

# Tropical like Cyclone "Udine" on 15-20 September 2020

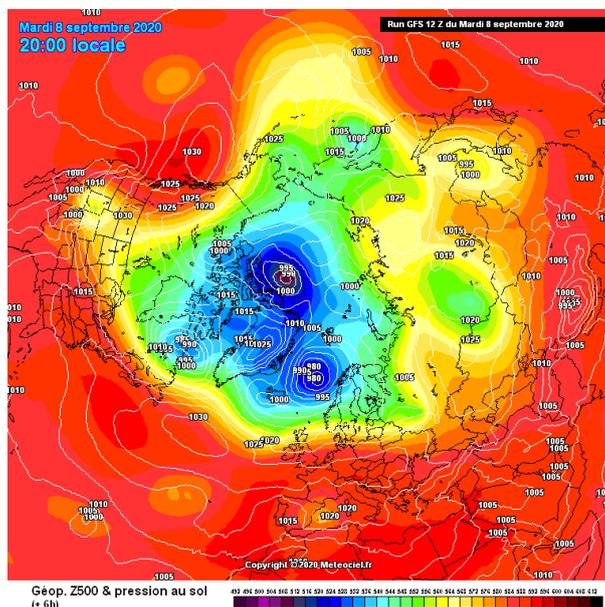
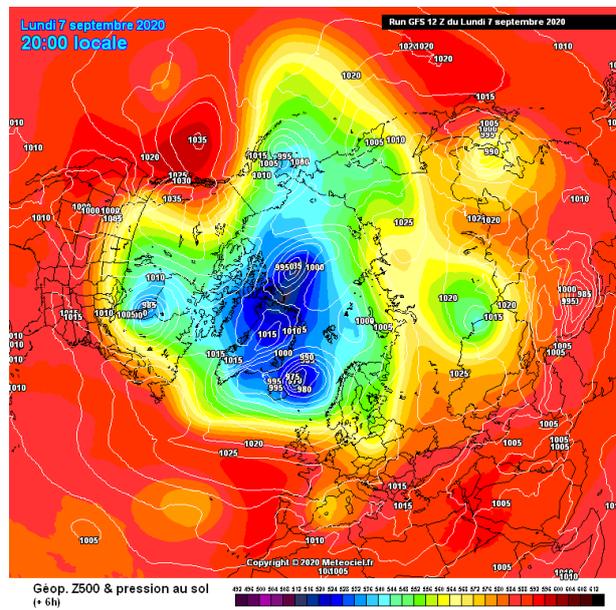
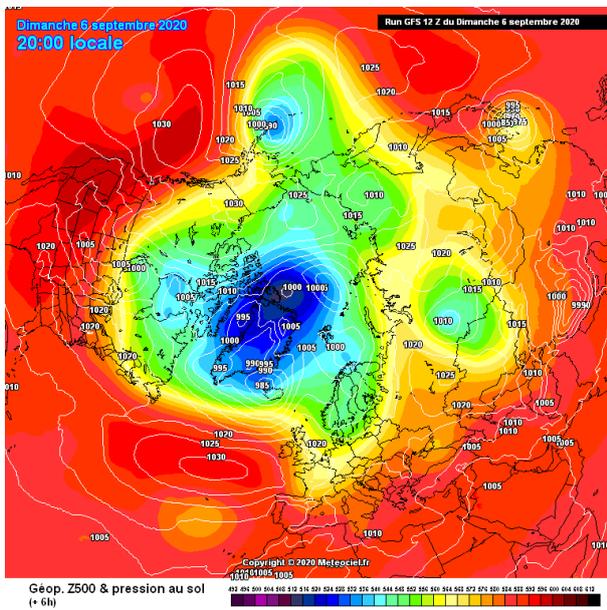
written by

Fabio Zimbo – Certified Meteorologist WMO compliant n°1083, AMPRO Meteorologist

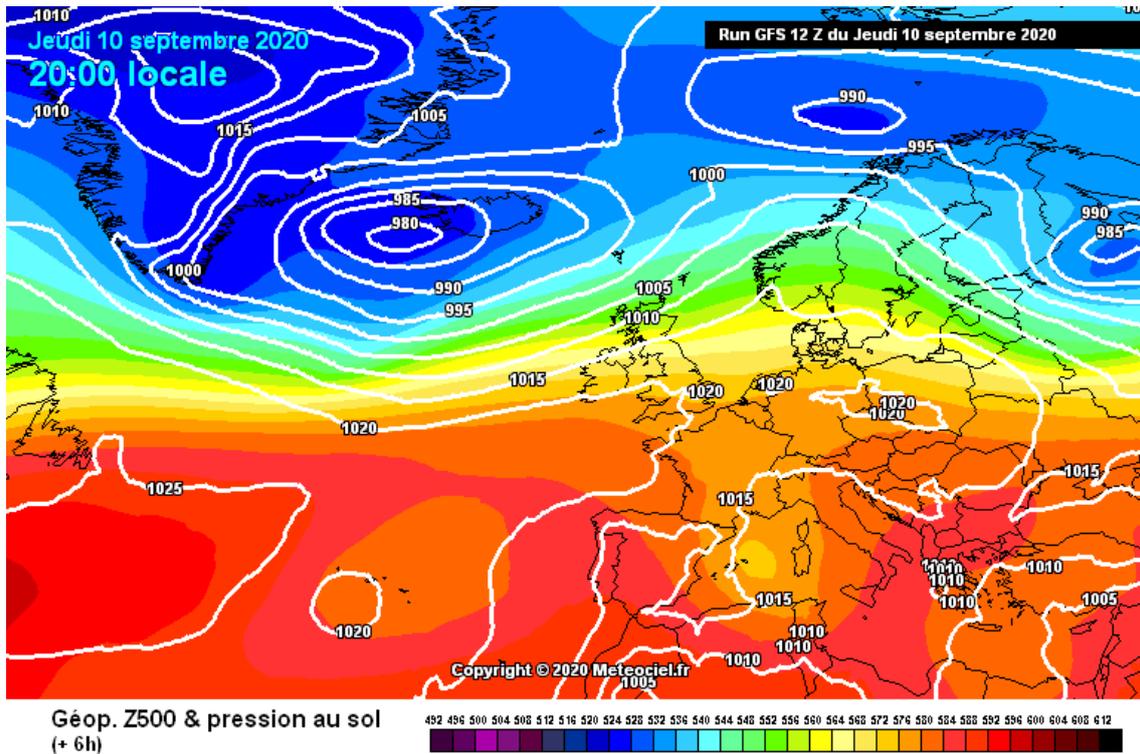
Daniele Ingemi – Certified Meteorological Technician WMO compliant n°1083, AMPRO Meteorological Technician

The tropical cyclone called "Udine" (according to the official name of the University of Berlin which traditionally assigns a name to the European depressive systems) affected the central Mediterranean basin from September 14 to September 20, 2020, bringing extreme events (such as **heavy rains, strong winds and storm surges**) in particular in Calabria (but only in the lower Crotona area and in the Locride area), eastern Sicily and Greece.

Its origin is explained with the formation of a trough in the perturbed Atlantic flow which on September 6 extended to France, going in "tear off" on September 7, and finally in "cut-off" on the Balearic Islands on September 8.

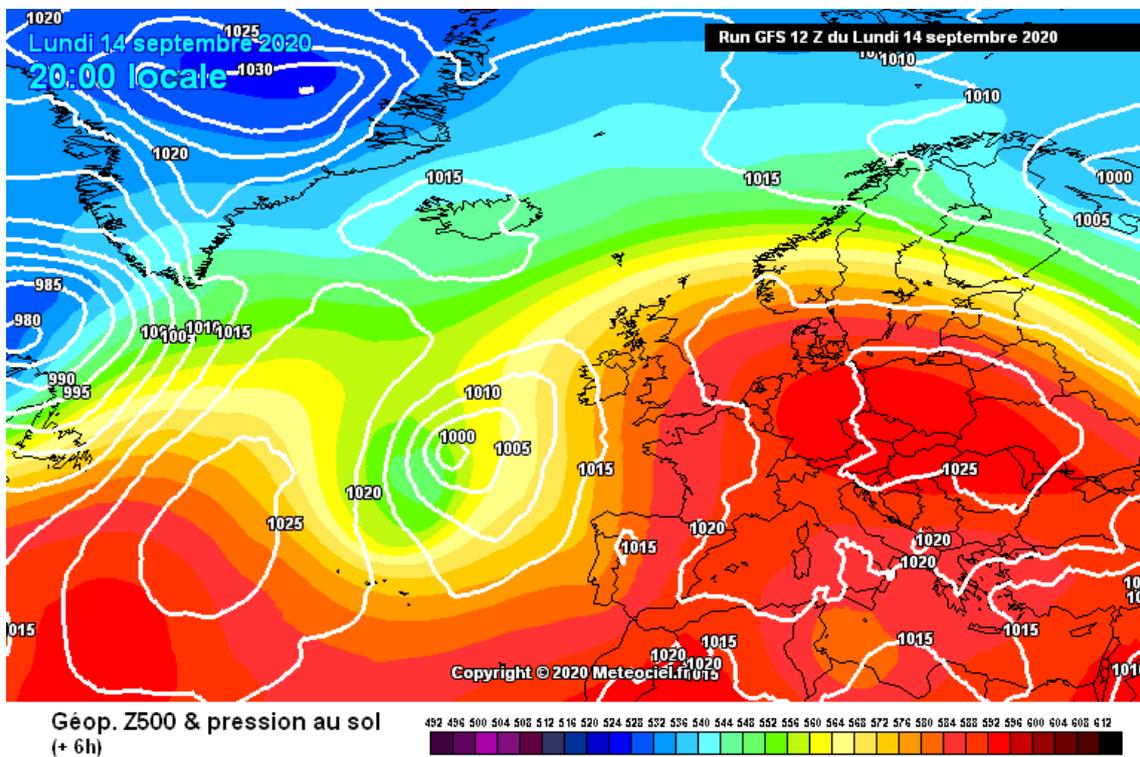


From that moment on, this cold-air drop began a very slow movement towards the west, at times reabsorbed again in "tear offs" on September 10 by the Atlantic flow



