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Changes in the last official and MeteoSwiss COSMO versions

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COSMO User Workshop, 17.1.2012



COSMO (last versions from DWD)

- 4.14
 - In `hydc_i_pp` (`itype_gscp=3`) the density correction of the terminal fall velocity of raindrops and snowflakes is now taken into account
- 4.15
 - New vertical advection discretisation option (3rd order implicit)
- 4.17
 - New `src_artifdata.f90` for a convenient setup of idealized simulations using a new namelist `INPUT_IDEAL`



Idealized COSMO Configurations

- Setup of ideal cases via a new namelist `INPUT_GEN`
- No need to recompile executable for each case
- Only changes to `src_artifdata.f90`, no other code touched
- Ideal for rapid/automatic testing of the model with idealised cases
- More or less easy to adapt



Vertical coordinate

```

!-----
!
! VERTICAL COORDINATE  Namelist for the definition of the vertical
!                       coordinate
!
!
! ivctype  Index denoting type of vertical coordinate
!          = 1, pressure-based vertical coordinate (default)
!          = 2, height-base vertical coordinate
!          = 3, SLEVE vertical coordinate
!
! vcflat   Height at which levels are flat (same unit as vcoord)
!
! vcoord   Vertical coordinate of COSMO. If ivctype=1 it is given
!          in dimensionless sigma=p/p0 values, if ivctype=2,3 it
!          is given in meters. Must supply ke+1 values. If -1 is
!          specified, default levels are chosen.
!
! nfltvc   If ivctype=3, number of filter applications for splitting
!
! svc1     If ivctype=3, vertical decay rate of small scales
!
! svc2     If ivctype=3, vertical decay rate of large scales

```

```

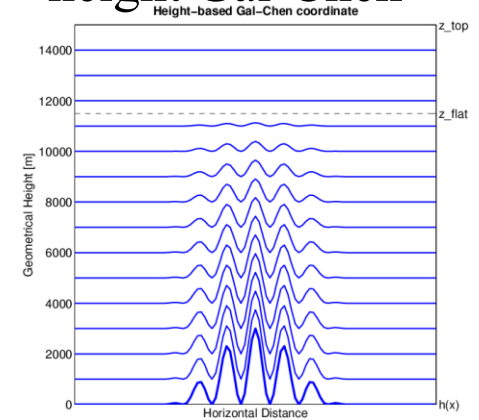
ivctype = 2
vcflat = 11357.0,
vcoordarr=
  23588.50,  22395.93,  21304.04,  20307.39,  19399.95,
  18574.03,  17821.88,  17135.64,  16507.79,  15930.60,
  15396.52,  14897.86,  14427.98,  13981.10,  13551.52,
  13133.53,  12721.37,  12312.04,  11900.03,  11485.37,
  11068.19,  10648.54,  10226.48,   9802.09,   9375.43,
   8946.58,   8515.59,   8082.55,   7647.52,   7210.55,
   6771.96,   6332.38,   5896.41,   5468.04,   5050.84,
   4647.96,   4261.91,   3893.26,   3542.15,   3208.52,
   2892.23,   2593.71,   2312.95,   2049.75,   1803.89,
   1575.57,   1364.68,   1170.90,   993.84,    833.44,
   689.53,    561.52,    448.82,    350.95,    267.55,
   197.67,    137.23,     87.33,     48.44,     20.00,
     0.00,
nfltvc = 100
svc1 = 8000.0
svc2 = 5000.0

