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Buoyant and gravity-driven transport on the Waipaoa shelf

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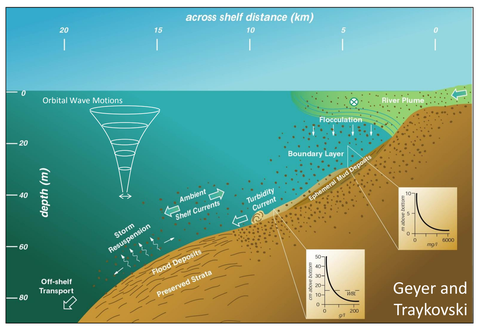
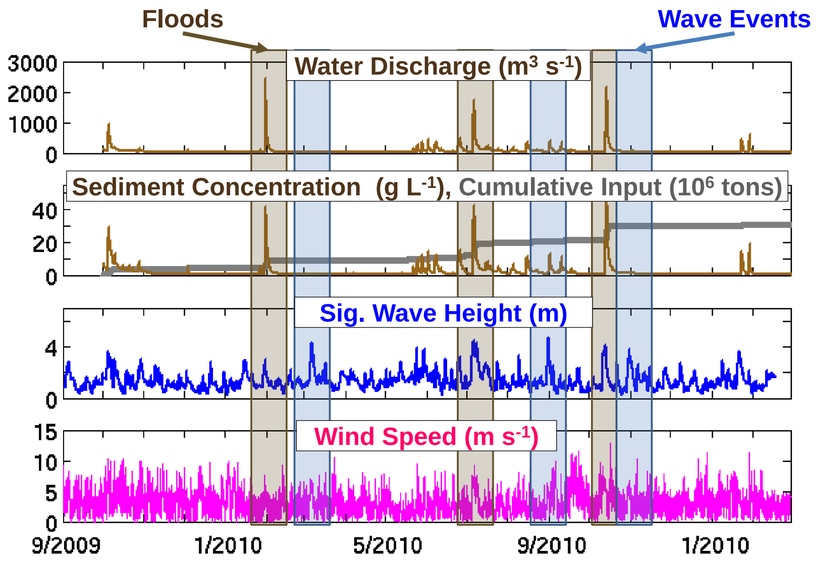
I. Motivation & Methods

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.



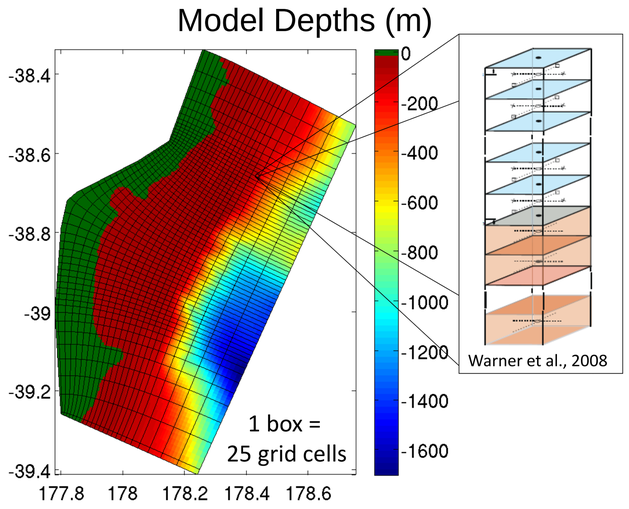


We used two numerical models to analyze sediment fluxes and fate on the continental shelf from January 2010 – February 2011.

Discharge and sediment rating curve: Greg Hall and D. Peacock (Gisborne District Council); Waves: New Zealand Wave model (NZWAVE: Tolman et al., 2001); Winds: New Zealand Limited Area Model (NZLAM: Davies et al., 2005)

Water-column Model: ROMS-CSTMS

Model Depths (m)



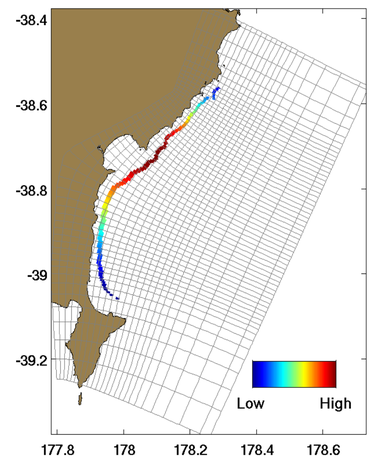
Buoyant fluxes were estimated with a 3D hydrodynamic-sediment transport model described in detail in Moriarty *et al.* (2014).

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

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

Gravity-Flow Model

Initial Sediment Distribution



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 turbid layer; computationally efficient

