

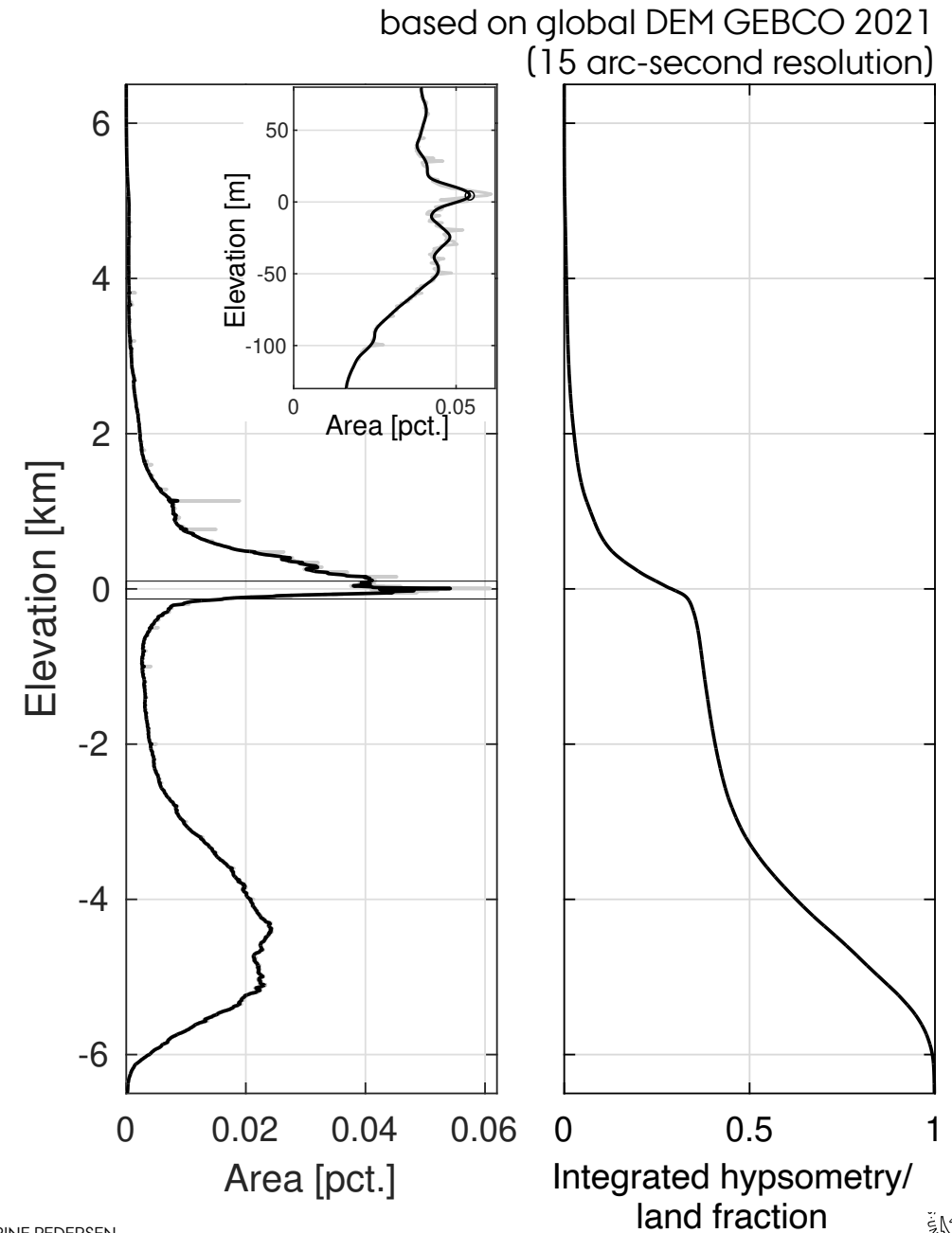
THE INFLUENCE OF EARTH'S HYPSONOMETRY ON GLOBAL SEA LEVEL THROUGH A GLACIAL CYCLE AND INTO THE FUTURE

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R. Winkelmann, J.X. Mitrovica

GLOBAL HYPSONOMETRY

“Hypsometry is the measurement of the elevation and depth of features of the Earth’s surface relative to mean sea level.”

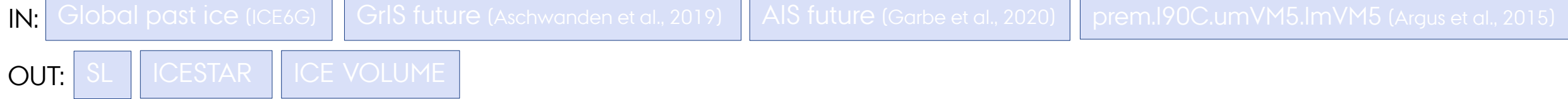
- *Wikipedia*



GLOBAL HYPSONOMETRY THROUGH TIME

FLOW CHART

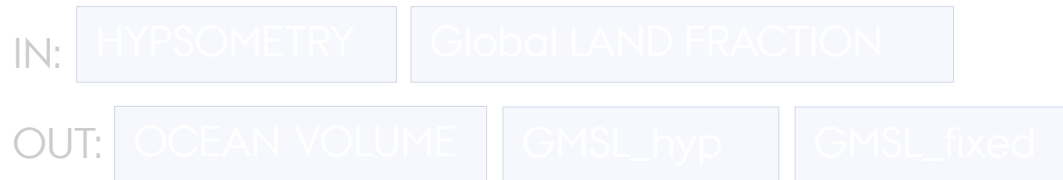
1: SEA-LEVEL MODEL [-122ka, +20ka]



2: INTERPOLATE sea-level changes onto global DEM (GEBCO) + CALCULATE GLOBAL METRICS



