Recent evaluation and improvements of the LIMA microphysical scheme

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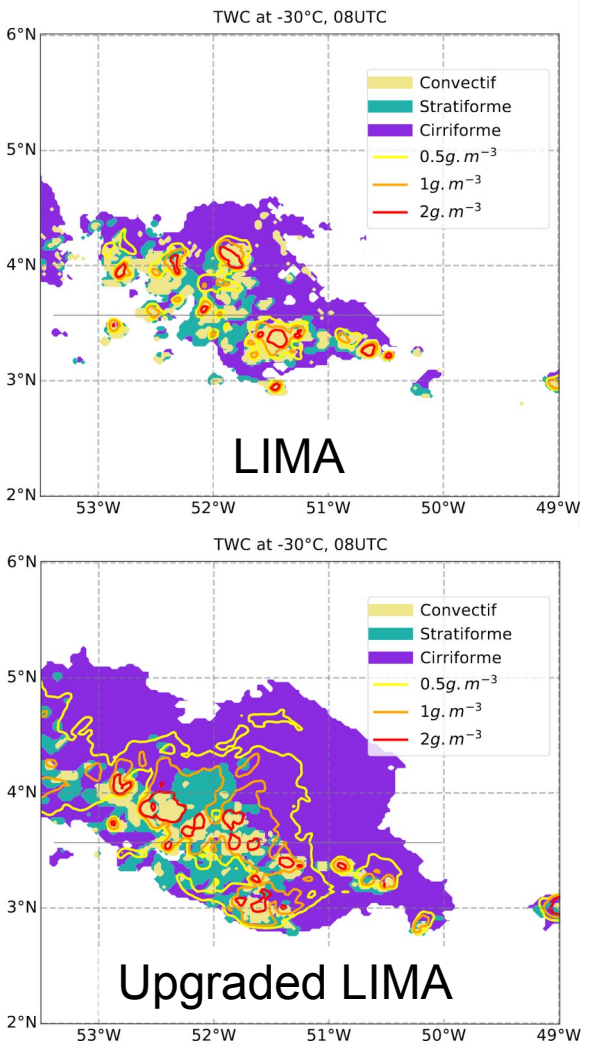
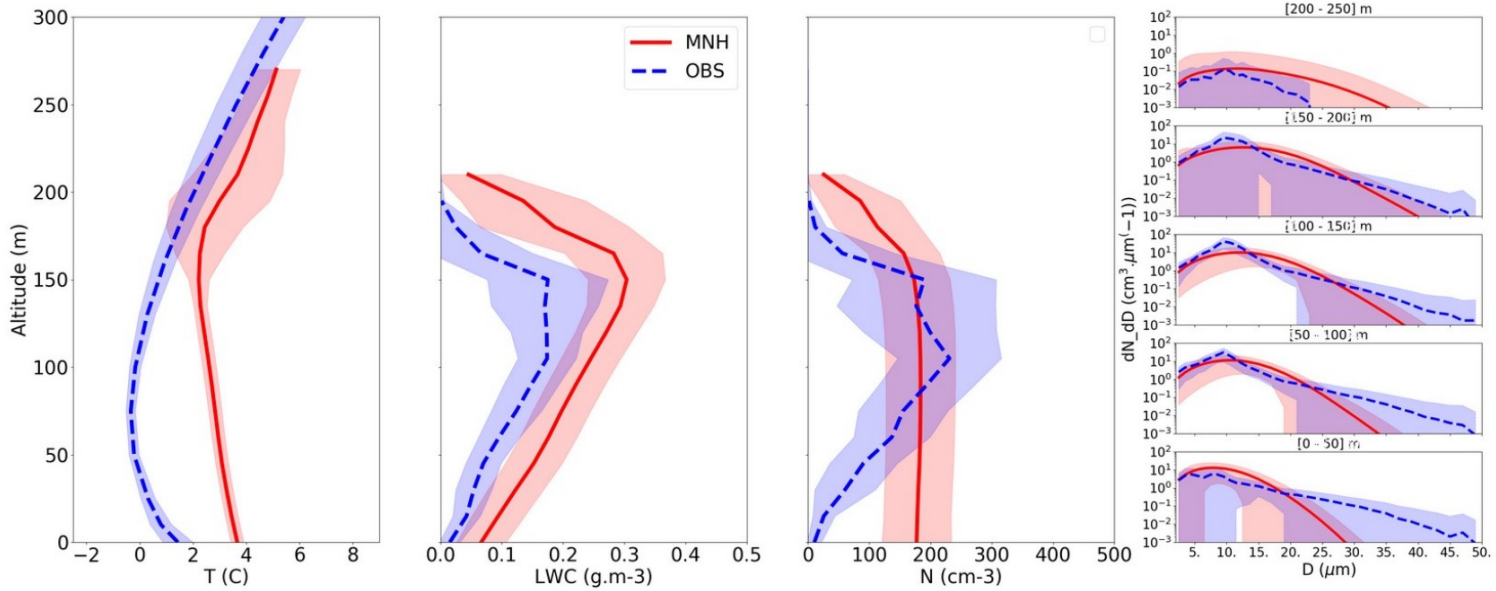
LIMA « recent » developments / papers