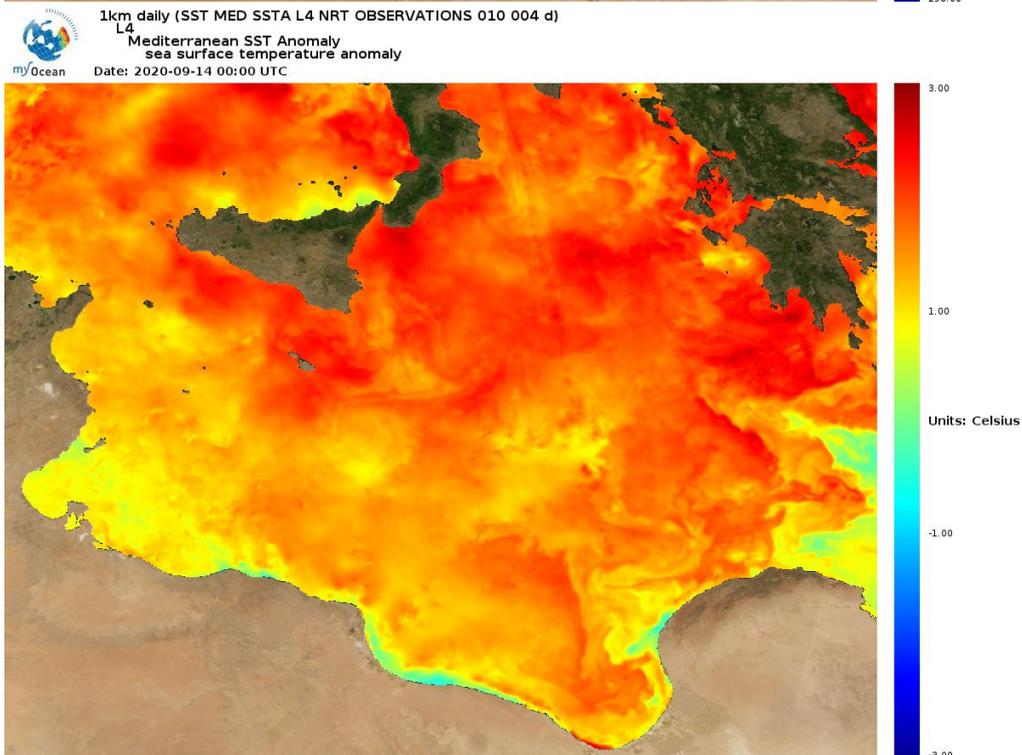
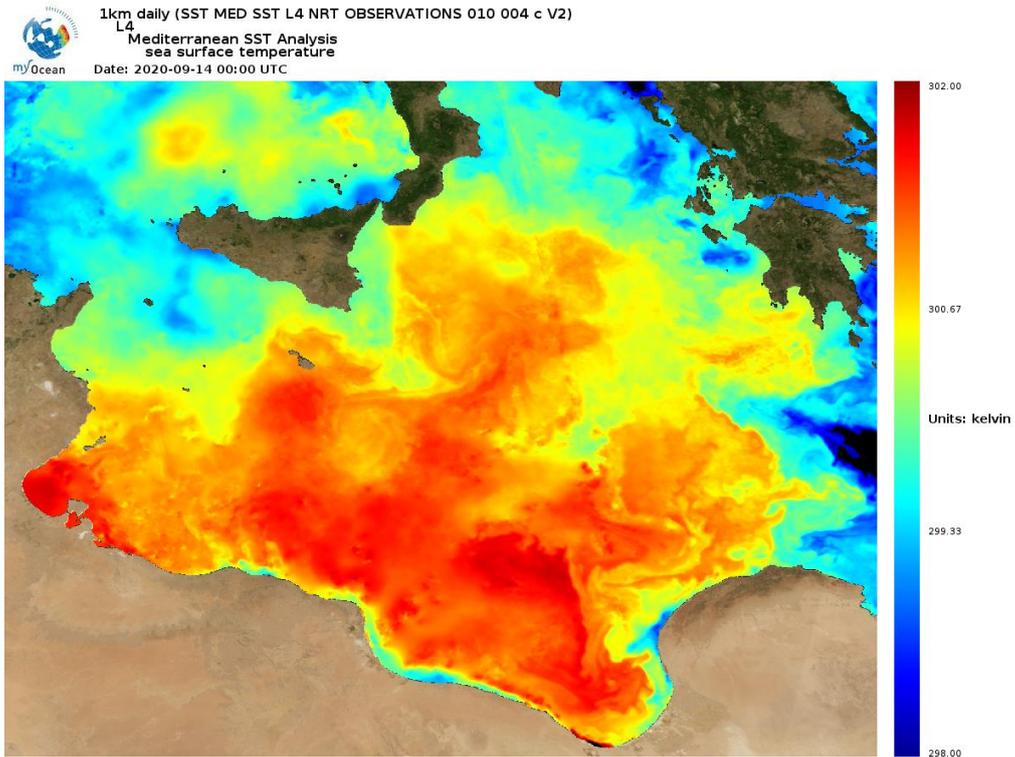
and again in "cut-off" starting from September 11.

In particular, on September 14 the situation at the isobaric surface of 500 mb looked like this:

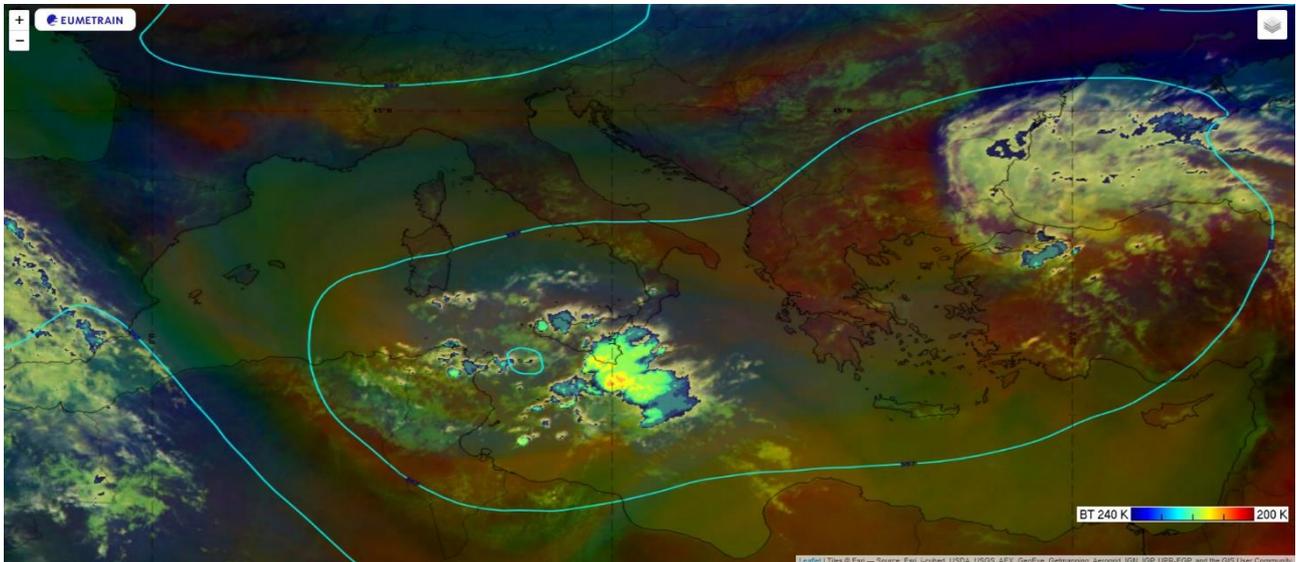


with the minimum of geopotential to the aforesaid isobaric surface, located approximately in front of the coasts of Tripoli, near the Gulf of Sirte.

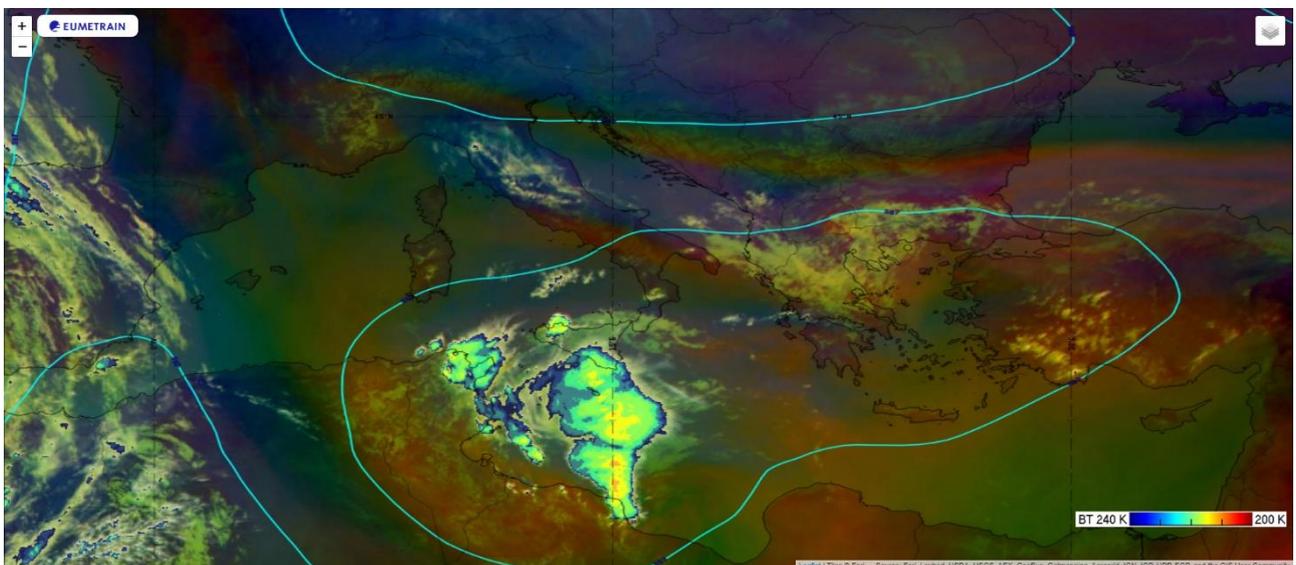
At that date, the **cold-air drop** was stationed on a **very warm sea surface**: as visible from the map of the sea surface temperatures detected, at night, by different satellite platforms on the infrared channel and accessible from the site of the European Copernicus project (<https://resources.marine.copernicus.eu/>), the sea surface at 0:00 UTC on September 14, in the area where the geopotential minimum was, had a temperature of about **28 °C (301 K)**, warmer than the average of about 1.5 ° C.



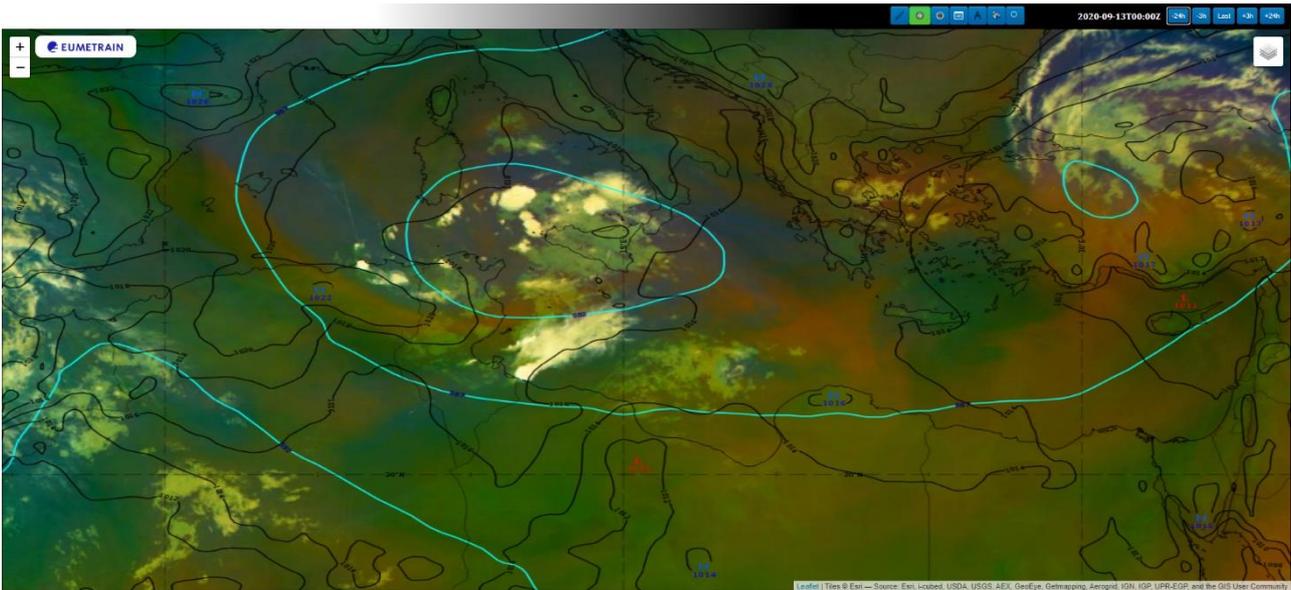
The high vertical thermal gradient present for days in front of the coasts of North Africa favored the development of intense convective activity since September 12/13, as shown by the following satellite image (taken from <http://eumetrain.org/>) of the composite RGB called “airmass” with the image from the infrared channel 10.8 superimposed on it, “enhanced” with the use of colors (which allows to identify the most intense storm nuclei with the red color) and the geopotential isolines to the isobaric surface of 500 mb (blue):



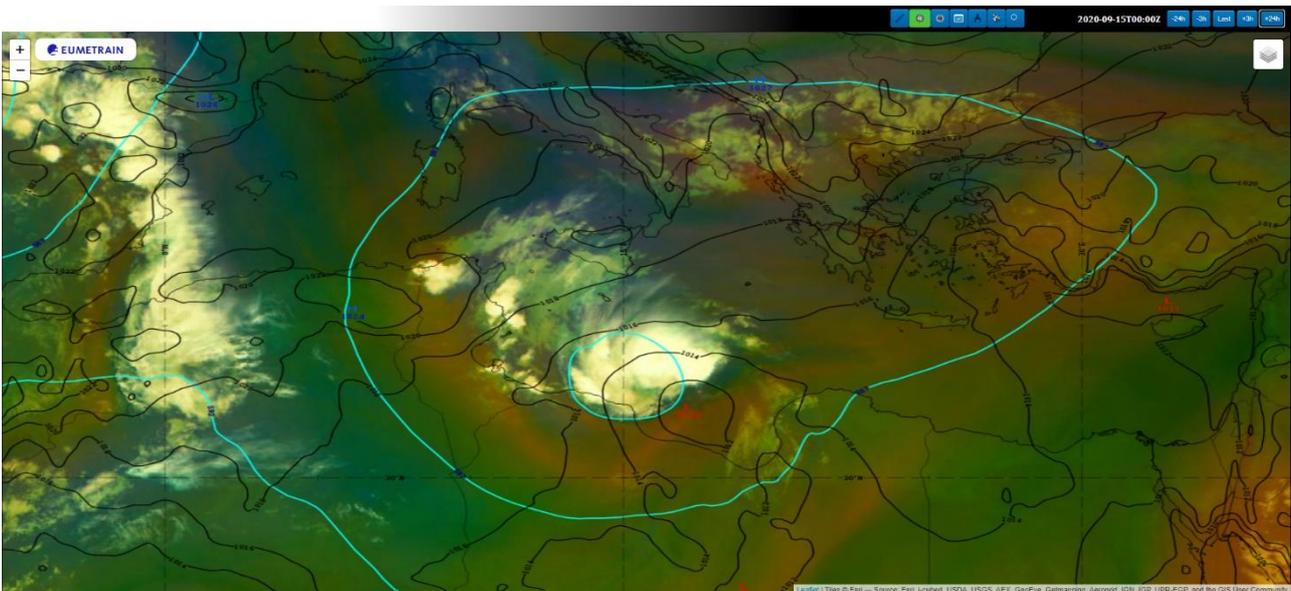
As you can see, the convective activity, although evidently present, was still completely disorganized, despite being fairly intense as shown by the image of September 14:



