GATWICK RNAV-1 SIDS – CAA PIR ROUTE ANALYSIS REPORT

This section explains the track distribution of conventional SIDs and the RNAV SID replications using a selection of traffic samples since RNAV-1 SID replications were introduced on a permanent basis from November 2013. The samples compared are selected from data provided by Gatwick to try to give as close as possible, like for like samples in terms of the numbers of departures during the given period..This is so we can isolate, so far as possible, the impact of introducing the RNAV-1 SIDs; in some cases there are slightly more conventional SIDs than RNAV-1 SIDs, and likewise, in other cases, there are more RNAV-1 SIDs than conventional SIDs. The difference in samples is indicated within the tables of this report. In some comparisons of track distribution diagrams and track density plots, the CAA has analysed more than 1 sample as shown in the table.

We have also included our observations on the incidence and impacts of tactical radar vectoring. This is a response to feedback which the CAA has received from some groups and individuals located near to Gatwick.

GUIDE TO TRACK DISPERSION AND DENSITY DIAGRAMS

To fully understand this document, readers will have to view the track dispersion diagrams which are associated with the SID route numbers and the descriptions of track dispersion, track density and associated impacts.

At the beginning of each route analysis, the CAA initially refers to Gatwick's consultation diagrams and forecast impacts of RNAV-1 SID replication implementation and describes the forecast impact. This forecast by Gatwick is cross referred to the diagram figure numbers portrayed in the Gatwick Consultation and Airspace Change Proposal (see http://www.caa.co.uk/default.aspx?catid=2111&pagetype=90&pageid=16983) for ease of reference. The analysis then compares the impact of the RNAV-1 SID replications with the conventional SIDs using a number of traffic samples provided since the implementation of RNAV-1 SIDs in November 2013 and indicates where departures are more concentrated as a result of the RNAV-1 SID replications and whether the anticipated impact, has been realised. Notes relating to the details provided in the table are highlighted below. Any sections in the table where details would not be relevant are shaded out.

The explanations of track distribution are described using references to locations shown on the diagrams to help to describe impacts of the RNAV-1 SID replications. Periods of traffic samples, together with numbers of departures are shown in the tables. For traffic samples used to illustrate impacts in 3 altitude bands (4-5000ft, 5-6000ft, and 6-7000ft), different traffic samples from those shown in the track dispersion and density plots are used for comparison purposes. These altitude plots illustrate when aircraft reach the relevant altitude band and are used to illustrate the flight paths flown by both the conventional departures and RNAV-1 departures when they are at and above 4000ft and illustrate the dispersion of traffic, where they are remaining on the SID and where aircraft are being vectored. In the tables where percentages are used to describe dispersions, these are estimated by visual interpretation of the density against the width of the NPR swathe as shown in the diagrams.

A variety of track dispersion plots have been presented to the CAA for PIR analysis. These comprise:

- Track density plots of Trial SIDs used for consultation purposes, and diagrams from the consultation which were used to describe forecast impacts of the RNAV-1 SIDs.
- Track dispersion plots up to 3900 ft for Route 4 (an explanation is shown at the bottom of each diagram).
- Track dispersion plots for all routes up to 4000 ft (an explanation is shown at the bottom of each diagram).
- Track density plots (an explanation is shown at the bottom of each diagram).
- Altitude Slice Diagrams in the altitude bands: 4-5000ft, 5-6000ft, 6-7000ft.

Track dispersion diagrams portray each aircraft track on a map, based on radar data. Tracks are overlaid upon each other, such that if many tracks are overlaid on top of each other, individual tracks may no longer be visible. They are useful for illustrating the dispersion of the traffic pattern, but are not as useful for determining the density/concentration of tracks.

Track density diagrams = these portray the concentration of flight tracks using a colour code to indicate differing concentrations of flight tracks. They are sometimes referred to as “heat plot” diagrams. Whilst they can be used to illustrate traffic dispersion, they are most useful for illustrating if traffic is concentrated along a route or over a geographic location. Depending on the key used for portraying track concentration, individual tracks towards the outer limits of the dispersion may not be visible on the diagram.

NOTES RELATING TO THE DATA IN THE TABLES

Col 2 Note 1. Reference to Consultation Document (Con Doc) and ACP diagrams. Month period analysed in the PIRand number of conventional SIDs flown is inserted. Comments provided on conventional SID track dispersion.

Col 3 Note 2. Reference to Consultation Document (Con Doc) and ACP diagrams. Month period analysed in the PIRand number of RNAV-1 SIDs flown inserted. Comments provided on RNAV-1 SID track dispersion.

Col 4 Note 3. Comments provided on impact of change compared with that portrayed in Gatwick’s consultation and ACP submission.

Col 5 Note 4. Observations on any discernible variance with tactical radar vectoring by ATC post RNAV-1 SID replication implementation. The altitude when vectoring is permitted by Air Traffic Control is illustrated at the top of the column. The following information was included in the consultation document.:

The altitude of 4000ft applies to:

- All routes during the night - period 2330-0600 local time;
- Rwy 26 Routes 4,7,8,9 during the day period 0600-2330 local time.
- Rwy 08 Route 2 during the day period 0600-2330 local time.

The altitude of 3000ft applies during the day period 0600-2330 local time to:

- Rwy 26 Route 1 and to Rwy 08 Routes 3, 5 and 6.

Col 6 Note 5. Any remarks of significance.

Abbreviations used in the PIR Assessment Route Report Form below.:

NPR	Noise Preferential Route.
CL	Centreline. (Note, in SID design terminology this is referred to as ‘nominal track’; for the purposes of this report CL and Nominal Track are deemed to have the same meaning and mean the flight path we anticipate the aircraft will follow when flying the SID unless and until vectored of the SID by air traffic control. However, aircraft may be either side of the RNAV-1 CL or Nominal Track by up to one nautical mile for 95% of the flight time which is within the navigation tolerance of RNAV-1 1 SID design parameters).
Deps	Departing aircraft on the SID.
SID	Standard Instrument Departure.
AC	Aircraft.
ACP	Airspace Change Proposal (V 1.1 submitted in January 2013).
Con Doc	Consultation Document (19 July 2012).

Deg	Degree (as in the size of any turn).
Approx	Approximately.
NT	Nominal Track (see comments above regarding CL and NT).
Conv	Conventional (meaning the SIDs predicated on conventional navigation techniques in operation prior to the introduction of RNAV-1 SIDs)

Terminology:

Swathe.	This refers to the 3 km wide NPR compliance monitoring swathe .
Vectoring.	This is an extensive ATC tactical radar vectoring operational practice to provide aircraft with an expeditious route to destination and safe separation against other aircraft.

ROUTE 6 – RWY 08 LAM – COMPARING JUN 13 (CONV) v JUN 14 (RNAV)

LINKS	SID Sample Of Relevant Track Dispersion Diagram	Conventional SID Comments (Note 1)	RNAV 1 SID Comments (Note2)	Impact of RNAV SID Replication (Note 3)	Observations on Vectoring (Note 4)	Remarks (Note 5)
600 601	Consultation Ref / Diagram	Con Doc Fig 5 **600A** ACP Fig 11 **601A**	Con Doc Fig 6 **600B** ACP Fig 3 **601B**	The forecast impact for this route was based on the impact shown in Con Doc Fig 6 and ACP Fig 3 which was predicated on the results of the Trial of Route 1. As the RNAV SID replicated the con SID it was forecast by GAL and the CAA that the mean track of the RNAV deps over the ground would be unchanged other than a more concentrated dispersion similar to that demonstrated during the RNAV Trial for Route 1. The RNAV SID CL was designed so that it would be directly aligned with the Conv SID CL. As shown in Con Doc Fig 7 the RNAV CL was co-located with the Conv SID CL.		
Folder Ref	Diagram **LAM (DTY)***	**Month** **Jun 13** / **Number** **542**	**Month** **Jul 14** / **Number** **468**		Day: 3000 Night: 4000	*LAM is the SID designator, but referred to by GAL as DTY (Daventry)
602	At 4000 ft	Deps using almost 30% of the width of the NPR swathe during the turn to the northeast. Some ac are being kept on the initial rwy heading after departure but there is a variety of vectoring taking place before ac reach the A22 causing dispersion towards Lingfield and Dormansland.	Deps using approx 10% of the width of the NPR swathe after departure around the first turn towards Crockham Hill and the northeast. Some ac are being kept on the initial rwy heading after departure but there is a variety of vectoring taking place before ac reach the A22 causing dispersion towards Lingfield and Dormansland.	The RNAV SID dispersion has reduced compared with the width of the conv SID departure track dispersion by nearly 40% although the RNAV traffic sample is less (- 74) . This is in line with data shown by GAL in consultation and the ACP. The deps are more concentrated than the conventional SID dispersion which was the aim of the RNAV SID replication, however, the impact has been reduced due to the continued tactical vectoring by ATC.	No significant change in vectoring.	RNAV track dispersion as expected. Traffic above 4000ft was not assessed in the ACP analysis as deps may be tactically vectored when reaching 3000/4000ft. RNAV sample is - 74 deps less. The Route 6 NPR does not reflect the routine flight path of this SID as vectoring is evident and frequently, LAM SIDs are following a similar route to the vectoring track of the CLN SIDs. This apparent for both conv and RNAV SIDs.
603	Density Plot	Deps occupy approx.10-15% of the width of the NPR swathe towards the turn to the northeast. Before the A22, the density dispersion plot splits into 3 distinct alignments – one towards Lingfield, and the other 2 towards Crockham Hill. The distinct split towards Lingfield arises from vectoring (i.e. remaining on runway heading after departure).	Deps occupy approx. 10% of the width of the NPR swathe towards the turn to the northeast. Before the A22, the density dispersion plot splits into 2 distinct alignments – one towards Lingfield, and the other towards Crockham Hill. The distinct split towards Lingfield arises from vectoring(i.e. remaining on runway heading after departure).	The RNAV SID dispersion towards Crookham Hill has reduced compared with the width of the 2 conv SID departure track concentrations by approx 50%. The picture shows both a steady turn towards Crockham Hill, and also ac staying on the runway heading towards Lingfiled – the Route 6 track concentrated flight path being reduced as a resutt of the RNAV design, and the track towards Lingfield as a result of remaining on runway heading after departure. The continued vectoring practice reduces the impact of an RNAV concentration as there is an operational need to treat traffic in different ways, potentially depending on other London TMA traffic patterns, and potentially the time of day. With data provided it is not possible to differentiate between day and night operations. The deps are more concentrated than the conventional SID dispersion which was the aim of the RNAV SID replication.	No significant change in vectoring.	RNAV track dispersion as expected on the LAM NPR, but traffic being vectored south of Edenbridge which is unchanged from operations prior to RNAV SID implementation. Traffic above 4000ft was not assessed in the ACP analysis as deps may be tactically vectored when reaching 3000/4000ft. RNAV sample is - 74 deps less.
	Alt Slice Diagrams (Note 7)	Period Number **1-31 Mar 14 283**	Period Number **1-11 Sep 14 253**			
	Alt 4-5000ft	Deps being vectored before reaching 4000ft (NPR is 3000ft)	Deps being vectored before reaching 4000ft (NPR is 3000ft)	For those deps which have not been vectored (i.e. on the NPR CL to Crookham Hill), the picture shows a good replication, and in this altitude	No significant change in vectoring.	Traffic above 4000ft was not assessed in the ACP analysis as deps may be tactically

