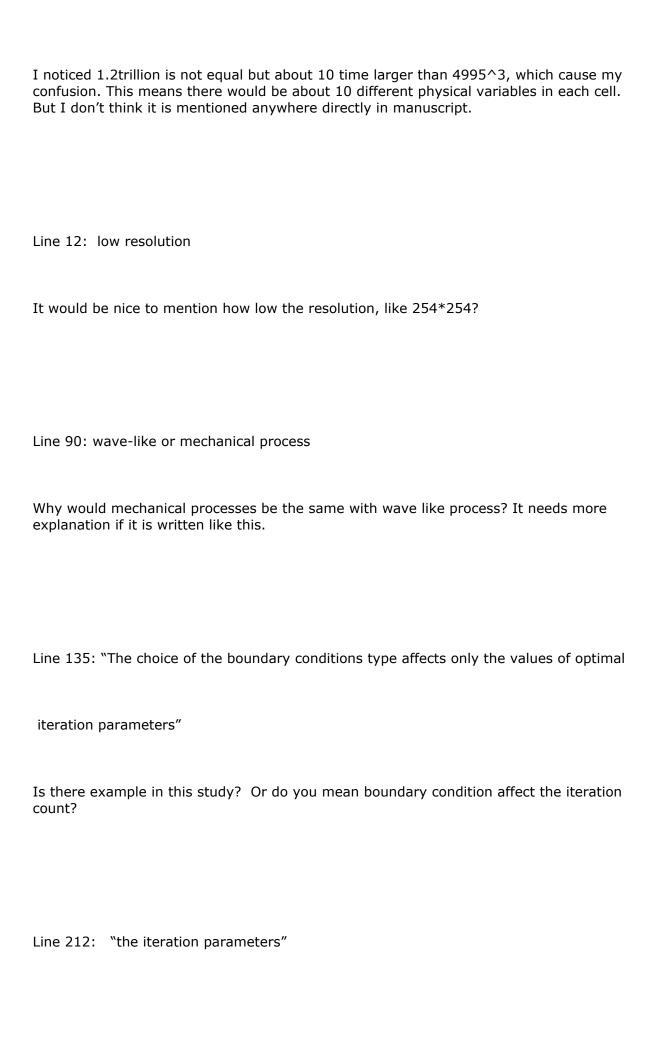# Comment on gmd-2021-411

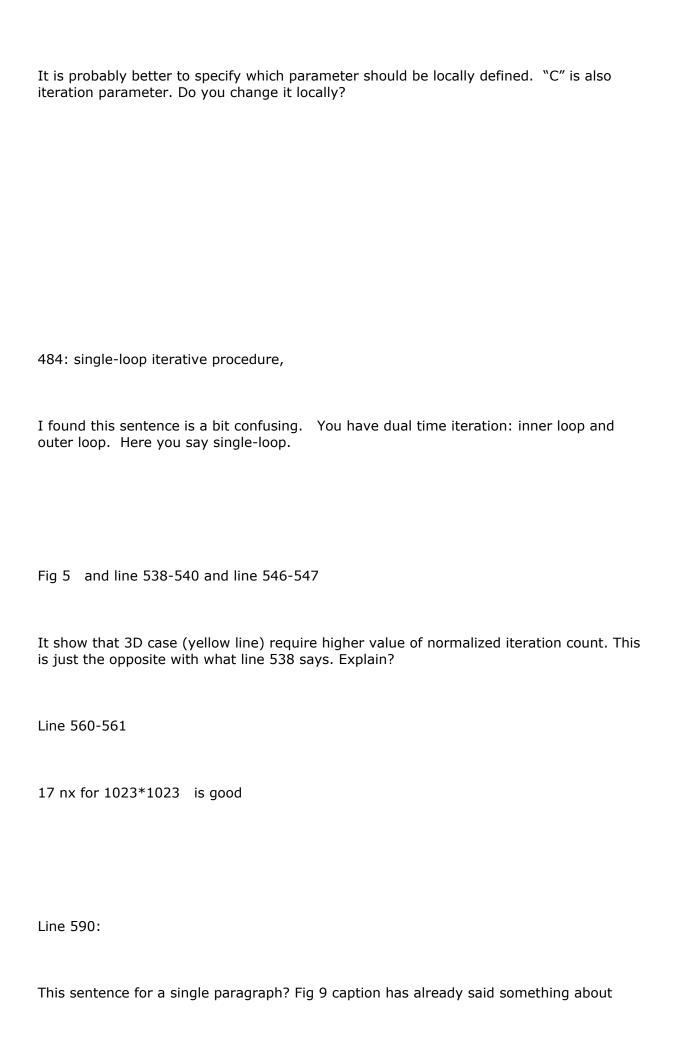Lawrence Hongliang Wang (Referee)

