

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)

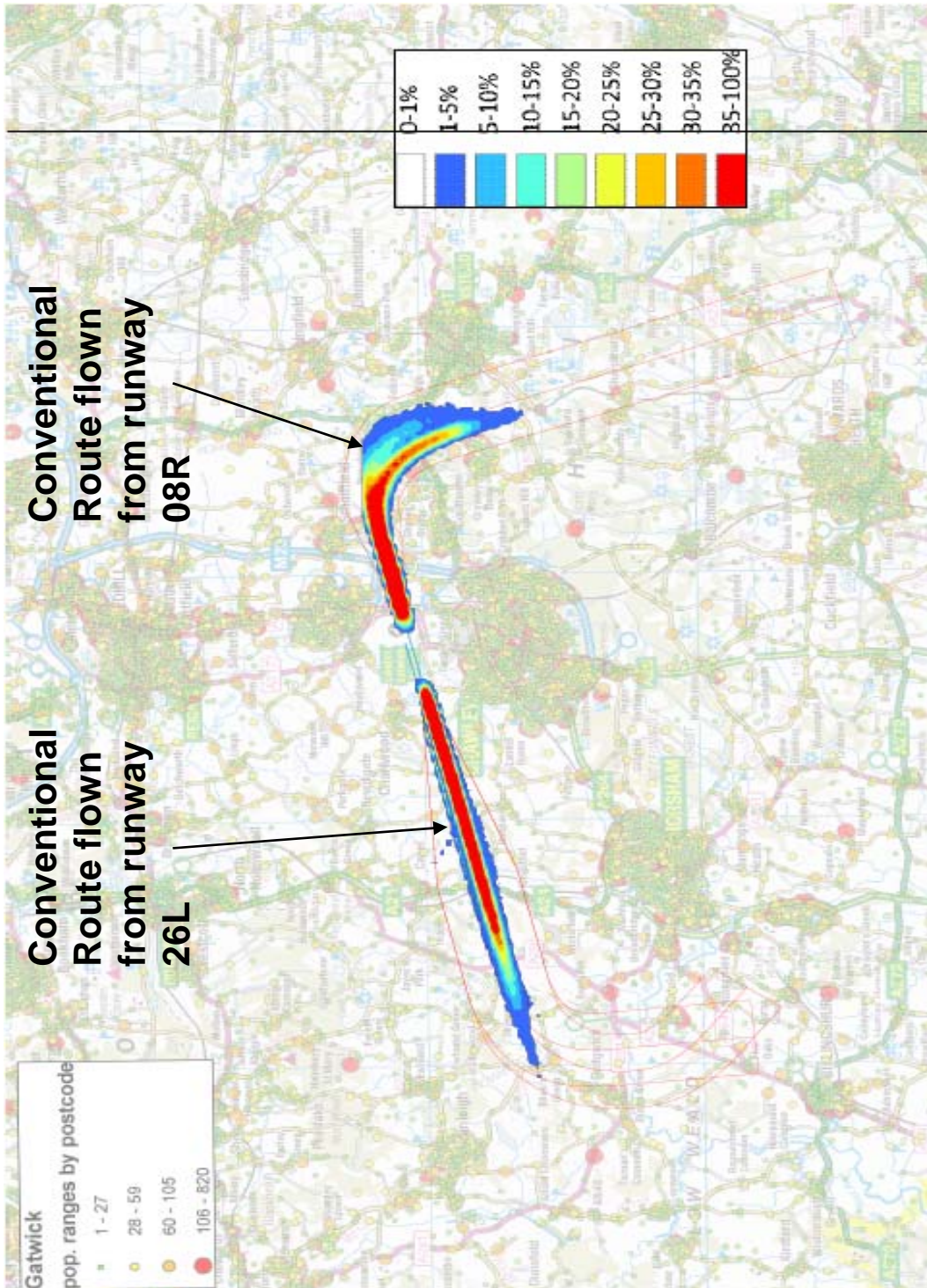
Terminology:

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 8 – RWY 26 SFD1X - COMPARING AUG 13 (CONV) v AUG 14 (RNAV)

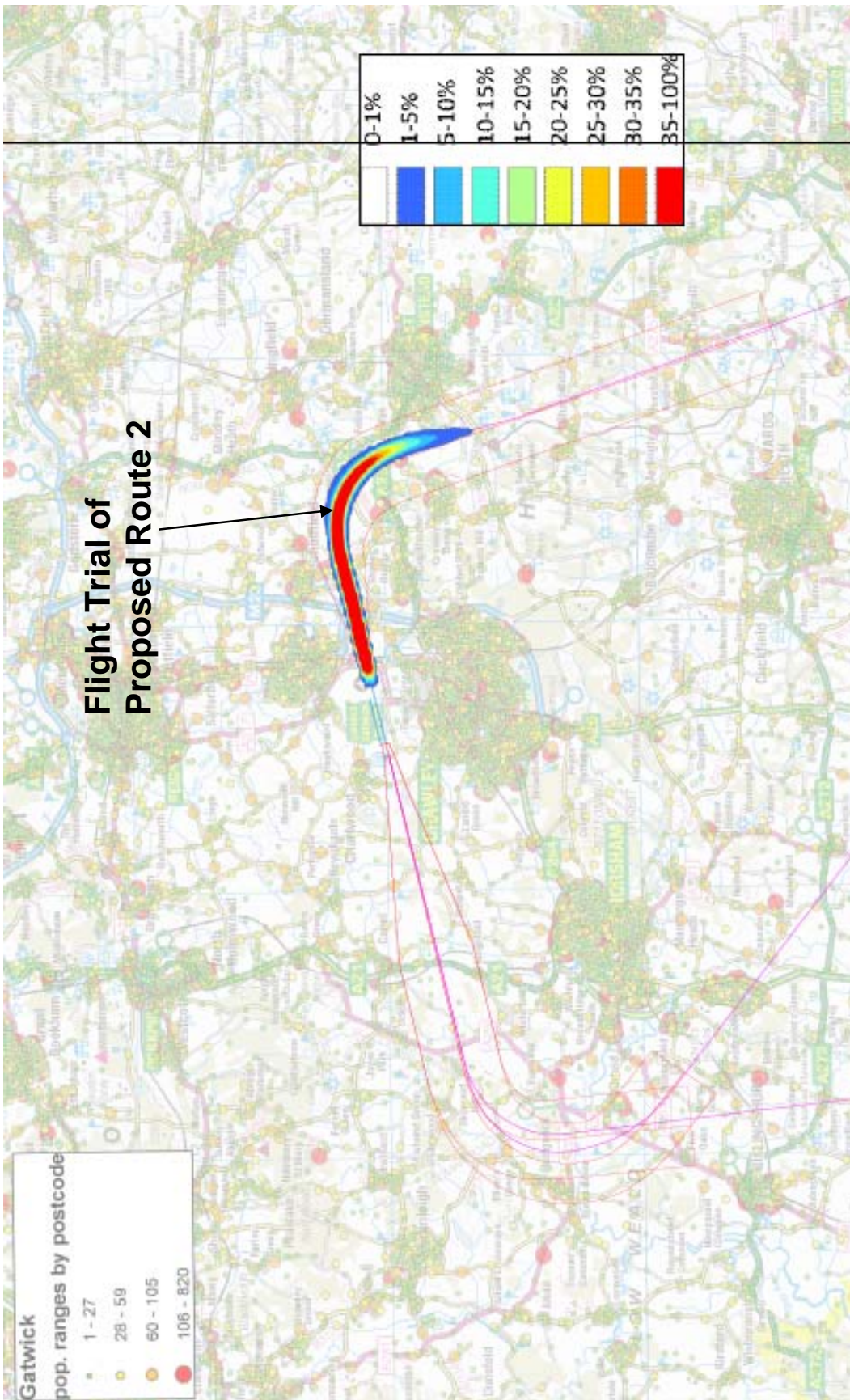
LINKS	SID Sample Of Relevant Track Dispersion Diagram	Conventional SID Comments (Note 1)		RNAV 1 SID Comments (Note2)		Impact of RNAV SID Replication (Note 3)	Observations on Vectoring (Note 4)	Remarks (Note 5)
800 801	Consultation Ref / Diagram	Fig 8 in Con Doc 800A		Fig 9 Con Doc 800B		The forecast 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 CL of the RNAV SID as shown in Con Doc Fig 9 which would result with ac following the turn to SFD remaining slightly to the east of the NPR CL as ac completed the turn until the SID CL rejoins the NPR CL at the end of the NPR. <i>The ERCD analysis of the impact is at Appendix TBC.</i>		
		Fig 13 in ACP 801A		Fig 5 in ACP 801B				
Folder Ref	Diagram SFD1X	Month Aug 13	Number 110	Month Aug 14	Number 160		Day: Not available Night: 4000	
802	At 4000 ft	Deps using approx 15% of the width of the NPR swathe spread evenly across the NPR CL until the turn to SFD. The majority of ac have reached 4000ft before the turn towards SFD; A few ac (3) appear to be given early vectoring off the SID CL.		Deps using less than 15% of the width of the NPR swathe spread evenly across the NPR CL until the turn to SFD. The majority of ac have reached 4000ft before the turn towards SFD.		The RNAV SID dispersion has slightly reduced compared with the width of the conv SID departure track dispersion. The deps are slightly more concentrated than the conventional SID dispersion which was the aim of the RNAV SID replication.	None seen in this RNAV sample.	RNAV track dispersion as expected. RNAV sample is + 50 deps more.
803	Density Plot	Deps using approx 10% of the width of the NPR swathe spread evenly across the NPR CL up to the turn to SFD. The design of this conv SID is such that ac then appear to be unable to comply with the NPR CL around the turn at Ellens Green and are flying up to the western extremity of the NPR swathe. In this sample, it is unclear whether this is due to vectoring or the actual SID design itself.		Deps using potentially less than 10% of the width of the NPR swathe spread evenly across the NPR CL before the turn at Ellens Green. Ac then appear to be following the turn to SFD I remaining extremely close to the NPR CL around the turn. There appears to be a few ac continuing straight ahead on runway heading. It is unclear whether these would have been instructed to do so by ATC.		Whilst the RNAV sample shows 50 more ac than the conv SID traffic sample, the RNAV SID dispersion has slightly reduced compared with the width of the conv SID departure track dispersion. The deps are slightly more concentrated than the conventional SID dispersion which was the aim of the RNAV SID replication. It is interesting to note that when comparing both conv and RNAV SID dispersion, the RNAV SID design has considerably improved the ability of aircraft to fly around the approximate 120 deg turn to SFD remaining extremely close to the CL, and therefore based on this comparison, in this sample, this is a significant improvement in SID track keeping compliance. This also appears to be very similar to a comparison of 75 conv SID in Jul 13 against 87 RNAV SIDs in Jul 14.	None seen in this RNAV sample.	RNAV track dispersion as expected. RNAV sample is + 50 deps more. This appears to be a successful design.
	Alt Slice Diagrams (Note 7)	Period 1-30 Sep 13	Number 72	Period 1-31 Oct 14	Number 59			
804	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 around the turn although this is a small sample. A few ac are flying the turn towards the outer extremity of the NPR swathe.		Deps reaching 4000ft before the A24 and using potentially less than 10% 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. RNAV SIDs are maintaining a good central position within the NPR swathe.	None seen in this RNAV sample.	Traffic above 4000ft was not assessed in the ACP analysis as deps may be tactically vectored when reaching 4000ft. RNAV sample is - 13 deps less.

