A Systematic Attempt to Measure Air Traffic Levels and Count Persistent Jet Trails/Chemtrails Using a Raspberry Pi-Based Computer Network

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Abstract

This research used a collection of software and hardware to receive and decode ADS-B messages from aircraft as well as photograph the sky at 1-minute intervals. The software ran on several Raspberry Pi computers stationed at up to 6 different locations in the UK. The objective was to count the number of aircraft detected at a given location and compare these counts, both on an hourly and a daily basis, when the skies were clear enough to have seen persistent jet trails or “chemtrails”. Time-stamped time-lapse videos were generated for images taken between sunrise and sunset each day. These were inspected to count the number of trails observed in each 30-min period of daylight. Trail counts and aircraft counts were collated into a Microsoft Access Database. SQL Queries were then developed to allow comparison of aircraft counts during periods when trails were observed and clear periods when no trails were observed.

Acknowledgements

I am grateful to the following people for their help with this project:

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And last but not least… The Raspberry Pi and Linux / Open Source / Developer Community!

Borrowash, UK 2009-10-09 07-56-29

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1. Introduction

1.1 Persistent Jet Trail/Chemtrail Phenomenon

Since the mid-late 1990's, people around the world have observed what have become known, correctly or incorrectly, as "Chemtrails". Mainstream science and commentary mostly considers these trails to be a normal result of everyday air traffic movements – i.e. they are purely and simply condensation trails formed as a result of burning kerosene. Others maintain they are part of a secret, clandestine "spraying programme" which is suggested to be either for

- Geoengineering in the form of some kind of "Solar Radiation Management" (SRM)[1]
- Introducing toxins into the atmosphere to affect/control human health
- Introducing toxins into the atmosphere to affect/control agriculture

This author has previously compiled 2 reports about these trails and their possible nature. The reports were posted on http://www.checktheevidence.com/ in 2007[2] and 2010[3] respectively.

1.2 Trail Days and "Non-Trail Days"

One of the main unanswered questions is why we observe days when no trails appear – not even ones that persist enough to actually see them – and then on other days, we can observe many, many trails for such a length of time that they can even seem to spread out and form a "haze blanket"[4]. There seems to be no satisfactory explanation for these different scenarios, beyond either "hand waving" or making claims which are not supported by the evidence. For example, if it is caused by the state of the jet stream, and its influence on the stratosphere, there has been no clear explanation as to exactly what sort of circumstances/conditions would cause trails to persist for many minutes and, specifically, how jet stream changes would cause these conditions to change.

1.3 Grids and Circles of Trails

In the photographs below, mainly from around the United Kingdom, a number of circles and grids of trails can be seen. There seems to be no good, clear explanation for this and, to my knowledge, military exercises have not been proven to be the cause of any of these "displays". In one instance, from the 16th of Jan 2012, it is alleged that a "NATO plane" created these circles of trails[5], though if this was true, the full purpose of the exercise that created them is not clear. An article in the Louth Leader[6] claims "the aircraft was a NATO Sentry E3, a surveillance plane, which was on a sortie completing a standard UK orbit." (As of writing this report, the photo shown below has disappeared from the site, though the story remains).

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[1] http://www.srmgi.org/

[2] Illegal Aerosol Spraying Operations over United Kingdom Airspace – 2007 http://www.checktheevidence.com/pdf/Chemtrail%20Report%20and%20Responses.pdf

[3] Re-Investigating Climate Change – 2010 - http://www.checktheevidence.com/pdf/Re-Investigating%20Climate%20Change.pdf

[4] http://www.checktheevidence.com/video/PiTrackerTL/2014-04-17-SN54HA-East-NE-10am%20onwards%20-%20trails%20smear%20out%20and%20form%20cloud%20.mp4

[5] http://www.louthleader.co.uk/news/local/circling-aircraft-revealed-to-be-from-nato-1-3425007

[6] http://www.louthleader.co.uk/news/local/circling-aircraft-revealed-to-be-from-nato-1-3425007

10 June 2005 - Borrowash, UK

21 Jan 2007, Humberside, UK

03 Aug 2007 – Borrowash, UK

15 Apr 2008 – Pyrenees, France/Spain

21 Feb 2009 – Borrowash, UK

16 Mar 2010 – Blaneau Ffestiniog, Wales, UK

Nov 2010 – Edinburgh, UK

16 Jan 2012 - Kidderminster, UK

15 Mar 2013 - Grimsby, UK

29 Nov 2012 - Hendon, UK

16 Jan 2012 – Louth, UK

04 Aug 2013 – Ashtead, UK

18 Aug 2013 – Ashtead, UK

10 Jan 2014 – Lancashire, UK

1.4 Questions, Petitions and Investigations

There has been little, if any, formal investigation into the phenomena shown in section 1.3, though a number of people have tried to raise questions formally using an FOIA[7] and through lobbying politicians – such as through the Skyguards group[8], which organized a meeting in the European Parliament in Brussels in April 2013[9]. In 2007, Rosalind Peterson gave an address to a UN Climate Change meeting in New York[10].

Many hundreds or even thousands of "YouTubers" have uploaded videos of various kinds – some are particularly strange and show planes trailing together – with examples in Germany[11] and in the USA[12]. A number of independent, good quality documentary films have been made by people such as Patrick Pasin[13], Clifford Carnicom[14], and Michael Murphy[15]. There are others of varying quality.

Despite all these strange instances of significant trailing, no official answers are forthcoming – only flat denials. It is therefore left to those people who have observed these troubling anomalies, to do their own investigation. This report is the result of one set of investigations.

1.4.1 "Overcast" Documentary by Matthias Hancke et al to "Sample a Trail"

This documentary has been in the works for almost 1 year and may be released later in 2014. Matthias Hancke intends to scientifically sample and test material from a persistent trail/chemtrail. Matthias has already done some sampling, but has had problems with the sampling process and has needed funds to complete scientific/chemical analysis. Further updates can be found on the Facebook page [16] and crowd-funding page.[17]

1.5 Standard "Explanations" for the Phenomenon

A number of websites, including http://contrailscience.com/ and Wikipedia claim that all trails that are ever seen are contrails. While these sites do contain some valuable scientific information, you will not find a full explanation for the phenomena shown in the photographs in section 1.3 – to be valid, these explanations would need to include flight numbers and identification of planes on the dates shown. Instead, this evidence

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[7] Gary Jones FOIA https://www.whatdotheyknow.com/request/contrails_chemtrails#incoming-284687
[8] This group was set up by Josefina Fraillle Martin in 2012 - http://www.guardacielos.org/?lang=EN
[9] Conference Report http://www.checktheevidence.co.uk/cms/index.php?option=com_content&task=view&id=370&Itemid=83
[10] Ms. Peterson was a Keynote Speaker at the 60th Annual DPI/NGO Conference on Climate Change (New York on September 5-7, 2007 http://www.agriculturedefensecoalition.org/content/about-rosalind-peterson
[11] Germany - https://www.youtube.com/watch?v=NT1xjMMAnEU
[12] USA - https://www.youtube.com/watch?v=NHRVmF8YkRc
[13] Bye Bye Blue Sky https://www.youtube.com/watch?v=dTxwDJ2ZDkk
[14] Aerosol Crimes - https://www.youtube.com/watch?v=dQugAtVNnwY
[15] What in the World Are They Spraying? - https://www.youtube.com/watch?v=jf0khstYDLA
[16] https://www.facebook.com/pages/OVERCAST/142678639222057
[17] https://www.indiegogo.com/projects/overcast#home

is hand-waved away and assumed to be covered with a tagline such as THE SCIENCE AND PSEUDOSCIENCE OF CONTRAILS AND CHEMTRAILS." Metabunk.org also has some interesting observations and analysis, though is somewhat selective about what it shows and analyses, as is the case with contrailscience.com.

1.5.1 Barium in Rainwater?

One claim that has been made several times is that there is a toxic level of barium in some rainwater – this claim has not really been proven to the point where it can be linked to "chemtrails". An example case is that of Bill Nichols of Arkansas, USA[18] – which was reported on KLSA news in 2007. There is a good analysis on contrailscience.com regarding this case[19]. Similar claims about aluminium levels have been made by Francis Mangels of California, USA[20] – but it is not well known that some soils can contain aluminium salts in clays and so on. However, the fact remains that barium titanate has been proposed by the likes of Dr David Keith as a compound to be used in possible Solar Radiation Management projects[21].

1.6 The Reasons for Persistent Jet Trails/Chemtrails Appearing

Many reasons are suggested for Chemtrails. Clifford Carnicom has proposed the following possible reasons

- To help create environmental or climate changes,
- To introduce biological materials to affect humans or agriculture
- For "military purposes"
- To change the electromagnetic properties of the atmosphere
- To cause geophysical or global effects
- To enable operation of exotic propulsion systems

At this point, it is clear the phenomenon is real – but it is not really clear if the trails are being created through the use of fuel additives or whether there are aircraft in operation that have a separate spraying system installed. Some people claim to have photographed additional nozzles on aircraft, but in some cases, these have been shown to be for other purposes such as science research projects (there are some examples on the "metabunk" forum[22] such as a study of a story entitled "Exclusive: Leaked Photos of Chemtrail Dispersal System"[23].)

1.6.1 Are Trails Appearing as a Result of External Manipulation of our Atmosphere?

One possible explanation that I have proposed in the past is that at least some of the trails are appearing because the atmosphere is being manipulated by some unknown technology – perhaps similar or the same as what was almost certainly used around the time of 9/11/01 to steer Hurricane Erin[24].

Perhaps it is based on some of Wilhelm Reich's Orgone technology[25].

1.7 Lack of Genuine Whistleblowers

Unfortunately, no genuine, knowledgeable whistleblowers seem to have come forward with detailed information that can be supported by comprehensive documents, photographs or videos. Though there has been internet chatter about people like A.C. Griffiths[26] and Kristen Meghan[27], they do not seem to have brought forth any verifiable, solid information[28]. Though they may have made reference to documents such

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[18] https://www.youtube.com/watch?v=rFpF-c8Jgx0
[19] http://contrailscience.com/barium-chemtrails/
[20] http://metabunk.org/threads/154-The-Claims-of-Francis-Mangels-a-Factual-Examination
[21] Page 25 - http://www.cspg.org/documents/Conventions/Archives/Gussow/2008Gussow/presentations/021-Climate_and_Carbon_Engineering.pdf
[22] https://www.metabunk.org/threads/exclusive-leaked-photos-of-chemtrail-dispersal-system.2772/
[23] http://www.reallibertymedia.com/2013/11/exclusive-photos-of-chemtrail-dispersal-system/
[24] http://www.drjudywood.com/articles/erin/
[25] http://www.bibliotecapleyades.net/ciencia/ciencia_reich05.htm
[26] http://sonomachemtrails.blogspot.co.uk/2009/05/ac-griffin-talks-about-chemtrails.html
[27] http://www.geoengineeringwatch.org/ex-military-bio-environmental-engineer-kristen-meghan-blows-whistle-on-air-force-chemtrails/
[28] https://www.metabunk.org/threads/kristen-meghan-former-us-air-force-whistle-blower.1066/

as “Owning the Weather by 2025”[29] and other documents that have been produced by the military, they don’t seem to have explained many – or even any – of the observations we have made.

1.8 Chemtrails/Jet Trails in Advertising and TV Visuals

There does seem to be an unusual prevalence of jet trails in advertising and in places where you might not expect them to be shown – I have collected some examples on this page[30]. One especially curious example was seen in a 2005 Virgin Trains commercial[31].

In 2013, the BBC Wimbledon Introductory Visuals[32] showed a trail in almost every shot where the sky was seen. Was it just innocent re-use of a stock image?

[29] http://csat.au.af.mil/2025/volume3/vol3ch15.pdf
[30] http://www.checktheevidence.co.uk/cms/index.php?option=content&task=view&id=52
[31] http://www.checktheevidence.co.uk/cms/index.php?option=com_content&task=view&id=296&Itemid=50
[32] https://www.youtube.com/watch?v=m6bWTTVaSs8

2. Air Traffic Investigation

This report represents the preliminary results of ongoing attempts to measure levels of air traffic over several locations during times of clear skies and during times when persistent trails or “chemtrails” appear.

It is not meant to be an explanation for chemtrails – and, indeed, it is not meant to “debunk” anything or anybody. This does not appear to prove there is a conspiracy to spray aerosol compounds in the sky – even though that it is possible that this is actually what is happening. It was simply an attempt to try and match or collect air traffic counts and log aircraft movements and then correlate this data with the appearance of trails. In this regard, at least, it has served a useful purpose.

2.1 ADS-B – What is it?

The whole project/system relies on the fact that many aircraft are now transmitting ADS-B (Automatic Dependent Surveillance – Broadcast) messages when in flight. These messages contain the following information

- A code number identifying the aircraft (sometimes called “ICAO”)
- Flight Number
- Altitude
- Position (Latitude/Longitude)
- Speed
- Heading

(This page has a good explanation: http://planefinder.net/about/ads-b-how-planefinder-works/.) The tracker simply receives and decodes these messages – then software can be used to process the messages in any way desired. For example, you can count the number of aircraft which are detected in a given period, within a certain range and above a certain altitude or between certain altitudes.

Not all aircraft broadcast all the information above. It seems only about an average of 40% of aircraft detected broadcast their position.

2.2 Detecting Aircraft Flying Over Your Location

2.2.1 Early Equipment

This project essentially started in perhaps 2006, when I found out that it was possible to detect aircraft flying over a particular location (e.g. your own house!). At that time, I became aware of a piece of equipment called the SBS-1 – which would decode ABS-B messages that it could receive from aircraft. It was then an obvious question to see if it could be used, in some way, to identify and/or track aircraft that appeared to be leaving persistent trails or “Chemtrails”. However, the cost of the equipment (£500) was an initial deterrent to taking this idea further, at that time.

SBS-1

Airnav Radarbox

2.2.2 More Recent Developments

In the last few years, websites such as www.FlightRadar24.com, Flight Aware and Planefinder.net have offered tracking and aircraft identification features, though they can in some cases be slow to update and somewhat cumbersome to use. Similarly, there are Android and iPhone Apps which interface to these online services and allow you, for example, to identify flights by holding up your phone in the direction of a plane in the sky. Of course, not everyone has an iPhone or Android phone...

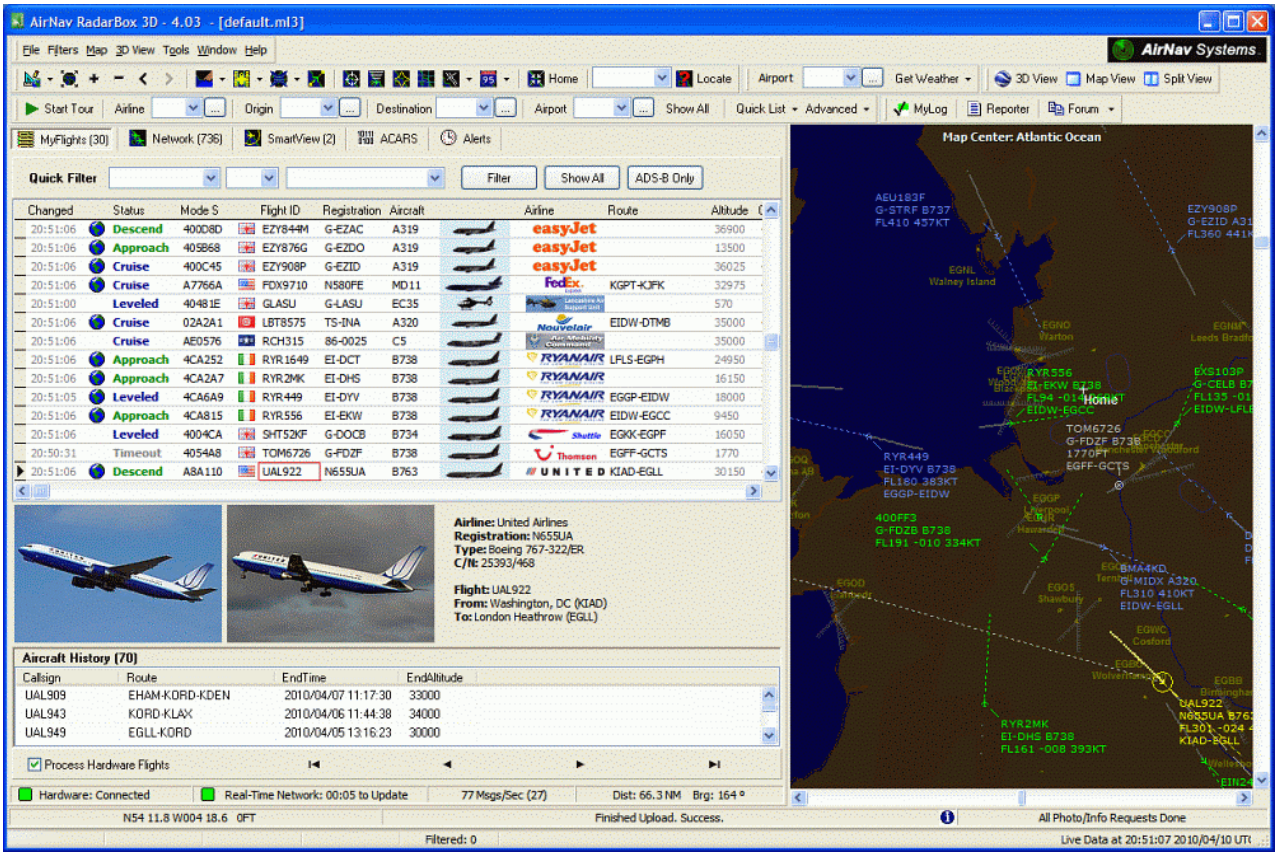
As far as I am aware, the Website and Phone App solutions don't have logging features of any great sophistication, so are not much use other than for "realtime viewing and tracking".

2.2.3 Airnav Radarbox

In 2010, I decided to invest in an AirNav Radar Box as I was still very curious as to what could be determined from using one to track aircraft. An important feature was that of "logging" any aircraft it detected – this meant that the unit could be left unattended and data could be examined retrospectively. However, there was still no easy way to get a visual record of trailing, other than deciding to go out with a camera and photograph the sky during periods of trailing. This was not very practical, as time could not be devoted exclusively to a "tracking project."

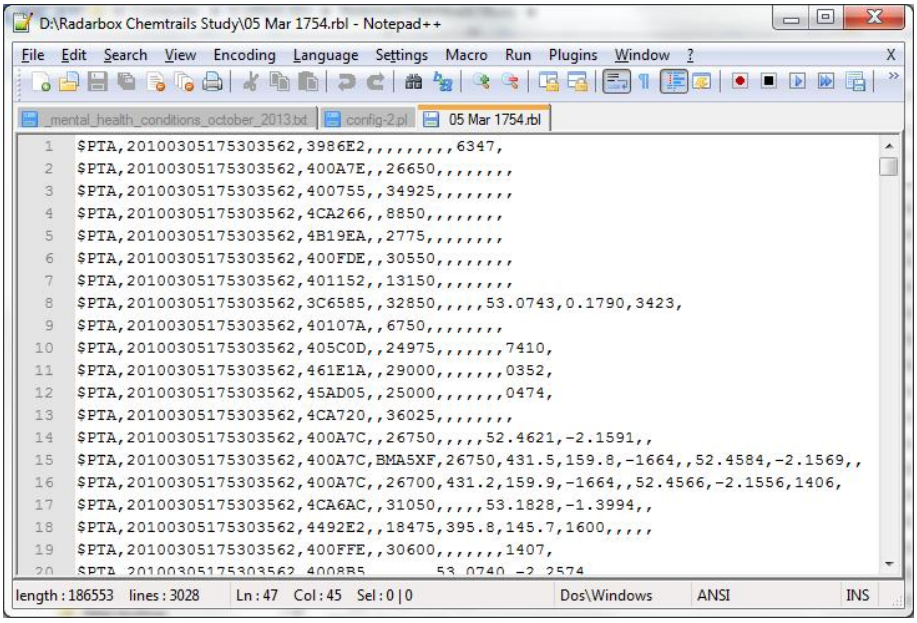
2.2.4 Airnav Software

The software that was shipped with the Radarbox provided a "virtual Air Traffic Controller's (ATC) display" – all quite natty, but its logging features were limited. For example, it could keep a list of all the aircraft detected – and it could even playback a recording of logged data, but it was not able to produce charts or, for example, count the number of aircraft detected during a specified period, such as 30 minutes.



2.2.5 Creating Charts of the Paths of Aircraft Detected

One of the original goals was to try and create charts which would show the path travelled by aircraft – this might allow the appearance of trails to be matched with the "charted path" of an aircraft – to see how close the visual trail matched the logged/charted path.



Airnav Radarbox Logfile

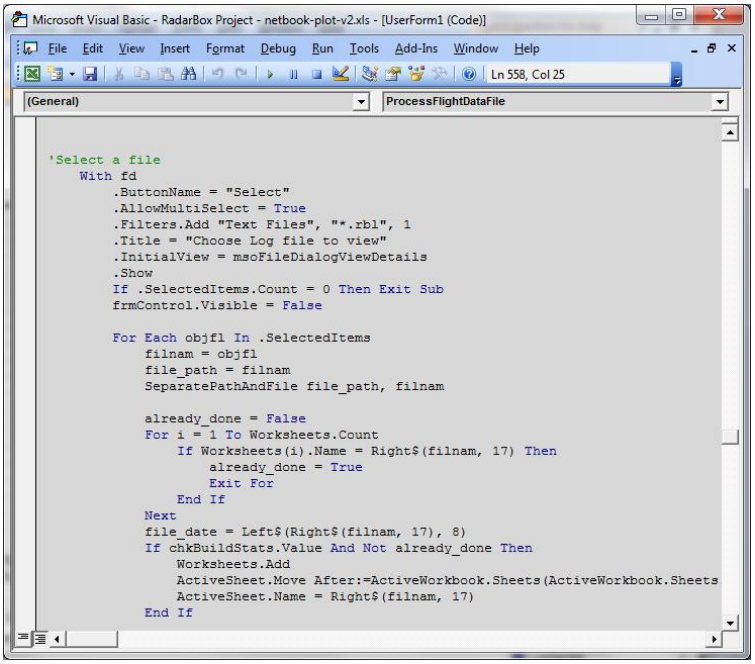
It was not initially clear how to do this, as the logfile simply consisted of lines of text, with the following columns:

- "PTA" (Text)
- Callsign
- Track
- Latitude
- Date and Time
- Altitude
- Vertical Rate
- Longitude
- Aircraft ID (ICAO)
- Groundspeed
- Airspeed

It was therefore possible, in theory, to determine the path of an aircraft by plotting the indicated/logged latitude and longitude figures, although this was made more complicated by the fact that the log file was simply a list of logged messages from all aircraft in range of the receiver – the list was not "sorted by aircraft".

