

Interactive comment on “The Enviro-HIRLAM online integrated meteorology–chemistry modelling system: strategy, methodology, developments, and applications” by Alexander Baklanov et al.

Anonymous Referee #3

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The manuscript presents the online coupled model Enviro-HIRLAM, which is well known in the atmospheric modelers community. The manuscript is well structured and provides a comprehensive presentation of Enviro-HIRLAM development with a description of the different approaches and physical schemes implemented during the model evolution. The computational schemes and parameterizations adopted by the models are properly introduced and referenced. A minor shortcoming of this approach is that it is somewhere not very clear to the reader which computational scheme is the one chosen for the present version of the model or what alternatives are provided to the user.

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A relevant number of applications are referenced for almost all the model development fields. Some of the items (e.g. pollen) are described providing explicit summary of the overall results that make the paper more readable and useful for a reader that is not willing to read the large number of referenced papers and documents. Other examples of application are mainly discussed through references and do not allow the reader to appreciate the model effectiveness and the improvement offered by the online modelling approach.

If the general approach of online coupling is physically sound and it can be agreed that it will probably become the prevailing modelling approach in the next future, the manuscript does not clarify, through its application examples, to what extent the online coupling and the main parameterizations introduced (e.g. urbanization) provide an improvement of model capability to predict observed pollutant concentrations and key meteorological parameters. An improvement of the analysis of the online coupling effectiveness is desirable and would make the manuscript more complete, interesting and valuable.

Text and figures include a large number of acronyms for project names, parameterization schemes, etc. Even if many of them are known, it is quite difficult for the reader to know and remind all their meaning. It would be helpful to add an acronym legend section.

Specific comments:

Section 1. Methodology

Lines 72-75 The authors say that Enviro-HIRLAM is being used for different research project, but most cited project have already concluded they activity. In the Figure 1 lowest box most project mentioned as ongoing are finished since a few years.

Section 2.1 Modelling system structure

Line 92 The URL <http://hirlam.org/trac/wiki/> is password protected and therefore not

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accessible to the reader. It should be substituted with an open access web site.

Section 2.3 Atmospheric chemistry

It is not clear if the “tropospheric sulfur cycle” is a simple scheme alternative to the CBM-Z, that is presently maintained for simplified simulations (what is the specific interest?), or if it is an obsolete option which is going to be abandoned. It is not specified how the CBM-Z gas-phase chemistry scheme is interfaced with the M7 aerosol module. Due to the relevance of secondary particle production modelling, more details would be appreciable to provide a comprehensive model description.

Lines 171-172 The authors say they “use KPP tools to create the gas-phase chemical mechanisms including the solvers for three chemical mechanisms.” What are the three mentioned chemical mechanisms? Only two of them have been previously presented: a) Tropospheric Sulfur Cycle, b) Gas-phase chemistry (CBM-Z).

Lines 172-173 The authors say that Rosenbrock solver is usually selected. Why?

Line 190 What is “NWP-Chem-Liquid”?

Section 2.4. Aerosol formation, dynamics and deposition

Line 197 Is CAC still available in Enviro-HIRLAM or it is mentioned only for historical development reasons?

Lines 205-206 Is the aerosol type identity maintained through the model simulation and provided as separated output contribution to the total PM?

Section 2.5. Emission modules and pre-processor

Line 254 Does wildfires emission module consider PM only or gas phase pollutants too?

Line 274 What are “transported modes”?

Section 2.7. Urban parameterizations and models urbanization

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This section is relevant because it highlights the need for a mass conserving transport scheme in on-line coupled NWP and ACT models. For offline coupling this request is less strict because mass consistency is usually guaranteed by the coupler module.

Line 311 Bracket missing.

Line 312 Grid nesting is an effective technique to increase model resolution but it is rather confusing to consider it a method to represent urban areas.

Line 315 The “calculation of the urban mixing height based on prognostic approaches” is neither described nor commented in the following text.

Section 2.8. Transport schemes

Line 371 Is hat symbol missing on “modified weight” in equation 6 ?

Line 377 “is are” should be corrected

Lines 388-390 This sentence concerning Enviro-HIRLAM mass consistency for tracer transport should be better explained and discussed. What are the possible limitations caused by this lack of mass conservation? What is TR4?

Section 3 Modelling system applications

What are the mentioned “EnvCLIMA, Enviro-HIRHAM”?

Lines 415-418 Do the mentioned temperature changes due to indirect effects improve model results? How relevant is the improvement? The reference given by the authors is to a Project report that can be hardly available, not to a journal publication. In the following sentence (lines 420-421) the authors mention a marginal improvement on surface temperature. They also mention a redistribution effect on NO₂ concentration, but they do not specify if this effect improves model results.

Lines 442-444 and Figure 9 The authors say “the ENV run bias for precipitation with respect to its frequency and amount has been decreased compared to the REF model

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run (Fig. 9).” Legends printed on the pictures seem opposite to what indicated in the caption (Enviro-HIRLAM on the left). Results showed in Figure 9 seem different during different parts of simulation: until July 21st the right side simulation seems better, while the left side one seems better during the last part of the simulation. What is the difference of the overall biases?

Lines 480-489 A grid size of 2.5 km seems quite crude to resolve Bilbao city. In x and y directions the city seems to be described by 2 to 4 grid cells which can be hardly considered sufficient to develop a “urban signal”. Why has not been used a finer resolution? Is it due to the hydrostatic model limitations?

Figure 10 Why different land use classifications have been used for the two considered cities? What is the P01 modelling domain mentioned in the caption?

Line 498 Does 10% improvement refer to the correlation value?

Lines 499-500 It is not clear how the mentioned correlations have been computed. Time correlation for separated hours? How many stations have been used to compute the mentioned correlations?

Lines 501-504 Where the mentioned results for Bilbao better than those obtained without urbanization? Was the improvement significant?

Lines 512-535 The authors show that model urbanization allows to describe UHI phenomenology in Paris and Bilbao, but they do not discuss if the urbanization improves results and reduces possible model bias with respect to urban observations.

Lines 635-639 The mentioned effects of aerosol feedbacks on chemical composition are quite interesting. Did the mentioned changes on NO₂ and O₃ improve model results and increase its capability to reproduce measured values?

Figure 15 Right side color scale legend needs correction. How are correlations for separated hours computed?

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Lines 675-677 The authors mention new model applications without providing any detail about recent results potentially relevant and interesting for the readers. The mentioned feedback mechanisms evaluation is one of the key point of the paper.

Section 4 Conclusions

Lines 692-702 These sentences contain repetitions of the same concepts that could be removed.

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