

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 2 – RWY 08 SFD 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 8 in Con Doc 200A Fig 4 in ACP 201A		Fig 9 in Con Doc 200B Fig 5 in ACP 201B		The forecast impact was as shown in Con Doc Fig 9 & ACP Fig 5. which was predicated on the results of the Trial of Route 2. A concentrated flightpath was forecast to occur on the eastern half of the NPR swathe.		
	Diagram SFD	Month Jun 13	Number 1052	Month Jul 14	Number 1227		Day: 4000 Night: 4000	
202	At 4000 ft GAL Slides: 4 v 7 CAA Slides 2v3	Deps using almost 30-40% of the width of the NPR swathe during the turn, mainly on the eastern side of the NPR CL, reducing as ac are climbed above 4000ft after passing East Grinstead.		In the main, the dispersion of deps is narrower than the conv SID dispersion – approx 25-30% of the width of the NPR swathe during the turn until ac pass the A264. There are a few RNAV deps seen performing very wide turns over North End.		The RNAV SID dispersion has reduced in width compared with the width of the conv SID departure track dispersion by, in the main around 40%. The main dispersion has moved very slightly further eastwards towards East Grinstead. However, the RNAV SIDs can be seen slightly further west of the A22 compared with the conv SIDs as they approach East Grinstead, the effect being a more concentrated dispersion of ac from the NPR CL to half way across the eastern half of the NPR swathe. 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.	Vectoring not apparent.	RNAV track dispersion as expected. RNAV sample is + 175 more. It is noted that there is a change in dispersion and concentration of the conv SID in this sample compared with that shown in consultation and ACP.
203	Density Plot CON DOC RTE 2 GAL Slides: 4 v 7 CAA Slides 2v3	Deps using almost 30% of the width of the NPR swathe during the turn, mainly on the eastern side of the NPR CL; after east Grinstead, the density plot widens, then reduces after passing West Hoathly.		The dispersion of deps is narrower than the conv swathe – approx 10-15% of the width of the NPR swathe on the east side of the NPR CL. After passing Sunnyside, the main density stream establishes along the CL of the NPR swathe.		The RNAV SID dispersion has reduced in width compared with the width of the conv SID departure track dispersion by, in the main around 50%. The picture shows a steady curved turn onto south towards Seaford. This is in line with data shown by GAL in consultation and the ACP. The deps are more concentrated than the conventional SID dispersion with the main concentration east of the NPR CL. The expectations of the RNAV replication design have been evident since permanent introduction.	Vectoring not apparent.	RNAV track dispersion as expected. RNAV sample is + 175 more. It is noted that there is a change in dispersion and concentration of the conv SID in this sample compared with that shown in consultation and ACP. Based on the RNAV SID track distribution, this appears to be a successful design.
	Alt Slice Diagrams (Note 7)	Period 1-31 Mar 14	Number 307	Period 1-7 Sep 14	Number 554			
204	Alt 4-5000ft Slides: 2&3 4&5 CAA Slides 2-5	Deps spread across approx 70% of the width of the NPR swathe as they complete the turn towards Seaford, although there are a few ac to the east of the NPR Swathe (above 4000ft). Ac appear to establish on the NPR CL by West Hoathly.		Deps in this altitude band are on the eastern side of the NPR CL as they pass East Grinstead then converge to the NPR CL.		The RNAV SID dispersion has reduced compared with the width of the conv SID departure track dispersion in this alt band with a more concentrated dispersion on the east side of the NPR CL. After passing East Grinstead there is a steady track dispersion on the NPR CL towards Seaford. The deps are more concentrated than the conventional SID dispersion which was the aim of the RNAV SID replication.	Vectoring not apparent.	Traffic above 4000ft was not assessed in the ACP analysis as deps may be tactically vectored when reaching 4000ft. RNAV sample is + 237 more
	Alt 5-6000ft Slides: 6&7	Some deps at 5000ft + after mid-way through the 90 deg turn. Ac steady up on the NPR CL towards Seaford.		Some deps at 5000ft + from mid-way through the 90 deg turn.		The RNAV SID dispersion is reduced in width compared with the width of the conv SID departure track dispersion in this alt band.	Some limited vectoring to the west of the track towards Seaford.	Traffic above 4000ft was not assessed in the ACP analysis as deps may be tactically vectored when reaching 4000ft.

205	8&9 CAA Slides 2-5	Some vectoring towards the west of the route alignment after East Grinstead.	Some vectoring towards the west of the route alignment after East Grinstead.	After passing East Grinstead there is a steady track dispersion on the NPR CL towards Seaford, although vectoring is apparent (similar to the conv SID). The deps are more concentrated than the conventional SID dispersion which was the aim of the RNAV SID replication.		RNAV sample is + 237 more
206	Alt 6-7000ft Slides: 10&11 12&13 CAA Slides 2-5	Most deps at 6000ft + before West Hoathly. Ac continue towards Seaford, but more vectoring apparent.	Most deps at 6000ft + before West Hoathly. For traffic remaining on the SID, the dispersion is slightly more concentrated Ac continue towards Seaford, but more vectoring apparent after Horsted Keynes.	The RNAV SID dispersion is slightly reduced in width compared with the width of the conv SID departure track dispersion in this alt band. For traffic remaining on the SID, the dispersion is slightly more concentrated compared with the conventional SID dispersion which was the aim of the RNAV SID replication.	Some limited vectoring to the west of the track towards Seaford.	Traffic above 4000ft was not assessed in the ACP analysis as deps may be tactically vectored when reaching 4000ft. RNAV sample is + 237 more.

ROUTE 2 – RWY 08 SFD SAMPLE 2 Comparing Jul 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)
		Month	Number	Month	Number			
	Diagram SFD	Jul 13	1544	Jun 14	1642		Day: 4000 Night: 4000	
207	At 4000 ft GAL Slides: 8 v 3 CAA Slides 2v3	Deps using almost 40-50% of the width of the NPR swathe during the turn, mainly on the eastern side of the NPR CL, reducing as ac are climbed above 4000ft after passing East Grinstead. There are a few RNAV deps seen performing very wide turns over North End.		In the main, the dispersion of deps is narrower than the conv SID dispersion – approx 25-30% of the width of the NPR swathe during the turn until ac pass the A264. There are a few RNAV deps seen performing very wide turns over North End.		The RNAV SID dispersion has reduced in width compared with the width of the conv SID departure track dispersion by, in the main around 40%. The main dispersion has moved very slightly further eastwards towards East Grinstead. However, the concentration is narrower. The RNAV SID deps are also generally slightly further west of the A22 compared with the conv SIDs as they approach East Grinstead, the effect being more concentration of ac from the NPR CL to half way across the eastern half of the NPR swathe. There is a shift in track dispersion away from Crawley Down. 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.	Vectoring not apparent.	RNAV track dispersion as expected. RNAV sample is + 98 more. It is noted that there is a change in dispersion and concentration of the conv SID in this sample compared with that shown in consultation and ACP.
208	Density Plot CON DOC RTE 2 GAL Slides: 8 v 3 CAA Slides 2v3	Deps using almost 30% of the width of the NPR swathe during the turn, mainly on the eastern side of the NPR CL; after East Grinstead, the density plot widens, then reduces after passing West Hoathly.		The dispersion of deps is narrower than the conv swathe – approx 10-15% of the width of the NPR swathe on the east side of the NPR CL. After passing Sunnyside, the main density establishes along the CL of the NPR swathe.		The RNAV SID dispersion has reduced in width compared with the width of the conv SID departure track dispersion by, in the main around 50%. The picture shows a steady curved turn onto south towards Seaford. This is in line with data shown by GAL in consultation and the ACP. The deps are more concentrated than the conventional SID dispersion with the main concentration east of the NPR CL. The expectations of the RNAV replication design have been evident since permanent introduction.	Vectoring not apparent.	RNAV track dispersion as expected. RNAV sample is + 98 more. It is noted that there is a change in dispersion and concentration of the conv SID in this sample compared with that shown in consultation and ACP.

