

Recent progress in AROME physics

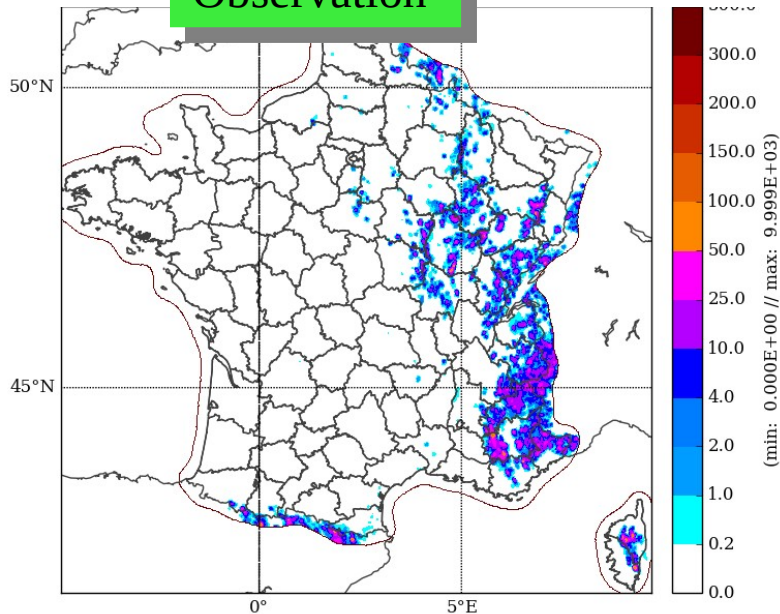
Yann Seity, Rachel Honnert, Sébastien Riette, Benoît Vié, V. Masson

Outline :

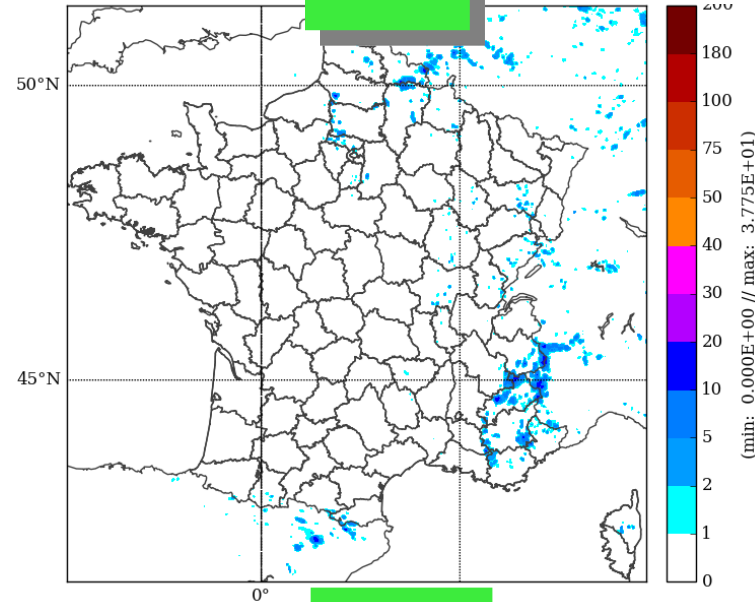
- New oper suite (cy46t1_op June 2022)
 - Better consistency microphysics/dynamics
 - Ensemble PE-AROME at the same resolution as deterministic (1,3km)
- Next e-suite (cy48t1_op start expected 2023)
 - Radiation : EcRad
 - Tunings in turbulence for low clouds
- For longer terms
 - Aerosols
 - Microphysics
- Paris 2024 RDP

On real case : 25 July 2018 (RR24)

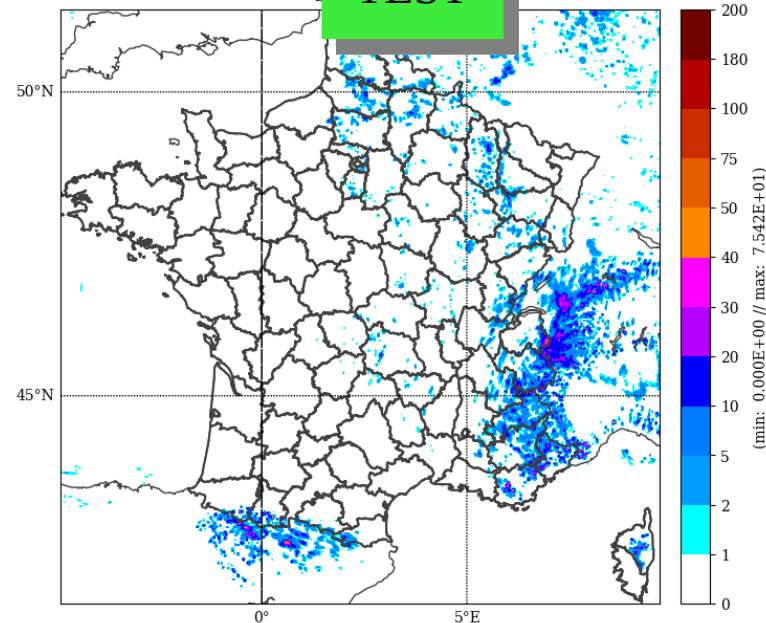
Observation



OPER



TEST

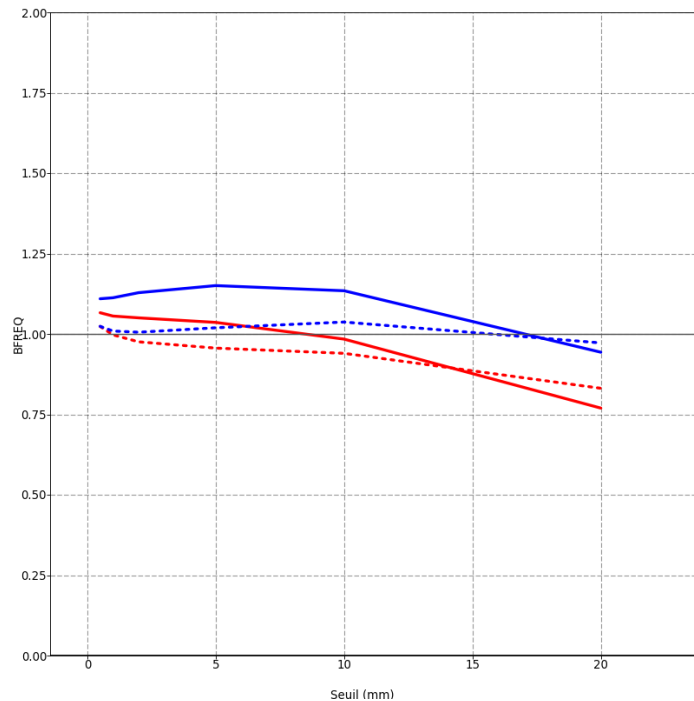


- Fix a problem of mass conservation by the use of linear interpolators for hydrometeors in semi-lagrangian, remove gridpoint diffusion (SLHD)
- Improve rain forecasts of weakly forced diurnal convection

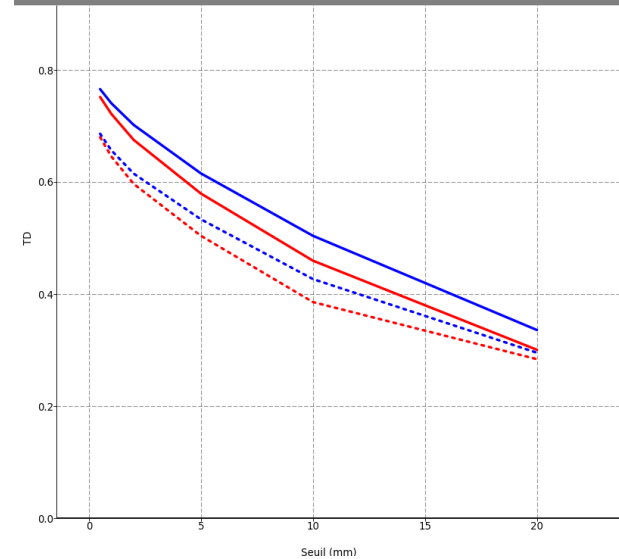
Evaluation over one year (RR6, 0 TU start)

TEST/OPER

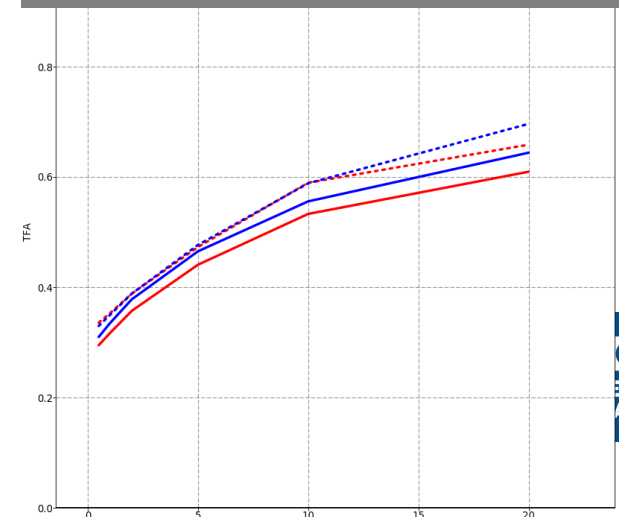
Frequency bias
At+18 (—) and at +30 (--)



Probability Of Detection
At+18 (—) and at +30 (--)



False Alarms Rate
At+18 (—) and at +30 (--)



