CEE 4674
Airport Planning and Design

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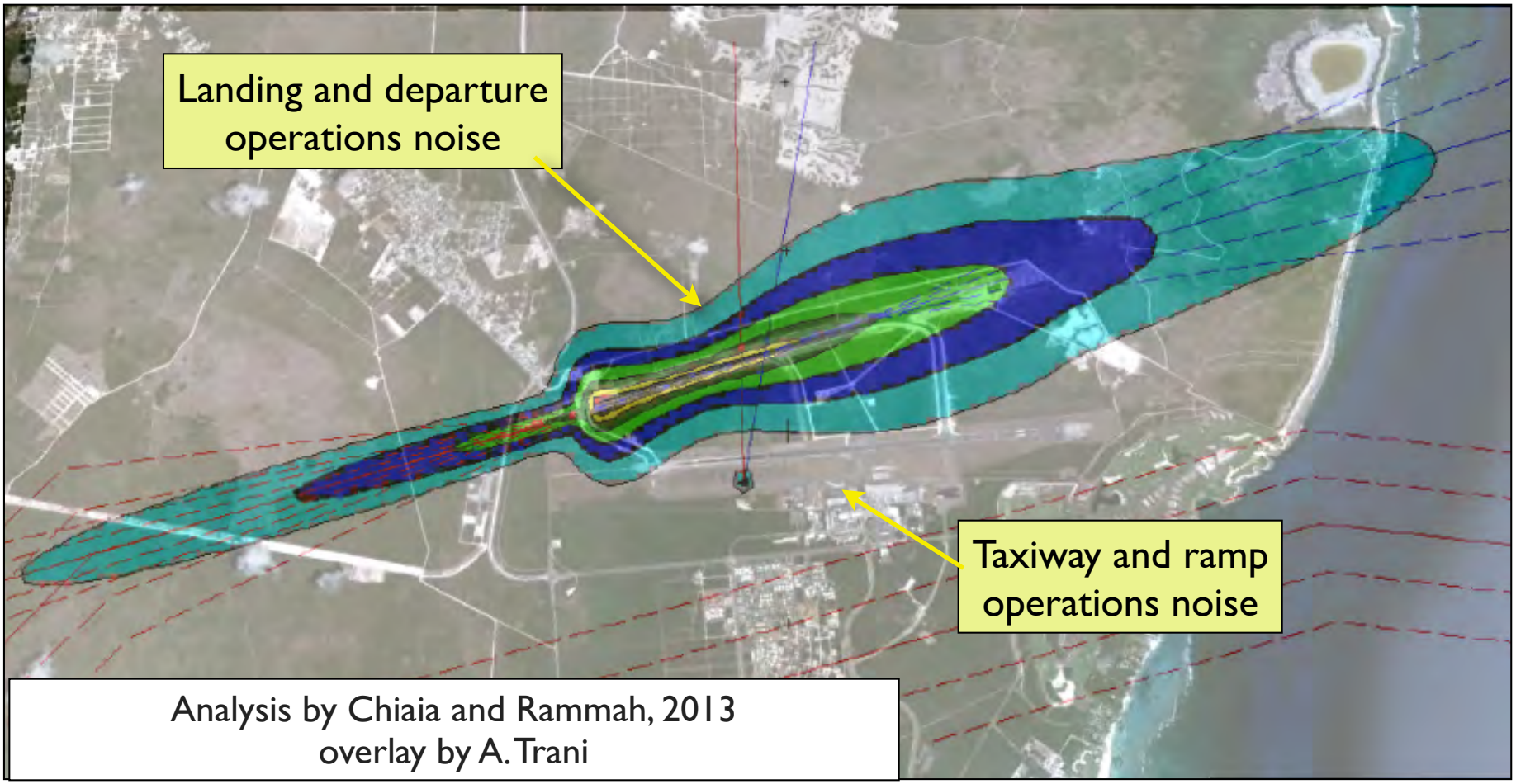
Punta Cana - Aircraft Operations and Airport Noise Data Collection

Issues

- The **airport noise** is an important part of the environmental impact study done for every airport facility
- Airport noise is a big concern for many airports around the world
- Collecting aircraft operations data will help us understand how efficient the runway and taxiway operations truly are

Final Product of the Noise Analysis (Final Project in 2013)

Noise contours around the airport



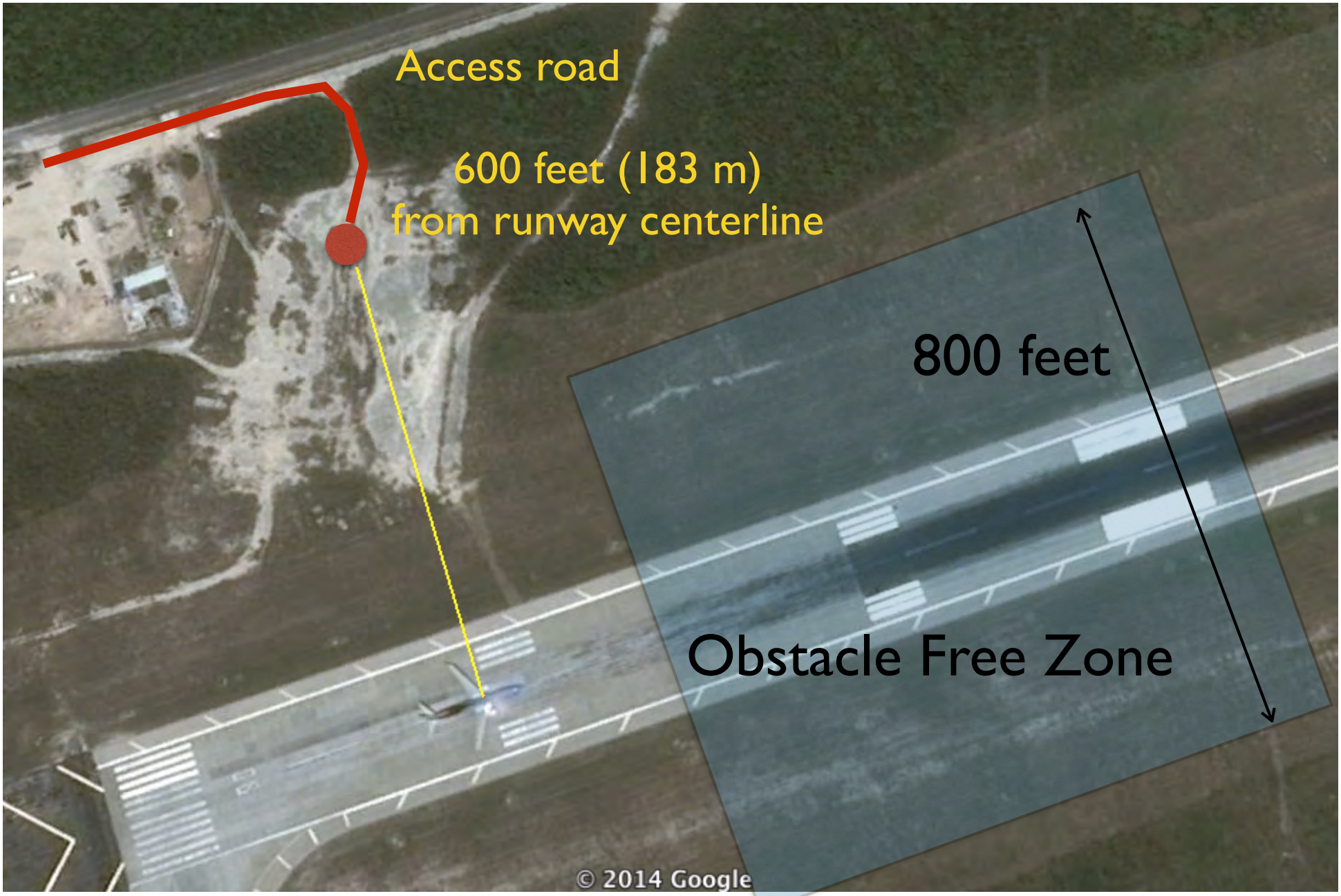
Noise Analysis Procedure

- Use the FAA Integrated Noise Model (INM) to develop noise contours around the airport
- Measure sample aircraft noise flyovers at the Punta Cana airport to verify some of the metrics derived in the INM model
- Noise will be measured at various points around the airport
- Correlate real-world data with a computer model used by airport consultants and the FAA to predict noise impacts

