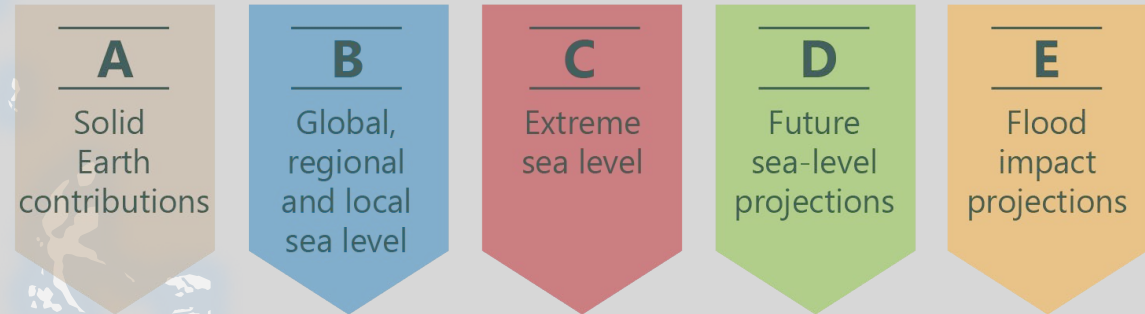


PAST, PRESENT AND FUTURE SEA LEVELS IN SINGAPORE

Timothy Shaw, Stephen Chua, Jedrzej Majewski, Adam Switzer,
Tanghua Li, Dhruba Samanta, Robert Kopp, Benjamin Horton et al...

Friday 30th April 2021; CL4.1 Sea Level Rise: Past, Present and Future



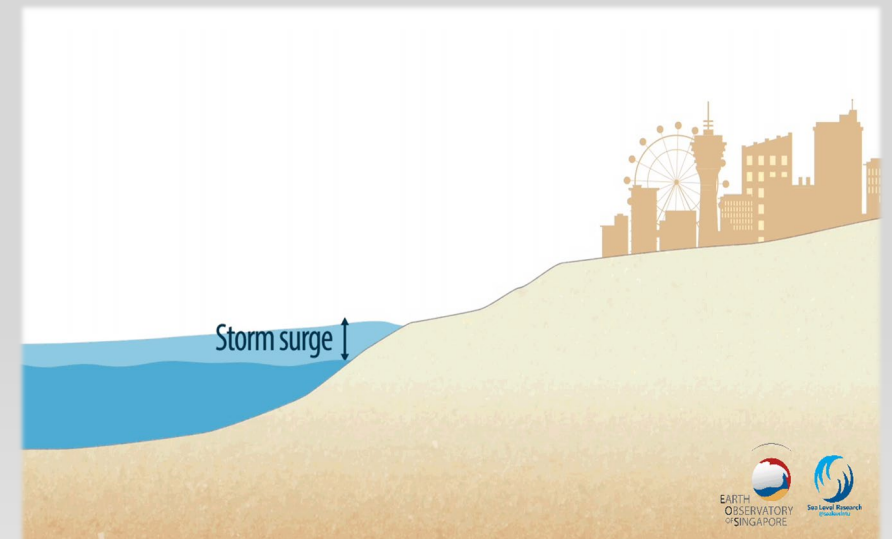
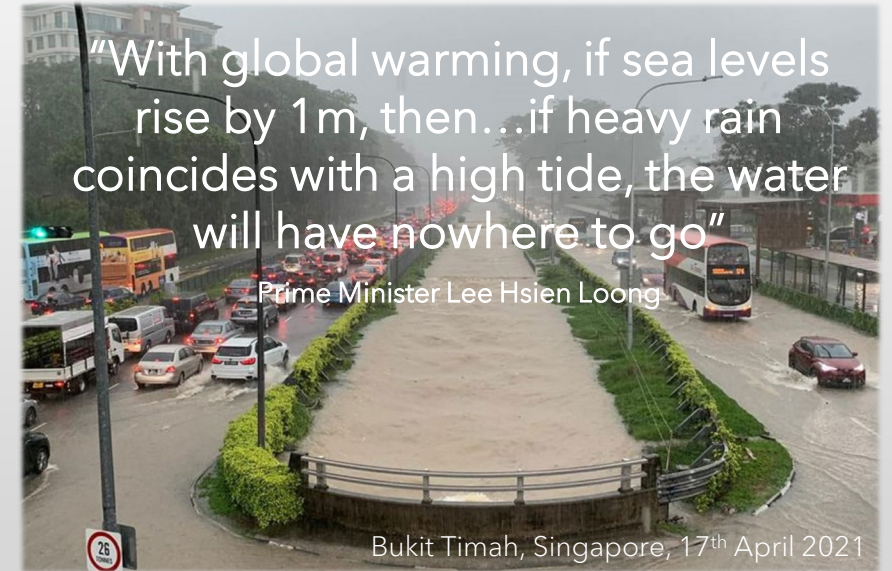
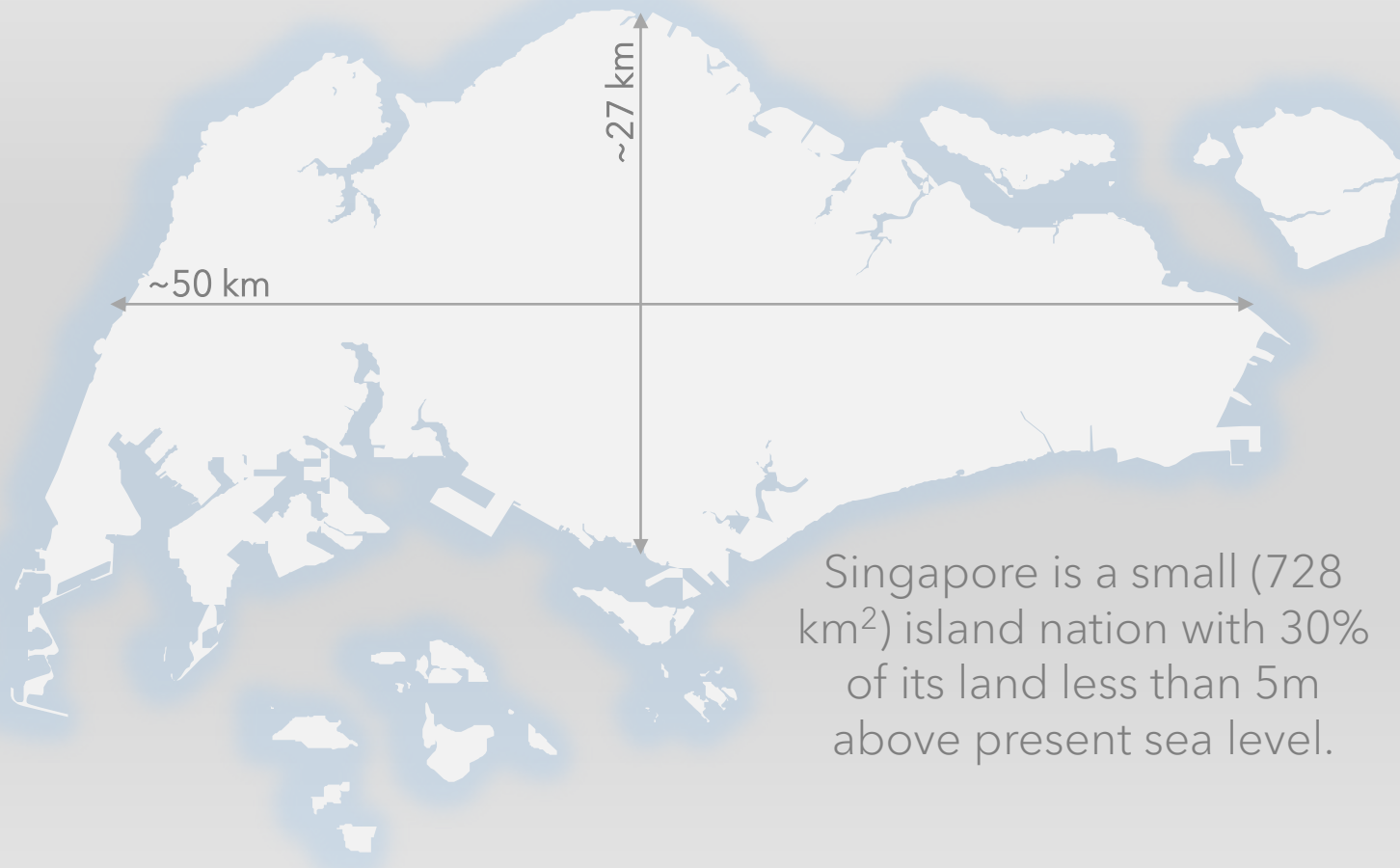
Pushing scientific frontiers to observe, reconstruct and project sea-level rise in Southeast Asia



