

## 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 PIR and 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 PIR and 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.

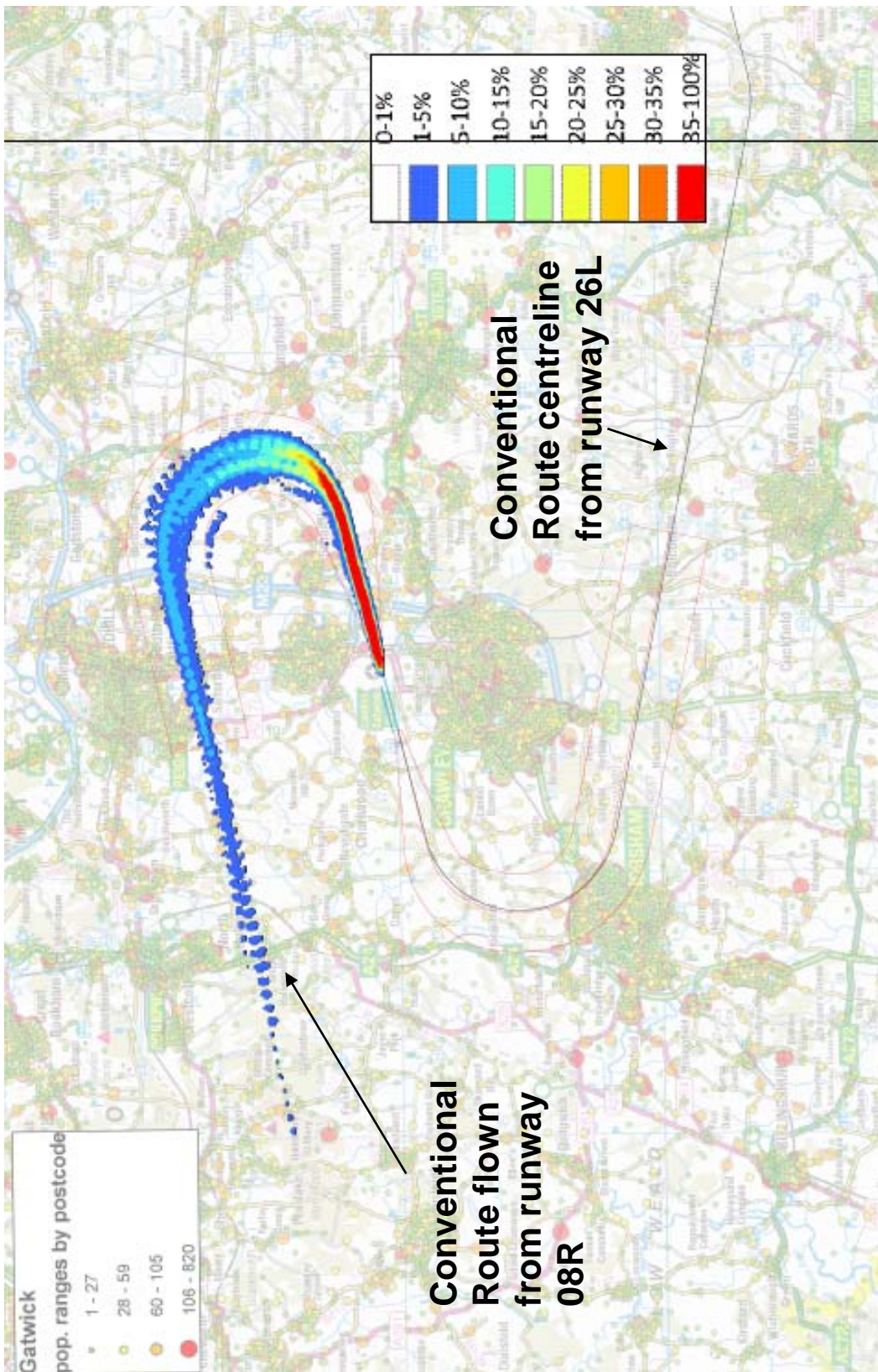
**ROUTE 3 - RWY 08 SAM / KENET – SAMPLE 1 Comparing Jun 13 (Conv) v Jul 14 (RNAV)**

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)
	Consultation Ref / Diagram	Fig 2 in Con Doc 300A  Fig 6 in ACP 301A		Fig 3 in Con Doc 300B  Fig 7 in ACP 301B		The forecast impact for this route was based on the impact shown in of the Con Doc Fig 3 and ACP Fig 7 which was predicated on the results of the Trial of Route 3.  A concentrated flightpath was forecast to occur on the NPR CL up to the first turn, and thereafter, just to the right of the NPR CL in the direction of travel for the remainder of the NPR swathe as shown in Con Doc Fig 7.		
Folder Ref	Diagram SAM3Z KENET1Z	Month <b>Jun 13</b>	Number <b>1098</b>	Month <b>Jul 14</b>	Number <b>1029</b>		Day: 3000 Night: 4000	
302	At 4000 ft  GAL Slides:4v7 CAA 2v3	Deps using almost 80% of the width of the NPR swathe during the turn, reducing to approx 20% of the width of the NPR swathe when aircraft steady up on west after crossing the M23. A few ac are outside the NPR swathe at Bletchingly.  There are also a number of deps to the west of the NPR swathe on the inside of the turn.		In the main, the dispersion of deps is 25-30% of the width of the NPR swathe during the turn; after the M23, deps steady up on west, with the main concentration to the north of the NPR CL north of South Earlswood. A few ac are outside the NPR swathe in the second half of the turn.  There are also a number of deps to the west of the NPR swathe on the inside of the turn.		The RNAV SID dispersion has reduced compared with the width of the conv SID departure track dispersion by, in the main over 50%. This is in line with data shown by GAL in consultation and the ACP.  Only a very insignificant number of deps are evident outside the NPR swathe on the outside and the inside of the turn (for both procedures).  The deps are more concentrated than the conventional SID dispersion which was the aim of the RNAV SID replication.	No significant change on vectoring.	RNAV track dispersion as expected.  RNAV sample is – 69 less.
303	Density Plot  CON DOC RTE 3  GAL Slides 4v7 CAA 2v3	Deps occupy approx. 50% of the width of the NPR swathe in the turn, then once the turn is complete when ac are steady on west, there are 3 distinct tracks extending westwards towards South & Mid Holmwood. Vectoring obvious after crossing the A23.		Deps occupy approx. 20% of the width of the NPR swathe in the turn, then there is a steady concentrated dispersion extending westwards towards Mid Holmwood. Vectoring obvious after crossing the A23.		The RNAV SID dispersion has reduced compared with the width of the conv SID departure track dispersion by, in the main over 50%. The picture shows a steady turn after departure around the 180 deg turn onto west. 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.  The resultant westbound track is slightly north of the NPR CL but well within the NPR swathe. This corresponds with the forecast impact in Fig 7 of the Con Doc.	No significant change on vectoring.	RNAV track dispersion as expected.  RNAV sample is – 69 less.  This appears to be a successful design.
	Alt Slice Diagrams (Note 7)	Period <b>1-14 Mar 14</b>	Number <b>223</b>	Period <b>1-7 Sep 14</b>	Number <b>355</b>			
304	Alt 4-5000ft  GAL Slides:2-5 CAA:2-5	Some deps at 4000ft just after commencement of the 180 deg turn.  Deps using the full width of the NPR swathe during second half of turn onto west.  Vectoring apparent after M23.  A few ac are outside the NPR swathe at Bletchingly.		Some deps at 4000ft just after commencement of the 180 deg turn.  Deps using right side of NPR swathe during second half of turn onto west.  Vectoring apparent after M23.  No ac detected outside the NPR swathe at Bletchingly.		The RNAV SID dispersion has reduced compared with the width of the conv SID departure track dispersion in this alt band.  After crossing the M23, the RNAV SID dispersion is comparable to the width of the conv SID departure track dispersion.	No significant change on vectoring.	Traffic above 4000ft was not assessed in the ACP analysis as deps may be tactically vectored when reaching 3000/4000ft.  RNAV sample is +123 more.

<p><b>305</b></p>	<p>Alt 5-6000ft                      GAL Slides:6-9                      CAA 2-5</p>	<p>Some deps at 5000ft + after mid-way through the 180 deg turn.                       Vectoring apparent after M23.</p>	<p>Some deps at 5000ft + from mid-way through the 180 deg turn.                       Vectoring apparent after M23.</p>	<p>The RNAV SID dispersion is comparable with the width of the conv SID departure track dispersion in this alt band due.</p>	<p>No significant change on vectoring.                       However, due to the increased number of RNAV deps in this sample, the density of ac being vectored is clearly evident.</p>	<p>Traffic above 4000ft was not assessed in the ACP analysis as deps may be tactically vectored when reaching 3000/4000ft.                       RNAV sample is +123 more.</p>
<p><b>306</b></p>	<p>Alt 6-7000ft                      GAL Slides:10-13                      CAA 2-5</p>	<p>Most deps at 6000ft + after completion of turn onto west.                       Vectoring apparent after M23.</p>	<p>Most deps at 6000ft + after completion of turn onto west.                       Vectoring apparent after M23.</p>	<p>The RNAV SID dispersion is comparable to the width of the conv SID departure track dispersion in this alt band due to vectoring after M23.</p>	<p>No significant change on vectoring.                       However, due to the increased number of RNAV deps in this sample, the density of ac being vectored is clearly evident.</p>	<p>Traffic above 4000ft was not assessed in the ACP analysis as deps may be tactically vectored when reaching 3000/4000ft.                       RNAV sample is +123 more.</p>

**ROUTE 3 - RWY 08 SAM / KENET – SAMPLE 2 Comparing Jul 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 (Note 3)	Observations on Vectoring (Note 4)	Remarks (Note 5)
		Month	Number	Month	Number			
Folder Ref	Diagram <b>SAM3Z</b> <b>KENET1Z</b>	<b>Jul 13</b>	<b>1549</b>	<b>Jun 14</b>	<b>1419</b>		Day: 3000ft Night: 4000ft	
<b>307</b>	At 4000 ft <b>GAL Slides 8&amp;3</b> <b>CAA 2v3</b>	Deps using almost 80% of the width of the NPR swathe during the turn, reducing to approx. concentration 20% width when aircraft steady up on west after crossing the A217. A few ac are outside the NPR swathe at Blenchingly.		In the main, the dispersion of deps is 25-30% of the width of the NPR swathe during the turn; after the M23, deps steady up on west, with the main concentration to the north of the NPR CL north of South Earlswood. A few ac are outside the NPR swathe in the second part of the turn.		The RNAV SID dispersion has reduced compared with the width of the conv SID departure track dispersion by, in the main over 50%. This is in line with data shown by GAL in consultation and the ACP.  Only a very insignificant number of deps are evident outside the NPR swathe on the outside of the turn.  The deps are more concentrated than the conventional SID dispersion which was the aim of the RNAV SID replication.	No significant change on vectoring.	RNAV track dispersion as expected.  RNAV sample is – 130 less.
<b>308</b>	Density Plot <b>CON DOC RTE 3</b> <b>Slides 8&amp;3</b> <b>CAA 2v3</b>	Deps occupy approx. 60-70% of the width of the NPR swathe in the turn, then there are 3 distinct tracks extending westwards towards South & Mid Holmwood. Vectoring obvious after crossing the A23.		Deps occupy approx. 20% of the width of the NPR swathe in the turn, then there are 3 distinct tracks extending westwards towards South & Mid Holmwood. Vectoring obvious after crossing the A23.		The RNAV SID dispersion has reduced compared with the width of the conv SID departure track dispersion by, in the main over 50%. The picture shows a steady turn after departure around the 180 deg turn onto west. 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.	No significant change on vectoring.	RNAV track dispersion as expected.  RNAV sample is – 130 less.



