What we know about regional sea level rise and how we are affected by variations from the global mean

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Regional and Global Sea level

Global	Regional
Density change: thermosteric	Density change: thermosteric+ halosteric
Land Ice mass change: glaciers+ Ice-sheets	Land Ice mass change: glaciers+ Ice-sheets+ graviational- +rotational effects+ solid earth deformation
Land water storage: reservoirs+ groundwater	Land water storage: reservoirs+ groundwater+ solid earth deformation
	Ocean circulation: Post glacial rebound Atmospheric pressure Temporal variability

Time Mean Regional Sea Level

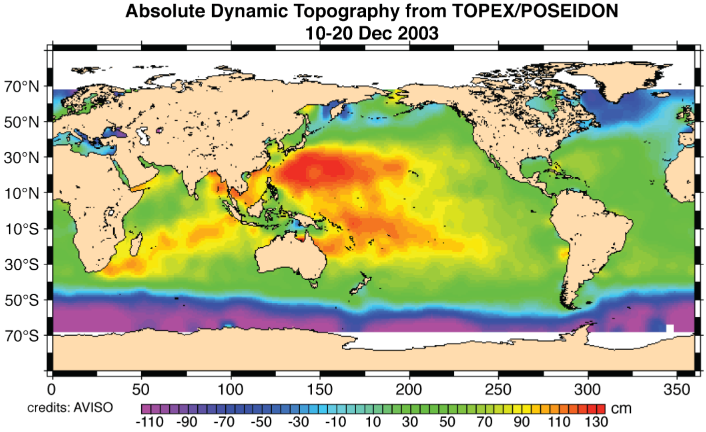

Figure: Global sea level pattern relative to the geoid

Current Sea Level trend

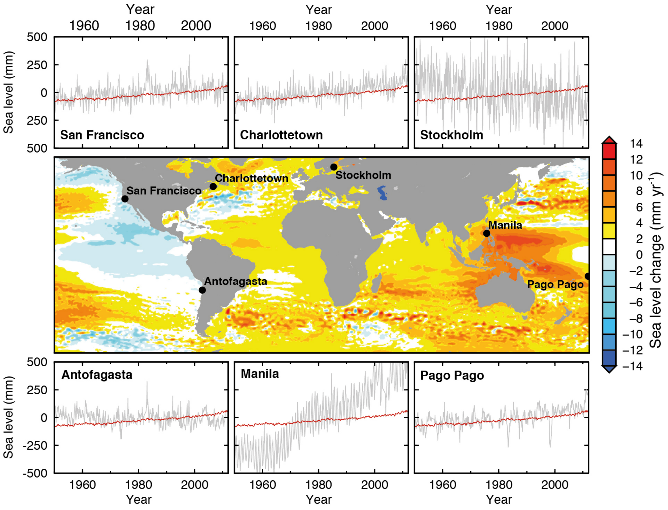

Figure: 1993-2012 trends in sea level from multiple satellite missions (geocentric) and relative sea level from stations

Coastal Sea level

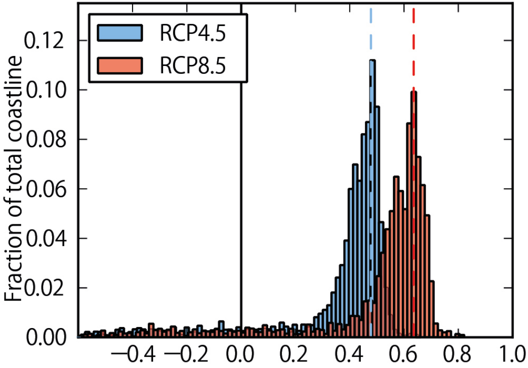

Figure: 2081-2100 sea level relative to the reference period 1986-2005 for all coastal locations (i.e. all grid points adjacent to land)

Probabilistic Scenarios for Sea level

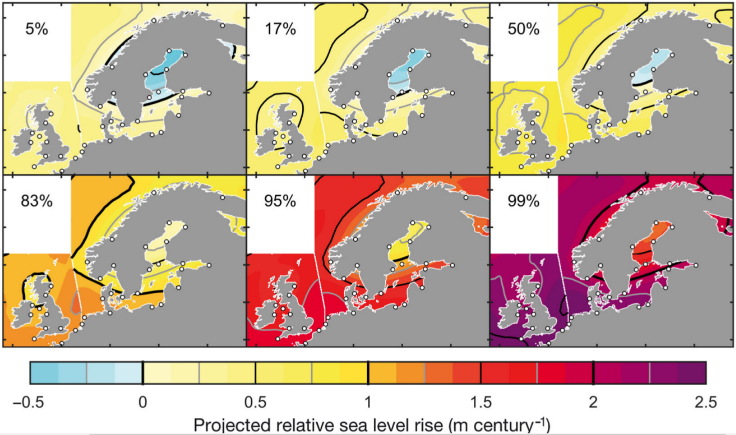

Figure: Probabilistic regional projection using RCP8.5 for the 5,17,50,83,95 and 99% uncertainty percentiles. From Grinsted et al. (2015)

