GAJSC

General Aviation Midair Collision Risk

February 2022

General Aviation Midair Collison Risk

Directed Study

Background

Aviation safety professionals worldwide examine and monitor the risk of midair collision continuously. One safety performance indicator commonly used to understand this risk is a measure of Traffic Alert and Collision Avoidance System (TCAS) Resolution Advisory (RA) rates.

In the Aviation Safety Information Analysis and Sharing (ASIAS) dataset, General Aviation (GA) operators, consistently over time, had a higher rate of TCAS RA rates compared to commercial (Federal Aviation Regulation (FAR) Part 121) operators. The difference in rates prompted the ASIAS Executive Board to commission a directed study of TCAS RA events with an emphasis on the GA community. The General Aviation Joint Steering Committee (GA JSC) received the specific details of the analysis and produced this report for public dissemination.

Methodology

The study fixed an analysis window of May 2015 through April 2018. This 3-year window reflects the data available when the directed study was initiated. The study relied on four sources of data: Tau Traffic Alert and Collision Avoidance System (TCAS) Resolution Advisory (RA) Simulator[1] using National Offload Program (NOP) radar surveillance, Automatic Dependent Surveillance-Broadcast (ADS-B), Flight Operations Quality Assurance (FOQA), and text-based safety reports.

Three locations were chosen as initial case studies. Using advanced analytical capabilities, areas of dense events that constitute clusters were identified at each airport, along with the type of event interaction occurring within each cluster. The clusters were labeled as one of the following interaction types: Level Flight, Climbing into Traffic, Descending into Traffic, Parallel Approach, or Intruder is Helicopter.

ASIAS analysts met with subject matter experts (e.g. air traffic controllers, pilots) at each of the three locations to understand the operational context and to validate the initial results. After validation, ASIAS analysts applied the techniques NAS-wide, specifically the 50 locations with the most simulated GA TCAS RA events.

[1] A TCAS Analysis Utility was designed to emulate TCAS II 7.0 RA detection logic. RAs generated by this utility are considered “simulated.”

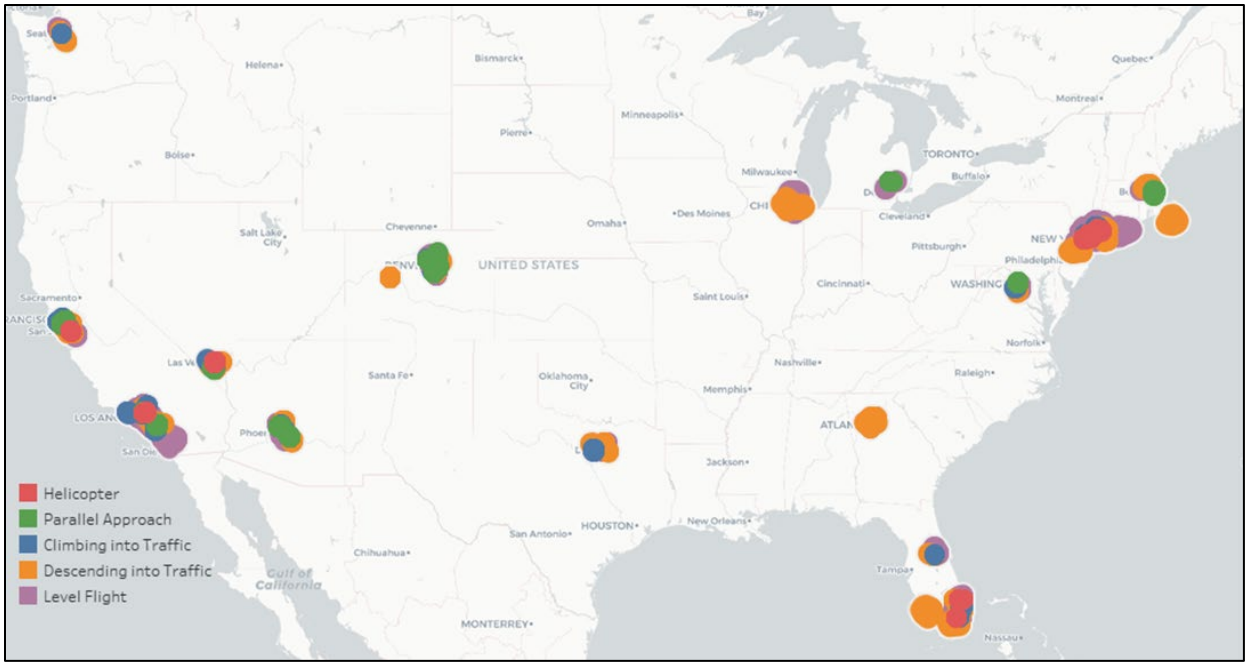


Figure 1. Labeled Clusters across the NAS

Interpreting the Safety Information

The figures below illustrate several pieces of safety information for a particular location. They are labeled by the relative position on the respective sectional chart.

The top portion displays the clusters of simulated TCAS RAs that were identified by ASIAS algorithms within the dataset, which is then overlaid on top of a Visual Flight Rules sectional chart. Each identified cluster has an associated color, which represents the interaction type that is predominant within that cluster (Level Flight, Climbing or Descending into Traffic, Parallel Approach, or Helicopter). For example, if a cluster on the sectional is orange, which is associated with the "Descending into Traffic" interaction, the majority of simulated RAs that make up that cluster are where the ownship aircraft is descending into the intruder aircraft. In other words, emphasis should be made on looking out below while descending in this area. If a particular interaction type is not present for a geographic location, it will not be shown. Secondly, the density of the color shows areas in which the simulated RAs happen more frequently. The darker the color represents a higher concentration of simulated RA interactions.

The bottom portion, or graph, displays the number of RAs associated with the separation between the two aircraft at the closest point of approach (CPA) within each interaction type.

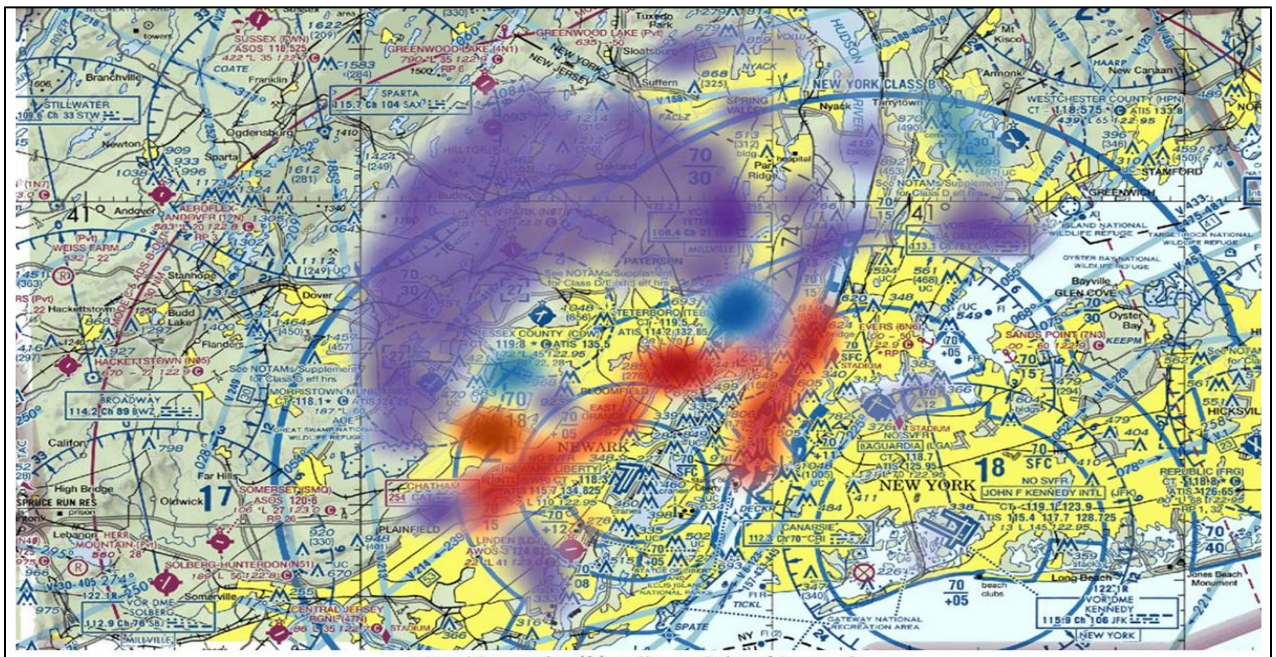
Note: The graph is only displaying the simulated RAs where the CPA is less than 1,000 feet. The clusters displayed on the sectional reflect ALL simulated RAs within the confines of the TCAS algorithm.

Example of Interpreting the Safety Information

Looking at one of the New York (South Central) examples below, one can glean from the safety information that a large area of simulated TCAS RAs are present to the northwest of the Teterboro Airport (TEB) and happen predominantly when the two interacting aircraft are in level flight (i.e. purple

= Level Flight interaction type). Within that specific cluster, the vast majority of the simulated RAs have a CPA of 500 feet or greater as shown in the graph. Even though the purple cluster covers a large area, one can see the densest part of that cluster lies along the corridor where southern operations approach from the north into TEB. One can also glean that there are other clusters present within the area too. A couple of "Climbing into Traffic" clusters (blue color), one "Descending into Traffic" cluster (orange color), as well as several clusters that involve interactions with helicopters (red color). There were no "Parallel Approach" clusters identified by the algorithm for this particular geographic location. In regards to the "Climbing into Traffic" cluster near the northern end of TEB, the RAs are most confined within one area (a lot of dark blue), however the majority of the interactions appear to have a CPA of greater than 1,000 feet due to the fact a small number of RAs are depicting in the bottom graph.

This is merely one example of how to interpret the safety information, and it should not be misconstrued as the only information that can be gleaned.



	100	200	300	400	500	600	700	800	900	1000
Climbing into Traffic					2		3	1		1
Descending into Traffic					1	1	3	2	1	2
Helicopter	1		4	20	37	41	48	48	42	37
Level Flight	4	2	24	86	285	367	317	246	281	244

Figure 2. Interactions around New York (South Central)

Appendix A displays the other locations for consideration by those who operate in and around the areas.

Insights

The reasons for TCAS RA interaction vary with location, not just by airport, but also by location at the airport. The most common cluster type was Level Flight with 39% of clustered events falling into that type. In descending order, the other types were Descending into Traffic (28%), Parallel Approach (23%), Climbing into Traffic (7%), and Helicopter (3%).

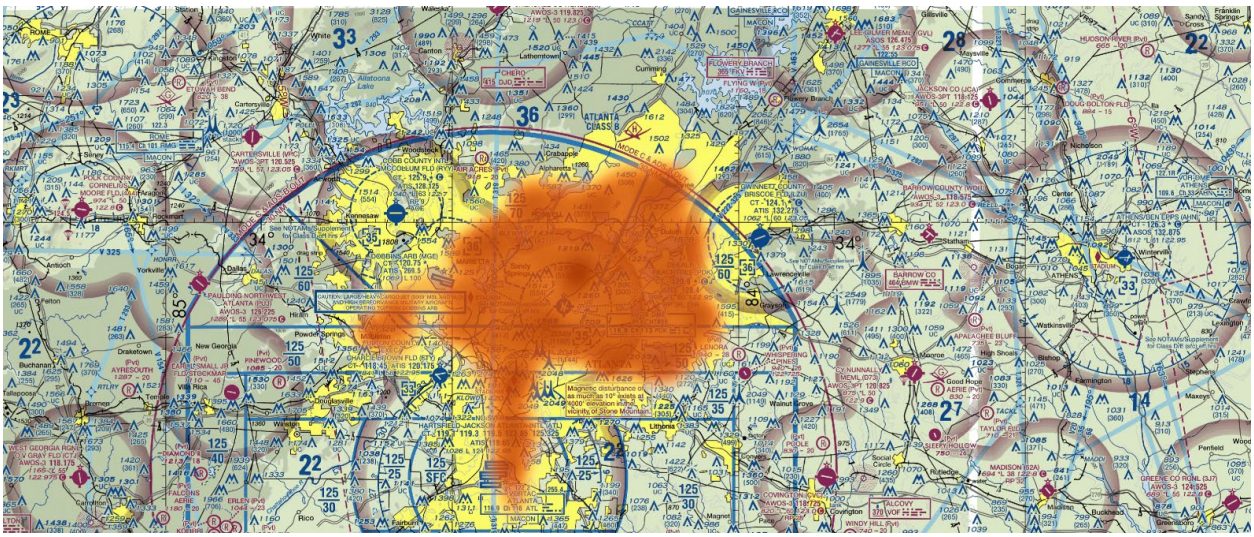
At all three locations initially studied, the intruder is most often another GA aircraft; less than 1% of the intruders are US Part 121 and the consensus is that the aircraft are operating according to the Federal Aviation Regulations and the events are primarily due to proximity and the parameters of the TCAS system.

Monitoring the Outcomes

The government and industry collaborative safety teams will continue to monitor the risk through ASIAS and will make any necessary changes to existing Midair Collision metrics to reflect the outcomes of the analysis. The GA JSC will explore efforts to increase awareness through outreach and develop additional mitigation strategies as necessary.

Appendix A. Clusters Across the National Airspace System
(Labeled by the relative position on the respective sectional chart)

1 Atlanta (Central)



Lateral Separation (ft) at Closest Point of Approach

	100	300	400	500	600	700	800	900	1000
Descending into Traffic	1	11	23	69	98	86	76	99	89

2 Atlanta (Central)

Lateral Separation (ft) at Closest Point of Approach

	100	300	400	500	600	700	800	900	1000
Descending into Traffic	1	3	8	13	25	13	16	24	17

