Towards the LES of some IOPs to study the surface heterogeneities impact on fog

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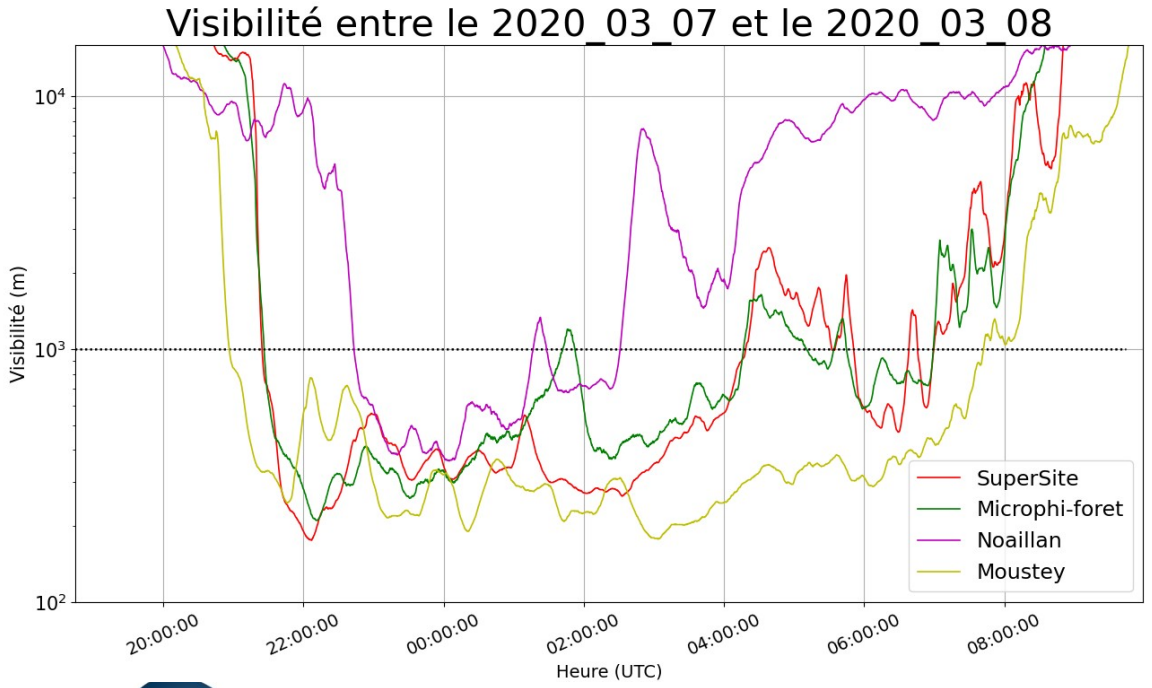
*18 month Post-doctoral position since April 2021

First results

- Work from Marie-Adèle Magnaldo, CNRM
- Identify the IOPs with heterogeneities of the fog life cycle between the sites

  ➔ Select IOP 14 (7-8 March 2020) representative of the SOFOG3d campaign statistics with numerous measurements



- Formation 3h shift
- Dissipation 5h shift
- Differences in mean visibility (<1km)

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Sensitivity study to surface heteogeneities: **Objectives**

I. Most advanced parameterization:

- Step 1: downscaling simulation
  - ➔ Best configuration (physics and coupling) 500m resolution
  - ➔ Refining resolution and run a reference simulation (100m → 20m)

Sensitivity study to surface heteogeneities: **Objectives**

I. Most advanced parameterization:

- Step 1: downscaling simulation
- Step 2: sensitivity study
  - Suface database:
    - Land cover resolution (ECO-SG 30m)
    - Orography resolution
  - Surface initialisation:
    - Arome Analyses 1.3km
    - Analyses SIM-v2 (Soil analyses system)
    - Tree drag parameterization
  - Vegetation scheme:
    - ISBA-3L (3 vertical levels)
    - ISBA-DIF (14 vertical levels)
  - Microphysics:
    - 1 moment with ICE3
    - 2 Moment with LIMA (+ initialization from observed aerosols)
  - Radiation parameterization:
    - Foucart and Bonel (1980) (5 bands SW) → ecRAD SRTM (14 bands)
    - Better cloud optical properties (Erfan Jahangir)

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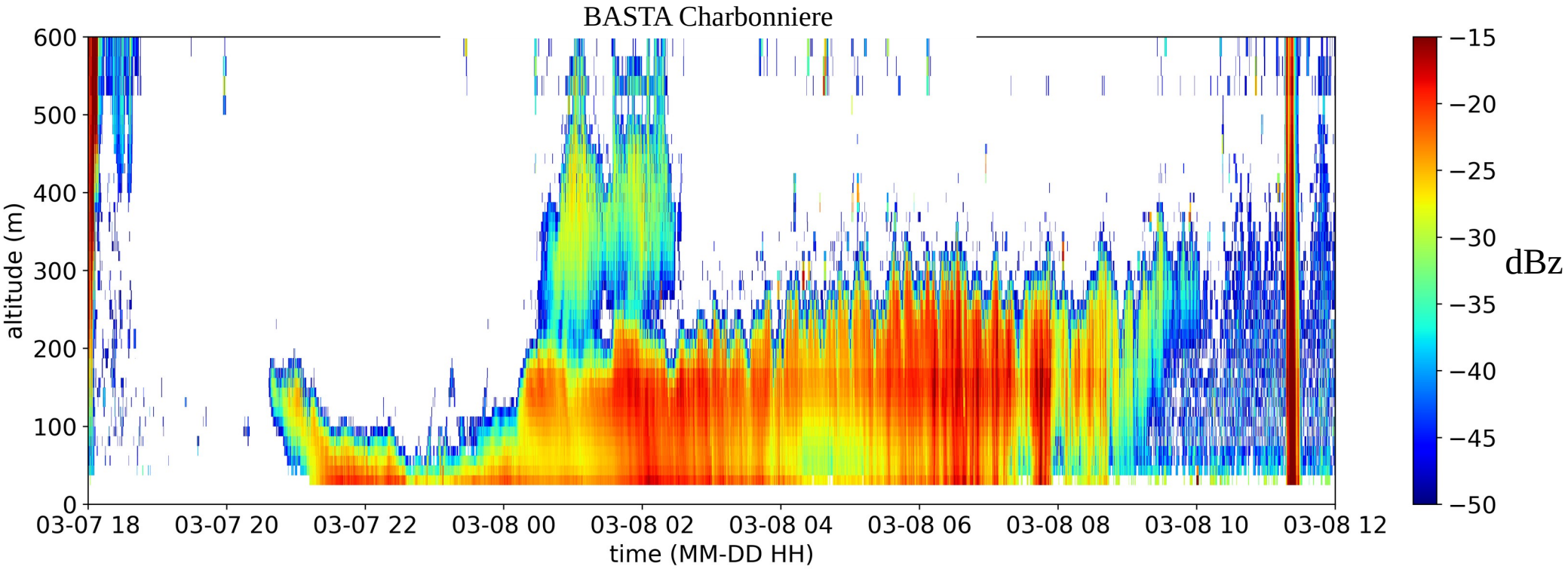
II. Process study: impact of the surface heterogeneities on fog:

- Comparison of surface and turbulence budget for different sites (with different vegetation types)
- Use the model as a laboratory (modifying vegetation type)

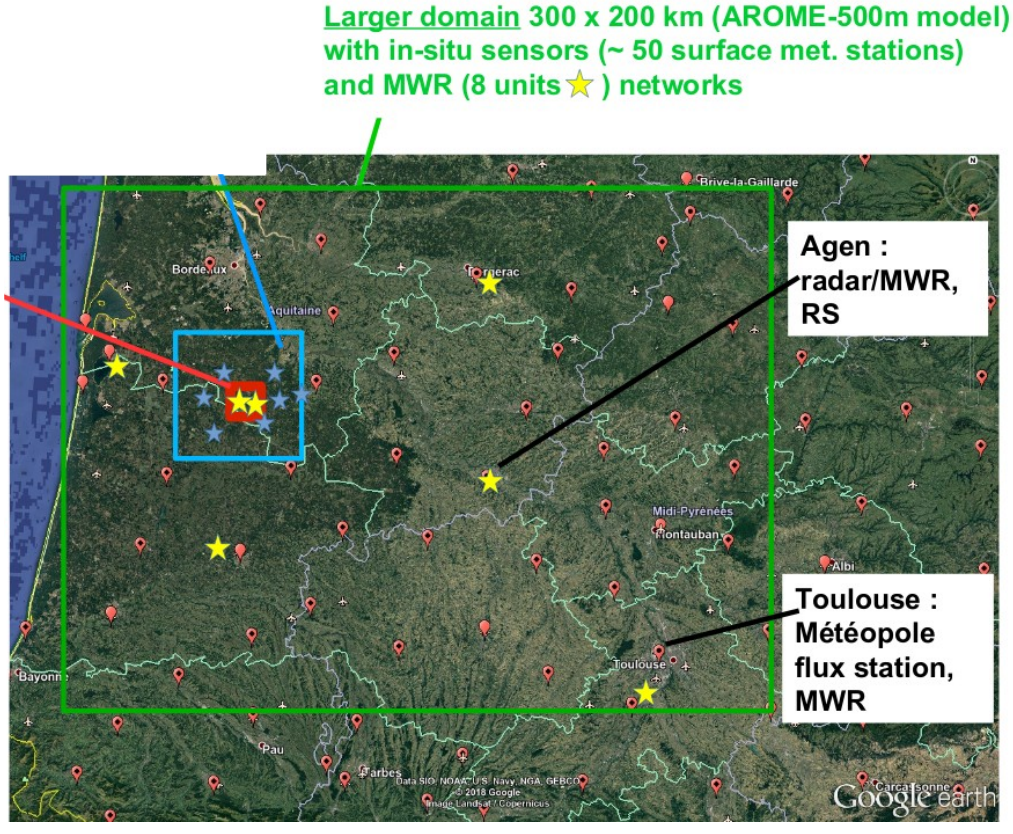
IOP 14 (7-8 March)



- Fog **from 9:30pm to 8am** at the Super Site
- Low cloud between 0 and 2am March 8th but **without fog dissipation**
- **Lower reflectivities between 4 and 6am** on the first levels

Méso-NH configuration: 500m resolution

- *Suface:* fully coupled with SURFEX (Masson et al 2013), ISBA-3L, TEB
- *Initialisation:* AROME analyses (1,3 km resolution)
- *Turbulence:* Cuxart et al. (2000), (TKE + mixing length) 1D with BL89
- *Radiation:* ECMWF with RRTM for LW and Fouquart-Bonnel for SW
- *Vertical resolution:* same as AROME500m with 2,3m at the ground
- *Microphysics:* ICE3 (1-moment)
- *Run:* 24 hours from March 7th 12am to March 8th 12am