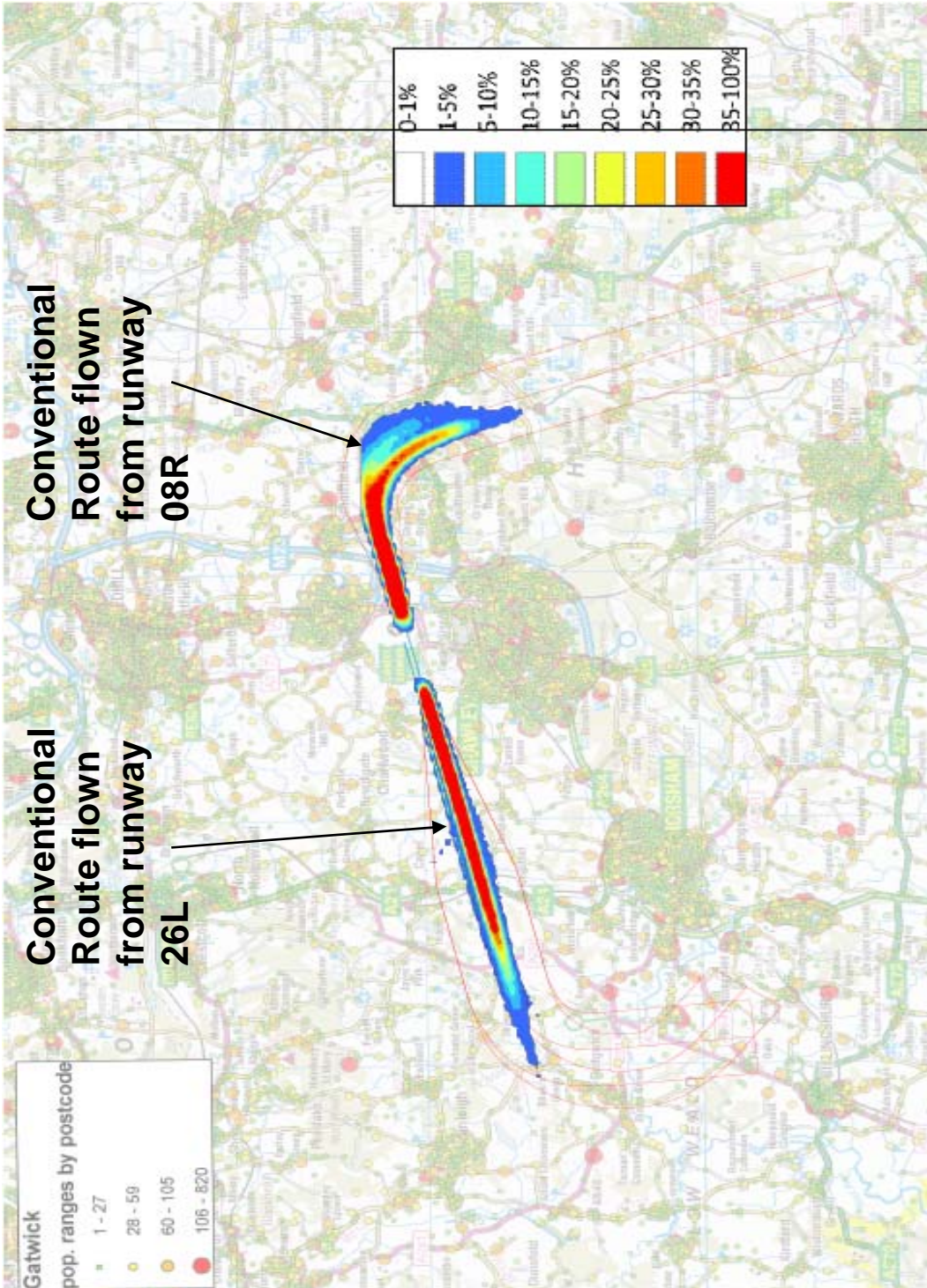
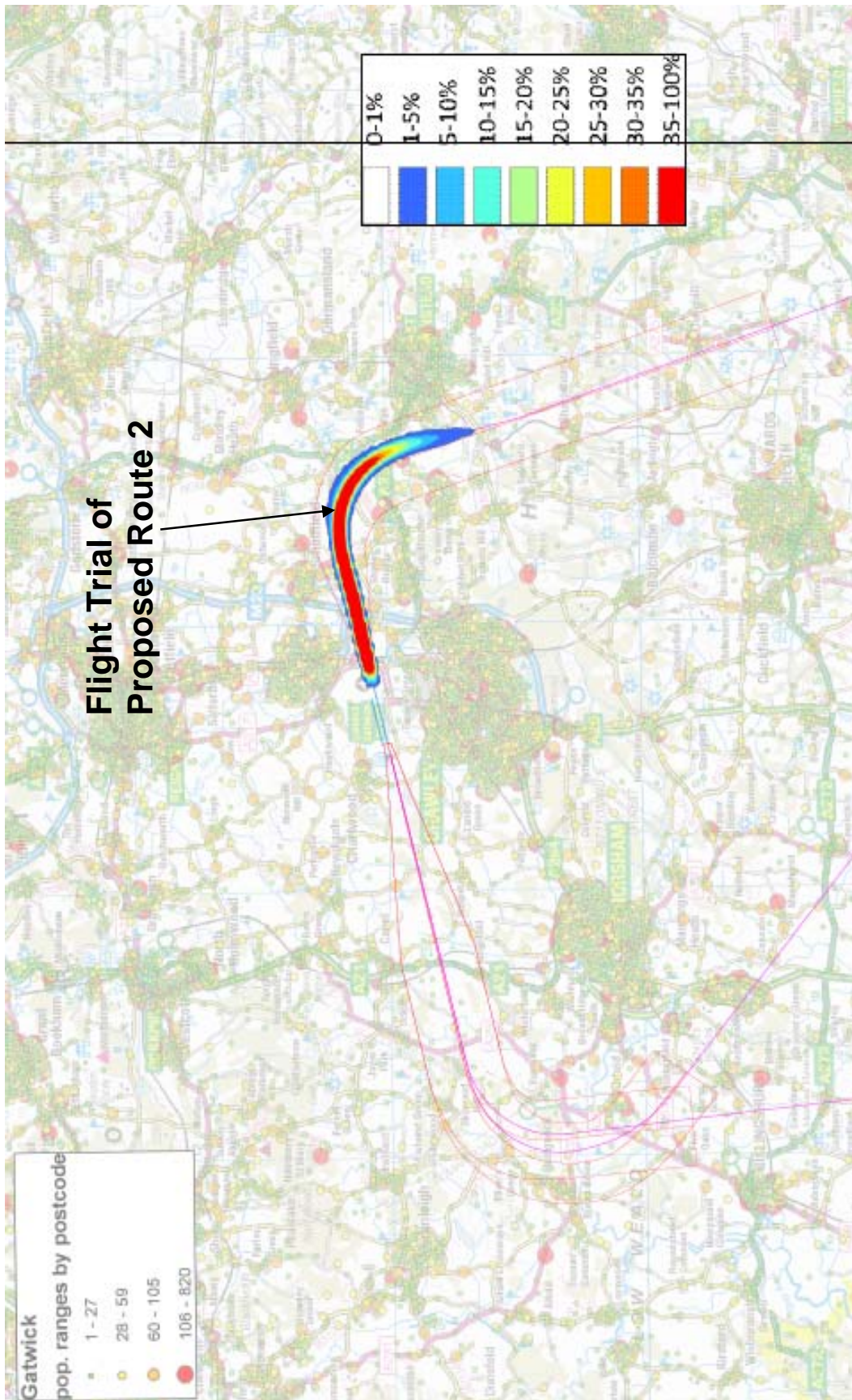
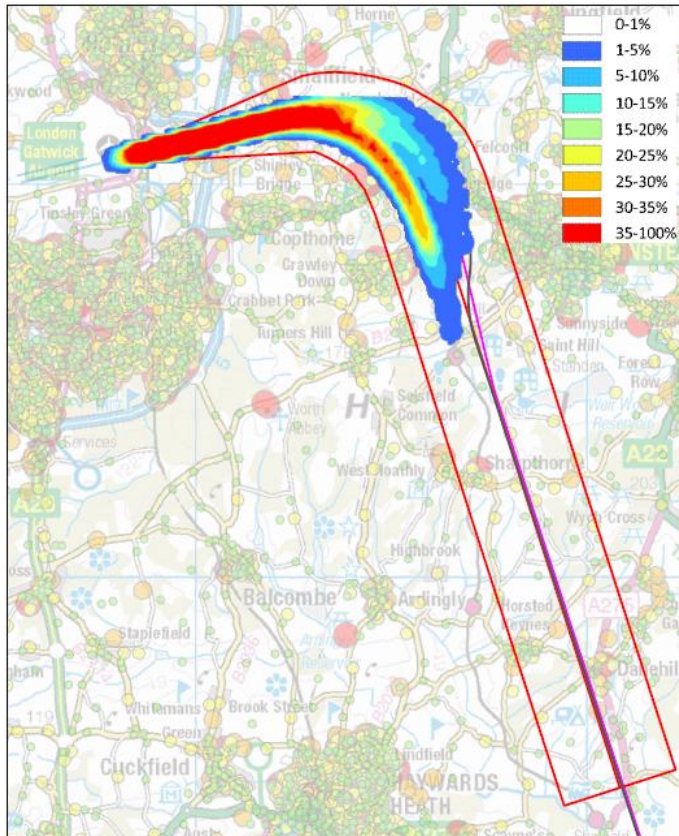


Figure 8) Density plots of aircraft tracks (up to 4000 feet AMSL) following the **conventional** (SFD) **SIDs** from Runway 08R, and Runway 26L (HARDY and BOGNA) SIDs



200 B
 < BACK

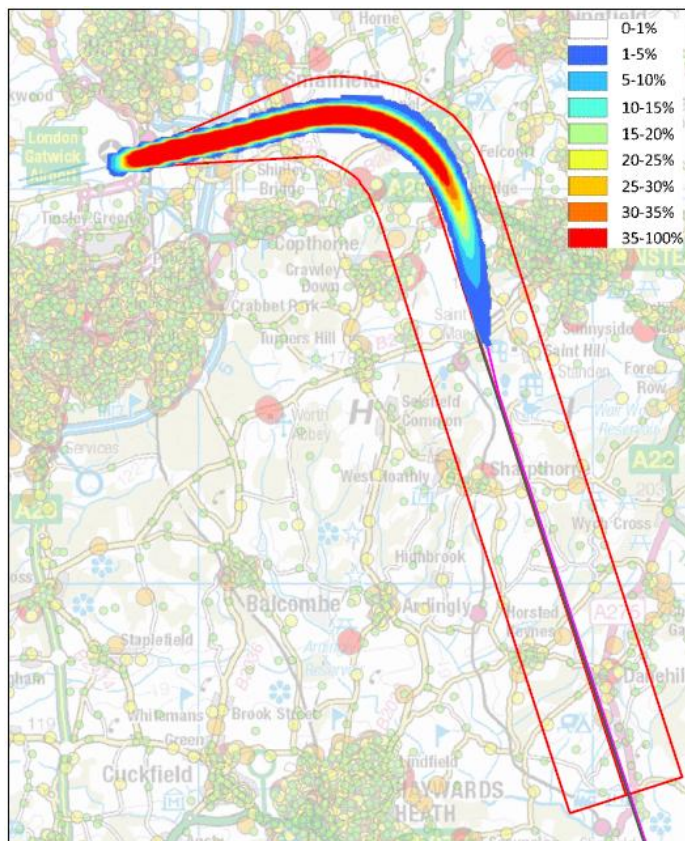
Figure9) Density plot of aircraft tracks (up to 4000 feet AMSL) following the PRNAV (**ROUTE 2**) flight trialed SID route from Runway 08R



