The manuscript “AQUA v1: The Application for QUality Assessment for the Climate Change Adaptation Digital Twin“ by Nurisso et al. the first part of a new software package (AQUA) that facilitates monitoring and evaluation of simulations performed by the Climate Change Adaptation Digital Twin of the Destination Earth initiative. The manuscript focuses on the description of the underlying code philosophy, code structure and core functionalities of AQUA and provides some examples about AQUA’s data handling performance.

The manuscript is very well written and well structured, and it provides the necessary information to understand the structure of the software without going too deep into technical details. The topic of the manuscript lays clearly withing the scope of GMD, and the new software could potentially be of interest to a substantial part of the climate modeling and Digital Twin community. There are, however, a few things that I would like to see addressed/discussed to help the reader better understand the work that has been done and what the novel parts of the work are.

I recommend the publication of the manuscript after revisions.

We thank the reviewer for the kind words about the relevance of the manuscript for the climate modeling community. We appreciate in particular the comment about the level of technical details included in the paper, which required important planning while structuring the paper.
We’ve addressed the recommendations listed below, together with, where available, updates which are already part of the final code and presenting in the conclusions new implementations that will soon be part of the main code.

Comments/recommendations:

- I understand that the software was created with the monitoring and evaluation of simulations from ClimateDT with its specific requirements and needs in mind. The authors explain that AQUA could potentially also be used to evaluate simulations from CMIP or CORDEX. There are several other software packages around (some of them are mentioned in the introduction of the manuscript), however, that are used to do exactly that, and successfully doing so. If it is indeed a near-term goal of AQUA to be used for simulations from these projects then I would want to see a much more detailed discussion where AQUA would fit in the landscape of these already existing software packages, where the overlap between these packages and AQUA are, and where AQUA is unique. If this is not a near-term goal of AQUA to evaluate the simulations from these projects then I think the discussion of AQUA should be more clearly focused on the capabilities of AQUA with respect to evaluating simulations from ClimateDT.

Yes, the software was initially forged around the needs of the online monitoring for the ClimateDT. The possibility to open and analyse data from CMIP and CORDEX simulations is in the near-term motivated by the need of comparing the ClimateDT results with other communities (e.g. the HighResMIP experiments).

However, we envision the usage of AQUA as not limited to some comparison of ClimateDT data. The software can be highly beneficial to models which are in the development phase,

for which the entire CMORization of data is not yet available but a monitoring framework is required. A recent example has been the EC-Earth4 model development, where AQUA has been used aside other tools to provide support during the tuning process. Additionally more projects dealing with km-scale models and complex workflows such the European Eddy-Rich ESMs (EERIE) and the DE_393 (Development and Implementation of Climate Emulator for Destination Earth) projects are currently undergoing and are starting to leverage AQUA for the model evaluation. Being focused on high resolution data, in this perspective AQUA greatly complements the capabilities of other diagnostic suites.

Finally different observational dataset start to have versions available on bucket as Zarr chunked data or ARCO dataset. We believe the capability and flexibility to open and work with those datasets is of general interest and not limited to the ClimateDT community.

- AQUA is software package that is added to a collection of already existing software packages that do similar things (although not specifically focused on the evaluation of data from ClimateDT). What are AQUA's plans to interact with the rest of the evaluation community? What priorities do the AQUA developers have with regards of sharing efforts with the rest of the community to avoid development duplications?

On the relevance of this point we completely agree with the reviewer: the interaction with other existing software packages is a priority for AQUA. The modularization of the code allows for having different possibilities to interact with other software packages: modules like the Fixer could be beneficial for other software as well, allowing a seamless metadata handling without duplicating the code. At the same time a module of AQUA could be substituted with features provided by other codes. AQUA can provide a layer of data access to run other diagnostics tools, and, despite not being part of this specific manuscript, the diagnostics suite is flexible and might be extended by incorporating external diagnostics to avoid reinventing the wheel.

A strong contribution to the software community could be to enhance the WMO GRIB to CMOR compatibility. It is of our interest to develop the possibility to open the ClimateDT data as CMOR-like data, so that the climate community could not only work with the usual software, but with the standard metadata format.

The focus of AQUA is intended to be on the high resolution data access, with the specialization of Zarr or cloud data access and the management of HEALpix grids. This setup is now the standard of the km-scale community, as shown in the recent km-Scale Hackathon 2025.