- CCN activation for fog LES
  - Vié et al., 2024 ; Ducongé, 2019
- Snow PSD for both ICE3 and LIMA →
  - Wurtz et al., 2021, 2023
  - 2-M for droplets and rain improves convective systems representation
- 2-M for all hydrometeors
  - Taufour et al., 2025
- ICE3-like LIMA
  - 1-M for all species + include some missing things



Fog forecasting with LIMA

- Ducongé et al. 2020, Antoine et al. 2023, Vié et al. 2024...
- Comparison to SOFOG3D observations
  - AROME-LIMA-CAMS works quite well
  - Case studies with Meso-NH ⟶ need for drizzle or a bimodal PSD ?

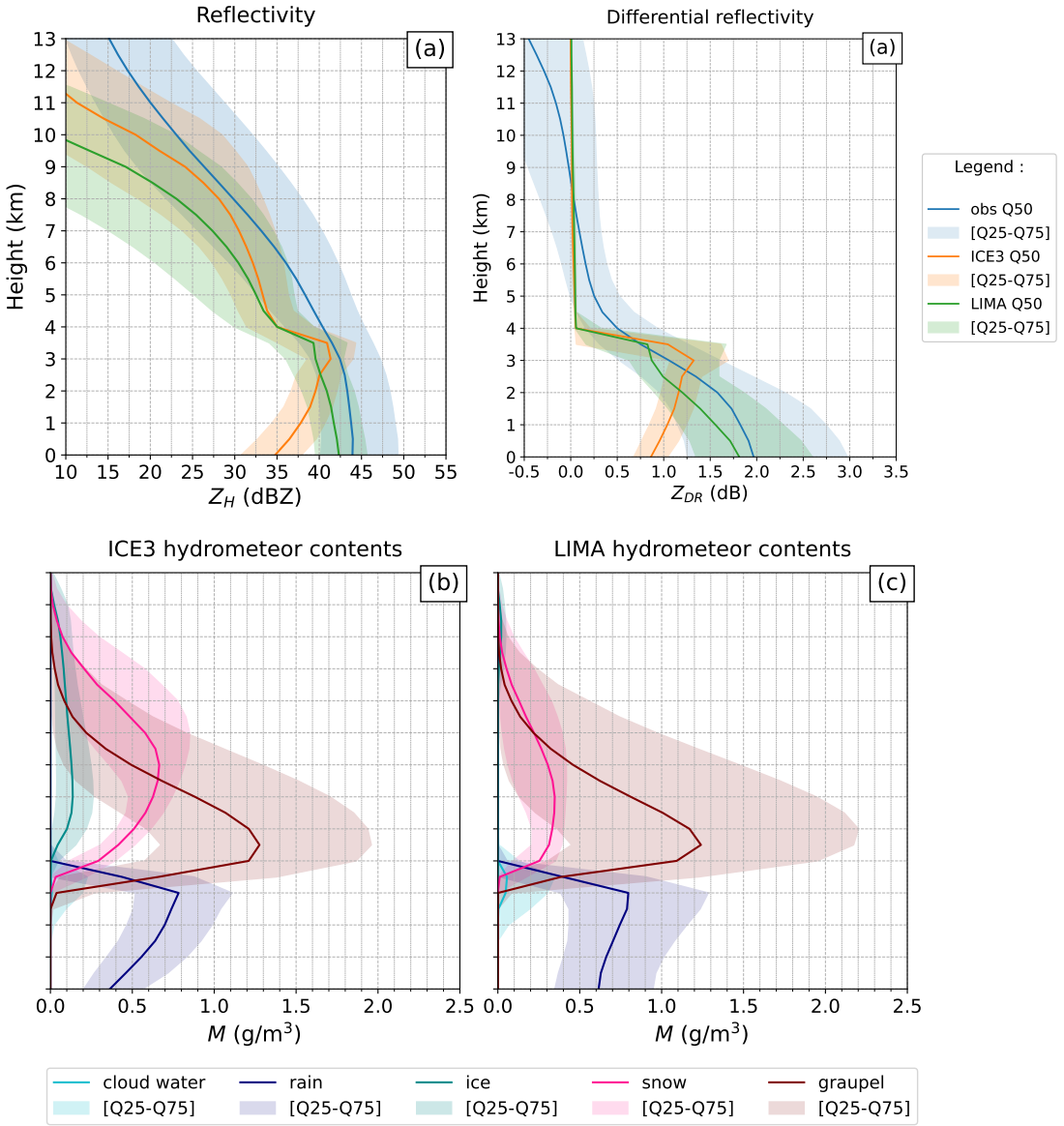


- Marie Mazoyer et al. (2025, in prep)

AROME-LIMA evaluation for convection

- AROME France
  - LIMA vs. ICE3
  - 34 days with deep convection
  - Cells / cores tracking
  - Comparison to 3D dual-pol radar
- With LIMA :
  - ✔ More realistic cells (number, lifetime, max Z_H in cores)
  - ✔ Better Z_H, Z_{DR} profiles
  - ✔ Better Z_{DR} columns in supercells
  - ✘ Lack of crystals and snow

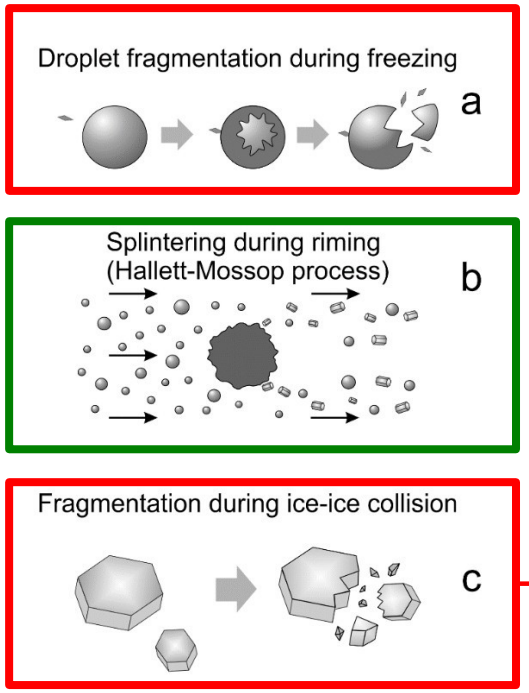
➢ Cloé David et al. (2025, in prep)



