The Calving and Icebergs CPT

Olga Sergienko[1] (PI), Alon Stern[1], Alistair Adcroft[1], Robert W. Hallberg[2], David Pollard[3], Jason Amundson[4], Leigh Stearns[5], Jeremy Bassis[6]
[1]Princeton Univ., [2]NOAA-GFDL, [3]Penn. State Univ., [4]Univ. Alaska Southeast, [5]Univ. Kansas, [6]Univ. Michigan

Objectives

- Develop parameterizations of the iceberg calving process.
- Develop physically based iceberg component for large-scale ocean/climate models.
- Compile relevant data sets of the glaciological and oceanographic observations.

Context

- Calving accounts for approximately 50% of ice mass loss from Antarctica (rest is melt).
- Majority of ice flux is in form of large icebergs that drift away the calving location.
- Melting icebergs alter water masses by delivering cold freshwater to regions far from ice sheet margins.
- Few climate models include the *ice sheet→icebergs→iceberg melt→ocean* links in the hydrological cycle.
- One exception: GFDL's CM2M/G included small icebergs but with no ice sheet, no ice shelf, no calving parameterization.

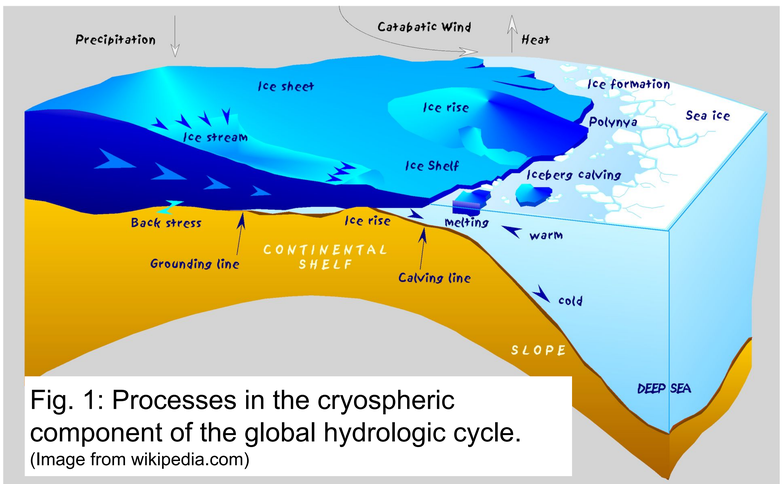

Fig. 1: Processes in the cryospheric component of the global hydrologic cycle. (Image from wikipedia.com)

Datasets

- Previous datasets used in testing global iceberg models were based primarily on ship-reported iceberg observations.
- Satellite imagery captures large icebergs.
- Compiling statistics of icebergs and glaciers will help develop and test new calving parameterizations.

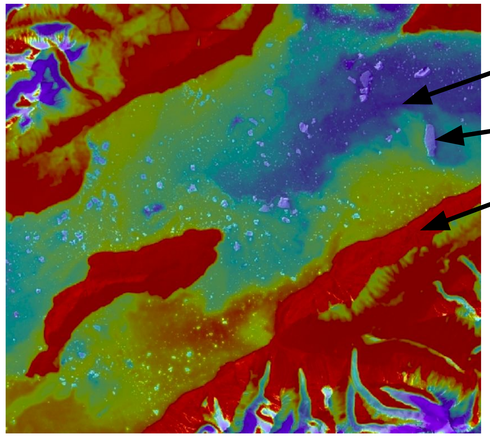

Fig 2.: False color infrared image from Polar View of fjord in Greenland. Image is appox. 100 km across

Calving parameterization

- Two calving schemes proposed using:
  - mass flux (Amundson, 2015),
  - damage evolution (Bassis & Ma, 2015).
- Evaluated in ice-shelf models (Pollard & DeConto, 2012).
- Replaces iceberg generator in climate model.

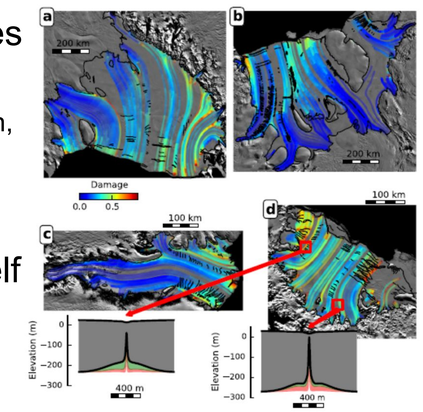

Fig. 3: Damage evolution model in ice shelves. (From Bassis & ma, 2015)

Iceberg modeling

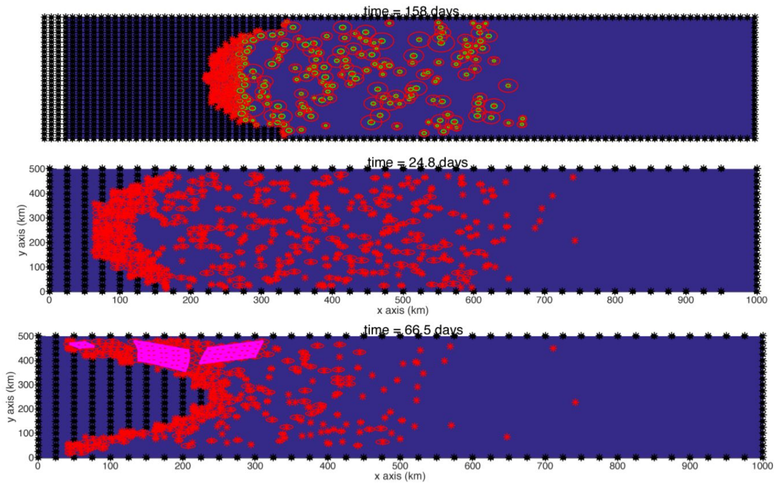

Fig. 4: Snapshot of iceberg distributions using (top) SPH method, (middle) DEM method, (bottom) DEM to represent tabular icebergs.

- Dynamic iceberg model treated icebergs as infinitesimal points (Martin & Adcroft, 2010).
- Modeling finite extent icebergs will allow:
  - icebergs to interact with each other,
  - icebergs to displace sea-ice,
  - iceberg particles to be joined via "bonds" to model tabular icebergs.
- Simulation of tabular icebergs will allow us to examine the impact of large calving events in a climate model, e.g. Larsen B breakup.

Publications / references

Amundson, J.M., in review. A mass-flux perspective of the tidewater glacier cycle. Submitted to J. Glaciol.

Bassis J.N. and Y. Ma. 2015. Evolution of basal crevasses links ice shelf stability to ocean forcing. Earth Plan. Sci. Lett., 409, 203-211.

Martin, T. and A. Adcroft, 2010: Parameterizing the fresh-water flux from land ice to ocean with interactive icebergs in a coupled climate model. Ocean Modelling 34 (3), 111-124.

Pollard, D. and DeConto, R. M., 2012: Description of a hybrid ice sheet-shelf model, and application to Antarctica, Geosci. *Model Dev.*, 5, 1273-1295, doi:10.5194/gmd-5-1273-2012, 2012.