Referee statement
I suggest to publish this article in GMD journal after Minor revisions.

General remarks
The manuscript is well written and also well constructed, it is then easy to follow the various cases tested by the authors, from simple 2D objects to more complex objects. The main objective of this manuscript is to demonstrate Firedrake’s applicability for geodynamical simulation. The first part of the manuscript focus of reproducing already approved analytical test cases and well known benchmarks. The authors must also be congratulate for the efforts they have put in describing the previous work done on the topic, which later help understanding the conducted experiments and results. The choice made by the authors to present their Python code by section, displaying each time only differences compared to the initial test case must be acknowledge, as it is very helpful in understanding the paper, and a great asset in reproducibility.

Major comments
Although the paper is well constructed and authors guideline conducting their test cases is relatively easy to understand, I believe the paper readability could be enhanced with the addition of a global table introducing the various cases(from the 2-D to a realistic application in 3-D spherical geometry), their differences and their interests. Some improvement could be brought to figures, in many cases the Y axes could homogeneous to ease reader analysis of the results (cf. Figure 1, 7, 8...).

Minor comments
None.