

# Preliminary Flight Data Analysis

(Lee A. Christel, Ph.D, Aug 19, 2015)

## Purpose

Palo Alto residents have noticed a dramatic increase in the amount of air traffic and associated noise over the city. It is suspected that Palo Alto has been unfairly burdened with increases that exceed what would be expected from overall increases in total traffic. The purpose of this analysis is to document some initial evidence that this is in fact true.

## Methods

Flight data were obtained from the National Offload Program (NOP). The initial data chosen for analysis were from the month of July for the years 2006 and 2014. July was chosen as a typical summer month, where the effects of weather are minimal. 2006 was chosen as the earliest year with data density similar to 2014.

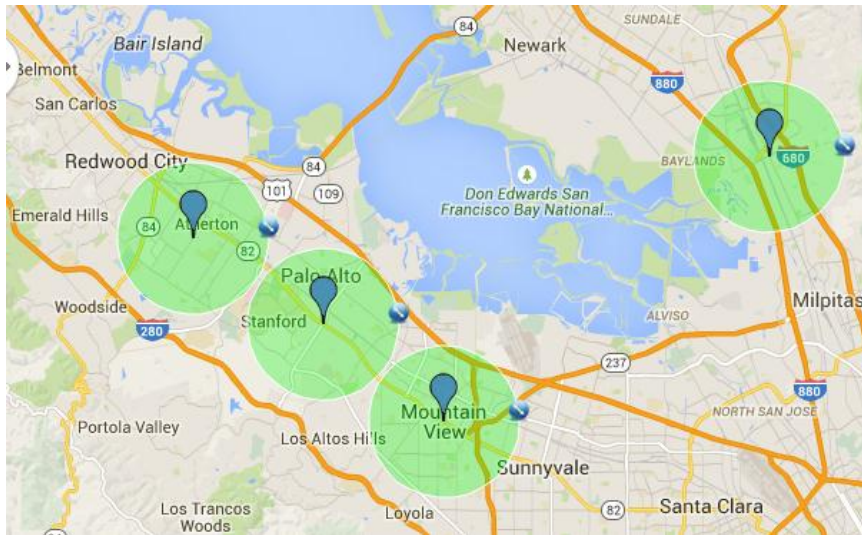
Four regions of equal area were defined for comparison. Each region is a circle of radius 2 miles (an area of 12.6 square miles). The center points of the regions are given in Table 1 and shown graphically in Figure 1.

**Table 1 – Definition of Palo Alto and Neighboring Regions**

<b>Region Name</b>	<b>Center Intersection</b>	<b>Center Latitude</b>	<b>Center Longitude</b>
Atherton	Atherton Ave and Austin Ave	37.45570	-122.20464
Palo Alto	Oregon Expressway and El Camino Real	37.42306	-122.14199
Mountain View	Castro Street and El Camino Real	37.38578	-122.08391
Fremont	Warren Ave and Warm Spring Blvd.	37.48711	-121.92793

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**Figure 1 – The four regions for this analysis**

The regions of Atherton and Mountain View were chosen as nearby areas for comparison to the north and south of Palo Alto. The region of Fremont was chosen because the eastern arrival route into SFO passes over this region.

The number of flights entering these circular regions were determined and compared for the month of July in 2006 and 2014. Flights were characterized by the minimum altitude for the flight within the region. The analysis primarily concentrated on flights with altitudes between 3000 and 8000 feet. This covers the majority of commercial airline traffic and excludes smaller aircraft at lower altitudes. The number of flights was broken down into 1000 foot intervals to assess changes in altitude distributions that have occurred.

## **Analysis – SFO Arrivals**

Per the SFO website (<http://www.flysfo.com/media/facts-statistics/air-traffic-statistics>) the number of July landings at SFO are shown in Figure 2 and Table 2. SFO landings increased by only 28% from 2006 to 2014. Thus if there was no shifting of traffic one would expect an increase of about 28% in the number of SFO arrival flights over each region.