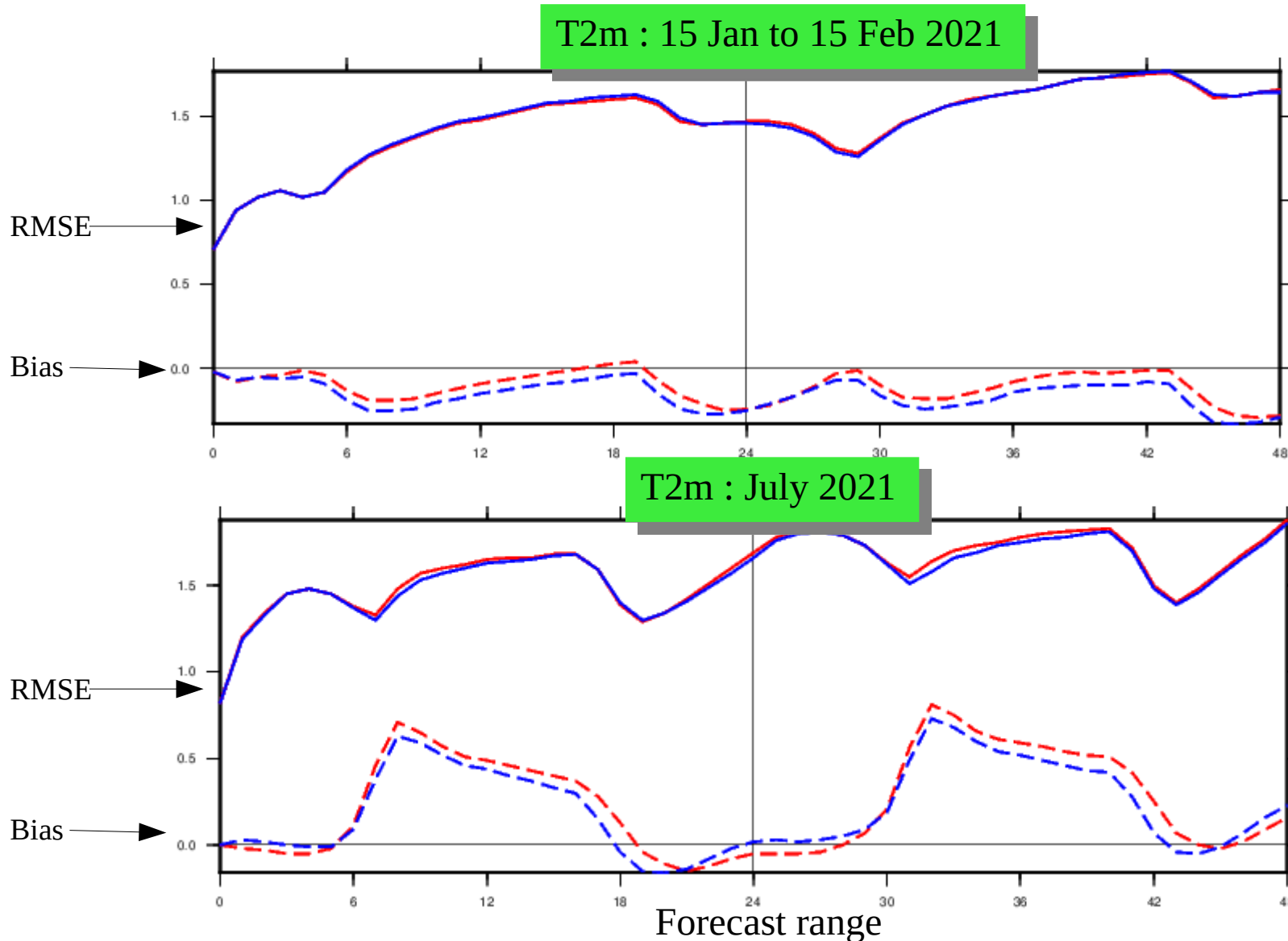
- Better Frequency bias except at convective time for $RR6 < 15\text{mm}$
- Better POD, worst FAR only at convective time

(→ Courtesy from F. Stoop)

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EcRad versus Oper

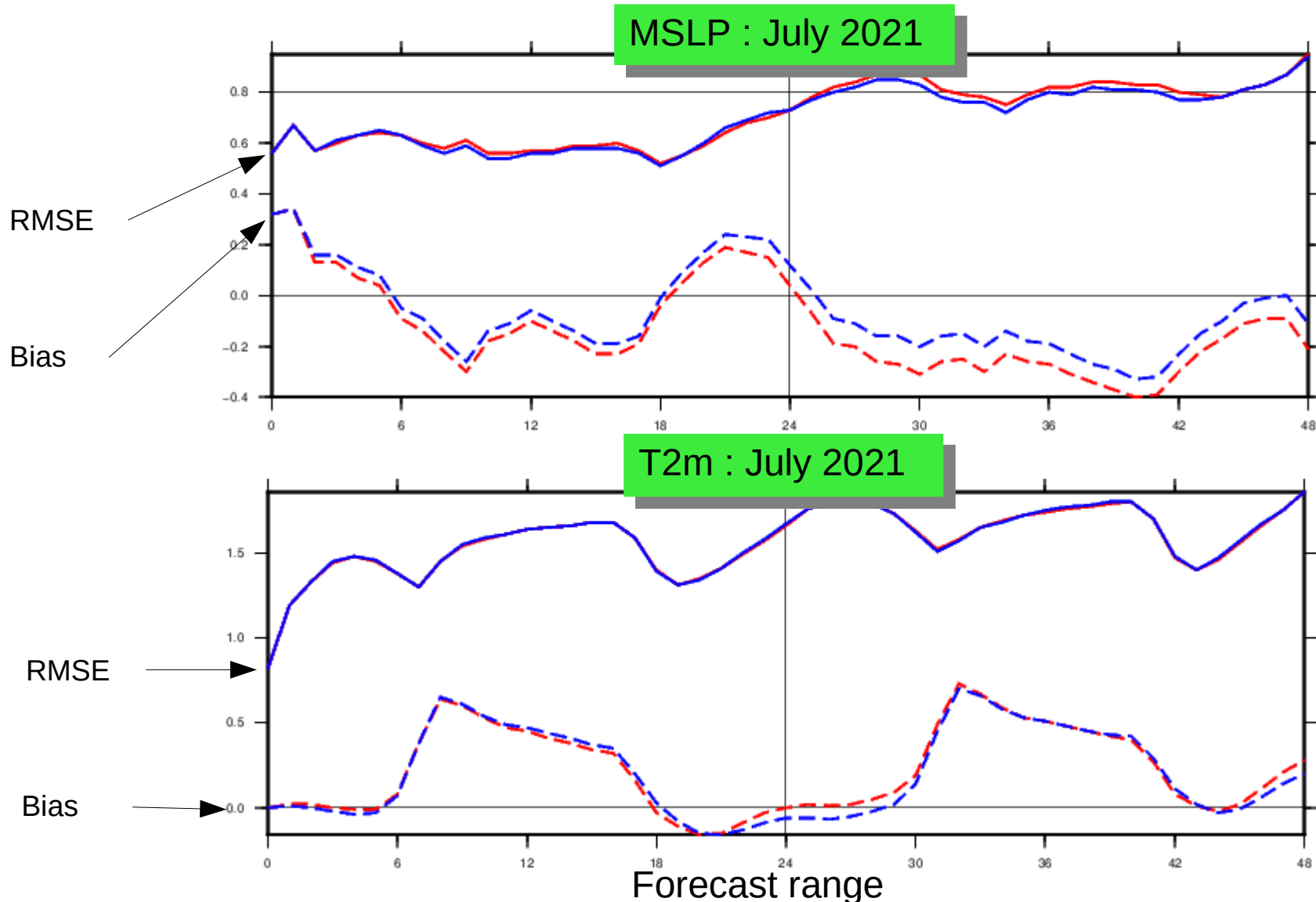


→ EcRad scores close to Oper

→ new optical properties also tested but with little impact on scores (not shown)

Aerosols : EcRad+CAMSAERO versus EcRad

- In EcRad : new aerosols climatologies available based on CAMS (in CY46T1 : 2D, in CY48T1 : 3D)