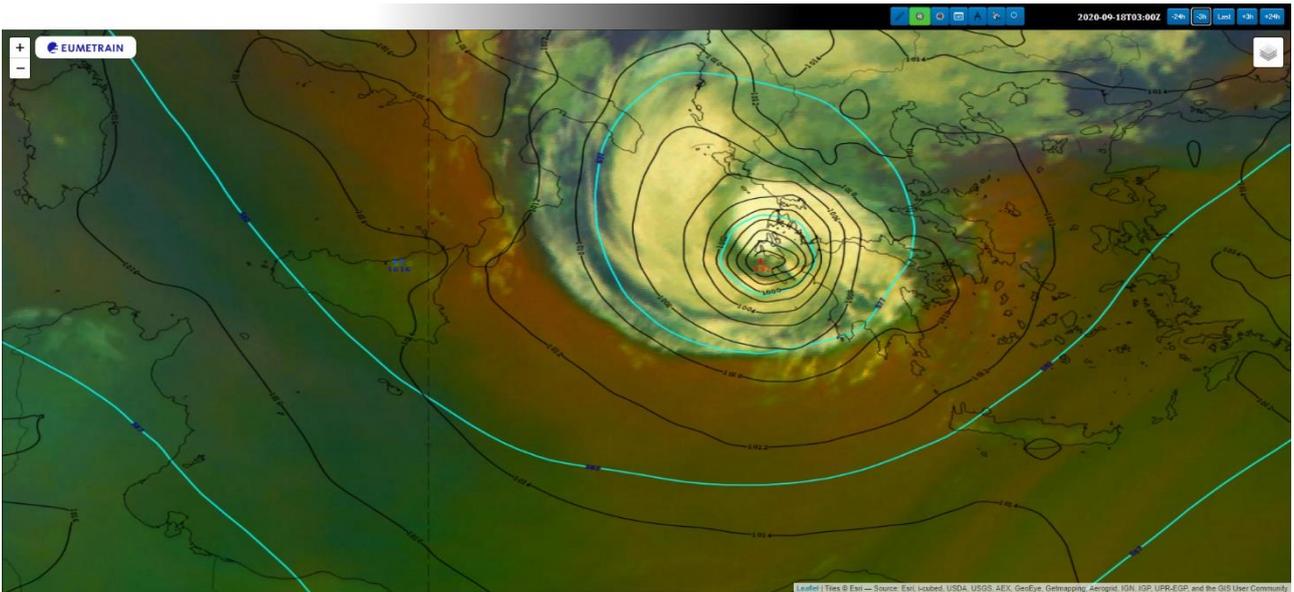
In fact, since September 13, a low ground pressure of about 1011 mb was formed along the ascending branch of the trough, which by now had positioned its axis along the parallels:



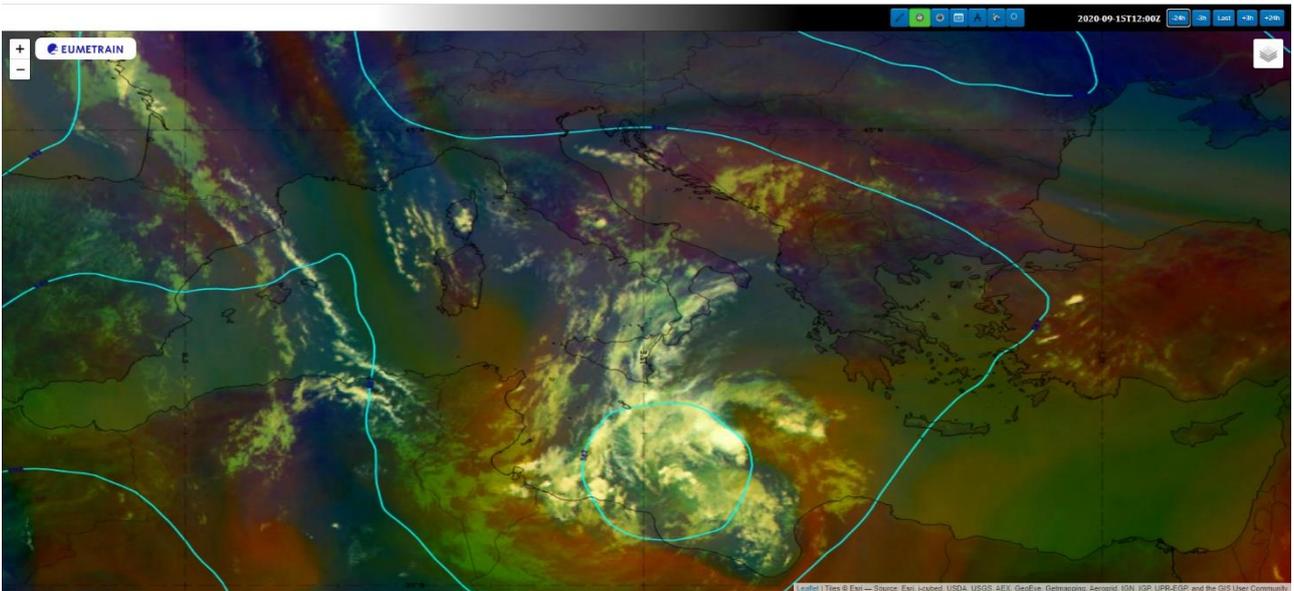
Over the following days, following the dynamics of the minimum at high altitude, this pressure moved towards north on the Gulf of Sirte:

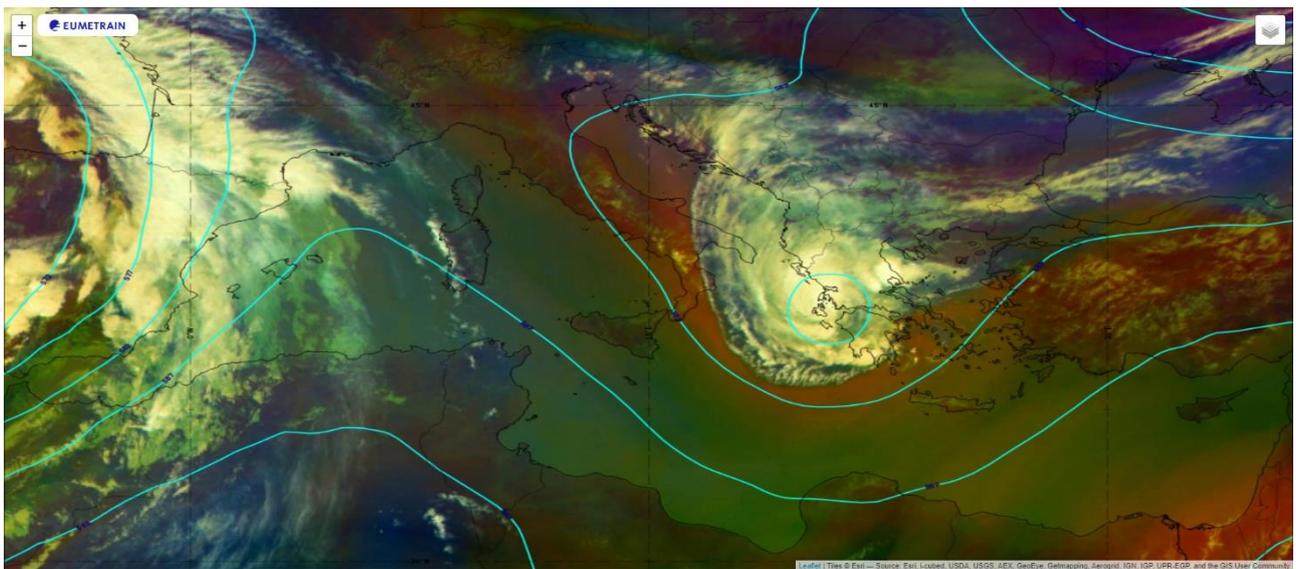
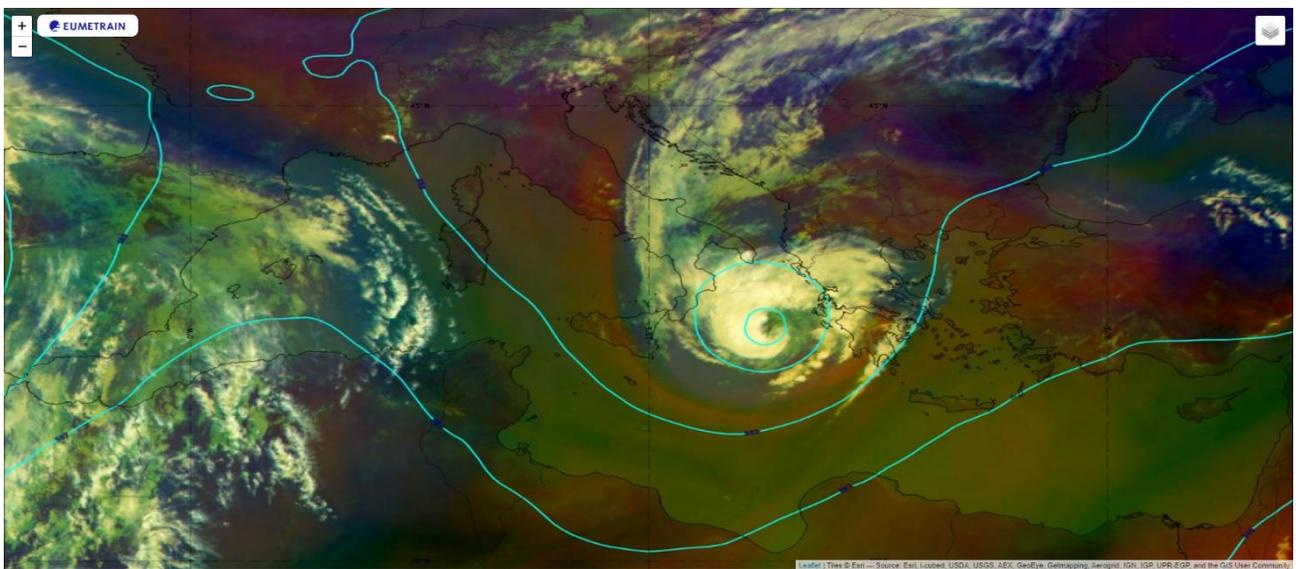
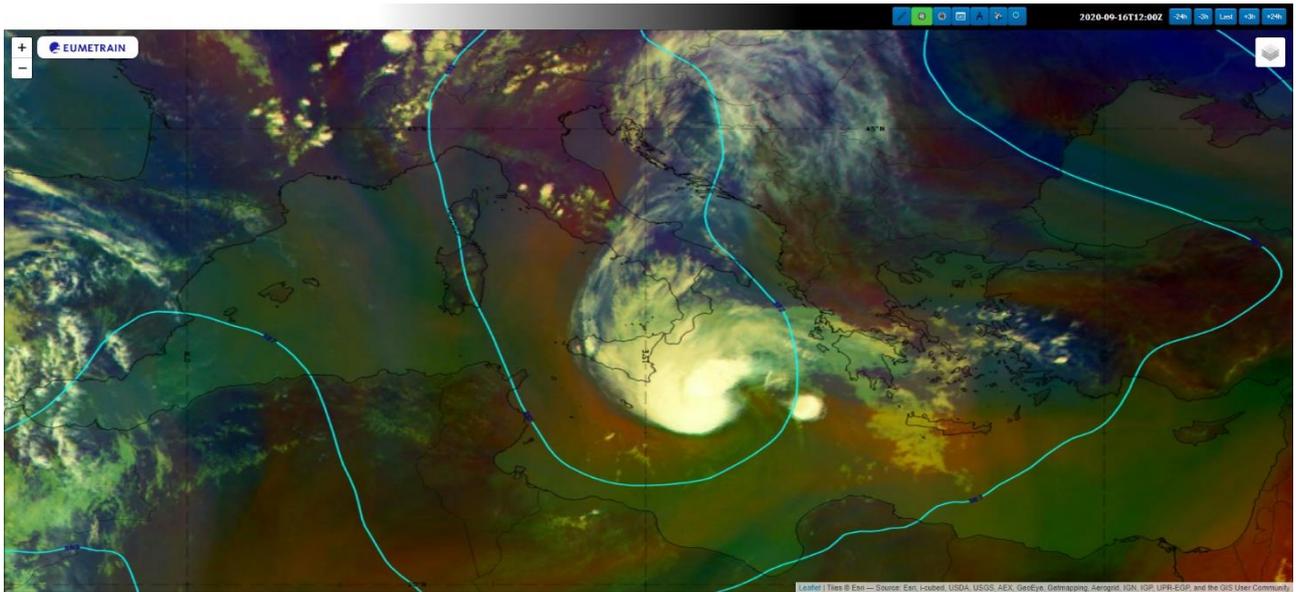


