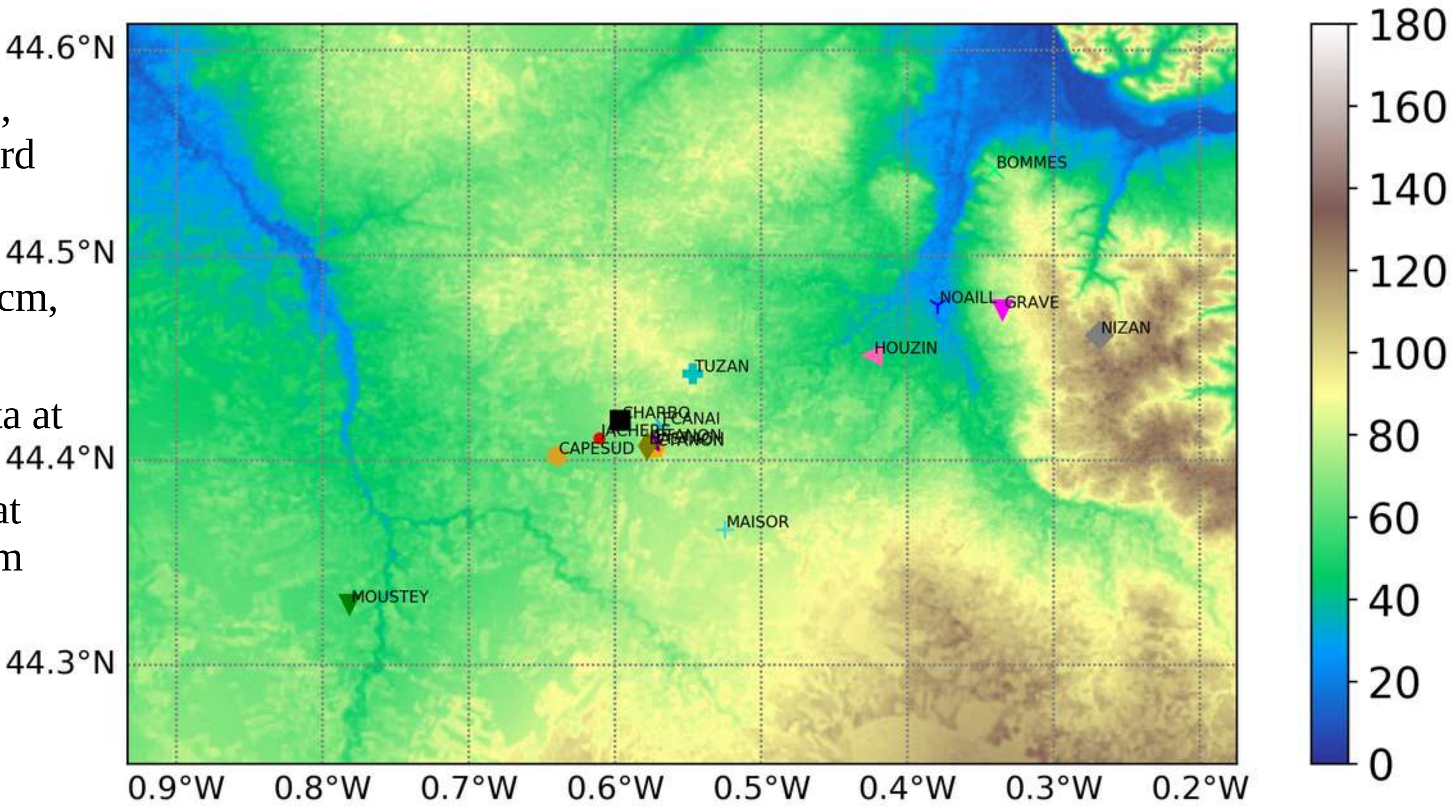
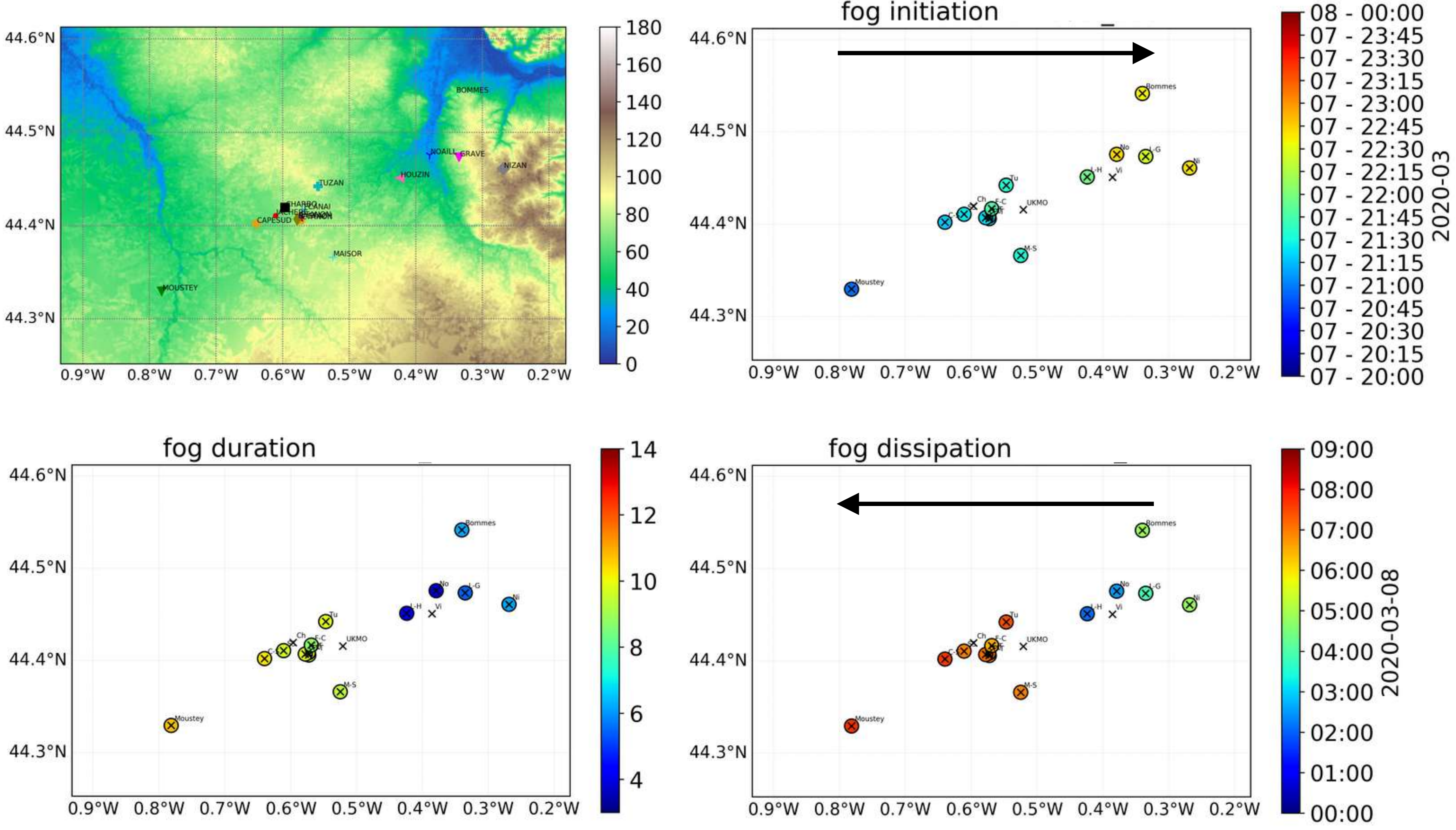
# Towards the LES of IOP14 to study the surface heterogeneities impact on fog

Marie Taufour*, Christine Lac, Quentin Rodier

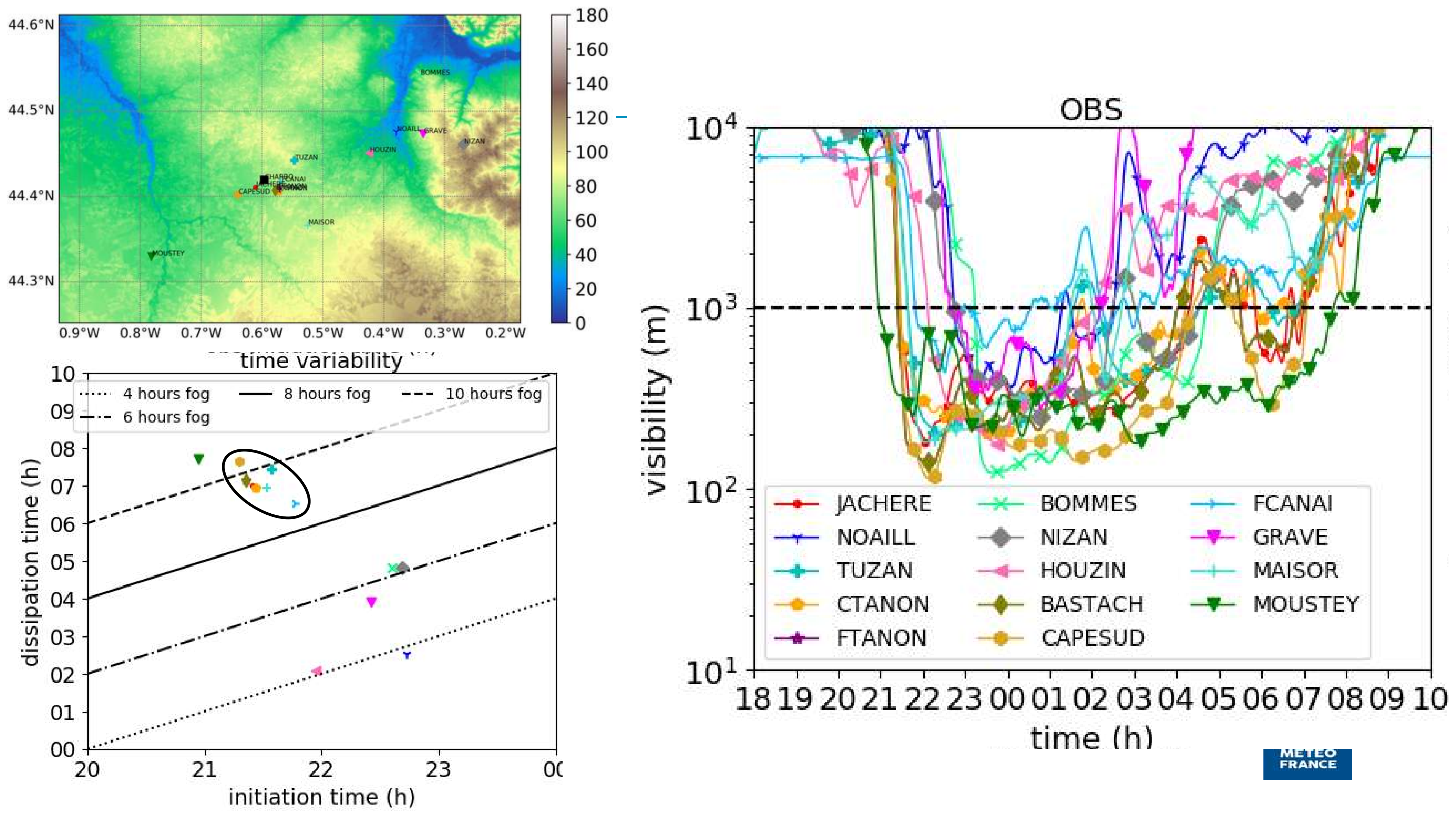
# 1) SOFOG3D – IOP14 (March 7th to 8th, 2020)

