What's new in AROME-France configuration ?

Yann Seity,
P. Brousseau, S. Riette, E. Wattrelot, P. Marquet
E. Perraud, C. Lac …

HIRLAM/ALADIN meeting Kracow, April 2010

METEO FRANCE
Toujours un temps d'avance

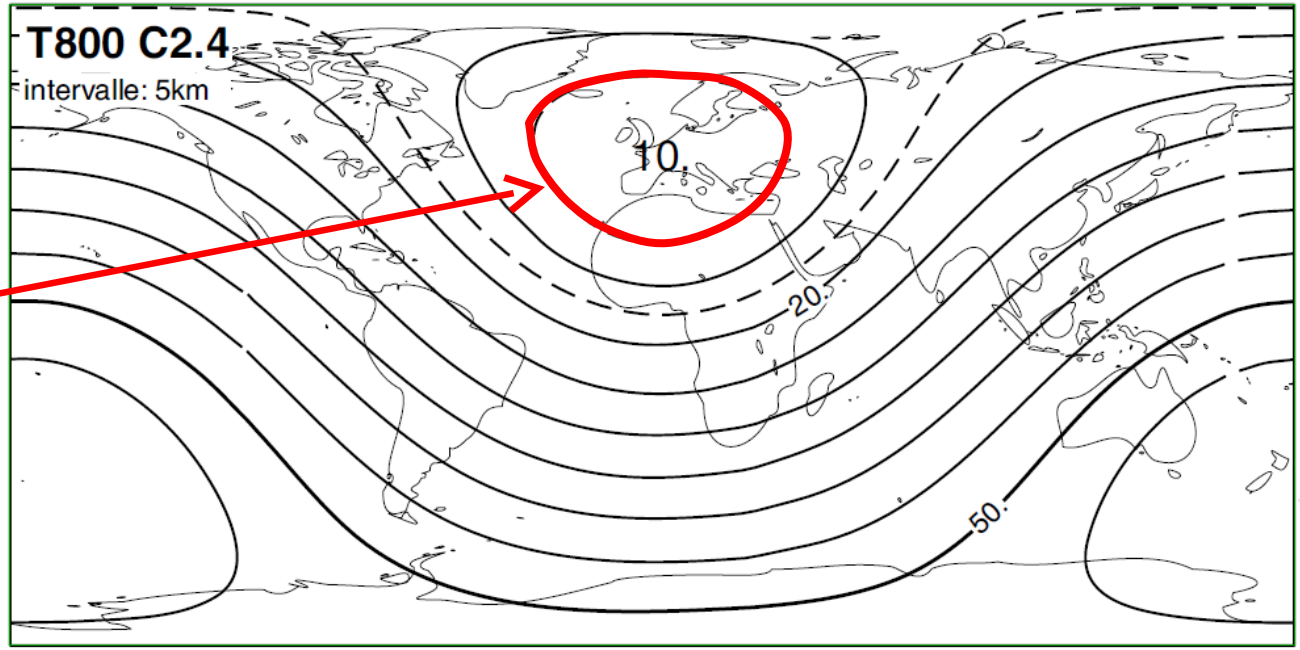
Contents

- AROME_v2 (operational since 6 April)
- Current works and preparation of AROME_v3

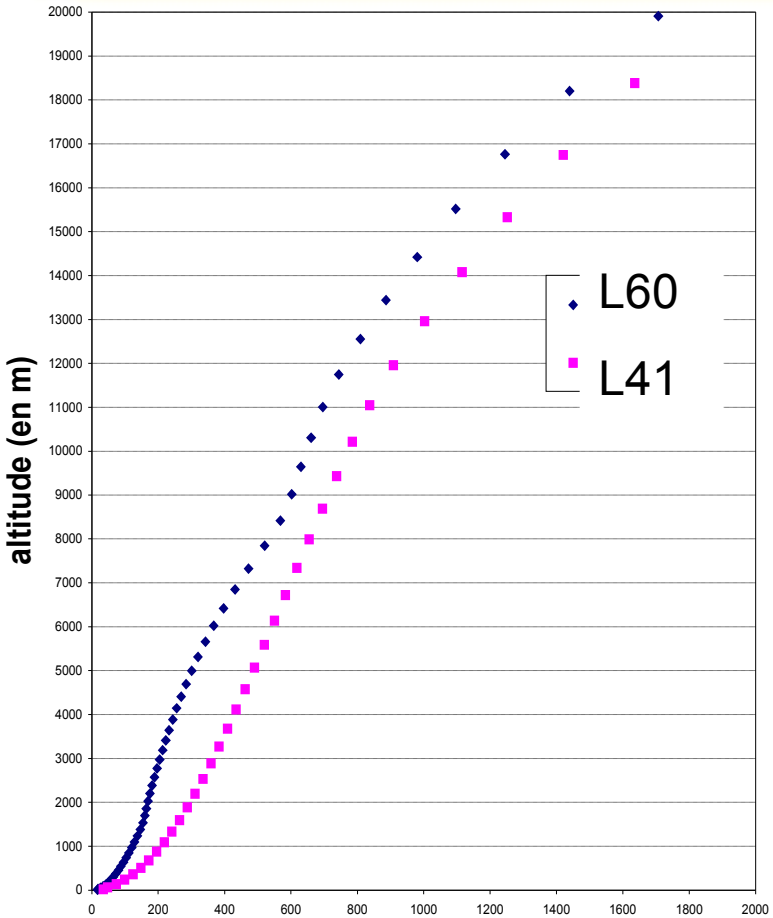
Direct coupling to ARPEGE

- ARPEGE resolution over France reaches 10 km
- Avoid an intermediate coupling with ALADIN
- Simplify operational suit, AROME forecasts available 15' earlier

12.5 km



Improve vertical resolution (L60)



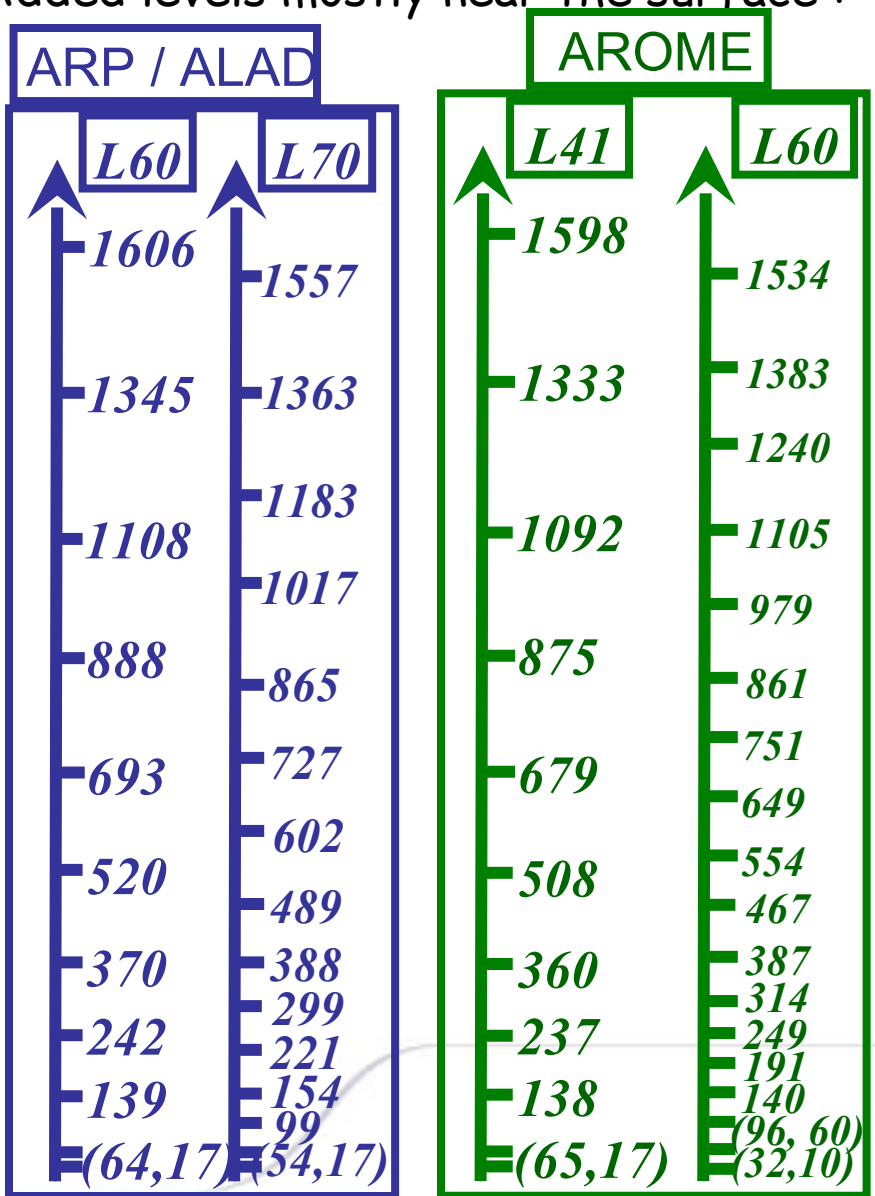
layer thickness (m)

<u>from L41 to L60 (+ 37% CPU)</u>

1st level at 10m (17m in L41)

27 levels below 3000m (15 in L41)

Added levels mostly near the surface :



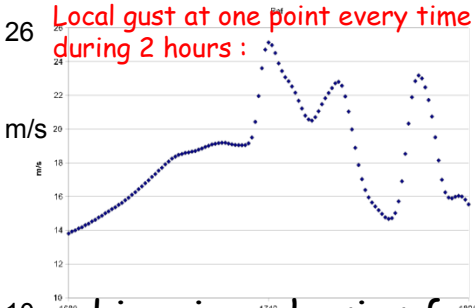
and for model part :

- Spectral relaxation towards ARPEGE on the top of the model

$$X_{arome}(t) = (1-\alpha)X_{arome}(t) + \alpha X_{coupleur}(t)$$

  - Vorticity, divergence and temperature
  - above 100 hPa
  - 30 first wave numbers (scales > 100 km)

Local gust at one point every time step during 2 hours :



- Harmonisation of gusts diagnostic (ARP/ALD/ARO) :
  - $U_{gust}=U_{10m} + a.TKE(h)^{\frac{1}{2}}$ (a = 3.5 and h = 20m)
  - max in 1h
- Modifications in turbulence to remove negative values of q_c and q_i, and in microphysics for negative q_g
- Sedimentation of fog (to fix problems over sea)
- Version 2 of EDKF scheme : Improvement of the entrainment formulation in dry boundary layer (which now changes according to flotability and updraft vertical velocity)
- Correction in simulated radar pictures concerning snow reflectivities
- Remove special treatment of fullpos FC+0 by a best initialisation of CANOPY

