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)

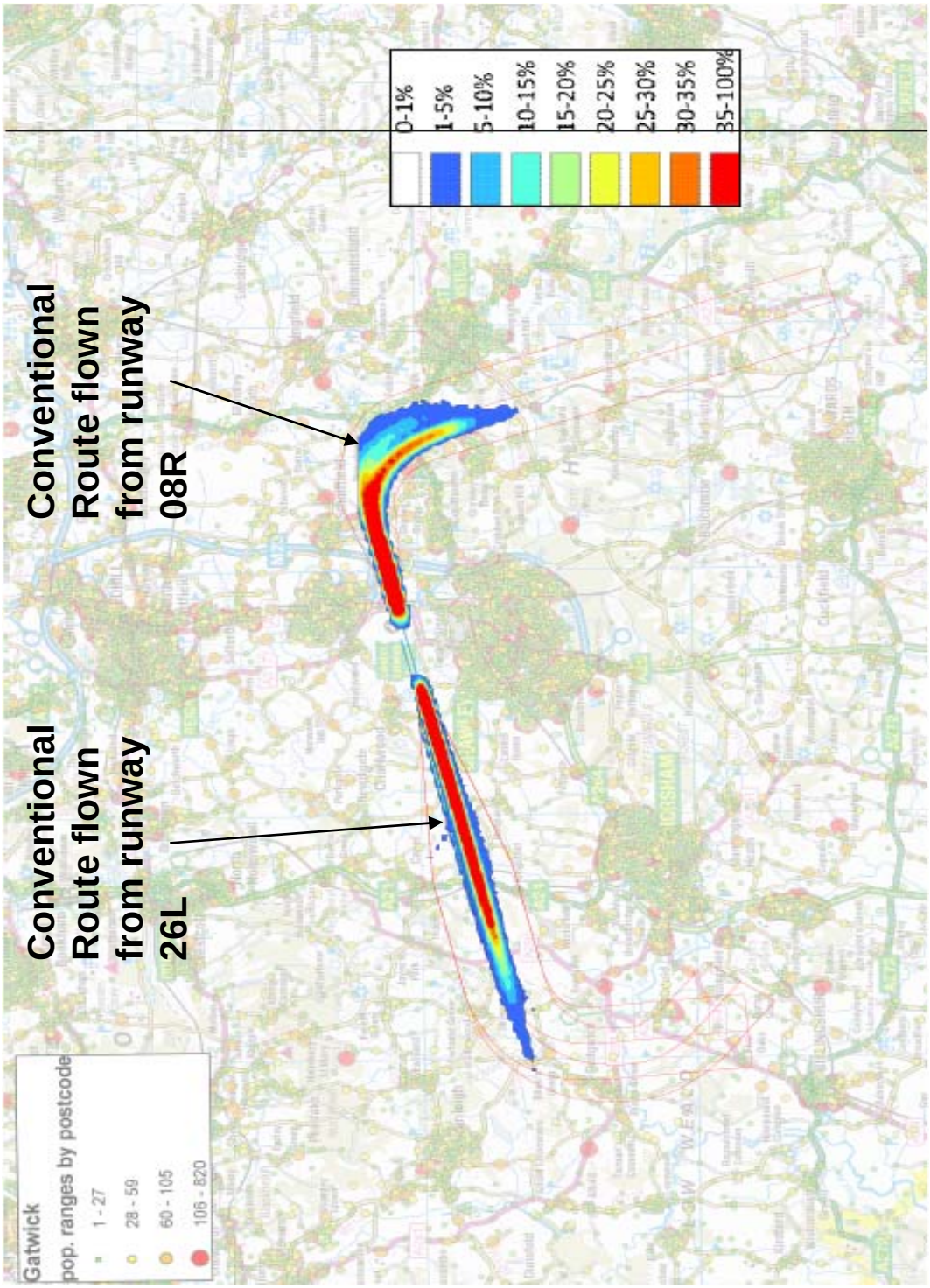
Terminology:

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 7 RWY 26 – BOGNA / HARDY COMPARING AUG 13 (CONV) v OCT 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)
700 701	Consultation Ref / Diagram	Fig 8 in Con Doc **700A** Fig 12 in ACP **701A**	Fig 9 Con Doc **700B** Fig 5 in ACP **701B**	The forecast impact for this route was based on the impact shown in Con Doc Fig 9 and ACP Fig 5 which was predicated on the results of the Trial of Route 2. A concentrated flightpath was forecast to occur along the nominal track of the RNAV SID as shown in Con Doc Fig 9 which would result on ac establishing a track towards BOGNA just fractionally to the east of the NPR CL.		
Folder Ref	Diagram **BOGNA**	**Month** **Number** **Aug 13** **2913**	**Month** **Number** **Oct 14** **2784**		Day: 4000 Night: 4000	
702	At 4000 ft	Deps using approx 20% of the width of the NPR swathe, spread evenly across the NPR CL. The majority of ac have reached 4000ft before the turn towards BOGNA; only a few ac at 4000ft are still at that altitude after the turn is initiated at Ellens Green. A few ac appear to be given early vectoring off the SID CL in the vicinity of Rusper.	Deps using less than 20% of the width of the NPR swathe, spread evenly across the NPR CL. The majority of ac have reached 4000ft before the turn towards BOGNA; only a few ac at 4000ft are still at that altitude after the turn is initiated at Ellens Green. A few ac appear to be given early vectoring off the SID CL (more than is apparent in the conv sample. The reasons for this are unknown and could be due to weather.	The RNAV SID dispersion has slightly reduced compared with the width of the conv SID departure track dispersion. This is in line with data shown by GAL in consultation and the ACP. The deps are slightly more concentrated than the conventional SID dispersion which was the aim of the RNAV SID replication. Vectoring is evident early after departure in this traffic sample and could be due to weather.	No significant change in vectoring.	RNAV track dispersion as expected. RNAV sample is - 129 deps less.
703	Density Plot	Deps occupy approx. 10-15% of the width of the NPR swathe on the straight ahead segment until the left turn is commenced to BOGNA. Ac are spread evenly across the NPR CL. The turn distribution is then spread from mid way across the eastern half of the NPR swathe to the western extremity, and once aircraft have steadied up on track to BOGNA, the main spread of the concentrated density dispersion reduces, except for a wide spread vectoring which extends from Slinfold to the west as far as Alfold Crossways. There is also a distinct density plot extending further west beyond the SID turning point to the south, which means there is widespread vectoring after the turn should have been initiated.	Deps occupy approx. 10-15% of the width of the NPR swathe on the straight ahead segment (but the spread is slightly less than the conv SID) until the left turn is commenced to BOGNA. Ac are spread evenly across the NPR CL. The turn distribution is then spread slightly further west across the NPR swathe (and evenly spread across the NPR CL in the turn) compared with the conv SID (slightly west of the mid way point across the east half of the NPR swathe) to the western extremity, and once aircraft have steadied up on track to BOGNA, the main spread of the dispersion density plot reduces, except for a wide spread vectoring which extends from slightly east of Slinfold to the west as far as Alfold Crossways. There is also a distinct density plot extending further west beyond the SID turning point (at Ellens Green) to the south, which means there is widespread vectoring after the turn should have been initiated. It is noted that the RNAV turn is slightly later compared with the	In the straight ahead segment before the turn, the RNAV SID dispersion has slightly reduced compared with the width of the conv departure track dispersion, and continues to reduce the main dispersion around the turn towards BOGNA as ac navigate around the turn to the south. However, there is a similar track dispersion continuing straight ahead further west when compared to the conv SID which is due to tactical vectoring and not associated with the SID design. Were it not for vectoring, aircraft would be centrally concentrated across the NPR CL. However, as vectoring is common practice, there remains a wide swathe of traffic across the region from Slinfold to Alford Crossways. This result of the RNAV track dispersion is in line with data shown by GAL in consultation and the ACP, however, the vectoring was not demonstrated as part of the consultation and ACP submission and is beyond the scope of the PIR. The deps are more concentrated than the conventional SID dispersion which was the aim of the RNAV SID replication. This is particularly noticeable after the turn, as traffic heads south past Slinfold. The greater concentration of RNAV traffic on this southbound segment means that more aircraft are closer to Slinfold as they fly south, and may be perceived by residents of Slinfold as being “overhead”. Coupled with what appears to be an increase in tactically vectored traffic to the east of the SID, above Slinfold, this may result in a general sense of being overflown more often in that location. However it should also be noted that the diagrams indicate that all traffic is above 4,000ft before reaching Slinfold.	A slight change in vectoring is evident to the east and south of Slinfold.	RNAV track dispersion as expected. RNAV sample is - 129 deps less. This appears to be a successful design although a slight change in vectoring is noticeable in the vicinity of Slinfold. Inserted 13 Jul 15: A separate gate analysis of altitude attained by BOGNA SIDs was provided by ERCD on 26 Jun 15. At position KKS11 (just to the north of Slinfold) the average altitude attained by conv SIDs in Summer 2013 was 6892ft amsl. In Summer 2014, the average altitude attained by RNAV SIDs was 7211ft amsl. **Inserted 4 Aug 15:** At a meeting on 3 Aug 15, the CAA further considered the gate analysis.