SINGAPORE

"We must prepare for the impact of climate change...Singapore is especially vulnerable to one grave threat, and that is rising sea levels"

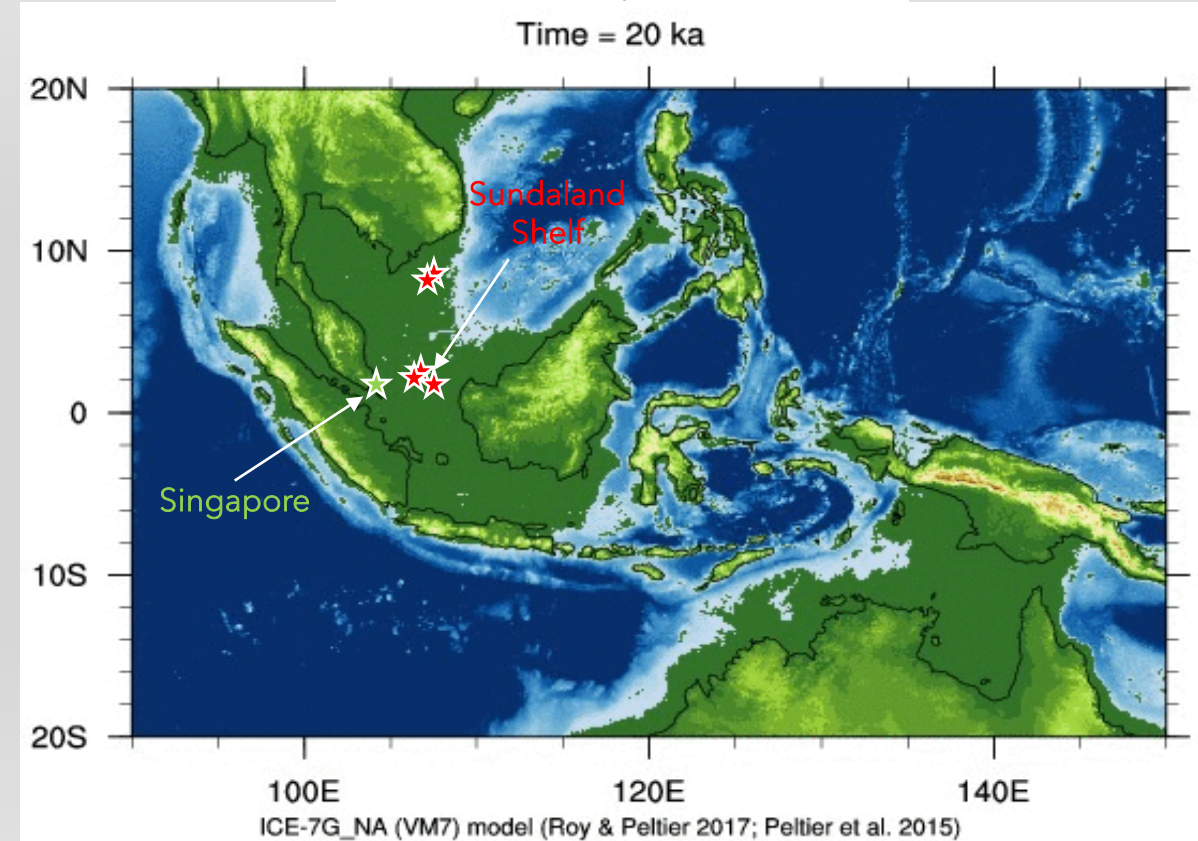
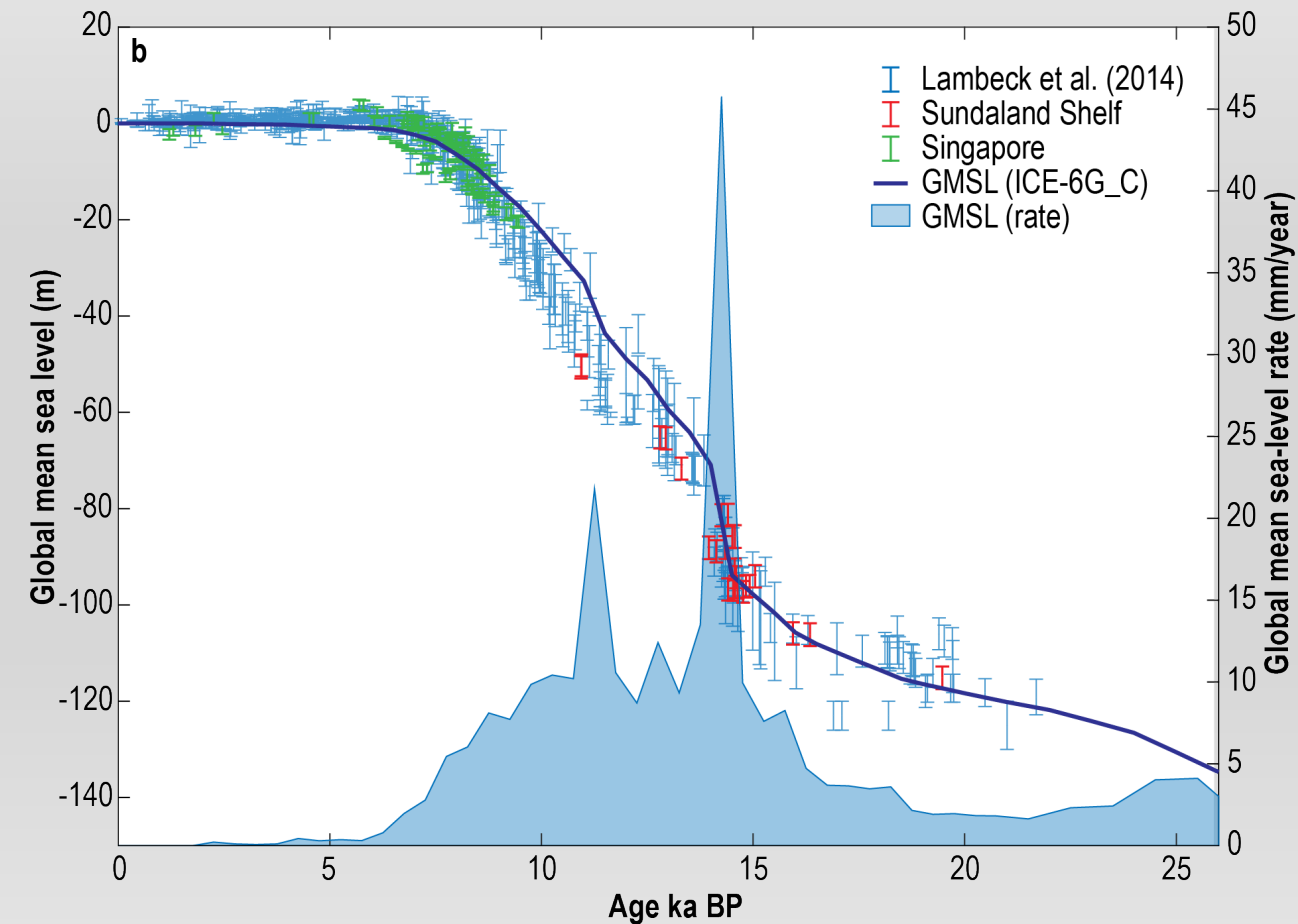
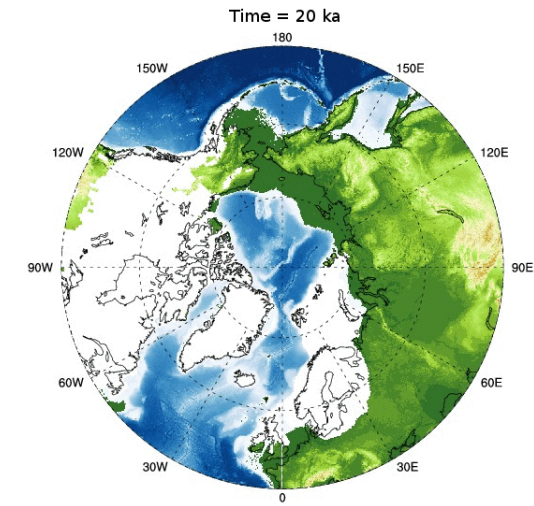
Prime Minister Lee Hsien Loong (National Day Rally August 18, 2019)





SEA LEVELS SINCE THE LGM

Global sea levels were ~130m below present at the last glacial maximum. In Southeast Asia, rising sea levels flooded the Sundaland Shelf segregating regions impacting the human demographic.

