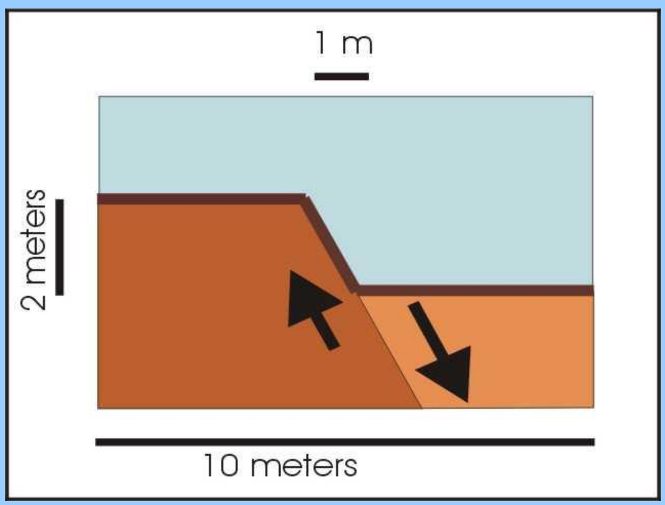
**Homework #7 earth surface processes Humphrey 2016**,

This is going to be our last investigation using the code you have now developed. We are now going to apply sheetwash to the homework of last week. We will use the same profile as the first homework on distributed creep, so below is the profile through a small fault (earthquake) scarp, which has broken the surface of a desert landscape. Question 1 is only a minor change from last week, we add a little sheetwash. Question 2 is also actually a small change but requires clear thinking, we are changing the boundary conditions to zero flux instead of fixed elevation. (I discussed this briefly in class, but I will mention it again on Tuesday). And question 3 illustrates the type of numerical/thought experiment you can run with these simple models. Just hand in the 3 resulting plots. Warning, sheetwash ( the increasing x*D term) makes the code much less stable, if you get huge spikes in your results, try taking smaller time steps.




The height of the scarp is 2 meters.

Question 1, This week we assume a whole suite of processes are operating over time; some purely diffusional, and some that depend on distance from the divide (you can think: rainslash and sheetwash). Assume; that in this desert environment, the time evolution of this feature can be approximately described by a simple addition of the 2 difference equations we developed in class, one for creep and one for sheetwash:

$$Z_{i,t+\Delta t} = Z_{i,t} + (x_i D_{process} + C_{process}) * (Z_{i+1} - 2Z_i + Z_{i-1})_t * \Delta t / (\Delta x)^2 + D_{process}(Z_{i+1} - Z_{i-1})_t * \Delta t / (2\Delta x)$$

………. Eqn A

where $Z$ is the elevation of "bin" $i$ at time $t$, and the $x$ length of bins is $\Delta x$. Note if $D_{process}$ is zero, this is the same as the pure creep equation. The time step size is $\Delta t$, and the governing rate coefficient for the distributed process is $C_{process}$ (assume a value of $5\text{x}10^{-12}\text{m}^2\text{s}^{-1}$) and for the slope length process is $D_{process}$ (assume a value of $5\text{x}10^{-12}\text{ms}^{-1}$). Note; in the equation all the quantities on the right are known at time "now" (or $t$) and only the new elevation at $t$+1 appears on the left as the unknown. Calculate the time evolution of this (2D) feature for 10,000yrs into the future. Assume the nodes at x=0 and at x=10 remains at a constant elevation. Note the only difficulty in re-writing your code for this problem is that you need to include the distance from the divide (x) into the first term on the right, this will make the $x*D$ term get larger as $i$ increases. The second term is a trivial modification. Assume the left and right boundary elevations are fixed over time.

Question 2, We will now try to apply a different Boundary Condition at the points x=0 and x=10. The BC we will apply is that the sed flux ($q_{sed}$) is zero at these two points. To make the flux zero, we need to force the slope to zero at both the left and right boundaries. Thus, the question is to repeat question 1, but with zero flux entering and exiting the diagram, and do it for 20,000 years.

Hints for question 2. You have the basic system set up in question 1, and this doesn't change, we just need to adjust the boundary nodes. So what is required is making $Z_{+1} - Z_{-1}$ and $Z_{N+1} - Z_{N-1}$ equal to 0, where the actual boundary nodes are at 0 and $N$. Note that $Z_{-1}$ and $Z_{N+1}$ are outside our current rows in out excel matrix. The easiest way to change the left BC to a zero slope condition is to add an extra node to the left of the zero node, and for the right BC, an extra node past the right end of the problem. So in detail, for the BC in question 2, you make the nodes on the boundaries, at x=0 and at x=10 interior nodes (that is variable in time instead of fixed), but add an extra node $\Delta x$ outside each boundary (you will have 2 extra nodes compared to question 1). At each time step you need to add an extra equation that sets this 'dummy' node outside the boundary equal to the node that just inside the boundary (note, don't set it equal to the boundary node but one node inside the boundary node; and note both the boundary node and the node inside will change with time!). This will force the slope at the boundaries to remain zero (note that this makes $Z_{i+1} - Z_{i-1}$ zero [ie the slope is 0] if the boundary node is $i$). It also allows you to calculate a curvature at the interfluve and to calculate the erosion of the node at the interfluve (left boundary). Extend the time out to 20,000 years.

Question 3. Now you have your code setup, try a small experiment: Make the creep parameter $C$ zero, and re-run question 2. From this you can see (if it works) that creep processes dominate at the interfluve.