GEWEX Convection-Permitting Climate M


4-6$^{th}$ Sep 2018, Boulder, USA

# Sensitivity tests on CORDEX FPS Convection permitting WRF configuration

L. Fita[1], S. Bastin[3], J. Polcher[2], E. Katragkou[5], T. M. Giannaros[6], R. Pennel[2], T. Arsouze[2,4]

[1]CIMA, CONICET-UBA, CNRS UMI-IFAECI, Argentina, [2]LMD, IPSL, CNRS, É. Poly., France, [3]LATMOS, IPSL, CNRS, France, [4]ENSTA ParisTech, France, [5]AUTH, Greece, [6]NOA-IERSD, Greece

Centro de Investigaciones del Mar y la Atmósfera (CIMA), CONICET-UBA, CNRS UMI-IFAECI

http://www.cima.fcen.uba.ar contact:lluis.fita@cima.fcen.uba.ar

## CORDEX FPS Alps

The CORDEX Flag ship Pilot study on convective permitting climate simulations over the Alps, is designed as a proof of concept of the challenges and opportunities of convection permitting simulations for climate studies. 33 different institutions from Europe coordinate a simulating experiment with different RCMs in a common domain

A first phase devoted to understand model uncertainty was designed to perform 2 sets of simulations of 3 case studies: *Austria*, *IOP* and *Foehn* in two experimental set-ups: Weather-like (**WL**, short runs [4-6 days]) and Climate-like (**CL**, long runs [1-month]).

E. Coppola et al., 2018: *A first-of-its-kind multi-model convection permitting ensemble for investigating convective phenomena over Europe and the Mediterranean*, Clim. Dyn., **under revision**

Additional simulation tests on IOP case study (2012 Oct. 23-29th) in WL mode with 'BE' configuration with WRF3.8.1:

| micro-phys | rad lw/sw | sfclay | surface | pbl | cu | shcu |
|---|---|---|---|---|---|---|
| Thompson aer.-aware (28) | RRTMG (4) | MYNN (5) | Noah-MP (4) | MYNN2 (5) | Grell-Freitas (3) | Park and Bretherton (2) |

These simulations are prepared to show uncertainty in model configuration

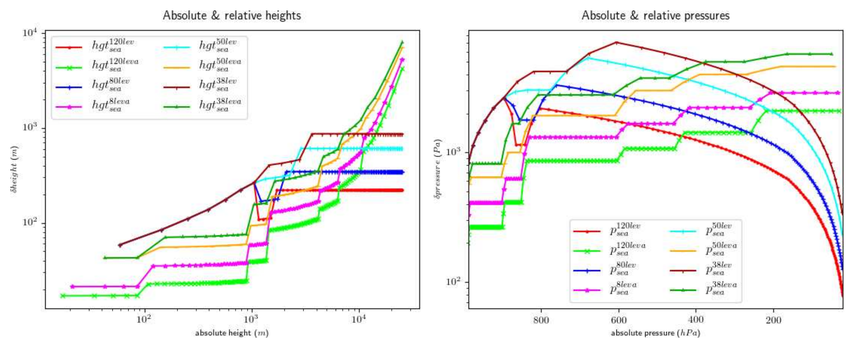
Experiments are analyzed from the scope of the new WRF-CORDEX module

## Additional experiments

**vertical resolution**

Model WRF runs are done at 50 vertical levels following WRF standard level distribution. 3 Additional vertical discretization: 120, 80 and 38 is tested. Also a new level generic distribution is proposed based in percentages of levels at different ranges. 2 simulations for each set of vertical levels is done: (1) standard WRF distribution, (2) assigned by % distribution

| | |
|---|---|
| $p_{sfc}$ - 975 hPa | 4 % |
| 975 - 900 hPa | 28 % |
| 900 - 850 hPa | 10 % |
| 850 - 600 hPa | 25 % |
| 600 - 450 hPa | 12 % |
| 450 - 250 hPa | 12 % |
| 250 - $p_{top}$ | 9 % |