- **Visibility** measurement
- **CNRM_MTO** (air temperature, humidity ,pressure, wind, upward and downward short-wave and longwave radiations, soil temperature and humdity at 10 cm, 30 cm and 50 cm depth)
- **CNRM_TURB** (turbulence data at different levels (3m, 25m 50m).This includes sensible heat flux, latent heat flux, momentum flux, friction velocity, kinetic energy)

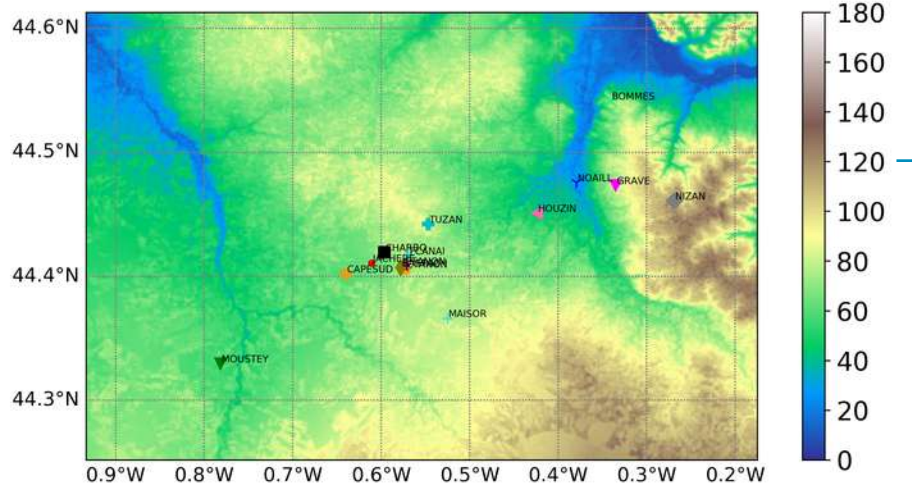


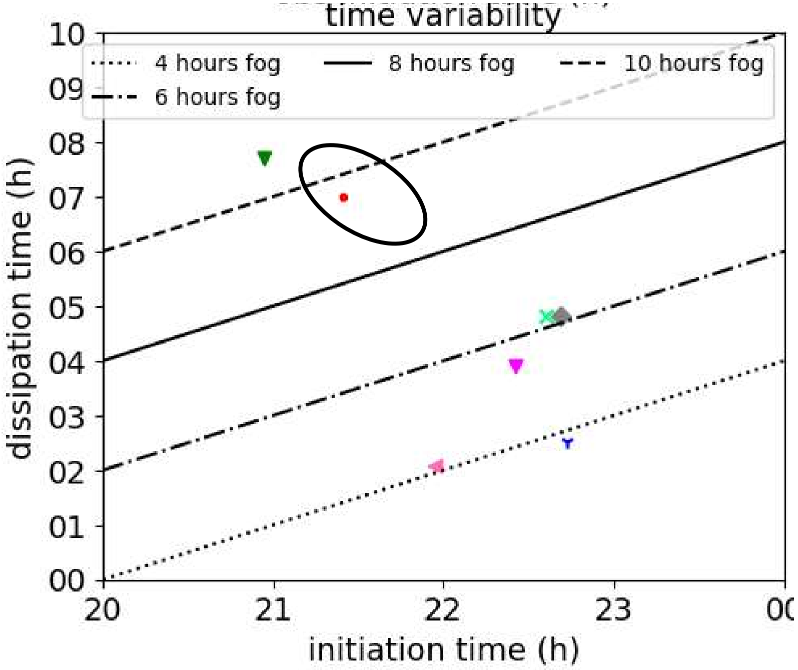


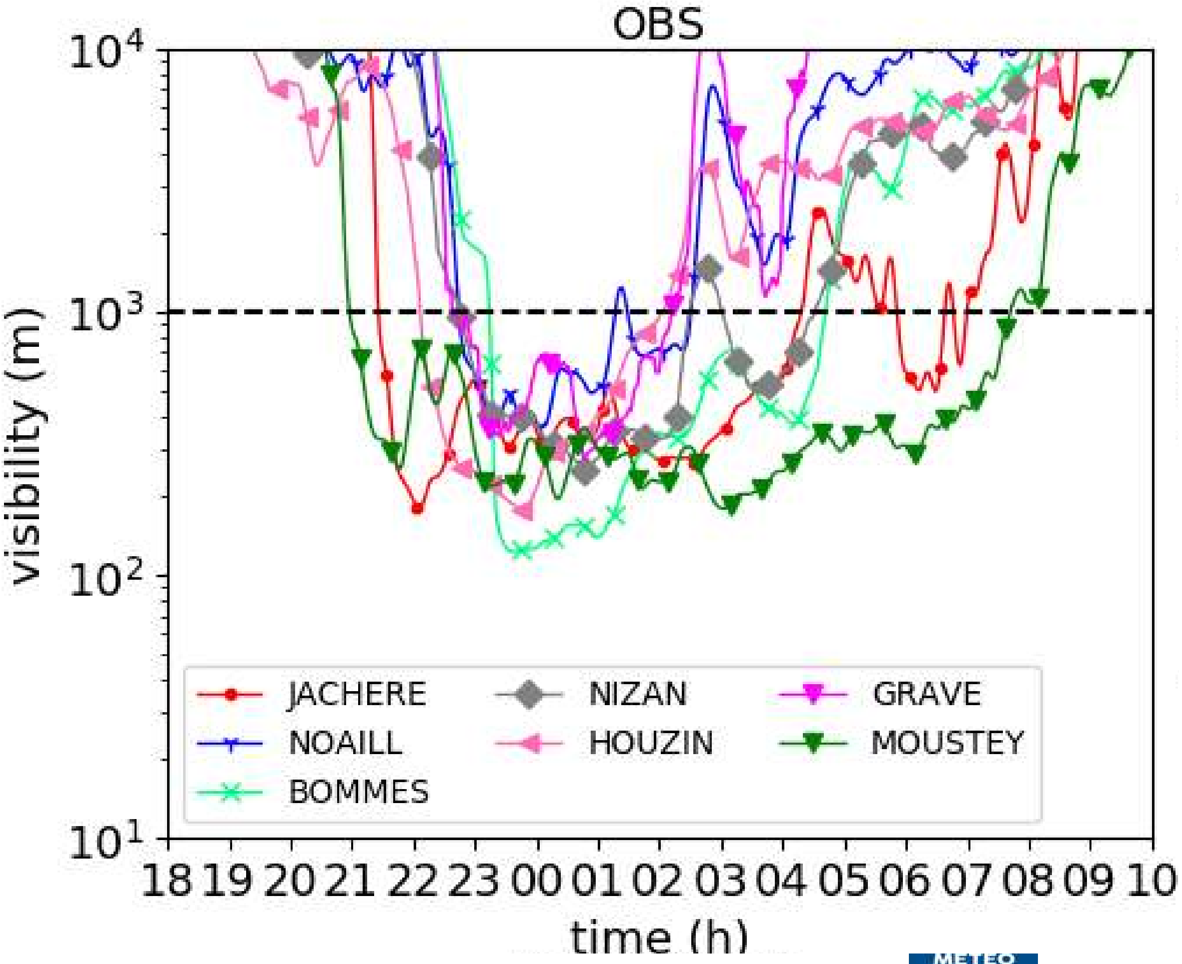
fog initiation
fog duration
fog dissipation
BOMMES
NOAILL
GRAVE
NIZAN
HOUZIN
TUZAN
CHARBO
CANAI
CAPESUD
MAISOR
MOUSTEY
Bommes
No
L-G
Ni
L-H
Vi
Tu
Ch
F-C
UKMO
M-S
Moustey
44.6°N
44.5°N
44.4°N
44.3°N
0.9°W
0.8°W
0.7°W
0.6°W
0.5°W
0.4°W
0.3°W
0.2°W
180
160
140
120
100
80
60
40
20
0
08 - 00:00
07 - 23:45
07 - 23:30
07 - 23:15
07 - 23:00
07 - 22:45
07 - 22:30
07 - 22:15
07 - 22:00
07 - 21:45
07 - 21:30
07 - 21:15
07 - 21:00
07 - 20:45
07 - 20:30
07 - 20:15
07 - 20:00
2020-03
14
12
10
8
6
4
09:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
2020-03-08



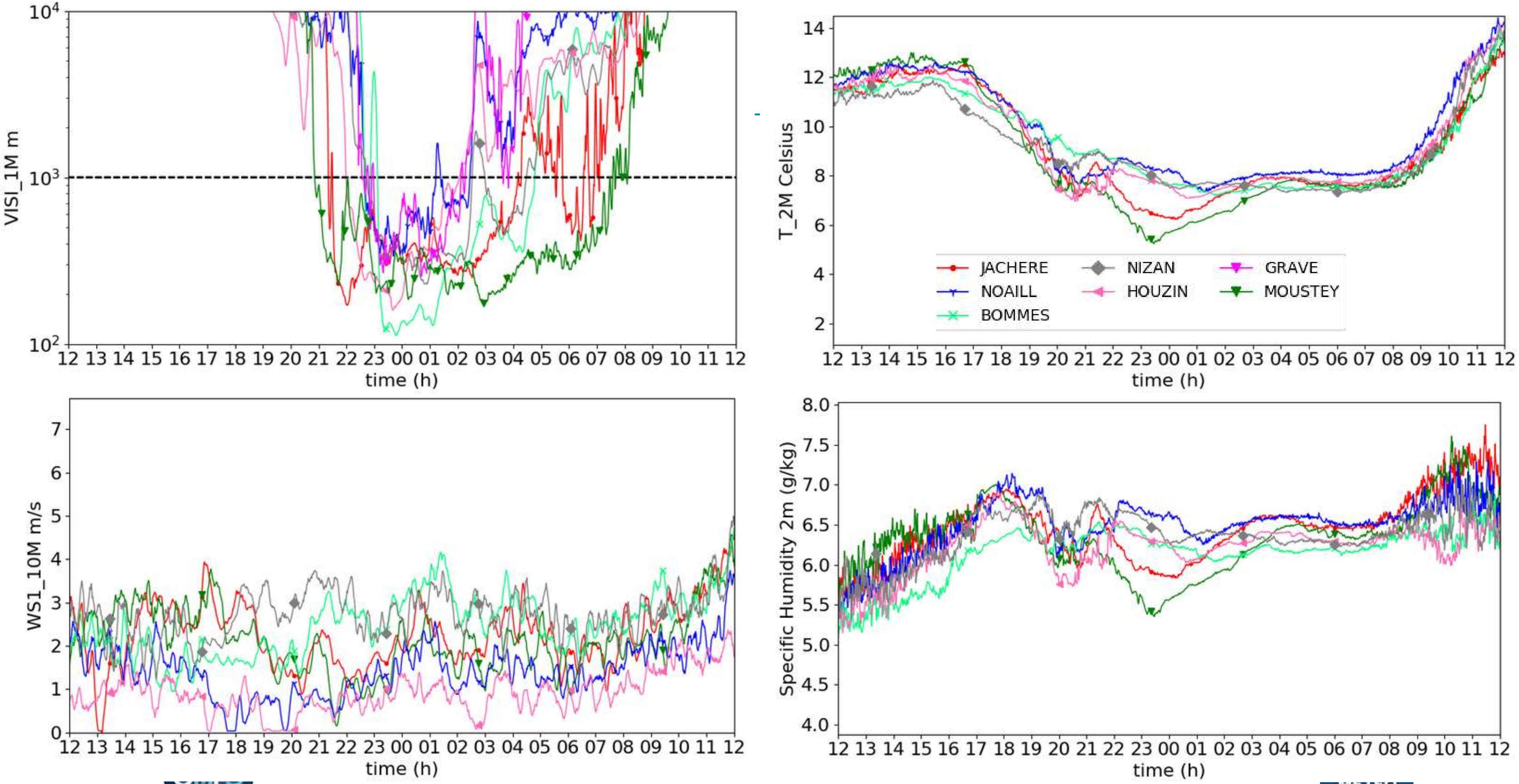
44.6°N
44.5°N
44.4°N
44.3°N
0.9°W
0.8°W
0.7°W
0.6°W
0.5°W
0.4°W
0.3°W
0.2°W
BOMMES
NOAILL
GRAVE
NIZAN
HOUZIN
TUZAN
FCANAI
CAPESUD
MAISOR
MOUSTEY
180
160
140
120
100
80
60
40
20
0
time variability
4 hours fog
8 hours fog
10 hours fog
6 hours fog
dissipation time (h)
initiation time (h)
OBS
visibility (m)
time (h)
JACHERE
NOAILL
TUZAN
CTANON
FTANON
BOMMES
NIZAN
HOUZIN
BASTACH
CAPESUD
FCANAI
GRAVE
MAISOR
MOUSTEY
METEO FRANCE