201 A

< BACK

Figure 4 Route 2 Conventional Navigation



201 B

< BACK

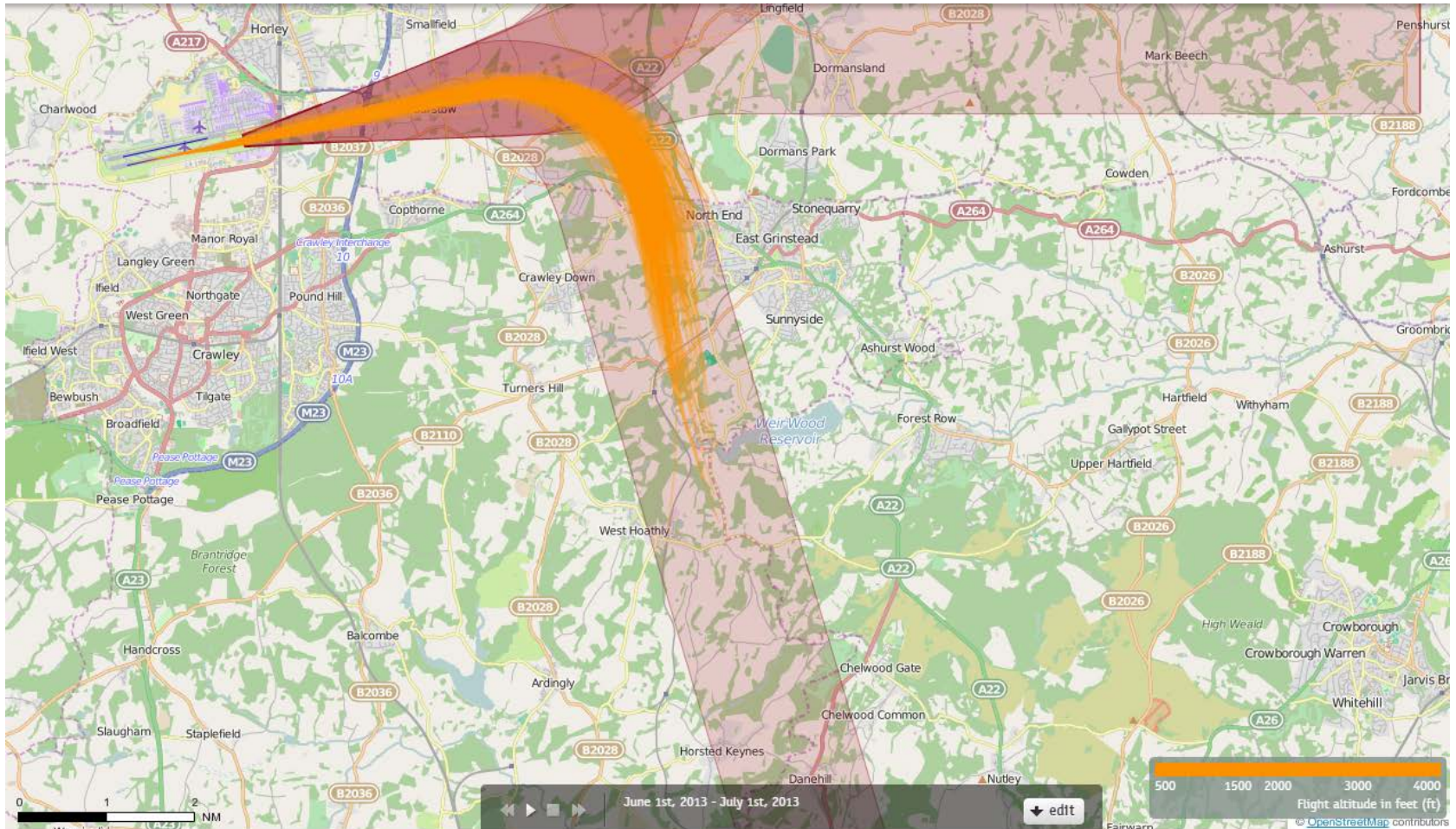
Figure 5 Route 2 PRNAV Navigation

08 SEAFORD

Route 2

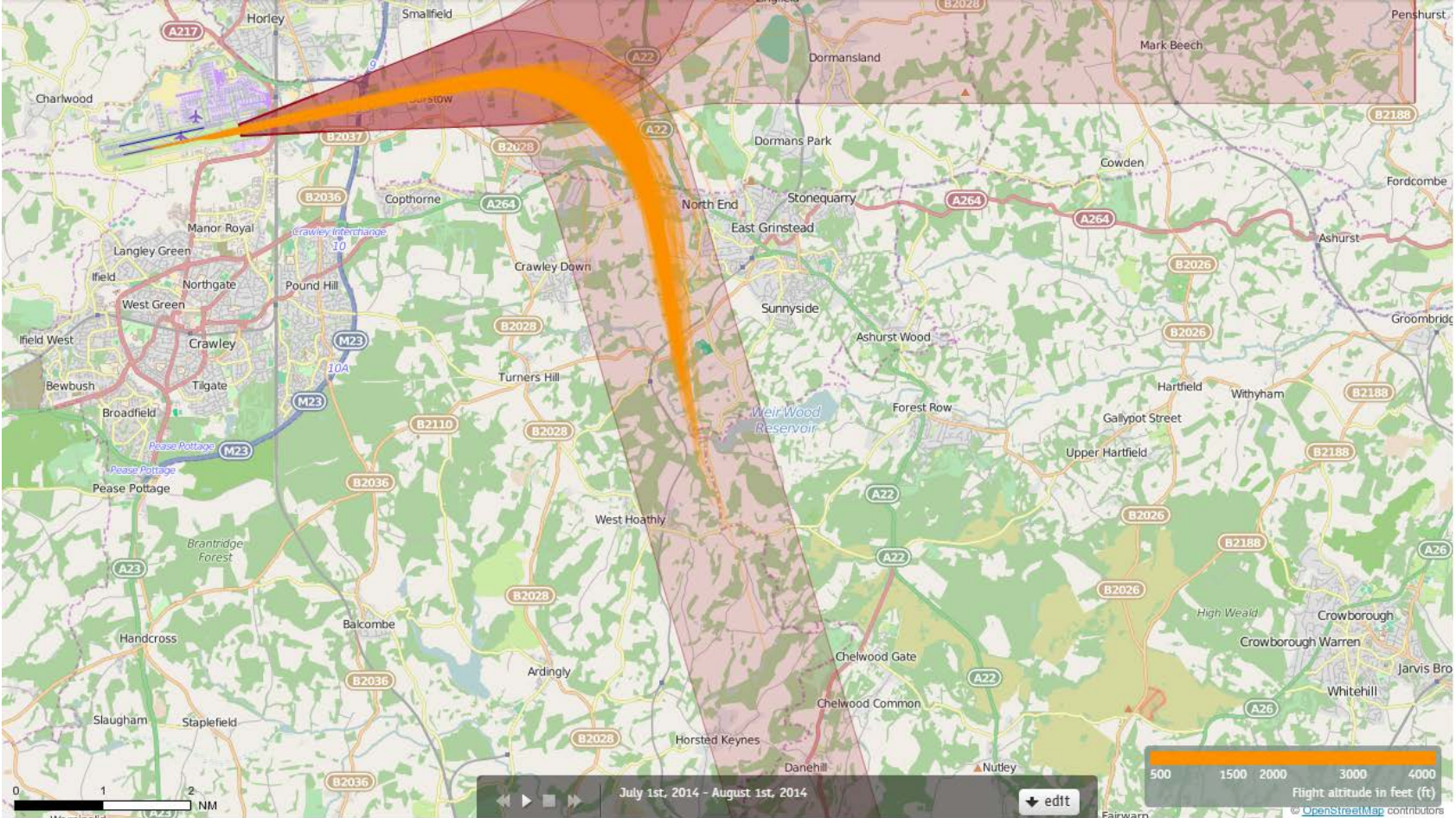
Pre and Post P-RNAV

08SEAFORD June 2013 Aircraft Tracks Cut Off at 4000ft Altitude 1052 Aircraft – Showing CONVENTIONAL Departures Only



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

08SEAFORD July 2014 Aircraft Tracks Cut Off at 4000ft Altitude 1227 Aircraft – Showing P-RNAV Departures Only



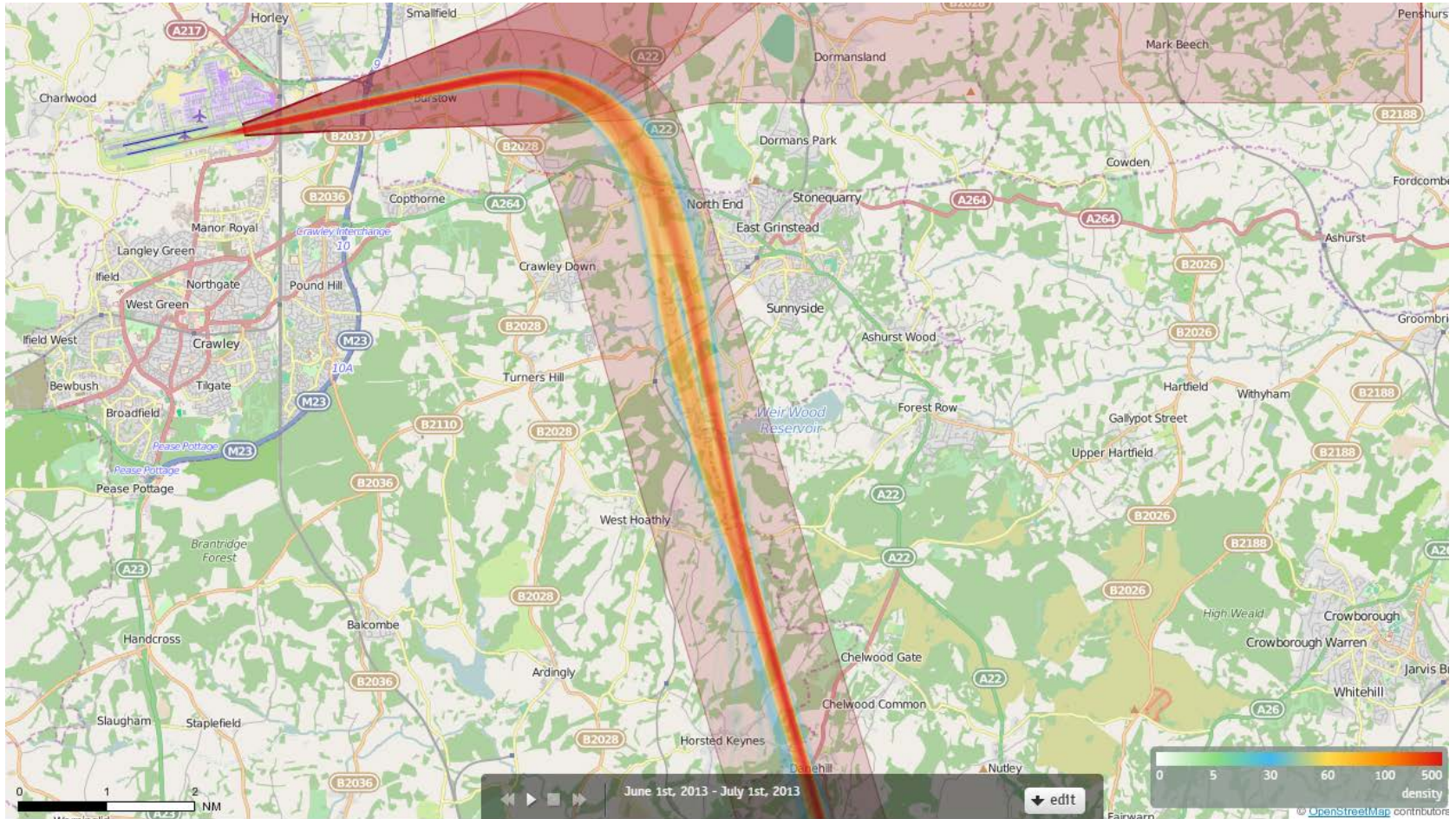
Orange plots show the tracks of aircraft until at an altitude of 4000ft

08 SEAFORD

Route 2

Pre and Post P-RNAV

08SEAFORD Density June 2013 1052 Aircraft – Showing CONVENTIONAL Departures Only



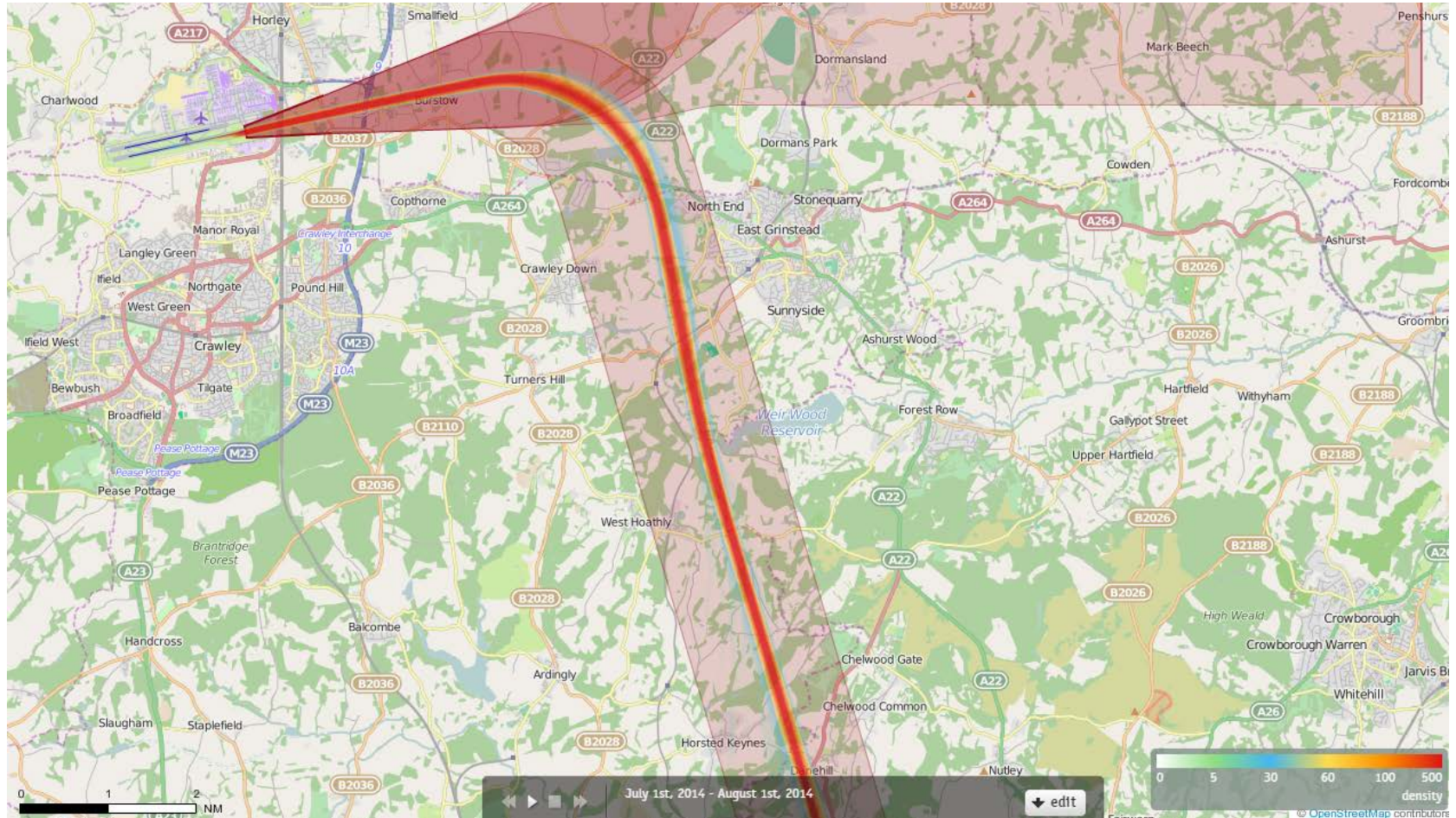
Track density

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.

