Farnborough Airport

Airspace Change Post Implementation Review

CAA Reference ACP-2013-07

Annex E General Aviation and Glider Study

Issue 1.1

Record of revisions

Issue	Date	Reason for Change
1.0	2023-05-15	Published
1.1	2024-04-26	Correction to errata in Section 5 re: Parham Box data. Insertion of new Section 7 appendix re: controllers' use of CAS and additional radar data analysis. Marked by a blue bracket.

Contents

1 About this document

1.1 Introduction

1.1.1 This document is part of the Farnborough Airport airspace change post-implementation review (ACP PIR). It should be read in conjunction with the main PIR document which provides the structure, the majority of the evidence, and details the regulatory requirements for the PIR. It should also be read in conjunction with Annex A Traffic Dispersion and Environmental Overflight specifically regarding the GU10 postcode area, including the village of Churt.

1.1.2 This document provides a sample-based study of General Aviation (GA) and glider operations in the region, to indicate where possible changes in flows or altitudes that may be attributed to the introduction of controlled airspace (CAS).

1.1.3 It covers the item 'Other information of relevance (a)' from the CAA's list of PIR requirements.

1.1.4 The topic required by the CAA in their list is:

(a) Transit GA traffic potentially rerouting around the CTR/CTA complex

A subsequent conversation with the CAA clarified the following areas of interest:

(b) West of Farnborough: west of Blackbushe, under CTAs 3, 6 & 5, out to the line coincident with the western boundary of overlying LTMA 5500' (8 miles west of Odiham), down to the NE apex of the Solent CTA.

(c) Under CTA 8 and across under CTA 7

(d) East of Farnborough: traffic routeing east of CTR 2 that would have otherwise routed Bagshot, Fairoaks, Guilford, Tongham, Frensham Pond, under CTA 4.

2 Background on flying outside CAS

2.1 What is the relationship between GA, gliders and Air Traffic Control?

2.1.1 Unlike most commercial flights, GA and gliders operate outside CAS. This means that, apart from basic flying rules, they are free to operate entirely autonomously, without any permission, without speaking to an air traffic control officer (ATCO) or to other air traffic service unit staff (ATSU) such as Aerodrome Flight Information Officers (AFISOs) or air-ground radio operators (A/G).

2.1.2 Farnborough Airport has ATC[1]. ATC provides a radar control service to all aircraft inside its defined airspace volumes; this means ATC instructions must be followed.

2.1.3 Outside CAS, Farnborough ATC also provides a Lower Airspace Radar Service (LARS) in the region. This is for the free use of any radio equipped aircraft wishing to receive a service while flying through the area, it is purely optional. A lot of flights in the area do not contact ATC, but a lot do, and request a service from ATC.

2.1.4 The scope of this document is not to detail the various types of service and their requirements; it is to provide sufficient understanding that the subsequent images have adequate context. In order to avoid excess technical detail for the lay reader, this document will simplify and make very broad statements on flying, ATC, CAS and air traffic services (ATS).

2.1.5 It is useful for the reader to understand that one Farnborough ATCO can be controlling aircraft inside CAS, another can be providing a service to participating aircraft outside CAS, and there will be aircraft outside CAS not known to ATC, some of which may be almost invisible on radar. Sometimes a participating aircraft outside

[1] As does RAF Odiham

CAS wishes to cross CAS; most of the time this will be rapidly coordinated between the two ATCOs, the aircraft is cleared to enter and becomes subject to mandatory ATC instructions rather than their own decisions. Upon leaving CAS their autonomy returns and they may fly where they will. In the Farnborough region this is a typical experience of locally based powered GA aircraft, i.e. light aircraft with an engine that allows them to maintain altitude.

2.1.6 Another typical experience may be for a pilot to simply inform ATC of their intentions as they pass through the region, outside CAS, until they leave the area. Others may fly through the area without contacting ATC at all.

2.1.7 Powered GA aircraft are capable of flying at many thousands of feet but most fly at low altitudes, generally below 3,000ft especially in the Farnborough region which is between Heathrow and Gatwick; the airspace must support all the London airports. This is partly to do with CAS in general, but it is also true that GA pilots tend to fly around that altitude even when there is no CAS to affect their navigation decision-making.

2.1.8 Gliders, by their nature, do not have an engine; height is their ‘fuel’ and they constantly strive to gain height where possible; the moment they are not climbing, they are descending. It is difficult for gliders to accurately maintain a specific height. Gliders tend to avoid CAS because, very generally, flying in CAS in accordance with a clearance tends to dictate a predictable path at a stable altitude. Glider pilots hunt for lift, varying their path and altitude all the time, trading height for speed, and this can make adhering to an ATC clearance difficult. Gliders are also not often equipped with suitable radios. Gliders are capable of great altitudes; some are equipped with oxygen to allow flight above 10,000ft, however as per powered GA most gliders in the Farnborough region fly lower.

2.2 What is Farnborough’s CAS?

2.2.1 This chart illustrates the region, showing the reference numbers of each CAS volume.

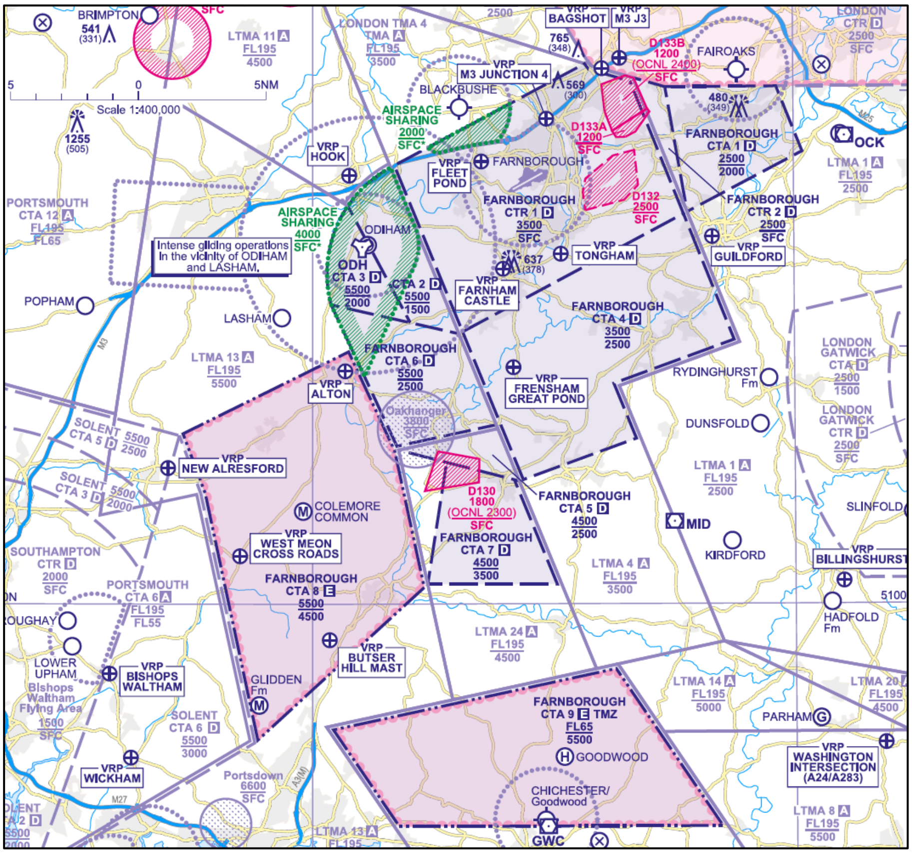

Figure 1 Farnborough's CAS is highlighted, CAS of adjacent airports is shown faded. Higher CAS is ‘owned’ by the control centre. All other airspace beneath is outside CAS.

2.2.2 Each CAS volume is defined laterally and vertically and there are two general types.

A control area CTA 'floats'; it starts at a defined altitude above the ground and has a defined ceiling, for example CTA7 starts at 3,500ft and ends at 4,500ft. Above that is LTMA24 which is restricted to faster and more complex aircraft, it starts at 4,500ft and extends to 19,500ft. However, beneath CTA7 there is no CAS so aircraft may fly there as they wish, as long as they do not climb above 3,500ft. The same applies to any CAS volume that starts above the ground; GA and gliders can fly beneath autonomously and without contacting anyone.
Farnborough has 7 of these CTAs, numbered 1-7.

A control zone CTR starts at the surface and extends to a defined ceiling, for example CTR1 is defined from the ground to 3,500ft; above that is LTMA4 that starts at 3,500ft and extends to 19,500ft. This protects the airport because aircraft near the airport must have been given permission to be there, and their intentions are known to the ATCO. Farnborough has two volumes of CTR, 1 and 2, which are contiguous.

For CTAs 1-7 and CTR1 and 2, aircraft with a radio can request to cross, and the ATCO will usually provide a clearance to do so.

There is a third type of CAS where suitably equipped GA aircraft and gliders may operate autonomously without a radio and without contacting anyone, but aircraft flying with reference to instruments (known as IFR) require a clearance. These are designated CTA8 and CTA9 and are highlighted in pale pink in the chart above.

Before the ACP, Farnborough's CTRs and CTAs did not exist, the chart would only show Heathrow, Southampton and Gatwick airspace, and the more restricted LTMA volumes.

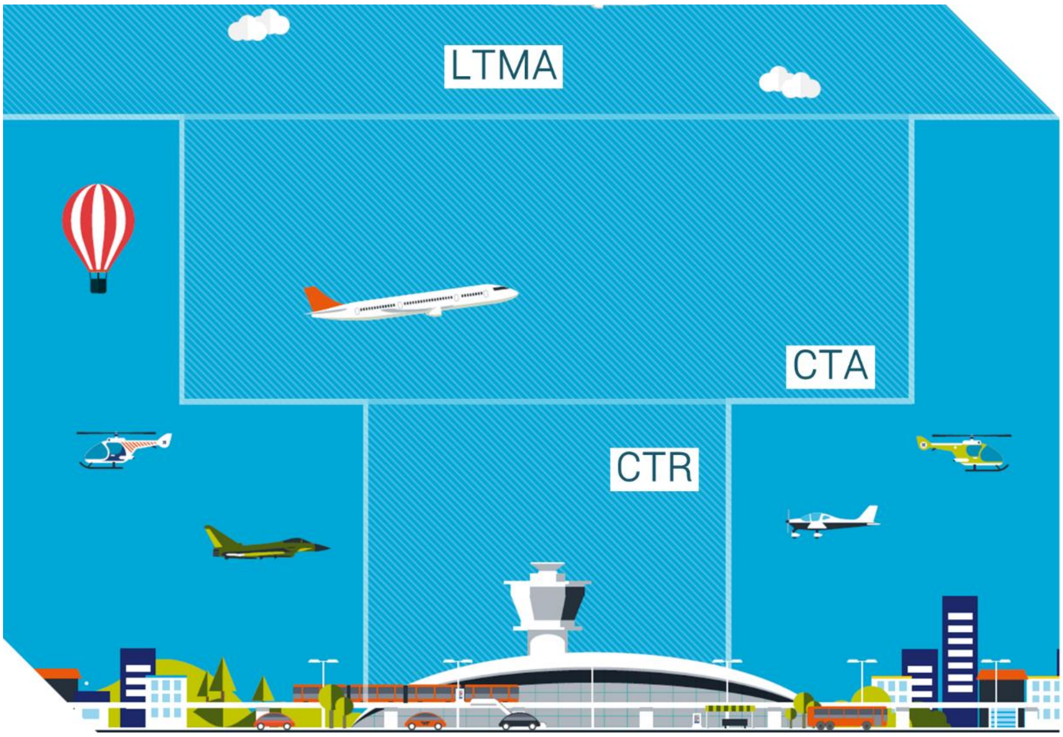

Figure 2 Side view of simplified generic CTR, CTA, LTMAS

2.3 What data samples were used?

2.3.1 There are two types of radar data available, known as Primary and Secondary. For this study only Secondary data is useful because it also contains altitude information and can show if the aircraft was talking to which ATC; it requires an aircraft to carry a radar transmitter/responder called a transponder. However, this means that not every aircraft can be shown; those aircraft that are Primary only, without Secondary equipage, cannot be studied.