©Figure SOFOG3D

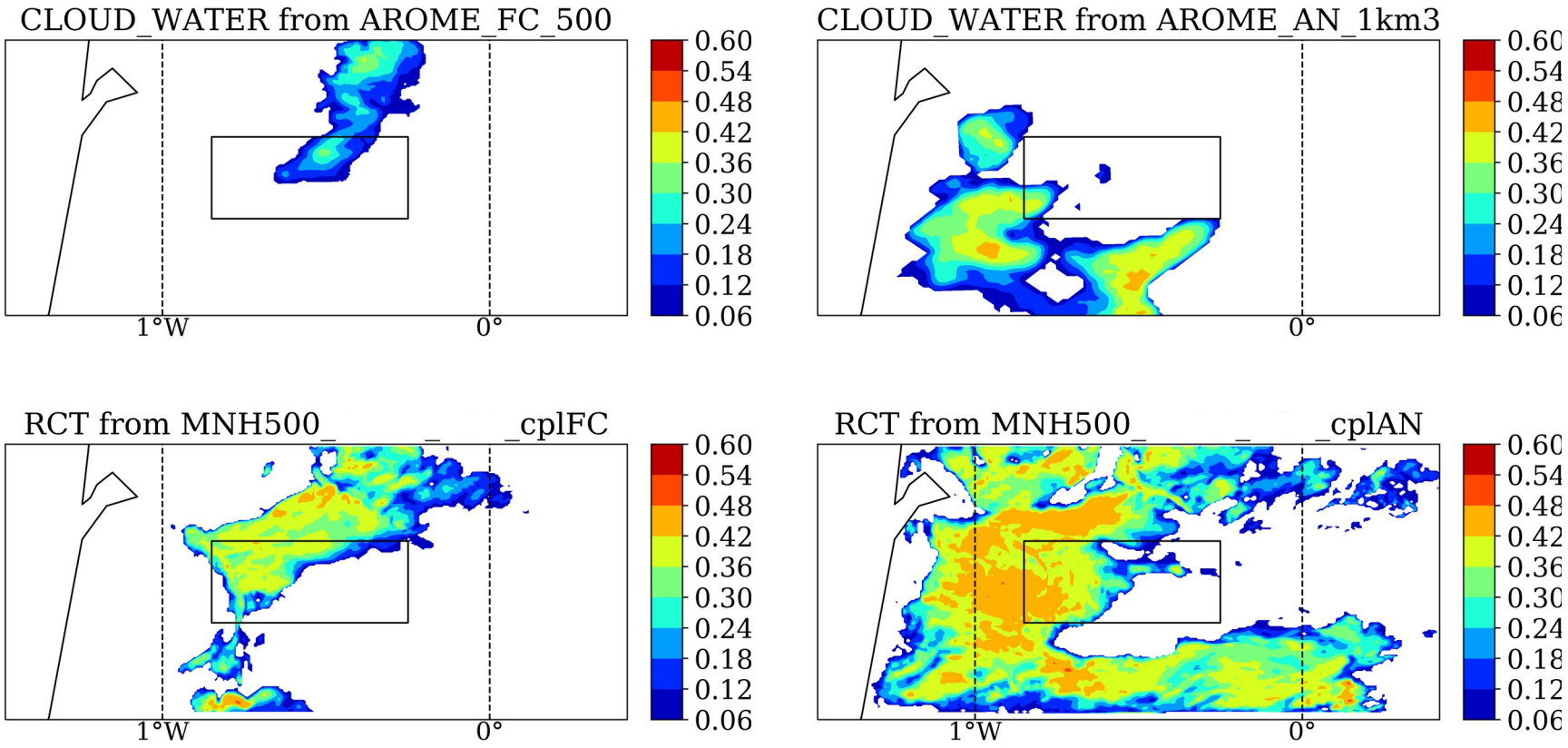
MNH run with 500m resolution

Simulations	Coupling conditions	Shallow convective scheme	LGZ (reduction of the mass-flux surface closure with the resolution)
MNH500_EDMF_LGZ_cplFC	AROME500m forecast	EDMF (Eddy-diffusivity-Mass-Flux)	True
MNH500_EDMF_LGZ_cplAN	AROME1.3km analyses	EDMF	True
MNH500_EDMF_cplAN	AROME1.3km analyses	EDMF	False
MNH500_cplAN	AROME1.3km analyses	None	–

Coupling conditions impact

Physical parameterisation

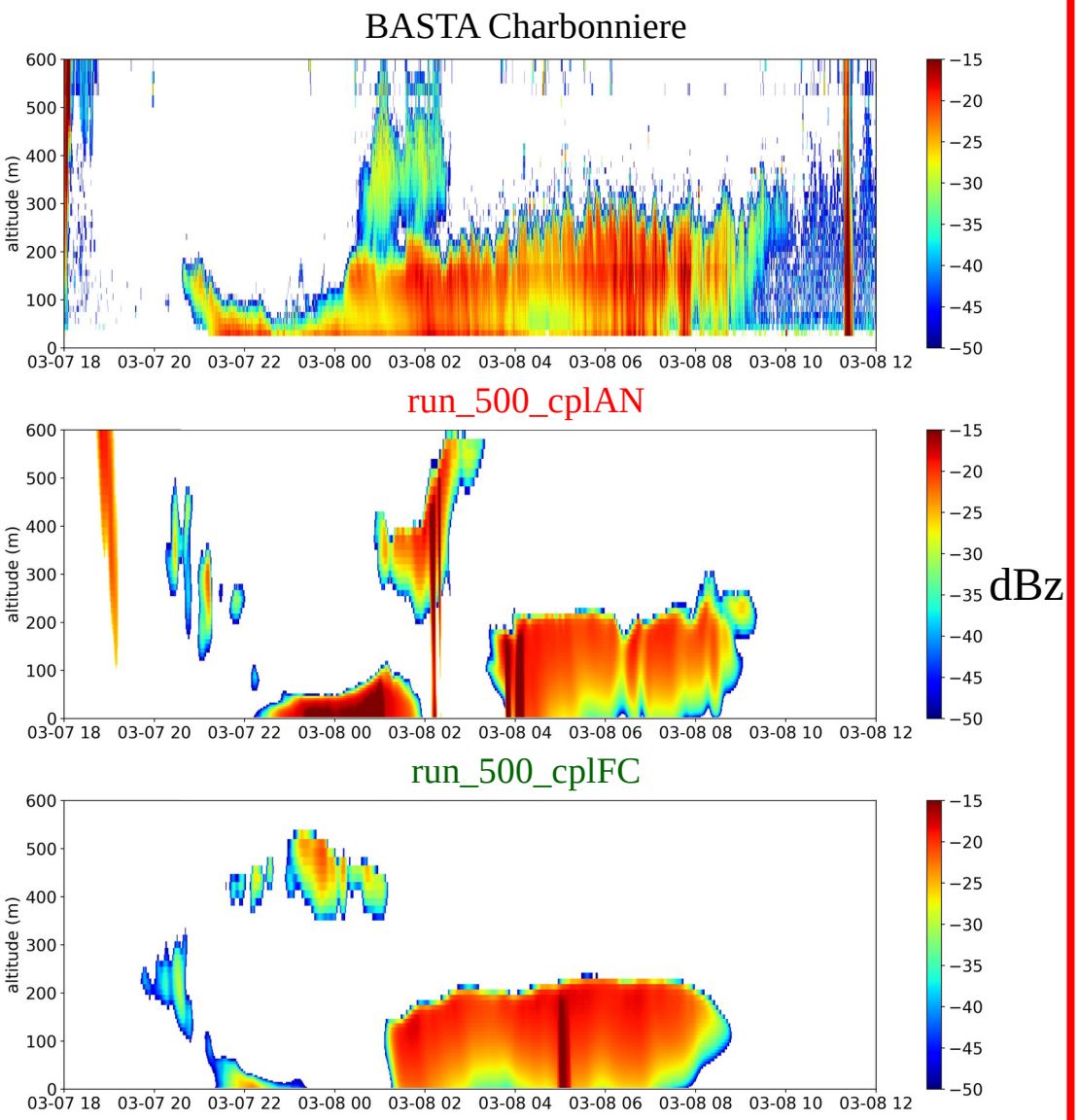
Cloud droplets mass mixing ratio (g/kg) at the first vertical level at 11pm



