Climate change, sea level, islands and coastal areas

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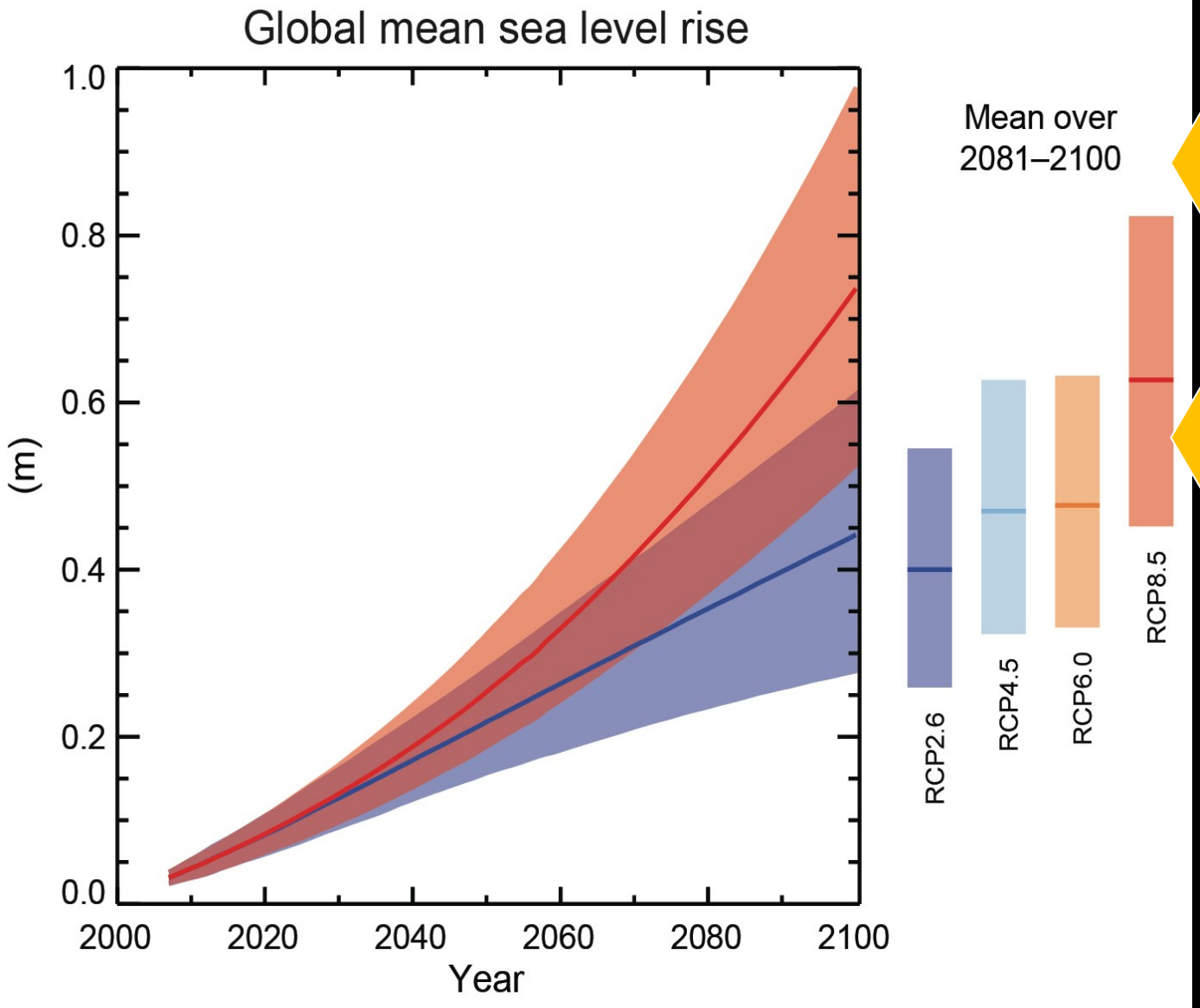
Climate change and sea level

- Warming raises averages sea levels from the oceans expanding as they warm and melting of land-ice
- These effects are modulated by other atmospheric processes leading to storm surges and extreme wave heights interacting with natural tidal processes
- Surges and waves may be affected by climate change (e.g. If typhoons become more extreme, wind patterns change)
- Local sea levels are affected by local land height which may change for other reasons (e.g. water abstraction)

Global sea-level rise projections



With large increases in global greenhouse gas emissions sea-levels will continue to rise exponentially

Even if global emissions peak within next few years then decline sea levels will continue to rise (for centuries)

