AROME-France Evolution

Y.Seity
CNRM-GAME, Météo-France

Contributors:
S. Riette,
C. Lac, D. Ricard, S. Donier

Talk's Overview

- Status and content of oper/E suites

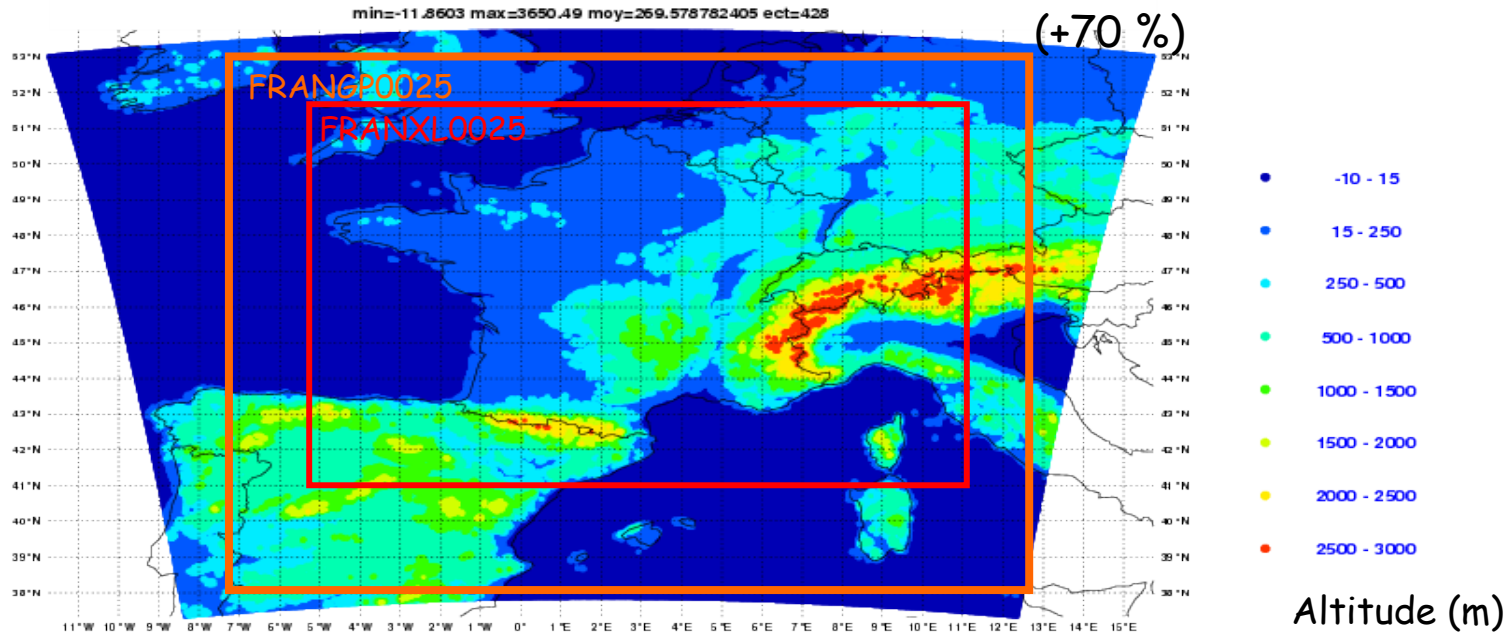
- Developments and perspectives on :
  - Surface
  - Shallow clouds and Fog
  - Dynamics/Physics coupling

AROME France Oper

- Since November 2010 : CY36T1_op1

Domain 750x720xL60 points

(+70 %)



AROME France E-suite

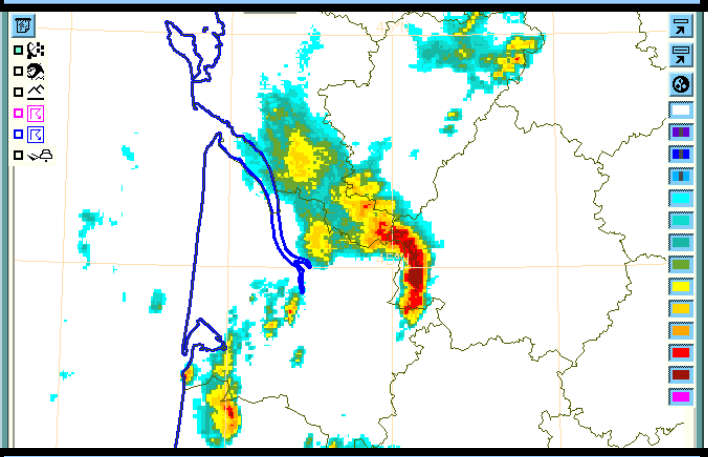
CONTENT (physics part):

- Hail diagnostic

Hail: case of the 13 May 2010

OBSERVATIONS :

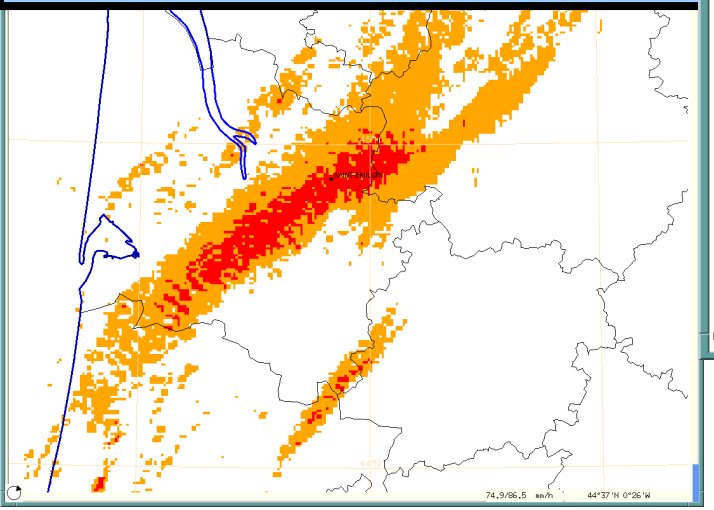
Observation (reflectivity at 2h30 UTC)



Hail risk (from radar)

