

# ICON-2I ensemble system at Arpae:

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Summer verification against IFS  
Introducing SPP, a first case study

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# Summary

## Operational EPS and PP KAOS activity

| Task /<br>Actions | <b>1.1.</b><br>SPP in ICON                             | <b>1.3</b><br>ICON-LEPS: Model<br>perturbation at 2.5<br>km | <b>3.1</b><br>Cosmo software to<br>verify ICON-LEPS                               | <b>3.2</b><br>Spatial verification<br>and diagnostics<br>methods for<br>ensembles |
|-------------------|--------------------------------------------------------|-------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
| Current           | - testing on<br>ICON-2I<br>- first storm<br>case study | - perturbations to be<br>defined                            | - ICON-2I-EPS: 2026<br>JJA against IFS.<br>SYNOP obs, not<br>aligned for iniTimes | - Arpae<br>colleagues are<br>working on<br>FSS                                    |

# ICON-2I ensemble system at Arpae:

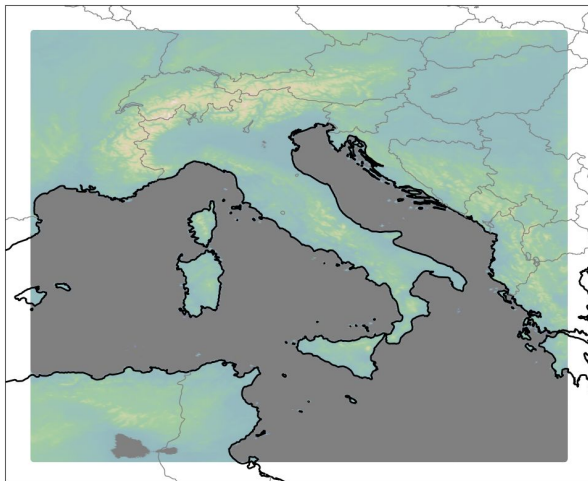
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Summer verification against IFS