```

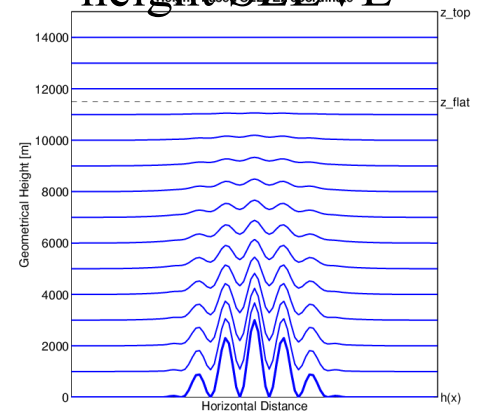
} levels

pressure Gal-Chen

height Gal-Chen



height SLEVE





Topography

!-----

```

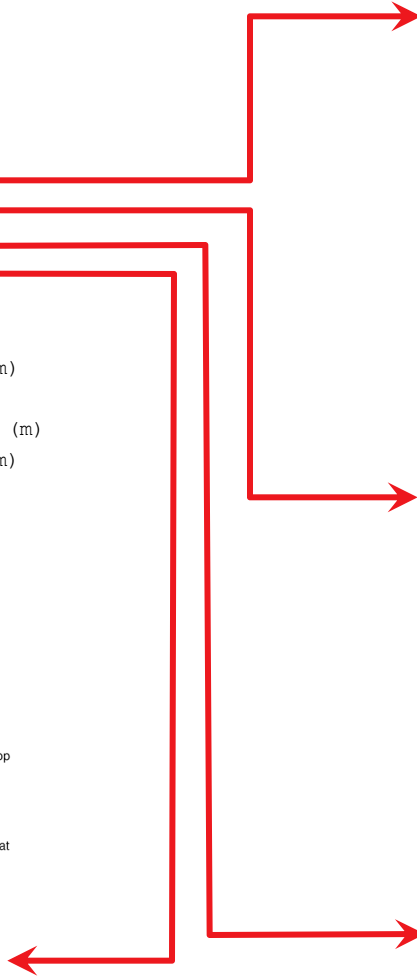
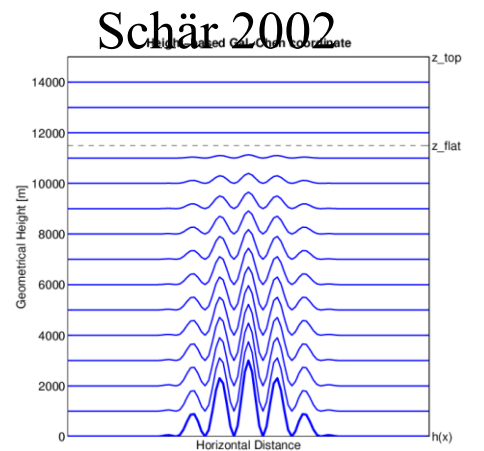
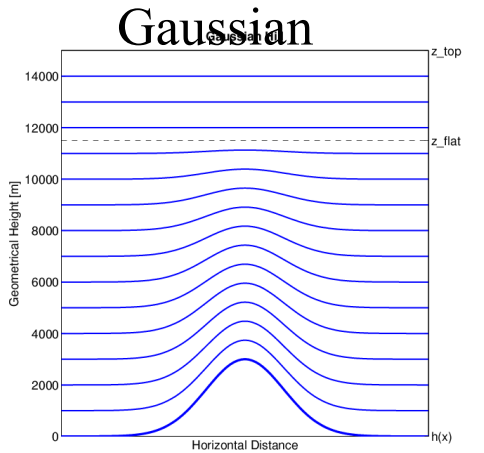
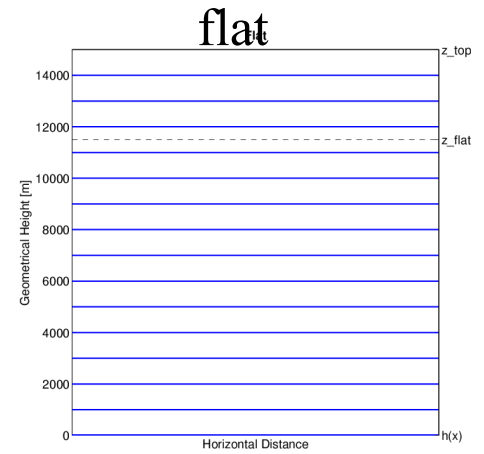
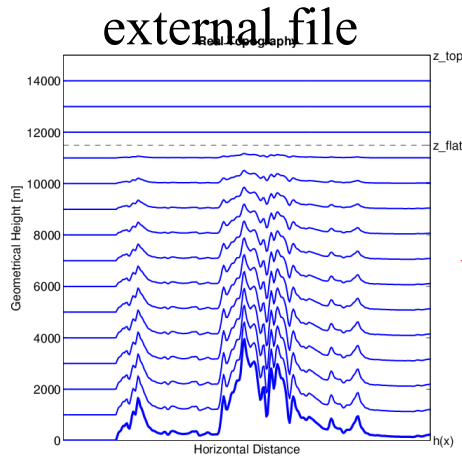
!
! TOPOGRAPHY      Namelist for the definition of the idealized
!                  model topography
!
! itopotype       Index denoting type of topography
!                 = 0, no terrain, flat ground (default)
!                 = 1, Bell-shaped mountain
!                 = 2, Schaer MWR 2002 mountain (in x-direction)
!                 = 20, terrain read from external file
! href            If itopotype=1/2, reference height (m)
! mntheight       If itopotype=1/2, mountain height (m)
! mntwidthx       If itopotype=1/2, half-width of mountain in x-dir (m)
! mntwidthy       If itopotype=1, half-width of mountain in y-dir (m)
!                 If itopotype=2, wavelength of perturbation in x-dir (m)
! mntctrx         If itopotype=1/2, x-coordinate of mountain center (m)
! mntctry         If itopotype=1, y-coordinate of mountain center (m)
! yexttopo        If itopotype=20, name of terrain data file
! iexttopo        If itopotype=20, format of terrain data file.
!                 = 1, Fortran unformatted (default)
!                 = 2, ASCII

