

Progress and plans in the ARPEGE and AROME models physics

Y. Seity



ALADIN/HIRLAM Meeting, Helsingor April 2015



METEO FRANCE
Toujours un temps d'avance

OUTLINE

- ARPEGE
 - Deep convection (PCMT)
 - Shallow convection (PMMC09)
- AROME
 - Radiation/surface interaction
 - Microphysics
 - Turbulence
- Conclusions

*E-suite (ARPEGE T1198c2.2 L105 and
AROME 1.3kmL90_RUC1h to be oper today
(more details on our poster, paper in preparation for QJRMS)
All that I will describe in this talk is not included in the E-suite*

ARPEGE-PCMT

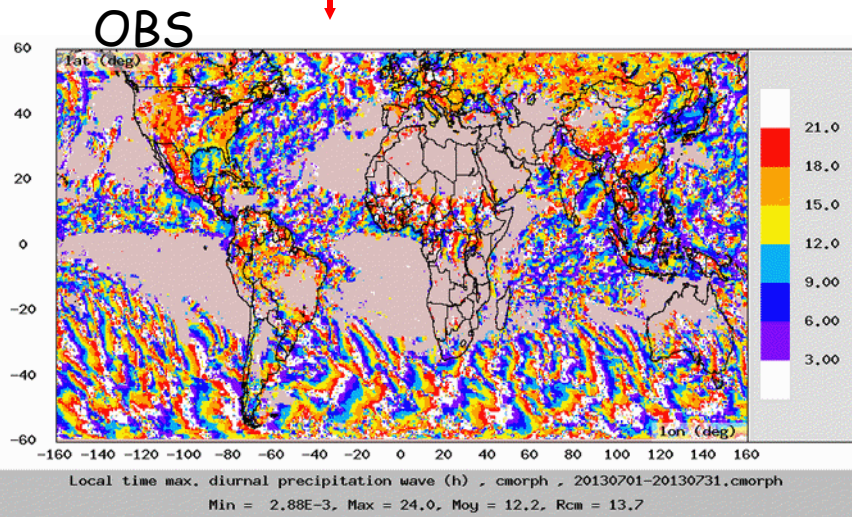
- PCMT (Piriou et al, 2007; Guérémy 2011). :

Motivations

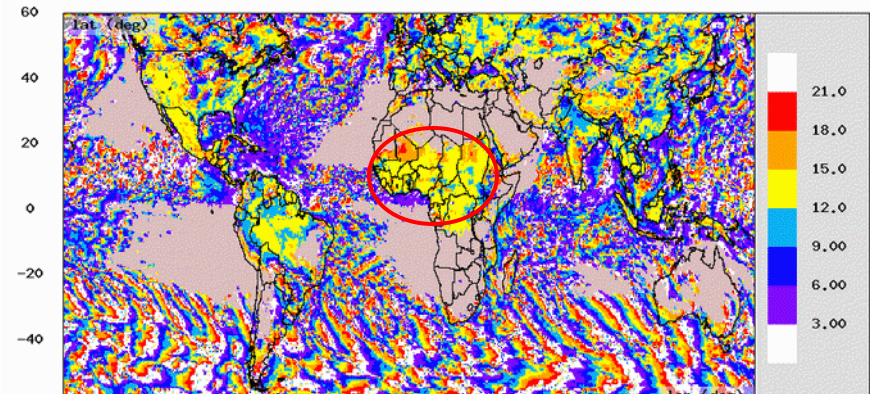
- ▶ More intermittent convective precipitation
- ▶ Delayed diurnal cycle
- ▶ Reduction of unexpected cyclogenesis
- ▶ Decreasing of high troposphere tropical cold bias

General characteristics

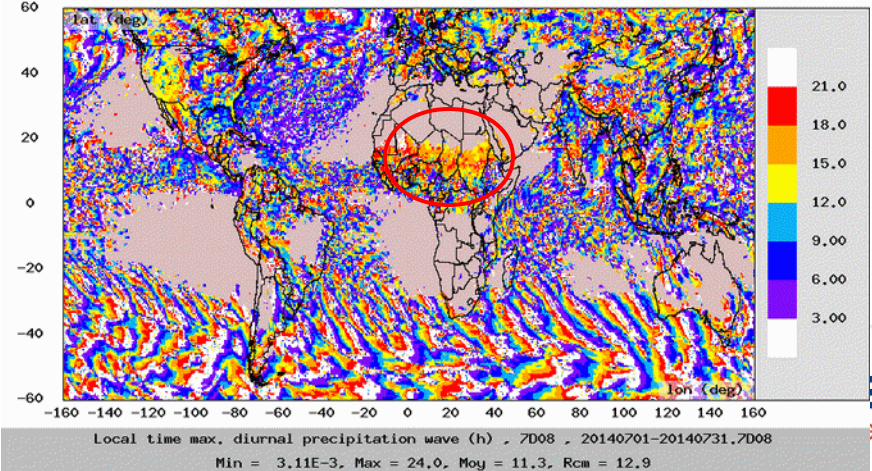
- ▶ Separation between microphysics and transport (Piriou 2007)¹
- ▶ 5 new prognostic variables w_u q_l q_i q_r q_s
- ▶ Same microphysics scheme as for stratiform precipitation
- ▶ Several formulations for entrainment, detrainment and closure



