



# Some recent and on-going works on ARPEGE and AROME physics

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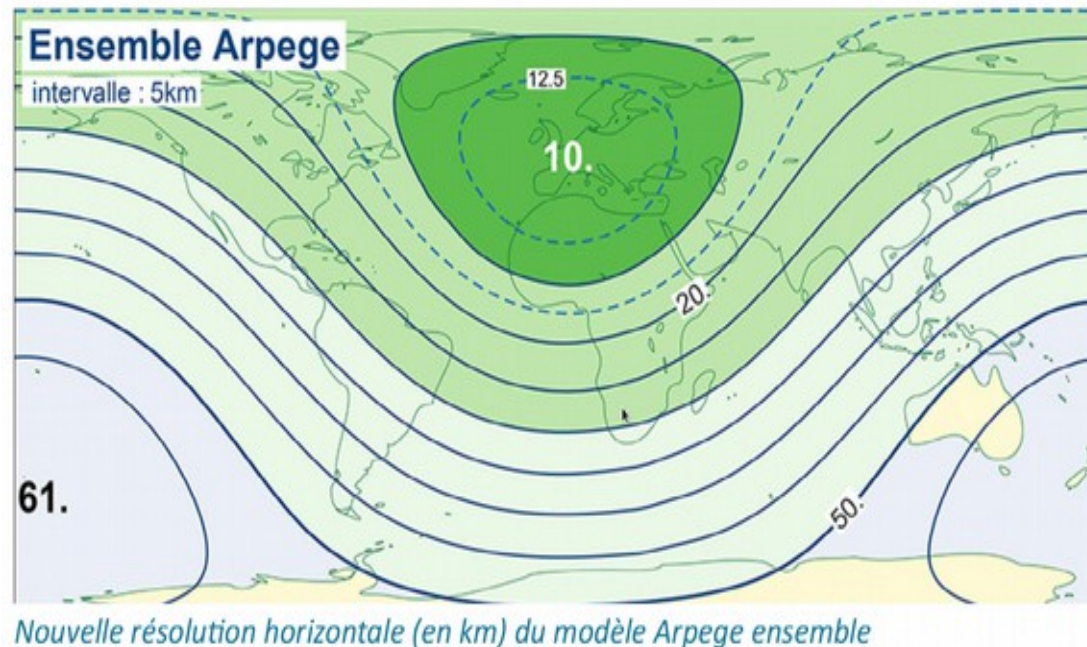
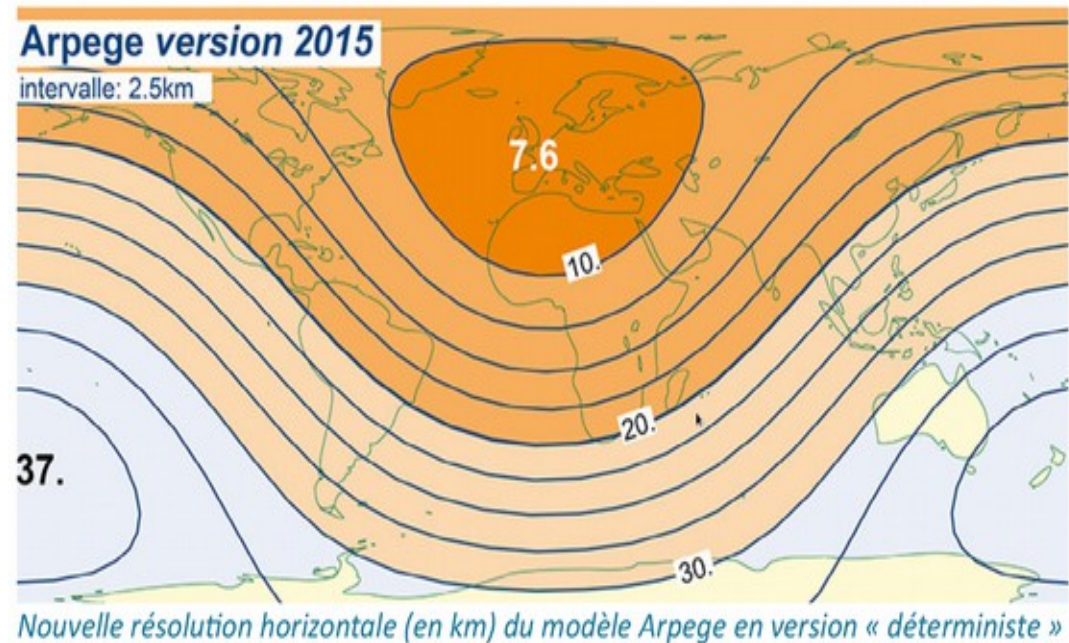
*Y. Seity, J.-M. Piriou, F. Taillefer, G. Faure, E. Bazile, Y. Bouteloup, I. Etchevers, S. Riette, B. Vié, C. Lac, ...*

*presented by F. Bouyssel  
Météo-France/CNRM/GMAP*

*Joint 27<sup>th</sup> Workshop & All-Staff Meeting, FMI, Helsinki, 3-7 April 2017*

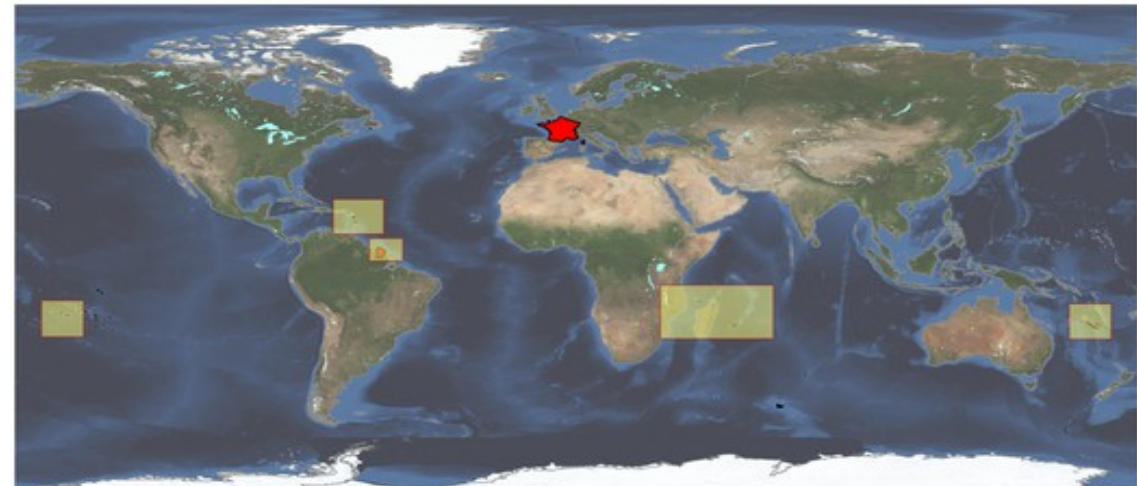
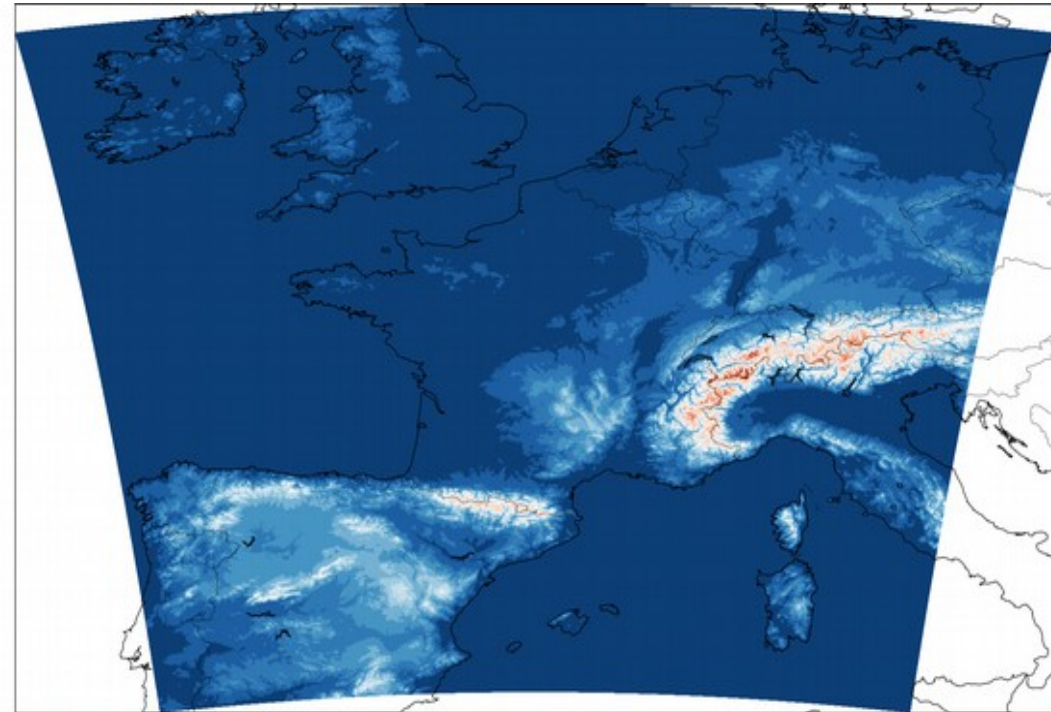
# Global NWP systems based on ARPEGE

Systems	Characteristics
ARPEGE <i>Deterministic</i>	TI1198c2.2 L105 (7.5km on W Europe) 4DVar (6h cycle): TI149c1L105 & TI399c1L105 5 forecasts per day up to 114h
AEARP <i>(EDA)</i>	TI479c1 L105 ; 25 members 4D-Var (6h cycle): TI149c1 L105 Background covariances averaged on 1.5 days and updated every 6h
PEARP <i>(EPS)</i>	TI798c2.4 L90 (10km on W Europe) 35 members ; twice a day up to 108h Using 17 EDA members and singular vectors New set of 10 physical packages (with new convection scheme "PCMT")



# Regional NWP systems based on AROME

Systems	Characteristics
AROME-France <i>Deterministic</i>	1.3km (1536 x 1440 pts) L90: from 5m to 10hPa 3DVar (1h cycle) 5 forecasts per day up to 42h
AROME-France Nowcasting	1.3km (1536 x 1440 pts) L90: from 5m to 10hPa 3DVar (no cycling – 10' cut-off) 24 forecasts per day up to 6h
PEARO (EPS)	2.5km L90 12 members Twice per day up to 45h Initial and boundary conditions from PEARP
AROME Overseas (5 domains)	2.5km L90 – Dynamical adaptation of IFS (altitude) and Arpege (surface) 4 forecasts per day up to 42h





