Latest and near futur improvements in Méso-NH/AROME physics

Sylvie Malardel

12 mai 2006

Contents

SW for mesoscale applications (Odile Thouron)

Very detailled tests have been made by CNRM/GMEI to compare ECMWF radiation scheme with the radiative transfert model SHDOM.

- Impact of cloud overlap hypothesis
  - **random ovelap** is necessary for zenithal angle computation
  - **maximum random overlap** is better for clear air fraction computation
- Impact of optical properties : a few corrections are proposed

Proposed modifications are sent to J.J. Morcrette.
3D tests should be done in 3D in Méso-NH and Arome.

Cloud sedimentation (Samuel Remy, 2006)

In the current version of the microphysics in Arome, only rain, snow and graupel precipitate. It was shown (fog intercomparaison, Bergot et al, 2006) that in fog situations, the sedimentation of cloud (small droplets) is essential to improve the realism of the fog.

A complete revision of the fog processes has been done in the 2 moments microphysical scheme (C2R2). The liquid cloud sedimentation introduced in C2R2 has been adapted for the 1 moment scheme ICE3. After 1D validations in Méso-NH, this new version of ICE3 is currently tested in Arome.

Sedimentation of droplets

Sedimentations in ICE3

- Raindrop and droplet distributions are different (Marshal-Palmer/more general γ function)
- Raindrop and droplet fall speed expressions are different

$\Longrightarrow$ a specific formulation of the precipitation fluxes had to be derived for r_c.

Land/sea droplet spectra

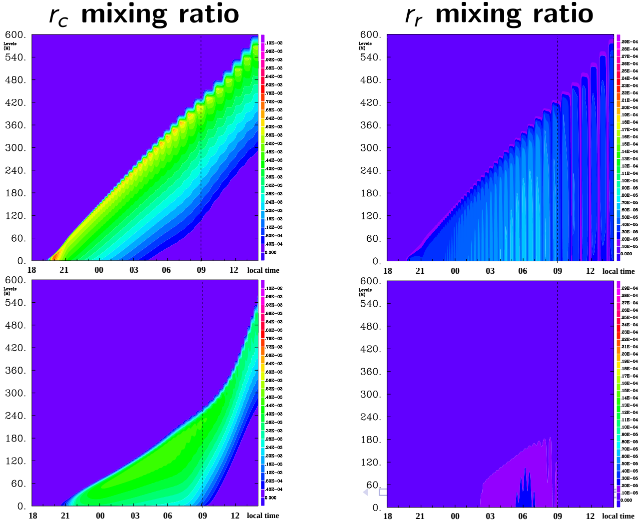
Measurements show that the droplet distribution and the droplet mean radius are significantly different in sea and land area (for example, in sea area the mean droplet radius is bigger than in continental area). It is then proposed to coupled the droplet sedimentation with the description of the grid in terms of *cover* in SURFEX/Ecoclimap (SURFEX equivalent of land/sea mask).

1D test with and without cloud sedimentation

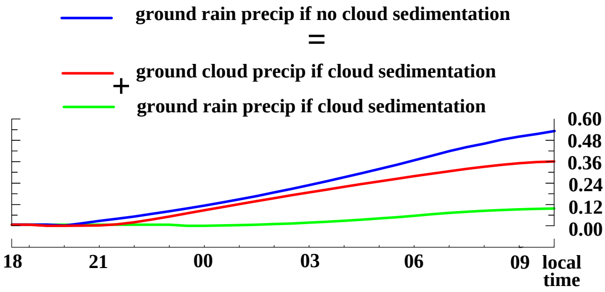
scheme = ICE3, vertical resolution : $\Delta z = 1$ m, $\Delta t = 3$ s