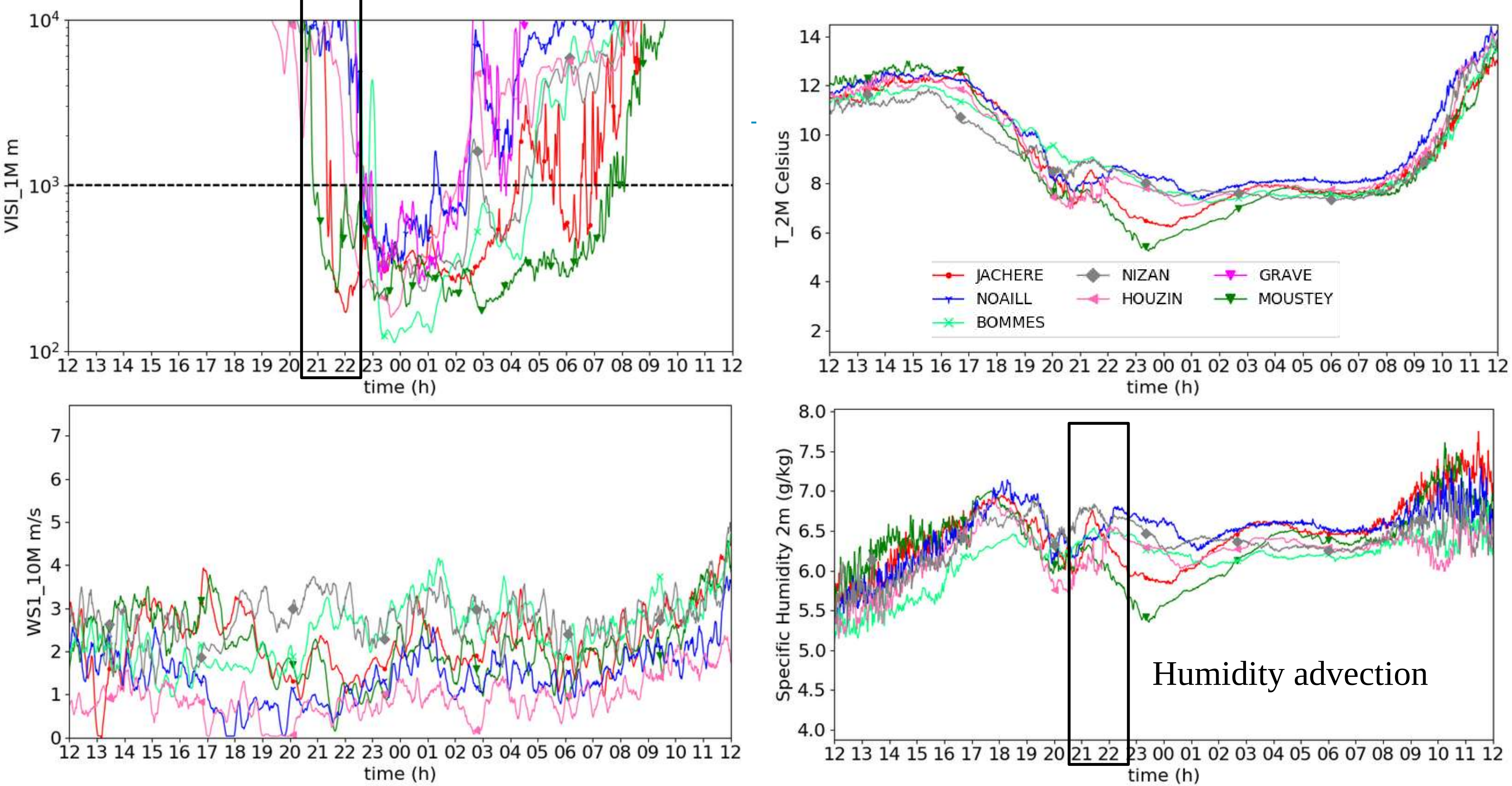




METEO FRANCE



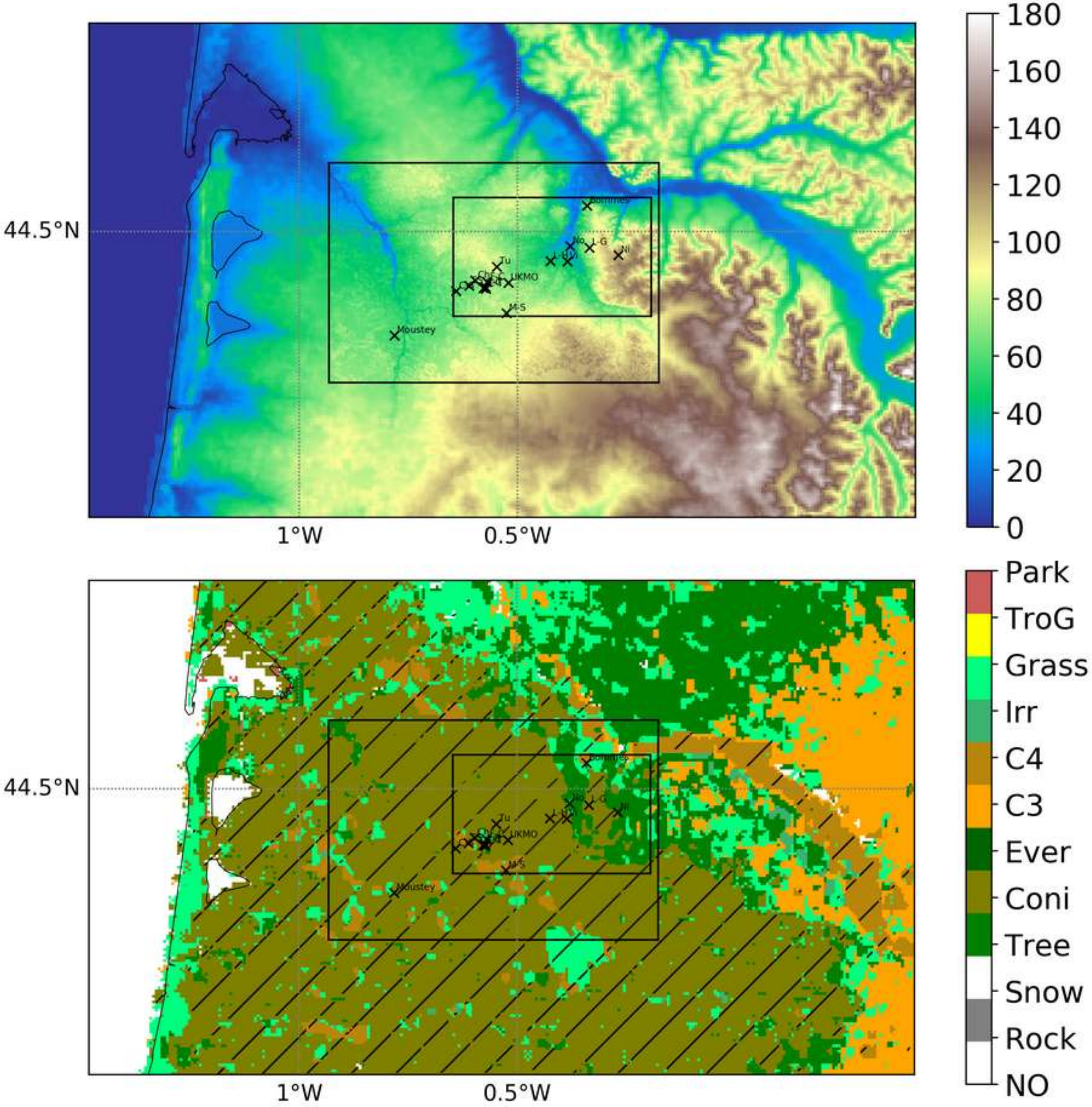
VISI_1M m
time (h)
T_2M Celsius
time (h)
JACHERE
NOAILL
BOMMES
NIZAN
HOUZIN
GRAVE
MOUSTEY
WS1_10M m/s
time (h)
Specific Humidity 2m (g/kg)
time (h)


VISI_1M m
time (h)
T_2M Celsius
JACHERE
NOAILL
BOMMES
NIZAN
HOUZIN
GRAVE
MOUSTEY
WS1_10M m/s
Specific Humidity 2m (g/kg)
Humidity advection

