Recent progress in convective scale Arome NWP system and on-going research activities

P. Brousseau, P. Chambon, G. Faure, R. Honnert, A. Mary, N. Merlet, Y. Seity, B. Vié, E. Wattrelot
(presented by F. Bouyssel)

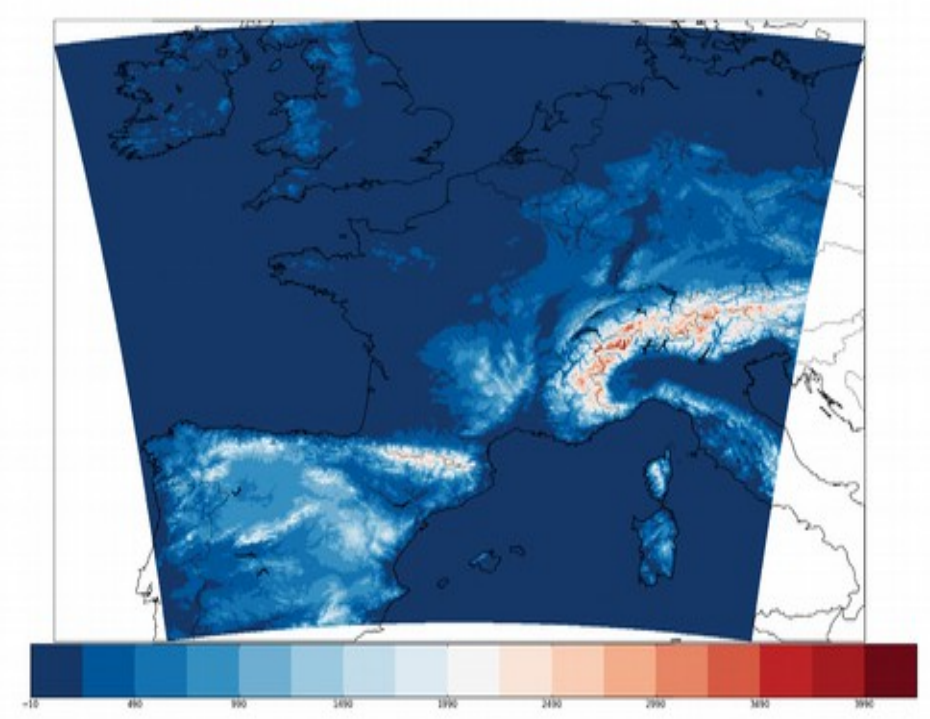
WGNE-31, 26-29 April 2016, Pretoria, South Africa

Outline

- Arome NWP operational configurations and recent evolutions
- On-going research activities

AROME system over France

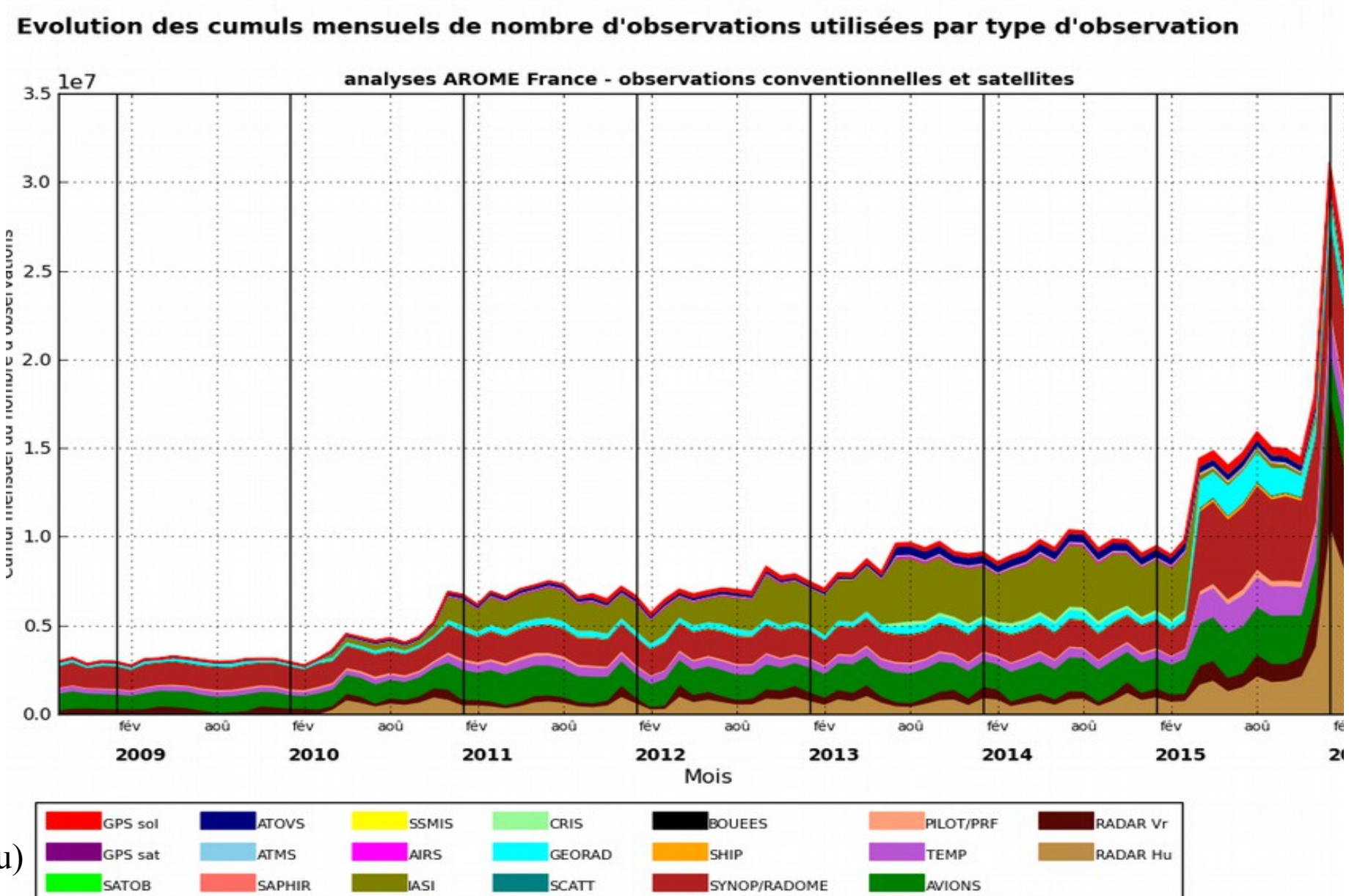
- Spectral limited area non-hydrostatic model with explicit moist convection (since 12/2008)
- Horizontal resolution : 1.3 km
- 90 vertical levels (from 5 m up to 10 hPa)
- 3D-Var assimilation (1-h window)
- Observing system : same as ARPEGE (+) 5 SEVIRI/MSG radiances (with Ts inversion) (+) radar DOW and Z (RH) (–) GNSS RO (+) IR and MW sounders with a different set of channels
- Coupling files : hourly forecasts from global model ARPEGE
- Forecast range : up to 42 hours