COSMO GM 2026

# ICON-2I-EPS : Summer verification against IFS-ENS

## ICON-2I-EPS Setup

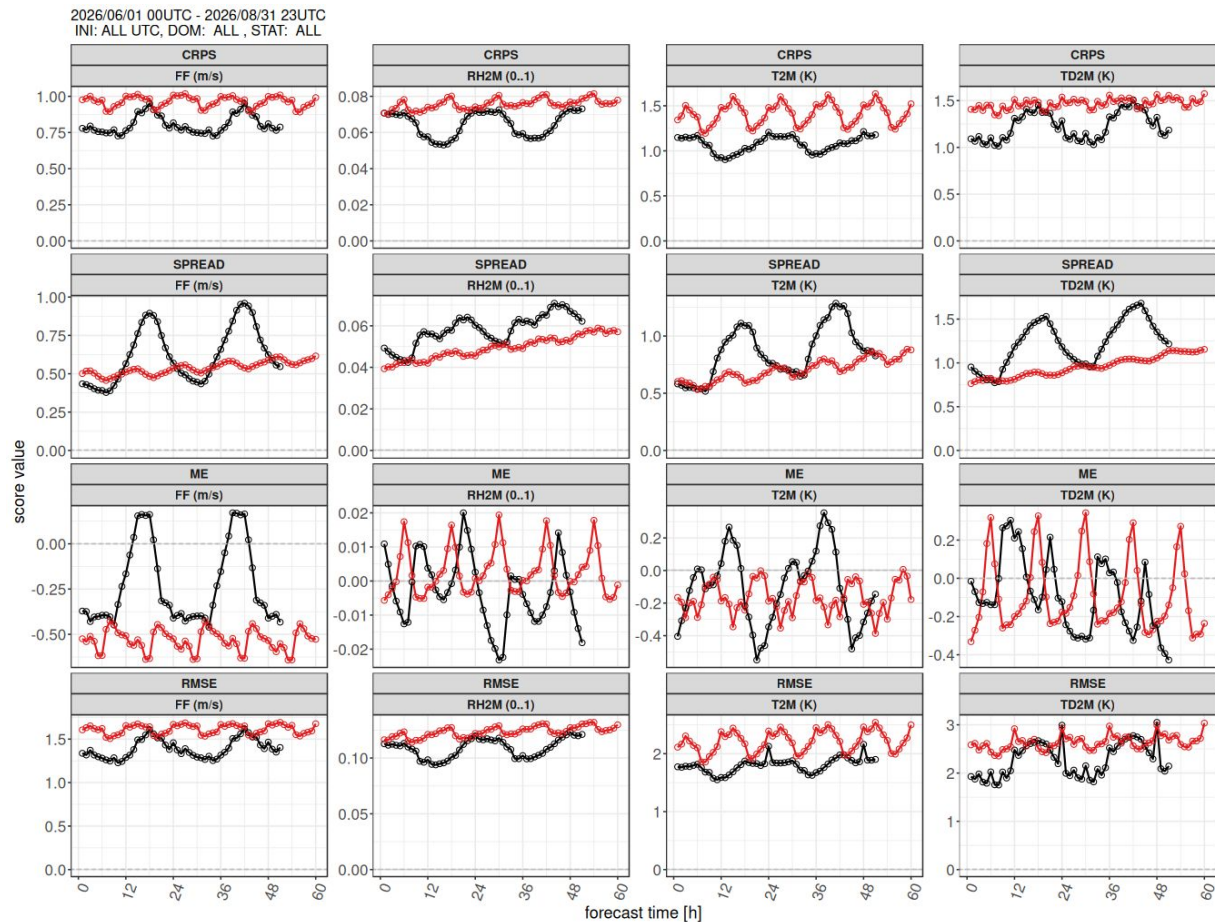


- Grid horizontal res. : 2.2 km
- v.l : 65
- [I.Cs](#): Kenda
- BCs : from IFS' first 20 members
- Init. Time : 21 UTC
- Time range: 51h
- Verification is not aligned for iniTimes (3h shift)

## Namelist

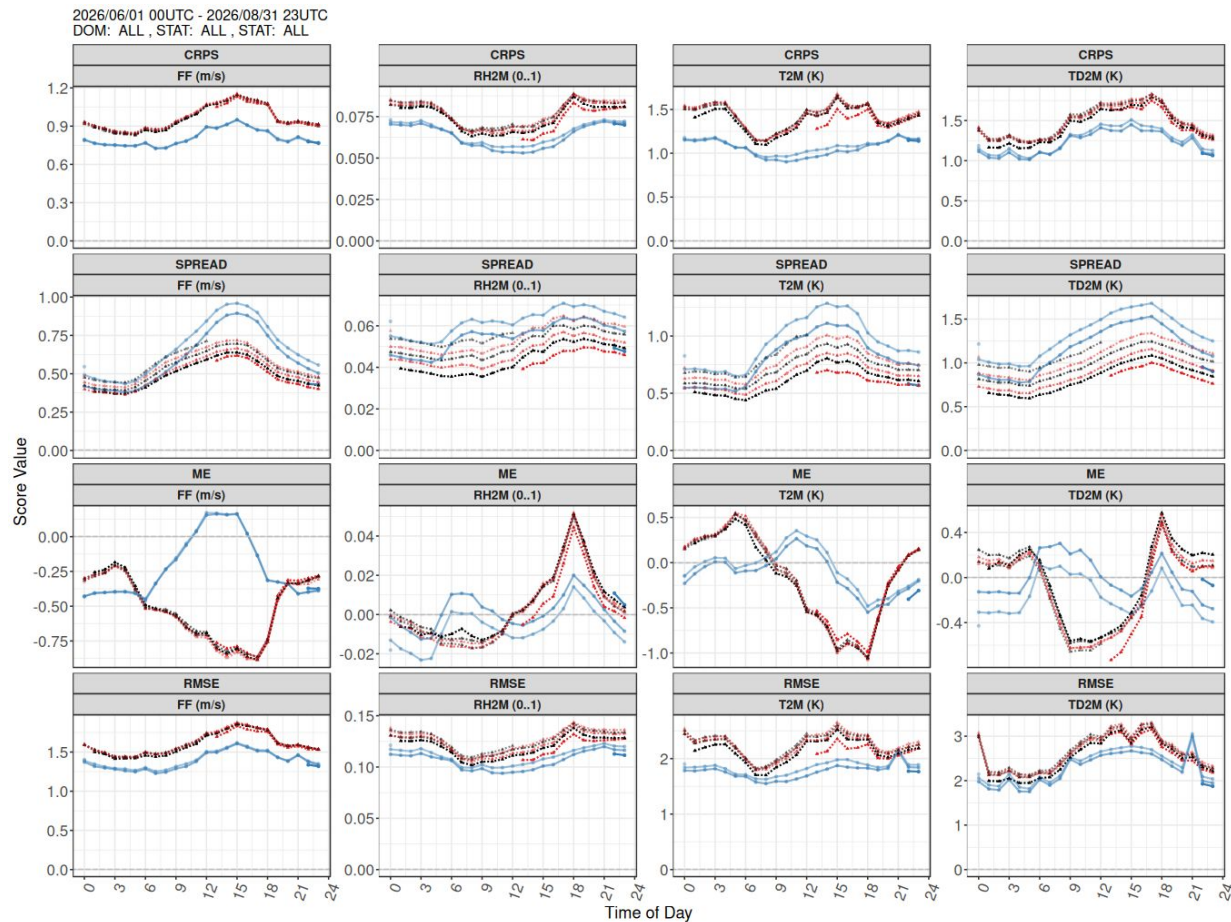
```
# SYNOP eps namelist (icon_2I - ifs settings)
varnoContinuous 'T2M,RH,RH2M,PS,TD2M,FF,DD,RAD_GL_1h,RAD_DF_1h,TMIN_12h,TMAX_12h,JJ_12h,N,N_L,N_M,N_H'
pectthresholds list('PS'=list('lower'=c(-500),'upper'=c(500)),'FF'=list('lower'=c(-3),'upper'=c(3)))
catthresholds list('GUST_1h'=c(5,10,15),'RR_1h'=c(0.1,1,2),'T2M'=c(290,300,310))
subdomains      'ALL'
filePattern      'vepSYNOP.'
timeSteps        '0'
timeBreaks       '0,-60'
veri_run_type    '0,4,3'
veri_run_class   '0,2'
state            '0,1,5,11'
#r_state         '0,1,5,11'
sigTest          'T'
expType          'standard'
experiment       'T'
expIds           'ICON-2I,IFS'
expDescr         '2026jja_I2I-IFS'
alignObs         'F'
fileDescr        '2026jja_I2I-IFS'
fdbkDirs         '/autofs/scratch-mod/afrigato/verifica_FF/icon_2I-eps/2026-jja./autofs/scratch-mod/afrigato/verifica_FF/ifs-ens/2026-jja'
outDir           './'
shinyAppPath     '/autofs/nfshomes/afrigato/ShinyApps'
nMembers         '20'
~
```

