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Météo Algérie
الديوان الوطني للأرصاد الجوية
Office National de la Météorologie

ACCORD
A Consortium for COnvection-scale modelling Research and Development

NWP Activities at ONM-Algeria

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1. Update of the NWP operational suite

Operational New HPC System: In November 2021,Météo-Algéria was equipped with a new supercomputer called "HPC-Fennec" with a theoretical power of 87 Tflops. In December 2021, the three operational configurations ALADIN, AROME and ALADIN-DUST were deployed to this new supercomputer and the old HPC was recovered for research and development.

The table below summarizes the characteristics of this new computer:

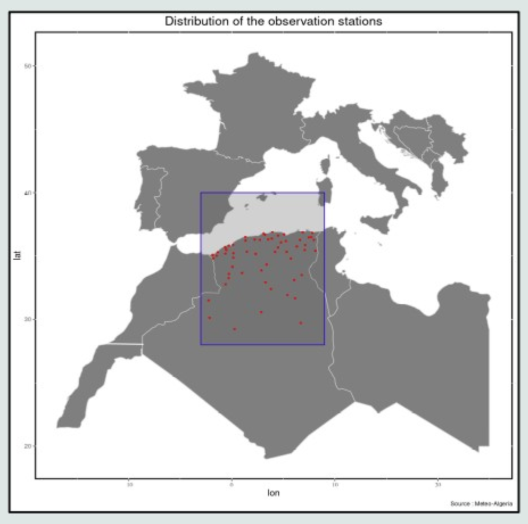
HPC-Fennec Characteristics	Operational	Development
Nodes	20	26
Sockets	20 x (Intel 4316 Silver)	08 x (Intel 4214 Silver)
Number of Cores	40	16
Max Turbo Frequency	3.40 GHz	3.20 GHz
Theoretical performance	87.04 Tflops	9.8 Tflops
Total Theoretical performance	96.84 Tflops	
Real Performance	81.81 Tflops	9.21 Tflops
Total Real Performance	91.02 Tflops	

Algerian HPC-Fennec

Validation of Cy46.T1.bf07: An update of our NWP operational suite based on the export version of cy46t1_bf.07 cycle has been prepared. This update affects :

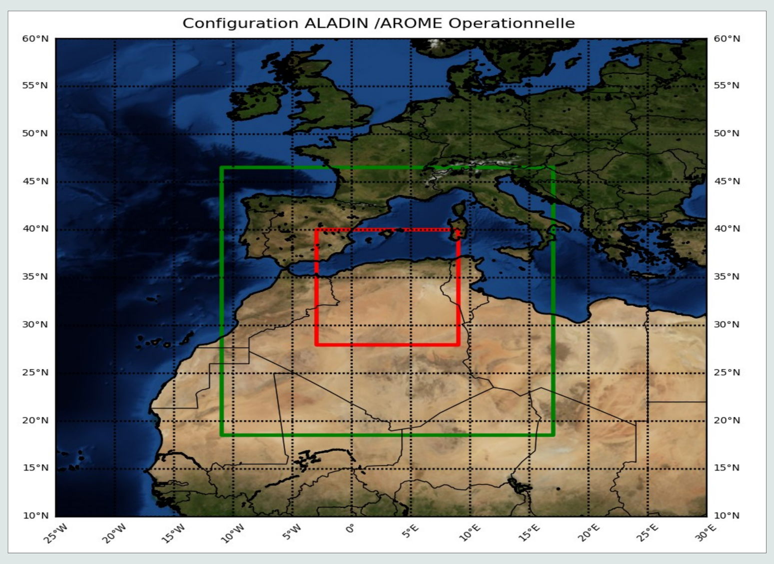
1- Cycle change .
2- Improvement of the horizontal and vertical resolution of AROME.
3- Standardization of post-processing grids.

