Royal Meteorological Society

SIG Aviation Meteorology
Newsletter 1 2016, April 2016

In this newsletter, the first since 2014, we talk about recent developments of the Met Office Aviation App. SKYbrary is a major project for the SIG, and latest activites are listed. Michael de Villiers has donated an article he wrote for the South African Weather Service. James Morrison has a few photos of Nacreous clouds he took in the Liverpool region in January 2016.

GASCo and the RMetS (through our SIG) are jointly hosting a "Weather for Private Pilot's License Holders" meet in Imperial College London in South Kensington on April 16, 2016. For more information please check out http://www.rmets.org/events/weather-private-pilot's-license-holders

Met Office Aviation App
By Jacob Kollegger

A significant amount of time during last year's meet (November 19, 2015) was utilized to discuss the new Met Office Aviation App. http://www.metoffice.gov.uk/aviation/ga The discussions involved may be found in the minutes of the meet: http://www.rmets.org/sites/rmets.org/files/minutessigmeet2015.pdf

Linda Jennings, Senior Marketing Manager, wrote recently about the modifications to the Aviation App:

"... we are currently mid-development for another release of content and features to the new product. In light of feedback from our customers, we are in the process of adding the global TAF and METAR search into the free product, along with other features like upper winds and temperatures, and significant weather charts – all of which will feature in the premium version, as they did in the old product. Alongside this, we have taken on board comments from customers about the home page, in terms of wanting more quick links. So you can look forward to seeing a new layout and a new layer picker since customers wanted to see maps on their mobile devices, and this has necessitated slight changes to this menu in order to work efficiently. We have also looked at improving the print functionality.

In terms of timings ... more changes will be taking place … during the spring. You should see these new features by the end of March, release permitting. Following release I will mail all users ... to take them through some of the changes. I will also be communicating with all those users who are still using the old product to migrate them across. All of our web pages will also be updated, along with the FAQs.

The old product is still alive and will be until the late spring, when we will retire it. The messages on this product will be updated to reflect a new retirement date. This will be agreed in consultation with CAA."

Feel free to look through the App yourselves, and, especially for our non-UK-based members, if you wish to share the link to your local aviation weather app, please let Jake know.

SKYbrary

by Jacob Kollegger

http://skybrary.aero/index.php/Portal:Weather

The SKYbrary project is moving ahead with a few projects, and additional articles. As stated during our November meet, users on SKYbrary included student pilots, who may be using SKYbrary to help study for their airline transport license exams, and here we may get user attention with such articles as the Bergeron-Findeisen process, nacreous clouds, saturated adiabatic lapse rate, etc. We have already had an excellent article written about QNH, QFF, and QNE, which was then incorporated into existing SKYbrary articles in altimetry, and we welcome further feedback and inputs, even contributions.

The following airports are currently being looked at in terms of meteorological content in their respective articles:

City of Derry, Ireland West Knock, Cork, Liverpool John Lennon, East Midlands, Prestwick, Sandefjord Torp, Gran Canaria, Tenerife South, Tenerife North, Lanzarote, Fuerteventura, Alicante, Girona, Malaga, Limoges, Carcassonne, Marseille, Nimes, Bergamo, Roma Ciampino, Faro, Porto.

If you would like to contribute some insight to these or other airports in the SKYbrary website, please let me know.

ARTICLE OF INTEREST:

With special thanks to Michael de Villiers and the South African Weather Service, and the Weather Bureau Newsletter.

A SEVERE TURBULENCE ENCOUNTER

M P de Villiers

INTRODUCTION

In the early evening, at about 15:55 UTC, on 19 January 1996, a Boeing 747SP encountered severe turbulence at FL 370 (Flight Level 3 700 ft) about 4 minutes south of the Makir reporting point, which is at 16° 11'S 31° 33'E on the Zambian Flight Information Region (FIR) border. The flight was *en route* from Johannesburg International Airport to Jeddah. According to reports in the Sunday Times (21 January 1996) and You (1 February 1996) numerous passengers were injured and damage was caused to the interior of the passenger cabin when the aircraft suddenly climbed about 250 metres and then immediately fell approximately 460 metres.

