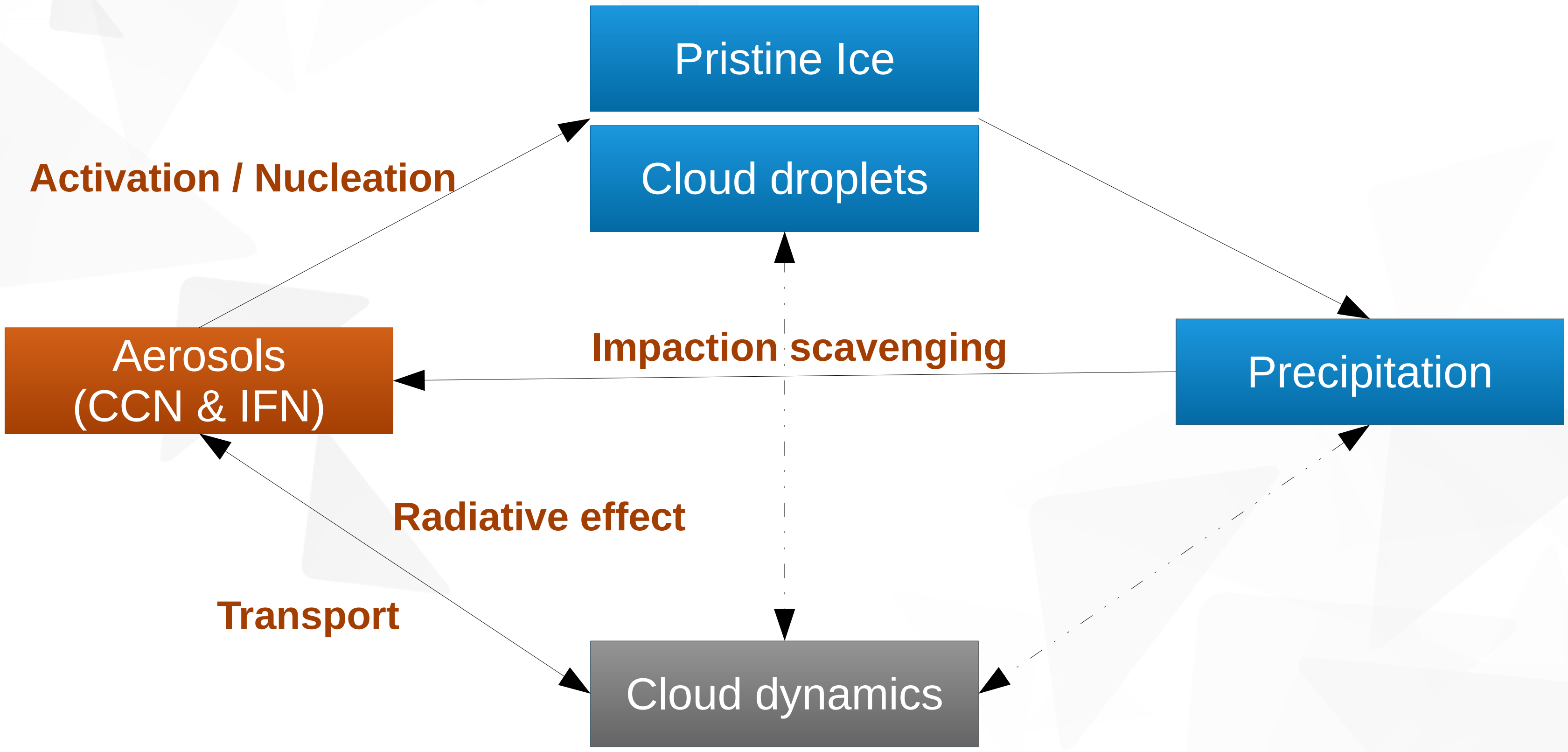
Two-moment microphysics for AROME

- B. Vié, CNRM, Météo-France/CNRS, Toulouse
- J.-P. Pinty, LA, University of Toulouse/CNRS, Toulouse

Motivations

- Complex aerosols – clouds – precipitations interactions



LIMA: Liquid Ice Multiple Aerosols

- 2-moment, mixed-phase microphysical scheme

Droplets	Drops	Ice	Snow	Graupel	Hail
r_c N_c	r_r N_r	r_i N_i	r_s	r_g	r_h

r: mass mixing ratio (kg.kg^{-1}) N: number conc. (#.kg^{-1})

- Prognostic evolution of a realistic aerosol population
  - Multimodal (lognormal psd), 3D externally mixed aerosols
  - Distinction between several types of CCN / IN / coated IN

- Vié *et al.*, 2016: *LIMA (v1.0): a two-moment microphysical scheme driven by a multimodal population of cloud condensation and ice freezing nuclei*, GMD, doi:10.5194/gmd-9-567-2016.

