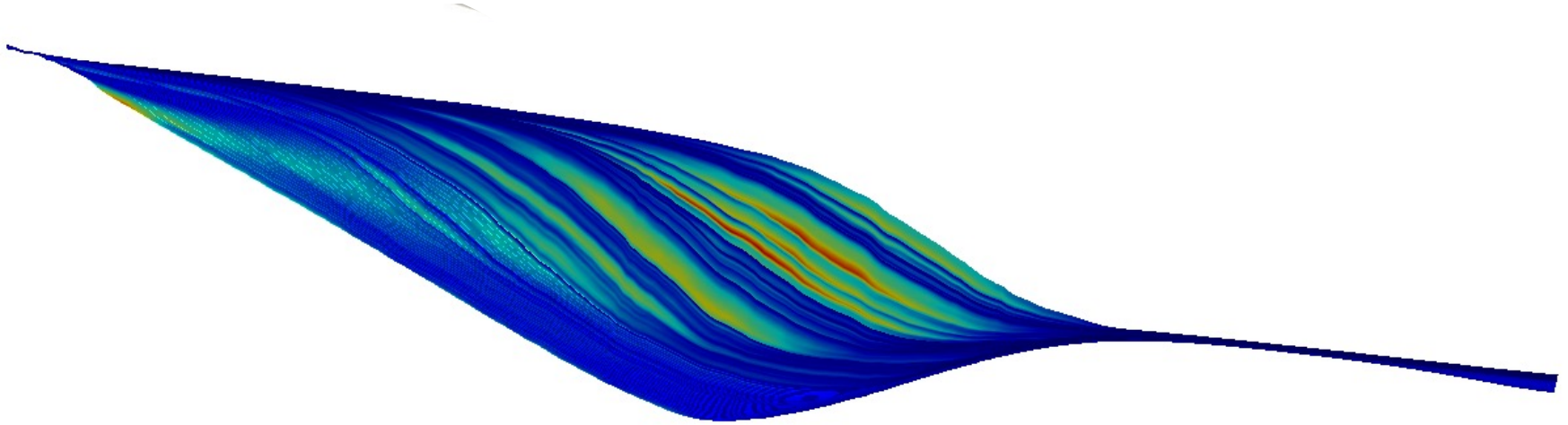
Isostasy amplifies relative sea-level change on continental-scale deltas



Sara Morón

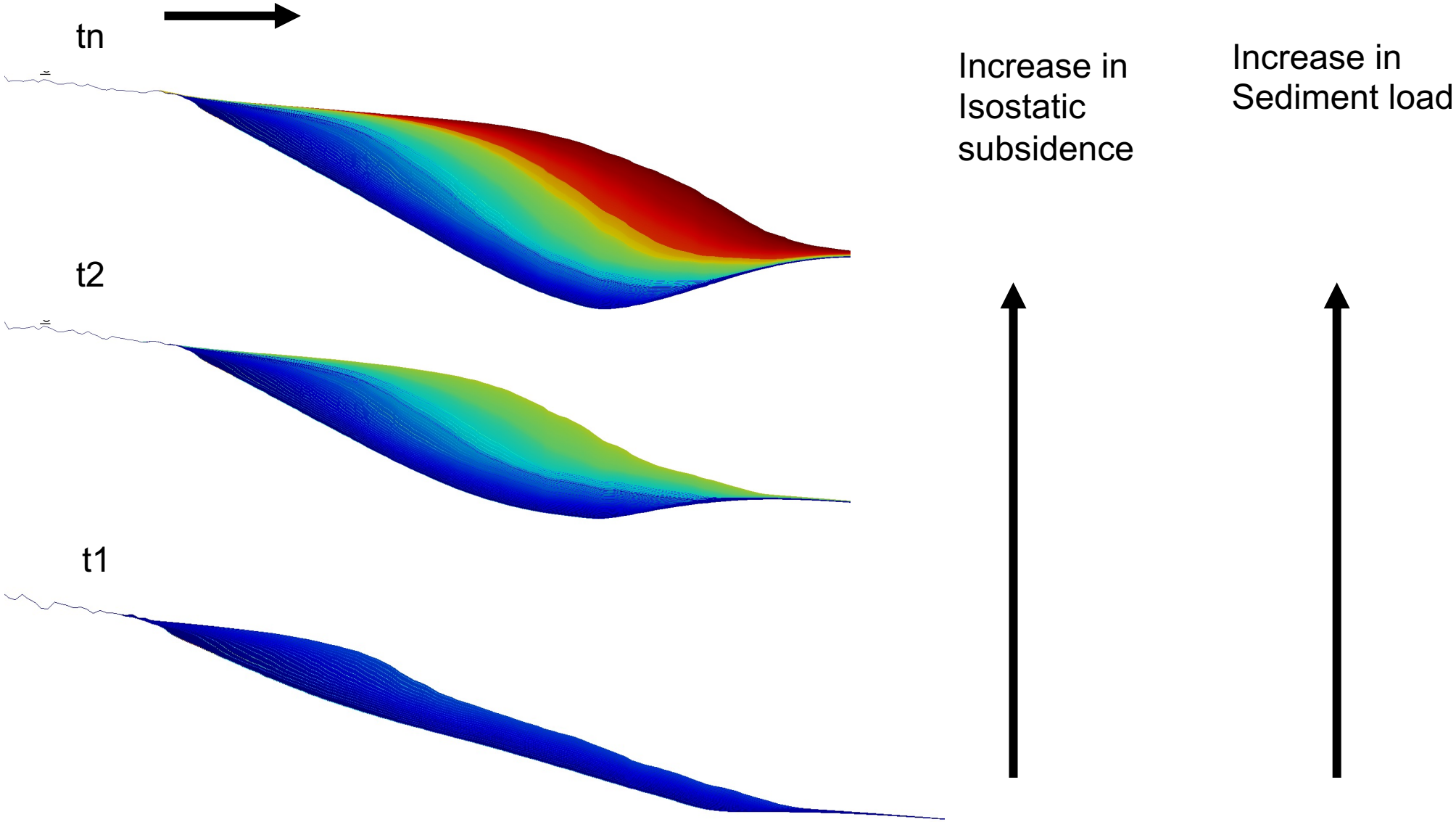
Mike Blum, Tristan Salles, Bruce Frederick, Rebecca Farrington, Claire Mallard, Louis Moresi

