ICON News

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Deutscher Wetterdienst

News from the ICON Coordination

ICON-Development

- **Latest release 2025.04; next release 2025.10**
- **Homepage** *https://icon-model.org*
- **Working towards stronger modularization of code**
  Cleaner structure and interfaces (e.g. ComIn)
  Inclusion of additional languages in ICON (C++, Kokkos, python)
- **Working towards open development**
  Documentation https://docs.icon-model.org
  CI/CD: style checks, buildbot

Highlights

- **ICON is Gordon Bell prize finalist in 2 submissions**
  DestinE coupled model
  Full 1km Earth System Model (including carbon cycle, …)
- **ICON running on all exascale Euro-HPC machines**
  (JUPITER, LUMI, LEONARDO, MARENOSTRUM, ALPS)

Courtesy of L. Schlemmer

Documentation

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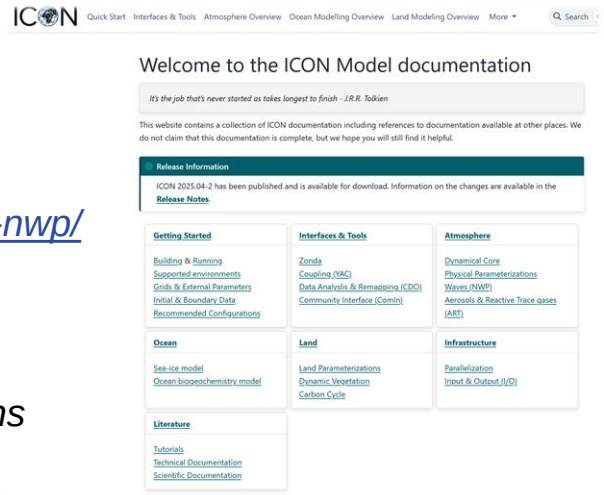
Wetter und Klima aus einer Hand

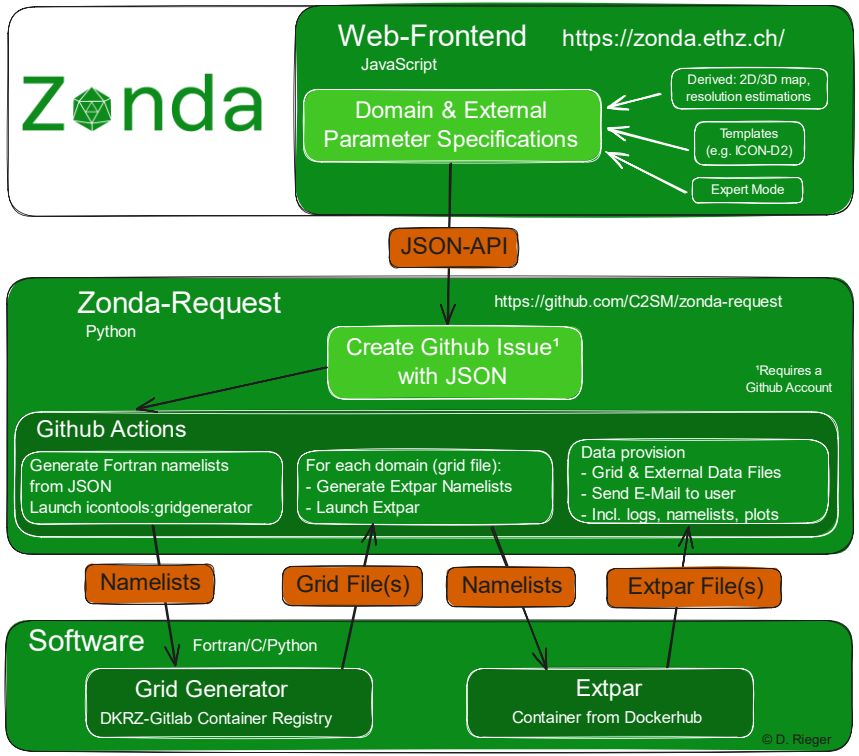
docs.icon-model.org

- **Part of the source code**
  Markdown files inside the folder **`doc/www`**
- **HTML generated in Gitlab's CI**
  For latest commit in each merge request
  For **`icon-nwp:master`** *https://icon.gitlab-pages.dkrz.de/icon-nwp/*
  For **`icon:main`** *https://icon.gitlab-pages.dkrz.de/icon/*
  For latest **`release`** *deployed to https://docs.icon-model.org*
- **Frequently updated & fast growing**
  95 merge requests with documentation label in the last 4 months



Still far away from 'complete', but it took the first few steps into the right direction!

