LACE
nwp central europe

Time step consistency aspects of 3MT

Radmila Brožková

LACE
nwp central europe

Introduction

- 3MT: prognostic character
  - Hydrometeors of sub-grid scale convective origin do not have their life-cycle shrunk to one time step like in case of ACCVIMP.
    - Treatment with respect to mean grid box values (cloud geometry, adjustment);
    - Phase change effects (latent heat);
    - Cloud decay.

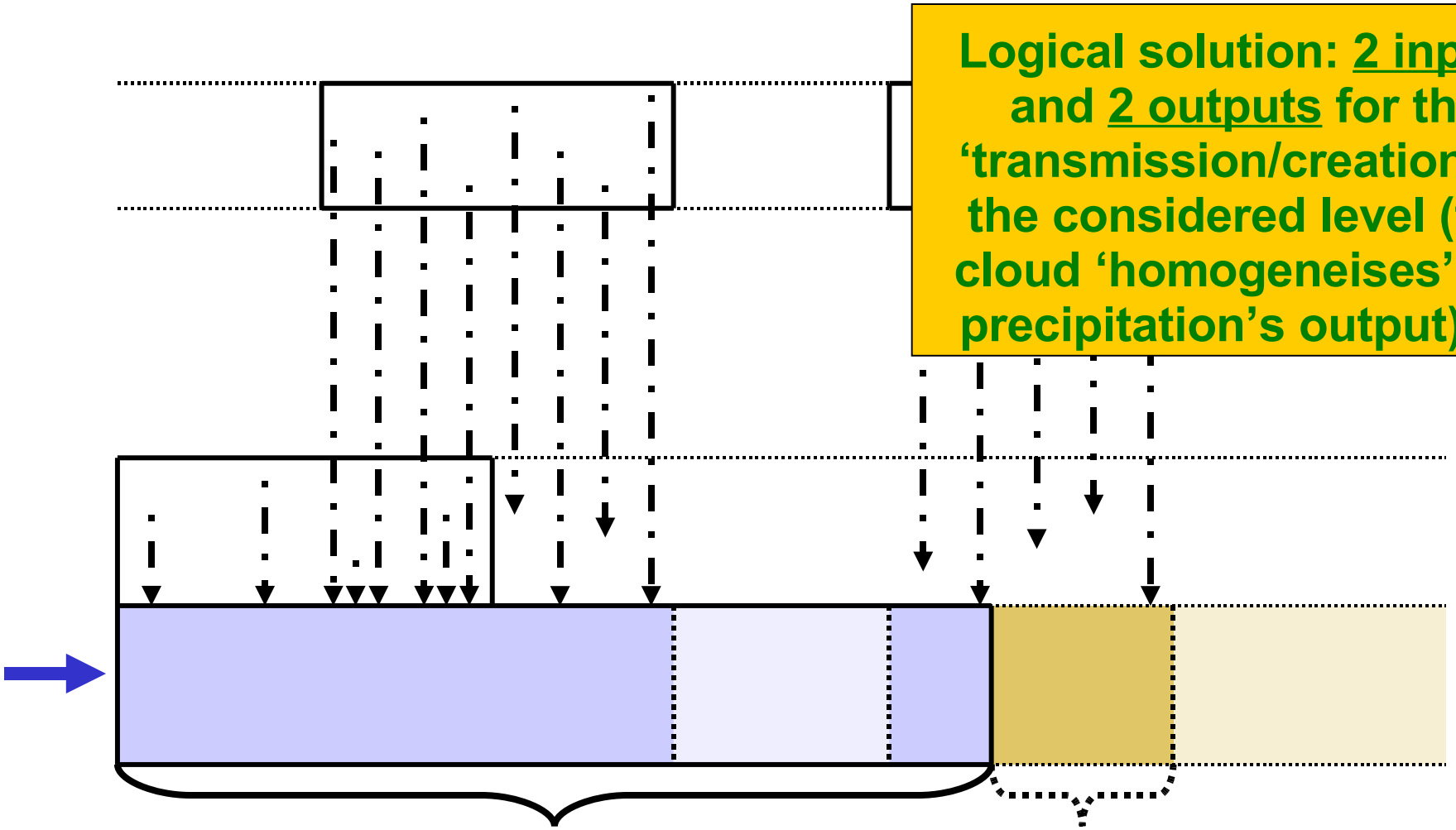
Geometry of clouds and rain

- Microphysics:
  - Processes of collection, evaporation and melting/freezing of falling precipitations depend on:
    - Cloudy or clear-sky environment locally and above;
    - Considered parcel is seeded or not.
  - Why: sub-grid convective clouds cannot be represented by mean grid values
  - How: the ‘process’ routine is called for the geometry categories as needed.