BGH

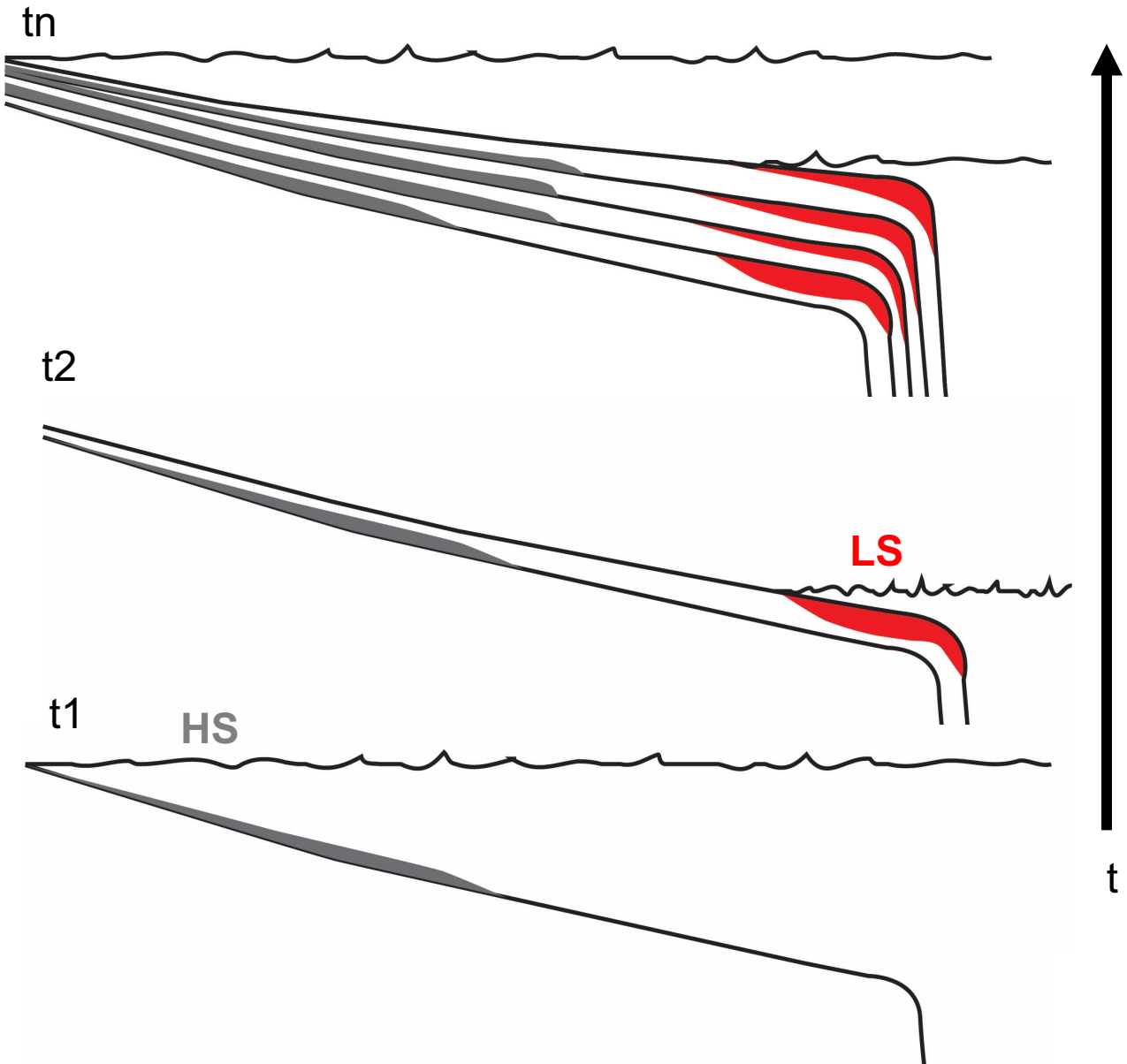
BADLANDS

THE UNIVERSITY OF SYDNEY

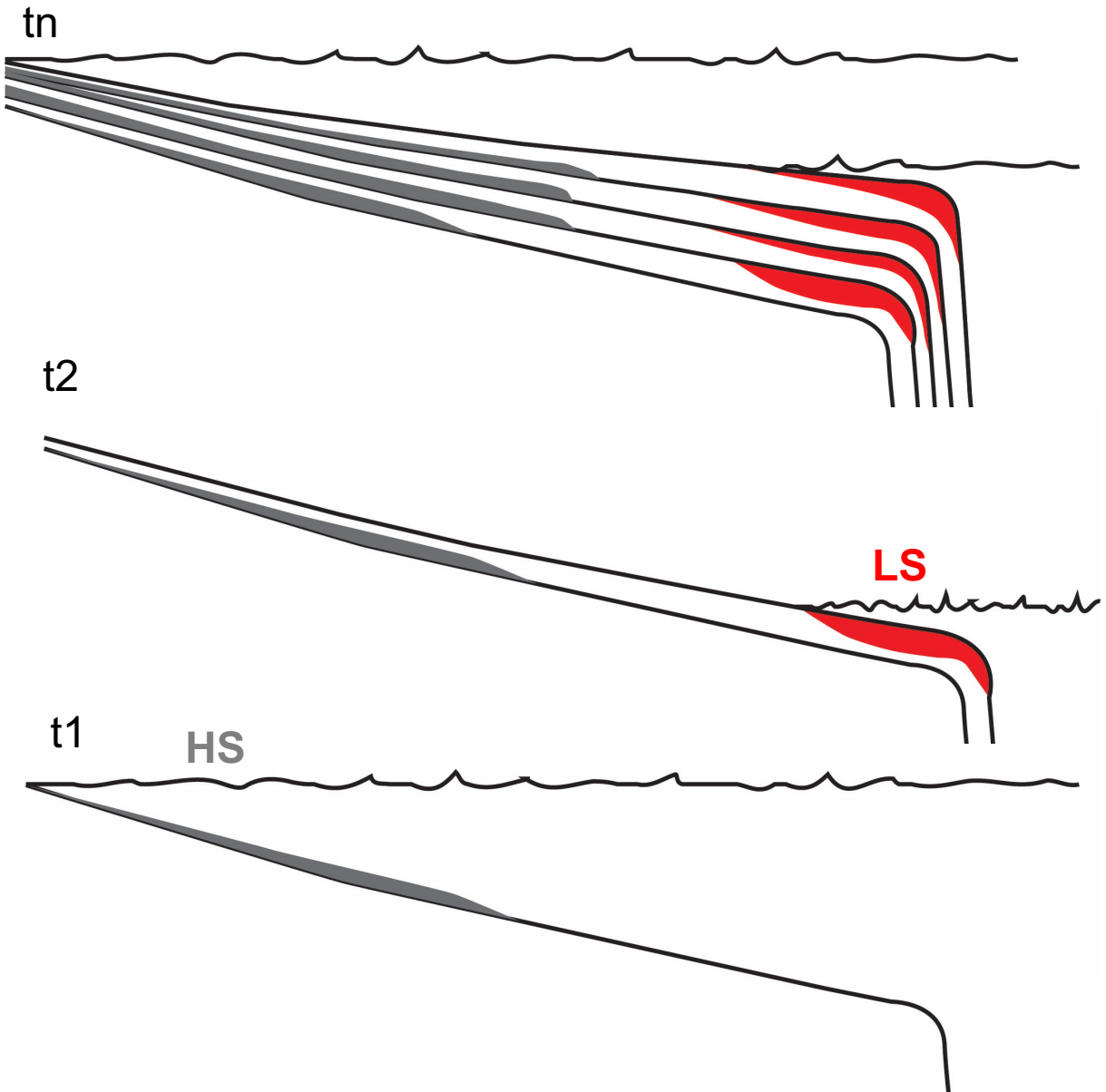
Unidirectional flexural isostasy



Sediment load partitioning and sea-level changes



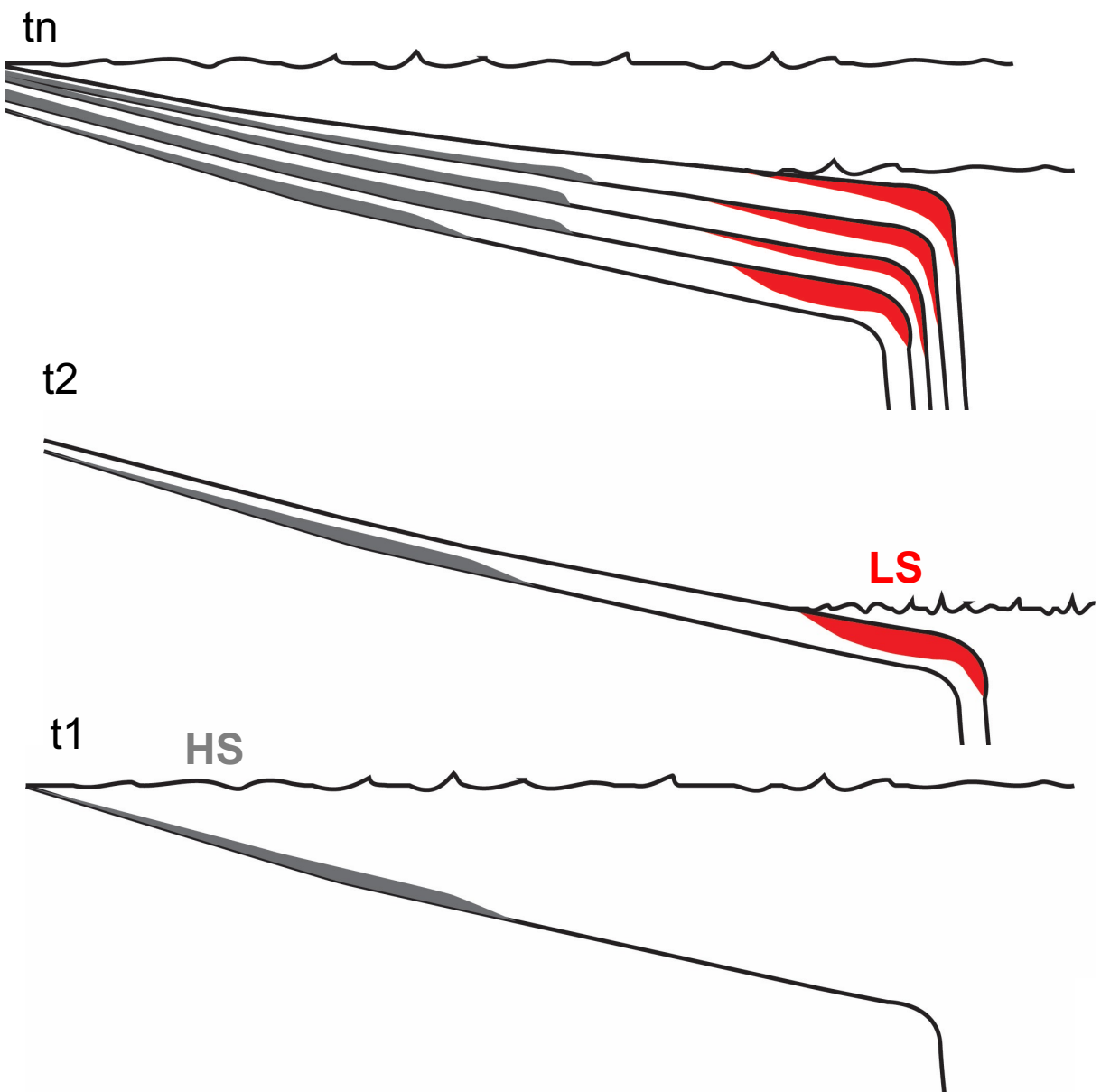
This study



Can flexural isostatic adjustments be of high frequency and bidirectional?

Is there a direct response of the flexural isostasy to the load partitioning due to eustasy?

This study



Can flexural isostatic adjustments be of high frequency and bidirectional?

Set of simulations with synthetic sea-level curves of different frequencies and amplitudes

Is there a direct response of the flexural isostasy to the load partitioning due to climatically-driven sea-level changes?

