

# **COSMO-Model 5.05**

## **Please Accept Late Delivery**

Ulrich Schättler  
Deutscher Wetterdienst  
BU Research and Development  
Department for Numerical Modelling

## Contents

- What we said last year
- Why you think, nothing happened since then
- Where we are now
- When can we expect the new versions
- Who cares

## What We Said Last Year

→ Current Releases are:

- COSMO-Model 5.03 from 24<sup>th</sup> November 2015
- (5.04 from 08<sup>th</sup> March 2016)
- INT2LM 2.02 from 11<sup>th</sup> June 2015

→ New Releases:

- INT2LM 2.03 from 27<sup>th</sup> January 2017 and 2.04 from 15<sup>th</sup> February 2017
- COSMO-Model 5.05: **can be expected in April 2017**

**PLEASE ACCEPT LATE DELIVERY!**

- But before an official release we have to understand the results of the COSMO NWP meteorological test suite.

## What We Have To Add This Year

- We have to understand the results of all the tests we did, which are rather heterogeneous:
  - Hindcasts (March to July 2016) show a benefit for the COSMO-ICON physics when activating new parts of the parameterizations (turbulence, soil model).
  - But numex Experiments with full data assimilation cycle perform worse.
  - One problem is the drying out of the soil during the simulated period.
  - There even were crashes of some ensemble members due to numerical instabilities.
- See presentation by Jürgen Helmert tomorrow, to learn more about the results of the different tests:

"Evaluation of the COSMO model with redesigned physics data structure and ICON physics components"

## What is the Outcome

- DWD decided that there is not enough time to test the new COSMO-ICON physics before introducing COSMO-D2 in May 2018, therefore we stay with the "old physics behaviour" (for the remaining lifetime of the COSMO-Model):
  - We use the new blocked code.
  - But configuration as with the old COSMO ijk-physics (including some hard-coded switches for turbulence):
    - these are activated with `loldtur= .TRUE.` and choosing some special values for other namelist variables)
- **NOTE:** Using the default values of these namelist variables you will get the ICON-like behaviour of the COSMO-ICON physics! This will be clearly documented when COSMO-Model 5.05 is released to the public.

## Why You Think Nothing Happened Since Then

- Although there have been other developments, we did not release new COSMO-Versions, because we wanted to understand at least a little, what we are experiencing with the COSMO-ICON physics.
- For most of the physical parameterizations we are using the same packages now in ICON and in COSMO. The hope was, that the COSMO results should be similar to ICON, which is not the case now.
- We sure have no „clean mathematical proof“, but at least we have some explanations of what is going on here.

## Why Do We Not Have The Same Results as in ICON

- For most parameterizations we use the same packages, but there are significant differences:
- External Parameters:
  - ICON reads "raw data", e.g. landuse class fractions.
  - It does not use the SSO contribution to  $z_0$ .
  - COSMO reads "end products" like plant cover fraction, stomata resistance, roughness lengths incl. SSO contribution etc. via INT2LM
- The latter precludes implementing a tile approach similar to ICON!
- There are several parameterization components in ICON that make direct use of landuse classes, e.g. snow albedo, snow-cover fraction, table for stomata resistances: **these cannot be transferred to the COSMO-Model!**
- Ok. At least not easily.

## Why Are We Not Doing Anything

- This is not true! Development actively goes on. For example we could show the drying out of the soil also in ICON, when switching off the soil moisture analysis.
- Investigations of the TERRA code then showed that a „problematic calculation“ of runoff and infiltration led to an unrealistic loss of soil moisture.
- Alas, this was detected only after the decision to stay with the „old“ physics in COSMO.
  
- Should we invest more resources in a further unification of COSMO and ICON?
  - NO! This would not make much sense.
  - The real unification of COSMO and ICON results in ICON-LAM.

## Where We Are Now

- ➔ There have been several development versions of the COSMO-Model in the last year.

