

Assessment of Climate Biases in OpenIFS Version 43R3 across Model Horizontal Resolutions and Time Steps

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Referee #2

Overall the manuscript is clear, concise, to the point and relevant. I appreciated the final recommendations on the recommended resolutions and timestep settings. One thing I did miss is a discussion on the wiggles in the surface fields in the LRA and MRA configurations.

This is in fact a known issue that one of the co-authors complained about in the OpenIFS CONFLUENCE page <https://confluence.ecmwf.int/pages/viewpage.action?pageId=188034913>. In this page it is described that the Tco (octahedral reduced Gaussian grid) grid is a poor choice for the low resolution configurations, instead I would encourage the use of compatible TL (reduced Gaussian grid) such as TL159 and TL399. Nevertheless, the findings of this study are valid and I do not recommend repeating the exercise using the TL grids, but I would expect some discussion on this in the introduction, why the authors did not use the TL grids for the LRA and MRA configurations, despite the known issues? Also this should be pointed out in the results section.

Thank you very much for raising this concern. Our choice of grid was motivated by finding a usable low resolution for atmosphere-only and coupled experiments that uses little resources. Tco95 was deemed to be the lowest acceptable resolution as the available lower-resolution configurations, e.g., TL95 and Tq42, were too coarse for our interests. As presented in this paper and elsewhere, the lack of spectral filtering introduces spectral wiggles. As shown in this paper, however, these wiggles are not the main source of model biases. For example, RMSE of T2m and precip biases are relatively insensitive to spatial smoothing. We have now added some motivation for our grid choices in sec 2 (lines 108 to 114).

“Our study is partly motivated by evaluating the suitability of various OpenIFS configurations for coupled climate simulations with FOCI-OpenIFS (Kjellsson et al., 2020) with an atmosphere horizontal resolution higher than that of ECHAM6 Tq63/N48 (~200km) in FOCI (Matthes et al., 2020). Our choices thus fall on three different horizontal resolutions: a low-resolution (Tco95, ~100 km), a medium-resolution (Tco199, ~50 km), and a high resolution (Tco399, ~25 km). The Tco95 grid is the lowest acceptable resolution since the supported lower-resolution grids, e.g., Tl95/N48 and Tq42/F32, are either similar to Tq63 in ECHAM6 or coarser. The Tco399 grid was chosen as an upper limit of what is computationally feasible for AMIP integrations and century-long coupled integrations given our computer resources.”

- p. 2 line 38 correct "have been widely used"
It is fixed now.

- p. 2 line 41 correct "which lead to"
It is fixed now.

- p. 2 line 60 correct "while increasing from"
It is fixed now.

- p. 2 line 63 correct "when increasing from"
It is fixed now.

- p. 2 line 66 correct "IFS models"
It is fixed now.

- p. 3 line 76 cite Döscher et al (2022) (Döscher et al., 2022) in which the timestep of various resolutions is given, instead of Van Noije et al (2021).

Thank you very much for noticing it, we have fixed it.

- p. 4 line 103, explain which CMIP6 forcings are used ? mole fraction of CO2? authors only specify that aerosol and ozone concentrations are from climatology

59 We modified the sentence:
60 “The external forcing is identical to that used in the CMIP6 AMIP simulation except for the aerosol and ozone
61 concentrations”
62
63 - p. 4 line 105, which scenario exactly ? SSP5-8.5 ?
64 It is fix now.
65
66 - p. 4 line 111, correct "OIFS simulation datasets"
67 It is fixed now.
68
69 - p. 4 line 130, please confirm that the Pearson's correlation is computed
70 The missing information is added.
71
72 - p. 5 line 156, authors should justify in the intro. why they did not run OIFS-HRA at 1h timestep (i.e. for numerical
73 stability) in order to evaluate if the improvements are due to resolution or timestep
74 We have not done performed time-step sensitivity experiments using OIFS-HRA configuration due to computer
75 restrictions (very expensive).
76
77 - p. 5 line 162, correct "large difference"
78 It is fixed now.
79
80 - p. 6 line 194, black lines are not visible, authors should give their values
81 We have now provided the net tendencies range in the text.
82
83 - p. 7 line 205, correct "lower stratosphere and troposphere"
84 It is fixed now.
85
86 - p. 7 line 215, is there any plausible explanation for this? predominance of ocean surface over continental ones?
87 The tendency magnitudes are stronger over the Southern Ocean than the Northern Hemisphere due to less rough
88 surface in the Southern Hemisphere.
89
90 - p. 7 line 220, The is an abrupt transition from analysis of winds to that of temperature, a proper sentence to
91 indicate this change of focus is needed.
92 We added a sentence to show the transition from wind to temperature.
93
94 - p. 7 line 224, Fig. 2b indicates there is no notable improvement in RMSE from the shortened timestep.
95 We modified this sentence as:
96 “Compared to the OIFS-LRA-1h, the SAT RMSE decreases with increased horizontal resolution (OIFS-HRA-
97 15m and OIFS-MRA-15m), and there is no notable improvement when shortened the time step (OIFS-LRA-30m
98 and OIFS-LRA-15m) (Fig. 2b).” (lines 255-257)
99
100 - p. 11 line 345, correct "accounting for most variability"
101 It is fixed now.
102
103 - p. 12 line 369, cite cite Doscher (et al 2022) instead or, or in addition to, Haarsma et al 2020
104 It is fixed now.