

# Prévision d'ensemble

- le chaos atmosphérique
- modélisation stochastique
- applications
- prévision saisonnière

# Prévision d'ensemble

**But :** produire une prévision stochastique (=qui reflète nos incertitudes)

**Prévision d'ensemble:** échantillonnage discret de la loi de probabilité de prévision. On lance  $q$  prévisions perturbées en parallèle ( $q \sim 50$ )

Par exemple avec  $A=L L^T$ , si l'on tire aléatoirement  $u$  suivant la loi Gaussienne, alors la prévision perturbée  $v=x_a + Lu$  suit la loi de probabilité d'analyse impliquée par  $A$  (matrice de covariances d'erreurs d'analyse)

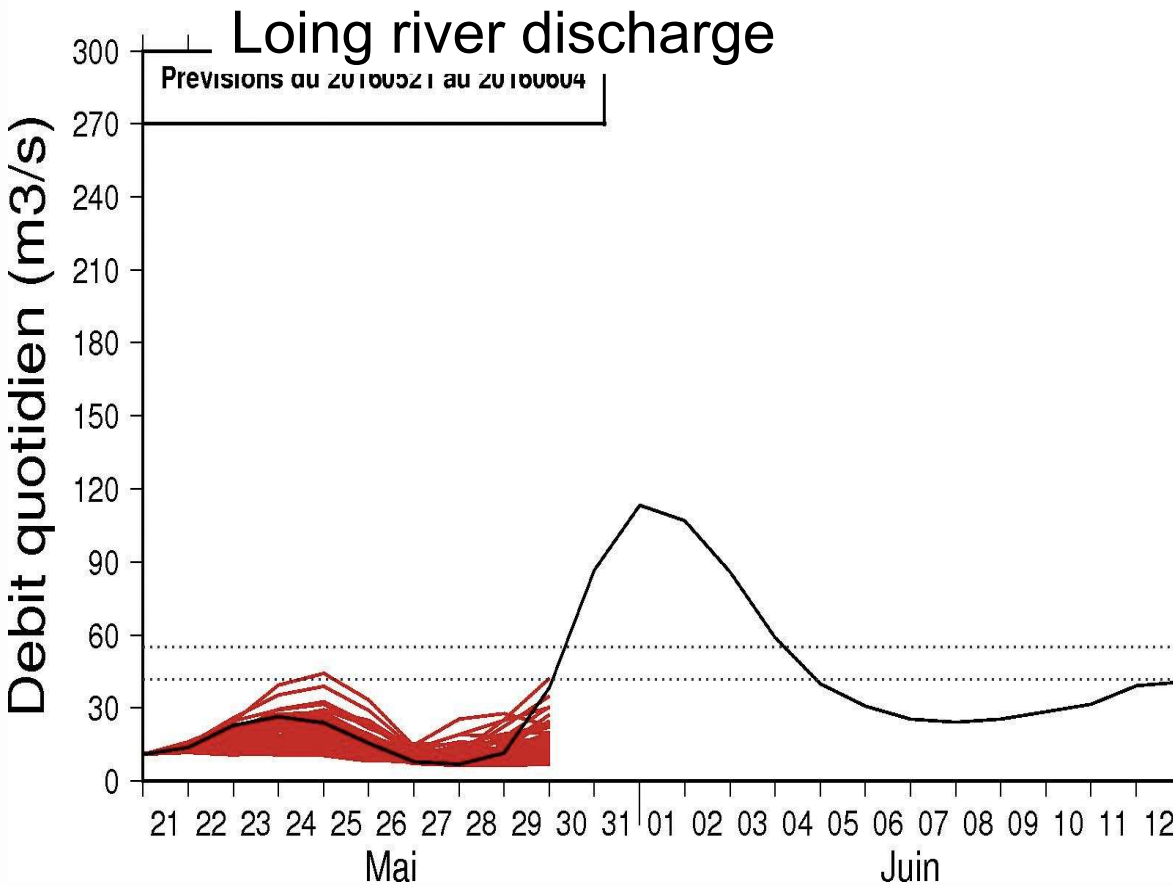
donc  $M(v)$  suit approximativement la loi de probabilité des erreurs de prévision

