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Using GIS to Allocate Elevated Aircraft Emissions Associated with Arrivals and Departures

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Sources of Airport Emissions

- Airports are often a major source of emissions in urban centers
- Sources of emissions from Airports can include:
  - Aircraft (Commercial, General Aviation, and Military),
  - Refueling,
  - Surface coating,
  - Vehicles,
  - Boilers,
  - Lawn and garden equipment, and
  - Other Equipment
- VOC and NOx emissions from Aircraft is the main focus of this study
- Latest data available is from the 2005 NET Emission Inventory

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Step 1: Calculating Aircraft Emissions

- Data on aircraft flight activities and aircraft type was collected from the "FAA/FPA Terminal Area Forecast" (TAF) software and "Airport IQ Data Center" Internet site
- Aircraft emissions for the SAIA were calculated using the Emission & Dispersion Modeling System (EDMS) version 4.21
- Aircraft emissions vary by mode of aircraft operation up to 3,000 feet:
  - Idling (geo-coded to the airport location),
  - Approach,
  - Take off, and
  - Climb out

The Federal Aviation Administration, Emissions & Dispersion Modeling System, Sept. 30, 2004. Available online: http://www.aee.faa.gov/emissions/edms/EDMShome.htm

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Commercial Aircraft Type and Arrival Activity, 2005
San Antonio International Airport

Type	Number of LTO Cycles	Aircraft Name	Number of Engine	Engine Type	Equivalent Aircraft Used in Modeling
A306	550	AIRBUS - A-300B4 - 600	2J/H		
A30B	1	AIRBUS - A-300B4 - 600b	2J/H		A306
A310	107	AIRBUS - A-310 (CC-150 Polaris)	2J/H		
A319	2,640	AIRBUS - A-319, ACJ	2J/L		
A320	87	AIRBUS - A-320	2J/L		
A321	9	AIRBUS - A-321	2J/L		
A331	1	AIRBUS - A-331	2J/L		A-330
AC11	1	Rockwell - Commander	1P/S		
AC90	1	Gulfstream Aerospace - 690 Jetprop Commander 840/900	2T/S	TPE 331	Swearingen Merlin
AC9L	1	Gulfstream Aerospace	2T/S	TPE 331	Swearingen Merlin
AT43	7	Aerospatiale - ATR-42-200/300/320	2T/L		ATR42
B190	276	Beech - 1900 (C-12J)	2T/S+	PT6A-65B	BH-1900
•	•	•	•	•	•
•	•	•	•	•	•
•	•	•	•	•	•
•	•	•	•	•	•
•	•	•	•	•	•
•	•	•	•	•	•

LTO Cycles = Landing Take-Off Cycles
J = Jet, T= Turbo, P = Piston
S = Small, L = Large, H = Huge

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Step 2: Temporal Allocation of Emissions

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- To accurately allocate aircraft emissions in photochemical models, hourly temporal factors must be applied
- Air carrier flight schedules for September 2005 were analyzed to determine the hourly temporal distribution for commercial flights.
- General Aviation hourly allocation was calculated base on hourly flight data for 2004 from the "Airport IQ Data Center" Internet site

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Hourly Distribution of General Aviation Operations by Aircraft Type, 2004 - San Antonio International Airport