## 2) Experimental design and model description

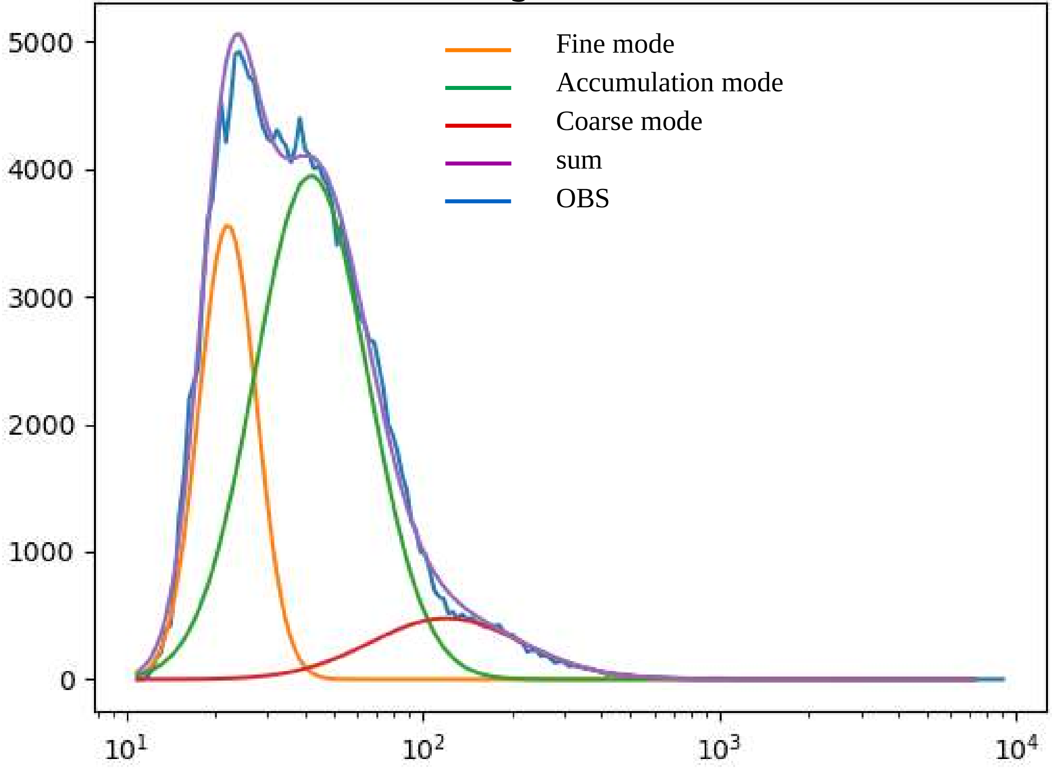
### a)Numerical set-up

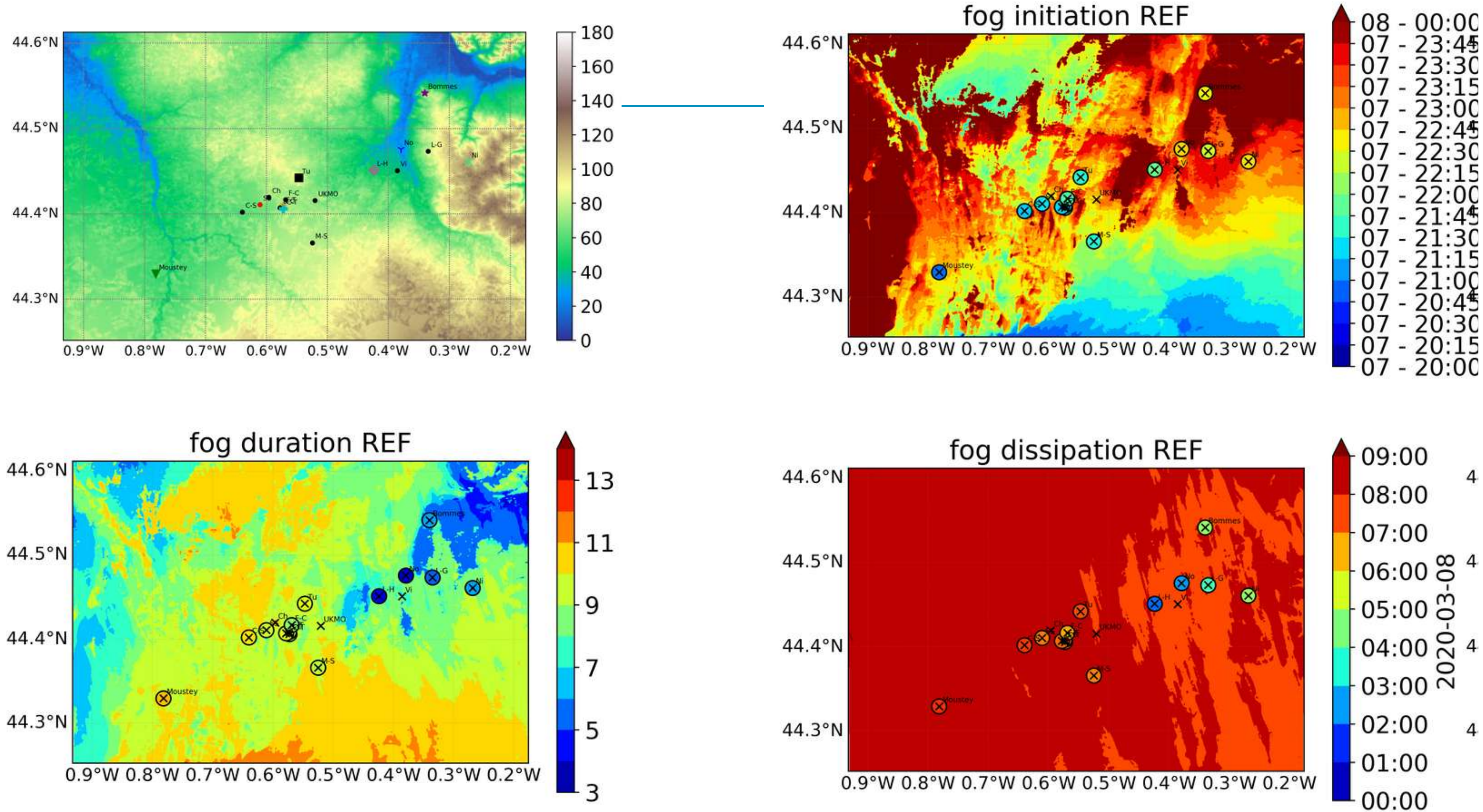
- Initiation : analyses AROME at 12h
- Couplages : hourly aromeForecast 500m
- Run 2-way grid nesting 500m → 100m
- Advection : Runge-Kutta fourth-order
- Orography : SRTM 90m (dad 500m) 30m (son 100m)
- Land cover / surface : ECOCLIMAP database at 1 km
- Shallow convection scheme : EDMF for 500m domain
- EcRad
- Turbulence: 1D at 500m, 3D at 100m
- Cloud scheme at 500m



- **LIMA** (2-moment microphysical scheme based on **ICE3** 1-moment microphysical scheme used in *AROME)*
  - Homogeneous aerosol loading
  - tri-modal
  - $N_{ccn1} = 850$ /cm³
    $N_{ccn2} = 1850$ /cm³
    $N_{ccn3} = 300$ /cm³

***REF** aerosol loading based on observations*





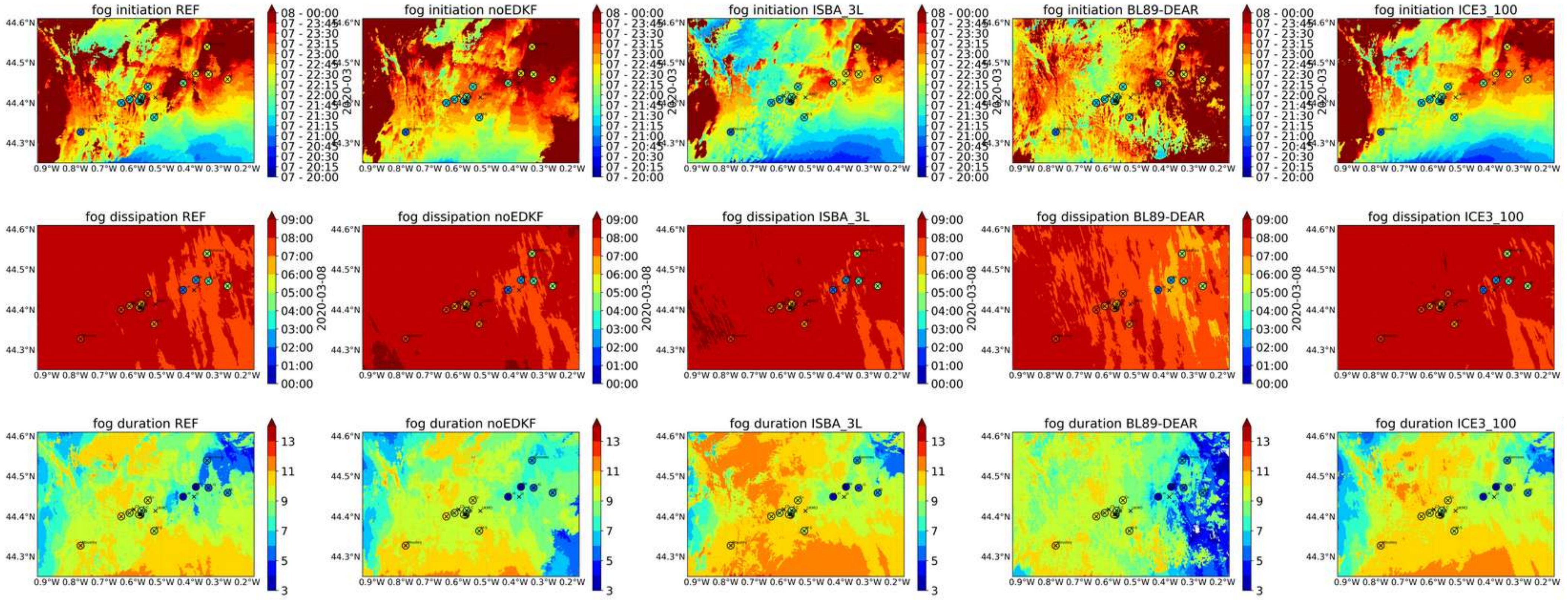
fog initiation REF
fog duration REF
fog dissipation REF
2020-03-08
44.6°N
44.5°N
44.4°N
44.3°N
0.9°W 0.8°W 0.7°W 0.6°W 0.5°W 0.4°W 0.3°W 0.2°W
180
160
140
120
100
80
60
40
20
0
08 - 00:00
07 - 23:45
07 - 23:30
07 - 23:15
07 - 23:00
07 - 22:45
07 - 22:30
07 - 22:15
07 - 22:00
07 - 21:45
07 - 21:30
07 - 21:15
07 - 21:00
07 - 20:45
07 - 20:30
07 - 20:15
07 - 20:00
13
11
9
7
5
3
09:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
Bommes
No
L-G
Ni
L-H
Vi
Tu
Ch
F-C
UKMO
C-S
M-S
Moustey

