CALMO over the Wider Eastern Mediterranean Area using COSMO model. Methodology and Outcome

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Presentation outline

- Domain choice
- Model version and set up
- Parameter list
- Optimization and evaluation strategy
- Computational resources
  - Computer system
  - Cost of model runs
  - Cost of output storage
- Conclusions.

❑ Domain choice: Wider Eastern Mediterranean Area

Model version and set up

- cosmo_190418_5.06_1
- int2lm_190524_2.06
- Horizontal grid size: 0.03^0 (~3 km)
- 890x487 grid points
- 53 vertical levels (Tropopause at 33 km)
- Integration time-step: 15 secs.
- Time interval of radiation scheme call : 15 mins
- Integration period: 42 hs.
- Boundary conditions : 6hr IFS Analysis.

Parameter list

PARAMETER	INTERPRETATION	RANGE	TEST VALUES (default)
rat_sea	ratio of laminar scaling factors for heat over sea	1-100	1, **10**, 50
rlam_heat	scaling factor of the laminar boundary layer for heat	0.1 – 10.0	0.1, **1.0**, 2.0
tkhmin tkmmin	minimal value of diffusion coefficient for heat and momentum (kept equal)	0.0-2.0	0.1, **0.40**, 2.0
tur_len	asymptotic maximal turbulent length scale (m)	10 – 10000	100, **150**, 1000
c_soil	surface area index of evaporative soil surfaces (dependent on surface area density of the roughness elements over land , c_lnd)	0-c_lnd(2.0)	0, **1**, 2

cosmo_userguide_5.06.pdf

Also in the namelist group /TUNING/ there are some variables that are chosen differently in the ICON setup. At least compared to the settings that were used at DWD for COSMO-DE or for the former COSMO-EU. Of course the choice of these variables depend on special configurations and domains. The following table lists the variables that are now chosen at DWD for COSMO-D2 ("OLD") and for ICON ("NEW").

/TUNING/	OLD	NEW	Explanation	Default
tkhmin	0.4	0.75	Minimal diffusion coefficients [in m^2/s] for vertical scalar (heat) transport.	1
tkmmin	0.4	0.75	Minimal diffusion coefficients [in m^2/s] for vertical momentum transport.	1
rat_sea	20.0	7.0	Ratio of laminar scaling factors for heat over sea and land.	10.0
pat_len	500.0	750.0	Effective length scale of subscale surface patterns over land [in m].	100.0
tur_len	150.0	500.0	Asymptotic maximal turbulent distance [in m].	500.0
a_hshr	1.0	2.0	Length scale factor for separate horizontal shear production.	1.0
c_soil	1.0	1.75	Surface area density of the (evaporative) soil surface.	1.0

❑Optimization and Evaluation strategy

Selection of cases, parameters and meteorological fields

↓

Station observations from Greece and Israel
(Daily Tdry max, Tdry min, Tdew max, Tdew min and Precipitation)

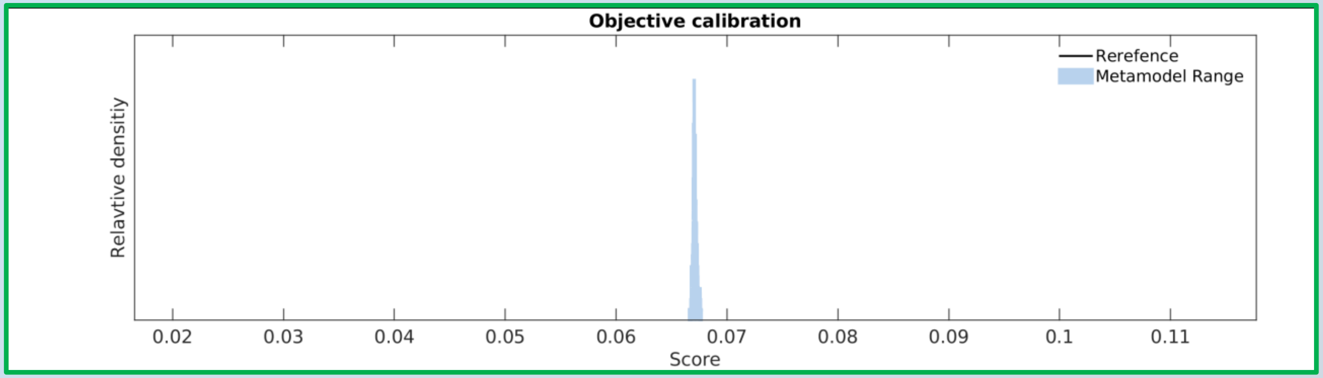
→ COSMO Model runs

↓

Metamodel calibration

↓

Derivation of optimum parameter values in reference to the default runs



Case choice for optimization

60 cases were chosen from the year 2019, 5cases/month (case_d2019**mmdd**_00/) i.e.:

