

Thank you for reading and taking on my comments. I am glad you found them useful, and appreciate the improved clarity of the article. It is good to see that the majority of points raised by both reviewers have been addressed, however, unless I have missed something, it still seems that there is some inconsistency with regards to the comparison between the nudging, the dynamics quasi-error, and the total tendency quasi-error.

For brevity I will not reproduce previous responses in full here, but rather just section headings and opening words.

Under the category “Major comments”

As I understand it, the residual term for CNTL...

... However, they are implicitly linked through their governing equations, with different assumption and approximation as indicated by referee #1. We think it is inappropriate to consider the two diagnostics to be completely independent.

...

Thank you for clarifying the agreement on the points that the tendencies and budgets are linked due to the governing equations, and that it is inappropriate to consider them independent. This did not come across in the original text and is useful to have clarified.

The only further note I have on section 2.5 is for line 259, I might suggest changing “but is not necessarily true by definition” to “but they are not necessarily exactly equivalent”.

I assume based on lines 260-266 that this is the intended meaning, but as written I do not think the sentence means that. As written it seems something of a contradiction, as is the derivation of the budget not also the definition of the components?

A consequence of this is: taking the mean CNTL-GLN tendency from dynamics (4b, 6b, 8b, 10b), will this not be disproportionately dominated by the model dynamics bias in the first 6 hours being balanced by the nudging...

It may be the case that I was very unclear in my first review, and phrased this badly.

I do not think it is adequately addressed as to why the CNTL-GLN nudging in figure 6(h) appears to have a similar character but with opposite sign to the dynamics in figure 6(f), and whether this is important to the conclusions.

The similarity is noted in line 402, but in lines 413-414 you write that nudging increments are comparable to forecast errors. The forecast error in figure 1(c, e) has a similar character to the total tendency error in 4(d) and 6(e), however these do not have

similar character to the resolved processes error (4e), the Coriolis error (5h) or the dynamics error (6f), which all instead are comparable to the nudging error (6h). Therefore it does not seem that nudging increments are comparable to forecast errors.

It is acknowledged in line 450 that the thermal budget and the momentum budgets are different. Here it is noted that there is similarity between the residual (8f) and the total (8d). This similarity is used to conclude deficiencies in physics parametrizations from the thermal budget. However by using the phrase “unlike the momentum budget”, this highlights my confusion that you also conclude for the momentum budget that it is a deficiency in the physics parametrizations in lines 413-417, with similar phrasing, despite the opposite result.

I interpret line 415-417 as saying that the model physics should be applying the same forcing that the nudging is, because you are using a nudged forecast as the truth.

A first look at figure 6 had me confused, as it seemed that the majority of the forcing of the nudging to move the GLN field towards the analysis was being directly un-done and opposed by the tendencies of the model dynamics. The majority of the nudging tendency being directly counteracted seemed to be an odd result, but as I have not personally used nudging in the same way as you are here in this study, it would be very useful if you could please provide your interpretation of what the cancellation of terms in figure 6(f) and 6(h) means, in terms of what the nudging is doing, how the model is responding, and how the differences between CNTL and GLN should be interpreted in light of this.

I feel like I really ought to be able to understand this, and so it may be likely that someone reading this article in the future would get similarly confused.

Furthermore, the nudging term in the thermal budget is not mentioned at all in the text of section 4.2, and as with the momentum is also of similar character and opposite sign to the resolved tendency, particularly at the lowest pressures.

L330-331: Is this conclusion necessarily true? ... (now L413)

... Similarity between residual term error and total tendency error, which is proportional to the error of the corresponding variable itself as shown in the equation described above, suggests that the error of the corresponding variable itself stems from the residual term error ...

I can agree that this would be true, however, as before, I do not see similarity between residual term error and total tendency error in figure 4. And, you also seem to acknowledge that this similarity is not there, in line 450.