2.3.2 Most gliders are typically Primary only, so it is much harder to study them using radar data. However, most gliders carry navigation loggers that work in 3D. With the kind assistance of, and permission from, Lasham Gliding Society we have acquired logged data from their 'FLARM[2]' system. This gives us enough position and height information for us to be able to make a study. Note that several gliders are also equipped with Secondary and it is likely they will be visible in the radar data. Therefore it is possible that the same glider flights might be present in both radar and FLARM; we have not attempted to account for that and the data is presented with potential duplicates.

2.3.3 In consultation with LGS we chose to compare June 2019 and August 2022 for GA and for glider FLARM; this is consistent with the flight density and overflight analysis carried out in Annex A for our commercial flights. Both these months had a mix of easterly and westerly winds, which cause different runways to be used in the region, thereby ensuring a breadth of different traffic scenarios are covered within the same samples.

2.3.4 Also note that August 2022 was a month of good weather in the summer holiday period during which GA are more likely to fly.

2.3.5 Finally Southdown Gliding Club requested information on a region they called 'The Parham Box' surrounding CTA7, to see Farnborough traffic's use of the box post-ACP. We will provide images using August 2022 radar data for Farnborough traffic.

2.4 What will we show?

2.4.1 For the GA radar heat data we will explain how the images are 'built' and then each combined image will be shown as a heat map, with different vertical 'slices', before and after the airspace was introduced. This will show where GA flew most frequently based on the 'heat' of how many spots overlaid each other. Note that these data are simply 500m x 500m spots in 3D according to time and in altitude bands, they are not fully tracked flights end to end.

2.4.2 We will do a similar heat map for the glider FLARM data; again the same caveat applies that the analysis will be by 3D spot, in this case 250m x 250m.

3 Heat Maps: Mainly Powered GA

3.1 How were the heat maps built?

3.1.1 We used Secondary data to identify, where possible, flights who were likely to be in contact with Farnborough ATC close to the airport, flights who were likely to be in contact with Farnborough ATC away from the airport and/or RAF Odiham, and flights unlikely to be receiving a service.

3.1.2 We combined the data with wireframe CAS maps, for before and after the ACP. We included other structures such as local aerodromes, navigational beacons, military danger areas and restricted areas to mimic the bare outlines of Figure 1 on page 4 above.

3.1.3 In the construction heat plots below, the annotations are:

'LF Service' means aircraft were likely to be receiving positive control from Farnborough ATC near the airport

'Other Service' means aircraft were likely to be receiving a LARS (from Farnborough) or other ATS in the region

'General' means these aircraft were not likely to be in contact with an ATSU.

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[2] FLARM is a portmanteau word, conflating Flight Alarm. It is typically used to provide an alert if a glider comes into proximity with another glider fitted with the same system, and also acts as a navigation log of position and height information.

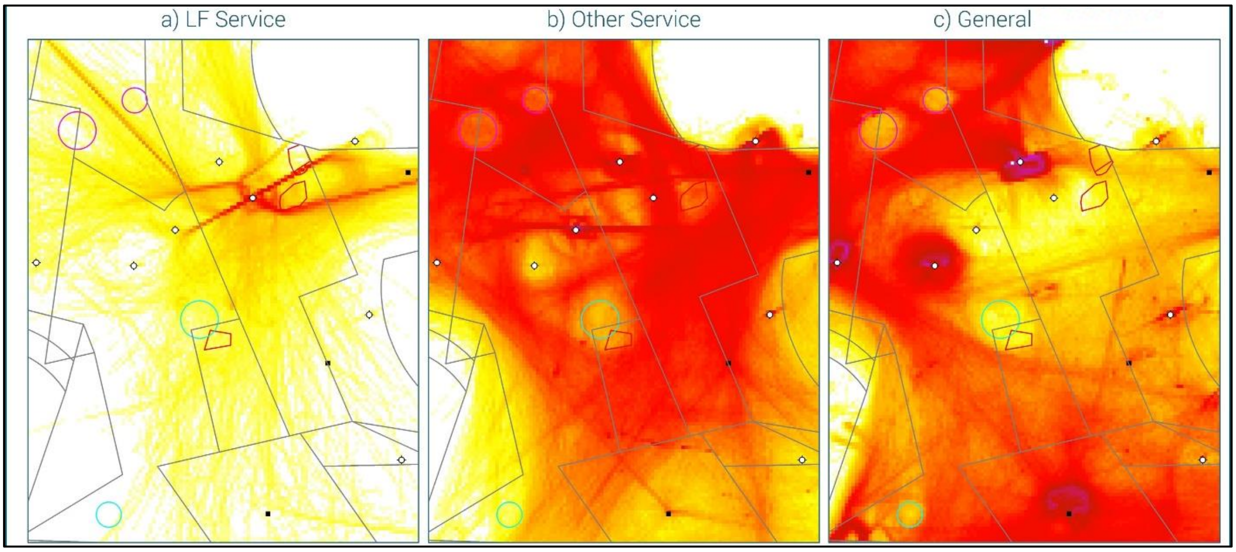
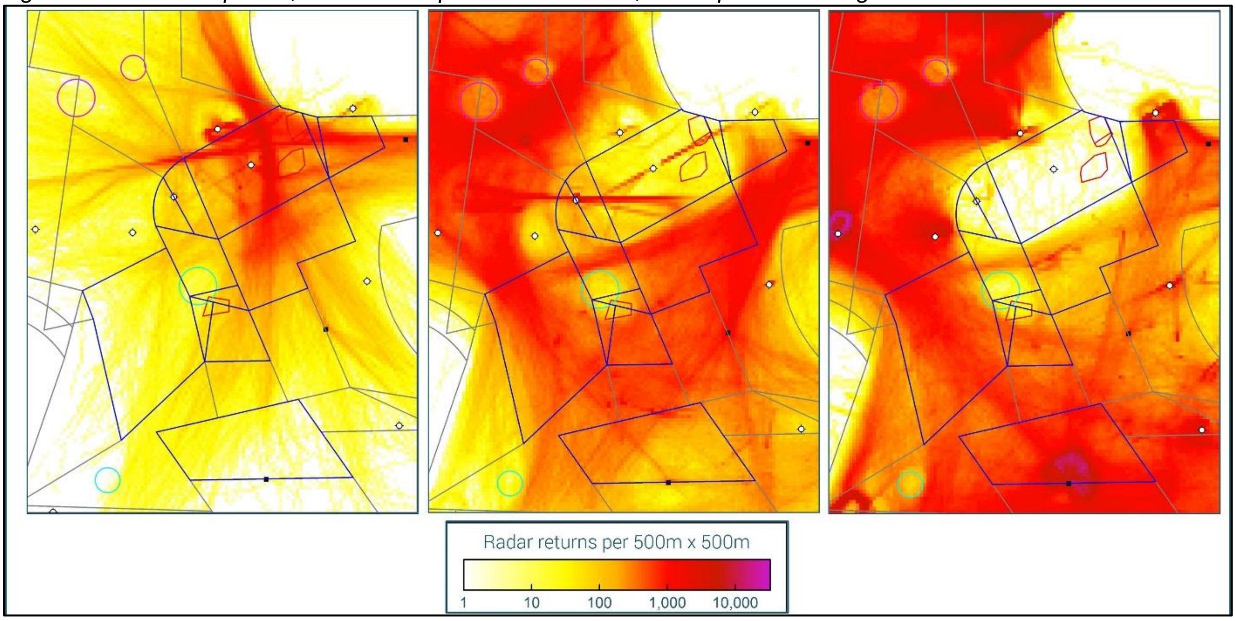


Figure 3 GA heat maps 0-7,000ft: Above pre ACP Jun 2019, below post-ACP Aug 2022



3.1.4 Note the Radar Returns colour key indicates the number of spots in a height band covering the same place, it is a measure of overflight density (heat). The density key is here for reference but will not be placed on the remaining images.

3.1.5 The LF Service post-ACP appears much ‘busier’ than the pre-ACP equivalent; with the Other Service reduced compared with pre-ACP. This is because the ATC arrangements (which flights get which type of service) have changed. It is clear that ‘adding’ the respective LF Service plot to the Other Service plot shows that the sum of the two arrangements is about the same, i.e. the combining the two left-plots illustrate aircraft likely to be receiving a service of some type.

3.1.6 The following heat maps combine all three into a single heat map. The left map is annotated with aerodromes and significant places, the right map has CAS boundaries and abbreviated vertical extents.