This study looks at the circumstances surrounding the incident. Sources of information were satellite imagery and a numerical model weather forecast from the World Area Forecast Centre (WAFC) at Bracknell, United Kingdom. The WAFC forecast was valid at 00:00 UTC on the 20th and was based on a 00:00 UTC 1996-01-19 analysis. Flight data from the aircraft was also available, as well as evidence from crew reports obtained during verbal discussion with Mr Drew from South African Airways Cabin Safety. Conclusions reached in this report are those of the author and are not to be construed as the findings of any official aviation authority.

WEATHER CONDITIONS

Analysis of the surface synoptic observations at 15:00 UTC and 18:00 UTC on 1996-01-19 indicated that thunderstorm activity was present or developing along the entire route from Johannesburg to the Zambian FIR. This was confirmed by the 16:00 UTC and 16:30 UTC infrared satellite images (Figures 1 and 2, respectively). By 24:00 UTC most of the thunder activity appears to have passed with lightning reported at some stations and light rain at others.

Upper-air conditions from radiosonde ascents were unknown due to the lack of atmospheric soundings north of Pietersburg earlier in the afternoon at 12:00 UTC. However, early the next morning the 00:00 UTC 1996-01-20 atmospheric soundings at Harare and Bulawayo, at 250 hPa (FL 340 according to ISA (International Standard Atmosphere), recorded air temperatures of -38°C and -40°C, respectively. The observed temperatures confirmed the accuracy of the Bracknell WAFC forecast temperatures and indicated a slight difference of 2°C to 4°C at FL 340. No Harare and Bulawayo wind information was available.

The forecast wind and temperature fields, valid at 00:00 UTC 1996-01-20 at FL 340 and FL 390 from the Bracknell WAFC, indicated a light westerly to south-westerly wind of 5 knots at 20°S for these levels over Zimbabwe becoming south-easterly 10-20 knots at 15°S over southern Zambia. Vertical and horizontal wind velocity and/or directional shear was therefore very weak. Anvil drift, determined from the two satellite images, was to the north-west, thereby confirming the forecast south-easterly wind towards 15°S.

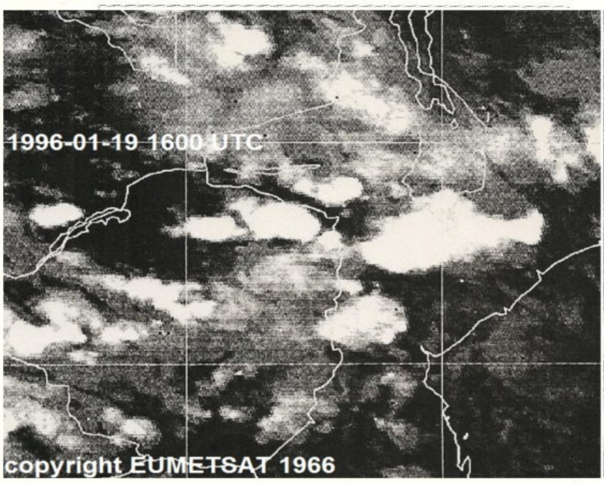

Fig 1: The Meteosat satellite image at 16:00 UTC 1996-01-19

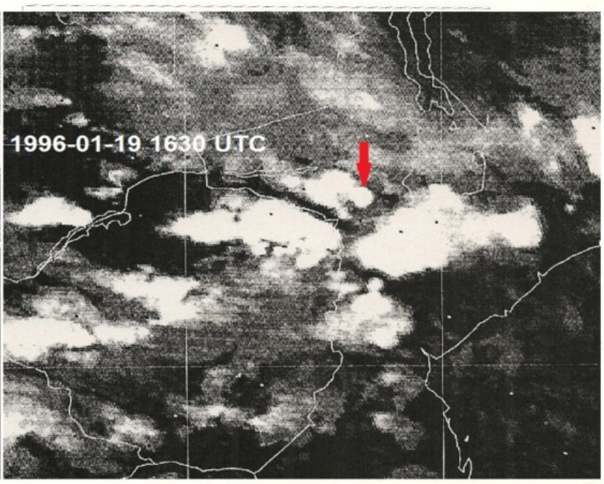

Fig 2: The Meteosat satellite image at 16:30 UTC 1996-01-20

Horizontal temperature shear was virtually non-existent, while vertical cooling was about 2,8°C/1000 feet. The forecast temperature at 15°S 30°E at FL 340 was -42°C and at FL 390 -56°C. Thunderstorms with tops up to FL 450 were forecast for the area by the aviation weather forecasting office at Johannesburg International Airport.

