Point-by-point response document

We thank the reviewers and the editor for their supportive feedback and constructive comments. We have responded to all comments online and, in this document, and outline below how they have been incorporated into the manuscript using the following structure: (1) comments, (2) responses, and (3) revisions.

REVIEWER 1

Comment

> The authors could mention CIG (https://community.geodynamics.org) somewhere as complementary to the work studied in this paper.

Response

> The reviewer raises an important point, there are indeed several complementary initiatives in this space, and we will incorporate this.

Revisions

> Lines 53–59:
>
> "The geoscience community can be broadly organized into several major research domains, each supported by representative organizations that coordinate community efforts, develop shared infrastructure, and accelerate scientific progress. These domains include hydrology (e.g., Consortium of Universities for the Advancement of Hydrologic Science, Inc.), Earth surface dynamics (e.g., Community Surface Dynamics Modeling System), geodynamics (e.g., Computational Infrastructure for Geodynamics), and atmospheric science (e.g., National Center for Atmospheric Research). Each of these domains is supported by organizations that foster collaboration, develop community standards and cyberinfrastructure, and engage researchers to advance understanding within their respective fields."

Comment

> Adding blank lines to separate new paragraphs would be helpful. This is done in some parts of the paper, but not others. In particular, it would be helpful in the references section.

Response

> If not part of the editorial process, we are happy to include blank lines throughout the manuscript. We can update the formatting style to better separate references as long as this is allowed by the style used by the journal.

Revisions

> Where missing, blank lines were included to separate new paragraphs.

Comment

I find some of the terminology here a little confusing. When I heat models today, I think of machine learning or AI. The models here are more modeling/simulation programs or functions. Note that the FAIR4RS principles are about Research Software. There is also a group working on FAIR4ML, where ML is machine learning models. If the authors want to keep using "models", it should clearly be defined at the start.

Response

We propose to include a sentence that better explains what we mean when discussing models.

Revisions

Line 29-32:

'In this study, the term "model(s)" refers broadly to process-based (mechanistic), empirical or statistical, stochastic, reduced-complexity (conceptual), and hybrid modeling approaches.'

Comment

Similarly, when looking at Figure 2, it's unclear to me if "publish data model and records" is discussing the software or the data that it produces. And in the F row, what metadata is being discussed? Metadata about data or metadata about the software? This is made more clear in the paper text, but the figure/caption could also be clarified.

Response

We agree with the reviewer that it can be confusing when talking about data models for models. We will add clarifying text to the Figure 2 caption including examples, for clarity.

Revisions

Line 130-132:

In phases 1 and 2, metadata v1 and metadata v2 refer to metadata about the models (e.g., Supplement Tables 2 and 3). In phase 3, the data model and records refer to the data model and records for the catalog items (e.g., Serna et al., 2025).

Comment

46 - perhaps mention https://www.researchsoft.org/tf-actionable-fair4rs/

Response

We agree and propose to include the reverence.

Revisions

Line 49-50:

(e.g., the Actionable FAIR4RS Task Force; https://www.researchsoft.org/tf-actionable-fair4rs/).

Comment

75 - Please add the names of the two model catalogs to the caption

Response

We propose to edit the caption to name the two catalogs.

Revisions (in bold)

Line 85:

Figure 1: To illustrate the subject matter contents of **the CSDMS Model Catalog and the USGS Model Catalog**, this figure shows the relative proportion of domain tags (Hydrology, Terrestrial, Coastal, etc.) for the two model catalogs.

Comment

332 - I strongly disagree with idea here that using a CC0 dedication/license is appropriate. While Creative Commons says this can be done (https://wiki.creativecommons.org/wiki/CC0_FAQ#May_I_apply_CC0_to_computer_software.3F_If_so.2C_is_there_a_recommended_implementation.3F), it mentions that OSI does not approve this, and given that many projects consider the use of an OSI-approved license the definition of open source, software that has a CC0 dedication may not be considered open source. Also, even CC says that CC0 is a dedication, not a license. See https://opensource.org/blog/public-domain-is-not-open-source for OSI's view.