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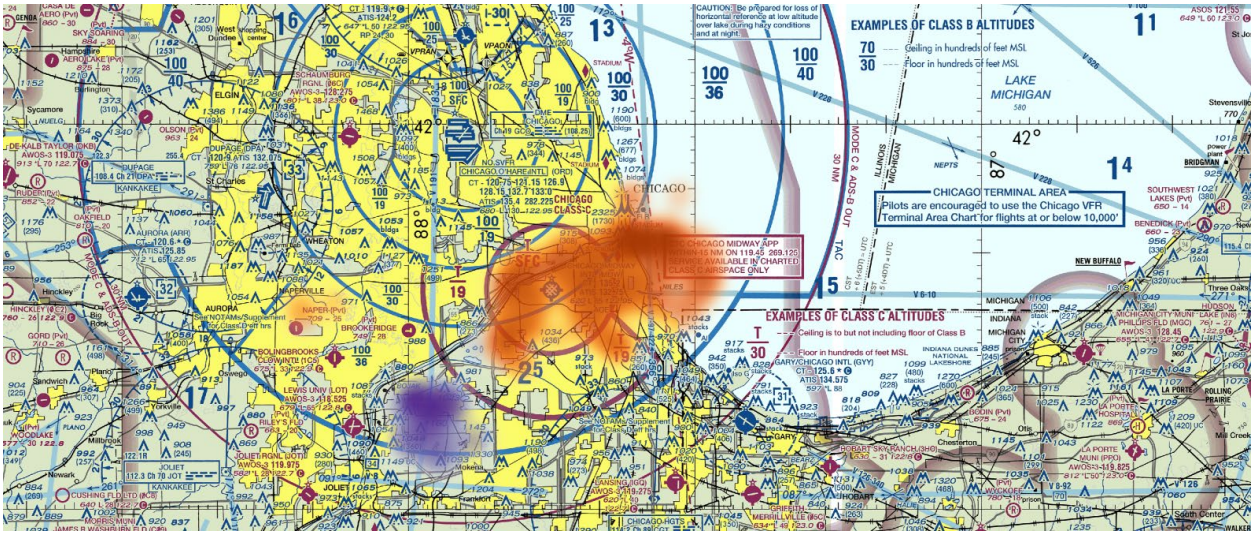
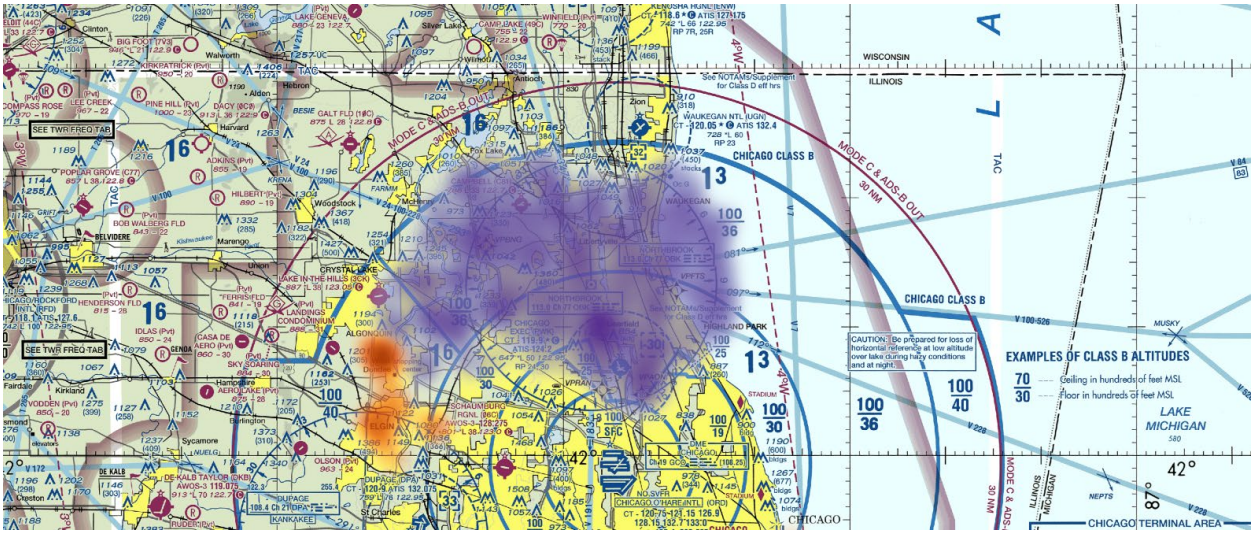
3 Chicago (Central)



Lateral Separation (ft) at Closest Point of Approach

	400	500	600	700	800	900	1000
Descending into Traffic	6	8	19	16	15	13	20
Level Flight		3	3	4	1		2

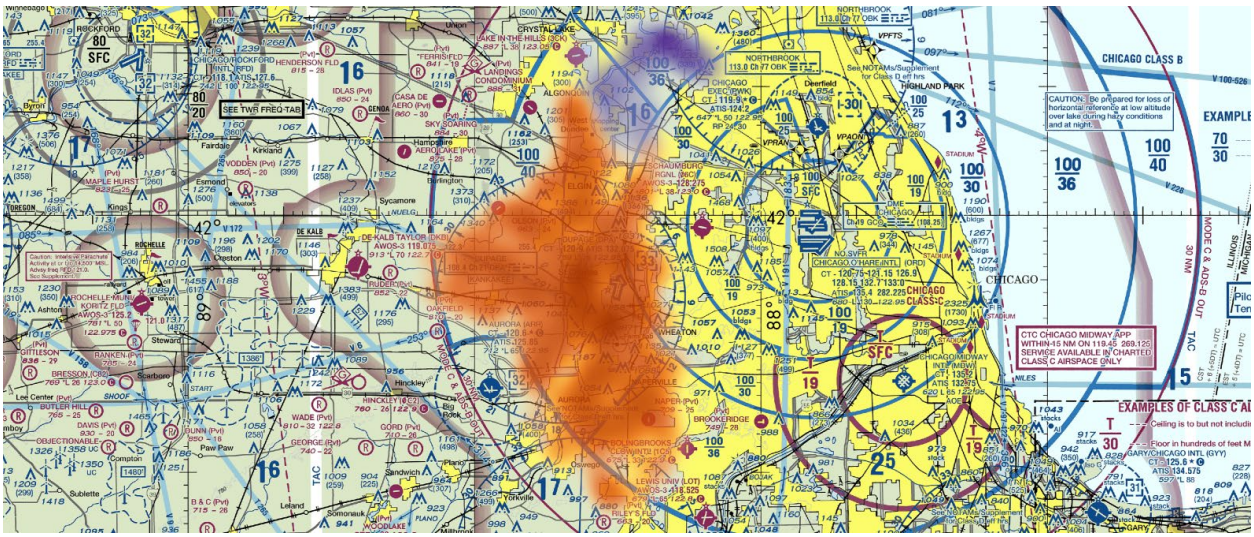
4 Chicago (Central)



Lateral Separation (ft) at Closest Point of Approach

	100	200	300	400	500	600	700	800	900	1000
Descending into Traffic							1		1	
Level Flight	3	1	7	12	24	30	32	29	30	25

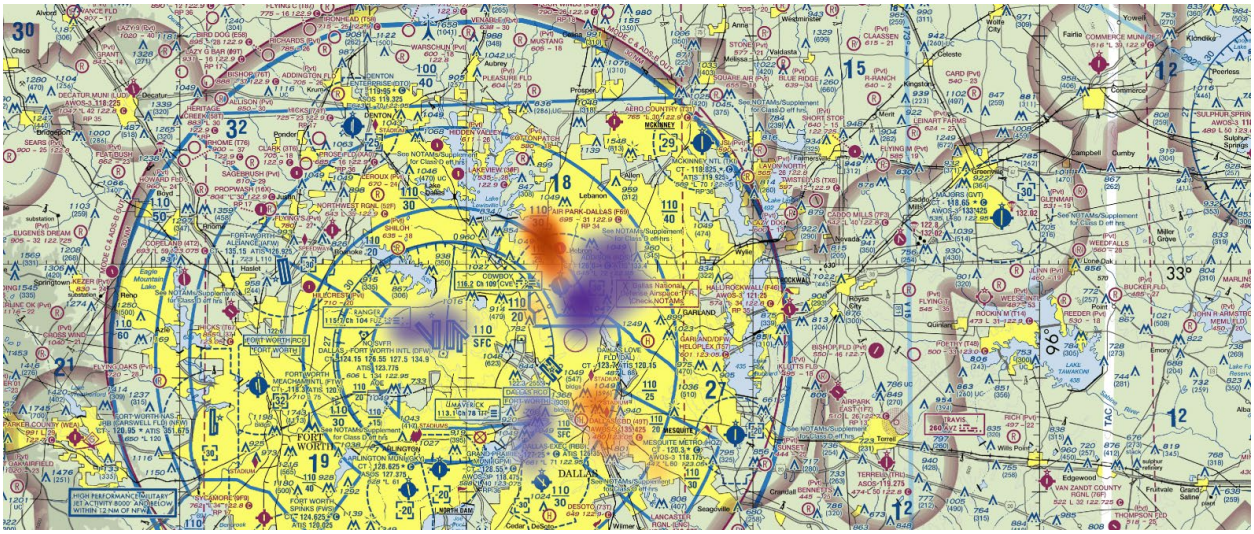
5 Chicago (Central)



Lateral Separation (ft) at Closest Point of Approach

	300	400	500	600	700	800	900	1000
Descending into Traffic	1	6	10	20	28	23	14	18
Level Flight			1	1	2	1		

6 Dallas – Ft. Worth (South East)



Lateral Separation (ft) at Closest Point of Approach

	200	300	400	500	600	700	800	900	1000
Descending into Traffic			1	3	6		1	2	4
Level Flight	1	2	18	54	63	41	47	45	47

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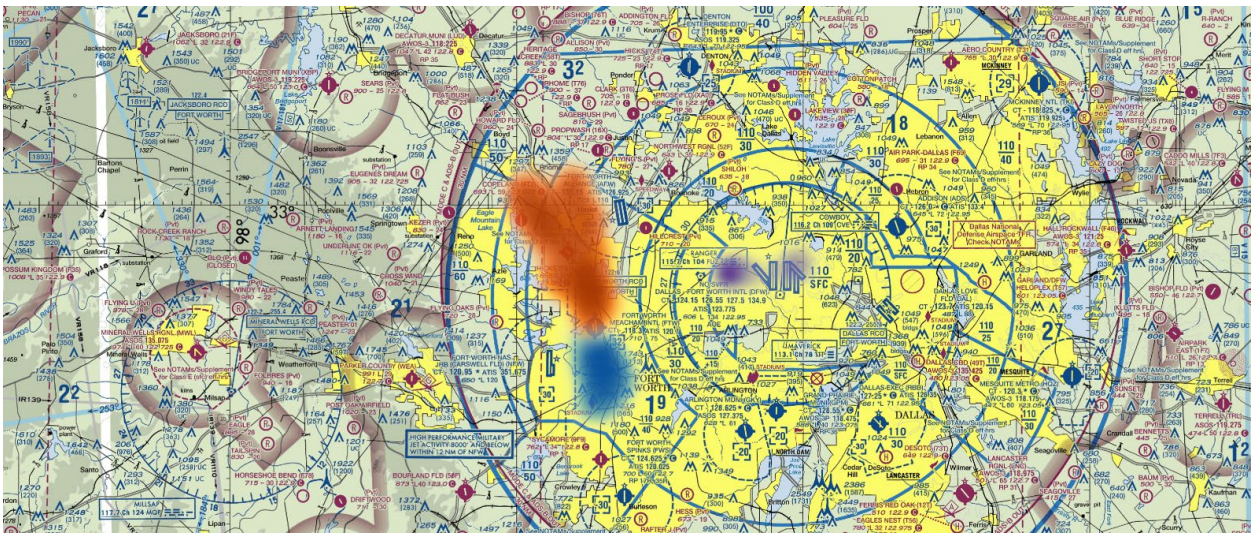
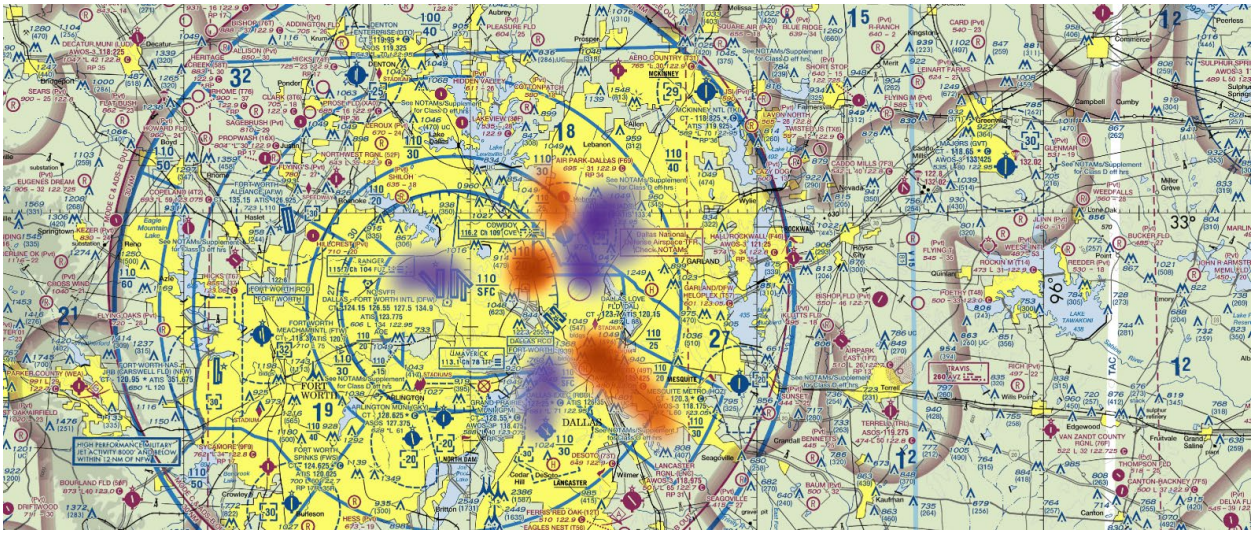
7 Dallas – Ft. Worth (South East)



Lateral Separation (ft) at Closest Point of Approach

	100	200	300	400	500	600	700	800	900	1000
Climbing into Traffic	1	1			3	13	2	3	4	6
Descending into Traffic		1	1	3	9	20	13	11	10	9

8 Dallas – Ft. Worth (South East)

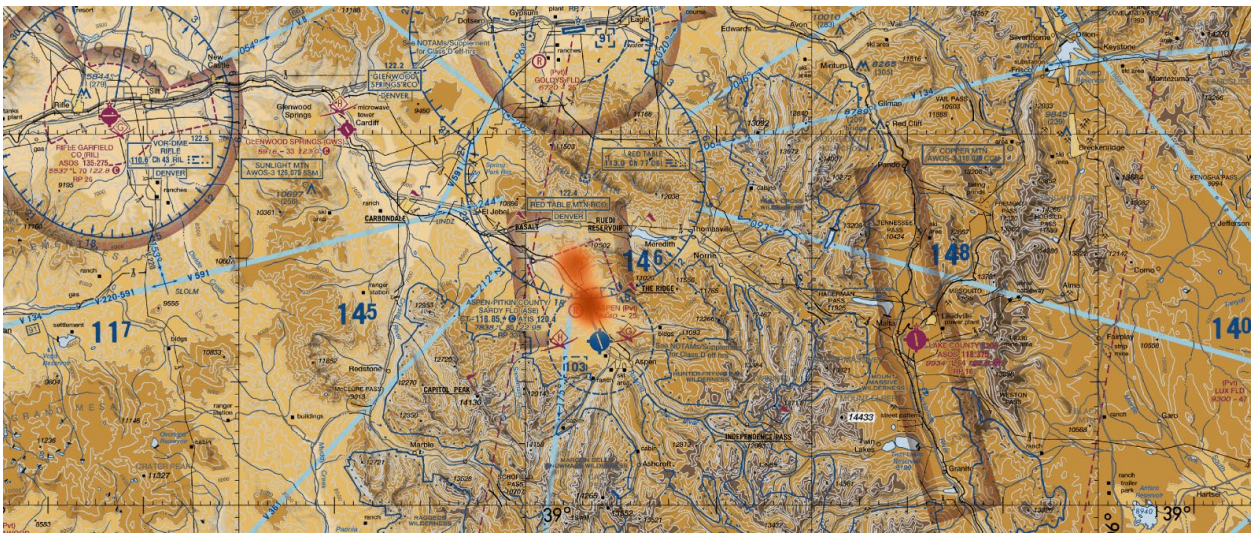


Lateral Separation (ft) at Closest Point of Approach

	300	400	500	600	700	800	900	1000
Descending into Traffic		2	5	22	12	5	9	6
Level Flight	1	7	19	17	24	20	29	18

Appendix A. Clusters Across the National Airspace System
(Labeled by the relative position on the respective sectional chart)

