Recent progress in AROME physics

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Outline :

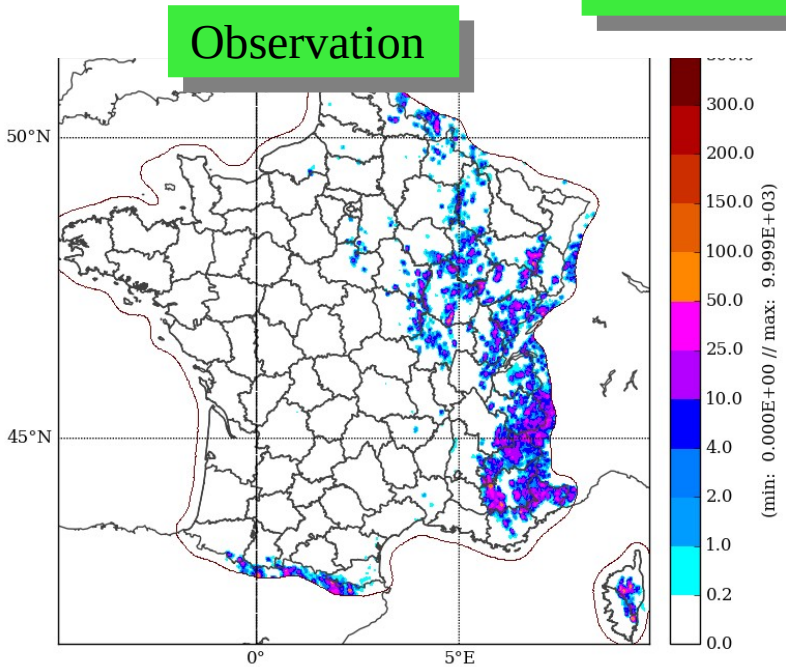
- For next e-suite (2021) :
  - Improve physics/dynamics consistency
  - Ecume v6 parametrisation
  - New diagnostics (Lightning, convection...)

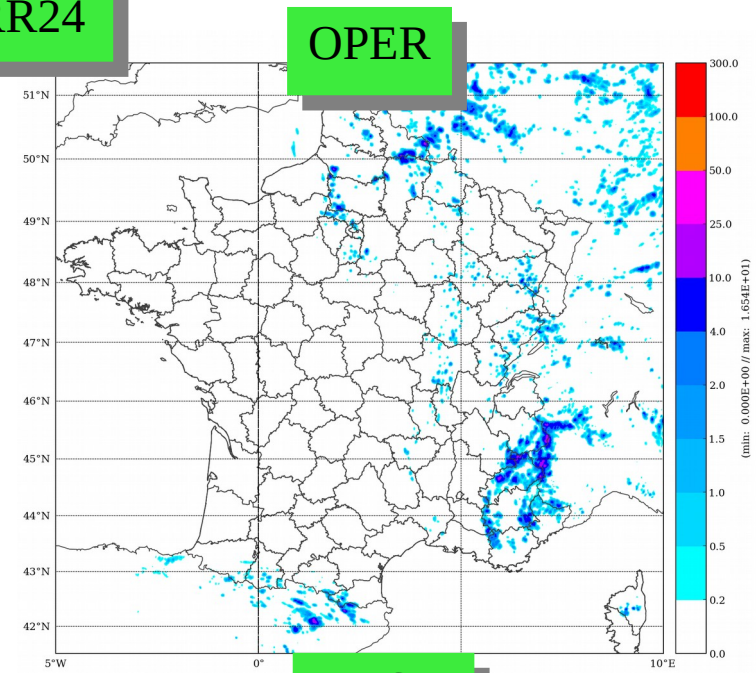
- For longer terms
  - Improve fog forecasts (SOFOG3D)
  - Convection triggering climatology
  - Cold microphysics
  - Radiation
  - New diagnostics

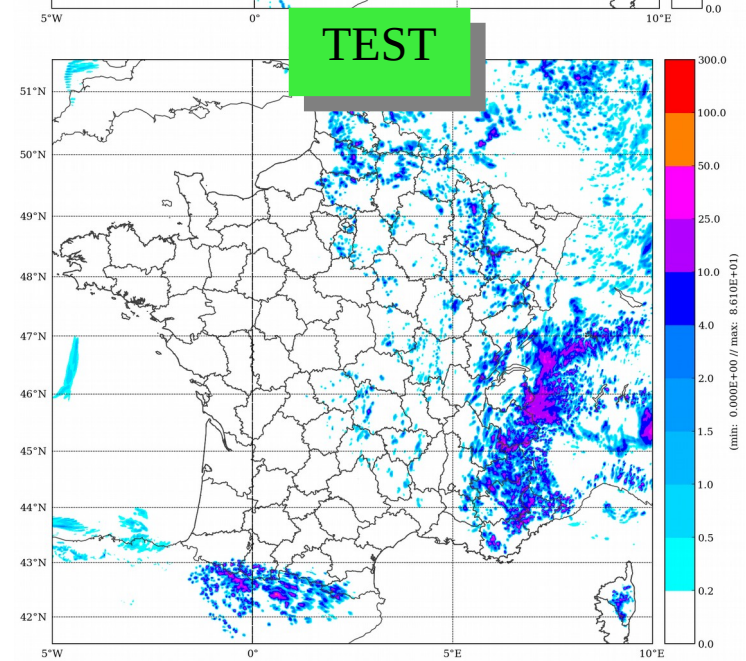
METEO FRANCE

New tunings for hydrometeors in order to fix mass conservation problem

25 July 2018 RR24







- For all hydrometeors :
  - Remove SLHD diffusion
  - Use Linear SL interpolators
  - Activate COMAD

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Sea surface fluxes : Ecume V6

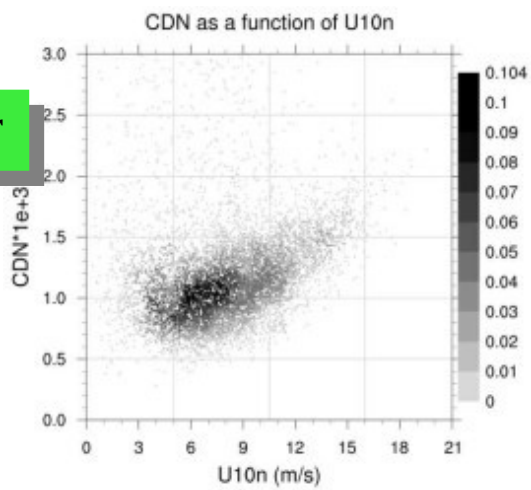
$$Param\_U = \left(\frac{C_{dn}}{\sqrt{C_{dn}}}\right) X \Delta U_{10m}$$

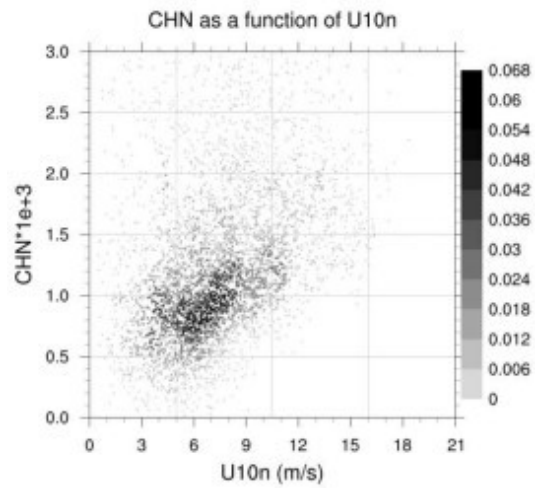
$$Param\_\theta = \left(\frac{C_{hn}}{\sqrt{C_{dn}}}\right) X \Delta U_{10m}$$

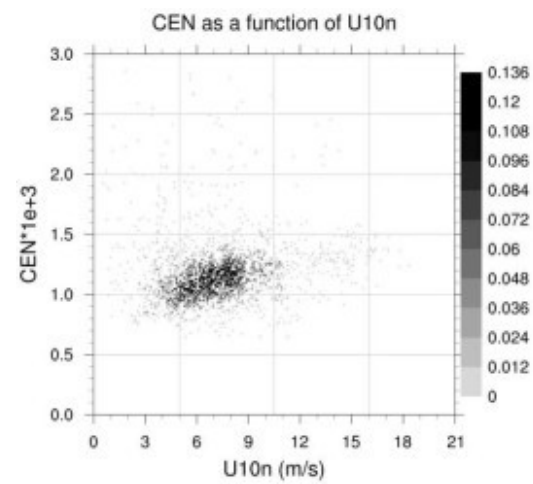
$$Param\_q = \left(\frac{C_{en}}{\sqrt{C_{dn}}}\right) X \Delta U_{10m}$$