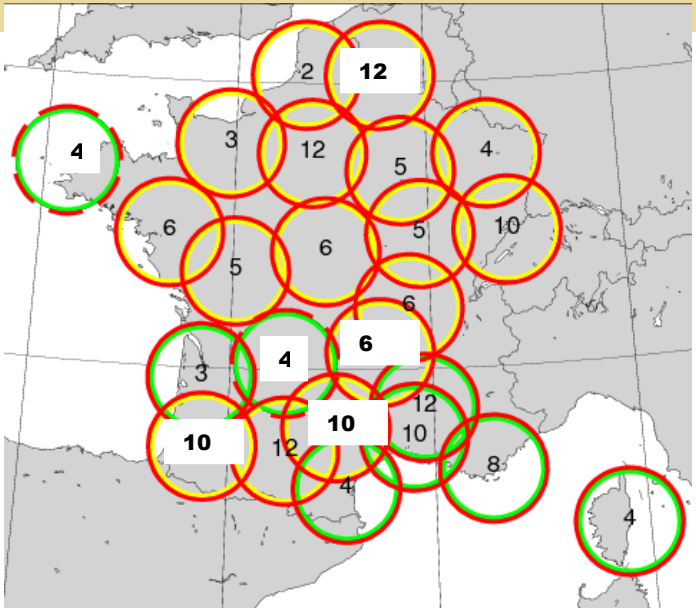
And assimilation part :

- Radar reflectivities *Z* :

24 radars: 16 C-band (yellow) +

8 S-band (green). Volumic Z

(from 2 to 13 elevation)



- Satellite Obs :
  - As in ARP/ALD (radiances density 250->125km)
  - AIRS/IASI

- New Jb calculated from an ensemble of AROME assimilations

- Day to day gridpoint Sigma B provided by ARPEGE ensemble assimilation:
  - vorticity, divergence, temperature, Ps

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Altitude scores

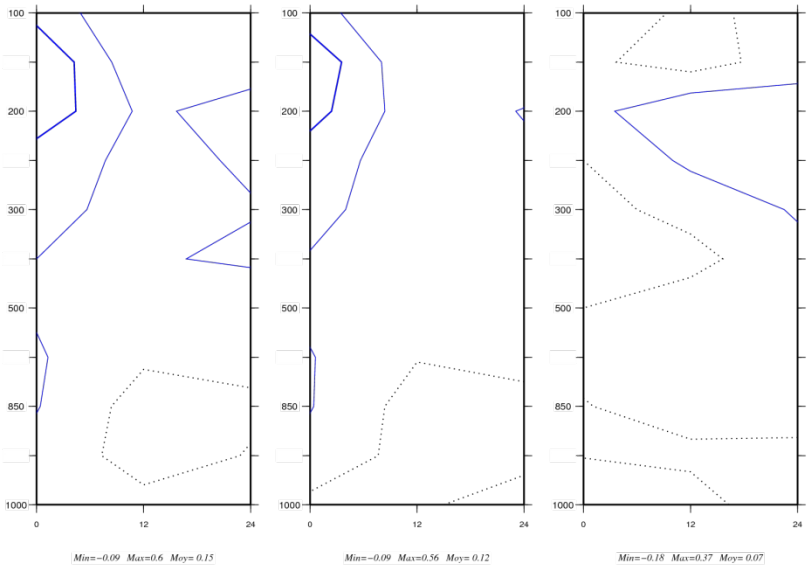
15 Sept 2009 – 3 March 2010

Comparison to radiosoundings

(AROME_v1 – AROME_v2)

