Preliminary evaluation of AROME 500m during the Olympic Games and potential improvement for the PBL

Eric Bazile, S. Antoine,

Y.Seity, L. Auger, R. Honnert, P. Le Moigne, V. Masson, A. Napoly, J. Wurtz

and L. Rogel & F. Voitus

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EWGLAM/SRNWP 30 Sep. - 3 Oct 2024

AROME- 500m for JO2024 :

	Paris 250km x 250km	MedAlp 480km x 576km
Forecast	1xP36 (00TU) Hourly outputs	1xP24 (00 TU) Hourly outputs
Nowcasting	24xP6 15 min outputs	12xP6 15 min outputs
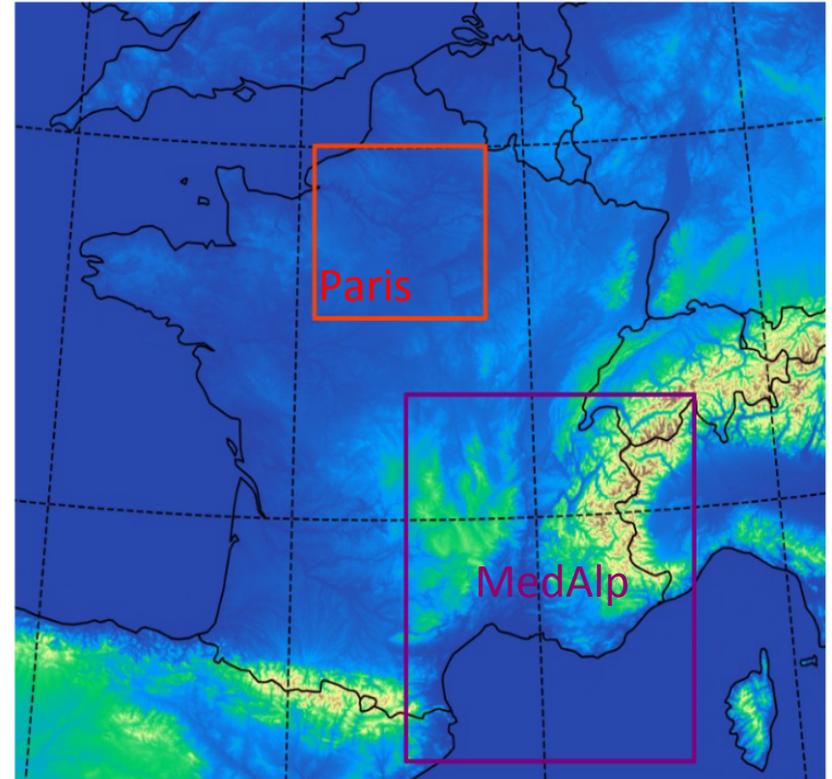
- dt=20s, 120 vert. Levels (1st @ 2.5m with 17 levels < 200m / 9 in AROME-oper L90 and 7 in ARPEGE L105)
- No data assimilation (analysis and LBC from AROME 15mn)
- Physics adaptation: water deposition on vegetation(fog impact Antoine et al (2023), new value for vegetation thermal capacities : low veg.=5.10-5 Km2J−1, high veg. = 2.5.10-5 Km2J−1 (resp. 2.10-5 and 1.10-5),Ri_max 0.2→ 0.05
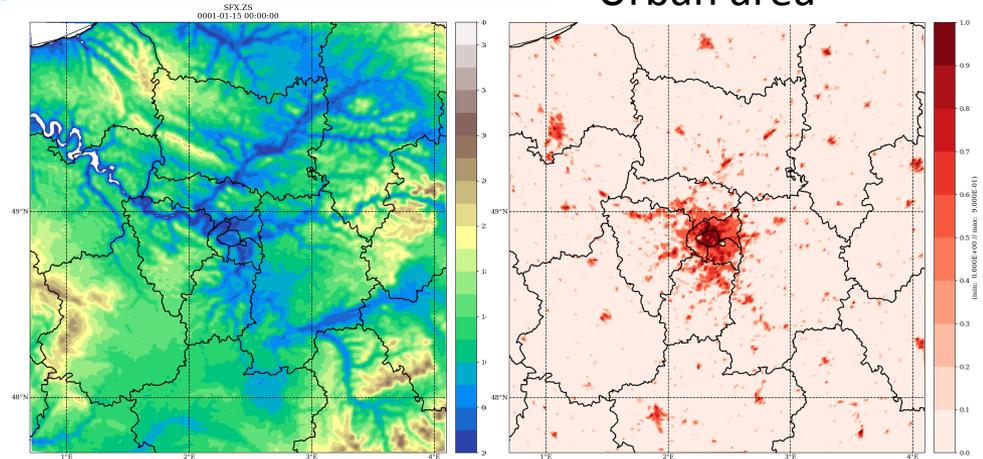

More details in Antoine S. talk (ACCORD website ASW 2024)

EWGLAM 2024 30 Sep - 3 Oct 2024, Prague, Czech Republic

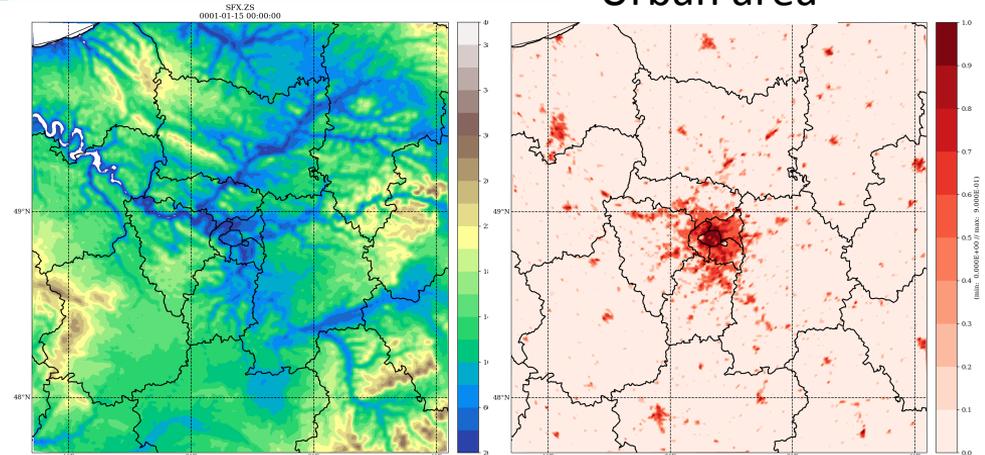# AROME- 500m for JO2024
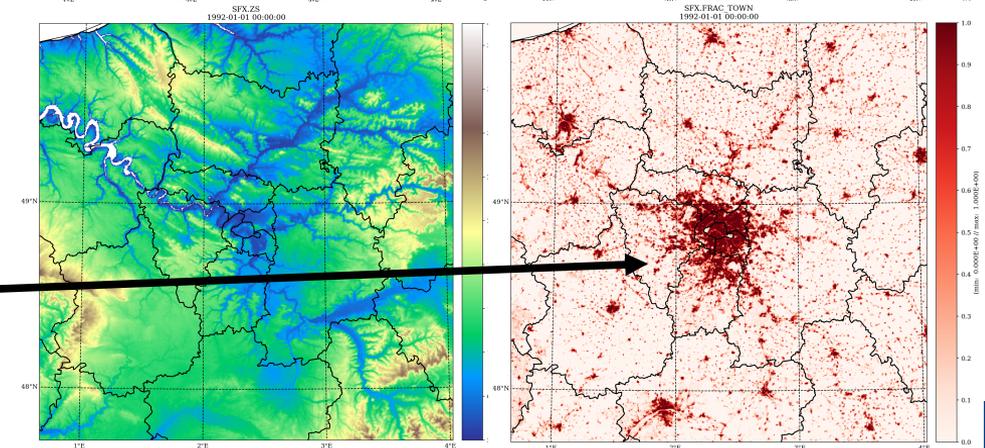
Urban area

AROME 1,3km
(GMTED 250m)

AROME- 500m for JO2024
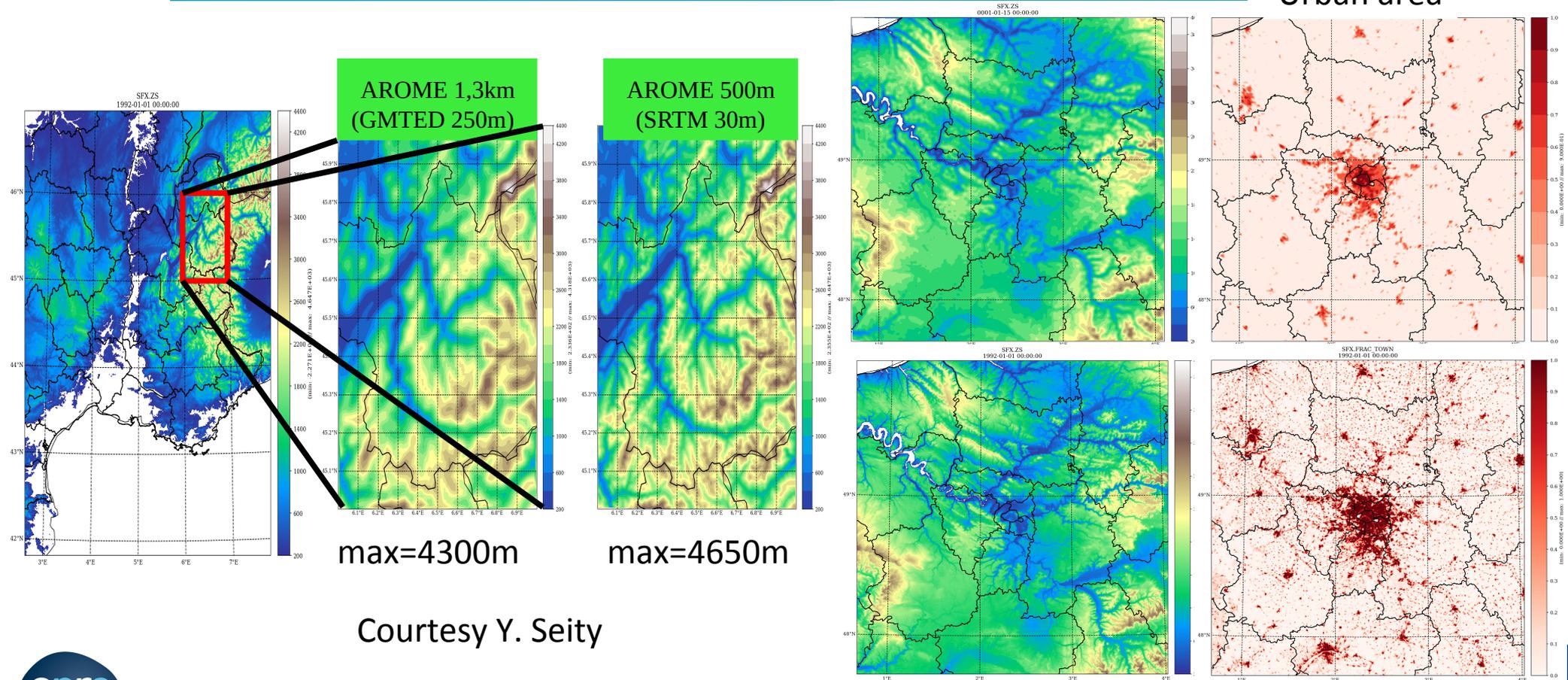
Urban area

AROME 1,3km
(GMTED 250m)