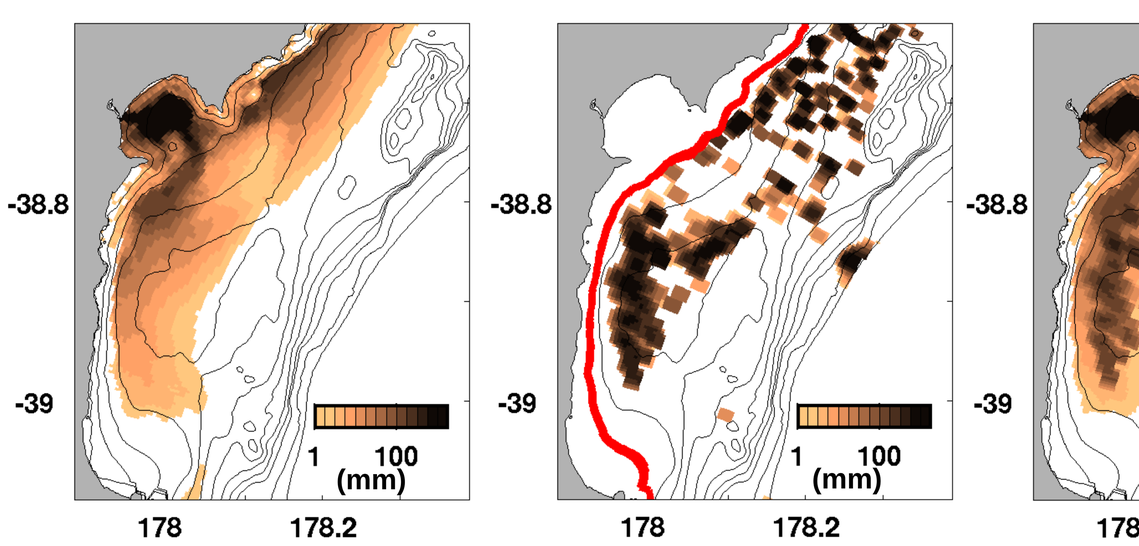
CONs: Cannot account for water column processes

ROMS (Regional Ocean Modeling System): Haidvogel et al., 2000, 2008; Shchepetkin and McWilliams, 2005, 2009; Moriarty et al., 2014. *CSTMS (Community Sediment Transport Modeling System):* Warner et al., 2008. Gravity Flow Model: Scully et al., 2003; Ma et al., 2010

II. Deposition from Buoyant and Gravity-Driven Processes

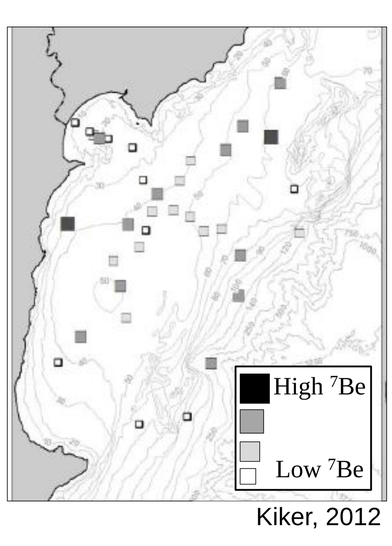
Estimated Deposition: Jan 2010 – Feb 2011

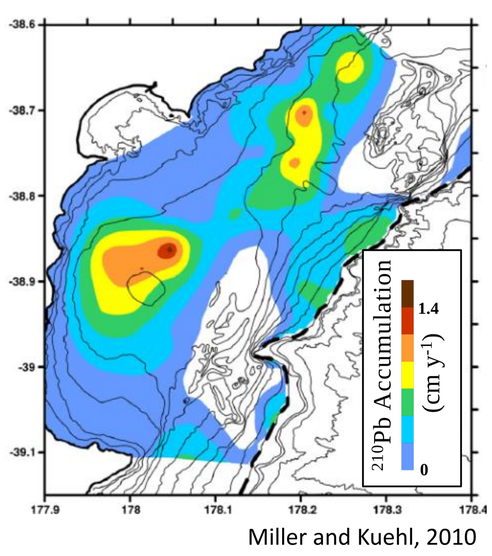
Water Column Model | Gravity Flow Model | Buoyant Transport + Gravity Flows



Observed Radioisotope Signatures:

Recent Deposition: ^{7}Be Inventories, 9/2010 | Long-term Accumulation: ^{210}Pb Accumulation Rates

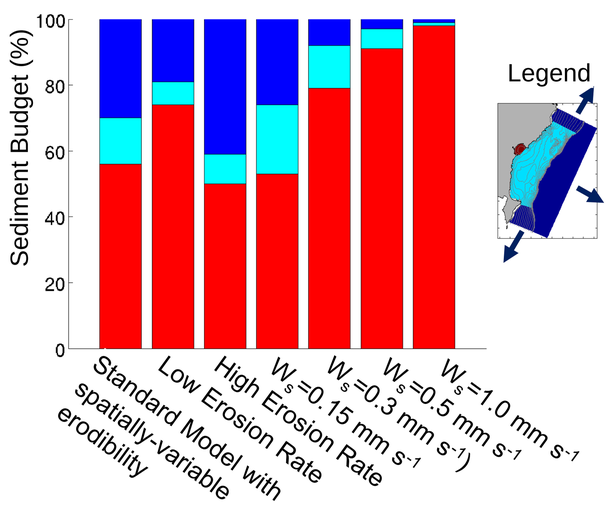




- Transport within the river plume during energetic wave events distributed sediment along-shore, to either side of Poverty Bay.
- Gravity flows transported material to long-term shelf depocenters (50-70 m water depth) and the continental slope during energetic wave events.

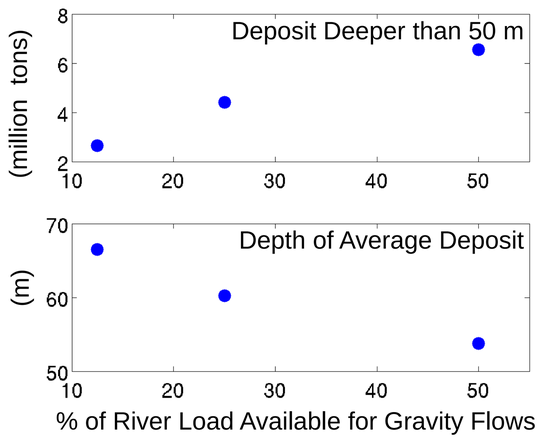
III. Model Sensitivity

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.

Acknowledgements

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