<p>805</p>	<p>Alt 5-6000ft GAL Slides:6-9 CAA Slides 2-5</p>	<p>Some deps reaching 5000ft before the A29 and using approx 20% of the width of the NPR swathe around the turn although this is a small sample.</p> <p>Some vectoring is occurring after the A29 (ac +4000ft).</p> <p>After Ellens Green, deps are no longer concentrated.</p> <p>After Cox Green, vectoring is also evident.</p>	<p>Some deps reaching 5000ft before the A24 and using less than 10% of the width of the NPR swathe around the turn until Cox Green, although this is a small sample.</p> <p>Some vectoring is occurring before the A29 (ac +4000ft).</p> <p>Concentration still apparent up to Cox Green.</p> <p>After Cox Green, vectoring is also evident.</p>	<p>The width of the RNAV SID dispersion is reduced compared with the conv SID dispersion and is evident around the turn at Ellens Green. RNAV SIDs are maintaining a good central position within the NPR swathe until some vectoring is evident.</p>	<p>A small amount of vectoring is evident earlier – just before the A29.</p>	<p>Traffic above 4000ft was not assessed in the ACP analysis as deps may be tactically vectored when reaching 4000ft.</p> <p>RNAV sample is - 13 deps less.</p>
<p>806</p>	<p>Alt 6-7000ft GAL Slides:10-13 CAA Slides 2-5</p>	<p>Most deps reaching 6000ft after the A29 and using approx 20% of the width of the NPR swathe around the turn although this is a small sample.</p> <p>Some vectoring is occurring after the A29 (ac +4000ft).</p> <p>After Cox Green, vectoring is also evident.</p>	<p>Some deps reaching 6000ft before the A29 and using less than 10% of the width of the NPR swathe around the turn until Cox Green, although this is a small sample.</p> <p>Some vectoring is occurring before the A29 (ac +4000ft).</p> <p>After Cox Green, vectoring is also evident.</p>	<p>The width of the RNAV SID dispersion is reduced compared with the conv SID dispersion and is evident around the turn at Ellens Green. RNAV SIDs are maintaining a good central position within the NPR swathe until some vectoring is evident.</p>	<p>A small amount of vectoring is evident earlier – just before the A29.</p>	<p>Traffic above 4000ft was not assessed in the ACP analysis as deps may be tactically vectored when reaching 4000ft.</p> <p>RNAV sample is - 13 deps less.</p>



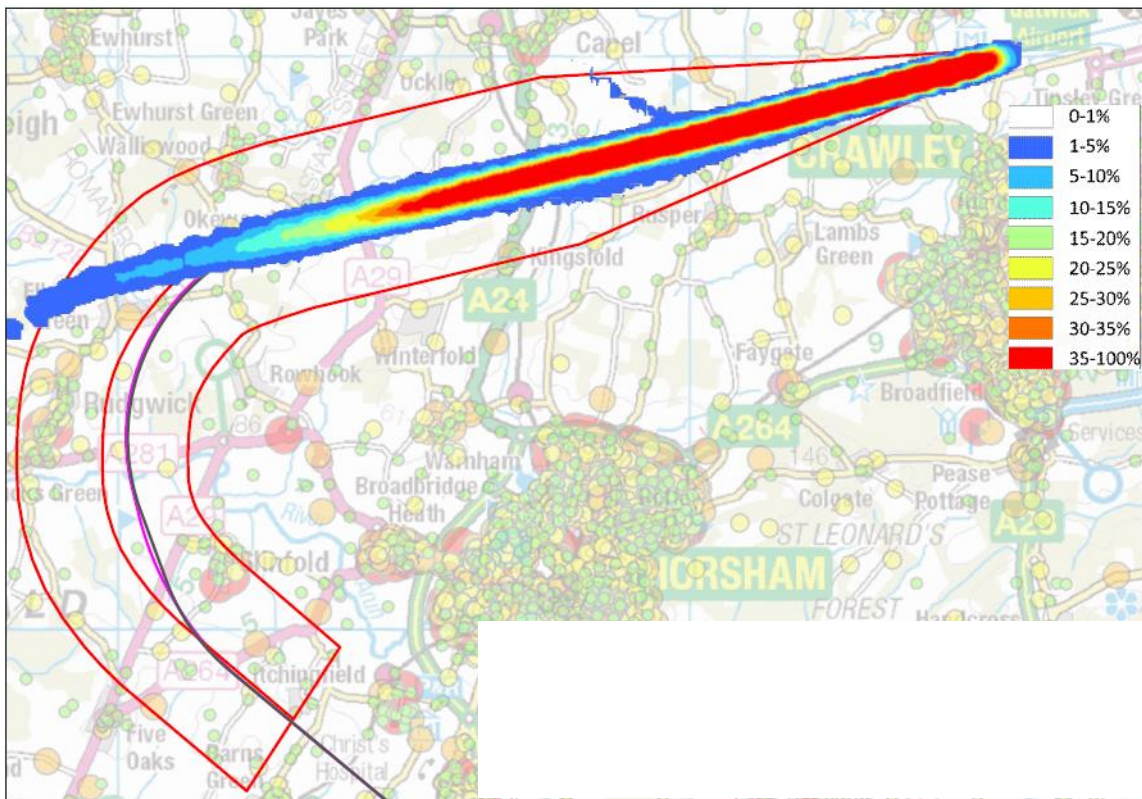
800 A
< BACK

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



800 B
 < BACK

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



801A
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Figure 13 Route 8 Conventional Navigation

The impact regarding noise and track dispersion for route 8 is expected to be identical to that seen from the flight trials of route 2. Note traffic is routinely given a standard radar heading to

