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pour la sécurité de l'aviation civile

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SAFETY INVESTIGATION REPORT

Accident to the Airbus A320-214 registered **F-HBNJ** on Wednesday 20 August 2025 in descent to Ajaccio (Corsica)

Time	Around 12:15[1]
Operator	Air France
Type of flight	Passenger commercial air transport
Persons on board	Captain (PF[2]), co-pilot[3] (PM), 4 cabin crew (PNC) and 143 passengers
Consequences and damage	Three cabin crew and two passengers seriously injured[4], some damage in the cabin and to the radome.
This is a courtesy translation by the BEA of the final report on the safety investigation. As accurate as the translation may be, the original text in French is the work of reference.	

Flight through an area of severe convective turbulence, during descent

[1] Except where otherwise indicated, the times in this report are in Coordinated Universal Time (UTC). Two hours should be added to obtain the legal time applicable in Metropolitan France on the day of the event.
[2] The glossary of abbreviations and acronyms frequently used by the BEA can be found on its web site.
[3] At Air France, a co-pilot is designated by the term First Officer (FO).
[4] Only those seriously injured were identified. No count was made of those slightly injured.

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1 HISTORY OF THE FLIGHT

Note: the following information is principally based on the CVR, FDR and statements.

The day of the accident, the flight crew had to carry out two rotations between Orly and Corsica: Bastia and then Ajaccio. A new cabin crew joined the pilots at the beginning of the second rotation at Orly. The captain informed them during a before-flight context briefing of the risk of turbulence in the coming flights.

For the flight between Orly and Ajaccio airports, the flight crew chose a course west of the Rhône valley to avoid areas of storm activity. The aeroplane cruised at FL 370. Some slight turbulence was encountered while flying over the continent.

Between 12:03 and 12:11, the flight crew mentioned the expected threats for the approach during the arrival briefing[5]. The briefing was interrupted by several exchanges with air traffic control, requiring a change of frequency and several path changes. At around 12:05, the aeroplane entered a cloud layer as it started flying over the Mediterranean sea (see **Figure 1**, point 1). From 12:10 (point 2), approximately 125 NM from destination, the flight crew started the descent and completed their briefing. The captain informed the cabin crew via the Public Address (PA) of the start of descent and then announced the arrival information to the passengers.

Between 12:11 and 12:15, the flight crew carried out several tasks including two frequency changes, updating the weather information from the ACARS and assessing the weather conditions at the potential alternate airports: Nice, Bastia and Rome (Italy). They also discussed the situation relating to a passenger lying down in the forward galley (see paragraph 2.1.2.1) who they could see on the screen of the cockpit access security camera, the screen being located on the back wall of the cockpit.

At 12:15:50, on descending through FL 288, the aeroplane was 8 NM from the centre of a convective cell. The flight crew identified various green radar echoes on the ND and discussed circumnavigating them (see paragraph 2.1.2.2). The co-pilot (PM) suggested and then activated the "Fasten seatbelts" light (point 3), after approval from the captain. The latter (PF) controlled a 30° heading change to the right in HDG lateral navigation mode at 12:16:07.

Between 12:16:20 and 12:16:35, following the appearance of a red echo on the ND close to the aeroplane's flight path, the PF engaged the NAV lateral navigation mode and then the HDG mode again. All these changes to the lateral navigation mode had little effect on the flight path which continued in a practically straight line (see **Figure 1**). During this sequence, the two flight crew modified the ND range selection, progressively passing from 160 to 20 NM (see paragraph 2.3.2).

In the cabin, after conferring with the purser (PNC 1) following the illumination of the fasten seatbelt light, PNC 2 made the "approach" safety announcement to the passengers and asked them to fasten and adjust their seatbelts in anticipation of the landing (see paragraph 2.6).

At 12:16:39, near FL 262, with a vertical speed of the order of -2,000 ft/min, the aeroplane entered an area of turbulence lasting thirty-one seconds, starting with four seconds of severe turbulence; the aeroplane then flew through a hail storm for twelve seconds (point 4).

[5] Ajaccio-Napoléon-Bonaparte airport requirements indicate that the captain must have completed specific simulator training and the co-pilot must have minimum experience.

During the turbulence, the main parameters of the aeroplane (see Figure 2) varied as follows:

- load factor at the aeroplane's centre of gravity between -0.2 and +3.2 g;
- load factor at the rear of the aeroplane[6] between -0.4 and +3.5 g;
- lateral acceleration at the aeroplane's centre of gravity between -0.3 and +0.3 g;
- lateral acceleration at the rear of the aeroplane[6] between -0.5 and +0.5 g;
- calibrated airspeed between 300 and 335 kt;
- pitch between -1.5 and -7.5°;
- vertical speed between -1,300 and +6,000 ft/ min.

The autopilot stayed engaged. There were no warnings or cautions during the turbulence. The PM selected the IGNITION mode as a reflex[7], she informed the PF of her action.

During the turbulence, most of the cabin crew and passengers who were standing up were thrown into the air before falling to the floor. Some were able to cling to a structural element. The acceleration calculations for various areas of the aeroplane show that the turbulence effect was more pronounced at the rear than at the front of the cabin.

On exiting the area of turbulence, the flight crew continued their course to Ajaccio airport with the NAV lateral navigation mode. The purser asked the passengers to keep their seatbelts fastened.

At 12:17:38, the captain called the crew cabin via the interphone. The purser answered, indicating that it had been rough[8] and then asked if the cabin crew could leave their seats. She then started checking the cabin through to the rear. Around three minutes later, the captain called the cabin crew again and PNC 4 informed him that she was in a lot of pain and made him understand that she would not be able to carry out her duties on the following flight. The captain replied that they would carry out a review of the situation once on the ground in order to get her back as a passenger and explained that they had not identified the area of turbulence.

At 12:22:45, when once again in the forward galley, the purser called the captain on the interphone and informed him that several people were injured and one passenger was bleeding from the head. They agreed that they would review the situation once on the ground. The captain asked if the passengers had had their seatbelts fastened and briefly explained that they had seen the area of convective activity late and were not able to avoid it.

At 12:23, descending through FL 110 (point 5), the flight crew were cleared to carry out a visual approach to runway 20[9]. They landed eight minutes later. While taxiing, the purser informed the passengers that following the severe turbulence encountered, assistance could be provided to those who desired it on arrival.

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[6] Data calculated using recorded parameters.

[7] This action is suggested by the manufacturer in case of heavy precipitation or severe turbulence. It is to be used for the approach and landing phases. When the IGNITION mode is activated in flight, continuous ignition is ensured to maintain combustion within the engine. This mode is activated automatically, without manual selection by the crew, if a flameout is detected.

[8] "*On s'est fait mal*"

[9] The 12:30 METAR specified wind 220°/6 kt, varying between 190° and 250°.

On the apron, at around 12:36, the purser entered the cockpit and asked the flight crew to request medical assistance. She mentioned the probable presence of seriously injured people and informed them of various damage in the cabin. The PM relayed the request to the operator's operational unit at the airport.