```

```

itopotype = 2
href       = 0.0
mntheight = 2000.0
mntwidthx = 25000.0
mntwidthy = 8000.0
mntctrx   = 150000.0
mntctry   = -1.0
yexttopo  = 'topo.dat'
iexttopo  = 1

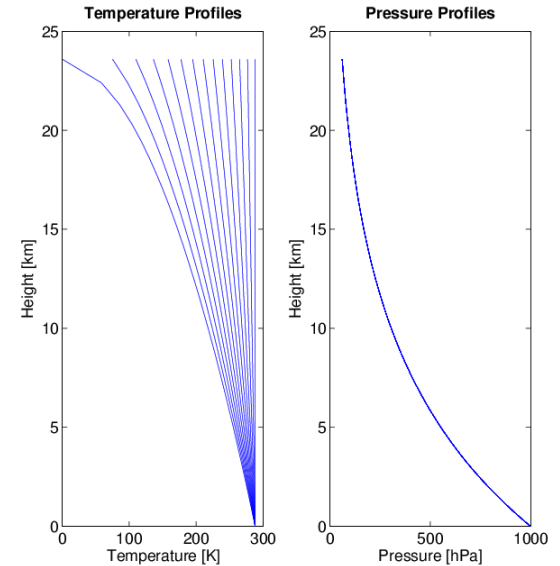
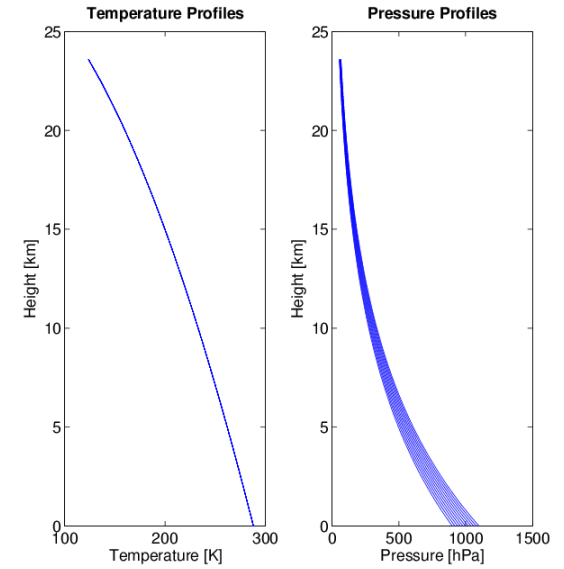
```