LACE
nwp central europe

Geometry of clouds and rain

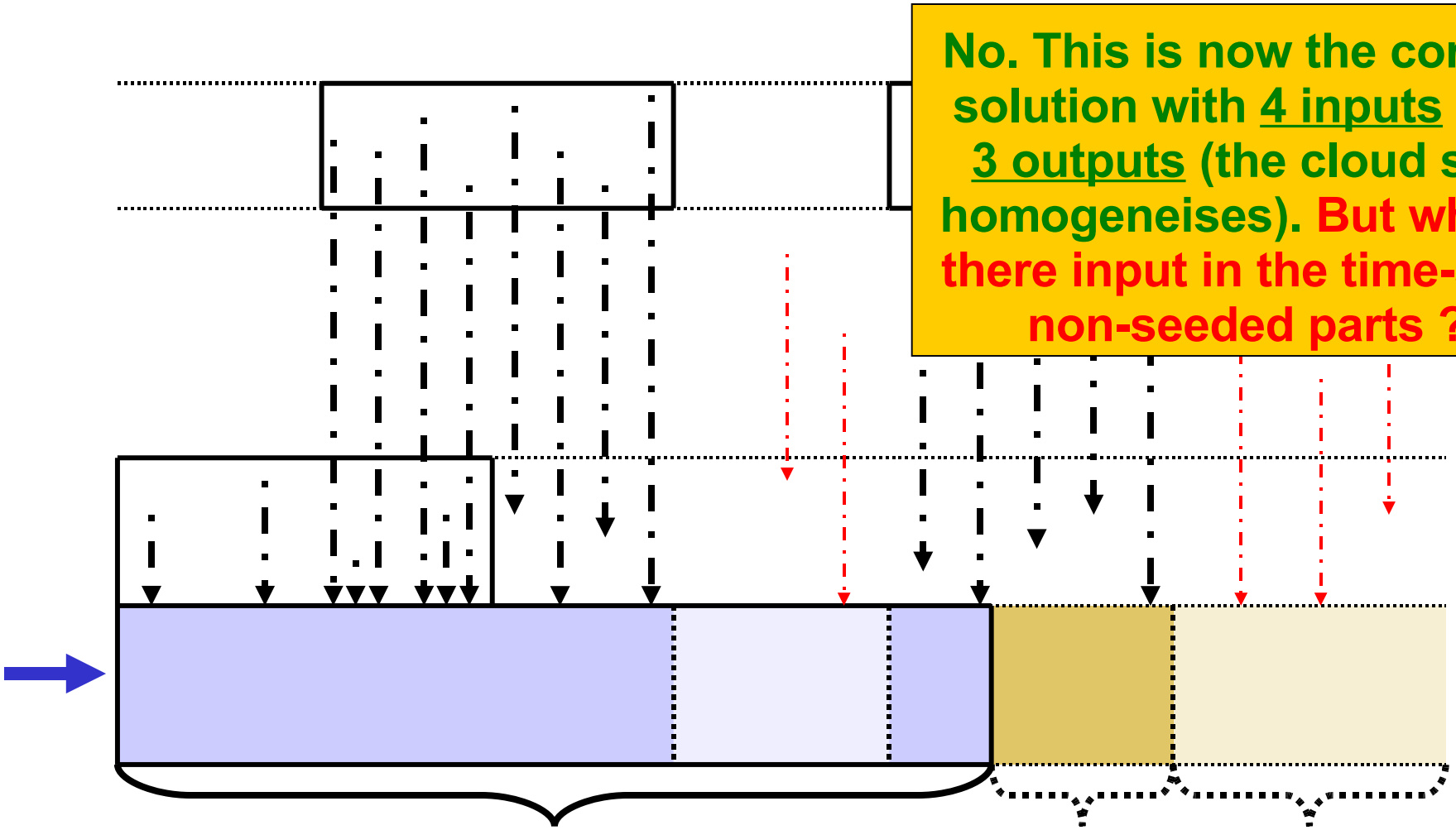
Geometry of clouds and rain



Logical solution: 2 inputs and 2 outputs for the 'transmission/creation' in the considered level (the cloud 'homogeneises' the precipitation's output) ??