604	GAL Slides:2-5 CAA Slides 2-5	and the turn towards the north east to Crockham Hill, hence the dispersion along the LAM SID and across the DVR SID NPR swathe is a result of leaving some deps on runway heading and the combination of vectoring.	and the turn towards the north east to Crockham Hill, hence the dispersion along the LAM SID and across the DVR SID NPR swathe is a result of leaving some deps on runway heading and the combination of vectoring.	band, the impact is increased concentration along the 2 distinct departure routes (including the southern stream which is due to ac being left on runway heading after departure).		vectored when reaching 3000/4000ft. RNAV sample is - 30 deps less. The Route 6 NPR does not reflect the routine flight path of this SID as vectoring is evident and frequently, LAM SIDs are being left on runway heading and are following a similar route to the vectoring track of the CLN SIDs (Route 5). This apparent for both conv and RNAV SIDs.
605	Alt 5-6000ft GAL Slides:6-7 CAA Slides 2-5	Some ac reaching 5000ft before the A22. Vectoring widespread along the Route 6 and Route 5 NPR swathes.	Most ac reaching 5000ft after the A22. Vectoring widespread along the Route 6 and Route 5 NPR swathes.	At this altitude band, the impact is slightly increased concentration along the 2 distinct departure routes (including the southern stream which is due to ac being left on runway heading after departure), but as vectoring continues to be widespread, the impacts of this RNAV SID are negligible in this altitude band. Ac may be taking longer to reach 5000ft on the RNAV sample in Sep as there is a possibility that a significant number of these departures are long haul as well as UK domestic departures. From data provided it is not possible to determine whether this theory is correct.	No significant change in vectoring.	Traffic above 4000ft was not assessed in the ACP analysis as deps may be tactically vectored when reaching 3000/4000ft. RNAV sample is - 30 deps less. The Route 6 NPR does not reflect the routine flight path of this SID as vectoring is evident and frequently, LAM SIDs are being left on runway heading and are following a similar route to the vectoring track of the CLN SIDs (Route 5). This apparent for both conv and RNAV SIDs.
606	Alt 6-7000ft GAL Slides: 10-13 CAA Slides 2-5	Ac reaching 6000ft before the railway line to East Grinstead, but widespread vectoring to the north and east is evident.	Some ac reaching 6000ft before the railway line to East Grinstead (albeit they have turned north by then after vectoring, and some reach 6000ft after the railway line. Widespread vectoring to the north and east is evident.	At this altitude band, the impact is similar concentration along the 2 distinct departure routes (including the southern stream which is due to ac being left on runway heading after departure), but as vectoring continues to be widespread, the impacts of this RNAV SID are negligible in this altitude band. Ac may be taking longer to reach 6000ft on the RNAV sample in Sep as there is a possibility that a significant number of these departures are long haul as well as UK domestic departures. From data provided it is not possible to determine whether this theory is correct.	No significant change in vectoring.	Traffic above 4000ft was not assessed in the ACP analysis as deps may be tactically vectored when reaching 3000/4000ft. RNAV sample is - 30 deps less. The Route 6 NPR does not reflect the routine flight path of this SID as vectoring is evident and frequently, LAM SIDs are being left on runway heading and are following a similar route to the vectoring track of the CLN SIDs (Route 5). This apparent for both conv and RNAV SIDs.

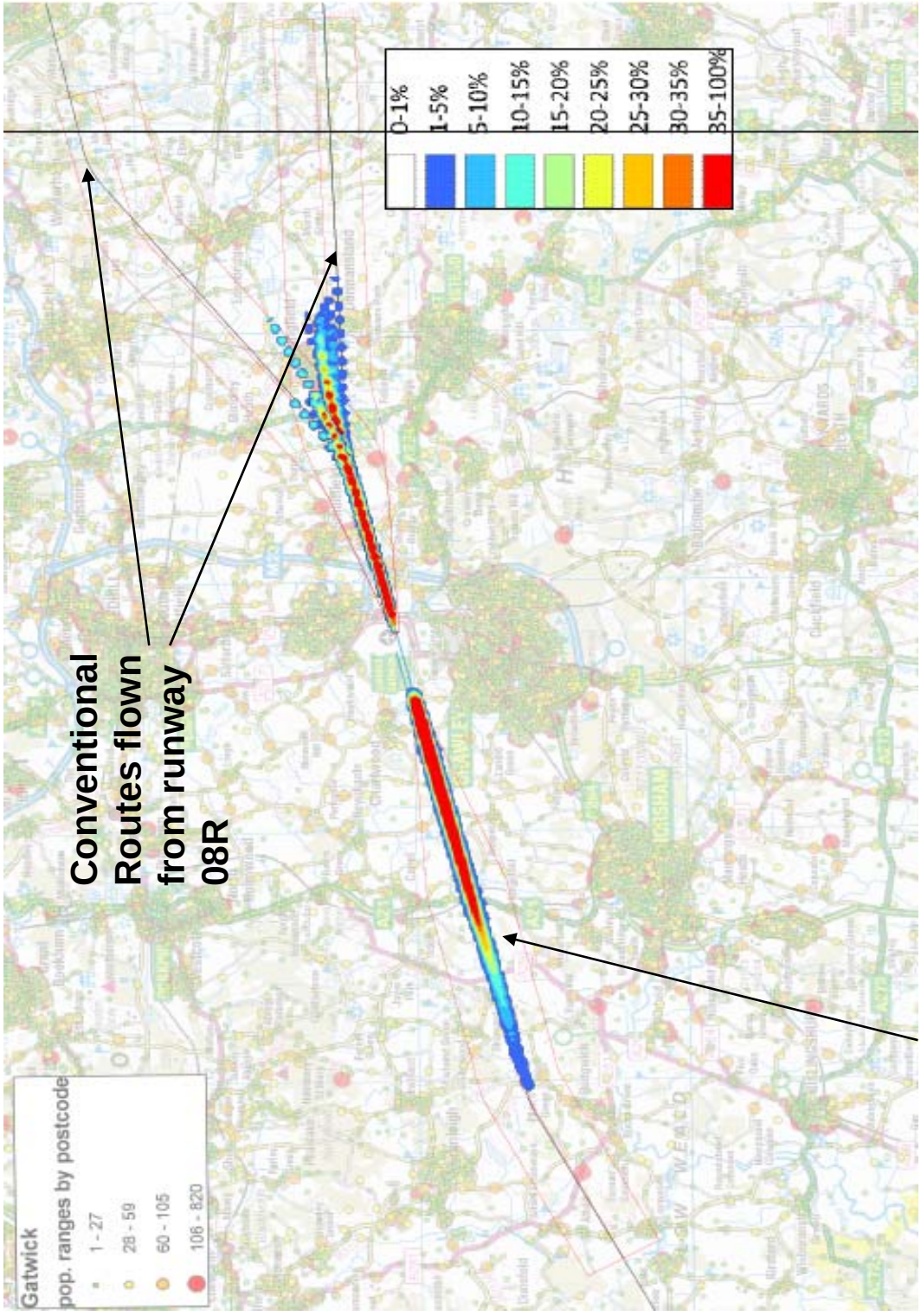

Figure5) Density plots of aircraft tracks (up to 4000 feet AMSL) following the **conventional departure SID** from Runway 26L and conventional (DVR/LAM) departure SID routes from runway 08R

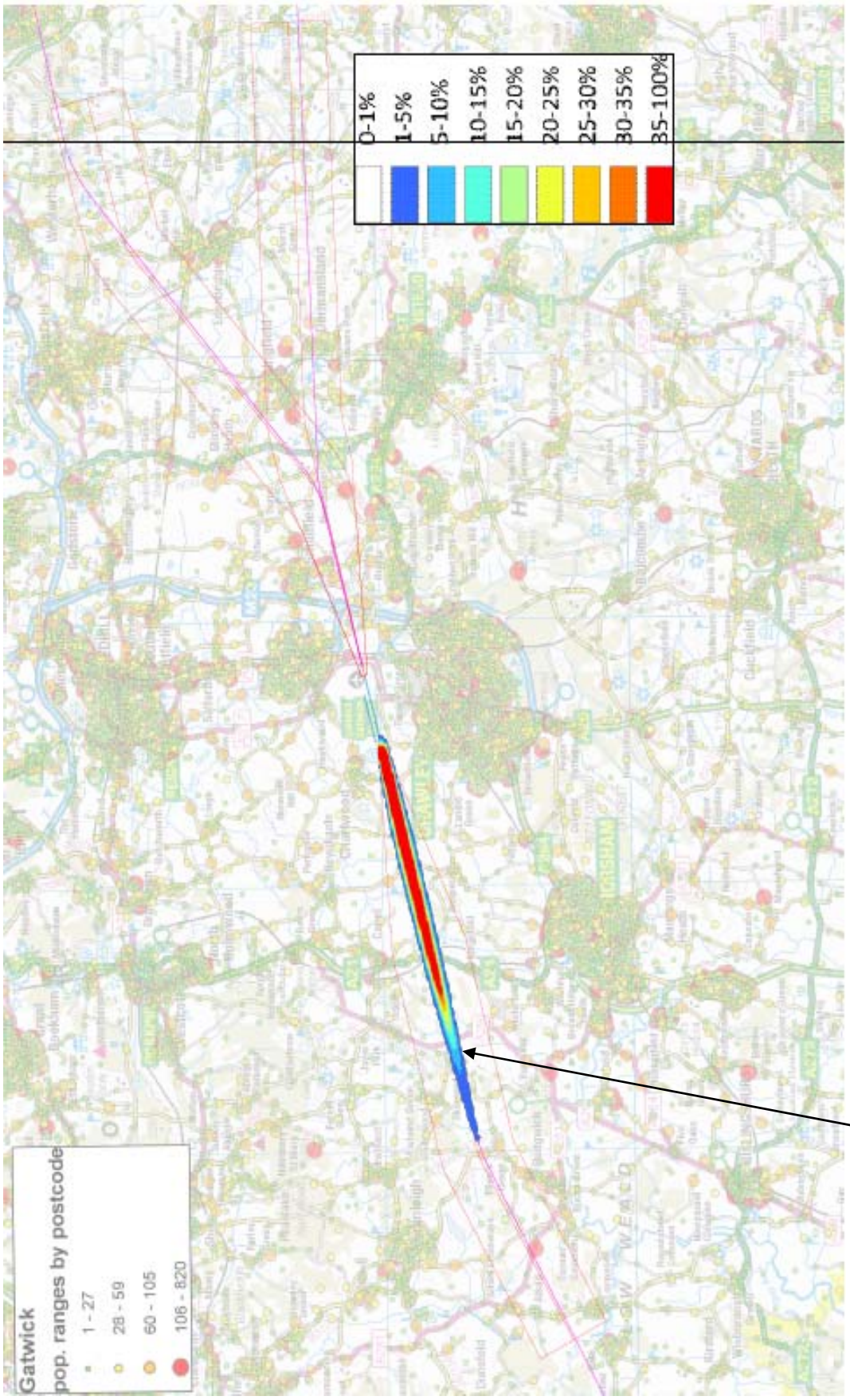

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Figure6) Density plot of aircraft tracks (up to 4000 feet AMSL) following **ROUTE 1** P-RNAV SID from Runway 26L