no cloud sedimentation

with cloud sedimentation



1D test with and without cloud sedimentation



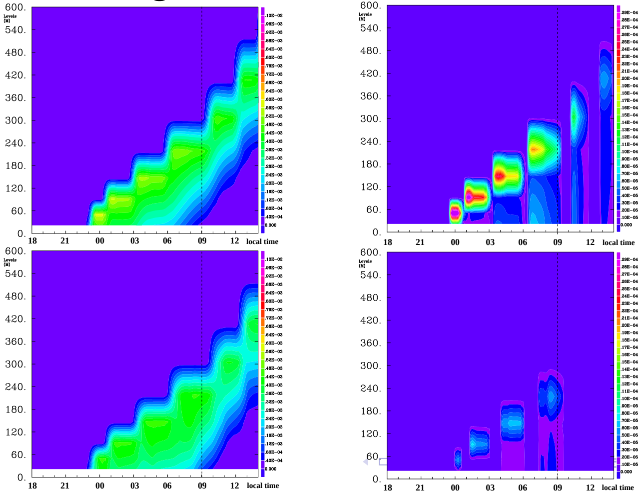
Vertical resolution sensitivity

scheme = ICE3, vertical resolution : $L46$ futur oper, $\Delta\ t = 60$ s

r_c **mixing ratio** | r_r **mixing ratio**

no cloud sedimentation

with cloud sedimentation



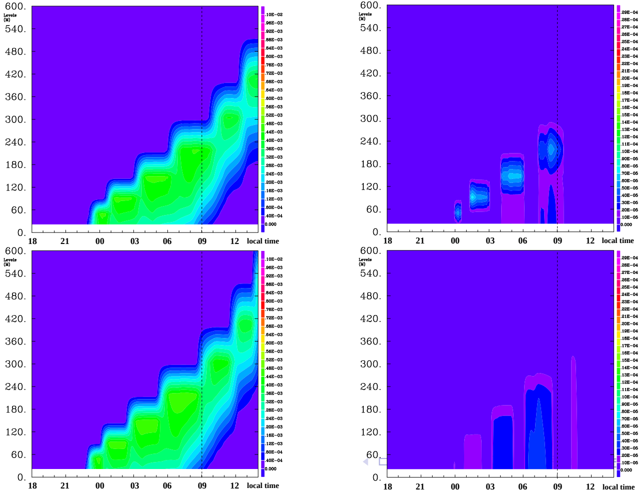
Time step sensitivity

scheme = ICE3, vertical resolution : *L*46 futur oper

r_c **mixing ratio** | r_r **mixing ratio**

$\Delta\ t = 60$ s

$\Delta\ t = 3$ s

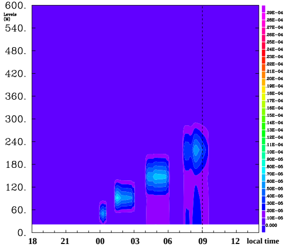


Sensitivity to the position of sedimentation in the $\mu\varphi$

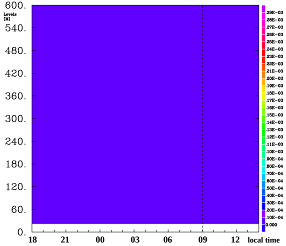
scheme = ICE3, vertical resolution : $L46$ futur oper, $\Delta\ t = 60$ s

r_r mixing ratio

sedimentation at the beginning of $\mu\varphi$

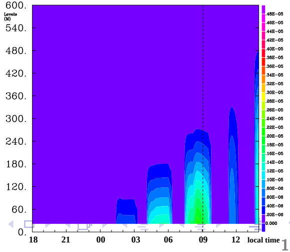


sedimentation at the end of $\mu\varphi$



But the ground precipitations do not depend on the position of the sedimentation.

zoom with a finer interval



Semi-lagrangian sedimentation

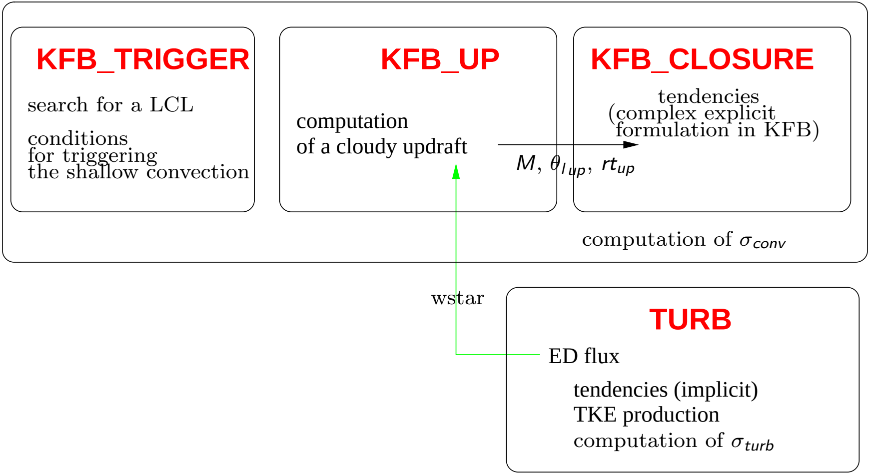
Sedimentation is a vertical advective process.
The stability condition of the current eulerian version imposes a time iterative computation with a sub-time step.