Previous configuration:
2.5 km resol. and L60 top at 1 hPa
3D-Var with 3-h assimilation window

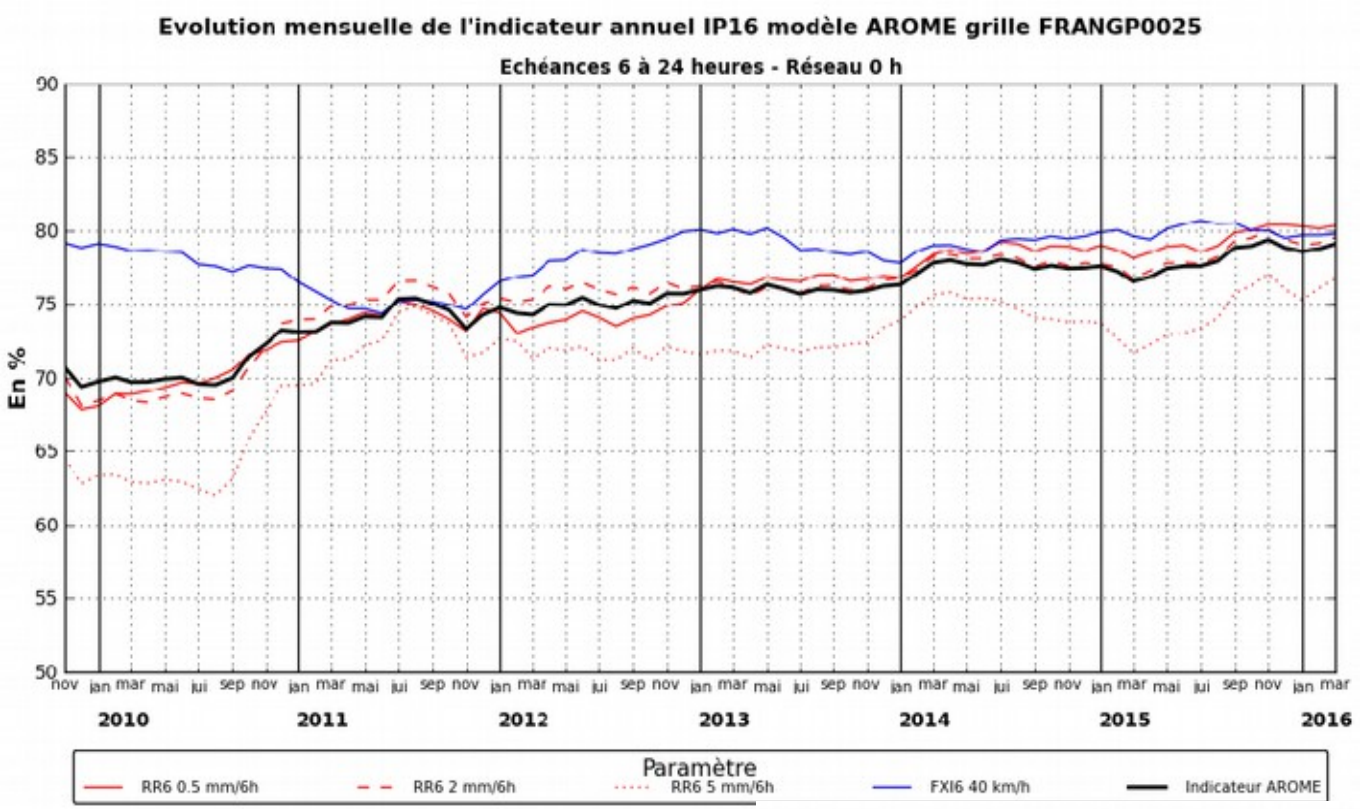
Observations in AROME 3D-Var

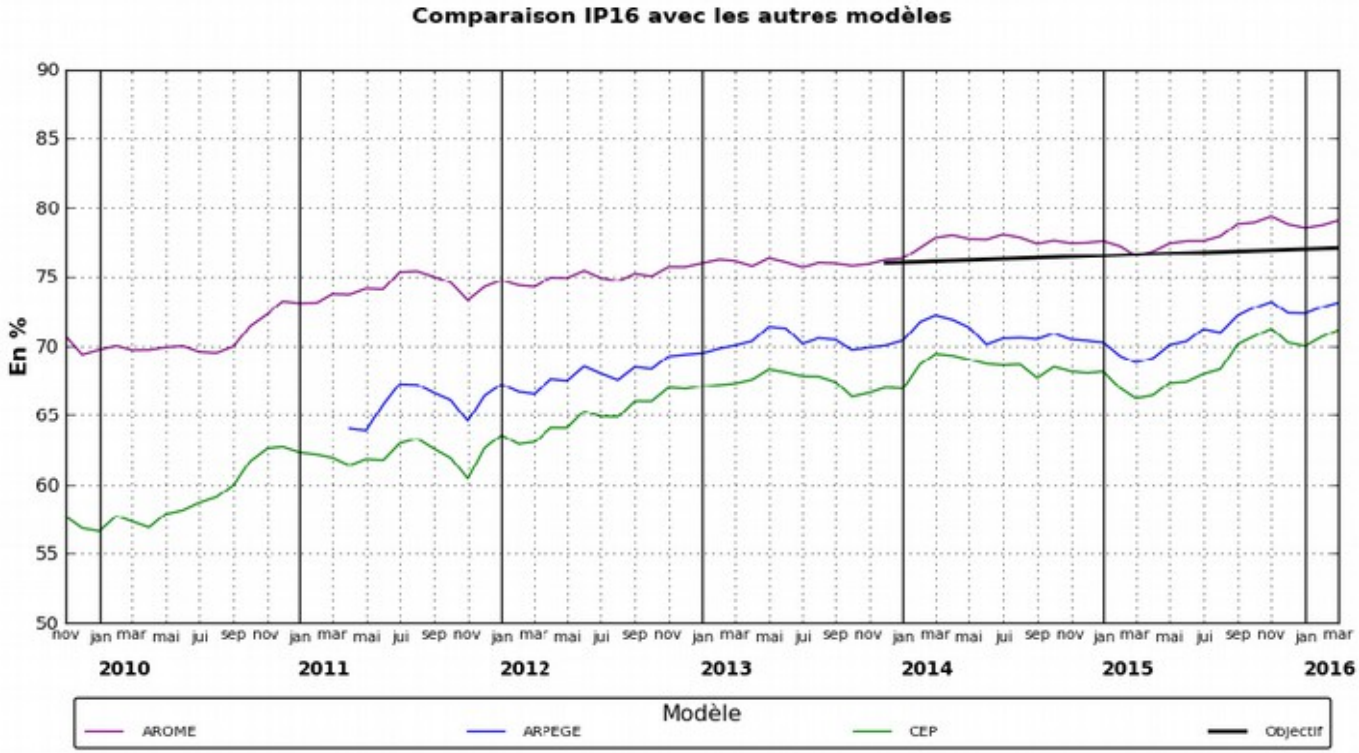
IASI
AIRCRAFTS
SURFACE
RADARS
SEVIRI
ATOVS
TEMP



(H.Benichou)

AROME NWP Index





(DIROP/COMPAS)

Increased density of radar data

- Assimilation of radar data at higher density:

- 8 km inter-distance of radial wind (Vr) and reflectivity pixels assimilated (against 15 km previously)