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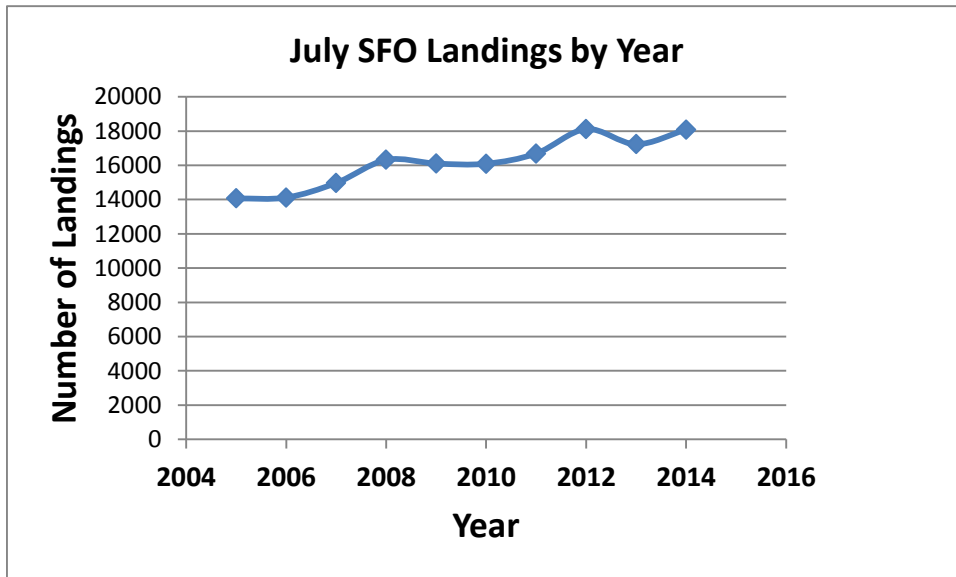


Figure 2 – July Landings at SFO by Year

Table 2 – SFO Landings in July

Year	July Landings	Growth from 2006
2006	14118	
2014	18084	28.1%

The number of SFO arrival flights in each interval, and the changes between 2006 and 2014 are shown in Table 3. The % increases are highest for Palo Alto (66%) and Mountain View (86%). However, in July 2014 Palo Alto had ~6 times as many flights as Mountain View (6017 vs. 1023).

Table 3 - SFO Arrival Traffic, July 2006 to July 2014

Altitude Range:	3000-4000			4000-5000			5000-6000			6000-7000			7000-8000			Total 3000-8000		
	2006	2014	Growth	2006	2014	Growth	2006	2014	Growth	2006	2014	Growth	2006	2014	Growth	2006	2014	Growth
Atherton	383	367	-4 %	629	838	33 %	736	894	21 %	531	627	18 %	123	186	51 %	2402	2912	21 %
Fremont	2		-100 %	12	1	-92 %	230	30	-87 %	3431	2934	-14 %	1043	2933	181 %	4718	5898	25 %
Mountain View	15	6	-60 %	58	54	-7 %	276	534	93 %	135	330	144 %	65	99	52 %	549	1023	86 %
Palo Alto	152	351	131 %	1173	2224	90 %	1681	2718	62 %	525	644	23 %	85	80	-6 %	3616	6017	66 %

The following points can be seen in the data:

- Atherton and Fremont experienced growth in approximate agreement with SFO landing growth.
- Altitudes in the Fremont region increased, with larger growth in the 7000-8000 feet range.
- Mountain View had high growth in the intermediate altitudes, but overall numbers were low.
- Palo Alto experienced very high growth at lower altitudes, and in large numbers of flights.

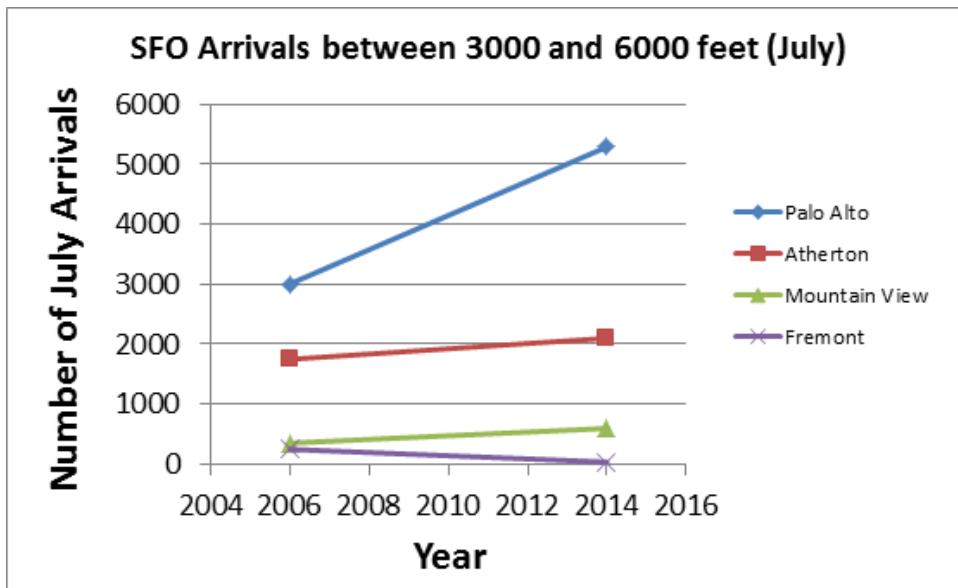
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Flights between 3000 and 6000 feet are particularly disturbing to people on the ground. The number of SFO arrival flights in this altitude range is given in Table 4 and shown graphically in Figure 3. Palo Alto saw an increase of 2287 flights per month in this altitude range, an increase of 76%, and well above the 28% growth in SFO landings.