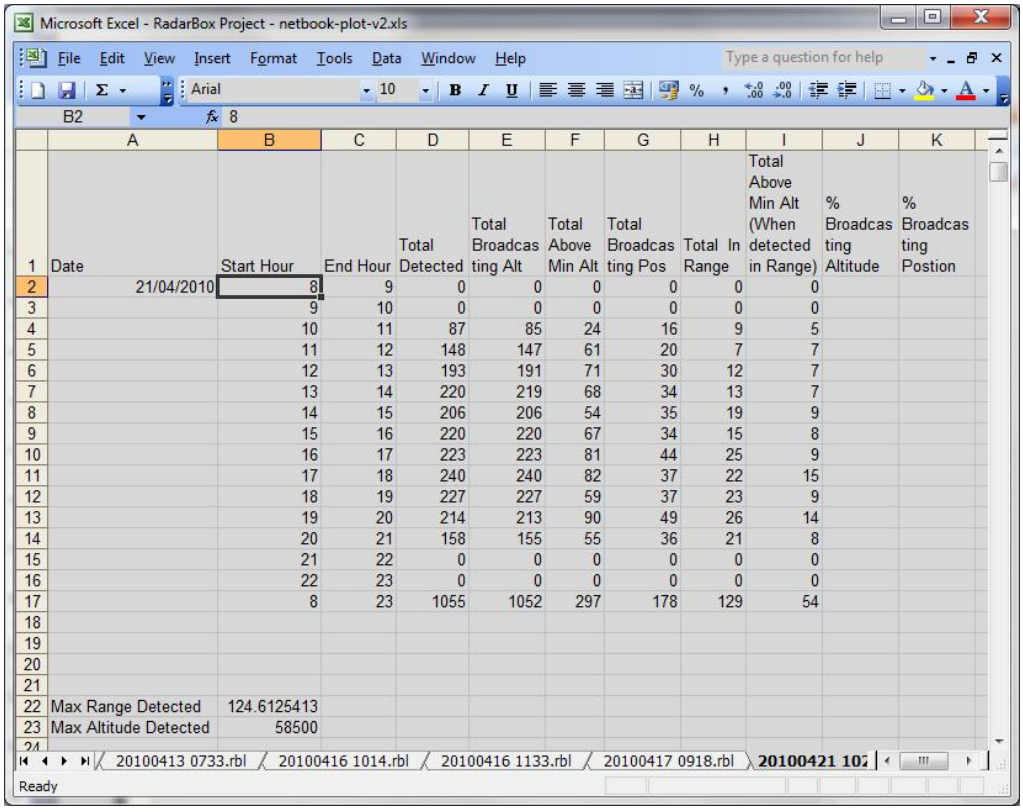
Some Visual Basic for Applications (VBA) routines were developed in Microsoft Excel to process these Radarbox files and

(a) Generate charts of the paths of aircraft and
(b) Generate counts of aircraft detected in certain time periods.



A short section of VBA code used to generate charts and counts.

Aircraft Chart Generated by VBA Code from Airnav Logfile.



	A	B	C	D	E	F	G	H	I	J	K
1	Date	Start Hour	End Hour	Total Detected	Total Broadcasting Alt	Total Above Min Alt	Total Broadcasting Pos	Total In Range	Total Above Min Alt (When detected in Range)	% Broadcasting Altitude	% Broadcasting Postion
2	21/04/2010	8	9	0	0	0	0	0	0		
3		9	10	0	0	0	0	0	0		
4		10	11	87	85	24	16	9	5		
5		11	12	148	147	61	20	7	7		
6		12	13	193	191	71	30	12	7		
7		13	14	220	219	68	34	13	7		
8		14	15	206	206	54	35	19	9		
9		15	16	220	220	67	34	15	8		
10		16	17	223	223	81	44	25	9		
11		17	18	240	240	82	37	22	15		
12		18	19	227	227	59	37	23	9		
13		19	20	214	213	90	49	26	14		
14		20	21	158	155	55	36	21	8		
15		21	22	0	0	0	0	0	0		
16		22	23	0	0	0	0	0	0		
17		8	23	1055	1052	297	178	129	54		
18											
19											
20											
21											
22	Max Range Detected	124.6125413									
23	Max Altitude Detected	58500									

Counts were stored in spreadsheet worksheets for days when logging was running.

The data obtained from these logfiles was satisfactory, but time consuming to process and match up with observations.

2.3 Wireless Webcams – Photographing the Sky

Time-stamped Webcam Image

FOSCAM Wireless Webcam

Another step was to try and photograph the sky at regular intervals automatically. This was achieved using a pair of FOSCAM wireless WebCams. These could be appropriately positioned on a window sill (indoors – weather proof units were more expensive and more difficult to cable up for power requirements).

2.4 Control Program for Webcams and Aimav Logging

A small program was developed which would then switch on the aircraft logging in the Airnav Box Software and also, between dawn and dusk, capture sky images from the 2 webcams and insert a time stamp in each image. All the data was saved on a Netbook computer, which had to be left running 24 hours per day. Unfortunately, this netbook was used for other purposes, for a few days at a time, which meant the logging could not be run for more than a few days at a time.

This programme was not 100% reliable, as the Airnav data logging could not always be successfully switched on. This meant it was not really possible to build a consistent set of data which could be used to count aircraft over an extended period of several weeks or months.

3. Raspberry Pi Air Traffic Monitoring System

3.1 Raspberry Pi

The Raspberry Pi is a small, credit card sized fairly powerful computer which runs a version of an Operating System called Debian Linux. It was released in 2012 – See http://www.raspberrypi.org/help/faqs/ for more information. I had obtained one not long after the release and set it up as a low-powered file server.

It is a credit to the way that Open-Source software systems work that allows developers now to plug together software and hardware components and build both hobbyist and professional projects – to a high level of sophistication – in a relatively short period of time. With appropriate programming knowledge, customisation of software is straightforward and practical. Coupled with the vast and easily searchable resources on the internet, solutions to common problems can quickly be found, enabling system reliability to be improved much more easily and more quickly. Significant computing power in a small, cheap and energy-efficient package also means that more and more advanced projects can be envisioned and developed at a modest cost of only a few hundred pounds.

In June 2013, I wondered if it was possible to connect the Raspberry Pi to the Airnav Radar Box – essentially to replace the Netbook and allow the Pi to take the data from the Airnav box and save it, so that I did not have to tie up a Netbook for this purpose.

After finding a forum discussion about this, I also found another and potentially better way of doing a similar sort of thing and “Pitracker” started to become a workable idea.

3.1.1 Dump1090 – ADS-B Message Reception and Decoding on Raspberry Pi

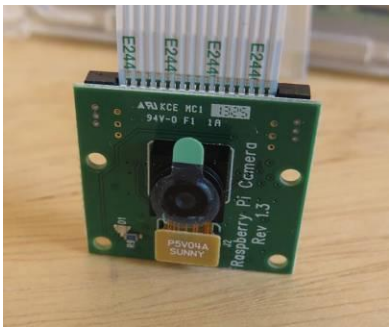
I discovered forum posts and web pages which showed how it was possible to connect a USB dongle to the Raspberry Pi and, having compiled some software, the Pi was able to do most – if not all – of what the Airnav Radar box would do – for a fraction of the cost. A page by Dave Taylor provided a solid basis for some further Raspberry Pi development.

By getting the right type of USB Dongle – a Digital Terrestrial Broadcast Receiver Dongle (DVB-T) with the correct chipset (R820T/RTL2832U), I could track aircraft in realtime using a Raspberry Pi. Hence, all that was now needed was additional software to do the logging and counting. This was made much easier because the program which decoded the ADS-B messages also presented data from them through a web page interface. This program was written in C. In other words, all the hard work of decoding ADS-B messages was already done – I just needed to add some code to count the detected number of aircraft and generate charts.

3.1.2 Counting Aircraft

It was relatively straightforward to adapt the Dump1090 program code to make it count detected aircraft in a set period. It was also possible to get it to count aircraft in various categories – such as those above 25000 feet, where trails are formed. All these counts were saved into a “daily data file”. Additionally a log of all aircraft detected was generated and saved. The main software development was done using a Ubuntu Linux installation with the help of the Codeblocks IDE. (The TV Dongle and Dump1090 code could also be used within a Linux installation.) The C code was simply copied onto the Raspberry Pi and compiled so that it would run on the Raspberry Pi directly.

3.1.3 Photographing the Sky



In May 2013, a custom camera board was released for the Raspberry Pi and this could be operated by software that ran on the Raspberry Pi. It was now therefore possible to have the Pi log and track the aircraft - and photograph the sky – unattended, and using less than 8 watts of power. Additionally, raspberry Pi camera images were of considerably better quality than the Web Cams, as the Pi Camera has a 5 megapixel sensor.

3.1.4 Automatic Capture of Weather Data

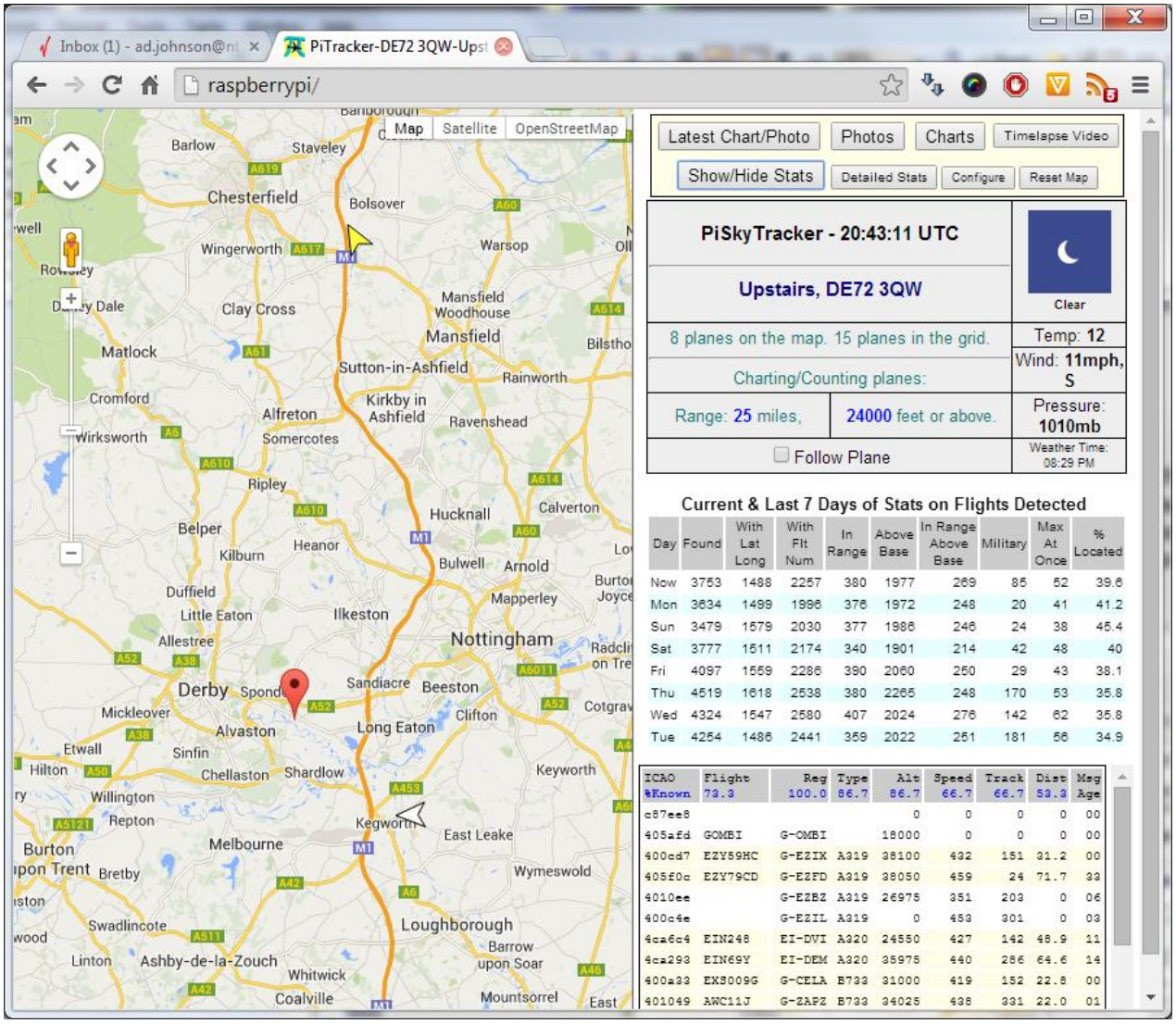
Using the World Weather Online website - www.worldweatheronline.com – it was possible to obtain weather data at regular intervals, to be saved with the air traffic counts. Although ground-level weather data is not especially useful in relation to conditions which may affect the formation of trails at 25,000 feet and above.

3.1.5 Configuration Data

In order to generate meaningful data, it was necessary to add a “configuration feature”. Most importantly, the latitude and longitude that the Raspberry Pi was located at needed to be set up – this would then allow measurements to be made based on this location.

3.1.6 Webserver/Webpage to Display Realtime Plane Positions

The Dump1090 software also contained features which allowed the software to generate a Webpage which would show the positions of detected aircraft on a Google Map in real-time, along with any available data about each aircraft detected. However, this Webpage view defaulted to show a location near London, so this part of the software was also modified to display a map based on the configured location. Additionally, the webpage was modified to include additional features, such as aircraft counts and local weather data.



Realtime-Webpage/Google Map view Generated By Raspberry Pi Tracker

3.2 Acknowledgements to Volunteers

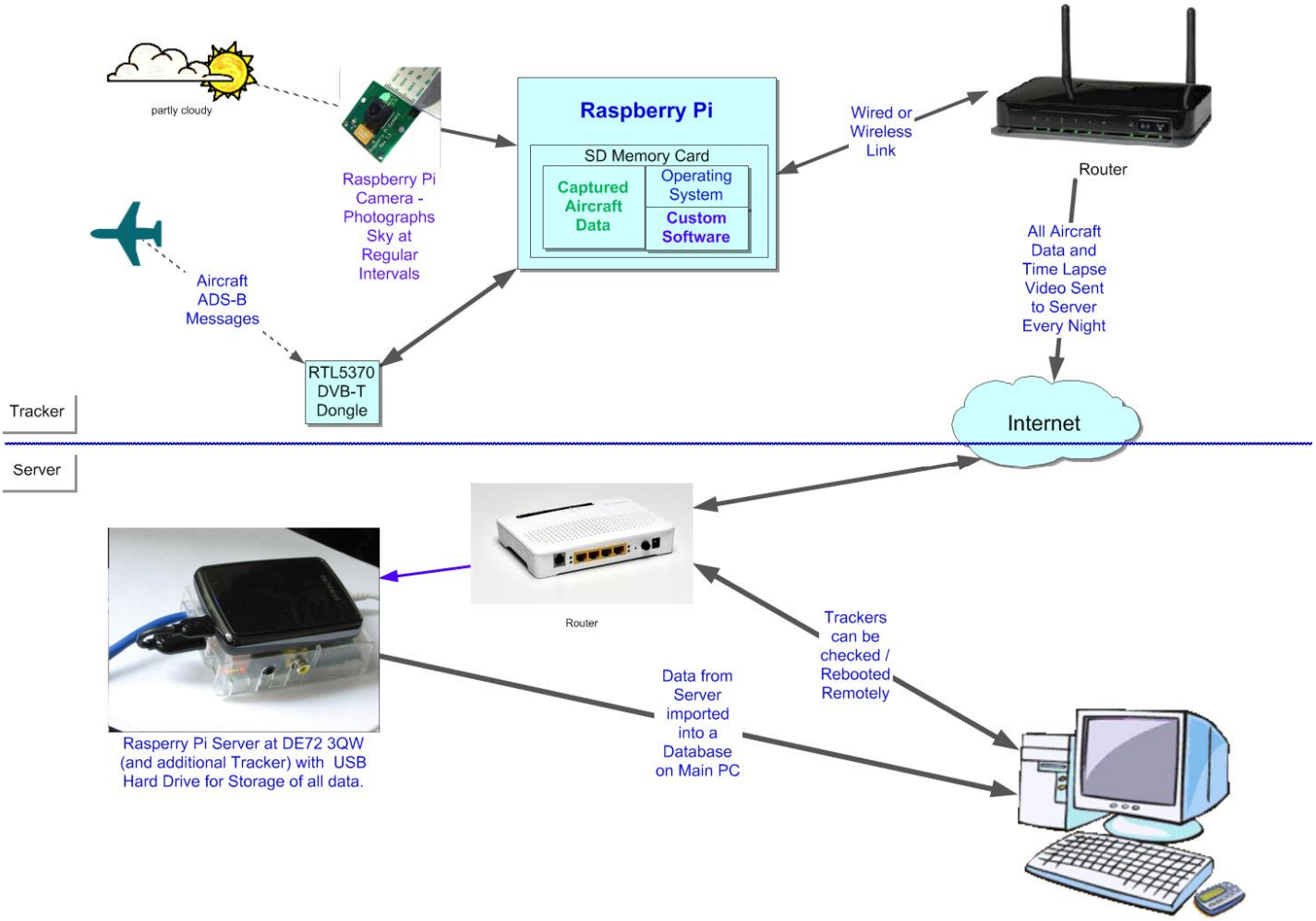
I am grateful to those 5 volunteers who agreed to host trackers and help me set them up. Without their help, this project would not have been able to gather nearly as much data.

3.2.1 Multiple Trackers – Remote Configuration and Upload of Captured Data

In order to get a better sample of data, it was decided early on that several “Pitrackers” should be put into operation, so several volunteers, from around the UK were asked to host them at their homes. This meant that a method had to be developed for transferring the data captured by these trackers to a central location (my own Raspberry Pi file server!) Hence, existing scripts were modified and a server was configured to accept and store the uploaded time-lapse video and aircraft data. Additionally, working with volunteers, the trackers were, when possible, set up to be remotely configurable, which meant that if certain problems developed in their operation, or software needed to be modified/updated, this was possible (and was necessary on more than one occasion). This was made possible by configuring the volunteer’s home router.

3.3 System Components and Overall Operation

This diagram illustrates the components and general operation of the tracker system.

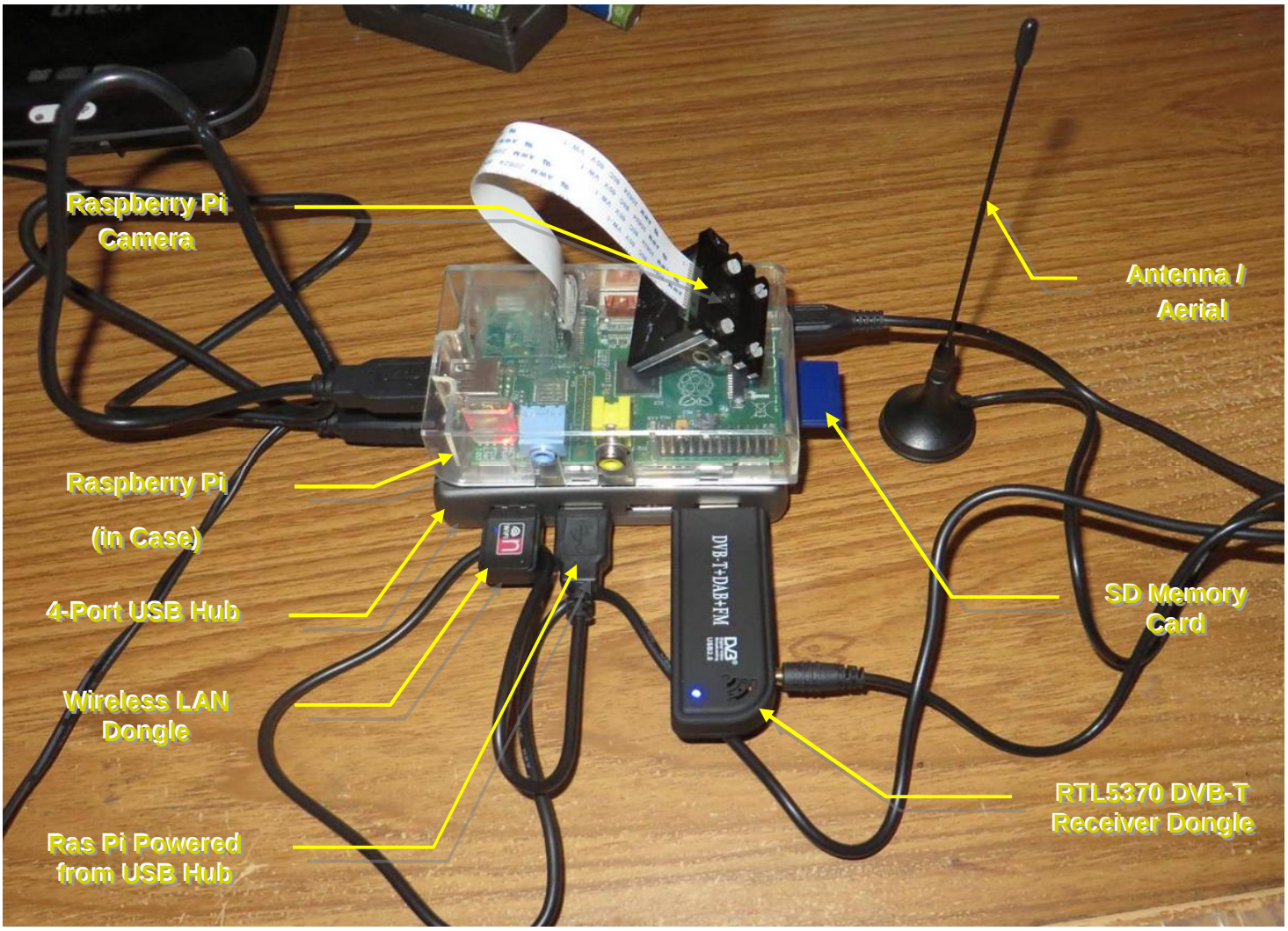


3.3.1 System Operation

The system uses an unmodified Raspberry Pi with an SD Memory card (like those used in Digital Cameras and similar devices). The memory card holds both the Raspberry Pi Linux Operating system ("Raspbian OS") and it is used to store the data acquired from the aircraft, as well as photos taken by the Raspberry Pi Camera.

Trackers were placed, when possible, on an upstairs window sill, which had a clear view of the sky. Once configured with a postcode, latitude, longitude and station name, they were left running 24 hours per day, 7 days per week. The tracker software included features to calculate local sunrise/sunset times and would only capture images and create plane charts during local day time.

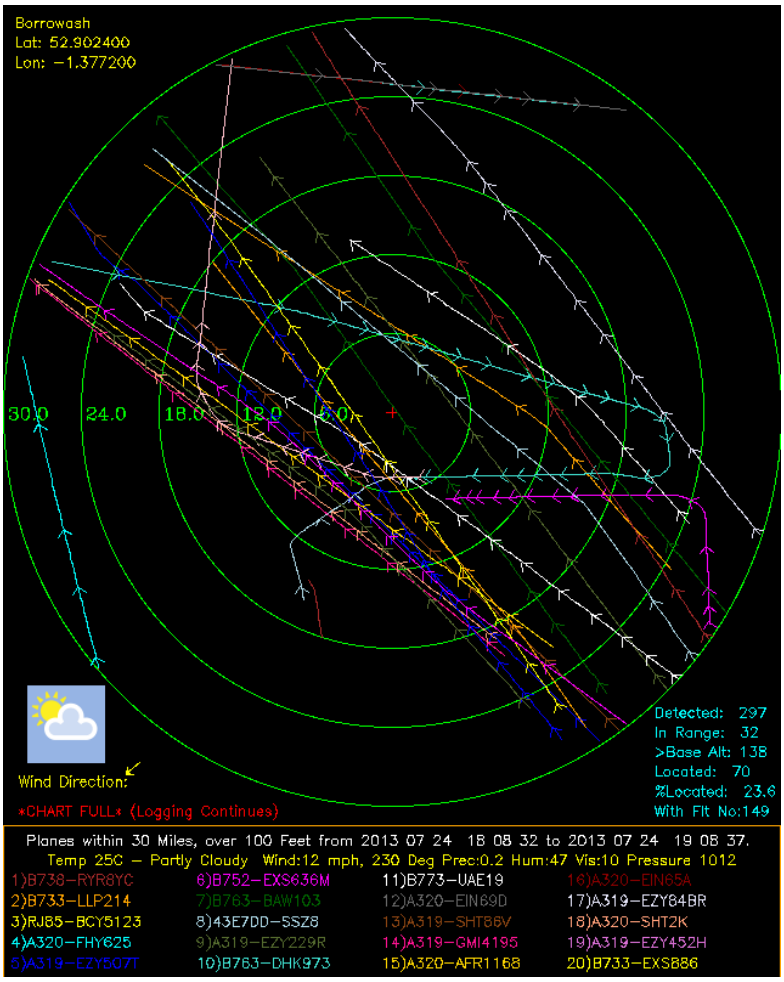
Linux "scripts" and commands were created to compress ("zip") each day's data files and upload them to the server between midnight and 6am. Similarly, time-lapse videos were generated and uploaded to the server every night.



