

The Cryosphere Discuss., referee comment RC3  
<https://doi.org/10.5194/tc-2021-224-RC3>, 2021  
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## Comment on tc-2021-224

Anonymous Referee #3

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Referee comment on "Can changes in deformation regimes be inferred from crystallographic preferred orientations in polar ice?" by Maria-Gema Llorens et al., The Cryosphere Discuss., <https://doi.org/10.5194/tc-2021-224-RC3>, 2021

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Review of ***Can changes in ice-sheet flow be inferred from crystallographic preferred orientations?*** by Llorens et al..

The paper provides a systematic modeling study to examine the effect of pre-existing CPO on final CPO in scenarios where stress state changes in the deformation history. The 4 simplified scenarios are well described and the results are interesting and can help inform interpretation of past flow inferred from core sample microstructures. I recommend publication after some modification.

My main issue is that it feels a little like a black box. I don't understand how you go from the physics of deformation described in section 2 to the results in, say figure 3c. I don't think you need to provide post-processing and exhaustive details, but it seems like it would help readers like myself who do not model if there was a very simple description of how you get figure 3c, so that a person doesn't have to go to Llorens et al. 2016 for the background needed.

Additionally, I provide line by line comments that may help improve readability.

Minor comments:

Line 36: Recommend deleting the word "on"

Line 49: consider reordering this sentence to be clearer. Maybe more like: "Polycrystalline ice (ice Ih) in glaciers, ice sheets, and ice shelves flows in response to gravitational forces."

Line 73: The Durham et al., 1983 paper doesn't have anything to do with CPO development or evolution so isn't appropriate there. Perhaps something by Montagnat?

Line 80: I would add Fan et al. 2020 to this list. I do see you mention it later in the paper, but would be good here as well.

Line 92: consider providing additional refs here to put this work into context with previous modeling efforts

Line 98: sorry, I don't know what a cloudy band is in this context...perhaps define? Are they layers containing dust particles? Perhaps explain why this is or isn't relevant to the effort here

Line 100: perhaps another half sentence for the non-glaciologists: "...experiences multiple changes in deformation regime during ice-sheet flow as it \_\_\_\_\_" (I don't know, changes course and rounds topographical features?...just a flavor of the type of changes made for those who don't know)

Line 107, 369: in intro you didn't use an apostrophe in CPOs for plural. I don't know which it should be, but just be consistent

Line 110: perhaps a sentence here to say something along the lines of flow in nature is complicated, but for ease of understanding you provide the simplified diagram in Figure 1, which divides the flow patterns into four distinct zones. If you are ignoring some aspects of flow (T?) then describe here.

Line 163: I recommend deleting "an"

Line 169: here you define  $n$  as the rate sensitivity exponent, but all other occurrences you call it the stress exponent. If you mean the same thing, I recommend calling it the stress exponent here.

Line 205 to 260: I recommend more clearly stating how you came up with the velocity gradient tensors for each zone. It is not clear if this should be a result or an assumption. If it is an assumption, I recommend more clearly stating that and have this section just be stating that you will run 4 series that represent different transitions from one V to another V, basically introducing Table 2. I would save the qualitative descriptions currently in 3.2.1 – 3.2.4 to instead appear at the beginning of results for each of those series.

Line 209: recommend changing “examples” to “example”

Line 223: recommend making “simulation” plural

Line 256: recommend deleting “of” and “before” from this sentence.

Line 374 (but really 366 – 381): It is unclear where in this paragraph you are referring to historically, as in past studies, and where you mean the results from this study. Try to make it very clear and emphasize how your results confirm or deny previous works by including some words at the beginning of sentences like: “Indeed, our experiments confirm that...” In case the reader does not have prior knowledge of CPO evolution, drag us along very explicitly. [ah, it is much clearer in the 2<sup>nd</sup> paragraph]

Line 429: change “loose” to “lose”

Line 431: recommend changing “effectivity” to “effectiveness”

Line 454: the double negative makes this sentence hard to follow. Consider changing “not destroyed” to “retained”

Line 459: if these results are also in agreement (or even if they are not in agreement) with other polycrystalline materials, here would be a good place to mention that. One study that comes to mind is Boneh and Skemer, EPSL 406, 2014, which experimentally looked at this very thing in olivine. Putting your ice modeling results into broader context might be a good idea.

Line 492: italicize c in c-axis.

Line 493: perhaps reword number 4 to exactly answer the title of the paper? (even if with

a caveat)