**Table 4 - Growth in SFO Arrival Traffic, July 2006 to July 2014**

Altitude Range:	3000-6000 ft		
	2006	2014	Growth
Atherton	1748	2099	20 %
Fremont	244	31	-87 %
Mountain View	349	594	70 %
Palo Alto	3006	5293	76 %



**Figure 3 - SFO Arrival Traffic, July 2006 to July 2014**

Figure 4 illustrates how SFO traffic over Palo Alto has shifted to lower altitudes. The number of flights in the lower ranges has approximately doubled while those at higher altitudes have grown less or even decreased. This shift to lower altitudes increases the noise impact on the city. For reference, the 28% overall growth in SFO arrivals is shown in red.

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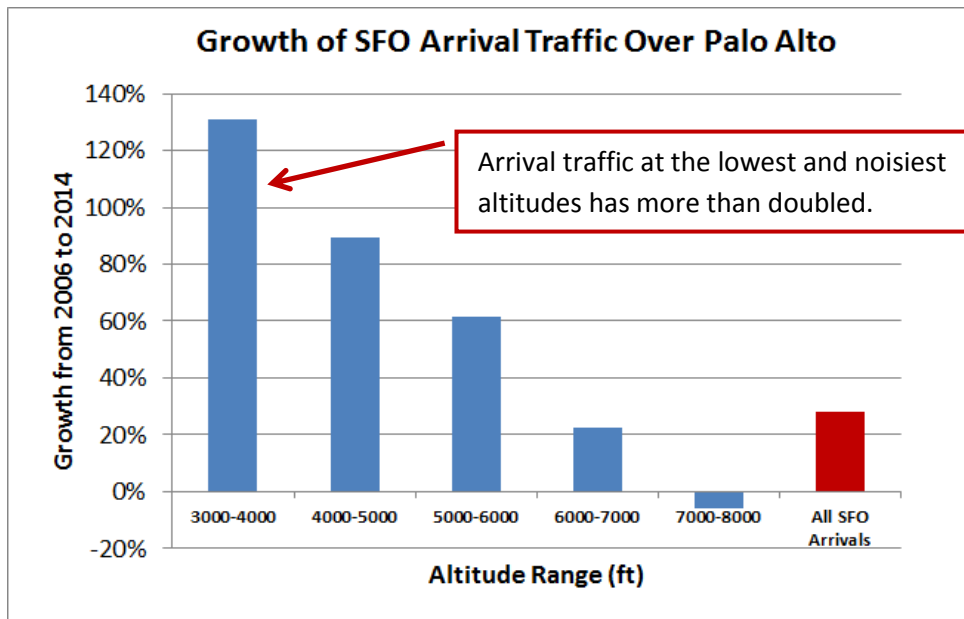


Figure 4 - Growth of SFO Arrival Traffic (2006 to 2014) by Altitude Range

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## Analysis – All Traffic

When looking at all air traffic, the growth trends are very similar to SFO arrival traffic as shown in Figure 5 and Table 5.

