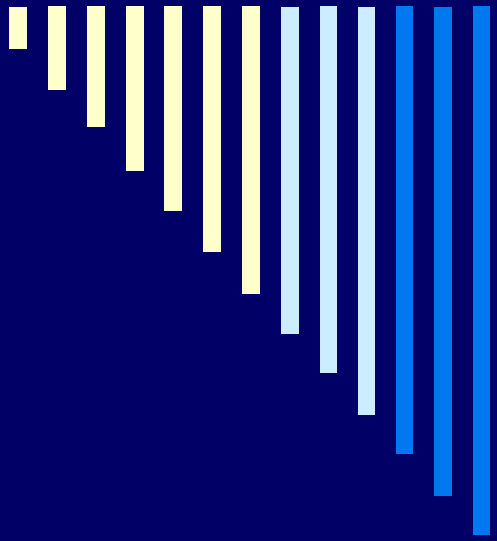


ALARO

ALARO-0

Status of developments

Plan of Lecture

- Some basic definitions (short recall)
  - Concept
  - Content of ALARO-0
- New developments
  - DDH tool: new budgets available
  - 3MT scheme
- Practical issues
  - How to run ALARO-0
  - Operational experiences
- Further (diversified?) R&D

Basic definitions: concept

- ALARO is a concept of development for the model of NWP systems, building on the IFS/ARPEGE/ALADIN tradition:
  - Modularity (ex. microphysics)
  - Flexibility
  - Generality (ex. interface - DDH)
  - Care for Numerical, Algorithmic and Efficiency issues
  - Operational continuity: multi-scale

Basic definitions: content of ALARO-0 (1)

- Equations and interface: valid for both HPE and NH case (CPTEND_NEW)
- Processes: toward complex, prognostic schemes when possible, staying CPU cheap, efficient, while improving the model skills
- Multi-scale issues: mastering the so-called grey-zone problems

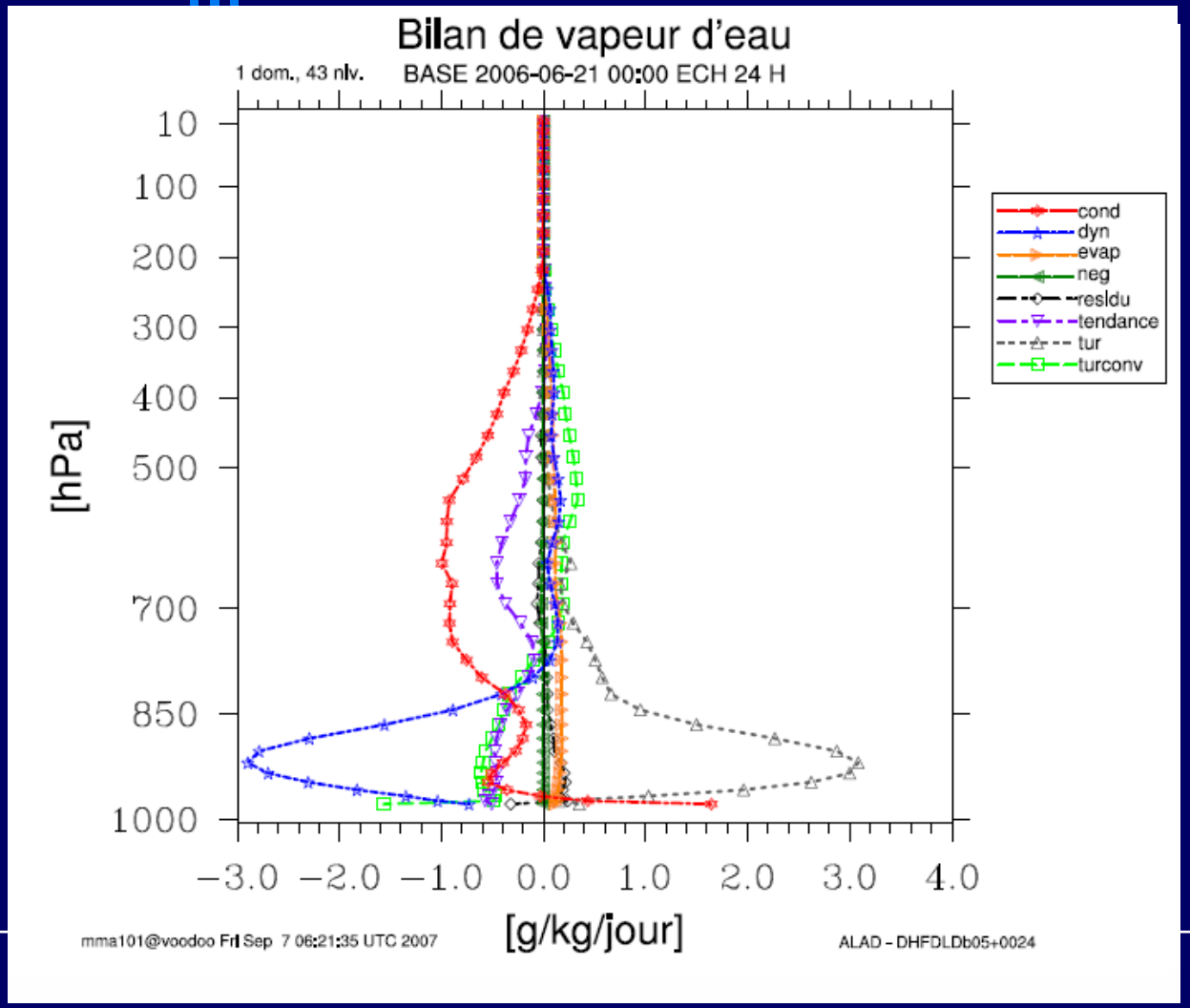
Basic definitions: content of ALARO-0 (2)

- Dynamics
  - SLHD, NH
- Physics
  - New interface (governing equations)
  - Radiation: NER scheme; cloud optical properties
  - Turbulence: pseudo-prognostic TKE
  - Mountains: new GWD and lift scheme
  - Moist processes:
    - Full prognostic microphysics
    - 3MT cascade
    - Prognostic convection
    - Historic entrainment
  - SURFEX

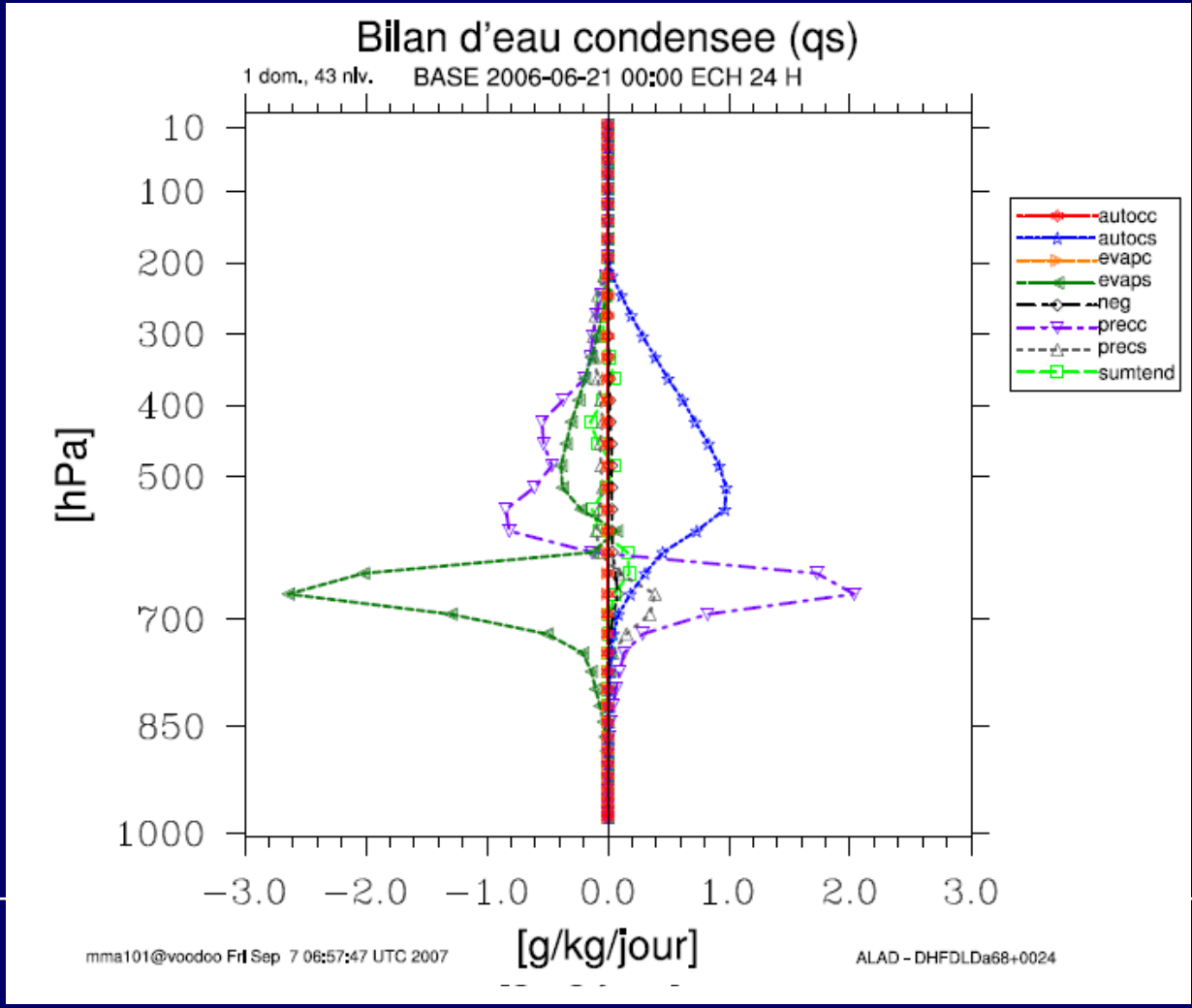
Developments of diagnostics (spring 2007)