Random overlap of parts separated by clear air, maximum overlap of adjacent parts (schematic view)

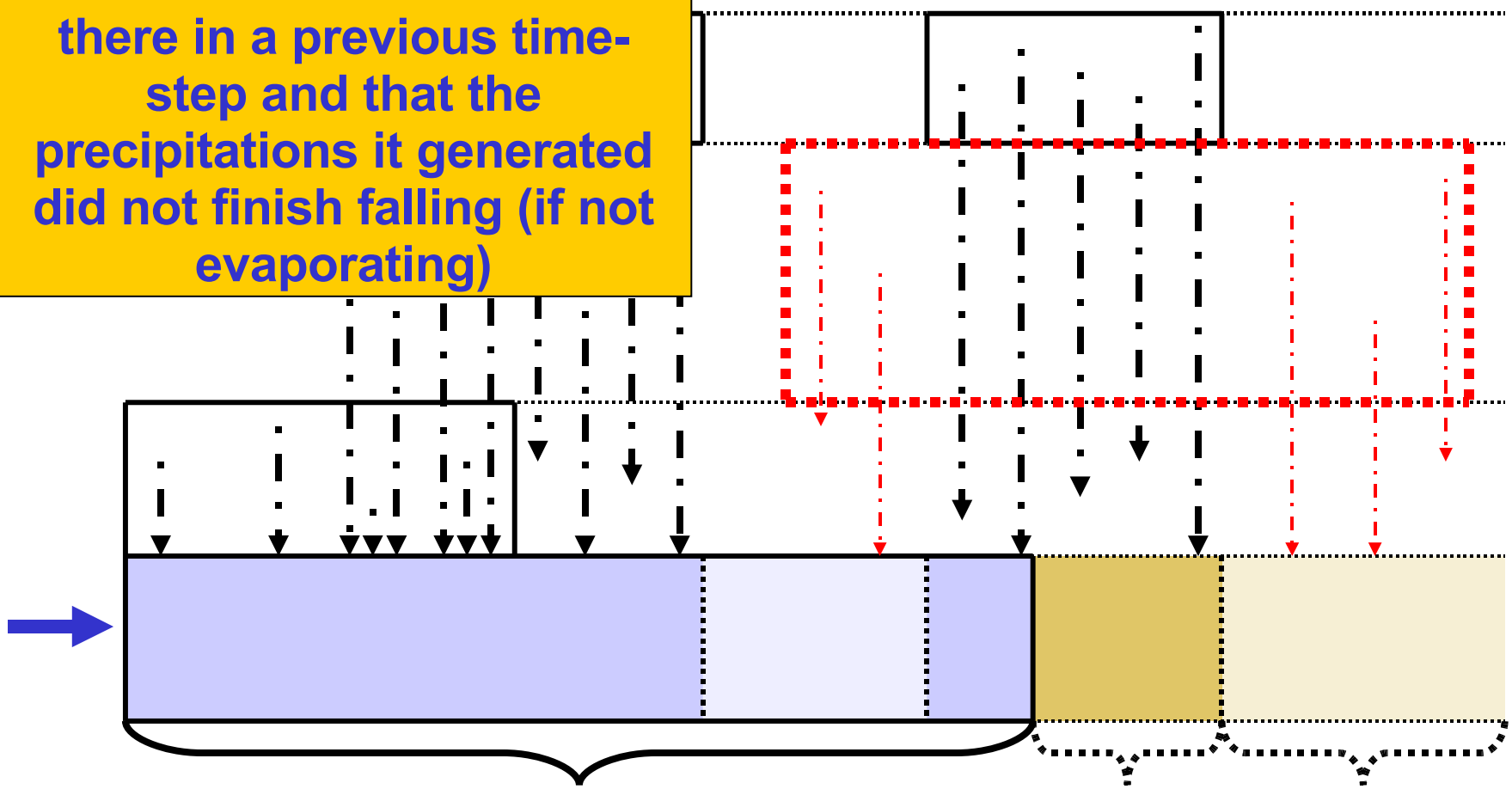
Geometry of clouds and rain



Random overlap of parts separated by clear air, maximum overlap of adjacent parts (schematic view)

