# Benefits of hectometric simulations of the 18 August 2022 derecho-producing mesoscale convective system over Corsica

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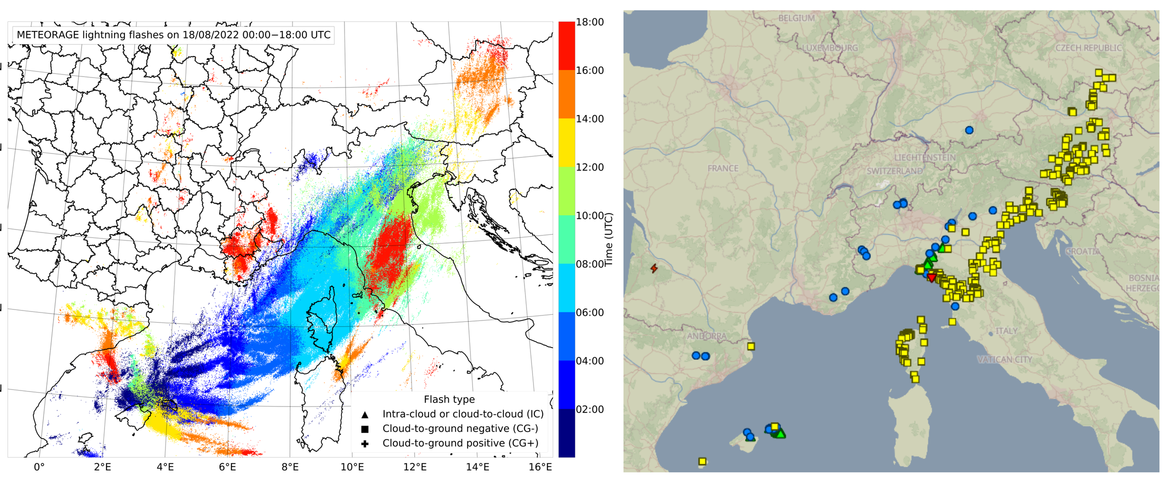
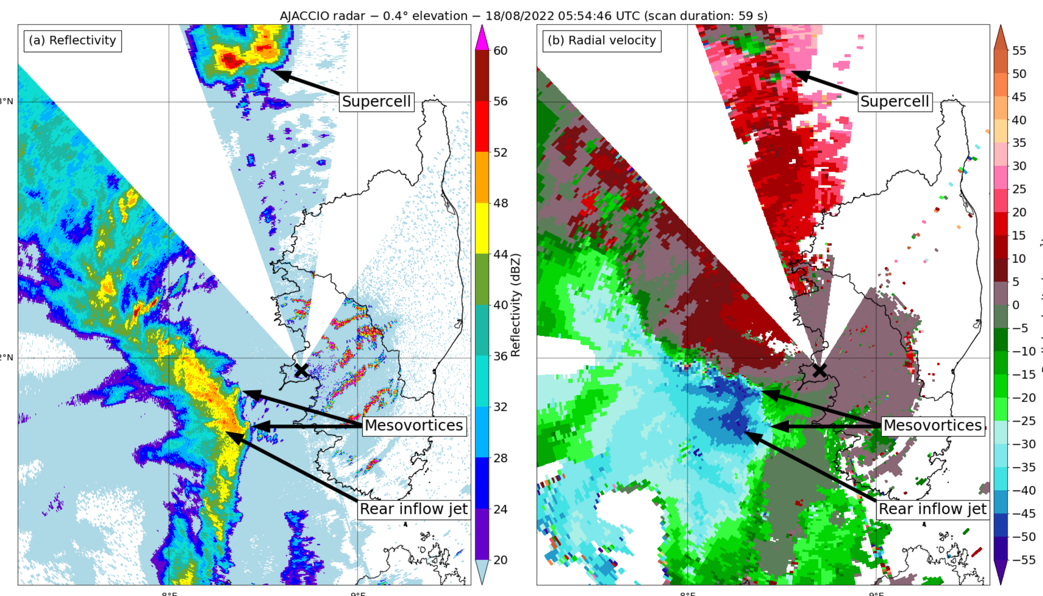
## The 18 August 2022 derecho-producing MCS: observations



*(Left) Meteorage lightning flashes cumulated and (right) European Severe Weather Database [1] reports between 18 August 2022 00:00 and 18:00 UTC. Yellow squares indicate gusts $\geq 25\,\mathrm{m\,s^{-1}}$ observed or estimated from damages.*

- ➤ On the night of 17 to 18 August 2022, disorganized thunderstorms located between Catalonia and the Balearic Islands (Spain) gradually strengthened, reaching the size of an MCS in the middle of the night.
- ➤ Moving rapidly over the Mediterranean Sea, this system organized into a squall line which bowed near Corsica around 05:15 UTC.
- ➤ A drifting buoy at 42.1°N, 6.4°E observed a 4.1 hPa mean sea level pressure (MSLP) surge between 03:00 and 04:00 UTC.