OPER



TEST



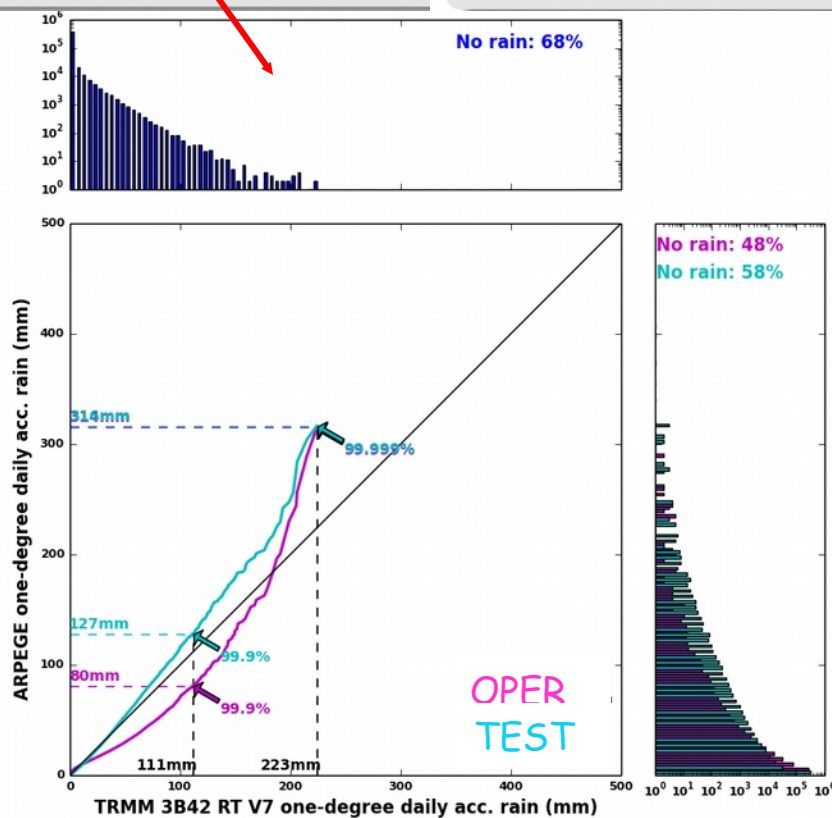
ARPEGE-PCMT

Motivations

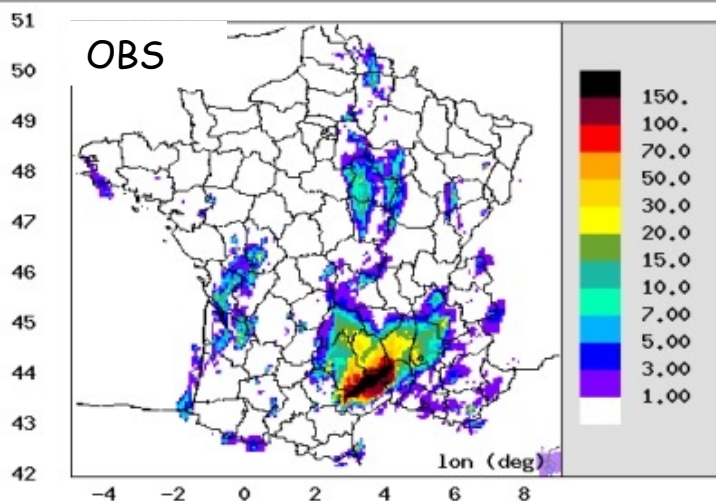
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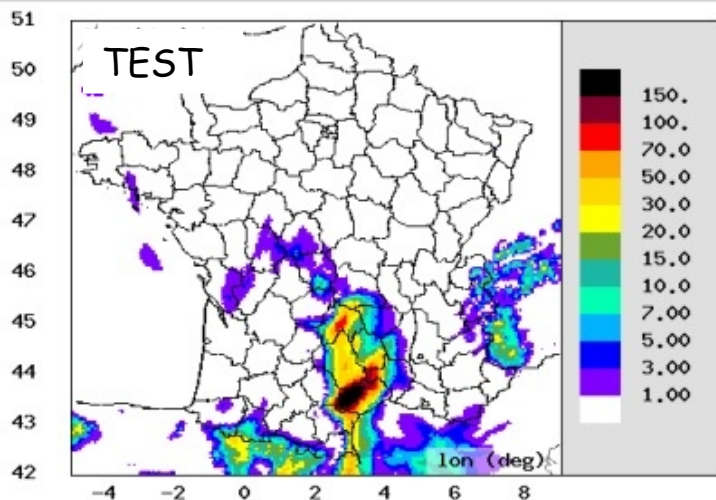


ARPEGE-PCMT

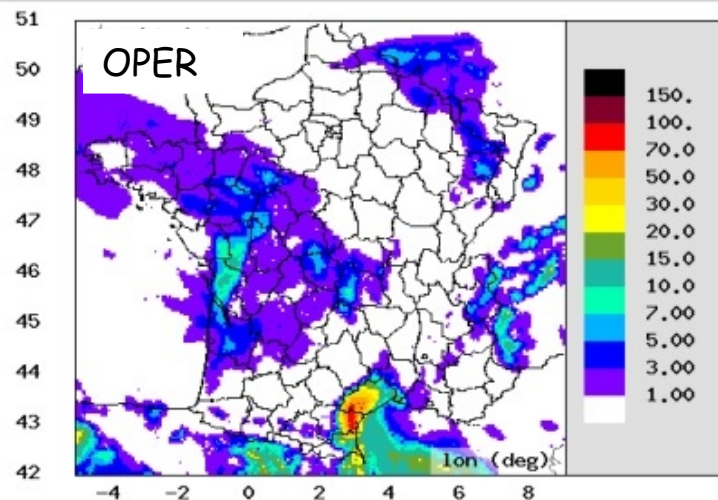


ARPEGE-PCMT closer to observations on the 2014-09-17 'Cevenol' event.

Lame d'eau ANTILOPE (mm/24h) , Cumul 24h le 2014-09-17
 Min = 0., Max = 350., Moy = 1.93, Rcm = 13.7



ARPEGE 7D08 (mm/24h) , Cumul 24h le 2014-09-17
 Min = $-9.13E-3$, Max = 267., Moy = 2.25, Rcm = 11.8

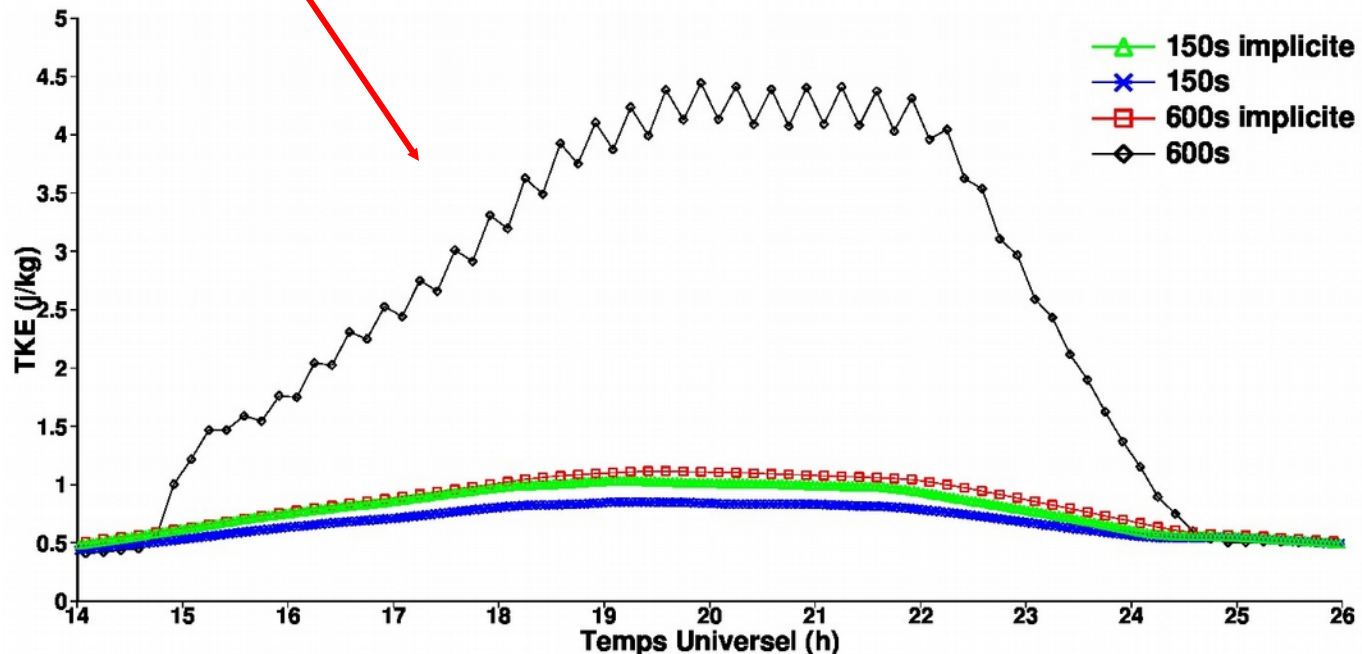


ARPEGE oper (mm/24h) , Cumul 24h le 2014-09-17
 Min = $-5.53E-3$, Max = 100., Moy = 1.80, Rcm = 5.01