Geometry of clouds and rain

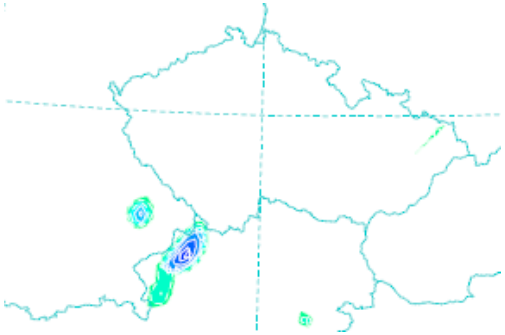
Because there was a cloud there in a previous time-step and that the precipitations it generated did not finish falling (if not evaporating)



Random overlap of parts separated by clear air, maximum overlap of adjacent parts (schematic view)

Geometry of clouds and rain

Liquid precipitation, OK;



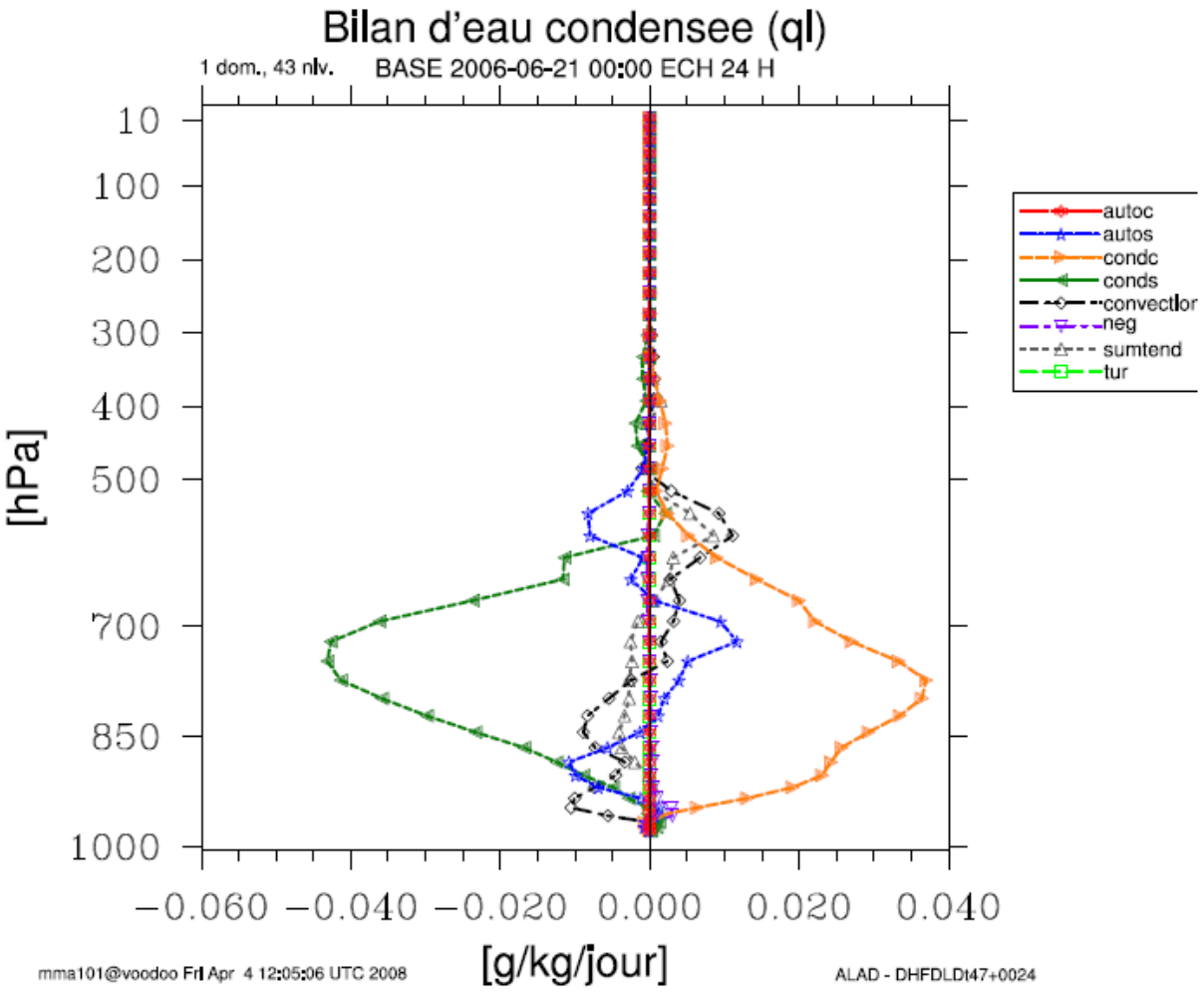
but also solid, despite warm air(!)

