Current work in ARPEGE and AROME physics

Yann Seity, Yves Bouteloup, Rachel Honnert, Sébastien Riette

Outline :

- What's new in ARPEGE ?

  New physics :

  - Surface
  - Radiation
  - Deep convection

- What's new in AROME ?

  - about rainfalls bias
  - about high resolution
  - about cloud scheme

Physics evolution of Arpege e-suite 2020

Scientific contents

- **Surface :** Ecume V6 (with θ_s) and 1D sea ice scheme Gelato (Salas y Melia 2002)
- **Radiation solar :** SRTM (may be EcRad (Hogan and Bozzo 2016) witch is avalaible in cy46t1
- **Deep convection :** Use of IFS deep convection scheme (Tiedtke 1989, Bechtold et al 2004, 2008, 2014)

Status of validations

- Two experimental 4DVAR/EDA with and without Gelato are running near real time (cy43t2)
- There is a problem of warm bias over Europe and Northen hemisphere (investigations underway)
- Next step is the phasing of these evolutions on cy46t1, witch would be the cycle use for this e-suite

METEO FRANCE

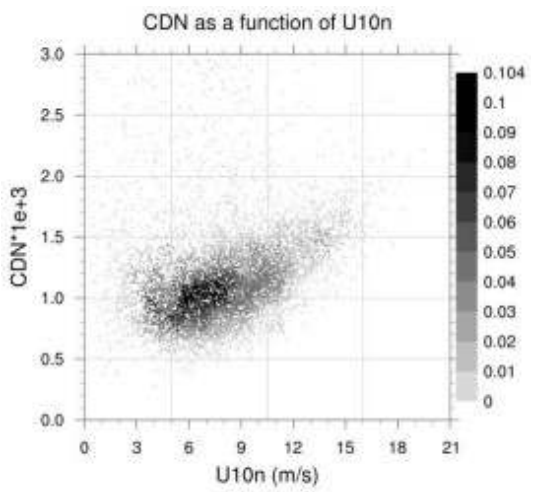
Ecume V6 *(from Sophie Belamari)*

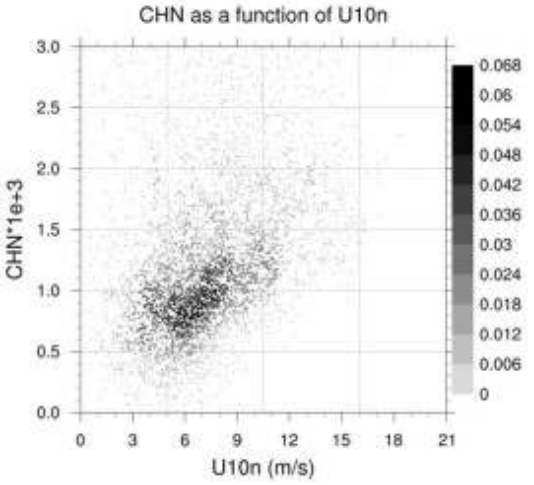
$$Param\_U = \left(\frac{C_{dn}}{\sqrt{C_{dn}}}\right) X\Delta U_{10m}$$

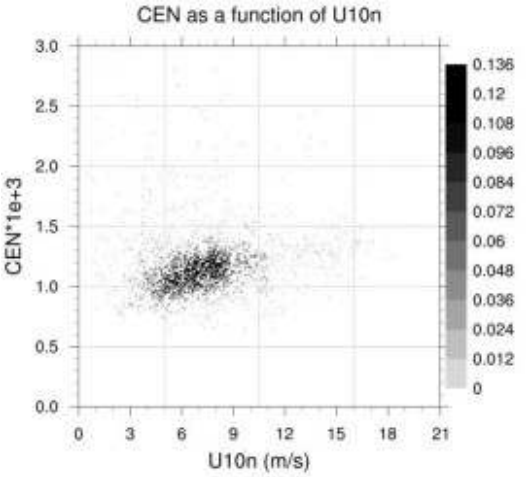
$$Param\_\theta = \left(\frac{C_{hn}}{\sqrt{C_{dn}}}\right) X\Delta U_{10m}$$