			conv SID design, however, this is intended as it results in a more central concentration in the centre of the NPR swathe.			The analysis showed that an average altitude of 7211ft amsl was being reached by departures before reaching KKS11 which is north of Slinfold. An option to increase the speed restriction around the turn was discussed and discounted as increasing the speed around the turn could also have the opposite effect of bringing departures further east of the NPR centreline and more towards Slinfold. Additionally, given the climb performance of departures, the average altitude attained before Slinfold, and the fact that aircraft are tactically vectored to be efficiently integrated with other traffic inbound to the LTMA and will continued to be vectored in the future in the existing LTMA airspace design, any change to the speed around the first turn and the consequent change to track over the ground would not produce any benefit because aircraft are vectored when above 4000ft, so the result of any speed changes around the first turn and consequent change of track over the ground would not be realised. Note: any such change would necessitate a change to the NPR alignment requiring a consultation and approval of the Secretary of State in accordance with the Air Navigation Guidance 2014. It was therefore concluded that the SID replication was a good replication which resulted in good adherence to the NPR centreline.
	Alt Slice Diagrams (Note 7)	Period Number **1-14 Mar 14 58**	Period Number **1-7 Sep 14 60**			
704	Alt 4-5000ft GAL Slides:2-5 CAA Slides 2-5	Deps reaching 4000ft before the A24 and using approx 20% of the width of the NPR swathe with a wide dispersion around the turn. This is a small sample.	Deps reaching 4000ft slightly after the A24 and using less than 20% of the width of the NPR swathe around the turn although this is a small sample.	The width of the RNAV SID dispersion is slightly reduced compared with the conv SID dispersion and is evident around the turn at Ellens Green. In this sample, only one ac is detected at 5000ft when passing Slinfold.	This is a smaller and different traffic sample to what is shown in the pre-ceding samples. Changes to vectoring in the vicinity of Slinfold is not evident in this altitude band.	Traffic above 4000ft was not assessed in the ACP analysis as deps may be tactically vectored when reaching 4000ft. Note gate analysis above. RNAV sample is + 2 deps more.
705	Alt 5-6000ft GAL Slides:6-9 CAA Slides 2-5	Some deps reaching 5000ft before the A24 and using approx 20% of the width of the NPR swathe with a wide dispersion around the turn. This is a small sample.	Some deps reaching 5000ft before the A29 and using less than 20% of the width of the NPR swathe around the turn although this is a small sample. The majority of deps are at 5000ft before they steady up on track to BOGNA as they pass Cox Green.	The width of the RNAV SID dispersion is slightly reduced compared with the conv SID dispersion with the turn being more concentrated than the conv SID, notably evident around the turn at Ellens Green.	This is a smaller and different traffic sample to what is shown in the pre-ceding samples. Changes to vectoring in the vicinity of Slinfold is not evident in this altitude band.	Traffic above 4000ft was not assessed in the ACP analysis as deps may be tactically vectored when reaching 4000ft. Note gate analysis above. RNAV sample is + 2 deps more.
706	Alt 6-7000ft GAL Slides:10-13 CAA Slides 2-5	Some deps reaching 6000ft before the A29 and are widely spread across the width of the NPR swathe (due to vectoring) which continues around the turn although this is a small sample.	Some deps (slightly less than the conv SID) reaching 6000ft before the turn at Ellens Green and are less widely spread across the width of the NPR swathe (due to vectoring) which continues around the turn although this is a small sample.	The width of the RNAV SID dispersion is slightly less compared with the conv SID dispersion where traffic is more concentrated around the turn at Ellens Green. Thereafter, there is wide spread vectoring. This is not associated with the design of the RNAV SID (or for that matter the conv SID).	This is a smaller and different traffic sample to what is shown in the pre-ceding samples. Changes to vectoring in the vicinity of Slinfold is not evident in this altitude band.	Traffic above 4000ft was not assessed in the ACP analysis as deps may be tactically vectored when reaching 4000ft. Note gate analysis above. RNAV sample is + 2 deps more.



700 A
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Figure8) Density plots of aircraft tracks (up to 4000 feet AMSL) following the **conventional** (SFD) **SIDs** from Runway 08R, and Runway 26L (HARDY and BOGNA) SIDs

700 B
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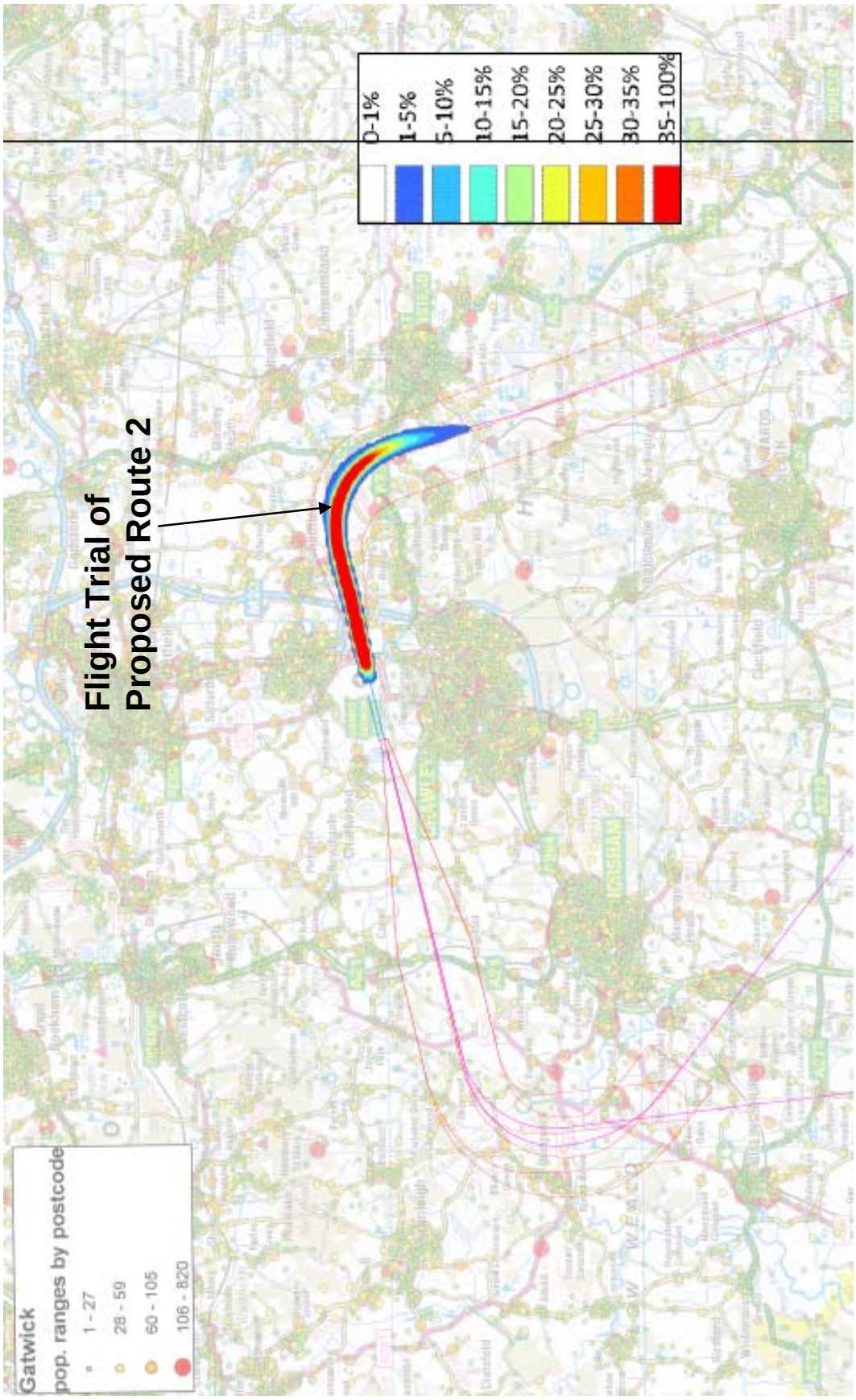

Figure9) Density plot of aircraft tracks (up to 4000 feet AMSL) following the PRNAV (**ROUTE 2**) flight trialled SID route from Runway 08R

