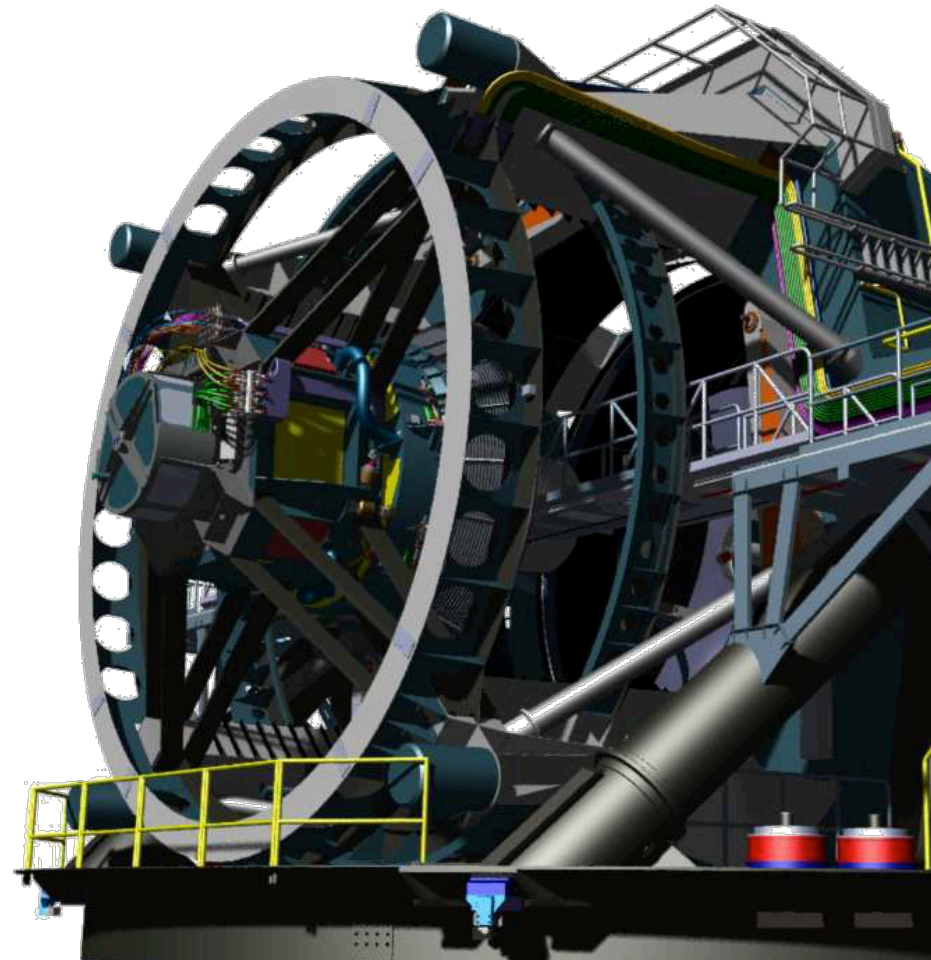# Effects of commercial airline traffic on LSST observing efficiency

Rose Gibson

Advisor: Chuck Claver

Large Synoptic Survey Telescope (LSST)

- 8.4-m mirror
- 3200 Megapixel camera
- 9.6 deg^2 FOV (visit ~39s)
- 30 terabytes/night
- Covers wavelength range 320-1050 nm (*ugrizy*)
- Operational by 2020

# Large Synoptic Survey Telescope (LSST)

Four science themes:

- Dark energy & dark matter
- Inventory of Solar System
- Exploring transient optical sky
- Mapping the Milky Way