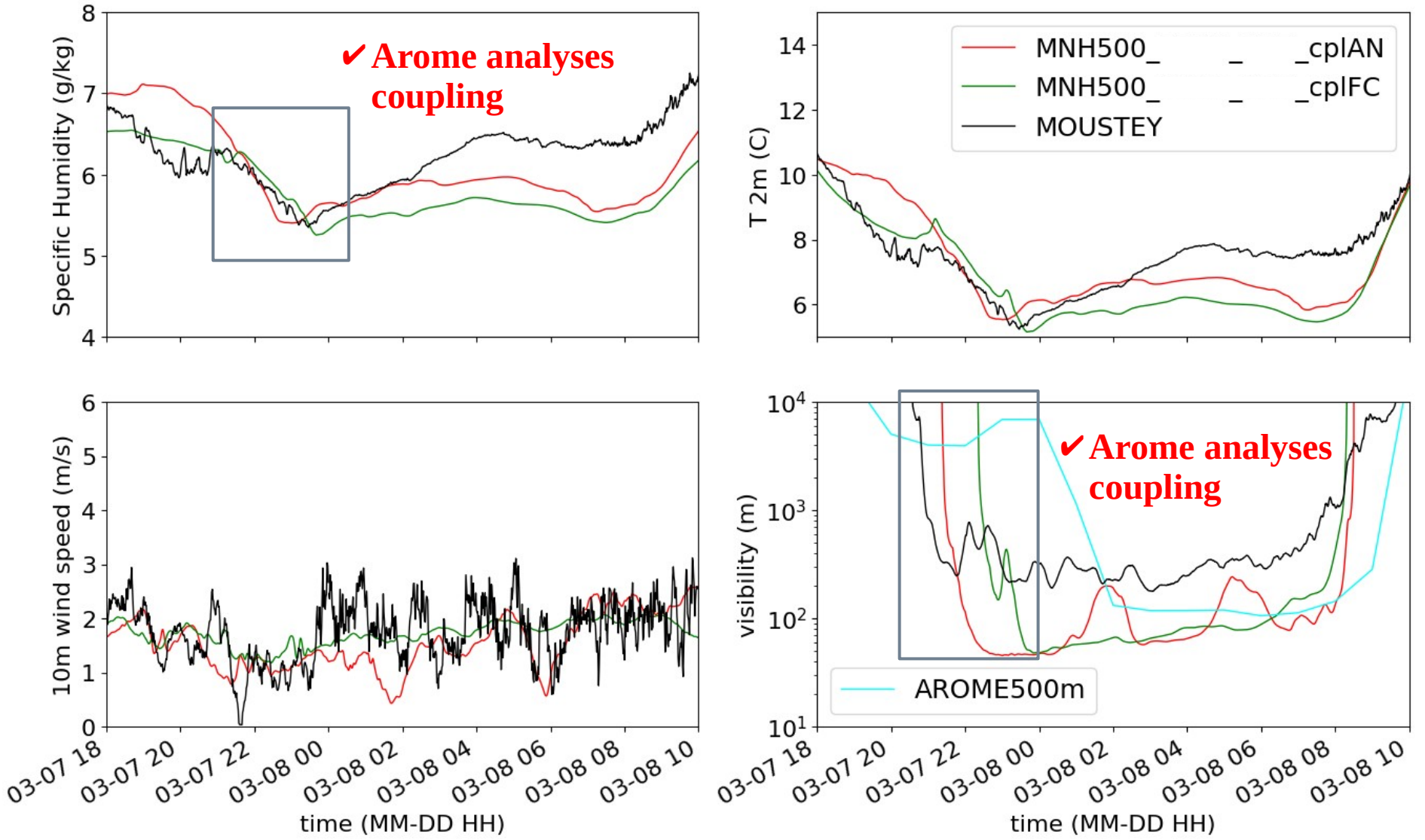
High impact of the coupling conditions

Simulated reflectivities: Super Site

- Coupling impact:
  - Fog highly dependant of large scale circulation
  - Low cloud initiation better represented with AROME Analyses coupling



MTO / VISI observations at Moustey



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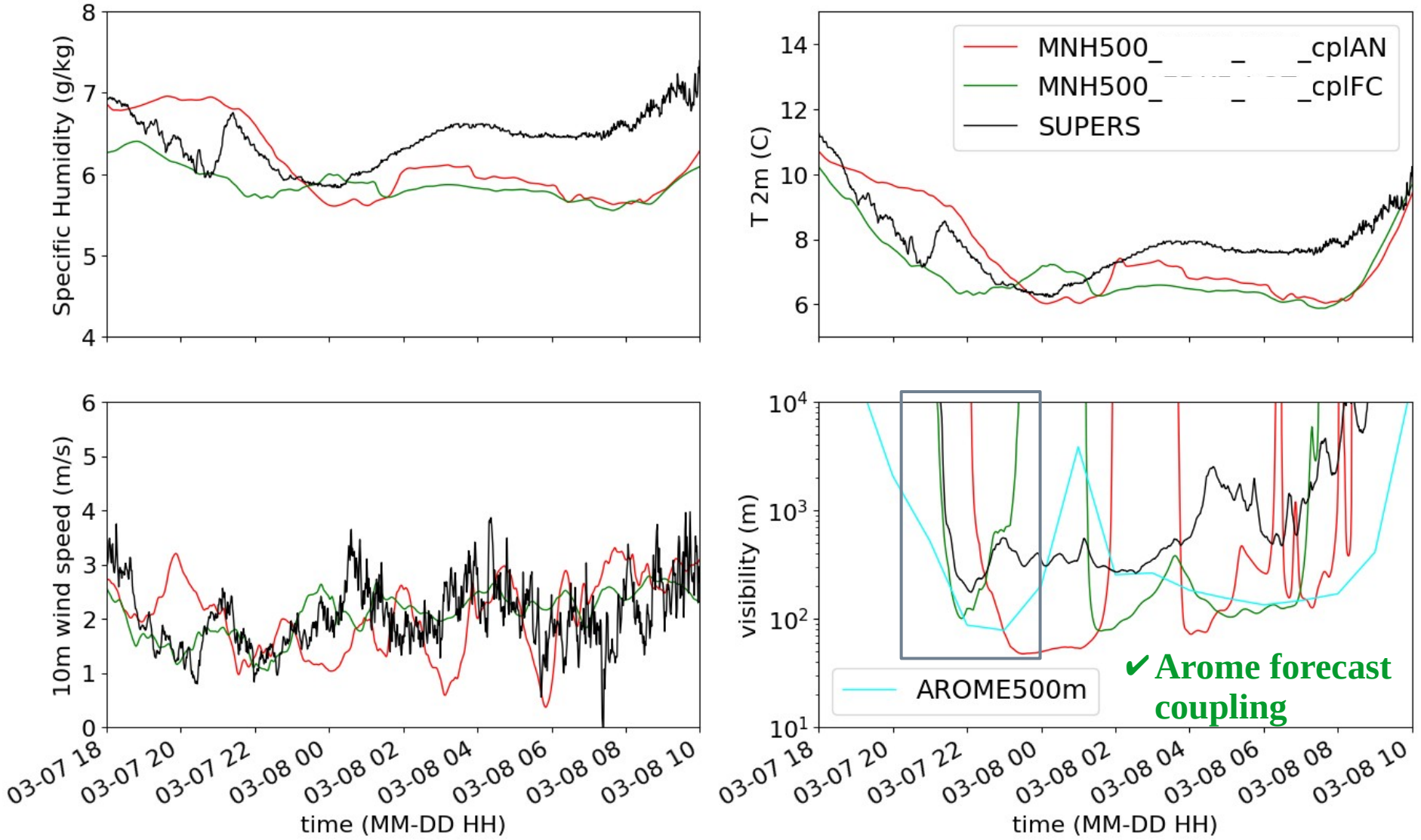
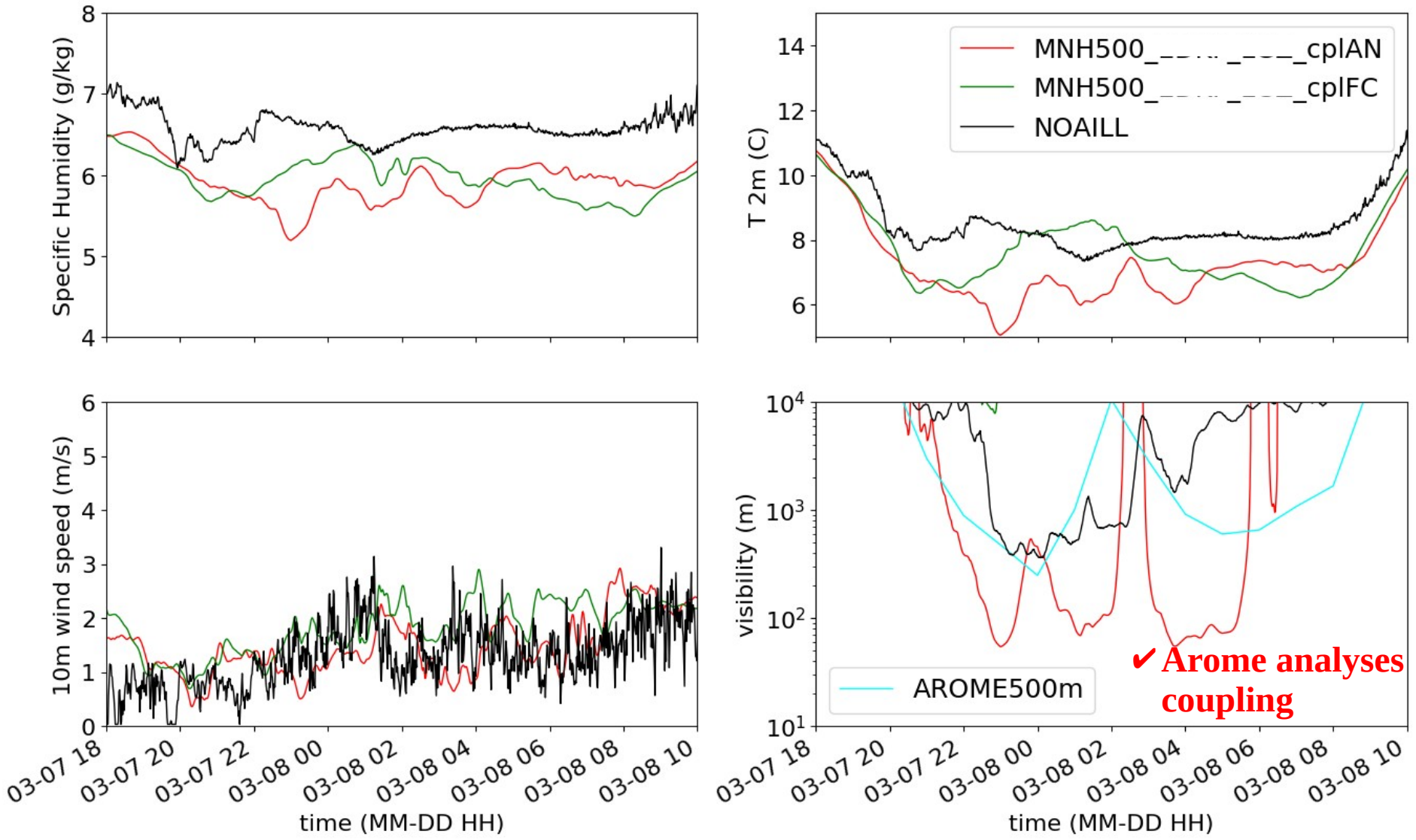