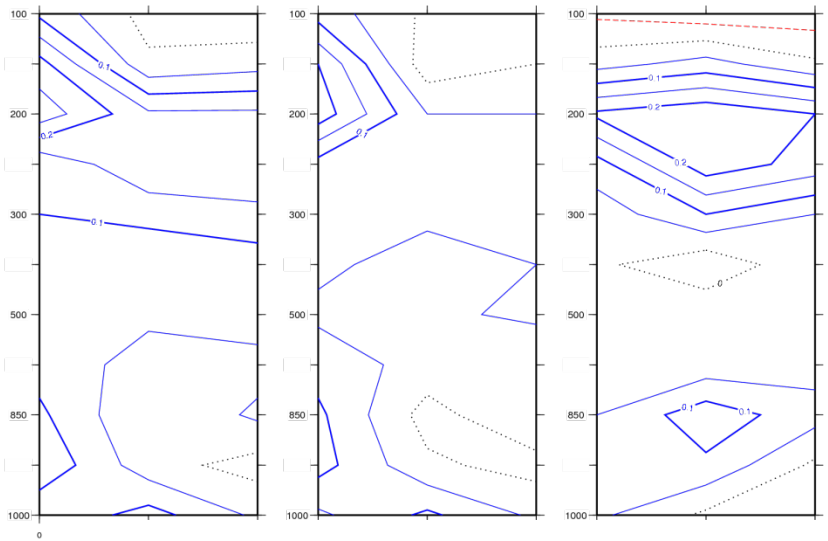
EQM StD |biais|

Wind

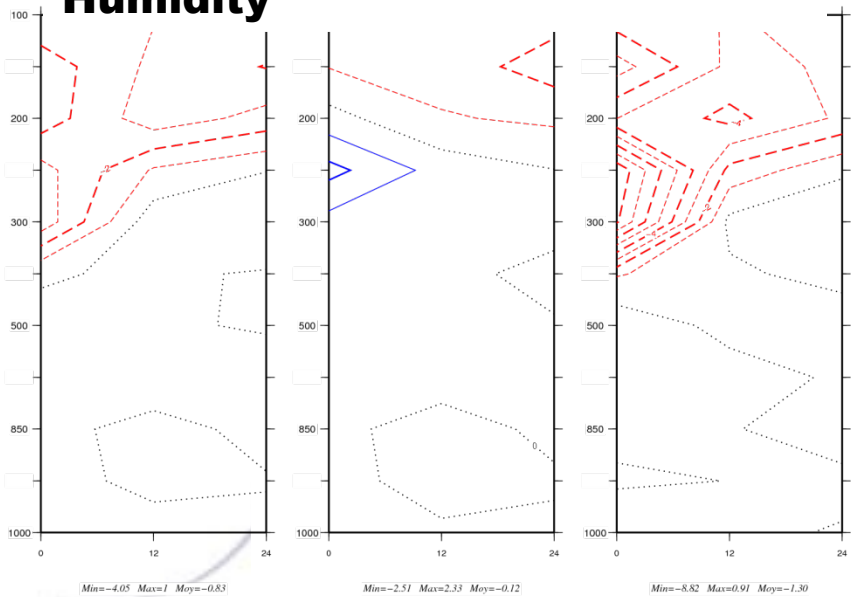


EQM StD |biais|

Temperature

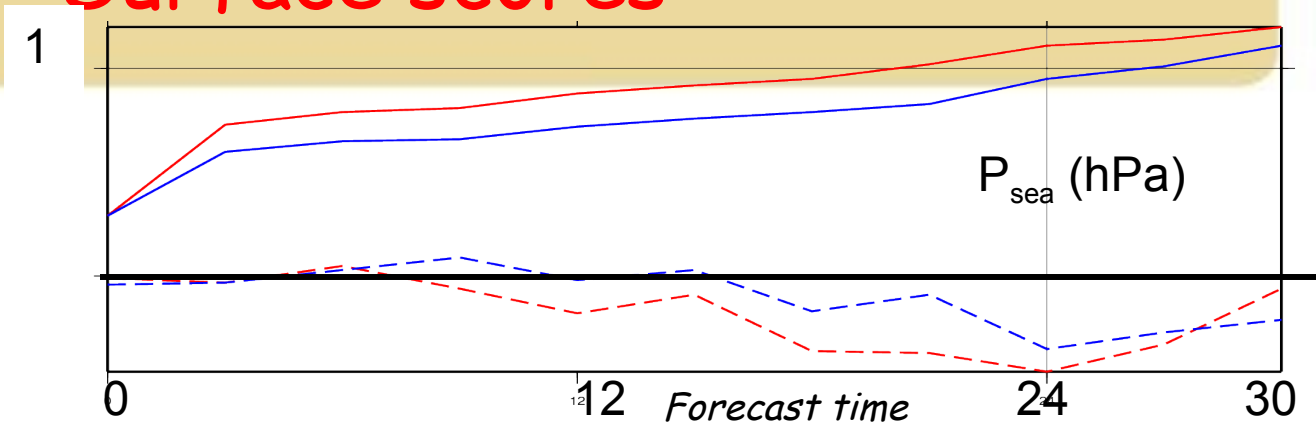


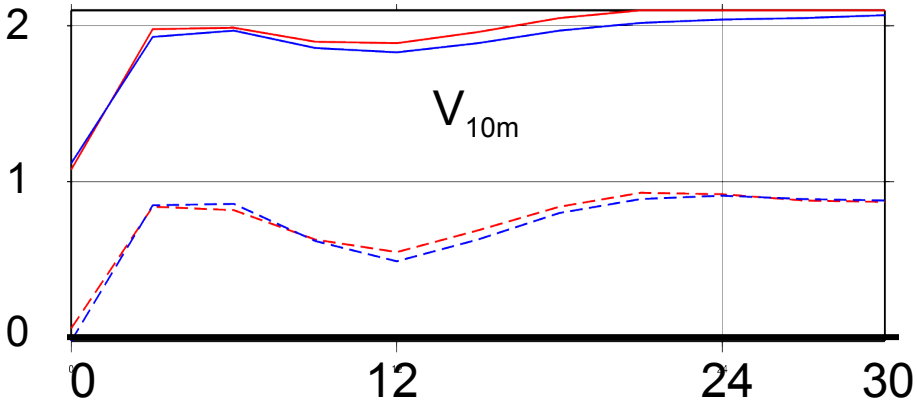
Humidity

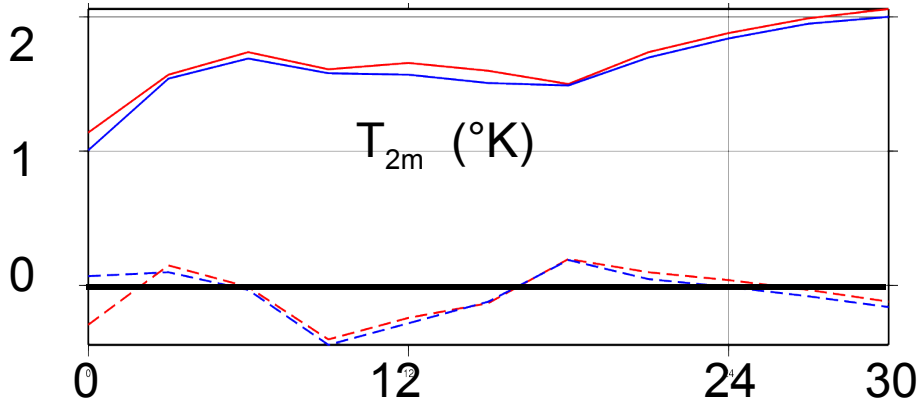


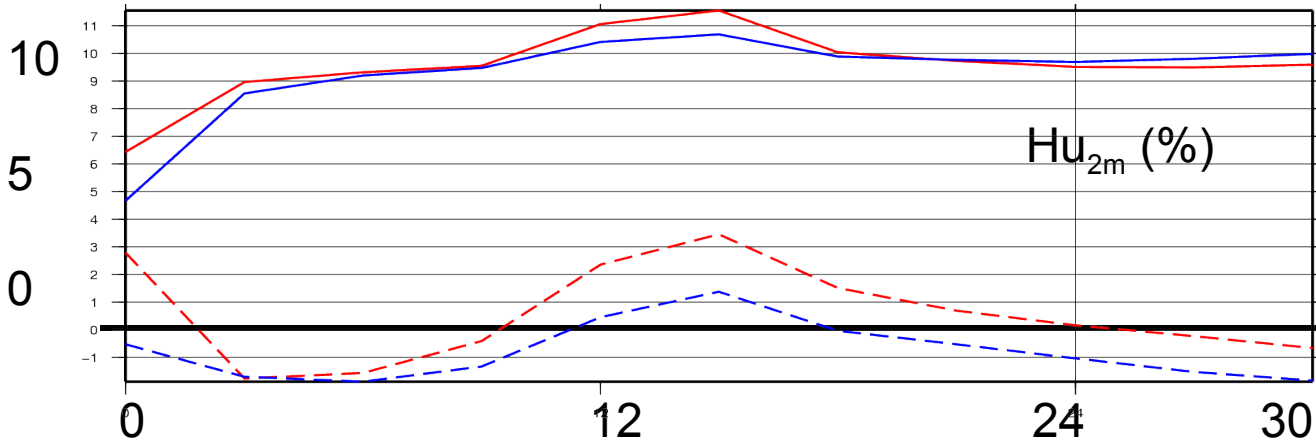
Surface scores

Rms AROME_v1
Bias AROME_v1
Rms AROME_v2
Bias AROME_v2









24h rainfall scores (0TU+6/+30h)

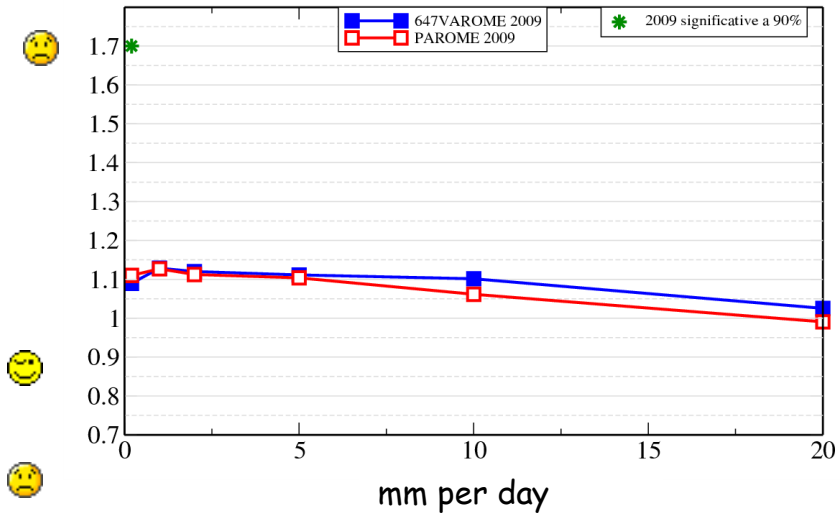
Comparison to 4000 observations network (15 Sept 2009 to 1 March 2010)