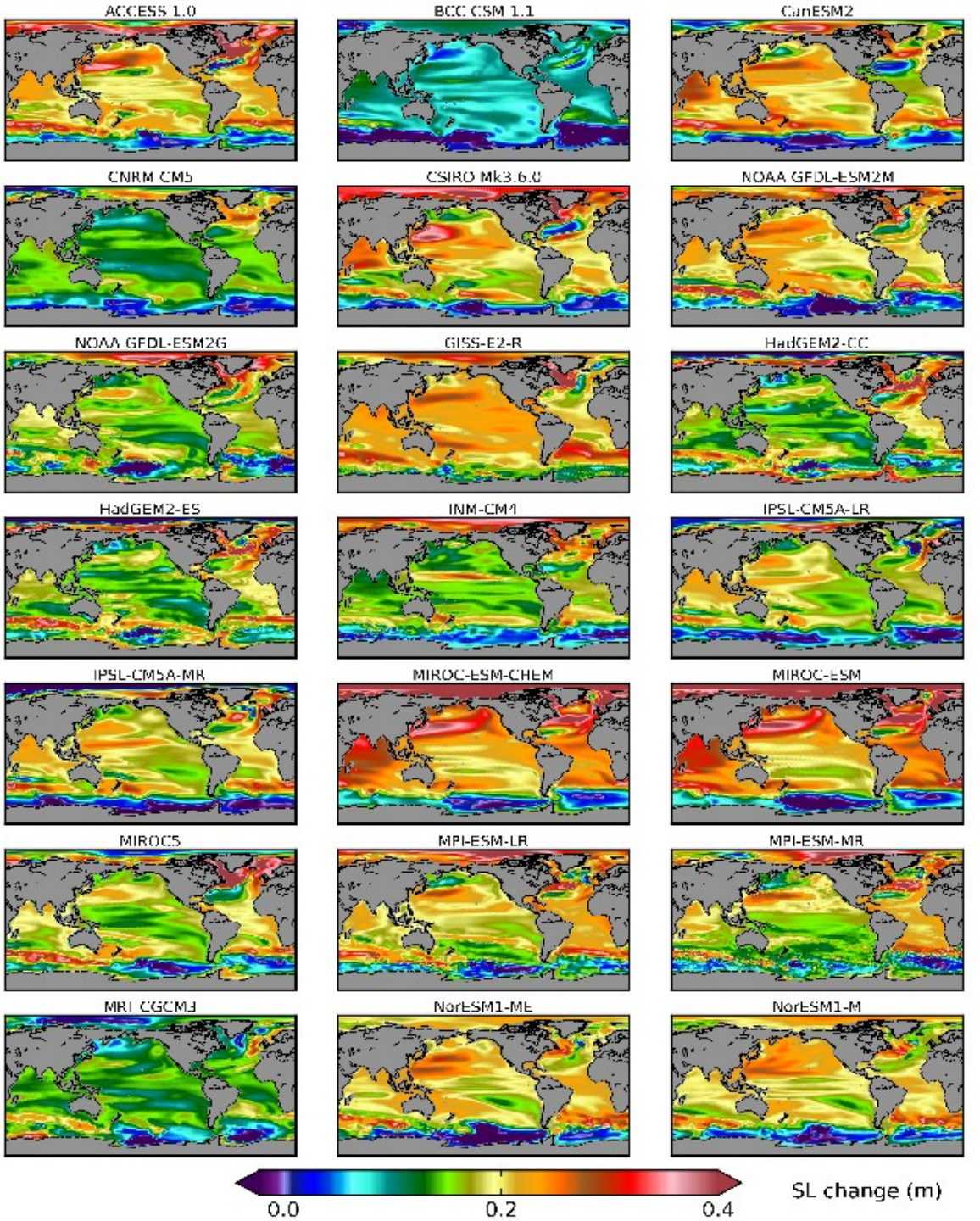
Projections from multiple global climate models assessed in the IPCC AR5 using four Representative greenhouse gas Concentrations Pathways (RCPs)

Met Office

Ranges in sea level rise estimates from global climate models are from different magnitudes of projected change

