Recent progress in ARPEGE and AROME physics

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September 30th 2021, 43rd EWGLAM and 28th SRNWP Meeting

Outline :

- Current e-suite (2021) :

  - ARPEGE
  - AROME

- Plans for next e-suite (2022)

  -ARPEGE
  -AROME

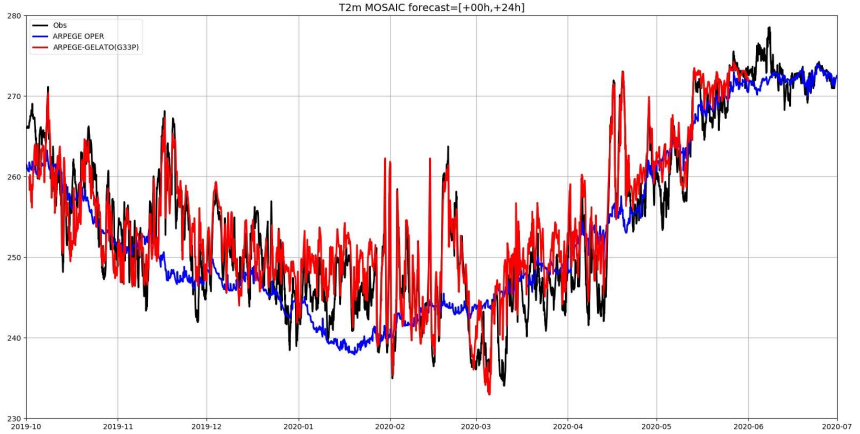
- For longer terms

  - AROME-500m for PARIS 2024
  - LIMA microphysics (SoFog 3D and convective cases)

Arpege physics evolution for cy46t1_op1 e_suite

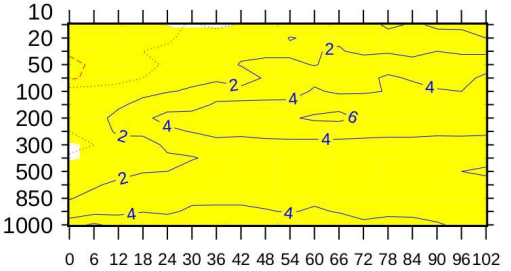
- *Implementation and tuning of the IFS deep convection scheme*
- *Use of RRTM shortwave (SRTM) radiation scheme and activation of McIca solver*
- *Use of a new version of the sea surface flux scheme ECUME*
- *Activation of the 1D sea ice scheme GELATO*

Temperature along the « polarstern » trajectory : observation (black), Arpege oper (blue) and Arpege + Gelato (red)

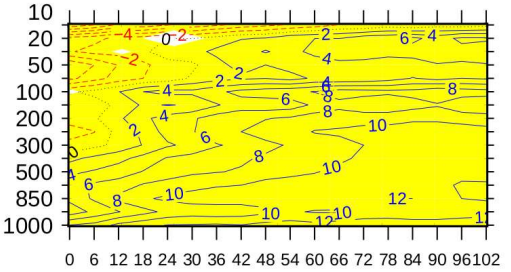


Normalized wind score (%)

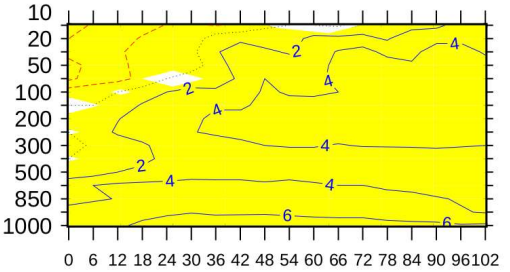
North 20

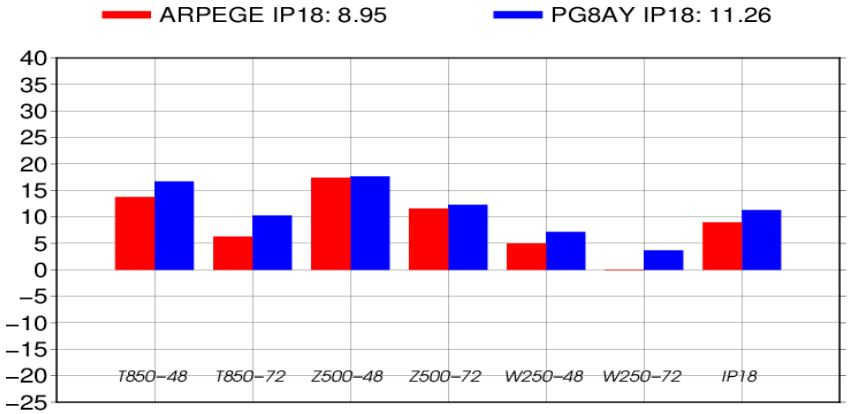


Tropic



South 20

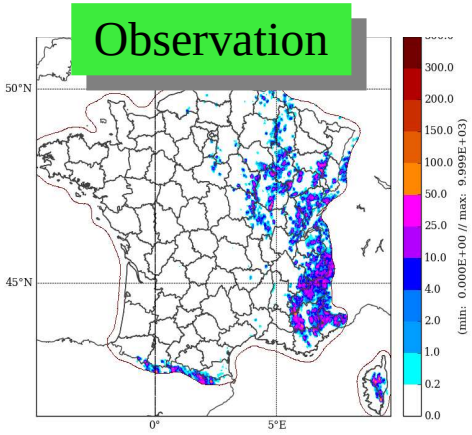


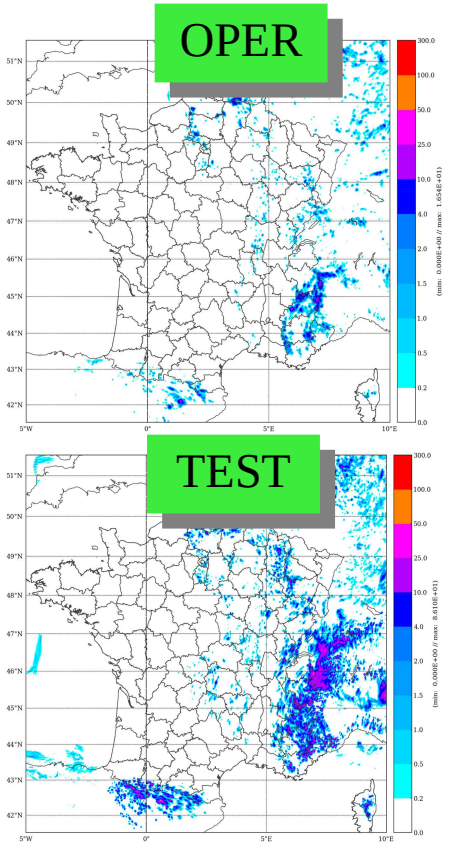


IP18 indicator over a period of 230 days

AROME e-suite in CY46t1-op1 (Physics part)

- New tuning of numerical diffusion with the use of more conservative SL interpolators