$$Param\_q = \left(\frac{C_{en}}{\sqrt{C_{dn}}}\right) X\Delta U_{10m}$$

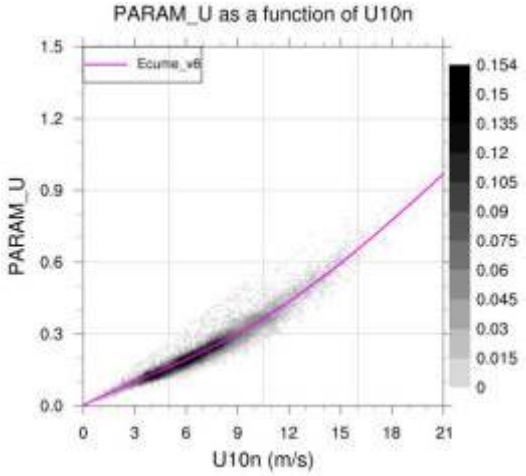
oper

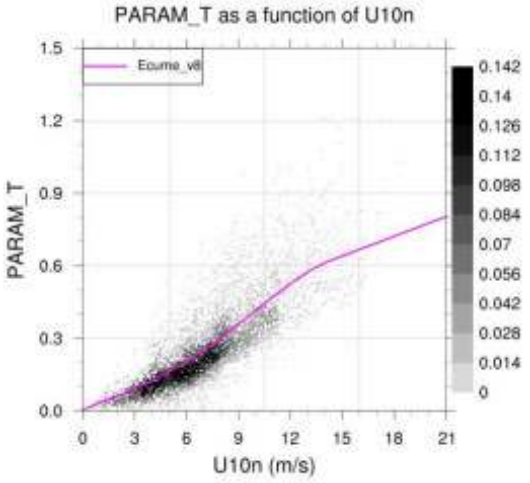


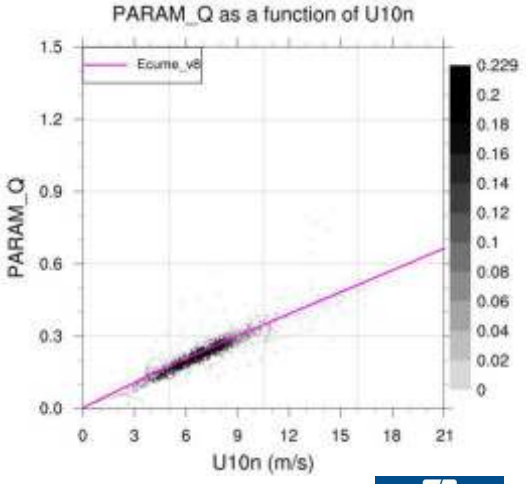




v6

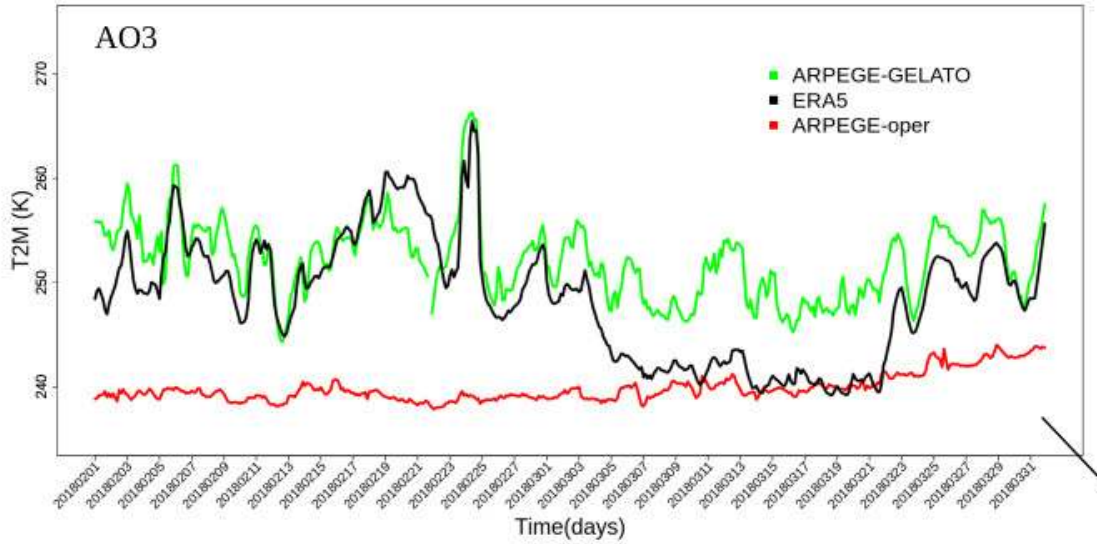


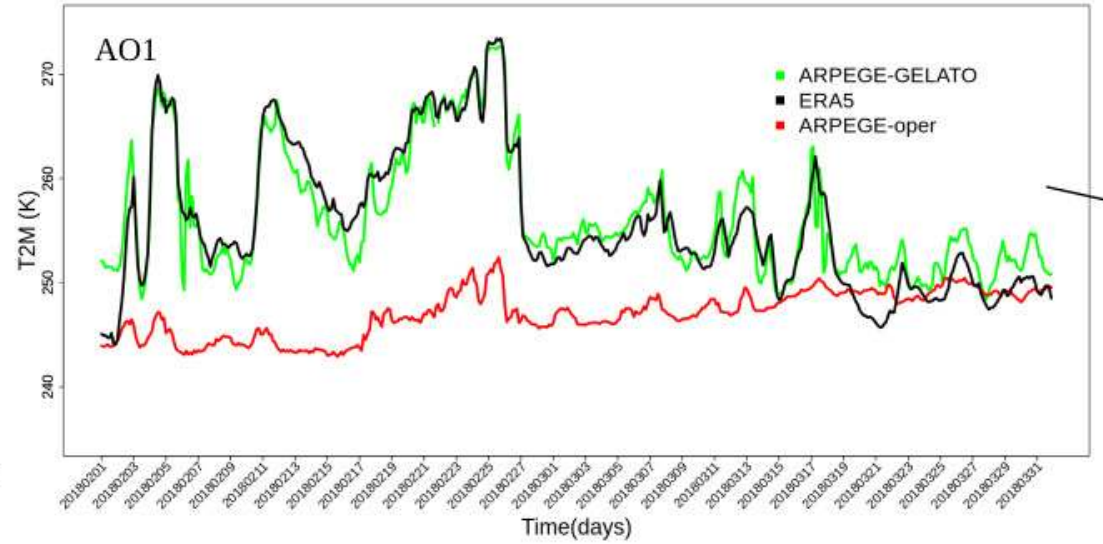




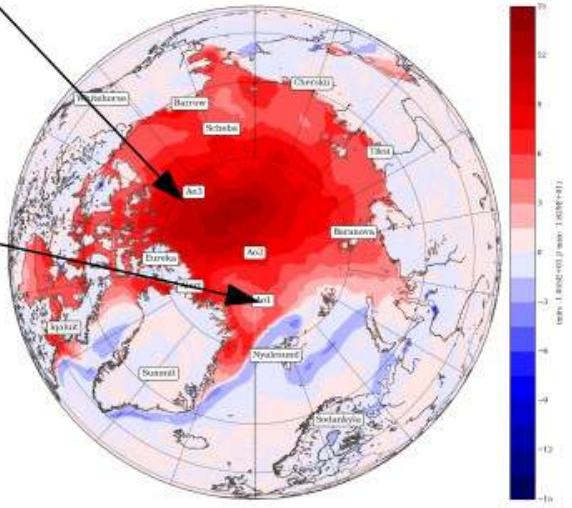
METEO FRANCE

Impact of Gelato in Arpege



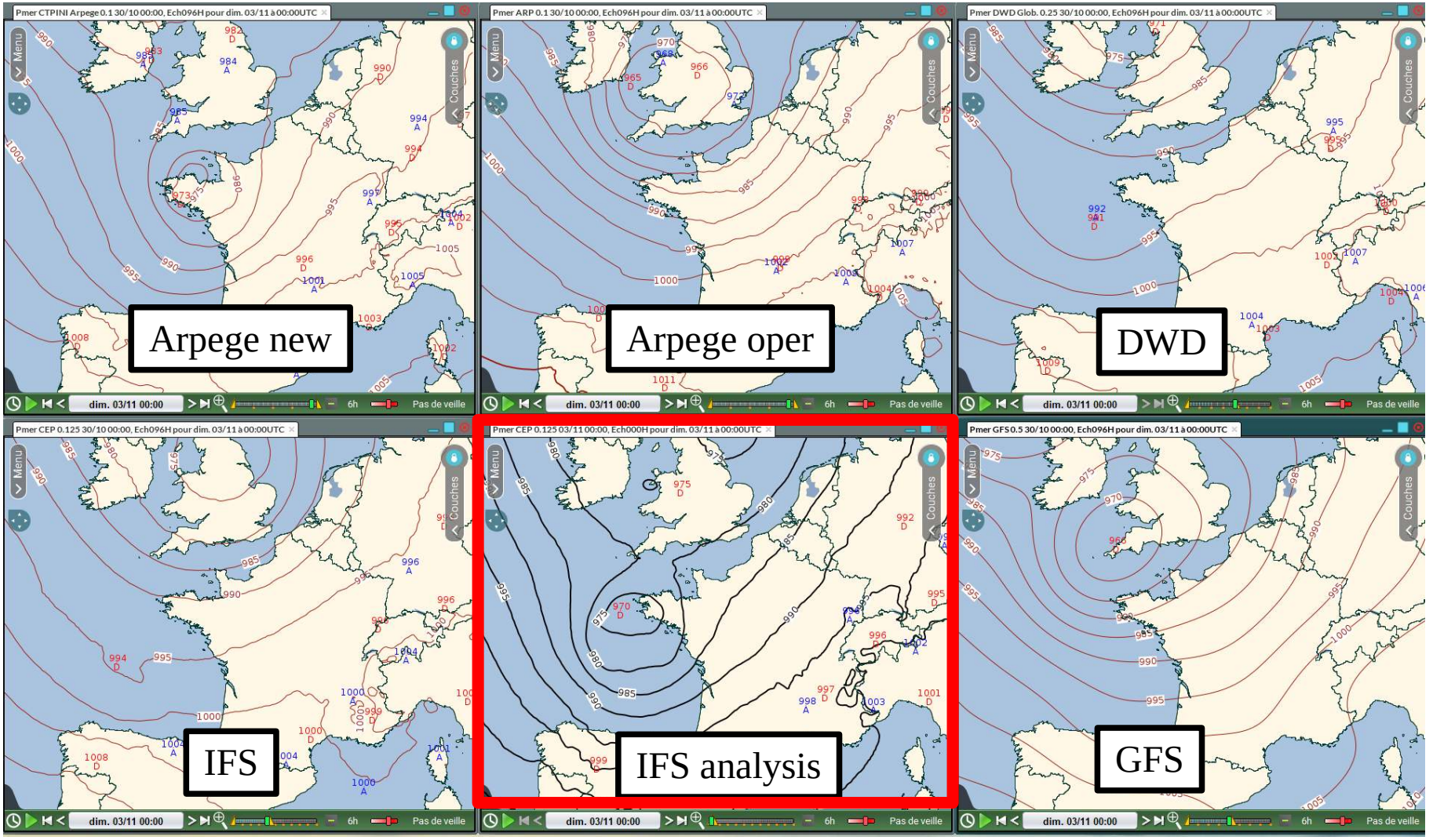


T2m mean impact over all the Arctic ocean and temporal Evolution on two stations



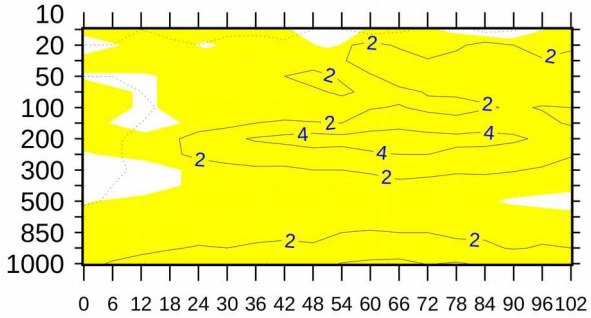
From Niramson Azouz (APPLICATE project, YOPP)

Behaviour of global models for Amélie storm at 96h (3rd November 2019 0TU)

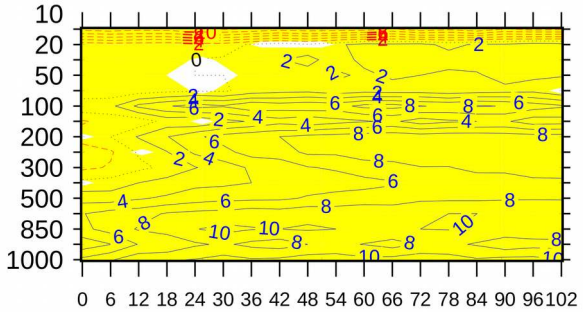


Some impacts of the new physics

Wind normalized scores (ref AC in %) 4DVAR-AEARP/oper 100 days from december to march



Nord20



Tropique

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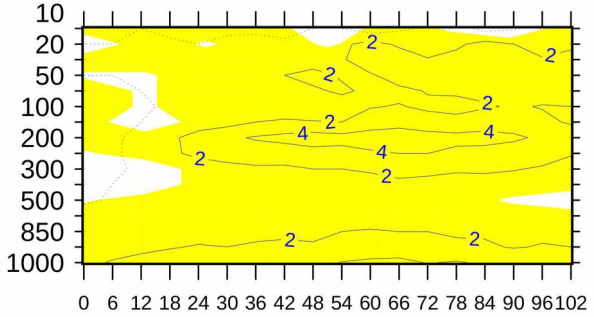
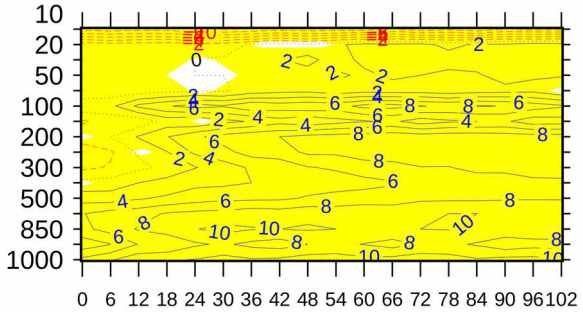


Nord20

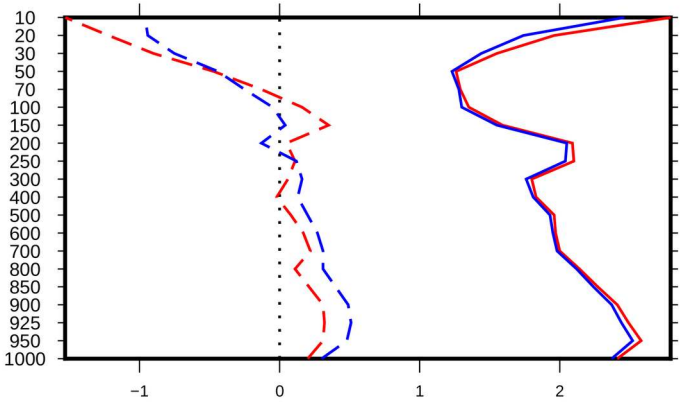


Tropique

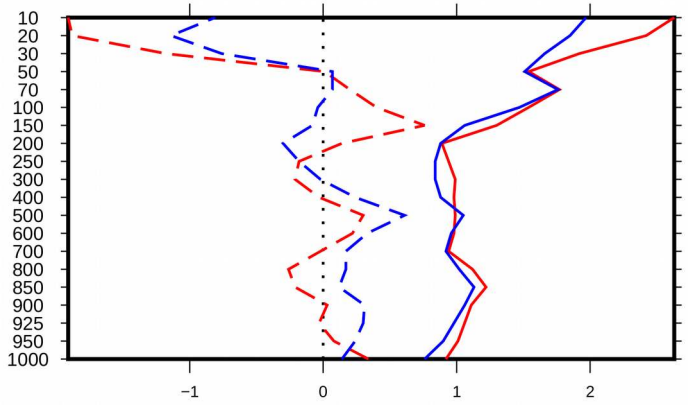
Temperature +96H

OPER/TEST

NORD20



TROPIQ



METEO FRANCE

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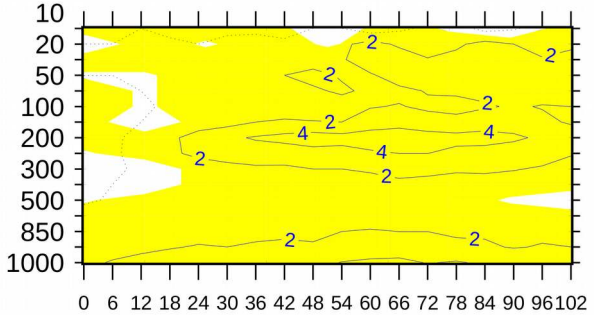
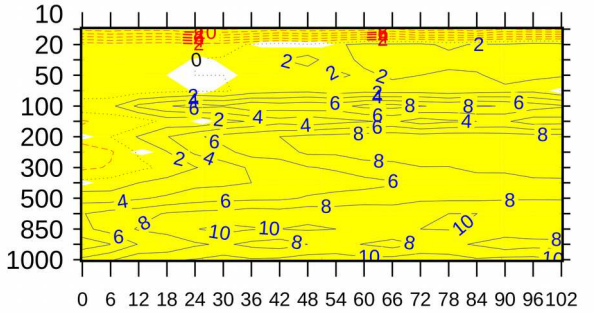