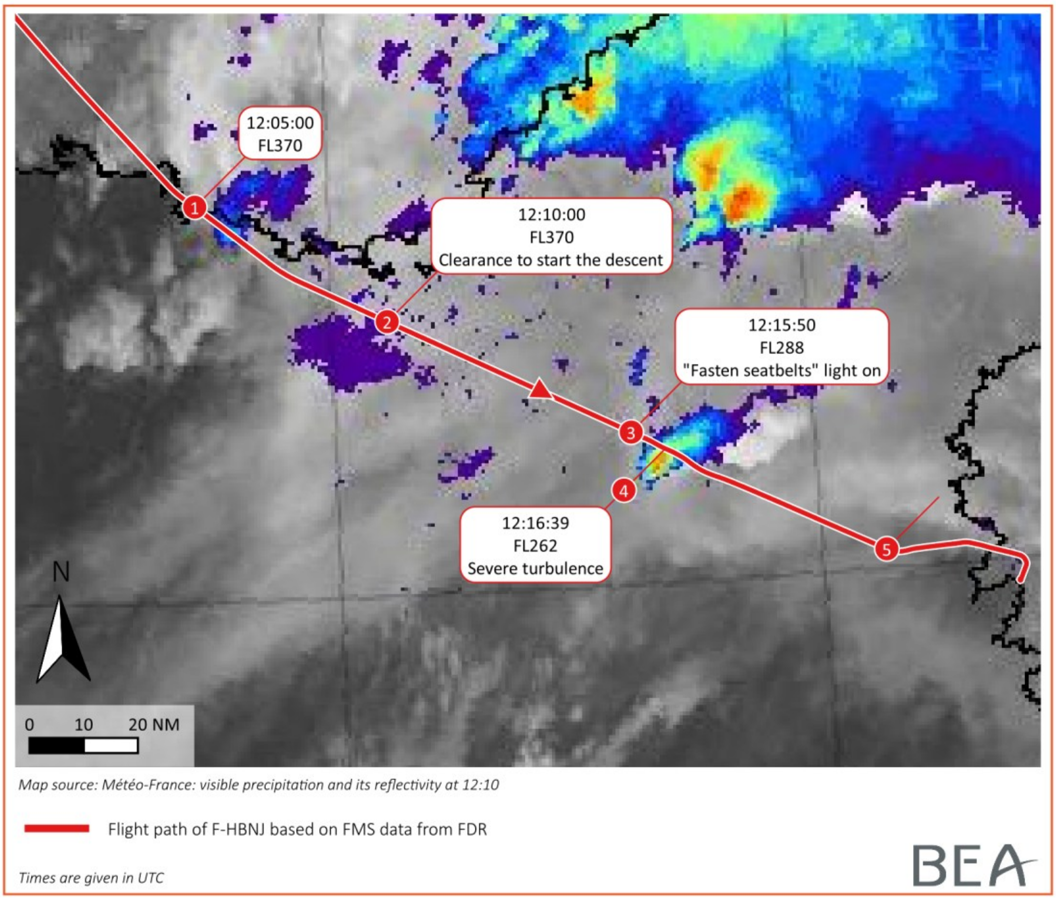


Figure 1: flight path of F-HBNJ from start of flight over sea

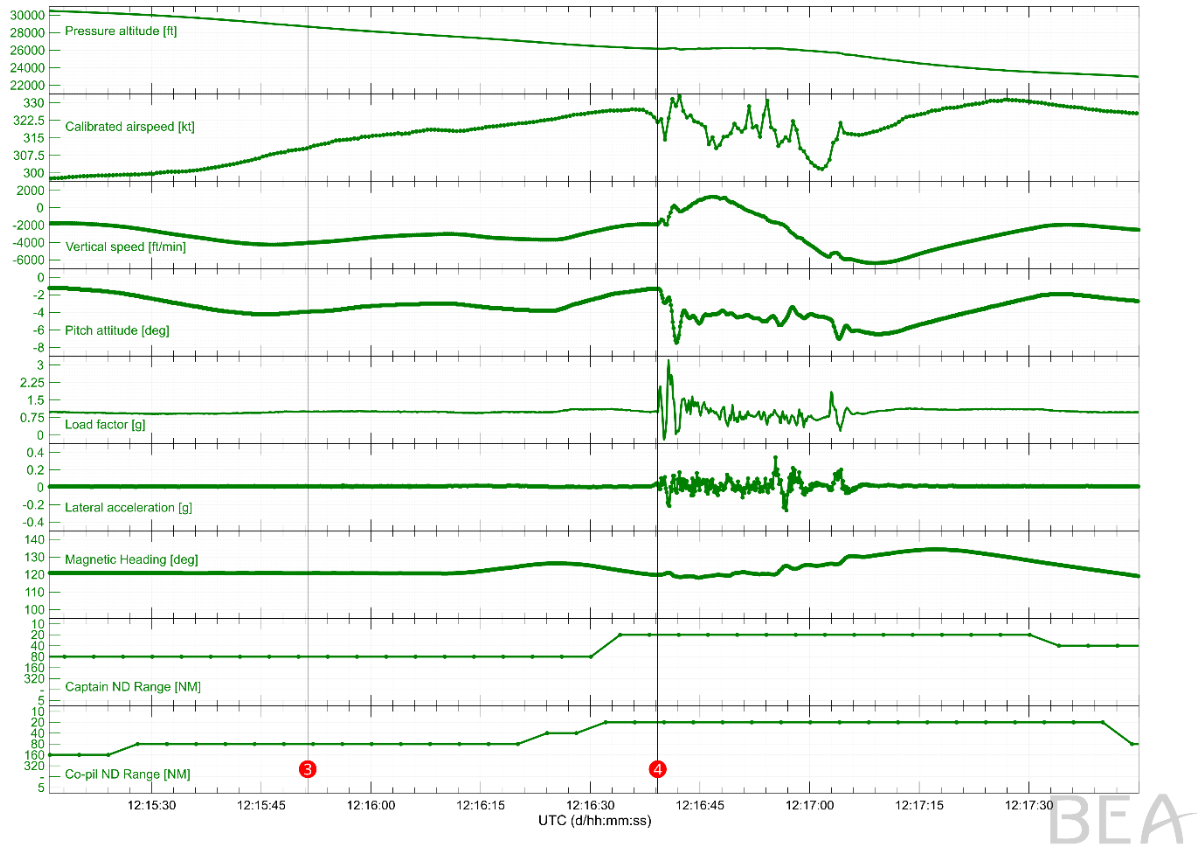


Figure 2: main flight parameters observed during turbulence

2 ADDITIONAL INFORMATION

2.1 Crew experience and statements

2.1.1 Experience

The 50-year-old captain held an Airline Transport Pilot Licence (ATPL (A)). He was also an instructor (TRI). He had logged 11,500 flight hours, including approximately 5,000 hours on the A320 family[10].

The 52-year-old co-pilot held an Airline Transport Pilot Licence (ATPL (A)). She had logged 19,600 flight hours, including approximately 2,500 hours on the A320 family.

The information regarding the cabin crew and their position during the accident flight are summarized in the following table:

	Age	Flight experience	Position in aeroplane
PNC 1, purser	54 years	31 years	Forward galley
PNC 2, public address	49 years	25 years	Aft galley
PNC 3	54 years	30 years	Aft galley
PNC 4	45 years	25 years	Forward galley

[10] Single Aisle fleet made up of the A318, A319, A320 and A321.

2.1.2 Statements

2.1.2.1 Start of flight, up to detection of convective cell

The two pilots indicated that they had identified the storms as a threat for the day's flight. The captain indicated that when the cabin crew arrived at the aeroplane, he gave a context briefing and explained that during the previous rotation between Orly and Bastia, they had encountered stormy conditions with turbulence. They had carried out avoidance actions using the airborne weather radar. He specified to them that there would be similar conditions during the rotation between Orly and Ajaccio. He reminded them that the food and drink service in the cabin was not a priority and that the pilots did not always have time to warn them in advance. He specified that the cabin crew could fasten their seatbelts without an announcement being made by the flight crew if they felt it was necessary, in the event of turbulence.

After departure, the captain informed the cabin crew that he would authorize them to get up once they had passed the storm cells located to the south of Orly. They thus stayed seated with their seatbelts fastened for around ten minutes more than usual. The cabin crew indicated that the captain was considerate and communicated in a satisfactory manner.

After passing the stormy area south of Paris, the flight proceeded without notable turbulence and the food and drink service was carried out in good conditions. Once the passenger service had been completed, the galleys were tidied up.

The captain indicated that once over the Mediterranean sea, there were no more echoes on the ND or on the eWAS (see paragraph 2.5.3) that he had updated before the descent. He specified that at this time, he thought that the worst was behind them. On the eWAS, there was a large red area of convective activity on the left-hand side of the flight path, south of Nice (see paragraphs 2.5.1 and 2.5.3), and the course to Corsica was unobstructed. The co-pilot added that when they started flying over the sea, they were in a cloud layer. The captain specified that he had informed the purser that the flight would be calmer once they were flying over the sea.

A little earlier in the flight, a passenger had asked the purser and PNC 4 if he could lie down in the forward galley to ease pain. The purser did not inform the flight crew of this. The purser indicated that subsequently she had not had time to carry out the last briefing with the flight crew as the partner of the passenger lying down in the galley had requested her help in relieving the pain of her partner. She had joined her partner with the children who were accompanying them, in the galley. In the cockpit, a few minutes before the turbulence, the two pilots had had discussions about the presence of this passenger on the floor.

2.1.2.2 Detection of the convective cell and flight in area of turbulence

The PF explained that a green radar echo had suddenly appeared on his ND, slightly to the left of their course at a distance of around 70 NM[11]. Shortly after this, the PM had proposed activating the "Fasten seatbelt" light. The PF had not considered that this echo was a threat, but accepted the preventive measure proposed by the PM. The PM could no longer recall the echoes on the radar, but in hindsight she thought that there must have been small green echoes, without risk, on the aeroplane's flight path. The PF specified that when he reduced the tilt of the airborne weather radar (see paragraph 2.4.3) to analyse the echo he had identified in the distance, the echo

[11] The investigation was not able to determine what caused this echo. Mont Cinto, its highest point being around 9,000 ft, was at a distance of 75 NM, 35° to the left of the aeroplane.

disappeared. He increased the tilt and yellow spots then appeared in the green echoes situated nearby. Suddenly, a small red radar echo appeared on the flight path ahead of them, just before the ND became completely red. The airborne radar gain remained in the CAL position (see paragraph 2.4.3). The PM explained that she modified the range of her ND to try to determine an immediate avoidance strategy and that she then looked outside the aeroplane to validate the consistency of the information shown on the ND; she made out a darker area on her right-hand side, embedded in the cloud mass. As a consequence, she indicated to the PF that she would have gone to the left. The PF explained that he first used the HDG lateral navigation mode to head to the right and then returned to NAV mode after the PM's comment to head left before using the HDG mode again having identified a way out on the right-hand side.

When the seatbelt light was illuminated, PNC 2 contacted the purser to ask whether she should carry out the standard turbulence announcement (see paragraph 2.6) or the last before landing announcement. As the aeroplane was in descent and the air was stable, they chose to make the before landing announcement. The purser specified that she anticipated this announcement, as the checks were longer for flights bound for Corsica[12]. PNC 2 made the associated announcement. PNC 3 starting from the aft of the cabin and PNC 4 starting from the front, began the cabin checks. The purser asked the passenger in pain and his family present in the forward galley to return to their seats

All the crew members specified that the turbulence was very severe and that they grabbed what they could when they could. After the turbulence, the aim of the injured cabin crew was to protect themselves by fastening their seatbelts (see paragraph 2.2.1). PNC 2 explained that she was able to haul herself up onto a seat in the aft galley, she principally had pain in her back. PNC 3 explained that her foot hurt after striking an armrest and that she was able to sit down in a passenger seat where she stayed until the end of the flight. PNC 4 was able to get up and walk to the forward galley, put away the few objects that had fallen to the ground and sit down. At the same time, the purser went to the rear to check on how PNC 2 and 3 were doing. Two passengers, including one who had fallen to the ground, asked her for help for pain. One passenger who was bleeding from the head, and who she thought seemed to be the most seriously injured, told her that he was fine (see paragraph 2.2.1). The purser explained that she had understood that the two cabin crew had hurt themselves but she did not realise that they had been seriously injured. The two cabin crew explained that they had perhaps not been sufficiently explicit about this, they were stunned. The purser explained that she saw PNC 4 continuing with her tasks and did not realise that she too had been seriously injured. All the crew members added that they were in shock. The purser explained that she lost the notion of time. She indicated that most of the passengers had their seatbelts fastened during the turbulence.

The two flight crew specified that they had not had time to make the prescribed announcement to warn the cabin crew (see paragraph 2.6). They added that no element available to them allowed them to identify this area.