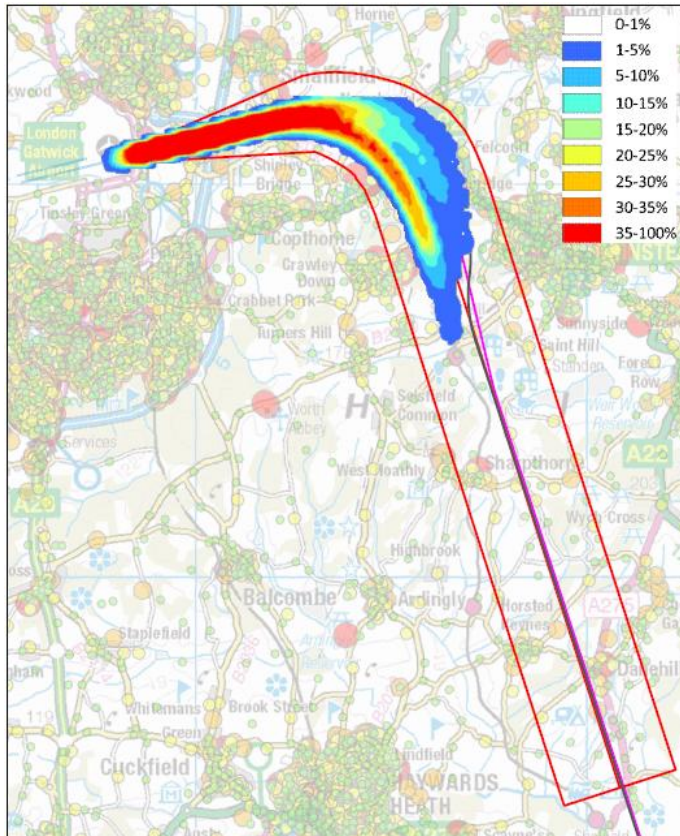


Figure 4 Route 2 Conventional Navigation

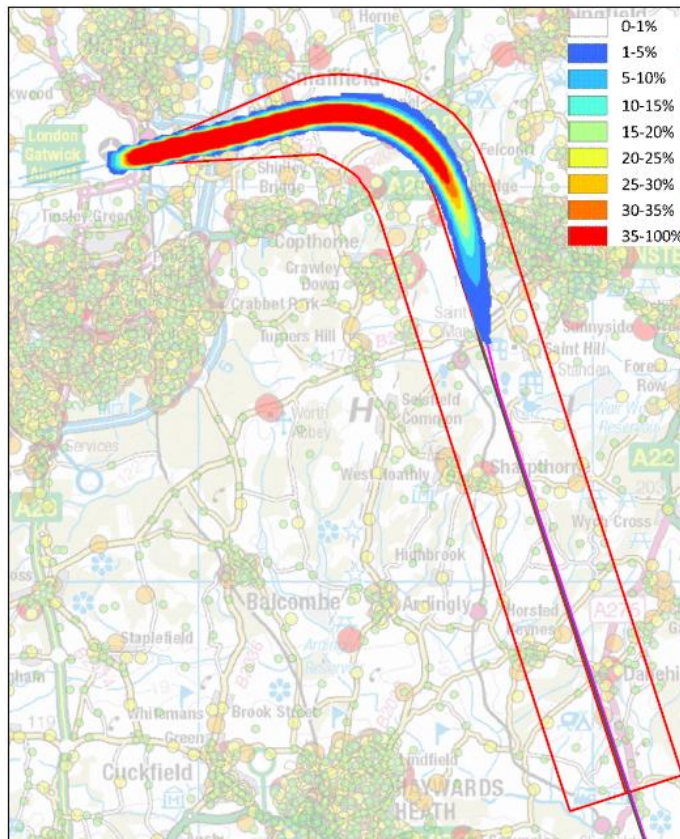


Figure 5 Route 2 PRNAV Navigation

801 B
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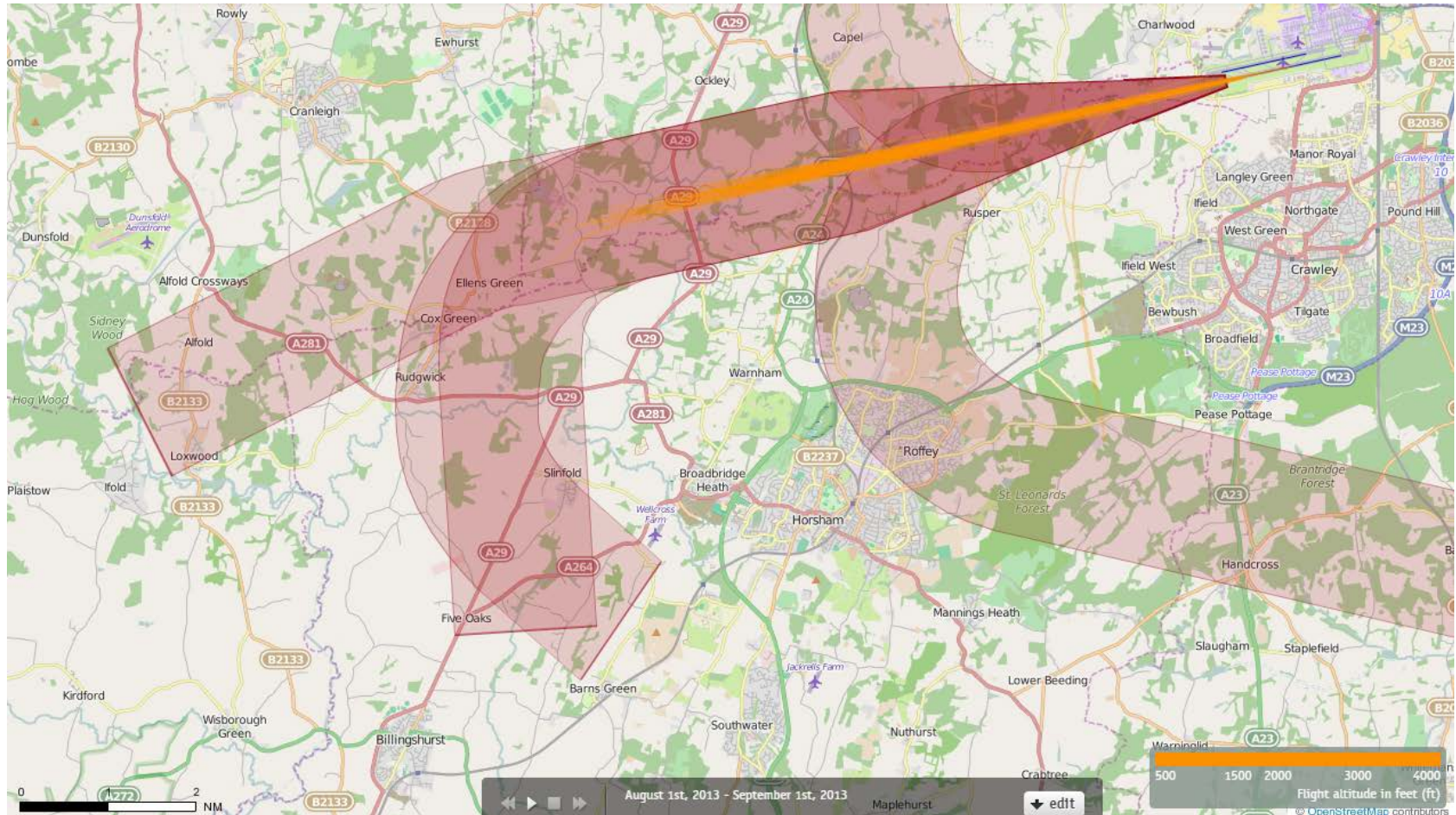
26 SEAFORD

Route 8

Pre and Post P-RNAV

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

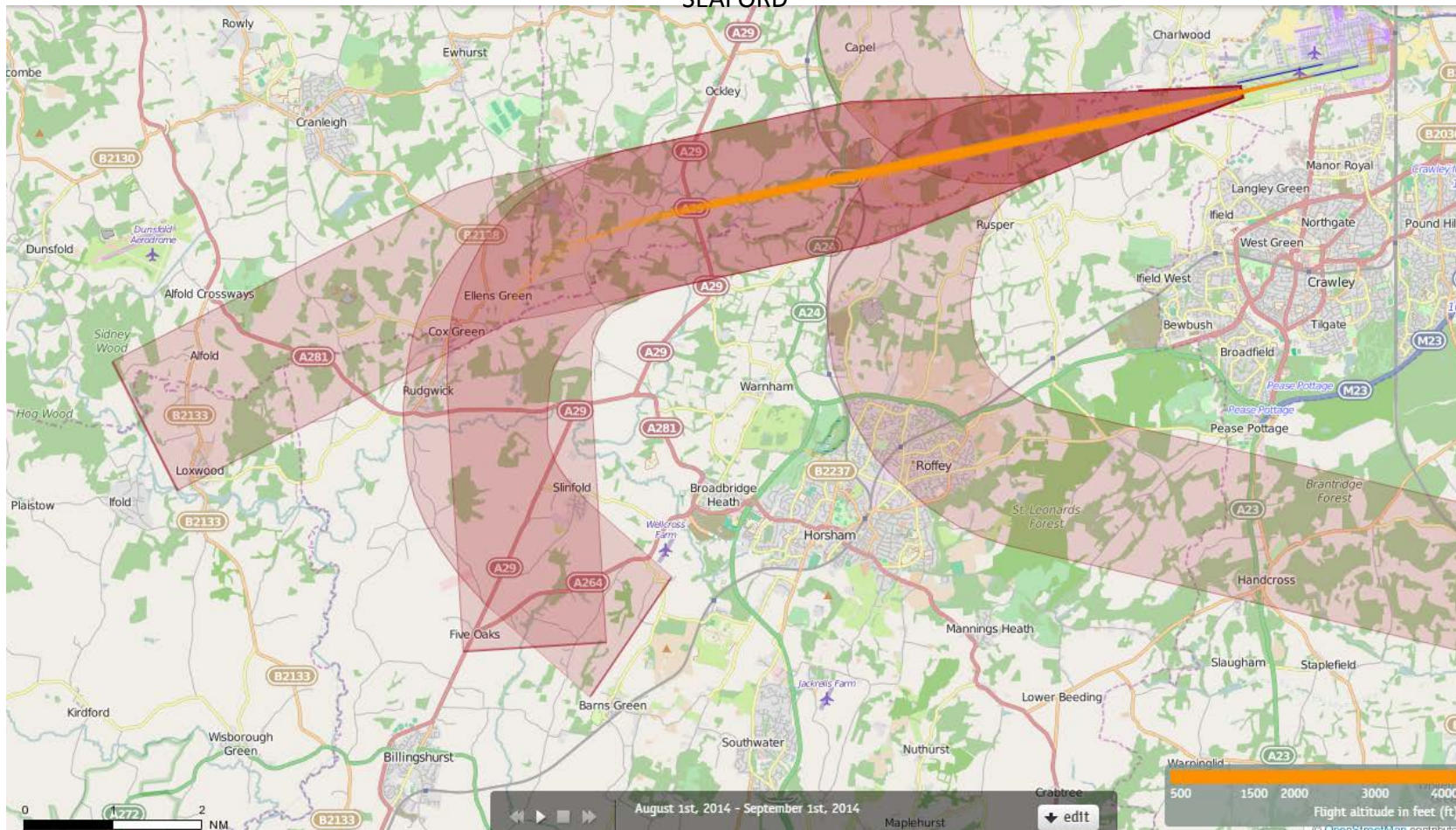
26SEAFORD August 2013 Aircraft Tracks Cut Off at 4000ft Altitude 110 Aircraft – Showing CONVENTIONAL Departures Only