90% of observing time will be deep-wide-fast survey mode

- Algorithms of observing importance determine telescope position

18,000 deg^2 region observed 800 times (over all six bands) during anticipated 10 years of operations
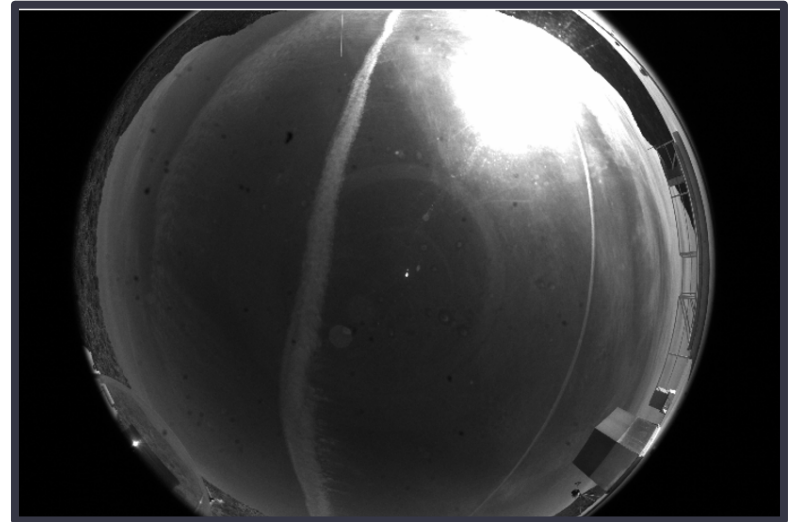
lucy_1002: night20
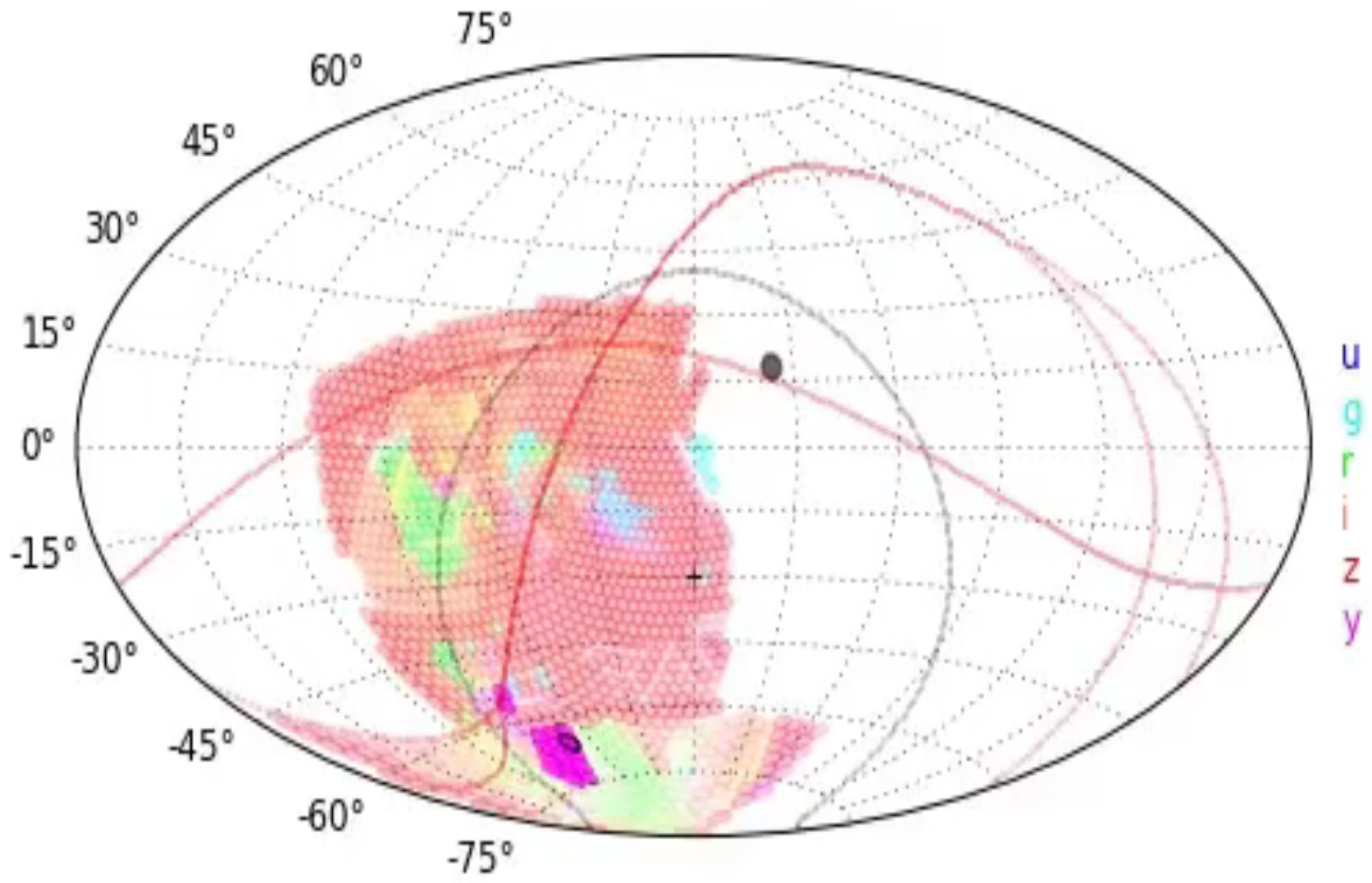
Commercial Airline Traffic & LSST