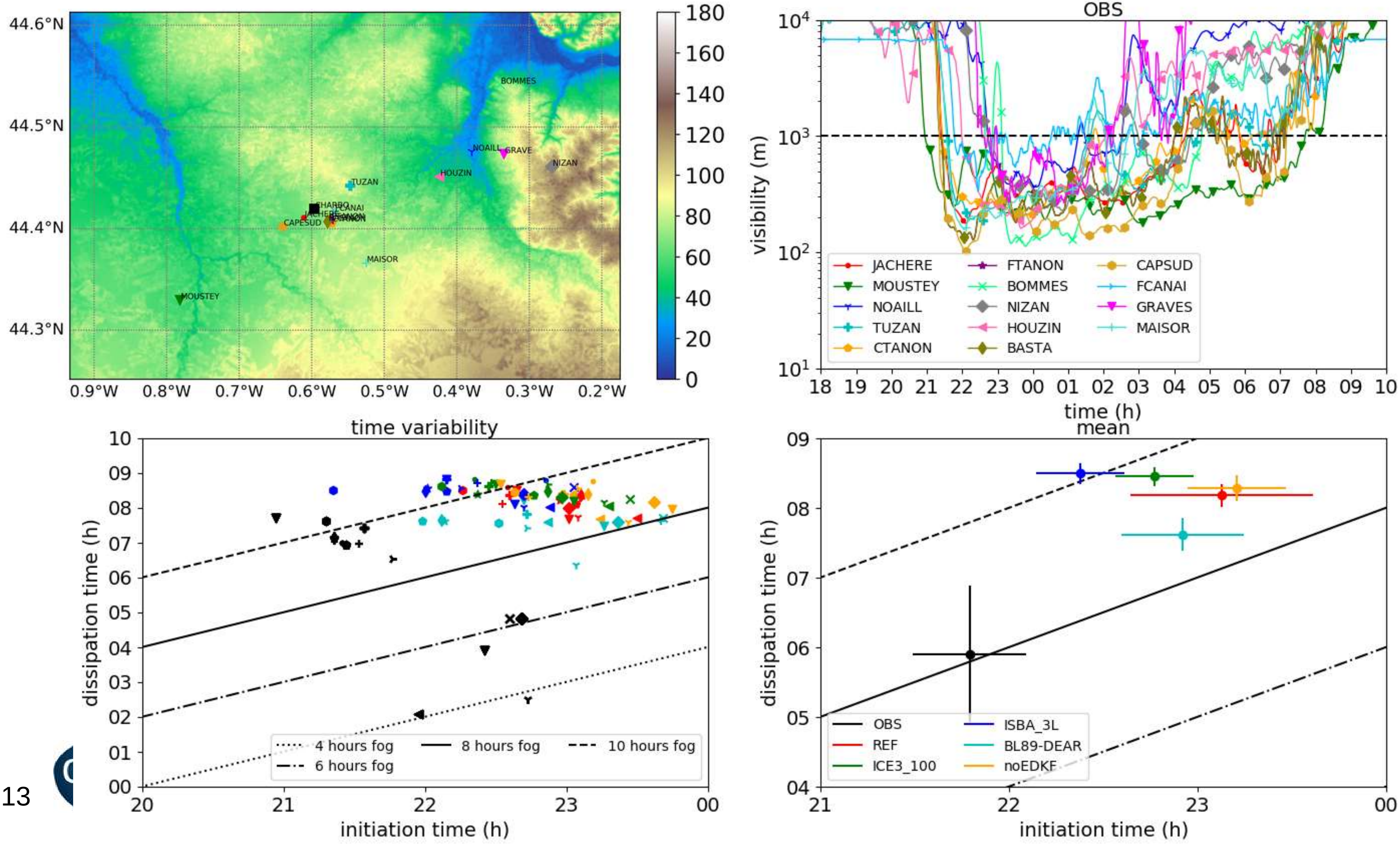
## 2) Experimental design and model description

### c) Sensitivity tests

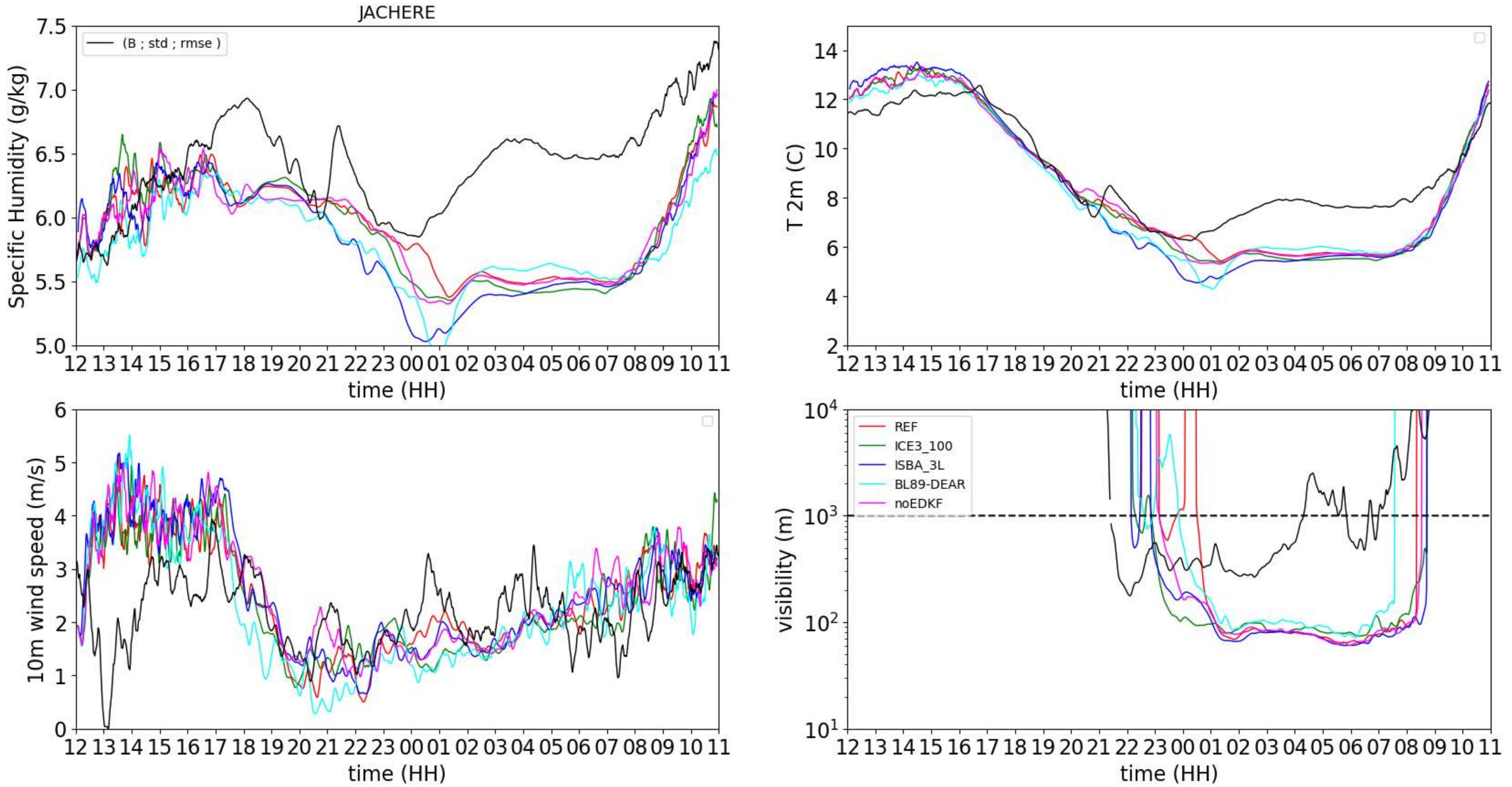
| | REF | | noEDMF | | ISBA_3L | | BL89_DEAR | | ICE3_100 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 500m | 100m | 500m | 100m | 500m | 100m | 500m | 100m | 500m | 100m |
| **convective scheme** | EDMF | ø | ø | ø | EDMF | ø | EDMF | ø | EDMF | ø |
| **surface scheme** | ISBA-DIF | | ISBA-DIF | | ISBA-3L | | ISBA-DIF | | ISBA-DIF | |
| **turbulent lenght** | ADAP | ADAP | ADAP | ADAP | ADAP | ADAP | BL89 | DEAR | ADAP | ADAP |
| **microphysical scheme** | LIMA | | LIMA | | LIMA | | LIMA | | ICE3 (Nc = 100 /cm3) | |