**Le calcul d'un petit ensemble  $M(v_i)$ ,  $i=1\dots q$  coûte  $q$  fois la prévision d'un modèle.**

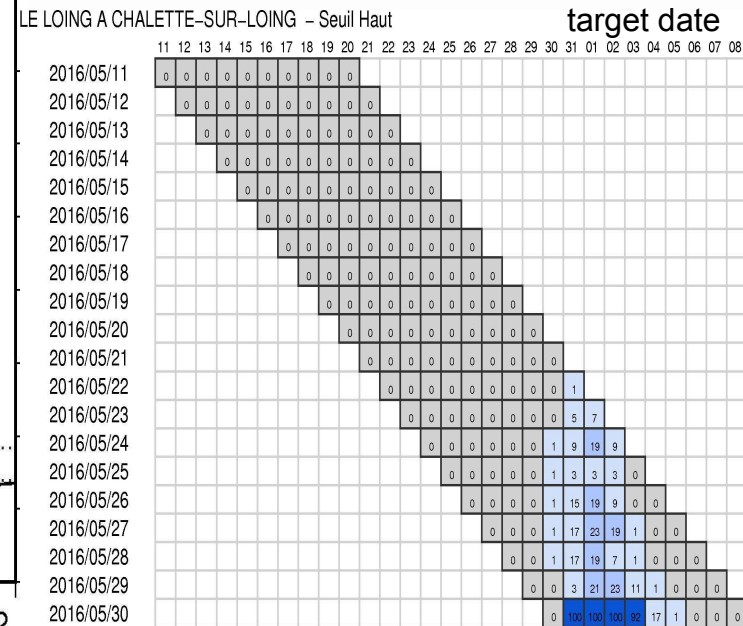
# Uncertainty in slow-flood prediction

flood forecasts, 10 days ahead

hydrological model forced by atmospheric ensemble



### Location-specific impact forecasts

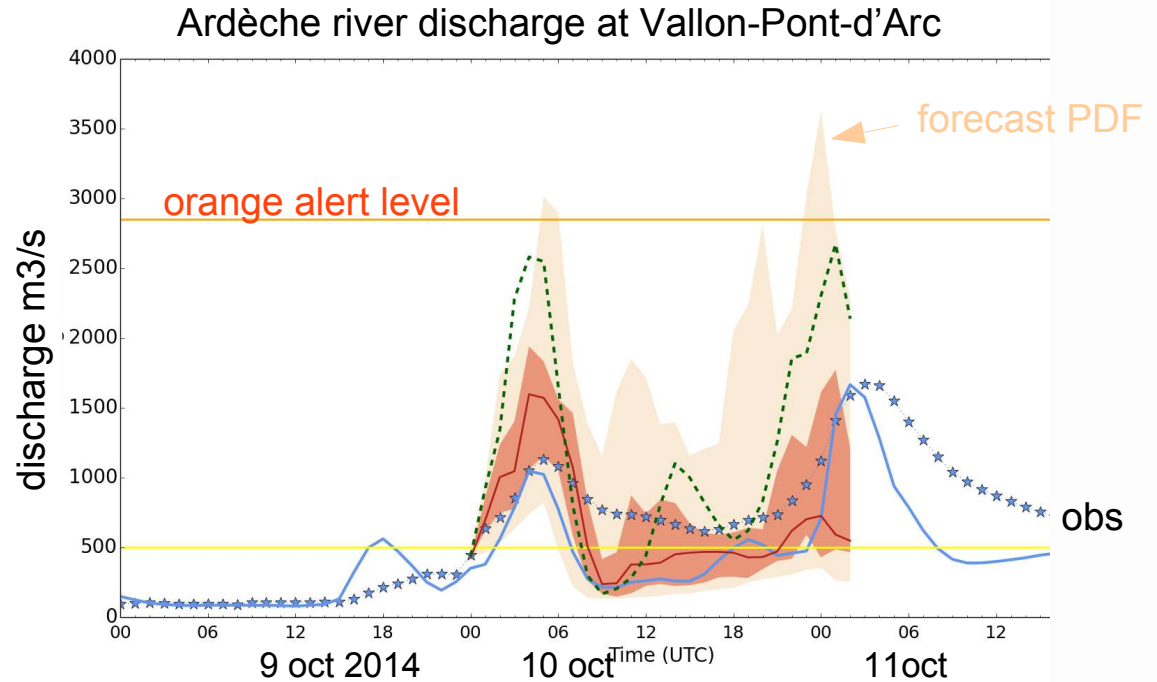
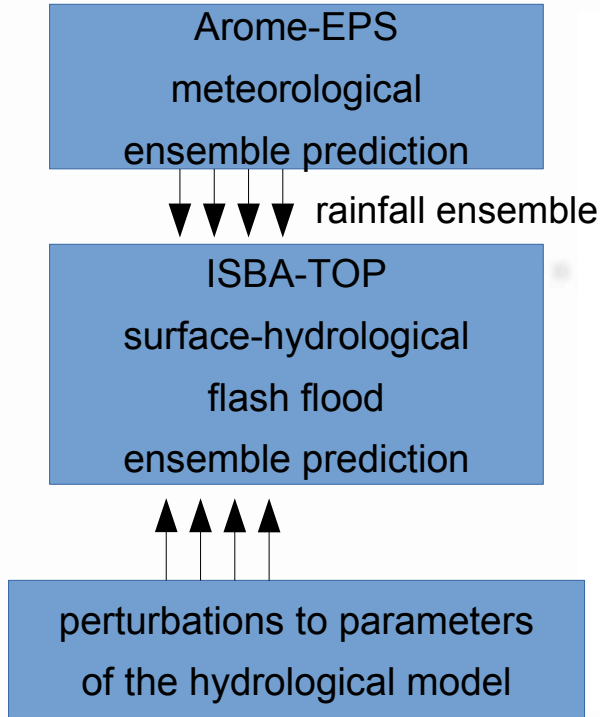


forecast  
update

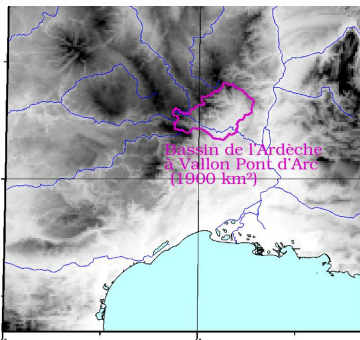


# Uncertainty in flash-flood prediction

various hydrological models, forced by atmospheric ensemble

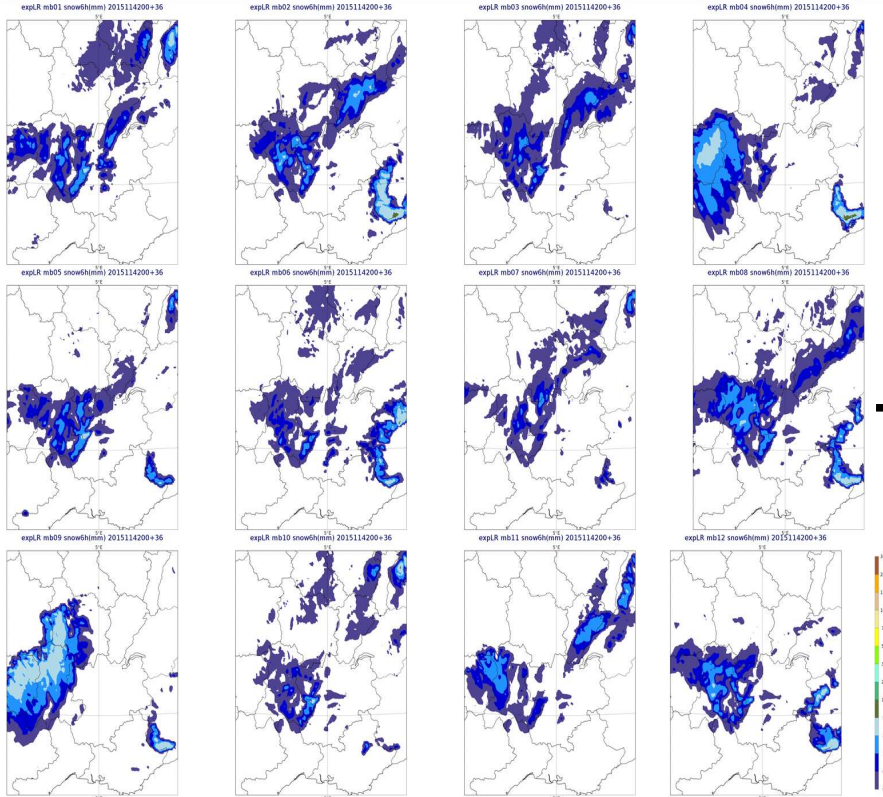


- ☆ measured discharge
- deterministic ISBA-TOP simulation driven by radar
- deterministic ISBA-TOP driven by Arome-France
- ISBA-TOP ensemble median, driven by Arome ensemble
- ISBA-TOP ensemble 25-75 % quantiles
- ISBA-TOP ensemble min-max