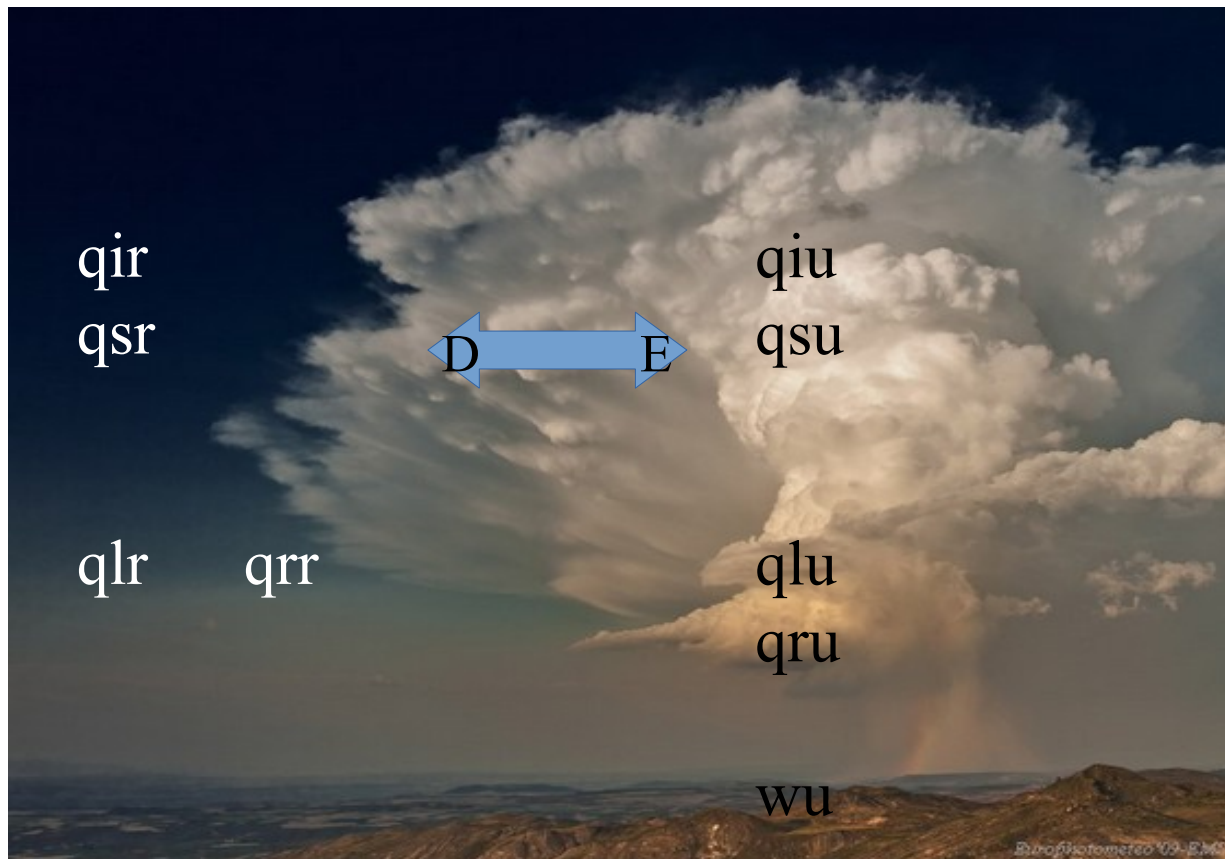
# Current e-suite CY42\_op2

- **Description for ARPEGE / AEARP (EDA) / PEARP (EPS)**
- **New convection scheme PCMT in ARPEGE and AEARP**
- **SURFEX model (surface parameterizations)**
- AEARP: resolution increase for the computation of background error variances
- AEARP: normalisation of variances induced by wavelet modelling of correlations
- VarBC on ground GPS observations
- Assimilation of 2 water vapour channels (183GHz) of GMI on GPM
- Assimilation of 3 water vapour channels (183GHz) of MWHS2 on FY3-C
- Higher density of GEORAD (from 250 to 125km)
- Assimilation of window SEVIRI channels (4, 6, 7, 8 over sea)
- 5 new channels (ozone) for IASI
- New physics in PEARP (ARPEGE EPS)
- Optimisations (new compiler version, etc.)
- New diagnostics (domain, variables, etc.)
  
- **Description for Arome**
- Same modifications as in Arpege for observations
- New version of IAU
- **New cloud optical properties**
- **New autoconversion threshold for transformation of cloud droplets into rain**
- **Ocean mixing layer scheme in Arome-OM**
- Optimisations (new compiler version, server for production of AROME-EPS coupling files)
- New diagnostics (domain, variables, etc.)

# New convection scheme used in ARPEGE

## PCMT: Prognostic Condensates Microphysics and Transport

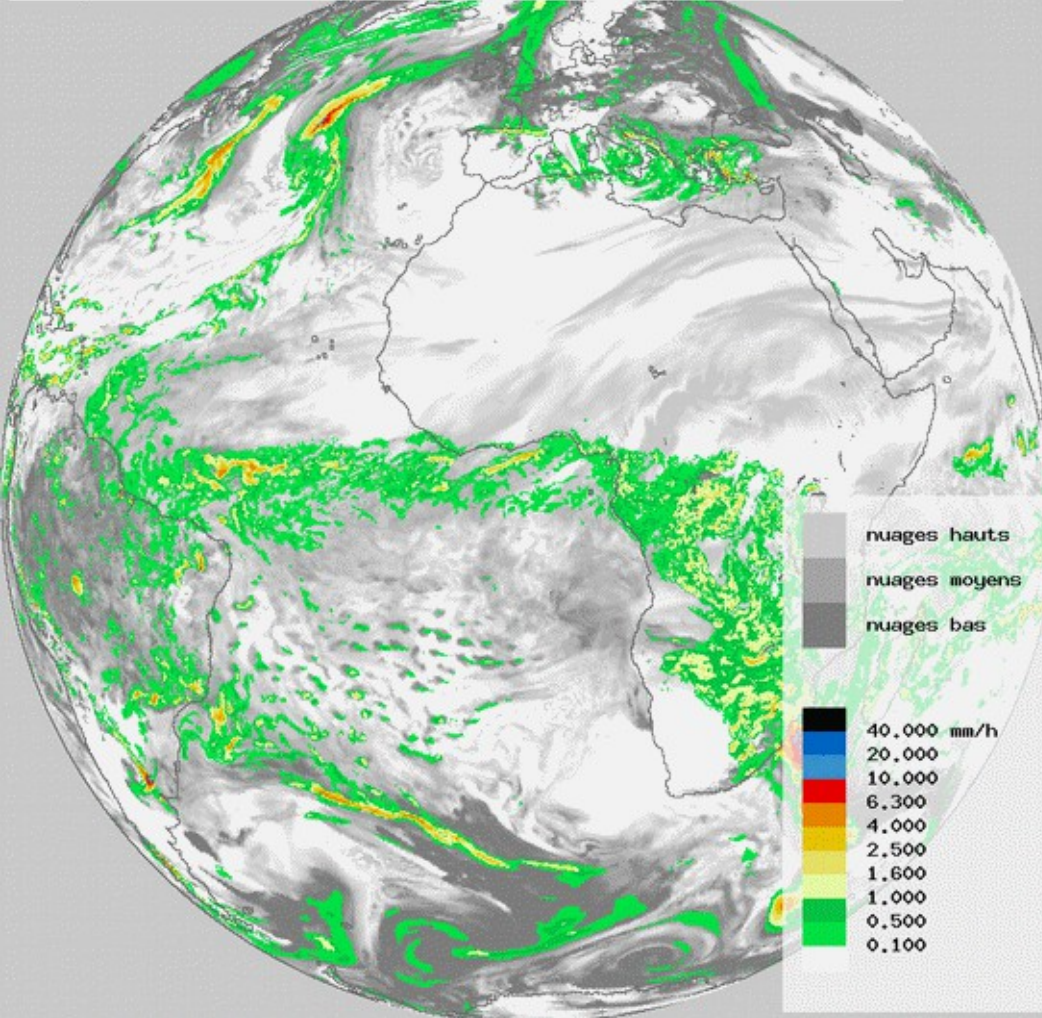
- dry, shallow and deep convection
- prognostic microphysics :  $q_{lu}$ ,  $q_{iu}$ ,  $q_{ru}$ ,  $q_{su}$
- prognostic vertical velocity :  $w_u$
- symmetry between updraft and its environment (« resolved »)
- for use in NWP T1200 , Climate T127 (CMIP6), Seasonal forecast T159





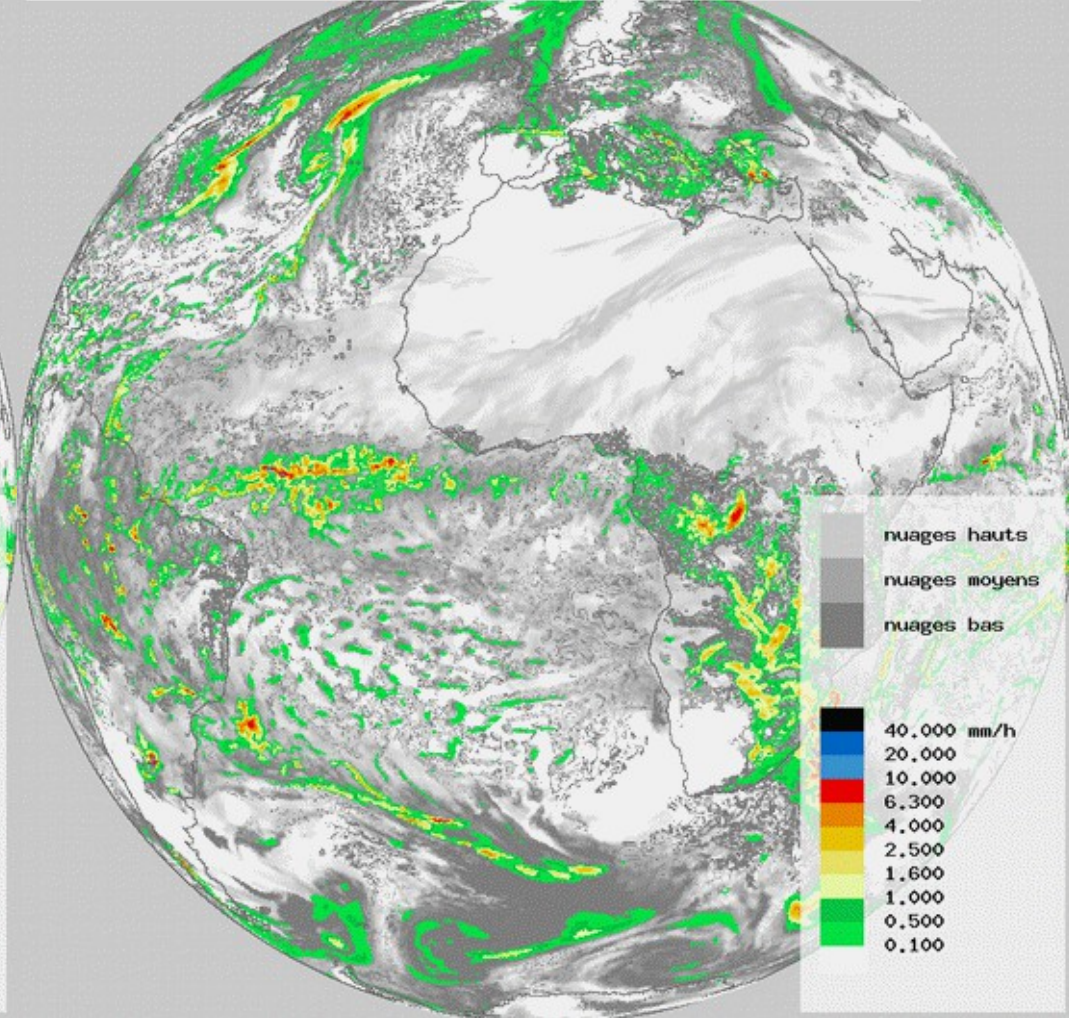
# Impact on precipitation distribution

NEB oper, BASE Dim 15.01.2017 00h UTC + 36h, VALID Lun 16.01.2017 12h UTC



ARPEGE operational (control)

NEB .dbl, BASE Dim 15.01.2017 00h UTC + 36h, VALID Lun 16.01.2017 12h UTC



ARPEGE « PCMT + SURFEX »  
( e-suite )

