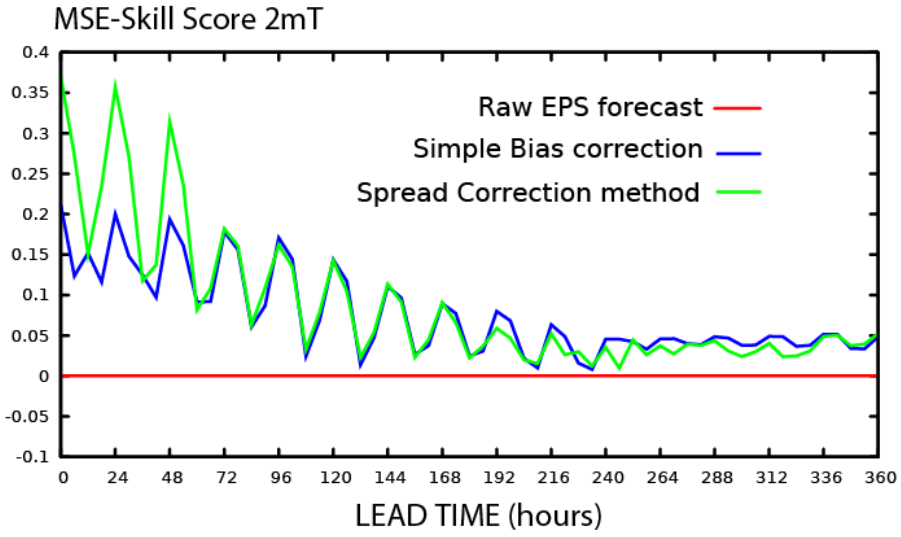
$\sigma_{\varepsilon,n}^{2}$ = ensemble spread for the ensemble index n

Verification Results

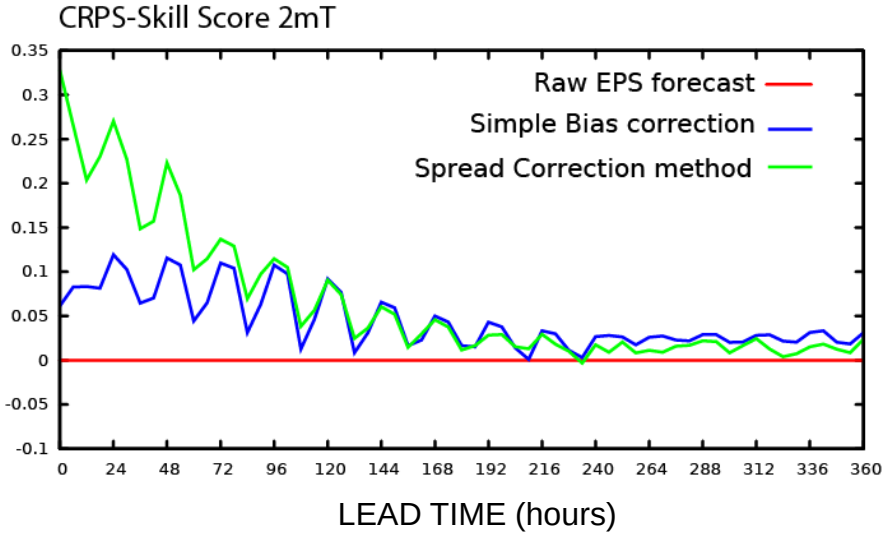
Bias Correction:



Ensemble-mean Correction



Ensemble-spread Correction



Exploitation of a HEP System for RR

The Hydrological Ensemble Prediction System (HEPS) is designed to give Early warnings for severe precipitation and flood events in (large) catchment basins at medium ranges.

HEPS is run every day using precipitation observations (AWS-RADAR-CLIM) and EPS-ECMWF forecasts for two (large) catchment basins (Meuse & Scheldt → ***see next slide***)

HEPS products are visualized on tables, probability plots (e.g. → ***see next slide***)

HEPS implementations are on progress:

-a logistic regression based on the Ensemble Mean (EM) is tested to calibrate the probability to overshoot a given precipitation threshold. The coefficients are calculated using hindcasts

An extension of this regression (Extended logistic regression) aims at getting consistent probability forecasts taking simultaneously different (severity) thresholds into account.

-forecasts will be extended up to 14 days for Belgium (not only two large basins)

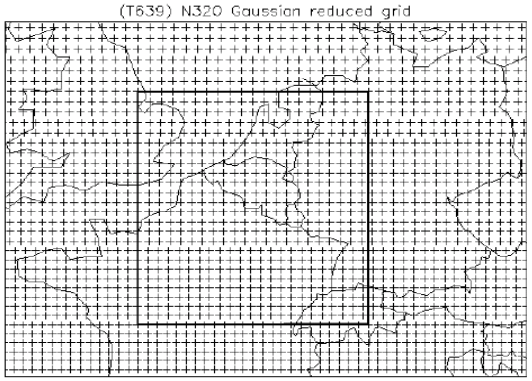
-tests will be made on a new version of a logistic regression to encompass the spread of the EPS distribution (not only the Ensemble Mean)

-use of GLAMEPS (Grand ensemble Limited Area Model based on EPS) are programmed for shorter ranges (co-operation with **Alex Deckmyn**)

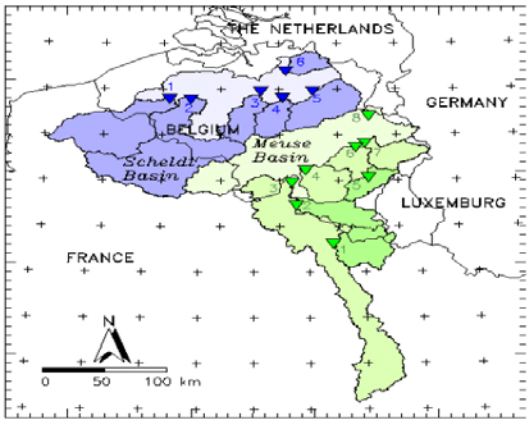
-Postprocessed probability of precipitation forecasts (PoP)

–> **INDRA project (*see next slide*)**

EPS-ECMWF grid resolution: 32 km



Included catchments in the Scheldt and Meuse basins



· **Scheldt** basin:
1. Leie – St. Baafs
2. Schelde – Asper
3. Zenne – Eppegem
4. Dijle – Wilsele-Wijgmaal
5. Demer – Diest
6. Kleine Nete – Grobbendonk

· **Meuse** basin:
1. Chiere – Chauvency
2. Semois – Haulme
3. Meuse – Chooz
4. Lesse – Gendron
5. Ourthe – Tabreux
6. Ourthe – Nisramont
7. Amblève – Martinrive
8. Meuse – Visé

The current HEP system exploiting EPS is run on two large catchment basins

To say the least …

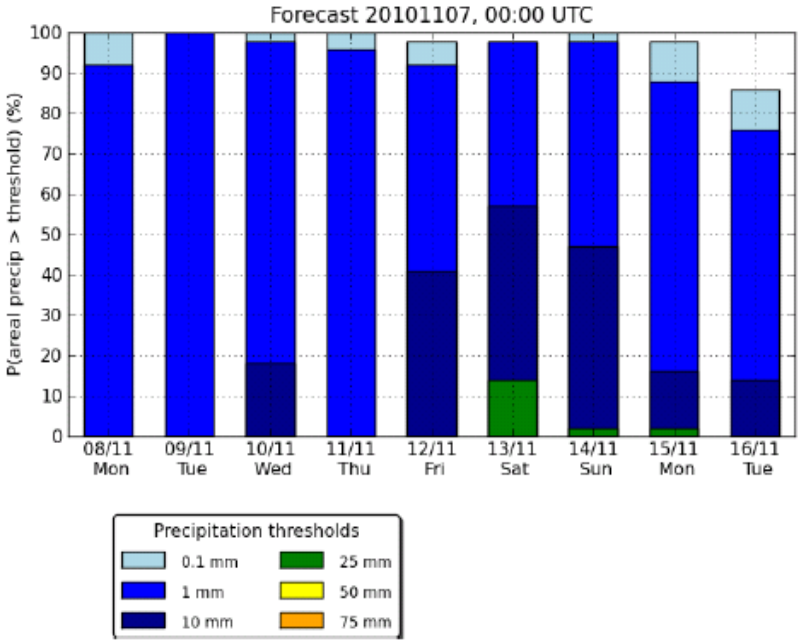
<u>HEPS is worth to be implemented and also appropriated by forecasters</u>

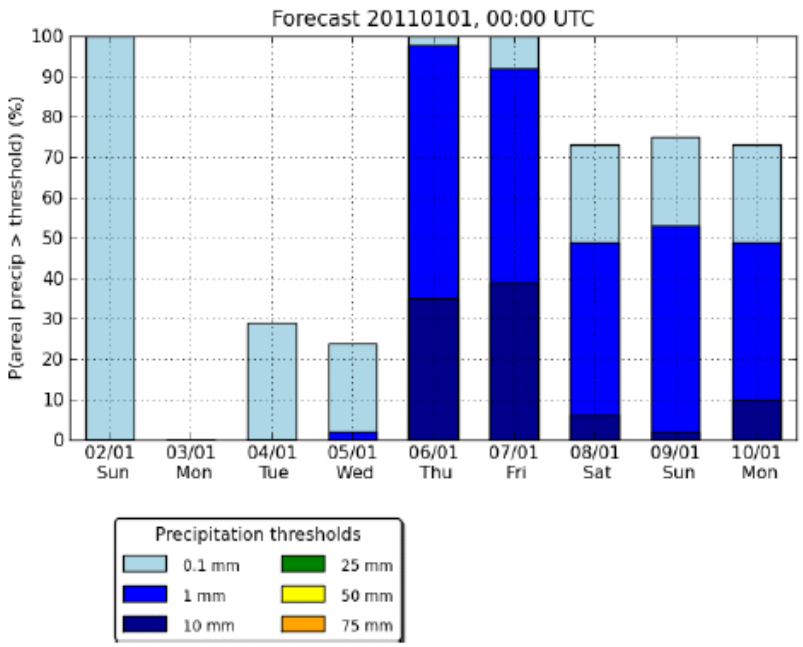
-HEPS will be calibrated and tested with several precipitation thresholds (on a daily base and/or consecutive days) helping the elaboration of Early warnings over Belgium and not only catchment basins

-Post-processing of 24h accumulated areal and localized precipitations are welcome as well for rain as snow [in the frame of the INDRA project]

Visualisation, flooding events of last winter

Probability plot for the 24h accumulated areal precipitation, for Meuse/Chooz. Forecast of 07.11.2010 (left) and 01.01.2011 (right).





Possible additional products

- Postprocessed probability of precipitation forecasts (PoP).
  - Combine different model forecasts, both deterministic and probabilistic.
  - E.g. GLAMEPS + EPS + Alaro.
  - Areal precipitation over catchments.
  - Precipitation at certain points.

→ **INDRA project**

- Probabilistic forecasts for other EPS fields (e.g. snow).

- Modeled snow cover:
  - SCHEME model output (snow water equivalent).
  - H-SAF satellite product.

D/ Early warnings – methodology to implement a DECISION matrix

➢Definition of a Decision matrix (Probability of impact – severity of impact)

T is defined as an high impact threshold (we admit a confidence interval ΔT) for each early warning.
T is closely linked to our 'local' climatology (value corresponding to a mean climatological return period for severe events) but also to the forecasters' expertise (severe case studies and their impacts)…

V is an estimated value of the probability of impact.
We plan to look only for high impact AND we propose to take one value for it; V = 50%.
This estimation must be weighted subjectively with the more likely weather scenario of forecasters.
A calibration to correct raw ECMWF probability forecasts for a selection of Belgian locations, weather parameters and lead times is needed AND forecasters have to 'translate' these probabilities in terms of an estimated probability of impact (V)

➢Decision [Early warning or NOT]

(An) Early warning(s) is(are) issued by forecasters if the estimated probability to overshoot a high impact threshold is reaching 50% at least for one day into the « time window » defined for Early warnings
[« time window »: D+2 to D+5 included].