The formation of this minimum initiated the loop, characterized by "**positive feedback**", typical of the formation of tropical cyclones: the minimum intensifies the convergence to the ground which facilitates upward movements and therefore the release of latent heat which, in turn, warming the heart of the system, intensifies the aforementioned upward movements and therefore, backwards, the convergence in the lower layers, deepening the minimum which, in fact, in the following days reached values of about 1007 mb at 00:00 UTC on September 16, 995 mb at the same time on September 17, and about 992 mb at 3:00 UTC on September 18 at the time of the landfall on the Greek coast:

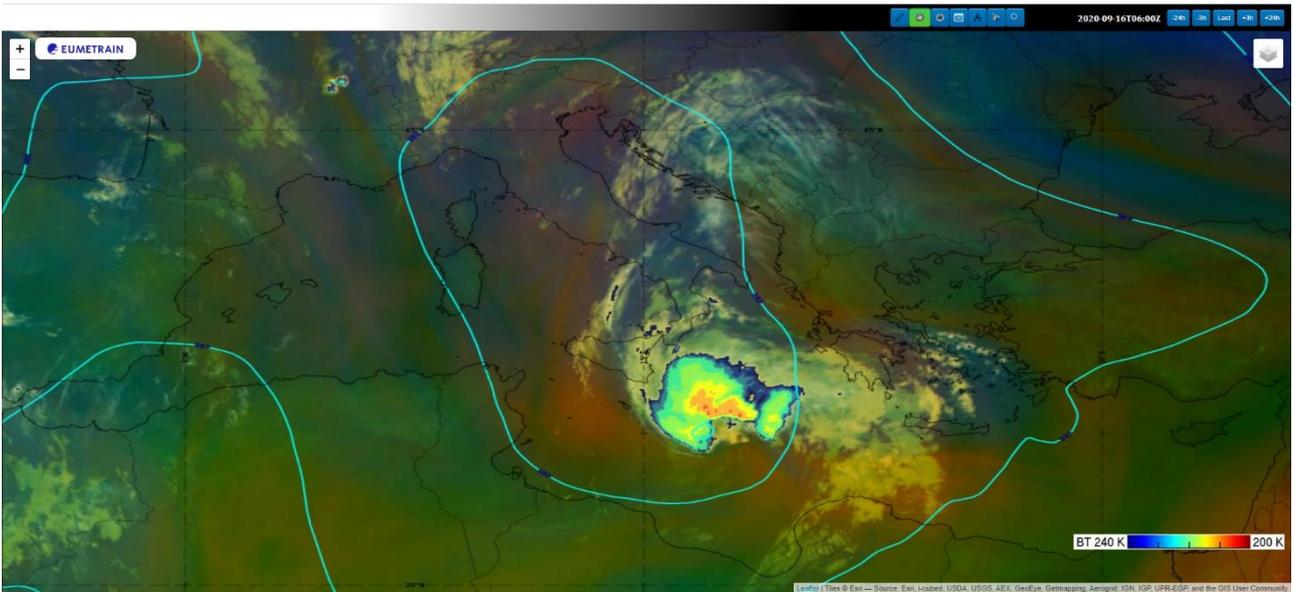


At the same time, starting from September 15, the first sketches of spiraling cloudiness began to be identified, and they become more and more definite in the following days:



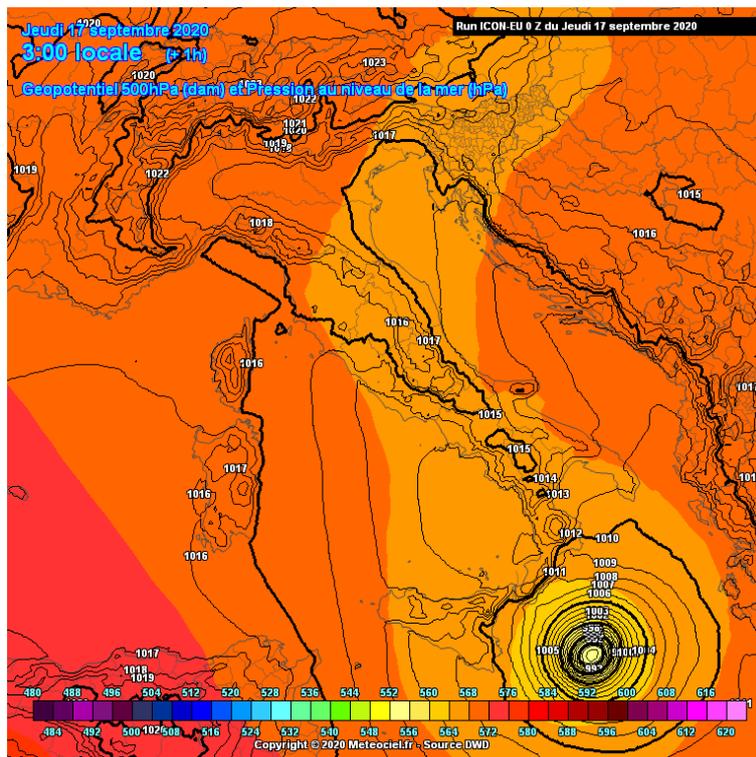


with convective cloud tops reaching up to 209 K (about -64 ° C):

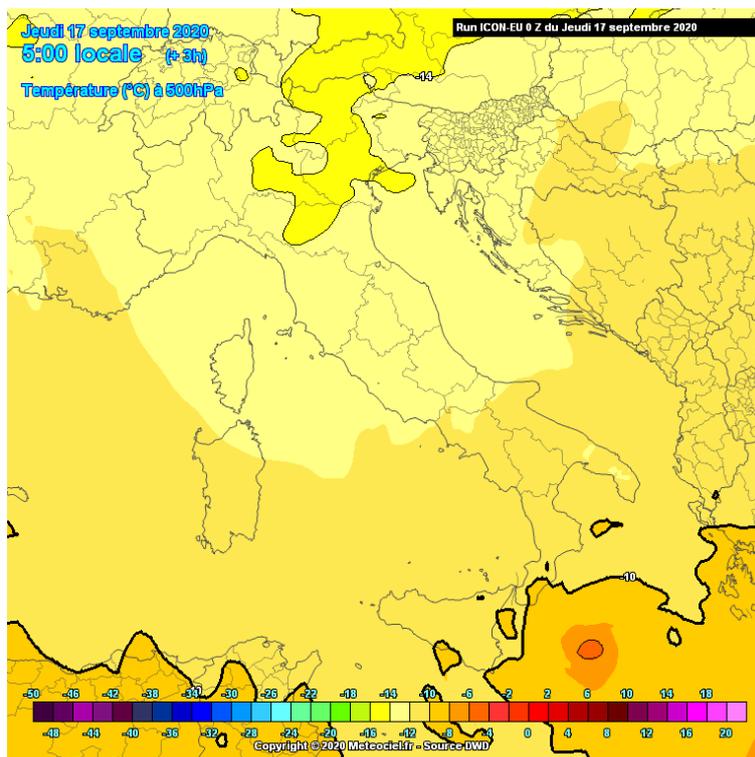
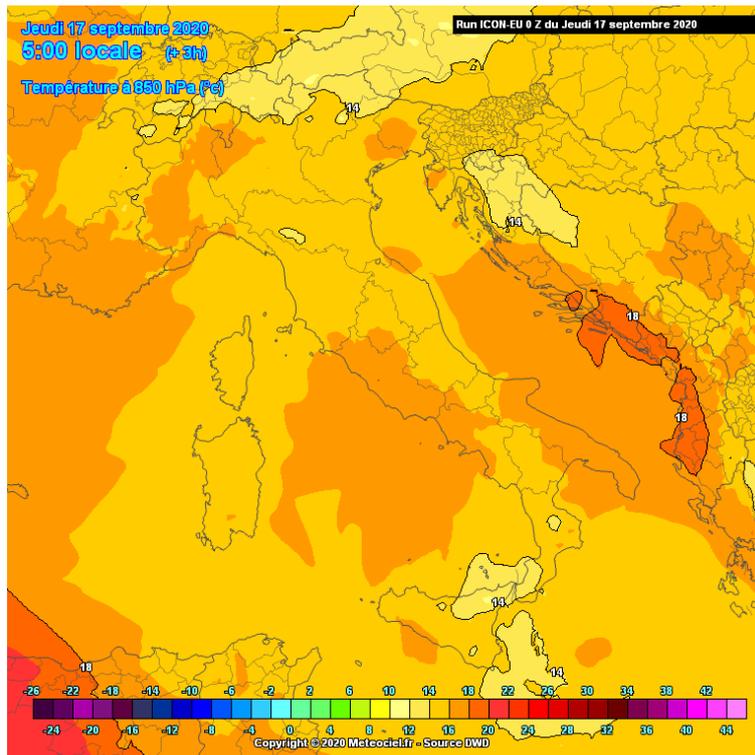


It is precisely in these situations that the system takes on more typically tropical characteristics.

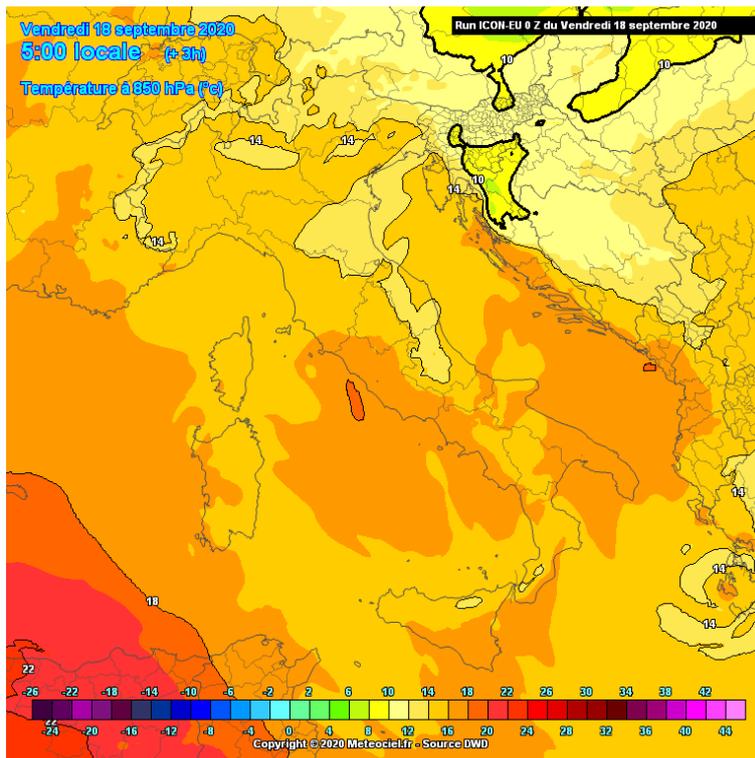
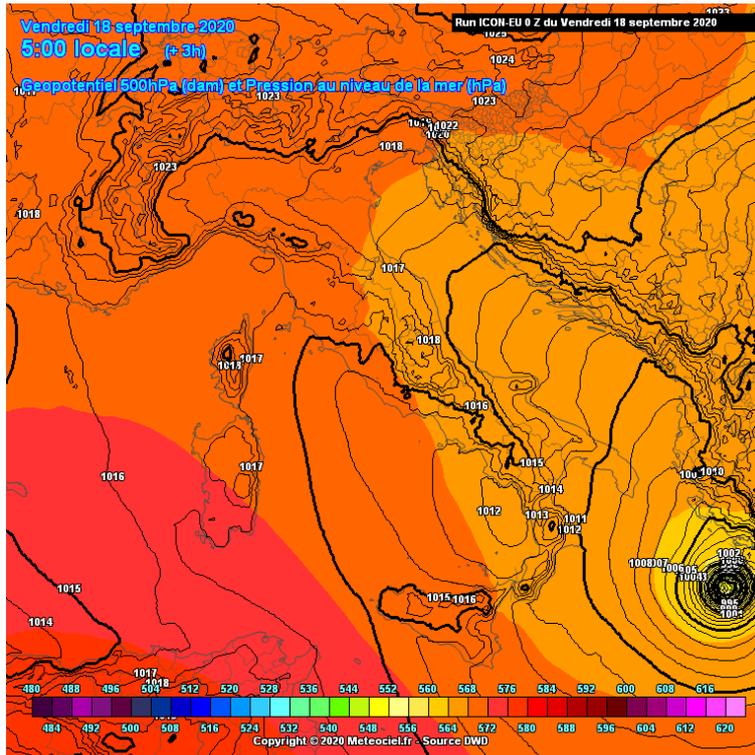
In particular, at the morning of September 17, the minima on the ground and at an altitude of 500 mb aligned on a sub-vertical line, presenting a closed conformation:

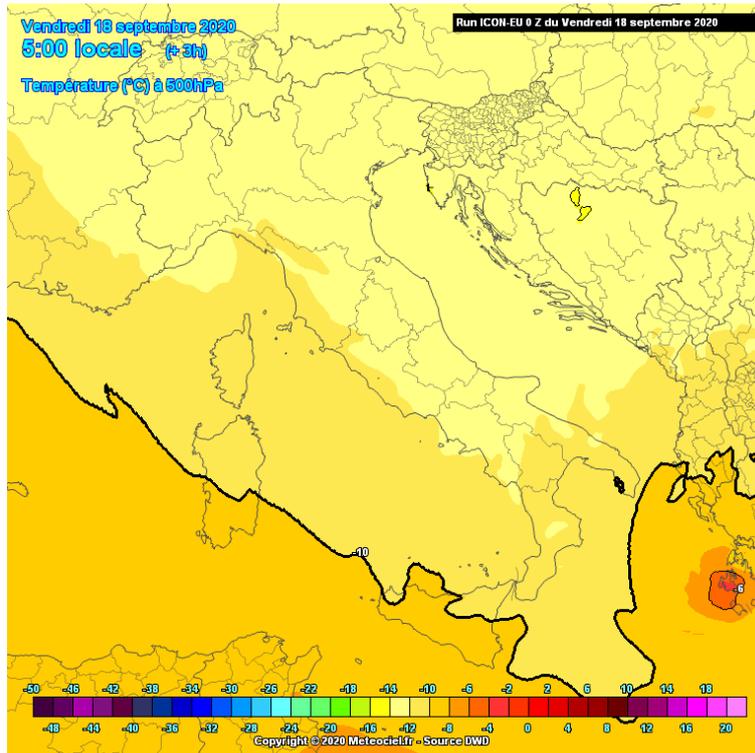


and a weak warm "heart" was presented at 850 mb and 500 mb:

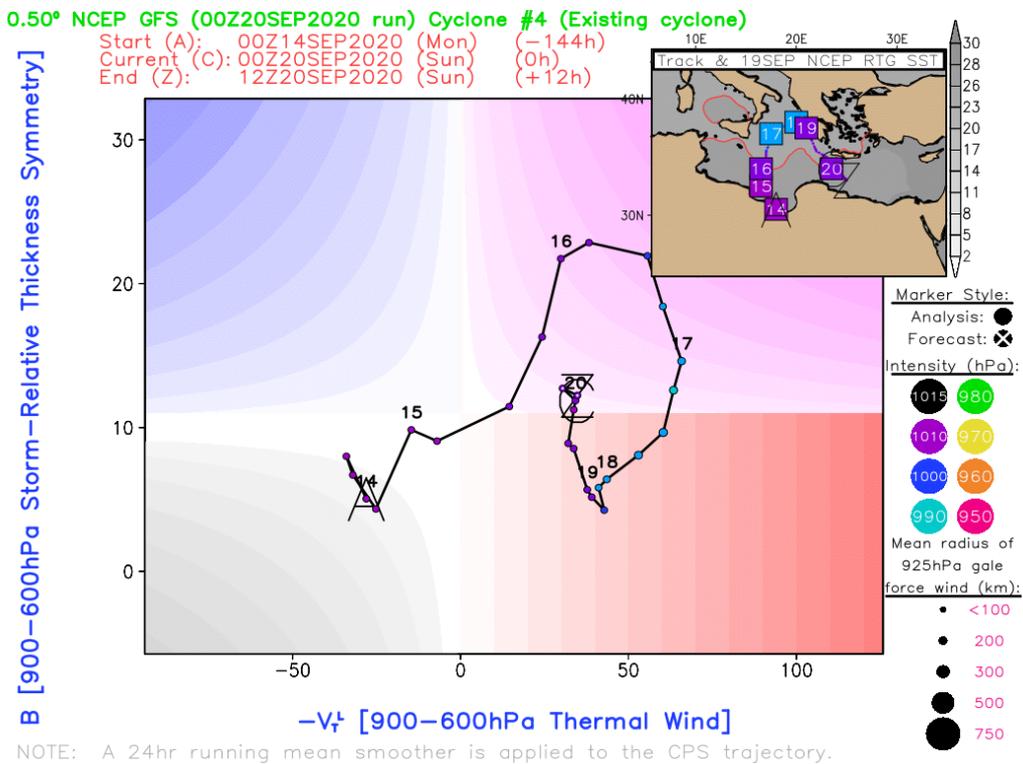


This situation was accentuated at the time of the landfall on September 18:



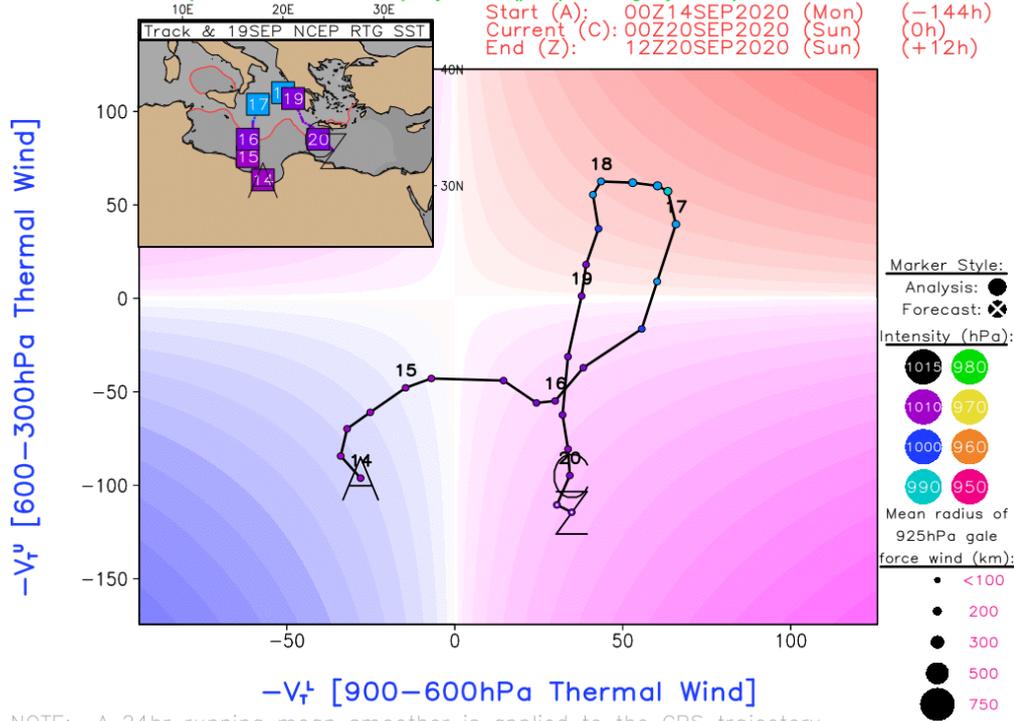


The transition phase is also confirmed by **Hart's phase diagrams** which show how between September 17 and 18 the hot heart became symmetrical (first phase diagram):



while the warm heart tended to deepen more and more (second phase diagram):

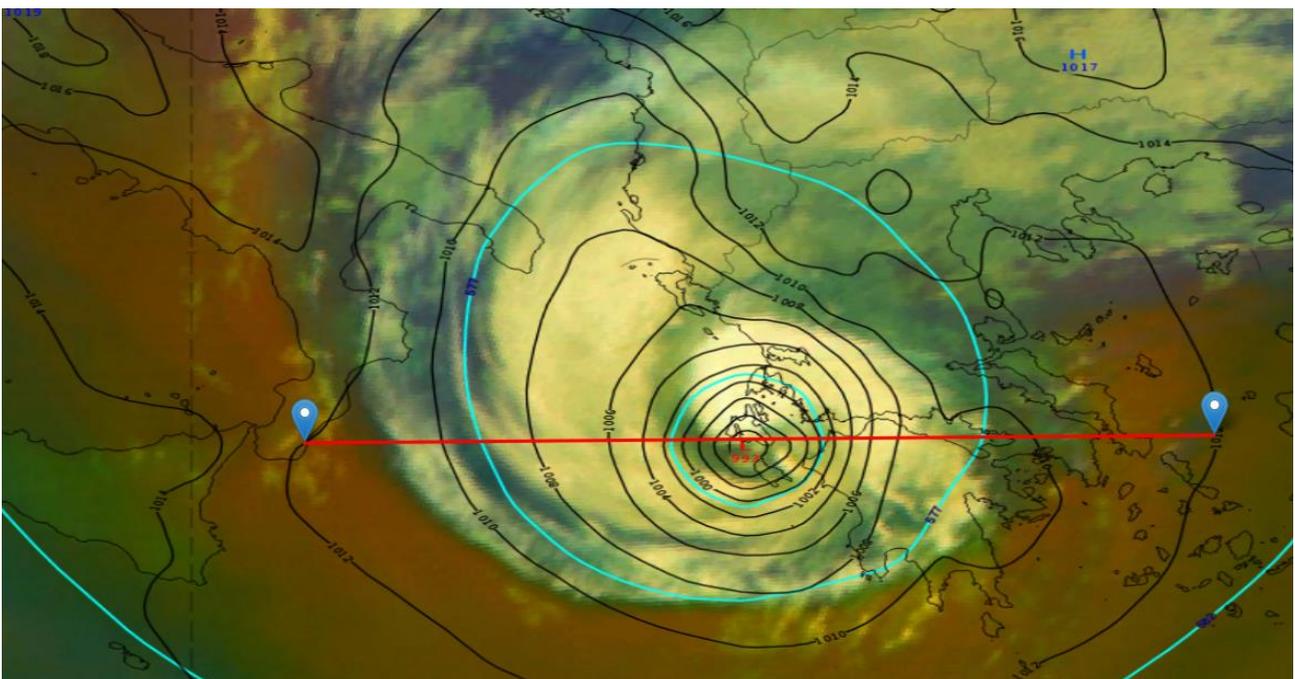
0.50° NCEP GFS (00Z20SEP2020 run) Cyclone #4 (Existing cyclone)

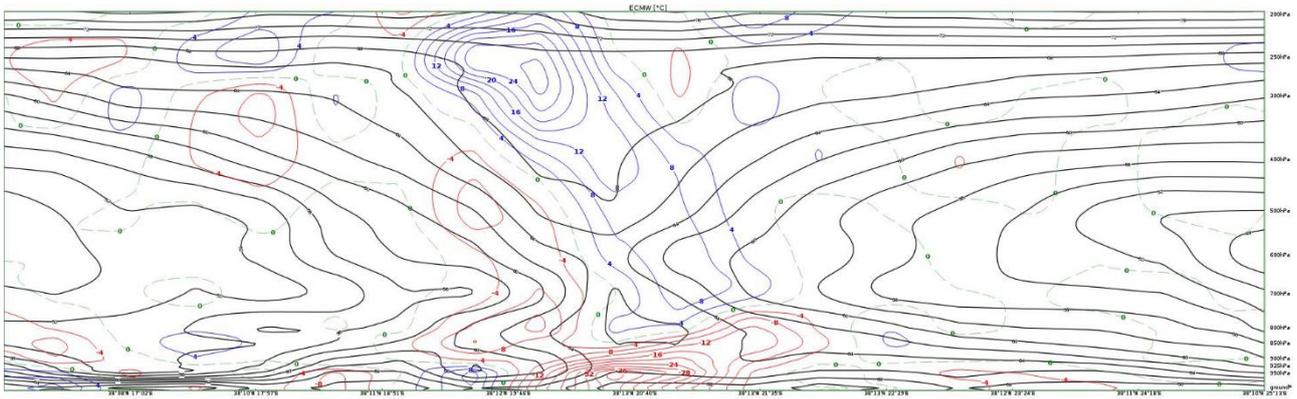


NOTE: A 24hr running mean smoother is applied to the CPS trajectory.