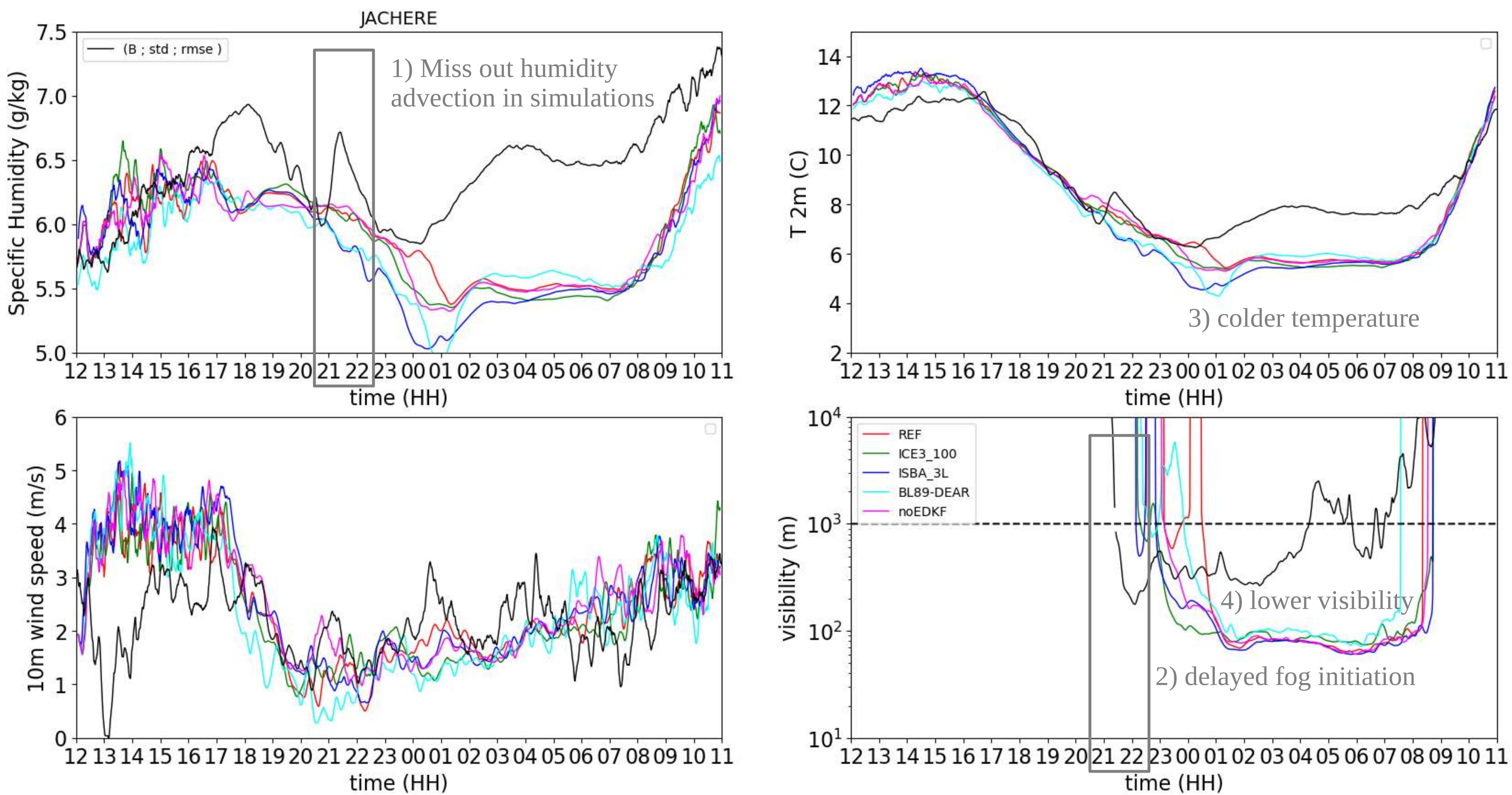
# 100m resolution results

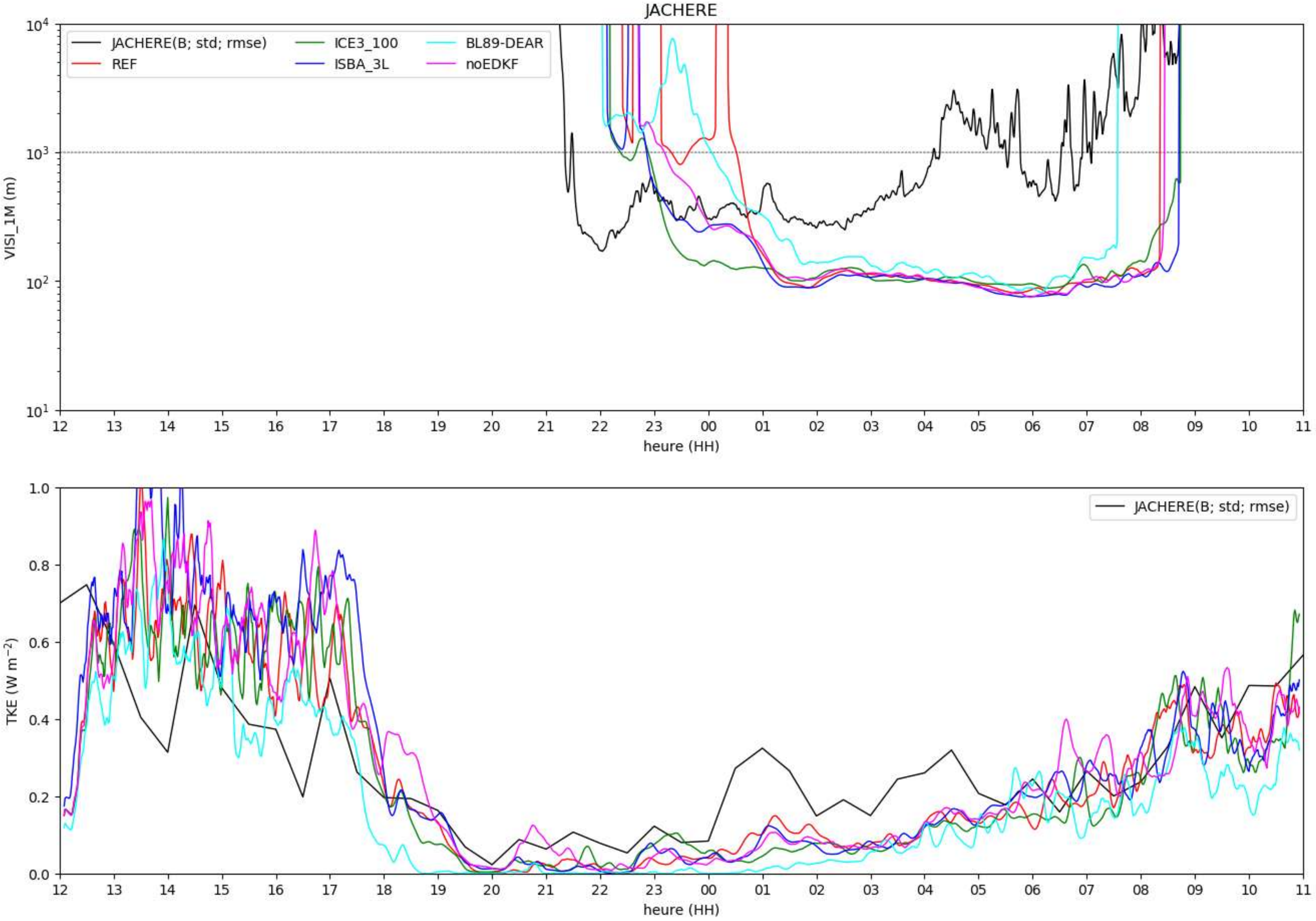


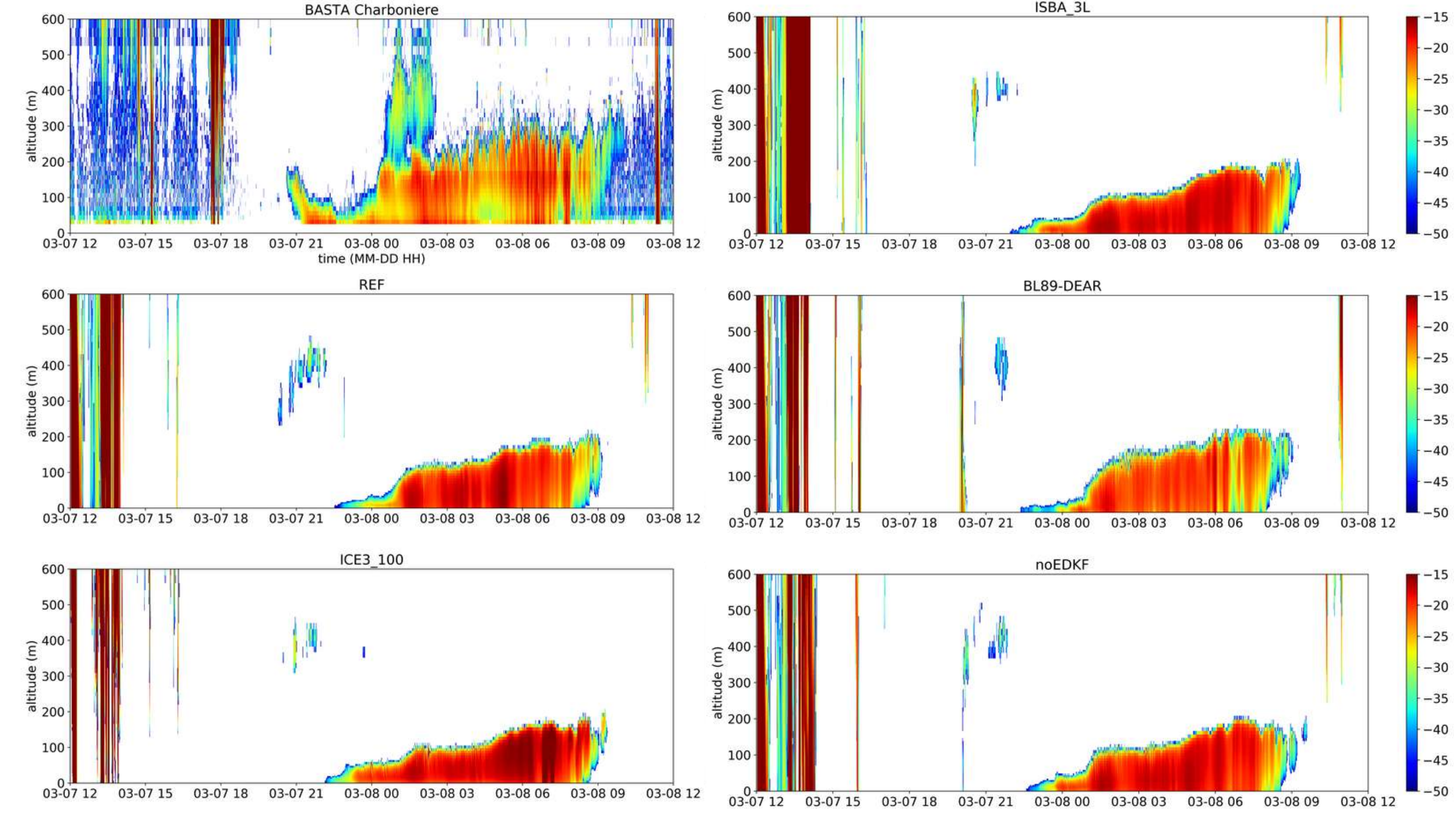


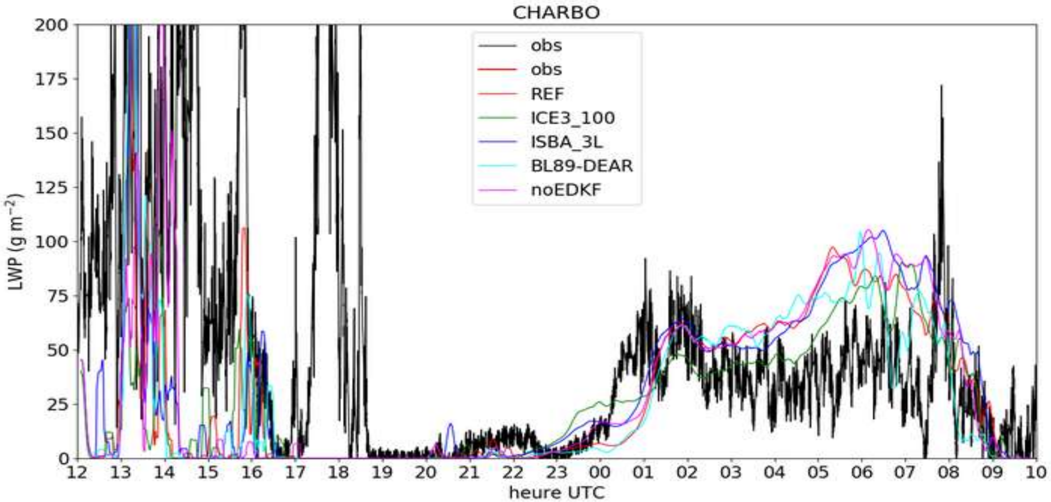
BOMMES
NOAILL
GRAVE
NIZAN
HOUZIN
TUZAN
CHARBO
FCANAI
CAPESUD
MAISOR
MOUSTEY
44.6°N
44.5°N
44.4°N
44.3°N
0.9°W 0.8°W 0.7°W 0.6°W 0.5°W 0.4°W 0.3°W 0.2°W
0 20 40 60 80 100 120 140 160 180
OBS
visibility (m)
time (h)
JACHERE
MOUSTEY
NOAILL
TUZAN
CTANON
FTANON
BOMMES
NIZAN
HOUZIN
BASTA
CAPSUD
FCANAI
GRAVES
MAISOR
time variability
dissipation time (h)
initiation time (h)
4 hours fog
6 hours fog
8 hours fog
10 hours fog
mean
OBS
REF
ICE3_100
ISBA_3L
BL89-DEAR
noEDKF