➢Nota bene

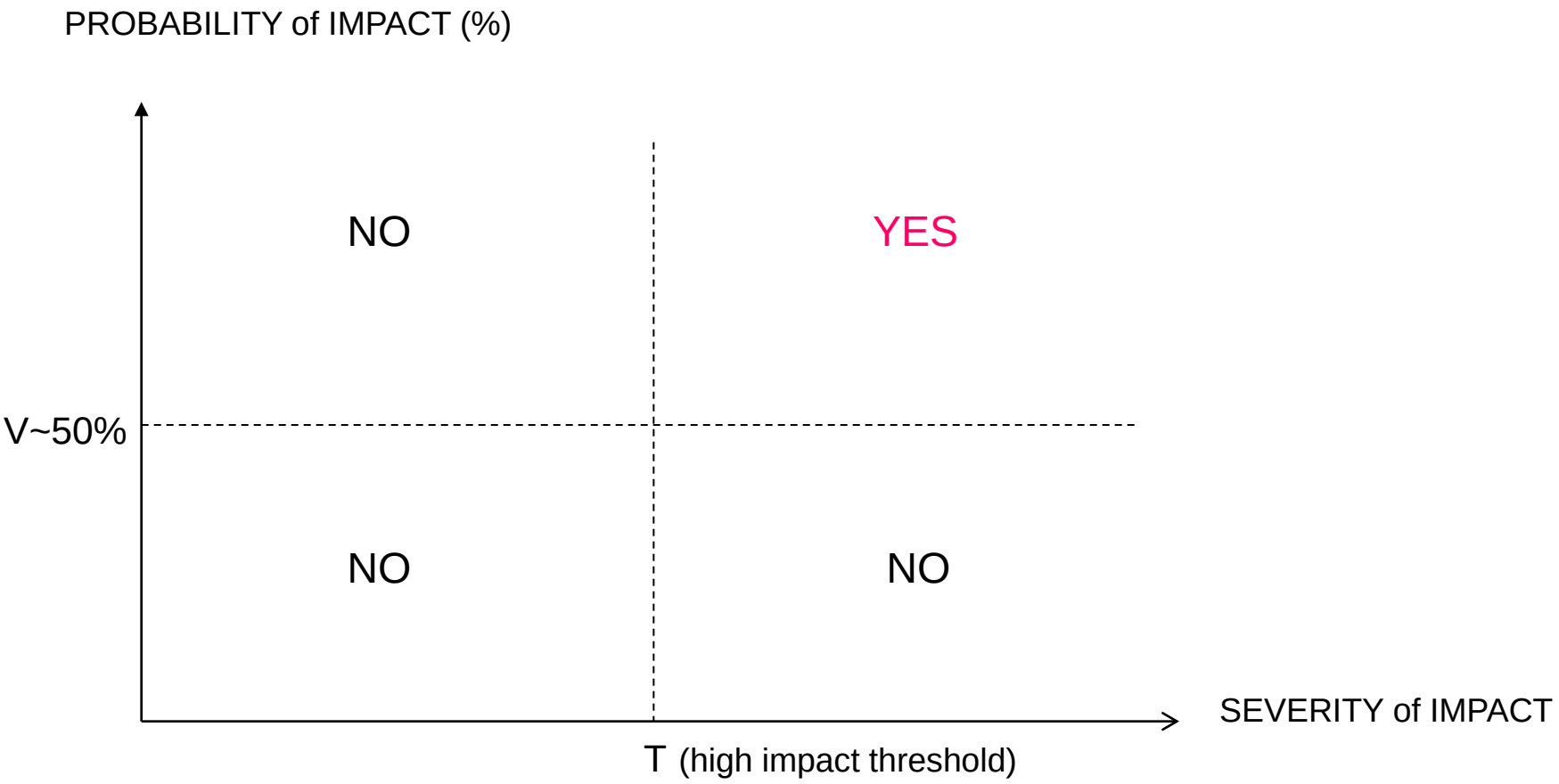
Early warnings will not be not necessary followed by short term warnings (D0, D+1 and/or Nowcast warnings (next hours) but a major objective is to avoid false alarms
To improve early warnings a verification is needed (exploiting different statistical scores and their synoptic background)

A proposed scheme for the DECISION matrix

-estimating the probability of high impact weather for at least one day into the D+2 to D+5 forecast period over Belgium. A probability of impact - V ~50% - is taken as benchmark

-selecting a high impact Threshold(s) T (with a ΔT confidence interval) defined for each weather parameter

-taking a « binary » decision [early warning: YES or NO]



EARLY WARNINGS ⟺ IMPACTS THRESHOLD*(S)*

In case of multiple warnings levels

IMPACTS = complex function of several parameters...

IMPACTS = Fct (I , R , t , Δt , x , Δx , …)

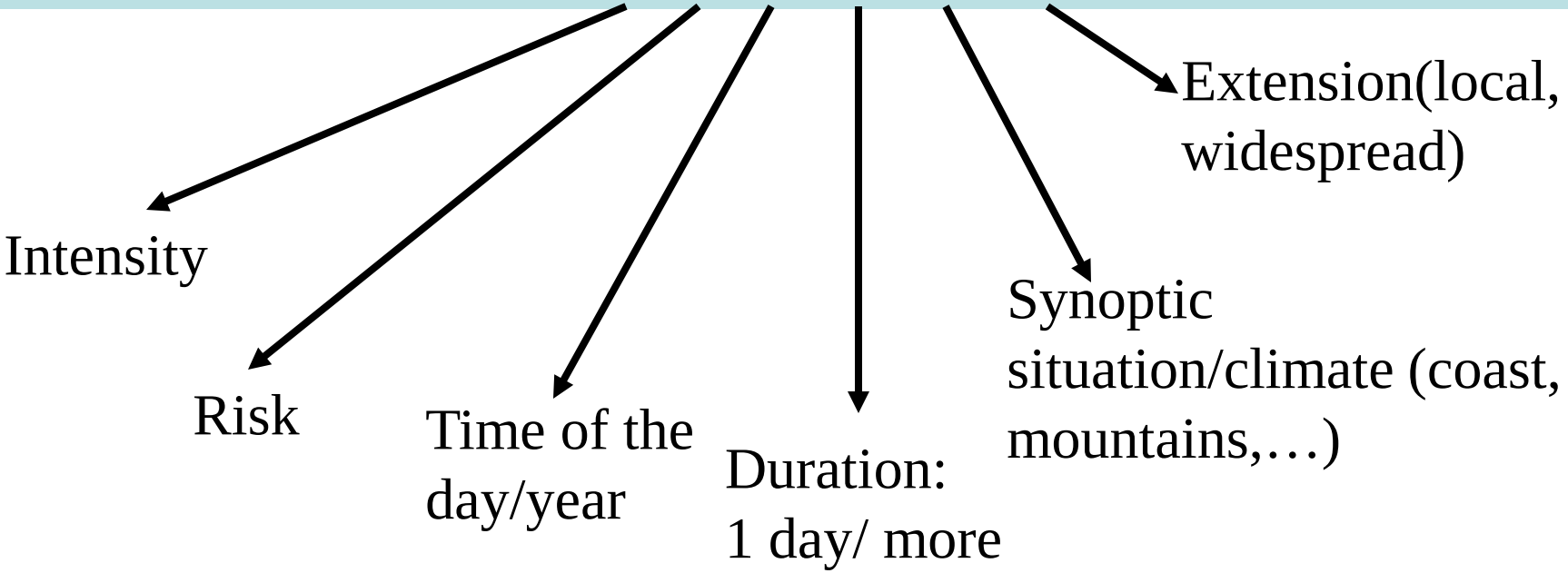


Illustration : Warnings for Strong wind (gusts)

Thresholds values must be adapted for early warnings

IMPACTS = Fct (**I** , R , **t** , Δt , x , Δx , …)

If t = summer period with leaves on the trees:

$I^*(t)$ = 70 km/h ; 90 km/h ; 120 km/h

If t = winter period without leaves on the trees:

I*(t) = 80 km/h ; 100 km/h ; 130 km/h

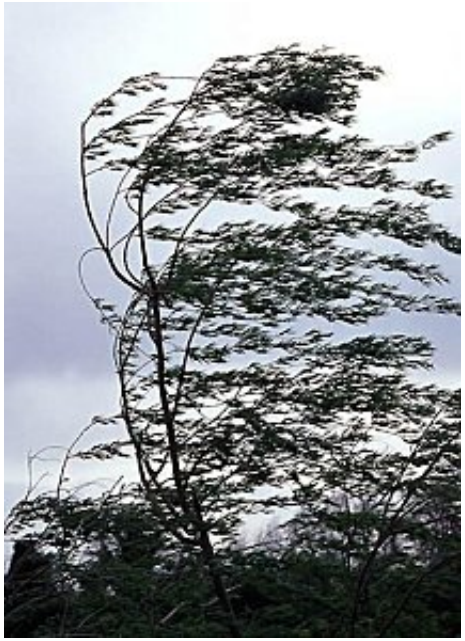


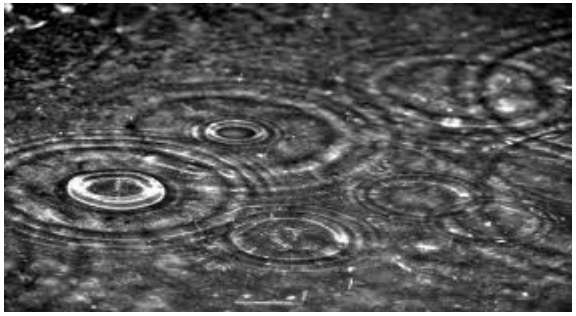
Illustration: Warnings for Heavy/large amount of rainfall

Thresholds values must be adapted for early warnings

IMPACTS = Fct (**I** , **(I.Δt)** R , t , **Δt** , x , **Δx** , …)

If **Δx** = local / widespread impacts

I = « intensity »
Δt = duration



For **Δt=6h ;** (I.**Δt**) = 20 mm ; 30 mm
For **Δt=12h ;** (I.**Δt**) = 30 mm ; 40 mm
For **Δt=24h ;** (I.**Δt**) = 40 mm ; 50 mm

If (**Δx, Δt,** (I.**Δt**), …) **such that Fct= Fct* AND soil already wet:**
Fct* => Fct*

If (**Δx, Δt,** (I.**Δt**), …) **such that Fct= Fct* AND soil already wet + floods problem reported:**
Fct* => Fct*

Illustration: Warnings for Wintry situation (ice/snow)

Thresholds values must be adapted for early warnings

IMPACTS = Fct (**I** , **(I.Δt)** , **R** , **t** , Δt , x , **Δx** , …)

I = « intensity »
Δt = duration

For snow:

0 < (I.Δt) < 1-2 cm

3-5cm < (I.Δt) < 10 cm OR Snow showers

(I.Δt) > 10 cm

If **Fct= Fct* AND continuous snowfall: Fct* => Fct***

(Early) Warnings for Heat wave

IMPACTS = Fct (**I** , **(I.Δt)** , **R** , **t** , Δt , x , **Δx** , …)

Mean Tmax [°C] AND Mean Tmin [°C]	[28;30] / [16;18]	[30;32] / [18;20]	> 32 / > 20
Number of days ▼			
1	Fct*	Fct*	Fct*
2	Fct*	Fct*	Fct*
3	Fct*	Fct*	Fct*

I = Intensity
Δt = duration

+ OZONE

(Early) warnings for Cold spell

IMPACTS = Fct (**I** , **(I.Δt)** , **R** , **t** , Δt , x , **Δx** , …)

Mean Tmax [°C] AND Mean Tmin [°C]	[-1;-5] / [-5;-9]	[-5;-9] / [-9;-13]	< -9 / < -13
Number of days ▼			
1	Fct*	Fct*	Fct*
2	Fct*	Fct*	Fct*
3	Fct*	Fct*	Fct*

I = Intensity
Δt = duration

Example of an early warning for a cold spell (« grand froid ») at the Swiss met office;
Criteria on TN and TX – duration (consecutive days) + wind chill

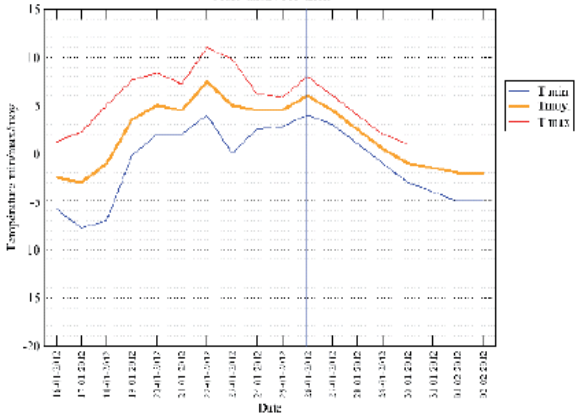
Bulletin météorologique du jeudi 26 janvier

Version corrigée.
A partir de samedi, les températures seront en baisse assez marquée et la bise se lèvera pour quelques jours. Les températures seront proches des seuils critiques. L'évolution de cette situation méritera donc d'être surveillée la semaine prochaine...

Facteur agravant : bise parfois > 50 km/h

date émission: 26.01.2012

Validité : 16.01.2012 au 02.02.2012



Cette prévision "grand froid" est un test pour l'hiver 2011-2012. En dehors de cette prévision, il n'y a pour l'heure pas d'avis de "grand froid" émis par MétéoSuisse.
Les critères suivants seront utilisés et testés :
A) Tmax <= 0° la journée, Tmin <= 0° : journée de gel.
B) Tmax <= 0°, Tmin entre -5 et -10° la nuit : grand froid.
C) Tmax <= 0°, Tmin < -10° la nuit : froid extrême.
Dans tous les cas, la durée (en jours) et le vent (refroidissement éolien) seront pris en compte.