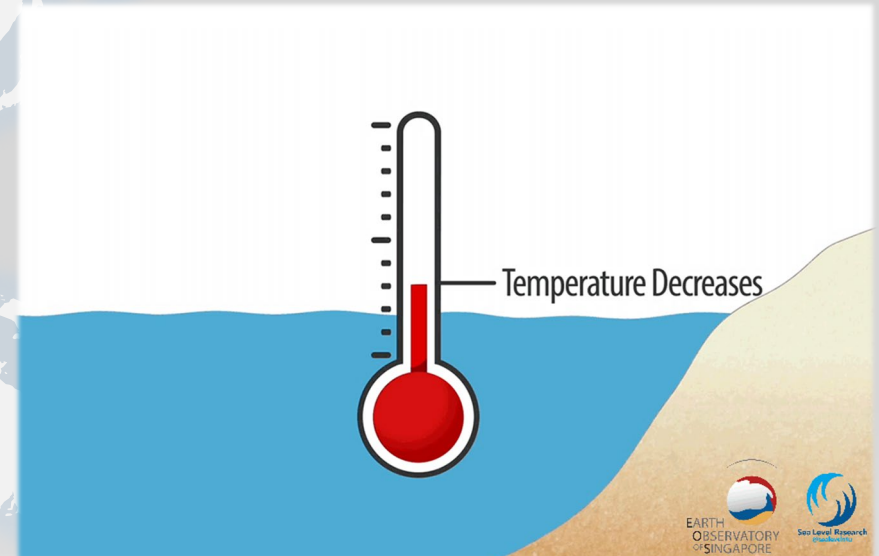
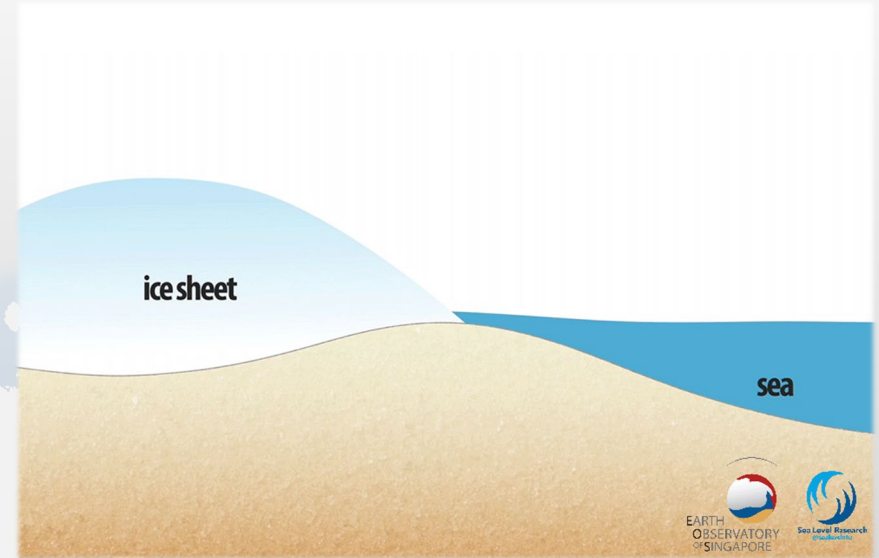




DRIVING PROCESSES

Sea levels are driven by a variety of **global**, regional and local processes that vary spatially and temporally

Global response to an increase in ocean mass and volume

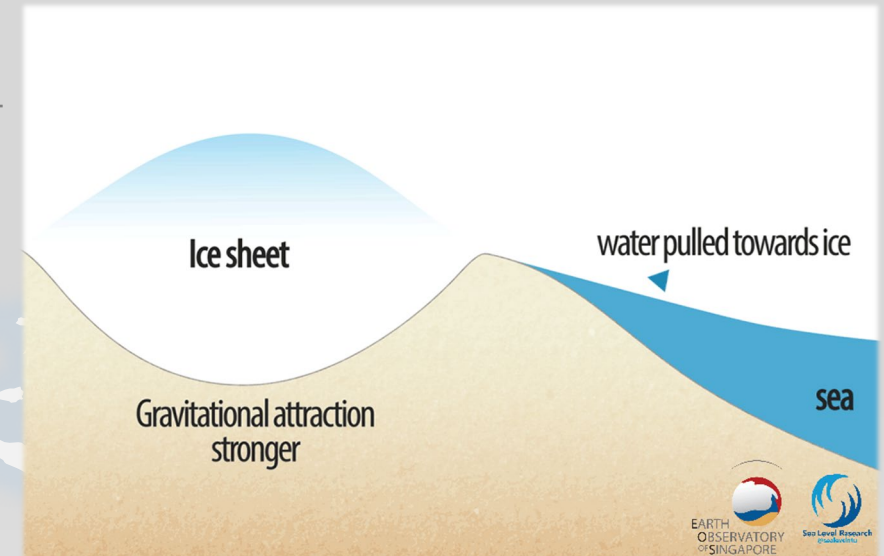
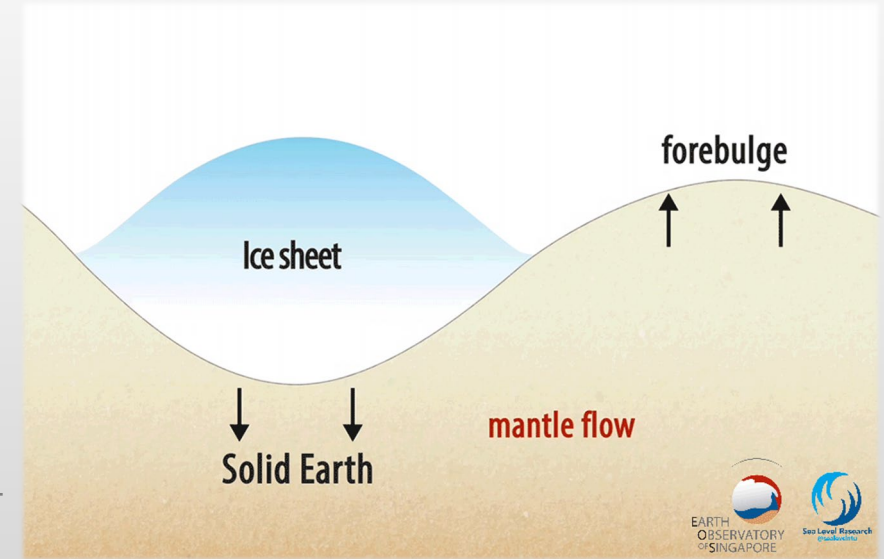




DRIVING PROCESSES

Sea levels are driven by a variety of global, **regional** and local processes that vary spatially and temporally

Regional response to the loading and redistribution of water



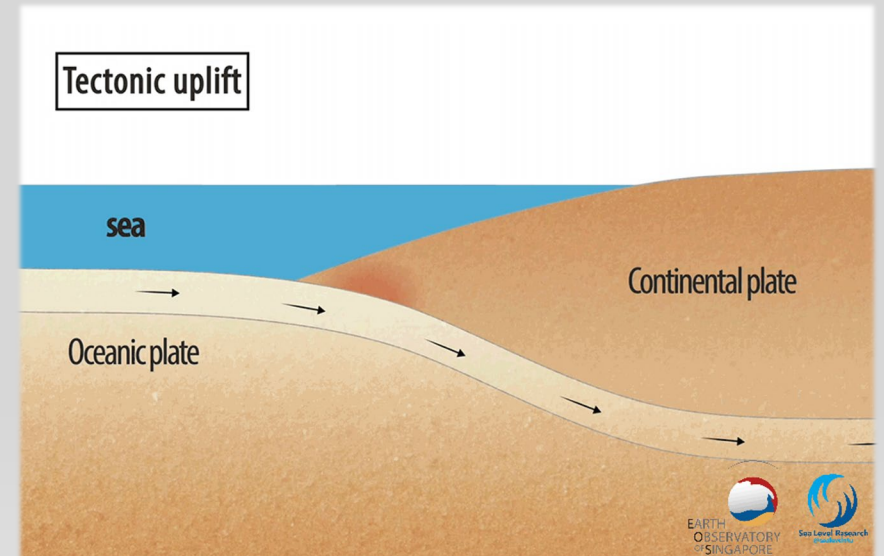
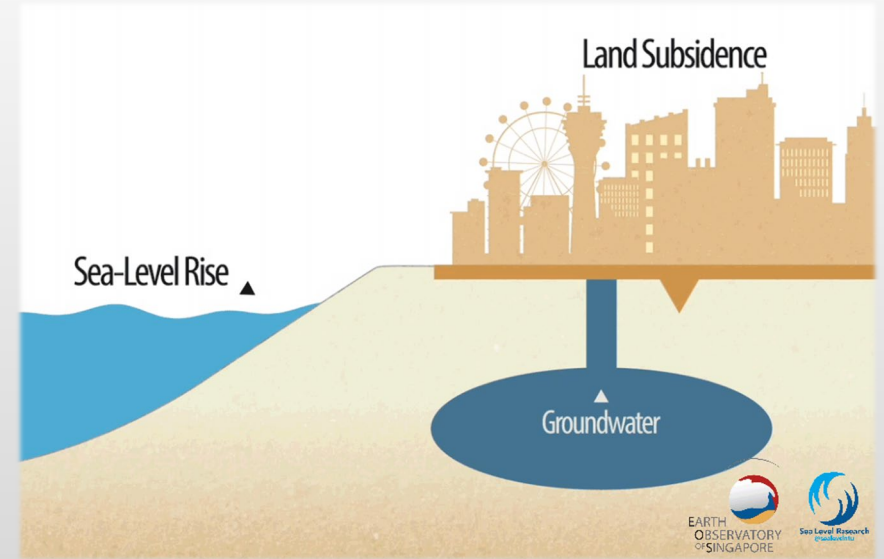