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

26SEAFORD August 2014 Aircraft Tracks Cut Off at 4000ft Altitude 160 Aircraft – Showing P-RNAV Departures Only

N.B. During this period the ADNID trial was in operation, therefore only 160 aircraft operated on SEAFORD



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

26 SEAFORD

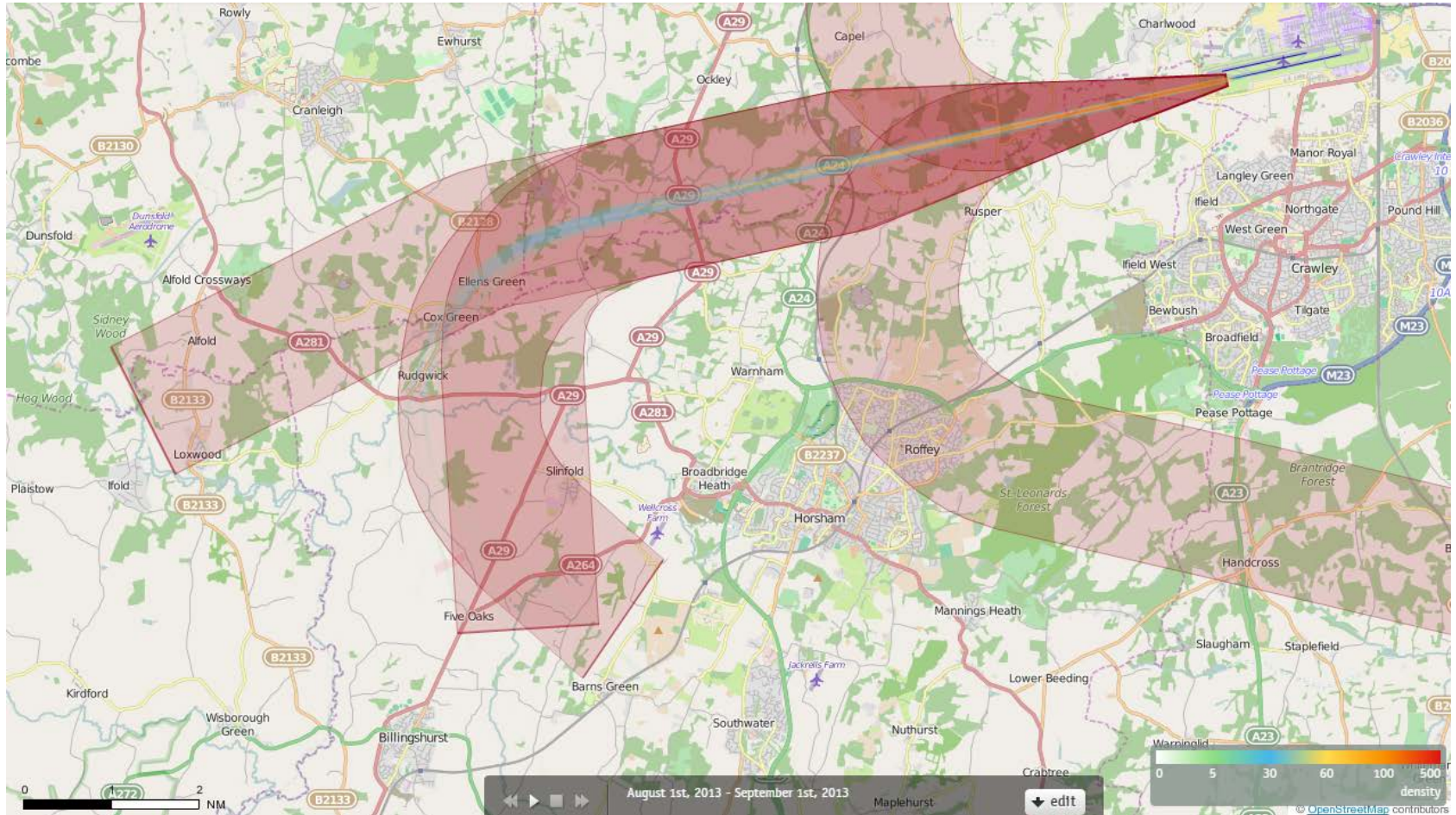
Route 8

Pre and Post P-RNAV

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

26SEAFORD Density August 2013

110 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.