**Figure 2)** Density of aircraft tracks (up to 4000 feet AMSL) following **Conventional SID departure** from runway 08R (no track density plots are available for SIDs turning left (between Crawley and Horsham) from runway 26L as there was insufficient radar track data available)

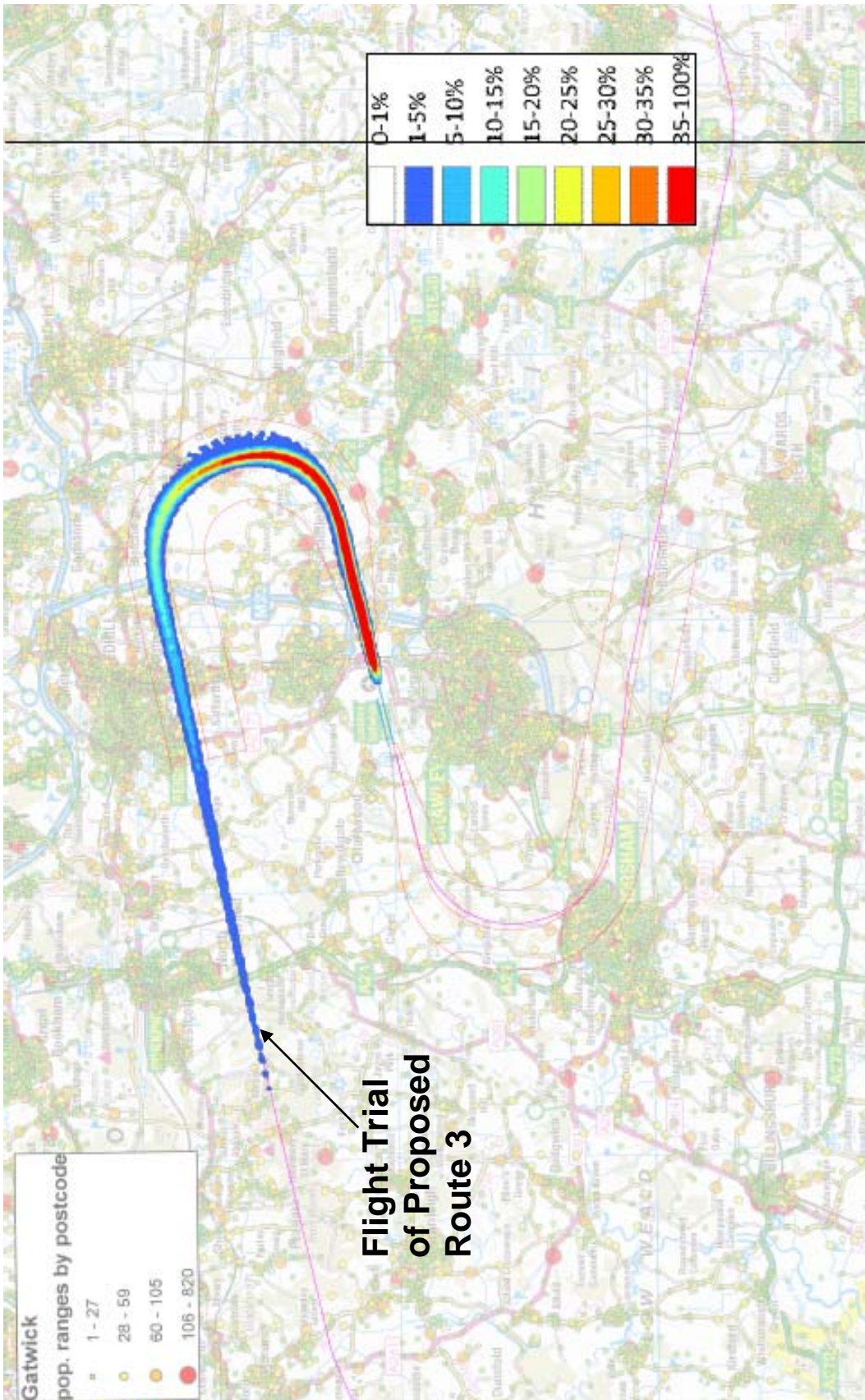
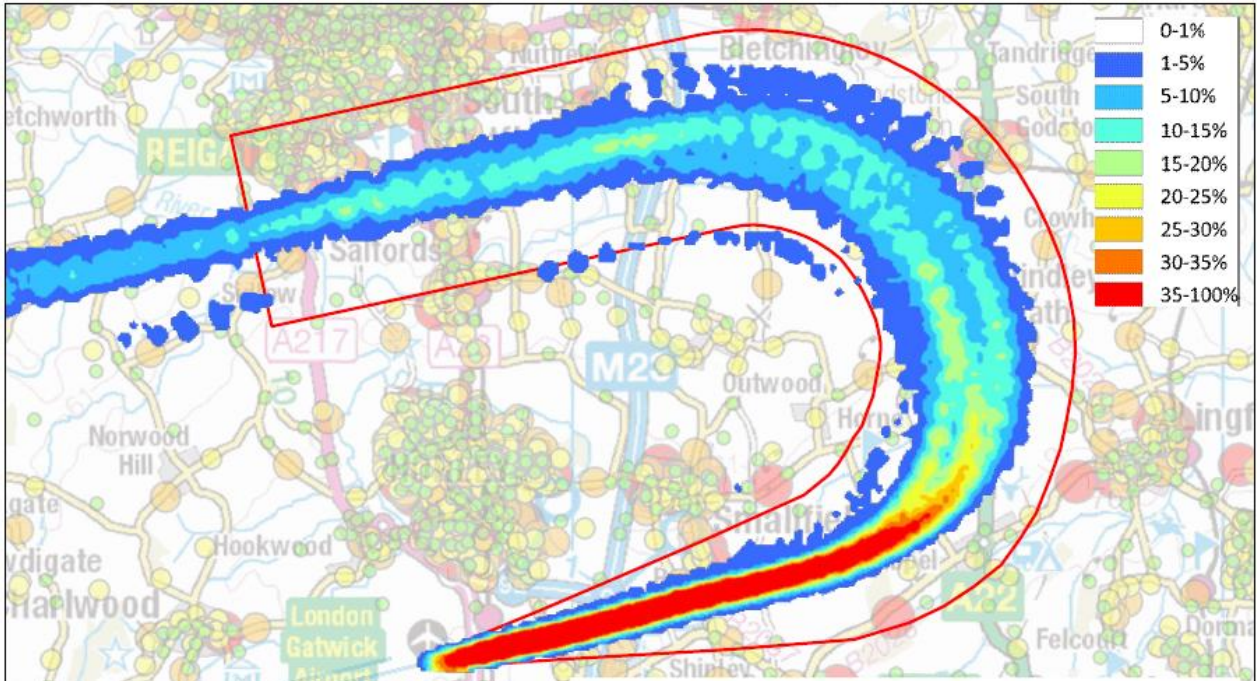


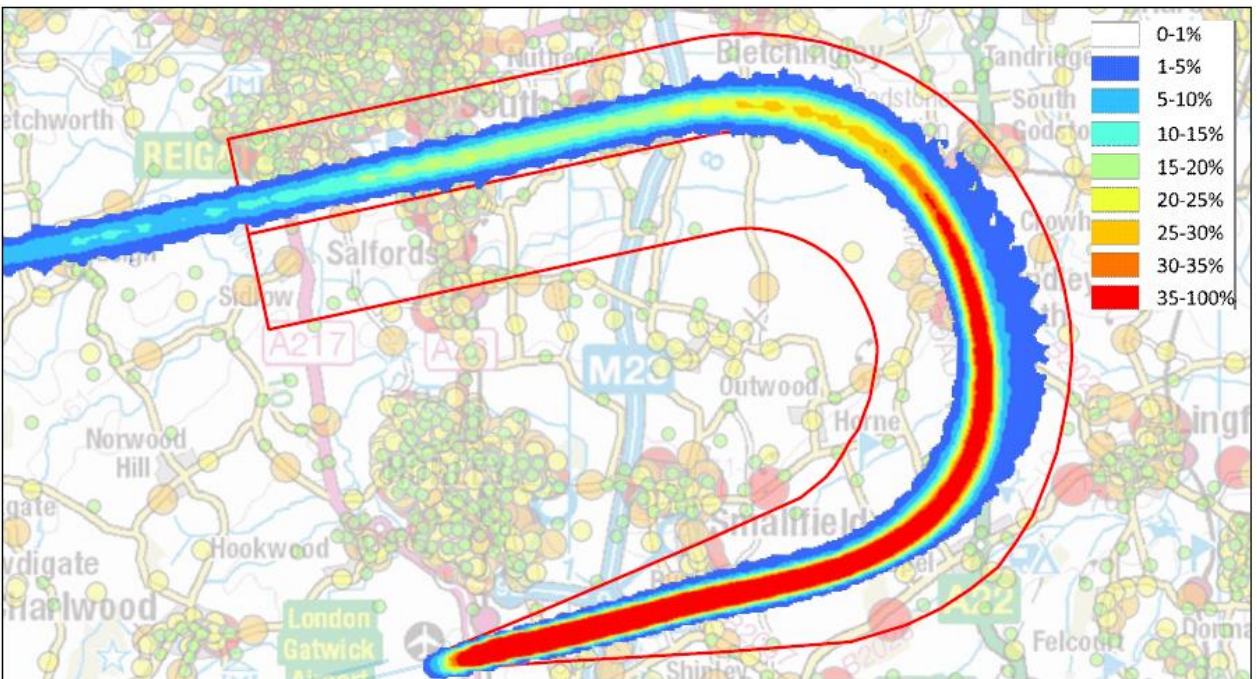
Figure 3) Density plot of aircraft tracks (up to 4000 feet AMSL) following P-RNAV (ROUTE 3) departure SID from runway 08R





301 A  
< BACK

Figure 6 Route 3 Conventional Navigation



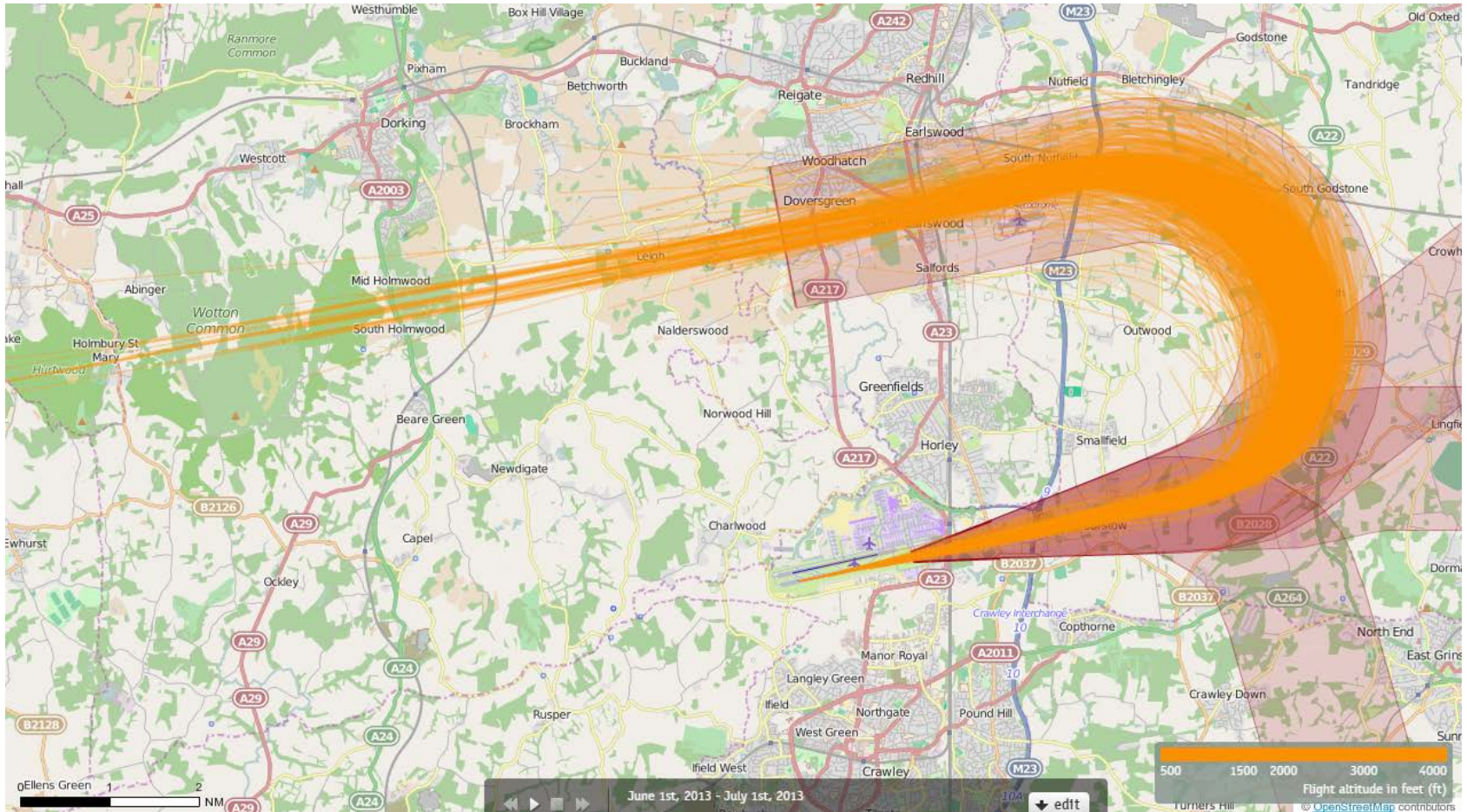
301 B  
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Figure 7 Route 3 PRNAV Navigation

