

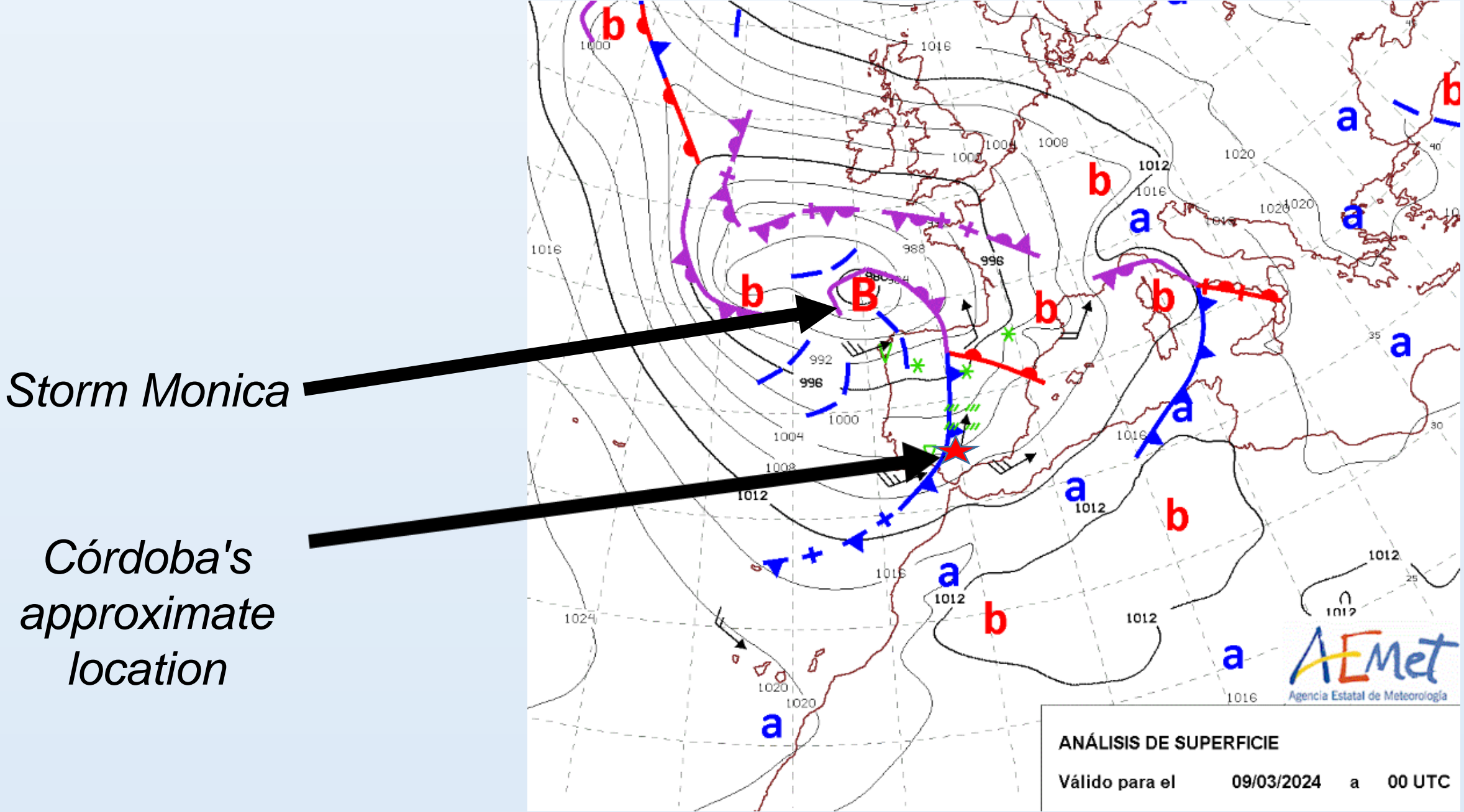
Severe wind damage in Córdoba, Spain, 9 March 2024 linked to a possible cold-frontal misocyclone

