B1.1.4 Key objectives

The key objectives of the Past4Future program can be succinctly summarized by the following questions / mission statements:

What are the dynamics of the climate over interglacial periods?

Climate variability at global scale during interglacials is small compared to the changes during glacial periods; nonetheless it has caused significant changes in components of the Earth system and at regional scale. Futhermore the difference between the warmest pasts of the last interglacial and the typical climate of the present interglacial is comparable to the change expected in the next century. These dynamics are a response to changing external forcing factors such as: orbital forcing, changing solar irradiance, and volcanic eruptions, and to the reaction of internal factors such as large-scale ocean circulation and shifts of the Inter Tropical Convergence Zone (ITCZ). New paleodata in unprecedented resolution will allow studying also of the interannual variability of climate change representing essential ground-truthing of climate models.

What causes climate changes and abrupt changes over the course of interglacial periods?

Reconstructions of past climates demonstrate clearly the ability for the climate system to jump abruptly—at a rate fast enough to impact ecosystems and societies. We know that these abrupt changes, regime shifts, and large scale ecosystem transitions have occurred during both our current interglacial and the previous one—a period with many climate features similar to those projected for our future. Yet, the underlying causes of these changes, their thresholds for activation, the rate at which they occur, and even the full extent of the areas they impact are still poorly understood. To improve our understanding of the likelihood and possible impacts of such climate changes and transitions in our future, there is therefore an urgent need to critically assess their past occurrences and underlying mechanisms using a combined data-model approach.

Can we understand the greenhouse gas records of the interglacial periods?

On the long timescale greenhouse gases mirror climate changes with lower concentrations in cold periods and higher concentrations in warmer periods before the anthropogenic period started. Some differences between climate changes and greenhouse gas concentrations have been puzzling; Why do the greenhouse gases overshoot at the onsets of interglacial periods and why do the gas records dip at around 5 ka BP in the present interglacial? Understanding the dynamics of biogeochemical cycles in the past is crucial for predicting the future.

What can the past tell us about risks for climate changes/threats in the future?

The 4th Assessment Report of the IPCC made estimates of climate change and its impacts, with a particular focus on those expected in the next century. For some of the most societally-important areas of prediction, the uncertainty is very large, either because of non-linear behaviour, or because understanding of some processes remains limited. The study of warmer periods in the past, in which we have increasingly detailed datasets, offers the possibility to test and limit the range of such predictions. Indeed, looking back at the past is the only way to observe processes, such as ice sheet dynamics, that have timescales far longer than the observational record. The last interglacial (LIG) has particular value in this regard, because the temperature in certain key regions (notably the Arctic

and Antarctic) was at levels expected towards the end of the 21st century, for some millennia in each case. The LIG can therefore be used as a test-case of the effects of such a warm climate, and to test whether events currently considered to have low probability actually occurred.

B1.1.5 Relation to specialists and international partners

Including paleorecords from available sources such as ice cores, marine cores, corals, pollen and spelotherms with the widest geographical coverage opens the opportunity and challenge to integrate and model the interglacial climate changes. To master this very big task the Past4Future team will include paleodata specialists and model experts. Science and Technology partners have been included from Canada and China. Several of the European and international partners have access to precious data archives that the project will benefit from. Table 2.3.1 lists the network of partners that will contribute to the Past4Future program. Beneficiary (19), as the international coordinating project for palaeclimate, will ensure access to expertise and datsets around the world. Several of he Past4Future researchers are closely involved in the main paleoclimate modeling project at global scale (PMIP), and will therefore bring the context of non-European comparative studies. Collaborators from the networks will be invited to join the annual workshops so the specialists and larger amount of paleorecords will be integrated in the program.
The expertise of the international S&T partners:

- The GEOTOP research group from Université de Québec, Canada will contribute to the programme mostly with data from the Canadian margins, the Arctic Ocean and sub-Arctic basins, i.e., from areas particularly sensitive to warming during interglacials (Canadian Polar Climate Stability Network). The expertise of the group in paleoclimatology and paleoceanography of the late Pleistocene and Holocene is based on the combined use of several proxies for dating and the reconstruction of ocean and climate parameters such as sea-ice cover, sea-surface temperature and salinity, and water mass stratification.
- The East China Normal University contribution concerns paleoclimate and paleoenvironments of the last 150,000 years. The involved research group is expert in the use of diatoms for paleoclimate (sea-surface temperature, paleoproductivity and sea ice) reconstructionespecially fromthe shallow shelf seas around northern Europe, the North Icelandic Shelf, West Greenland, the South China Sea and the East China Sea.
- The University of Ottawa, Canada has expertise in modelling the response of sea level, the solid Earth and gravity field to changes in ice sheets and glaciers. This technique will play a central role in achieving the goals in Work Package 4.