From LM 3.1 to COSMO-Model 4.1

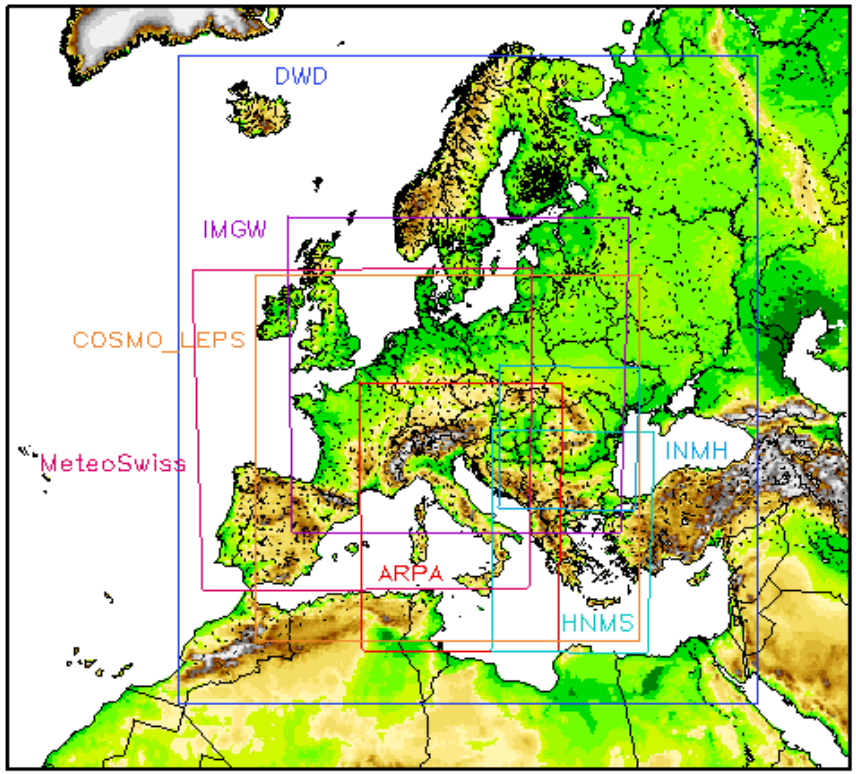
Ulrich Schättler
(with contributions from all of you!)

Deutscher Wetterdienst
GB Forschung und Entwicklung
(Research and Development)

Contents

- The name of the game
- New features in the COSMO-Model
- Details of the changes for major components
- Outlook

How the Problem began



The Name of the Game

- Within COSMO (Consortium for small scale modelling) a number of different applications are operated, each having its own name: LME, aLMo, LAMI, LMK, aLMo2, ….
- All applications are based on a regional nonhydrostatic model, formerly known as the “Lokal Modell” or “Local Model”, the LM.

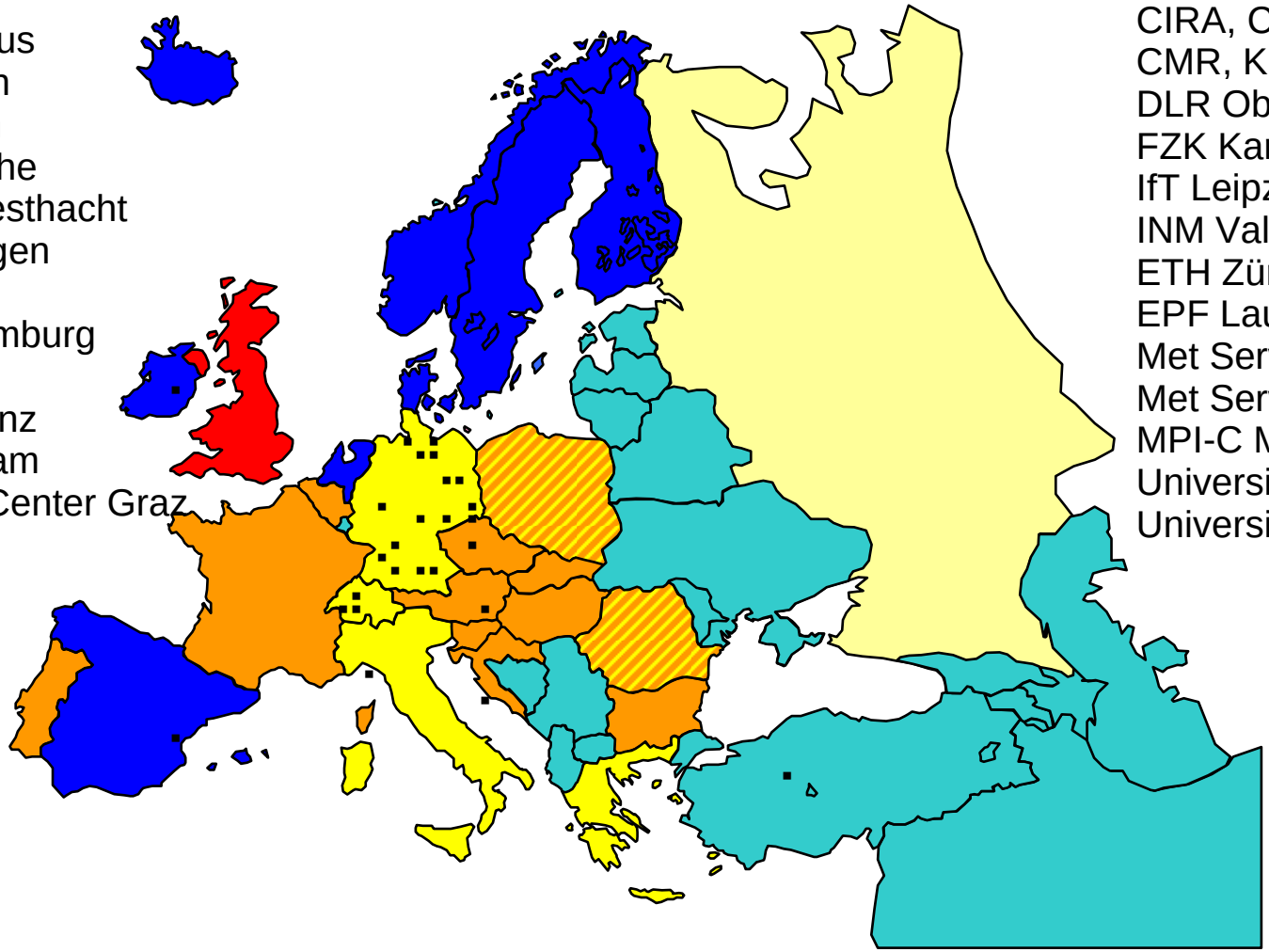
The Name of the Game (II)