Reason: one forgotten category to call melting: clear-air parcel receiving precipitations generated in some previous time steps.

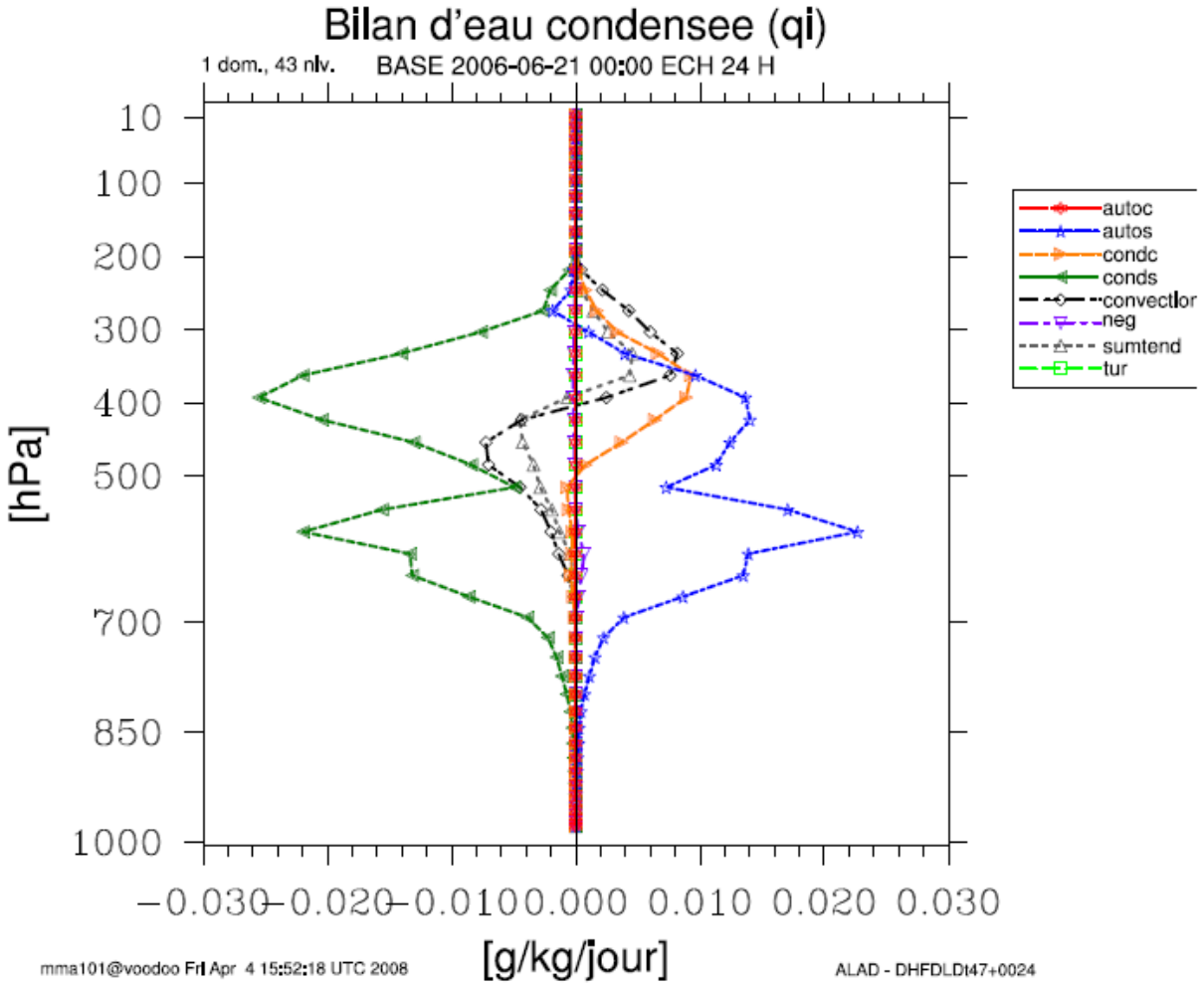
Condensation/evaporation

- Resolved condensation/evaporation scheme
  - Working with mean grid values;
  - Convective sub-grid scale generated condensates in convective cloud surrounded by dry air:
    - These clouds exist from previous time-step;
    - Information: historic mesh fraction of detrainment area and prognostic mesh fraction of updraught.
  - It is then possible and useful to include existing N_{cv} into the adjustment algorithm.