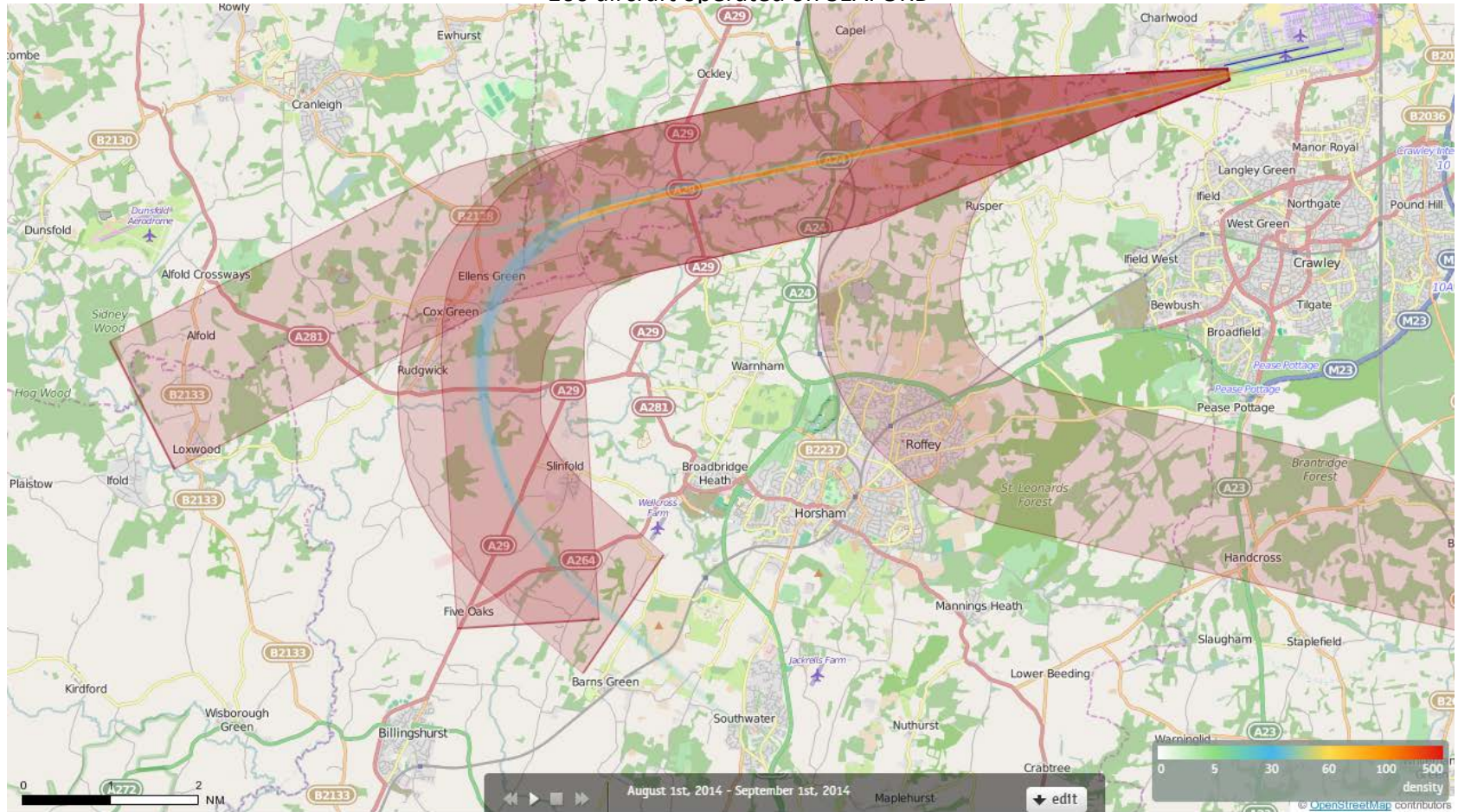
When all the tracks have been drawn, each pixel decides upon its colour based on the number of times a 'track line' has come across that pixel. The conversion from "count" to "colour" is guided by the numbers and colours given in the current Palette.

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

26SEAFORD Density August 2014

160 Aircraft – Showing P-RNAV Departures Only

N.B. During this period the ADNID trial was in operation, therefore only 160 aircraft operated on SEAFORD



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.

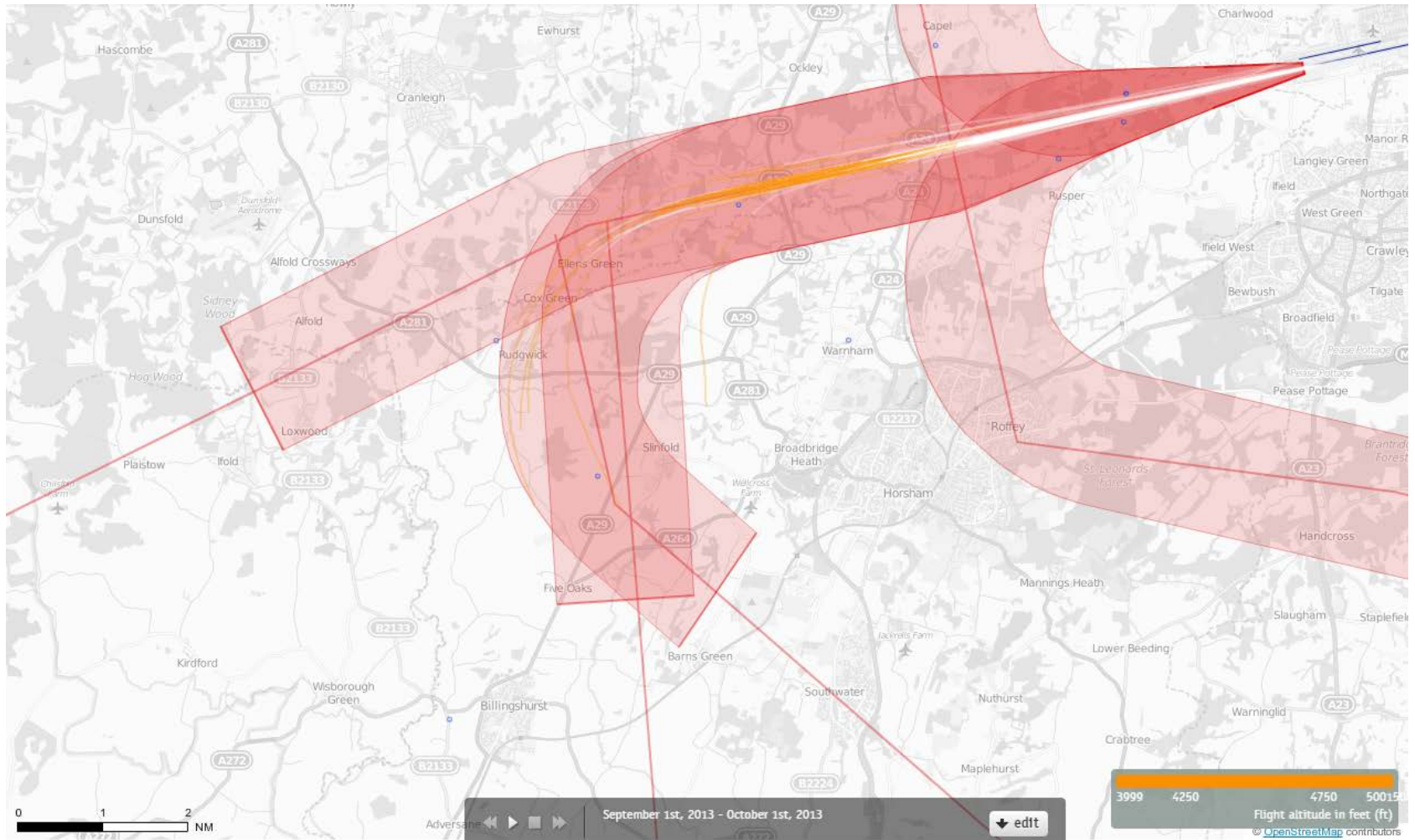
Counts in between are mapped to colours in between. If 100 were orange and 200 were red, then 150 would be coloured some orangy red.