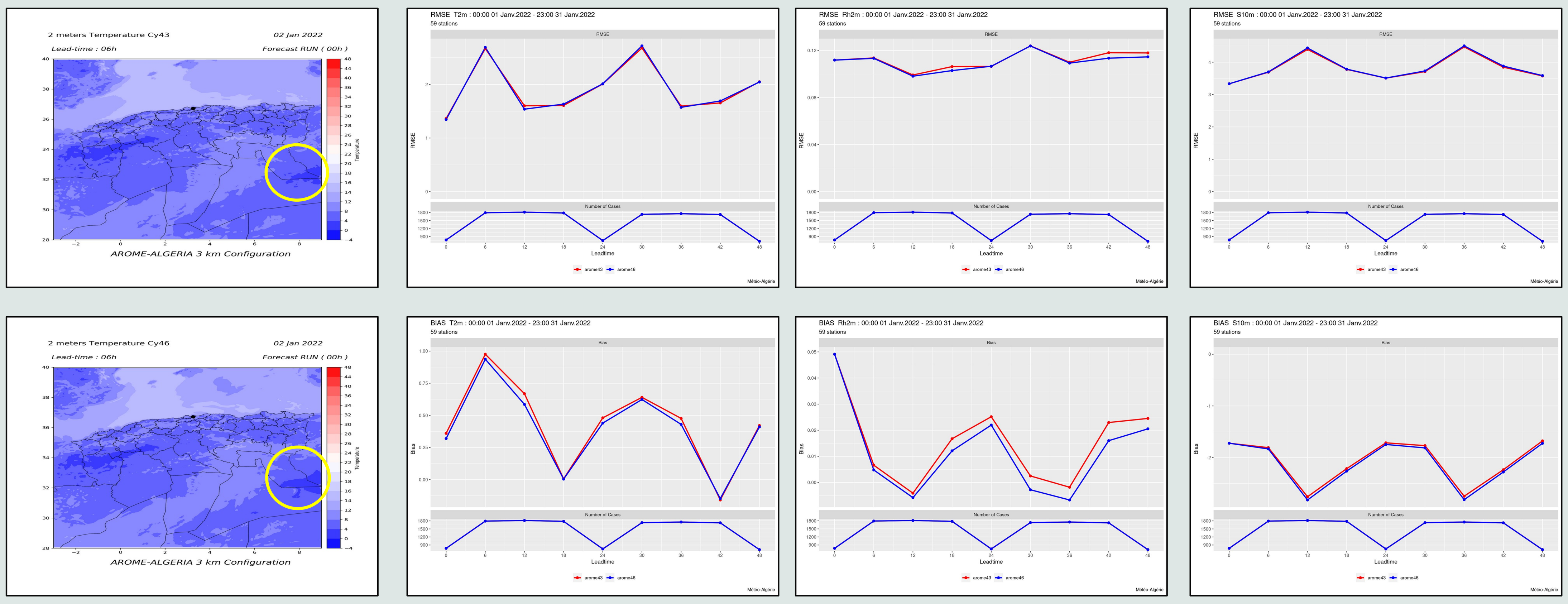
Below are the verification scores against observations obtained by this suite compared to the current suite based on the Cy43t2.bf.10 cycle.
We have used Harp tools to calculate RMSE and Bias of temperature, humidity and wind speed for January 2022.



Operational AROME / ALADIN / ALADIN-DUST configurations:

Models	AROME	ALADIN	ALADIN-DUST
Cycle	Cy46t1.bf.07	Cy46t1.bf.07	Cy46t1.bf.07
Horizontal Resolution	2.5km	6km	14km
Vertical Resolution	90 Lev	70 Lev	70 Lev
Grid	600 x 600	600 x 600	250 x 250
Time Step	60s	514s	420s
Initial conditions	ALADIN	ARPEGE	ARPEGE





2. Scientific Activities

2.1 Testing visibility diagnostics in AROME at high resolution:

Introduction: The main objective of this work has been to test and evaluate new visibility diagnostics fields coded in AROME by Ingrid Etchevers (Dombrowski-Etchevers et al., 2018). In order to take full advantage of the physical parametrization of AROME, two configurations at very high resolution have been prepared: 1.3km and 0.5km resolution.

This new diagnostic is calculated separately due to hydrometeors (precipitation) and clouds (fog) at the height of the lowest model level, which is 5 meters. However, this height could be defined at namelists by the key 'HVISI' :

- If HVISI < 5 meters, visibility will be calculated automatically at the lowest model level.
- If HVISI > 5 meters, visibility will be calculated at the predefined height at namelist.