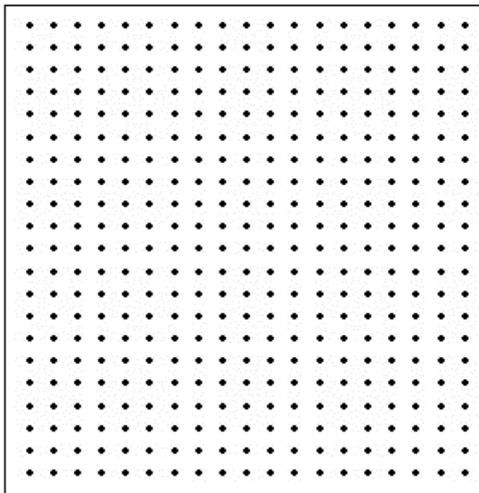
Version	Date	Contents (Highlights)	Results Changes
5.04e	23.03.17	<ul style="list-style-type: none"> <li>• activated blocked turbulence scheme</li> <li>• implemented blocked surface schemes from ICON (TERRA, FLake, SeaICE)</li> <li>• blocked version of SSO scheme</li> <li>• eliminated non-blocked parameterization</li> </ul>	<p>yes</p> <p>yes</p> <p>no</p>

- ➔ 5.04d is the last version with non-blocked turbulence and surface schemes.
- ➔ 5.04e runs all parameterizations in the blocked format with modified turbulence and surface schemes. A new configuration is necessary (TUNING, PHYCTL)

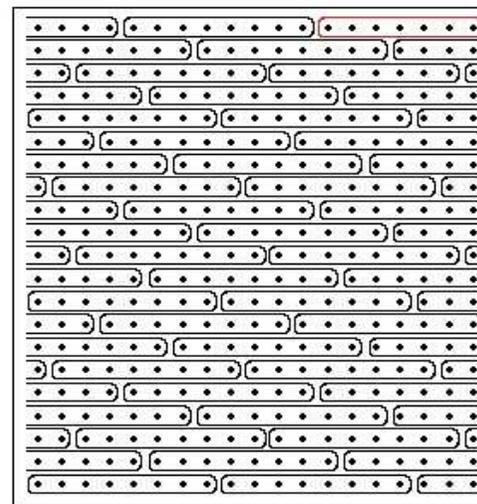
## COSMO-ICON Physics: Background

- Before calling the parameterizations, data in the COSMO-Model **will be copied from  $(i, j, k)$  to the  $(n_{proma}, k)$**  structure.

Grid points in the  $ij(k)$ -data structure



Grouped together in the blocked data structure



- Every model has its own **interface routines** to access the parameterizations and provide the proper data (For example, the COSMO-Model has to interpolate the horizontal wind speeds to the mass grid point)

Version	Date	Contents (Highlights)	Results Changes
5.04f	01.09.17	<ul style="list-style-type: none"> <li>• additional modifications to COSMO-ICON physics (new namelists, bug fixes, GPU version of TERRA)</li> <li>• Possibility to reproduce behaviour of old turbulence scheme (not TERRA!)</li> <li>• changes in data assimilation</li> <li>• new diagnostic output to highlight convective cell tracks (for ESSL testbed)</li> <li>• changes in handling statistically processed fields (min, max, avg, sums)</li> <li>• possibility to use RTTOV12</li> </ul>	<p>yes</p> <p>yes</p> <p>eventually</p> <p>no</p> <p>no</p> <p>SynSat</p>

It is possible to reproduce the behaviour of the „old“ physics „rather“ closely.

Version	Date	Contents (Highlights)	Results Changes
5.04g	13.11.17	<ul style="list-style-type: none"> <li>• reproducing "old" COSMO physics</li> <li>• update of TERRA</li> <li>• GPU port for Tiedtke convection</li> <li>• modified computation of HPBL</li> <li>• modifications to SPPT</li> </ul>	<p>yes no only HPBL only if Isppt</p>

### Modifications in TERRA

- modified calculations of runoff and infiltration to avoid loosing too much soil moisture (GZ, JH)
- bug fix for index accessing (by L. Schlemmer, ETHZ)
- soil ice parameterization according to Schaefer and Jafarov (JH)
- new option `itype_trvg==3`: needs additional input fields not available in COSMO (therefore not usable for COSMO)

Version	Date	Contents (Highlights)	Results Changes
5.04h	15.12.17	<ul style="list-style-type: none"> <li>• changes in data assimilation</li> <li>• adjust computational domain for saturation adjustment in dynamics</li> <li>• lshallowconv_only for Tiedtke-Bechtold convection</li> <li>• GPU port for turbulence</li> </ul>	yes (dep. on situation)