*Cumulonimbus arcus murus photographed by Pierre-Mathieu Paolini from La Parata cape, west of Ajaccio, on 18 August 2022 at 05:45 UTC [2].*




*(a) Reflectivity and (b) radial velocity observed by the 0.4° elevation scan of the Ajaccio radar on 18 August 2022 at 05:54:46 UTC. The black cross indicates the location of the radar. Le Bastard's algorithm is used to clean the velocities.*

- ➤ At around 05:55 UTC, the Ajaccio radar detected radial velocities $\geq 55\,\mathrm{m\,s^{-1}}$, up to $60\,\mathrm{m\,s^{-1}}$ at a height of around 1 km above ground level (AGL) caused by a violent rear-inflow jet, and also detected two mesovortices.
- ➤ The MCS reached Corsica shortly after 06:00 UTC, accompanied by exceptionally violent winds:
  - ➠ At 06:12 UTC, at La Parata cape (alt: 124 m), an ultrasonic anemometer measured a 0.25 s gust speed of $44.0\,\mathrm{m\,s^{-1}} = 158\,\mathrm{km\,h^{-1}}$.
  - ➠ At 06:20 UTC, in Marignana (alt: 515 m), a cup anemometer measured a 0.5 s gust speed of $62.4\,\mathrm{m\,s^{-1}} = 225\,\mathrm{km\,h^{-1}}$.
- ➤ 5 deaths, 20 injured, 45 000 households without electricity in Corsica, 90 ships stranded, damaged or sunk [3].
- ➤ Derecho criteria of Squitieri et al. [4] of $\geq 5$ observations of 3 s gust speed $\geq 33\,\mathrm{m\,s^{-1}}$ separated by at least 80 km seems reached with $34.2\,\mathrm{m\,s^{-1}}$ in Ajaccio, $50.9\,\mathrm{m\,s^{-1}}$ in Calvi, $45.2\,\mathrm{m\,s^{-1}}$ in Ersa - Cap Corse, and the observations over Italy and Austria given by Pucik [5].
- ➤ What benefits do high-resolution simulations of this case offer? How do they compare with available observations?

## Numerical simulations and comparison to observations

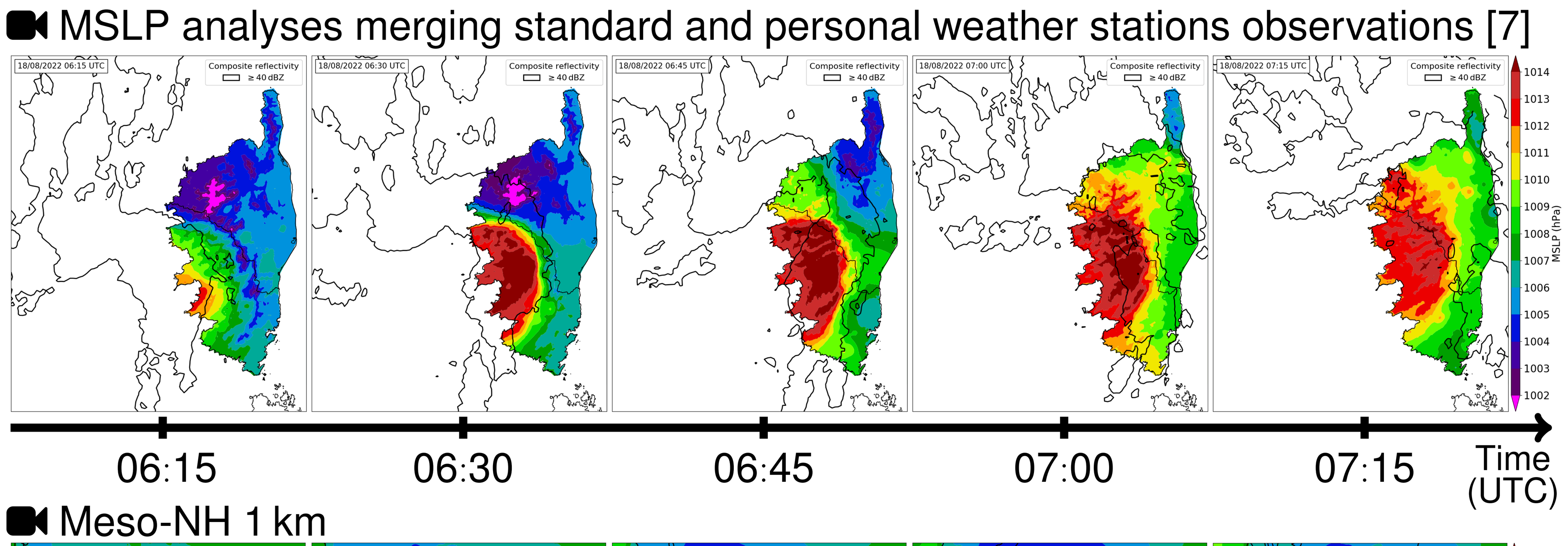
### Meso-NH atmospheric model v5.7.2 + SURFEX surface model v9.0 [6]