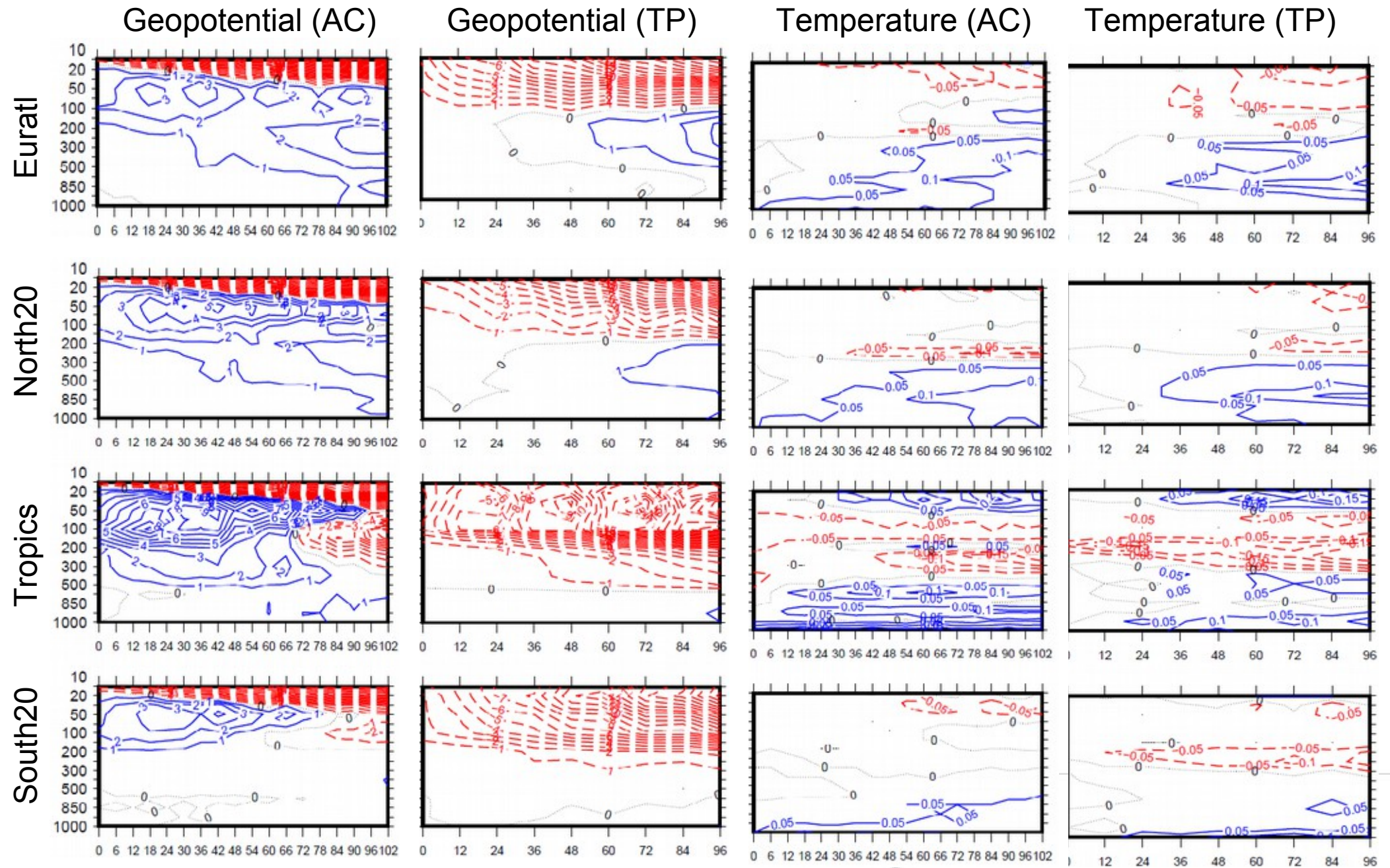
# SURFEX in ARPEGE

- Physiography : ECOCLIMAP v1 (1km), HWSD (1km)
- Same configuration as in Arome-France (ISBA-3L, D95, etc.) except:
  - soil and vegetation heat capacity modified
  - characteristic time changed for ice scheme
  - minimum value for snow albedo
  - modified surface turbulent exchange coefficient for moisture over sea
  - no subgrid orographic radiation activated
  - default limitation for maximum roughness length
- Same surface analysis as before except:
  - no relaxation to climatologies for snow, deep temperature, total soil water
  - no spatial smoothing of total soil wetness index

A problem has been identified recently in e-suite because the surface temperature for sea (or lake) with fractional coverage below approximately 50% was kept constant



# RMSE differences between "e-suite" and "oper" for 2016 against ECMWF analysis (AC) & TEMP (TP)





# RMS errors differences between "e-suite" and "oper" for 2016 against ECMWF analysis (AC) & TEMP (TP)



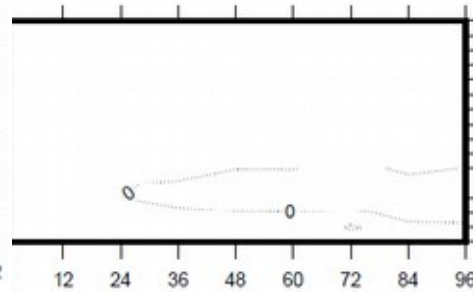
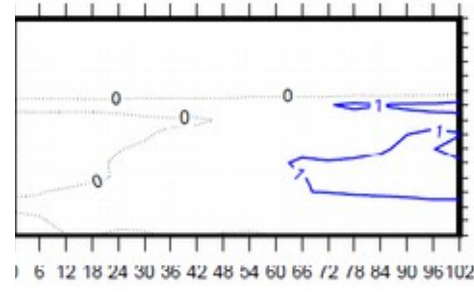
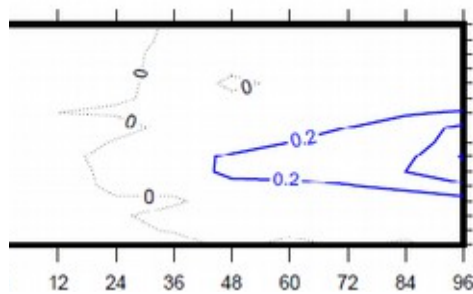
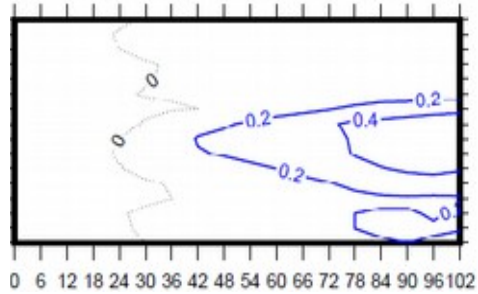
Wind (AC)

Wind (RS)

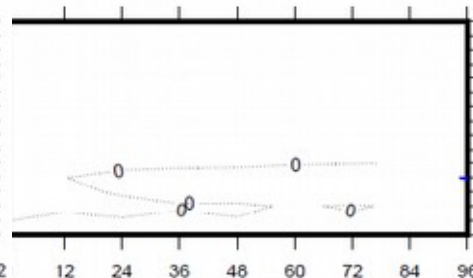
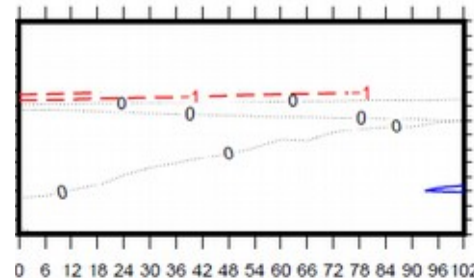
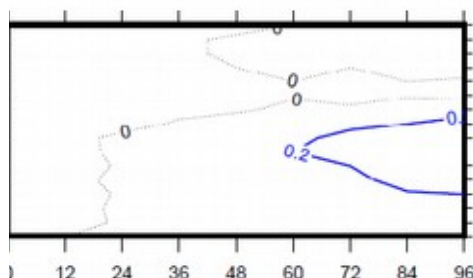
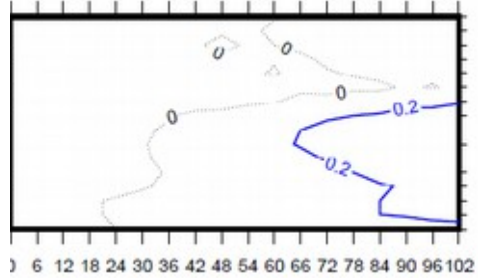
Rel. humidity (AC)

Rel. humidity (RS)

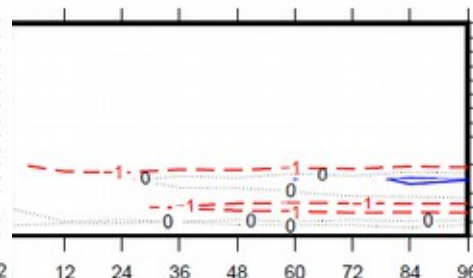
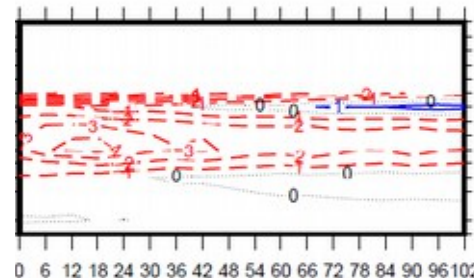
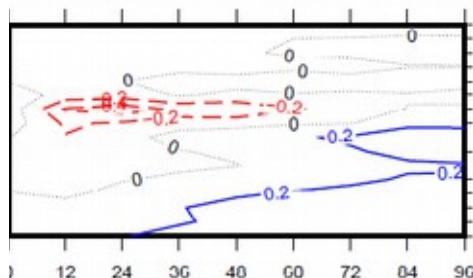
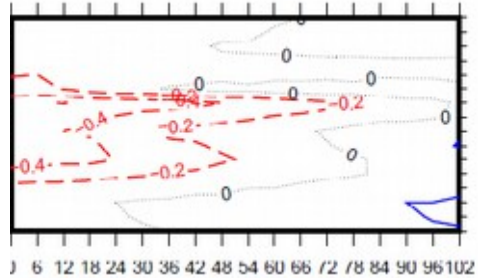
Euratl



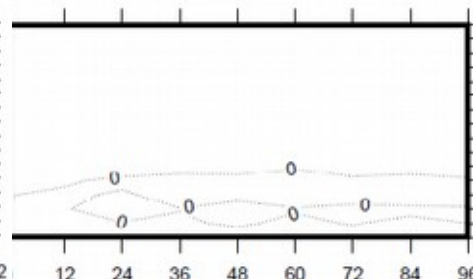
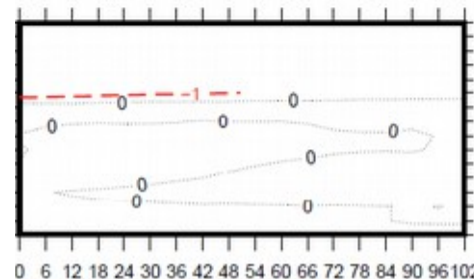
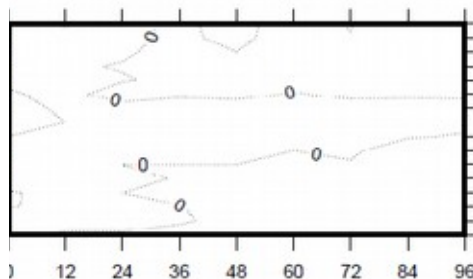
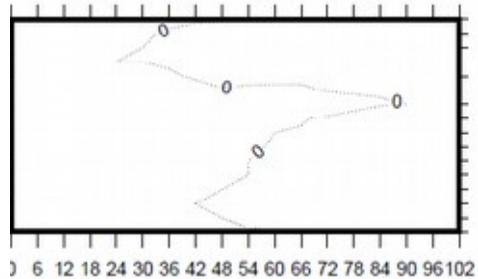
North20