The visibility computations formulas are coded in the new routine "acvisih.F90" which is directly called from "apl_arome.F90", and are activated by switching-on the key LXVISI in the forecast namelist (LXVISI=.TRUE.). Figure (01) shows the main input required by this routine and the calculated outputs (PVISICLD, PVISIHYD and PMXCLWC).

This new diagnostic was tested and evaluated for a total of 41 days : 28 days for December 2018 and 13 days for May 2018. The situations have been selected based on the METAR observations. For each situation, we performed 24h run starting from the day before the event (j-1).

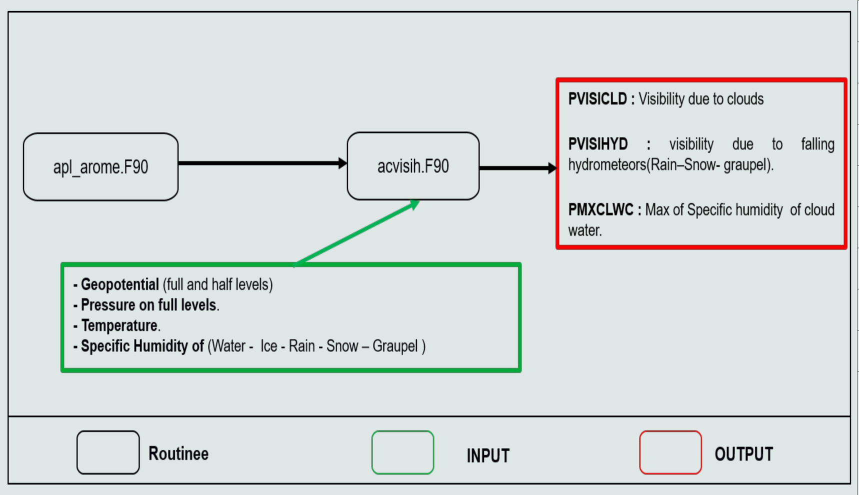


Fig.01: Acvisih outputs and inputs organigram.

Characteristics		AROME 1.3	AROME 0.5
Cycle		CY46T1.bf.06	
Initial conditions		ARPEGE	
Coupling frequency		1H	
Horizontal resolution		1.3 km	0.5 km
levels		90 level	
First level from ground		5 meters	
Time-step		40 s	10 s
Grid		232 x 232	241 x 241
Domain	Center	3.2°E – 36.5°N	
	Latitude	35°N – 38°N	35.9°N – 37.1°N
	Longitude	1.7°E – 4.7°E	2.6°E – 3.8°E

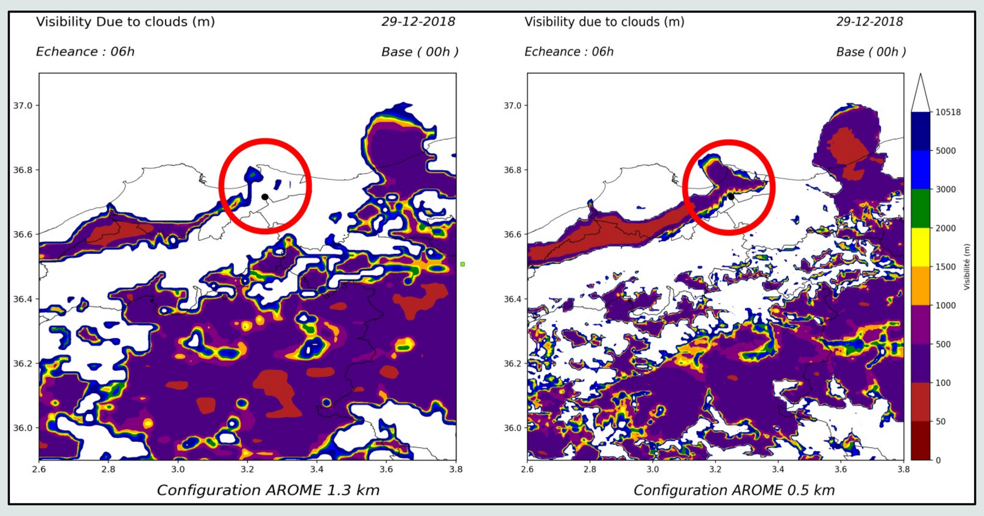
Results and Discussion: The results are very promising for both configurations; the percentage of correct forecasts is quite high: 79% with AROME 1.3km and 77% with AROME 0.5km. In most cases, simulated visibility due to hydrometeors and clouds were in the same categories of the observed visibility from METAR.