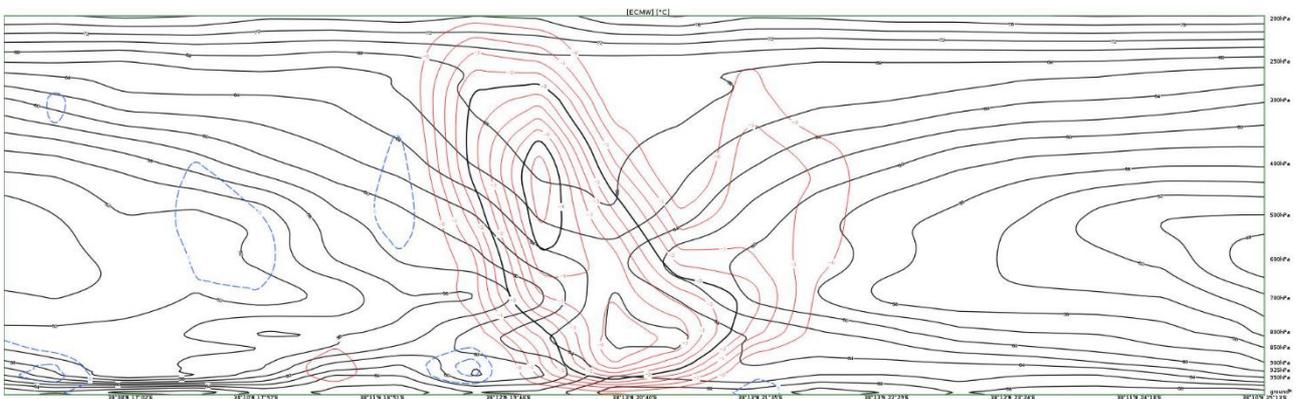
Shortly, starting approximately from the central hours of September 17, the tropical system "Udine" assumed purely tropical characteristics: symmetrical structure and a deep warm heart.

Below is the isentropic, divergence and omega (upward motions), along the indicated cross section: in addition to underlining the **very high values of convergence on the ground and divergence in high altitude**, and the consequent intense upward motions, note how at the time of landfall, when "Udine" assumed full tropical characteristics, there was a non-perfect alignment along the vertical between the divergence core at altitude (about 275 mb) and the convergence core on the ground:



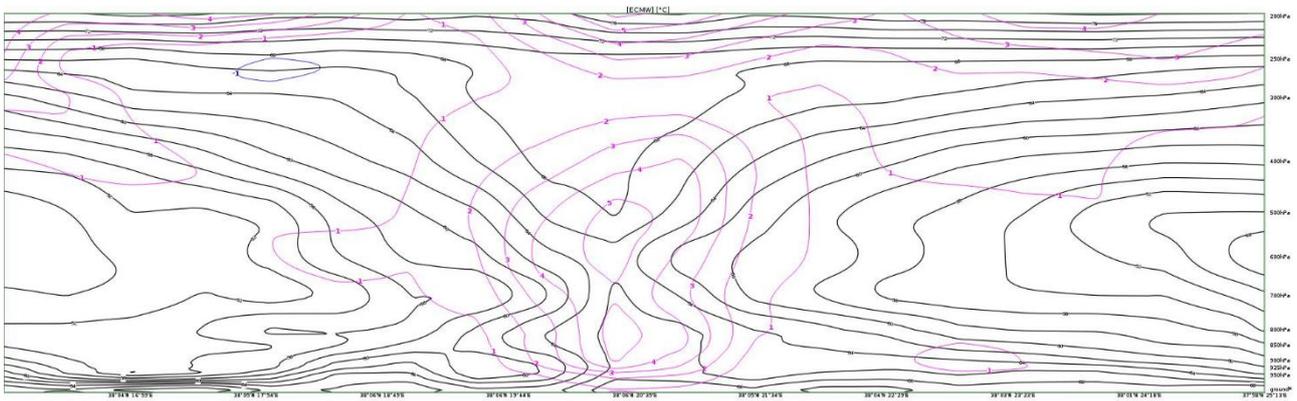


Cross-Section from map **Equivalent Potential Temperature and Convergence/Divergence**  
for 38°05'N 16°08'E - 38°10'N 25°13'E, valid 18.09.2020 03:00

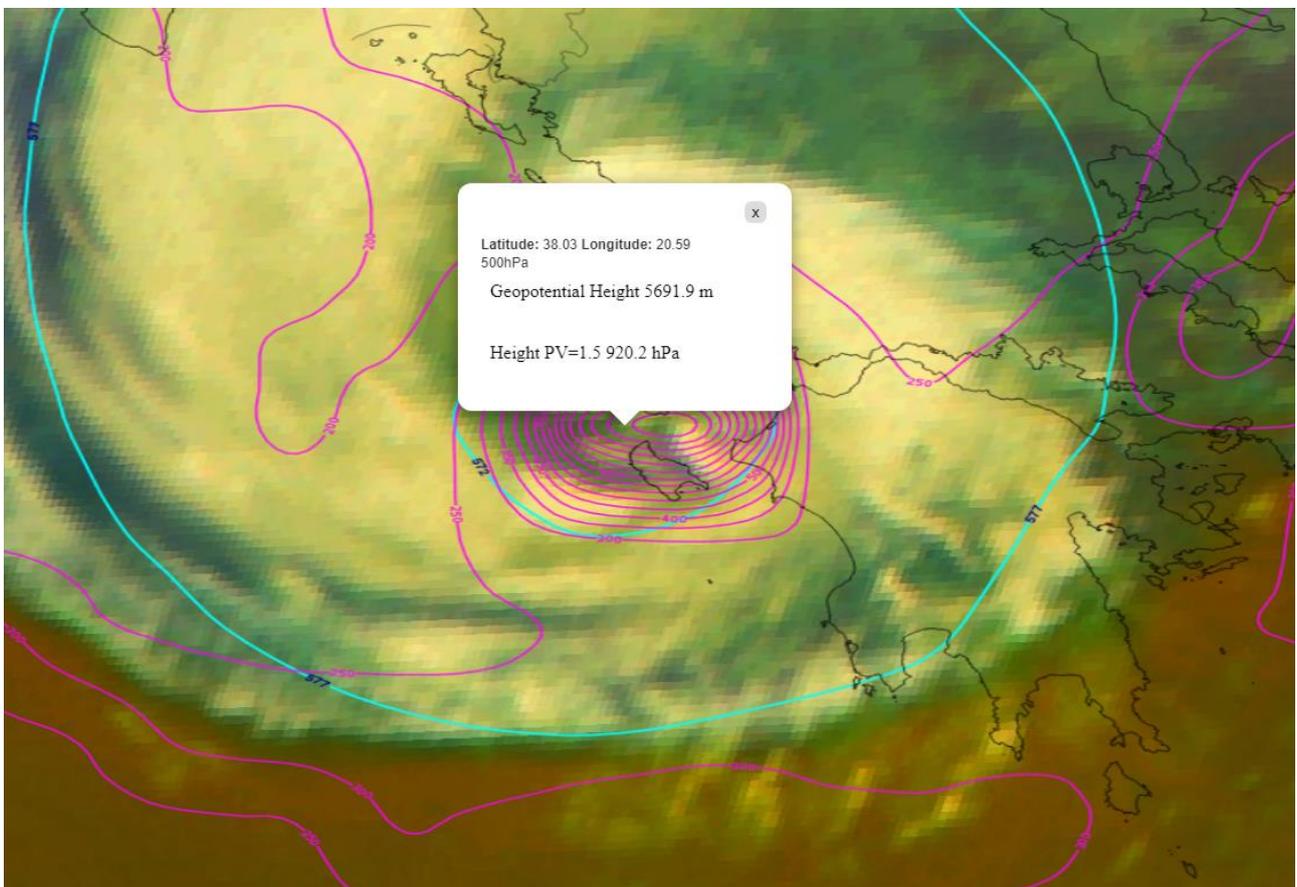


Cross-Section from map **Equivalent Potential Temperature and Omega**  
for 38°05'N 16°08'E - 38°10'N 25°13'E, valid 18.09.2020 03:00

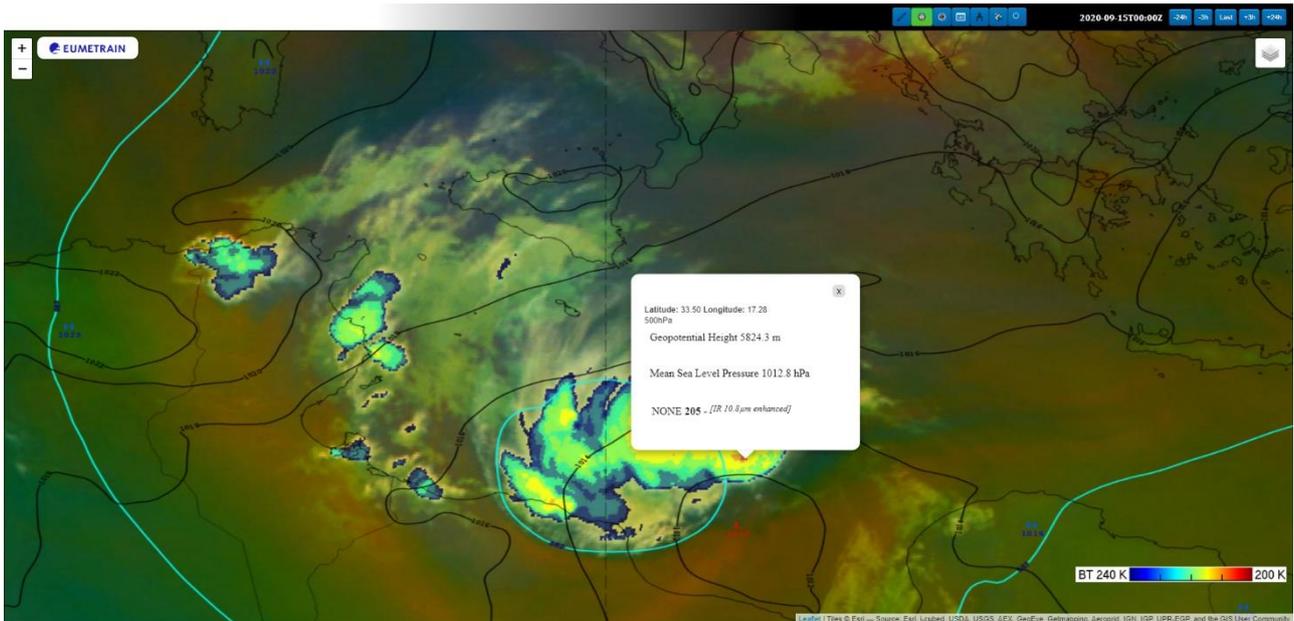
It is also interesting to note the **high potential vorticity values** in the vicinity of the cyclone core, also remarked by the very low altitude at which the surface 1,5 PV was positioned, i.e. 920 mb: please note (NEC #013 link → <http://www.meteoprofessionisti.it/nec.php> by M.M. Miglietta) that the intrusions of dry air from the lower stratosphere, towards the middle and lower troposphere, are one of the peculiar characteristics that differentiate TLCs such as "Udine" from "real" tropical cyclones: in fact, *"the intrusions of dry air (have) the effect of inhibiting the further development of convection near the center of the cyclone in the mature phase, and of producing less intense and lasting vortices than what could happen in the absence of this process"*.