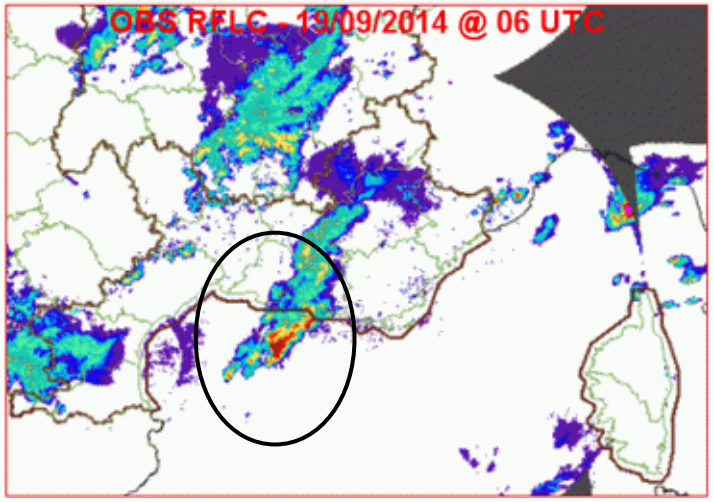
- Revisited Obs Error Stdev for Vr

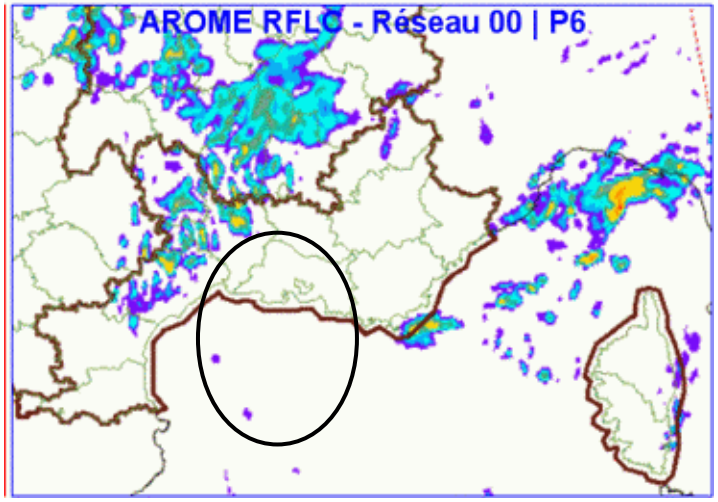
- Retuned parameters for the Bayesian retrieval of RH profiles from reflectivity profiles

☞ these combined changes seem to have a positive effect on the onset of heavy convection in cases where model first guess and radar data have large discrepancies

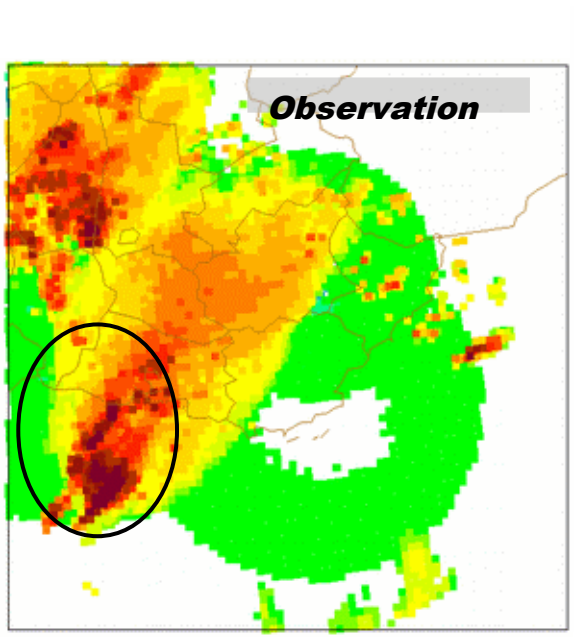
(E. Wattrelot)