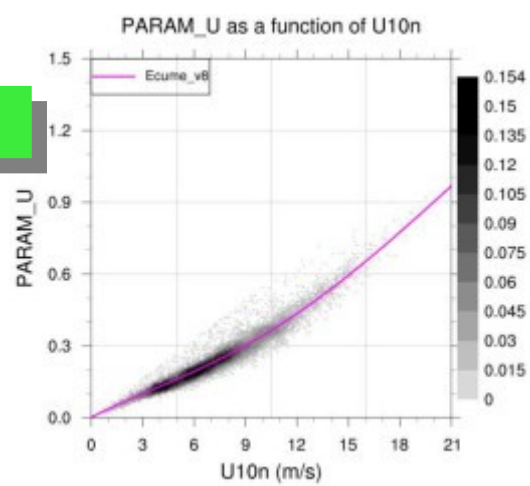
Oper

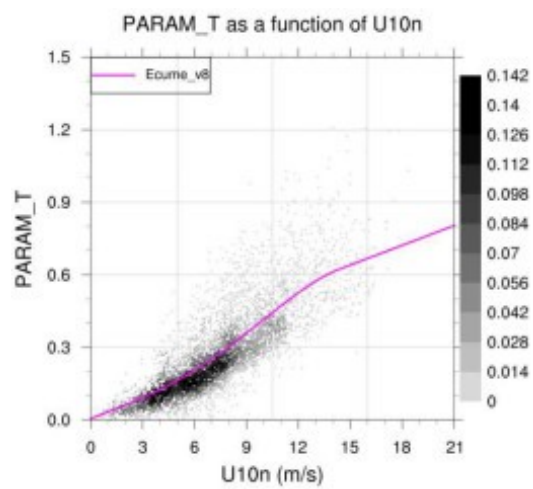
Test

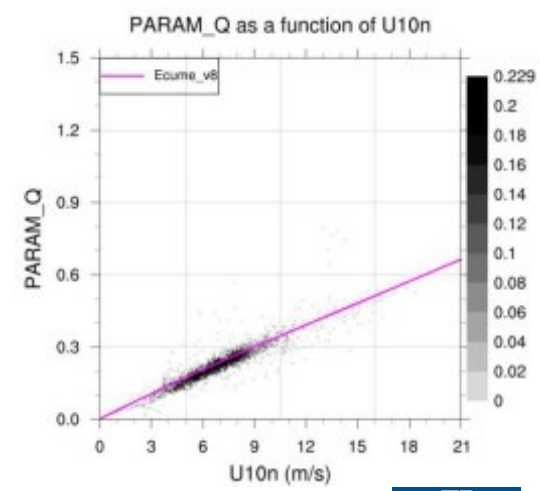












From S. Belamari

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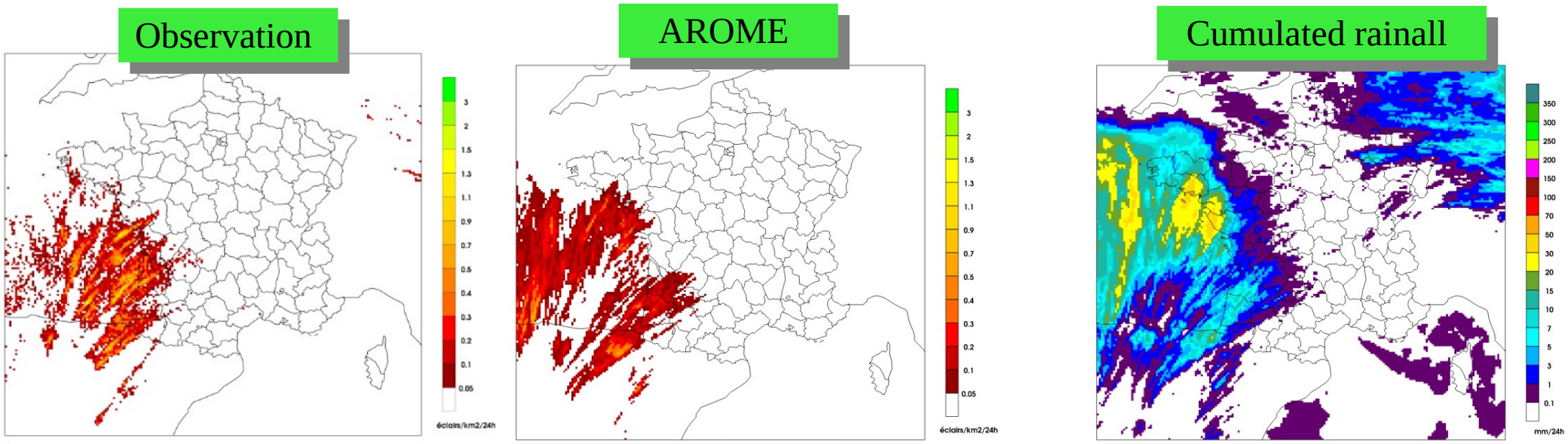
Diagnostics

- Lightning diagnostic based on Mc Caul (2009)
- Related to gaupel flux at -15°C
- Example of May, 5th 2020, 24h cumulated :



- + other convection diagnostics (CIN,MLCAPE,Cloud base and top)

Outline :

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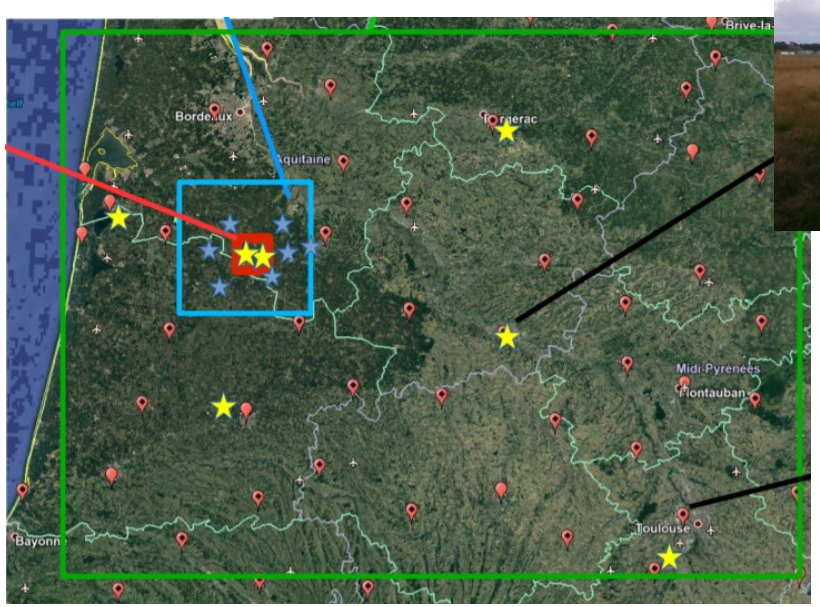
  - New diagnostics (Lightning, convection...)