Single tracker in operation.

3.3.2 Plane Charting

By using Linux Open Source Graphics Libraries (libplot and libglib), it was possible to plot aircraft paths on charts – as the data was captured by the Rasperry Pi. Charting parameters could be set so that planes within a certain range were drawn on the charts (which were created every 30 minutes by default). Only planes above a certain altitude were logged on the chart.

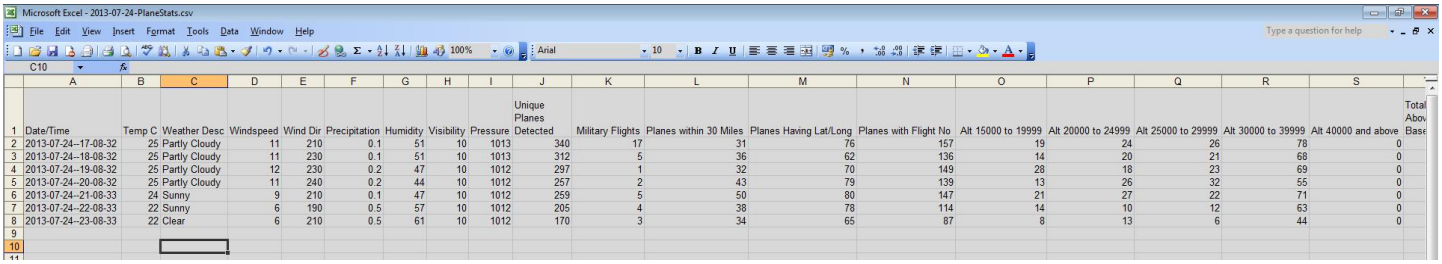


Aircraft "Traffic Chart" generated by Raspberry Pi Software (100 foot base altitude)

These charts were saved in PNG format (a useful feature of the graphics libraries).

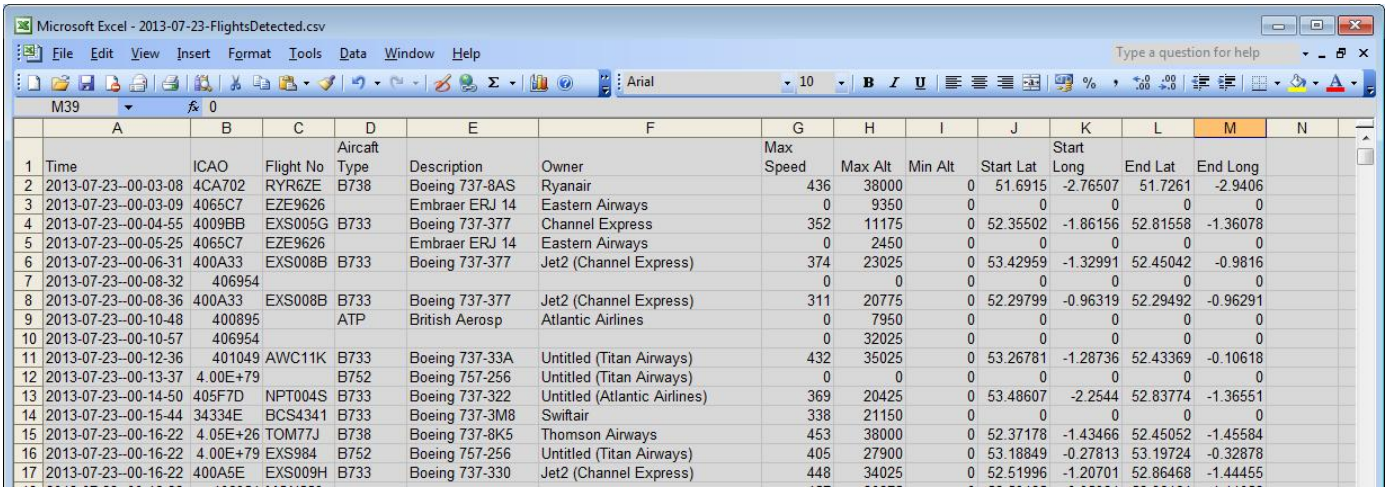
3.3.3 Aircraft Data Saved in CSV Format

Aircraft Data was saved on the Raspberry Pi's SD Card - in a standard Comma Separated Value (CSV) format, which could be easily read and processed by other software.



Date/Time	Temp C	Weather Desc	Windspeed	Wind Dir	Precipitation	Humidity	Visibility	Pressure	Unique Planes Detected	Military Flights	Planes within 30 Miles	Planes Having Lat/Long	Planes with Flight No	Alt 15000 to 19999	Alt 20000 to 24999	Alt 25000 to 29999	Alt 30000 to 39999	Alt 40000 and above	Total Abov Base
2013-07-24--17-08-32	25	Partly Cloudy	11	210	0.1	51	10	1013	340	17	31	76	157	19	24	26	78	0	
2013-07-24--18-08-32	25	Partly Cloudy	11	230	0.1	51	10	1013	312	5	36	62	136	14	20	21	68	0	
2013-07-24--19-08-32	25	Partly Cloudy	12	230	0.2	47	10	1012	297	1	32	70	149	28	18	23	69	0	
2013-07-24--20-08-32	25	Partly Cloudy	11	240	0.2	44	10	1012	257	2	43	79	139	13	26	32	55	0	
2013-07-24--21-08-33	24	Sunny	9	210	0.1	47	10	1012	259	5	50	80	147	21	27	22	71	0	
2013-07-24--22-08-33	22	Sunny	6	190	0.5	57	10	1012	205	4	38	78	114	14	10	12	63	0	
2013-07-24--23-08-33	22	Clear	6	210	0.5	61	10	1012	170	3	34	65	87	8	13	6	44	0	

Aircraft Count Data



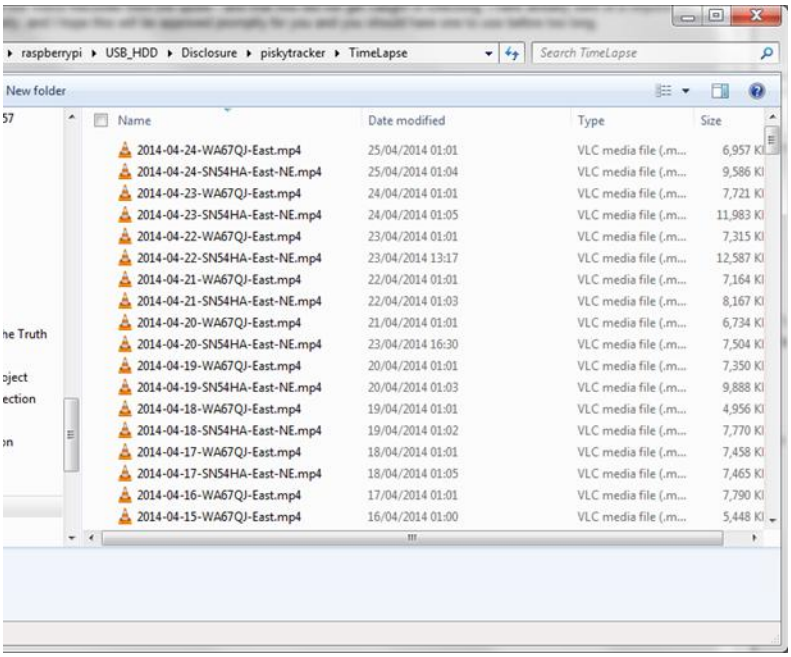
Microsoft Excel - 2013-07-23-FlightsDetected.csv

	Time	ICAO	Flight No	Aircaft Type	Description	Owner	Max Speed	Max Alt	Min Alt	Start Lat	Start Long	End Lat	End Long
2	2013-07-23--00-03-08	4CA702	RYR6ZE	B738	Boeing 737-8AS	Ryanair	436	38000	0	51.6915	-2.76507	51.7261	-2.9406
3	2013-07-23--00-03-09	4065C7	EZE9626		Embraer ERJ 14	Eastern Airways	0	9350	0	0	0	0	0
4	2013-07-23--00-04-55	4009BB	EXS005G	B733	Boeing 737-377	Channel Express	352	11175	0	52.35502	-1.86156	52.81558	-1.36078
5	2013-07-23--00-05-25	4065C7	EZE9626		Embraer ERJ 14	Eastern Airways	0	2450	0	0	0	0	0
6	2013-07-23--00-06-31	400A33	EXS008B	B733	Boeing 737-377	Jet2 (Channel Express)	374	23025	0	53.42959	-1.32991	52.45042	-0.9816
7	2013-07-23--00-08-32	406954					0	0	0	0	0	0	0
8	2013-07-23--00-08-36	400A33	EXS008B	B733	Boeing 737-377	Jet2 (Channel Express)	311	20775	0	52.29799	-0.96319	52.29492	-0.96291
9	2013-07-23--00-10-48	400895		ATP	British Aerosp	Atlantic Airlines	0	7950	0	0	0	0	0
10	2013-07-23--00-10-57	406954					0	32025	0	0	0	0	0
11	2013-07-23--00-12-36	401049	AWC11K	B733	Boeing 737-33A	Untitled (Titan Airways)	432	35025	0	53.26781	-1.28736	52.43369	-0.10618
12	2013-07-23--00-13-37	4.00E+79		B752	Boeing 757-256	Untitled (Titan Airways)	0	0	0	0	0	0	0
13	2013-07-23--00-14-50	405F7D	NPT004S	B733	Boeing 737-322	Untitled (Atlantic Airlines)	369	20425	0	53.48607	-2.2544	52.83774	-1.36551
14	2013-07-23--00-15-44	34334E	BCS4341	B733	Boeing 737-3M8	Swiftair	338	21150	0	0	0	0	0
15	2013-07-23--00-16-22	4.05E+26	TOM77J	B738	Boeing 737-8K5	Thomson Airways	453	38000	0	52.37178	-1.43466	52.45052	-1.45584
16	2013-07-23--00-16-22	4.00E+79	EXS984	B752	Boeing 757-256	Untitled (Titan Airways)	405	27900	0	53.18849	-0.27813	53.19724	-0.32878
17	2013-07-23--00-16-22	400A5E	EXS009H	B733	Boeing 737-330	Jet2 (Channel Express)	448	34025	0	52.51996	-1.20701	52.86468	-1.44455

Flight Data for Each Aircraft

3.3.4 Time-lapse Videos

After realizing that the sky needed to be photographed approximately once every minute, it was realized that several hundred photos per day would be generated and these would need to be reviewed to check for trails. Clicking through hundreds of photos per day would have been a slow process, so it was soon determined that the Raspberry Pi was capable of automatically generating time-lapse video files (in MP4 format) by using another package called libav-tools.

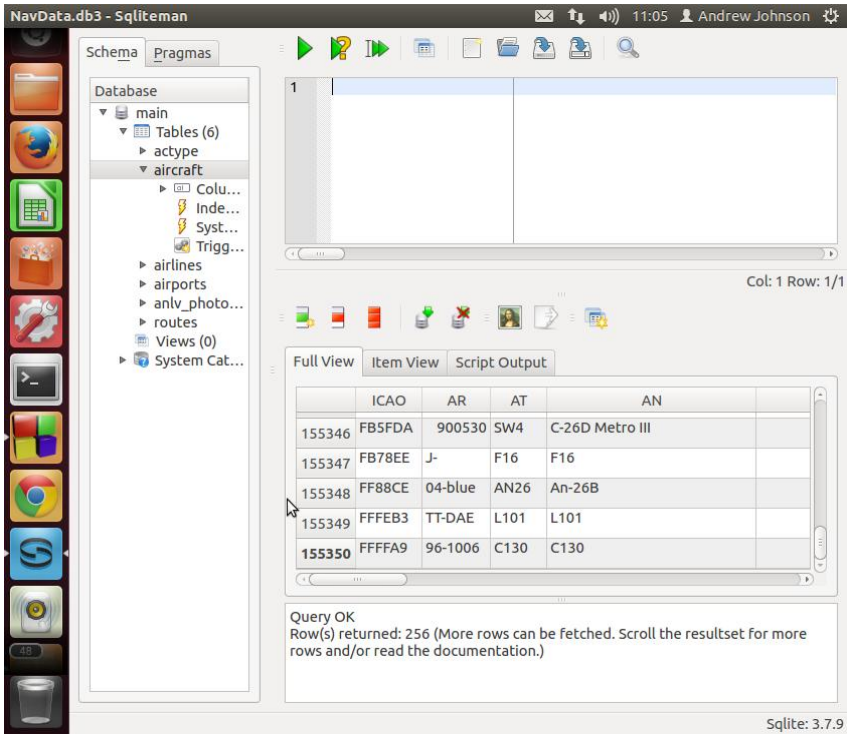


Time-lapse Video Files Stored on Server

3.3.5 Aircraft Data Database – Stored with Tracker Software

In experimenting with the AirNav Radarbox Software, it was discovered that it held an aircraft database which contained records for about 155000 aircraft. Each record held information about

- The type of aircraft
- Country of "Residence"
- Airline / Owner



This Database was stored in a single file, which was copied onto the Raspberry Pi's SD card. This allowed data about most of the detected aircraft to be written to a log file. Before the trackers were put into operation, this database was updated using additional data held in a text file from a free Windows package called PlanePlotter.

3.4 Tracker Database Development

In order to generate some statistics from all the data files collected, a method was needed to collate all the data. Originally, some tests were made just using collections of daily spreadsheets that had been generated by the trackers. However, this method was too cumbersome and it was much more difficult to, for example, average out sets of figures over weeks or months. Hence, after data had been successfully collected for several months, a Microsoft Access Database was developed and data from the CSV files was manually imported into this database.

4. Operational Considerations

4.1 Tracker Reliability and Continuous Operation

Over a period of several weeks, the reliability of the tracker was tested – could it run autonomously for days or weeks at a time? Updates to the Raspbian OS were still appearing every few weeks and by about Sept 2013, it seemed that trackers could run for long enough periods. However, it was still necessary to implement strategies to ensure continuous/smooth running of a tracker. This included such things as:

4.1.1 Watchdog Reset

If the Raspberry Pi "froze", then a watchdog timer would reset/restart it after a short period. The watchdog was not enabled by default, but again forum postings were found which gave instructions as to how to enable the watchdog reset.

4.1.2 Dongle Reset

Under certain circumstances, it seemed that the DVB-T Receiver Dongle would become unresponsive, so a method to detect this situation and then reset the dongle was devised.

4.1.3 Memory Card Capacity

A 4GB card was used on some trackers and an 8GB card was used on others. In both cases, however, it was not exactly clear how many days it would be before the card became filled with saved data. Most storage space was used by the time-lapse videos and the hundreds of camera images. In practice, it turned out that between about 15 and 25 days worth of data could be stored. A method was therefore added to delete data after a certain number of days (this could normally be done safely, because each day's data was uploaded to the server every night – and the upload method proved fairly reliable).

4.1.4 Remote Control, Update and Reboot

Using what is called an SSH login, trackers were set up to be controllable remotely (although this required the volunteer's router to be set up properly). This meant that both the Raspberry Pi software and the tracker software could be updated when necessary.

4.1.5 Data Capture

Essentially, all the data that was needed was collected by the trackers – except for one thing – a count of the number of observed trails! The original intention was then to review photos taken by each tracker and count any trails that appeared in each image, noting the time of the appearance of trails, when a particular trail or trails appeared on more than 2 consecutive images.

4.1.6 Need for Time-lapse Video

When the trail-counting started in earnest, it was realized that it was very time-consuming to inspect individual images for trails – even using something like Google Picasa image viewer – which has a very fast/responsive image viewer. Therefore, scripts were added to the raspberry Pi software to generate time-lapse MP4 movies as soon as the tracker stopped taking photographs at dusk.

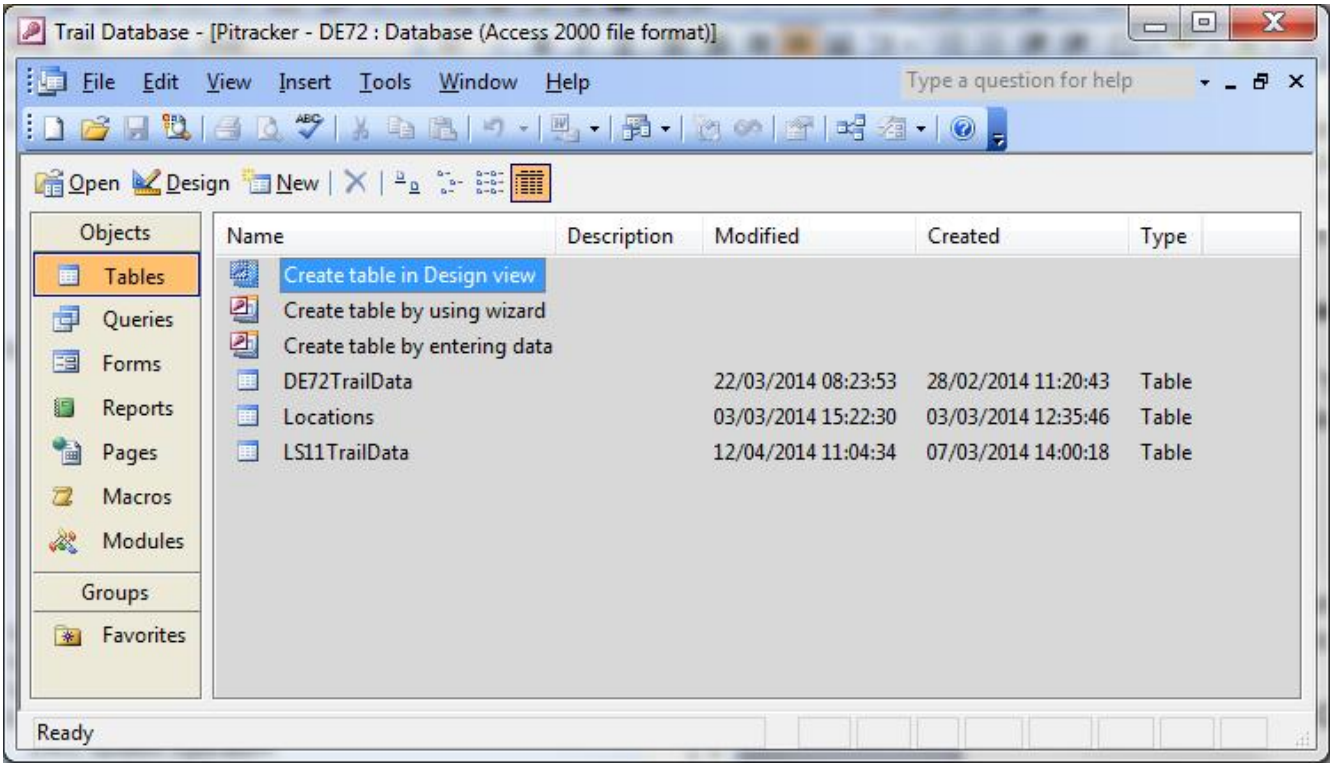
4.1.7 Cloudy Hours and Days – Sky Blueness

As time-lapse videos were reviewed, another problem became apparent – in the UK, where all the trackers are situated, days where the sky is completely free of cloud for more than a few hours are rare. A whole day could be reviewed and there were no usable sky images at all – as the weather was too cloudy to observe trails. A method had to be devised, therefore to measure how "clear" (blue) the sky was – which allowed a determination of how usable the image was. A software package called "Imagemagick" (which was used to add timestamp text to images and make a composite image with the plane chart and weather icon) was

therefore used to analyse each sky image, immediately after it was captured, to determine the "blueness". This was calculated as a number which ranged from about -85 to +250. Following some tests, it was determined that in most cases, images that had "blueness values" of greater than about 50 could be used to look for trails.

4.2 Microsoft Access Database

Initially, use of OpenOffice "Base" was tried, but difficulty was encountered in importing the data efficiently and successfully, but more success was achieved more quickly with Microsoft (Access 2003).



Microsoft Access Database Tables

4.2.1 Importing Data

Daily Data (CSV) files from each of the trackers were merged together every few days or weeks and imported into a "holding" table. (Some of the earlier weeks of data had to be reformatted as additional data columns, such as the sky blueness measurements were added to the tracker after a few weeks of data had already been collected. "Blueness" data was then generated from the time-lapse videos from those early weeks and added to the database retrospectively.)

4.2.2 Database Queries

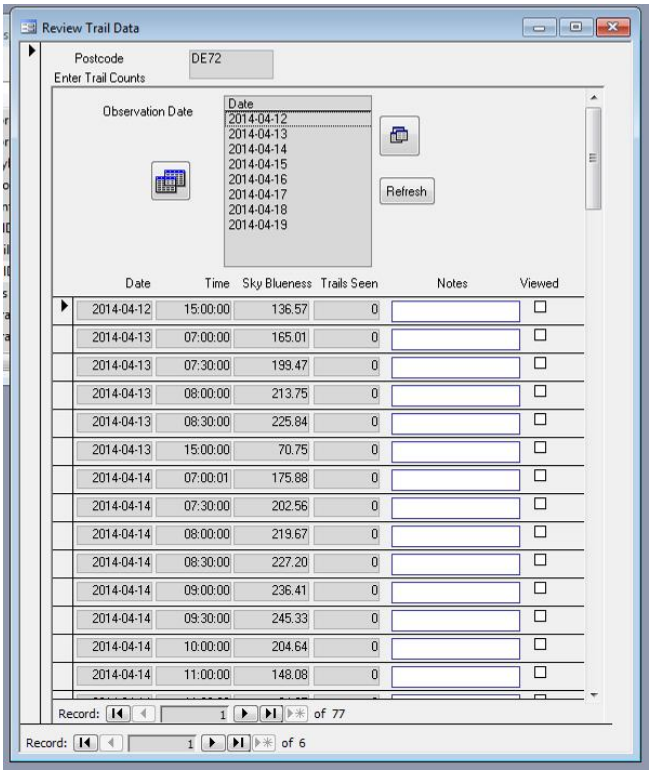
SQL Queries were developed to sort and group data by location, date and time. This data could then be presented on forms for inspection and modification. For example, a "notes" field was included so that any unusual trails or weather effects could be noted while sky images were reviewed.