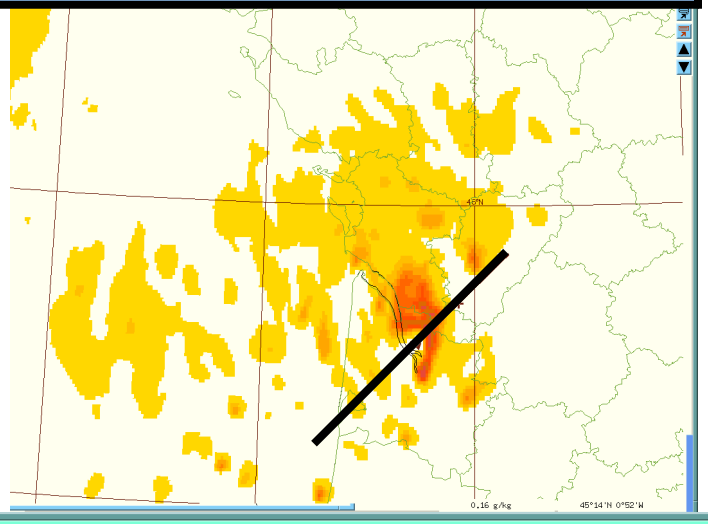
Orange : hail probable

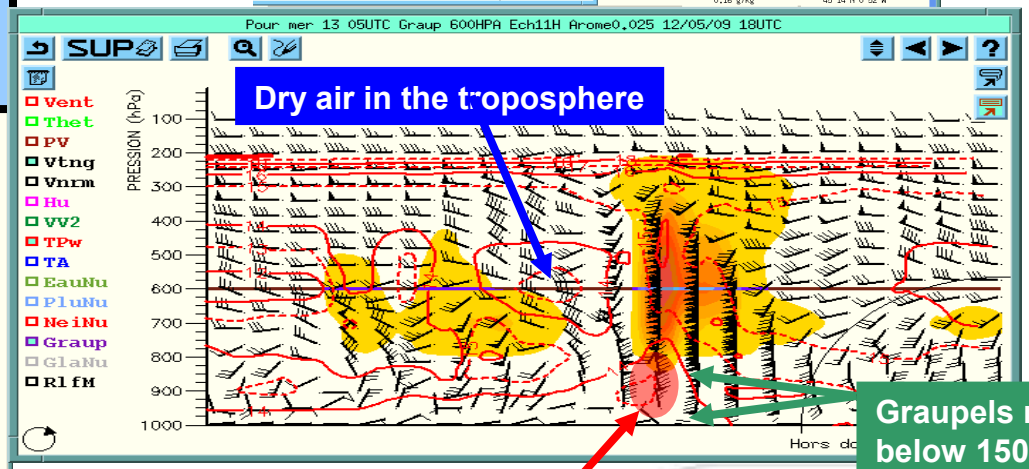
Rouge : strong hail probable



AROME-oper :

Graupels at 600hPa at 5UTC (r18)





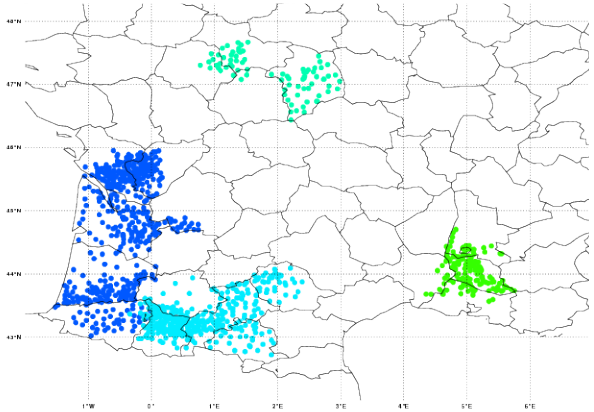
METEO FRANCE
Toujours un temps d'avance

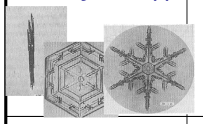
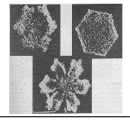
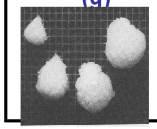
Evaluation of ICE4 scheme in AROME

- In operational AROME version, ICE3 is used (hail is part of graupels)
- ICE4 separates graupel and hail as 2 prognostic species
- ICE4 has been evaluated over 2009 on South West of France

Grêlimètres (30x40cm polystyrene plate) :

ANELFA Network (1054 grêlimètres) :



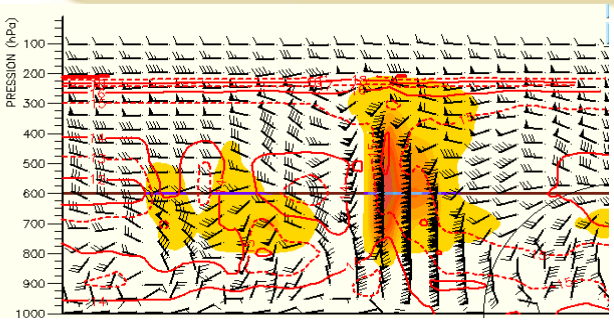
TYPE	Caracteristics
Ice crystals (i) 	D~10-100µm
Snow (s) 	D~1-10mm ρ_s~100kg/m^3 V~0,3-1,5m/s
Graupel (g) 	Hail and graupels D>7mm $\rho_g > \rho_s$ V~1-5m/s V_{lim}=10m/s

- Disappointing results : Scheme very sensitive to the time step, and too active (small amount of hail but everywhere there is graupel in altitude)
- Despite a lot of sensitivity tests, we did not manage to tune the scheme correctly