AROME 500m
(SRTM 30m)
+ Open Street Map

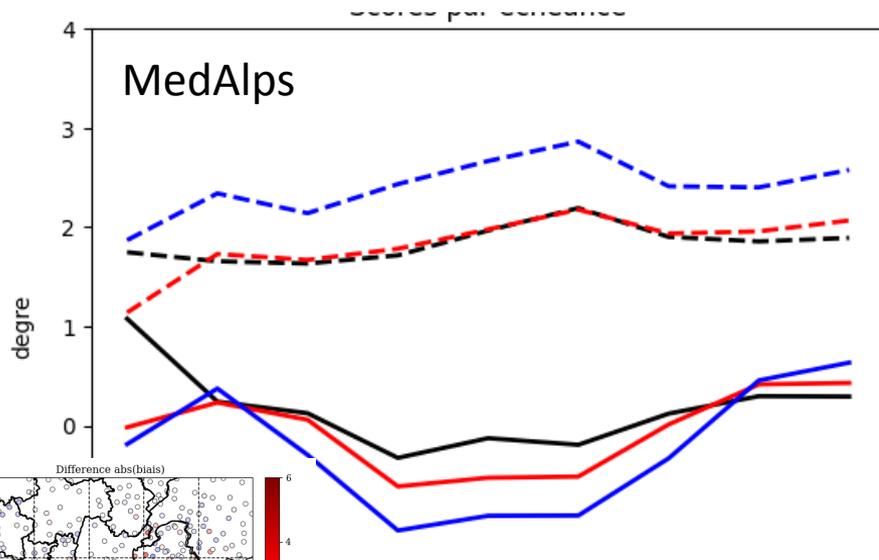**EWGLAM 2024 30 Sep - 3 Oct 2024, Prague, Czech Republic**
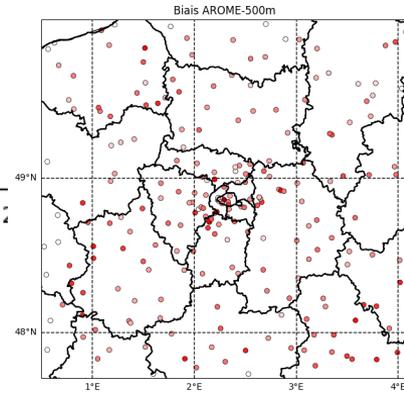
AROME- 500m for JO2024

Urban area

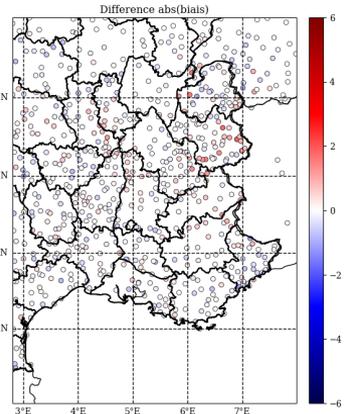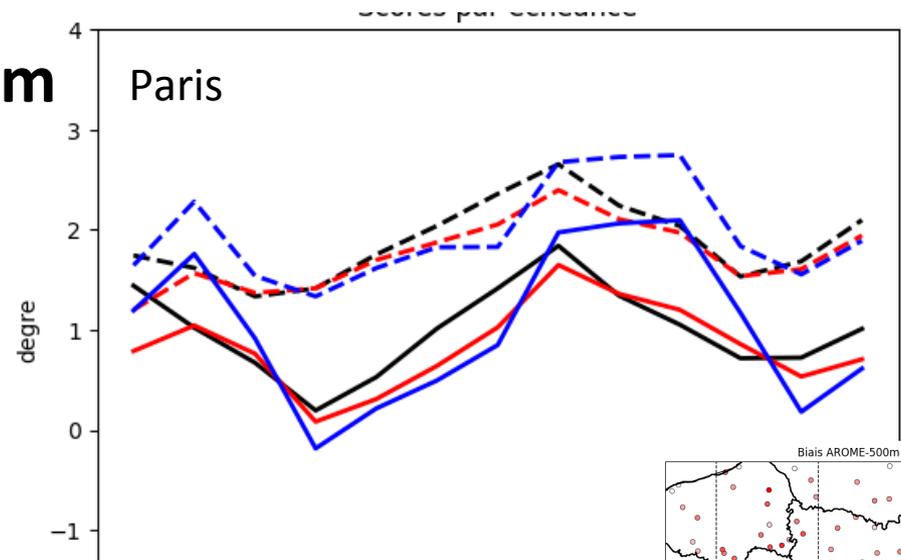AROME 1,3km
(GMTED 250m)

AROME 500m
(SRTM 30m)

max=4300m

max=4650m

Courtesy Y. Seity

EWGLAM 2024 30 Sep - 3 Oct 2024, Prague, Czech Republic

AROME-500 vs AROME-1.3km : 15 May 2024 → 15 Sept 2024

MedAlps

T2m Paris

AROME-500m
AROME-OP-1.3km
ARPEGE
Full line Bias
Dashed Line Rms

Lead time

Lead time

EWGLAM 2024 30 Sep - 3 Oct 2024, Prague, Czech Republic

AROME-500 vs AROME-1.3km : 15 May 2024 → 15 Sept 2024

MedAlps

T2m Paris

Clear benefit of AROME vs ARPEGE, less impact with the 500m but ...

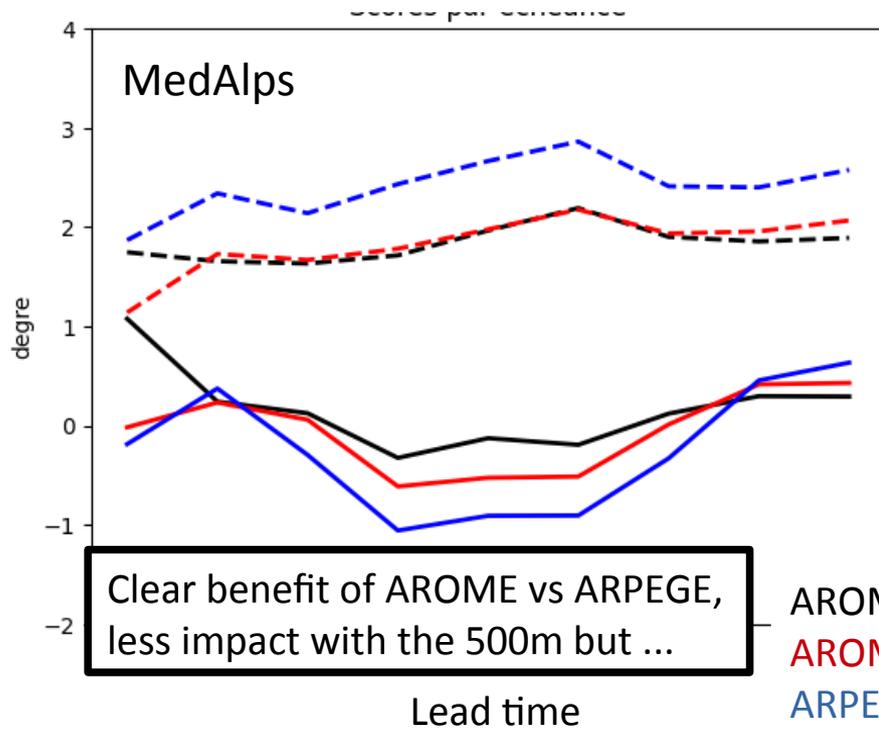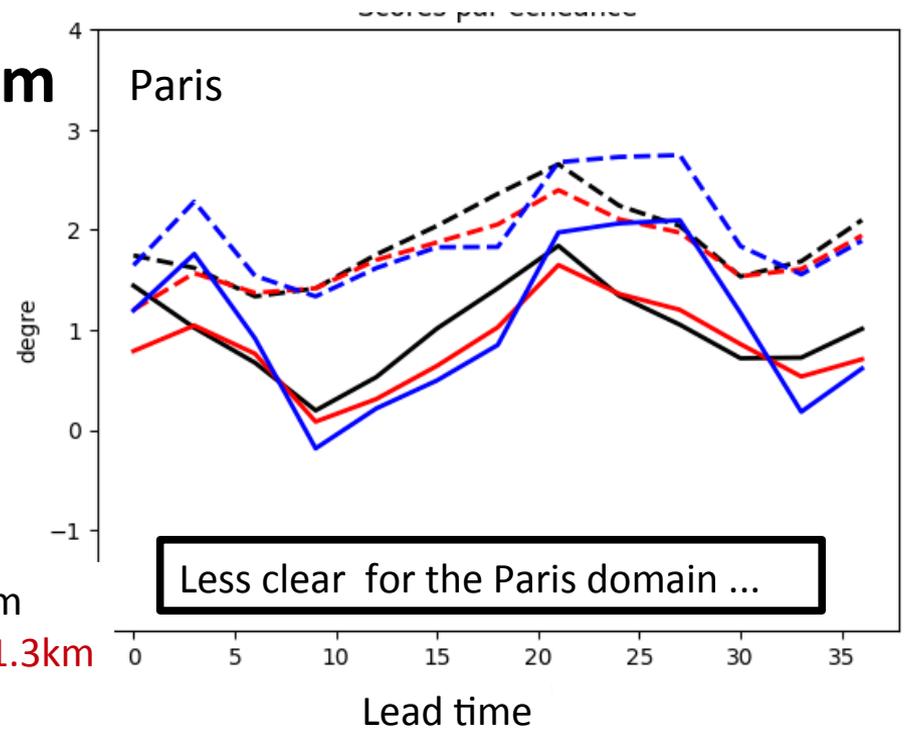Less clear for the Paris domain ...