Grid & Extpar web interface ‘Zonda’

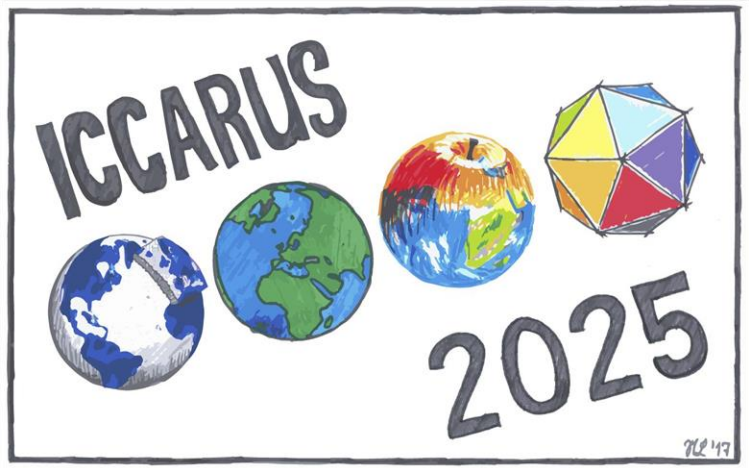


https://zonda.ethz.ch

- **Web interface**
  EXTPAR data
  on ICON triangular grids
- **For research and on-demand simulations**
  Only a github account required
- **Based on containers**
  Easily portable
  Local version available at DWD
- **Joint project**
  ***C2SM**, MeteoSwiss and DWD*
- **Documentation available**
  https://zonda.ethz.ch/docs

ICON-NWP Updates: Summary ICCARUS

- **ICON-D05 and ICON-A05**
  ICON-D05: (Technical) operationalization (500 m over Germany)
  ICON-A05: quasi-operational 500-m forecasts for TEAMx
  Including corresponding model development
- **Further steps in adaptive parameter tuning (APT)**
  Several extensions, also after ICCARUS
- **Revision of ensemble perturbations in global EPS**
  revised EPS perturbations in convection scheme
  combined with reducing the SST perturbations by 25%
- **Upgrades in ICON-D2(-RUC)**
  Several changes to microphysics and convection
  TERRA-URB
  Revised gust parameterization
- **Preparation of resolution enhancement in global EPS**
  Significant improvement at the surface and, to a lesser extent, in the lower troposphere
  No time planning yet (cause: storage hardware)



ICON-NWP Updates: Part I

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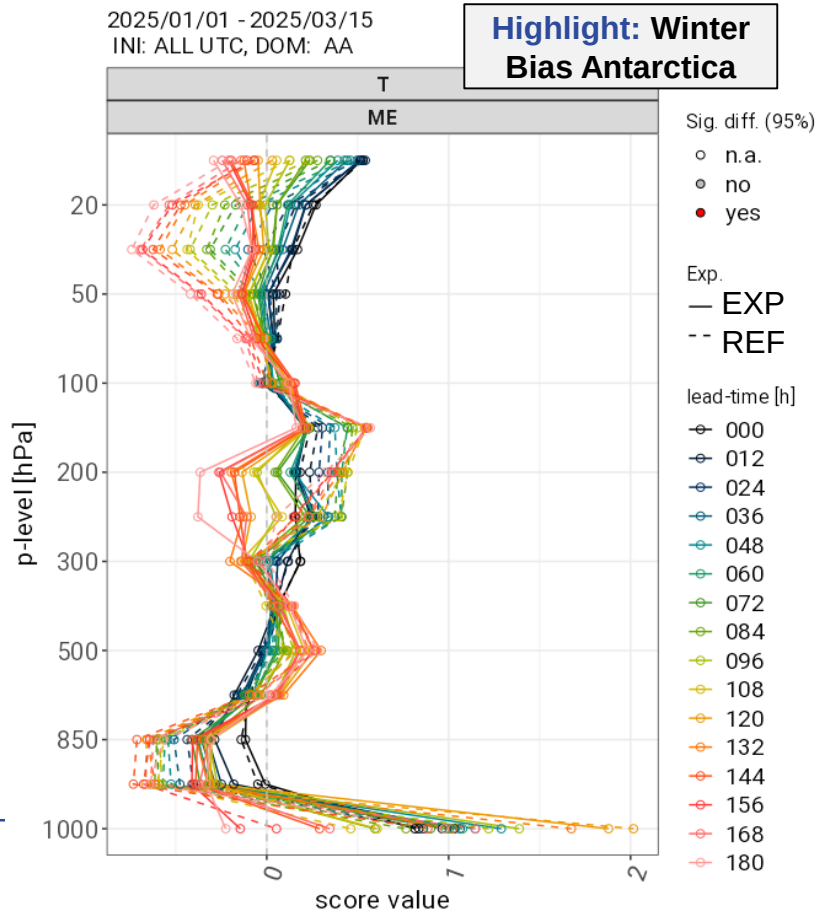
Wetter und Klima aus einer Hand

Update package

- **SST warm-layer-scheme**
  account for diurnal cycle
- **Consider momentum dissipation heat** ⚠
  with eq. from momentum dissipation
- **Using `tkhmin` for TKE**
  Improved consistency
- **Modifications to ozone**
  tropopause coupling, reduction of stratospheric tuning
- **Tuning systematic bias differences**
  between ENS mean and DET
- **Land-tile averaging in DA**
  already used for verification
- **Sub-grid-scale glaciers**
  Fix bug in evaporation, ad-hoc fix for wrong land-use data



