

# **SCA Report for ICON-NWP**

#### and still: COSMO-Model and INT2LM

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# **COSMO 6.01 and INT2LM 3.01**







#### COSMO 6.01 implemented on 24.08.23

04.03.22	GPU	Removed vector index lists in Tiedtke-Bechtold convection (conv_cuascn.f90) due to a compiler problem with some NVIDIA compiler versions.
30.05.22	URB	Variable tcm in turb_transfer.f90 has to be INTENT(INOUT) instead of INTENT(OUT). Important for itype_kbmo_uf > 0 or lurbfab.
31.08.22	LEPS	Reading GRIB 2 meta data for special local section 28: global communication problem in src_input.f90.
08.11.22	C2SM	Fix distribution of rlon/rlat values for grid point output (meteographs).
11.11.22	C2SM	Fix tracer recycling for spinup runs with GHG extensions.
14.11.22	MCH	Corrections and updates for snowpolino.
23.11.22	C2SM	Fix compression of NetCDF restart files (option "nc-4" only).
23.11.22	GPU	Fix issues related to GPU arrays in output
15.05.23	CLM	Add SP_AV to list of fields for statistical processing (was forgotten before).

Note: This version is only available on github. It will not be distributed.







#### INT2LM 3.01 implemented on 24.08.23

22.08.23	CLM	src_read_coarse_grid.f90: write variable zvcflat_in (read from NetCDF files) to internal structure vcoord_in (was forgotten before).
22.08.23	ICON	Problem when reading ICON data set containing synthetic satellite images: leveltyp unknown. Just ignore this leveltyp

Note: This version is only available on github. It will not be distributed.





#### **Actions Taken**

- → All fixes have been implemented on github master and have been tagged on August 24th, 2023.
  - → But these versions will not be distributed officially
- → COSMO 6.01 and INT2LM 3.01 have been implemented on ECMWF computer ATOS (on Sept. 05th)
  - >/ec/res4/hpcperm/dwg/cosmo/cosmo\_230824\_6.01
  - /ec/res4/hpcperm/dwg/int2lm/int2lm\_230824\_3.01







# **Latest ICON Releases**







# Where to Find Information

- Protocol of Release Commits  $\rightarrow$ 
  - → https://gitlab.dkrz.de/icon/wiki/-/wikis/Protocol-of-Release-Commits
  - $\rightarrow$  From gitlab:  $\rightarrow$  icon / ICON developer wiki  $\rightarrow$  Protocol of Release Commits (in: Source Code Management)
- icon-nwp commits:  $\rightarrow$ 
  - → https://gitlab.dkrz.de/icon/icon-nwp/-/commits/master
  - $\rightarrow$  From gitlab:  $\rightarrow$  icon / icon-nwp  $\rightarrow$  Commits

Informations following on the next slides have been compiled by Daniel Rieger.





#### **ICON Release 2.6.6**

#### Ensemble:

- → Stochastic Perturbation of Physics Tendencies (SPPT)
- TERRA-URB:
  - ➔ Albedo of urban surface tiles
- Microphysics:
  - New two-moment cloud ice scheme inwp\_gscp=3
- → GPU:
  - → ACC port of ecRad
  - → ACC port of Two-moment microphysics scheme
  - → ACC port of 3D Smagorinsky turbulence scheme
  - → ACC port of NWP seaice module
  - ACC port of diagnostics DURSUN, DURSUN\_R, DURSUN\_M, TWATER, convective indices, DBZ, ECHOTOP, SDI, HBAS\_SC, HTOP\_SC, SMI
- Radiation:
  - ➔ Update to ecRad version 1.5
- → Land:
  - ➔ Added jsbach/vdiff from former ICON echam-physics







#### **ICON Release Candidate 2.6.7**

#### → Tuning:

- → Additional namelist options for improved SSO/gravity-wave tuning
- → Set of changes to allow numerically stable integrations at mesh sizes below about 100 m

#### → Land:

→ Add interface between NWP physics package and vdiff

#### ➔ Dynamics:

➔ Integrate separate deep-atmosphere dycore into standard dycore

#### Coupling:

Update from YAC2 to YAC3

#### ➔ Microphysics:

- Two-moment scheme changes for rapid update cycle and cloud cover
- Implementation of warm-rain spectral bin microphysics (SBM)
- → Option to modify diagnostic cloud scheme to enhance cloud cover in stratocumulus regions





### **ICON Release Candidate 2.6.7**

#### → Radiation:

- → Generic hydrometeors for ecRad
- Latitude-dependent decorrelation length scale for cloud overlap
- → New gas optics option available (ecckd)

#### → Waves:

- Implement full suite of parameterizations
- ICON-Seamless:
  - → Finalized prototype 2 (coupled atmosphere-ocean)

#### → TERRA-URB:

→ Prevent evaporation from bare soil; "Puddles" on impervious surface areas; anthropogenic heat flux

→ GPU:

- OpenACC port of totint, synsat and albedo\_type=3; optimized port of LHN and two-moment microphysics; vertical output interpolation; 3D turbulence scheme; diagnostics; SPPT; sstice\_mode=6
- → ART:
  - Enable reduced radiation grid for ART+ecRad







# **News for ICON Developers**







# **Developing for ICON**

- First steps for ICON developers: see https://www.cosmo-model.org/content/support/icon/default.htm and my presentation from last year.
- To contribute to the ICON development, you need access to the git repository (https://gitlab.dkrz.de) and have to be familiar with basic git commands:
  - → git clone --recursive git@gitlab.dkrz.de:icon/icon-nwp.git
  - shows: → git branch \* master
- Contributions are added to the ICON master by "feature branches" and "merge requests"
  - NEVER work on the master!  $\rightarrow$  git checkout -b <mybranch>:
  - now shows: → git branch
- - \* <mybranch>
    - master
  - $\rightarrow$  After successful implementation of your contribution you can open a "merge request" on the gitlab page.







## **Developing for ICON**

→ When working on your branch you should save your work from time to time on your local clone:

- $\rightarrow$  git add <all the work>
- > git commit you will be asked to write a (reasonable) commit message!
- ➔ And you can also save this branch on the global repository:
  - → git push origin <mybranch>
- After successful implementation of your contribution you can open a "merge request" for your branch on the gitlab page.

Then the work for the reviewers and the gatekeepers starts!





# seiner Hand

DWD

# An Improved Gatekeeping Workflow for icon-nwp

See: <u>https://gitlab.dkrz.de/icon/icon-nwp/-/wikis/home</u> → ICON-NWP Workflow

- → Please read these instructions carefully! Here are some highlights:
  - → Only one feature per merge request is allowed!
  - → Provide a short, but precise description of the changes.
  - → Each merge request needs a scientific review.
  - Other mandatory requirements:

clean code up-to-date with the master, green buildbot tests.

- When a merge request is ready, the developer adds the label reviewRequested.
- The gatekeepers decide on the assignee in a weekly meeting.
- When your branch has been assigned to a gatekeeper it gets the label inReview.









#### **Troubles You Might Experience**

- Unifying your branch with the master (git merge master) can lead to conflicts, if several contributors modify the same file. This might need coordination.
- Running buildbot can be problematic: sometimes machines are not available, leading to red buildbot tests. Or you need to update the reference data, if your changes do modify the results of the simulation.
- For machine availability see: <u>https://gitlab.dkrz.de/icon/icon-nwp/-/wikis/Buildbot-Maintenance-Calendar</u>
- → Buildbot tests on GPU machines are red: this might involve a GPU expert.
- → Furthermore: ICON-C plan is that all code parts must be covered by buildbot tests or they are removed.
- > The gatekeeper complains about a "lousy code": Then you have no chance but to clean up your code. E.g.
  - → use proper indentation in the ICON style.
  - $\rightarrow$  do not list variables in USE statements, which are not used in the code.
  - → do not use: debugging print statements; private comments; markers with developer's initials, etc.

But always keep in mind:

The gatekeeper is your friend!







# **License and Support Issues**







#### **New ICON Licenses**

- Licenses for NMHS available since December 2022:
  - → Using ICON is for free now:
  - → Support License for NHMS requires a license fee:

ICON\_License\_Use\_NMHS ICON\_License\_Support\_NMHS

New formula to compute the license fee depends on GDPpc (gross domestic product per capita):

- → Fee = MIN (20000.00 ; 4800.00 + MAX (0.0 ,  $\frac{GDPpc c1}{c2}$ )
  - $\rightarrow$  c1 = 4256 (2023): limit of GDPpc for lower-middle income countries. This value is adapted yearly.

→ c1 = 4465 (2024)

- $\rightarrow$  Countries with GDPpc < c1 do not have to pay the fee: Fee = 0.0
- $\rightarrow$  c2 = 0.5: arbitrarily chosen factor for adapting increase of fee.
- → Will be rounded down to 100 Euro level.







#### **COSMO Money 2023 and Beyond (Using World Bank Data from 2023)**

Country	Future ICON Fee	COSMO Fee 2023	GDPpc <sup>4</sup>
Botswana	10900	20000	7347.6
Brazil (INMET)	11300	60000 <sup>1</sup>	7518.8
Brazil (Navy)	11300	20000	7518.8
Georgia	6300	0	5042.4
Namibia	5700	20000 <sup>2</sup>	4729.3
Oman	20000	20000	16439.3
Turkmenistan	11500	20000 <sup>3</sup>	7612.0
Ukraine	5900	0	4835.6
UAE	20000	20000	36284.6

1) Missing money from 2021/2022 has been paid this year

2) Namibia cannot pay at the moment and does not get ICON data.

3) Missing money from 2022. Invoice has now been waved by DWD. See next slides.

4) GDPpc taken from <a href="https://data.worldbank.org/indicator/NY.GDP.PCAP.CD">https://data.worldbank.org/indicator/NY.GDP.PCAP.CD</a> (2023)





#### **First ICON Licensees**

- Jemen, Kyrgyzstan, Lesotho
- Contracts sent to: Niger, Oman, Tanzania, Mauritius, Brazil, Zimbabwe
- Research contracts: Brazil, Kenya, UAE, Malawi, Pakistan

**Special Situations:** 

- Turkmenistan and Central Asia
- Oman

See next slides.