701 A
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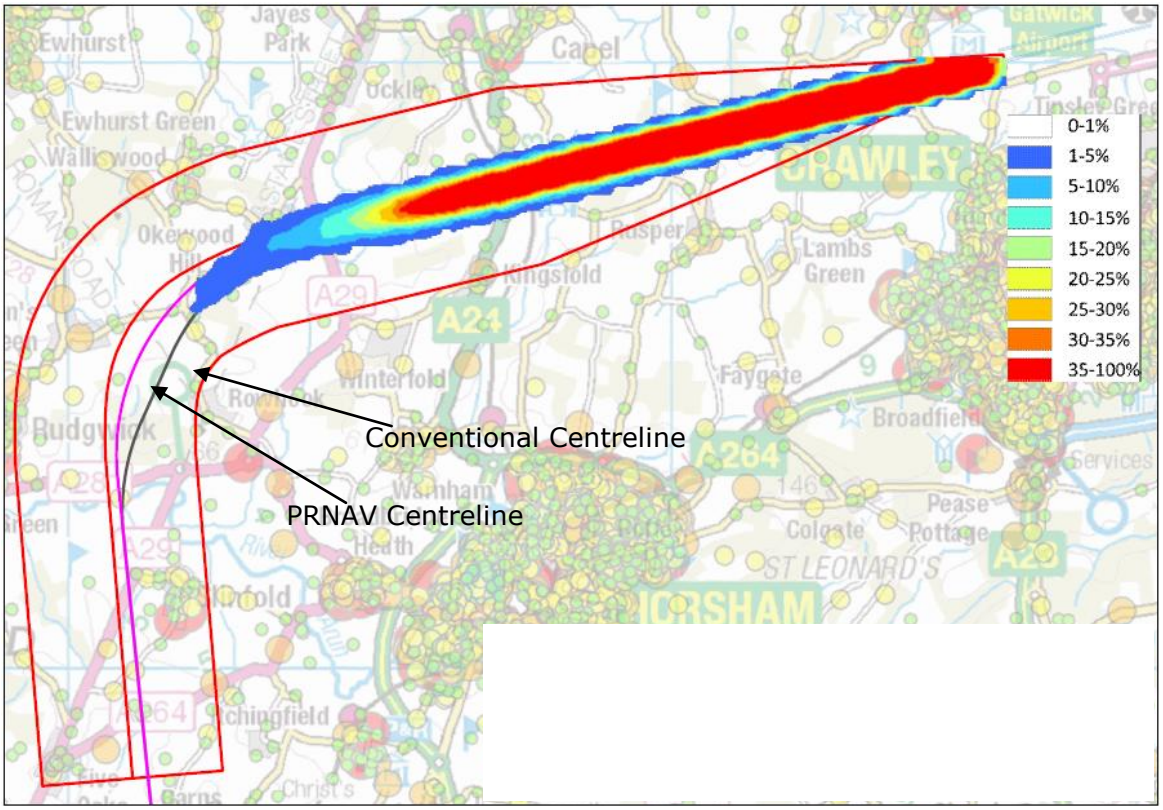

Figure 12 Route 7 Conventional Navigation

The impact regarding noise and track dispersion for route 7 is expected to be identical to that seen from the flight trials of route 2.

