# Analysis of vertical flight efficiency during climb and descent

*Technical report on the analysis of vertical flight efficiency during climb and descent*

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| Edition Number: | 00-04 |
| Edition Date: | 19/01/2017 |
| Status: | Submitted for consultation |
| Intended For: | External |
| Category: | Performance Monitoring and Reporting |

European Organisation for the Safety of Air Navigation

| TITLE | | |
|---|---|---|
| **Analysis of vertical flight efficiency during climb and descent** | | |
| | **Publications Reference:** | |
| | **ISBN Number:** | |
| **Document Identifier** | **Edition Number:** | 00-04 |
| | **Edition Date:** | 19/01/2017 |

**Abstract**

This document describes the conceptual, mathematical and platform independent approach of the analysis of vertical flight efficiency during the climb and descent phases of flight.

**Keywords**

Vertical Flight Efficiency
Data Processing

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# 1 Introduction

## 1.1 General

This document describes the conceptual, mathematical and platform independent approach for the analysis of vertical flight efficiency during the climb and descent phases of flights, as used by the Performance Review Unit of EUROCONTROL.

Since many years flight efficiency was targeted and monitored solely by reference to the horizontal profile of the aircraft's trajectory [1]. Stakeholders have indicated to be interested in the vertical aspect of flight efficiency as well. This need has been responded to in 2008 with a technical note estimating the impact of ATM on vertical flight efficiency [2]. Since 2015, the PRU are continuing this work by developing and testing possible performance indicators for vertical flight efficiency which might be proposed to be used in the future.

During 2015 and 2016, the PRU have provided input to the CCO/CDO Task Force. This group was composed of many different interested stakeholders including airspace users, FABs/ANSPs and aircraft manufacturers and has tried to harmonise the different methods of assessing vertical flight efficiency during climb and descent that exist in Europe. Nevertheless, the harmonised methodology that was proposed by the Task Force still needed to be completed since the method for detecting level flight was not completely detailed. Therefore, the PRU have further developed and improved the methodology, of which the result is detailed in this document.

This document focuses on the analysis of vertical flight efficiency during climb and descent. A separate document regarding the analysis of en-route vertical flight efficiency is also available [3].

## 1.2 Purpose of the document

This document is intended to present the methodology used by the Performance Review Unit for the analysis of vertical flight efficiency during climb and descent.

## 1.3 Scope

This document provides a technical description on the methodology used in the analysis of the vertical profile of the aircraft's trajectory during the climb and descent phases.

The objective of the methodology is to measure and observe vertical flight efficiency without highlighting specific reasons for the observed behaviour. More detailed case studies are needed to find out reasons for particular observations.

While this document focuses on the methodology itself, more results will be available in the Performance Review Report 2016.

## 1.4 Summary of the analysis information

<table>
<tr><th colspan="4">Vertical Flight Efficiency during climb and descent: Summary</th></tr>
<tr><td>Current version status</td><td>Prototyping / Validation</td><td colspan="2"></td></tr>
<tr><td rowspan="6">Version status and evolution</td><td>Conceptual Phase</td><td></td><td>Phase completed</td></tr>
<tr><td>Technical Development</td><td></td><td>Phase completed</td></tr>
<tr><td>Prototyping / Validation</td><td></td><td>Ongoing</td></tr>
<tr><td>Monitoring</td><td>2017</td><td>N/A</td></tr>
<tr><td>Target Setting</td><td>TBD</td><td>N/A</td></tr>
<tr><td>Phase Out</td><td></td><td>N/A</td></tr>
<tr><td>Context</td><td colspan="3">KPA : Efficiency<br>Focus Area: Vertical Flight Efficiency<br>Trade-offs: local and network performance</td></tr>
<tr><td>Description</td><td colspan="3">The climb and descent analysis provides the following results, per airport:<br>• Average value per flight and median value of the distance and time flown level<br>• The percentage of distance and time flown level with respect to the total climb or descent distance and time<br>• Average value per flight and median value of the number of level segments<br>• Median CDO/CCO altitude<br>• Percentage of flights considered as CDO/CCO</td></tr>
<tr><td>Units</td><td colspan="3">Nautical miles (distance results)<br>Minutes (time results)<br>Percentage (percentage results)<br>Number of level segments<br>Feet (Median CDO/CCO altitude)</td></tr>
<tr><td>Used in</td><td colspan="3">EUROCONTROL: Performance Review Report (as from PRR 2016)</td></tr>
</table>