Nord20



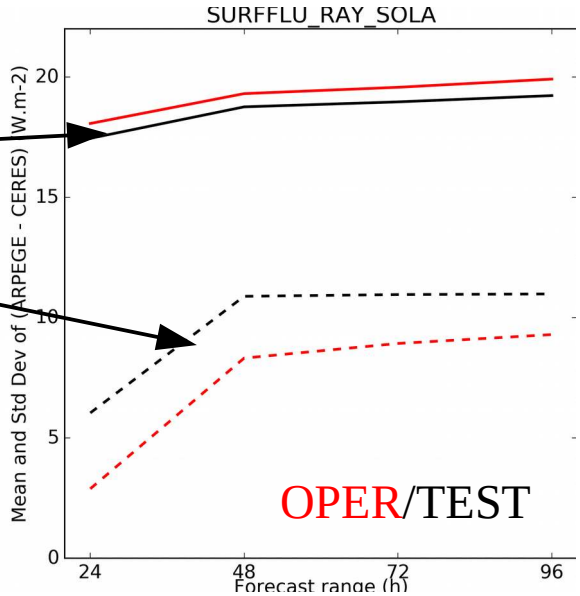
Tropique

Surface radiation flux / CERES January 2019 (black: exp, red : ref)

- *Solid line : standard deviation*
- *Dashed : bias*

Improvment of standard deviation

Radiation bias increased consistent with temperature bias increased at 96h



Temperature +96H

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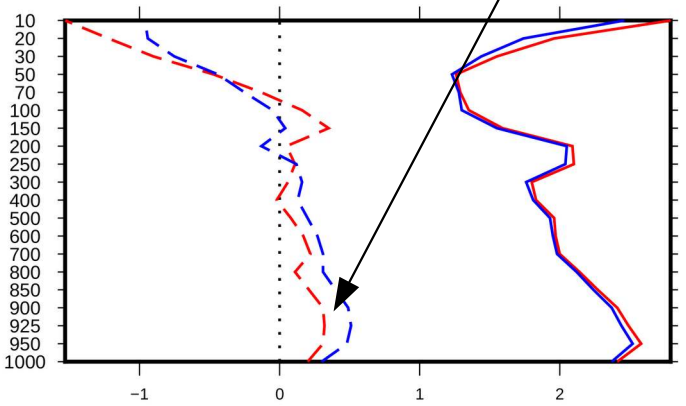

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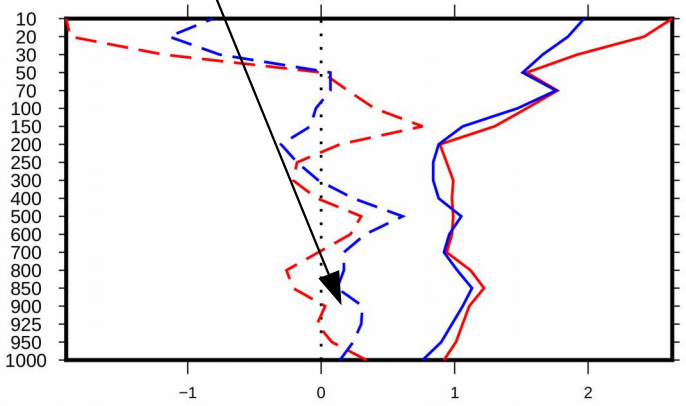


OPER/TEST

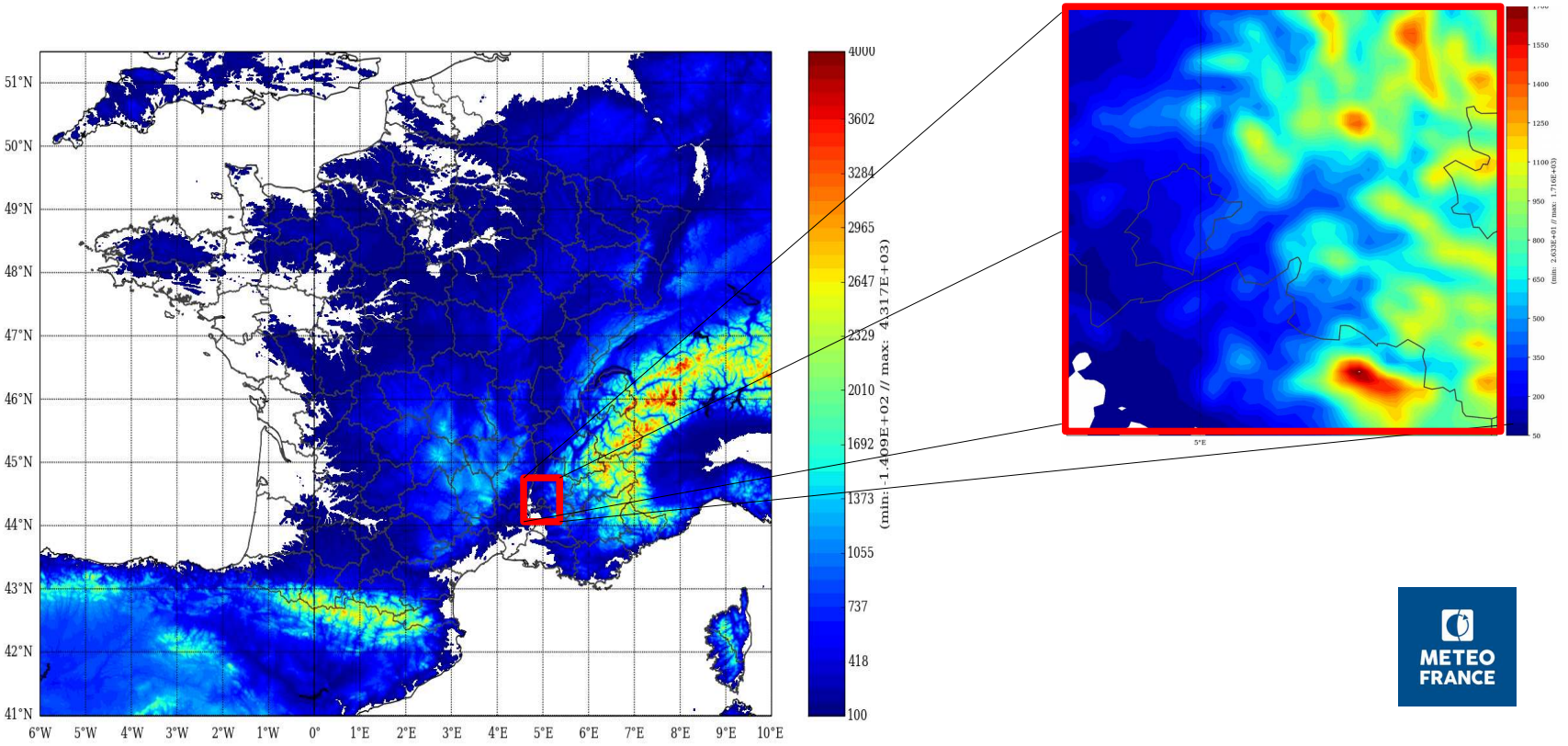
Outline :

- What’s new in ARPEGE ?

- What’s new in AROME ?
  - about rainfalls bias
  - about high resolution
  - about cloud scheme

Semi-academic 3D AROME :

- 48x48x90 points @1250m, setup and coupled with AROME-oper
- Start with $q_c=q_i=q_r=q_s=q_g=0$ except in (24,24,2000m) : q_r=1g/kg
- Microphysics off except sédimentation.
- Turbulence and shallow convection off.
- Forecast term = 40 time steps (dt=50s)



About mass conservation

- Complicated to verify it in a full LAM
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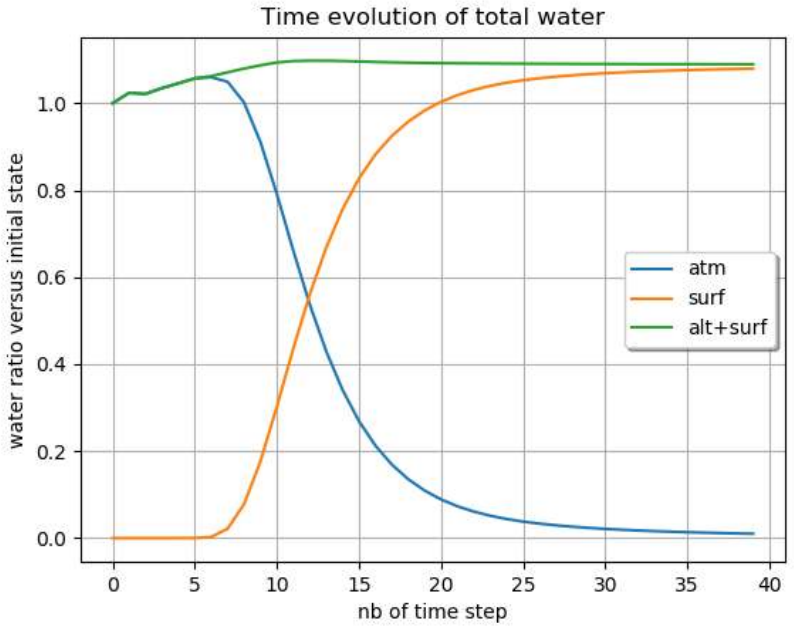