- Sometimes there are difficulties to distinguish between the model and the applications. This lead to confusion: How many models are there within COSMO?
- We were looking for a better solution of the naming problem
  - to avoid confusion,
  - to reflect the common responsibility for the development of the model,
  - and to increase the visibility of COSMO.
- And then the directors of COSMO decided to use the name: COSMO
- This decision needs some additional regulations.

Meteorological Landscape

CLM Community:

BTU Cottbus
ETH Zürich
FUB Berlin
FZ Karlsruhe
GKSS Geesthacht
Uni Göttingen
Uni Bonn
MPI-M Hamburg (M&D)
MPI-C Mainz
PIK Potsdam
Wegener Center Graz



AdW, Prag
AWI Bremerhaven
CIRA, Capua
CMR, Kroatien
DLR Oberpfaffenhofen
FZK Karlsruhe
IfT Leipzig
INM Valencia
ETH Zürich
EPF Lausanne
Met Service Israel
Met Service Turkey
MPI-C Mainz
University College Dublin
Universitäten:
Berlin, Bern, Bonn, Köln, Dresden, Frankfurt, Genua, Hannover, Hohenheim, Karlsruhe, Kiel, Leipzig, Mainz, München

The Name of the Game (III)

- COSMO (Consortium for small scale modelling) uses the COSMO-Model!
- But (to be honest): Because we had long discussions about this issue (and they are still going on), the usage is not yet unified!

You will now hear about the changes in the

COSMO-Model

New Features in the COSMO-Model

- The option to use a 2 time level dynamical core, based on Runge-Kutta methods.
- The option to run the model in „climate mode“ for long term climate simulations.
- The possibility to write and read restart-files.
- The option for NetCDF-IO
- An optional parameterization of lakes: the FLake-Model

Details of the Changes for major Components

Main Changes in the Dynamics

- Prognostic treatment of rain and snow
- Introduction of (cloud ice and) graupel
- Several options for the 2 time level dynamical core based on Runge-Kutta methods

Main Changes in the Physics

- Microphysics
  - Introduced additional components: cloud ice, rain, snow ("prognostic precipitation"), graupel
  - For prognostic precipitation the microphysics is now run after the dynamics
  - Technical: replaced power functions by EXP … (LOG(…))

Main Changes in the Physics

- Radiation
  - Adaptation for interpretation of clouds when running with cloud ice
  - Introduced new external parameters for coverage of evergreen and deciduous forest (`FOR_E, FOR_D`)
  - The radiation scheme is now called in the first 2 time steps to have a better interaction between the different parameterizations
  - The option of calculating the radiation on a coarser grid has been introduced

Main Changes in the Physics

- Turbulence
  - Introduction of an optional 3D Turbulence scheme
  - Introduction of an optional dry turbulence scheme
  - For some computations the use of the new FLake model is checked
  - Some namelist parameters have been moved to the new Namelist group /TUNING/
  - Technical: Optimizations for vectorizations

Main Changes in the Physics

- Convection
  - Introduced Kain-Fritsch scheme and prepared the use of Bechtold scheme
  - Introduced a shallow convection scheme (based on Tiedtke scheme) for convection resolving runs
  - Changes to suppress “convective drizzle”

