ÉCOLE DOCTORALE
SCIENCES DE LA TERRE ET DE L'ENVIRONNEMENT
ET PHYSIQUE DE L'UNIVERS, PARIS

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Subject title:

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Host lab/ Team : **IPGP- Team Géodésie – UMR7154**

Financing: Doctoral contract with or without teaching assignment

Presentation of the subject: (Maximum 2 pages)

Influence of Glacial Isostatic Adjustment Modeling on the Estimation of Current Ice Mass Balances

During the last ice age, ice covered regions beyond the present polar ice sheets, including Canada and Scandinavia, where it could reach thicknesses of several thousand meters during the last glacial maximum, about 25000 years ago. Since then, the ice has retreated, causing the ground to unload and creating ongoing visco-elasto-gravitational deformations of the solid Earth known as postglacial readjustment or Glacial Isostatic Adjustment (GIA). The GIA can be observed in various ways, including ground motions that can be detected by GNSS (in particular by GPS), variations in the Earth's gravity field visible by space and terrestrial gravimetry, and changes in sea level. Understanding the Earth's response to GIA is crucial for understanding the long-term evolution of climate and the internal rheological structure of the planet. Accurate knowledge of GIA is also essential for estimating the current mass balance of the polar ice sheets and predicting variations in sea level due to climate change. Improving our understanding of GIA could also enhance our comprehension of non-linear motions of space geodetic stations utilized to create the International Terrestrial Reference Frame (ITRF) managed by the IPGP-IGN geodesy team. Therefore, developing a realistic GIA model is currently one of the significant challenges in Earth sciences.

Numerous mathematical and numerical models for GIA have been proposed in recent decades, yet reference models remain highly uncertain. These models typically rely on simple rheological models (of the Maxwell type). However, we have demonstrated that incorporating transient relaxations within the Earth is essential for GIA modelling, as it significantly alters the amount of ice involved during the ice age. This thesis aims to create a new GIA model that explains past sea level data, current geodetic, gravity, and geomaterial data, while considering the complex rheological structure of the Earth. Special attention will be given to GNSS measurements of horizontal ground motions, which are more sensitive to the viscous component of viscoelastic deformations, and can help distinguish deformations caused by present and past melting, particularly in Greenland and Antarctica. We will also focus on the impact of the Little Ice Age (LIA), whose significance is likely underestimated in current observations. Finally, this study will assess the potential impact of a change in the GIA model on current ice mass balances and sea level variations caused by climate change, as well as its implications for evaluating and predicting the future evolution of the ITRF.

This project will involve data processing and numerical modelling, including building an inverse problem from pre-existing codes. Basic programming skills are recommended.