Tropics



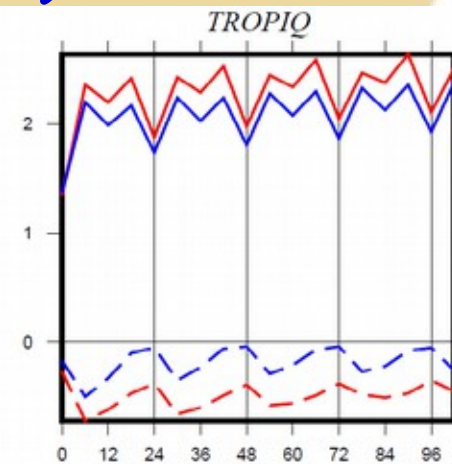
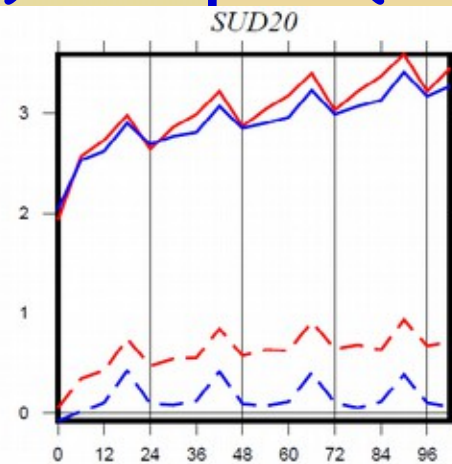
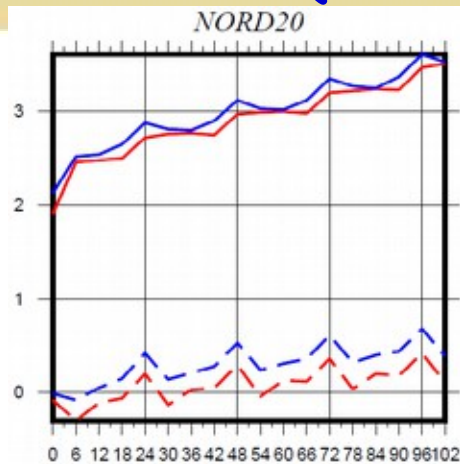
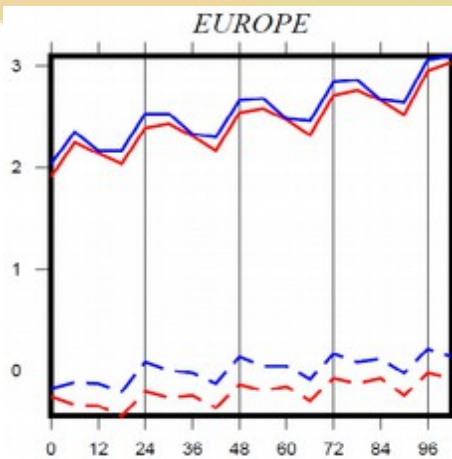
South20



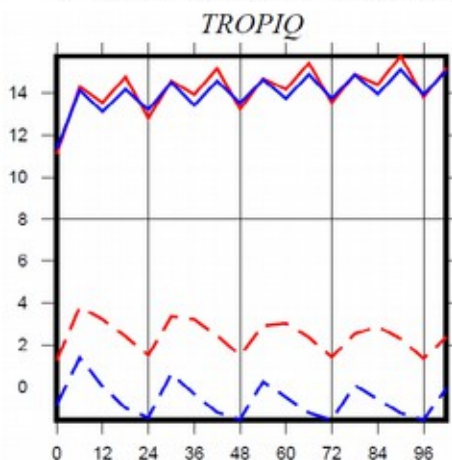
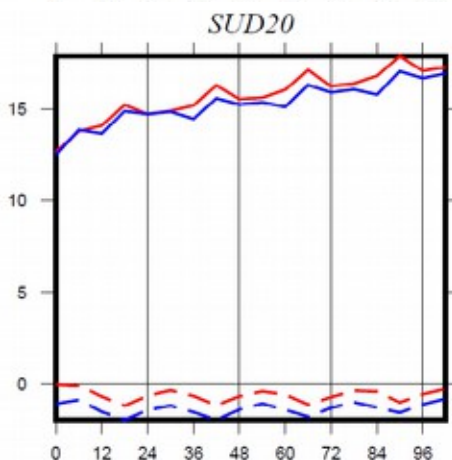
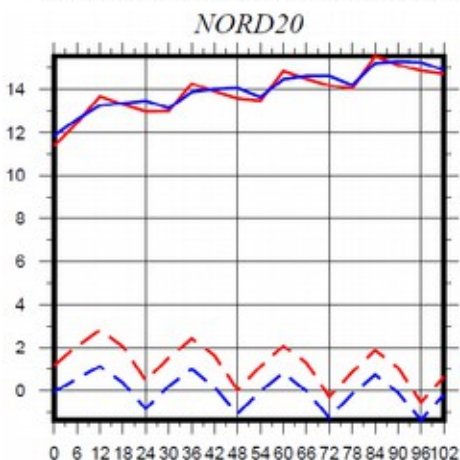
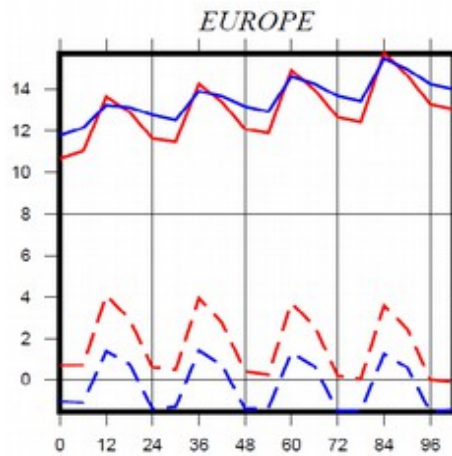
# BIAS & RMS errors to SYNOP (20160713 - 20170314)

"e-suite" (in blue) vs "oper" (in red)

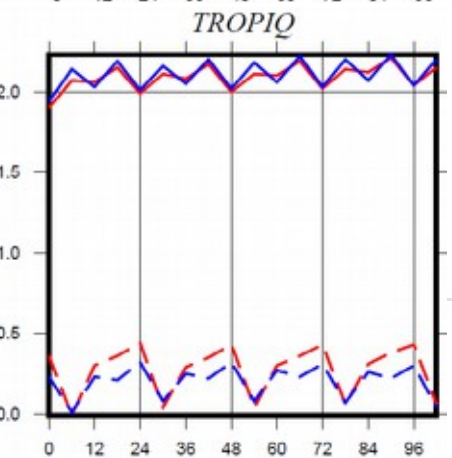
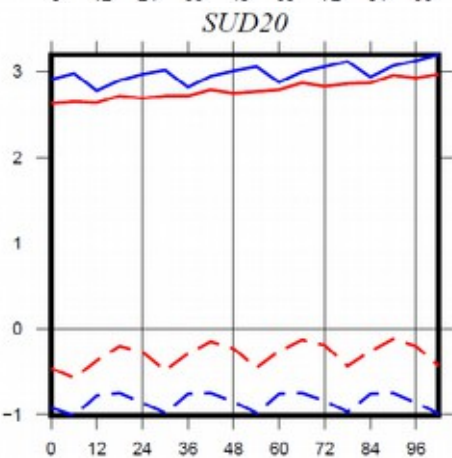
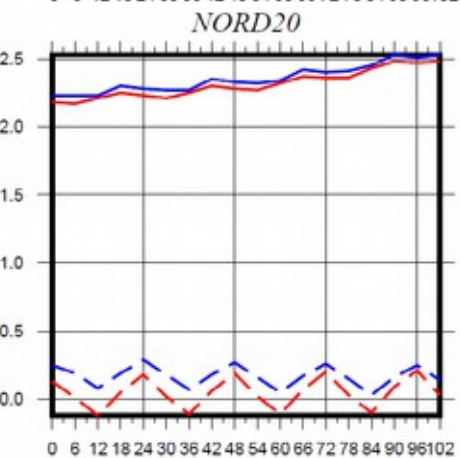
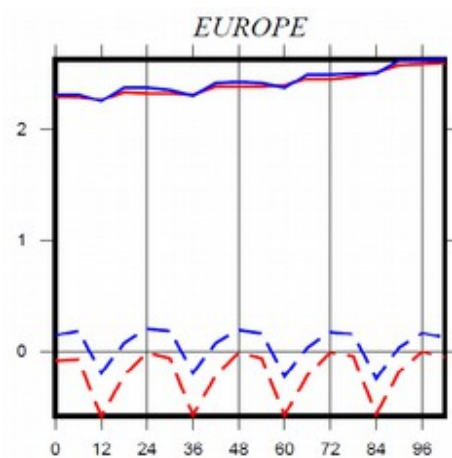
T2m



