PCMT :
Prognostic Condensates Microphysics and Transport
A new convection scheme for the global Climate and NWP model ARPEGE

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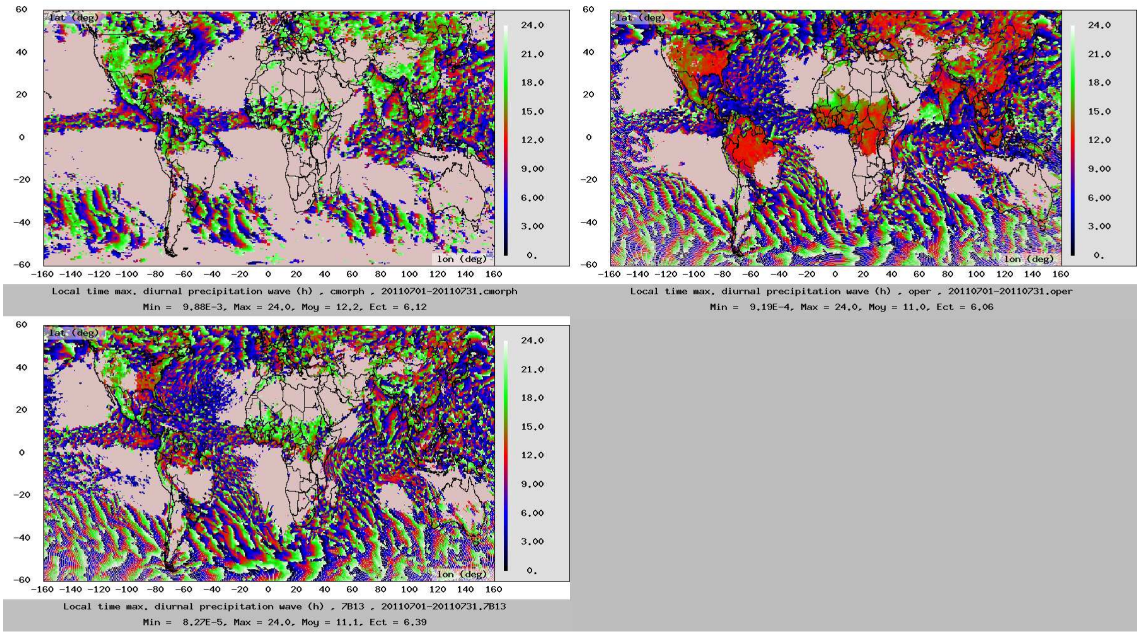

PCMT (Prognostic Condensates Microphysics and Transport) is a convection scheme under

development, to provide better sensitivity to environmental humidity, through 4 prognostic variables (liquid water, ice water, rain, snow). The vertical velocity equation is also prognostic. The grid-scale equations from the convection scheme separate microphysical processes and transport processes, after (Piriou et al., 2007). The prognostic microphysics is taken from (Lopez, 2000), entrainment and closure of the scheme from (Guérémy, 2011). The vertical transport of udpdraft species is done by an unconditionnally stable algorithm, following (Geleyn et al., 2008). One of the objectives is to increase the sensitivity of model convection to environmental humidity.

As an example, the liquid water equation stands

$$\begin{aligned} \frac{\partial}{\partial t}\overline{q_{lc}} &= \text{Advec}(\overline{q_{lc}}) \\ & -\frac{1}{\rho}\frac{\partial}{\partial z}\rho\left[\alpha_u w_u + \alpha_d w_d\right] q_{lc} \\ & +(E_u + E_d)\, q_{lr} - (D_u + D_d)\, q_{lc} \\ & +\text{CondensEvap}_{q_{lc}} - \text{AutoconvColl}_{q_{lc}} + \text{MeltingIcing}_{q_{lc}} \end{aligned} \quad (1)$$

where $\text{Advec}(\overline{q_{lc}})$ is resolved 3D advection, α is the surface of draft, u stands for updraft, d for downdraft, w is vertical velocity, E entrainment, D detrainment, q_{lc} convective liquid water, on the fourth line are the three microphysical processes condensation-evaporation, autoconversion-collection, melting-icing.

The above figure presents some results obtained with the PCMT scheme on the diurnal cycle of convective precipitation, as simulated by two versions of the global NWP model ARPEGE of Meteo France :

1. The upper left panel shows the observed precipitation timing (local time when precipitation rate is a maximum) computed on the basis of the NOAA CMORPH analysis data set. The data are averaged over one month, viz., July 2011. Over land, the precipitation rate peaks in late afternoon as indicated by green colours. Over much of the World Ocean, the signal is weak, and no conclusive statement can be made.
2. The upper right panel shows the results from simulation with the standard version of ARPEGE used operationally at Meteo France. As in many other global NWP models, precipitation rate peaks around local noon, i.e. too early as compared to observations.
3. The lower left panel shows the results from ARPEGE simulation, where the standard ARPEGE cumulus convection scheme is replaced by the PCMT scheme. As seen from the plot, the timing of precipitation maximum is clearly improved over many regions, e.g. over Central Africa, India, Amazonia, Mexico, and United States.

Références

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