Simulations with sea-level curves from polar ice-free (Green-house) and polar ice-dominated (Ice-house) periods

Compared to a suite of non-flexurally-compensated models

The code

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Basin an**d** **Lands**cape Dynamics

Simulates
Hillslope processes (**linear** & **non-linear** diffusion)
Fluvial incision (*'modified'* **Stream Power Law**, **Transport)**
Sea-level fluctuations
Uses **gFlex** to solve elastic plate flexure

Not accounted in this study:

- Compaction
- Submarine gravity currents
- Grain sizes
- Tectonic subsidence

The code

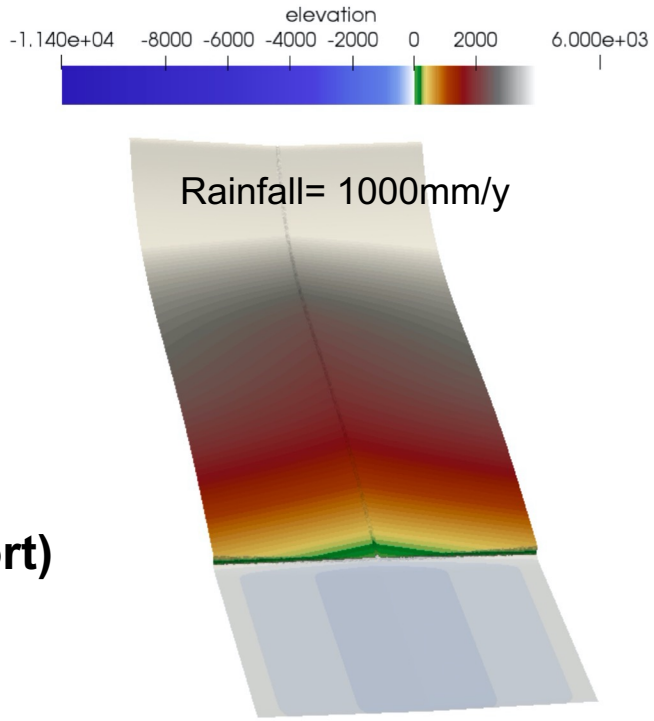
Basin an**d** **Lands**cape Dynamics

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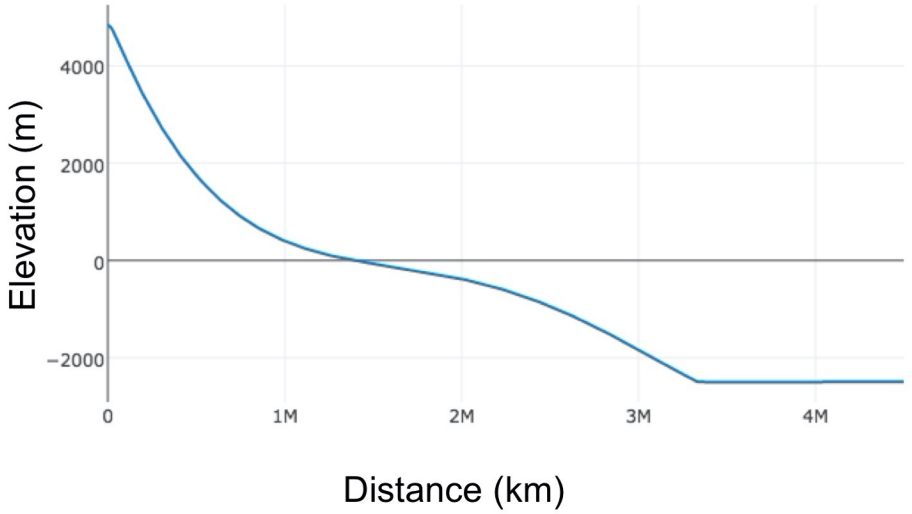
Model setup



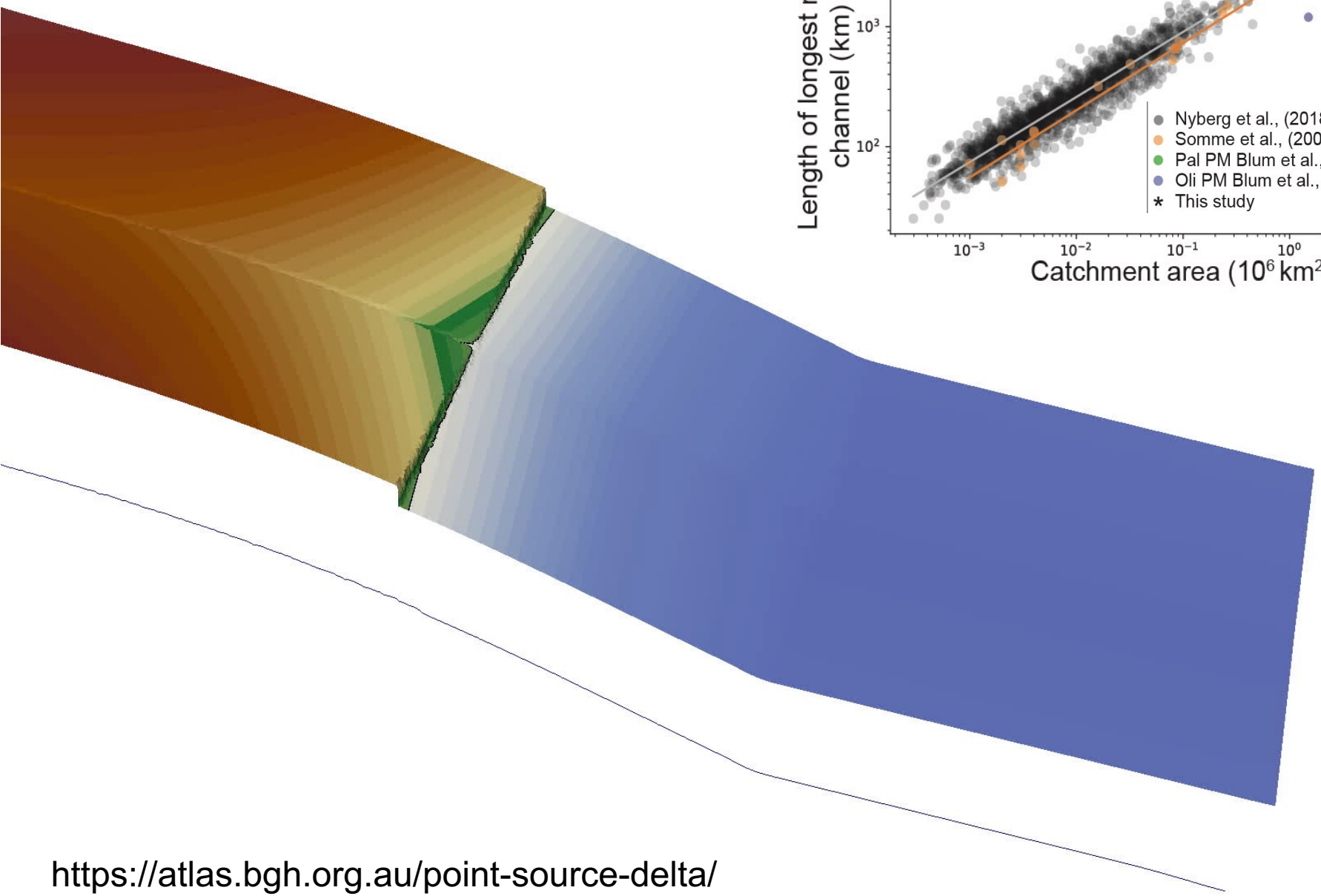
The initial configuration of the modeling domain resembles the topography of a natural source to sink system

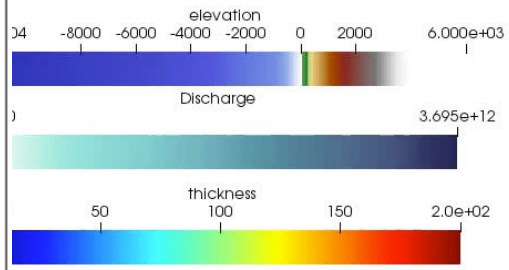
Elastic thickness=50km
range of passive margins

Temporal resolution
~100ky

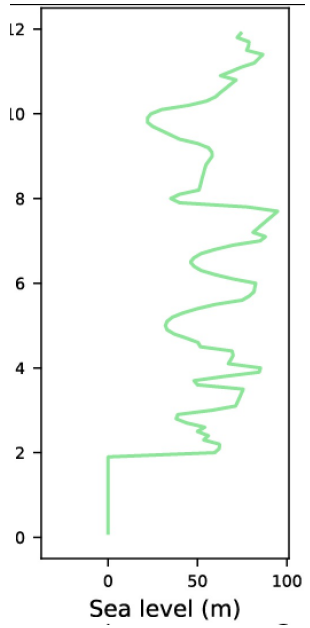


Time: 0 years



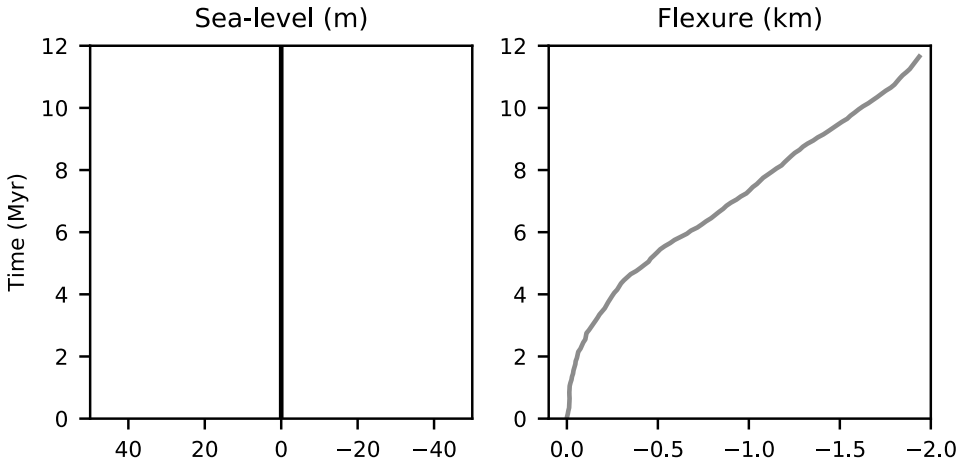


"Green house"