Base state

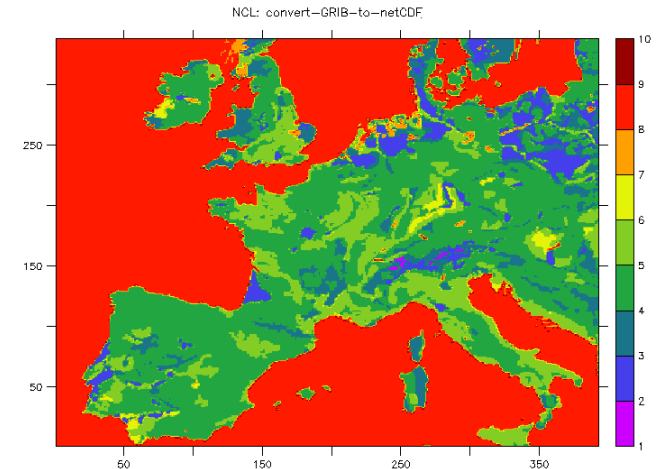
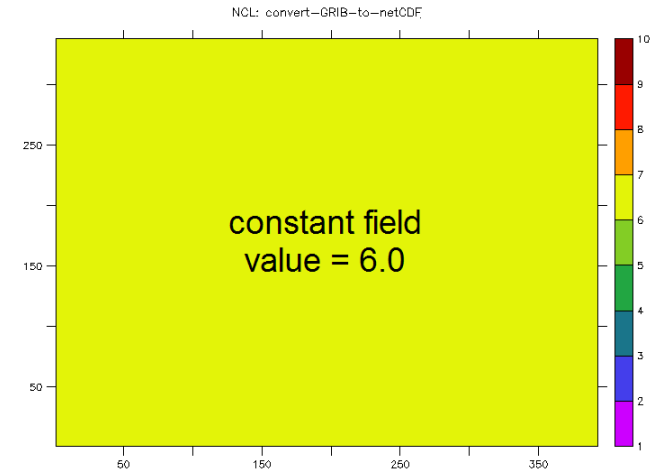
```
!-----  
!  
! BASE STATE   Namelist for the definition of the model base  
!              state  
!  
! ibasetype   Index denoting type of model base state  
!             = 0, no model base state T0=0, p0=0, rho0=0  
!             = 1, constant dT/dlnp atmosphere (default)  
! p0sl       Sea level pressure of base state  
! t0sl       Sea level temperature of base state  
! dt0lp      If ibasetype=1, gradient dT/dlnp of base state  
!  
  
ibasetype = 1  
p0sl = 1.0e5  
t0sl = 288.15  
dt0lp = 42.0
```





Soil Parameters

```
!-----  
!  
! SOIL          Namelist for the definition of the model soil  
!  
! isoiltype    Index denoting type of model base state  
!              = 1, constant soil parameters (default)  
!              = 2, read soil parameters from external grib file  
! z0_c         If isoiltype=1, surface roughness (m)  
! fr_land_c    If isoiltype=1, land fraction (0.0-1.0)  
! soiltyp_c    If isoiltype=1, soil type (class 0.0-9.0)  
! plcov_c      If isoiltype=1, fraction of plant cover (0.0-1.0)  
! lai_c        If isoiltype=1, leaf area index of plants (0.0-...)  
! rootdp_c     If isoiltype=1, depth of the roots (0.0-...)  
! t_soil_c     If isoiltype=1, temperature of soil (K, t_s if <0)  
! t_snow_c     If isoiltype=1, temperature of the snow surface (K, t_s if <0)  
! wf_soil_c    If isoiltype=1, water saturation of soil as fraction of pore volume (0.0-1.0)  
! w_snow_c     If isoiltype=1, water content of snow (m H2O)  
! w_i_c        If isoiltype=1, water content of interception water (m H2O)  
! for_e_c      If isoiltype=1, ground fraction covered by evergreen forest (0.0-1.0)  
! for_d_c      If isoiltype=1, ground fraction covered by deciduous forest (0.0-1.0)  
! yextsoil     If isoiltype=2, grib file containing soil parameters  
  
isoiltype = 1  
z0_c      = 1.0e-5  
fr_land_c = 1.0  
soiltyp_c = 3.0  
plcov_c   = 0.6  
lai_c     = 3.0  
rootdp_c  = 0.7  
t_soil_c  = -1.  
t_snow_c  = -1.  
wf_soil_c = 0.0  
w_i_c     = 0.0  
w_snow_c  = 0.0  
for_e_c   = 0.0  
for_d_c   = 0.0  
yextsoil  = 'soil.grb'
```