2.1.2.3 End of flight after flight in area of turbulence

The two pilots indicated that given the violence of the turbulence, they suspected that there would be injured persons in the cabin. The message from the purser confirmed this. The purser explained that she communicated with the pilots in the cockpit by interphone to avoid disturbing them as

[12] According to the purser, the passengers bound for Corsica are generally holidaymakers travelling in family units and requiring more attention.

they would have been busy with the end of the flight and that she preferred staying seated at this point. She expected the pilots to ask for medical assistance after her message. The captain explained that he decided not to inform traffic control (nor make an AIREP[13] nor ask for assistance) following this occurrence, due to lack of time, in order to prioritize piloting and the flight path and to keep resources available for managing the imminent approach and landing phases. According to him, there would have been no benefit in doing this. He specified that he did not share this thought process with the co-pilot. They were cleared for the approach, were number 1 and close to their destination. The co-pilot specified that in hindsight, the provision of information could have raised the awareness of other pilots in the area of the severity of the phenomenon encountered, however, there was little available time.

After landing, the purser realised that the cabin crew in the aft galley could not disarm the slides and open the door for the passengers to disembark. She headed towards the rear and saw a passenger in uniform, a pilot for another operator, carry out, on being requested to do so by the aft galley cabin crew, the passenger disembarkation actions. On the apron, the purser entered the cockpit and asked the pilots to call the emergency services. The pilots then asked for medical assistance.

2.2 Injuries and damage

2.2.1 Injuries brought to the knowledge of the BEA

During the turbulence, the purser was standing in the forward galley; she was accompanying passengers who had been in the forward galley back to their seats (these passengers were not injured). She was slightly injured and had some bruises.

PNC 2 was standing in the aft galley during the turbulence, she was finishing the passenger announcement. Two of her lumbar vertebrae were fractured, one of which was dislocated; surgery was required.

PNC 3 had started the cabin check from the rear. She had multiple injuries:

- several fractures to her left foot;
- two fractured ribs;
- compression of the cervical vertebrae;
- total rupture of the ligaments of the right knee and a torn meniscus.

PNC 4 had started the cabin check from the front. One of her sacral vertebrae was fractured.

A 77-year-old passenger was returning from the toilets to join her seat in row 24. She was thrown from side to side and then up into the air and onto the ground. One of her lumbar vertebra was fractured.

Another 60-year-old passenger was sat in row 17. She specified that her seatbelt was fastened and adjusted but that it loosened during the turbulence. One of her lumbar vertebra was fractured.

[13] Or PIREP (pilot report). The AIREPs (air report) transmitted to traffic control are shared with other aeroplanes in the sector and with Météo-France, according to the procedures in force at the DSNA (see paragraph 2.9.1). They are also available via the eWAS (see paragraph 2.5.3).

A passenger was in the toilets at the rear of the aeroplane. He received scratches to his face and was bleeding. He did not require assistance.

2.2.2 Emergency services response

The chronology of the emergency services response is given below:

- 12:31: landing;
- 12:36: arrival on apron;
- 12:37: the co-pilot called the operator's operational unit and asked for the intervention of the emergency services;
- 12:40: Ajaccio tower asked for the intervention of the Rescue and Fire Fighting Service (RFFS);
- 12:42: two emergency responders from the RFFS arrived on the apron. They counted several injured people and asked for reinforcements from the RFFS and the SDIS (Departmental Fire and Rescue Operations Centre);
- 12:59: arrival of a first SDIS emergency care vehicle and a SAMU vehicle;
- 13:06: arrival of a second emergency care vehicle;
- 13:10: arrival of a second RFFS vehicle[14] and deployment of all RFFS personnel; information transmitted to the control tower according to RFFS;
- 13:16: arrival of a third emergency care vehicle;
- 13:25: end of RFFS intervention;
- 13:55: end of emergency services response.

Between 13:10 and 13:25, the RFFS had engaged all of its personnel, however the vehicles' resources in terms of water and foam were not used. The DSAC indicated that if a more serious event had occurred, the RFFS could have changed priorities according to the seriousness identified and that the RFFS level of the airport was not affected.

The airport operator specified that this in-flight accident created several incidents during the emergency response:

- the control tower did not inform the aircraft manoeuvring on the airport of the non-availability of the RFFS resources for around 15 minutes[15];
- the deployment of vehicles, notably the SDIS vehicles, around the aeroplane on the apron, interfered with a departing aeroplane which was delayed and an arriving aeroplane which had to change stands on arrival.

These two aspects were the subject of feedback to the Ajaccio tower control services and the SDIS.

The airport operator's analysis of the emergency response brought to light the following points:

- prior information would have enabled the control services to have the aeroplane parked at the end of the apron to avoid any interference;
- prior identification of the number of victims would have enabled a quicker suitable response (directly engaging the SDIS resources) and would have avoided engaging all the RFFS personnel.

[14] Ajaccio airport RFFS has three vehicles, as from time to time, the RFFS level can increase from 7 to 9.
[15] During this period, several aircraft took off or landed at the airport.

2.2.3 Damage

The following damage was observed in the cabin:

- the handset of one of the aft galley interphones was severely damaged[16];
- an armrest at the rear of the cabin was damaged;
- the lid of the rear toilet in the aeroplane was broken.

The inner face of the aeroplane's radome was delaminated in the centre (area of light colour in **Figure 3** below). The manufacturer, Airbus, indicated that this was characteristic damage from hailstone impacts.

Figure 3: damage on inner face of radome (source: Air France)

All of the seatbelts were checked by the operator according to the requirements of the AMM. No deviation was detected. Two seatbelts from row 17, that of an injured passenger and her neighbour were replaced as a conservatory measure.

The operator carried out a detailed inspection of the aeroplane, in cooperation with the manufacturer due to the high level of in-flight turbulence encountered. No anomaly was detected. The aeroplane was returned to service after the radome had been replaced and damage in the cabin repaired.

2.3 Flight recorders

2.3.1 CVR information

The CVR contained a two hours ten minutes recording which included the flight crew's conversations, exchanges with the cabin crew, exchanges with the air traffic control services and the background noise in the cockpit. The first thirty-seven minutes of the recording contained the end of the accident flight, from the before arrival briefing up to the landing and then the intervention of the emergency services.

[16] The aft galley has a second interphone.

The signal from the Cockpit Area Microphone (CAM) was broken for seven seconds while the aeroplane was flying through the area of turbulence[17]. This break was preceded by numerous sporadic interferences which contaminated the CAM signal recorded by the CVR. This interference phenomenon, known by Airbus as ESD popping, is produced by electrostatic discharges building up around the windshields on approaching or crossing stormy areas.

A study of this phenomenon observed several times on Airbus Single Aisle (A318 to A321), Long Range (A330 and A340) and Wide Body (A310 and A300) aircraft is being carried out by the BEA so that measures can be taken to correct this fault which presents a non-negligible risk of losing essential data for understanding incidents and accidents in commercial air transport.

2.3.2 FDR information

Several types of information were not recorded in the FDR of F-HBNJ. They would have clarified certain elements of the investigation:

- the airborne weather radar parameters: tilt and gain[18] (see paragraph 2.4.3);
- the airborne weather radar data displayed on the ND.

The BEA investigators had no recording of the radar data available to the flight crew before and while crossing the area of turbulence. Only the display mode and range of the ND were recorded. It was not possible from the pilots' statements to determine the tilt values used during the flight.

Between the end of cruise and the beginning of the turbulence, the ND were in ARC[19] display mode and the ranges were modified as follows:

<table>
<tr><th></th><th>Distance to Ajaccio</th><th>Distance to Cb</th><th>PF range (Captain)</th><th>PM range (co-pilot)</th></tr>
<tr><td>End of cruise</td><td></td><td></td><td rowspan="3">160 NM</td><td>160 NM</td></tr>
<tr><td>12:10:25 (start of descent)</td><td>125 NM</td><td>55 NM</td><td>80 NM</td></tr>
<tr><td>12:13:16</td><td>100 NM</td><td>30 NM</td><td rowspan="2">160 NM</td></tr>
<tr><td>12:15:05</td><td>85 NM</td><td>15 NM</td><td rowspan="4">80 NM</td></tr>
<tr><td>12:15:28</td><td>80 NM</td><td>10 NM</td><td rowspan="2">80 NM</td></tr>
<tr><td>12:15:51 (seatbelts light ON)</td><td>78 NM</td><td>8 NM</td></tr>
<tr><td>12:16:23[20]</td><td>72.5 NM</td><td>2.5 NM</td><td>40 NM</td></tr>
<tr><td>12:16:32[19]</td><td>71.2 NM</td><td>1.2 NM</td><td rowspan="2">20 NM</td><td rowspan="2">20 NM</td></tr>
<tr><td>12:16:39 (start of turbulence)</td><td>70 NM</td><td>0 NM</td></tr>
</table>

[17] The pilots were wearing their headset at this time, the recording of their exchanges was not affected.

[18] Since 2025, Airbus has proposed a Service Bulletin (SB) to its operators so that these two parameters can now be recorded.

[19] Display of a 90° sector ahead of the aeroplane.

[20] The turbulence mode (WX+T) of the airborne weather radar was activated when the selected range of the ND was less than 50 NM (see paragraph 2.4.3).

In 2018, ICAO required that aeroplanes with a maximum take-off mass exceeding 27,000 kg for which the type certificate application is made on or after 1 January 2023[21], be equipped with a protected flight recorder that records the information displayed to the flight crew on the electronic screens (Flight Crew Machine Interface Recording (FCMIR)) and the flight crew's use of the switches and selectors (see Annex 6 to the Convention on International Civil Aviation). The BEA had issued a safety recommendation to this end in 2011. Several investigation authorities have also issued similar recommendations.

EASA published minimum specifications to be complied with concerning this type of recorder (ETSO-2C176a), but the ICAO provision was not set out in Consolidated European Regulation (EU) No 965/2012 related to air operations and known as "Air Ops", nor in the Certification Specifications CS-25 for large aeroplanes.

This type of recorder would have made it possible to specify what weather radar information was displayed to the flight crew on the ND. It was not possible to precisely reconstruct this information from the statements. However, the above-mentioned provision is not intended to be retroactive.

EASA informed the BEA that this aspect was included in Rule Making Task RMT.0392 (sub-taks 3) in order to assess the incorporation of the latest standards and recommended practices defined by ICAO into the European regulations.