case_d2019**0102**_00/ case_d2019**0109**_00/ case_d2019**0114**_00/ case_d2019**0119**_00/ case_d2019**0123**_00/
case_d2019**0205**_00/ case_d2019**0207**_00/ case_d2019**0212**_00/ case_d2019**0214**_00/ case_d2019**0222**_00/
case_d2019**0302**_00/ case_d2019**0312**_00/ case_d2019**0314**_00/ case_d2019**0316**_00/ case_d2019**0327**_00/
case_d2019**0405**_00/ case_d2019**0411**_00/ case_d2019**0414**_00/ case_d2019**0417**_00/ case_d2019**0420**_00/
case_d2019**0504**_00/ case_d2019**0507**_00/ case_d2019**0513**_00/ case_d2019**0523**_00/ case_d2019**0527**_00/
case_d2019**0601**_00/ case_d2019**0605**_00/ case_d2019**0610**_00/ case_d2019**0614**_00/ case_d2019**0617**_00/
case_d2019**0705**_00/ case_d2019**0710**_00/ case_d2019**0716**_00/ case_d2019**0718**_00/ case_d2019**0722**_00/
case_d2019**0804**_00/ case_d2019**0815**_00/ case_d2019**0816**_00/ case_d2019**0817**_00/ case_d2019**0824**_00/
case_d2019**0901**_00/ case_d2019**0912**_00/ case_d2019**0914**_00/ case_d2019**0920**_00/ case_d2019**0923**_00/
case_d2019**1002**_00/ case_d2019**1007**_00/ case_d2019**1017**_00/ case_d2019**1024**_00/ case_d2019**1030**_00/
case_d2019**1103**_00/ case_d2019**1109**_00/ case_d2019**1112**_00/ case_d2019**1115**_00/ case_d2019**1124**_00/
case_d2019**1201**_00/ case_d2019**1203**_00/ case_d2019**1210**_00/ case_d2019**1213**_00/ case_d2019**1224**_00/

The main criterion for the case choice is the development of extensive precipitation

22 runs per case according to parameter default, min/max, cross and optimum values.

