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1 Methods

1.1 Model design

We modeled the vertical accretion of a tidal platform ($d\eta/dt$) using a zero-dimensional mass balance approach initially described by **?** and validated by subsequent studies (**????**). The rate of vertical accretion is described as

$$\frac{d\eta(t)}{dt} = \frac{dS_m(t)}{dt} + \frac{dS_o(t)}{dt} + \frac{dP(t)}{dt} + \frac{dM(t)}{dt}, \tag{1}$$

where $dS_m(t)/dt$ is the rate of mineral sedimentation, $dS_o(t)/dt$ is the rate of organic matter sedimentation, $dP(t)/dt$ is the rate of compaction of the deposited sediment, and $dM(t)/dt$ is the rate of tectonic subsidence. Studies show only $\sim$3 % of organic matter is presereved in the region so we chose to neglect organic sedimentation. We set the rate of tectonic subsidence to 6 mm which is consistent with measured rates for the region **?** . We also effectively internalize the compaction term by using dry bulk density within the mineral sedimentation term. Thus, we set terms $dS_o(t)/dt$, $dP(t)/dt$, and $dM(t)/dt$ to zero.

Need ref

Need to investigate further. Look into Steckler papers from 2010 and 2013.

In order to solve $dS_m(t)/dt$, we began by conceptualizing a tidal platform periodically inundated by cyclical tides. We first defined depth to be

$$h(t) = \zeta(t) - \eta(t), \tag{2}$$

where $\zeta(t)$ is the water-surface elevation and $\eta(t)$ is the sediment-surface elevation which also implies that

$$\frac{dh(t)}{dt} = \frac{d\zeta(t)}{dt} - \frac{d\eta(t)}{dt}. \tag{3}$$

Independently, we assume when $h(t) > 0$, the rate of mineral sedimentation is

$$\frac{dS_m(t)}{dt} = \frac{w_s C(t)}{\rho_b}, \tag{4}$$

where w_s is the nominal settling velocity of sediment grain, $C(t)$ is the depth-averaged suspended sediment concentration (SSC) in the water column, and ρ_b is the bulk density of the sediment. We assumed no resuspension of mineral sediment which is practical and consistent with previous studies (**?????**). We used Stoke's law to determine w_s. Stoke's law assumes unhindered settling which likely overestimates actual settling rates and, therefore, mineral sedimentation rates. However, we only considers a median grain size which likely underestimates mineral sedimentation rates from coarser material. Model calibration further corrects for these errors. Thus, the w_s given by Stoke's law should be considered an imprecise, but reasonable approximation.

In order to solve for $C(t)$ in **??**, we first defined a mass balance of sediment within the water column as

$$\frac{d}{dt}[h(t)C(t)] = -w_s C(t) + C_b \frac{dh(t)}{dt}, \tag{5}$$

which can be expanded and rerranged as

$$\frac{dC(t)}{dt} = -\frac{w_s C(t)}{h(t)} - \frac{1}{h(t)}[C(t) - C_b]\frac{dh(t)}{dt}. \tag{6}$$

The mass flux from the boundary term was constrained to only occur during flood tide ($d\zeta/dt > 0$) which is consistent with previous studies (**?????**). We formalized this mathematically using a Heaviside function which serves as a binary switch controlling the flux of sediment from the boundary. The Heaviside function is given as

$$S = \frac{d\zeta}{dt}, H(S) = \{ 0 \text{ if } S < 0 1 \text{if } S \geq 0. \tag{7}$$

?? then becomes

$$\frac{dC(t)}{dt} = -\frac{w_s C(t)}{h(t)} - \frac{H(S)}{h(t)}[C(t) - C_b]\frac{dh(t)}{dt}. \tag{8}$$

Finally, we solved **??????** in that order. Our apporoach differs from previous studies in that we resolve each **??????** at every timestep. The system of equations was solved using an explicit Runge-Kutta method of order 5(4) (**?**) and implemented in Python using SciPy (**?**).

Software and/or data availability

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