Initial and boundary conditions given by the AROME-France run whose forecasts are the closest to the observations, i.e. the 18 August 2022 00:00 UTC run (18r00).

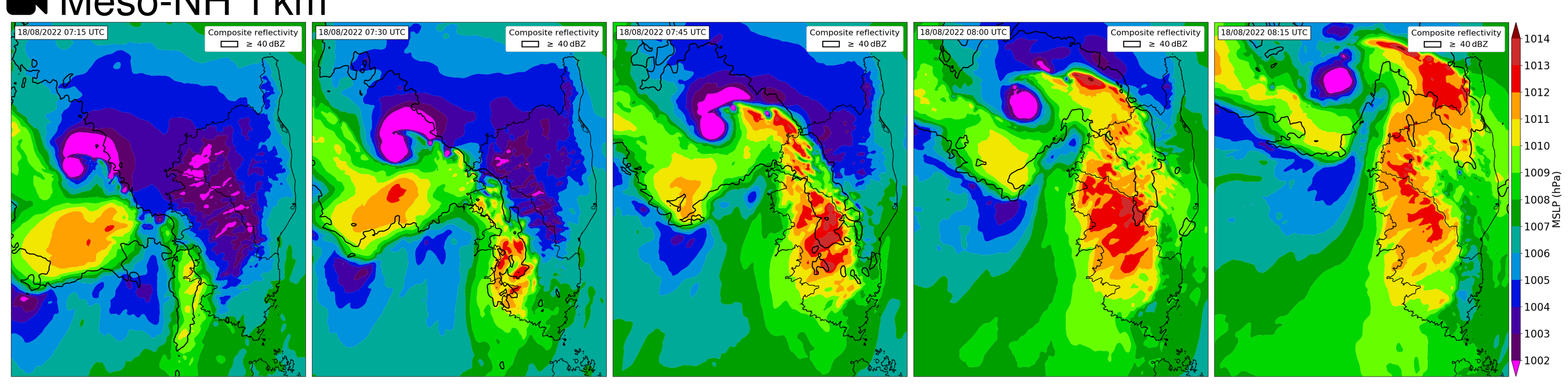
| | Meso-NH 1 km | Meso-NH 250 m |
|---|---|---|
| ↔ / ↕ Grid spacing | **1 km** / 90 levels | **250 m** / 90 levels |
| Turbulence | 1D | 3D |
| Shallow convection | PMMC09 scheme | None |
| Microphysics | ICE3 scheme with 6 water species | |