There also is a new version of INT2LM:

Version	Date	Contents (Highlights)	Results Changes
2.05	26.02.18	<ul style="list-style-type: none"> <li>• Processing of new external parameters for Kinne aerosol climatology</li> <li>• Processing of CAMS aerosols from IFS</li> <li>• Processing of ICON-ART mineral dust aerosols</li> <li>• Possibility to process only COSMO external parameters</li> <li>• activated check of uuidOfVGrid and uuidOfHGrid</li> </ul>	<p>if used</p> <p>if used</p> <p>if used</p> <p>no</p> <p>no</p>

Version	Date	Contents (Highlights)	Results Changes
5.05	23.02.18	<ul style="list-style-type: none"> <li>• GPU port for additional COSMO parts:               <ul style="list-style-type: none"> <li>• all physical parameterizations but seaice; including organize_physics.f90</li> <li>• can run full physics now on GPU</li> <li>• nudging and latent heat nudging</li> </ul> </li> <li>• included GCL for communication between GPUs</li> <li>• alternative method for cold pool diffusion</li> <li>• modifications for Radar Forward Operator</li> </ul>	<p>no</p> <p>if activated no</p>

Please read more about the changes in the [Release Notes](#) for the different versions.

# Habemus Versionem 5.05



Checked in to the  
version control system  
on Friday 23rd of  
February 2018!

## When Can We Expect The New Versions

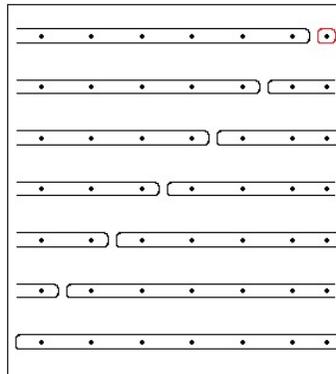
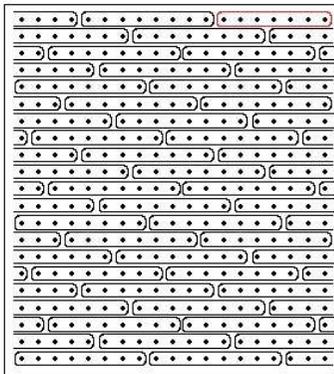
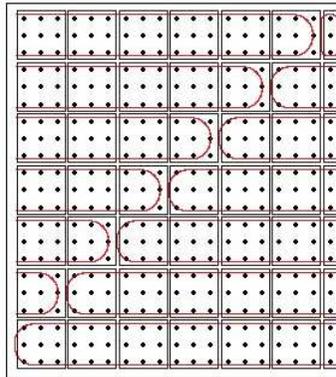
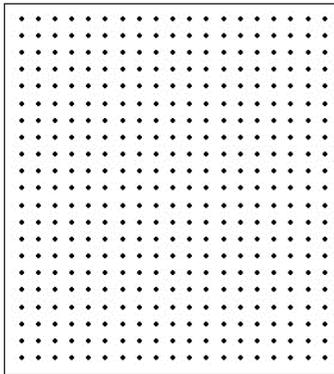
- We still have to do the mandatory actions for every new version:
  - Running the NWP Test Suite.
  - Final documentation.
  - Release to the public will be within the next three months.

## When Can We Expect Other Developments

Roadmap for next developments in the COSMO-Model

- Version 5.06 (planned for autumn 2018)
  - Radar forward operator ✓
  - Improvement for Bott Advection depending on results
  - Higher order horizontal discretizations ✓ (already available)
  - 2-moment microphysics ✓
  - Urban module depending on results
  - Mire parameterization (optional)
  - POMPA (GPU port) as work progresses
  - Removing the coarse radiation grid
- Developments will again be implemented in sub-versions 5.05a, 5.05b, etc.
- Planning unification with COSMO-CLM version: 6.0

## (Blocked) Coarse Radiation Grid



Blocking for the COSMO grid

And for the coarse radiation grid

COSMO-Model 5.01 (microphysics blocked)

nrادcoarse:	1	2
all physics:	138.32	125.25
microphysics:	41.30	41.16
radiation:	24.53	10.98
turbulence:	60.62	61.17
copying:	8.09	8.08