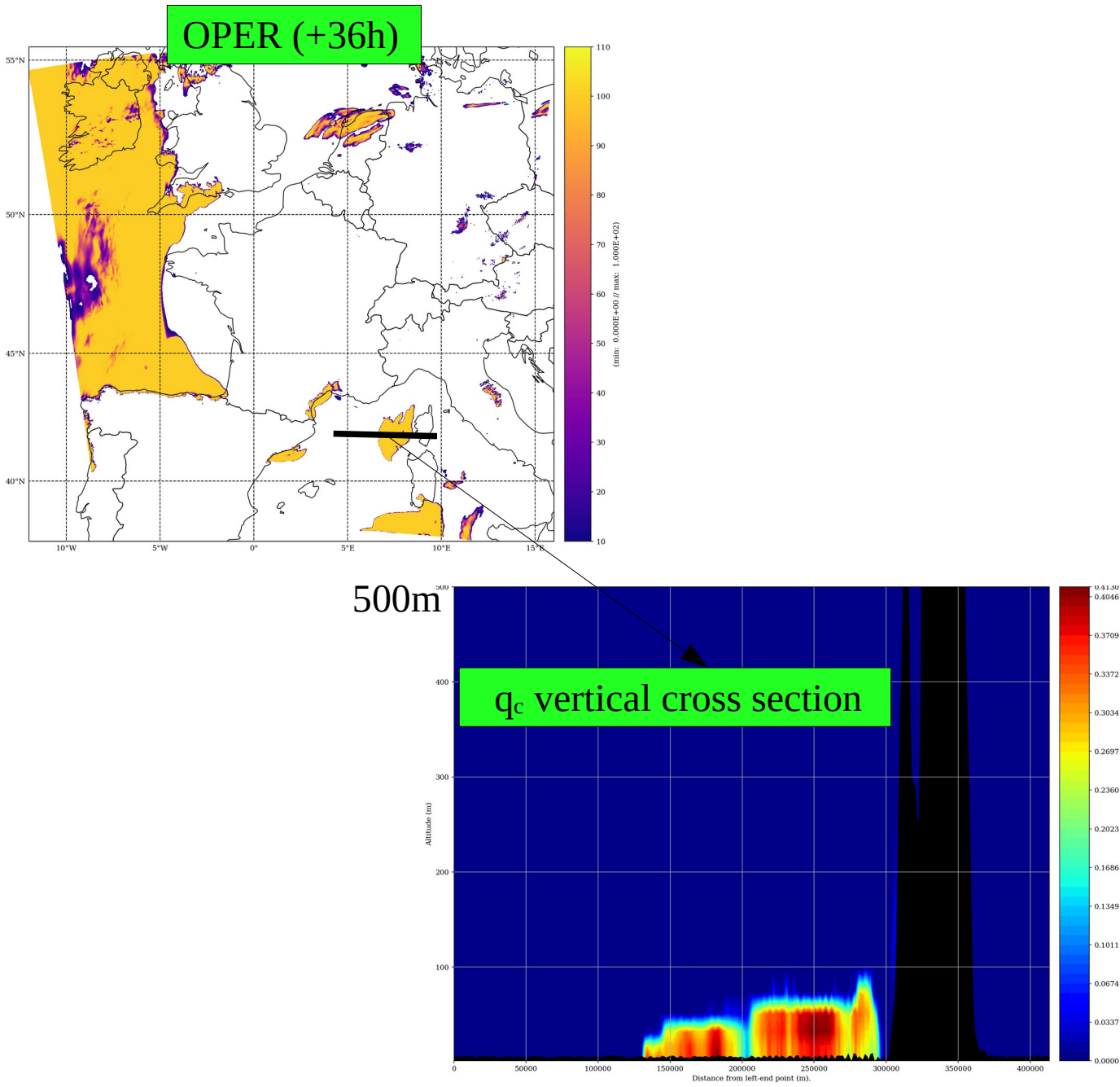


→ On July, improvements on surface pressure with CAMS Aerosols clims.

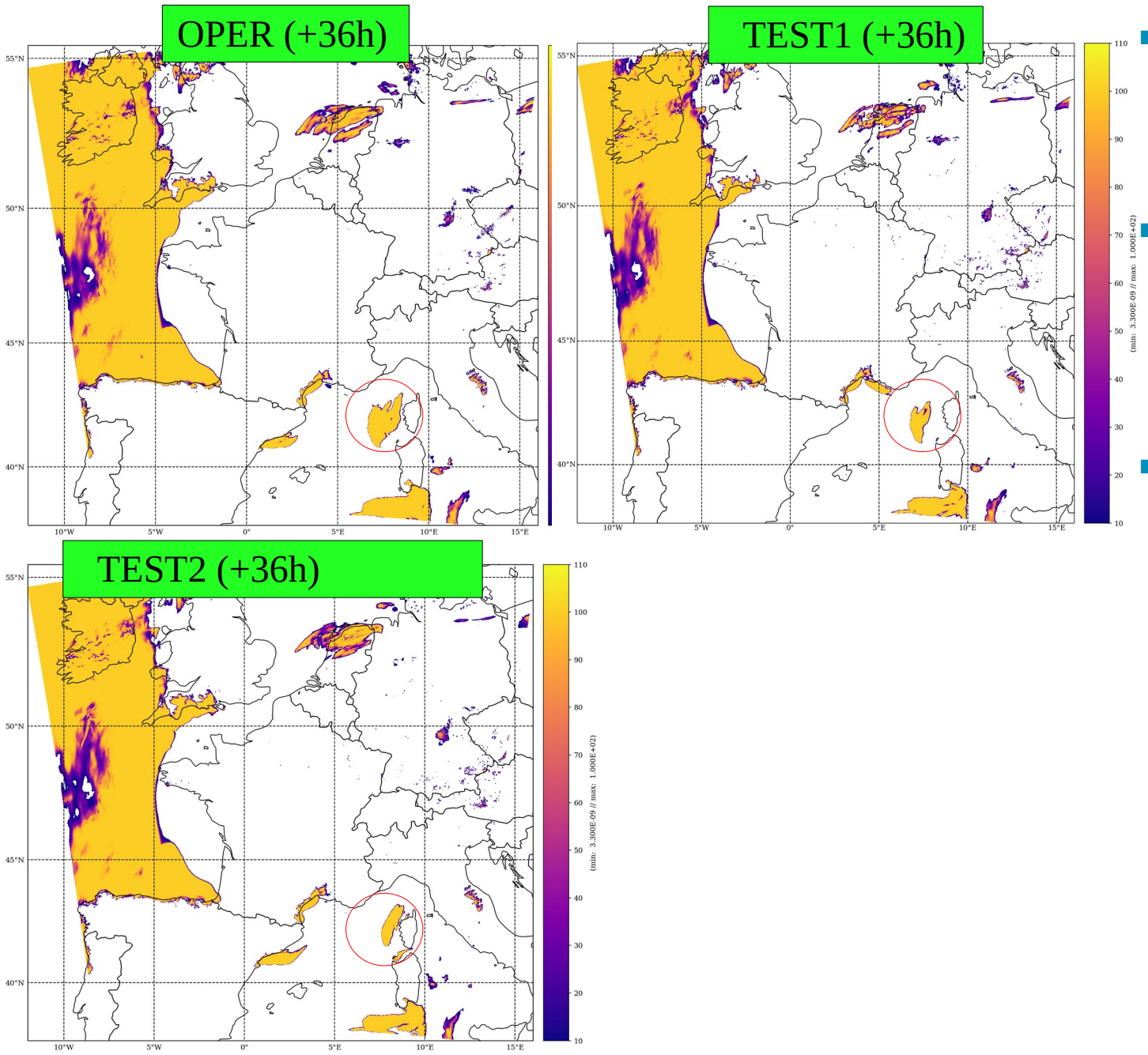
Persistent low clouds over sea

- Forecasters complain 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

1st June 2019 case (run starting 31 May 0TU)



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



In oper, turbulence parametrisation increment on conservative variable q_t ($q_v + q_c + q_i$) is put on q_v

In TEST1, 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

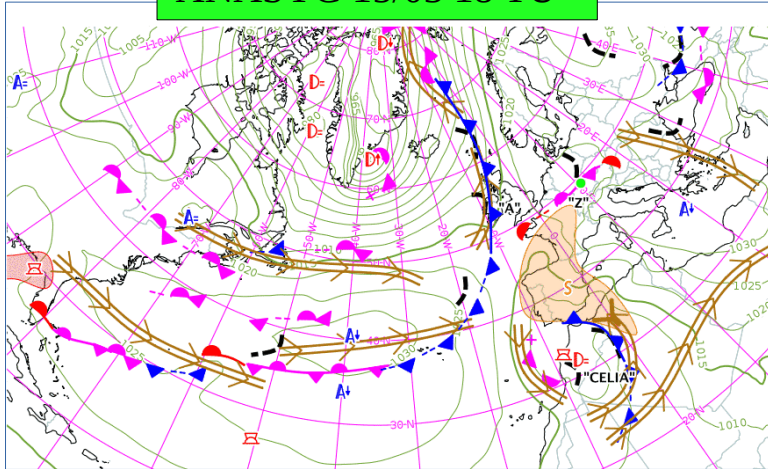
In TEST2, coefficients in BL89 corrected (Bugfix from Pascal Marquet), and Lup modified as in ARPEGE (more mixing in the top of clouds)

Outline :

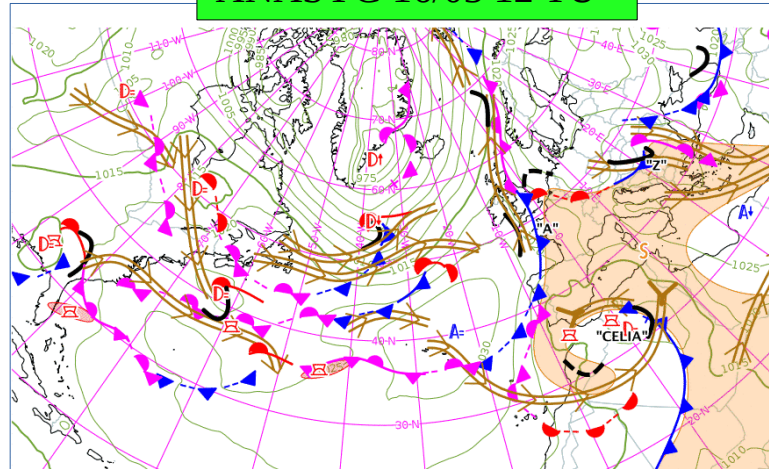
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A significant saharian dust event over France (15 - 17 March 2022)