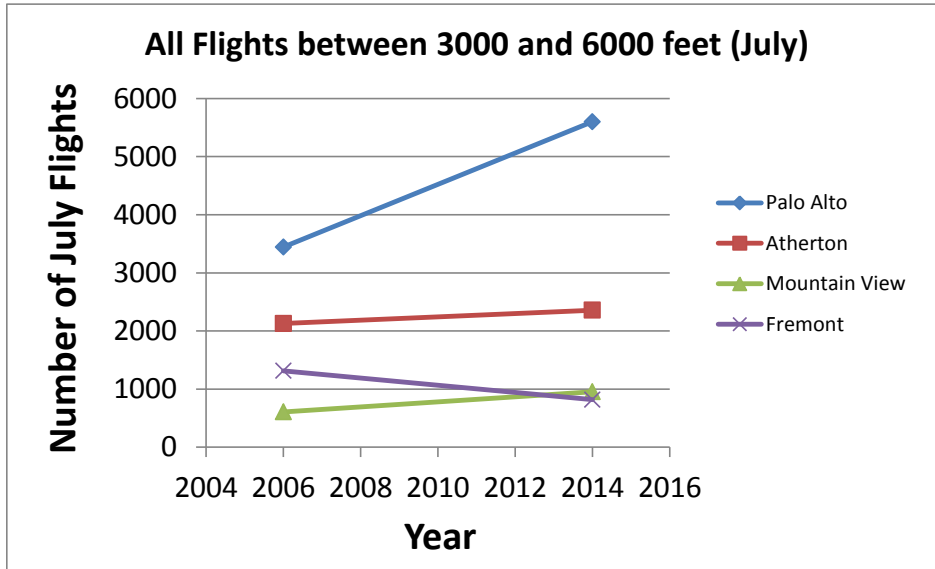


Figure 5 - Total Air Traffic, July 2006 to July 2014

Table 5 - Total Air Traffic, July 2006 to July 2014

Growth in All Traffic, July 2006 to July 2014																		
Altitude Range:	3000-4000			4000-5000			5000-6000			6000-7000			7000-8000			Total 3000-8000		
	2006	2014	Growth	2006	2014	Growth	2006	2014	Growth	2006	2014	Growth	2006	2014	Growth	2006	2014	Growth
Atherton	658	571	-13 %	695	882	27 %	776	904	16 %	601	635	6 %	153	190	24 %	2883	3182	10 %
Fremont	596	343	-42 %	387	379	-2 %	331	97	-71 %	3484	2953	-15 %	1065	2945	177 %	5863	6717	15 %
Mountain View	220	310	41 %	83	95	14 %	304	549	81 %	171	344	101 %	76	109	43 %	854	1407	65 %
Palo Alto	412	551	34 %	1276	2309	81 %	1757	2741	56 %	569	656	15 %	106	87	-18 %	4120	6344	54 %

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## Additional Recent Data

Additional flight data for Jan-May of 2015 were obtained from the National Offload Program (NOP). The data for May 2013, May 2014 and May 2015 were analyzed in more detail. Two regions of equal area (2 mile radius) were defined as “N. Atherton” and “Palo Alto” as shown in Figure 6.

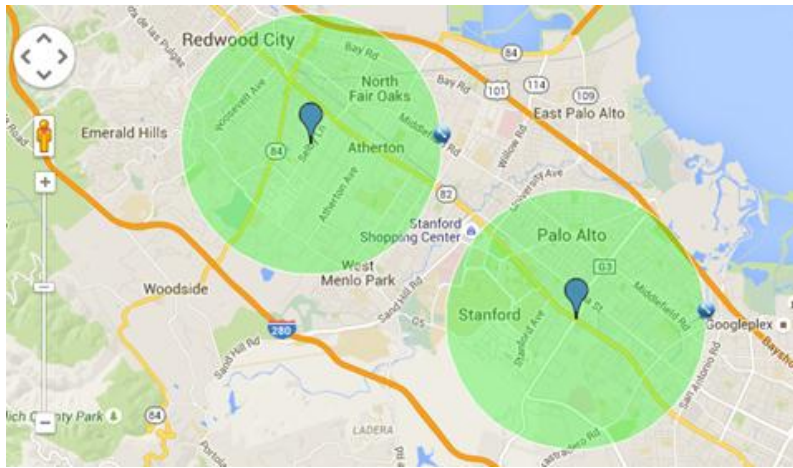


Figure 6 – Two regions for Analysis of May Flight Data

When we include all regional airports, including general aviation, the growth in overall May traffic over Palo Alto in the altitude range 0 to 5000 feet is shown in Figure 7. In this impactful altitude range, there were 209 flights/day on average over Palo Alto, an increase of 53% since 2013.