=> not ready for operational use

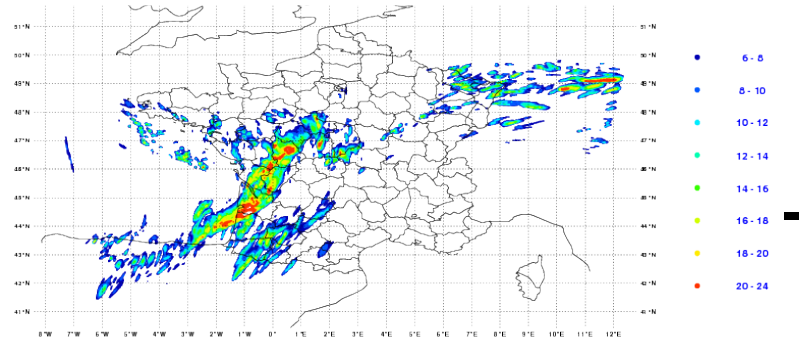
We tried to diagnose hail in the model

Hail diagnostic

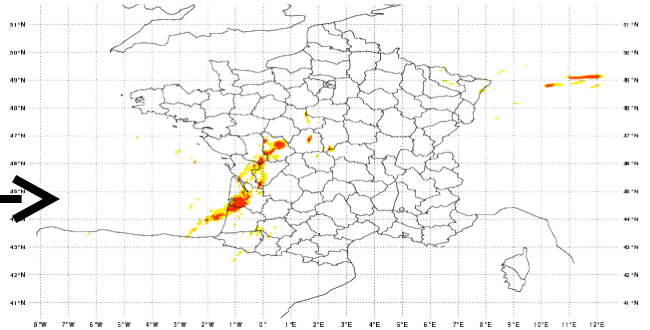


1. Compute each time step, vertically integrated graupel content
2. Save in files the maximal value since last file (as for gusts)

Ex : 11 May 2009 r12+12 Max over 12h

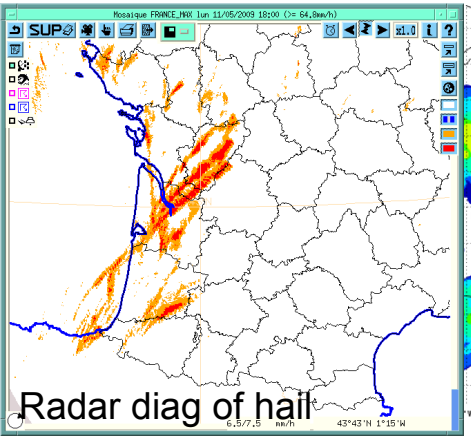


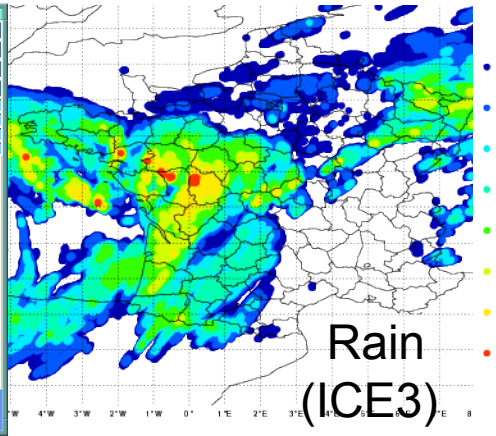
Thresholds at 16 et 20 kg/m²

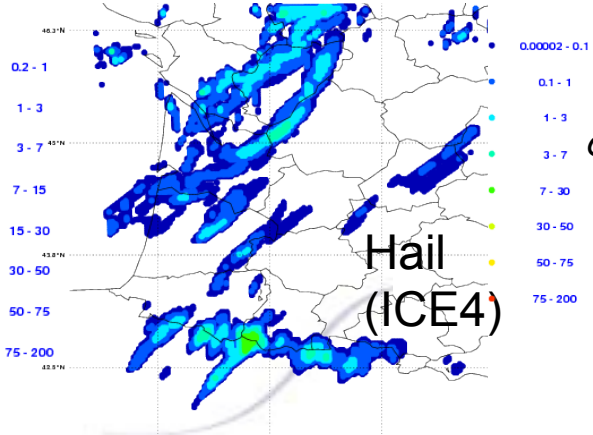


small hail

large hail







Evaluation / improvements will continue in 2011 (diag available for forecasters)

Low clouds variability

- Several scales of variability and processes for boundary layer clouds:
  - Turbulent motions (parameterized with ED schemes)
  - Shallow cumulus forces by BL thermals (with MassFlux scheme)
  - Mesoscale variability (e.g. gravity waves, humidity heterogeneity in nocturnal & residual boundary layer, orography, residual clouds from previous convection, etc…)

- AROME statistical cloud scheme uses $Q = \frac{q_t - q_{sat}}{\sigma_s}$ (=normalized distance to saturation curve)

  - Condensation starts for $Q > Q_c$

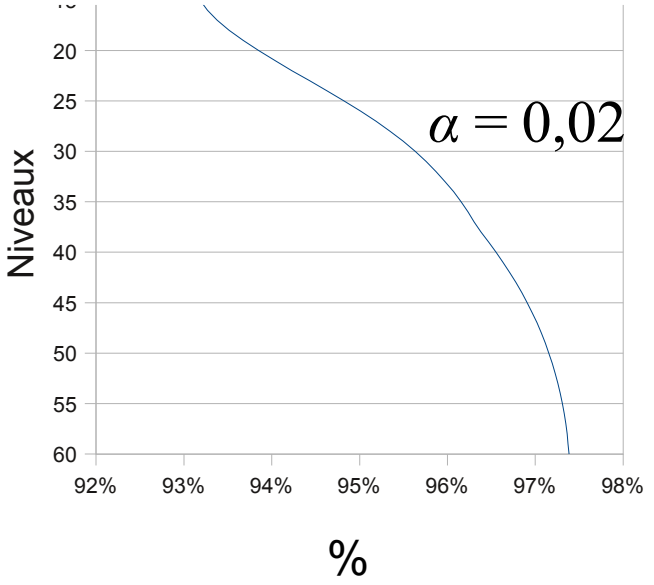
- Wim de Rooy formulae used for mesoscale variability

  - suppose $\sigma_s = \alpha \times q_{sat}$

  - then one will have condensation for :