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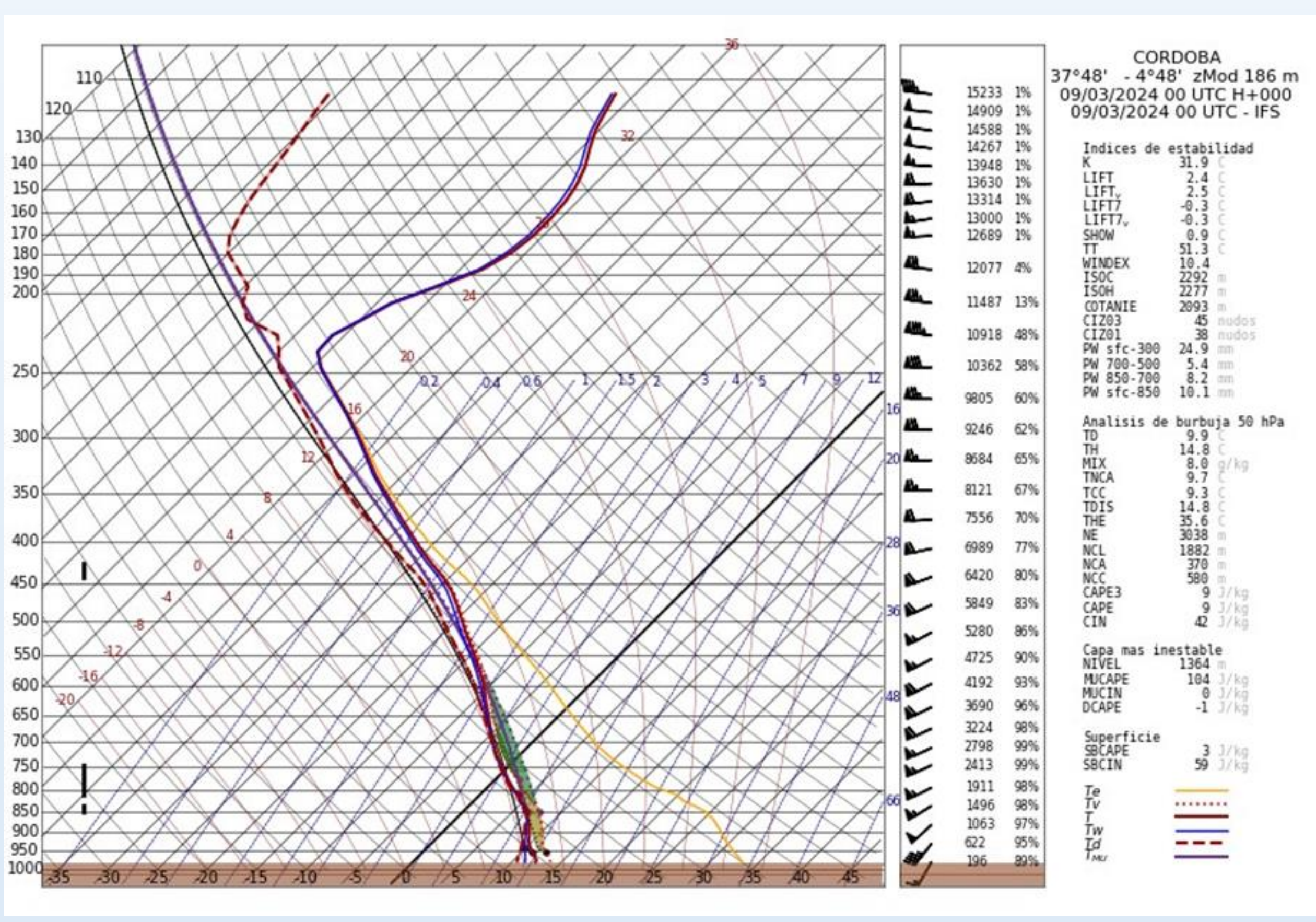
(1) AEMET, Agencia Estatal de Meteorología

Early 9/3/2024, a cold front associated with Storm Monica brought widespread rain and moderate to strong westerly winds to the western Iberian Peninsula. The winds caused significant damage in Córdoba, which local reports attributed to a tornado. Serious damage was also reported at 'La Africana', a solar thermal power plant about 25 km SW of the city.

