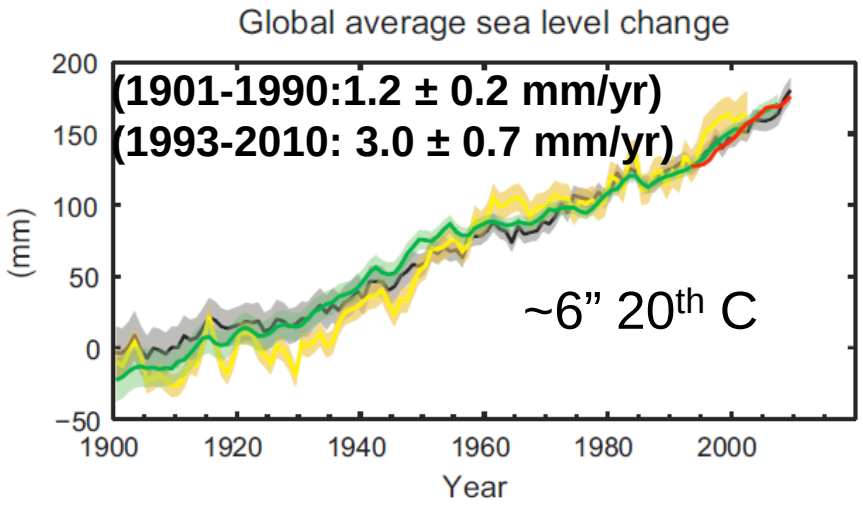
Coastal Impacts

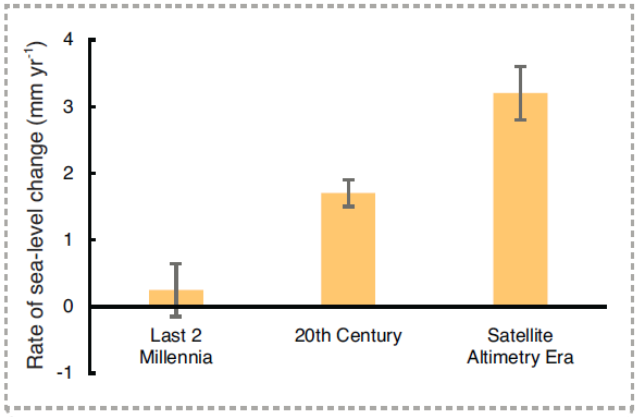
Michael Oppenheimer

Climate Migration Modeling Workshop