H2m



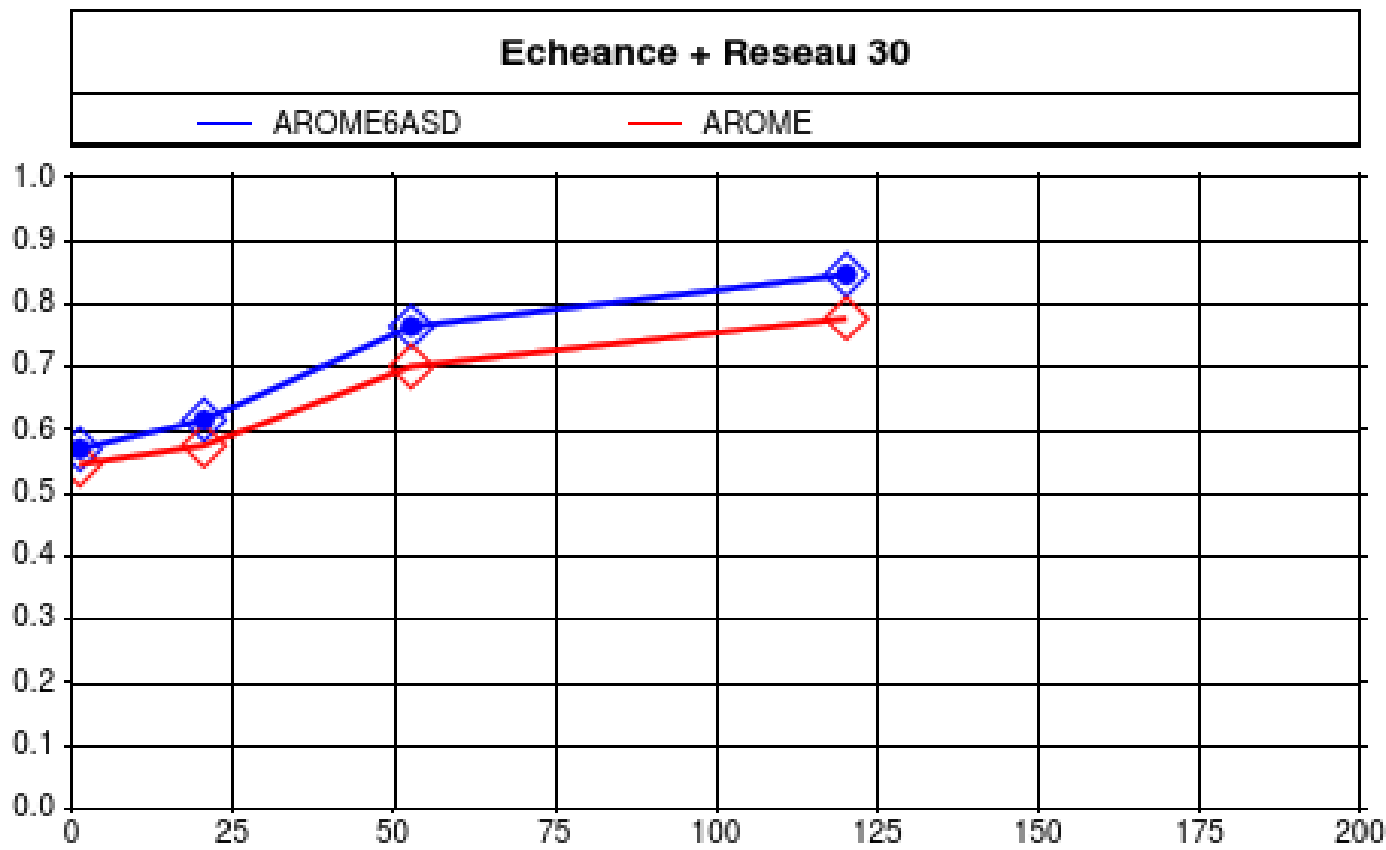
V10m





# Changes in AROME e-suite (CY42\_op2)

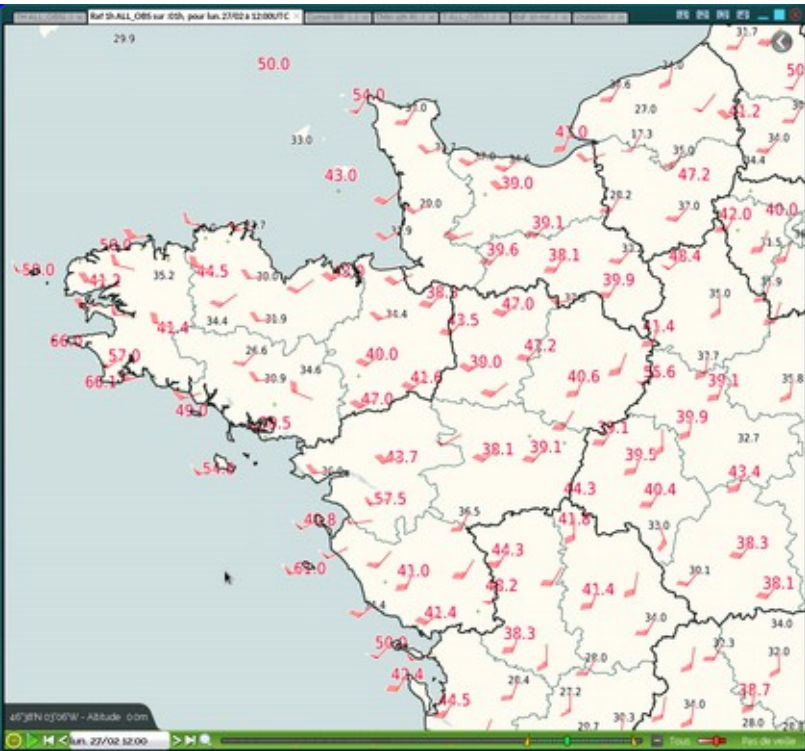
- modification of rain autoconversion threshold
- new cloud optical properties
- retuning of wind gust formulation
- optimisations, more diagnostics



***BSS of 6h > 80 km/h wind gusts at FC0+30 (July 2016-January 2017) as a fonction of neighboring in km (TEST/OPER)***

# Case Study : 27-02-2017

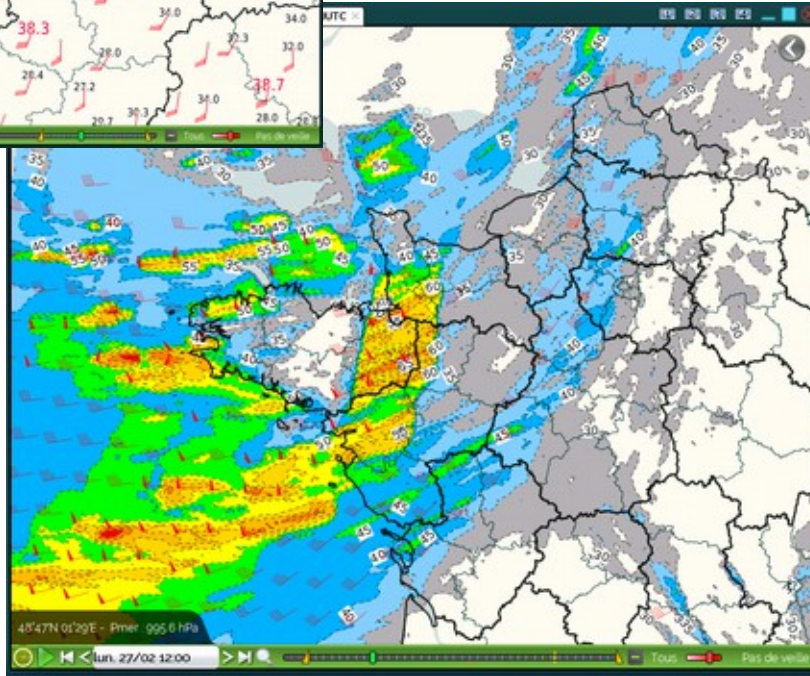
AROME-oper + obs FFX1 12TU :



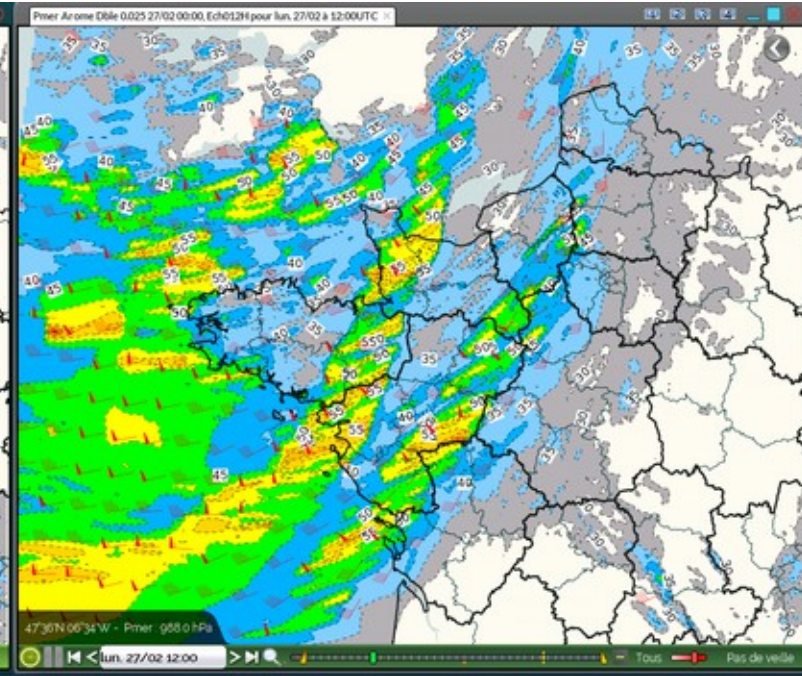
Over-estimated wind gusts in OPER,  
more realistic in E-suite

Why ? (not because of diagnostic change which  
would increase FFX1)

AROME-oper :



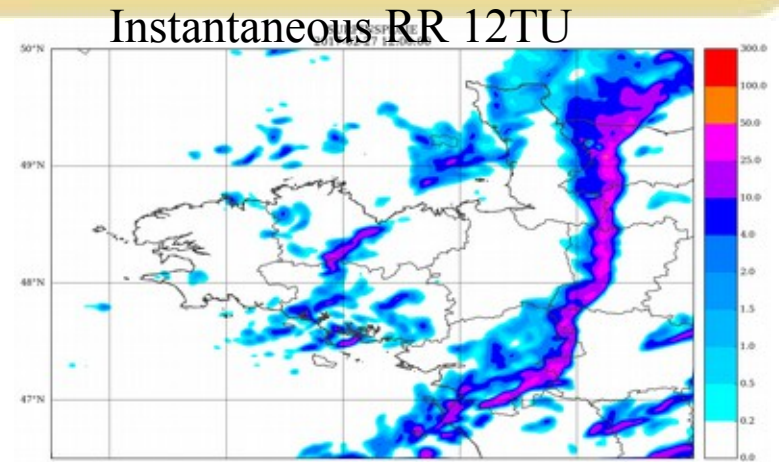
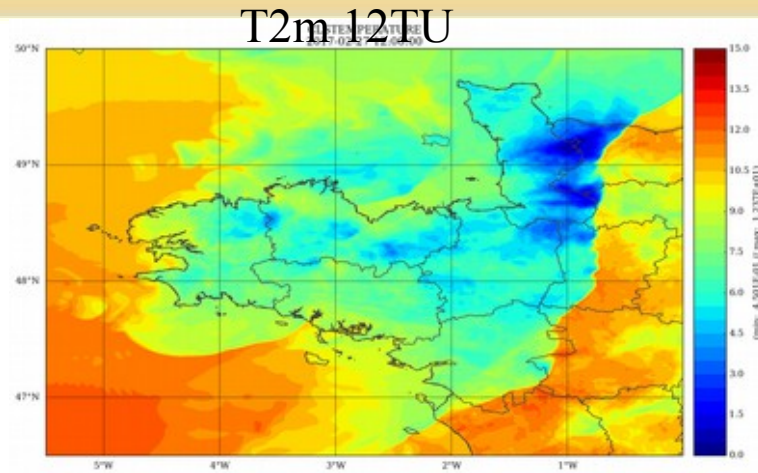
AROME-E-suite :



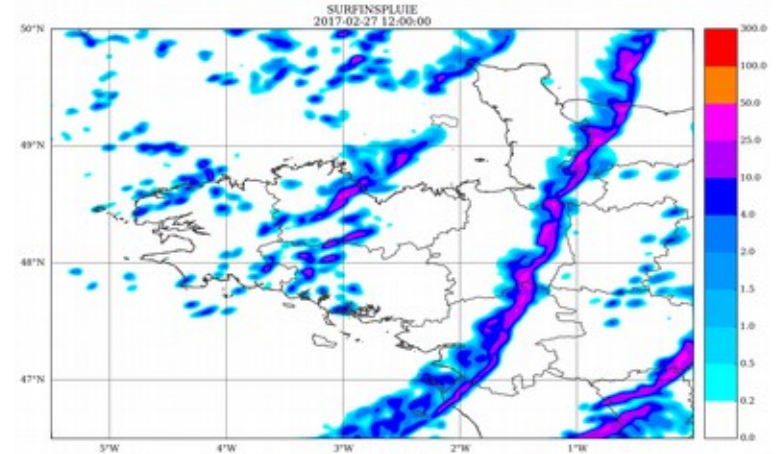
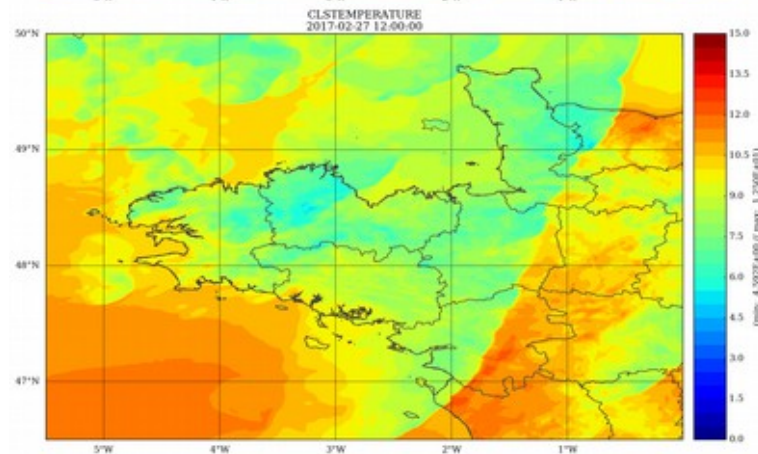