### Mean sea level pressure

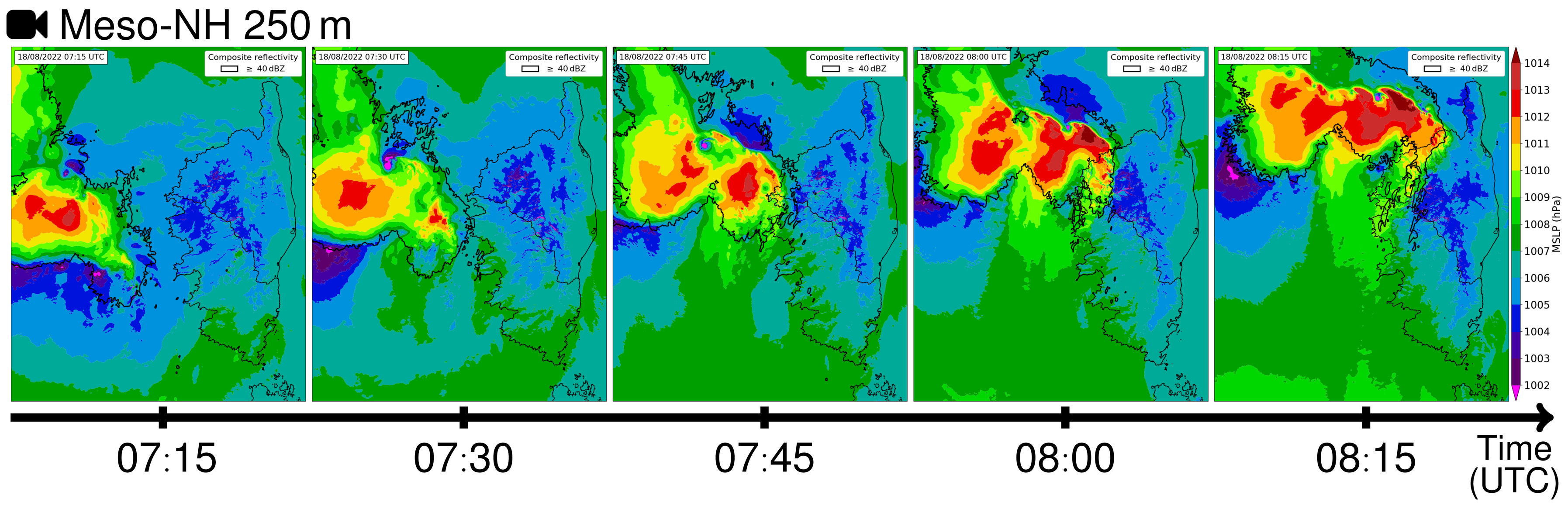
MSLP analyses merging standard and personal weather stations observations [7]




Meso-NH 1 km

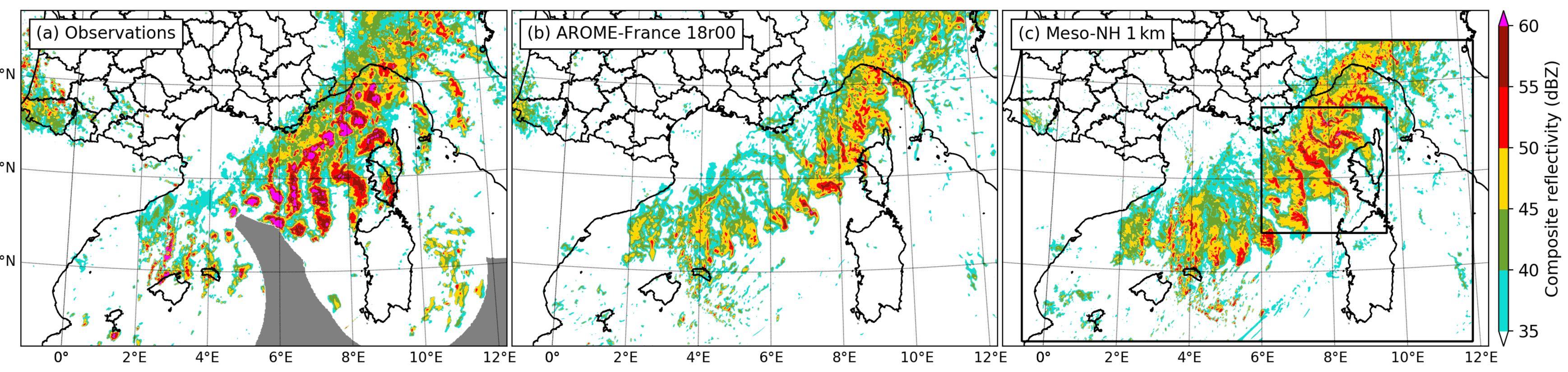


Meso-NH 250 m




- ➤ Complex MSLP structures with large gradients appear both in simulations and observations. Observations show at 06:35 UTC a gradient of $12.6\,\mathrm{hPa} \times (80\,\mathrm{km})^{-1}$. In Calvi, the MSLP jump reaches 7.4 hPa in 2 min and 9.0 hPa in 7 min.
- ➤ Very different MSLP structure forecast by Meso-NH 1 km and Meso-NH 250 m, the former more closely resembles the observations.
- ➤ The increase in horizontal resolution reveals finer physical structures. However, greater realism is not necessarily guaranteed by finer physical structures.