Office fédéral de météorologie et de climatologie
MétéoSuisse
7bis, avenue de la Paix, 1211 Genève 2.
Téléphone confidentiel : 022 716 28 04

Bulletin météorologique du lundi 13 février

La vague de grand froid touche à sa fin. Aujourd'hui encore les températures resteront négatives mais la sensation de froid sera moins marquée en raison de la fin de la bise.
A partir de mardi, de l'air moins froid mais plus humide se frayera un chemin en plaine et remplacera l'air continental sibérien qui nous a envahi depuis le début du mois (chutes de neige jusqu'en plaine surtout mercredi). Mardi après-midi, nous devrions repasser pour la première fois légèrement au-dessus du 0° et donc quitter les critères "Grand Froid".

date émission: 13.02.2012

Validité : 03.02.2012 au 20.02.2012

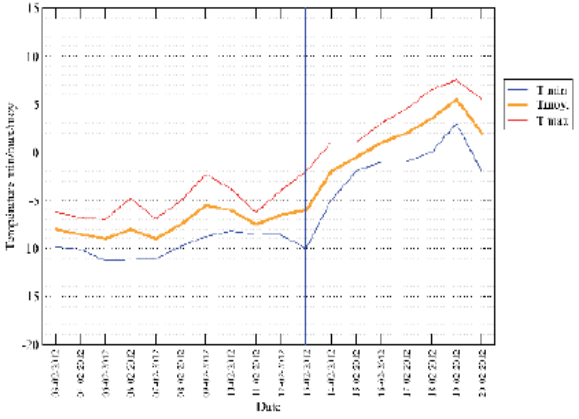


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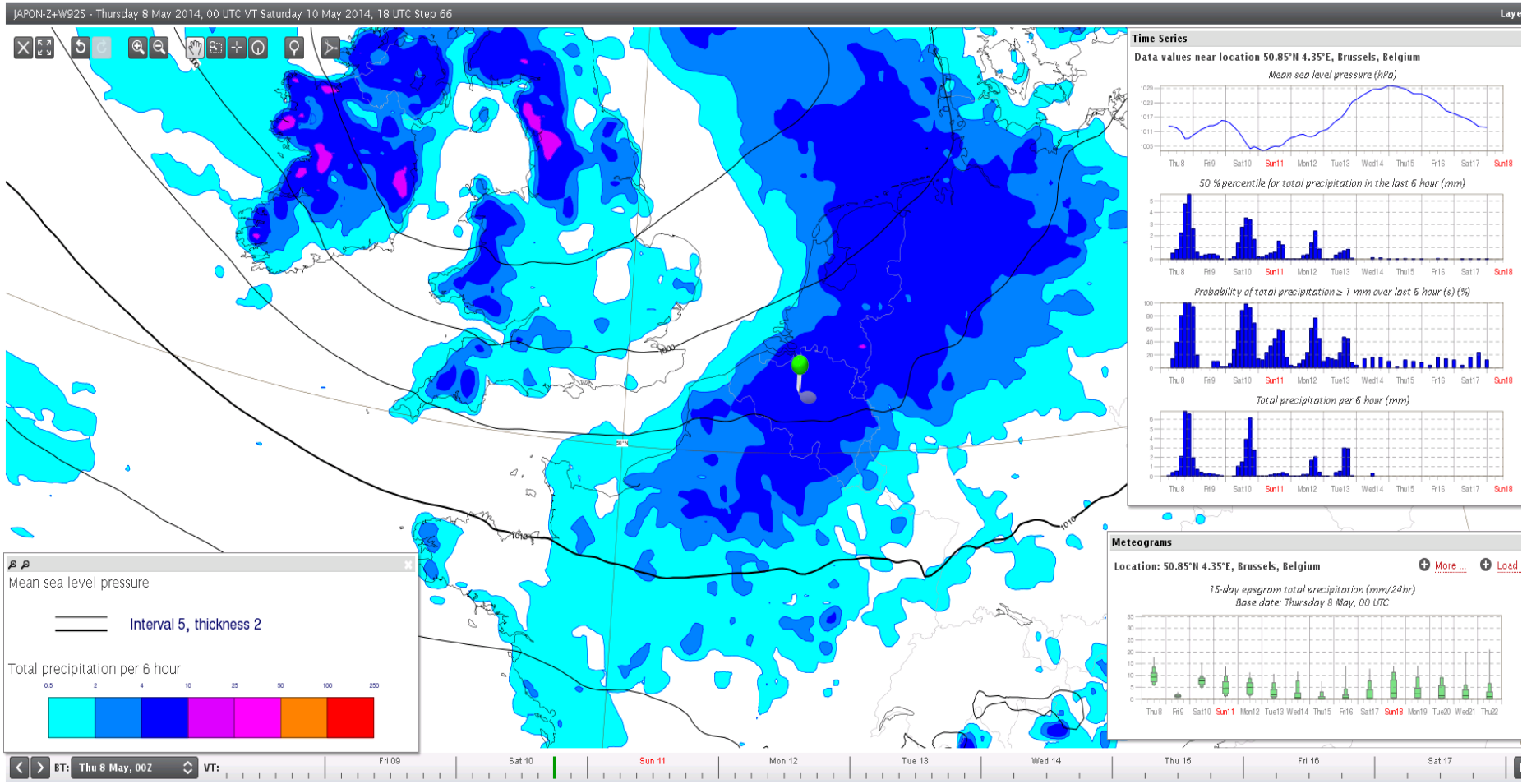
Figure 4: Example of "extreme cold" bulletins sent to health services, on the left and the right, before, respectively after the cold spell.

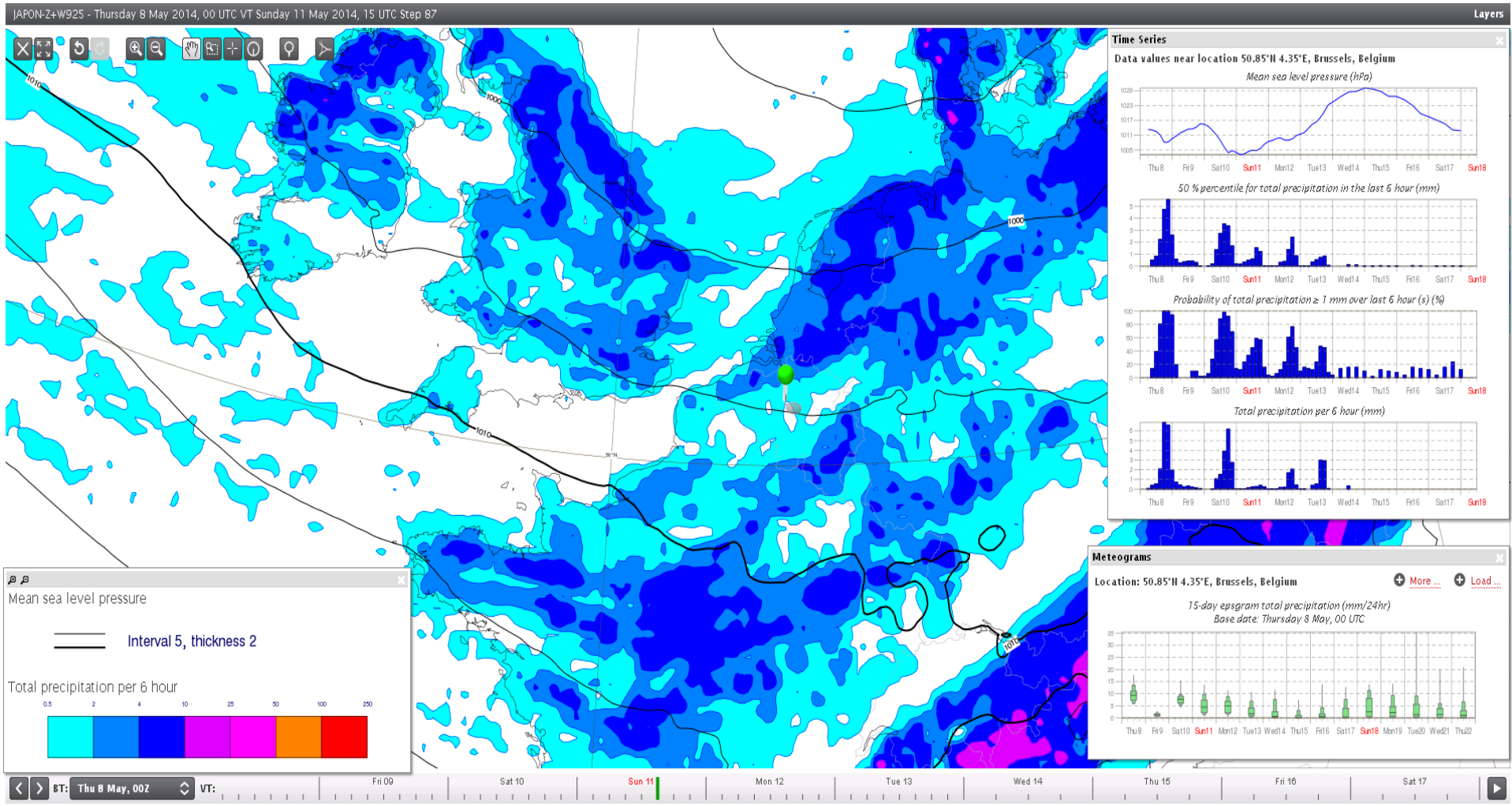
E/ illlustration of the methodology exploiting raw ECMWF model data : DECISION: early warning for precipitations or NOT ?

ECMWF run date: 8/5/2014 at 00h00 u.t.c.



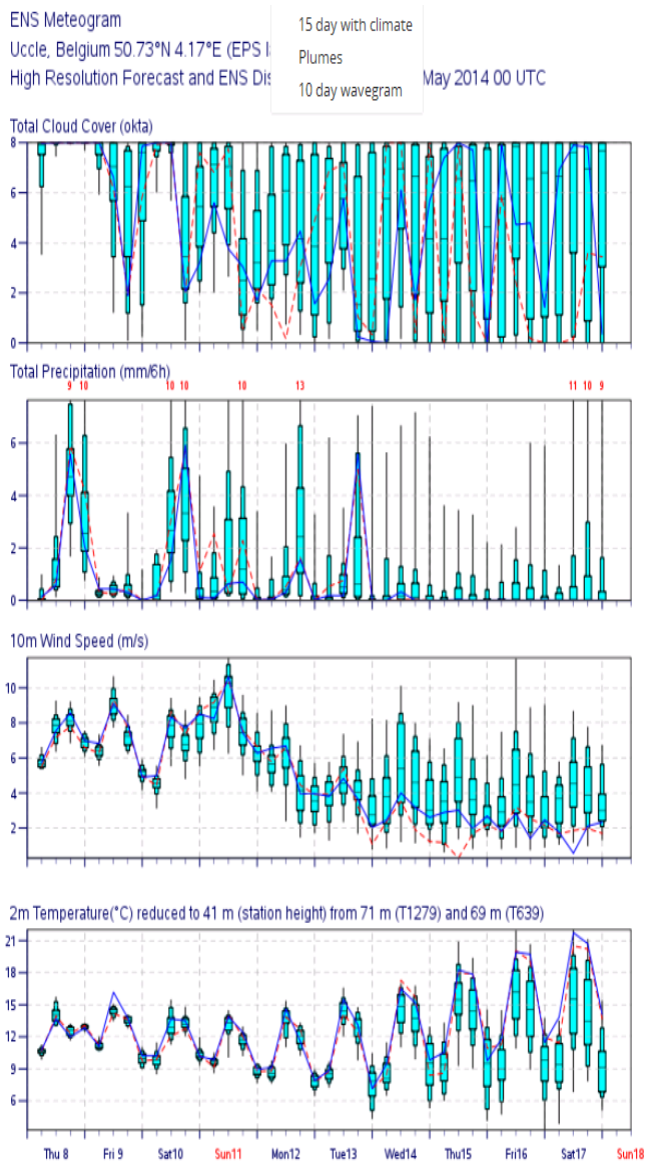
HRES forecasts: MSLP and RR (mm/6h) + legends > **LOW /G. Britain/ & significant precip.** (left) : D+2 HRES forecast verifying on Saterday 10/5/2014 at 15h00 Z
(right): EPS forecasts: meteograms and time series for BRUSSELS (location=green spot)