08SEAFORD Density July 2014 1227 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.

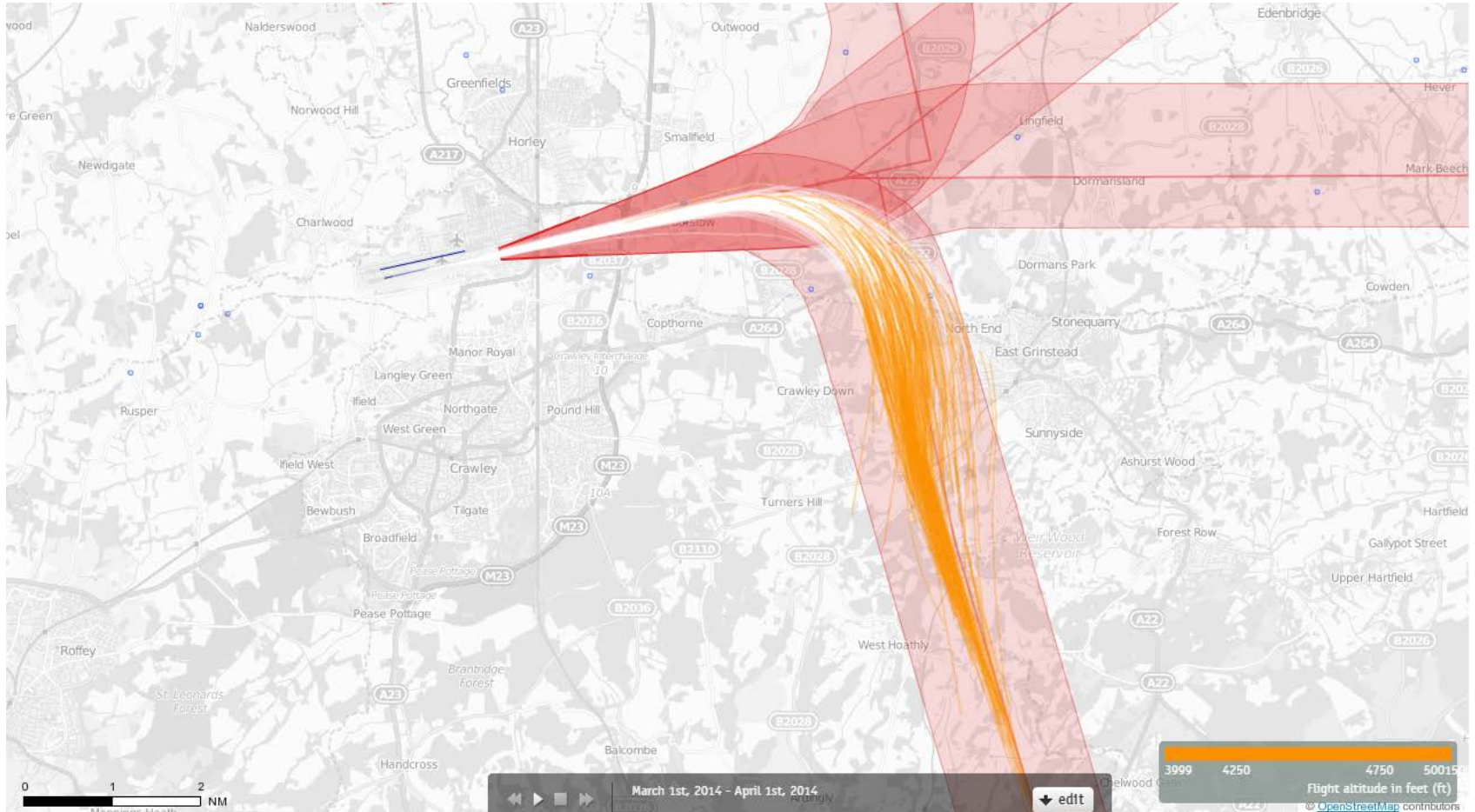
Counts in between are mapped to colours in between. If 100 were orange and 200 were red, then 150 would be coloured some orangy red.

08 SEAFORD

Route 2

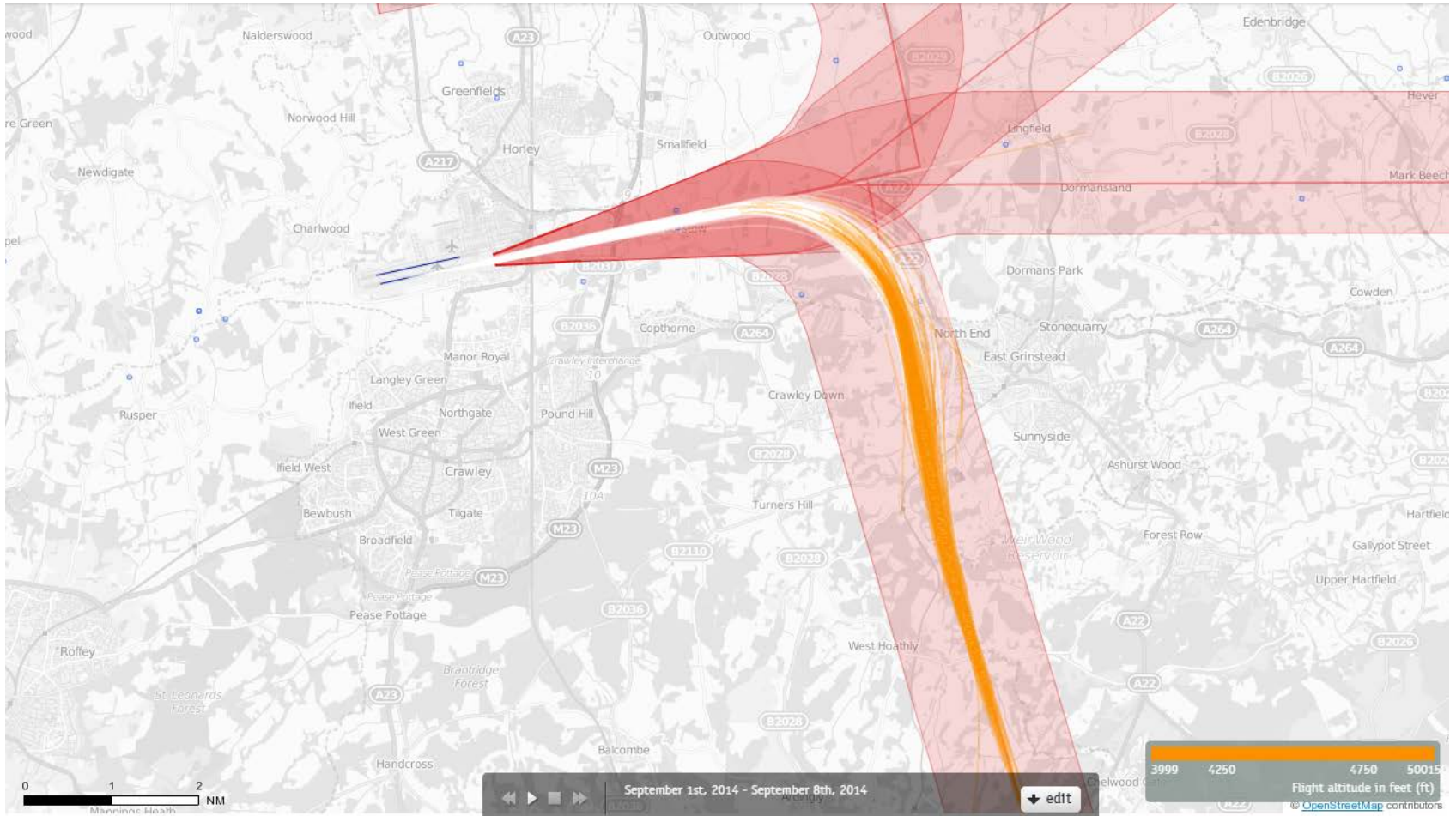
Altitude Bands
4000-5000ft

08 SFD Departures March 2014 4000-5000 feet (307 Aircraft – CONVENTIONAL ONLY)



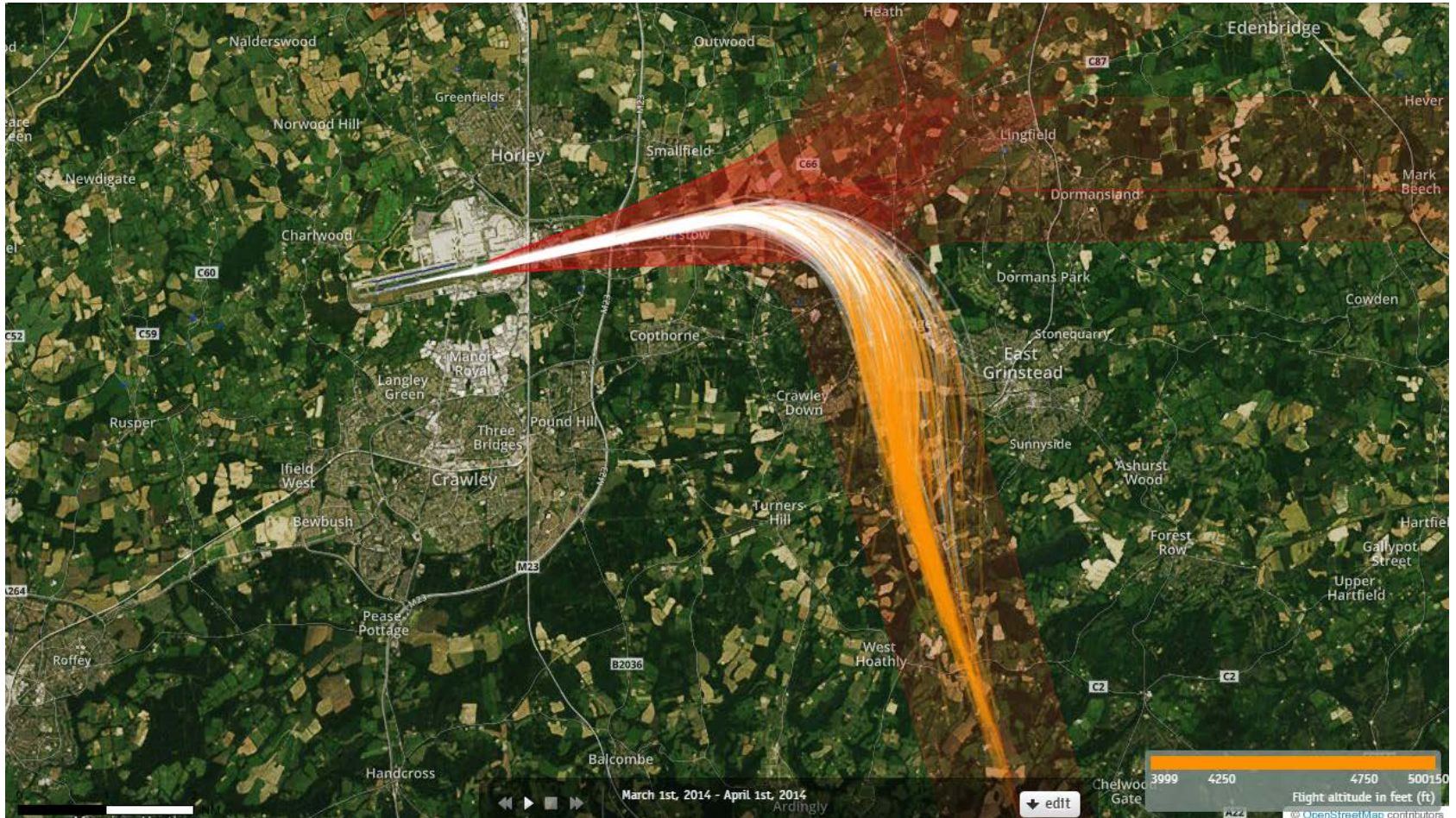
Orange plots shows the points at which an aircraft was between 4000 and 5000ft altitude.

