Nourishment evolution and impacts at four southern California beaches: a sand volume analysis: Supporting Material

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Abstract

Supporting Material

References

Warrick, J.A., Rosenberger, K., Lam, A., Ferreira, J., Miller, I.M., Rippy, M., Svejkovsky, J., and Mustain, N., 2012, Observations of coastal sediment dynamics of the Tijuana Estuary Fine Sediment Fate and Transport Demonstration Project, Imperial Beach, California, U.S. Geological Survey Open-File Report 20121083, 29 p and data files.

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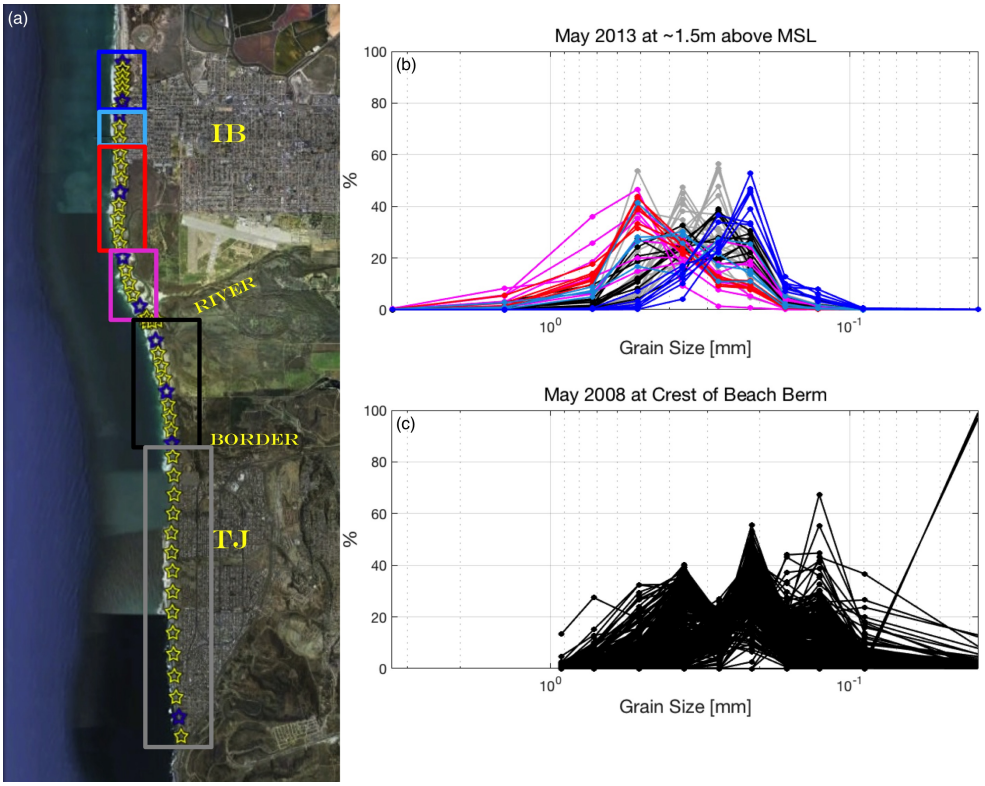

Figure S1: Sand samples taken at Imperial Beach, Border Field State Park and Playas, Tijuana. (a) Stars mark the locations of sand samples collected. Yellow stars indicate where a single surface sample was taken near the 1.5m contour (rel. MSL). Blue stars mark locations where multiple samples were collected: Approximately 5 cross-shore locations were sampled from MSL to the backbeach, both at the surface and at about 1m dug below the surface. Samples at the mouth of the river were collected on May 14, 2013; north of the river on May 18, 2013; south of the river and north of the border on May 20, 2013; and in Tijuana (TJ) on May 22, 2013. (b) Surface samples collected in May 2013 at ∼1.5m above MSL. Colors correspond to regions outlined in (a). The sand north of the south jetty (blue) is distinctly finer than the nourishment sand (red). Other distributions are less distinguishable. (c) Sand samples from May 2008 at crest of beach berm (Warrick et al., 2012) show that native sands near the river mouth have diverse distributions, making the southward propagation of nourishment sand difficult to track. Samples dug 1m below the surface and from higher and lower on the beach did not provide helpful insight (not shown).