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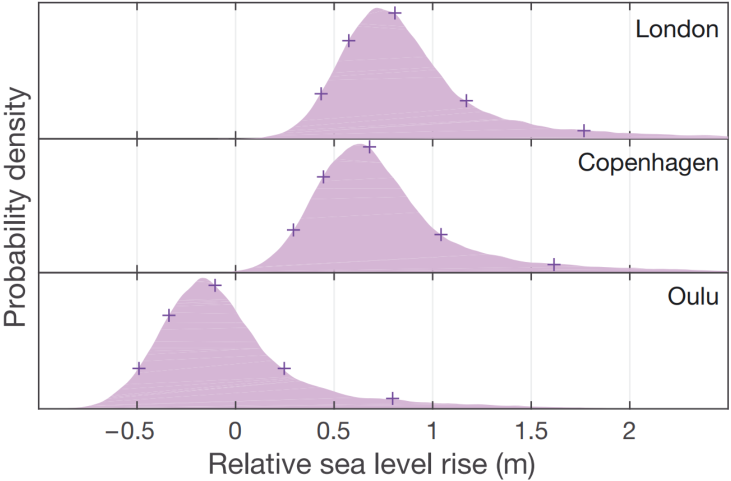

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Post Glacial Rebound & Fingerprints

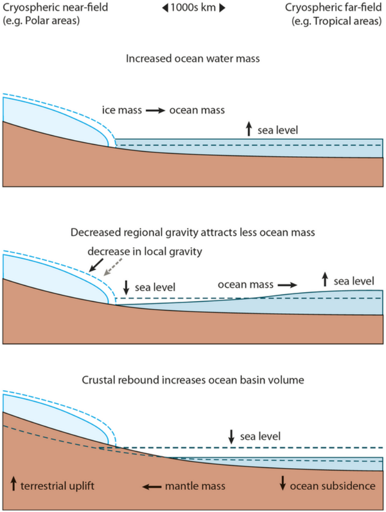
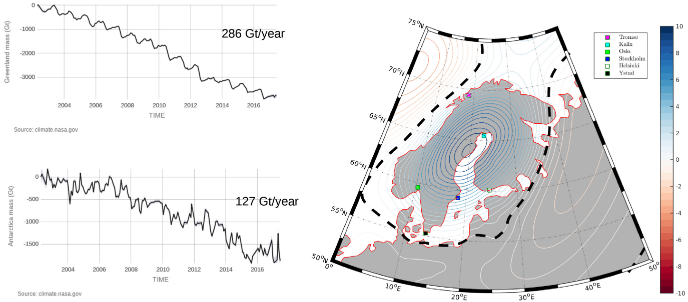


Figure: Top left) ice melt Greenland. Bottom left) ice melt Antarctica. Right) Post glacial rebound Scandinavian Peninsula

Post Glacial Rebound and Ice Melt



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Consequences of Regional Ice Loss

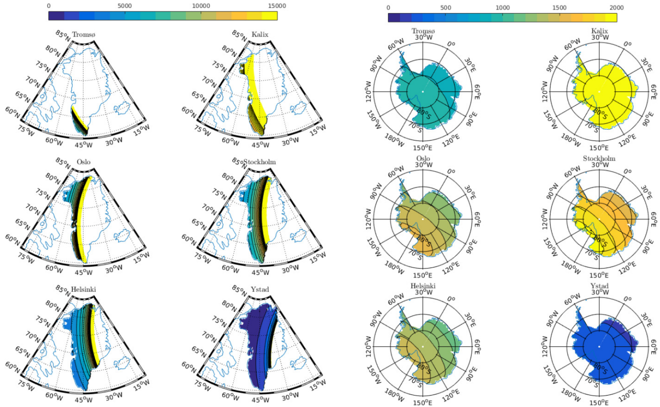

Figure: Equilibrium melt rates when post glacial rebound balances ice melt induced sea level rise. left) Greenland. Right) Antarctica.

