

IPCC AR6 Sea level projections

Helene Hewitt on behalf of AR6 WG1 Chapter 9

Working Group I - The Physical Science Basis

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CHAPTER 9: OCEAN, CRYOSPHERE & SEA LEVEL CHANGE





Brown University



UK

University of Iceland



China **Beijing Normal** University



Unnikrishnan ALAKKAT Benjamin HORTON Singapore/UK CSIR-National Institute of Narwang Technological University (86)



CHAPTER 9 Mark Herner Australia **Commonwealth Scientific** and Industrial Research



Robert KOPP **United States of America** Exteers University



Gerhard KRINNER France Université Grenoble Alpes



Oregon State University

Université





Dirk NOTZ Germany Max Planck institute for Meteorology

China institute of Atmospheric Physics



Gross MARCAND Australia **CSIRO Climate Science** Centra



Subren DRUFHOUT Netherlands **Royal Netherlands**



India

Oceanography

(RE)

Nicholas GOLLEDGE New Zealand/UK **Fictoria University of** Wellington



United States of America niversity of Washingto





Lucas BUIZ Argentina IANIGLA CCT-MENDOZA CONICET



Aircáe SLANGEN Netherlands NICZ Royal Netherlands Institute for Sea Benearch

+5 chapter scientists (including Tim Hermans and Greg Garner) and 74 contributing authors

Working Group I – The Physical Science Basis

CALIBRATED UNCERTAINTY LANGUAGE

Step 1: Evaluate evidence and agreement								
0	bservations	Theory	Statistics	Models	Experiments	Process		
	~	~	~	~	~	~		
	Sufficient evidence and agreement to evaluate confidence?							
Št	ep 2: Eva	2: Evaluate confidence						
1	High ag Limited (Emer	reement evidence ging)	High agreement Aedium evidence	High agrement Robust evidence (Robust)		Language		
Agreement •	Medium a	agreement M evidence N	edium agreement Nedium evidence	Medium a Robust e	greement vidence	o Medium		
	Low agr Limited of	reement evidence ted)	Low agreement Aedium evidence	Low agr Robust e (Diver	eement widence gent)	o Low Very low		
Evidence (type, amount, quality, consistency)								

4	Sufficient	confidence and	quantitative/probabilistic	evidence	to evaluate	likelihood?
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Step 3: Evaluate statistical likelihood

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Likelihood Language	Statistical Level (assessing change)	Statistical Range (assessing range)
Virtually certain	greater than 99%	
Extremely likely	greater than 95%	
Very likely	greater than 90%	5-95% range
Likely	greater than 66%	17-83% range
More likely than not	greater than 50%	25-75% range
About as likely as not	33-66%	
Unlikely	less than 33%	<17% and >83% (both tails)
Very unlikely	less than 10%	<5% and >95% (both tails)
Extremely unlikely	less than 5%	
Exceptionally unlikely	less than 1%	



[Credit: Shari Gearheard | NSIDC]

There's no going back from some changes in the climate system. However, some changes could be slowed and others could be stopped by limiting warming.





Sea level projections in AR6 are consistent with the assessment of Equilibrium Climate Sensitivity and Surface Temperature

- Methodology for producing sea level projections is updated relative to AR5 and SROCC
- Emulators are used with input from CMIP6, ice sheet and glacier simulations to give the *likely* range to 2100 based on processes in which there is at least *medium confidence*
- Deep uncertainty captured by *low confidence* ice sheet processes
- Sea level projections to 2300 are based on assessed literature of ice sheet response giving a *low confidence* range



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Schematic based on 9.6.3.2; Table 9.7; 9.SM.4

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Through 2050, projections show limited sensitivity to emissions scenario

Projected global mean sea level rise under different SSP scenarios



Relative to 1995-2014, the likely global mean sea level rise (medium confidence)

by 2050

0.16-0.25 m under the low GHG emissions scenario (SSP1-2.6)

0.18-0.27 m under the high GHG emissions scenario (SSP3-7.0)

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Beyond 2050, projections are increasingly sensitive to emissions scenario, and it is *virtually certain* that sea level will continue to rise through 2100 Relative to 1995-2014, the likely global mean



sea level rise (medium confidence):

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by 2100:

0.32-0.62 m under the low GHG emissions scenario (SSP1-2.6)

0.55-0.90 m under the high GHG emissions scenario (SSP3-7.0)

Approaching 2m sea level rise cannot be excluded

by 2150:

0.46-0.99 m under the low GHG emissions scenario (SSP1-2.6)

0.98-1.88 m under the high GHG emissions scenario (SSP3-7.0)

Projected global mean sea level rise under different SSP scenarios

Regional differences in sea level arise from ocean dynamics, changes in Earth gravity, rotation and deformation in response to land-ice and land-water changes, and vertical land motion

Temporal variability in ocean dynamics dominates regional patterns on annual to decadal time scales *(high confidence)*

The anthropogenic signal will emerge in most regions by 2100 (medium confidence)

Projected Sea Level Change Contributions under SSP1-2.6 and SSP5-8.5

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It is very likely to virtually certain that regional mean relative sea level rise will continue throughout the 21st century, except in a few regions with substantial geologic land uplift rates.