- Governing equations: streamlining of fluxes and pseudo-fluxes definition
- Flux-form of the interface: easy extension of the existing DDH tool to new equations
- Budgets of new moist variables: ql, qi, qr, qs
- New contributions to the budgets of temperature, re-organization of the water vapor budget
- DDH is an important tool for development, tuning, detection of problems

Budgets: prognostic microphysics



Budgets: 3MT


Bilan d'eau condensee (qs)
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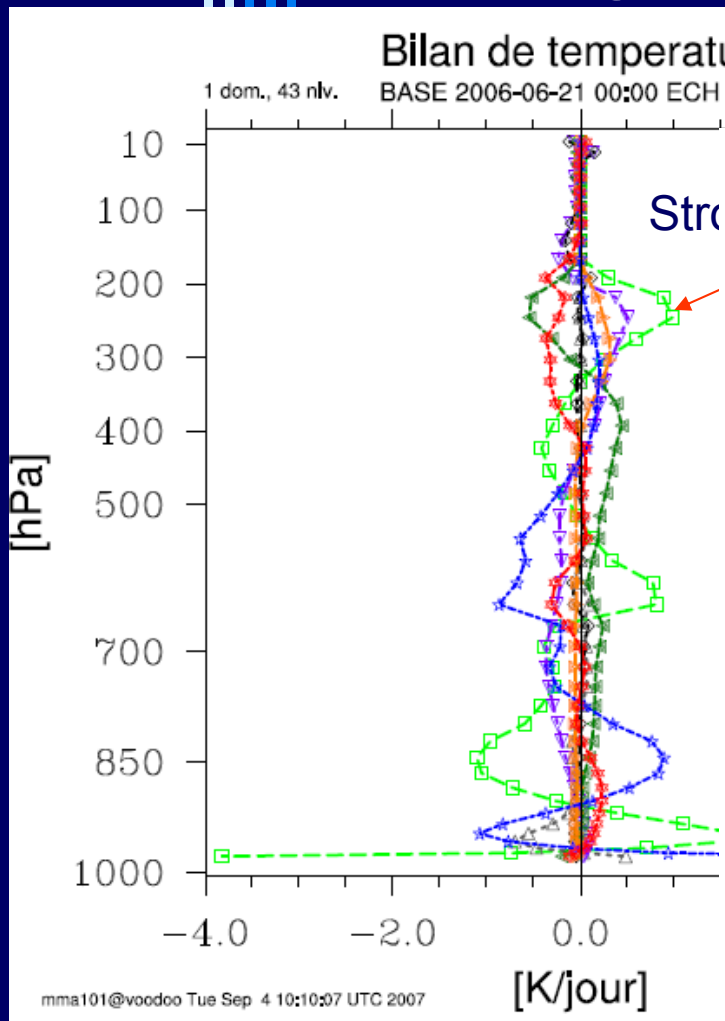
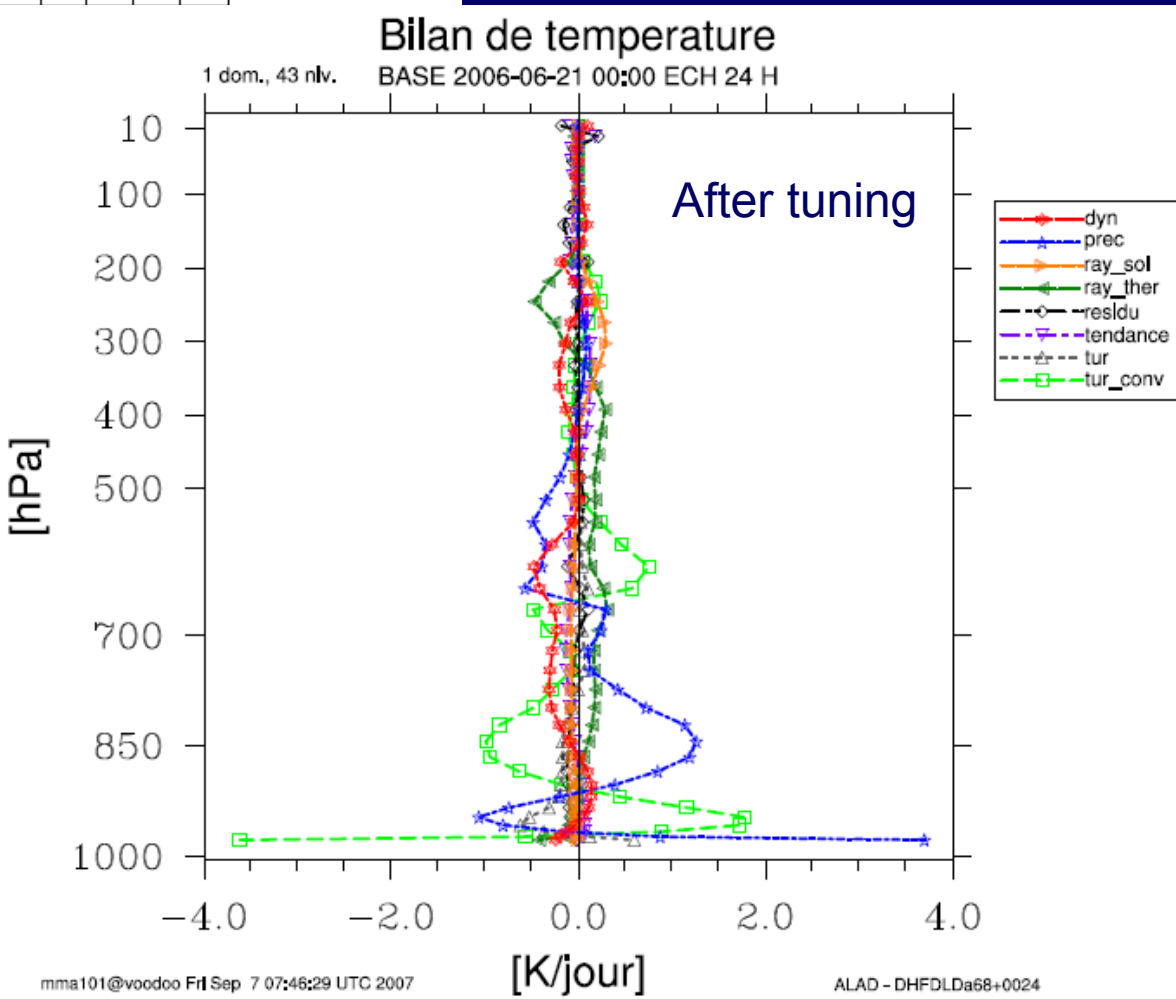
precc
precs
sumtend
mma101@voodoo Fri Sep 7 06:57:47 UTC 2007
ALAD - DHFDLDa68+0024