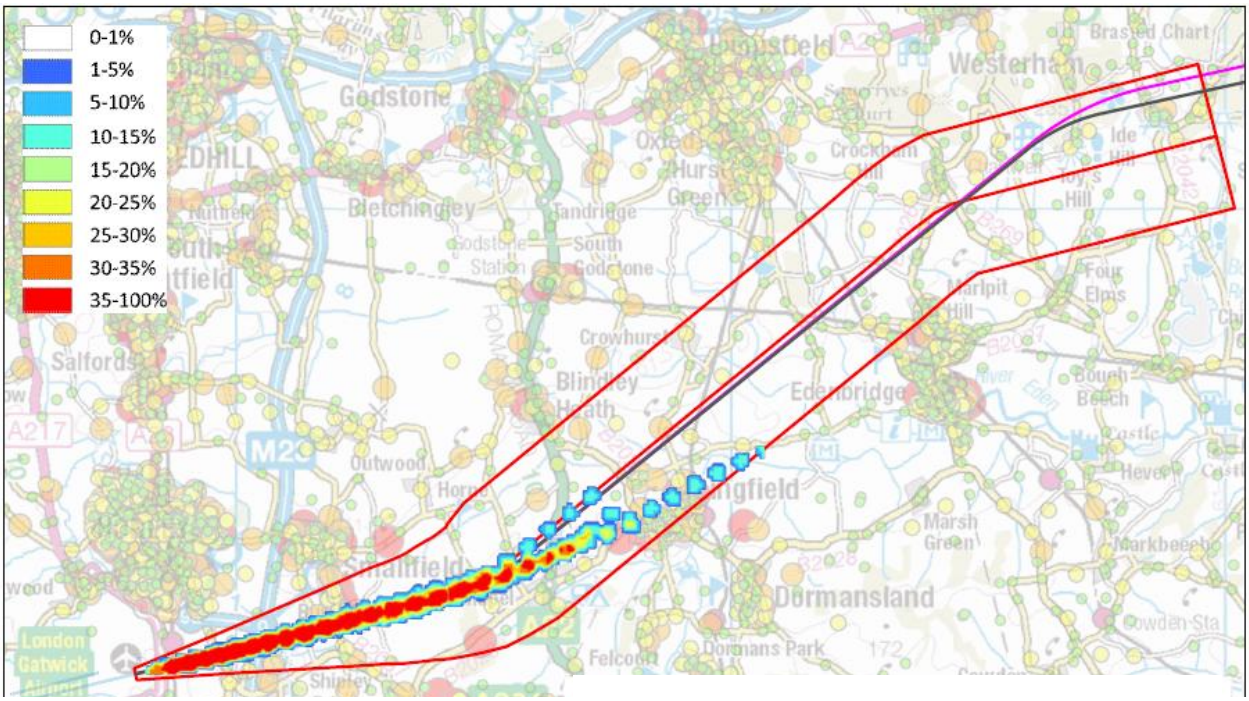

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Figure 11 Route 6 Conventional Navigation

The impact regarding noise and track dispersion for route 6 is expected to be identical to that seen from the flight trials of route 1.

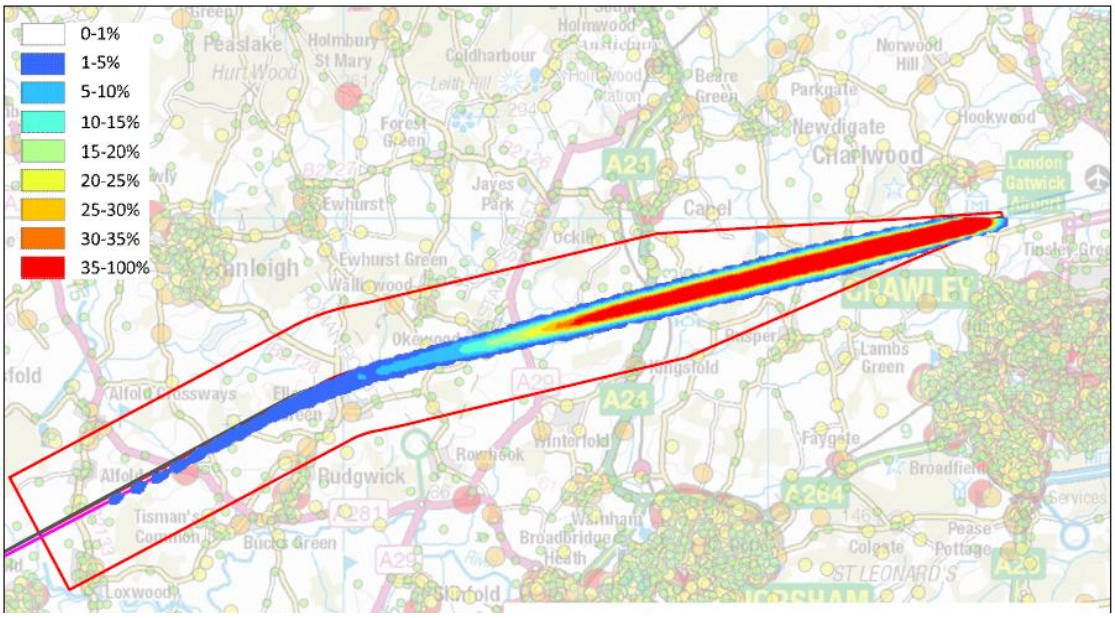

Figure 2 Route 1 Conventional Navigation

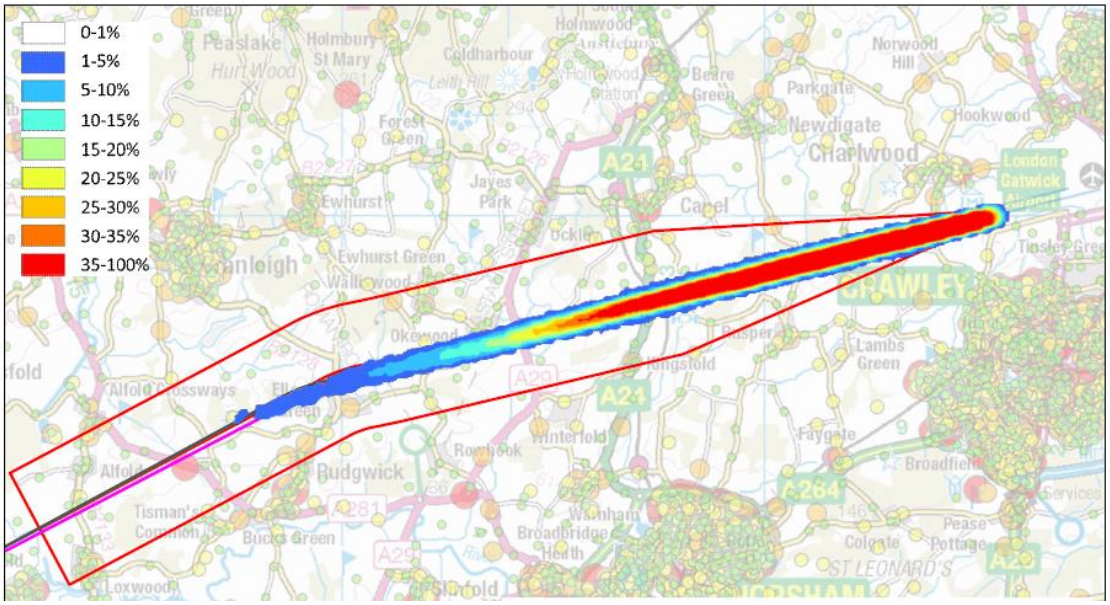

Figure 3 Route 1 PRNAV Navigation

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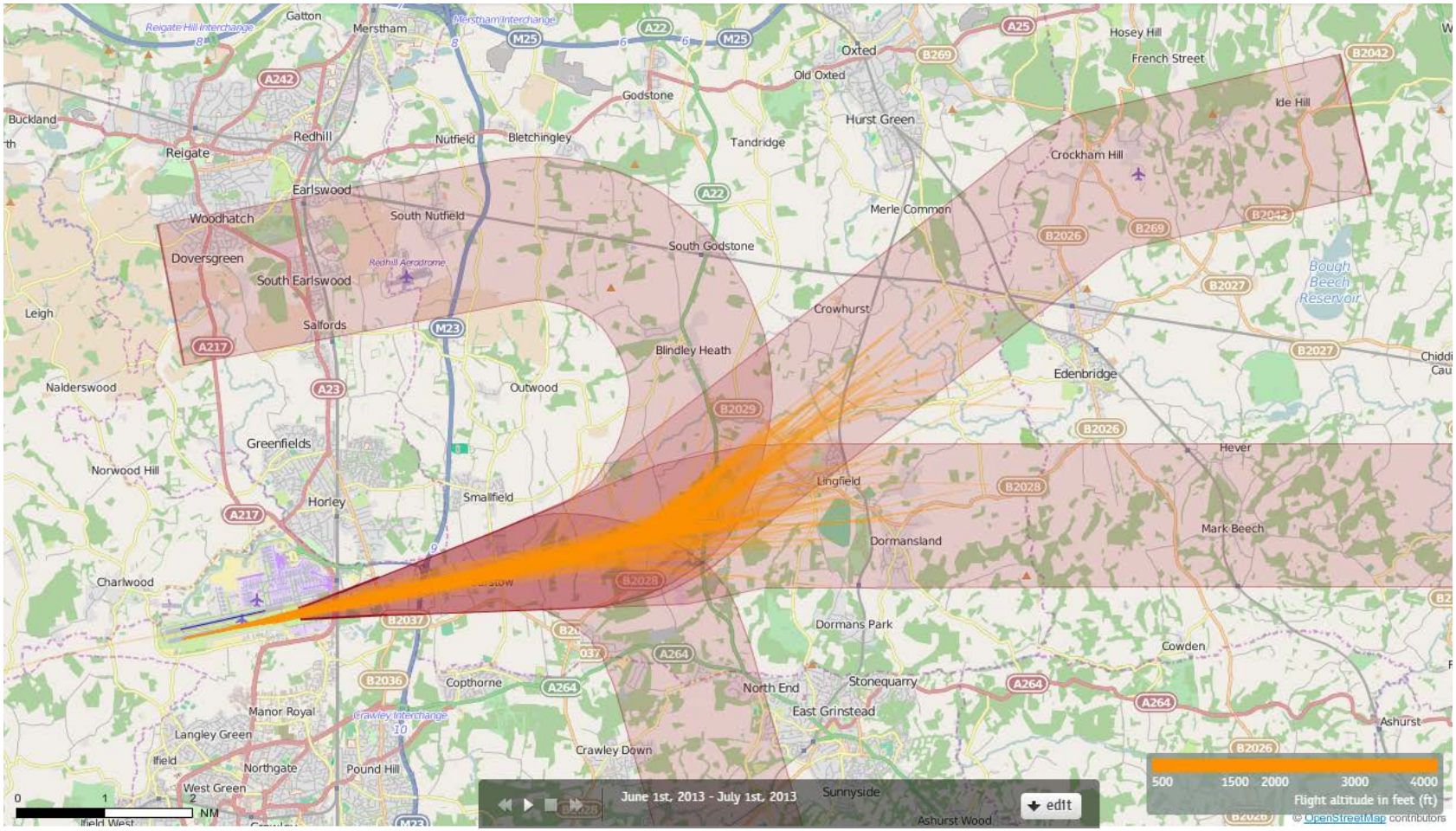
NOTE: The densities illustrated in Figures 2-14 were constructed by calculating the proportion of radar returns within a defined grid square, and colouring according to the relative density of the returns compared to the square with the highest observed density (for example yellow shading indicates radar return density is 20 – 25% of the highest density square). As such the colour coding cannot be related easily to the number of aircraft in a particular defined grid square. However, the number of radar returns in each sample has been taken into account in this calculation, and therefore the plots are all directly comparable.

