1D shallow convective case studies and comparisons with LES

CNRM/GMME/Méso-NH

24 novembre 2005

Contents

Case description

Météorological situation : stationnary cumuli

Non-precipitating cumuli which were the only type of cumulus convection that was observed during the undisturbed BOMEX period of phase 3 from 22 to 26 June 1969 over the ocean near Barbados.

Prescribed forcings

- Large scale subsidence
- Radiative cooling
- Large scale horizontal advection of moisture
- Geostrophic wind

A new closure

Convective vertical velocity w^*

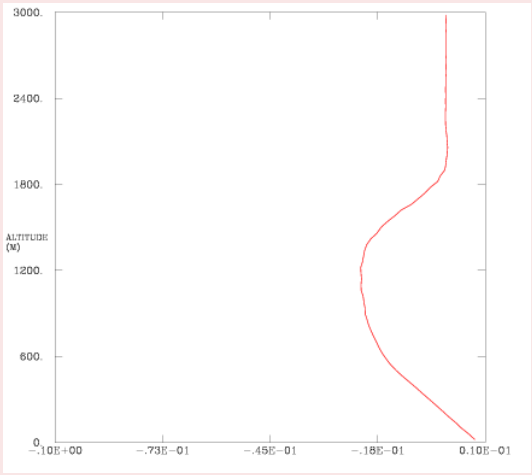
Instead of the CAPE iterative closure, we directly compute the cloud bottom mass flux with a convective vertical velocity proportionnal to the shallow convective activity in the boundary layer (for exemple, Grant et al, 1999)

$$M^u(\mathrm{LCL}) = \overline{\rho}\, w^*\, S$$

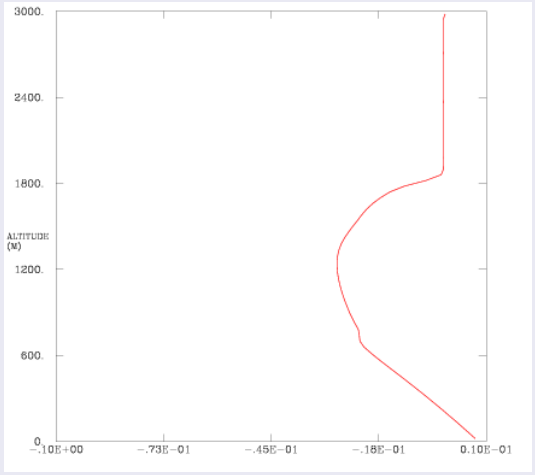
with w^* computed in the turbulence scheme as a function of the surface fluxes and the depth of the boundary layer.

θ_l vertical flux

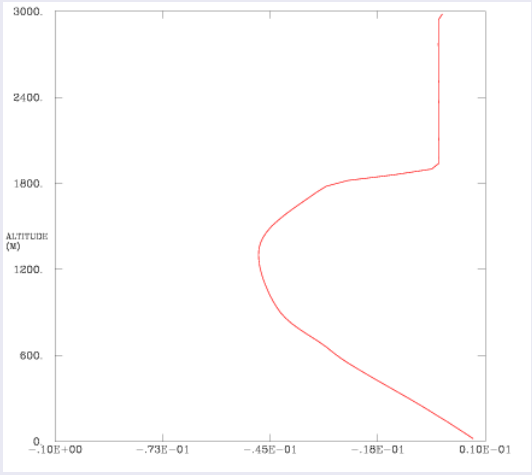
LES



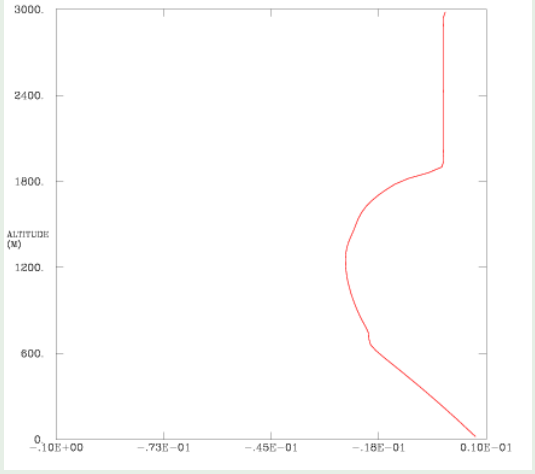
Méso-NH REF ($\tau = 3$h)



