Zentralanstalt für Meteorologie und Geodynamik

Action about selective externalisation of the AROME microphysics

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Outline

(3) AROME/MESO-NH vs. ALARO-0 microphysics
(4) APLMPHYS (microphysical computations in ALARO-0)
(5) Algorithmic constraints
(6) Physical constraints
(7) Prognostic species
(8) Summary

AROME vs. ALARO-0 microphysics I

ALARO-0	AROME
Interactions acting on precipitation fluxes	Interactions acting on rain/ snow quantities
Sedimentation in a single vertical loop, subroutines called for one level (stand alone routines)	Each subroutine/process computed for all levels (processes called 'en bloc')
Sedimentation is preformed several times throughout APLMPHYS	Sedimentation computed only once
Precipitation produced within actual time step sedimented via P3	Precipitation produced within actual time step sedimented as if it was already present before (P1)
Moist quantities represented via mass ratios (with respect to q_t)	Moist quantities represented via mixing ratios (with respect to q_d)

AROME vs. ALARO-0 microphysics II

ALARO-0	AROME
Bulk treatment of species (except for sedimentation)	Each process based on Γ – law distribution (bulk treatment for tendency computation)
4 prognostic moist quantities; graupel effect treated diagnostically	5 prognostic moist quantities (graupel as prognostic quantity)
Time step ~ 300 s	Time step ~ 60 s
8 mass exchanges possible	~30 mass exchanges possible
Running variables updated after full list of processes (available mass as limit for processes)	Running variables updated after each process (available mass as limit for processes)
Geometry of cloud overlap taken into account, mass ratios for 4 different parts	Mixing ratios homogenous over entire layer
Scientific options coded for: Autoconversion, evap./melting, collection, sedimentation	Scientific options for sedimentation