# 08 KENET Route 3

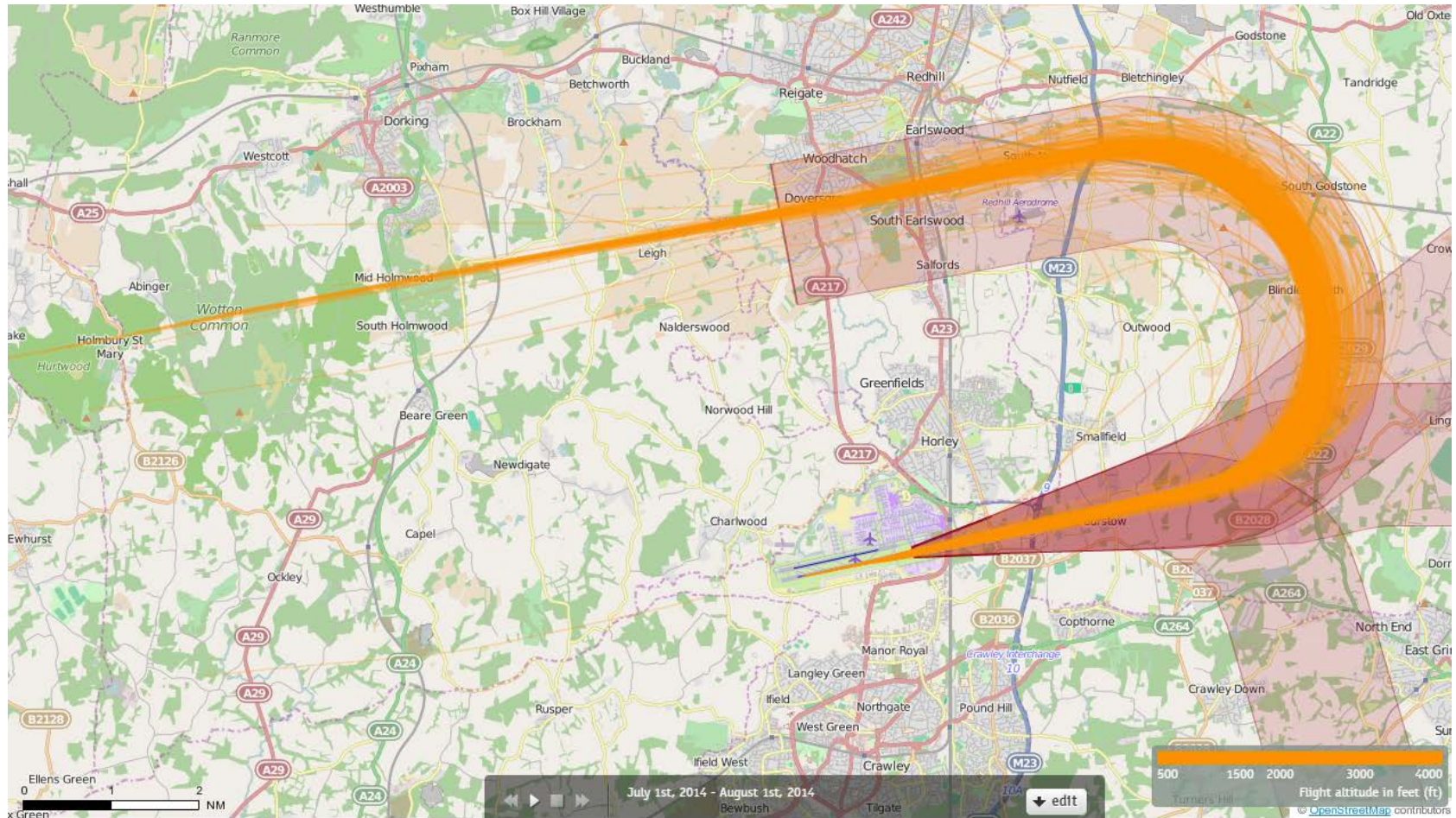
Pre and Post P-RNAV

# 08KENET June 2013 Aircraft Tracks Cut Off at 4000ft Altitude 1098 Aircraft – Showing CONVENTIONAL Departures Only



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

# 08KENET July 2014 Aircraft Tracks Cut Off at 4000ft Altitude 1029 Aircraft – Showing P-RNAV Departures Only



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

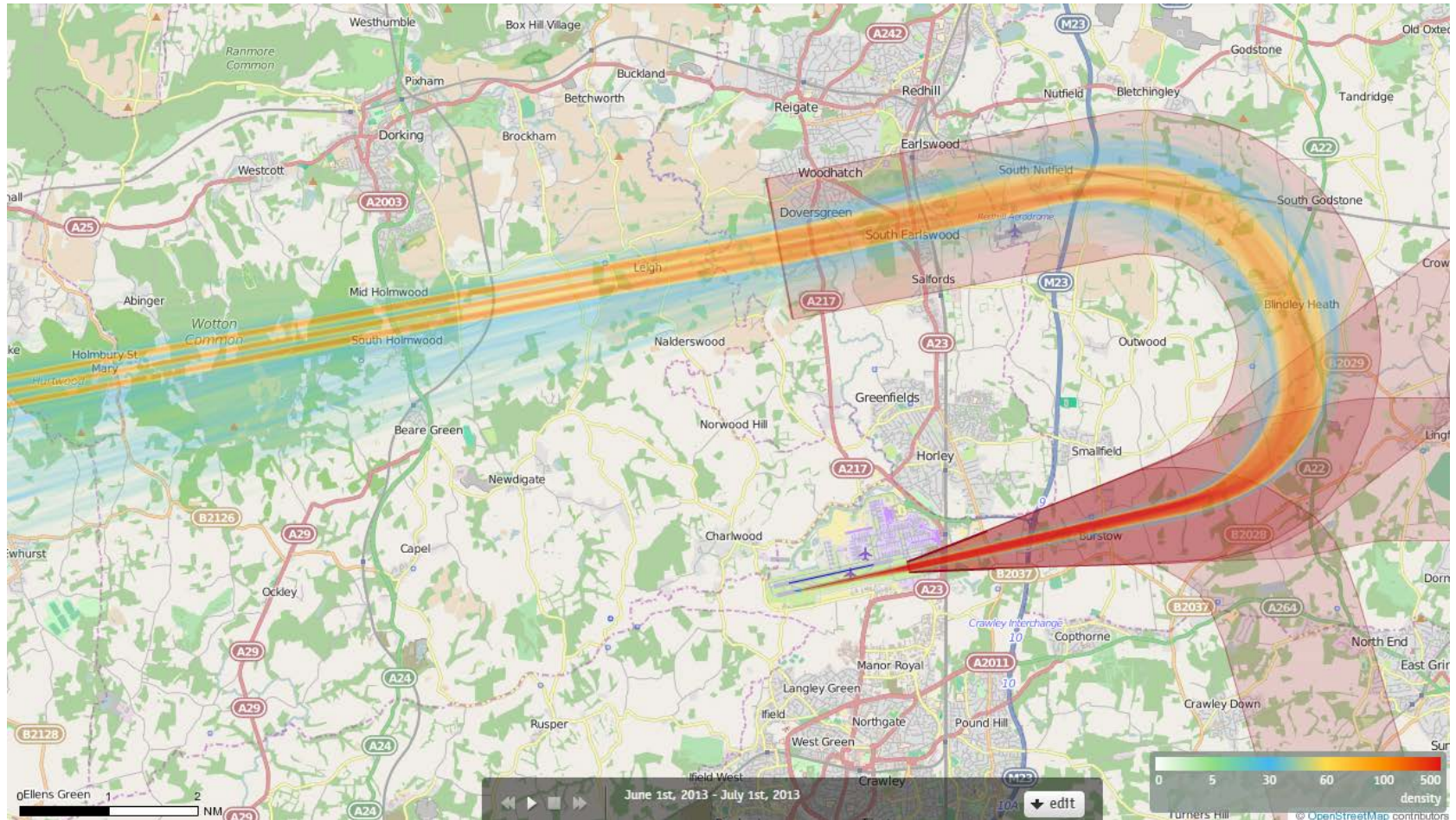
# 08 KENET

## Route 3

Pre and Post P-RNAV

# 08 KENET Density June 2013

## 1098 Aircraft – Showing CONVENTIONAL Departures Only



### Track density

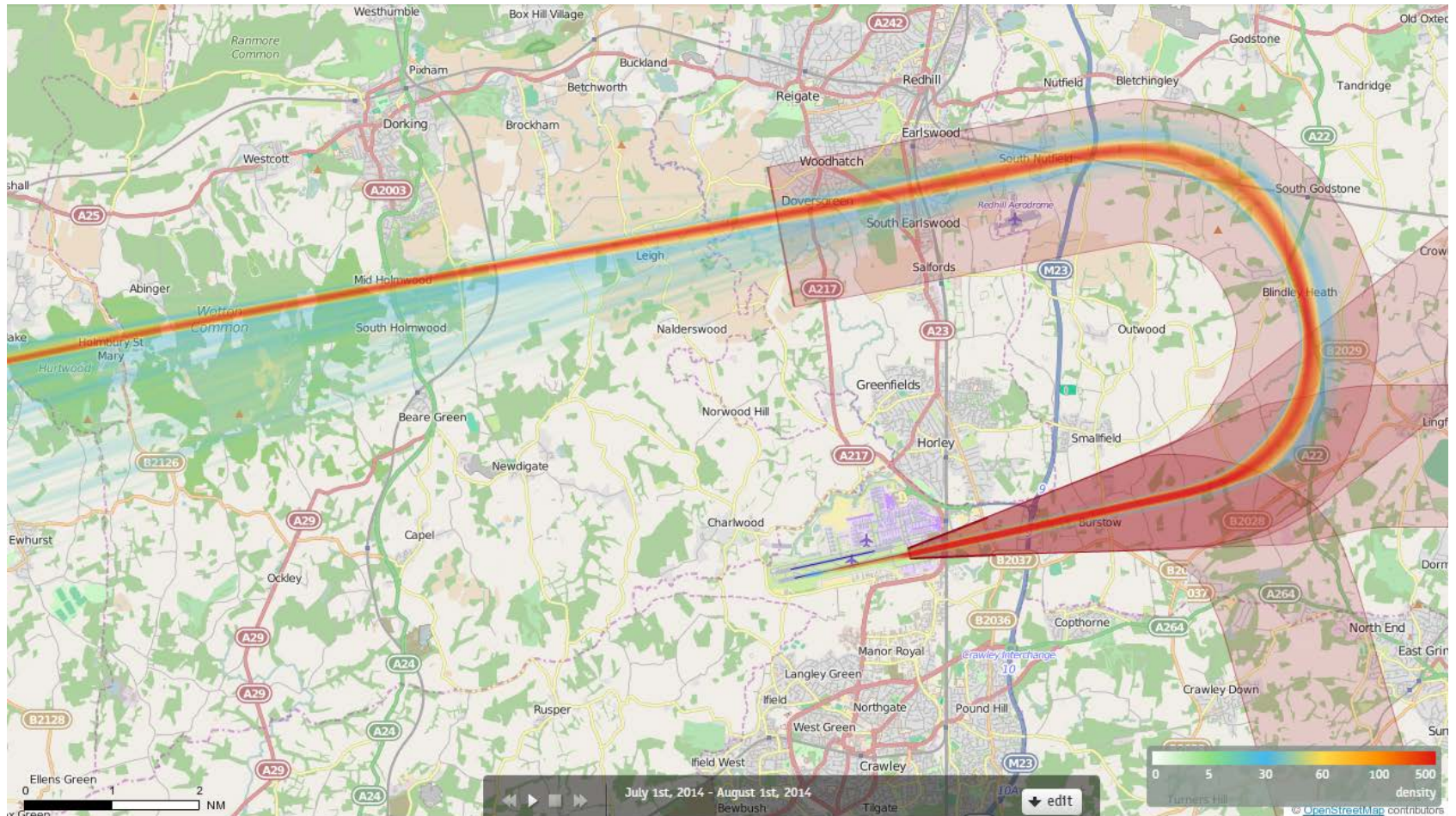
Each track is drawn as a line which has a width of just a few pixels and each pixel on the screen counts how often a 'track line' comes across this pixel when drawing all the tracks.