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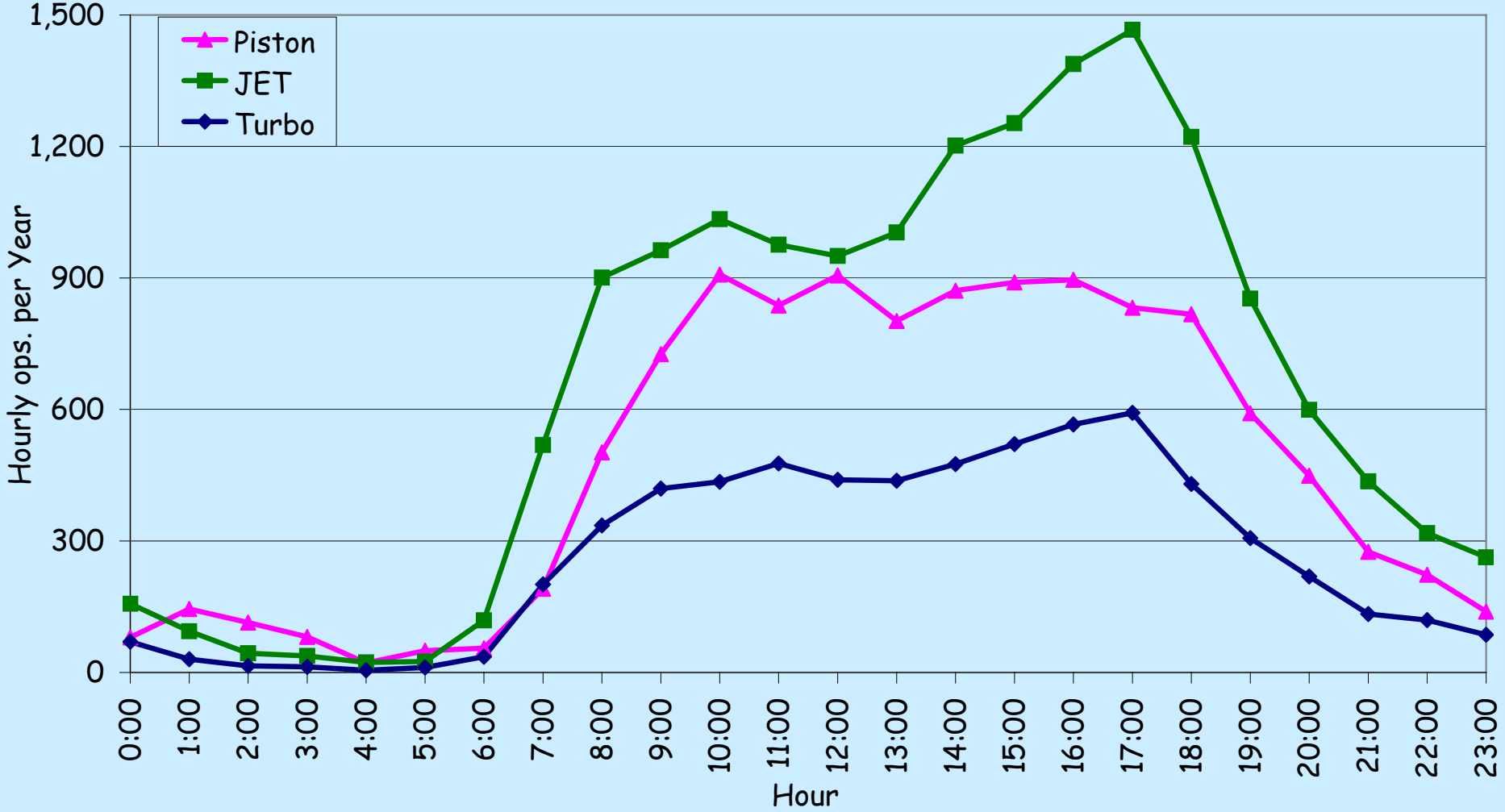

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Step 3: Assigning Emissions to Runways

- Information on runway operations by aircraft class was obtained from the San Antonio Department of Aviation
- The information provided the annual percentages of take off and landings that take place at each end of the runways
- Using this data, aircraft emissions were allocated beyond each runway end point for arrival and departure flights.

