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The Cryosphere Discussions

Interactive comment on "Reduced glacier sliding caused by persistent drainage from a subglacial lake" *by* E. Magnússon et al.

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This is an interesting paper, which presents evidence that changes in the 'seal' region downglacier of Grimsvotn had the effect of reducing basal water pressures and ice velocities. On the whole, the authors' arguments are persuasive, although the following points should be taken into consideration and the paper amended accordingly.

(1) A curious feature of the velocity difference maps in Figure 2b-e is that the upper extremity of the zone of decreased flow does not coincide with the channel (as indicated in Fig. 2a), but veers off to the north-west. The authors should comment on this anomaly, since it is not what should be expected if low water pressures in the leakage zone are the sole cause of the observed slowdown.

(2) The discussion of the cause of the glacier slowdown invokes steady state hydraulic theories, which posit contrasting pressure-discharge relationships for distributed and channelized drainage systems. However, it should be recognized that recent work on glacial drainages has shown that systems fed from the surface undergo large fluctuations in both pressure and discharge, and that pressure-discharge relationships can differ widely from those predicted by steady state theory. For example, work by Hubbard et al. (J Glac. 41, 572-583) on Arolla Glacier shows that, water pressure in a surface-fed subglacial conduit is higher than in the surrounding bed at times of rising recharge, and lower at times of falling recharge. This results in a reversal of the hydraulic gradient at different times of the day. Furthermore, observations and modelling work have demonstrated that, during 'spring events', the glacier speeds up over the channel axis and for a short distance on either side (Hubbard et al., J Glac. 44, 368-378).

Now, given that there are seasonal variations in water accumulation at Grimsvotn (568.9), we might expect that flow conditions along the leakage route will be non-steady, and that pressure-discharge relations may vary throughout the year. All of the velocity maps (Figure 2) are for mid-winter. Are there any data for the summer months? It would be interesting to see if there were any seasonal variations in the flow field. Does the 'slowdown effect' apply for the whole year? Or only parts of the year? If such data are available, they should be included to provide a better picture of the relationship between lake drainage and glacier flow. In any case, the authors should acknowledge the limitations of steady state glacier hydraulic theory, and consider the implications of fluctuating discharges, citing the papers mentioned above.

In addition, I note the following typographical points.

566.23: change 'in' to 'as'

567.26: change 'exceed' to 'have exceeded'

568.11: In view of the previous statement that it was not possible to tell whether draiange occurred continuously or episodically (567.23), change ‘leaked continuously’ to ‘continued to leak’

568.19-20: It is not clear what is meant by ‘a stepwise function of 5 m3 s-1 from June 1997 to June 1999 and 2 m3 s-1 after that’. Rephrase and clarify.

570.9: change ‘constrains’ to ‘constraints’

570.15: change ‘accelerate’ to ‘influence’

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