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*Supplement of*

# Rock glaciers on the run – understanding rock glacier landform evolution and recent changes from numerical flow modeling

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# S1 Rockglacier

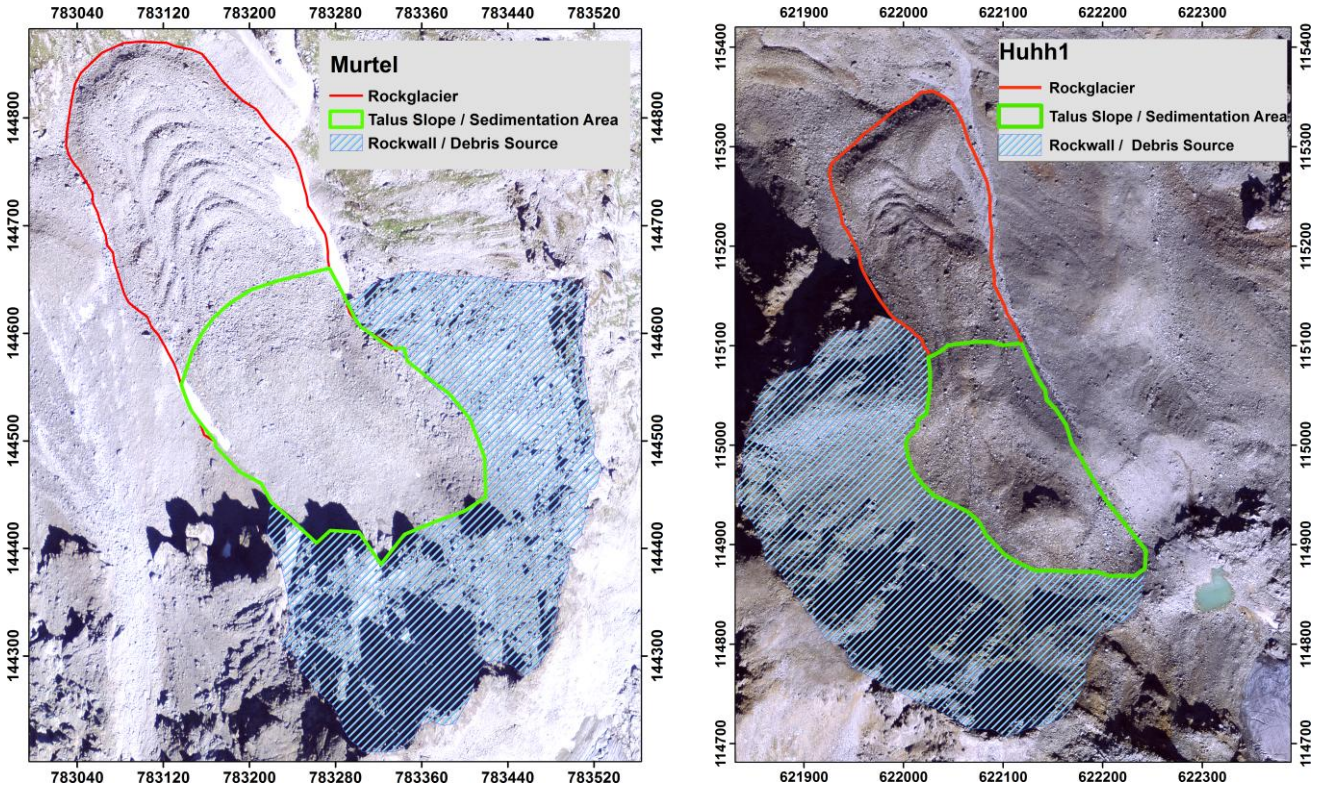



**Figure S1: Orthophotos oft he two selected rockglaciers.**

# S2 Perturbation Experiments

12 scenarios for each rockglacier were developed assuming three different initial thermal states of each rockglacier (-2°C, -1.5°C and -1°C). A potential warming of 1°C was combined with four different scenarios concerning the material input resulting from the suggested temperature increase:

| Model run | Creep Rate change | Accumulation change |
|---|---|---|
| 1.4*A and 0*Acc | 1.4*A | 0*$a_r$ |
| 1.4*A and 0.4*Acc | 1.4*A | 0.4*$a_r$ |
| 1.4*A and 1*Acc | 1.4*A | 1*$a_r$ |
| 1.4*A and 2*Acc | 1.4*A | 2*$a_r$ |
| 1.7*A and 0*Acc | 1.7*A | 0*$a_r$ |
| 1.7*A and 0.4*Acc | 1.7*A | 0.4*$a_r$ |
| 1.7*A and 1*Acc | 1.7*A | 1*$a_r$ |
| 1.7*A and 2*Acc | 1.7*A | 2*$a_r$ |
| 2.7*A and 0*Acc | 2.7*A | 0*$a_r$ |
| 2.7*A and 0.4*Acc | 2.7*A | 0.4*$a_r$ |
| 2.7*A and 1*Acc | 2.7*A | 1*$a_r$ |
| 2.7*A and 2*Acc | 2.7*A | 2*$a_r$ |

The following presents the evolution of surface along central flow line, thickness, thickness change and horizontal velocities of all experiments for the modelled time and both rockglaciers.

## S2.1 Murtèl perturbation experiments

### S2.1.1 Initial rockglacier temperature -2°C, therefore 1.4*rate factor A for a 1°C warming.

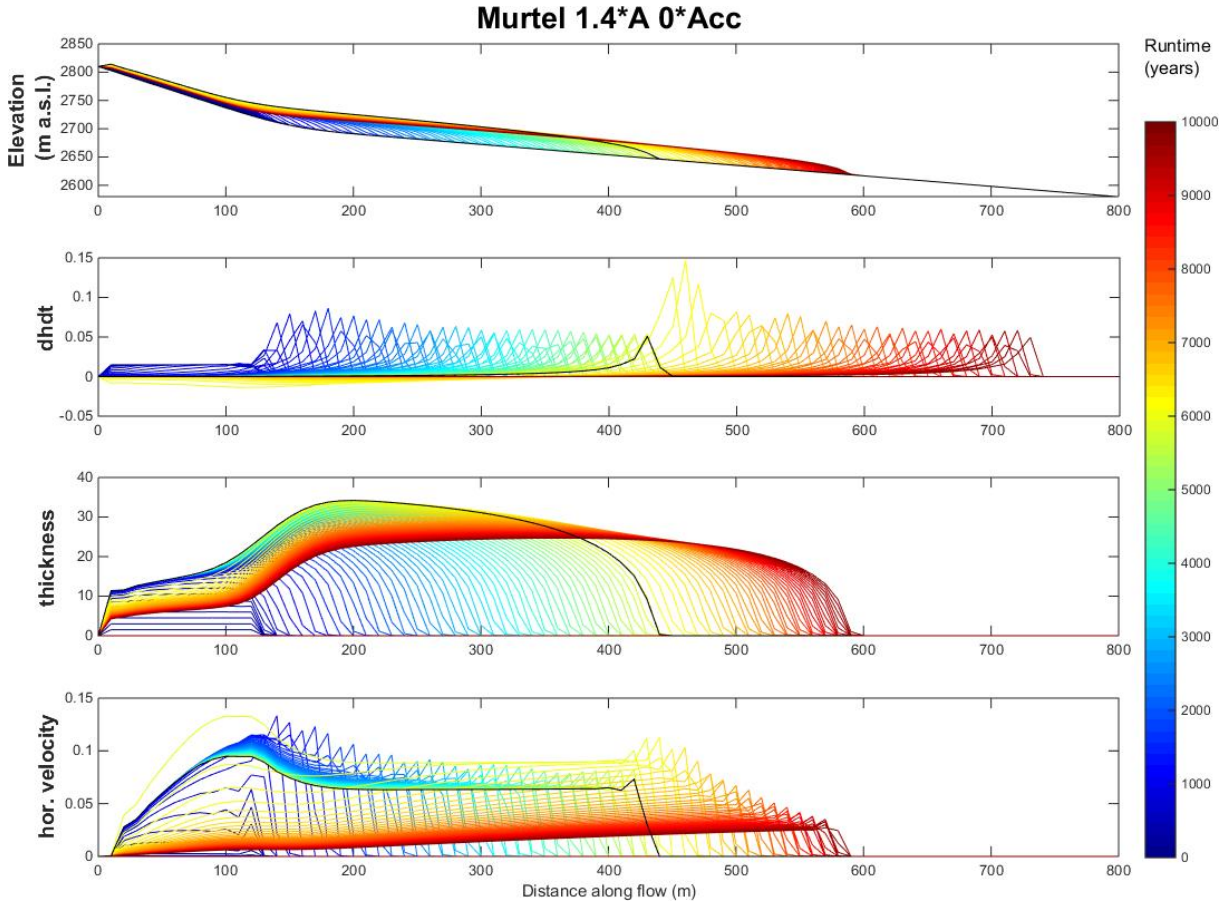



**Figure S2: The evolution of surface geometry, thickness change (dhdt) absolute thickness in m horizontal velocity along the central flow line for rockglacier built-up (6000 years runtime / black line) and complex perturbation experiment (temperature increase of 1°C for a -2°C rockglacier and no material input after 6000 years). The lines are plotted in 100yr steps. Colour scale applies to all following Figures.**

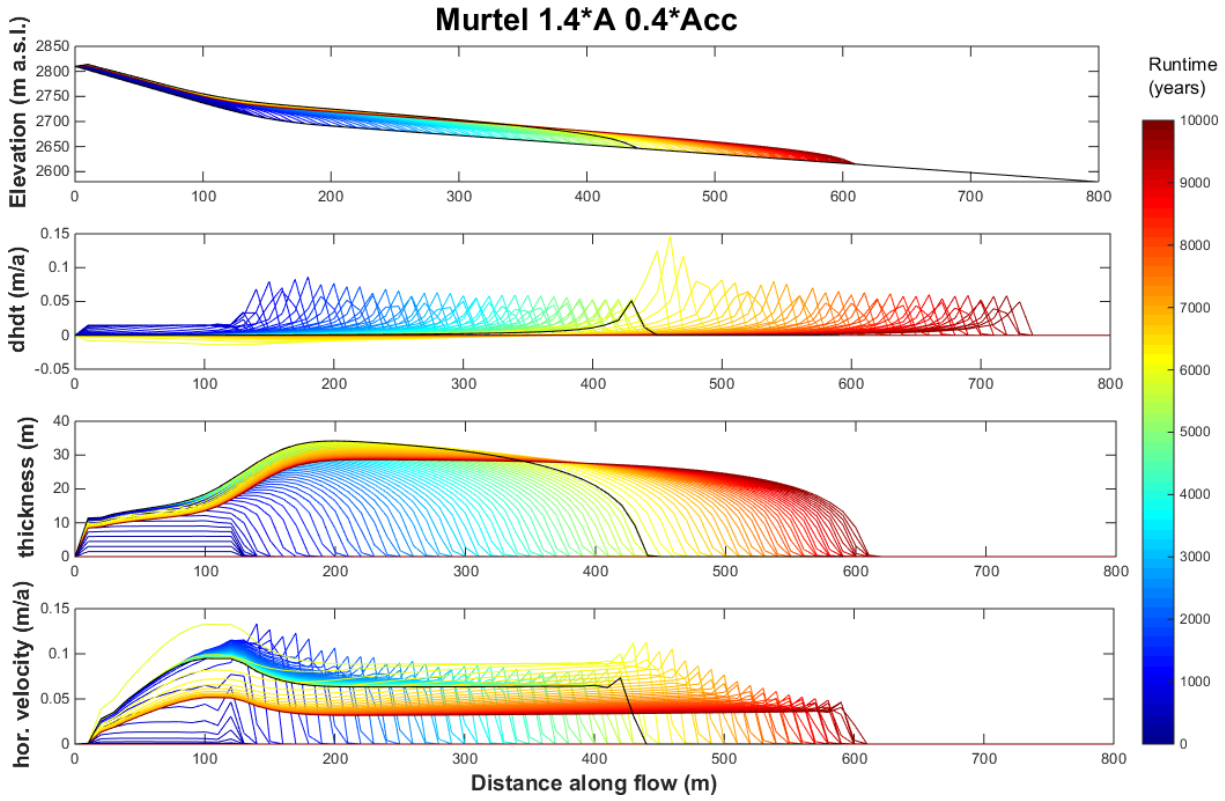



**Figure S3: The evolution of surface geometry, thickness change (dhdt) absolute thickness in m horizontal velocity along the central flow line for rockglacier built-up (6000 years runtime / black line) and complex perturbation experiment (temperature increase of 1°C for a -2°C rockglacier and reduced material input (40%) after 6000 years). The lines are plotted in 100yr steps. Colour scale applies to all following Figures**