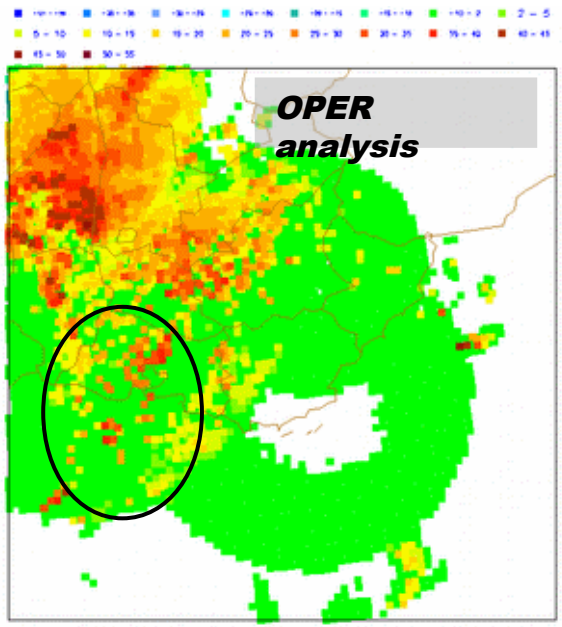
Illustration – Toulon supercell case (19/09/14)

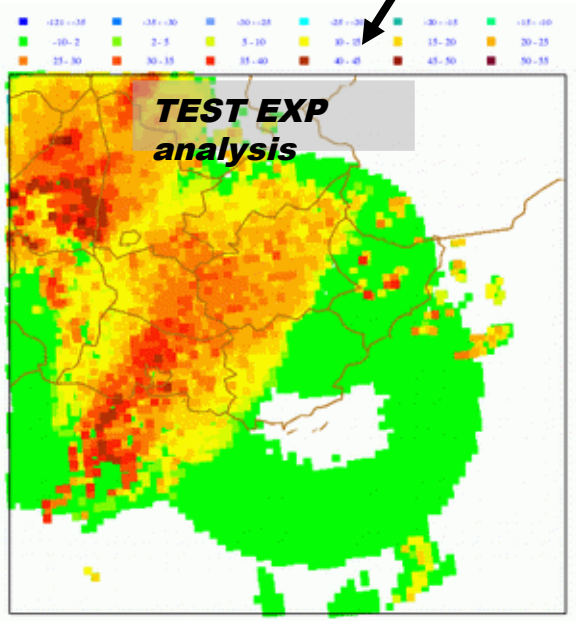




HD radar plus tuning of Sigma_o and tuned param of Refl retrieval







(E. Wattrelot)

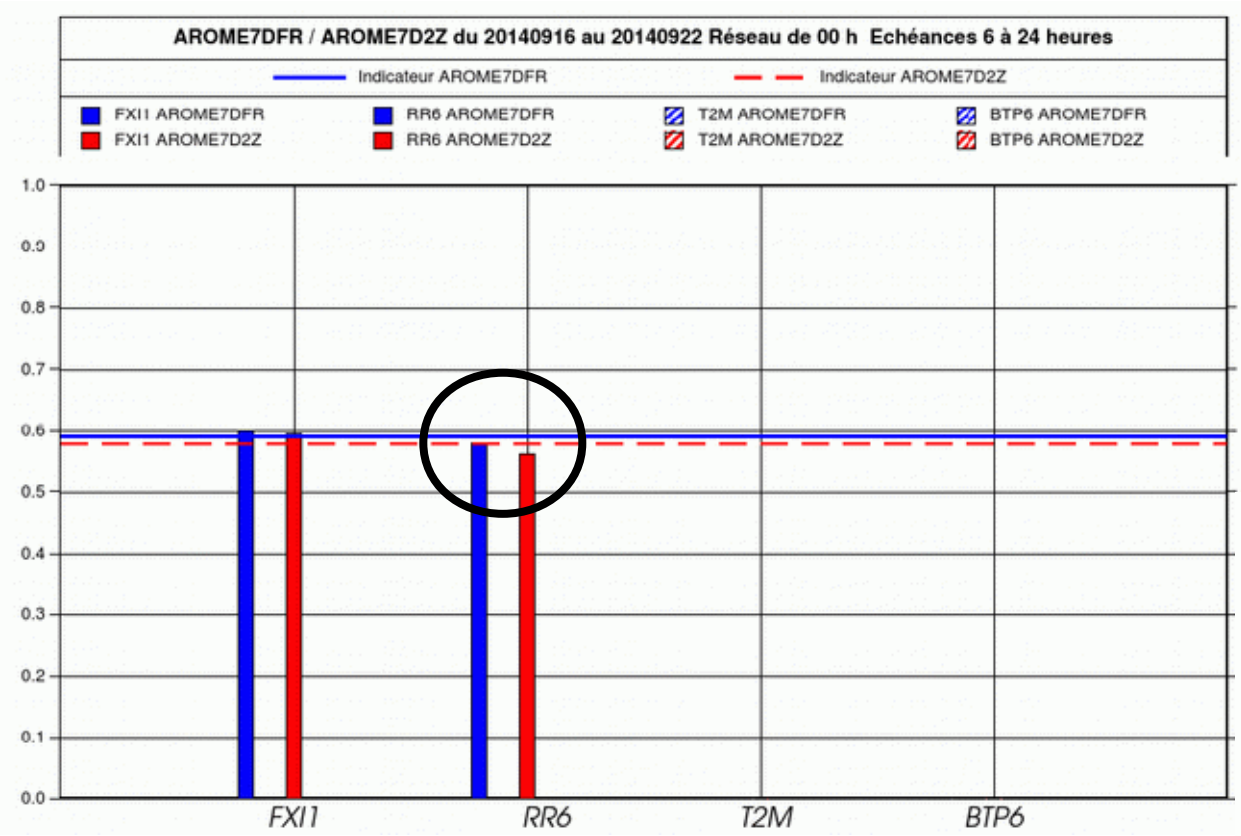
Brier-Skill scores for the 19/09/14 period