2.4 Airborne weather radar

2.4.1 General information

The airborne weather radar is designed to detect water in liquid form (rain or wet hail). It has difficulty in detecting water in solid form, such as ice crystals or dry snow.

Different types of airborne weather radar exist:
- manual radars where the tilt is adjusted manually by the flight crew, with the setting either shared by both ND or independent for each ND;
- autotilt radars where the tilt is automatically adjusted according to the range, altitude and terrain (using the terrain database of the TAWS);
- multiscan radars where the tilt and gain are automatically adjusted according to the geographical position, altitude and season. Two beams are used to display combined information on the ND;
- fully-automatic radars where a volumetric scan is stored in a memory. These radars display the detectable weather situation at the altitude chosen by the flight crew on the ND.

2.4.2 Distribution of different types of radar in the A320 family

According to the manufacturer, Airbus, at the time of publication of this report, the different versions of airborne radars were distributed over the A320 family as follows:
- 8% manual radars;
- 16% autotilt radars;
- 76% multiscan and fully automatic (latest generation) radars.

[21] The type certificate for the Airbus A320 was requested in 1987.

Airbus proposes Service Bulletins (SB) for operators to replace manual radars by the latest generation radars. The most recent SB in force is costly in terms of resources, as it requires several days of work. A previous SB, which is now obsolete due to the end of production of the radar to be installed, enabled it to be replaced in less than half a day.

The distribution of the different versions of airborne radar in the Air France A320 family is as follows:

- 75% manual radars (case of F-HBNJ);
- 25% multiscan radars.

The operator explained this difference with respect to the world fleet by the policy of replacing the A320 fleet started four years previously, with an Airbus A220 fleet equipped with the latest generation multiscan radar.

In the document, Weather Information to pilots strategy paper, published in 2018, EASA issued a recommendation to promote the installation of the latest generation airborne weather radars, with emphasis on including the capability for wind shear and turbulence detection. EASA was not able to quantify the impact of this recommendation. However, it should be noted that the latest generation radars can have their own limitations.

2.4.3 Airborne radar on F-HBNJ

F-HBNJ was equipped with a WRT-701X weather radar manufactured by Collins Aerospace. It is a manual radar with a shared tilt setting for both ND.

It displays on each ND, the strength of the precipitation in contrasting colours against a black background. The areas of precipitation appear in different colours:

- the most abundant, in red (reflectivity more than 40 dBz);
- average, in yellow (reflectivity more than 30 dBz, less than 40 dBz);
- the lightest in green (reflectivity more than 20 dBz, less than 30 dBz).

Two modes (WX+T or TURB) can be used to display areas of turbulence in magenta, when the range of the ND is less than 50 NM.

The image obtained on the ND depends on three parameters: the gain, the tilt and the range of the ND. The tilt setting determines the angle of the radar beam with respect to the horizon. The gain setting is used to adjust the sensitivity of the radar, it includes a CAL[22] position (automatic calibration) which is the position normally used in flight.

[22] In the CAL (AUTO) position, the gain is in the optimum position for detecting standard convective clouds. The gain can be manually adjusted to be used to analyse the radar echoes.

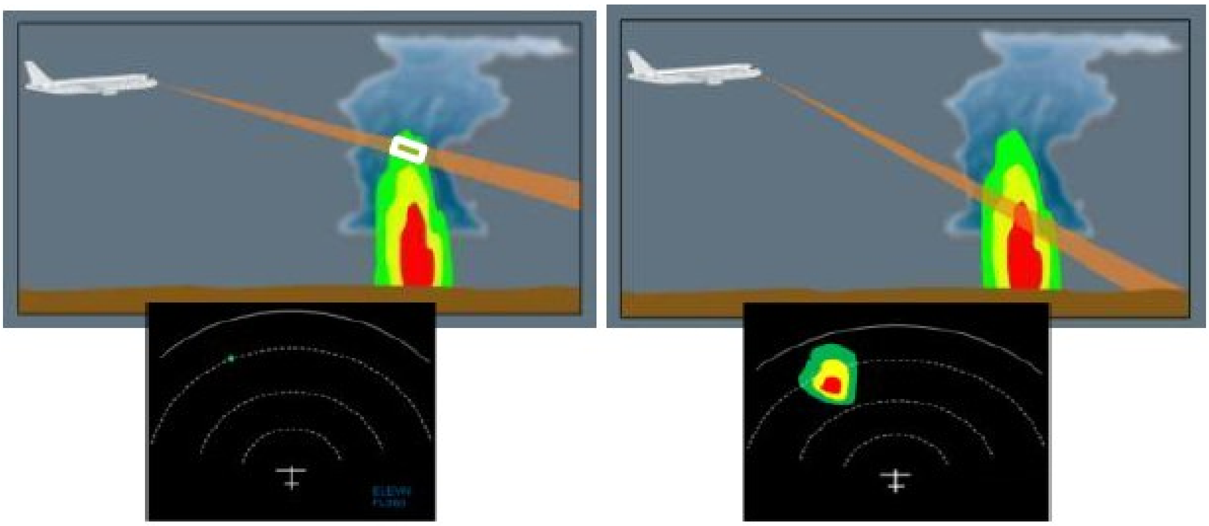


Figure 4: detectability according to tilt (source: Airbus)

The radar on F-HBNJ was tested at the manufacturer's, Collins Aerospace. No failure that might have contributed to the accident sequence was brought to light.

As there was no recording, it was not possible to simulate the data that was measured by the airborne weather radar and displayed on the ND with sufficient confidence in the validity of the result. Furthermore, as the technology of the Météo-France ground precipitation radars and the airborne weather radars is different, and the radar beams propagate in different environments, it is impossible to precisely determine the reflectivity measured by the airborne radar (see paragraph 2.5.1).

2.4.4 Procedures

For flight over the sea, the manufacturer recommends using a tilt of:

- -6° for a display range of 40 NM;
- -2° for a range of 80 NM;
- -1° for a range of 160 NM.

The operator's documentation[23] specifies that any storm must be considered dangerous and that it is mandatory to monitor the radar during all of the flight. It requires that flight crews:

- avoid storms;
- use all information available to assess the situation;
- alert the cabin crew as soon as it is necessary.

It also specifies that:

- green echoes in the 80 NM band are to be analysed;
- the decision to take avoidance action is made at around 40 NM;
- at an altitude below FL 230, a red or magenta area must be circumnavigated by a lateral distance of more than 20 NM.

[23] The operator uses the manufacturer's documentation.

2.5 Meteorological data

2.5.1 Analysis by Météo-France

Météo-France specified that unstable weather, conducive to the outbreak of potentially intense storms, was present around the golf of Genova and Corsica due to:

- a high-altitude cold air pool, positioned over France, with an influence extending as far north as the Mediterranean sea;
- a minimum low-pressure system, closer to the ground, west of Sardinia, causing a surge of very warm and humid air towards Corsica and the southern Alps.

Over the Mediterranean sea, a large convective system had notably formed off the coast of Toulon at around 08:30 and had continued its path along the coast towards Monaco (visible in red in **Figure**). This convective system was the subject of a SIGMET. It was not situated on the aeroplane's flight path.

An isolated convective cell had also formed over the Mediterranean sea, off the coast of Ajaccio (visible in red in Figure), on the flight path of the aeroplane, from 11:30. The centre of the convective cell had initially remained below FL 230 before rapidly developing between 12:10 and 12:20, reaching the highest flight levels and giving rise to high vertical speeds and as a consequence severe turbulence along with the presence of hail. Dense cloud cover over the Mediterranean sea, between FL 200 and FL 390, might have visually concealed the convective cell (visible in yellow on the sandwich image[24] shown in **Figure**).

[24] The sandwich image is an image where the bands are superimposed and not combined, hence the name sandwich: the infra-red band is superimposed on the visible band. A colour range is applied to the infra-red band to indicate the coldest temperatures of the cloud tops (in red). The partial transparency of the upper layer allows the morphology of the clouds detected by the visible band (in yellow) to show through.

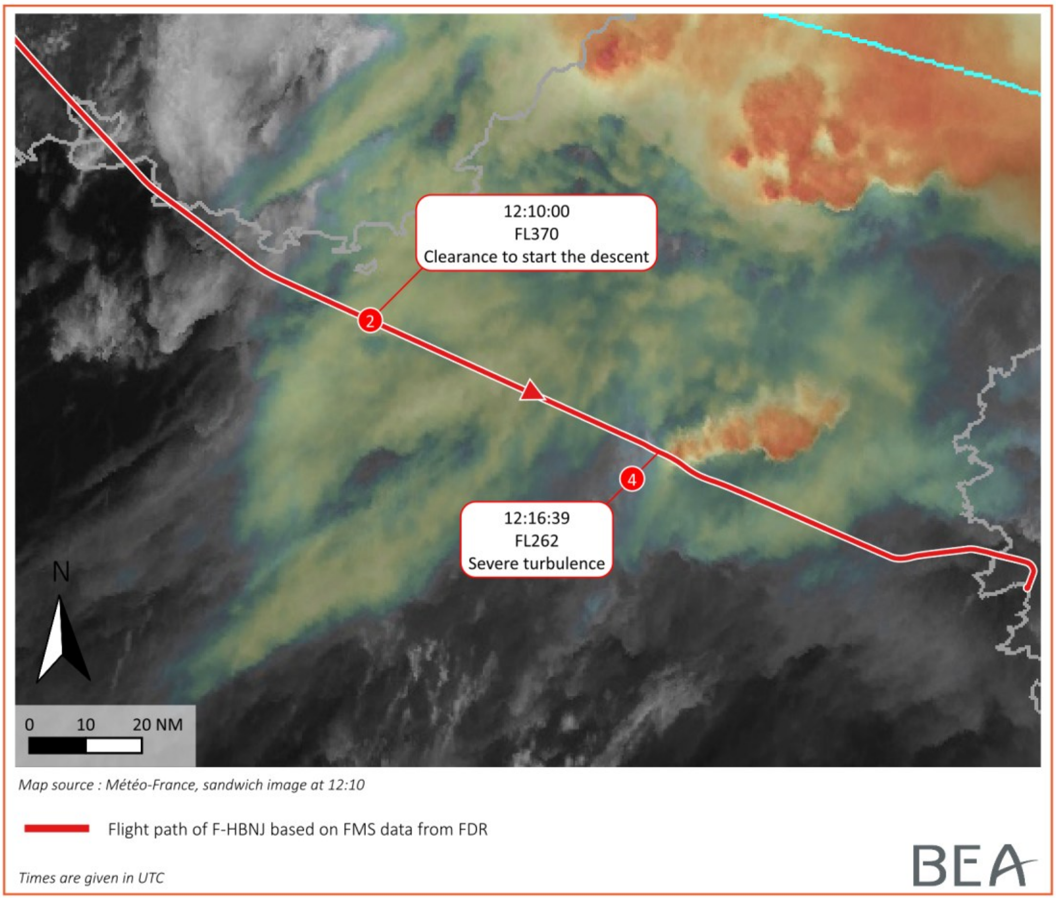


Figure 5: sandwich image at 12:10

The analysis of the data from the Météo-France ground precipitation radar concerning the convective cell which the aeroplane flew through at FL 262 showed:

- from 11:30:
  - light to moderate precipitation (reflectivity greater than 20 dBz) culminating at FL 210,
  - heavy precipitation (reflectivity greater than 40 dBz) culminating at FL 140,
- from 12:00, and notably 12:10:
  - light to moderate precipitation culminating at FL 350,
  - heavy precipitation culminating at FL 230,
- from 12:20, heavy precipitation culminating at FL 270.

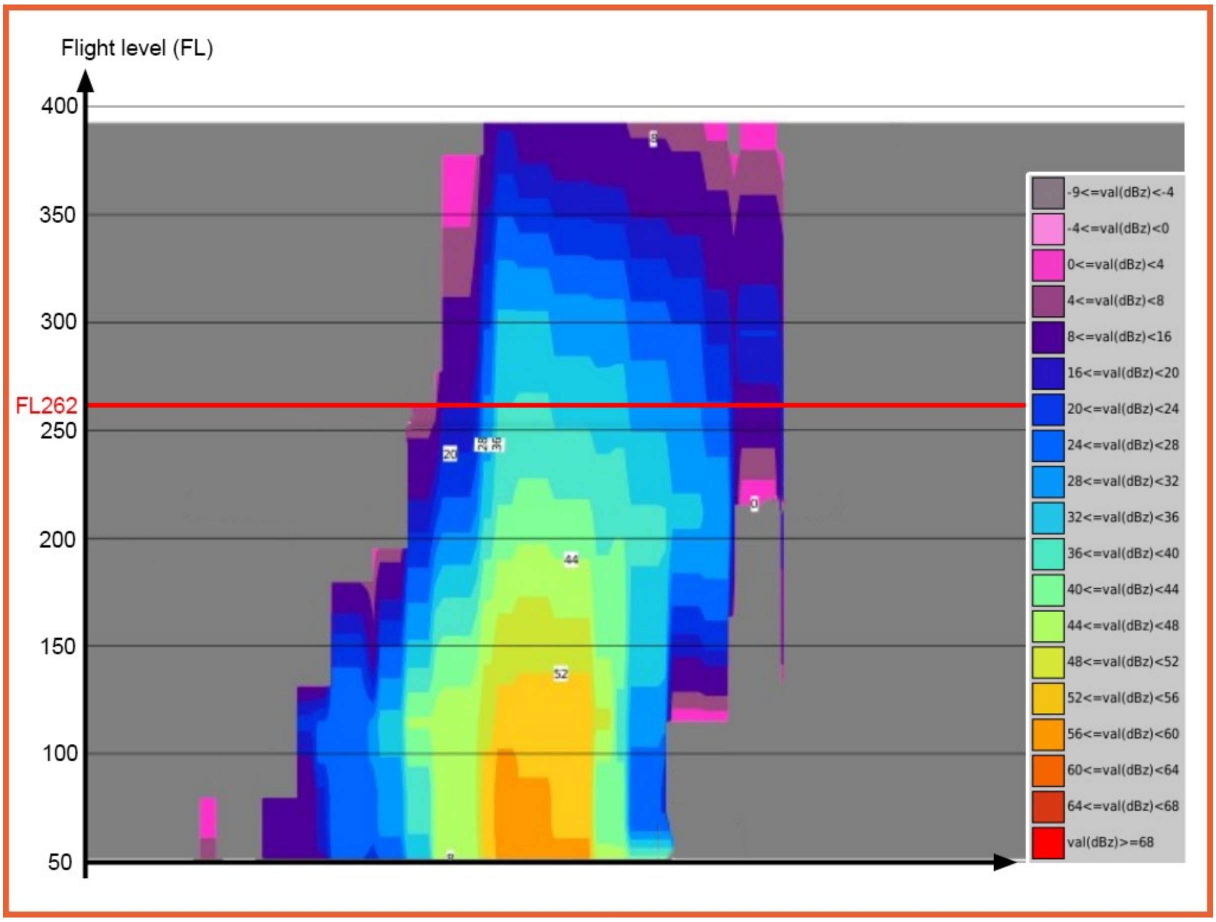


Figure 6: vertical profile of radar reflectivity field at 12:10 of convective cell on flight path of aeroplane, reflectivity scale on RH side (source: Météo-France)

The most reflective precipitation is that containing water in liquid form (rain or wet hail). Like the airborne weather radar, the ground weather radar has difficulty in detecting water in solid form, such as ice crystals or dry snow.

Given the levels of reflectivity shown by the ground observation equipment and based on the experience of Météo-France and Collins Aerospace, this convective cell was theoretically detectable by the airborne weather radar before the aeroplane flew through it.

2.5.2 Available data in flight file

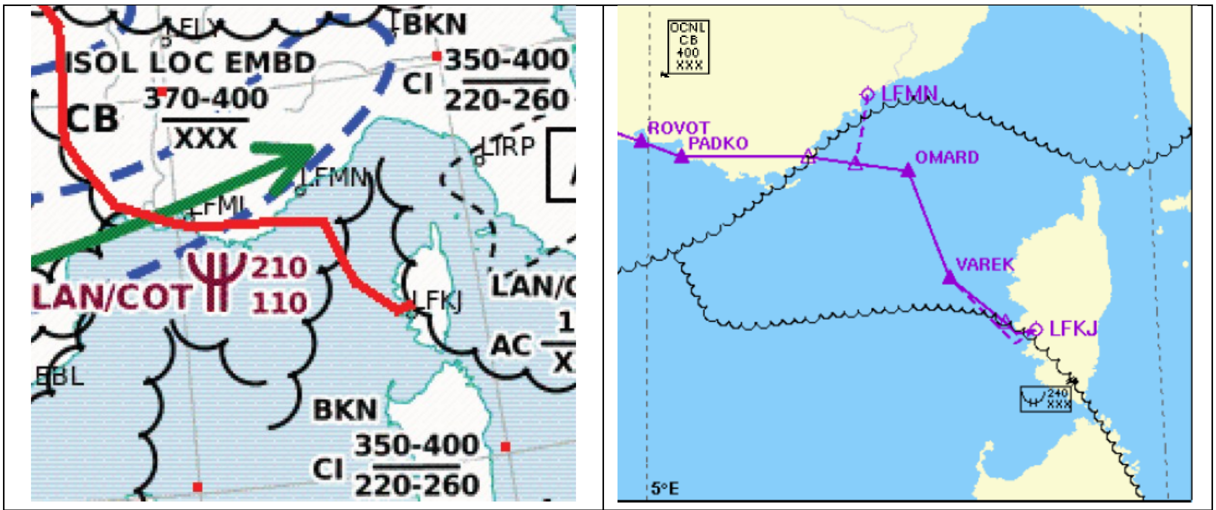
The flight crew had various information at their disposal before the flight:

- significant weather (SIGWX) charts valid at 12:00 from Météo-France and the Met Office (UK);
- flight profile with wind;
- TAF and METAR reports for the aerodromes concerned by the flight.

The Météo-France EUROC SIGWX chart (see **Figure 7**) mentioned, close to the area of the accident, at the edge of the scalloped zone, the following cloud cover:

- cumulonimbus, isolated and locally embedded in the mass[25], with a cloud base below FL 100 and top between FL 370 and 400;
- broken cirrus with a cloud base between FL 220 and FL 260 and top between FL 350 and FL 400.

The Met Office SIGWX chart (see **Figure 8** below) did not mention the presence of isolated cumulonimbus embedded in the cloud mass in the area of the accident.



Météo-France	Met Office

Figure 7 and Figure 8: excerpts from SIGWX charts, flight path specified in flight plan (source: Air France)

2.5.3 eWAS data[26]

Air France provides each pilot with the eWAS application on their EFB. This application provides weather forecasts and reports from various sources in the form of an interactive chart with a display in the vertical and horizontal profiles. The eWAS user manual provided by the operator specifies that the use of the eWAS is limited to help with strategic decisions during flight preparation or in anticipation. It also indicates that the eWAS application is not a substitute for the airborne weather radar for any tactical decision and must not be used as such. The time required to process information before it is made available to users creates a time lag of around 20 min.

The captain indicated that he updated the eWAS system data before the descent. The investigation was not able to determine what information was available for the pilots at this time.

[25] Since January 2025, international conventions no longer require the indication of the presence of isolated cumulonimbus clouds embedded within the cloud mass (CB ISOL EMBD) on significant weather charts. However, Météo-France has maintained this practice.

[26] Electronic/Enhanced Weather Awareness System.

The operator was able to provide the recreated image[27] available at 12:00 (see **Figure 9**), a few minutes before the briefing and around ten minutes before the start of the descent. It showed:

- the convective system off the coast of Nice mentioned by the PF in his statement;
- clear sea between the continent and Corsica except for the small, isolated convective cell off the coast of Ajaccio, the cause of the turbulence encountered. The information regarding this cell was: severe cumulonimbus observed between the ground and FL 310 from 11:40.