Science Po

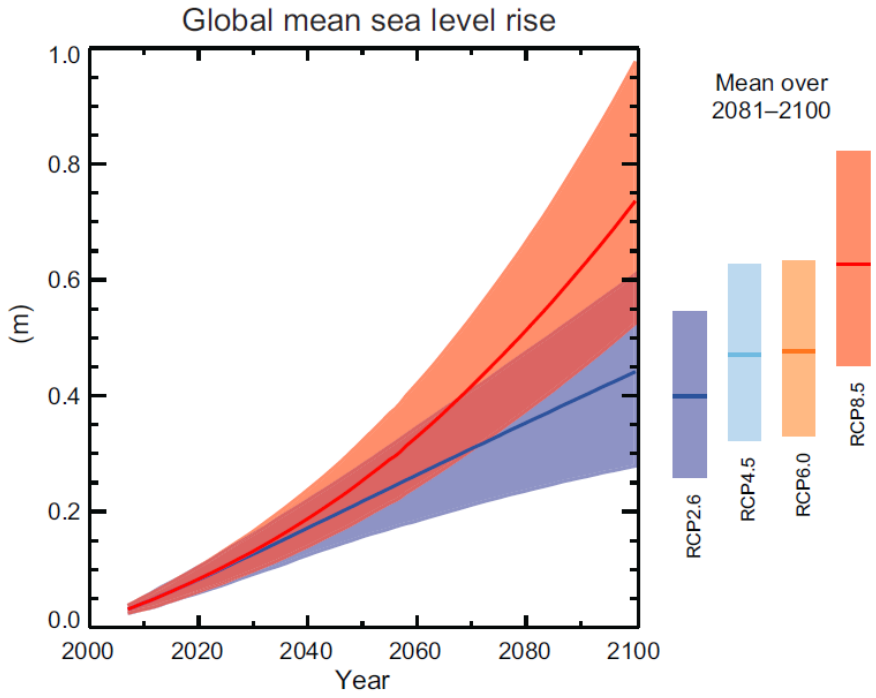
5 December 2016





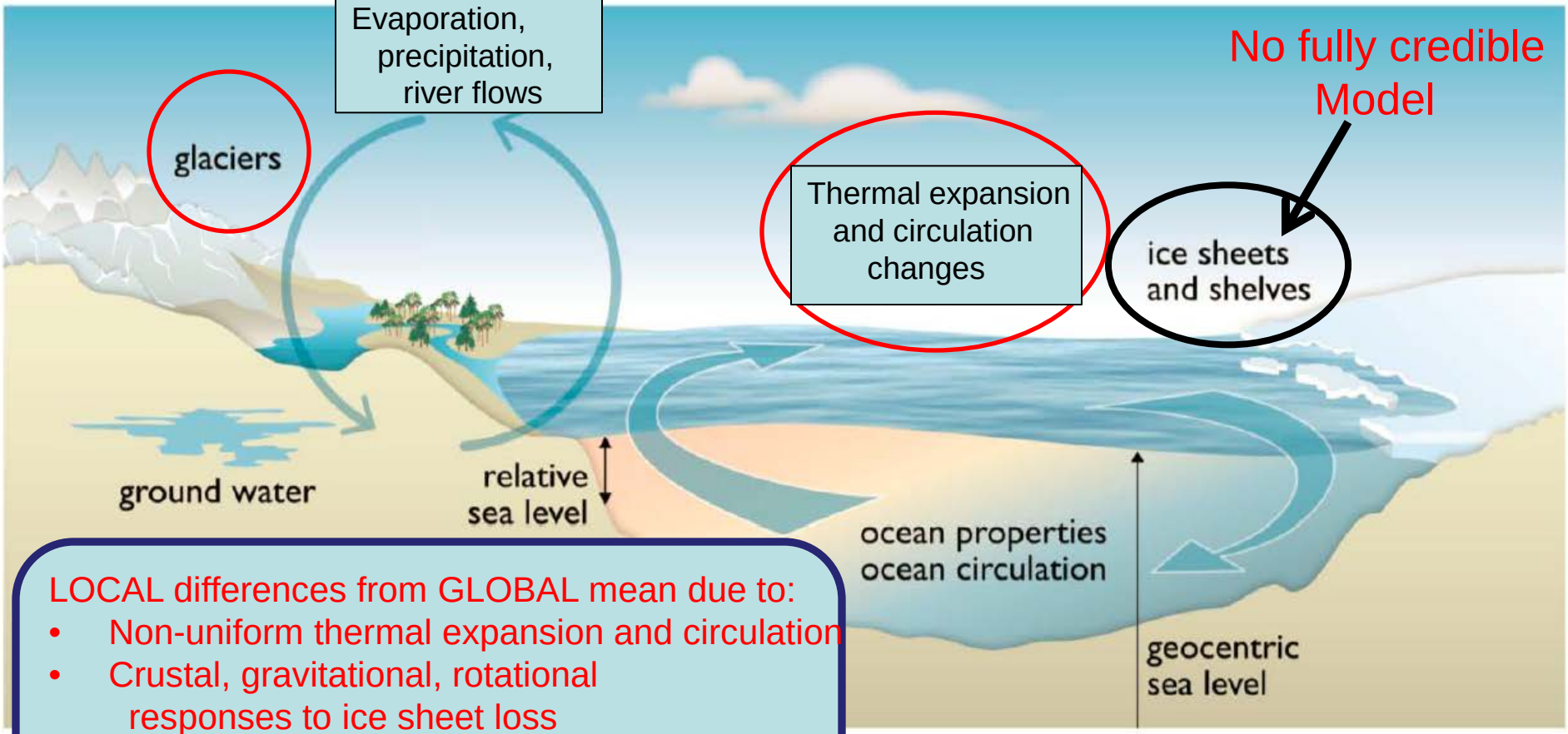
Past Sea Level Rise (SLR)

