Status Report COSMO & ICON

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COSMO Developments

Highlights of the developments in the last year

COSMO-Model

5.06b (_1, _2, _3, _4)

- ➔ Fix in 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
- Modifications for MESSy

2.07 (a)

- Reading / writing RBF coefficient files to interpolate ICON fields (saves setup time)
- Technical Testsuite for INT2LM
- Corrections for HadGEM input and itype_profiles_vert_interp=2

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)

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 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

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 anymore
  - Uli Schättler still can do the SCA, but only with an epsilon of FTEs

Documentation

- 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

COSMO Priority Projects & Tasks

Current foci of the COSMO Consortium

Priority Project & Task Overview

KENDA-O: Further improve and extend the data assimilation system and use of observations in the framework of the KENDA-LETKF in view of better convective-scale deterministic and ensemble forecasts, particularly of quantities related to cloud and precipitation.
Project lead: C. Schraff (DWD), succeeded by PP KENDAscope

CAIIR: New developments regarding cloud optics and related aerosols-radiation or aerosols-cloud interaction into ICON. Testing of new sources of aerosol data not yet accessible in ICON. Investigate to what extend the statistical information of a stochastic shallow convection scheme can be integrated into the formulation of cloud-radiation interaction.
Project lead: H. Muskatel (IMS Israel)

CALMO-MAX: The overarching goal of the project is to consolidate and extend the findings of the CALMO project, in order to provide a permanent framework for objective model calibration.
Project lead: A. Voudouri (HNMS Greece)

SAINT: Improving the current multi-layer snow cover scheme.
Project lead: Sascha Bellaire (MeteoSwiss)

Priority Project & Task Overview

AEVUS2: Consolidate the implementation of the TERRA_URB scheme in the COSMO model, drafta new PT or PP aiming at transferring these developments into the ICON model
Project lead: P. Mercogliano (CMCC Italy)

AWARE: How to objectively to evaluate forecasts of extreme weather. The main weather phenomena of interest are: thunderstorms (heavy precipitation, lightning), severe wind (and wind gusts), min-max temperature (persistence), visibility (fog), and other extreme phenomena like tornadoes, dust devils, clear-air turbulence (CAT), etc.
Project lead: F. Gofa (HNMS Greece) and A. Bundel (RHM Russia)

CARMA: The goal is to replace the existing VERSUS verification software environment with the MEC-Rfdbk software developed by DWD, as a Common Verification Software (CVS), in order to perform part of the verification activities in the consortium.
Project lead: A. Iriza-Burca (NMA Romania)

C2I: Ensure a smooth transition from the COSMO model to the ICON model
Project lead: D. Rieger (DWD)

Priority Project & Task Overview

IMPACT: The aim of this project is to adapt the ICON model to run on various architectures such as x86 multicore CPUs and GPU accelerators, focusing in the LAM mode for NWP applications.
Project lead: C. Osuna (MeteoSwiss)

APSU: Development of model perturbation methodologies, post-processing methods for the CP ensembles, better use of the KENDA analyses as initial conditions to initialize the CP ensembles and improvement of perturbed boundary conditions
Project lead: C. Marsigli (DWD), succeeded by PP PROPHECY

New Priority Project & Task Overview

Deutscher Wetterdienst
Wetter und Klima aus einer Hand
DWD

PROPHECY: Developing, in a well-coordinated manner, the future generation of convection-permitting ensemble systems based on the ICON(-LAM) model; the scientific focus being on the development and testing of model perturbation methods
Project lead: C. Marsigli (DWD)

MILEPOST: Providing the COSMO community with new and/or advanced and elaborated methods of post-processing based on artificial intelligence and machine learning ideas
Project lead: A. Mazur (IMGW)

VAINT: Improving the current phenology of vegetation and photosynthesis in the COSMO model
Project lead: M. Tölle (Uni Kassel, Germany)

KENDAscope: Further improving and extending the KENDA data assimilation system and using observations in view of better convective-scale deterministic and ensemble forecasts with ICON-LAM, particularly for weather-related quantities
Project lead: C. Schraff (DWD)

