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Evaluation in a weather-forecast mode of convective parameterization developments aiming at improving the quality of climate simulations at high-resolution

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Using climate models at increasingly fine resolutions raises the issue of the sensitivity of physical parameterizations to horizontal resolution. The question is particularly critical for convective parameterizations, whose behaviour at high resolution can be problematic. In this study, we assess the behaviour of the IPSL climate model simulations over a large range of horizontal resolutions, and test some developments of the convective parameterization aiming at improving the performance of the model at high resolutions. For this purpose, we evaluate the IPSL climate model in a weather-forecast mode (an approach referred to as "Transpose-AMIP"). First we show that some errors seen in long-term climate simulations arise and develop very quickly after the start of the integration (a few days), suggesting that these errors are related to the representation of fast physical processes. This confirms the value of the Transpose-AMIP approach to evaluate physical parameterizations. By comparing the short-term forecasts errors with model errors found in Single-Column Model simulations forced by observed large-scale forcings (e.g. from the TOGA-COARE campaign), we discuss the relative merits of Transpose-AMIP and of the more traditional "test cases" approach to evaluate physical parameterizations. Then, we use the Transpose-AMIP approach to assess the behaviour of physical parameterizations over a wide range of horizontal model resolutions. We note that at high resolution, the large-scale condensation scheme tends to supplant the convective parameterization, leading to so-called "grid-point storms". To avoid this behaviour, some parameterization developments are tested aiming at making the convection scheme dependent on the horizontal resolution of the model. This is done using a physical approach taking advantage of the role played in the convective closure by the lifting generated at the gust fronts of convective cold pools: the smaller the grid cells relative to the cold pools, the stronger the concentration of the lifting in grid cells containing gust fronts. Taking into account this concentration factor yields a convective closure depending on the grid-cell size.