We are looking for somebody to help for the development of a more stable SL scheme according to the solution proposed by Yves Bouteloup for Lopez scheme.

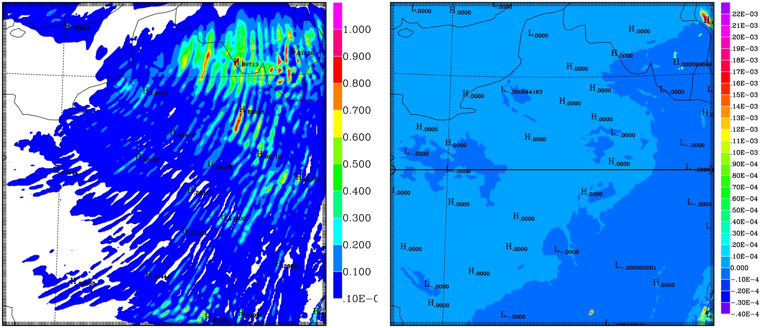
Subscale convective cloud parametrisation

For gridmeshes around 2 km and vertical resolution of several tens of meter in the lower levels, several types of cloud are not explicitely represented by the mean grid size parameters (saturation is not reached by mean parameter but it may be more localy)
$\Longrightarrow$ need of subgrid could parametrisation for Cu and Sc.

The current parametrisation : ED+KFB



Cloud fraction at 1500 m, the 07/06/2005 at 12TU and KFB shallow convective tendencies



In test : ED+MF (modified version from Soares et al, 2004)

MF

computation of
a dry and cloudy updraft

$M, \theta_{l\,up}, rt_{up}$

MF_TURB

MF flux : $\overline{w'\phi'} = M(\phi_{up} - \overline{\phi})$

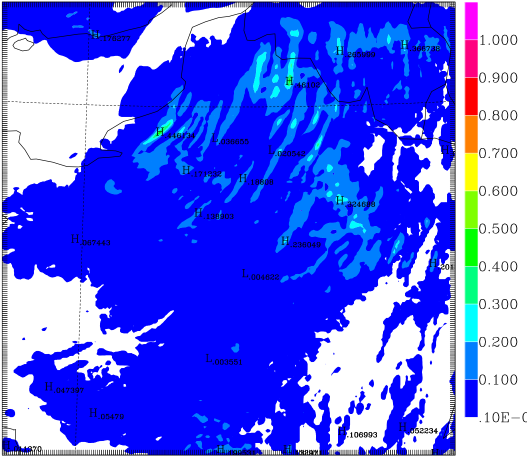
tendencies (explicit) :
$\partial\overline{\phi}/\partial t = -\partial\overline{w'\phi'}/\partial z$
computation of σ_{MF}

TURB

ED flux : $\overline{w'\phi'} = -K\partial\overline{\phi}/\partial z$

tendencies (implicit)
TKE production
computation of σ_{turb}

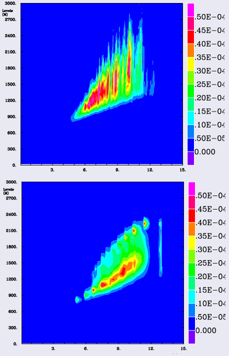
Cloud fraction at 1500 m, the 07/06/2005 at 12TU