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.

# 08KENET Density July 2014

## 1029 Aircraft – Showing P-RNAV 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.

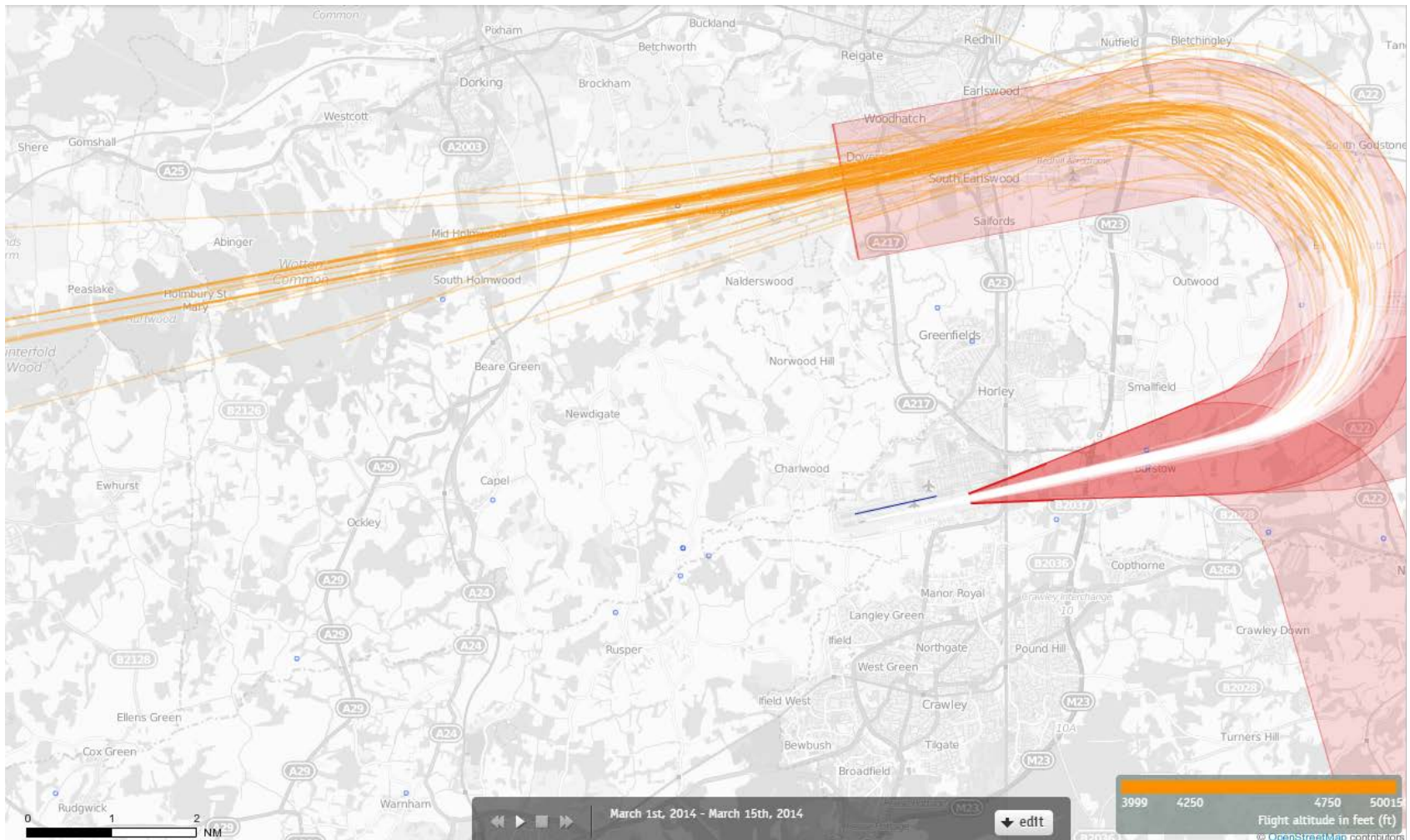
Counts in between are mapped to colours in between. If 100 were orange and 200 were red, then 150 would be coloured some orangy red.

# 08 KENET Route 3

Altitude Bands  
4000-5000ft

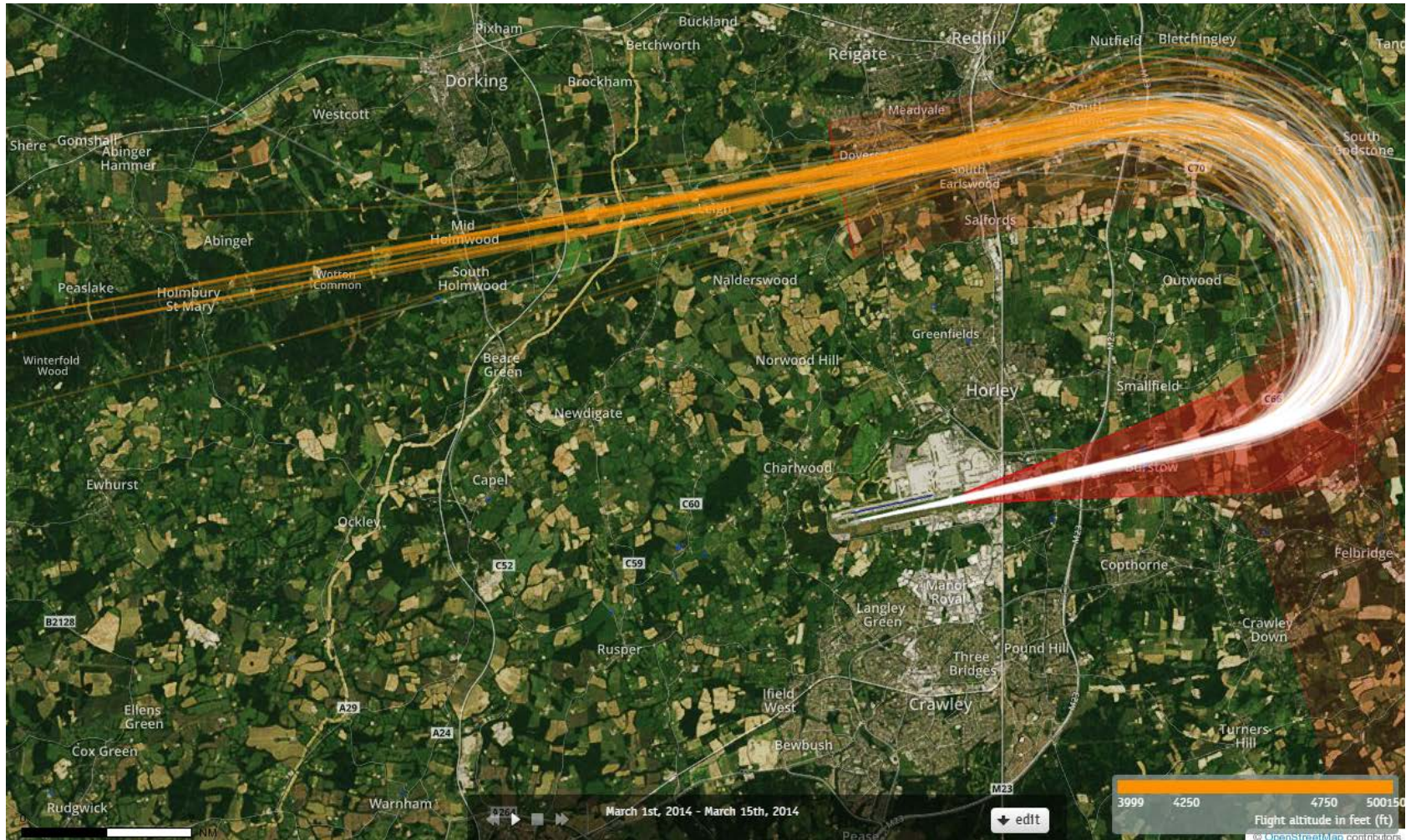


# 08 KEN Departures 1<sup>st</sup>-14<sup>th</sup> March 2014 4000-5000 feet (223 Aircraft – CONVENTIONAL ONLY)



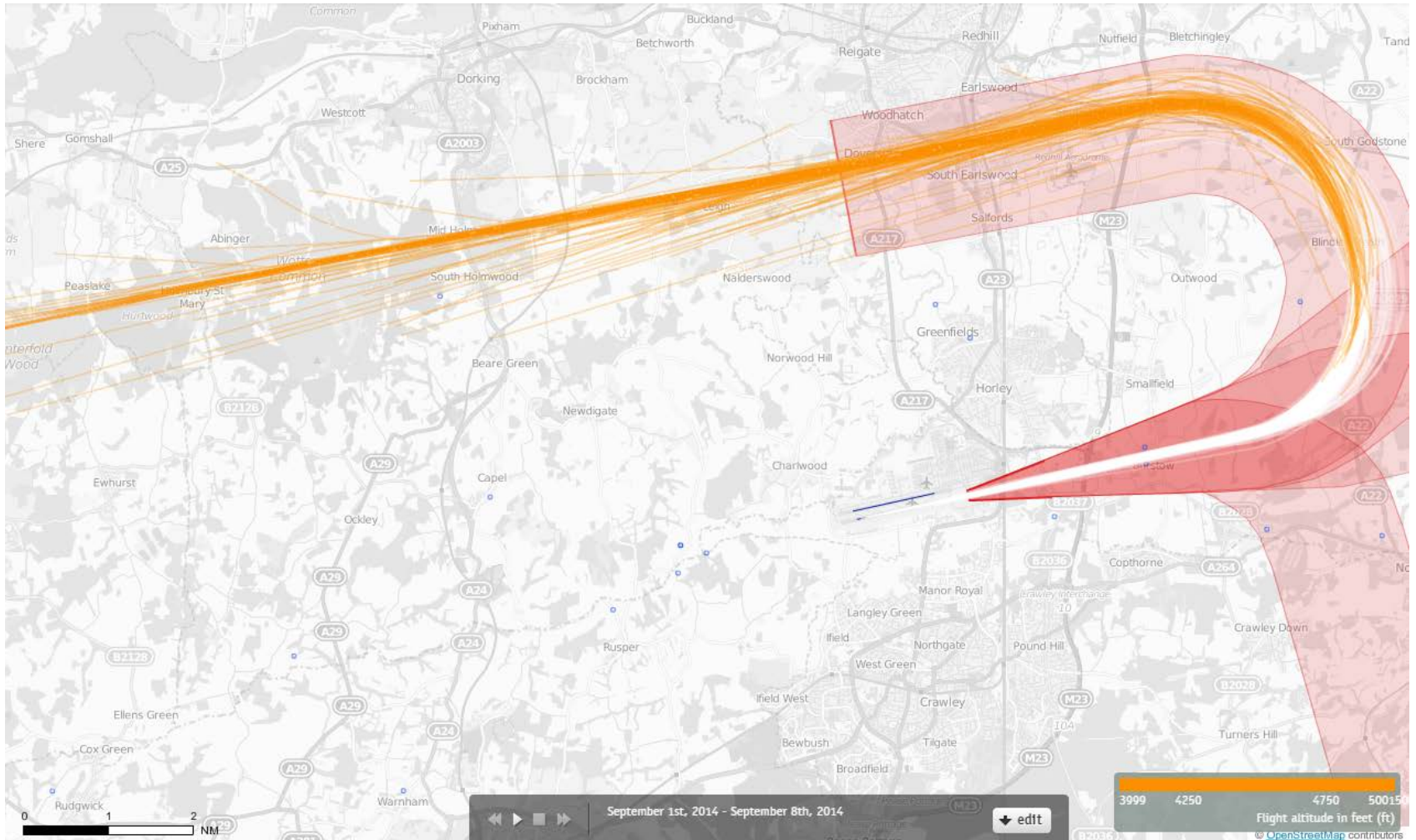
Orange plots show the points at which an aircraft was between 4000 and 5000ft altitude.