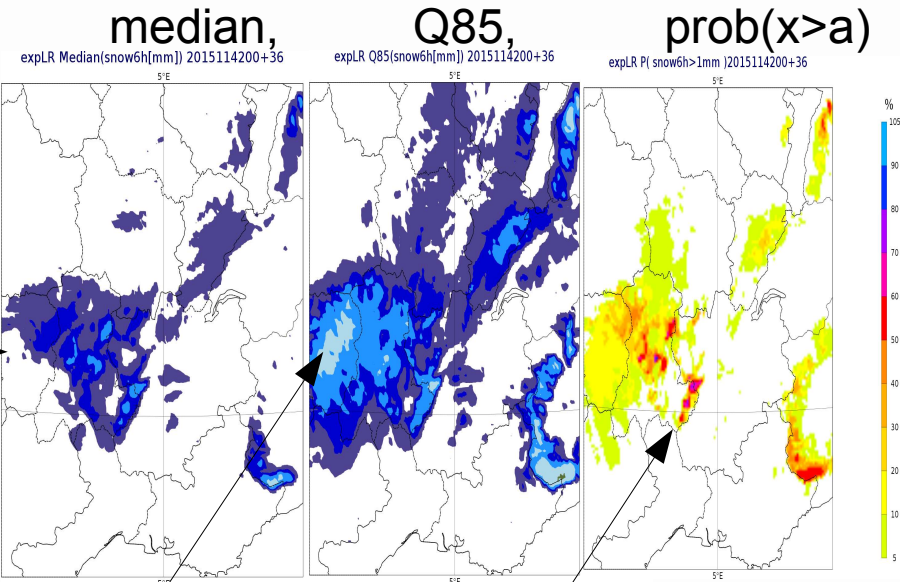


# Arome-EPS : sample snow forecast

raw ensemble: 12 members



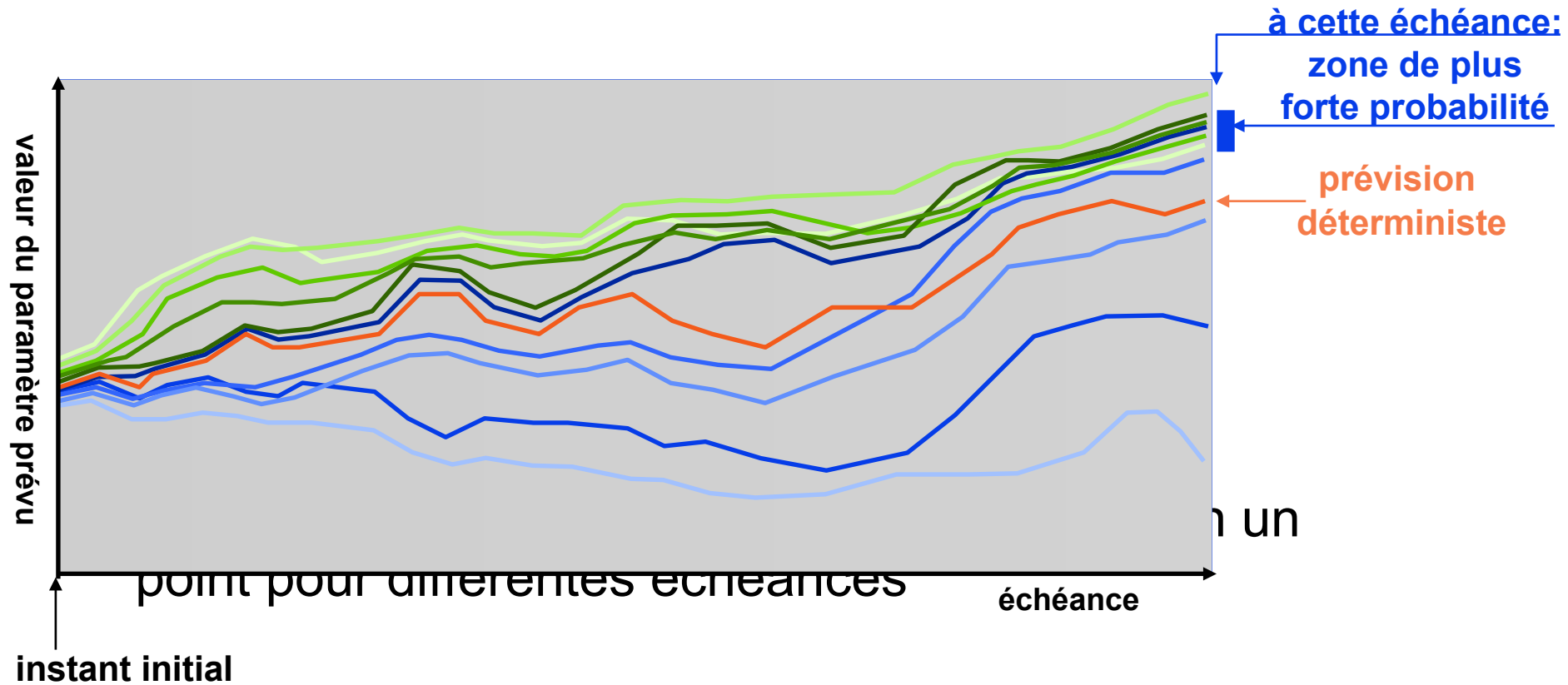
probability maps :



