SPECIAL PROJECT PROGRESS REPORT

Progress Reports should be 2 to 10 pages in length, depending on importance of the project. All the following mandatory information needs to be provided.

Reporting year	2016
Project Title:	Assessment of the AROME NWP model at sub-kilometre horizontal resolution over highly orographic terrain (Arome-500)
Computer Project Account:	spfrmary
Principal Investigator(s):	Alexandre MARY
Affiliation:	Météo-France
Name of ECMWF scientist(s) collaborating to the project (if applicable)	Yann Seity Ghislain Faure Claude Fischer Marie-Dominique Leroux David Barbary Ludovic Auger Rachel Honnert
Start date of the project:	Jan 1st, 2015
Expected end date:	Dec 31st, 2016

Computer resources allocated/used for the current year and the previous one

(if applicable)

Please answer for all project resources

		Previous year		**Current year**	
		Allocated	Used	Allocated	Used
High Performance Computing Facility	(units)	14,450,000	~11,000,000	7,000,000	0
Data storage capacity	(Gbytes)	30,000	0	30,000	0

Summary of project objectives

(10 lines max)

This special project aims at addressing by experimental means the properties of AROME for a typical resolution of 500m in mountainous regions both over inland France and over tropical islands (La Réunion or Tahiti). A specific attention will be paid to the four following issues: a) locally steeper slopes; b) 3D effects at surface level; c) adaptation of turbulence schemes at sub-kilometre scale; d) triggering of convection.

Summary of problems encountered (if any)

(20 lines max)

The issue we faced last year with regards to I/O server with AROME was finally solved, but a bit later than expected. Hence, much of the simulations intended to be ran on CCA (especially, experiments about 3D radiative parametrizations at surface level) were meanwhile ran on the Météo France BULL clusters.

Moreover, experiments with regards to triggering of convection on overseas domains have been delayed due to other priorities.

For these reasons, the resources allocated for 2016 have not been used.

Summary of results of the current year (from July of previous year to June of current year)

This section should comprise 1 to 8 pages and can be replaced by a short summary plus an existing scientific report on the project

The main experiments ran on CCA (autumn 2015) concerned adaptation of turbulence schemes at sub-kilometre scale. The results of these experiments are summurized below:

Hectometric resolutions are in the grey zone of turbulence as proved by Honnert et al. (2011). In this range of scale, the coarsest boundary-layer (BL) eddies (BL thermals) are partly resolved and partly subgrid. Thus, there parametrisations in numerical weather prediction (NWP) models at hectometric scale should be scale-aware. AROME BL parametrisation is an Eddy-Diffusivity Mass-Flux (EDMF) : the shallow convection as well as dry BL convection is treated by a mass-flux parametrisation (Pergaud et al., 2009) while the rest of the turbulence is treated by a K-gradient scheme (Cuxart et al, 2000). It has been proved that this mass-flux parametrisation is not adequate to represent the grey-zone thermals (Honnert et al. (2014)) in the grey zone. Pergaud's parametrisation has been modified to be scale-aware at hectometric resolutions.

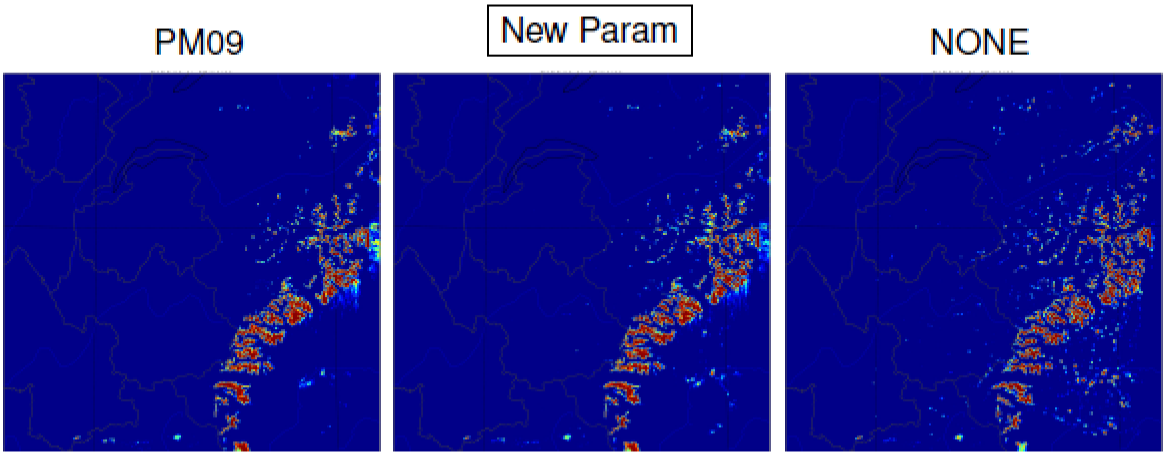
This new version has been tested in AROME at 500 m resolution over the Alps. 11 combinations of the following options of a new parametrisation in the gray zone based on Honnert et al. (2011) have been compared :