Issue 1: Direct impact of aircraft within FOV

- Plane lights would blow out entire image

Issue 2: Secondary impact of contrails

- Artificial clouds behind aircraft
- Form at high altitudes (+8,000m) and low temp (-36.5°C) and depends on humidity
- Persist for a few minutes to an hour, can morph into cirrus clouds

Commercial Airline Traffic & LSST

Approach/Strategy

- ✈ Commercial aircraft send out Automatic Dependent Surveillance-Broadcast (ADS-B)
- ✈ Receive transmissions with Software Defined Radio (SDR)
- ✈ Translate signals into useable data with dump1090
- ✈ Read out signals in Basestation/SBS-1 format

Basestation Format

Properties
- ✈ 8 message types, 22 data slots

What we use
- ✈ Hex ID, call sign, date and time message logged, altitude, latitude and longitude

	1	2	3	4	5	6	7	8	9	10
MSG 1	MT	TT	SID	AID	Hex	FID	DMG	TMG	DML	TML
MSG 2										
MSG 3										
MSG 4										
MSG 5										
MSG 6										
MSG 7										
MSG 8										

11	12	13	14	15	16	17	18	19	20	21	22
CS											
	Alt	GS	Trk	Lat	Lng						Gnd
	Alt			Lat	LNG			Alt	Emer	SPI	Gnd
		GS	Trk			VR					
	Alt							Alt		SPI	Gnd
	Alt						Sq	Alt	Emer	SPI	Gnd
	Alt										Gnd
											Gnd

Hex ID

Call sign

```
MSG,1,111,11111,E8043C,111111,2015/07/24,18:18:32.986,2015/07/24,18:18:32.975,LAN134  ,,,,,,,,,,,0
MSG,3,111,11111,E8043C,111111,2015/07/24,18:18:33.391,2015/07/24,18:18:33.369,,38000,,,-30.20323,-71.11620,,,,,,0
MSG,3,111,11111,E80416,111111,2015/07/24,18:18:33.478,2015/07/24,18:18:33.435,,35000,,,-29.83524,-71.81095,,,,,,0
```