IPCC WGI AR5



Future SLR

Sea Level Changes Vary from Place to Place

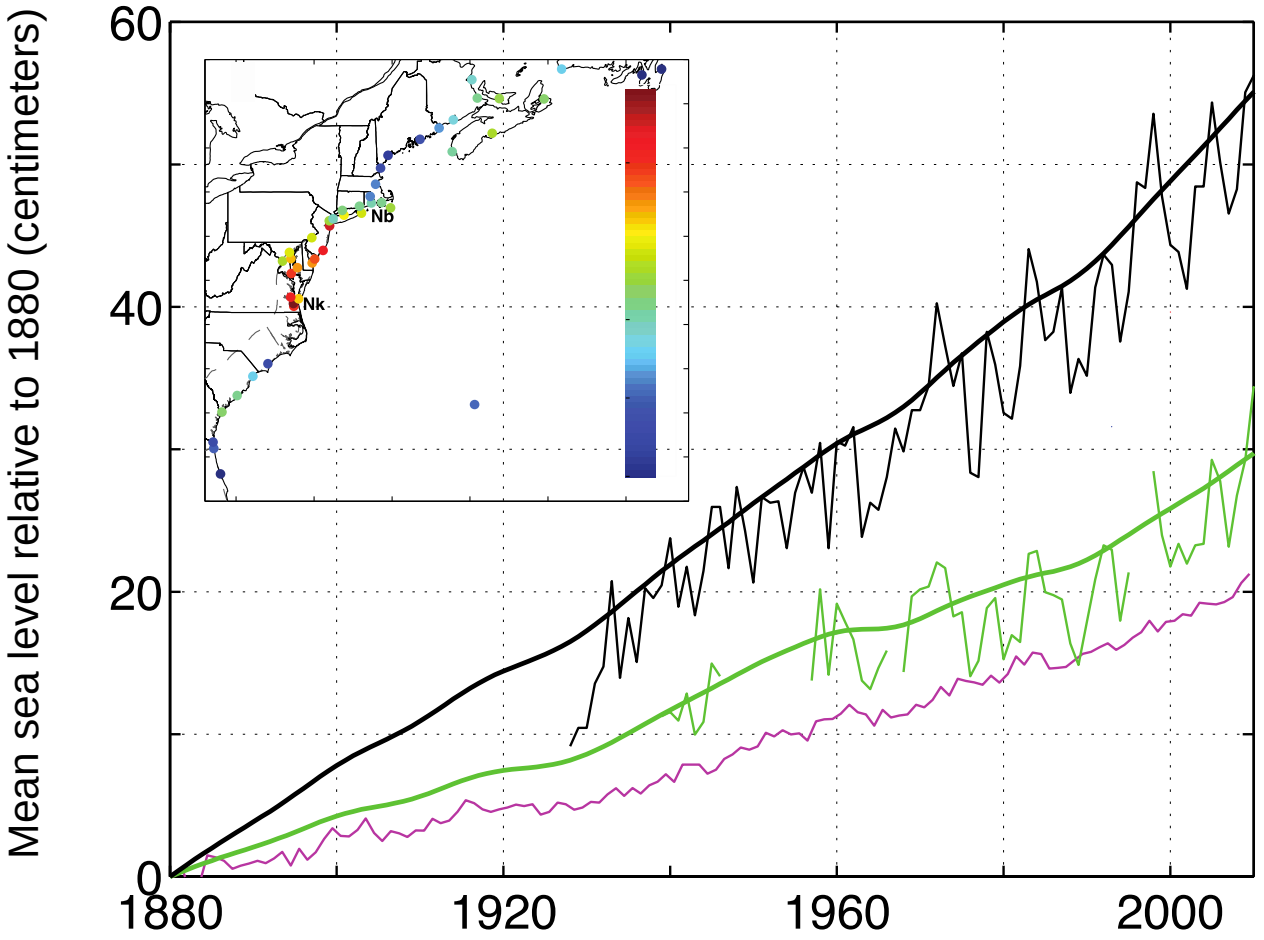


LOCAL differences from GLOBAL mean due to:

- Non-uniform thermal expansion and circulation
- Crustal, gravitational, rotational responses to ice sheet loss
- Glacial Isostatic Adjustment
- Tectonics
- sediment compaction, erosion

after AR5 Fig. 13-1)

