

Responses to Reviewers' Comments for Manuscript egusphere-2023-1078

**Analytical and adaptable initial conditions
for dry and moist baroclinic waves in the
global hydrostatic model OpenIFS
(CY43R3)**

Addressed Comments for Publication to

Geoscientific Model Development

by

Clément Bouvier, Daan van den Broek, Madeleine Ekblom and Victoria
Sinclair

Dear Dr. Travis O'Brien,

Please find enclosed the final revised version of our previous submission entitled “Analytical and adaptable initial conditions for dry and moist baroclinic waves in the global hydrostatic model OpenIFS (CY43R3)” with manuscript number egusphere-2023-1078. We would like to thank you for the handling of the review process and your relevant comments. In this final revision, we have carefully addressed your comments. A summary of the main modifications and a detailed point-by-point response are given below.

Sincerely,

Clément Bouvier, Daan van den Broek, Madeleine Ekblom and Victoria Sinclair

Authors' Response to the Editor

General Comments. Thank you for all the work from you and your co-authors in addressing the reviewer concerns. This is a very cool paper. At this stage I am happy to accept this paper for publication in GMD pending some technical revisions. The revisions mainly involve modifying language to avoid ambiguity, though I do have an apparent discrepancy to note.

Response: We appreciate your handling of the review process.

We carefully answered your remarks as follow.

Comment 1

l18: suggest rewording to "create a large ensemble of baroclinic lifecycles"

Response: Thank you for the comment.

We agree with the editor's comment and changed the sentence accordingly.

Comment 2

l22: I suggest rewording this sentence as "These GCMs provide numerical solutions to the governing equations..."

Response: Thank you for the comment.

We agree with the editor's comment and changed the sentence accordingly.

Comment 3

l57: you use the term "run without physics" which is potentially ambiguous (since GCMs numerically approximate conservation equations that are derived from first-principles physics). I take it that you mean "run without physics parameterizations"? If so, I suggest using that rewording. There are some other places in the text where the term "physics" should be reworded as "physics parameterization(s)".

Response: Thank you for the comment.

We agree with the editor's comment and changed the expression as "physics parameterisation scheme(s)" through all the text.

Comment 4

l60: I suggest adding "e.g., " before "Kuo et al., 1991,..." since these are only a representative sample of papers on this topic

Response: Thank you for the comment.

We agree with the editor's comment and changed the sentence accordingly.

Comment 5

l65: "physics" -> "physics parameterizations"

Response: Thank you for the comment.

We agree with the editor's comment and changed the expression as explained in 3.

Comment 6

l218: The last sentence of this paragraph seems like a non-sequitur. Consider whether it is necessary here.

Response: Thank you for the comment.

We agree with the editor's comment and removed the sentence.

Comment 7

l230: "Implementation into OpenIFS" -> "Implementation in OpenIFS"

Response: Thank you for the comment.

We agree with the editor's comment and changed the title accordingly.

Comment 8

l244: I suggest rewording th sentence "It was attributed..." as "This background state was referred to as NTESTCASE41 (dry case)..."

Response: Thank you for the comment.

We agree with the editor's comment and changed the sentence accordingly.

Comment 9

l254: "physics" -> "physics parameterizations"

Response: Thank you for the comment.

We agree with the editor's comment and changed the expression as explained in 3.

Comment 10

l255: "Hence, the SST definition presented Section 2.3" -> "Hence we use the SST definition presented in Section 2.3"

Response: Thank you for the comment.

We agree with the editor's comment and changed the sentence accordingly.

Comment 11

l274: The sentence starting with "The proposed background state" is confusing, and I'm not sure how to interpret what you intended to communicate. Part of my confusion is that you start the sentence talking about the background state (which I take to be the initial conditions of the model state variables), but then the sentence discusses parameterization details: it seems like the sentence is implying that the background state and parameterizations are equivalent. This sentence should be revised.

Response: Thank you for the comment.

We agree with the editor's comment and changed the text as follow:

The proposed solution has been implemented as a new idealised case (indicated by the NTESTCASE parameter in OpenIFS), where the model state variables are initialised based on the equations for geopotential, virtual temperature, the horizontal wind components and, in the case of moist simulations, the specific humidity that were derived above. Once the initial values of the state variables are defined in the model, the OpenIFS simulations are integrated forward in time on an aquaplanet.

Comment 12

l286: "humidity (HDIRQ) diffusions) and the other are set to zero." -> "humidity (HDIRQ) diffusions, and the other coefficients are set to zero."

Response: Thank you for the comment.

We agree with the editor's comment and changed the sentence accordingly.

Comment 13

l299: "A standalone version have been developed" -> "A standalone version has been developed"

Response: Thank you for the comment.

We agree with the editor's comment and changed the sentence accordingly.

Comment 14

l308: it looks like there is an extra ")" after 2023-12-05

Response: Thank you for the comment.

We agree with the editor's comment and changed the sentence accordingly.

Comment 15

l340: it has been hundreds of lines since BWS was defined, and it isn't a terribly common acronym; I had forgotten the acronym's meaning by the time I got to this sentence. It might be better to use the whole phrase here rather than the acronym.

Response: Thank you for the comment.

We agree with the editor's comment and changed the sentence accordingly.

Comment 16

l347: "to enable to first" -> "to enable the first"

Response: Thank you for the comment.

We agree with the editor's comment and changed the sentence accordingly.

Comment 17

Figure 4e: in the vicinity of latitudes -20 and 20, theta-E is non-monotonic. It decreases from approximately 345K at the surface to 240K at about 500 hPa, and then it increases again after that. This seems to suggest there is conditional instability in this region. Line 330 seems to indicate that you are aiming to create the theta-E profiles such that they increase monotonically everywhere. Does the language around line 330 need to be revised?

Response: Thank you for the comment.

We agree with the editor's comment and have revised section 4 as follow:

For the initial state to be absolutely stable to dry and saturated vertical displacements (static stability), equivalent potential temperature must increase with height everywhere. In the situation where equivalent potential temperature decreases with height, conditional instability is present, meaning that the atmosphere is stable to displacements of dry and unsaturated air parcels but unstable to displacements of saturated air parcels. If potential temperature decreases with height, then the atmosphere is absolutely unstable - both dry and saturated displacements are

unstable. Thus, for the initial state to be absolutely stable potential temperature must increase with height and the Brunt-Väisälä frequency must be positive. Regions where equivalent potential temperature decreases with height are also stable and acceptable in the initial state as long as these regions are not saturated.

Comment 18

line 480: the sentence refers to 'friction' twice, which seems like it might be a typo

Response: Thank you for the comment.

We agree with the editor's comment and changed the sentence accordingly.

Comment 19

line 536: "However, as this CAPE can only be addressed" -> "However, as this CAPE can only be accessed"

Response: Thank you for the comment.

We agree with the editor's comment and changed the sentence as follow:

However, as this CAPE can only be released once the surface parcel reaches saturation or is substantially lifted, and the fact that this area is not affected by the baroclinic wave, this does not influence the meteorological stability of our setup.