Supplemental Material

Bulletin of the American Meteorological Society
Anthropogenic Warming Had a Crucial Role in Triggering the Historic and Destructive Mediterranean Derecho in Summer 2022
https://doi.org/10.1175/BAMS-D-23-0119.2

Supplementary Material

Supplementary Text

More information on the pseudo-global warming approach:

MPAS was configured with a variable resolution mesh: from 3 km in the storm-affected area to 60 km in the outermost regions. Current ACC forcing was derived from CMIP6 model experiments for the thermodynamic variables, as stated in the main text. This forcing was calculated as the difference (for the dates of the event, i.e., mid-August) between a 31-year period centered on 2022 (2007-2014 from the historical experiment and 2014-2037 from the SSP2-4.5 scenario experiment) and the pre-industrial (piControl) experiments. For future ACC forcing, the difference between the same variables averaged in a high emissions scenario (SSP5-8.5; Riahi et al. 2017) for 2070-2100 and in the 31-year period centered on 2022 was used. The anthropogenic signals were calculated separately for each of the five CMIP6 models considered.

Evaluation of MPAS-PGW factual simulation:

Given the simulated characteristics, such as the size, the path it traveled (~800 km; Figure ES1) and the reflectivity signal (Figure ES1c-f), it can be easily concluded that MPAS was able to simulate a convective system compatible with the definition of derecho. It is also remarkable that the model is able to reproduce the development of the bow echo (Figure ES1c) and a comma-shaped echo (Figure ES1e) with a bookend vortex (Fujita, 1978). However, the model locates this feature more northward (~100 km) than observed and it is not fully able to reproduce the extreme wind gusts observed in Corsica and northern Italy (Figure ES1b, Table ES1 and Figure ES2a-b).

References:

Fujita, 1978: Manual of downburst identification for project NIMROD. *Satellite and Mesometeorology Res. Pap. No. 156*, University of Chicago, Dept. of Geophysical Sciences, pp. 104.

Riahi, K., Van Vuuren, D. P., Kriegler, E., Edmonds, J., O'neill, B. C., Fujimori, S., ... and Tavoni, M, 2017: The Shared Socioeconomic Pathways and their energy, land use, and greenhouse gas emissions implications: An overview. *Global environmental change*, 42, 153-168.