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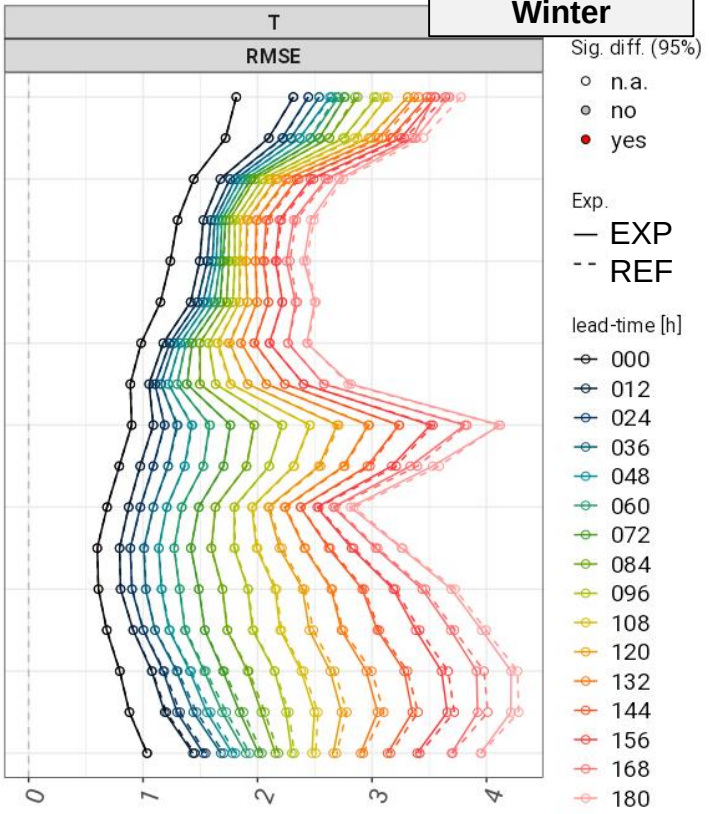
NH RMSE in Winter



ICON-NWP Updates: Part I

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Following slides provide some more details on:

- **SST warm-layer-scheme**
  account for diurnal cycle
- **Consider momentum dissipation heat**
  with eq. from momentum dissipation
- **Using `tkhmin` for TKE**
  Improved consistency
- **Modifications to ozone**
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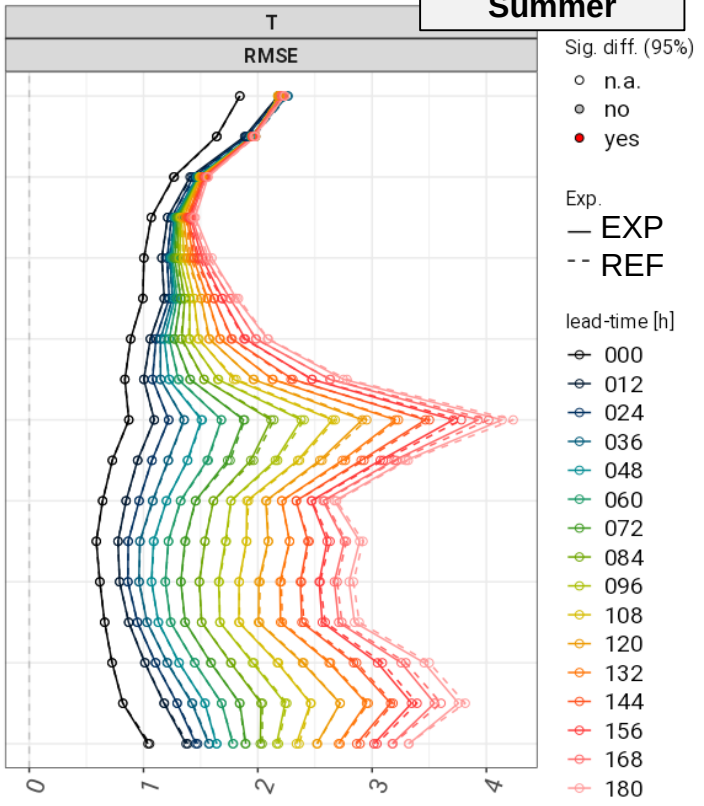
NH RMSE in Summer



ICON-NWP Updates: Part I

Consider momentum dissipation heat

- **Simple parameterization**
  for momentum tendencies from SSO & GWD

$$\frac{dT}{dt} = \frac{1}{c_v}\left(-u \cdot \frac{du}{dt}\right)$$

- **Using param. from turbdiff (`ltmpcor=.true.`)**
  Reduction of cold bias in winter (esp. Antarctic coast)
  Numerically not stable ☹
- **Pragmatic solution: use simple param.**
  `itype_dissip_heat=2` *(`&nwp_phy_nml`)*
- **Compensating tuning**
  DET: `gkdrag_enh=0.125,0.14`
  ENS: `gkdrag_enh=0.11,0.125`

Using `tkhmin` for TKE

- **Motivation: consistency**
  between TKE and param. vertical diffusion in stable regions without TKE source contributions
- **Tuned version `imode_tkemini=3`**
  Slight improvements in cloud cover
- **Compensating tuning**
  `tune_box_liq_asy=3.1`

