WorkShop SoFog3D

AROME FOG FORECASTS AND INFLUENCE OF MICROPHYSICAL PARAMETERIZATIONS

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Modeling data - AROME weather forecasts

Adapted from operational AROME (Seity et al., 2011)

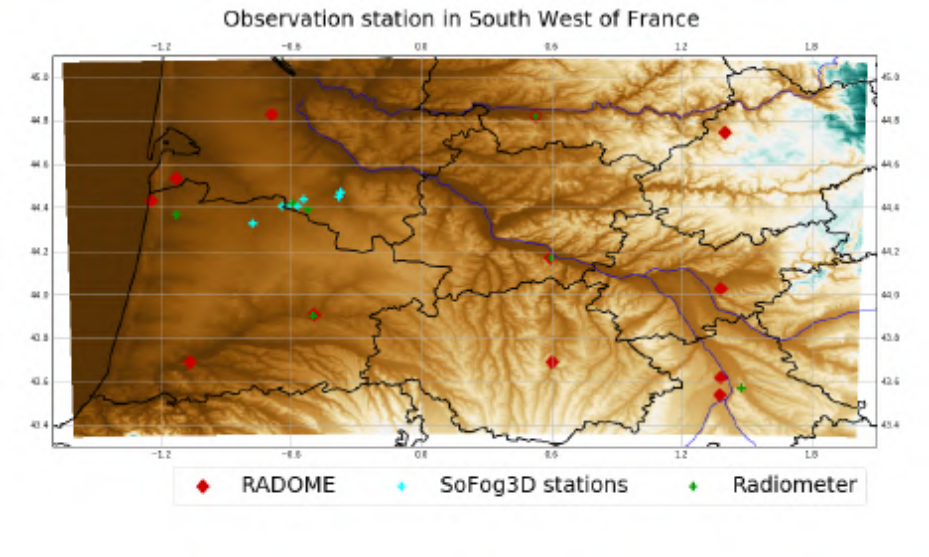
Reference simulation (*1250mL90-REF*) :
1250mL90 grid

ICE3 microphysics

without deposition

Runs start at 0000 UTC for 48h
Focus night : +19 - +36

Small domain on the SW of France



Visibility diagnostic

Historic diagnostic Kunkel, (1984)

$$VISI_{cloud} = \frac{-ln(0.05) * 1000}{(144.7(LWC)^{0.88})}$$

Formulation not adapt in all cases. Too low visibility.

New formulation in liquid phase (formulation used)

$$VISI_{cloud} = \frac{-ln(0.05)}{(a_0 * LWC^b * exp(a_1 * ln(LWC)^2) * exp(a_2 * ln(LWC)^3))}$$

with $a_0 = 0.07649$, b $= 0.92246$, $a_1 = 0.15602$ and $a_2 = 0.01937$.

Contents

- **Statistical evaluation of AROME**
- Aerosol initialisation in LIMA
- False alarms during SoFog3D IOPs

Statistical evaluation of AROME

Statistical evaluation of reference simulation

- Under estimation of fog events early in the night
- Delay at the fog dissipation in the morning
- Fogs too thick
- Fog with too much water content, impact visibility

How to improve fog forecast ?

How to improve fog forecast ?

Model grid modification

From

1250mL90 first level at 5 m

To

500mL156 first level at à 1 m

- More fog events forecast

+ Decrease of under estimations of fog events at the beginning of the night

How to improve fog forecast ?

A missing physical process : deposition

Take account of the deposition term : should reduce liquid water content over estimation in fog (Mazoyer 2016, Zhang et al. 2014)

\+ Decrease visibility bias, less water content in fog

More important impact on 1250L90 grid (due to first model level height)

How to improve fog forecast ?

A new microphysical scheme

ICE3 (1 moment) vs LIMA (2 moment Vié et al. (2016))

+/- More fog events forecast with LIMA

\+ Decrease visibility bias - Less water content in LIMA fogs than in ICE3 fogs

\+ Reduce fog dissipation delay on morning

How to improve fog forecast ?

