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Semi-automatic tuning procedure for a GCM targeting continental surfaces: a first experiment using in situ observations

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The tuning or calibration of General Circulation Models (GCMs) is an essential stage for their proper behavior. The need to have the best climate projections in the regions where we live drives the need to tune the models in particular towards the land surface, bearing in mind that the interactions between the atmosphere and the land surface remain a key source of uncertainty in regional-scale climate projections [1].

For a long time, this tuning has been done by hand, based on scientific expertise and has not been sufficiently documented [2]. Recent tuning tools offer the possibility to accelerate climate model development, providing a real tuning formalism as well as a new way to understand climate models. High Tune explorer is one of these statistic tuning tool, involving machine learning and based on uncertainty quantification. It aims to reduce the range of free parameters that allow realistic model behaviour [3]. A new automatic tuning experiment was developed with this tool for the atmospheric component of the IPSL GCM model, LMDZ. It was first tuned at the process level, using several single column test cases compared to large eddies simulations; and then at the global level by targeting radiative metrics at the top of the atmosphere [4].

We propose to add a new step to this semi-automatic tuning procedure targeting atmosphere and land-surface interactions. The first aspect of the proposition is to compare coupled atmosphere-continent simulations (here running LMDZ-ORCHIDEE) with in situ observations from the SIRTA observatory located southwest of Paris. In situ observations provide hourly joint colocated data with a strong potential for the understanding of the processes at stake and their representation in the model. These data are also subject to much lower uncertainties than the satellite inversions with respect to the surface observations. In order to fully benefit from the site observations, the model winds are nudged toward reanalysis. This forces the simulations to follow the effective meteorological sequence, thus allowing the comparison between simulations and observations at the process time scale. The removal of the errors arising from the representation of large-scale dynamics makes the tuning focus on the representation of physical processes «at a given meteorological situation». Finally, the model grid is zoomed in on the SIRTA observatory in order to reduce the computational cost of the simulations while preserving a fine mesh around this observatory.

We show the results of this new tuning step, which succeeds in reducing the domain of acceptable free parameters as well as the dispersion of the simulations. This method, which is less

computationally costly than global tuning, is therefore a good way to precondition the latter. It allows the joint tuning of atmospheric and land surface models, traditionally tuned separately [5], and has the advantage of remaining close to the processes and thus improving their understanding.

References:

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