SYNOP-Verification DET Jan-Mar 2025

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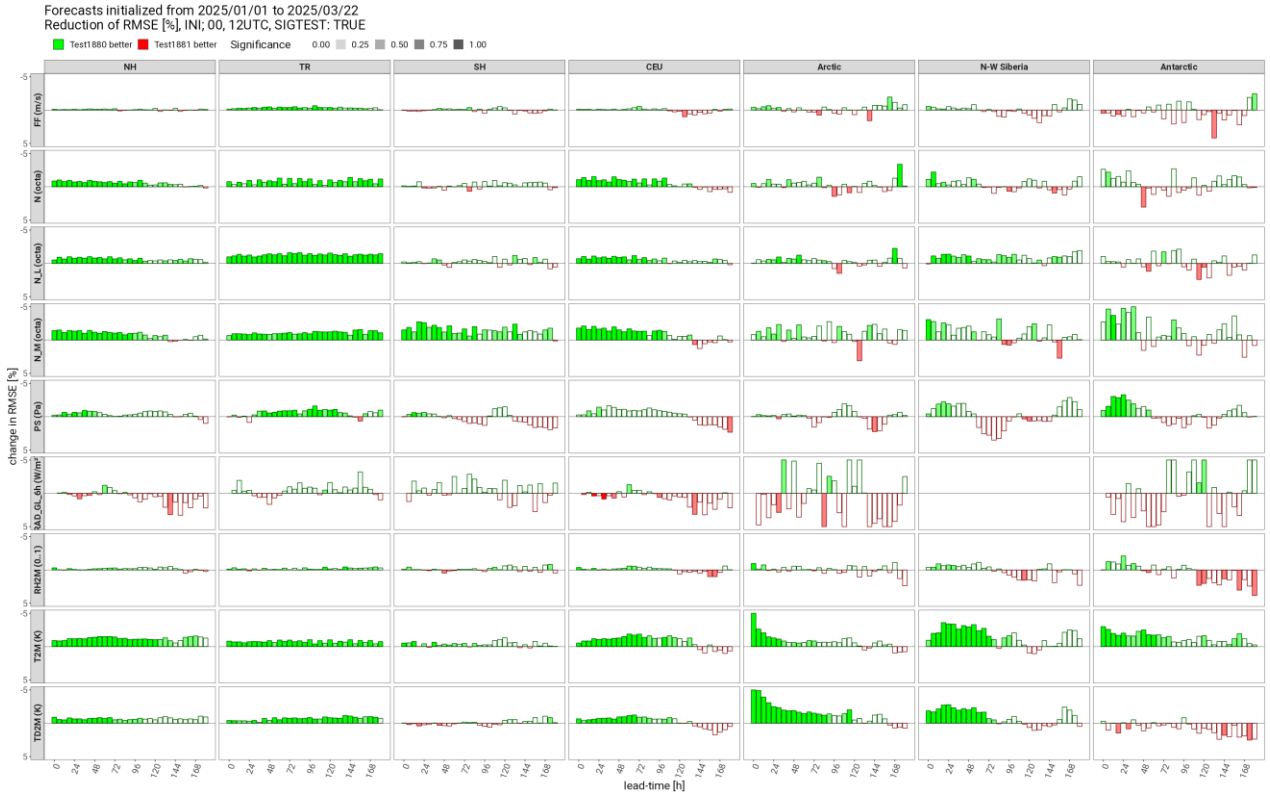

