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Interactive comment on "The Brazilian developments on the Regional Atmospheric Modeling System (BRAMS 5.2): an integrated environmental model tuned for tropical areas" *by* Saulo R. Freitas et al.

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We thank the anonymous reviewer for his/her insightful and helpful comments. The paper is now much improved by his/her comments and corrections. Below, we respond to his/her specific comments.

Q) The paper presents a description of the new developments in the last version of the BRAMS (Brazilian Regional Atmospheric Modeling System) model, so-called BRAMS 5.2. It consists in a unified version of the previously independent weather, carbon cycle and chemistry versions. The paper is well written and provide key elements for

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the documentation on the new features of the models. Having said this, my opinion is that the paper needs clarification and improvements before it can be published in GMD. Major comments: Q) In the text it is not always clear when the authors talk about version 5 (even 4.2) or version 5.2. As the paper aims at describing version 5.2, in each subsection, it should be explicitly mentioned which version the new developpements refer to (it is sometimes recalled but not always). For example, section 2.1.2 page 5 l19. Is this new option is a new development of version 5.2 and absent in version 5?

R) Some developments were done in previous versions but all of them described in this manuscript are incorporated in the version 5.2. Also, as there were not papers describing the previous versions, we included those developments in the present manuscript.

Q) I am also surprised that section 2.5, p21, discussing computing cost, shows comparisons between version 4 and V4.2 while we are talking about version 5.2 in the paper. I may understand that the new need for an increase number of cores for operational purpose leads to make the tests with a higher number of cores, but why with version 4.2 then?

R) BRAMS 5.2 inherit the computational improvements described in this section, which was not fully published before. So, for a full description of capabilities of this model version, we included a section in this manuscript. We clarified this information in this section.

Q) There are several occurrences in the paper where the author almost do not describe the simulation presented in figures. They use sometimes some reference to avoid a long description but to me, the essential modelling setup should be given in a couple of lines, without making the paper substantially longer – especially when the references are in Brazilian journals, or in PhD. Manuscript in Portuguese. It is the case p17, l15-19 (for results presented in Fig. 11 and 12), p19 l15-20.

R) Throughout in the text, short descriptions of the main aspects of model configuration were included for each numerical experiment presented.

minor comments: Q) The typing of the units are is always coherent throughout the paper(use of "/" p9 l11, p14 l34 , no blank in gm-3 p9 l1), etc. Please recheck.

R) Thanks. The units were rechecked throughout in the text.

Q) Page 3 line 15 : "we believe. . . " This is only your opinion (this is probably mine too), but personal opinions do not have to appear here. This statement could be presented in a more objective way if you give arguments here or few elements of comparison with other similar models.

R) The expression "At this point, we believe BRAMS has capabilities . . ." was replaced by "As shown in the present paper and references herein, this BRAMS version has capabilities. . ."

Q) Page 4-5, section 2.1.1, and table 2. It would be interesting here to introduce typical computational cost change between each option given in table 2, especially for the Exner function prognostic equationâA ÌĘ ÌĄltaking into account the full formulation or not.

R) We do have a computation cost change associated with the full formulation. However, the increase is not noticeable at the point to be worth to discuss in the paper.

Q) Page 4 line 11 Ân ÌĄ which shall not discussed here Âz ÌĞ to be replaced by Ân ÌĄ which shall not be discussed here Âz ÌĞ R) Done, thanks.

Q) Results in Figure 1 p6, l1-10. It Is not straightforward to see the improvement of the new scheme here since the original result is not shown, though discussed in Freitas et al. (2012). I would recommend here to add a third panel showing the previous results.

R) A third panel (B) was included and the text was changed appropriately.

Q) P12 l16 discussing Fig 4. The conversion to pdf format of the figure makes figure unfocussed for the axis labels. Please improve the resolution.

R) Done

Q) P13, l3-5. “The shallow scheme produces realistic. . .” Can you justify this statement with a reference or more quantitative elements? R) This sentence was removed from the text.

Q) P15, second paragraph about Figure 7. Is there a way on Fig 7 to illustrate that the GF+B2014 closure does a better job than the GF without the diurnal cycle closure? Fig 7 just illustrates the difference and the measurements discussed in the text to explain that GF+B2014 is an improvement should appear somehow in the Figure.