Budgets - example of tuning: difference of budgets between experiments

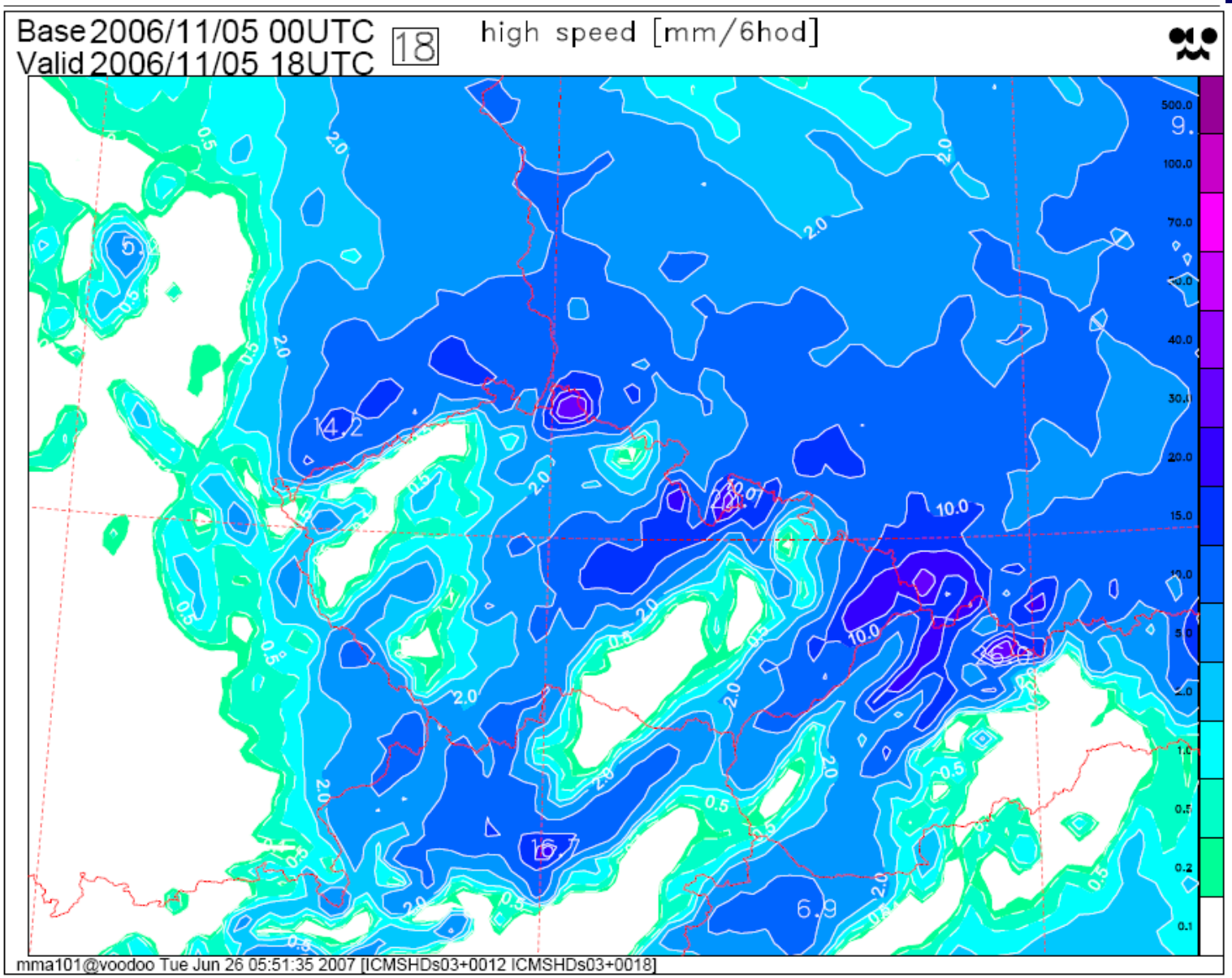




Prognostic Microphysics: modularity (1)

- Sedimentation computation:
  - PDF P0: spectrum of fall speeds;
  - Ensuing probabilities P1 (drops present in the layer), P2 (drops coming from above), P3 (source/sink);
  - Two sets of expressions are coded in APLMPHYS:
    - Statistical one;
    - Step function one (mimic of pure Lagrangian sedimentation scheme).

Sedimentation options in results:



Prognostic Microphysics modularity (2)

- APLMPHYS organization:
  - 1 vertical loop (thanks to the sedimentation solution)
  - Individual routines per process called inside the vertical loop:
    - ACACON (auto-conversion)
    - ACCOLL (collection)
    - ACEVMEL (evaporation/melting)
  - Each ‘process’ routine may contain options (currently coded: ALARO-0, ARPEGE)
  - Cloud geometry categories (cloudy seeded, cloudy non-seeded, clear seeded, clear non seeded), all still likely to generate precipitation fluxes
  - Cloudy & seeded part vertical overlap options (random and maximum-random, alike in radiation) => important for convection

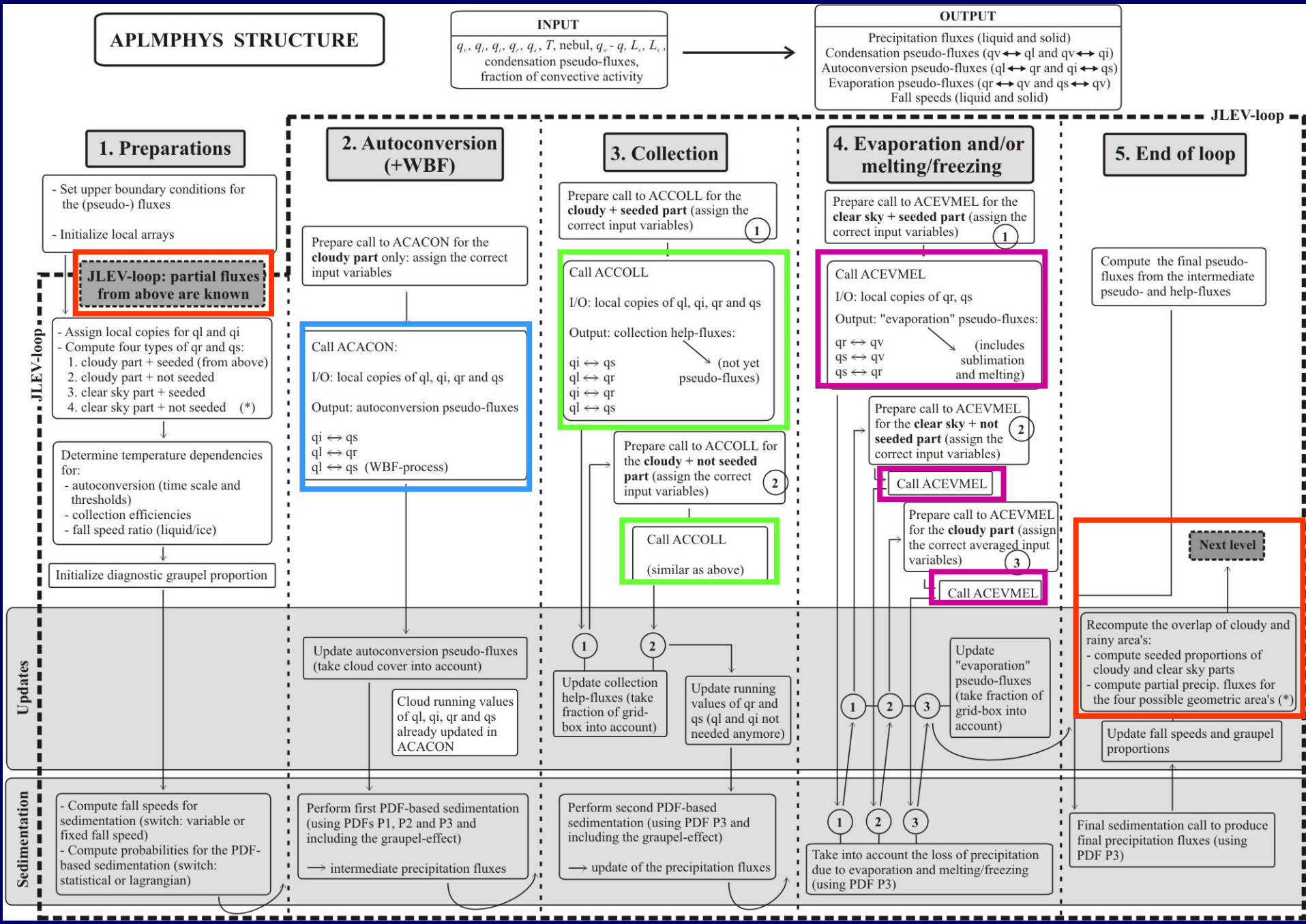
ACEVMEL example

```
SUBROUTINE ACEVMEL ( KIDIA,KFDIA,KLON,&
 !-----------------------------------------------------------------------
 ! - INPUT 1D .
 & PDQ,PHPLSL,PHPLSN,PIPB,PIPH,PIPOI,PLPLSL,PLPLSN,PPOID,PQNST,PQRST,&
 & PSTAL3,PSTAN3,PTST,PLPRSF,PLSCP,PRHOAIR,&
 ! - OUTPUT 1D .
 & PEVAN,PEVAR,PFONT,PTEST,&
 ! - LOCK ARGUMENTS .
 & CDLOCK)
```

```
IF (LLA0MPS) THEN

  ZEPS1=1.E-14

  DO JLON=KIDIA,KFDIA

!     EVAPORATION.
!     EVAPORATION.

    ZRME=PHPLSN(JLON)/MAX(ZEPS1
    ZRPTH=SQRT(MAX(0.0_JPRB,PHP
    ZRPTB=SQRT(MAX(0.0_JPRB,PLP
    ZEVA=EVAP
    ZFON=FONT
    ZARG=ZEVA*(PIPH(JLON)-PIPB(
    ZEVAPO=MAX(0.0_JPRB,PDQ(JLO
    PEVAR(JLON)=ZEVAPO*(1.0_JPR
    PEVAN(JLON)=ZEVAPO*ZRME
```

```
IF (LLARPSC) THEN

  ZEPS1=1.E-20
```

```
ENDIF

!     SECURITES.
!     SECURITIES.

DO JLON=KIDIA,KFDIA
  ZFONTLP=PLPLSN(JLON)/(PPOID(JLON)*PSTAN3(JLON))
  ZFONTLM=-PLPLSL(JLON)/(PPOID(JLON)*PSTAL3(JLON))
  PFONT(JLON)=MAX(MIN(PFONT(JLON),ZFONTLP),ZFONTLM)
  PEVAR(JLON)=PEVAR(JLON)-PFONT(JLON)
  PEVAN(JLON)=PEVAN(JLON)+PFONT(JLON)
  PTEST(JLON)=1.0_JPRB-MAX(0.0_JPRB,SIGN(1.0_JPRB,PEVAR(JLON)+ZFONTLM))&
   &*MAX(0.0_JPRB,SIGN(1.0_JPRB,PEVAN(JLON)-ZFONTLP))
  PEVAR(JLON)=MIN(PEVAR(JLON),-ZFONTLM)
  PEVAN(JLON)=MIN(PEVAN(JLON),ZFONTLP)
  PEVAR(JLON)=PEVAR(JLON)+PFONT(JLON)
  PEVAN(JLON)=PEVAN(JLON)-PFONT(JLON)
ENDDO

IF (LHOOK) CALL DR_HOOK('ACEVMEL',1,ZHOOK_HANDLE)
END SUBROUTINE ACEVMEL
```