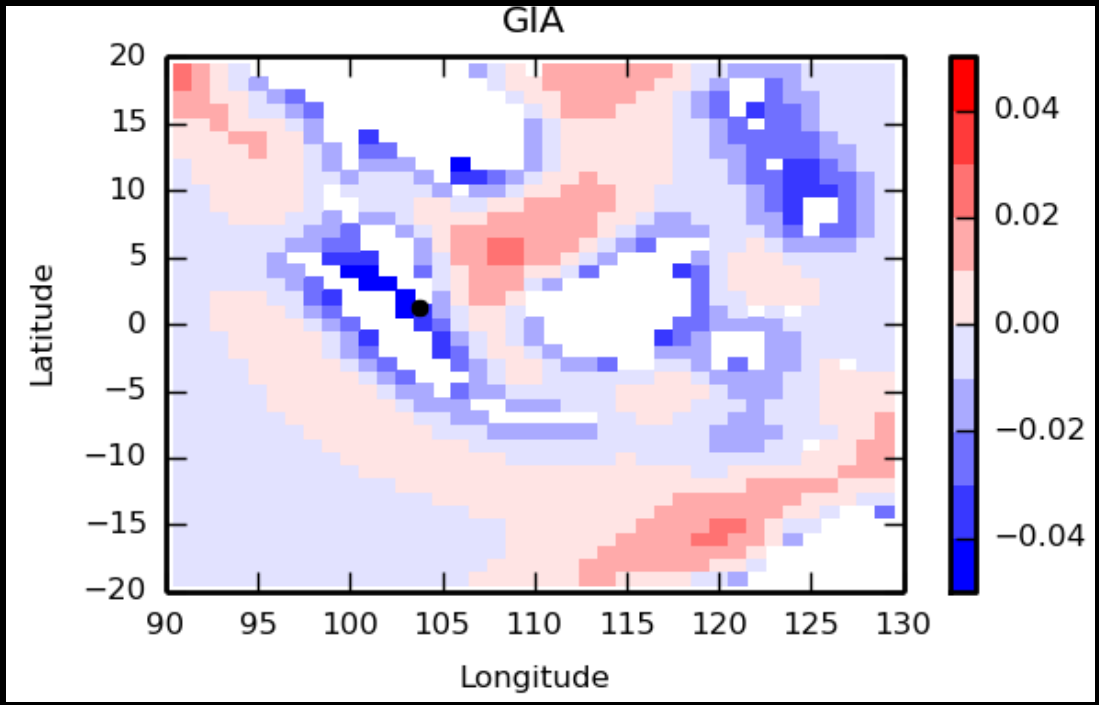
Also, spatial patterns of change vary so regional sea level rise will have different ranges