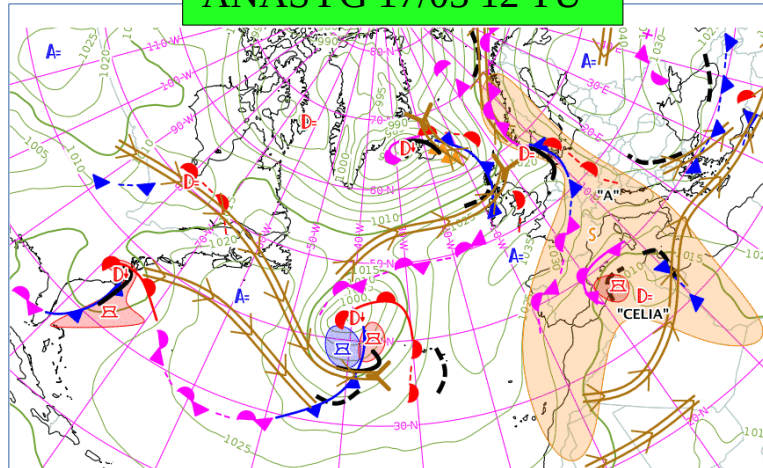
ANASYG 15/03 18 TU



ANASYG 16/03 12 TU



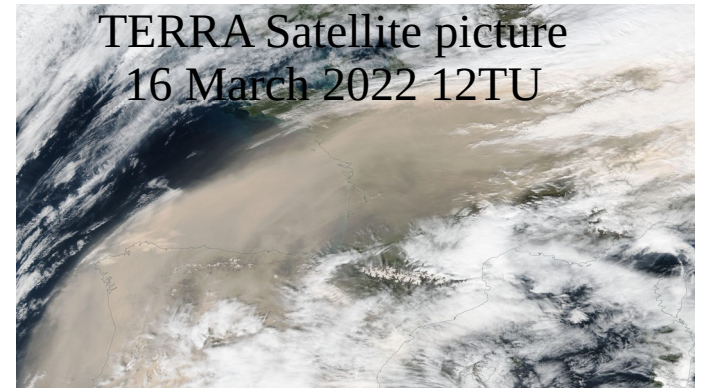
ANASYG 17/03 12 TU



Piau ski-resort
webcam (Pyrenies)



TERRA Satellite picture
16 March 2022 12TU

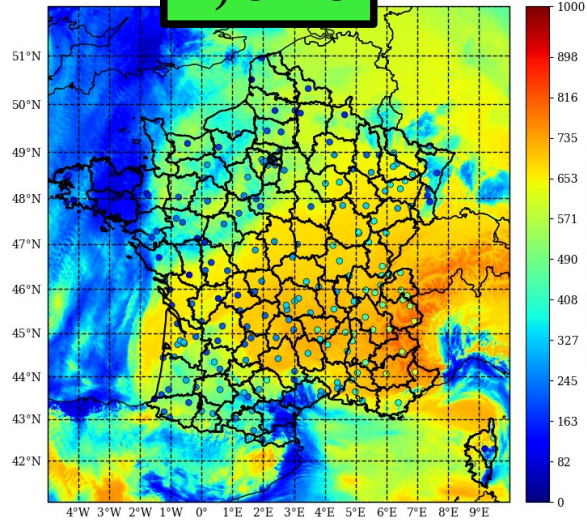


- Large errors in T2M by our operational models (→ pb for energy sector, as electricity for instance)

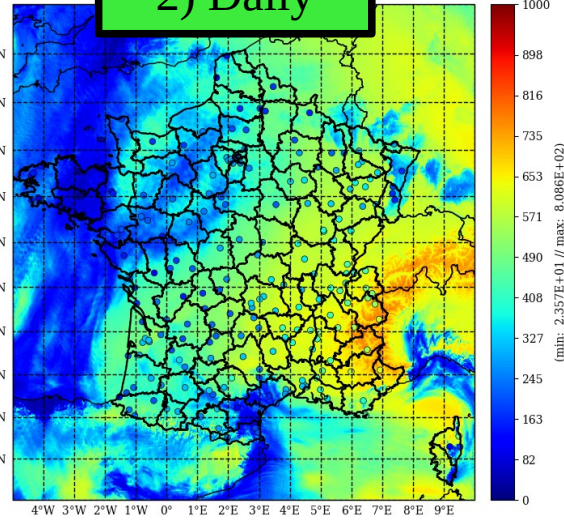
Radiative impact of the use of daily CAMS aerosols in EcRad :

Mean surface downward SW flux between 11 and 12 TU :

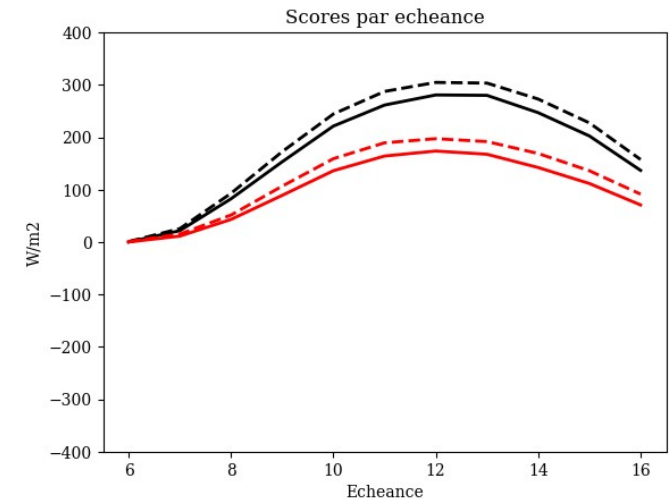
1) clims



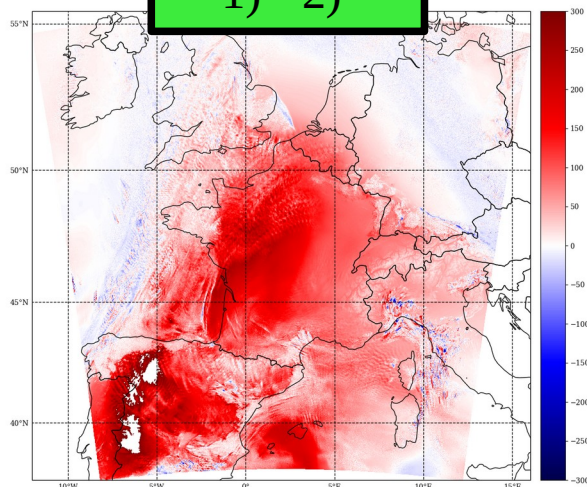
2) Daily



— Biais clim de CAMS 2D — Biais aerosols de CAMS du jour
- - Rms clim de CAMS 2D - - Rms aerosols de CAMS du jour



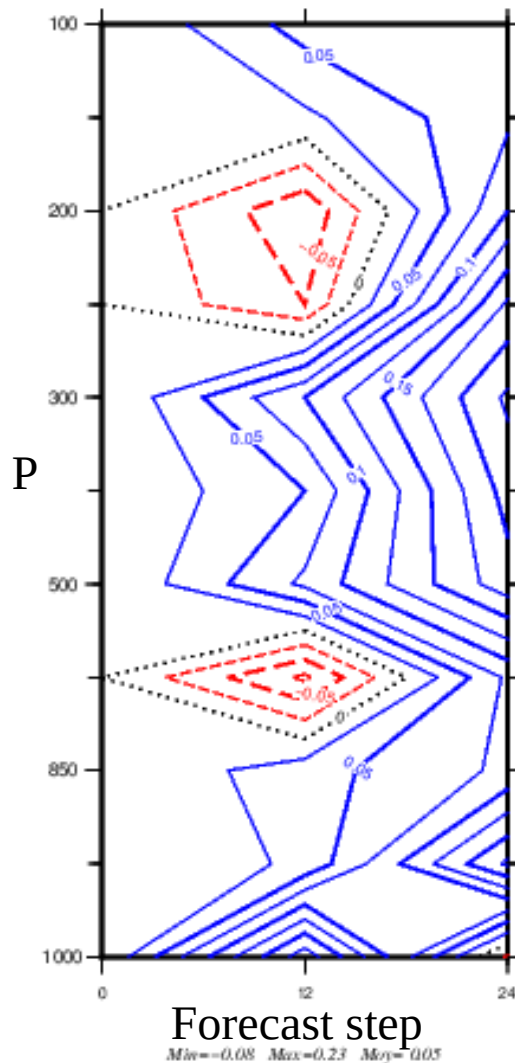
1) - 2)



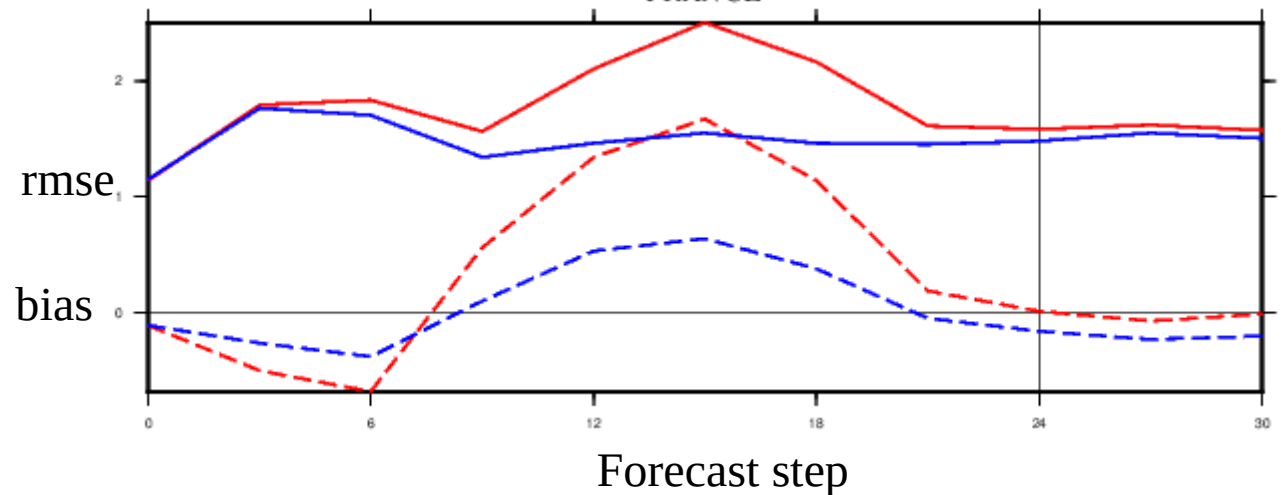
→ The use of daily CAMS aerosols fix half of the radiative bias (with -120 W/m²)