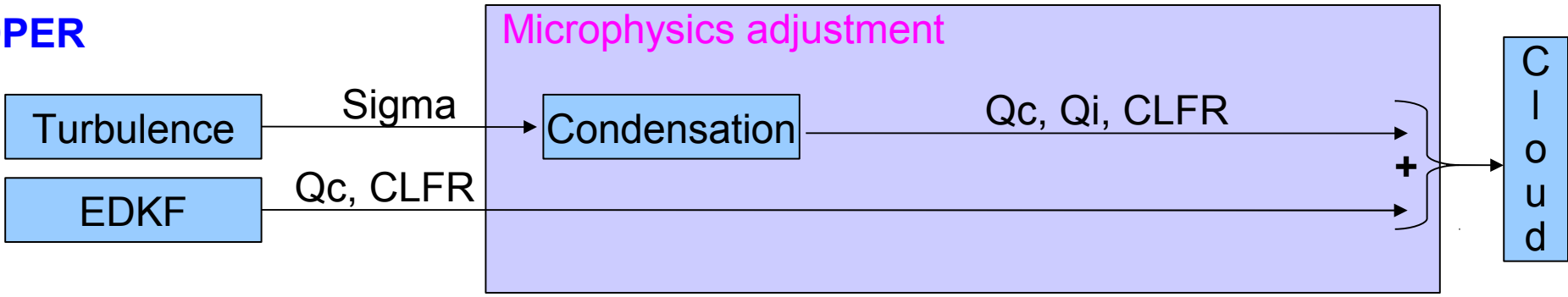
$$Hu > Hu_c = Q_c \times \alpha + 1$$

Critical saturation humidity Hu_c

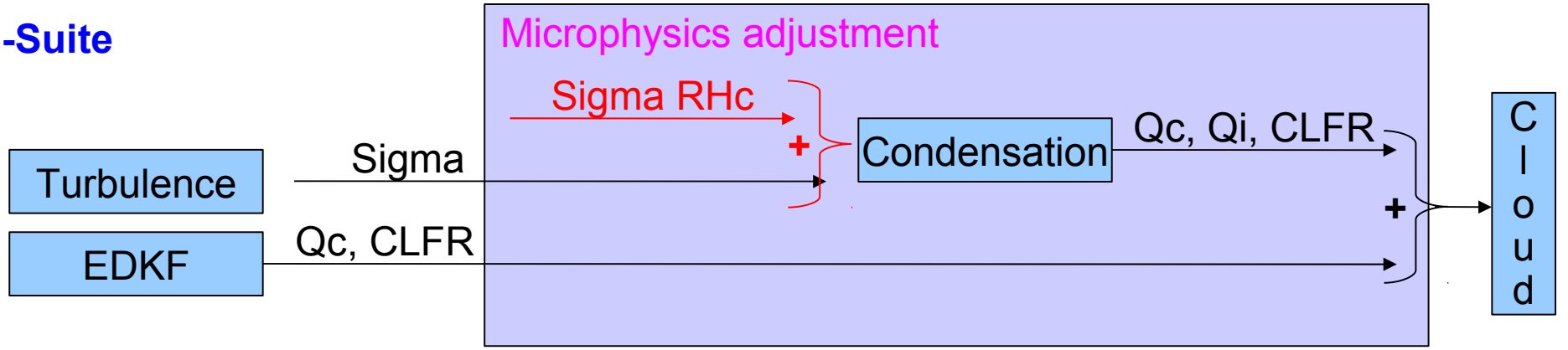


Modifications for low clouds

OPER

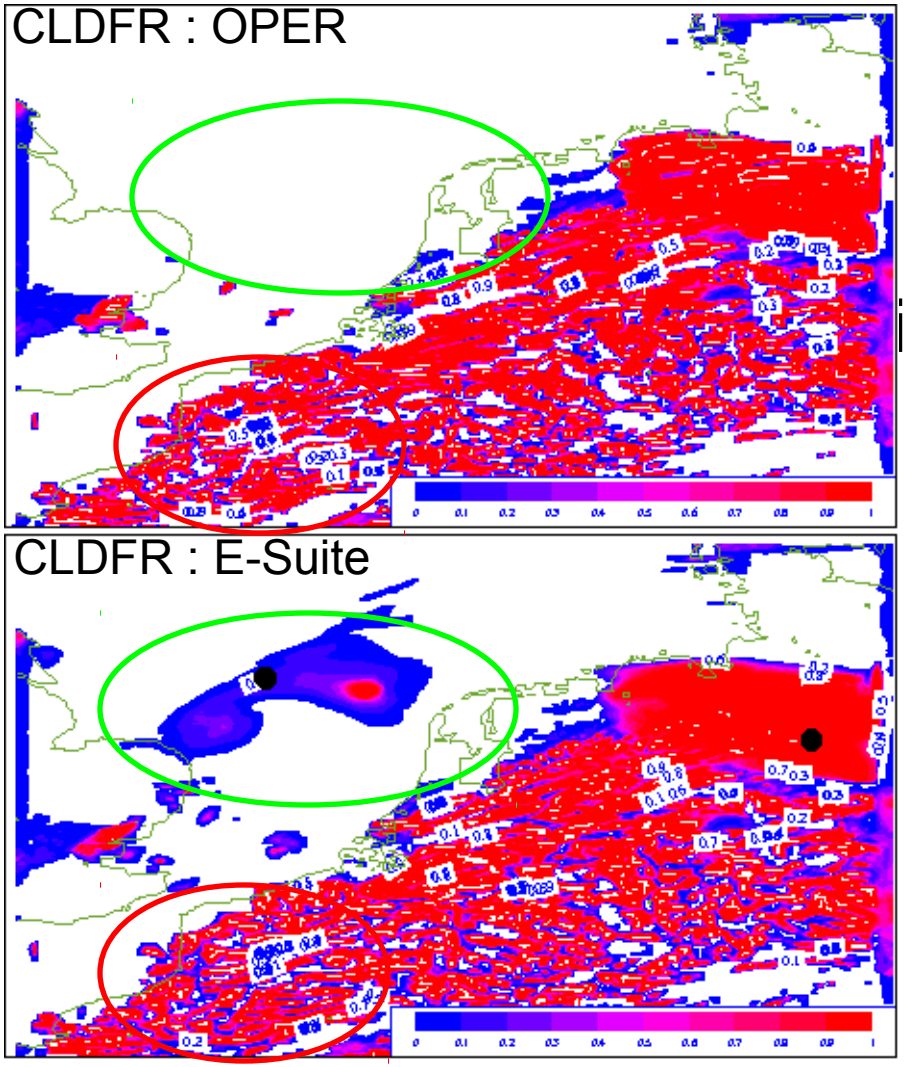


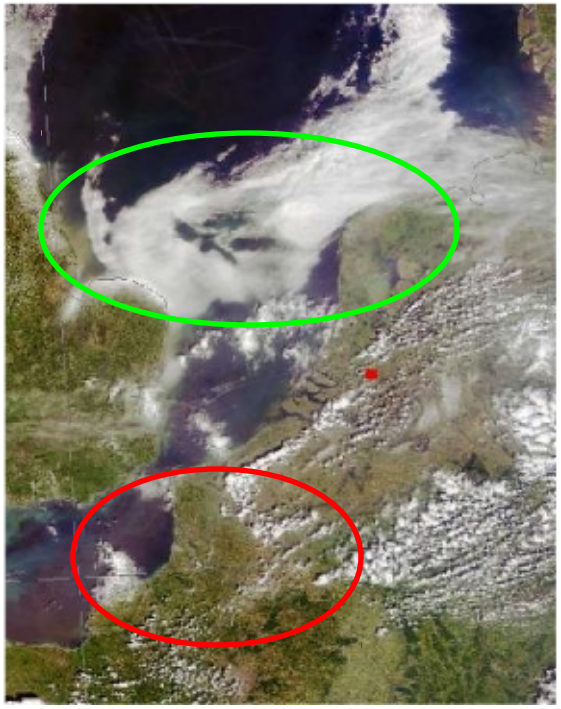
E-Suite



We use $\alpha = 0{,}02$ and $\sigma = \sqrt{\sigma_{turb}^2 + \sigma_{RH_c}^2}$

Example : 13 May 2008 :





Add clouds at some places they were missed

Still over-estimation of cloud fractions on the South

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  - Dynamics/Physics coupling

New version of ECOCLIMAP

Available in surfex6 (CY37T1)

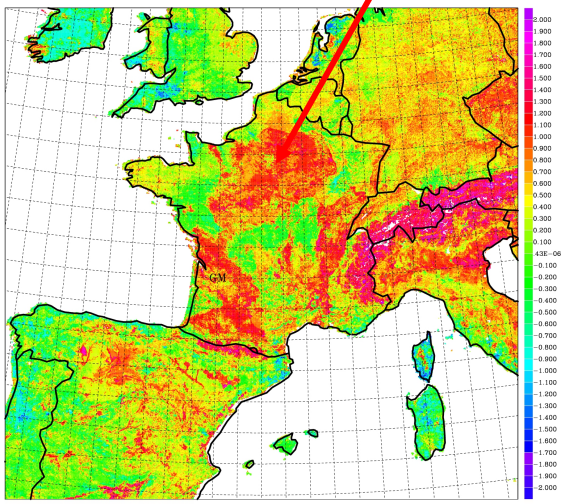