The general circulation indicated that the aircraft's path lay almost through the eastern centre of an anticyclone, as indicated by the forecast winds mentioned above and the light winds recorded on board the aircraft (Table 1).

Table 1: Position, Wind velocity, Total Air Temperature, Pressure Altitude (in feet) and Ground Speed (in knots) from the aircraft flight recorder.

LAT	LONG	WIND	TAT °C	PALT	G/S
20°31,7'S	29°54,8'E	273/03	-15,8	36997	504
20°31,1'S	29°55,0'E	283/01	-15,3	37007	504
20°30,7'S	29°55,2'E	338/01	-15,3	37005	504
20°30,1'S	29°55,4'E	205/03	-15,4	37003	504
16°53,3'S	31°13,6'E	268/11	-08,8	37182	499

The Total Air Temperature (TAT), in Table 1, is the sum of the ambient air temperature and the frictional heating effect from the aircraft fuselage. Using a ground speed of 504 knots and the last position point in Table 1, a time of 5 minutes from the Makir reporting point is obtained. Allowing for minor calculation discrepancies this places the aircraft very close to where the turbulence was encountered (about 4 minutes south of Makir was quoted).

DISCUSSION

General

A comparison of the two satellite images at 16:00 and 16:30 UTC (in Figures 1 and 2) shows enlargement of two large thunderstorm anvils in the area of the incident over northern Zimbabwe. The eastern cell shows the most development (with newer cells to its south-east). Development of a cell between the two large cells and another to the north and between them is also evident on the two images with the gap between the two large cells almost entirely closed at 16:30 UTC. The aircraft was clearly flying into an area of increasing thunderstorm activity.

The report of the aircraft suddenly rising and then falling is consistent with it having encountered a strong updraught in a developing thunderstorm cloud and the falling again once it exited the updraught. The nearly 7°C warmer temperature at the last position report (in Table 1) near to or at the time of onset of the turbulence, is further confirmation of a strongly rising column of air warmer than the surrounding atmosphere and which would be found in a developing thunderstorm. Note, the aircraft altitude at this point is also nearly 180 feet higher than the earlier nearly consistent altitude and the ground speed shows a compensatory decrease.

According to personal discussion with Mr Drew the aircraft was in cloud at the time of the incident and a passenger in the forward part of the first class cabin heard a noise on the nose cone which is consistent with hail or ice striking the aircraft.

In view of the above and the lack of vertical and horizontal wind shear, as well as light winds, it is believed that high altitude clear-air turbulence can be ruled out as the cause of the severe turbulence. From the weather conditions discussed above and the report in the You magazine, where thunderstorm activity and prior turbulence is mentioned, it is believed that the upset was caused by severe turbulence in or near thunderstorm tops (TNTT) (Lester 1993:465) as shown in Figure 3.

Lester, Wingrove and Bach (1991:261) cite an incident where a DC-10 flight through the top of a thunderstorm near Bermuda at FL 370 on 1983-12-10 resulted in G-loads of +1,6 and -0,6. The turbulent period lasted 86 seconds with G-load in excess of 1,0 for 1% of the time. This is not as strong as the G-loads of +2,1 and -1,5 experienced by the Boeing 747SP aircraft.

The You report and discussion with Mr Drew revealed that the aircraft was passing between two radar-identified thunderstorm echoes when the severe turbulence was experienced. This is confirmed by the satellite image in Figure 1 which shows two strong cells in the vicinity. It is therefore also possible that the aircraft was subjected to turbulence between the two cells and/or thunderstorm wake turbulence. Lester et al. (1991:261) quote two incidents of thunderstorm wake turbulence where a DC-10 suffered G-loads of +1,7, and -1,0, and a L-1011 experienced +2,1 and -1,0.