26 SEAFORD

Route 8

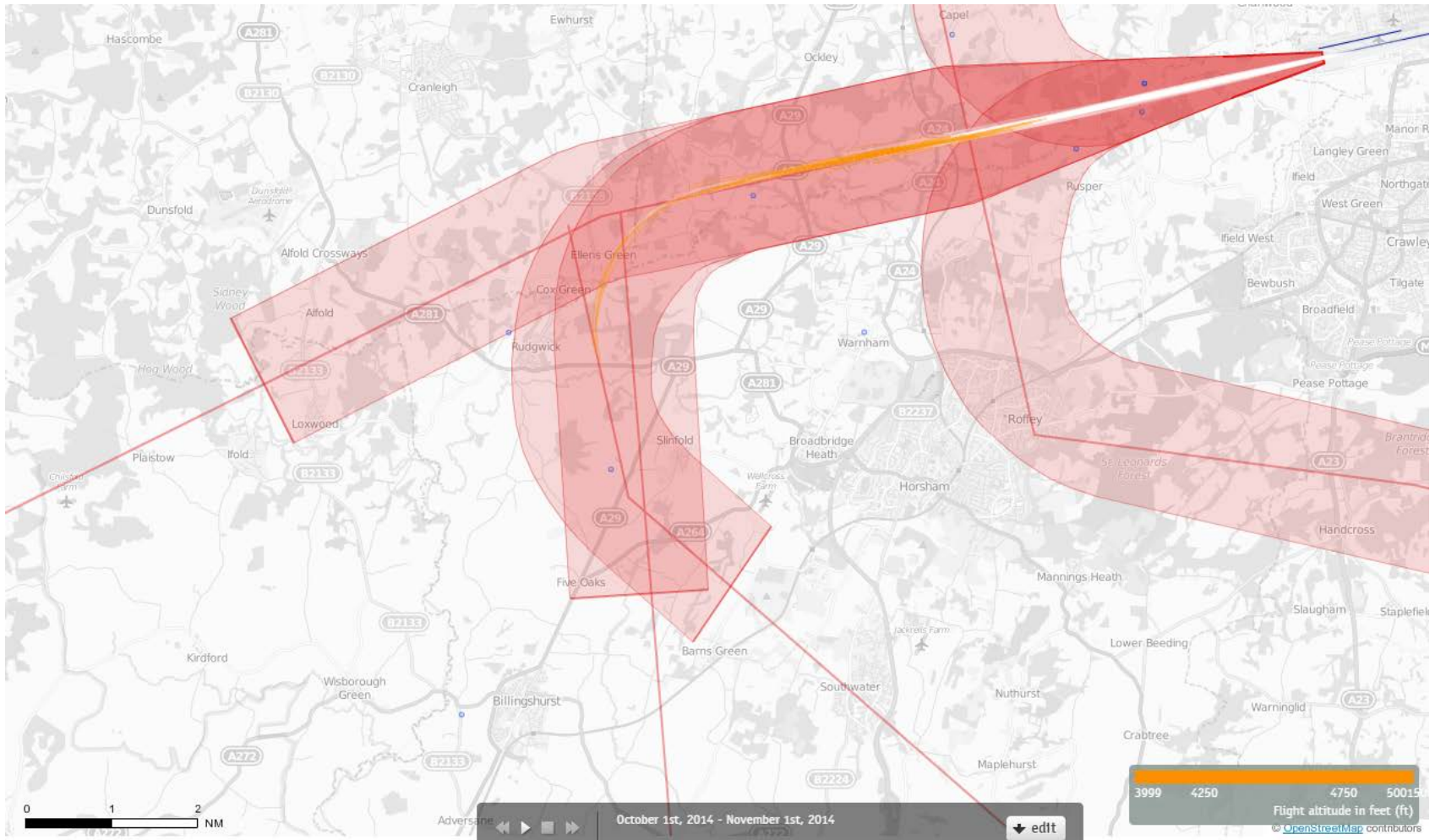
Altitude Bands
4000-5000ft

26 SFD Departures September 2013 4000-5000 feet (72 Aircraft – CONVENTIONAL ONLY)



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

26 SFD Departures October 2014 4000-5000 feet (59 Aircraft – P-RNAV ONLY)



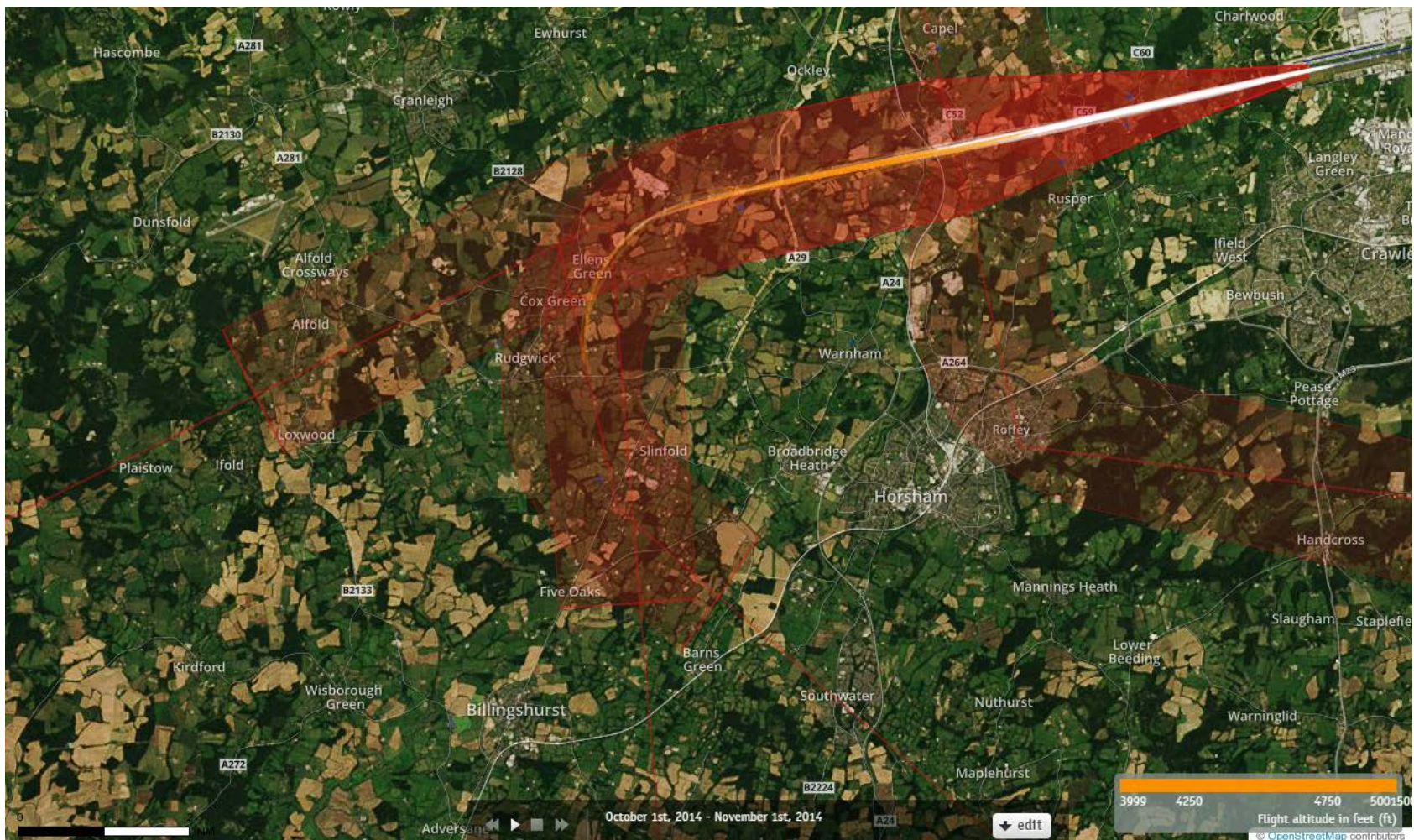
Orange plots show the points at which an aircraft was between 4000 and 5000ft altitude.

26 SFD Departures September 2013 4000-5000 feet (72 Aircraft – CONVENTIONAL ONLY)



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

26 SFD Departures October 2014 4000-5000 feet (59 Aircraft – P-RNAV ONLY)



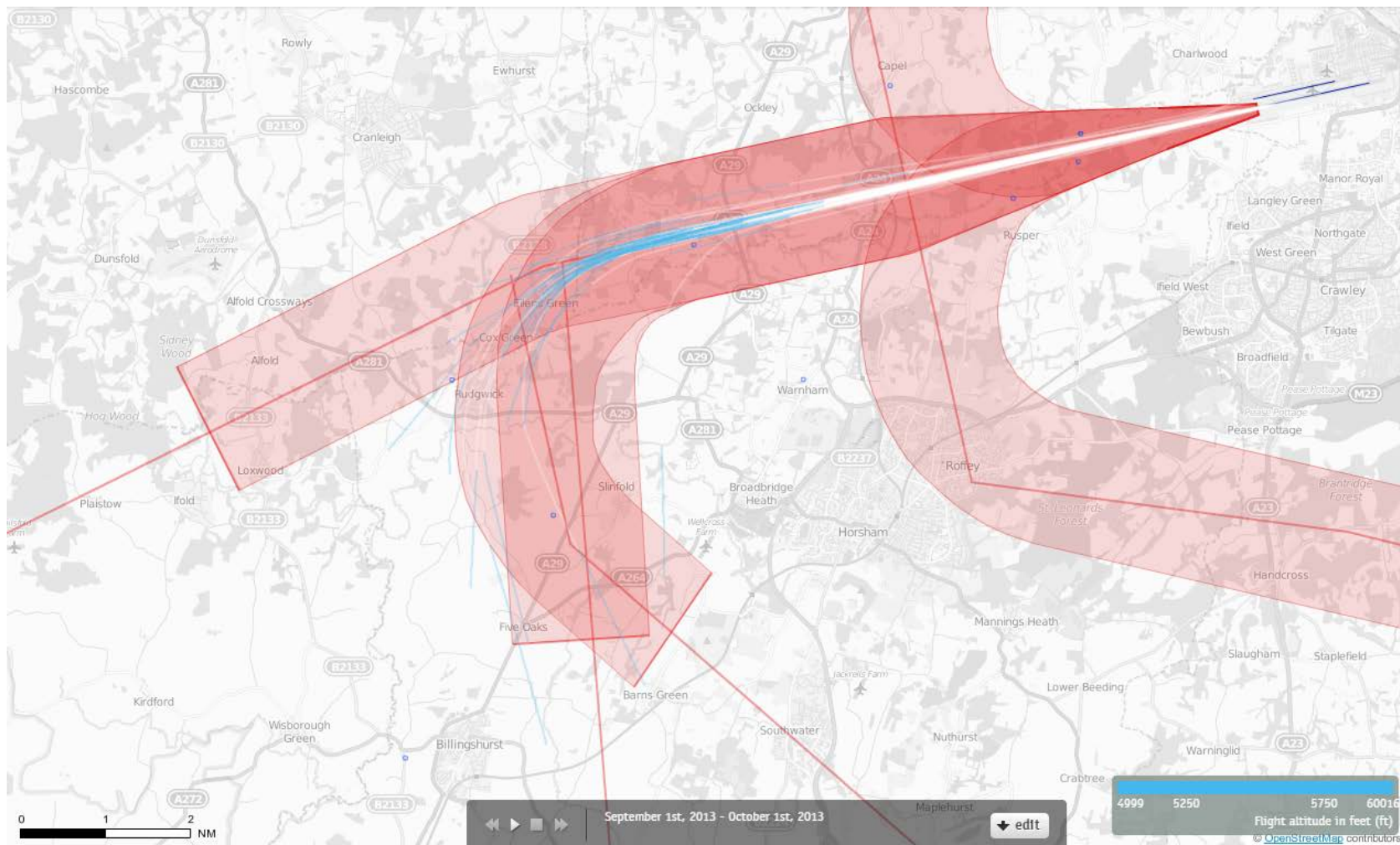
Orange plots show the points at which an aircraft was between 4000 and 5000ft altitude.