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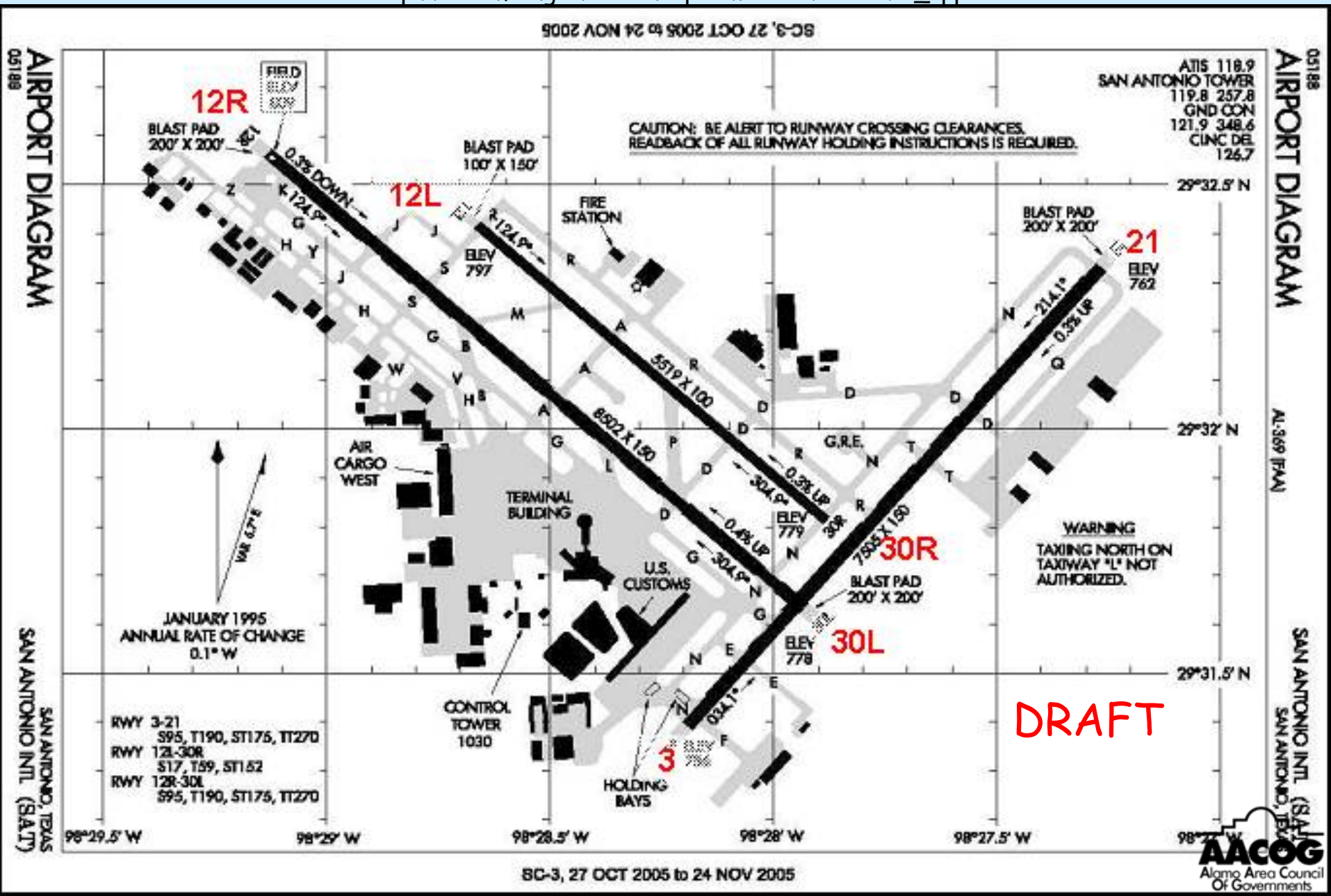
San Antonio International Airport Runway Schematic

Source: Federal Aviation Administration, National Flight Database, 2005. Available online: http://naco.faa.gov/index.asp?xml=naco/online/d_tpp



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Percentage of Arriving Aircraft Operations Allocated by Runway and Aircraft Class, 2005.

Runway	Arrival				
	Direction	Commercial	Jet	Turbo	Piston
RW 12R	West	74%	70%	72%	58%
RW 12L	West-Small	0%	2%	5%	13%
RW 21	North	3%	2%	2%	4%
RW 30R	East-Small	0%	0%	1%	4%
RW 30L	East	13%	15%	11%	10%
RW 3	South	10%	11%	9%	11%
Total		100%	100%	100%	100%

Jet, Turbo, and Piston are based on General Aviation (GA)
Source: San Antonio Department of Aviation

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Step 4: Spatial Allocating Emissions

- Aircraft emissions by flight modes of were allocated horizontally and vertically to the photochemical grid-cell system.
  - take-off (0 – 1,000 feet),
  - climb out (1,000 – 3,000 feet), and
  - approach (3,000 – 0 feet),
- Emissions from aircraft above 3,000 feet in elevation were not calculated.
- To allocate emissions to the photochemical model grid cells, vertical height, latitude, and longitude were calculated for 8 nodes at incremental ground distances from the ends of each runway.
- Aircraft landing angles were set at 3° and departure angles were set at 9°.
- Once the emissions were geocoded to correct location and height, the data was converted to a format suitable for photochemical modeling.