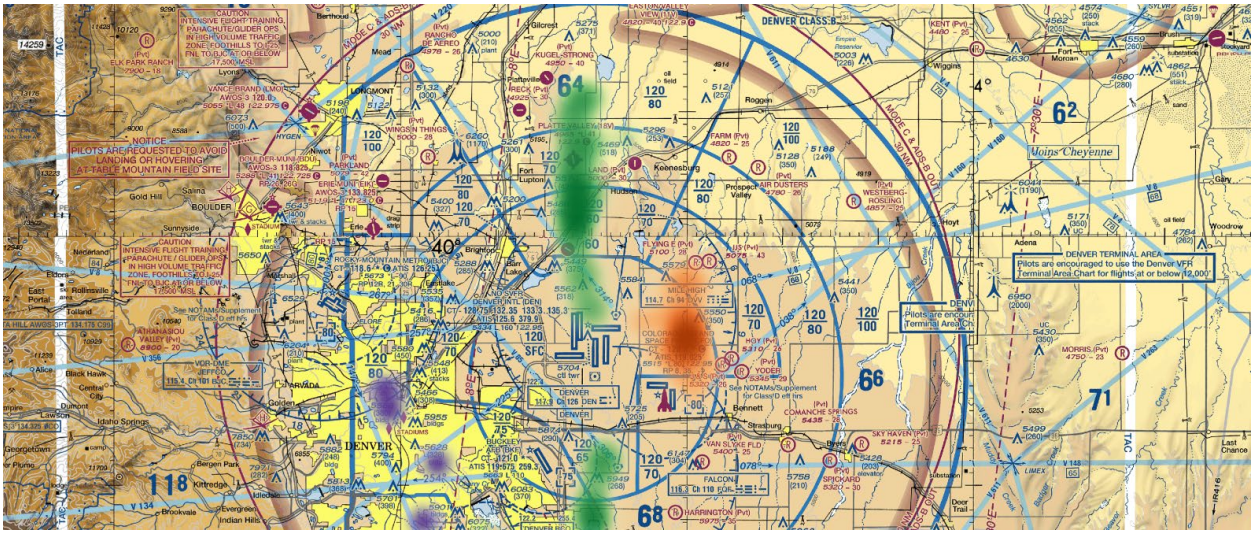
9 Denver (North Central)



Lateral Separation (ft) at Closest Point of Approach

	500	600	1000
Descending into Traffic	1	1	1

10 Denver (North East)



Lateral Separation (ft) at Closest Point of Approach

	300	400	500	600	700	800	900	1000
Descending into Traffic		2	5	22	12	5	9	6
Level Flight	1	7	19	17	24	20	29	18

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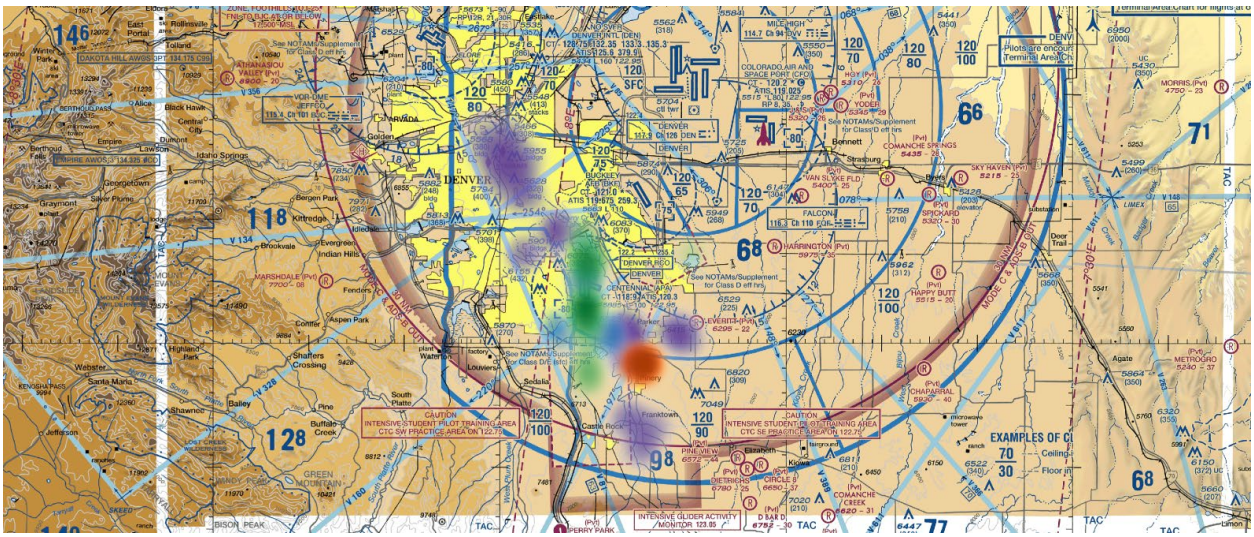
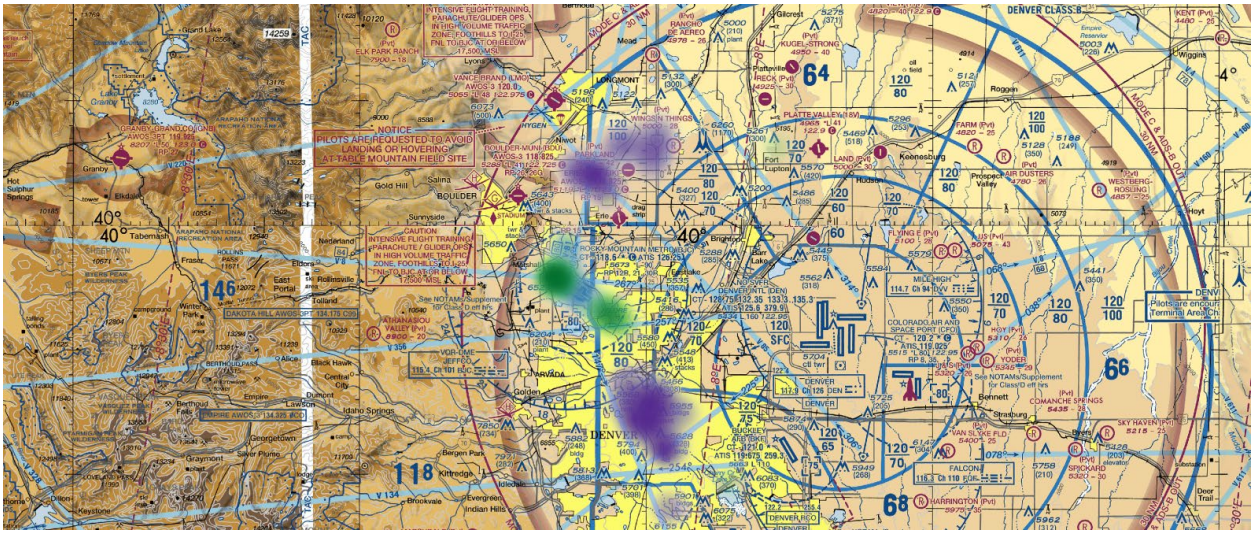
11 Denver (North East)



Lateral Separation (ft) at Closest Point of Approach

	100	200	300	400	500	600	700	800	900	1000
Climbing into Traffic	2	1	8	16	24	65	134	165	146	144
Descending into Traffic								3		
Level Flight			1	1	8	11	10	9	15	10
Parallel Approach	7	9	23	66	126	293	449	572	621	615

12 Denver (North East)



Lateral Separation (ft) at Closest Point of Approach

	400	500	600	700	800	900	1000
Climbing into Traffic		1	4	5	10	15	26
Level Flight	1		2	1	3	1	1
Parallel Approach		1	4	7	5	2	14

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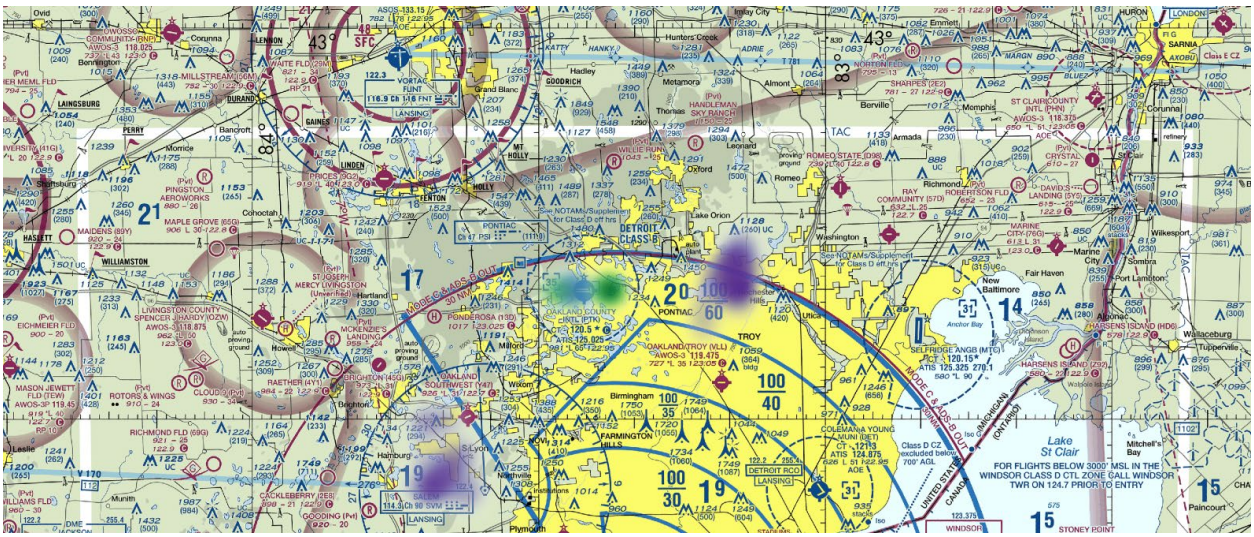
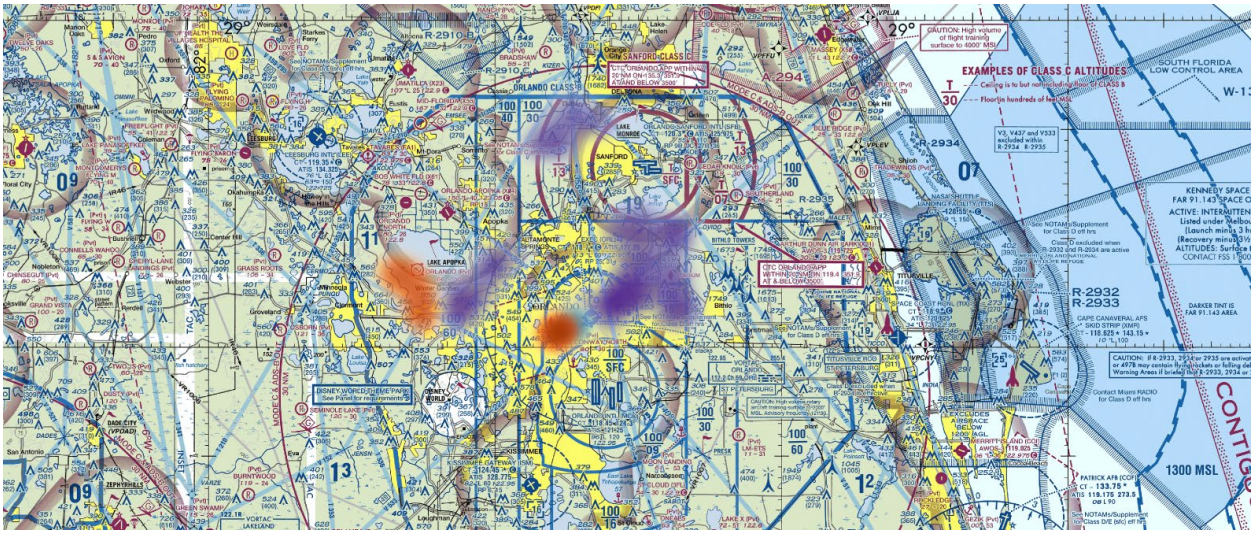
13 Detroit (West Central)



Lateral Separation (ft) at Closest Point of Approach

	0	100	200	300	400	500	600	700	800	900	1000
Climbing into Traffic	2	2	5	6	7	17	22	32	36	41	34
Level Flight							3	1	2	1	1
Parallel Approach			1	3	3	3	6	5	6	6	6

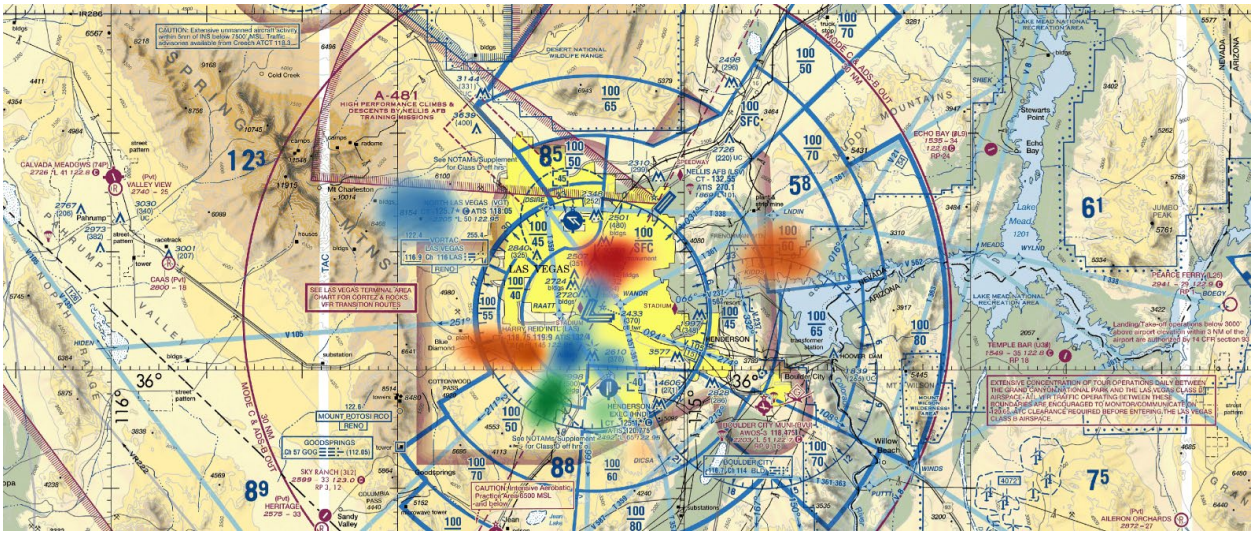
14 Jacksonville (South Central)



Lateral Separation (ft) at Closest Point of Approach

	300	400	500	600	700	800	900	1000
Climbing into Traffic				1				
Descending into Traffic		2	5	2	2	3	3	
Level Flight	1	4	9	11	10	5	5	14

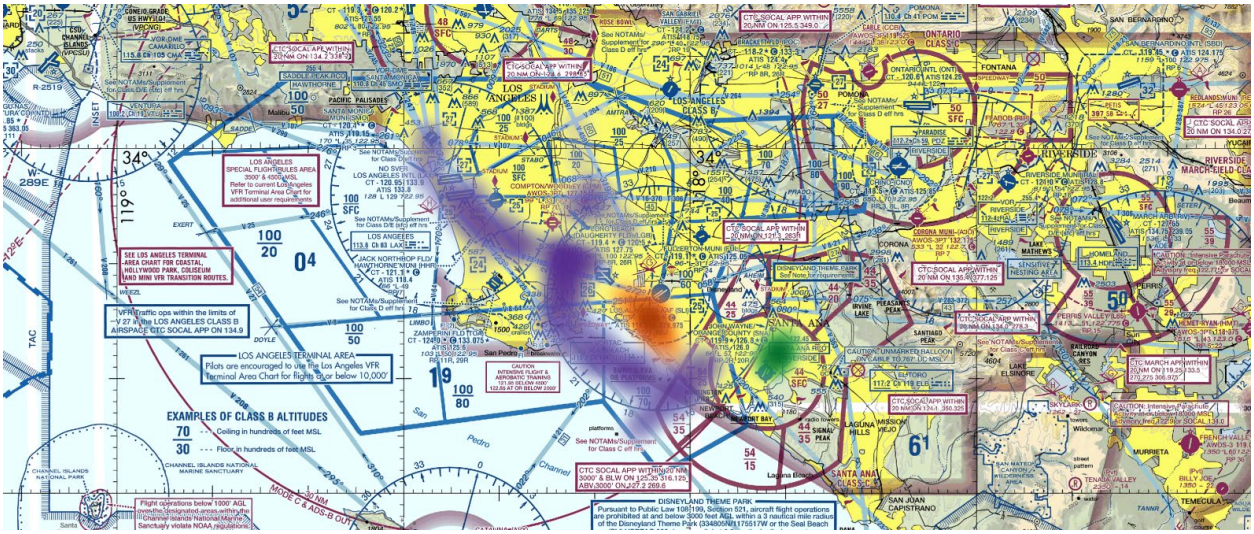
15 Las Vegas (South Central)



