Simulation of Deep Convective Clouds from the HyMeX Campaign using a Realistic Population of CCN and IFN

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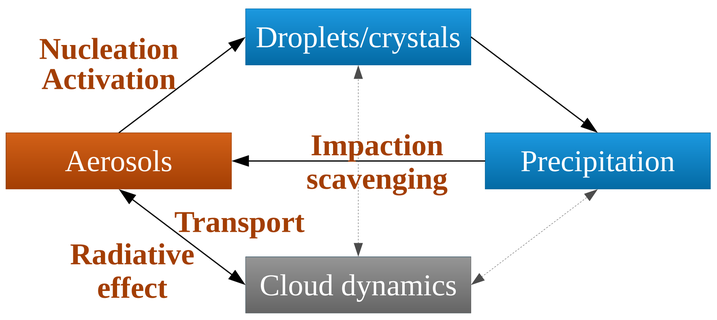
INITIALIZING THE 2-MOMENT SCHEME LIMA WITH CAMS AEROSOL ANALYSES

The 2-moment scheme LIMA *(Vié et al. 2016)*

- Built upon ICE3, Météo-France's operational 1m scheme
- Explicitly represents **aerosol-cloud interactions**



- Competition between several types of CCN / IFN
- **Prognostic** variables for **hydrometeors and aerosols**

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. ($\#.kg^{-1}$)

+

For each aerosol mode (log-normal PSD):
Free N_{free} and activated N_{acti} number concentrations ($\#.kg^{-1}$)

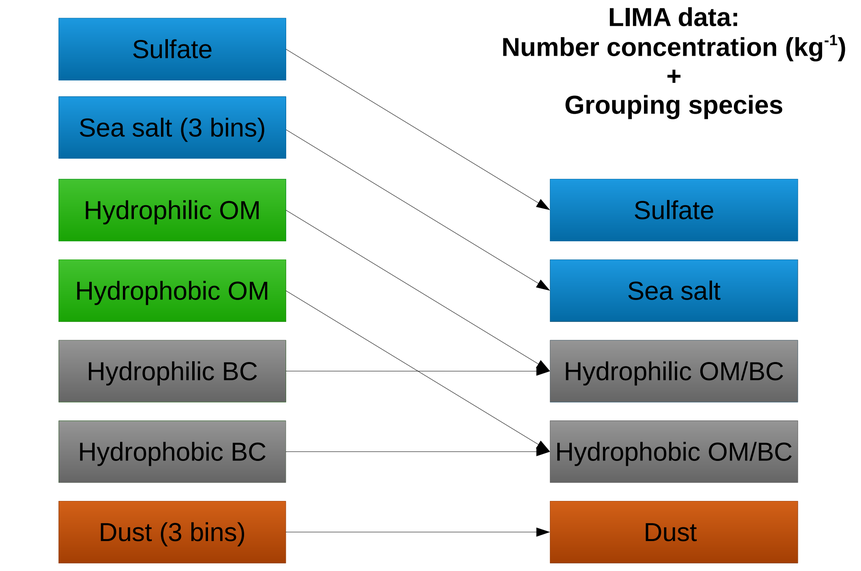
➔**Needs a realistic aerosol population**

CAMS aerosol analyses and forecasts

- Produced twice daily, in **near-real-time**
- **~40km** horizontal resolution and **60 vertical levels**
- Assimilation of MODIS AODs to constrain C-IFS
- 11 prognostic **aerosol mass mixing ratios**

➔**Conversion into number concentration needed !**

➔**Choice of activation properties needed !**



Choice of size distribution parameters to convert CAMS mass mixing ratios into number concentrations

- Parameters chosen to use a CAMS aerosol climatology in the IFS radiative transfer scheme *(Bozzo et al. 2017)*
- Climatological aerosol properties from the Global Aerosol Data Set *(Köpke et al. 1997)*
- Average aerosol properties in the Mediterranean region from the ESCOMPTE experiment *(Mallet et al. 2003)*
- Average aerosol properties over Europe from a 3-month MOCAGE (CNRM's CTM) forecast period

➔**Despite some differences and the necessity to choose between Aïtken and accumulation modes for some aerosols, there seems to be a good agreement for the following PSD parameters:**

Microphysical properties Size distribution parameters
CCN, r=0.05 µm, σ=2, ρ=1700 $kg.m^{-3}$
CCN, r=0.2 µm, σ=2, ρ=2200 $kg.m^{-3}$
Coated IFN, r=0.02 µm, σ=2.2, ρ=1800 $kg.m^{-3}$
IFN, r=0.02 µm, σ=2.2, ρ=1800 $kg.m^{-3}$
IFN, r=0.4 µm, σ=2, ρ=2600 $kg.m^{-3}$

CAMS REANALYSES EVALUATION

During HyMEX (autumn 2012), 29 flights of the ATR42 aircraft sampled air masses before heavy precipitating events with several aerosol observation instruments

- 1 CCNC: number of CCN at S=0.3%
- 2 CPCs: number of aerosols >10nm
- 1 FMPS: PSD of aerosols 5 → 500nm
- 1 SMPS: PSD of aerosols 20 → 400nm
- 1 OPC: PSD of aerosols 0.25 → 32µm