$\tau = 1$h

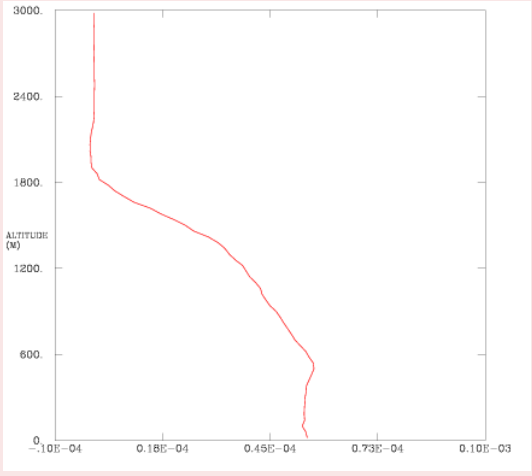


w^* closure

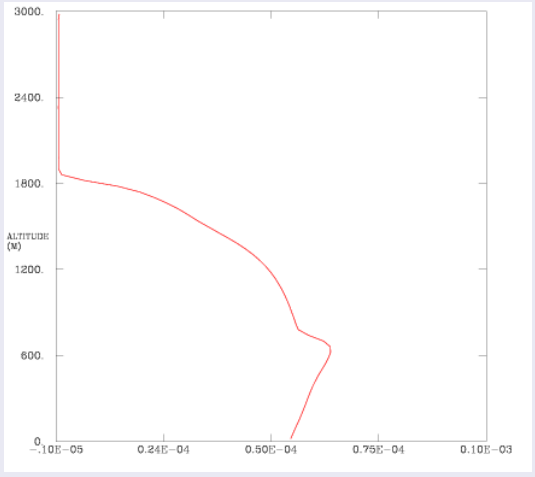


r_t vertical flux

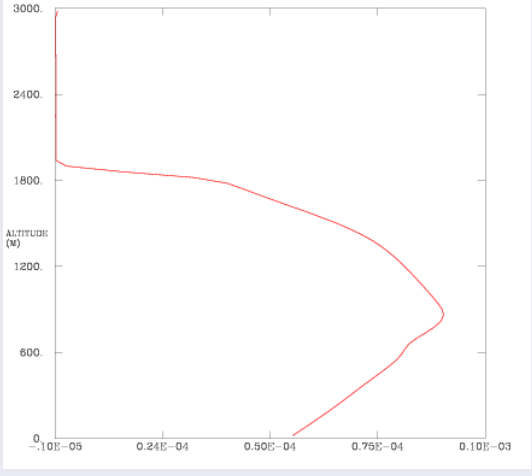
LES



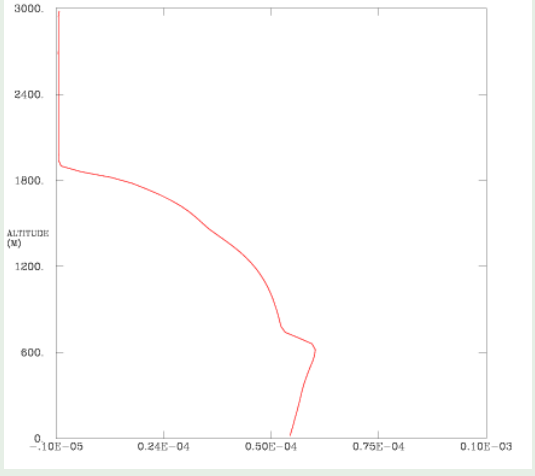
Méso-NH REF ($\tau = 3$h)