AROME-v1

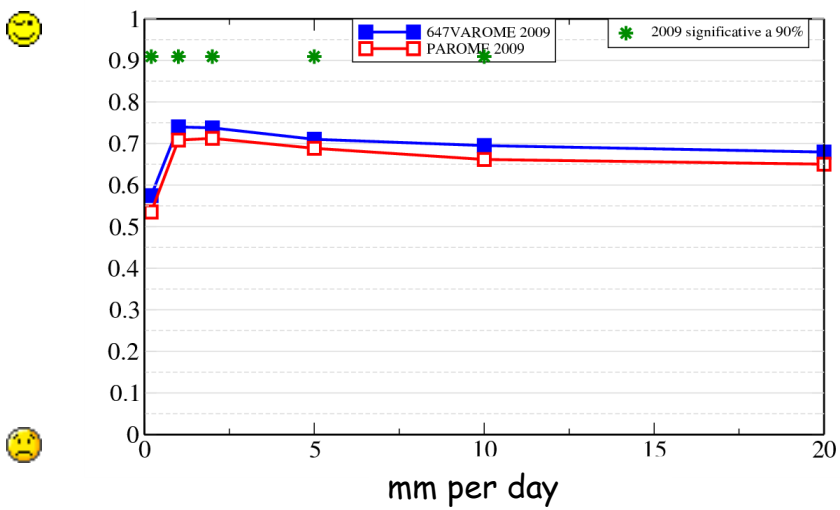
AROME-v2

* Statistical significativity of differences

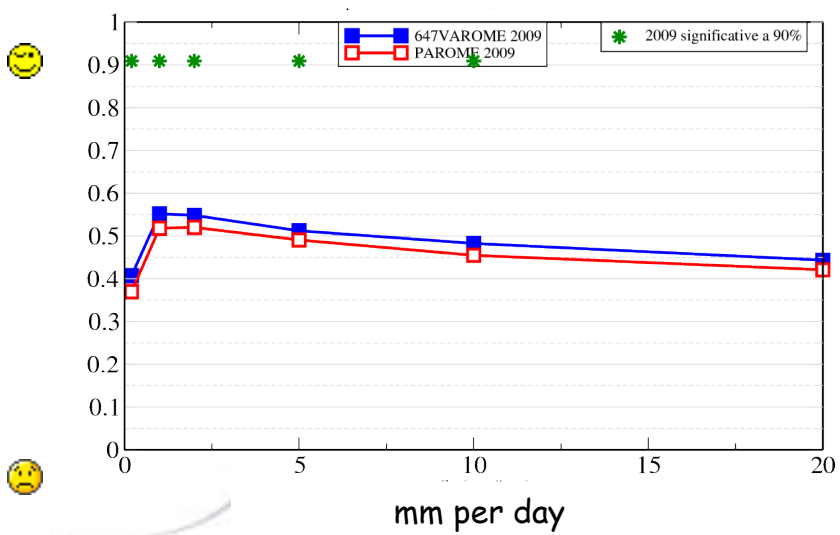
BIAS



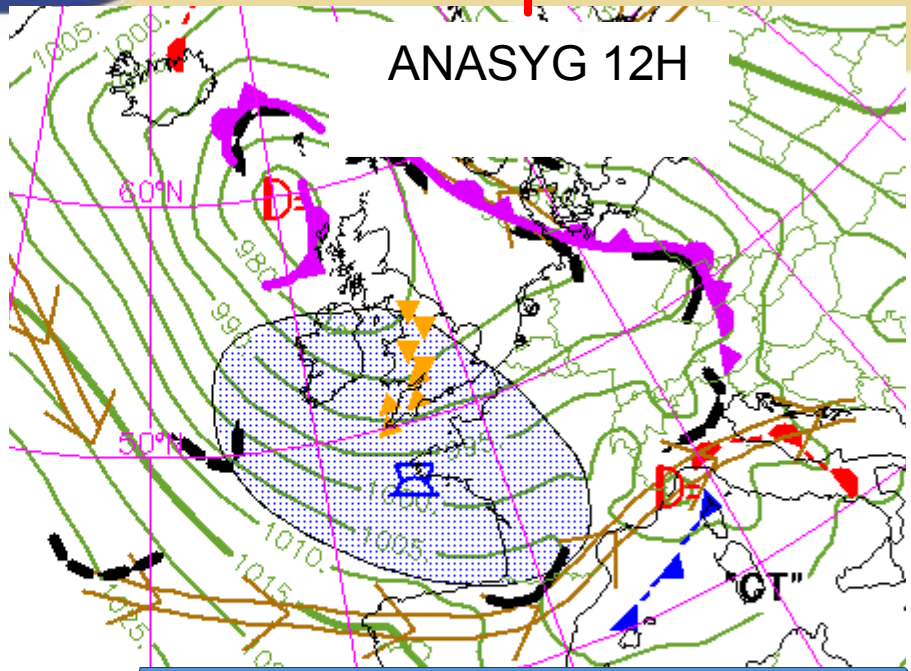
Brier Skill Score

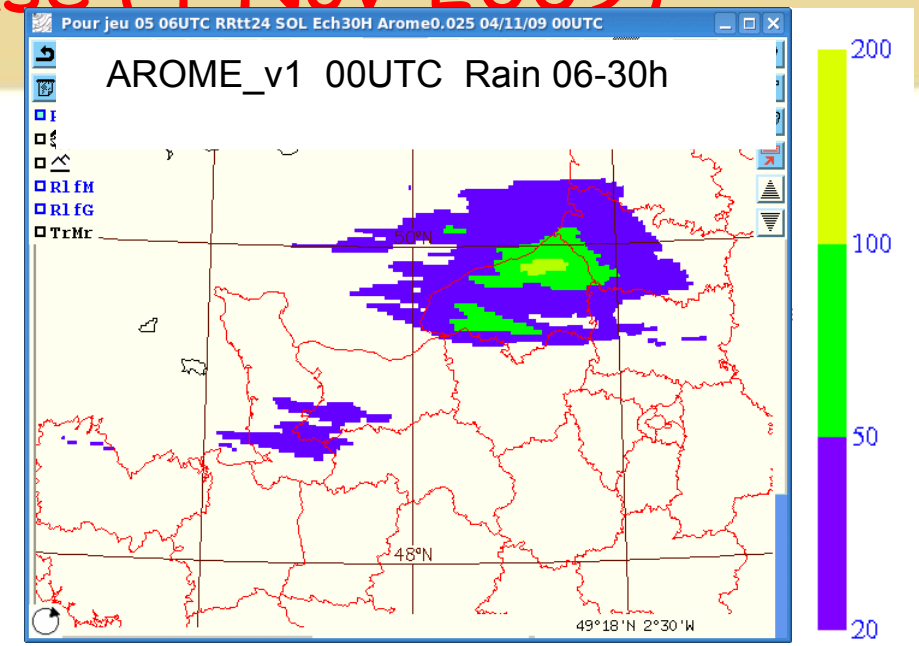


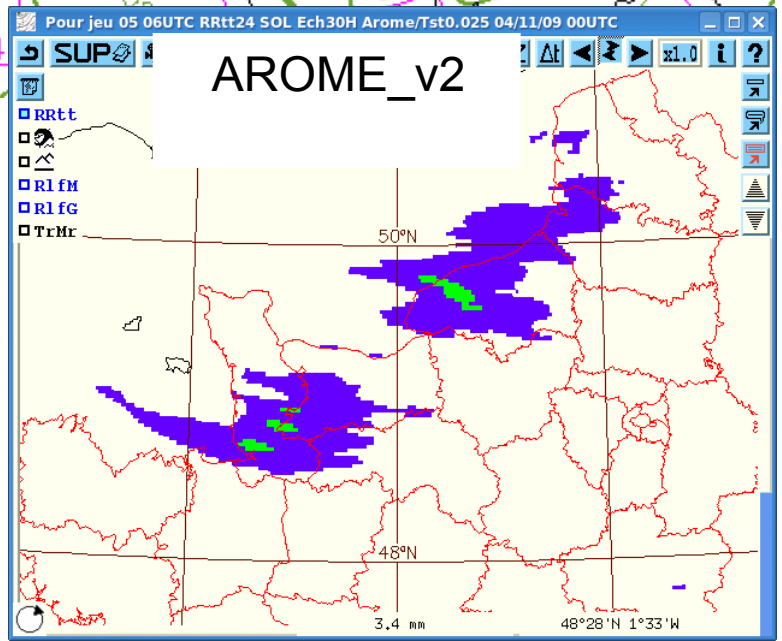
Heidke Skill Score

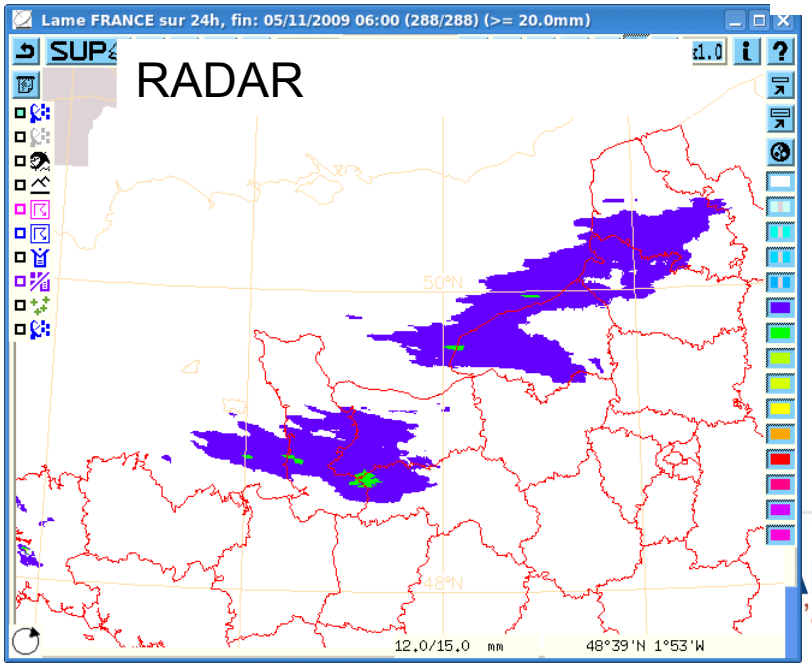


Example of a case (4-Nov-2009)









Contents

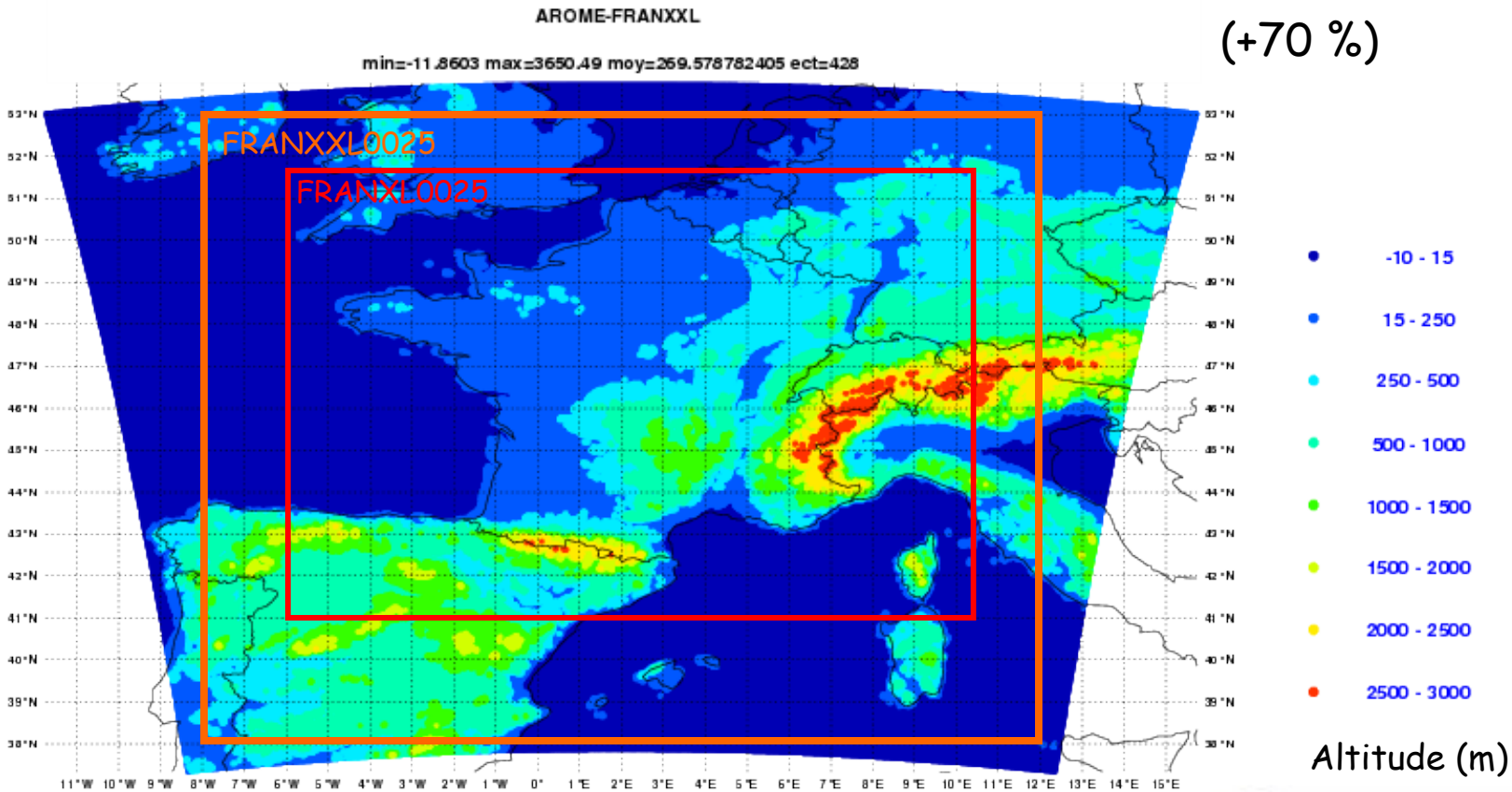
- AROME_v2

- Current works and preparation of AROME_v3
  - New domain
  - Hail
  - Orography
  - Low clouds
  - Other works

AROME-France v3 domain

Domain 750x720 points

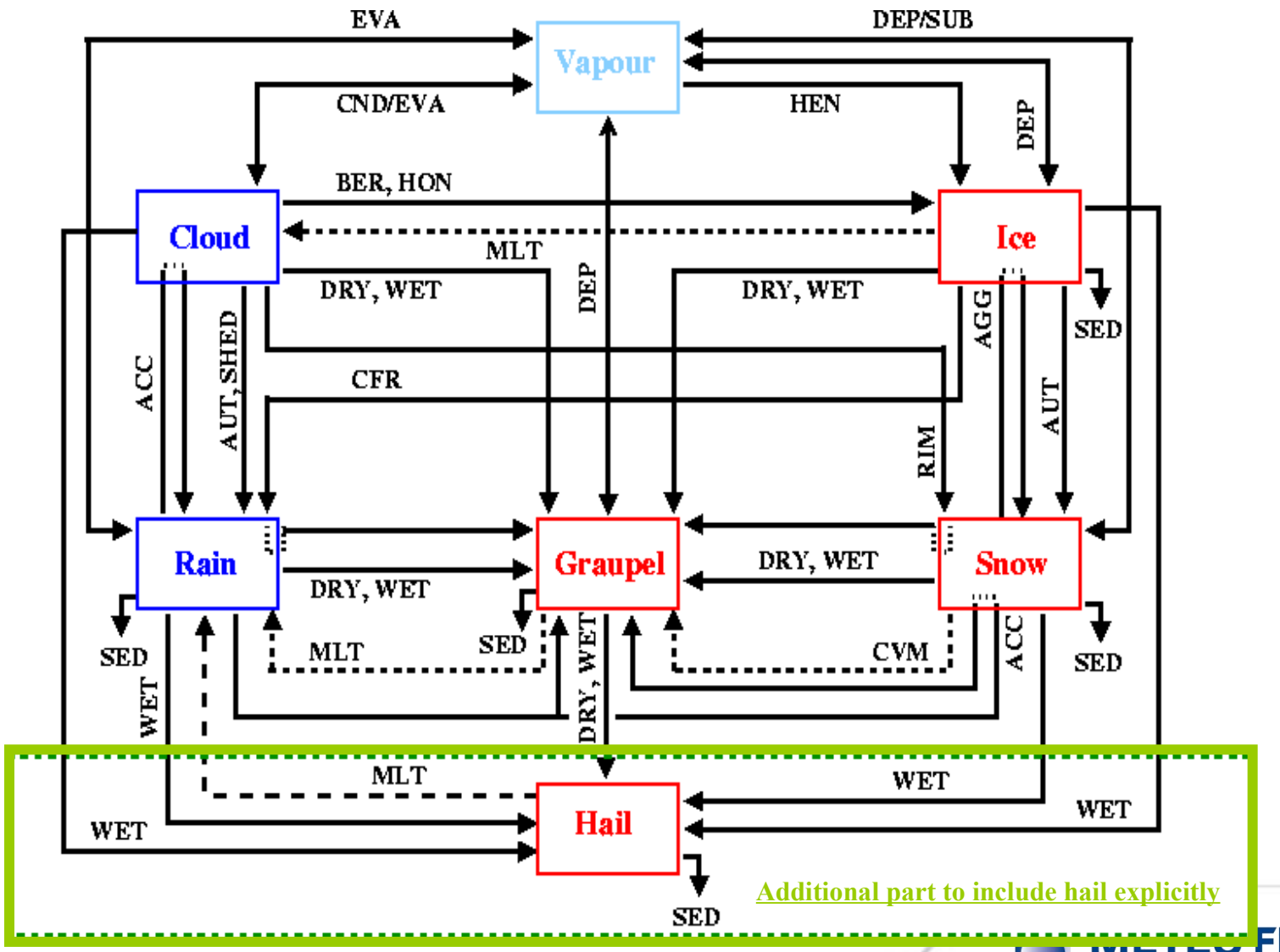
(+70 %)