Punta Cana Airport

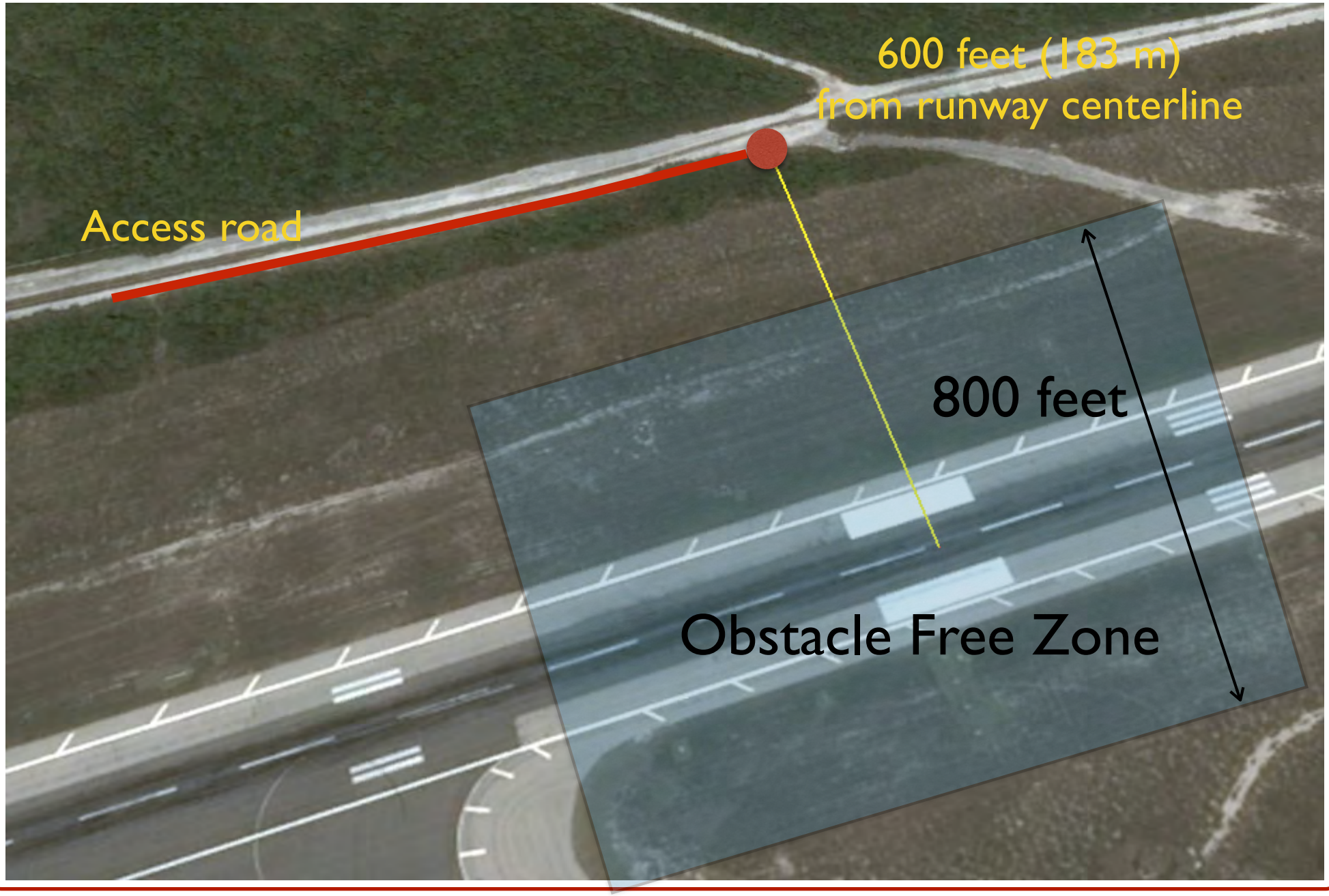
Areas De Medición de Ruido 2014

Detail Zone 2

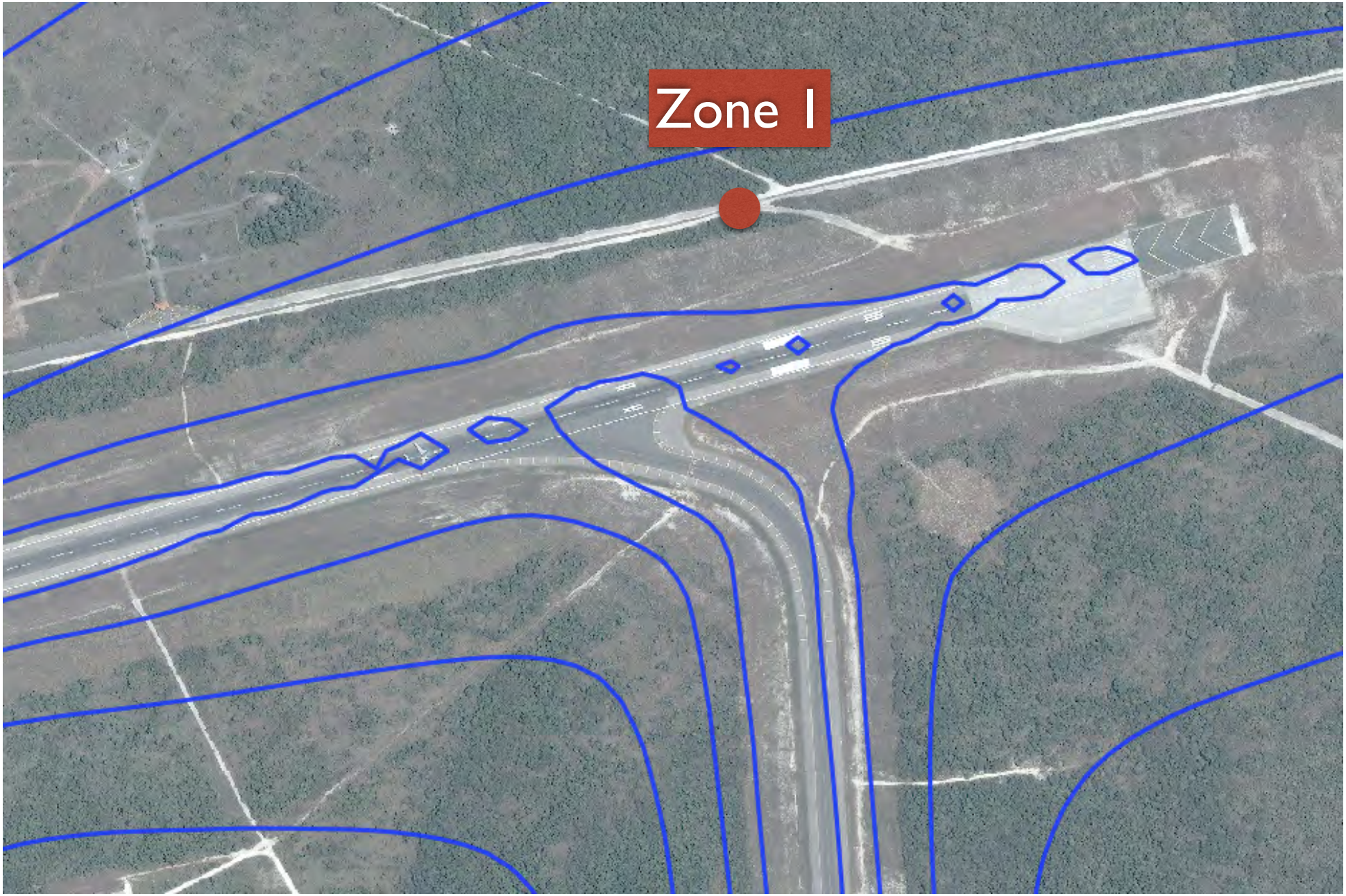


Last Year's Noise Contours (INM Model)