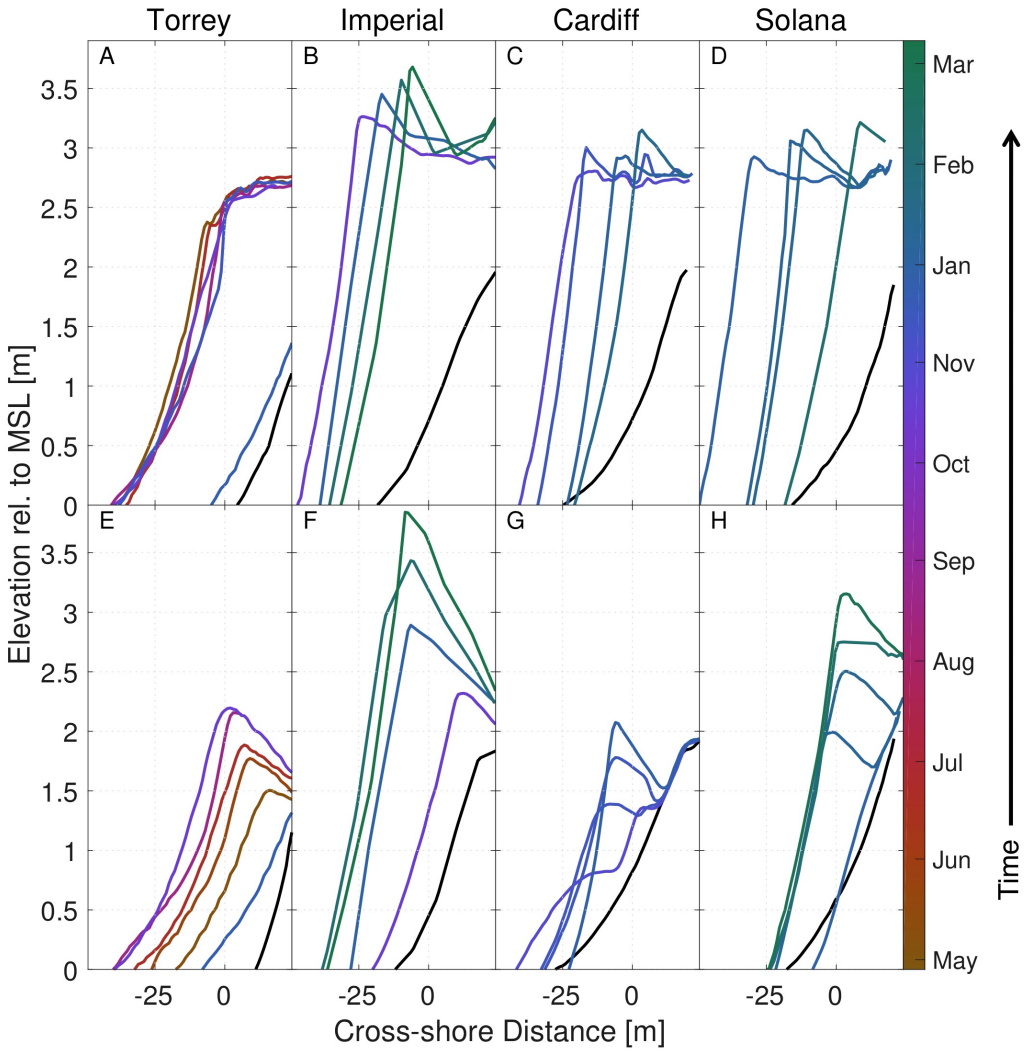

Figure S2: Subaerial beach elevation (above MSL) versus cross-shore distance at (left to right) Torrey, Imperial, Cardiff, and Solana Beach. **(A-D)** Original placement region. **(E-H)** Adjacent to original placement region. Transect line locations (A-H) are shown in Figure S3. Colors (see scale) correspond to month and are consistent with Figures 3, 5,6, S3 and S4. Black is prenourishment.