# Influence of coupling model

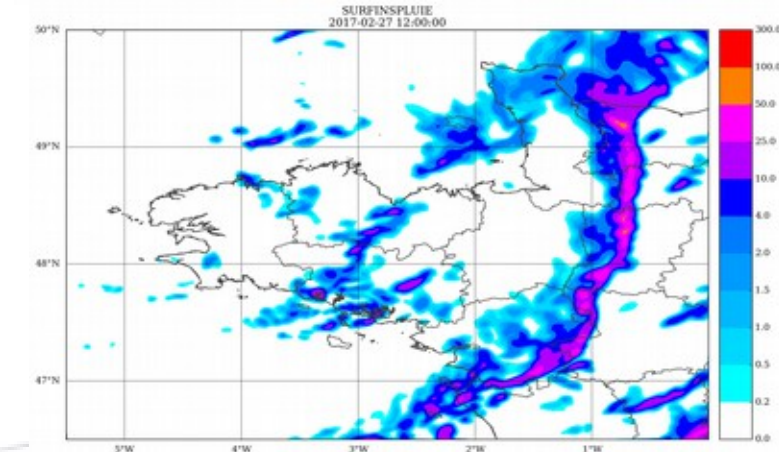
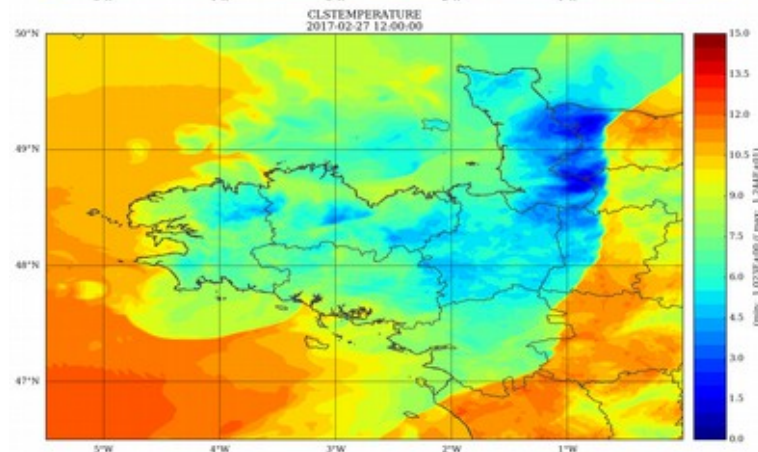
AROME-oper :



AROME-E-suite :



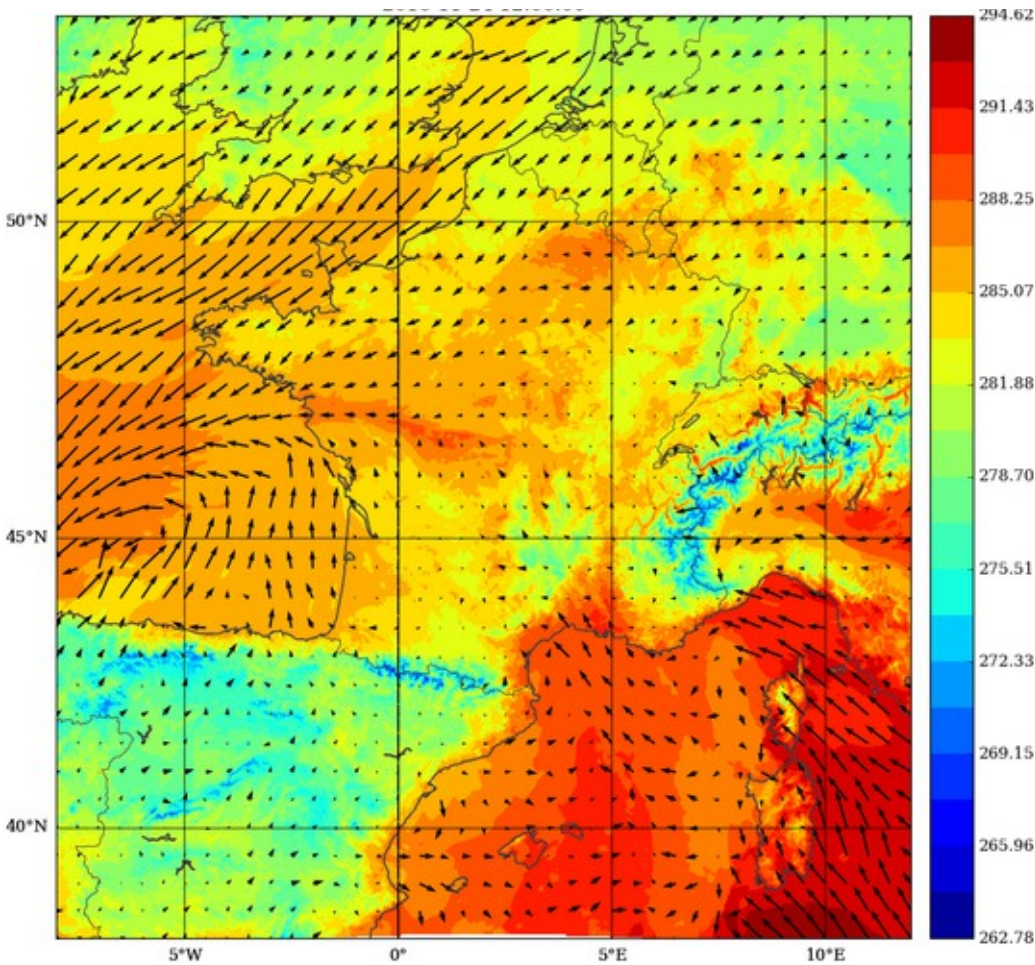
AROME-E-suite using coupling files from ARPEGE-oper (instead of ARPEGE-E-Suite) :



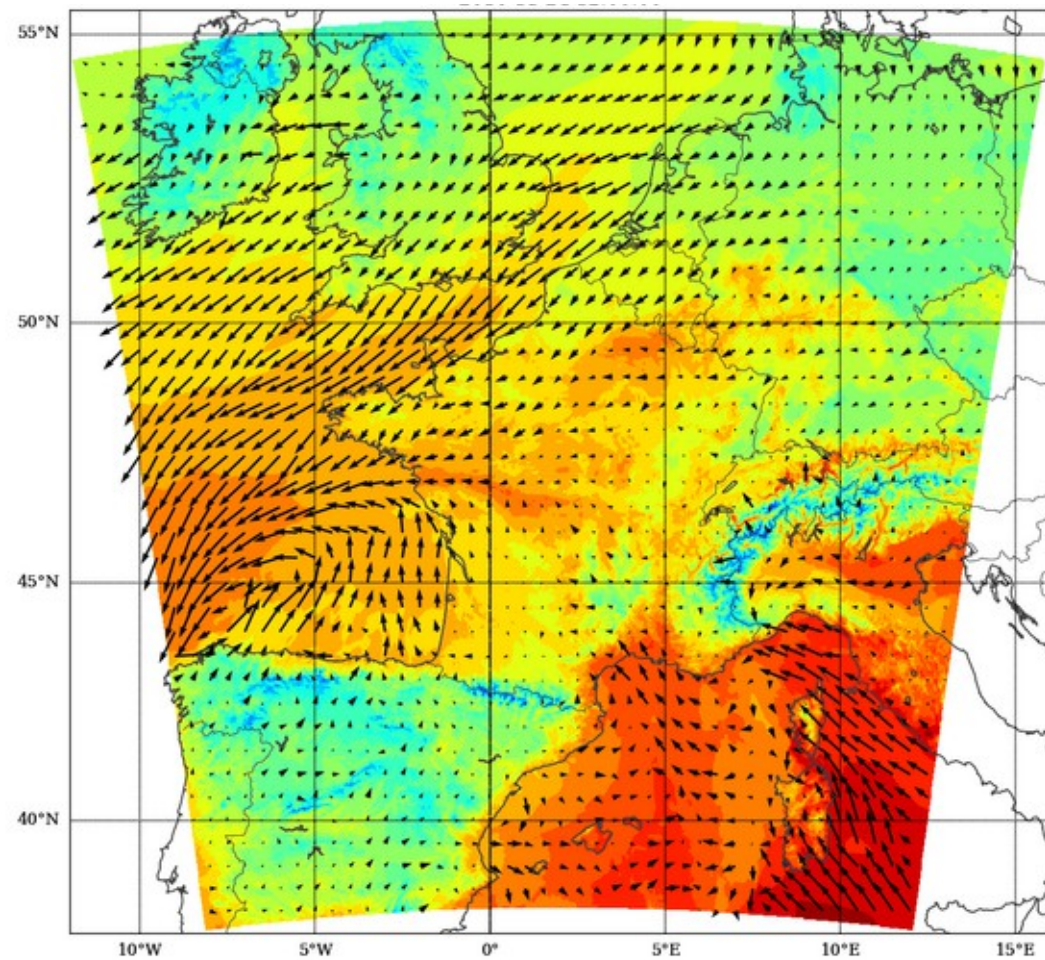


# Post-processing

Developments done in Fullpos to interpolate towards a lat-lon regular domain including the whole computational domain



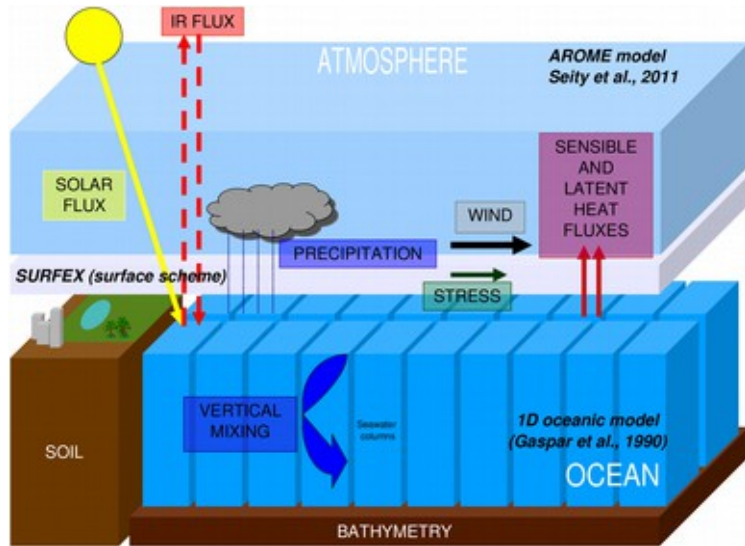
FRANGP0025



EURW1S40



# Ocean mixed layer 1D model in Arome Overseas versions

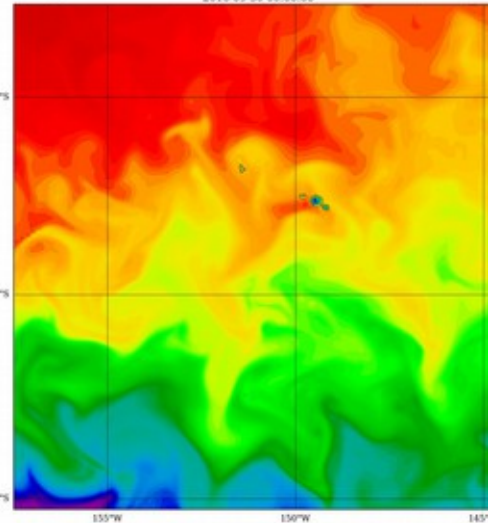


- Daily initial conditions from Mercator PSY4 operational ocean model

SST with coupling (e-suite)

SST Initial conditions

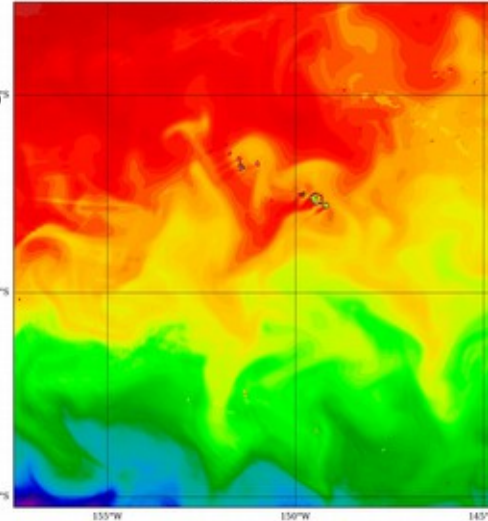
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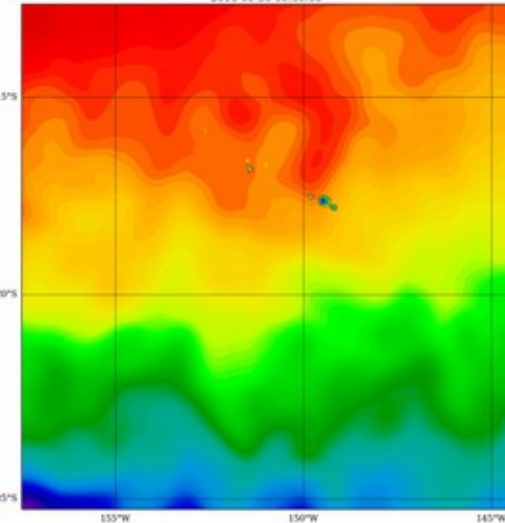
SST without coupling (oper)