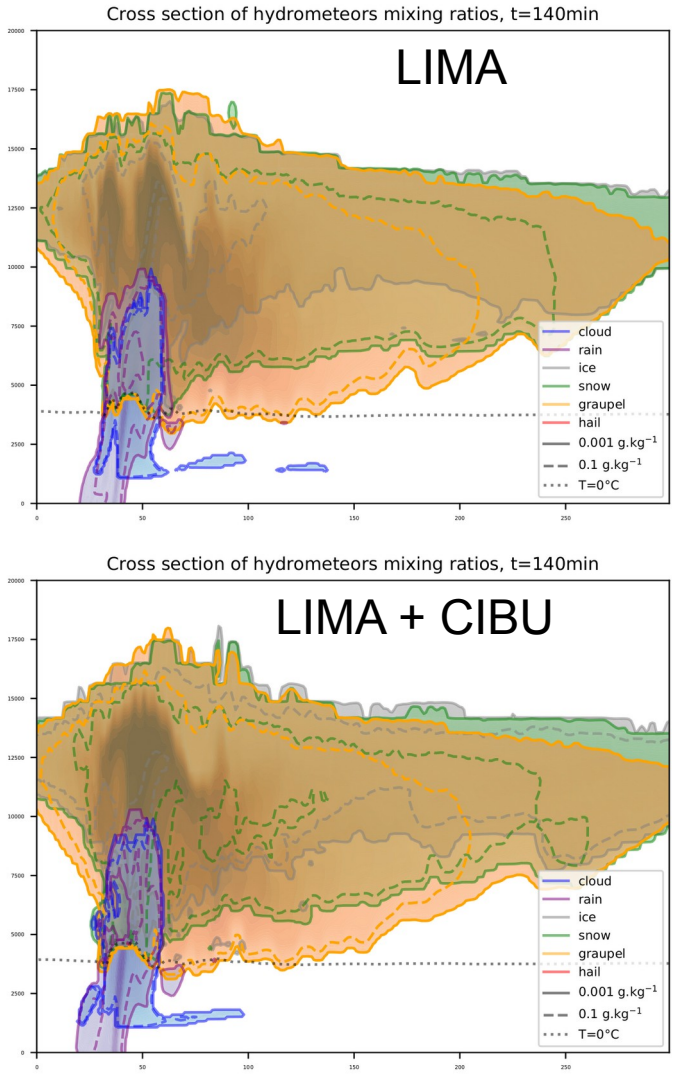
AROME-LIMA evaluation for convection (2)

RDSF

CIBU



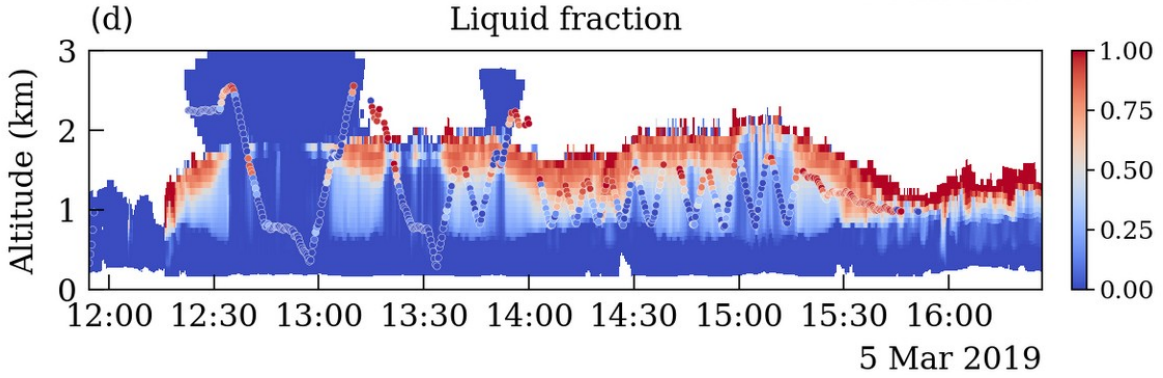
Korolev et Leisner (2020)



- Secondary ice production (SIP)
- ✔ More ice and snow
- ✗ Still graupel everywhere ?

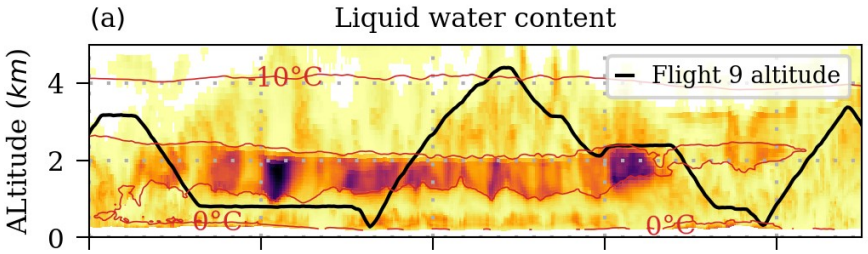
Supercooled liquid water

- ICICLE (Rockford, USA, 2019)
  - 29 flights in icing conditions, all simulated with Meso-NH/LIMA
  - Lake effect ⟶ liquid clouds at cloud top

