SMEAIS

Seismic Monitoring of the East-Antarctic Ice Sheet

DURATION
1/10/2013 - 31/12/2015

BUDGET
149.600 €

PROJECT DESCRIPTION

The current threat of global warming has raised particular attention on the study of the stability of polar ice sheets due to their potential large impact on sea level rise (IPCC 2007). The present combined contribution of the melting of polar ice sheets represents only a small part of the total current sea level rise (Lemke et al., 2007). However, the dynamics of the Antarctic Ice Sheet (AIS) in response to global warming remains a large unknown in projecting future sea level rise (IPCC 2007) though it represents 80% of the fresh water on Earth. The AIS is gaining mass from snowfall accumulation on the inland plateau and loses mass predominantly by iceberg calving and for a small part by surface and basal melt of ice floating over the ocean (Jacobs et al. 1992). The ice flows from the inland plateau via narrow fast-moving ice streams and terminates into floating ice-shelves which act as ice flow buttresses. These floating ice-shelves and ice streams are the most vulnerable pieces of the ice sheet system as they are in permanent contact with a warming ocean. Ice-shelf instabilities and ice stream accelerations have already been observed in the Antarctic Peninsula and on the West Antarctic Ice Sheet affecting the overall ice mass balance (Scambos et al. 2004). In contrast, the East Antarctic Ice Sheet (EAIS) appears still fairly stable in regard of its ice mass balance (Shepherd et al. 2012). However with 90% of the whole AIS ice volume, the EAIS is regarded as potentially the main contributor to sea level rise in the future and possible changes of its ice mass balance yield intense debate.

General Objectives and underlying research questions

The objective of the project is to understand the mechanisms involved in the ice stream flow of the poorly constrained EAIS via the analysis of ice flow-induced seismicity in order to shed new light on its stability. Seismicity has already been shown to be a good indicator of ice sheet stability (Ekström et al. 2003, 2006, Tsai and Ekström 2007). We will investigate whether and to which degree seismic events affects the EAIS ice flow along its way from the inland plateau to the austral ocean and whether inter-connections of timing and localization of seismicity exist between the grounded ice, the grounding line transition zone and the floating ice-shelf providing highly relevant information for defining ice stream rheology and basal conditions.

Methodology

To achieve these goals, we propose to acquire seismic and displacement measurements via the deployment of a seismic-geodetic array on the Sør Rondane ice stream which has been recognized as one of the major ice streams of East-Antarctica in regard to its large dimension (500 km long, 100 km wide, 2000m of ice thickness; Rignot et al. 2011, Fretwell et al. 2012). However with a moderate flow speed (up to 300-400 m/y at the coast), it appears rather as a moderate speed ice stream and as such could indicate what is happening at other surrounding ice streams. The seismic-geodetic array will be deployed along this ice stream with a dense coverage at the grounding line. Covering the whole ice-stream was foreseen prior to the start of the project but is unfortunately hampered by various technical, logistical and timing issues. Nevertheless, the deployment will be focused on the main interesting part of the ice-stream: the grounding line area. 15 coupled seismometer-GPS instruments will run continuously and autonomously over the 3 months of the austral summer (November to February) and will be able to detect and localize local movements and seismicity. The combination of both types of measurements will provide a better understanding on how the mechanism of the ice flow-induced stresses is accommodated between brittle (fracture) and ductile (strain) regimes key observations to understand the internal ice deformation and thus the ice stream dynamics.

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Nature of interdisciplinarity

To achieve the goals presented in this project and beyond the fact the project gathers various scientific fields (seismology, geodesy and glaciology), we will closely collaborate with IGN-LOEMI in France. The lab has a strong expertise in electronics development with application in photogrammetry, optic, LIDAR or GPS positioning. We will merge the expertise of IGN-LOEMI with the expertise of ROB in seismology and experience in Antarctica building a stimulating collaboration. This collaboration is also original because IGN is a public institute dedicated to the production and diffusion of geographical information for daily use while ROB is recognized for observational and more fundamental research.

Potential impact on science, society and/or on decision-making

In rapidly changing polar regions, this study will stand as a reference study of the currently stable EAIS prior to its possible future destabilization. This will shed new light on the possible unique features of the EAIS and its drainage ice-streams explaining their relativity insensitivity to recent global warming till today and whether this is changing or not, which is of considerable societal importance.

Description of finished products of research

Eventually, this study would help the scientific community to understand evolution of the EAIS and would be used for predictive models of sea level rise. The results will be published in scientific journals and will be presented at international conferences.

CONTACT INFORMATION

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LINKS

http://homepage.oma.be/lombardi/research_SMEAIS.html