08 SFD Departures 1st – 7th September 2014 4000-5000 feet (554 Aircraft – P-RNAV ONLY)



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

08 SFD Departures March 2014 4000-5000 feet (307 Aircraft – CONVENTIONAL ONLY)



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

08 SFD Departures 1st – 7th September 2014 4000-5000 feet (554 Aircraft – P-RNAV ONLY)



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

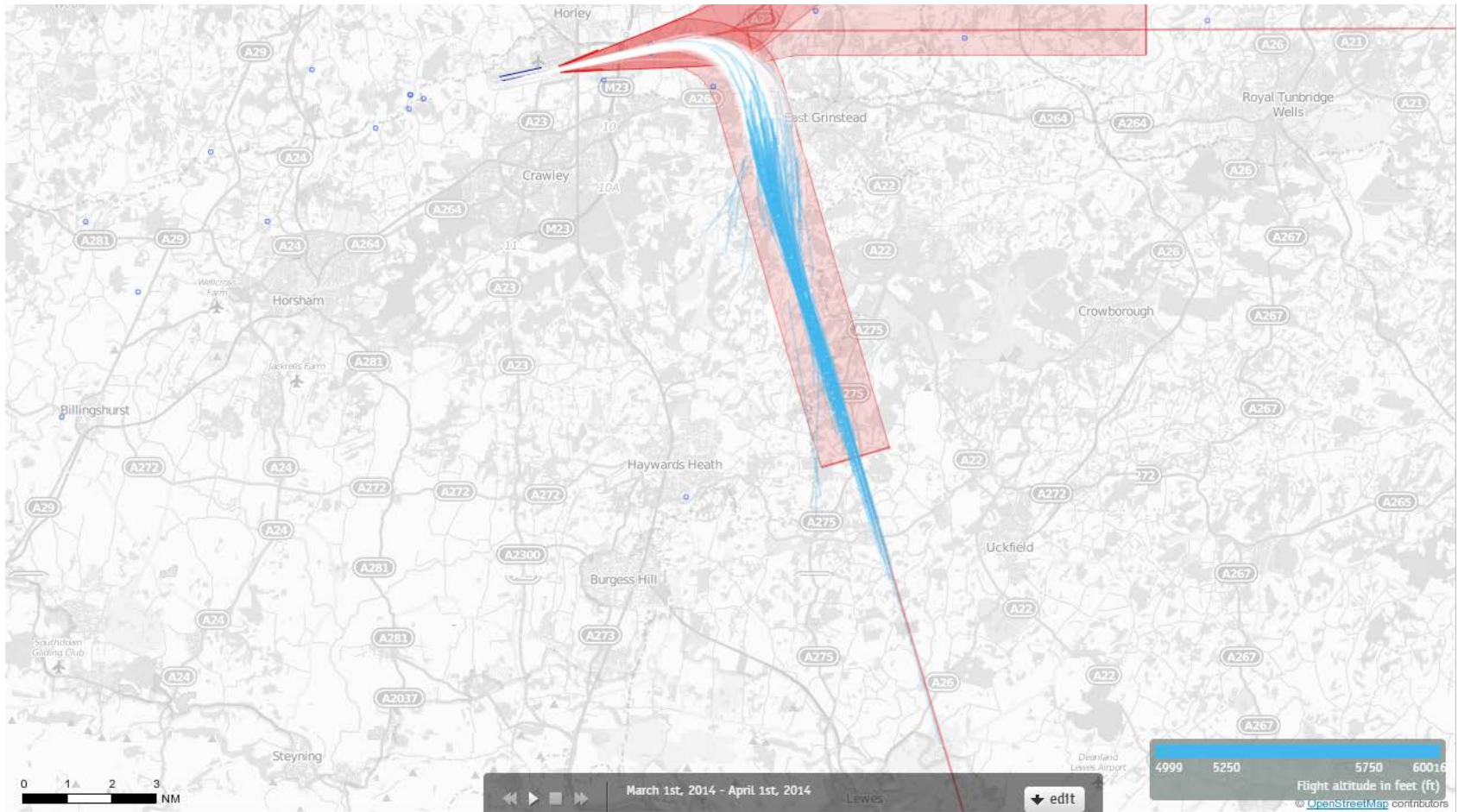
08 SEAFORD

Route 2

Altitude Bands
5000-6000ft

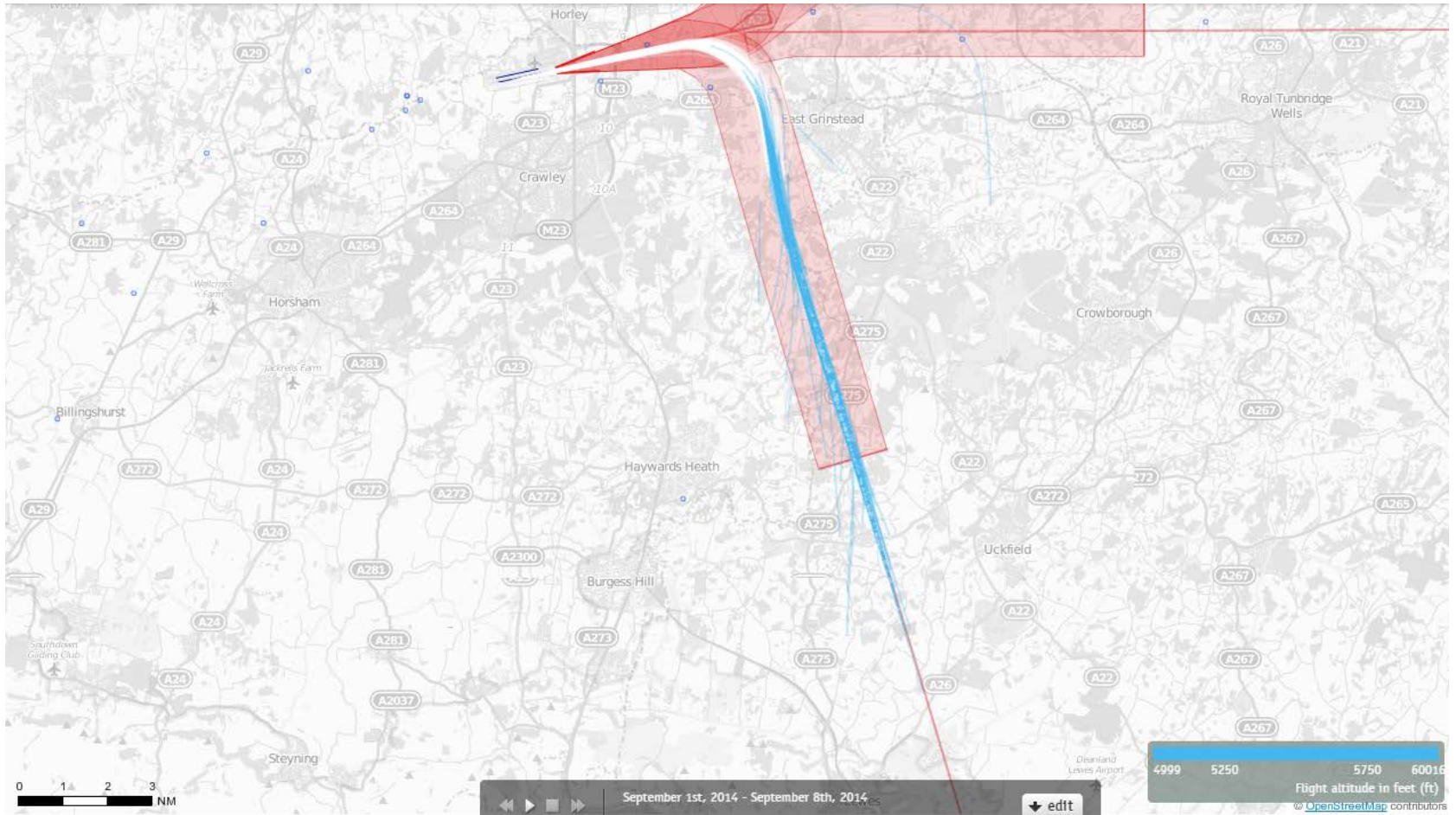
08 SFD Departures March 2014

5000-6000 feet (307 Aircraft – CONVENTIONAL ONLY)