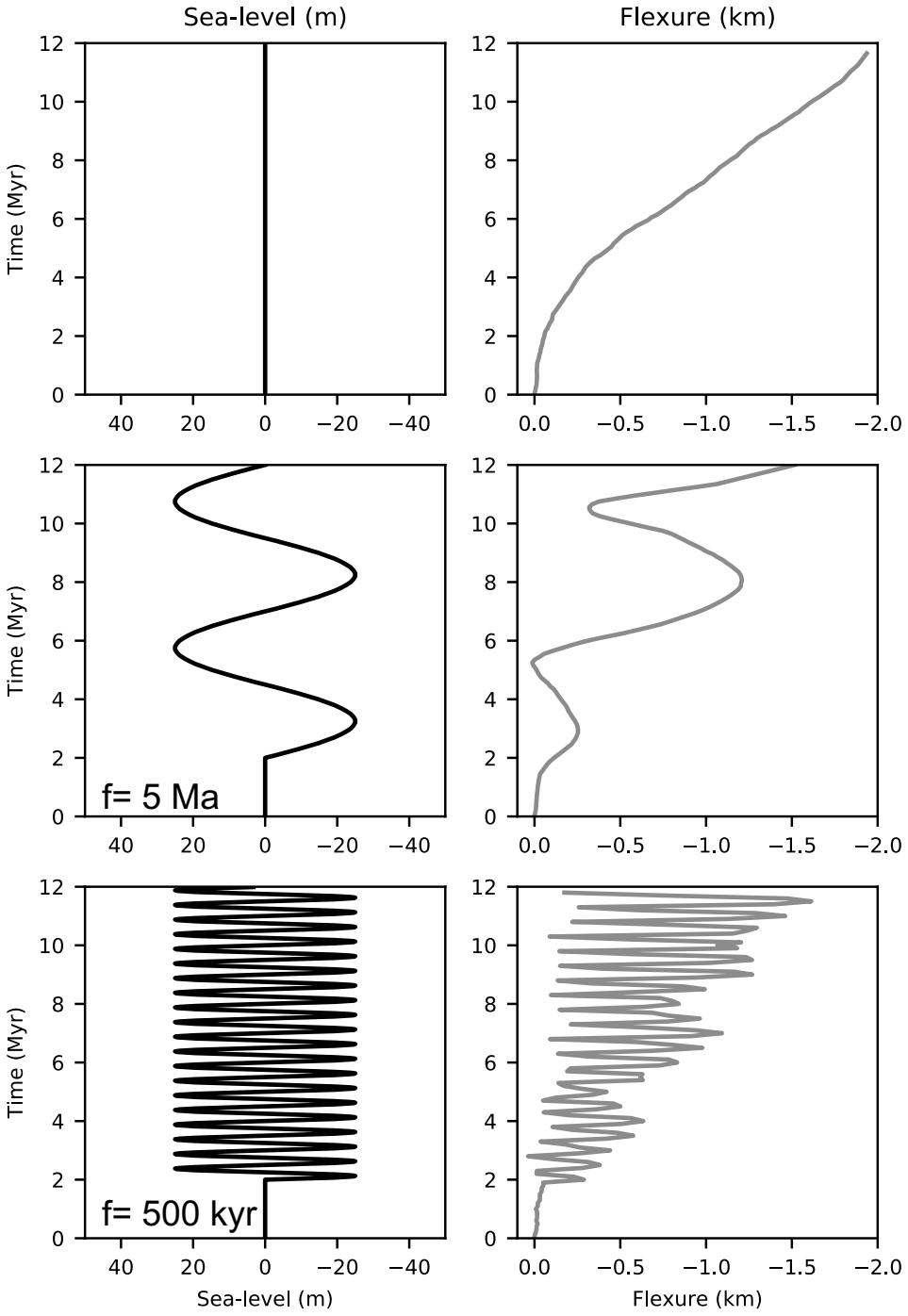
https://atlas.bgh.org.au/point-source-delta/

Kominz et al., (2008)


Sea-level (m)
Flexure (km)
Time (Myr)
12
10
8
6
4
2
0
40
20
0
−20
−40
0.0
−0.5
−1.0
−1.5
−2.0

Frequency

Frequency

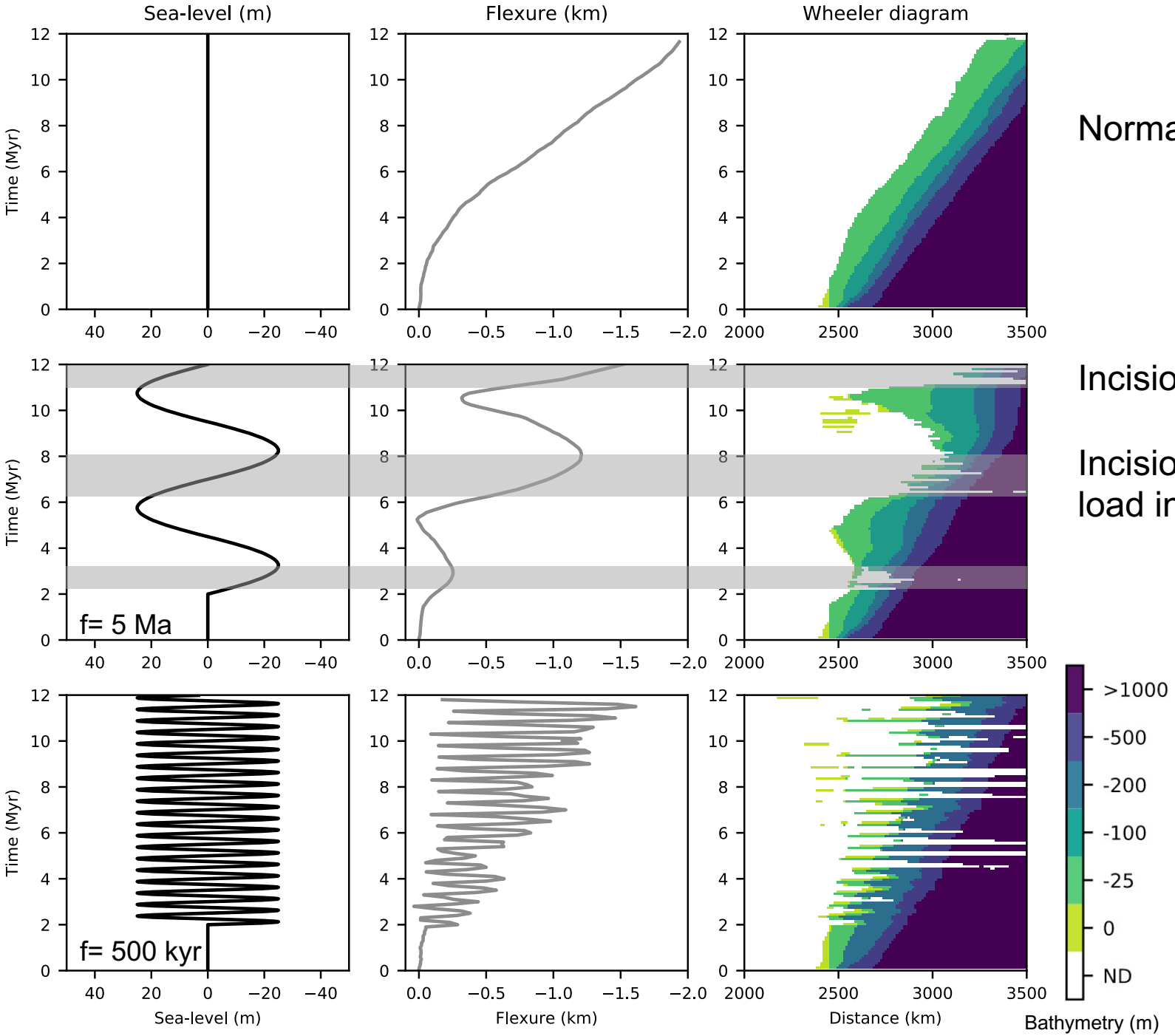


Flexural isostatic compensation is monotonic ONLY if sea-level change is not considered

Flexural isostatic compensation is in sync the frequency of the sea-level changes.