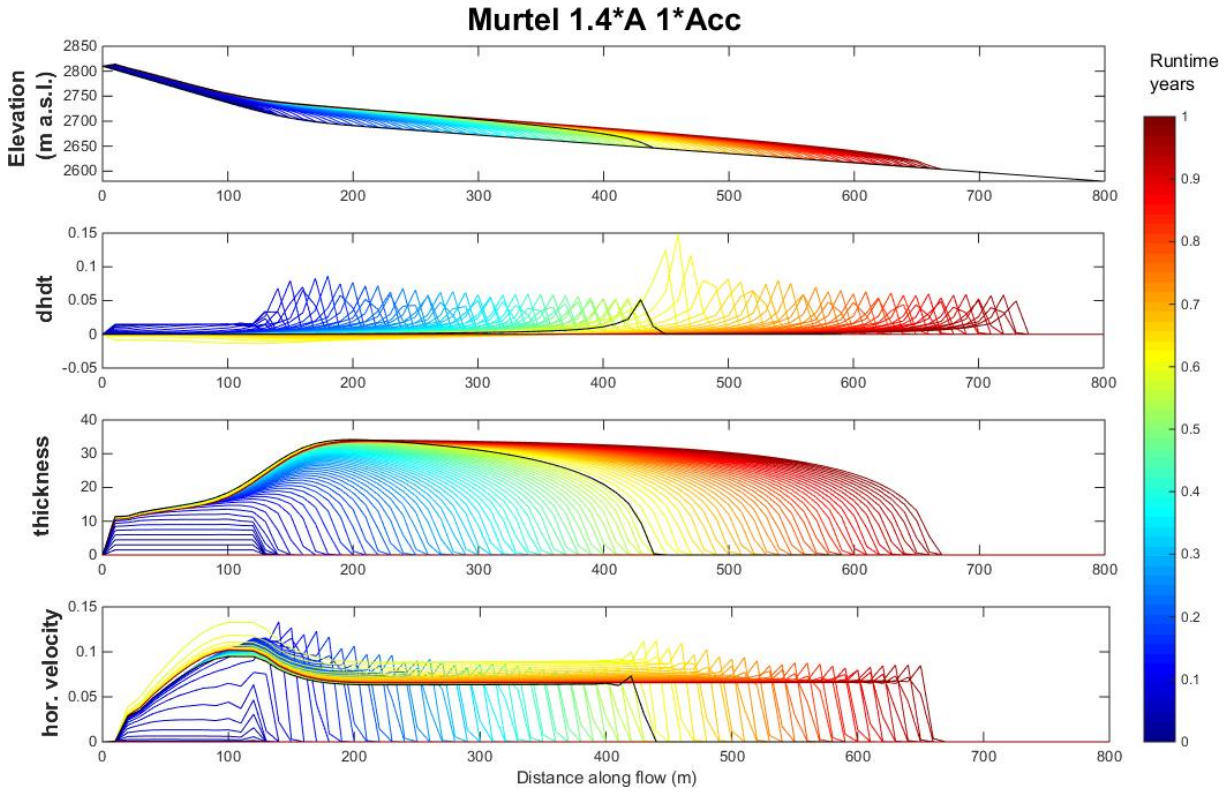



**Figure S4: The evolution of surface geometry, thickness change (dhdt) absolute thickness in m horizontal velocity along the central flow line for rockglacier built-up (6000 years runtime / black line) and complex perturbation experiment (temperature increase of 1°C for a -2°C rockglacier and no change in material input after 6000 years). The lines are plotted in 100yr steps.**

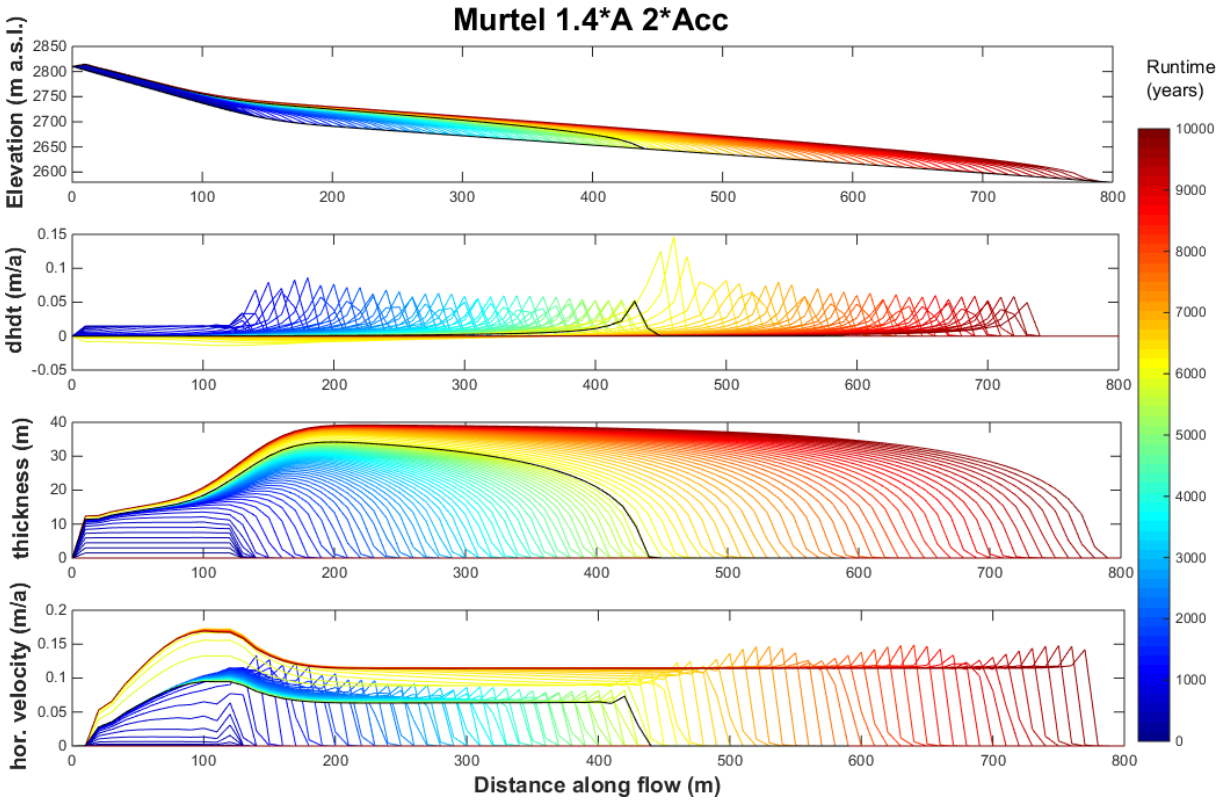



**Figure S5: The evolution of surface geometry, thickness change (dhdt) absolute thickness in m horizontal velocity along the central flow line for rockglacier built-up (6000 years runtime / black line) and complex perturbation experiment (temperature increase of 1°C for a -2°C rockglacier and doubled material input after 6000 years). The lines are plotted in 100yr steps.**

**S2.1.2 Initial rockglacier temperature -1.5°C, therefore 1.7*rate factor A for a 1°C warming.**

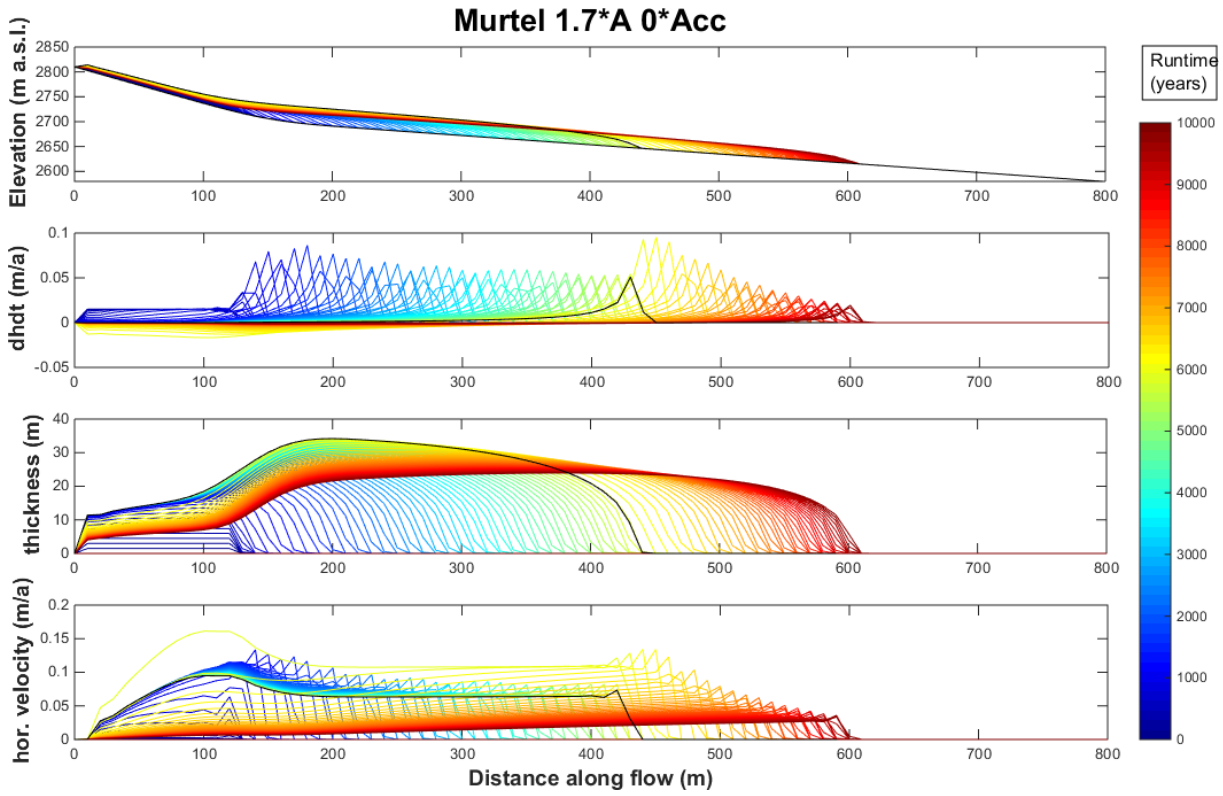



**Figure S6: The evolution of surface geometry, thickness change (dhdt) absolute thickness in m horizontal velocity along the central flow line for rockglacier built-up (6000 years runtime / black line) and complex perturbation experiment (temperature increase of 1°C for a -1.5°C rockglacier and no material input after 6000 years). The lines are plotted in 100yr steps.**