APLMPHYS STRUCTURE
INPUT
q_v, q_l, q_i, q_r, q_s, T, nebul, q_w - q, L_s, L_v, condensation pseudo-fluxes, fraction of convective activity
OUTPUT
Precipitation fluxes (liquid and solid)
Condensation pseudo-fluxes (qv ↔ ql and qv ↔ qi)
Autoconversion pseudo-fluxes (ql ↔ qr and qi ↔ qs)
Evaporation pseudo-fluxes (qr ↔ qv and qs ↔ qv)
Fall speeds (liquid and solid)
JLEV-loop
1. Preparations
- Set upper boundary conditions for the (pseudo-) fluxes
- Initialize local arrays
JLEV-loop: partial fluxes from above are known
JLEV-loop
- Assign local copies for ql and qi
- Compute four types of qr and qs:
1. cloudy part + seeded (from above)
2. cloudy part + not seeded
3. clear sky part + seeded
4. clear sky part + not seeded (*)
Determine temperature dependencies for:
- autoconversion (time scale and thresholds)
- collection efficiencies
- fall speed ratio (liquid/ice)
Initialize diagnostic graupel proportion
2. Autoconversion (+WBF)
Prepare call to ACACON for the cloudy part only: assign the correct input variables
Call ACACON:
I/O: local copies of ql, qi, qr and qs
Output: autoconversion pseudo-fluxes
qi ↔ qs
ql ↔ qr
ql ↔ qs (WBF-process)
3. Collection
Prepare call to ACCOLL for the cloudy + seeded part (assign the correct input variables) 1
Call ACCOLL
I/O: local copies of ql, qi, qr and qs
Output: collection help-fluxes:
qi ↔ qs
ql ↔ qr
qi ↔ qr
ql ↔ qs
(not yet pseudo-fluxes)
Prepare call to ACCOLL for the cloudy + not seeded part (assign the correct input variables) 2
Call ACCOLL
(similar as above)
4. Evaporation and/or melting/freezing
Prepare call to ACEVMEL for the clear sky + seeded part (assign the correct input variables) 1
Call ACEVMEL
I/O: local copies of qr, qs
Output: "evaporation" pseudo-fluxes:
qr ↔ qv
qs ↔ qv
qs ↔ qr
(includes sublimation and melting)
Prepare call to ACEVMEL for the clear sky + not seeded part (assign the correct input variables) 2
Call ACEVMEL
Prepare call to ACEVMEL for the cloudy part (assign the correct averaged input variables) 3
Call ACEVMEL
5. End of loop
Compute the final pseudo-fluxes from the intermediate pseudo- and help-fluxes
Next level
Recompute the overlap of cloudy and rainy area's:
- compute seeded proportions of cloudy and clear sky parts
- compute partial precip. fluxes for the four possible geometric area's (*)
Update fall speeds and graupel proportions
Final sedimentation call to produce final precipitation fluxes (using PDF P3)
Updates
Update autoconversion pseudo-fluxes (take cloud cover into account)
Cloud running values of ql, qi, qr and qs already updated in ACACON
Update collection help-fluxes (take fraction of grid-box into account)
Update running values of qr and qs (ql and qi not needed anymore)
Update "evaporation" pseudo-fluxes (take fraction of grid-box into account)
Sedimentation
- Compute fall speeds for sedimentation (switch: variable or fixed fall speed)
- Compute probabilities for the PDF-based sedimentation (switch: statistical or lagrangian)
Perform first PDF-based sedimentation (using PDFs P1, P2 and P3 and including the graupel-effect)
⟶ intermediate precipitation fluxes
Perform second PDF-based sedimentation (using PDF P3 and including the graupel-effect)
⟶ update of the precipitation fluxes
Take into account the loss of precipitation due to evaporation and melting/freezing (using PDF P3)

3MT definition

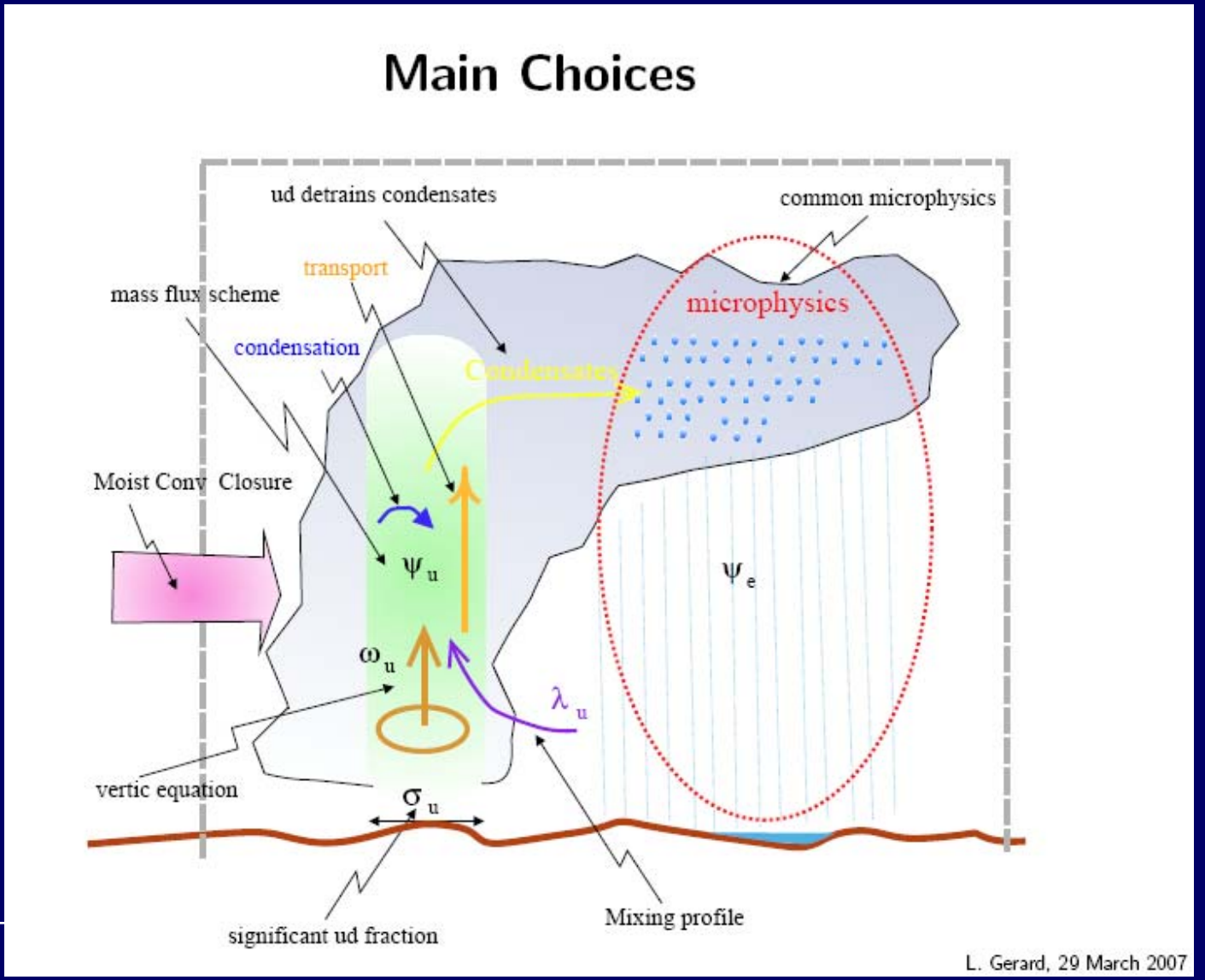
Modular

Multi-scale

Microphysics and

Transport

3MT


Main Choices
ud detrains condensates
common microphysics
transport
mass flux scheme
microphysics
condensation
Condensates
Moist Conv Closure
ψ_u
ψ_e
ω_u
λ_u
vertic equation
σ_u
significant ud fraction
Mixing profile
L. Gerard, 29 March 2007