Time message logged   *Lat & Lon*
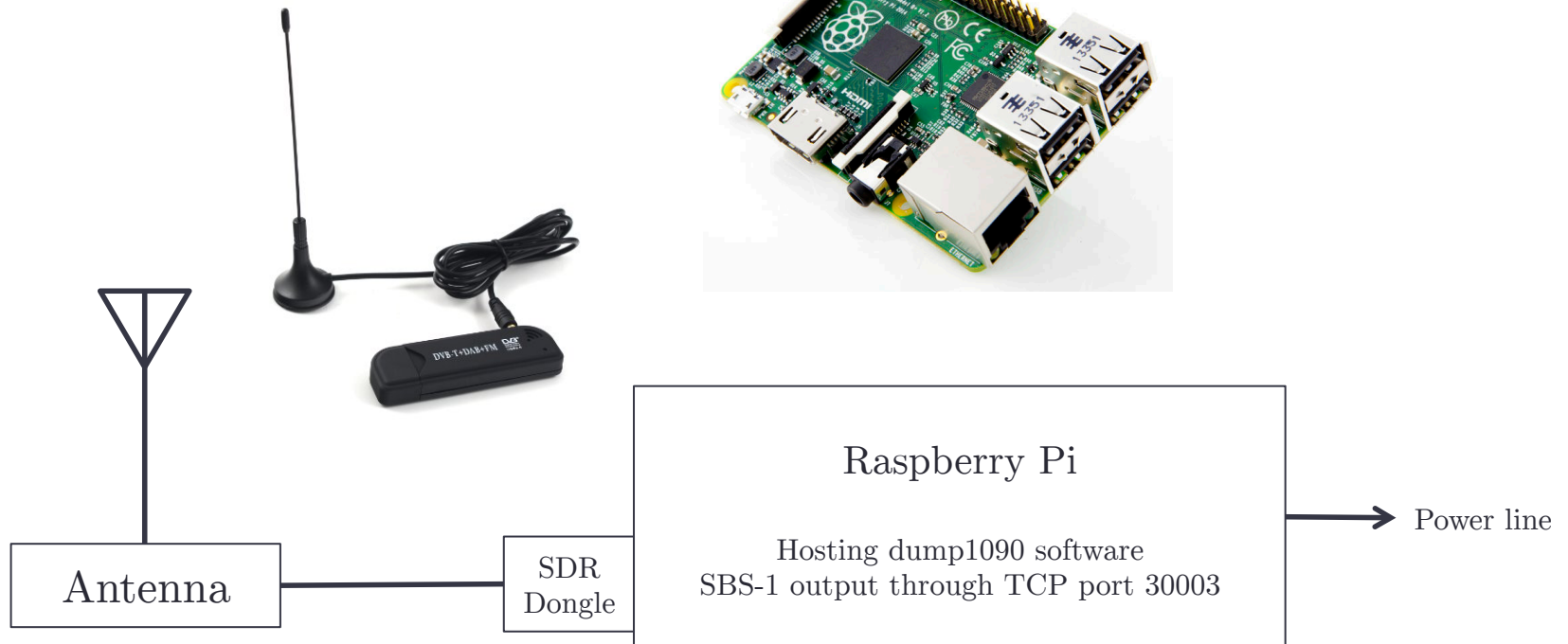
Hardware

System 1: Tucson

✈ Raspberry Pi & prototyping hardware/software

		Raspberry Pi
	SDR	Hosting dump1090 software
Antenna	Dongle	SBS-1 output through TCP port 30003