Comparison of ECOCLIMAP2 / ECOCLIMAP1 databases for surface covers :

Proportion of C3 cultures decreases but bare lands and grasslands increases

In ECOCLIMAP1, vegetation stats growing sooner than in ECOCLIMAP2

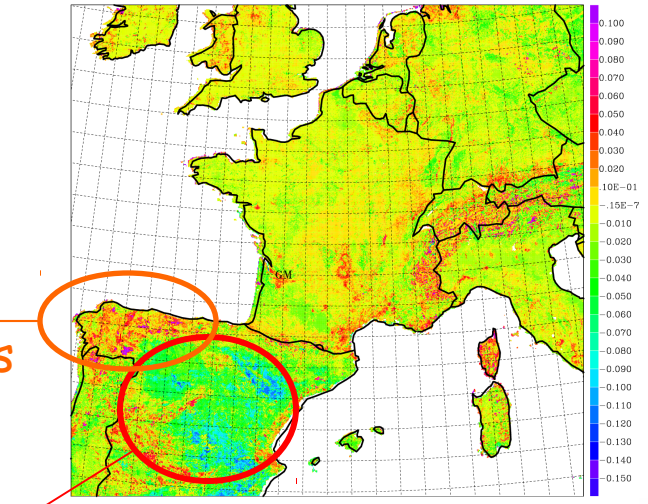
Example of impacts on surface parameters :

LAI in March ECO1-ECO2 :



LAI ECOCLIMAP1 – LAI ECOCLIMAP2

Albedo in March ECO1-ECO2 :



ALBEDO ECOCLIMAP1 – ALBEDO ECOCLIMAP2

More coniferous

More bare soil

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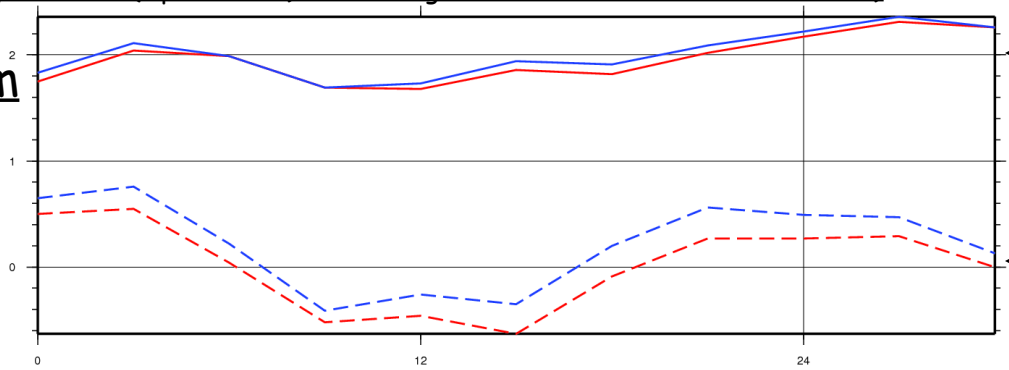
New version of ECOCLIMAP

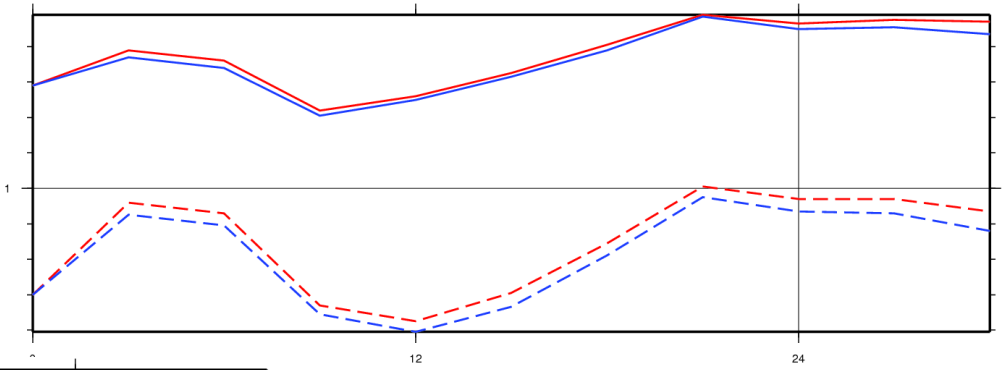
Impact on AROME real cases simulations ECOCLIMAP1 / ECOCLIMAP2 :