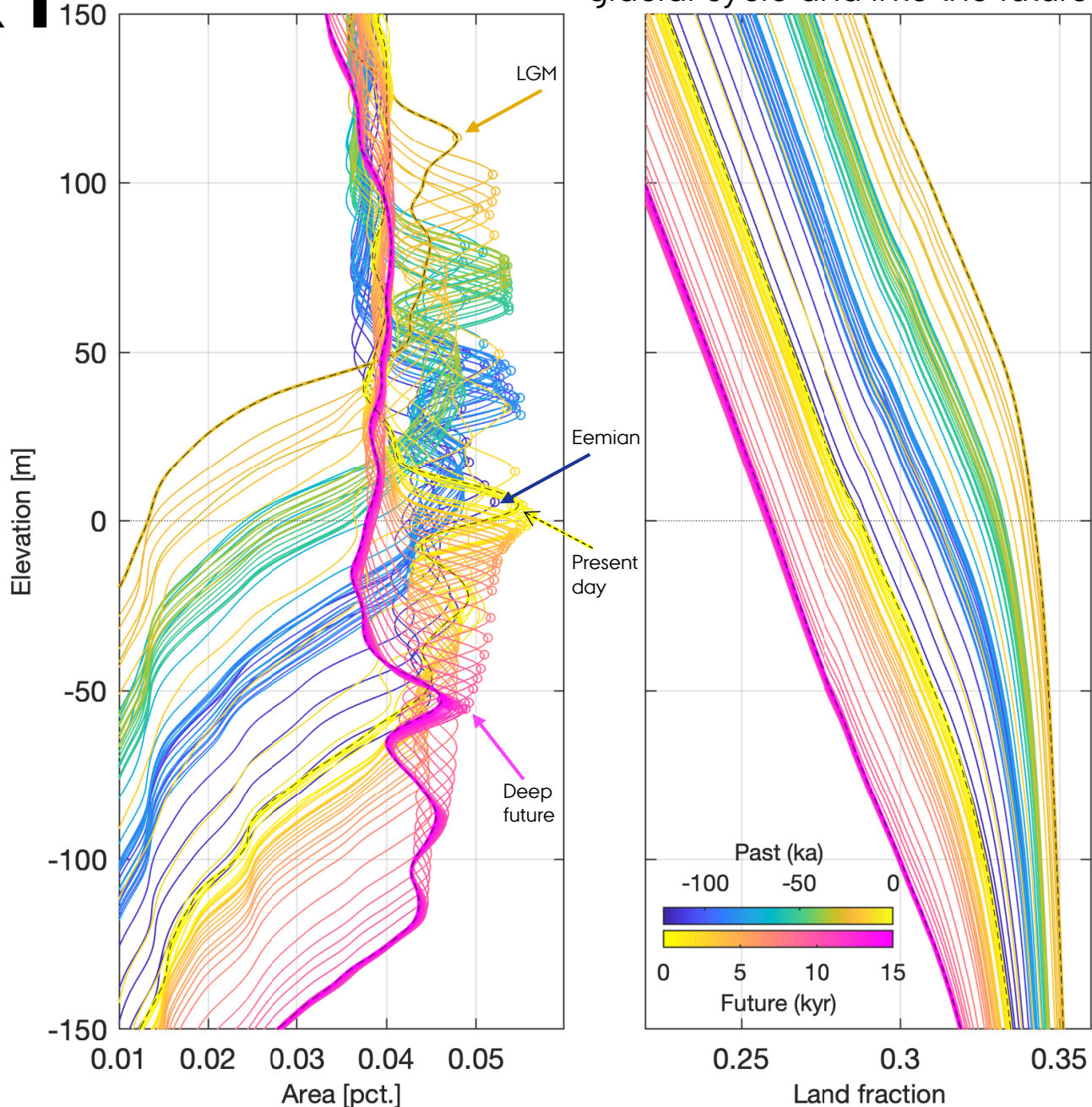
3: GMSL CALCULATION



GLOBAL HYPSONOMETRY

Changes in global hypsometry and land fraction over the last glacial cycle and into the future.

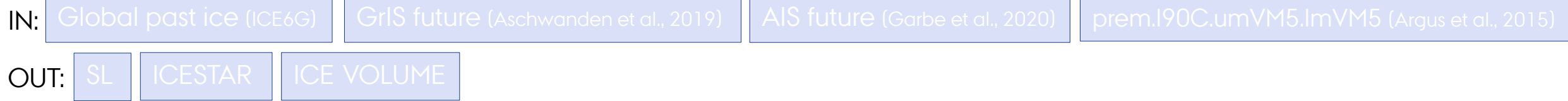
GEBCO 2021, modified over the last glacial cycle and into the future



GLOBAL HYPSONOMETRY THROUGH TIME

FLOW CHART

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2: INTERPOLATE sea-level changes onto global DEM (GEBCO) + CALCULATE GLOBAL METRICS



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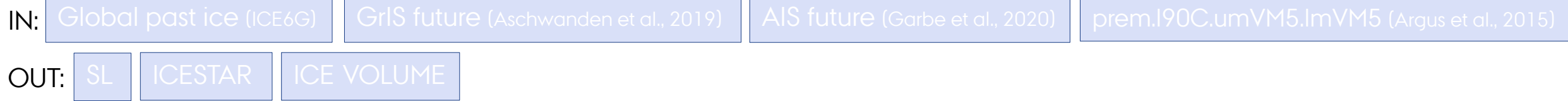


$$GMSL_{hyp}(t_i) = GMSL_{hyp}(t_{i-1}) + \frac{\Delta V_{ocean}(t_{i-1} \rightarrow t_i)}{A_{ocean}(t_{i-1} \rightarrow t_i)} \quad \text{for timestep } t_i$$

GLOBAL HYPSONOMETRY THROUGH TIME

FLOW CHART

1: SEA-LEVEL MODEL [-122ka, +20ka]