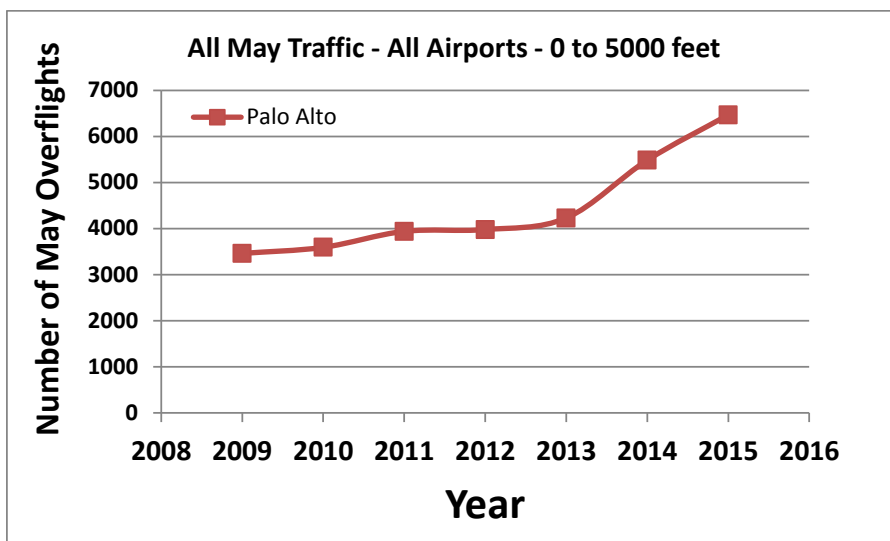


Figure 7 – Growth of All Traffic over Palo Alto in the 0 to 5000 foot altitude range

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For the period July 2006 through May 2015 which includes the recent implementation of NextGen procedures, the number of flights over Palo Alto in the 3000-5000 foot range from all airports increased from 1688 to 4303 (a factor of 2.5 times).

The growth in May SFO arrival traffic alone in the 3000 – 5000 foot altitude range over the two regions by year is shown in Figure 8. Volumes were basically flat until 2013 at which time a dramatic increase is seen for Palo Alto.

