FINAL REPORT PROGRAM LEFE

Program LEFE/ IMAGO	Project DEPHY2	Year 2017

Marie-Pierre LEFEBVRE (CNRM/LMD), mpllmd@lmd.jussieu.fr
Catherine RIO (CNRM), Catherine.Rio@meteo.fr
Laboratories: CNRM, GET, IPSL, LA, LadHyX, Latmos, LEGOS, LGGE, LMD, LSCE, Metis

Contribution to:
International projects: AMMA, GASS, CMIP, CFMIP
ANR projects: CALVA, APRES3, COCOA, HIGH-TUNE
Other funding sources : None

Context : DEPHY2 (2014-2017) is the second phase of the LEFE DEPHY project (2010-2013) which objective is to improve the physical parameterizations of atmospheric processes in French weather forecast and climate models. 2017 was dedicated to the finalization of ongoing work and the preparation of the next phase of the project.

Objectives / scientific questions :

- Promote collaborations between observations, high resolution modelling, numerical forecast and climate modelling communities.
- Promote and coordinate the common development of codes, tools and methodologies within the French community of model developers.
- Improve physical parameterizations and performances of weather forecast and climate projections.

Main results :

Main achievements of the whole DEPHY2 project concern:

- The development of new schemes for turbulence, convection and clouds: Turbulent Kinetic Energy models for stable and very stable boundary layers, mass-flux schemes for the convective boundary layer, a new unified convection scheme, a cold pool parameterization, a bi-gaussian scheme for shallow clouds, a two-moment microphysics scheme.
- The improvement of atmosphere/surface coupling based on systematic comparisons between models and in-situ observations: Dôme C, Sirta, Meteopole-flux, AMMA-Catch (see example in figure 2).
- The production of LES simulations of shallow and deep convection (Giga-LES for Hector the Convector), of CRM runs at the continental scale, and of new methodologies to identify coherent structures such as updrafts, downdrafts, cold pools or convective systems within such simulations (see example in figure 1).
- The reduction of some of the systematic biases of atmospheric models: underestimation of low-level clouds, SST warm biases on the eastern side of tropical oceans in climate models, too early peak of continental rainfall, underestimation of intra-seasonal variability.
- Interactions within the framework of DEPHY led to several accepted ANR projects such as CALVA and APRES3 (clouds and precipitation in Antarctica), HighTune (model tuning) and COCOA (ocean/atmosphere fluxes).

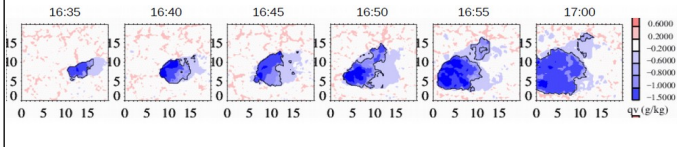

Figure 1: Cold pool evolution under a convective system over Niamey as simulated by a LES simulation

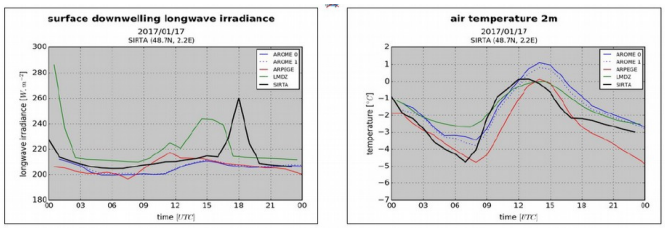

Figure 2: Comparison of surface downwelling longwave radiation and surface temperature between models and SIRTA observations

Figure 1: Application of the tracking algorithm TOOCAN (Fiolleau and Roca, 2013) to detect cold pools within an LES simulation of a convective system initiated over Niamey performed with MESONH: the deficit of qv in the first model layer is used to detect and follow cold pools identified by the black line. Cold pools properties can the be used to evaluate the cold pool parameterization implemented in LMDZ.