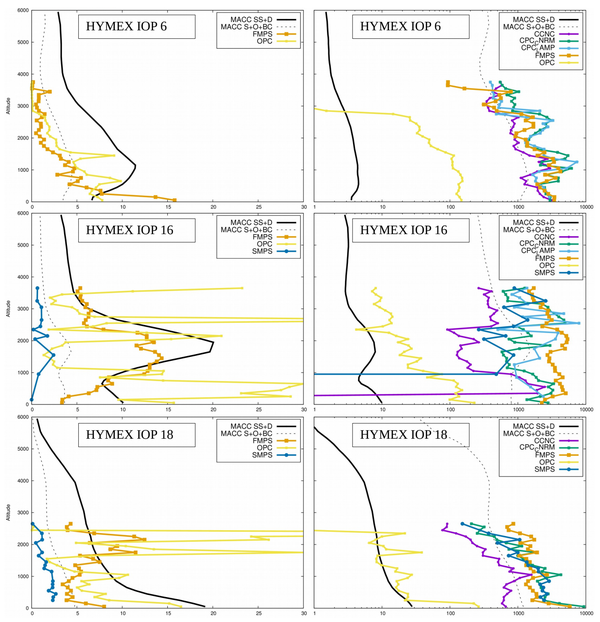
CAMS evaluation

- Compare CAMS to the aerosol mass estimated from observed PSDs
- Good representation of aerosol loading and vertical profile in most cases

Evaluation of retrieved concentrations

- Some cases show an underestimation of aerosols in the accumulation mode
  - ✗ Dust → 0.8 µm mode not obs. in OPC
  - ✗ Assumed PSDs too wide comp. to OPC
- Number of Aïtken mode aerosols fits observations well for most cases

Average vertical profiles of aerosol mass mixing ratio ($\mu g.m^{-3}$) *Average vertical profiles of aerosol number concentrations (cm^{-3})*

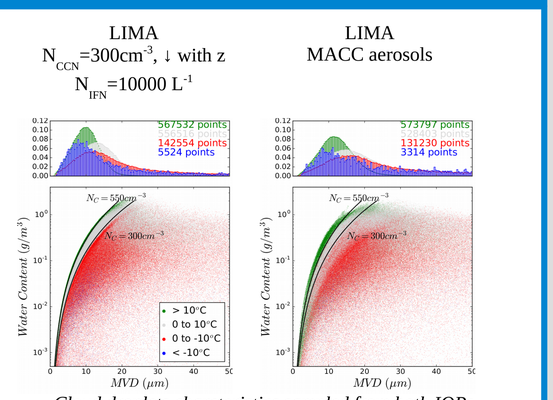


HYMEX DEEP CONVECTION SIMULATION

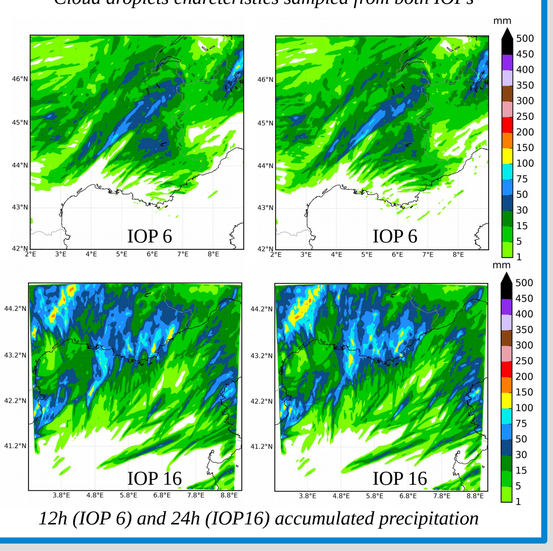
Simulations of HyMeX IOP 6 (2012/09/24) and IOP 16 (2012/10/26) heavy precipitating events were carried out using LIMA in the Meso-NH model *(Lac et al. 2018)* with various aerosol initializations to perform an evaluation of the scheme *(Taufour et al. 2018 + poster 254)* and study the impact of aerosols on HyMeX deep convection.

Homogeneous vs. CAMS aerosols

- Using CAMS aerosols results in a **higher variability** of cloud composition.
- **Differences** on accumulated precipitation for IOP 6 are small, and located SE of the main system, **where orographic forcing is lower**.
- IOP 16 accumulated precipitation is more sensitive to aerosol loading, both over sea and land, but using CAMS aerosols slightly degrade scores.
- In both cases, **a higher impact was found on instantaneous rain rates** and the evolution of convective systems.



Cloud droplets charcteristics sampled from both IOPs



12h (IOP 6) and 24h (IOP16) accumulated precipitation

CONCLUSION

Initializing aerosols for LIMA with CAMS analyses and forecasts:

✔**CAMS provides global analyses and forecasts of mixing ratios for several aerosols**
✔**PSD parameters are estimated from different bibliographical references**
➔**LIMA benefits from a realistic, day-to-day aerosol population**

Evaluation of CAMS aerosols compared to in-situ observations from HyMeX:

✔**CAMS provides a good representation of aerosols compared to 29 ATR42 flights**
✗ **Some cases show an underestimation of retrieved aerosol concentration (SS + D)**

Simulation of HyMeX heavy precipitating events with realistic CAMS aerosols:

✔**Higher impact on cloud composition and rain intensity than on accumulated rain**
✔**Sensitivity to aerosols depends on case characteristics (e.g. forcing mechanisms)**

Prospects:
➔**Investigate the choice of dust and sea-salt PSD parameters**
➔**Study the impact of aerosols for other situations: fog (poster 41), aircraft icing...**

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ACKNOWLEDGMENTS

Data were obtained from the HyMeX program, sponsored by Grants MISTRALS/HyMeX and ANR-11-BS56-0005 IODA-MED project. The authors especially thank T. Bourrianne and F. Burnet (CNRM), and A. Schwarzenboek and E. Freney (LaMP) for their help with the aerosol observations.