ARPEGE-PMMC09

Modifications to use PMMC09 in ARPEGE

- ▶ Numerical stabilization by implicit resolution of full EDMF equation :
$$\left(\frac{\partial \psi}{\partial t}\right)_{edmf} = \frac{1}{\rho} \frac{\partial}{\partial z} \left(-k \frac{\partial \psi}{\partial z} + M(\psi_{up} - \bar{\psi})\right)$$
- ▶ New formulation of entrainment and detrainement (Rio et al 2011)²
- ▶ Optionally, new formulation of closure (Hourdin et al 2002)³



OUTLINE

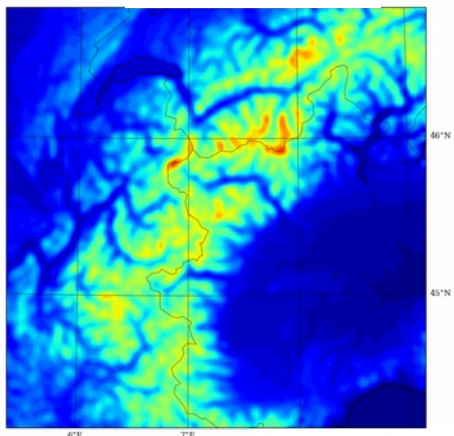
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AROME : Radiation/Surface

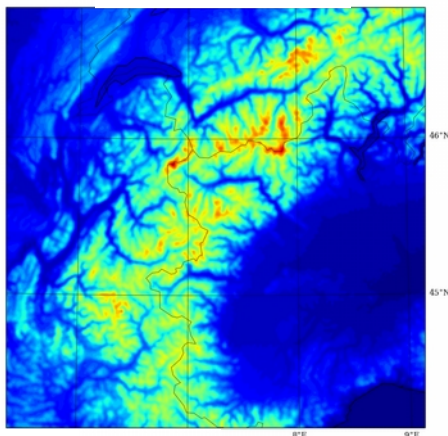
- Validate ORORAD parametrisation described in Christoph's talk at various grid size (ororad parameters computed in PGD (Alexandre Mary's code in CY41T1))

Domain Orography :

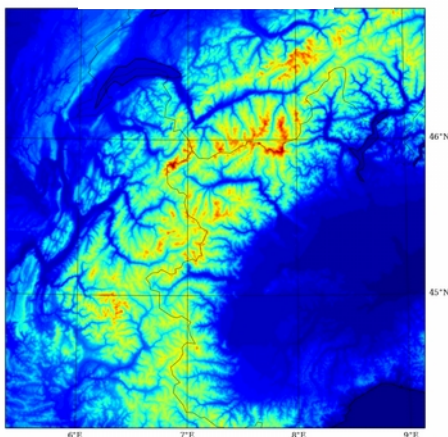
@2500 m :



@1250 m :



@500 m :



-100 3121 6343 9564 12786 16007 19229 22450 2567

0 25671 28893 32114 35336 38557 41779 45000

-100 3121 6343 9564 12786 16007 19229 22450 25671 28893 32114 35336 38557 41779 45000

Evaluate separately the impact of :

Slope (`_sl`)

Shadows (`_sh`)

Sky view factor (`_sv`)

`sl+sh+sv = all`

On 3 dates without significant clouds over the domain :

2013-12-12

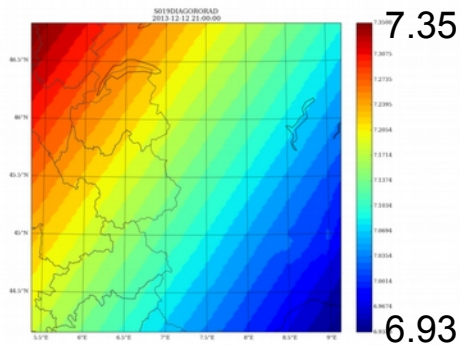
2014-03-14

2014-06-21

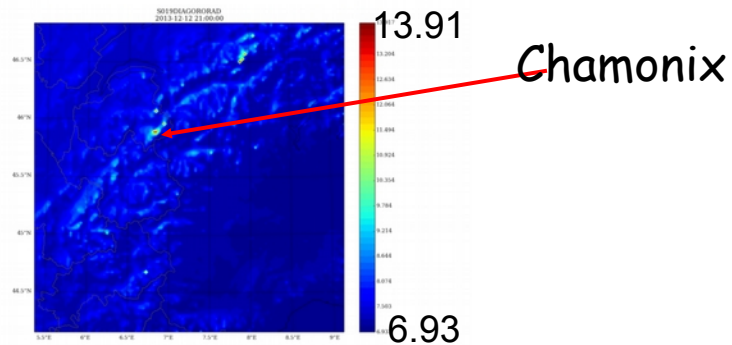
Sunshine duration (20131212 @ 2.5km)

Sunrise
time

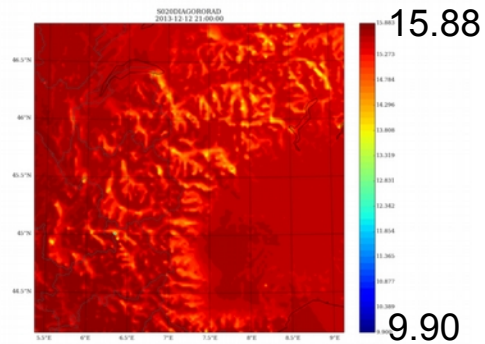
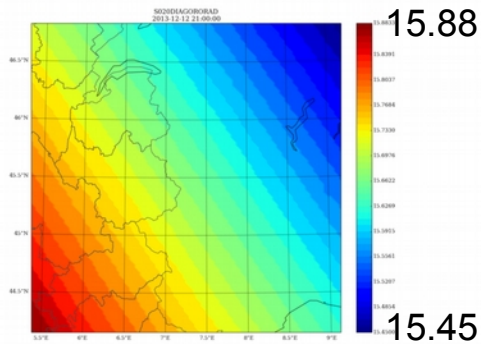
REF



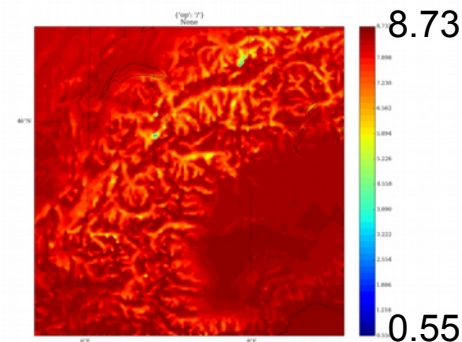
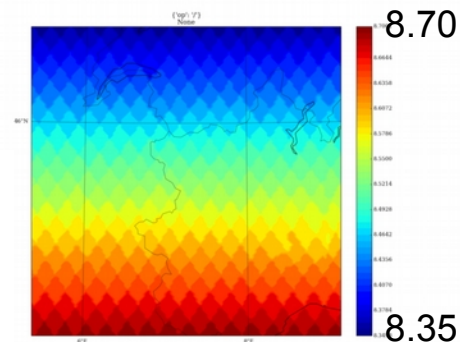
ALL



