The LM Package in 2001/2002

- Major Software Changes for LM
- Major Software Changes for GME2LM
- The Implementations
- Overview on LM options
- Outlook on future changes

Major Software Changes for LM

15.02.02	SLEVE: smooth level vertical coordinate (option) Adaptations to the cloud ice scheme (to be conform with GME) Height of snow fall limit as diagnostic quantity	2.14
20.03.02	Changes to the TKE scheme (Diagnosis of 10m wind; vectorization)	2.15
08.05.02	New multi-layer soil model (option) Kain-Fritsch convection scheme (option) Optimizations in I/O, TKE-scheme Bug corrections	2.17
17.07.02	Prognostic precipitation scheme (option) Boundary data defined on frames (option) Modified 2 timelevel scheme (option) Improvements to multi-layer soil model (option) Bug corrections	2.18

Major Software Changes for GME2LM

19.02.02	SLEVE: smooth level vertical coordinate (option) Bug corrections	1.14
28.03.02	Optimizations for I/O (adaptation to IBM) Bug corrections	1.15
17.07.02	Corrected bug in the wind rotation on the southern hemisphere	1.16

The Implementations

Partner	Grid Size	GME2LM	LM	Computer	Assimilation
DWD	$325 \times 325 \times 35$	1.15	2.16	IBM SP	yes
HNMS	$95 \times 113 \times 35$	1.15	2.16	Convex	—
IMGW	$193 \times 161 \times 35$	1.13(?)	2.12(?)	Origin 3000	—
MeteoSchweiz	$385 \times 325 \times 45$	1.15	2.16+	SX-5	yes
SMR-ARPA	$234 \times 274 \times 35$	1.15	2.16	IBM SP	—
UGM	$234 \times 274 \times 35$	own IFS2LM	2.16	VPP5000	—

Overview on LM options

This is only an excerpt. Take a look at the new Scientific Documentations.

Dynamics and Numerics:

- Generalized terrain-following height coordinate with the options
  - base-state pressure based on height coordinate
  - Gal-Chen height coordinate
  - exponential height coordinate (SLEVE)
- Options for time integration
  - 2nd order leapfrog HE-VI split-explicit (default)
  - two time-level 2nd order Runge-Kutta split-explicit
  - three time-level 3-d semi-implicit
- Numerical smoothing
  - 4th order linear horizontal diffusion
  - option for a monotonic version including an orographic limiter

Physical Parameterizations:

- Subgrid scale turbulence
  - Diagnostic 2nd order K-closure of hierarchy level 2 for vertical turbulent fluxes
  - Option for a prognostic turbulent kinetic energy closure at level 2.5 including effects from sub-grid scale condensation and from thermal circulations
- Surface layer parameterization
  - Stability-dependent drag-law formulation of momentum, heat and moisture fluxes
  - Option for a new surface layer scheme (based on TKE) including a laminar-turbulent roughness layer
- Grid scale clouds and precipitation
  - Cloud water condensation and evaporation by saturation adjustment. Precipitation formation by a bulk microphysics parameterization including water vapour, cloud water, rain and snow with column equilibrium for the precipitating phases
  - Option for a new bulk scheme including cloud ice
  - Option for a 3-d precipitation transport

- Moist convection
  - Tiedtke mass-flux correction scheme with equilibrium closure based on moisture convergence
  - Option for the Kain-Fritsch convection scheme with non-equilibrium CAPE-type closure
- Soil model
  - Two-layer soil model employing the extended force-restore method; snow and interception storage are included
  - Option for a new multi-layer version of the model based on the direct numerical solution of the heat conduction equation

Initial and Boundary Conditions:

- Initial Conditions
  - Interpolated initial data from a coarse-grid driving model (GME, IFS, LM(soon))
  - Continuous LM data assimilation stream based on the nudging scheme
  - Option for user-specified idealized initial fields
- Boundary Conditions
  - 1-way nesting by Davies-type lateral boundary formulation (from driving models GME, IFS, LM(soon))
  - Options for idealized boundary fields, periodic boundary conditions
- Top boundary: Options for rigid lid condition and Rayleigh damping layer
- Two-way nesting (interactive) available in a test-version
- Initialization: Digital filter initialization of unbalanced initial states with options for adiabatic and diabatic initialization.

Outlook on future changes

Interpolation Program:

- Implementation of a unified interpolation program (GME,IFS,LM $\rightarrow$ LM)

LM:

- Code reorganization of the TKE scheme
- Vertical profiles from surface observations in the nudging scheme
- Adaptations to the climate version of LM
  (restart-files, technical changes, option of NetCDF I/O)
- Further bug corrections and optimizations