# Coupling glacial and fluvial erosion models to simulate sediment dynamics

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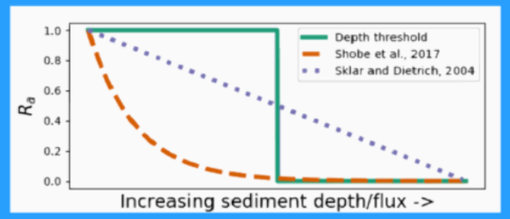
## The model

1. Glacier mass balance updates based on an input ELA curve; Bedrock erosion occurs through quarrying, proportional to sliding velocity *(Iverson, 2012; MacGregor et al., 2000)*:

$$E = 0.00125 * Us^{0.46}$$

2. Bedrock eroded by glacier is tracked and input to the start of the fluvial system. Any glacial melt is added to the initial stream discharge.

3. The glacier can widen the valley up to 500 meters, and sediment deposited by the glacier and river is spread over the valley. This sediment enters the river system through a lateral erosion rate proportional to shear stress.




4. Sediment is transport in a modified Meyer-Peter and Mueller equation. Then bedrock erosion is implemented, proportional to shear stress and modified by sediment:

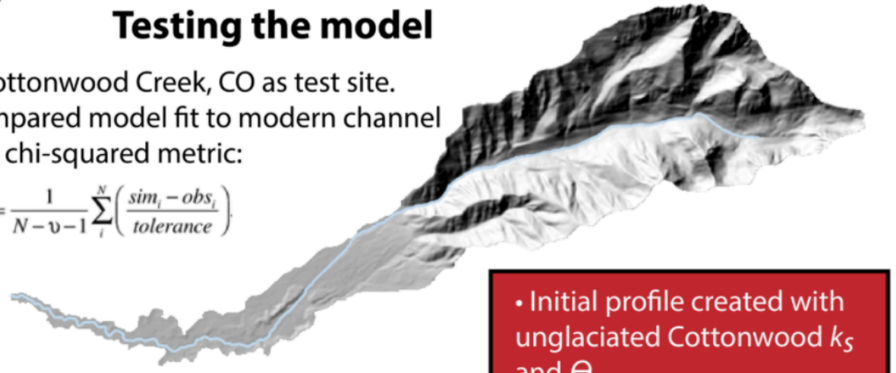
$$E = R_a k \tau^a$$

Model fit is sensitive to sediment characteristics more than uplift:

## Testing the model

Cottonwood Creek, CO as test site. Compared model fit to modern channel using chi-squared metric:

$$X^2 = \frac{1}{N-\upsilon-1}\sum_i^N \left(\frac{sim_i - obs_i}{tolerance}\right)$$



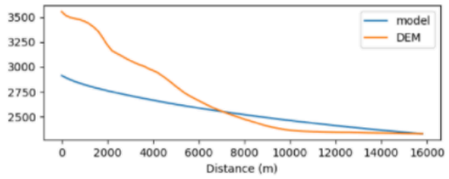
- Initial profile created with unglaciated Cottonwood $k_s$ and $\Theta$
- Sklar & Dietrich (2004) erosion model
- Set ELA fluctuations based on Pinedale ELA and Vostock temperature patterns
- Ran for 400 ky

Testing sensitivity to different parameters

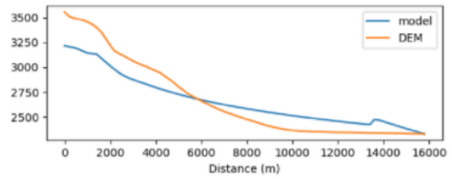
Sediment characteristics

Initial sediment size

0.07 m - 11.9 $X^2$

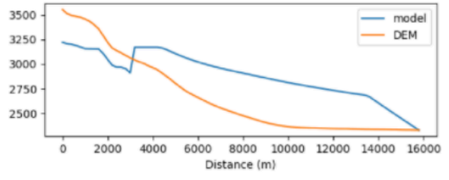



0.17 m - 8.8 $X^2$

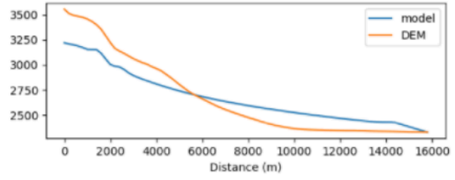



Sediment attrition

2e-6 m/m - 20.6 $X^2$

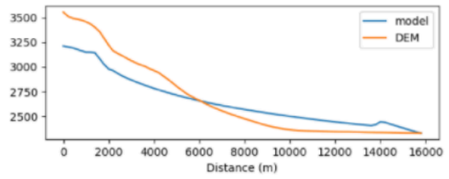



4e-5 m/m - 7.75 $X^2$




Uplift

0.05 mm/yr - 8.5 $X^2$




0.15 mm/yr - 9.1 $X^2$