



## ***SINGLE-CELL THUNDERSTORM MADRID***

### ***JUNE 7, 2003***

**Jose A. Quirantes (rayo)**

**e-mail:** [jose.quirantes@inm.es](mailto:jose.quirantes@inm.es) y [rayo@spainsevereweather.com](mailto:rayo@spainsevereweather.com)

On Saturday, June 7, 2003 a weak but beautiful thunderstorm hit part of the Madrid, Guadalajara and Cuenca provinces - an alley-like area along the Tajo river, not far from the Entrepeñas and Buendía dams, in the Spanish southern Meseta. This area is actually a typical "storm factory", particularly active in northwesterly circulations, and very prone to convective developments in minimally good conditions. Park Juan Carlos I in NE Madrid (where the pictures were taken) provides an excellent view of the whole area, located more or less southeast of that position. This is why the Cbs in the pictures look that wonderful at sunset (sun's position is northwest of the observation point).

From 18h30' GMT (20h 30' local time) to 19h50' GMT (21h 50' local time) I took more than fifty pics, of which I have selected eight for the report. The pictures selected clearly show the different stages which characterize the lifespan of a single-cell storm, from its onset as Cumulus Congestus till it dies out as Cumulonimbus Capillatus Incus after going through the intermediate stages of Cumulonimbus Calvus and Cumulonimbus Capillatus. For the sake of teaching it would have been better to have pictures of the whole episode (i.e. including the "germinal" Cumulus Mediocris or even Cumulus Humilis stages), but I just didn't make it on time in my chase. The storm did not produce dramatic reflectivities (the highest was 54 dBz, and quite isolated too). As for echo tops (or cell height limit with at least 12 dBz reflectivity), the storm reached up to 12 km. No significant showers were reported. Rain accumulations recorded by the INM (Spanish Weather Office) did not exceed 5 mm in any case.

As for maps, I have chosen echo tops instead of reflectivities, because the echoes were very weak in the latter and the cell structure could hardly be seen. As you can see, some of the cloud picture chronologically correspond to the Madrid radar pictures. It was a rather symmetrical thunderstorm generated in a very dry atmosphere in lower levels and a wet atmosphere in higher levels, with hardly any vertical shear (changing wind force and/or direction with height), which favored the formation of a perfect anvil. Just beautiful. This factor makes the updraft and downdraft in the cell associate in such way that the updraft is quickly neutralized by the downdraft (which is linked to the precipitation curtain), thus hampering the persistence and severity of the storm, considering the unstable conditions that evening.

#### **PICTURE 1 - GROWING STAGE: CUMULUS CONGESTUS**

20h30'. This is the first picture of the storm, showing a powerful Cumulus congestus (1) about 7,5 km high (see echo top picture of 20h30' local time) located some 70 km southeast of the capital, right above the village of Estremera in the Tajo valley. In the radar pictures I have added an arrow to indicate the approximate direction of observation. A second Cu Congestus (2) (less developed as it reaches just 5,5 km high) is located some way southwest of the main one nucleus. (3) and (4) are even less developed Cu congestus (some 3 km high). (5) is a Cb Capillatus over Tarancon, Cuenca. This cloud was reaching a height of 12 km at that time, according to the radar picture, where you can see how the line of storms stretches well into southerly Ciudad Real.

## **PICTURE 2 - GROWING STAGE: CUMULUS CONGESTUS**

20h42'. This picture shows to what extent things have changed, only twelve minutes later. The Cu congestus is now higher (about 9 km) and has split in two: (1a) and (1b). It is now in the process of becoming a Cumulonimbus Calvus. (1c) shows a sort of cirrus area "sandwiched" into them and surrounding the main tower. It might be caused by a small inversion easily superseded by the strong updraft. The other tower (2) has now reached the same height as (1). A group of beautiful Pileus (hat clouds) (x, y) have built right on top of the towers. The cloud is increasingly reflecting the sun light and becoming whiter and brighter. If you zoom in this point in the radar picture of 20h40' you will see both towers clearly apart. Quite a privilege to get it "live". Nuclei (3), (4) and (5) have not changed much.