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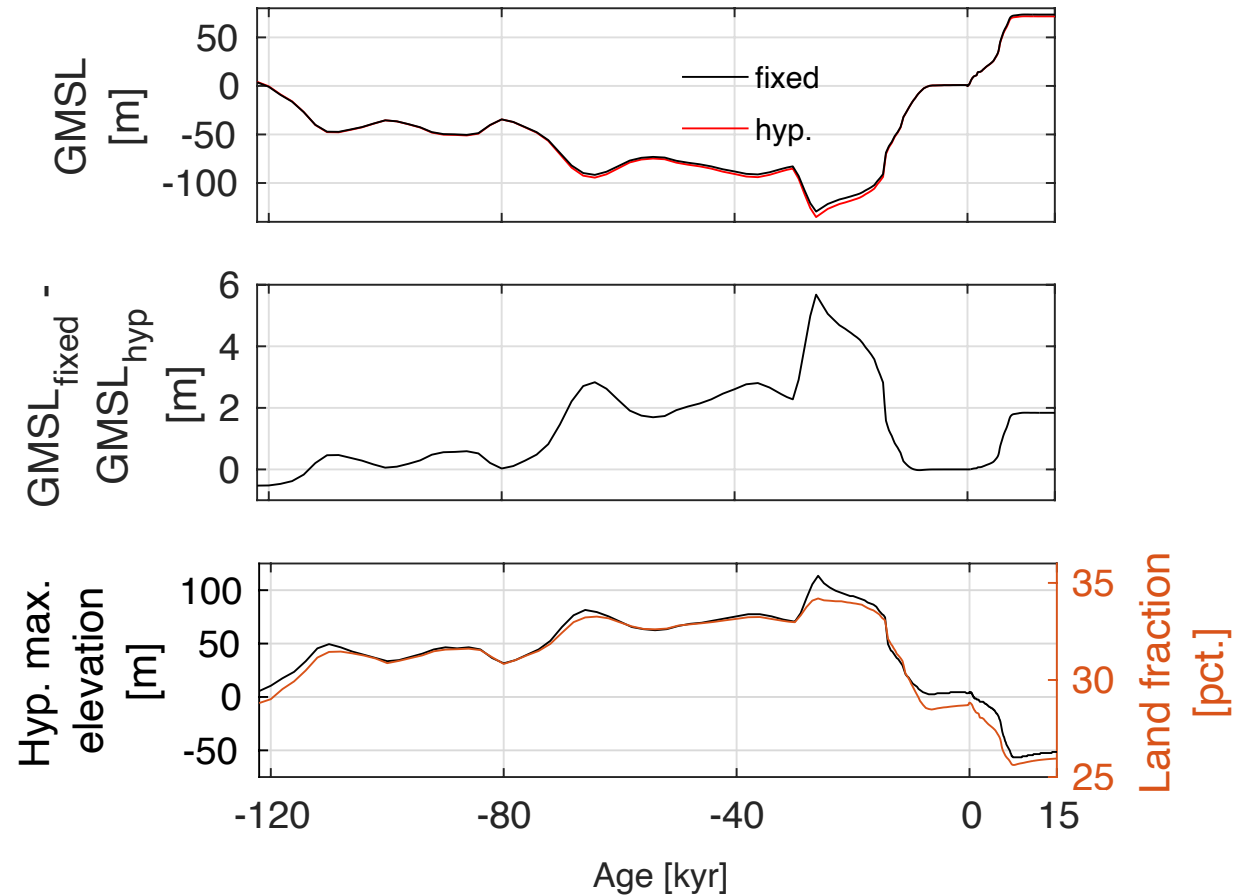
$$GMSL_{fixed}(t_i) = \frac{V_{ocean}(t_i)}{A_{present\ ocean}}$$

GLOBAL MEAN SEA LEVEL

Global mean sea level over the last glacial cycle and into the future for a fixed-ocean function (present day) and a variable ocean function

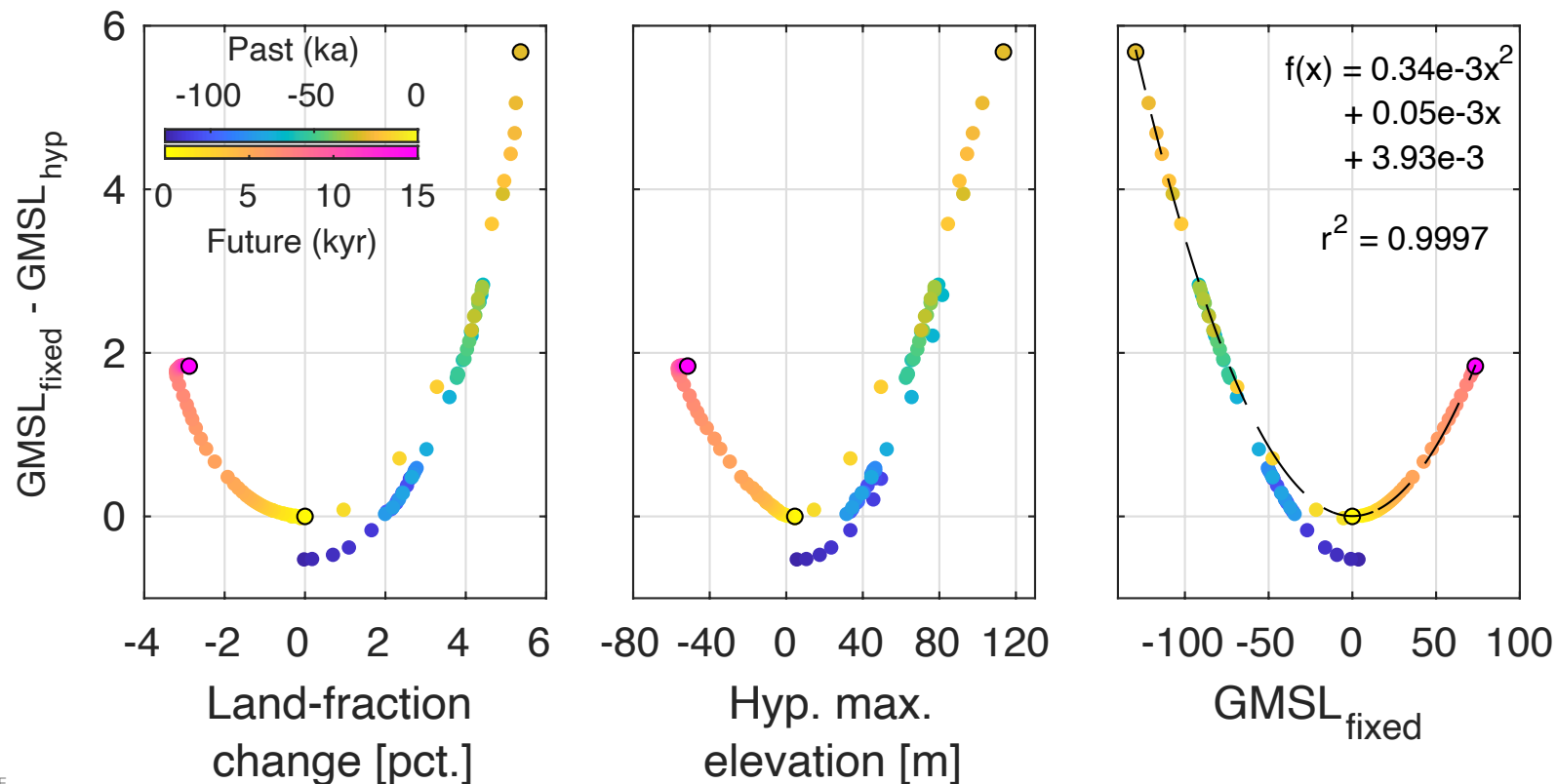
Up to ~5.7 m of difference between the two at LGM