MTO / VISI observations at Noaillan



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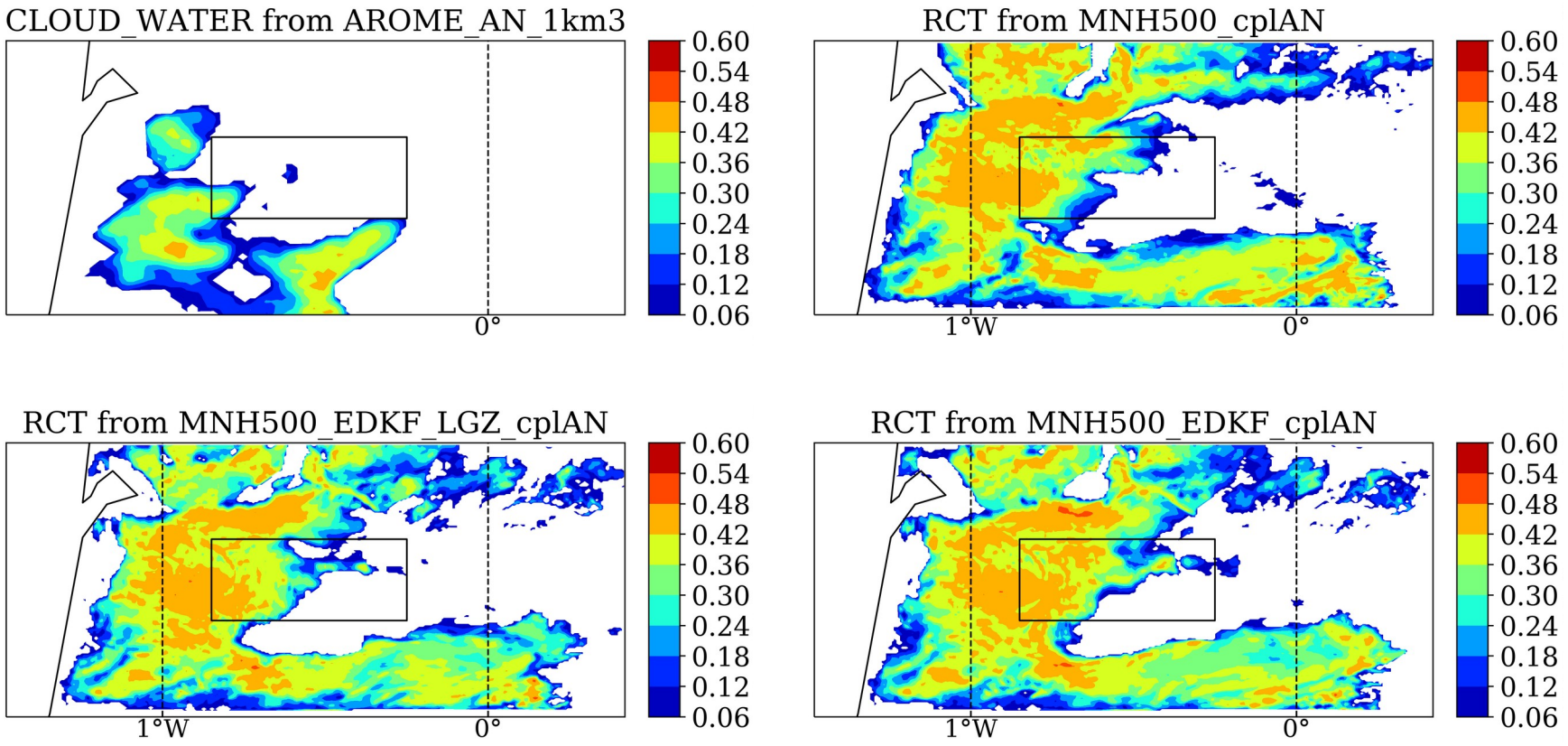
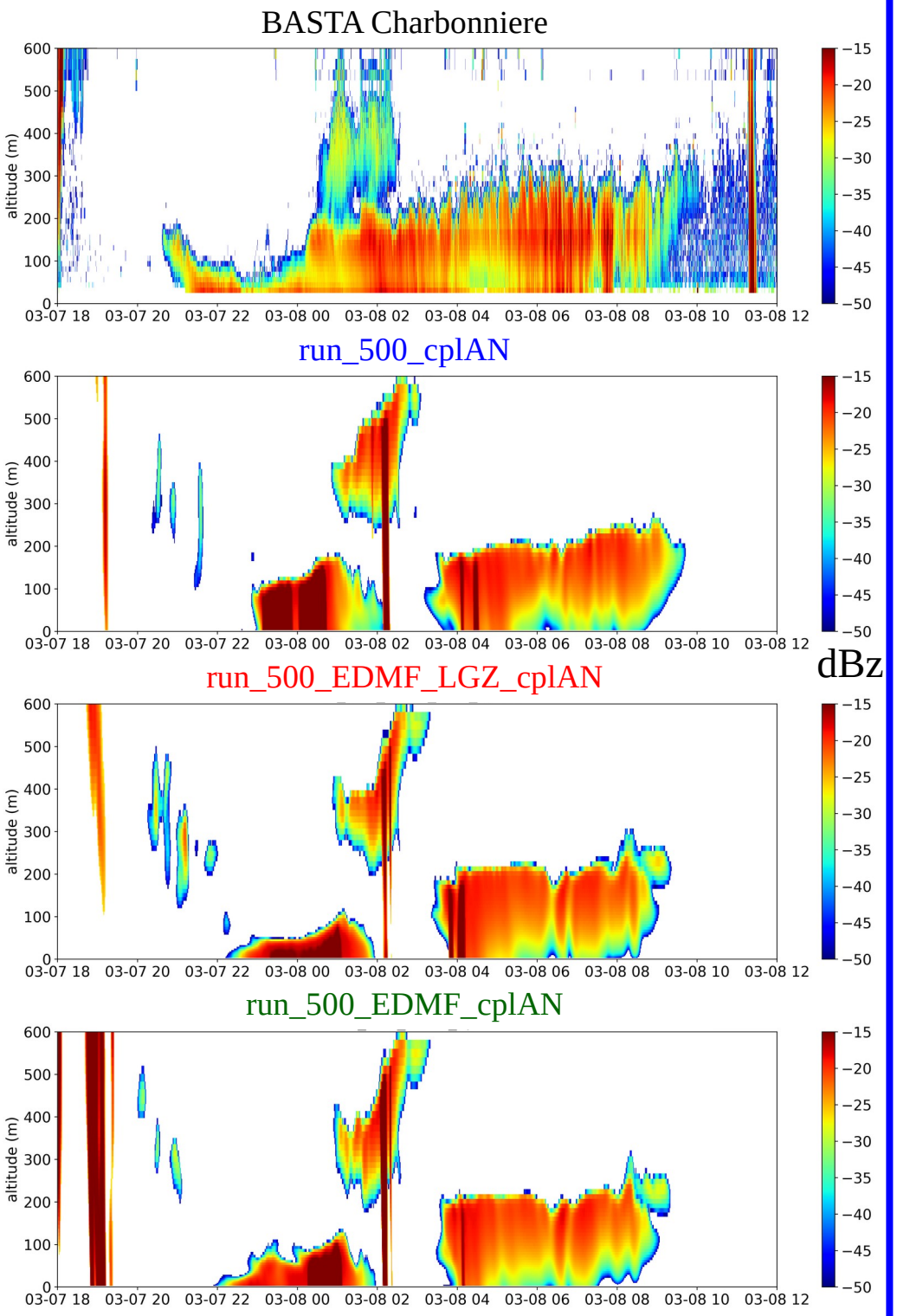