No guidance available on which patterns are more reliable

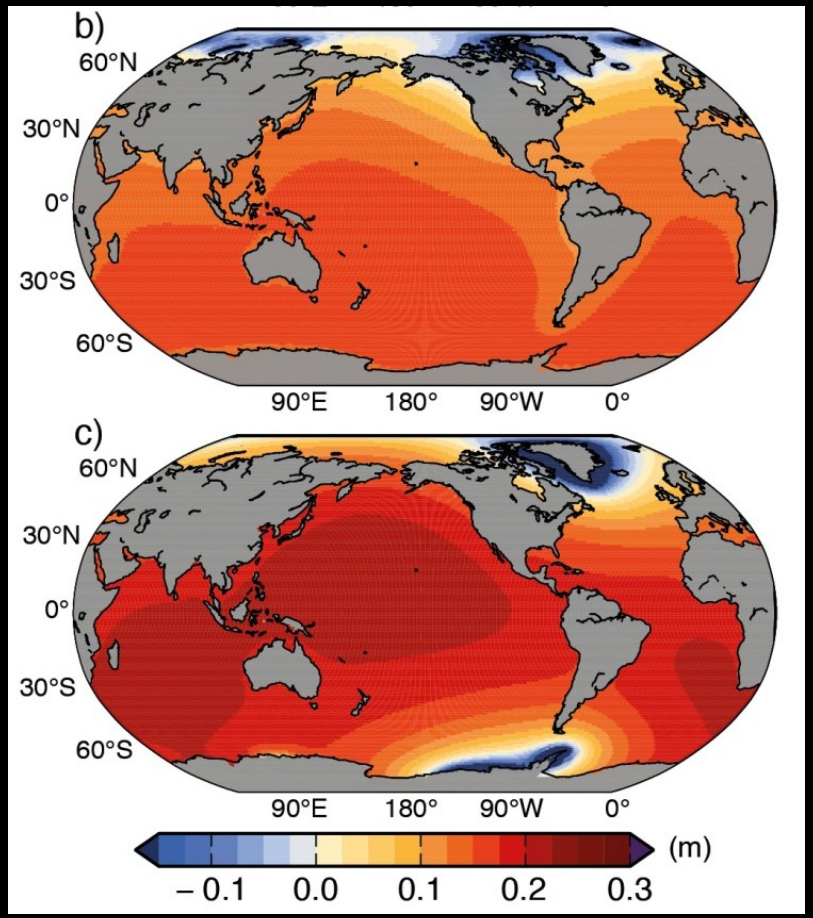


Other contributing factors

Glacial Isostatic Adjustment



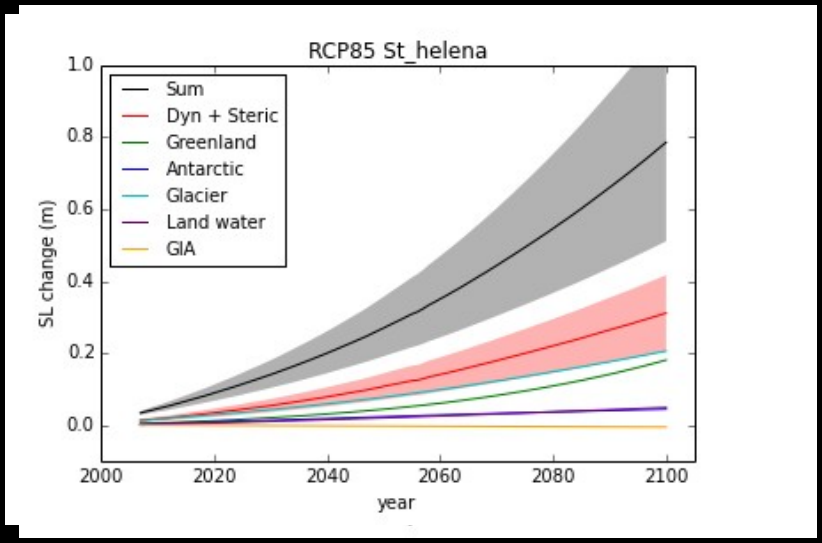
Glacial melting (b)
Ice-sheet metling (c)



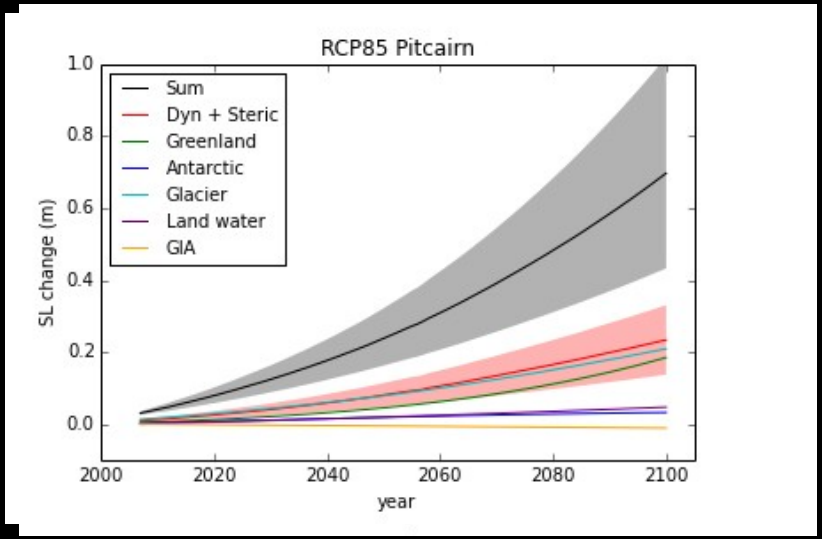
Also:

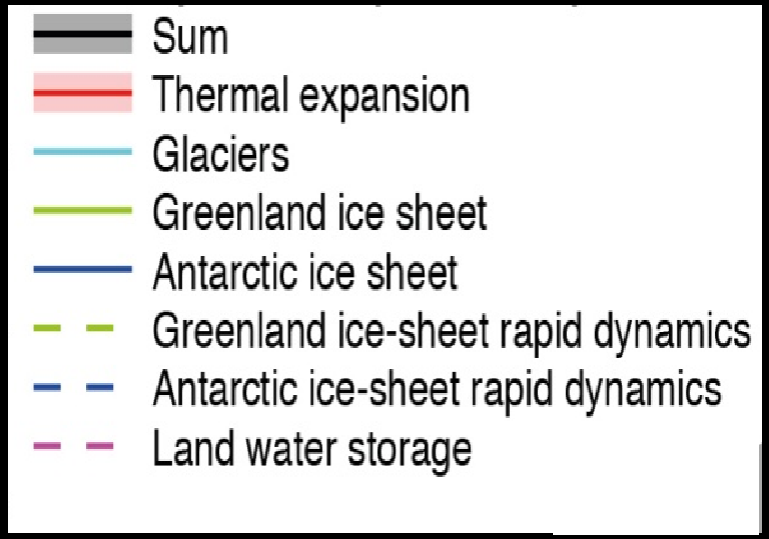
- Land water storage (reservoirs, groundwater)
- Rapid ice-sheet dynamics