SYNOP-Verification ENS Jan-Mar 2025

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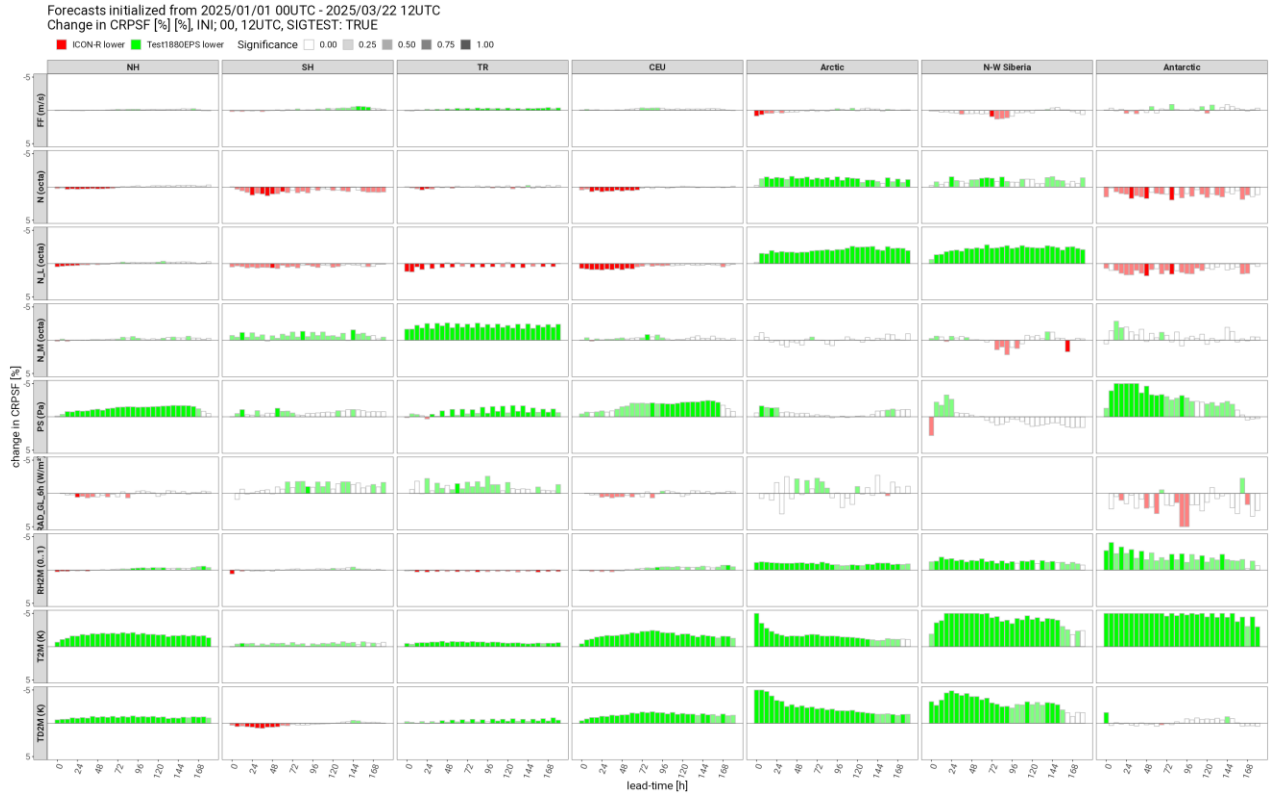

ICON-NWP Updates: Part I - Impact on ICON-D2

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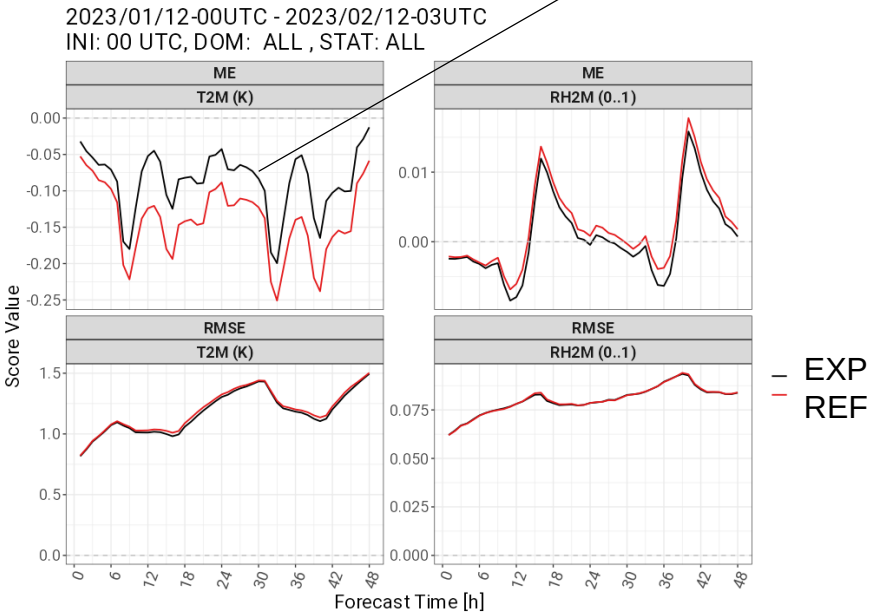
- `imode_tkemini=3`
  slightly worsening of categorical cloud cover verification
  Thus, also no change in box_liq_asy!
- **Bias differences between DET/EPS**
  Significantly smaller in ICON-D2
  Thus, only used for ICON-Global/EU
- **Experiments**
  DJ 2023/24, JJA 2024, FM 2025
- **Summer**
  no significant impact on precipitation
  slight improvements in T2M (about 0.5%)
- **Winter**
  T2M improvement about 2%
  slight improvements in PS and TD2M