Sunset
time

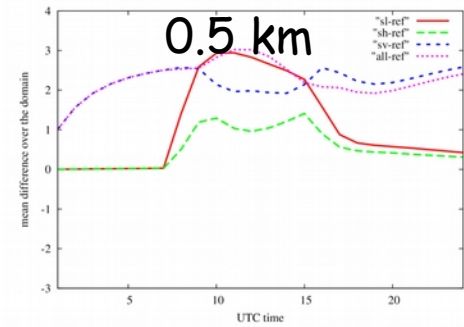
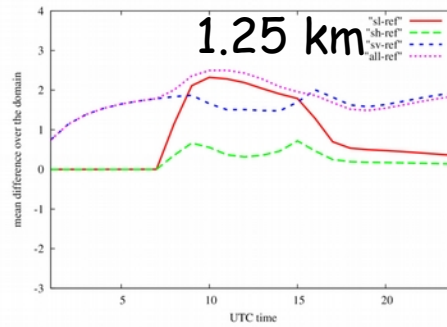
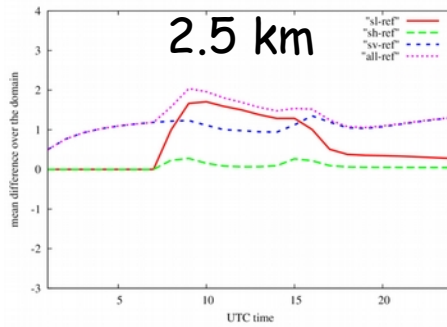


Sunshine
duration

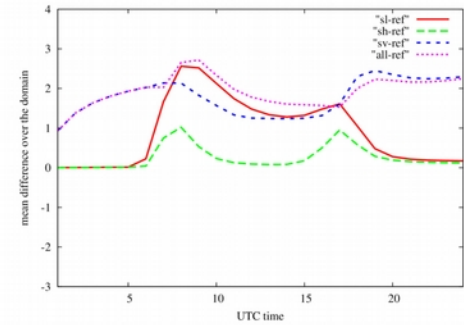
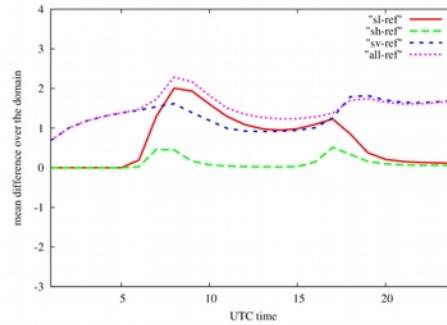
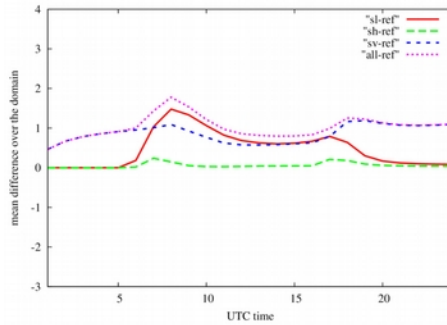


Average impact (ABS($T_{s_exp} - T_{s_ref}$))

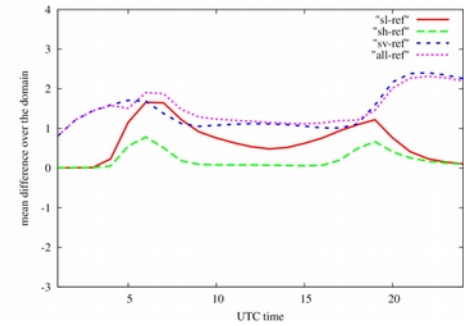
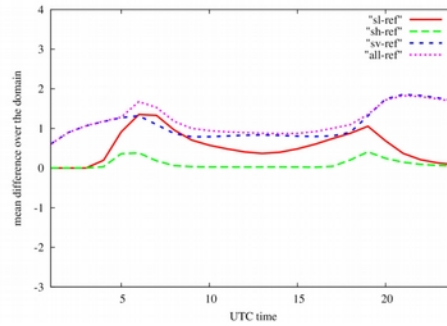
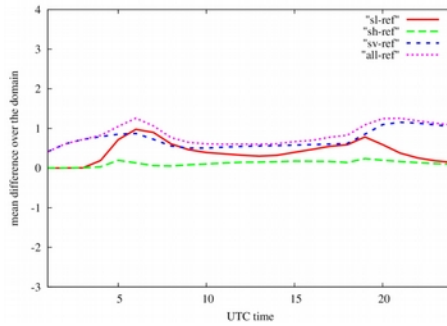
12-12-2013



14-03-2014



21-06-2014



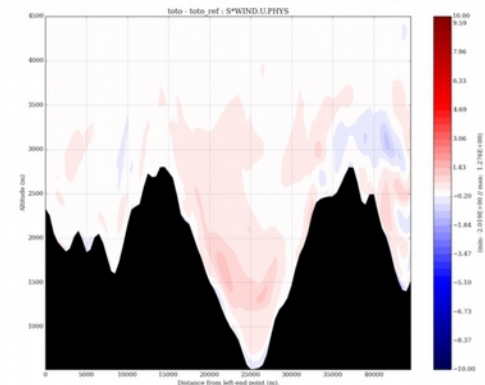
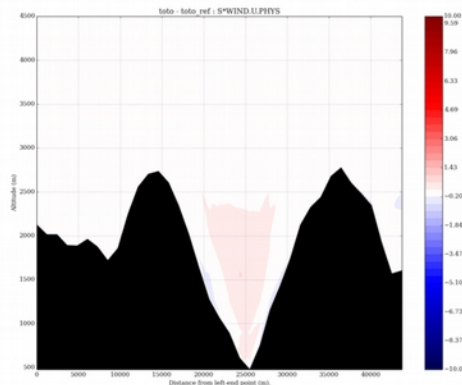
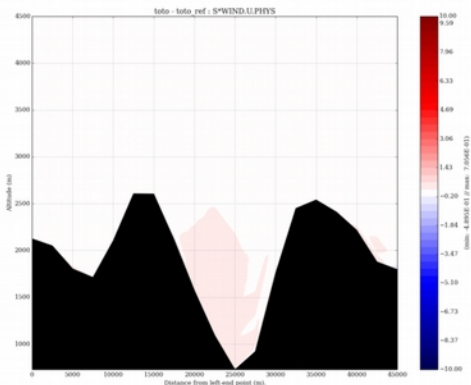
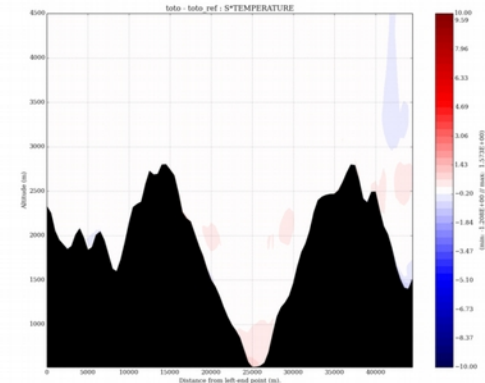
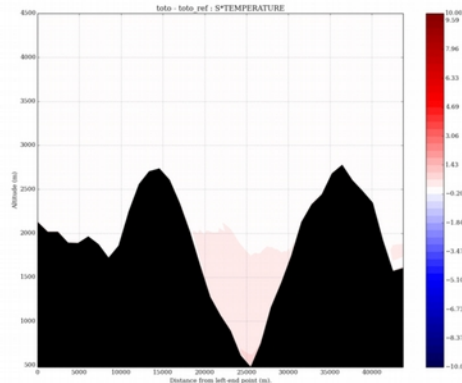
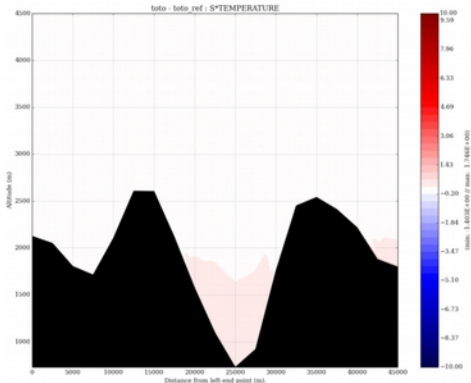
- Impact increases with higher resolution
- Impact stronger in winter
- Sky view has the strongest impact, next slopes, next shadows