# 08 KEN Departures 1<sup>st</sup>-14<sup>th</sup> March 2014 4000-5000 feet (223 Aircraft – CONVENTIONAL ONLY)



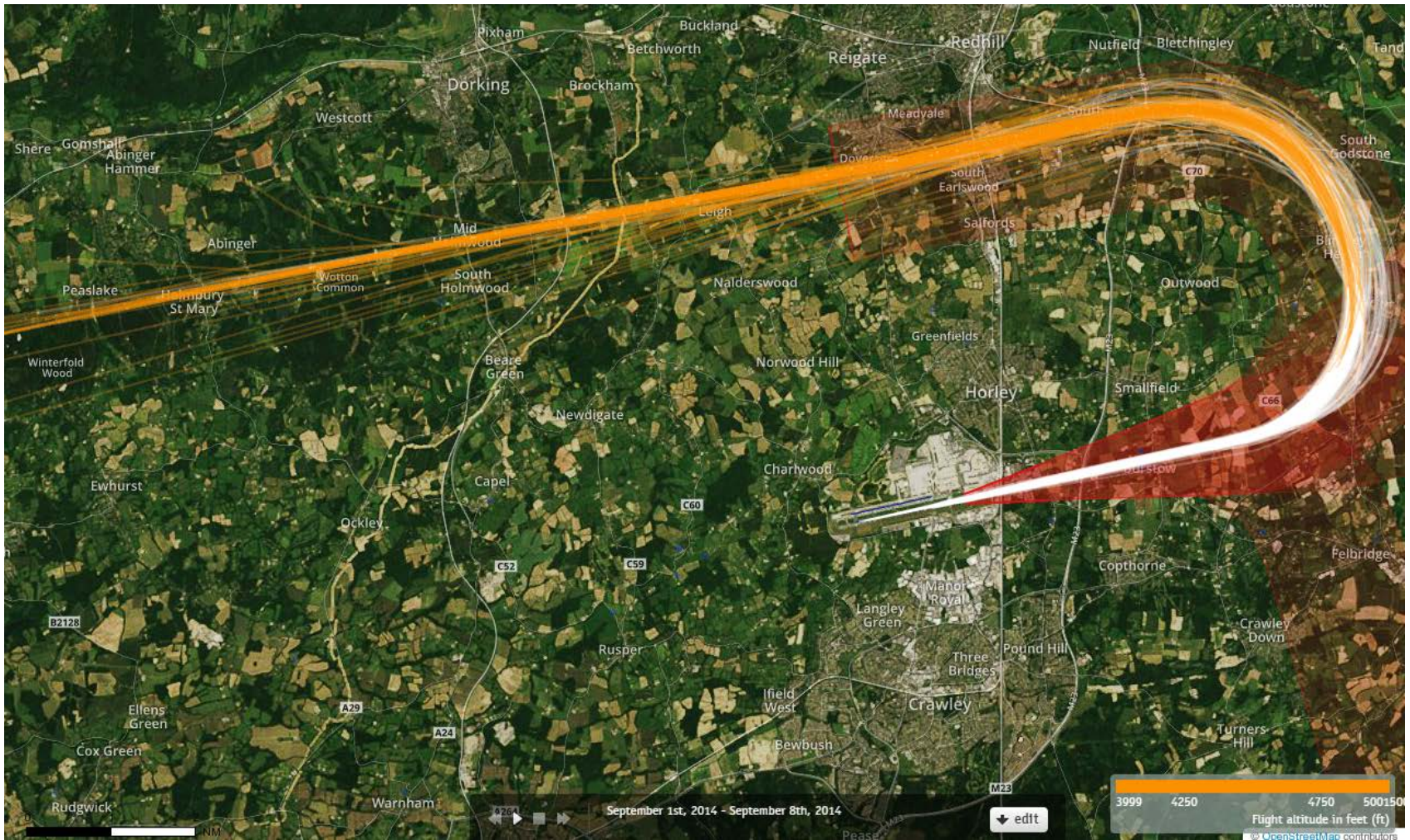
Orange plots show the points at which an aircraft was between 4000 and 5000ft altitude.

# 08 KEN Departures 1<sup>st</sup> – 7<sup>th</sup> September 2014 4000-5000 feet (355 Aircraft – P-RNAV ONLY)



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

# 08 KEN Departures 1<sup>st</sup> – 7<sup>th</sup> September 2014 4000-5000 feet (355 Aircraft – P-RNAV ONLY)

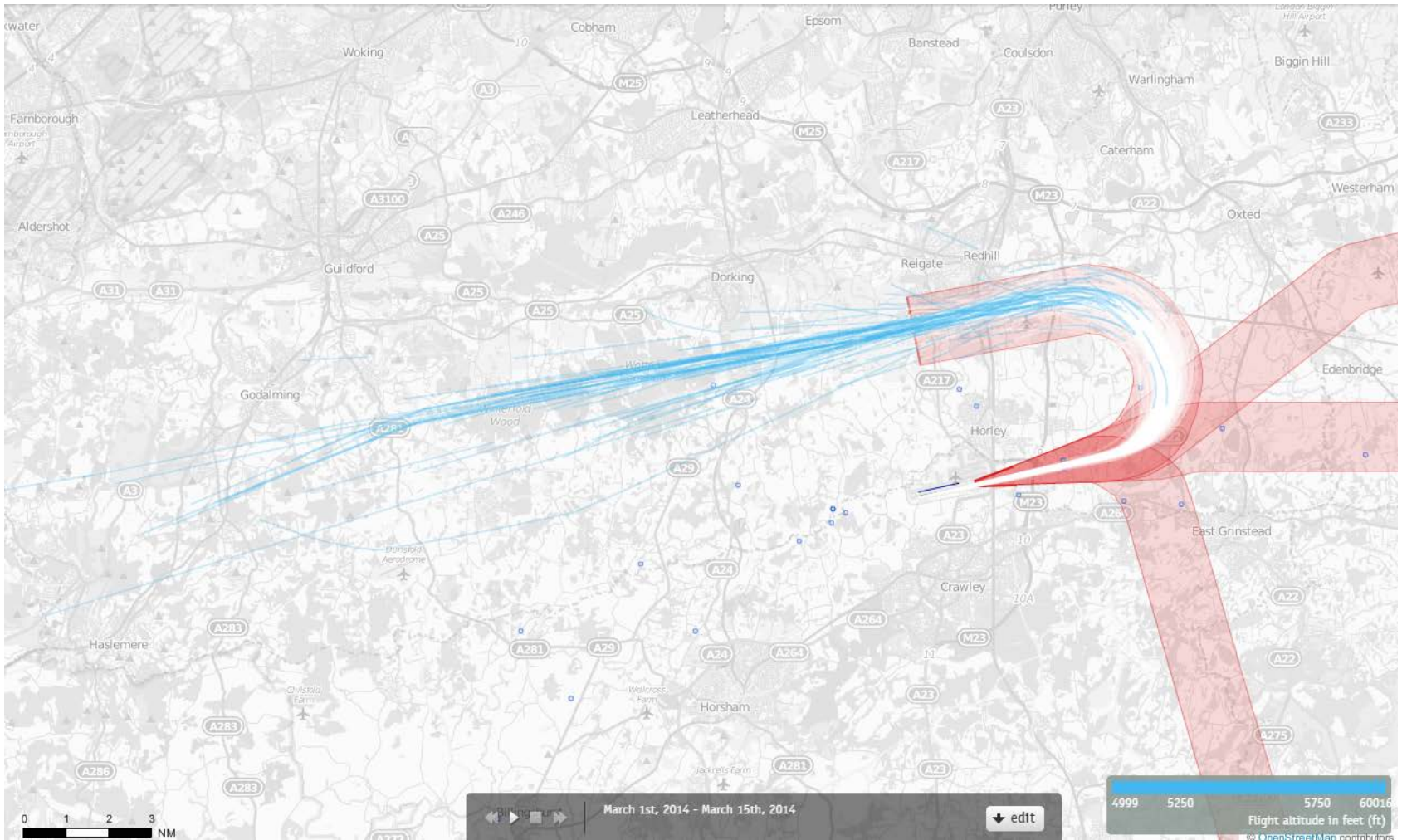


Orange plots show the points at which an aircraft was between 4000 and 5000ft altitude.