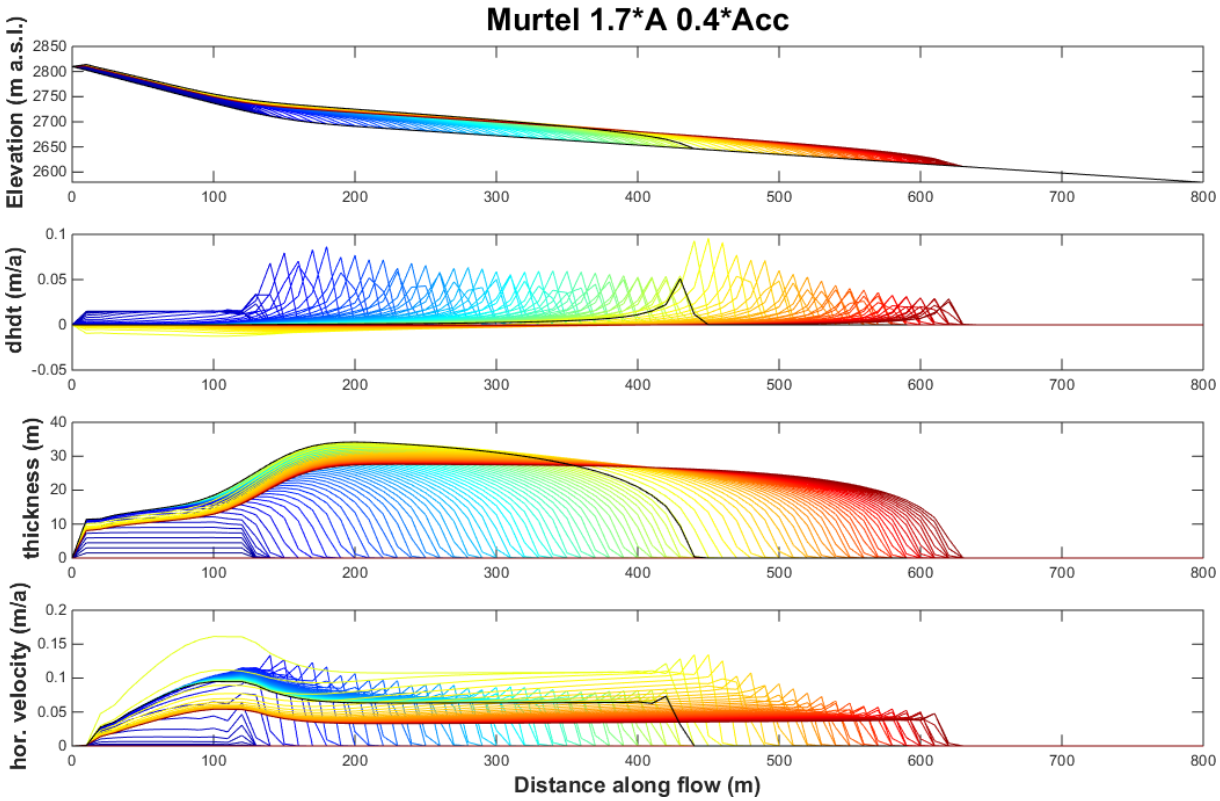



**Figure S7: The evolution of surface geometry, thickness change (dhdt) absolute thickness in m horizontal velocity along the central flow line for rockglacier built-up (6000 years runtime / black line) and complex perturbation experiment (temperature increase of 1°C for a -1.5°C rockglacier and reduced material input (40%) after 6000 years). The lines are plotted in 100yr steps. Colour scale applies to all following Figures**

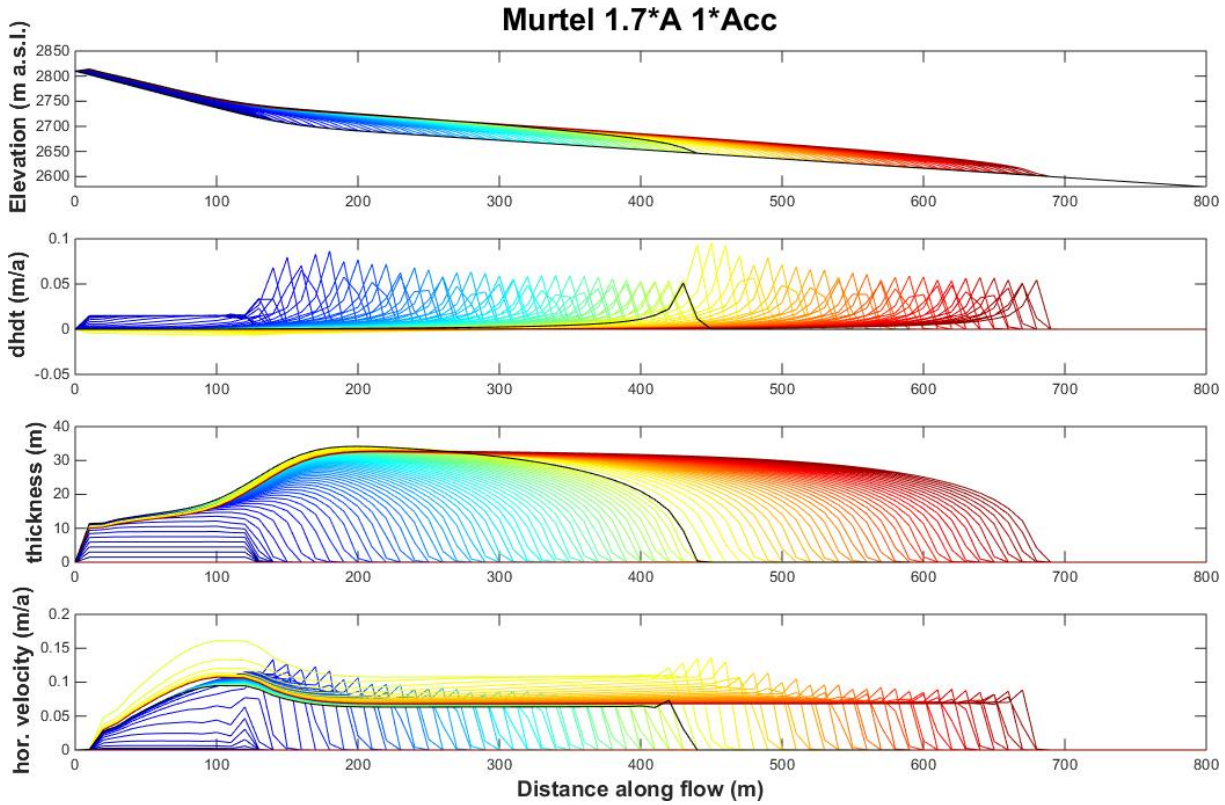



**Figure S8: The evolution of surface geometry, thickness change (dhdt) absolute thickness in m horizontal velocity along the central flow line for rockglacier built-up (6000 years runtime / black line) and complex perturbation experiment (temperature increase of 1°C for a -1.5°C rockglacier and no change in material input after 6000 years). The lines are plotted in 100yr steps.**

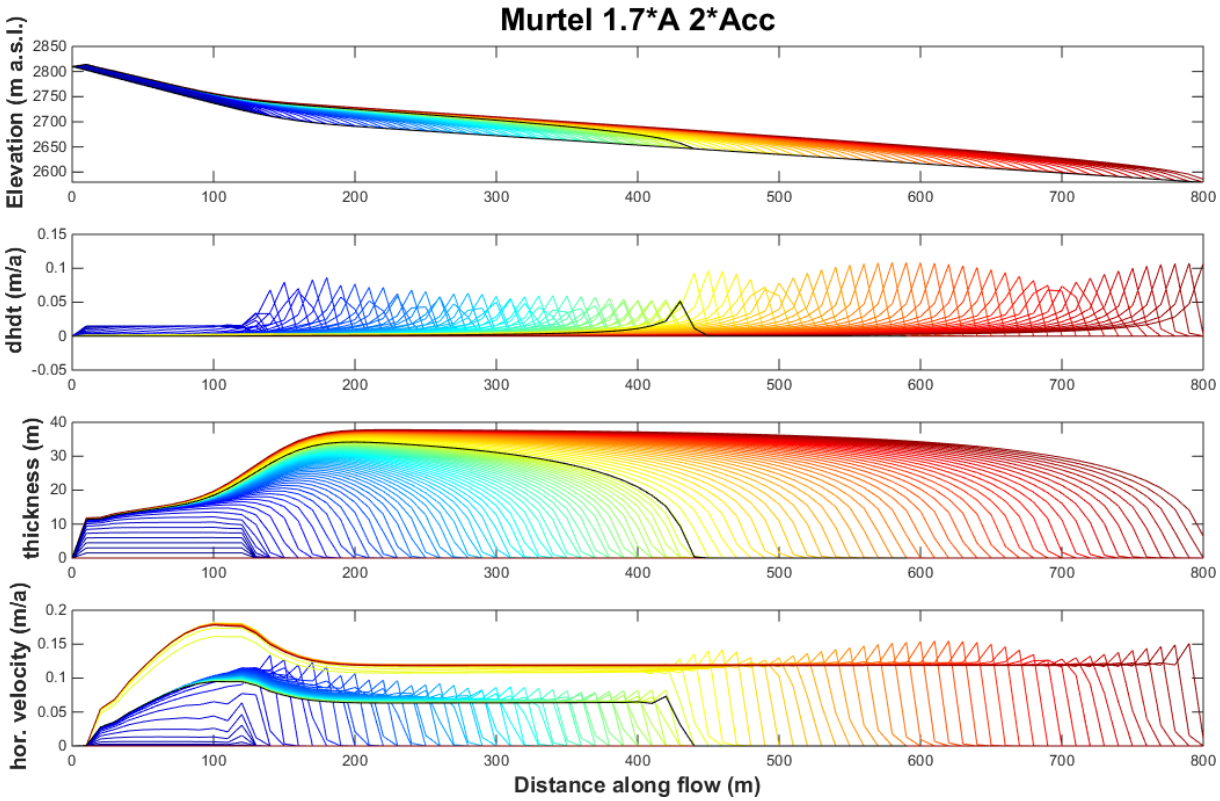
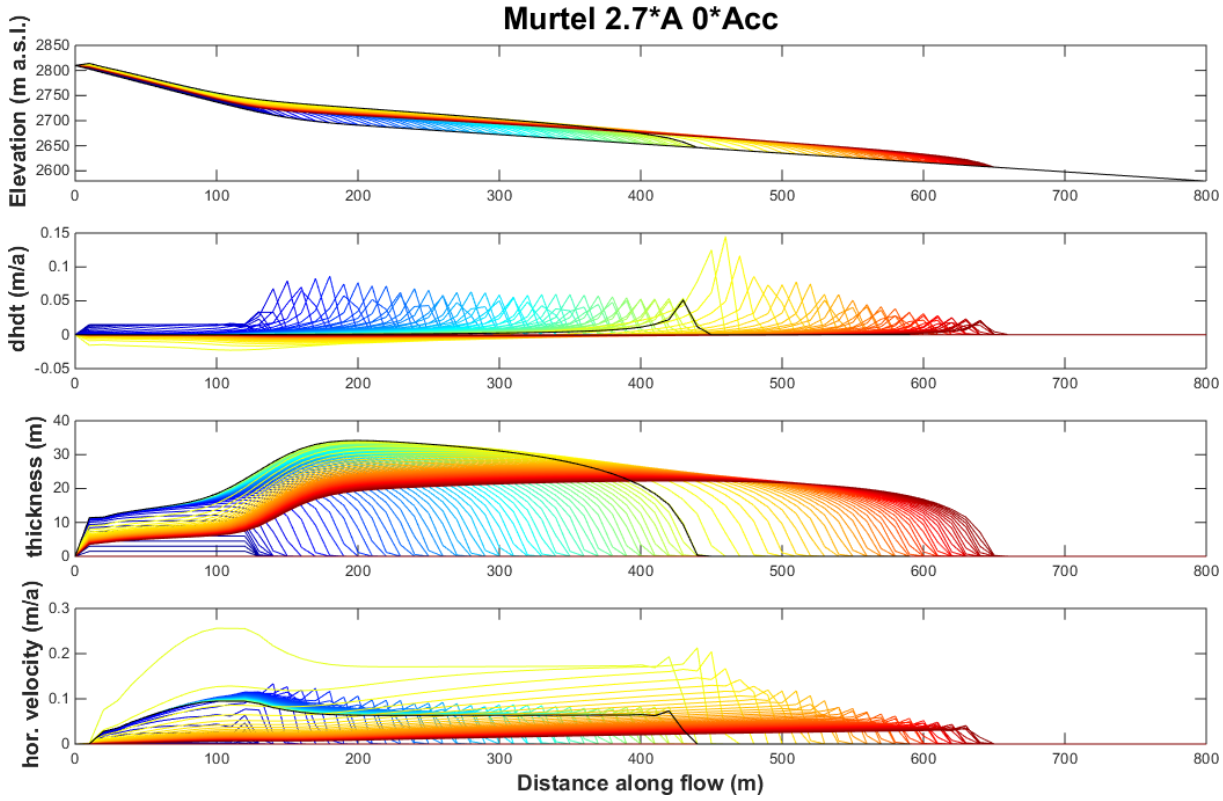