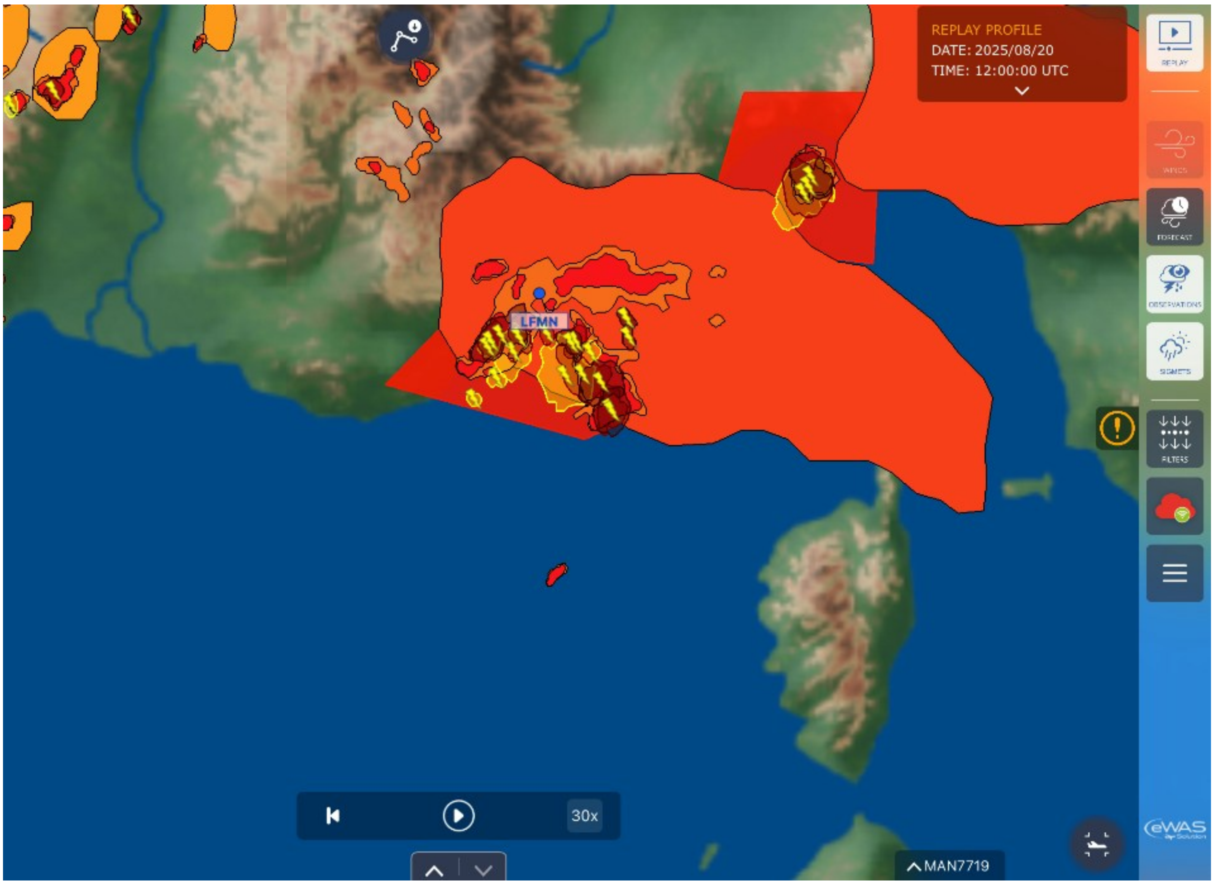


Figure 9: information available on eWAS at 12:00 (source: Air France)

According to the CVR data, the flight crew consulted the eWAS application at around 12:22, after the turbulence, and confirmed that the convective cell was indeed displayed on the application. The investigation was not able to determine at what point this consulted image had been updated on the EFB of the two flight crew. If, however, the image had been updated before the aeroplane passed into the convective cell, given its small size, it could have gone unnoticed due to the convective system off the coast of Nice or even been hidden by the line showing the course, according to the zoom setting chosen by the pilots.

2.5.4 EDR (Eddy Dissipation Rate) function

Certain aeroplanes are equipped with the EDR (Eddy Dissipation Rate) reporting function. Using the airborne systems, the EDR function calculates the amplitude of the turbulence and automatically shares harmonized information with the community. The data is first transmitted from the aircraft to the ground, and then sent via a dedicated network infrastructure to the IATA database. This

[27] Air France was able to access, via SITA, the weather data as it was used by the eWAS at the time of the accident.

information is thus available for other aeroplanes via the eWAS application for example, subject to the operators concerned having subscribed to receive this data. The information is only useful, therefore, if at least two aircraft able to use this data fly through the same area. The authorities and manufacturers promote the EDR function. There was no EDR report in the area.

F-HBNJ was not equipped with the EDR function. The operator specified that the EDR function is deployed on its Boeing 777 and Boeing 787 fleets. This function has also been deployed on its Airbus A350 fleet since June 2026.

2.6 Operational procedures in the event of turbulence

The operator’s documentation specifies that the exchange of information between the flight crew and the cabin crew is crucial in the management of the turbulence risk. It contains the following tables summarising the actions according to the severity of the turbulence:

<table>
<tr><td></td><td colspan="3">Start of turbulence</td></tr>
<tr><td></td><td>Light</td><td>Moderate/severe forecast</td><td>Severe/extreme not forecast</td></tr>
<tr><td>Pilot actions</td><td>Switch on
“Fasten seatbelt” light</td><td>Check “Fasten seatbelt” light is on or switch it on.
Warn purser and/or all of crew by interphone or PA by making an appropriate announcement</td><td>Check “Fasten seatbelt” light is on or switch it on.
Make the following announcement on the PA: “This is your captain, cabin crew please be seated, seatbelts fastened, severe turbulence.”</td></tr>
<tr><td>Passenger announcements</td><td>The cabin crew make the prescribed announcement over the PA, even at night: “We are about to fly through turbulence. For your own safety, the captain asks you to return to your seat, sit down and keep your sealbelt fastened.”</td><td colspan="2">The cabin crew inform the passengers as soon as possible by making the following announcement on the PA: “We are about to fly through heavy turbulence. For your own safety, the captain asks you to return to your seat, sit down and keep your sealbelt fastened.”</td></tr>
<tr><td rowspan="2">Cabin crew actions</td><td colspan="2">Ensure that all the passengers, including any passengers that may be in the toilets, have returned to their seats.</td><td rowspan="2">Block the trolleys.
If possible, place on the ground any objects that could be thrown around.
Immediately sit down in the nearest seat and fasten seatbelt.
If the cabin is full, sit or crouch down in the aisle and hang onto the seat structure or to the arms of passengers sat in the lateral seats.</td></tr>
<tr><td>Make sure that all the passengers have their seatbelts fastened […].
Pay attention to any pilot announcement or any evolution in the situation in order to rapidly stow any loose objects.
The cabin crew may continue serving food and drink with care.</td><td>Rapidly stow objects, check passenger seatbelts. […].
Return to your jumpseat and fasten your seatbelt and shoulder harness.</td></tr>
<tr><td>Crew communication</td><td colspan="2">The cabin crew report actions carried out to the purser</td><td>The cabin crew, if possible, inform the purser of the situation in the cabin. The purser reports to the captain.</td></tr>
</table>

	End of turbulence		
	Light	Moderate/severe forecast	Severe/extreme not forecast
Pilot/cabin crew actions	The pilots switch off the “Fasten seatbelt” light.	Cabin crew are authorized by pilots to leave their seats by a general call to the cabin crew or by a PA announcement “Cabin crew, you may leave your seats”.	Cabin crew are authorized by pilots to leave their seats by a PA announcement “Cabin crew, you may leave your seats”.
Cabin crew actions	[…].	[…].	[…]. Inspect toilets. Make sure that self-service units are correctly secured.[…].

As the flight crew had not detected a serious threat, they were in a logic of “light turbulence” and had switched on the “Fasten seatbelt” light, asking the cabin crew to make the associated announcement and to carry out the cabin check. When the red radar echo was detected, in accordance with the operator’s and manufacturer’s recommended practices, the crew prioritized managing the flight path. They no longer had available resources to warn the cabin crew by means of the specified announcement.

A European operator, consulted during the investigation, imposes that passengers remain seated with their seatbelt fastened for all of the flight. Thus, in the case of light turbulence, the cabin crew do not have to check the cabin and can continue with their tasks. Air France recommends to its passengers that they keep their seatbelt fastened and visible to facilitate checks in the event of turbulence. The announcement to this effect is made at the beginning of the flight.

In the cabin, the purser chose to make the “Approach” safety announcement to the passengers, asking them to fasten and adjust their seatbelts for landing. This announcement is usually made after passing 10,000 ft. The expected passenger actions following this announcement are the same as for light turbulence - seatbelts fastened and adjusted - however, the speed of execution may be slower in the case of an “Approach” safety announcement, turbulence being an imminent danger. The cabin crew then checked the cabin. The “Approach” safety announcement requires the cabin crew to also check the position of the seats, tablets and window blinds. Moreover, it does not inform the passengers of the coming turbulence. Ultimately, this most likely had no influence on the passengers’ injuries.

Lastly, it should be noted that as a general rule, the cabin checks carried out by the cabin crew in the event of turbulence (light, moderate/severe forecast), expose them at a time that the risk increases.

2.7 Air navigation information

The flight crew were in communication with four sectors in the south-east ACC (radio call sign: “Marseille control”)[28]:

- sector M3, from 11:51:45;
- sector F3, from 12:04:57;
- sector E2, from 12:12:22;
- sector AJ, from 12:15:11 up to 12:18:16.

In sectors F3, E2 and AJ, the frequency was in use less than 40% of the time.

The analysis of the radio communications shows that more than fifty avoidance manoeuvres were requested by the pilots in the sectors mentioned. No avoidance manoeuvre was carried out in the vicinity of the convective cell before it was flown through by F-HBNJ.