small probability  
of heavy snow

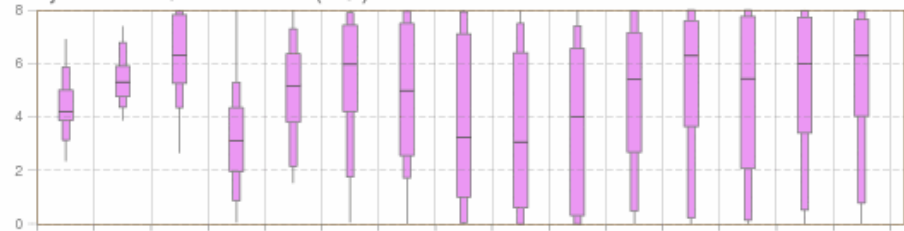
high probability  
of light snow

# exemple de produit de prévision d'ensemble

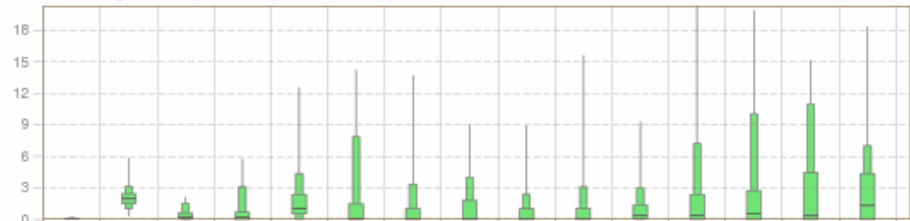


# exemple de produit de prévision d'ensemble

Daily mean of Total Cloud Cover (okta)



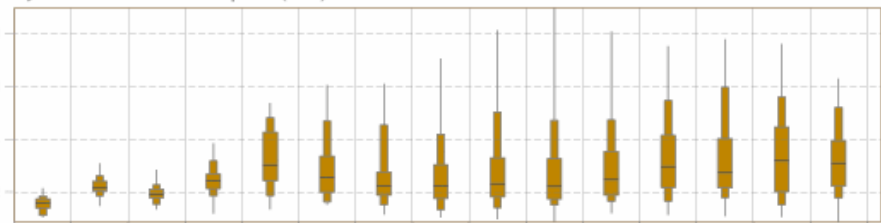
Total Precipitation (mm/24h)



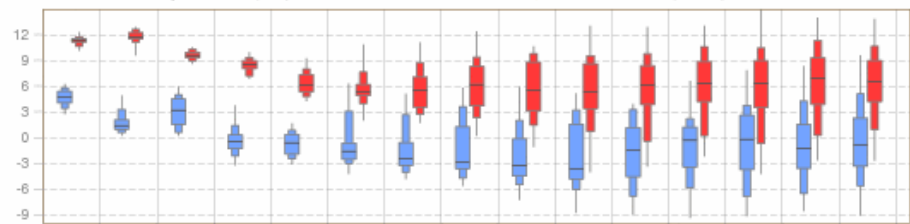
Daily distribution of 10m Wind Direction



Daily mean of 10m Wind Speed (m/s)



2m min/max temperature (°C) reduced to the station height from 230m (T319)



Wed 25 Thu 26 Fri 27 Sat 28 Sun 29 Mon 30 Tue 31 Wed 1 Thu 2 Fri 3 Sat 4 Sun 5 Mon 6 Tue 7 Wed 8  
January 2012 February 2012