Detail of Zone 1



Last Year's Noise Contours (INM Model)

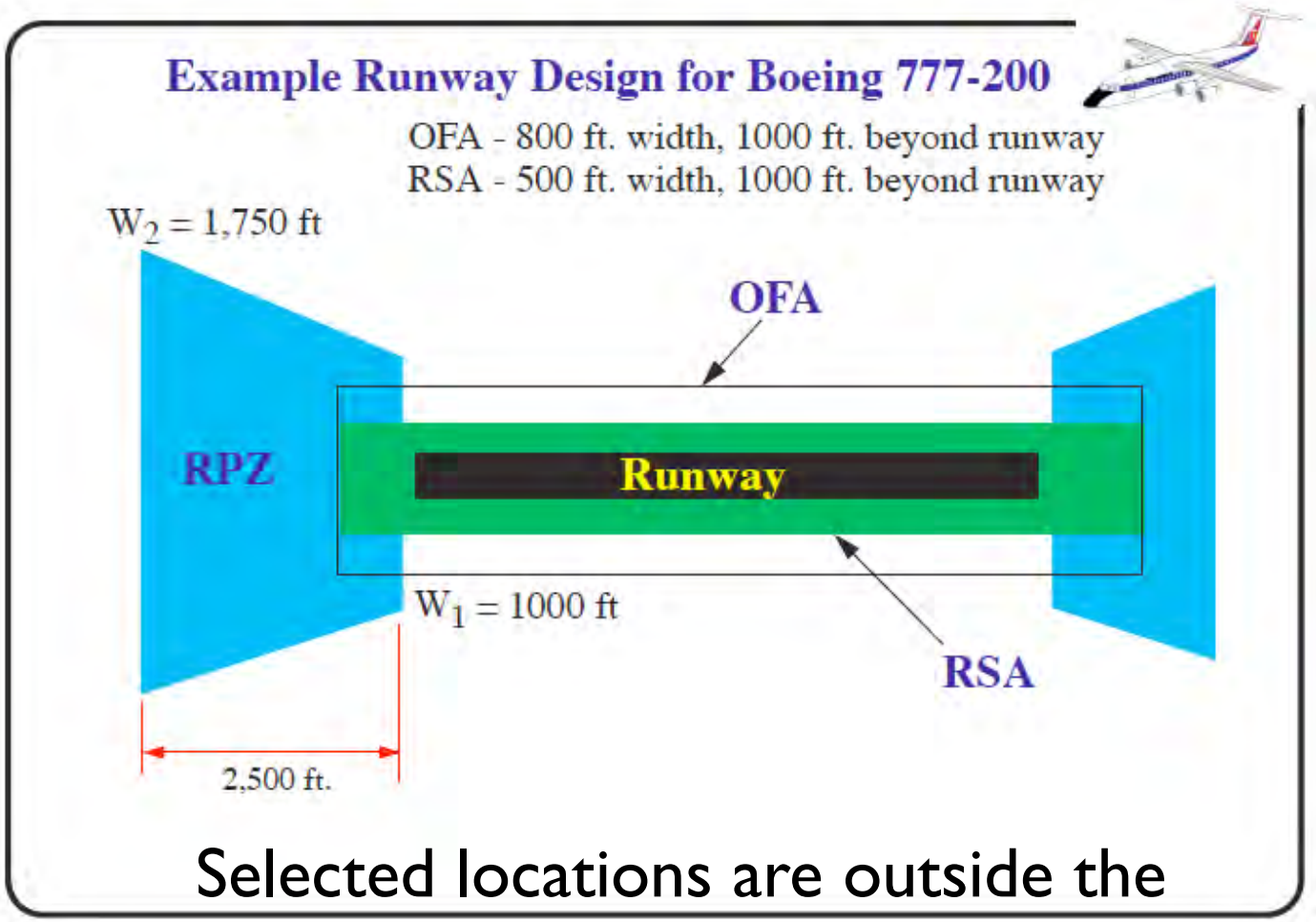


Noise Data Collection

- Noise measurements at 2 locations (called zones 1 and 2)
- Measurements near runways
  - Collect data near runways, taxiways Echo, Hotel and Alpha and also in the ramp areas.

Safety Considerations

- Airport runways are protected by several critical surfaces (see notes Aircraft Performance 2)



Selected locations are outside the runway safety areas : OFA, RSA and RPZ areas

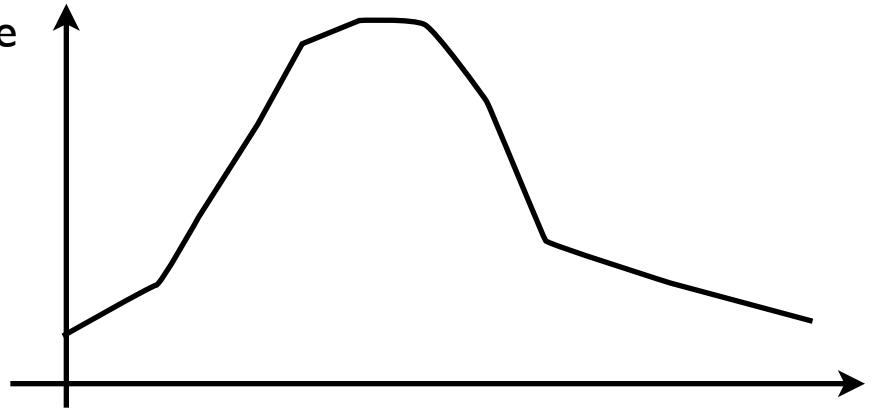
Measuring Single Flyover Events

Instruments can Record
SPL every Second

Sound Pressure
Level (dBA)

Integrate
Numerically
(Using Excel /
Matlab)

Sound Exposure
Level (SEL)



Measuring Single Flyover Events

$$L_E = 10log\left[\frac{1}{t_0}\int_{t_2}^{t_1} 10^{L(t)/10}\,dt\right]$$

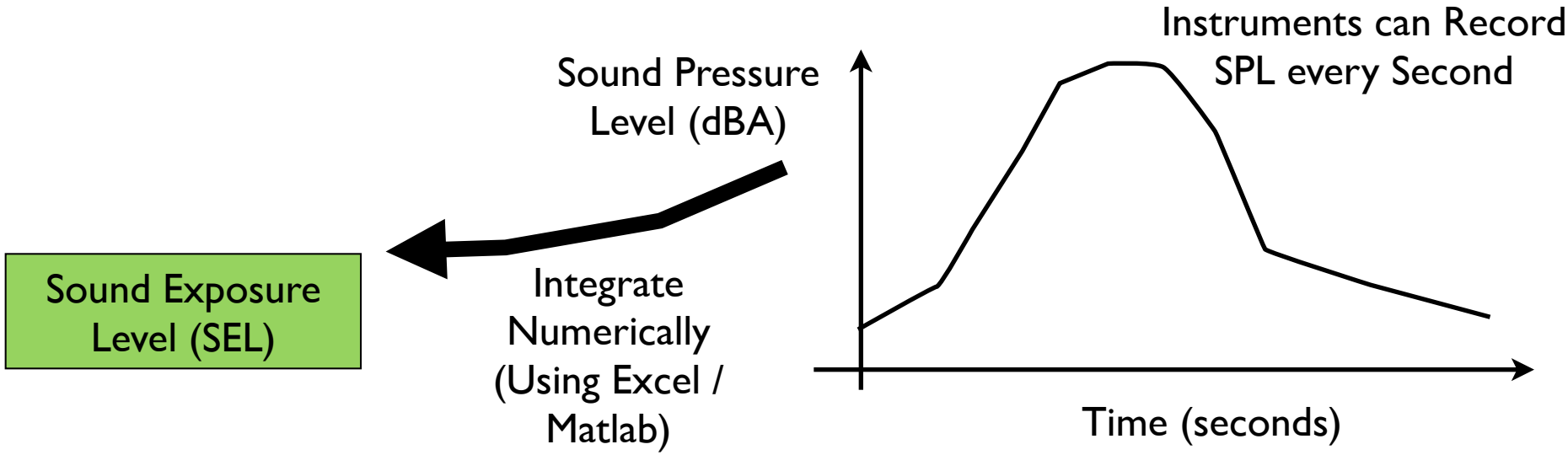
In Practice we use a summation to compute the value of L_E