Fix value of droplet concentration in ICE3

Unrealistic fix droplet concentration in ICE3 - 300 cm^{-3} (ref) replaced by More realistic values (1250L90) : 100 cm^{-3} and 50 cm^{-3}

- Decrease the number of fog forecast events (1250mL90)

How to improve fog forecast ?

Article submitted in Weather and Forecasting
Influence of microphysical parameterizations on high resolution forecast of fog events. Salomé Antoine, Rachel Honnert, Yann Seity, Ingrid Dombrowski-Etchevers, Olivier Mestre, Benoît Vié, Frédéric Brunet

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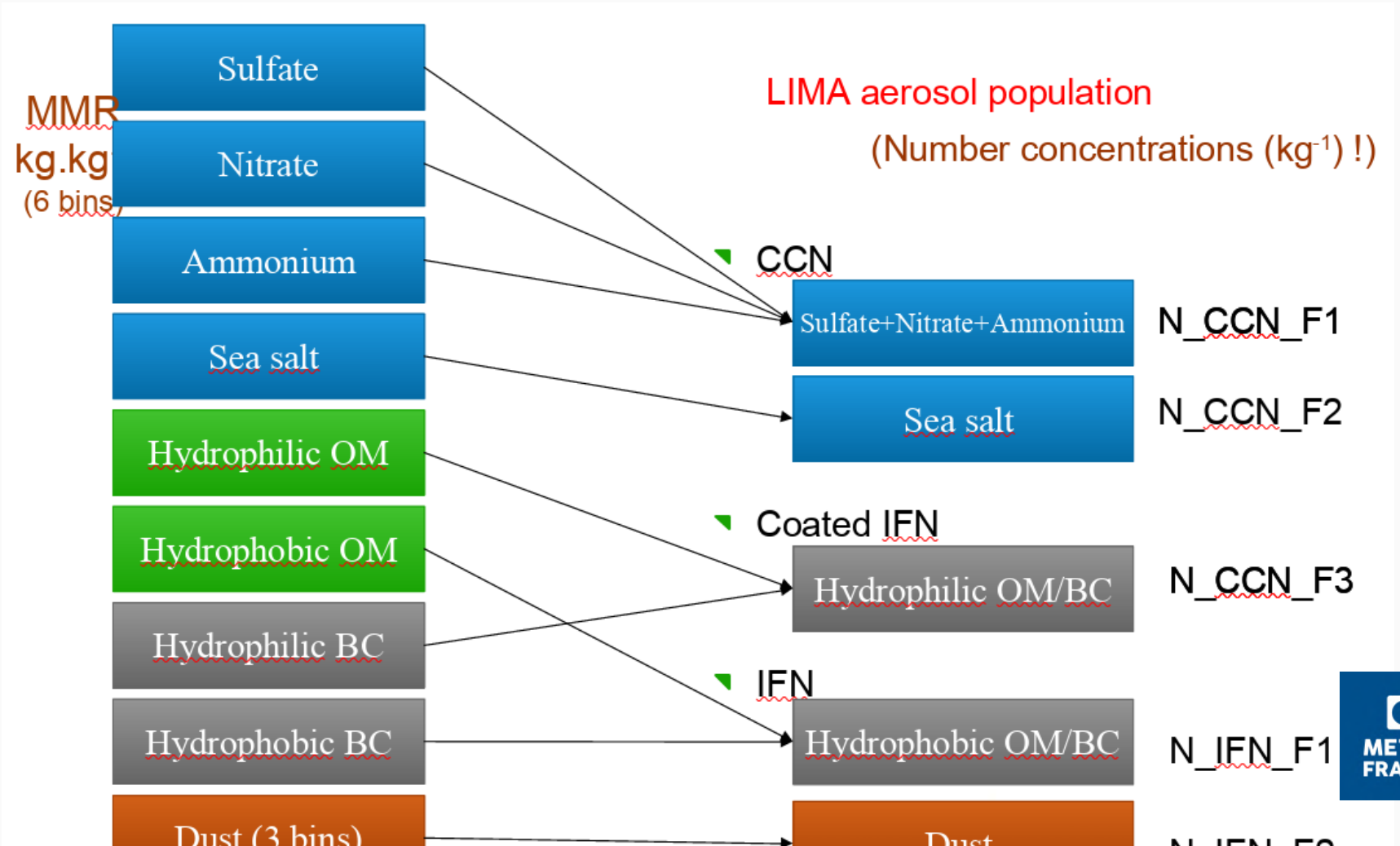
Aerosol initialisation in LIMA