Lead time

Lead time

AROME-500m
AROME-OP-1.3km
ARPEGE
Full line Bias
Dashed Line Rms

EWGLAM 2024 30 Sep - 3 Oct 2024, Prague, Czech Republic

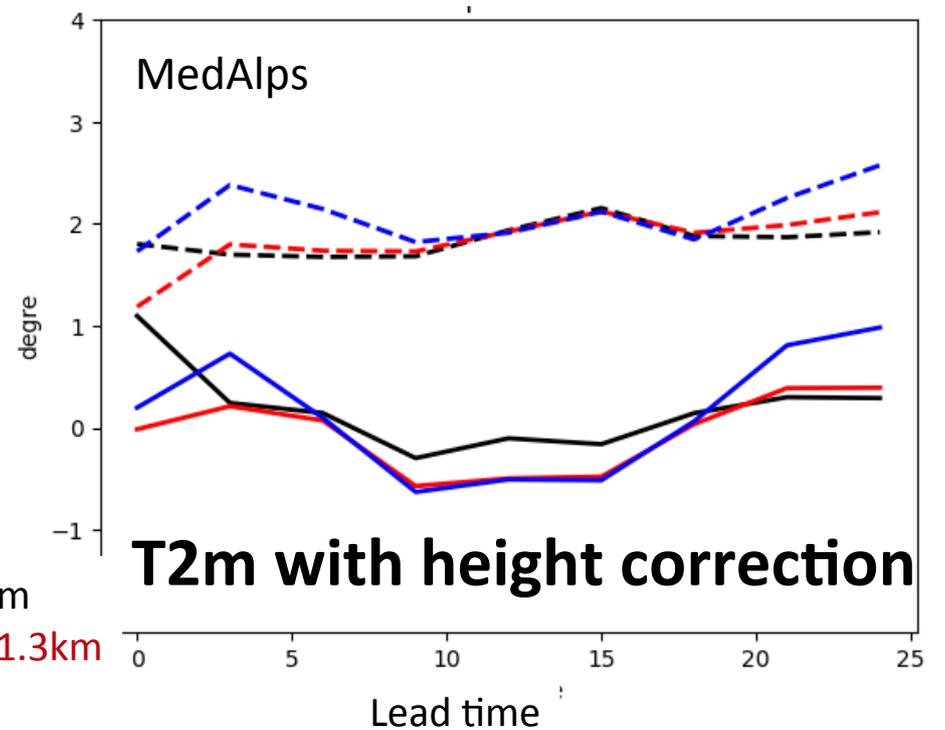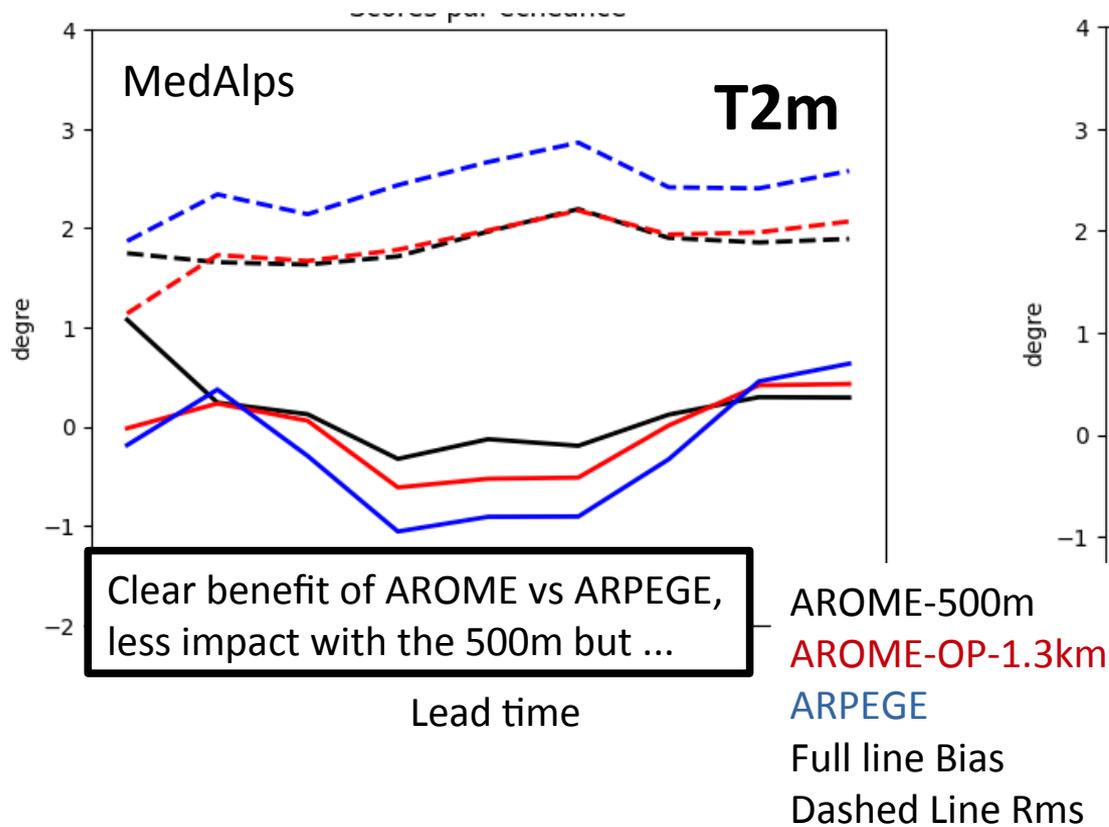# AROME-500 vs AROME-1.3km : 15 May 2024 → 15 Sept 2024

MedAlps

T2m

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Lead time

AROME-500m
AROME-OP-1.3km
ARPEGE
Full line Bias
Dashed Line Rms

MedAlps

T2m with height correction

Lead time

EWGLAM 2024 30 Sep - 3 Oct 2024, Prague, Czech Republic

Model orography – obs altitude used for validation

Arpege biais -- Mean:272.05 Min:-812.47 Max:1844.66 RMSE:441.46   Oper biais -- Mean:24.75 Min:-792.98 Max:823.38 RMSE:116.17   edalp biais -- Mean:2.99 Min:-854.59 Max:926.81 RMSE:78.45

Arpège   AROME-1.3km   AROME-500m

Model height – Obs height

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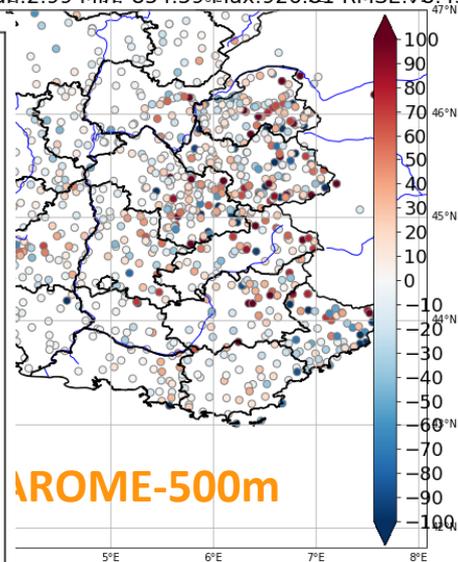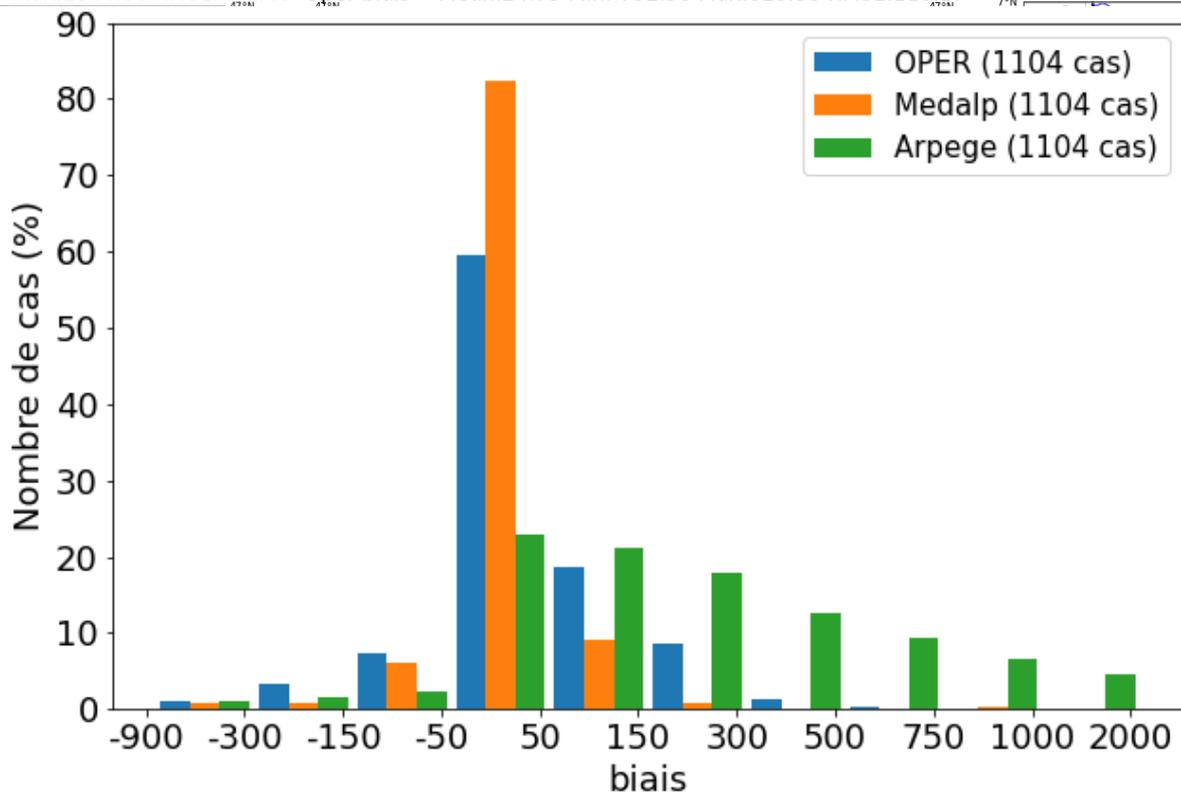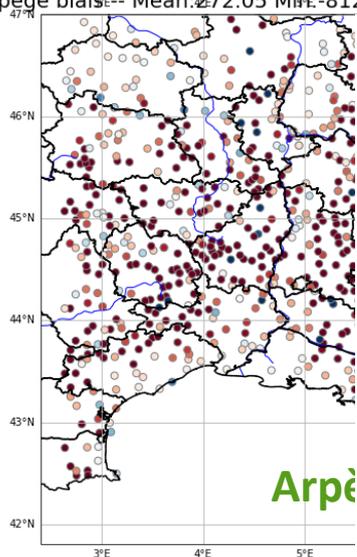# Model orography – obs altitude used for validation
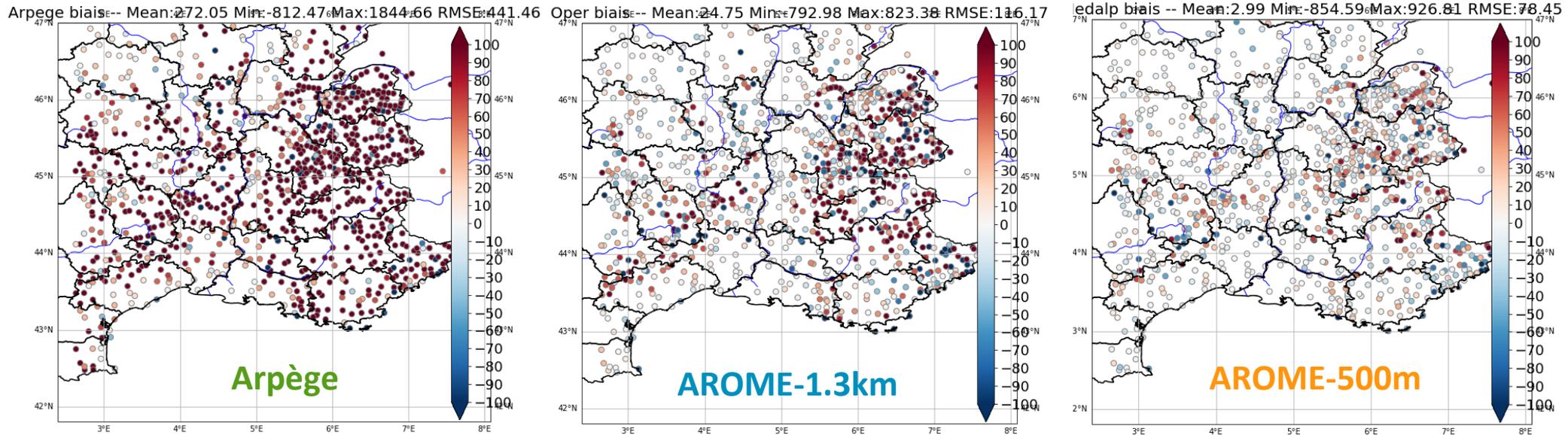
Model height – Obs height
EWGLAM 2024 30 Sep - 3 Oct 2024, Prague, Czech Republic