This difference correlates with the elevation of the hypsometric maximum and the land fraction over time



GLOBAL MEAN SEA LEVEL

Relationship between GMSL difference (GMSL_{fixed} – GMSL_{hyp}) vs. a number of metrics, including GMSL_{fixed}. This shows a non-linear correction that should be applied to GMSL_{fixed}, in order to consider Earth's hypsometry



SUMMARY

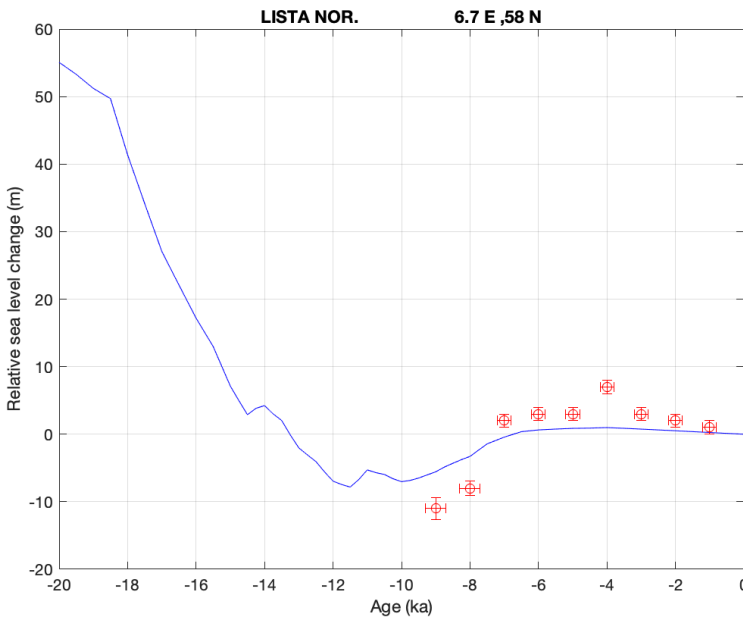
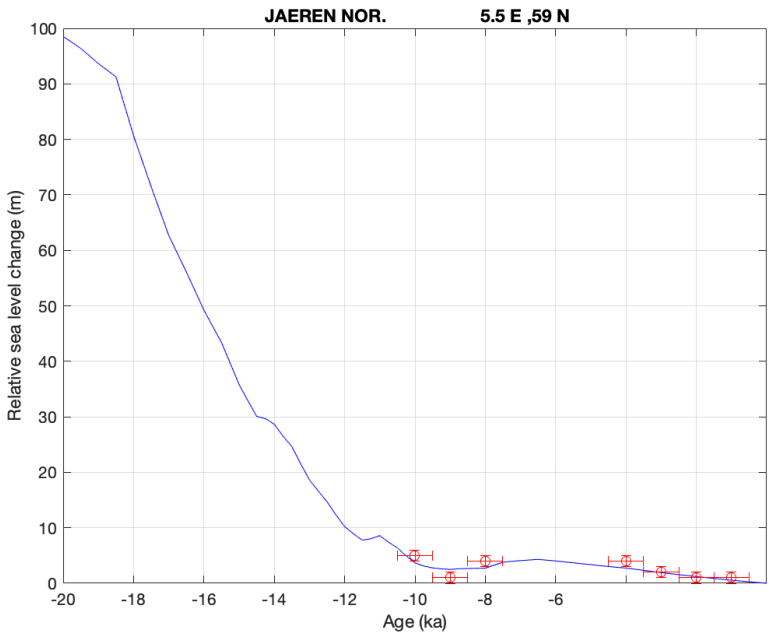
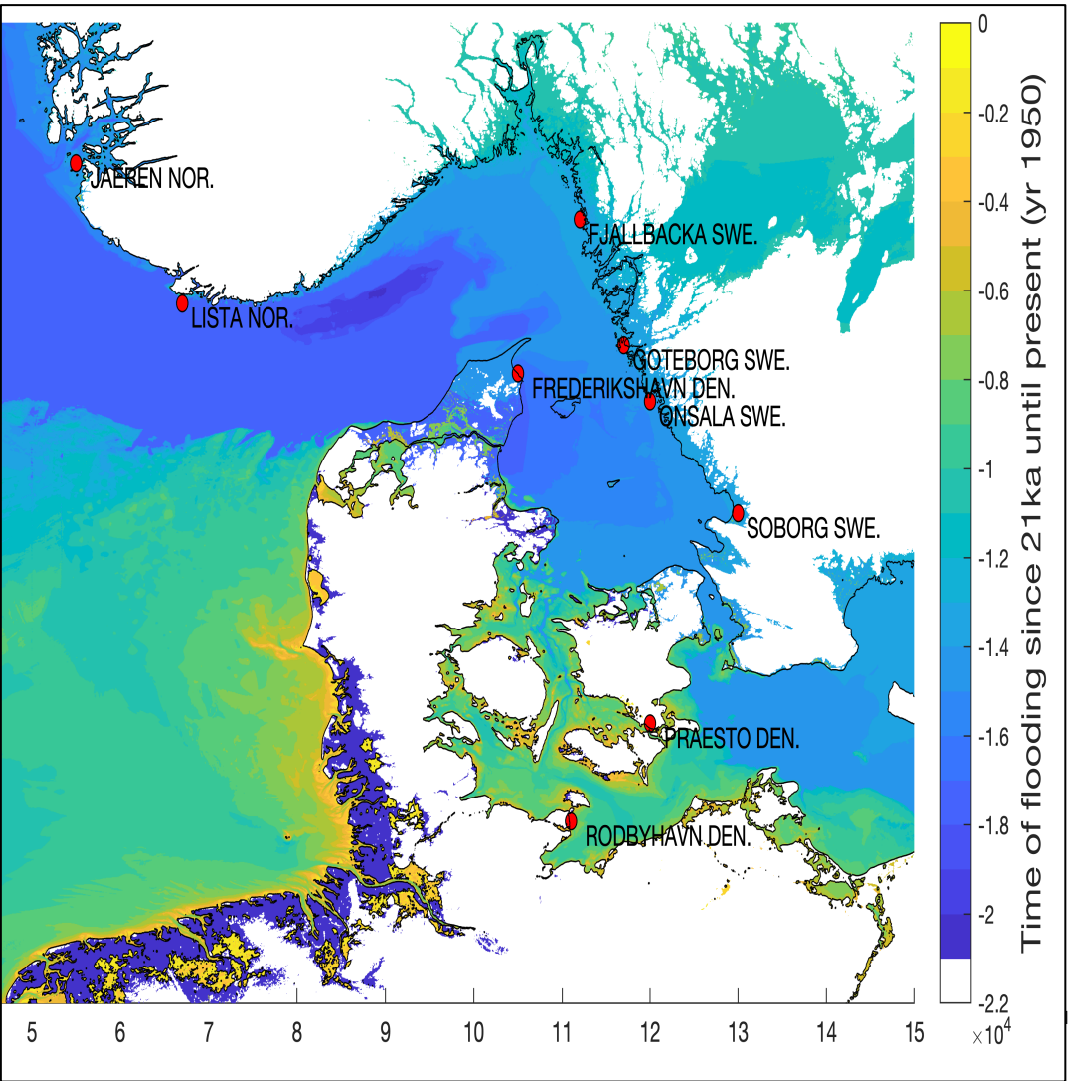
Earth's hypsometry shows a distinct maximum near present sea level

Considering Earth's hypsometry when calculating GMSL makes a difference of nearly 6 m at LGM and ~2 m in the 'extreme future'