COSMO Priority Project C2I

Transition of COSMO to ICON

CONSORTIUM FOR SMALL SCALE MODELING
COSMO

Overview

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Phase 1

- ICON Training 2018
- Installation
- Setup
- First experiments

Q2 2018 – Q4 2018

Phase 2

- Daily forecasts
- Verification

Q1 2019 – Q2 2020

Phase 3

- Daily forecasts
- Verification
- Data assimilation
- Forecasters' feedback

Q3 2020 – Q1 2022

PP C2I – Status 09/2020

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	NMA	IMGW	COMET	IMS	HNMS	RHM	ARPAE	ARPAP	CIRA	INMET	CLM
Installation	●	●	●	●	●	●	●	●	●	●	●
Experiments running	●	●	●	●	●	●	●	●	●	●	●
Daily Forecasts	●	●	●	●	●	●	●	●	●	●	●
Verification started	●	●	●	●	●	●	●	●	●	●	●
Data Assimilation	●	●	●	●	●	●	●	●	●	●	●

● Done/Ongoing
● Issues left
● Not yet done
● Does not apply

Outlook ICON

Major changes affecting CLM

Recent and Ongoing Model Development Work

- Limiter for exaggerated overshooting in convection scheme
  - Counteracting cold and moist bias in extratropical tropopause
  - Artificial limiter for overshooting in stable environments (stratosphere)
- Skin-temperature parameterization in TERRA by J.-P. Schulz
  - Improved diurnal cycle for 2m-temperature
  - Revised numerical implementation for stability (Newtonian Relaxation)
- Ongoing: Bug fix in physics-dynamics coupling of turbulence scheme (missing cp/cv factor on temperature tendency for coupling at constant volume) and ensuing retuning work

Turbulence-coupling Bugfix

- Heat budget calculations confirmed that the temperature tendency from the turbulence scheme needs to be adapted to the physics-dynamics coupling at constant volume used in ICON (factor cp/cv)
- Taken in isolation, this change increases daytime temperatures by about 1 K on sunny days
- In regular assimilation cycles, the SMA partly compensates this change, but nevertheless, further tuning is required in order to avoid a pronounced warm bias during the summer months
- The tuning changes involve reverting/revising previous tuning measures against the cold bias we had in winter and spring so far
- In addition, the ecRad radiation scheme will be used in the future model configuration because it provides small radiation biases without prescribing excessive cloudiness; however, there is still an unresolved warm-bias problem in the stratosphere

Most Important (tuning) Changes

- ➔ Turn off artificial reduction of high albedo values in the Sahara
- ➔ Specify a lower threshold for the cloud number concentration over land, yielding higher cloud albedo in regions with very clean air
- ➔ Treat tropospheric sulfate aerosol like stratospheric sulfate aerosol
- ➔ Assume slower sedimentation of cloud ice in order to compensate the cold bias in the upper tropical troposphere induced by ECRad
- ➔ Increase rlam_heat from 1 to 10 in order to reduce the early evening cold bias and the warm bias around noon in order to avoid excessive soil moistening by the SMA

Experiment period for subsequent slides: March 15 – June 15, 2020; reference corresponds to currently operational configuration

