Preface

The climate has a significant impact on life on Earth as well as on human activities. Temperature and precipitation strongly constrain the type of vegetation that could grow in a particular region. The design and location of houses depend on summer and winter temperatures but also on the probability of flooding. One single late frost or a heavy hail storm could ruin an entire crop. Since the beginning of humanity, people had thus to cope with climate and, if possible, to adapt to it. As a consequence, the various human civilisations have observed and have tried to understand the climate variations. They first provide mythological or religious explanations, often relying on weather lore to obtain forecast. In parallel, climate has evolved as a science, elaborating more and more sophisticated representations of the observed phenomena. Such a description of climate involves now a very broad range of expertise, corresponding to different domains of the sciences including physics, chemistry, biology and geology.

A comprehensive analysis of all the components of the climate system (atmosphere, ocean, ice sheets, etc) and of all the interactions between them is out of the scope of any course or book. We have thus chosen here to provide only a brief overview of the processes that rule the behaviour of those different components. More detailed descriptions are provided in meteorology, oceanography and glaciology courses, for instance. Our first goal here is rather to provide enough information on the interactions between the different elements of the climate system and on the dominant feedbacks to allow the student to analyse the variability of the climate and its response to a perturbation. By this mean, the reader should be able to understand the dominant causes of past climate changes and to critically evaluate the projections of the climate change over the next centuries or millennia.

Because of the complexity of the climate system, many analyses devoted to a quantitative estimate of climate change or climate variability rely on the use of comprehensive three-dimensional numerical models. However, simple models are also widely used to underline clearly the fundamental properties of the climate. Our second goal is thus to give the student the bases to understand how climate model are built and how they could be used to make quantitative estimate of climate variability and climate change as well as to illustrate how models could be used to understand the most important concepts of climate science.

At the origin, this textbook was designed as a support to a course proposed to students in their first year of Master at the Université catholique de Louvain. However, the majority of the sections could already be followed by undergraduate students. Quizzes including questions that provide an overview of the matter covered in the different chapters are available online. If you are able to answer all of them, this likely shows that you have not missed the most important elements of the discussion. As the textbook is devoted to an audience presenting different backgrounds, some fundamental terms or concepts, highlighted using **bold** characters, are explicated in the glossary. If you do not understand some terms or notion, do not hesitate to contact us so that we could append the glossary.

In addition to the material freely proposed online, the UCL students registered for the course PHY2153 “Introduction à l’étude du système climatique et à sa modélisation” will also receive some practical information on the course, including a precise list of the chapters or sections of the online textbook that will be studied during the academic year. Registered students are also encouraged to answer the quizzes on the virtual campus of UCL rather than on the textbook web site.