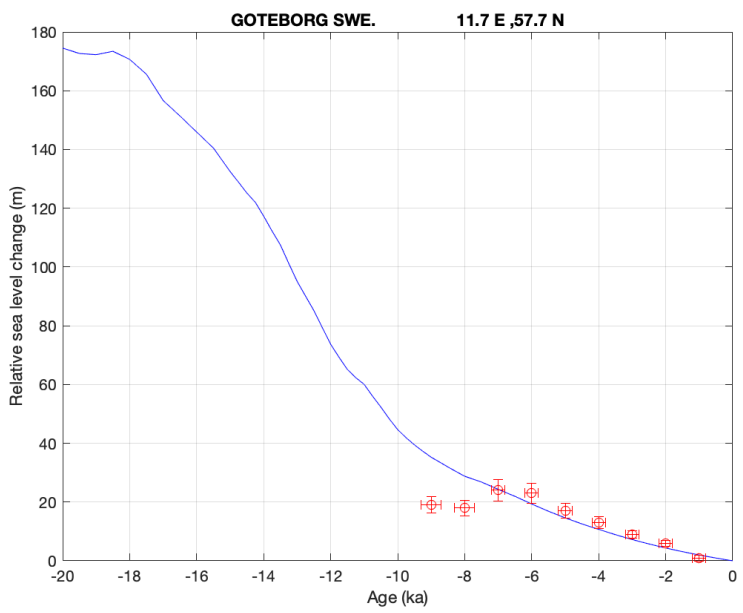
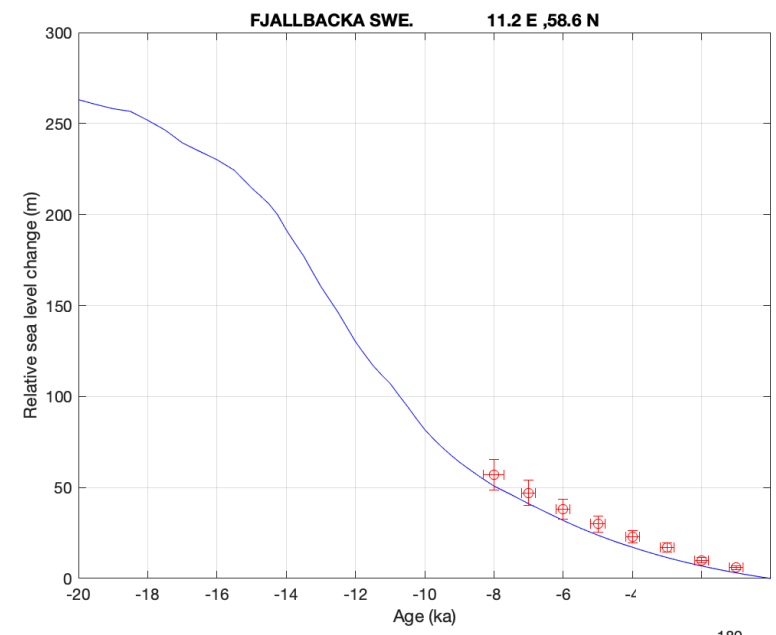
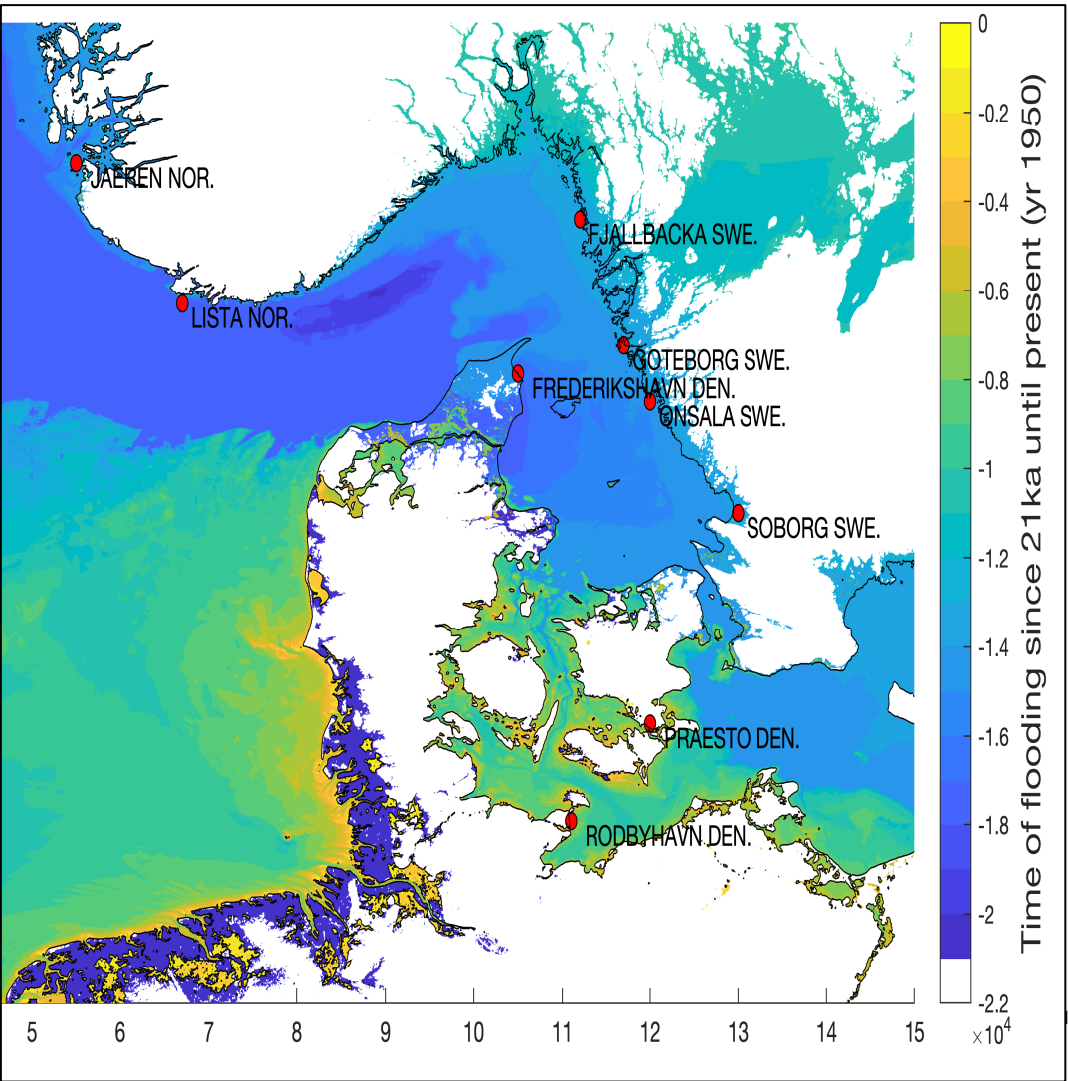
Mapping out the influence of Earth's hypsometry on global sea level allows us to define a correction function for the hypsometric effect