Reference LIMA : aerosol initialization with a constant value 300 cm^{-3}

MOCAGE/CAMS : chemistry forecast model, more realist initialization



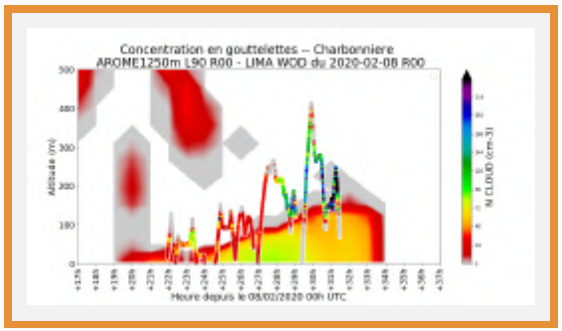
Aerosol initialisation in LIMA

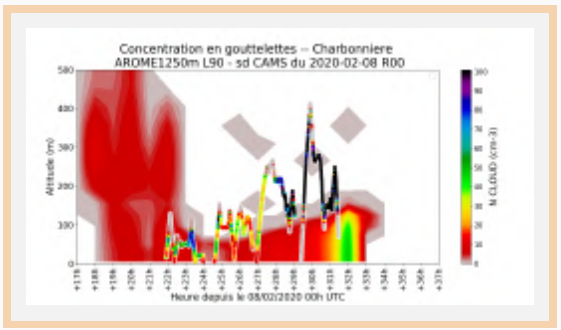
IOP-11 – 8^{th} to 9^{th} /02/2020

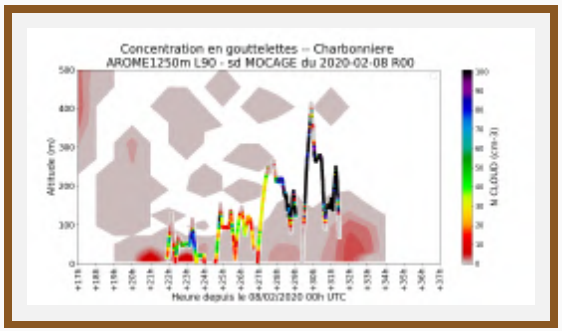
Forecast and observed droplets concentrations