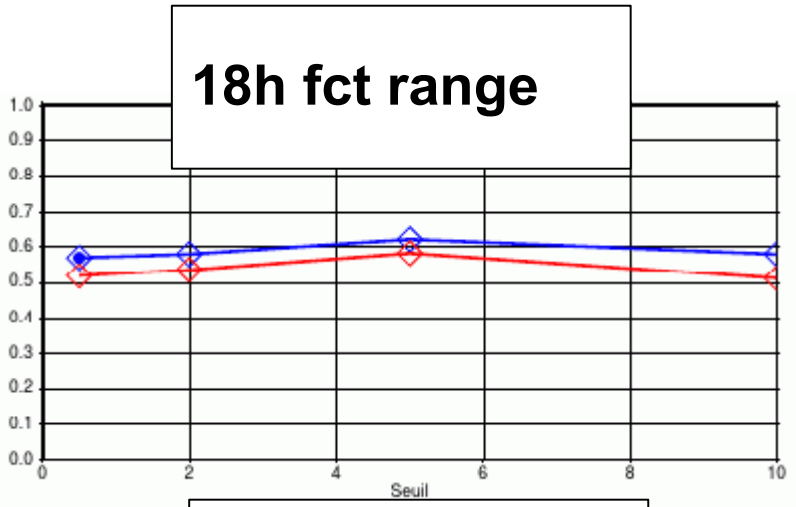
Blue: HD radar

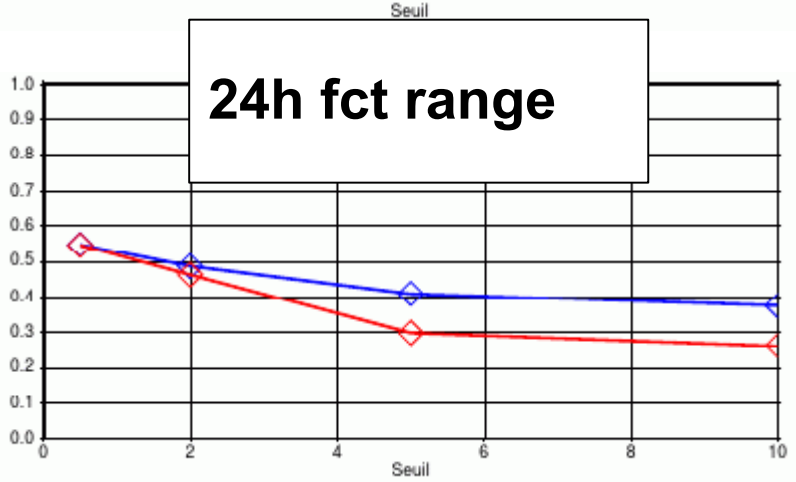
Red: Arome ref oper – 1.3 km

Scores are for the 00 UTC network fcts

Improved BSS for short and mid-term forecast ranges

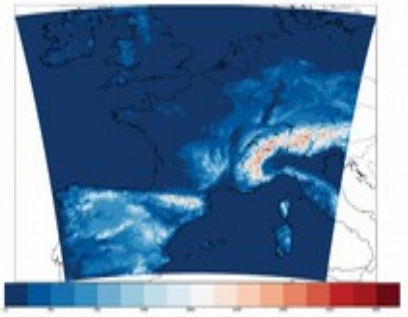




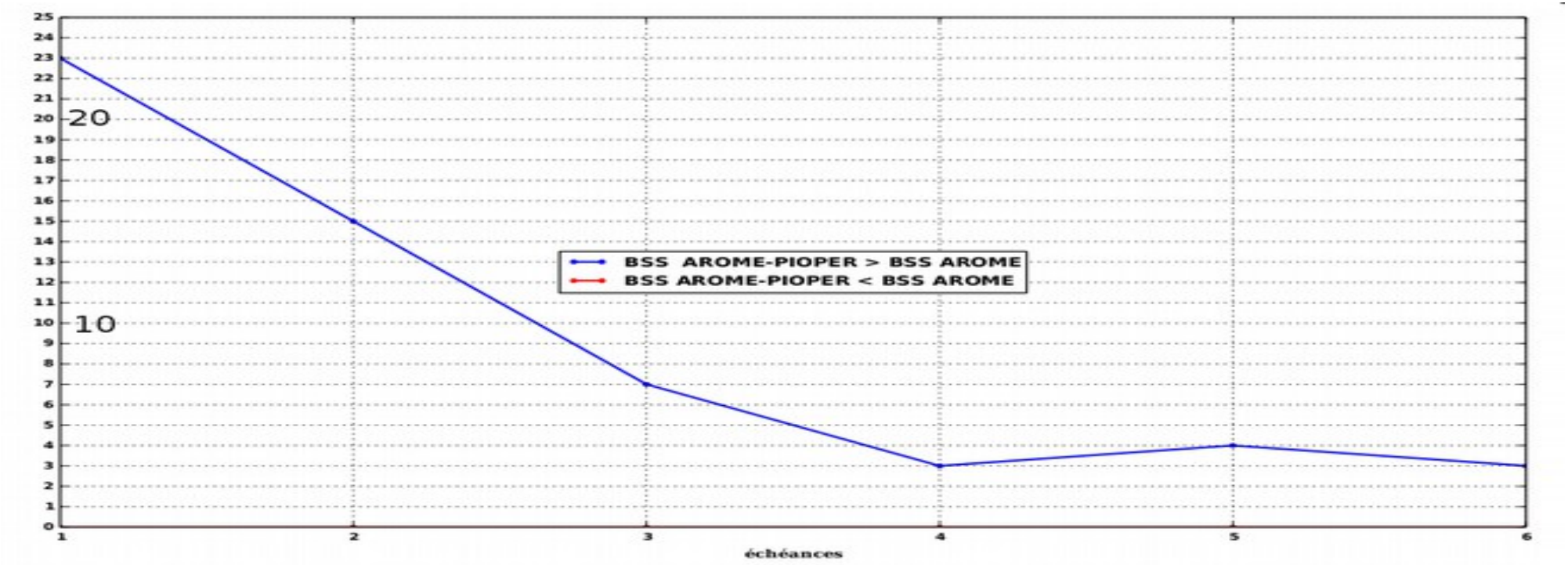


(E. Wattrelot)