# 08 KENET Route 3

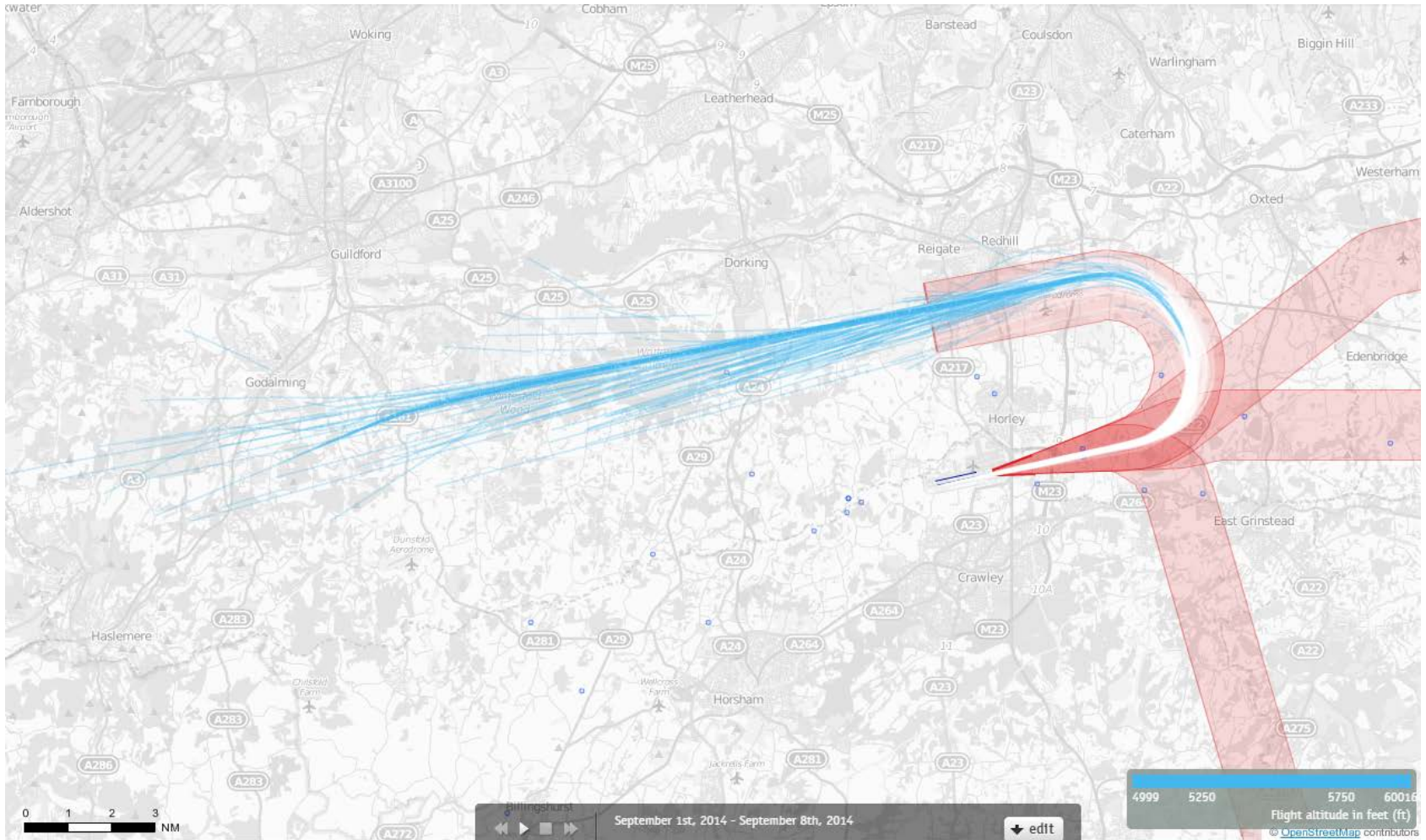
Altitude Bands  
5000-6000ft

# 08 KEN Departures 1<sup>st</sup>-14<sup>th</sup> March 2014 5000-6000 feet (223 Aircraft – CONVENTIONAL ONLY)



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

# 08 KEN Departures 1<sup>st</sup> – 7<sup>th</sup> September 2014 5000-6000 feet (335 Aircraft – P-RNAV ONLY)



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

# 08 KEN Departures 1<sup>st</sup> – 14<sup>th</sup> March 2014 5000-6000 feet (223 Aircraft – CONVENTIONAL ONLY)



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



# 08 KEN Departures 1<sup>st</sup> – 7<sup>th</sup> September 2014 5000-6000 feet (335 Aircraft – P-RNAV ONLY)



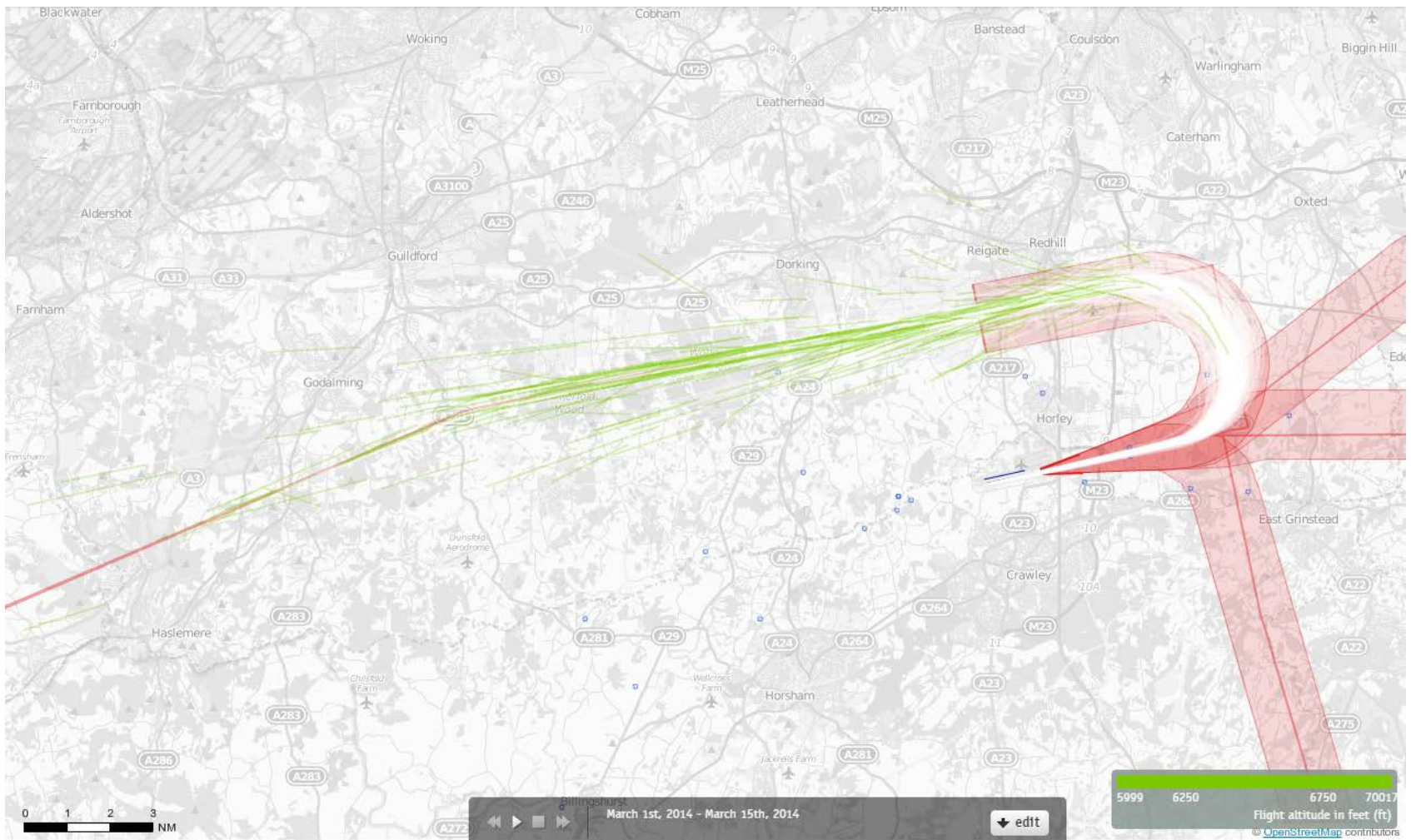
Blue plots show the points at which an aircraft was between 5000 and 6000ft altitude.

# 08 KENET Route 3

Altitude Bands  
6000-7000ft

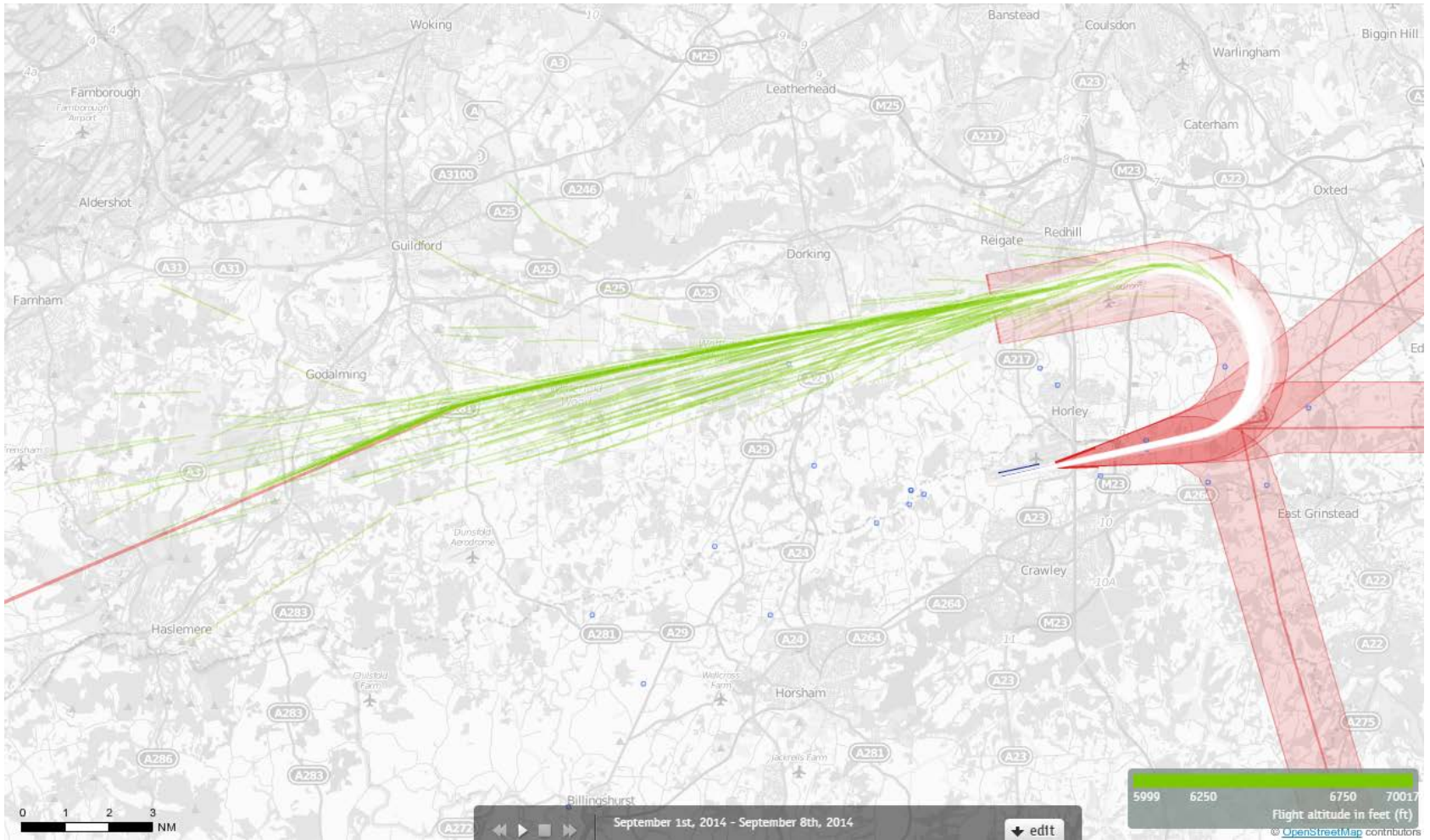
# 08 KEN Departures 1<sup>st</sup> – 14<sup>th</sup> March 2014

## 6000-7000 feet (223 Aircraft – CONVENTIONAL ONLY)



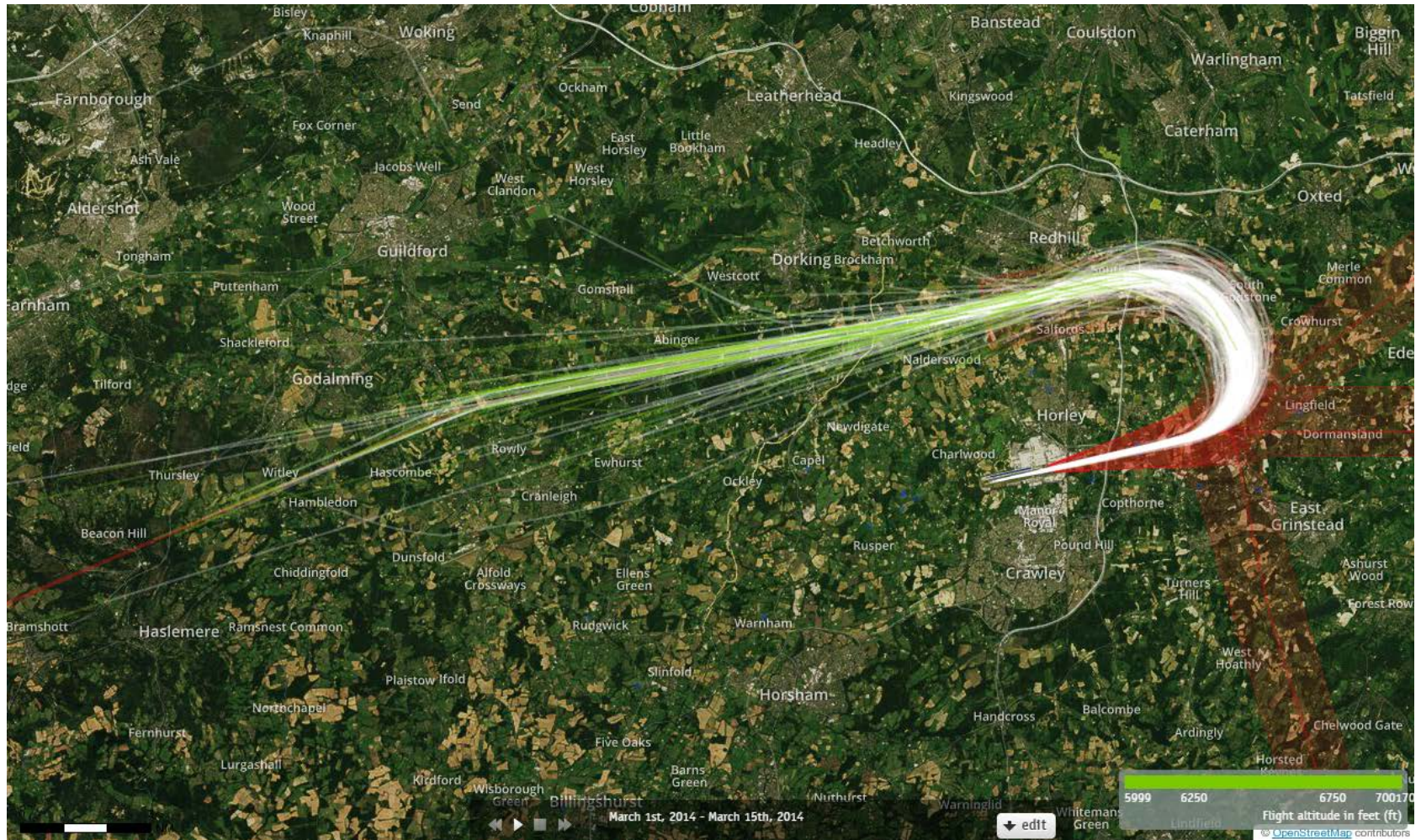
Green plots show the points at which an aircraft was between 6000 and 7000ft altitude.