Regional sea level change at 2100 for different scenarios (with respect to 1995-2014)





Approximately two-thirds of the global coastline has a projected regional relative sea level rise within ±20% of the global mean increase (*medium confidence*).



SSP3-7.0 median change



Due to relative sea level rise, extreme sea level events that occurred once per century in the recent past are projected to occur annually or more frequently at about 19–31% of tide gauges by 2050 and at about 60% (SSP1-2.6) to 82% (SSP5-8.5) of tide gauges by 2100 (*medium confidence*).

Relative sea level rise contributes to increases in the frequency and severity of coastal flooding in low-lying areas and to coastal erosion along

SIXTH ASSESSMENT REPORTIDECWorking Group I - The Physical Science BasisIntercovernmental PANEL on Climate ChangeImage: Constraint of Clamate Science BasisBeyond 2100, global mean sea level will continue to continuing deep ocean heat uptake and mass loss of the ice sheets (high confidence)Image: Confidence Science BasisBy 2300, GMSL will riseBy 2300, GMSL will riseImage: Confidence Science Basis

between 0.3 m and 3.1 m under SSP1-2.6

between 1.7 m and 6.8 m under SSP5-8.5 in the absence of Marine Ice Cliff Instability

and by up to 16 m under SSP5-8.5 considering Marine Ice Cliff Instability

(low confidence)

Substantially higher values by 2300 than UKCP18



comparison

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In the longer term, sea level is committed to rise for centuries to millennia and will remain elevated for thousands of years.



Over the next 2000 years, global mean sea level will rise by about 2 to 3 m if warming is limited to 1.5°C, 2 to 6 m if limited to 2°C and 19 to 22 m with 5°C of warming, and it will continue to rise over subsequent millennia (*low confidence*)

Projections of multi-millennial global mean sea level rise are consistent with reconstructed levels during past warm climate periods:

likely 5–10 m higher than today around 125,000 years ago, when global temperatures were *very likely* 0.5°C–1.5°C higher than 1850–1900;

and *very likely* 5–25 m higher roughly 3 million years ago, when global temperatures were 2.5°C–4°C higher (*medium confidence*).

AR6 take home messages

- It is *virtually certain* that sea level will continue to rise throughout the 21st century and beyond - deep and rapid cuts in emissions are the route to minimise sea level rise (particularly risk of large loss from Antarctic ice sheet)
- Sea level rise at 3C by 2100 is 62cm (50-81cm) (medium confidence) BUT

1. extreme flooding events that happened once per century will occur annually in more locations at higher warming levels (60% versus 80%)

2. higher levels by 2100 cannot be excluded due to ice sheet processes

- 3. 3C warming would have significant implications for sea level rise post 2100
- Deep uncertainty is associated with ice sheet processes and this area would be one of my priorities to reduce uncertainty in the projections beyond AR6





ONLINE RESOURCES

[Credit: NASA]





Interactive Atlas

interactive-atlas.ipcc.ch



NASA sea level tool

https://sealevel.nasa.gov/data_tools/17

EARTH**DATA**

SEA LEVEL CHANGE | IDCC **

Sea Level Projection Tool

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Thank you.

More Information:

IPCC: www.ipcc.ch

Many thanks to:

Chapter scientists Gregory Garner & Tim Hermans

The Chapter 9 Author Team

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Regional sea-level change will be the main driver of a substantial increase in the frequency of extreme still water levels over the next century *(medium confidence)*

Median Amplification Factor of Extreme Still Water Level by:



Due to relative sea level rise, extreme sea level events that occurred once per century in the recent past are projected to occur annually or more frequently at about 19–31% of tide gauges by 2050 and at about 60% (SSP1-2.6) to 82% (SSP5-8.5) of tide gauges by 2100 (*medium confidence*).

Relative sea level rise contributes to increases in the frequency and severity of coastal flooding in low-lying areas and to coastal erosion along most sandy coasts (*high confidence*).