Working with Ncv (1/2)



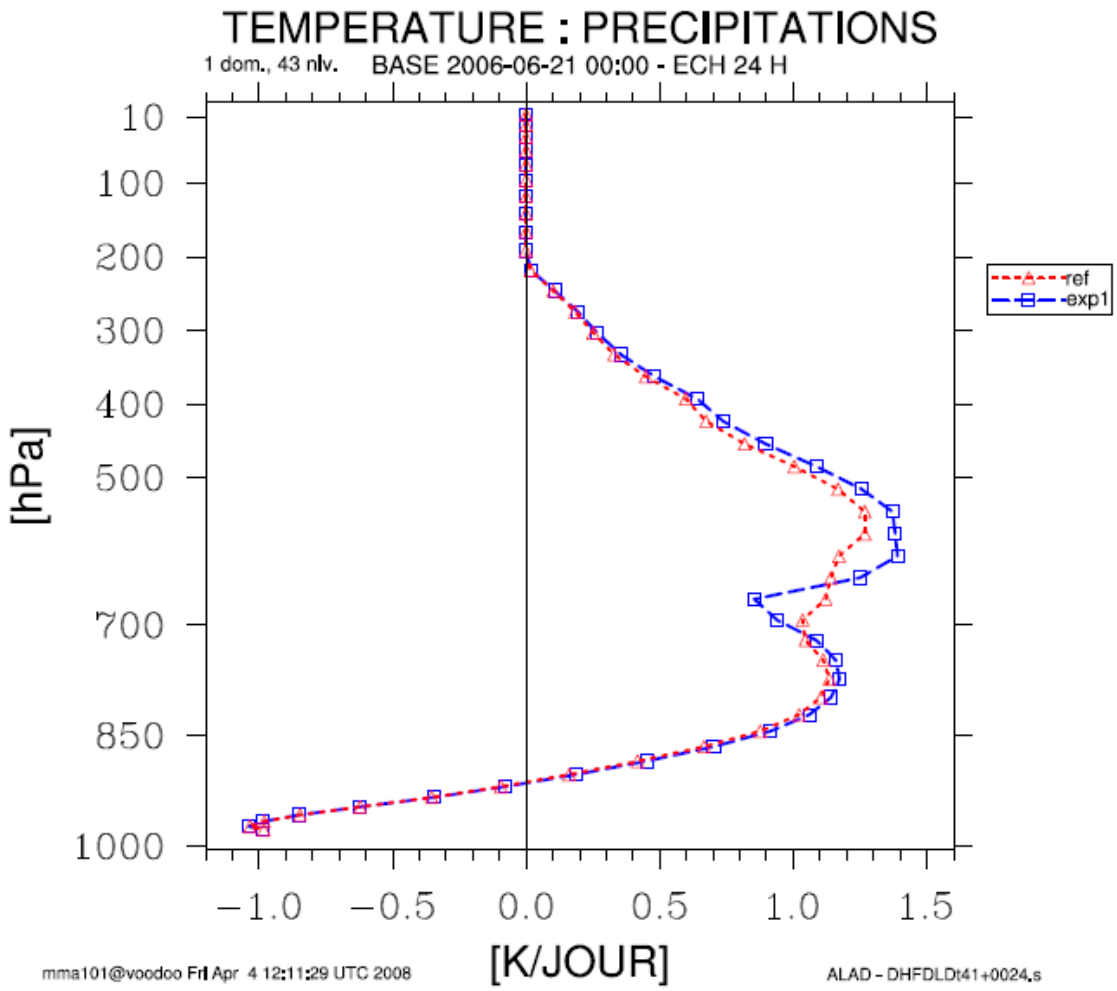
Working with Ncv (2/2)



Phase change effects (1/3)

- Melting/freezing of falling precipitation of sub-grid scale origin
  - Cumulative in the vertical, i.e. not local (as assumed in native M-T);
  - How to take into account the latent heat effects when computing convective condensation rates in the updraught;
  - If nothing is done, there is an artificial ‘double detrainment’ like effect.