Droplet concentration decreases

LIMA | LIMA CAMS | LIMA MOCAGE



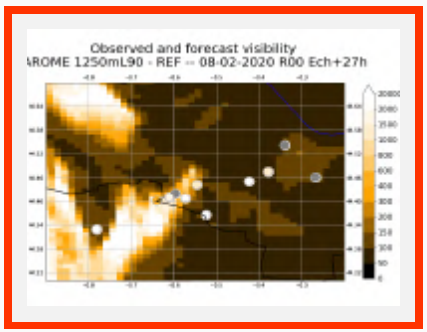


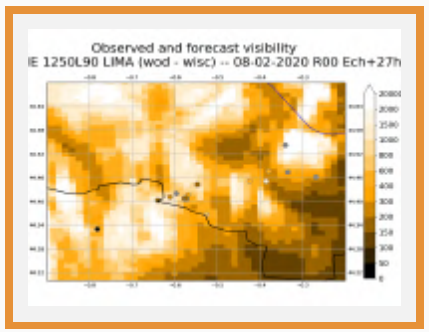


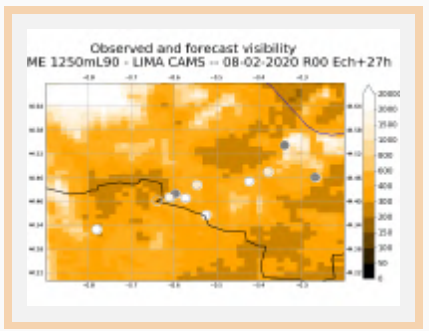
Forecast and observed visibility

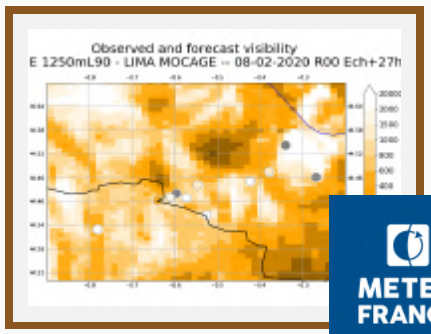
Visibility increases

ICE3 = OPER | LIMA | LIMA CAMS | LIMA MOCAGE









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Aerosol initialisation in LIMA

6 months MOCAGE statistics

Hours since 00h : +25h à +30h

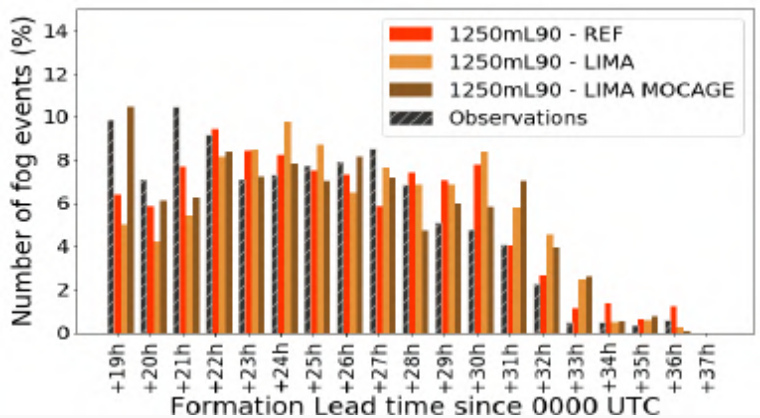
			CSI	TD (%)	TFA (%)	FBI	BIAS (m)
1250L90	LIMA	300 cm^{-3}	0.36	52	47	0.97	86.11
1250L90	LIMA	MOCAGE	0.35	57	**53**	**1.21**	**50.20**
1250L90	LIMA WID	300cm^{-3}	0.33	46	46	0.86	53.66
1250L90	LIMA WID	MOCAGE	0.33	53	**54**	**1.14**	39.67