AROME Nowcasting



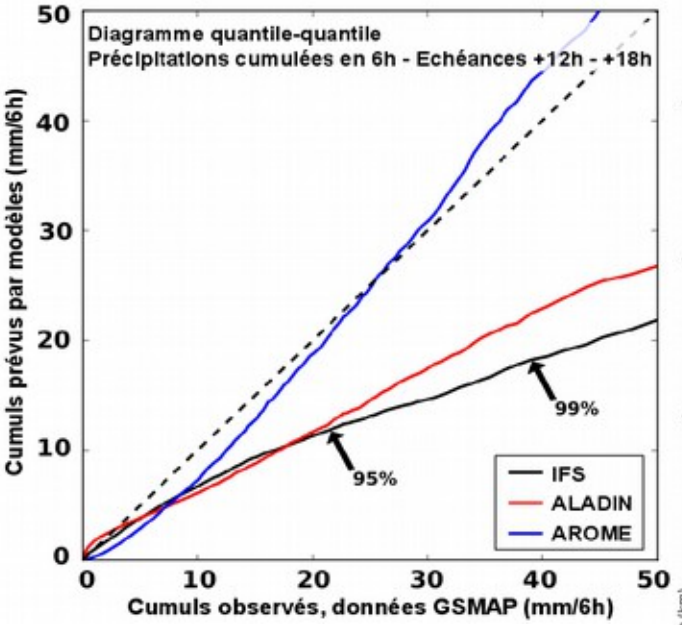
- implemented in December 2015 and available to forecasters since March 2016
- 1 run every hour, up to 6 hour range, with outputs every 15 minutes
- 1,3 km resolution, 90 levels
- 3D-VAR assimilation, with 10 minute cut-off time (window [-10 min, +10 min])
- guess from AROME-France, similar model with 30 minute cut-off time
- boundary conditions from the ARPEGE global model
- delivery 25 minutes after cut-off time
- designed mainly for surface condition forecasting (rainfall, snow, fog, gusts, humidity and cloudiness)

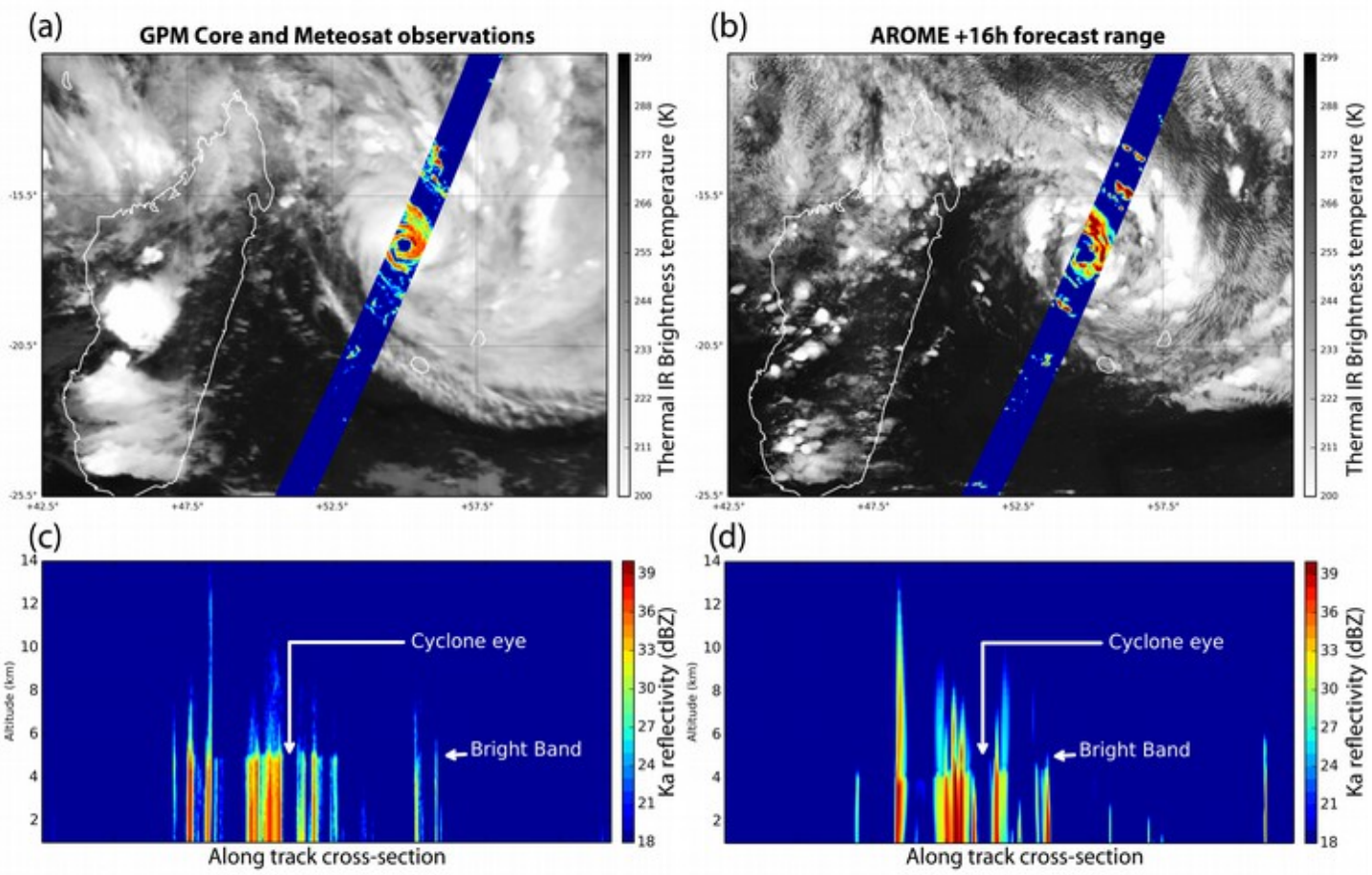


(DIROP/PI)