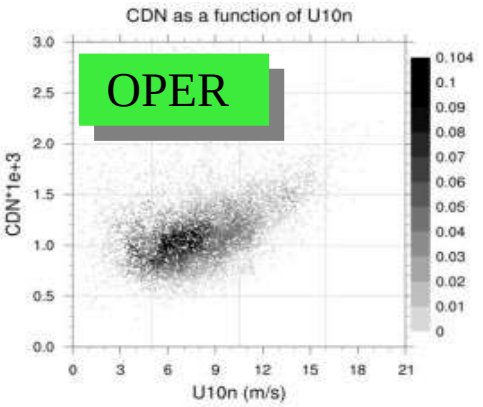


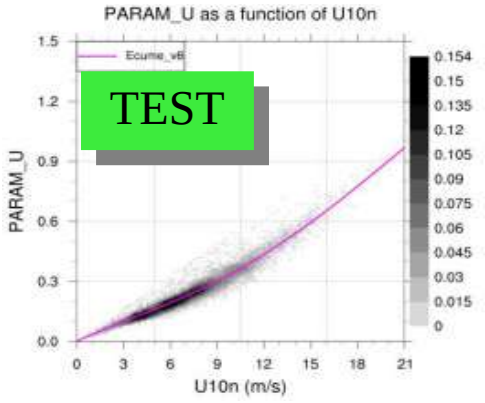


→ Improve rain forecasts in weakly forced diurnal convection cases

- New version of ECUME sea-flux parametrisation

$$Param\_U = \left(\frac{C_{dn}}{\sqrt{C_{dn}}}\right) X \Delta U_{10m}$$





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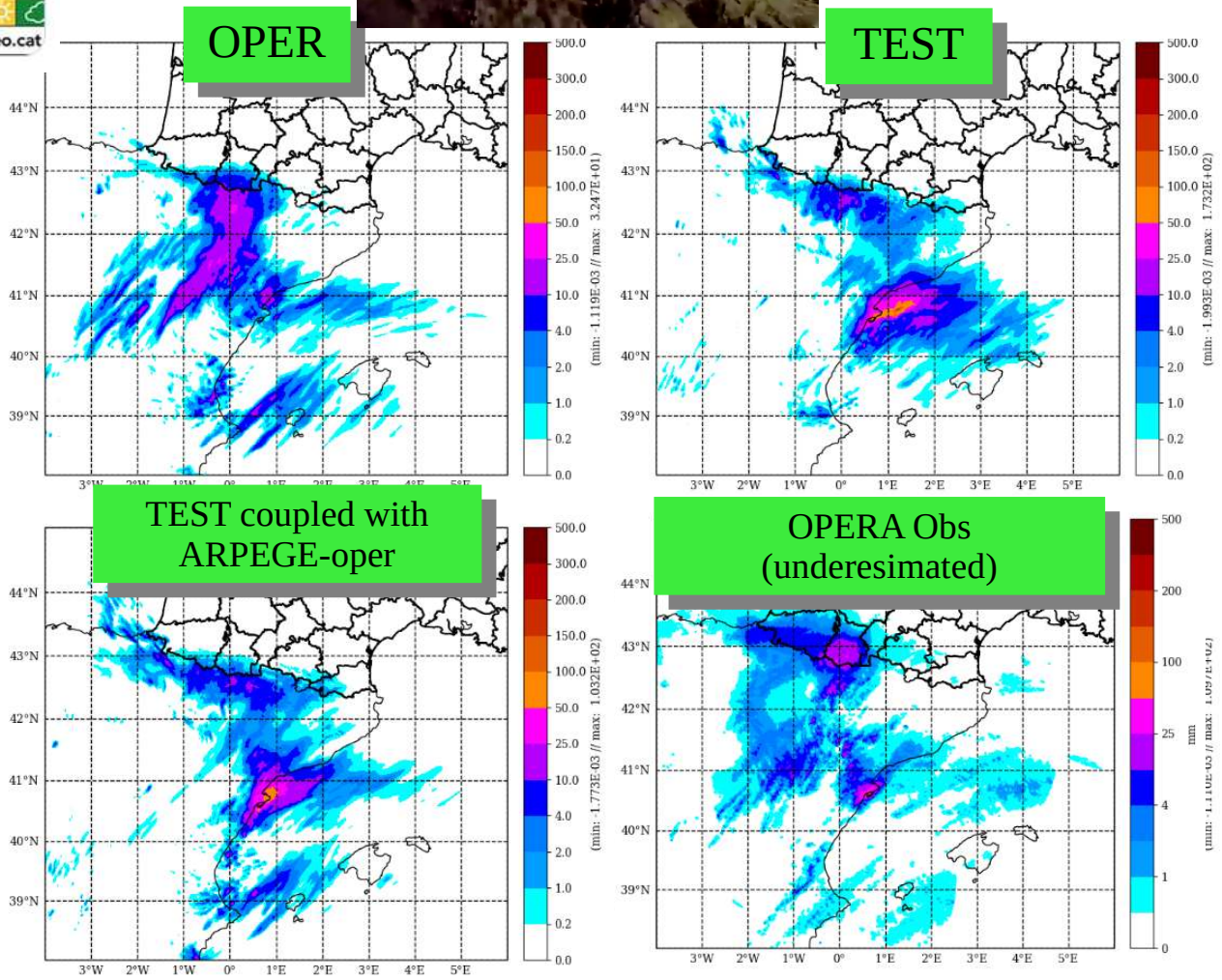
Convective case example (stationary thunderstorm in Catalunya 1st September 2021):

Estació	Comarca	Precipitació acumulada	Precipitació màxima en 30 minuts	Precipitació màxima en 1 minut
Alcanar	Montsià	216.6	77.7	4.0
els Alfacs	Montsià	105.2	51.5	4.4
Amposta	Montsià	58.4	15.8	0.9
Ulldecona - els Valentins	Montsià	33.3	15.0	1.7
Illa de Buda	Montsià	29.7	16.9	1.8
l'Aldea	Baix Ebre	26.6	6.6	0.7
PN dels Ports	Baix Ebre	26.4	7.3	0.8

Precipitació recollida per les estacions de la XEMA el dia 01/09/2021 fins a les 14 h

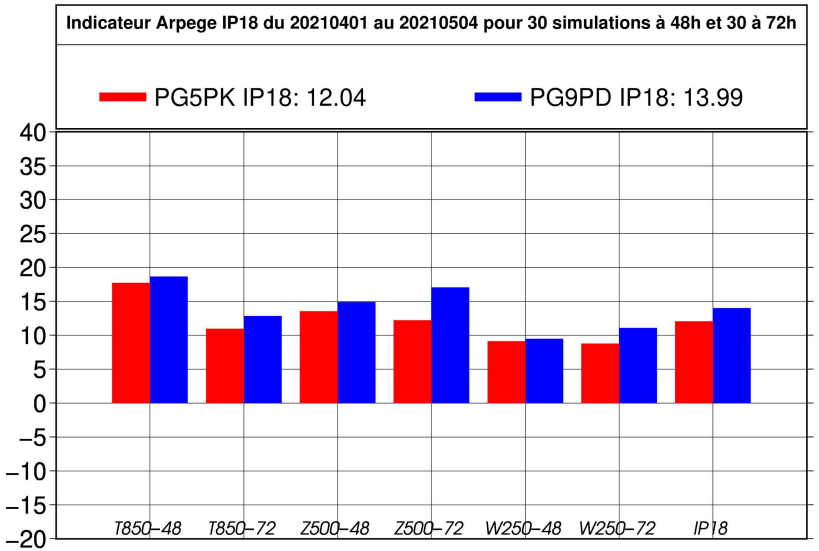
meteo.cat



- OPERA underestimation
- TEST better than OPER
- Due to AROME specific modifications

Arpege physics perspectives (for 2022 e-suite in cy48t1)

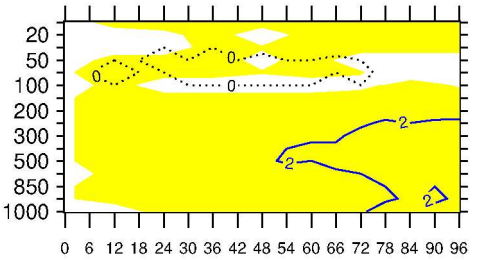
- *Use of the new EcRad radiation scheme but still with McIca solver*
- *New version of the IFS deep convection scheme (new closure and limitation of overshoot)*
- *Prognostic convective microphysics (PCMT like approach)*
- *Activation of Flake scheme*
- *Works on linear physics, especialy convection*



Impact of EcRad over cy46t1 e-suite with some cloud tuning

Normalized wind score (%)

North 20



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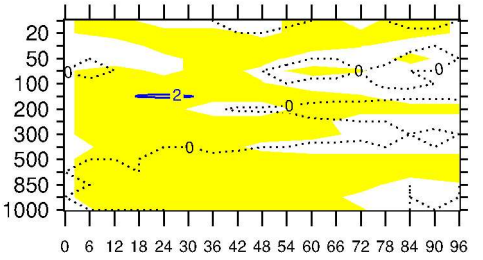
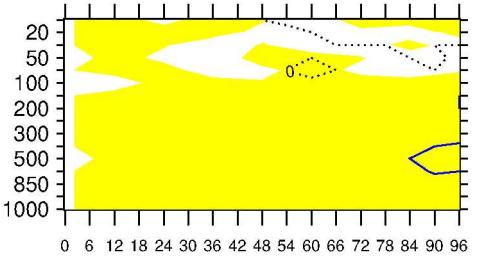