26 SEAFORD

Route 8

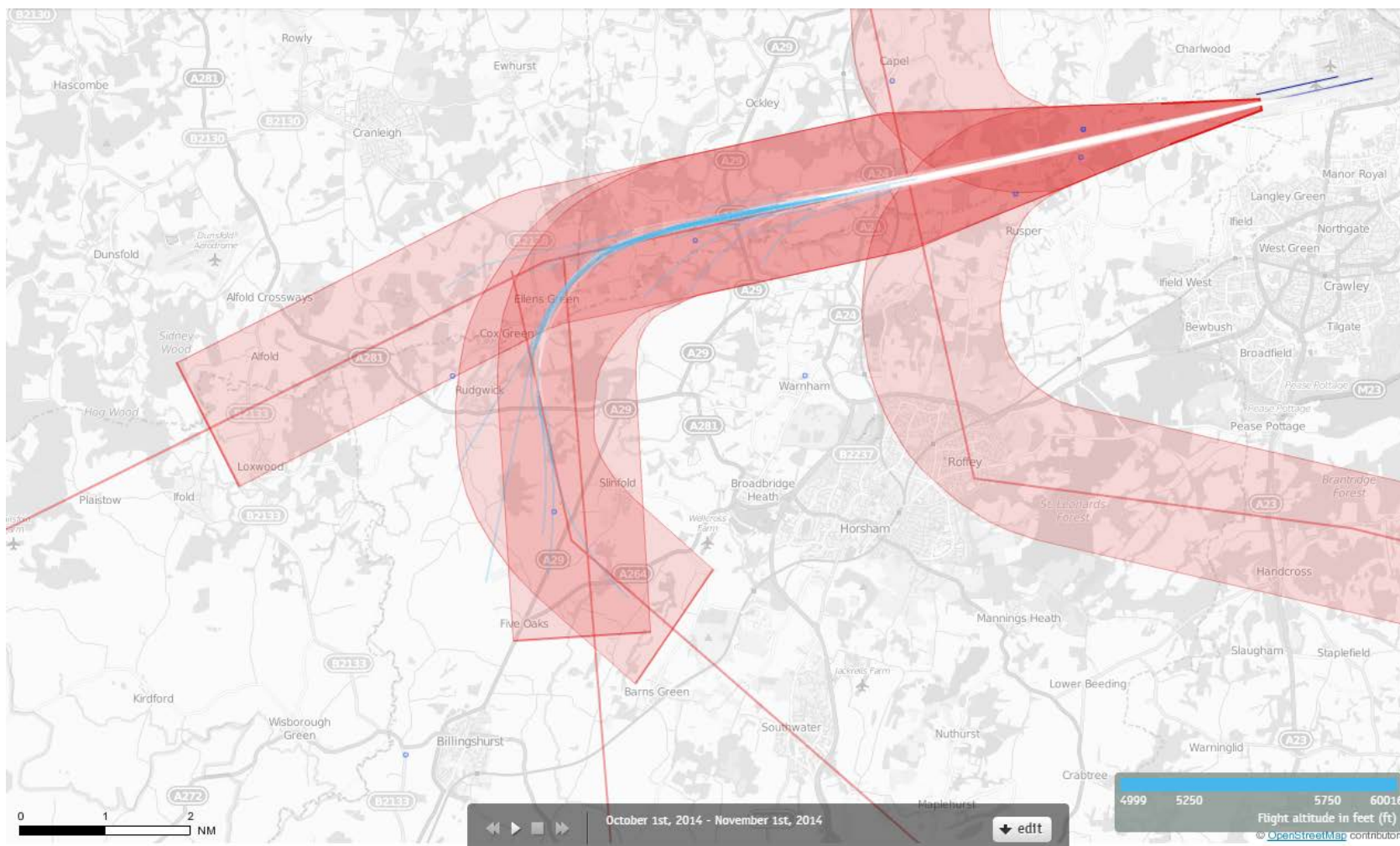
Altitude Bands
5000-6000ft

26 SFD Departures September 2013 5000-6000 feet (72 Aircraft – CONVENTIONAL ONLY)



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

26 SFD Departures October 2014 5000-6000 feet (59 Aircraft – P-RNAV ONLY)



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

26 SFD Departures September 2013 5000-6000 feet (72 Aircraft – CONVENTIONAL ONLY)



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

26 SFD Departures October 2014 5000-6000 feet (59 Aircraft – P-RNAV ONLY)



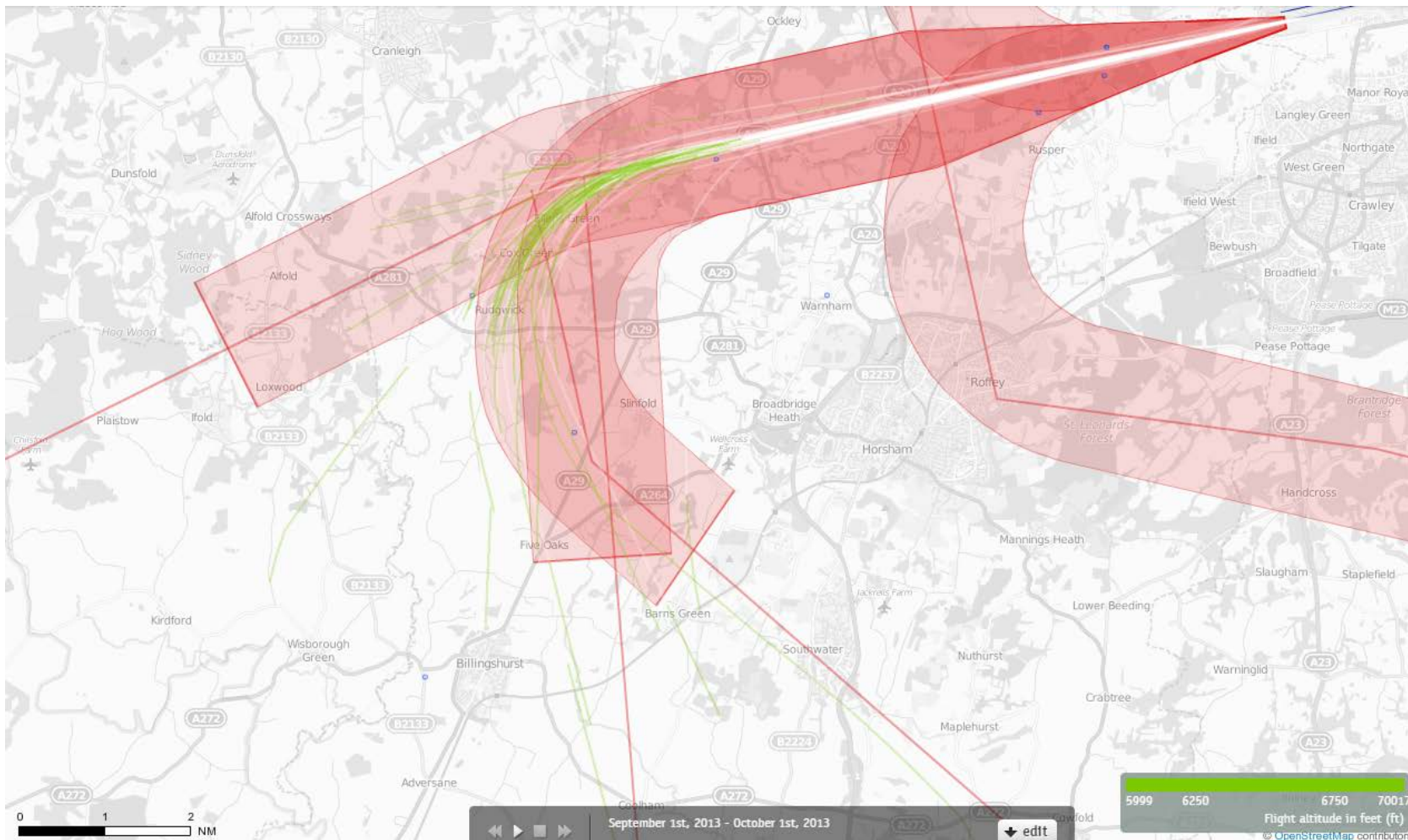
Blue plots show the points at which an aircraft was between 5000 and 6000ft altitude.

