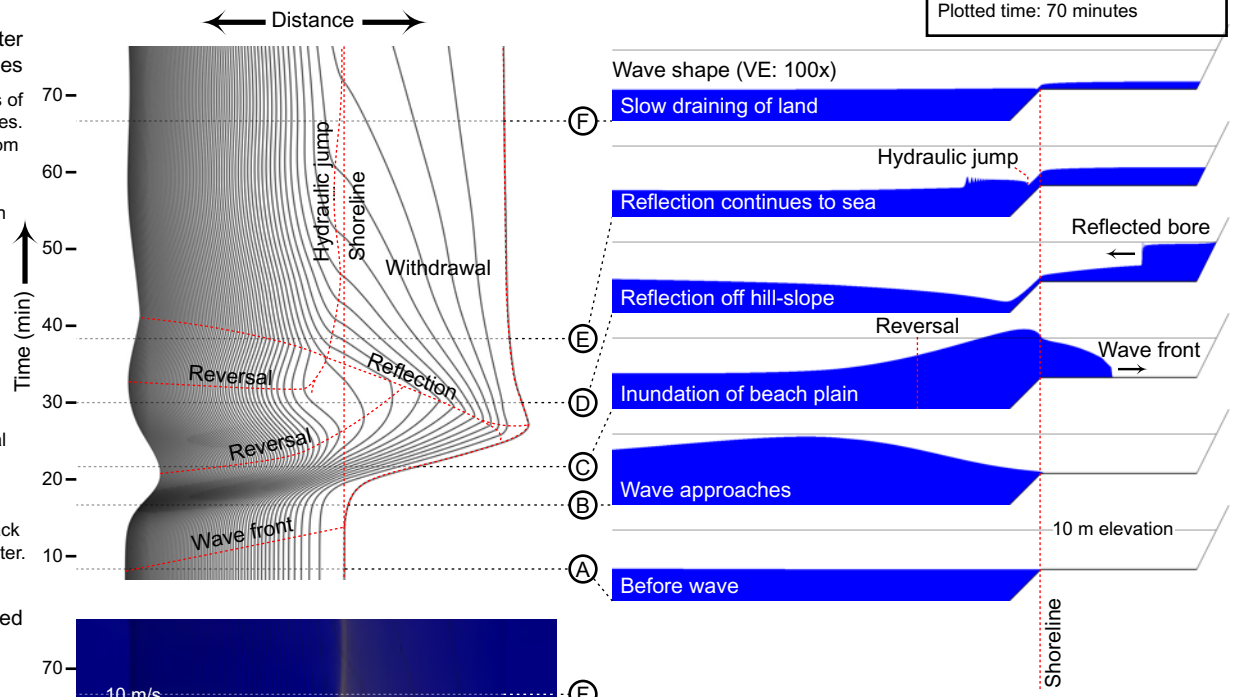
INUNDATION OF A SLOPE-TERMINATED BEACH PLAIN: This is model output from a depth-integrated runup model that implements wave breaking (Lynett et al., 2002). It shows a simple positive wave inundating a flat coastal plain and forming a reflected bore that propogates back out to sea.

Lynett, P., Wu, T., Liu, P., 2002. Modeling wave runup with depth-integrated equations, Coastal Engineering 46, p. 89-107.

Timestep: 1/24 s. (10 s plotted)
Horizontal grid size: 8.22 meters
Total domain width: 189 km
Plotted width: 12.3 km
Total modeled time: 83 minutes
Plotted time: 70 minutes