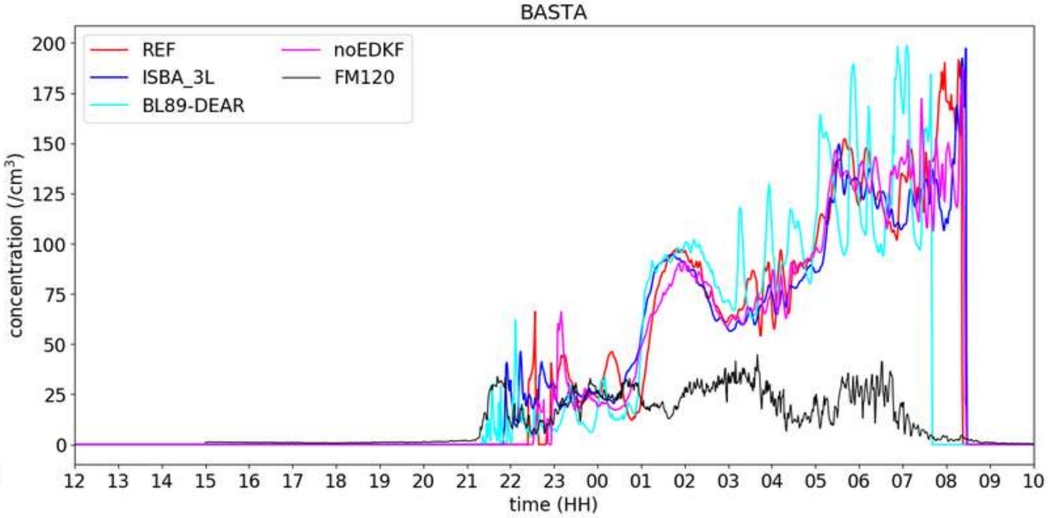

JACHERE
(B ; std ; rmse )
Specific Humidity (g/kg)
7.5
7.0
6.5
6.0
5.5
5.0
12 13 14 15 16 17 18 19 20 21 22 23 00 01 02 03 04 05 06 07 08 09 10 11
time (HH)
T 2m (C)
14
12
10
8
6
4
2
10m wind speed (m/s)
visibility (m)
REF
ICE3_100
ISBA_3L
BL89-DEAR
noEDKF

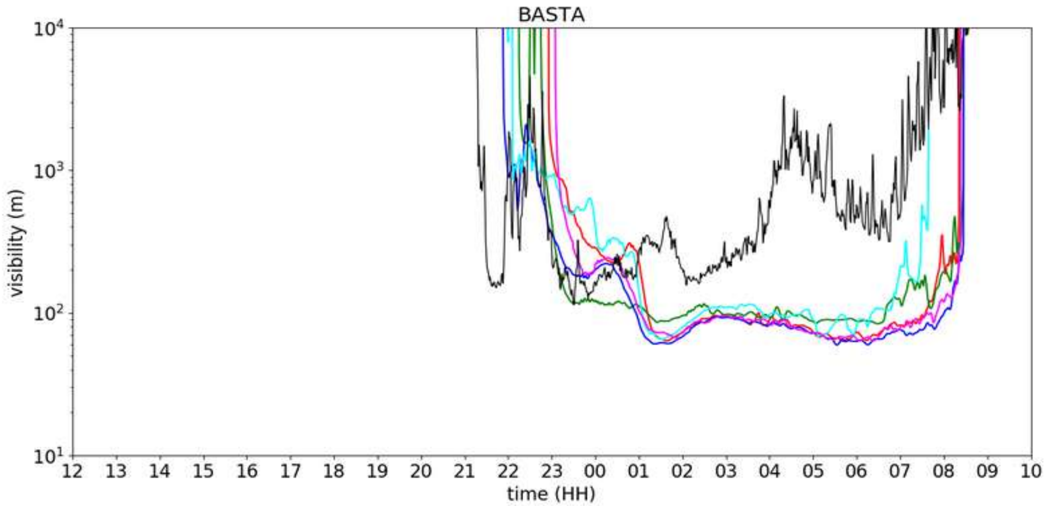

JACHERE
(B ; std ; rmse )
1) Miss out humidity advection in simulations
Specific Humidity (g/kg)
time (HH)
T 2m (C)
3) colder temperature
10m wind speed (m/s)
visibility (m)
REF
ICE3_100
ISBA_3L
BL89-DEAR
noEDKF
4) lower visibility
2) delayed fog initiation

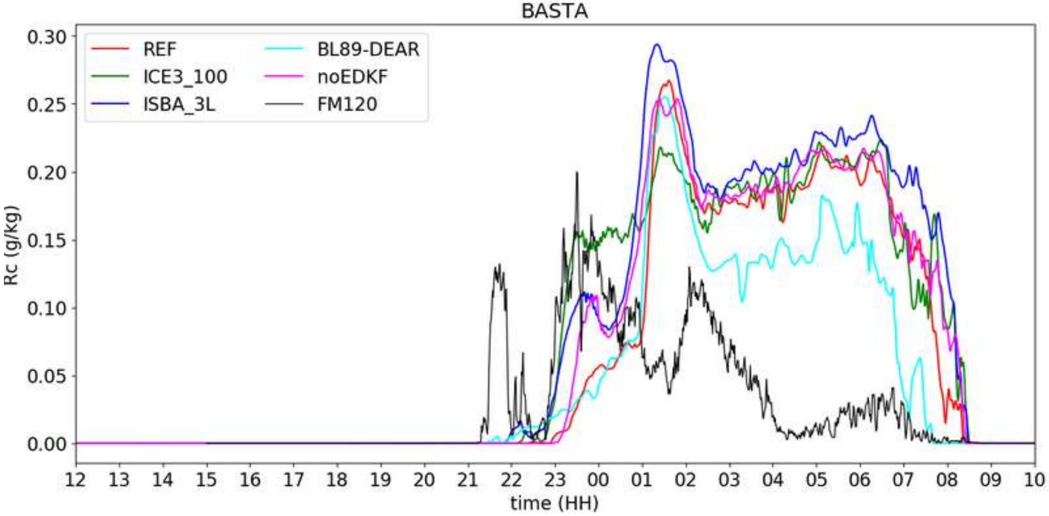

JACHERE
JACHERE(B; std; rmse)
REF
ICE3_100
ISBA_3L
BL89-DEAR
noEDKF
VISI_1M (m)
heure (HH)
TKE (W m−2)
JACHERE(B; std; rmse)
heure (HH)


BASTA Charboniere
ISBA_3L
REF
BL89-DEAR
ICE3_100
noEDKF
altitude (m)
time (MM-DD HH)
0
100
200
300
400
500
600
03-07 12
03-07 15
03-07 18
03-07 21
03-08 00
03-08 03
03-08 06
03-08 09
03-08 12
−15
−20
−25
−30
−35
−40
−45
−50


CHARBO
LWP (g m$^{-2}$)
200
175
150
125
100
75
50
25
0
12 13 14 15 16 17 18 19 20 21 22 23 00 01 02 03 04 05 06 07 08 09 10
heure UTC
obs
obs
REF
ICE3_100
ISBA_3L
BL89-DEAR
noEDKF


BASTA
concentration (/cm$^3$)
200
175
150
125
100
75
50
25
0
12 13 14 15 16 17 18 19 20 21 22 23 00 01 02 03 04 05 06 07 08 09 10
time (HH)
REF
ISBA_3L
BL89-DEAR
noEDKF
FM120


BASTA
visibility (m)
$10^4$
$10^3$
$10^2$
$10^1$
12 13 14 15 16 17 18 19 20 21 22 23 00 01 02 03 04 05 06 07 08 09 10
time (HH)

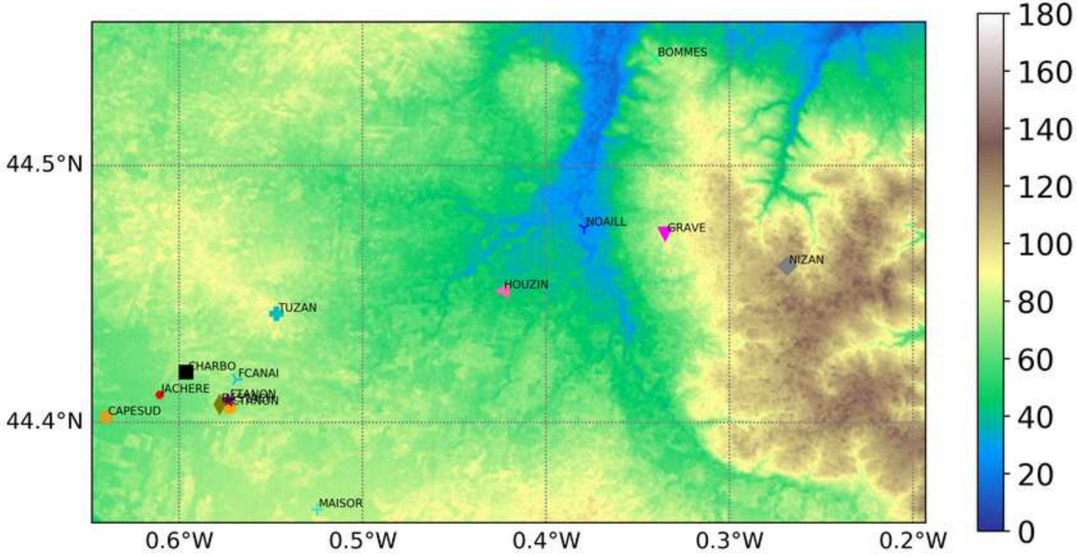

BASTA
Rc (g/kg)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
12 13 14 15 16 17 18 19 20 21 22 23 00 01 02 03 04 05 06 07 08 09 10
time (HH)
REF
ICE3_100
ISBA_3L
BL89-DEAR
noEDKF
FM120