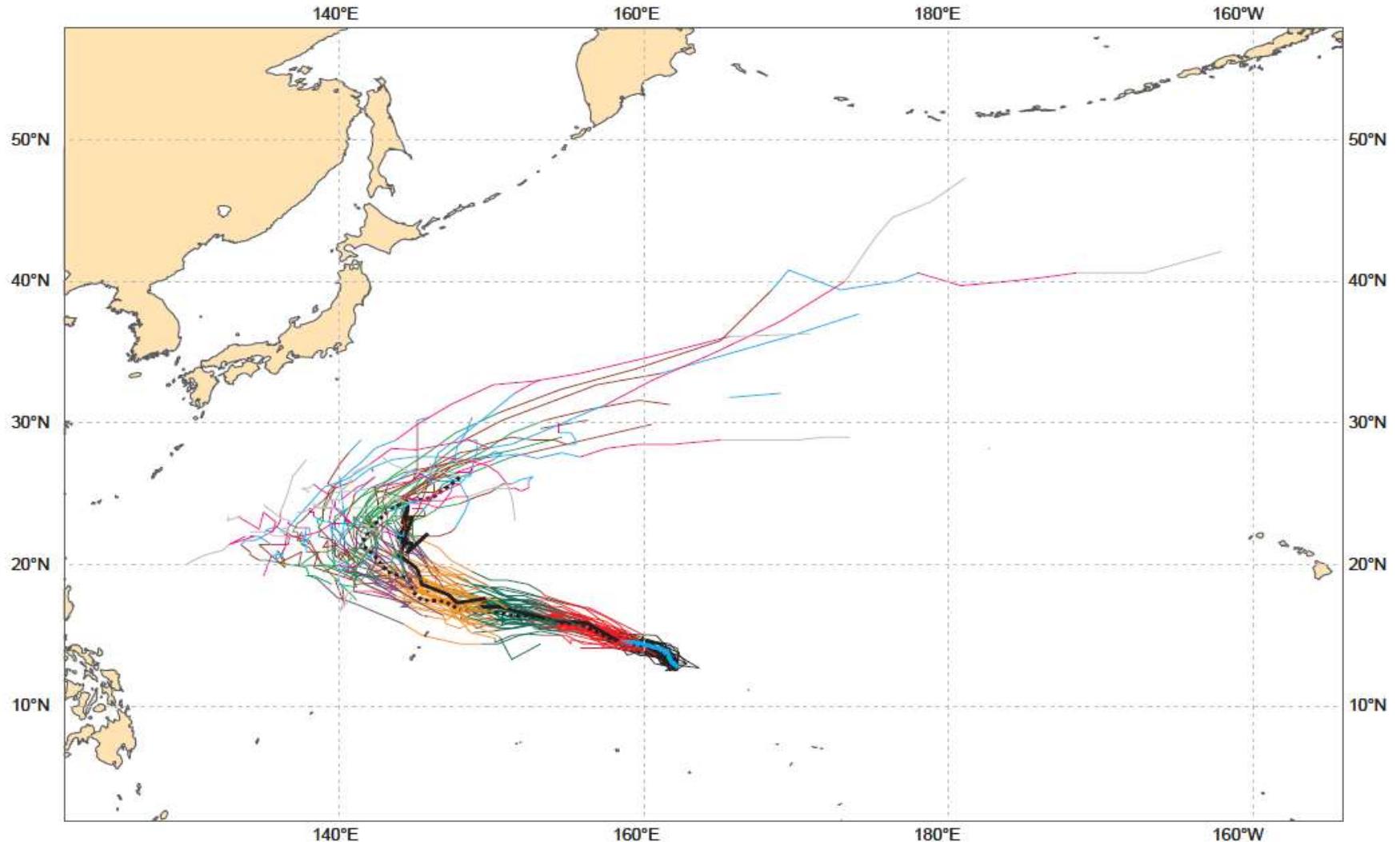
# prévision cyclonique par un ensemble

Date 20151013 00 UTC @ECMWF

Individual trajectories for **25W** during the next **240** hours

tracks: **thick solid**=HRES; **thick dot**=CTRL; **thin solid**=EPS members [coloured]

0-24h 24-48h 48-72h 72-96h 96-120h 120-144h 144-168h 168-192h 192-216h 216-240h



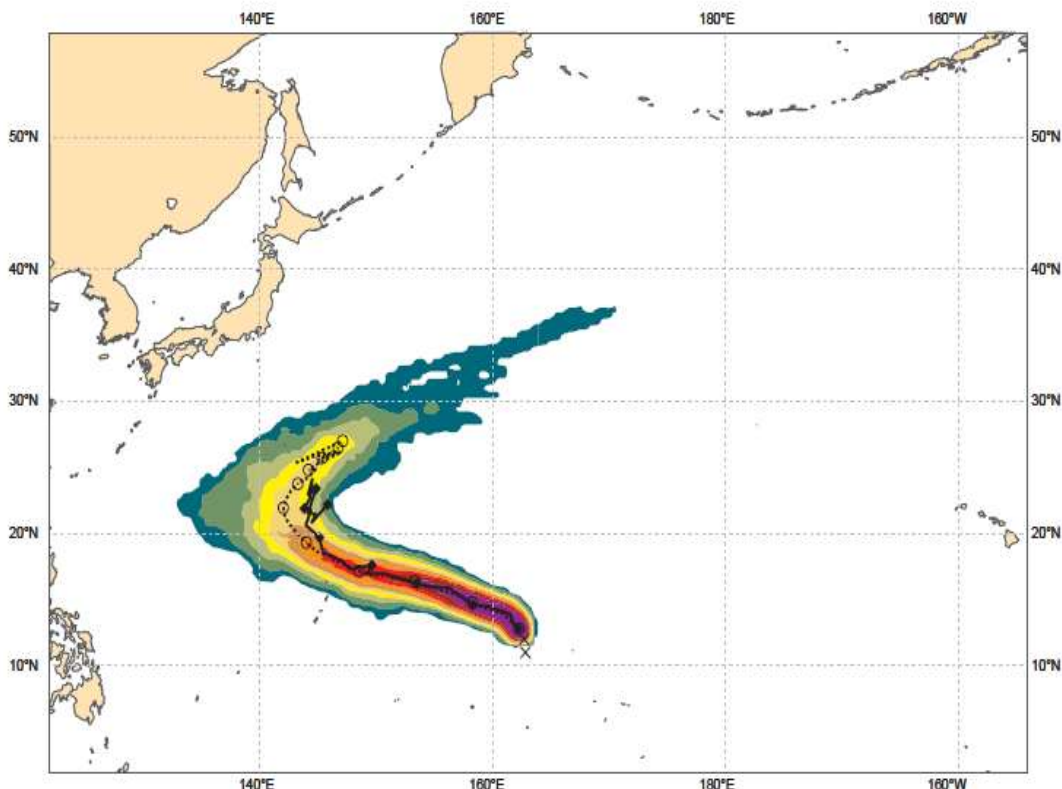


# prévision cyclonique par un ensemble

Date 20151013 00 UTC @ECMWF

Probability that **25W** will pass within 120 km radius during the next 240 hours

tracks: **solid**=HRES; **dot**=Ens Mean [reported minimum central pressure (hPa) **1004** ]

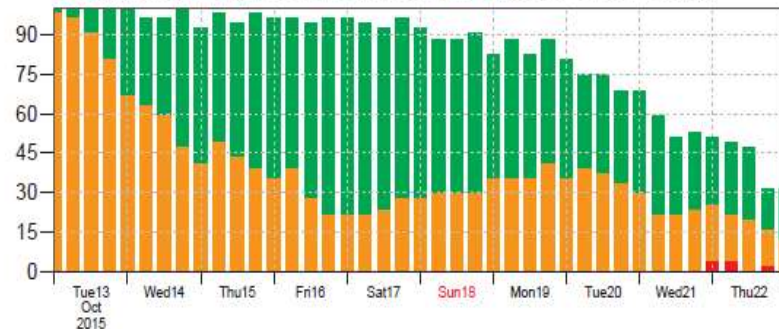


List of ensemble members numbers forecast Tropical Cyclone

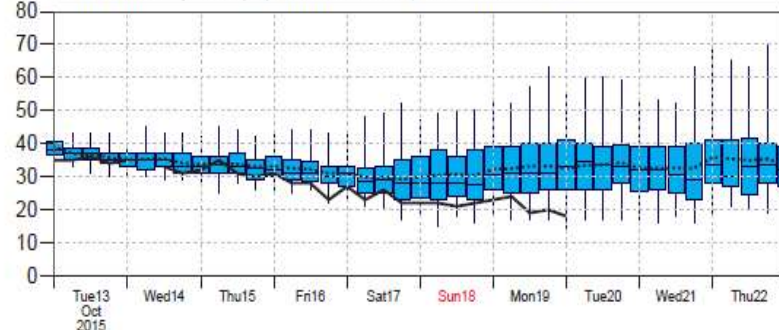
Intensity category in colours: **TD**[up to 33] **TS**[34-63] **HR1**[64-82] **HR2**[83-95] **HR3**[> 95 kt]

+024 h :	hr	ct	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	
+048 h :	hr	ct	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	
+072 h :	hr	ct	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	
+096 h :	hr	ct	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	
+120 h :	hr	ct	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	
+144 h :	hr	ct	01	02	03	04	05	07	09	10	11	12	14																																								
+168 h :	hr	ct	01	03	04	05	08	09	10	11	13	14	15																																								
+192 h :	01	03	04	05	07	08	09	10	11	13	14																																										
+216 h :	01	03	05																																																		
+240 h :	01	05																																																			