The south-east ACC controllers have a multi-service secondary screen called the 4Me at their disposal, close to their main radar screen used for the traffic control function (See **Figure 10**). The MAP function of the 4Me screen includes the simultaneous display of the ASPOC[29] weather situation and the ARTAS[30] air picture in the control area (see **Figure 11** and **Figure 12**) to reinforce the controller’s situational awareness with the aim of defining traffic management strategies. It should be noted that the ASPOC data can have a lag of up to 15 min.

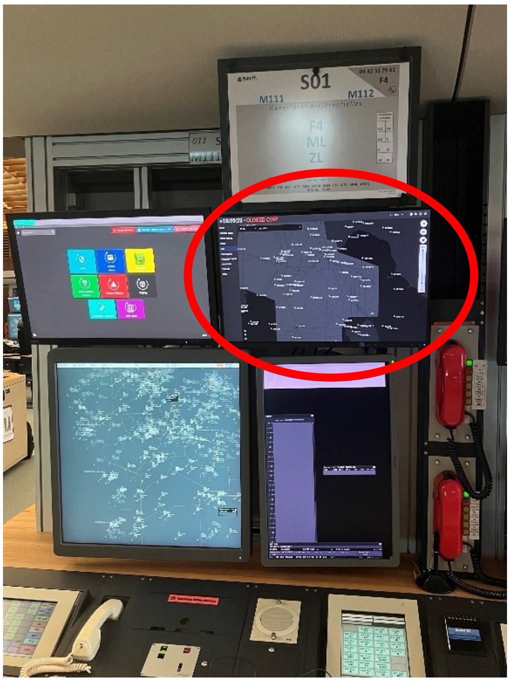
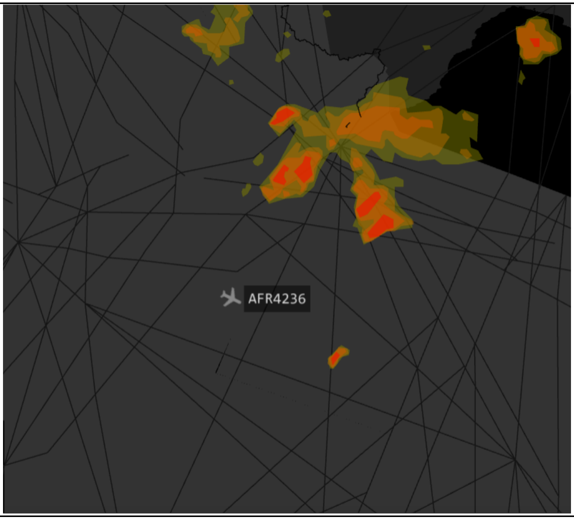
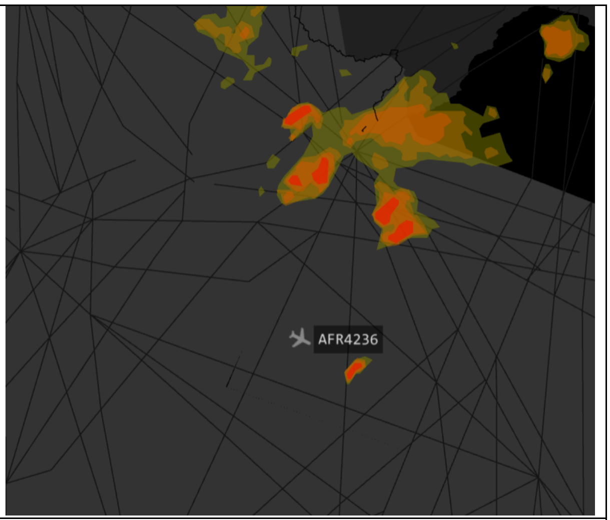


Figure 10: position of 4Me multifunction screen in control position
(source: DSNA/south-east ACC)

[28] Given the nature of the accident, the BEA did not take statements from the controllers who had managed the flight close to the convective cell.
[29] Application de Signalisation et Prévision des Orages pour le Contrôle aérien (Storm cell warning and forecasting application for air traffic control).
[30] ATM suRveillance Tracker And Server.



When changing Frequency
at 12:12:20



When changing Frequency
at 12:15:10

Figure 11 and Figure 12: recreation of 4Me image[31] and position of F-HBNJ based on ASPOC data (source: DSNA/DTI)

The south-east ACC operations manual specifies that an aircraft which is probably going to enter an area of adverse weather should be forewarned sufficiently early for the crew to decide on the measures to be taken, as proposed by GM1 associated with requirement ATS.TR.155(C)(5) of Consolidated European regulation (EU) No 2017/373 laying down common requirements for providers of air traffic management/air navigation services:

> "*INFORMATION REGARDING ADVERSE WEATHER CONDITIONS*
> *(a) Information that an aircraft appears likely to penetrate an area of adverse weather should be transmitted sufficiently early to permit the pilot to decide on a course of action, including that of requesting, if so desired, advice on the best way to circumnavigate the adverse weather area;*
> *(b) Depending on the capabilities of the ATS surveillance system, areas of adverse weather may not be presented on the situation display. The airborne weather radar generally provides better quality detection and characterisation of adverse weather phenomena than the radar sensors used by the air traffic services;*
> *(c) When vectoring an aircraft so that it circumnavigates any area of adverse weather, the air traffic controller should ascertain that the aircraft can be returned to its intended or assigned flight path within the coverage of the ATS surveillance system. If this does not appear possible, the controller should inform the pilot of this.*"

The DSNA specified, however, that the 4Me secondary screen is multi-service and that the MAP function is not always displayed on the screen. It can be replaced, for example, by another window (amount of traffic, flight plans, etc.). The DSNA added that it is expected of a controller to give this type of flight information if he has the time to do so.

[31] The 4Me data is not recorded. It was recreated based on weather information recordings produced by Météo-France and managed by the MetSafe service provider.

One of the practices mentioned in Directive 03-38/13 issued by the DSNA's Operations Directorate is to wait for pilots to confirm the presence of the convective cell before passing on the information to the other pilots. Directive 03-38/13 does not include the provisions of ATS.TR.155(C)(5), furthermore it does not mention the systems currently deployed in the units, notably the 4Me.

The investigation brought to light that in the conditions of the occurrence, the flight crew had an on-board display of the adverse weather phenomenon that was less precise than that provided by the sensors used by the air traffic services.

In 2022, in the investigation report into the accident to the Boeing 737 registered SE-RPE on 25 July 2021 in cruise to Nice (convective turbulence), the BEA issued the following recommendation:

"EASA, in coordination with Eurocontrol:

1. conduct a global review of existing systems and those being developed that display near-real-time weather images on the radar screens of air traffic controllers, and their use by air navigation service providers as part of the flight information service, with the aim of facilitating meteorological avoidance strategies developed by flight crews,

2. on the basis of the above review and other available data, identify the system specifications, tools and working methods that would be most suitable for use by the European air navigation service providers in order to facilitate weather avoidance strategies developed by flight crews,

3. promote the implementation and use of such systems, tools and working methods by the European air navigation service providers in order to facilitate meteorological avoidance strategies developed by flight crews.

[Recommendation FRAN-2022-014]."

The BEA had considered that EASA's response to this recommendation was inadequate notably because it mentioned the weather information made available to pilots. The response did not enable the BEA to clearly assess the actions undertaken or being undertaken with respect to weather information for air traffic controllers.

At the time of publication of this report, EASA's work to make weather images available in near real time on the air traffic controller radar screens was on-going but it was still too early for EASA to communicate on the progress of the work.

2.8 Similar occurrences

The occurrences that the BEA records in its database include those where it carries out an investigation and those for which it has received a notification from a foreign investigation authority as the State of design, manufacture, registration or operator in accordance with the provision of ICAO Annex 13.

During the last eleven years (2015-2025), the BEA has recorded 79 occurrences[32] in the "TURB: turbulence encounter" category according to the international taxonomy, for a total of 91 seriously injured people. This number is subject to the variability than can exist globally with respect to the assessment of the severity of the injury and the notification system in general.

[32] Accidents or serious incidents involving aeroplanes of more than 5.7 t or operated for commercial air transport.

In four of these occurrences, the small amount of available information, notably the absence of a report, means that it is not possible to determine the type of turbulence encountered (convective, wake or CAT[33]).

However, out of the 75 remaining cases, 45 concern turbulence associated with a convective phenomenon. The analysis of these cases which gave rise to 67 serious injuries showed that:

- the cabin crew form the majority of the victims (49 seriously injured);
- when the convective cell was detected, the flight crew did not take or was not able to take a sufficient margin with respect to this cell and encountered turbulence close-by (17 cases);
- the cells are sometimes not detected or detected too late due to the limits or incorrect use of the airborne weather radar (23 cases).

In its 2025 Safety risk portfolios, EASA identified a Safety Issue (SI-0003) concerning:

> "*Adverse convective weather (turbulence, hail, lightning, and ice):*
> *This safety issue addresses the ability and capability of the flight crew to manage the entire flight, including dispatch, and the possibility to detect, avoid and/or mitigate the effects of adverse convective weather on the flight. If not managed well, a flight crew may experience aircraft upset after being forced out of its flight envelope by a severe atmospheric phenomenon, or a significant degradation in performance or the handling qualities of the aircraft, or injuries due to abrupt movements. It also reviews the requirements for the aircraft to fly in certain atmospheric conditions. The main threats of convective phenomena affecting the flight, such as convective turbulence, up/down-drafts, wind shear, hail precipitation, lightning, and icing are reviewed in this safety issue."*

At the time of publication of this report, EASA was not able to communication on the progress of the work regarding this identified risk. EASA indicated that this work was included in SI-0003B dealing with clear air and wave turbulence and that its scope had been extended to significant convective turbulence occurrences.

To better take into account the effects of climate change on aviation safety, in 2023, EASA launched the European Network on Impact of Climate Change on Aviation (EN-ICCA) which draws on the work of scientific experts (in particular the GIEC) and aviation specialists tasked with reviewing the state of knowledge regarding the impact of climate change on aviation activities.

[33] Clear Air turbulence.