- **For longer terms**
  - **Improve fog forecasts (SOFOG3D)**
  - **Convection triggering climatology**
  - **Cold microphysics**
  - **Radiation**
  - **New diagnostics**

METEO FRANCE

SOFOG 3D experiment

- October 2019 → March 2020 in SO of France
- Dedicated instruments : UAVs, tethered baloon (microphysics, turbulence), instrumented mast, radiometers, cloud radars...
- 15 IOPs



SOFOG 3D experiment : AROME forecasts

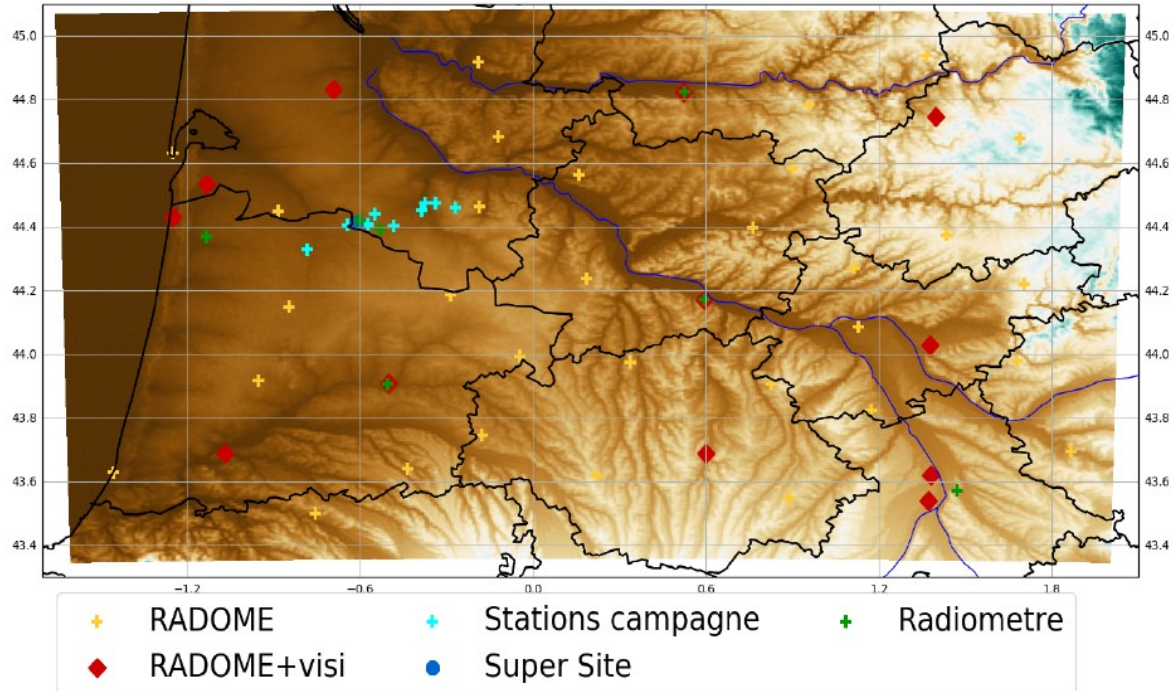
- dedicated runs on SOFOG domain, without data assimilation, starting and coupled with AROME oper :

  AROME 1,25 km L90 (as oper), 1st level at 5m

  AROME 500m L156, 1st level at 1m (Philip et al., 2016)

  AROME with LIMA microphysics (Vié et al., 2016)

	Droplets	Drops	Ice	Snow	Graupel
mixing ratios	q_c	q_r	q_i	q_s	q_g
concentration	N_c	N_r	N_i		

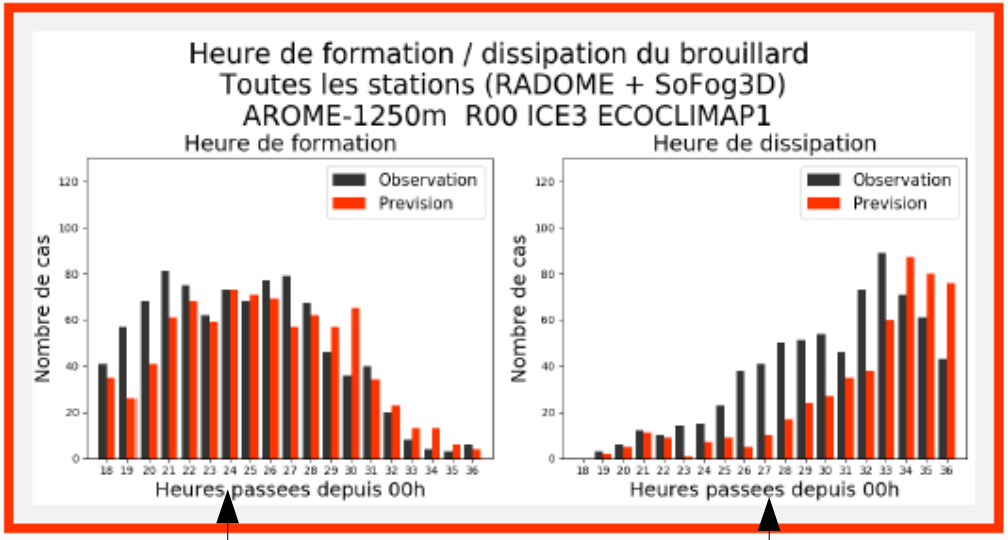


~ 200 km

Statistics on the 6 months (on all surface stations)

- More fog in 500m configurations, but also more false alarms
- Model delay in fog formation (especially @1250m) and dissipation
- Too long fog events in the model

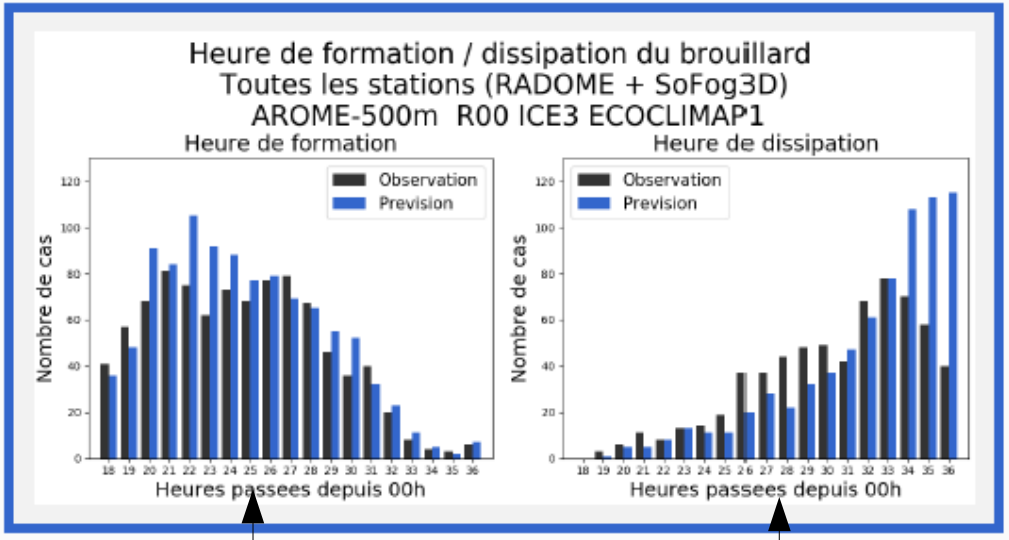
AROME-1250mL90 ICE3 (wod-wisc)



Starting time of Fog

Dissipation time of Fog

AROME-500mL156 ICE3 (wod-wisc)