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

08 SFD Departures 1st – 7th September 2014 5000-6000 feet (554 Aircraft – P-RNAV ONLY)



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

08 SFD Departures March 2014 5000-6000 feet (307 Aircraft – CONVENTIONAL ONLY)



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

08 SFD Departures 1st – 7th September 2014 5000-6000 feet (554 Aircraft – P-RNAV ONLY)



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

08 SEAFORD

Route 2

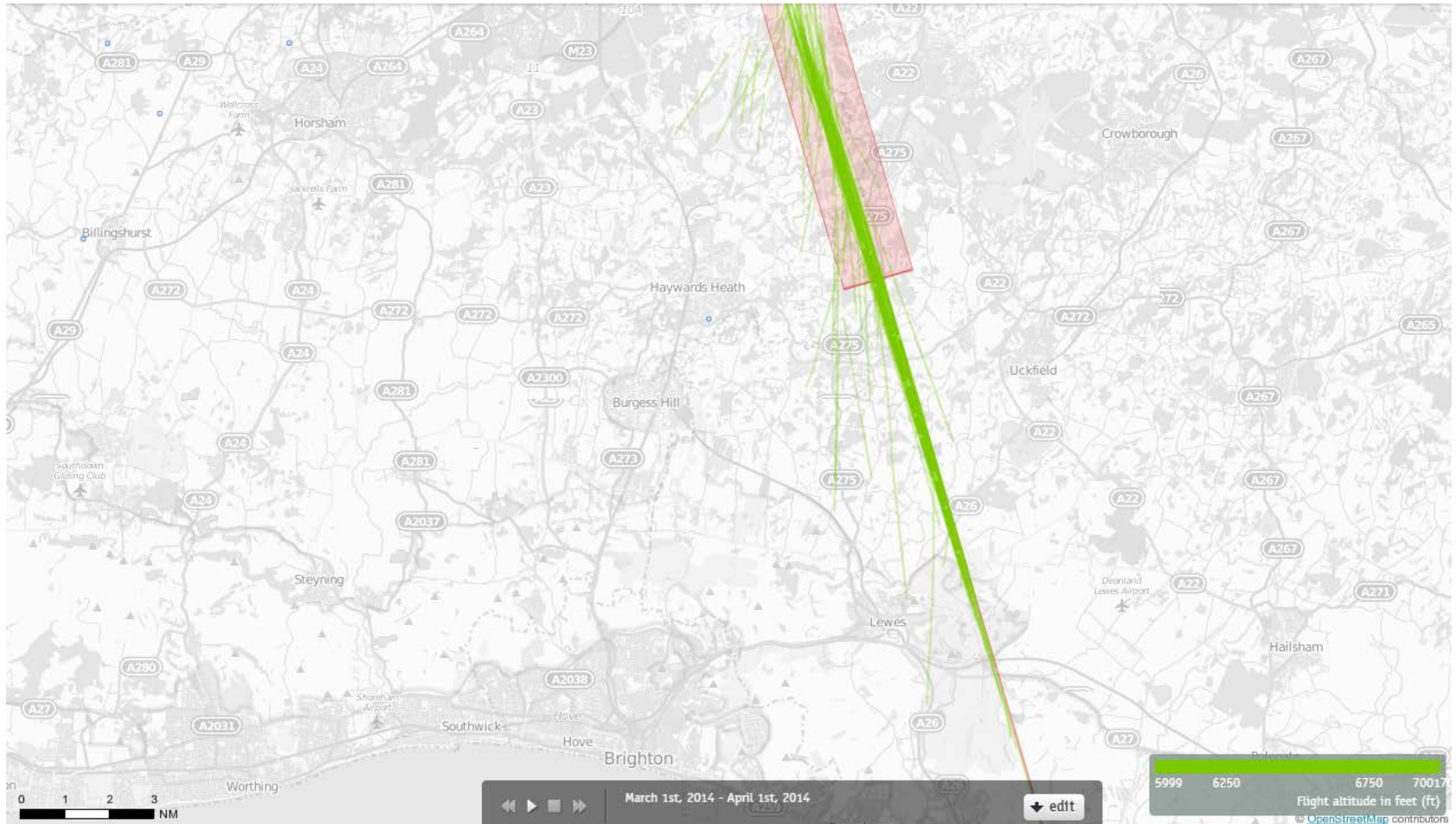
Altitude Bands

4000-5000ft

5000-6000ft

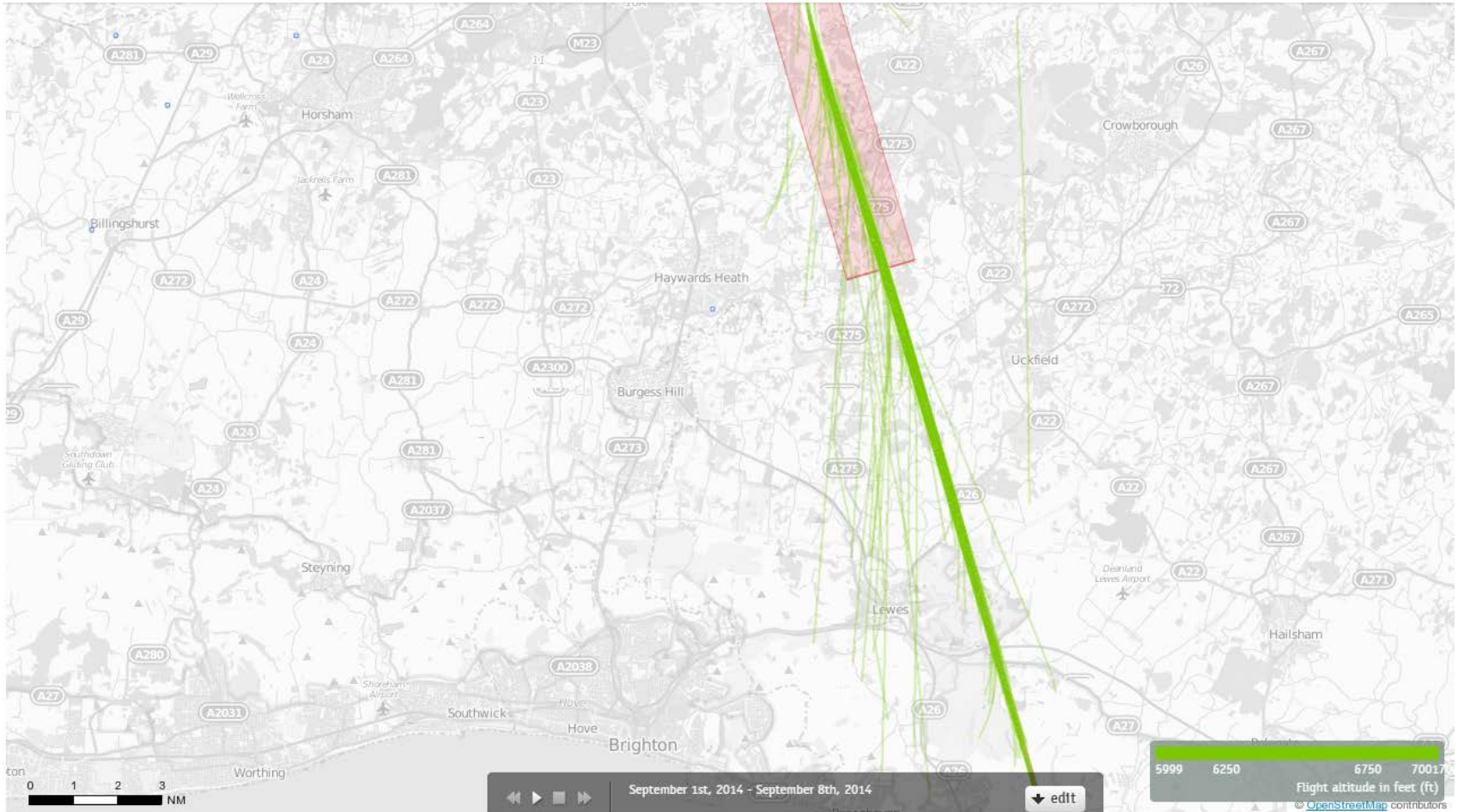
6000-7000ft

08 SFD Departures March 2014 6000-7000 feet (307 Aircraft – CONVENTIONAL ONLY)



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

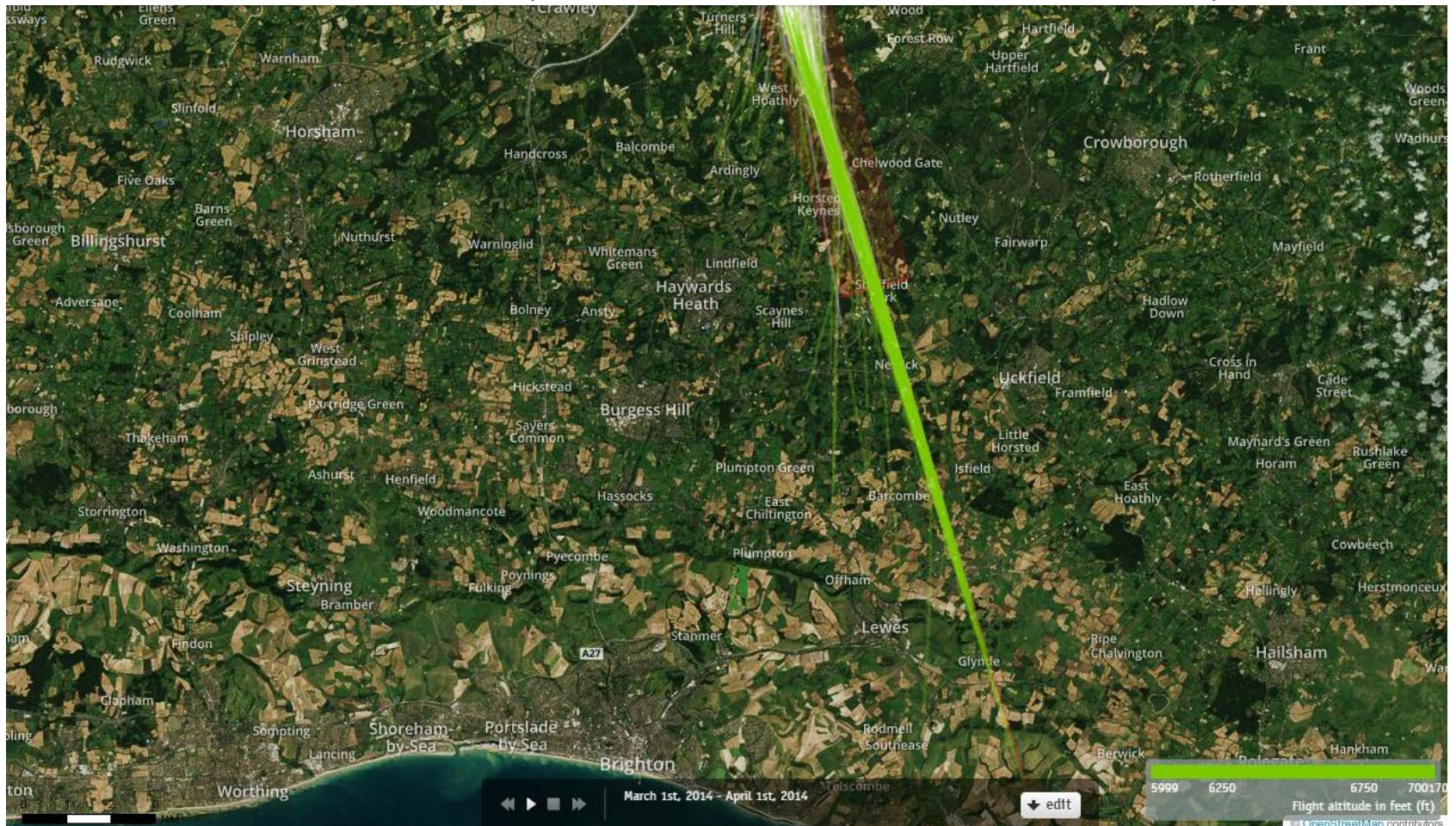
08 SFD Departures 1st – 7th September 2014 6000-7000 feet (554 Aircraft – P-RNAV ONLY)