## **PICTURE 3 - GROWING STAGE: CUMULONIMBUS CALVUS**

20h47'. Five minutes later, a powerful Cumulonimbus Calvus (1) emerges distinctively from the rest, reaching nearly 11 km. It has forced its way through the nearby cirrus layer. The 1b-1c is now independent and tower (2) begins to merge with tower (1). Pileus cloud (y) is still visible. This tower is growing less fast, as it is the other one which has the more powerful updraft. Cu Congestus (3) has split and seems to have emerged from its lethargy. Cu Congestus (4) seems eager to grow too. Cb Capillatus (5), now clearly in dissipating phase, remains in the same position.

## **PICTURE 4 - GROWING-MATURE STAGE: CUMULONIMBUS CALVUS**

20h50'. Things are going on quickly: Cumulonimbus (1), now fully mature, keep growing fast. (1bc) and (2) look like wanting to join the race. Even (1a) has reached out an "arm" (1d) to merge into (2), which splits in (2a) and (2b). (3a) and (3b) keep growing on, as opposed to (4) and (5), which remain "quiet". We can now use a new radar image for comparison: the 20h50' one. What we recommend is to zoom in with any Windows tool. The cell has isolated from the dissipating storms located south of it, while a new storm, wholly independent from ours and invisible to our eyes, begins to build up some 25 km east, over the Buendía dam. The echo tops are now at their highest: 12 km.

## **PICTURE 5 - MATURE STAGE: CUMULONIMBUS CAPILLATUS**

20h52'. Things get clearer. (1) is now a compact unit – still a Cb Calvus but beginning to evolve into Cb Capillatus. (2) has virtually merged with (1), and (3) is on its way too. Anvil (5) keeps dissipating. Cb (1) has reached stratospheric levels, where its powerful updrafts find warmer air, so the bubbles of condensed air begin to lose the floating power that had driven them up to 12 km high. Strong horizontal drafts expand now the Cb top, creating the typical "anvil". "Corners" 1b, 1c, 1d, 1e, 1f and 1g are the examples of these divergent "hits".

## **PICTURE 6 - MATURE-DISSIPATING STAGE: CUMULONIMBUS CAPILLATUS**

21h05'. The Cb Capillatus is nicely outlined now: the outflowing currents at the cloud top produce a rounded anvil. Look at the remarkable thickness of the anvil tip: this is a sign of the strength with which the updraft reached the cloud top and is also a consequence of the humidity rate in the 10 to 12 km high layer. A further proof of this are the numerous condensation trails present at that level, as well as the thin layer of Ci fibratus that can be made out in some of the pictures. If you look at the radar image from 21h00', you can see how the anvil (brown) stretches over a wide area (12 km), The Cb Capillatus is at the height of its mature stage. Updraft and downdraft are on par, and it is at this stage that the heaviest precipitation can be expected. The cloud has still a "strong" core. Part of the updraft currents just don't want to surrender, a sign of which is a slight overshooting protruding over (1). I don't have any radar picture to confirm it, but it's likely that this last offensive should bring the cloud up to 13 km. Look at the thickness and density of the anvil, right under the overshooting, and at the embryonic mammatus. On the other hand, cells (2) are (3) merging with (1) and forming one single system. The cloud begins now to show a typical fibrous appearance, being formed as it is by ice crystals.