# 08 KEN Departures 1<sup>st</sup> – 7<sup>th</sup> September 2014 6000-7000 feet (335 Aircraft – P-RNAV ONLY)



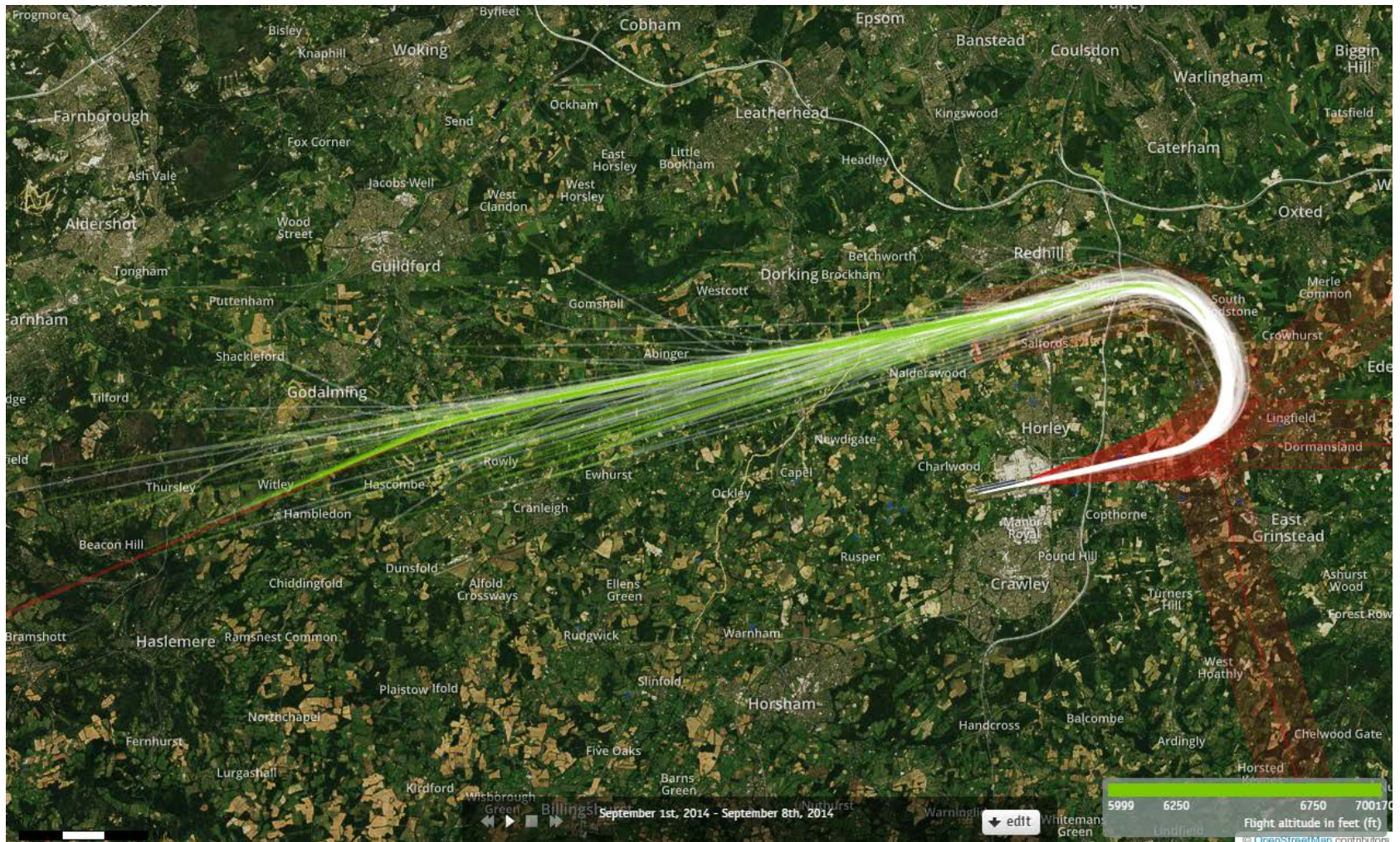
Green plots show the points at which an aircraft was between 6000 and 7000ft altitude.

# 08 KEN Departures 1<sup>st</sup>-14<sup>th</sup> March 2014 6000-7000 feet (223 Aircraft – CONVENTIONAL ONLY)



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

# 08 KEN Departures 1<sup>st</sup> – 7<sup>th</sup> September 2014 6000-7000 feet (335 Aircraft – P-RNAV ONLY)

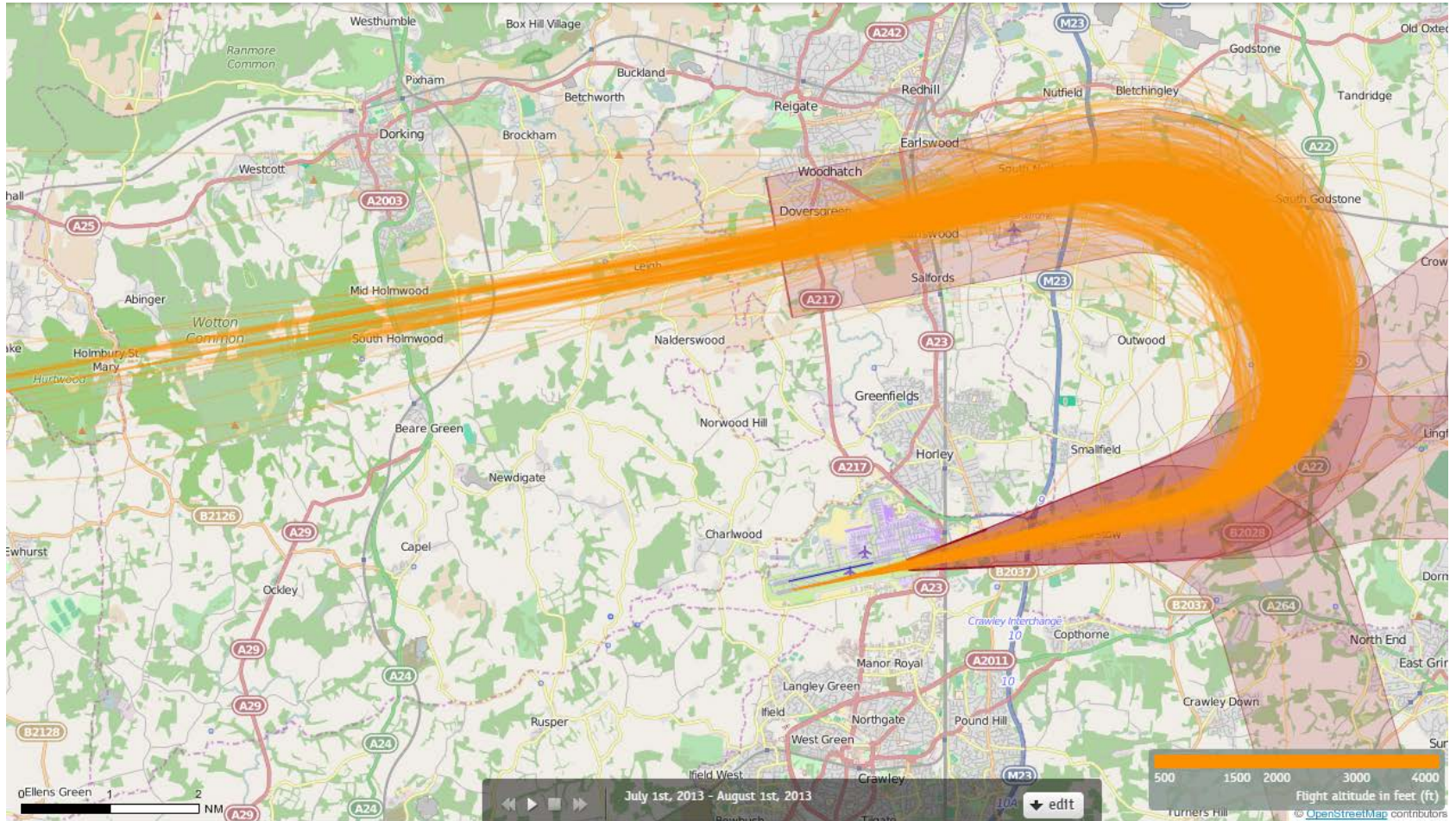


Green plots show the points at which an aircraft was between 6000 and 7000ft altitude.

# 08 KENET Route 3

Pre and Post P-RNAV

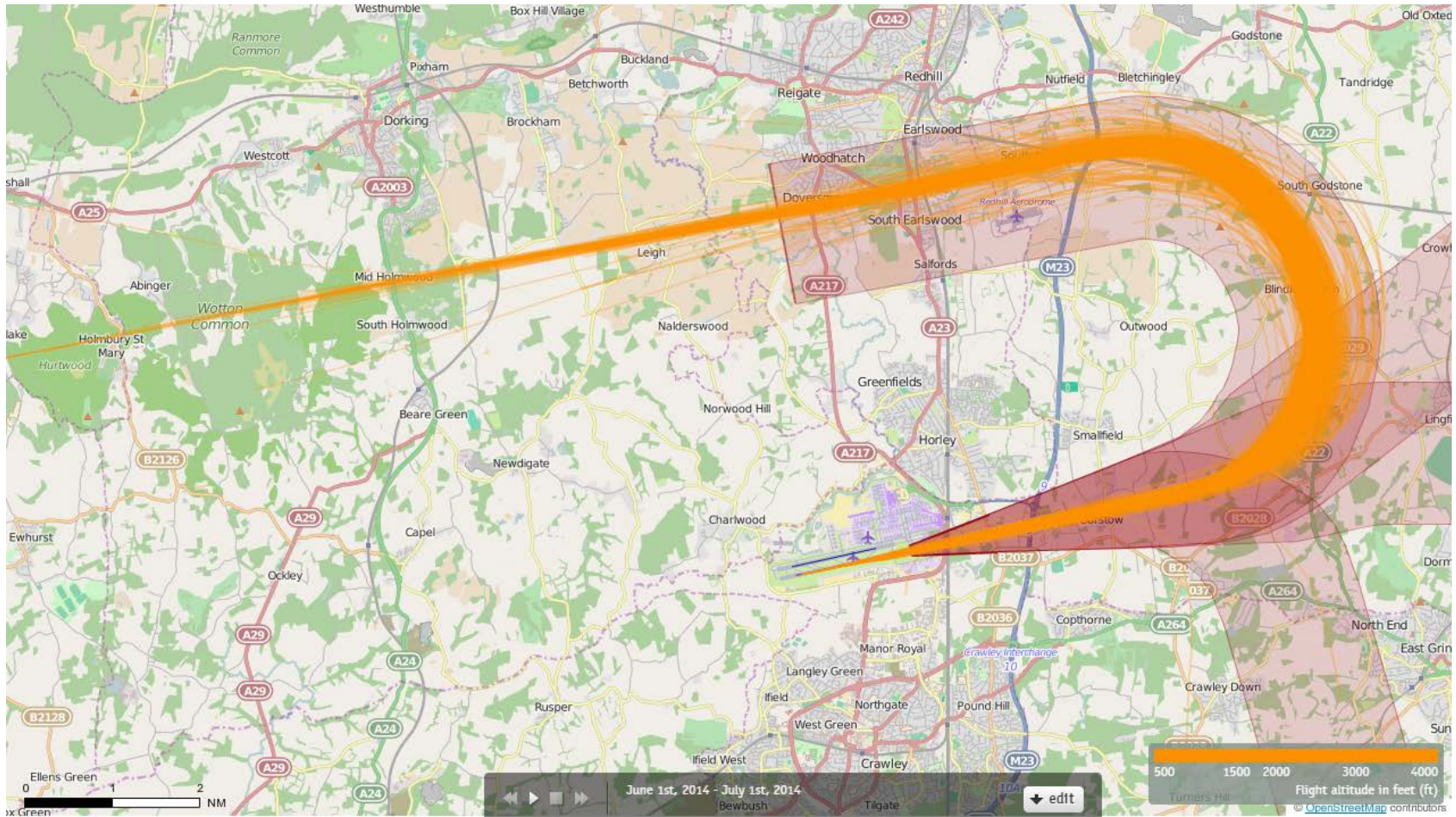
# 08KENET July 2013 Aircraft Tracks Cut Off at 4000ft Altitude 1549 Aircraft – Showing CONVENTIONAL Departures Only