Referee comment on "Assessing the robustness and scalability of the accelerated pseudo-transient method" by Ludovic Räss et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2021-411-RC1, 2022
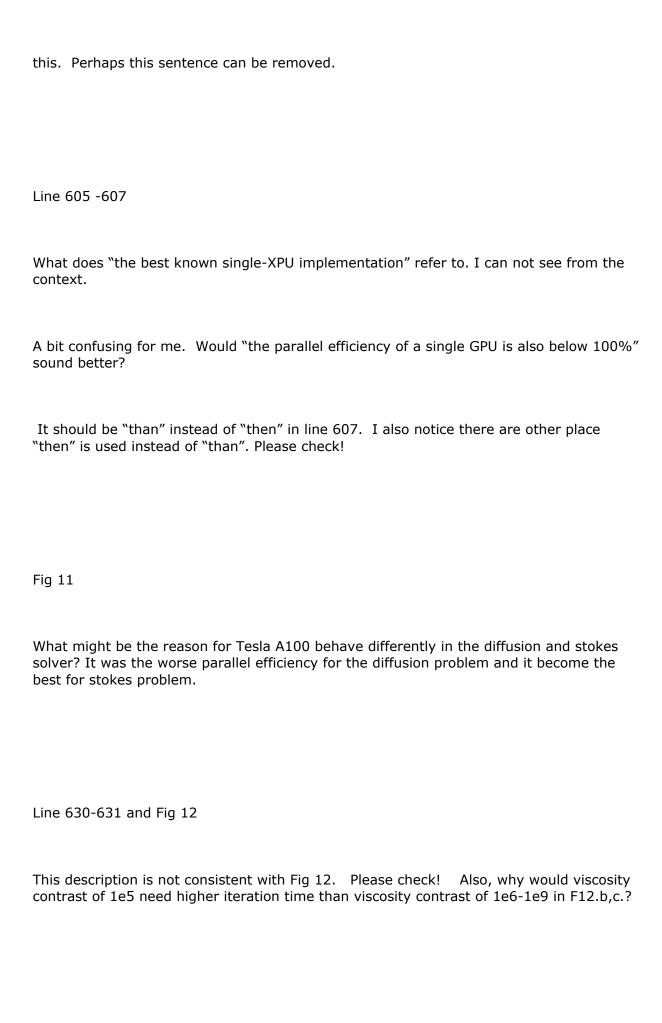
Review of "Accessing the robustness and scalability of the accelerated pseudo-transient method towards exascale computing"

This manuscript addresses the robustness and scalability of a type of pseudo-transient method on solving 2D and 3D multi-physics problem with complex rheology. The present PT method is derived based on a physical description of a process and has been used to solve high resolution 2D and 3D diffusion and visco-elastic Stokes problems. It can handle high contrast of material properties up to 10^9 and the convergence doesn't depend on the initial condition. Most importantly, the present method scale very well up to 2197 GPUs with a parallel efficiency of >96%, which can solve Stokes equation a resolution about 4995^3. These results push beyond the capacity of the current state-of-the-art numerical method and provide a promising future for exascale computing in geoscience, as well as in other fields. The conclusions are well supported by research result and discussion. According to my point of view, the study in this manuscript is of highly importance and it should be published in GMD after some minor revision. My detail comments are as below:

Line 8: 1.2 trillion degrees of freedom

I noticed 1.2trillion is not equal but about 10 time larger than 4995^3, which cause my confusion. This means there would be about 10 different physical variables in each cell. But I don't think it is mentioned anywhere directly in manuscript.

Line 12: low resolution

It would be nice to mention how low the resolution, like 254*254?

Line 90: wave-like or mechanical process

Why would mechanical processes be the same with wave like process? It needs more explanation if it is written like this.

Line 135: "The choice of the boundary conditions type affects only the values of optimal

 iteration parameters"

Is there example in this study? Or do you mean boundary condition affect the iteration count?

Line 212:   "the iteration parameters"

It is probably better to specify which parameter should be locally defined. "C" is also iteration parameter. Do you change it locally?

484: single-loop iterative procedure,

I found this sentence is a bit confusing. You have dual time iteration: inner loop and outer loop. Here you say single-loop.

Fig 5   and line 538-540 and line 546-547

It show that 3D case (yellow line) require higher value of normalized iteration count. This is just the opposite with what line 538 says. Explain?

Line 560-561

17 nx for 1023*1023   is good

Line 590:

This sentence for a single paragraph? Fig 9 caption has already said something about

this. Perhaps this sentence can be removed.

Line 605 -607

What does "the best known single-XPU implementation" refer to. I can not see from the context.

A bit confusing for me. Would "the parallel efficiency of a single GPU is also below 100%" sound better?

 It should be "than" instead of "then" in line 607. I also notice there are other place "then" is used instead of "than". Please check!

Fig 11

What might be the reason for Tesla A100 behave differently in the diffusion and stokes solver? It was the worse parallel efficiency for the diffusion problem and it become the best for stokes problem.

Line 630-631 and Fig 12

This description is not consistent with Fig 12.   Please check!   Also, why would viscosity contrast of 1e5 need higher iteration time than viscosity contrast of 1e6-1e9 in F12.b,c.?

Line 634-635

Which iteration parameter do you use local values in each grid cell? Re?

Line 651.   Eta_vp is not consistent with Eq.46.

Line 794:   extremely low

I agree it is very low. But it would be nice to have a comparison when one say "extremely low". What are the normal/standard value for the iteration count when other iterative method is used!

Line 795. Or numerical additions

It is not clear here what you want to express here!

Line 802:   shear bad

You mean "shear band", I suppose.

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