Model orography – obs altitude used for validation

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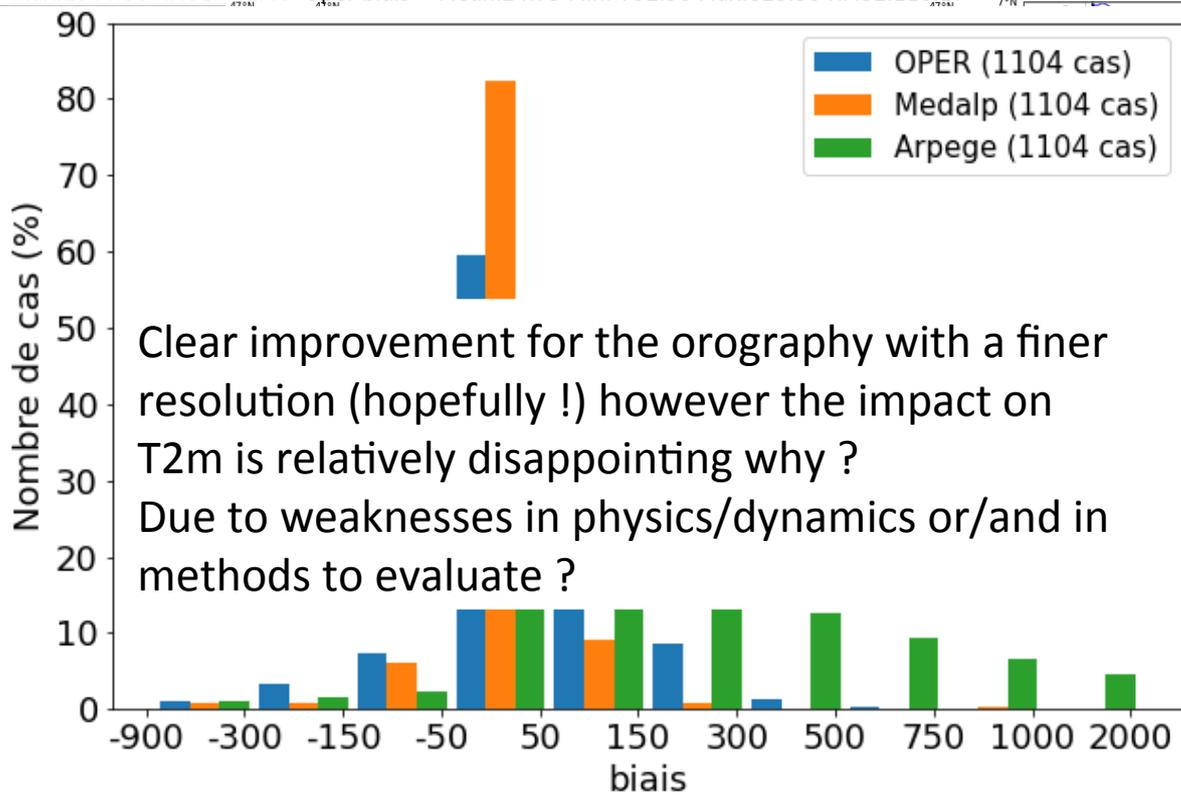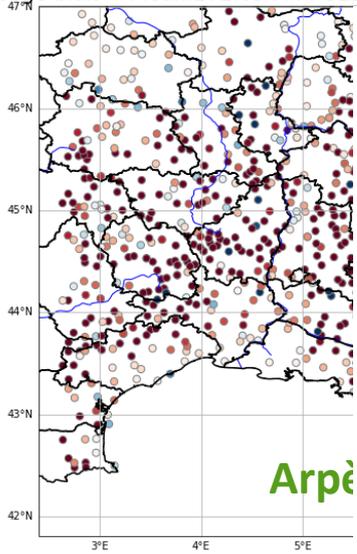
Clear improvement for the orography with a finer resolution (hopefully !) however the impact on T2m is relatively disappointing why ?
Due to weaknesses in physics/dynamics or/and in methods to evaluate ?
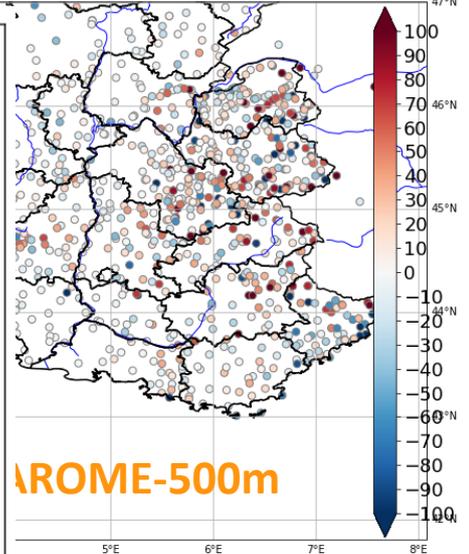
Model height – Obs height

EWGLAM 2024 30 Sep - 3 Oct 2024, Prague, Czech Republic

AROME-500 vs AROME- 1.3km : 15 May 2024 → 10 Sept 2024

10m Wind

MedAlps

Paris

ARPEGE
AROME-OP-1.3km
AROME-500m

EWGLAM 2024 30 Sep - 3 Oct 2024, Prague, Czech Republic
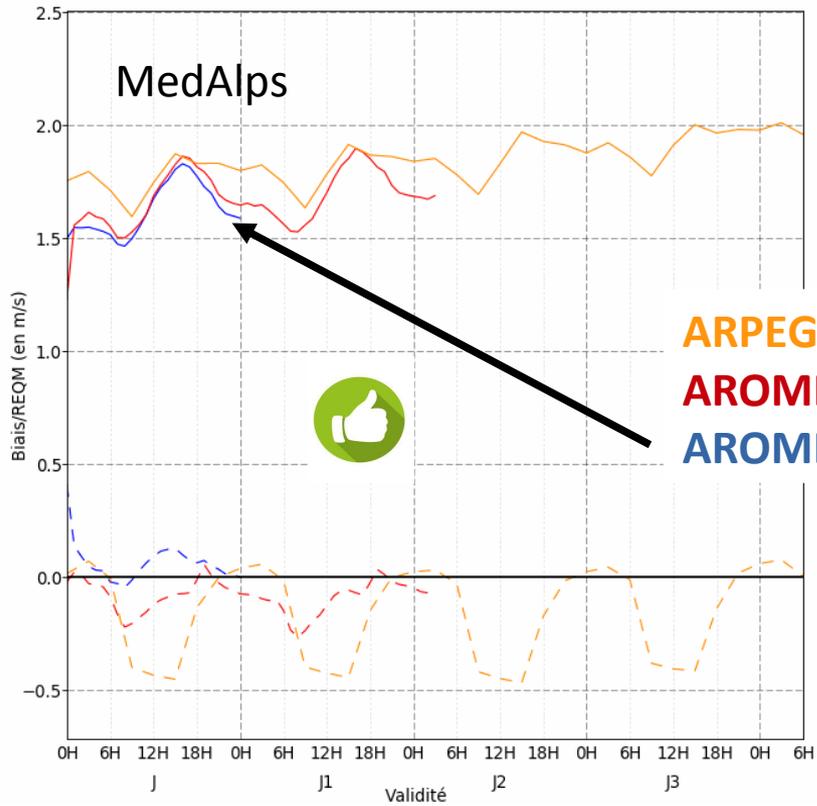
25/08/2024 relatively cold but with a strong UHI
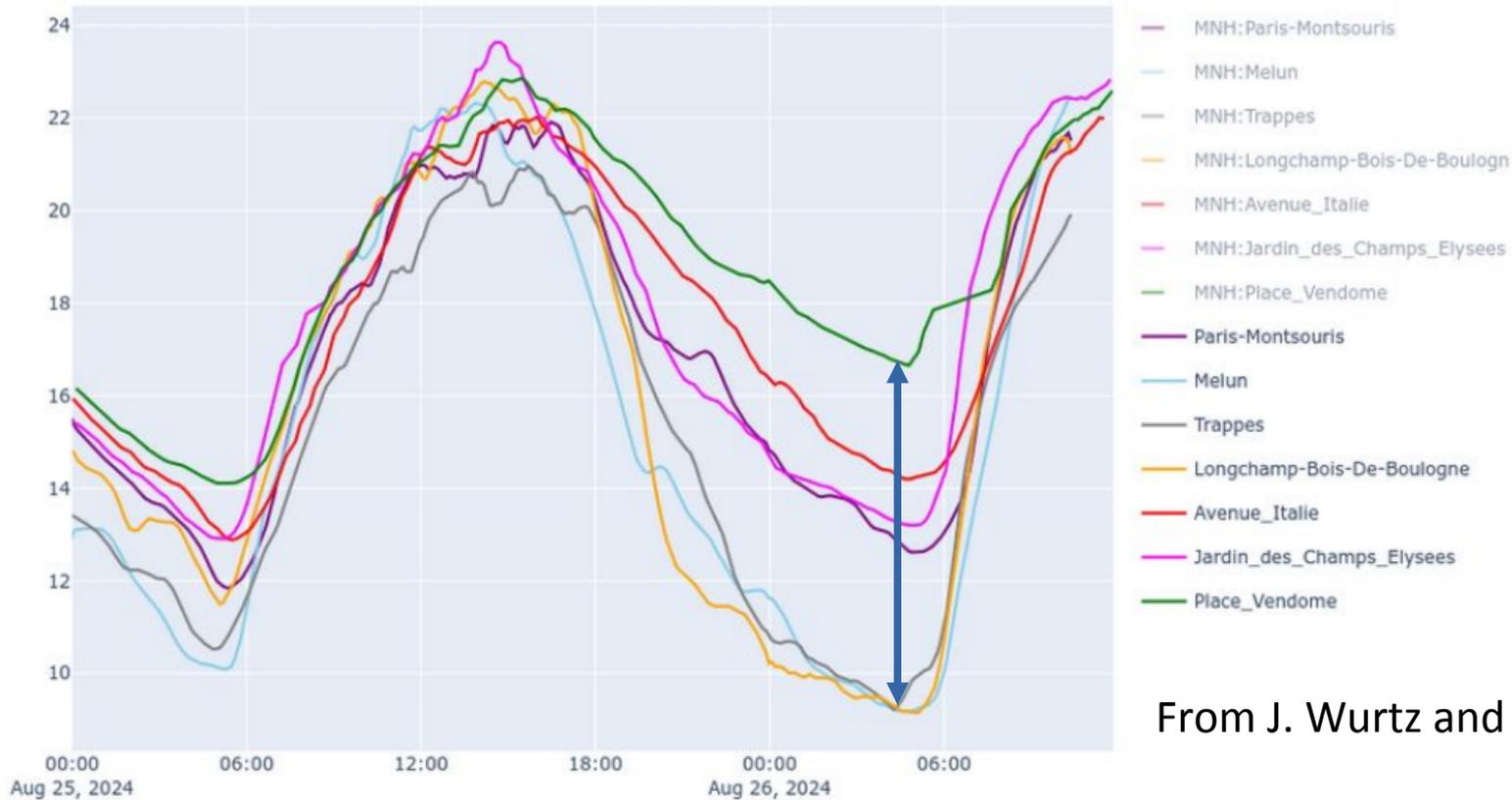
From J. Wurtz and RDP team

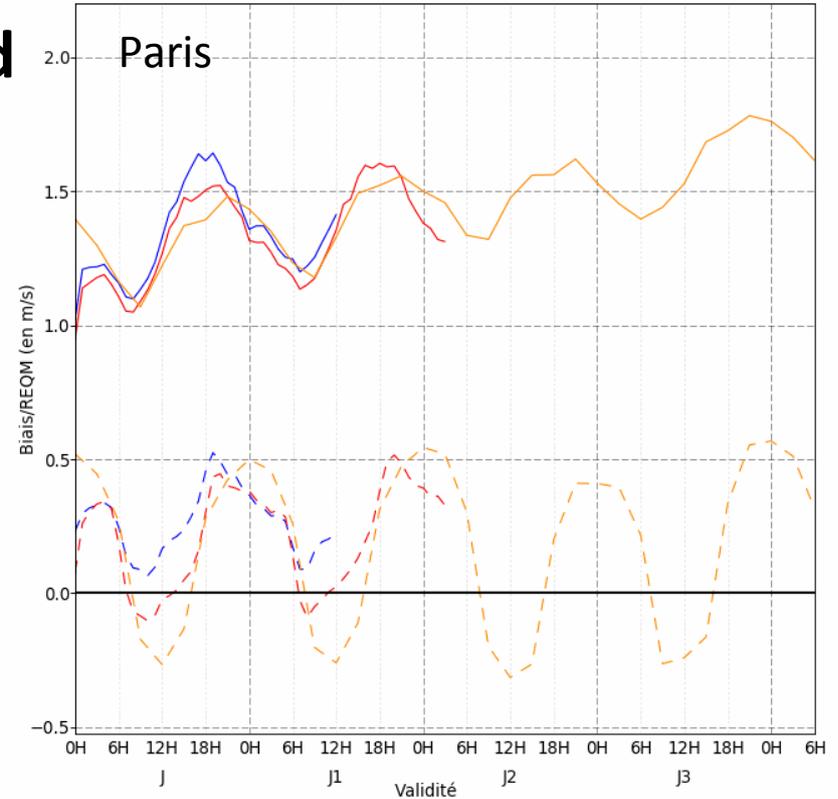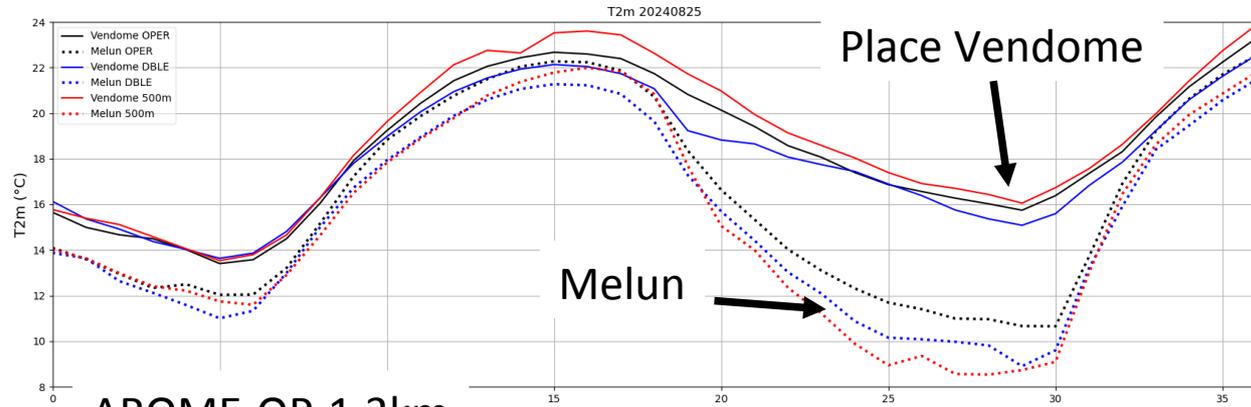**EWGLAM 2024 30 Sep - 3 Oct 2024, Prague, Czech Republic**