South 20



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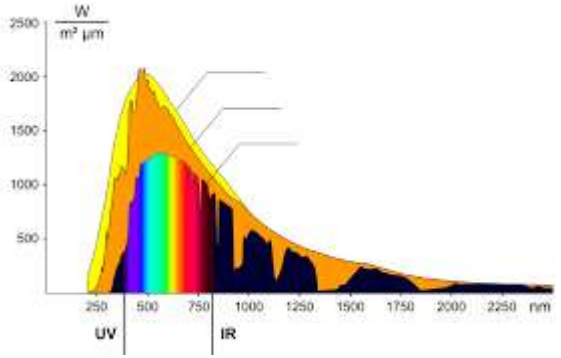
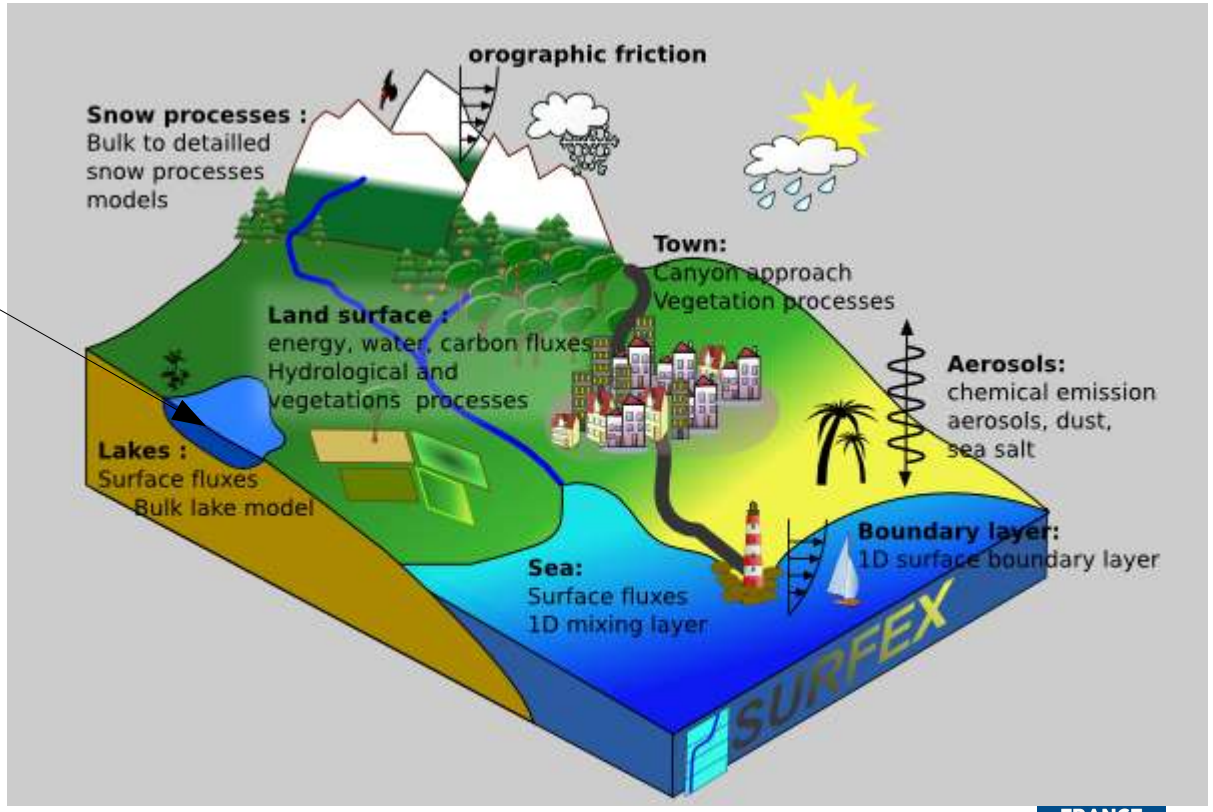
AROME perspectives for next e-suite (CY48T1_op1 in 2022)