One Location's Sea Level Change – Historical Perspective



Norfolk
~ 4.3 mm/yr

Newport
~ 2.7 mm/yr

Global mean
~ 1.7 mm/yr

Modified from Kopp 2013

Projections - selected locations

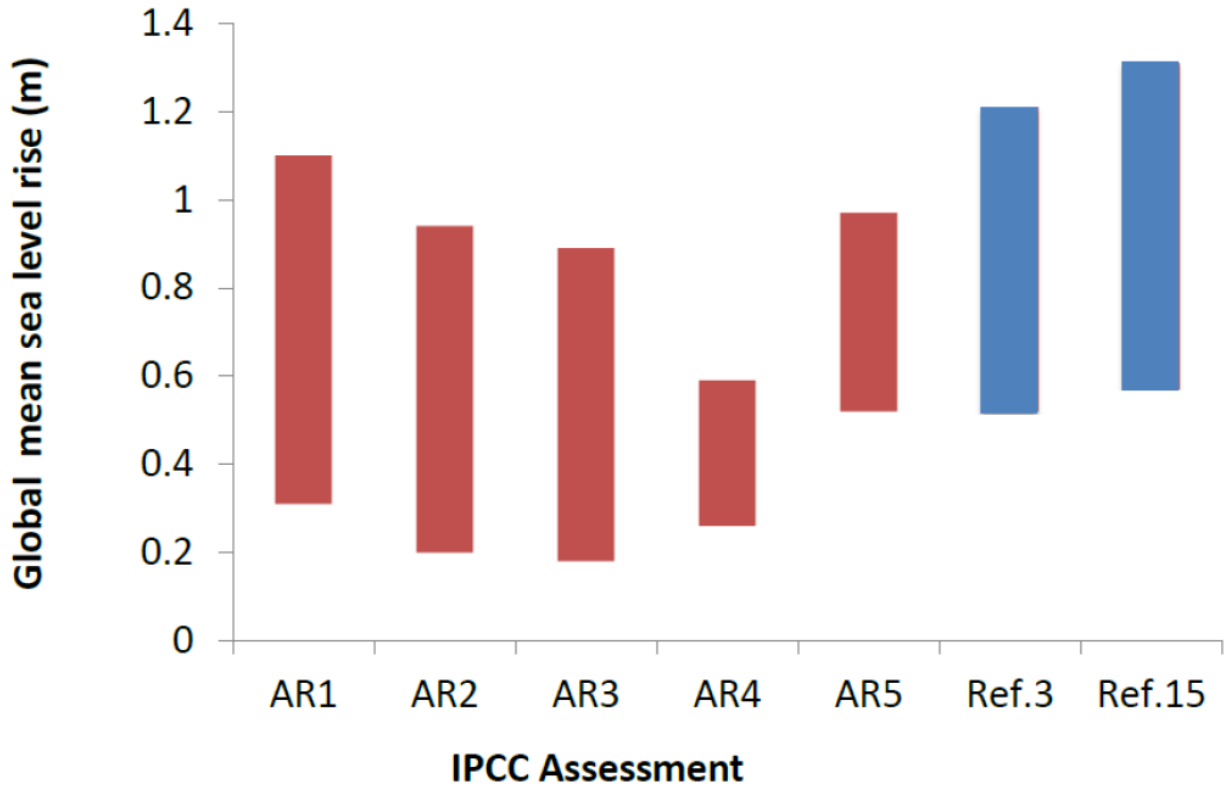
High emissions case (RCP8.5)

Percentile	Median	5	95
NYC, USA	96	44	154
Cuxhaven, Ger.	81	41	128
Kushimoto, Japan	104	53	163
Valparaiso,Chile	54	23	99
Global Mean	79	52	121

Sea level rise (cm) year 2100 compared with year 2000 (from Kopp et al 2014).

The global mean differs from IPCC value due to different methods used to estimate ice sheet behavior