# Verification 2026 JJA - FFV2 - Lead time



IniTimes:  
ICON-2I: 21  
IFS: 00, 12

# Verification results - FFV2 - DayTime



Experiment

— ICON-21

- - - IFS

Init

— 00

— 12

— 21

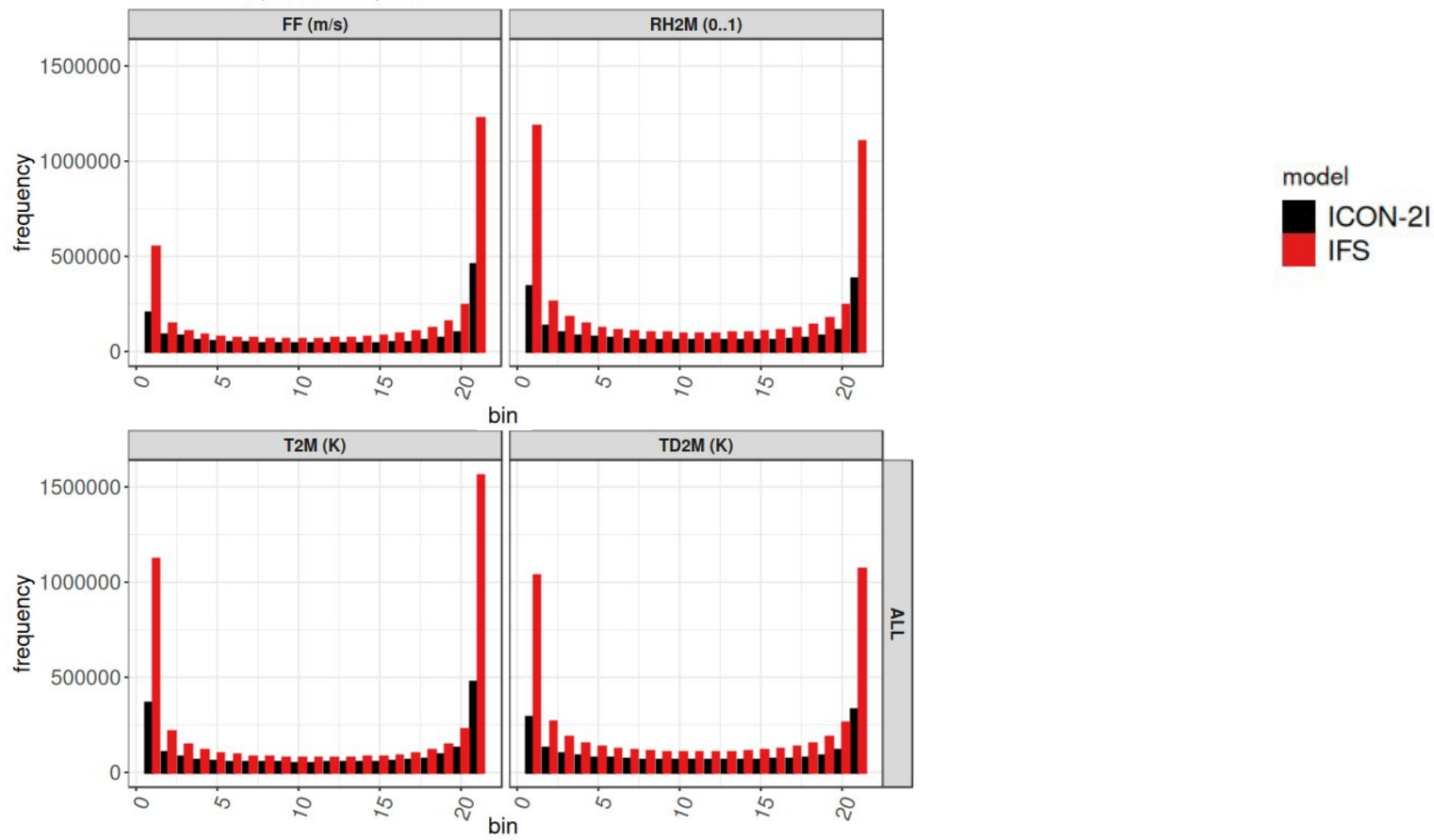
InitTimes:

IFS: 00 12

ICON-21: 21

# Verification results FFV2 - rank histogram

2026/06/01 00UTC - 2026/08/31 23UTC  
INI: ALL UTC, DOM: ALL, STAT: ALL



# Verification next steps:

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## Operational:

Implement a verification setup with same lead Times to compare ICON-2I to IFS

## Research [PP KAOS]

- Task 3.1 :
  - Cosmo software to verify ICON-LEPS
- Task 3.2 : Spatial verification  
specific focus on precipitation

Both points overlap with WGs VA, EPS, PHY

# ICON-2I ensemble system at Arpae:

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Introducing SPP, a first case study

# SPP in ICON at Arpae

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## Why testing SPP at Arpae ?

[PP KAOS, Action I]: to improve representation of model uncertainty in the ensembles, with a focus on severe weather and convection.

- Research:
  - continue testing of SPP in ICON
- Operational:
  - comparability of EPS diagnostics
  - seasonal performance, and to severe and convective events
- Current Gaps:
  - tested branch of SPP is from Master ICON (spp\_multi)
  - ICON-LEPS perturbations to be defined for years 2-3

# SPP case study: storm in Bologna, 2026 june 29-30<sup>th</sup>

## ICON-2I

## Experiments

### Common Setup

- Grid : 2.2 km
- v.l : 65
- Perturbed ICs : Kenda analysis
- Initial Time : 202606282100
- BCs : from IFS-ENS first 20 members
- Fc range : 51h
- forecastTimes : 24, 27, 30
- Microphysics: 1-mom
- parameter : tp 3h

### Differences

- control [ctrl]: no model pert.
- operational [ope] : phy. parameter pert.
- SPP : from master ICON config.  
SPP\_multi (rdepth, r\_bsmin)

# Operational phy perturbation scheme

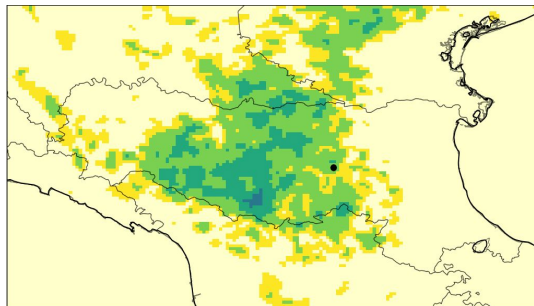
|     | ram     |      |        |        |         |        |         | rain_n0_factor | gkwake |
|-----|---------|------|--------|--------|---------|--------|---------|----------------|--------|
|     | tur_len | heat | tkhmin | tkmmin | rat_sea | q_crit | mu_rain |                |        |
| M1  | 500     | 10   | 0.5    | 0.75   | 0.8     | 2      | 0.5     | 0.1            | 0.25   |
| M2  | 300     | 2    | 0.5    | 0.75   | 0.8     | 2      | 0       | 0.1            | 0.25   |
| M3  | 300     | 10   | 0.3    | 0.75   | 0.8     | 2      | 0.5     | 0.1            | 0.25   |
| M4  | 300     | 10   | 0.5    | 0.5    | 0.8     | 3      | 0.5     | 0.1            | 0.25   |
| M5  | 300     | 10   | 0.5    | 0.75   | 10      | 2      | 0.5     | 0.1            | 0.25   |
| M6  | 300     | 10   | 0.5    | 0.75   | 0.8     | 2      | 0.5     | 0.1            | 1.5    |
| M7  | 300     | 2    | 0.5    | 0.75   | 0.8     | 2      | 0.5     | 0.1            | 0.25   |
| M8  | 300     | 10   | 0.7    | 0.75   | 0.8     | 2      | 0.5     | 0.1            | 0.25   |
| M9  | 300     | 10   | 0.5    | 0.5    | 0.8     | 2      | 0.5     | 0.1            | 0.25   |
| M10 | 300     | 10   | 0.5    | 0.75   | 0.8     | 2      | 0.5     | 0.1            | 1.5    |
| M11 | 150     | 10   | 0.5    | 0.75   | 0.8     | 2      | 0       | 0.1            | 0.25   |
| M12 | 300     | 10   | 0.5    | 0.9    | 0.8     | 2      | 0.5     | 1              | 0.25   |
| M13 | 300     | 18   | 0.5    | 0.75   | 0.8     | 2      | 0.5     | 0.1            | 0.25   |
| M14 | 300     | 10   | 0.3    | 0.75   | 0.8     | 3      | 0.5     | 0.1            | 0.25   |
| M15 | 300     | 10   | 0.5    | 0.75   | 10      | 2      | 0.5     | 0.1            | 0.25   |
| M16 | 150     | 10   | 0.5    | 0.75   | 0.8     | 2      | 0.5     | 0.1            | 0.25   |
| M17 | 300     | 10   | 0.5    | 0.9    | 0.8     | 2      | 0.5     | 0.1            | 0.25   |
| M18 | 300     | 10   | 0.7    | 0.75   | 0.8     | 2      | 0.5     | 1              | 0.25   |
| M19 | 300     | 18   | 0.5    | 0.75   | 0.8     | 2      | 0.5     | 0.1            | 0.25   |
| M20 | 500     | 10   | 0.5    | 0.75   | 0.8     | 2      | 0.5     | 0.1            | 0.25   |

