COSMO Priority Project CALMO :
Calibration of COSMO Model (Supplementary Version)

Version 12.0, 18.02.2016

Project leader : **A.Voudouri / HNMS**

Duration of extension : **09.2016 – 12.2016**

Project additional resources : **~0.8 FTE**

Contributing scientists :

A.Voudouri / HNMS	**2017: 0.2 FTE**
E. Avgoustoglou /HNMS	**2017: 0.2 FTE**
P. Khain /IMS	**2017: 0.1 FTE**
I. Carmona /IMS	**2017: 0.1 FTE**
F.Grazzini/ARPA	**2017: 0.1FTE**
JM. Bettems / MeteoSwiss	**2017: 0.1 FTE**

Summary

CALMO project is based on applying the calibration method proposed by Dr Omar Bellprat for regional climate modelling NWP. In the first phase of CALMO, the method has been applied to COSMO-7. Preliminary results showed that the method is valid for NWP and meta-model can be adjusted to reproduce COSMO NWP outputs, while the NWP forecast quality seems to be improved when the set of optimum parameter values is used.

In the extended version of the project the method has been expanded to seven model parameters. Furthermore, the current implementation of the method needs to be shifted to mesh-sizes which are more relevant to current and future model implementation. The new kilometric configuration of the COSMO model, COSMO-1, has been scheduled to be used as the potential to show a significant impact of the calibration method on COSMO-1 is much larger than with COSMO-7, since the kilometric configuration differs substantially from the configurations used in the development process at DWD.

Besides assessing the usefulness of the calibration method for an NWP model, the two additional scientific goals of this project are to understand the sensitivity of the NWP model quality with respect to some of the model parameters and to optimize the calibration procedure, in order to make it practicable on a standard HPC production system. Therefore following the extended version of CALMO project an additional 3 month extension is proposed in order to thoroughly evaluate and analyse the outcome of CALMO simulations. It should be noted that both human and computer resources have already secured.

It should be noted that 0.8 FTEs have been ensured by the contribution of the above mentioned scientists, while CSCS already agreed to extend the Daint allocation till end of September rather than end of March as it was originally planned.

The main scientific impact of a positive outcome of this project remains the generation of an objective calibration tool to determine the optimal setting of free or poorly defined model parameters. Depending on minimum computing resources, modellers should be able to objectively and reproducibly calibrate their NWP modelling system whenever needed: e.g. after major model changes, for an unbiased assessment of different modules (e.g. parameterization schemes), for optimal perturbation of parameters when run in ensemble mode, for a better understanding of the sensitivity of the model quality to a specific model parameter, etc.

Milestones reached

- Preliminary work (Task 1)
- Adaptation of the existing method for NWP applications (Task 2, 2.1-2.5,2.8)
- Documentation and dissemination of results-Part I (Task 5)

Milestones remaining

- Compute experiments and analyse results with the MM (Task 2, 2.6-2.7,)
- Assessing the usefulness of the calibration method (Task 3)
- Define optimal methodology in terms of computing time and quality gain (Task 4)
- Documentation and dissemination of results –Part II(Task 5)

Main deliverables:

1. Provide an objective and practicable methodology, a tool that can substitute expert tuning for calibrating NWP models.
2. Provide the associated technical and scientific documentation.
3. Understand the sensitivity of the NWP model quality with respect to the unconfined model parameters.

Description of individual tasks

Note: *Estimated resources for each task are referred only to supplementary version of CALMO*

Task 0: Administration and support *(remains with additional 0.03 FTEs for 2017)*

Due to the distributed nature of the project team, a particular effort will be necessary to keep a good information flow between all participants (e.g. by organizing regular phone or web conferences).

Deliverables:

(1) Project coordination, meeting, workshop and web conference organization.

Estimated resources:

J.M. Bettems / MeteoSwiss **2017: 0.01**

A. Voudouri /HNMS 2015: **2017: 0.02**

Task 1: Preliminary work *(this Task has finished)*

Task 2: Adaptation of the method *(remains with additional 0.03 FTEs for 2017)*

This task is divided into the following sub-tasks:

2.1: Documentation of tuning parameters and choice of parameters subspace *(finished)*

2.2: Selection of performance function(s) *(finished)*

2.3: Identification of key-variables for NWP *(finished)*

2.4: Experimental set-up *(finished)*

2.5: Collection of data *(finished)*

2.6: Modifications on the meta-model (on going)

Once the key variables and the appropriate parameters to be calibrated have been chosen, further adjustments of the meta-model have to be performed. For example scripts considering different statistical measures as performance score, manipulation of data etc.