DRIVING PROCESSES

Sea levels are driven by a variety of global, regional and **local** processes that vary spatially and temporally

e.g., Manila, Philippines ●

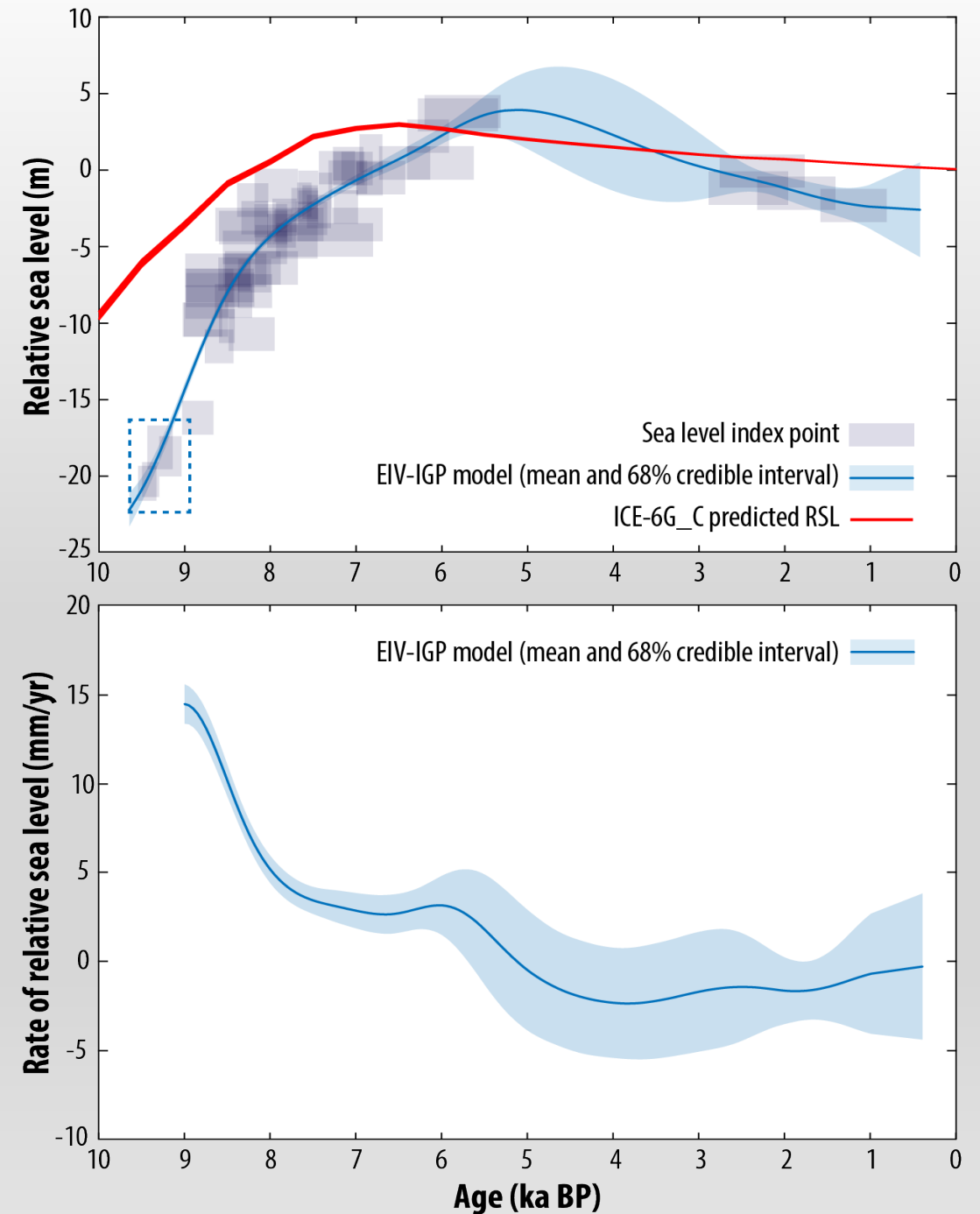
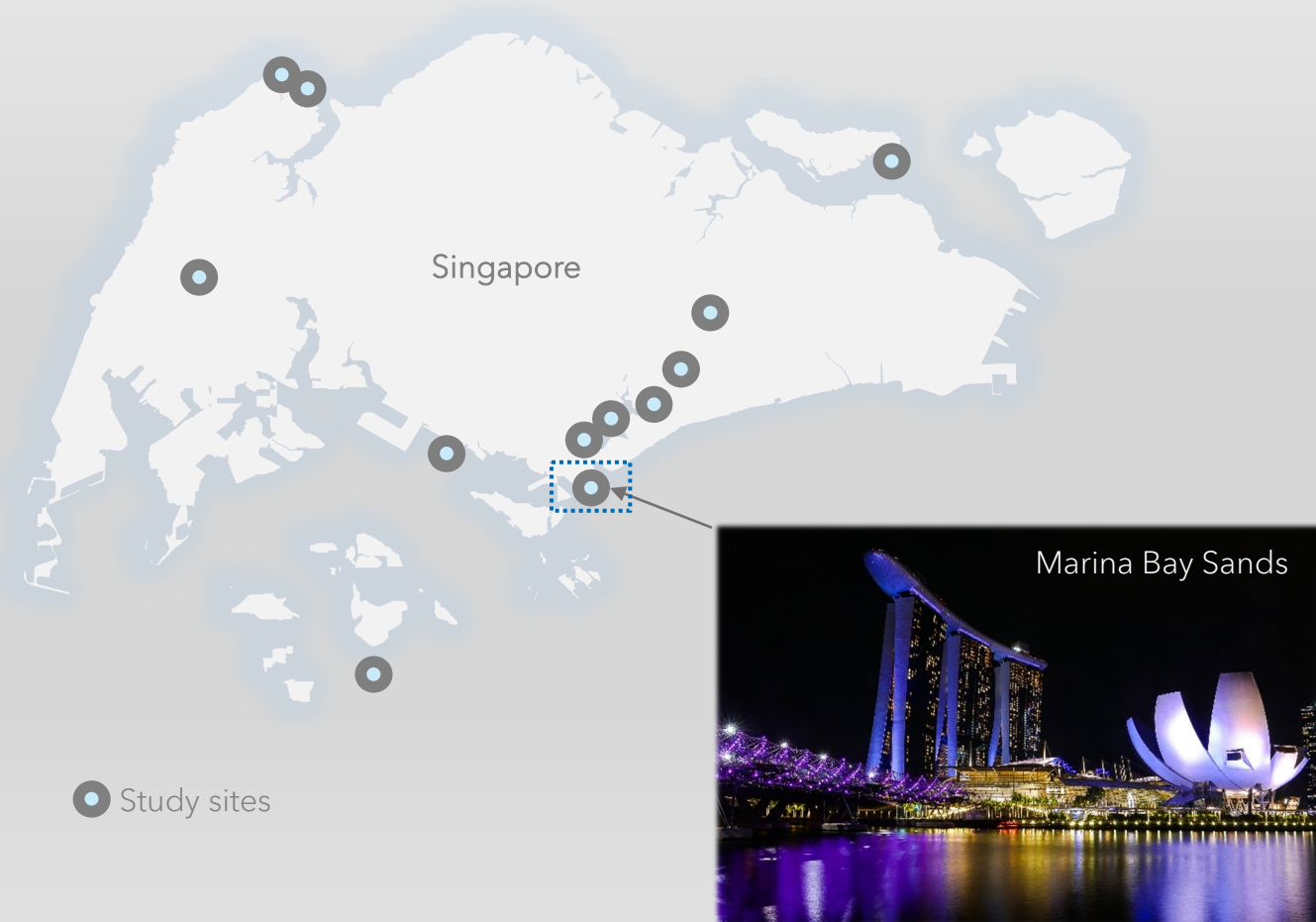
Local response to processes such as subsidence and tectonics