Low impact of the shallow convection parameterisation

Simulated reflectivities: Super Site

- Impact of physics:
  - The EDMF scheme improves the fog onset time
  - LGZ has a small positive impact on the BL clouds before the fog



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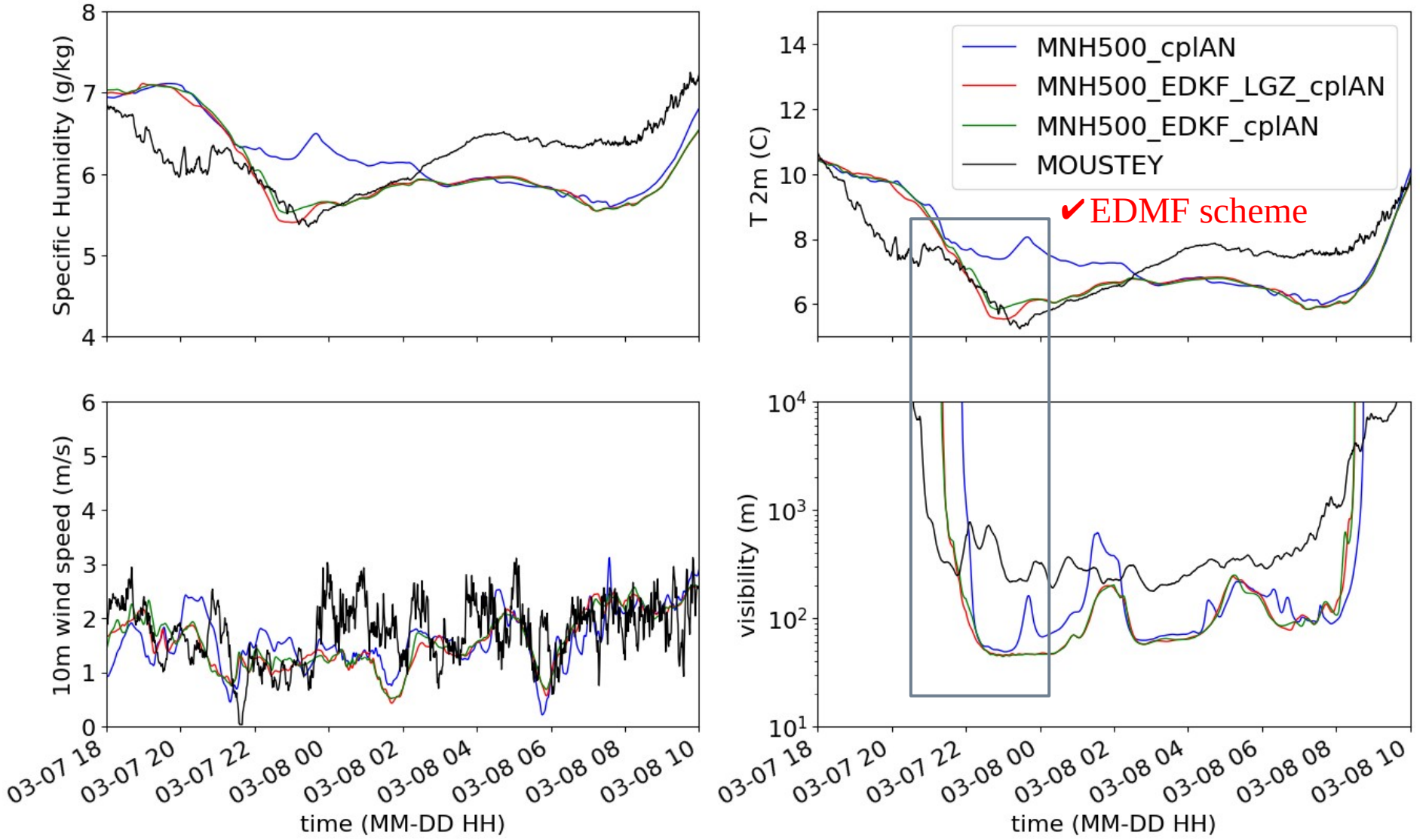