3.2 Powered GA Data Plots: Overview 0-7,000ft

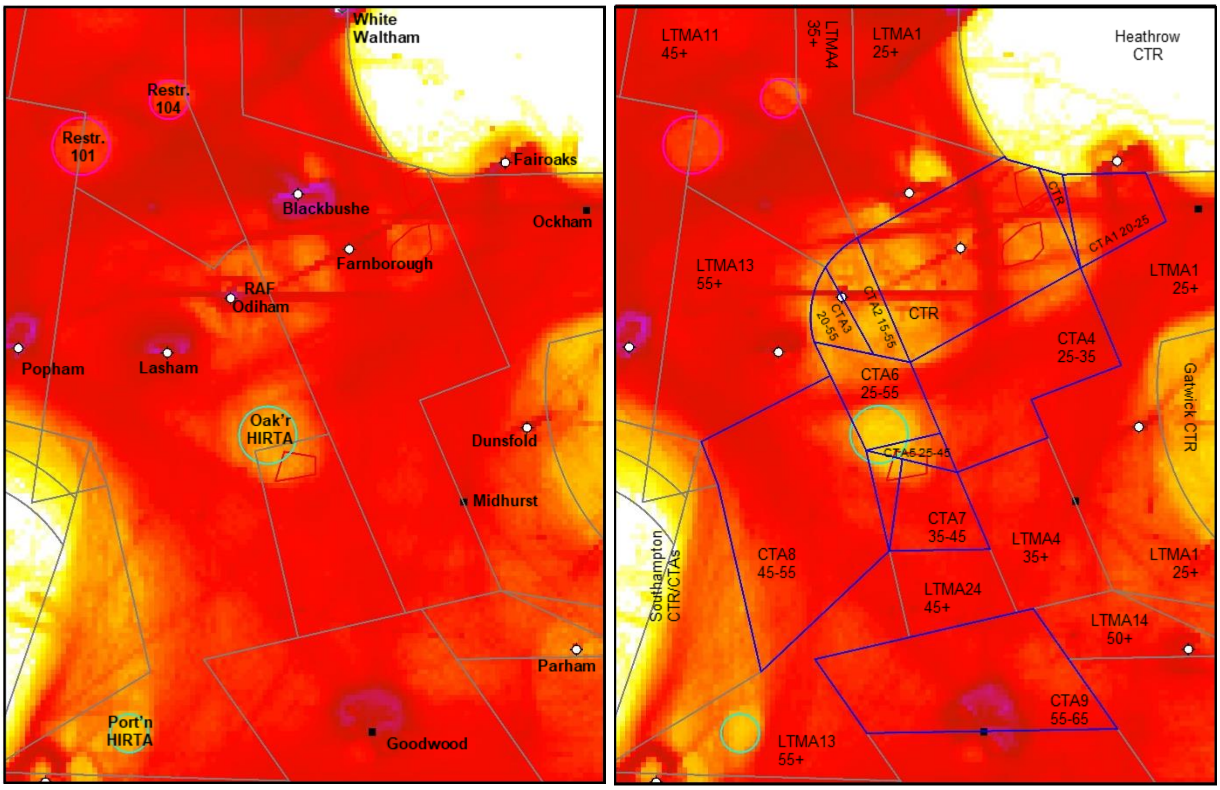


Figure 4 GA heat maps to 7,000ft (L) Pre ACP (R) ACP

3.2.1 The pre-ACP plot shows the densest regions surround the aerodromes as expected, with gaps around the restricted areas (pink circles to the north) and the High Intensity Radio Transmission Areas (HIRTAs) shown as green circles to the south and southwest. There is a north-south stripe overhead Farnborough.

3.2.2 The Heathrow, Southampton and Gatwick CTRs are practically empty or have a very low density, both pre- and post-ACP.

3.2.3 In both plots there is a C-shaped dark red density with White Waltham at the northeast of the C (right at the top of the image on the Heathrow CAS boundary), Popham at the centre (at the eastern edge of the image), and southeast of Popham the dark red density spreads towards Goodwood (black square to the south of the image).

3.2.4 In both plots there is a dark red area from Lasham, north of the Oakhanger HIRTA, to the east/northeast slightly south of Ockham (black square to the north-eastern edge of the image south of the Heathrow CTR). Post-ACP that region is more visible as it roughly aligns with the southern Farnborough CTR boundary.

3.2.5 Post-ACP there is a lower density visible between Farnborough and RAF Odiham. The north-south oriented stripe over Farnborough pre-ACP has somewhat resolved into a narrower denser stripe to the east, with another less dense stripe to the west, and some infill.

3.2.6 Data note re Blackbushe: A data collection error meant the Blackbushe 7010 code for circuit traffic was unintentionally excluded. The Pre-ACP images show intense circuit activity at the lowest altitudes. The Post-ACP images show Blackbushe circuit as very light, whereas in fact the purple traffic intensity of the pre-ACP plots would continue in a similar way. The Blackbushe operation itself continues similar to pre-ACP. We apologise for this data presentation issue, the rendering of the heat plots is a significant task and the error came to light too late to replace them before publication.

3.3 Powered GA Data Plots: 0-2,000ft

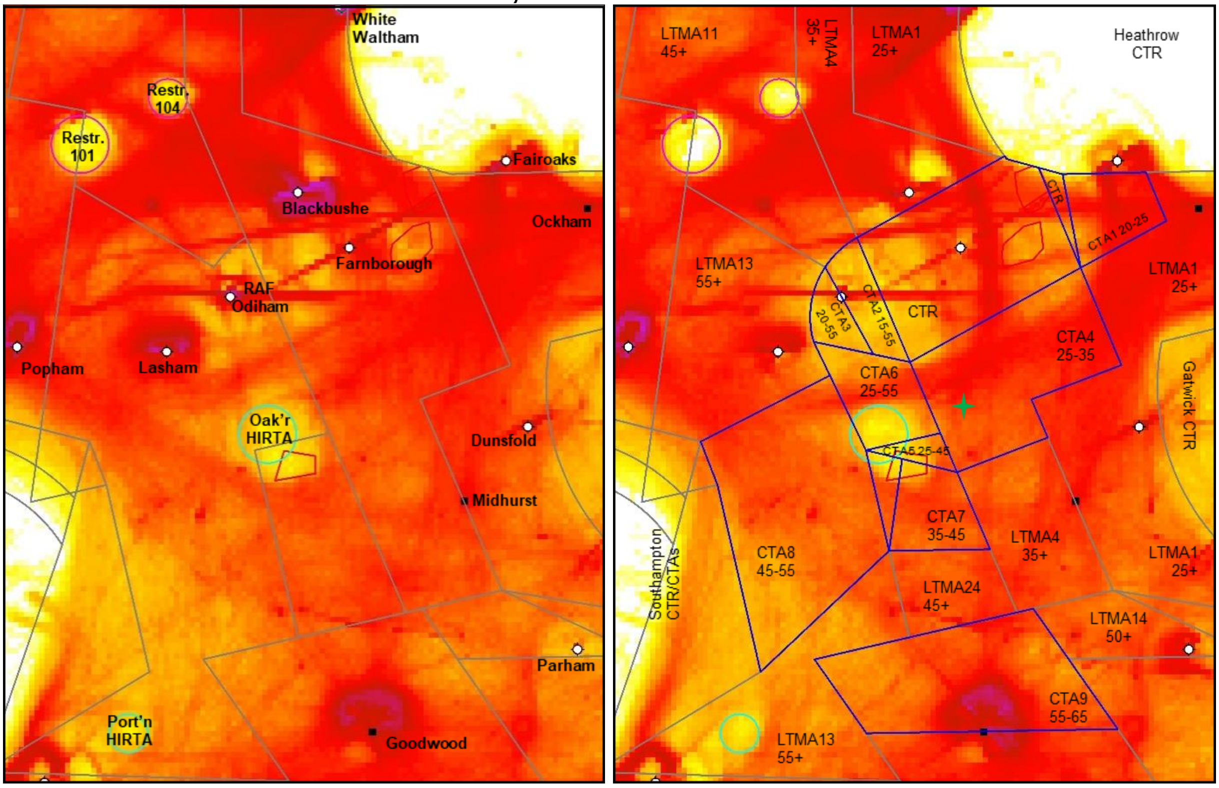


Figure 5 GA heat maps 0-2,000ft (L) Pre ACP (R) Post ACP

3.3.1 Relevant Farnborough CAS vols: CTR1, CTR2, CTA2, CTA3.

3.3.2 The pre-ACP plot still shows the densest regions surround the aerodromes as expected due to the 0-2,000ft band, with gaps around the restricted areas and the HIRTAs. The Heathrow, Southampton and Gatwick CTRs are practically empty or have a very low density, both pre- and post-ACP.

3.3.3 Post-ACP rather than the Farnborough CTR being near-empty (white) similar to Heathrow, Southampton and Gatwick, there is clear GA use of the Farnborough CTR. There is a slightly lower density visible between Farnborough and RAF Odiham; this would be expected. The north-south oriented stripe over Farnborough pre-ACP has somewhat resolved into a narrower denser stripe to the east, with another less dense stripe to the west, and some infill. The stripe to the east is likely to be either transiting GA traffic under Farnborough ATC control being kept to the east of the Runway 24 threshold; conversely the lesser stripe to the west may be transits being kept to the west of the Runway 06 threshold, or Blackbushe departures/arrivals cleared through the CTR south to north or north to south. This is more pronounced than pre-ACP.

3.3.4 Activity immediately around Lasham appears less dense post-ACP based on this data, please see the equivalent FLARM data later in this document. CTA3/CTA6 are likely to be a factor. The Blackbushe density would be comparable to pre-ACP, see data-error paragraph 3.2.6 on page 8.

3.3.5 In both plots there is a C-shaped dark red density with White Waltham at the northeast of the C, Popham at the centre, and southeast of Popham the dark red density spreads towards Goodwood. This is similar pre and post ACP; in the area south of a line from Oakhanger HIRTA to Dunsfold there appears minimal difference. There appears to be a slight density increase around Parham; it is not clear why this would be a result of the ACP. More likely this is similar traffic flying for longer than in the June dataset.

3.3.6 In both plots there is a dark red area from Lasham, north of the Oakhanger HIRTA, to the east/northeast slightly south of Ockham. Post-ACP that region is more visible as it roughly aligns with the southern Farnborough CTR boundary. Traffic between Fairoaks, Ockham, Gatwick CTR and the south seems similar pre and post-ACP.