LIMA: Liquid Ice Multiple Aerosols

- Derived from ICE3, with improved representation of some processes
  - Explicit deposition of water vapour on ice crystals
  - Improved pristine ice $\longrightarrow$ snow conversion
- Aerosol treatment
  - Transport by the resolved flow and turbulence
  - CCN activation (Cohard and Pinty, 2000) $\longrightarrow$ cloud droplets
  - IFN nucleation (Phillips *et al.* 2008, 2013) $\longrightarrow$ ice crystals
  - Below-cloud aerosol washing-out by rain (Berthet *et al.* 2010)

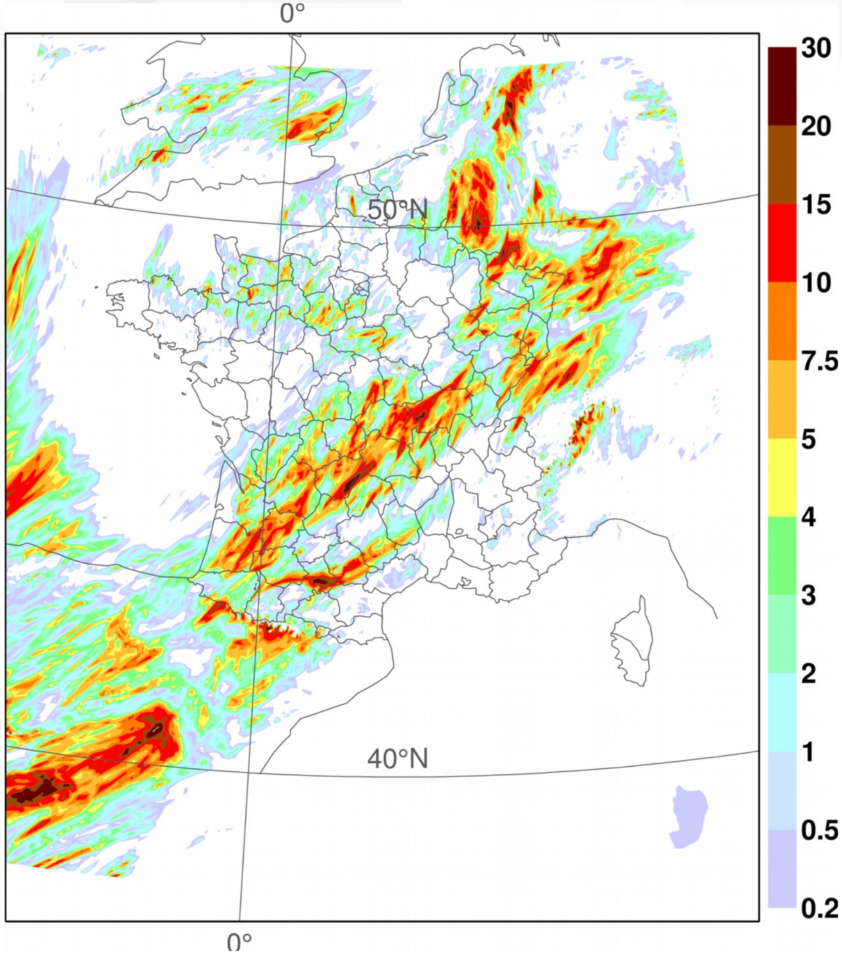
Current implementation of LIMA

- LIMA was integrated in AROME (cycle 42)
  - New GFL variables for number concentrations
  - Complete microphysical parameterization
  - Homogeneous initial aerosol concentration