Context

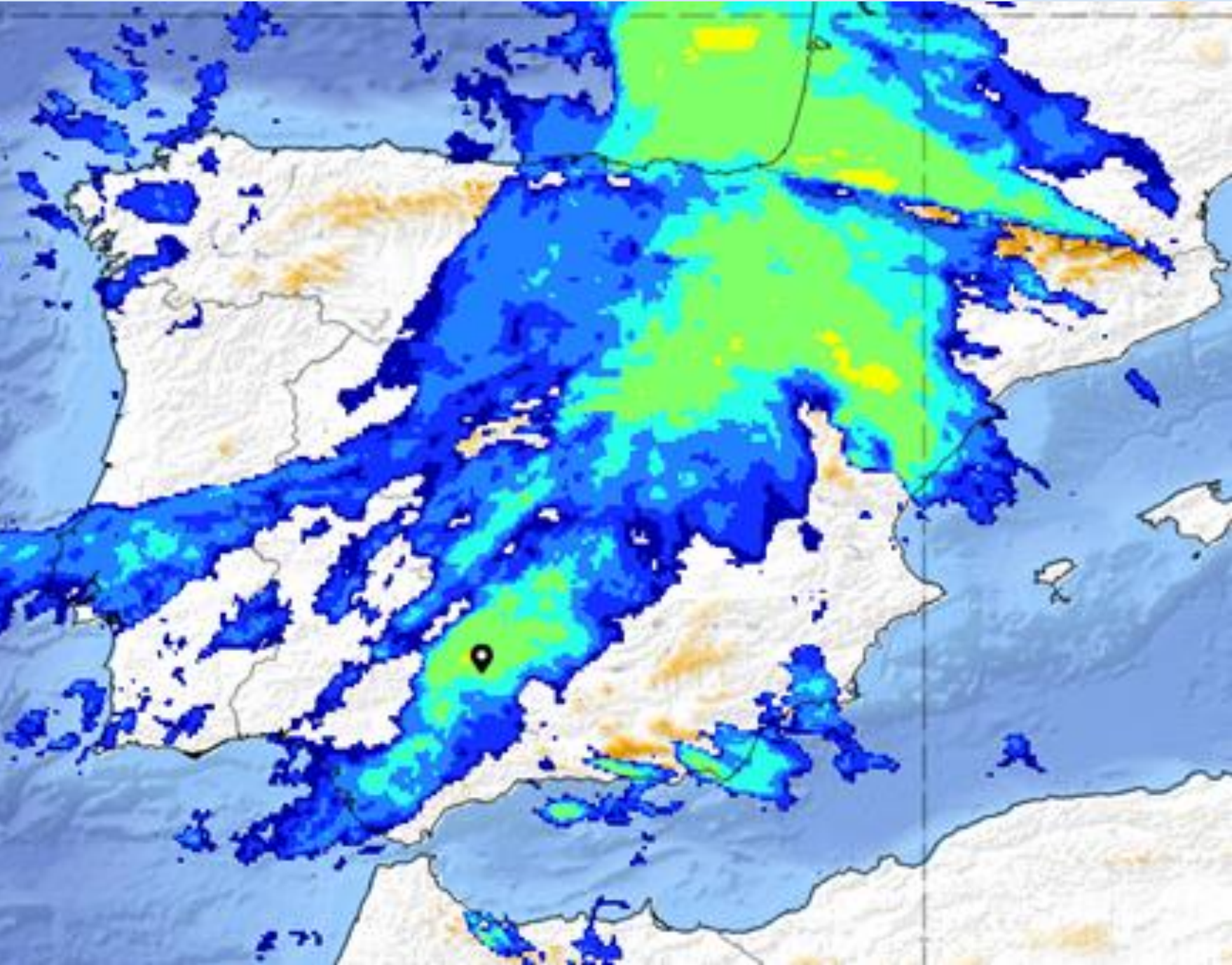


Very humid, HSLC environment
Max CAPE: 104 J/kg.
0-1 km shear: 38 kt.
0-3 km shear: 45 kt

