FINAL REPORT PROGRAM LEFE

Program LEFE/ IMAGO	Project Title GABLS4	Years 2015-2017

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Context: Accurate surface fluxes and vertical profiles in stable boundary layer are still a challenge for many Numerical Weather Prediction (NWP) or climate models despite of several improvements done in the PBL parameterization since the first GABLS exercise (Cuxart et al 2006). Significant biases at the surface over land and especially over snow are often reported (Holtslag et al 2013) .

Objectives: The GABLS4 case aims at studying the interaction between the boundary layer and the surface in strong stability and during the diurnal transition focussing on the decrease of the turbulence. For those topics, several models (Single Column Model (SCM), Snow models and Large Eddy Simulation) intercomparison have been organized for a selected ("golden") day based on the boundary layer and surface observations at Dome-C on the Antarctic Plateau.

Main results: For the NWP models, since the first exercise in 2006 the simulation of the low level jet for the stable case is improved for many models thanks to the use of a 1.5 order scheme (TKE) such as in ARPEGE (Météo-France) or in the Canadian model. However, the height of the first level must be below 3m with a fine vertical grid. For the LES, to reduce the differences or the uncertainties in the LES results it is necessary to use a resolution about 1meter for the horizontal and the vertical

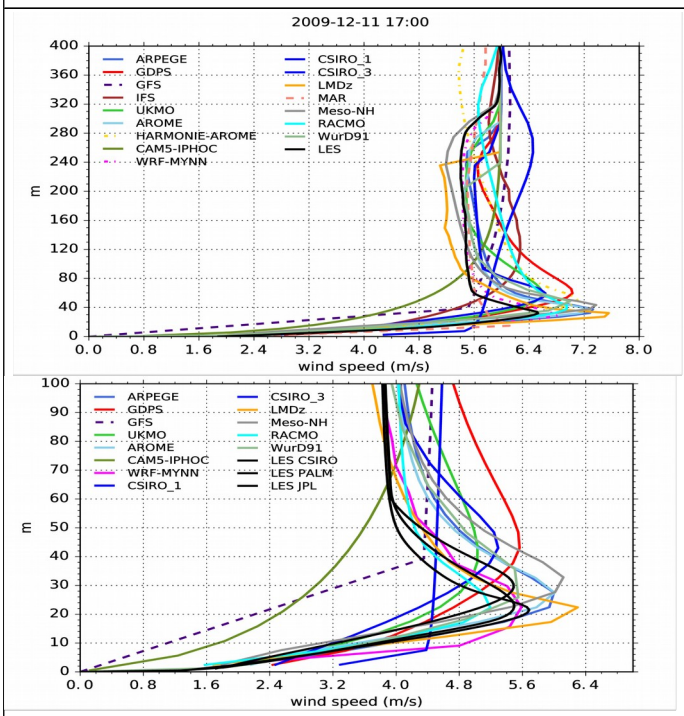

Fig1: vertical wind profile at 17UTC for the real case (top) and for the "ideal" case (bottom)