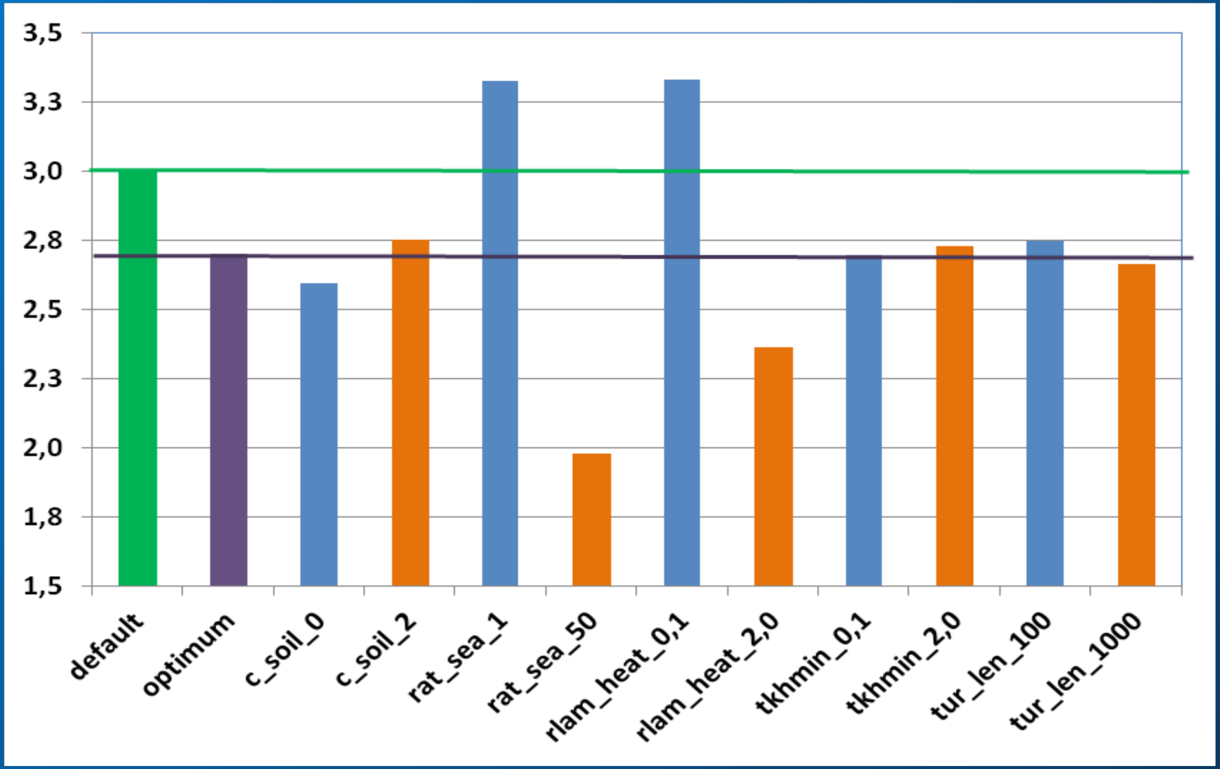
dyyyymmdd_00_**default**.tar.bz2

dyyyymmdd_00_**rat_sea_1**.tar.bz2
dyyyymmdd_00_**rat_sea_50**.tar.bz2
dyyyymmdd_00_**c_soil_0**.tar.bz2
dyyyymmdd_00_**c_soil_2**.tar.bz2
dyyyymmdd_00_**rlam_heat_0.1**.tar.bz2
dyyyymmdd_00_**rlam_heat_2.0**.tar.bz2
dyyyymmdd_00_t**khmin_0.1**.tar.bz2
dyyyymmdd_00_**tkhmin_2.0**.tar.bz2
dyyyymmdd_00_**tur_len_100**.tar.bz2
dyyyymmdd_00_**tur_len_1000**.tar.bz2

dyyyymmdd_00_**c_soil_2_tkhmin_2.0**.tar.bz2
dyyyymmdd_00_**c_soil_2_tur_len_1000**.tar.bz2
dyyyymmdd_00_**rat_sea_50_c_soil_0**.tar.bz2
dyyyymmdd_00_**rat_sea_50_rlam_heat_0.1**.tar.bz2
dyyyymmdd_00_**rat_sea_50_tkhmin_2.0**.tar.bz2
dyyyymmdd_00_**rat_sea_50_tur_len_1000**.tar.bz2
dyyyymmdd_00_**rlam_heat_2.0_c_soil_0.tar**.bz2
dyyyymmdd_00_**rlam_heat_2.0_tkhmin_2.0.tar**.bz2
dyyyymmdd_00_**rlam_heat_2.0_tur_len_1000.tar**.bz2
dyyyymmdd_00_**tkhmin_2.0_tur_len_1000**.tar.bz2

! dyyyymmdd_00_**optimum**.tar.bz2

60 day areal <tot_prec_42hs> [kg/m^2]



Optimization and Evaluation strategy

Selection of a new set of cases

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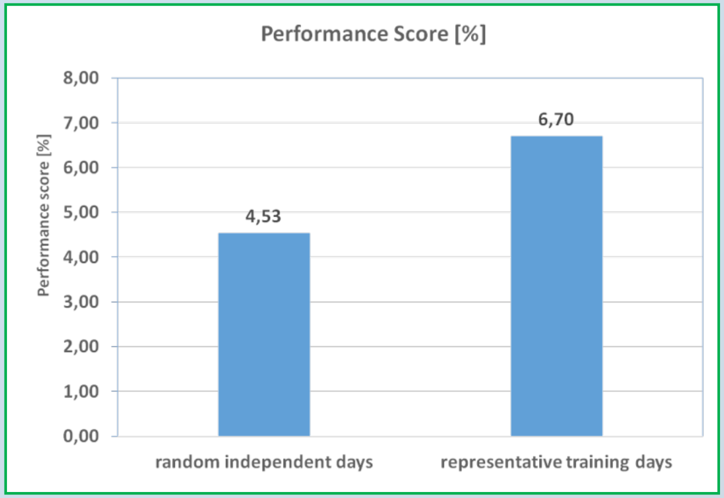
COSMO Model runs (default and optimum parameter values)