Oper

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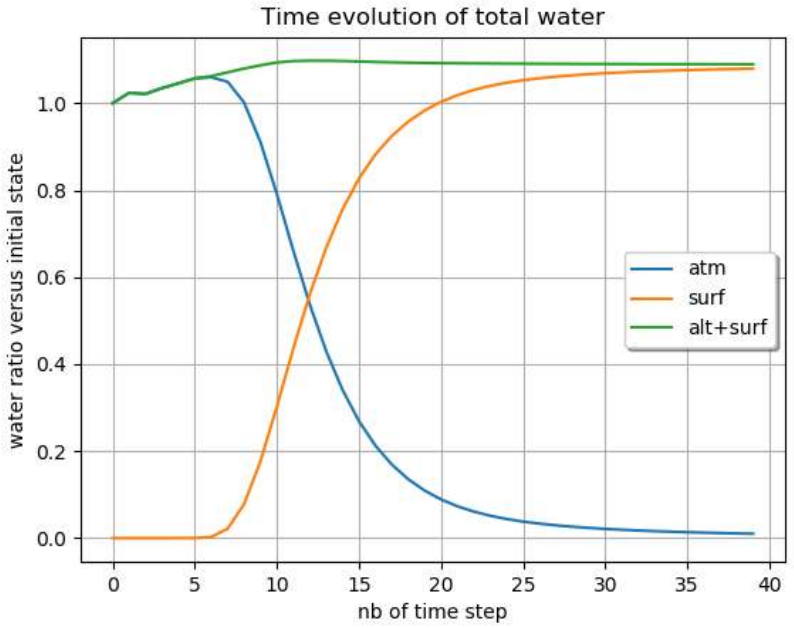
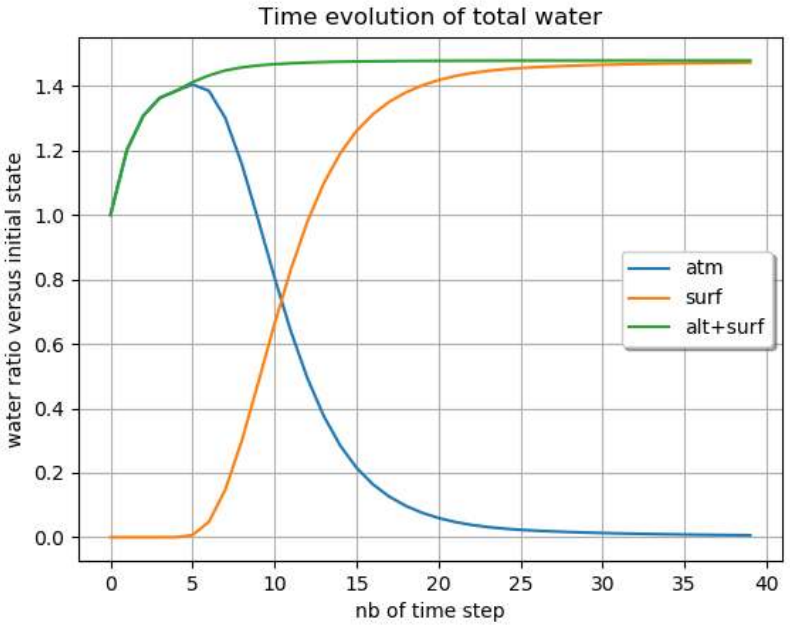


Oper

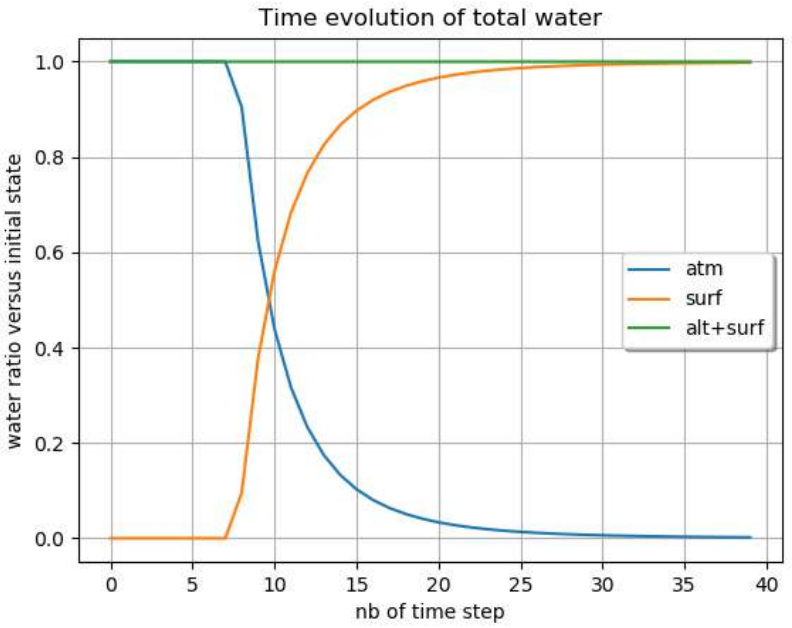


Oper without SLHD

→ AROME is currently not mass conservative. In that case, SLHD diffusion applied on hydrometeors partly compensate a positive bias !

sedimentation / advection ?

- Same runs without advection / sedimentation :



without advection

sedimentation / advection ?

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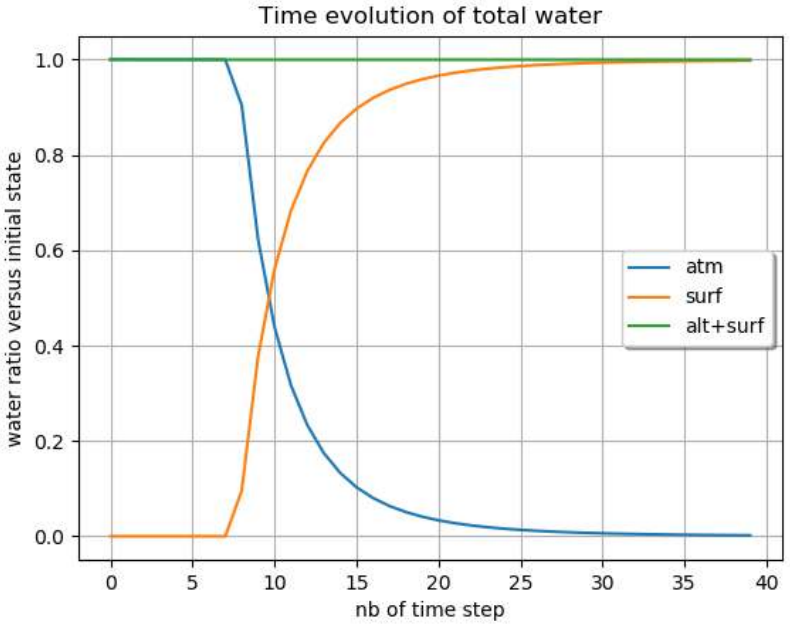
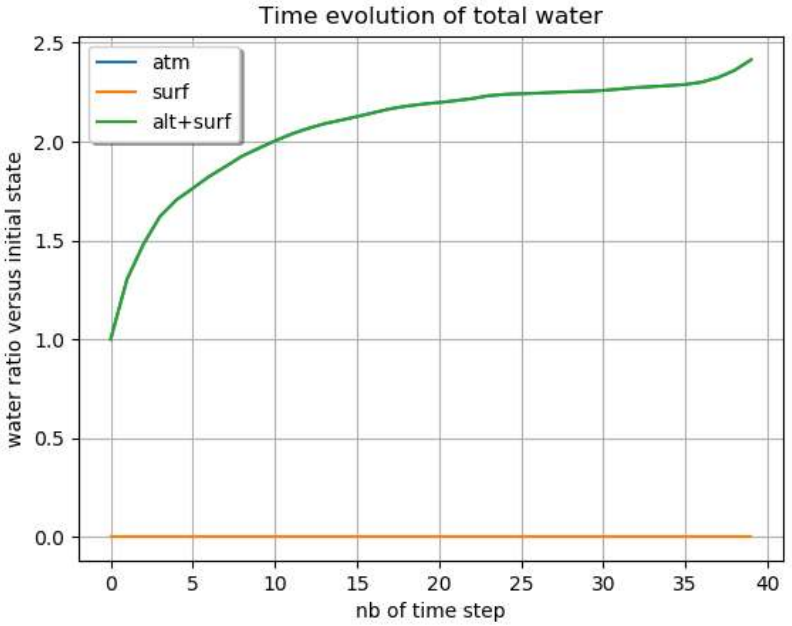


without advection



without sédimentation

→ Mass added by SL advection scheme !

More academic tests :

- Flat domain (Z_s=0.)
- T=280K, U = V = 2 m/s
- Hydrostractic dynamics

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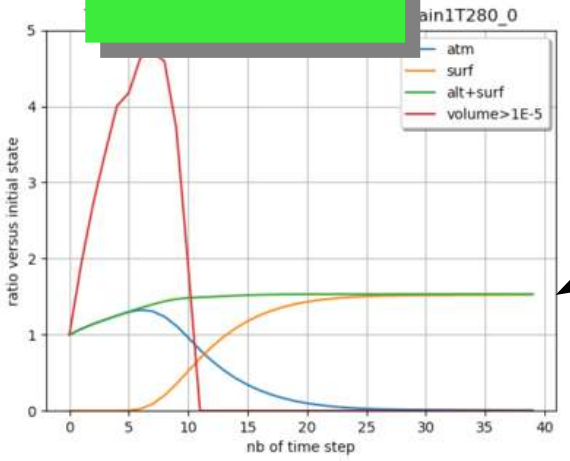
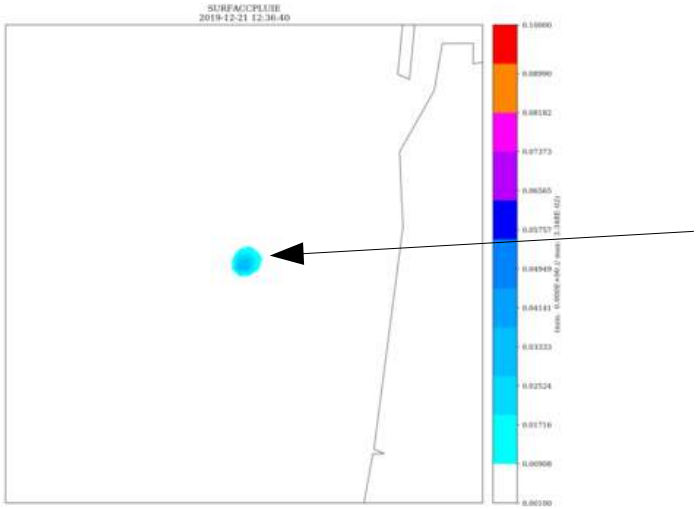
‘oper’