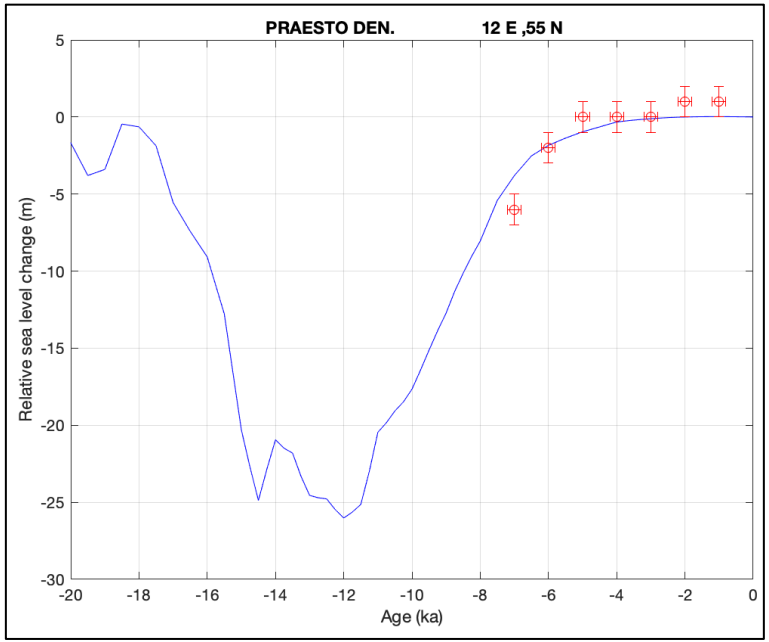
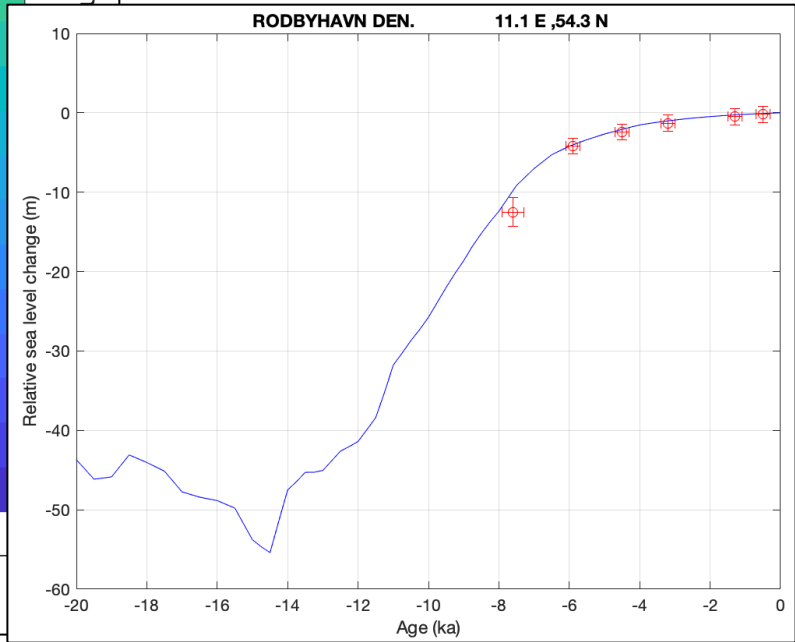
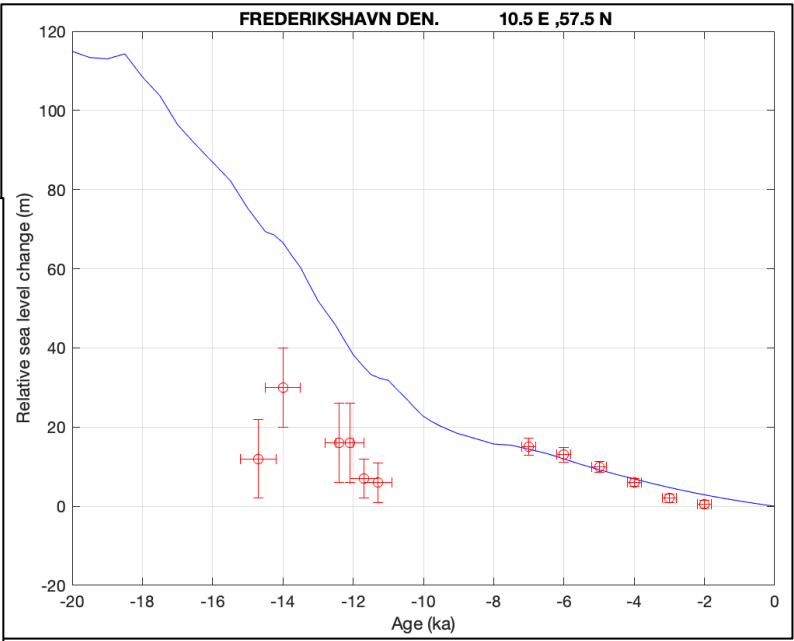