L_E = Single event noise level (dbA)

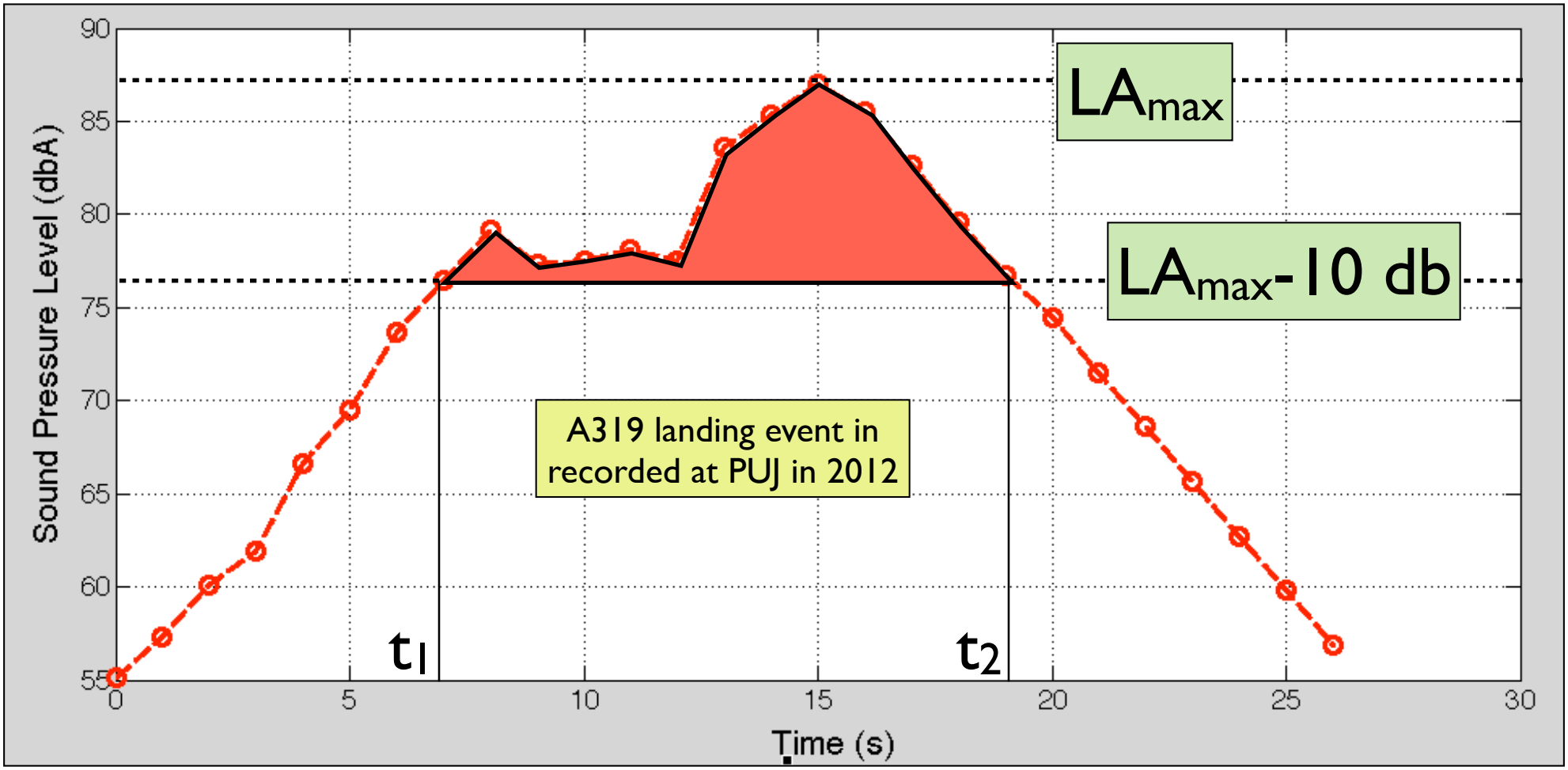
$L(t)$ = Instantaneous Sound Pressure Level recorded

t_0 = reference time

t_1, t_2 = times used to perform the numerical integration



Sample Single Flyover Event
Selection of Limits of Integration



Sound Exposure Level (SEL) calculation

Sample Single Flyover Event (Airbus A319 Landing at Punta Cana)

Highest Value of SPL recorded (known as LAmax) in Casela 240 instrument

Sound Exposure Level (SEL) Calculation using all values of SPL dbA recorded

Date	Time	LCA	SPL (LAI) dBA	Ignore LCI	Ignore SPL (LAI) dBC	Scale A Calculation 10^SPL/10
5/29/12	12:56:27	LAI	55.10	LCI	63.2	323,594
5/29/12	12:56:28	LAI	57.30	LCI	64.9	537,032
5/29/12	12:56:29	LAI	60.10	LCI	67.4	1,023,293
5/29/12	12:56:30	LAI	61.90	LCI	70.3	1,548,817
5/29/12	12:56:31	LAI	66.60	LCI	73.7	4,570,882
5/29/12	12:56:32	LAI	69.50	LCI	74.7	8,912,509
5/29/12	12:56:33	LAI	73.70	LCI	76.8	23,442,288
5/29/12	12:56:34	LAI	76.50	LCI	77.8	44,668,359
5/29/12	12:56:35	LAI	79.20	LCI	79.9	83,176,377
5/29/12	12:56:36	LAI	77.30	LCI	78.2	53,703,180
5/29/12	12:56:37	LAI	77.50	LCI	78.7	56,234,133
5/29/12	12:56:38	LAI	78.10	LCI	80	64,565,423
5/29/12	12:56:39	LAI	77.50	LCI	80.2	56,234,133
5/29/12	12:56:40	LAI	83.60	LCI	86.3	229,086,765
5/29/12	12:56:41	LAI	85.30	LCI	89	338,844,156
5/29/12	12:56:42	LAI	87.00	LCI	89.5	501,187,234
5/29/12	12:56:43	LAI	85.50	LCI	87.1	354,813,389
5/29/12	12:56:44	LAI	82.60	LCI	84.2	181,970,086
5/29/12	12:56:45	LAI	79.60	LCI	81.3	91,201,084
5/29/12	12:56:46	LAI	76.70	LCI	78.3	46,773,514
5/29/12	12:56:47	LAI	74.50	LCI	76.7	28,183,829
5/29/12	12:56:48	LAI	71.50	LCI	74.3	14,125,375
5/29/12	12:56:49	LAI	68.60	LCI	74	7,244,360
5/29/12	12:56:50	LAI	65.7	LCI	71.1	3,715,352
5/29/12	12:56:51	LAI	62.7	LCI	68.4	1,862,087
5/29/12	12:56:52	LAI	59.8	LCI	69.3	954,993
5/29/12	12:56:53	LAI	56.9	LCI	69.6	489,779
					sum of values	2,199,392,022
					SEL (dbA)	93.42

Sample Single Flyover Event (Airbus A319 Landing at Punta Cana)

