Evaluation of the 2 moment microphysical scheme LIMA based on HyMeX observations

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INTRODUCTION

The new LIMA (Liquid Ice Multiple Aerosols) microphysical scheme (Taufour et al. 2016) predicts six water species (water vapor, cloud water, rainwater, primary ice crystals, snow aggregates, and graupel). LIMA uses a two-moment parameterization for three hydrometeor species (ice crystals, cloud droplets, and raindrops) (Cohard et al. 2000), and is derived from the one-moment scheme ICE3 used daily in the AROME cloud resolving operational model at Météo-France. In addition, it integrates a prognostic representation of the aerosol population. The Cloud Condensation Nuclei (CCN) activation is parameterized following Cohard et al. (1998) and was extended to handle competition between several CCN modes. Ice Forming Nuclei (IFN) nucleation is parameterized according to Phillips et al. (2000).

METHODS

The French anelastic research model Meso-NH (Mesoscale Non-Hydrostatic) (Lac et al. 2010) is used to simulate two well-documented Heavy Precipitation Events from the HyMeX campaign. The simulations are compared to a large variety of IOP 6 and Hail observations, using a neighborhood square of length 12.5 km. Lines represent the reflectivities measured and simulated combining both IOPs. Around 3 km above the ground: more continuous profile with the LIMA scheme — better transition between ice and liquid water.

ONE-MOMENT VERSUS TWO-MOMENT PARAMETERIZATION

Rain mixing ratio (r) and number concentration (N) of hydrometeors (shaded contours) on a function of rain rate simulated or derived from the observed rain drop size distribution:

Cloud top (~ upper part of the highest frequencies): observed to be near 10 km in an IOP 6 event (r) and N profile increases up to 15 km in the LIMA simulation and overestimated near 12 km by ICE3. Around 3 km above the ground: more continuous profile with the LIMA scheme — better transition between ice and liquid water.

More results are presented in Taufour et al. (2018).

SENSITIVITY TO SIZE DISTRIBUTION SHAPE

Rain drops MVD mean vertical profile (left), rain drops N (middle) and r (right) budget calculated over the box between 11 and 11:15 UTC.

Cloud droplets distribution shifts to the right (resp. left) of the N=300 cm$^{-3}$ line for higher (resp. lower) CCN concentration. Increasing CCN concentration leads to more numerous, but smaller, droplets for a given liquid water content.

Reducing IN concentration increase the frequency of cloud droplets at temperatures below -10°C.

REFERENCES


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