Initial Profile (Energy)

```
-----
!  
!  
! INITIAL STATE  Namelist for the definition of the initial  
!                 state of the model atmosphere.  
!  
!  
! ithermptype  Index denoting type of model base state  
!              = 1, 3-layer atmosphere with dT/dz, RH specified (default)  
!              = 2, isentropic atmosphere  
!              = 3, isothermal atmpshere  
!              = 4, constant static stability atmosphere  
!              = 5, analytic thermodynamic sounding (W&K 1982, MWR)  
!                 (t00  
!              = 20, external sounding  
!              = 21, column from external grib file  
!  
! p00          If ithermptype=1/2/3/4/5, surface pressure (Pa, p0sl if <0)  
! t00          If ithermptype=1/2/3/4/5, surface temperature (K, t0sl if <0)  
! zh1          If ithermptype=1, top of first layer (m)  
! zh2          If ithermptype=1, top of second layer (m)  
! zgat1        If ithermptype=1, gradient -dT/dz in first layer (K/m)  
! zgat2        If ithermptype=1, gradient -dT/dz in second layer (K/m)  
! zgat3        If ithermptype=1, gradient -dT/dz in third layer (K/m)  
! zr1          If ithermptype=1, top of first layer (m)  
! zr2          If ithermptype=1, top of second layer (m)  
! zr3          If ithermptype=1, top of third layer (m)  
! zrhb         If ithermptype=1, surface relative humidity (0.0-1.0)  
! zrh1         If ithermptype=1, relative humidity at top of first layer (0.0-1.0)  
! zrh2         If ithermptype=1, relative humidity at top of second layer (0.0-1.0)  
! zrh3         If ithermptype=1, relative humidity at top of third layer (0.0-1.0)  
! nstab        If ithermptype=4, Brun-Vaisala frequency of atmosphere (1/s)  
! wk_pttrop    If ithermptype=5, tropopause potential temperature (K)  
! wk_ttrop     If ithermptype=5, tropopause temperature (K)  
! wk_htrop     If ithermptype=5, tropopause height (m)  
! wk_qvmixed   If ithermptype=5, mixed layer mixing ratio (kg/kg)  
! wk_rhmixed   If ithermptype=5, upper limit of relative humidity (0.0-1.0)  
! wk_mixtop    If ithermptype=5, mixed layer height (m)  
! yextsound    If ithermptype=20, filename of external sounding  
! yextcolumn   If ithermptype=21, filename of grib file  
! icol         If ithermptype=21, i-index of column to extract from file  
! jcol         If ithermptype=21, j-index of column to extract from file  
!  
!
```

- 3-layer atmosphere ($dT/dz, RH=const$)
- Isentropic atmosphere ($d\theta/dz=0$)
- Isothermal atmosphere ($dT/dz=0$)
- Constant static stability ($N=const$)
- W&K 1982 MWR souding
- External sounding (in namelist)