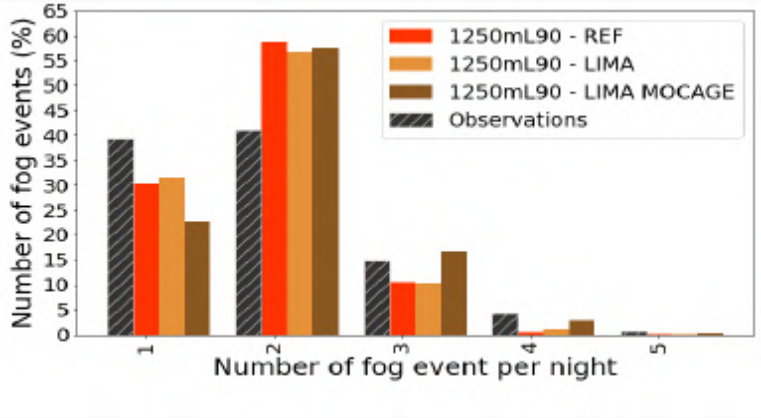
\+ Visibility bias improvement

\+/- More fog events forecast with MOCAGE and more False Alarm

Aerosol initialisation in LIMA

6 months MOCAGE statistics



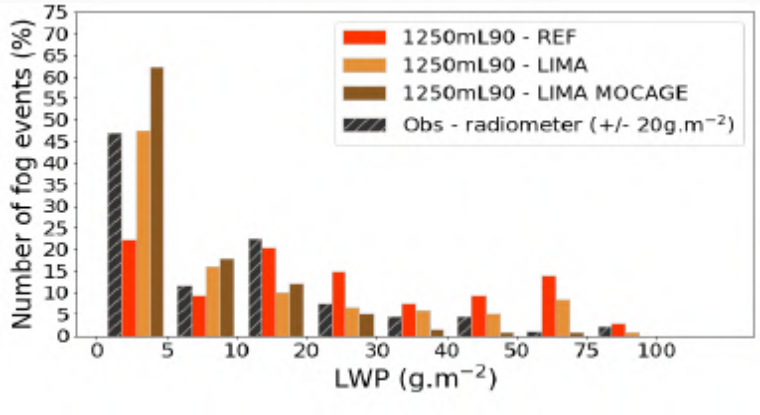


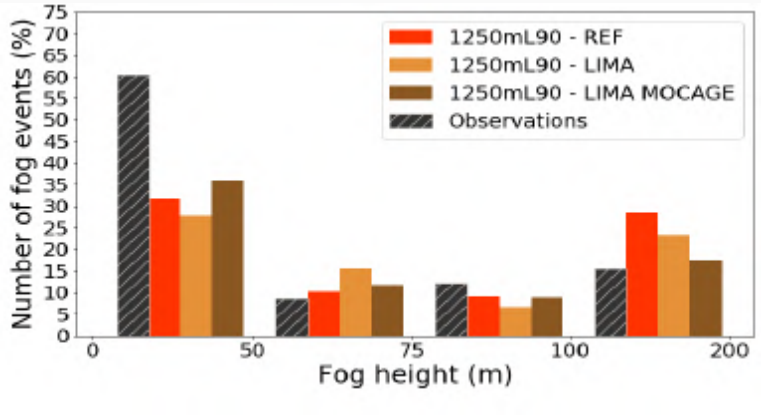
+ under-estimation of fog events on the beginning of the night is reduced

+ + Number of fog events forecast per night is improved, until 4 and 5 events on one nights

Aerosol initialisation in LIMA

6 months MOCAGE statistics





+/- Number of weak LWP fogs increased

\+ \+ Number of thin fogs increased

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False Alarms during SoFog3D

Common felling during IOPs of SoFog3D

Too much fog forecast by AROME,

- Fogs too thick
- Fogs too spread out
- Fogs with too much water content ...

False Alarms during SoFog3D IOPs

False alarms / overestimated fogs could be separated in 2 types

(1) No fog / Thin fog observed due to **Stratocumulus clouds** (IOP-2.1, IOP-2.2, IOP-2.3, IOP-3.1, IOP-6.1, IOP-7.1, IOP-13.1, IOP-13.2, IOP-15.1)

(2) No fog / Thin fog observed due to **wind** (IOP-3.1, IOP-7.1, IOP-9.2, IOP-12.1)

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False Alarms during SoFog3D – StratoCumulus

Were StratoCumulus clouds forecast by AROME ?

Yes

(5 cases over 9)

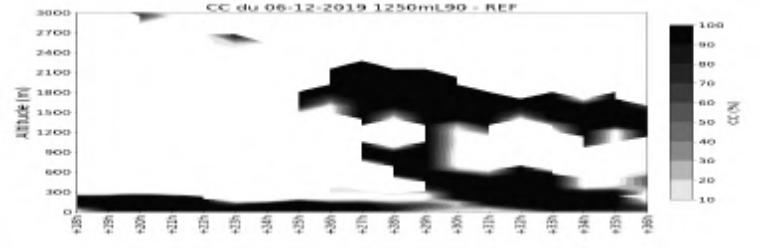
Among the 4 cases without stratocumulus, 2 cases have a combined effect of StratoCumulus and wind

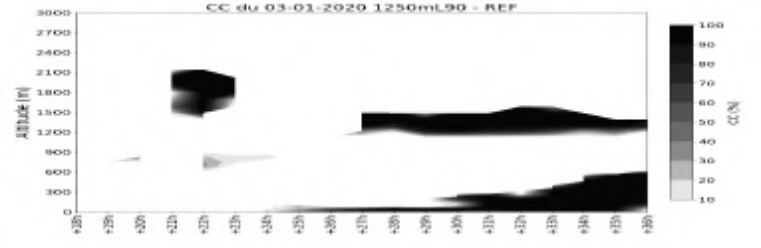
We focused on the 5 cases, where low-level clouds are forecasted by AROME
We wonder in that case, why fog still forms/develops in the model ?