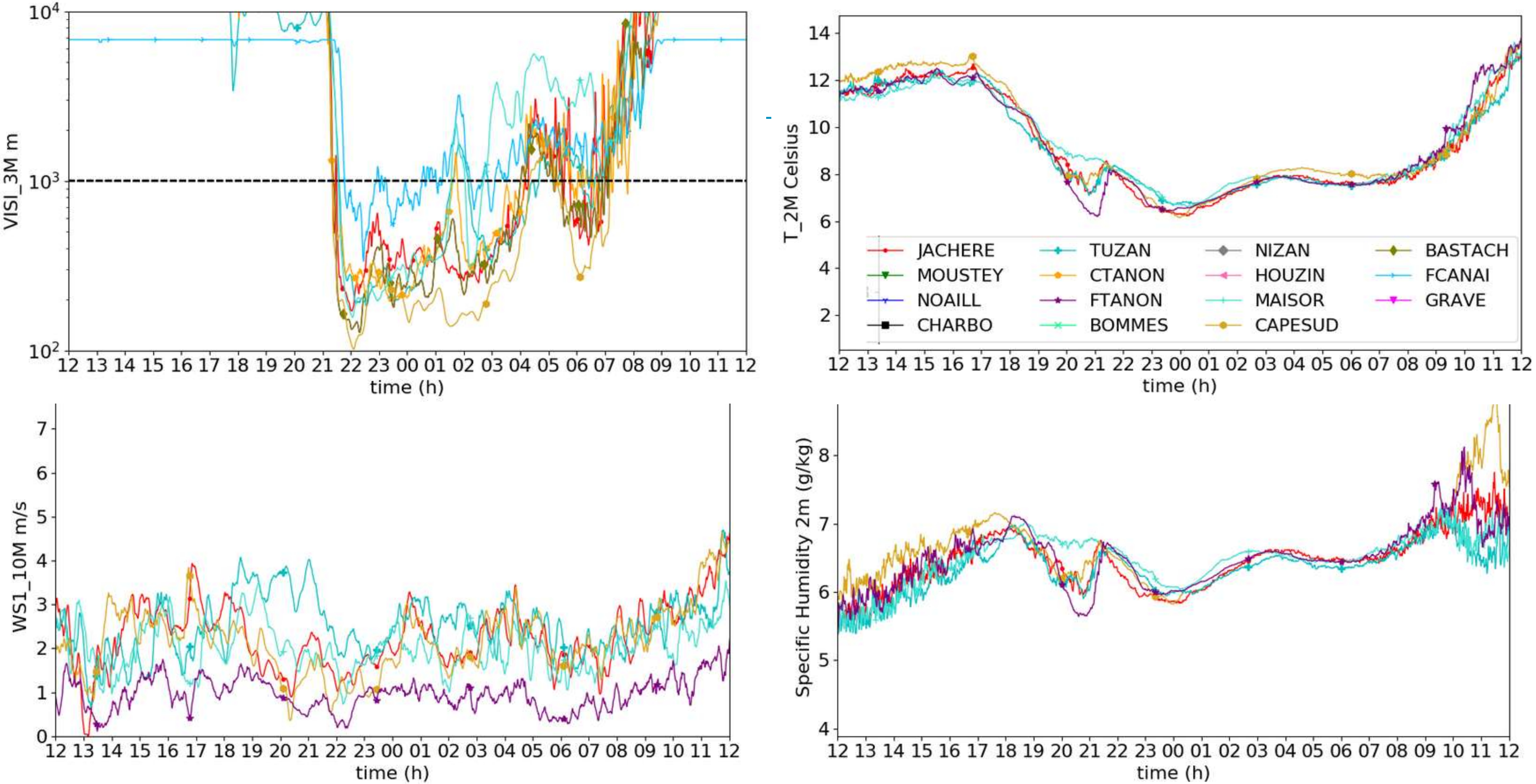
## Conclusions

- Reference simulation quite satisfying (EDMF / ISBA-DIF / ADAP-ADAP / LIMA)
  - Delayed initiation time due to missing out humidity advection → lower temperature
  - Fog optically thicker due to Nc and Rc

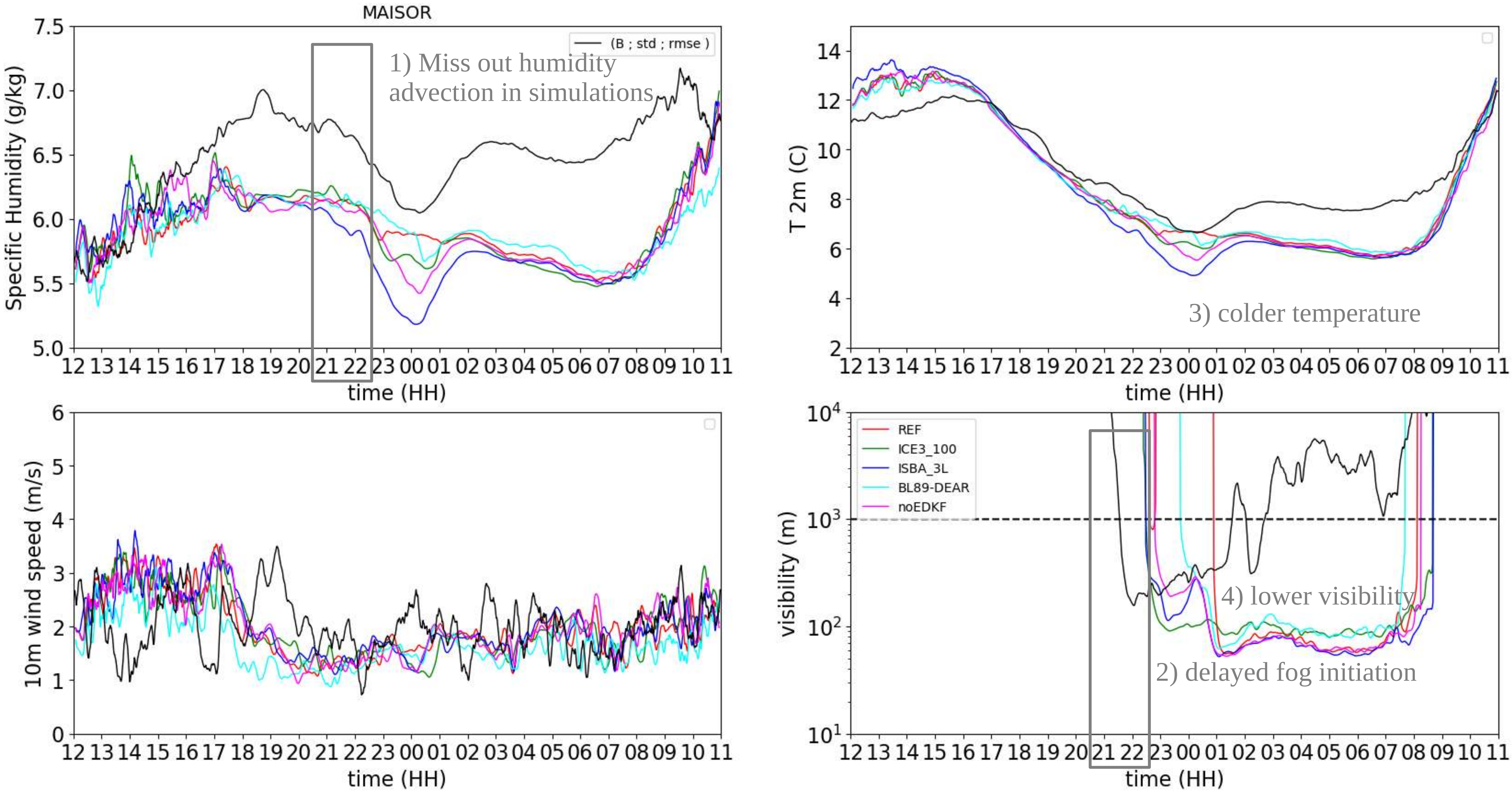
## Perspectives

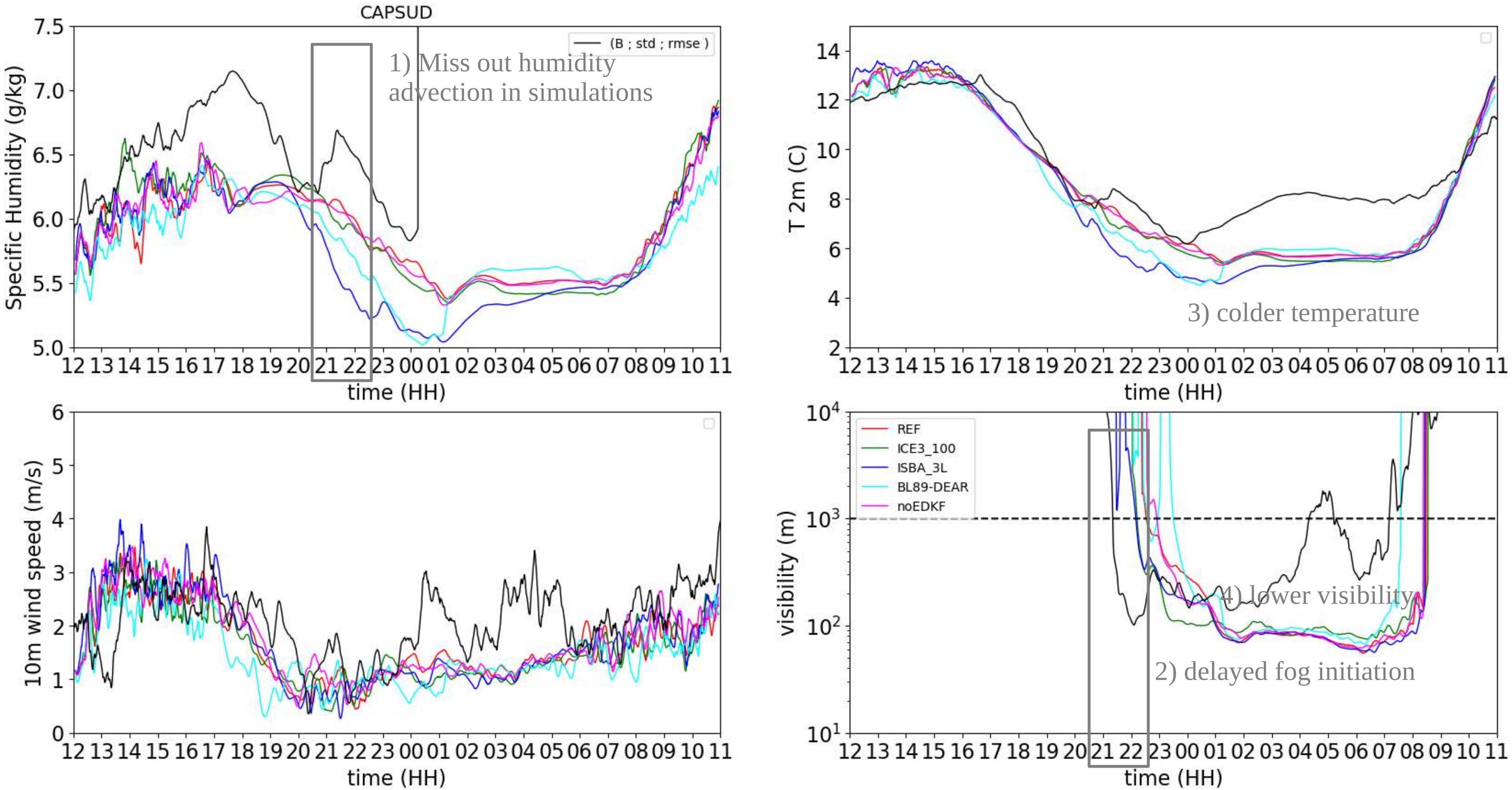
- Try to improve meteorological forcing
- Improving surface heterogeneities study with process study
- Study LES (20m) simulations on fog life cycle
- Reproducing study on other IOP





VISI_3M m
time (h)
T_2M Celsius
JACHERE
MOUSTEY
NOAILL
CHARBO
TUZAN
CTANON
FTANON
BOMMES
NIZAN
HOUZIN
MAISOR
CAPESUD
BASTACH
FCANAI
GRAVE
WS1_10M m/s
Specific Humidity 2m (g/kg)


MAISOR
(B ; std ; rmse )
1) Miss out humidity advection in simulations
Specific Humidity (g/kg)
time (HH)
T 2m (C)
3) colder temperature
10m wind speed (m/s)
visibility (m)
REF
ICE3_100
ISBA_3L
BL89-DEAR
noEDKF
4) lower visibility
2) delayed fog initiation


CAPSUD
(B ; std ; rmse )
1) Miss out humidity advection in simulations
Specific Humidity (g/kg)
time (HH)
T 2m (C)
3) colder temperature
10m wind speed (m/s)
visibility (m)
REF
ICE3_100
ISBA_3L
BL89-DEAR
noEDKF
4) lower visibility
2) delayed fog initiation