The probability of detection of "very bad" and "bad" visibility classes is acceptable but not good enough for both resolutions: 0,47 for AROME 1.3km and 0,53 for AROME 0.5km. It shows that improving the horizontal resolution of AROME from 1.3 km to 0.5km, improved slightly the probability of low visibility conditions forecasts. In terms of seasons, we noticed that this skill score is significantly more important during May than during December. This should be proved by performing simulations for a longer period (a year at least).

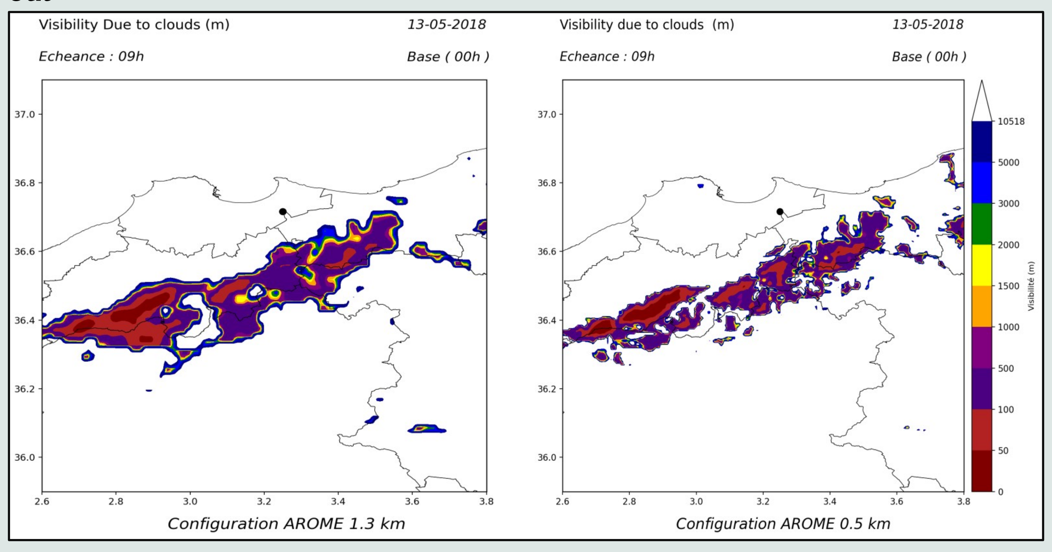
The false alarm ratio score is just acceptable and quite similar for both configurations: 0,54 for AROME 1.3km and 0,55 for AROME 0.5km. It turns out that false alarms are more frequent during December than during May.

	AROME 0.5	AROME 1.3
	All period	
PC	77,29	79,02
POD	0,53	0,47
FAR	0,55	0,54
	December	
PC	79,55	81,19
POD	0,38	0,29
FAR	0,64	0,65
	May	
PC	72,43	74,35
POD	0,71	0,69
FAR	0,46	0,44

Skill scores calculated for AROME 1.3 km and AROME 0.5 km.



Comparison of visibility due to clouds simulated by AROME 1.3km and AROME 0.5km on 29 December 2018 at 06utc.



Comparison of visibility due to clouds simulated by AROME 1.3km and AROME 0.5km on 13 May 2018 at 09utc.

2.2 Coupling LIMA-Aerosol-CAMS:

Introduction: The impact of aerosols on climate and the mechanism of its interactions have been widely discussed. In microphysics, aerosols could act as cloud condensation nuclei (CCN) and/or as ice freezing nuclei (IFN). LIMA (Liquid Ice Multiple Aerosols) is a two moment microphysical scheme which inserted into the Meso-NH model to improve the complex aerosol–cloud interactions modeling (B. Vié et al.,2016). This scheme has been implemented in AROME model since cy42t1 cycle (Viktória Homonnai, 2016). In 2019, during his scientific stay at Météo France, A. Ambar has managed to achieve the offline coupling of LIMA scheme with desert dust in AROME (A .Ambar, 2019). But problems were encountered for online coupling of LIMA and desert dust schemes. Solving this problem was one of the objectives of Mr. Mokhtari's scientific stay at Météo France in June 2022. effectively, Mr. Mokhtari had succeeded in solving these problems related to the code and these are presented here some results of the two simulations carried out:

1- The first simulation is an interactive online coupling of LIMA with dust schemes. Here, the IFNs LIMA variables are provided by the coarse and medium modes of desert dust, calculated by dust scheme at each time step.