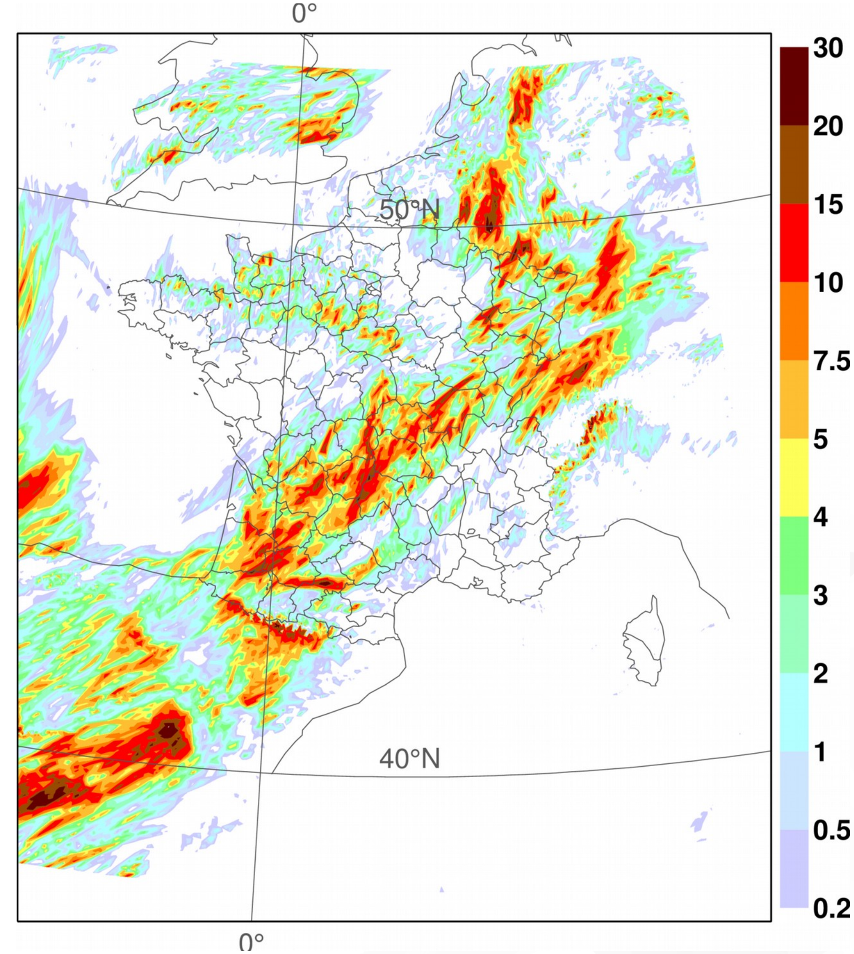
- First test on PROLIX supercomputer
  - AROME operational domain
  - 12-h forecast, 32 nodes (384 tasks)
  - LIMA simulation: time-splitting sedimentation, 10 additional variables
  - ~30% more time for LIMA simulation (*vs.* ICE3)

AROME & LIMA: First test

- 00UTC April 13th, 2016, 12-h accumulated rainfall (mm)



ICE3



LIMA

LIMA: To-Do list

- Statistical sedimentation scheme
- Computation cost analysis
  - Simplify the representation of time-consuming processes if necessary
- Choice of an optimal configuration
  - Minimal number of additional variables
- Subgrid cloud fraction
- Microphysics sensitivity to the time step (S. Riette)
- Some more technical work (DDH, fullpos, radar simulator...)

Radiation parameterization

- In AROME, the radiative transfer parameterization is currently unaware of the aerosols and hydrometeors number concentrations

- In Meso-NH:
  - The cloud droplets and pristine ice number concentrations are used in the computation of cloud optical properties
  - The radiative effect of aerosols is accounted for using the detailed scheme by Aouizerats et al. (2010) and the prognostic aerosol population from LIMA.

Aerosols representation

- LIMA accounts for aerosol-cloud interactions (nucleation, scavenging)

- What precision in the representation of aerosols do we need ?
  - Homogeneous initial population ?
  - Realistic aerosol population ?
    - MACC analyses can be used to provide realistic 3D initial and lateral boundary conditions for aerosols (under development)
    - Including data assimilation / nudging ?
  - Complete aerosol scheme, including sources, ageing... ?
    - Emission schemes for dust and sea-salt
    - Complete chemistry-aerosol module ORILAM (Tulet *et al.* 2005, Meso-NH)

LIMA: Evaluation

- HyMeX: heavy precipitation
  - PhD thesis, Marie Taufour
- Lanfex: LES of fog and impact on visibility
  - PhD proposal, starting 09/2016
- Sesar: Application to aircraft icing
- Statistical evaluation of LIMA over long periods

West of Toulouse, 1745UTC, April 12th, 2016