(12 days in 2007 (1 per month) without significant clouds over France r0+30h)

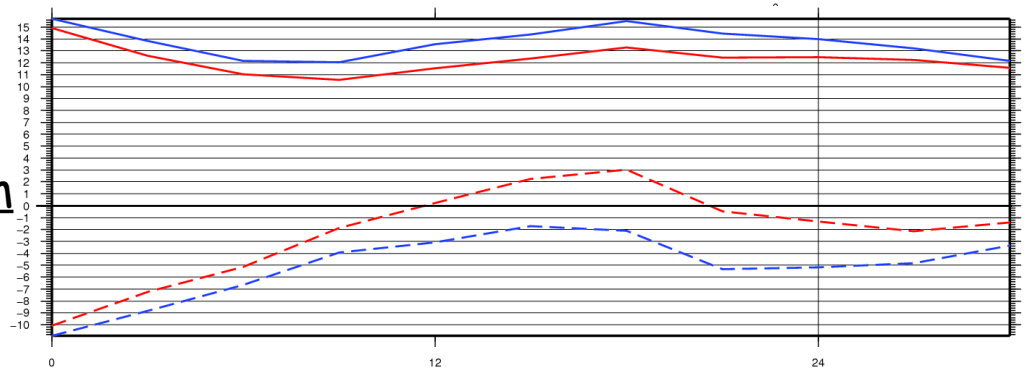
T2m



V10m



Hu2m



+ on V_{10m}, - on Hu_{2m}, +/- T_{2m}

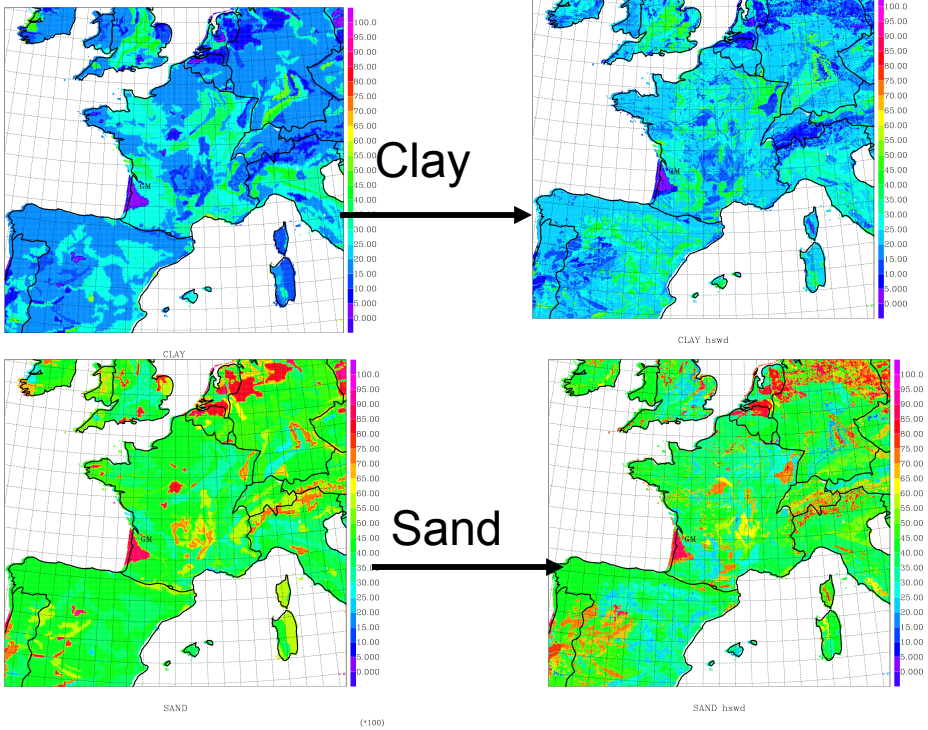
Deeper evaluation will continue

Other tests

- New climatologies of sand and clay :

OPER (10km database)

New (1km database)



- Patchs (positive impact at 8km on ARPEGE-Climat and during CARBO-Europe exp.)

- Isba Diffusion ?

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FOG : Comparison COBEL – AROME 1D on Paris-CdG international airport

COBEL (Bergot et al., 2005) : **1D operational** prediction model of **fog and low clouds** on a few **airports**.

Characteristics : - High vertical resolution
- Local assimilation scheme
- Physics adapted to the low clouds :
  - Turbulence : same 1D TKE scheme. A mixed of mixing length (Bougeault-Lacarrere and Estournel)
  - Microphysics : Warm microphysics without rain and imposed fall velocity for droplets
  - Surface : ISBA-DIFFUSION vegetation scheme (7 layers) (ISBA-3L in AROME)
  - Radiation scheme : Quite similar but more numerous spectral bands

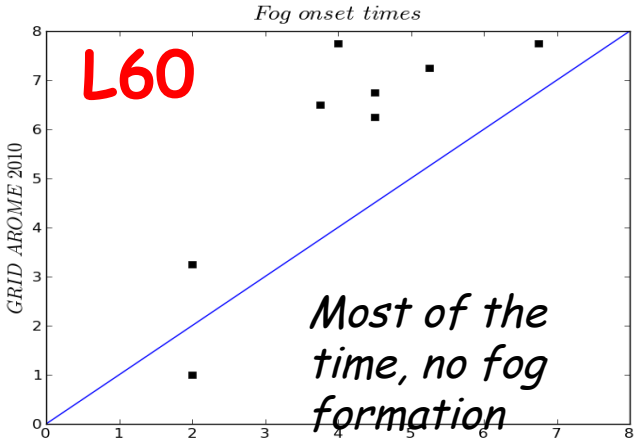
QUESTION : In the same initial conditions, is AROME-1D able to produce the same forecast quality ? Impacts of : - the vertical resolution
- the differences in the physics