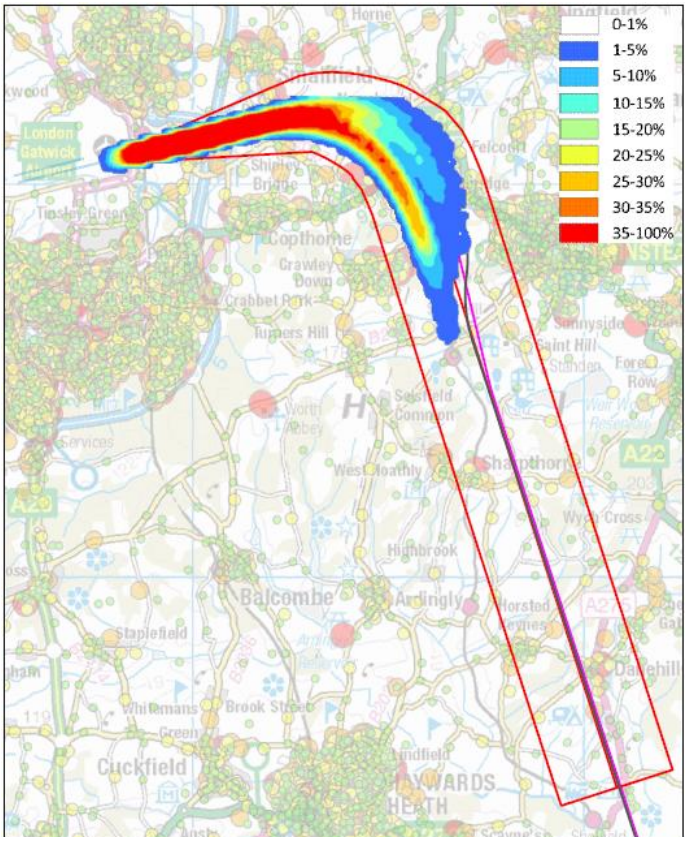

Figure 4 Route 2 Conventional Navigation

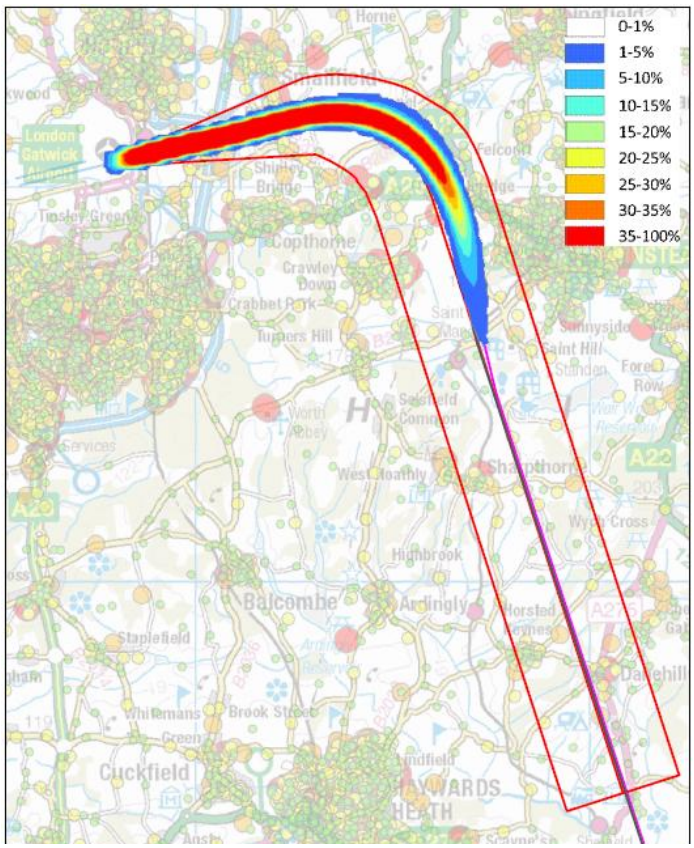

Figure 5 Route 2 PRNAV Navigation

701 B
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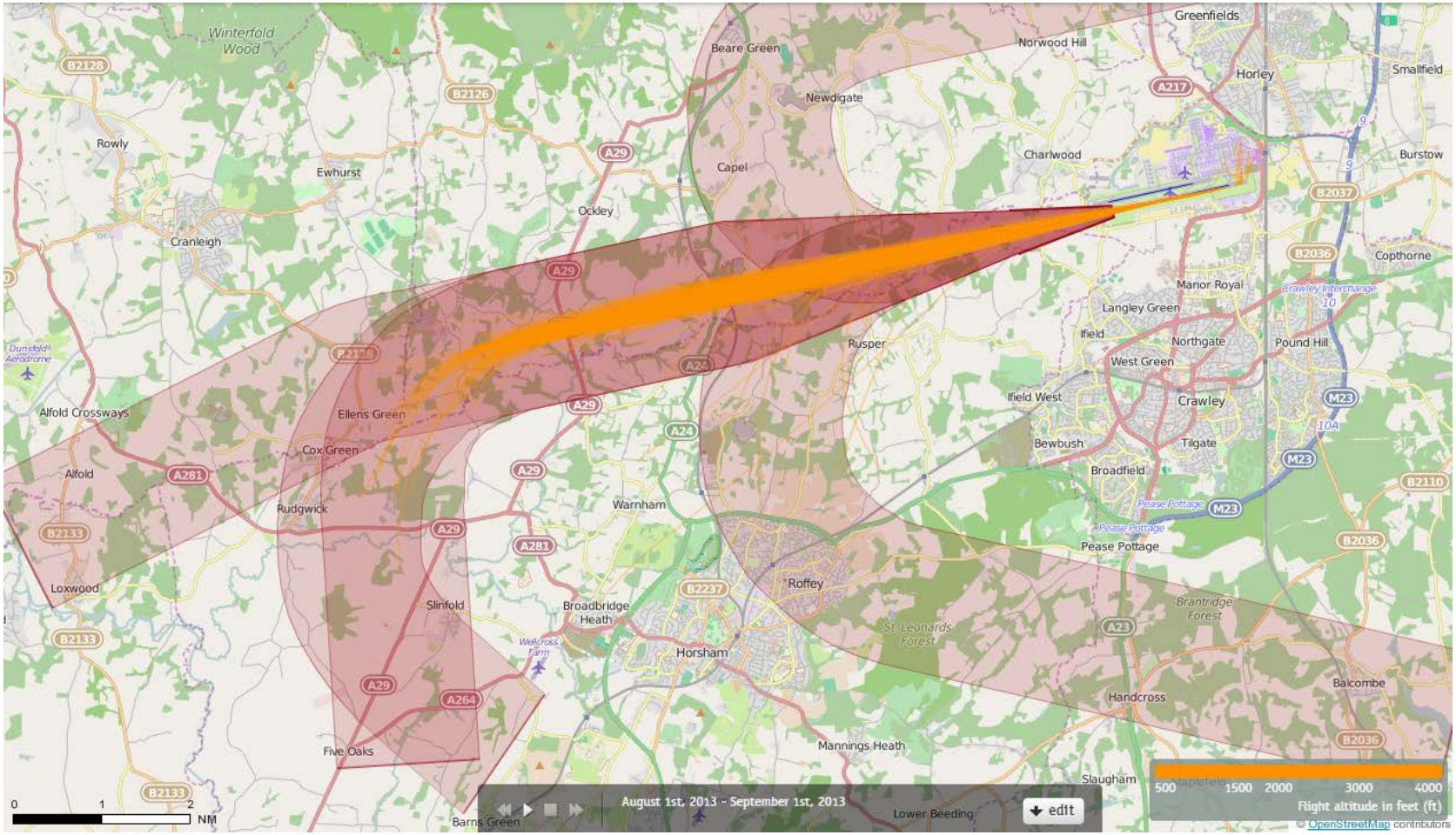
26 BOGNA
Route 7

Pre and Post P-RNAV

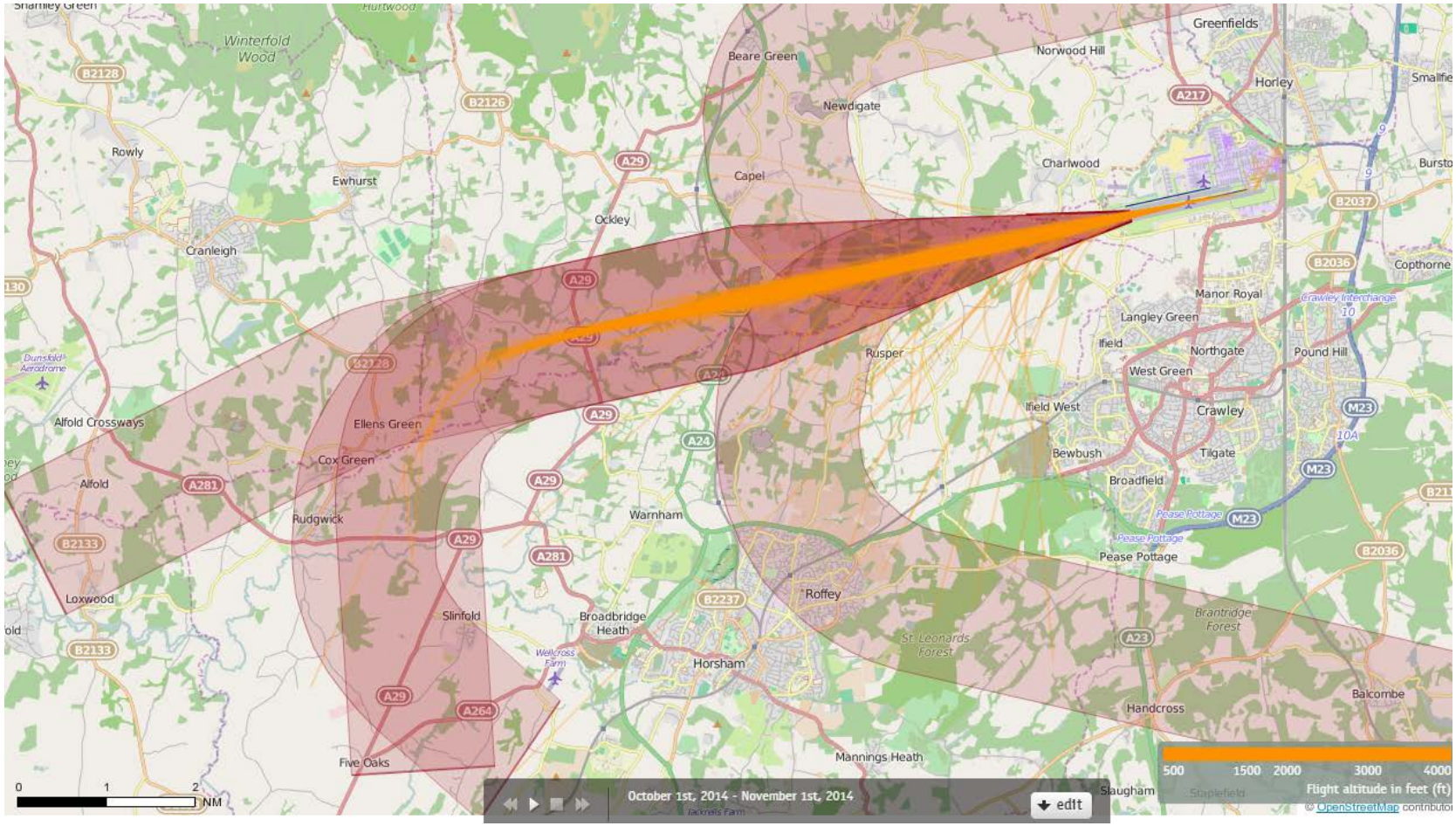
During June, July and August 2014, 26BOGNA was utilised much less due to ADNID1X departure trial route. Therefore these maps show September, October & November 2014 as well as summer months.

26BOGNA August 2013 Aircraft Tracks Cut Off at 4000ft Altitude
2913 Aircraft – Showing CONVENTIONAL Departures Only



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

26BOGNA October 2014 Aircraft Tracks Cut Off at 4000ft Altitude
2784 Aircraft – Showing P-RNAV Departures Only