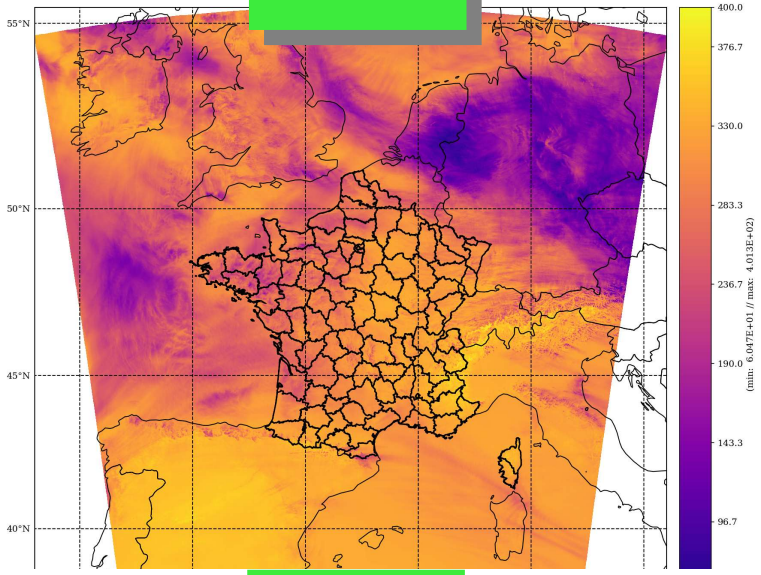


- EcRad radiation scheme
- Flake
- Modifications for low clouds over sea

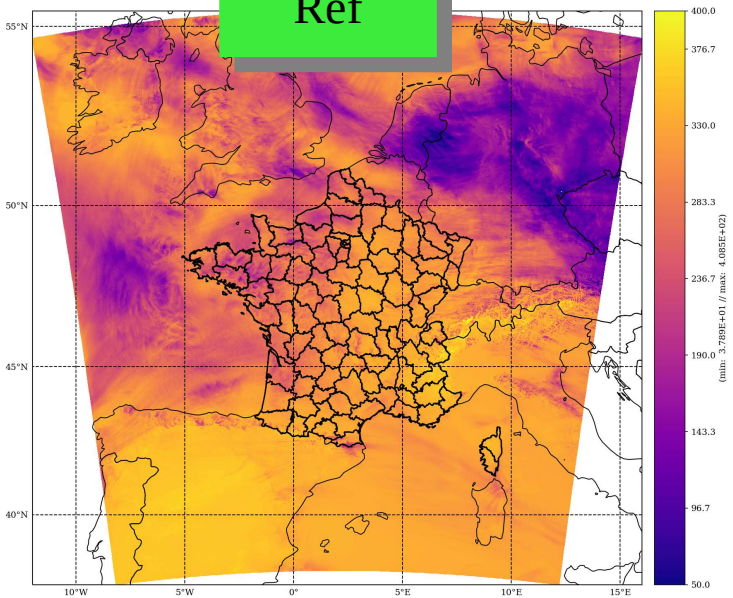


First results / impact : EcRad / Oper : 1st July 2021

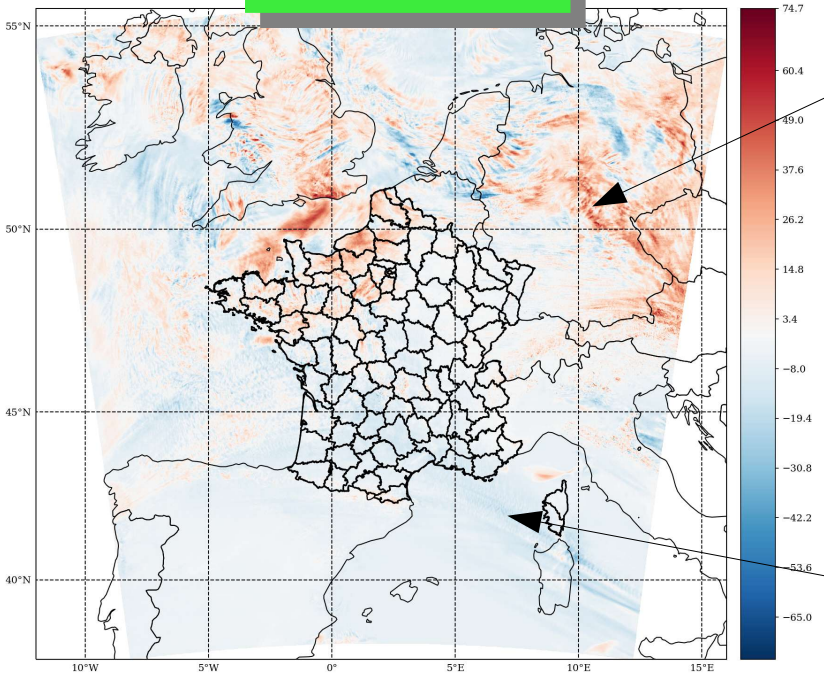
EcRad



Ref



EcRad-Ref

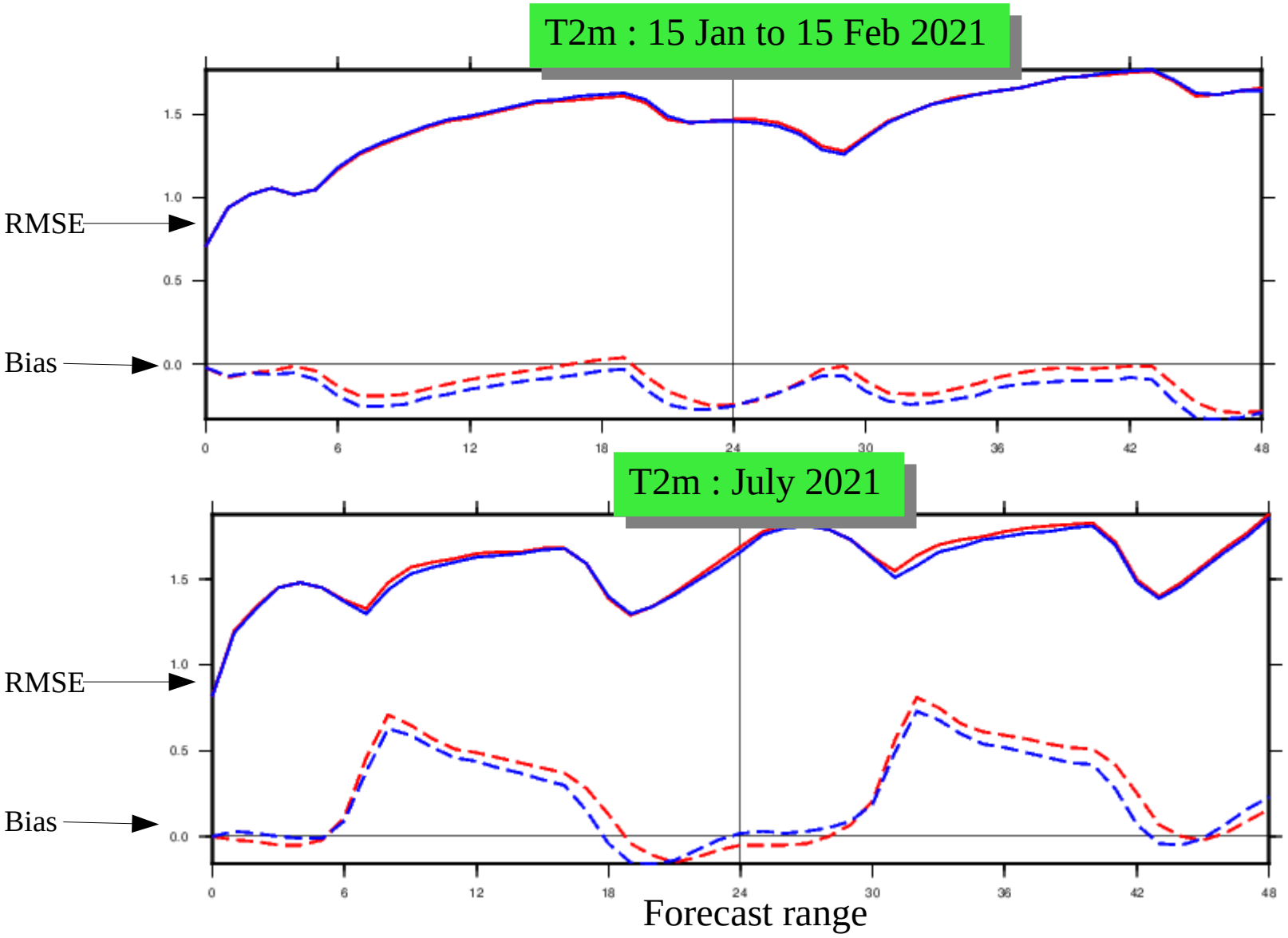


Low clouds

cirrus clouds

→ ± 70w/m² on +24 averaged SW Down

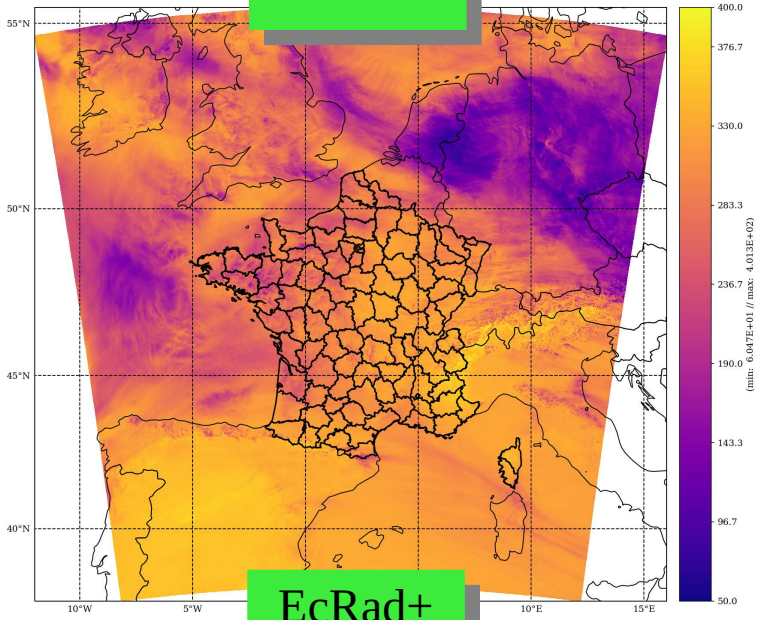
First results / impact : EcRad versus Oper



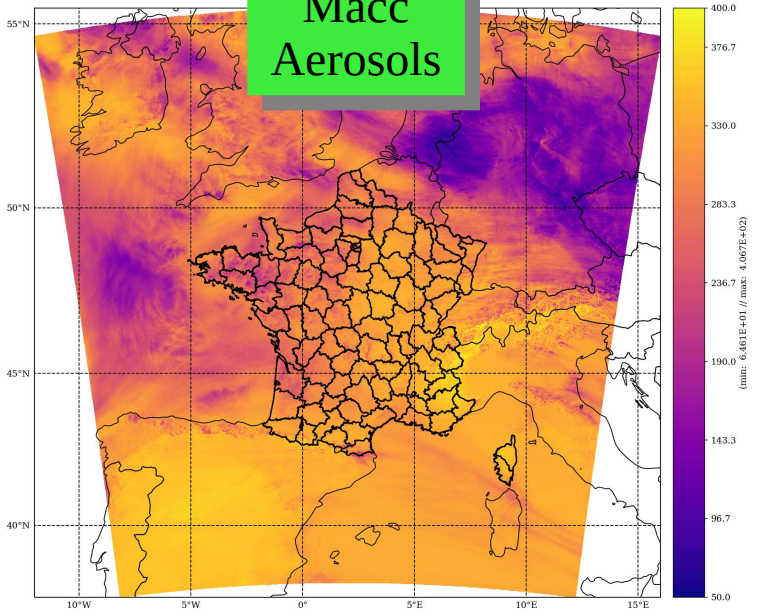
→ EcRad scores close to Oper

First results / impact : EcRad+MACCAERO / EcRad

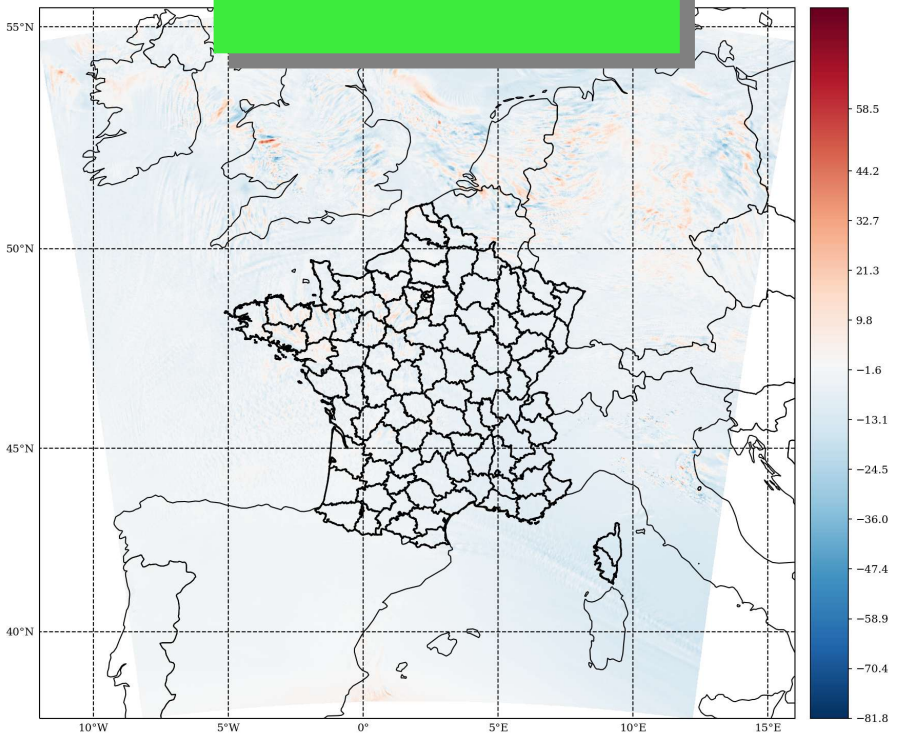
EcRad



EcRad+ Macc Aerosols



EcRad - EcRad+MACC Aero



→ reduced SWd surface flux with MACC aerosols climatologies compared to Tegen aerosols used in oper.