Lateral Separation (ft) at Closest Point of Approach

	0	100	200	400	500	600	700	800	900	1000
Climbing into Traffic	1	2	1		2	2	1		9	4
Descending into Traffic					1	2	1	1	1	
Helicopter				2	10	18	8	10	12	8
Parallel Approach						2			2	1

16 Los Angeles (Central)



Lateral Separation (ft) at Closest Point of Approach

	300	400	500	600	700	800	900	1000
Descending into Traffic		1	5	9	4	2	3	2
Level Flight	2	2	5	21	19	18	20	16
Parallel Approach			1		1			

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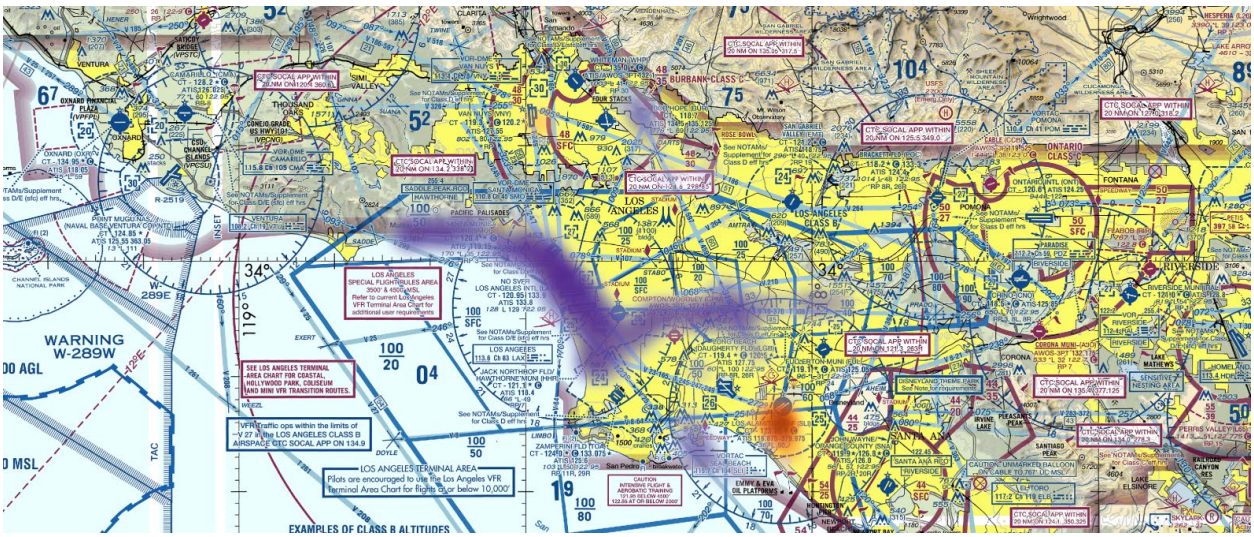
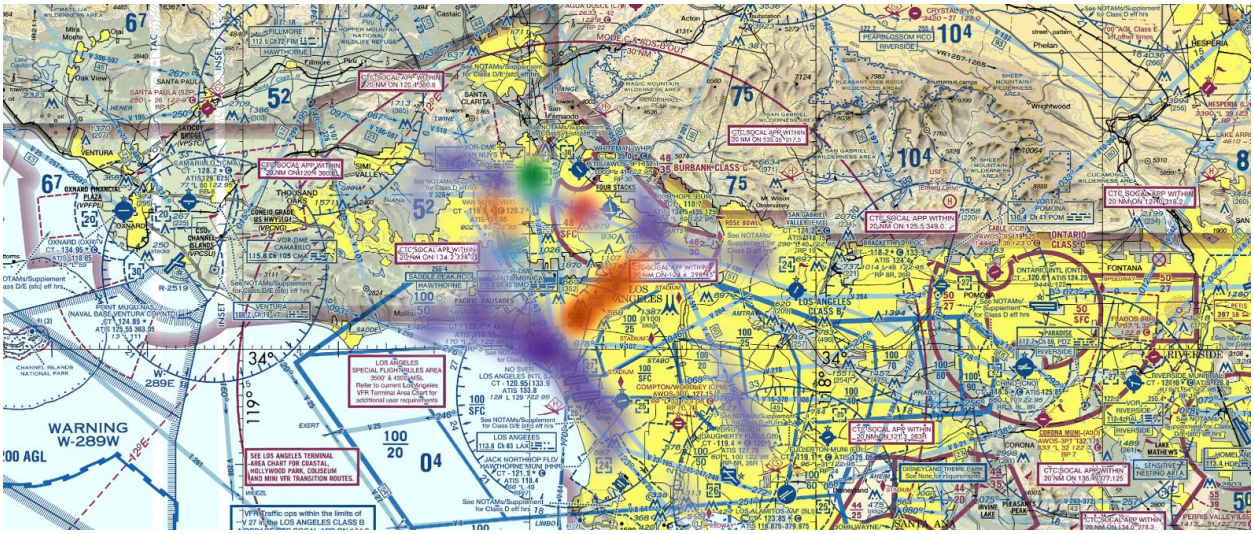
17 Los Angeles (Central)



Lateral Separation (ft) at Closest Point of Approach

	200	300	400	500	600	700	800	900	1000
Descending into Traffic				2		1			2
Level Flight	2	8	32	84	106	76	68	67	85

18 Los Angeles (Central)

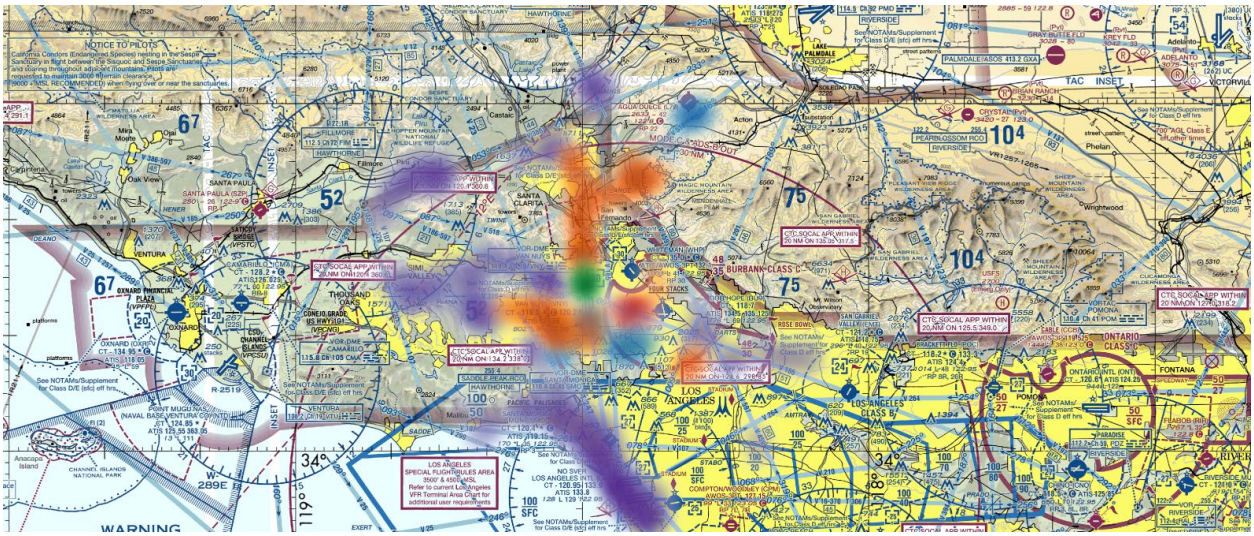


Lateral Separation (ft) at Closest Point of Approach

	200	300	400	500	600	700	800	900	1000
Climbing into Traffic				1		1			
Descending into Traffic	1	1	5	12	15	11	10	19	6
Helicopter				1	1	1	1	1	2
Level Flight			3	22	23	27	18	15	26

Appendix A. Clusters Across the National Airspace System
(Labeled by the relative position on the respective sectional chart)

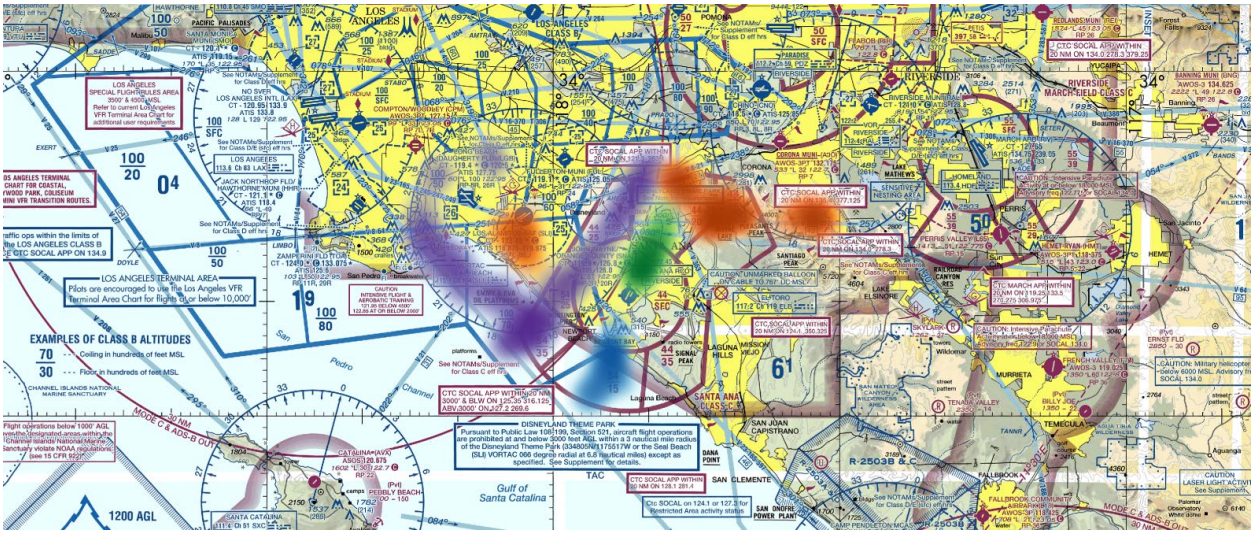
19 Los Angeles (Central)



Lateral Separation (ft) at Closest Point of Approach

	0	100	200	300	400	500	600	700	800	900	1000
Climbing into Traffic				2	5	13	17	37	38	54	66
Descending into Traffic			2	2	12	27	26	30	37	32	35
Helicopter							2				1
Level Flight					6	26	28	23	30	19	24
Parallel Approach	1	3	19	54	94	152	164	201	214	216	219

20 Los Angeles (Central)

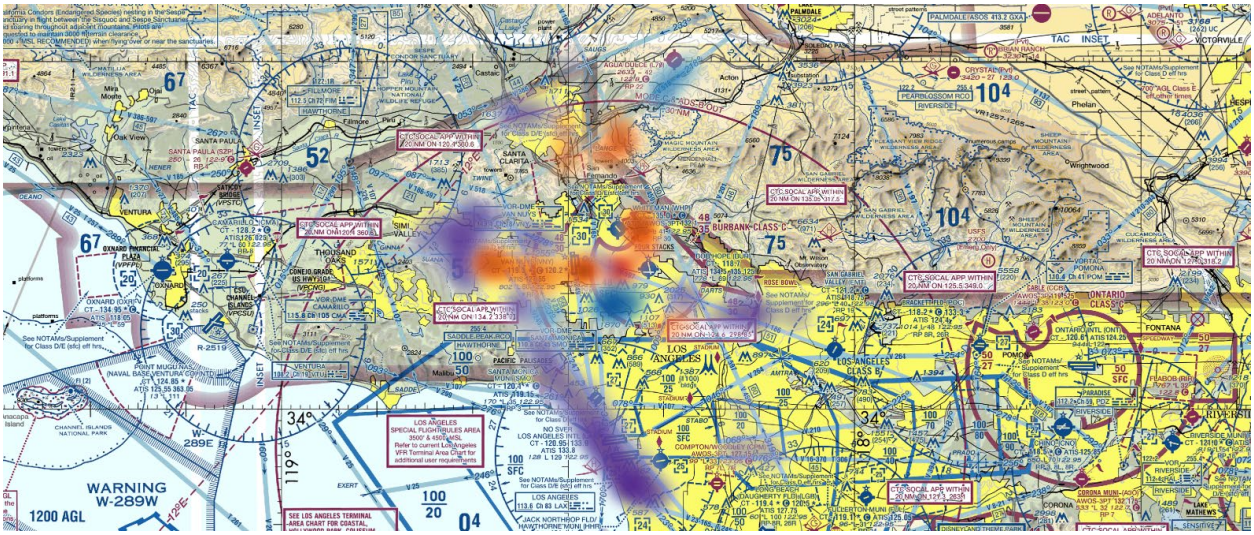


Lateral Separation (ft) at Closest Point of Approach

	300	400	500	600	700	800	900	1000
Climbing into Traffic		4	10	15	7	8	9	9
Descending into Traffic			1	3	3	2	1	4
Level Flight		2	18	28	18	19	13	22
Parallel Approach	1		2	2		2	2	

Appendix A. Clusters Across the National Airspace System
(Labeled by the relative position on the respective sectional chart)

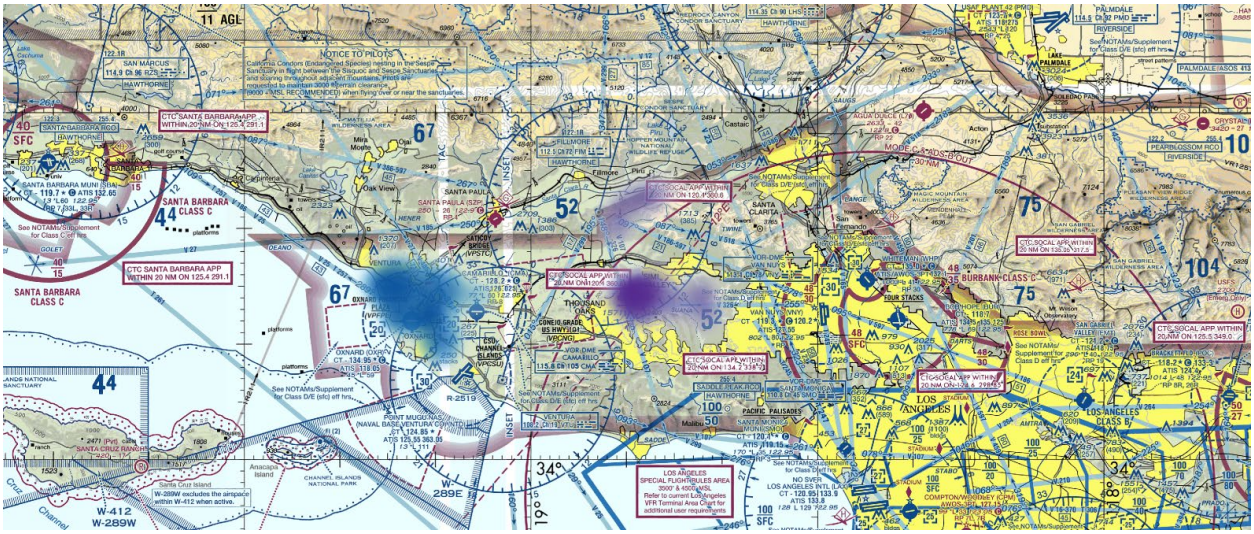
21 Los Angeles (Central)