PAST SEA LEVELS

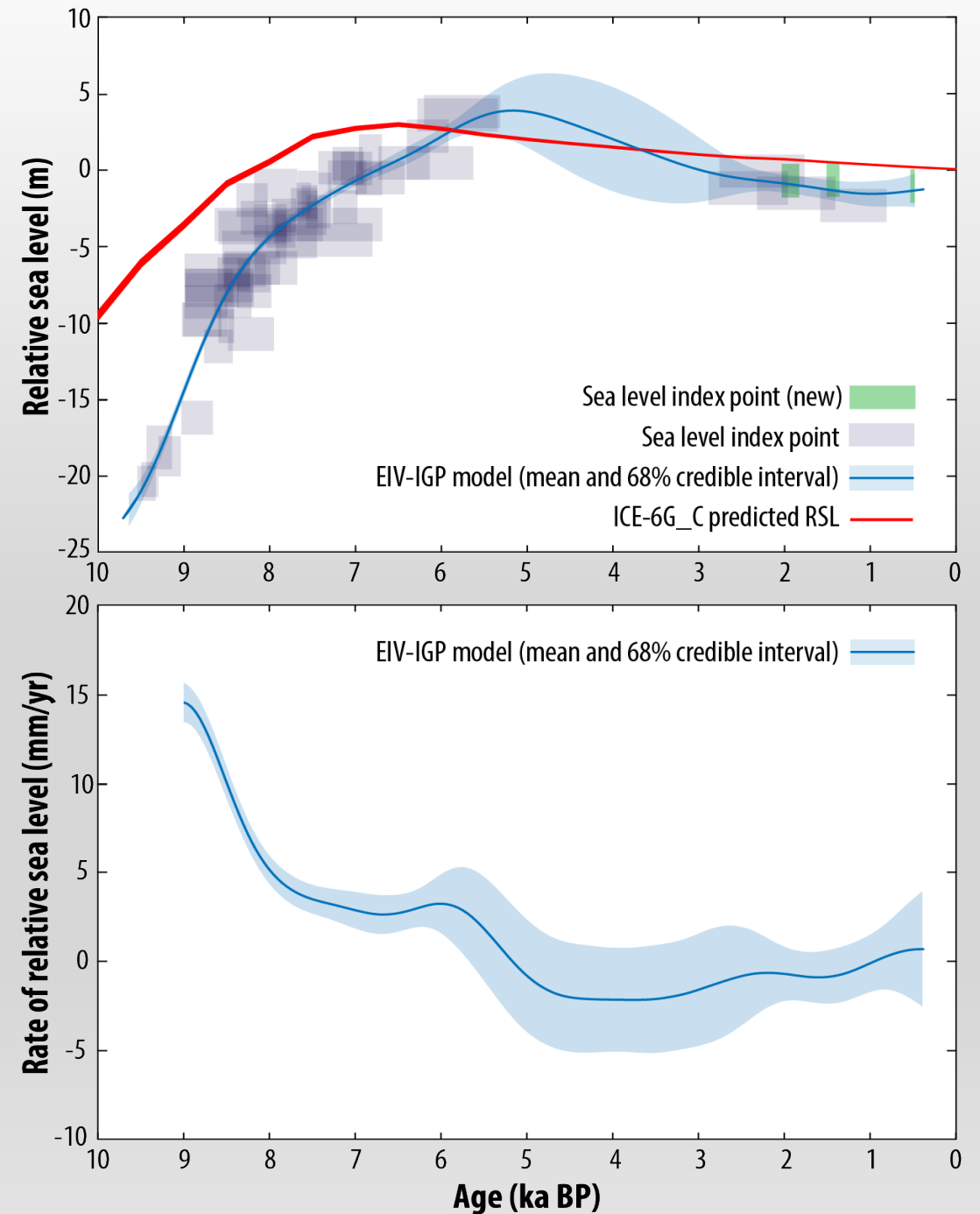
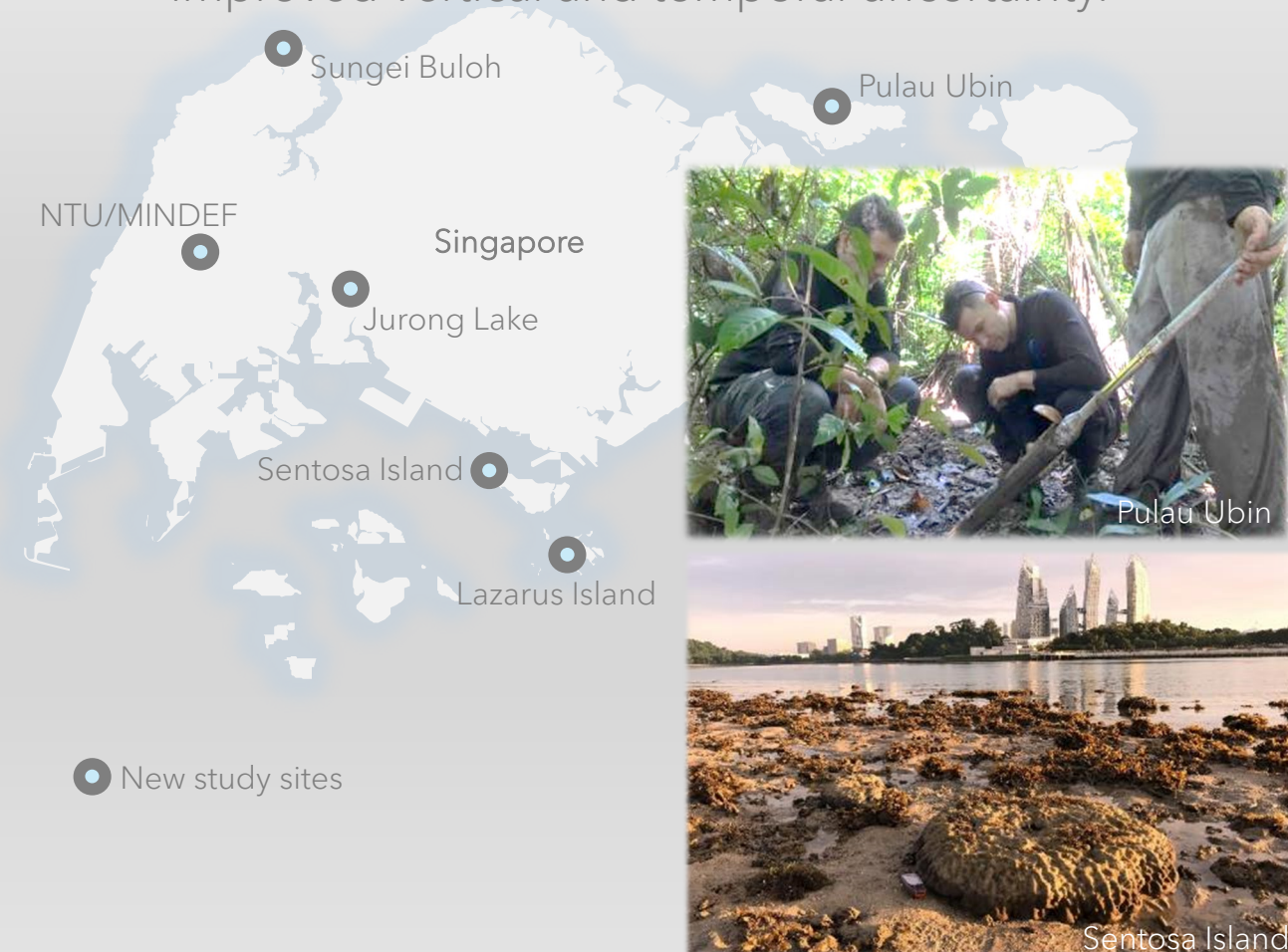
Holocene sea levels in Singapore rose from -20.7m at 9.5ka BP to a ~4m highstand at 5.2ka BP before falling thereafter. Misfit with GIA predictions.