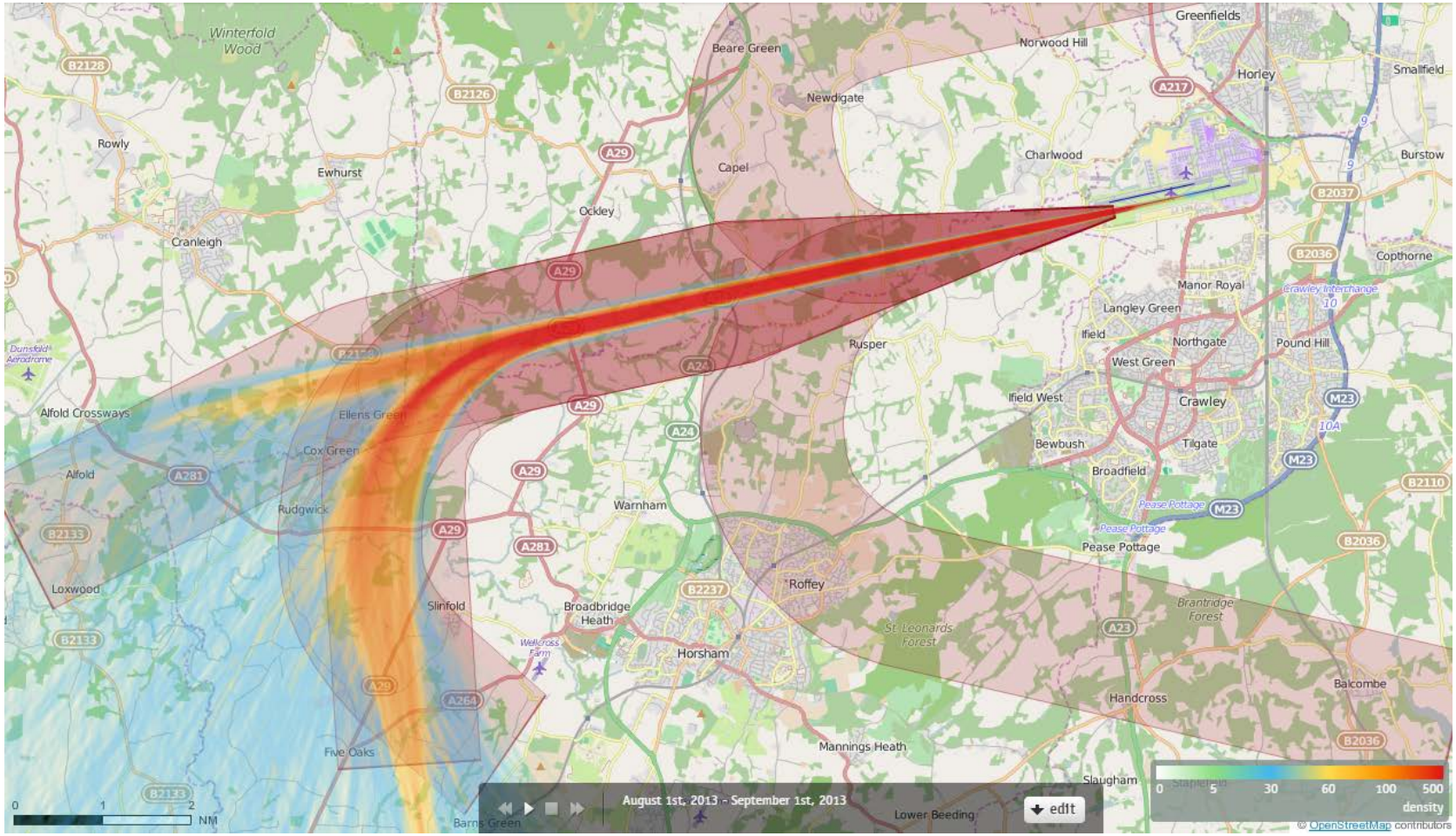
Orange plots show the tracks of aircraft until at an altitude of 4000ft

26 BOGNA
Route 7

Pre and Post P-RNAV

During June, July and August 2014, 26BOGNA was utilised much less due to ADNID1X departure trial route. Therefore these maps show September, October & November 2014 as well as summer months.

26BOGNA Density August 2013
2913 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.

26BOGNA Density October 2014
2784 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.

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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.

