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Iceberg Meltwater Estimates

for the Southern Ocean Including Giant Icebergs

***Figure 1*: Cover image of the April 2017 issue of JGR:Oceans.** *The photo shows a large tabular iceberg in the Amundsen Sea. The caves/caverns directly above sea level are due to erosion from surface waves, one of the main processes (besides basal melting) leading to the decay of icebergs. The inset shows the windmill-like paths of modelled icebergs in the 12-yr FESOM simulation.* ▶

1. Abstract

- It is still unclear what the best way is to include **giant icebergs (length ≥ 10km)** into model estimates of the Southern Ocean freshwater cycle (Fig.1), and **typically only smaller icebergs up to ~2km** side length are modelled (e.g. Gladstone et al. 2001)
- Our novel approach to include giant icebergs into meltwater estimates is to initialize a (thermo-)dynamic iceberg model with a realistic near-coastal snapshot of satellite-observed positions and sizes for September 1997 (Wesche and Dierking 2015)
- An **I**ce**B**erg module (**IB; Rackow et al. 2017**) is integrated into FESOM, the Finite Element Sea Ice-Ocean Model developed at AWI, and run for 12 years with CORE.v2 forcing (1997—2008) (Large and Yeager 2009)

2. Results

- **Small icebergs (SMA)** and **giant** icebergs show different **melting** **… and different dynamics**

- **Zonally summed meltwater input**

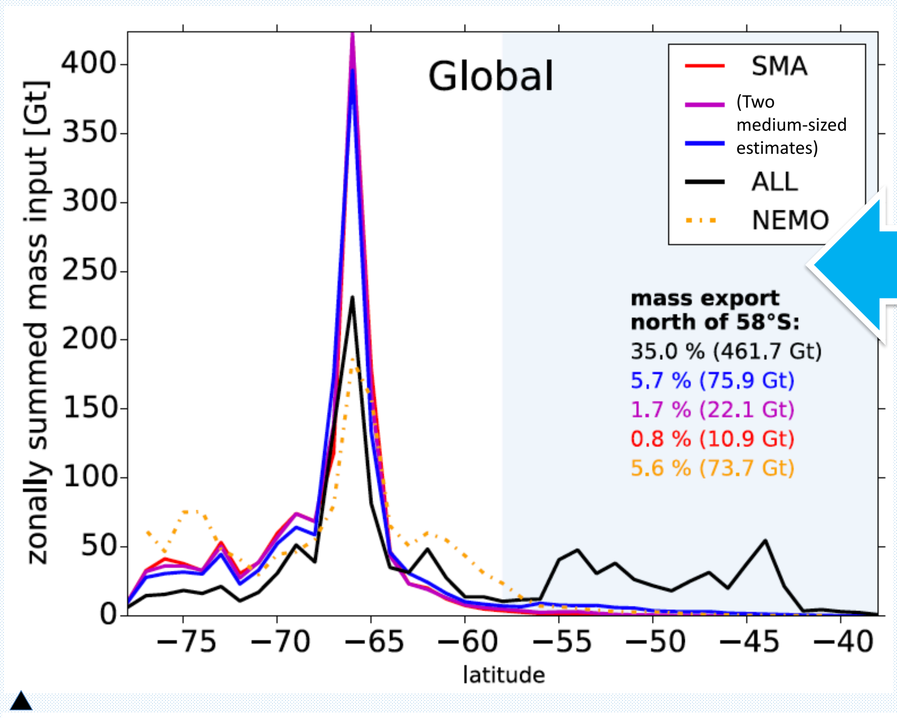

***Figure 3*: Globally, when accounting for giant icebergs, 35% of the iceberg mass is exported to the north of 58°S (*black line*). In the estimates based on smaller icebergs, this number is only 0.8% (*red line*). Close to the coast, the relation is reversed. This suggests that estimates based on only small icebergs introduce systematic meridional biases.**