2- In the second simulation, all related LIMA variables (IFN and CCN) are provided by CAMS aerosol fields every three hours.

The results of these two simulations were compared to ICE3 scheme simulations (reference).

The convective situation over Sahara that occurred on March 12th, 2021 has been chosen. It was characterized by severe dust storm and rainfall as shown by satellite image (Fig.01). The precipitations amount and the AOD values were nicely simulated by AROME over this region (Fig.02). Vertical sections are calculated along the parallel 27° north, while the vertical profiles are averaged over the red area as indicated in figure 02. Are presented here the vertical sections of ice crystal and snow fields simulated by AROME with Lima-dust and Lima-CAMS and compared with ICE3 scheme.

Conclusion: The confusion between LIMA fields and dust aerosols has been solved: now it is possible to perform AROME simulations by activating simultaneously the LIMA scheme with desert dust processes. Also, we succeeded to make an online post-processing of all the LIMA variables and those of the dust. We have also noticed that the order of magnitude of the fields is quite reasonable and consistent. Further investigation about the inter-comparison between the LIMA simulations with DUST and LIMA with CAMS will be made later in order to better understand the impact of aerosols fields on microphysics.

Results and Discussion:

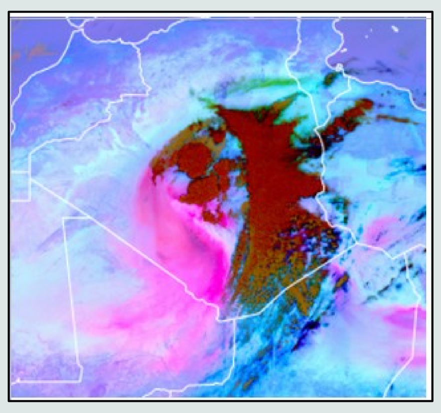


Fig.01: Satellite image of dust plumes for March 12th, 2021 at 15h UTC.

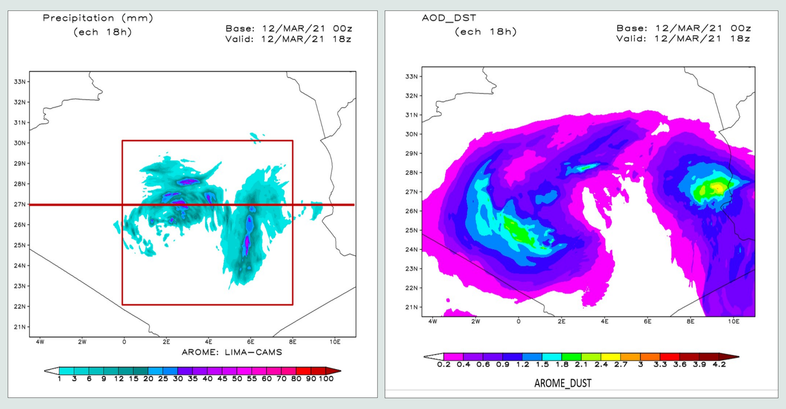


Fig.02: Total precipitations (at left) and AOD (at right) simulated by AROME for March 12th, 2021 at 18h UTC.