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

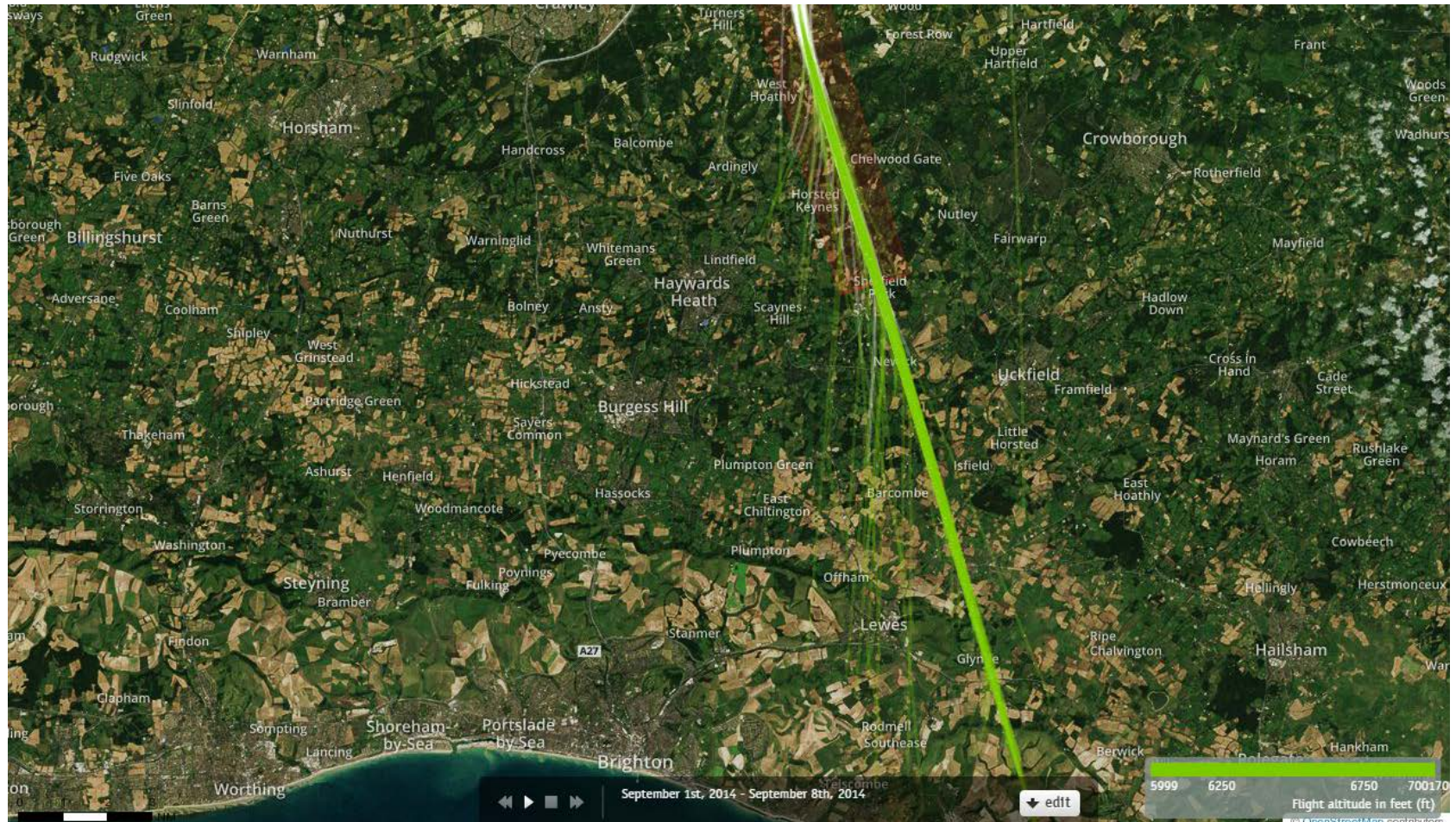
08 SFD Departures March 2014

6000-7000 feet (307 Aircraft – CONVENTIONAL ONLY)



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

08 SFD Departures 1st – 7th September 2014 6000-7000 feet (554 Aircraft – P-RNAV ONLY)



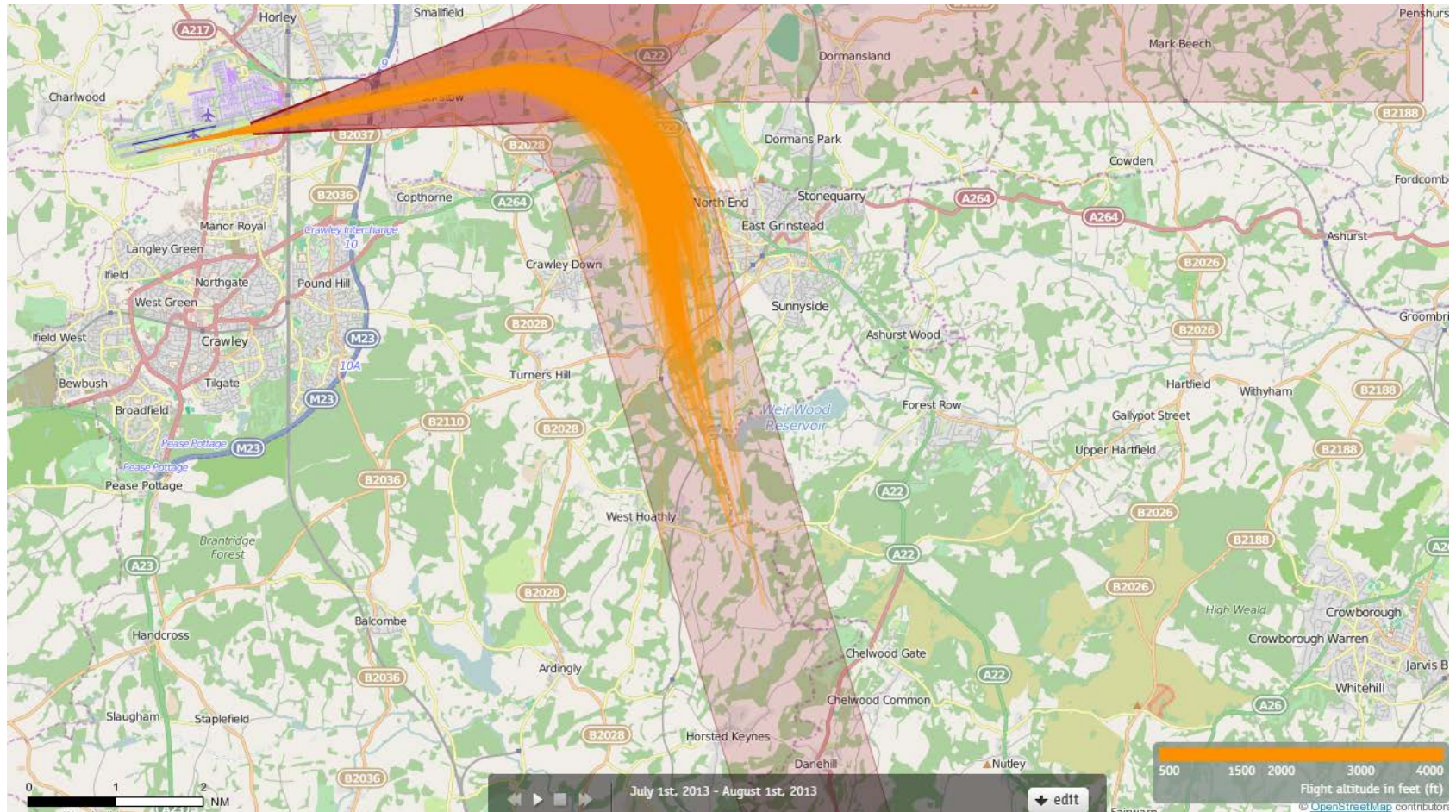
Green plots show the points at which an aircraft was between 6000 and 7000ft altitude.

08 SEAFORD

Route 2

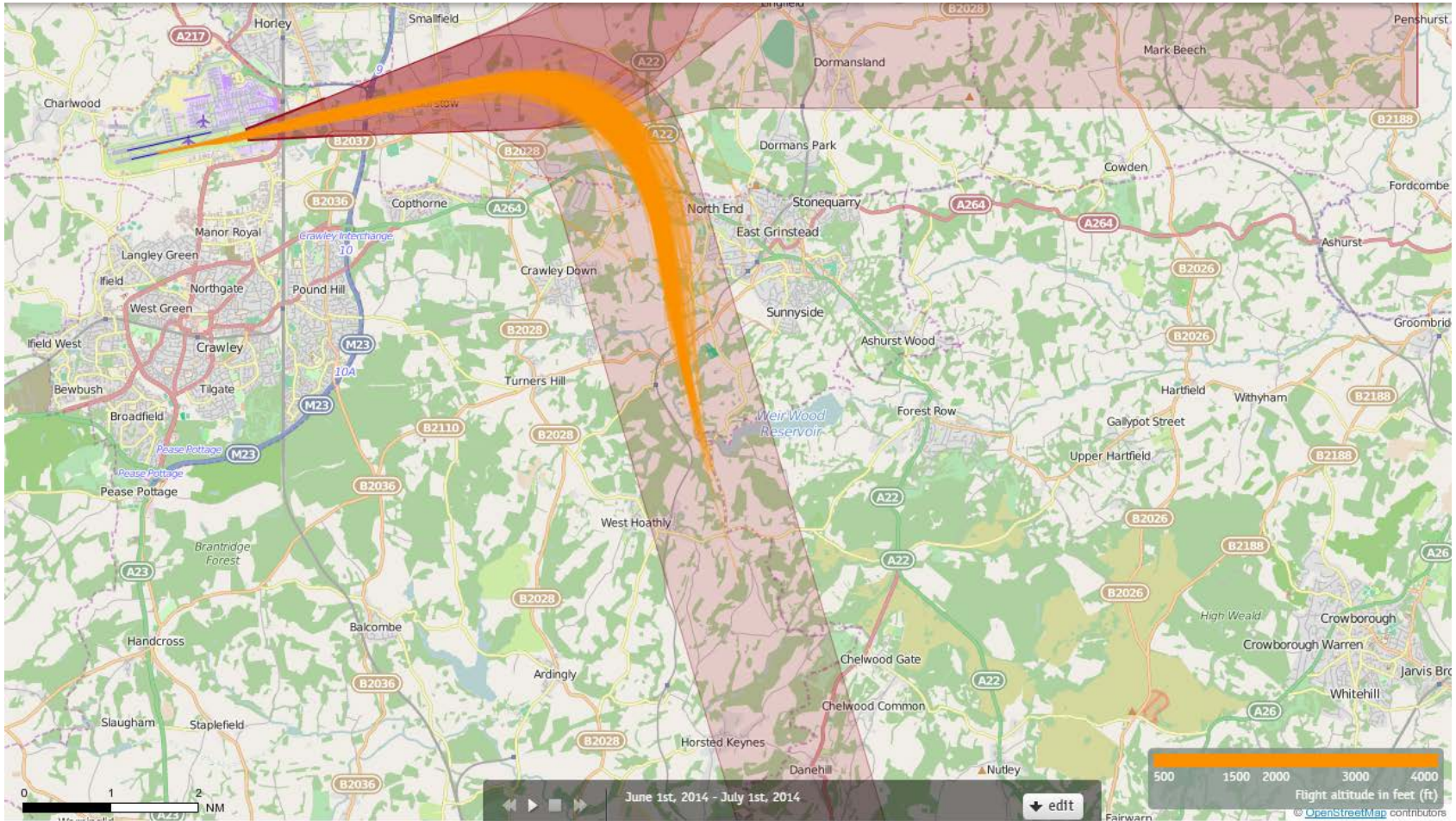
Pre and Post P-RNAV

08SEAFORD July 2013 Aircraft Tracks Cut Off at 4000ft Altitude 1544 Aircraft – Showing CONVENTIONAL Departures Only



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

08SEAFORD June 2014 Aircraft Tracks Cut Off at 4000ft Altitude 1642 Aircraft – Showing P-RNAV Departures Only