As the winds relative to the thunderstorms were light at the flight level (according to Table 1) and at other levels (according to the forecast wind charts), two- and three-dimensional lee waves are not believed to have been the cause of the severe turbulence.

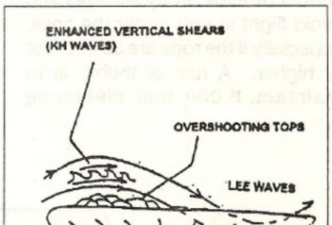

Fig 3: Sources of TNTT from Lester, et al. 1993:468

The cause of TNTT

According to Lester (1993:466) the "primary causes of turbulence in or near thunderstorm tops (TNTT) are convection within the main body of the storm and a variety of atmospheric gravity wave phenomena caused by interactions between the thunderstorm and its stable environment" as shown in Figure 3. In more simple terms, the severe TNTT can result from an encounter with a rapidly growing cumulonimbus cloud, or with the overshooting top above the anvil in a stable layer such as the stratosphere.

Lester (1993:466) adds that TNTT may be produced in weak winds with "thunderstorms protruding into an otherwise quiescent, stable environment."

Avoidance

The United States of America Federal Aviation Authority Advisory Circular 00-24B, Thunderstorms (1983:7), from Lester (1993:466), gives some guidelines to avoiding TNTT, which are briefly repeated below.

Shear turbulence has been encountered several thousand feet above and 20 miles laterally from a severe storm. It is suggested that any storm identified as severe should be avoided by 20 miles and avoid flight in and under the anvil, especially if the tops are 35 000 feet or higher. A rule of thumb is to maintain 1 000 feet clearance above for every 10 knots of wind speed, while another rule is a minimum of 5 000 feet above the top. Also beware of an overshooting top. Occasionally tilting the airborne radar downwards will permit detection of thunderstorm activity at lower altitudes.

A problem which arises is that the convective elements that overshoot a smooth anvil top or rapidly rising pre-anvil tops often lack a radar echo (Lester 1993:467). Furthermore, restricted forward and downward vision from the cockpit and/or darkness creates added problems. Inspection of the 16:00 UTC satellite image in Figure 1 shows that there was another horizontally less developed cell north of and between the two large cells, as well as one in the southern part of the corridor between the two large cells. These cells may still have been developing earlier and not visible in the radar cone, as well as not visible to the crew due to their being in cloud. Due to the scale of the map it is not possible to determine the exact geographical location of the aircraft on the satellite image relative to the cells. Consequently it is not certain which of the cells caused the turbulence, but the last position in Table 1 is very close to the small cell between the two large cells.

CONCLUSION

The available information leads one to believe that the aircraft encountered severe turbulence in the top of a strongly developing thunderstorm, the tops of which were forecast to reach 45 000 feet. It is also possible that the aircraft encountered wake turbulence from one of two large thunderstorm cells between which the aircraft was passing, but this is considered to be less likely.

Unfortunately the aircraft happened to pass through the area at a critical time in the level of thunderstorm activity and development. Given the erratic and temporary nature of such activity, it is highly likely that passage a short time earlier or later would have been much less eventful.

REFERENCES

Lester, P. F., Wingrove, R. C. and Bach, R. E. 1991. *A summary of severe turbulence incidents using airline flight records.* Fourth International Conference on Aviation Weather Systems. June 24 - 28. Boston: American Meteorological Society. p. 257-261.

Lester, P. F., 1993. *Turbulence near thunderstorm tops.* Fifth International Conference on Aviation Weather Systems. August 2 - 6. Boston: American Meteorological Society. p. 465-468.

On two wings and a prayer. 1996. *Sunday Times.* 21 January 1996, p. 2.

Our plane is falling out of the sky. 1996. *You.* 1 February 1996, p. 16-17.

PHOTOS

The above three photos are from James Morrison on nacreous clouds over the region of Liverpool in late January of this year.

FEEDBACK/SUGGESTIONS:

Feedback and suggestions are always welcome. If you know of a project or undertaking that the SIG or Society may be interested in, please let us know.