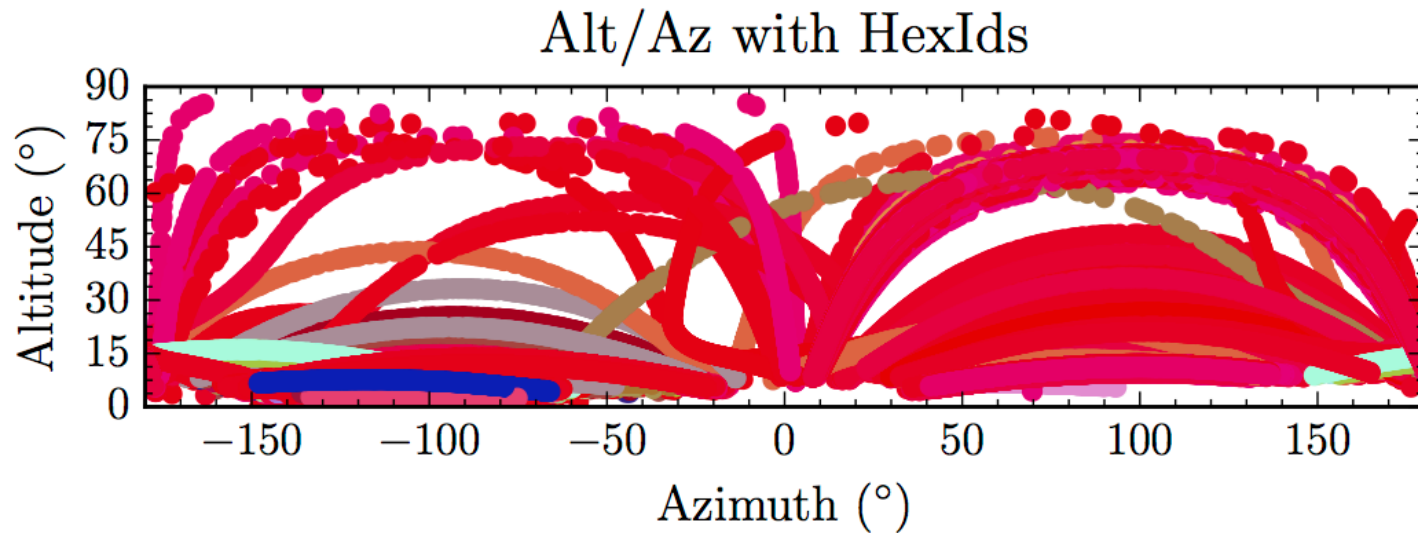Power line

Hardware

System 2: Cerro Pachón

✈ Mac Mini & data collection

Antenna — Pre-amplifier — Power adapter → 12V

BNC Cable to Inline & 1090MHz filter

Mac Mini

Hosting dump1090 software
SBS-1 output through TCP port 30003

SDR Dongle
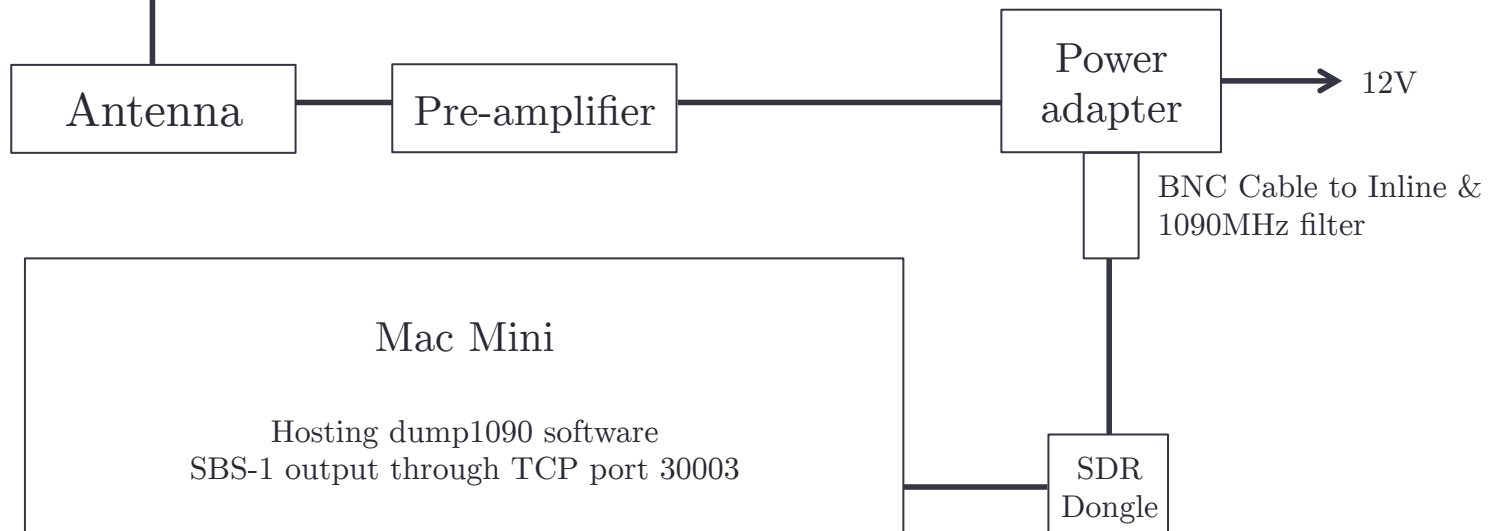
Coordinate Transformation
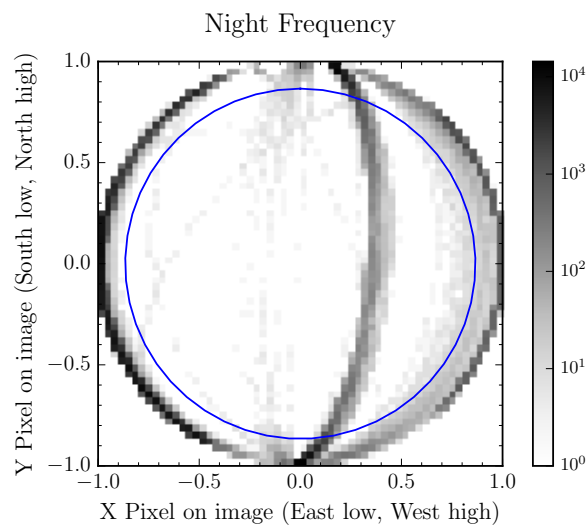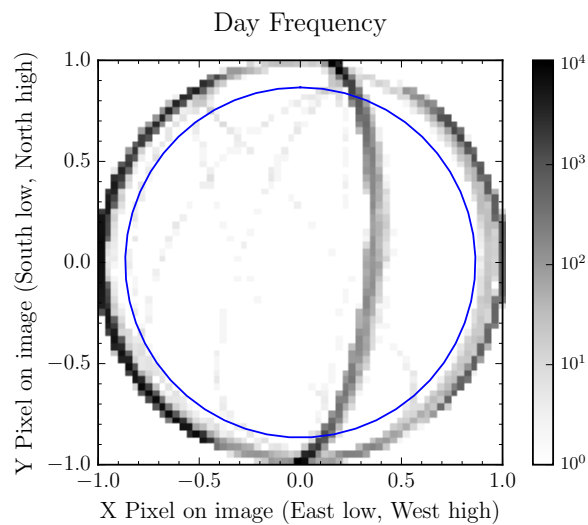
Turning raw data into useful information
- ✈ Geographic ➜ Horizontal (Celestial) ➜ All Sky Camera