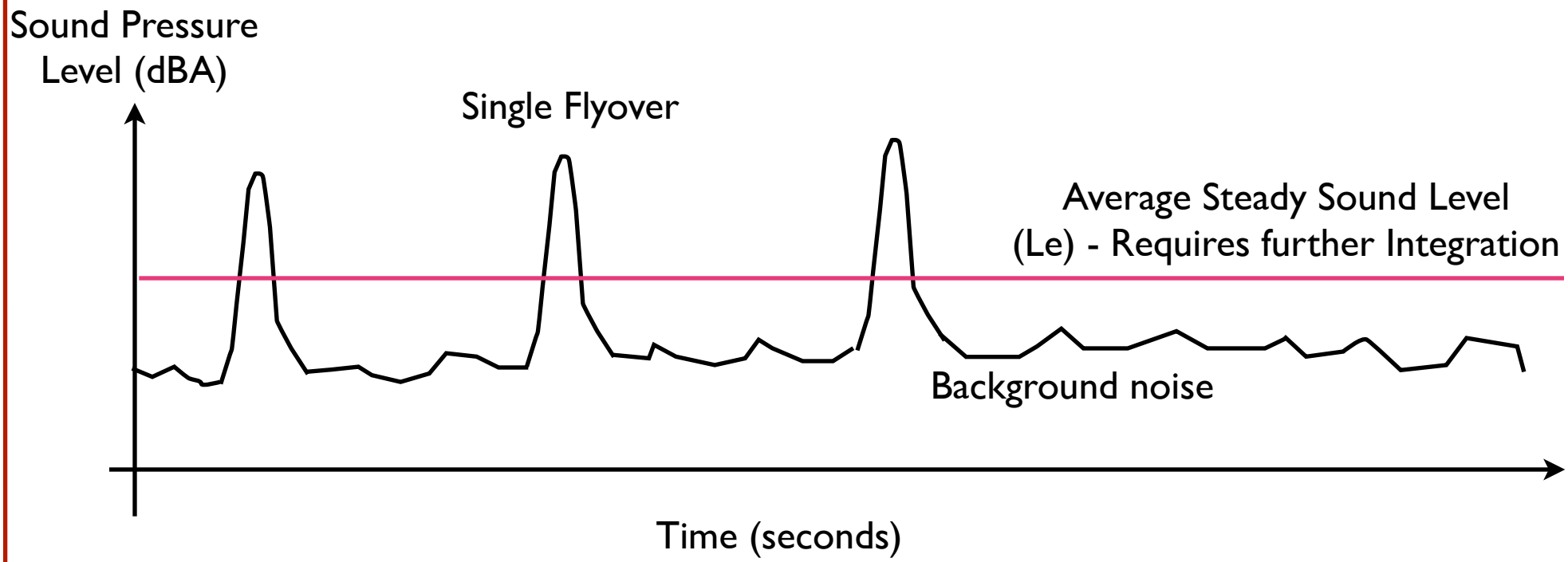
Highest Value of SPL recorded (known as LAmax) in Casela 240 instrument

Sound Exposure Level (SEL) Calculation using data from LAmax to LAmax -10 db

Date	Time	LCA	SPL (LAI) dBA	Ignore LCI	Ignore SPL (LAI) dBC	Scale A Calculation 10^SPL/10
5/29/12	12:56:27	LAI	55.10	LCI	63.2	-
5/29/12	12:56:28	LAI	57.30	LCI	64.9	-
5/29/12	12:56:29	LAI	60.10	LCI	67.4	-
5/29/12	12:56:30	LAI	61.90	LCI	70.3	-
5/29/12	12:56:31	LAI	66.60	LCI	73.7	-
5/29/12	12:56:32	LAI	69.50	LCI	74.7	-
5/29/12	12:56:33	LAI	73.70	LCI	76.8	-
5/29/12	12:56:34	LAI	76.50	LCI	77.8	44,668,359
5/29/12	12:56:35	LAI	79.20	LCI	79.9	83,176,377
5/29/12	12:56:36	LAI	77.30	LCI	78.2	53,703,180
5/29/12	12:56:37	LAI	77.50	LCI	78.7	56,234,133
5/29/12	12:56:38	LAI	78.10	LCI	80	64,565,423
5/29/12	12:56:39	LAI	77.50	LCI	80.2	56,234,133
5/29/12	12:56:40	LAI	83.60	LCI	86.3	229,086,765
5/29/12	12:56:41	LAI	85.30	LCI	89	338,844,156
5/29/12	12:56:42	LAI	87.00	LCI	89.5	501,187,234
5/29/12	12:56:43	LAI	85.50	LCI	87.1	354,813,389
5/29/12	12:56:44	LAI	82.60	LCI	84.2	181,970,086
5/29/12	12:56:45	LAI	79.60	LCI	81.3	91,201,084
5/29/12	12:56:46	LAI	76.70	LCI	78.3	46,773,514
5/29/12	12:56:47	LAI	74.50	LCI	76.7	-
5/29/12	12:56:48	LAI	71.50	LCI	74.3	-
5/29/12	12:56:49	LAI	68.60	LCI	74	-
5/29/12	12:56:50	LAI	65.7	LCI	71.1	-
5/29/12	12:56:51	LAI	62.7	LCI	68.4	-
5/29/12	12:56:52	LAI	59.8	LCI	69.3	-
5/29/12	12:56:53	LAI	56.9	LCI	69.6	-
					sum of values	2,102,457,832
					SEL (dbA)	93.23

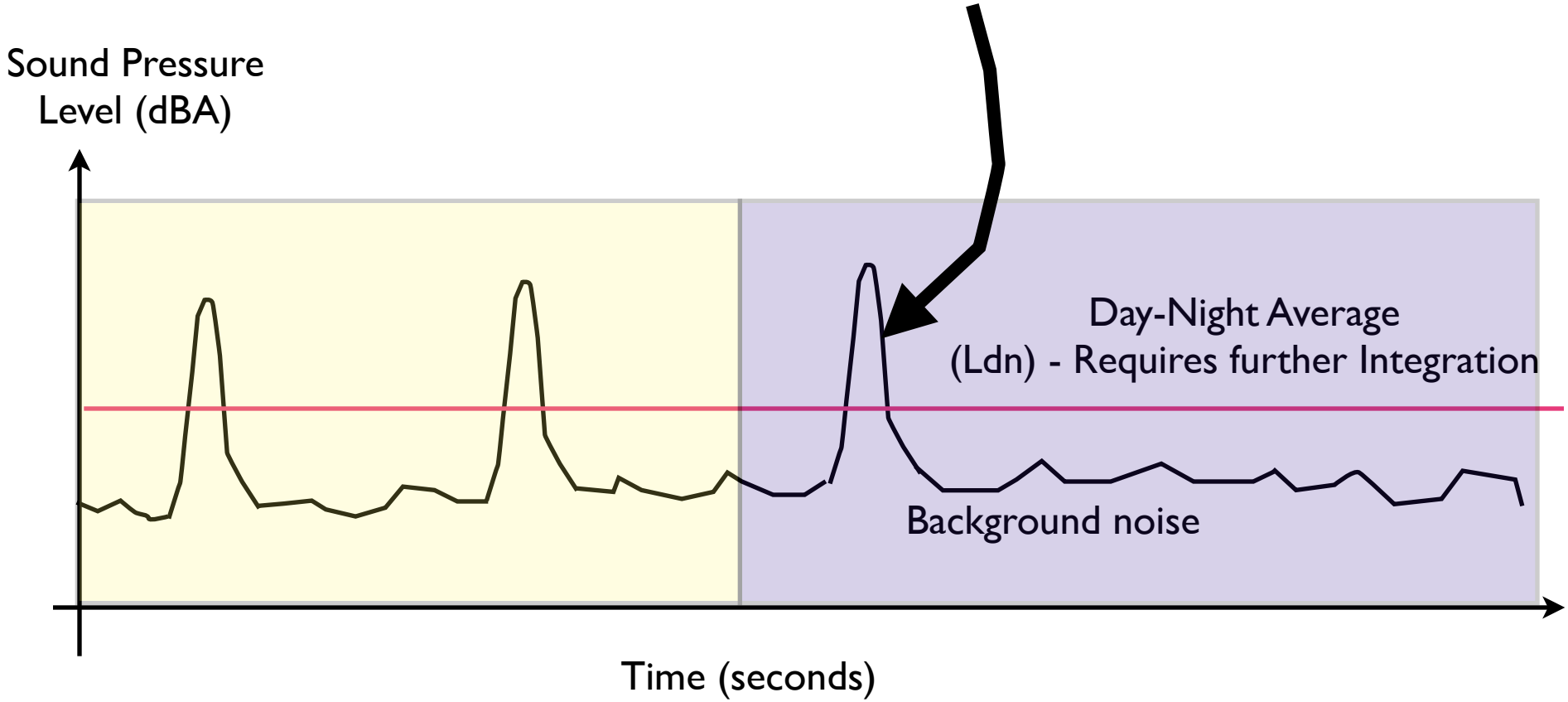
Need to Measure Background Noise

- When no aircraft operations is in place, we need to understand the background noise at the location where single flyovers are to be measured