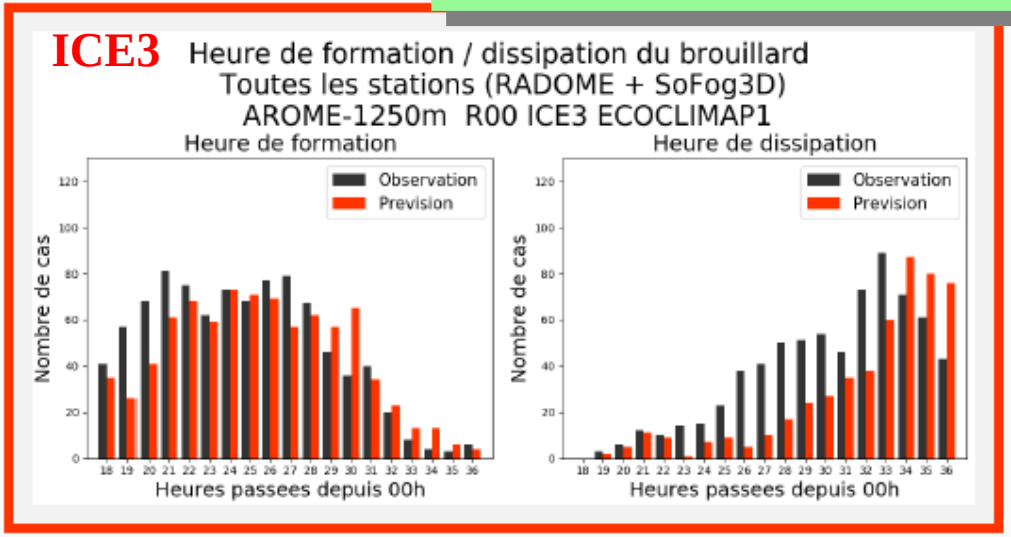
Starting time of Fog

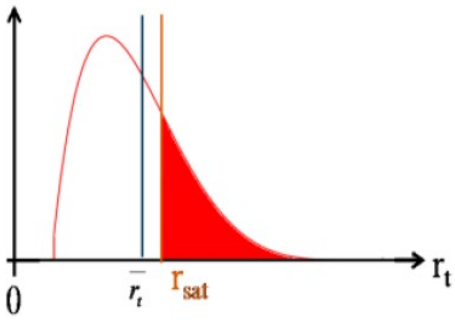
Dissipation time of Fog

Strong impact of Subgrid condensation Scheme

AROME-1250mL90

With subgrid condensation



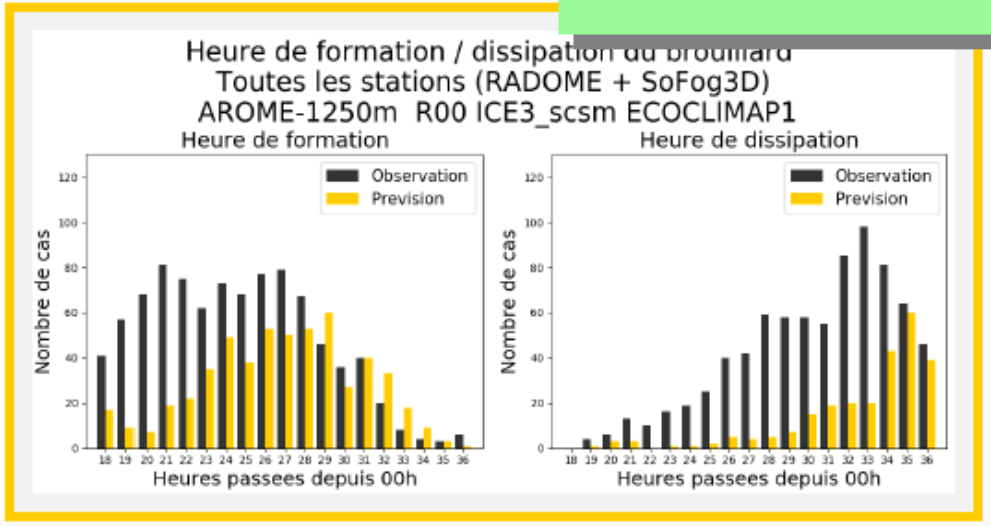


B/ **Partially saturated** case

$\Rightarrow$ **0<CF<1**

AROME-1250mL90 ICE3

Without subgrid condensation (CF=0 or 1)

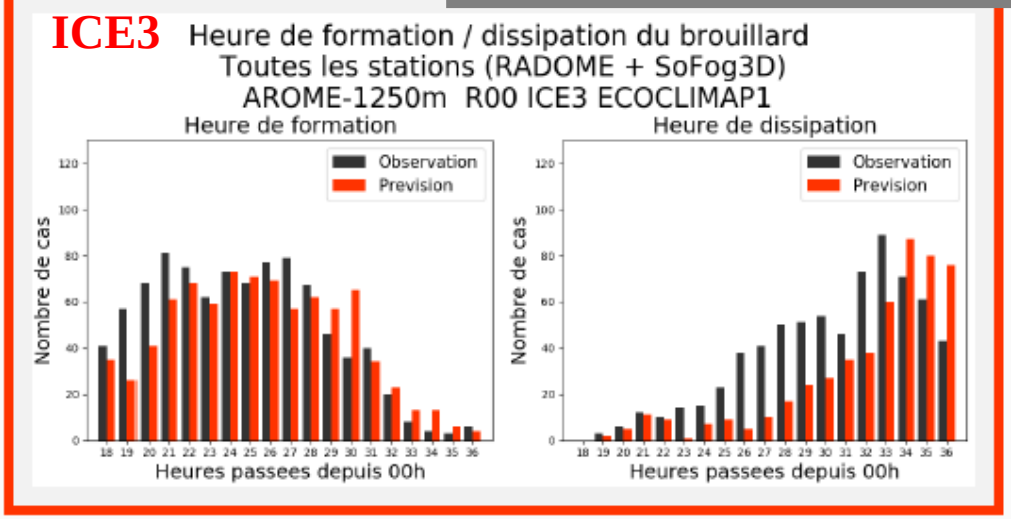


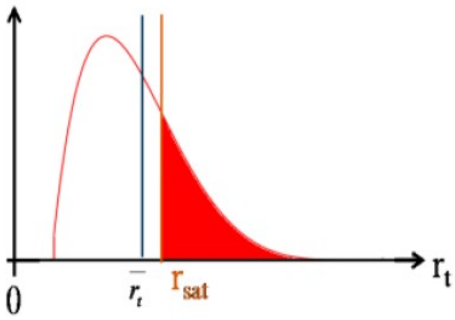
Strong impact of Subgrid condensation Scheme

- A possible explanation of current LIMA underforecasts ?

AROME-1250mL90

With subgrid condensation





B/ **Partially saturated** case

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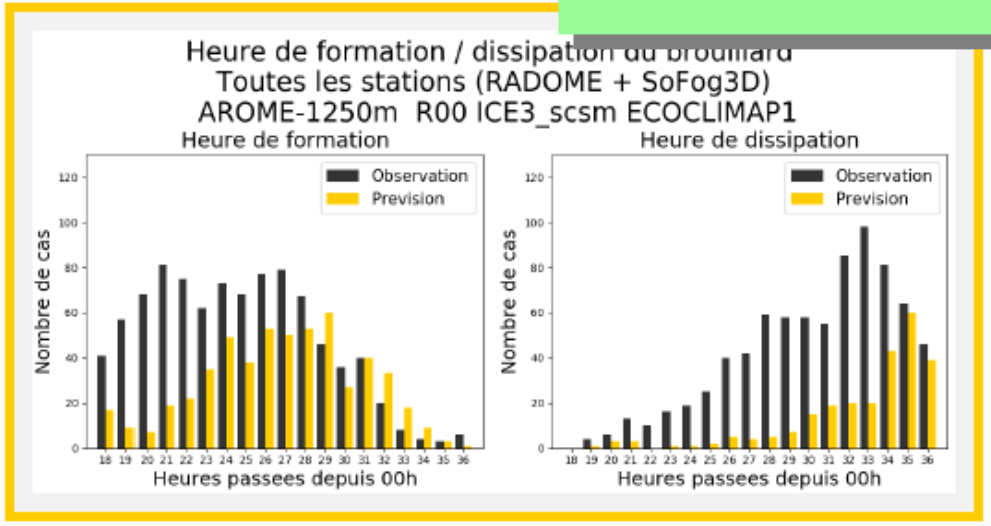
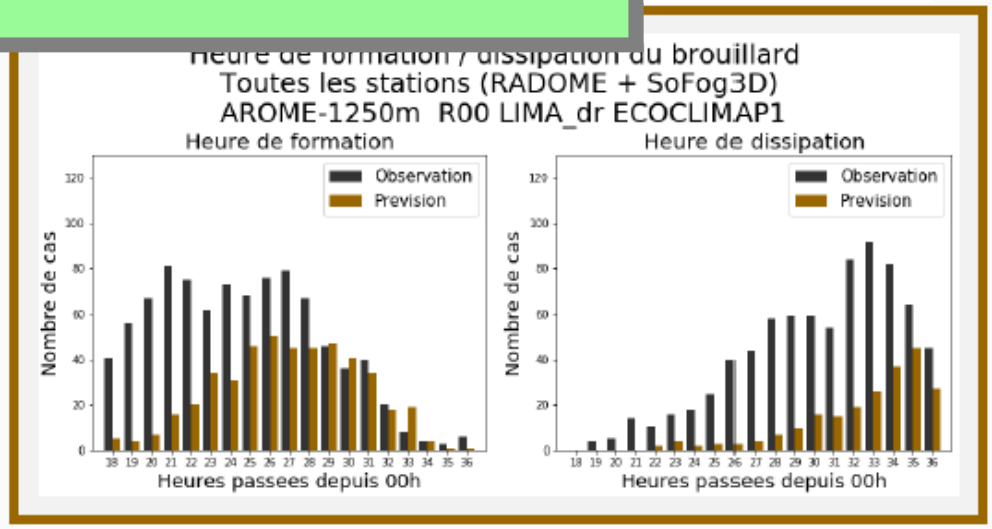
AROME-1250mL90 ICE3