PAST SEA LEVELS

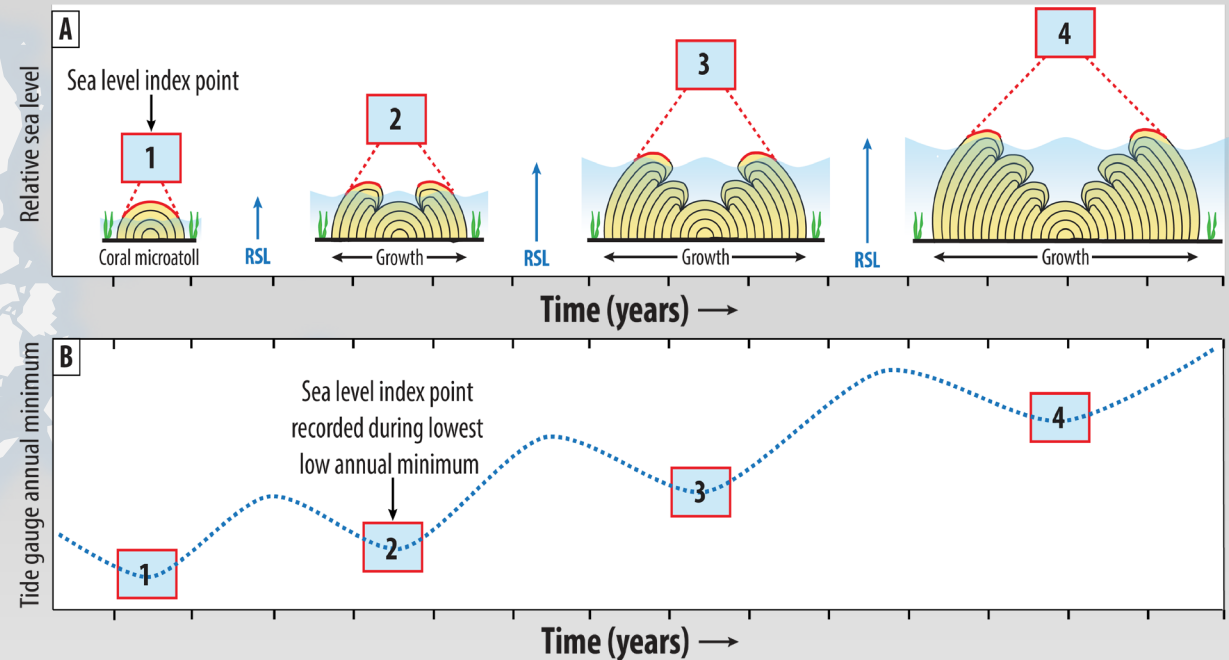
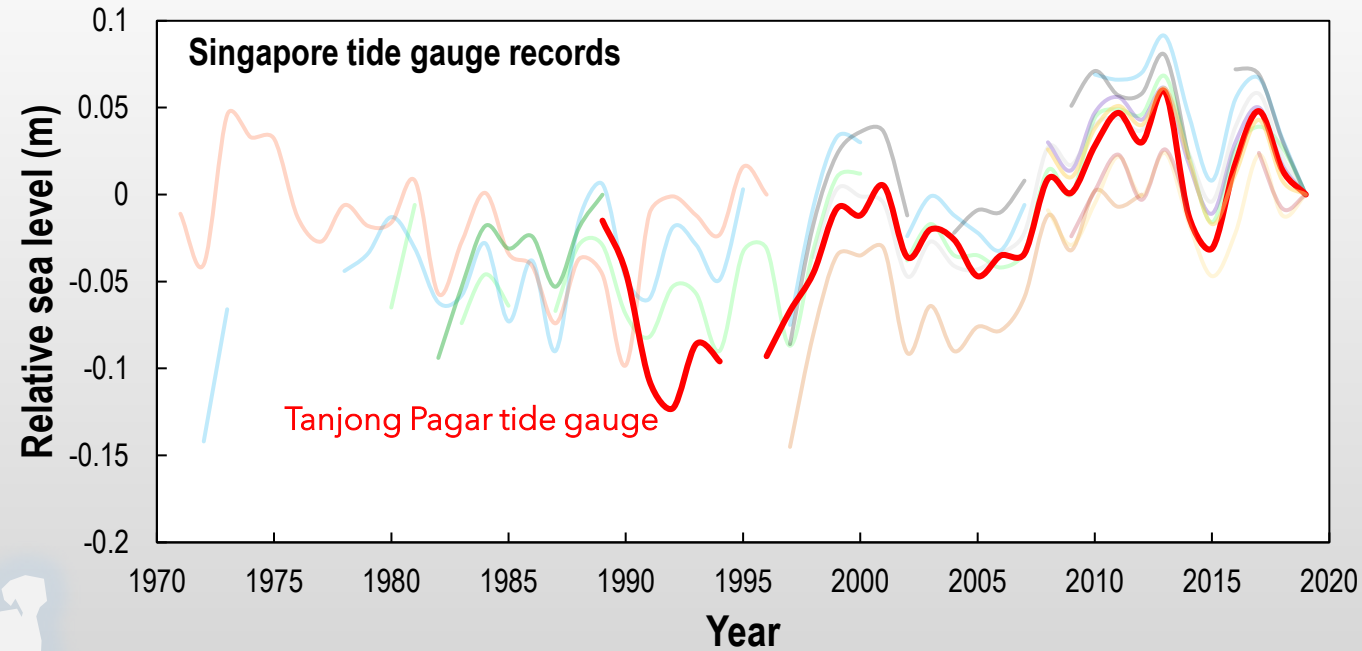
Sea levels from the mid- to late-Holocene are poorly constrained. New sites using mangroves and coral microatolls to develop sea-level index points with improved vertical and temporal uncertainty.





PRESENT SEA LEVELS

Instrumental sea-level records in Singapore extend back to the ~1970's. Exploring the use of proxy reconstructions from coral microatolls to extend beyond this period.





PRESENT SEA LEVELS

We produced 16 new sea level index points recording relative sea-level changes since the early 1900's.

Singapore

Indonesia

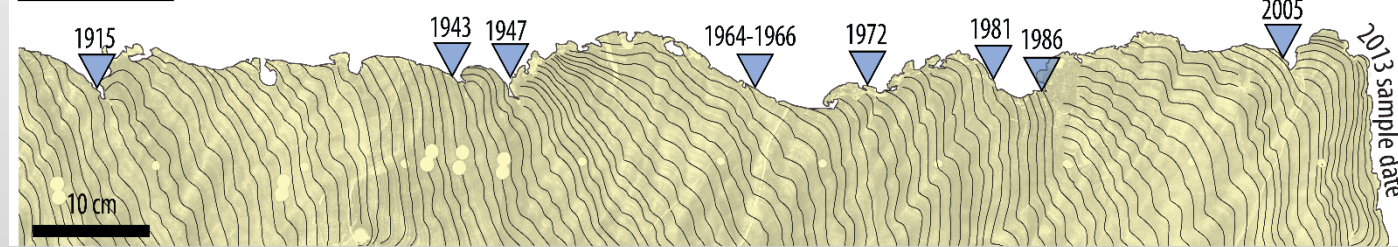
Mapur Island coral microatolls

45km

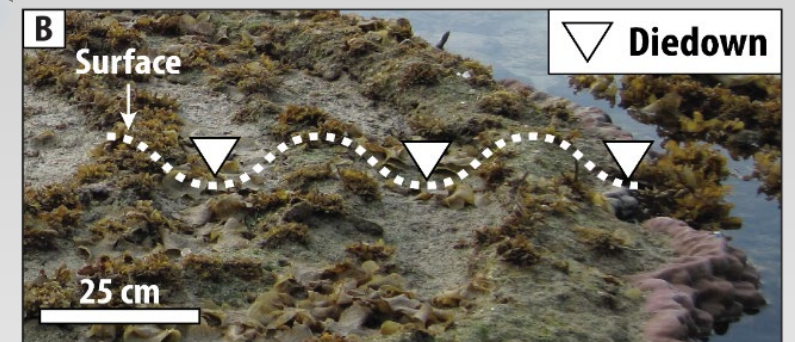
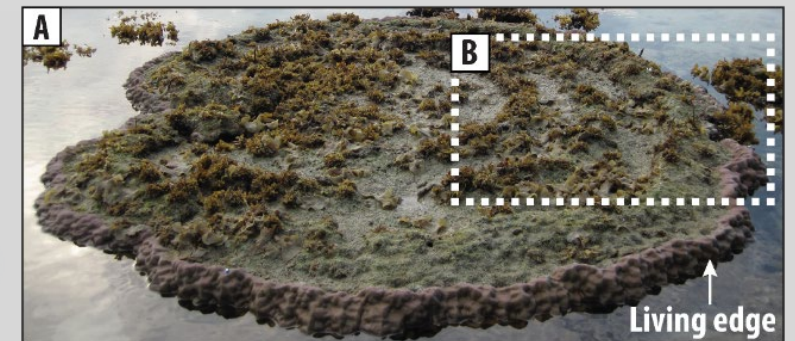
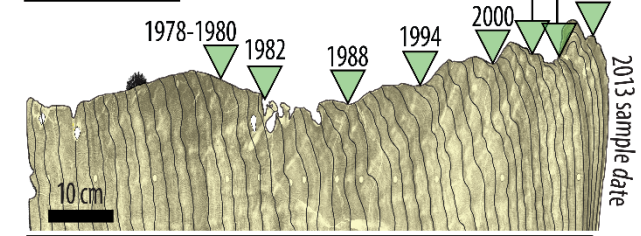
Majewski et al., submitted (*Geology*)