AROME Overseas

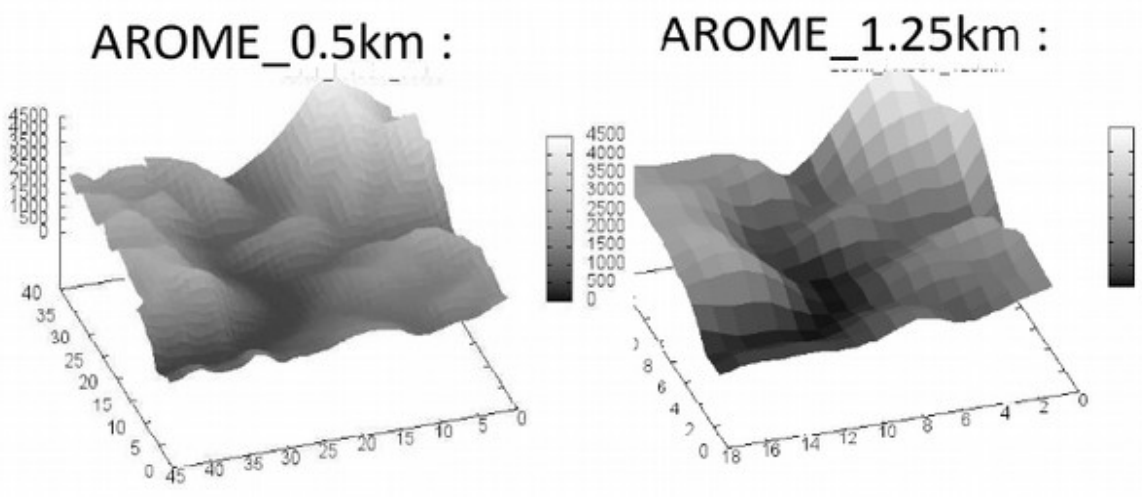
Arome 2.5km L90 in dynamical adaptation coupled with IFS for upperair and Arpege for surface : operational since early 2016

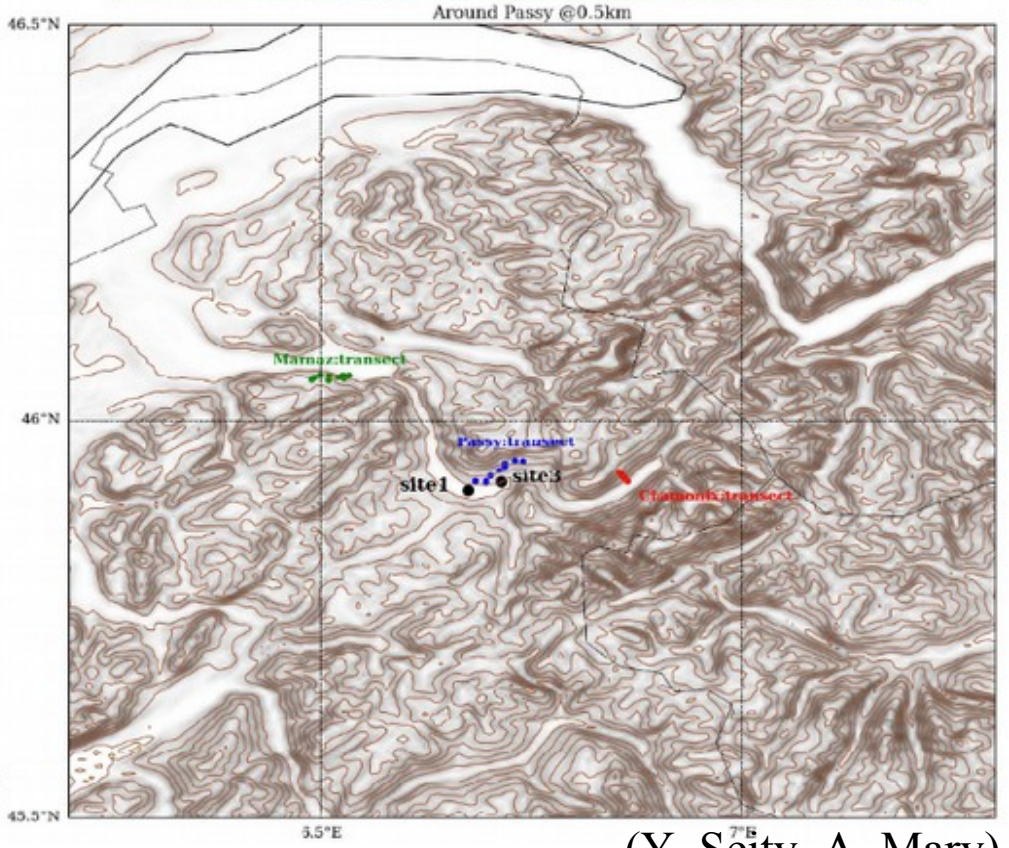




(G. Faure, P. Chambon)

Radiation / Surface interaction over Orography schemes evaluated with PASSY campaign observations





- French field campain to study winter pollution in Chamonix Valley (stable conditions, road trafic + firewood use)
- From January to March 2015.
- 2 POIs : 6-14 Feb and 17-20 Feb.
- Radiation measurments on 2 sites
- 3 Instrumented slopes (T2m, Hu2m) (DECOMBIO Network)
- Others (Scintillometer, Microwave radiometer, Radiosoundings ...)