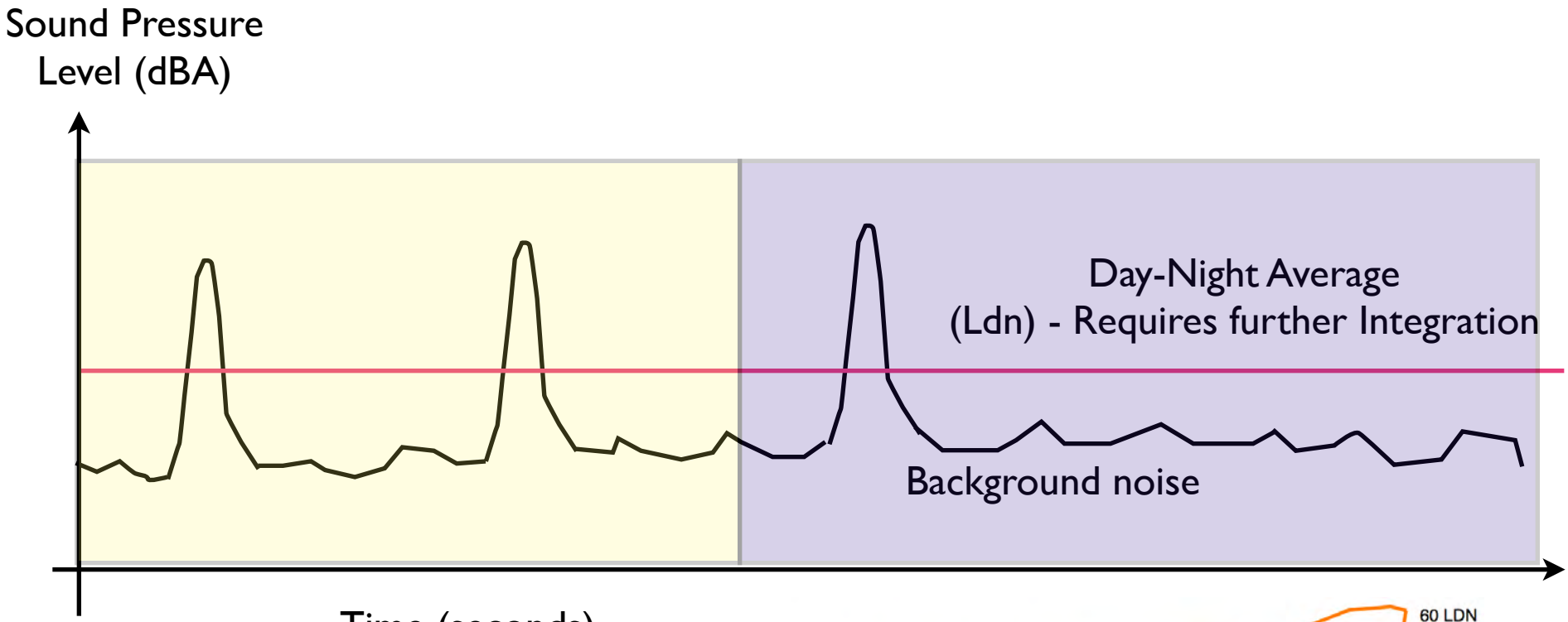


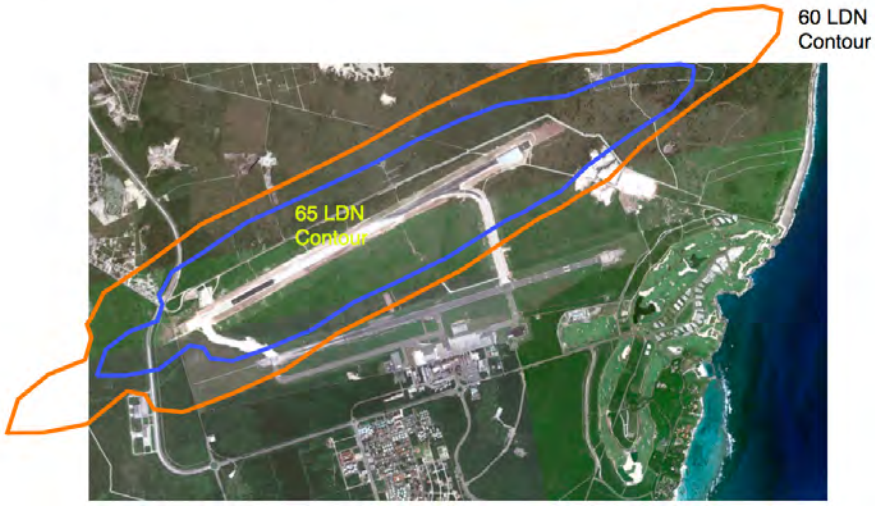
Day-Night Average Noise Metric (LDN)

- LDN or DNL is computationally similar to Le
- However, Ldn includes weighting nighttime operations (10 PM to 7 AM) by a factor of 10



Day-Night Average Noise Metric (LDN)





Explanations and Demos of Noise Meter Use

Casella CEL 240

Casella CEL-240 Noise Meter

- Two range scales (30-100 and 60-130 dBA)
- Scales A and C
- Slow, fast and impulse modes
- Data logging capabilities

Organization of the Groups

- Two group leaders:
  - Julio and me
  - Students will be assigned to 3 teams (2 teams collocated in zone 2)
  - Groups of 3 people per team
  - Each group will have one noise meter
  - Each group will also collect runway operational data

Security and Precautions

- Wear your safety vests at all times
- 3 noise meter (2 in zone 2 and one in zone 1)
- Julio y Toni Trani will communicate via cell phone
- Bring your water bottles
- Data collection between 1:30 and 7 PM
- Bring a poncho or an umbrella (if you have one)
- Hats and plenty of suncreen is recommended

Planned Departures (PUJ)
June 2, 2014 (1)

Destination	Flight	On-time Rating	Airline	Departure Sched	Departure Actual	Term Gate	Status	Equip
YUL Montreal	AC 1781		Air Canada	12:15 PM		T--	Scheduled	319
YUL Montreal	AC 1781^		Air Canada	12:15 PM		T--	Scheduled	319
CLT Charlotte	US 1963	★★★★★	US Airways	12:25 PM	12:25 PM ~		Scheduled On-time	319
CLT Charlotte	AA 1963^		American Airlines	12:25 PM	12:25 PM ~		Scheduled On-time	319
YUL Montreal	RV* 1781		Air Canada rouge	12:25 PM	12:25 PM ~		Scheduled On-time	
PHL Philadelphia	US 791	★★★★★	US Airways	12:35 PM	12:35 PM ~		Scheduled On-time	319
PHL Philadelphia	AA 791^		American Airlines	12:35 PM	12:35 PM ~		Scheduled On-time	319
PTY Panama City	CM 109	★★★★★	Copa Airlines	12:35 PM		4	Scheduled	738
BWI Baltimore	FL 812	★★★★★	AirTran	1:00 PM	1:00 PM ~	N/A	Scheduled On-time	73G
BWI Baltimore	WN 5812^	★★★★★	Southwest Airlines	1:00 PM	1:00 PM ~	N/A	Scheduled On-time	73G
EWR Newark	UA 1515	★★★★★	United Airlines	1:05 PM	1:15 PM ~		Scheduled On-time	753
MIA Miami	AA 2468	★★★★★	American Airlines	1:25 PM	1:25 PM ~	10	Scheduled On-time	738
MIA Miami	US 2468^		US Airways	1:25 PM	1:25 PM ~	10	Scheduled On-time	738
MIA Miami	IB 4529^	★★★★★	Iberia	1:25 PM	1:25 PM ~	10	Scheduled On-time	738
ATL Atlanta	DL 742	★★★★★	Delta Air Lines	1:26 PM	1:36 PM ~		Scheduled On-time	73H
JFK New York	B6 268	★★★★★	JetBlue Airways	1:29 PM	1:29 PM ~	T-A	Scheduled On-time	321
JFK New York	EK 6844^		Emirates	1:29 PM	1:29 PM ~	T-A	Scheduled On-time	321
PIT Pittsburgh	F9 25	★★★★★	Frontier Airlines	1:30 PM	1:30 PM ~	7	Scheduled On-time	320
FLL Fort Lauderdale	NK 784		Spirit Airlines	1:37 PM	1:37 PM ~		Scheduled On-time	319
SJU San Juan	BB 4564		Seaborne Airlines	1:45 PM	1:55 PM ~		Scheduled On-time	SF3