**Figure S9: The evolution of surface geometry, thickness change (dhdt) absolute thickness in m horizontal velocity along the central flow line for rockglacier built-up (6000 years runtime / black line) and complex perturbation experiment (temperature increase of 1°C for a -1.5°C rockglacier and doubled material input after 6000 years). The lines are plotted in 100yr steps.**

**S2.1.3 Initial rockglacier temperature -1°C, therefore 2.7*rate factor A for a 1°C warming.**




**Figre S10: The evolution of surface geometry, thickness change (dhdt) absolute thickness in m horizontal velocity along the central flow line for rockglacier built-up (6000 years runtime / black line) and complex perturbation experiment (temperature increase of 1°C for a -1°C rockglacier and no material input after 6000 years). The lines are plotted in 100yr steps**

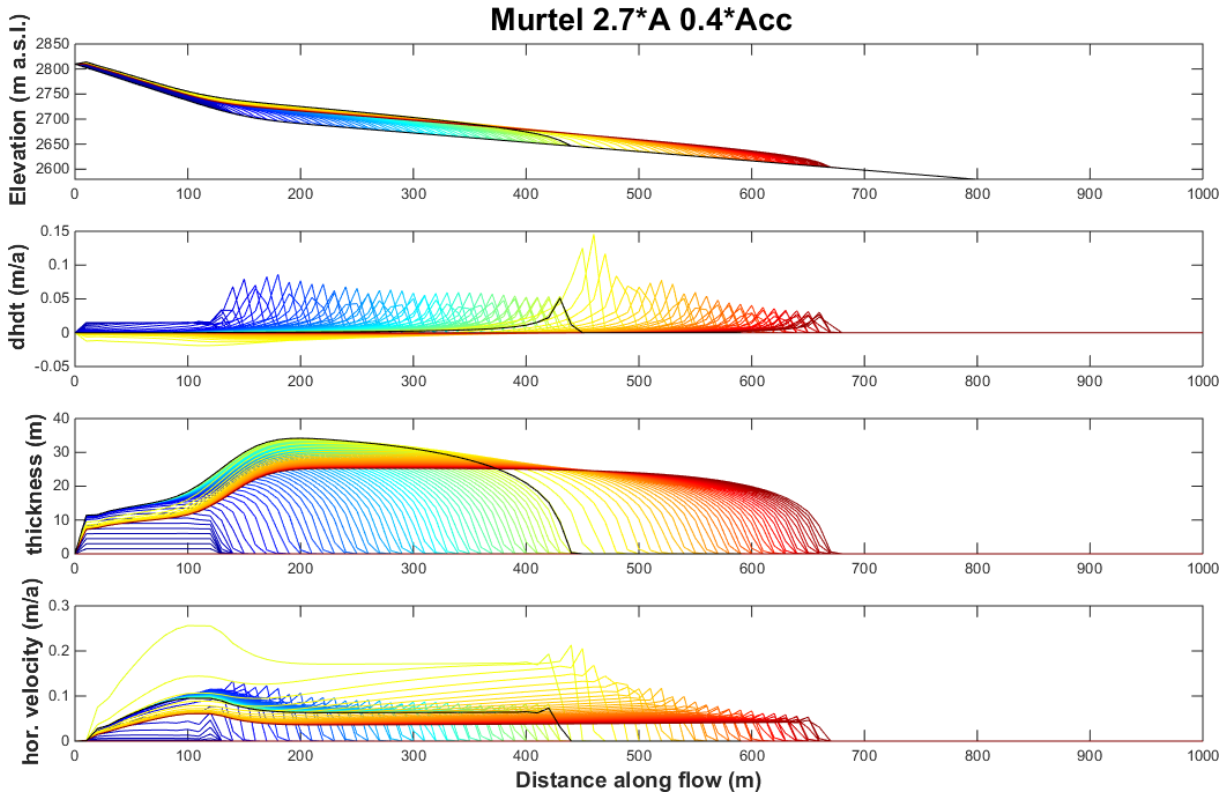



**Figure S11: The evolution of surface geometry, thickness change (dhdt) absolute thickness in m horizontal velocity along the central flow line for rockglacier built-up (6000 years runtime / black line) and complex perturbation experiment (temperature increase of 1°C for a -1°C rockglacier and reduced material input (40%) after 6000 years). The lines are plotted in 100yr steps. Colour scale applies to all following Figures**

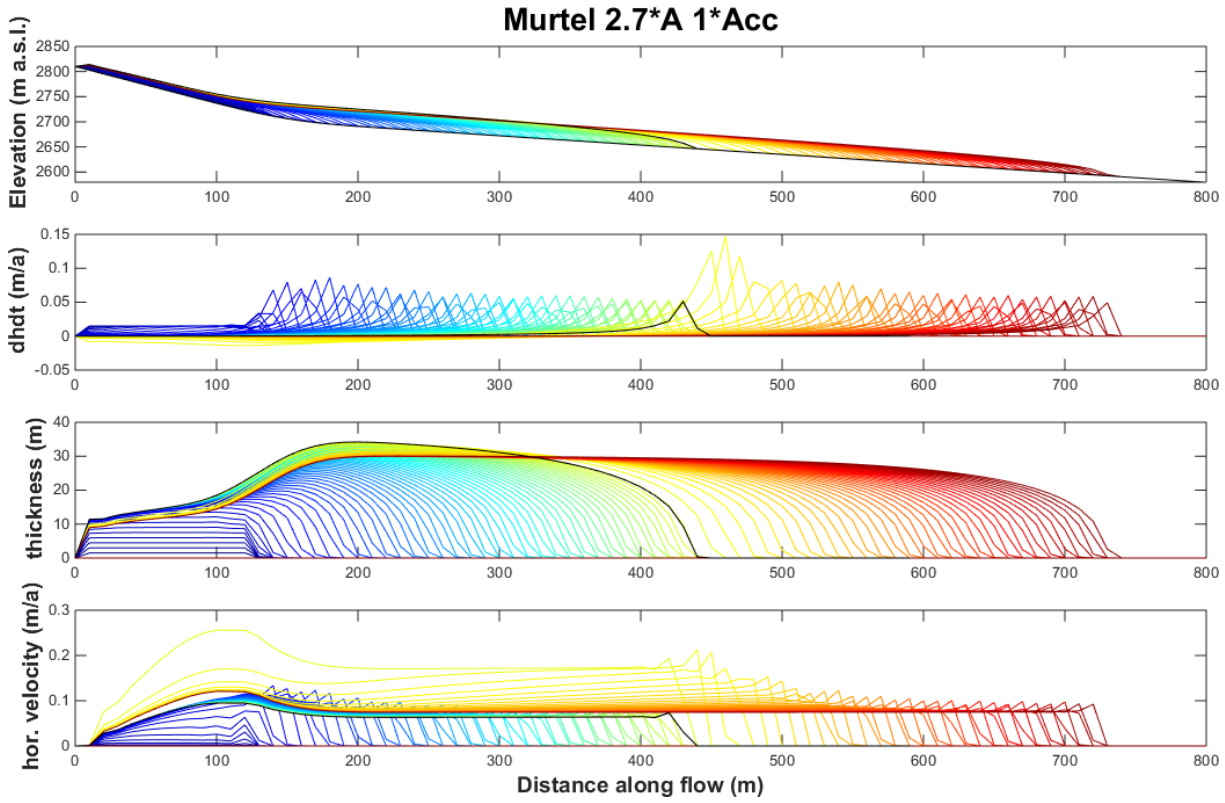



**Figure S12: The evolution of surface geometry, thickness change (dhdt) absolute thickness in m horizontal velocity along the central flow line for rockglacier built-up (6000 years runtime / black line) and complex perturbation experiment (temperature increase of 1°C for a -1°C rockglacier and no change in material input after 6000 years). The lines are plotted in 100yr steps.**