Vertical cross section (across the Rhône valley in Switzerland) 20131212 9TU (all-ref)

2.5 km

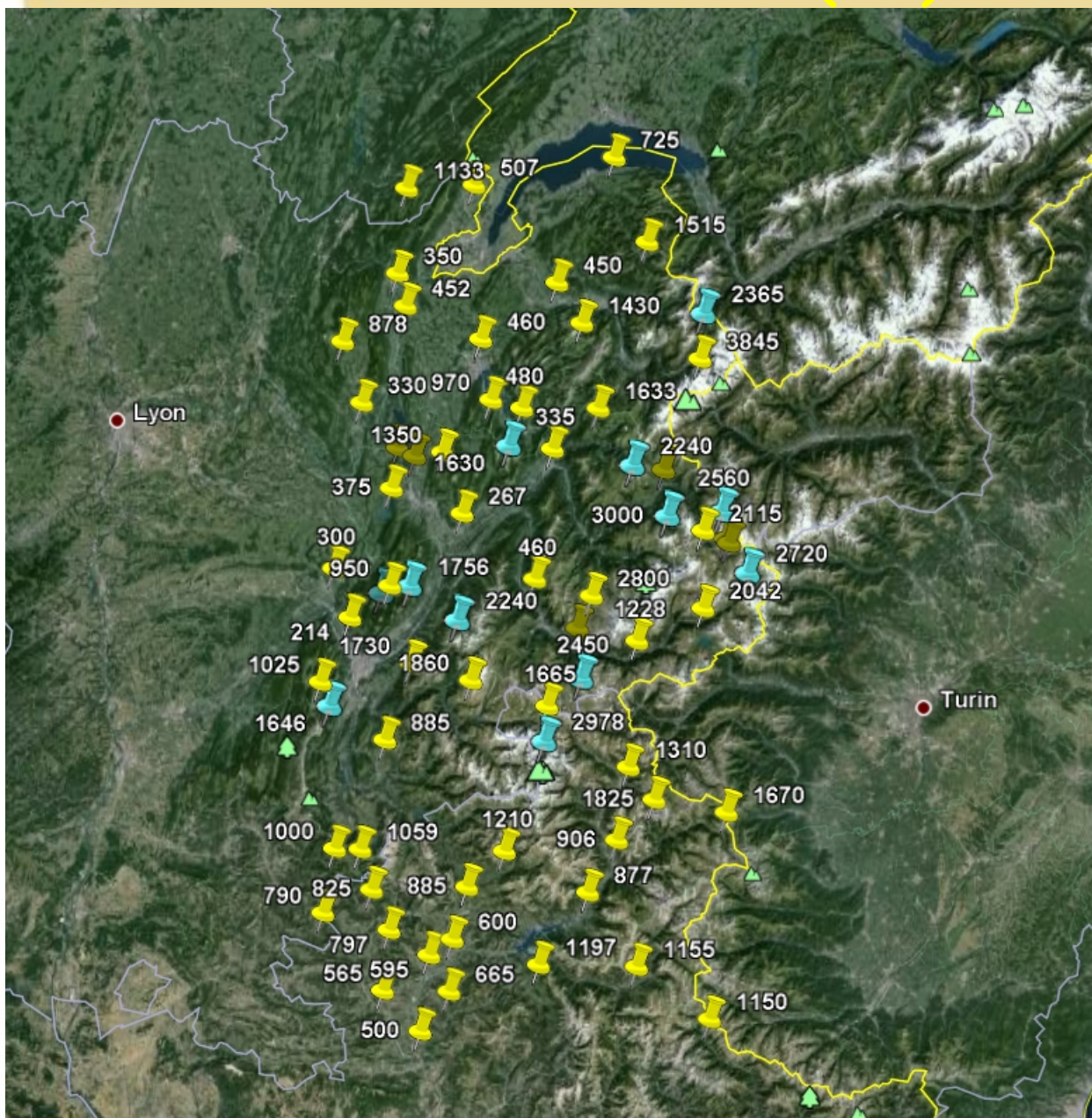
1.3 km

0.5 km



At that time, heating in the Valley, and stronger winds

Validations SYNOP (60) / NIVOSSES (12)



NIVOSSES are always at high altitude, on slopes, whereas most of the SYNOP are in valleys



Scores T2m

SYNOP (60 stations)

NIVOSE (12 stations)