**Table 1: Analysis summary**

## 1.5 Acronyms and terminology

| Term | Definition |
|---|---|
| **AGL** | Above Ground Level |
| **CCO** | Continuous Climb Operations |
| **CDO** | Continuous Descent Operations |
| **CPF** | Profile based on correlated positions reports |
| **KPA** | Key Performance Area |
| **PRISME** | Pan-European Repository of Information Supporting the Management of EATM |
| **PRR** | Performance Review Report |
| **PRU** | Performance Review Unit |
| **SES** | Single European Sky |
| **ToC** | Top of Climb |
| **ToD** | Top of Descent |

**Table 2: Acronyms and terminology**

# 2 Methodology

The main assumption for the analysis of vertical flight efficiency during climb and descent is that, all other factors being equal, level flight is considered as inefficient.

The methodology presented here is very similar for the climb and descent phases so the results for the climb and descent phases are directly comparable.

## 2.1 General overview

The analysis is performed in 5 major steps. First, the trajectory data has to be loaded into the analysis software. Then the climb or descent part is identified in these trajectories. In these parts of the trajectories the level segments are detected and saved and additional filters are applied. The next step is the determination of the Top of Climb or Top of Descent. Finally, the results are calculated and processed for presentation. This process is visualised in Figure 1.


**Figure 1: Different steps of the analysis**

## 2.2 Loading of the trajectories information

The data used for the analysis are downloaded from the PRISME database. CPF data is used in order to assess the actually flown trajectories. Section 3 discusses more about the data sources available and suitable for this analysis.

The most important data fields that are of interest for the analysis are the altitude, position (latitude and longitude) and time information.

## 2.3 Identification of the climb or descent part of the flight

For each flight, the climb part is defined as the part of the trajectory before the Top of Climb (ToC) and the descent part as the part of the trajectory after the Top of Descent (ToD).

Optimal climb and descent parts until/from the cruising altitude generally require less than 200NM of track distance from/until the airport, especially when the cost index is low or high for respectively the climb and descent [4], [5]. With this in mind, the analysis is limited to the parts of the trajectories within a 200NM radius around the departure/arrival airport. This is to avoid including into the analysis climbs during the cruise phase which are used to optimise the flight altitude to account for the reducing weight of the aircraft.

The identification method of the climb or descent part corresponds strongly to the method proposed by the CCO/CDO Task Force and is further detailed below. It should be noted that the CCO/CDO Task Force uses a 300NM radius for the climbs instead of 200NM as used in this analysis. The reasons for choosing a 200NM radius for the climb are threefold:

- Having the same radius for both the climb and descent analysis enables a direct comparison between the climb and descent results; and

- Examination of aircraft trajectories showed that when a radius of 300NM is used, a lot of level flight at slightly lower altitudes than the cruising altitude is detected as inefficient, while this could be a consequence of the optimisation of the cruising altitude with respect to the aircraft's weight. This type of level flight should not be seen as being inefficient and can influence the final results significantly in such a way that the results are not representative; and
- 300NM was chosen by the CCO/CDO Task Force because some very heavy aircraft could not be able to reach the cruising altitude within a 200NM radius. Nevertheless, it is preferred to have a stable methodology that suits best the behaviour of most of the flights and provides statistically correct results and analyses.

### 2.3.1 Identification of the climb part of a flight

For each flight, the 4D point where the flight crosses the 200NM radius around the departure airport (for the first time) is determined. This point is defined as D200. Within the part of the trajectory from take-off until D200 included, the first 4D point at which the aircraft reaches the highest altitude is defined as the ToC-D200. If the aircraft is still climbing when passing the 200NM radius, D200 and ToC-D200 are the same.

The climb phase is considered to start at 3000 feet AGL since the Noise Abatement Departure Procedures (NADP) defined by ICAO end at this altitude [6].

Overall, the part of the trajectory considered for the analysis goes from 3000 feet AGL (included) until ToC-D200.

The CCO/CDO Task Force uses 2500 feet as lower limit which is chosen in relation to the availability of trajectory data.

### 2.3.2 Identification of the descent part of a flight

For each flight, the 4D point where the flight crosses the 200NM radius around the destination airport (for the last time) is determined. This point is defined as A200. Within the part of the trajectory from A200 included until touchdown, the last 4D point at which the aircraft leaves the highest altitude is defined as the ToD-A200.