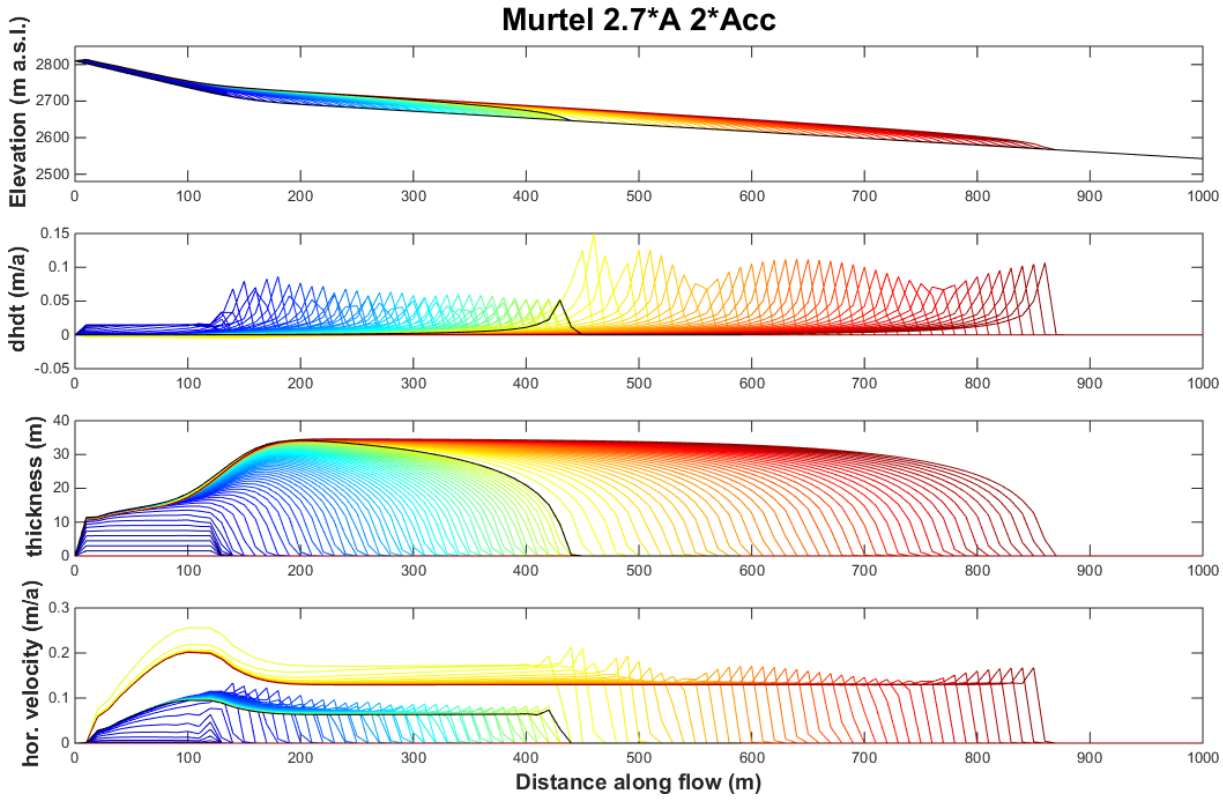



**Figure S13: The evolution of surface geometry, thickness change (dhdt) absolute thickness in m horizontal velocity along the central flow line for rockglacier built-up (6000 years runtime / black line) and complex perturbation experiment (temperature increase of 1°C for a -1°C rockglacier and doubled material input after 6000 years). The lines are plotted in 100yr steps.**

## S2.2 Huhh1 perturbation experiments

### S2.2.1 Initial rockglacier temperature -2°C, therefore 1.4*rate factor A for a 1°C warming.

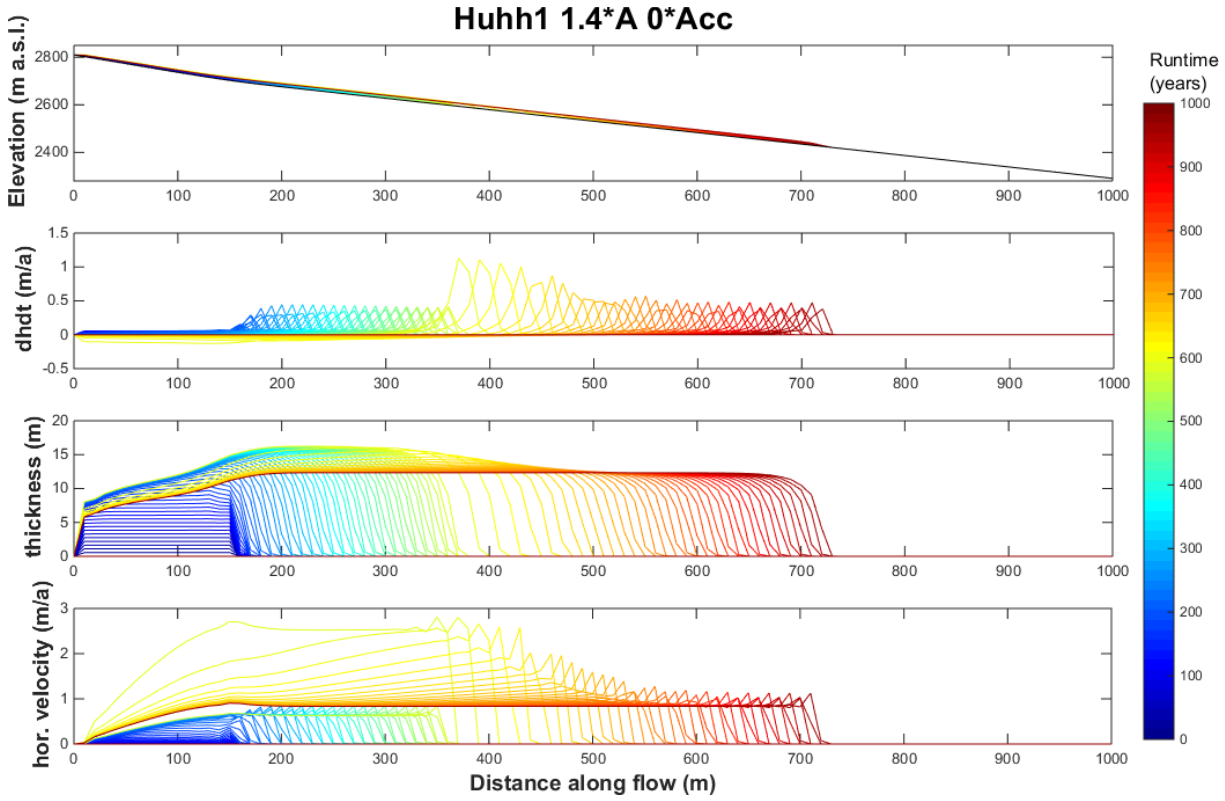



**Figure S14: The evolution of surface geometry, thickness change (dhdt) absolute thickness in m horizontal velocity along the central flow line for rockglacier built-up (600 years runtime) and complex perturbation experiment (temperature increase of 1°C for a -2°C rockglacier and no material input after 600 years). The lines are plotted in 10yr steps. Colour scale applies to all following Figures.**

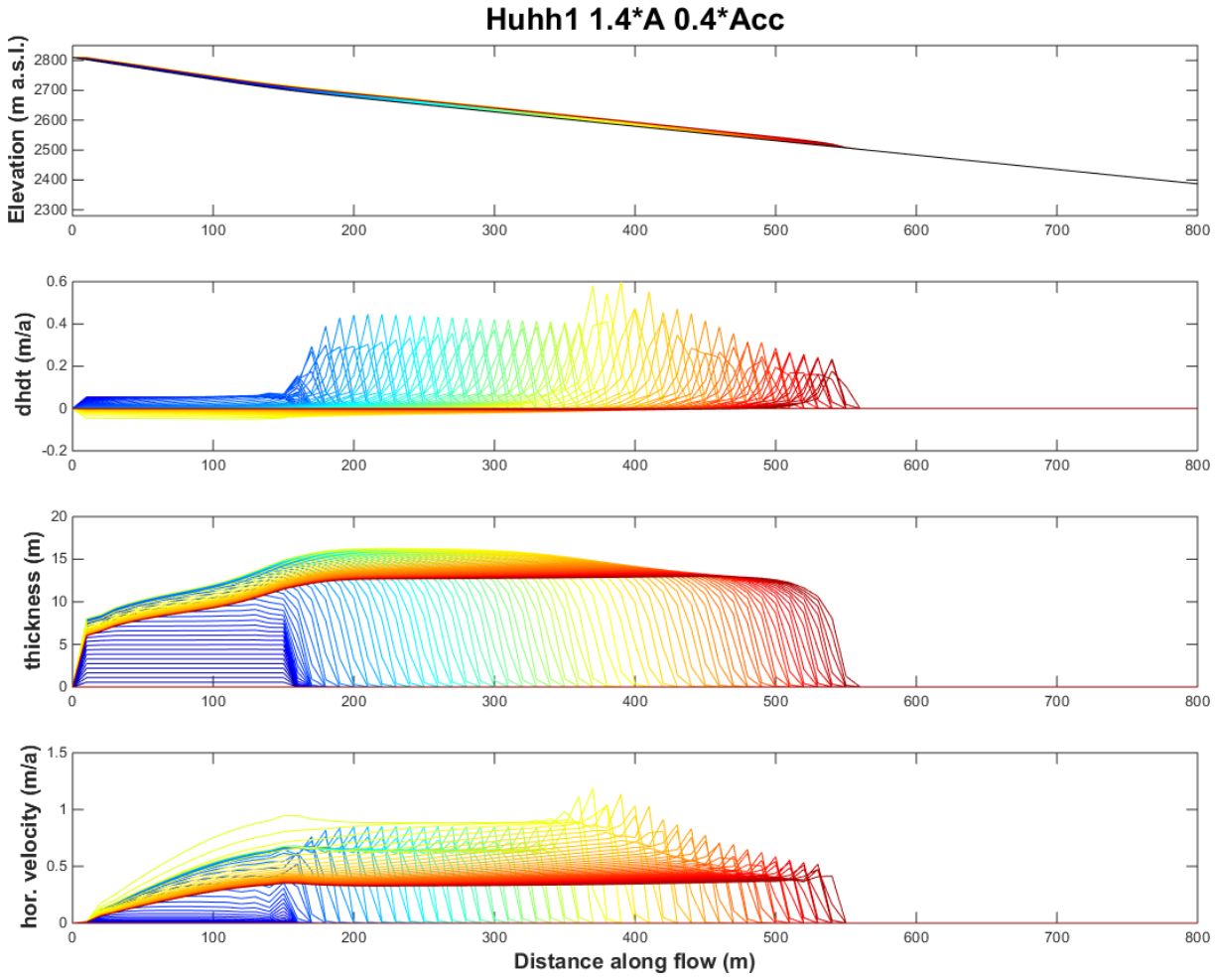



**Figure S15: The evolution of surface geometry, thickness change (dhdt) absolute thickness in m horizontal velocity along the central flow line for rockglacier built-up (600 years runtime) and complex perturbation experiment (temperature increase of 1°C for a -2°C rockglacier and reduced material input (40%) after 600 years). The lines are plotted in 10yr steps.**