↓

Station observations from Greece and Israel
(Daily Tdry max, Tdry min, Tdew max, Tdew min and Precipitation)

→ Evaluation of model performance scores for optimum parameter values in reference to the default runs



Case choice for evaluation

60 cases were chosen from the year 2019, 5cases/month (case_d2019**mmdd**_00/) i.e.:

case_d2019**0103**_00/	case_d2019**0104**_00/	case_d2019**0110**_00/	case_d2019**0119**_00/	case_d2019**0125**_00/
case_d2019**0201**_00/	case_d2019**0213**_00/	case_d2019**0217**_00/	case_d2019**0221**_00/	case_d2019**0227**_00/
case_d2019**0308**_00/	case_d2019**0317**_00/	case_d2019**0320**_00/	case_d2019**0322**_00/	case_d2019**0330**_00/
case_d2019**0402**_00/	case_d2019**0412**_00/	case_d2019**0427**_00/	case_d2019**0428**_00/	case_d2019**0430**_00/
case_d2019**0505**_00/	case_d2019**0509**_00/	case_d2019**0511**_00/	case_d2019**0512**_00/	case_d2019**0525**_00/
case_d2019**0604**_00/	case_d2019**0615**_00/	case_d2019**0620**_00/	case_d2019**0622**_00/	case_d2019**0624**_00/
case_d2019**0707**_00/	case_d2019**0711**_00/	case_d2019**0723**_00/	case_d2019**0728**_00/	case_d2019**0729**_00/
case_d2019**0801**_00/	case_d2019**0819**_00/	case_d2019**0820**_00/	case_d2019**0827**_00/	case_d2019**0829**_00/
case_d2019**0906**_00/	case_d2019**0908**_00/	case_d2019**0918**_00/	case_d2019**0925**_00/	case_d2019**0927**_00/
case_d2019**1001**_00/	case_d2019**1006**_00/	case_d2019**1016**_00/	case_d2019**1023**_00/	case_d2019**1031**_00/
case_d2019**1102**_00/	case_d2019**1116**_00/	case_d2019**1121**_00/	case_d2019**1122**_00/	case_d2019**1125**_00/
case_d2019**1205**_00/	case_d2019**1217**_00/	case_d2019**1221**_00/	case_d2019**1225**_00/	case_d2019**1231**_00/

The cases were chosen *randomly* from 2019 but were *different* from the optimization ones.

2 runs per case according to parameter default and optimum values.

dyyyymmdd_00_**default**.tar.bz2

dyyyymmdd_00_**optimum**.tar.bz2

- Computational resources
  - Computer system

ECMWF Cray XC40, Xeon E5-2695v4 18C 2.1GHz, Aries interconnect

#103 (TOP 500, June 2021)

https://www.ecmwf.int/en/computing/our-facilities/supercomputer

❑Computational resources

- Computational cost of model runs:
  In kind provision of billing units by HNMS at ECMWF supercomputing system to run the model
- Computational cost of a single run:
  ~ 18000 b.us., ~3000 secs (2880 cpus).
- Total use of b.us.: ~ 30 million

- Computational resources
  - Volume of output storage:

    ~ 11.5 GB / run (*.tar.bz2).

    ~ 17 TB Total at ECFS.

CONCLUSIONS

- **Calibration of COSMO model using CALMO technology over the wider Eastern Mediterranean area should be considered a succesfull endeavor towards the benefit of COSMO, ICON and CCLM as well as the meteorological and climatological communities in general.**

- **This work nicely completes the CALMO works over Switzerland and Northern Italy, especially under the fact that COSMO model was optimized using rather sparse station observations instead of gridded data.**

- **Although this work was computationally expensive, it should be considered computationally quite affordable for smaller domains as well as quite adequate regarding local meteorological features.**