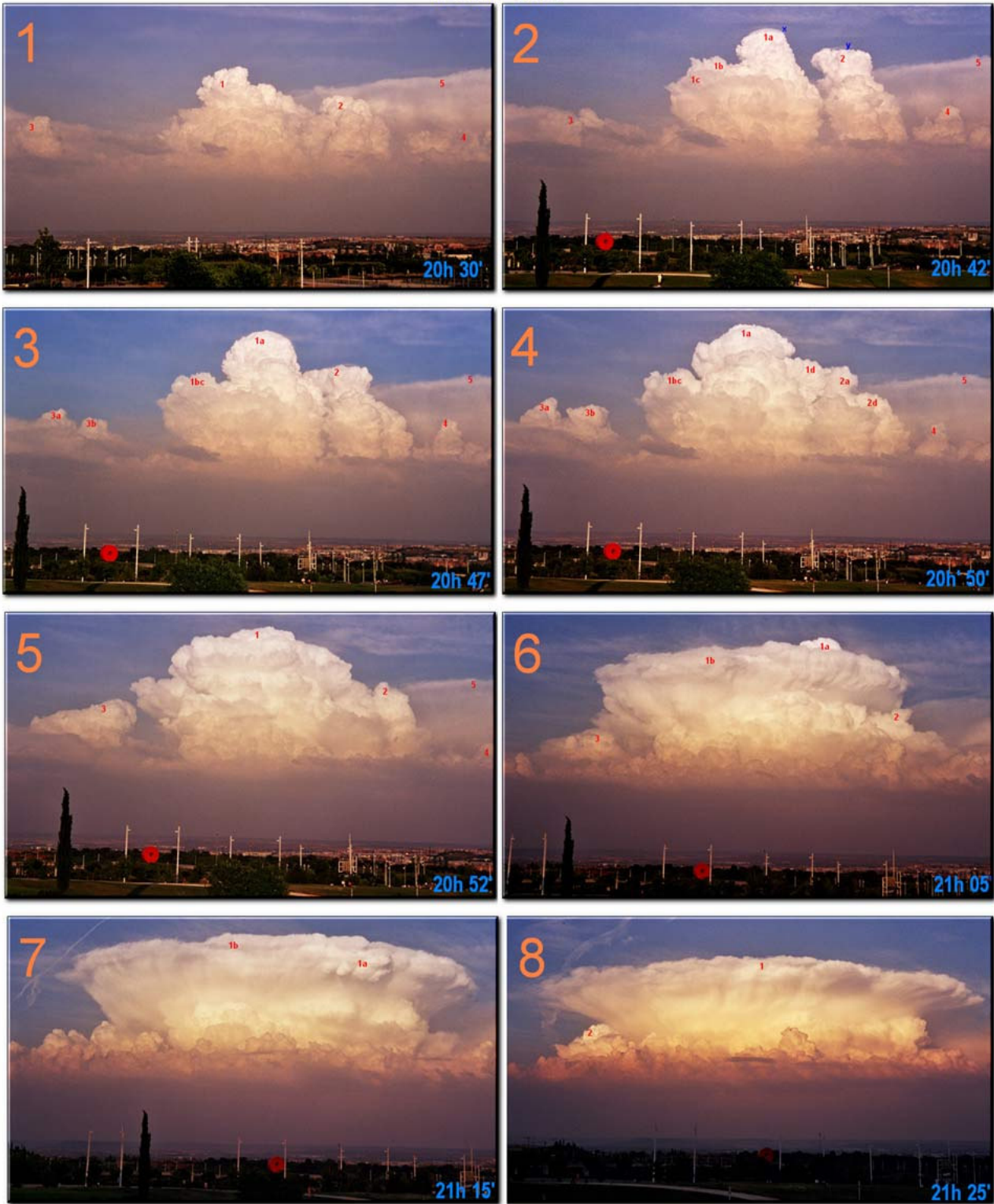
## **PICTURE 7 - DISSIPATING STAGE: CUMULONIMBUS CAPILLATUS INCUS**

21h15'. Ten minutes after the previous shot, things are slowing down. We are now in the dissipating stage of the thunderstorm. The cloud has become a Cumulonimbus Capillatus Incus. (1a) shows a weak formation of mammatus, as we mentioned before. The overshooting has given in. However, the storm base and medium levels still show a heavily sprouting appearance. Take a look at the radar image from 21h10': we can see how the cloud top at 12 km (dark-brown) is located in the western area of the "mushroom", that is, the one I could see from my position. Notice also the dramatic gradient between the anvil and the ground: orange for 10-km echo top to black for no-data or ground.

### **PICTURE 8 - DISSIPATING STAGE: CUMULONIMBUS CAPILLATUS INCUS**

21h25'. The next radar image (21h20') shows hardly any brown pixel: virtually the whole anvil is now orange-colored (=10 km). The dissipating stage proceeds slowly, the cloud appearance lingers on. Ten minutes after the previous picture the anvil is evaporating little by little and the sprouts in the low and medium levels lose strength. Conversely, (2) keeps developing. The radar image of 21h30' shows just one difference from the previous one: another storm, located 15 km farther east, is now mature and shows up at (2). This storm has been constantly moving away from my position and is now over the Entrepeñas and Buendía (100 km from Madrid). The higher areas of the cloud, still caught by the light of the setting sun, gradually fade into orange-reddish hues.

7- Junio - 2003



**SECUENCIA FORMACION DE TORMENTA UNICELULAR**

Fase Cumulus Congestus, fotos 1 y 2.