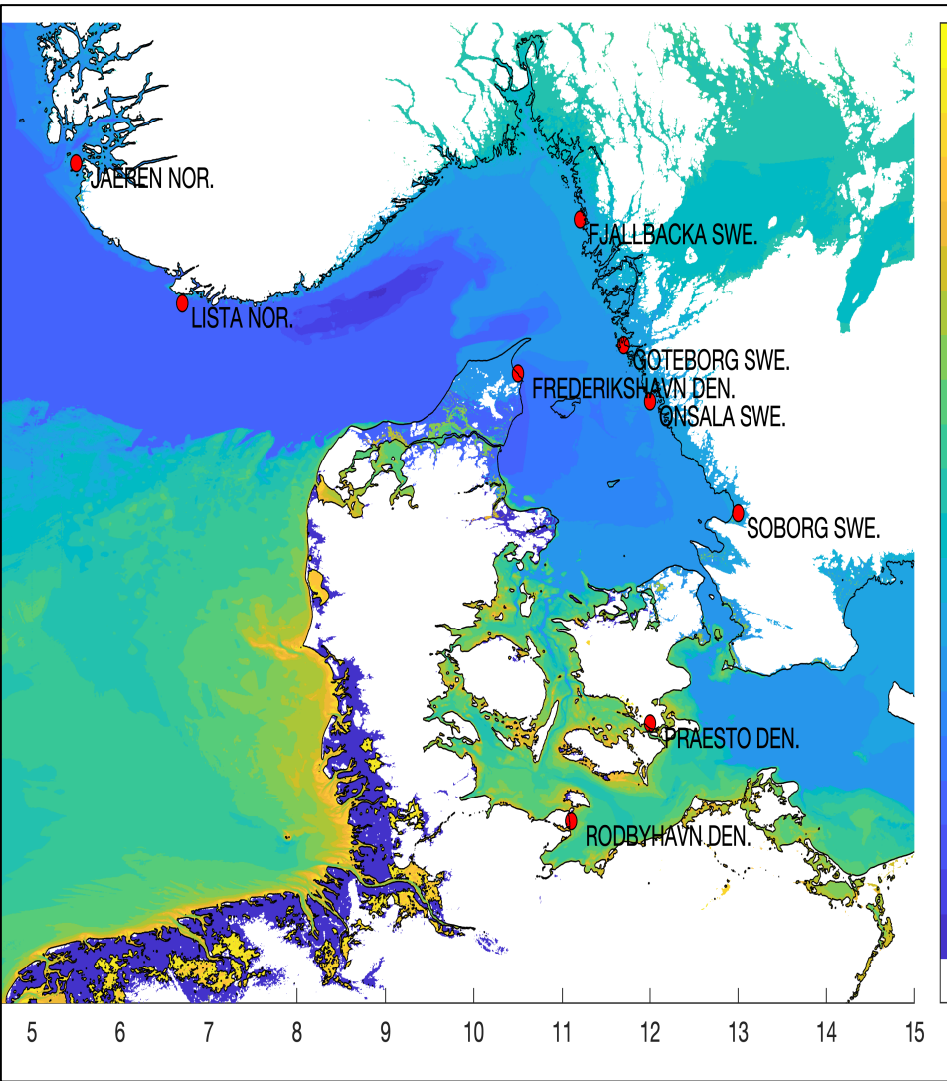
LOCAL SEA-LEVEL CHANGES VS OBSERVATIONS