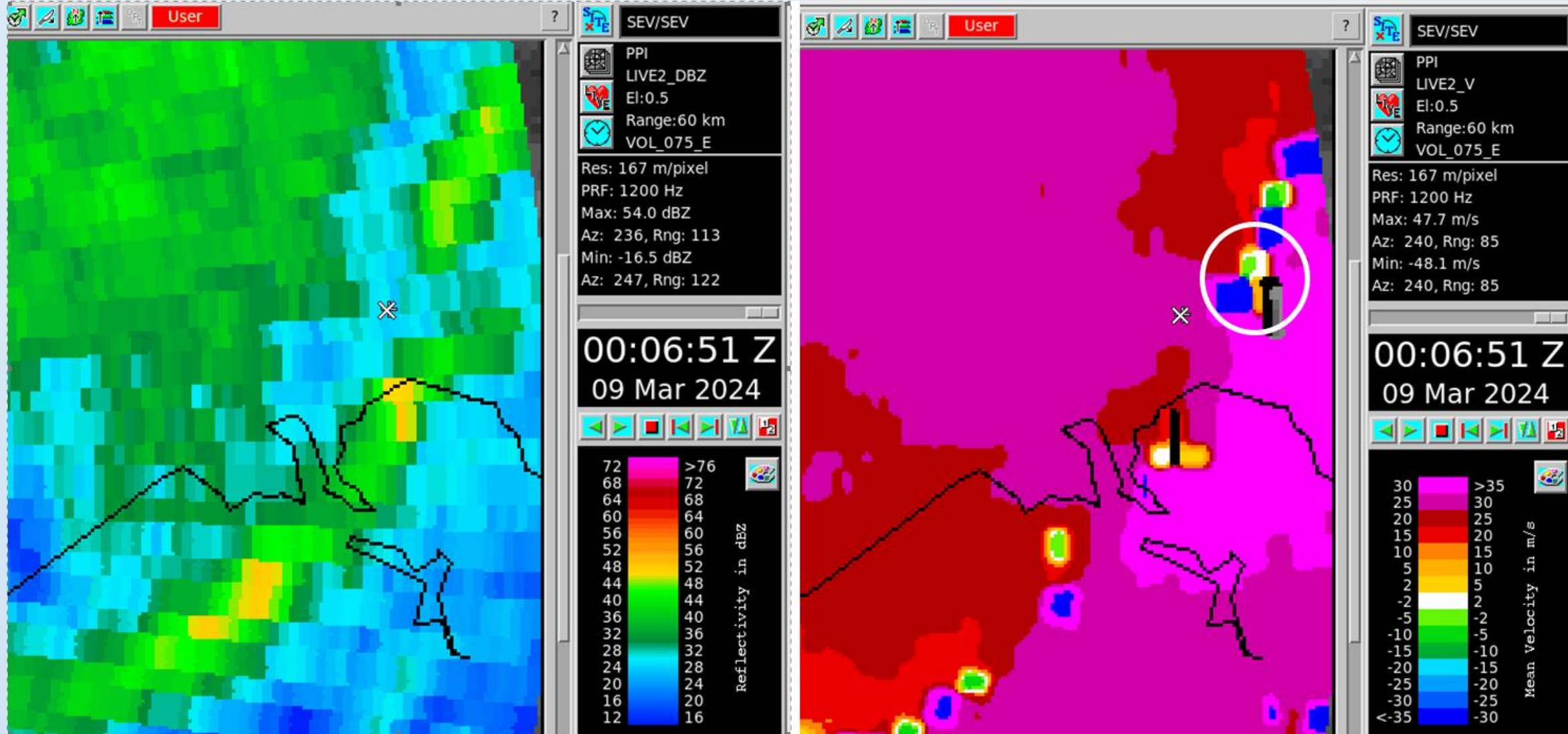


A relatively compact cloud band stretches from the eastern Cantabrian Sea to the Gulf of Cádiz. In the southern part of this frontal band, an undulation and some higher cloud tops are visible. At 00 UTC, the center of this undulation is positioned just SW of Córdoba (marked by a pin).