The descent phase is considered to end at 1800 feet AGL because the interception altitude for ILS systems is generally at or above this altitude. Using 1800 feet AGL as lower limit allows capturing the level segments before ILS interception but on the other hand disregarding the trajectory below 1800 feet AGL where the aircraft are on the ILS glideslope and no level segments should occur.

Overall, the part of the trajectory considered for the analysis goes from ToD-A200 until 1800 feet AGL (included).

## 2.4 Detection of the level segments

In the climb or descent parts of the trajectories the level segments should be determined. The trajectory part between two points on that trajectory is considered as level when the trajectory stays within a fictional window as can be seen in Figure 2.

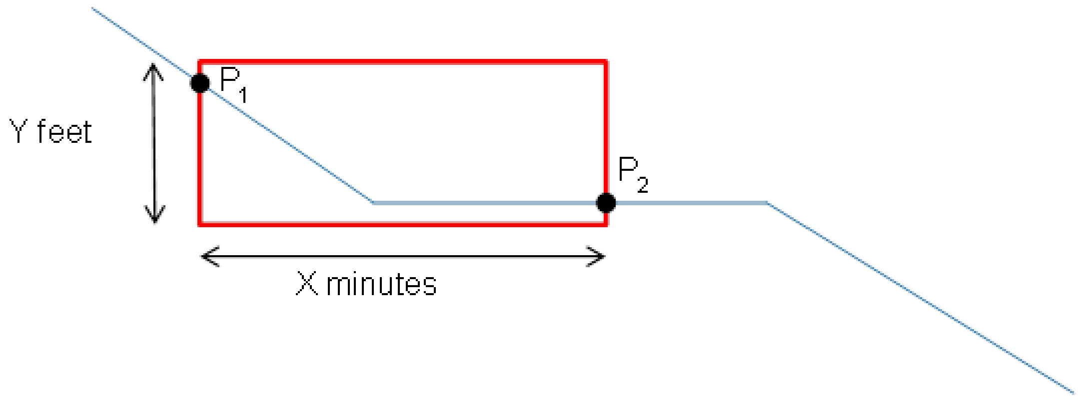


**Figure 2: Rolling window for level segment detection**

This window has temporal and altitude dimensions related to a specific vertical velocity that is considered to be the limit between level flight and climb/descent. After consultation in the CCO/CDO Task Force, this vertical velocity is chosen to be 300 feet per minute. Consequently, the dimensions of the window have to adhere to the following relationship:

$$\frac{Y}{X} = 300\, feet\ per\ minute$$

E.g. when a temporal size of 10 seconds is used, the window is 50 feet high. In this case the altitude information of the climb or descent trajectory is considered at every interval of 10 seconds. However, since the CPF data are a discrete representation of the actual trajectories, the necessary altitude information is not available for every required time instance. Because of this and whenever required, a linear interpolation is done to obtain the information needed for the analysis.

## 2.5 ToC/ToD determination

In order to avoid considering level segments that happen slightly below the cruising altitude of a flight, an exclusion box is defined. The exclusion box ranges from the altitude of ToC-D200 or ToD-A200 down to 90% of this altitude. When a level segment is detected inside the exclusion box and it lasts longer than 5 minutes, it is not considered in the final results. The new top of climb or top of descent is in that case put at the start of (the first of) such segment(s) for climbs or at the end of (the last of) such segment(s) for descents. This new ToC or ToD is called respectively ToC-CCO or ToD-CDO. When no level segments longer than 5 minutes are detected inside the exclusion box, ToC-CCO/ToD-CDO coincides with ToC-D200/ToD-A200.

The determination of the ToC-CCO or ToD-CDO corresponds as well to the CCO/CDO Task Force's approach.

## 2.6 Processing of the results

The final results are calculated taking into account all level segments before ToC-CCO for the climbs and after ToD-CDO for the descents.

The results of the analysis include the total number of flights, the average value and median value of the distance flown level, the percentage of distance flown level with respect to the total climb or descent distance, the average value and median value of the time flown level, the percentage of time flown level with respect to the total climb or descent time and the average value and median value of the number of level segments.

An additional metric is the median CDO/CCO altitude. This metric is calculated by taking the altitude of the lowest level segment for each flight. This information is then aggregated by taking the median value over all considered flights. The rationale for using the lowest level segment is the following. It is best to have no level flight because this increases the fuel burn. However, if needed, the higher the level segment occurs, the better because the higher the level segment occurs, the lower the fuel burn. E.g. a level segment of a fixed duration at FL100 burns more fuel than at FL300. So, the lowest level segment is considered since it has the highest environmental impact.