Wind, Surface Pressure, T2M, RH2M

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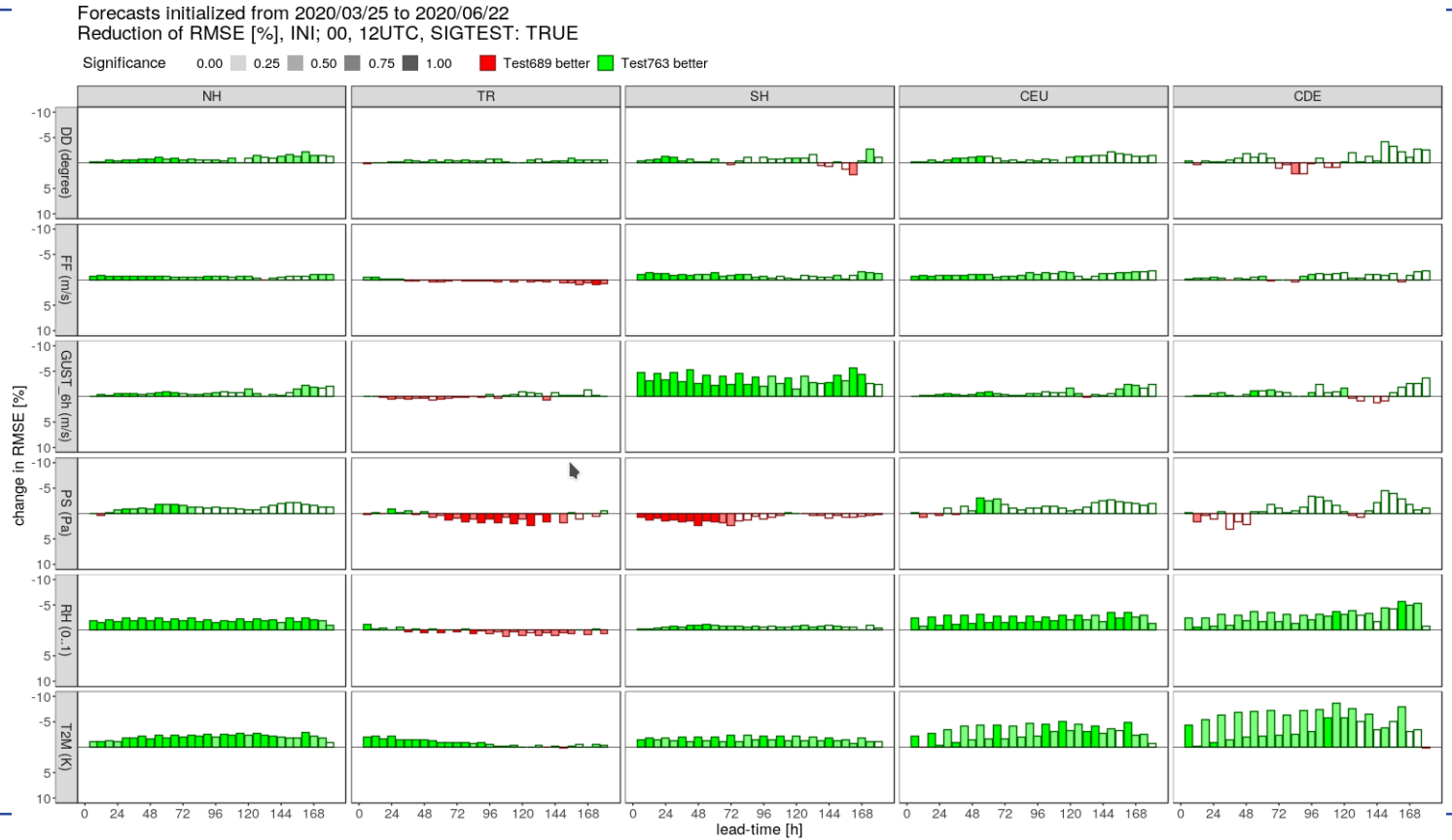