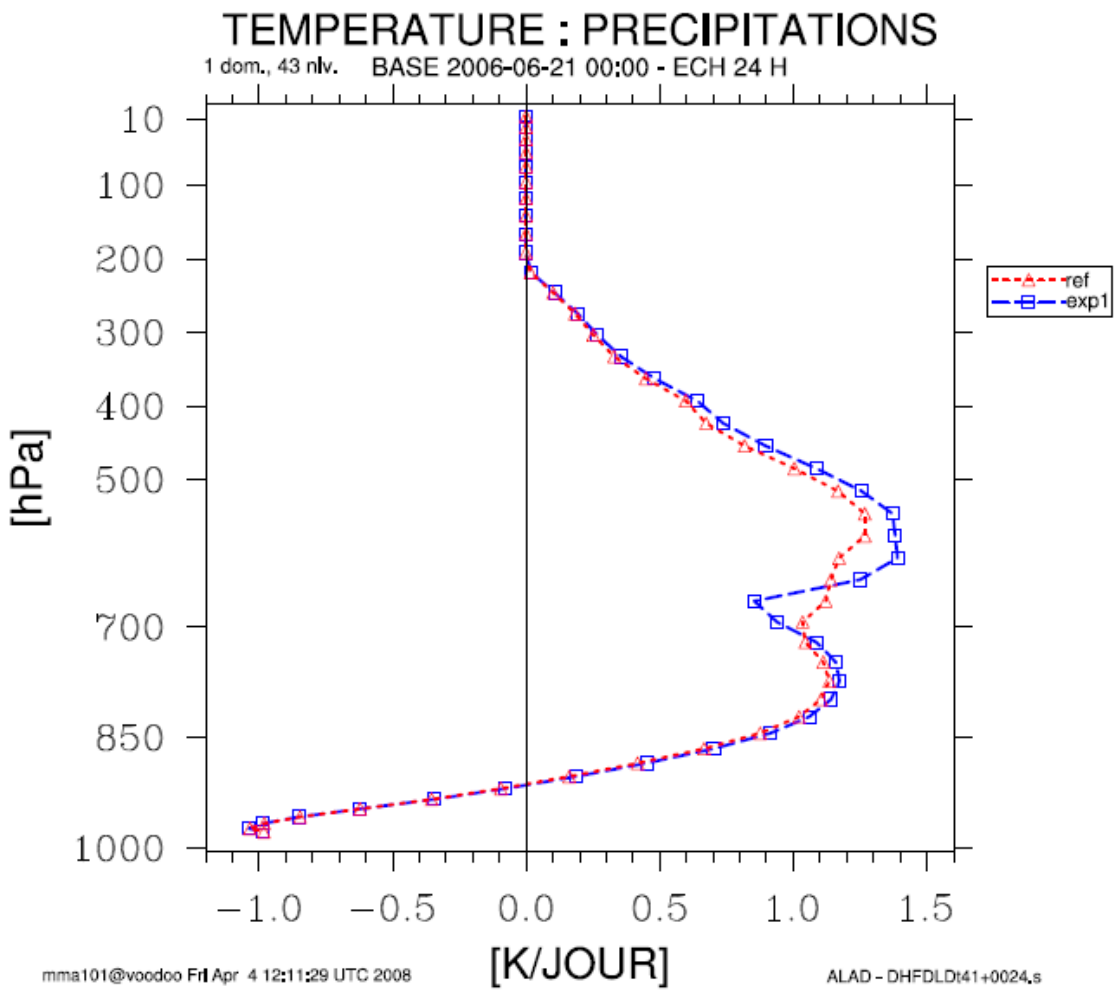
Phase change effects (2/3)



Blue curve: ‘double detrainment syndrome’

Phase change effects (3/3)

- Cure:
  - Iterative computation
    - Latent heats with help of ‘minimum’ of microphysics (autoconversion, melting/freezing, …) having as input the convective condensation fluxes;
    - Correction of convective condensation fluxes;
  - Convergence is fast (one iteration is enough).



Red curve: iterative latent heats effect

LACE
nwp central europe

Cloudiness life time

- Refreshed at each time-step:
  - Historic value of detrained mesh fraction;
  - Prognostic updraught mesh fraction.
- Idea how to use past values and how to tune amount of convective cloudiness
  - Introduction of e-folding time decay for the convective cloudiness.

LACE
nwp central europe

Conclusions

- 3MT cannot be viewed as convective scheme only;
- Prognostic character and treatment of both resolved and sub-grid scale moist processes requires cross time-stepping solution.