| parameter      | description                                                                                                                                                                                                                             |
|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| gkwake         | Low level wake drag constant                                                                                                                                                                                                            |
| q_crit         | Critical value for normalised super-saturation                                                                                                                                                                                          |
| rain_n0_factor | Intercept parameter of raindrop size distribution                                                                                                                                                                                       |
| tur_len        | Asymptotic maximal turbulent distance                                                                                                                                                                                                   |
| tkhmin         | Scaling factor for minimum vertical diffusion coefficient (proportional to $Ri^{-2/3}$ ) for heat and moisture                                                                                                                          |
| tkmmin         | Scaling factor for minimum vertical diffusion coefficient (proportional to $Ri^{-2/3}$ ) for momentum                                                                                                                                   |
| ram_heat       | Scaling factor of the laminar boundary layer for heat (scalars). The change in ram_heat is accompanied by an inverse change of rat_sea in order to keep the evaporation over water (controlled by $ram\_heat \cdot rat\_sea$ ) the same |
| rat_sea        | Ratio of laminar scaling factors for scalars over sea and land                                                                                                                                                                          |
| mu_rain        | shape parameter in gamma distribution for rain                                                                                                                                                                                          |

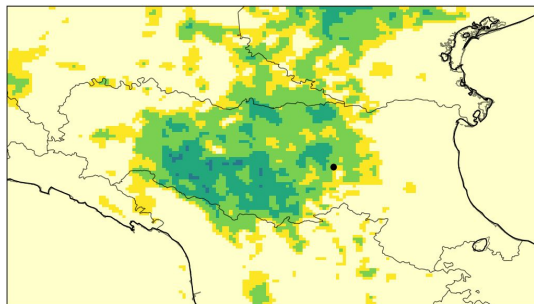
ENS mean 3h tp +24  
18 - 21 UTC

IT : 2026-06-28  
21:00

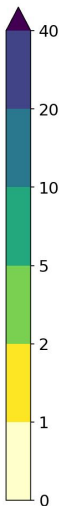
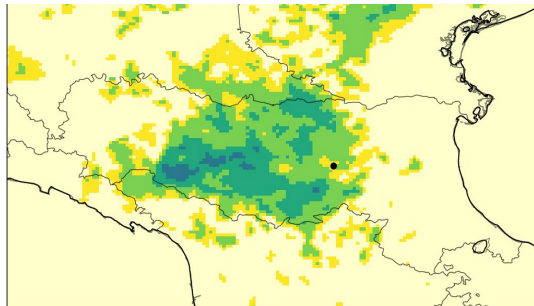
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SPP

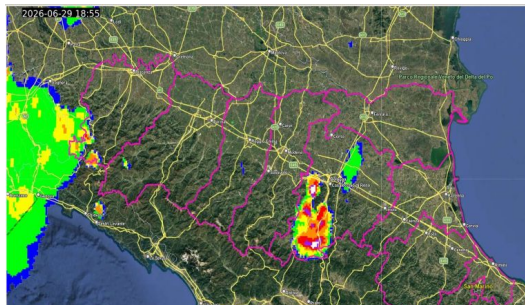


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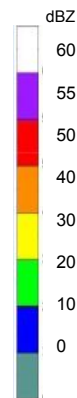
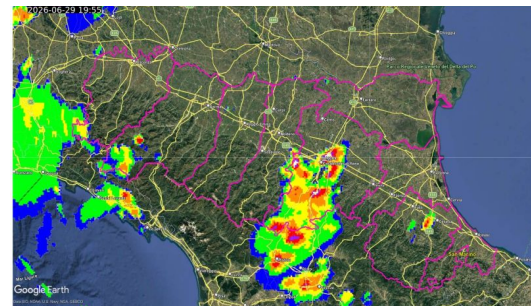


