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Geoscientific Model Development Discussions

Interactive comment on "PatCC1: an Efficient Parallel Triangulation Algorithm for Spherical and Planar Grids with Commonality and Parallel Consistency" *by* Haoyu Yang et al.

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We thank Reviewer #1 for the comments and suggestions very much. We have modified the manuscript accordingly. In the following, we will reply them one by one.

1. The strength of the paper lies in the discussion of parallel consistency and the hybrid-parallel task scheduling. However, the objective of the overall design should be made more clearly: Do the authors aim for a data-parallel algorithm in order to avoid memory bottlenecks? In this case the step (1) in 4.7 would need revision. Otherwise, why should the principal goal be a task parallel algorithm if "most existing couplers can read in ofïňĆine remapping weights" (l.28)? Furthermore, enforcing a unique triangu-

lation would have no practical use for the calculation of ofïňĆine remapping weights. – Please clarify the design objective.

Response: Online remapping weights generation can improve the friendliness of couplers, because users will no longer be forced to manually generate offline remapping weights after changing model grids or resolutions. Some existing couplers such as OASIS and C-Coupler already have the ability of generating online remapping weights. C-Coupler1 and C-Coupler2 have already employed a sequential Delaunay triangulation algorithm for the management of horizontal grids. When cell vertexes of a horizontal grid are not provided, they can be automatically generated from the Voronoi diagram based on the triangulation and further used by non-conservative remapping algorithms (the couplers will force users to provide real cell vertexes of grids involved in conservative remapping).

PatCC1 should be a data-parallel algorithm. To minimize memory usage and synchronizations among computing resource units, we prefer data parallelization for each step of PatCC1, where different computing resource units generally handle different sub-grid domains. Considering that the sub-grid domains to be decomposed dynamically change throughout the main recursive procedure of the grid decomposition (Step 3), we implemented task-level OpenMP parallelization to achieve data parallelization, where all tasks correspond to the same procedure but different sub-grid domains.

The manuscript has been modified accordingly. Please refer to P2L31∼P2L34, P11L350∼P11L354, and P15L487∼P16L490.

2. Strictly speaking, the paper does not formulate a concise algorithm. The scientiïňĄc results will be reproducible only after the source code has been published (announced in the manuscript summary).

Response: The source code of PatCC1 will be publicly available with the final version of the manuscript.

3. The introduction is well written; however, the problem of data interpolation in Earth system modelling is formulated in a rather narrow sense: Vertical remapping, grid staggering, the treatment of over- and undershoots, interpolation of tangent vector ïňĄelds etc. should be mentioned. All these aspects highly depend on the set of variables and the grid under consideration.

Response: Other aspects related to data interpolation in Earth system modelling have been mentioned in the revised manuscript. Please refer to P1L24∼P1L25.

4. The proposed algorithm applies to horizontal interpolation of scattered data sets only. Neglecting the grid topology and rebuilding a Delaunay triangulation means that the algorithm is unsuitable for masking and conservative remapping of ïňĄnite volume data.

Response: C-Coupler1 and C-Coupler2 have already employed a sequential Delaunay triangulation algorithm for the management of horizontal grids. When cell vertexes of a horizontal grid are not provided, they can be automatically generated from the Voronoi diagram based on the triangulation and further used by non-conservative remapping algorithms (conservative remapping algorithms must use the real cell vertexes provided by users). This point has been stated in the revised manuscript (P15L488∼P16L490).

5. The decomposition method is actually very similar to classical algorithms like kdtree half-space subdivision in lon-lat space. The authors should at least expose this similarity and maybe shorten their presentation.

Response: The grid decomposition is similar to k-d tree in longitude-latitude space. This point has been stated in the revised manuscript (P9L265).

6. How do the authors deal with load imbalance due to meridional convergence of a source latitude-longitude grid?

Response: To address this problem, we developed a fast triangulation procedure (its time complexity is O(N)) specific for latitude-longitude grid domains, which will be used

when a polar sub-grid domain has been confirmed as a latitude-longitude grid domain. The manuscript has been modified accordingly. Please refer to P10L298∼P10L303.

7. Points which geometrically coincide at the poles are modiïňĄed in an elaborate way. For Earth system models, this should not be of practical use, since the source grid points may be topologically different but (should) consistently contain the same value.

Response: As PatCC1 is unable to guarantee that all points at a pole consistently correspond to the same value of each field throughout any model integration, no polar point can be pruned by PatCC1. The manuscript has been modified accordingly. Please refer to P5L42∼P5L146.

8. Does the computing resource manager take the faster shared-memory communication into account when decomposing the domain?

Response: As introduced in the manuscript, if two computing resource units are two threads belonging to the same MPI process, the communication between them will be achieved through their shared memory space; otherwise, the communication will be achieved by MPI calls. In the grid decomposition, shared-memory communication is also used among the OpenMP threads in a process.

9. A practical parallel algorithm for merging the local triangulations is not presented (e.g. k-way merge)

Response: To merge the local triangulations, the root computing resource unit will gather all triangles within or across any boundary of each kernel sub-grid domain from all computing resource units, and then prune repeated triangles (after passing the parallel consistency check, any pair of triangles with overlapping area are the same). The manuscript has been modified accordingly. Please refer to P10L315∼P10L319.

10. Round-off problems, which typically appear (e.g. in the local triangulation step) are not discussed.

Response: The round-off problems have discussed in the revised manuscript

(P16L493∼P16L500).

11. The user-deïňĄned expansion rate (l.255) is not explained in detail. How could this rate be determined automatically, ensuring an optimal workload?

Response: The expansion rate has been discussed in the revised manuscript (P8L259∼P9L260, P12L358, P16L501∼P16L505).

12. l.42: “horizontal grids”

Response: This error has been fixed in the revised manuscript.

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