Update on Developments for the COSMO-Model

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Contributions for COSMO-Model 5.1

http://www.cosmo-model.org/content/model/releases/histories/cosmo_5.01.htm

Dynamics and Numerics

➔ Targeted diffusion to avoid unrealistic cold pools in narrow valleys: performs 2nd order diffusion on temperature, but only for grid points where the deviation from the reference state temperature is much larger than for surrounding grid points.

➔ Reformulation of divergence damping coefficients in the new fast-waves solver to improve the behaviour over steep slopes and improve numerical stability in complex terrain.

➔ Adaptation of Runge-Kutta dynamical core to SPPT.

➔ Usage of explicit formulation of lateral Davies relaxation is now mandatory:

  ➔ Removed namelist variables `lexpl_lbc, crltau`.

  ➔ Introduced namelist variable `crltau_inv` (which is `1/crltau`): with `crltau_inv=0` the relaxation can be switched off completely.
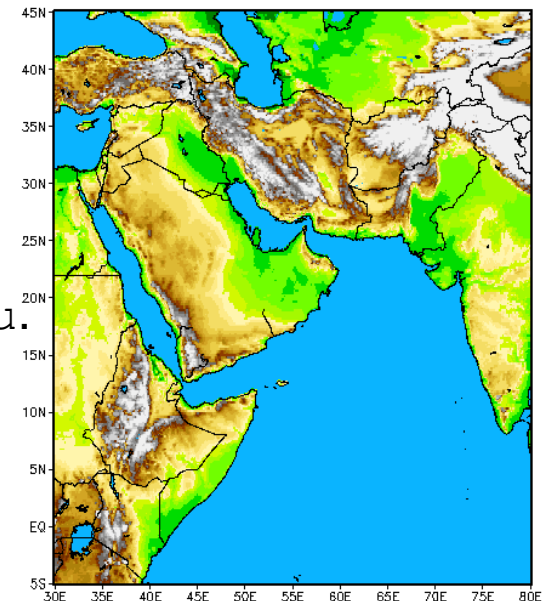
Physical Parameterizations

➔ Implemented possibility for Stochastic Perturbations of Physical Tendencies: SPPT is activated by the new namelist switch lsppt: 3D random number fields are produced to modify the tendencies from the paramerizations.

➔ Advection of TKE: the namelist switch `lprog_tke` now activates advection of TKE for all settings `of itype_turb` (for `itype_turb=3`, `SQRT(2*TKE)` is advected.

➔ Horizontal diffusion of TKE has been activated for the prognostic TKE schemes in case of 3D turbulence (`l3dturb=.TRUE.`) and an additional horizontal shear mode (`itype_sher=3`).

➔ Consolidation of tracer module: Some inconsistencies in the treatment of the microphysics tracers, which have arisen historically, have been removed from the code (e.g. clipping, enforcement of zero-gradient boundary conditions for some tracers).

Physical Parameterizations (II)

→ COSMO-ICON Microphysics

  → All microphysics schemes have been implemented in own modules (`gscp_kessler, gscp_hydor, gscp_cloudice, gscp_graupel`) using the blocked data structure `(nproma,k)` together with an interface module `gscp_interface`, which is called from `organize_physics`.

  → To use the blocked data structure, all input variables for the microphysics have to be copied from the `(i,j,k)` COSMO structure to the blocked structure. This is due to the desired common COSMO-ICON physics.

  → Improved supercooled liquid water content (new namelist switch `lsuper_coolw`): reduced rain freezing rate, depositional growth of ice and snow at cloud top and the number of ice crystals.

  → Cloud ice sedimentation has been implemented in `gscp_cloudice` and `gscp_graupel`. Adapted sticking efficiency accordingly and implemented a limitation for maximum evaporation.

Assimilation

➜ Implemented interfaces for the radar forward operator EMRADSCOPE (*Efficient Modular RADar SCanning forward OPErator*) to simulate synthetic radar images. Note, that the code itself is not yet available together with the model.

➜ New option to assimilate Mode-S aircraft observations. This is activated by the new namelist switch `lcd146=.TRUE.`

Technical Changes

➔ GRIB2 and grib_api: grib_api has been implemented and can now also work with GRIB2. But we still do not recommend to use GRIB2, because the documentation is not finished. Note that reading DWD GRIB2 data (ICON, COSMO-EU, etc.) should be possible in INT2LM without problems.

➔ Single Precision Version: Usage of single precision for the COSMO-Model has been reconstructed. The KIND-parameter `ireals` has been renamed to `wp` (working precision), which could be set to `sp` (single precision) or `dp` (double precision: default). In single precision, the model runs faster, because of less memory traffic, but the results are slightly different to double precision. Note that the data assimilation is not yet working with single precision.

➔ Changes in restart functionality: The directory `ydir_restart` has been replaced by `ydir_restart_in` and `ydir_restart_out`. For output restart files the status while opening has been changed to `UNKNOWN`. Existing restart files are now overwritten without notice.

Technical Changes (II)

→ Changes in reading namelist input: All calls to reading namelist groups have been extended with the new entry `IOMSG`. This returns more precise error messages, if a namelist group could not be read. This is a Fortran2003 feature.

→ Reformatting of `YUSPECIF`: The format of the output of several namelist groups has been adapted for a better reading by the CLM Namelist tool.

→ Check for NaNs in the main program: Such a check has been implemented for the prognostic variables. If a NaN is found, the program will abort. This is helpful, if a compiler would not abort in such a case, but continue to produce NaNs. The check looks like:

```
IF (field(i,j,k,l) /= field(i,j,k,l)) THEN

    there is a NaN value in field(i,j,k,l)

ENDIF
```

External Contributions: Online Trajectory Module

➔ An online trajectory module has been implemented into the COSMO-Model. For documentation see COSMO Technical Report Online Trajectory Module in COSMO: A short User Guide

➔ Work has been done by ETH Zürich (A.K. Miltenberger, A. Roches, S. Pfahl, H. Wernli)

Ongoing Developments

COSMO-ICON Physics

➔ All physical parameterizations will be ported to the blocked data structure in the next weeks / months. The following parameterizations have been significanctly changed in ICON. These changes have to be tested now also in the COSMO-Model:

➔ prognostic TKE turbulence scheme

➔ soil model TERRA

➔ The old versions of the parameterizations will remain in the code for some time, but to activate them needs some changes in the source code.

More POMPA Developments

→ In the last years the COSMO POMPA Project (Performance on Massively Parallel Architectures) worked on delivering a COSMO version which can run on GPUs. A prototype has been delivered end of last year.

→ These developments will be integrated into the official COSMO Version in the near future. But it could take some considerable time until this version will be available for public use.

COSMO-Model 5.2

➔ A new model version 5.2 can be expected during summer.

➔ You can get informations from:

   ➔ http://www.cosmo-model.org/content/model/releases/default.htm

Thank you

very much

for your

attention