LOCAL SEA-LEVEL CHANGES VS OBSERVATIONS



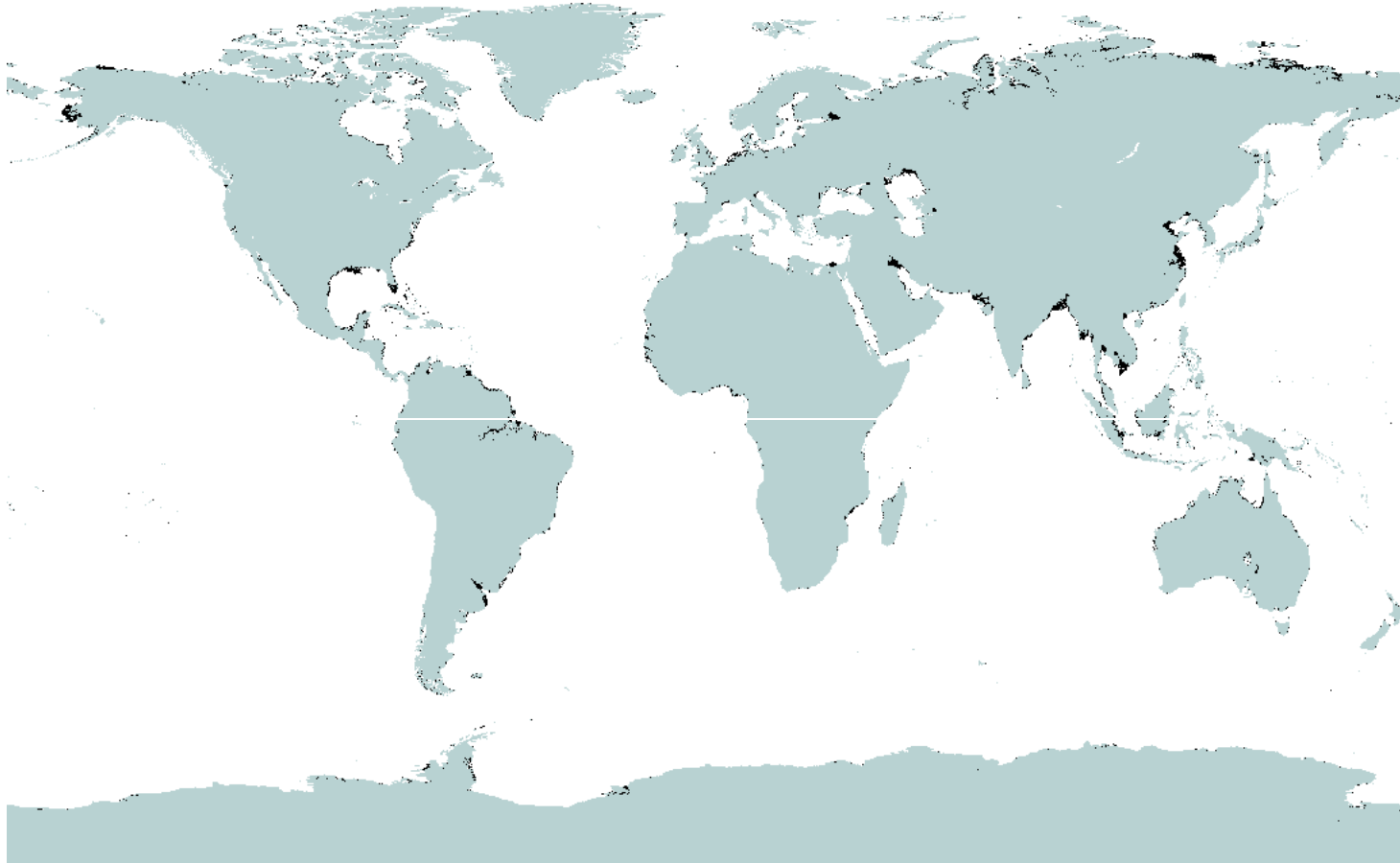
LOCAL SEA-LEVEL CHANGES VS OBSERVATIONS



PRESENT-DAY HYPSONOMETRIC MAXIMUM

BASED ON GEBCO 2021 with ice

5.5 m +/- 5 m



PRESENT-DAY HYPSONOMETRIC MAXIMUM

5.5 m +/- 50 m

BASED ON GEBCO 2021 with ice