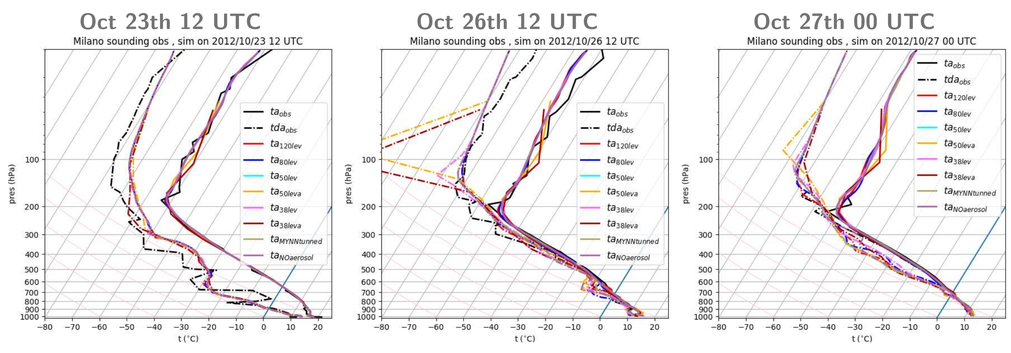

**NO aerosol-effects**

Model configuration without direct/indirect aerosol effects.

**PBL tunning**

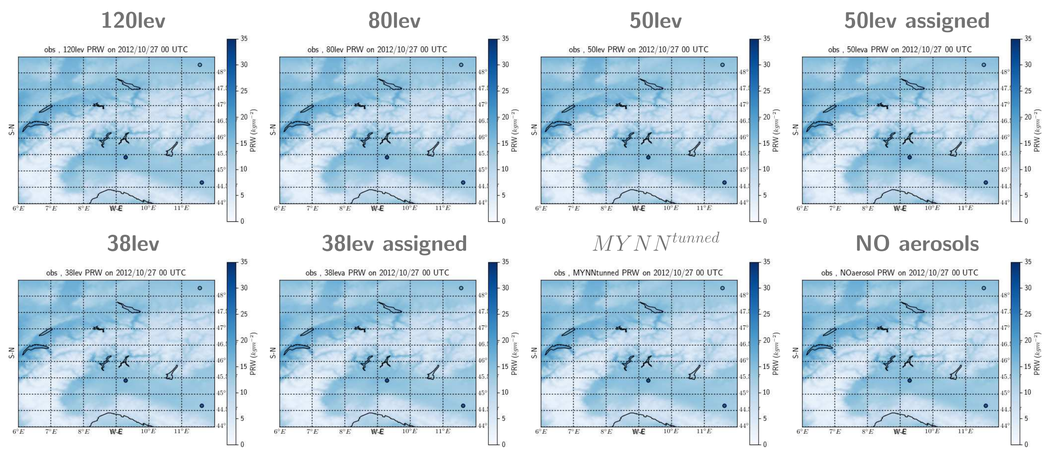
Model set-up uses MYNN 2.5 PBL scheme. Some extra refinements are also tested in this run.

## Soundings: Milano




- Larger differences on tda and growing with height
- Simulations at $\simeq$ 3 $km$, soundings should take into account displacement of weather balloon?

## Environment: prw on 2012 Oct 27 at 00 UTC




- Small differences among different model set-ups
- Small differences with respect observations

## Acknowledgements

The contributions from L. Fita are funded by project European Climate Prediction System (EUCP) Funded by the European Union under Horizon 2020, Grant Agreement 776613. Also funded by the CORDEX IPOC. For the module CORDEX-WRF authors wish to thank all the coders of WRF, LMDZ, ORCHIDEE for their work on the developing and maintaining of the models. M. A. Jiménez from Universitat de les Illes Balears (UIB) is acknowledged by her explanations on certain PBL calculations. J. Milovac from U. Hohenheim for her comments is also acknowledged. D. Argüeso from UIB. G. Sofiadis from U. Thesaloniki, T. Lorenz from Uni Research, the Bjerknes Centre and J. Milovac from U. Hohenheim for their assistance in the additional tests. V. Galligani, J. Ruiz and M. Sebastián from CIMA. All the development of the module has been carried out in the CIMA 'hydra' cluster, L. Fita thanks the IT support for their work. Sounding data was obtained from U. Wyoming data portal. This work was performed using HPC resources from GENCI- [TGCC/CINES/IDRIS] (Grant 2018-A0030106877). All figures have been done with python's matplotlib package and full set of scripts are available under PyNCplot suite: http://www.xn-llusfb-5va.cat/python/PyNCplot