There is a direct response of the flexural isostatic compensation to sea-level changes

Frequency



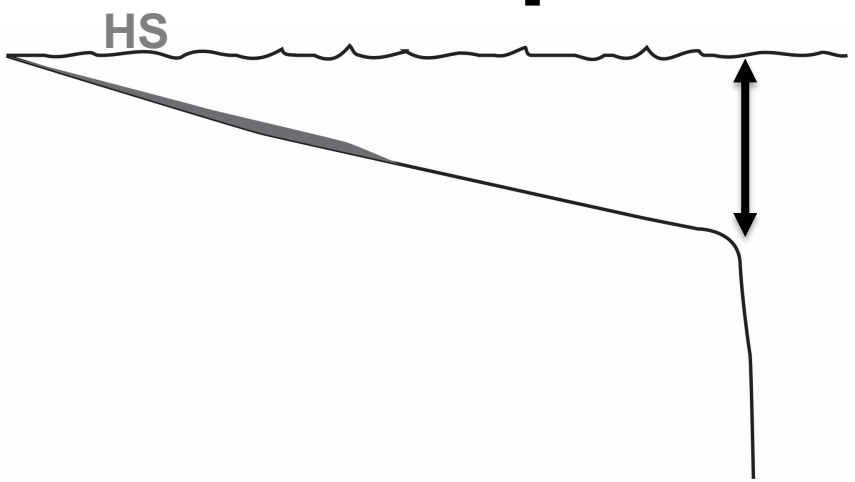
Normal regression

Incision during sea-level fall “Forced regressions”

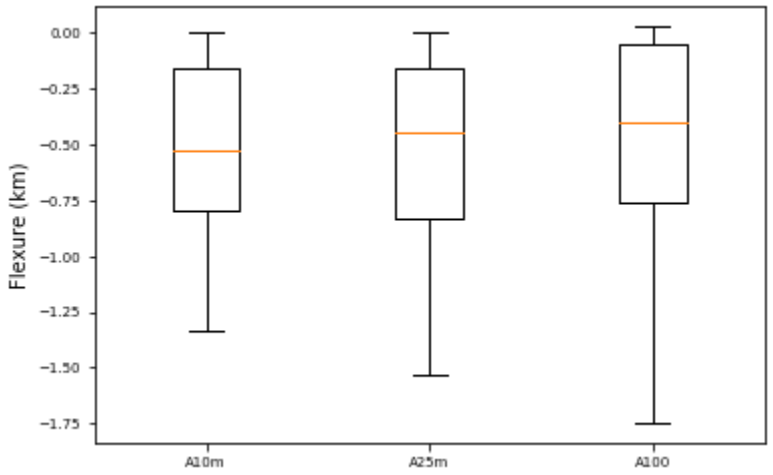
Incision further into the basin as the sediment load increases with time

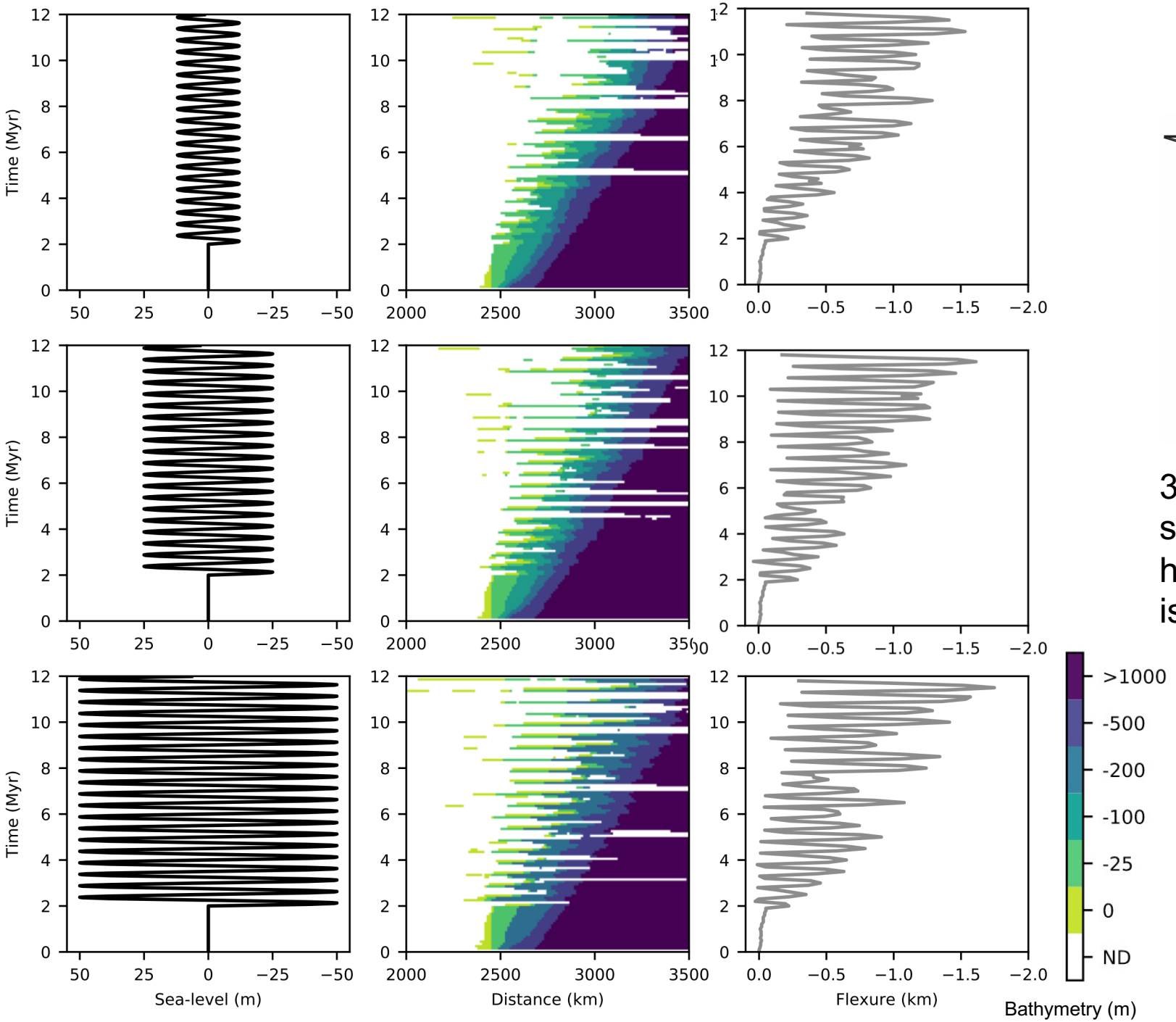
The interplay between the flexural isostatic compensation and sea-level change controls sediment dispersal and accumulation patterns

Amplitude

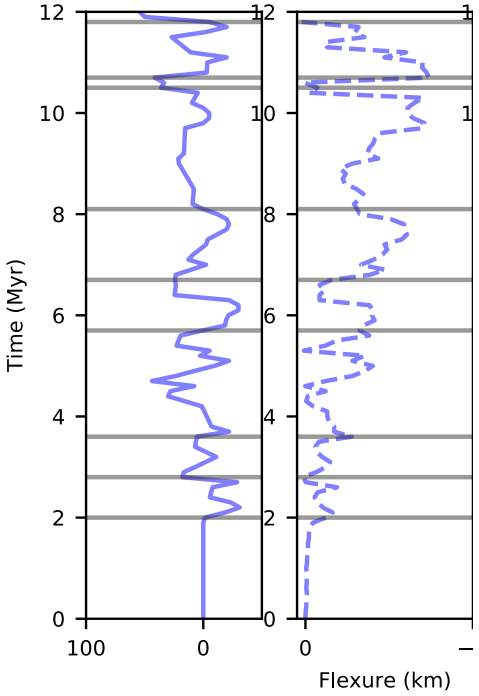


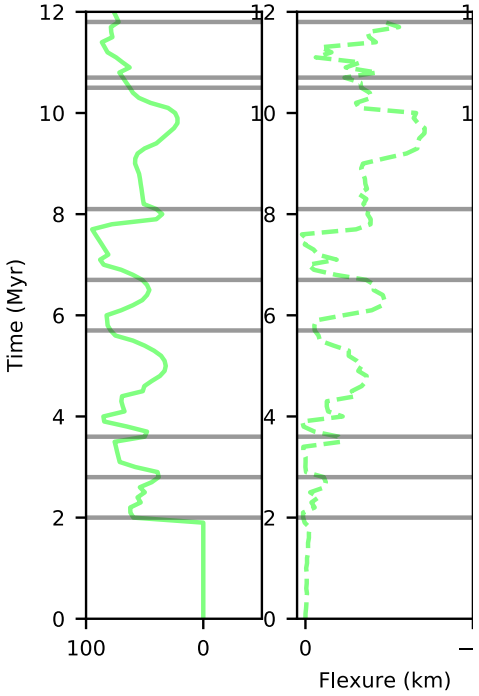
30% difference in flexural response shows the importance of the hydrostatic component of the isostatic compensation