2.5 km

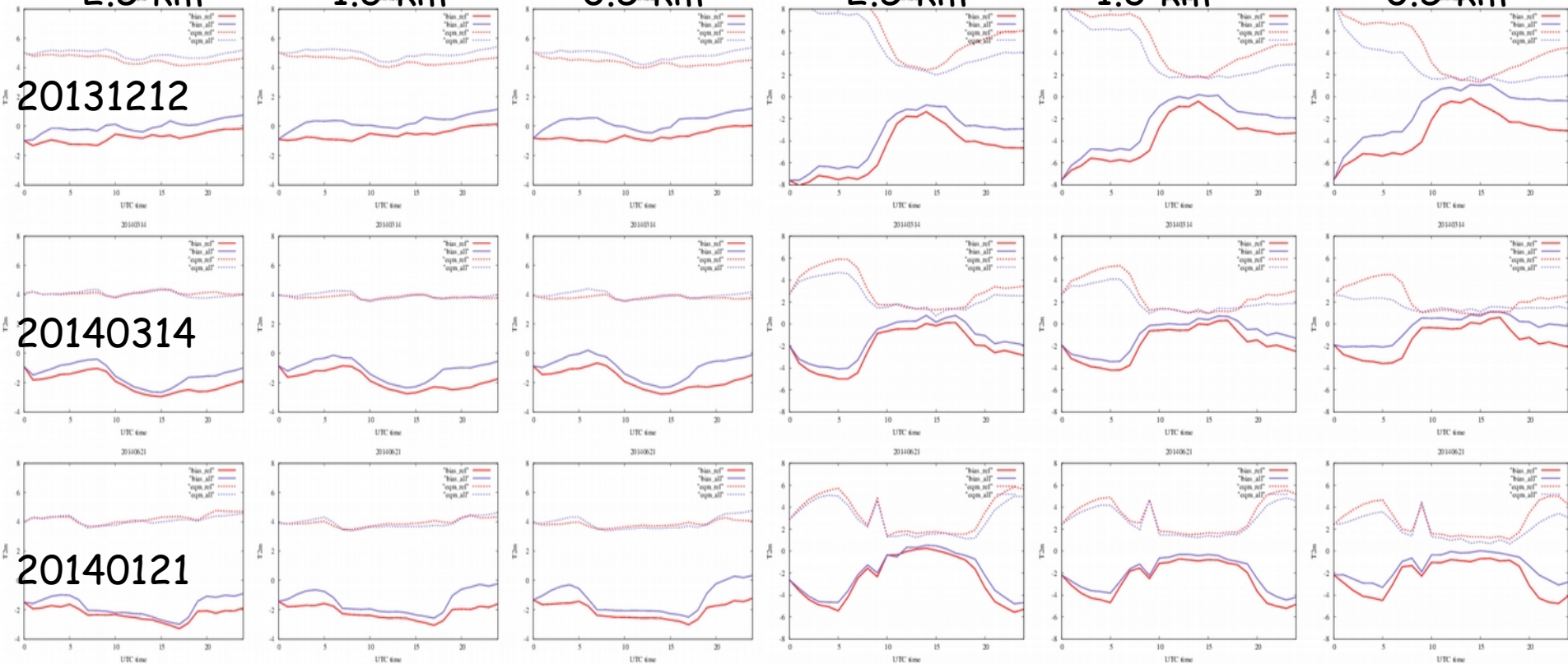
1.3 km

0.5 km

2.5 km

1.3 km

0.5 km



- Improvements of scores with increased resolution (altitude correction)
- Reduced negative bias
- Stronger improvement for NIVOSE, deteriorates RMSE for SYNOP in 20131212

Scores Wind@10m

SYNOP (60 stations)

NIVOSE (12 stations)

2.5 km

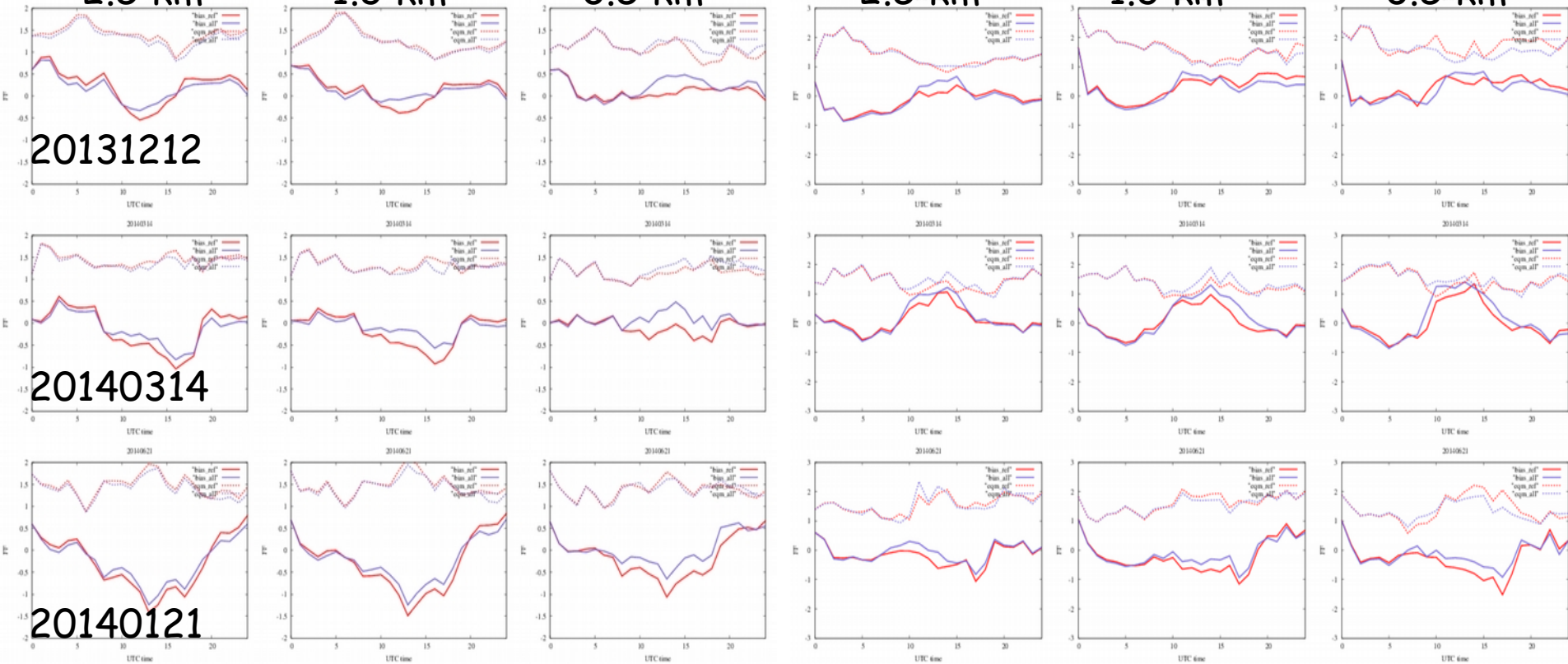
1.3 km

0.5 km

2.5 km

1.3 km

0.5 km



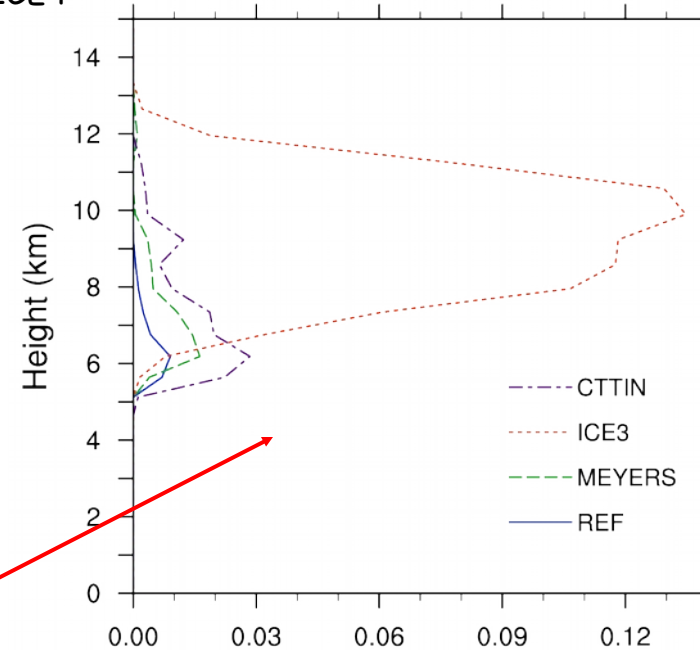
- Improvements of scores with increased resolution (more realistic orography)
- Reduced night-time bias, increased day-time bias, not so systematic for RMSE.
- Largest differences at 0.5 km

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AROME : Microphysics

- Work to reduce time step sensitivity of ICE3 (Sebastien Riette) and ICE4 (start in 0d, next test in 3D) :
- Ongoing tests on ICE4 in Meso-NH (-> improvements expected for AROME)
- Sensitivity tests to the ordering of the processes
- Inclusion of microphysics in Surface Boundary Layer scheme for fog (Alexandre Philip PHD).