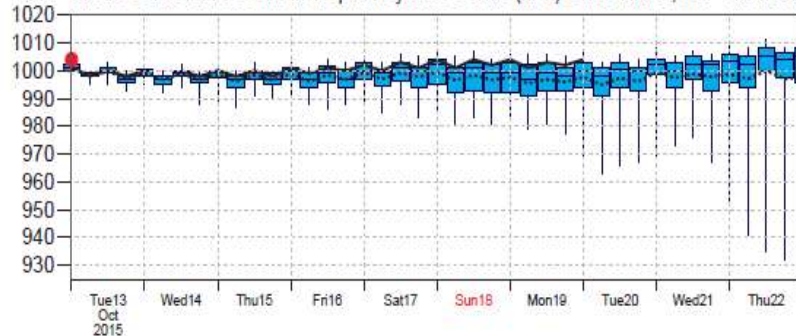
Probability (%) of Tropical Cyclone Intensity falling in each category  
**TD**[up to 33] **TS** [34-63] **HR1**[64-82] **HR2** [83-95] **HR3** [> 95 kt]



10m Wind Speed (kt) **solid**=HRES; **dot**=Ens Mean



Mean Sea Level Pressure in Tropical Cyclone Centre (hPa) **solid**=HRES; **dot**=Ens Mean

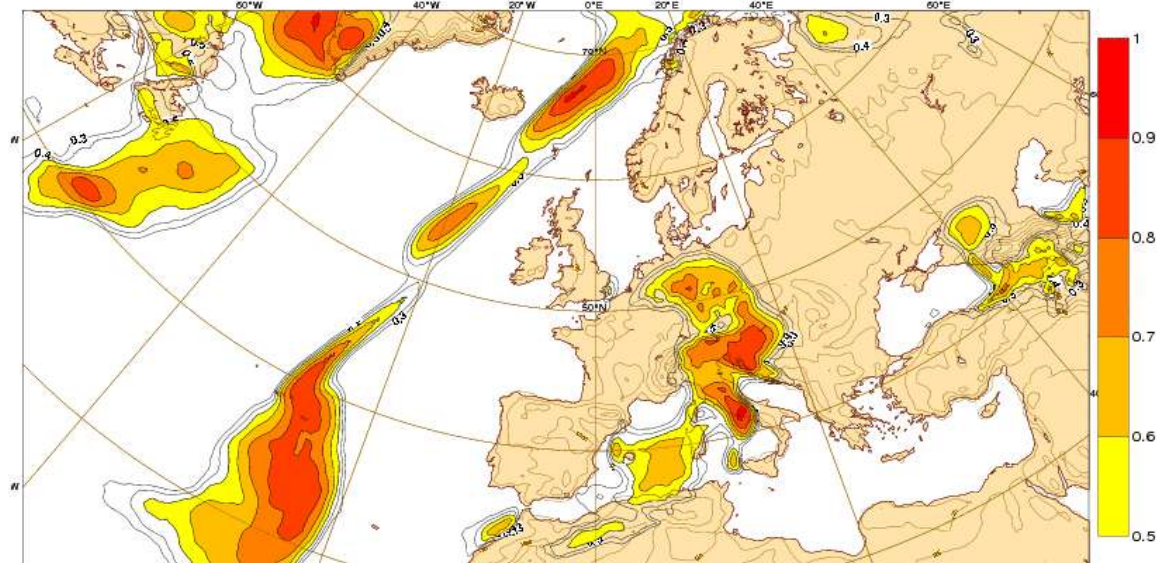


# prévision d'extrêmes climatiques par des ensembles

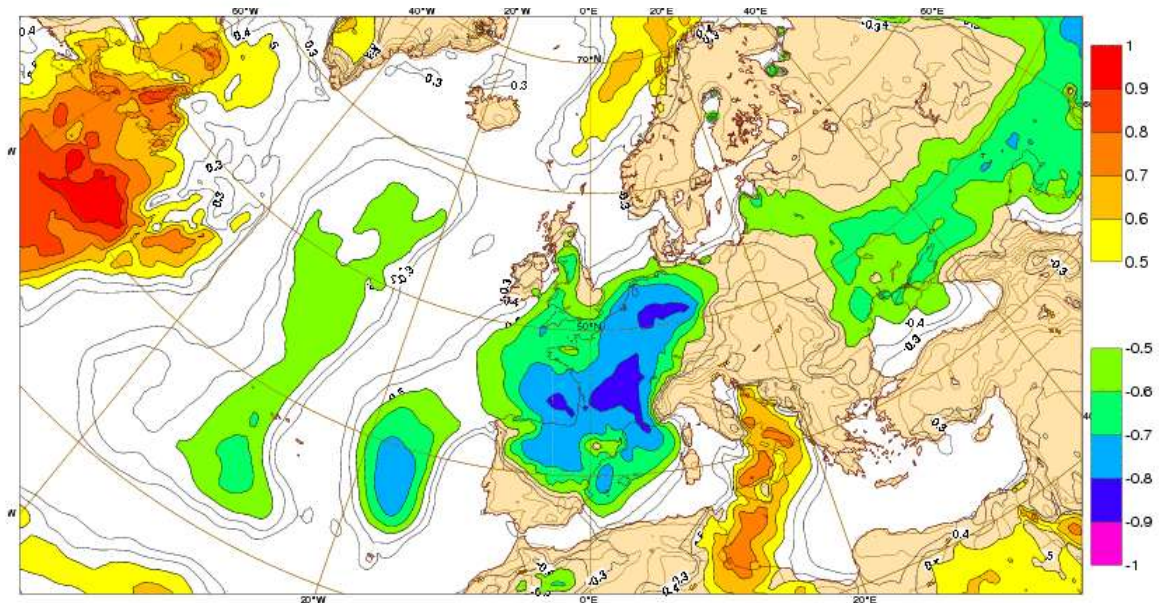
probabilité que la prévision soit dans un quantile extrême du climat en chaque point