25/08/2024 relatively cold but with a strong UHI

T2m 20240825

Place Vendome

Melun

AROME-OP-1.3km
AROME-DB-1.3km
AROME-500m

T2m Vendome - T2m Melun

Taken from summary table at the top	
	Intensity Pl. Vendome - Melun at 4 UTC D+1
Observations	16.78 - 9.27 = 7.51
MESONH	16.67-10.62 = 6.05
RDP models	15.4 - 8.59 = 6.81
	15.47 - 10.83 = 4.64
	17.17 - 11.05 = 6.12
	13.92 - 10.57 = 3.35
	16.83-12 = 4.83
	17.01-8.71 = 8.3

From J. Wurtz and RDP team

Acc. Rain 0-24h : 1/7/2024 → 23/09/2024
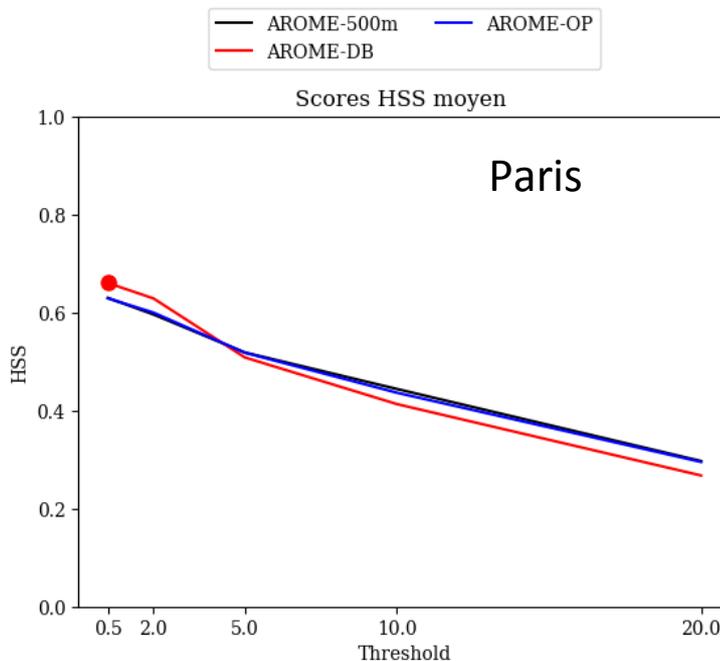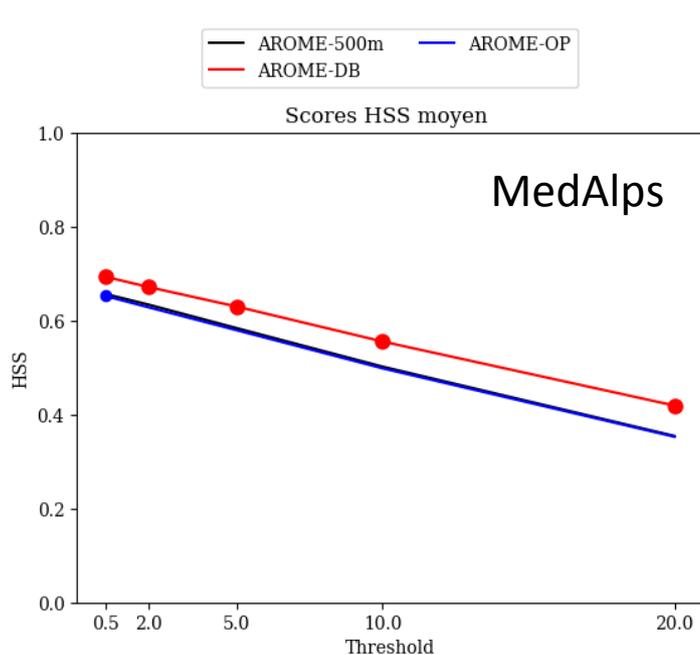
From Y. Seity (Feb. 2024, DWD workshop): too small and numerous cells in AROME-500m but, at 500m, we have correct 3h rainfall distribution

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Fréjus 4th Sept. 2024 : 74 mm in 1 hour

Radar 18h-19h UTC

Radar 19h-20h UTC

EWGLAM 2024 30 Sep - 3 Oct 2024, Prague, Czech Republic
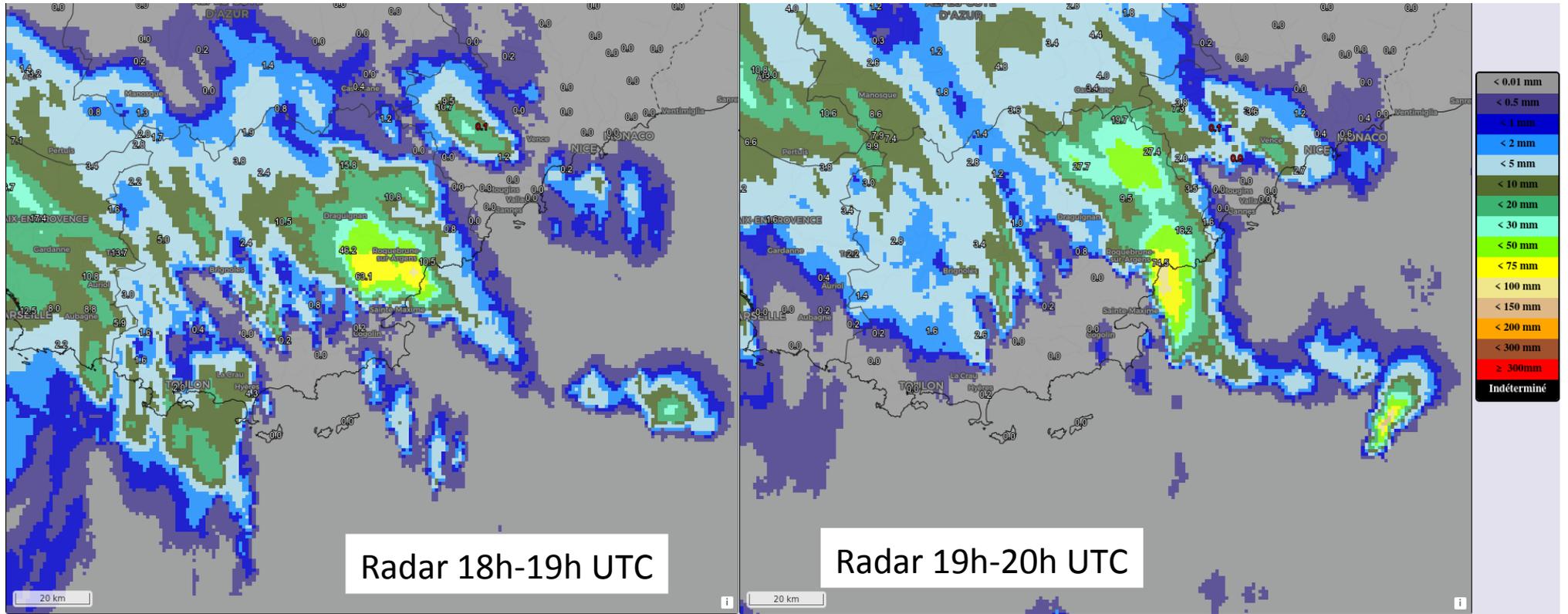
Fréjus 4th Sept. 2024 : 3h precip. Base 00UTC fc+18-21h

antilope

AROME-OP max=173

AROME-500m max=104

EWGLAM 2024 30 Sep - 3 Oct 2024, Prague, Czech Republic

Fréjus 4th Sept. 2024 : 3h precip. Base 00UTC fc+18-21h

antilope

AROME-DB max=139

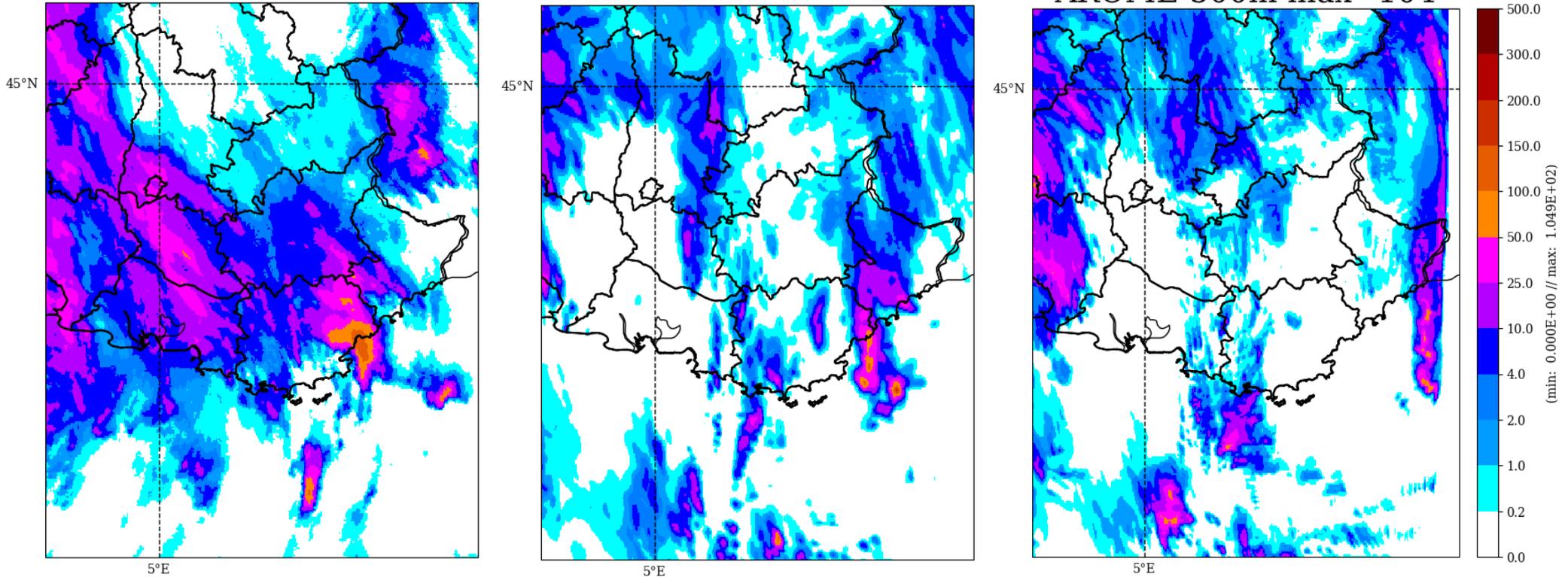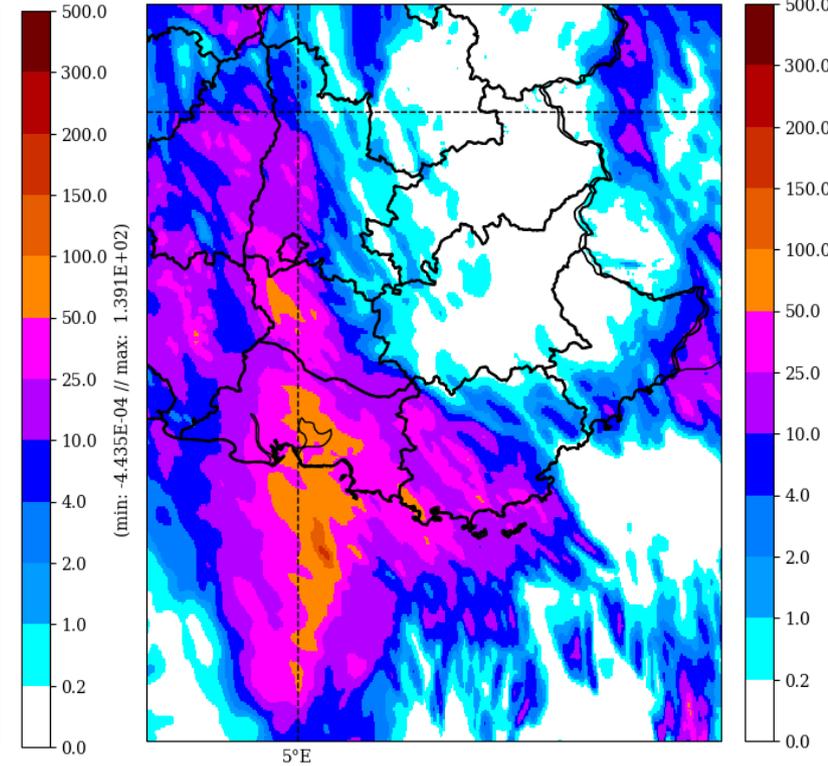AROME-AD max=168