4.2.3 Counting Trails – Entering Data into the Database

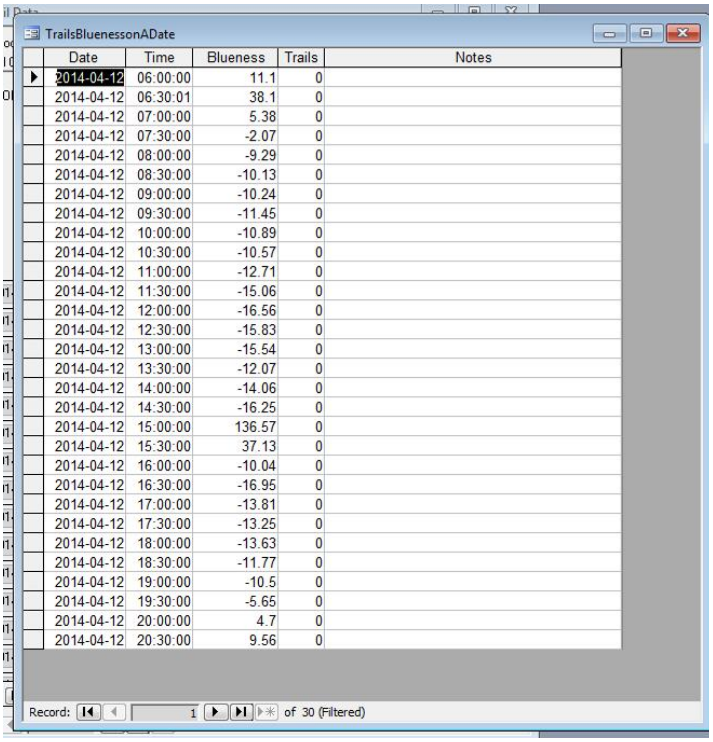
Once data was imported into the database, a query could be run to determine if there were any periods in each day when the sky was clear enough (based on the "Sky Blueness factor" – see section 4.1.7) for trails to be observed. A form was developed which allowed trail counts to be entered for the times that the sky was clear enough to see them. i.e. the query would "filter out" any days where there were no periods clear enough to see trails, which saved some time during reviewing time-lapse video. It was also noticed that the "blueness factor" was generally a fairly good indication of when trails would be visible, although for example, if the Pi camera was pointing at the sun, and there was some haze in the sky, the image would not appear to

have much blueness, but it was still possible to see some trails. So the blueness factor calculation was not always reliable. (Data between about September and November 2013 was inspected by volunteers and trail counts were added by them – this data was imported into the database too).

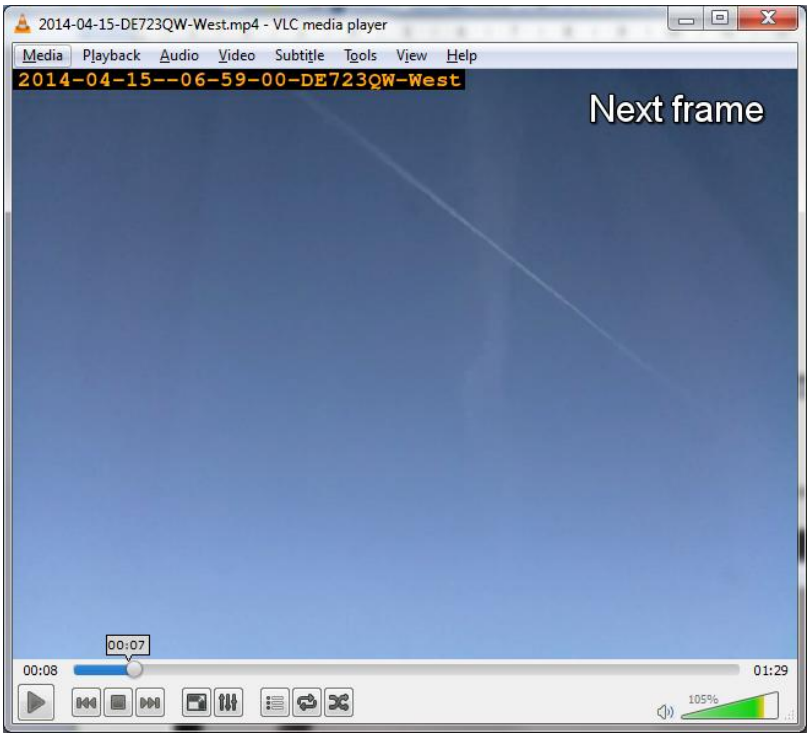
The time-lapse video was reviewed in **VLC Player** – which has the ability to step through 1 frame at a time (by pressing the E key). This allowed closer examination of some video frames for some sections of each video.



MS-Access 2003 Form which lists days where there were clear periods.



Form used to enter trail counts in each half-hourly period during daylight.



VLC Player used to review Time-lapse videos.

4.3 Some Trackers Ran Longer than Others…

As of the date of compiling this report, 3 trackers have been running on most days – and 2 have been running every day. 3 of the original trackers stopped running and volunteers, for various reasons were not able to re-start them. Hence, for 3 trackers, there is not as much usable data. It is hoped, however, that these trackers ran for long enough that the average counts of aircraft etc, at least, are usable in some way.

5. Data Considerations

In this section we consider how data requirements were determined and how the data was analysed after it had been acquired.

5.1 Data Requirements

In this section, we consider what counts were needed to make determinations about trailing patterns.

5.1.1 Counting Detected Aircraft

When the software detected a "new" aircraft, it was counted. Once it had been detected, it was assumed it could remain in range for 90 seconds and therefore it would not be "re-counted" if the tracker temporarily lost the signal from the aircraft (for less than 90 seconds). If the same aircraft was detected by the tracker at periods greater than 90 seconds apart, it would be counted twice.

5.1.2 Aircraft Broadcasting Their Location

Even when originally using the Airnav Radar Box, it was discovered that only a certain proportion of aircraft seemed to be broadcasting their location data (latitude/longitude). Nearly all would broadcast their altitude and call sign.

5.1.3 Military Flights

These were identified based on data in the Database mentioned in Section 3.3.5 and it seemed none of these flights broadcast their location. However, it was at least possible to count them.

5.1.4 Aircraft Altitude

The Tracker software was designed to allow aircraft in certain altitude bands to be counted and these counts were stored separately and also, total counts of aircraft detected above the base altitude were stored. **It was assumed that aircraft at or above 25,000 feet had the potential to form trails and aircraft below this altitude should not form trails.**

5.1.5 Aircraft Range

Depending on where the tracker was sited, it could detect aircraft over 100 miles away. For the purposes of this study, it was considered that an aircraft within 25 miles of the tracker could be seen if it was leaving some type of trail. When the data was analysed, this figure did not seem unreasonable.

5.1.6 "Above Base and In Range"

Hence, most of the counts and figures were considered with regard to the assumption that for a trail to be viewed, an aircraft would have to be in range of the tracker and above the base altitude for forming a trail. A count was therefore kept of aircraft that fulfilled both these criteria.

5.1.7 Main Counts To Be Determined

Taking the factors/assumptions in this section as a whole, the main objective was therefore to try and establish if the following average counts differed on days and/or during periods when trailing was observed compared to days/times when no trailing was observed.

- Count of Planes Detected
- Count of Planes Located (those which had latitude and longitude)
- Count of Planes Above Trail Altitude
- Count of Planes which came within 25 Miles of the tracker's location
- Count of Planes Above Trail Altitude and within 25 Miles of the tracker's location

This also necessitated that the "blueness factor" (see section 4.1.7) was used to determine periods of clear skies, so that a fair comparison of figures could be attempted.

5.1.8 Trail Count Considerations – Camera Field of View

The Raspberry Pi camera has a 49 degree horizontal field of view and a 37 degree vertical field of view[33]. This means that it can only capture about one eighth of the horizontal view and about one fifth of the vertical field of view. This therefore means that trails may have appeared on some days, but not been picked up on any time-lapse videos. Conversely, it means that it is possible that on days when light trailing *was* seen, there may have been many more trails than indicated in the counts entered into the database.

5.2 General Assumptions

In this section, we consider assumptions made in trying to analyse the data.

5.2.1 Weekly Air Traffic Patterns

It is generally assumed that air traffic over the locations where trackers were cited followed a weekly cycle – and it was mainly civilian in nature. That is, the volume of air traffic on every Monday would be roughly the same and, the volume of air traffic on every Tuesday would be roughly the same etc.

5.2.2 Counts of Detected Aircraft and Those Coming Into Range of The Tracker

The trackers were kept in the same physical location during the time they were running – this was important because if they were moved, say, from an upstairs room to a downstairs room, an immediate effect on the ability of the trackers to detect aircraft could be observed. Also, with repeated observation, it could be seen that a tracker may detect aircraft at a greater range in one direction (e.g. looking towards the South West). This was likely to be a result of a clear line-of-sight view to the horizon in this direction. That is, a signal from the aircraft is impeded by buildings, trees etc in between the tracker and the aircraft. However, this should be less of an issue for aircraft that came into the range where trails were to be observed, because the signal would be stronger when the aircraft was nearer to the tracker.)

5.2.3 Daily Count Totals

It was necessary to develop an easy method to sum all the required counts from all the half-hourly periods for which the tracker logged counts – this is discussed further in the section on how database queries were used to collate results.

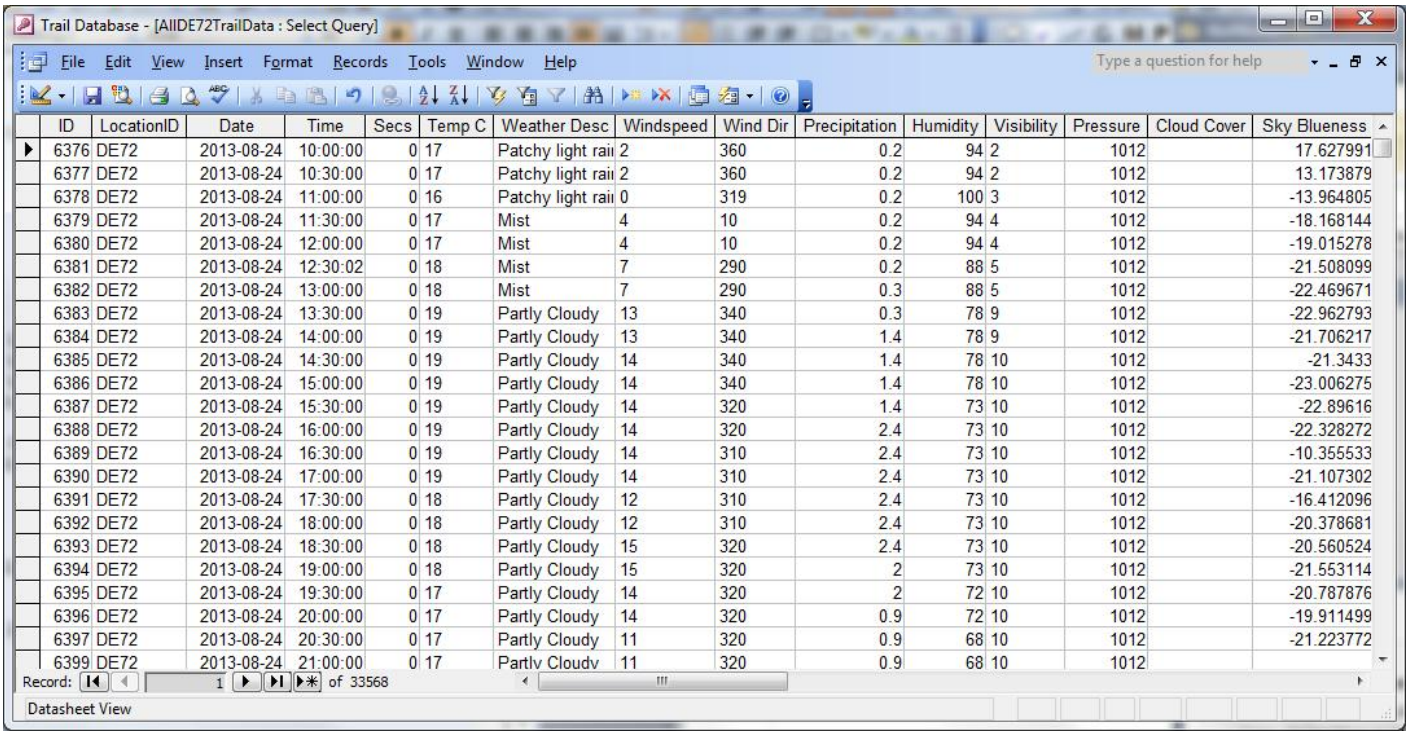
[33] See forum discussion: http://www.raspberrypi.org/forums/viewtopic.php?t=46063&p=364426

6. Database Development

In this section we discuss some details of how the database was structured and also the queries that were developed to process and analyse the data.

6.1 Main Table

When all the data was imported from the trackers, it ended up in a Database table – part of which is shown below. This allowed the data to be filtered, processed, averaged etc in a variety of ways, using queries.



Trail Database - [AllDE72TrailData : Select Query]

File Edit View Insert Format Records Tools Window Help — Type a question for help

ID	LocationID	Date	Time	Secs	Temp C	Weather Desc	Windspeed	Wind Dir	Precipitation	Humidity	Visibility	Pressure	Cloud Cover	Sky Blueness
6376	DE72	2013-08-24	10:00:00	0	17	Patchy light rai	2	360	0.2	94	2	1012		17.627991
6377	DE72	2013-08-24	10:30:00	0	17	Patchy light rai	2	360	0.2	94	2	1012		13.173879
6378	DE72	2013-08-24	11:00:00	0	16	Patchy light rai	0	319	0.2	100	3	1012		-13.964805
6379	DE72	2013-08-24	11:30:00	0	17	Mist	4	10	0.2	94	4	1012		-18.168144
6380	DE72	2013-08-24	12:00:00	0	17	Mist	4	10	0.2	94	4	1012		-19.015278
6381	DE72	2013-08-24	12:30:02	0	18	Mist	7	290	0.2	88	5	1012		-21.508099
6382	DE72	2013-08-24	13:00:00	0	18	Mist	7	290	0.3	88	5	1012		-22.469671
6383	DE72	2013-08-24	13:30:00	0	19	Partly Cloudy	13	340	0.3	78	9	1012		-22.962793
6384	DE72	2013-08-24	14:00:00	0	19	Partly Cloudy	13	340	1.4	78	9	1012		-21.706217
6385	DE72	2013-08-24	14:30:00	0	19	Partly Cloudy	14	340	1.4	78	10	1012		-21.3433
6386	DE72	2013-08-24	15:00:00	0	19	Partly Cloudy	14	340	1.4	78	10	1012		-23.006275
6387	DE72	2013-08-24	15:30:00	0	19	Partly Cloudy	14	320	1.4	73	10	1012		-22.89616
6388	DE72	2013-08-24	16:00:00	0	19	Partly Cloudy	14	320	2.4	73	10	1012		-22.328272
6389	DE72	2013-08-24	16:30:00	0	19	Partly Cloudy	14	310	2.4	73	10	1012		-10.355533
6390	DE72	2013-08-24	17:00:00	0	19	Partly Cloudy	14	310	2.4	73	10	1012		-21.107302
6391	DE72	2013-08-24	17:30:00	0	18	Partly Cloudy	12	310	2.4	73	10	1012		-16.412096
6392	DE72	2013-08-24	18:00:00	0	18	Partly Cloudy	12	310	2.4	73	10	1012		-20.378681
6393	DE72	2013-08-24	18:30:00	0	18	Partly Cloudy	15	320	2.4	73	10	1012		-20.560524
6394	DE72	2013-08-24	19:00:00	0	18	Partly Cloudy	15	320	2	73	10	1012		-21.553114
6395	DE72	2013-08-24	19:30:00	0	17	Partly Cloudy	14	320	2	72	10	1012		-20.787876
6396	DE72	2013-08-24	20:00:00	0	17	Partly Cloudy	14	320	0.9	72	10	1012		-19.911499
6397	DE72	2013-08-24	20:30:00	0	17	Partly Cloudy	11	320	0.9	68	10	1012		-21.223772
6399	DE72	2013-08-24	21:00:00	0	17	Partly Cloudy	11	320	0.9	68	10	1012		

Record: 1 of 33568

Datasheet View

Partial Datasheet view of Main Database Table

6.2 Statistical Considerations

The author freely admits that the way the results have been generated may not be the most appropriate or accurate. It is quite possible that using methods involving variance and standard deviations may have been more usual and more accurate.

As it was, the general approach was simply to try and produce average figures for counts over a period of weeks and then compare these averages on days of trailing and no trailing.

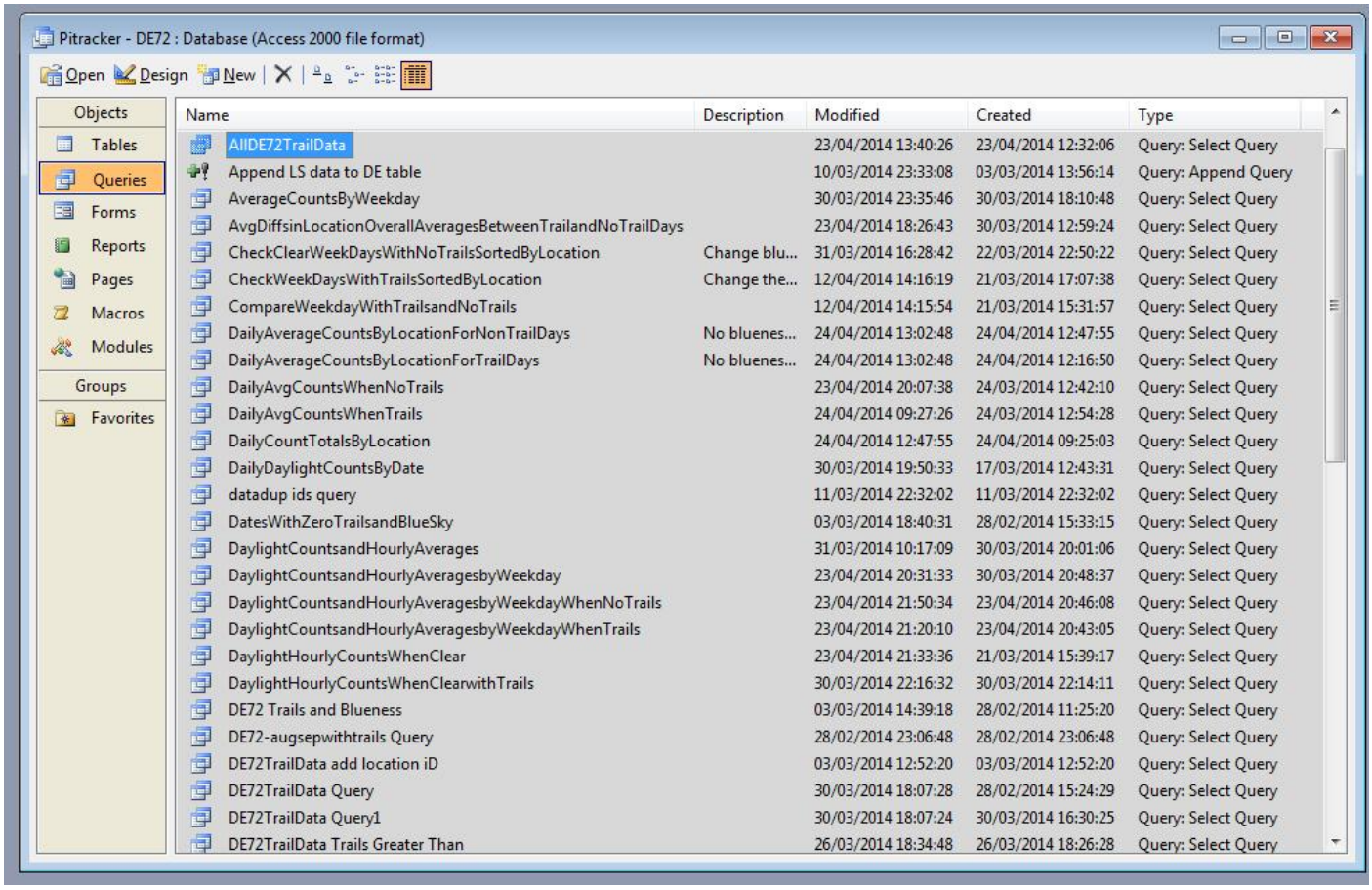
Anyone who is interested in generating results, based on different methods, is welcome to contact the author for a copy of the database or some version of it, for example, converted into Microsoft Excel format.

6.3 Database Query Development

Essentially, queries were developed for 2 purposes:

- To facilitate database table building (i.e. copy data from a holding/import table into one main table of data)
- To generate and calculate average figures by several methods.

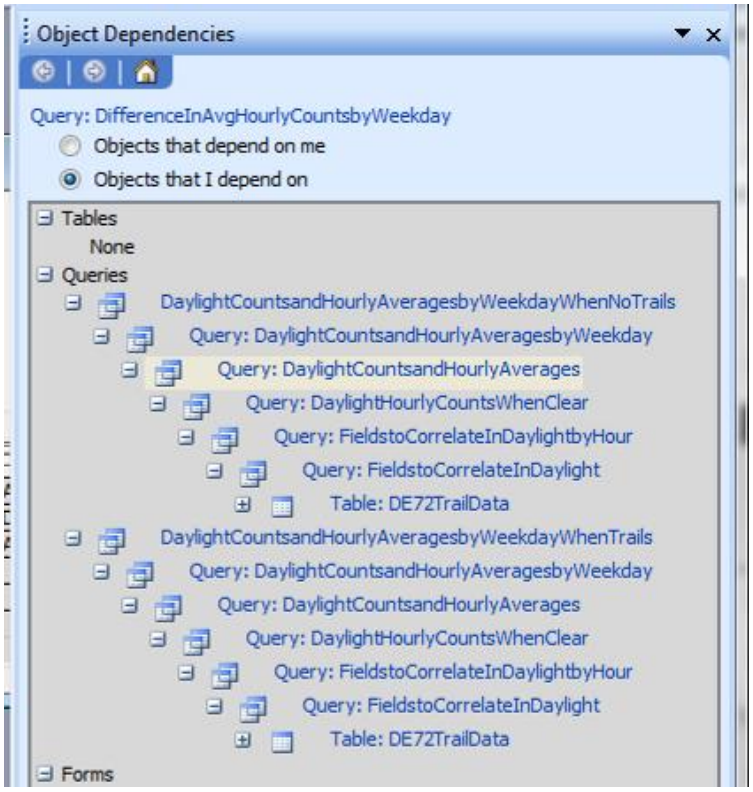
This was a somewhat complicated task – because first, half-hourly observations had to be collated and then summed to give daily figures. Additionally, it was necessary to consider weekday averages, as it was seen there is generally less detected air traffic at the weekend than during the week.



A view of Some of Database Queries Developed

6.3.1 Query Dependency

One feature in the Access Database Package allows one to show the dependency of one query on another. Below, we can see the "path" of the query as outlined in sections 6.6.1 to 6.6.4:



6.4 Comparisons Taking into Account Clear Skies (Blueness Factor)

Queries needed to take into account whether the sky was clear or not, so that a fair comparison could be drawn. This was achieved by considering the blueness factor – as discussed in section 4.1.7, "blueness factors" of greater than about 50 would indicate clear enough skies for trails to be seen, so this figure was generally used as a "baseline" for comparisons.

6.5 Comparisons Using Overall Average Counts

Several queries were developed which did not take account of the sky blueness factor – they simply averaged out figures for days where trails were recorded compared to days where no trails were recorded.