$\tau = 1$h

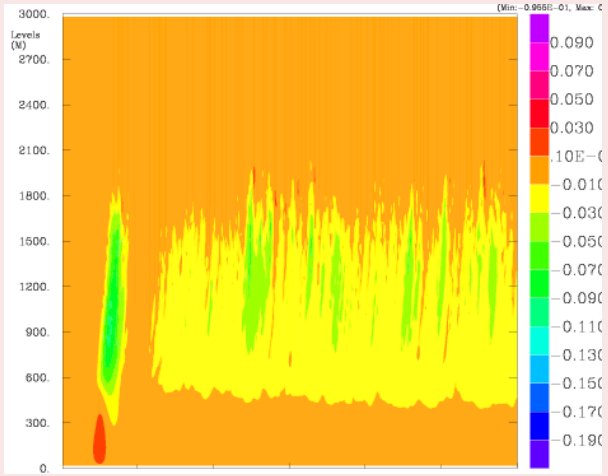


w^* closure

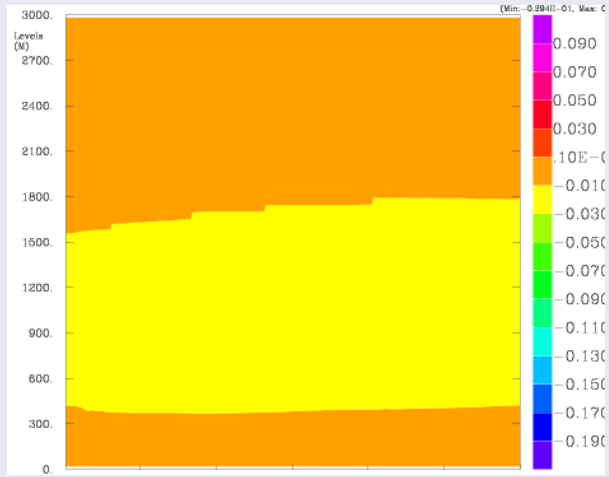


θ_l vertical flux

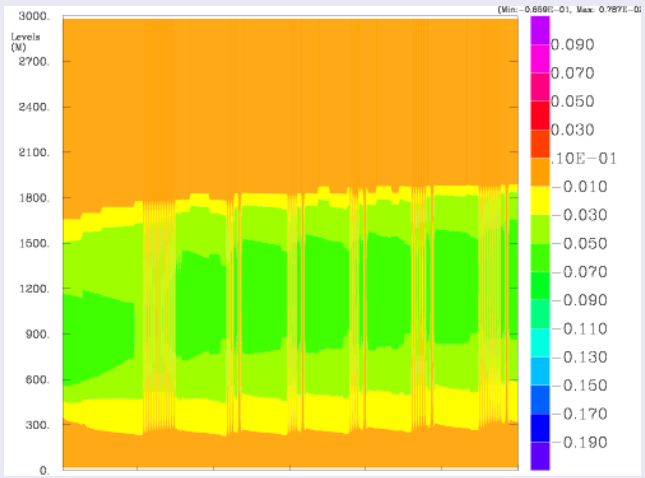
LES



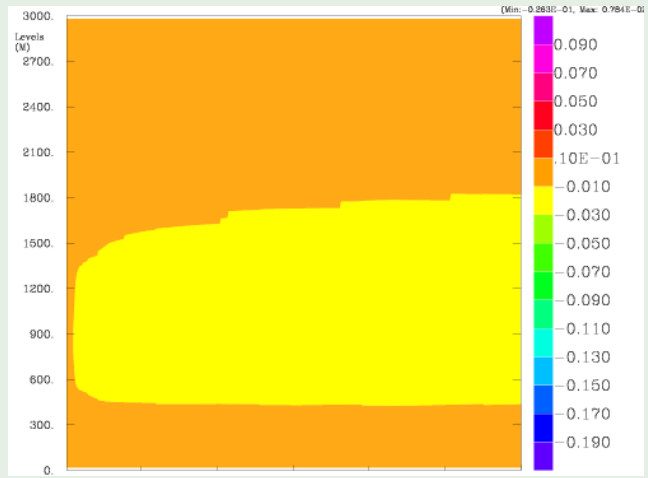
Méso-NH REF ($\tau = 3$h)