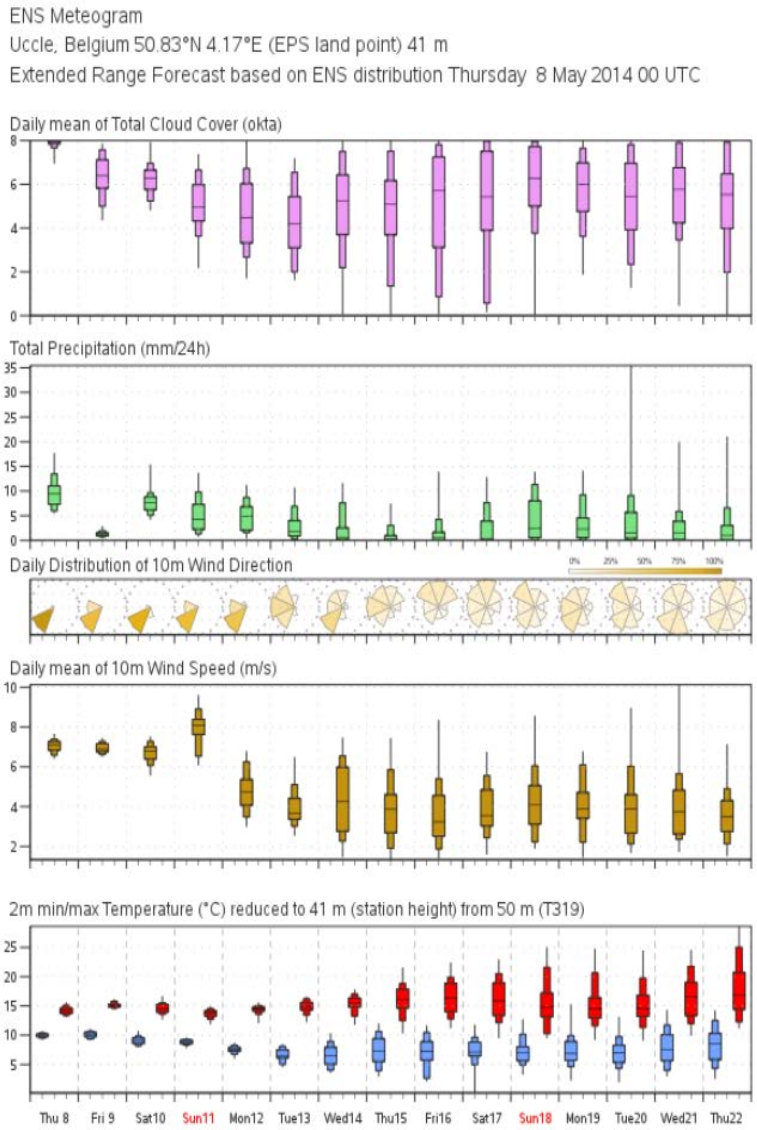
ECMWF run date: 8/5/2014 at 00h00 u.t.c.



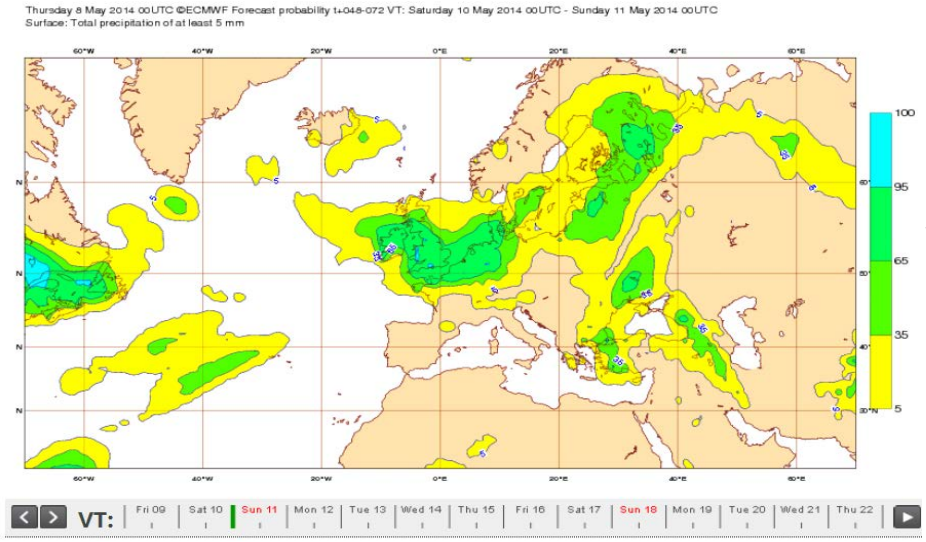
HRES forecasts: MSLP and RR (mm/6h) + legends > LOW North Sea + significant precip.
(left): D+3 forecast verifying on Sunday 11/5 at 15h00 Z
(right): EPS forecasts: meteograms and time series for BRUSSELS (location=green spot)

EPSgrams for RR: run date 8/5/2014 at 00h00 Z – location: Brussels
EPS forecasts: next 10 days (left) – next 15 days (right)

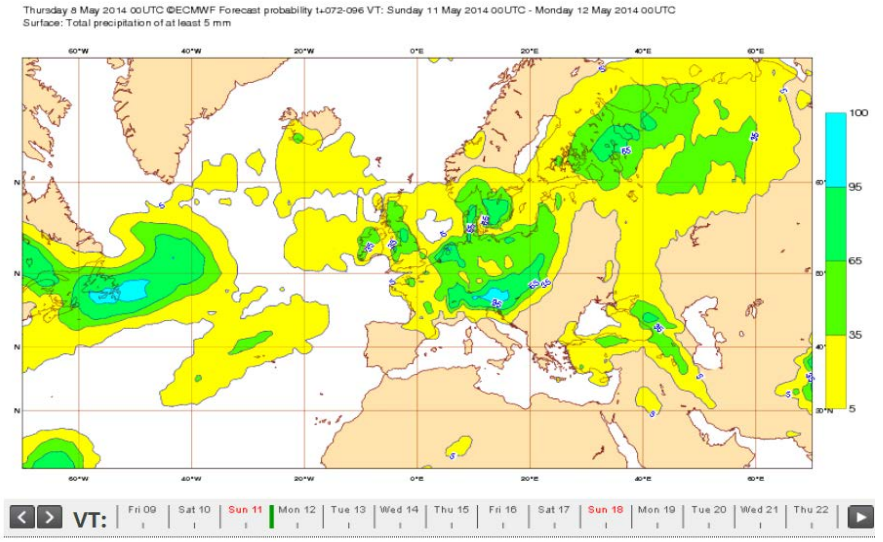




Probability forecasts for RR issued from EPS – run date 8/5/2014 at 00h00 Z – north Atlantic + Europe
– RR thresholds respectively 5 and 10 mm/day AND for the weekend : SATERDAY (10/05) and SUNDAY (11/05)

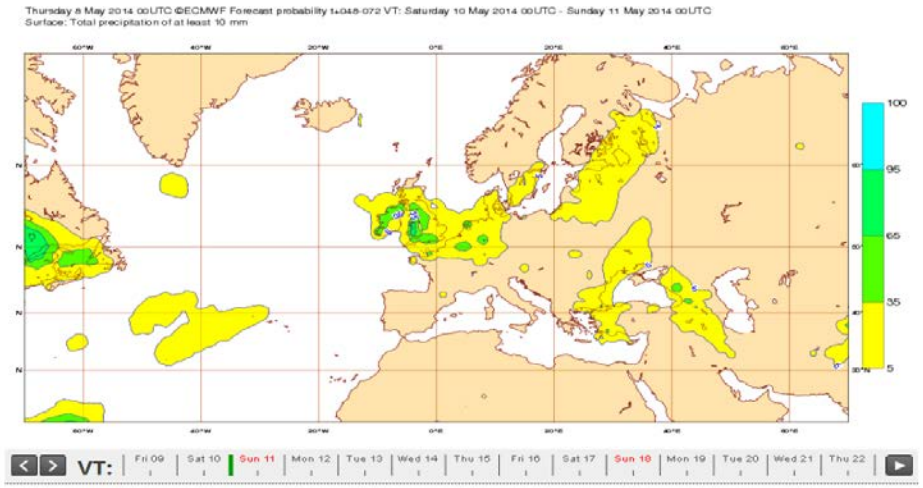


5 MM

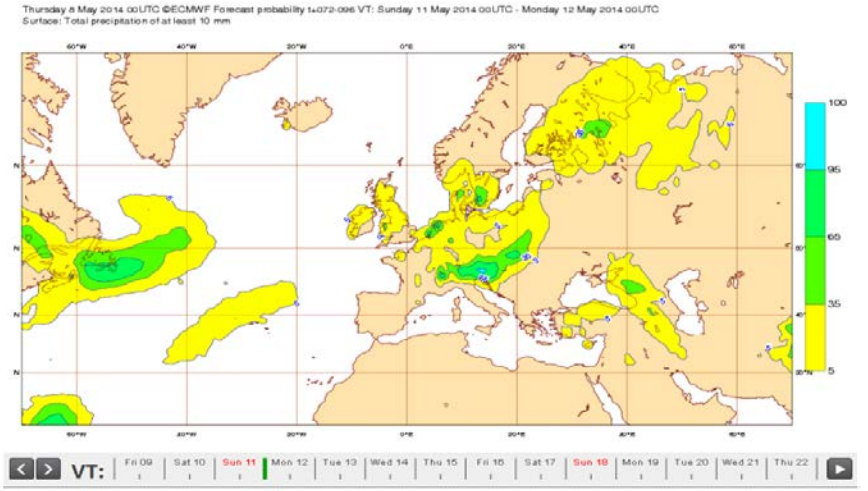


Probabilities: 24h precipitation FCT 10/5

Probabilities: 24h precipitation FCT 11/5



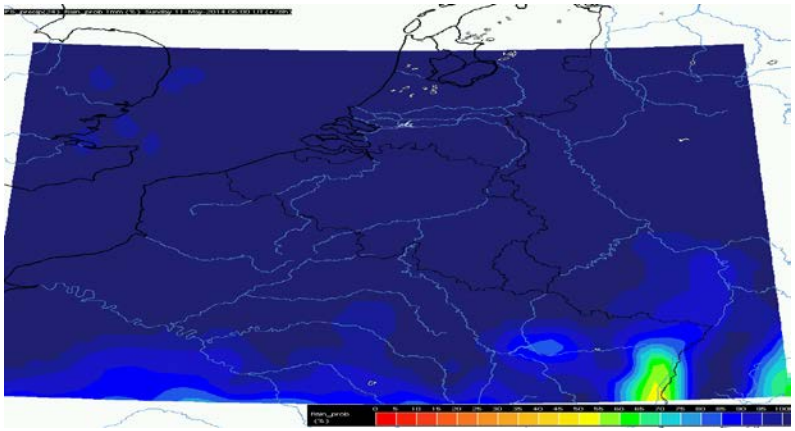
10 MM



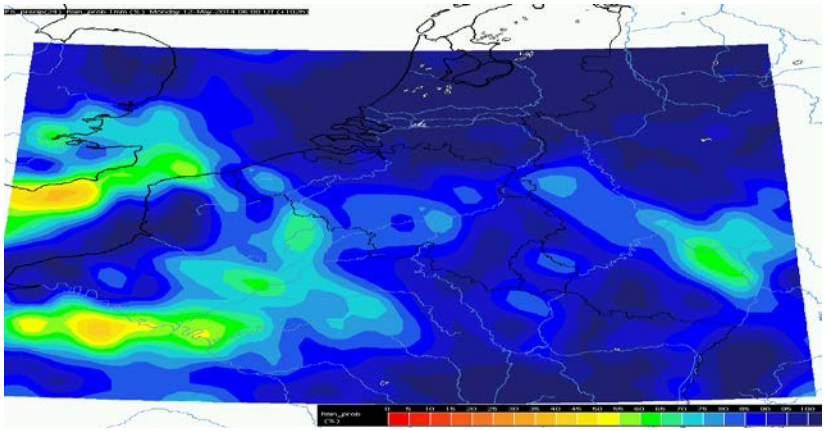
Probabilities: 24h precipitation FCT 10/5

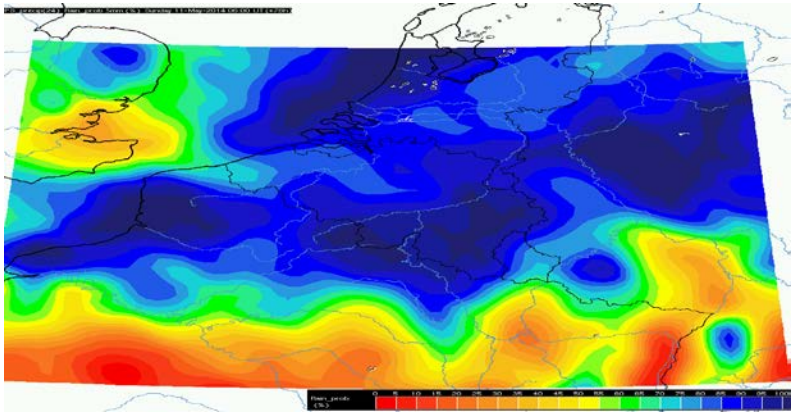
Probabilities: 24h precipitation FCT 11/5

RR probability forecasts: different thresholds for Belgium & surroundings: run date 8/5/2014 at 00h00 Z

