Review of GMD-2021-349

Title:
TriCCo v1.0.0 – a cubulation-based method for computing connected components on triangular grids

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This is a well written manuscript that details the application of a novel algorithm for 3D coordinate labelling of triangular meshes based on embedding these meshes into the space of stacked cubes. While I enjoyed reading through the manuscript, the authors are not particularly convincing about how their algorithm is an improvement among other simpler and more efficient methods. The manuscript largely comes across as describing a mathematical curiosity (i.e., from the right angle a cube looks like a hexagon) rather than an algorithm that one might expect to adopt in practice. My concerns about proper motivation fit into three categories:

Connectivity: It appears that the cubulation-based method does not aid in the identification of connectivity in a given triangular grid. Indeed the algorithm described for the construction of the cubulation is based on a graph search of the dual grid. However, construction of the dual grid requires that we already know the connectivity between triangles of the grid, so that graph edges could be identified between these regions. The authors seem to engage in a bit of circular logic to justify their approach: "Because [triangular meshes] are unstructured, neighbor relations are not self-evident and identifying connected components is challenging. Our method addresses this challenge by involving the mathematical tool of cubulation." But the method itself doesn't actually address this challenge since the connectivity information needs to be known a priori to build the cubulation.

Connected Components: While the authors have clearly shown that the cubulation can be used to identify connected components, no significant effort has been made to compare and contrast their approach with other simpler, robust and efficient algorithms from the literature. For instance, consider the review by He et al. (2017). As mentioned in the previous paragraph, since the connectivity information must be known prior to computing the cubulation, simple O(n) graph search algorithms applied to this connectivity graph can be used for both edge connectivity and vertex connectivity as well. These simple graph search algorithms also have well-known and efficient parallel implementations (e.g., Wu et al., 2009).

He, L., Ren, X., Gao, Q., Zhao, X., Yao, B. and Chao, Y., 2017. The connected-component labeling problem: A review of state-of-the-art algorithms. Pattern Recognition, 70, pp.25-43.

Wu, K., Otoo, E. and Suzuki, K., 2009. Optimizing two-pass connected-component labeling algorithms. Pattern Analysis and Applications, 12(2), pp.117-135.

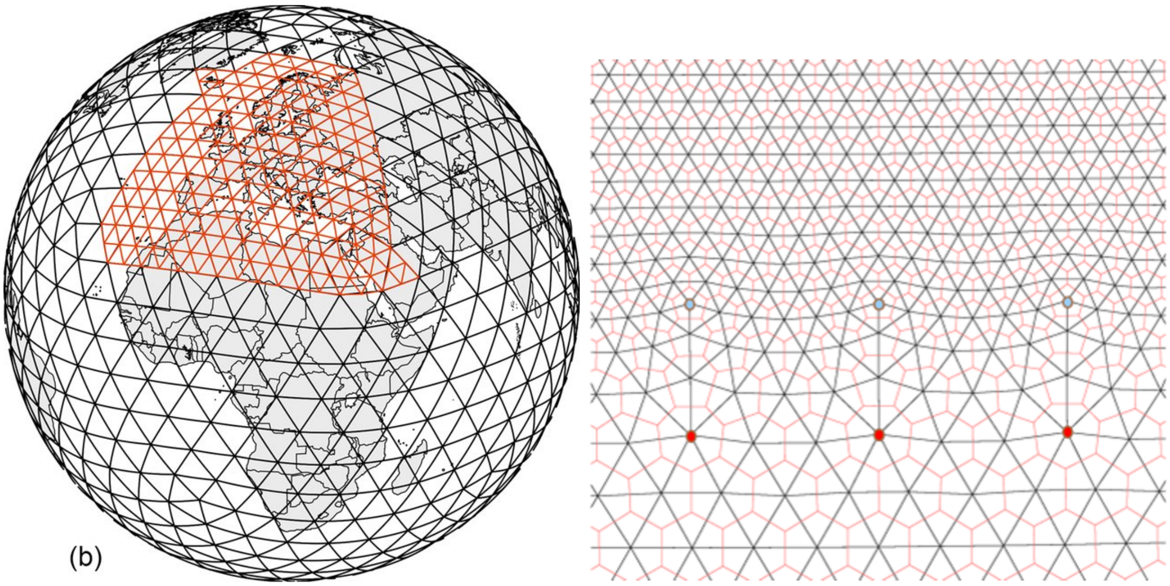

Figure 1: (Left) A regionally refined mesh in the ICON model providing finer resolution over Europe. (Right) A triangular voronoi tesselation and its dual from the OLAM model, here capturing a smooth transition between mesh resolutions.

Robustness: While the authors emphasize early on that their study is focused on unstructured meshes, the only examples given in the text are structured triangular meshes (i.e., isometric grids consisting of equilateral triangles). Is this algorithm applicable to common refined triangular grids used in atmospheric science, such as those depicted in Figure 1?

Given that there is nothing fundamentally incorrect about the manuscript, I am recommending this paper for major revisions, but expect that in a subsequent revision that the authors address the points above and provide some comprehensive justification of how their method is an improvement to existing analysis methods.