Geographic Coords 2D

Local Horizon 2D
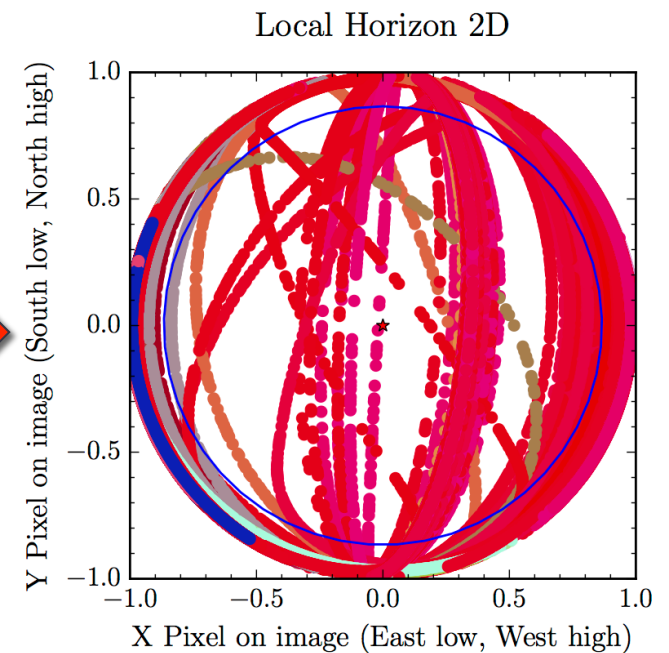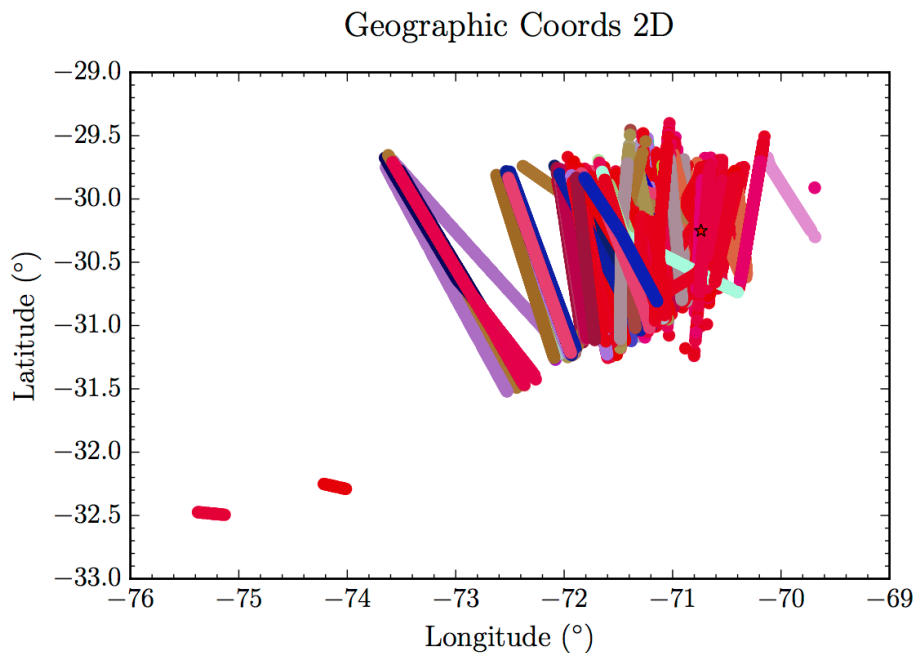
Calculated Altitude & Azimuth

