CONSORTIUM FOR SMALL SCALE MODELING

COSMO

Deutscher Wetterdienst

Wetter und Klima aus einer Hand

DWD

Towards COSMO-Model 6.0

and Beyond

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Source Code Administrators

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Highlights of the Developments in the last COSMO Year

For more details see

- SCA presentation of WG 6 (in the parallel sessions)
- Release Notes of COSMO and INT2LM

COSMO-Model

5.06b (_1, _2, _3, _4)

- ➔ Fix in the graupel scheme for numerical stability: limit terminal fall velocity of rain / snow /graupel

5.07 (a, b, c)

- ➔ GPU port of Tiedtke-Bechtold convection scheme
- ➔ Replaced STELLA by GRIDTOOLS
- ➔ Run surface schemes in double precision (even when model runs in double)
- ➔ Fix in shallow convection interface: a loop index „k“ was used outside the loop
- ➔ Added EULAG dynamical core
- ➔ Changes for Data Assimilation
- ➔ Update of TERRA with latest ICON version (including a fix for evaporation)
- ➔ Unification with MESSy

INT2LM

2.06a (_1)

➔ GRIB 2: additional packing; running COSMO-LEPS in GRIB 2

2.07 (a)

➔ Reading / writing RBF coefficient files to interpolate ICON fields (saves setup time)

➔ Technical Testsuite for INT2LM

To be Expected Soon

COSMO 5.08:

- Removed coarse radiation grid
- Modifications to run assimilation in single precision (KENDA, not full Nudging)
- Unification with CLM, crCLIM
  - Diagnostics for wind compass rose
  - Diagnostics for clear-sky radiation variables
  - New hydrology scheme (by Linda Schlemmer)
- Use GRIDTOOLS 2.0

INT2LM 2.08:

- Unification with CLM / crCLIM
- Pack HSURF also with 24 bits (as HHL)

COSMO-ICON Physics

Status of COSMO-ICON Physics

- Two packages are unified between COSMO and ICON
  - Turbulence Scheme
  - Soil and surface schemes: TERRA, FLake, SeaIce
- We did not manage to work on the other schemes in the last year
  - Microphysics
  - SSO scheme
  - Tiedtke-Bechtold
- There are opinions now, that this is not necessary any more.
  - Any remarks?

Documentation

Documentation for Model Version 5.0 has got DOIs

- Colleagues from the CLM Community asked for permanently available Model Documentation for specific model versions, to be cited in peer-reviewed papers.
- Or for a peer-reviewed model documentation (which is not practical).
- Therefore we restored the documentation for COSMO Version 5.00 (which is the basis for the CLM work in the last years) and provided DOIs.
  - Example: DOI: 10.5676/DWD_pub/nwv/cosmo-doc_5.00_I for „Part I: Dynamics and Numerics“
  - Available on the COSMO Web Page (Documentation) and on https://www.dwd.de/EN/ourservices/cosmo_documentation/cosmo_documentation.html
- In preparation: Documentation for Model Version 5.05 with modified physics (blocked data structure; modified packages)
- Final Version 6.0 will also get DOIs

Update of Documentation

- ➔ Release Notes for the latest versions are available
- ➔ Update of User Guides is in preparation

The Last Episode

Outstanding Developments (I)

- Unification with CLM / crCLIM: 3 branches under review / testing
  - New hydrology scheme (working since end of July)
  - crCLIM diagnostics (available since end of July)
  - CLM diagnostics (available since end of May)

- Status: Colleagues from CLM / crCLIM could not do much testing up to now!
- At CSCS in Lugano there were problems implementing COSMO-ORG repository on other GPU computers (Daint, DOM) than the MCH operational computer (problems with build scripts, PGI compiler, …)
- Colleagues from universities, research institutes are also working on other projects.

Outstanding Developments (I+)

- Latest News from CLM Group
  - A 6 year run with branch „CLM diagnostics“ gives similar results as version COSMO5.0_CLM16 (but only „eye-verification“)
  - A run using the new hydrology scheme crashes after about 20 days with „floating point division by zero“
  - Seems to depend on configuration of soil layers and whether layers are saturated or not. Developers are discussing…..
- Latest News from crCLIM Group: Technical issues are ongoing
  - New build environment for COSMO (based on SPACK): should be implemented on all computers now
  - Nevertheless, some tests could already be started.
- Timeline for integration: ???

Outstanding Developments (II)

- Integration of work from PT SAINT: new multi-layer snow model
  - Status: Model now running also on GPUs (but could be problematic on the NEC);
  - Timeline: ready to be integrated.
- Integration of work from PT AEVUS, AEVUS2
  - Status: Version available based on COSMO 5.05;
  - Integration into latest version will be done in steps (different branches)
    - poor man‘s tile approach
    - TERRA-URB model (additional fields; new code; modifications to TERRA, …)
  - Timeline: September / October

By the Way: Vector vs. GPU

- Now that DWD runs a vector system, this question becomes interesting again
- A vector processor needs a long innermost loop for efficiency
  - In our models, the horizontal loops are ok, vertical loops are not.
  - In principle, GPUs can also work with innermost horizontal loops
- But there are some caveats:
  - Multi-layer snow model: number of soil layers can be different for different grid points; easy (and GPU efficient) implementation is with innermost vertical loops. This might not work on vectors!
  - Special algorithms: For computing the LPI, a Newton method is used in the COSMO-Model. An efficient GPU implementation needs an innermost loop over the Newton iterations per grid point (implemented with „ifdef“)
  - Similar situation with ecRAD (radiation parameterization tested in ICON): needs different innermost loops than the horizontal ones for efficient GPU implementation: not sure how to handle that

COSMO-Model After-Life

- Episode VI.0 will be the last official release of the COSMO-Model.
  - Make a branch: cosmo_stable for distribution to all partners
  - On this branch only maintenance will be done
- What about later developments?
  - If necessary at all, they can only be submitted by a github branch to the master, not to cosmo_stable. This means: every developer has to have access to github.com/COSMO-ORG
  - Whoever wants to use such developments can use the master of the github repository github.com/COSMO-ORG (on his own responsibility)
  - The master will not be tested with the NWP Test Suite any more
  - I still can do the SCA, but only with an epsilon of FTEs

COSMO → ICON

Actions in the Last Year

- Following branches are now existing in the ICON Repository:
  - icon-cosmo-master (to be synchronized with icon-nwp/icon-nwp-dev)
  - icon-cosmo-dev (to be synchronized with icon-cosmo-master)
  - icon-clm-dev (to be synchronized with icon-cosmo-master)
- All COSMO developments have to branch from icon-cosmo-dev (and CLM developments from icon-clm-dev)
- icon-cosmo-master (and icon-cosmo-dev/icon-clm-dev) have been synchronized with icon-nwp/icon-nwp-dev several times
- Up to now there is one active development below icon-cosmo-dev
  - Developments for 2d aerosols within PP CAIIR (by Daniel Rieger)


Thank you
very much
for your
attention!