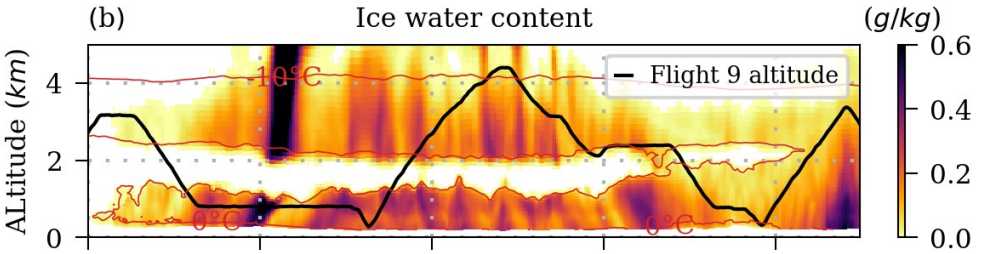


  - Freezing rain :

Liquid water



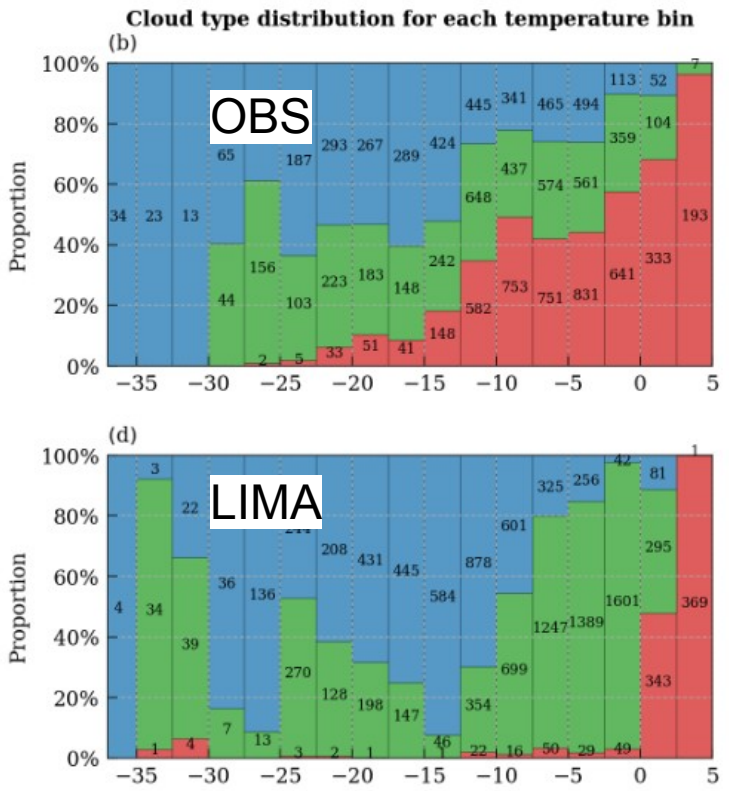
Ice



- ✗ Graupel everywhere !

Supercooled liquid water (2)

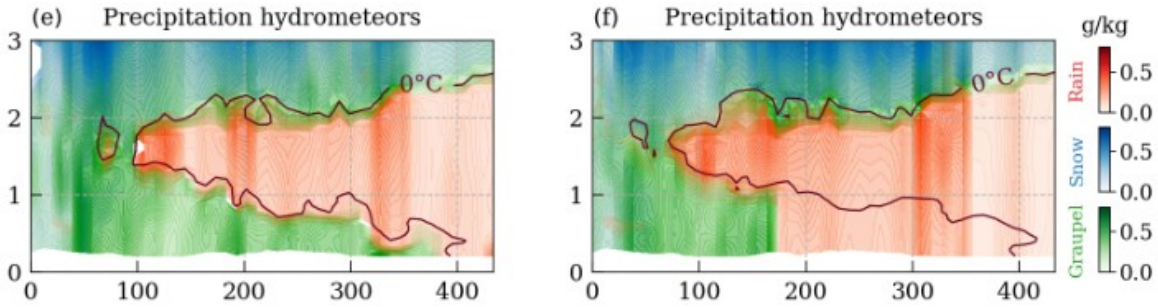
- ICICLE (Rockford, USA, 2019)
  - 29 flights in icing conditions
  - all simulated with Meso-NH/LIMA