(min: -4.435E-04 // max: 1.391E+02)
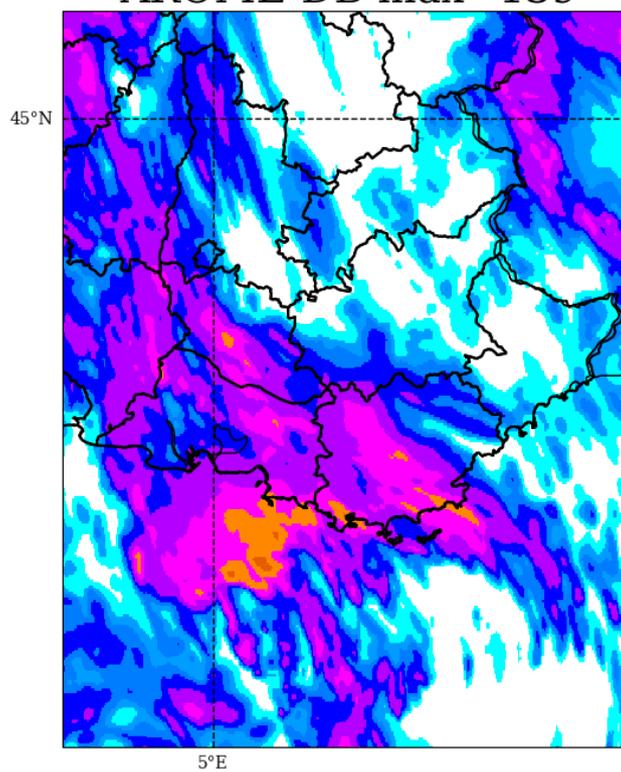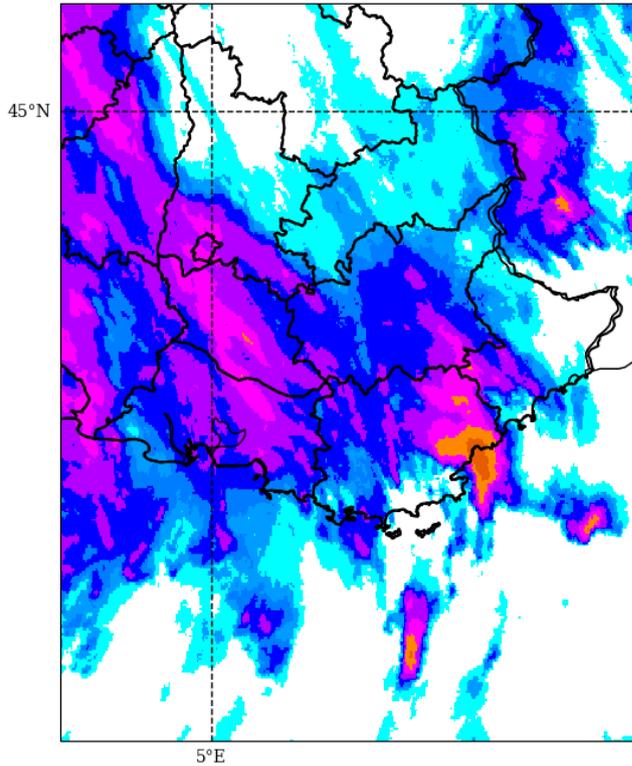
Cannes 23th Sept. 2024 : flash flood only 40-70mm but 40 in 30mn !
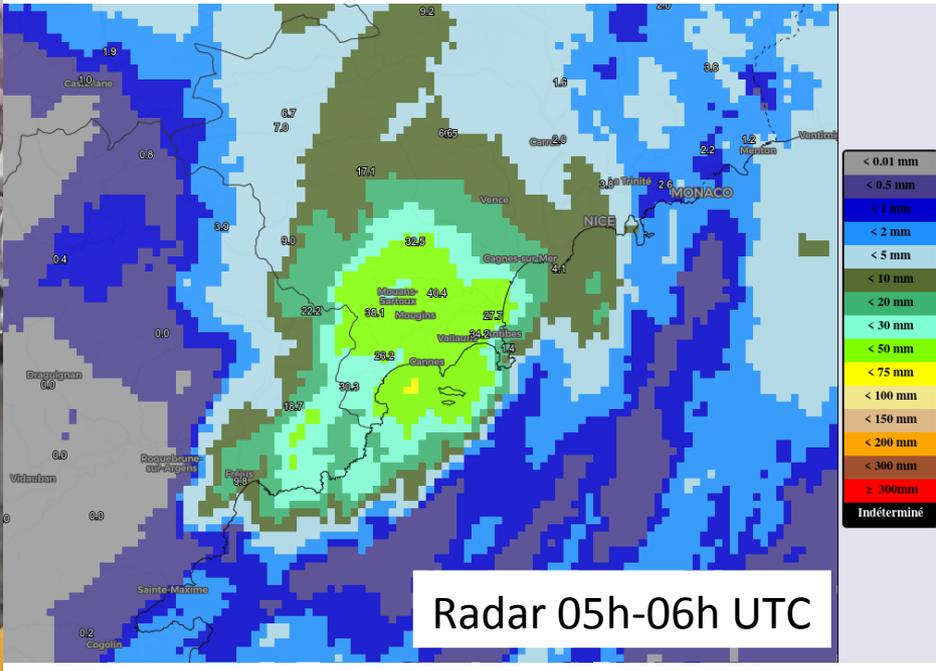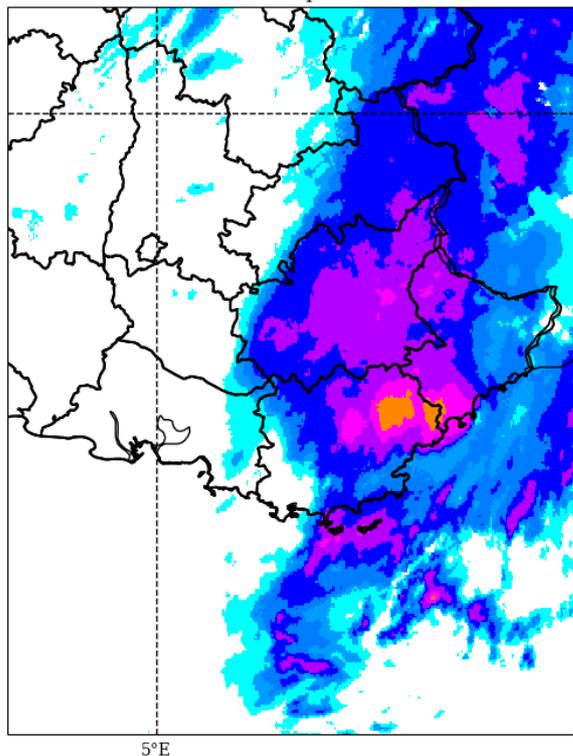
Radar 05h-06h UTC

EWGLAM 2024 30 Sep - 3 Oct 2024, Prague, Czech Republic

Cannes 23th Sept. 2024 : flash flood Base 00UTC fc+03-06h

antilope

AROME-OP max=94

AROME-500m max=193

Antilope 03h-06h UTC

Acc. Rain 03h-06h UTC
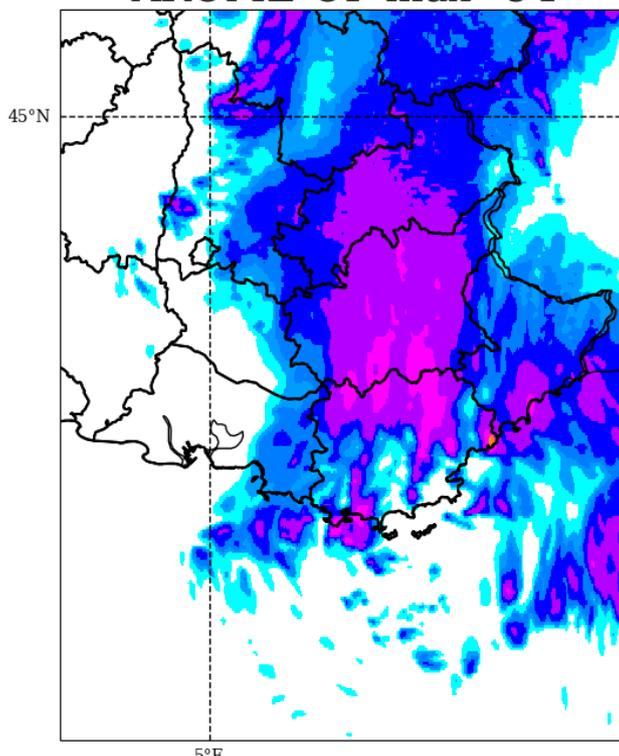
EWGLAM 2024 30 Sep - 3 Oct 2024, Prague, Czech Republic
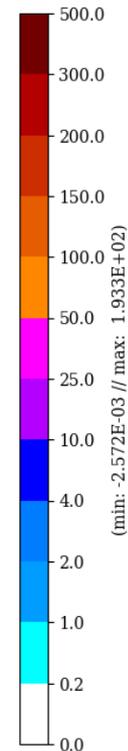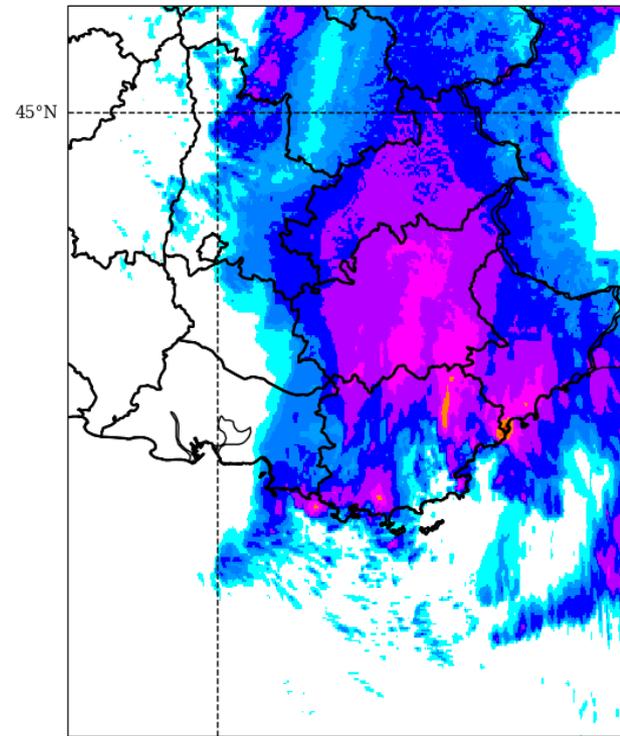
Cannes 23th Sept. 2024 : flash flood Base 00UTC fc+03-06h
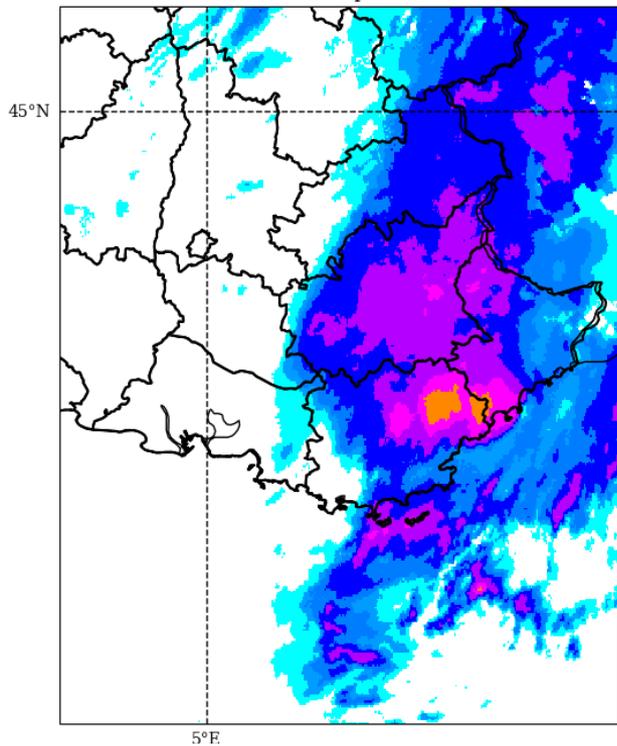
antilope

