What would happen to sea level if Greenland’s ice sheet melted? (part 2)

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MATH 111A
Introduction to Mathematical Modeling
La Jolla, CA, 20 November 2017
The non-uniformity of sea level rise could be due to many factors:

- Change in ocean temperature will change water volume.
- The Earth’s rotation causes a bulge at the equator.
- Melting of Greenland ice sheet will allow Earth’s crust to rebound.
- Melting of Greenland ice sheet will change gravitational field.
- ... 

Which of these effects are important relative to the \( \approx 7 \text{m} \) rise in global sea level from complete melting of the Greenland ice sheet, specifically for Nuuk?
Global geology of the Earth

DIGITAL TECTONIC ACTIVITY MAP OF THE EARTH
Tectonism and Volcanism of the Last One Million Years

DTAM - 1
NASA/Goddard Space Flight Center
Greenbelt, Maryland 20771

Robinson Projection
October 2002

Actively-spreading ridges and transform faults
Total spreading rate, cm/year
Major active fault or fault zone; dashed where nature, location, or activity uncertain
Normal fault or rift; hachures on downthrown side
Reverse fault (overthrust, subduction zones); generalized; hachures on upthrown side
Volcanic centers active within the last one million years; generalized. Minor basaltic centers and seamounts omitted.

Tectonic plates

The North American Plate

area $\approx 7.6 \times 10^7 \text{ km}^2$

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Global geology of the Earth

Crust 0-100 km thick
Asthenosphere
Lithosphere (crust and uppermost solid mantle)
Mantle
Core
Inner core
Solid
Liquid
Outer core
Mantle
Crust

... from the Greek, ἀσθένης, weak.

The upper mantle, from about 80km to 200km below the surface. Temperature above 1300°C, so ductile.

Density $\approx 3g/cm^3$, i.e., about three times the density of water.
Glacial isostatic adjustment

Recall that the $2.9 \times 10^6 km^3$ of the Greenland ice sheet would melt into approximately $V = 2.61 \times 10^6 km^3$ of water.

That weight is currently displacing approximately a volume $V/3$ of asthenosphere.

Assuming the North American Plate is rigid, this corresponds to a vertical displacement of

$$d \approx \frac{2.61 \times 10^6 km^3/3}{7.6 \times 10^7 km^2} \approx 0.011 km = 11 m.$$  

(If Greenland rose independently of the rest of the North American Plate, its vertical displacement would be

$$d \approx \frac{2.61 \times 10^6 km^3/3}{2.2 \times 10^6 km^2} \approx 0.395 km = 395 m.$$ )
Glacial isostatic adjustment

But the asthenosphere flows very slowly, so glacial isostatic adjustment is a long process.
Bathurst Inlet, Nunavit Bay
Glacial isostatic adjustment

But the asthenosphere flows very slowly, so glacial isostatic adjustment is a long process.

The North American Plate is still rebounding from the Last Glacial Maximum, about 20K years ago.

Water level in the Lake Superior Basin over the last 12K years:

So while glacial isostatic adjustment might eventually lift Nuuk back above sea level, it still seems likely to flood first.