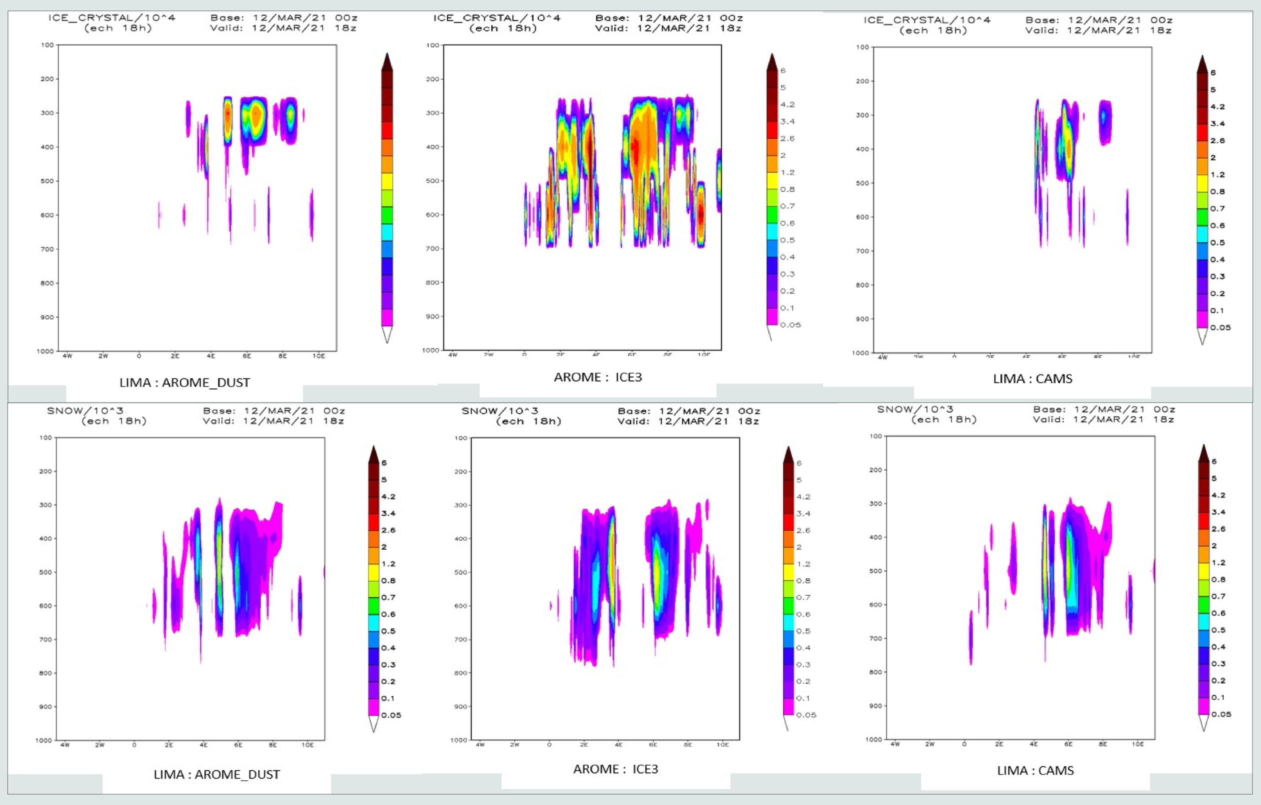


Fig.03: Vertical sections of hydrometeor fields simulated by AROME at 18h UT with: LIMA-Dust, ICE3 and LIMA-CAMS.