AROME-DB max=147

AROME-AD max=134

Antilope 03h-06h UTC
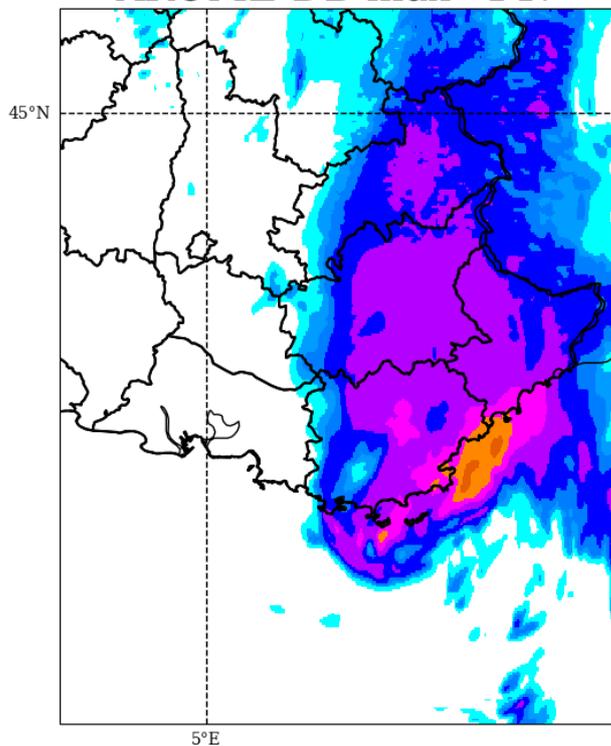
Acc. Rain 03h-06h UTC
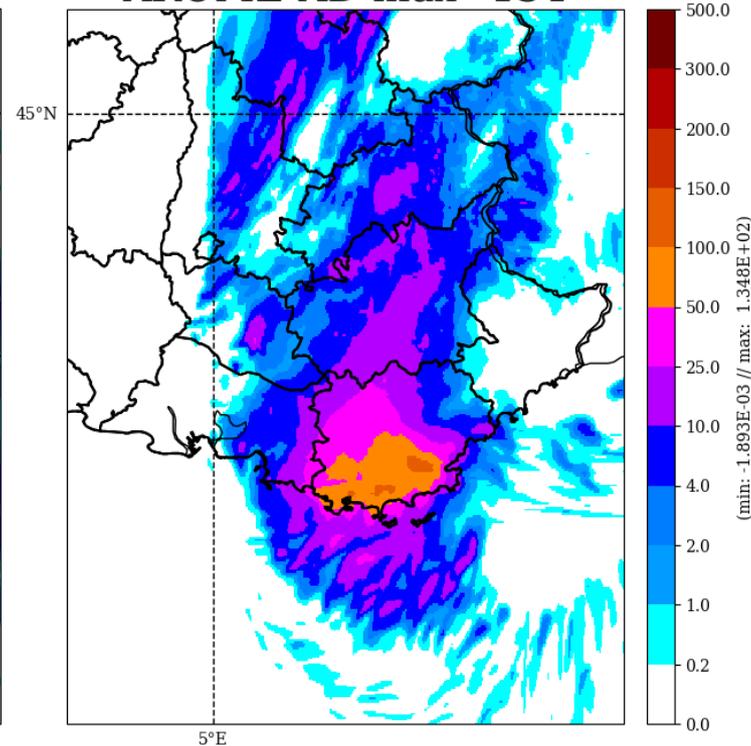
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Work in progress on shallow convection (mass flux)
Phd work : Adrien Marcel with D. Ricard and S. Riette

- Add a break term to the steady vertical velocity equation for the pressure perturbation effect
- Wet and dry entrainment and detrainment changes
- Adding turbulent fluxes from the shallow convection to the mean TKE balance.
- Bimodal pdf for the cloud calculation : turbulent and convection mode (updraft)

SCM Results: Cloud fractions
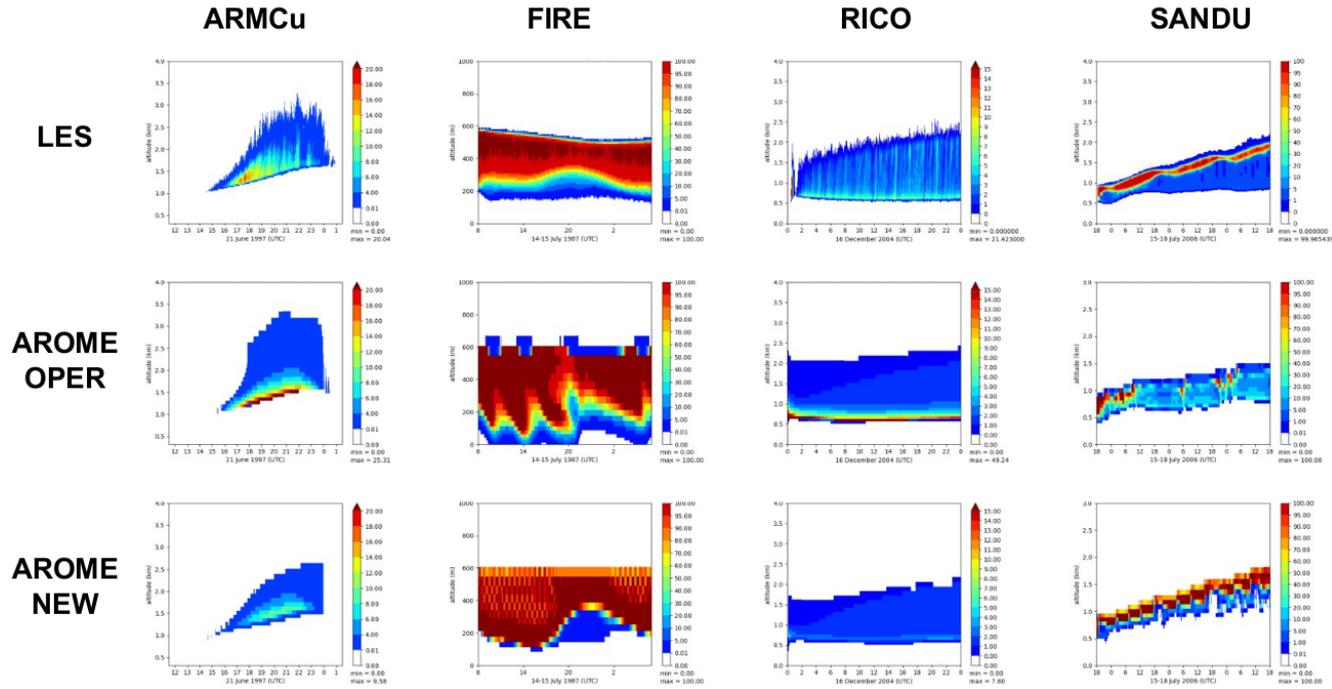
Towards 3D turbulence in AROME : Leo Rogel (DE_330), F. Voitus

Motivation :
- for VHR 1D physics is not any more valid especially for turbulence but not only
- Can horizontal shear TKE production "emulate" or mimic the 3D turbulence ?
- Full 3D turbulence is available in Meso-NH → comparison with AROME is very useful

- By adding this horizontal shear also in Meso-Nh → clean comparison

- Test at 500m on the TEAMx domain : Cold air pool case Inn Valley. Forecast starts the 15/10/2017@ 12UTC
  - Several test: 1D/3D ,mixing length : BL89/Deardorff, 1D with BL89 with pseudo 3D

$$\frac{\partial e_T}{\partial t} = advec - \left(\overline{u'w'} \frac{\partial u}{\partial z} + \overline{v'w'} \frac{\partial v}{\partial z} \right) + \beta \left(\overline{w'\theta'} \right) - \frac{1}{\rho} \cdot \frac{\partial \overline{\rho w'e_T'}}{\partial z} - c_\varepsilon \cdot \frac{\overline{e}_T^{3/2}}{l}$$

Towards 3D turbulence in AROME : Leo Rogel (DE_330), F. Voitus

$$\frac{\partial e_T}{\partial t} = advec - \left(\overline{u'w'} \frac{\partial u}{\partial z} + \overline{v'w'} \frac{\partial v}{\partial z} \right) + P_d^h + \beta \left(\overline{w'\theta'} \right) - \frac{1}{\rho} \cdot \frac{\partial \overline{\rho w' e_T'}}{\partial z} - c_\varepsilon \cdot \frac{\overline{e}_T^{3/2}}{l}$$

$$P_d^h = L_H^2 \sqrt{C_{mh}^3/C_\varepsilon} \left(\sqrt{\text{DEF}^2 + C_1^2 \text{DIV}^2} - C_1 \text{DIV} \right)^3$$

$$\text{DEF}^2 = \text{DST}^2 + \text{DSH}^2 \qquad \text{DIV} = \frac{\partial U}{\partial x} + \frac{\partial V}{\partial y} \qquad \text{DST} = \frac{\partial U}{\partial x} - \frac{\partial V}{\partial y} \qquad C_1 = \frac{1}{2\sqrt{C_{mh}C_\varepsilon}},$$

$$\text{DSH} = \frac{\partial V}{\partial x} + \frac{\partial U}{\partial y} \qquad C_{mh} = \frac{C_h}{C_{pv}}$$

Pseudo-3D formulation corresponds to Goecke et Maschulskaya (2021),
Lh as Wang et al. (2021) and a limiter on the term