$\tau = 1$h

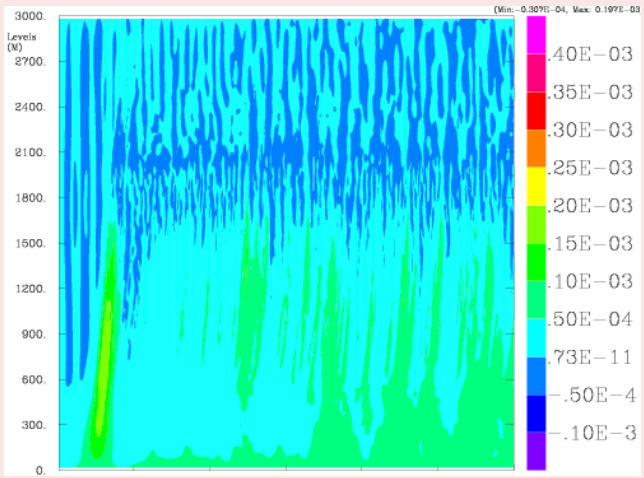


w^* closure

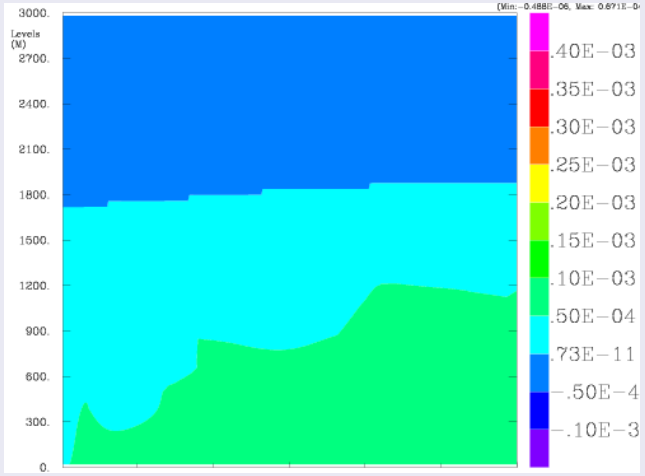


r_t vertical flux

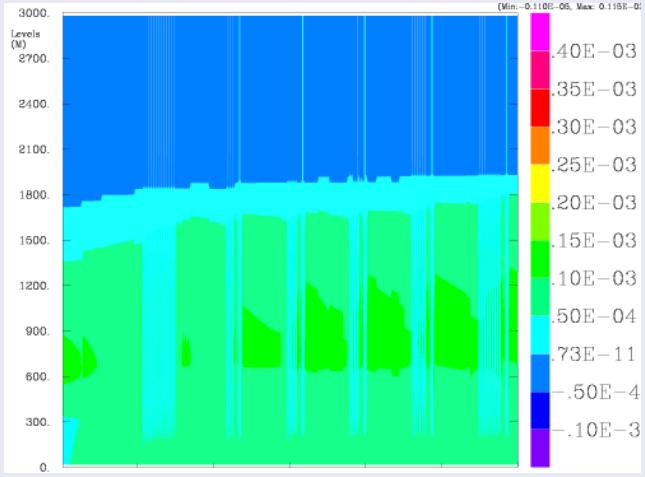
LES



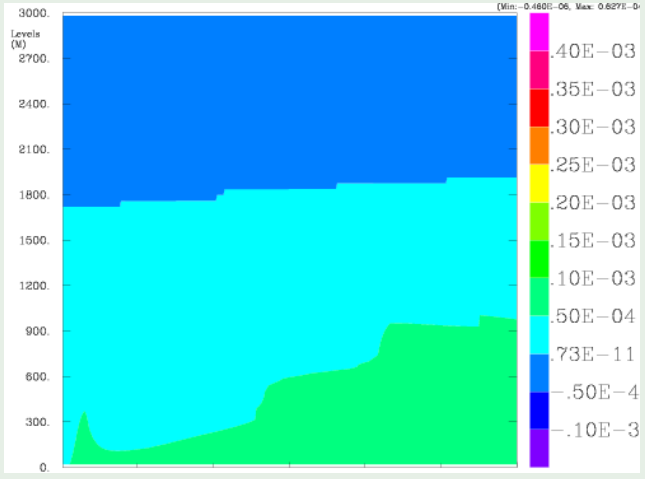
Méso-NH REF ($\tau = 3$h)



$\tau = 1$h

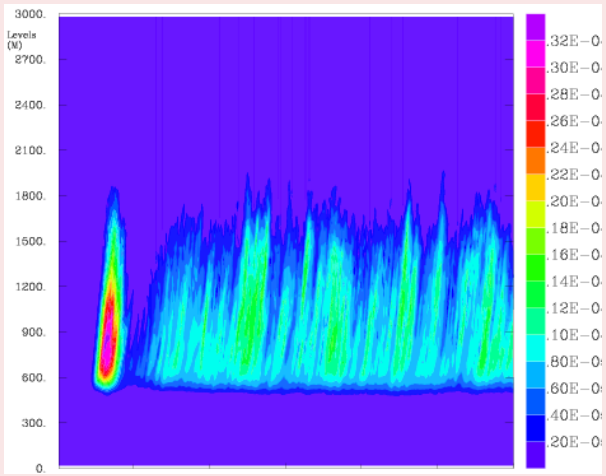


w^* closure

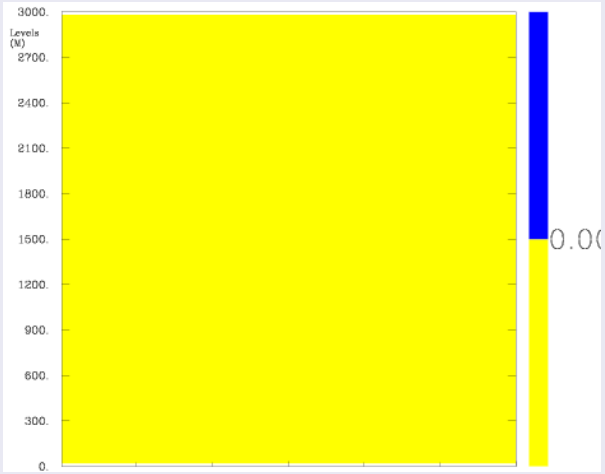


Cloud mixing ratio r_c

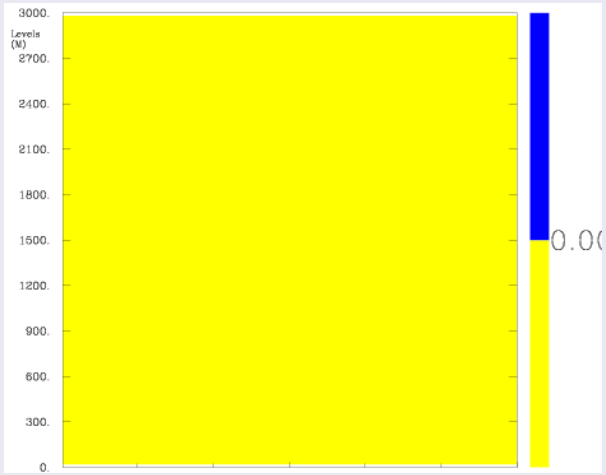
LES



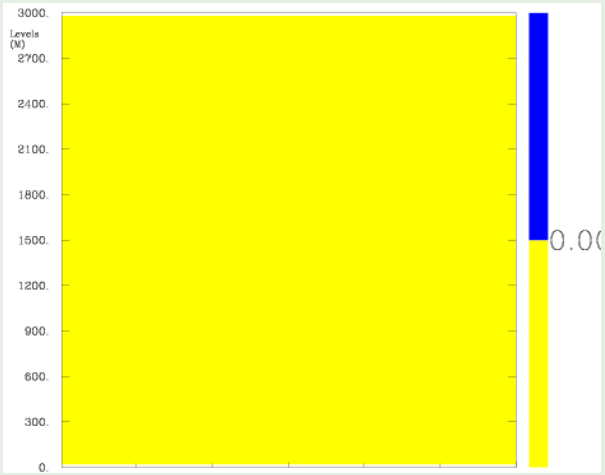
Méso-NH REF ($\tau = 3$h)