Main Changes in the Physics

- Soil Model
  - General update (and operational introduction) of multi-layer soil model
  - Introduced indicator of fresh snow and prognostic snow density
  - Technical: For the multi-layer soil model there are no more 2 different calls (before and after convection), but only one call after the convection
  - Some Namelist parameters have been moved to the new Namelist group /TUNING/

Main Changes in the Physics

- FLake Model
  - Introduction of the new parameterizations for lakes
  - Needs new external parameters:
    - FR_LAKE: Fraction of lakes in a grid box
    - DEPTH_LK: Depth of a lake
    - Additional external parameters are not active yet
  - Big Problem: Derivation of these external parameters (soon we will have covered Europe and western Russia)

Main Changes in the Diagnostics

- Removed diagnostics `YUPRDIAG` and `YUPRDIFF`
- The file `YUPRMEAN` has been splitted to `YUPRMASS` and `YUPRHUMI`
- Grid point output
  - every grid point is now written to a single file `M_xxx`; `YUPRGRPT` no longer available
  - Specifications of grid points possible with lat/lon
  - Possibility to give a special name to the grid point (and the file)
- Option to compute cell-integrals (e.g. to check conservation properties)
- Computation of synthetic satellite images

Main Changes in the I/O

- Option to read and write Restart-files
- Option to read and / or write NetCDF files
- Introduced extra module for routine `setup_vartab`
- Some GRIB names were changed to unify them with other models (GME)
- Possibility to write subdomain fields
- Output in 15- or 30-minute intervals

Main Technical Changes

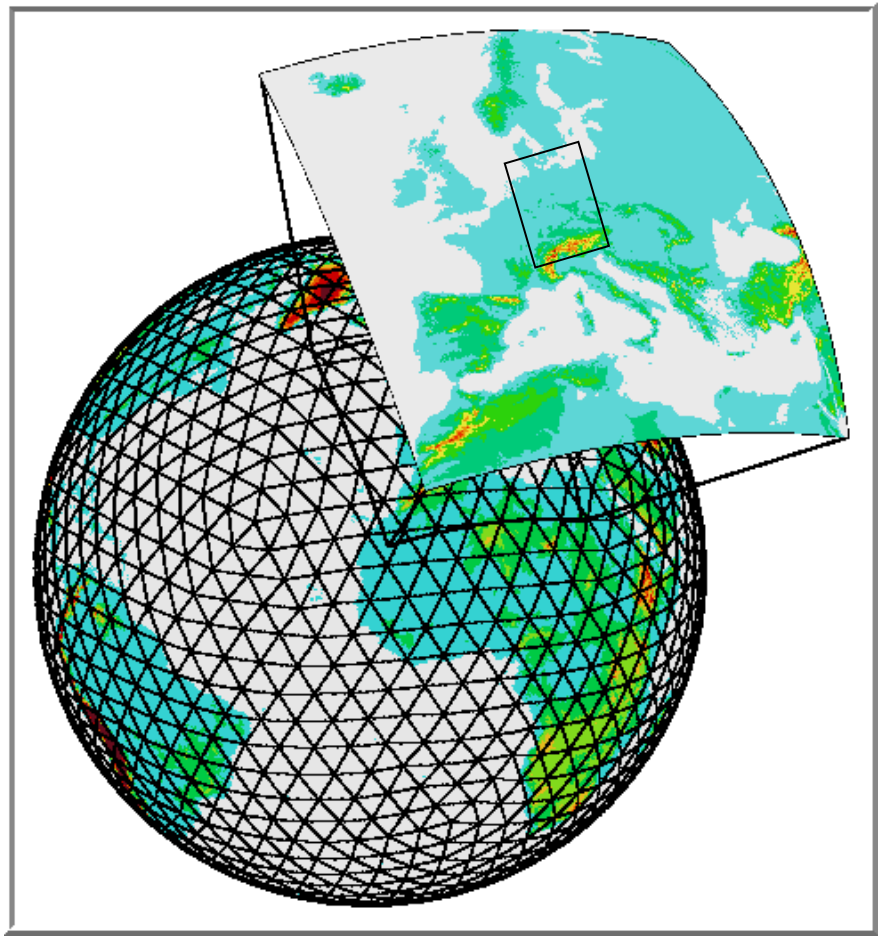
- Optimizations in the communications:
  - Usage of MPI-derived data types.
  - Several options for performing the boundary exchange.
  - Removed most MPI_Barrier calls.
- Introduced the first "`ifdef`" for calling a special Floating Point Exception handler on the IBM

Changes to introduce the CLM

- Introduced logical switch `lbdclim`
  - To read additional boundary fields
  - To specify CO_2 concentrations
  - To enable option for spectral nudging
- Possibility for Restarts
- NetCDF I/O

Outlook

- COSMO-Model 4.1 will be the next major release. It can be expected in the next weeks.
- Before the official release we have to update the documentation (on paper, on the Web, …)
- And more developments are ready to be introduced:
  - Sunshine duration and shadowing in the mountains
  - COSMO-Model and Chemistry



Thank You!

Any Questions?