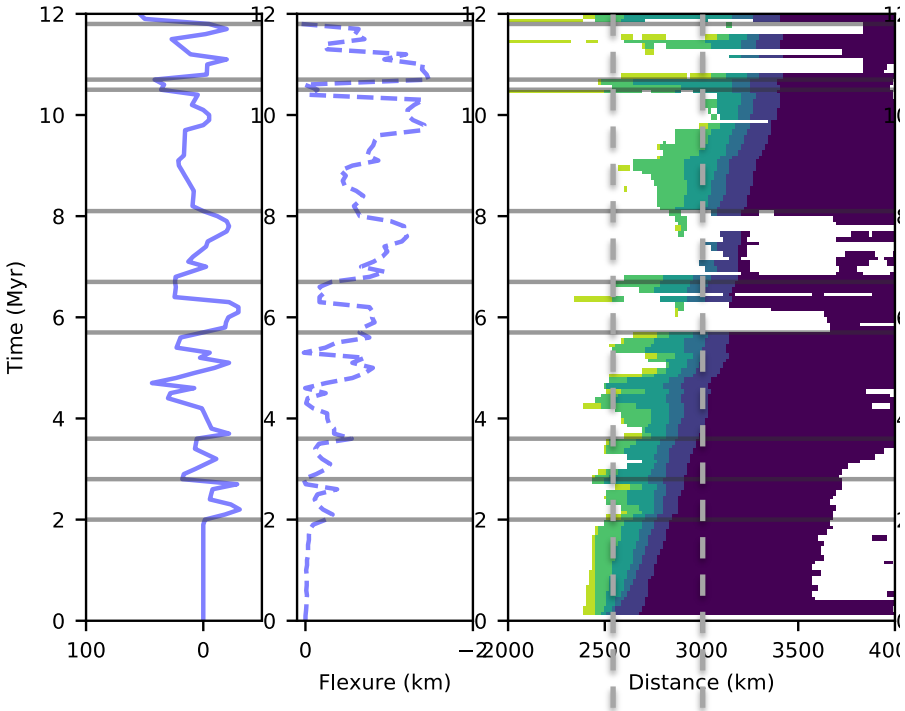


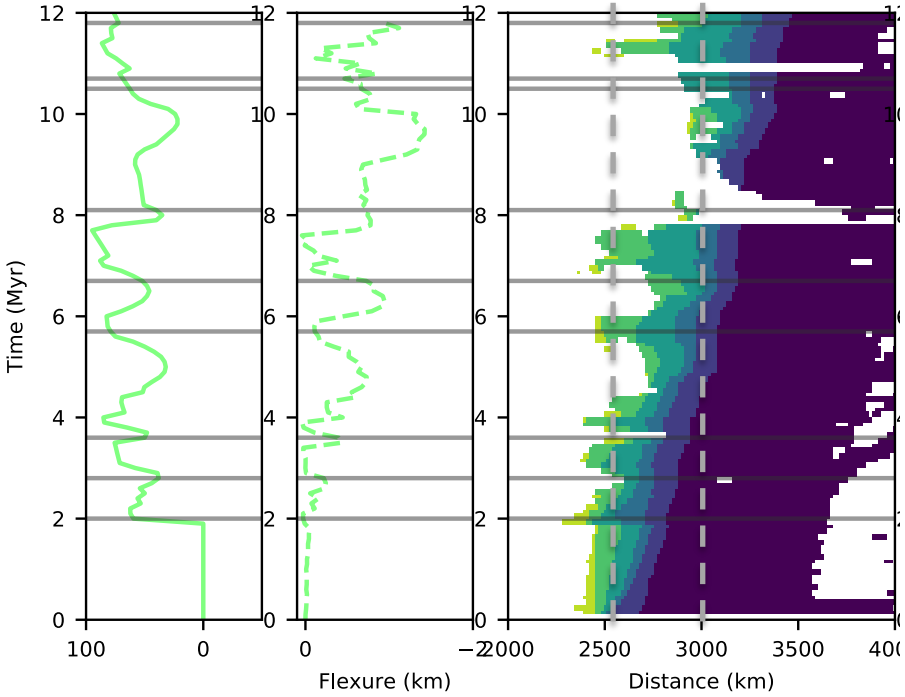


Green house vs Ice house



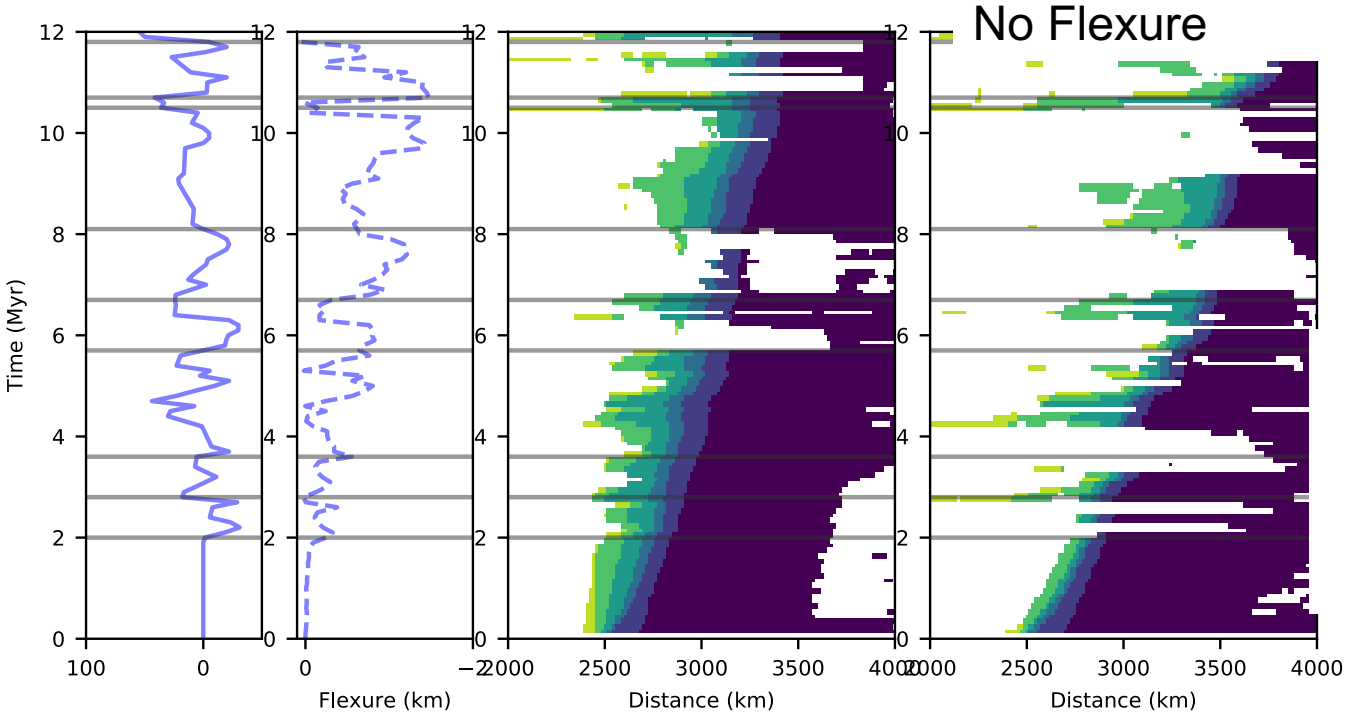


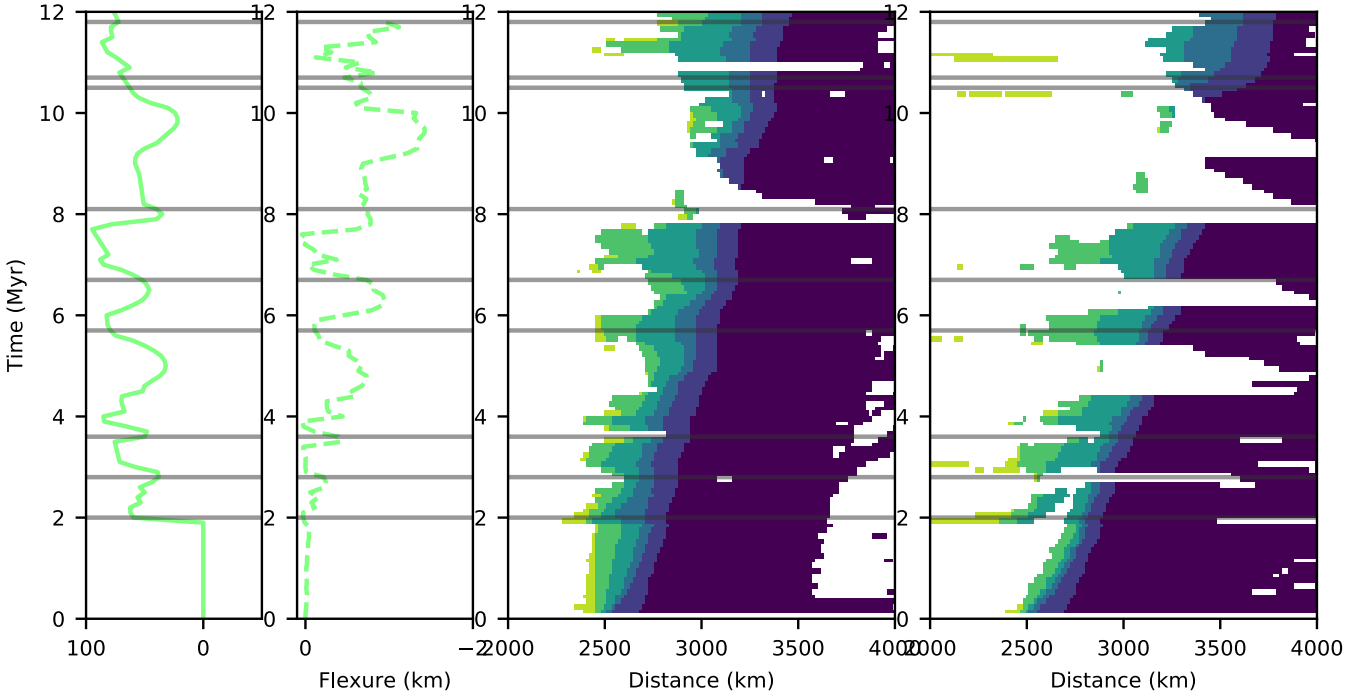


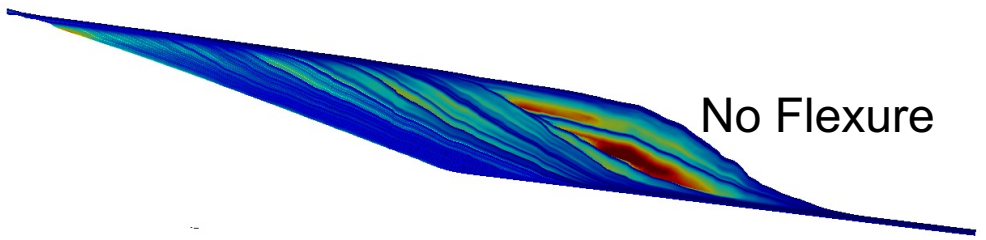


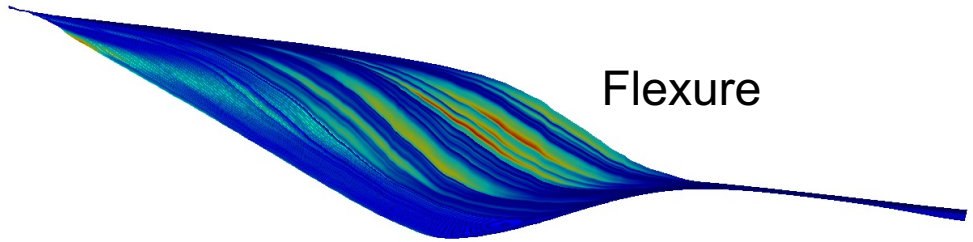
Green house vs Ice house

Green house vs Ice house



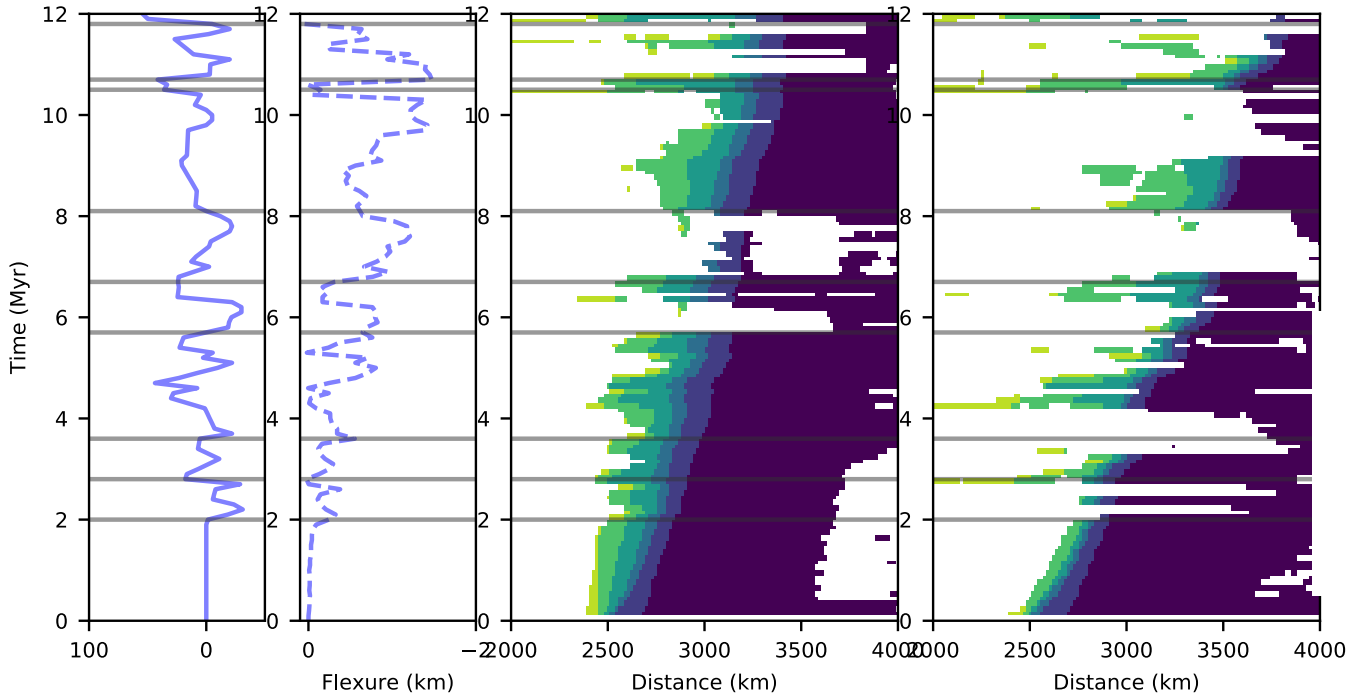


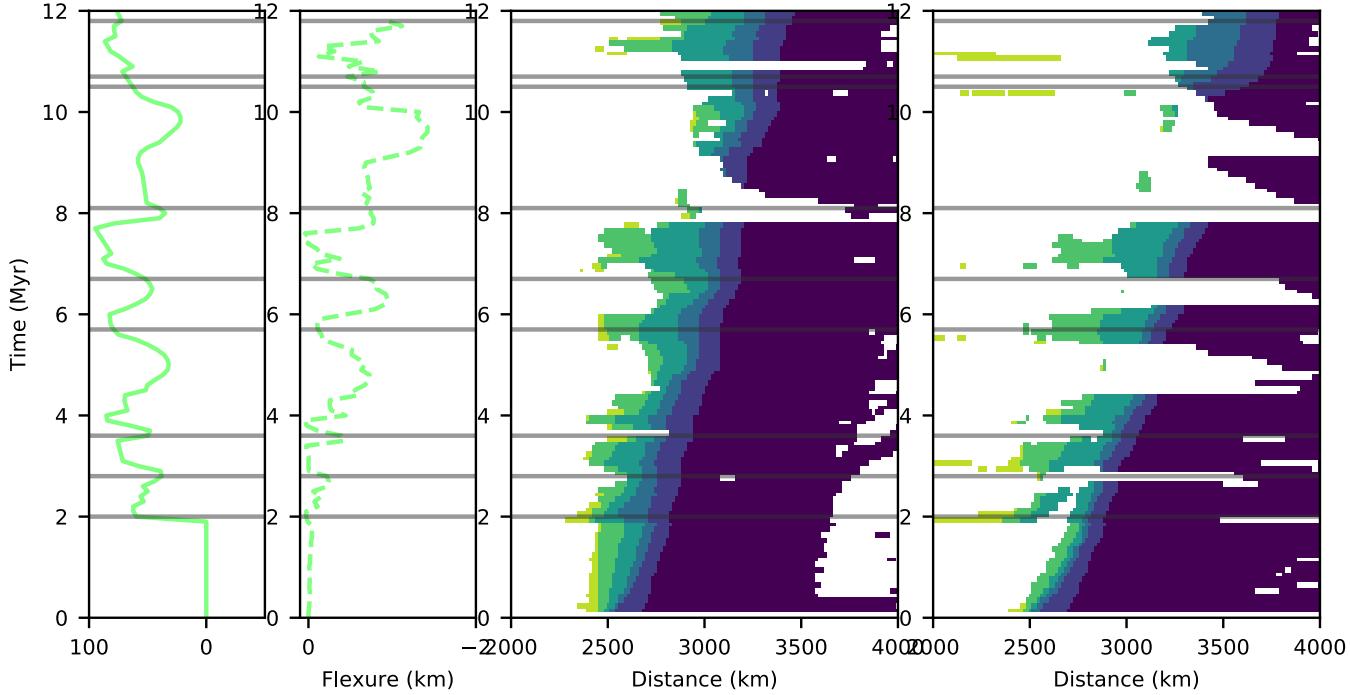


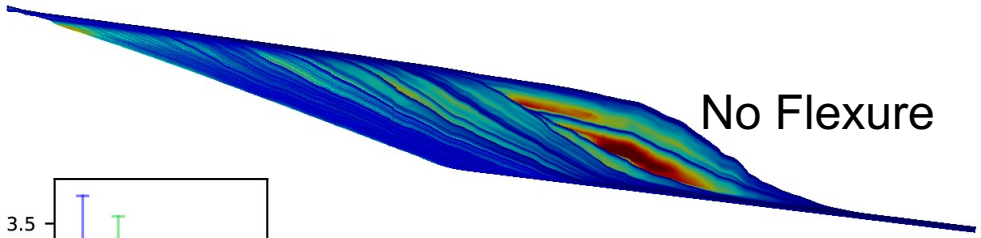


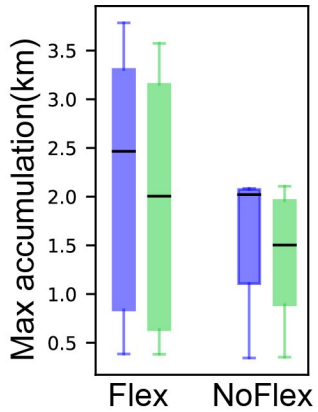