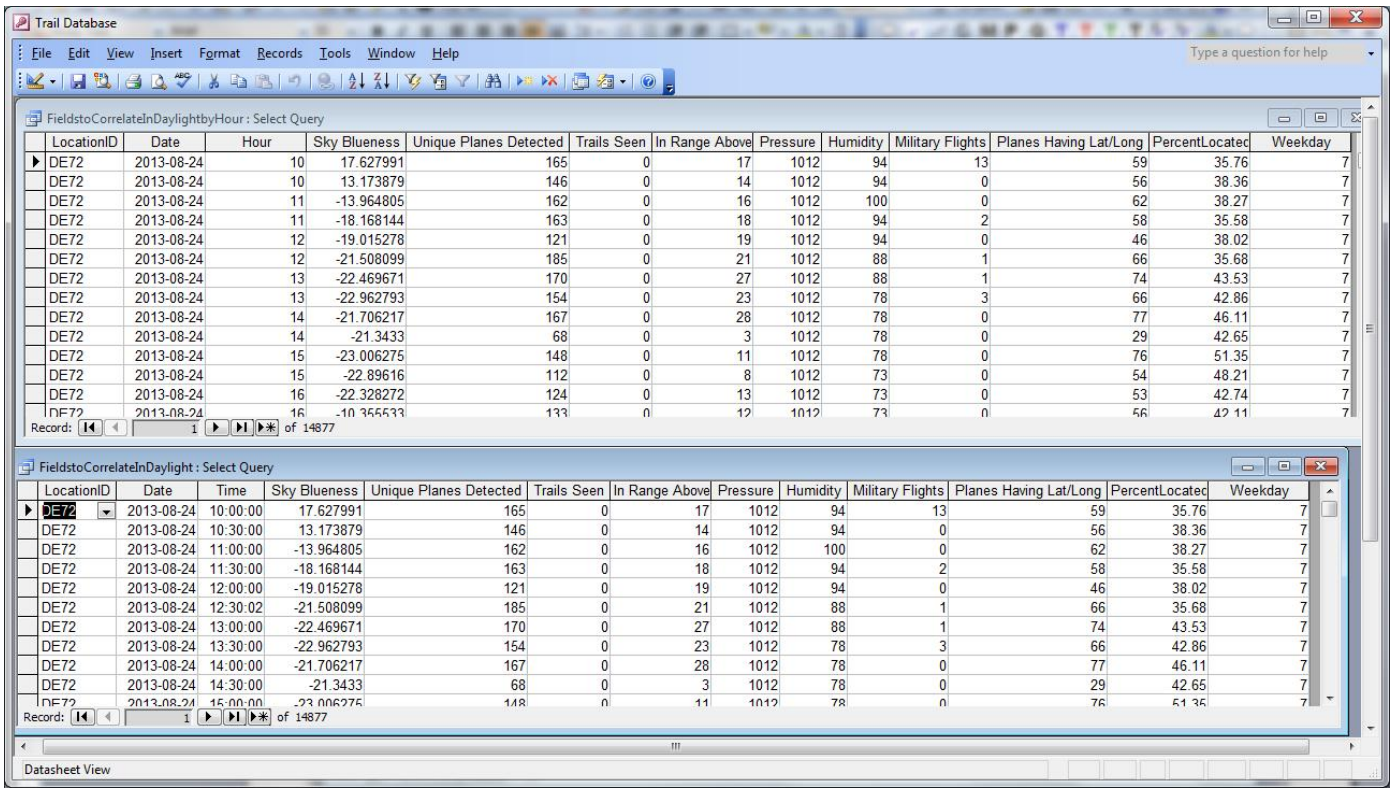
6.6 Notes on Queries Developed

6.6.1 "Percentage Located" Calculation

If it was true that, as some people claimed, chemtrails were the result of clandestine spraying by the military or some other group, it was considered that this figure might give some indication of this. The logic behind this consideration is that "clandestine flights" would be less likely to broadcast their position in ADS-B messages, so during hours or days of trailing, the proportion of aircraft that were **not** broadcasting their position should increase.

6.6.2 Selecting Records for Daylight Hours

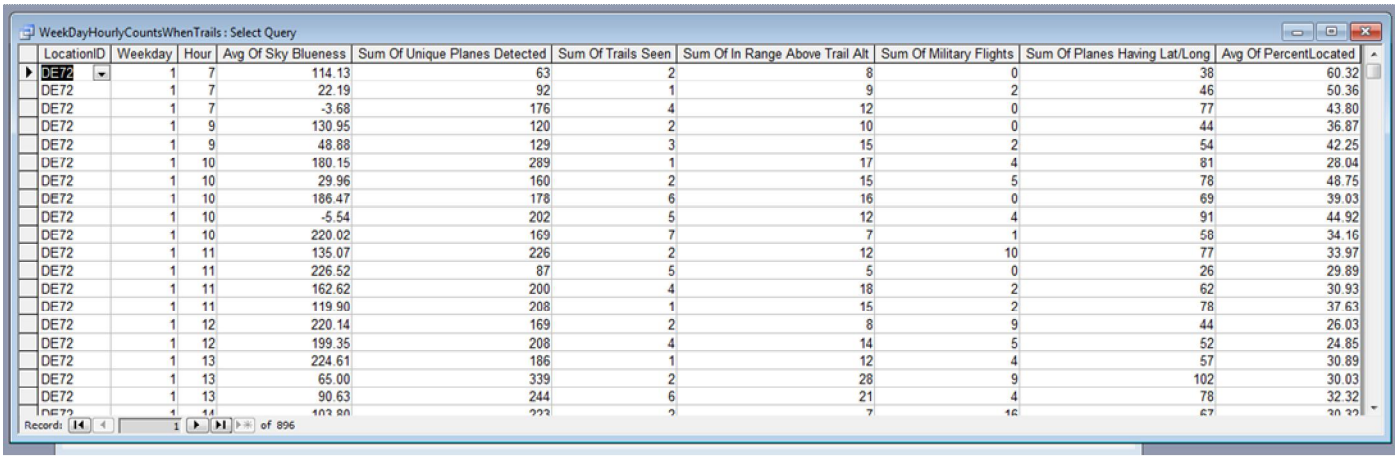
2 Queries were made initially - "FieldstoCorrelateInDaylight" and "FieldstoCorrelateInDaylightbyHour". These selected fields and collated hourly results, while generating a "weekday" field for the date in question. These queries checked for a non-zero blueness factor, which meant only records that were generated in daylight hours were selected and used in calculations.

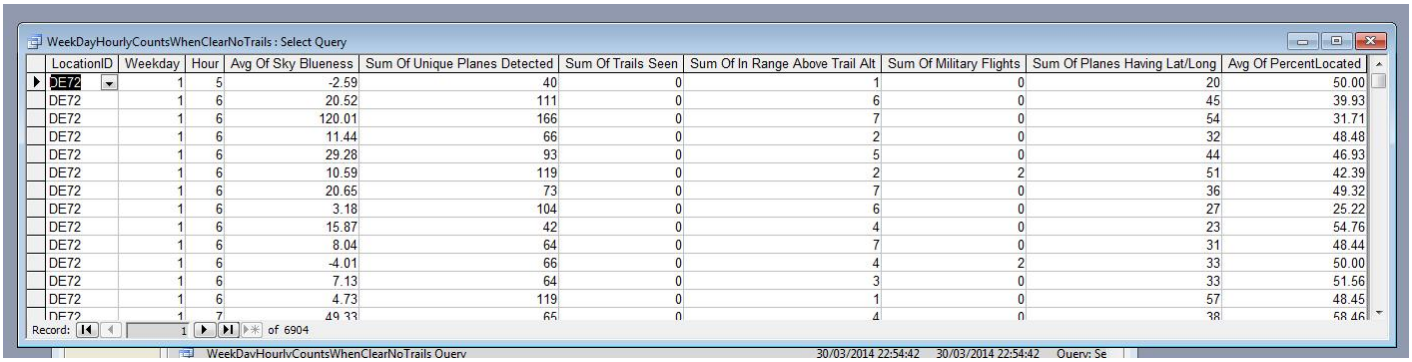


6.6.3 Grouping and Summing Records by Weekday

Two further queries were next created - “Week Day Hourly Counts When Trails” and “Week Day Hourly Counts When No Trails.”

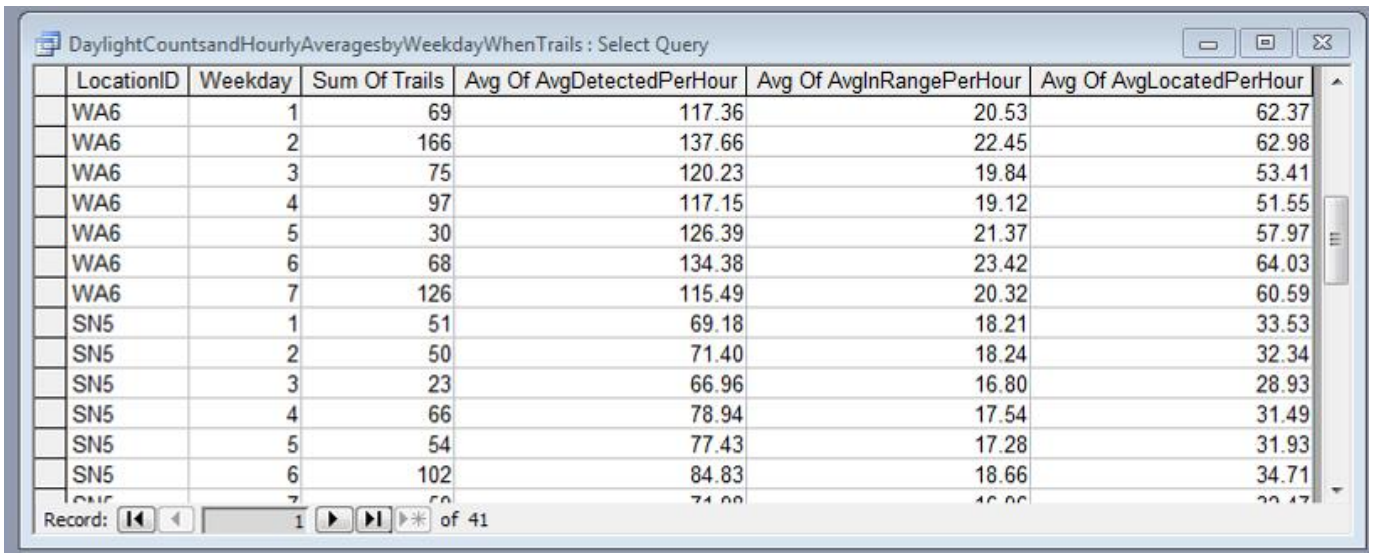
These summed records from the “FieldstoCorrelateInDaylightbyHour” query to give figures for each *weekday* from the sets of records for each location:





6.6.4 Averaging Out Daylight Hourly Counts for Trailing Days and Non-Trailing Days

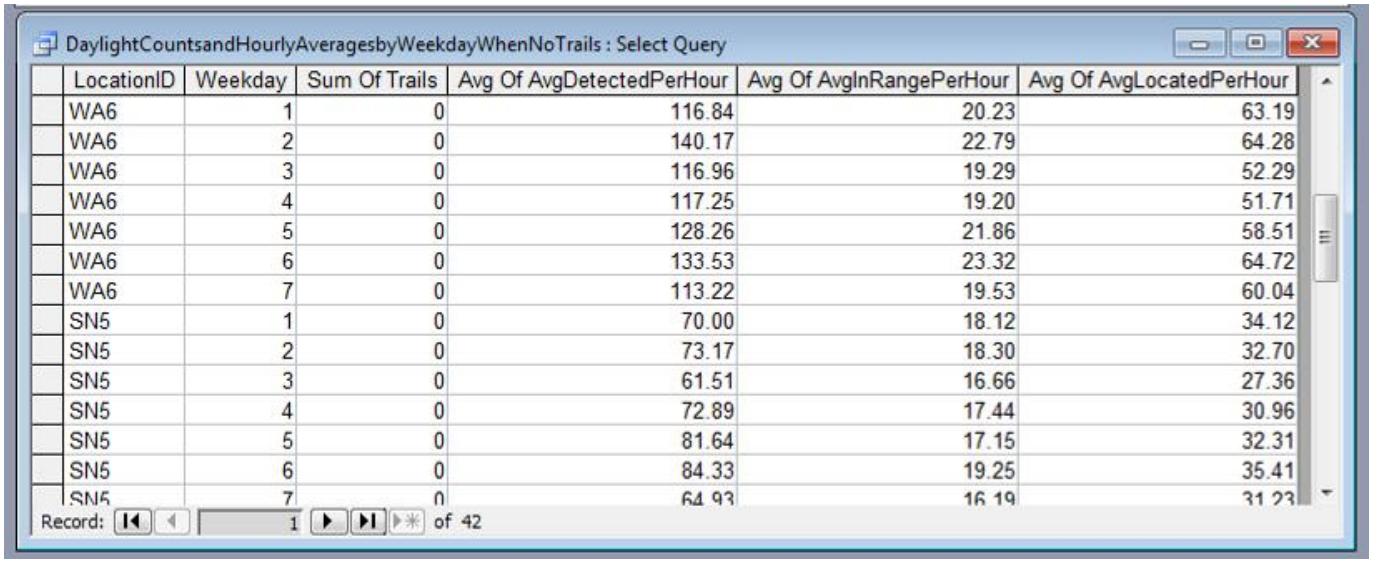
Next, queries were generated to calculate average daylight hourly counts for days when trails were seen and days when no trails were seen. These checked the "Blueness factor" in each record for the periods of trailing that was greater than 0. (The logic being that all records where trails were actually noted would probably have a value greater than 0.)



DaylightCountsandHourlyAveragesbyWeekdayWhenTrails : Select Query

LocationID	Weekday	Sum Of Trails	Avg Of AvgDetectedPerHour	Avg Of AvgInRangePerHour	Avg Of AvgLocatedPerHour
WA6	1	69	117.36	20.53	62.37
WA6	2	166	137.66	22.45	62.98
WA6	3	75	120.23	19.84	53.41
WA6	4	97	117.15	19.12	51.55
WA6	5	30	126.39	21.37	57.97
WA6	6	68	134.38	23.42	64.03
WA6	7	126	115.49	20.32	60.59
SN5	1	51	69.18	18.21	33.53
SN5	2	50	71.40	18.24	32.34
SN5	3	23	66.96	16.80	28.93
SN5	4	66	78.94	17.54	31.49
SN5	5	54	77.43	17.28	31.93
SN5	6	102	84.83	18.66	34.71

Record: 1 of 41



DaylightCountsandHourlyAveragesbyWeekdayWhenNoTrails : Select Query

LocationID	Weekday	Sum Of Trails	Avg Of AvgDetectedPerHour	Avg Of AvgInRangePerHour	Avg Of AvgLocatedPerHour
WA6	1	0	116.84	20.23	63.19
WA6	2	0	140.17	22.79	64.28
WA6	3	0	116.96	19.29	52.29
WA6	4	0	117.25	19.20	51.71
WA6	5	0	128.26	21.86	58.51
WA6	6	0	133.53	23.32	64.72
WA6	7	0	113.22	19.53	60.04
SN5	1	0	70.00	18.12	34.12
SN5	2	0	73.17	18.30	32.70
SN5	3	0	61.51	16.66	27.36
SN5	4	0	72.89	17.44	30.96
SN5	5	0	81.64	17.15	32.31
SN5	6	0	84.33	19.25	35.41

Record: 1 of 42

6.6.5 Calculating Difference in Hourly Counts between Days of Trailing and No Trailing

Another query was generated called “DifferenceInAvgHourlyCountsbyWeekday” – this subtracted the values calculated in the queries in section 6.6.4. In this query, the average value calculated on a weekday with trails was subtracted *from* the same value for the average value for a weekday when no trails were observed. Here we see one portion of the query for calculating the difference in the “Average Number Detected” (per hour) value:

```
DaylightCountsandHourlyAveragesbyWeekdayWhenNoTrails.[Avg Of AvgDetectedPerHour] -
DaylightCountsandHourlyAveragesbyWeekdayWhenTrails.[Avg Of AvgDetectedPerHour] AS [Diff Avg
Detected]
```

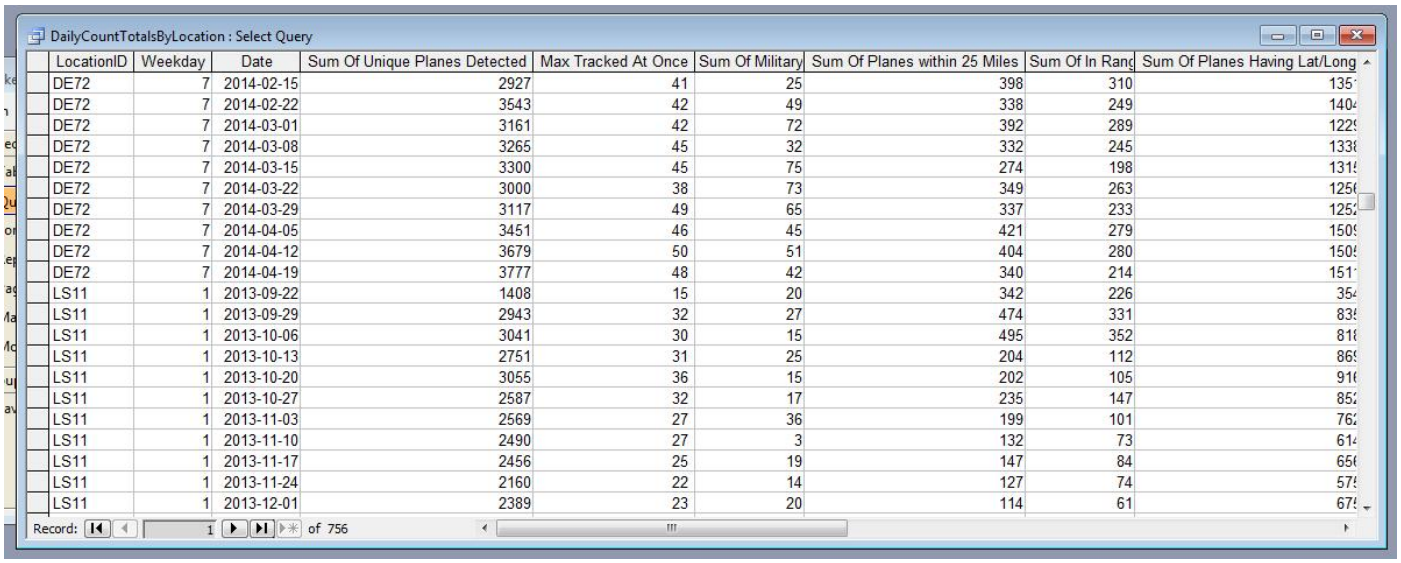
The results of this query are discussed in section 7.4.

6.7 Overall Daily Average Counts – Ignoring Blueness of Sky

In an attempt remove any bias caused by use of the blueness calculation, a simpler set of queries were generated to calculate overall daily average counts for days of trailing and no trailing, thus:

6.7.1 Daily Counts – with Weekday

These were calculated by a query called “DailyCountTotalsByLocation”



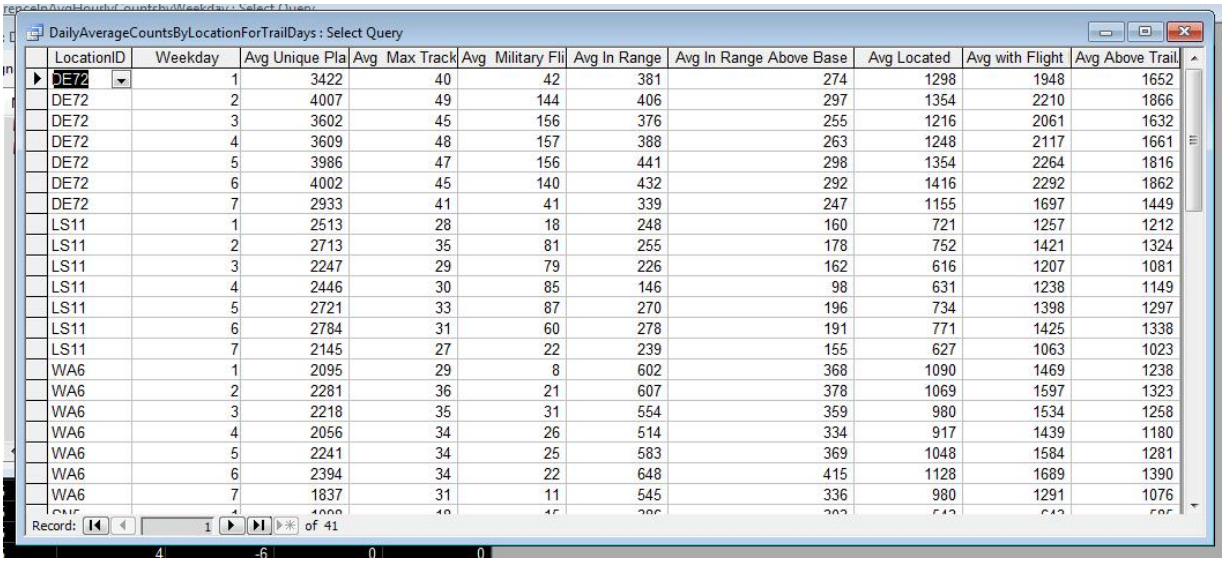
DailyCountTotalsByLocation : Select Query

LocationID	Weekday	Date	Sum Of Unique Planes Detected	Max Tracked At Once	Sum Of Military	Sum Of Planes within 25 Miles	Sum Of In Rang	Sum Of Planes Having Lat/Long
DE72	7	2014-02-15	2927	41	25	398	310	135
DE72	7	2014-02-22	3543	42	49	338	249	140
DE72	7	2014-03-01	3161	42	72	392	289	122
DE72	7	2014-03-08	3265	45	32	332	245	133
DE72	7	2014-03-15	3300	45	75	274	198	131
DE72	7	2014-03-22	3000	38	73	349	263	125
DE72	7	2014-03-29	3117	49	65	337	233	125
DE72	7	2014-04-05	3451	46	45	421	279	150
DE72	7	2014-04-12	3679	50	51	404	280	150
DE72	7	2014-04-19	3777	48	42	340	214	151
LS11	1	2013-09-22	1408	15	20	342	226	35
LS11	1	2013-09-29	2943	32	27	474	331	83
LS11	1	2013-10-06	3041	30	15	495	352	81
LS11	1	2013-10-13	2751	31	25	204	112	86
LS11	1	2013-10-20	3055	36	15	202	105	91
LS11	1	2013-10-27	2587	32	17	235	147	85
LS11	1	2013-11-03	2569	27	36	199	101	76
LS11	1	2013-11-10	2490	27	3	132	73	61
LS11	1	2013-11-17	2456	25	19	147	84	65
LS11	1	2013-11-24	2160	22	14	127	74	57
LS11	1	2013-12-01	2389	23	20	114	61	67