• LIMA (Benoit Vélizy)
- validation in Meso-NH on Hymex cases (aircraft measurements...)
- validation on 2D COPTB1 squall line
- paper in preparation for GMD
- modifications from Sebastien Riette will be included into LIMA
- LIMA in AROME will be available by the end of 2015 (research version, need to be simplified to be used in oper, version ready for oper by the end of 2016).

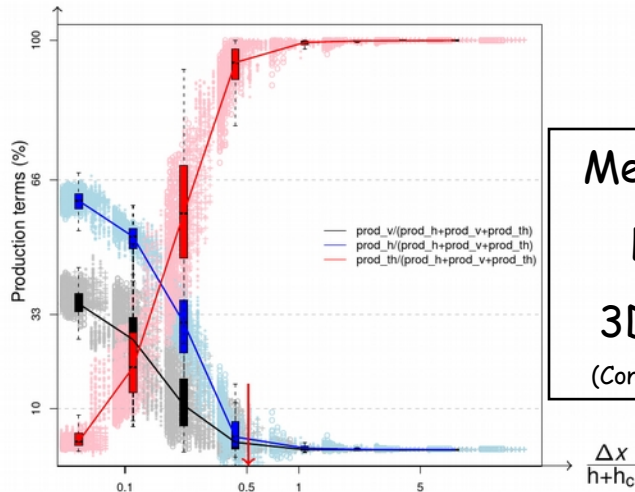


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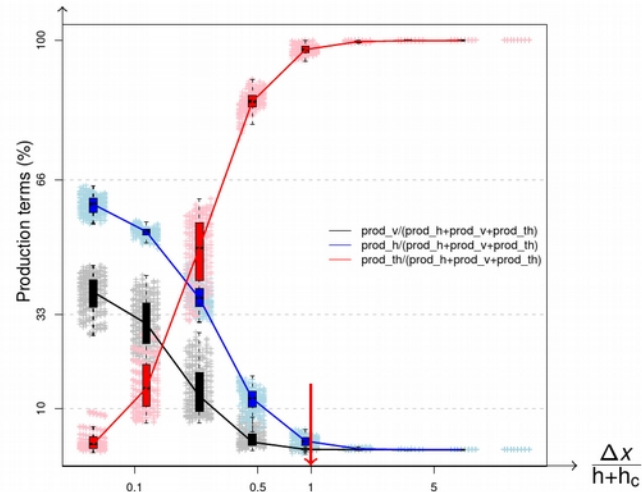
AROME : Turbulence

- Work towards a 3D turbulence (R. Honnert)



Meso-NH
LES
3D turb
(Convective BL)

Thermal (red), horizontal (blue) and vertical (gray) dynamic production terms as a function of the resolution in **free** CBL.



Thermal (red), horizontal (blue) and vertical (gray) dynamic production terms as a function of the resolution in **forced** CBL.

Quantification of horizontal and vertical K and L (non-isotropic turbulence) :

$$\overline{u'_i \phi'}^{\Delta x} = -K(\Delta x) \frac{\partial \bar{\phi}^{\Delta x}}{\partial x_i}$$

$$K(\Delta x) = \alpha L(\Delta x) \sqrt{e(\Delta x)}$$

Conclusions

- For a next e-suite (this summer ?)
 - ARPEGE : shallow and deep convection (PCMT+PMMCO9) ??
 - AROME, if long term validation OK, activate ororad parametrisation
- For longer terms :
 - Ongoing work on microphysics (ICE3/ICE4/LIMA)
 - On Turbulence (3D/1D)
 - Test Surfex8 (ISBA-diff, MEB...) this Autumn.

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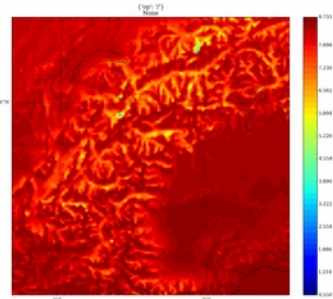


METEO FRANCE
Toujours un temps d'avance

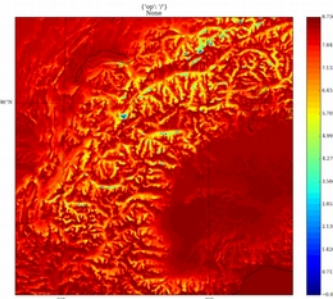
Sunshine duration

20131212

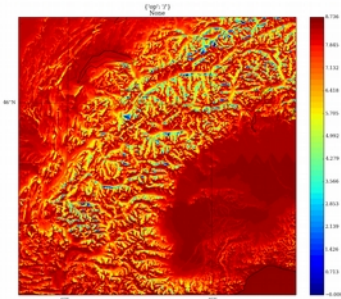
2.5km



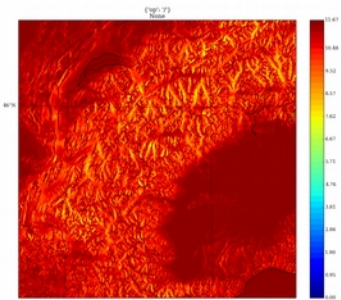
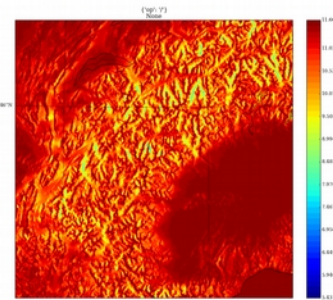
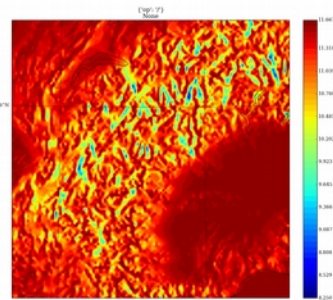
1.25km



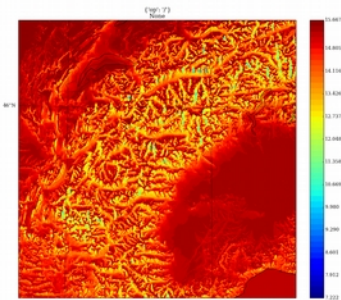
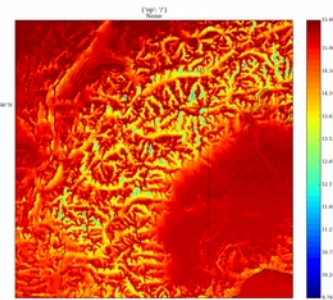
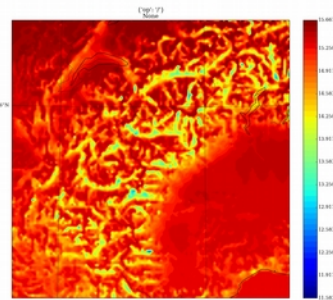
0.5km