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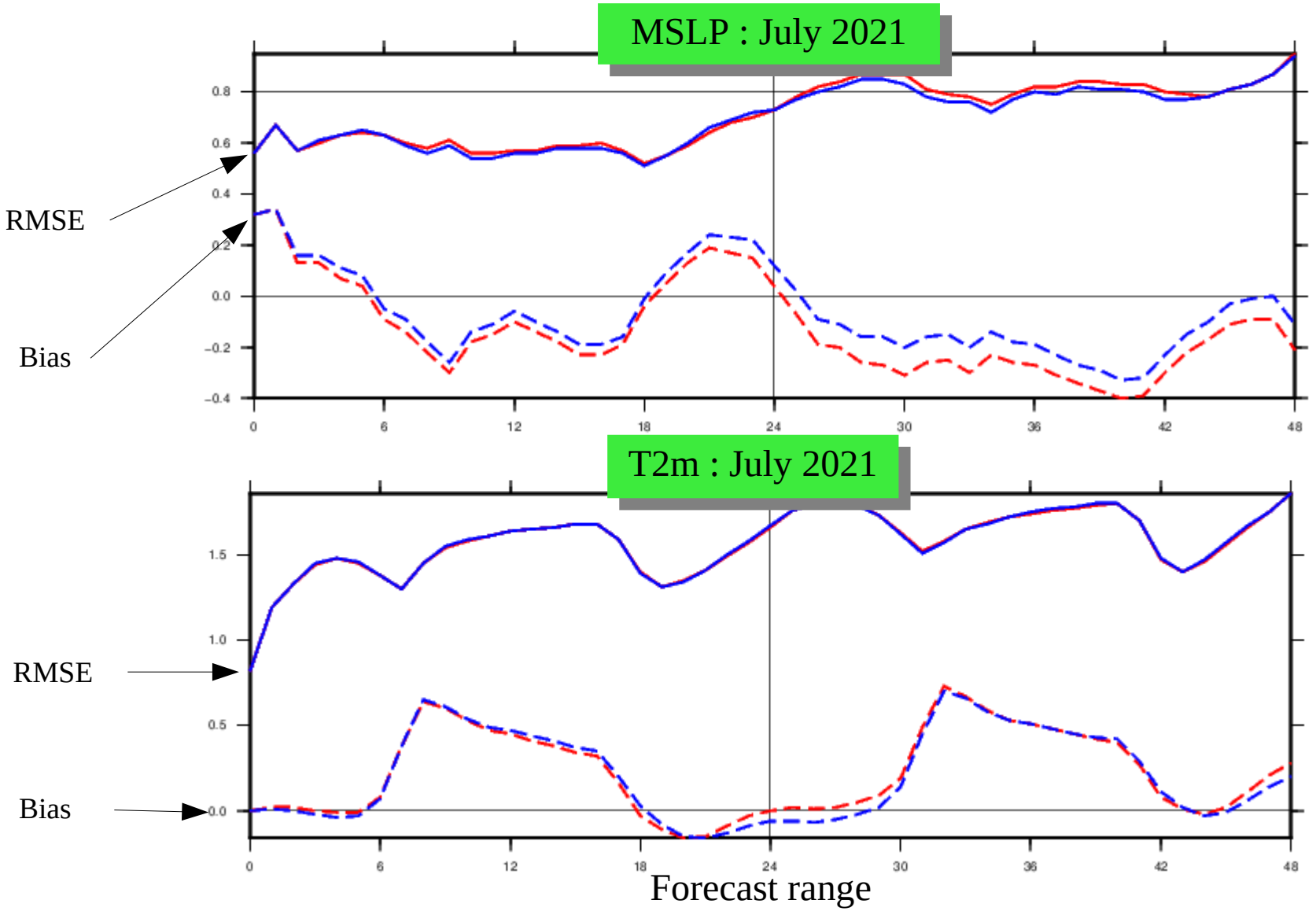
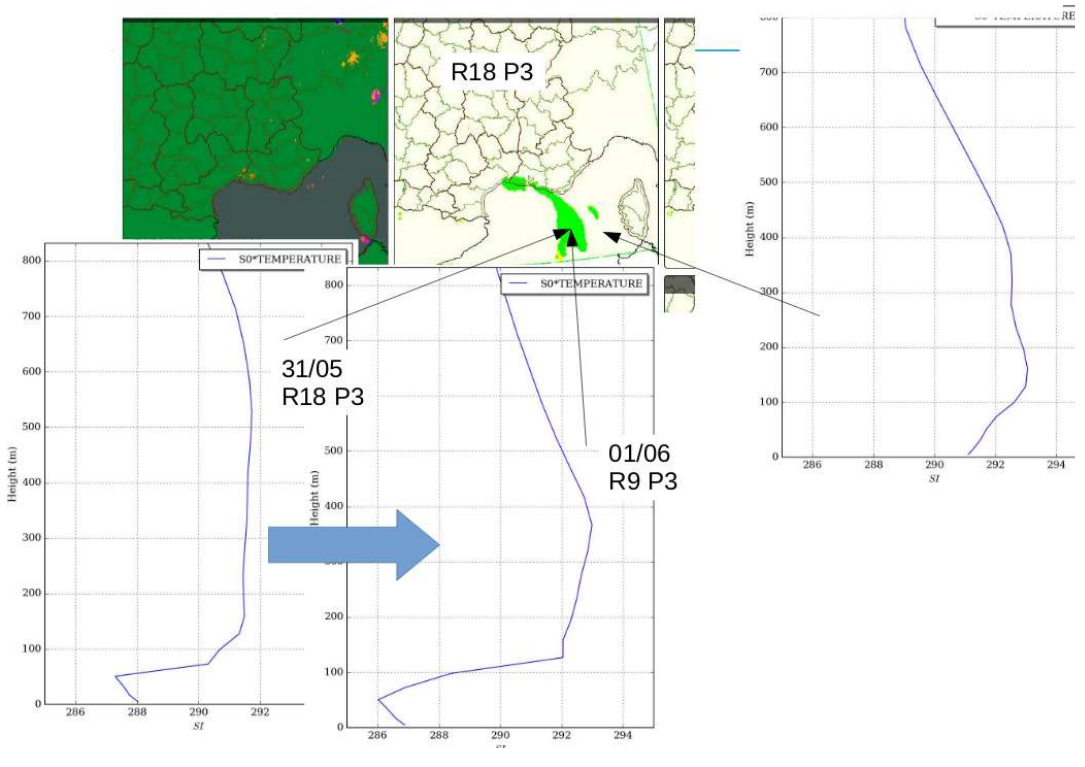
First results / impact : EcRad+MACCAERO versus EcRad



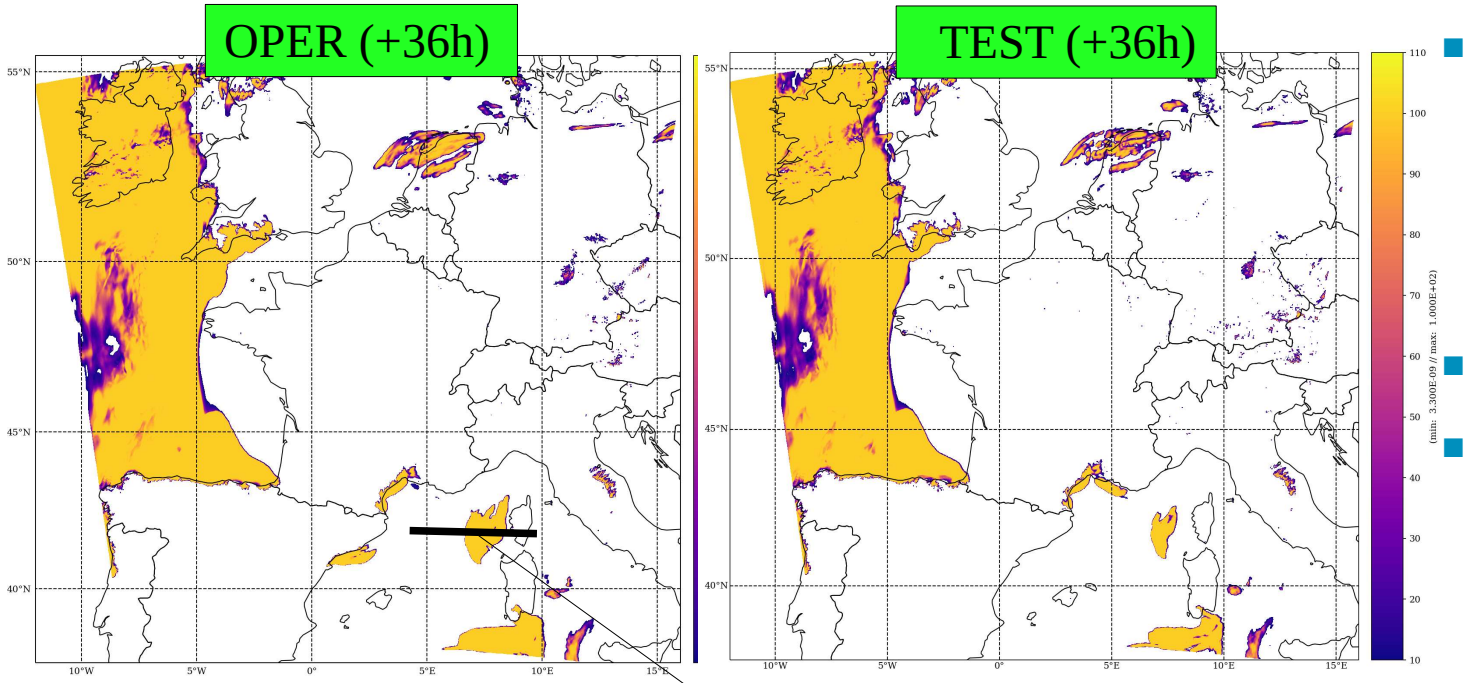
→ On July, improvements on surface pressure with MACC Aerosols

Plans for next e-suite (CY48T1_op1 in 2022)