3MT: goals

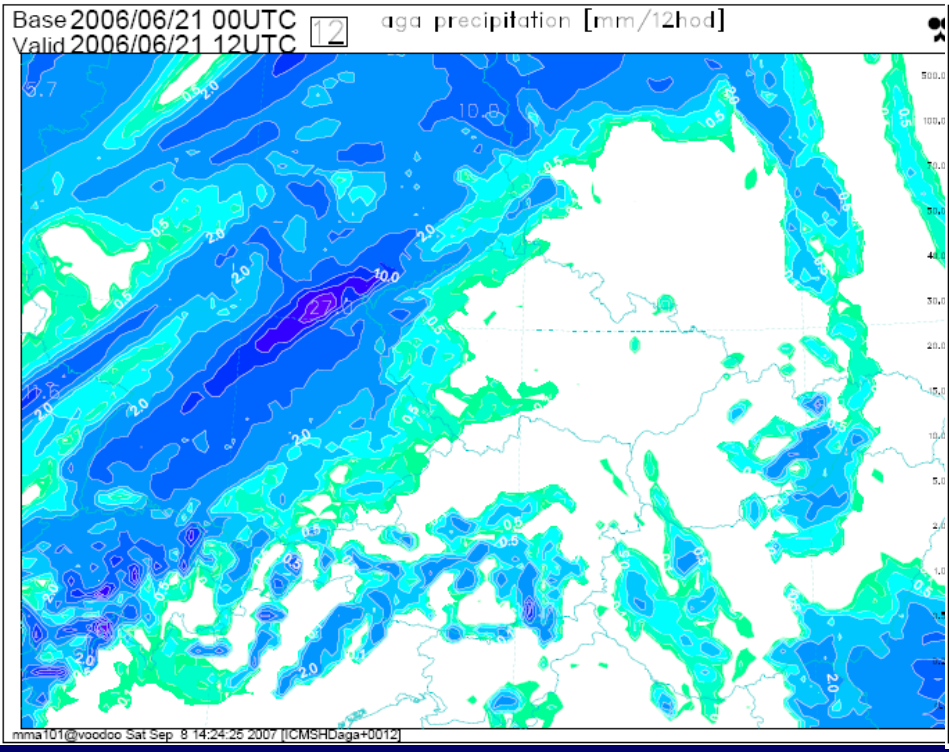
- Simulation of water cycle with results as independent as possible from Δx => grey zone challenge.
- Introduction of ‘memory’ for the convective activity.
- Use of advanced microphysics for the treatment of convective condensation.

3MT: Means

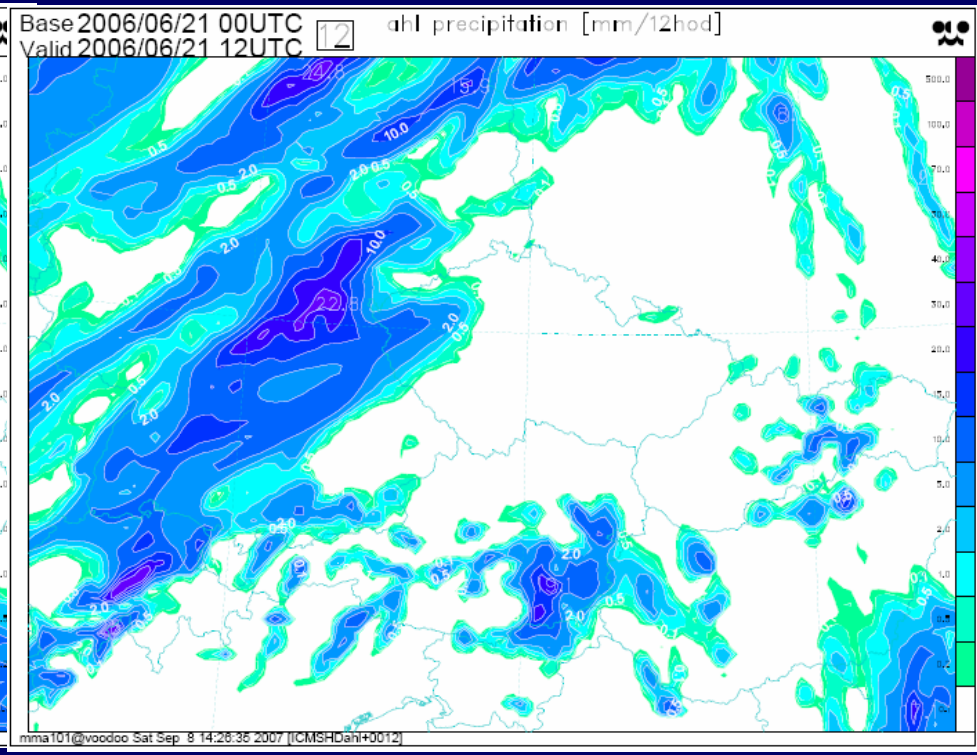
- Cascade approach with one unique (total) source of condensation for microphysics.
- Prognostic equations for mass-flux, condensates and precipitating species.
- Taking into account cloud & precipitation geometry in microphysical computations.

Catalyser: M-T approach for convective equations => entrainment (diagnostic now, prognostic later) at the heart.

3MT: outcomes (provisional,1)

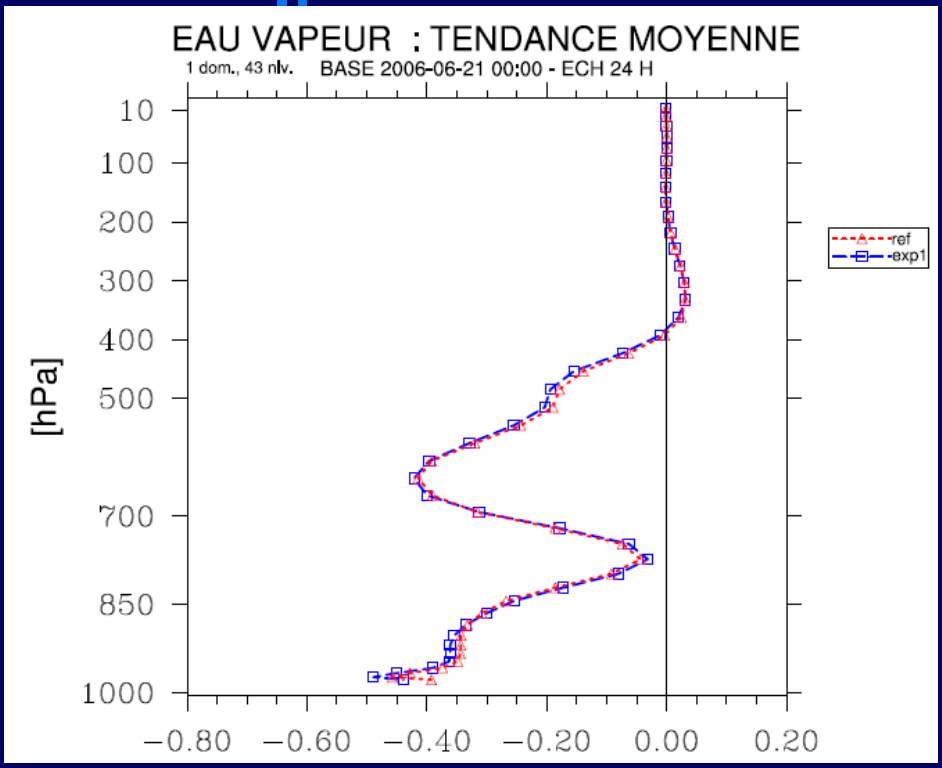


Without 3MT

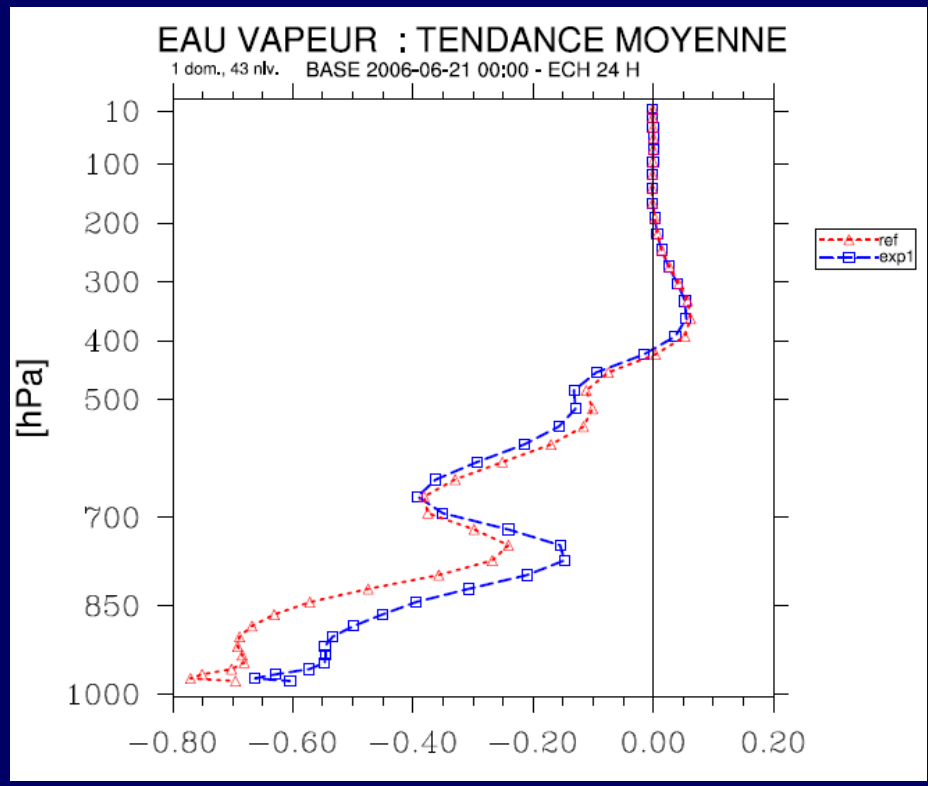


With 3MT

3MT: outcomes (provisional,2)