According to the work examined by EN-ICCA, the impact of climate change on weather phenomena could include:

- an increase in the frequency of certain meteorological phenomena dangerous to aviation;
- an increase in their severity;
- the appearance of severe weather phenomena in regions hitherto little exposed;
- a change in their seasonality;
- a more frequent combination of several severe weather phenomena.

2.9 Exchanges after flight in area of turbulence

Following the turbulence:

- just over five minutes elapsed until the clearance to start the approach: the flight crew principally debriefed with respect to the situation encountered and had two exchanges with the cabin crew;
- then eight minutes elapsed until landing: the exchanges were principally devoted to managing the approach;
- then five minutes elapsed until arriving on the apron.

The analysis of the crew's exchanges (CVR) and statements showed that the crew members were in shock following the occurrence. The pilots then re-activated their resources for the approach.

2.9.1 AIREP

After the turbulence, the pilots did not inform air traffic control of the phenomenon encountered by means of an AIREP. In the operator's documentation, it is specified that the captain must inform, without delay, the air traffic services of any in-flight incident or risk of an incident and in particular, those concerning weather conditions, and conditions which have not been forecast or are dangerous, including severe turbulence, in compliance with requirement SERA.12005 of European Regulation (EU) No 923/2012 laying down the common rules of the air and operational provisions regarding services and procedures in air navigation which specifies that pilots shall compile an AIREP report, notably in the cases of severe turbulence and embedded thunderstorms with hail. The captain assumed this decision according to his statement (see paragraph 2.1.2.3). In hindsight, the co-pilot believed that this type of information could have been useful for other pilots.

2.9.2 Identification of number of victims

The operator's documentation specifies that any situation which may impact safety shall be reported to the pilots. It adds that sharing information between crew members facilitates situational awareness and must give rise to coordination between the cockpit and cabin.

The purser, in shock and based on the partial information given to her, was not aware of the serious injuries to her colleagues, that she may have unconsciously minimized:

- her own injuries were slight;
- the passenger who was bleeding indicated that he was fine;
- PNC 4 working alongside her, continued her tasks;
- the indication, that it had been rough, was not very precise;
- turbulence is generally not so strong in the front part of the cabin.

The purser thus informed the captain that there were some injuries in the cabin and they agreed to review the situation later, on the ground. There was a pressing time constraint. This partial analysis took place while the crew were preparing the approach. There was therefore no estimation of the number/seriousness of the injuries and a sized medical response not immediately set up for their arrival.

On the captain's side, during his exchanges with the purser and PNC 4, he wanted to know if the passengers had their seatbelts fastened. He also explained that they had entered an area of turbulence without it having been first detected on the radar.

The recordings show a communication failure in these exchanges, with each party expressing their own point of view, their concerns and their feelings without really taking into account the message being given to them by the other person. The information transmitted in these exchanges was taken into account in a very limited way and an assessment was pushed back to after the landing.

2.9.3 Cabin crew incapacitation

Following the turbulence, three cabin crew could no longer perform the essential tasks, such as managing an emergency evacuation. This was detected neither by the purser nor by the flight crew.

The operator's documentation contains some indications regarding the incapacitation of a cabin crew member during a flight. These include having the cabin crew stations manned in an optimal manner. An injured cabin crew member is then managed according to the ill or injured person procedure. The documentation does not include full procedures for a cabin crew in-flight incapacitation, unlike the incapacitation of a pilot. Paragraph 8.3.14 of AMC3 associated with requirement ORO.MLR.100 of Consolidated European regulation (EU) No 965/2012, related to air operations (Air Ops) specifies that, *"Incapacitation of crew members. Procedures to be followed in the event of incapacitation of crew members in-flight. Examples of the types of incapacitation and the means for recognising them should be included*." The operator specified that in these conditions, the cabin crew are expected to take initiatives and improvise in the face of the unforeseeable to obtain the safest result.

The operator specified that the reported cases of an in-flight cabin crew incapacitation were managed, in the majority of cases, in accordance with its documentation.

3 CONCLUSIONS

The conclusions are solely based on the information which came to the knowledge of the BEA during the investigation.

Scenario

During the descent in a layer of clouds, the flight crew were late in detecting echoes on their flight path on the airborne weather radar. This late detection did not leave them time to analyse these echoes and define an avoidance strategy. The aeroplane entered an isolated convective cell at around FL 260 and flew through an area of severe turbulence accompanied by hail.

As the airborne weather radar data (parameters and display on ND) is not recorded, the investigation was not able to explain the reason for the flight crew's late detection of the convective cell. The weather radar was functional, the convective cell had developed around 45 min before the aeroplane flew into it, and it was particularly associated with moderate to severe liquid water precipitation according to the altitude. The centre of the cell remained below FL 230 until around 12:10. When the aeroplane flew through it six minutes later, it was rapidly developing vertically which explains the severity of the turbulence.

This convective cell could have been indicated by the eWAS system, a secondary tool available to the flight crew. In the absence of a recording, the investigation was not able to determine the content of the eWAS information available to the pilots before the turbulence.

The cell was present in the 4Me system, a secondary screen, available to the air traffic controllers on the ground. The investigation was not able to determine if the controllers in position had consulted this information. No information about the convective cell was given to the crew.

When the "Fasten seatbelt" light was switched on in the cabin, the cabin crew decided to carry out the checks for landing and made the associated announcement to the passengers without mentioning turbulence. The purser indicated that she wanted to optimise the cabin preparation time.

The severe turbulence was not preceded by light turbulence. It suddenly started at the beginning of the cabin checks. The cabin crew and passengers who were not sat down with their seatbelts fastened, were thrown into the air and then to the ground, which explains the serious injuries and their state of shock.

The substance of the discussions between the cabin crew and the pilots, between the end of the turbulence and the arrival on the apron did not include a concrete appraisal of the injuries suffered during the flight, the subject having been postponed. The captain chose not to inform the air traffic control services of the situation encountered in flight in order to stay concentrated on the management of the end of the flight. This lack of information during the flight meant that the deployment of the emergency services was not optimal and led to the total engagement of all the ARFF personnel for approximately fifteen minutes at the destination airport.

Contributing factors

The following factors may have contributed to the late detection of an area of severe convective turbulence during the descent:

- a relatively high workload in the 15 min preceding the flight through the area of turbulence: arrival briefing and performance calculations, flight path changes, radio frequency changes, discussions about the passenger in the forward galley, acquisition of weather conditions at the neighbouring aerodromes, passenger information announcement;
- a possible reduction in vigilance while flying over the Mediterranean sea which may have degraded the active monitoring of the radar. The weather forecasts consulted before departure were favourable for the flight over the sea and the isolated convective cell had not been identified with the eWAS, consulted before the descent;
- the use of an airborne weather radar requiring regular manual adjustments to the tilt, in a flight phase which already had a high workload. The latest generation radars have automatic functions facilitating detection;
- the absence of information provided by air traffic control of the development of the convective cell on the aeroplane's flight path. This information could be displayed on a secondary screen for use by controllers in position. The instructions given to the controllers suggest, wrongly, that this information is less precise than the on-board information.

Measures envisaged

Air France is considering modifying its policy and procedures to make passengers and the cabin safe in the event of turbulence and adjusting the communication model between the flight crew and cabin crew.

Air France is envisaging improving the clarity of its documents to make them more explicit about cabin crew incapacitation.

Air France is planning to use this event as an example in the next Crew Resource Management (CRM) training sessions in order to reinforce communication between the cabin crew and the pilots in these circumstances.

Safety messages

Pilot information regarding convective areas

An area of severe turbulence may be detected late by pilots. Effective detection is based on active use of the radar to analyse green echoes as early as possible in order to understand what has caused them.

Understanding may be increased using modern connected tools such as the eWAS which gives information about the medium to long term weather situation or the IATA Turbulence Aware which shares EDR (Eddy Dissipation rate*)* reports in real time transmitted by equipped aeroplanes.

To supplement this, the air traffic controller tools can be used to display the air picture and weather information on a secondary screen. The provision of information to the pilots about the presence of a convective cell on the aeroplane's flight path is likely to help the crew supplement their awareness of the surrounding situation.

Lastly, sharing information with the air traffic controllers about the situation encountered in flight, in the form of an AIREP, will improve the situational awareness of all the actors, notably pilots who may be flying in the same sectors and confronted with the same detection difficulties.

Safety concerns regarding the provision of weather information

The procedures available to air traffic controllers (manual and directives) do not guarantee that an early and effective warning will be given to crews on aircraft which may be flying close to convective areas as illustrated by this occurrence.

GM1, associated with requirement ATS.TR.155(C)(5), certain elements of which are included in DSNA directive 03-38/13 (see paragraph 2.7), mentions that pilots "generally" have better quality information via their airborne radar. The analysis of the accident shows that this is not always the case and that pilots may be confronted with difficulties of various kinds linked to the airborne weather radar.

Directive 03-38/13, which has not been updated since 2018 and does not take into account the new tools available to control centre controllers, specifies that information shall be transmitted to crews once there has been prior confirmation from another crew who have already encountered the phenomenon. This practice is likely to delay the circulation of information, notably for a convective cell with rapid development.

Communication between cabin crew and pilots

When an unusual situation is encountered, the sharing of information between the cockpit and the cabin contributes to a better assessment of the situation and facilitates decision-making. Sometimes, in certain flight phases, the operational concerns of the various parties may differ and make some information less salient.

The use of a communication structure such as the NITS (Nature, Intention, Time, Special instructions) model, initially developed for the pilot to inform the cabin crew of an abnormal situation, may facilitate the transmission and correct understanding of the information between the cockpit and the cabin. The method prescribes that the cabin crew member who receives the message repeats it so that the pilot can check that it has been correctly understood. This method has the advantage of systematically establishing feedback that is essential for effective communication. This method could also be used for communications from the cabin to the cockpit.

Prior information for the emergency services

The early transmission of information to the emergency services regarding the presence of injured persons following an in-flight occurrence may facilitate the adaptation of the ground service response in order to:

- position the aircraft in a dedicated area while not interfering with the operation of the airport;
- size the human and material resources implemented by the emergency services.

The BEA investigations are conducted with the sole objective of improving aviation safety and are not intended to apportion blame or liabilities.