### **Support for First ICON Licensees**

After the contracts had been signed, ICON was provided to Yemen, Lesotho and Kyrgyzstan:

Lesotho:

- installed the model but had "issues with running". I checked on their computer and noticed that their test cluster was not able to run parallel programs at all. After availability of a big cluster I installed it and run a first test successfully.
- $\rightarrow$  They now should test on their own.

Kyrgyzstan:

- Installed the full software stack with spack, but could not handle config-wrappers. I wrote a config-wrapper which can deal with spack installations, installed ICON on their cluster and run a first test.
- They now should test on their own.

Yemen:

Several support requests were answered, but it seems they have problems with the installation. No news at the moment.







### **Special Situation: Turkmenistan and Central Asia**

- From 2018 to 2022 the COSMO license fee for Turkmenistan was payed by a company "Cheper Gurlusyk Individual Enterprise".
  - → Collaboration with this company ended in 2022 and Turkmen Hydromet could not pay the COSMO fee.
  - → Therefore DWD stopped the ICON data transfer.
- In July the german "Gesellschaft f
  ür internationale Zusammenarbeit" (GIZ: society for international collaboration) contacted DWD:
  - They are about to start a collaboration with the 5 central asian states, including Turkmenistan: "Climate Risk Management in Central Asia"
  - → They are willing to pay the ICON license fee for 2 years.
- Turkmen Hydromet wrote a letter to the president of DWD explaining the situation and asking for a further collaboration using ICON-LAM. This has not been decided yet.







## **Special Situation: Turkmenistan and Central Asia**

In case of a continued collaboration:

- → GIZ asks for a NWP training in Central Asia (also for the other states):
  - → DWD does not agree to send somebody for such a training (there had been similar requests earlier).
  - → Is anybody else from the Support Group interested to do that?
- → GIZ asks for an online workshop to give information on ICON-LAM, licensing issues, etc.
  - $\rightarrow$  I think this is a good idea, also for other countries!
  - ➔ For Central Asia it should be this autumn!





### **Special Situation: Oman, UAE**

- Oman might be the first country running ICON-LAM operationally. They get support from IBL Software Engineering (which also delivers a new computer).
- Lately IBL Software Engineering informed us that Oman and UAE are interested in "ICON-LAM and data assimilation". Tests have already been done with brazilian Navy.
  - → What is the progress of PP KENDAScope?
- → Also, Oman and UAE are interested in ICON-ART.
  - → IBL Software Engineering contacted KIT.
- Lately DWD has been contacted by a company Xebia (an IT consultancy company), doing a proof-of-concept for OMAN by running ICON-LAM in the cloud (AWS). We assisted in installing and running ICON-LAM and provided a test-data set.
  - ICONIC still is of interest!







### **Consequences for PP C2I4LC and the Support Group**

- → Prepare an online workshop to give information on ICON-LAM and the migration from COSMO to ICON-LAM.
- Activities to support new ICON-LAM licensees already started (via: <u>icon.support@dwd.de</u>). The Request Tracker should go online as soon as possible!
- We have to be prepared to do the installation on the hardware of some partners ourselves: are you familiar with spack?
- → Components still missing:
  - Scheduling
  - Verification
  - Data Assimilation
- And next step is: ICONIC
  - → Working in the cloud, with containers, ...







# ICON on ATOS (ECMWF)







### **Problems with INTEL Compiler**

Rerunnability / Repeatability:

- Running the same experiment can give different results: This has been experienced by colleagues in Rome running ICON with dace coupling. Some runs produced (e.g.) surface temperature values of 0, causing the next ICON run to crash.
- → Similar issues have been experienced by DWD colleagues also earlier this year.

Reproducibility:

Running ecRad with different OMP\_NUM\_THREADS does not give reproducible results. When investigating this with new ecckd gas optics, the program even crashed. Most probably due to a not working compiler option "--assume realloc-lhs"

Latest News:

ECMWF User Support could not help earlier this year. To get an update, I contacted also colleagues from the HPC group, who gave some recommendations for helpful compiler options. This has to be tested now.





# **GNU Compiler Suite**

- → Runs about 20 % slower than intel, but is stable without reproducibility or repeatability problems.
- A new version GCC 12.2.0 is available and can be tested.  $\rightarrow$







#### **Buildbot**

Only few actions taken up to now:

- Running buildbot tests on ATOS is not impossible. Details have to be discussed between DKRZ and ECMWF. Tests will run using DWD SBUs.
- → To run buildbot tests we need an automatic build and run-system for ATOS:
  - Modify scripts collect.set-up.info.in and create\_target\_header to include ATOS information: I worked on that lately.
  - → Define tests that can be run by buildbot:

Who can contribute such tests? What do we want to test?





It is difficult to predict

especially the future.

And we have only just begun...