ANTARCTIC CLIMATE & ECOSYSTEMS
COOPERATIVE RESEARCH CENTRE

ACE CRC Intern Project for 2015/16 **Number: RP1.2_01**

Supervisors: Dr Adam Treverrow and Dr Lenneke Jong

ACE CRC Project (RP): 1.2

Project Title:

Using finite element modelling techniques to assess the distribution of stresses within samples used in laboratory ice-deformation experiments.

Background/context of project:

The greatest source of uncertainty in 21st century predictions of sea level rise is the contribution from the Antarctic and Greenland ice sheets in a changing climate. The currently poor constraints on ice sheet mass loss exist due to i) inadequate numerical descriptions within models of ice dynamic processes, e.g. deformation, fracture and sliding and ii) uncertainty in ice sheet boundary conditions, e.g. bedrock topography and processes occurring at the boundary between the land-based ice sheet and floating ice shelves

The ACE CRC conducts research to improve the numerical description of ice flow properties used in ice sheet/ice shelf models. This involves a combination of laboratory ice-deformation experiments, microstructural analyses and modelling. Data from laboratory deformation experiments are used to define flow properties of ice under various conditions of temperature and stress.

In this project finite element modelling of samples from laboratory deformation experiments will be used to optimise sample geometries and hence the experimental data available for flow relation development.

Project outline:

Data from laboratory ice-deformation experiments plays a vital role in improving the physical realism of the numerical ice flow relation used in dynamic models of the Antarctic ice sheet.

Within an ice sheet the configuration of stresses, which cause the ice to flow, vary spatially. Furthermore, the flow properties of ice are known to vary according to the stress configuration. To allow development of a flow relation applicable to the diverse range of in situ conditions, experiments are conducted over a range of physically relevant stress configurations. To this end the experimental apparatus used at the ACE CRC is capable of performing experiments in a combination of stress configurations. Previous research has demonstrated that the appropriate sample geometry necessary to minimise stress (or strain) heterogeneities within the samples varies according to the experimental stress configuration.

In this project the finite element ice sheet modelling software Elmer/Ice will be used to simulate the static and dynamic distribution of stresses within deformation samples. Elmer/Ice is based on Elmer,

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a multi-physics finite-element modelling suite. As a starting point, existing sample geometries will be simulated. Based on analyses of the resulting stress distributions the sample geometries will be refined to suit the various stress configurations appropriate to the existing apparatus. Further work will involve establishing deformation limits for the identified combinations of stress configuration and sample geometry.

Key deliverables:

1. Provide an assessment of the stress distributions applicable to samples geometries used in previous and current ice-deformation experiments.

2. Develop guidelines specifying the sample geometries suited to specific stress configurations.

3. Develop accumulated strain limits for each identified sample geometry.

4. Provide (if necessary) recommendations for alterations to sample geometries and/or the deformation apparatus.

Any specific skills required:

1. Experience in finite-element modelling, including stress analyses.

2. Competence in technical computing and programming (e.g. unix/linux, Fortran)

3. A basic understanding of material properties, including rheological properties.

4. An interest in ice sheet modelling and laboratory-scale deformation experiments on ice.

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