3.4 Powered GA Data Plots: 2,000-2,500ft

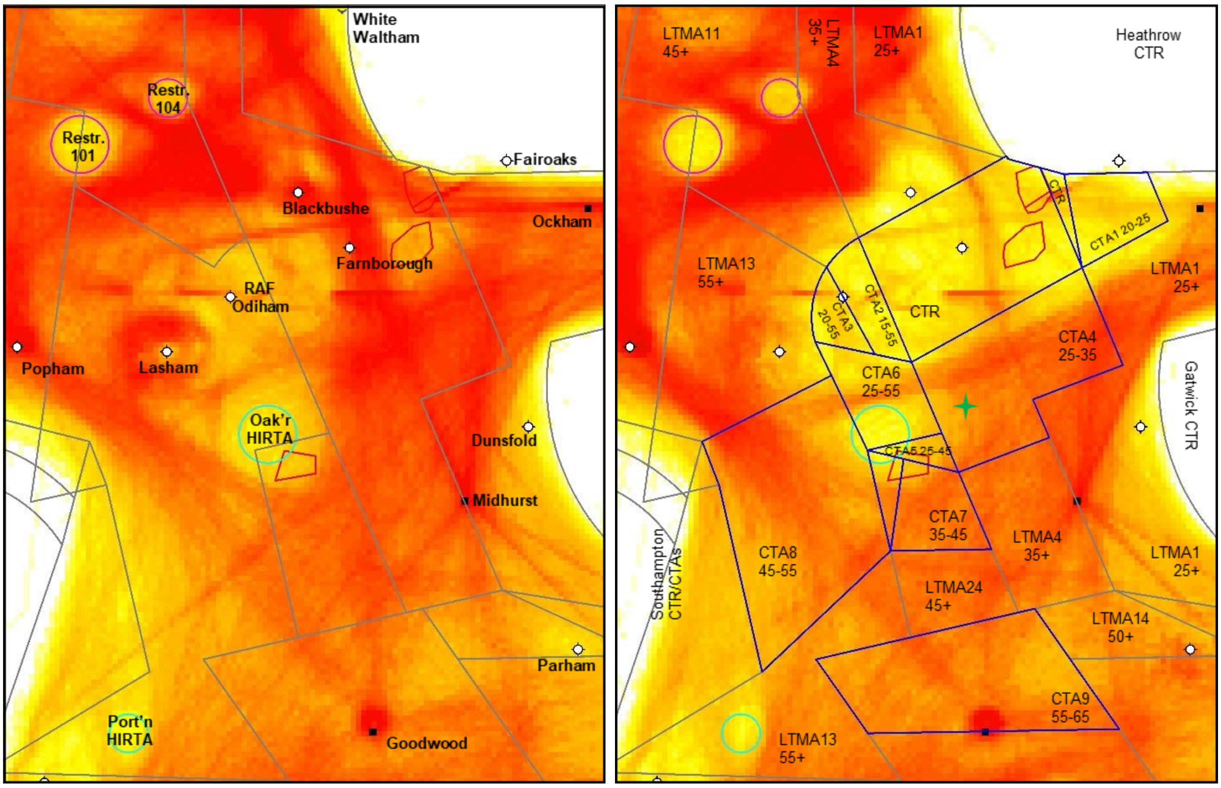


Figure 6 GA heat maps 2,000-2,500ft (L) Pre ACP (R) Post ACP

3.4.1 Relevant Farnborough CAS vols: CTR1, CTR2, CTA1, CTA2, CTA3, CTA4, CTA5, CTA6.

3.4.2 The pre-ACP plot still shows the densest regions surround the aerodromes as expected, with gaps around the restricted areas and the HIRTAs. The Heathrow, Southampton and Gatwick CTRs are empty (almost completely white) both pre- and post-ACP at this altitude band. As per the previous 0-2,000ft altitude band above, rather than the Farnborough CTR being empty, there is a clear GA use albeit lesser than the lower band. The north-south oriented stripe over Farnborough pre-ACP has thinned to the east post-ACP.

3.4.3 Activity east of Lasham appears less dense post-ACP based on this data, please see the equivalent FLARM data later in this document. CTA3/CTA6 are likely to be a factor. The Blackbushe density would be comparable to pre-ACP, see data-error paragraph 3.2.6 on page 8, and it is apparent where the 'missing' Blackbushe traffic to/from the northwest change their code because we can infer that the missing data 'reappears'.

3.4.4 North of a line through Popham-Blackbushe-Heathrow there is no significant difference (considering the previous paragraph re missing Blackbushe data). From Popham southeast towards Goodwood there is a slight reddening of the stripe. From Ockham to Midhurst to Goodwood the density reduces post-ACP. From Ockham to the north of the Oakhanger HIRTA towards Southampton, the density decreases post-ACP and the stripe moves slightly south away from the Farnborough CTR boundary.

3.4.5 The southern half of the images from Midhurst are similar; the post-ACP image could be considered slightly less dense at this altitude band.

3.5 Powered GA Data Plots: 2,500-3,500ft

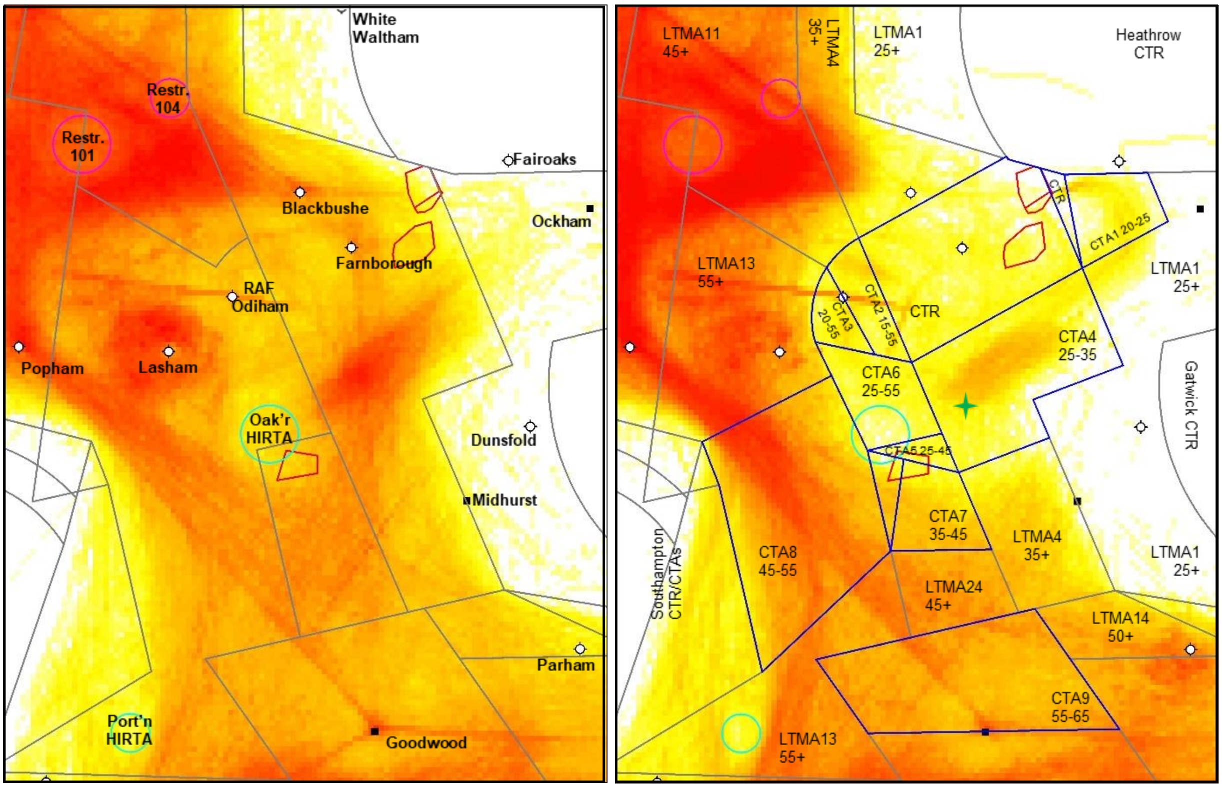


Figure 7 GA heat maps 2,500-3,500ft (L) Pre ACP (R) Post ACP

3.5.1 Relevant Farnborough CAS vols: CTR1, CTR2, CTA1, CTA2, CTA3, CTA4, CTA5, CTA6, CTA7.

3.5.2 In this altitude band the aerodrome traffic is present but less dense, as is logical. The restricted areas are being infilled because they can be fully overflown in this band. The Oakhanger HIRTA appears to be overflown more frequently pre-ACP than post-ACP, possibly due to partially avoiding CTAs 5, 6 and 7. The Heathrow, Southampton and Gatwick CTRs are empty (almost completely white) both pre- and post-ACP at this altitude band. As per the previous altitude bands, rather than the Farnborough CTR being empty, there is a clear GA use such that the pre and post ACP densities are becoming more similar.

3.5.3 Activity east of Lasham appears less dense post-ACP based on this data, please see the equivalent FLARM data later in this document. CTA3/CTA6 are likely to be a factor. The Blackbushe density would be comparable to pre-ACP, see data-error paragraph 3.2.6 on page 8, and it is apparent where the 'missing' Blackbushe traffic to/from the northwest change their code because we can infer that the missing data 'reappears'.

3.5.4 At this band there are two main differences pre and post-ACP:

- The band between Popham, south of Lasham towards Goodwood is slightly denser, then near the Oakhanger HIRTA the spread becomes similar to pre-ACP.
- Due south of Farnborough the dense area present pre-ACP fades to a much cooler colour.

3.5.5 An additional minor difference is the slight increase in density over Parham in the data sample; this slight increase is also common to the lower altitude bands. It is not clear how this would relate to the ACP and just indicates an increase in traffic at this altitude band.

3.6 Powered GA Data Plots: 3,500-4,500ft

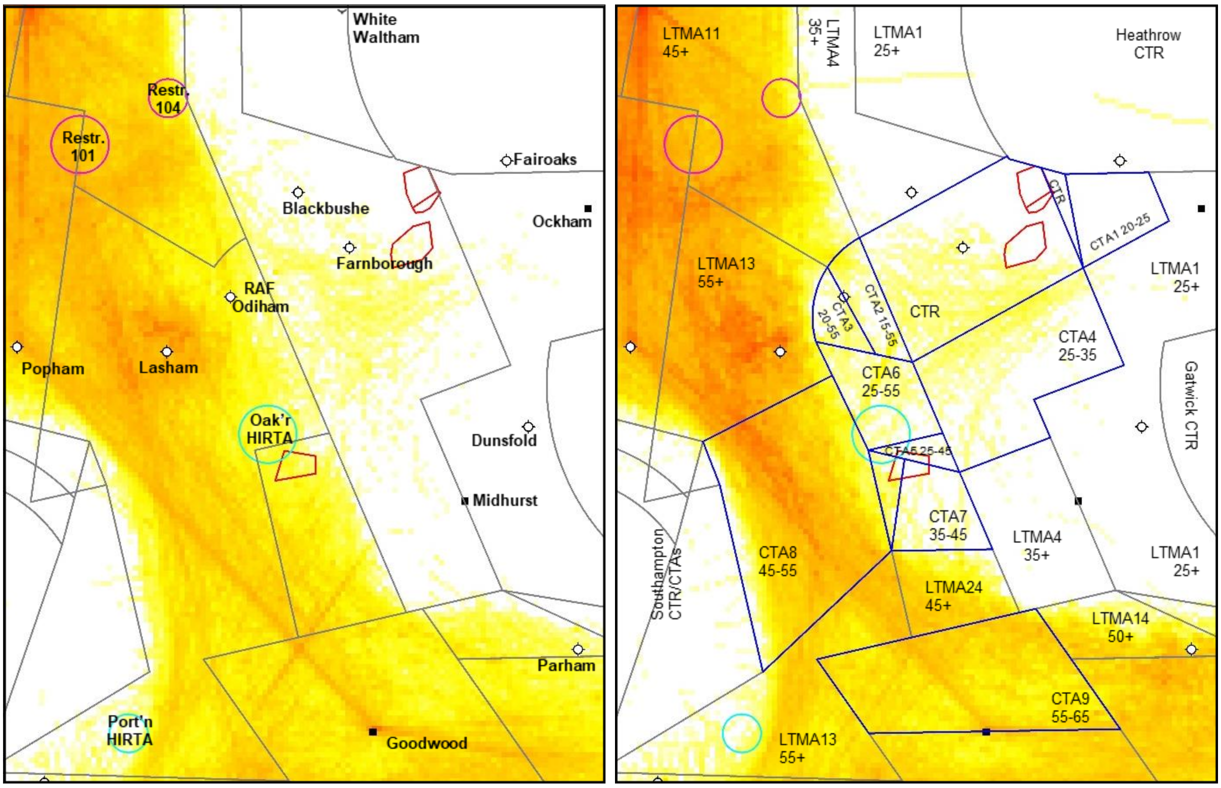


Figure 8 GA heat maps 3,500-4,500ft (L) Pre ACP (R) Post ACP

3.6.1 Relevant Farnborough CAS vols: CTR1, CTR2, CTA2, CTA3, CTA4, CTA5, CTA6, CTA7, CTA8.

3.6.2 In this altitude band, the restricted areas are no longer of interest. The Oakhanger HIRTA appears to be overflown more frequently pre-ACP than post-ACP, likely due to partially avoiding CTAs 5, 6 and 7 but also near the boundary of LTMA13 where the base is 1,000ft higher than the adjacent LTMA24.