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Aerial View of Calculated Nodes

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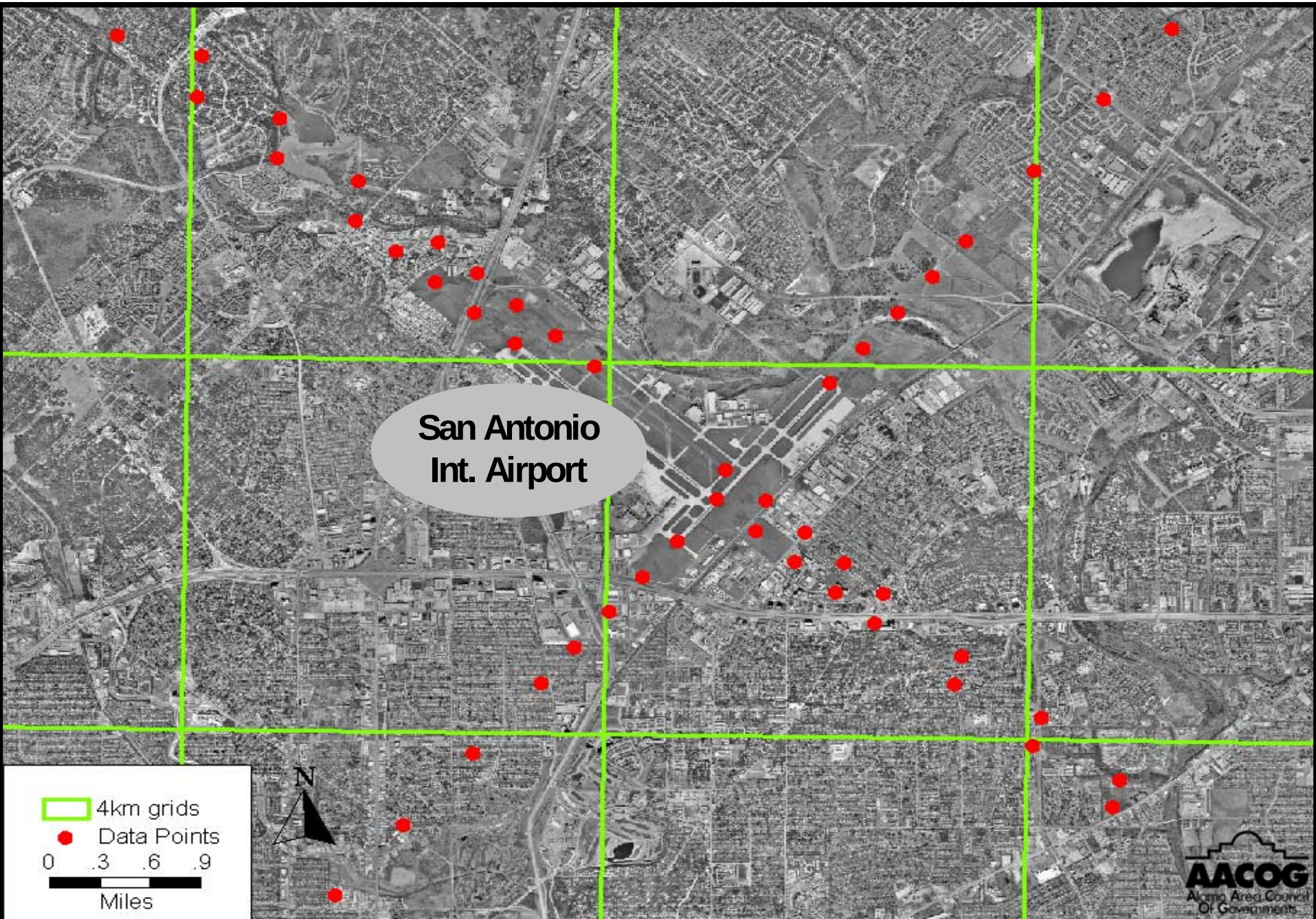