Radar reflectivity  
29/06/2026

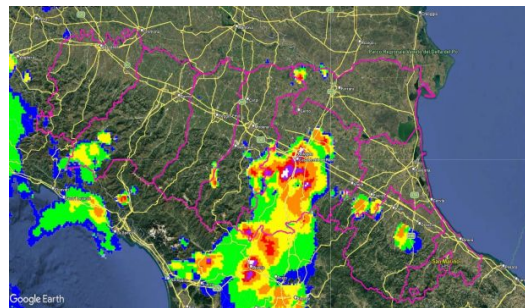
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19:55 UTC

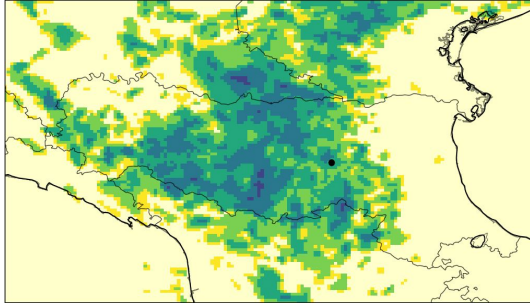


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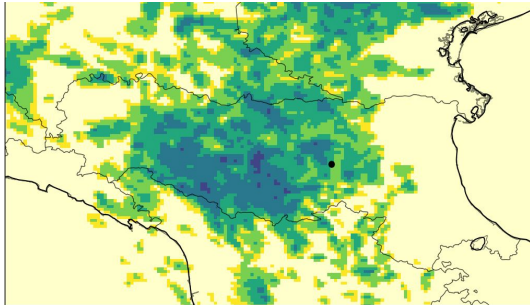


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18 - 21 UTC 21:00

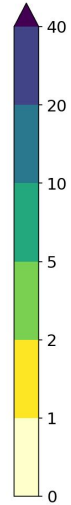
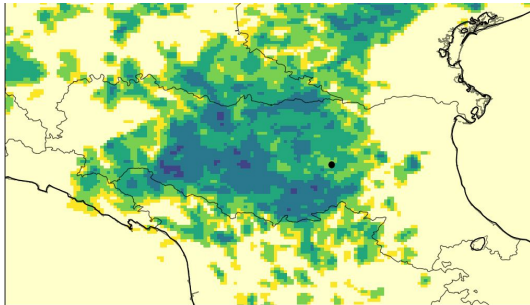
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SPP



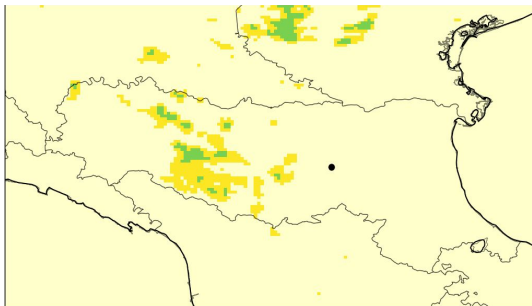
ctrl



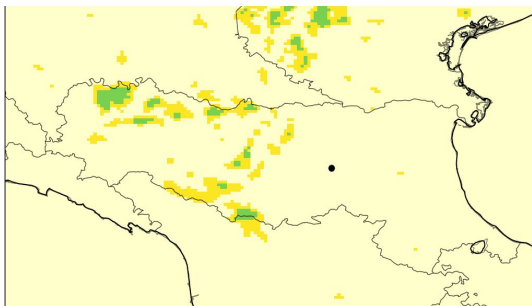
ENS mean 3h tp +27  
21 - 24 UTC

IT : 2026-06-28  
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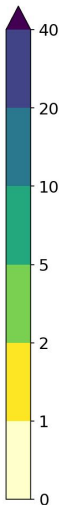
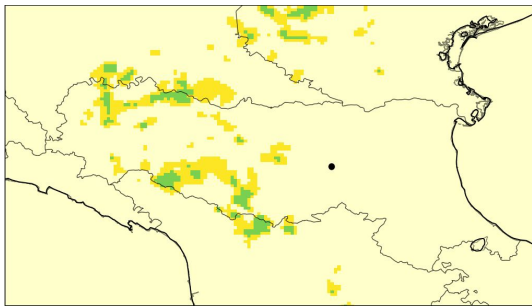
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SPP