In addition, each flight can be assessed as being CCO (Continuous Climb Operations) or CDO (Continuous Descent Operations). The fact whether a flight is considered as being CCO or CDO depends on the allowed amount of level segments and their allowed lengths or durations.

The formulas used for the calculation of all these results are shown in Table 3.

**Table 3: Formulas used for the calculation of the results**

| Result | Formula |
|---|---|
| Total distance flown by flight $f$ during the climb/descent | $D_f^+ = \begin{cases} D_{3000,f} - D_{TOC-CCO,f} & (climbs) \\ D_{TOD-CDO,f} - D_{1800,f} & (descents) \end{cases}$ |
| Percentage of distance flown level during the climb/descent | $D_{perc} = \frac{\sum_f D_f}{\sum_f D_f^+} \cdot 100$ |
| Average value of the distance flown level per flight | $D_{avg} = \frac{\sum_f D_f}{n}$ |
| Median value of the level distance | $D_{med} = \begin{cases} D_m & (n\ is\ odd, m = (n+1)/2) \\ \frac{D_m + D_{(m+1)}}{2} & (n\ is\ even, m = n/2) \end{cases}$ |
| Total time flown by flight $f$ during the climb/descent | $T_f^+ = \begin{cases} T_{3000,f} - T_{TOC-CCO,f} & (climbs) \\ T_{TOD-CDO,f} - T_{1800,f} & (descents) \end{cases}$ |
| Percentage of time flown level during the climb/descent | $T_{perc} = \frac{\sum_f T_f}{\sum_f T_f^+} \cdot 100$ |
| Average time flown level per flight | $T_{avg} = \frac{\sum_f T_f}{n}$ |
| Median value of the level time | $T_{med} = \begin{cases} T_m & (n\ is\ odd, m = (n+1)/2) \\ \frac{T_m + T_{(m+1)}}{2} & (n\ is\ even, m = n/2) \end{cases}$ |
| Average number of level segments per flight | $L_{avg} = \frac{\sum_f L_f}{n}$ |
| Median value of the number of level segments | $L_{med} = \begin{cases} L_m & (n\ is\ odd, m = (n+1)/2) \\ \frac{L_m + L_{(m+1)}}{2} & (n\ is\ even, m = n/2) \end{cases}$ |
| Percentage of flights considered as CCO or CDO | $P = \frac{n_o}{n} \cdot 100$ |

| | | |
|---|---|---|
| With: | $n$ | Total number of flights considered in the analysis |
| | $n_o$ | Number of flights considered as CCO or CDO |
| | $L_f$ | Number of level segments for flight $f$ |
| | $D_f^+$ | Total distance flown by flight $f$ during the climb/descent |
| | $D_f$ | Total distance flown level by flight $f$ during the climb/descent |
| | $D_{3000,f}$ | Track distance flown by flight $f$ when passing 3000 feet AGL |
| | $D_{TOC-CCO,f}$ | Track distance flown by flight $f$ when passing TOC-CCO |
| | $D_{TOD-CDO,f}$ | Track distance flown by flight $f$ when passing TOD-CDO |
| | $D_{1800,f}$ | Track distance flown by flight $f$ when passing 1800 feet AGL |
| | $T_f^+$ | Total time flown by flight $f$ during the climb/descent |
| | $T_f$ | Total time flown level by flight $f$ during the climb/descent |
| | $T_{3000,f}$ | Time at which flight $f$ passes 3000 feet AGL |
| | $T_{TOC-CCO,f}$ | Time at which flight $f$ passes TOC-CCO |
| | $T_{TOD-CDO,f}$ | Time at which flight $f$ passes TOD-CDO |
| | $T_{1800,f}$ | Time at which flight $f$ passes 1800 feet AGL |

# 3 Data sources

As mentioned before, CPF data from the PRISME database are used to do the analyses. For this type of data, the time interval between two data points is on average 37 seconds. This means that a short level segment might not be detected in the analysis. Because of this, the recent developments related to ADS-B are followed up by the PRU.

ADS-B data should have a higher update rate which would make it possible to detect smaller level segments. For the time being, the ADS-B samples that have been received have in some cases indeed a higher update rate. However, the data quality is not always as stable as for CPF data. For example, a lot of vertical but especially horizontal glitches are seen in the data samples. This significantly reduces the quality of the ADS-B data so for the moment ADS-B is not seen as a good replacement for the CPF data. However, in the future CPF and ADS-B could be merged in order to obtain more detailed trajectories.