Coral x-rays and recorded diedown events

▼ Diedowns



▼ Diedowns





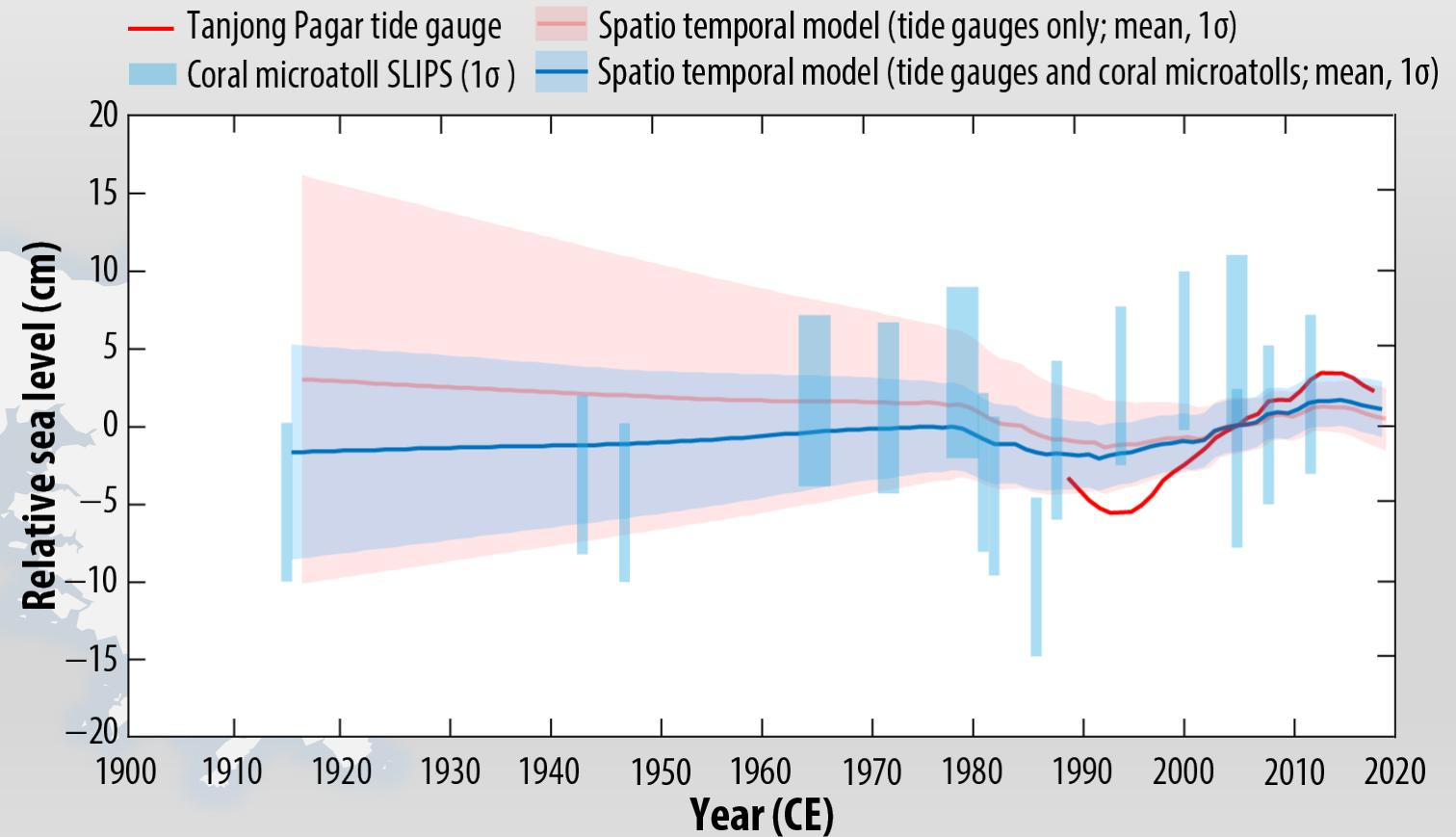
PRESENT SEA LEVELS

Between 1915 and 1990, RSL was stable at 0 ± 1.6 mm/yr, before increasing to 1.0 ± 2.1 mm/yr between 1990 and 2019. Through the addition of microatoll data we extended the record of modern sea-level change by over 50 years and reduced its uncertainty by ~50%.

Singapore

● **Tanjong Pagar tide gauge**

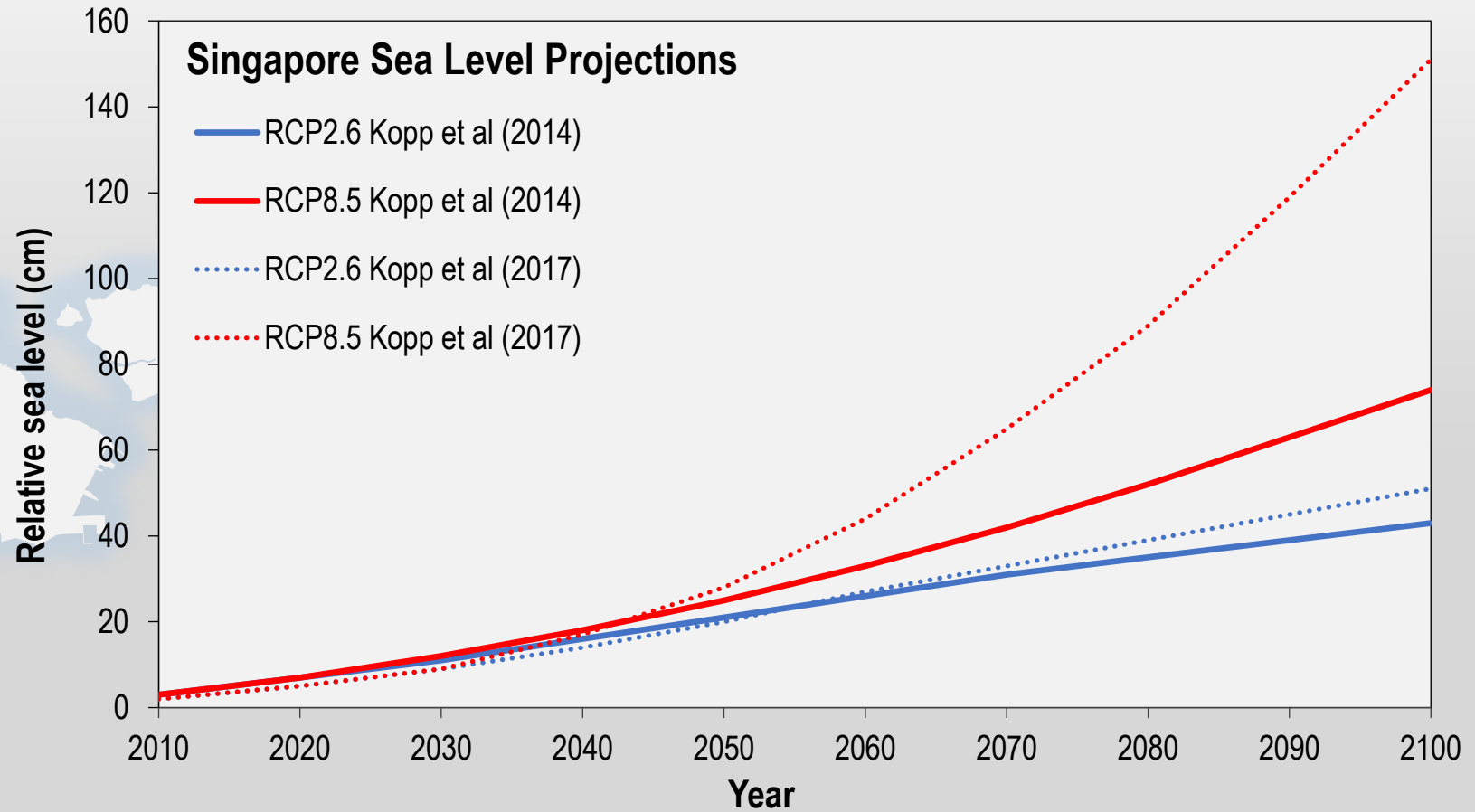
Indonesia





FUTURE SEA LEVELS

Probabilistic projections to 2100.
Uncertainty of process contributions
from ice sheet, ocean and
atmospheric dynamics in response to
future climate change.



