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ARPEGE-Climat behavior on a stable boundary layer at Dome C and statistical analysis of its sensitivities to the turbulence parameterization internal parameters.

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The Antarctic continent is a key component of the climate system. In particular, its influence on the atmospheric circulation of the southern hemisphere and the formation of Antarctic bottom water is well known. However, current climate and weather forecast models still struggle to capture properly the Antarctic atmosphere climate, in particular its strongly-stable boundary layers. In that later regard, the turbulence parameterization is central. The purpose of this study is to document the ability of the current climate model of Météo France, ARPEGE-Climat, to represent stable boundary layers and to assess the extent to which the related errors result from an intrinsic limit of the model, i.e. independent of the tuning of the internal parameters of ARPEGE-Climat parameterizations. The methodology used consists of a systematic comparison of single-column model simulations with ARPEGE-Climat with some high-resolution large-eddy simulations, which largely resolve turbulent scales. This approach follows mainly the framework develop within the GABLS4 project. An initial step permitted to identify the most relevant parameters in the turbulence scheme. Then statistical emulators are built to predict different metrics characterizing the night-time cooling and the nocturnal low-level jet, and used to more systematically explore the model sensitivity to these parameters. Some structural limitations of the model are highlighted. The need for a proper vertical resolution to correctly represent the GABLS4 stable boundary layer is also discussed. Besides, this study is an opportunity to assess the relevance of statistical tuning approaches and to develop a methodology adapted to the problems encountered in atmospheric modeling.