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



# 08KENET June 2014 Aircraft Tracks Cut Off at 4000ft Altitude 1419 Aircraft – Showing P-RNAV Departures Only



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

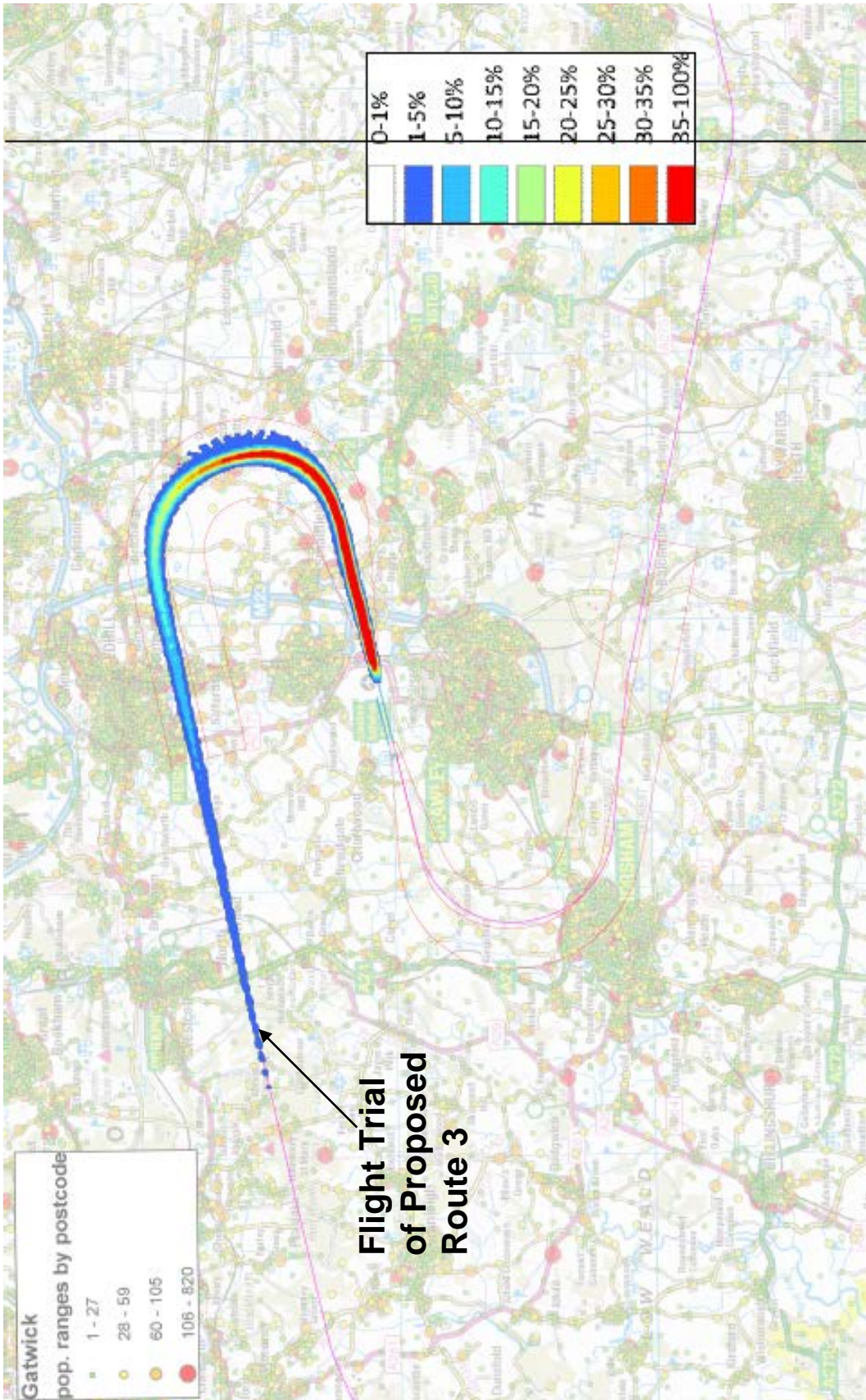


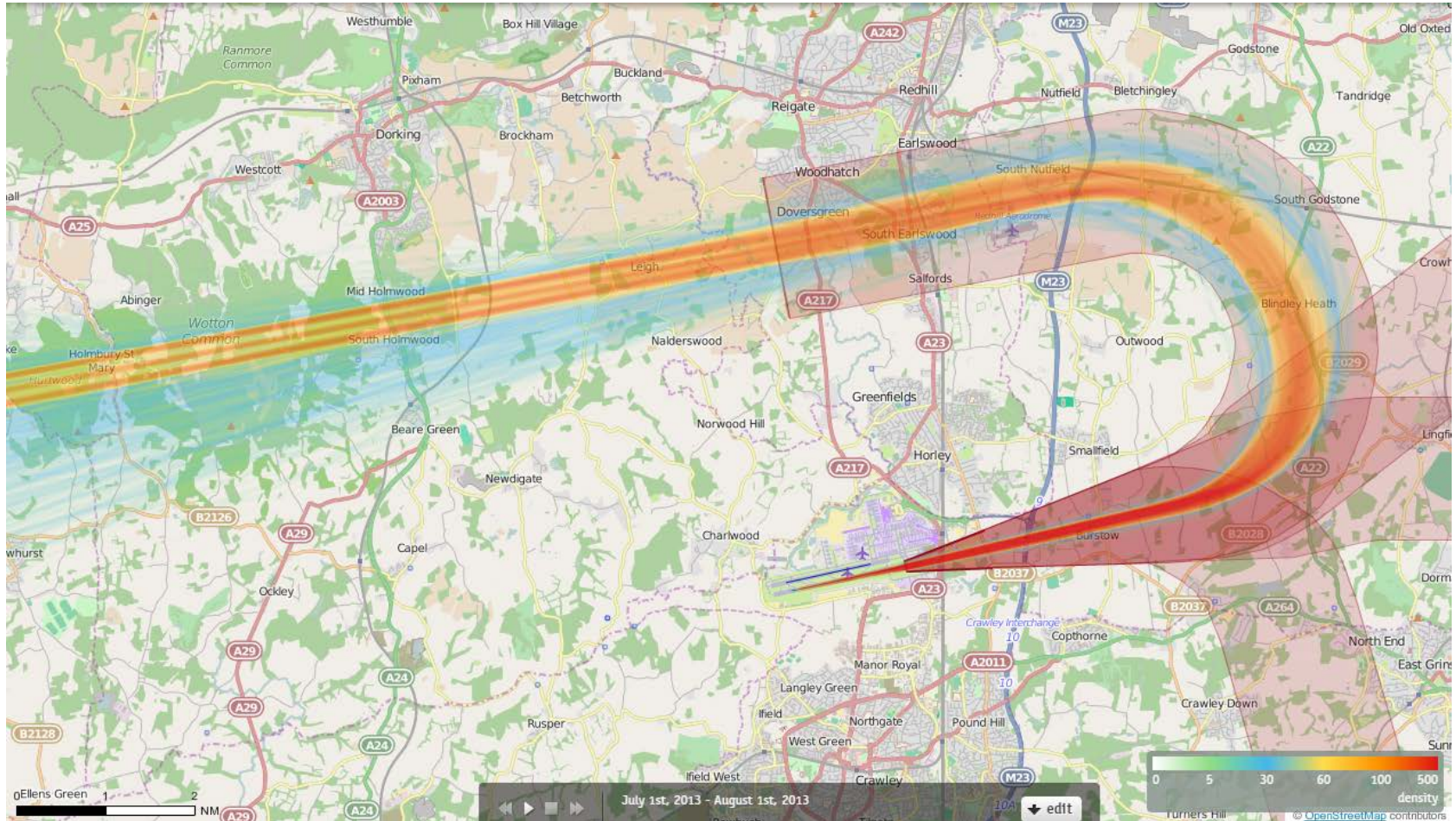
Figure 3) Density plot of aircraft tracks (up to 4000 feet AMSL) following P-RNAV (ROUTE 3) departure SID from runway 08R

# 08 KENET Route 3

Pre and Post P-RNAV

# 08KENET Density July 2013

## 1549 Aircraft – Showing CONVENTIONAL Departures Only



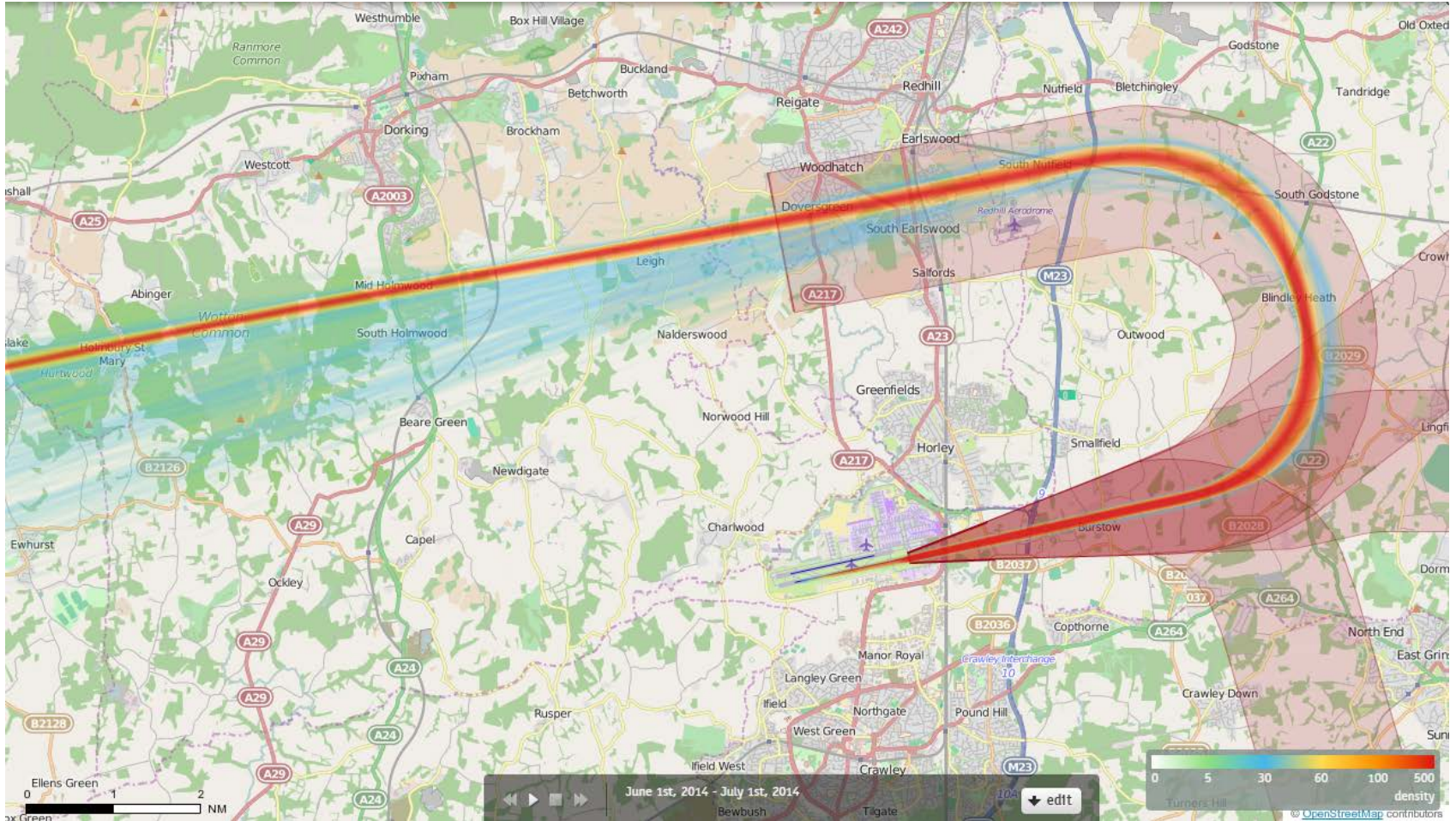
### Track density

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.

# 08KENET Density June 2014 1419 Aircraft – Showing P-RNAV 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.