Alt/Az with HexIds

2D Histogram of Total Received Signals (Alt/Az)
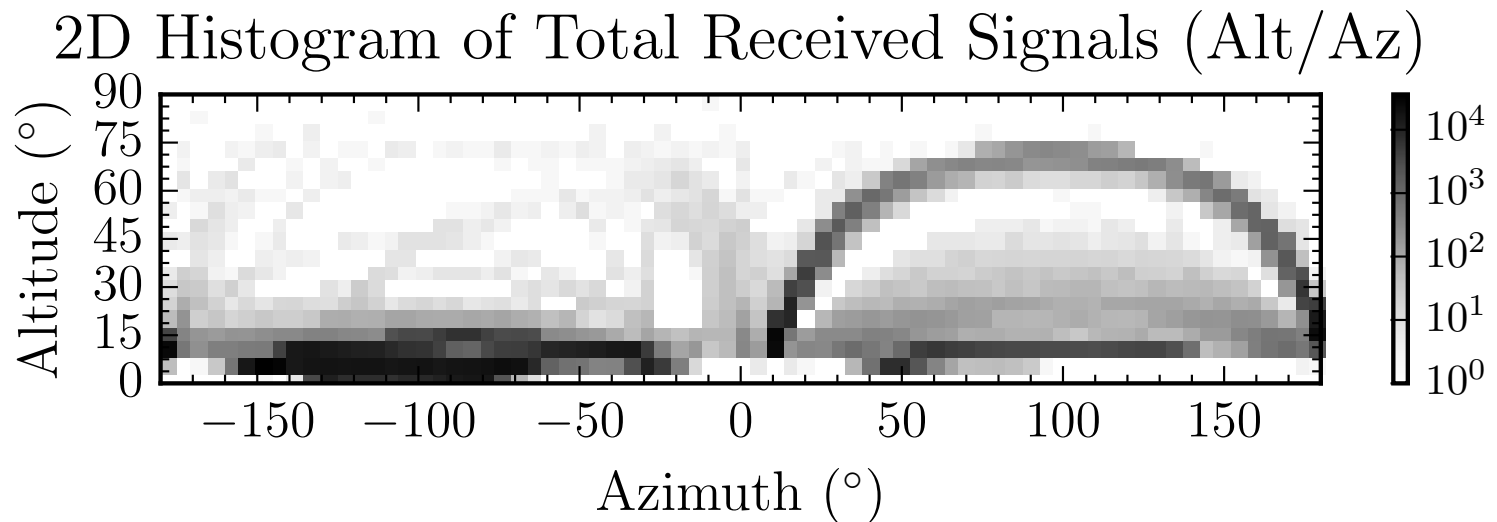
Flight paths on All Sky Camera
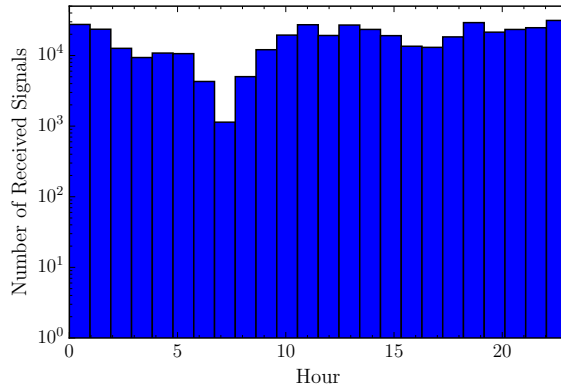