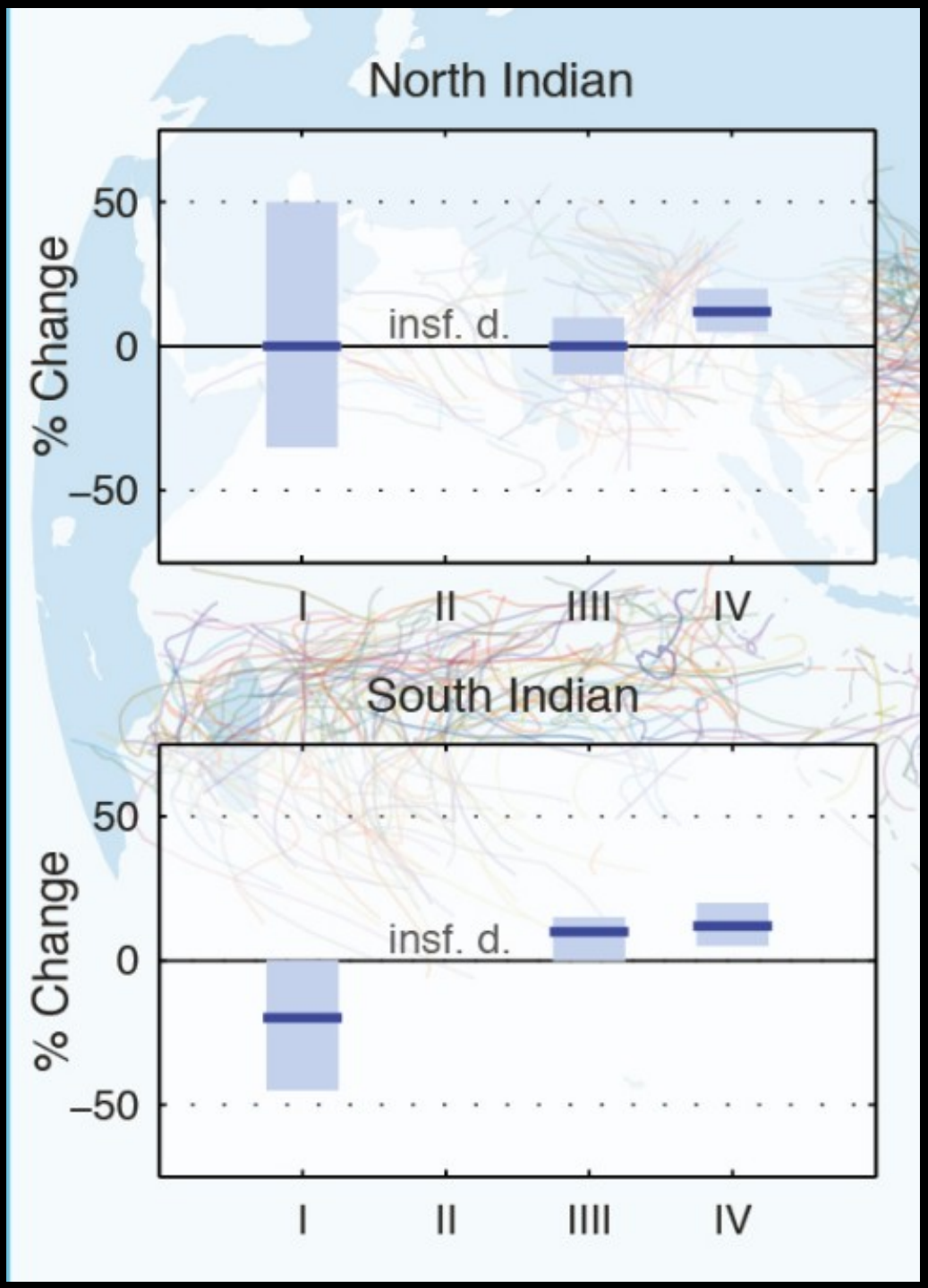
Regional sea level rise: Island examples – St. Helena, Pitcairn



These different processes and the different levels of confidence in their magnitudes lead to different ranges of local sea level rise