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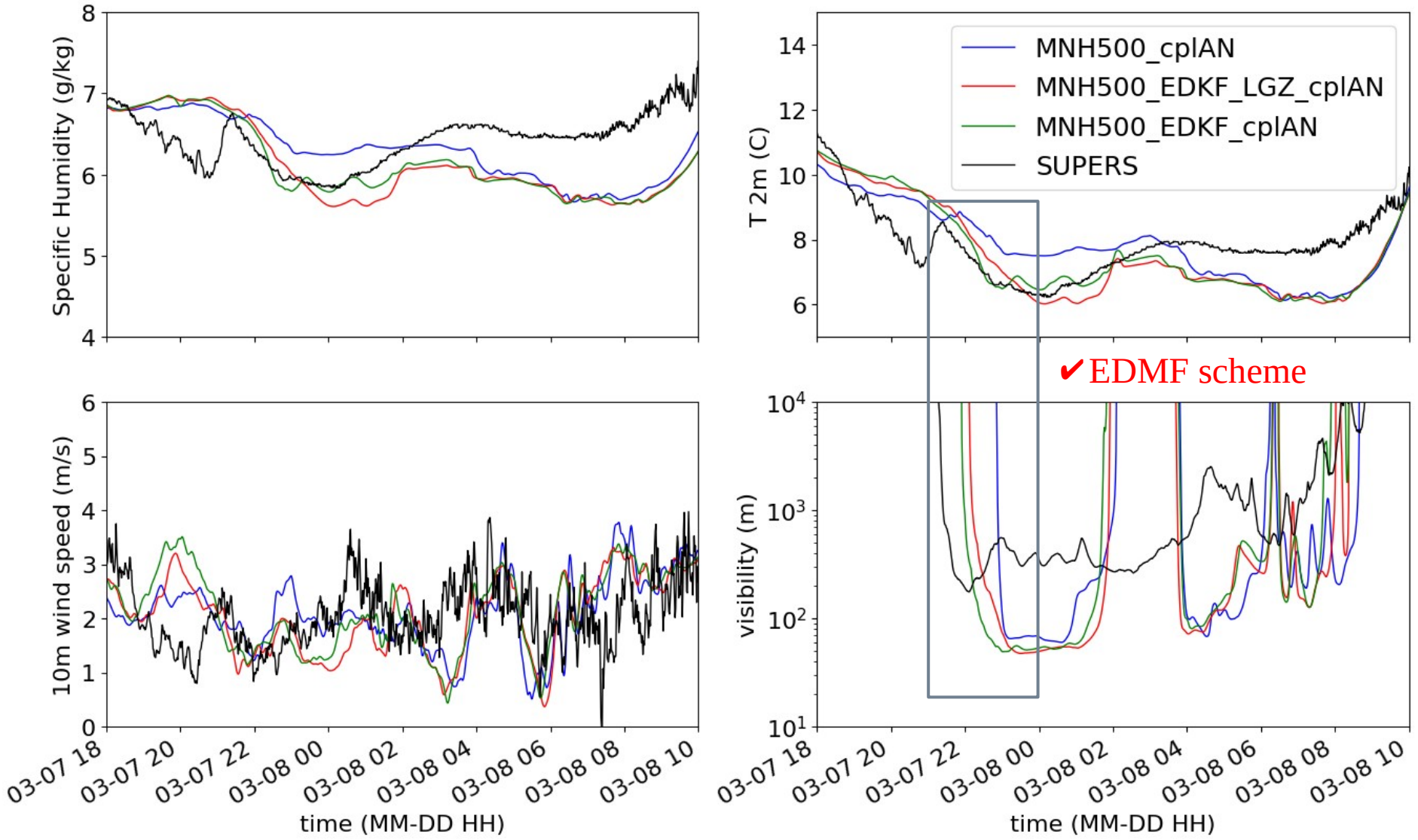


MNH run with 500m resolution → CONCLUSION

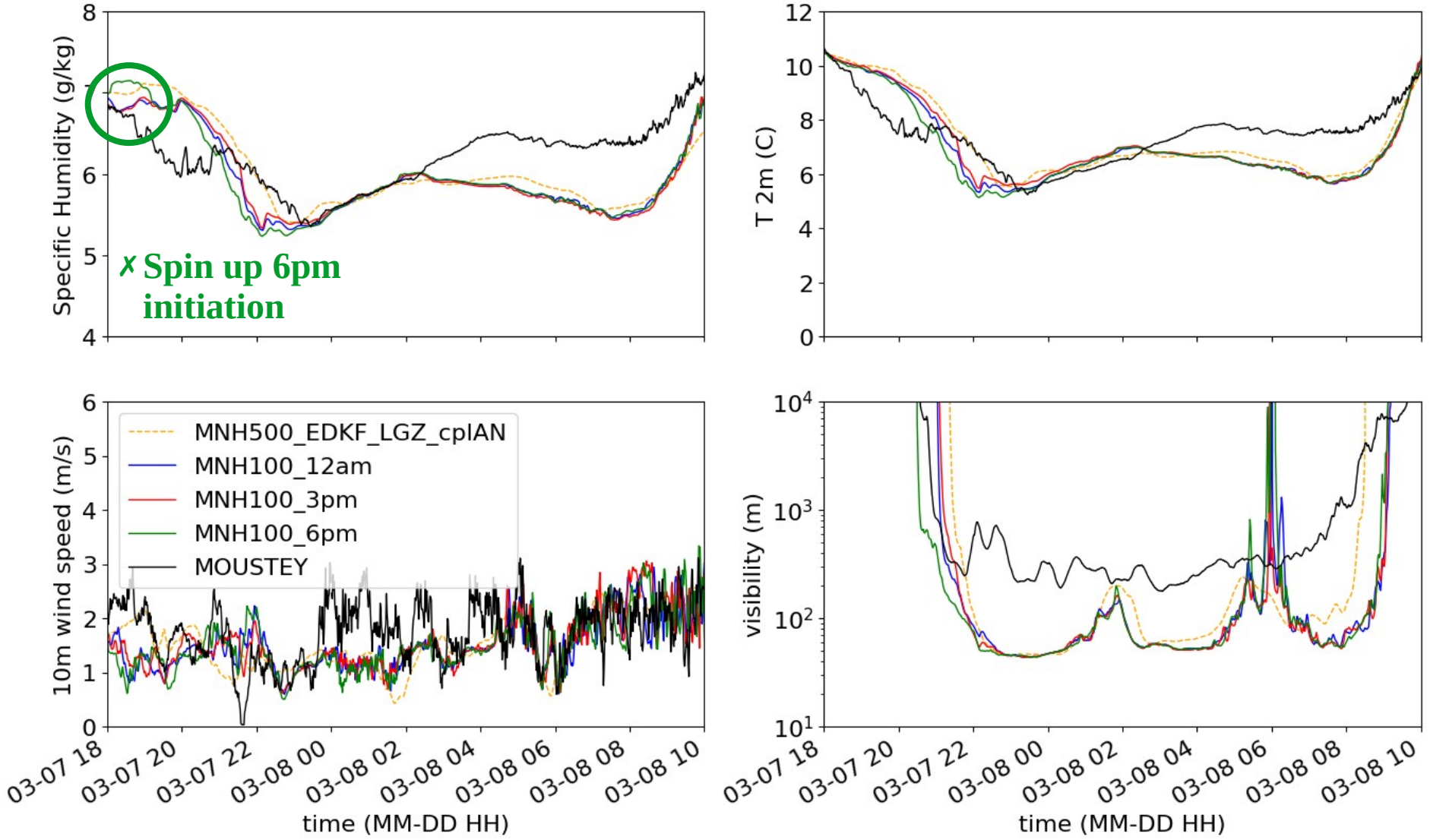
Simulations	Coupling conditions	Shallow convective scheme	LGZ (reduction of the mass-flux surface closure with the resolution)
MNH500_cplAN	AROME1.3 analyses	None	–
MNH500_EDMF_cplAN	AROME1.3 analyses	EDMF	False
MNH500_EDMF_LGZ_cplAN	**AROME1.3 analyses**	**EDMF**	**True**
MNH500_EDMF_LGZ_cplFC	AROME500 forecast	EDMF	True

