3MT in ARPEGE – ALADIN: implementation, first results

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Why 3MT?

1. Create a cloud and precipitation scheme that can be used in the « grey zone » : between 2.5 and 10km horizontal grid mesh. Partly resolved convective vertical velocities.

2. « MT » spirit: externalize microphysical computations from the subgrid convection code, in order to share microphysical routines between subgrid and resolved convection, and use « up to date » microphysics.

What is 3MT?

1. « Microphysical cascade »: prognostic water species, (i) subgrid-updraft-condensation and resolved-condensation are combined, (ii) enter a common microphysics of precipitation and evaporation, (iii) evaporation is an input of subgrid-downdraft.

2. Prognostic subgrid convective vertical velocity equation.

3. Double geometry: fraction of clouds (prog.), fraction of precipitating areas (diag.).

Results in ARPEGE

1. Aquaplanet: « 3MT shows a clear improvement in terms of sensitivity of precipitation to resolution and displays more variability mainly due to greater Kelvin wave activity in the tropics. For coarse resolutions along the stormtrack, 3MT shows larger sensitivity to resolution than the Bougeault scheme. When resolution is high enough, in the mid-latitudes precipitation shows less dependance to resolution. » Olivier Rivière, 2008.

2. NWP context, large scale 3MT behaviour: when used with the Morcrette-RRTM radiation scheme, the 3MT scheme gives comparable zonal temperature tendencies, and precipitation fluxes.

Perspectives 3MT-ARPEGE 2008-2009

1. Combining 3MT and « present parallel suite physics » : Morcrette – RRTM – Prognostic TKE CBR – Non-precipitating convection KFB (Jean-Marcel Piriou). NWP context ARPEGE runs.

2. Test of APLMPHYS microphysics versus ACPLUIZ microphysics (Yves Bouteloup).

3. What cloudiness and subgrid water condensates for use in 3MT and the above physical package?

4. Extend 3MT to the non-precipitating convection (Jean-François Guérémy). Climate context ARPEGE runs.

Séparation microphysique – transport – MT, 3MT, 3MT-FP

3MT-FP (Fully Prognostic): n modes pronostiques interactifs.

transport horiz. transport vert.

microphysique

$$
\begin{cases}
\frac{1}{\overline{\rho}^i}\left(\frac{\partial \overline{\rho}^i \sigma_i}{\partial t}\right)_{cp} = & & & & & & & & \sum_{j\neq i}(E_{ij}-D_{ij}) & - & \frac{1}{\overline{\rho}^i}\frac{\partial}{\partial z}\overline{\rho}^i\sigma_i\overline{w}^i \\
\frac{1}{\overline{\rho}^i}\left(\frac{\partial \overline{\rho}^i \sigma_i \overline{q_v}^i}{\partial t}\right)_{cp} = & -\overline{C}^i & + & \overline{E_C}^i & + & \overline{E_P}^i & & & + \sum_{j\neq i}(E_{ij}\overline{q_v}^j - D_{ij}\overline{q_v}^i) & - & \frac{1}{\overline{\rho}^i}\frac{\partial}{\partial z}\overline{\rho}^i\sigma_i\overline{w}^i\overline{q_v}^i \\
\frac{1}{\overline{\rho}^i}\left(\frac{\partial \overline{\rho}^i \sigma_i \overline{q_l}^i}{\partial t}\right)_{cp} = & \overline{C}^i & - & \overline{E_C}^i & - & \overline{A}^i & & & + \sum_{j\neq i}(E_{ij}\overline{q_l}^j - D_{ij}\overline{q_l}^i) & - & \frac{1}{\overline{\rho}^i}\frac{\partial}{\partial z}\overline{\rho}^i\sigma_i\overline{w}^i\overline{q_l}^i \\
\frac{1}{\overline{\rho}^i}\left(\frac{\partial \overline{\rho}^i \sigma_i \overline{q_r}^i}{\partial t}\right)_{cp} = & \overline{A}^i & & & - & \overline{E_P}^i & & & + \sum_{j\neq i}(E_{ij}\overline{q_r}^j - D_{ij}\overline{q_r}^i) & - & \frac{1}{\overline{\rho}^i}\frac{\partial}{\partial z}\overline{\rho}^i\sigma_i\overline{w_s}^i\overline{q_r}^i \\
\frac{1}{\overline{\rho}^i}\left(\frac{\partial \overline{\rho}^i \sigma_i \overline{s}^i}{\partial t}\right)_{cp} = & \overline{LC}^i & - & \overline{LE_C}^i & - & \overline{LE_P}^i & + & \overline{H}^i & + \sum_{j\neq i}(E_{ij}\overline{s}^j - D_{ij}\overline{s}^i) & - & \frac{1}{\overline{\rho}^i}\frac{\partial}{\partial z}\overline{\rho}^i\sigma_i\overline{w}^i\overline{s}^i \\
\frac{1}{\overline{\rho}^i}\left(\frac{\partial \overline{\rho}^i \sigma_i \overline{u}^i}{\partial t}\right)_{cp} = & \overline{S_u}^i & & & & & & & + \sum_{j\neq i}(E_{ij}\overline{u}^j - D_{ij}\overline{u}^i) & - & \frac{1}{\overline{\rho}^i}\frac{\partial}{\partial z}\overline{\rho}^i\sigma_i\overline{w}^i\overline{u}^i \\
\frac{1}{\overline{\rho}^i}\left(\frac{\partial \overline{\rho}^i \sigma_i \overline{w}^i}{\partial t}\right)_{cp} = & \overline{S_w}^i & & & & & & & + \sum_{j\neq i}(E_{ij}\overline{w}^j - D_{ij}\overline{w}^i) & - & \frac{1}{\overline{\rho}^i}\frac{\partial}{\partial z}\overline{\rho}^i\sigma_i\overline{w}^i\overline{w}^i
\end{cases}
$$

sources/puits de vent horiz. et vert.

(2)

n modes sous-maille, i=1,n. Pour chaque mode: un jeu d'équations pronostiques pour le bilan de masse (sigma), vapeur d'eau, condensats nuageux et précipitants, chaleur, vent horizontal et vertical. En rouge: microphysique: condensation, évaporation, autoconversion, collection, chal. sens. préc. air environnant, etc.

Description. Proximité 3MT/3MT-FP. Proximité équ. primitives ➔ pont superparamétrisations.