Record: 1 of 756

6.7.2 Average of Counts for a Weekday - for Trailing Days and Non-Trailing Days

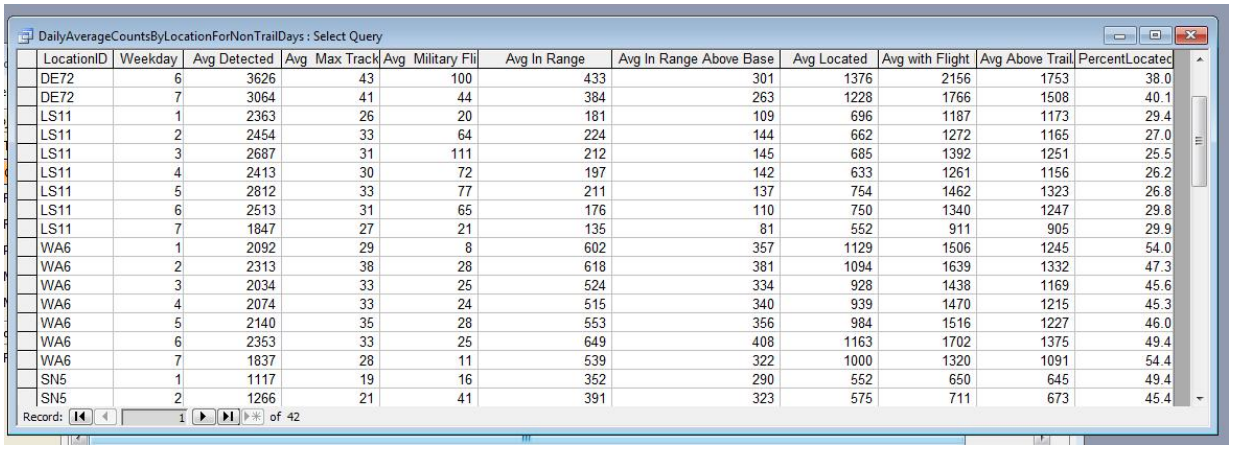
In the same way as is shown in section 6.6.3 and 6.6.4, queries were generated to average counts on trailing and non-trailing days – "Daily Average Counts By Location For Trail Days" and "Daily Average Counts By Location For Non Trail Days"



DailyAverageCountsByLocationForTrailDays : Select Query

LocationID	Weekday	Avg Unique Pla	Avg Max Track	Avg Military Fli	Avg In Range	Avg In Range Above Base	Avg Located	Avg with Flight	Avg Above Trail
DE72	1	3422	40	42	381	274	1298	1948	1652
DE72	2	4007	49	144	406	297	1354	2210	1866
DE72	3	3602	45	156	376	255	1216	2061	1632
DE72	4	3609	48	157	388	263	1248	2117	1661
DE72	5	3986	47	156	441	298	1354	2264	1816
DE72	6	4002	45	140	432	292	1416	2292	1862
DE72	7	2933	41	41	339	247	1155	1697	1449
LS11	1	2513	28	18	248	160	721	1257	1212
LS11	2	2713	35	81	255	178	752	1421	1324
LS11	3	2247	29	79	226	162	616	1207	1081
LS11	4	2446	30	85	146	98	631	1238	1149
LS11	5	2721	33	87	270	196	734	1398	1297
LS11	6	2784	31	60	278	191	771	1425	1338
LS11	7	2145	27	22	239	155	627	1063	1023
WA6	1	2095	29	8	602	368	1090	1469	1238
WA6	2	2281	36	21	607	378	1069	1597	1323
WA6	3	2218	35	31	554	359	980	1534	1258
WA6	4	2056	34	26	514	334	917	1439	1180
WA6	5	2241	34	25	583	369	1048	1584	1281
WA6	6	2394	34	22	648	415	1128	1689	1390
WA6	7	1837	31	11	545	336	980	1291	1076

Record: 1 of 41



DailyAverageCountsByLocationForNonTrailDays : Select Query

LocationID	Weekday	Avg Detected	Avg Max Track	Avg Military Fli	Avg In Range	Avg In Range Above Base	Avg Located	Avg with Flight	Avg Above Trail	PercentLocated
DE72	6	3626	43	100	433	301	1376	2156	1753	38.0
DE72	7	3064	41	44	384	263	1228	1766	1508	40.1
LS11	1	2363	26	20	181	109	696	1187	1173	29.4
LS11	2	2454	33	64	224	144	662	1272	1165	27.0
LS11	3	2687	31	111	212	145	685	1392	1251	25.5
LS11	4	2413	30	72	197	142	633	1261	1156	26.2
LS11	5	2812	33	77	211	137	754	1462	1323	26.8
LS11	6	2513	31	65	176	110	750	1340	1247	29.8
LS11	7	1847	27	21	135	81	552	911	905	29.9
WA6	1	2092	29	8	602	357	1129	1506	1245	54.0
WA6	2	2313	38	28	618	381	1094	1639	1332	47.3
WA6	3	2034	33	25	524	334	928	1438	1169	45.6
WA6	4	2074	33	24	515	340	939	1470	1215	45.3
WA6	5	2140	35	28	553	356	984	1516	1227	46.0
WA6	6	2353	33	25	649	408	1163	1702	1375	49.4
WA6	7	1837	28	11	539	322	1000	1320	1091	54.4
SN5	1	1117	19	16	352	290	552	650	645	49.4
SN5	2	1266	21	41	391	323	575	711	673	45.4

Record: 1 of 42

6.7.3 Difference in Daily Counts for Trailing Days and Non-Trailing Days

This query subtracted results from the previous 2 queries. Here, we can see one part of the query to calculate the difference in average detected plane counts.

```
[DailyAverageCountsByLocationFor NonTrailDays].[Avg Detected] -
[DailyAverageCountsByLocationFor TrailDays].[Avg Unique Planes Detected]
```

The results of this query are shown in section 7.5.

6.8 Number of Days Trails Were Observed On

Another query "NoLocationsSeeingTrails on a Date" was developed to determine how many locations saw trailing on the same day, and how many days trails were observed on. This result is shown in section 7.6.

6.9 Maximum Trails Seen on One Day

A query called "Total Trails on Date" to calculate the number of trails seen on the dates which was sorted by location. It must be noted that not every tracker was running on every day. This could then be further sorted, in descending order, to show which days had the most trails observed. These results are shown in section 7.7.

6.10 Days with High Numbers of Trails and Days with High Numbers of Detected Aircraft

One of the main areas of interest was to try and find out if there was any correspondence between high numbers of aircraft being detected (and/or coming into visible range of the tracker) and high numbers of trails being counted. The "Total Trails on Date" query could also be sorted by location and "Detected Aircraft Count". This allowed a basic comparison to be made. These results are shown in section 7.8.

6.11 Weather Anomalies

Another observation on some of the time lapse video footage were apparent weather anomalies, which are discussed in section 7.9.

6.12 Identification of Flights Leaving Trails

Another goal was to try and identify, from the time lapse video and charts which were generated, which flights were creating trails. (In 2010, I had done this on only 2 occasions using the Airnav Radarbox[34]). These new results are shown in section 7.9.

[34] http://www.checktheevidence.co.uk/cms/index.php?option=com_content&task=view&id=291&Itemid=50

7. Results

This section shows the results of the queries developed and described in section 6. In the data shown, Weekday 1 is Sunday and Weekday 7 is Saturday.

7.1 Amount of Data Collected from Each Tracker

The table below shows the approximate number of days of data collected from each tracker (up to 22 Apr 2014)

Location	CountOfDate
DE72	228
LS11	102
WA6	162
SN5	106
NE16	89
PO33	45

7.2 Note about Percentage of Aircraft Located Figure

If clandestine planes are operating – broadcasting only their altitude or their ID, then the percentage located figure may decrease. As can be seen if all the data is studied, the "percentage located" figure varied between about 30% of aircraft and 50% - depending largely, it seemed, on the total number of aircraft detected rather than anything else. However, there could be a number of reasons for the variability in this figure.

7.3 Note about Daily Average Counts for Weekdays and Weekends

It was noted that the average counts of detected aircraft showed little variation on Mondays-Fridays and were most usually reduced on a Saturday and Slightly reduced (compared to weekday counts) on a Sunday. This can be seen in a Snapshot from 02 May from the WA6 and DE72 Trackers

Day	Found	With Lat Long	With Flt Num	In Range	Above Base	In Range Above Base	Military	Max At Once	% Located
Thu	4565	1814	2635	539	2407	390	101	53	39.7
Wed	4826	1749	2689	522	2269	332	120	45	36.2
Tue	4556	1615	2506	351	2283	277	143	46	35.4
Mon	4355	1672	2492	433	2241	281	130	55	38.4
Sun	4074	1675	2297	475	2100	331	42	45	41.1
Sat	3647	1549	2123	462	1884	315	27	48	42.5
Fri	4360	1798	2574	496	2308	324	62	53	41.2

DE72 – 02 May 2013 - 7 Days of Stats on Flights Detected

Day	Found	With Lat Long	With Flt Num	In Range	Above Base	In Range Above Base	Military	Max At Once	% Located
Thu	2608	1267	1829	746	1428	461	20	42	48.6
Wed	2428	1158	1697	671	1369	422	22	32	47.7
Tue	2586	1175	1714	702	1391	442	26	38	45.4
Mon	2585	1230	1787	745	1371	478	28	41	47.6
Sun	2360	1252	1655	706	1346	449	14	32	53.1
Sat	1998	1133	1435	638	1202	416	13	35	56.7
Fri	2648	1298	1861	742	1436	462	21	39	49

WA6 - 02 May 2013 - Last 7 Days of Stats on Flights Detected

7.4 Finally! Calculating Difference in Hourly Counts between Days of Trailing and No Trailing

The results are shown in table form, rather than as a screen capture.

7.4.1 Diff Avg Detected Figure

This figure is the difference in the average number of planes detected per hour, calculated by subtracting the average number of planes detected during daylight hours on days of some trailing from the average number of planes per hour detected during daylight hours on days of no trailing.

DifferenceInAvgHourlyCountsbyWeekday				
Location	Weekday	Diff Avg Detected	Diff Avg in Range	Diff Avg Located
DE72	1	-5.80	0.60	1.70
DE72	2	-5.90	-0.30	0.20
DE72	3	-6.30	0.20	0.20
DE72	4	-11.40	-0.20	-2.20
DE72	5	-5.10	0.00	0.40
DE72	6	-10.50	0.20	-0.80
DE72	7	0.70	0.20	1.00
LS11	1	1.30	-1.30	2.10
LS11	2	-11.00	-0.90	-2.80
LS11	3	1.40	-1.50	-0.20
LS11	4	-16.20	-0.10	-3.60
LS11	5	-7.70	-1.50	-2.20
LS11	6	-16.30	-1.10	-2.00
LS11	7	1.50	-2.30	0.00
WA6	1	-0.50	-0.30	0.80
WA6	2	2.50	0.30	1.30
WA6	3	-3.30	-0.50	-1.10
WA6	4	0.10	0.10	0.20
WA6	5	1.90	0.50	0.50
WA6	6	-0.90	-0.10	0.70
WA6	7	-2.30	-0.80	-0.60
SN5	1	0.80	-0.10	0.60
SN5	2	1.80	0.10	0.40
SN5	3	-5.40	-0.10	-1.60
SN5	4	-6.00	-0.10	-0.50
SN5	5	4.20	-0.10	0.40
SN5	6	-0.50	0.60	0.70
SN5	7	-7.10	-0.80	-1.20
NE16	1	-0.40	-0.20	0.00
NE16	2	7.80	0.80	4.40
NE16	3	-0.50	-0.10	0.10
NE16	4	-1.50	-0.20	-1.10
NE16	5	-4.20	-0.20	-1.00
NE16	6	-0.80	-0.60	-0.70
NE16	7	6.00	0.60	3.40
PO33	1	-5.70	-2.30	-4.10
PO33	2	0.30	-0.50	0.80
PO33	4	-4.20	0.60	0.70
PO33	5	1.30	0.20	1.20
PO33	6	-2.90	-1.20	-0.10
PO33	7	6.40	0.70	4.50

As can be seen, these differences in the hourly averages are small. For the DE72 Tracker, which had collected the most data, the data was the most consistent, showing a slightly higher detected number on trailing days, but no real difference in the average detected coming into range of the tracker.

For the other trackers, the picture is more mixed – the WA6 tracker, which had about 70% the amount of captured data as the DE72 tracker, there was very little overall detectable difference in average hourly traffic on “trailing” and “non-trailing” days.

Re-running the query with a negative blueness factor (e.g. -2) made some of the differences smaller, for those stations which had more data:

DifferenceInAvgHourlyCountsbyWeekday				
Location	**Weekday**	**Diff Avg Detected**	**Diff Avg in Range**	**Diff Avg Located**
DE72	1	-2.10	0.60	0.80
DE72	2	-3.10	-0.20	0.20
DE72	3	1.40	0.70	1.80
DE72	4	-5.90	0.00	-0.90
DE72	5	0.10	0.20	1.10
DE72	6	-0.40	0.90	1.30
DE72	7	-0.10	-0.20	0.80
LS11	1	-1.70	-1.70	0.80
LS11	2	-20.80	-2.00	-4.50
LS11	3	4.50	-1.50	0.50
LS11	4	-23.10	0.10	-4.90
LS11	5	-5.20	-1.20	-1.80
LS11	6	-15.80	-0.30	-3.00
LS11	7	10.10	-2.20	2.20
WA6	1	-2.50	-0.40	0.20
WA6	2	4.10	0.70	1.80
WA6	3	-3.50	-0.20	-1.10
WA6	4	0.90	0.40	0.80
WA6	5	-2.20	0.00	-1.00
WA6	6	0.00	0.00	-0.30
WA6	7	-4.20	-1.10	-1.60
SN5	1	1.90	0.10	0.90
SN5	2	1.60	-0.60	0.00
SN5	3	-3.80	-0.30	-1.40
SN5	4	-5.90	-0.20	-0.10
SN5	5	3.60	-0.40	0.30
SN5	6	-3.70	-0.20	-0.70
SN5	7	-5.70	-0.60	-1.00
NE16	1	-2.90	-0.40	-1.00
NE16	2	-1.30	-0.90	2.10
NE16	3	0.40	-0.10	0.10
NE16	4	-1.80	-0.30	-1.00
NE16	5	-3.40	-0.20	-0.70
NE16	6	-2.40	-0.70	-1.60
NE16	7	5.70	0.20	3.10
PO33	1	-3.70	-2.50	-2.70
PO33	2	-1.10	-0.80	-0.60
PO33	4	-5.40	0.70	1.50
PO33	5	-4.60	-0.50	-2.10
PO33	6	-14.00	-3.80	-7.10
PO33	7	2.10	1.40	4.00

7.5 Difference in Daily Counts for Trailing Days and Non-Trailing Days

This table shows the results for daily (rather than hourly) average counts on days of trailing and when no trailing was recorded (but the blueness factor is not taken into account).

DiffDailyAvgCountsbyWeekDayLocation

Location	Weekday	Diff Detected	Diff Max Tracked	Diff Military Flights	Diff In Range	Diff In Range Above Base	Diff Avg Located	Diff Avg with Flight No	Diff Avg Above TrailAlt
DE72	1	-243.00	-2.00	-15.00	2.00	9.00	13.00	-99.00	27.00
DE72	2	-393.00	-3.00	-41.00	-7.00	-10.00	-21.00	-107.00	-107.00
DE72	3	-202.00	-1.00	-22.00	9.00	8.00	4.00	-44.00	-39.00
DE72	4	-542.00	-8.00	-50.00	-43.00	-24.00	-154.00	-317.00	-238.00
DE72	5	-442.00	-3.00	-36.00	-36.00	-20.00	-63.00	-173.00	-124.00
DE72	6	-376.00	-2.00	-40.00	1.00	8.00	-40.00	-135.00	-109.00
DE72	7	132.00	0.00	3.00	45.00	16.00	74.00	69.00	60.00
LS11	1	-150.00	-2.00	2.00	-67.00	-51.00	-25.00	-70.00	-38.00
LS11	2	-259.00	-3.00	-17.00	-31.00	-34.00	-90.00	-150.00	-159.00
LS11	3	440.00	3.00	32.00	-13.00	-17.00	68.00	185.00	170.00
LS11	4	-32.00	0.00	-13.00	51.00	44.00	2.00	23.00	8.00
LS11	5	91.00	1.00	-10.00	-59.00	-58.00	21.00	65.00	26.00
LS11	6	-272.00	0.00	5.00	-102.00	-82.00	-21.00	-85.00	-91.00
LS11	7	-298.00	0.00	-1.00	-104.00	-74.00	-75.00	-152.00	-119.00
WA6	1	-3.00	0.00	0.00	0.00	-10.00	39.00	38.00	7.00
WA6	2	32.00	2.00	7.00	11.00	3.00	26.00	42.00	9.00
WA6	3	-184.00	-2.00	-7.00	-31.00	-25.00	-52.00	-96.00	-89.00
WA6	4	19.00	-1.00	-2.00	2.00	6.00	23.00	31.00	35.00
WA6	5	-101.00	1.00	3.00	-30.00	-12.00	-64.00	-67.00	-55.00
WA6	6	-40.00	-1.00	3.00	1.00	-8.00	35.00	13.00	-15.00
WA6	7	0.00	-3.00	0.00	-6.00	-13.00	20.00	29.00	15.00
SN5	1	19.00	1.00	0.00	-33.00	-12.00	9.00	7.00	59.00
SN5	2	113.00	1.00	20.00	16.00	6.00	19.00	40.00	34.00
SN5	3	-397.00	-3.00	-10.00	-76.00	-85.00	-171.00	-230.00	-225.00
SN5	4	-316.00	-5.00	-10.00	-41.00	-50.00	-83.00	-157.00	-155.00
SN5	5	-160.00	1.00	8.00	-93.00	-73.00	-119.00	-114.00	-119.00
SN5	6	-71.00	0.00	-11.00	-13.00	4.00	3.00	-23.00	-5.00
SN5	7	-128.00	-3.00	-7.00	35.00	9.00	6.00	-23.00	-13.00
NE16	1	-31.00	0.00	7.00	-8.00	-5.00	-7.00	-41.00	-31.00
NE16	2	-131.00	5.00	-32.00	-25.00	-6.00	-23.00	-91.00	-39.00
NE16	3	111.00	4.00	-12.00	9.00	7.00	64.00	138.00	50.00
NE16	4	-47.00	-3.00	1.00	-7.00	-6.00	-43.00	-48.00	-73.00
NE16	5	-377.00	-10.00	-17.00	-37.00	-20.00	-113.00	-303.00	-122.00
NE16	6	32.00	2.00	-18.00	-32.00	-18.00	2.00	27.00	0.00
NE16	7	154.00	6.00	13.00	32.00	19.00	99.00	150.00	111.00
PO33	1	-227.00	-3.00	0.00	-111.00	-83.00	-178.00	-161.00	-160.00
PO33	2	1.00	0.00	1.00	-14.00	-16.00	17.00	-9.00	38.00
PO33	4	37.00	-1.00	-8.00	48.00	20.00	92.00	18.00	72.00
PO33	5	56.00	0.00	-2.00	1.00	-2.00	46.00	51.00	56.00
PO33	6	-404.00	-4.00	-2.00	-82.00	-63.00	-185.00	-259.00	-158.00
PO33	7	-187.00	-3.00	1.00	-70.00	-49.00	-100.00	-158.00	-87.00

On first looks, it appears that, overall and on a number of weekdays, more flights are detected on days with trails – as we get negative figures when we subtract the trailing days' figures from the non-trailing days. However, the picture is not consistent, yet it does not seem completely random either.

7.6 Number of Days Trails Were Observed On and No. of locations Which Saw Trails on Same Day

Between 28 Aug 2013 and 22 Apr 2014, trails were observed in 1 or more locations on 161 days from about 233 Days across 6 locations. The table below shows the dates where the most numbers of trails were seen – totalled together from all 6 locations.

NoLocationsSeeingTrails on a Date		
Date	**Num Locatoions**	**SumOfTrails Seen**
2013-11-30	6	165
2013-11-25	5	143
2013-11-10	6	135
2013-12-06	6	106

It was often the case that trailing was seen in more than 1 location on the same day, when more than 1 tracker was running on that day. This table shows how many days trails were seen at different locations:

Num Locations	Count Of NoLocationsSeeingTrails on Same Date	% of Total Days
1	16	10%
2	37	23%
3	43	27%
4	24	15%
5	11	7%
6	30	19%

So, trails were most commonly seen in 3 locations – but this would of course be dependent on which trackers were running.

7.7 Maximum Trails Seen on One Day

The maximum number of trails counted in a single day was from the WA6 tracker – 91 trails on 25-11-2013. A few of the other "high trail count days" are shown below.

Location	Date	Weekday	Trails Seen	Detected	Max Tracked	Military	InRange	LatLong	Percent Located
WA6	2013-11-25	2	91	2321	41	41	360	1018	43.86
WA6	2013-11-30	7	79	1635	29	4	345	867	53.03
NE16	2013-12-16	2	51	1131	19	69	103	450	39.79
DE72	2014-04-11	6	45	4308	49	160	284	1597	37.07
LS11	2013-10-06	1	44	3041	30	15	352	818	26.90
LS11	2013-11-25	2	42	2512	36	108	78	598	23.81
SN5	2013-11-10	1	42	646	13	14	257	386	59.75
WA6	2013-11-13	4	41	2185	37	34	353	935	42.79
DE72	2013-12-06	6	40	3695	42	166	209	1222	33.07
DE72	2013-11-07	5	39	3359	43	175	302	1089	32.42
WA6	2014-04-11	6	39	2500	34	16	441	1173	46.92

7.8 Days with High Numbers of Trails and Days with High Numbers of Detected Aircraft.

In this section we look at the counts for days where the highest number of trails were observed at each location.

The counts are then compared to days where no trails were observed, but high counts of planes detected and/or planes coming into range (and above the base altitude) were observed. This was done using a version of the "DailyCountTotalsByLocation" query (with a check on Average Blueness being > 20) and a Trail Count of zero.

7.8.1 DE72 High Trailing on 06 Dec 2013 and 11 Apr 2014

From these figures, we can see that the days with the highest recorded number of trails seen have lower counts for planes coming into range and being detected than some days where no trails were seen.

Total Trails on Date Summary (Sorted by Descending Trail Count)									
Location	Date	Weekday	Trails Seen	Detected	Max Tracked	Military	InRange	Located	Percent Located
DE72	2014-04-11	6	45	4308	49	160	284	1597	37.07
DE72	2013-12-06	6	40	3695	42	166	209	1222	33.07

These results are for days which were clear enough, but no trails were seen – and we see the totals are higher.

Location	Date	Weekday	Trails Seen	Detected	Max Tracked	Military	In Range	Located	Percent Located
DE72	2013-08-26	2	0	5963	48.00	59	445	2147	36.0
DE72	2013-09-07	7	0	4336	49.00	71	245	1415	32.6

7.8.2 LS11 Trailing on 6th Oct 2013 and 30th Nov 2013

Total Trails on Date Summary (Sorted by Descending Trail Count)									
Location	Date	Weekday	Trails Seen	Detected	Max Tracked	Military	InRange	Located	Percent Located
LS11	2013-10-06	1	44	3041	30	15	352	818	26.90
LS11	2013-11-25	2	42	2512	36	108	78	598	23.81

These results are for days which were clear enough, but no trails were seen – and we see the totals are higher.

Location	Date	Weekday	Trails Seen	Detected	Max Tracked	Military	In Range	Located	Percent Located
LS11	2013-11-04	2	0	3278	37	104	166	829	25.3
LS11	2013-11-05	3	0	2848	30	146	146	734	25.8

7.8.3 WA6 Trailing on 25th and 30th Nov 2013

Total Trails on Date Summary (Sorted by Descending Trail Count)									
Location	Date	Weekday	Trails Seen	Detected	Max Tracked	Military	InRange	Located	Percent Located
WA6	2013-11-25	2	91	2321	41	41	360	1018	43.86
WA6	2013-11-30	7	79	1635	29	4	345	867	53.03

These results are for days which were clear enough, but no trails were seen – and again we see that most totals are higher.