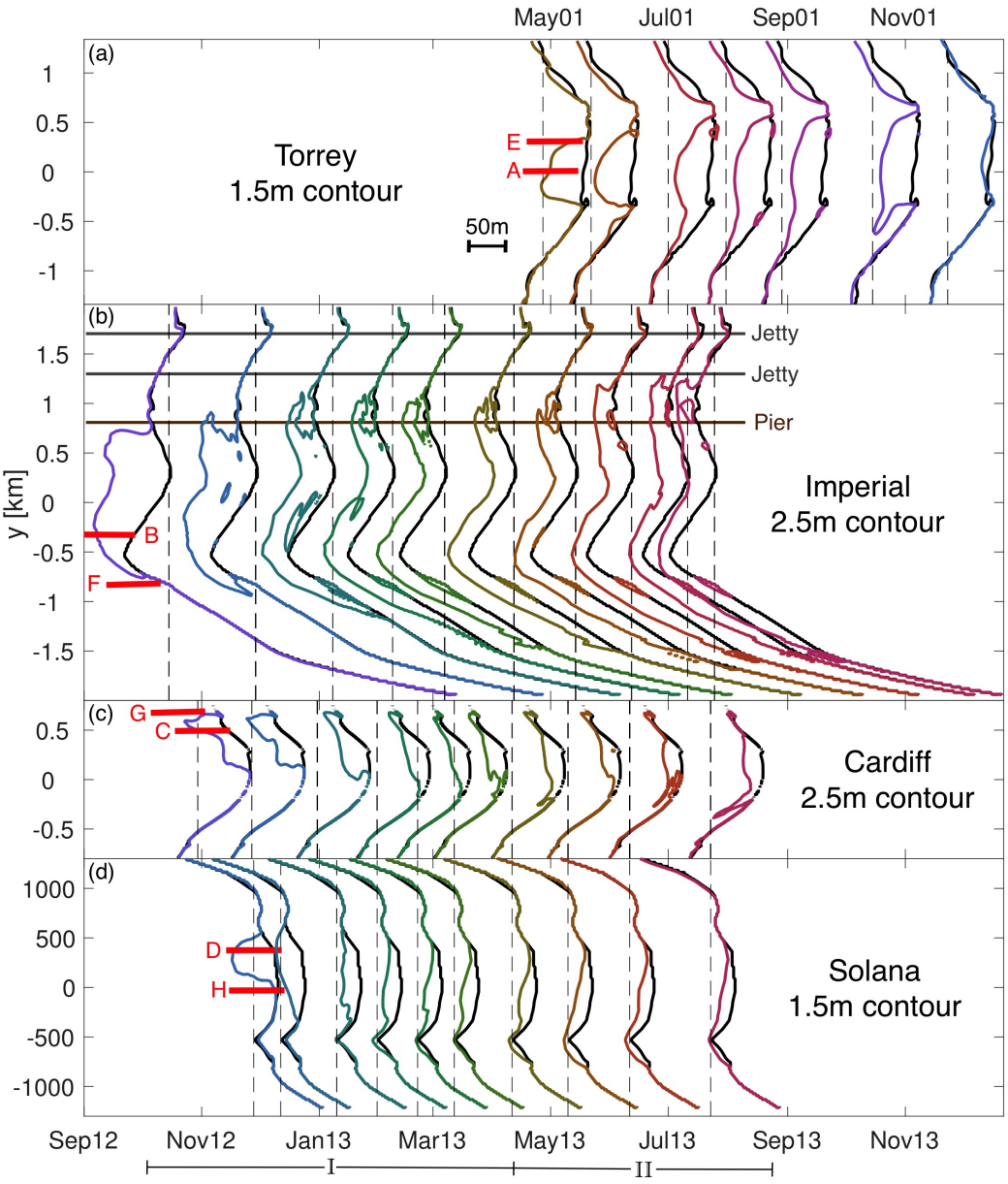

Figure S3: Horizontal location of a subaerial depth contour versus time at **(a)** Torrey Pines (1.5m contour), **(b)** Imperial (2.5m), **(c)** Cardiff (2.5m), and **(d)** Solana Beach (1.5m). The time scale is at the figure top for Torrey, and at the bottom for the others. Colors correspond to survey dates and are consistent with Figures 3, 5, 6, S2 and S4.