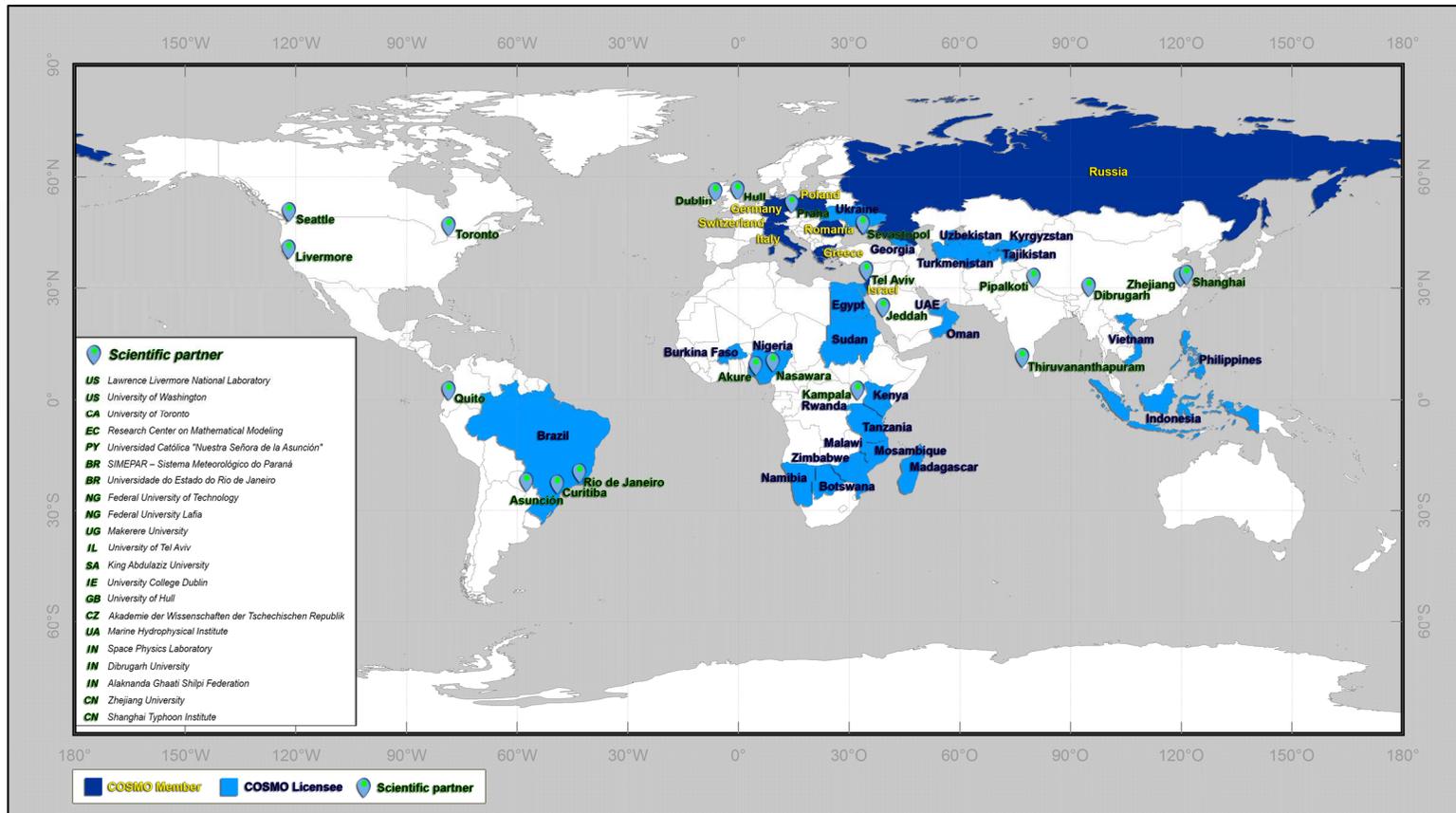
COSMO-Model 5.05 (all physics blocked)

nrادcoarse:	1	2
all physics:	167.81	160.63
microphysics:	40.45	40.42
radiation:	16.11	9.32
turbulence:	37.56	37.50
copying:	56.66	56.67