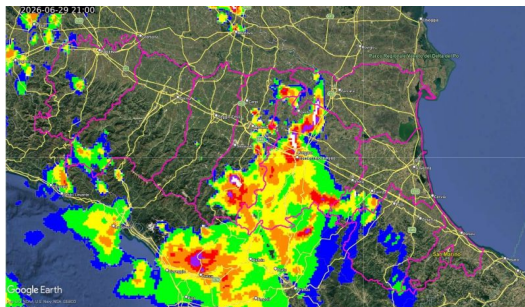


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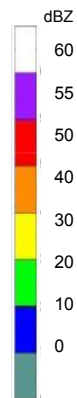
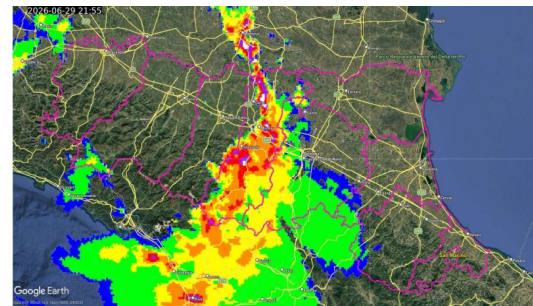


Radar reflectivity  
29/06/2026

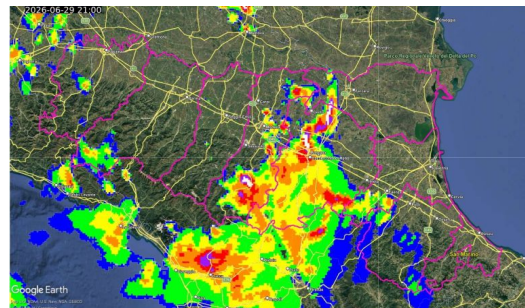
21:00 UTC



21:55 UTC

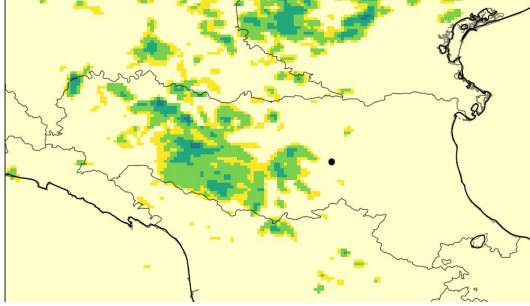


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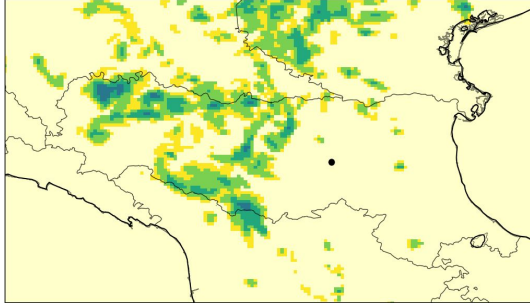


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21 - 24 UTC 21:00

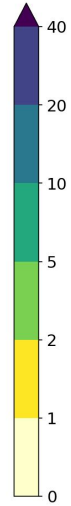
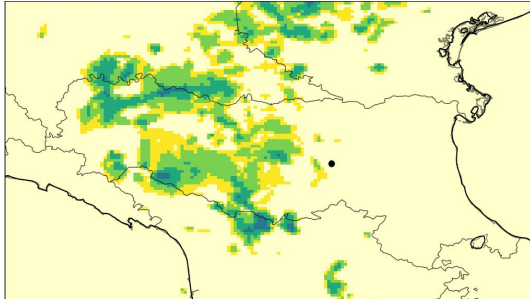
ope



SPP



ctrl

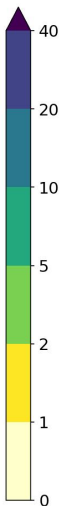
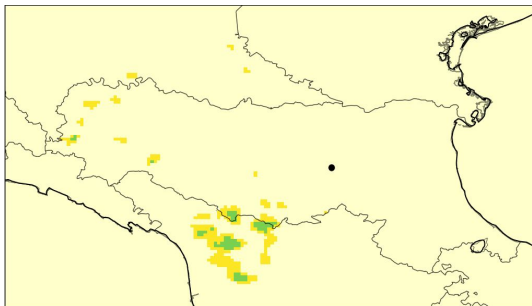


ENS mean 3h tp +30  
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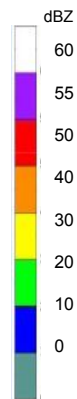
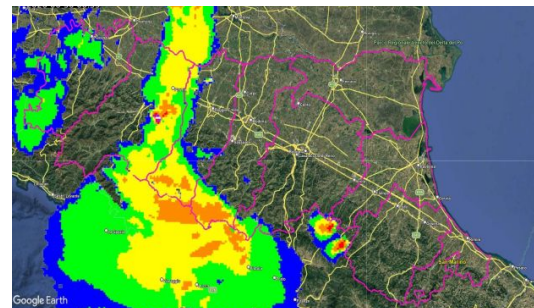
IT : 2026-06-28  
21:00