- Best simulation with 500m resolution: **MNH500_EDMF_LGZ_cplAN**

  ➔ Use as coupling data for a 100m resolution simulation

  - ➔ Choose for the 100m simulation an initial setup
    12am? 3pm? 6pm?

MTO / VISI observations at Moustey



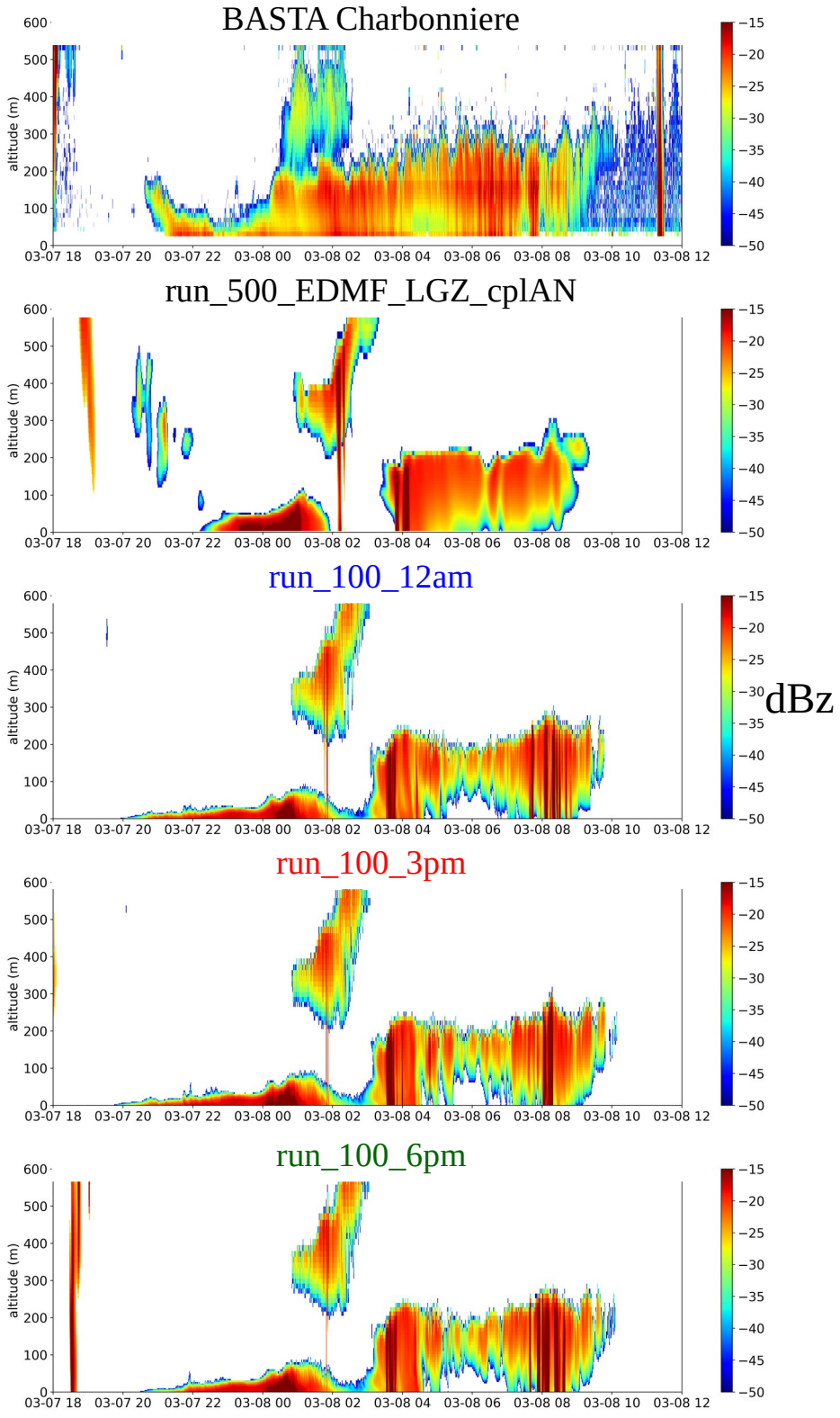
Simulated reflectivities: Super Site

- 100m resolution better captures:
  - the formation stage
  - the vertical development

- Fog dissipation simulated between 5 and 7 am

✗ run_100_6pm: spin up

✔ **run_100_3pm**



Conclusions and Perspectives

I. Most advanced parameterization:

- Step 1: downscaling simulation
  - ➔ Best configuration (physics and coupling) 500m resolution
    run_500_EDMF_LGZ_cplAN
  - ➔ Refining resolution and run a reference simulation (100m → 20m)
    run_100_3pm → run_20_to do
- Step 2: sensitivity study
- Step 3: run LES configuration to other IOPs

Solve/Improve:
Low cloud formation (0-2am) and impact on fog ?
Fog dissipation (5-7am) ?

II. Process study: impact of the surface heterogeneities on fog:

- Surface and turbulence budget for different vegetation type
- Use the model as a laboratory (modifying vegetation type)