Reply to comments by Referee #2

This paper describes a suite of software tools that are intended to calculate a range of quite sophisticated diagnostics relating to the energy and entropy budgets of the global atmosphere and ocean circulations from large-scale numerical models, and to aspects of the hydrological cycle. The overall thrust of the computations are based on a thermodynamic interpretation of the climate system as a complex heat engine, allowing for energy and entropy fluxes in various forms at a level of sophistication that matches that of the most recent Earth System models. The authors have a strong track record of research in this field and have published widely on various aspects of these diagnostics as applied to a number of existing climate model simulations. The present tool would seem to offer the possibility of others carrying out similar analyses. This is to be commended in the interests of aiding model intercomparisons.

The range of options being offered seems fairly comprehensive, the only significant restrictions appearing to be the assumption of hydrostatic balance in the dynamical equations. The technical details are described fairly fully in a set of appendices, and some typical results are presented in the later sections through applications of the tool to CMIP5 model runs under three different scenarios, representing pre-industrial conditions, historic anthropogenic forcing and a future “business as usual” projection. This serves well to illustrate the potential insights provided by the diagnostics on offer.

The paper overall is well structured and reasonably well written, although the English in a few places is a little “clunky” with occasional words missing or with awkward phrasing, which may tend to distract some readers. My main criticism (speaking as an “outsider” - not directly involved in diagnostic studies of state of the art Earth climate models) would be of the description in Section 2 of the data requirements for use of the tool. This is quite short and seems to presume quite a lot of knowledge on the part of the reader (unless they are prepared to spend a lot of time and effort consulting the documentation for the ESMValTool software, referenced as Eyring et al. (2016b)). Table 1 lists the variables required to be presented to the tool for the various calculations, but simply names the variables according to the CMOR convention without explanation. This is not helpful if you don’t know that convention, and it is not explained anywhere in the paper except in external references. Why not provide a key for these variables or an explanation in another column of Table 1? Given the general applicability of much of the tool to climates that are not restricted to Earth (as acknowledged in the paper itself), readers would appreciate a bit more help and guidance for novice users. Is there a graphical interface, for example, or is it run via a shell script? Some more guidance here and perhaps an example script would be helpful, either in the text or another appendix.

We thank the reviewer for the constructive criticism. We addressed the issue in two steps. We rearranged Table 1, in order to include a short description of each variable. In addition to that, we substantially rephrased the last part of Section 2, shortly explaining the algorithm. We did not dig into the details of the procedure, because the documentation of the code contains all the necessary information, either one uses it through the ESMValTool v.2, or prefers downloading the stand-alone version of the diagnostic tool (which is now available in a GitHub repository: https://github.com/ValerioLembo/TheDiaTo_v1.0.git)

In other respects, this looks to be a potentially useful facility for anyone interested in model inter comparisons and/or complex climate diagnostics, and could be even more attractive if made a little more user-friendly. I outline below a few more minor points and suggestions.

- Figure 5 and associated text: The reservoir terms ASE, ATE, KSE and KTE are not explained or defined very obviously. They presumably refer to stationary and transient components of AE and KE? It would be helpful to state this in the caption and perhaps mention in the text?

Thank you for the comment. We have modified the caption to Figure 5 and we added a short period at Section A2: "The contribution of eddies to APE (EPE) and KE (EKE) consists of two terms, the first one is the term accounting for stationary eddies (ASE and KSE in the diagrams of Figure 5, respectively). The second term accounts for the transient eddies (ATE and KTE in the diagrams of Figure 5, respectively). A discussion on the derivation of these terms is found in Ulbrich and Speth, 1991."

- P.17 line 23 as example of awkward phrasing: should probably read ". . .as a possible reason for the well known cold pole bias. . .." But there are quite a few others – too numerous to list in detail. Perhaps recruit someone whose first language is English to proofread - or the authors should proofread more thoroughly before submission!

We thank the reviewer for the constructive criticism. We have undergone a comprehensive proofread of the manuscript, together with a native speaker. We hope that this effort has substantially improved the quality of the language.

- Presumably this tool could be used on reanalysis datasets too? Perhaps comment further?

Thank you for the suggestion. We have added a sentence in the first paragraph of Section 2, explicitly mentioning that the software is also suitable for the ingestion of Reanalysis datasets: "Therefore, the tool is suitable for the evaluation of any kind of gridded datasets, provided that they contain the necessary variables on a regular grid, including blends of observations and Reanalyses. In our description of the software feature, we focus on model evaluation and multi-model intercomparison."