Tuesday 13 October 2015 00UTC ©ECMWF Extreme forecast index I+024-048 VT: Wednesday 14 October 2015 00UTC - Thursday 15 October 2015 00UTC  
Surface: Total precipitation index

pluies



température



# Exemple: probabilités de pluies en chaque point un jour d'orage: phénomène intense, mais localisation peu prévisible

cumul sur 18h  
déterministe

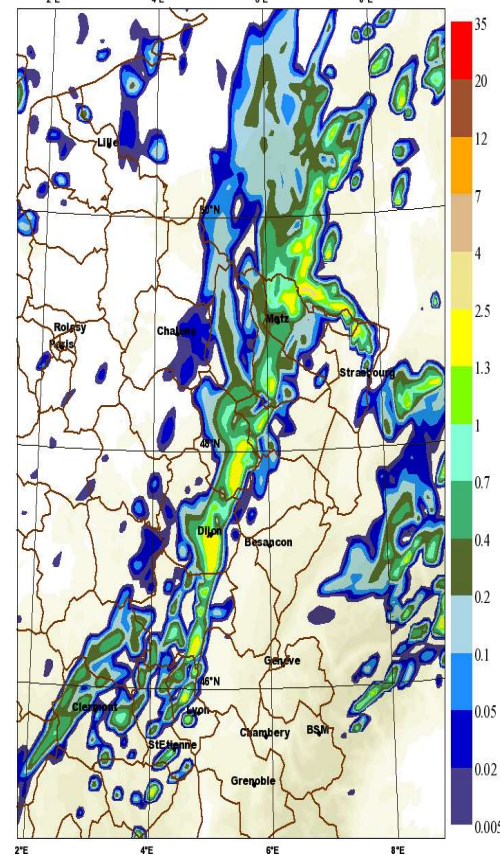
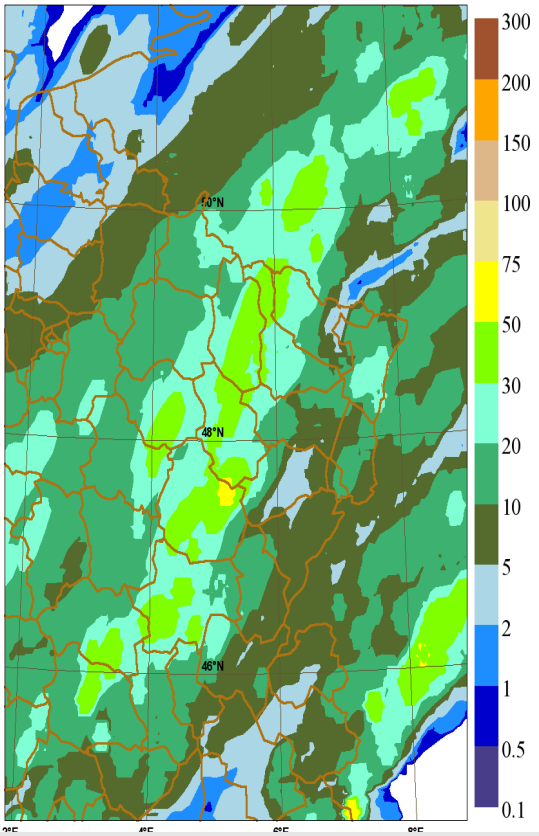
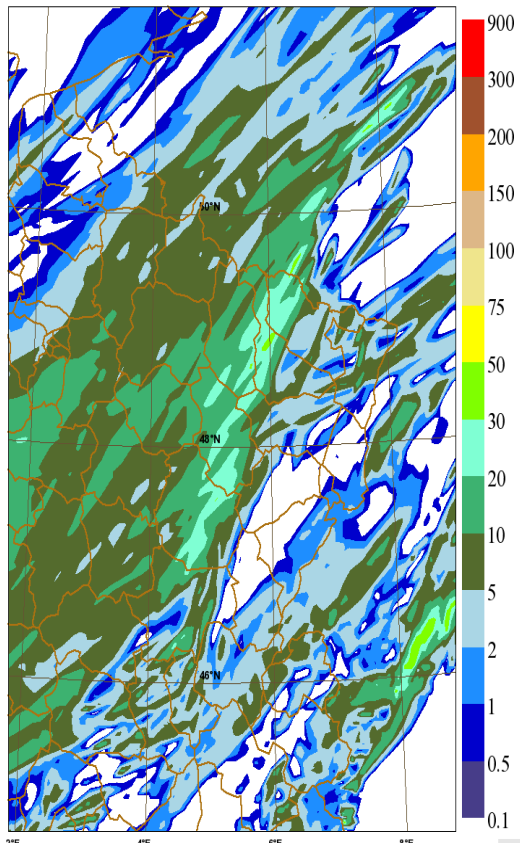
cumul sur 18h  
proba > 10%

précip instantanée

aroexpAroDet 2011062118+1800 totalrain(mm) over last 18h

Qmax RR lev=1 mb=16 Ga max=83.3889007568

aroexpAroDet 2011062118+1800 falling hydrometeors (g/kg) at model level 40 (z=1900m)



quantile Q90 de la distribution de la  
prévision d'ensemble

# Arome-ensemble research: warnings of dangerous small-scale events

case study :

small-scale intense raining cells with high spread

location/timing uncertainties can hide probabilities

decision-making needs to choose a cost/loss ratio (~false alarm tolerance)

the most likely forecast is not the most useful !