Performances : cf Ryad's talk

METEO FRANCE
Toujours un temps d'avance

Hail (ICE4)

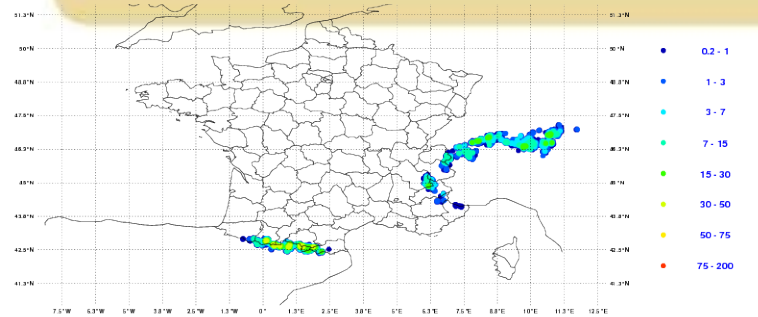

EVA
DEP/SUB
Vapour
CND/EVA
HEN
DEP
BER, HON
Cloud
Ice
MLT
DEP
DRY, WET
DRY, WET
AGG
SED
ACC
AUT, SHED
CFR
AUT
RIM
Rain
Graupel
DRY, WET
Snow
DRY, WET
SED
MLT
SED
CVM
ACC
SED
WET
DRY, WET
MLT
WET
Hail
WET
WET
SED
Additional part to include hail explicitly

29 April 2007 r12 FC+6

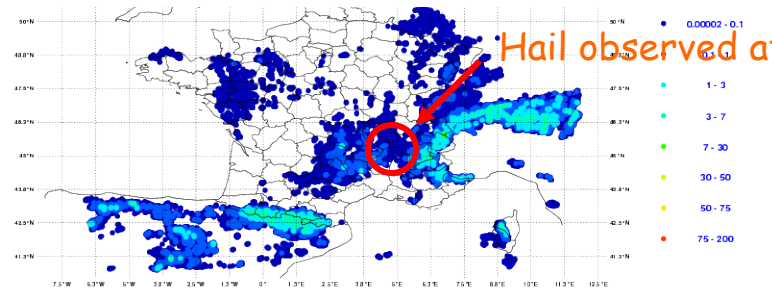
dt=60s

Cumulated precipitations

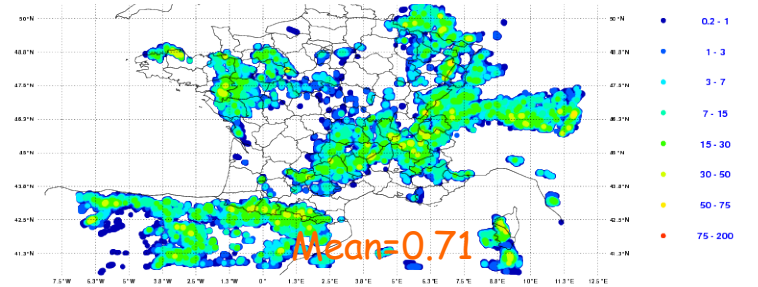
dt=15s



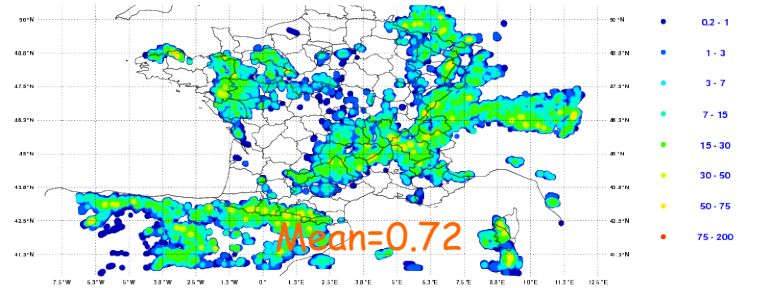
Graupel ICE4



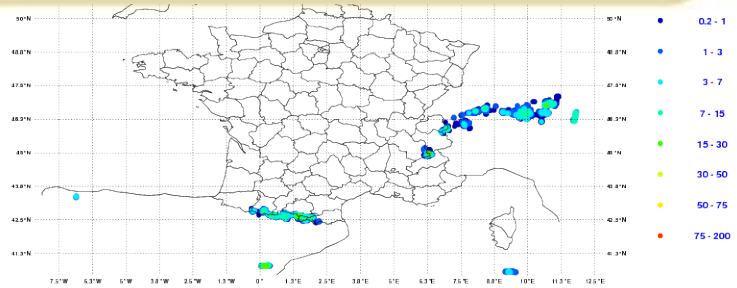
Hail ICE4

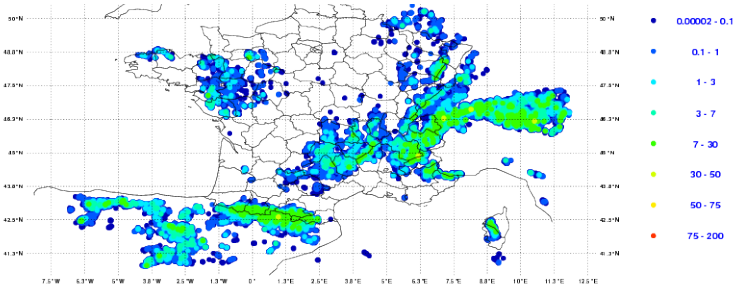


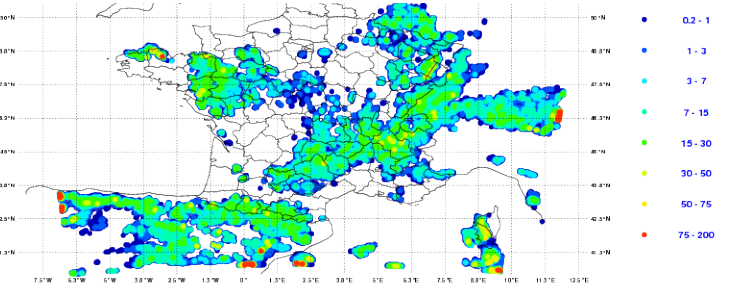
Rain ICE4



Rain ICE3







- ICE3 and ICE4 are similar in terms of rain
- Hail sensitivity to the time step

METEO FRANCE
Toujours un temps d'avance

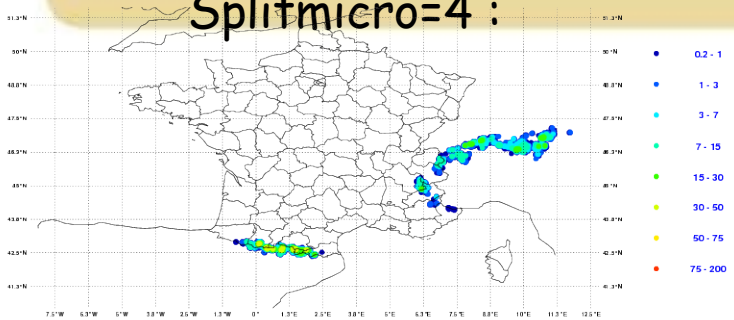
29 April 2007 r12 FC+6

Cumulated precipitations

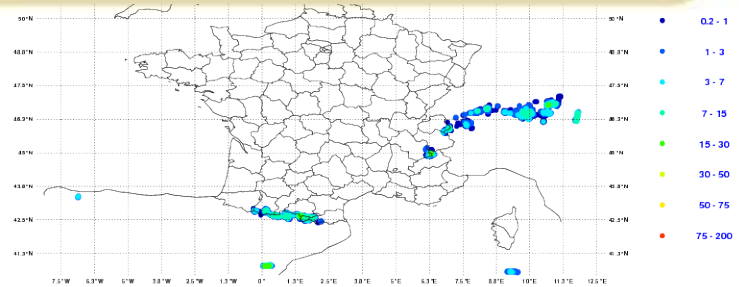
dt=60s

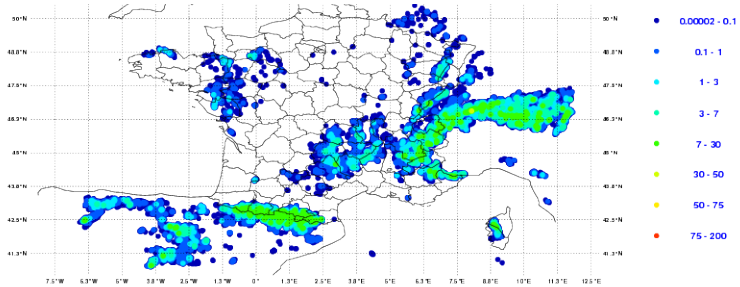
Splitmicro=4 :