$\tau = 1$h



w^* closure



Case description

Meteorological situation : diurnal cycle of cumuli

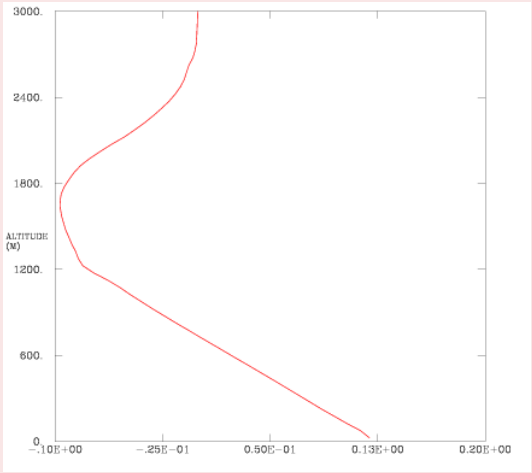
This case is based on observations at the ARM site on the Southern Great Plains (USA) on 21st june 1997. During that day, Cumulus clouds developed at the top of an initially clear convective boundary layer.

Prescibed forcings

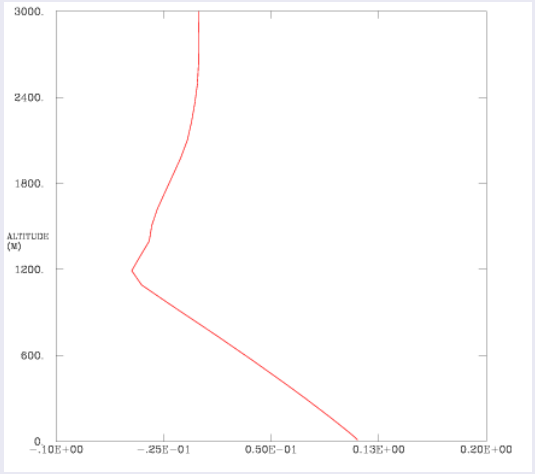
- Prescibed surface fluxes
- Large-scale forcings and radiation
- Geostrophic wind

θ_l vertical flux

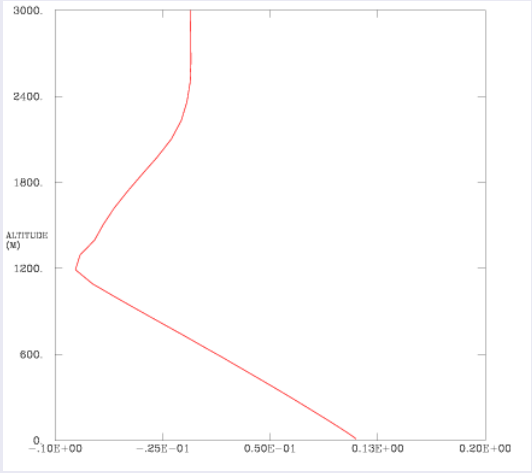
LES



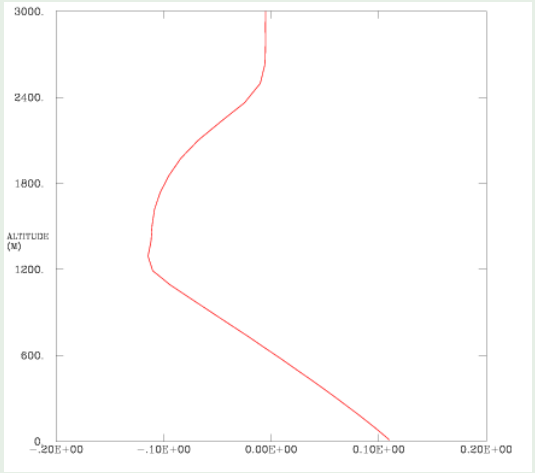
Méso-NH REF ($\tau = 3$h)