+50 %



cumulated
surface rain

More academic tests :

- Flat domain (Z_s=0.)
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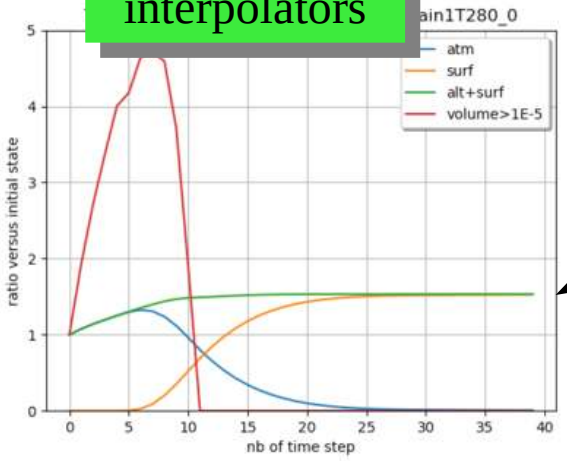
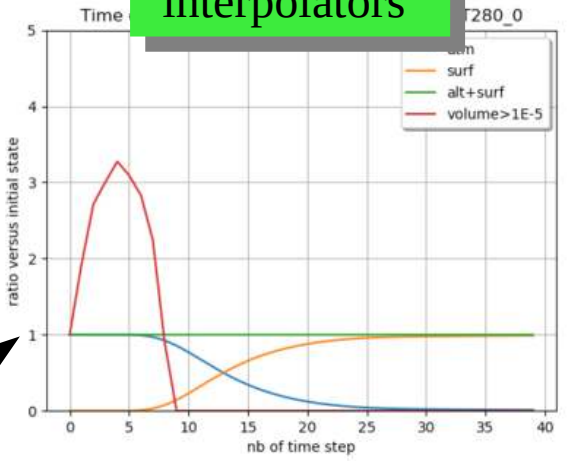
QM SL interpolators

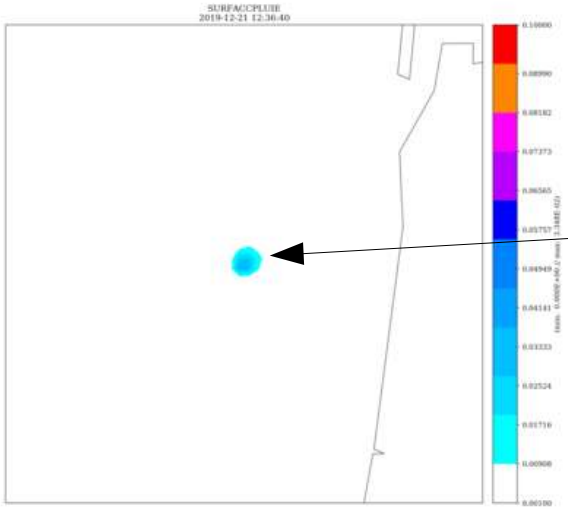


+50 %

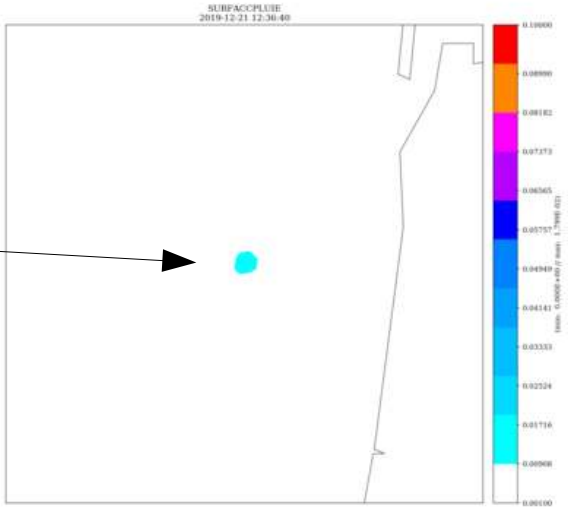
linear SL interpolators



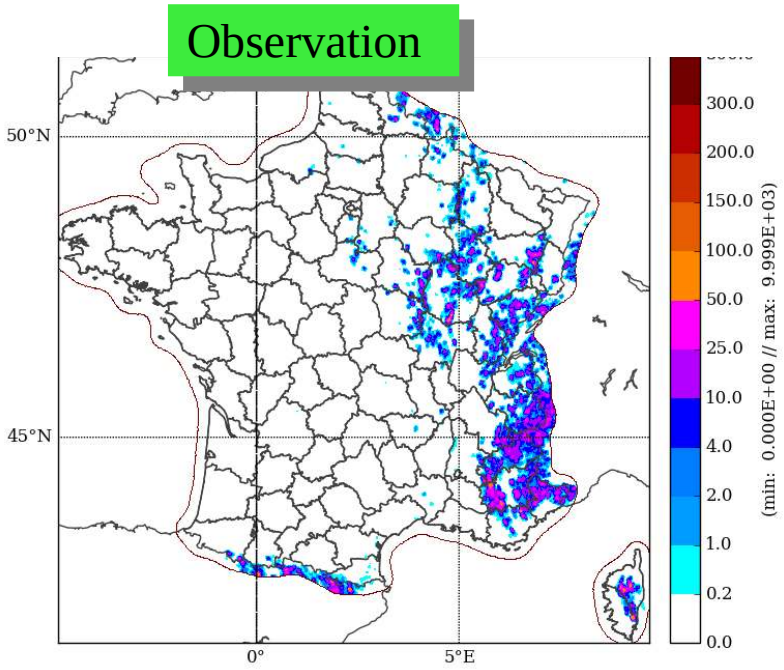
mass conservation

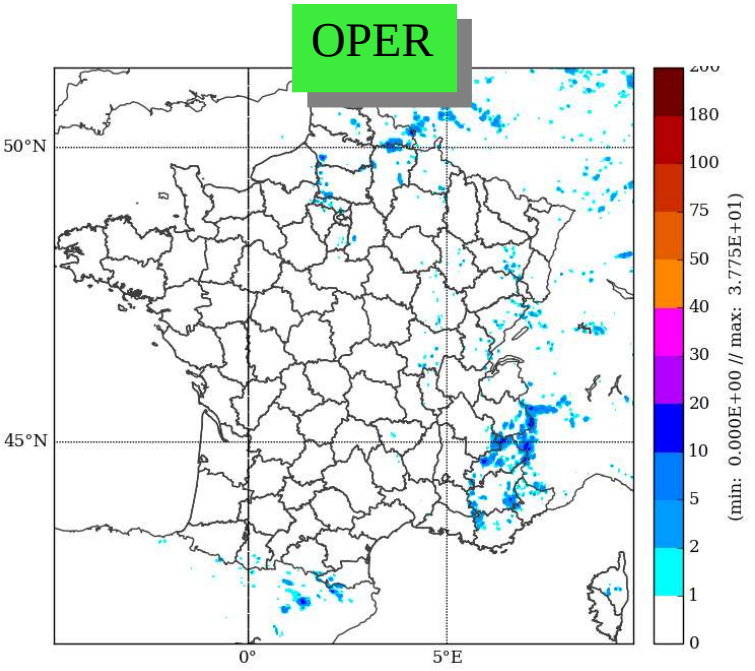


cumulated surface rain



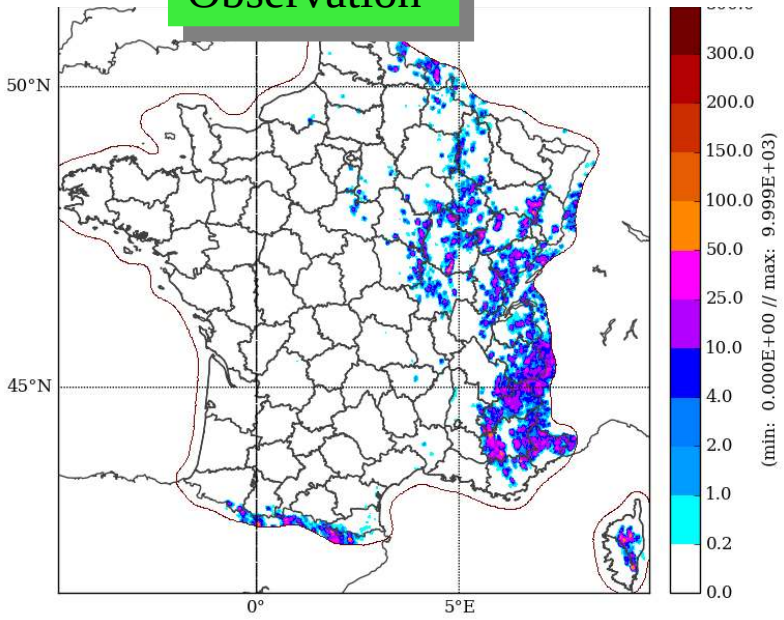
On real case : 25 July 2018 (RR24)



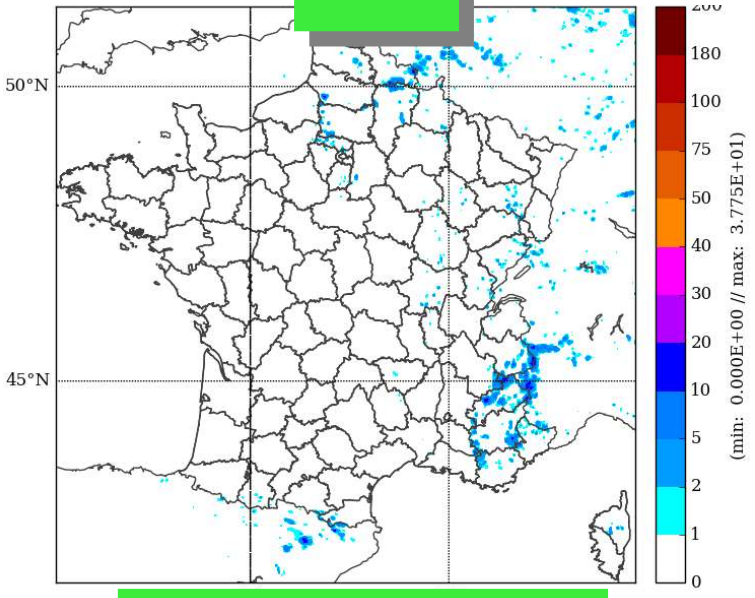


On real case : 25 July 2018 (RR24)