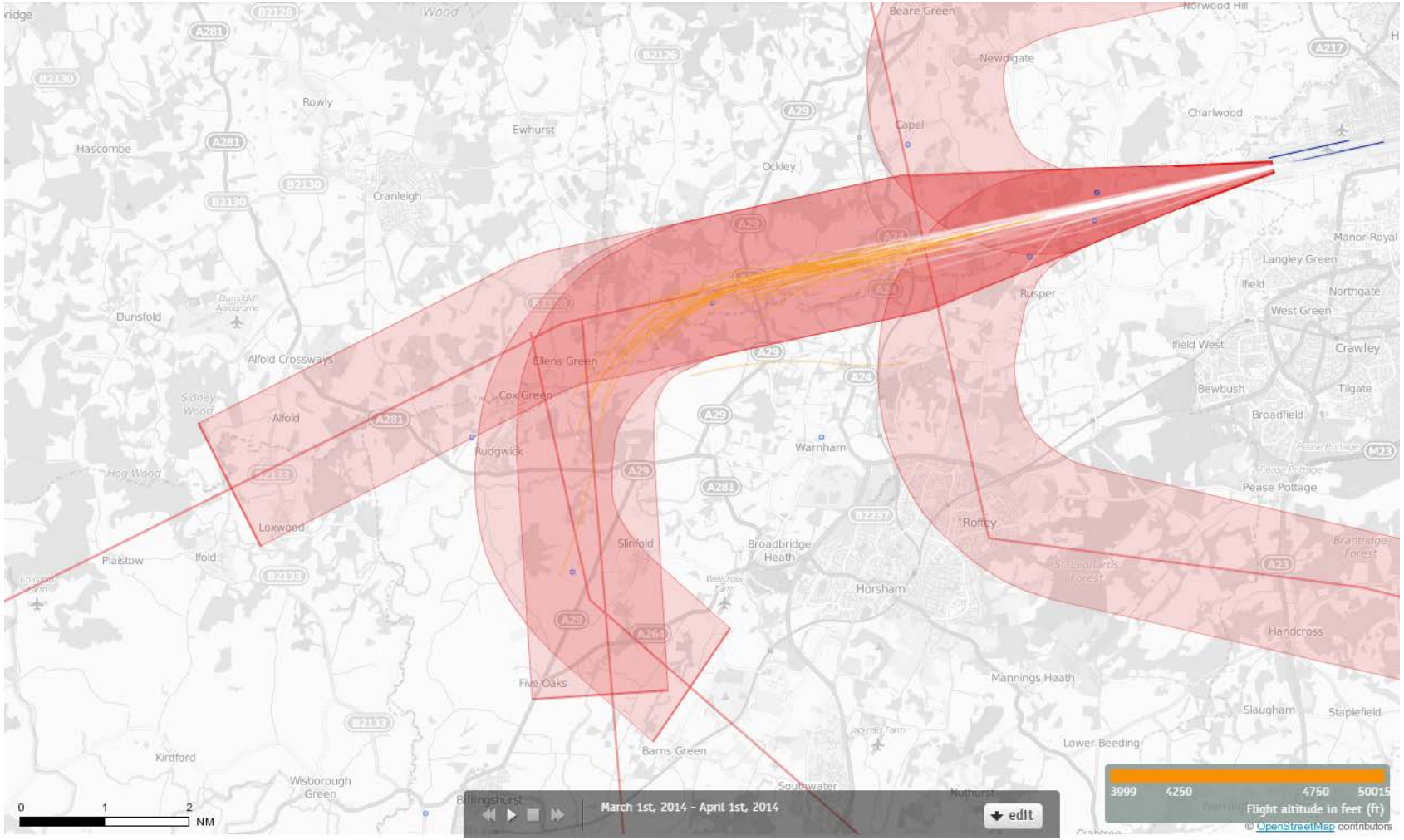
26 BOGNA
Route 7

703

Altitude Bands

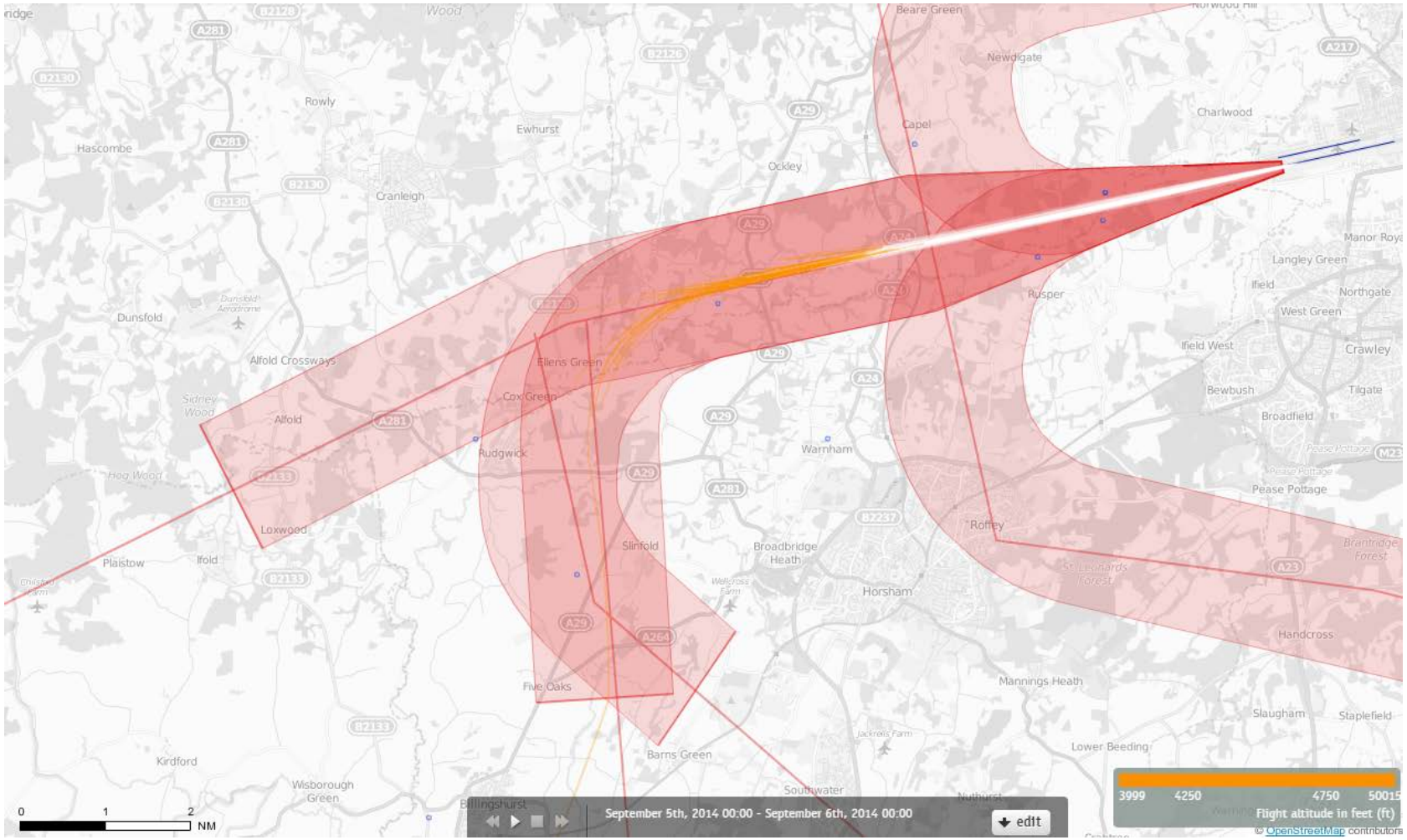
4000-5000ft

26 BOG Departures March 2014
4000-5000 feet (58 Aircraft – CONVENTIONAL ONLY)



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

26 BOG Departures 5th September 2014
4000-5000 feet (60 Aircraft – P-RNAV ONLY)



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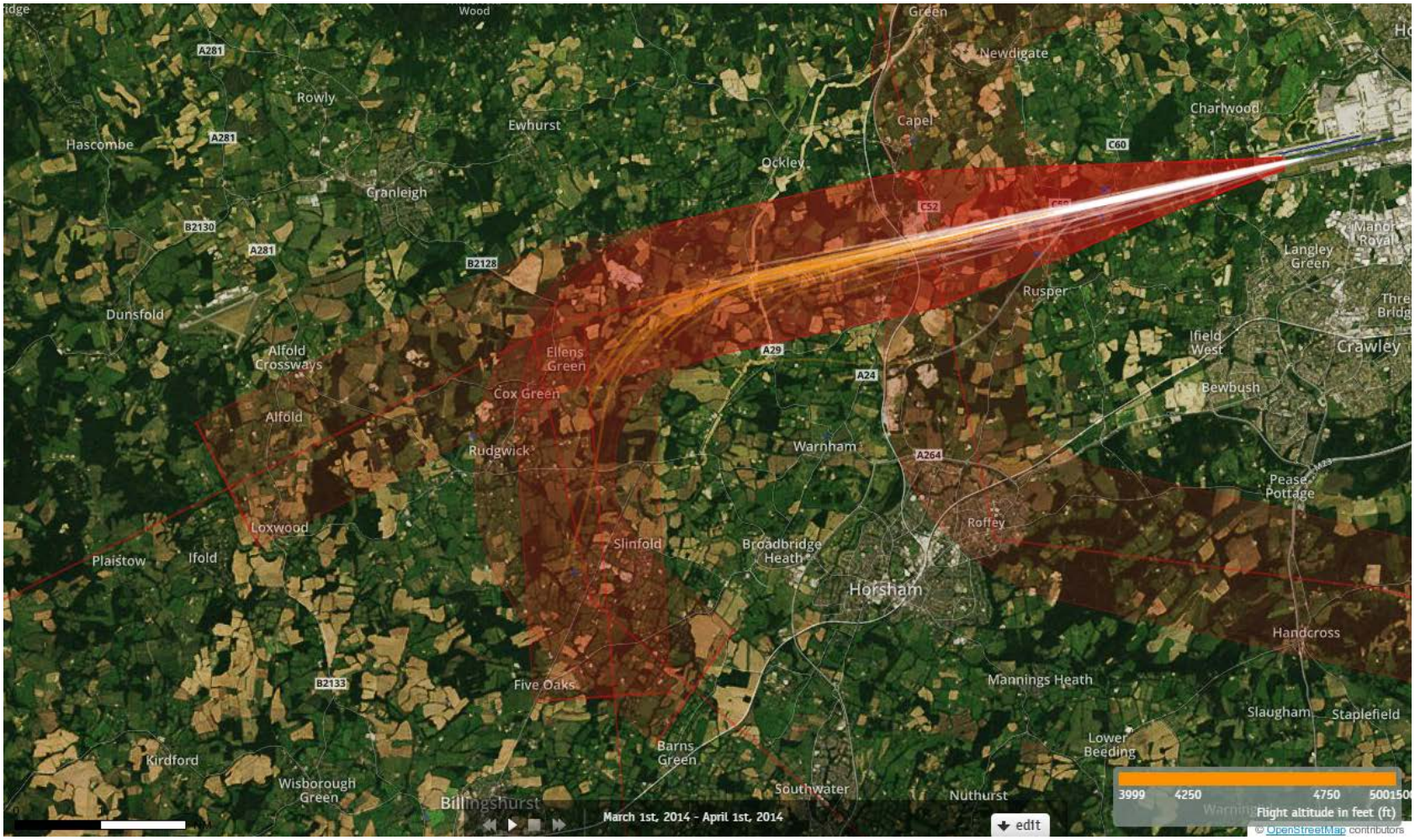
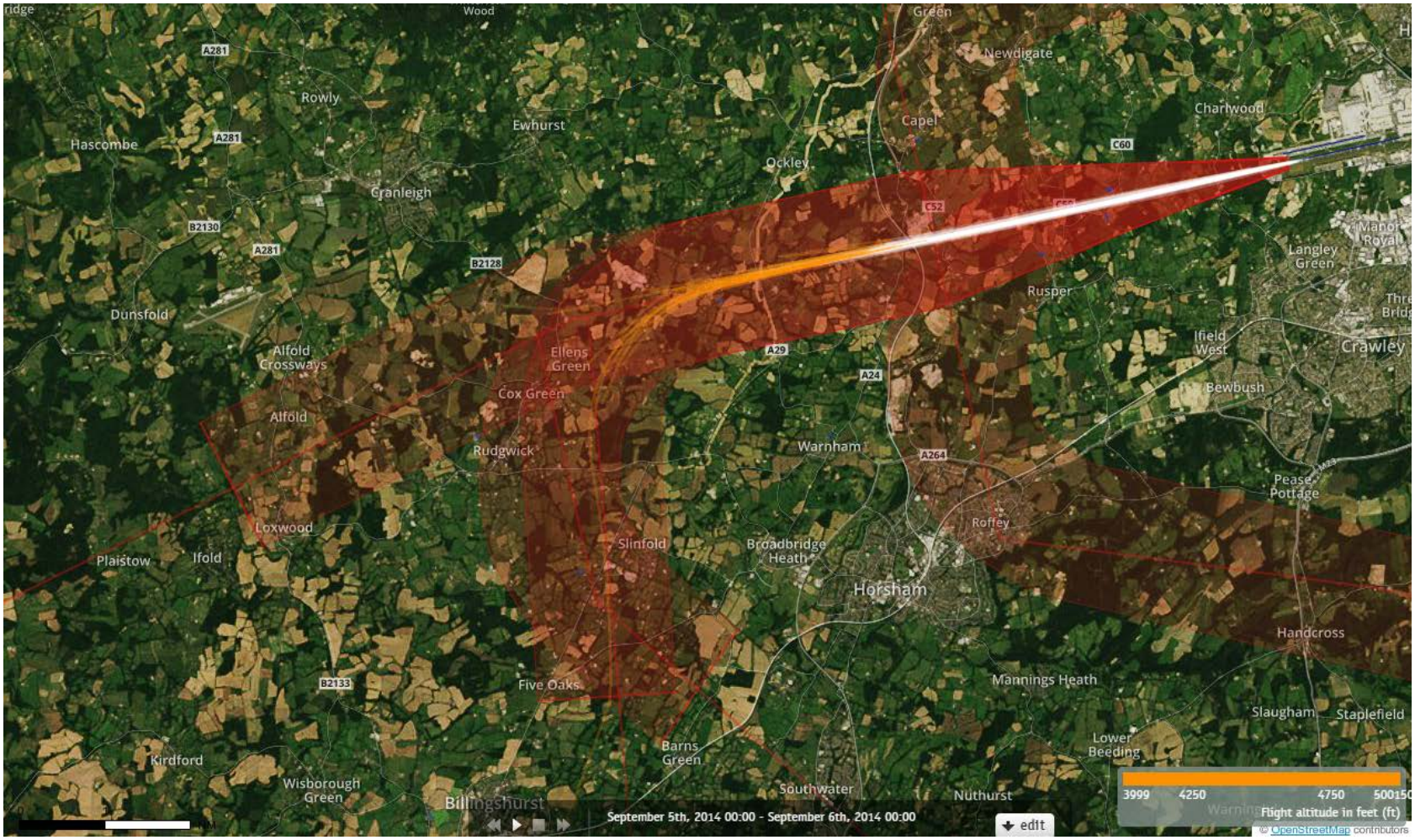
26 BOG Departures March 2014
4000-5000 feet (58 Aircraft – CONVENTIONAL ONLY)