08 DAVENTRY
Route 6

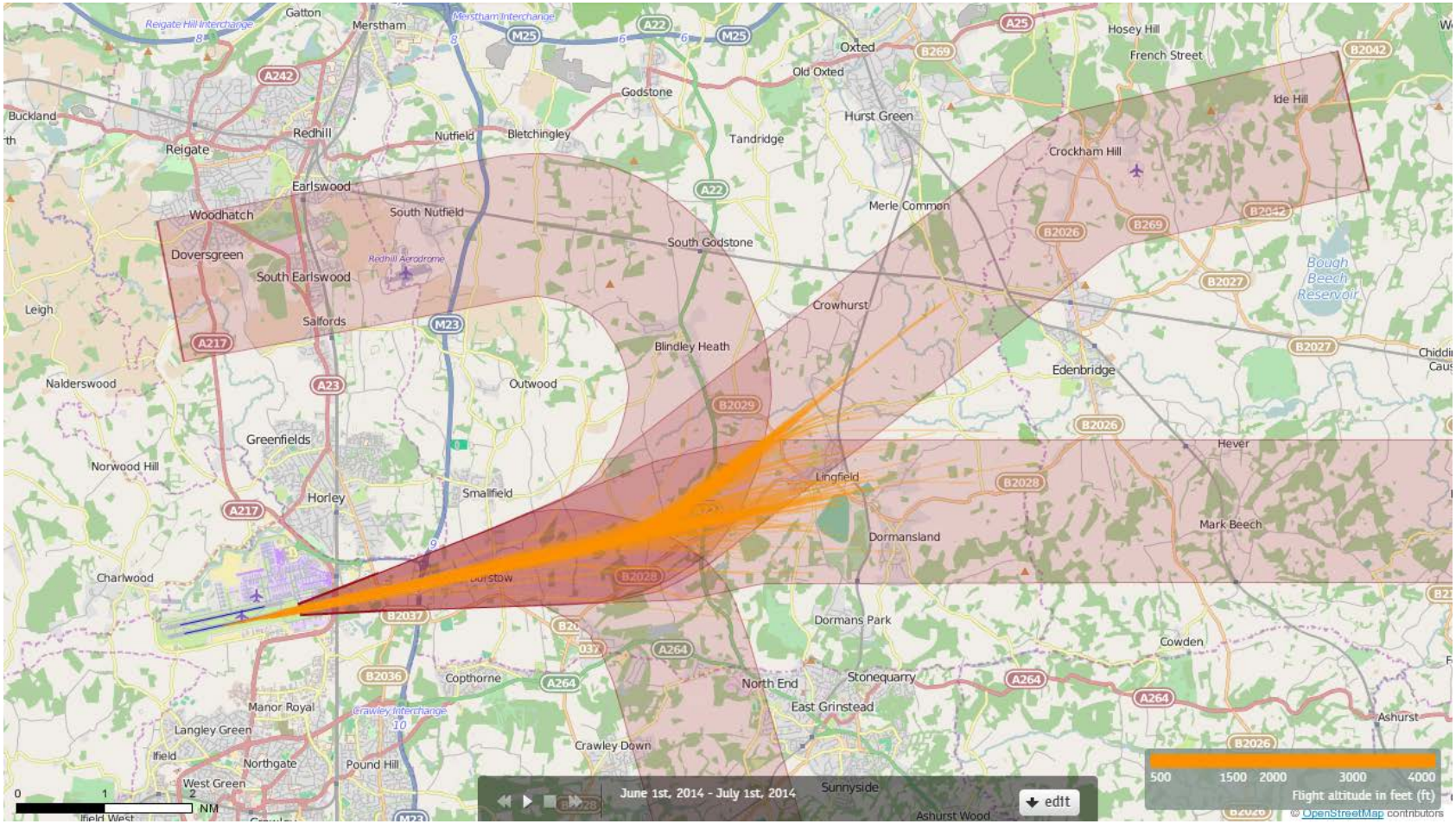
Pre and Post P-RNAV

08DAVENTRY June 2013 Aircraft Tracks Cut Off at 4000ft Altitude
542 Aircraft – Showing CONVENTIONAL Departures Only



Orange plots show the tracks of aircraft until at an altitude of 4000ft

08DAVENTRY June 2014 Aircraft Tracks Cut Off at 4000ft Altitude
468 Aircraft – Showing P-RNAV Departures Only