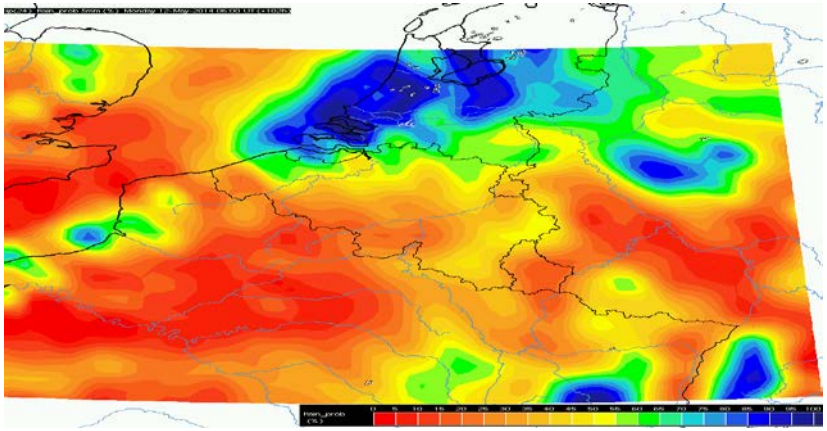


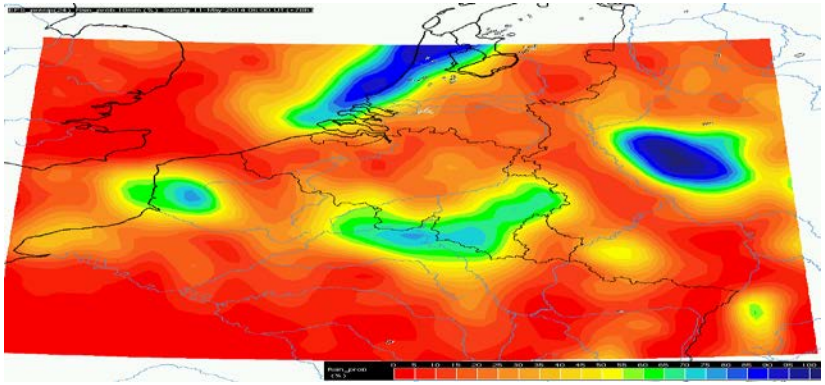
>1 MM



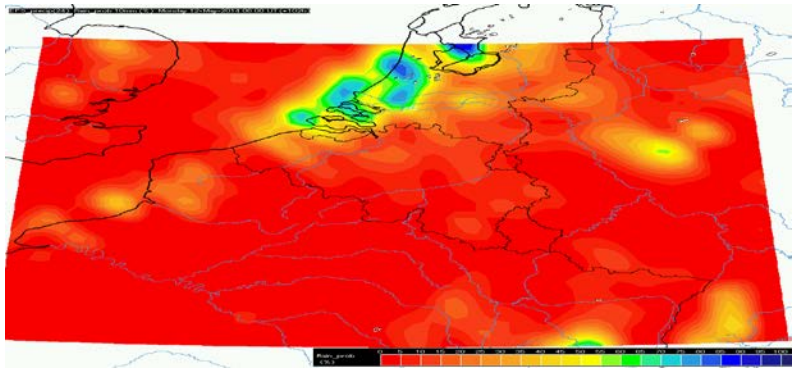


>5 MM





>10 MM



RR forecasted on 24h from 10/5 6h00 to 11/5 6h00 Z (D+2)

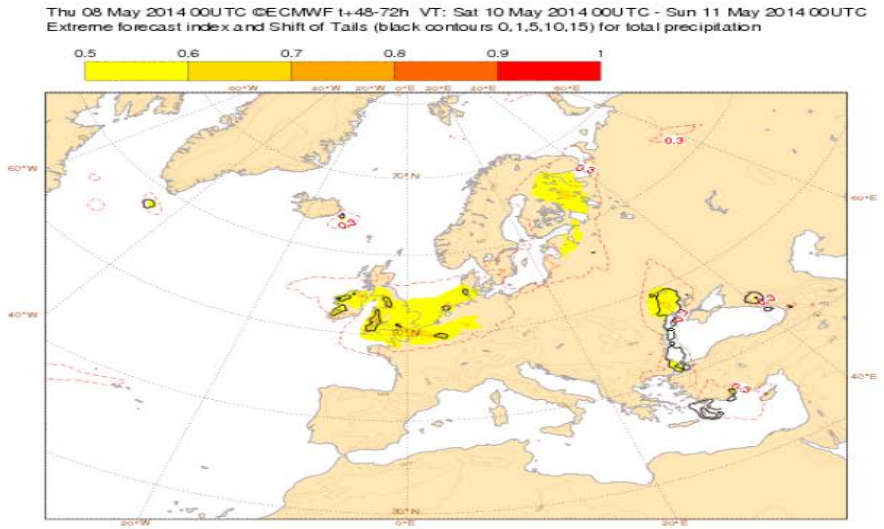
RR forecasted on 24h from 11/5 6h00 to 12/5 6h00 Z (D+3)

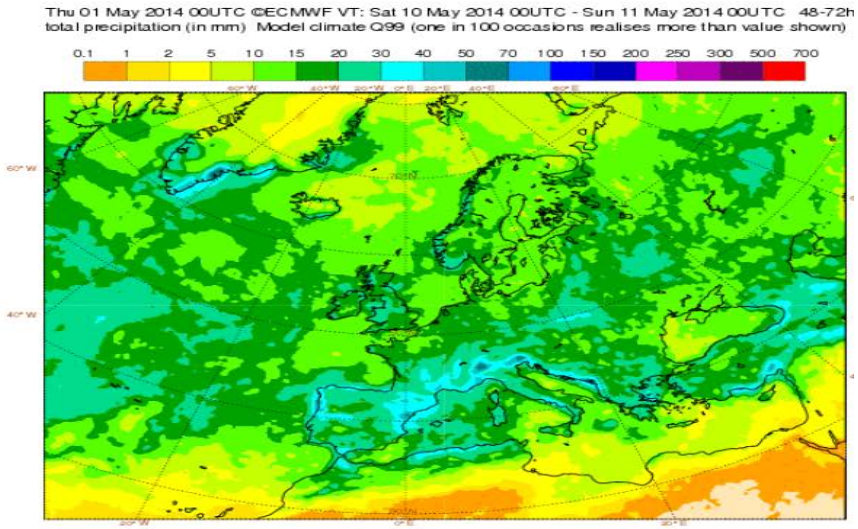
« Extreme forecasts » indices (EFI and SOT): run date 8/5/2014 at 00h00 Z

EFI precipitation for Saterday 10/5 (D+2)

Percentile 99: 15<x<20 mm/day

Forecast base time | Area | Quantile | Day

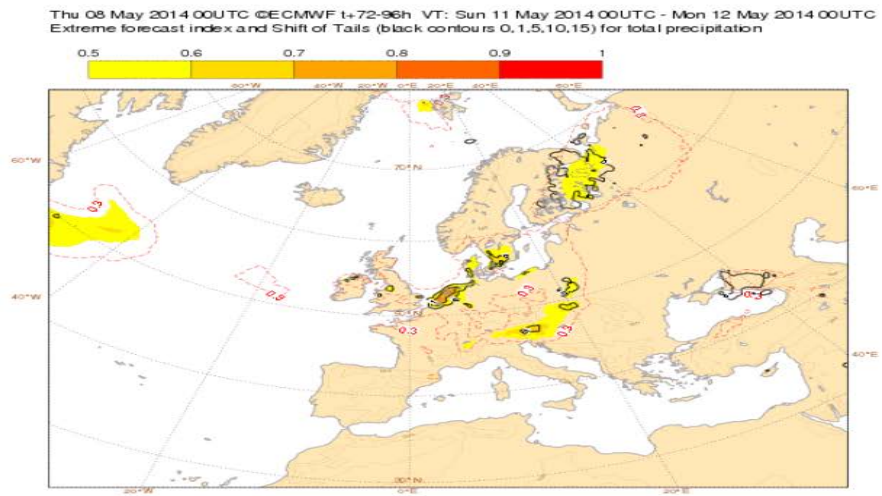


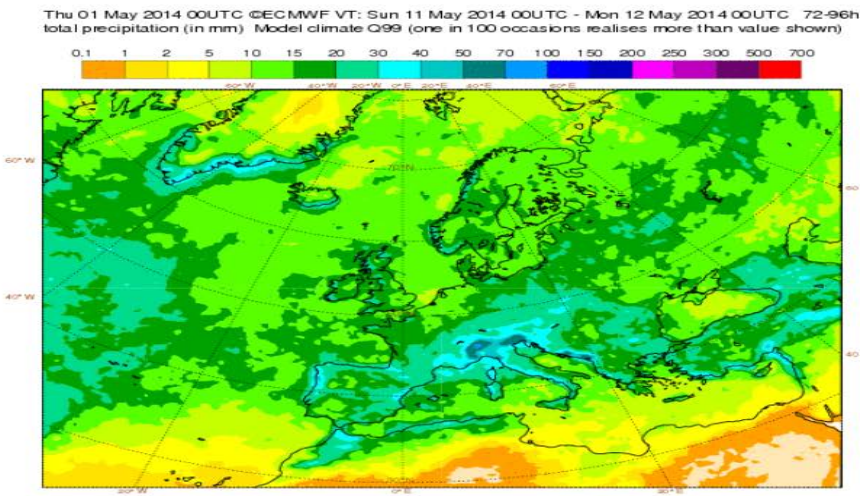


EFI precipitation for Sunday 11/5 (D+3)

Percentile 99: ~15 mm/day

Forecast base time | Area | Quantile | Day





Checking the consistency of successive raw EPS-ECMWF forecasts (1)

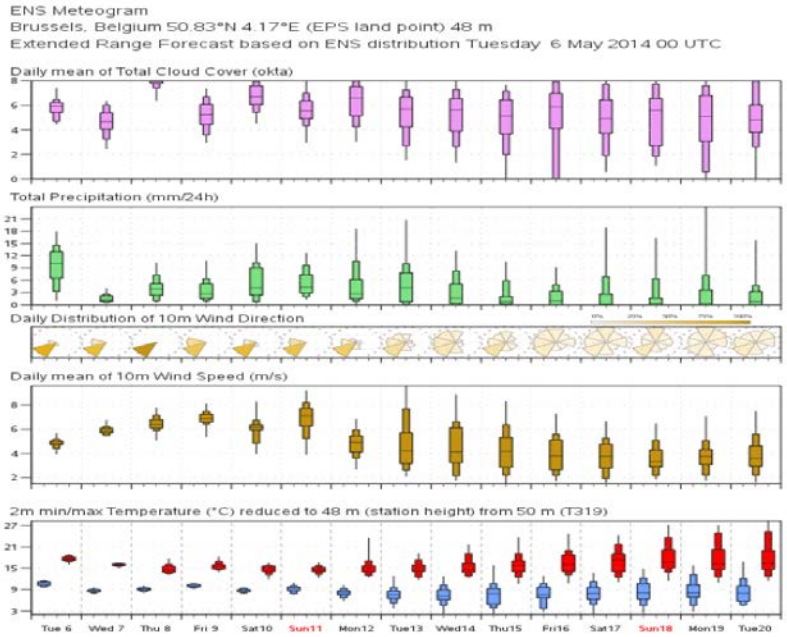
To estimate whether a potential Early warning related to severe precipitations
Forecasts is going to be issued for the next weekend
[dates: D+2 and D+3 => (10 & 11/05/2014)]

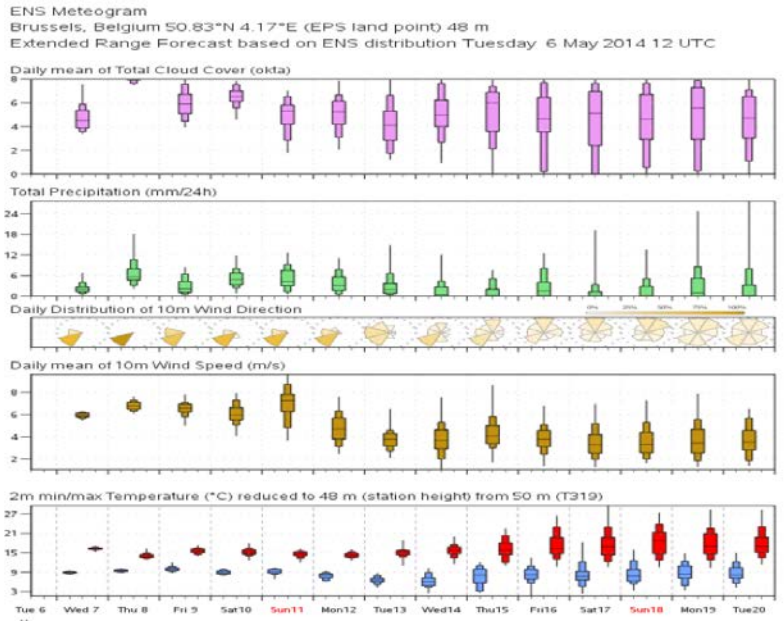
The consistency of successive EPS forecasts (here no HRES shown) wil be examined:
-for more likely (synoptic) weather scenarios
-for probability forecasts
-for « extreme » indices (EFI & SOT)