26 SEAFORD

Route 8

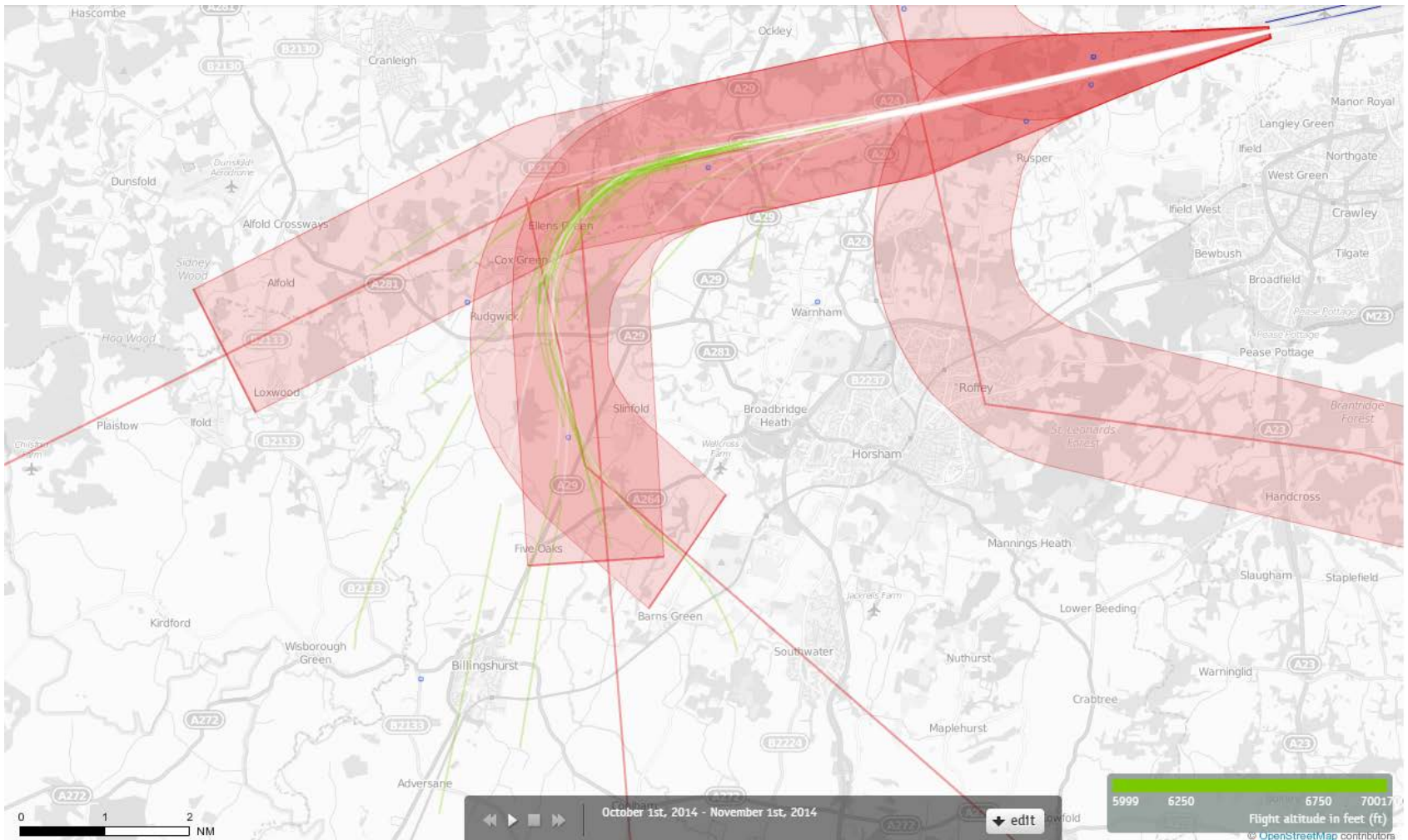
Altitude Bands
6000-7000ft

26 SFD Departures September 2013 6000-7000 feet (72 Aircraft – CONVENTIONAL ONLY)



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

26 SFD Departures October 2014 6000-7000 feet (59 Aircraft – P-RNAV ONLY)



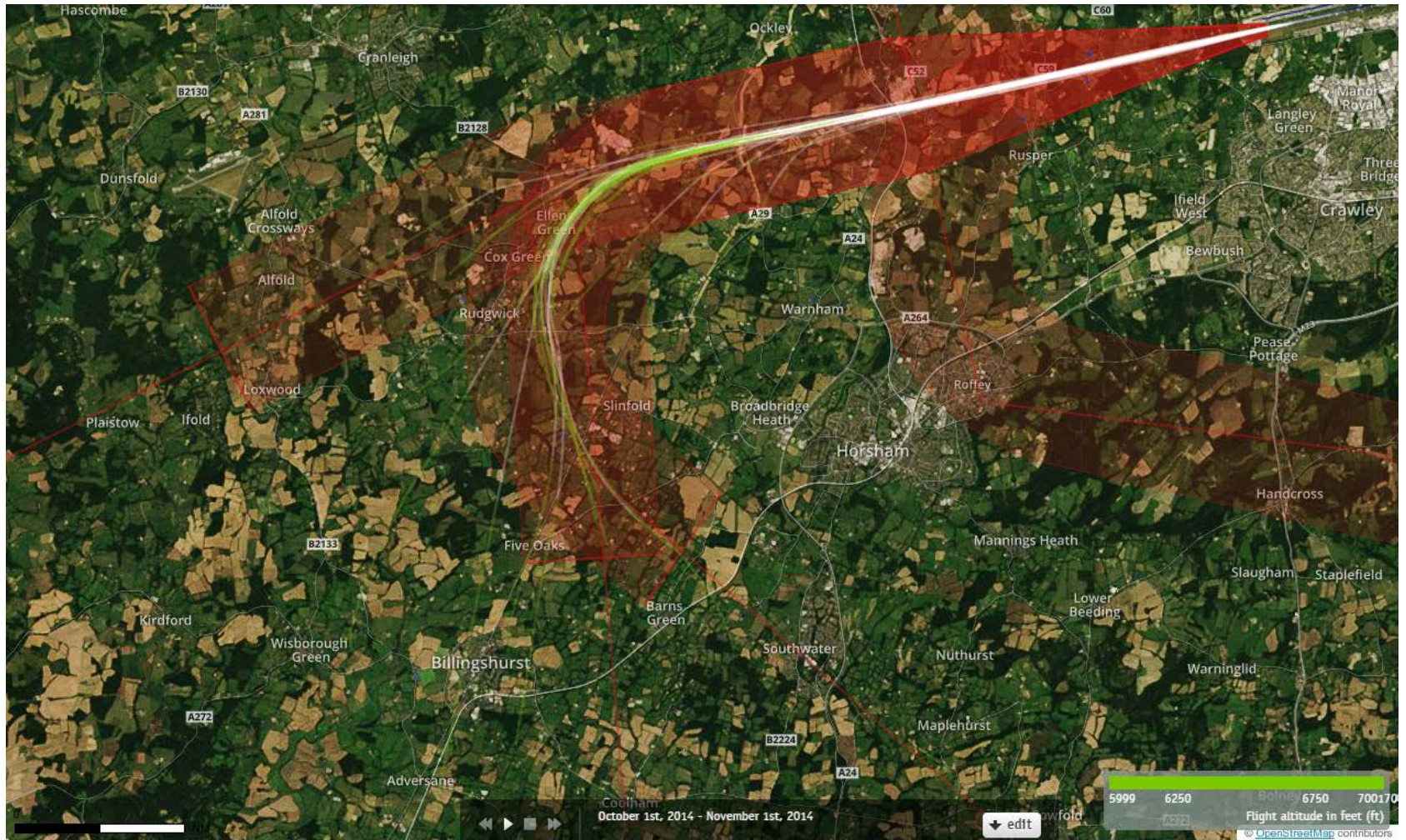
Green plots show the points at which an aircraft was between 6000 and 7000ft altitude.

26 SFD Departures September 2013 6000-7000 feet (72 Aircraft – CONVENTIONAL ONLY)



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

26 SFD Departures October 2014 6000-7000 feet (59 Aircraft – P-RNAV ONLY)



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