AUFRANDE

Université Grenoble Alpes

UNIVERSITY of TASMANIA

Position Description

1. General Information

Name of the position	**The Mid-Pleistocene Climatic Transition**
Foreseen date of enrolment	1 October 2023
Position is funded by	• COFUND, Marie Skłodowska-Curie Actions (MSCA), Horizon Europe, European Union • Université Grenoble Alpes (UGA) • University of Tasmania (UTAS)
Research Host	Université Grenoble Alpes
PhD awarding institutions	Université Grenoble Alpes & University of Tasmania
Locations	Primary: Grenoble, France Secondary: Hobart, Australia
Supervisors	Frédéric Parrenin (UGA, IGE) and Lenneke Jong (UTAS, AAPP & AAD)
Group of discipline	Earth and Environment Sciences

2. Research topics (only one of these projects will be funded)

Project 1: *3D pseudo-steady age modelling in the Dome C region, Antarctica*

Understanding how ice flows in East Antarctica is of uppermost importance to determine the distribution of age with depth for deep ice cores, to determine potential future drilling sites or improve the ice-dynamic context of a chosen site to support the correct interpretation of ice-core climate proxies. One of the most important applications is to produce the depth vs age relationship, hence the first age model, for the Oldest Ice projects, such as the European Beyond EPICA (BE) project and the Australian Million Year Ice Core project (MYIC). Hence, this study will concentrate on the wider Dome C area. However, the methodological results of this project can also be applied to other deep drilling targets, as proposed under the IPICS umbrella (http://pastglobalchanges.org/science/end-aff/ipics/intro).

The approach of this PhD project will be twofold. First, the candidate will develop a 3D numerical model to simulate the age in an ice sheet on a regional scale, using a novel numerical approach. The model will be a so-called pseudo-steady model, where the geometry of the ice sheet and the velocity profiles are steady. Only a temporal factor can be applied to the surface accumulation rate. Then, the candidate will use existing isochronal horizons traced and dated by linking them to the EPICA DC ice core to constrain the 3D numerical model, involving innovative inverse approaches. We will invert for the thickness of a possible layer of stagnant ice, which has been suggested by preliminary studies

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(Lilien et al., 2021). For a faster inversion of the 3D model, it might be necessary to implement an analytical Jacobian of the forward model.

The outcomes of this PhD project will be: 1) A more reliable model of the age of ice in an ice sheet; 2) an improved estimate of the age and age resolution of basal ice in the Dome C region; 3) an improved mapping of the stagnant layer and basal melting rate at the base of the ice sheet; 4) an improved mapping of the surface accumulation rate in the Dome C region; 5) an improved mapping of the velocity profiles in the ice sheet.

Supervisors:

Dr Frédéric PARRENIN (UGA), Dr Lenneke JONG (UTAS AAPP and AAD), Dr Yan ROPERT-COUDERT (IPEV)

Research Fields: Glaciology

Project 2: *Modelling the past movements of the dome at Dome C, Antarctica*

Understanding how ice flows in East Antarctica is of uppermost importance to determine the distribution of age with depth for deep ice cores, to determine potential future drilling sites or improve the ice-dynamic context of a chosen site to support the correct interpretation of ice-core climate proxies. One of the most important application is to produce the depth vs age relationship, hence the first age model, for the Oldest Ice projects, such as the European Beyond EPICA (BE) project and the Australian Million Year Ice Core project (MYIC). Hence, this study will concentrate on the wider Dome C area. However, the methodological results of this project can also be applied to other deep drilling targets, as proposed under the IPICS umbrella (http://pastglobalchanges.org/science/end-aff/ipics/intro).

Dome positions and flow lines may have been affected by the evolution of the Antarctic ice sheet over glacial interglacial cycles. Here we will use the GRISLI ice sheet model) to study possible dome migrations in the past and their impact on ice flow lines and ice sheet stratigraphy. GRISLI is a 3D thermomechanical ice sheet model which allows for long (i.e. several glacial-interglacial cycles) transient ice sheet simulations in response to atmospheric, oceanic and sea level forcings. First, we will make use of the existing ensemble of simulations of the last 400 kyr from Quiquet et al. (2018) to assess the occurrence of dome migrations in the past. This ensemble of simulations covers the uncertainty in terms of mechanical parameters in the model for a given climate and sea level forcing. Second, as a complement to these simulations, we will explore the sensitivity of dome positions to past climate uncertainties. While Quiquet et al. (2018) used homogeneous atmospheric and oceanic perturbations in the past, we will test here spatially heterogeneous climatic perturbations. All new simulations will make use of the passive tracer transport model of Clarke and Marshall (2002) embedded in GRISLI (Lhomme et al., 2005) which will provide the modeled ice sheet stratigraphy (age-depth relationship). The coarse spatial resolution of the model (40 km) will not allow us to perform direct data-model comparisons but in turn we will be able to quantify the effect of regional ice sheet geometry changes (e.g. elevation changes and grounding line migration) on ice sheet stratigraphy and ice flow in the vicinity of the domes.