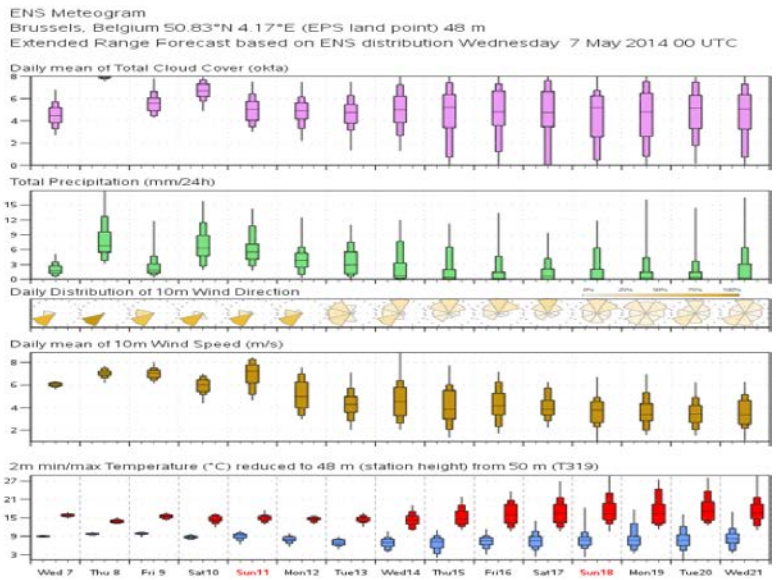
(1) EPS-ECMWF forecasts are run respectively
from Tuesday 6/5 – Wednesday 7/5 and Thursday 8/5/2014
These forecasts are verifying on the following week-end (10 & 11/05/2014)

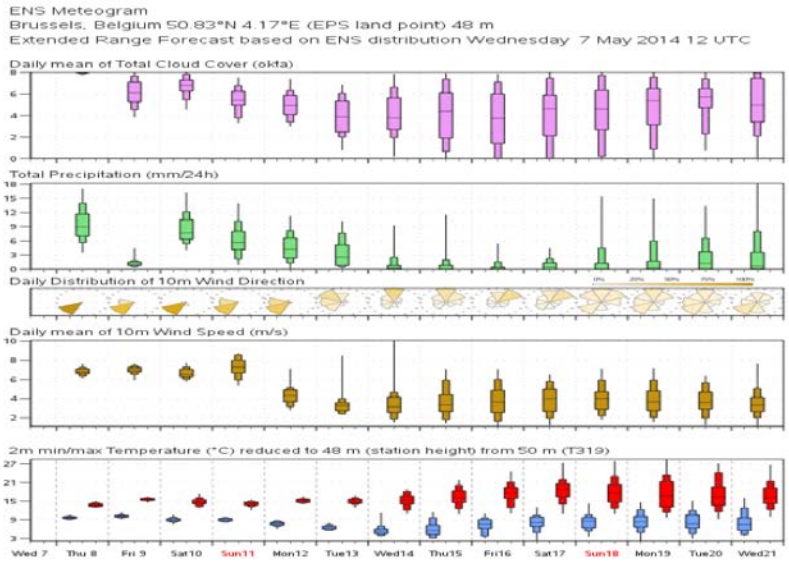
EPSgrams for Brussels: RR (mm/24h) – last four runs from 6/5 and 7/5/2014

(see a way to synthetize these forecasts > bar diagrams for RR (mm/24h) …

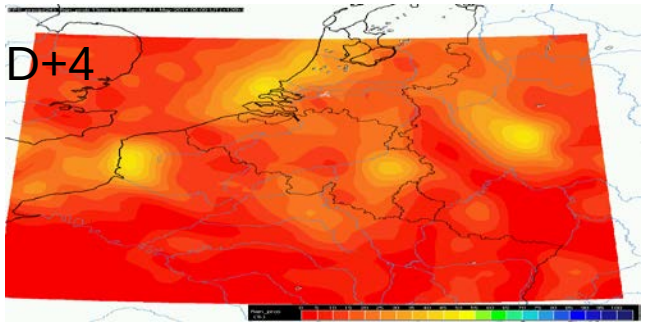


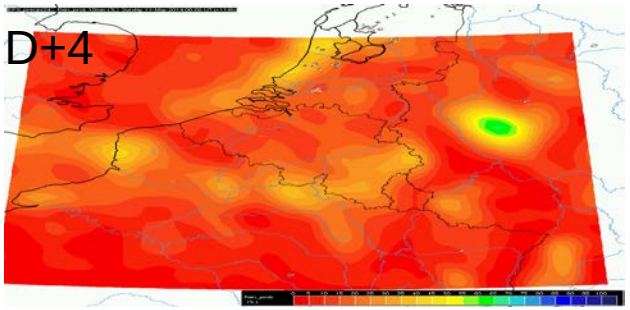


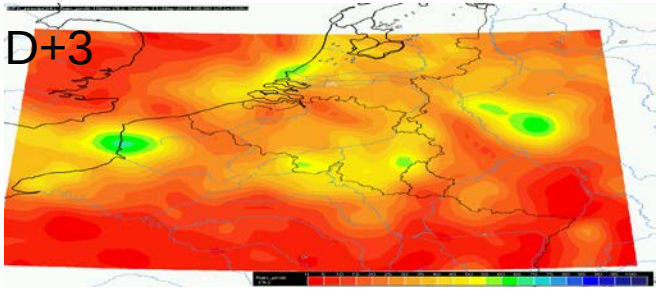


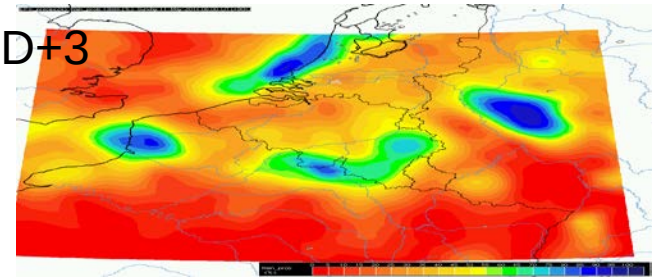


Successive probability forecasts for daily RR: run dates 6/5 and 7/5/2014 at 00h and 12h00 Z



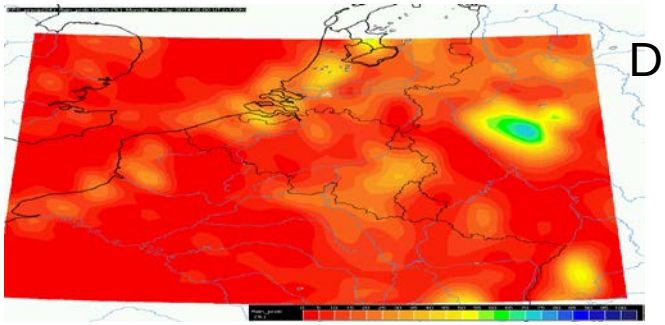


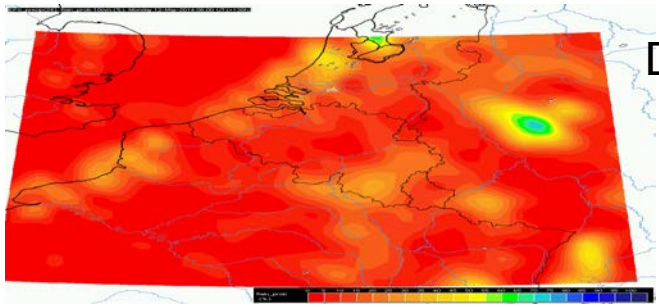


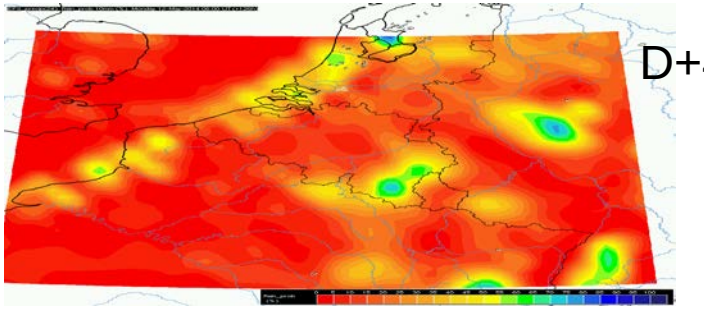


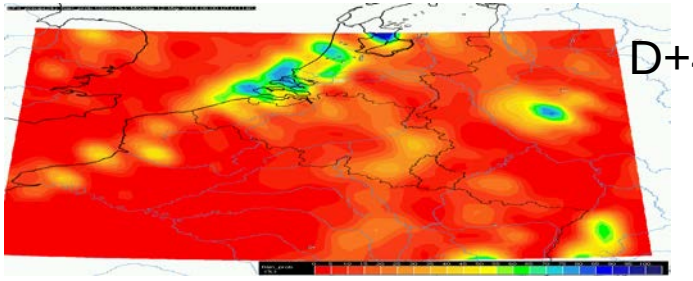
Threshold :
RR >10 mm/day

Probabilities increasing from yellow to blue (red= small probabilities <30%)





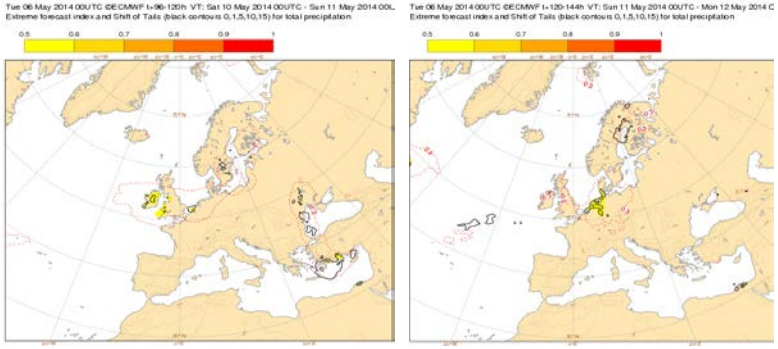




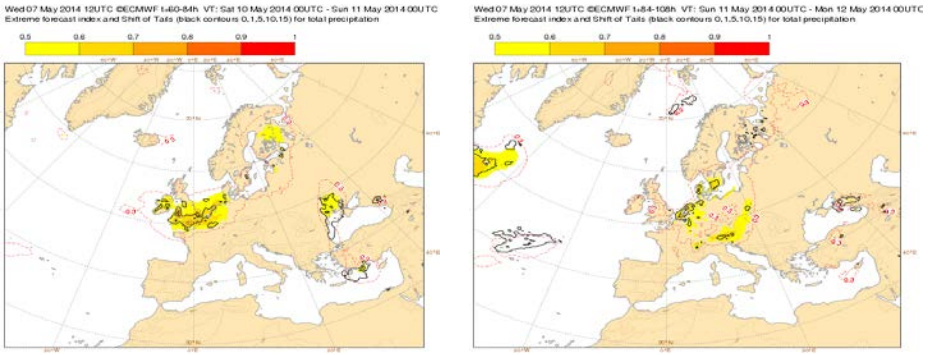
EPS charts forecasted from SAT (10/5) 6h00 Z to SUN (11/5) 6h00Z

EPS charts forecasted from SUN (11/5) 6h00 Z to MON (12/5) 6h00Z

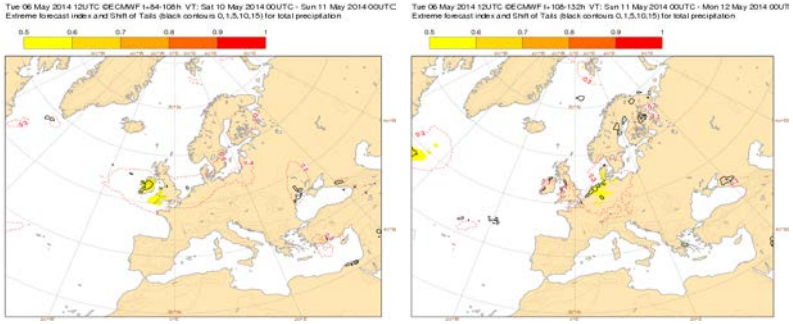
Successive « extreme forecast » indices: run dates 06 and 07 and 08/05/2014



