Response of the Southern Ocean dynamics to the changes in the Antarctic glacial runoff and icebergs discharge

Yevgeny Aksenov¹ (yka@noc.ac.uk)

Sheldon Bacon¹, Paul Holland², Vladimir Ivchenko⁴, Joakim Kjelsson^{2,3}, Robert Marsh⁴, Gareth Marshall², Pierre Mathiot^{2,5}, George Nurser¹, Jeff Ridley⁵, Alex Megann¹, Craig Rye⁴ and Andrew Coward¹

¹National Oceanography Centre, Southampton, UK, ²British Antarctic Survey, Cambridge, UK, ³University of Oxford, Oxford, UK, ⁴University of Southampton, Southampton, UK, ⁵MetOffice, Exeter, UK



European Geosciences Union Congress 2016 Vienna, Austria, 18-22 Apr 2016





National Oceanography Centre natural environment research council



Outline



- Motivation: Do runoff and icebergs affect Antarctic sea ice and upper Southern Ocean?
- Model and experimental setup
- Results: Oceanic heat and sea ice changes
- Discussion: observed & projected high-resolution changes in the Southern Ocean
- Summary and Outlook



(cc

 $(\mathbf{\hat{I}})$

National Oceanography Centre Natural environment research council





Why should we care?



 Changes in the Southern Ocean: ocean warming & freshening (Böning et al., 2008); sea ice (Holland et al., 2014; Swart and Fyfe 2013); pCO₂ (Takahashi et al., 2012); Southern Annular Mode (Bindoff 2013)

- Do runoff and icebergs affect sea ice and upper ocean on intra-decadal scales? Is there a feedback to the icebergs calving?
- Future changes in the Southern Ocean and Sea Ice
- Sparse data: use models to examine influences



National Oceanography Centre NATURAL ENVIRONMENT RESEARCH COUNCIL





NEMO Model



- NEMO "Nucleus for European Modelling of the Ocean" is a EU consortium; in the UK MetOffice GO6
- Global sea ice-ocean OGCM, 1/4° (12-28 km) res.
- z*coordinates (1-m vert.); non-linear free surface
- LIM imbedded sea ice & interactive icebergs model (Marsh et al., 2015); glacial ice cavities (switched off)
- DRAKKAR Forcing Set (DFS5) (CORE & ERA winds)
- Projection with UKESM2-CMIP5 forcing 2005-2099.



National Oceanography Centre NATURAL ENVIRONMENT RESEARCH COUNCIL





Experiments



 FW partitioning: <u>Control</u> (climatological runoff cycle) vs. <u>Run1</u> partitioning between glacial melt and icebergs calving; 1958-1975 (spin-up) & 1976-2005 (analysis)

- Increased FW input: Run1 (partitioning between glacial melt and icebergs calving) vs. the same but with increased melt by factor of two (Run2)
- Projection: historical (1860-2004) and forward no bergs 2005-2099 runs, UK-ESM2 CMIP5 RCP8.5 forcing.



National Oceanography Centre natural environment research council







Icebergs Simulations



Icebergs numbers and thickness in 2005 of Run 1 (Marsh et al. 2015)



National Oceanography Centre NATURAL ENVIRONMENT RESEARCH COUNCIL





Difference in sea ice fraction



National Oceanography Centre NATURAL ENVIRONMENT RESEARCH COUNCIL

noc.ac.uk



Difference in Sea Ice Thickness



National Oceanography Centre NATURAL ENVIRONMENT RESEARCH COUNCIL

noc.ac.uk



National Oceanography Centre NATURAL ENVIRONMENT RESEARCH COUNCIL

noc.ac.uk



Thermodynamical Contribution Dynamical Contribution



National Oceanography Centre NATURAL ENVIRONMENT RESEARCH COUNCIL

noc.ac.uk



Difference in sea ice fraction



National Oceanography Centre NATURAL ENVIRONMENT RESEARCH COUNCIL

noc.ac.uk

NERC SCIENCE OF



Difference in Sea Ice Thickness



National Oceanography Centre NATURAL ENVIRONMENT RESEARCH COUNCIL

noc.ac.uk



Thermodynamical Contribution Dynamical Contribution



National Oceanography Centre NATURAL ENVIRONMENT RESEARCH COUNCIL

noc.ac.uk



Sea ice area in the 2000s and 2090s



National Oceanography Centre Natural environment research council







National Oceanography Centre NATURAL ENVIRONMENT RESEARCH COUNCIL

noc.ac.uk



Summary & Outlook



- Model experiments addressed effects on Antarctic sea ice:
 (1) FW flux partitioning; (2) enhanced FW input (icebergs)
- Icebergs have seasonal effects on sea ice: most impact in the Bellingshausen-Amundsen and Ross Seas, and near the Antarctic Peninsula
- Excess FW has most affect on sea ice fraction in spring
- Forward projections until 2099 show significant subsurface ocean warming in the Atlantic sector and in the Ross Sea

Outlook: Examine oceanic heat & related sea ice trends



National Oceanography Centre Natural environment research council





Thank you



National Oceanography Centre NATURAL ENVIRONMENT RESEARCH COUNCIL