$\tau = 1/2$h

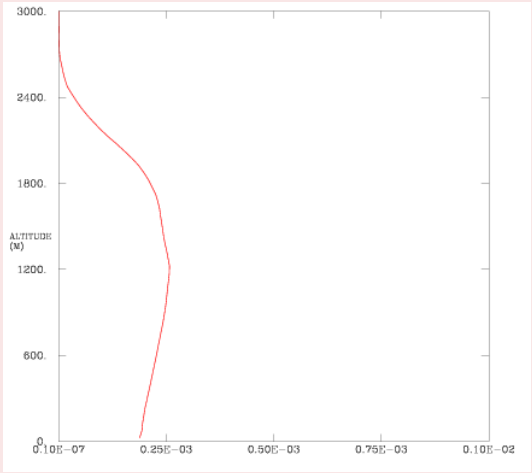


w^* closure

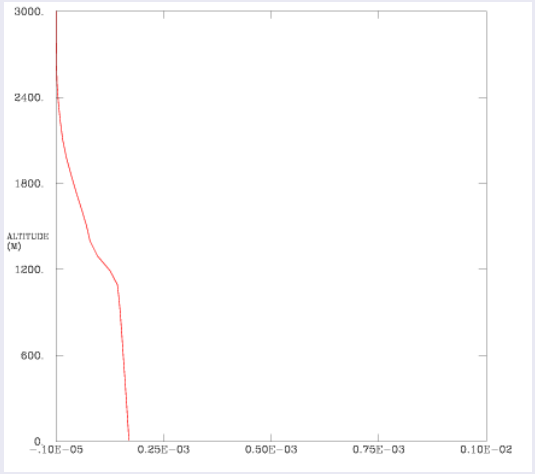


r_t vertical flux

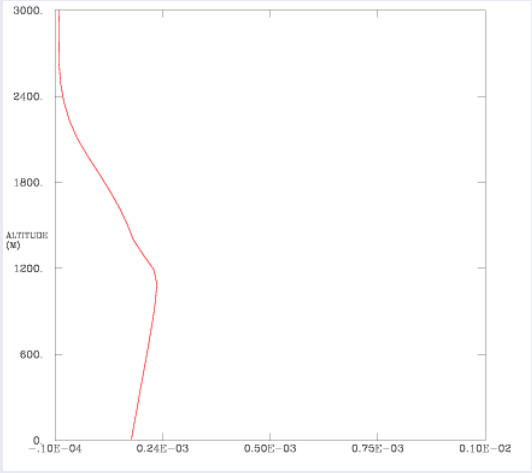
LES



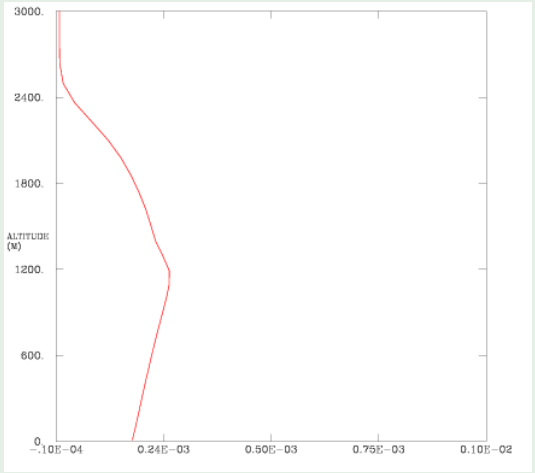
Méso-NH REF ($\tau = 3$h)