Temperature impact of the use of daily CAMS aerosols in EcRad :

Temperature : Exp -
Ref bias compared
to RS



T2m : Exp / Ref



- Half of the T2m bias is also fixed (correction de -1°C)
- Improvements also higher in the atmosphere, increasing with forecast lead time

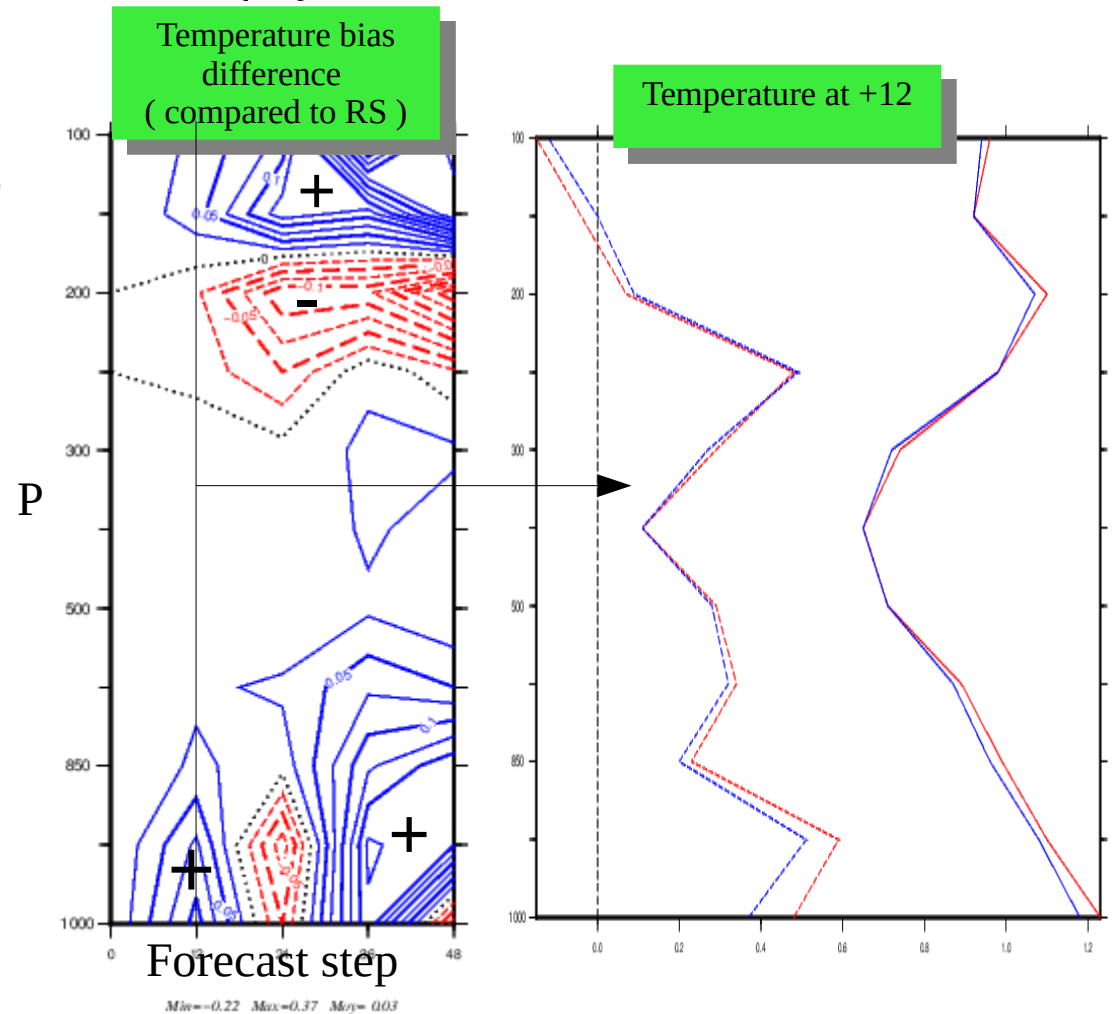
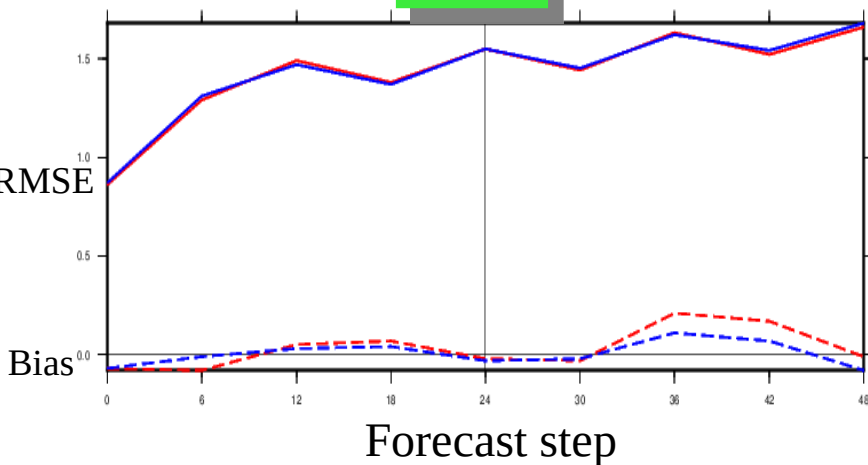
Impact on a longer period

- 11 aerosols taken from CAMS forecasts, added in model initial file and provided to EcRad.
- Fields are advected by SL with no significant extra cost (linear interpolators)
- Only radiative effect, no interaction with microphysics

24-07 to 31-08-2021 :

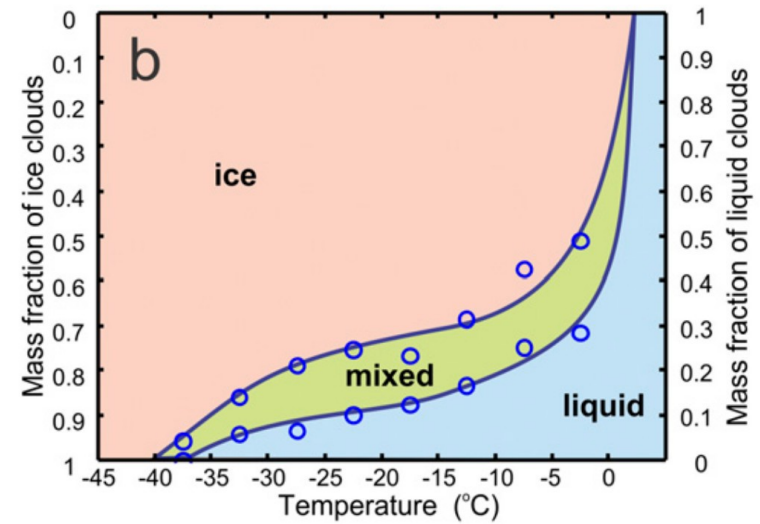
EcRad /
EcRad+CAMS

T2m



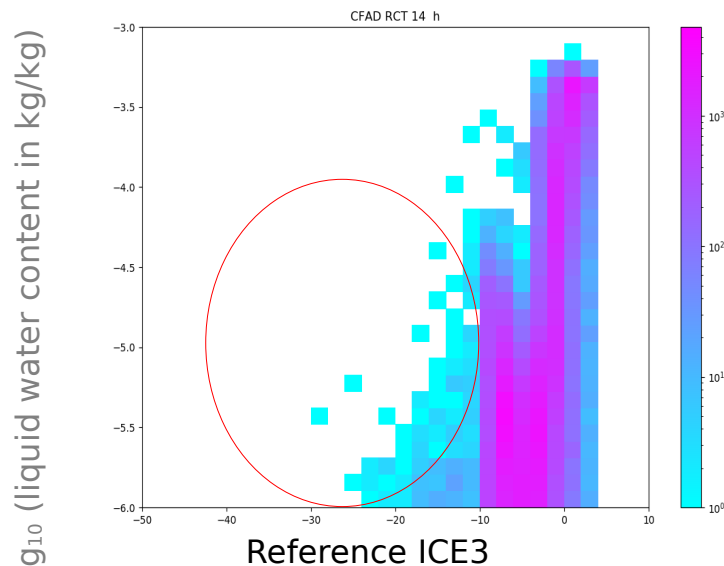
Work on the representation of supercool liquid water

- Oper model microphysics is not able to reproduce observations



Korolev et al (2017)

