Report on Airplane Sightings, May - October, 1997

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Introduction

Following our initial expression of concern[1], a series of naked-eye observations has been done, aiming to independently quantify the amount of night-time air-plane traffic near Paranal.

It is recalled that aviation is one of several anthropogenic effects, which may have a malign influence on observing conditions. The effect is mainly caused by jet exhaust, in situations when condensations trails (contrails) are formed, but also the thermal instability contained in the exhaust plume, as well as the emitted gases and particles, may have negative effects on seeing, photometry, and spectroscopy.

While the physics of contrail formation is a well studied subject, for reason of its climathological effects, all or almost all published observations refer to day-time, and little is known about contrails at night-time.

Observations

The acquired data state the moment of maximum elevation, the direction of flight (towards North or South), and the approximate maximum elevation in degrees (over the Western or Eastern horizon).

No records were made of con-trails, as the mere naked-eye observation is not reliable at night-time, in particular for airplanes at low elevation. Neither was any attempt made to distinguish between jet- or propeller driven airplanes, nor to estimate the flight altitude. Some sightings can undoubtedly be identified with individual aircraft, using publicly available information; however, no such attempt has been made.

For the period May 25 to July 22, 1997, the sightings were made during the regular operation of the DIMM seeing monitor. From July 23 onwards, recordings were done in a systematic way, so as to achieve uniform coverage through the night. To minimize strain on the observer, the data collection was limited to one hour per night; this interval was shifted by one hour for each clear and moon-less night. In that way, the equivalent of six (almost) entire nights has been composed. Figures 1 show the totality of sightings and Figure 2, the sub-set of systematic observations. The elevations have been

[1] http://www.eso.org/gen-fac/pubs/astclim/contrails/

randomized within a 2^o window, to minimize overlap.

Analysis

Table 1 gives the hourly rates for the six full nights. The average number of sightings was about 2, until local midnight, and one or less, during the rest of the night. As revealed by Table 2, some 80% of the planes passed West of Paranal, i.e. in the direction where the malign influence to astronomy is potentially largest. The Western sightings probably arise from traffic in Upper Air Routes UL 300 and UW 200.

The median (maximum) elevation is 20^o, for airplanes passing West of Paranal, and likewise 20^o for those passing to the East. These values were determined for the full set of sightings (which should not be biased towards any particular range of elevations).

For an annual mean wind speed of 30 m/s, the typical 20^o elevation implies that the aircraft exhaust will be about 10 minutes old, when it passes through zenith, at Paranal.[2]

Discussion and Conclusion

While a final conclusion regarding the influence of aviation on observing conditions at Paranal is still premature, some provisional conclusions can be made:

1. Each night, some 10 - 18 aircraft pass in the vicinity of Paranal, mostly West of the observatory. Their typical maximum elevation is 20^o. Occasionally, a plane passes almost overhead.

2. If most aircraft are jets flying at their normal cruising altitude, the exhaust plumes will be typically 10 minutes old, when sweeping over Paranal.

3. While temperature gradients and turbulence within the plumes will have vanished at this typical age, contrails may well persist, depending of meteorological conditions.

[2] At the 200 mb level, above Paranal, the monthly average wind speed ranges from 20 m/s during summer, to 40 m/s, during winter, ref. http://www.eso.org/gen-fac/pubs/astclim/

It is recommended that the monitoring continues until one full year of observations has been compiled. Means should be found to quantitatively describe the occurrence of contrails at night. These can be low-light level photographic, intensified video, or CCD imaging[3], to name the most obvious. LIDAR observations[4] are also possible, but may not have sufficient time-resolution.

Acknowledgment

The aircraft sightings were made by Srs. Carlos Aguirre N. and Francisco Gomez Compiano. Their assistance with this rather mundane undertaking is gratefully acknowledged.