More ambitiously, the integration of the AQUA code with a selected list of diagnostics in the REF would be a great contribution to the software packages. This is envisioned by our team and development of new features takes into consideration this possibility and we hope to have the opportunity to proceed along this path with the support from the specific projects.

- The authors have stressed the fact that AQUA is based on the WMO GRIB standards. However, the example of the smmregrid code performance is based on netCDF files. Would it not make sense to base this performance test on GRIB data?

AQUA is based on the WMO GRIB2 when we refer to the metadata convention. This means that we refer to the GRIB2 tables and the WMO definitions to define a variable's metadata. However there is no assumption on the data format required by AQUA, since it can work with whatever data format is ingested by intake and opened as a xarray dataset. For this reason we didn't involve GRIB data on our smmregrid test, but only netCDF files. We've better explained the difference between the two concepts while introducing the WMO GRIB2 metadata convention in the manuscript.

More specific comments:

- Line 65: Spelling of "EsmValTool" should be "ESMValTool"

Thanks, this has been corrected in the revised version of the manuscript.

- Line 85: In the sentence "The Application for QUality Assessment (AQUA) is a Python3 package specifically tailored to address this challenge" it would be good to mention (again) that you refer to version 1 of AQUA (as stated in the manuscript title but not anywhere else)

We've added the specification of the version (1.0.0). We will also update the title to match the specific details of the version that will be released upon resubmission.

- Line 88: "Paper II" is mentioned here and in some other parts of the manuscript, but this paper is not mentioned in the literature or in more detail in the text. I guess this paper is planned, but not in a stage yet to be referenced with more details. But if this is the case, I would recommend to mention in the text ONCE that this paper is planned and what the content of the paper will be, and then remove the rest of the references to this paper since it is not clear when it will be available.

We removed as suggested the mentions to the Paper II in the text and left only a mention of a companion manuscript at the end of the introduction. The manuscript is very close to submission but indeed not mentioned in the literature yet.

- Line 176: "variables metadata" should be "variable metadata"?

Thanks, this has been corrected in the revised version of the manuscript.

- Line 202: "dataset" should be "datasets"?

Thanks, this has been corrected in the revised version of the manuscript.

- Line 291: "the coordinates nature" should be "the coordinates' nature"?

Thanks, this has been corrected in the revised version of the manuscript.

- Line 309: "and a metadata" should be "and metadata"?

Thanks, this has been corrected in the revised version of the manuscript.

- Line 343: “to generate in highly efficient and modular” should be “to generate in a highly efficient and modular”?

Thanks, this has been corrected in the revised version of the manuscript.

- Line 396: The sentence “The computations have been done 3 times and the results presented average the times” seems redundant since very similar text is present in the paragraph before.

The sentence has been removed from the final text.

- Line 416: What do the authors mean with the sentence “It should be noted that Polytope is also sensitive to bandwidth, as it is based on remote access”? Does it mean that accessing the data as soon as it is the Data Lake is harder and slower? But is that not the whole point of doing analyses on data that span several years and not just the most recent month?

In the new version of the manuscript we better specify the difference among local FDB and Polytope access. The FDB access happens on the same machine as the data and it is available only to the team part of the ClimateDT computational project. For this reason it is inevitably faster than any remote access. The Polytope access, on the other side, needs to query a remote machine, the Data Lake, and then download chunks of data as GRIB format on the local machine. For this reason we mentioned the bandwidth as a limiting factor and possible bottleneck depending on the machine in which the evaluation is performed.

- Line 512: “CORDE” should be “CORDEX”?

Thanks, this has been corrected in the revised version of the manuscript.

- Line 517 to 521: In my opinion this last paragraph is aiming too high. There are novelties to AQUA in comparison to other software packages, but claiming that AQUA can be seen as a blueprint for future software packages that are “grounded in solid engineering, adapted to the new data landscape, and committed to enabling scientific progress” implies that all other software packages cannot provide any of this. And that is not correct. I would strongly recommend to carefully rephrase this paragraph.

The last paragraph has been rephrased and the statement has been toned down as suggested. We stress the goal of interoperability and comparison among different modeling communities. Additionally we better explain our vision on the contribution of AQUA in the landscape of analysis tools, with a better perspective on collaboration among them (e.g. developing modular parts of the code which can be useful for other tools or integrating already developed solutions in order to avoid duplication of effort).

- Figure 4 figure heading: “the different dataset” should be “the different datasets”?

Thanks, this has been corrected in the revised version of the manuscript.