Geoscientific
Model Development
Discussions

Interactive comment on "Shingle 2.0: generalising self-consistent and automated domain discretisation for multi-scale geophysical models" *by* Adam Candy and Julie Pietrzak

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Anonymous Referee #1

We would like to thank the reviewer for their constructive comments which have enabled us to produce a revised version which we feel is significantly improved. Parts of the review that have been included below are shown in *italics* and quotes from the paper in serif type. The changes made to the manuscript are highlighted in the attached supplement PDF file.

General comments

This manuscript presents the general structure and design of the Shingle 2.0 library. The goals of the library are to allow the full description of domain discretizations in a reproducible and shareable manner. From this perspective meshes are an integral part of the overall model description. This contrasts with the somewhat ad-hoc manner in which meshing is often treated in today's literature. Shingle 2.0 uses the Spud library, which allows common model features to be exposed to users through a hierarchical options interface, diamond, that is easily extensible when new features are required.

The general idea of this library is excellent. Meshes and domain discretizations should be treated much better than they often currently are and allowing users to share and build on other authors' work in a reproducible manner will certainly be helpful. I am however concerned that while this paper does a reasonable job of the difficult task of presenting the library, much of the theory (and the original version of the Shingle library) appears to be in a paper (Candy, A.S., 2016. A consistent approach to unstructured mesh generation for geophysical models.) that is still under review. This manuscript relies heavily on this paper, frequently citing and referencing it, and the authors have made it available online, which is useful, but it would seem odd if this manuscript was published first.

We appreciate the comments on the use of the library. We also agree that there is a clear split in focus, that theory and a consistent approach is the main driver of Candy (2016) and handling very complex, multi-scale spatial discretisations with many constraints the motivation of this work. We have tried to ensure the distinct aims are listed and made clear in the outset of both. Preprints are openly available online. While both are under review we hope they will be published in a similar timeframe. This will open the overall approach to a wider audience in general.

Beyond this manuscript the library appears to be well documented and I was able to install it however the claim is made (e.g. line 541) that deviations in the mesh are only expected to depend on the version of the shingle library. This seems like quite a bold claim, given that the library has a number of dependencies. These dependencies should be discussed in the manuscript - some are mentioned throughout but some more discussion or a table would be useful (a full list is provided in the manual).

The reviewer is correct that dependencies can cause deviations in the output spatial discretisations. In fact there are a number of dependencies highlighted in line 541 (now line 613). We agree this is a useful point to discuss further and have expanded this

part of the paper in response. In order to clarify, the new table 3 has an exhaustive list of dependencies, together with the potential deviations they may cause, the risk and mitigation approaches employed. Line 541 (now 613) has also been modified to mention tessellation algorithm implementations and link to the table for more details.

In the large part this is an issue with all numerical simulation models which are linked to and use other libraries. The version of these depend on the build environment, which can vary between systems and over time. Here we are taking the opportunity to be more explicit about these dependencies. We thank the reviewer for the encouragement to clearly highlight the dependencies and their potential impact on the use of the library.

In addition to the dependencies that have the potential to cause deviations, we note that the new table 2, listing the functions in Shingle that use external libraries has also been added, supplementing the details in the schematic of figure 2.

> *A number of example snapshots are given but these are mostly taken from the aforementioned paper, Candy 2016. I think it would be very useful if a full worked example was included in this manuscript. This would demonstrate the workflow and could be used to direct potential users to more complete examples in the manual.*
>
> *A worked example may also help to illuminate Figure 2, which is referenced a lot but did not help me to understand the manuscript very much. It's quite a confusing list set of arrows and labels, with no clear workflow presented. I realize there may be multiple possible workflows depending on how the user interacts with the library but these could be described much better in worked examples.*

The 2010 Chile earthquake example was intended to be a full worked example in the paper and guide the reader through a sample workflow. A description of the domain is presented in words in (*) on page 4 from line 70. This is then shown entered into the Diamond GUI in figure 4, which in the background negotiates with the Shingle library to ensure options are valid and follow the structure shown in figure 3. This generates the BRML file (in XML) in figure 5. This is then processed by the Shingle library to generate the output spatial discretisation shown in figure 7.