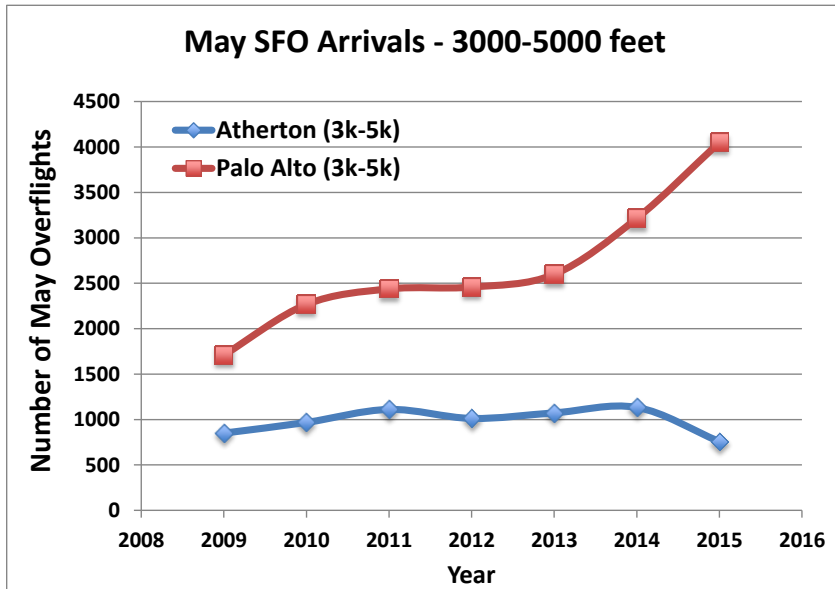


Figure 8 – Growth of May SFO Arrival Traffic by Year



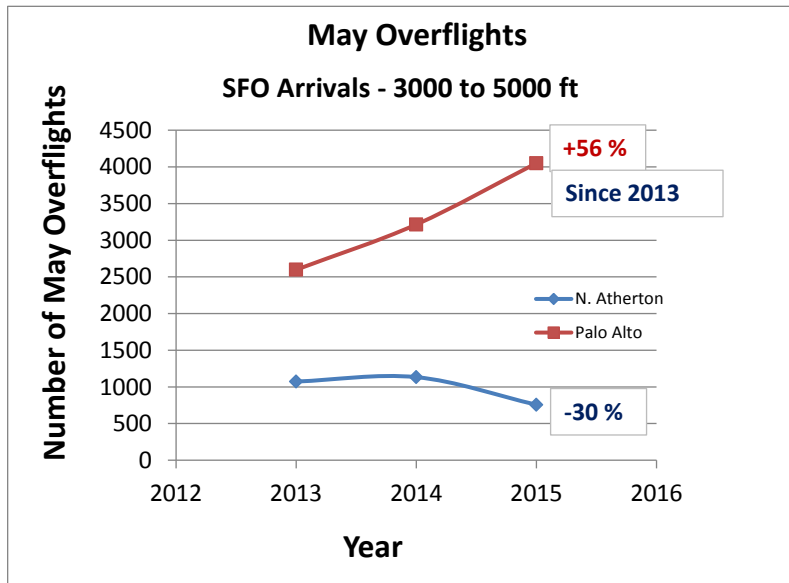
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Focusing on recent years, the growth in May SFO arrival traffic from 2013 to 2015 between 3000 and 5000 feet is shown in Table 6 and Figure 9. Since 2013, the traffic volume grew by 56% over Palo Alto to over 4000 flights per month, but decreased by 30% over N. Atherton to 757 flights.

**Table 6 – May SFO arrivals by year – 3000 to 5000 feet**

SFO Arrivals - 3000 to 5000 ft			
Year:	2013	2014	2015
N. Atherton	1073	1133	757
Palo Alto	2598	3215	4051
Increase from 2013 (%)			
Year:		2014	2015
N. Atherton		5.6%	-29.5%
Palo Alto		23.7%	56.0%



**Figure 9 – Growth in SFO arrivals since May 2013, 3000-5000 feet**

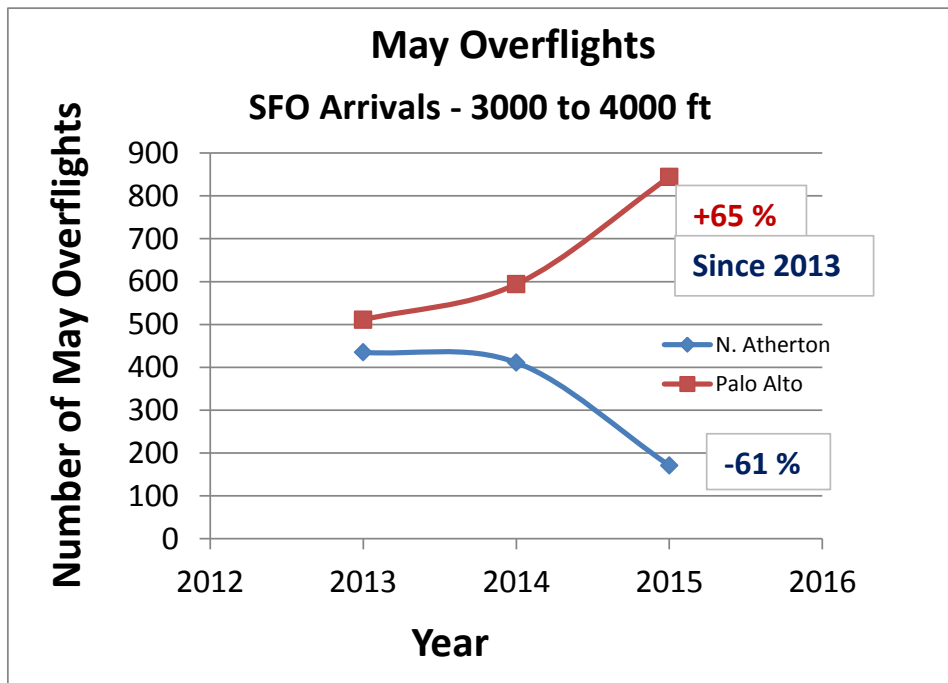
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The data for the lower altitude range 3000-4000 feet shown in Table 7 and Figure 10 are even more dramatic, with a 65% increase in flights over Palo Alto and a 61% decrease over N. Atherton.