Lateral Separation (ft) at Closest Point of Approach

	400	500	600	700	800	900	1000
Climbing into Traffic	1		1	1	3		1
Descending into Traffic		24	57	58	47	40	40
Helicopter		1	1		4		2
Level Flight	1	19	14	11	10	10	9

22 Los Angeles (Central)

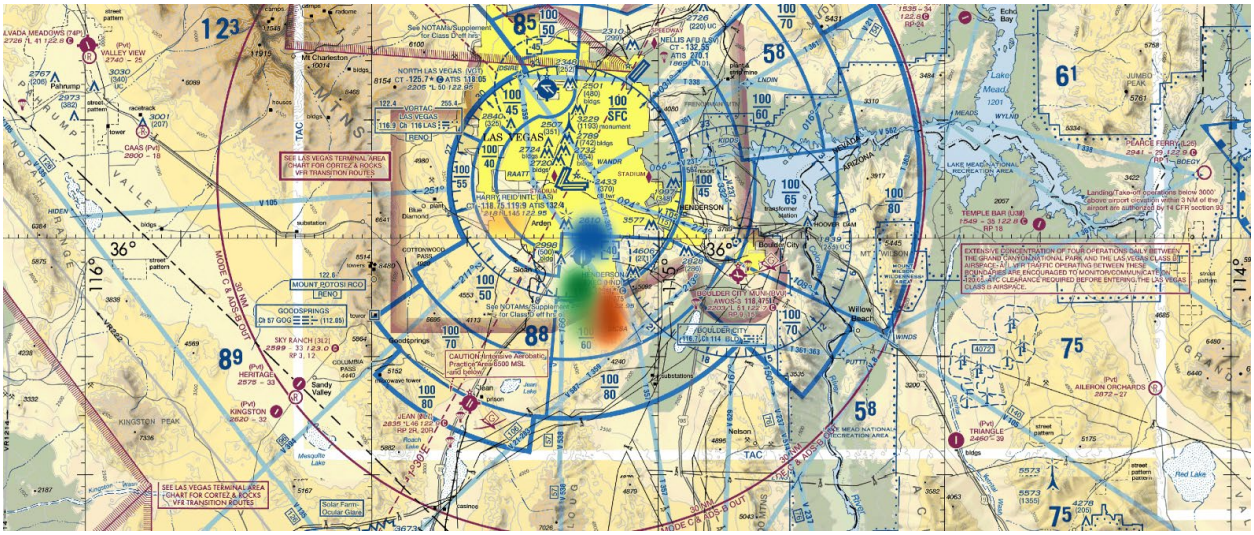


Lateral Separation (ft) at Closest Point of Approach

	300	400	500	600	700	800	900	1000
Climbing into Traffic	1		1		2	1	1	
Level Flight		1	5	3	7	6	3	4

Appendix A. Clusters Across the National Airspace System
(Labeled by the relative position on the respective sectional chart)

23 Los Angeles (North East)



Lateral Separation (ft) at Closest Point of Approach

	200	400	500	600	700	800	900	1000
Climbing into Traffic				2		1		
Descending into Traffic				2		4	2	
Parallel Approach	1	2	7	12	13	17	27	3

24 Los Angeles (South Central)

Lateral Separation (ft) at Closest Point of Approach

	200	300	400	500	600	700	800	900	1000
Level Flight	1	5	14	56	71	57	47	45	47

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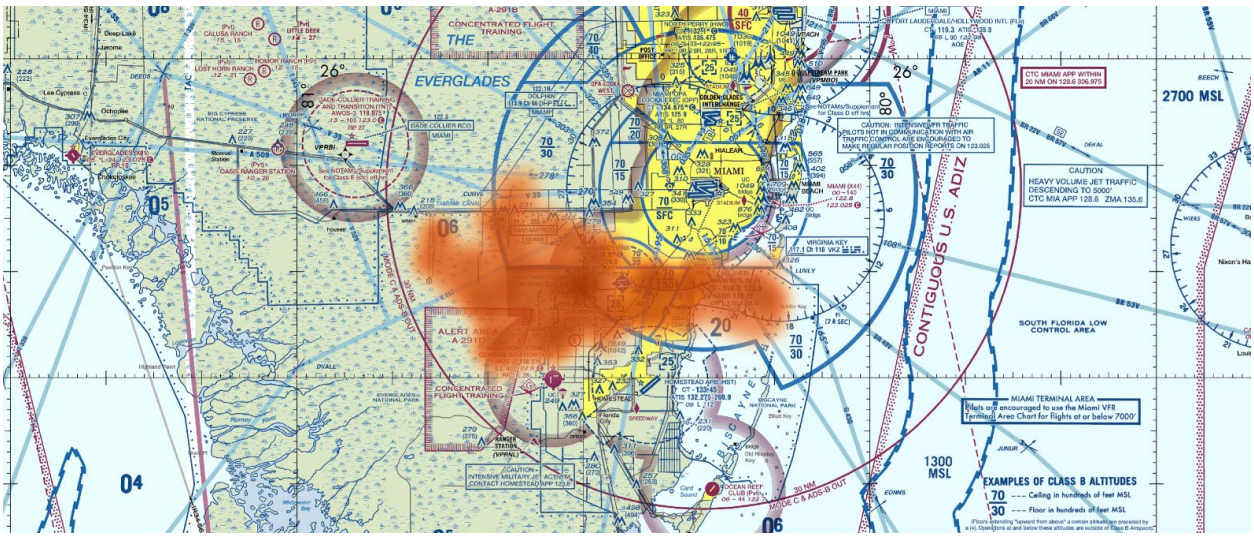
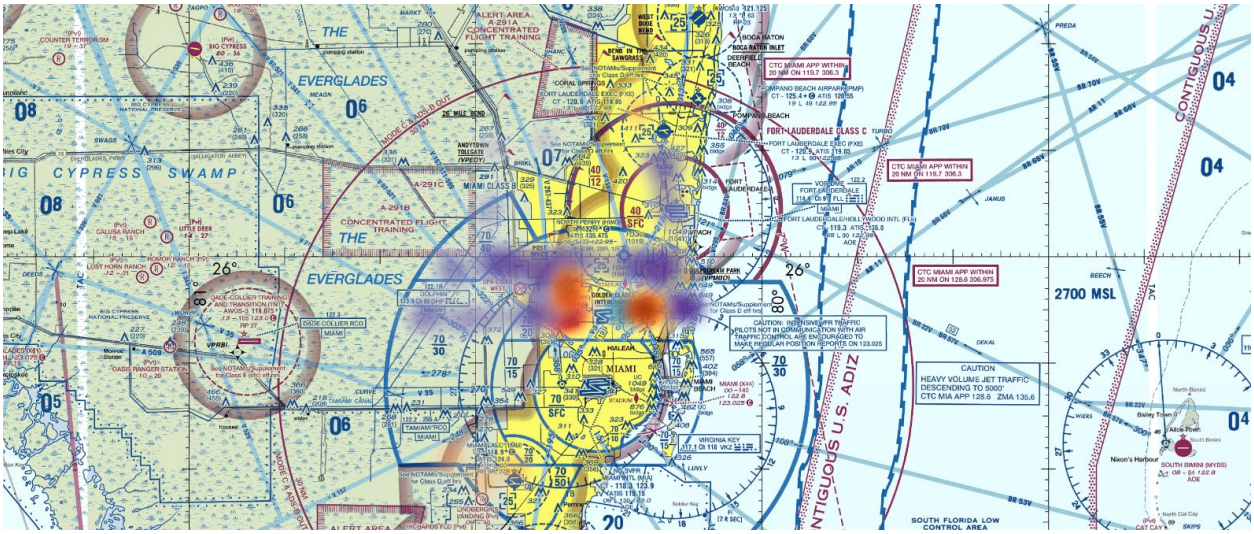
25 Miami (Central)



Lateral Separation (ft) at Closest Point of Approach

	100	200	300	400	500	600	700	800	900	1000
Descending into Traffic	1	3	6	16	26	39	31	28	38	35

26 Miami (Central)



Lateral Separation (ft) at Closest Point of Approach

	200	300	400	500	600	700	800	900	1000
Climbing into Traffic				1	1		1	1	
Descending into Traffic	1		2	8	9	4	6	7	7
Helicopter			1		2		1	1	5
Level Flight	2	6	12	30	47	41	27	33	24

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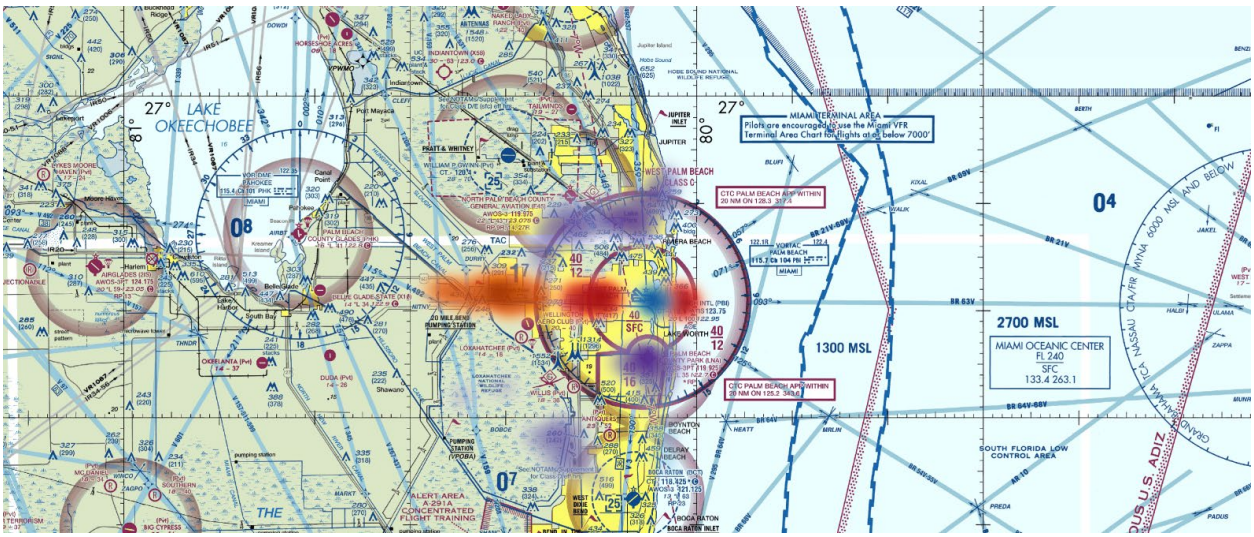
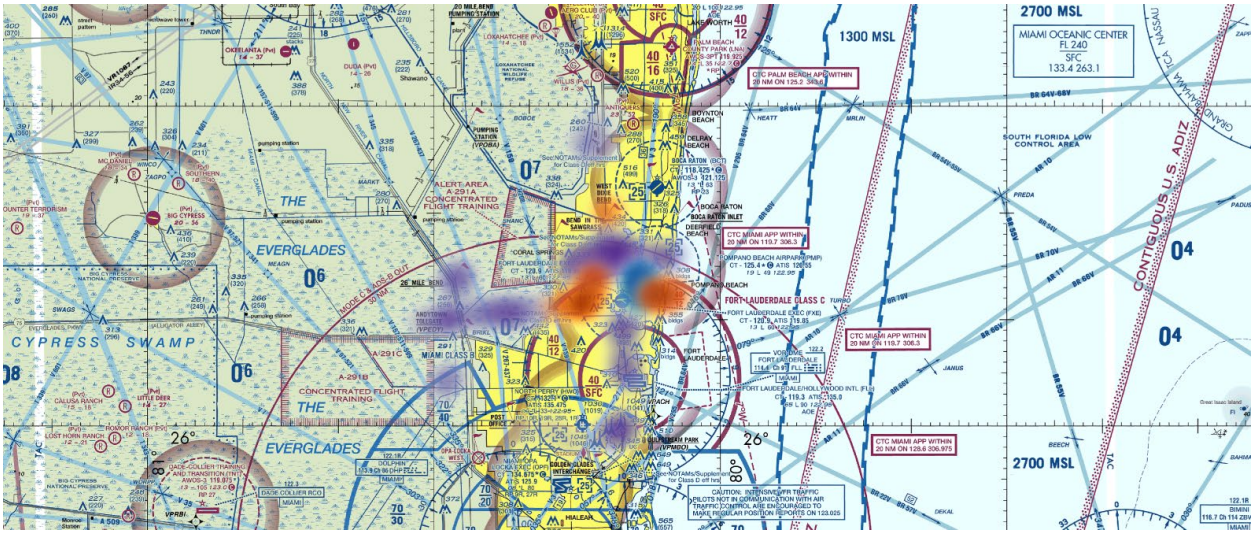
27 Miami (Central)



Lateral Separation (ft) at Closest Point of Approach

	300	400	500	600	700	800	900	1000
Climbing into Traffic			1			4	1	1
Descending into Traffic			3	6	8	1	5	2
Helicopter	1		2	3	6	2	6	4
Level Flight		1	2	4	4	6	6	3

28 Miami (Central)



Lateral Separation (ft) at Closest Point of Approach

	200	300	400	500	600	700	800	900	1000
Climbing into Traffic		1	1	2	2	1		2	5
Descending into Traffic		1	4	12	12	12	8	17	12
Level Flight	1	4	11	29	32	33	24	20	22