SST after 24h integration

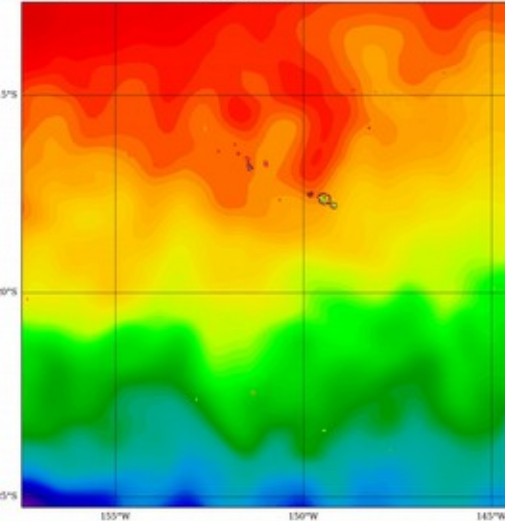
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2016-09-30 00:00:00



(TypeOfLevel: 'surface', table2Version: 1, indicatorOfParameter: 11, level: 0)  
2016-10-01 00:00:00



# FOG

→ MesoNH/AROME overestimate cloud condensates in fogs (Philippe et al. 2016, Mazoyer et al. 2017)

→ New process added in ICE3 in lowest model level :

Deposition of droplets on the vegetation (direct droplet interception by the plant canopies)

$$F_{\text{DEP}} = \rho_a \cdot r_c \cdot V_{\text{DEP}} \text{ with } V_{\text{DEP}} = 2\text{cm/s}$$

→ Validation in AROME using BURE\_2015 data



● 120m : visibility (PWD22)

● 50m : LWC / Visibility (PVM-100)

● 10m : visibility (PWD22) ; LWC (FM-100)



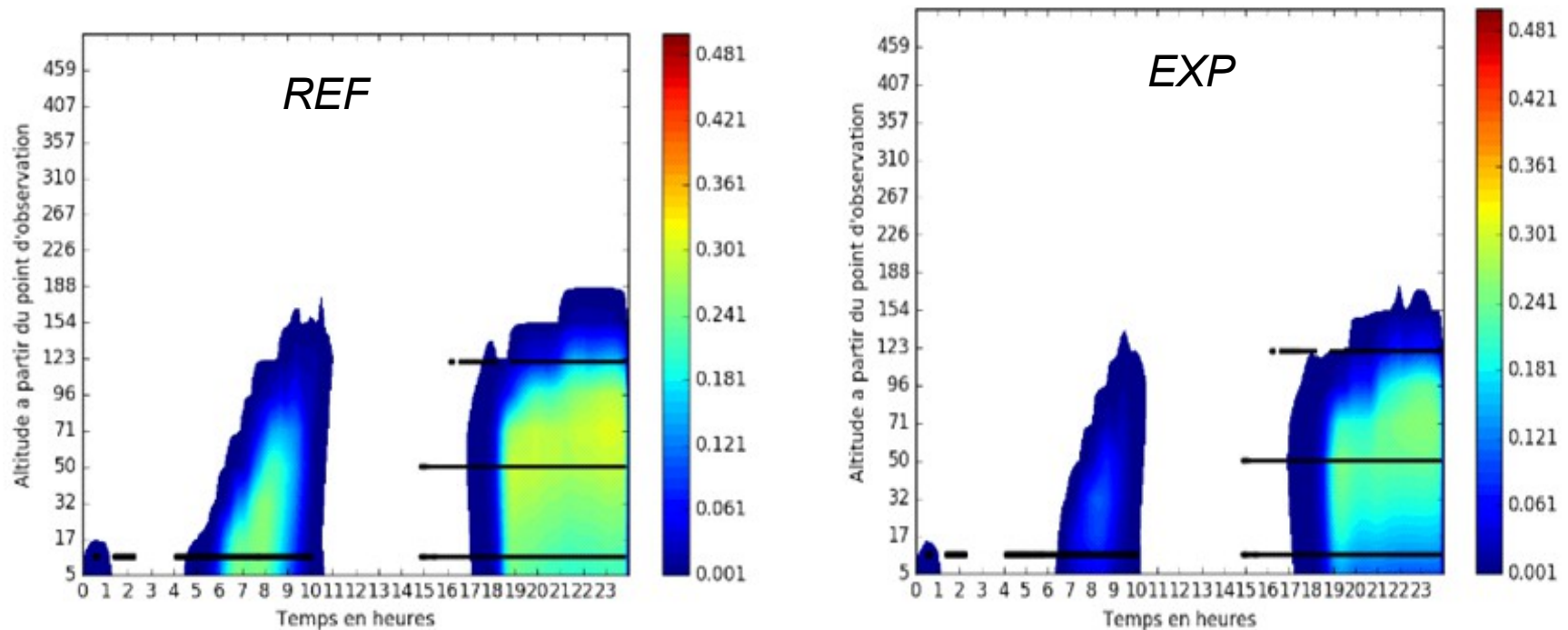


# Evaluation of deposition term in AROME

From Mallet, VanHyfte, Wurtz, Seity, Lac, Burnet

→ 39 foggy days

**1 novembre  
2015 :  
LWC (g/kg)**

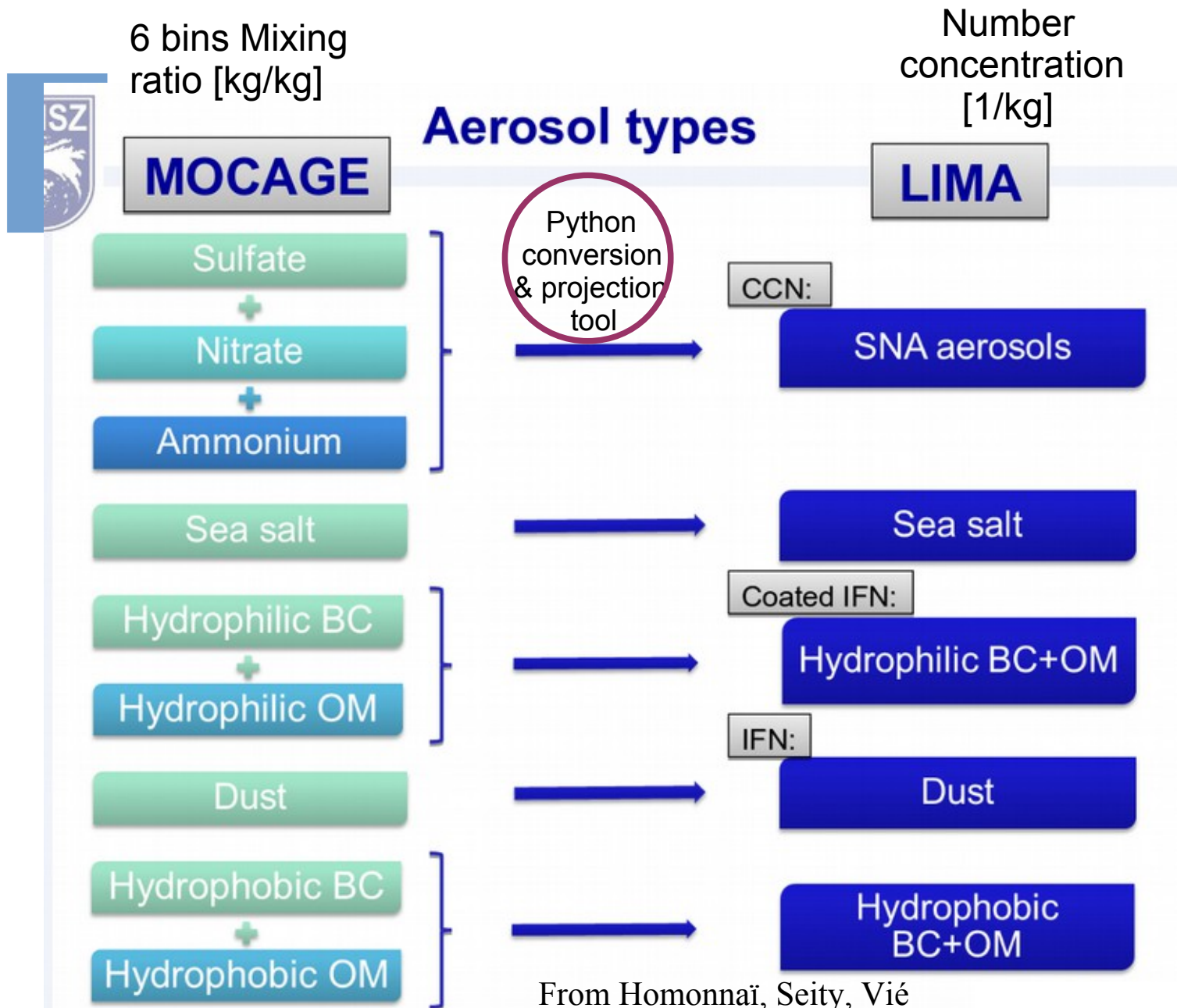


LWC contingency table at 10m	<i>REF</i>	<i>EXP</i>
<i>Good detection</i>	<b>32%</b>	<b>36%</b>
<i>Overestimation</i>	<b>35%</b>	<b>19%</b>
<i>Underestimation</i>	<b>33%</b>	<b>45%</b>

→ Perspectives : BURE\_2016 (deposition measurements)

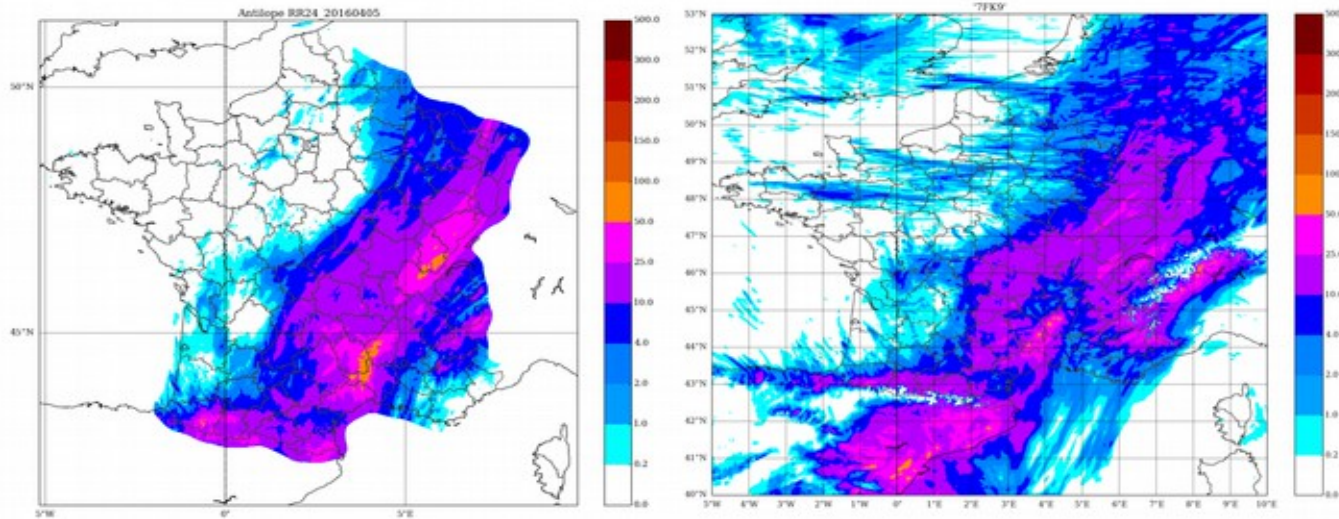
Reduce VDEP / test a more advanced formulation linked with LAI, wind...