3.6.3 The vicinity of the Farnborough CTRs is overflown similarly pre and post ACP; most of these flights would either be right at the bottom of this band at the top of CTR1, or would be transiting LTMA4 above which starts at 3,500ft.

3.6.4 Activity west of Lasham appears slightly denser post-ACP based on this data, please see the equivalent FLARM data later in this document.

3.6.5 Tracks between aerodromes are still discernible – for example, the Popham to Goodwood track is clear in both images.

3.6.6 At this band there is an additional statement we can make: The impact of 'moving' the small amount of traffic from the areas newly covered by CTAs 3, 5, 6 and 7 to the west would not in itself cause the increase in warmth shown.

The whole main region is therefore 'warmer', i.e. it has more data in general, there were more GA flights in this altitude band overall compared with the pre-ACP data. That general increase in flying in this altitude band is unlikely to be caused by the ACP.

3.7 Powered GA Data Plots: 4,500-5,500ft

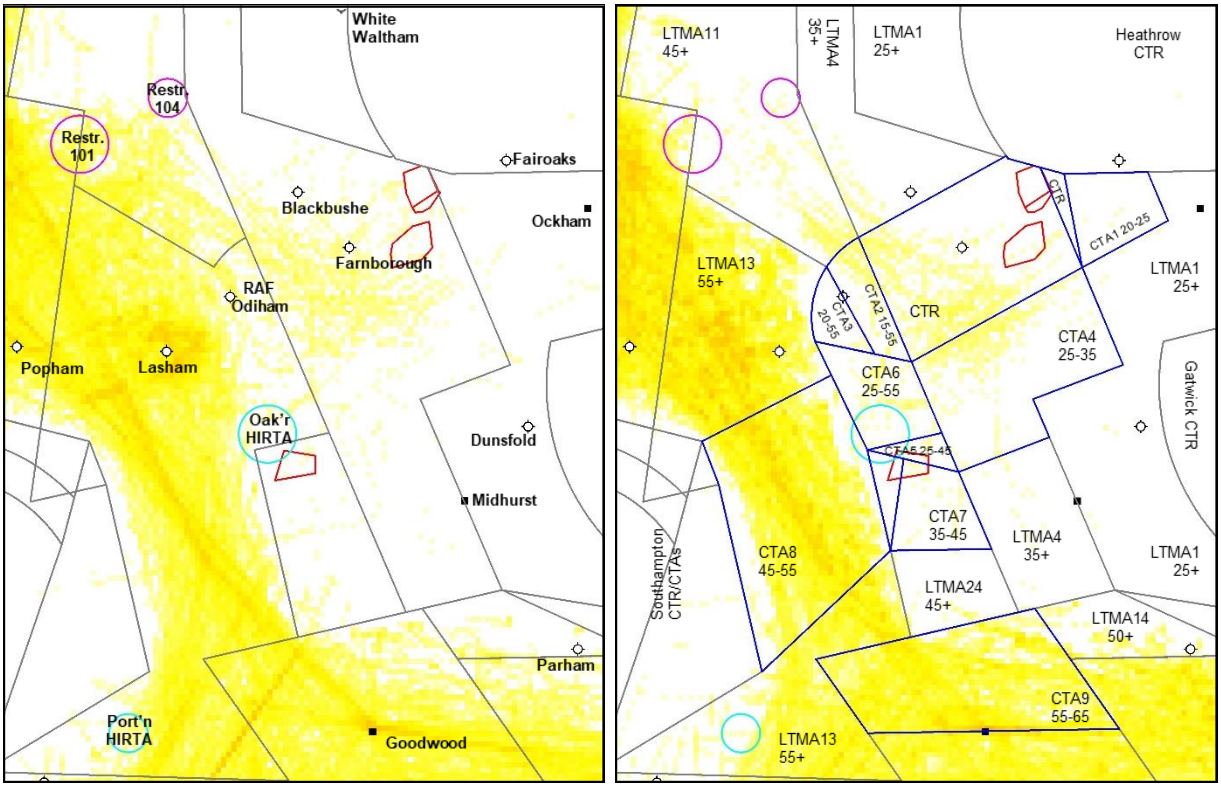


Figure 9 GA heat maps 4,500-5,500ft (L) Pre ACP (R) Post ACP

3.7.1 Relevant Farnborough CAS vols: CTA2, CTA3, CTA5, CTA6, CTA7, CTA8, CTA9.

3.7.2 There is little difference between the locations overflown. The overall heat difference between the images is due to the greater quantity of GA flying at this altitude band in August 2022.

3.7.3 There is a very slight difference in the small wedge shaped region of LTMA11 south of the two restricted areas and north of RAF Odiham, where there are fewer flights post-ACP. Many seem to stop at the southern edge of LTMA11 but there seems no reason for the ACP to have caused this.

3.8 Powered GA Data Plots: 5,500-7,000ft

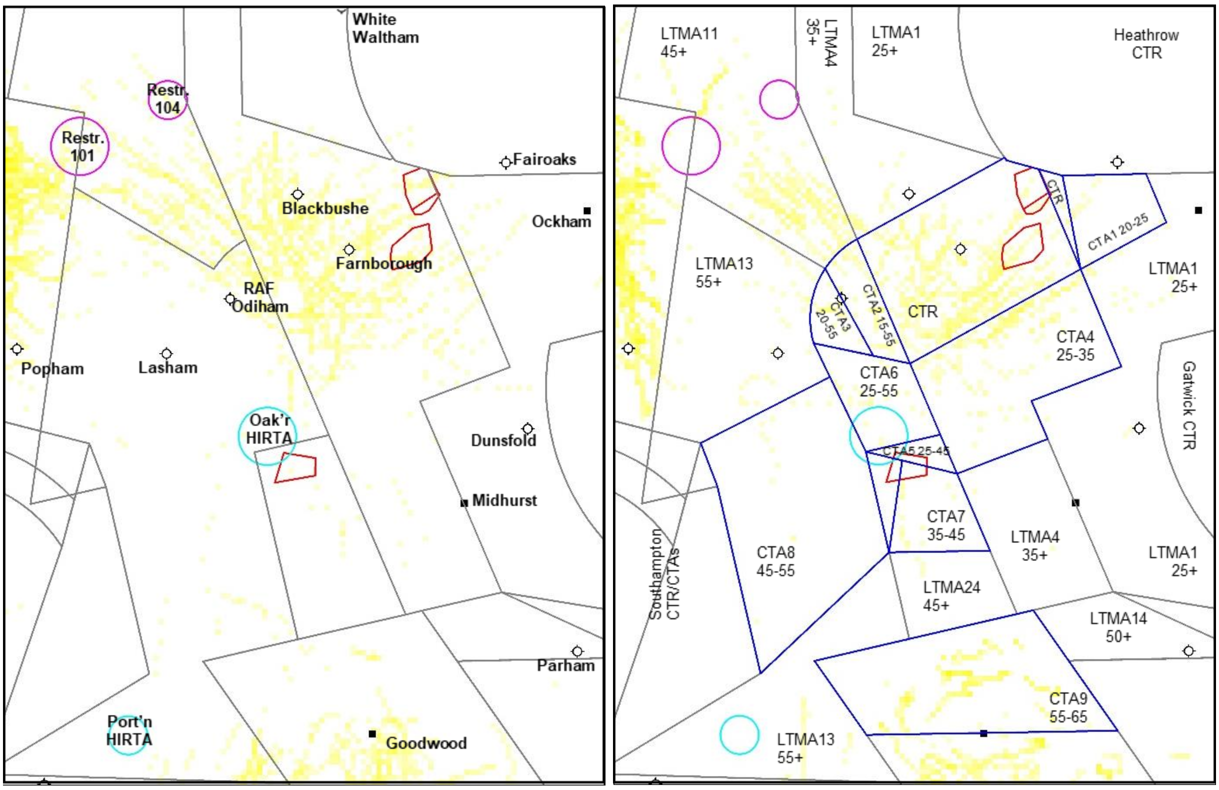


Figure 10 GA heat maps 4,500-5,500ft (L) Pre ACP (R) Post ACP

3.8.1 Relevant Farnborough CAS vols: CTA2, CTA3, CTA6, CTA8, CTA9.

3.8.2 There is little difference between the locations overflown in this altitude band.

3.9 Powered GA Heat Map Conclusions

3.9.1 Most areas of density are more similar (pre-ACP and post-ACP) than they are different. The heat maps do not show evidence of new high-density funnelling regions predicted by some stakeholders. Similar densities exist, pre and post-ACP, along commonly flown tracks between aerodromes and navigation aids.

3.9.2 The introduction of the CTR means all flights at all altitudes must request a clearance or avoid the volume. It is logical that this would cause some redistribution around the outside, however the data does not show a pronounced difference.

3.9.3 As a consequence the CTR is less dense than pre-ACP, this is also logical. However, the comparison of the Farnborough CTR with Heathrow, Southampton and Gatwick's is clear at all relevant altitudes – Farnborough's CTR is the same as the other airports', but GA aircraft are much more frequently cleared to transit through.

3.9.4 As the altitude bands increase, the differences diminish further, especially above 3,500ft. However there is evidence to suggest some flights moved into a slightly higher altitude band, as the general region-wide density post-ACP at higher altitudes appears to be slightly greater than the pre-ACP equivalent.

3.9.5 There is some evidence of the Farnborough CAS boundaries contributing in a limited way to GA redistribution at lower altitudes:

- Along the southern edge of CTR1, the red stripe running approximately east-west shifted slightly south compared with the pre-ACP equivalent.
- Traffic east of Lasham towards RAF Odiham has reduced; CTA3/CTA6 are likely to be a factor. However it is not clear that there has been a corresponding increase in density to the west or elsewhere nearby, as the heat colours are similar and do not provide a clear indication of a density change.

3.10 Powered GA overflight and the village of Churt

3.10.1 Churt is a village in Surrey with a GU10 postcode. Since the ACP was introduced, most noise complaints originate in GU10 (see Annex D Stakeholder Feedback and Complaints). Noise alleged to be from GA aircraft, flying lower more frequently due to the lowered CAS base, has been cited as a reason for complaint.