Cloud Cover and Radiation

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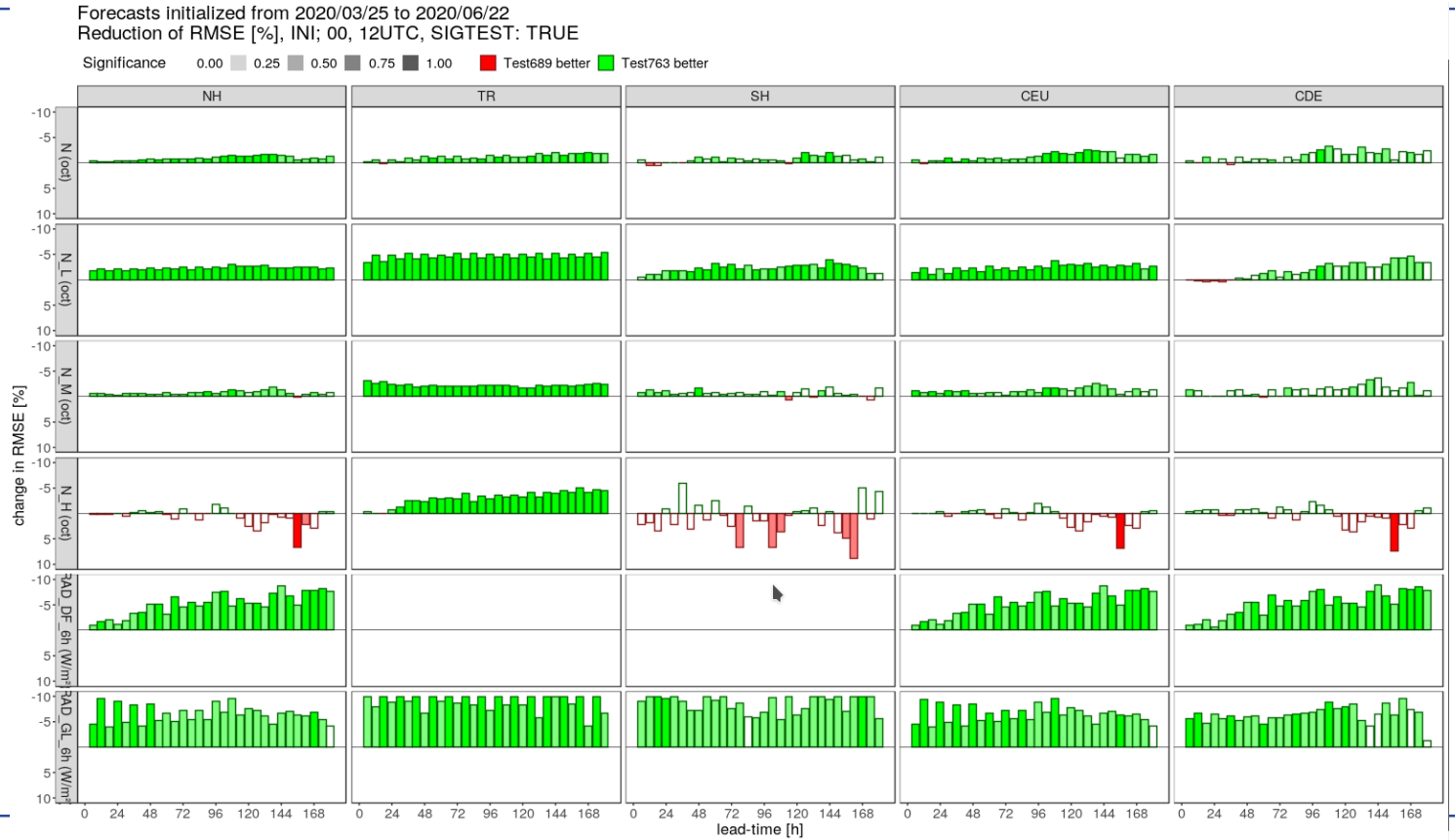

Transition from COSMO-D2 to ICON-D2

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DWD

- Parallel routine with complete data assimilation running since late November 2019
- Since then, our standard verification scores show improvements for nearly all quantities (exception: CLCH) in all months; improvements for T2M and RH2M exceed 20% in several months
- After substantial delays in the migration to our new NEC computer, operationalization of ICON-D2 is now planned for Jan 20, 2021 (exactly 6 years after the start of global ICON forecasts)

ICON Steering Group Summary

Meeting 5 March 2020

- ➔ Responsibility of DKRZ for SW-Infrastructure
- ➔ Preparation of the BMBF National Modelling Initiative
- ➔ Presentation of a common model infrastructure proposal (ICON)
- ➔ Cooperation agreement MPI, DWD, DKRZ, and KIT
- ➔ ICON-ART will be moved to gitlab at DKRZ

ICON Steering Group Summary

Meeting 26 June 2020

- ➔ Main topic: Improve cross-institute coordination of code development for shared code parts
- ➔ Create a list of code parts for which one of the developing institutions has the primary development responsibility.
- ➔ Create a coordination page for development activities in shared code parts. Developers starting a new activity in such code parts are asked to provide a short summary of there planned work and to check for potential conflicts with other ongoing work
- ➔ If conflicting developments happen despite our enhanced coordination efforts, and developers become aware of a potential conflict before an upcoming backmerge into the release candidate, the conflict shall be resolved before the backmerge. In general, resolving such conflicts is the task of the responsible developers.