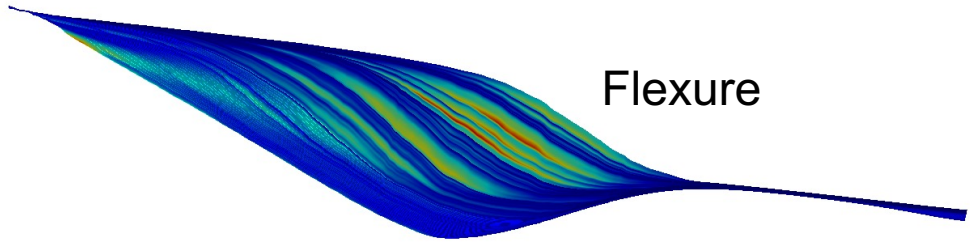
Green house vs Ice house





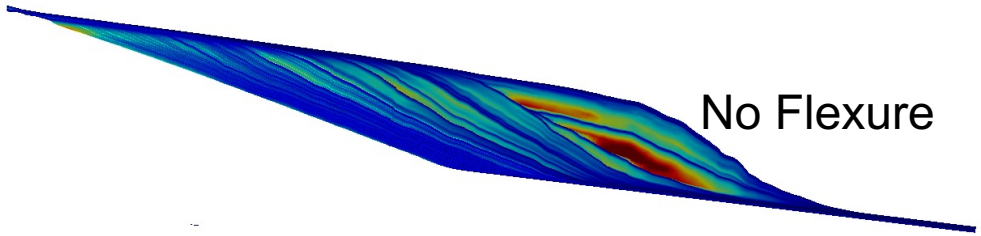




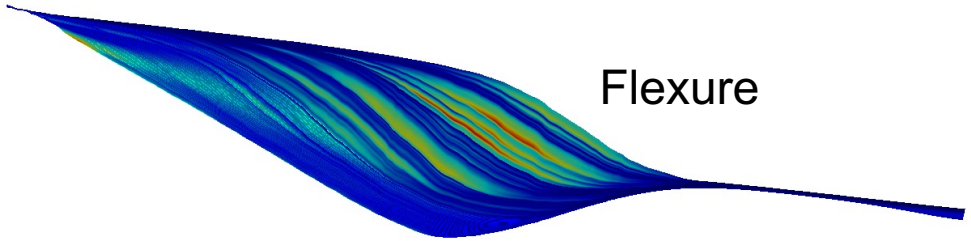




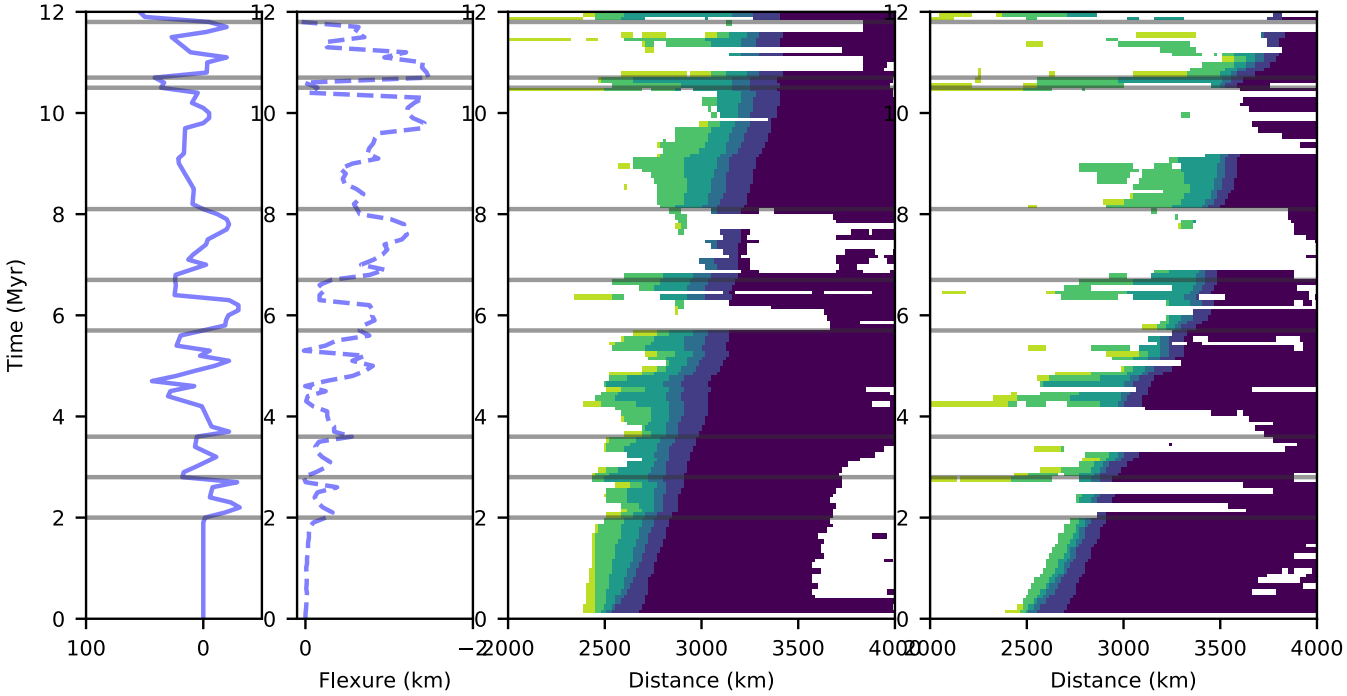
Green house vs Ice house

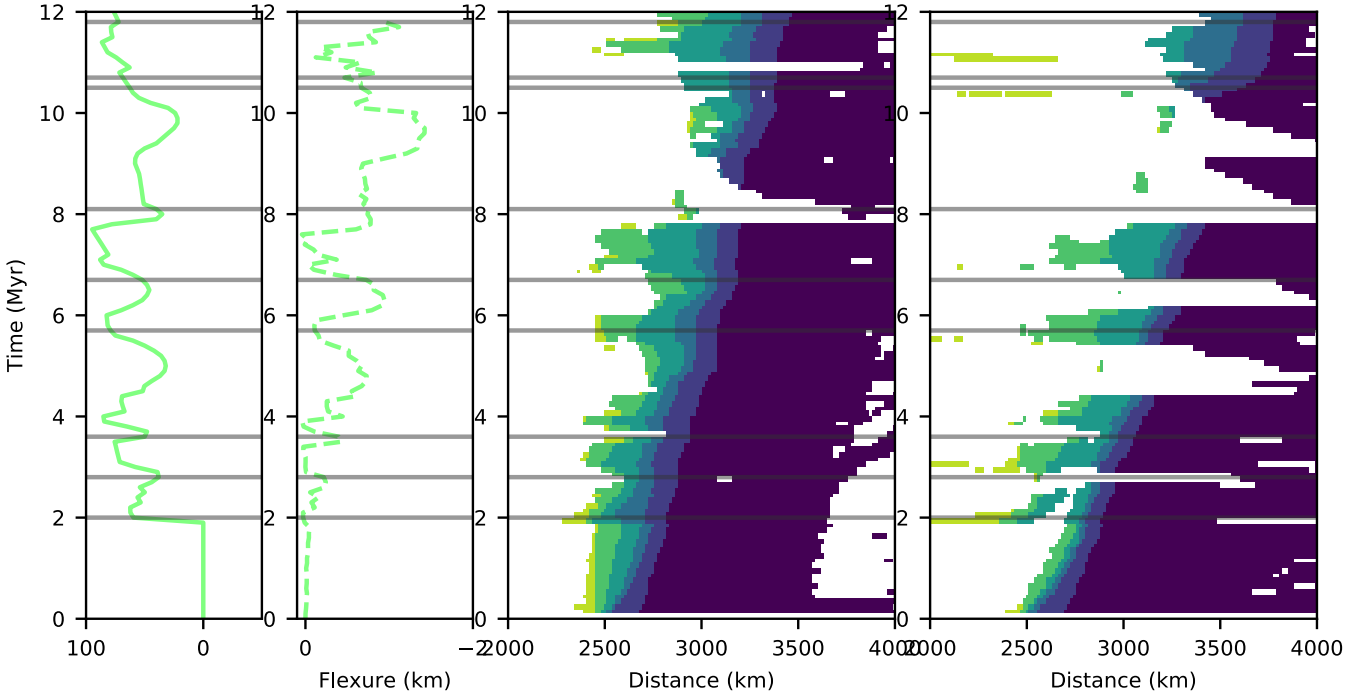


Isostatic compensation of the water and sediment load amplifies vertical adjustments caused by eustatic changes.









Conclusions

- Flexural isostatic adjustments are bidirectional over 100-1000 kyr time-scales and mirror the magnitude, frequency, and direction of sea-level fluctuations

- Isostatic adjustments play an important role in driving along-strike and cross-shelf river-mouth migration and sediment accumulation.

- Climate-forced sea-level changes set up a feedback mechanism that results in self-sustaining creation of accommodation into which sediment is deposited and plays a major role in delta morphology and stratigraphic architecture

Thanks!!!

BGH

bgh.org.au

Basin Genesis Hub

Australian Government

Geoscience Australia



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