Classical 1D case : cloud mixing ratio

Eurocs/ARM/Cu

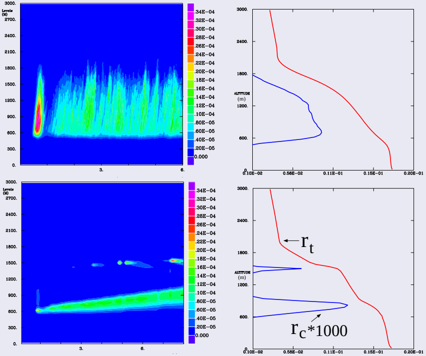
LES



EDMF

BOMEX

LES

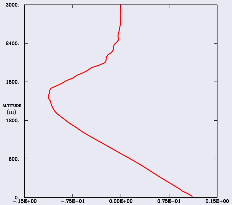


EDMF

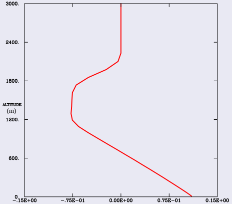
Classical 1D case : θ_l fluxes

Eurocs/ARM/Cu

LES

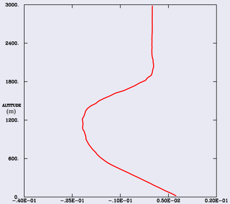


EDMF

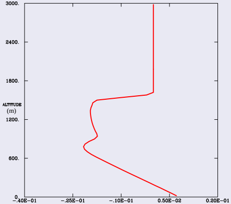


BOMEX

LES



EDMF



Current development

UPDRAFT

computation of the « best »
dry and cloudy updraft

M, $\theta_{l\,up}$, rt_{up}

MF_TURB

flux MF

tendencies (explicit)

computation of σ_{MF}

TURB

ED flux

tendencies (implicit)
TKE production
computation of σ_{turb}

1D tests
3D validations

(before september 2006 ?)

What's SCUM

Just a switch ...

A 1D option of the operationnal 3D code Arpege/Aladin/IFS (but also sooner or later Alaro, Arome, Hirlam).

From the existing 2D version of the 3D operationnal system

A 2D vertical plane version was already developped for ideal case studies (for a meridional vertical plane (O, y, z)).

A pseudo-1D

- A 2D model with 4 identical columns, 1 meridionnal wave number ($NSMAX = 1$)
    - stationnary solution if no physics and no forcing
    - still go to spectral space but horizontal derivatives are zero
- Cyclic geometry (no coupling, no bi-periodicisation)

Why an embedded 1D model for Arpège/Aladin/Arome/(Alaro)/(IFS)/(Hirlam)

- A common «official» tool to work on all the physics sets of the community
- A code evolving automaticaly with the Arpge/IFS cycles
- A code validated as the 3D and 2D options before each new cycle («mitraillette» tests)
- A code automatically distributed to the 3D users of Arpège/Aladin/Arome/(Alaro)/(IFS)/(Hirlam)
- A code benefiting immediately from the improvements of the 3D (data flux modification (GFL), new physics interfaces, new diagnostics interfaces)

Drawbacks and current limitations of an embedded 1D model for Arpège-Aladin-Arome

- Loose most of the development which have been made for the «off line» Arpège 1D model
- Loose a bit of portability
- Loose the flexibility of a non operationnal code
- Looose the facilities of Méso-NH 1D for an ideal case preparation
- Loose the large set of output/diagnostics of Méso-NH 1D (easy comparisons to LES references)

When ?

CY31t1

- Personnal tests in CY30t1
- Official implementation in the Arpege/IFS library for CY31t1 (beginning of June)
- A portable PC version should be prepared with the help of Ryad before summer

Running a 1D case

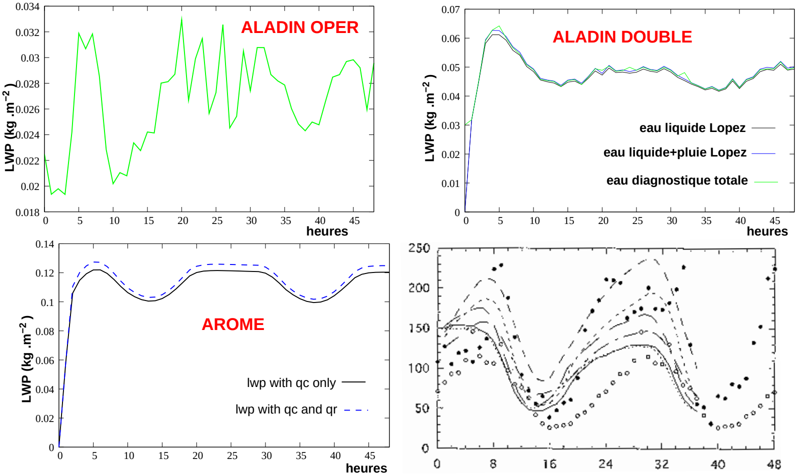
You need :

- the initial FA file (acsii2FA=acadfa1D)
- an arpege/aladin namelist
- a standart script

You get :

output FA files (+ output from SURFEX) (FA2ascii=flux)

LWP


ALADIN OPER
LWP (kg .m^{-2})
heures
ALADIN DOUBLE
eau liquide Lopez
eau liquide+pluie Lopez
eau diagnostique totale
LWP (kg .m^{-2})
heures
AROME
lwp with qc only
lwp with qc and qr
LWP (kg .m^{-2})
heures

Cloud top and bottom