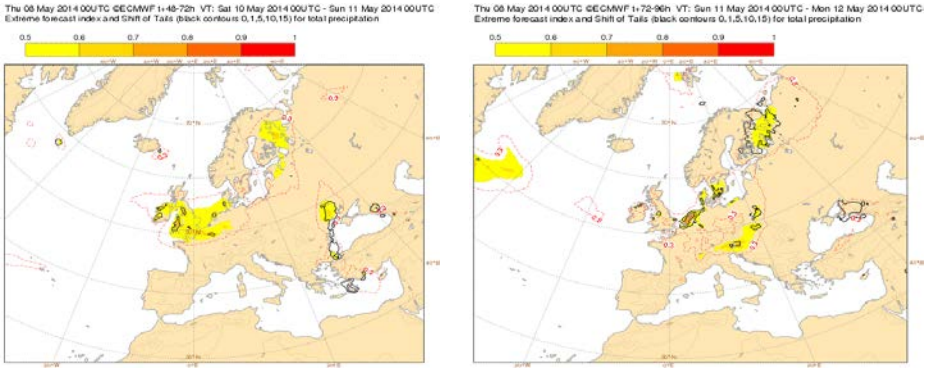
Run date: 6/5 at 00h00 Z



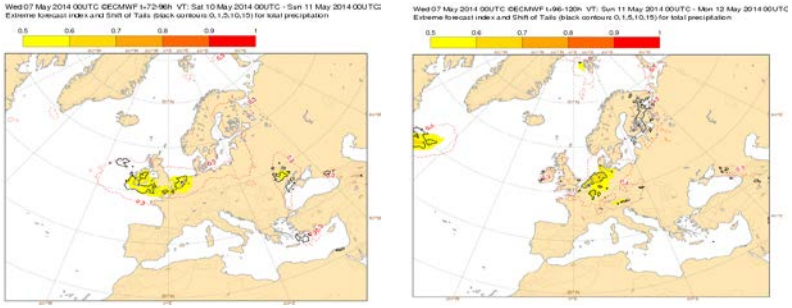
Run date: 7/5 at 12h00 Z



Run date: 6/5 at 12h00 Z



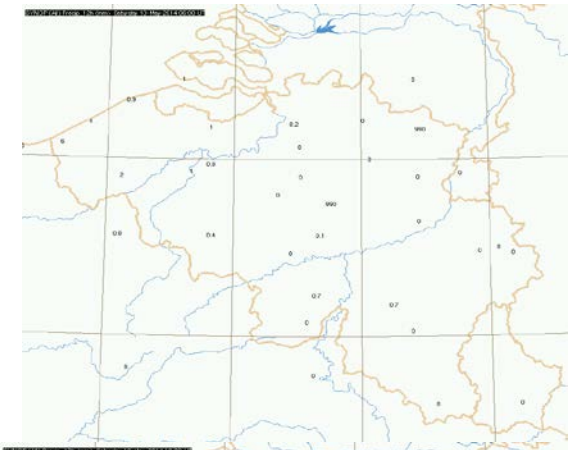
Run date: 8/5 at 00h00 Z

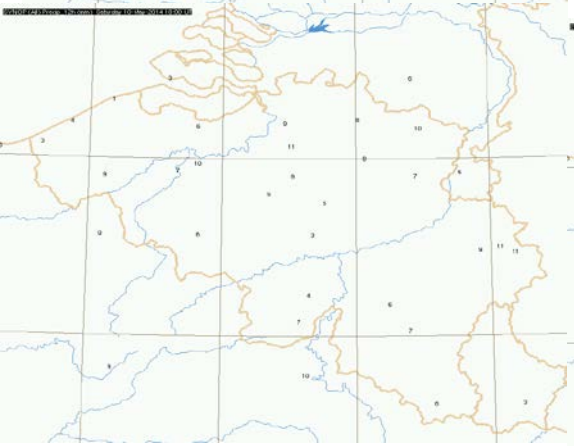


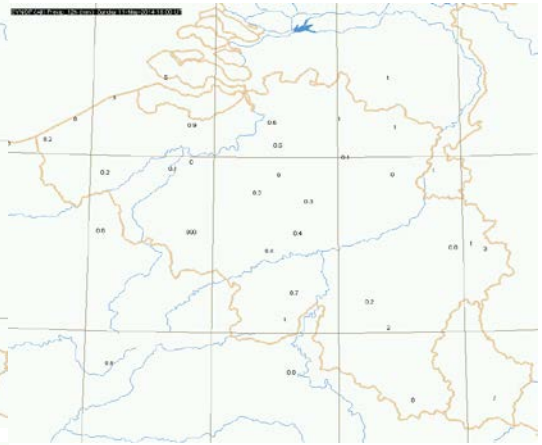
Run date: 7/5 at 00h00 Z

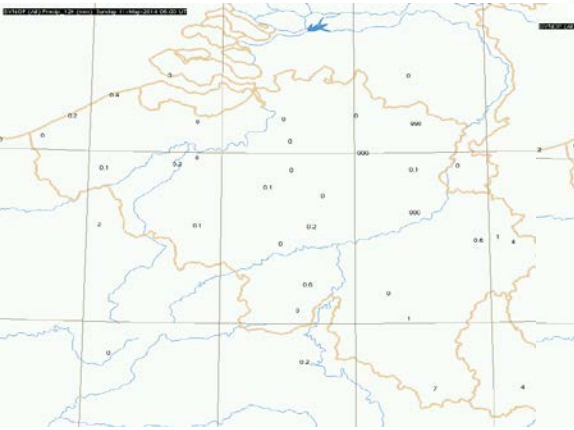
EFI (coloured areas) and SOT (black lines) forecasts from successive EPS runs;
respectively for Saterday (10/5): columns 1 and 3
AND Sunday (11/5); columns 2 and 4

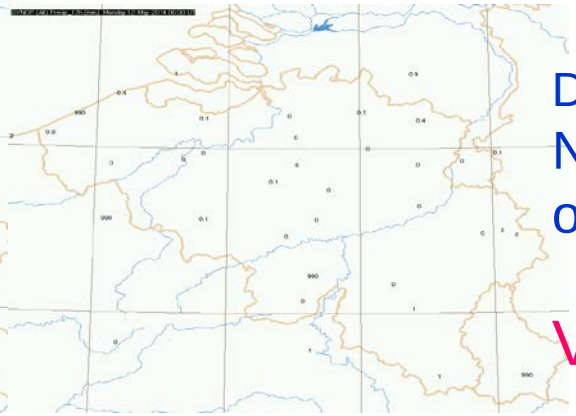
RR observations : Synoptic stations (left) – one Radar estimation (Jabbeke) (right)



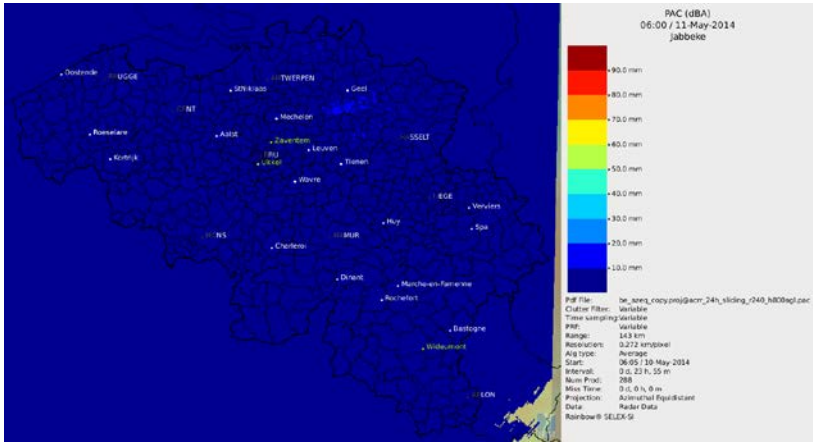


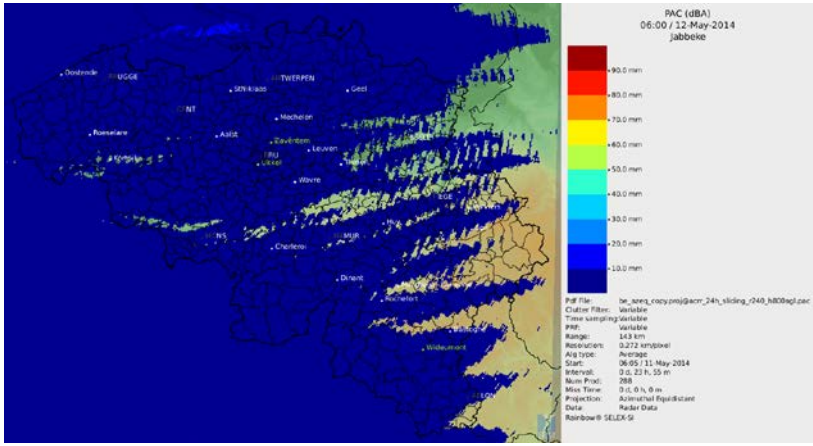






Dates:
SAT 10/5/2014
&
SUN 11/5/2014





DECISION: for the next weekend
No early warning for precipitations over Belgium

Verified by observations

(for information)
Post processing EVMOS (calibration=post-processing)

EVMOS is a deterministic-like approach: each ensemble member is corrected in a similar fashion: it works
-using model variables as predictors: (uncorrected values for p predictors …)
-assume Gaussian error statistics (Gaussian distribution of errors; ε and variance error (corrected FCT – OBS)
-a removal of biases is allowed (combination simple BIAS method and EVMOS based on hindcasts with compute regression coefficients α and β ?)
-a more stable method ? (see reliability constraints like correlations … ?)

+ CRPSS score results

Statistical-like approaches include NGR: non-homogeneous Gaussian Regression.
The spread and mean of each ensemble are modified by minimizing the CRPS (Continuous Ranked Probability Score) > a new ensemble distribution is produced

+ idem (more information on NGR – hypothesis …)

CHECK this information – needed ?

•Each week we train using 9 x 18 (now 20) hindcasts with 5 members: each Thursday EPS with 5 members,
for 9 weeks including the targetted week (see the date) and for the last 18 years (now 20 years).
So the hindcast training provides stable post-processing for the wind (u,v) and the temperature near the surface:
a stable linear relationship is found between past forecast variables and corresponding observations in stations

•For the verification set (e.g. EPS 2011 - 2012) this stable linear relationship is applied in the post-processing to the members of a new EPS Forecast (EPS run) in order to produce corrected (EPS) forecasts for each member which are compared to observations in 30 stations

II. Experimenting a new clustering

Motivation of forecasters

Taking the current Z500 EPS clustering for granted forecasters would like to **better discriminate « air masses » patterns or areas / transitions / durations** by exploiting a new and complementary EPS clustering for the first week of the forecasts (D+2 to D+7) which would include fields with their « anomalies » (using a model climatology)

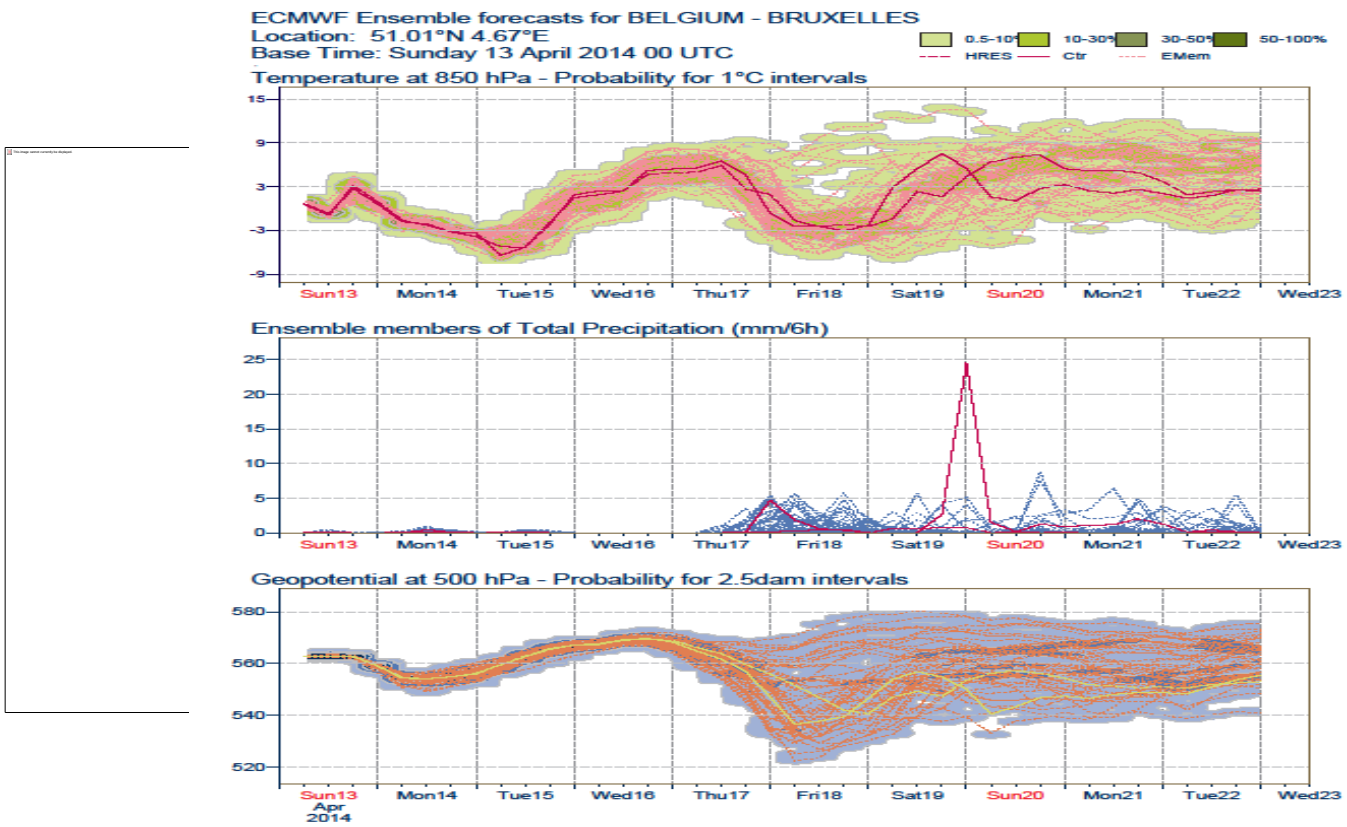
Objective / how ?

a new clustering on a smaller domain:
-a synoptic scale domain over Western Europe ; PROPOSAL [40/60 North – 20 W/20 East]
-using near surface or lower tropospheric levels; like 700, 850, 925, 1000 hPa
-for a few variables (not only standard ones currently available on MARS)
PROPOSAL: Z, T, W and thetae or theta'w

Which products ?