Projections have varied widely over time

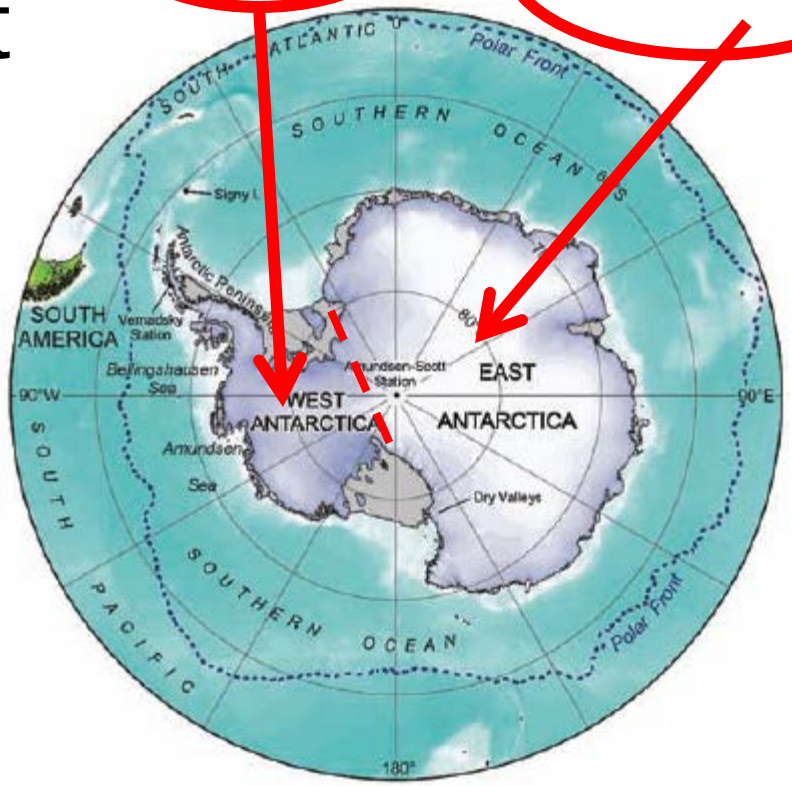


Uncertainty arises largely in ice sheet behavior

~7m

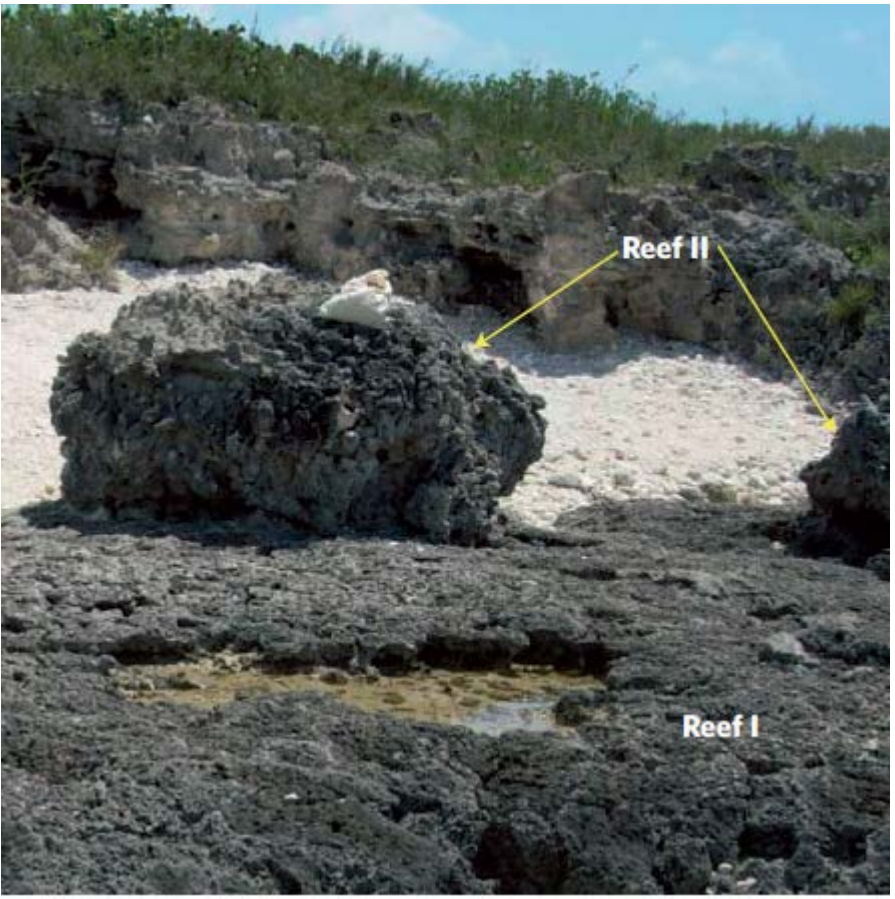
~4m

~52m



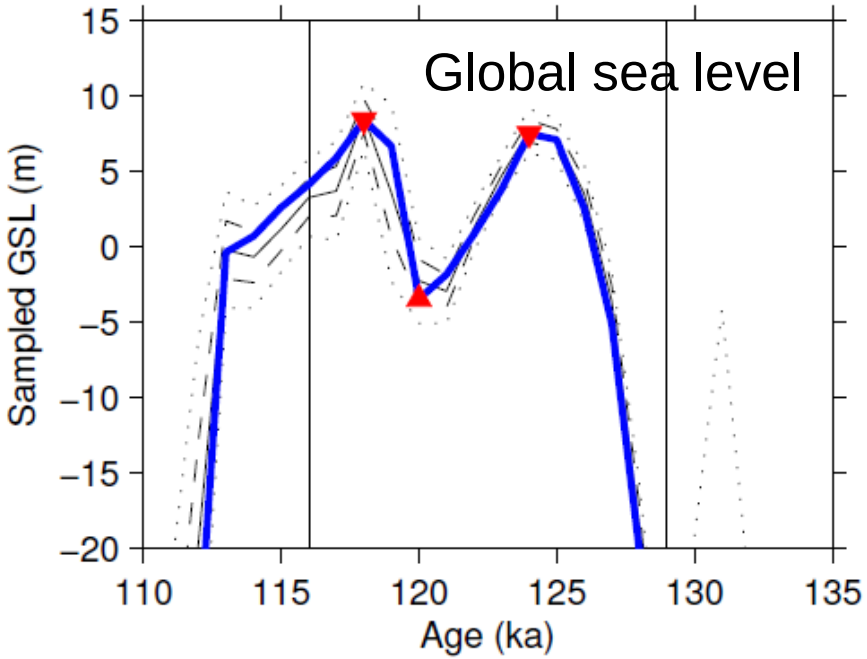
– Temperature trigger for disintegration?
– If so, how fast?