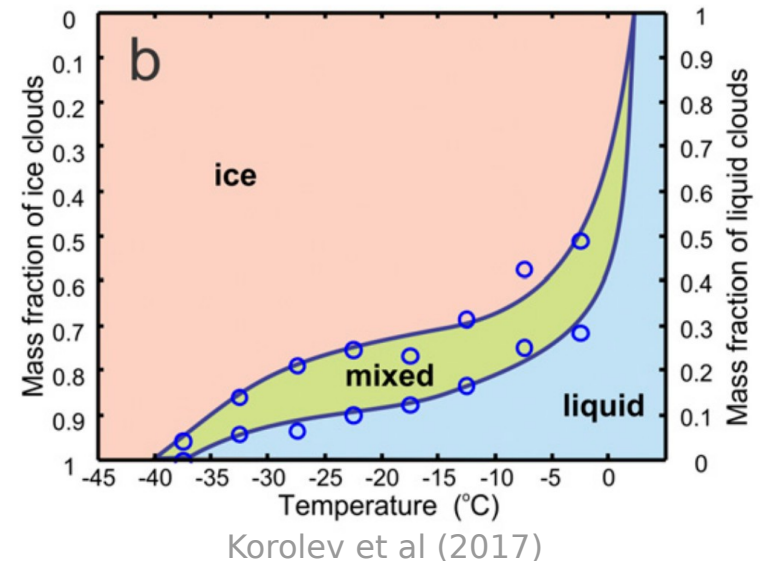
Number of grid boxes classified in bins of temperature and cloud liquid water content in an ICE3 simulation



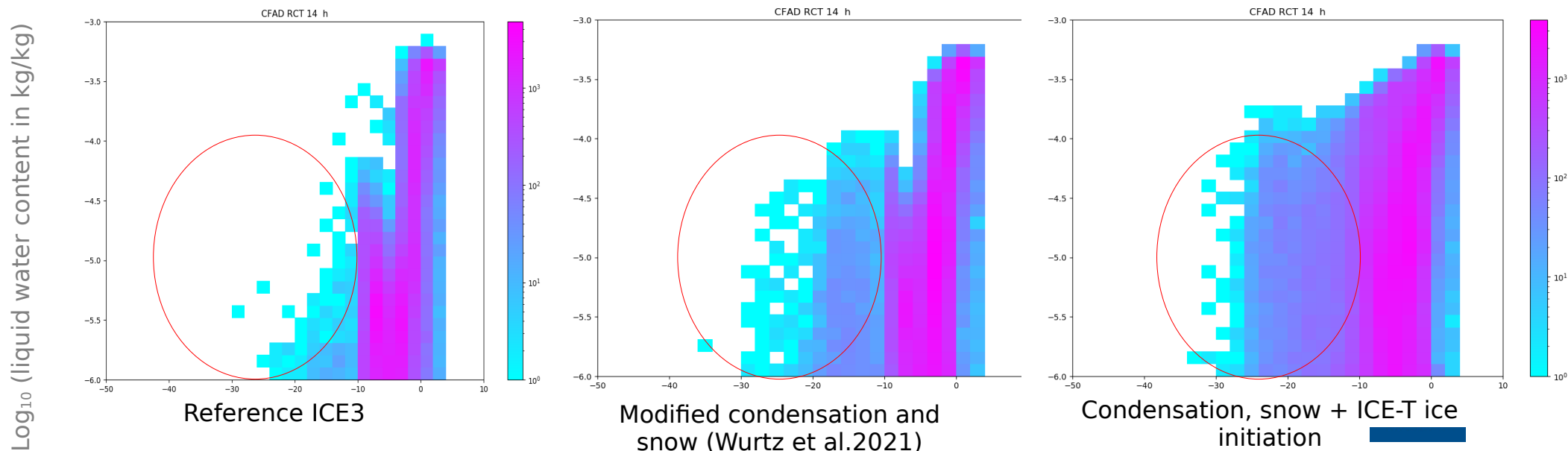
(→ Courtesy from R. Dupont)

Work on the representation of supercool liquid water

- Oper model microphysics is not able to reproduce observations
- Some promising results with modifications...



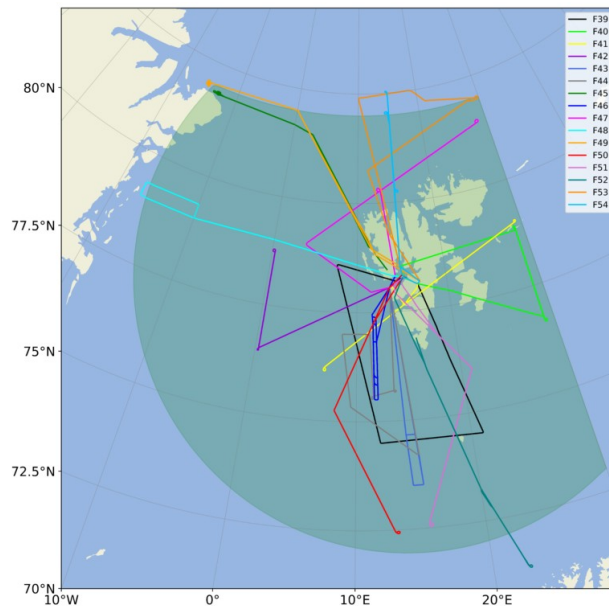
Number of grid boxes classified in bins of temperature and cloud liquid water content in an ICE3 simulation



(→ Courtesy from R. Dupont)

Work on the representation of supercool liquid water

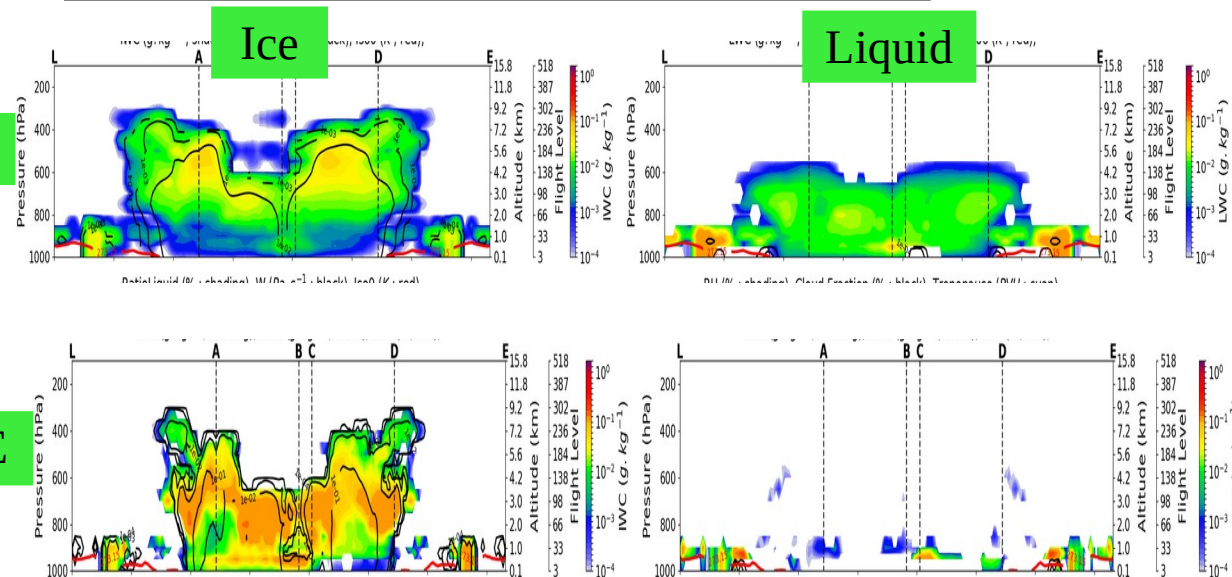
- We need observations and will use :
- ICICLE  (March 2019 US)
- (RALI-)THINICE (August 2022 around Svalbard)



ARPEGE

AROME

25th August vertical cross section (FL53) :



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Paris Olympics Research Development Project 2020-2024

Endorsed by WMO/WWRP



Objectives, partners and their interests

To advance research on the “future Meteorological Forecasting systems at 100m (or finer) resolution for urban areas”.



	Urban Heat Island (Paris)	Thunderstorm (Paris)	Air Quality (Paris)	Sea Breeze (Marseilles)
BoM	x	(x)		x
ECCC	x	x		
ECMWF	x	x		x
IUM	x	x		
JMA	x	x		
UKMO	x	x	x	
CNRM	x	x		x
SMHI	x		x	
NCAR	x			
univ. Cologne	x			
KNMI	x	x		
univ. Wageningen	x			

- High-res NWP
- Nowcasting
- Impacts

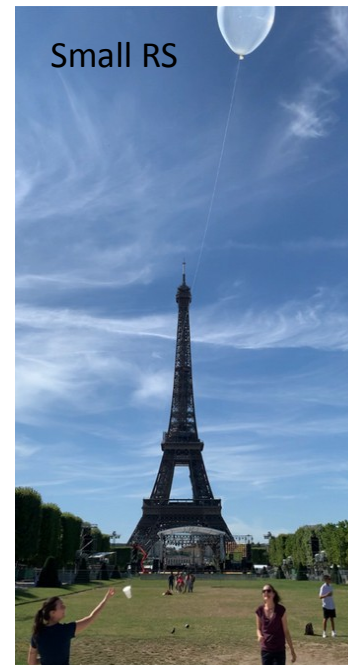
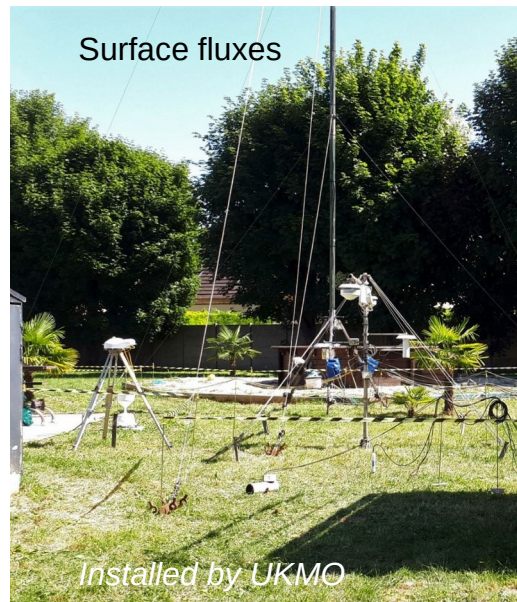