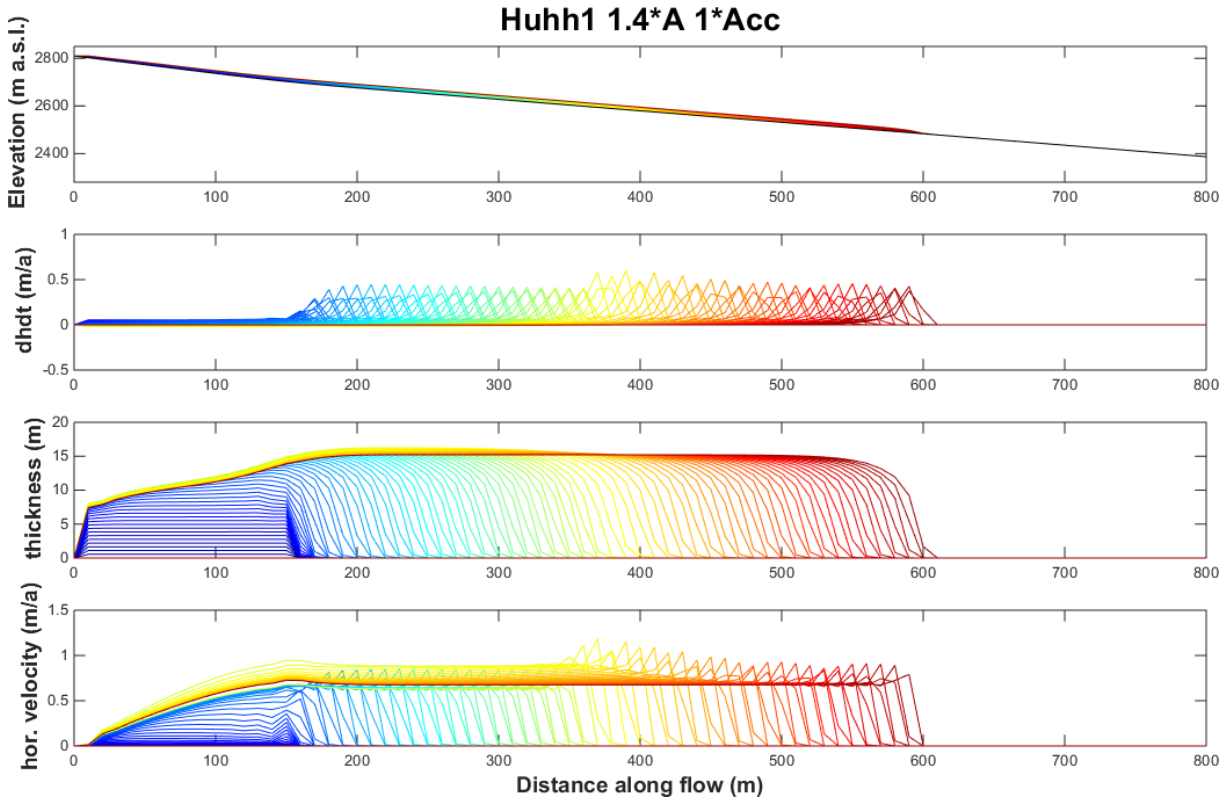



**Figure S16: The evolution of surface geometry, thickness change (dhdt) absolute thickness in m horizontal velocity along the central flow line for rockglacier built-up (600 years runtime) and complex perturbation experiment (temperature increase of 1°C for a -2°C rockglacier and no change in material input after 600 years). The lines are plotted in 10yr steps.**

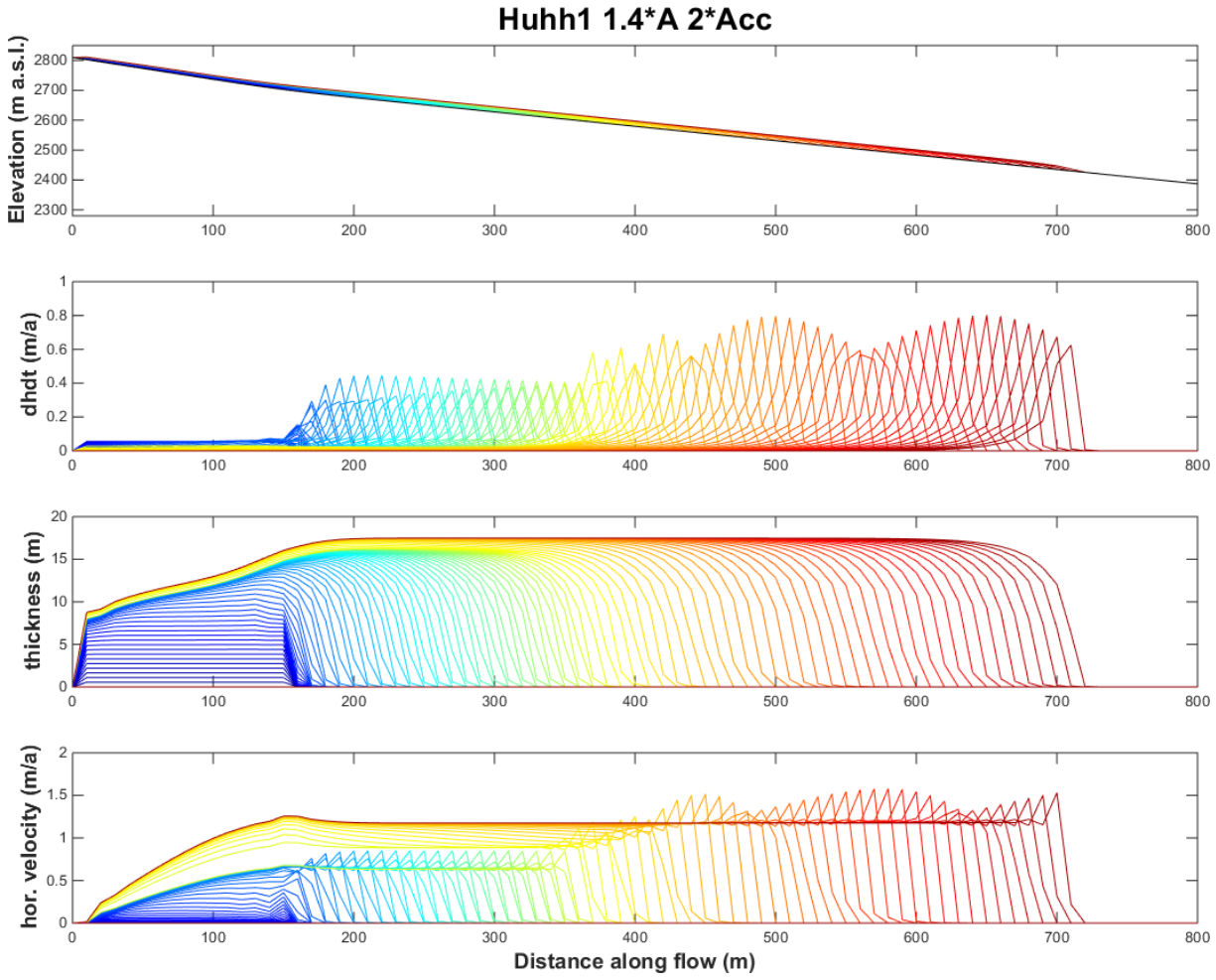



**Figure S17: The evolution of surface geometry, thickness change (dhdt) absolute thickness in m horizontal velocity along the central flow line for rockglacier built-up (600 years runtime) and complex perturbation experiment (temperature increase of 1°C for a -2°C rockglacier and doubled material input after 600 years). The lines are plotted in 10yr steps.**

**S2.2.2 Initial rockglacier temperature -1.5°C, therefore 1.7*rate factor A for a 1°C warming.**

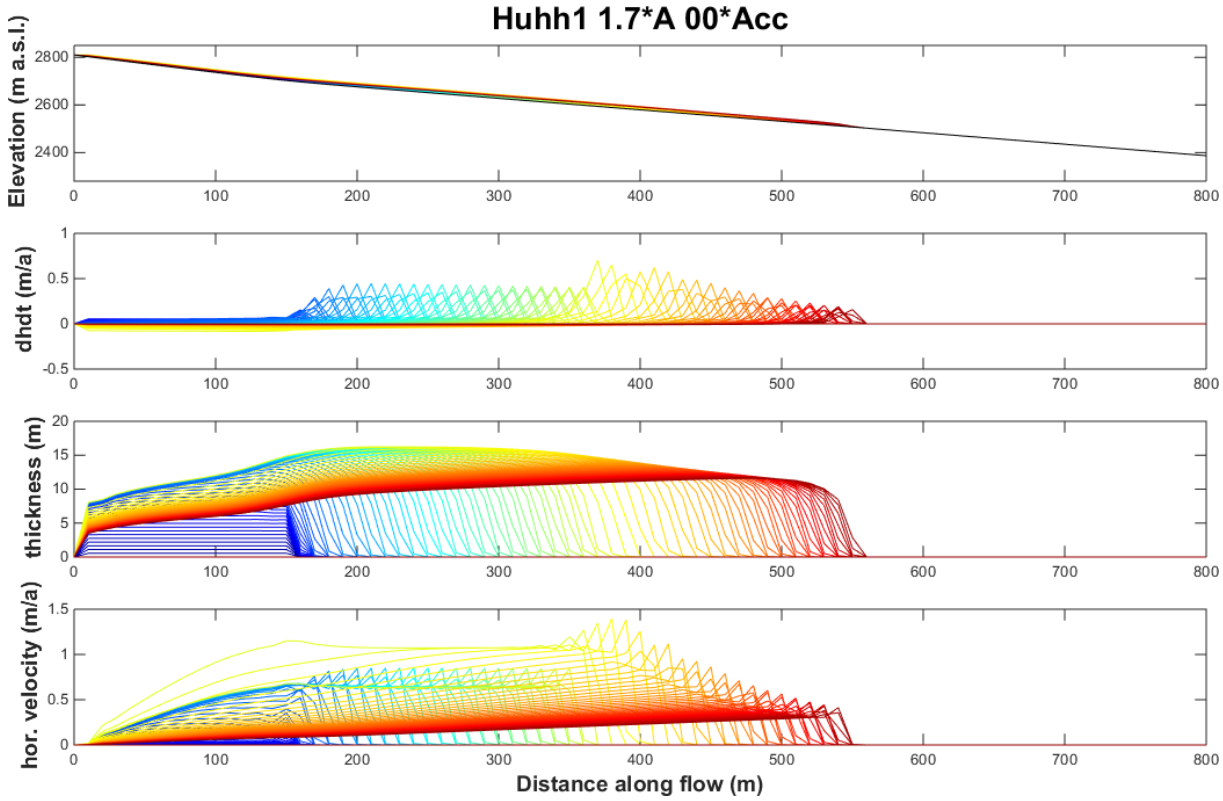



**Figure S18: The evolution of surface geometry, thickness change (dhdt) absolute thickness in m horizontal velocity along the central flow line for rockglacier built-up (600 years runtime) and complex perturbation experiment (temperature increase of 1°C for a -1.5°C rockglacier and no material input after 600 years). The lines are plotted in 10yr steps. Colour scale applies to all following Figures.**

