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Ice Sheet Modelling and Applications to Greenland, Antarctica and the Martian Polar Ice Caps

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Abstract

Ice sheets, ice shelves, ice caps and glaciers are active, dynamic components of the climate system of the Earth, and they deserve the same scientific attention as the atmosphere and the oceans. Since the late 1970s, numerical modelling has become established as an important technique for the understanding of ice dynamics. Ice sheet models are particularly relevant for predicting their possible response to climate change and consequent sea level rise, and thus a number of such models have been developed over the years. Recent observations actually suggest that ice dynamics could play a crucial role in predicting future sea level rise under global warming conditions. Despite this great relevance, ice sheet modelling is still underrepresented within the international climatology communities, compared to the large efforts made into atmosphere and ocean research. In this contribution, I will review the state of the art and current problems of ice sheet modelling. An outline of the underlying fluid-dynamical theory will be given, and crucial processes (basal sliding, calving, interaction with the solid Earth) will be discussed. Further, I will present selected applications to problems of past, present and future glaciation of Greenland, Antarctica, and also the polar ice caps of the planet Mars.