**Table 7 - May SFO arrivals by year – 3000 to 4000 feet**

SFO Arrivals - 3000 to 4000 ft			
Year:	2013	2014	2015
N. Atherton	435	411	171
Palo Alto	511	594	844
Increase from 2013 (%)			
Year:		2014	2015
N. Atherton		-5.5%	-60.7%
Palo Alto		16.2%	65.2%



**Figure 10 - Growth in SFO arrivals since May 2013, 3000-4000 feet**

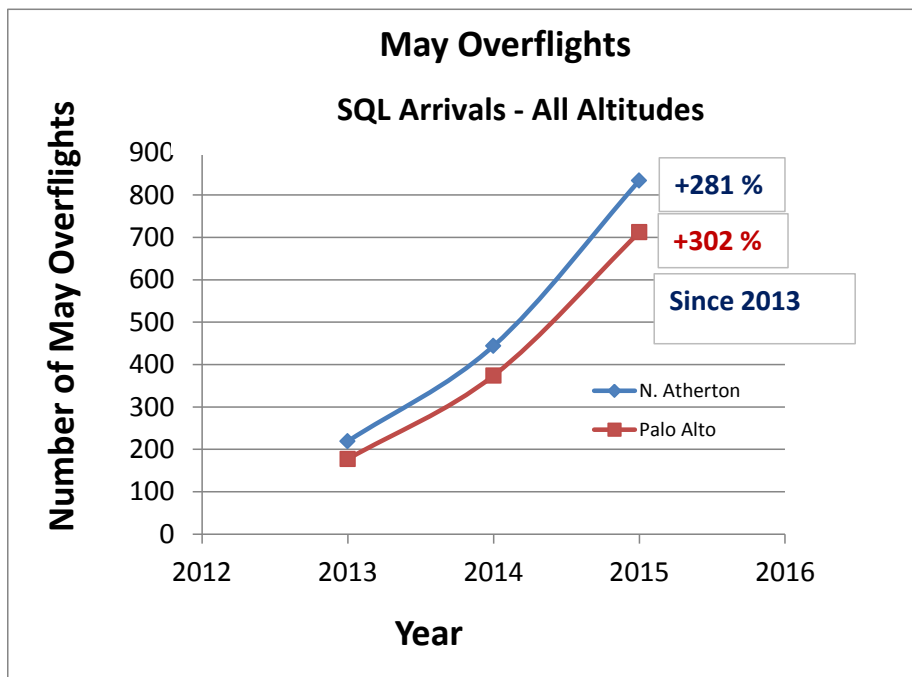
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Table 8 and Figure 11 show the dramatic increase in traffic arriving at San Carlos Airport. This is in large part due to the introduction of the “commuter” airline Surf Air.

**Table 8 - May SQL arrivals by year – All Altitudes**

SQL Arrivals - All Altitudes			
Year:	2013	2014	2015
N. Atherton	219	444	834
Palo Alto	177	374	712
Increase from 2013 (%)			
Year:		2014	2015
N. Atherton		102.7%	280.8%
Palo Alto		111.3%	302.3%



**Figure 11 – Growth in May Arrivals into San Carlos Airport**

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## Summary

This initial data analysis supports the following conclusions

- Between July 2006 and July 2014, the growth of air traffic over Palo Alto has increased by over 2x what would be expected based on SFO arrival growth (66% vs. 28%).
- The growth continued unabated into 2015 with more dramatic increases in flight volume and lowering of altitudes.
- The altitudes of the flights over Palo Alto have decreased, resulting in more noise impact per flight. Some regions within Palo Alto have experienced enormous amounts of low altitude flight increases.
- Neighboring communities have not experienced the same levels of impact.
- Palo Alto has been disproportionately impacted by air traffic changes and increases.

## About the Author

Lee A. Christel received a B.S. degree in Applied Mathematics and Engineering Physics from the University of Wisconsin, Madison in 1978 and a Ph.D in Applied Physics from Stanford University in 1981. He has worked as a process engineer and engineering executive in solar energy research, micro mechanical systems (MEMS) and Molecular Diagnostics. Much of his work involves data analysis, reporting, and presentation.

James Sun, an engineer in big data representation, also contributed to this analysis.

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**Table 9 - SFO Arrival Traffic, July 2006 to July 2014**

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**Table 10 - Total Air Traffic, July 2006 to July 2014**

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