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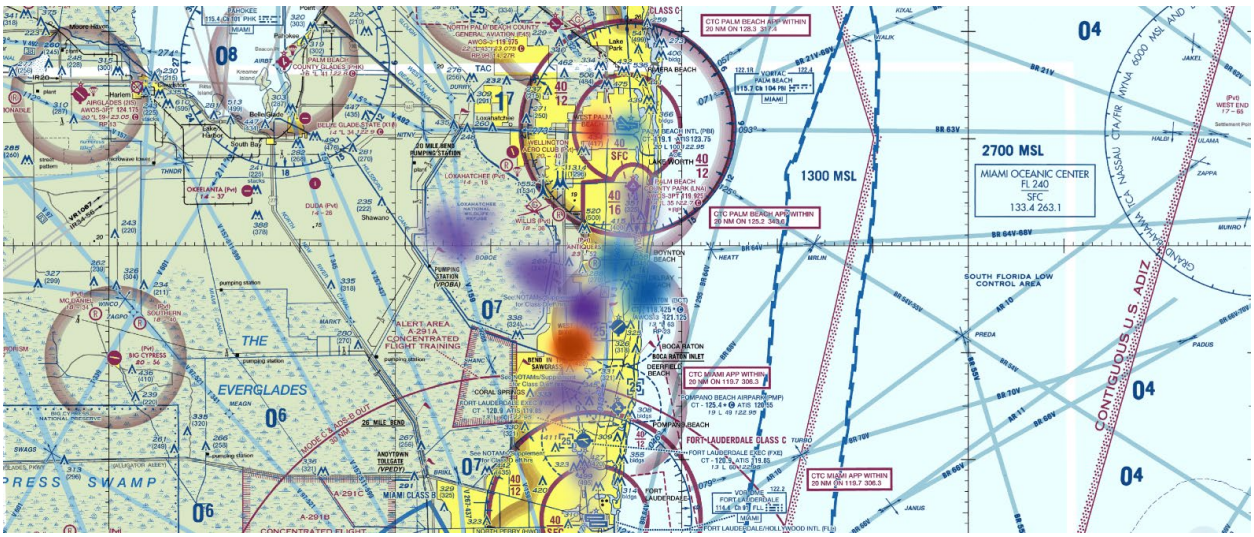
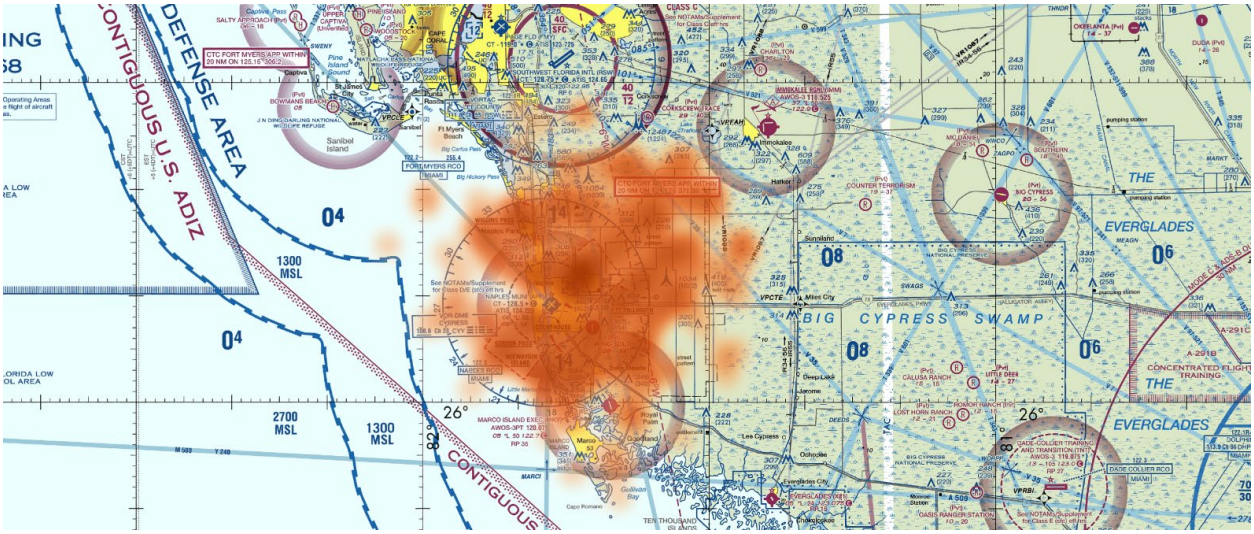
29 Miami (Central)



Lateral Separation (ft) at Closest Point of Approach

	200	300	400	500	600	700	800	900	1000
Climbing into Traffic	1	2	1	3	7	5	9	4	12
Descending into Traffic			1		1		2		
Level Flight		2	6	8	17	6	7	9	6

30 Miami (West Central)

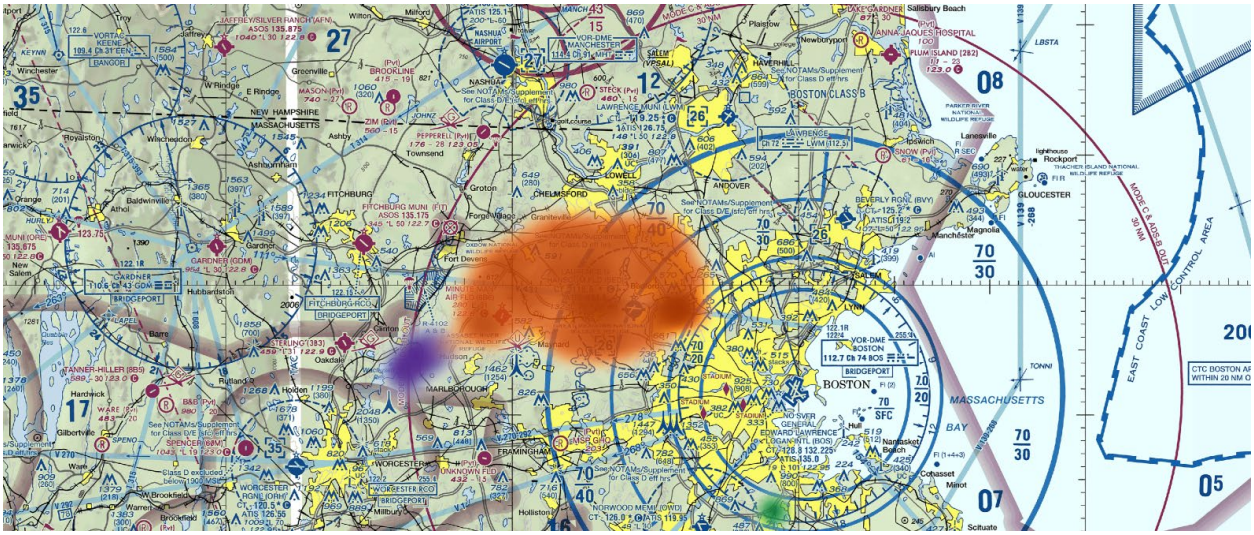


Lateral Separation (ft) at Closest Point of Approach

	200	300	400	500	600	700	800	900	1000
Descending into Traffic	1	6	7	14	24	18	18	17	19

Appendix A. Clusters Across the National Airspace System
(Labeled by the relative position on the respective sectional chart)

31 New York (East Central)



Lateral Separation (ft) at Closest Point of Approach

	100	300	400	500	600	700	800	900	1000
Descending into Traffic	1	4	9	33	35	33	35	29	29
Level Flight				5	1	1		2	5
Parallel Approach					1				

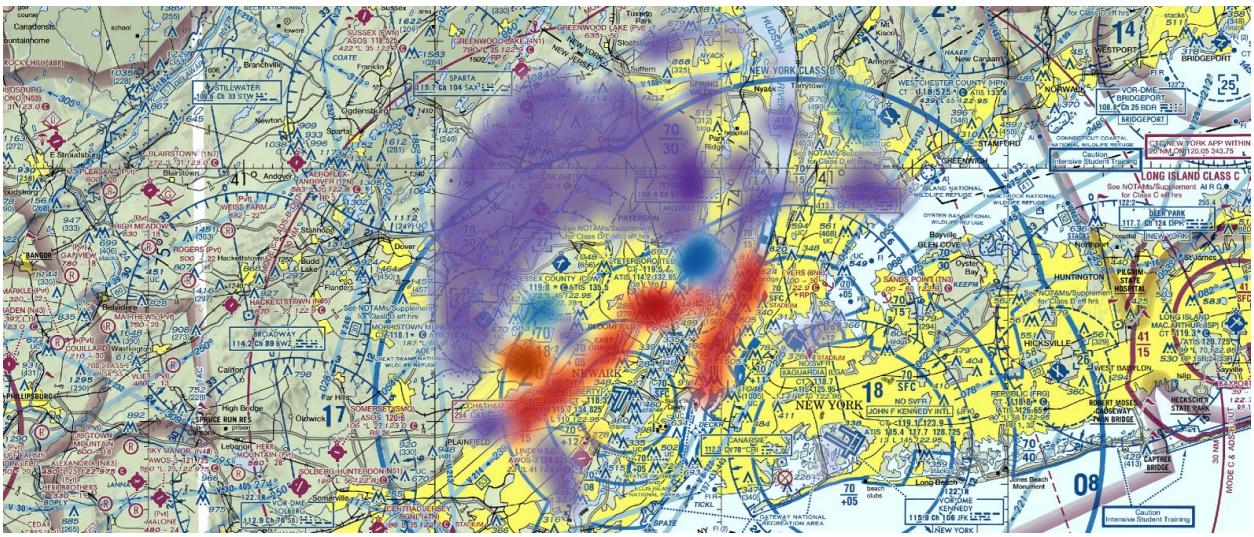
32 New York (East Central)

Lateral Separation (ft) at Closest Point of Approach

	100	300	400	500	700	800	900	1000
Descending into Traffic				1	1	1		
Parallel Approach	1	1	1	2	3		2	7

Appendix A. Clusters Across the National Airspace System
(Labeled by the relative position on the respective sectional chart)

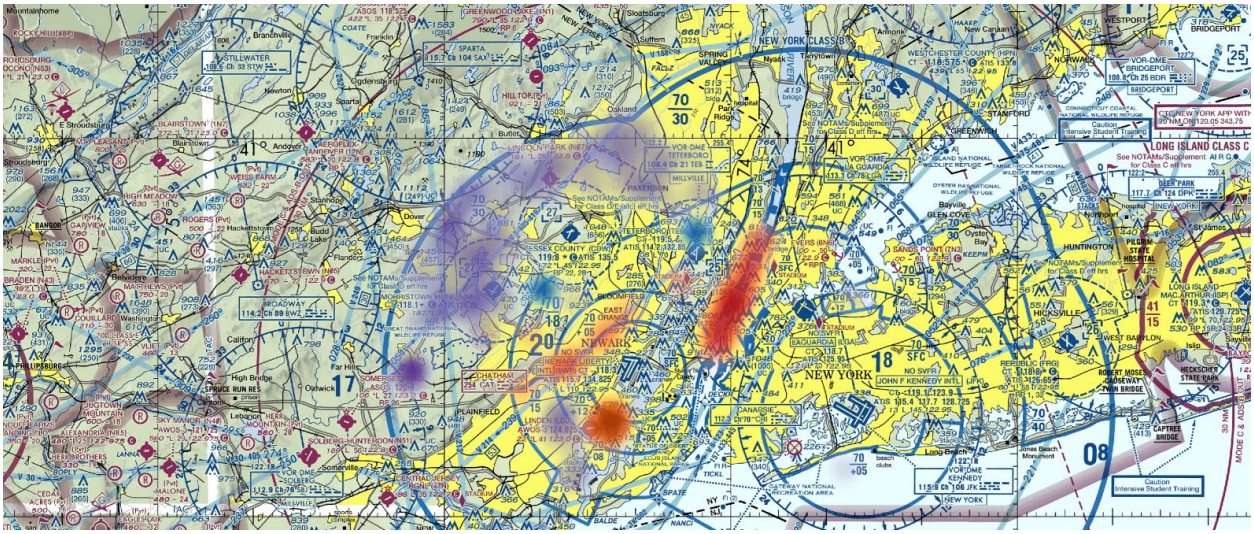
33 New York (South Central)



Lateral Separation (ft) at Closest Point of Approach

	100	200	300	400	500	600	700	800	900	1000
Climbing into Traffic					2		3	1		1
Descending into Traffic					1	1	3	2	1	2
Helicopter	1		4	20	37	41	48	48	42	37
Level Flight	4	2	24	86	285	367	317	246	281	244

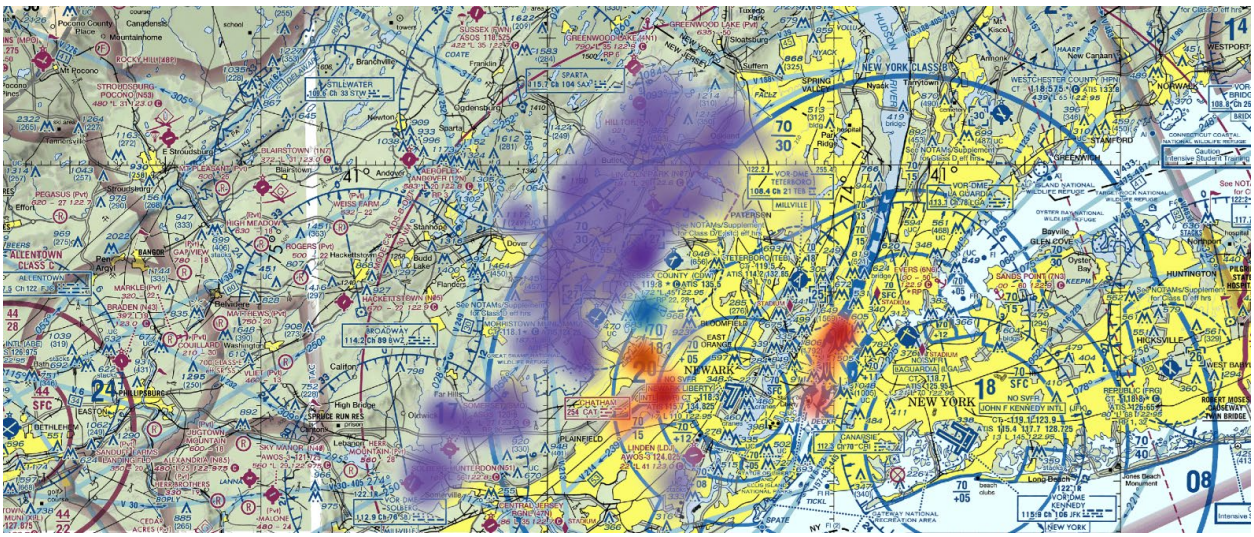
34 New York (South Central)



Lateral Separation (ft) at Closest Point of Approach

	200	400	500	600	700	800	900	1000
Climbing into Traffic						1		
Descending into Traffic			1	1		1	1	
Helicopter			1		3	1	1	2
Level Flight	1	1	1	1		3	1	

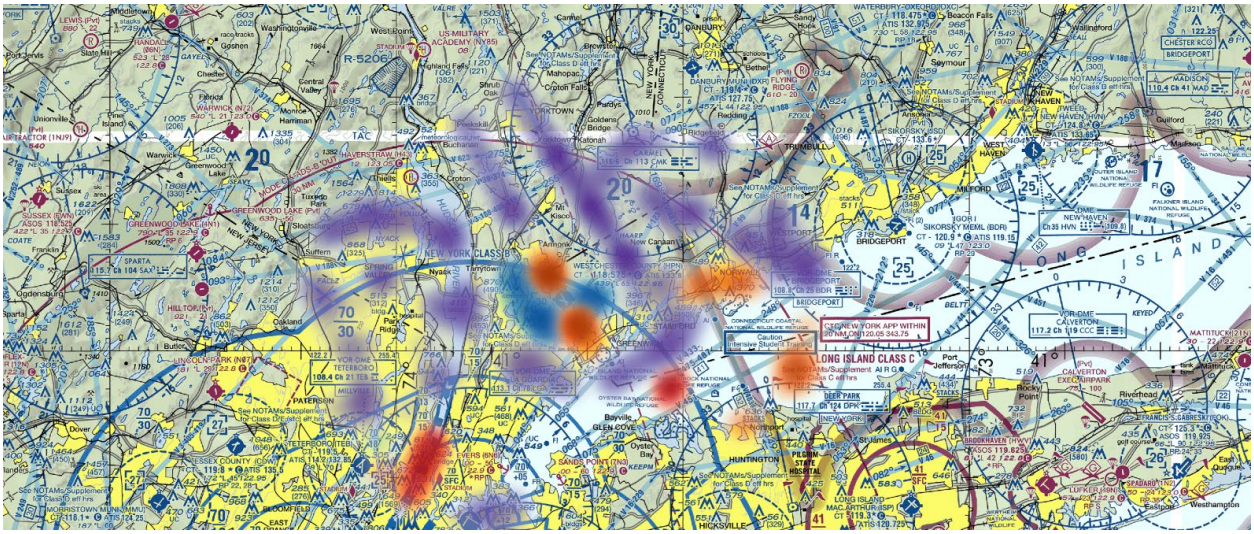
35 New York (South Central)



Lateral Separation (ft) at Closest Point of Approach

	100	200	300	400	500	600	700	800	900	1000
Climbing into Traffic										1
Helicopter							1	2		
Level Flight	1	1	8	15	55	59	53	49	59	42

