EMS Annual Meeting Abstracts,
Vol. 6, EMS2009-67, 2009
9th EMS / 9th ECAM

9th European Conference on Applications of Meteorology
9th EMS Annual Meeting
High resolution meteorology - applications and services

Parametrization of the subgrid-scale condensation in mesoscale NWP models

E. Perraud (1), S. Malardel (2), C. Lac (3), F. Couvreux (4), and V. Masson (5)

(1) Météo-France, France (emilie.perraud@meteo.fr), (2) ECMWF, England (Sylvie.Malardel@ecmwf.int), (3) Météo-France, France (christine.lac@meteo.fr), (4) Météo-France, France (fleur.couvreux@meteo.fr), (5) Météo-France, France (valery.masson@meteo.fr)

Clouds are a major element for the hydrological cycle and the Earth system. In the atmosphere, the water can exist under three phases (water vapour, liquid water and ice) which have a different impact on atmospheric processes. A good representation of clouds is a quality condition for all numerical weather forecast models such as the operational model AROME or the research model Méso-NH used at Météo-France. With a horizontal resolution of 2.5km (AROME resolution), thick stratiform clouds and deep cumulonimbus can be considered as resolved clouds but shallow cumulus and stratocumulus are still treated by subgrid processes. The objective of our work is to develop a prognostic subgrid cloud scheme well suited for the AROME resolution and for all types of clouds.

At the scale of the "continuum", the cloud formation requires a thermodynamic equilibrium between the three phases of water. In numerical models, this process is parametrized. It is supposed that the water phases reach this thermodynamic equilibrium with a characteristic time scale much smaller than the time step. The cloud scheme is then reduced to an adjustment to saturation of a guess of the prognostic variables of the model.

In this work, we focus on the subgrid condensation scheme which deals with variations of temperature and humidity at scales lower than the grid size. The subgrid scheme is valid for resolved and homogeneous clouds but it should also be able to produce cloud condensates and cloud cover when the mean grid is not saturated. Both the water cloud content and the cloud cover should depend on the variability of the thermodynamic parameters in the grid and on the distance to the saturation. This scheme is able to reproduce the impacts of all types of clouds on the mean prognostic variables of operational NWP models.

In this aim, we started the development of a new subgrid cloud scheme for AROME and Méso-NH. The idea is to implement a solution originally proposed by Tompkins (2001). The use of a tunable beta function allows a flexible representation of the thermodynamical parameters and then offers a better chance to correctly represent a large range of clouds. The parameters of the beta functions may also be treated in a prognostic way for a better representation of the cloud life cycles. In other words, this type of scheme with an evolutive distribution in time allows to consider the effects of dynamical processes such as shallow convection or eddy diffusivity.

LES Simulations for various cloud cases (shallow cumulus, transition stratocumulus/cumulus, cirrus,…) are used to calibrate the beta functions and their evolution in the NWP parametrization. For these simulations, clouds are processed with the "All or Nothing" adjustment which supposes a quasi-homogeneous distribution of the thermodynamical parameters inside the grid and which is only dedicated to the clouds well resolved by the

horizontal and vertical grid sizes. Then, the parametrization will be tested first with academic 1D, 2D and 3D cases before the final validation for real cases in Méso-NH and in the operational context of AROME.