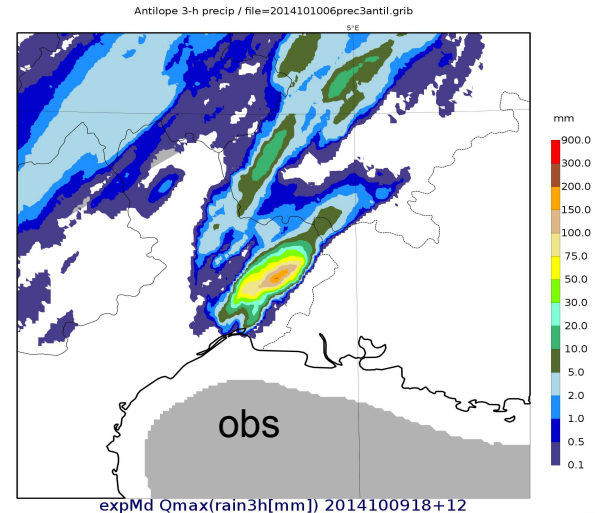
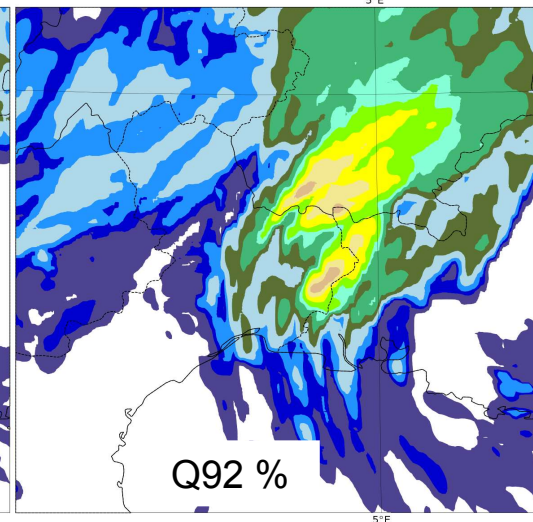
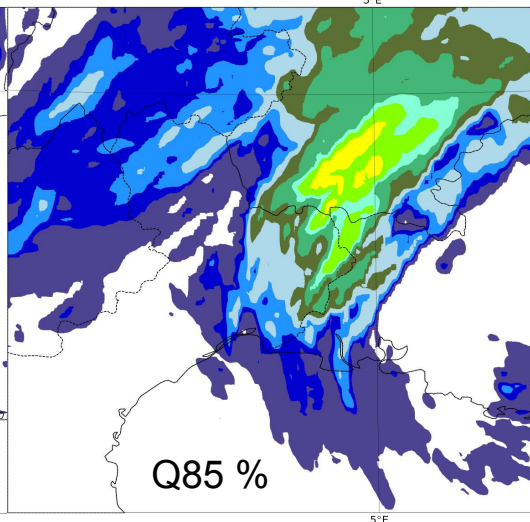
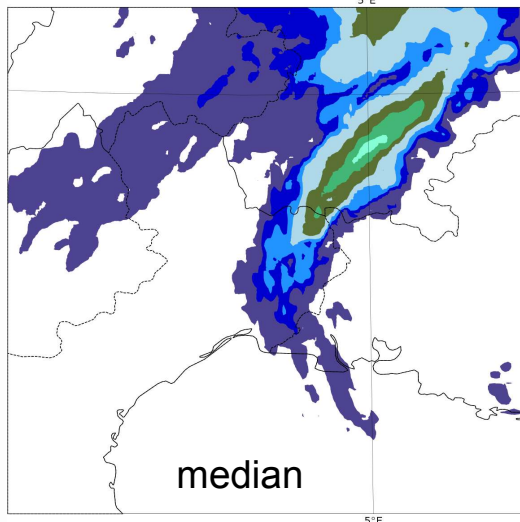
*Three points of view*

*on the same rain event :*

expMd Median(rain3h[mm]) 2014100918+12

expMd Q85(rain3h[mm]) 2014100918+12

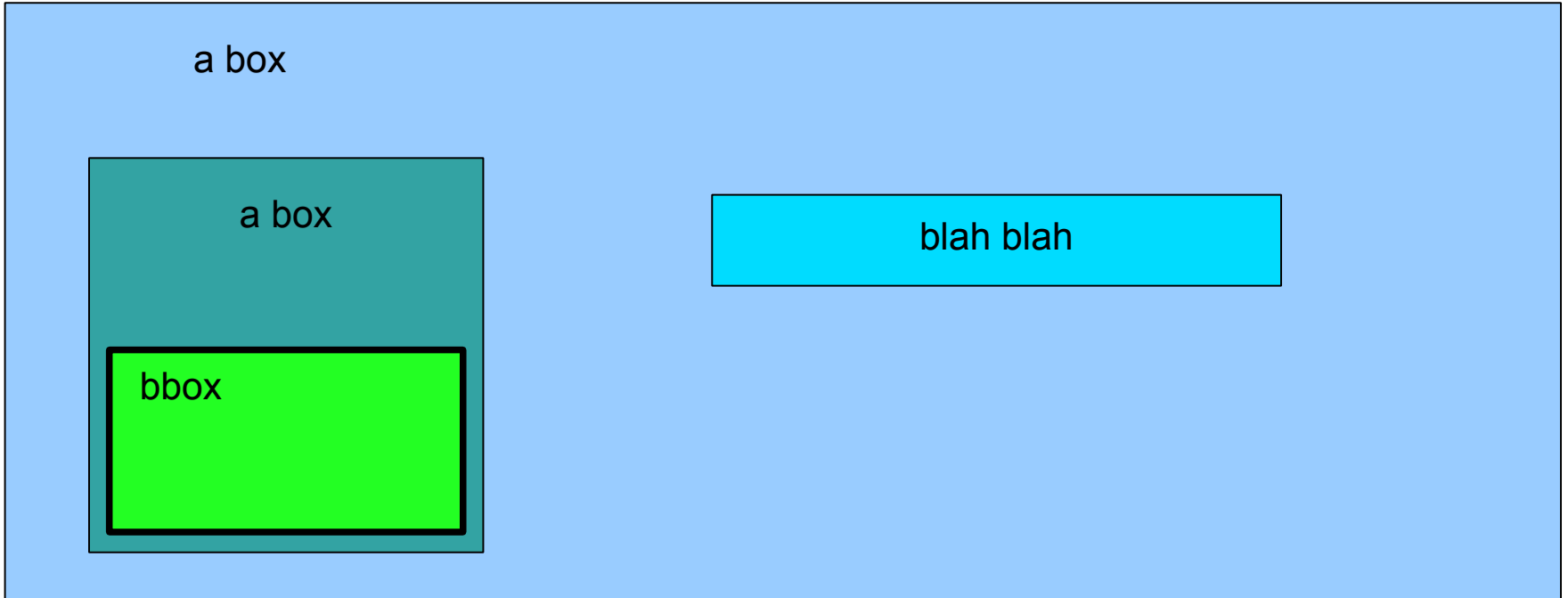
expMd Qmax(rain3h[mm]) 2014100918+12



*Merci pour votre  
attention*

# a slide

some text



a box

a box

bbox

blah blah

-

more text

*a text*