

Reply to Reviewer 1.

I am somewhat surprised by the general comment of Reviewer 1 regarding the use of the term “geometric force balance” especially because this reviewer acknowledges to have reviewed the most recent paper by Hughes (2016) for TCD. Admittedly, Hughes has never used the term in the title of his papers. Nevertheless, the term “geometric” originates with Hughes. Most recently, the 2016 paper in *The Cryosphere* (vol. 10, 1993-225) refers to “A geometrical force balance...” in the first sentence of section 3.1. According to the caption, Figure 5 shows “The geometrical force balance on an ice stream...” And on p. 201: “These are real stresses. They are obscured using holistic continuum mechanics in conventional ice-sheet models, but they visibly emerge from the geometrical force balance in the holistic ice-sheet model based on Fig. 5.” Similarly, the earlier paper submitted to *The Cryosphere Discussions* (vol. 8, 2043-2118, 2014) refers several times to “geometrical force balance.” I did change “geometrical” to “geometric” to be in agreement with “analytic.” An internet search failed to give an answer to which form is preferred or correct. My preference goes to “geometric” and “analytic.”

The evaluation of the geometric approach to Byrd Glacier is presented in Section 4 and in Figures 1 and 2. I have added “on Byrd Glacier” to the caption of Figure 2.

Line 169-171: averaged over the length of the segment, gradients in longitudinal stress average -140 kPa, compared to a driving stress of 160 kPa. The minus sign indicates that the stress gradients work in the same direction as the driving stress: adding an additional force driving the glacier forward. I find this surprising. Longitudinal stress gradients may be important on a local scale of a few km, but cannot be as important as the driving stress over a distance of 30 km. The argument that “water buttressing produces a backstress” is not convincing, nor is the idea correct, as is explained in Section 5.

Line 291-293 has been deleted.

Line 337: my apologies for misspelling Whillans’ name.

Reply to Reviewer 2.

Line 33: I will take the analogy out.

Line 45: corrected.

Line 99: done.

Section 3: Interesting question. One can argue that eq. (10) represents the transition from inland-style flow to ice-shelf spreading. However, the way that ϕ is calculated in eq. (12) is incorrect, at least according to my interpretation.

Line 128: changed.

Line 139: done.

Line 142: Leave out: "The achievement here is that"

Line 173: The finding that longitudinal stress gradients act in cooperation with the driving stress over a distance of more than 30 km is surprising and there is no credible evidence that can explain this.

Line 208: eq. (7) has been changed to include the expression (3) for the driving stress explicitly on the left-hand side. I added: with the term on the left-hand side describing the driving stress.

Line 227: yes, that should be equation (2)

Line 235: added a sentence on why this term enters into eq. (17)

Line 248: I don't understand the reviewer's comment.

Line 273: Replace with: As shown in this contribution, the geometric force balance as presented by Hughes in a series of papers cannot be applied successfully to ice streams and outlet glaciers.

Line 280: delete "phantom"

Line 290: deleted