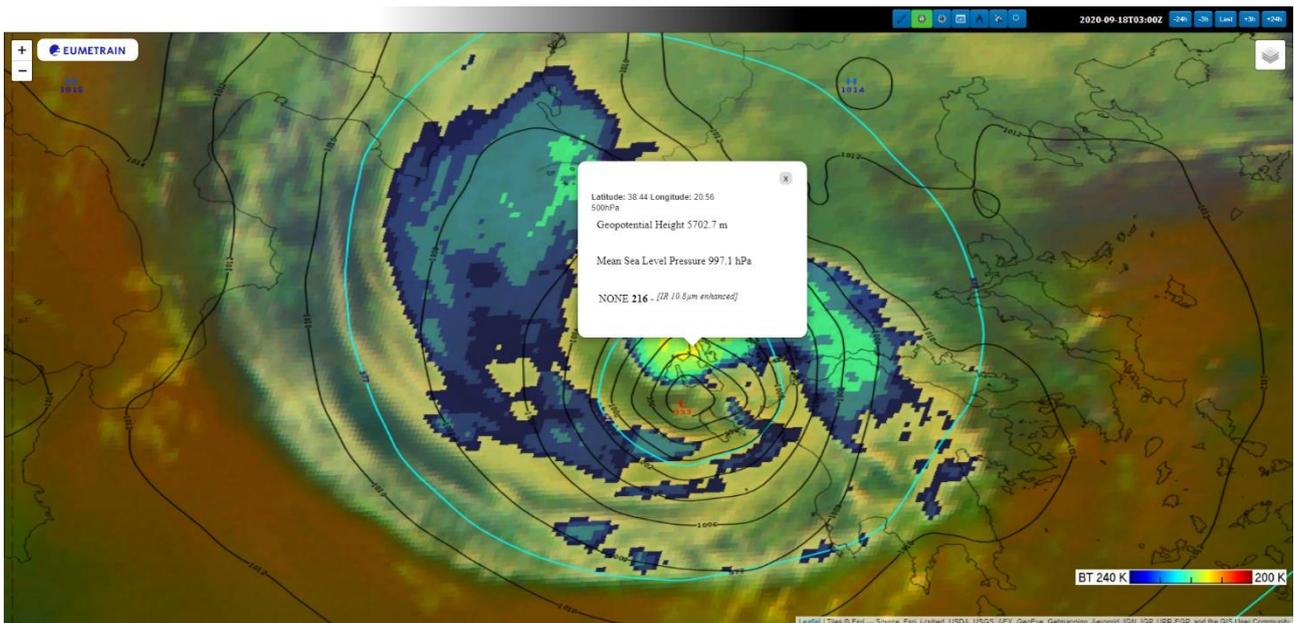
Cross-Section from map **Equivalent Potential Temperature and Potential Vorticity**  
for 38°03'N 16°04'E - 37°58'N 25°13'E, valid 18.09.2020 03:00



Finally, it should be noted that the **most intense convective activity** occurred in the **early stages of its development**, in particular between September 14 and 16, when at the top of the cumulus clouds, temperatures of only 207 K were measured on September 14 at 18:00 UTC, 205 K (approximately -68 °C) on September 15 at 00:00 UTC, and 206 K on September 16 at 06:00 UTC:



while in the maturity phases, in particular at the time of landfall (September 18 at 03:00 UTC), the values measured at the top of the clouds were higher: 216 K (about  $-57^{\circ}\text{C}$ ), a sign of a "weakening" convective activity, in any case already started from September 17:



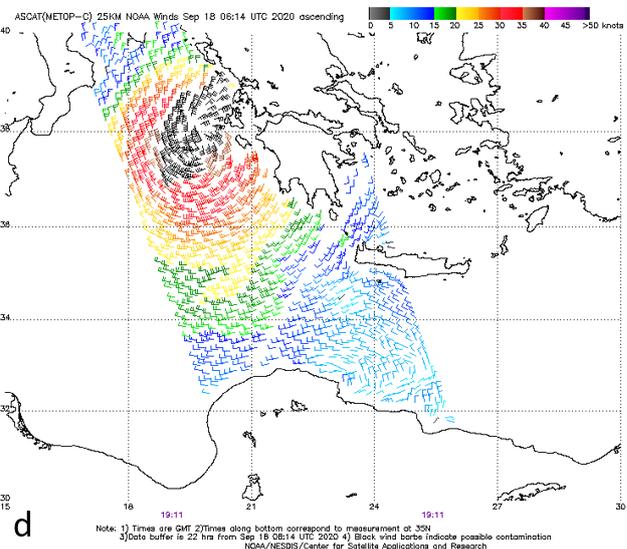
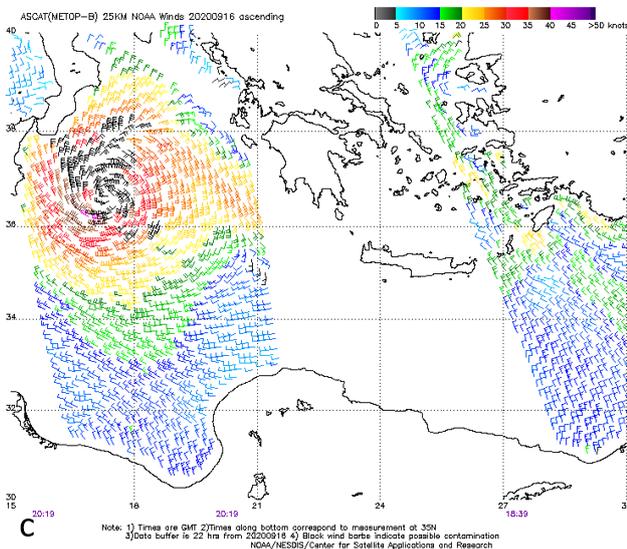
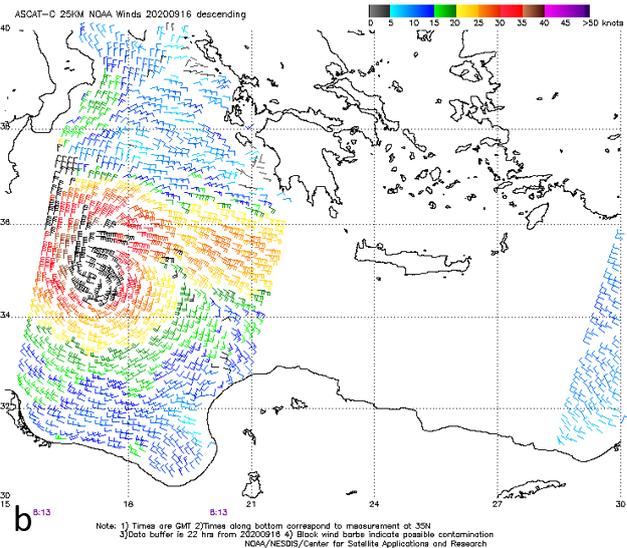
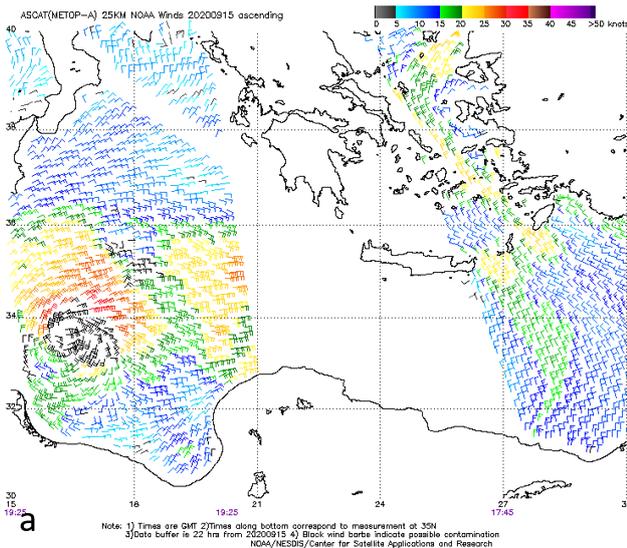
This result is in full agreement with another study (above all: Price, C., Asfur, M. & Yair, Y. Maximum "Hurricane intensity preceded by increase in lightning frequency". Nature Geosci 2, 329–332 (2009). → <https://doi.org/10.1038/ngeo477>) which, analyzing 56 hurricanes worldwide, has shown how the frequency of lightning strikes (linked to the intensity of convective motions) and the maximum sustained winds are significantly correlated (with a value of 0.82): **in particular, the maximum winds (and therefore the minimum pressure values) are preceded by an increase in lightning activity about 1 day earlier.**

## Dynamic analysis

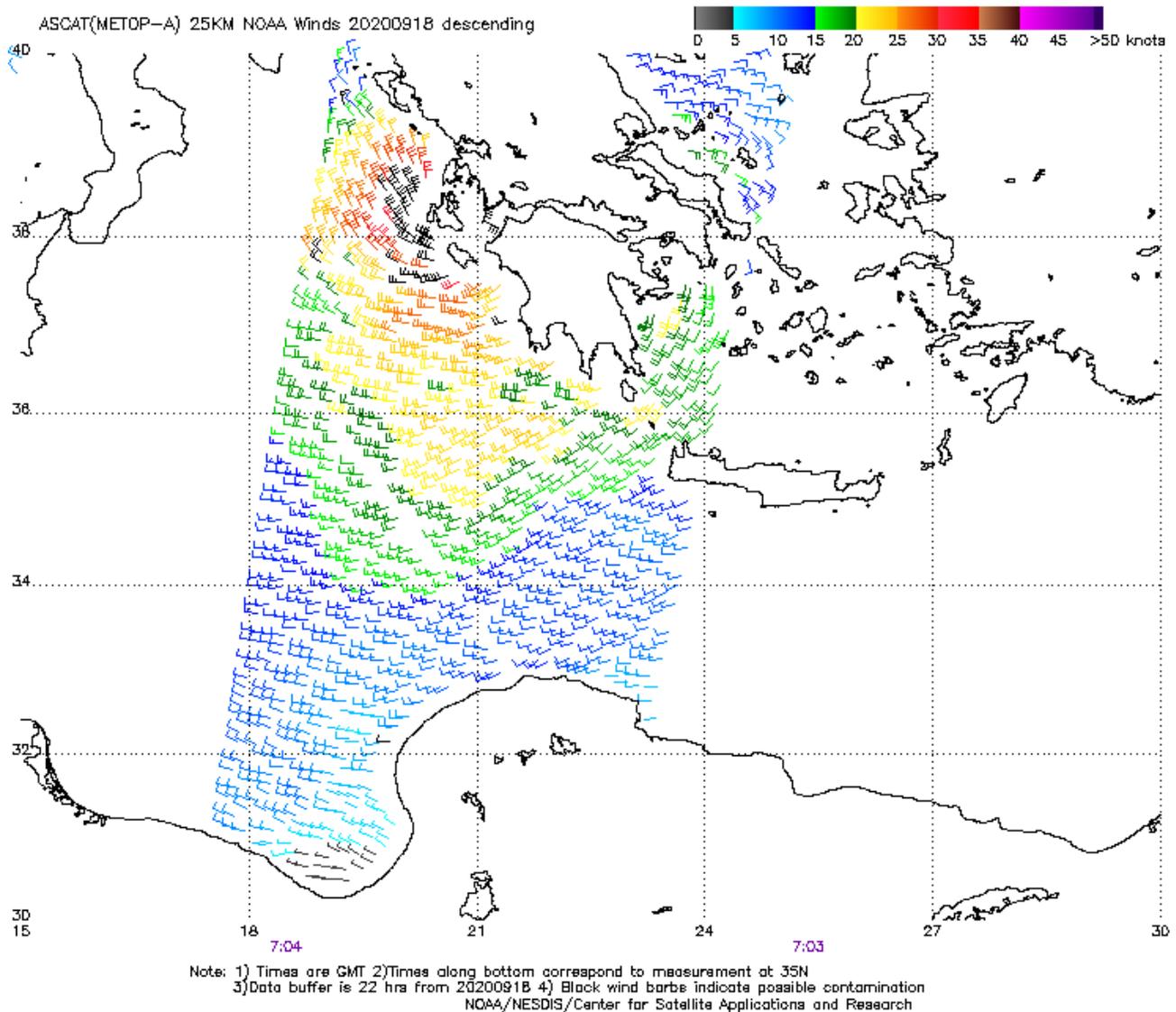
Among the many elements favorable to its rapid investigation, we find that one in particular is generally fundamental for the development of a "**TLC**" (**tropical like the cyclone**): the passage in the **upper troposphere of a "Jet Streak"**, a maximum speed of the "jet" that intercepts the depressive circulation, giving it further positive vorticity. In this case, since the "polar jet", with its main branch, was kept away from the central Mediterranean, it was the passage of a "**drift**", a maximum wind speed in the upper troposphere not associated with the "**jet stream**", over Sicily, to give further vorticity to the system, causing a lowering of the upper limit of the troposphere on the Ionian Sea, with the consequent entry of very cold and dry air, of stratospheric origin above of the mesoscale depression ("stratospheric invasion"), causing it to degenerate. The overlap of this cold and very dry flow in the upper troposphere represents in many cases the real trigger factor of these cyclones, which in the phase of deepening, during the passage over the warm waters of the Mediterranean, start to absorb a large quantity of latent heat, sucked by the intensification of convective motions (ascending currents) inside the depressed circulation. In the initial phase, the cyclone had to deal with a **moderate "shear"** of the wind, induced by the passage on its southernmost edge of a branch of the "**sub-tropical jet**", which cut the convection out of the eye, pushing it towards north-northeast. Going up north, between September 17 and 18, "Udine" entered an area on the central Ionian, characterized by a weak "**wind shear**", which did not affect its development too much.

