Ice sheet surface mass balance
Drivers, trends and sea level contribution

NY Times: As Greenland melts, where’s the water going?

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CESM Sea Level Session – January 10, 2018
SMB = input (snowfall)…
...minus output (meltwater runoff)
SMB and sea level
(based on regional climate modeling)

Per year:

Greenland

Precipitation (IN)

Runoff + Sublimation (OUT)

Surface mass balance (IN-OUT)

Antarctica

1 mm sea level equivalent
Introduction

How much water has melted and refrozen?
- Surface melt, refreezing, runoff

Where does this water come from?
- Water transport

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What is the impact on SL and dynamics?
Surface mass balance
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What is the ice sheet impact on climate?  
*Ice sheet – climate coupling*
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Climate models *can complement* observations in providing ice sheet wide fields and long-term time series of all these parameters.

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Blame the weather

CESM wind speed
Source: NCAR VisLab
Recipe for a delicious SMB

1. Start with a (good) atmospheric model
   Community Atmosphere Model (CAM)

- clouds
- radiation
- precipitation
- turbulence
- winds

Lenaerts et al., 2017 (GRL)
Lenaerts et al. (in prep)
Recipe for a delicious SMB

1. Start with a (good) atmospheric model
   Community Atmosphere Model (CAM)
Recipe for a delicious SMB

2. Develop and improve a snow and firn model
   Community Land Model (CLM)

Van Kampenhout et al., 2017 (JAMES)

Go see Leo’s talk tomorrow for more details!
Trends: Greenland

Half an ice cube less SMB in 16 years

When do we reach threshold?

D has increased until ~2005 but is leveling off.

Van den Broeke et al., 2016
Trends: Antarctica

Twelve ice cubes more SMB in last 110 years
Go see Jeremy Fyke’s talk tomorrow for more details

Medley and Thomas, in review
What about the climate models?

Greenland

Antarctica

Slangen et al., 2017
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IPCC AR5 ice sheet mass loss vs. GRACE

Greenland = -281 Gt yr\(^{-1}\)
Antarctica = -118 Gt yr\(^{-1}\)
Conclusions

• Ice sheet SMB is not constant in time or space (also not in the past)

• Greenland SMB decrease contributes to recent sea level rise, while Antarctic SMB increase mitigates it (a lot)

• This is a window into the future: Greenland zero SMB threshold and Antarctic SMB increase

• Models are not (yet) able to reproduce observed trends. That said, we need better (longer-term) reconstructions!