Without subgrid condensation (CF=0 or 1)

LIMA

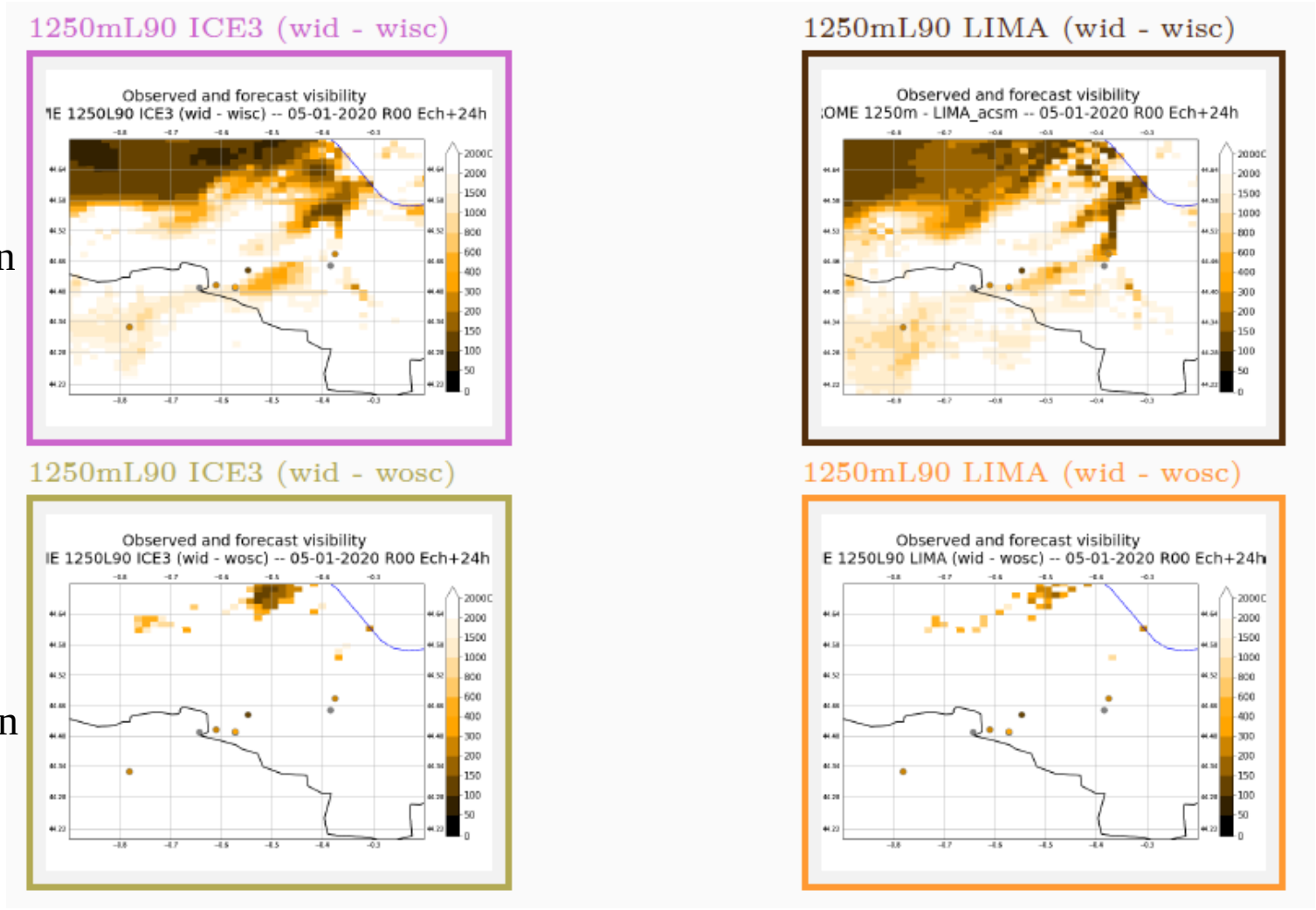




Subgrid condensation in LIMA : IOP-6 of 5 Jan 2020 +24

With Subgrid Condensation

Without Subgrid Condensation

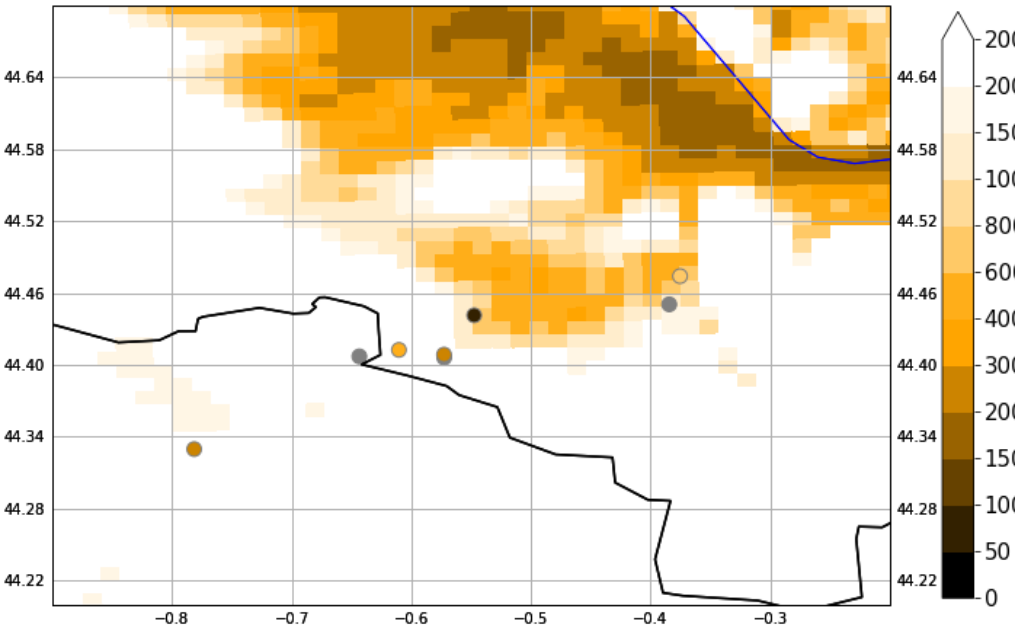


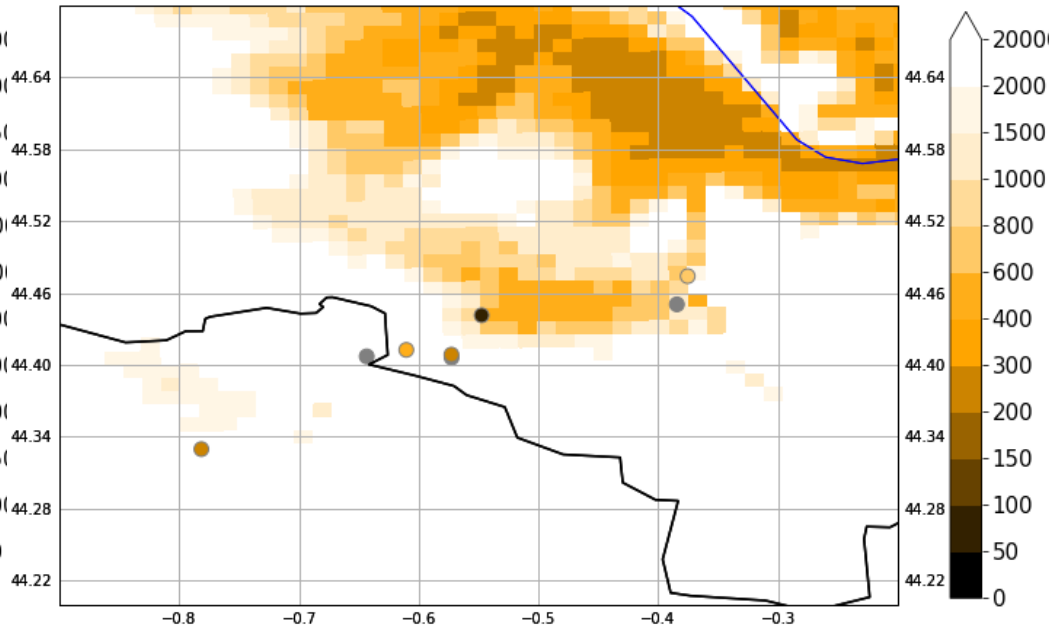
- Positive impact in that case !