Initial Profile (Momentum)

```
!-----  
!  
! INITIAL STATE Namelist for the definition of the initial  
! state of the model atmosphere.  
!  
!  
! iwindptype Index denoting type of model base state  
! = 1, constant wind components (default)  
! (i.e.  $u(z) = u00$ ,  $v(z) = v00$ ,  $w(z) = w00$ )  
! = 2, 3-layer atomsphere with  $du/dz$  specified  
! = 3, Schaer MWR 2002 wind profile  
! = 5, analytic wind sounding (W&K 1982, MWR)  
! (i.e.  $u(z) = u00 * \tanh(z/zw1)$ ,  $v=0$ ,  $w=0$ )  
! (e.g.  $u00=20.0$ ,  $zw1=3000.0$ )  
! = 20, external sounding (see yextsound above)  
! = 21, column from external grib file (see yextcolumn,icol,jcol above)  
! u00 If iwindptype=1/2, x-component of wind at surface (m/s)  
! If iwindptype=3/5, wind at  $z \rightarrow \infty$   
! v00 If iwindptype=1/2, y-component of wind at surface (m/s)  
! w00 If iwindptype=1/2, z-component of wind at surface (m/s)  
! zw1 If iwindptype=2/3, top of first layer (m)  
! If iwindptype=5, scaling height for wind profile  
! zw2 If iwindptype=2/3, top of second layer (m)  
! zgu1 If iwindptype=2, gradient  $du/dz$  in first layer (1/s)  
! zgu2 If iwindptype=2, gradient  $du/dz$  in second layer (1/s)  
! zgu3 If iwindptype=2, gradient  $du/dz$  in third layer (1/s)  
! zgv1 If iwindptype=2, gradient  $dv/dz$  in first layer (1/s)  
! zgv2 If iwindptype=2, gradient  $dv/dz$  in second layer (1/s)  
! zgv3 If iwindptype=2, gradient  $dv/dz$  in third layer (1/s)  
! zgw1 If iwindptype=2, gradient  $dw/dz$  in first layer (1/s)  
! zgw2 If iwindptype=2, gradient  $dw/dz$  in second layer (1/s)  
! zgw3 If iwindptype=2, gradient  $dw/dz$  in third layer (1/s)
```

- Constant wind ($u=\text{const}$)
- 3-layer atomsphere ($du/dz=\text{const}$)
- Schaer 2002 MWR profile
- W&K 1982 MWR profile
- External sounding (in namelist)

```
iwindptype = 3  
u00 = 10.0  
v00 = 0.0  
w00 = 0.0  
zw1 = 3000.0  
zw2 = 5000.0  
zgu1 = 0.0  
zgu2 = 0.0
```



Perturbation

```
!-----  
!  
! PERTURBATION  Namelist for the definition of the perturbations  
!               to be introduced into the atmosphere  
!  
!  
! iperttype  Index denoting type of perturbation  
!           = 0, no perturbation (default)  
!           = 1, temperature bubble disturbance  
!           = 2, random temperature perturbations  
!  
! ptpert0    If iperttype=1/2, magnitude of temperature perturbation (K)  
! ptradx    If iperttype=1, x-radius of perturbation bubble (m)  
! ptrady    If iperttype=1, y-radius of perturbation bubble (m)  
! ptradz    If iperttype=1, z-radius of perturbation bubble (m)  
! ptctrx    If iperttype=1, x-center of perturbation bubble (m)  
! ptctry    If iperttype=1, y-center of perturbation bubble (m)  
! ptctrz    If iperttype=1, z-center of perturbation bubble (m)  
  
iperttype = 0  
ptpert0   =   2.0  
ptradx    = 2000.0  
ptrady    = 2000.0  
ptradz    = 2000.0  
ptctrx    = 33000.0  
ptctry    = 33000.0  
ptctrz    = 2000.0
```