Coastal flooding is expensive

Figure: Flooding at Norra dragsundet Kalmar

- Expected annual damage for Europe today is 1.25 billion euro and projected to rise to between 93 and 961 billion euro by the end of the century unless flood protection is upgraded (Vousdoukas et al. 2018)
- Expected annual number of people exposed is likewise projected to rise from 102000 to 1.52-3.65 million

Coastal flooding is expensive

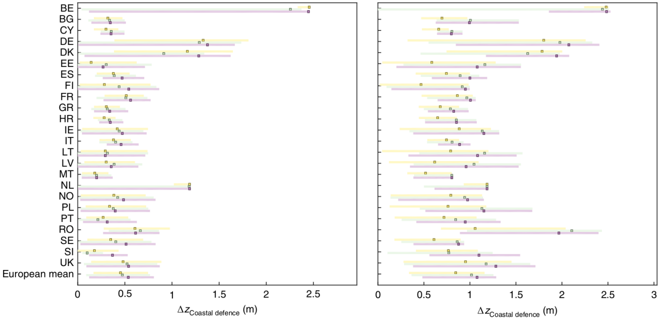

Figure: Estimated rise of coastal defences needed to keep flood damage as a fraction of GDP at today's level (Vousdoukas et al. 2018)

- European coastal flooding costs today 0.01% of the GDP
- European river flooding costs today 0.04% of the GDP
- Projected European coastal flooding costs rise to between 0.29-0.86% of the GDP for scenarios considered (RCP4.5 and RCP8.5 with SSP1, SSP3 and SSP5) unless protection is upgraded

Extreme value distributions

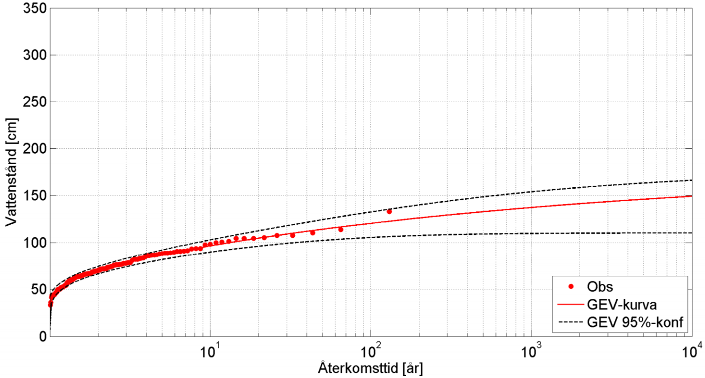

Figure: Return level (y-axis) and return period (x-axis) from GEV distribution for Kungsholmsfort

Using blocks of 1 year and drawing the maximum value from those we can calculate extreme value statistics

100 year return levels

	100-year return level [cm]	return periods [a] (2081 to 2099)		
		RCP 2.6	RCP 4.5	RCP 8.5
Kungsvik	153	82	38	10
Smögen	137	35	14	4
Stenungsund	155	28	14	4
Göteborg	154	32	18	6
Ringhals	156	26	16	6
Viken	171	12	8	3
Barsebäck	149	7	5	3
Klagshamn	129	3	2	1
Skanör	135	2	1	1

Figure: What a 100 year return levels has for return period in the different scenarios, given that the mean sea level rise equals the global mean

Different estimates of high sea levels

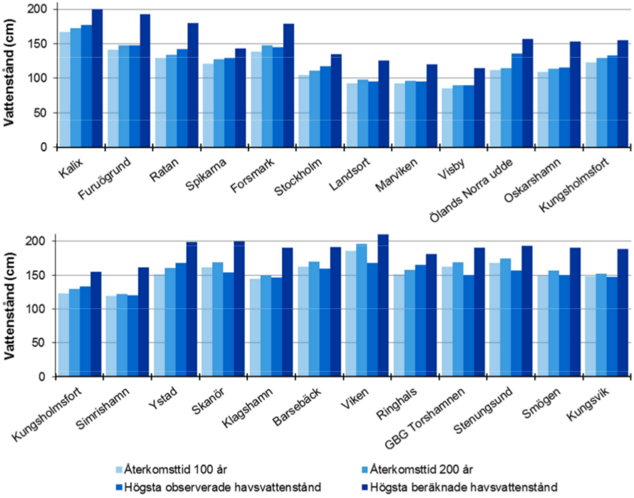

Figure: Bars from left to right: 100 return level, 200 year return level, highest observed sea level, highest estimated sea level

Conclusions

- Regional sea level rise can divert significantly from the global average
- Regional sea level rise is more uncertain and more complex than the global average
- Scandinavia is much more susceptible to sea level rise from melt occurring on Antarctica than on Greenland
- Sea level extremes will be more severe in the future as a consequence of sea level rise
- Water levels that occur very seldom today can be frequent already towards the end of the century in many Swedish coastal cities