Location	Date	Weekday	Trails Seen	Detected	Max Tracked	Military	In Range	Located	Percent Located
WA6	2013-11-04	2	0	2603	46	22	411	1233	47.4
WA6	2014-04-07	2	0	2563	42	27	443	1182	46.1

7.8.4 SN5 Trailing on 10th Nov 2013 and 15th Nov 2013

Total Trails on Date Summary (Sorted by Descending Trail Count)									
Location	Date	Weekday	Trails Seen	Detected	Max Tracked	Military	InRange	Located	Percent Located
SN5	2013-11-10	1	42	646	13	14	257	386	59.75
SN5	2013-11-15	6	34	1122	18	49	255	468	41.71

These results are for days which were clear enough, but no trails were seen – and we see the totals are higher.

Location	Date	Weekday	Trails Seen	Detected	Max Tracked	Military	In Range	Located	Percent Located
SN5	2013-11-22	6	0	1671	26	51	329	620	37.1
SN5	2013-12-20	6	0	1611	31	27	392	703	43.6

7.8.5 NE16 Trailing on 14th Dec 2013 and 16th Dec 2013

Total Trails on Date Summary (Sorted by Descending Trail Count)									
Location	Date	Weekday	Trails Seen	Detected	Max Tracked	Military	InRange	Located	Percent Located
NE16	2013-12-16	2	51	1131	19	69	103	450	39.79
NE16	2013-12-14	7	17	695	15	10	81	357	51.37

These results are for days which were clear enough, but no trails were seen – and we see the totals are higher.

Location	Date	Weekday	Trails Seen	Detected	Max Tracked	Military	In Range	Located	Percent Located
NE16	2013-10-17	5	0	1775	35	30	75	737	41.5
NE16	2013-10-31	5	0	1683	34	58	91	704	41.8

7.8.6 PO33 Trailing on 06 Dec 2013 and 30th Nov 2013

Total Trails on Date Summary (Sorted by Descending Trail Count)									
Location	Date	Weekday	Trails Seen	Detected	Max Tracked	Military	InRange	Located	Percent Located
PO33	2013-12-06	6	17	1323	26	7	233	731	55.25
PO33	2013-11-30	7	12	1150	22	3	213	700	60.87

These results are for days which were clear enough, but no trails were seen – and we see the totals are higher.

Location	Date	Weekday	Trails Seen	Detected	Max Tracked	Military	In Range	Located	Percent Located
PO33	2013-10-28	2	0	1576	24	4	282	950	60.3
PO33	2013-10-29	3	0	1504	23	5	287	937	62.3

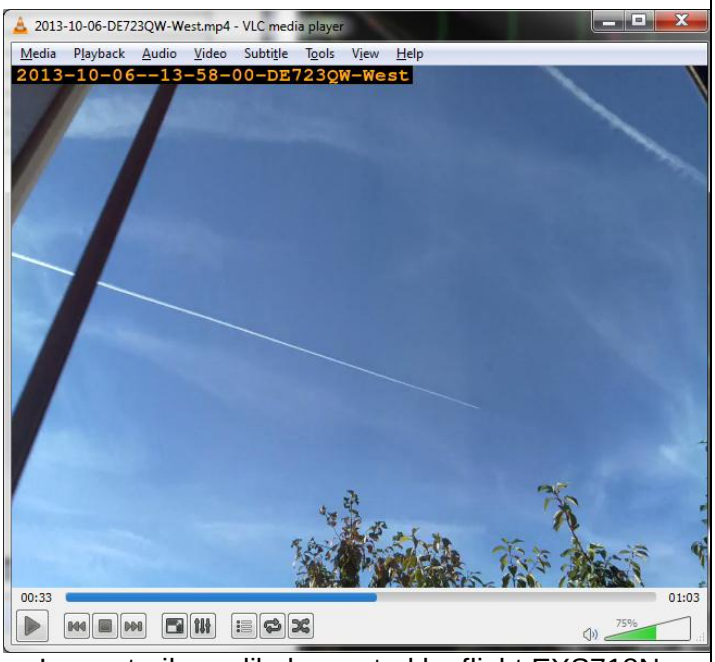
7.9 Identification of Flights Leaving Trails

One intended goal was to be able to identify any flights that were creating persistent trails. In practice, it proved quite difficult to achieve this. The table below lists 19 identification attempts (on 2 days of heavy trailing), of which only 5 were successful. NOTE: The DE72 Camera was facing almost due West. The WA6 camera was facing approximately South-South East (not East as might be implied from the incorrect labelling on the camera images).

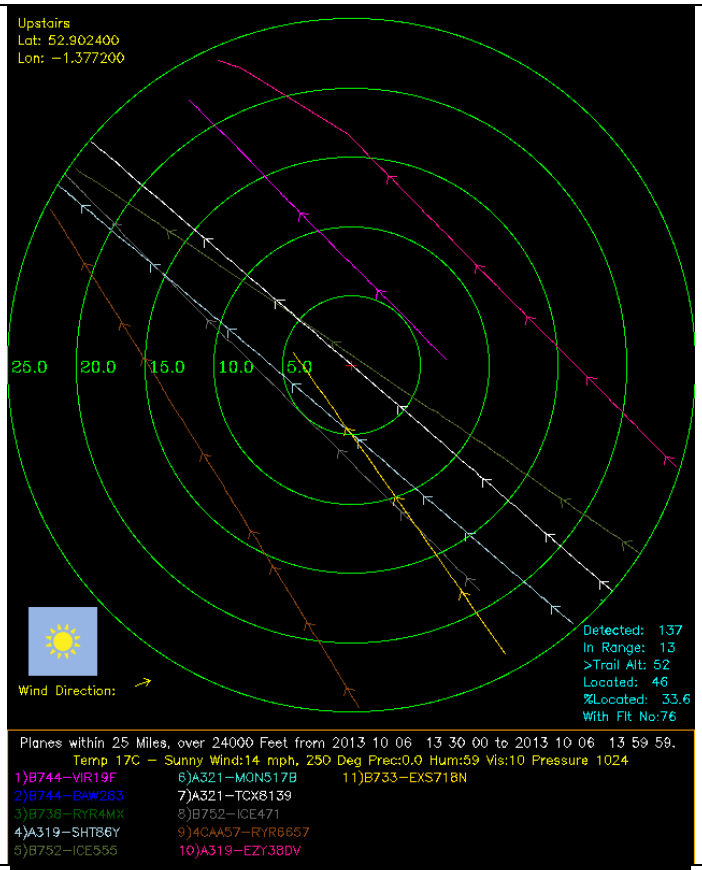
Date	Location	Time of Appearance	Identified As	Approx Direction	Notes
2013-10-06	DE72	10:42	?	SE->NW	
		11:18	?	SE->NW	
		11:20	?	SE->NW	
		12:22	SHT86M	SE->NW	Probably SHT86M
		13:22	?	S->N	
		13:26	?	S->N or N->S	
		13:52	?	SE->NW	
		13:58	EXS718N	SE->NW	
2013-12-06	DE72	11:01	?	S->N or N->S	Only a few tracks on this chart…
		11:32	?	S->N or N->S	Even Less on this chart!
		12:44	?	SE->NW	2 parallel trails – neither on chart.
2013-11-25	WA6	07:39	?	N->S	
		07:44	?	N->S	
		07:47	?	SE->NW	
		07:57	?	SE->NW	
		09:31	?	NW->SE	
		09:52	EIN1C6	NW->SE	Turns and is the only trail that is curved in this segment
		15:59	BAW3304	W->E	Turns and is the only trail that is curved in this segment
2013-11-30		08:53	VIR6J	NW->SE	Turns and is the only trail that is curved in this segment

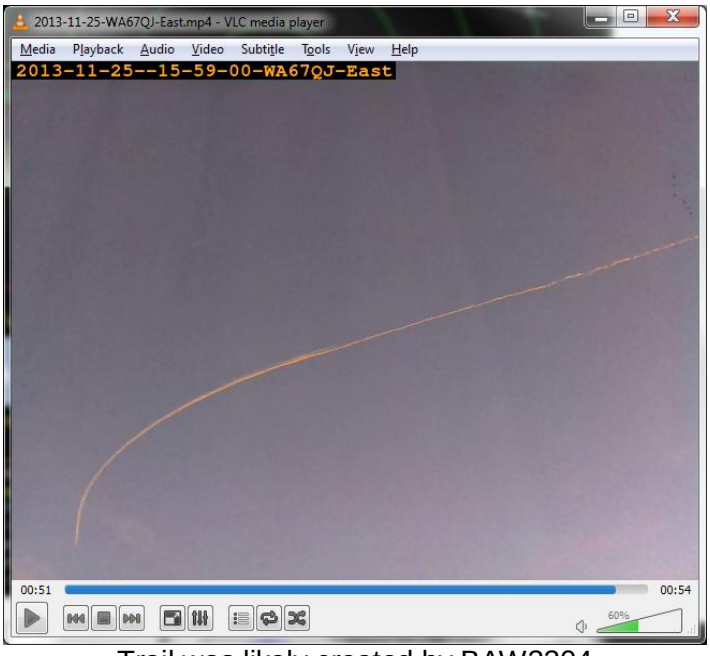
7.9.1 Example images and charts

The images and charts below were used to identify some of the flights shown in the table in section 7.9 above. On the charts, North is at the top.

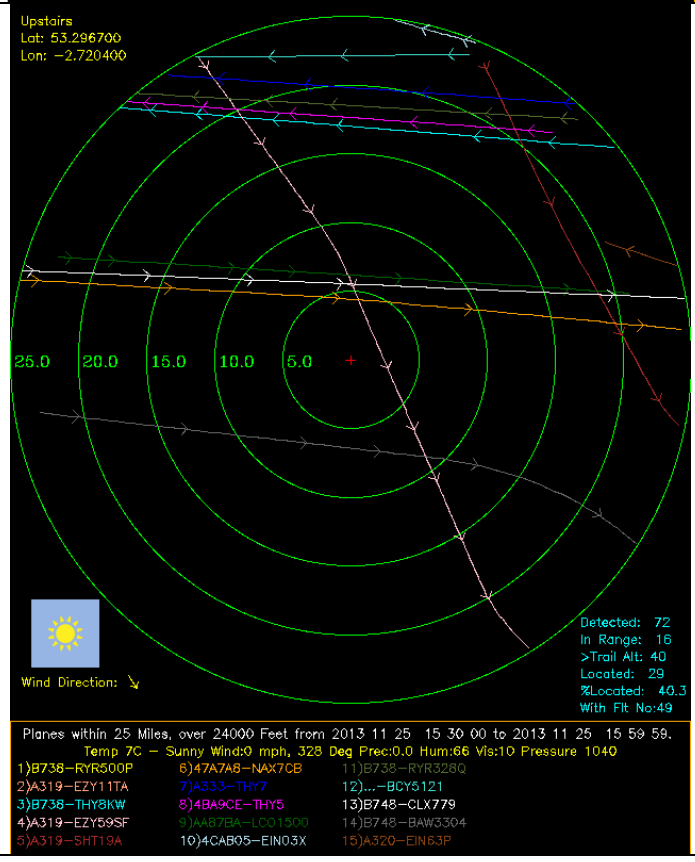


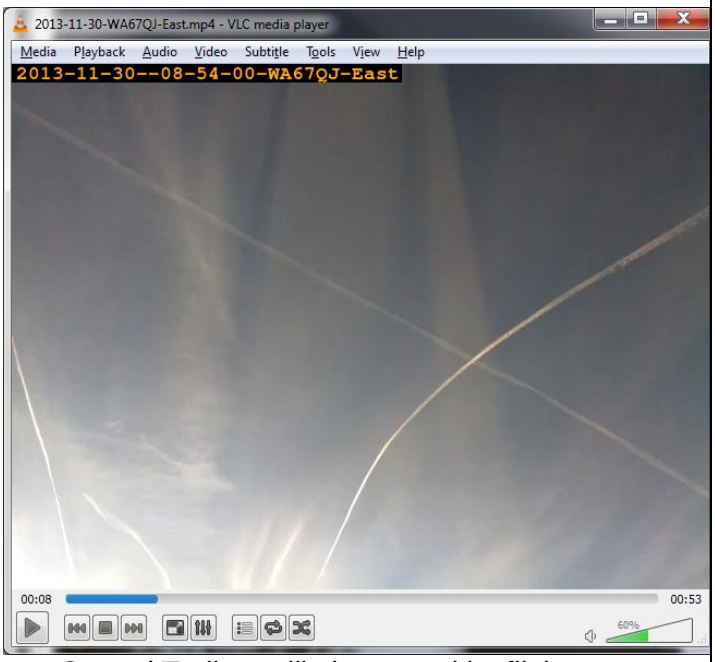
Lower trail was likely created by flight EXS718N



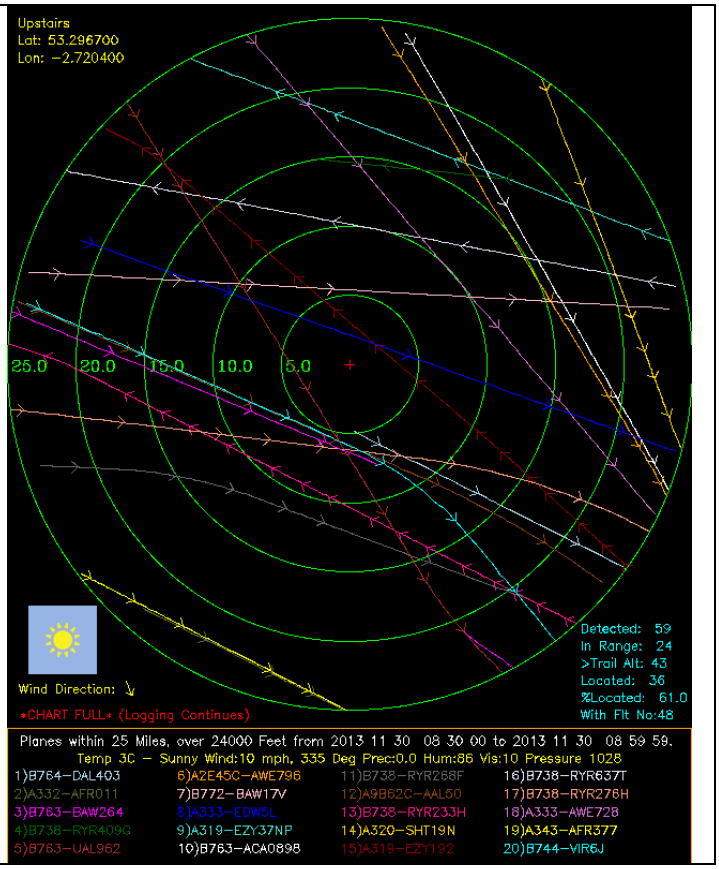


Trail was likely created by BAW3304





Curved Trail was likely created by flight VIR6J

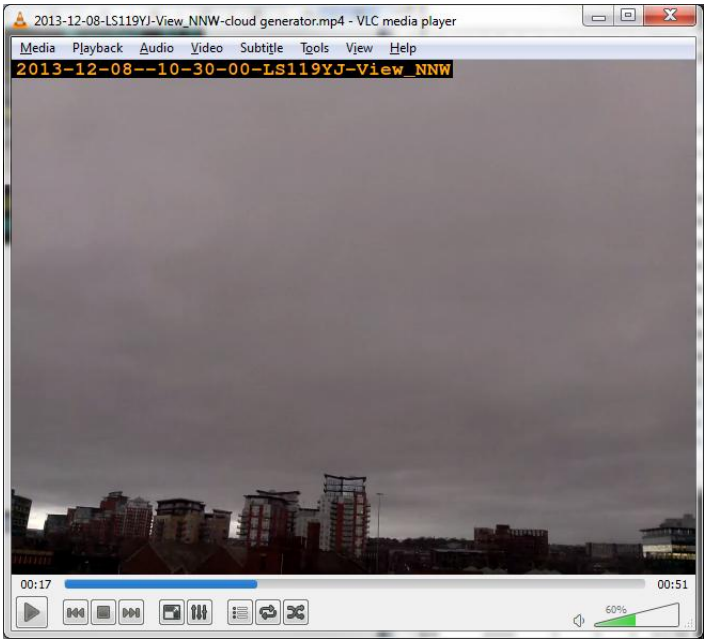


7.10 Weather Anomalies

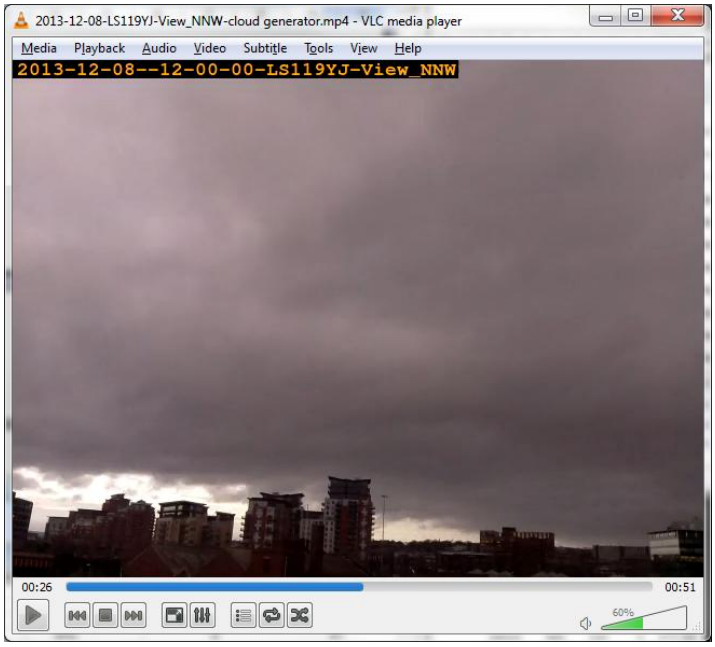
On close inspection of some of the time lapse videos from the Leeds tracker (which had the longest view to the horizon), it was seen that some apparently strange cloud movements and formations could be observed. Obviously, these are best illustrated by watching the video itself, though I have tried to describe a few stills below.

7.10.1 Leeds 08 Dec 2013

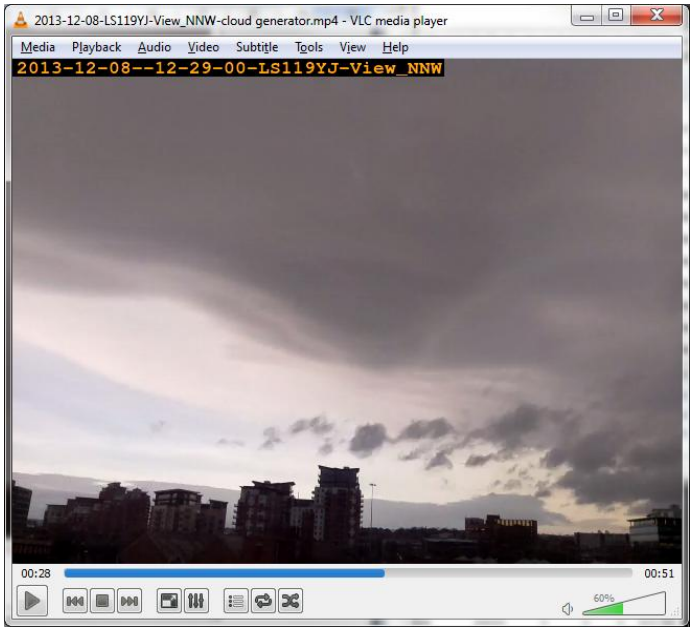
On this particular day, the view showed thick cloud covering most of the visible sky area – with clearer weather in the distance (to the north).



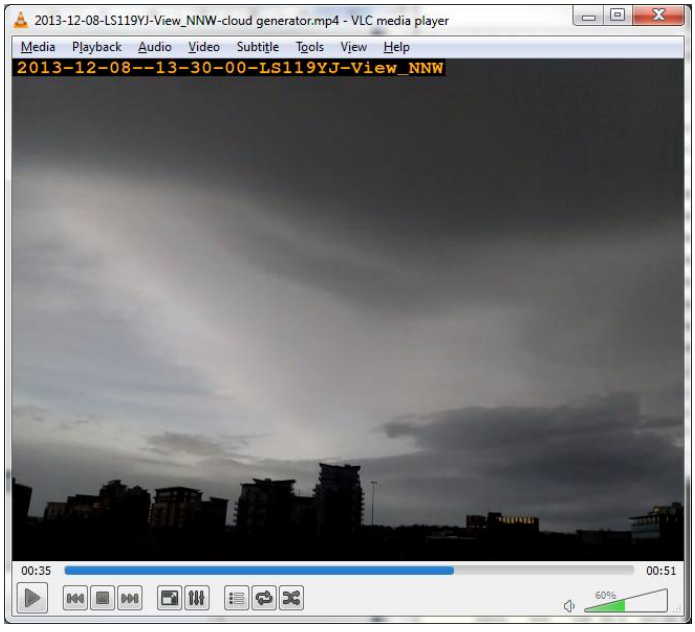
This view persisted for about 90 mins until 12:00 (noon).



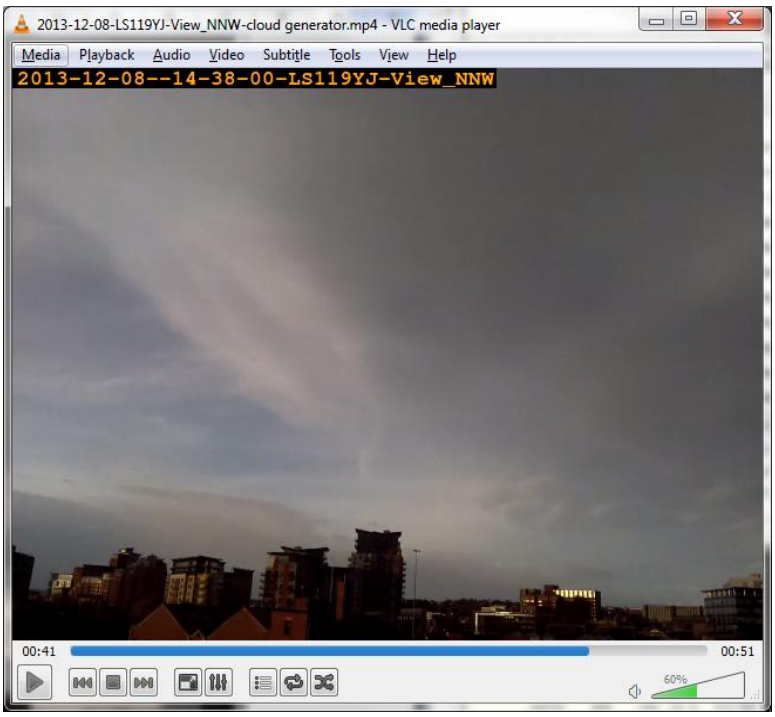
In a 30-minute period, the lower cloud layer clears to the left (east) and reveals 2 higher cloud layers – a lower, thicker dark layer and an upper, lighter coloured layer



An hour later, the cloud configuration looks remarkably similar, with slight easterly movements of the upper and lower cloud banks



Overall, a similar view persists for over 2 hours.