Subgrid condensation + CAMS in LIMA : IOP-6

LIMA subgrid condensation
CAMS aérosols
2020-01-05 r12 +18

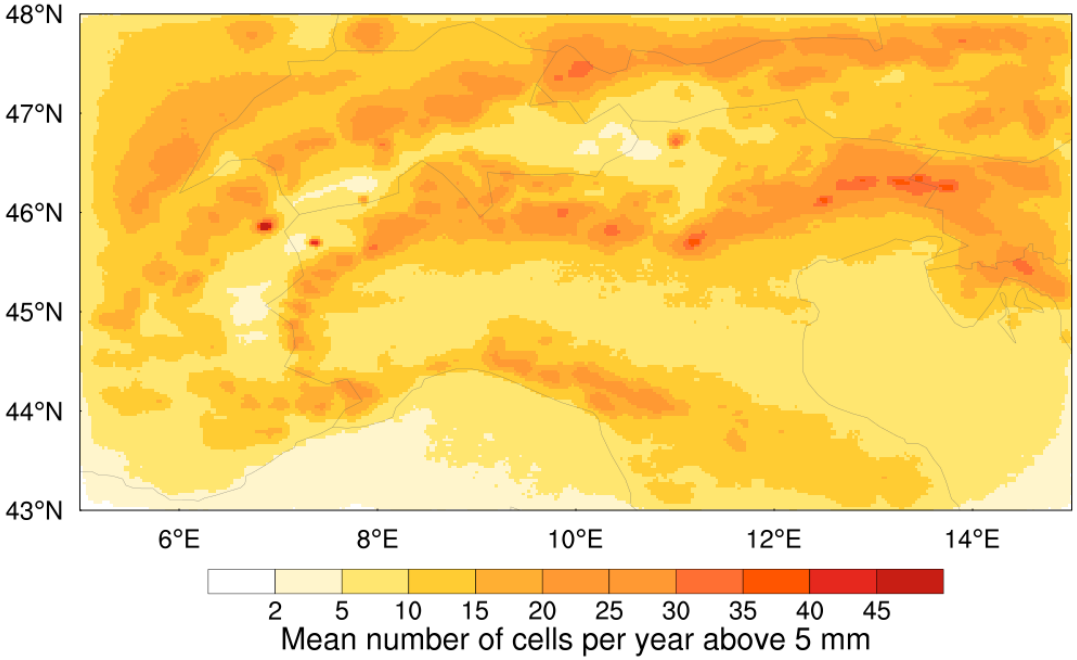
LIMA subgrid condensation
(constant aerosols)
2020-01-05 r12 +18

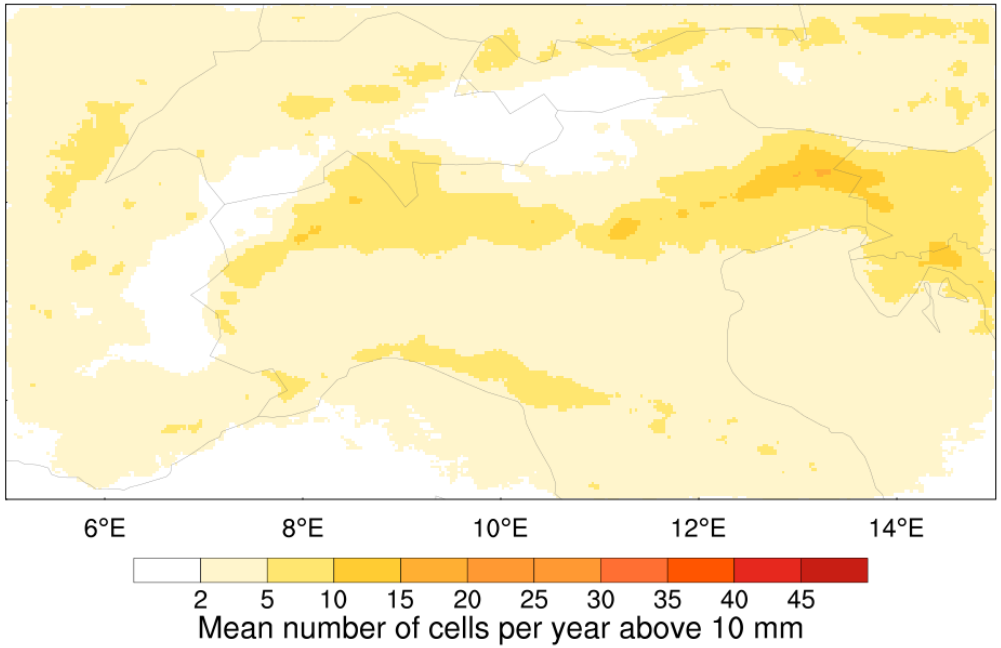




- Use of gl to interpolate and convert CAMS to CCN/IFN (thanks Ulf and Daniel !)
- Next steps : - test subgrid condensation on the whole period and @500m
  - LIMA intialisation with CAMS/MOCAGE aerosols

Statistics on convection initialisation over the Alps (1981-2018 AROME_2,5kmL60 cy41t1) May-Oct