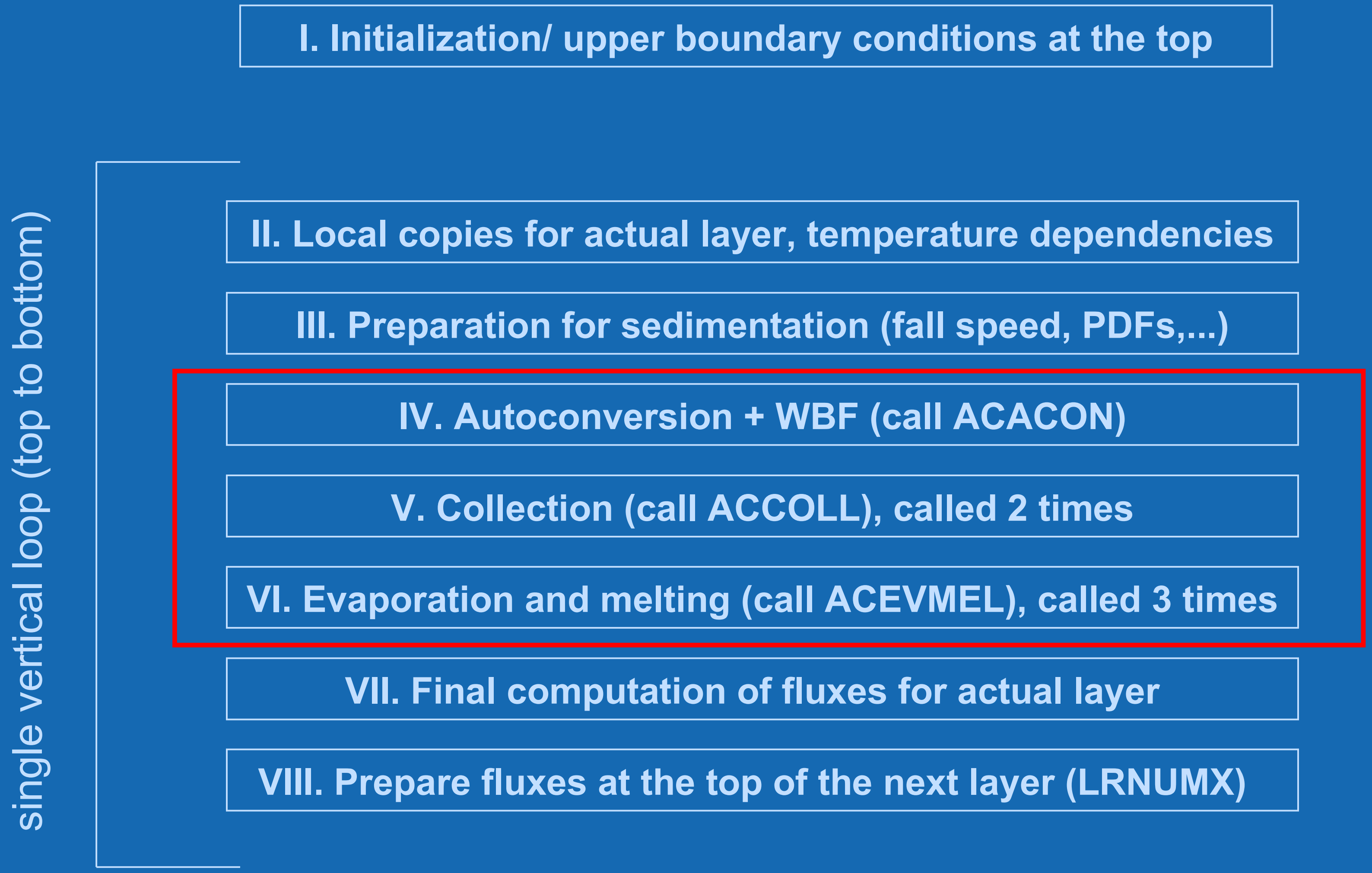
APLMPHYS I

- ALPMPHYS is the central routine for microphysical computations inside ALARO
- APLMPHYS called between updraught and downdraught computation
- Unified handling of condensates (resolved + convective part)
- Computational efficiency given through modularity (single vertical loop, modularized microphysical computations, …)

Call sequence within APLPAR:

Fix negative water contents (APLPAR)
ACNEBCOND (resolved cloud fraction for microphysics)
ACNEBN, ACNEBPART (not relevant)
ACRANEB
ACDIFUS
ACCDEV (resolved cond.)
ACCVUD (updraught computation) + ACUPU
APLMPHYS (microphysics) + ACUPM
ACMODO (downdraught) + ACUPD

APLMPHYS II

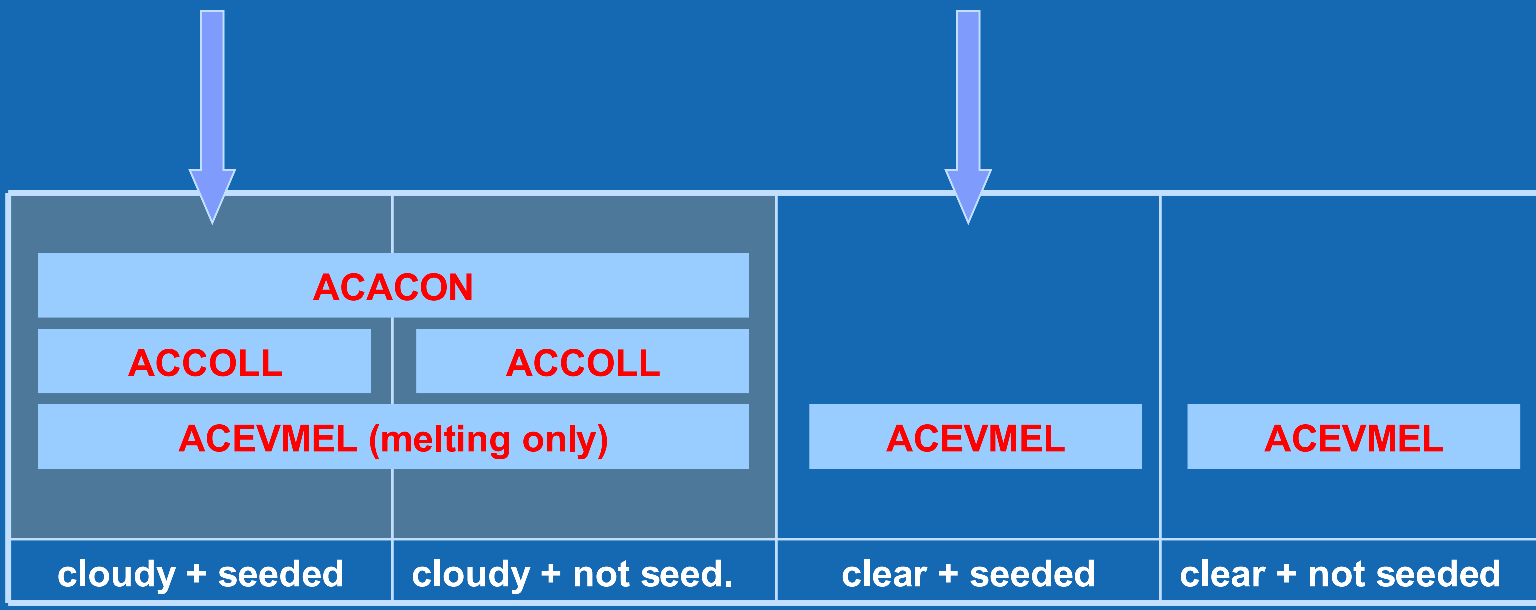

I. Initialization/ upper boundary conditions at the top
single vertical loop (top to bottom)
II. Local copies for actual layer, temperature dependencies
III. Preparation for sedimentation (fall speed, PDFs,...)
IV. Autoconversion + WBF (call ACACON)
V. Collection (call ACCOLL), called 2 times
VI. Evaporation and melting (call ACEVMEL), called 3 times
VII. Final computation of fluxes for actual layer
VIII. Prepare fluxes at the top of the next layer (LRNUMX)