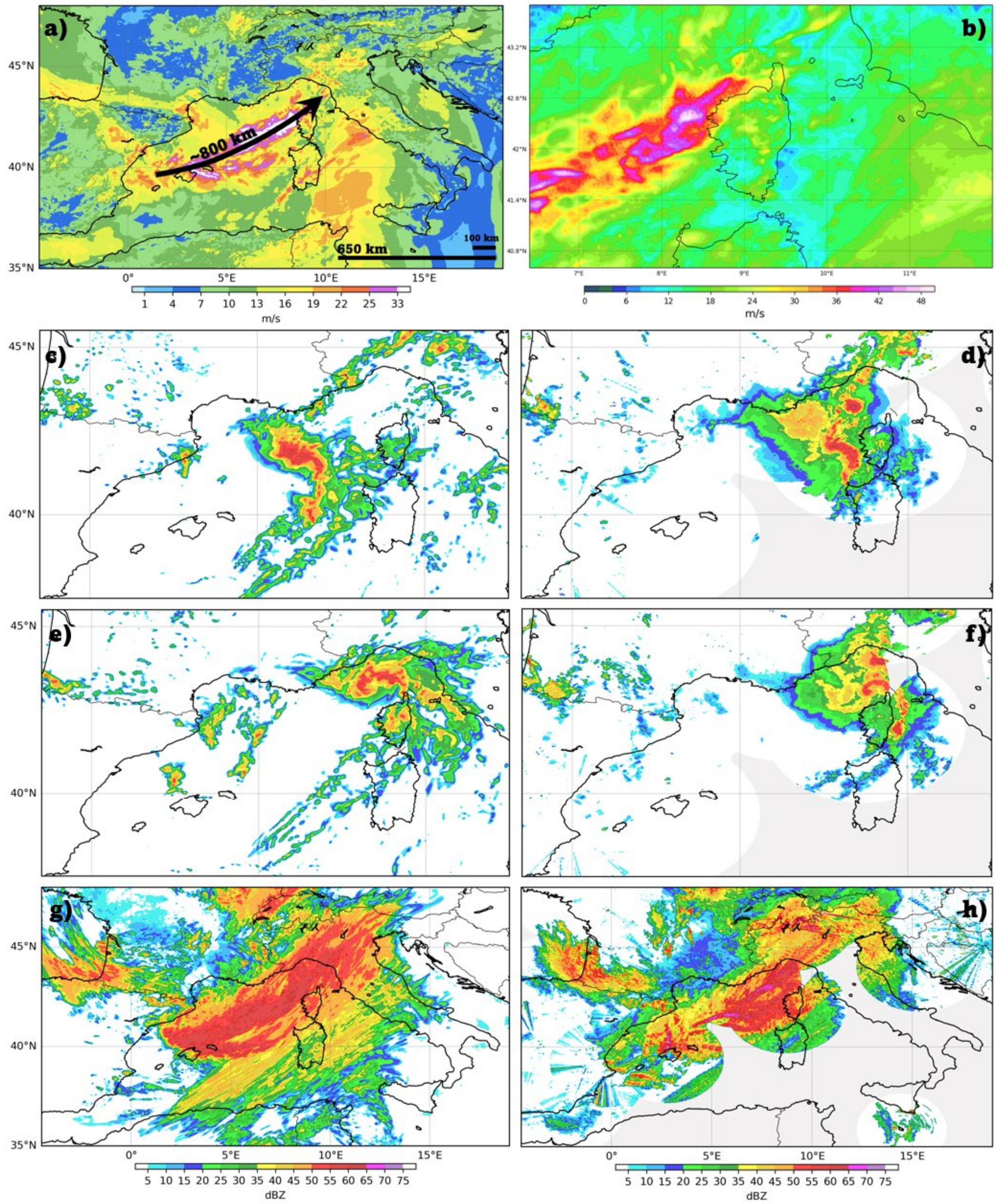

Figure ES1: Model evaluation: (a) As Fig. 2c, but indicating the path and the distance traveled of the simulated derecho. Derechos are characterized by a swath (>650 km long and >100 km wide) of wind damage with ≥25 m s^{-1} gusts along most of its length, with several, well-separated ≥33 m s^{-1} gusts. (b) As Fig 2c but zoomed in. (c) Simulated maximum reflectivity (dBZ) by the MPAS-PGW simulations in the factual world and (d) observed reflectivity (dBZ) for 18 Aug 2022 at 0600 UTC. (e) and (f) as in (c) and (d), respectively, but for 18 Aug 2022 at 0700 UTC. (g) and (h) as (e) and (f), respectively, but for maximum reflectivity from 17 August 2022 2100 UTC to 18 August 2022 1200 UTC.

Station	Max Wind Gust (ms⁻¹)	Monthly Record (ms⁻¹)	Annual Record (ms⁻¹)
Marignana [Ma]	62.4	27.3	49.0
Calvi [Ca]	54.7	28.0	44.0
Bocognano [Bo]	52.2	31.5	42.8
Ile Rousse [Ir]	51.3	39.0	59.0
Ajaccio-La Parata [Aj]	44.0	36.8	46.1
Renno [Re]	37.5	26.0	40.2
Pietralba [Pi]	35.9	30.0	36.0
Sampolo [Sa]	34.3	34.2	47.0
Oletta [Ol]	34.3	25.0	38.4
Corte [Co]	23.4	21.9	40.5
Cap Corse [Cs]	49.4	-	-
Cap Sagro [Cs]	48.3	-	-
Santo Pietro Di Tenda [Sa]	27.5	-	-
Bastia [Ba]	34.2	35.0	51.4
Calacuccia [Cl]	46.4	-	-
Sponde-Nivose [Sn]	41.7	-	-
Maniccia-Nivose [Mn]	27.2	-	-
Alistro [Al]	31.1	-	-
Ajaccio-Campo dell'Oro [Ac]	36.4	36.7	36.7
Sari d'Orcino [Sd]	30.8	-	-
Solenzara [So]	25.8	28.9	48.1

Table ES1: Observed maximum wind gusts (m s^{-1}) during the passage of the derecho convective event through middle and northern Corsica weather stations in the morning of 18 Aug 2022 and their respective latest monthly and annual records (hyphen indicates unknown). Dark red and gold color indicate if the observed maximum wind gust is a new annual or monthly record, respectively. Source: Météo-France.