Planned Departures (PUJ)
June 2, 2014 (2)

JFK New York	DL 944	★★★★★	Delta Air Lines	2:14 PM	2:24 PM ~		Scheduled On-time	738
FLL Fort Lauderdale	B6 174		JetBlue Airways	2:25 PM	2:25 PM ~	T-A	Scheduled On-time	320
ORD Chicago	F9 41	★★★★★	Frontier Airlines	2:35 PM	2:35 PM ~	7	Scheduled On-time	320
MIA Miami	AA 1331	★★★★★	American Airlines	2:40 PM	2:40 PM ~	10	Scheduled On-time	738
MIA Miami	IB 4521^	★★★★★	Iberia	2:40 PM	2:40 PM ~	10	Scheduled On-time	738
MIA Miami	US 1331^		US Airways	2:40 PM	2:40 PM ~	10	Scheduled On-time	738
CLT Charlotte	US 1966	★★★★★	US Airways	2:50 PM	2:50 PM ~		Scheduled On-time	321
CLT Charlotte	AA 1966^		American Airlines	2:50 PM	2:50 PM ~		Scheduled On-time	321
MDW Chicago	FL 1999		AirTran	3:00 PM	3:00 PM ~	N/A	Scheduled On-time	73G
MDW Chicago	WN 6999^		Southwest Airlines	3:00 PM	3:00 PM ~	N/A	Scheduled On-time	73G
PHL Philadelphia	US 846	★★★★★	US Airways	3:00 PM	3:00 PM ~		Scheduled On-time	332
PHL Philadelphia	AA 846^		American Airlines	3:00 PM	3:00 PM ~		Scheduled On-time	332
ATL Atlanta	DL 542	★★★★★	Delta Air Lines	3:12 PM	3:22 PM ~		Scheduled On-time	M88
PTY Panama City	CM 151	★★★★★	Copa Airlines	3:21 PM			Scheduled	738
ATL Atlanta	FL 1239	★★★★★	AirTran	3:25 PM	3:25 PM ~	N/A	Scheduled On-time	73G
ATL Atlanta	WN 6239^	★★★★★	Southwest Airlines	3:25 PM	3:25 PM ~	N/A	Scheduled On-time	73G
SJU San Juan	B6 32	★★★★★	JetBlue Airways	3:44 PM	3:54 PM ~		Scheduled On-time	320
CLT Charlotte	US 1968	★★★★★	US Airways	4:45 PM	4:45 PM ~		Scheduled On-time	321
CLT Charlotte	AA 1968^		American Airlines	4:45 PM	4:45 PM ~		Scheduled On-time	321
BOG Bogota	P5 551		Copa Airlines Colombia	5:05 PM	5:15 PM ~		Scheduled On-time	E90
BOG Bogota	CM 551^		Copa Airlines	5:05 PM	5:15 PM ~		Scheduled On-time	E90

Planned Departures (PUJ)
June 2, 2014 (3)

SDQ Santo Domingo	AF 741	★★★★★	Air France	5:10 PM			Scheduled	77W
SDQ Santo Domingo	KL 2235^	★★★★★	KLM	5:10 PM			Scheduled	77W
LIM Lima	LP 2595	★★★★★	Lan Peru	5:20 PM		T-1 2	Scheduled	320
LIM Lima	LA 2595^	★★★★★	LAN Airlines	5:20 PM		T-1 2	Scheduled	320
PTY Panama City	CM 351	★★★★★	Copa Airlines	6:01 PM			Scheduled	738
JFK New York	B6 368	★★★★★	JetBlue Airways	6:15 PM	6:25 PM ~		Scheduled ● On-time	320
BOG Bogota	AV 253	★★★★★	AVIANCA	6:49 PM	6:59 PM ~		Scheduled ● On-time	320
CCS Caracas	G3 7625		Gol	8:05 PM			Scheduled	738
MAD Madrid	EB 1108		Pullmantur Air	9:20 PM			Scheduled	744
FRA Frankfurt	DE 1233	★★★★★	Condor	9:50 PM			Scheduled	767

Planned Arrivals (PUJ)
June 2, 2014 (1)

Origin	Flight	On-time Rating	Airline	Arrival Sched	Arrival Actual	Term Gate	Status	Equip
BWI Baltimore	FL 811		AirTran	12:10 PM	12:10 PM ~	N/A	Scheduled On-time	73G
BWI Baltimore	WN 5811^		Southwest Airlines	12:10 PM	12:10 PM ~	N/A	Scheduled On-time	73G
MIA Miami	AA 2468		American Airlines	12:20 PM	12:20 PM ~	1	Scheduled On-time	738
MIA Miami	US 2468^		US Airways	12:20 PM	12:20 PM ~	1	Scheduled On-time	738
JFK New York	B6 869		JetBlue Airways	12:22 PM	12:22 PM ~	T-A	Scheduled On-time	321
JFK New York	DL 489		Delta Air Lines	12:26 PM	11:35 AM ~		Scheduled On-time	73H
ORD Chicago	F9 40		Frontier Airlines	12:34 PM	12:34 PM ~		Scheduled On-time	320
FLL Fort Lauderdale	NK 783		Spirit Airlines	12:52 PM	12:28 PM ~		Scheduled On-time	319
SJU San Juan	BB 4545		Seaborne Airlines	1:00 PM	12:47 PM ~		Scheduled On-time	SF3
PTY Panama City	CM 150		Copa Airlines	1:01 PM			Scheduled	738
ATL Atlanta	DL 543		Delta Air Lines	1:14 PM	12:45 PM ~		Scheduled On-time	738
FLL Fort Lauderdale	B6 173		JetBlue Airways	1:29 PM	1:29 PM ~	T-A	Scheduled On-time	320
MIA Miami	AA 1331		American Airlines	1:35 PM	1:35 PM ~	1	Scheduled On-time	738
MIA Miami	US 1331^		US Airways	1:35 PM	1:35 PM ~	1	Scheduled On-time	738
CLT Charlotte	US 1965		US Airways	1:36 PM	1:36 PM ~		Scheduled On-time	321
CLT Charlotte	AA 1965^		American Airlines	1:36 PM	1:36 PM ~		Scheduled On-time	321

Planned Arrivals (PUJ)
June 2, 2014 (1)

PIT Pittsburgh	F9 24	★★☆☆☆	Frontier Airlines	1:40 PM	1:40 PM ~		Scheduled On-time	320
PHL Philadelphia	US 845	☆☆☆☆☆	US Airways	1:58 PM	1:58 PM ~		Scheduled On-time	332
PHL Philadelphia	AA 845^		American Airlines	1:58 PM	1:58 PM ~		Scheduled On-time	332
BOG Bogota	P5 550		Copa Airlines Colombia	2:07 PM	1:41 PM ~		Scheduled On-time	E90
BOG Bogota	CM 550^		Copa Airlines	2:07 PM	1:41 PM ~		Scheduled On-time	E90
MDW Chicago	FL 1234	★☆☆☆☆	AirTran	2:10 PM	2:10 PM ~	N/A	Scheduled On-time	73G
MDW Chicago	WN 6234^	★☆☆☆☆	Southwest Airlines	2:10 PM	2:10 PM ~	N/A	Scheduled On-time	73G
ATL Atlanta	DL 743	★☆☆☆☆	Delta Air Lines	2:22 PM	2:01 PM ~		Scheduled On-time	M88
ATL Atlanta	FL 1238	★☆☆☆☆	AirTran	2:35 PM	2:35 PM ~	N/A	Scheduled On-time	73G
ATL Atlanta	WN 6238^	★☆☆☆☆	Southwest Airlines	2:35 PM	2:35 PM ~	N/A	Scheduled On-time	73G
SJU San Juan	B6 31	★★☆☆☆	JetBlue Airways	2:48 PM	2:29 PM ~		Scheduled On-time	320
LIM Lima	LP 2594	★★★★★	Lan Peru	2:50 PM			Scheduled On-time	320
LIM Lima	LA 2594^	★★★★★	LAN Airlines	2:50 PM			Scheduled On-time	320
CLT Charlotte	US 1967	★★☆☆☆	US Airways	3:31 PM	3:31 PM ~		Scheduled On-time	321
CLT Charlotte	AA 1967^		American Airlines	3:31 PM	3:31 PM ~		Scheduled On-time	321
PTY Panama City	CM 352	★★★☆☆	Copa Airlines	3:34 PM			Scheduled	738
CDG Paris	AF 741	★☆☆☆☆	Air France	3:35 PM	3:00 PM ~		Scheduled On-time	77W