- PM09 Pergaud et al. (2009) : the current operational parametrization.
- NONE : switched off mass-flux scheme.
- HRIO : the new version of the mass-flux (without assumptions such as a small thermal fraction or a zero large scale vertical velocity, which are not verified in the grey zone). It is based on a parametrisation of Rio et al. (2008).
- LSAEDKF : A new scale-dependent initialisation of the mass-flux at the surface.
- RANDOM : The use of stochastic parametrisations in the grey zones is commonly justified by the large variance which exists in the responses to one forcing at these scales. A random version of LSAEDKF, based on Honnert et al. (2014).
- BLH/LUP : determination of the thermal height from the BL height (BLH) or from the upward part of the Bougeault-Laccarère mixing length (LUP) at the surface (Bougeault and Lacarrère, 1989).

The dynamical environment of these parametrization test has been proposed by Karim Yessad from the AROME version cy40.

General

In general, the new version of the scheme provide BL characteristics intermediate between the OPER and a version without mass-flux parametrization. In this matter, it reproduces well the behaviour of a half-parametrize thermal.



The thermal height

Contrary to tests in previous idealised cases, there is no real differences between LUP and BLH. It can be explained by the fact that the BL height is diagnosed from the TKE instead of the buoyancy flux. But LUP is easier to implement and use and it actually represent the thermals height which is more consistent with theoretical studies (Honnert et al. (2011, 2012)).

Randomisation or not randomisation

While there is no real differences between RANDOM and LSAEDKF at 1.3 km resolution, at 500~m resolution, RANDOM is colder (until 1K) than LSAEDKF

Bibliography :

Bougeault, P., et P. Lacarrère, 1989, Parametrisation of orography-induced turbulence in a mesobeta-scale model, Mon. Wea. Rev., 117, 1872–1890, 1989.
Cuxart C, Bougeault P, Redelsperger JL (2000). A turbulence scheme allowing for mesoscale and large-eddy simulations. Quart. J. Roy. Meteor. Soc., 126 :1–30.
Honnert, R., V. Masson, et F. Couvreux, 2011, A diagnostic for evaluating the representation of turbulence in atmospheric models at the kilometric scale., J. Atmos. Sci., 68, 3112–3131, 2011
HONNERT, R. and V. MASSON, 2014 : What is the smallest physically acceptable scale for 1D turbulence schemes ? Front. Earth Sci. 2 :27. doi : 10.3389/feart.2014.00027
HONNERT, R., F. COUVREUX. and V. MASSON, 2016 : Sampling the structure of convective turbulence and implications for grey-zone parametrizations. Boundary-layer Meterol.
Pergaud J and V. Masson and S. Malardel and F. Couvreux(2009)A parametrisation of dry thermals and shallow cumuli for mesoscale numerical weather prediction. Boundary-Layer Meteorol.132 :83-106
Rio, C., et F. Hourdin, 2008, A thermal plume model for the convective boundary layer : Representation of cumulus clouds, J. Atmos. Sci., 65, 407–425, 2008.

List of publications/reports from the project with complete references

Summary of plans for the continuation of the project

(10 lines max)