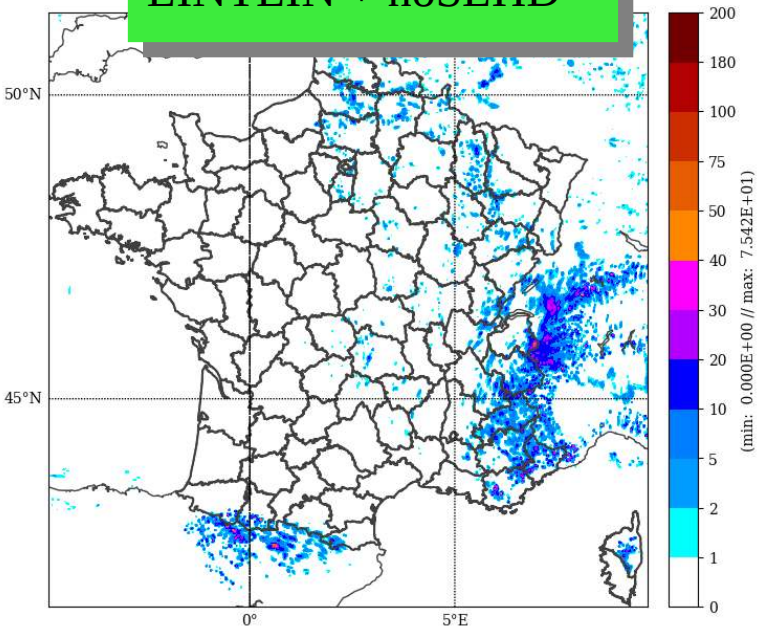
Observation



OPER



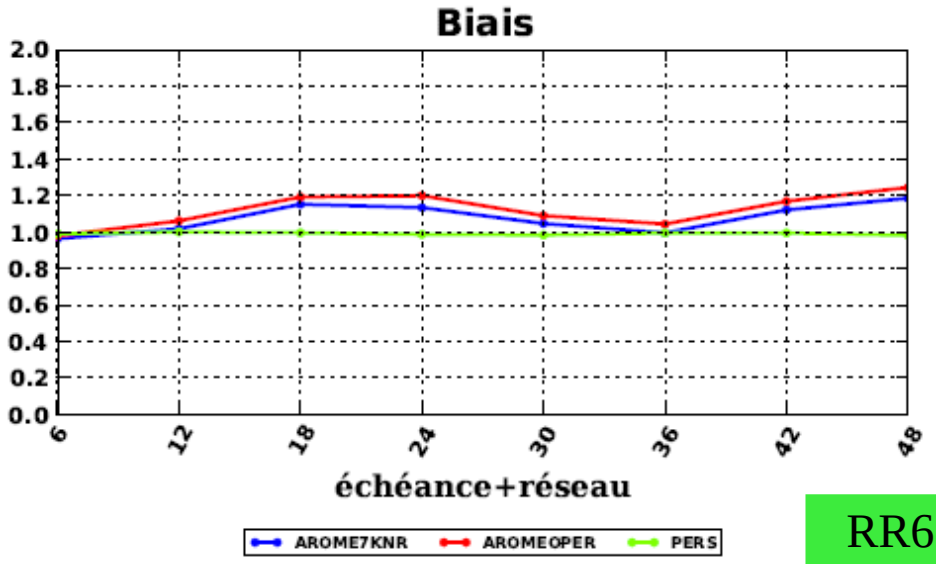
LINTLIN + noSLHD

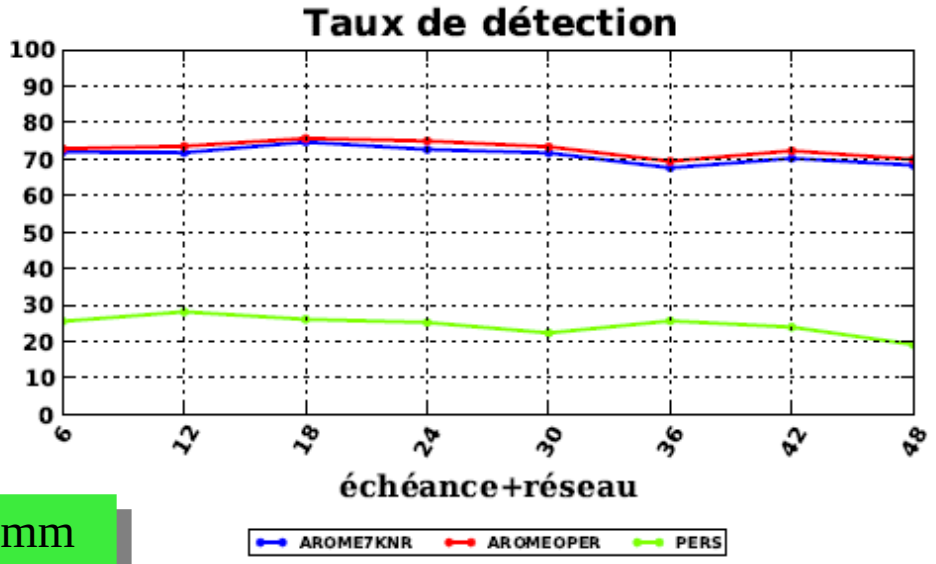


METEO FRANCE

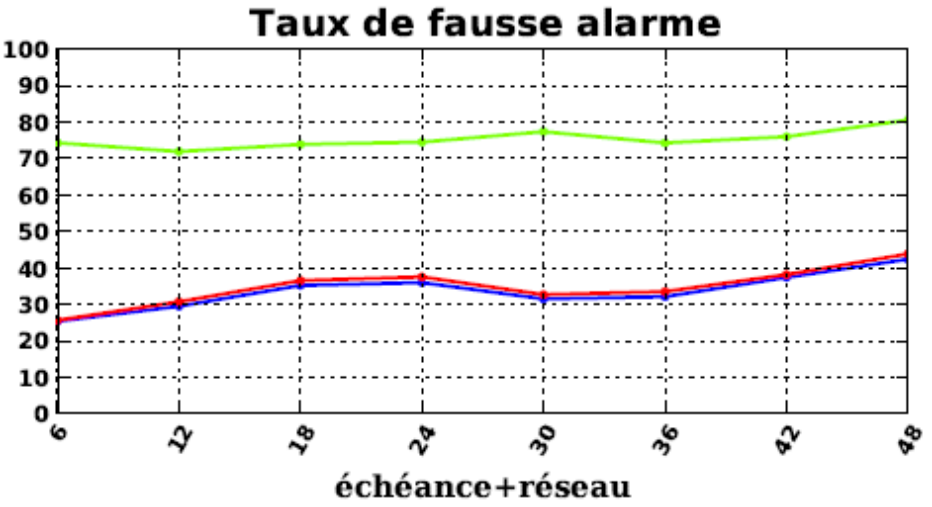
LINTLIN+COMAD+noSLHD

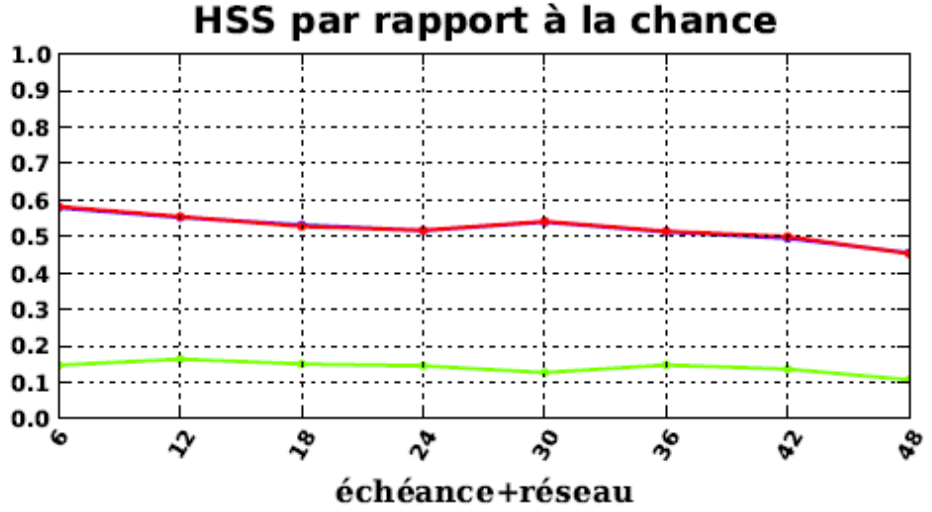
- Janvier/Fev 2020 : OPER/TEST -> OK





RR6 > 0.5 mm





Towards operational ...

- Tests on 2x2 months in forecast mode
- Tests in severe convection cases
- Tests on underestimated convective cases
- Energy spectra (→ less diffusive than SLHD)
- Statistics on convective cells (→ smaller cells)
- AROME 2.5km (AROME-IFS)
- First tests in 3DVar promising
- Ongoing 3DVar tests ...

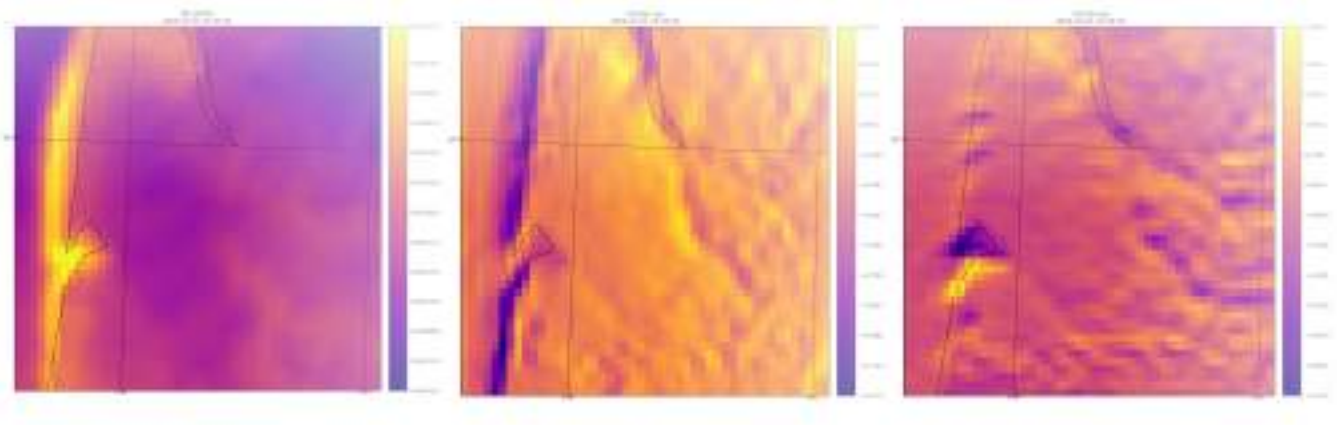
A step towards 3D physics...