For simplicity, study leaded with MESO-NH (As 1D, same conclusions as for AROME)
Evaluation leaded on 2 winters

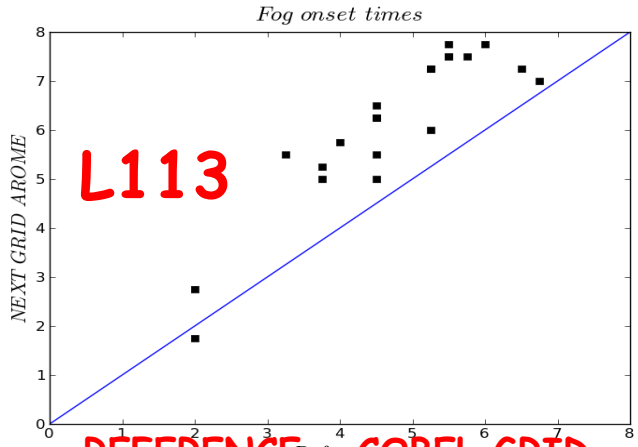
-> with same vertical resolution and same surface options Meso-NH and COBEL are close

Impact of the vertical resolution with MESO-NH/AROME 1D

COBEL vertical levels	Current AROME (L60)	2013 possible AROME (L113)
0,25	-	-
1,075	-	-
2,35	-	-
3,895	-	-
5,76	-	5,205
8,015	-	-
10,745	-	-
14,045	-	16,277
18,035	18,07	-
22,865	-	-
28,705	-	29,15
35,765	-	-
44,305	40,73	44,24
54,635	-	-
67,13	71	61,408
82,24	-	-
100,515	**-**	**101,755**
122,615	-	124,9
149,34	156,44	149,97
181	-	176,96
220,756	**211,52**	**205,86**



REFERENCE = COBEL GRID



REFERENCE = COBEL GRID

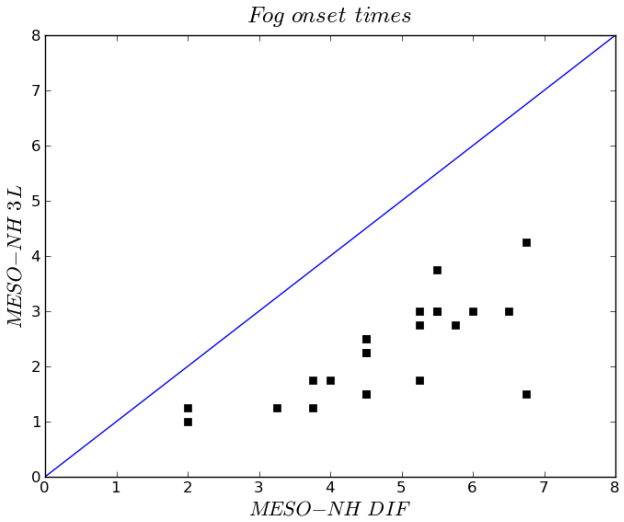
Huge impact on the formation with delay or absence of formation with L60.

Significative improvements with L113

Smaller impact on dissipation (not shown)

Impact of the physics

Significative differences between ISBA-DIFFUSION (Explicite diffusion, 7 soil layers) and ISBA-3L (Force-Restore, 3 soil layers) : soil saturation too rapid with ISBA-3L -> Advance on the fog formation



Current ICE3 microphysics adapted to the fog

No major differences due to different mixing lengths in the turbulence

QUESTION : In the same initial conditions, is AROME-1D able to produce the same forecast quality ?

FIRST ANSWER : YES, IF vertical resolution is finer, and explicit diffusion vegetation scheme

Perspectives on shallow convection & cloud scheme

- Improve cumulus scheme :
  - Test 2 new detrainment/entrainment (Wim De Rooy and Rio et al.) in clouds in our MassFlux scheme
  - New statistical cloud scheme (explicitely separating cumulus contribution), double gaussian PDF (S. Riette continue the work of E. Perraud's PhD)

- Validate AROME clouds modifications against :
  - Surface downwards solar radiation
  - Cloud experiments databases
  - Scores with satellite images

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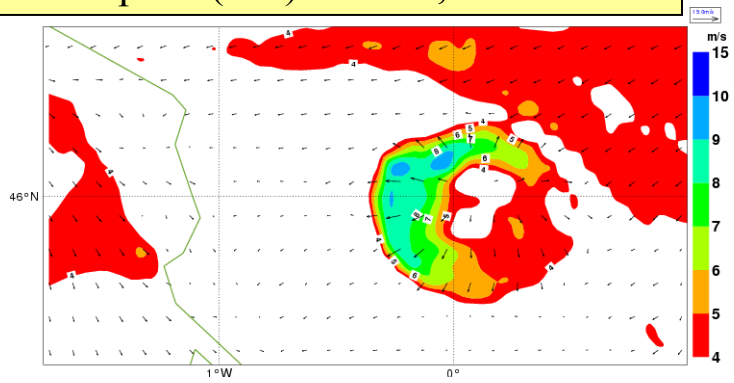
First tests of modification of Semi-Lagrangian scheme in AROME

Sylvie Malardel (ECMWF), Didier Ricard (GAME-CNRM)

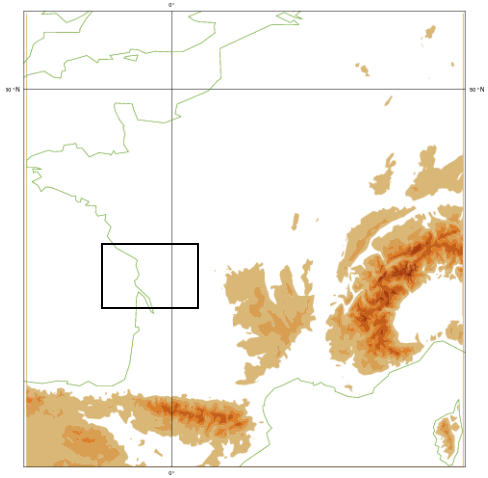
- Purpose: a more conservative scheme (via modifications of SL interpolators)
- Implementation in AROME: → Test on idealized cases: warm bubble experiments