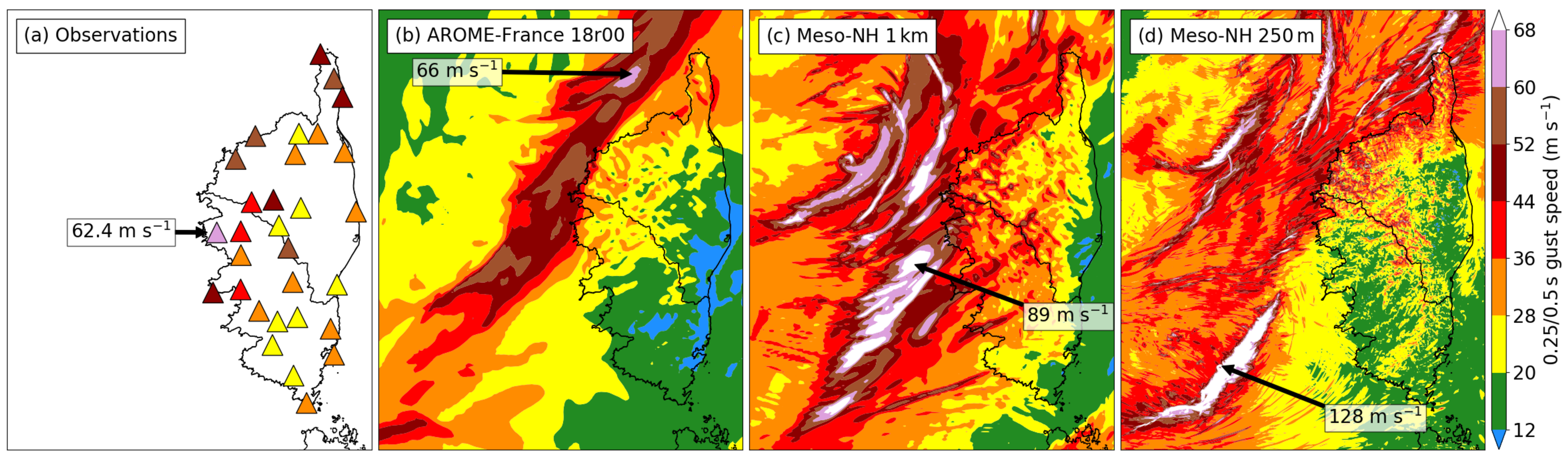
### Composite reflectivity



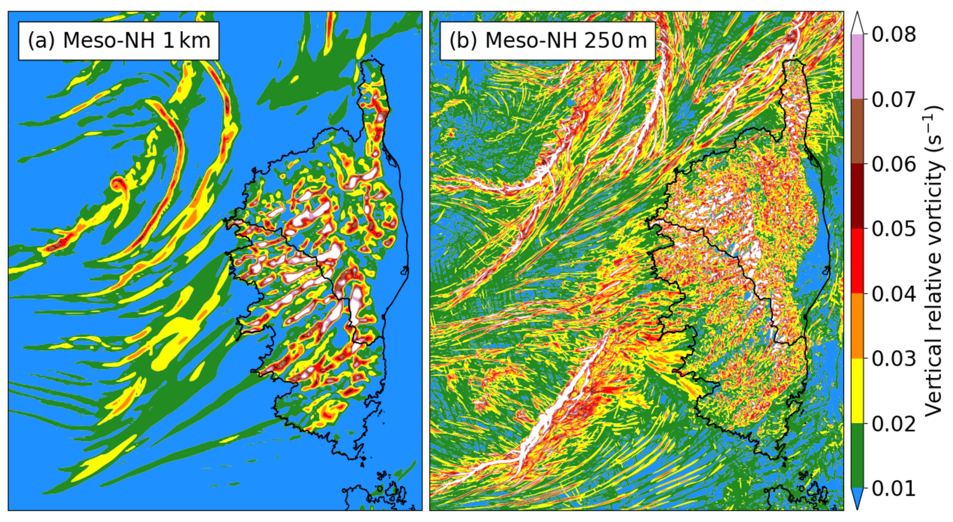

*Composite reflectivity (a) observed and simulated by (b) AROME-France 18r00 and (c) Meso-NH 1 km superimposed every hour between 01:00 and 10:00 UTC. Observations are combining OPERA composite reflectivity with the Italian surface rainfall intensity product provided by the ItaliaMeteo "MeteoHub". The large and small black rectangles indicate grid domains of the Meso-NH 1 km and 250 m, respectively.*

- ➤ The composite reflectivity is systematically underestimated by both AROME-France 18r00 and Meso-NH 1 km compared to the observations.
- ➤ Limiting discrepancies may be possible through improvements in the radar observation operator and the use of the 2-moment LIMA microphysics scheme [8].