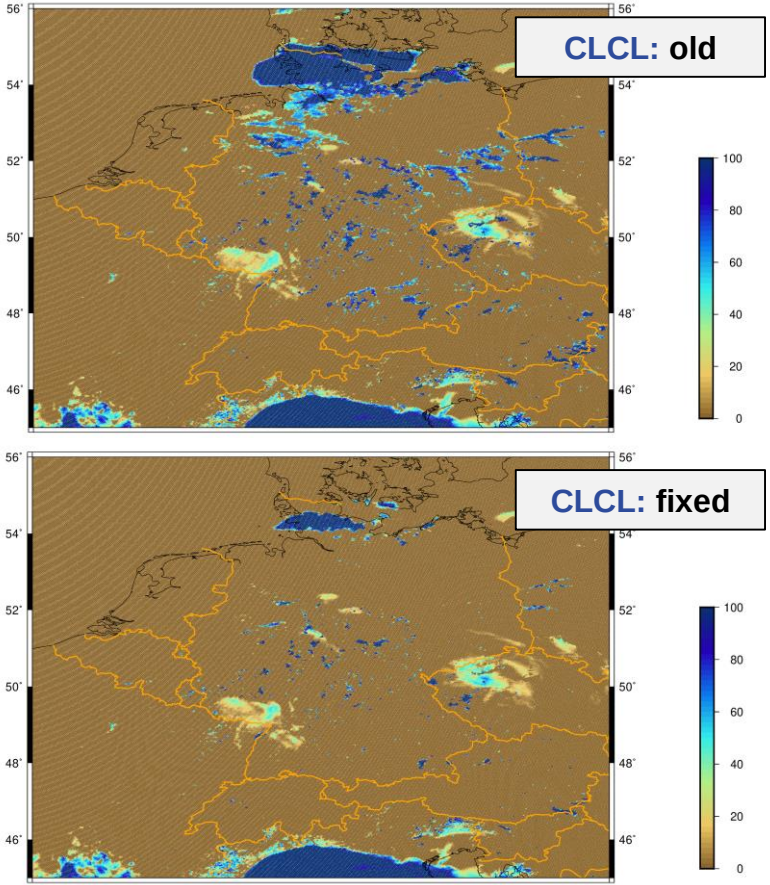
Effect of
`itype_dissip_heat=2`



ICON-NWP Updates: Part II

Correction of rime deposition ⚠

- **Background: ground fog overestimation**
  ICON-D2, several dates in March 2025
- **Bug in TERRA**
  Basically no rime deposition on snow free surfaces
- **Correction worsened the results under certain conditions**
  Thus: Retuning of interception storage evaporation
- **Retuning (global, EU, D2)**
  `cwimax_ml = 7.5e-4` *(so far* `5.e-4`*)*
  `tune_eiscrit = 5` *(so far* `7`*)*



ICON-D2, January 2025

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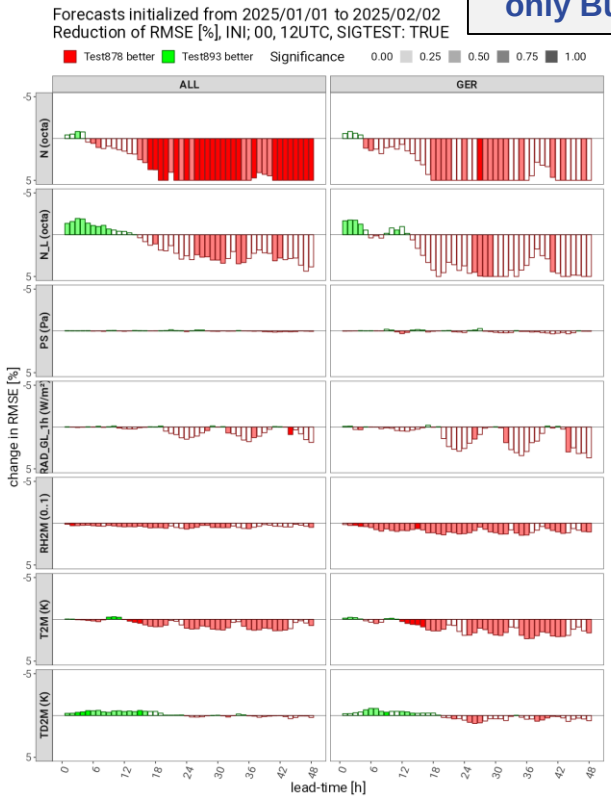
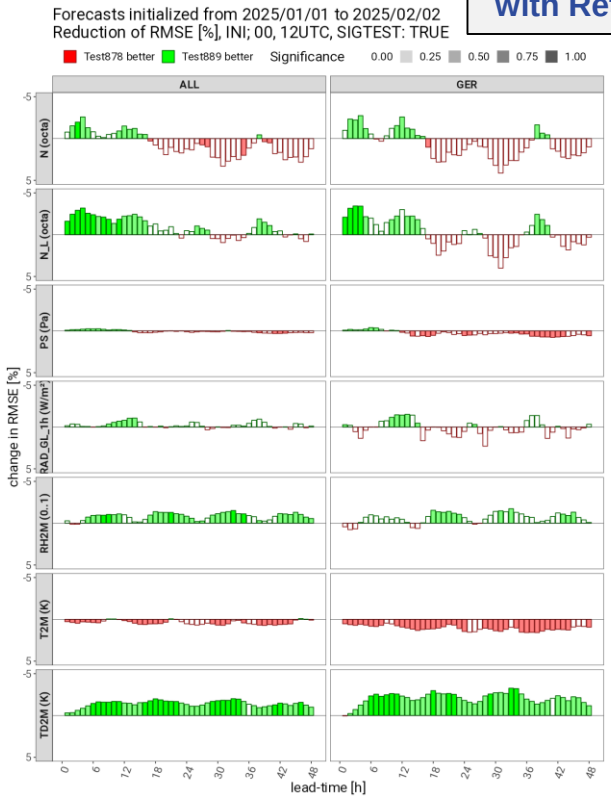
only Bugfix