Timings (in seconds) for a 12 hour COSMO-D2 forecast

# Who Cares?

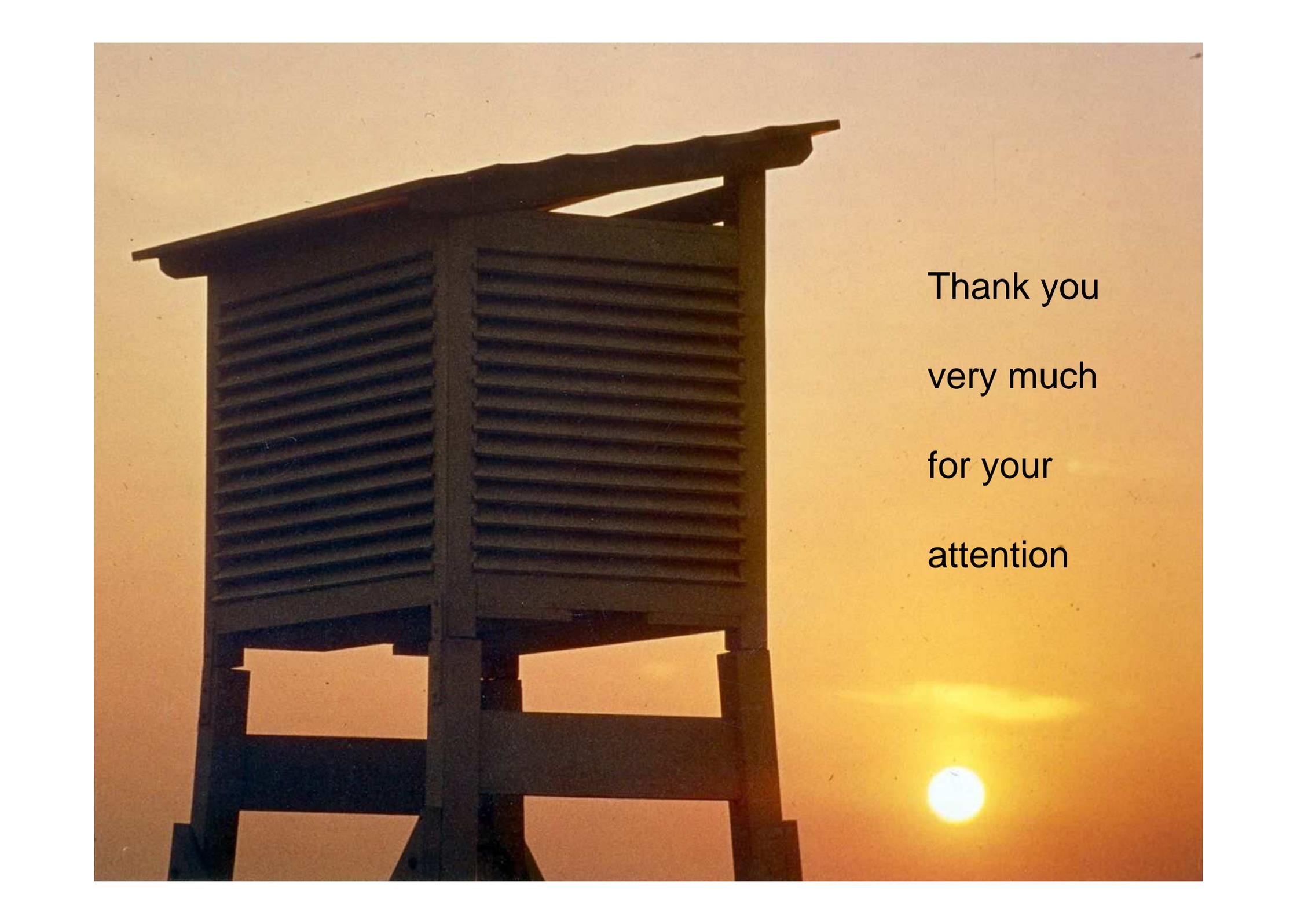
➔ There are still many users of the COSMO-Model who really care.



## Who Cares?

- But: DWD plans to replace the COSMO-Model system during 2020 by ICON-LAM.
- Nevertheless: the COSMO-Model still does its job and will be supported for some more years to come.
- And we will support all our users to migrate their work and applications gradually to ICON-LAM.

So stay tuned for future news about the COSMO-Model and its developments.



Thank you  
very much  
for your  
attention