Last time Earth was about two-degrees Celsius warmer for sustained period, sea level was 5-10 meters higher!



Thompson et al NGEO 2011

How long did it take?



Kopp et al 2012

Flood frequency multipliers due to sea level rise only

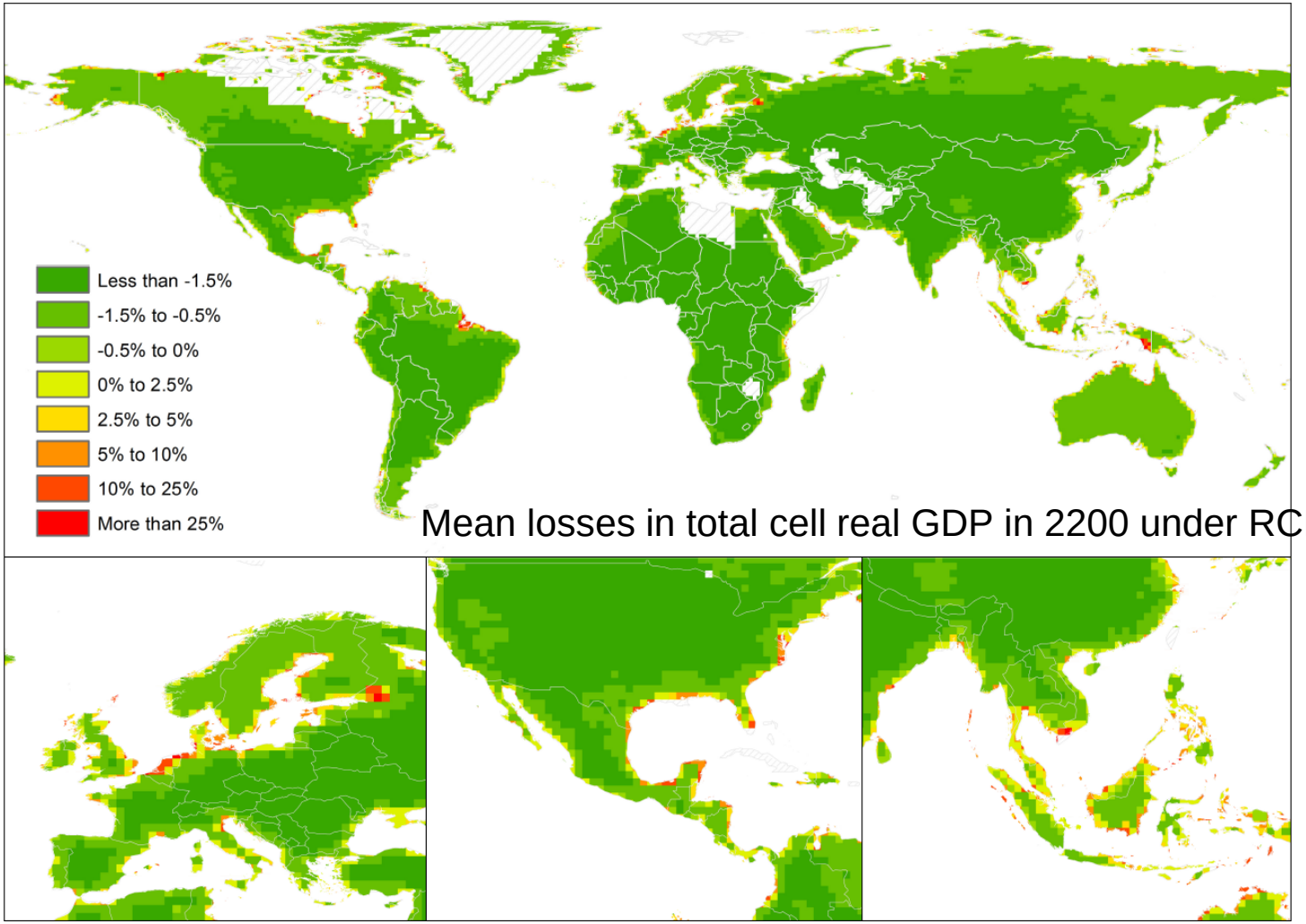
Table 4. Expected Number of Years with Flood Events of a Given Height Under Different RCPs[a]