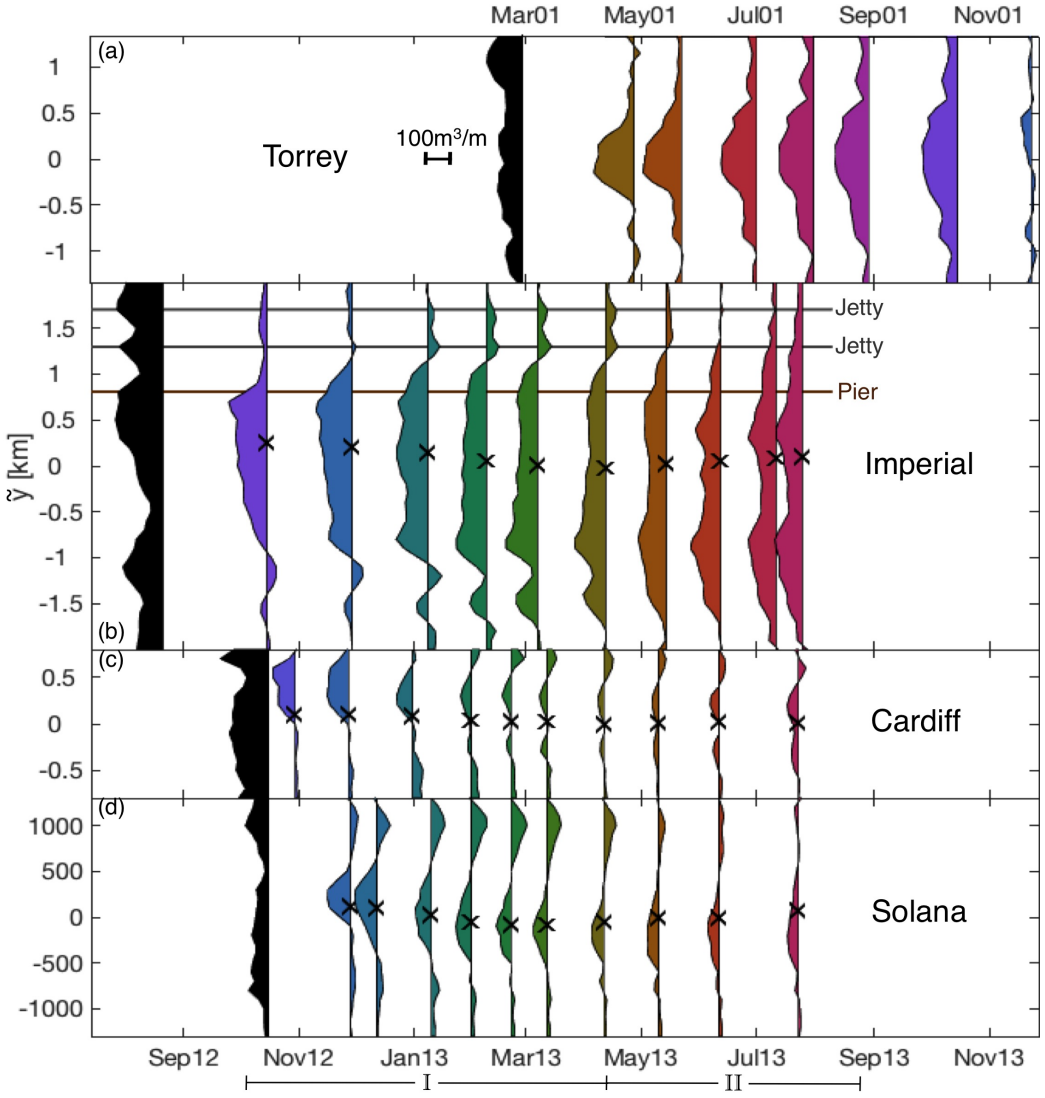

Figure S4: Subaerial sand-in-play (above the minimum surface) versus alongshore location $\tilde{y}$ and time at **(a)** Torrey Pines ($100 m^3/m$ scale is shown), **(b)** Imperial, **(c)** Cardiff, and **(d)** Solana Beach. To highlight the nourishment, prenourishment volume (black) is subtracted from later times. Colors correspond to survey dates and match the color scheme in Figures 3, 5, 6, S2 and S3. The time scale is at the figure top for Torrey, and at the bottom for the others. Time periods I and II are labeled. The black x indicates the subaerial center of mass $\tilde{y}_{com}$ (Equation 2) (Figure 8b).