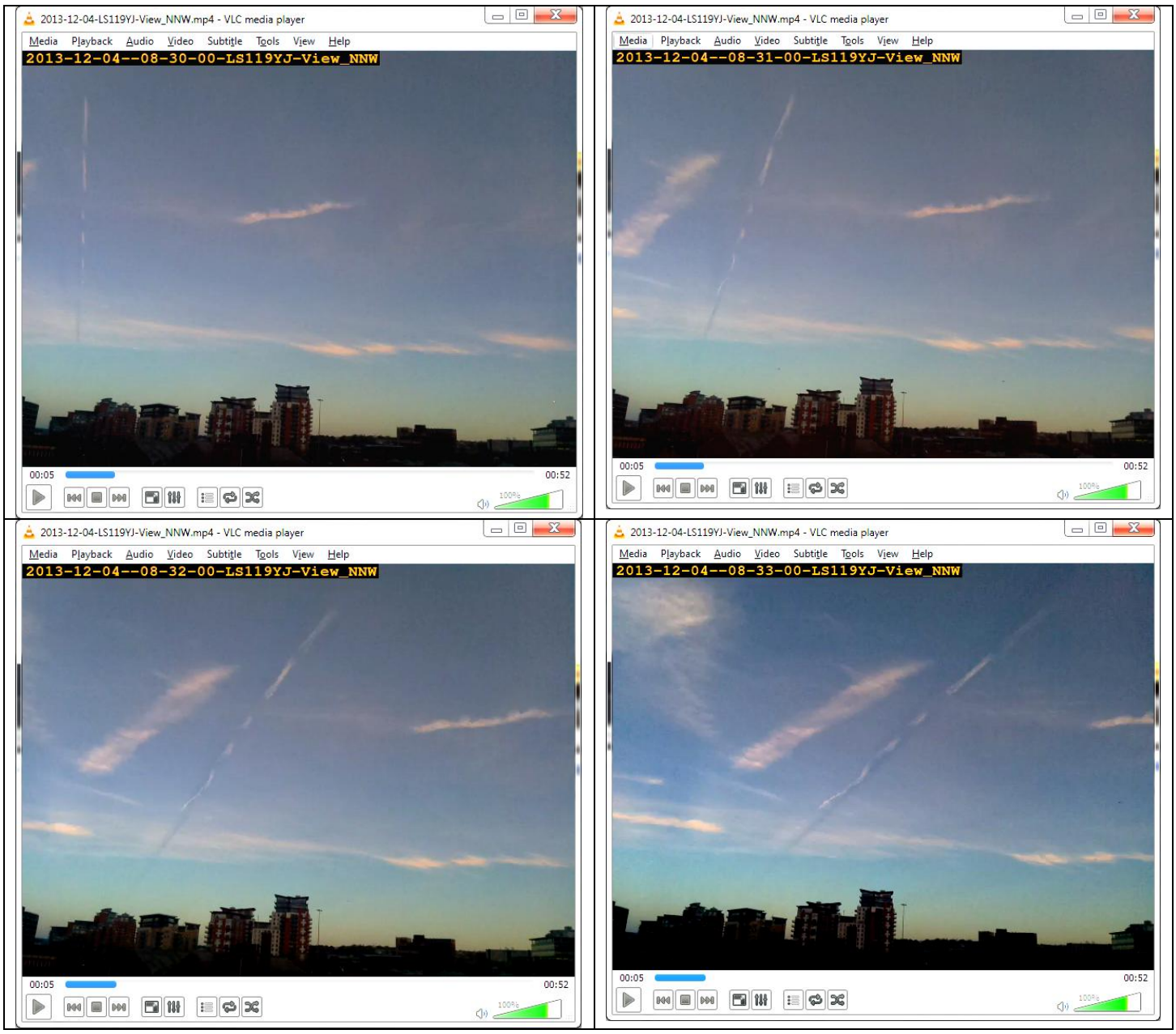
Why would these cloud banks persist over a fixed point on the ground, when there are no mountain or high hill ranges below them?

In other videos, it seems there are banks of “persistent cloud” formations – cloud forms and reforms over a fixed point on the ground and the “rest of the weather” seems to flow past these clouds. Again, these effects only become obvious from watching the time lapse videos[35].

[35] http://www.checktheevidence.com/video/index.php?dir=PiTrackerTL/

7.10.2 Contrail/Distrail

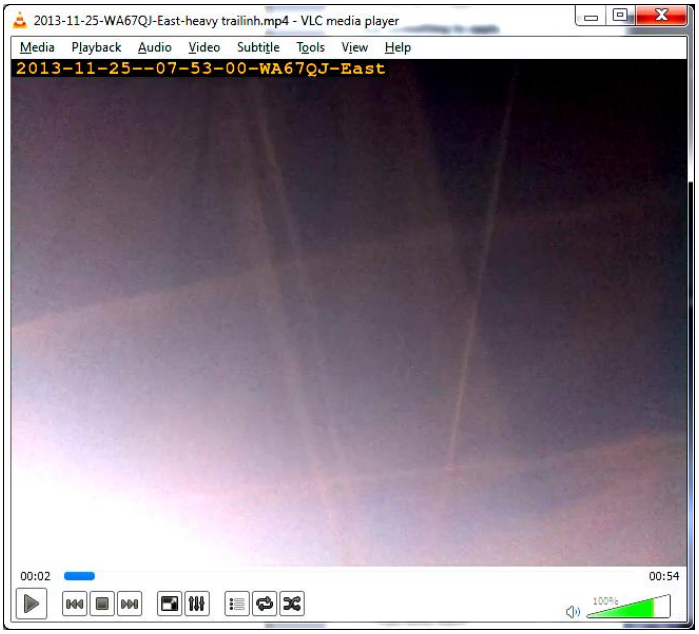
On the Leeds tracker – 08:30 – 04 Dec 2013 – two of these curious trails were observed in quick succession and these are less commonly seen than the “ordinary” trail. The unusual “shadow” effects are also somewhat difficult to explain (or are they…?)



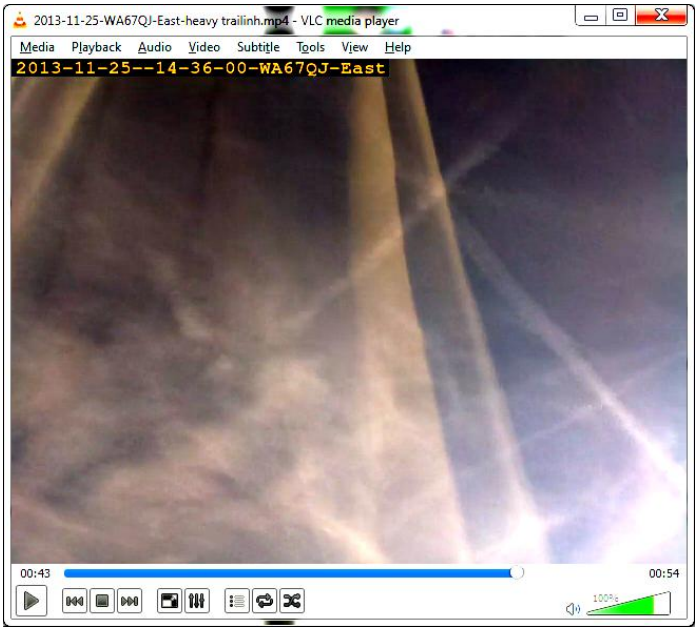
7.11 Potential for Grids to Form – Case Study 25 Nov 2013

In a chart from the WA6 tracker, shown in section 0, it is relatively easy to see the potential for grids of trails to form. However, further examination of the captured/generated charts and time-lapse video was needed to establish if this could actually be seen happening.

In the 25 Nov 2013 time-lapse video from the WA6 tracker, we can actually see 2 grids form, at approximately 7:53 am and 14:36:



Contrast enhanced image to show grid of trails



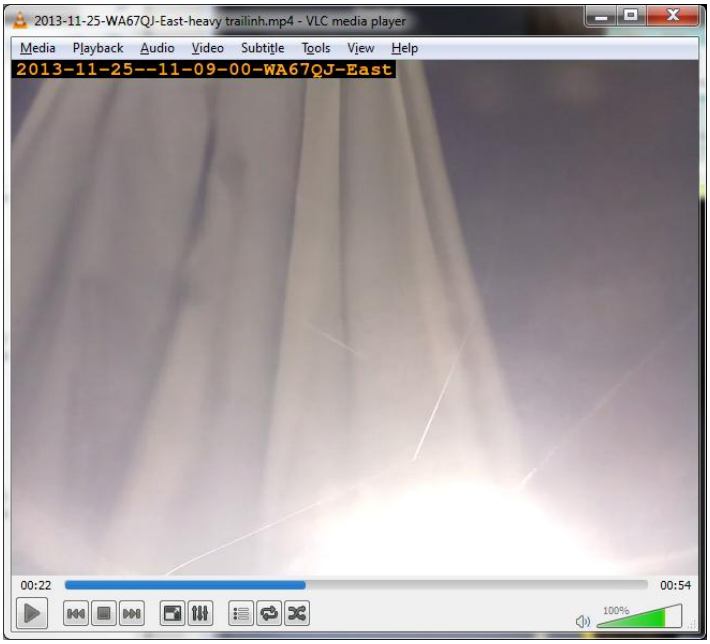
Contrast enhanced image to show grid of trails – (central vertical lines are a reflection of the curtain)

I studied the 54 second video carefully (consisting of approximately 540 frames) and was interested to see when planes were travelling something near to a north/south direction. This happened at the approximate following times 07:39, 07:43, 07:48, 07:57, 09:35, 10:20*, 10:30*, 11:09*, 11:34, 11:45, 11:59, 12:18, 14:12, 14:23, 14:36. Therefore, about 15 planes in all were travelling north => south, or in a similar direction. (The ones marked * did not leave a persistent trail, only a “normal” one. These flights seemed to be travelling directly over the house – appearing fairly centrally in the picture. Thus, it should have been easy to see these flights plotted on the charts generated for the appropriate 30-minute period.

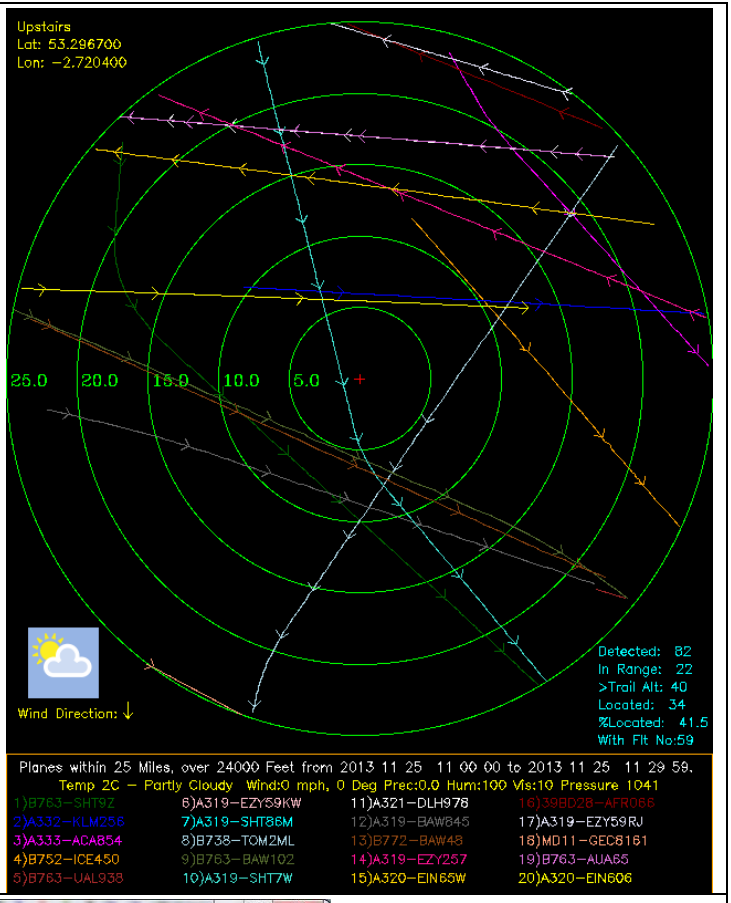
Studying the 19 charts generated on 25 Nov 2013, only 2 possible flights seemed to be travelling in the correct direction. The 11:09 was probably SHT 7W (no persistent trail). The only other flight logged travelling N => S or NW => SE (over the tracker’s location) was at about 3:15pm (see chart below).

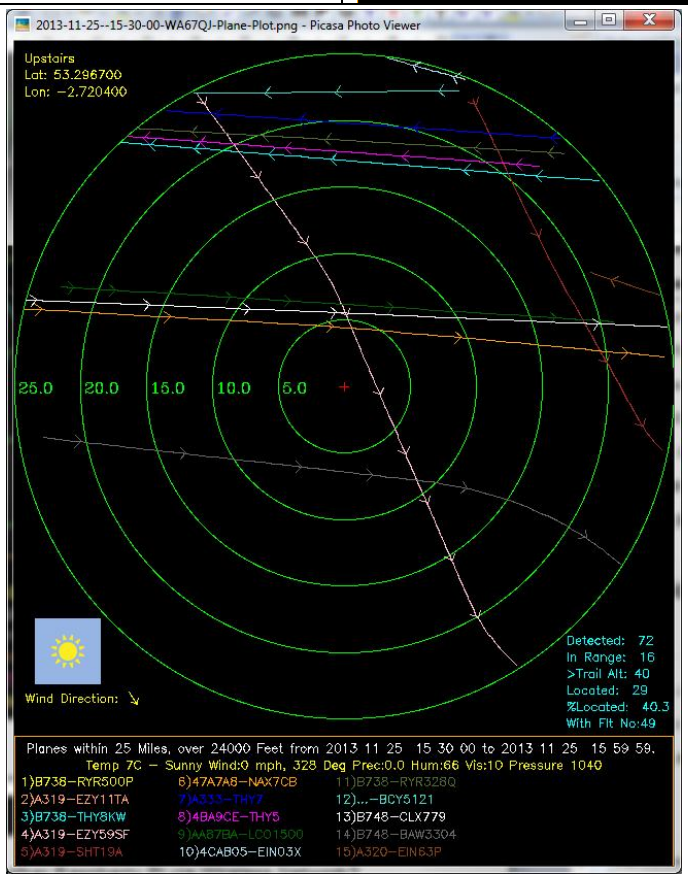
7.11.1 Planes Apparently “Flying Along the Trail” Of Earlier Planes

In this video, we can see several instances where one plane flights in almost exactly the same path as an earlier plane e.g. at 14:13 and 14:25. This can be observed on repeated occasions – maybe this is just because the plane is following an exact flight path, but to the casual observer, and considering how these trails seem to form x’s and/or grids, it does look peculiar.



Trail central and just above sunburst is likely SHT7W





Flight EZY59F (pink) was the only other flight shown on all the 25 Nov 2013 charts which was travelling in a NE => SW direction over the tracker (at the centre of the chart)

8. Conclusions

8.1 Detected Air Traffic Levels and Trailing

From all the data gathered so far, it seems there is no large difference in "ADS-B detectable" aircraft on days of high trailing than there are on days of no trailing. The data here does *not* establish a clear link between levels of aircraft and levels of trailing. Looking at some figures in isolation, it could be argued that there is a *lower* amount of aircraft on days of trailing. This result, therefore would tend to disprove a general statement that trailing is seen because of *increased* levels of air traffic – if that is the case, then it is air traffic which is not detectable in the same way as "regular" air traffic.

Perhaps a better detector is needed, although this is unlikely – as a range of 20 miles should be sufficient to "detect planes and see trails" with this sort of equipment. For example, if one examines the charts, most of them have an unbroken line of travel for the planes, which means enough of the messages were picked up, while the plane was in range, to plot the path of the plane.

8.2 Identification of Flights Leaving Trails and Formation of Grids

It was sometimes quite difficult to identify which flights left trails – perhaps because only a maximum of about 50% of the flights could have their latitude and longitude decoded. Without this information, it was impossible to know if the flight was precisely overhead, or whether it was 100 miles away. The "percentage located" figure showed no appreciable variation between days of trailing and no trailing.

The study from 25 Nov 2013 of the WA6 tracker shows that it is was not possible, using ADS-B data, to identify all of the flights which made the grids. Though, looking at some of the charts, the potential for grids to form can be seen, these were not seen "in the right place" and not enough flights were detected to prove, from this data, that civilian air traffic is responsible for forming these grids. So they remain a mystery.

A study of data from the DE72 tracker seemed also to show that flights that were travelling in a North⇔South Direction were rarely seen on charts – and if they were, it was over the far west of Derby – about 20 miles from where the tracker was sighted. Further attempts at identifying "trailing flights" could be undertaken, even with the existing data.

8.3 Days of Trails or No Trails?

No obvious reason could be observed why trails were seen on some days and not others. Again, taking the 25 Nov 2013 time-lapse video, it can easily be seen that there are persistent and non-persistent trails appearing in the same periods of time and the same part of the sky. So this remains unexplained.

8.4 Weather Anomalies

The tracker with the best view did seem to observe some kind of weather anomalies on some days – why would cloud formations remain in the same place above the ground, whilst "other weather" drifts past? Why would this happen the clouds both at lower and higher altitudes? What is the cause of linear weather fronts?

9. Further Research

Further research could be done either on the existing data from this project, or by modifying the configuration/set-up already used. Ideas could include:

- More study of the charts and time-lapse videos to try and match up flights and trails – especially when grids or similar patterns are seen.
- Additional Raspberry Pi Cameras or IP Based cameras could be added for greater sky coverage – or a wider angle lens could be fitted.
- Additional trackers could be located in other countries and the tests repeated to see if the same sort of statistics are determined.
- Relocation of the antenna/aerial to a place with a clearer signal could be done to see if this improves the percentage of aircraft located.
- Co-ordinate the trail-logging/time-lapse video with more photography using high powered zoom digital cameras such as the Canon SX-50 of Panasonic FZ-72 or newer models.
- Obtain/download daily Satellite Photos and compare them on days of trailing and no trailing.

10. Appendix A – Location of Trackers

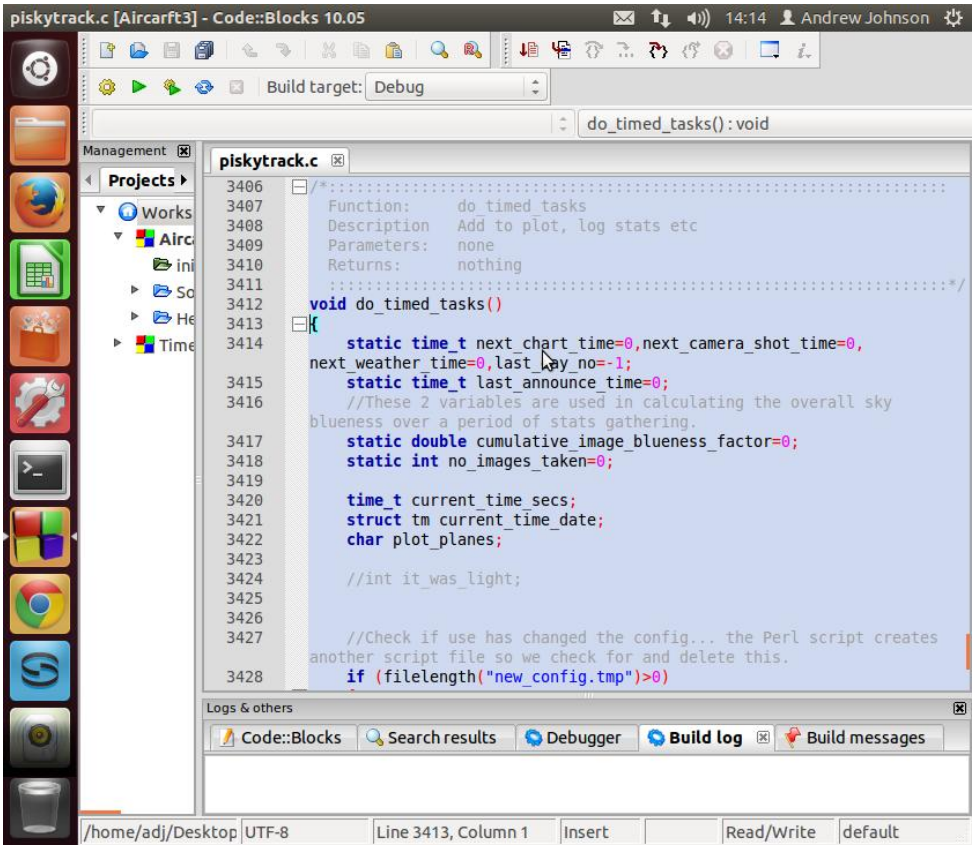
- DE72 3QW – Near East Midlands Airport
- SN5 – Near Bristol Airport
- NE16 – Near New Castle Airport
- WA6 – Near Manchester Airport and Liverpool Airport
- PO33 – Isle of Wight

11. Appendix B – Software Development and Component Parts

11.1 Software Used in Pitracker Development

11.1.1 Open Source/C Code to be compiled on Linux platforms

- The main tracker software was based on the Dump1090 package by Salvatore Sanfilippo[36].
- Mongoose - Simple Webserver code – by Sergey Lyubka[37].



Codeblocks IDE Running under Ubuntu

11.1.2 Linux/Windows Software

- Oracle Virtual Box
- Ubuntu Linux Version 12
- CodeBlocks IDE and Source-level Debugger
- SQLiteman (SQLite Database Package)

11.1.3 Raspberry Pi

- Raspbian OS
- PureFTPd (server)
- Libraries and Packages: Glib, Lib Plot, Libdev, libav-tools, zip, ftp, watchdog
- SQLITE3 Database Software and Development libraries
- Festival Speech synthesis
- SAMBA (Networking)
- Imagemagick – image processing and analysis tool

11.2 Windows/PC Software

- Microsoft Office 2003 – Word 2003, Excel 2003, Access 2003
- Putty
- VLC Player
- Notepad ++

[36] See https://github.com/antirez/dump1090
[37] See https://code.google.com/p/mongoose/

11.3 Parts List

11.3.1 UK Links valid in UK as of 21 Aug 2013

Raspberry Pi	Model A – Amazon Model B – Amazon	Model A - Farnell Model B - Farnell	£25-£30
Raspberry Pi Camera Board	Amazon	Farnell	£25
RasPi case	Amazon	Ebay	£3 - £5
DVB – T TV Dongle - **Has to use Realtek RTL2832U+R820T Chipset to work!**	Amazon	Ebay CosyCave	£7 - £10
Wireless Lan Adapter - Has to be Raspberry Pi compatible – using RaLink Chipset	Amazon	Ebay Ebay 2	£3
USB Hub with 2A Power Supply	Amazon	Ebay	£10
4GB SD Card	Amazon	Ebay	£5
8GB SD Card	Amazon	Ebay	£6
USB/Micro USB Power Cable	Amazon	Ebay	£2

Total Cost about £85

11.3.2 US Parts List

Raspberry Pi	Model A or Model B	$35 / $43
Raspberry Pi Camera Board	Amazon	$36
RasPi case	EBay	$6
TV Dongle - **Has to use Realtek RTL2832U+R820T Chipset to work!**	Amazon Ebay	$13 - $15
Wireless Lan Adapter - Has to be Raspberry Pi compatible – using RaLink Chipset	Amazon Ebay	$5 -$6
USB Hub with 2A or More Power Supply	EBay	$15
4GB SD Card	Amazon Ebay	$5-$6
8GB SD Card	Ebay Amazon	$8 – or $3
USB/Micro USB Cable	Ebay Amazon	$2 -$3

Total Cost around $120

11.4 Copies of Database, Data, Raspberry Pi Disk "Image" etc

If you would like a copy of the Database or the software image to drive the system, please contact ad.johnson@ntlworld.com – I can mail 1 or 2 DVDs to you for the cost of shipping and materials.