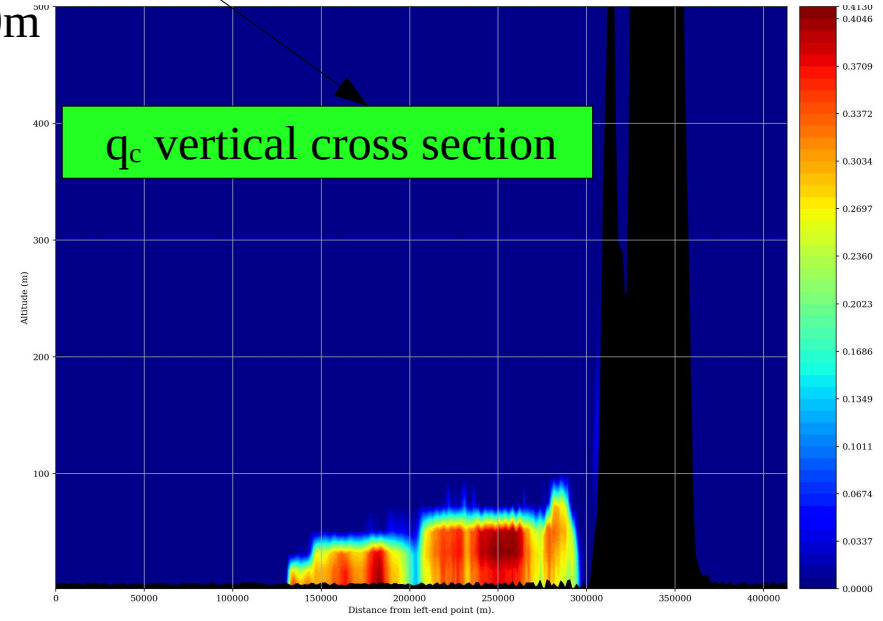
- Modifications for low clouds over sea :
- Forcasters complains about cases of overestimated cloud cover over mediterranean sea (but not only)
- As clouds are cycled from the guess to analyses (not directly modified by data assimilation, and not a lot of available observations over sea), the problem grows forecast by forecast.
- Surface and atmosphere are de-coupled



Modifications for low clouds over sea : 1st June 2019 case



500m



- In oper, turbulence parametrisation increment on conservative variable q_t (q_v+q_c+q_i) is put on q_v
- In TEST,
- it is re-projected on q_c and q_i, as it is done in Meso-NH : It reduces fog cloud cover in that case
- Ongoing tests on the subgrid condensation scheme ...

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Outline :

- Current e-suite (2021) :

  - ARPEGE

  - AROME

- Plans for next e-suite

  -ARPEGE

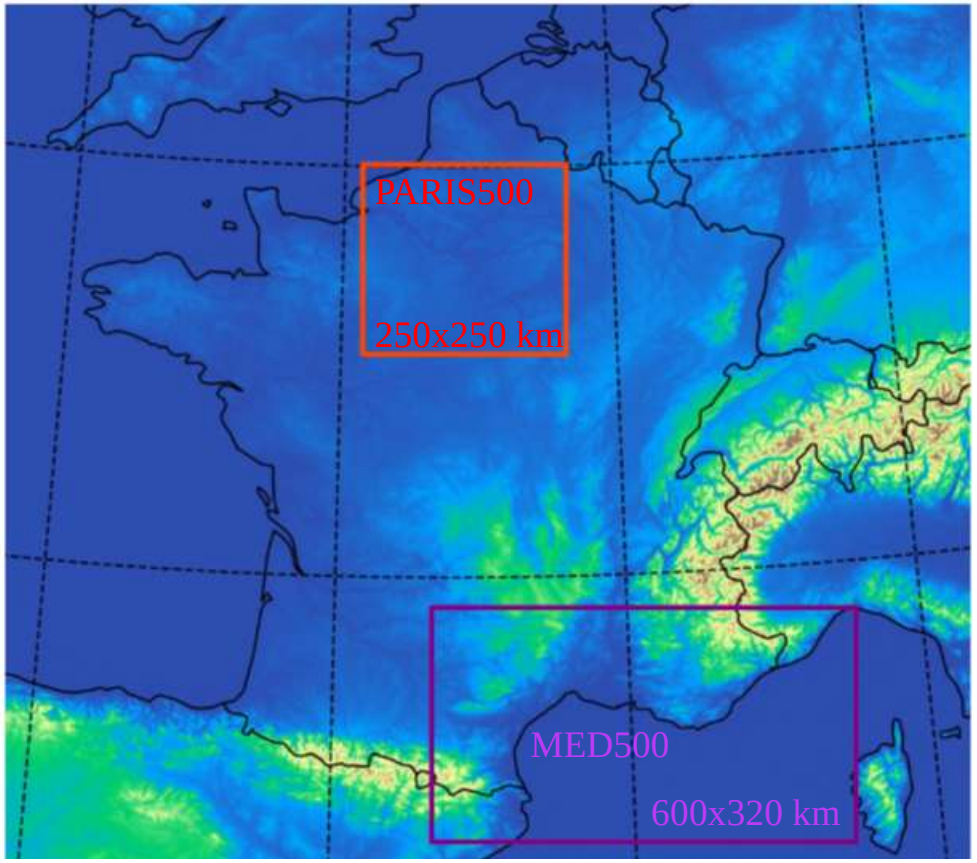
  -AROME

- **For longer terms**

  - AROME-500m for PARIS 2024

  - LIMA microphysics

Operational AROME-500m in 2024



2 domains for PARIS 2024 :
Long forecasts + Nowcasting mode
PARIS500 : P36 r0 + hourly P6 → thunderstorms
MED500 : P24 r0 → wind

Configuration :
120 vertical levels
Physics as close as possible to AROME-Fr but :
- adaptation of shallow convection to grey zone
- SST Mercator 1/36° and 1D Oceanic Boundary Layer
- adaptations of TEB town scheme (new options switched on...)

2023 : Research mode
2024 : Oper

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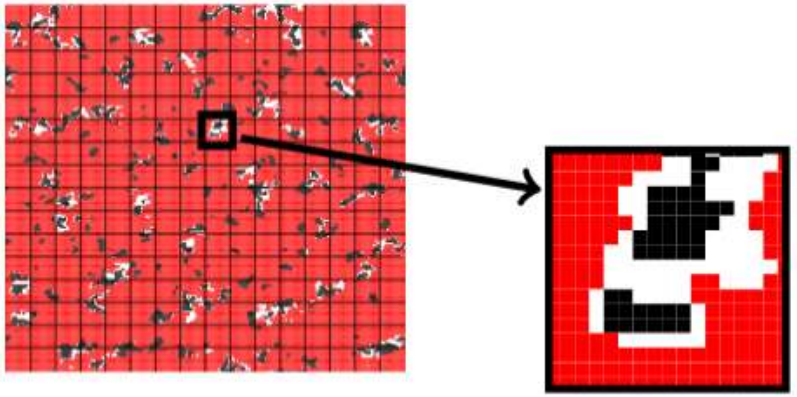
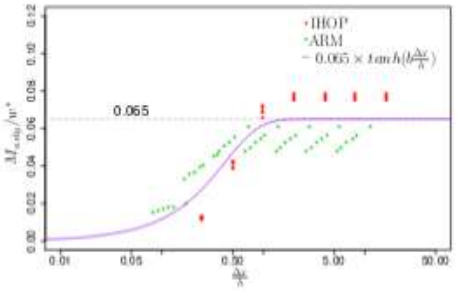
Modifications in the mass-flux scheme @500m

1/ At hectometric scales, the structure of the thermal field changes.

meso-scale $\Longrightarrow$ micro-scale



2/ Thus the mixing from the mass-flux scheme is too strong. By reducing the

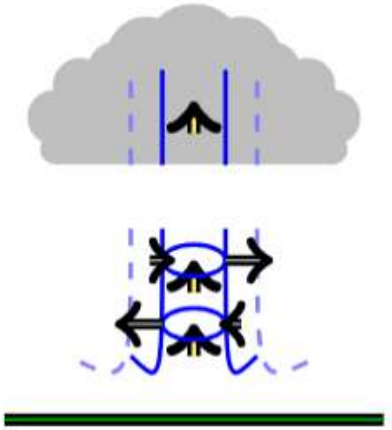


surface closure,

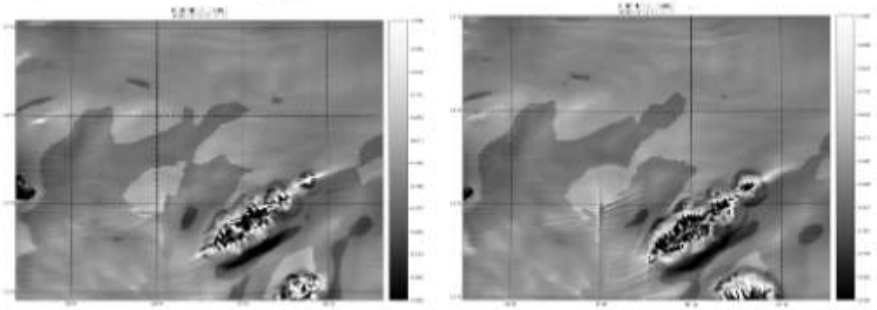
$$\frac{M_u(z=0)}{w*} = \text{Cst} \Rightarrow \frac{M_u(z=0)}{w*} = f\left(\frac{\Delta x}{h}\right)$$