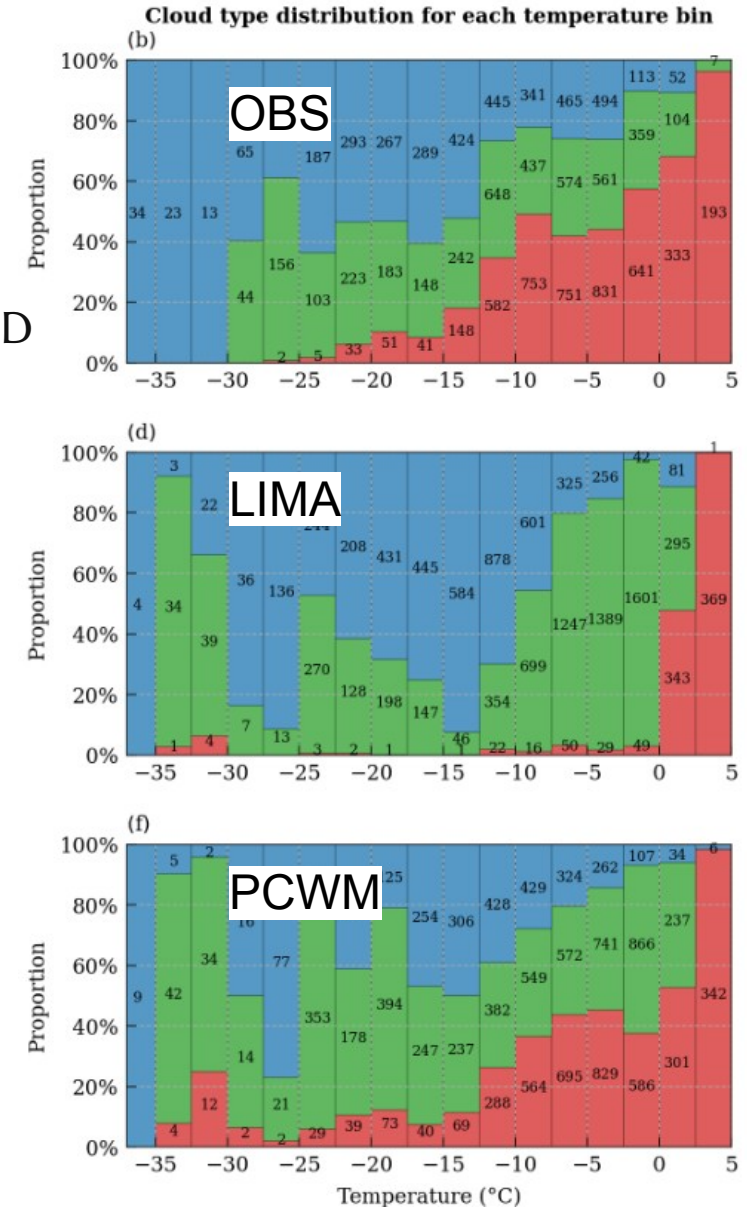
- ✔ LIMA better than ICE3
- ✔ LWC down to -30°C…
- ✘ …only in mixed phase
- ✘ TWC and LWC too low

Supercooled liquid water (3)

- Improved configuration of LIMA “PCWM”
  - Secondary ice production, ice nucleation, snow PSD
  - Graupel growth modifications