Teledetection & Observation

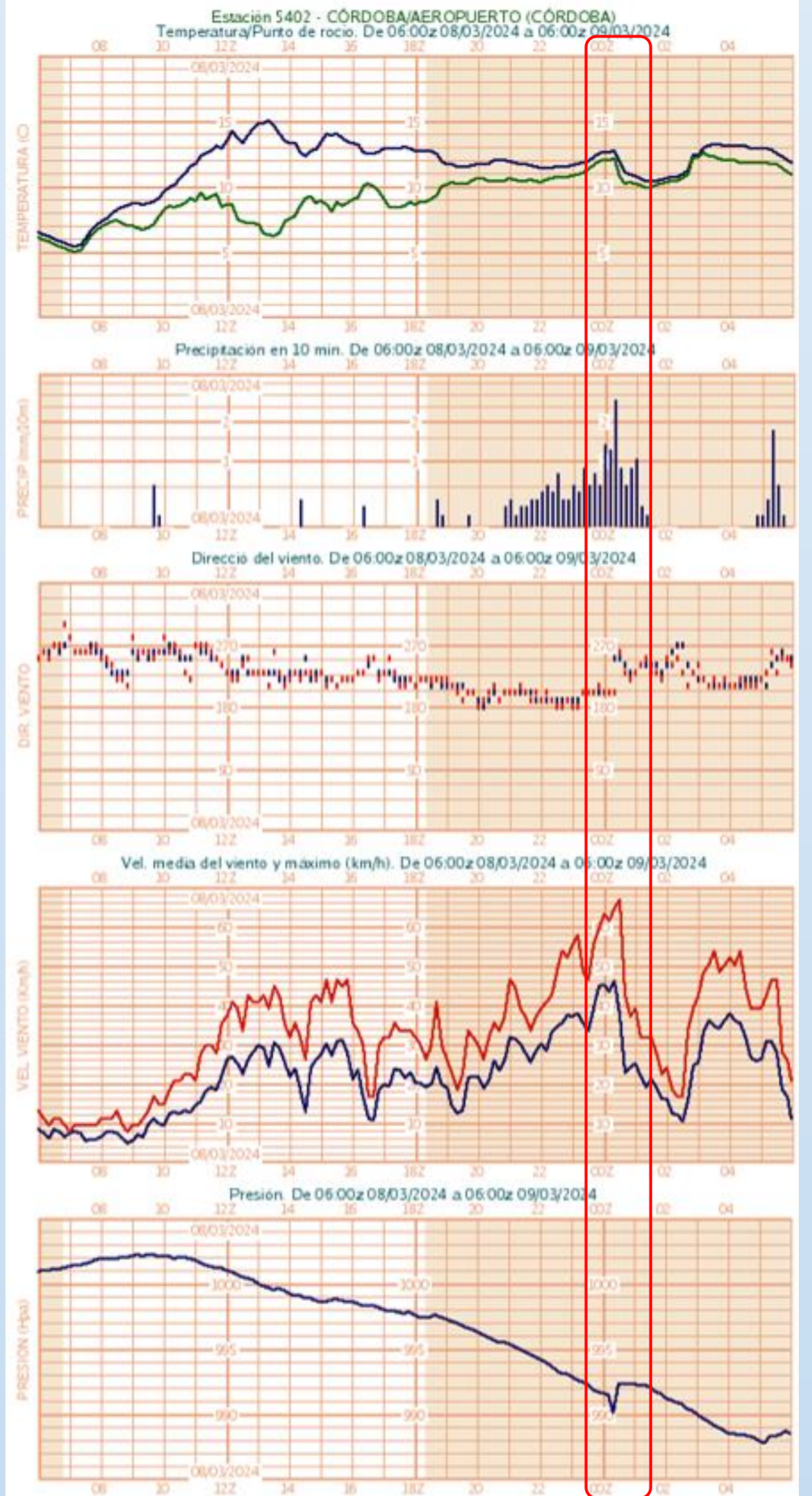


Meteosat 11. Enhanced IR 10.8 channel. 00 UTC



Reflectivity (left) and radial velocity (right), 00:06 UTC. White cross marks the location of the damaged power plant. A circle (right) surrounds the possible misocyclone that may have passed over the plant. The vortex coincides with the gap in the reflectivity pattern (left). The maximum exit velocity south of the vortex, after accounting for aliasing, is estimated to be ≥ 58 m/s. The radar beam elevation at this location is $\sim 2,200$ m

Records from our AWS at the city airport (~ 4 km southwest, outside the affected area), show the front passing between 00:20 and 00:30 UTC. The maximum recorded gust of 66.6 km/h cannot explain the extent of the damage observed.