3.10.2 Before the ACP, the airspace over Churt started at 3,500ft, meaning that GA aircraft not wishing to fly in CAS could fly at that maximum altitude. As noted in paragraph 2.1.7 on page 4, most GA fly at low altitudes, generally below 3,000ft.

3.10.3 Figure 5, Figure 6 and Figure 7 on pages 9, 10 and 11 illustrate GA heat maps for the altitude bands 0-2,000ft, 2,000-2,500ft and 2,500-3,500ft respectively.

3.10.4 Each of these heat maps is marked with a small green four-sided star like this: This marks the village of Churt. The following paragraphs concern the immediate vicinity of the green star.

3.10.5 In Figure 5 on page 9, 0-2,000ft, there is no noticeable difference in density between the pre-ACP and post-ACP GA heat maps indicating there was no increase or decrease in traffic at this altitude around Churt.

3.10.6 In Figure 6 on page 10, 2,000-2,500ft, there is a clear reduction in density between the pre-ACP and post-ACP GA heat maps, i.e. post-ACP the colour at Churt changed from red to orange meaning Churt was overflown less frequently by GA at this altitude.

3.10.7 In Figure 7 on page 11, 2,500-3,500ft, there is a clear reduction in density between the pre-ACP and post-ACP GA heat maps, i.e. post-ACP the colour at Churt changed from orange to yellow meaning Churt was overflown less frequently by GA at this altitude.

3.10.8 Based on this evidence, we conclude that GA aircraft fly either the much same, or actually less frequently, over Churt post-ACP.

4 Heat Maps: Gliders

4.1 How were the FLARM heat maps built?

4.1.1 As described in paragraph 2.3.2 on page 6, most gliders carry navigation loggers. We thank Lasham Gliding Society for the provision of anonymised data that our analysts have converted and plotted in a way similar to the heat maps built for the powered GA in section 3 above.

4.1.2 Note that June 2019’s data contained the data for c.1,500 glider flights. August 2022’s data contained c.2,400, which is 900 more flights.

4.1.3 In discussion with Lasham’s Chief Flying Instructor (CFI) and the data analyst, we agreed to reduce the number of August’s flights so that the dataset contained c.1,500 flights similar to June 2019.

4.1.4 Note also that August 2022 was a month of good weather during the school holidays, so most flights were of a longer distance and duration than those of June 2019.

This makes August’s FLARM data appear busier (‘warmer’) i.e. a greater heat density than June 2019 even with a similar number of flights, because the August 2022 flights were generally airborne for longer, producing more overlapping 3D spots.

4.2 Glider Data Plots: Overview

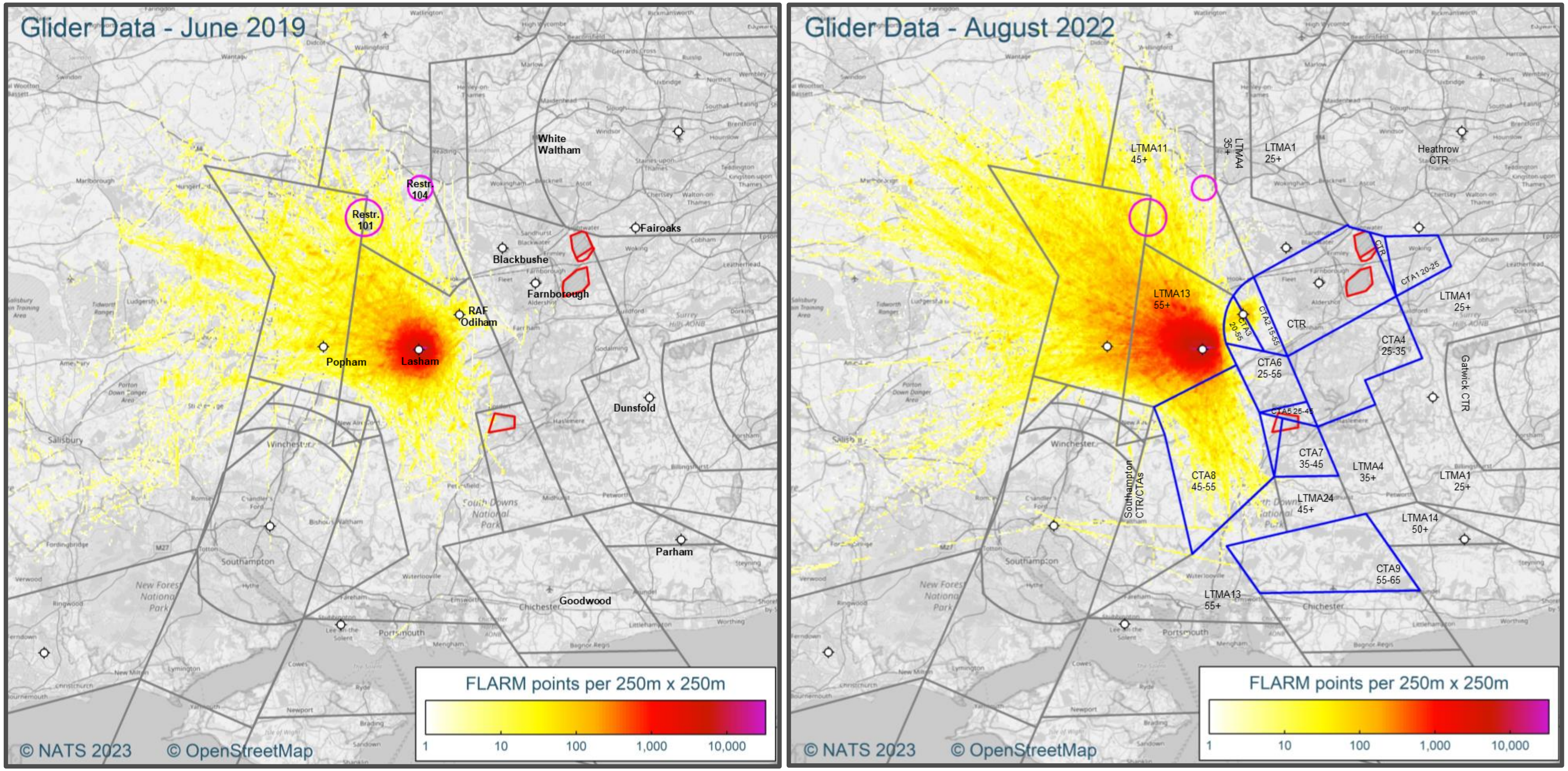


Figure 11 Glider FLARM heat maps (L) Pre ACP (R) Post ACP

4.2.1 Lasham aerodrome is the area of greatest density as expected. The post-ACP image indicates the densest region may have a slight skewing to the west, likely to prevent unintended entry into CTA2/3/6. Both pre and post-ACP, data extends to the east over RAF Odiham as arrangements are in place for gliders to operate there under certain conditions.

4.2.2 The main difference between these plots is that there are more data points in the post-ACP image, otherwise the patterns are similar.

4.3 Glider Data Plots: Zoomed to CTA2/3/6 region

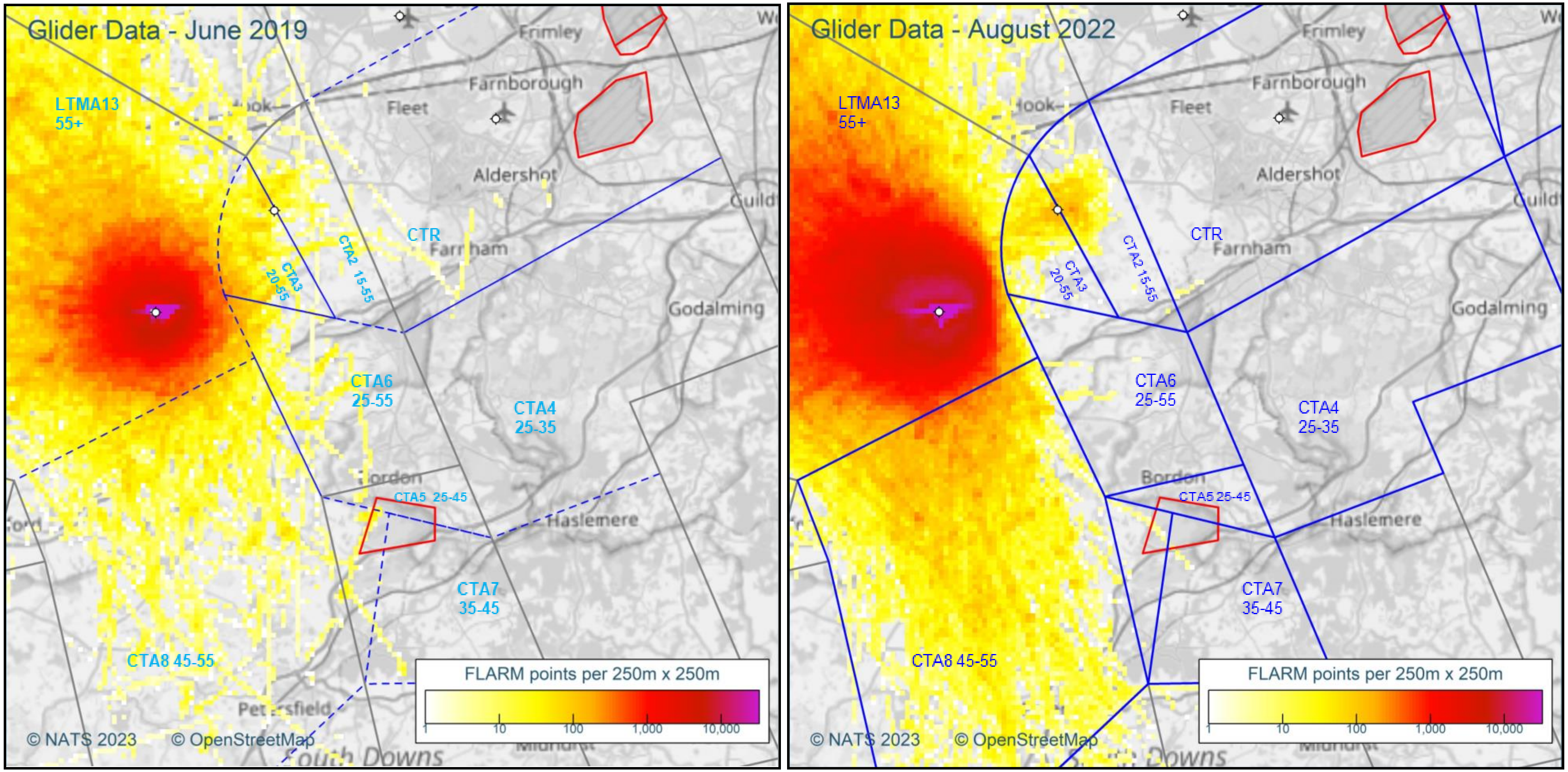


Figure 12 Glider FLARM heat maps (L) Pre ACP overlaid with dashed ACP CAS lines (R) Post ACP, both zoomed in

4.3.1 Pre-ACP there were a small number of plots, northwest of Bordon, where CTA6 would be. Post-ACP that small number has almost disappeared. The possible skewing of the densest area to the west is slightly more noticeable.