dt=15s

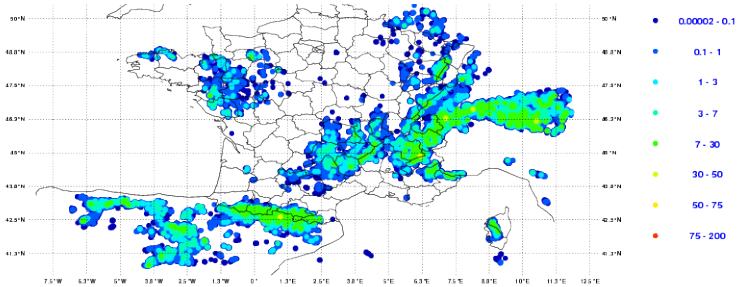


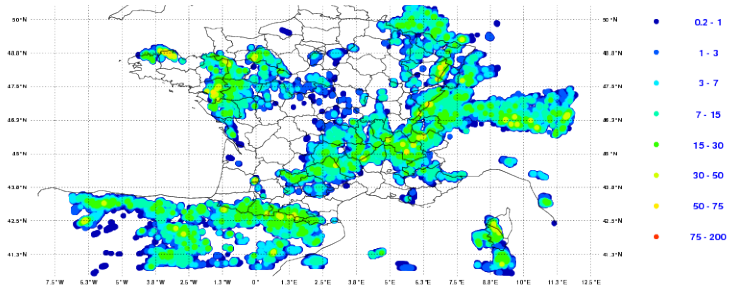
Graupel ICE4



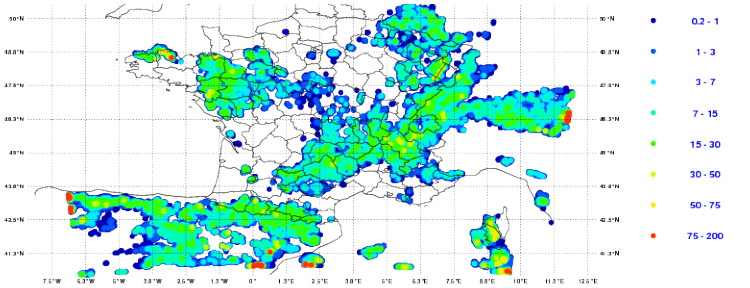


Hail ICE4





Rain ICE4

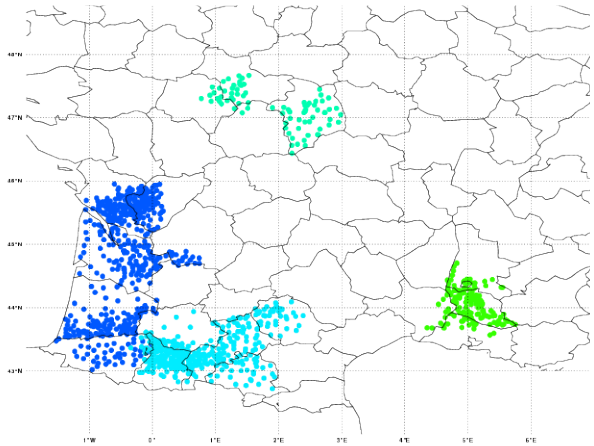


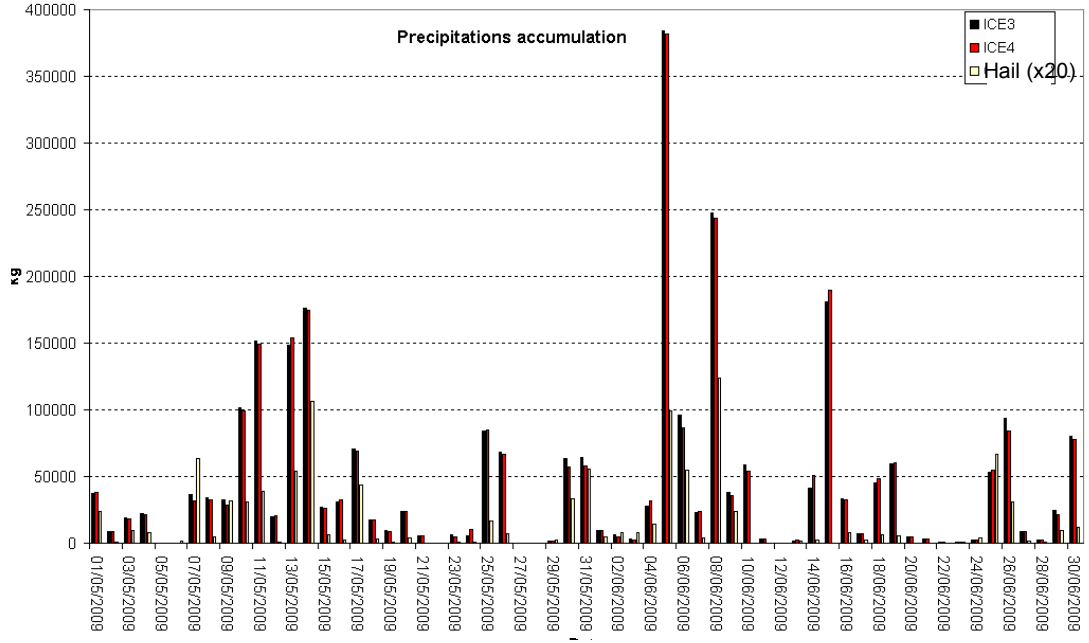
- Splitting the microphysics seems to improve hail fields

Evaluation on a longer period

Mai-Nov 2009 in South-West of France in comparison with hail observations and possibly polarimetric radars

Observation network (1054 stations) :





Preliminary results over 2 months (May, June) :

- 8 cases of correct forecast of hail
- 22 cases of correct forecast of rain only
- 10 cases of false alarm
- 2 cases of no detection

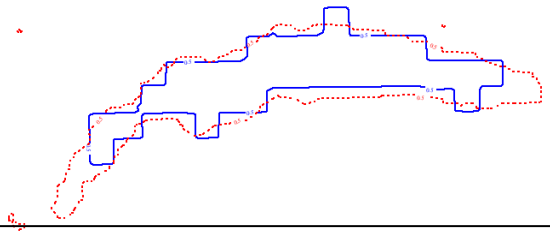
METEO FRANCE
Toujours un temps d'avance

Use meso-NH gtopo30 database for AROME orography and land-sea mask

Currently : Old GTOPO 30 → Pre-treatment → 2'30" grid (5km) → C923 → Quadratic orography

Max slope FRANXL = 41%

Land-sea mask at 500m of Geneve lake (old, new).



New way : GTOPO 30 → PGD → PGD in FA → C923 → Quadratic orography

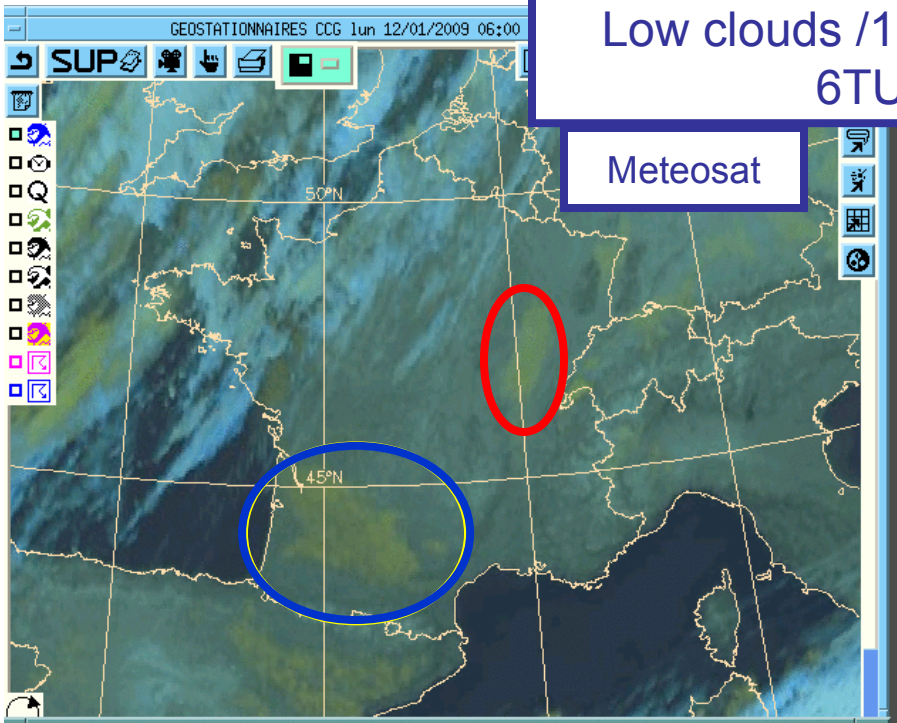
Max slope FRANXL = 51%

Evaluation on October 2009 in AROME_v2 in dynamical mode :

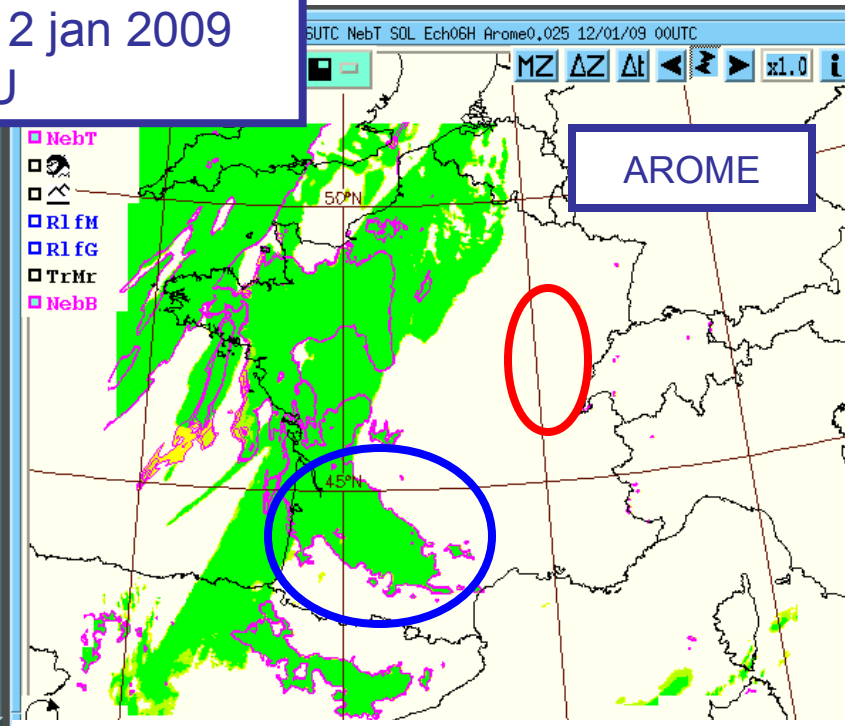
Improve V_{10m} but 2 crashes of the model in the first time step near points of max slope

(pb of adaptation of the wind to the orography, no pb in assim mode)