	1-in-10 Year Events					1-in-100 Year Events				
	Height (m)	No SLR	RCP 2.6	RCP 4.5	RCP 8.5	Height (m)	No SLR	RCP 2.6	RCP 4.5	RCP 8.5
2001–2100										
New York	1.11	10	50	53	56	1.80	1	4	6	9
Sewell's Point	1.12	10	61	62	64	1.66	1	11	14	19
Key West	0.43	10	81	81	81	0.66	1	40	43	48
Galveston	0.99	10	62	62	64	1.89	1	4	5	8
San Francisco	0.67	10	65	66	67	0.88	1	26	31	36
Cuxhaven	4.14	10	21	22	27	4.85	1	3	3	4
Stockholm	0.81	10	15	13	23	1.03	1	4	2	9
Kushimoto	1.24	10	79	79	79	1.34	1	63	64	65
Valparaiso	1.17	10	68	69	72	1.24	1	45	48	54

[a]Heights for U.S. sites are with respect to the local mean higher high water datum for the 1983–2001 epoch. Heights for non-U.S. sites are with respect to the local mean sea level datum for the 1983–2001 epoch.

Dynamic Economic Model of coastal **inundation → population shifts, ΔGDP**

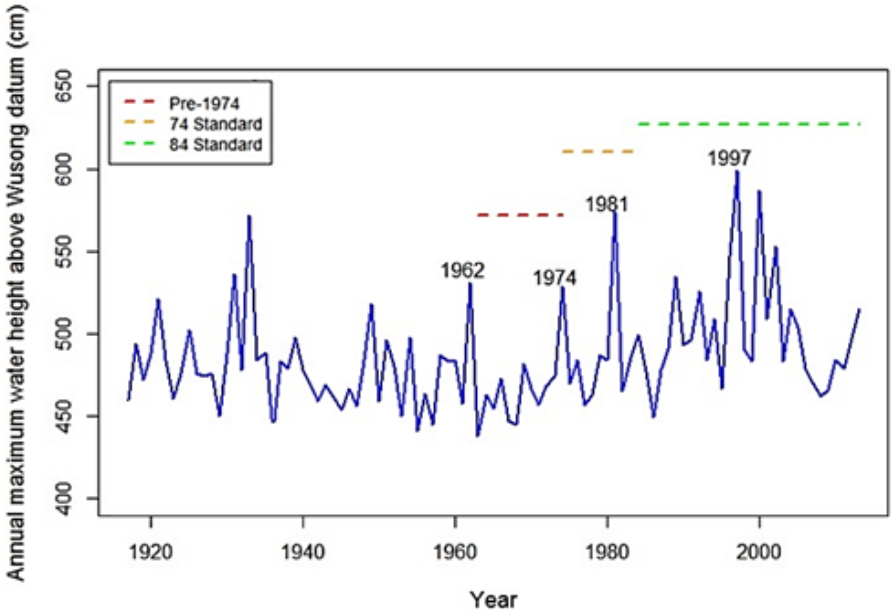
trade and migration endogenous but zero “hard” adaptation



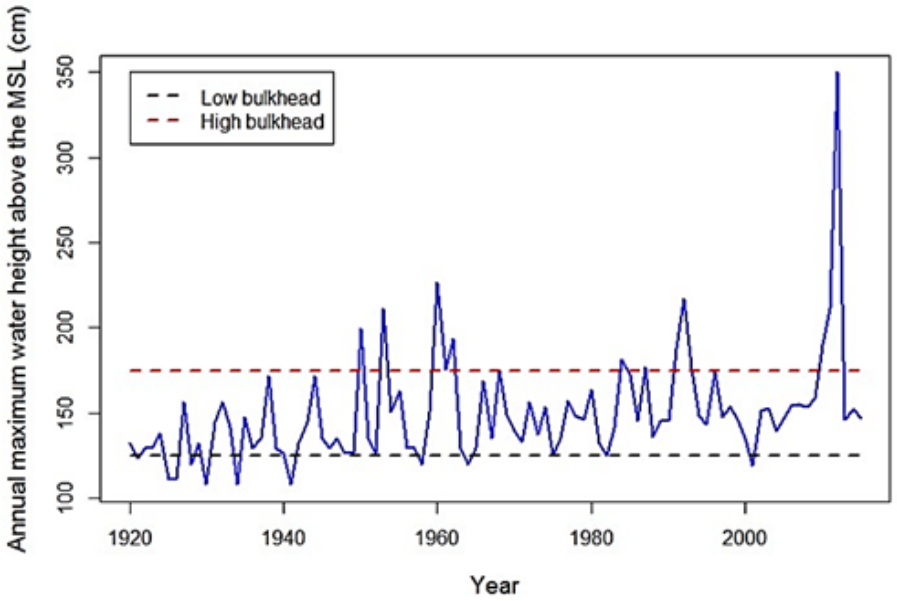
Mean losses in total cell real GDP in 2200 under RCP 4.5

Desmet et al 2017

How well did coastal cities protect their coastlines?