4.3.2 RAF Odiham has a plot density overhead, both pre- and post-ACP as described above.

4.3.3 The main difference between these plots is that there are more data points in the post-ACP image, otherwise the patterns are similar.

4.4 Glider Heat Map Conclusions

4.4.1 The heat maps were based on the two sample periods kindly provided by Lasham Gliding Society.

4.4.2 They do not show evidence of significant changes in Lasham glider behaviour, apart from a slight skewing of the densest regions slightly westwards to avoid the CAS boundaries east of Lasham.

4.4.3 The larger dataset of August 2022 ‘increases the temperature’ overall of the post-ACP heat map (each flight being longer), but the patterns themselves do not appear to be significantly different.

5 Parham Box

5.1 What is The Parham Box?

5.1.1 Southdown Gliding Club (SDGC) at Parham Aerodrome supplied Farnborough Airport with specifications for data presentation in what is known as the Parham Box.

5.1.2 Figure 13 shows the position of Farnborough CTA7 (yellow polygon, altitude 3,500ft-4,500ft), displayed relative to the Parham Box (red polygon, altitude 3,500ft-7,500ft).

5.1.3 A portion is also shown of the Standard Arrival Route (STAR) for Farnborough designated KATHY1V, ELDAX1V, and SOKDU1V (routing through the Parham Box and CTA7 via IBGON – LUXIV – EVATA – LFS03 – VEXUB).

5.1.4 These arrival procedures are associated with vertical constraints of 4,000ft at EVATA and 3,000ft at VEXUB.

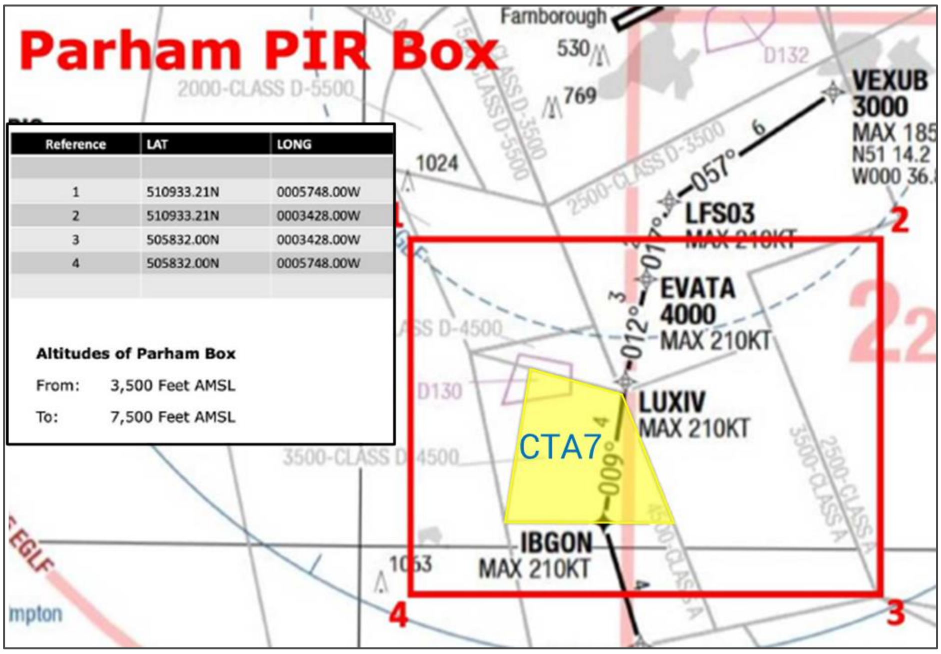


Figure 13 Farnborough CTA7 (yellow polygon, altitude 3,500ft-4,500ft) and the Parham box (red polygon 3,500ft-7,500ft).

5.1.5 SDGC also requested a side elevation, with track whiskers, of Farnborough arrivals through a view from the east looking west.

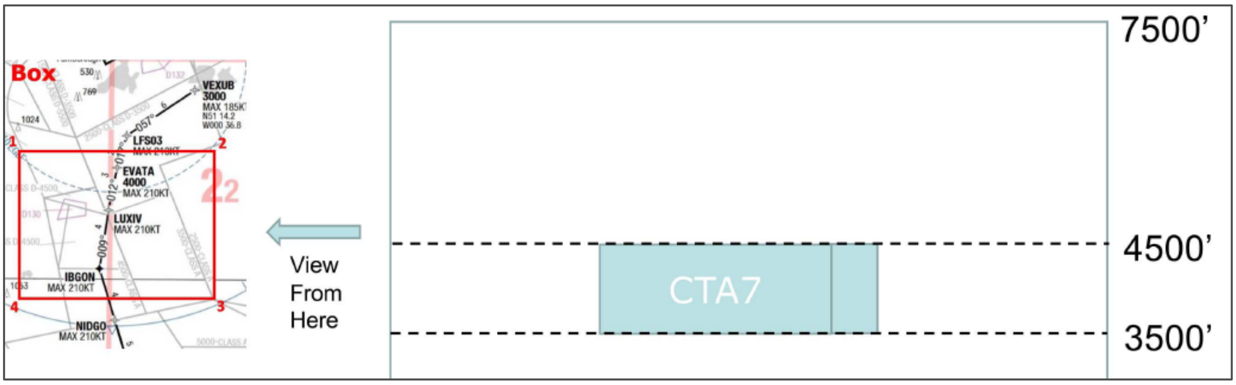


Figure 14 SDGC Side elevation request of CTA7

5.1.6 Utilisation of Farnborough CTA7 has been analysed using trajectory plots for the month of August 2022, see Figure 15 and Table 1 below. In Figure 15, flights are shown in green because the tool used to create this image does not reliably differentiate between arrivals and departures.

5.1.7 CTA7 is highlighted as a yellow polygon, and the trajectory calculation, results shown in Table 1, provides the number of flights crossing the northern CTA7 boundary (depicted by the blue line).

5.1.8 The number of flights is also provided for tracks crossing the 2nm CAS containment region to the south (depicted by the red line).

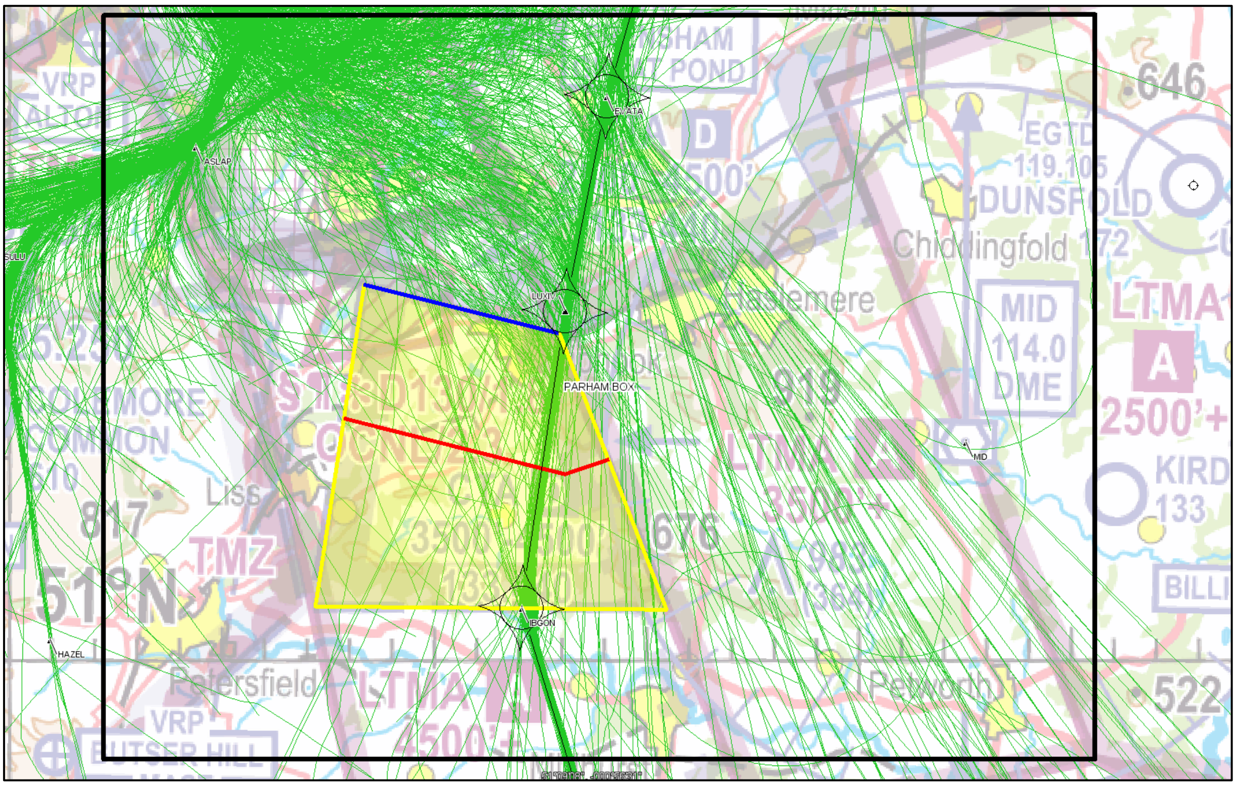


Figure 15 Using data from August 2022, plot of aircraft trajectories penetrating Farnborough CTA7

	Altitude	<= 3,500	3,500-4,000	4,000-4,499	4,500-4,999	5,000-5,499	5,500-5,999	>= 6,000	Total
No of Flights	Northern CTA7 CAS Boundary	0	4	34	28	13	1	61	**141**
	2nm south containment	0	0	9	108	215	153	166	**651**
Percentage of flights through both measurement lines		0%	0.51%	5.4%	17%	29%	19%	29%	100%

Table 1 Using data from August 2022, number of flights crossing the Northern CTA7 CAS boundary and the 2nm CAS containment region to the south [corrected from Issue 1.0].

5.1.9 Below are two diagrams using a different tool that illustrates the Parham Box in blue, first a 3D view then a side elevation view. In neither case is CTA7 visible but its general position can be inferred from Figure 13 and Figure 15 above.