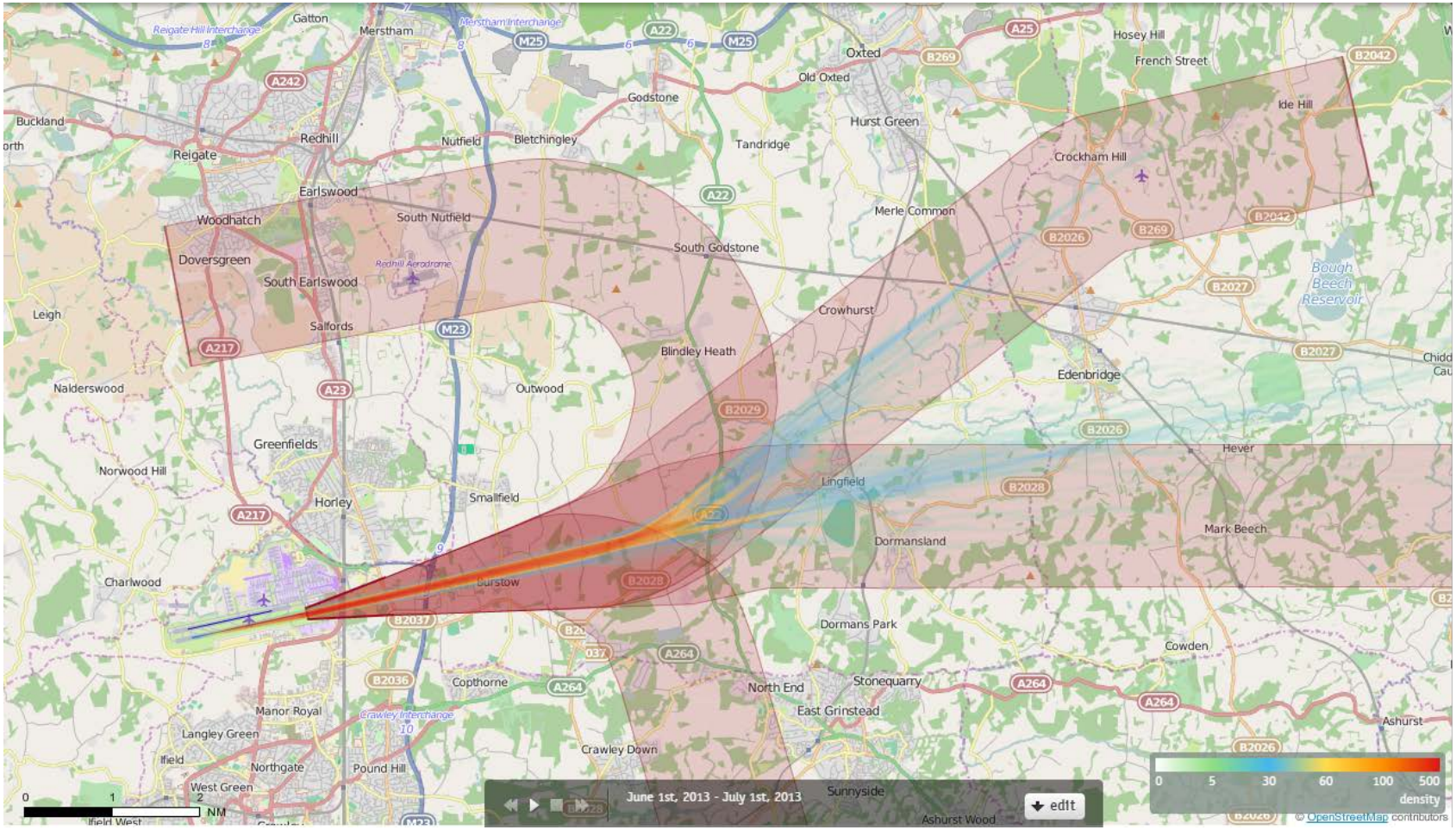


Orange plots show the tracks of aircraft until at an altitude of 4000ft

08 DAVENTRY
Route 6

Pre and Post P-RNAV

08DAVENTRY Density June 2013
542 Aircraft – Showing CONVENTIONAL Departures Only



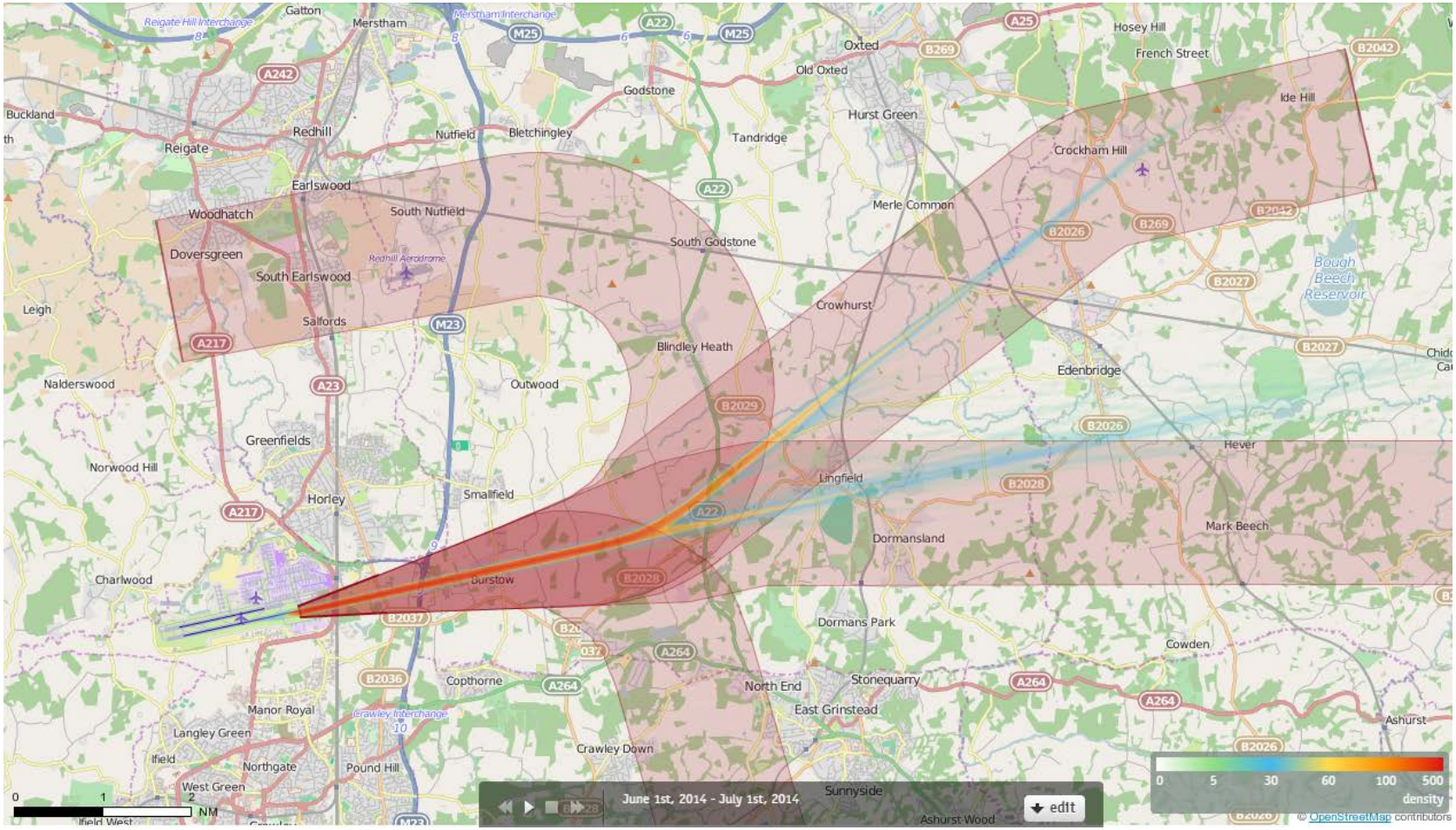
Track density

Each track is drawn as a line which has a width of just a few pixels and each pixel on the screen counts how often a ‘track line’ comes across this pixel when drawing all the tracks.

When all the tracks have been drawn, each pixel decides upon its colour based on the number of times a ‘track line’ has come across that pixel. The conversion from "count" to "colour" is guided by the numbers and colours given in the current Palette.

Counts in between are mapped to colours in between. If 100 were orange and 200 where red, then 150 would be coloured some orangy red.

08DAVENTRY Density June 2014
468 Aircraft – Showing P-RNAV Departures Only



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Counts in between are mapped to colours in between. If 100 were orange and 200 where red, then 150 would be coloured some orangy red.

08 DAVENTRY Route 6

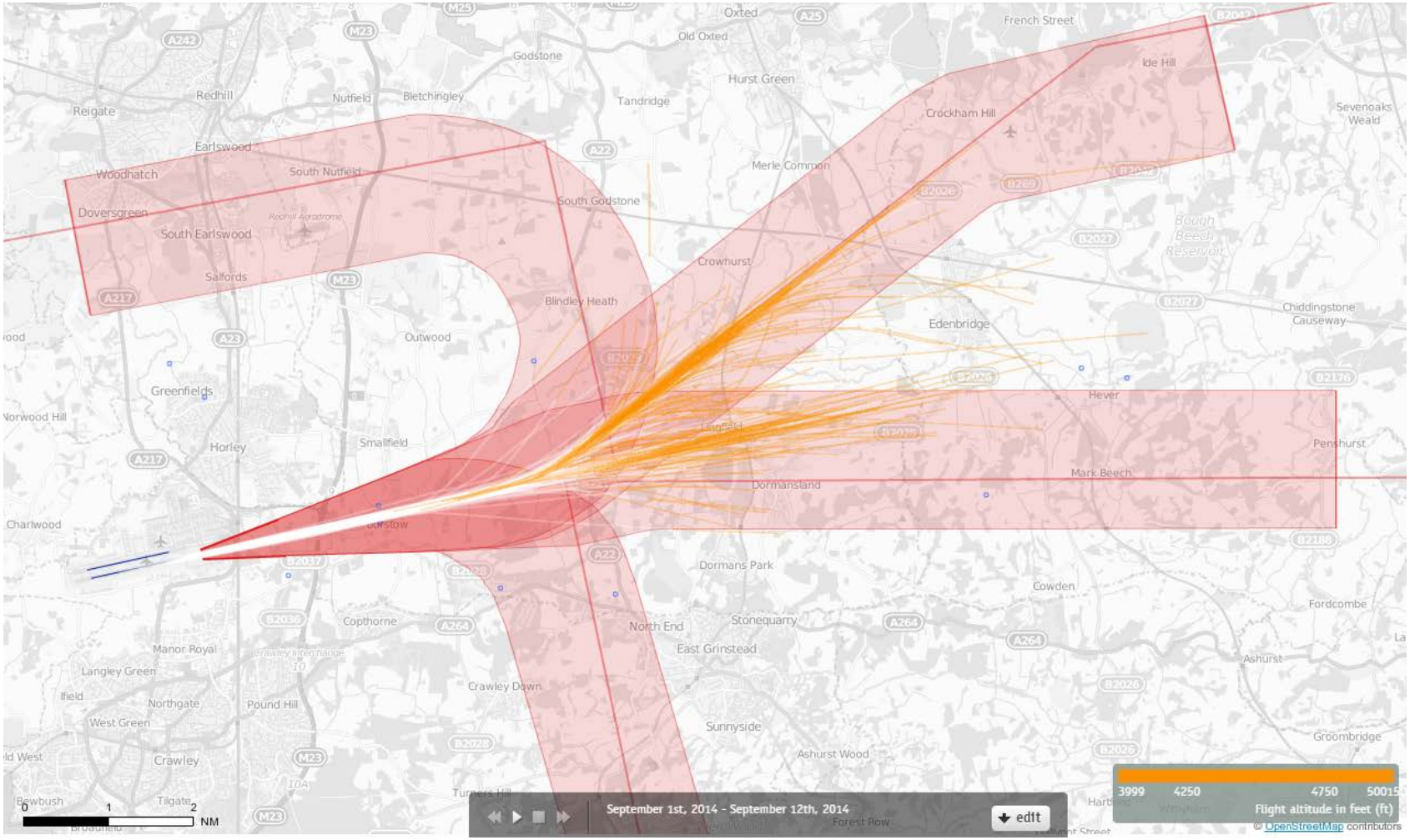
Altitude Bands

4000-5000ft

08 DTY Departures March 2014
4000-5000 feet (283 Aircraft – CONVENTIONAL ONLY)

Orange plots show the points at which an aircraft was between 4000 and 5000ft altitude.

08 DTY Departures 1st-11th September 2014
4000-5000 feet (253 Aircraft – P-RNAV ONLY)



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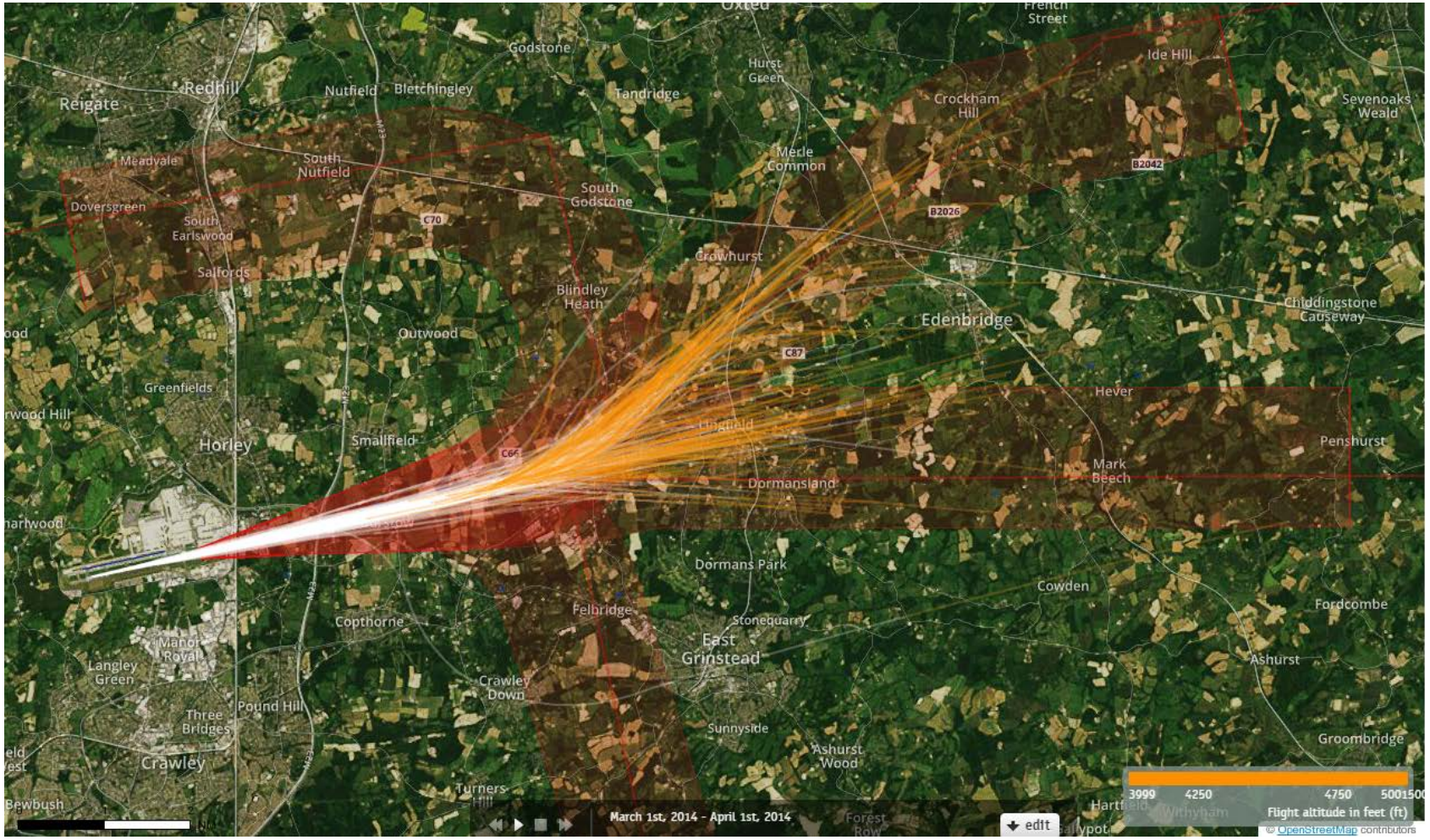
4000-5000 feet (283 Aircraft – CONVENTIONAL ONLY)