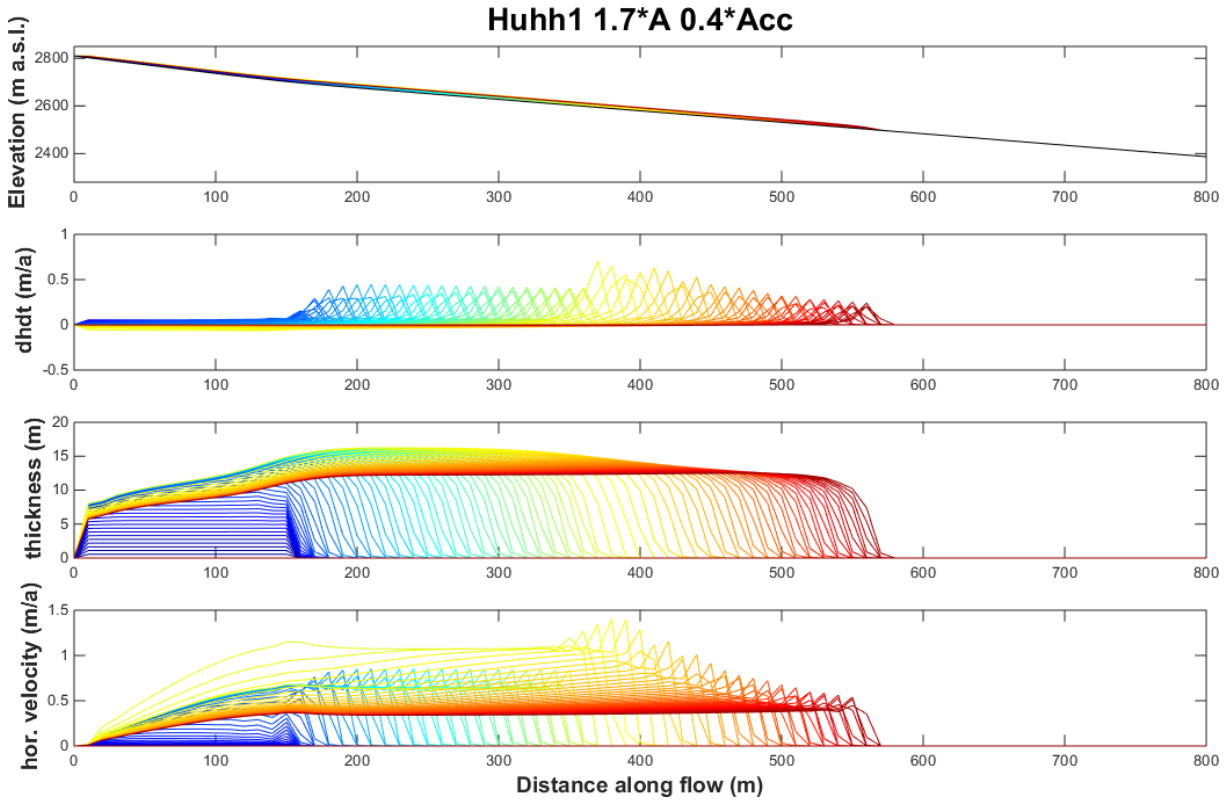



**Figure S19: The evolution of surface geometry, thickness change (dhdt) absolute thickness in m horizontal velocity along the central flow line for rockglacier built-up (600 years runtime) and complex perturbation experiment (temperature increase of 1°C for a -1.5°C rockglacier and reduced material input (40%) after 600 years). The lines are plotted in 10yr steps.**

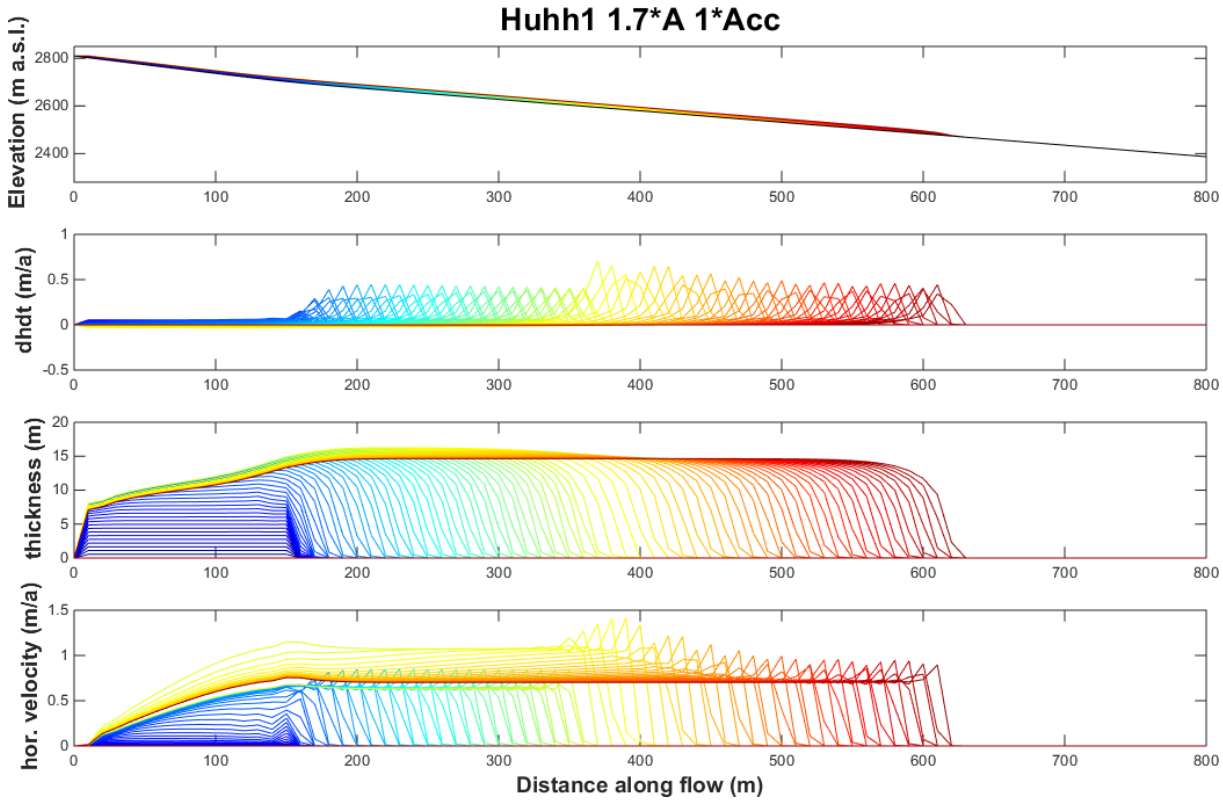



**Figure S20: The evolution of surface geometry, thickness change (dhdt) absolute thickness in m horizontal velocity along the central flow line for rockglacier built-up (600 years runtime) and complex perturbation experiment (temperature increase of 1°C for a -1.5°C rockglacier and no change in material input after 600 years). The lines are plotted in 10yr steps.**

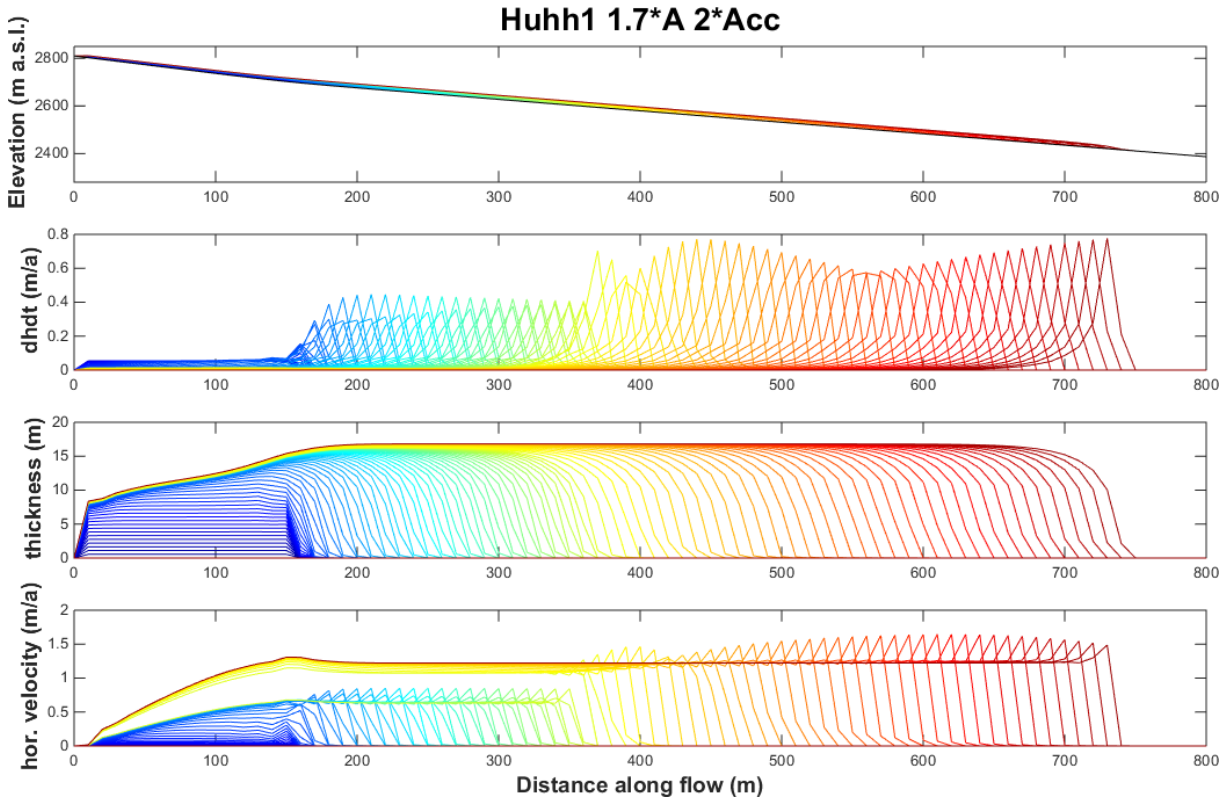



**Figure S21: The evolution of surface geometry, thickness change (dhdt) absolute thickness in m horizontal velocity along the central flow line for rockglacier built-up (600 years runtime) and complex perturbation experiment (temperature increase of 1°C for a -1.5°C rockglacier and doubled material input after 600 years). The lines are plotted in 10yr steps.**

**S2.2.3 Initial rockglacier temperature -2°C, therefore 2.4*rate factor A for a 1°C warming.**

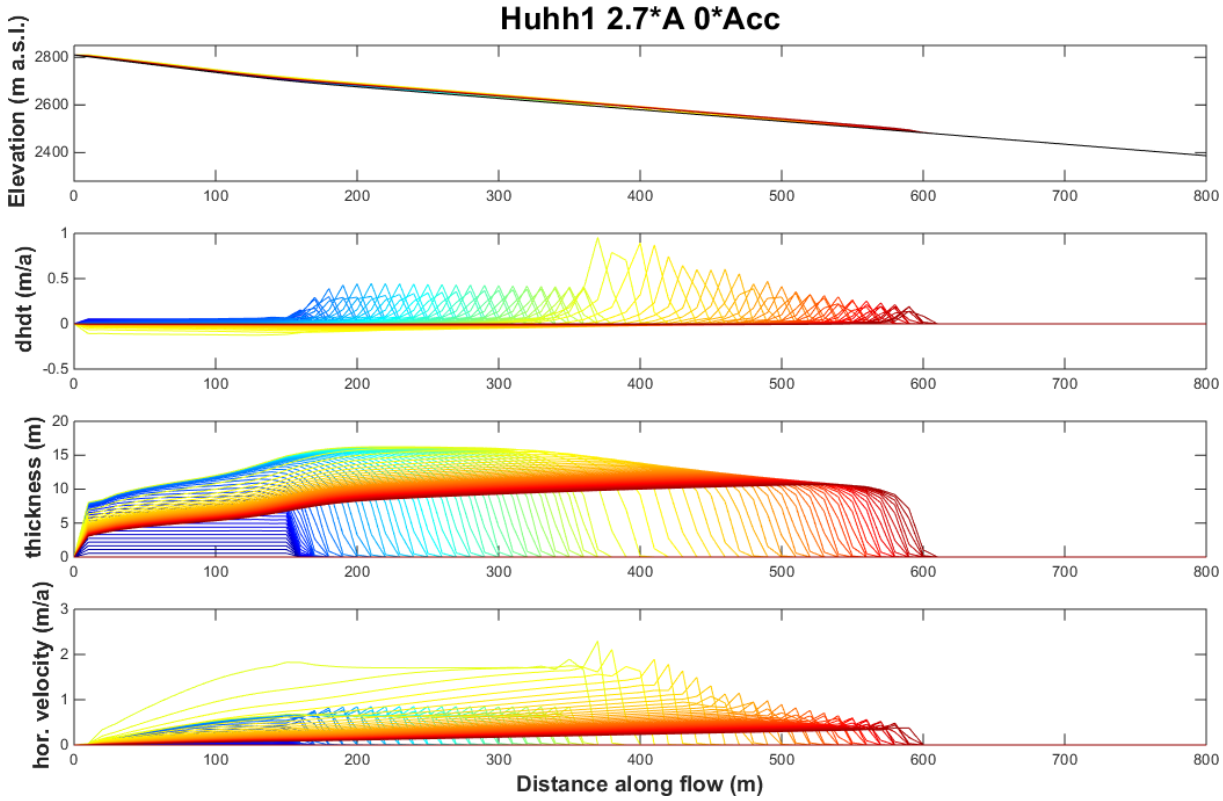



**Figure S22: The evolution of surface geometry, thickness change (dhdt) absolute thickness in m horizontal velocity along the central flow line for rockglacier built-up (600 years runtime) and complex perturbation experiment (temperature increase of 1°C for a -1°C rockglacier and no material input after 600 years). The lines are plotted in 10yr steps. Colour scale applies to all following Figures.**