# 4 Error description

The error on the detected amount of distance and time flown level is related to the interpolation method, the fact that a continuous trajectory is represented with discrete data points and the update rate of this discretisation. A more in-depth examination of the error is ongoing.

The altitude information in the CPF data can be the flight level or barometric altitude. For the moment there's no information on which of these two options is used in the data of (a part of) a flight. When assuming that all altitude information is given in flight levels and it is actually barometric altitude, the altitude error could be several thousands of feet when the airport elevation is high.

# 5 Results

The results of the analysis have been limited to the top 15 European airports in terms of IFR traffic in 2016. Airports for which only a limited amount of radar data is available are not included in the analysis. The problem in those cases is mainly that the radar data below a certain altitude are missing. These data are presently not provided to EUROCONTROL but the Network Manager and the involved Member States are working together to resolve this data issue.

It is generally considered that the benefit pool regarding vertical flight efficiency is larger for descents than for climbs, which is confirmed by several studies and reference material related to this topic [2], [7], [8], [9]. The results in Figure 3 show the average time flown level per flight. In general, climbs are less subject to level offs (red bars) than descents (green bars) so the analysis also confirms the conclusions of the previously mentioned studies. For descents, a significant amount of level flight can be observed.

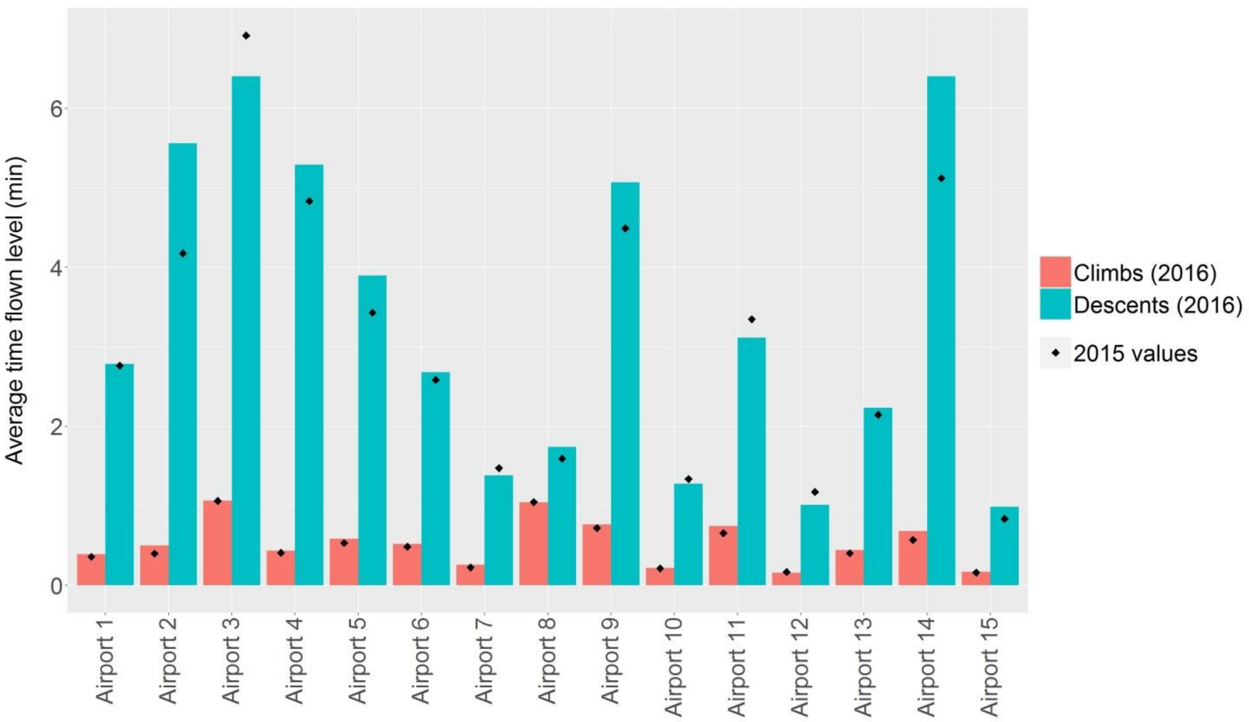


**Figure 3: Average time flown level per flight for the top 15 airports**

While Figure 3 deals with the time dimension of vertical flight efficiency, Figure 4 gives an idea about the altitude dimension using the median CDO/CCO altitudes at which continuous descents started and continuous climbs ended, so the higher the value, the better the vertical flight efficiency.

