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Interactions of ice sheets and glaciers with the ocean

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Cover illustration The marine terminating face of Breiðamerkurjökull calving into Jökulsárlón lagoon, Iceland. Photo credit: Mark Brandon.

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PREFACE

The theme of this Annals of Glaciology is "Interaction of glaciers and ice sheets with the ocean". Ice-ocean interaction is a crucial topic in land-ice research because the mass balance of the Antarctic and Greenland ice sheets is strongly linked to the circulation in the adjacent oceans through physical processes occurring at the ice-ocean interfaces: the fronts and bases of ice shelves and glacier tongues and the termini of tidewater glaciers. Improved understanding of these processes is essential so that they can be realistically represented in models of ice sheet and glaciers evolution in a changing climate, and to improve predictions of global sea level change and ocean circulation. The goals of this theme were to: (1) assess the state of our knowledge of ice-ocean interactions; and (2) identify future scientific priorities required to enable ice-ocean interactions to be included in ice sheet models.

An IGS Symposium related to this theme was held at Scripps Institution of Oceanography in La Jolla, 10–15 July 2016, in the new Scripps Seaside Forum, an extraordinary, oceanfront conference center facility with a breathtaking view over the Pacific Ocean. The IGS Symposium was an enormous success, with 160 attendees from 14 countries.

Thirteen papers were accepted for the Annals volume. The papers cover a wide variety of optics related to ice-ocean interaction, in a range of geographical settings from Antarctica, Greenland, the Arctic and Iceland, as summarized below:

Antarctica

1. Seth Campbell and others use over 1300 km of ground penetrating radar data to map the distribution of internal brine layers and associated englacial structures of McMurdo Ice Shelf, providing valuable information on the dynamics and stability of this ice shelf.

2. Alexander Robel and others use a simple viscoelastic model to demonstrate that asymmetries in the contact stress during tidal migration of an ice stream grounding line can explain the range of fortnightly variations in ice flow observed at Rutford and Bindschadler ice streams.

3. Adam Campbell and others identify how sudden glacier flux changes into the Ross Ice Shelf might echo in long-term elevation and flow line shifts in the ice shelf.

4. Yuri Romanov and others use ship observation data between 1954 and 2014 to derive the geographical distribution and volume of Antarctic icebergs.

5. Monica Nelson and others describe measurements, obtained with an autonomous ocean glider, of the distribution and characteristics of Ice Shelf Water near the Ross Ice Shelf front, include serendipitous profiles under the ice shelf itself.

6. Craig Stevens and others present new observations of ocean hydrography around the Drygalski Ice Tongue in the western Ross Sea, and demonstrate both the ice tongue's influence on the northward-flowing coastal current and its impact on the water masses feeding the Terra Nova Bay polynya, an important site of dense water formation in the Ross Sea.

7. Michael Chester and others took a Systems Analysis approach to investigate the complex glaciological processes that occur on Amery Ice Shelf, East Antarctica, pecifically with respect to iceberg calving

Greenland/Arctic/Iceland

1. Rachel Carr and others look at satellite images for 273 marine-terminating outlet glaciers across the Atlantic Arctic during the period 1992–2010 and showed that there was a threefold increase in retreat rates.

2. Daniel Sulak and others quantify the iceberg properties and distributions in three Greenlandic fjords using satellite imagery to show that the underwater area of all icebergs exceeds the area of the glacier termini by an order of magnitude, suggesting that iceberg meltwater could be a significant fraction of total freshwater in a fjord.

3. Nick Beaird and others present hydrographic observations, including inert geochemical tracers, to provided the first quantitative description of the glacially-modified waters exported from the Jakobshavn Isbræ and Ilulissat Icefjord.

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4. Sam Pimentel and others paper revealed the impact of meltwater drainage on the sub-seasonal/seasonal dynamics of Belcher Glacier, Canadian Arctic, using observations and a hydrologically coupled ice flow model.

5. Mark Brandon and others explored an unusual lagoon setting at the front of an Icelandic glacier, and the ice-ocean interaction of the system. It appears that the lagoon is an amplified example of more typical fjord and sub-ice-shelf circulation and melting in more open ocean conditions. See front cover photograph.

In a final general paper, Hermann Engelhardt and Michael Engelhardt looked at a force that acts upon icebergs due to their floatation on an ellipsoidal earth. The force was discussed as a possible component of continental drift many decades ago, but rejected. It does appear that it would be a detectable component of large iceberg drift.

I would like to take the opportunity to thank all of the authors, reviewers and Scientific Editors for this volume of Annals of Glaciology. We all hope you enjoy reading the papers.

Helen Amanda Fricker

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