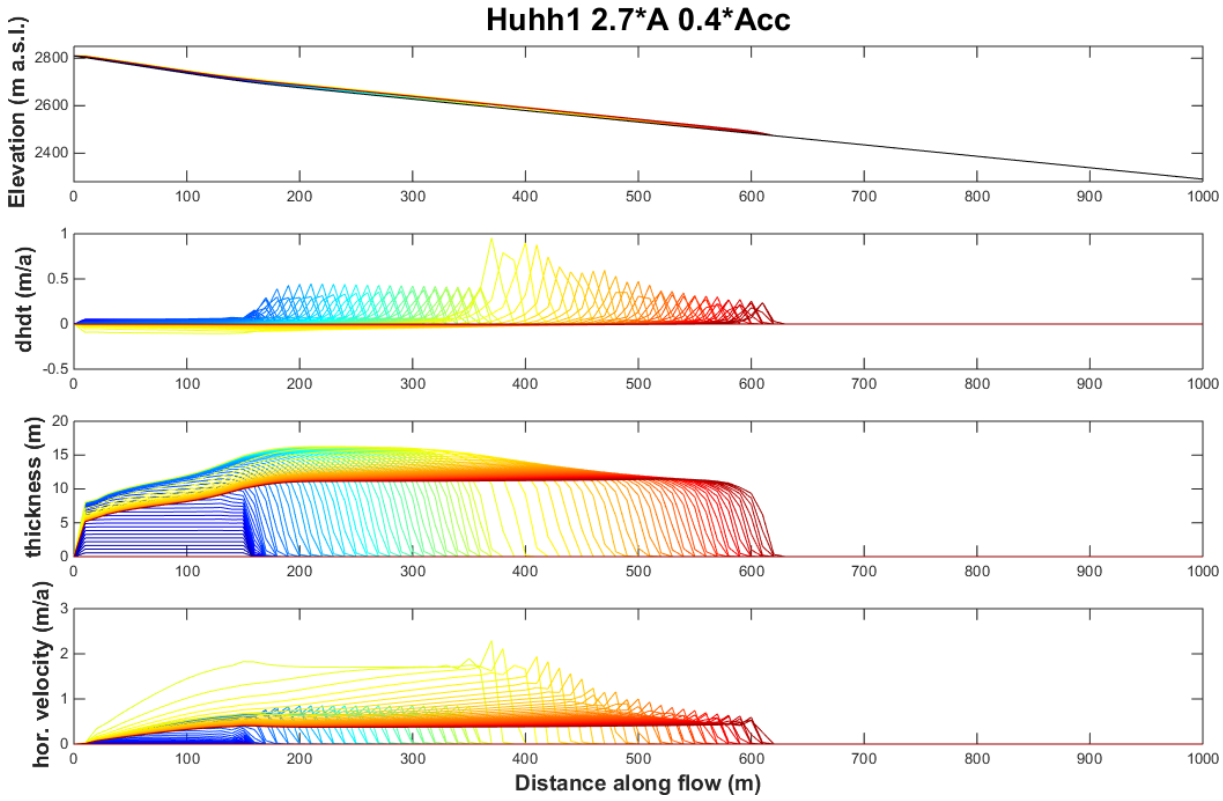



**Figure S23: The evolution of surface geometry, thickness change (dhdt) absolute thickness in m horizontal velocity along the central flow line for rockglacier built-up (600 years runtime) and complex perturbation experiment (temperature increase of 1°C for a -1°C rockglacier and reduced material input (40%) after 600 years). The lines are plotted in 10yr steps.**

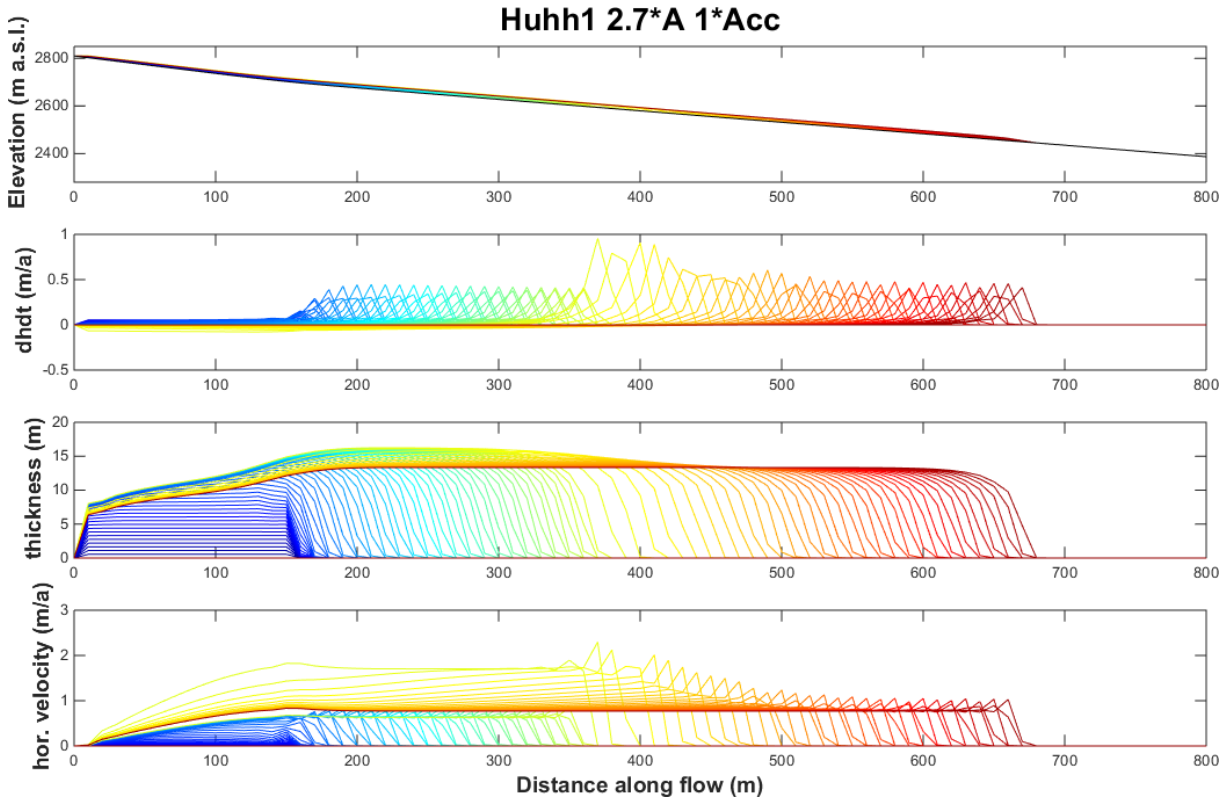



**Figure S24: The evolution of surface geometry, thickness change (dhdt) absolute thickness in m horizontal velocity along the central flow line for rockglacier built-up (600 years runtime) and complex perturbation experiment (temperature increase of 1°C for a -1°C rockglacier and no change in material input after 600 years). The lines are plotted in 10yr steps.**

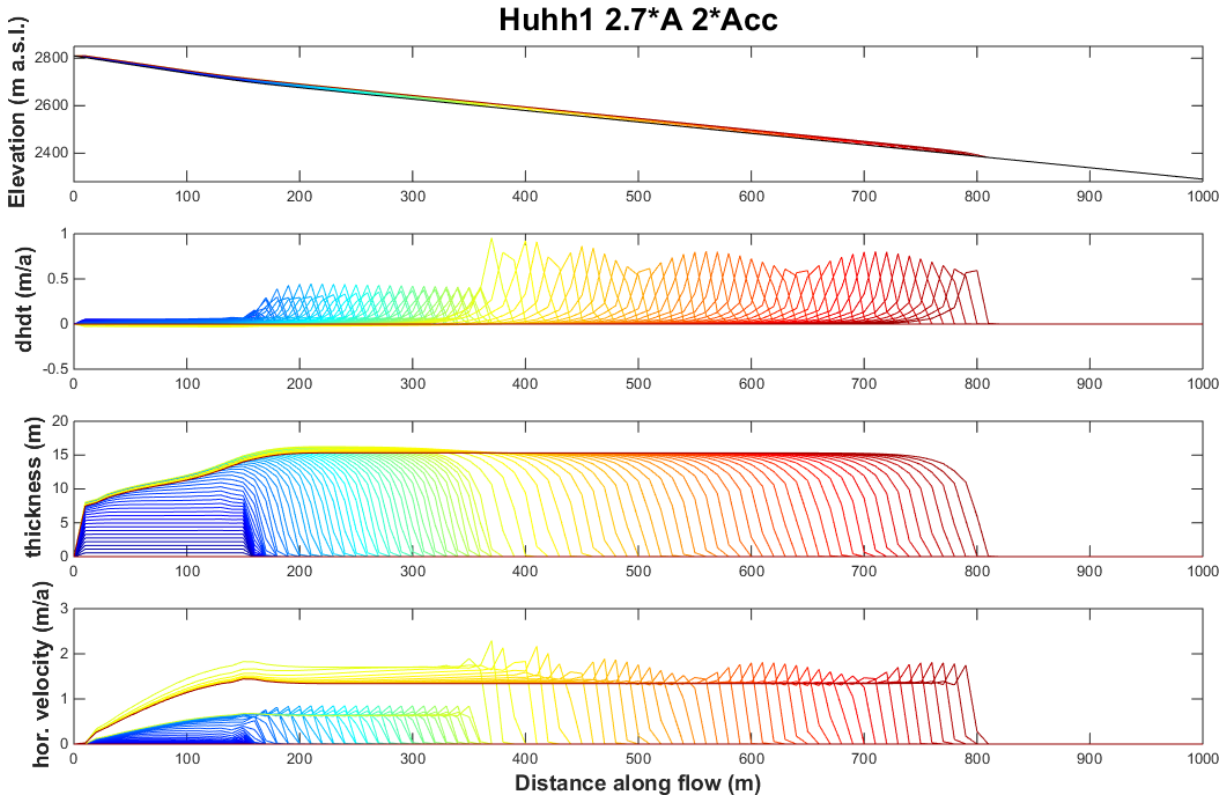



**Figure S25: The evolution of surface geometry, thickness change (dhdt) absolute thickness in m horizontal velocity along the central flow line for rockglacier built-up (600 years runtime) and complex perturbation experiment (temperature increase of 1°C for a -1°C rockglacier and doubled material input after 600 years). The lines are plotted in 10yr steps.**