20140314



20140621



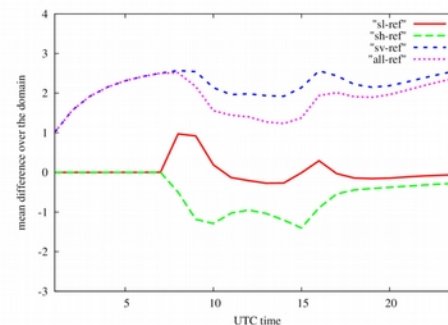
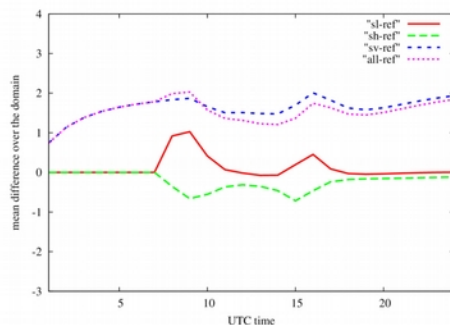
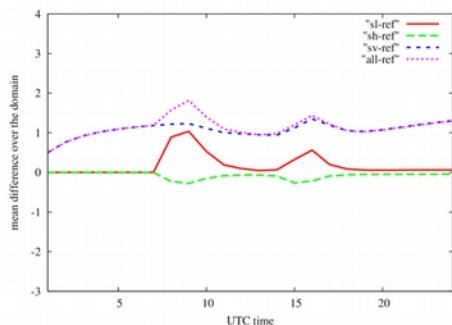
Average impact ($Ts_{exp} - Ts_{ref}$)

2.5 km

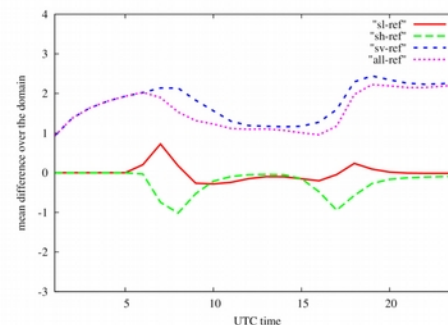
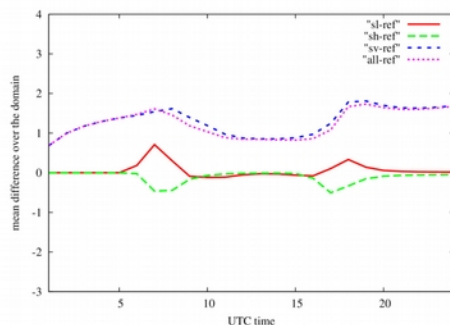
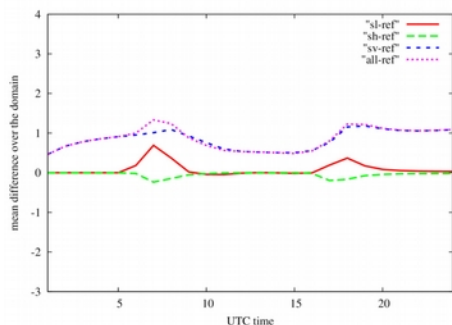
1.25 km

0.5 km

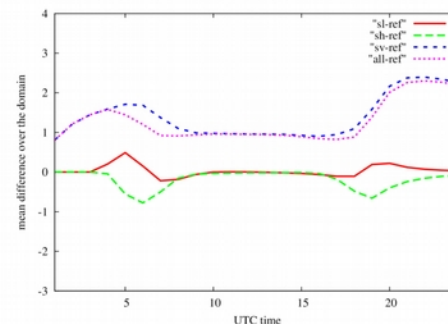
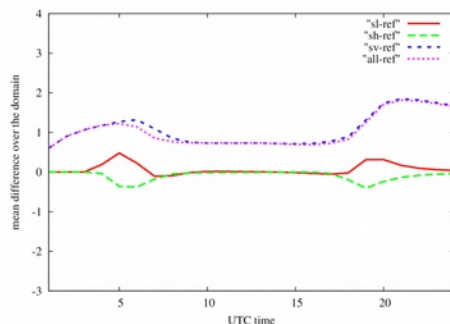
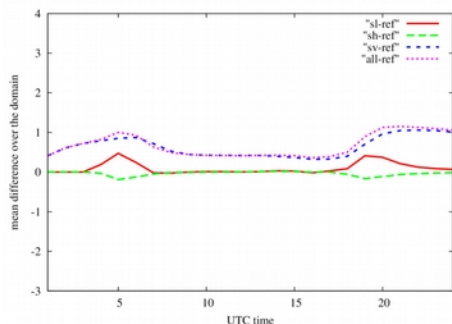
12-12-2013



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21-06-2014



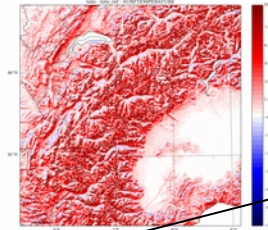
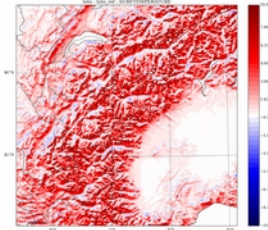
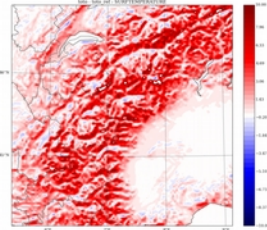
Effect on Ts at +9TU 12-12-2013 :

2.5 km

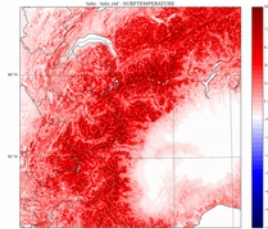
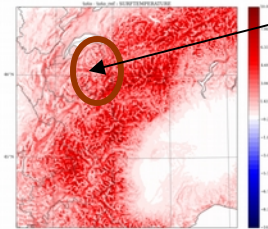
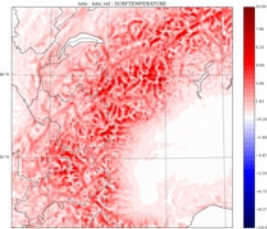
1.3 km

0.5 km

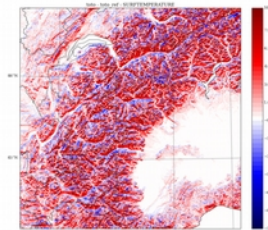
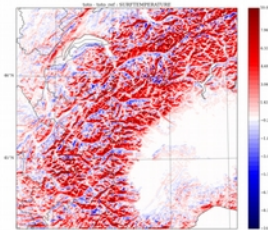
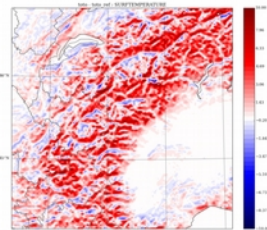
All



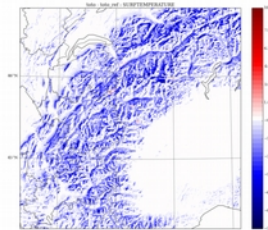
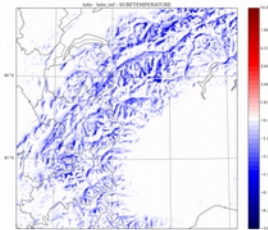
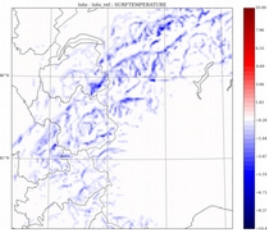
Sky view



Slope



Shadows



Max impact in case of snow cover (White Mont, etc) -> something to modify if the formulation ?

Effect on Ts at +5TU 21-06-2014 :