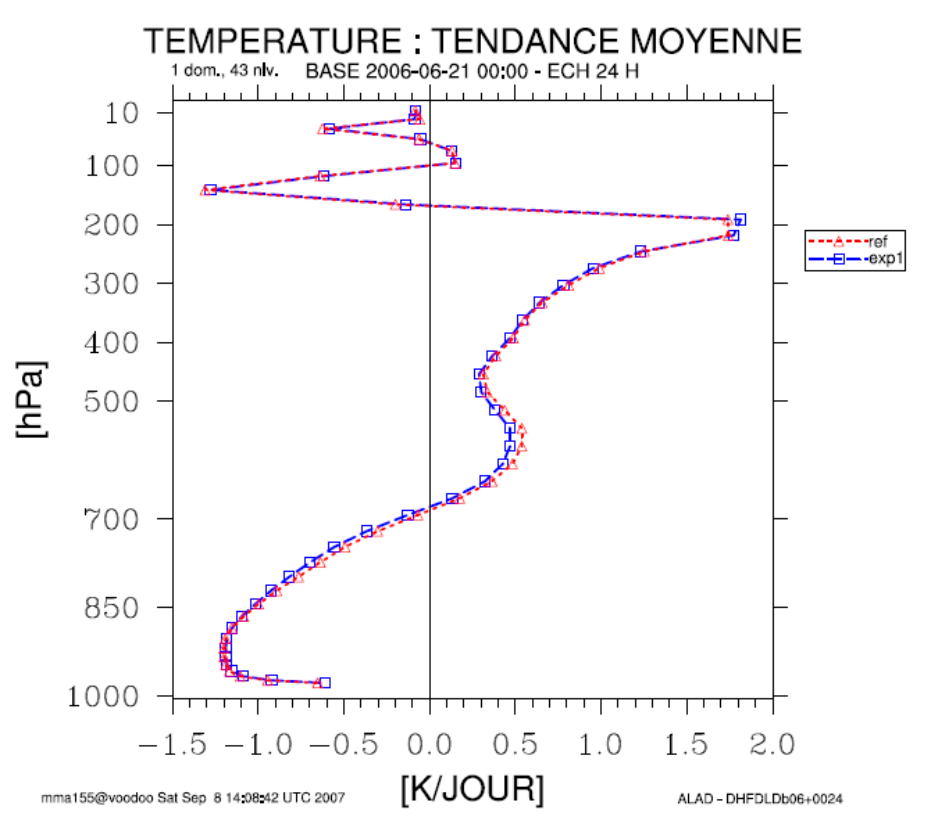


Change of the entrainment rate:
Without 3MT

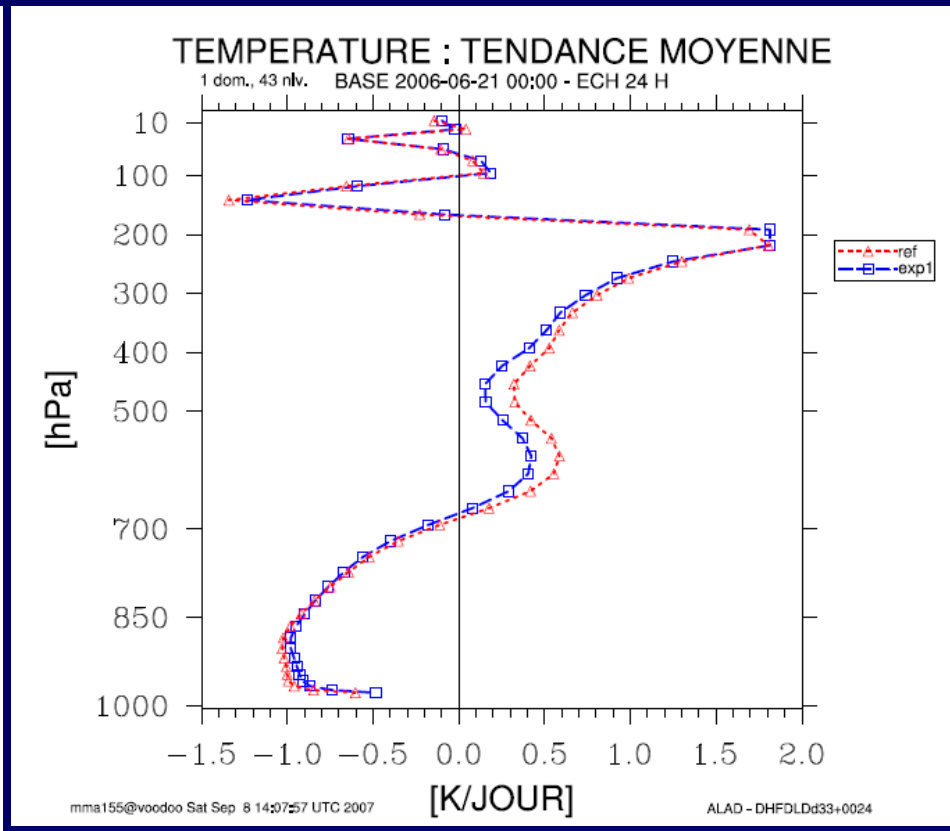


Change of the entrainment rate:
With 3MT

3MT: outcomes (provisional,3)



Change of the entrainment rate:
Without 3MT

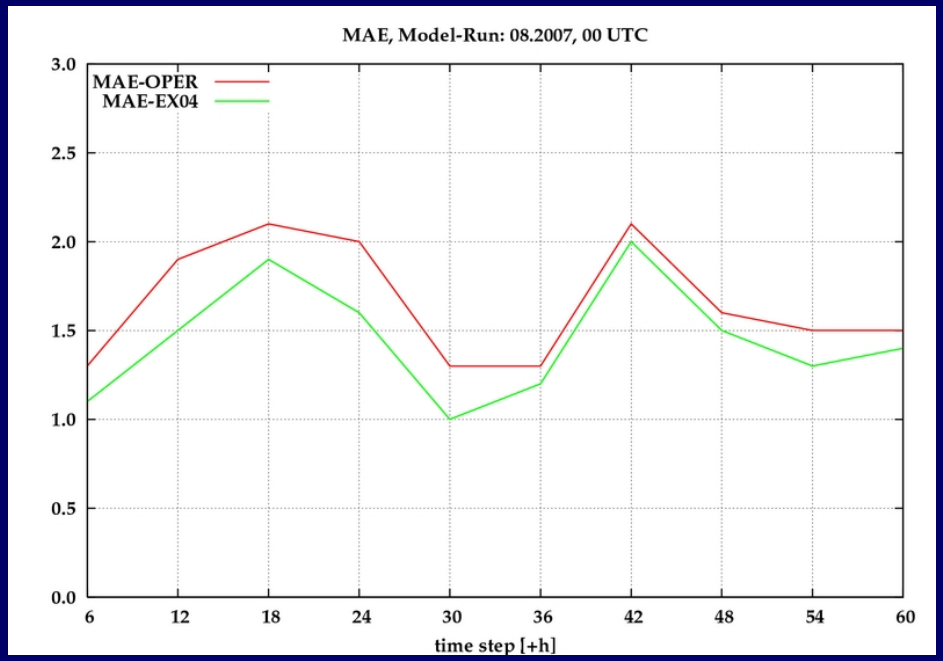


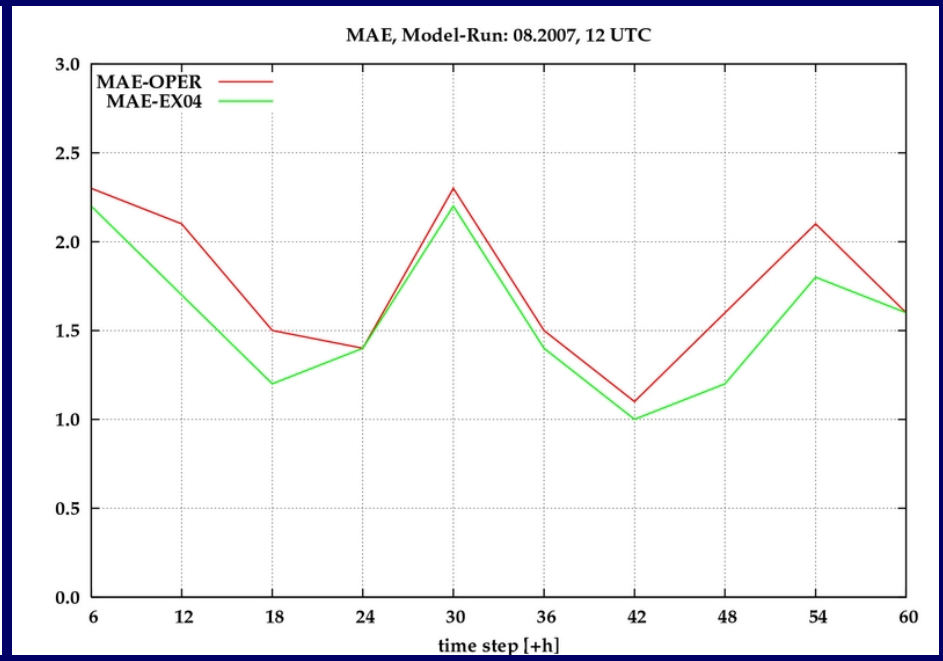
Change of the entrainment rate:
With 3MT