## Intensity of cyclone

Already on September 15, 2020, the cyclone had begun to intensify, during the ascent from the Libyan Sea towards the Ionian Sea, presenting sustained average winds of **65 km / h** and a central pressure that began to drop below **1010 mb**. On September 16, the cyclone had significantly intensified in the lower Ionian Sea, with the consequent intensification of winds in the area around the central eye. The figure below shows the winds measured by the **ASCAT** (scatterometer) satellite, indicating wind speeds in excess of **90 km / h (25 m / s)** around the cyclone.



According to the data provided by **Ascat**, at this stage, the cyclone would be classified as a real tropical storm. At the beginning of September 17, the cyclone had approached the Italian coast on the Ionian Sea, with the advancement of extended bands of almost stationary rain that reached the Ionian coasts of Calabria, where there were very consistent rainfall accumulations at local level (see next paragraph). The last analysis of the Ascat, carried out on September 18, just before the approach to the Ionian islands (see following figure), suggests that "Udine" had reached its maximum intensity, becoming a real Mediterranean hurricane, with sustained average winds, around the central eye, up to **120 km/h** (about **65 knots**) and a central pressure estimated around **992 mb**. Shortly after its approach on the island of Kefalonia, wind gusts of over **120 km/h** were recorded; they uprooted dozens of trees and seriously damaged the power lines, causing blackouts.

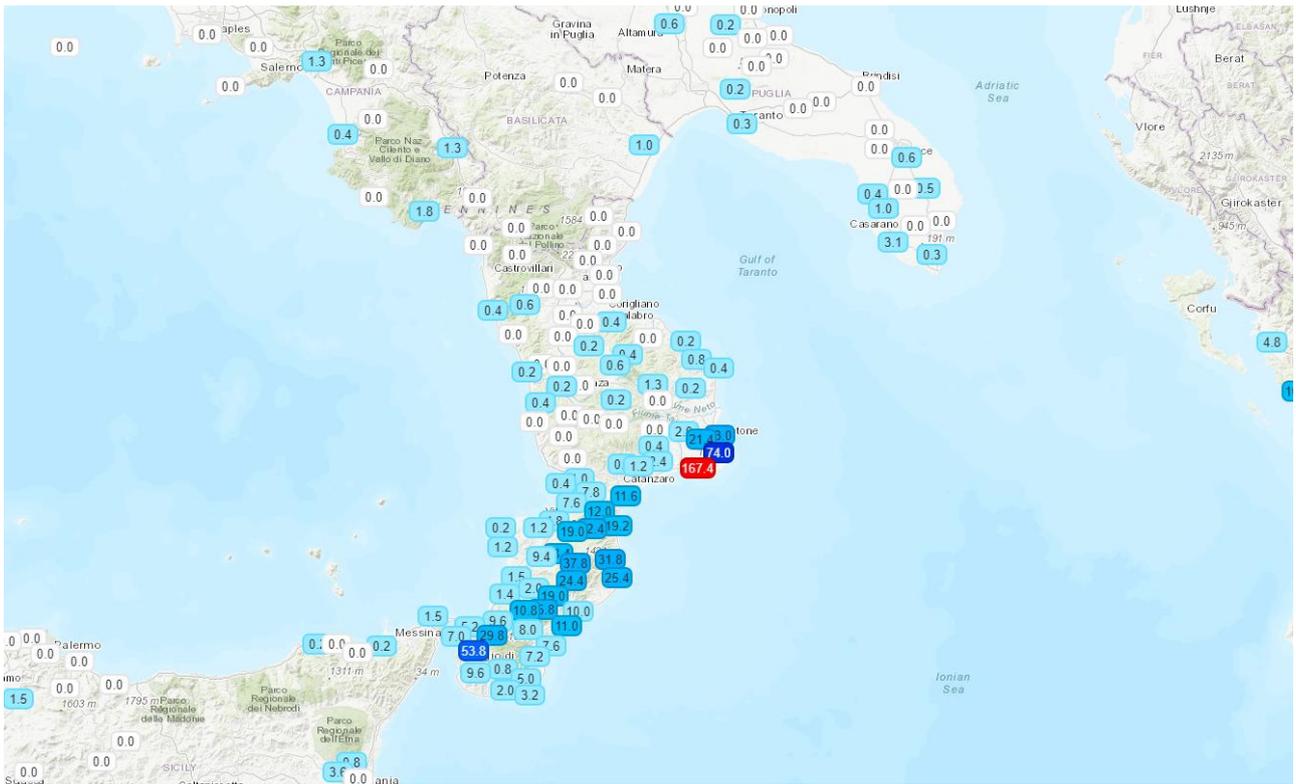


## Effects on the territory

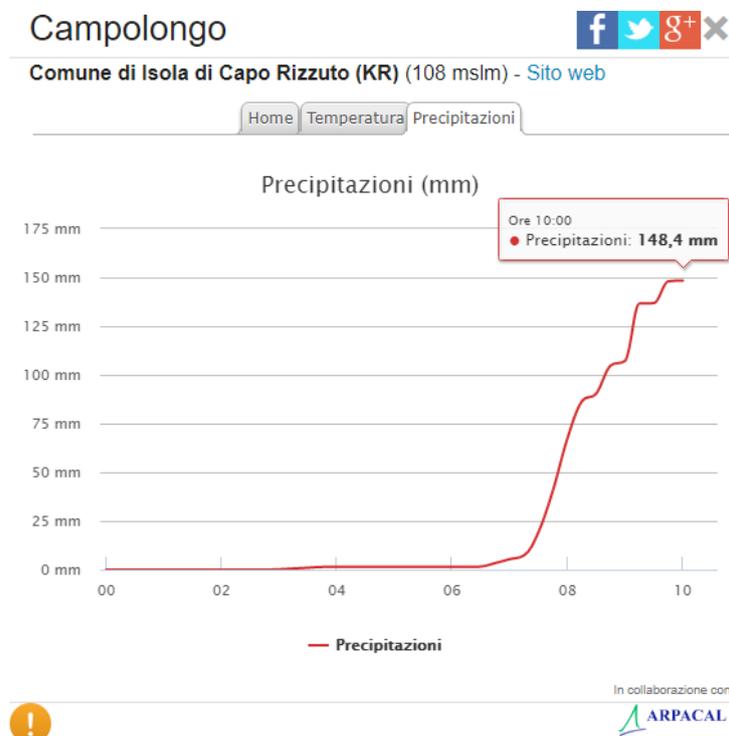
### Calabria and Sicily

The tropical cyclone “Udine” has interested Calabria in the day of September 17, bringing rain on almost all the regional territory (largely spared only the Cosentino area), with more consistent accumulations on the lower Reggio (the weather station called "Arasi", located within the territory of the municipality of Reggio Calabria at 645 m above sea level, recorded **53.8 mm**), on the Ionian slopes of the Vibonese (the station of Mongiana recorded **37.8 mm**), and in the lower Crotonese (with values of **33 mm** at Crotone, **74 mm** at "Salica" also in the municipality of Crotone, and a good **167.4 mm** at the station "Campolongo" within the municipality of Isola Capo Rizzuto at 108 m a.s.l.) (all the stations indicated here are managed by the Multirisk Functional Center of Arpacal).

The rains on the lower Crotonese area were caused by a long series of **thunderstorms with very high ceraunic activity**.



In particular, as reported in the article <https://www.meteoincalabria.com/il-ciclone-tropicale-sfiora-la-calabria-nubifragio-a-isola-capo-rizzuto/22193/>, from 7:15 a.m. to 8:15 a.m. the station of "Campolongo" recorded an accumulation of **79 mm**, as shown in the pluviogram in the figure:



These storms caused **considerable damage**. As reported in the Gazzetta del Sud (<https://catanzaro.gazzettadelsud.it/foto/cronaca/2020/09/17/maltempo-sulla-costa-ionica-calabrese-106-interrotta-e-allagamenti-a-isola-capo-rizzuto-21088a2a-0552-4115-a45e-6e8e282781a9/> )

*"The strong gusts of sirocco that sweep the coast combined with the violence of the heavy rain that fell caused the fall of mud on the Ionian State Road 106, interrupted in two points at km 231 and km 232, between Crotona and Catanzaro at the height of the territory of Isola Capo Rizzuto".*

*"Floodings also occurred in the inhabited center of Isola Capo Rizzuto. In via Tesoriere the most critical point, where the Civil Protection teams of the Municipality had to intervene. Flooding also in Crotona with the Fire Brigade engaged in numerous interventions".*

As well as (from "Il Crotonese" <https://www.ilcrotonese.it/il-ciclone-tropicale-sfiora-isola-capo-rizzuto-in-poche-ore-caduti-148-mm-di-pioggia/> ):

*"Again in the tourist location (of Le Castella) the rain swelled the stream Acquavrava that flows near the tourist villages: the water overwhelmed everything".*

Other salient data were the **storm surges** both on the lower Crotonese (see the article in Il Crotonese <https://www.ilcrotonese.it/il-ciclone-tropicale-sfiora-isola-capo-rizzuto-in-poche-ore-caduti-148-mm-di-pioggia/> ):

*"At the port of Le Castella the strong wind and wave motion created caused problems for the boats, some of which broke their moorings and sank in the port and dock. The intervention of the Naval League, the Blue Mediterranean Cooperative with the support of volunteers of Isola Ambiente Apnea prevented other boats from sinking".*

and in Locride, as reported in the beautiful photographic report of Lentelocale (<https://www.lentelocale.it/home/maltempo-a-siderno-le-mareggiate-distruggono-i-lidi-del-lungomareimmagini-e-video/>) on the damage caused to the waterfront of Siderno (for the latter, read also the article: <https://www.telemia.it/2020/09/siderno-le-onde-si-abbattono-su-lidi-e-barche-gravi-danni-paura-per-il-lungomare/>).

Also in **Sicily**, the close passage of the cyclone, during its ascent to the north, caused several damages, due to the heavy rains, but especially for the storms that hit the eastern coasts. During the night between September 16 and 17, a part of the **imposing waves** raised by the strong eastern winds, active along the northern quadrant of the deep cyclone, headed towards the coasts of eastern Sicily, in the form of long or **very long waves (swell)**, even more than **3 meters high**, causing sudden swells between the Ionian coasts of Messina, Catania, Syracuse and part of the coast of Ragusa. On the coast of Messina, the first big waves reached the beaches, causing a lot of **damage to the bathing establishments** still open, and **sinking several boats**, especially in the area between Roccalumera and Letojanni, where about ten boats and motorboats, still attached to the buoys, sank in the sea.

## Greece

Much greater damage was recorded in Greece, where the cyclone stationed for almost 24 hours, with the eye positioned close to the Ionian Islands. In **Kefalonia**, dozens of felled trees and widespread blackouts were reported. During the approach to the Greek coast, the islands of **Ithaca, Zakynthos and Kefalonia** were affected by a high wave that flooded the coastal roads and many seaside villages. The greatest damage occurred on the island of Ithaca, where waves, up to **5 meters high**, moved large masses of decomposing organic matter, which on the coastline produced huge amounts of foam, blown by strong gusts of wind to the inhabited center. In Kefalonia the torrential rains, which exceeded **200 mm in 24 hours**, caused landslides and the overflowing of small watercourses. More than 5000 houses were damaged, many of which are located between Zakynthos, Kefalonia and Ithaca. But also dry land was damaged. In all Greece, "Udine" caused the **death of 4 people**, while one is missing. On September 19, a man was found dead in his farm at the north of Athens, while the body of a woman was recovered from his flooded house in a city not far from the Greek capital. On September 20, the body of a 62-year-old farmer was found under the collapsed roof of his house in a village at the north of Athens. In addition, a 43-year-old woman was found dead on September 24, after being declared missing on September 20. The woman was washed away several kilometers from her car, swept away by a river of water and mud. A **bridge also collapsed in Karditsa**, one of the most affected areas, while in Thessaly, heavy rains seriously affected crops.

Here are some interesting links about the damage caused in Greece by the passage of the cyclone "Udine":

The "foam" in Ithaca: <https://www.facebook.com/924055637648706/videos/3644640105588571>

Flood of the Kaletzis River in Karditsa:

<https://www.facebook.com/924055637648706/videos/3361073060783760>

Kefalonia Island: <https://www.facebook.com/SevereWeatherReportsGr/posts/2750808528495660>

Assos of Kefalonia: <https://www.facebook.com/watch/?v=2945205922390335>