Impact of surface melt and ponding on the stability of Larsen C Ice Shelf, Antarctic Peninsula

Bernd Kulessa (1), Adrian Luckman (1), Bryn Hubbard (2), Suzanne Bevan (1), Martin O’Leary (1), David Ashmore (2), Peter Kuipers Munneke (3), Daniela Jansen (4), Adam Booth (5), Heidi Sevestre (6), Paul Holland (7), Daniel McGrath (8), Alex Brisbourne (7), and Ian Rutt (1)

(1) Glaciology Group, College of Science, Swansea University, Swansea SA2 8PP, United Kingdom (b.kulessa@swansea.ac.uk), (2) Centre for Glaciology, Department of Geography and Earth Sciences, Aberystwyth University, Aberystwyth SY23 3DB, UK, (3) Institute for Marine and Atmospheric Research, Utrecht University, The Netherlands, (4) Alfred Wegener Institute, Helmholtz-Zentrum für Polar- und Meeresforschung D-27568, Bremerhaven, Germany, (5) School of Earth and Environment, University of Leeds, Leeds LS2 9JT, United Kingdom, (6) School of Geography & Sustainable Development, University of St Andrews, KY16 9AJ, United Kingdom, (7) British Antarctic Survey, High Cross, Cambridge, CB3 0ET, United Kingdom, (8) Cooperative Institute for Research in Environmental Sciences, University of Colorado Boulder, Boulder, Colorado, USA

Several ice shelves on the Antarctic Peninsula have disintegrated rapidly in recent decades, and surface meltwater is strongly implicated as a driver. The Larsen C Ice Shelf is the largest ice shelf on the peninsula and one of the largest in Antarctica, and is subject to pronounced surface melting and meltwater ponding, especially in the northern sectors and landward inlets. As part of the MIDAS project we have investigated the structure and physical properties of the firn and ice layers in the 2014/15 and 2015/16 austral summers, using a combination of radar and seismic geophysical surveys together with hot water drilling and borehole optical televiwing and temperature measurements. We found that Larsen C’s firn column and ice temperatures are modified strongly by surface melting and ponding, including the presence of massive ice bodies in the Cabinet and Whirlwind inlets. Numerical modelling reveals that these modifications have been altering ice shelf deformation, flow and fracture significantly. The findings from our MIDAS project thus suggest that the response of Antarctic ice shelves to climatic warming is more complex than previously thought.