Final
Report

CSCS
Centro Svizzero di Calcolo Scientifico
Swiss National Supercomputing Centre

Principal Investigator: Dr Antigoni Voudouri, Hellenic National Meteorological Service (HNMS), Greece

Project Title: Optimization of a calibration procedure for weather prediction model

Duration of the project: One year (October 2017-September 2018)

List of milestones and goals of your original project proposal and statement of your achievements.

This proposal was a follow-up on the Production Project 'Objective calibration of weather prediction models' which took place from 01.04.2015 to 30.09.2016 on Piz Daint[1]. A practicable objective multivariate calibration method build on a quadratic meta-model was introduced in the previous project, and successfully applied for the calibration of the COSMO-2 model[2]. The present project aimed at a full calibration of COSMO over an entire year using the1.1 km mesh-size configuration used in production at MeteoSwiss (the so-called COSMO-1).

*The **specific goal*** of the project was to optimize the calibration method by finding a compromise between the quality of the calibration and the computer costs. COSMO-1 configuration was used as test bed, with the soil memory activated, and consider a one year sampling for the calibration.

The ***main milestones*** to achieve the above stated goal were:

(1) Compute a full year COSMO-1 ensemble simulation with different tuning parameters, and derive the coefficients of the meta-model. The optimum values of tuning parameters were obtained and an independent validation of the calibration is performed.

(2) Refinement and optimization of the calibration method.

First milestone
Configuration and setup of the COSMO-1 configuration was finalized, including the consideration of the soil memory and the prior 3 years soil spin up. Simulations using COSMO-1 have been successfully performed to test the calibration method for a convection-permitting model. Calibration has been performed, for 5 model parameters (rlam_heat, tkhmin, v0smow, uc1 and radfac) for the full year 2013, by using Piz Daint resources. Note that the number of calibrated parameters has been reduced with respect to the original plan in order to fit the computation in the reduced allocation offered by the CSCS (we asked for 780'000 node hours, but got 400'000). Note also that a wide verification area is used for the calibration, including Northern Italy in addition to Switzerland (the same tools are used independently from the verification region, but different sets of observations have to be collected). The calibration with the 5 parameters required all of the 400'000 allocated node hours.

During this phase, the Meta-Model has been significantly consolidated and extended, adding in particular new meteorological fields, such as near surface dew point temperature and sunshine duration. An updated COSI performance score, using FSS instead of ETS for precipitation, was included.

Following these adaptations, the calibration is currently on going and the optimal parameters combination is under investigation. An independent verification, using MeteoSwiss standard verification tools, still remains to be done.

[1] http://www.cosmo-model.org/content/tasks/priorityProjects/calmo/docs/CSCS_Proposal.pdf
[2] http://www.cosmo-model.org/content/tasks/priorityProjects/calmo/docs/CSCS_final_report.pdf,
http://www.cosmo-model.org/content/model/documentation/techReports/docs/techReport31.pdf

Second milestone

This milestone has only been partially reached.Due to delays in finishing the simulation the refinement and the optimization of the calibration method has not been performed. Only the question of the minimal number of simulations to fit the meta-model, and how this affects the accuracy of the meta-model, has been considered, and a specific strategy to fit the meta-model is now under review. Additionally, different strategies for reducing the computation costs of the calibration (e.g. build two separates MM's for tuning the parameters which are not interacting with each other) are now under investigation.

Description of problems that have prevented you from using the entire granted allocation (if applicable) or in general that have prevented to successfully complete your project.

Although almost the entire amount of allocated resources has been used, we were not able to successfully complete the project and reach the second milestone.

Due to many technical issues in setting the model experiments, we were not able to start the simulations at the beginning of the allocation period, thus a very limited usage of the first quarter (namely October, November and half December) has been made. In an attempt to 'catch up' on our time schedule, by the end of January we exhausted the quarterly quota for the second quarter and had to wait till the beginning of April. This was also the case for the remaining quarters. Although jobs had been submitted in the low queue as an alternative solution, the prepost queue, in which fieldextra was submitted for the data thinning process, could not be used without valid allocation leading to additional delays.

The amount of raw data produced during the simulations was huge and the post-processing software had to be configured to support an aggressive data thinning policy. A disk space increase of approximately 15TB had been asked and approved by the CSCS, but still the available disk space during the COSMO-1 simulations had to be carefully re-considered, resulting in additional minor delays.

Finally, due to the distributed nature of the project team (Greece, Israel, Italy, Switzerland), and due to competing priorities between project duties and other national duties, the time needed to refine the meta-model and to analyse the results had been under-estimated.

List of papers published already (if any) or in preparation related to the project.

1. Voudouri A.**,** Khain P., Carmona I., Avgoustoglou E., Kaufmann P., Grazzini F., and Bettems J.M, 2018: *Optimization of high resolution COSMO model performance over Switzerland and Northern Italy*.Atm. Res. 213, 70-85, https://doi.org/10.1016/j.atmosres.2018.05.026
2. Voudouri A., Carmona I., Avgoustoglou E., Levi Y. and Bettems J.M., 2018: *Optimization of COSMO model interannual variability*. 14th International Conference on Meteorology, Climatology and Atmospheric Physics, October 15-17, 2018, Alexandroupolis, Greece
3. Voudouri A., Carmona I., Avgoustoglou E., Levi Y., Bettems J.M. and E. Bucchignani, 2019: Impacts on model performance score from CALMO and CALMO-MAX, COSMO Newsletter No 19