## WRF-CORDEX module

A new module designed to meet CORDEX output requirements has been implemented in WRF model, which computes variables whilst model integration

http://wiki.cima.fcen.uba.ar/mediawiki/index.php/CDXWRF

Grouped by layers: Core, Tier and additional. Managed by pre-compilation flags in order to do not overload WRF performance. Defintion of variables from: WRF, LMDZ GCM (http://lmdz.lmd.jussieu.fr/), literature, author's knowledge Inclusion of a new namelist section cordex& and a new output file auxhist9

- **Core:** lon, lat, cltmean, cllmean, clmmean, clhmean, mrso, prw, psl, clwvi, clivi, hurs, huss, slw, uas, vas, wsgsmax, usgsmax, vsgsmax, totwsgsmax, totugsmax, totvgsmax, wsz100max, uz100max, vz100max, sund, tauu, tauv, tauugen, tauvgen, rsds, rlds, hfls, hfss, rsus, rlus, rsusgen, rlusgen, evspsbl, evspsblpot, cd, cdgen, snc, snd, mrros, mrro, mrsol, pr, prl, prc, prsh, prsn, snw, rsdt, rsut, rlut, ps, ts
- **Tier:** clivg, clivh, zmla, [cape/cin/zlfc/plfc/lidx]{min/max/mean} (with parameter convxtrm_diag = 1)
- **Additional:** ua, va, ws, ta, press, zg, hur, hus, tfog, fogvisbltymin, fogvisbltymax, fogvisbltymean, tdsmin, tdsmax, tdsmean and the Water-Budget related ones (with parameter wb_diag = 1): wbacdiabh, wbacpw, wbacpw[c/r/s/i/g/h], wbacf, wbacf[c/r/s/i/g/h], wbacz, wbacz[c/r/s/i/g/h], wbacdiabh{l/m/h}, wbacpw{l/m/h}, wbacpw{l/m/h}[v/c/r/s/i/g/h], wbacf{l/m/h}, wbacf{l/m/h}[v/c/r/s/i/g/h], wbacz{l/m/h}, wbacz{l/m/h}[v/c/r/s/i/g/h]

Some variables introduced as **'generic'** compilation of diagnostics in order to be scheme/model-independent allowing proper inter comparisons: ta[u/v]gen, rsusgen, rlusgen, cdgen, zmla

Model performance changes accordingly to pre-compilation flags, the namelist option and variables to be computed:

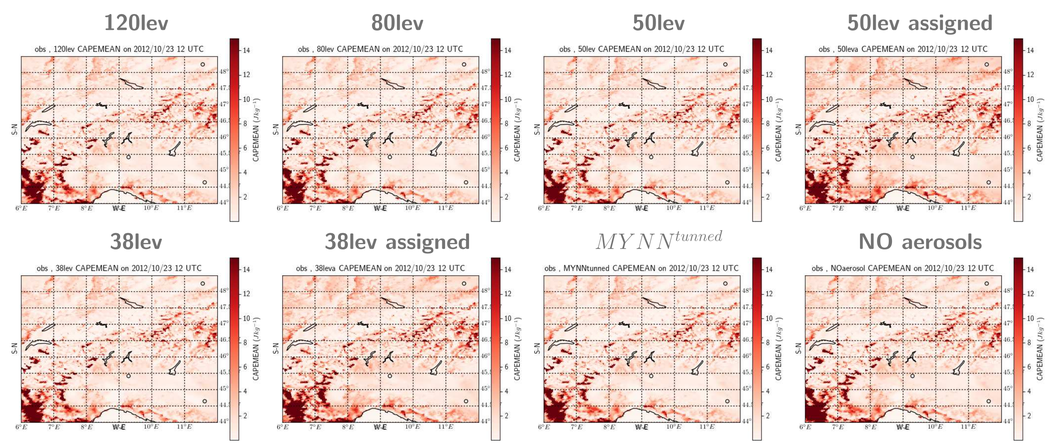
| | | ifort | | gcc | |
|---|---|---|---|---|---|
| **label** | **description** | $< t_{step} >$ (s) | gain (%) | $< t_{step} >$ (s) | gain (%) |
| v381orig | original WRF 3.8.1 | 2.4248 | - | 3.5174 | - |
| NOCDXWRF | without CDXWRF | 2.5058 | 3.34 | 3.6486 | 3.73 |
| CDXWRF1 | CDXWRF=1 | 2.6938 | 11.09 | 3.5070 | -0.27 |
| CDXWRF2 | CDXWRF=2 | 4.8296 | 99.17 | 5.9958 | 70.46 |
| CDXWRF2_00 | CDXWRF=2 wb_diag=0 & convxtrm_diag=0 | 4.2038 | 73.37 | 5.0736 | 44.24 |
| CDXWRF2_01 | CDXWRF=2 wb_diag=0 & convxtrm_diag=1 | 4.2388 | 74.81 | 5.4120 | 53.86 |
| CDXWRF2_10 | CDXWRF=2 wb_diag=1 & convxtrm_diag=0 | 4.8510 | 100.06 | 5.7534 | 63.57 |