with Retuning



ICON-D2, March 2025

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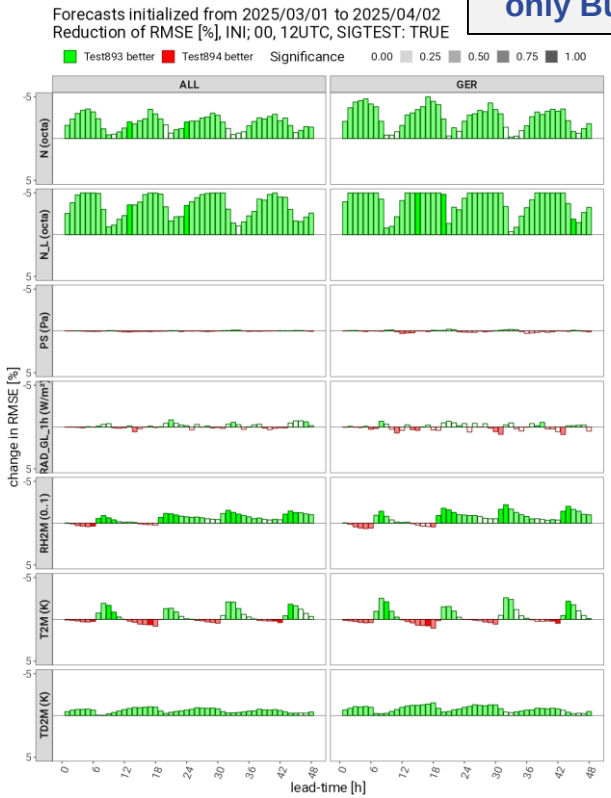
only Bugfix



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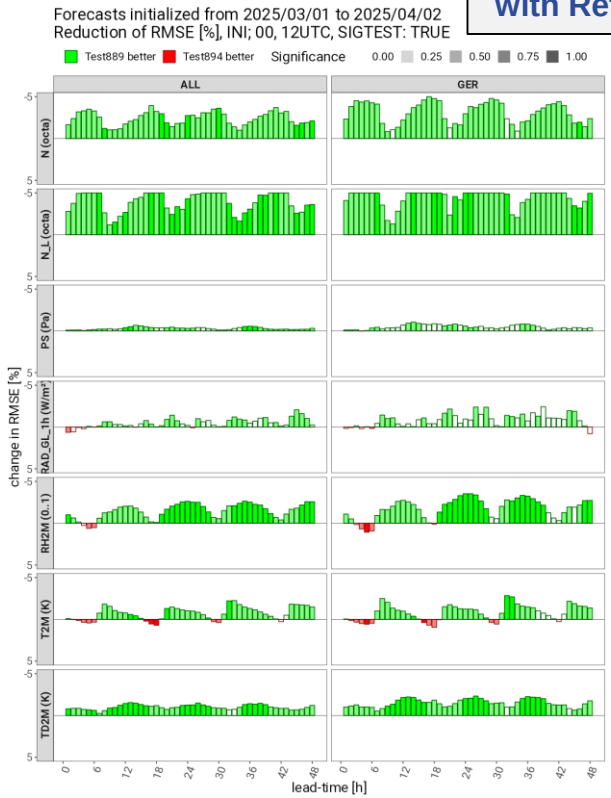

ICON-NWP Updates: Part II

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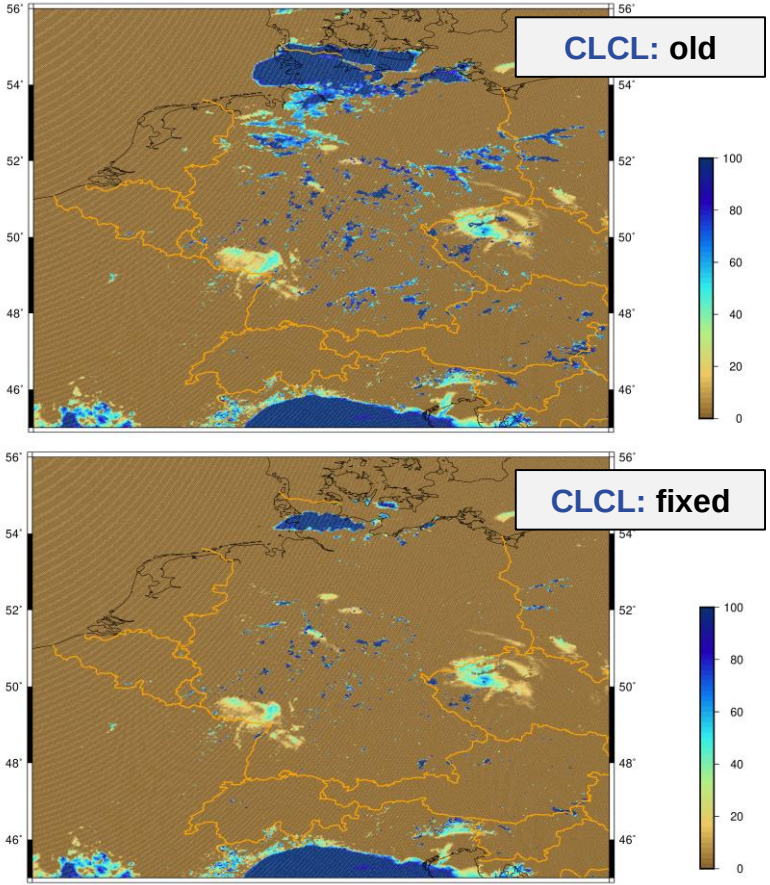
Summary of the Results