RDP

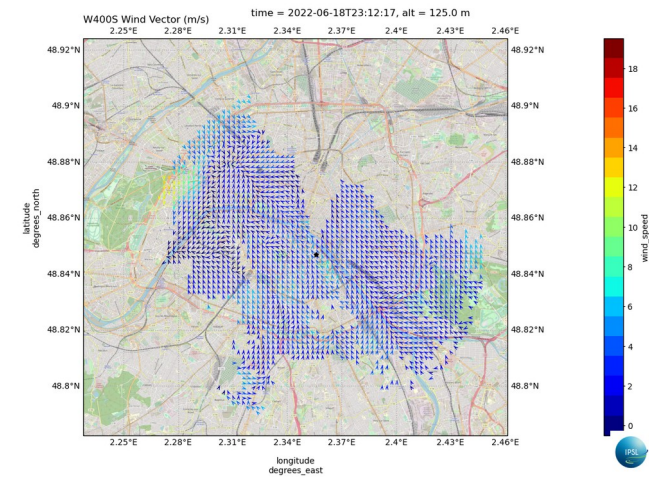


Experimental campaign in summer 2022: PANAME2022

PARis region urbaN Atmospheric observations and models for Multidisciplinary rEsearch



PANAME
2022



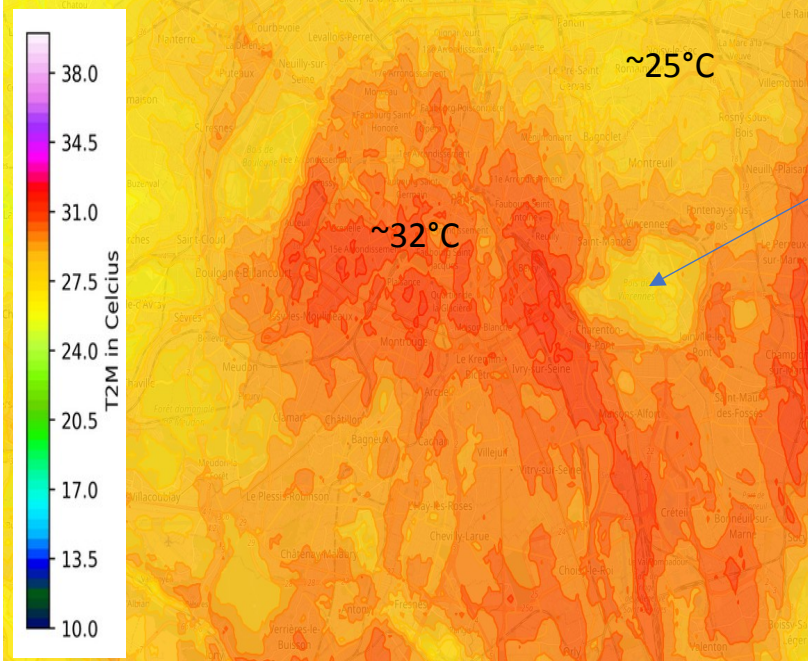
Forecast & real-time Numerical simulations

- Real time 48h simulations for whole 2022 summer (AROME @500m and MesoNH @100m)
- Objective:
 - Study of capability of hectometric model to simulate the **Urban induced weather phenomena**

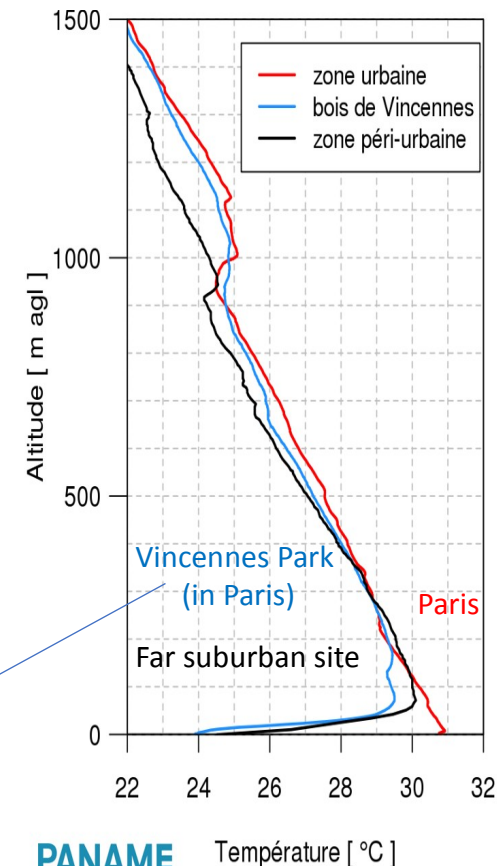
Example of Input : Building density
(computed from Open Street Map)



Urban Heat Island at midnight the 20th June
(MesoNH model @ 100m of res.)



20th June 22TU



PANAME
2022

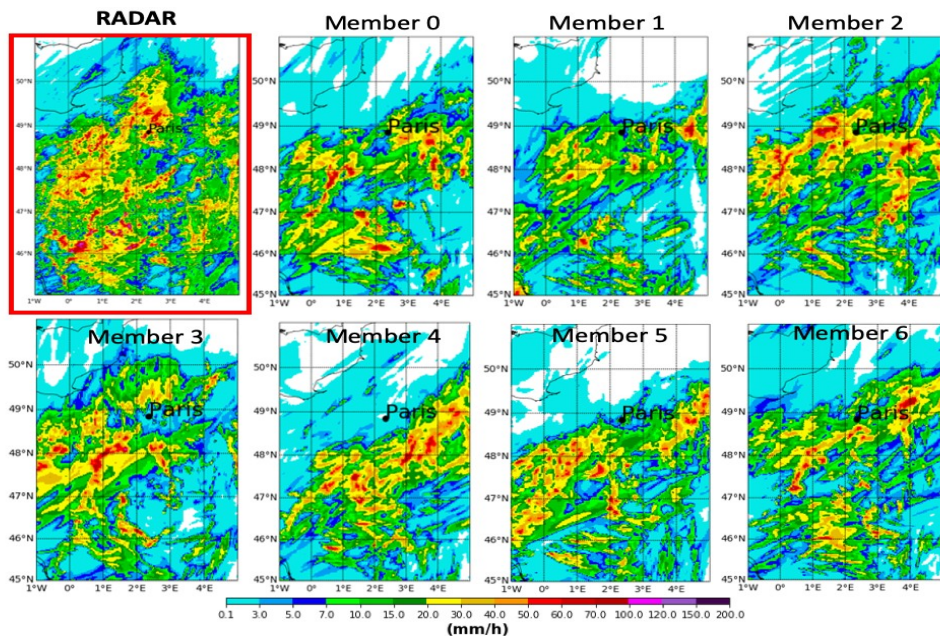
Température [°C]

J. Wurtz (CNRM)



High-resolution modeling : 1) Thunderstorm case (2017)

Large-scale validation Ensembles

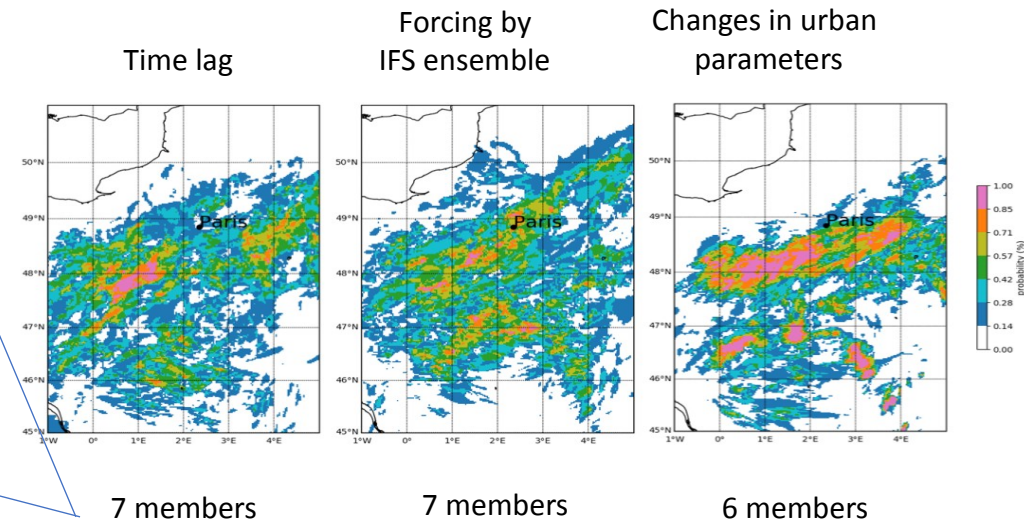


36h accumulated rainfall

AROME model members

Source: Ashriah Andani, KNMI

Probability of 36h accumulated rainfall ≥ 20 mm



- Urban impacts to be studied next
- synoptic forcing has a significant impact on that case
- more recent cases will be studied