Algorithmic constraints

Algorithmic constraints for the use of AROME microphysics inside ALARO-0:

- Unified treatment of (resolved and convective) condensates needs subdivision of layer in different areas to take into account geometric aspects of adjacent layers
- Level by level computation of various processes needed for PDF-based sedimentation (already introduced in AROME). Together with the previous constraint => stand alone subroutines are unavoidable
- Some 3MT related aspects (downdraft sedimentation, ...) are anticipated in APLMPHYS

Algorithmic constraints II



Combination of convective and resolved condensates requires subdivision in 4 parts (where processes are assumed to be homogenous)

Physical constraints

APLMPHYS is constructed around 3 stand-alone routines fullfilling the physical rules:

- ACACON should handle the in-cloud processes related to non-precipitating species (autoconversion-type, including WBF)
- ACCOLL should group processes concerning the mechanical growth of precipitating species (collection-type)
- ACEVMEL should group processes describing mass-changes of precipitating species, excluding mechanical growth (-> eva-poration-type)

Physical constraints II

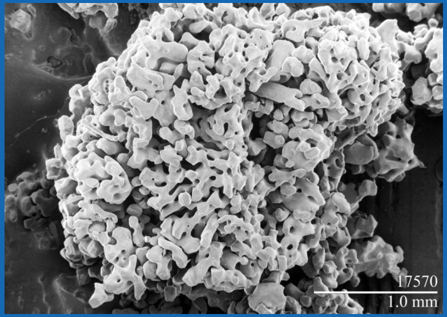
The microphysical processes from AROME could be categorized like:

ACACON	ACCOLL	ACEVMEL
autoconversion (liquid)	aggregation of snow	spontaneous freezing
autoconversion (solid)	accretion of water by rain	deposition/evap. of snow
homog. nucleation	riming of snow and graupel	deposition/evap. of rain
WBF	rain contact freezing	evaporation of rain
cloud ice melting	dry growth	conversion-melting
	wet growth	melting of graupel

Diagnostic vs. prognostic graupel I

Current situation for ALARO-0:

- Diagnostic treatment of graupel within APLMPHYS
- Graupel created in ACACON (WBF source added to graupel)
- Graupel pseudo-flux updated after ACCOLL with snow collection sources
- Graupel pseudo-flux updated after ACEVMEL with evap./melting-freezing source/sink
- Effect on:
  - collection efficiency
  - ratio of fall speed between rain and snow



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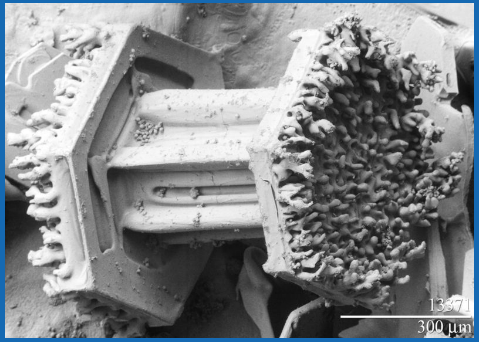
Diagnostic vs. prognostic graupel II

Possible new structure:

- Prognostic treatment (switch for diagnostic treatment)
- Additional input/output to APLMPHYS (related fluxes)
- Graupel flux created in ACACON by WBF (or addition to graupel flux)
- Graupel flux updated after ACCOLL with collection sources
- Graupel flux updated after ACEVEMEL with corresponding sources/sinks
- Modifications concerning collection efficiency and fall speed
- Extend the Physics-Dynamics Interface for additional species (graupel and later hail)



Summary

In order to be able to call AROME microphysics either from AROME and ALARO-0 two unavoidable conditions have to be fulfilled

- the concept of 3MT requires a geometric subdivision of layers
- Subroutines should be single level, stand alone and without model-characteristic computations

On the ALARO side we also forsee the following work

- Solution for the graupel compatibility inside ALARO-0 (diagnostic vs. prognostic)
- Solution for the PDFs (options)
- Solution for the data flow of qr, qs, ql and qi (options)
- Solution for the computation of the final precipitation fluxes (options)