$\tau = 1/2$h

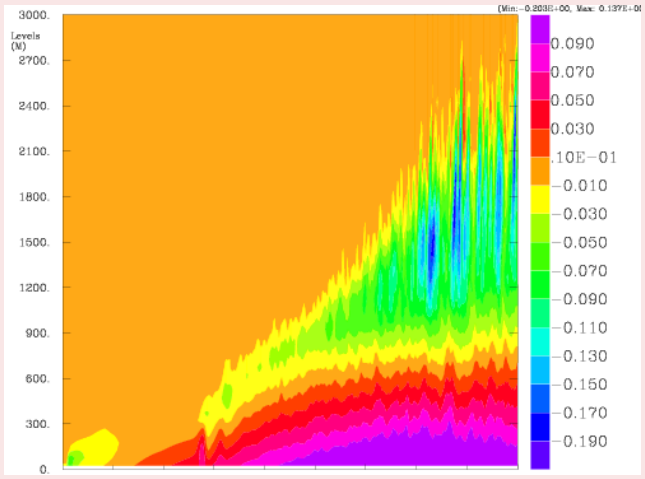


w^* closure

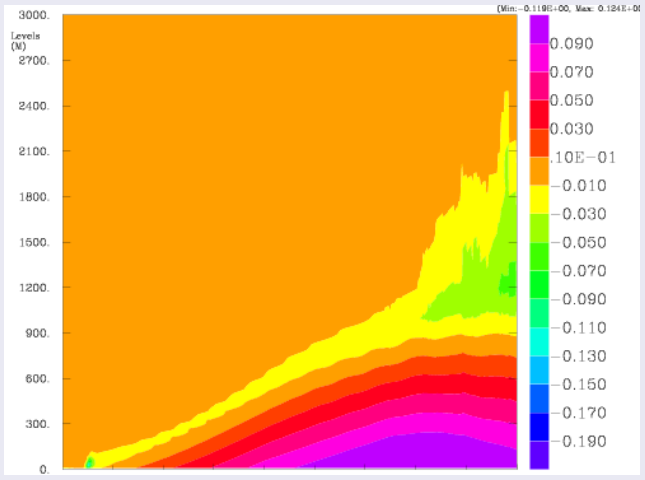


θ_l vertical flux

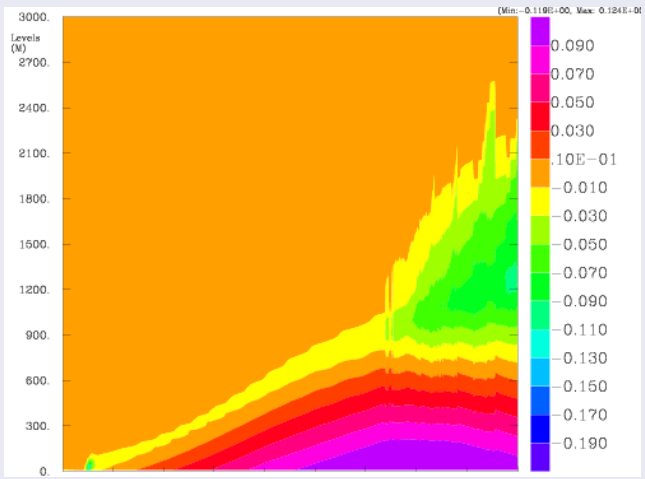
LES



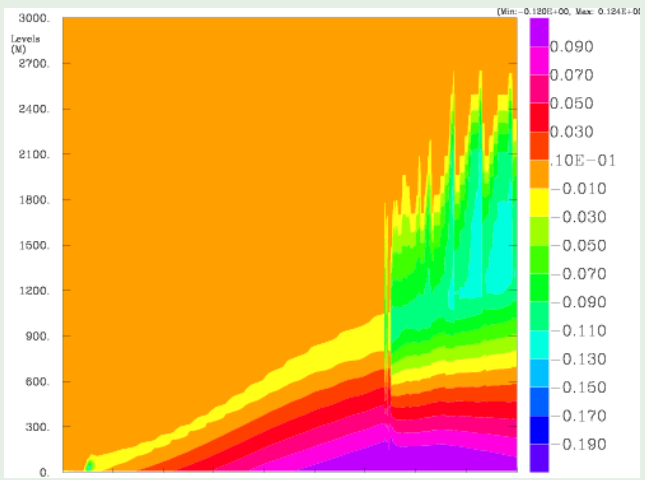
Méso-NH REF ($\tau = 3$h)



$\tau = 1/2$h

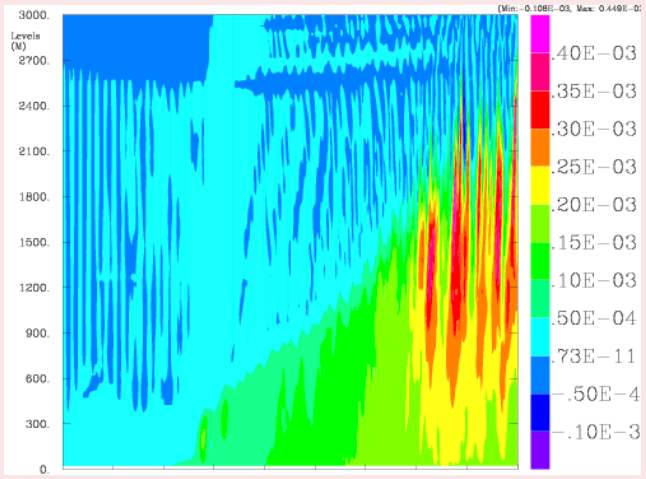


w^* closure

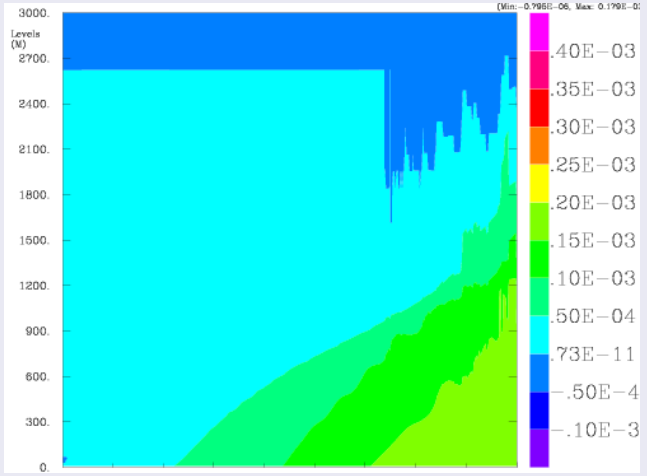


r_t vertical flux

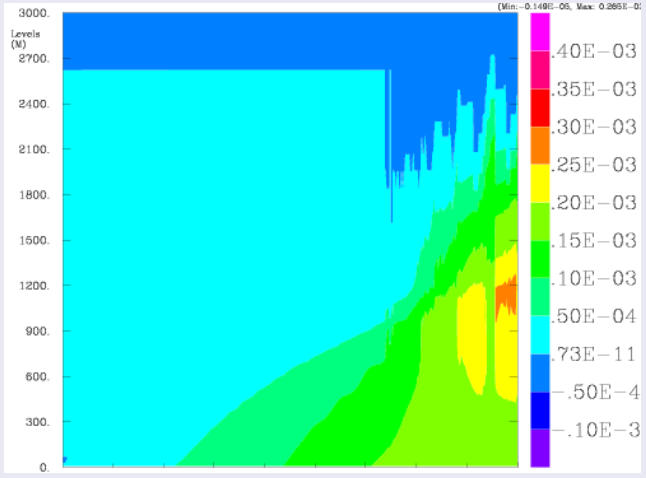
LES



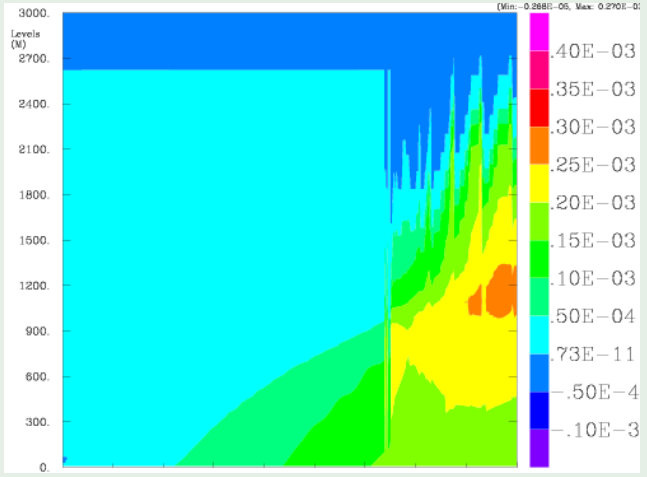
Méso-NH REF ($\tau = 3$h)