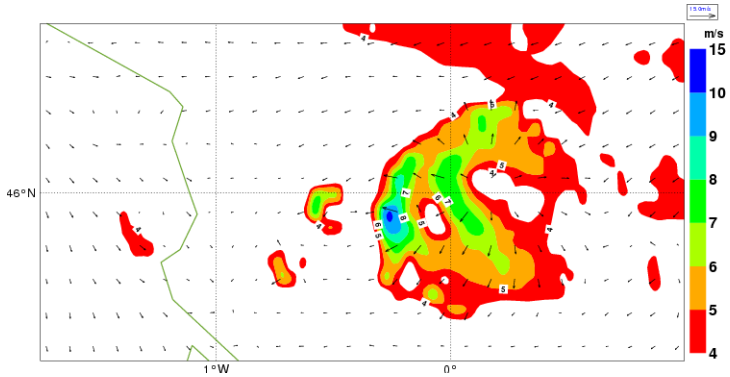
→Test on real cases: convective cells over plain (11 April 2007)

Wind speed (m/s) at 10 m, 15 UTC

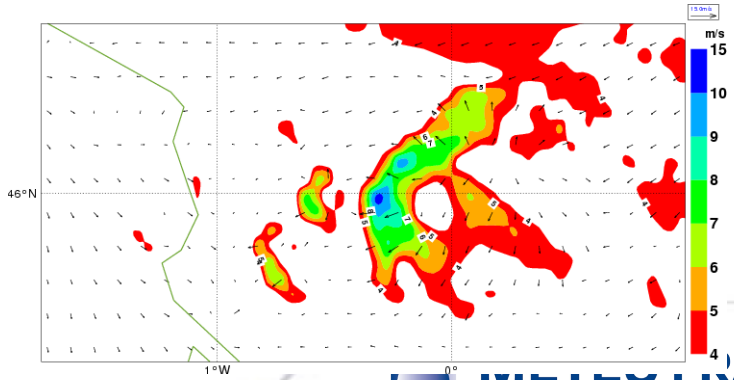


Strong spectral diffusion





Operational spectral diffusion



Modified SL scheme

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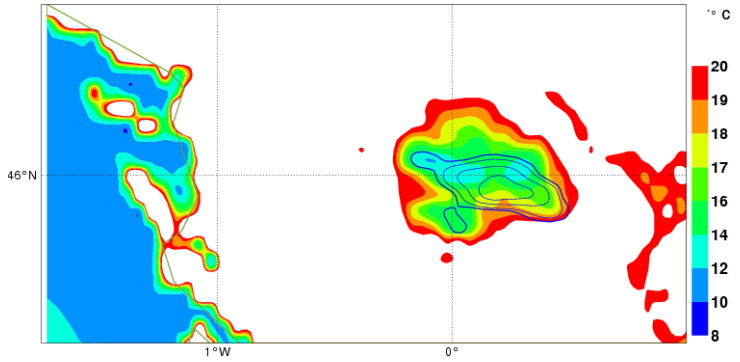
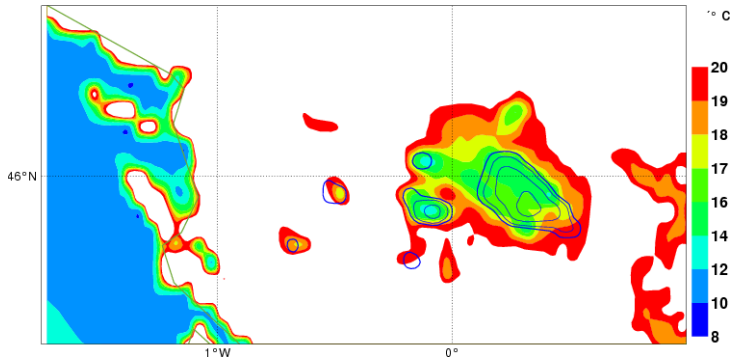
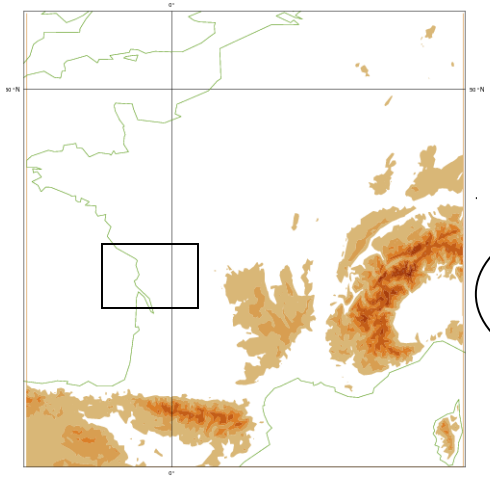
RR (1, 2, 5, 10 mm) and T2m (°C), 15 UTC



Strong spectral diffusion

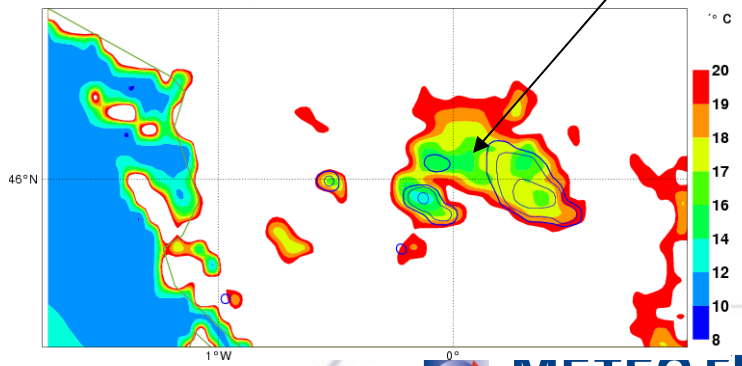


Operational spectral diffusion



T cold pool +2°C

cumulated rain -50%



Modified SL scheme

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Toujours un temps d'avance

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To finish …

- Participation to the BLLAST campain :

(Boundary Layer Late Afternoon and Sunset Turbulence)

15 June- 15 July around Lannemezan (SW of France) (http://www.aero.obs-mip.fr)
To study the transition from the mixed layer convective boundary layer to a residual layer overlying a stably-stratified surface layer in late afternoon