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

26 BOG Departures 5th September 2014
4000-5000 feet (60 Aircraft – P-RNAV ONLY)



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

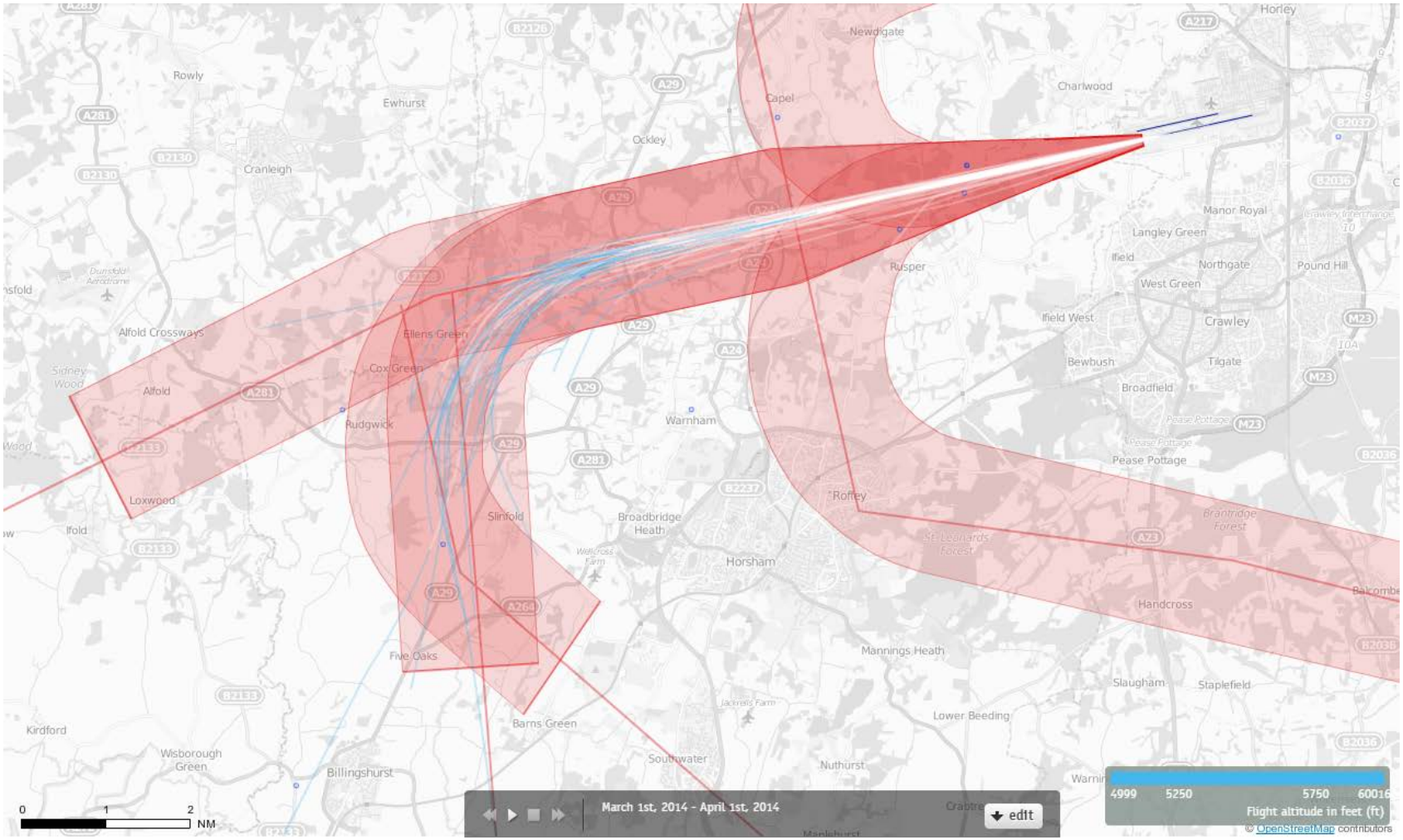
26 BOGNA
Route 7

Altitude Bands

704

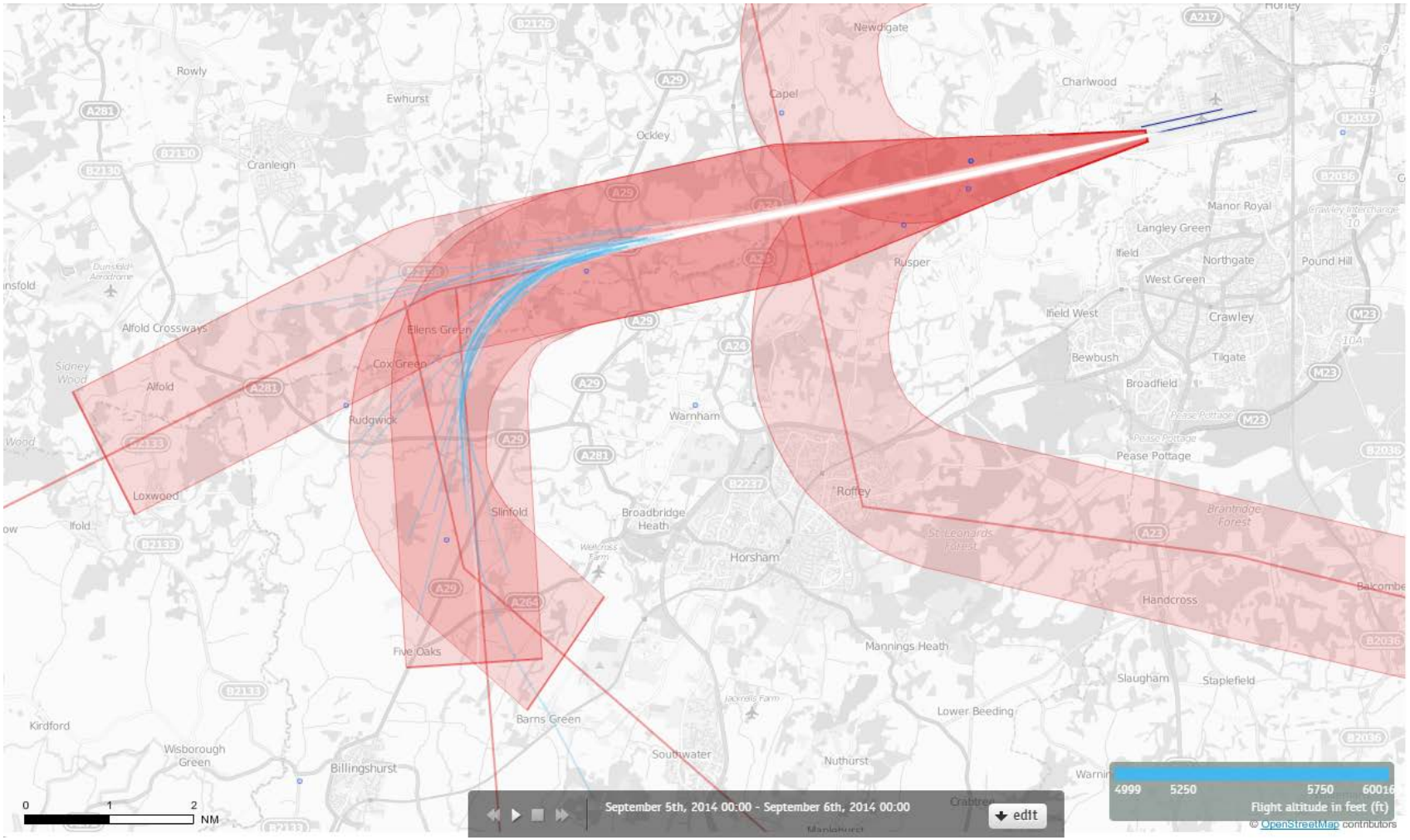
5000-6000ft

26 BOG Departures March 2014
5000-6000 feet (58 Aircraft – CONVENTIONAL ONLY)



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

26 BOG Departures 5th September 2014
5000-6000 feet (60 Aircraft – P-RNAV ONLY)



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

26 BOG Departures March 2014
5000-6000 feet (58 Aircraft – CONVENTIONAL ONLY)

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

26 BOG Departures 5th September 2014