2.7: Compute experiments and analyse results (on going)

The set of experiments required for the calibration process has to be evaluated iteratively associated with the number of parameters selected to fit the meta-model. As a consequence, the number of required simulations has been increased and a significant amount of computing resources is required. A workshop will be held in order to analyse results, evaluate the experimental design followed and decide on next steps to proceed with the calibration of COSMO-1.

2.8 Data thinning policy and application *(finished)*

Deliverables:

(1) An updated documentation of the tuning parameters in the COSMO model.

(2) The definition of a performance function applicable on NWP.

(3) The documentation of the experimental set-up.

(4) An updated version of the meta-model.

(5) A scientific discussion of the results obtained.

(6) A revised protocol on model calibration.

Estimated resources:

A.Voudouri / HNMS 2017: 0.05

E.Avgoustoglou/HNMS 2017: 0.05

I. Carmona/IMS 2017: 0.05 FTE

F.Grazzini/ARPA 2017: 0.05FTE

JM. Bettems / MeteoSwiss 2017: 0.02 FTE

Task 3: Assessing the usefulness of the calibration method *(still pending)*

The goal of this task is to show that the method is indeed able to improve the quality of the model. The sensitivity of the optimum with respect to the model resolution will be investigated in this task, as well as the 'fair' assessment of the impact of improved resolution. This task could be used as a test bed to refine the developments of task 2. This task is also strongly affected by the available computing resources which have now been extended by 09.2016. It will start after the end of Task 2 and will be divided into:

3.1: Application of the method using COSMO-1
Experience gained by using the calibration methodology and its applicability to NWP models will be transferred from simulations using COSMO-2 to selected COSMO-1 simulations. More specifically the aim of this subtask is the calibration of the 1.1 km mesh-size COSMO version using at least 4 parameters to test the calibration method for a convection-permitting COSMO configuration. An objective inter-comparison between the COSMO-2 and COSMO-1 as well as an assessment of the added value of higher resolution will then be feasible.

3.2: Analyse results
Once simulations are finalized the meta-model will be applied. Both model and meta-model results will be analysed and gain of meteorological quality when using the optimal configuration against the standard configuration will be examined.

Deliverables:

(1) Refinement of the method to be used for higher-resolution configurations.

(2) An objective inter-comparison between the two model versions COSMO-2 and COSMO-1

(3) Dissemination of analysis results to be discussed among scientific groups responsible on model development.

Estimated resources:

A.Voudouri / HNMS 2017: 0.05

P.Khain/IMS 2017: 0.05

I. Carmona/IMS 2017: 0.05 FTE

F.Grazzini/ARPA 2017: 0.05FTE

JM. Bettems / MeteoSwiss 2017: 0.02 FTE

Task 4: Practicability of the method *(….started)*

The third important objective of this project is to optimize the calibration procedure with respect to the required amount of computing resources, such that a model re-calibration can be computed on any standard production system.

This task aimed at finding a compromise between the forecast quality gain and the computing cost of the method. Therefore, the extend that the data set of full model runs can be reduced to still obtain a robust and good quality calibration result will thoroughly be investigated.

It is now scheduled to start after the end of tasks 2, in 2016.

Deliverables:

(1) Practicable methodology in terms of computing resources, associated tools.

Estimated resources:

A.Voudouri / HNMS 2017: 0.05 FTE

P.Khain/IMS 2017: 0.05 FTE

Task 5: Documentation *(remains with additional 0.2 FTEs for 2017)*

Publish scientific results of the project in a peer reviewed journal on the basis of the task 2 (and 3 if the associated results are available soon enough). A paper already submitted to Atmospheric Research is currently reviewed. At least one more manuscript will be prepared by the end of the project, summarizing results of calibration procedure.

A complete description of the methodology, including a ‘cookbook’ to facilitate the usage of this method by other COSMO members, will be made available in a COSMO Technical Report.

Deliverables:

(1) Peer reviewed scientific papers

(2) Technical description of the method, including ‘cookbook’, final report

Estimated resources:

A.Voudouri / HNMS 2017: 0.03

E.Avgoustoglou/HNMS 2017 0.15

Risks

The main risk of the proposed methodology is that it even after its optimisation it remains prohibitively expensive in terms of computing times..