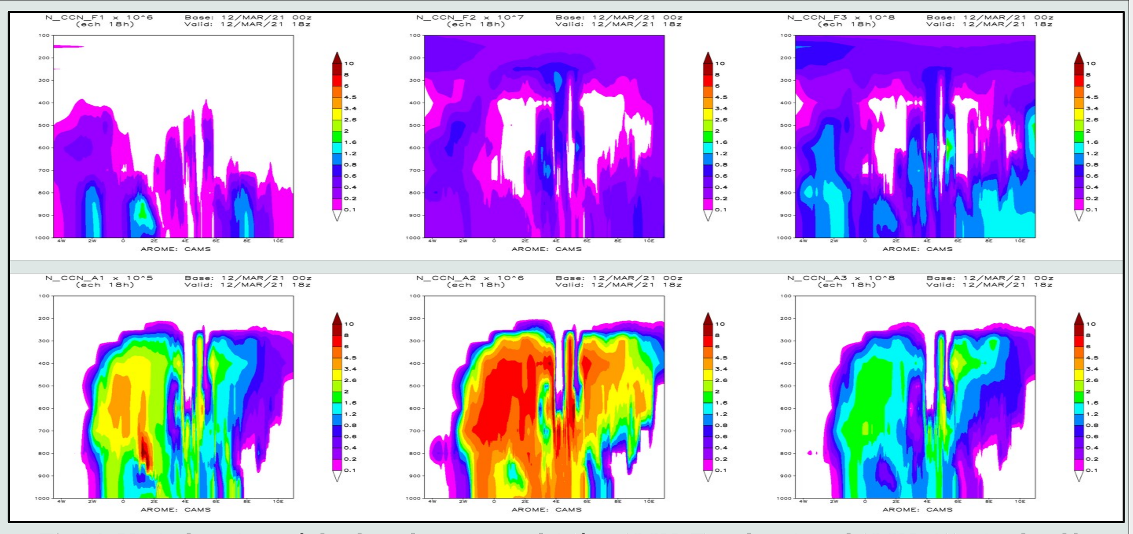


Fig.04: Vertical sections of cloud condensation nuclei (free (CCN_F) and activated (CCN_A)), simulated by AROME at 18h UT with LIMA-CAMS

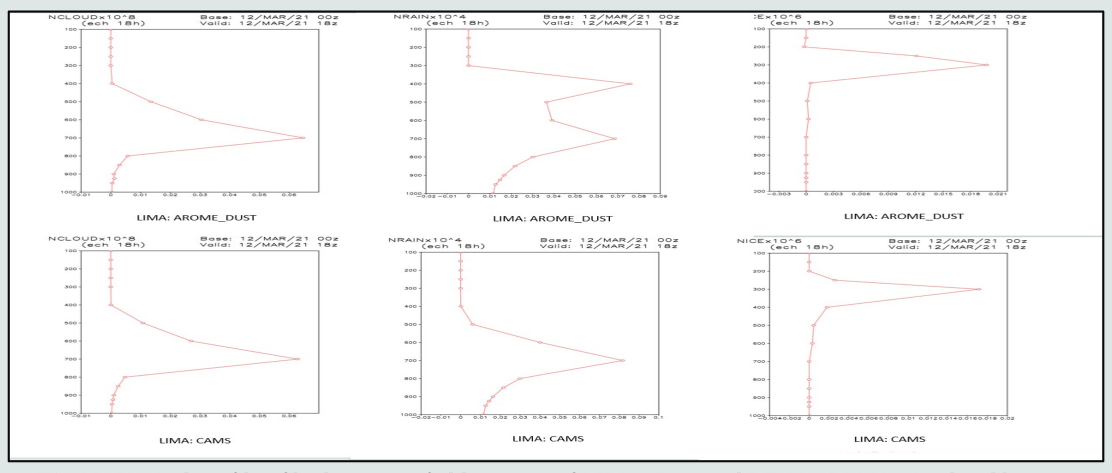


Fig.05: Vertical profile of hydrometeor fields in case of LIMA_Dust and LIMA_CAMS, simulated by AROME at 18h UT.

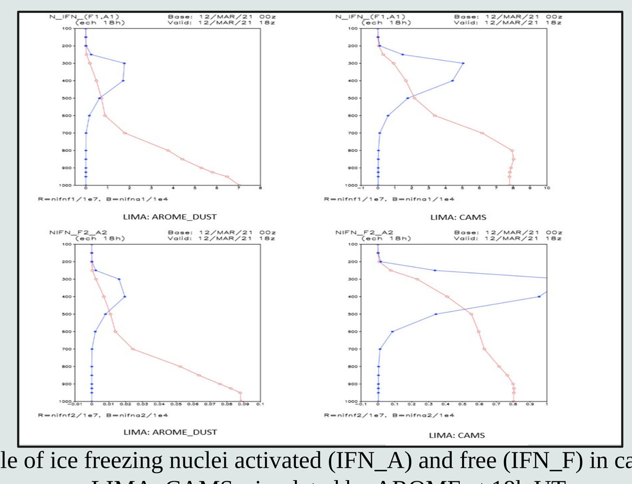


Fig.06: Vertical profile of ice freezing nuclei activated (IFN_A) and free (IFN_F) in case of LIMA_DUST and LIMA_CAMS, simulated by AROME at 18h UT.

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Vié, B., Pinty, J.P., Berthet, S., and Leriche, M. M.: LIMA (v1.0): A quasi two moment microphysical scheme driven by a multimodal population of cloud condensation and ice freezing nuclei, Geosci. Model Dev., 9, 567 586, doi:10.5194/gmd 9 567 2016, 2016.

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