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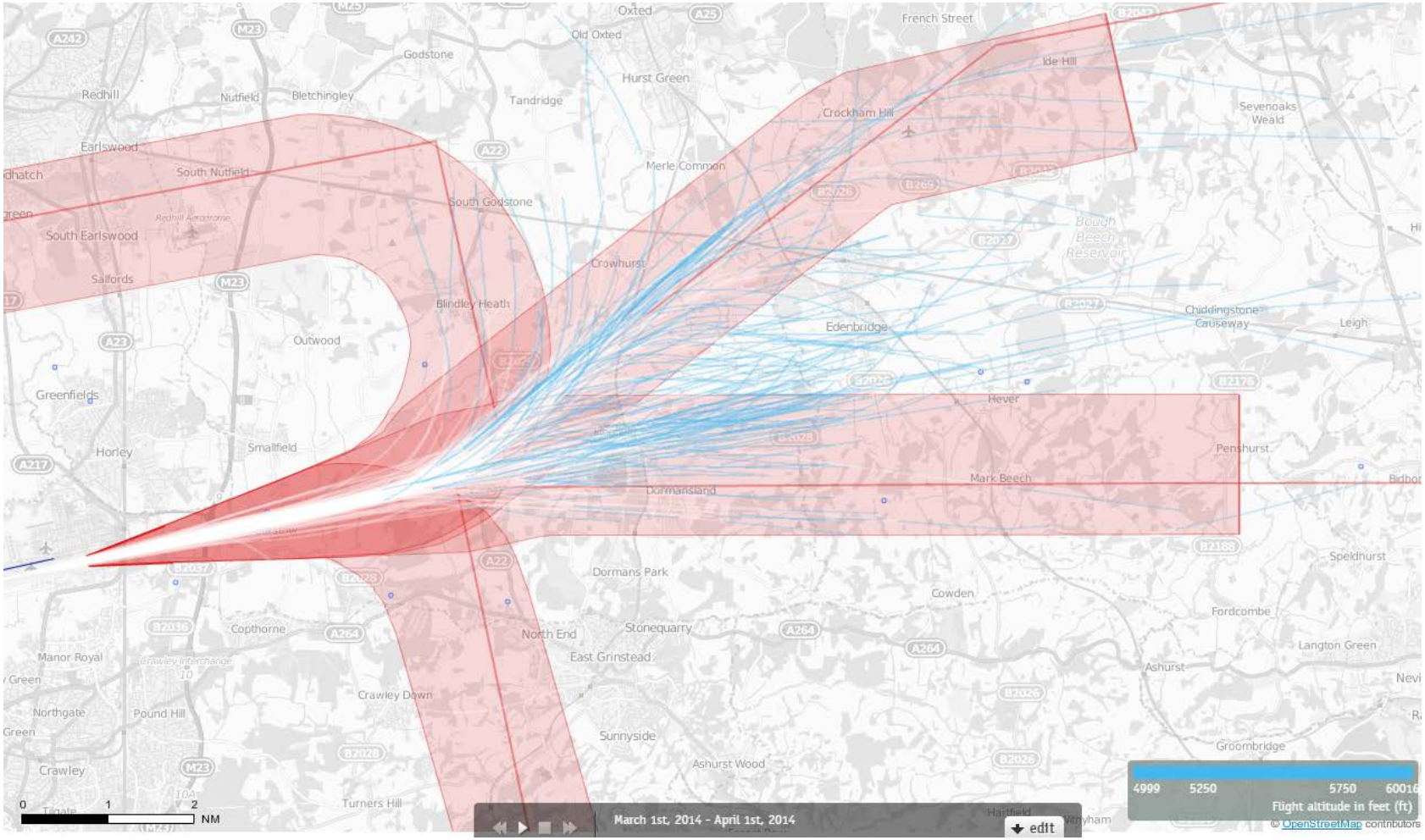
08 DAVENTRY Route 6

Altitude Bands

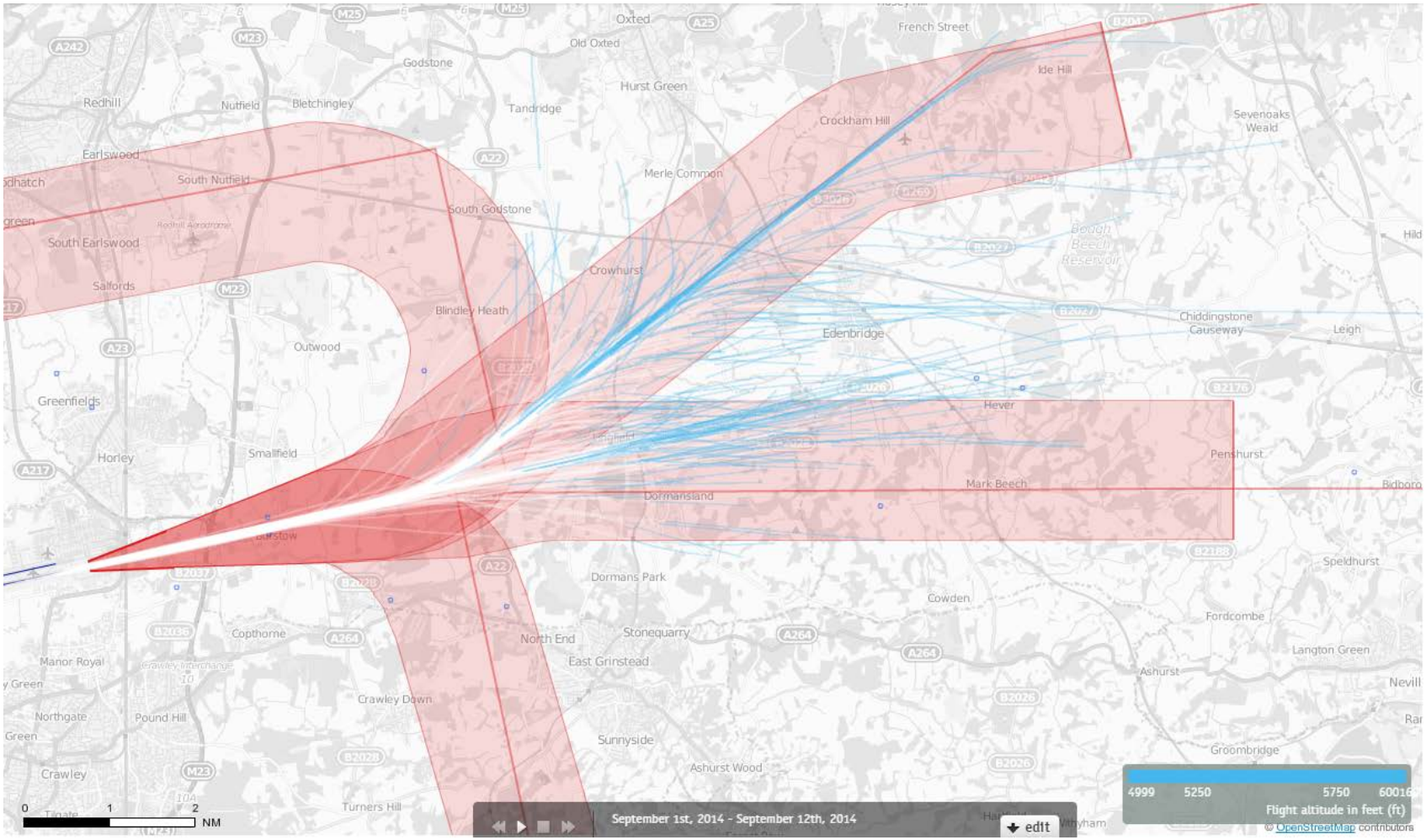
5000-6000ft

08 DTY Departures March 2014
5000-6000 feet (283 Aircraft – CONVENTIONAL ONLY)



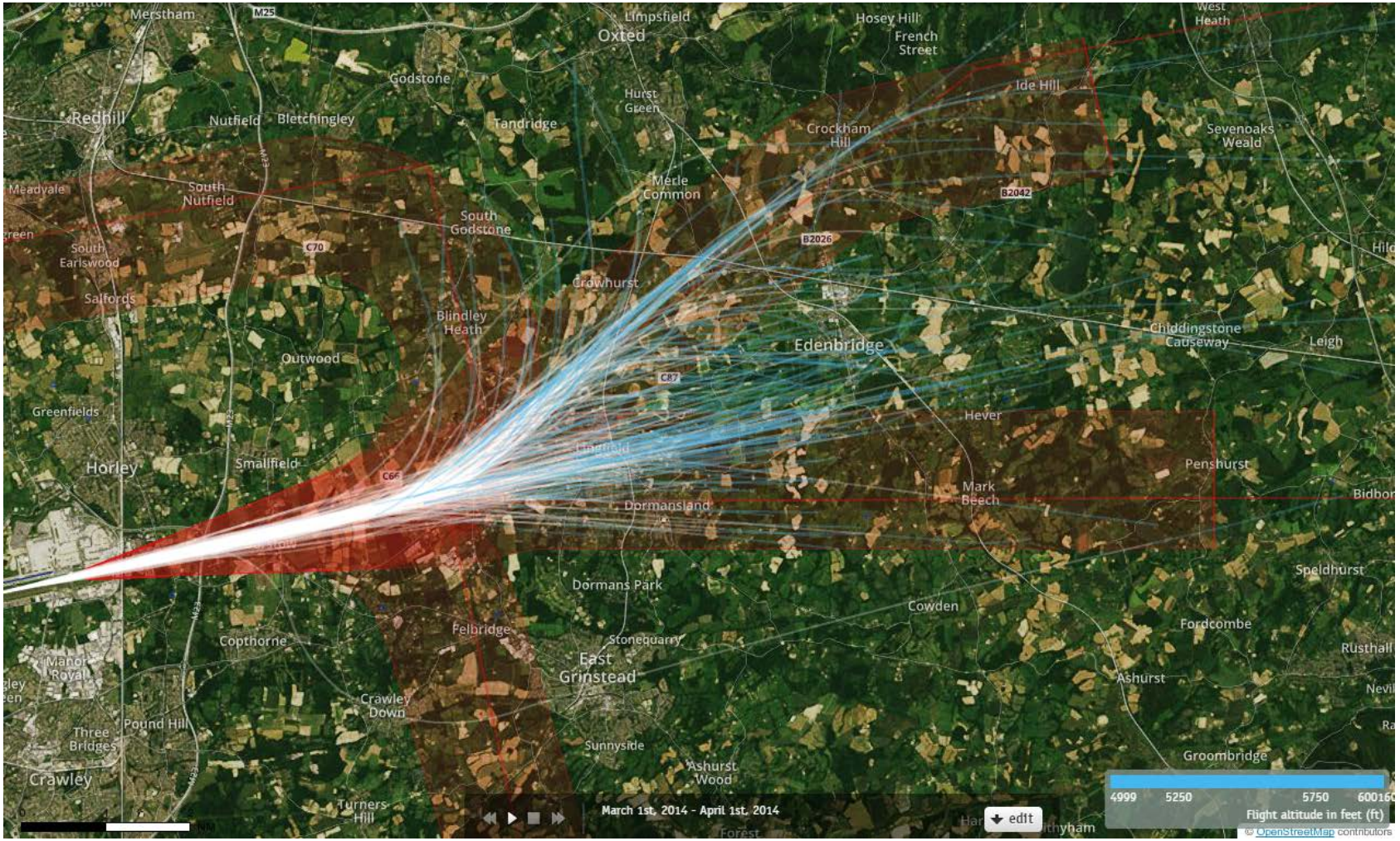
Blue plots show the points at which an aircraft was between 5000 and 6000ft altitude.