Honnert et al. (2016), Dávid Lancz et al. (2017)

3/ We reduce the mixing



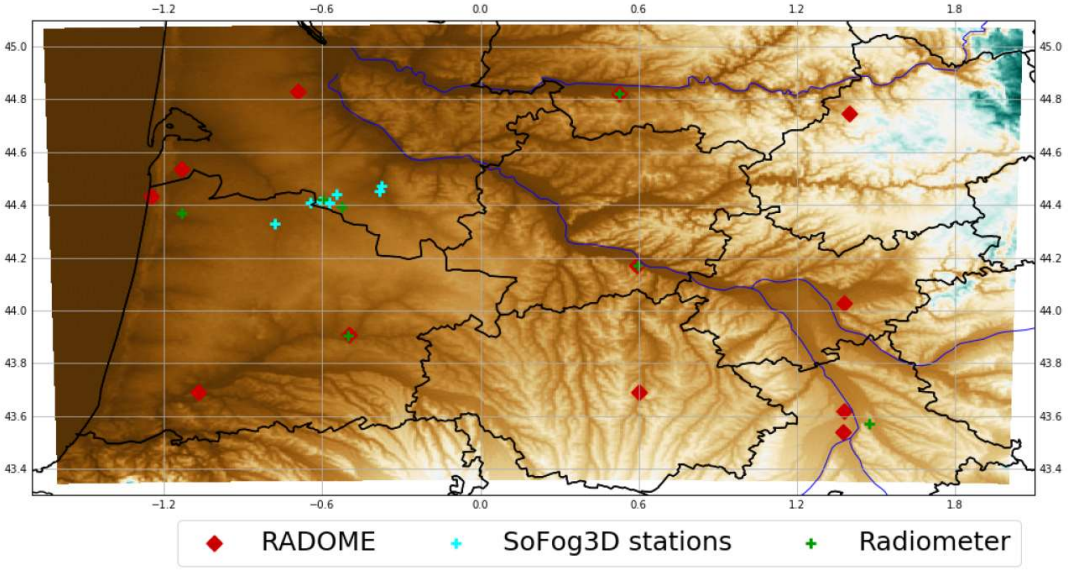
4/ and trigger resolved structures.



Cloud fraction 1300m and 500m simulations over Barbados islands, 02/02/2021 9UTC

LIMA microphysics (SOFOG 3D experiment)

- 5 months scores : (from +25 to+30h FC 0TU)
- AROME 500m
- 156 vertical levels (lowest at 1m)

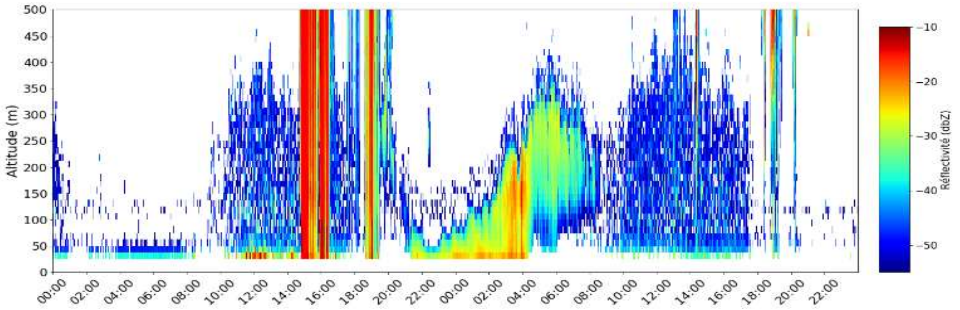


	Detection Rate	False Alarms Rate	Visibility bias
ICE3	64 %	43 %	117 m
LIMA	64 %	49 %	**49 m**

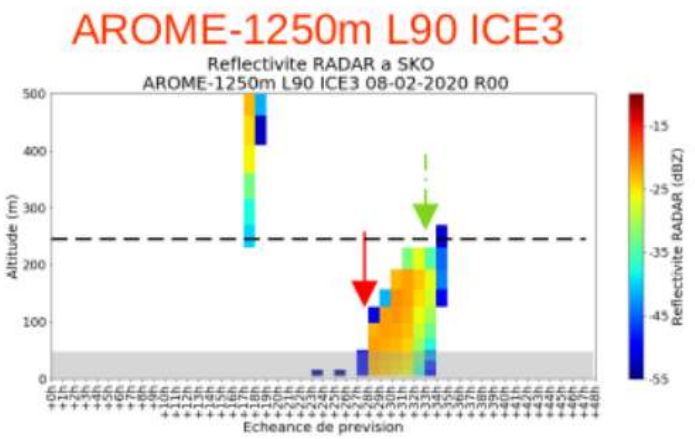
→ With subgrid condensation scheme recently added in LIMA, its quality is close to ICE3, with lower visibility bias (→ more realistic q_c).

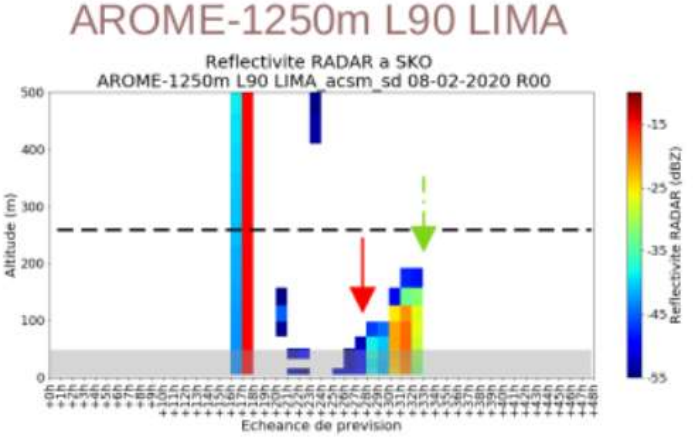
LIMA microphysics (SOFOG 3D experiment) IOP 11

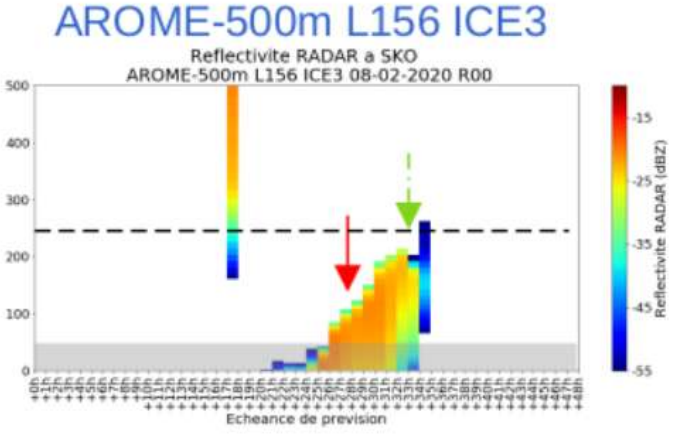
Cloud radar OBS reflectivities

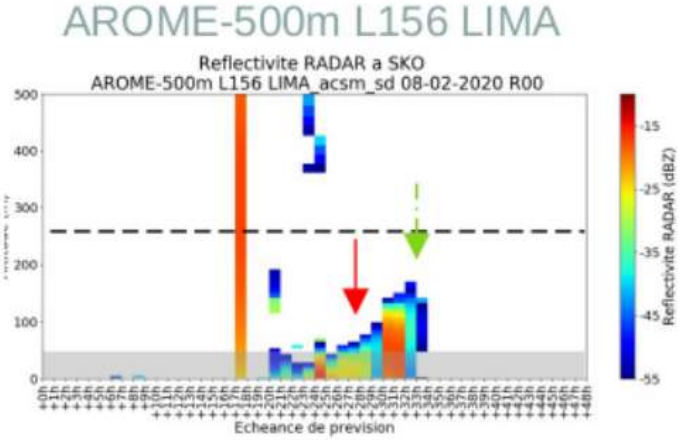


- IOP is well captured by the model
- Model retrieved cloud radar reflectivities more correct with LIMA
- But fog top a little underestimated