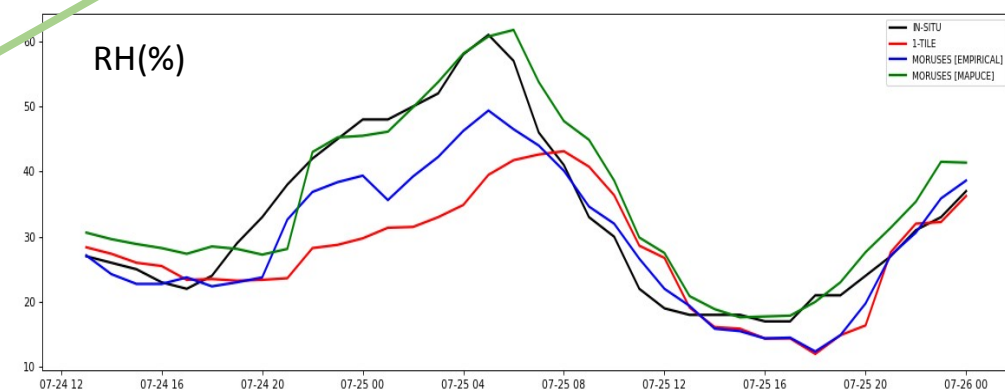
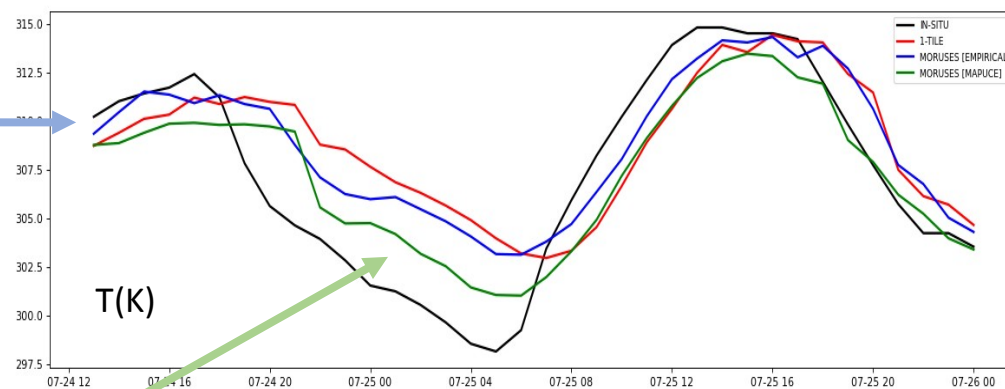
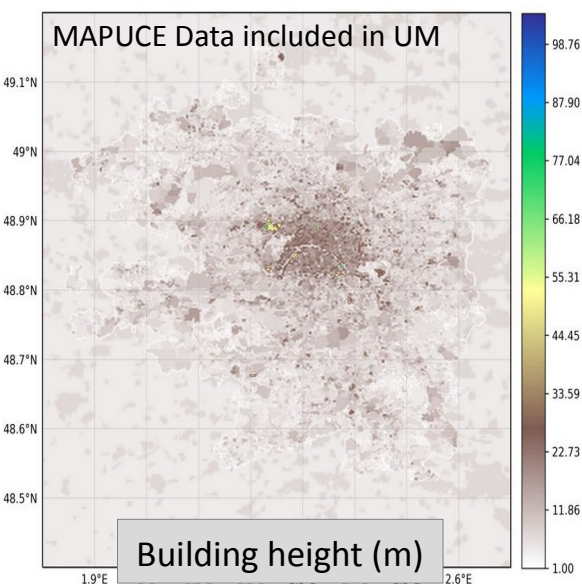
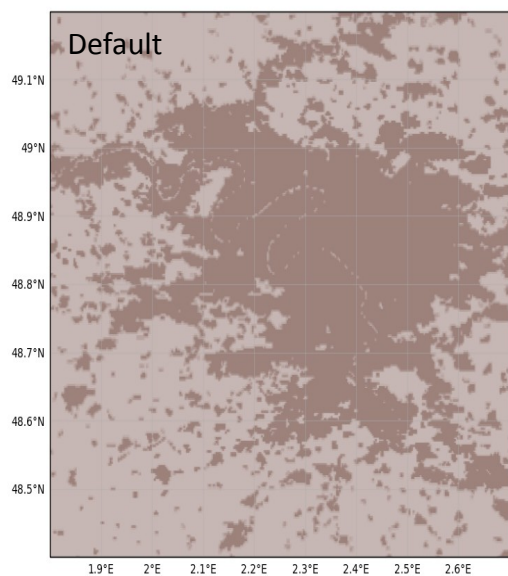
High-resolution modeling : 2) Urban Heat Island case (July 2019 Case)

Inclusion of High-resolution urban dataset



Australian Government
Bureau of Meteorology

Example in *Unified Model*



Source: Vinod Kumar, BoM



**Thank you for your attention !
Question ?**



M. July-Wormit: Evaluate and improve LIMA

- LIMA is a 2-moment microphysical scheme

Droplets	Drops	Ice	Snow	Graupel	Hail
r_c N_c	r_r N_r	r_i N_i	r_s N_s	r_g N_g	r_h N_h

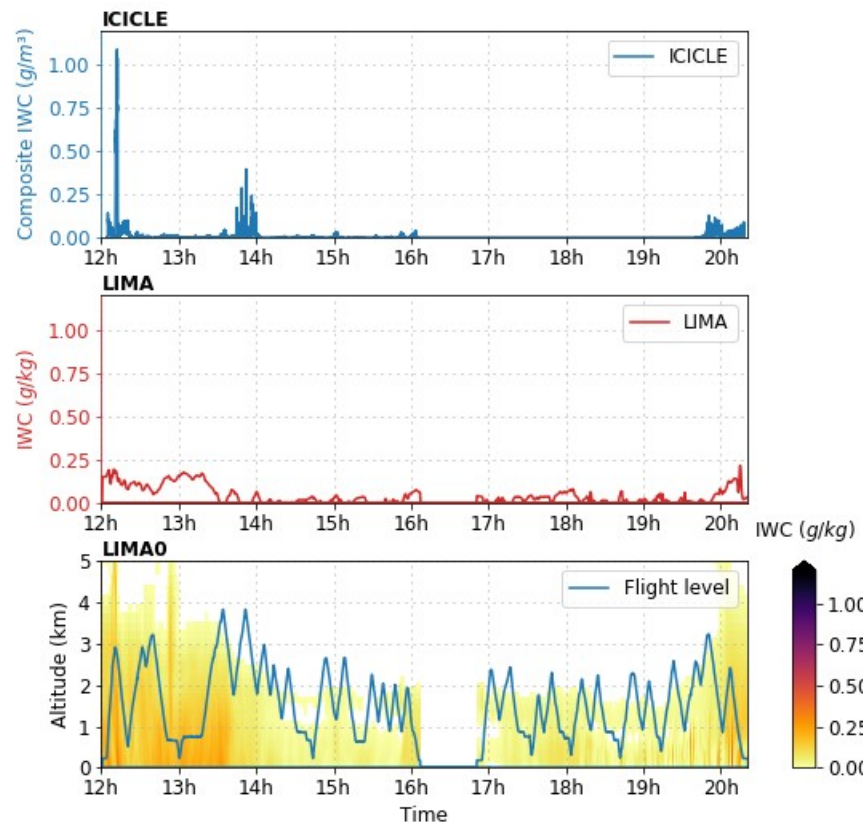
r: mass mixing ratio (kg.kg⁻¹)

N: number conc. (#.kg⁻¹)

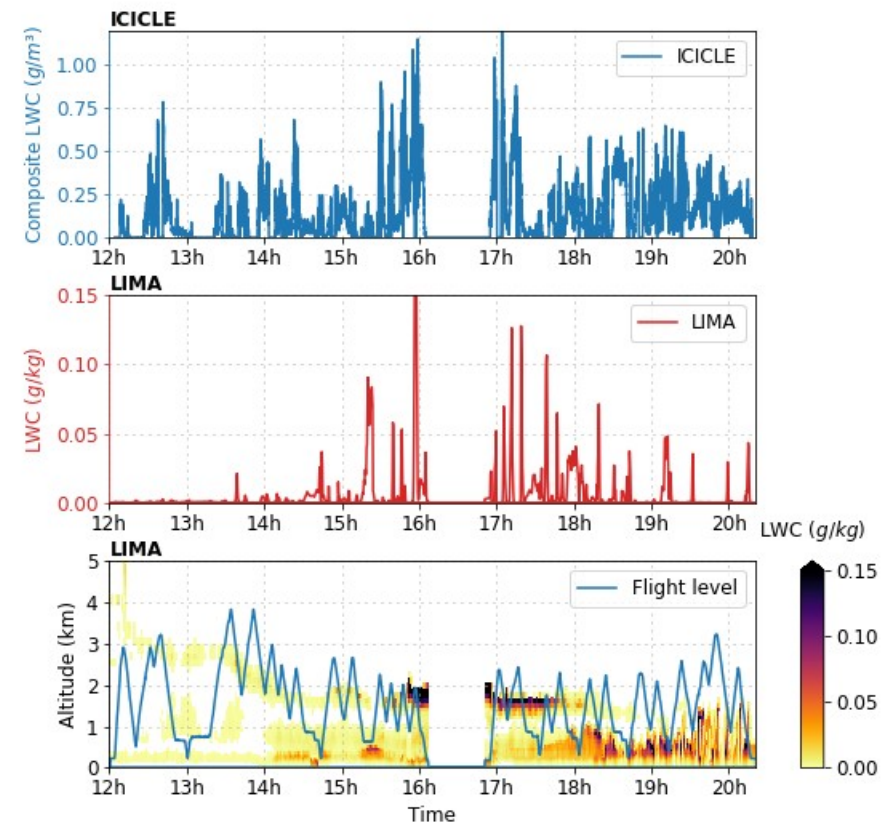
- Built upon ICE3, with improved representation of processes
- Includes prognostic aerosol-cloud interactions
 - no ice initiation if no ice nuclei available

M. July-Wormit: Evaluate and improve LIMA

Solid water content



Liquid water content



Along flight ice and liquid water contents (M. July-Wormit)