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Cold Pool case : Wind Speed 16/10/2017 at 2UTC (+14h fc)

Obs
AROME 1.2km 4pts
AROME 500m 9 pts
AROME 200m 25pts

- 500m or even 200m do not improve the WS vs RS

Cold Pool case : Wind Speed 16/10/2017 at 2UTC (+14h fc)

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- Pseudo 3D in AROME → more mixing → not better

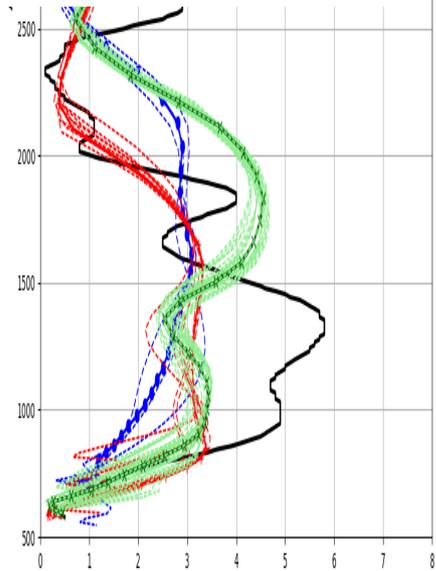**EWGLAM 2024 30 Sep - 3 Oct 2024, Prague, Czech Republic**

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- 500m or even 200m do not improve the WS vs RS
- Pseudo 3D in AROME → more mixing → not better
- In Meso-NH 3D or pseudo 3D with BL89 negative impact

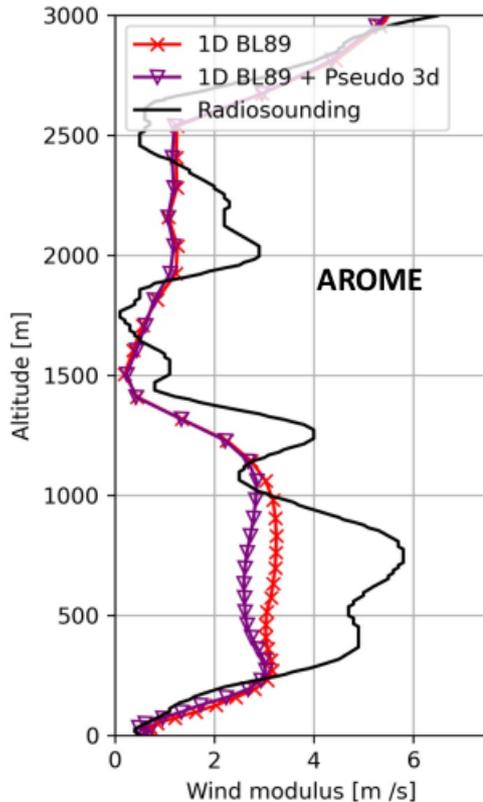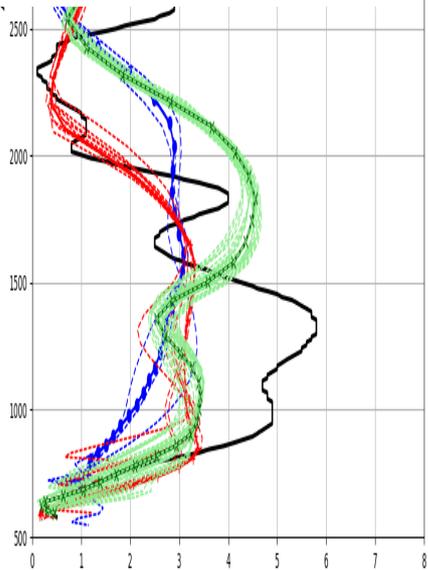**EWGLAM 2024 30 Sep - 3 Oct 2024, Prague, Czech Republic**

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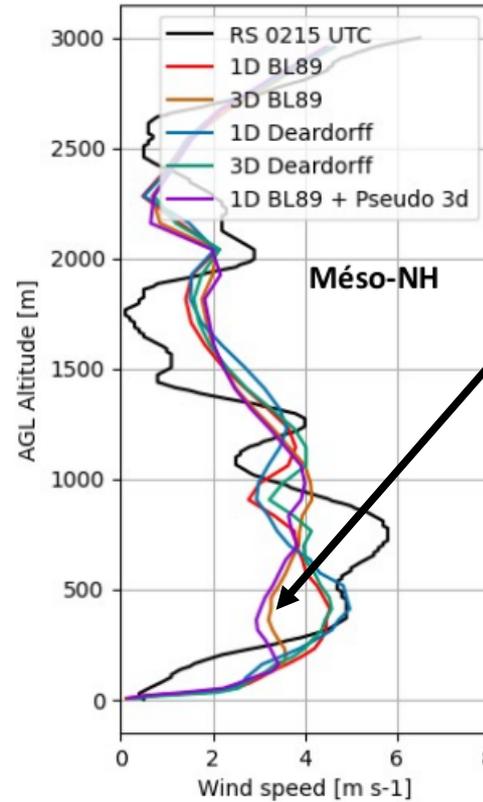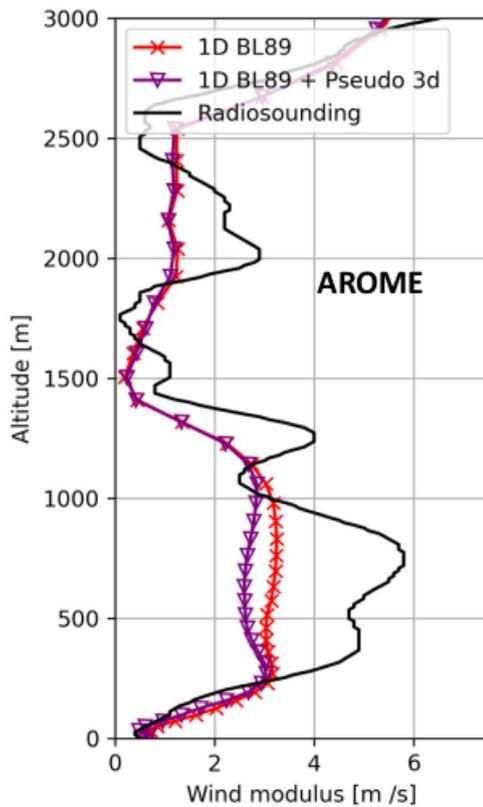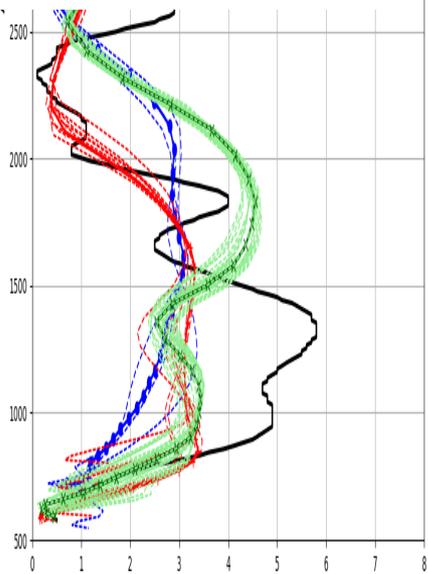- Pseudo 3D in AROME → more mixing → not better
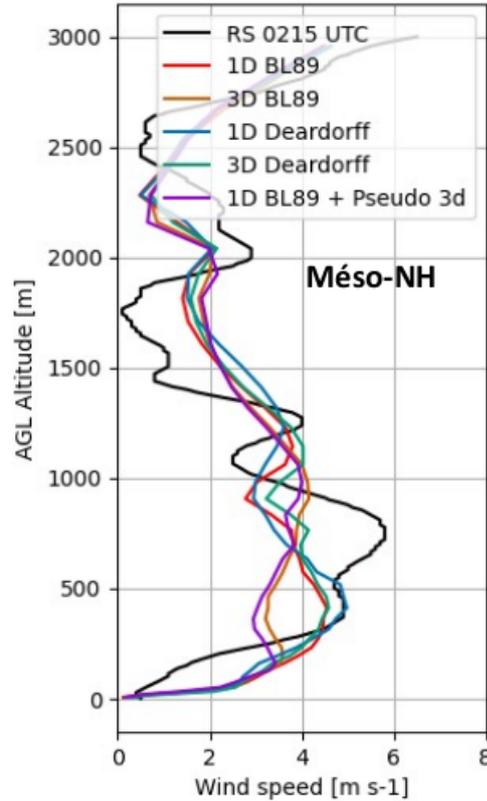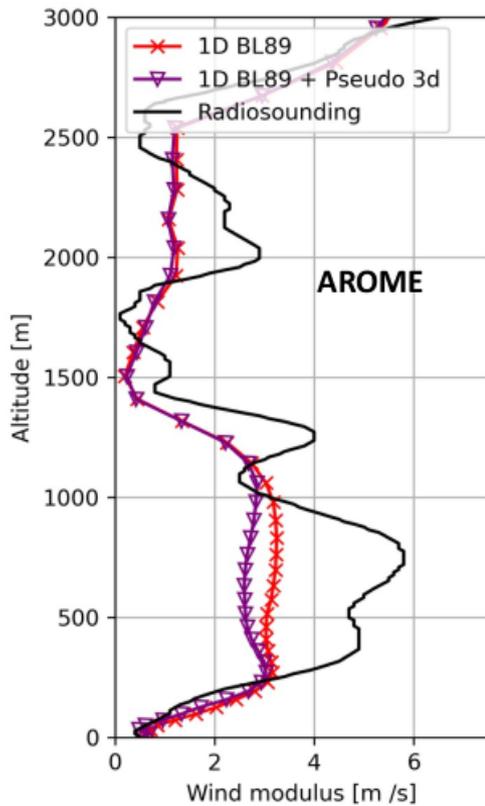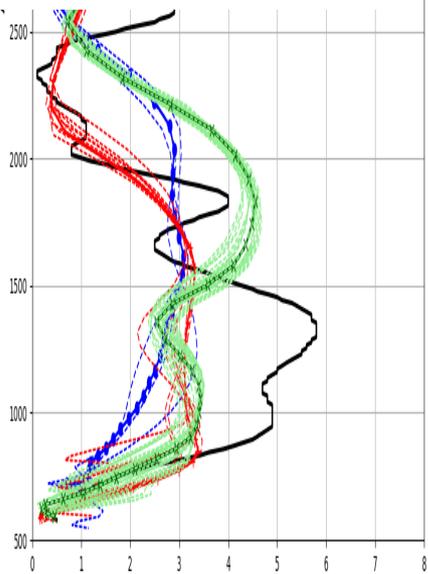- In Meso-NH 3D or pseudo 3D with BL89 negative impact

- The vertical mixing length (Lv) is also a key parameter to evaluate the horizontal shear production
- Lh need to be improved also !

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Conclusions and ...

- Not easy to show the added value of the 500m vs 1.3km
  - 10m Wind is improved for the MedAlps domain but not for Paris, the multi-layer scheme (Schoetter et al. 2020), interaction between TEB and several levels can help
  - In mean 2m temperature is neutral but UHI is better simulated at 500m at least for some cases
  - Almost no impact on precipitations but it was necessary to increase the coupling frequency (15mn) at least for the Paris domain
- However, now the two AROME@500m can be used by the forecasters and their feedback will be very useful

- High density observations not really available for NWP validation in near real time → difficult to show the added value

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Conclusions and some doubts ..

- Increasing horizontal resolution only is not enough, work on physics is still needed !
- Doing only dynamical adaptation for the 500m without surface assimilation especially with new input data as ECO-SG, OSM etc .. could be one the reason of the poor added value ...

- For the 3D aspect in turbulence: better understanding of the results with the horizontal shear production, need to work on Lh but also on the vertical one (BL89) comparison with Méso-Nh was very beneficial especially to better understand the slope effect in the turbulence (not shown ... next year !)

- Encouraging results for the shallow convection (A. Marcel) but need to be confirmed in 3D, especially the scale aware aspect linked with the turbulence

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