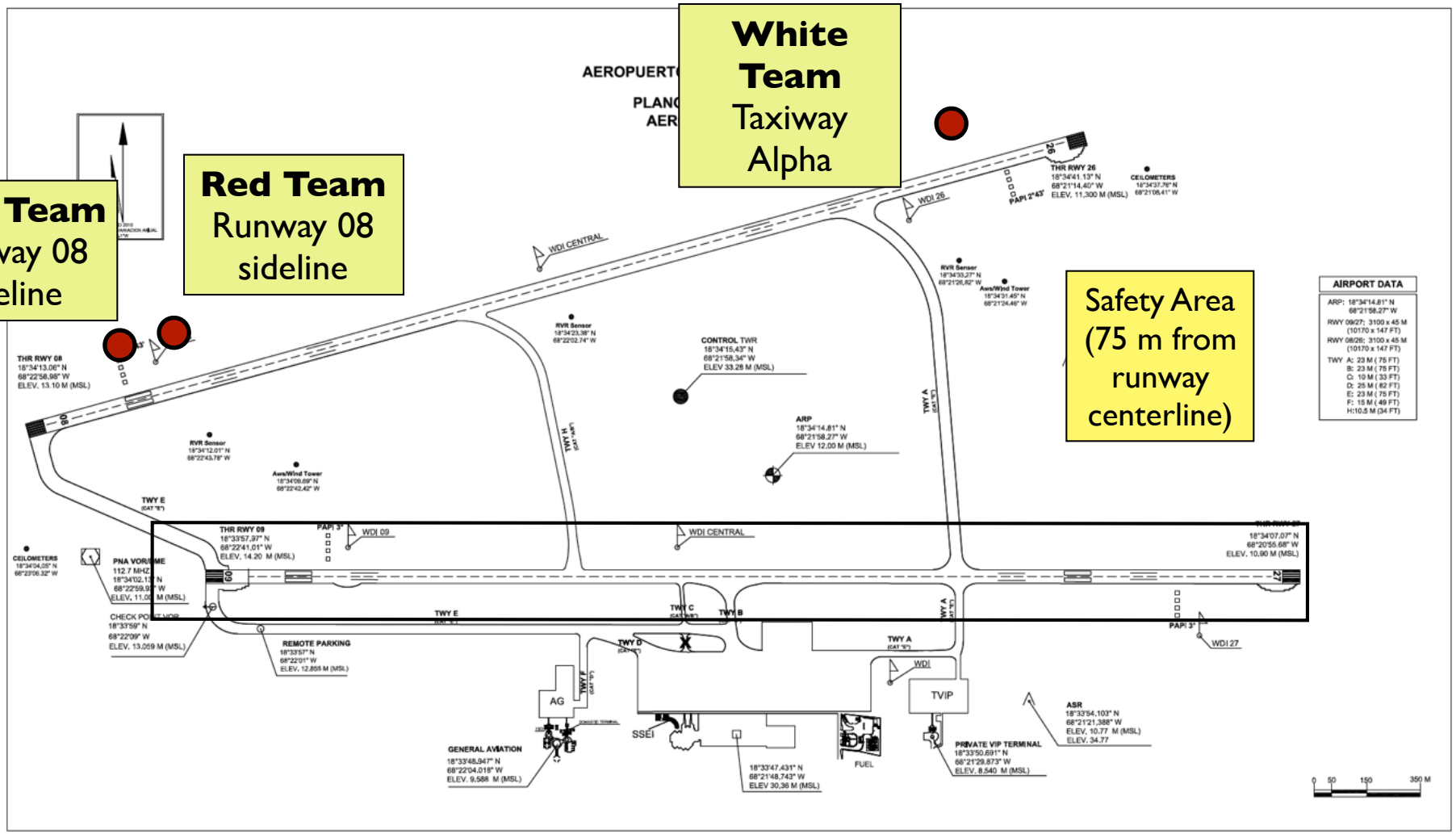
Logistics

- Plan on leaving the Foundation by 12:30 PM after lunch
- We have to go through security at the airport (20 minutes at least)
- Each team will probably be taken independently to your location
- We will be at your stations from 1:15 to 7:00 PM
- We need water so bring your bottles full
- Bring a poncho or an umbrella (if you have one)
- Hats and plenty of suncreen is recommended

All Teams

- Casella 240 equipment
- One person handles the computer
- One person records information by hand (old fashion with the shortest time interval possible)
- One person records the type of aircraft and the time of the operations (describe the aircraft/airline or take a picture with a smart phone - could also record video if the smart phone has such capability)
- One person records Arrival and Departure ROT if you have a clear shot of the operations (Red and Blue teams only)

Airport Diagram
Locations for Data Collection

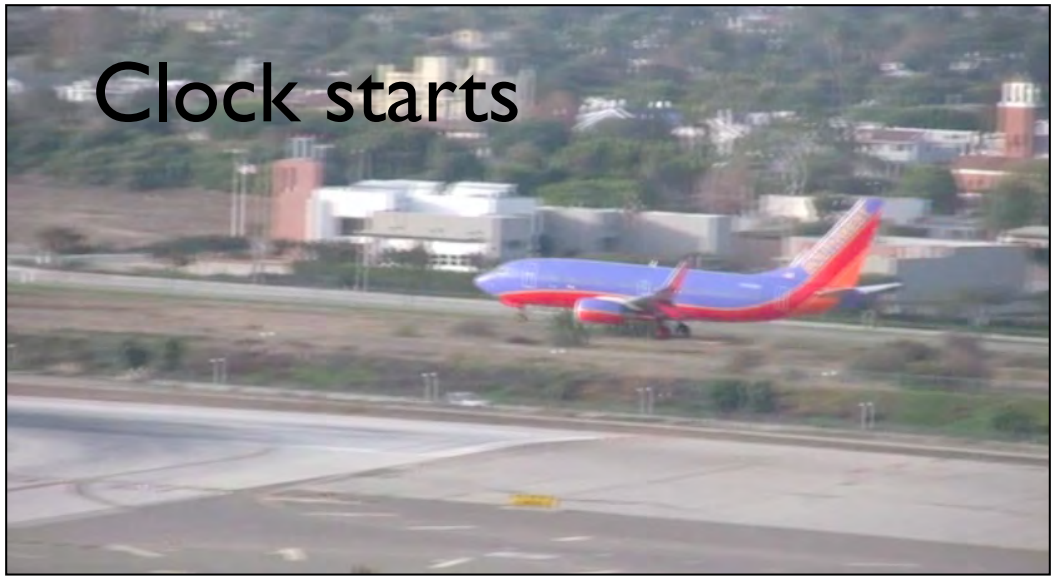


- Noise measurement points

Definitions

- Arrival Runway Occupancy Time (A-ROT)
  - The time elapsed between an aircraft crossing the runway threshold and the time when the same aircraft crosses the imaginary plane of a runway exit paved area
- Departure Runway Occupancy Time (D-ROT)
  - Time from initial acceleration on runway until clearing the opposite end of the runway
- Inter-Arrival Time (IAT)
  - The time elapsed between two successive arrivals to the same runway threshold
  - Can be easily obtained if arrival times are known

Runway Occupancy Time



Line Up and Wait Time