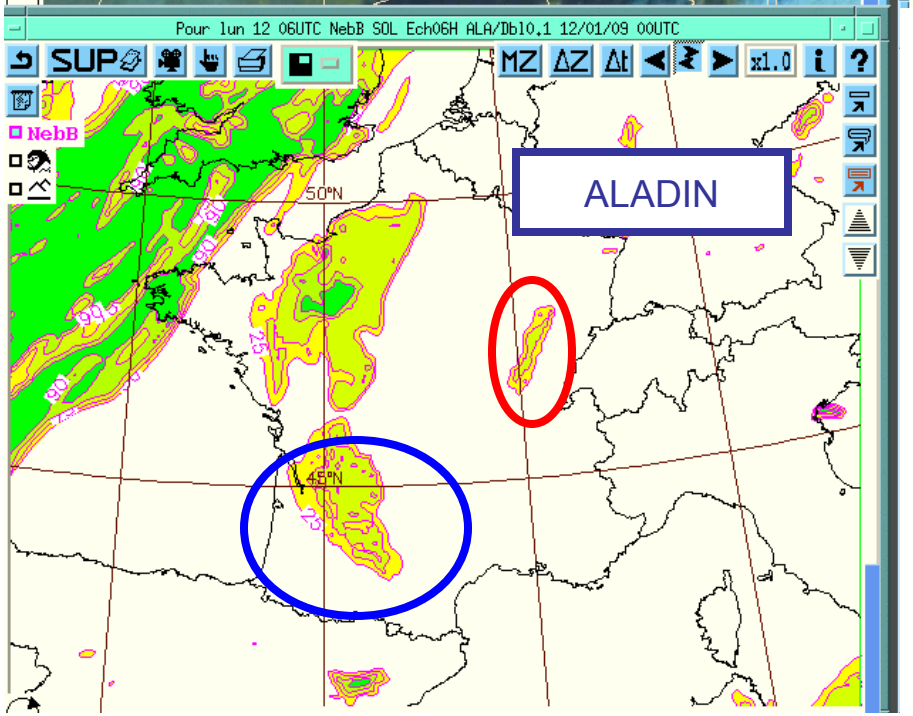
Low clouds /12 jan 2009 6TU



Meteosat

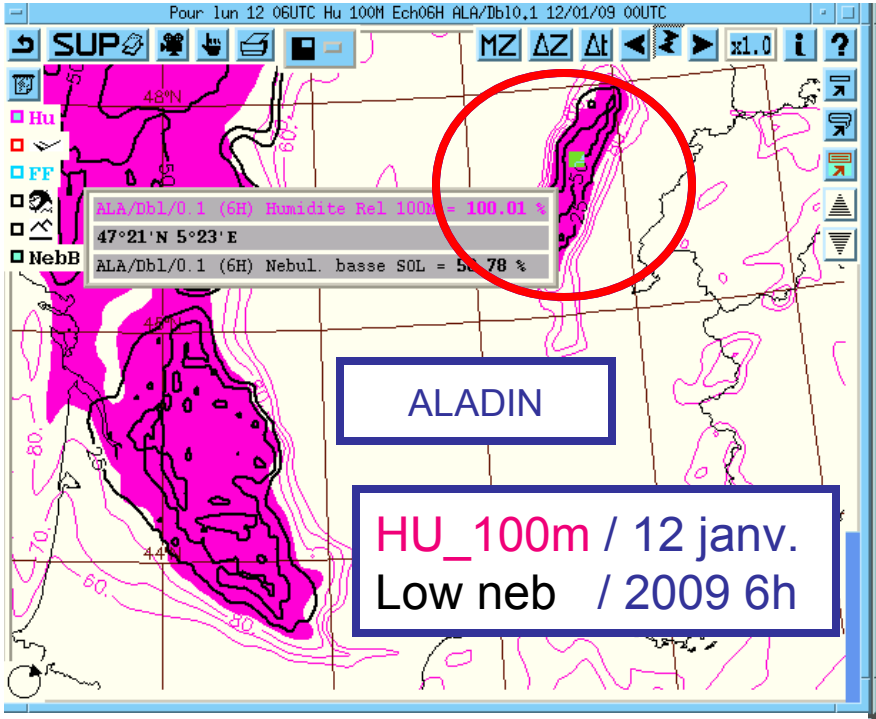


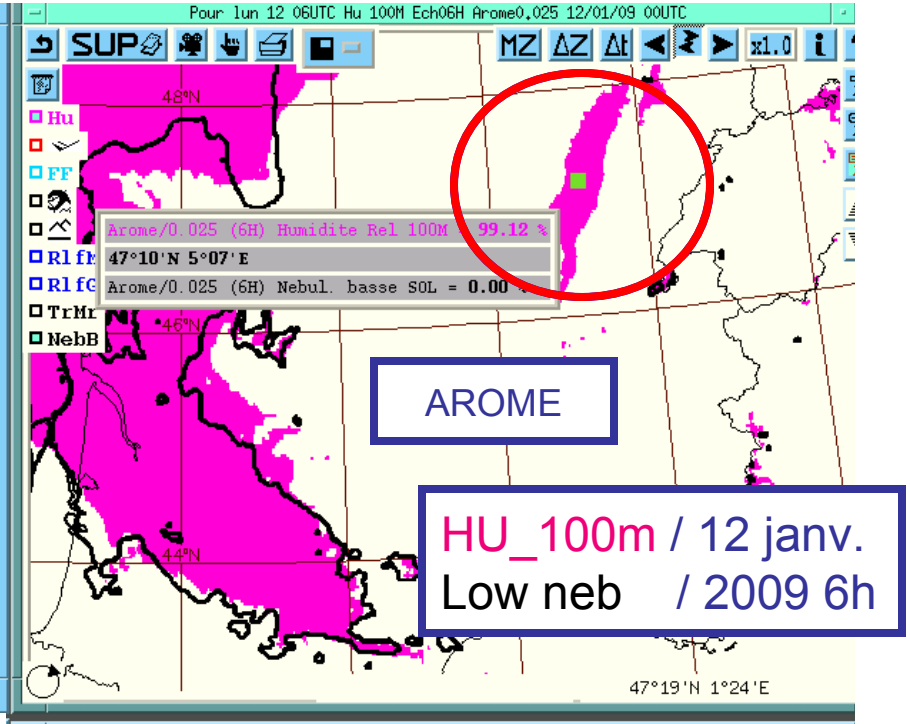
AROME



ALADIN

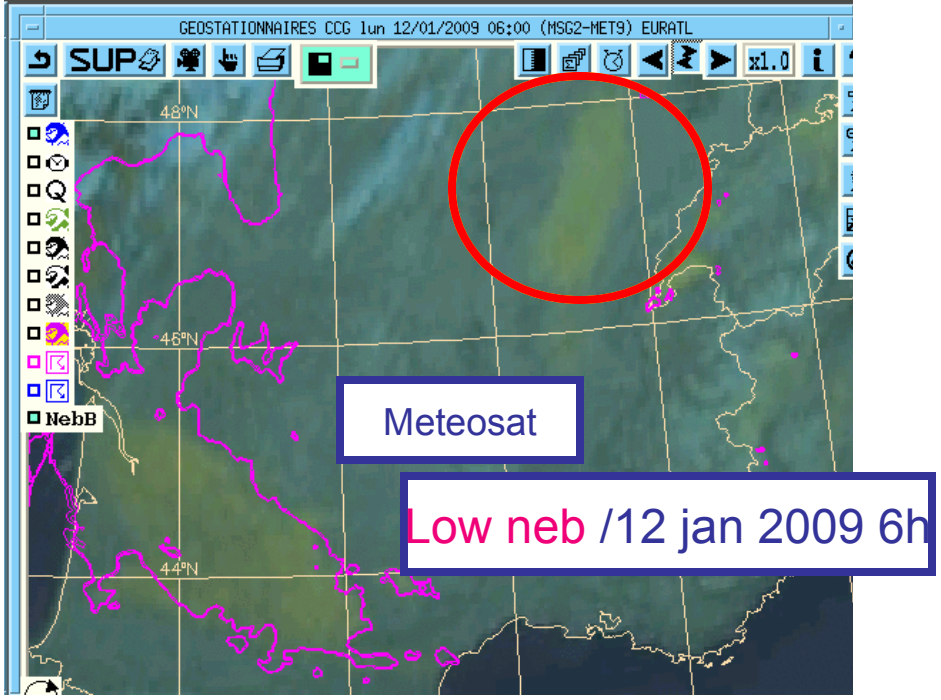
From forecasters point of view, the main drawback in AROME concerns low clouds





AROME Neb is 1 or 0. In stable conditions, we are not able to create clouds if Hu<100%

Link with SW radiation bias.



Tests in Meso-NH to improve the cloud scheme

tion of the subgrid cloud variability according to a **Probability Density Functio**

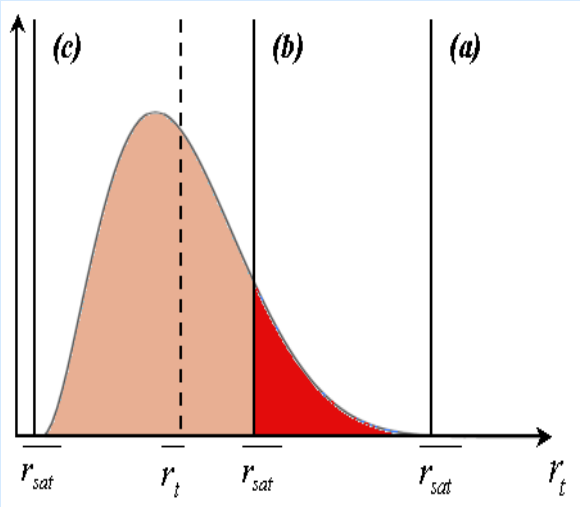
•**Cloud fraction and cloud water content calculation :**

$$CF = \int_{\overline{r_{sat}}}^{+\infty} G(r_t)\, dr_t$$

and

$$\overline{r_c} = \int_{\overline{r_{sat}}}^{+\infty} (r_t - \overline{r_{sat}})\, G(r_t)\, dr_t$$

With *G = PDF*



The cloud fraction is the red area under the PDF curve beyond the saturation :

***(a)* No saturated : CF=0**

***(b)* Partially saturated : 0<CF<1**

***(c)* Fully saturated : CF=1**

The choice of the PDF is essential

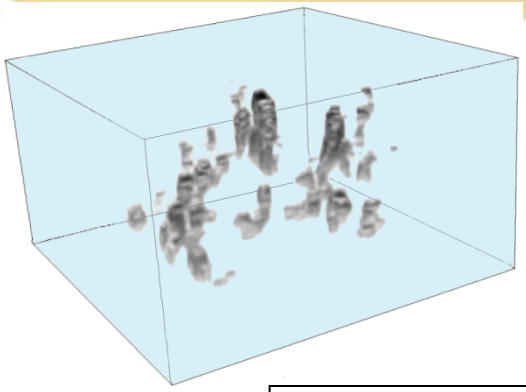
Methodology to improve the cloud scheme for BL clouds :

1. Comprehensive statistical analysis of PDF obtained with Large Eddy Simulation (LES)
2. Test of different theoretical PDF to fit the best the LES data
3. Parametrization of the best theoretical PDF with turbulent and convective parameters (*work in progress, not yet achieved, first results in real cases expected by the end of 2010*).