An article will be submitted soon to Geophysical Model Development

Pending improvements:

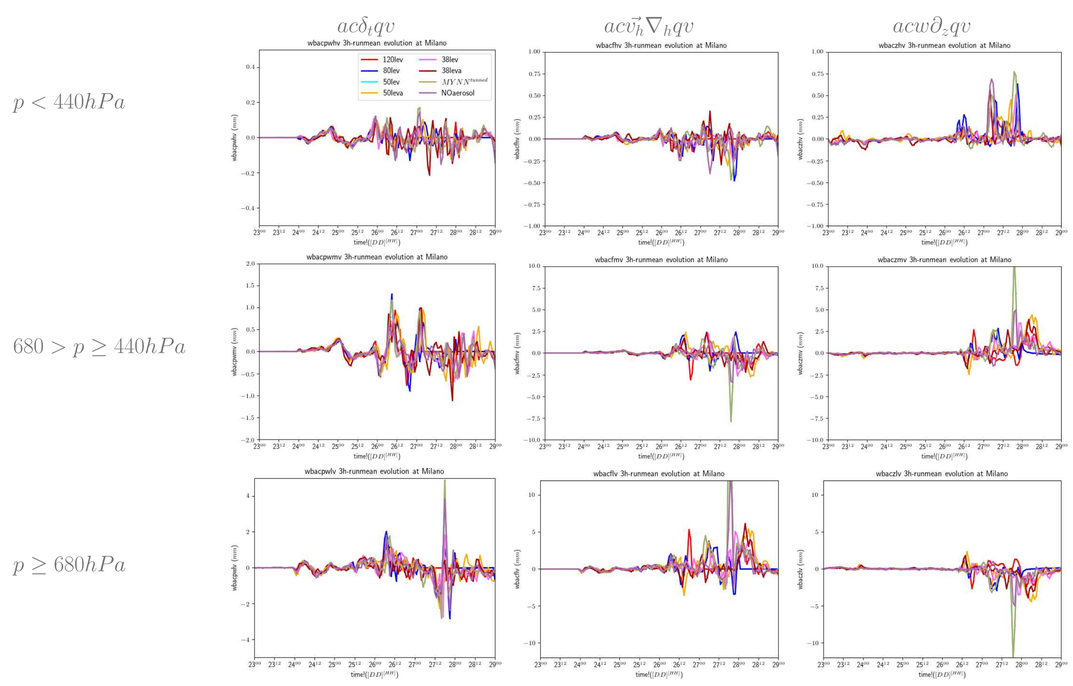
- Adding CMOR-zization of WRF output (full account of CF-conventions)
- Add pending CORDEX variables: windgustz100, lightning
- Adding new generic variables like: tkegen,
- Adding new diagnostics: 0-isotherm, and other requirements from impact and stake holders scientists

## Instability: cape on 2012 Oct 26 at 12 UTC




- Small differences among different model set-ups
- Large differences with respect observations

## Water-Budget: Milano




- Marked differences among different model set-ups
- Stronger differences at low-levels

## Work in progress

- Improve vertical-percentage discretization at upper levels
- Analyze why WRF shows low sensitivity to vertical resolution
- Enhance CORDEX-WRF module: adding CMOR-zization of WRF output; pending CORDEX variables: windgustz100, lightning; new generic variables like: tkegen; new diagnostics: 0-isotherm, and other from impact and stake holders communities