Response

We do not disagree with the reviewer. However, the Department of the Interior official policy dictates that we use CC0 - this was decided in order to align with the policy that government-funded work must be public domain and used freely. The CC0 license is specified in the Department of the Interior SHARE IT Act Memorandum, Attachment A.

If the reviewer (or readers of this response letter) are interested, the rest of the Department of the Interior license wording is:

CC0 1.0 Universal This software and associated documentation files are works of The

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Revisions

Line 351 – 336

For models developed by USGS scientists, the Creative Commons CC0 1.0 Universal Public Domain Dedication is applied to model source code (USGS Office of Science Quality and Integrity FAQ 137). We note that CC0 is a public domain dedication rather than an OSI-approved open-source license; it is applied here because USGS, as a bureau of the U.S. Department of the Interior, is required by the SHAREIT Act Memorandum to dedicate federally-funded software to the public domain through CC0. Code released under CC0 enters the public domain, allowing anyone to use it without restrictions from the copyright holder (https://creativecommons.org/public-domain/cc0).

Comment

455 - it might be worth mentioning LLMs here, as this is the technology that is being most tested for this purpose.

Response

Agreed, we will address this comment.

Revisions

Line 475:

"for example through the use of LLMs (large language models)"

Comment

551 - JOSS could be cited - One recent paper is https://doi.org/10.31274/jlsc.18285 (Note that I am an author of this.)

Response

We propose to add the suggested reference to support the mention of the JOSS Journal.

Diehl, P., Soneson, C., Kurchin, R. C., Mounce, R., and Katz, D. S.: The Journal of Open Source Software (JOSS): Bringing Open-Source Software Practices to the Scholarly Publishing Community for Authors, Reviewers, Editors, and Publishers, Journal of Librarianship and Scholarly Communication, 12, https://doi.org/10.31274/jlsc.18285, 2025.

Revisions (in bold)

Line 573:

"CSDMS now relies on the JOSS journal, the Journal of Open Source Software **(Diehl et al., 2025)**"

Comment

577 - It would be useful to mention SciCodes.org here, and for the authors to participate in it if they don't already, or at least to make sure that their lessons get back to that community.

Response

This is an excellent suggestion, and we will include a mentioning of SciCodes

Revisions

Line 602-604:

"Representatives of the product teams of both model catalogs are part of the SciCodes Consortium (https://scicodes.net), which aims to foster collaboration and standardization among scientific software registries to improve the discoverability, interoperability, and reuse of research software across disciplines."

REVIEWER 2

Comment

From the perspective of a model user, easy installation and clear instructions for the setup and execution are critical for effective reuse. Even when models are openly

available, complex installation procedures or incomplete documentation can make them difficult to adopt in practice. Users benefit greatly from straightforward installation processes, well-documented dependencies, and clear guides for running and adapting the model. Including example workflows or usage demonstration can further help new users understand how to use the model. Emphasizing how these aspects are done by the two catalogues will strength the discussion of the model adoption and reuse (Reusability)

Response

We agree with the reviewer that clear installation instructions and well-documented model code are essential for enabling the reuse of, and further development based on, existing models. Additional contributions from model developers or the user community, such as providing example use cases for executing simulations, for instance in the form of executable notebooks, can further lower the barrier to model adoption. At the same time, we recognize that not all scientific projects have the resources to support such efforts. Accordingly, while well-documented model code and the inclusion of executable notebooks is strongly encouraged for submission to the described model catalogs, it is not a formal requirement.

For clarity, we addressed the importance of this in the first paragraph of section 2.4.2: "Software typically relies on other software components, such as libraries, modules, or external packages, to function properly. These dependencies can be cumbersome to install or integrate. It is a good practice for model developers to provide detailed documentation regarding dependencies such as up-to-date Makefiles, environment.yml, requirements.txt, and README documents. This supports potential model users that have less experience with a model to execute a model simulation on their platform of preference. Following good coding practices, this information is included in the source code, consequently, CSDMS does not include these detailed dependency specifications as part of its metadata records."

However, the catalog initiatives have intensions to emphasize more on the above mentioned aspects and we propose to include this in the text, under future efforts.