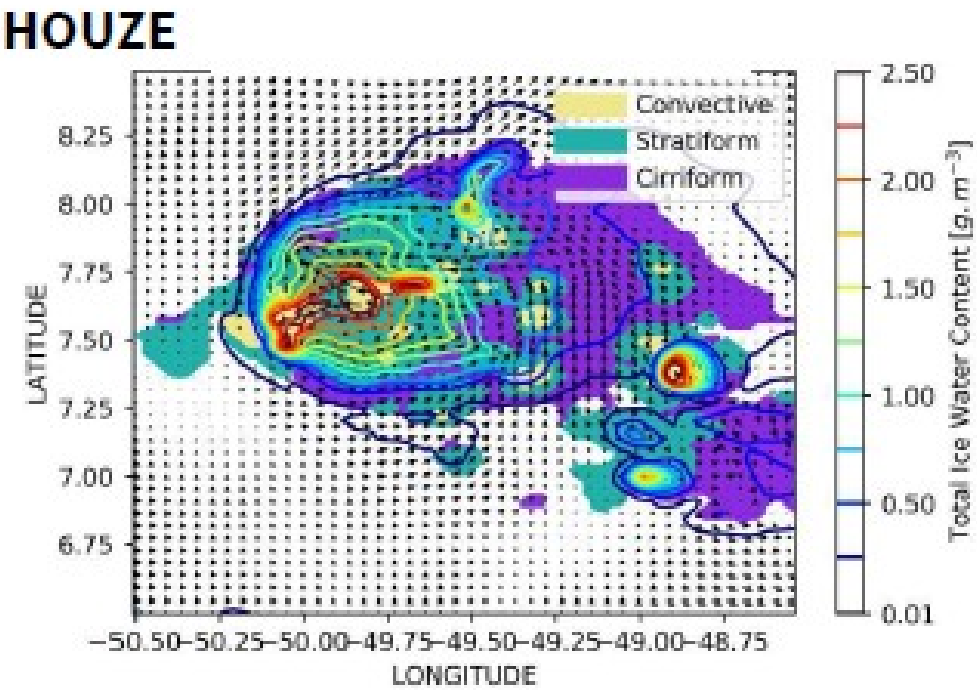


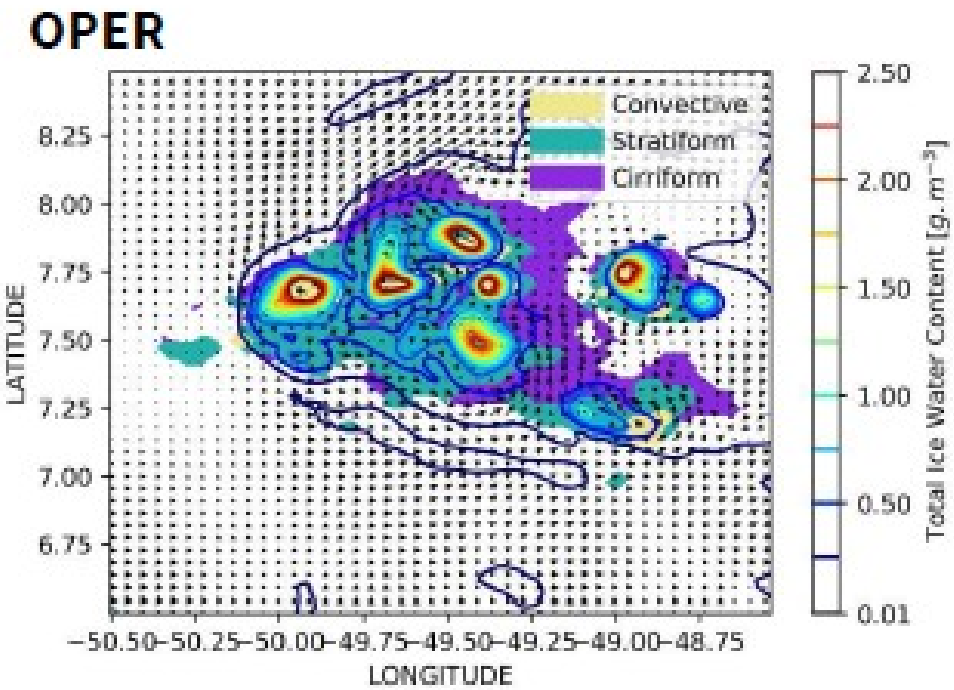


- Thanks to huge work of Cécile Caillaud !
- Use of a cell tracking algorithm on the whole period (on RR1H)
- To be compared with OBS / other models in TEAMx Convection WG (http://www.teamx-programme.org/)

Improvments in the cold microphysics (J. Wurtz)

- Work on the HAIC Campain data (Study high ice/snow concentration in tropical convective systems) : https://www.eol.ucar.edu/field_projects/haic-hiwc
- Modifications of snow Particle Size Distribution, based on observations → more snow in Cb anvils in AROME-Guyana (more realistic contents)
- Benefits both for ICE3 and LIMA



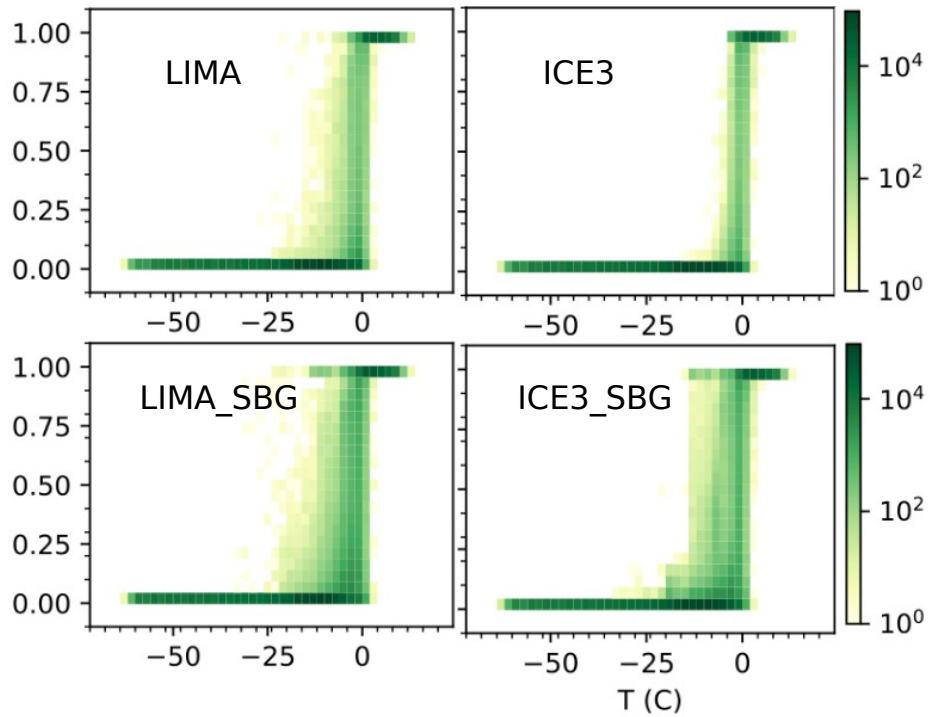


LIMA : ICICLE experiment

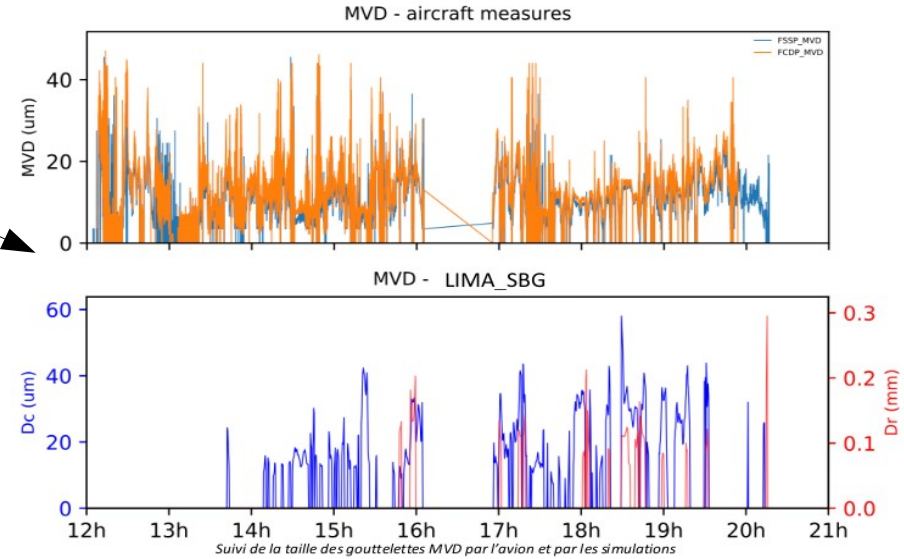
- Icing dedicated campain

  (Rockford (USA) February 2019)

- Meso-NH with ICE3 or LIMA :
  - More supercooled water in LIMA
  - Very sensitive to subgrid condensation
  - Cloud droplets diameters OK in LIMA