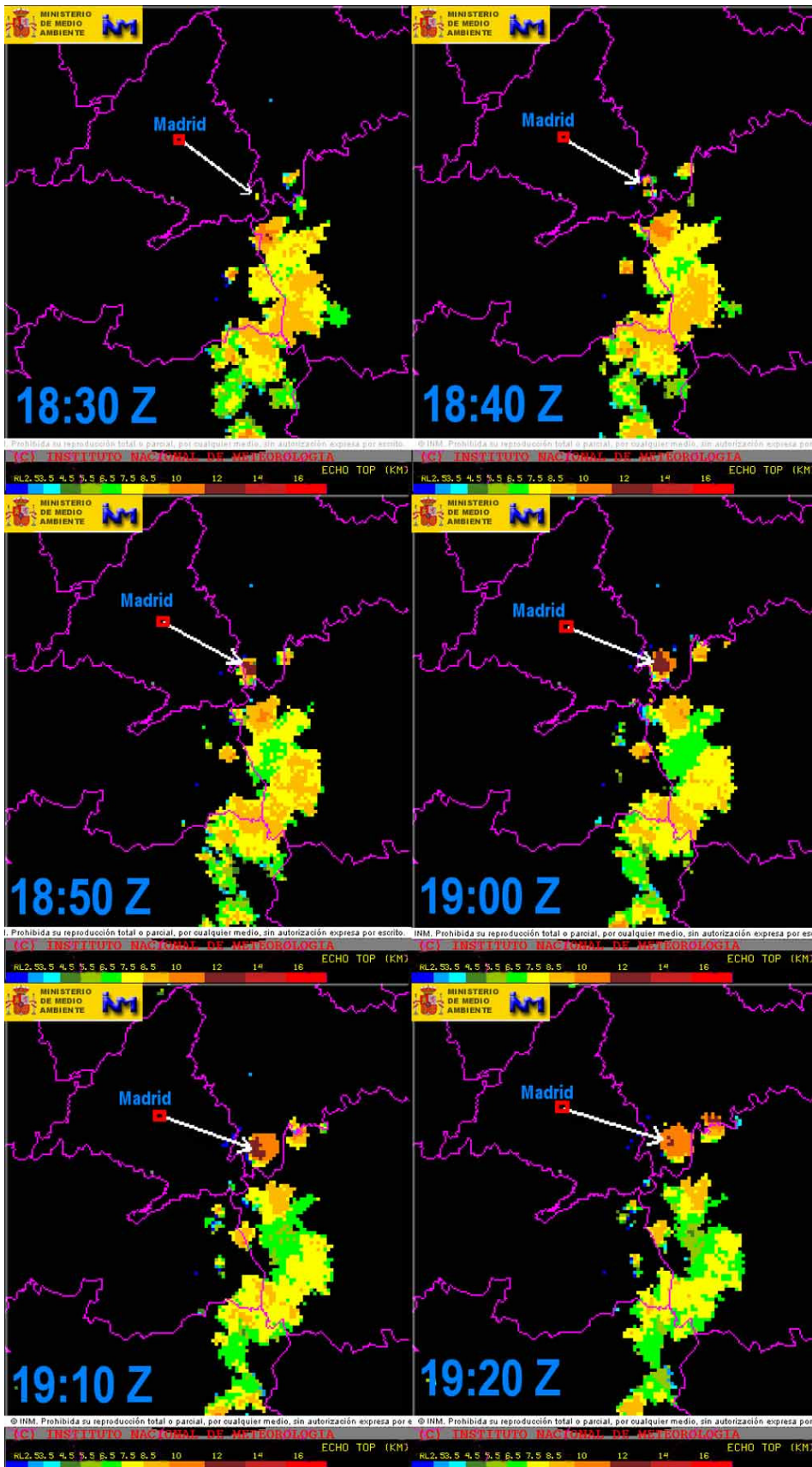
Fase Cumulonimbus Calvus, fotos 3 y 4.

Fase Cumulonimbus Capillatus, fotos 5 y 6.

Fase Cumulonimbus Capillatus Incus, fotos 7 y 8.

**IMÁGENES DE ECHOTOPS DEL RADAR DE MADRID (INSTITUTO NACIONAL DE METEOROLOGÍA)**





Top