### Wind gust speed at 10 m height AGL




*▲ Maximum on 18 August 2022 between 00:00 and 12:00 UTC of (a) 0.25/0.5 s wind gust speed observations at 10 m height AGL and gust diagnostic ($G_{10\,\mathrm{m}} = \sqrt{(U_{10\,\mathrm{m}})^2 + (V_{10\,\mathrm{m}})^2} + 3.8\sqrt{\mathrm{TKE}_{20\,\mathrm{m}}}$) for (b) AROME-France 18r00 (c) Meso-NH 1 km, and (d) Meso-NH 250 m.*




*➤ Maximum on 18 August 2022 between 00:00 and 12:00 UTC of the vertical component of relative vorticity at 10 m height AGL ($\zeta_{10\,\mathrm{m}} = (\vec{\nabla} \times \overrightarrow{v_{10\,\mathrm{m}}}) \cdot \vec{u_z}$) for (a) Meso-NH 1 km, and (b) Meso-NH 250 m.*

- ➤ In most observation messages, Météo-France provides an "instantaneous wind speed" which is a mix of 0.25 s gust speed from ultrasonic anemometers, 0.5 s gust speed from cup anemometers, and gust speed from propeller anemometers.
- ➤ The 3 s gust speed, following the World Meteorological Organization standard, is currently only provided in METAR messages, but will replace the current mix in all observations messages.
- ➤ The gust diagnostic increases with horizontal resolution towards unrealistic values. The formulation should also be revised to adapt to the 3 s and 0.25 s averages.
- ➤ In Meso-NH simulations, high wind gust corridors location correlates with corridors of large vertical relative vorticity, showing vortices trajectories.

## References and acknowledgements

[1] Dotzek, N. et al. "Overview of ESSL's severe convective storms research using the European Severe Weather Database ESWD". *Atmospheric Research* 93.1–3 (2009), pp. 575–586. DOI: 10.1016/j.atmosres.2008.10.020.
[2] Le HuffPost. *Orages en Corse : l'histoire derrière cette photo impressionnante*. https://www.huffingtonpost.fr/france/article/orages-en-corse-l-histoire-derriere-cette-photo-impressionnante_206747.html (last access: 13 November 2025). 2022.
[3] Corse Matin. *Tempête du 18 août en Corse: retour sur un record de violence jamais atteint*. https://www.corsematin.com/articles/tempete-du-18-aout-en-corse-retour-sur-un-record-de-violence-jamais-atteint-133604 (last access: 13 November 2025). 2022.
[4] Squitieri, B. J., Wade, A. R., and Jirak, I. L. "On a Modified Definition of a Derecho. Part I: Construction of the Definition and Quantitative Criteria for Identifying Future Derechos over the Contiguous United States". *Bulletin of the American Meteorological Society* 106.1 (2025), E84–E110. DOI: 10.1175/BAMS-D-24-0015.1.
[5] Pucik, T. *The derecho and hailstorms of 18 August 2022*. https://www.essl.org/cms/the-derecho-and-hailstorms-of-18-august-2022/ (last access: 12 November 2025). 2022.
[6] Lac, C. et al. "Overview of the Meso-NH model version 5.4 and its applications". *Geoscientific Model Development* 11.5 (2018), pp. 1929–1969. DOI: 10.5194/gmd-11-1929-2018.
[7] Mandement, M. and Caumont, O. "Contribution of personal weather stations to the observation of deep-convection features near the ground". *Natural Hazards and Earth System Sciences* 20.1 (2020), pp. 299–322. DOI: 10.5194/nhess-20-299-2020.
[8] David, C. et al. "Improved simulation of thunderstorm characteristics and polarimetric signatures with LIMA two-moment microphysics in AROME". *Atmospheric Measurement Techniques* 18.15 (2025), pp. 3715–3745. DOI: 10.5194/amt-18-3715-2025.

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