# Implementation of TERRA-URB into COSMO-Model 6.0

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# Why Are We So Late?

→ Because of the tile-approach, there are quite some technical modifications to the code.

→ In order not to disturb other developments, I wanted to add TERRA-URB as last modificaton, but it turned out that development and testing of the new multi-layer snow scheme SNOWPOLINO took longer than expected: official implementation was aimed for summer / autumn 2020, but still has not finished.

→ Therefore I started implementation of the tile-approach beginning of this year.

# Implementation of the Tile-Approach in 5.09

→ Only the tile-approach, not yet the urban parameterization!

→ Implementation is different to 5.05_urb"x":

  → 5.05_urbx: tile variable tl_<name> and I/O variable z<name>; with several hacks for I/O

  → 5.09: only variable <name> with tiles and used for I/O: Therefore needed restructuring of I/O (now with 5D pointers), but can avoid the hacks

→ Also did a proper implementation of the GPU code: Needed modifications to GridTools dycore and the serialization procedure.

→ If running with ntiles=0, results do not change compared to former versions.

# Adding the TERRA-URB Code

➔ Additional fields in data_fields.f90, data_block_fields.f90, src_allocation.f90, src_block_fields_org.f90, src_setup_vartab.f90

➔ Modifications to read / write and initialize these fields in src_input.f90, organize_data.f90, lmorg.f90

➔ New modules: sfc_ahf.f90, sfc_tile_approach.f90

➔ New namelist variables in organize_physics.f90: lterra_urb, lurbfab, ntiles, itype_ahf, itype_eisa, itype_kbmo_uf

➔ Modifications to the parameterizations

    ➔ Radiation: modified computation of zalso, zalth

    ➔ Turbulence: added fields sa_uc, kbmo (turbtran) and modified subroutine init_canopy (turb_utilities)

    ➔ Soil Model: added (activated) code from 5.05_urb7

➔ A first test with the Torino-case run successfully.

# Issues for Investigation / further Development

→ GPU implementation of new code is not yet working.

→ Restarts in NetCDF: not tested yet with tile-approach

→ Radiation, subroutine surface_albedo: how to compute ralth in case of lemiss?

→ Treatment of external parameter field skinc: different than in official COSMO version, which does not have a scaling with factor cskinc. Which one is correct?

→ Treatment of additional developments: new hydrology scheme (itype_hydmod=1), mires (itype_mire=1)

→ Variables w_imp, w_isa: in version 5.05_urbxx these variables were practically deactivated (set to 0.0 at the beginning of terra)???

# Differences between Versions 5.05 and 5.09

➔ Changes of results:

  ➔ sfc_terra.f90 has been updated with ICON version; fixed a few issues:

    ➔ Due to implementation of mires, an expression (eai(i)/sai(i)) has been replaced by a local variable, which changes order of computation → numerical differences.

    ➔ Numerical stability bug fixes for soil ice freezing / melting

    ➔ Distinction between density for new snow and graupel

    ➔ Increased hydraulic conductivity for clay (variable ckw0(7) in sfc_terra_data.f90)

  ➔ gscp_graupel.f90: bug fix in the terminal fall velocity

  ➔ conv_shallow.f90: bug fix because of using a wrong k-index

  ➔ seaice scheme: forgot to update t_s after melting seaice

# Differences between Versions 5.05 and 5.09

➔ Changes of namelists (only highlights):

➔ DYNCTL: new option (BOTT_DC2) for y_scalar_advect: it is not necessary to use it, but it saves computational time, while having the same stability properties as BOTT2_STRANG (but modifies results).

➔ PHYCTL

➔ new variable itype_mire (0: no mires (default); 1: using mires): but has not been tested for TERRA-URB

➔ new variables: itype_hydmod (0: old scheme (default); 1: new hydrology scheme from L. Schlemmer); lsoil_init_fill: but has not been tested for TERRA-URB

➔ REMOVED: nradcoarse, lradf_avg: no more coarse radiation grid

➔ REMOVED: cimpl: because of modifications to itype_canopy=2

# And Now:

➔ Test, test, test…