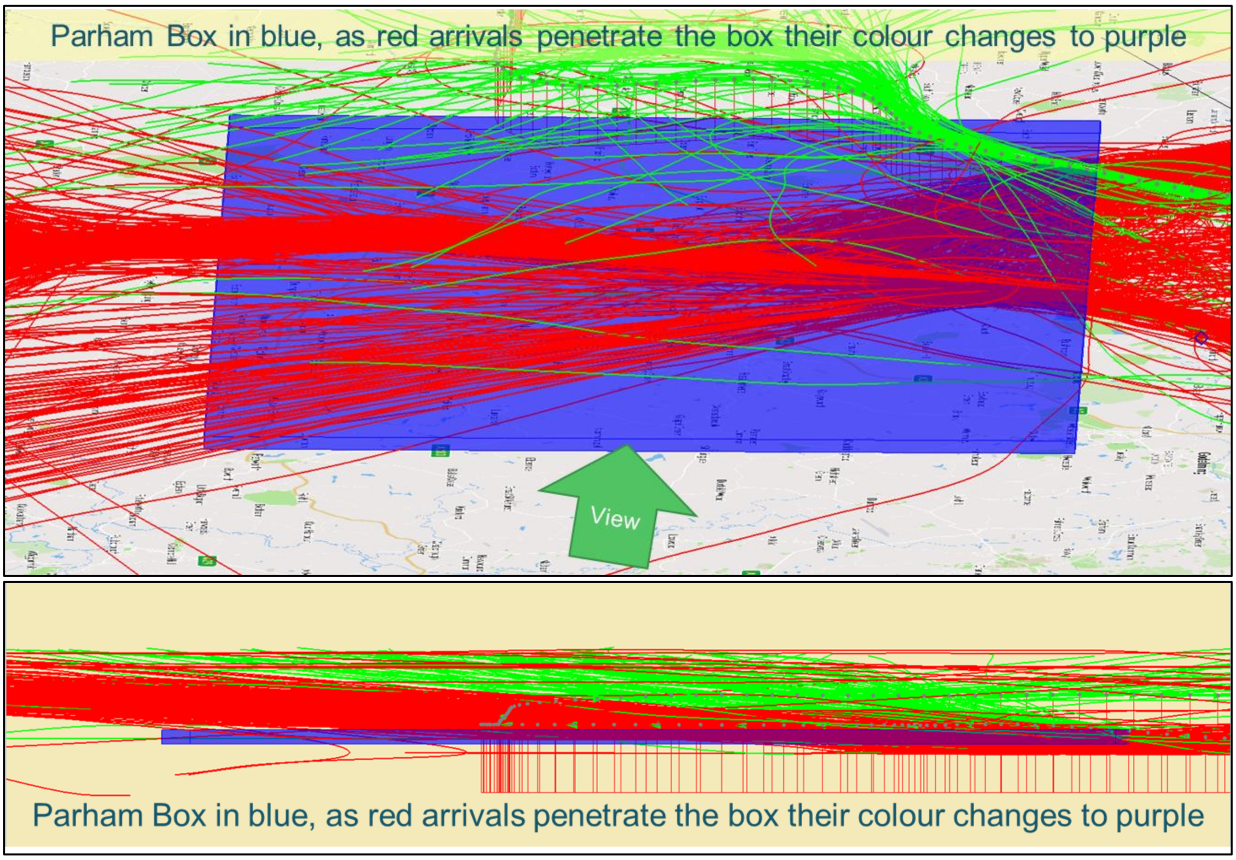


Figure 16 Response to SDGC's side elevation request, using a different tool

5.1.10 Note that the technical design criteria for Farnborough CTA7 is in alignment with the CAA's Policy for the Design of Controlled Airspace Structures [version 1 in force at the time of ACP] which describes the lateral and vertical relationship between instrument flight procedures and the dimensions of the controlled airspace that contains them. Specifically, section B4.4 which states:

B4.4	**RNAV 1 STARs and ATS Route Lateral Containment.**
B4.4.1	Specified nominal tracks designed to RNAV 1 (RNP 1) standard should be not less than 3 NM from the lateral limits of controlled airspace (which includes the RNAV 1 (RNP 1) standard of +/- 1 NM for 95% or more of the flight time[31]) unless new RNAV 1 procedures are established within existing CTAs where, under previous arrangements, the lateral limit is less than 3 NM from the centreline and a safety case supports the safe operation of such a route.

Figure 17 Extract from CAA Controlled Airspace Design Policy

5.1.11 Farnborough CTA7 has been designed to provide 2nm CAS containment for the aforementioned STARs routing through the Parham Box. 2nm containment has been used for other flight procedures in areas where we tried to reduce the CAS requirement. We did this by submitting safety documentation to mitigate the lateral containment from 3nm to 2nm; the CAA accepted this material and the airspace was approved for use with 2nm containment.

5.2 Parham Box Conclusion

5.2.1 The data analysed from August 2022 demonstrates that 5.5% of Farnborough arrival aircraft profiles cross CTA7 below 4,500ft in the descent to achieve the STAR vertical constraint of 4,000ft by EVATA.

5.2.2 Section 7 below provides additional context and data, describing how controllers use CTA7 to ensure containment when giving an instruction to descend. This captures 78% of arrivals from the south.

5.2.3 CTA7 is used, and is compliant with CAA airspace design policy including CAS containment requirements.

6 Summary of Heat Map Conclusions

6.1 Powered GA Heat Map Conclusions

6.1.1 Most areas of density are more similar (pre-ACP and post-ACP) than they are different. The heat maps do not show evidence of new high-density funnelling regions predicted by some stakeholders. Similar densities exist, pre and post-ACP, along commonly flown tracks between aerodromes and navigation aids.

6.2 Glider Heat Map Conclusions

6.2.1 The data does not show evidence of significant changes in Lasham glider behaviour, apart from a slight skewing of the densest regions slightly westwards to avoid the CAS boundaries east of Lasham.

7 Appendix regarding Parham Box Section 5, and CTA7

7.1 Controller thought processes

7.1.1 A pilot can only descend to 4,000ft once cleared to do so by the controller, this can only happen once inside the lateral boundary of airspace which has a base of 3,500ft and there is no conflicting traffic to affect the descent.
In accordance with CAP493 Manual of Air Traffic Services Part 1 (Edition 11, 28 Dec 2023) page 144, Section 1 (General) Chapter 7 (Altimeter Setting and Vertical Reference) Section 9 (Use of Levels by Controllers) paragraph 9.1:
"Except when aircraft are leaving controlled airspace by descent or climb, controllers should not allocate a level to an aircraft which provides less than 500 ft vertical separation above the lower limit of a control area (including TMAs and ATS routes), or below the upper limit of a control zone or control area (including TMAs) where Class G airspace adjoins vertically. This will provide some vertical separation from aircraft operating at the lower limit, or at the upper limit of controlled airspace."

7.1.2 When the controller issues the instruction, the pilot may descend immediately to 4,000ft, or may descend at a slower rate, provided they make any required altitude restriction notified along the route.

7.2 Additional analysis

7.2.1 Subsequent to the original publication of this Annex E Issue 1.0, we analysed radar data for Farnborough arrivals within a box representing the CTA7 region.

7.2.2 Part of the radar data is known as "Mode S SFL (Selected Flight Level)". This data element is the record of the altitude the pilot has selected on their flight management system; in effect, it shows the pilot's intent and what instruction the controller has issued.

7.2.3 Alongside other flight data, the SFL altitude is transmitted to the radar screen for each flight, so that controllers have an opportunity to identify and correct any inaccurate altitude selection.

7.2.4 A comparison can be made between the overall number of flights within the box, vs. the number of flights in the box where the pilot has selected 4,000ft.

7.2.5 Table 2 below shows that, over the PIR period, 78% of flights were cleared to enter CTA7 via descent to 4,000ft.

Flights:	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22	Jan-23	Feb-23	Mar-23	**Annual total**
Via CTA7	604	741	770	684	676	656	599	502	489	514	550	525	**7,310**
Cleared to 4,000ft	469	576	609	516	508	514	495	386	385	420	445	411	**5,734**
Proportion	78%	78%	79%	75%	75%	78%	83%	77%	79%	82%	81%	78%	**78%**

Table 2 Number of Farnborough arrivals cleared to 4,000ft within a box representing CTA7

7.2.6 This data demonstrates that 78% of Farnborough inbound traffic from the south required a clearance into the airspace volume of CTA7 to ensure CAS containment.

8 Appendix Methodology GA Heat Maps

8.1 Technical information for specialist readers

8.1.1 NATS (NERL) maintains a record of ARTAS/NODE data (radar). It is only this data that is to be used for the analysis. The pre-ACP period data of 2019 is from NODE, the post-ACP period of FY2022/23 utilises ARTAS. Both datasets record the position of flights at 4 second intervals. There is no impact on the analysis by using differing radar datasets.

8.1.2 The position records within the radar data are recorded in lat-long format (WGS84), these are then converted in British National Grid co-ordinates (BNG - Ordnance Survey system - in metres).

8.1.3 Each point is then grouped into a 500m x 500m pixel. 500m is the highest resolution due to typical aircraft speed (250kias/~125ms-1) and the 4s interval between radar points.

8.1.4 A count is made of the number of radar points in the sample period for each pixel. This count is in effect the density.

8.1.5 A plot is made by colouring the pixel based on the radar counts. A log scale is used to assist traffic pattern recognition.

8.1.6 To assist analysis, General Aviation is split into several categories based on SSR code.

8.1.7 Pre-ACP the categories and codes are:

8.1.8 Farnborough Service: 0421-0427

8.1.9 Other ATM Service: 0430-0466, 3640-3653

8.1.10 General Aviation: 4572, 7000

8.1.11 Post-ACP the categories and codes are:

8.1.12 Farnborough Service: 0460-0467

8.1.13 Other ATM Service: 0421-0457, 1730-1757, 5020-5037, 3640-3653

Note: In error, 7010 was missed from this list, meaning Blackbushe circuit traffic is missing from the GA heat plots. See paragraph 3.2.6 on page 8.

8.1.14 General Aviation: 4572, 7000

8.1.15 Pre- and Post-ACP data with all codes on the same image is also provided.

9 Appendix Methodology Glider FLARM

9.1 Technical information for specialist readers

9.1.1 To complete the Farnborough PIR, the Lasham Gliding Society has provided FLARM data of glider profiles. The profiles are in kml format, with one file per flight.

9.1.2 The pre-ACP period covers June 2019, with 1,521 example flights.

9.1.3 The post-ACP period covers August 2022, with 2,421 example flights. This was reduced by 900 to enable a more direct comparison of flight numbers[3] . The August sample's flights were longer, as noted in paragraph 4.1.4 on page 15.

9.1.4 Each kml file is individually parsed and formatted.

9.1.5 Points outside of the area (2°W to 0.3°W, 50.6°N to 51.7°N) are filtered out as they represent a rare positioning error in the data, which impacts plotting.

9.1.6 The position records within the FLARM data are recorded in lat-long format (WGS84), these are then converted in British National Grid co-ordinates (BNG - Ordnance Survey system - in metres).

9.1.7 Each point is then grouped into a 250m x 250m pixel. A resolution representing the best accuracy to the large region flights cover, without undue processing time or loss of detail.

9.1.8 A count is made of the number of FLARM points in the sample period for each pixel. This count is in effect the density.

9.1.9 A plot is made by colouring the pixel based on the FLARM counts. A log scale is used to assist traffic pattern recognition.

9.1.10 The plot is on a background map to provide positional context. Controlled airspace regions may also be added as annotations.

[3] The first 1,500 flights in the dataset were used, the rest were not.

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