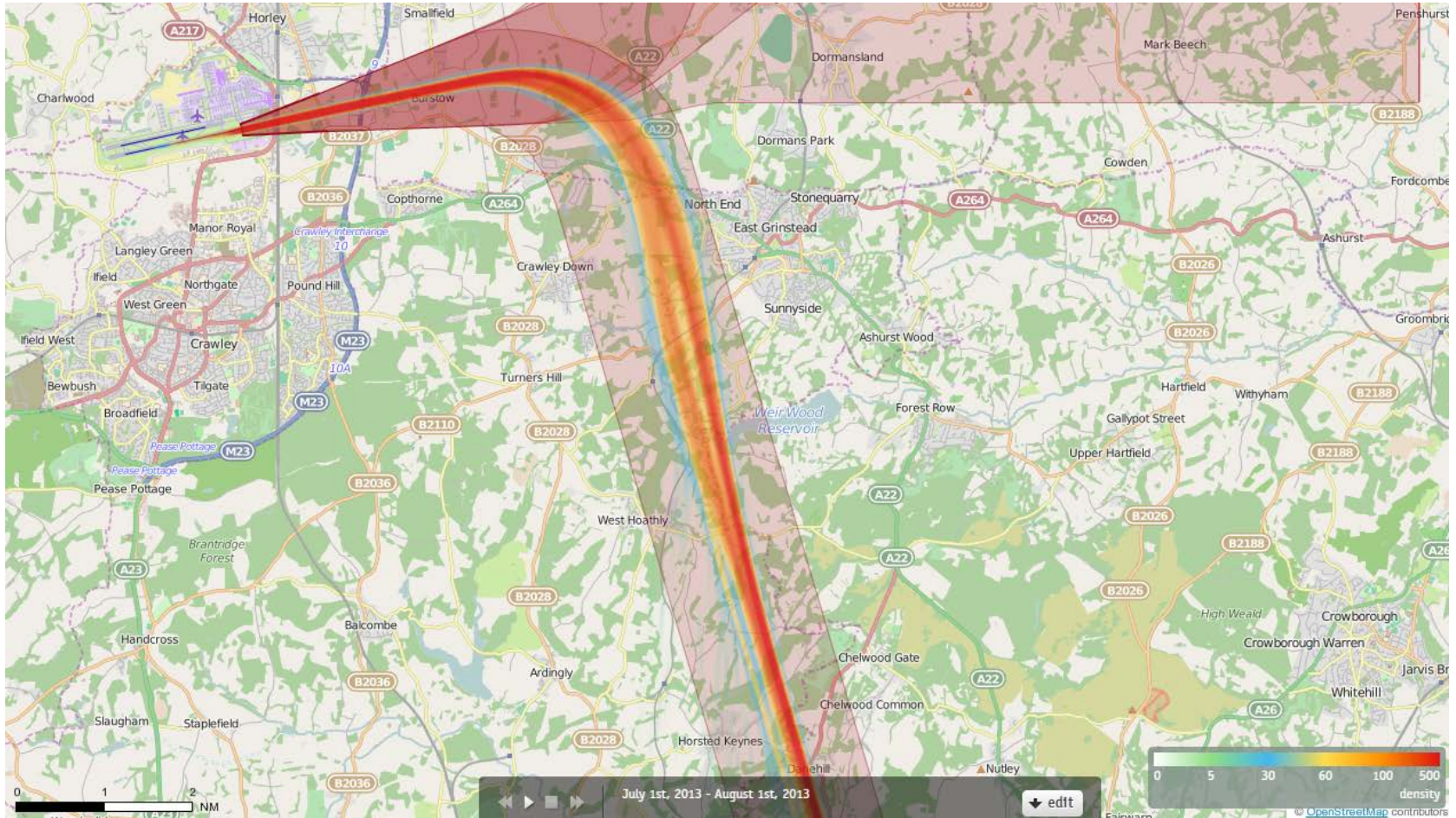
Orange plots show the tracks of aircraft until at an altitude of 4000ft

08 SEAFORD

Route 2

Pre and Post P-RNAV

08SEAFORD Density July 2013 1544 Aircraft – Showing CONVENTIONAL Departures Only



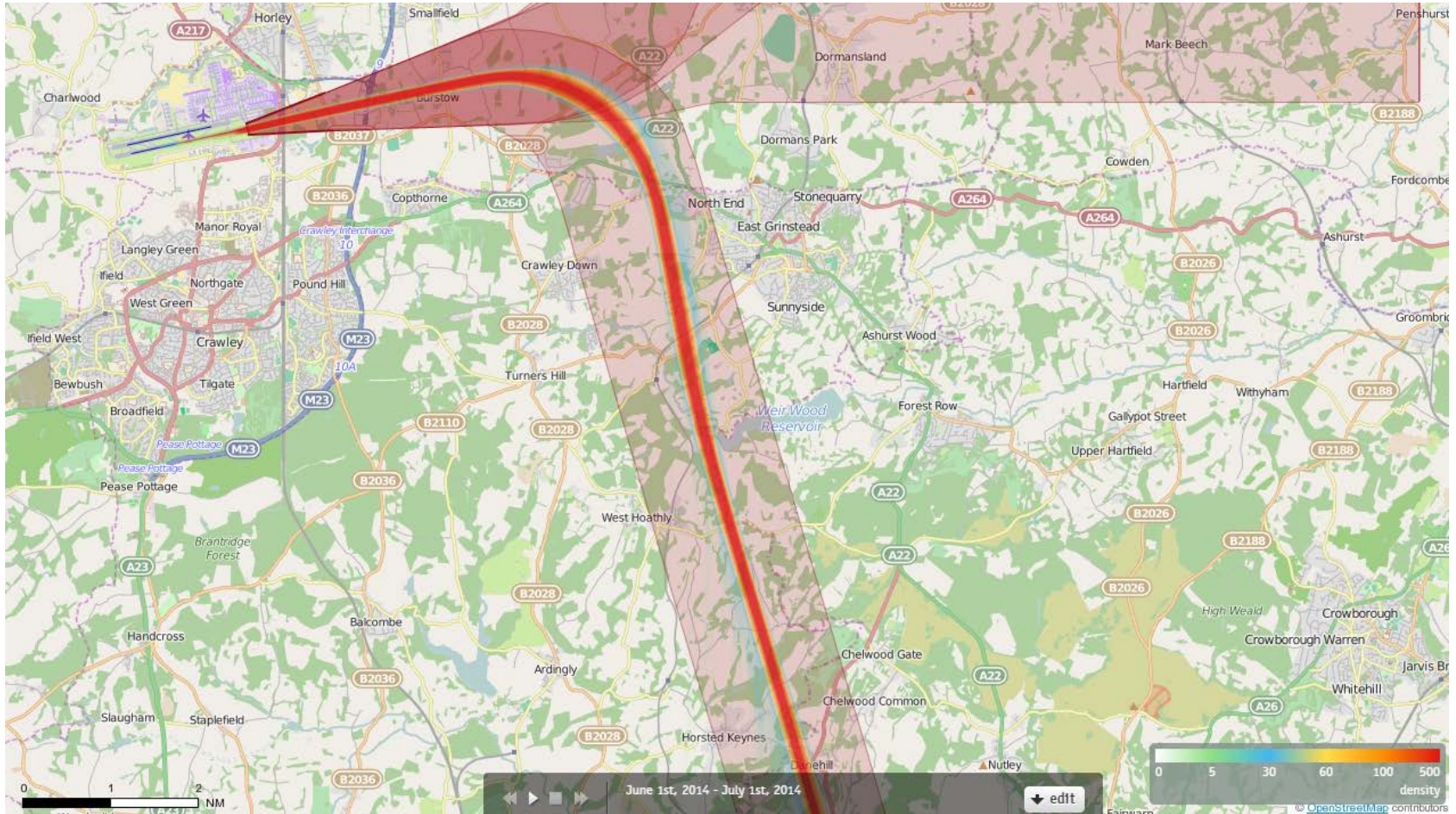
Track density

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.

08SEAFORD Density June 2014 1642 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.

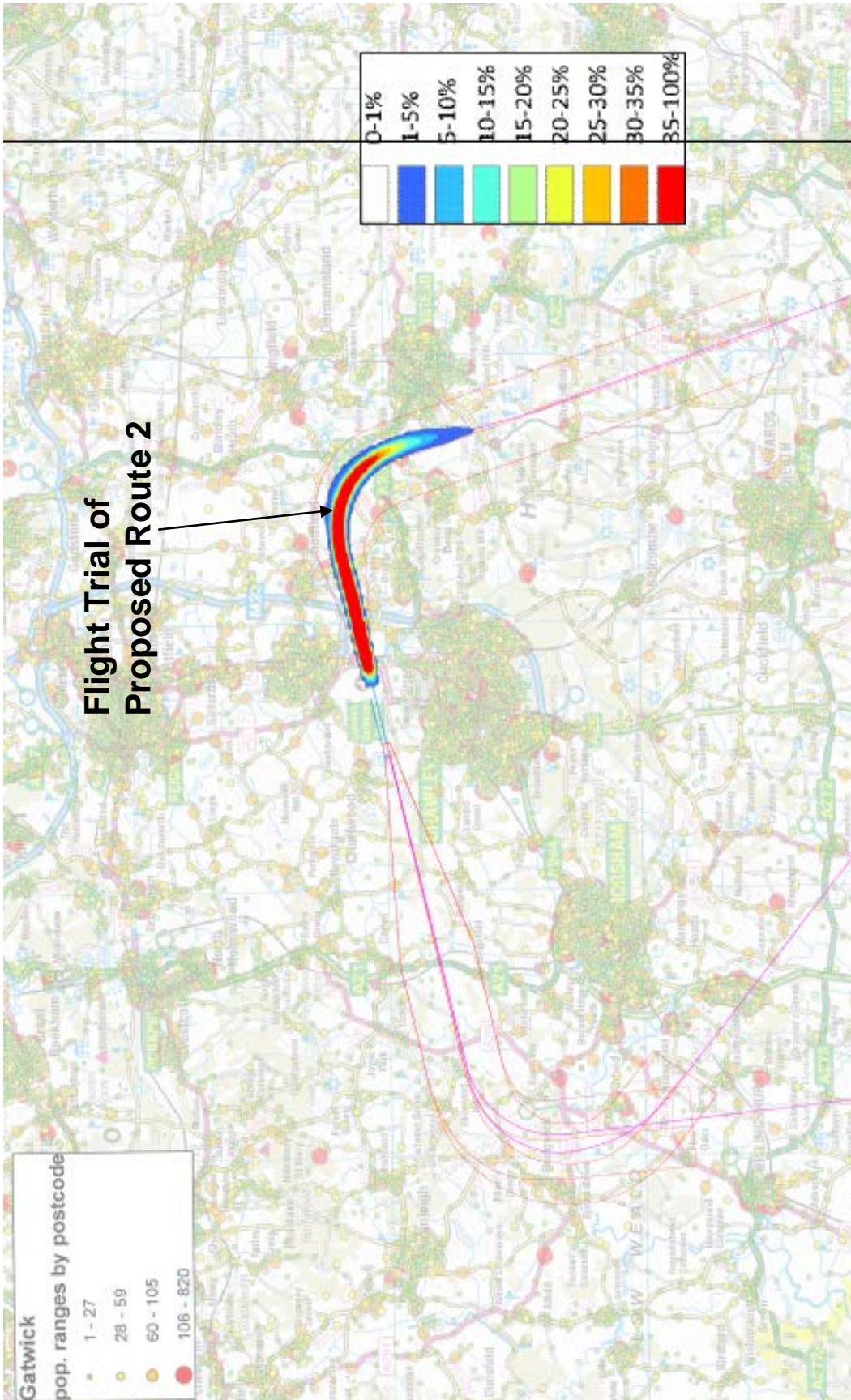


Figure9) Density plot of aircraft tracks (up to 4000 feet AMSL) following the PRNAV (**ROUTE 2**) flight trialled SID route from Runway 08R