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# Forecasting supercells in the Iberian Peninsula using the WRF-ARW model

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## 1. INTRODUCTION AND GOALS

- ✓ The Iberian Peninsula is one of the most topographically complex territories in Europe.
- ✓ Supercells are one of the most difficult weather phenomena to predict, causing many times a severe impact on society (Duda and Gallus, 2010; Cintineo and Stensrud, 2013).
- ✓ The aim of this project is to predict supercell formation in the Iberian Peninsula.

## 2. DATA AND METHODOLOGY

**Confirmed Supercells (Martin et al., 2020):**

- ✓ Database developed by a supervised citizen science project for 2011-currently.
- ✓ More than 250 confirmed supercells and more than 1300 medium-high confidence supercells.
- ✓ Evaluation only of the 2018 confirmed supercells events (28 supercells).

**WRF-ARW model configuration:**

- ✓ Parametrization schemes used are in Table 1.
- ✓ D1-15 Km of 115x90 grids points; D2-3Km of 85x85 or 100x100 grids points; D3-1Km of 110x90 grids points.
- ✓ For each supercell, three different simulations, differing each in the input: 18Z, 00Z, 12Z.
- ✓ GFS operational 0.25° input from RDA repository.
- ✓ Criteria to identify supercells in Table 2.
- ✓ Code to evaluate simulation in Table 3.

| Parameterization | 15 km domains | 3 - 1 km domains |
|---|---|---|
| Microphysics | Thompson aerosol-aware (28) | Thompson aerosol-aware (28) |
| LW radiation | RRTMG (4) | RRTMG (4) |
| SW radiation | RRTMG (4) | RRTMG (4) |
| Radiation call (min) | 5 | 5 |
| Convection | New Tiedke (16) | Disabled |
| Surface layer | Revised MM5 (1) | Revised MM5 (1) |
| Land surface | 5-layer (1) | 5-layer (1) |
| Boundary layer | BouLac (8) | BouLac (8) |

Table 1: Parametrization schemes used in WRF-ARW model.

| |
|---|
| 1. Annomaly displacement on simulated radar and shape (AM) |
| 2. Cyclonic or anticyclonic circulation of winds at different heigths (CC) |
| 3. Updraft Helicity (UH) |

Table 2: Criteria to identify supercells in WRF-ARW simulations.

| Code | Description |
|---|---|
| Code 1 | Outstanding Simulation. Supercell is clearly visible in simulated reflectivity, CC of winds and UH is high. +/- 2 hours margin and maximum displacement of 50-75 Km. |
| Code 2 | Good simulation. AM is appreciable and CC is totally or partially visible. UH is visible. Time margin is 3 hours and spatial margin máximum of 100 Km. |
| Code 3 | Fair simulation. CC circulation is not visible, but some AM in some cases. UH high positive values. Spatial margin 150 Km. |
| Code 4 | Poor simulation. None of the indicators are present. |

Table 3: Code to evaluate WRF-ARW simulations.

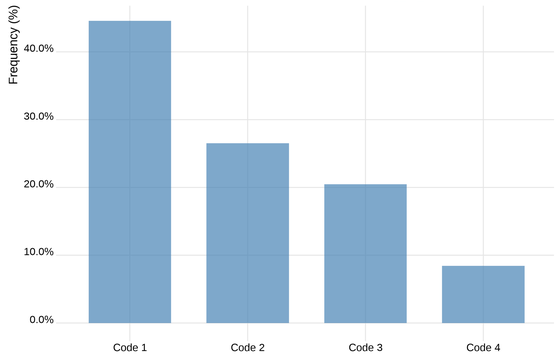



Figure 2: Frequency of each code respect supercells events in WRF-ARW.

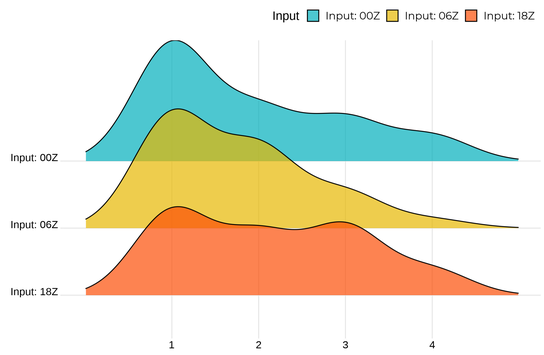



Figure 3: Density of each data input to simulate supercells events.

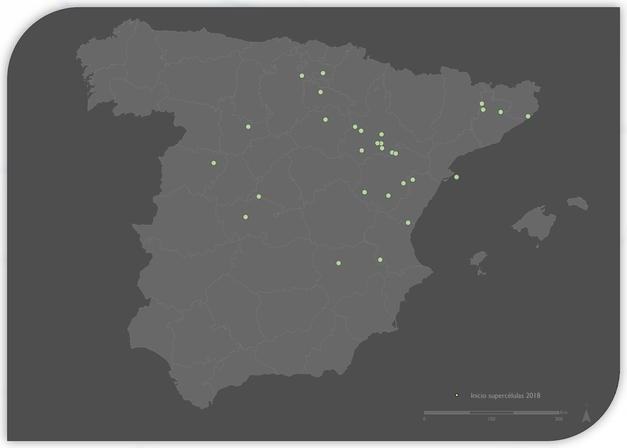



Figure 1: Location of the confirmed start supercells 2018.

Supercell Spatiotemporal distribution for 2011-2020 period

## 3. RESULTS

- ✓ All simulations have been conducted using the same model configuration (Table 1).
- ✓ More than 40% of the supercells are in Code 1, and more than 25% are in Code 2, i.e., more than 65% of the supercells have good results and could be predicted in a determined area and time.
- ✓ Around 20% are Code 3, which could be interpreted as areas with certain potential for supercell formation.
- ✓ Less than 10% of the events are classified as Code 4, meaning that the supercell failed to predict the supercell.
- ✓ The best input to predict supercells is 00Z (Figure 3).

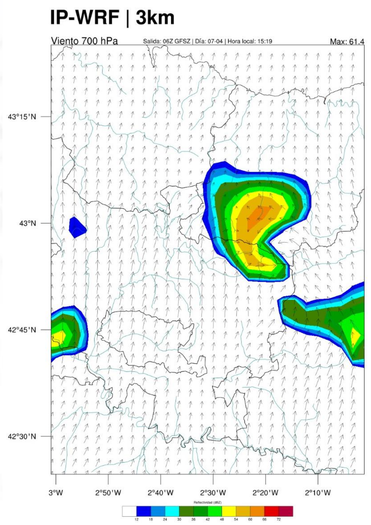



Figure 4: Reflectivity of tornadic Supercell in Basque Country July 4th, 2018.

## 4. CONCLUSIONS

- ✓ Many of the supercells could have been predicted (around 70%).
- ✓ The remaining 30% of the events, 20% shows a potential environment for supercell development and 10% were poor results.
- ✓ This research still needs further development. For instance, increasing the number of events using supercells from other years or investigating simulations using finer spatial resolutions.
- ✓ The model configuration presents positive results. However, it might be subject to improvement through boundary layer parametrization.

**References:**

Martín, Y., Cívica, M., and Pham, E. 2020. Constructing a database of supercells in Spain using publicly available PPI radar and citizen science. *Annals of the American Association of Geographers.*

Duda, J. D., and W. A. Gallus, Spring and summer mid-western severe weather reports in supercells compared toother morphologies,Weather and Forecasting,25(1), 190–206

Cintineo, R. M., and D. J. Stensrud, On the predictability ofsupercell thunderstorm evolution,Journal of the Atmosp-heric Sciences,70(7), 1993–2011,