- **Impact of rime deposition fix varies**
  Due to feedback with errors from different sources
- **Retuning advantageous**
  In all tested months (Oct 2024 – March 2025)
- **Reduction dry bias**
  for anticyclonic conditions in autumn/winter
- **Improved diurnal cycle RH2M**
- **Worsening in January due to rime deposition**
  Only partly counteracted by retuning
  subsequently improved by Part III changes



ICON-NWP Updates: Part III

Update cloud cover diagnostic below PBL inversion

- **Used in ICON-Global since 2023**
  Reduce neg. cloud cover bias in Sc regions (tropical oceans)
- **Inversion diagnostic**
  Increase cloud cover in RH transition zone
- **Applicable also for St clouds!**
  Minimal inversion height from 400m to 100m
- **In addition**
  Bugfix in inversion diagnostic
  Change temperature gradient calculation
- **Namelist changes**
  `tune_sc_invmin = 100.` *(global + D2)*
  `tune_sc_eis = 7` *(only D2; was already effective for global)*
  `c_diff = 0.1` *(before:* `0.2`*)*
  `tkhmin = 0.4` *(only D2, before:* `0.5`*)*
- **Highest impact on high pressure systems late autumn and winter**

ICON-NWP Updates: Part III – January 2025

Update cloud cover diagnostic below PBL inversion

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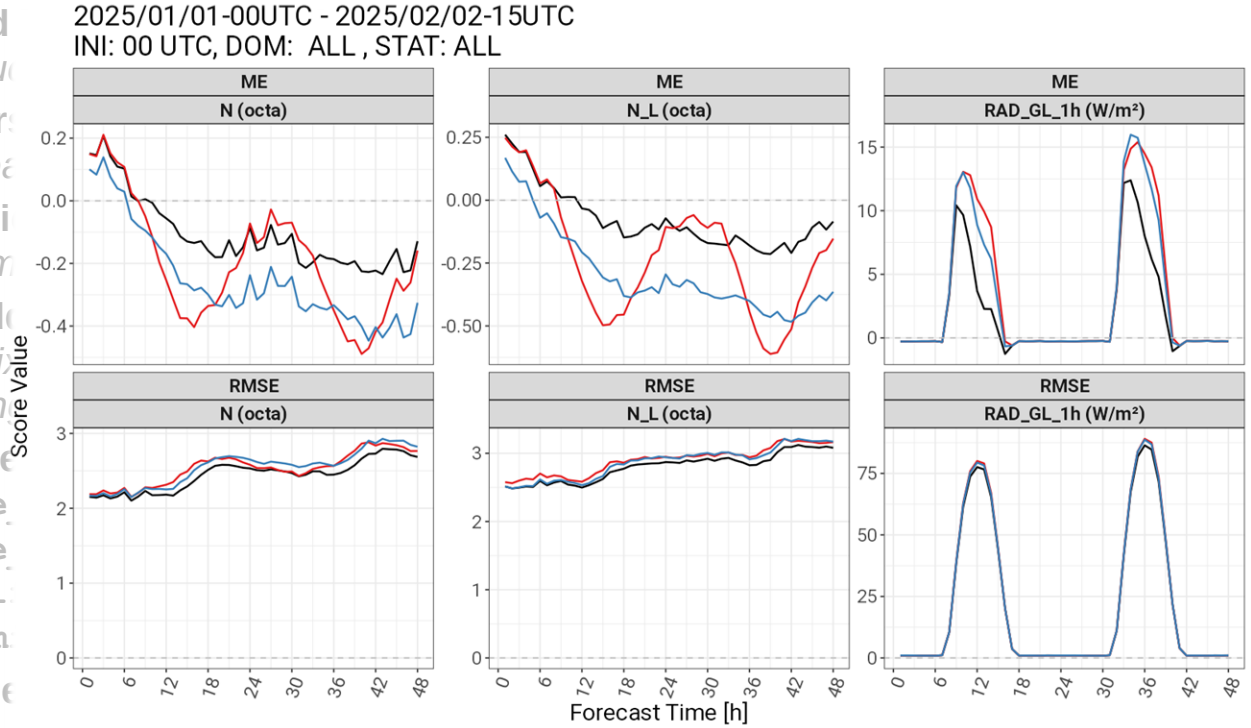

Modified CLC
Routine
(wo. Part II changes)
Reference

Domain
— ALL

Experiment
— Test918
— Test878
— Test889

Questions?

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