Calculated Heights of Nodes for LTO Operations at End of Runways*

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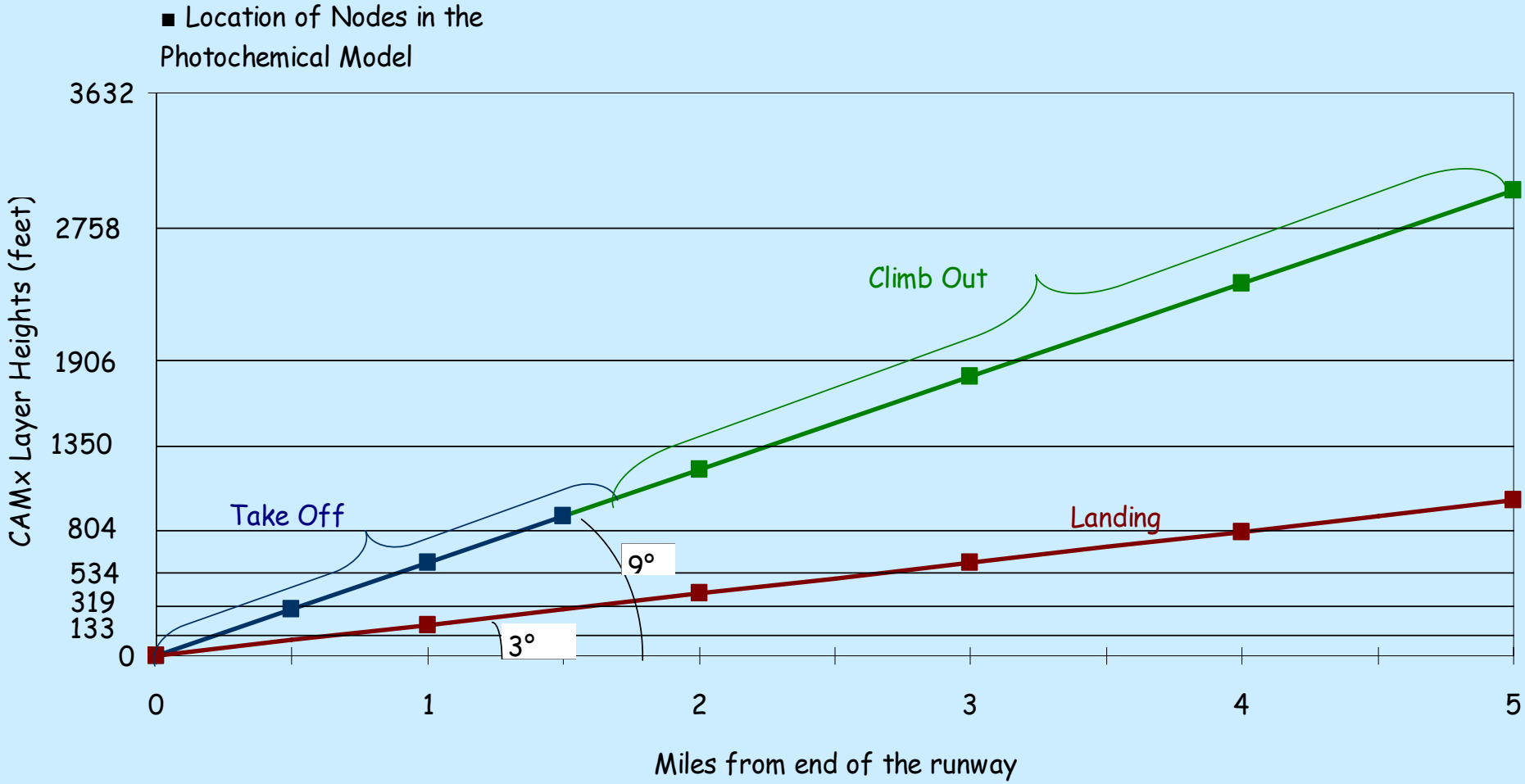

*Note: Angles in diagram are for illustration purposes only and are not to scale

CAMx = Comprehensive Air Quality Model with Extensions (CAMx), ENVIRON, July 13, 2005. Novato, California, Available online: http://www.camx.com/ .

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Heights of Selected Nodes for Take off and Landing Operations at Runway 3

Runway Nodes (Direction)	Distance from End of Runway (meters)	UTM Latitude (Y coordinate)	UTM Longitude (X Coordinate)	Node Height (feet) for 9° Take off	Node Height (feet) for 9° Climb out	Node Height (feet) for 3° Landing
Runway 3 Nodes (Northeast)	0	-1157.7	151.0	0	N/A	0
	500	-1157.3	151.3	300	N/A	N/A
	1,000	-1156.9	151.6	600	N/A	200
	1,500	-1156.6	151.9	900	N/A	N/A
	2,000	-1156.2	152.2	N/A	1,200	400
	3,000	-1155.4	152.8	N/A	1,800	600
	4,000	-1154.7	153.5	N/A	2,400	800
	5,000	-1153.9	154.1	N/A	3,000	1,000

N/A: these nodes were not used to allocate emissions

UTM = Universal Transverse Mercator projection (Zone 15)

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Next Steps

- Update Military Aircraft EF
- Apply methodology to other airports
- Run results in photochemical model to determine impact on Ozone levels

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Hourly Distribution of Commercial Aircraft Operations, September 2005 San Antonio International Airport