Projected changes in tropical cyclones

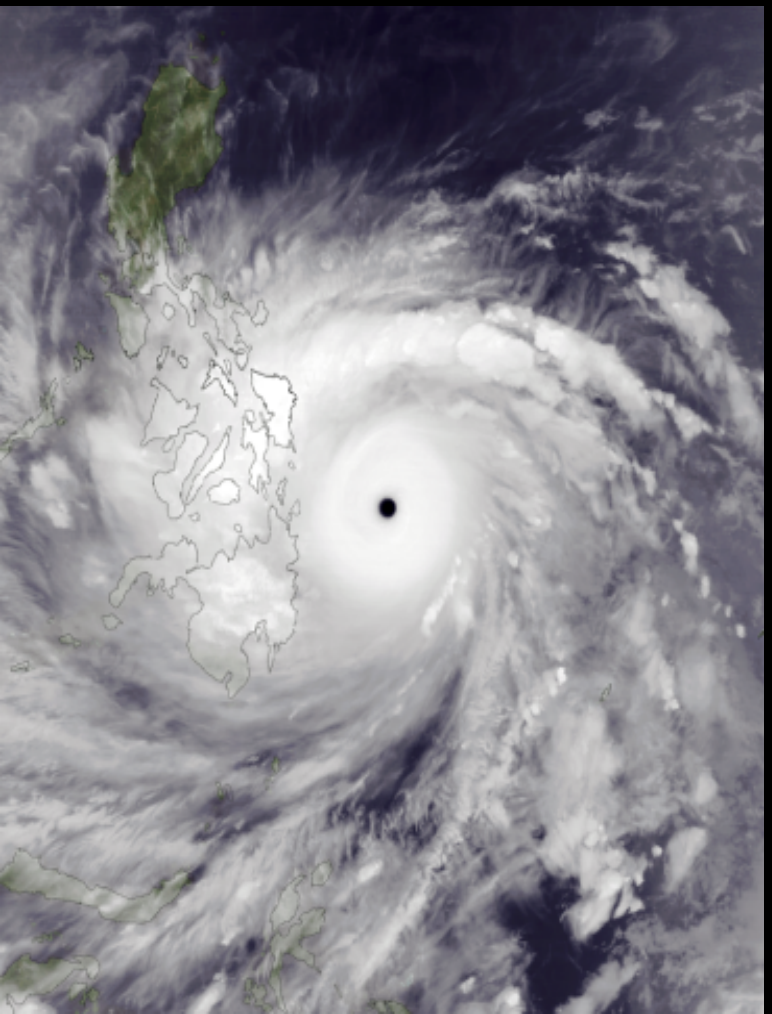
Climate models suggest:

- increases in intensity
- this would lead to an increase in associated storm surge heights

Tropical Cyclone (TC) Metrics:

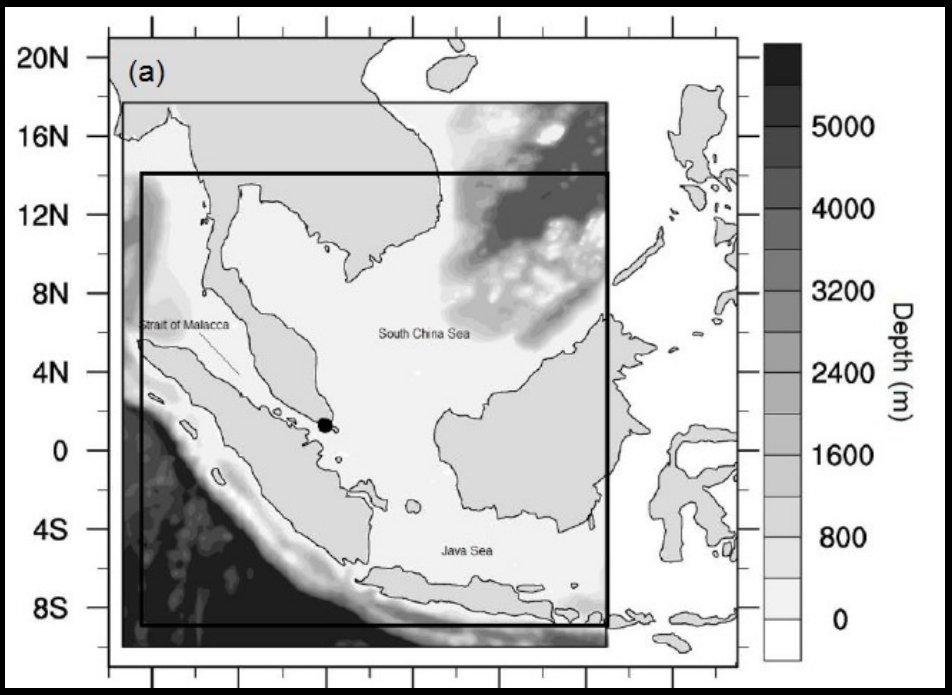
I All TC frequency
II Category 4-5 TC frequency
III Lifetime Maximum Intensity
IV Precipitation rate