The reviewer has highlighted that this was not made clear enough in the paper. In

response we have added two sentences (lines 65-8) to explain the Chile 2010 case is used as a worked example, starting from line 65, straight into (*) and concluding with figure 7. To additionally help illuminate figure 2, this new text points out this follows the simplest high-level workflow illustrated across the top, from Diamond GUI to Shingle to mesh.

A selection of example discretisations are shown in figure 1, some of which appear in the paper Candy (2016). These are included to motivate the aims of the paper – that a generalised approach is needed, that is model-independent and applicable to a range of Earth Systems.

The only other case also appearing in Candy (2016) is part of figure 9, which was useful to include to highlight that global domains can be considered. The rest of figure 9 contains new studies on selected regions.

All other cases are new and do not appear elsewhere. This includes the full worked example of the 2010 Chile tsunami in figures 4, 5 and 7; the Caribbean Sea basin in figure 8; and new studies on selected regions of Antarctica in figure 9.

In addition to the main full worked example of the 2010 Chile tsunami that follows the simple Diamond to Shingle to mesh workflow, other ways to interact and full workflows are provided. Figure 6 includes three example Python codes, which with Shingle installed, directly run to give output spatial discretisations. The conclusions discuss Jupyter notebooks, which are a good interactive way to see and explore full workflows. Example notebooks are provided with the Shingle library (now noted in footnote 10, below line 694) and discussed in more detail in the manual.

Technical corrections

> – *line 32: missing "is": "... - is likely to grow."*

The word 'is' added such that the sentence reads better, as suggested.

– *line 49: first reference to table 1 (page 3) but then table 1 doesn't appear until page 9. Please move up.*

Table 1 has been moved up to appear directly following its first reference.

– *line 100: the sentence beginning "Its modular library framework, ..." is very long and unwieldy. Please break up.*

This sentence has been broken into two:

> It has a modular library framework, with for example, geospatial operations, homeomorphic projections, meshing algorithms and model format writers the focus of distinct modular parts.
> This together with the use of standard external libraries where possible allows development to remain in small sections of the code base such that developers can stay within their specialisms.

– *line 133: typo? "Lower-lever" → "Lower-level"?*

Corrected to 'Lower-level'.

– *line 148: Another unwieldy sentence. Consider changes marked by *: "The LibShingle library*,* central to the generalised approach (illustrated in figure 2)*,* is detailed in section 5 *and* ways to *interact* with the framework *are* presented in section 6. Examples and validation *are* covered in section 7,..."*

Sentence improved following suggestions.

– *line 162: outcome*s**

Corrected to 'outcomes'.

– *after equations 7 and 8: "identification elements" are not defined*

The text following equations 7 and 8 has been expanded to clarify the "identification elements", to become:

<div align="center">C5</div>

> to give the full domain discretisation of $\Omega \subset \mathbb{R}^3$, consisting of a tessellation or honeycomb together with identification of the boundary and internal regions (i.e. $n_{\Gamma'}$ and $n_{\Omega'}$).

– *figure 4: make bigger (text width?) and higher resolution?*

Figure 4 has been regenerated at a higher resolution and widened to the text width as suggested.

– *line 313: "This information can *be* presented..."*

Sentence corrected to include 'be'.

– *line 537: "... if possible, *is* better handled automatically..."*

Sentence corrected to include 'is'.

– *line 673: "... in *the* COPYING *file*..."*

Sentence corrected following this suggestion.

Bibliography

Details of all references cited above are provided in the revised paper.

Please also note the supplement to this comment:
https://www.geosci-model-dev-discuss.net/gmd-2017-47/gmd-2017-47-AC1-supplement.pdf