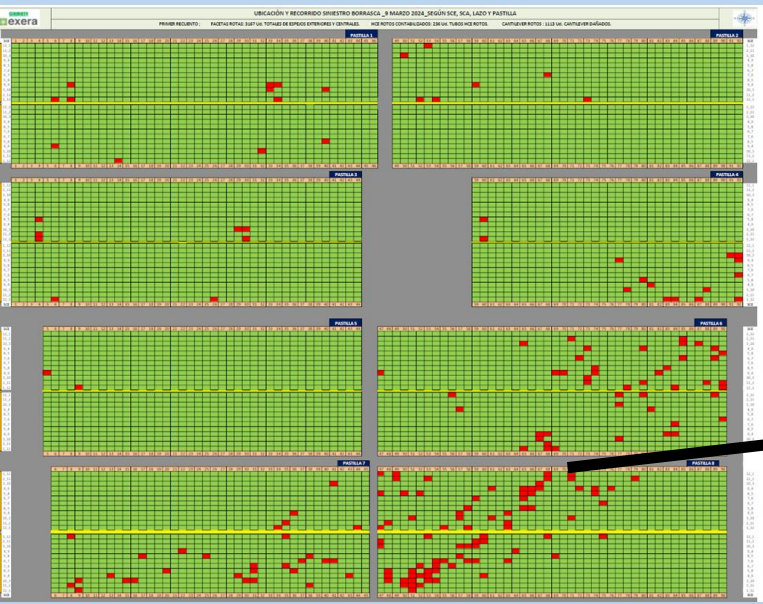
Damage analysis



DI: TRS (strong trees)
DoD: 3 (uprooted)
Rating: \geq IF1.5 (≥ 180 km/h)



DI: FWAB (Free-standing Wall, concrete blocks reinforced)
DoD: 2 (near complete destruction)
Rating: \geq IF2 (≥ 220 km/h)