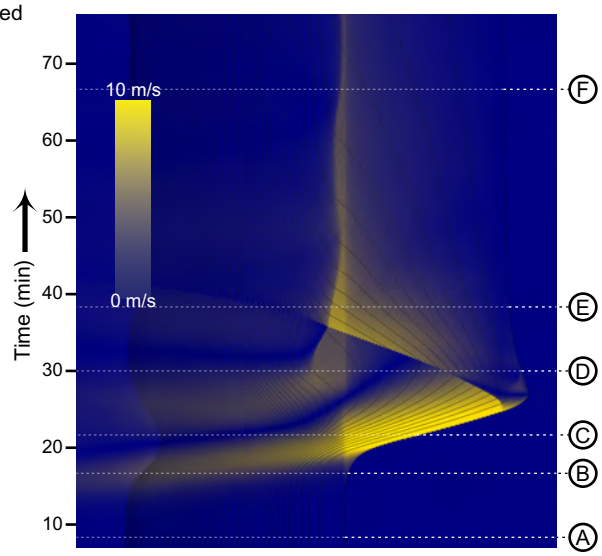
Paths of water particles

This diagram traces the paths of depth-integrated water particles. This information is inferred from the modeled free surface elevations by assuming conservation of volume. Each path seperates water with cross sections slightly over 2000 m^2. The rightmost path is the water's edge. Closely spaced lines indicate deep water, and widely seperated lines indicate shallow water. Vertical lines track stationary water (no change in position with time) while sub-horizontal lines track fast moving water. Concave up paths track substantively slowing water, while concave down paths track substantively decelerating water.



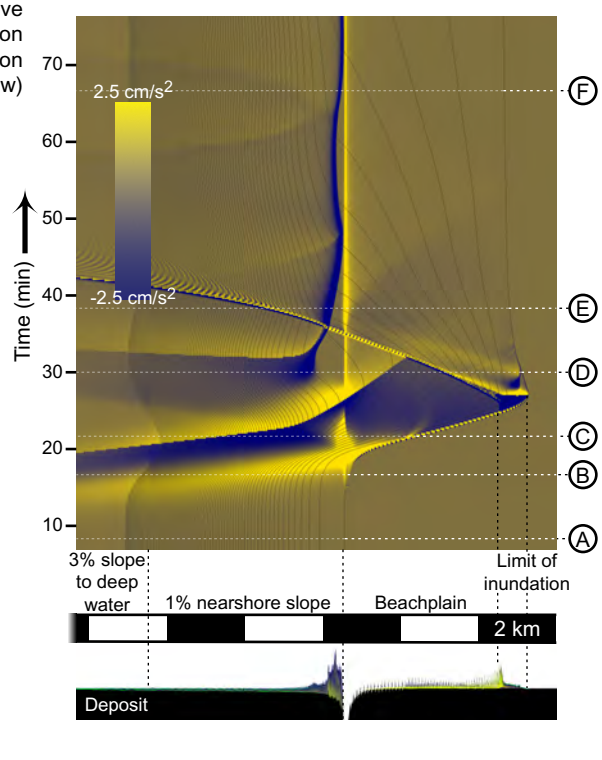
Water speed

This diagram shows variation in modeled speed (the absolute value of velocity) through time and space. Yellow indicates fast moving water, while blue indicates slow or stationary water. Sharp transitions in velocity (appearing as kinks in the water paths) indicate steps in the water surface. In general I assume that faster water tends to deposit coarser sediment, if it is depositional (see below). Note that this diagram is redundant with the one above, except that it is higher resolution.



Substantive acceleration (in direction of flow)

This shows variation in substantive acceleration through time and space, in the direction of flow. This is the change in the speed of water particles as they pass all points in this time/space domain. In general I assume that substantively accelerating water (yellows) is erosive, while substantively decelerating water (blues) is depositional. This diagram is also redundant with the water paths, except that it is higher resolution.



By assuming that substantively decelerating water deposits sediment, and that faster water deposits coarser sediment than slower water, we can begin to predict depositional trends using hydrodynamic models such as this one.

In this case, still water (A) is accelerated by an approaching tsunami (B). Substantive acceleration is particularly strong right near the beach where the flow concentrates, however this acceleration transitions to substantive deceleration by time (C) except at the breaking front of the wave. Deposition occurs all across the beachplain following the leading front, leaving a normally graded sheet of sand.

When the reflected bore (D) propogates back across the beach plain it leads to a sudden shift in the flow toward the ocean, followed by a long period of substantively non-accelerated withdrawal that neither deposits nor erodes much.

The exception is the first 1.5 km of beachplain where the withdrawal begins before the reflected bore arrives, and does erode some of the top of the sand sheet. Right at the top of the beach flow is spatially concentrated during inundation and much more so during withdrawal, leading to much greater erosion there than anywhere else (E, F).

During the withdrawal, a hydraulic jump forms lower on the beachface (E,F). This is a location of strong substantive deceleration that leads to more deposition than anywhere else.

At the bottom of this figure a plot of the integral of substantive deceleration is plotted colored by speed (same scale as on the water speed plot. This can be thought of as a rough cartoon of the deposit, where high points represent more deposition, low points erosion, yellow represents coarse sediment, and blue fine sediment. Because of poor interpolation on my part the reflected bore leads to noisy erosion across the beach-plain.