Representative EPS members and an « anomaly » fields in a defined domain centred over Belgium
for the first two « time windows » of the EPS clustering; [RUN DATE +72h to +96h AND RUN DATE +120h to +168h]

EPS forecasts for Easter 2014



EPS plumes for Brussels:
a large EPS spread for Easter and following days (so from Friday 18/04/2014)

First attempts exploring EPS clustering and questions/expectations

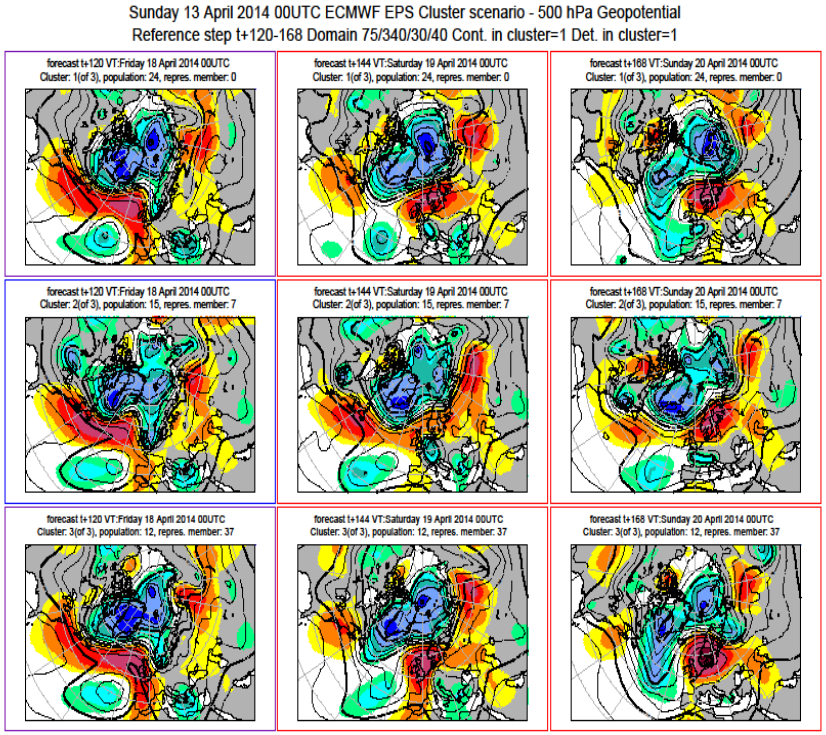
- Large dispersion (spread) in Z500 clustering over a large domain?
- Large dispersion (spread) in Z500 clustering over a small domain?
- Large dispersion (spread) in Z850 clustering over a small domain?

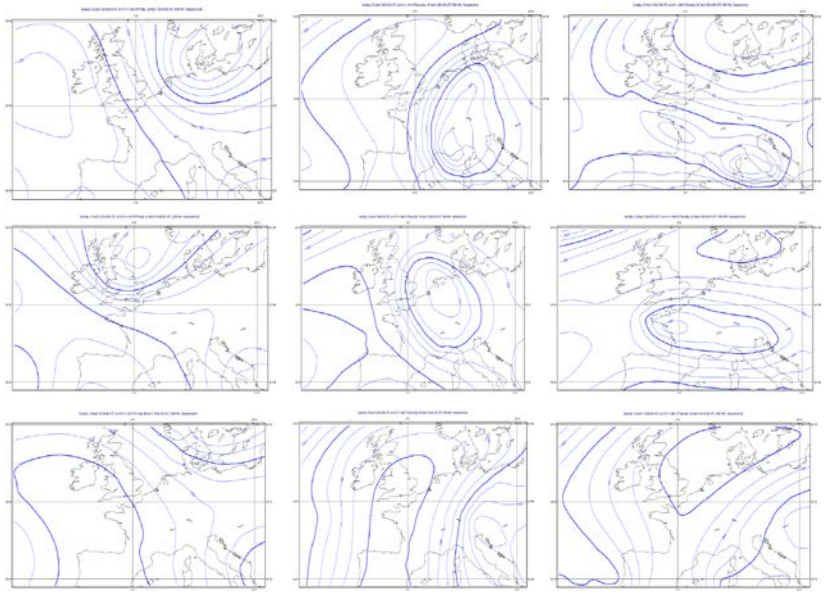
➢ *Let's examine the number of clusters and representative cluster patterns for Z500 and Z850 hPa*

➢ *let's test new parameters at a fixed pressure level , e.g. at 850 hPa like T ,Thetae, Theta'w;*

A formulation of Thetae and Theat'w from [p (hPa), T (K) and RH (%)] is used (Reference: Robert Davies-Jones (2008))

➢ *let's make also tests at surface parameters like T 2m , W 10m, RH…*





Analyzing the large EPS spread on Z500

for the Easter weekend 18 – 20/4/2014

EPS Z500 clustering
Large domain [30-75N; 20W-40E]

3 clusters: representative EPS member
3 lead times +120 +144 +168h

Verifying on FRIDAY 18/4 –SATERDAY 19/4
And SUNDAY 20/4/2014 at 00h00Z

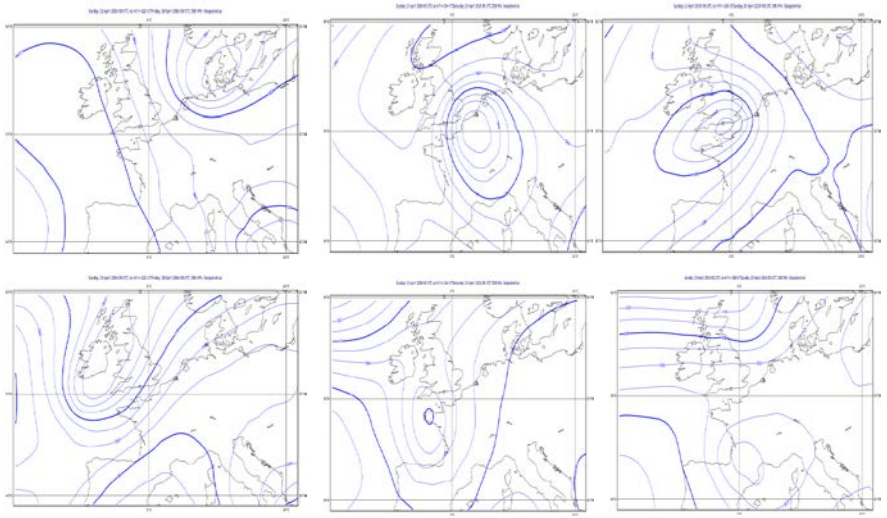
IMPACT of a smaller DOMAIN

EPS Z500 clustering
Small domain [40-60N; 20W-20E]

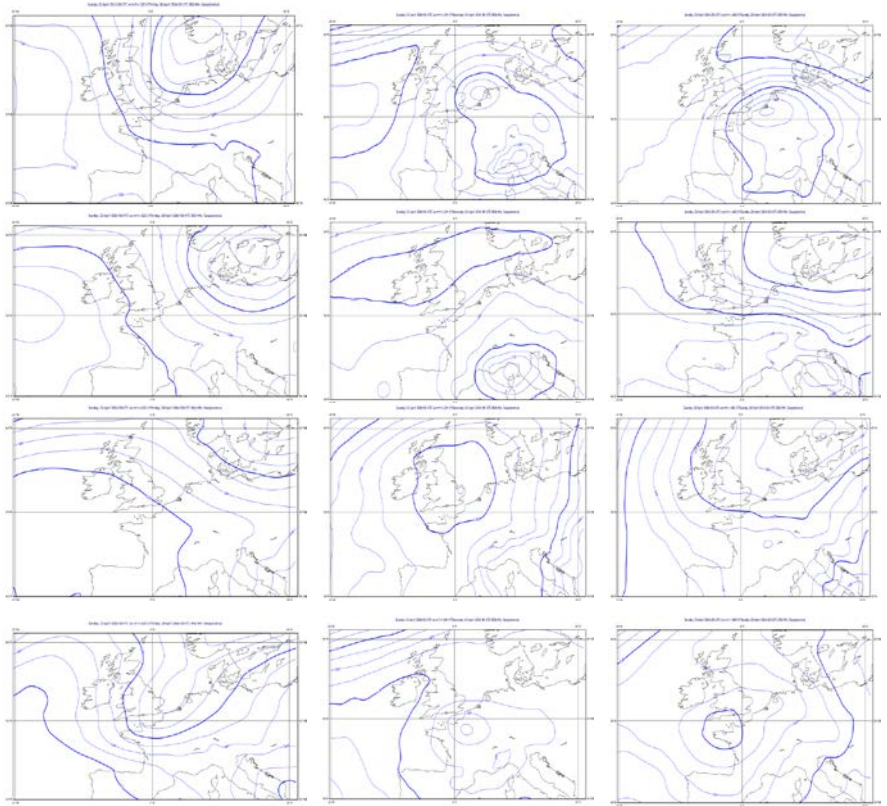
5 clusters: representative EPS member
(here three first ones)
3 lead times +120 +144 +168h

Verifying on FRIDAY 18/4 –SATERDAY 19/4
And SUNDAY 20/4/2014 at 00h00Z

No Z500 regime (coloured frame)
No model climate anomalies (coloured area)



+120h +144h +168h



EPS Z500 clustering
Small domain [40-60N; 20W-20E]

5 clusters: representative EPS member
(two last ones; clusters 4 and 5)
3 lead times +120 +144 +168h

Verifying on FRIDAY 18/4 –SATERDAY 19/4
And SUNDAY 20/4/2014 at 00h00Z

No Z500 regime (coloured frame)
No model climate anomalies (coloured area)

IMPACT of another PARAMETER

EPS Z850 clustering
Small domain [40-60N; 20W-20E]

4 clusters: representative EPS member

3 lead times +120 +144 +168h

Verifying on FRIDAY 18/4 –SATERDAY 19/4
And SUNDAY 20/4/2014 at 00h00Z

No Z500 regime (coloured frame)
No model climate anomalies (coloured area)

What did we observe for Easter ?

III. Motivations and perspectives to exploit extended range forecasts

- more and more extended forecast products are now available on the ECMWF web site and they are more frequently updated.

Nevertheless we haven't yet integrated these forecsts in our operational tasks.

- what could we expect now and in a near future from the more recent EPS-ECMWF model developments for monthly and seasonal forecasts ?

Could we expect a significant signal:
-in terms of predictability with mean (median) and spread … from EPS forecasts for suface temperature, wind, precipitations (anomalies)…
-for upper-air variables like Z500 and T850 pattern anomalies…
-with enough consistencies; comparing model run twice a week and/or if the « time window » of forecasts is slightly shifted from one month to the next one or grouping successive ones…
-how to cope with extended forecasts for small countries (Belgium)

- our forecasters are faced to many questions about the predictability for more extended ranges. These questions are raised by the general public but mostly Medias (interviews) – authorities and Key users like in the fields of energy, hydrology agriculture, transport and tourism…

- training of forecasters on extended range forecasts are needed to get a 'clear' commmunication and consistent comments on the quality of these extended range forecasts.
Which are currently the more reliable (raw) products synthetizing these forecasts ?

IV. Comments and discussions on these projects

More suggestions for our challenging projects are welcome

Taking advantage of a much closer co-operation between forecasters AND colleagues working in model research and observations fields ALSO for METEOALARM

And developing a regular communication with external users to implement and/or orientate new meteorological products and verification tools

Thank you very much for your attention and support …