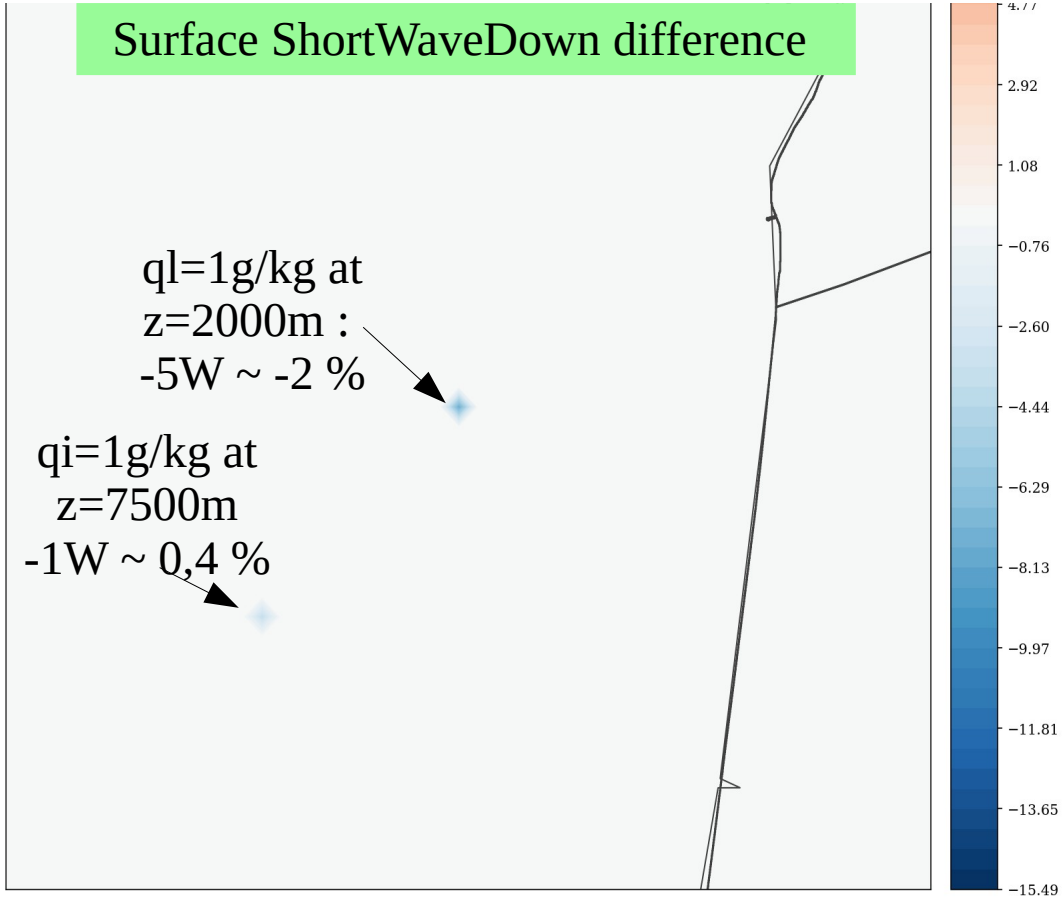


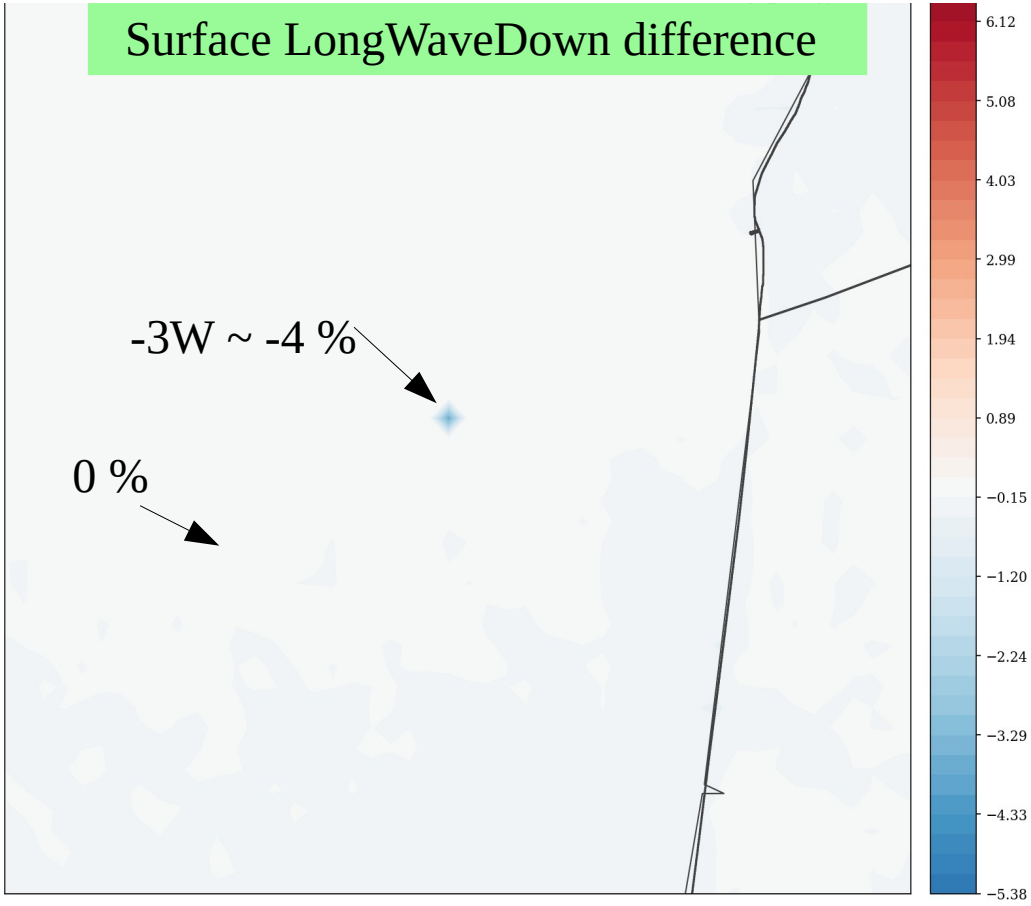
Liquid fraction as a function ot temperature



Radiation : validation of EcRad in AROME an a toy domain

- EcRAD (srtm+rrtm) compated to radlswr (srtm+rrtm) on 1 dt
- OK without clouds
- Differences on surface downward fluxes with clouds (much smaller with qli=0,1g/kg) :

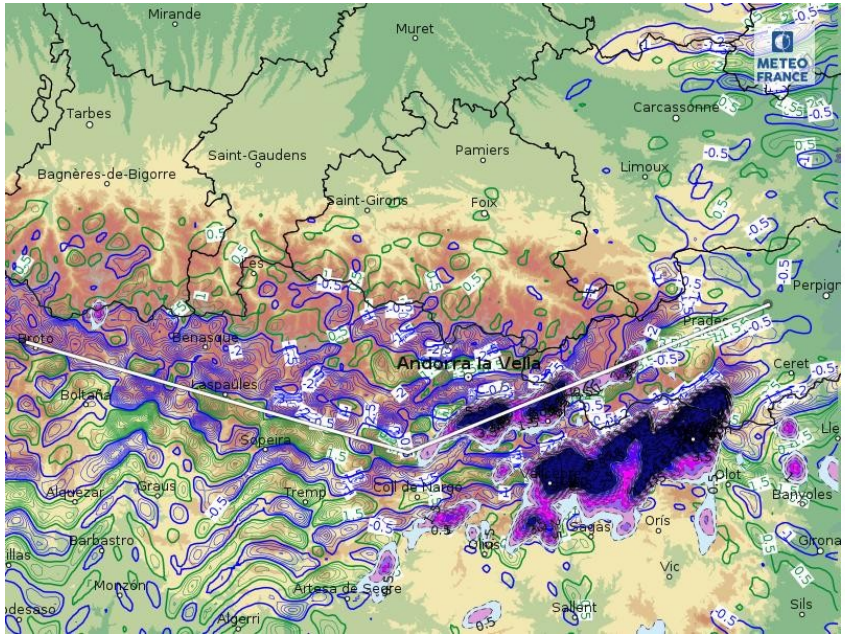




New diagnostics : Thermal w for Gliding

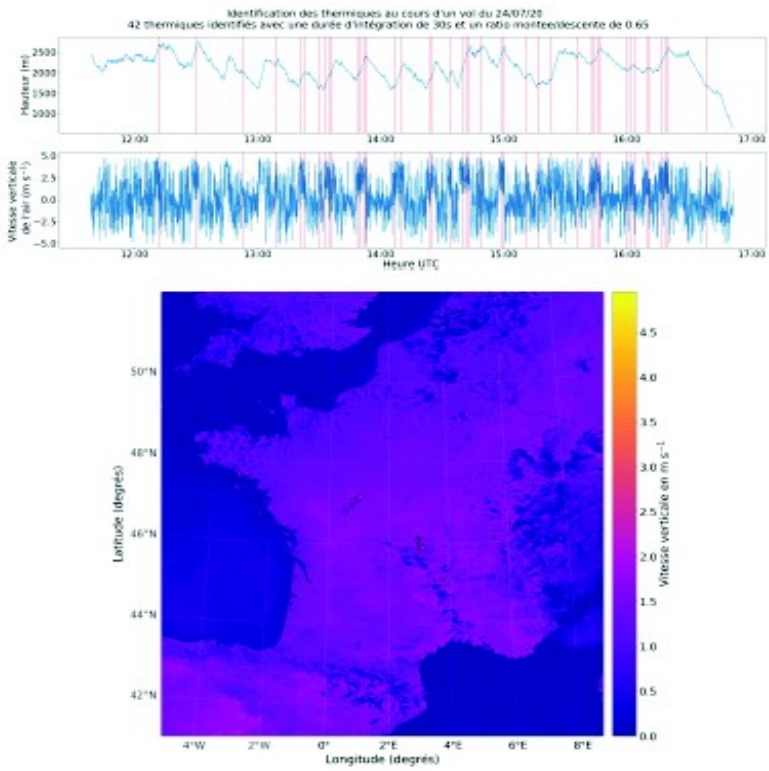
Arome high-resolution fields are appreciated by glider pilots.

Lee waves downstream of the reliefs well-represented by AROME as well as hazardous turbulence area.



Dynamical Waves over the Pyrennees (2019-05-12 TKE and vertical velocity 4200 m)

New Maximal Vertical Velocity Diagnostic from thermal velocities is currently evaluated.



Thermal Vertical Velocities vs glider data (24/07/2020-13h)

Thank you for your attention !
Question ?