

Author's answers to referee 1 of GMDD Discussion paper Geosci. Model Dev. Discuss., 2018 "Development of a module for the Weather Research and Forecasting (WRF) model to support the CORDEX community", by Lluís Fita et al.

We appreciate the positive commentaries of the referee which certainly improve the quality of the manuscript.

### General points

1. : The technical description looks accurate to someone familiar with the model structure and methods.

*We got a similar comment from second referee. Certain parts of the document have been re-written in order to facilitate the comprehension of WRF structure to the non-familiar readers. Two new subsections has been added ('WRF code main characteristics' and 'Module implementation') and text has been re-organized accordingly.*

2. : WRF has a previous set of output diagnostics (wrfxtrm output option) that also probably includes necessary outputs for CORDEX. Is it true or not that those fields such as daily max/min/mean surface values would also be required, or is the set presented here a complete requirement for CORDEX. The context of the existing wrfxtrm output needs to be mentioned.

*A new paragraph into the introduction has been added in order to contextualize the module: "This new module comes to complement the modifications introduced in the CLimate WRF (clWRF, <http://www.meteo.unican.es/wiki/cordexwrf/SoftwareTools/ClWrf>; , Fita et al. 2010). In clWRF climate statistical values (such as minimum, maximum and mean values) of certain surface variables were introduced into the model. At the same time, evolution of Green House Gases (GHG; CO<sub>2</sub>, N<sub>2</sub>O, CH<sub>4</sub>, CFC – 11, CFC – 12) can be selected from an ASCII file instead of being hard coded. Before these modifications, WRF users could only retrieve those statistical values via post-processing the standard output of the model (at a certain frequency). With the clWRF modifications (incorporated into the WRF source code since version 3.5) statistical values are directly computed during model integration. This new CORDEX module proposes one step further by incorporating a series of new variables and diagnostics which are important for climate studies and currently WRF users can only obtain via post-processing the standard model output. At the same time, additional variables have been added into the WRF capabilities of output at pressure levels. At the current version of the module, if WRF adaptive time-step is used, some diagnostics with certain relation with the length of the time-step (e.g.: pr, prls, sund) will not properly work because module it is not yet adapted to it."*

### Specific Points

1. p12, line 20: The model geopotential height is at full levels while others are at half levels. Does CORDEX expect that vertical staggering?

As far we know, CORDEX does not expect any vertical staggering. In fact, CORDEX expects it at pressure levels which is already provided. In the module variable was already provided de-staggered, it is now clarified in the text as follows:

“As in the case of air-pressure, WRF model also integrates the perturbation of the geopotential field from a reference or base one. Thus to obtain the full geopotential height on staggered model  $\eta$  levels, it is required to combine the two WRF fields and it is also de-staggered as it is shown in equation 1,

$$\begin{aligned} z_{g_{staggered}} &= PH + PHB \\ z_g(k) &= 0.5(z_{g_{staggered}}(k) + z_{g_{staggered}}(k+1)), \quad k = [1, dz] \end{aligned} \quad (1)$$

where  $PHB$ : WRF base geopotential height ( $m^2s^{-2}$ ),  $PH$ : WRF perturbation of the geopotential height ( $m^2s^{-2}$ ),  $z_{g_{staggered}}$ : staggered geopotential height  $k = [1, dimz + 1]$ ,  $z_g$ : unstaggered geopotential height  $k = [1, dimz]$  ”

2. p13, line 10: The way these summations over time are done would preclude using adaptive time steps and just using a fixed step. This should be mentioned. In fact, wrong results could be obtained if adaptive steps are used. Slight modifications to the algorithms would allow for time-varying dt.

*We agree on the comment. However we can not effort to take into account the required modification at this stage of the development of the module. Definitively it must be incorporated in a new update. A sentence has been added at the end of the paragraph and at the introduction in order to clarify this point.*

*“Current version of the accumulations does not take into account configurations of the model with adaptive time-step. When adaptive time-step is used, we strongly discourage the use of these variables.”*

3. p14, line 7: It should be mentioned that sund has units of seconds. It was not obvious why it had such large values and a reader might first expect it to be in hours, for example.

*We followed CORDEX requiremnts which demands the variable in seconds. A sentence has been added to clarify it:*

*“... implemented following equation 12 and provided in seconds.”*

4. p18, line 2: Is  $z_p$  then used to simply vertically interpolate the wind? The description misses out this step.

*Not exactly,  $z_p$  corresponds to the height until which the relation of equation 15 is satisfied. A new description of the variable has been added as follows:*

*“ $z_p$  height of the considered parcel (m, maximum height which satisfies equation 15)”*

5. p19, line 23: Why would not the Brasseur method also apply to gusts at 100 m? Assuming  $z_p$  is above 100 m, it may be the same gusts.

*We are not specialists in the methodology. As far we understood it, this might be certain for the wind gusts which are deflected from above 100 m. On doing that, wind gusts at surface and 100 m will be the same, since this will correspond to the deflected winds passing in their way until they reach surface. Without being confident with this assumption, we prefer to keep our diagnostic of the maximum wind at 100 m as a complement. A paragraph has been added in order to clarify this point as follows:*

*“The calculation of wind gust at 100 m should follow a similar implementation used for calculating the `wsgsmax`, but at 100 m. An extrapolation of such turbulent phenomena would require a complete new set of equations which have not been placed yet. However, it could be considered as first approach to take the same wind gust as the one at the surface (when it is deflected from above 100 m). The assumption would be that the wind gust at 100 m would correspond to the deflected wind on its ‘way’ to the surface. Instead, as a way to complement, the estimation of maximum wind speed at 100 m is provided.”*

6. **Figure 13 and others:** I am not sure the best figure quality has been achieved. The resolution looks low.

*Figures have been re-rendered to higher PNG quality and now look at finer resolution*

7. **p26.:** Radiative fluxes. Are not the outward longwave and shortwave at the top also required? These would also be available from other WRF fields with CAM and RRTMG options.

*They are already available from the module as 'RSUT' and 'RLUT' for short and long wave fluxes. They were not mentioned in the text of the article. They are now included as follows: "Outgoing radiative fluxes at top the atmosphere are also provided being 'rsut' for mean Top of the Atmosphere (TOA) outgoing shortwave radiation (in  $Wm^{-2}$ ) and 'rlut' for longwave. However there is not a 'generic' implementation of these variables."*

### **Minor Typos/Spelling**

1. : The paper could benefit from a editing read through, as I probably only caught a small percentage of errors.

*A re-lecture of the entire manuscript has been carried out, and significant parts of the text have been re-written and improved.*

2. **p17, line 13:** zclout

*Corrected to 'zcloud'*

3. **p37, line 25:** doamins

*Corrected to 'domains'*

4. **p39, line 19:** oder

*Corrected to 'other'*

5. **p40, line 25:** beneficed -> benefit

*Correction done*

6. **p41, line 9:** cmorzization (cmorization?)

*Being a new term there is not 'academic' source, thus googling it 'cmorization' has more entries, then changing to it*