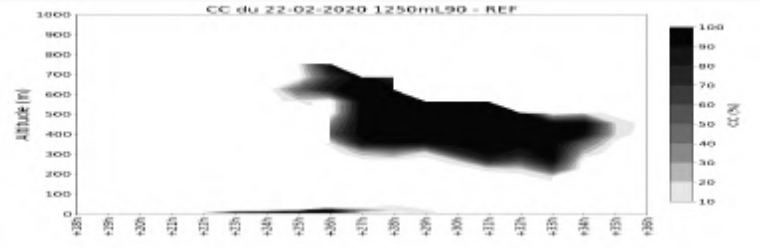
False Alarms during SoFog3D – StratoCumulus

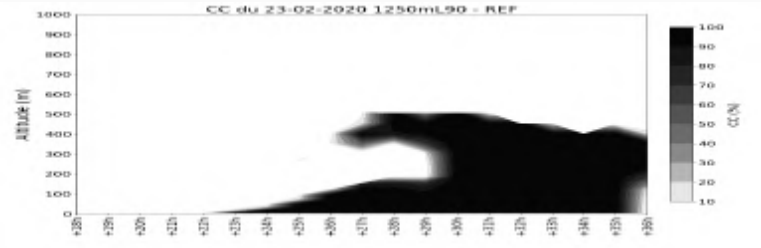
Were forecasted fogs thick ?

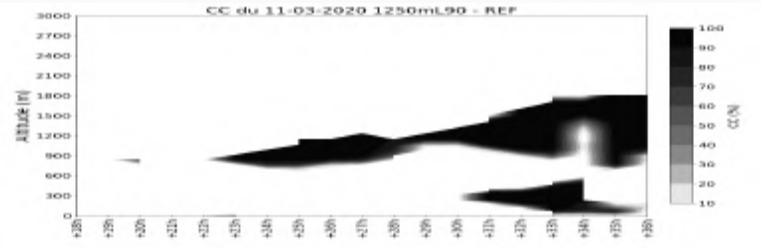
Yes (3 cases over 5)











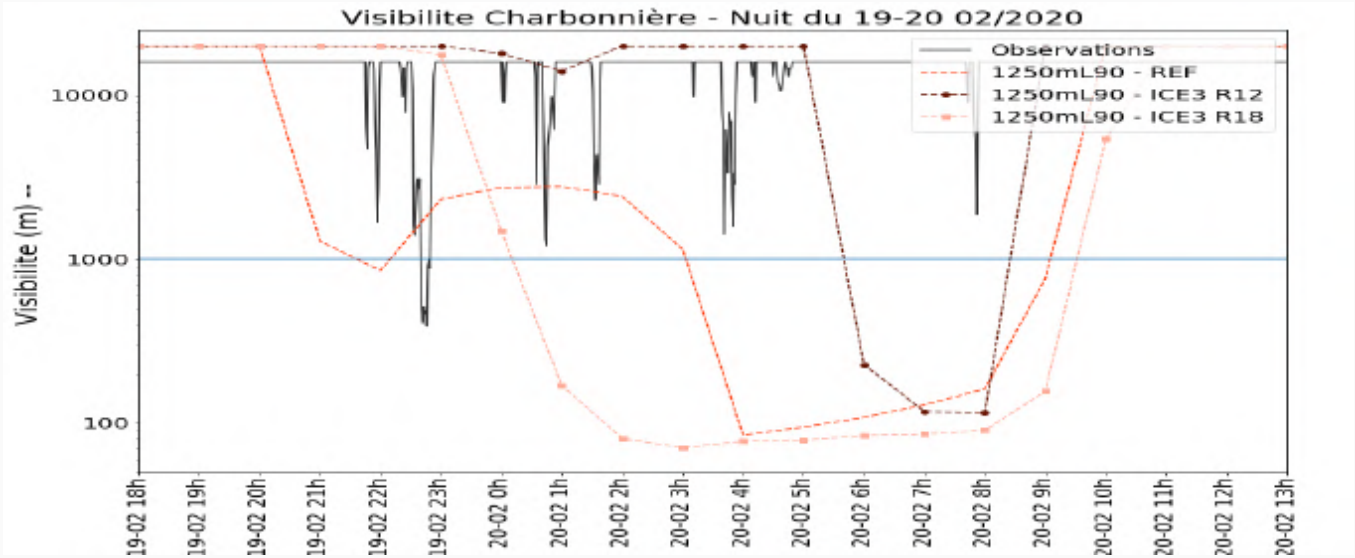
Why does the fog persist under Stratocumulus ?