Shanghai

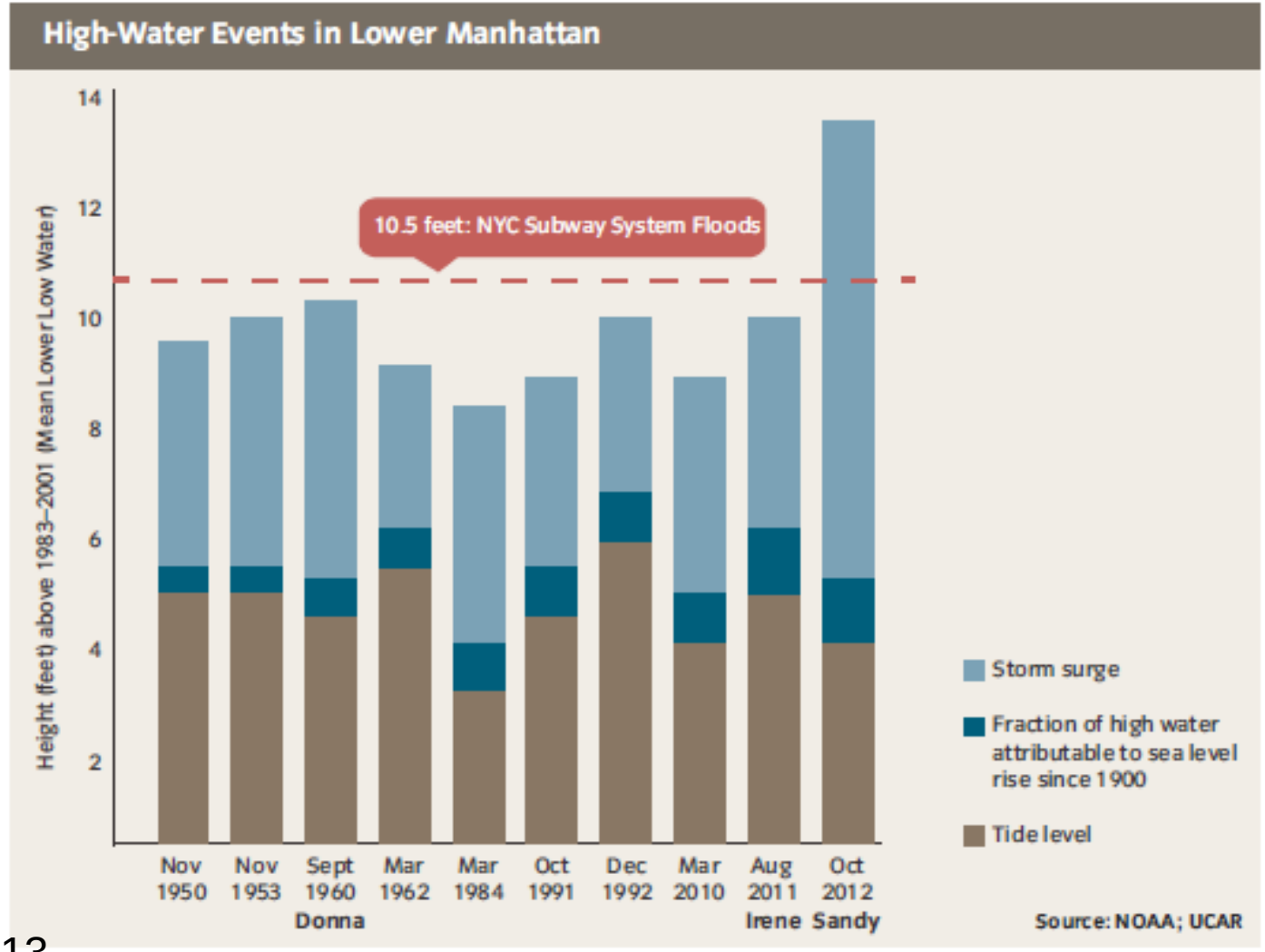


NYC

Protection level updated over time in Shanghai

Low protection in NYC

Infrastructure: Modest amount of rise can make a big difference



SIRR 2013