Revisions

Line 634-637:

"CSDMS might explore the use of containerization technologies such as Apptainer and Docker, which encapsulate code, dependencies, and runtime environments into portable, versioned units (Vanegas Ferro et al., 2022). This approach supports reproducibility and interoperability across platforms while enhancing the findability, accessibility, and reusability of numerical models through easier distribution and reuse."

Comment

In section 2.4, the paper could include more examples of how models have been reused across projects or disciplines to illustrate the practical benefits of FAIR principles. The example could include: workflow, required adaptations, and the time saved compared with a “pre-FAIR” approach.

Response

This is an excellent suggestion that now incorporated in the manuscript.

Revisions

Line 332-339:

“Using model components of LandLab, Campforts et al. (2022) developed the landscape evolution model Hylands to investigate the influence of landslides and their associated sediments on landscape evolution. This effort involved creating three new LandLab components, reusing two existing components (FlowAccumulator and ChannelProfiler), and leveraging five service components, such as functionality for reading NetCDF data files. While we cannot quantify the exact time savings, the reuse of existing LandLab components and services likely reduced development time substantially by eliminating the need to reimplement and validate core functionality. This enabled the authors to focus their effort on developing new process representations rather than rebuilding standard modeling infrastructure.”

Comment

The paper has omitted in the “Interoperability & reusability” discussion the portable images using containerization technologies like Docker and Apptainer. These tools are essential for enhancing the FAIR aspects and enabling easier access and functionality for model users. These technologies facilitate the creation and sharing of reproducible research environments. For instance, Docker allows user to package applications with their dependencies into portable containers and makes them accessible across various systems. Similarly, Apptainer emphasizes security and use in high-performance computing context.

Response

In section 3.3 we propose to include the mentioning of Docker and Apptainer, something CSDMS is already experimenting with. Next steps for the USGS Model Catalog are already mentioned in that section.

Revisions

Lines 634-637

“CSDMS might explore the use of containerization technologies such as Apptainer and Docker, which encapsulate code, dependencies, and runtime environments into portable, versioned units (Vanegas Ferro et al., 2022). This approach supports reproducibility and interoperability across platforms while enhancing the findability,

accessibility, and reusability of numerical models through easier distribution and reuse."

REVIEWER 3 / EDITOR

Comment

I have gone through your manuscript, and I would like to point out that the "Code and Data Availability" section, in its current form, is misleading. The section is there to declare the provenance and where to get the software necessary to replicate the presented work. Your manuscript discusses software, but does not depends on the mentioned ones to replicate it. Therefore, in this case, it is more accurate that declare in the section that **no code is necessary to produce the discussion and results presented in your manuscript.**

Response

Thank you for this comment. We propose to follow the Editor's suggestion and revise the paragraph in the "Code and Data Availability" section to read: "No code is necessary to produce the discussion and results presented in this paper." At the same time, we will retain the statement describing the availability of the USGS catalog, including the link to the Zenodo repository: "The U.S. Geological Survey (USGS) model schema and metadata files describing USGS models are available under a Creative Commons CC0 1.0 Universal (CC0) license at: https://doi.org/10.5281/zenodo.17408255."

Revisions (in bold)

Line 680

"**No code is necessary to produce the discussion and results presented in this paper. However,** the U.S. Geological Survey (USGS) model schema and metadata files describing USGS models are available Creative Commons CC0 1.0 Universal (CC0) at: https://doi.org/10.5281/zenodo.17408255."

Comment

If I am wrong and I have missed any piece of code or model that you really use, then of course you should cite it, but GitHub sites and others not accepted according the policy of the journal are not valid. USE E.G. ZENODO

Response

To comply with the journal's requirements, we will remove references to GitHub and other open-source code repositories and instead cite the corresponding resources via Zenodo repositories.

Revisions

Line 377: CSDMS: LandLab (see changelog.md file):

Line 378: USGS: MODFLOW6 and related programs website and is an example for a very large model project.

Line 380: USGS: StreamMetabolizer README (Example for a smaller model project).