5000-6000 feet (60 Aircraft – P-RNAV ONLY)

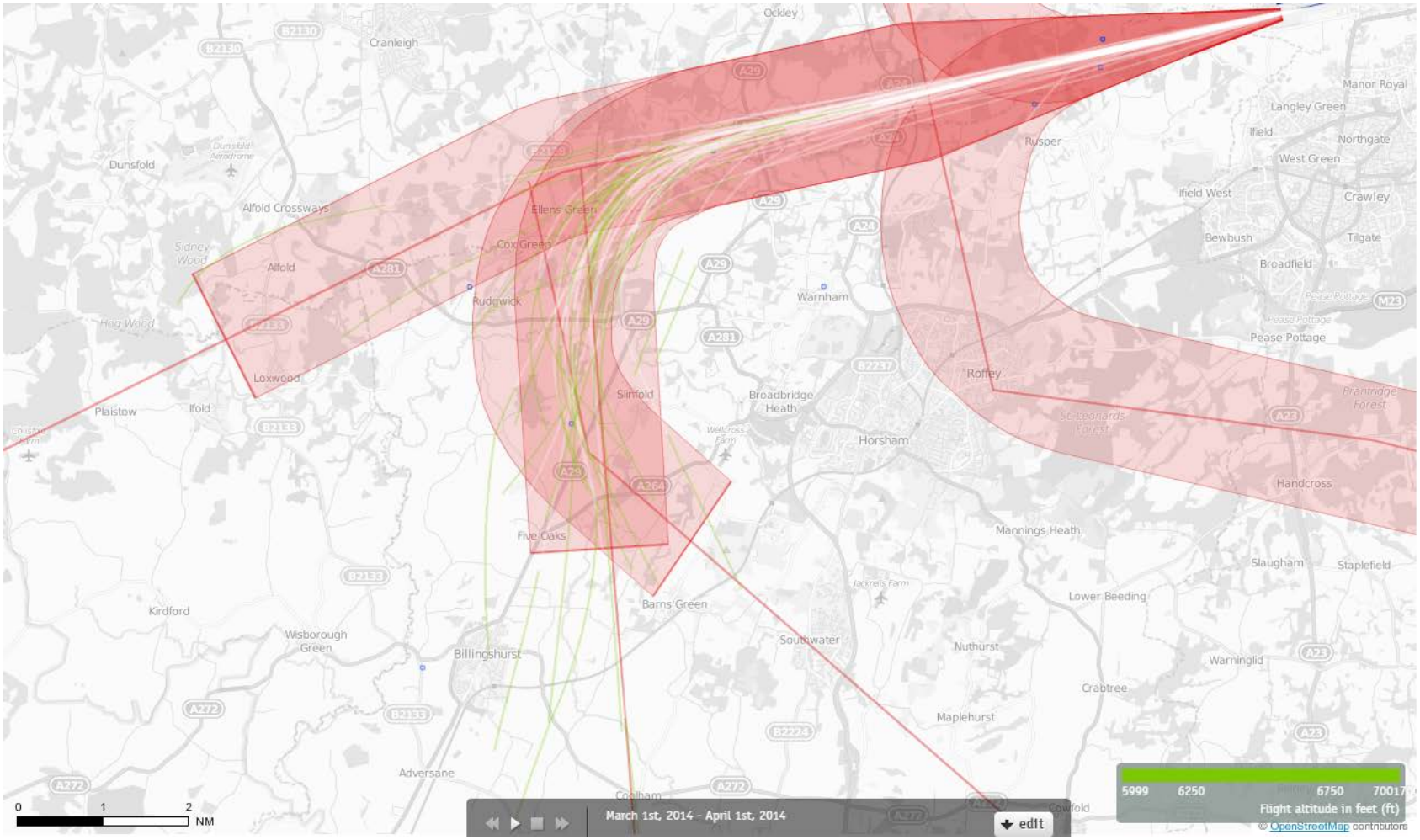
Blue plots show the points at which an aircraft was between 5000 and 6000ft altitude.

26 BOGNA
Route 7

Altitude Bands

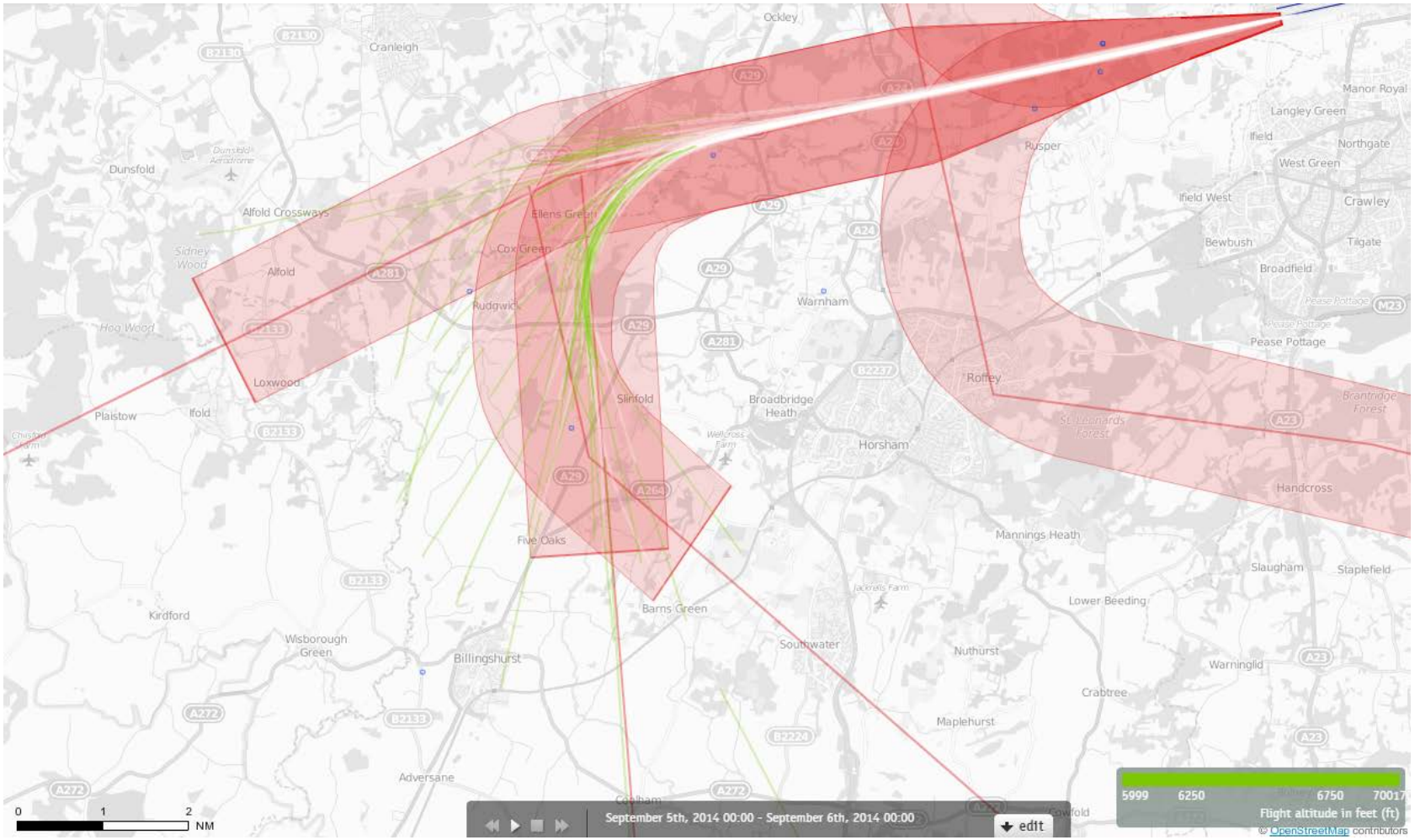
6000-7000ft

26 BOG Departures March 2014
6000-7000 feet (58 Aircraft – CONVENTIONAL ONLY)



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

26 BOG Departures 5th September 2014
6000-7000 feet (60 Aircraft – P-RNAV ONLY)



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

26 BOG Departures March 2014
6000-7000 feet (58 Aircraft – CONVENTIONAL ONLY)

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

26 BOG Departures 5th September 2014
6000-7000 feet (60 Aircraft – P-RNAV ONLY)

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