Figure 2: Evaluation of D+1 forecast performed with ARPEGE, AROME and LMDZ models against SIRTA observations (quick looks available on http://observations.ipsl.fr/espri/cosydata/). Such systematic comparisons are also available with Météopole Flux data in Toulouse.

Future of the project : A specific meeting was organized in 2017 to discuss the form and content of the next phase of the project. As suggested by the LEFE program we proposed the creation of a GDR to ensure the continuity of DEPHY activities over the long term, covering three scientific themes: turbulence and surface coupling, transport and cloud/radiation interactions, and one transversal axis : the reduction of model systematic errors.

Number of publications, communications and thesis

Number of publications: 17

Number of communications:

+ 16 communications during the DEPHY session at “Ateliers de Modélisation de l’Atmosphère” in Toulouse in February 2017

+ 50 communications during the workshop “From Dephy2 to Dephy3” organized in Banyuls in May 2017

Number of thesis (*started or defended in 2017*): 7

Maximum 5 publications directly linked with the project

Bouniol D, Roca R, Fiolleau T (2017): Macrophysical, Microphysical, and Radiative Properties of Tropical Mesoscale Convective Systems over Their Life Cycle, J Clim, 29, http://dx.doi.org/10.1175/JCLI-D-15-0551.1

Hourdin , Mauritsen, T., Gettelman, A., Golaz, J.-C., Balaji, V., Duan, Q., Folini, D., Ji, D., Klocke, D., Qian, Y., Rauser, F. Rio, C. Tomassini, L., Watanabe, M. and Williamson, D. 2017, The art and science of climate model tuning, BAMS, https://doi.org/10.1175/BAMS-D-15-00135.1

Marquet P., Maurel W. and Honnert R. (2017c). On consequences of measurements of turbulent Lewis number from observations. WGNE Blue Book publication

Rodier Q, Masson V, Couvreux F, Paci A, 2017: Evaluation of a buoyancy and shear based mixing length for a turbulence scheme in revision for Frontiers, 5, 65. doi: 10.3389/feart.2017.00065

Vignon E., Hourdin F., Genthon C., Gallée H., Bazile E., Lefebvre M.-P., Madeleine J.-B., van de Wiel B. J.H.(2017a). Antarctic Boundary Layer parametrization in a General Circulation Model: 1D simulations facing summer observations at Dome C. J Geophys Res, 122 (13): 6818-6843. doi:10.1002/2017JD026802

Page 3: Informations à destination des instances LEFE uniquement (ne seront pas rendues publiques)

Nombre d'ETP mobilisés par le projet: 50

Montant du financement LEFE: 16,4k€

Avenir du projet (ANR, européen, … ?) : Création d'un GDR

Quel impact ce projet a-t-il eu sur la communauté (structuration, innovation ?, …)?

- **Partage d'outils** autour de la simulation de cas d'étude dans la version uni-colonne des modèles (format commun de fichiers de forçage des modèles, format commun de fichiers de sortie et outil de comparaison des modèles).
- **Rapprochement entre la communauté des modèles haute résolution et celles des modèles de prévision et de climat**: Réalisation de simulations LES/CRM de cas de convection et développement d'algorithmes permettant de détecter et caractériser dans les simulations haute résolution l'équivalent des structures que l'on cherche à paramétriser (détection des ascendances convectives, des poches froides, suivi des systèmes, ...)
- **Rapprochement entre la communauté de l'observation et celles des modèles de prévision et de climat**: Comparaisons des modèles avec les données des sites d'observations sur de longues périodes, mise en place de comparaisons systématiques entre les prévisions des modèles à J+1 (ARPEGE, AROME, LMDZ) et les observations sur sites (SIRTA, Meteopole-Flux).
- **Participation des modèles de climat français aux exercices CMIP**: Physique atmosphérique du modèle de l'IPSL complètement revisitée pour CMIP5, nouveaux schémas de turbulence et de convection dans le modèle du CNRM pour CMIP6.