Day Frequency

Night Frequency
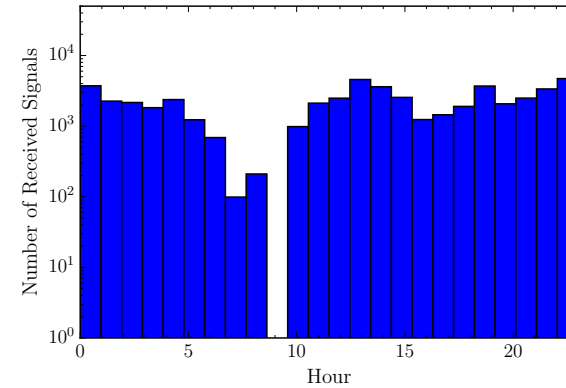
Plane signal overlay 31/07/15
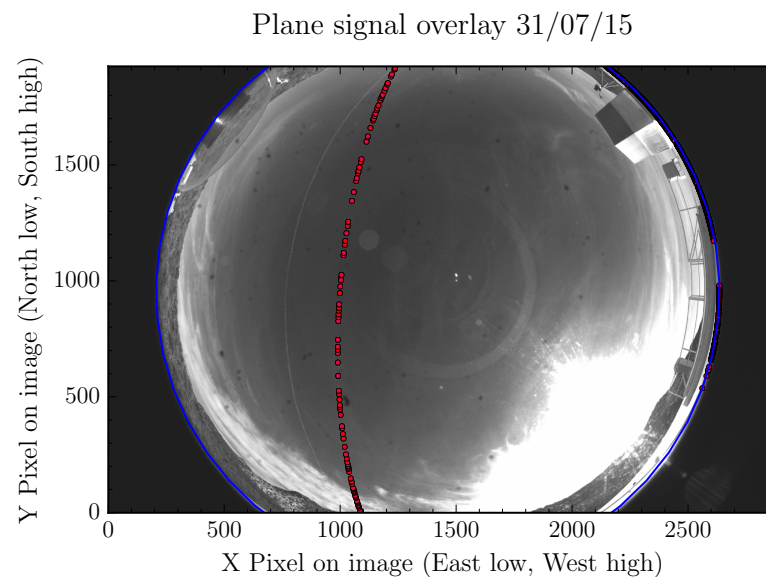
Altitude & time of day
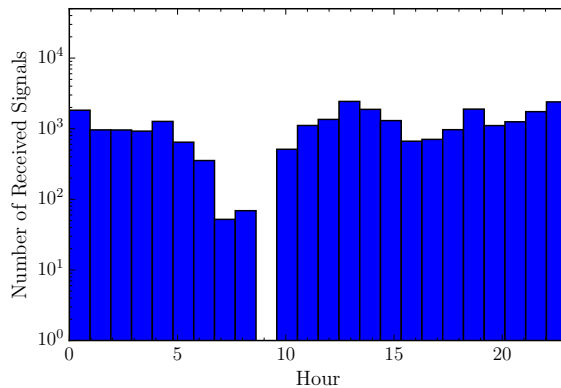

Planes Above 10°

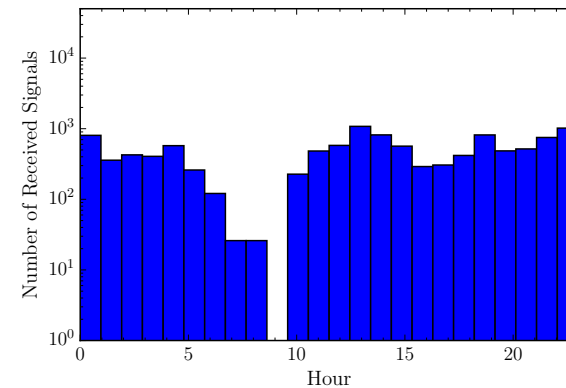Busiest times: hour 23, 19

Planes Above 30°

Busiest time: hour 23, 13

Planes Above 45°

Busiest time: hour 13, 23

Planes Above 60°

Busiest time: hour 13, 23

Conclusions

Successfully set up ground station on Cerro Pachón

Now know most travelled area in the sky
- North to South path towards Santiago

Direct aircraft interference is *not* an issue
- During busiest time of day, frequency is low

A few steps closer to knowing how aircraft will interfere with LSST observations.

Continuing Work

Compare results to LSST simulations

✈ Confirm low probability planes will pass over field of view

Contrail formation, persistence, and evolution near Cerro Pachón