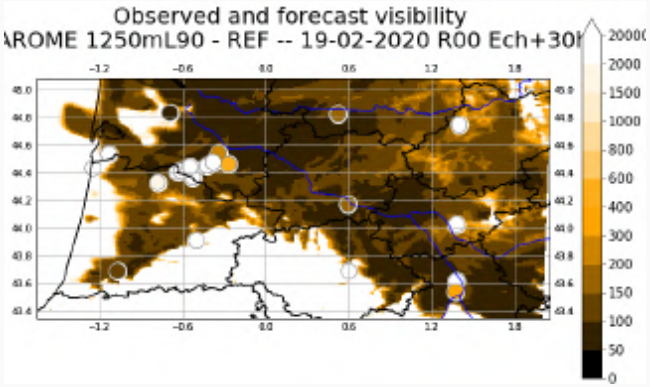
Study in progress, no identified reason yet

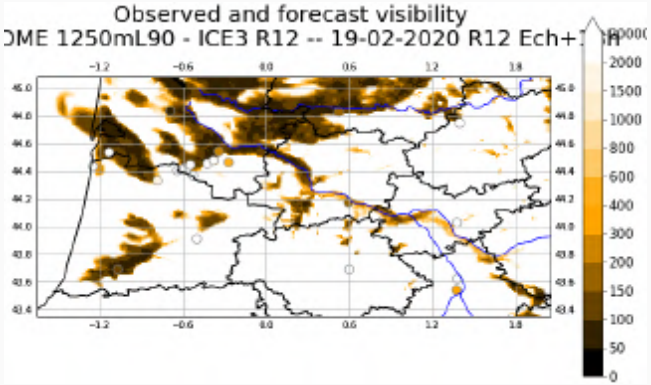
Contents

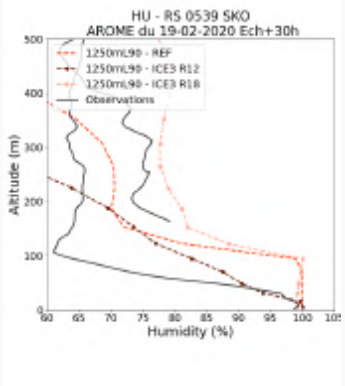
False Alarms during SoFog3D – Wind

IOP-12 – 19^{th} - 20^{th} / 02 /2020







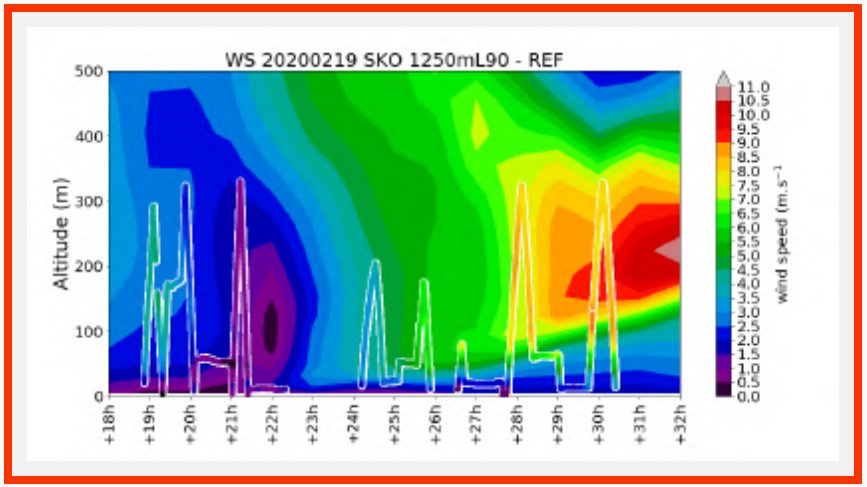


- Too much fog in 1250L90 R00 forecast
- Less fog with 1250L90 R12 forecast

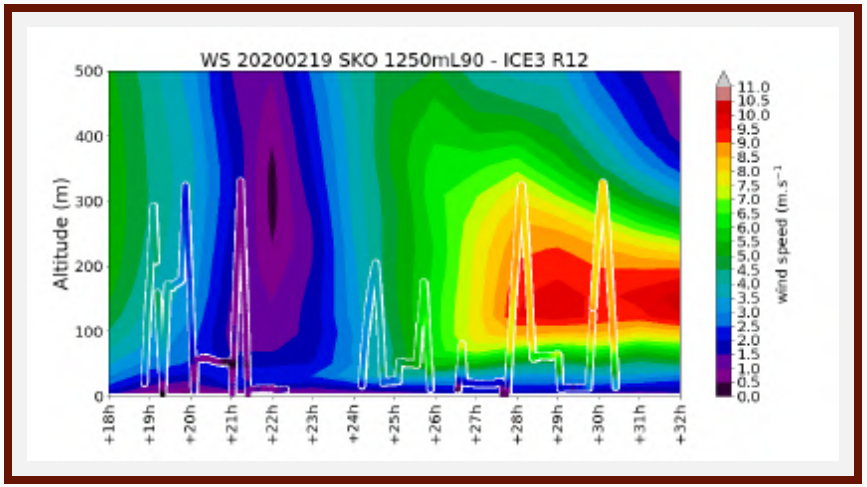
False Alarms during SoFog3D – Wind

IOP-12 – 19^{th} - 20^{th} / 02 /2020

1250mL90 - R00



1250mL90 - R12



- Wind strengthen too late 1250L90 R00
- More correct with 1250L90 R12

Low level wind gets stronger too late in R00. Pb in model large scales conditions ?

Conclusions and outlooks

- Statistic evaluation and different tests have shown potential improvements in AROME-oper forecasts (resolution, microphysics, deposition...).
- Strong impact of aerosols initialisation in LIMA fog forecast
- Two types of false alarms observed during SoFog3D IOPs : due to wind and/or due to Stratocumulus clouds
- In case of Stratocumulus, model often forecasts a stratocumulus above fog : why does the fog persist in the model ?
- In case of wind (IOP-12) : Wind gets stronger too late. Large scales pb ? Is it the same issue with other IOPs with wind ?

Futures works

- Finalize False Alarms case studies
- Test MACC initialisation for the 6 months period
- Test also this initialisation at 500L156
- Change visibility formulation in LIMA (Gultepe et al. 2006, Gultepe et al. 2006)

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Thank you for your attention
Any questions ?

Visibility diagnostic – LIMA

Until an uncertainty on visibility of 50% if prognostic N_c and an diagnostic with only LWC [7]

Possible ways to improve with LIMA : use a combined diagnostic with LWC and N_c :

$$VISI = \frac{c}{(N_c LWC)^d}$$

with	c = 1.002 and d = 0.6473	(Gultepe et al. 2006)
or	c = 1.113 and d = 0.51	(Gultepe et al. 2006)

Under test, no result available for the moment

Références I

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