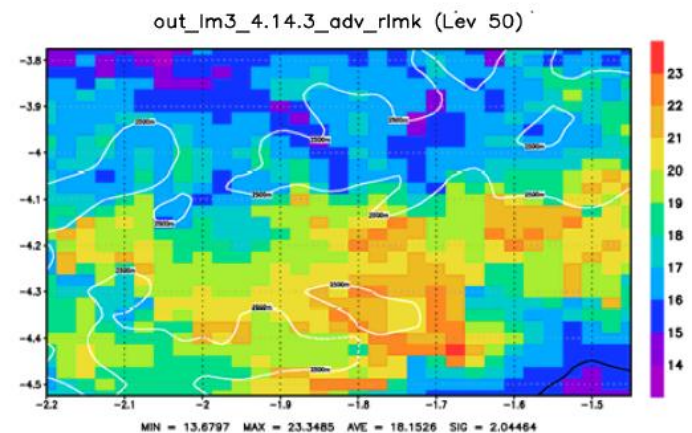
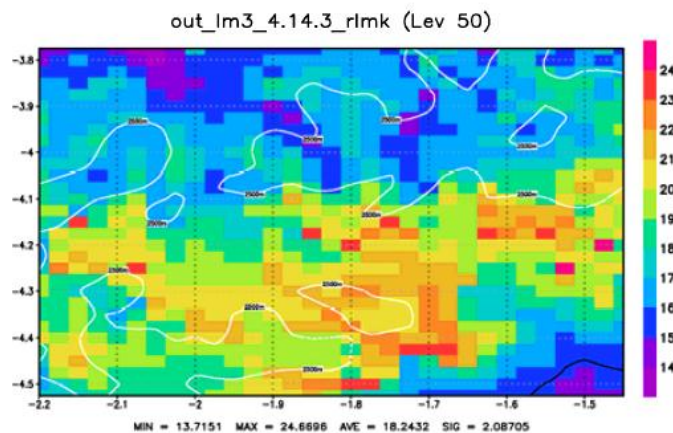
- **Temperature bubble**
- **Random temperature perturbations**



COSMO (last versions from DWD)

- 4.18
 - Support for Runge Kutta in COSMO ART
- 4.19
 - Altered horizontal advection of temperature and pressure deviation (avoids spurious heat sources which can lead to grid point storms)

Potential temperature [C]





COSMO (last versions from DWD)

- 4.20 (underestimates precipitation, do not use!)
 - Additional small time step in RK timestepping (more stable, but also more expensive)
 - Additional terms in TKE production (convection, SSO)
 - OASIS coupler interface
- 4.21
 - Bug fix for 4.20 problem
 - Horizontal nonlinear Smagorinsky diffusion



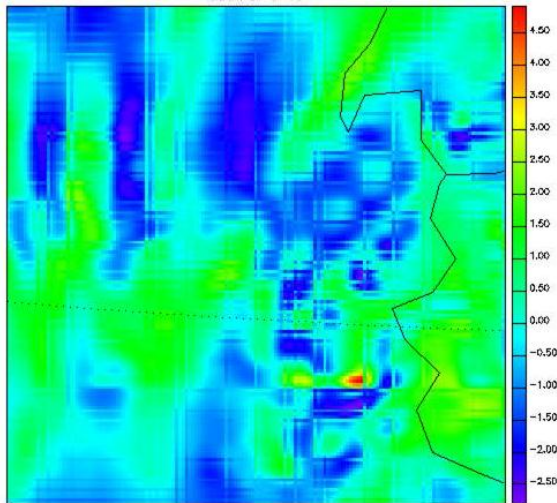
Current operational setup

- COSMO Version 4.12.1.6 with
 - Bug fix in Iradtopo
 - Explicit humidity correction in turbulence scheme switched off (lexpcor=false)
 - Support for pollen forecasts
 - Namelist switches (updated!) available under
 - COSMO
<http://www.cosmo-model.org/content/tasks/operational/nmlDoc/cosmoDefault.htm>
 - INT2LM
<http://www.cosmo-model.org/content/tasks/operational/nmlDoc/int2lmDefault.htm>



INT2LM

- Currently operational: 1.14, but we noticed problems with «stripes» in the interpolated fields, reason not clear.



- In test: 1.18 with input of QR/QS from IFS (and «stripes» removed)



COSMO in C2SM SVN Repository

- Code released by DWD (do not use, not adapted to CSCS)
 - `$SVN/cosmo/vendor_tags/cosmo`
- Code running at CSCS
 - `$SVN/cosmo/trunk_tags/cosmo_c2sm`
- Code with all modifications for MeteoSwiss
 - `$SVN/cosmo/trunk_tags/cosmo_opr`
- Current operational MeteoSwiss version
 - `$SVN/cosmo/trunk_tags/cosmo_opr/CURRENT`
- Where `$SVN = https://cosmo.cscs.ch`

- Same structure holds for int2Im