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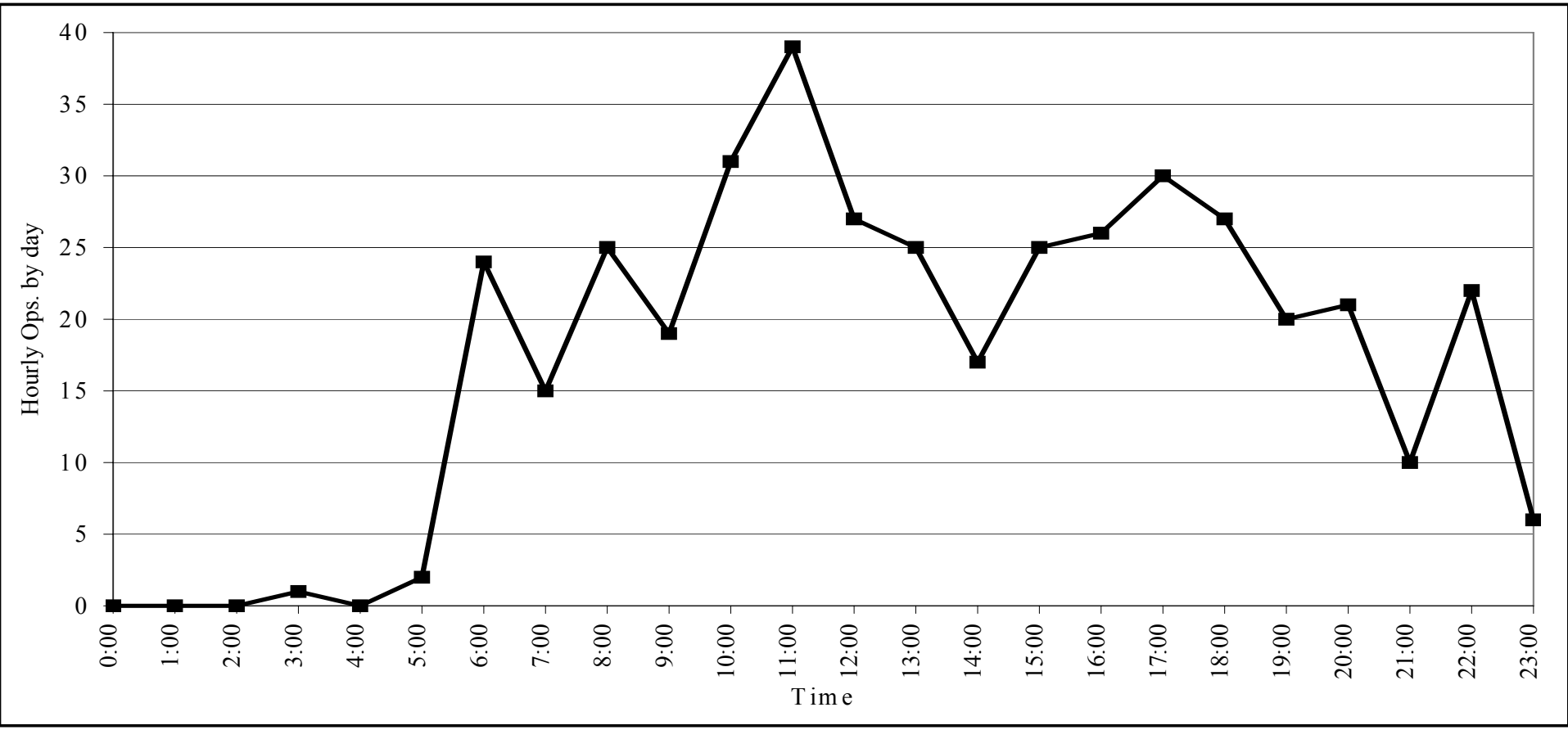

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Emissions by Aircraft Class and Mode, 2005
San Antonio International Airport

Aircraft Class	VOC (tons/day)			NOx (tons/day)		
	Take Off	Climb Out	Approach	Take Off	Climb Out	Approach
Commercial	0.003	0.004	0.015	0.438	0.290	0.206
Military	0.002	0.002	0.019	0.037	0.024	0.026
GA – Jet	0.001	0.001	0.014	0.035	0.022	0.021
GA – Turbo-Prop	0.000	0.000	0.004	0.002	0.001	0.004
GA – Piston	0.001	0.001	0.002	0.000	0.001	0.001
Total	0.007	0.008	0.054	0.512	0.338	0.259

GA = General Aviation

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