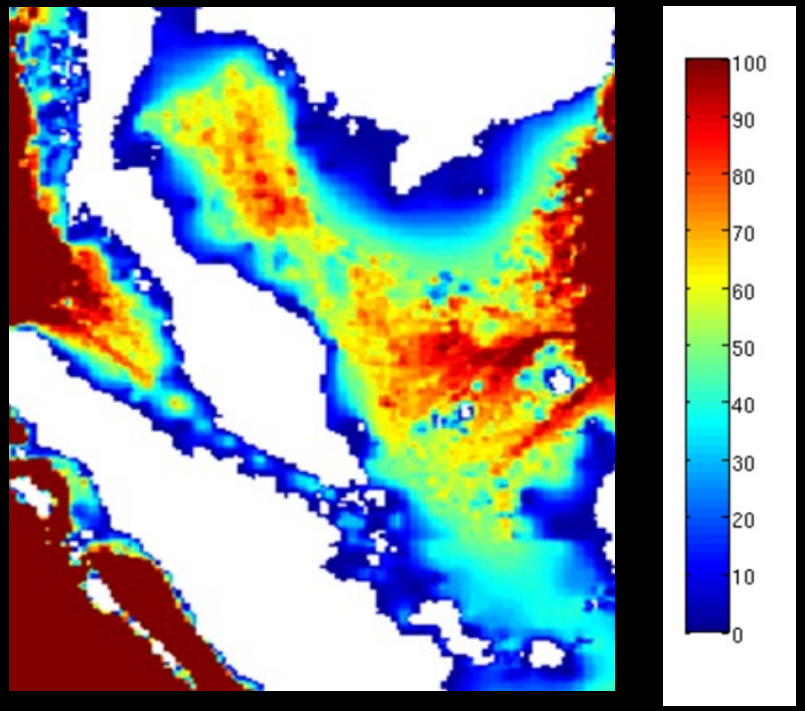
Typhoon Haiyan (Yolanda)
November 2013



- Most severe land-falling typhoon on record
- Winds reaching 197mph
- 5-6m storm surge
- Over 6300 people killed and four million people displaced
- Even if climate change was not a factor in the intensity then sea-level rise was in the surge height and storms of this size clearly need to be planned for in the future

Providing information on storm surges and waves requires detailed local models





Surge model

- 1/12th degree resolution, constant density, 9 vertical levels
- Forced by tides at lateral boundaries
- Forced by atmospheric pressure and winds at sea surface

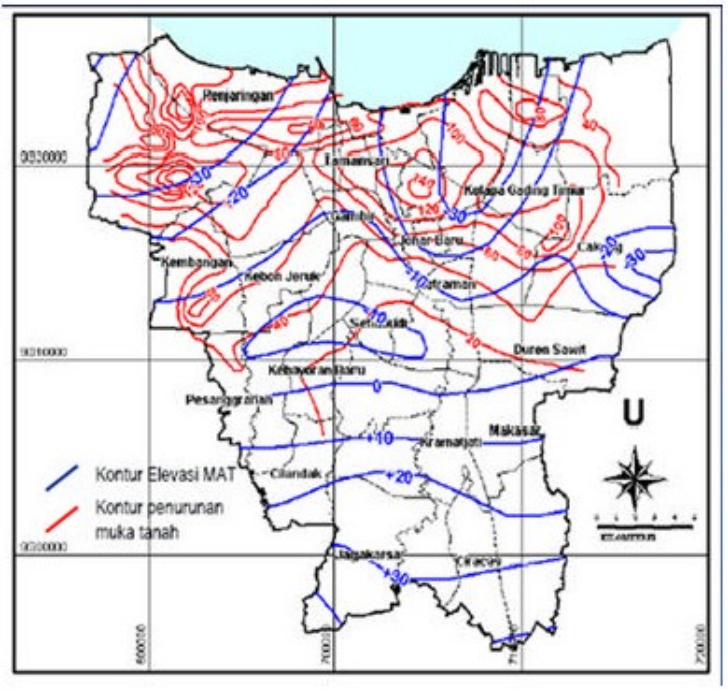
Wave model

- 1/12th degree resolution
- Forced by 50km global wave model at lateral boundaries
- Forced by winds at sea surface

Vertical land movement - An example for Jakarta

Jakarta is subsiding due to groundwater extraction

Sea levels **relative to coastal land** are increasing



Elevation of ground water (cm)

Land subsidence contour (cm)