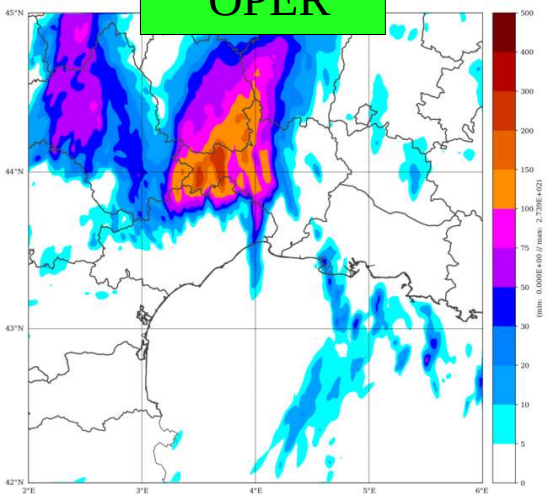




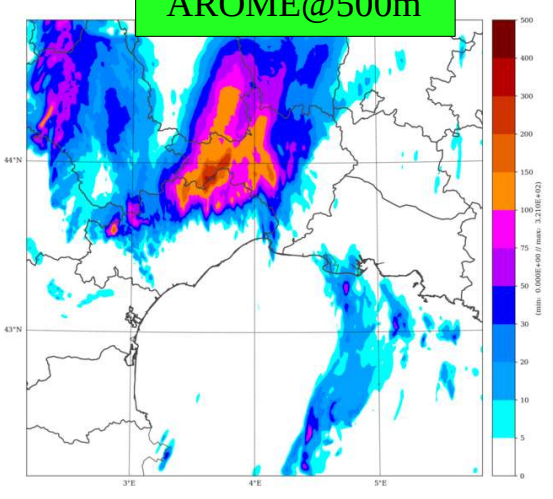


LIMA@500m on convective cases : case of 19 Sept. 2020

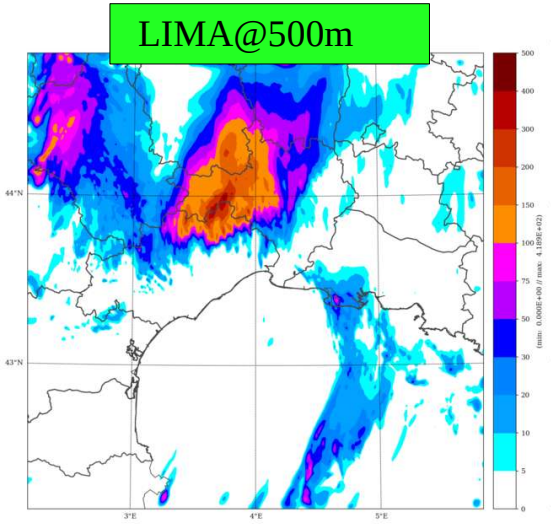
OPER



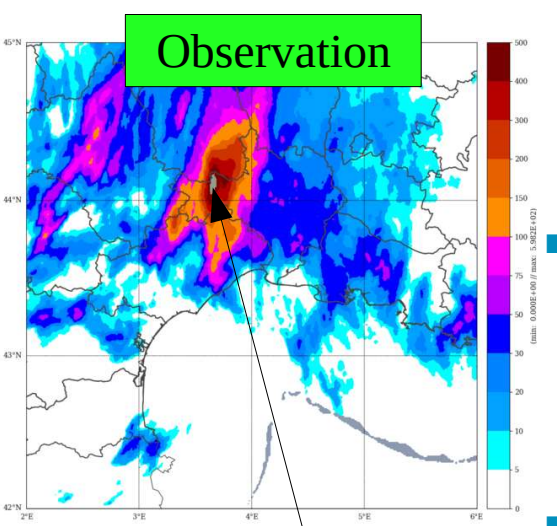
AROME@500m



LIMA@500m

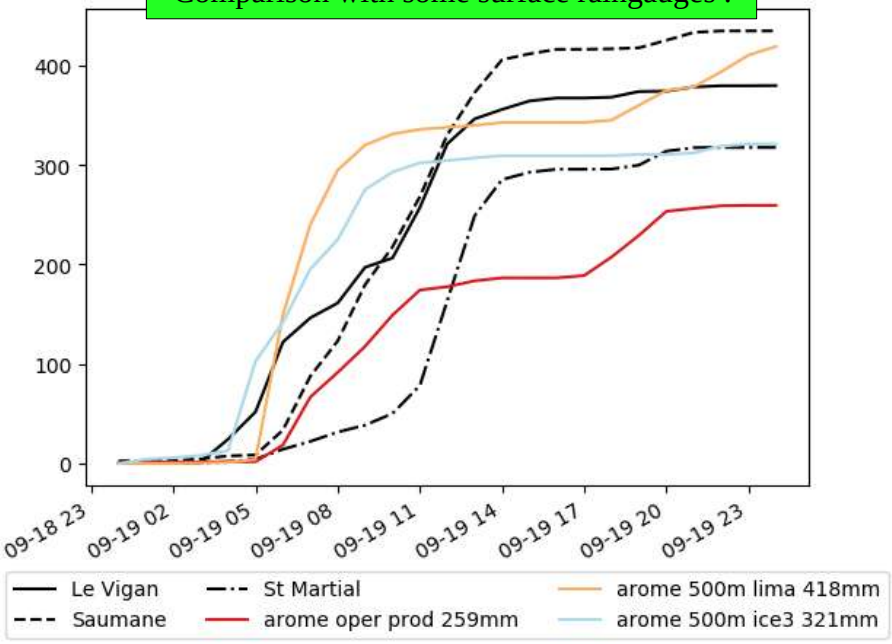


Observation



>500mm/24h

Comparison with some surface raingauges :

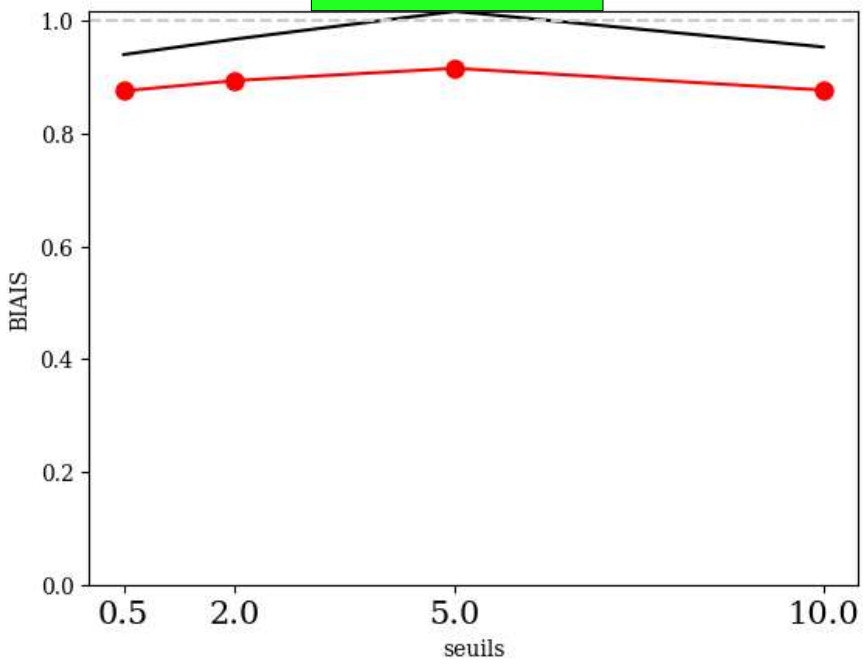


- 500m simulations better capture the maxima and the timing of this extreme event
- LIMA provides larger values

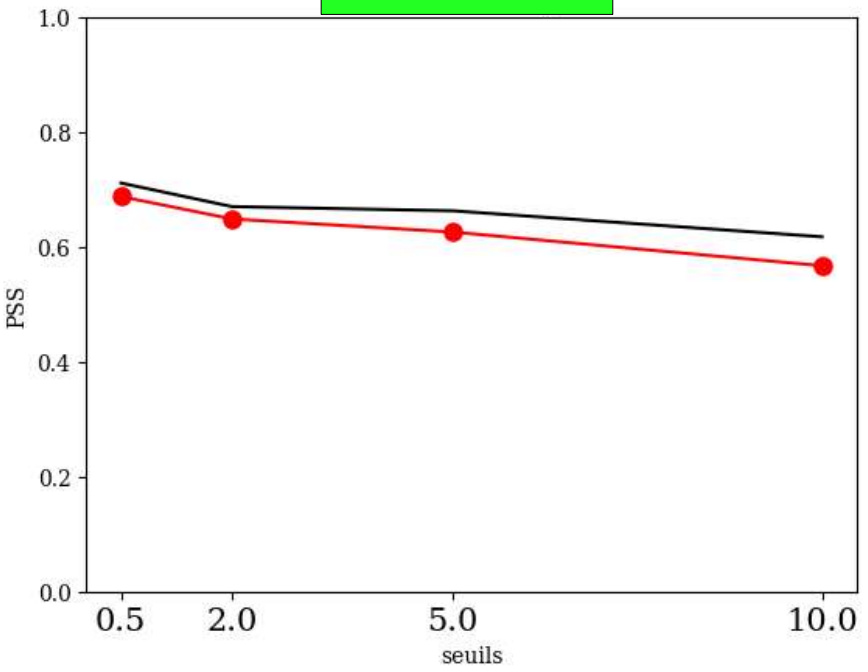
LIMA@500m on convective cases : Scores on 1 month

October 2021 : Ref@500m / LIMA@500m

Mean Bias



Mean PSS



- 500m simulations with LIMA microphysis improves the rain forecasts for this month in this domain.

- → to be confirmed at longer periods and larger domains

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Thank you for your attention !
Question ?