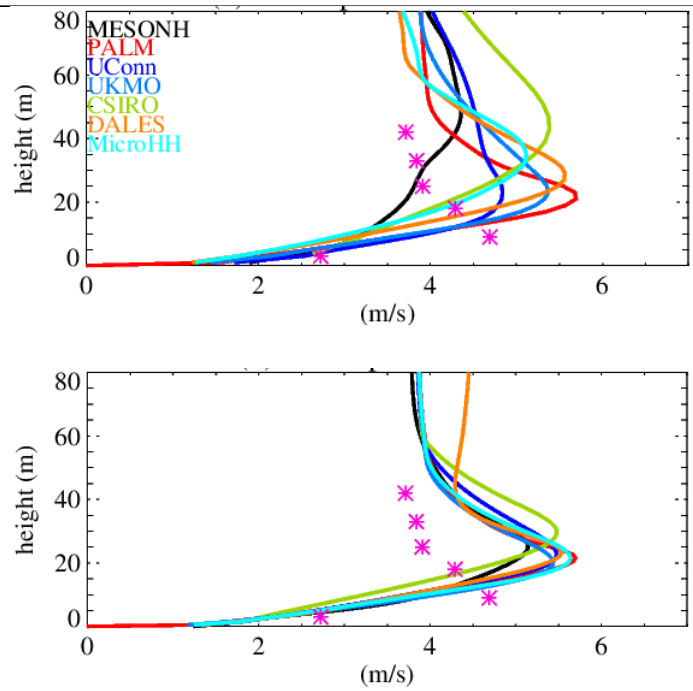

Fig2: vertical wind profile at 17TU for the LES with a dx=5m (top) and with dx=1m (bottom). Wind speed observations: magenta cross

Fig1 (top) shows the vertical wind speed for the Single Column Model at 17h for the real case. For many models, the height of the Low level Jet (LLJ) is located below 40m above the surface in good agreement with the LES in full black line even if the maximum wind speed is over estimated. However, despite of the fine vertical grid some models such as ECMWF, CSIRO over estimates the mixing and are not able to simulate the LLJ. Fig2 shows

the impact of the increase of the resolution for the LES models on the “ideal” or “simplified” case (the simplified case was used by nine LES) from the 5m (Fig2, top) to 1m resolution (Fig2, bottom), the spread among the LES is significantly reduced with a height for the LLJ about 20m for a maximum wind speed about 5m/s. The SCM models also simulate this “ideal” case (Fig1 bottom), the differences between the “real” case and the “ideal” case are very small with a similar general behaviour among the SCM. In general, the SCM over estimates the maximum wind speed by 1m/s. The height of the LLJ is in good agreement with the LES (Dx=1m) for some SCM such as AROME, ARPEGE, LMDz and WRF around 20/30m.

The near future for GABLS4 is to finish the related publications (at least two, one for the SCM results and for the LES) and to provide all the results: LES data, SCM data and observations. The future of GABLS exercise has been discussed during the last GABLS4 workshop in September 2018 and the boundary layer community (observation, LES and NWP) would like to continue with a GABLS5 may be focussed on the polar night.

Cuxart, J., and Coauthors, 2006: Single-column model intercomparison for a stably stratified atmospheric boundary layer. *Bound.-Layer Meteorol.*, **118**, 273–303, doi:10.1007/s10546-005-3780-1.

Holtslag, A. A. M., and Coauthors, 2013: STABLE ATMOSPHERIC BOUNDARY LAYERS AND DIURNAL CYCLES Challenges for Weather and Climate Models. *Bull. Am. Meteorol. Soc.*, **94**, 1691–1706, doi:10.1175/BAMS-D-11-00187.1.

Nombre de publications, de communications et de thèses

2014: GABLS4: An Intercomparison Case to Study the Stable Boundary Layer Over the Antarctic Plateau. GEWEX Newsletter Vol. 24 No. 4, November 2014. E. Bazile, F. Couvreux, P. Le Moigne, C. Genthon, et al.

2015 : First Workshop on the GABLS-4 Intercomparison Météo-France, Toulouse, France 20–22 May 2015. GEWEX Newsletter Vol. 25 No. 3, August 2015 Eric Bazile, Fleur Couvreux, Patrick Le Moigne and Christophe Genthon

2016 : Momentum and heat flux parametrization over the Antarctic Plateau: a sensitivity study Vignon E., Genthon C., Barral H., Amory C.,Picard, G., Gallée H., Casasanta G., Argentini S Boundary-Layer Meteorol.,Volume 162, issue2, pp 341–367, doi:10.1007/s10546-016-0192-3 Stable boundary layer regimes at Dome C, Antarctica: observation and analysis

2017 : The extreme atmospheric boundary layer over the Antarctic Plateau and its representation in climate models, E. Vignon, PhD thesis defended on October, 10th 2017.

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