Practical issues

- How to run ALARO-0
  - With the ‘old’ ISBA surface scheme: there is no difference with the classical ALADIN (namelist options only)
  - Libraries:
    - CY32T1-export (ALARO-0 without 3MT)
    - CY32T3: ALARO-0; including DDH and research 3MT (small bugfixes and cleanings still to come)
  - With SURFEX: new preparation of the surface files (hopefully soon)

Experiences with ALARO-0 (1) Austria (without 3MT)



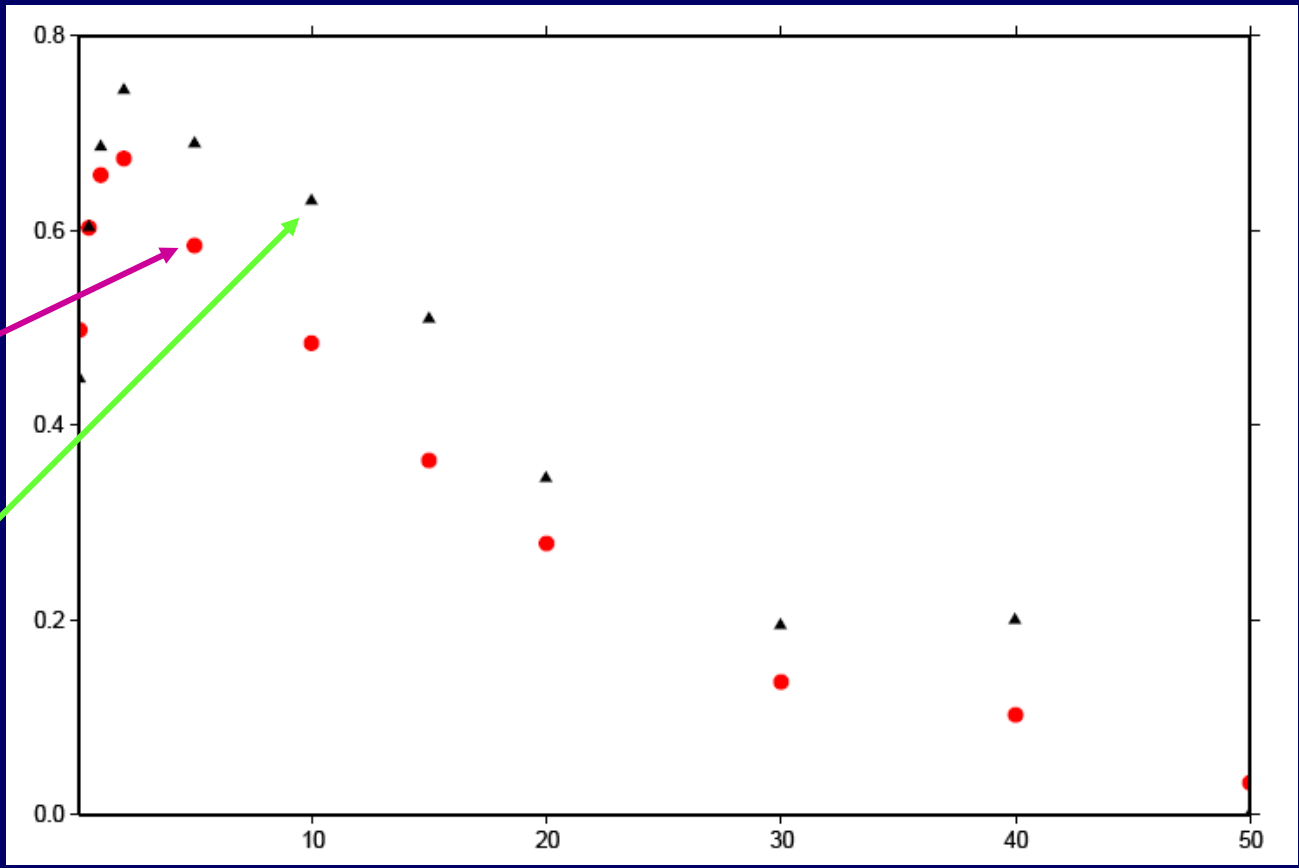


00h UT network

12h UT network

Reduction of Mean Absolute Error in precipitation forecast compared to INCA analysis

Experiences with ALARO-0 (2) Slovakia (without 3MT)