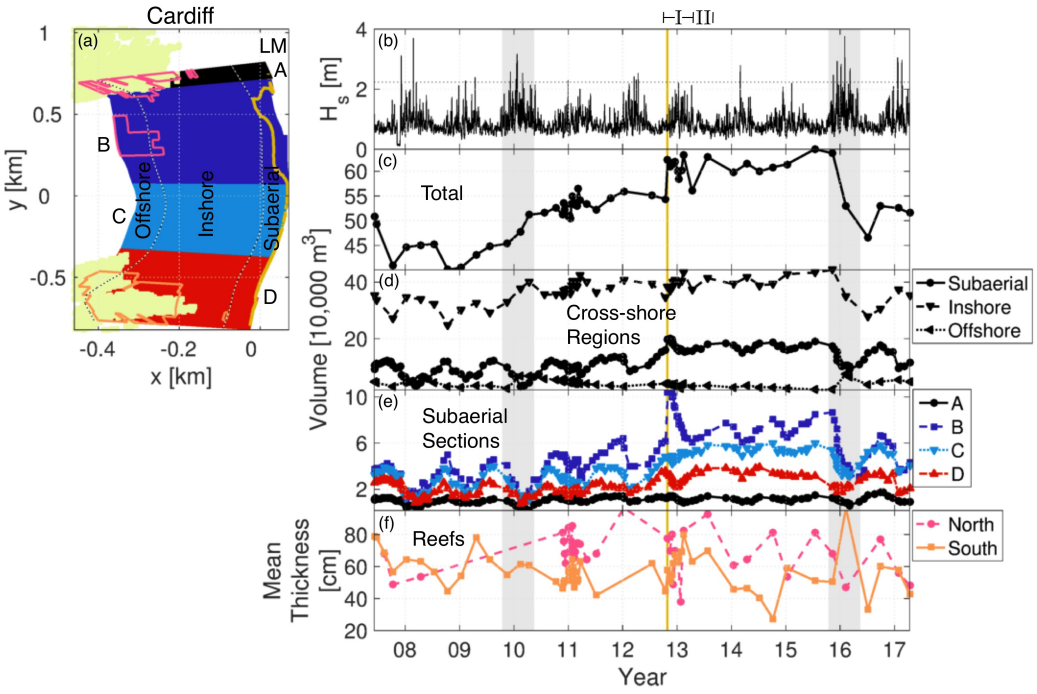

Figure S5: Cardiff Beach **(a)** map of subareas, **(b)** daily averaged significant wave height, and **(c-f)** volumes versus time. See Figure 10 caption.