08 DTY Departures 1st-11th September 2014
5000-6000 feet (253 Aircraft – P-RNAV ONLY)



Blue plots show the points at which an aircraft was between 5000 and 6000ft altitude.

08 DTY Departures March 2014
5000-6000 feet (283 Aircraft – CONVENTIONAL ONLY)



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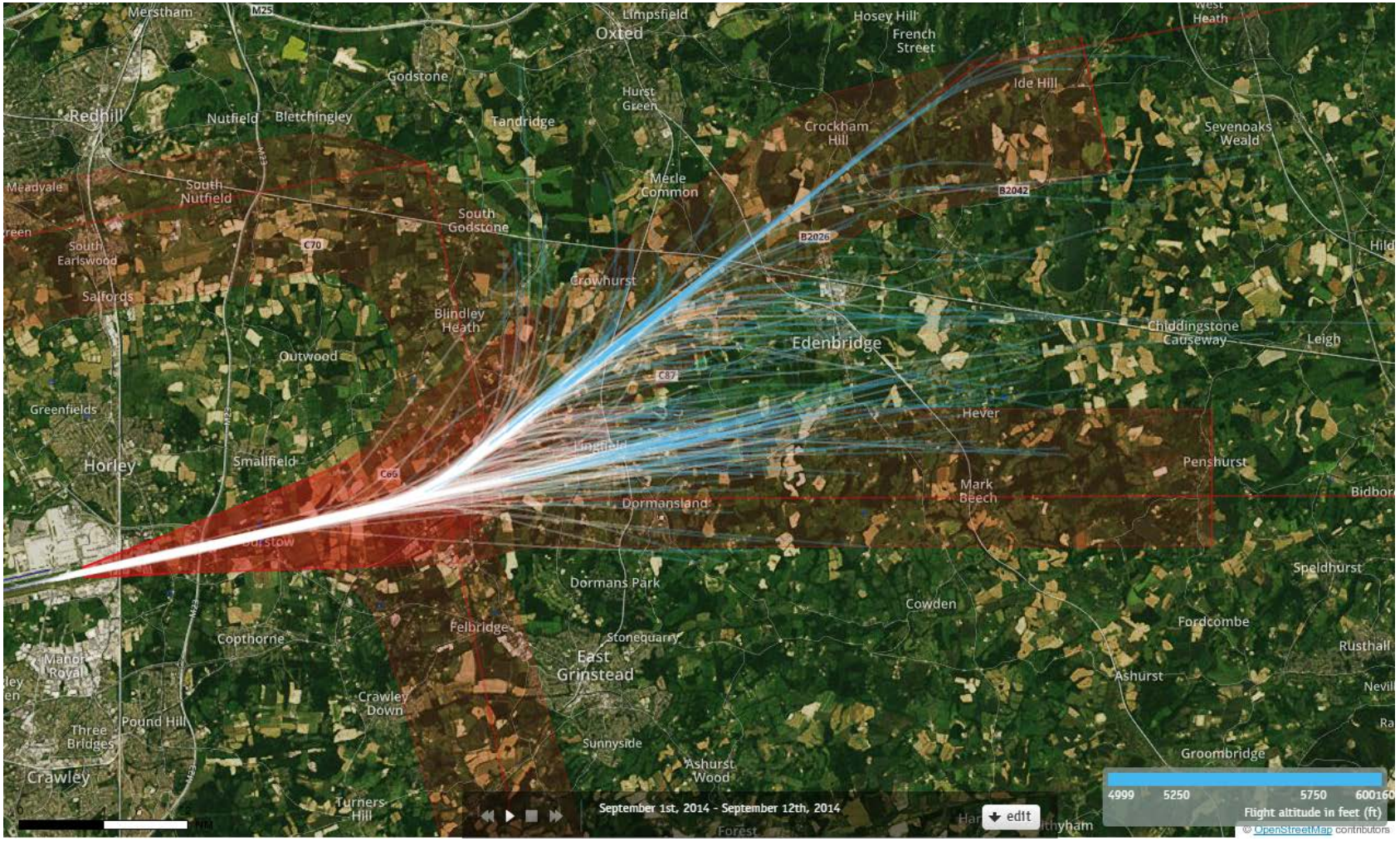
08 DTY Departures 1st-11th September 2014
5000-6000 feet (253 Aircraft – P-RNAV ONLY)



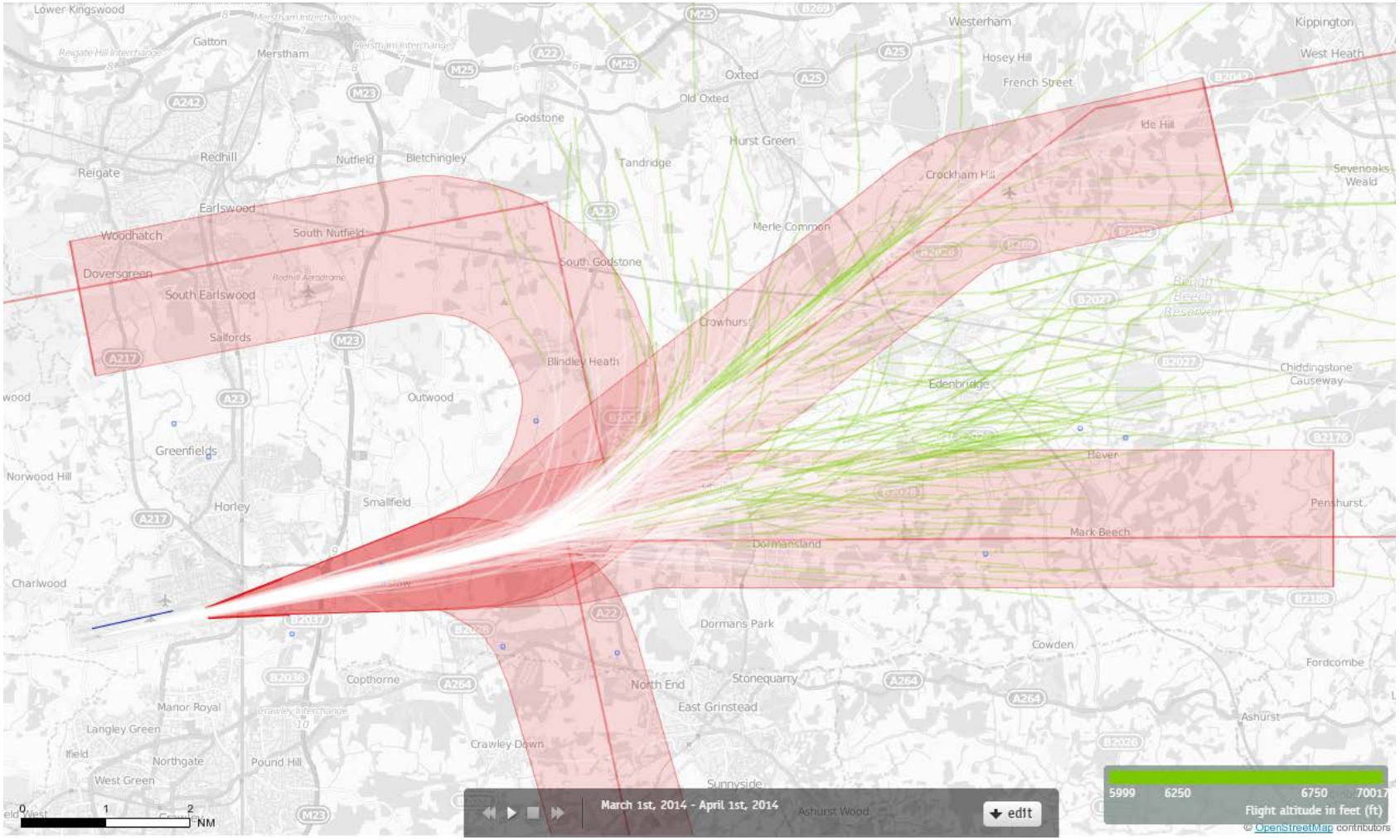
Blue plots show the points at which an aircraft was between 5000 and 6000ft altitude.