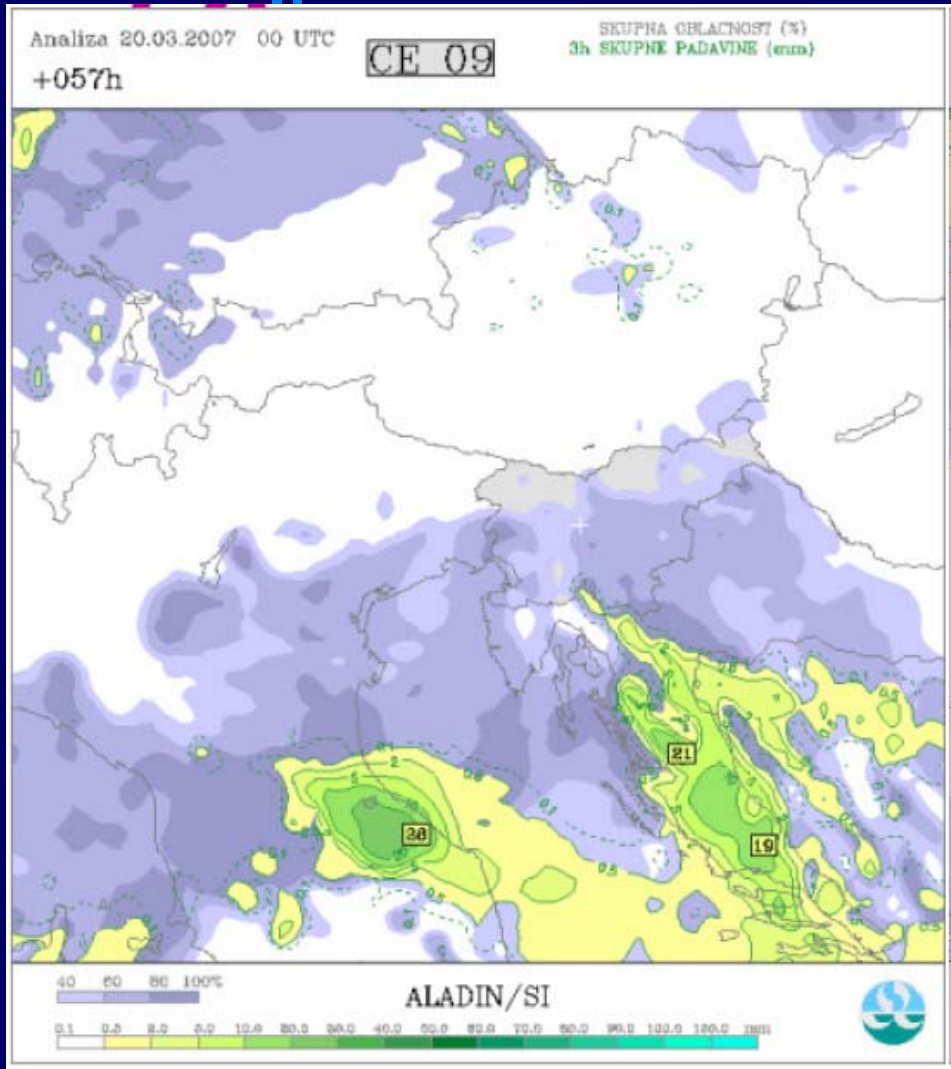


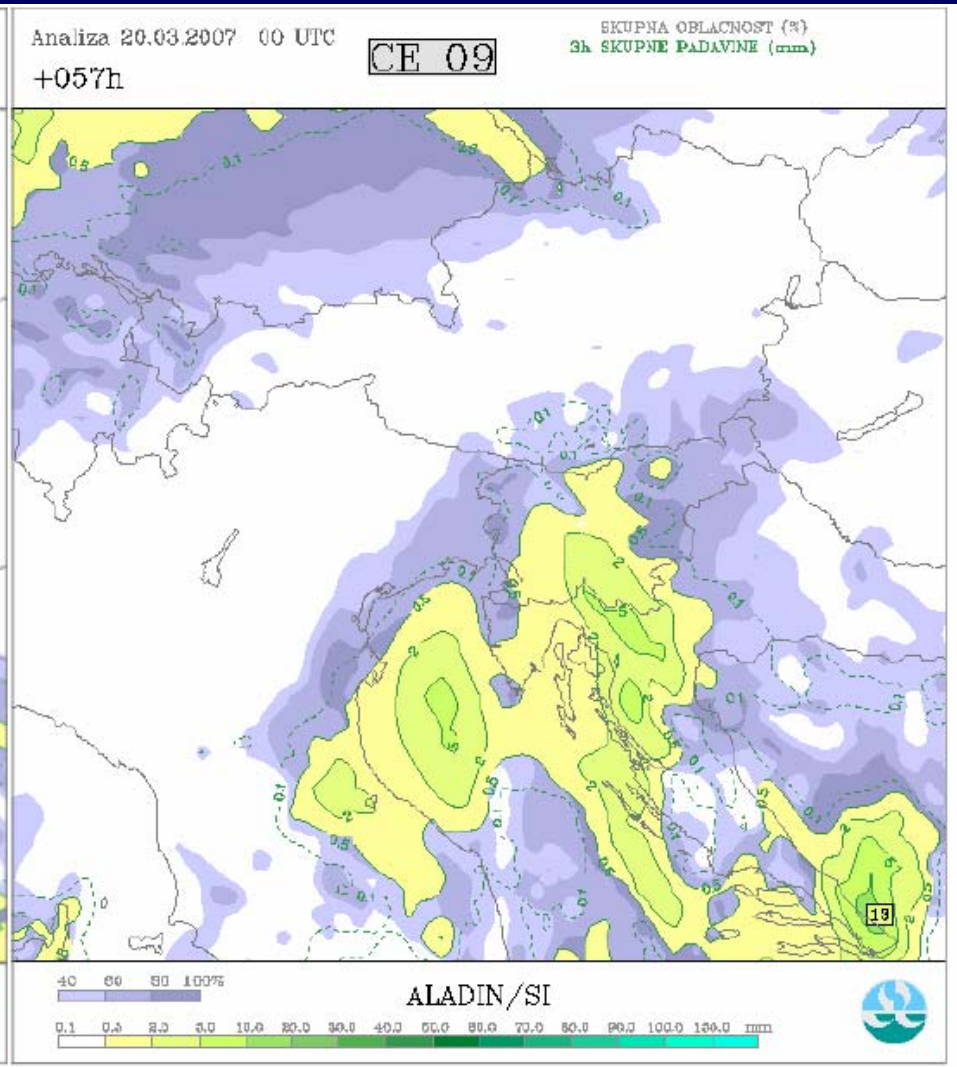
oper

test

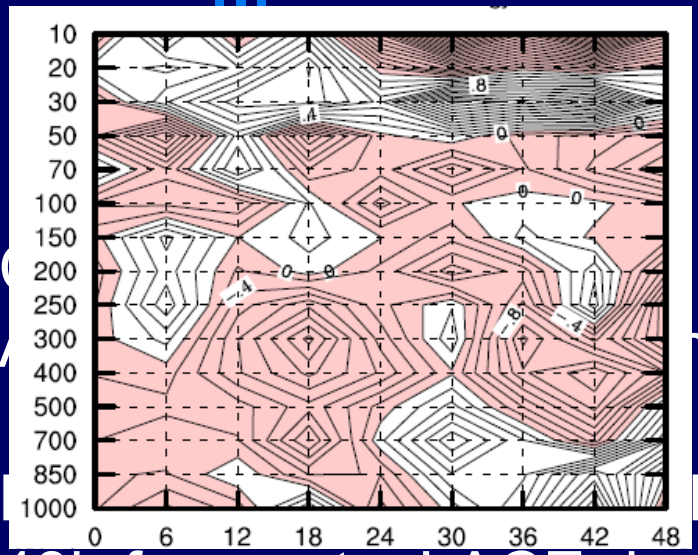
Heidke skill score: 600 stations over Slovakia, 24h accumulated rainfall

Experiences with ALARO-0 (3) Slovenia (without 3MT)





Experiences with ALARO-0 (4) Czech Republic



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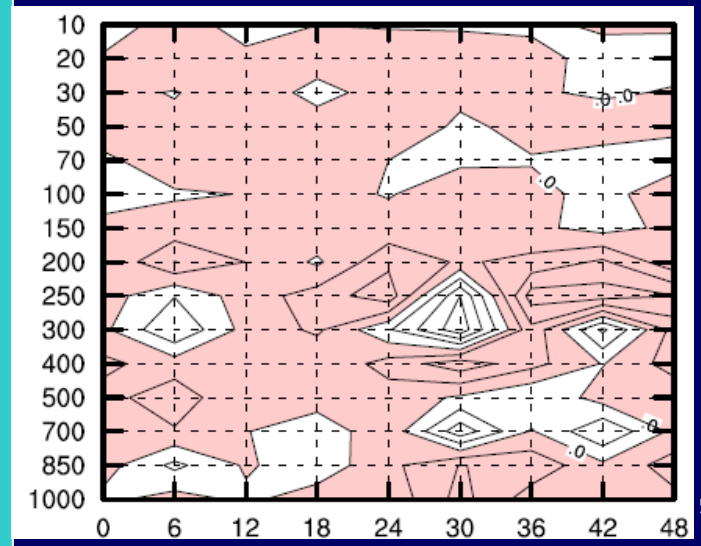

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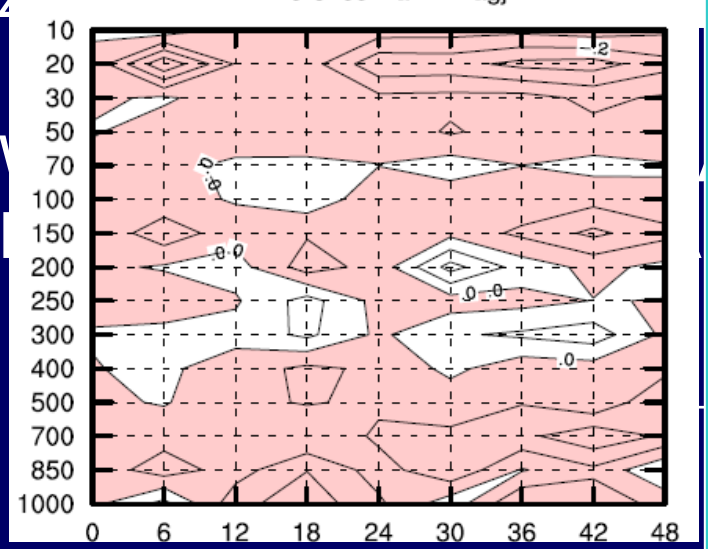

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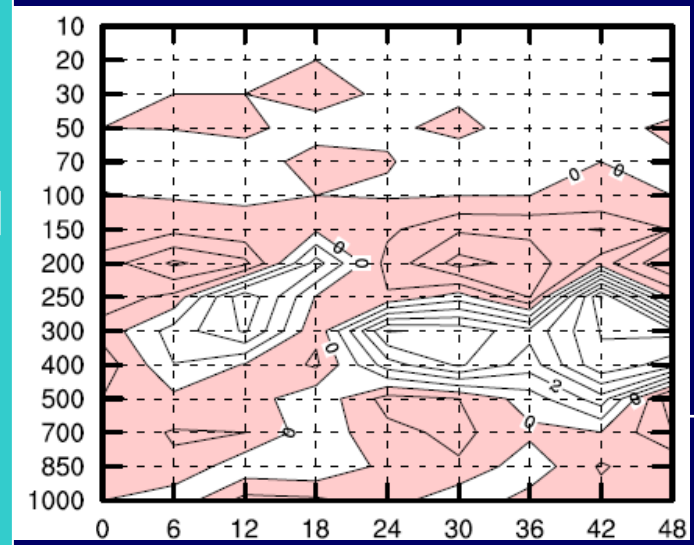

RHu

Future R & D avenues

- Turbulence: We can emulate the CBR scheme science while keeping the anti-fibrillation and shallow convection in the prognostic framework;
- Moist physics: Interplay between microphysics and entrainment rate;
- Modularization of the algorithms:
  - Already achieved for microphysics;
  - Planned for radiation (intermittency issue), turbulence (putting a solver in the heart of computations), convection (separating ascent, closure, M-T, etc.)
  - Within HARMONIE, can we agree on the strategy of separation between the science of processes (cf. ACEVMEL) and algorithmic framework streamlining (cf. APLMPHYS) ?

Thank you for your attention

Questions welcome now or later in the week