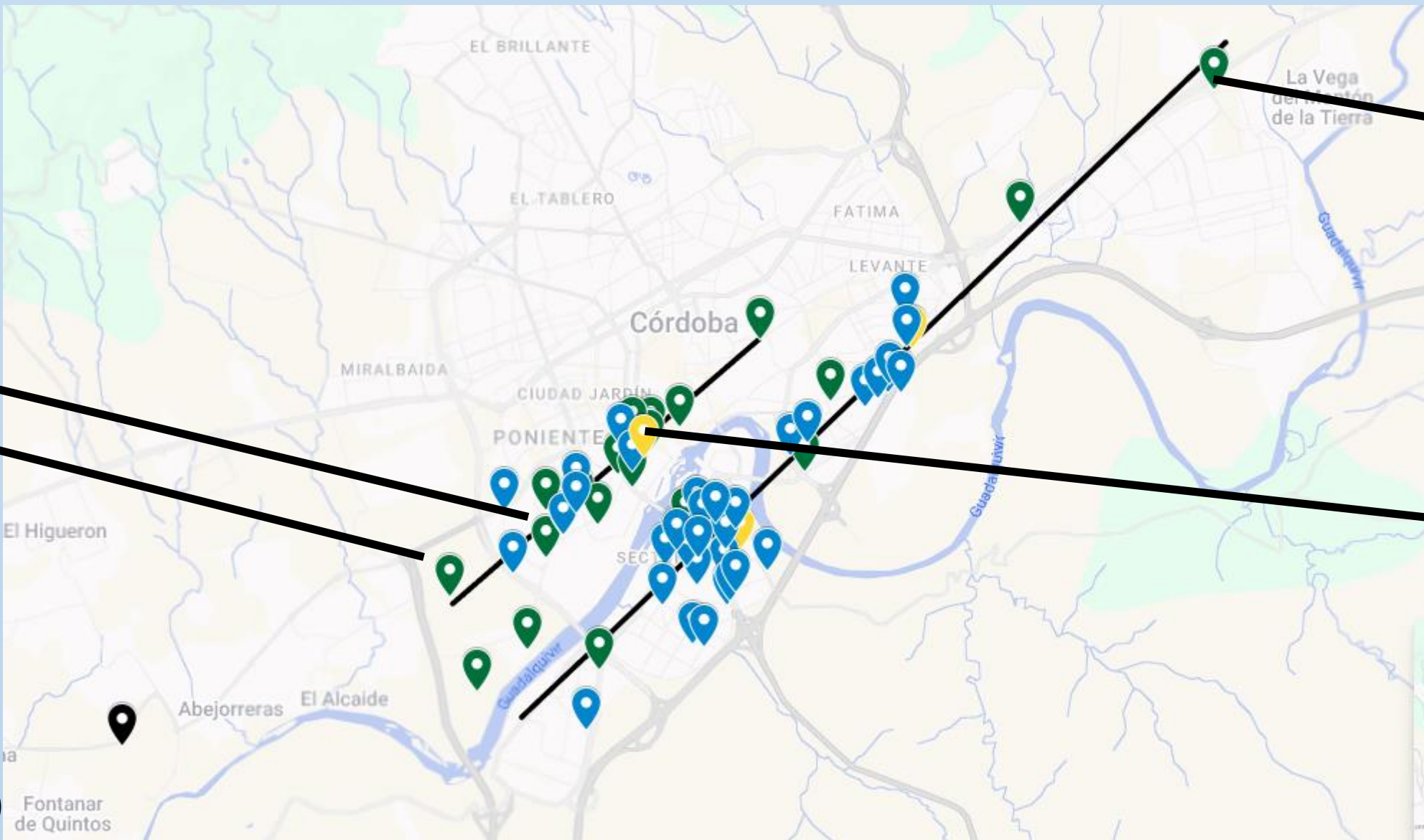


Path of damaged heliostats at La Africana.
AWS at the SW end recorded 96.48 km/h at 00:06 UTC



DI: SP (Solar Panels*)
DoD: 0 (no structural failure)
Rating: \leq IF1.5 (≤ 180 km/h)

*Strictly speaking, these are heliostats



Color marks: damages known from various sources.
Black mark: Airport AWS.
Northern path is ~ 4 km long and ~ 400 m wide.
Southern path is ~ 10 km long and ~ 800 m wide.
Testimonies and records suggest that both trajectories occurred simultaneously, around 00:20 UTC.



DI: TSA (Tree Stand Average)
DoD: 2 (fewer than half snapped or uprooted)
Rating: IF1 (150 km/h)



DI: SNM (metal frame billboard)
DoD: 1 (inclination or buckling of pillars)
Rating: IF1.5 (180 km/h)

Pictures from the field survey carried out by the authors on March 11.
All wind assesment according to International Fujita (IF) scale



Conclusions

The intensity and distribution of damage are compatible with a convective wind phenomenon. Radar analysis suggests that the two parallel, simultaneous, and close tracks in the city resulted from a single vortex larger than a tornado—a misocyclone. The southern track is attributed to the misocyclone's downdraft winds, and the northern track to a small tornado on its opposite flank. Although there is no evidence of a funnel cloud, it would have been difficult to observe since the event occurred at night.

Damage in the city reached an estimated IF2 category on the International Fujita scale, with maximum wind intensity around 220 km/h, while at the solar thermal plant damage is estimated at IF1 to IF1.5, with maximum winds around 150-180 km/h.

Ref. & Ack.

Groenemeijer, P. et al. (2023): The International Fujita (IF) Scale for tornado and wind damage assessments. European Severe Storms Laboratory.
Smart, D.J. and Browning, K.A. (2009): Morphology and evolution of cold-frontal misocyclones, Q. J. R. Meteorol. Soc. 135: 381–393 (2009)
Thanks for valuable info about the damage to Colectivo Meteofreak @Colectivo_Meteo, Óscar Díaz @osdiol, Almu @Almudory, María José Pérez @MJ_PerezMorales, Ayuntamiento de Córdoba, Planta Termosolar La Africana, Centro IFAPA Alameda del Obispo, Emergencias 112 Andalucía. Special thanks to Kike Muñoz Iraundegi @atmosferasur for his kind support during the field survey.