- Thanks to technical work of R. El Khatib and R. Honnert, horizontal gradients of 3D fields can be available in the AROME physics :

  → D. Ricard will work on increasing the mixing into the cumulus deep clouds by adding turbulence terms from Moeng et al. (2010) Verrelle et al. (2015)

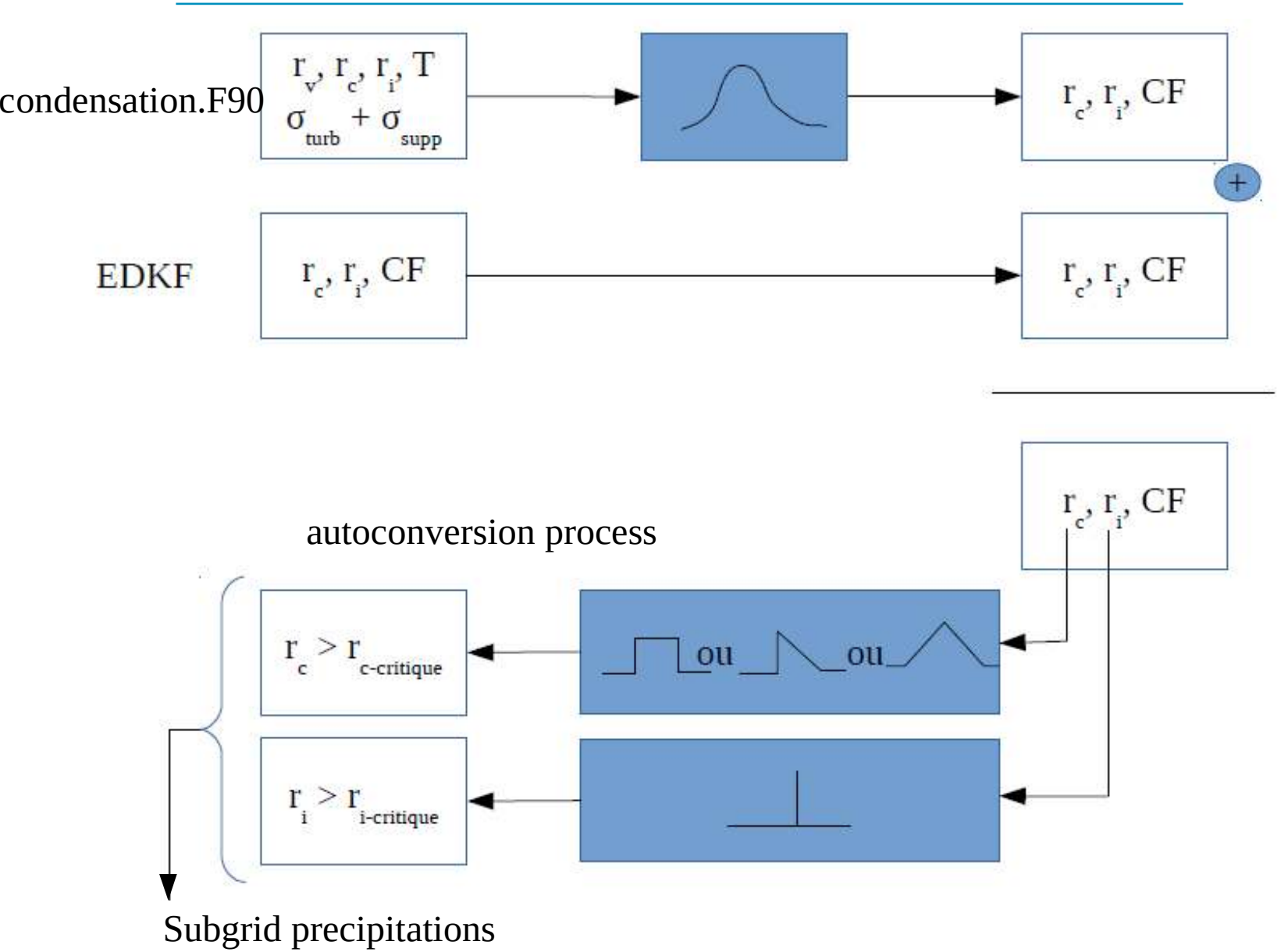
  → shear production term for TKE over orography (Arnold et al. 2014; Goger et al. 2018), could be implemented (TEAMx collaboration)

  → 3D scheme of MesoNH : additional technical work required in order to make mesoNH code more modular (manpower need)



qv d(qv)/dx d(qv)/dy

AROME cloud scheme : oper



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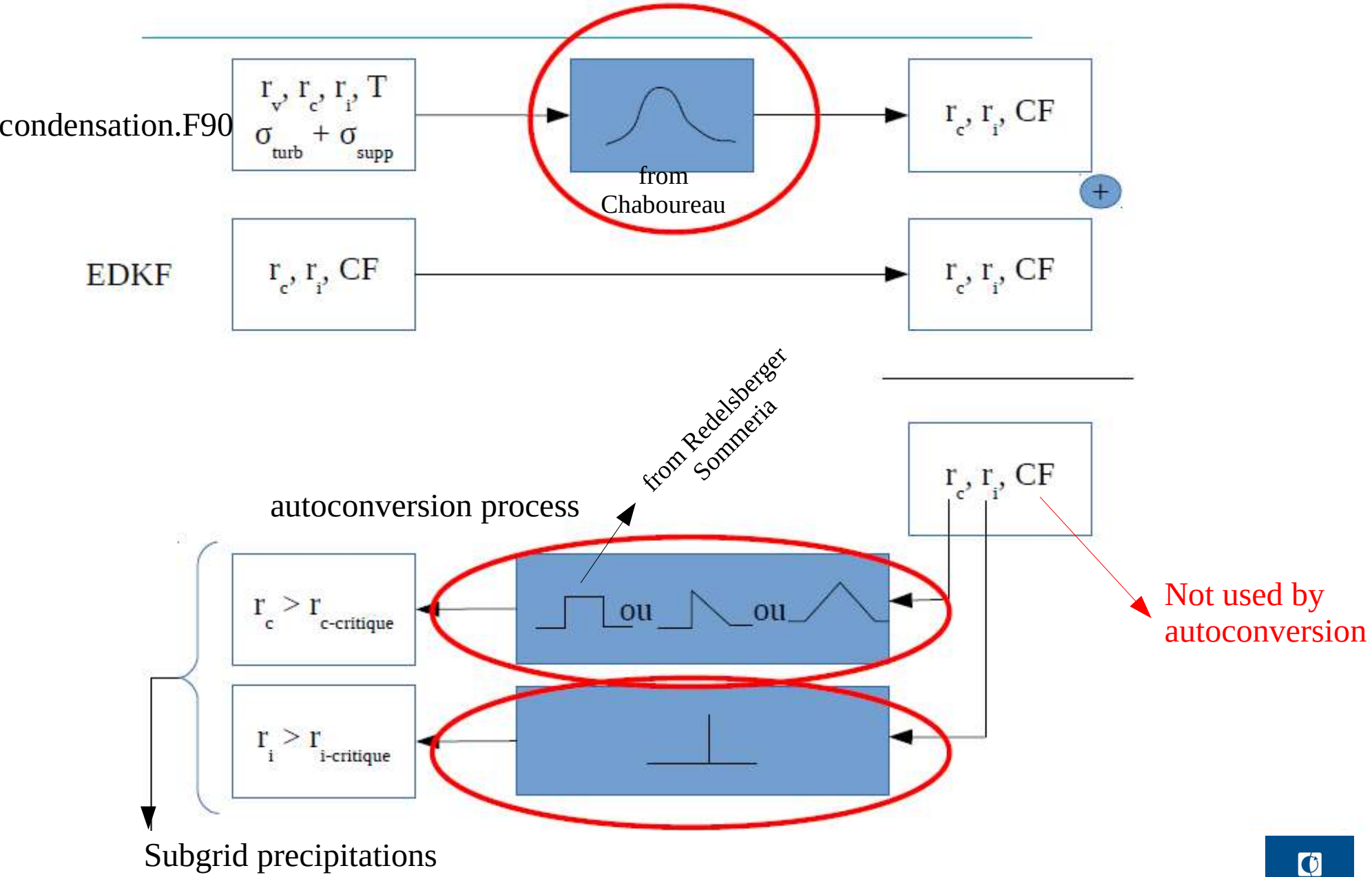


→ work to harmonise pdfs (S. Riette + G. Noual)