[3]For use in connection with laser guide stars, a CCD-based aircraft detector has already been developed elsewhere, ref. http://aquarius.as.arizona.edu:8080/satell.html

[4]ref. http://lidardev.larc.nasa.gov/Vortex.html

TABLE 1: Hourly rates

1997 UTC	July 23 -Aug 03	Aug 18 -Aug 31	Sept 01 -Sept 12	Sept 15 -Oct 01	Oct 02 -Oct 12	Oct 14 -Oct 25	Total sight's	Total hours	Average sight's^{-h}
23-00	1	3	-	-	0	4	8	4	2.0
00-01	4	1	2	0	2	3	12	6	2.0
01-02	4	2	-	3	1	4	14	5	2.8
02-03	2	3	4	2	1	0	12	6	2.0
03-04	1	0	1	2	0	1	5	6	0.8
04-05	1	1	0	0	1	0	3	6	0.5
05-06	1	1	1	1	2	1	7	6	1.2
06-07	1	2	0	0	0	1	4	6	0.7
07-08	2	0	2	-	0	1	5	5	1.0
08-09	1	0	1	1	-	0	3	5	0.6
09-10	0	0	0	1	-	0	1	5	0.2
sight's	18	13	11	10	7	15	74		
hours	11	11	9	9	9	11		60	
sight's^{-h}	1.6	1.2	1.2	1.1	0.8	1.4			1.2

TABLE 2: Summary

	All observations		Full nights	
	West	East	West	East
Flying North	98	1	40	1
Flying South	42	36	20	13
Total	140	37	60	14
Total	79%	21%	80%	20%
Median maximum elevation	20^o	20^o		

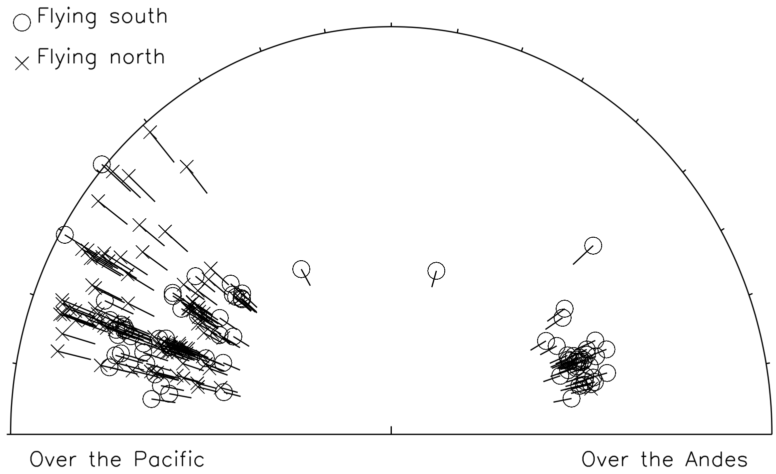

Figure 1: Airplanes passing near Paranal. All observations between May 25 until October 25, 1997. The sightings are plotted with radius incrementing during the night: 0^h UT at radius 0.5 and 10^h UT at the perimeter. The observed elevation has been randomized within a 2^o window.

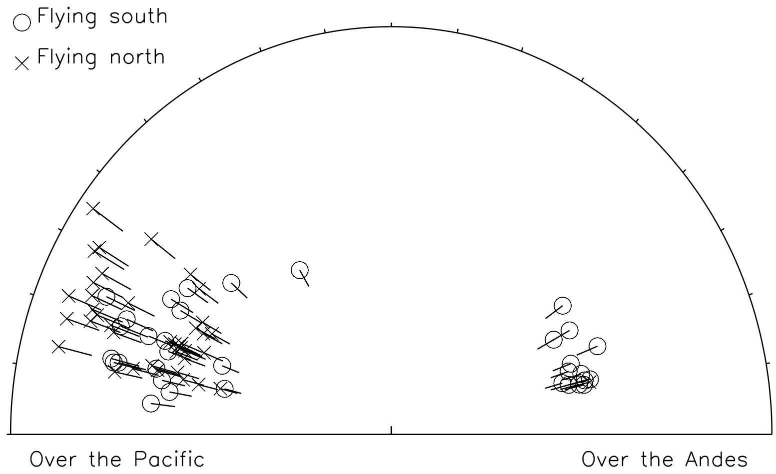

Figure 2: Airplanes passing near Paranal. Observations made during six almost full nights from July 23 to October 25, 1997. Other comments as on Figure 1.