Figure 3.8 Groundwater extraction in Jakarta and the resulting land subsidence

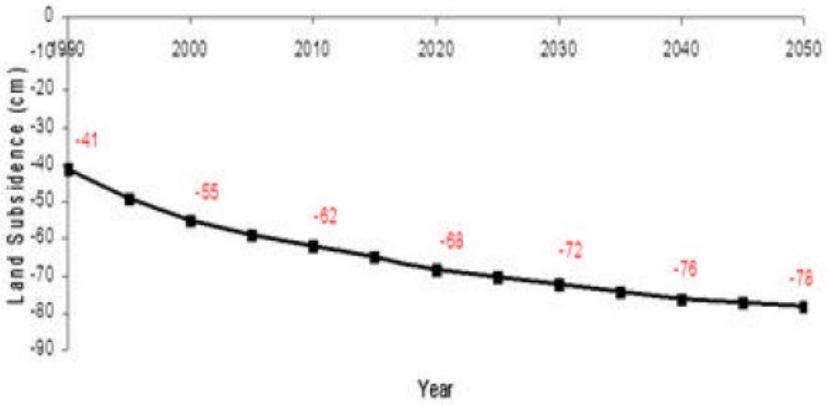
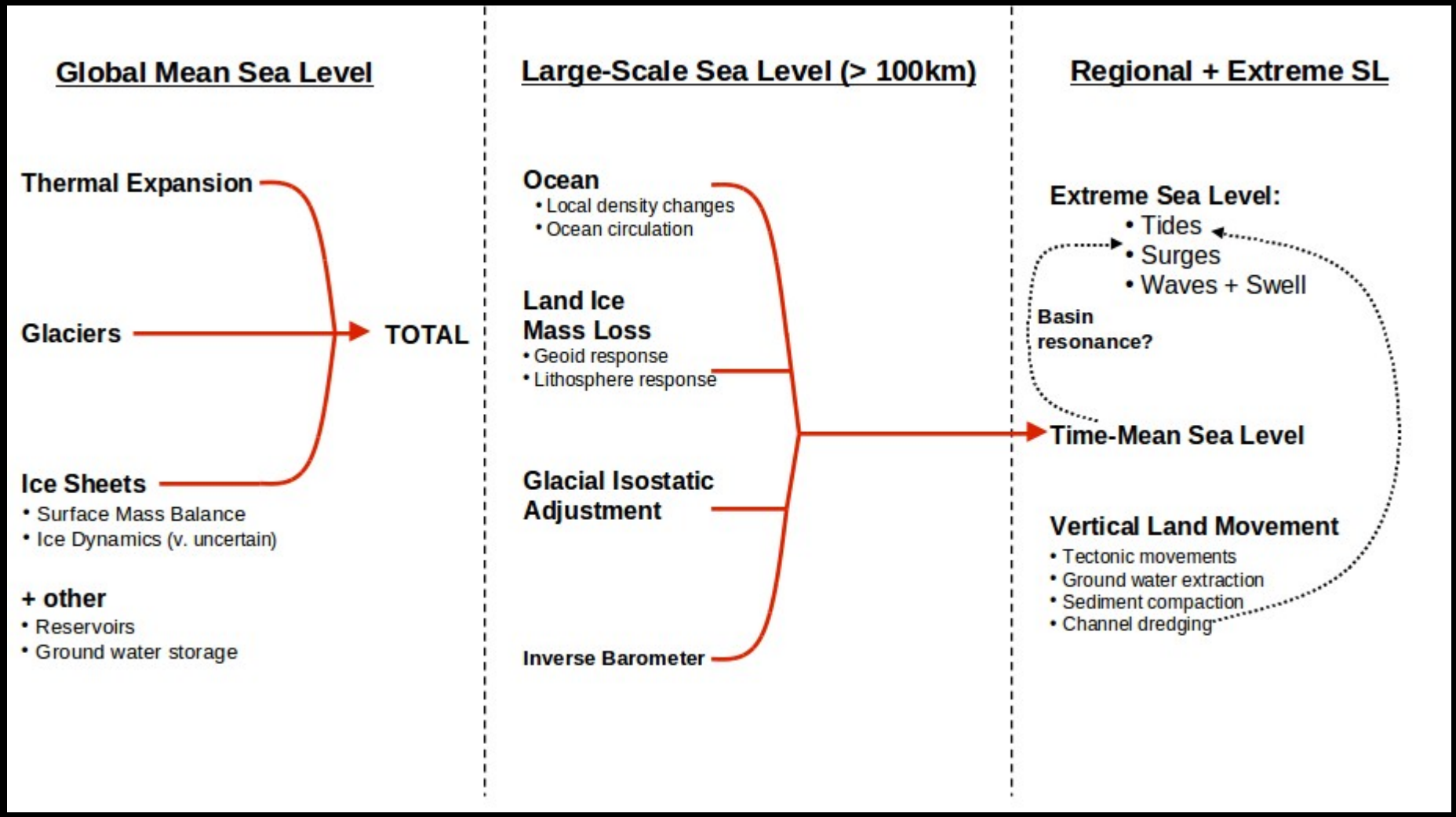


Figure 3.9 Projected land subsidence in the vicinity of Jakarta (Priyambodo, 2005)

Further subsidence will contribute an additional component to **local** sea level rise

The Sea Level Rise "Jigsaw Puzzle"



Conclusions

Temperature increases raise sea levels by expanding the oceans and melting land ice

The magnitude of sea level rise from these processes differs regionally and in the accuracy of the estimated changes

This gives rise to different estimates of the range of future sea-level rise at different island and coastal locations

Storm surges, waves and other non-climate factors such as local subsidence also affect local sea-levels – and extremes of the climate-related factors can cause very large (and damaging) local sea-level rise

Providing comprehensive local information on future sea-levels is a complex process