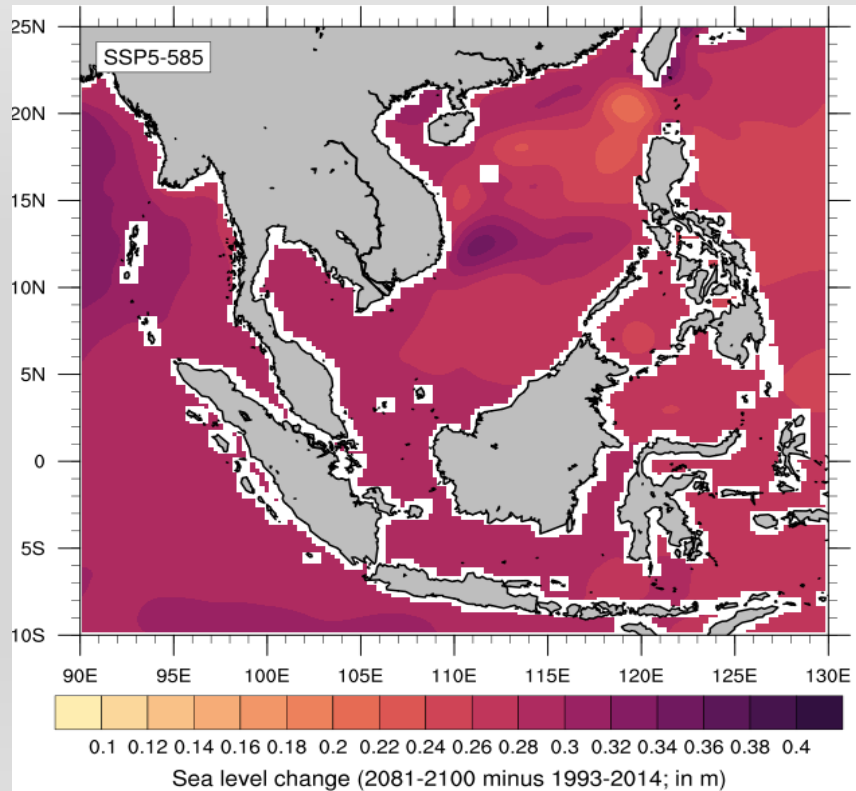
	Kopp et al (2014)	
	50% (cm)	5–95% (cm)
RCP2.6 2100	43	6–96
RCP8.5 2100	74	28–140

	Kopp et al (2017)	
	50% (cm)	5–95% (cm)
RCP2.6 2100	51	8–105
RCP8.5 2100	151	81–263

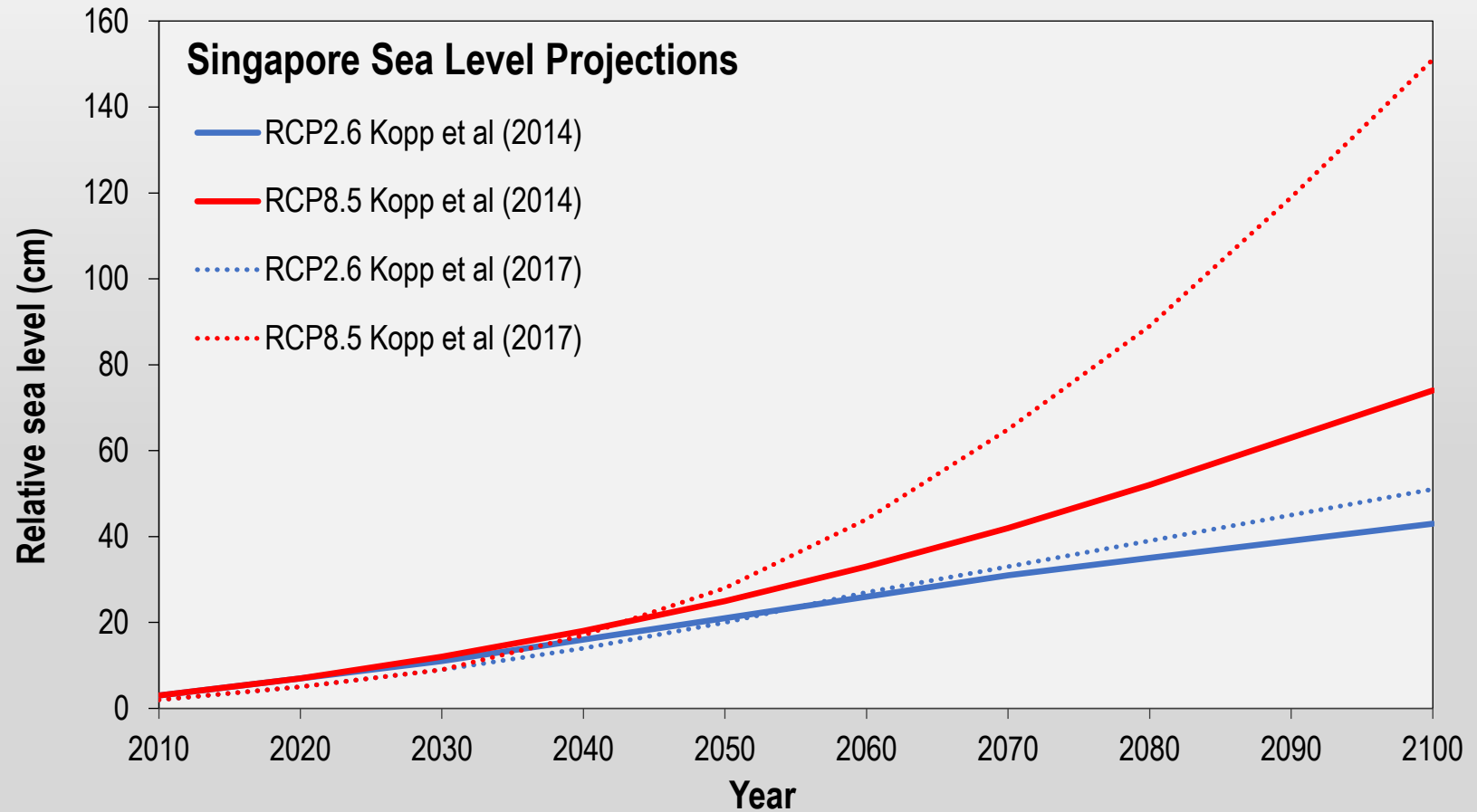


FUTURE SEA LEVELS

Multimodel ensemble of HighResMIP models shows ~0.5 m or dynamic sea-level rise (including thermosteric component) by the end of 2100.



Samanta et al., (in following 2nd session)



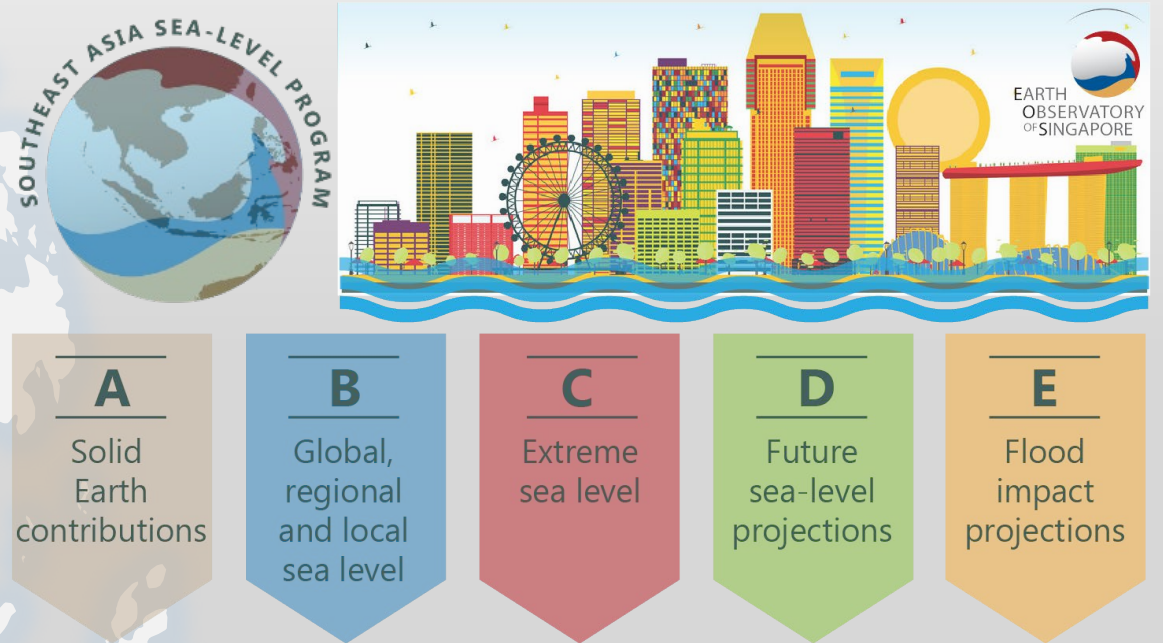
	Kopp et al (2014)	
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	Kopp et al (2017)	
	50% (cm)	5–95% (cm)
RCP2.6 2100	51	8–105
RCP8.5 2100	151	81–263

SUMMARY

- Paleo proxy reconstructions using mangrove sediments and coral microatolls constrain Holocene sea levels in Singapore and Southeast Asia.
- Proxy records used to extend beyond limited instrumental period in this region.
- More accurate relative sea level data can provide inferences to magnitudes, rates and driving processes and help inform future local sea-level projections for appropriate planning and adaptation measures.

Southeast Asia Sea-Level Program (Sea²)



Pushing scientific frontiers to observe, reconstruct and project sea-level rise in Southeast Asia