# Initialisation of LIMA (2 moments microphysics scheme) in AROME





# First test 5 April 2016 : RR24

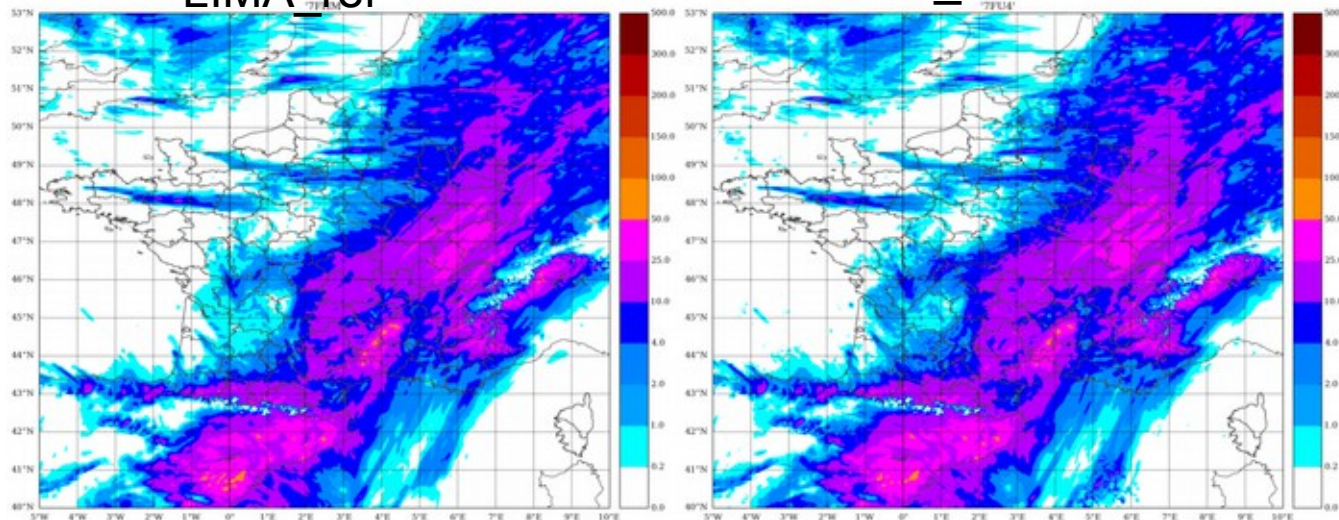


Antilope obs

ICE3

LIMA\_ref

LIMA\_MOCAGE



Small impact, but still some problem when starting from MOCAGE : too much CCN due to too much Sulfates ?  
Future tests starting from C-IFS, Fog cases, longer period ...

# Perspectives

## **Current E-suite:**

- modifications done 23<sup>rd</sup> of March (surface temperature correction, using SWI to interpolate soil moisture from SURFEX fields to ISBA fields)
- operational switch planned for June 2017

## **Next E-suite** (scheduled from autumn 2017 to mid 2018):

- New horizontal resolutions for global systems: ARPEGE (~5km over France), ARPEGE-EDA: 50 members at 40 km, ARPEGE-EPS: 35 members at ~7.5km over France, 4x/day
- Modifications in the physics: tunings in PCMT convection scheme, inclusion of prognostic graupel in Arpege's microphysics, revision of surface evaporation over sea, surface albedo from MODIS, etc.

**AROME-France** forecasts: 8 times per day up to 48h

**AROME-EPS:** 4 times per day up to 51h

Implementation of new system **AROME-EDA**



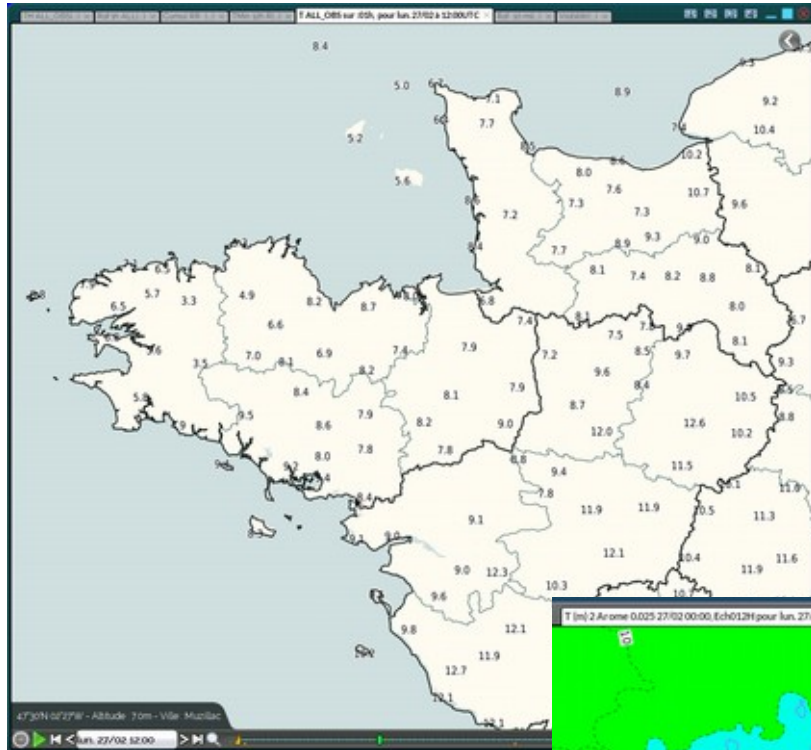


**Thank you for your attention**

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# Case Study : 27-02-2017

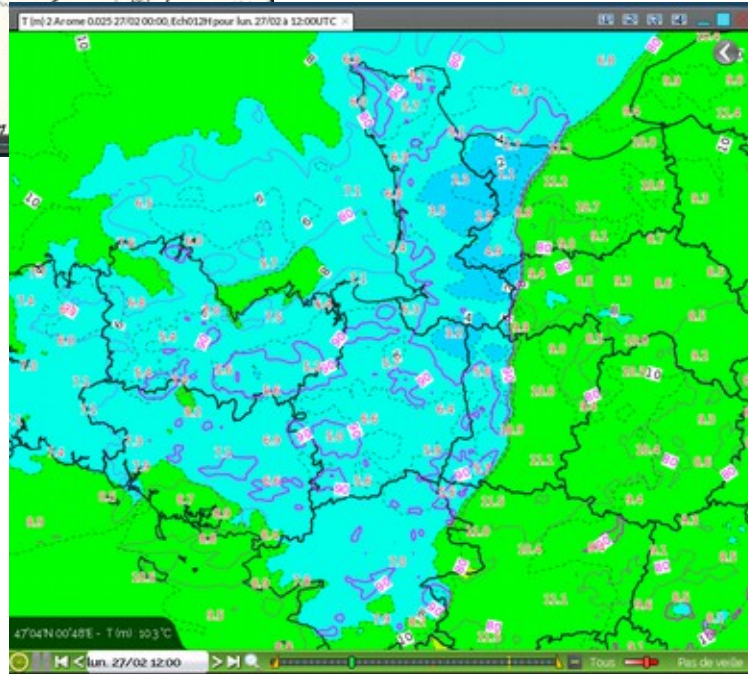
OBS T2m 12TU :



Cold pools much more realistic in AROME-E-suite  
(too cold in oper)

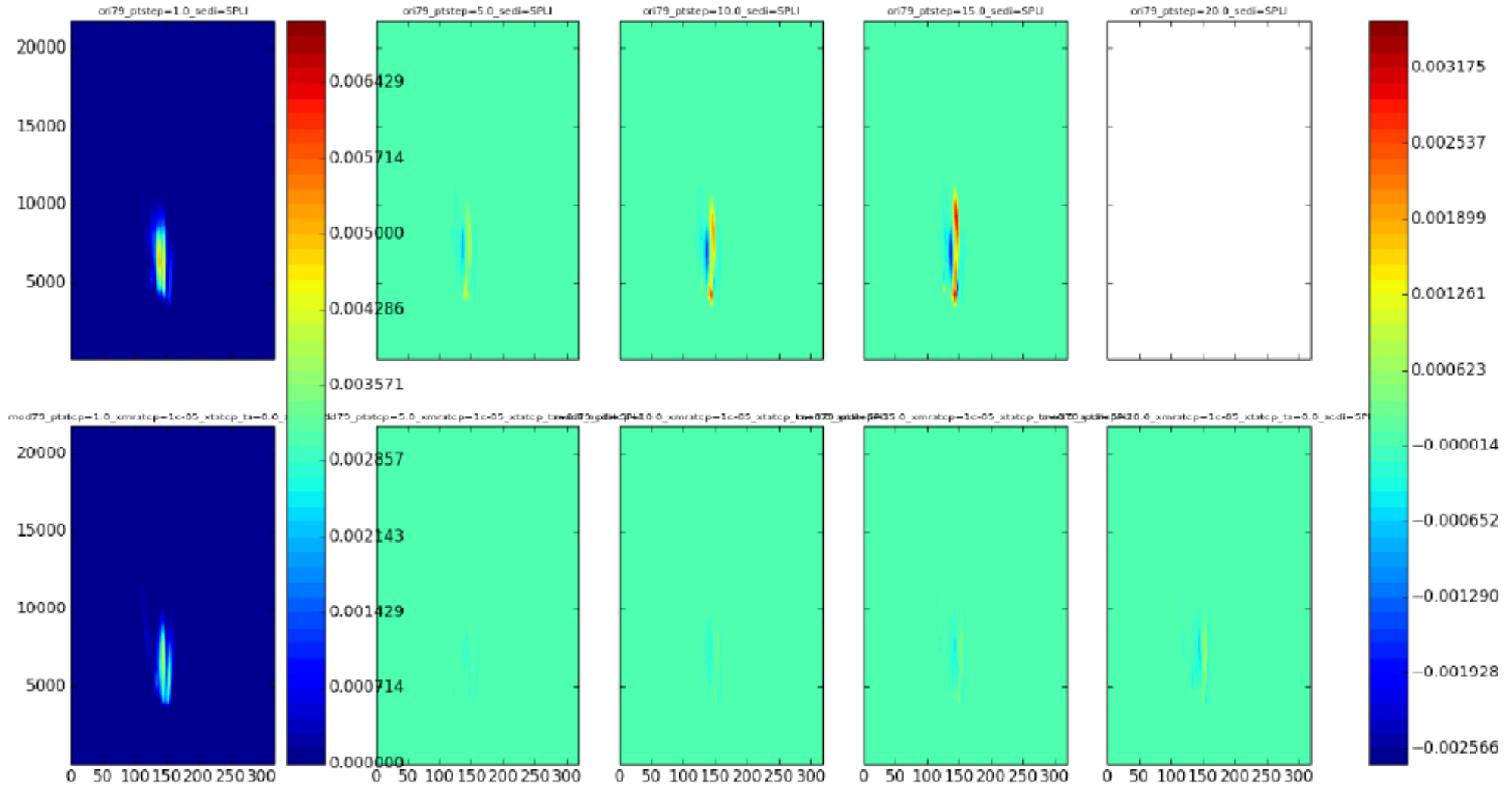
AROME-oper :

AROME-E-suite :





# On-going algorithmic work to reduce time-step dependency and improve modularity of ICE3/ICE4 microphysics schem



Graupel after 3.5+1h, before modification (top) and after (below) for  $Dt=1s$  simulation (left). Other columns are differences between  $Dt= 5, 10, 15$  and  $20s$  simulations and the left column.