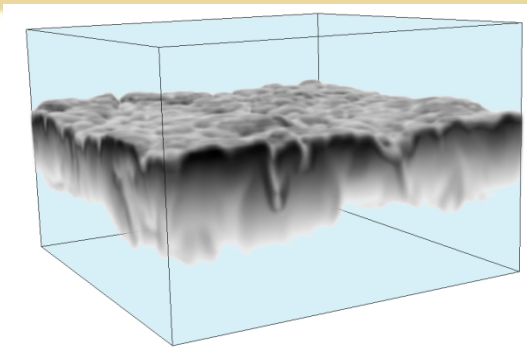
E.PERRAUD et al., 2010

1. Statistical analysis of LES data :

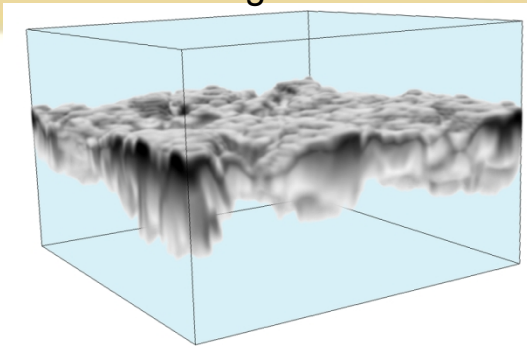
ARM Cu case



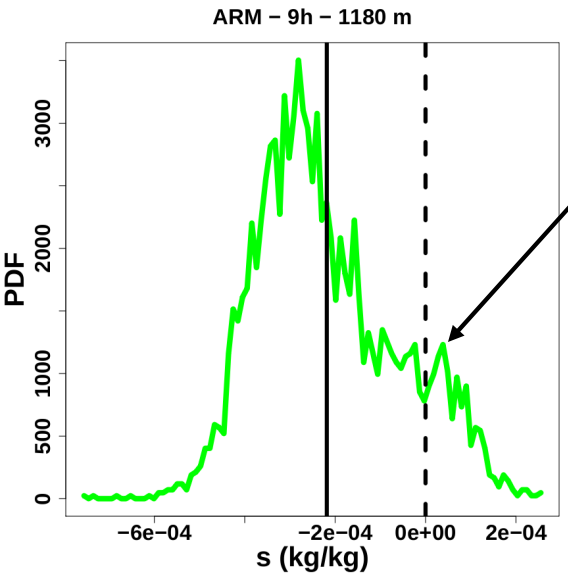
ACE homogeneous Sc case

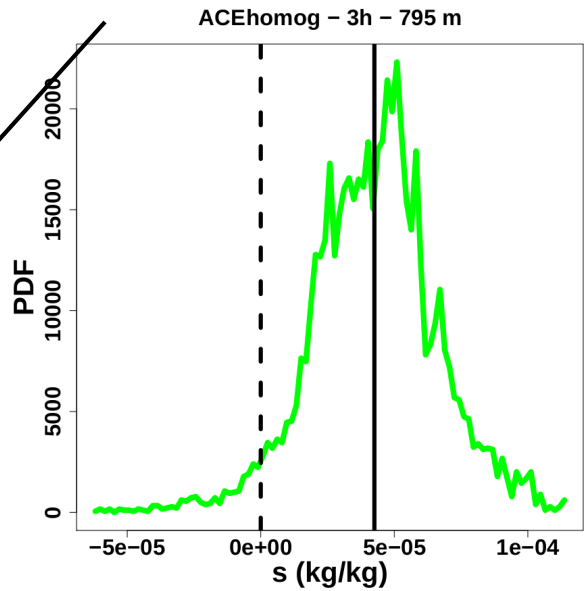


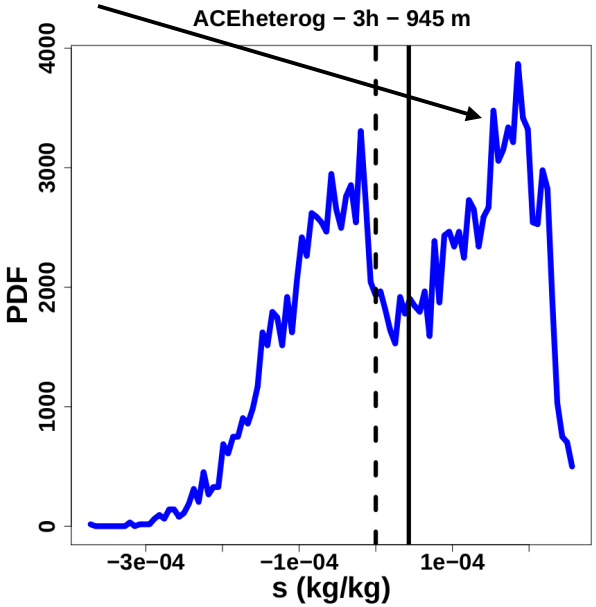
ACE heterogeneous Sc case



Apparition of a second mode in the cloudy values of *s* linked to the convective thermals







LES distributions of *s* (saturation deficit) inside the cloud layers

E.PERRAUD et al., 2010

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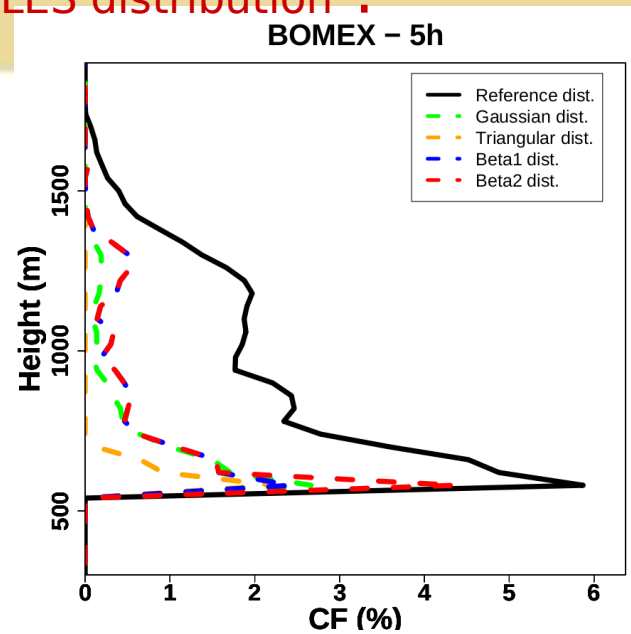
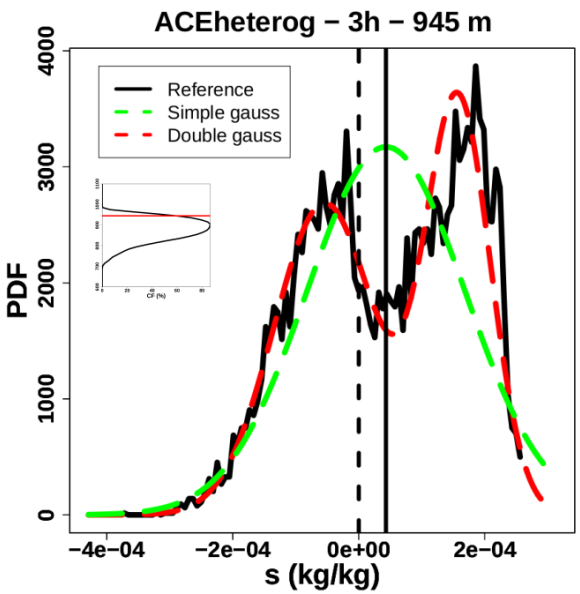
2. Evaluation of the theoretical distributions

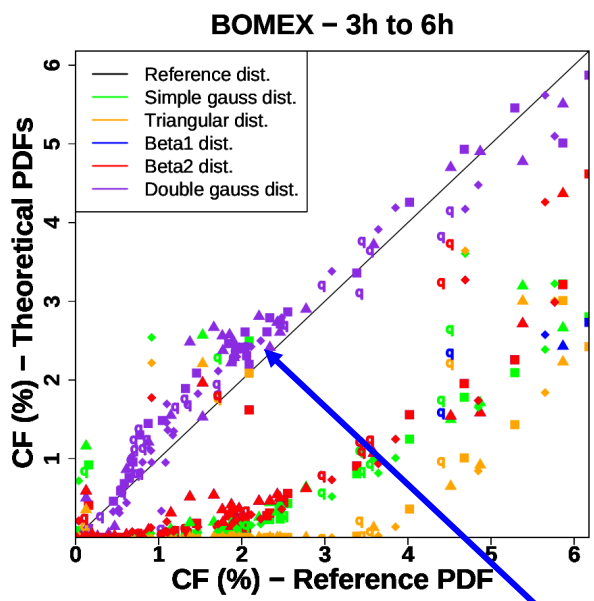
by comparison to the reference LES distribution :

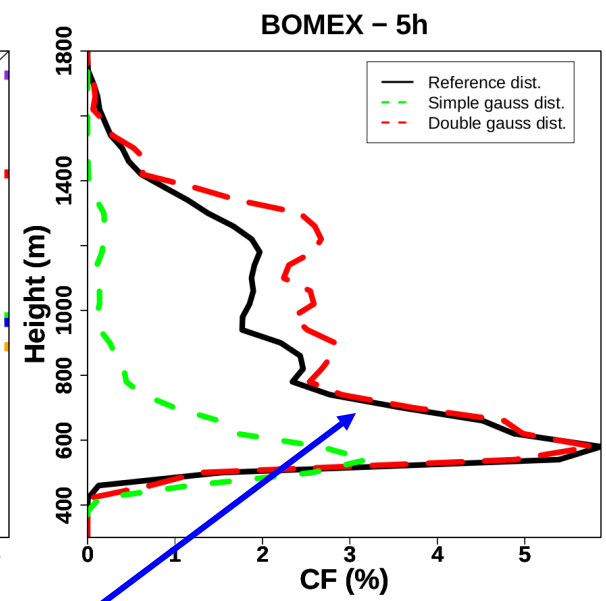
- **Gaussian distribution** (*Sommeria and Deardorff, 1977; Bougeault, 1981*)
- **Triangular distribution** (*Smith, 1990*)
- **Beta1 and Beta2 distributions** (*Tompkins, 2002*)



Introduction of a double gaussian distribution to improve the representation of the second mode







E.PERRAUD et al., 2010

Significant improvements with the double gaussian PDF

Other works, outlooks

- Optimized version of shallow convection scheme (EDKF)
- Test ECOCLIMAP II (second half of 2010)
- Test modifications in SL scheme proposed by S. Malardel in real 3D case of 'fireworks'.
- Data assimilation in Surfex (cf J-F Mahfouf talk)
- Continue investigations at higher resolution
- Start of AROME_v3 in E-suit in summer. Content is not yet fully fixed.

What's new in AROME-France configuration ?

Yann Seity,
P. Brousseau, S. Riette, E. Wattrelot, P. Marquet
E. Perraud, C. Lac …

HIRLAM/ALADIN meeting Kracow, April 2010

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