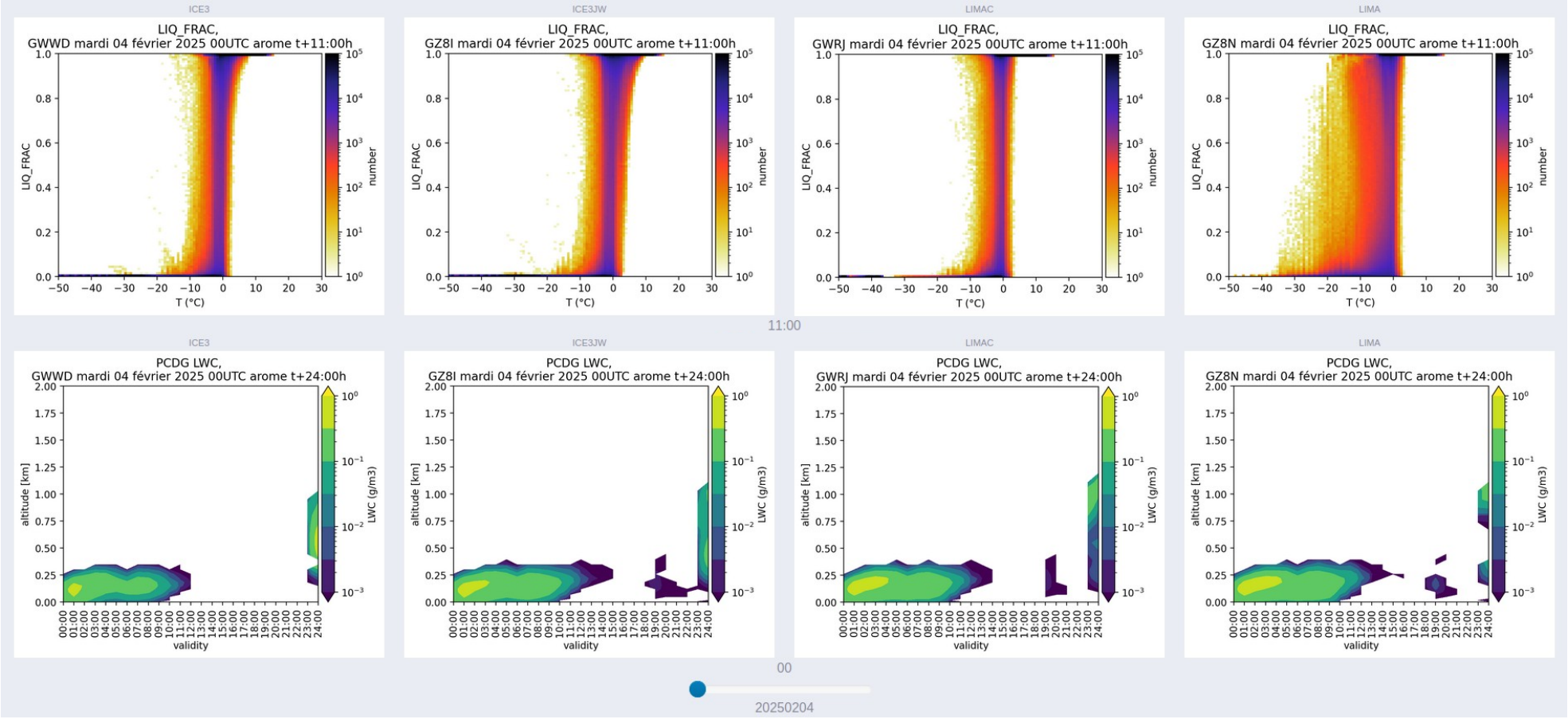
PCW PCWM



- Mareva July-Wormit et al. (2025, in prep)

AROME-LIMA real time evaluation

- Daily simulations, several configurations, online visualisation



- systematic assessment for interesting cases (convection, fog, low clouds...)

Ongoing / future work

- Interaction with assimilation
  - 3D-EnVar with direct radar data assimilation
  - First without changing anything in the assimilation part
  - Include number concentrations ?
  - Include polarimetric radar variables (PRAISE ANR-DFG project submitted) ?

- Aerosols
  - CAMS ? Inline aerosols in AROME ? Conversions tuning ?

- Technical aspects
  - Optimization, GPU...