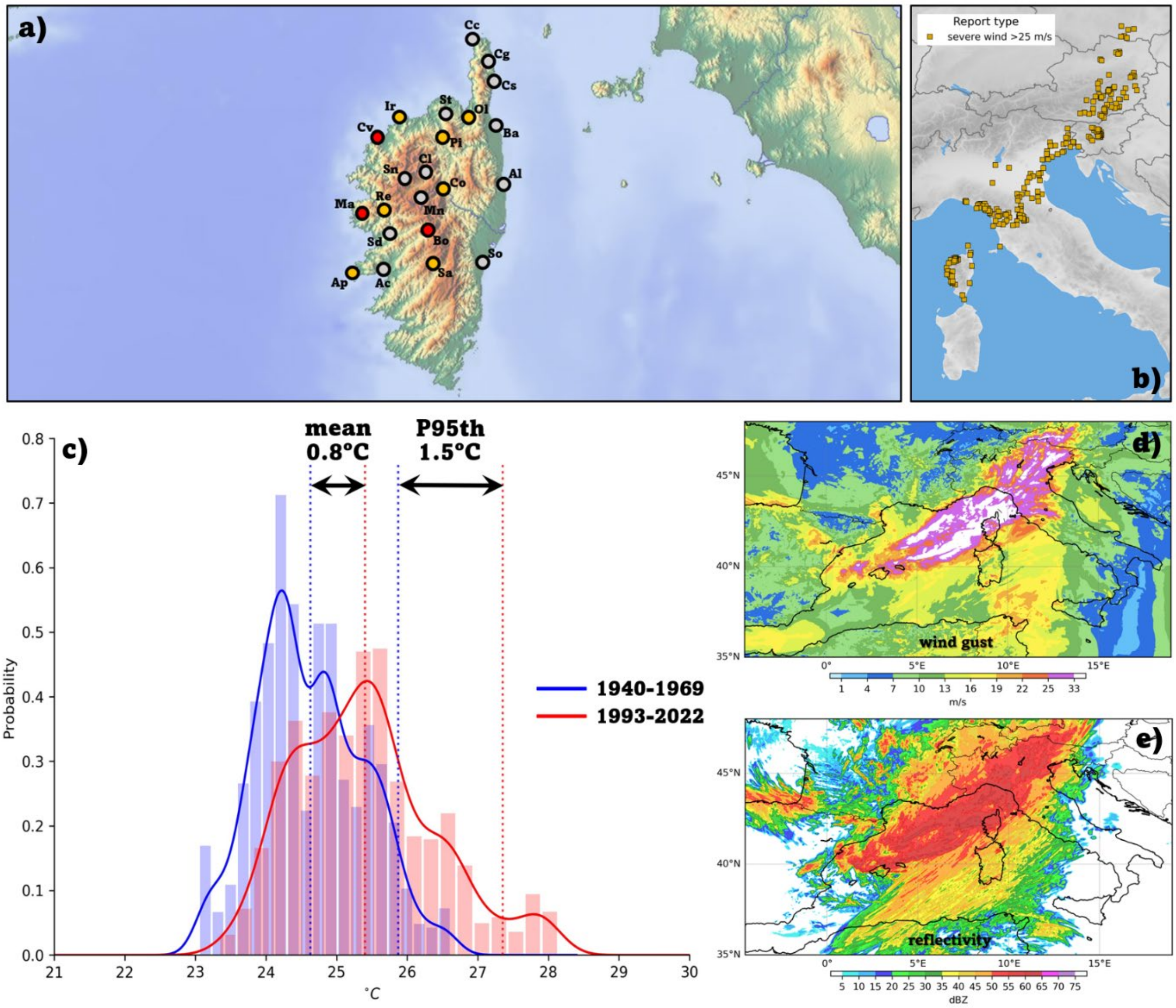

Figure ES2: (a) Locations of the observed maximum wind gust shown in Table ES1, with the same colors and acronyms. (b) Severe wind (>25 m s^{-1}) reports on 18 August 2022 between 0000 and 1800 UTC from the European Severe Weather Database (Dotzek et al. 2009). (c) Western Mediterranean (as in Fig. 1b) ERA5 daily SST probability distribution between 1940 and 2022 for August. A separation between 1940-1969 and 1993-2022 distributions is indicated with their respective means and 95th percentile. (d) Maximum wind gusts (m s^{-1}) and (e) maximum reflectivity (dBZ) from 2100 UTC 17 August 2022 to 1200 UTC 18 August 2022 in the MPAS-PGW simulations for the counterfactual future (SSP5-8.5 scenario) world simulations perturbed with the EC-Earth3 CMIP6 model.