Buoyant and gravity-driven transport on the Waipaoa shelf

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I. Motivation & Methods

Riverine deposits on continental shelves reflect terrestrial signatures, but are typically modified by the marine environment. Partitioning between various transport mechanisms (dilute suspension vs. gravity-driven) may influence the location and characteristics of these deposits.

II. Deposition from Buoyant and Gravity-Driven Processes

Water Column Model

Buoyant fluxes were estimated with a 3D hydrodynamic-sediment transport model described in detail in Moriarty et al. (2014).

PROs: Includes water column processes, including river plume behavior, and wave resuspension

CONS: Insufficient vertical resolution for the wave-current boundary layer

Wave- and current- driven gravity fluxes were estimated with a 2D Chezy equation model that balances friction and gravity following Ma et al. (2010).

PROs: Accounts for near-bed turbidity layer; computationally efficient

CONS: Cannot account for water column processes

Estimated Deposition: Jan 2010 – Feb 2011

Buoyant Transport + Gravity Flows

- Transport within the river plume during energetic wave events distributed sediment along-shore, to either side of Poverty Bay.

- Gravity flows transported material to long-term shelf depocenters (50-70 m water depth) and the continental slope during energetic wave events.

III. Model Sensitivity

Water Column Fluxes

- Slow settling material was dispersed farther from the river mouth and to deeper depths.

- High erosion rate parameters affected the distribution of sediment within Poverty Bay and the shelf.

Gravity Flows

- More sediment input created thicker deposits, but shifted deposition closer to shore, implying that gravity flows on the Waipaoa shelf are transport-limited.

- Spatial distribution of modeled deposits also depended on the along-shore distribution of riverine sediment.

Conclusions

Buoyant fluxes within ROMS-CSTMS

- distributed sediment along-shore, to either side of Poverty Bay.

- did not extend to water deeper than 50 m.

- were especially sensitive to settling velocity.

Wave- and current- gravity flows

- exported sediment to long-term shelf depocenters (50 – 70 m water depth) and to the continental slope.

- were sensitive to parameterizations of sediment input.

Implications

- Both buoyant fluxes and gravity flows can be important for modeling shelf deposition.

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