08 DAVENTRY Route 6

Altitude Bands

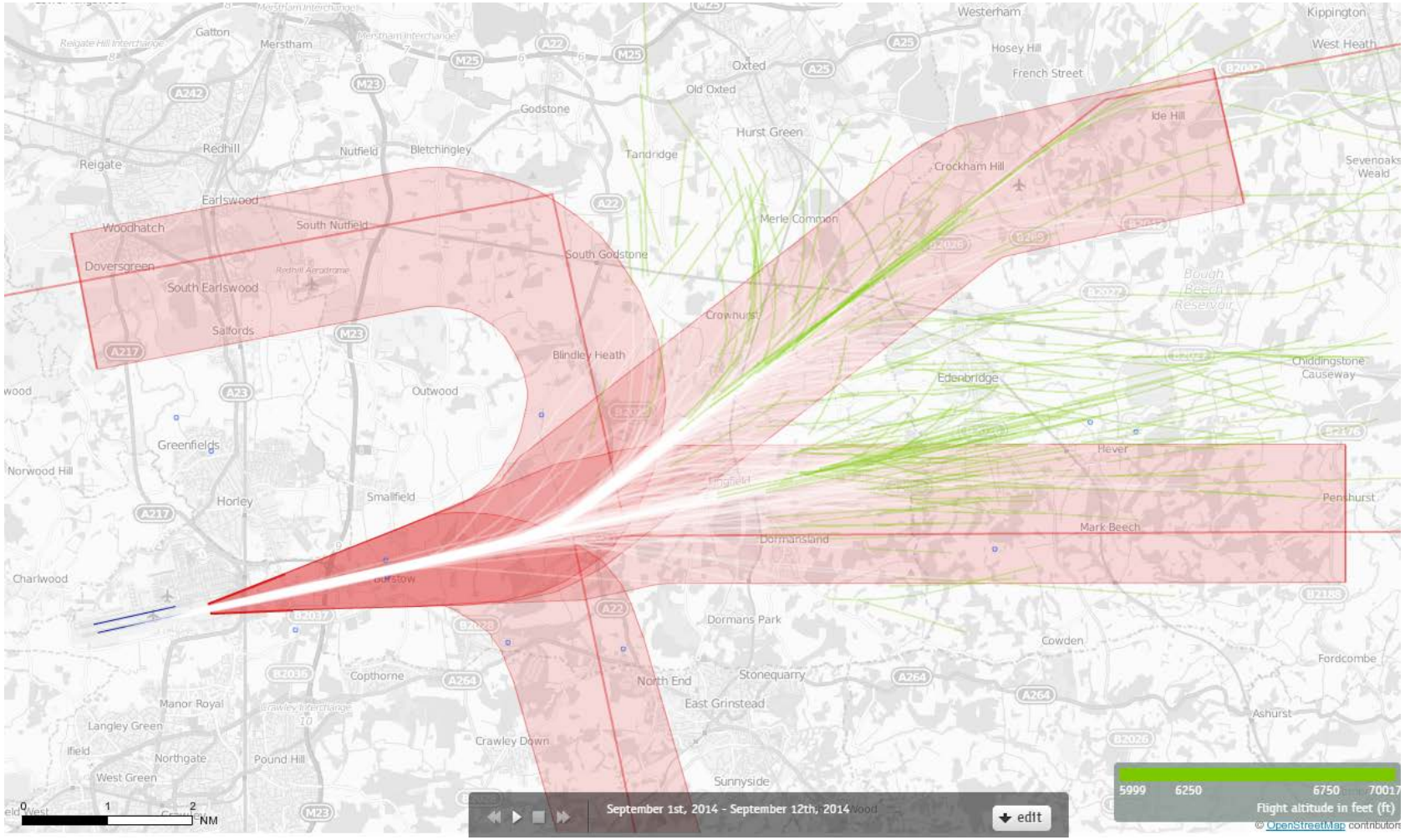
6000-7000ft

08 DTY Departures March 2014
6000-7000 feet (283 Aircraft – CONVENTIONAL ONLY)



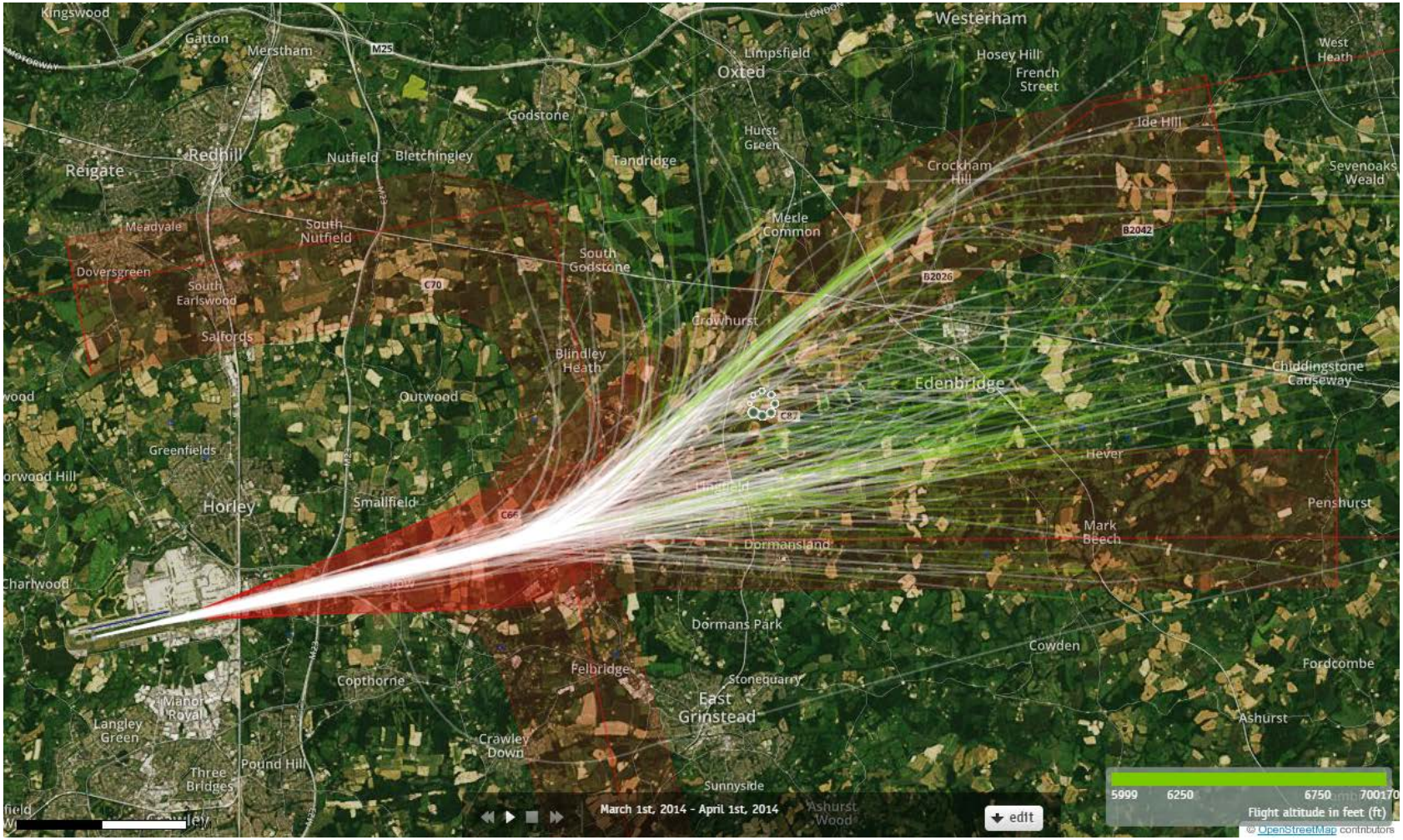
Green plots show the points at which an aircraft was between 6000 and 7000ft altitude.

08 DTY Departures 1st-11th September 2014
6000-7000 feet (253 Aircraft – P-RNAV ONLY)



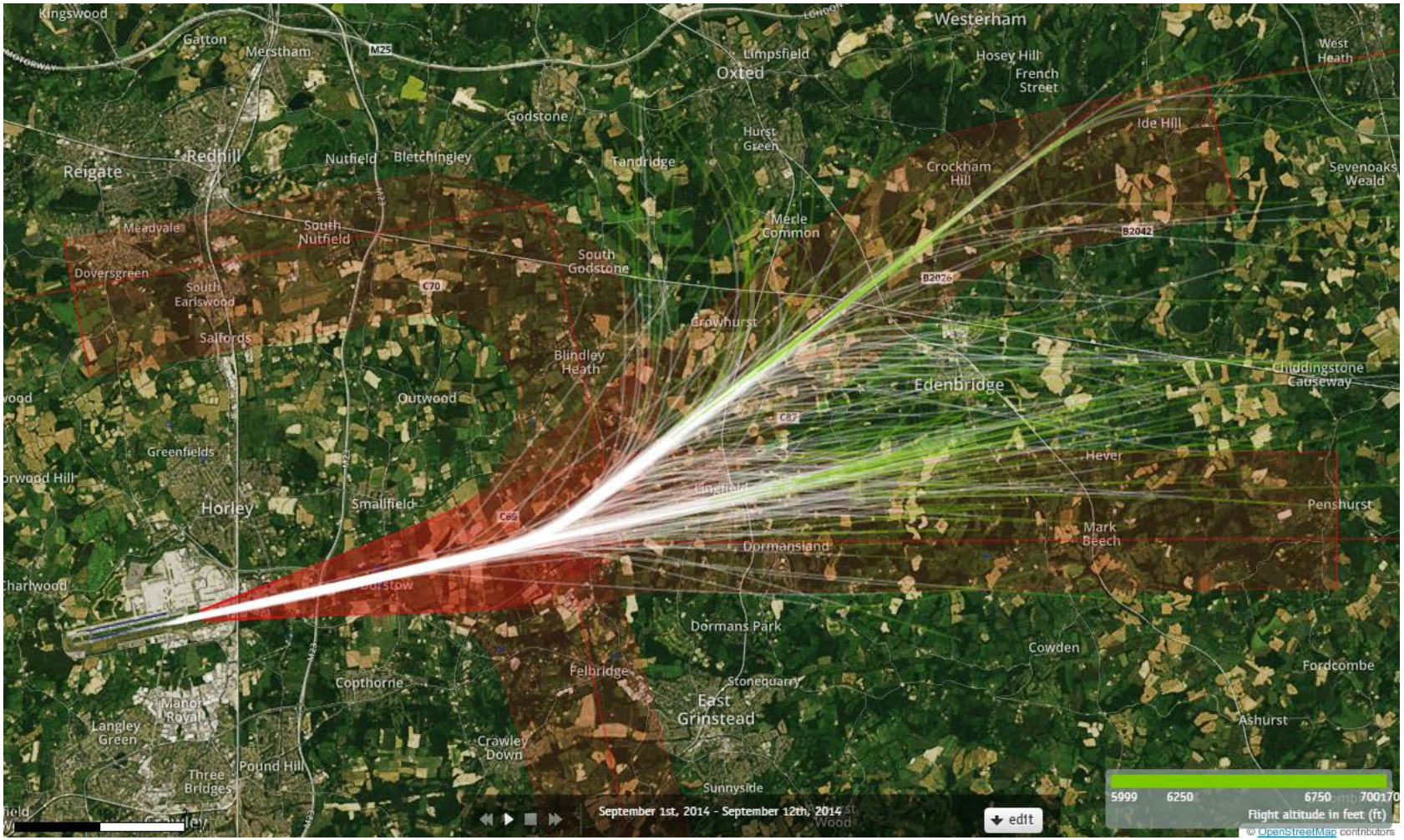
Green plots show the points at which an aircraft was between 6000 and 7000ft altitude.

08 DTY Departures March 2014
6000-7000 feet (283 Aircraft – CONVENTIONAL ONLY)



Green plots show the points at which an aircraft was between 6000 and 7000ft altitude.

08 DTY Departures 1st-11th September 2014
6000-7000 feet (253 Aircraft – P-RNAV ONLY)



Green plots show the points at which an aircraft was between 6000 and 7000ft altitude.