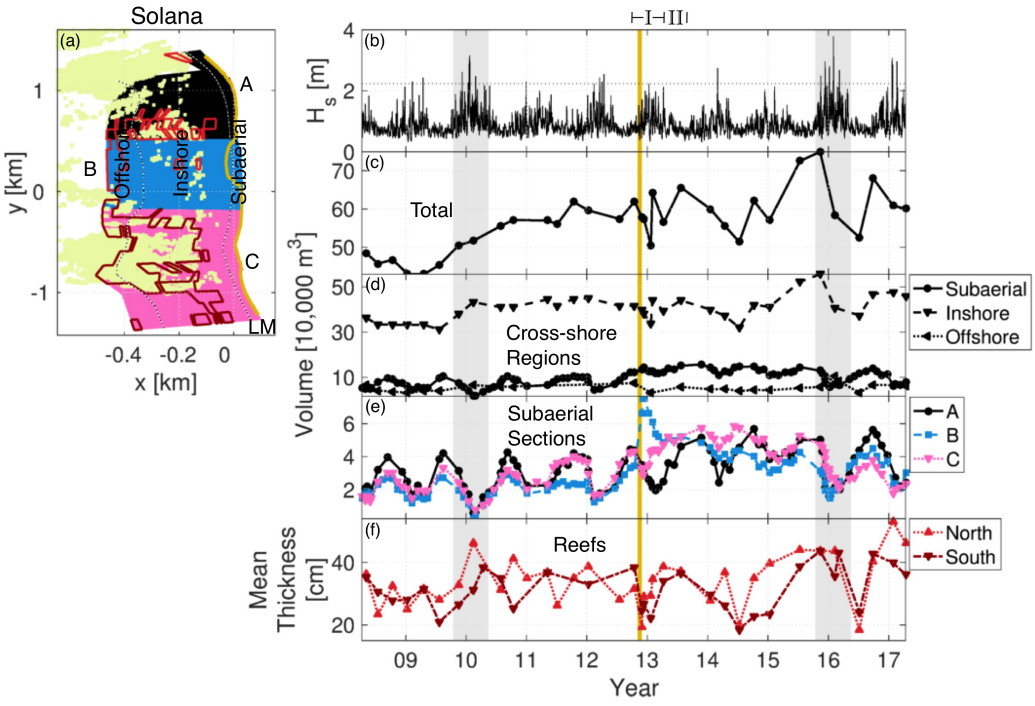

Figure S6: Solana Beach **(a)** map of subareas, **(b)** daily averaged significant wave height, and **(c-f)** volumes versus time. See Figure 10 caption.

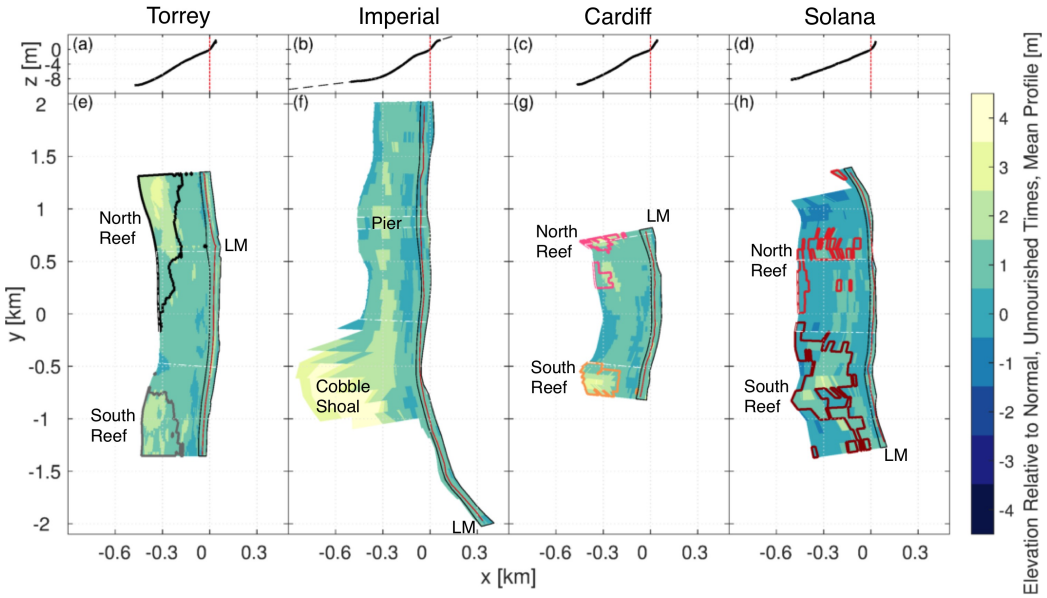

Figure S7: Same as Figure A1 except maximum surface (instead of minimum) is plotted in (e)-(h).

Movie: Torrey Super-elevation See file: "Torrey Super-elevation.mov". Elevation relative to maximum surface in Figure S7. Also found at: `https://youtu.be/p-kLahQf_Js`

Movie: Imperial Super-elevation See file: "Imperial Super-elevation.mov". Elevation relative to maximum surface in Figure S7. Also found at: `https://youtu.be/J2pUG6qNPGs`

Movie: Cardiff and Solana Super-elevation See file: "Cardiff and Solana Super-elevation.mov". Elevation relative to maximum surface in Figure S7. Also found at: `https://youtu.be/0LrcuSWAiOs`