AROME cloud scheme : modifications

condensation.F90

r_v, r_c, r_i, T
$\sigma_{turb} + \sigma_{supp}$

r_c, r_i, CF

$r_c > r_{c\text{-critique}}$
$r_i > r_{i\text{-critique}}$

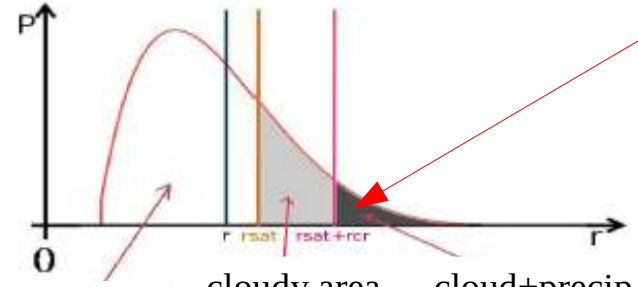
+

EDKF

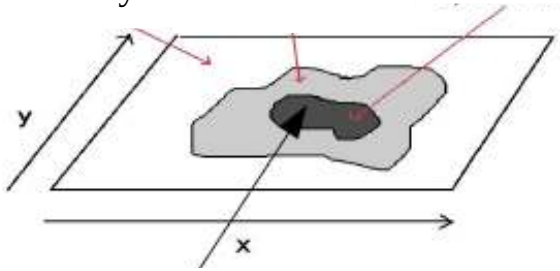
r_c, r_i, CF

r_c, r_i, CF

$r_c > r_{c\text{-critique}}$
$r_i > r_{i\text{-critique}}$



clear sky cloudy area cloud+precip



r_c, r_i, CF

$r_c > r_{c\text{-critique}}$
$r_i > r_{i\text{-critique}}$

Subgrid precipitations
computed using consistent precipitating fraction

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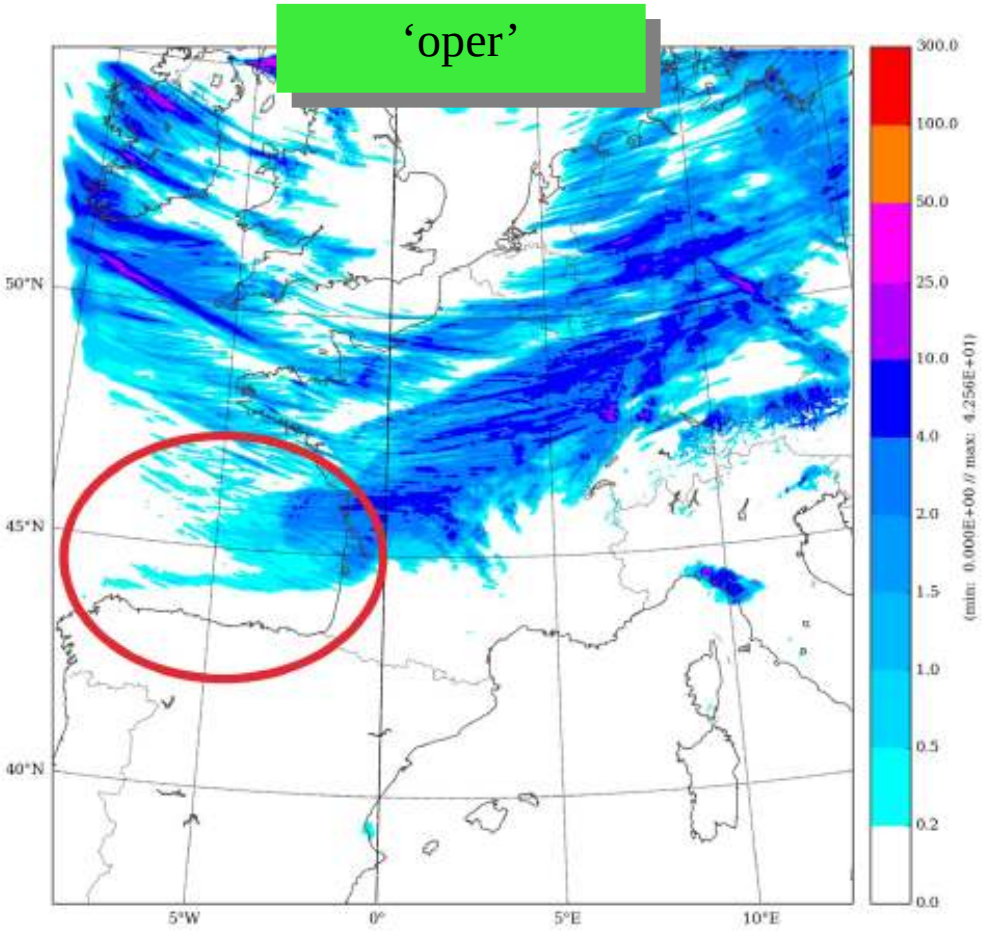
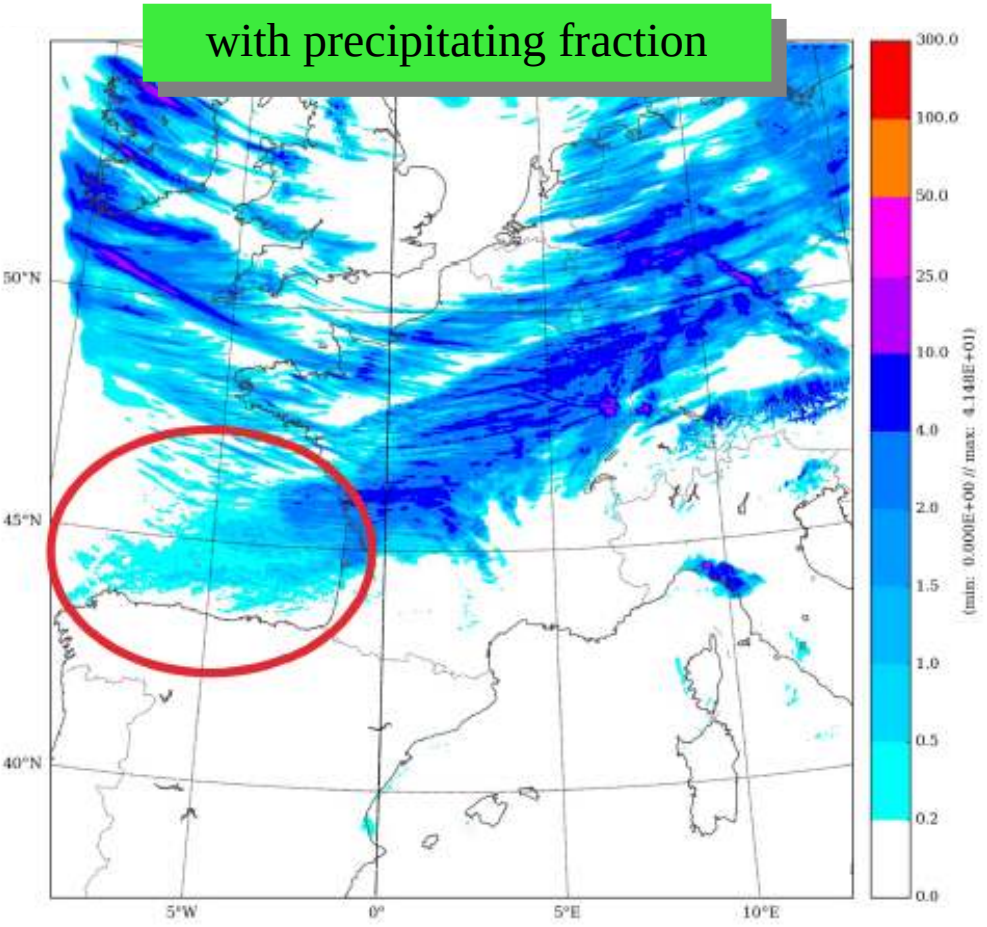
AROME cloud scheme : evaluation (Case study)

RR12





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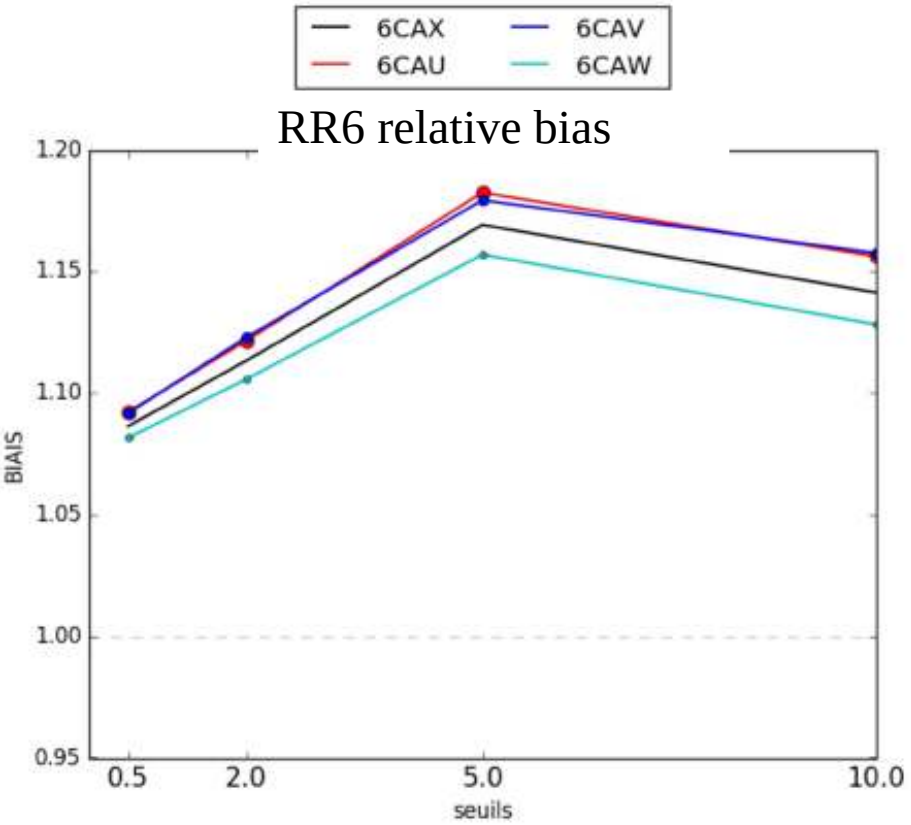
AROME cloud scheme : evaluation (March 2018)

	condensation.F90	$r_c \rightarrow r_r$	$r_i \rightarrow r_s$
6CAX (Opérationnel)	Chaboureau	Redelsperger	Threshold
6CAU	gaussian	Redelsperger	Threshold
6CAV	gaussian		Threshold
6CAW	gaussian		



- Need to change $r_c \rightarrow r_r$ threshold ?
- PDF for $r_i \rightarrow r_s$ promising...

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Summary

- New ARPEGE physics (Tiedke+SRTM+Ecume_v6+Gelato)
- New settings of hydrometeors diffusion in AROME (LINTLIN+COMAD+noSLHD)

→ *for cy46t1_op suite end of 2020*

- work on cloud scheme in AROME
- on 3D physics in AROME

→ *for cy48t1 end of 2020 ?*

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Summary

- New ARPEGE physics (Tiedke+SRTM+Ecume_v6+Gelato)
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→ *for cy46t1_op suite end of 2020*

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- on 3D physics in AROME

→ *for cy48t1 end of 2020 ?*

+ Fog side meeting at 14:30 this afternoon

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