Radar reflectivity  
30/06/2026

ope

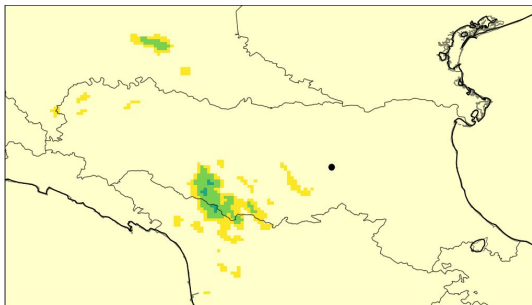


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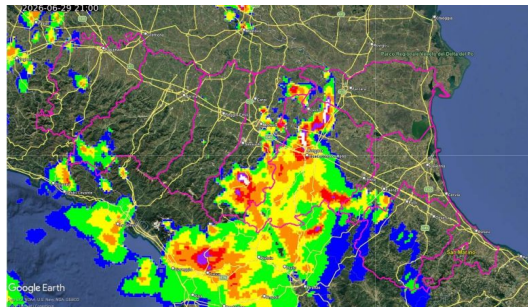
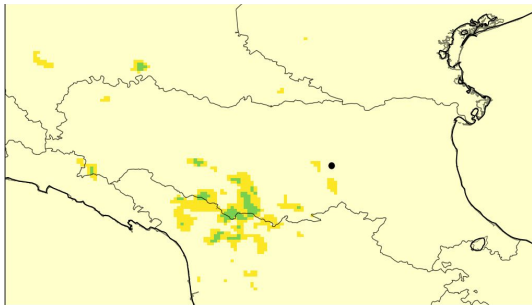


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SPP

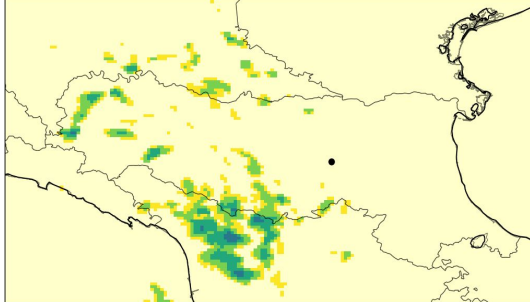


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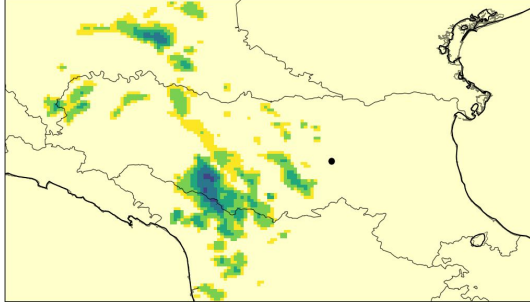


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00 - 03 UTC 21:00

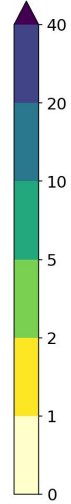
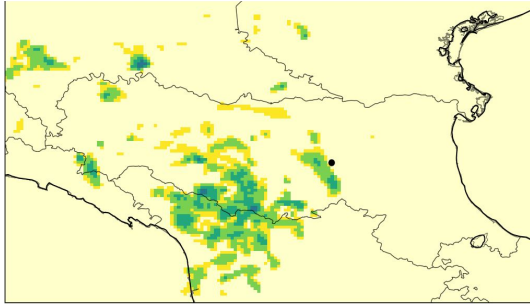
ope



SPP



ctrl



# SPP case study : remarks

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Comparison between mean and spread of SPP and operational :

- event localisation varies at southern region Apennines boundaries
- spread differences between experiments over area appeared as not adding meanings

## ICON-2I ensemble system at Arpae :

| Task / Actions | <b>1.1.</b><br>SPP in ICON                                                                       | <b>1.3</b><br>ICON-LEPS: Model perturbation at 2.5 km | <b>3.1</b><br>Cosmo software to verify ICON-LEPS                                                         | <b>3.2</b><br>Spatial verification and diagnostics for EPSs                                                                        |
|----------------|--------------------------------------------------------------------------------------------------|-------------------------------------------------------|----------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|
| Current        | - tested on ICON-2I                                                                              | - To begin with pp_multi phy SPP branch ?             | ICON-2I verification: <ul style="list-style-type: none"><li>- how to align obs ?</li></ul>               | <ul style="list-style-type: none"><li>- (VA) development of FSS for EPS</li><li>- how to link to SPP for precipitation ?</li></ul> |
| Next Steps     | <ul style="list-style-type: none"><li>- seasonal test</li><li>- WG PHY: new parameters</li></ul> | - perturbations tests                                 | <ul style="list-style-type: none"><li>- extension to LEPS</li><li>- ICON-2I-EPS to operational</li></ul> |                                                                                                                                    |