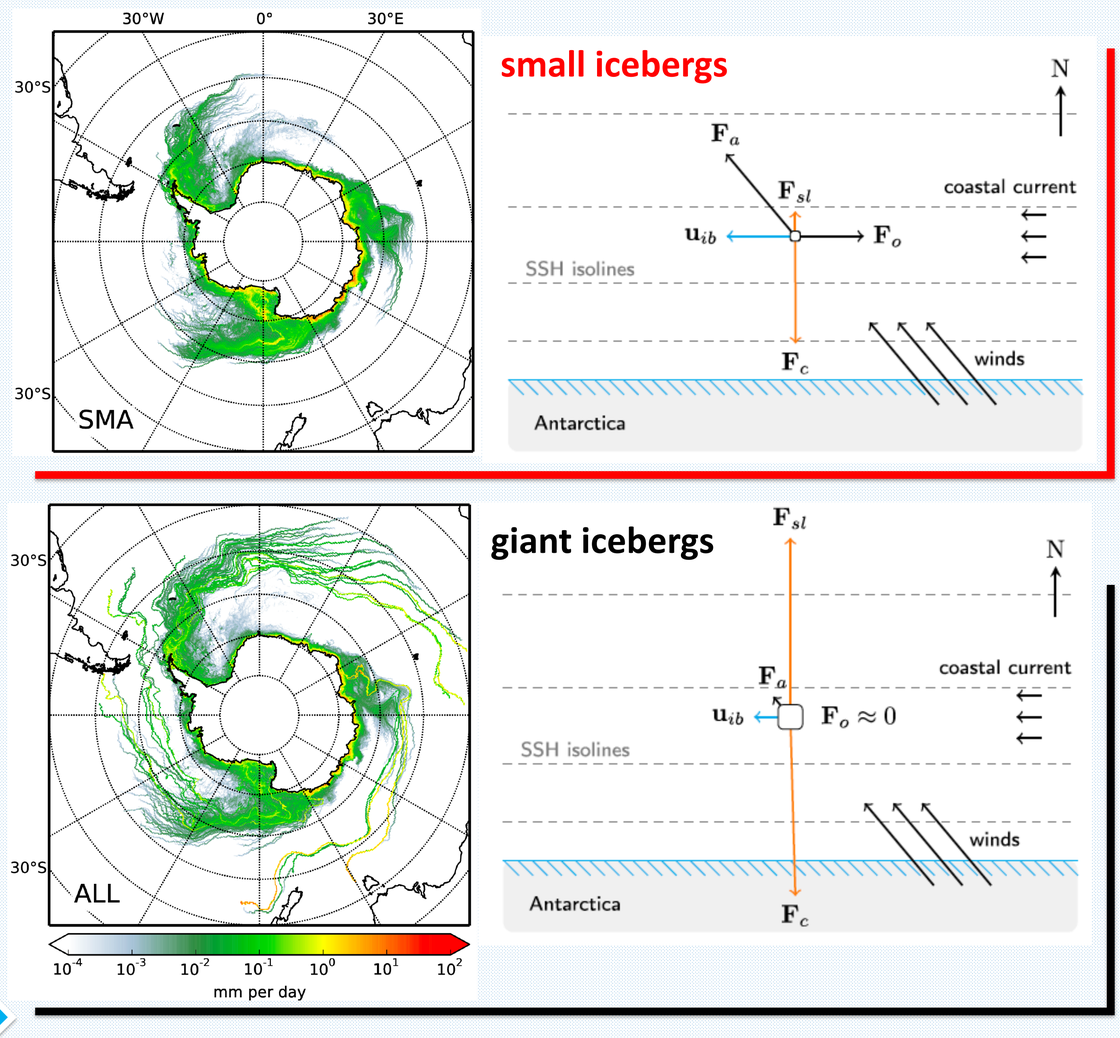

***Figure 2:** Meltwater estimates when including small icebergs (SMA) or all icebergs, including giant icebergs (ALL). **Right:** Schematic showing the typical balance between body and surface forces (**orange** and **black** arrows) for icebergs drifting in the coastal current. The balance is strongly dependent on the iceberg size, leading to different drift (and melt) patterns.*

- Meltwater estimate including **giant** icebergs (ALL)
  … compared to P-E **… compared to sea ice**

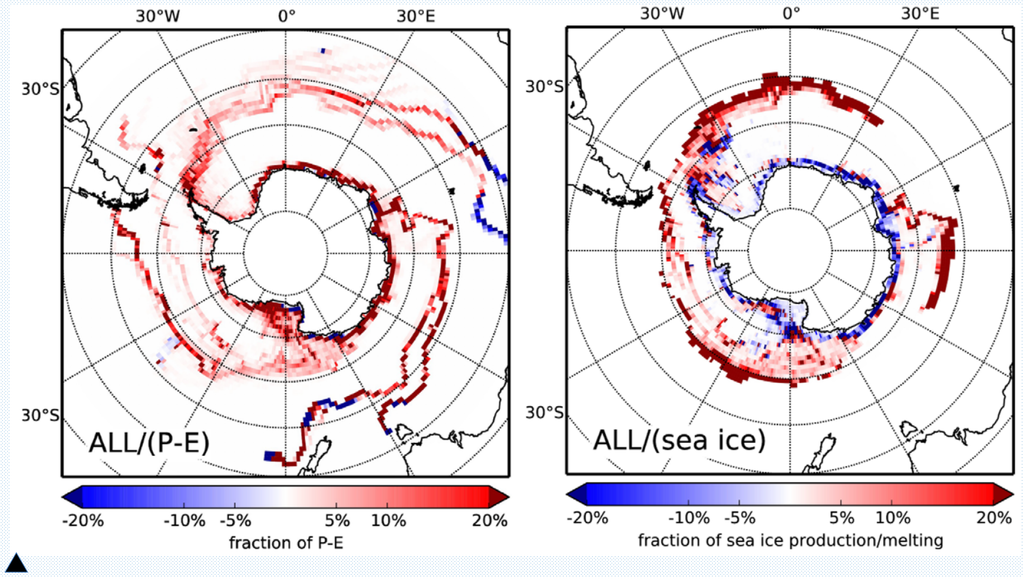

***Figure 4*: The meltwater input is generally on the order of 5–20% of the P-E balance in large areas of the Southern Ocean, especially around the coast, with local maxima even exceeding P-E. It is also on the order of 5–20% of coastal sea ice production rates and, thus, partly compensates the effect of brine rejection in the annual mean.**

3. Summary and outlook

- Iceberg model reproduces large-scale drift patterns in the Southern Ocean for all size classes from „**small**“ to „**giant**“
- Accounting for giant icebergs, a large percentage (**35%**) of the meltwater reaches latitudes **north of 58°S** (Fig. 3). Strongly reduced seasonality of the meltwater flux for giant icebergs due to increasing importance of basal melting
- Meltwater input is about **5—20%** of precipitation minus evaporation (P-E) and of coastal sea ice production rates. Iceberg melting is the largest vector of freshwater input from frozen ice along (and northward of) the sea-ice edge (Fig.4)
- **Monthly meltwater climatology estimates (small to giant icebergs) available @ *doi:10.1594/PANGAEA.865335***
- More iceberg snapshots, with different decades of atmospheric forcing, will be used to compute uncertainty estimates for the meltwater fields

References:
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