36 New York (South Central)



Lateral Separation (ft) at Closest Point of Approach

	200	300	400	500	600	700	800	900	1000
Climbing into Traffic		1		6	13	8	5	13	9
Descending into Traffic			2	1	3	7	6	5	6
Helicopter			1	3	3	2	2	1	1
Level Flight	3	4	15	55	77	73	55	57	58

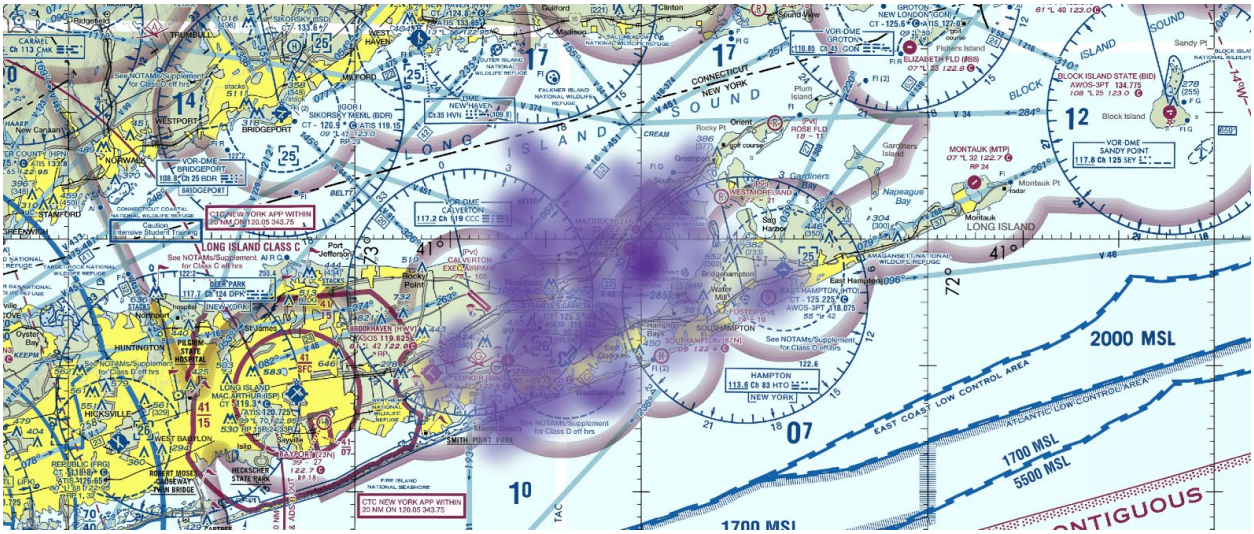
Appendix A. Clusters Across the National Airspace System
(Labeled by the relative position on the respective sectional chart)

37 New York (South Central)

Lateral Separation (ft) at Closest Point of Approach

	300	400	500	600	700	800	900	1000
Level Flight	1	2	8	13	9	2	8	9

38 New York (South Central)



Lateral Separation (ft) at Closest Point of Approach

	200	400	500	600	700	800	900	1000
Level Flight	1	4	13	27	23	14	14	16

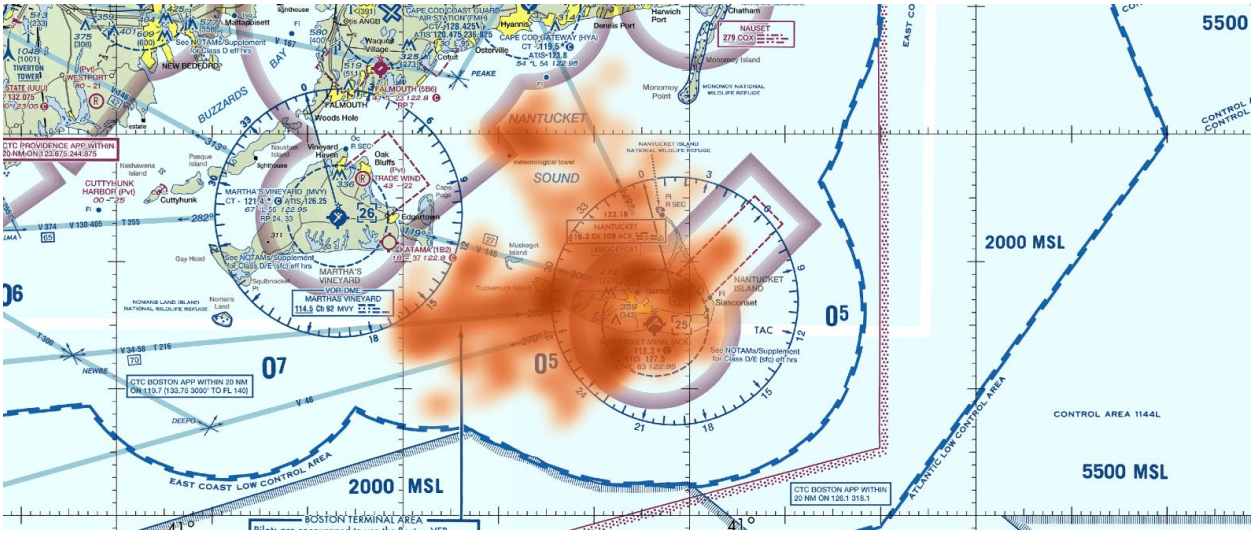
Appendix A. Clusters Across the National Airspace System
(Labeled by the relative position on the respective sectional chart)

39 New York (South Central)

Lateral Separation (ft) at Closest Point of Approach

	200	300	400	500	600	700	800	900	1000
Descending into Traffic	2	4	31	58	76	67	51	39	51
Level Flight			2	4	2	3	3		4

40 New York (South East)

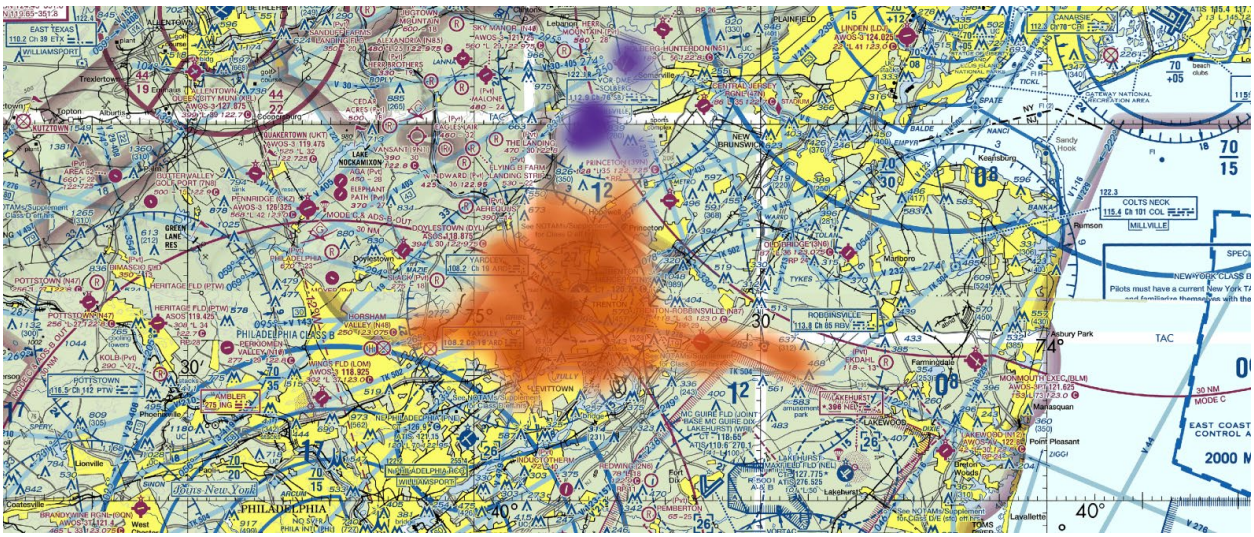


Lateral Separation (ft) at Closest Point of Approach

	200	300	400	500	600	700	800	900	1000
Descending into Traffic	1	2	4	9	12	9	6	10	12

Appendix A. Clusters Across the National Airspace System
(Labeled by the relative position on the respective sectional chart)

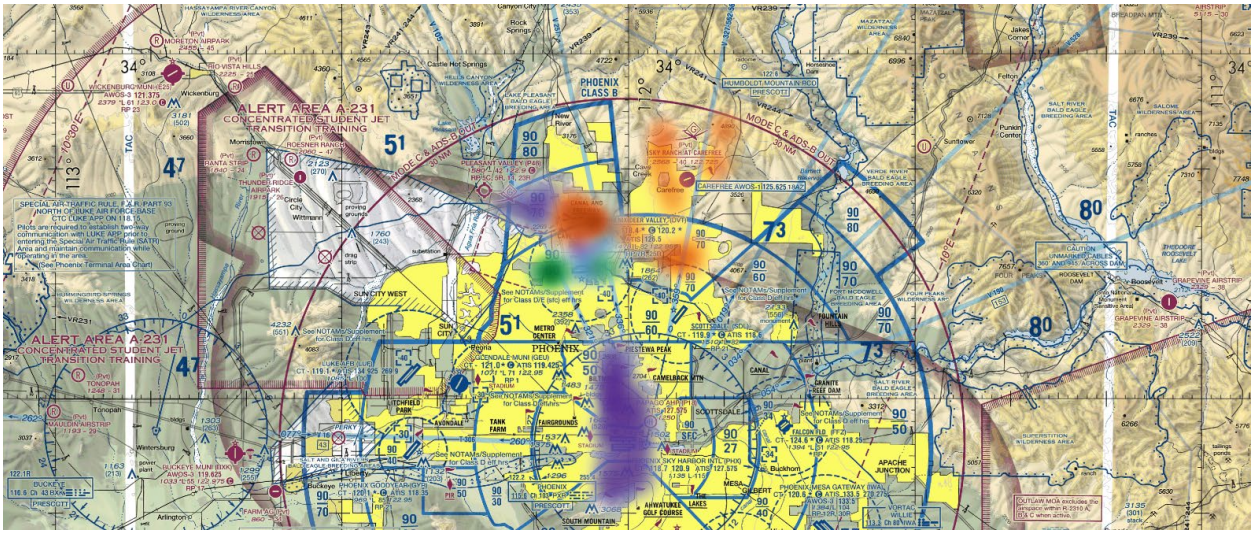
41 New York (South West)



Lateral Separation (ft) at Closest Point of Approach

	200	300	500	600	700	800	900	1000
Descending into Traffic	1	3	12	18	11	10	5	5
Level Flight						2		

42 Phoenix (Central)

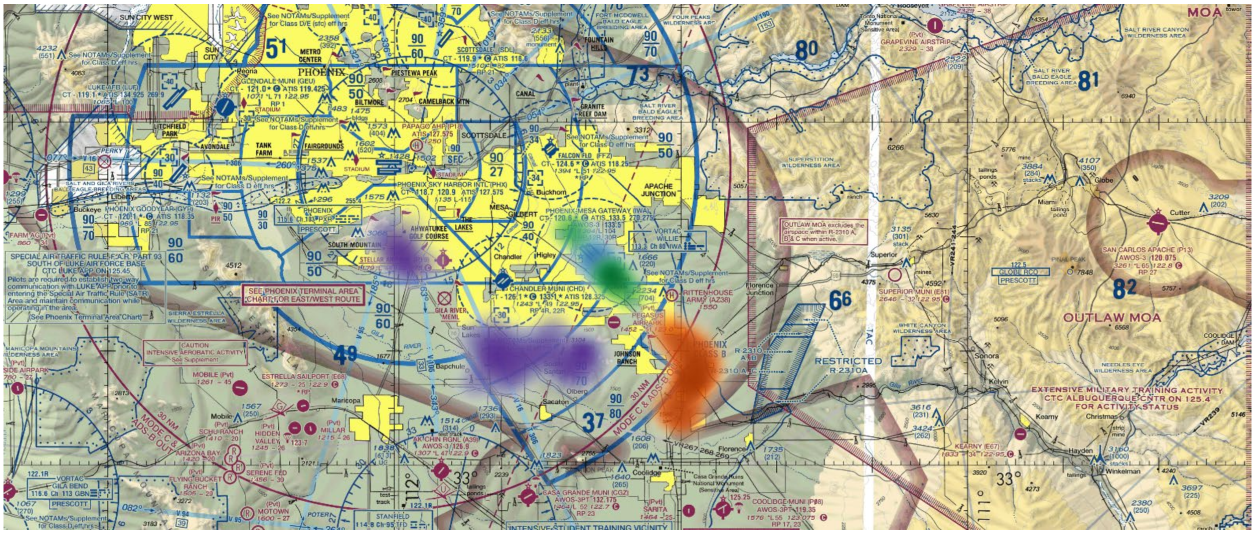


Lateral Separation (ft) at Closest Point of Approach

	0	100	200	300	400	500	600	700	800	900	1000
Climbing into Traffic	1	1	1	5	2	5	13	11	18	18	12
Descending into Traffic						2		1		1	
Level Flight				1	3	10	8	3	6	12	6
Parallel Approach			1		4	1	6	5	16	11	15

Appendix A. Clusters Across the National Airspace System
(Labeled by the relative position on the respective sectional chart)

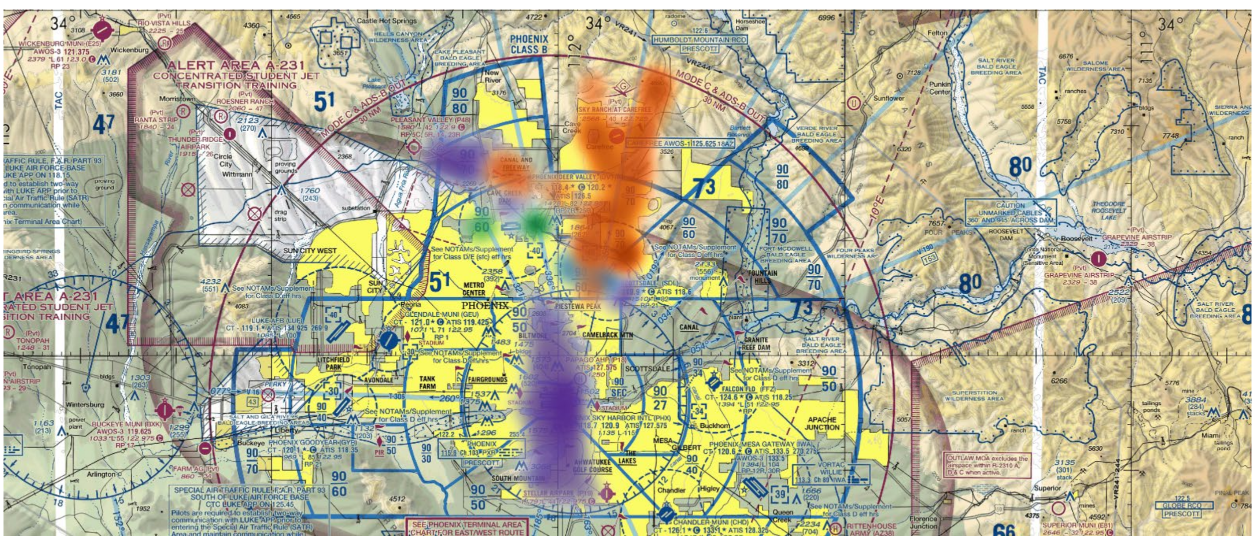
43 Phoenix (Central)



Lateral Separation (ft) at Closest Point of Approach

	200	400	500	600	700	800	900	1000
Climbing into Traffic	1	1	1		4	4	5	7
Descending into Traffic				2		1	1	
Level Flight			2	5	4	2	1	1
Parallel Approach			1		2	2	2	3