R) A quantitative evaluation of GF convection scheme with and without the diurnal cycle closure (DCC) is an ongoing work. In BRAMS 5.2 the decision to apply or not the DCC is let to the user. For now, we can only affirm that it improves the phase of the convective precipitation over land, as demonstrated in the Figure 7 and discussed in the text.

Q) P17 l16-19: a short description of the model setup for the simulations presented in Fig 11 and Fig 12 should be given here. What do the vertical dashed lines mean in these figures? It should appear in the associated captions. I also recommend to write CCATT-BRAMS instead of CATT-BRAMS into the rectangle of the caption in each figure.

R) The vertical dashed lines were deleted since they are not relevant in the present context. The name CCATT-BRAMS was fixed. The text below was included informing about the model setup: “For this specific experiment, the model was configured in order to simulate smoke emission, transport and climate effects during the 2012 South American biomass burning season. The applied domain covered the whole South America with a horizontal resolution of 25 km and 42 vertical levels. Atmospheric initial and boundary conditions were assimilated from analysis of the Brazilian Center for Weather Forecasting and Climate Studies global circulation model. The tropospheric chemistry mechanisms used was RACM and biomass burning emissions for carbon monoxide and ozone precursors were estimated by the PREP-CHEM-SRC based on

satellite remote sensing fire detections (Freitas et al., 2011)".

Q) P17 section 2.3.2: same remark, a short description of the simulation should be provided here. Though it is explained in Carvalho (2010), this reference is a PhD thesis manuscript in Portugese, not easily accessible to all the readers.

R) The following sentence was included: "For the simulations, the author used the Global Forecast System (GFS) analysis for the initial and boundary conditions. The model was setup with two nested grids of 16 km and 4 km horizontal grid spacing, respectively, with 33 vertical sigma-z type levels. Both grids were centered at 22.80° S and 43.25° W. The coarser domain covered an area of 61.440 km2 (60 x 30 grid points) while the inner domain covered a 22464 km2 area (54 x 26 grid points). The primary pollutant emission was based on the inventories provided by INEA and considered both vehicular and industrial emissions for the five elements previously mentioned (CO, VOC, NOx, SO2 and PM)".

Q) P17 section 2.3.3. l34-36 Here again a few more info about the model setup is needed here.

R) The following text was included in the manuscript: "For this case, BRAMS model was set with 20 km horizontal resolution, covering the northern part of South America. The simulation was carried out for 45 days, starting on the 15th of August 2010 at 00:00 UTC, with the first 15 days discarded due to model spin-up. The NCEP Global Forecast System analysis (http://rda.ucar.edu/datasets/ds083.2/), with $1° \times 1°$ spatial resolution, provided initial and boundary conditions for the meteorological fields. The carbon data assimilation system, Carbon Tracker 2015, (Krol et al., 2005), with $3° \times 2°$ horizontal resolution, provided the CO2 initial and boundary conditions. Biomass burning emissions of trace gases and aerosols were from 3BEM (Longo et al., 2010). The land use map, with 1 km spatial resolution, was provided by USGS (United States Geological Survey), merged with a land cover map for the Brazilian legal Amazon region (Sestini et al., 2003). "

Q) P19 from line 15: A quick model setup is required. More info is given in Pavani et al., 2016 but not accessible yet, and in Portugese. Fig 16 colour codes should be explicated or at least commented.

R) Pavani et al., 2016 is now published (but in Portuguese). The following text was included in the manuscript: “The BRAMS simulation to study the transport of the Puyehue volcano ash was carried out for 40 days starting on the 4th of June 2011 00 UTC, with 30 km horizontal resolution and a vertical resolution starting at 100 m at the surface, stretching with a ratio of 1.1 up to 500 m at the model top”. Color codes explanation appears in the figure caption.

Q) P20, section 2.4.2: I remember a possibility of computing air mass trajectory with previ- ous version of BRAMS/RAMS. What is new here? Is should be explained more clearly.

R) There is nothing new here. But we would like to have an unified document, where all BRAMS functionalities are described. So, if this is ok for the reviewer, we will keep this section.

Q) P24 about Figure 23: can you explain more clearly what are each colour bar on the left side and on the right side? I could not find the information neither in the text, nor in the Figure caption.

R) An explanation was included in the figure caption.

Q) P24 section 2.6.2. This very short section states that there is an improvement in the representation of the surface radiation budget. Could you give more details here?

R) The section was deleted.

Q) P49 Figure 15 caption, l4. JULES instead of Jules.

R) Done.

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