The outcomes of this project will be: 1) an improved reconstruction of the past movements of Dome C and the flow lines in this region; 2) an improved understanding of the relationship between ice sheets boundary conditions and domes movements.

Supervisors:

Dr Frédéric PARRENIN (UGA), Dr Lenneke JONG (UTAS AAPP and AAD), Dr Yan ROPERT-COUDERT (IPEV)

Research Fields: Glaciology

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Project 3: *Conceptual models of global climate for the Mid-Pleistocene transition*
In the context of the current continuing greenhouse gas emissions in the atmosphere, it is essential to turn to the past to understand how the climate system behaves. A particularly interesting problem is the shift in Earth's climate response to orbital forcing during the 'Mid-Pleistocene Transition' (MPT), around 1 Myr ago, when the dominant glacial/interglacial cyclicity changed from 40 kyr to 100 kyr. Several hypotheses have been formulated to explain this MPT, and one in particular relates to the long-term cycle of CO_2 in the atmosphere. In this PhD project, we will use so-called conceptual models to explain and understand the global climate evolution during the last 2 million years. These models do not have spatial representations derived from the fundamental laws of physics, but only contain a few variables which are supposed to represent the most important mathematical features of the global climate. Several formulations will be tested and the resulting models will be tuned onto observations, such as the global ice volume or atmospheric CO_2 concentrations derived from paleoclimatic archives. The outcomes of this project will be: 1) a better understanding of the main mathematical features of the global climate evolution; 2) a better understanding of the causes of the MPT; 3) a better understanding of the mechanisms responsible for the glacial-interglacial cycles, and in particular the role of atmospheric CO_2 variations; 4) a synthetical curve of CO2 variations before the 800,000 years ice core era.
Supervisors: Dr Frédéric PARRENIN (UGA), Dr Lenneke JONG (UTAS AAPP and AAD), Dr Yan ROPERT-COUDERT (IPEV)
Research Fields: Paleoclimatology

3. Employment Benefits and Conditions

The Université Grenoble Alpes offers a 36-months full-time work contract (with the option to extend up to a maximum of 42 months). There is a probation period of 2 months and the total working hours per week is 36h40.

The remuneration, in line with the European Commission rules for Marie Skłodowska-Curie grant holders, will consist of a gross annual salary of 27,907 EUR. Of this amount, the estimated net salary to be perceived by the Researcher is 1,870 EUR per month. However, the definite amount to be received by the Researcher is subject to national tax legislation.

Benefits include

- Access to all the necessary facilities and laboratories at Université Grenoble Alpes and University of Tasmania, including GRICAD computational facilities.
- Tuition fees exemption at both PhD awarding institutions.
- Yearly travel allowance to cover flights and accommodation for participating in AUFRANDE events.
- 10,000 EUR allowance to cover flights and living expenses for up to 12 months in Australia.
- 45 days paid holiday leave.
- Sick leave.
- Parental leave.

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4. PhD enrolment

Successful candidates for this position will be enrolled by the following institutions and must comply with their specific entry requirements, in addition to AUFRANDE's conditions.

Université Grenoble Alpes

To enrol in a Doctorate program you must meet the general conditions, namely:

- to hold a French diploma conferring the degree of master at the end of a training programme establishing the aptitude for research;
- to hold a foreign diploma of equivalent level (obtained at the end of a training programme establishing the aptitude for research). In this case, you should request an exemption from the Master's degree when you apply;
- benefit from the validation of prior learning as provided for by the Education Code.

More information: https://doctorat.univ-grenoble-alpes.fr/preparing-a-phd/doctorate-enrolment/apply-and-register-in-doctoral-school-890537.kjsp?RH=1611137559271

University of Tasmania

The minimum course entry requirements for a Doctoral Degree are:

i. Completion of a previous qualification in a relevant discipline that includes a substantive thesis, where the research component of that degree comprises:
   - 50% of a Bachelor Honours (equivalent to AQF Level 8) with an overall grade of at least Second Class Upper (Class IIA) standard, or
   - 25% of a two-year Masters Coursework degree (equivalent to AQF Level 9) with a thesis component grade of at least Distinction grade, or
   - Masters Research degree (equivalent to AQF Level 9) of at least Distinction grade.

OR

ii. A record of research or professional qualifications deemed by the Dean, to be of a standard equivalent to at least Bachelors Honours degree Second Class Upper (Class IIA) and providing a suitable background for the Doctoral research the candidate is proposing to undertake.

In addition, an applicant must provide evidence of their English language proficiency in accordance with the University of Tasmania's requirements at the time they submit their application. Note that results of an English language proficiency test must have been awarded within 2 years of application date.

Furthermore, international applicants must satisfy the Australian Department of Home Affairs English language proficiency criteria to obtain a student visa to study in Australia. This requirement is in addition to the applicant meeting the University's English language proficiency requirements.

More information: https://www.utas.edu.au/policy/procedures

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