44 Phoenix (Central)

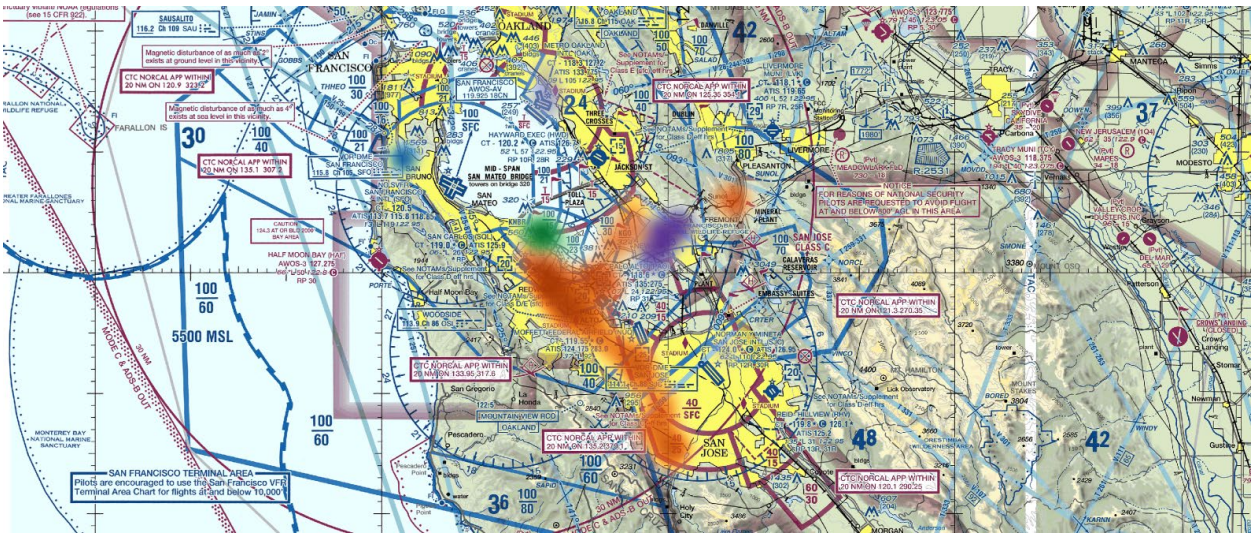


Lateral Separation (ft) at Closest Point of Approach

	100	300	400	500	600	700	800	900	1000
Climbing into Traffic	1	2	5	3	10	10	7	2	9
Descending into Traffic		1	7	18	18	21	22	18	17
Level Flight		1	25	65	52	52	57	53	32
Parallel Approach				1					

Appendix A. Clusters Across the National Airspace System
(Labeled by the relative position on the respective sectional chart)

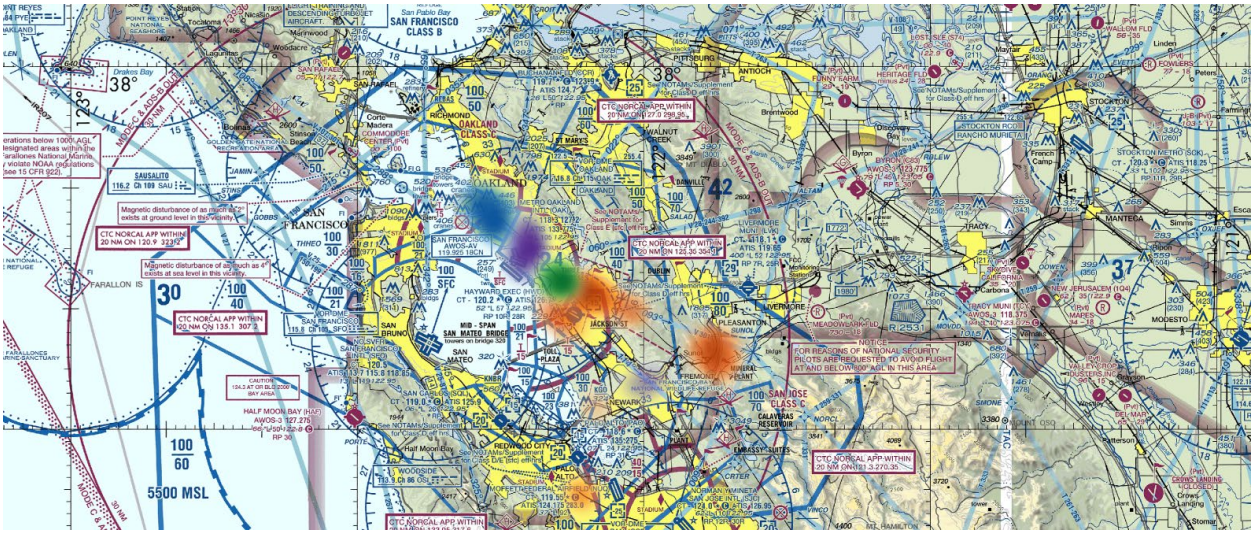
45 San Francisco (Central)



Lateral Separation (ft) at Closest Point of Approach

	200	300	400	500	600	700	800	900	1000
Descending into Traffic	2	2	10	20	20	26	17	24	30
Level Flight			1		1	2		2	1
Parallel Approach					1			1	

46 San Francisco (Central)

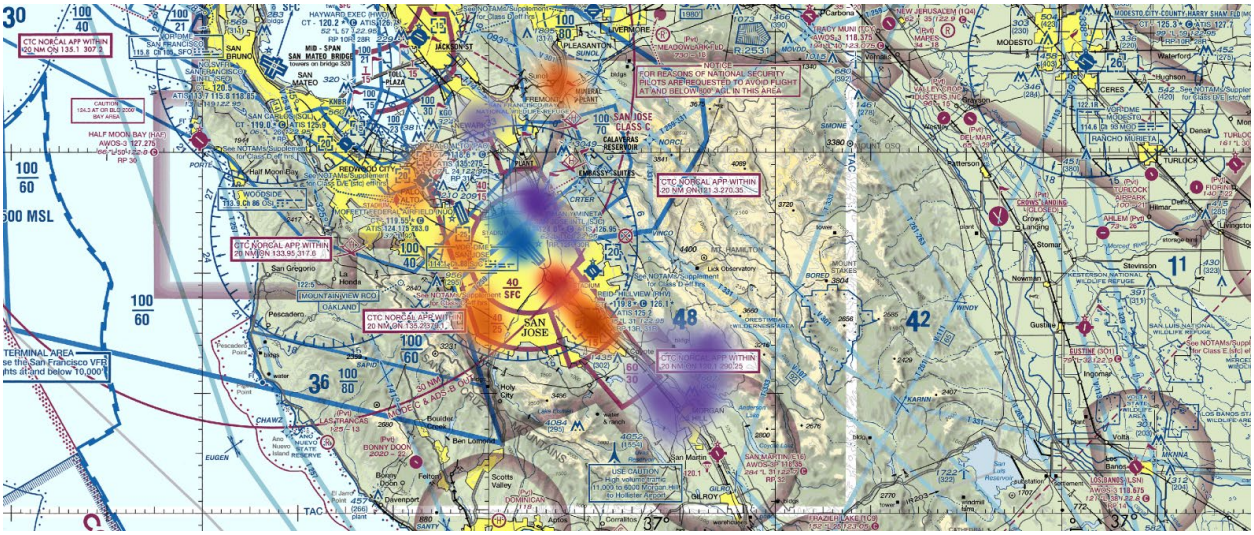


Lateral Separation (ft) at Closest Point of Approach

	400	500	600	700	800	900	1000
Climbing into Traffic			1			2	2
Descending into Traffic	9	16	33	28	18	16	23
Level Flight		2			2		
Parallel Approach		1	5			2	1

Appendix A. Clusters Across the National Airspace System
(Labeled by the relative position on the respective sectional chart)

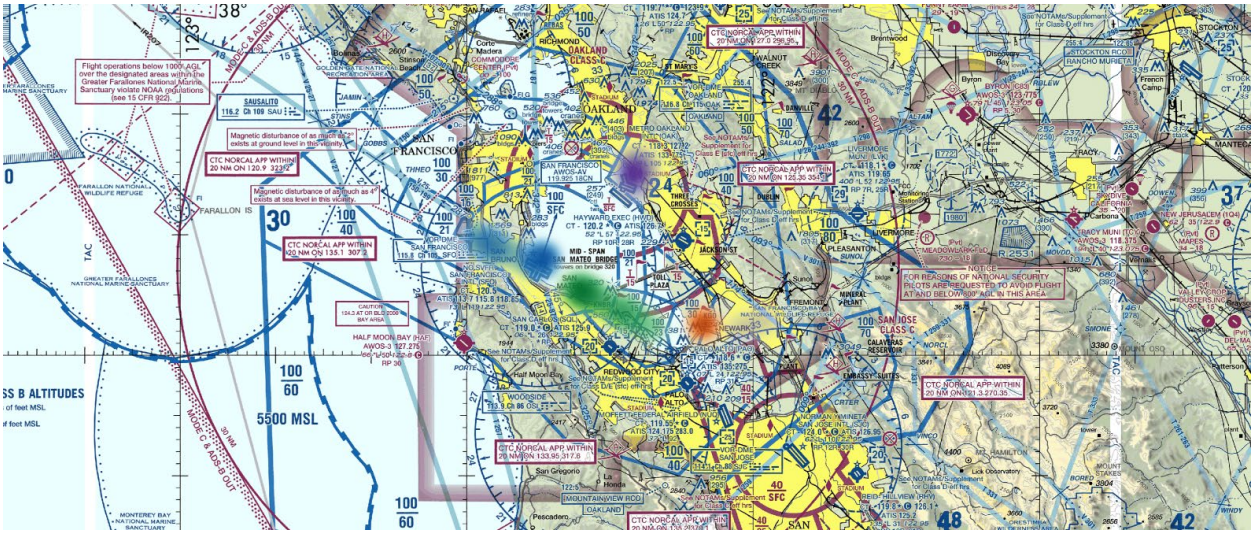
47 San Francisco (Central)



Lateral Separation (ft) at Closest Point of Approach

	500	600	700	800	900	1000
Climbing into Traffic		1	1		1	1
Descending into Traffic		1	2	2	2	1
Helicopter		1		1	2	
Level Flight	4	5	7	4	5	5

48 San Francisco (Central)

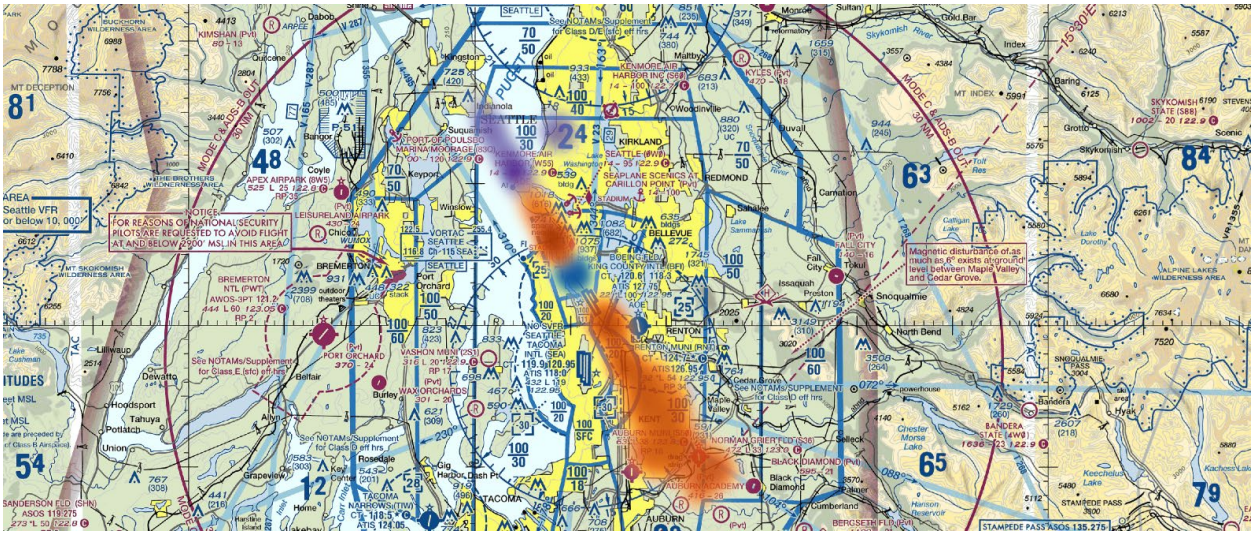


Lateral Separation (ft) at Closest Point of Approach

	400	500	600	700	800	900	1000
Climbing into Traffic	1	4	3	3	9	10	14
Parallel Approach	2	12	23	59	89	149	189

Appendix A. Clusters Across the National Airspace System
(Labeled by the relative position on the respective sectional chart)

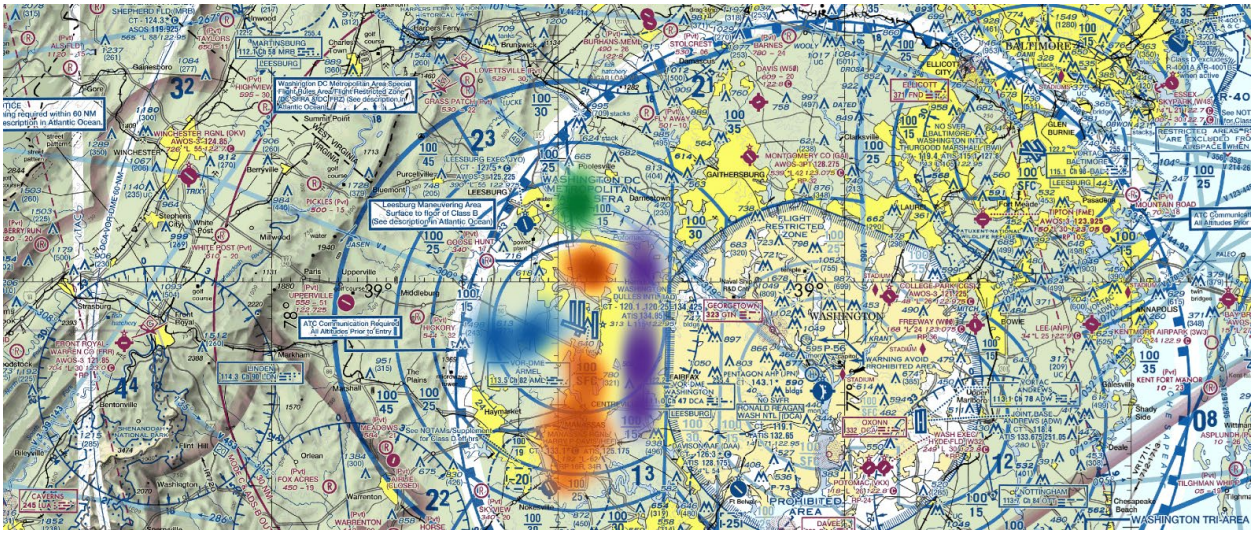
49 Seattle (West Central)



Lateral Separation (ft) at Closest Point of Approach

	200	300	400	500	600	700	800	900	1000
Climbing into Traffic			1		2	3	3	2	5
Descending into Traffic	1	2	9	28	59	65	47	52	60
Level Flight		1	1	8	5	5	4	8	6

50 Washington (West Central)



Lateral Separation (ft) at Closest Point of Approach

	400	500	600	700	800	900	1000
Climbing into Traffic	1				1	1	
Descending into Traffic	1			3	1		2
Level Flight		3	4	2	3	1	1
Parallel Approach						1	