$\tau = 1/2$h

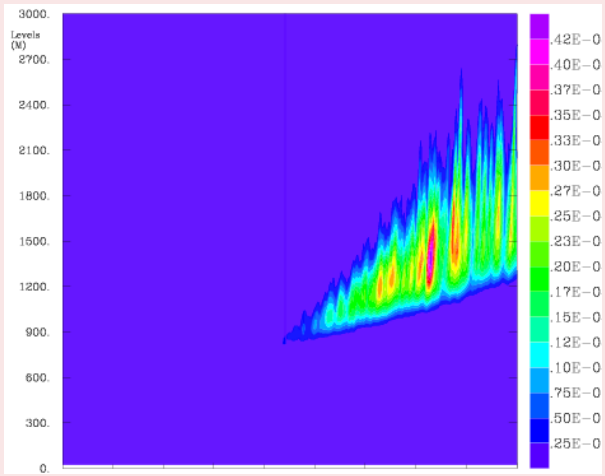


w^* closure

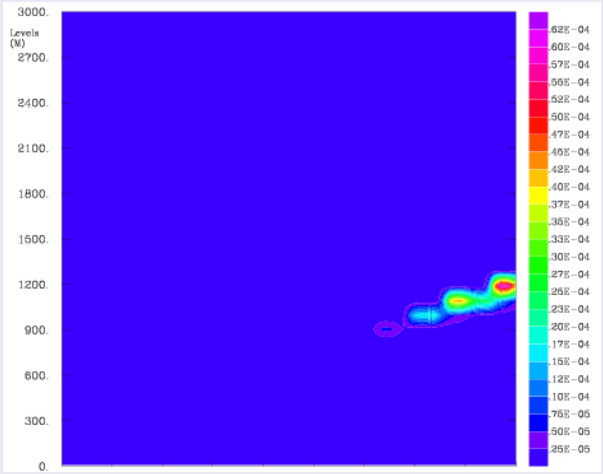


Cloud mixing ratio r_c

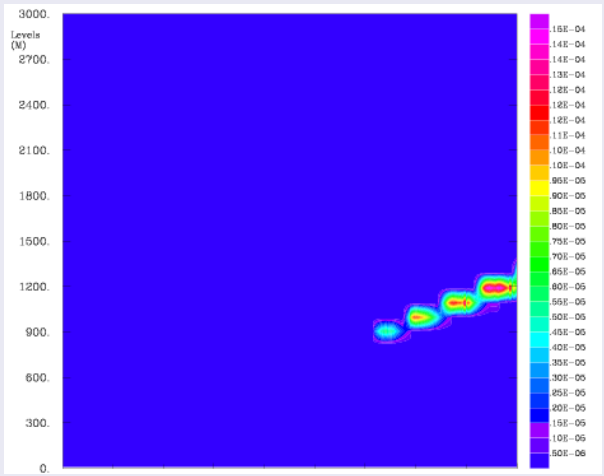
LES



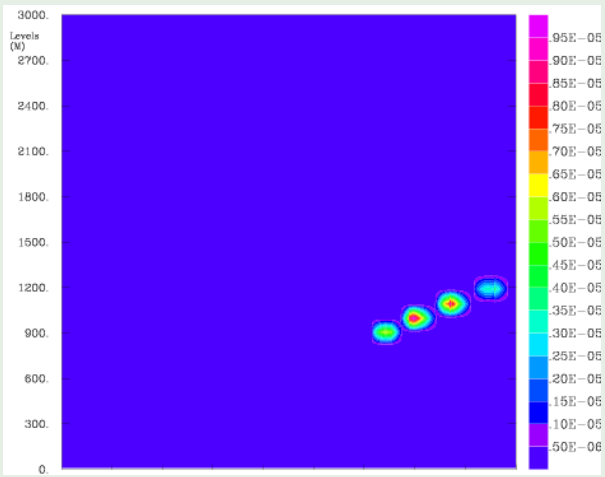
Méso-NH REF ($\tau = 3$h)



$\tau = 1/2$h



w^* closure



Summary of « cloud physics for subgrid motions »

- In Arome/Méso-NH, the microphysics is the cloud/precipitation physics of grid scale motions.
- In Arome/Méso-NH, the turbulence scheme and the shallow convection scheme are quite well tuned for the subgrid transport of conservative variables (good pronostic evolution of conservative variables), but the « projection » of these variables on the cloud variables and θ is not yet well tuned. And it is an important problem for the interaction with radiation and with the surface.

- we are still working to improve the current schemes (see Christine's presentation)
- we cooparate with other communities (P.Soares/KNMI, Hirlam)

Summary of « cloud physics for subgrid motions »

Everybody is welcome to help

- for the objective of a pre-operational model in 2006
- or for a longer term evolution of Arome