(Y. Seity, A. Mary)

From 1D to 3D turbulence

Honnert and Masson (2014) suggested 3D turbulence scheme is needed at 500 m. 3D version of CBR exists in Méso-NH. But :

- No 3D scheme in AROME $\Longrightarrow$ technical challenge.
- The 3D version works only in isotropic turbulence : the grey zone is not isotropic.

Quantification of vertical and horizontal K (eddy diffusivity) and L (mixing length) by LES

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

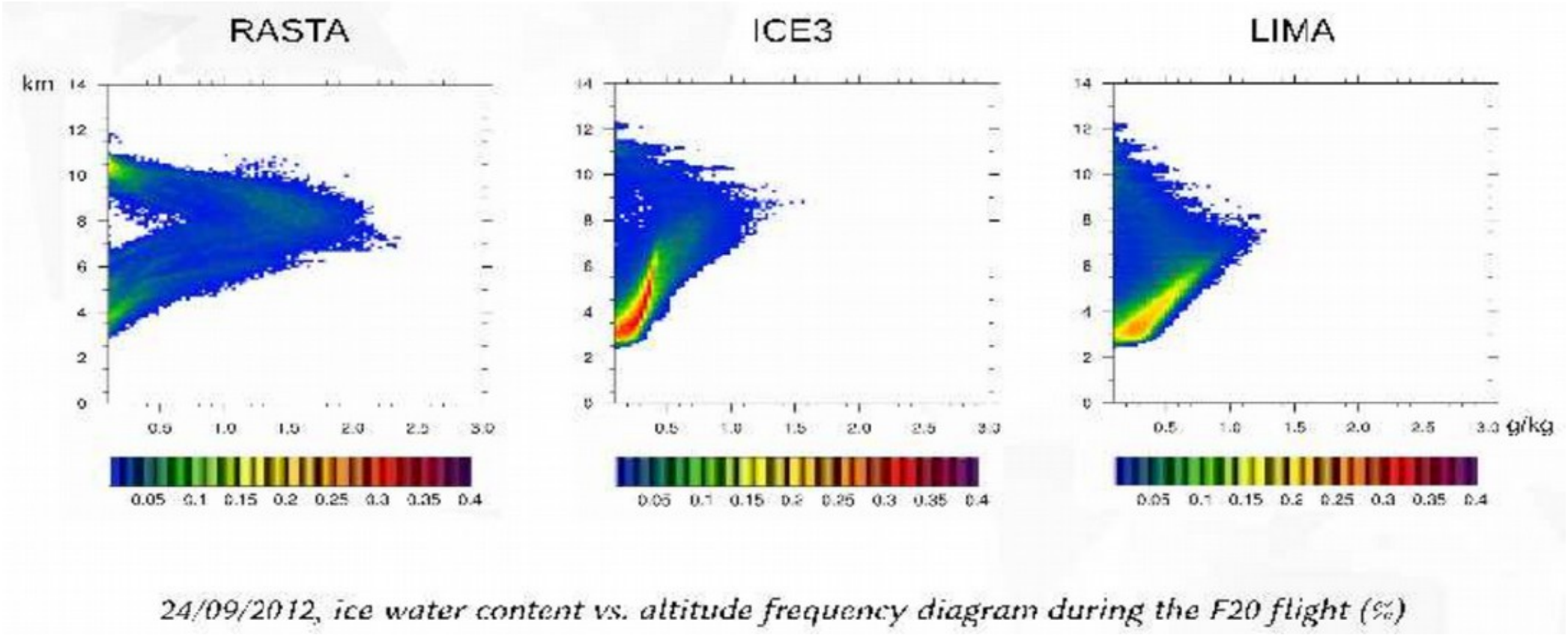
$$K(\Delta x) = \alpha L(\Delta x) \sqrt{e(\Delta x)}$$

Honnert R., Masson V., 2014 : What is the smallest physically acceptable scale for 1D turbulence schemes ? Front. Earth Sci. 2 :27

(R. Honnert)

Microphysics: LIMA 2-moments scheme

Progress in the LIMA scheme validation in MesoNH (using HYMEX observations)



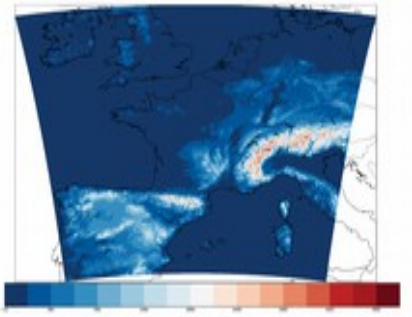
24/09/2012, ice water content vs. altitude frequency diagram during the F20 flight (%)

=> Implementation in AROME as it is in MesoNH

Vié, B., Pinty, J.-P., Berthet, S., and Leriche, M.: LIMA (v1.0): A quasi two-moment microphysical scheme driven by a multimodal population of cloud condensation and ice freezing nuclei, Geosci. Model Dev., 9, 567-586, doi:10.5194/gmd-9-567-2016, 2016.

(B. Vié et al.)

AROME-EPS (pre-operational)



A preoperational convection-permitting ensemble prediction system :

- daily runs since August 2015 in near real time
- real time production in Sept 2016, operational status in Dec 2016
- good evaluations (by scores & forecasters) - main value is in high precipitation & resolution-sensitive events (fog, convection, winter weather...)

Model :

- same as main Arome-1.3km over France
- except horizontal resolution : 2.5km
- production at 9 and 21utc (coupled to 6 and 18utc global PEARP ensemble)
- 12 members at 42-h range

Perturbations :

- initial & boundary conditions from PEARP (members selected by clustering)
- initial condition centered on interpolated Arome-1.4km analysis
- perturbed surface & model physics (SPPT stochastic scheme)

Main uses :

- help human forecasters, with dedicated visualization tools (for convection, high precip, fog, winter weather...)
- (later) automated weather forecast products
- input to other ensemble/probabilistic systems : flood prediction, air quality, customers (energy, wind farms...)

(F. Bouttier, L. Raynaud)