It is obvious that climbs (red bars) are performed more efficiently than descents (green bars). Most airports have their median CCO altitudes above FL300 which is close to the nominal cruising altitude of jet aircraft. For arriving traffic, the median CDO altitude is significantly lower for all considered airports which is probably due to the application of arrival procedures and the use of holding stacks.

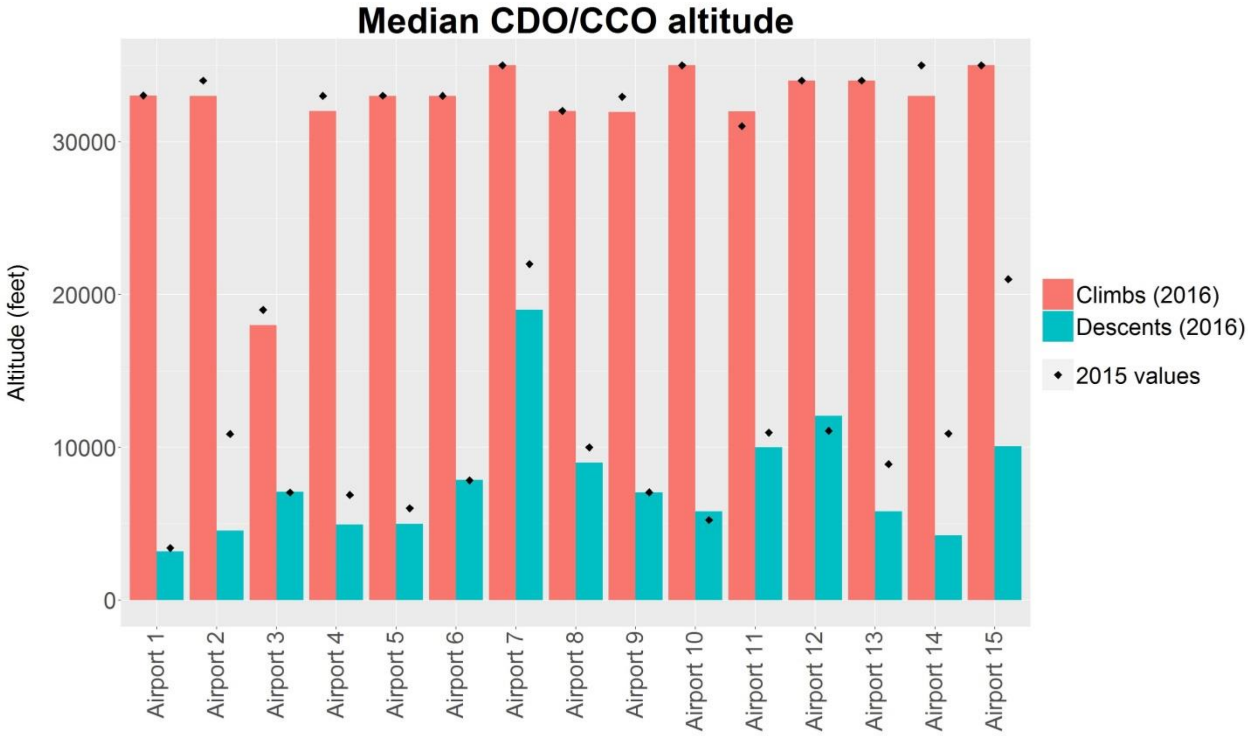


**Figure 4: Median CDO/CCO altitude for the top 15 airports**

Table 4 (below) provides more information on the average time flown level per flight (as in Figure 3), the two altitude bands with the highest share of time flown level and the measured share of time flown level in these altitude bands. It is apparent that for the descents the altitude bands with the highest share of level flight are mostly below FL100 which is probably due to approach procedures and vectoring towards the runway. Airport 9 and Airport 11 are exceptions to this observation.

For the climbs, the altitude bands with the highest share of level flight are generally above FL300. This observation and the observations regarding the descents are in correspondence with the median CDO and CCO altitudes in Figure 4.

**Table 4: Altitude bands with highest share of level flight**

| | Descents | | | Climbs | | |
|---|---|---|---|---|---|---|
| Airport | Average time flown level (min) | Altitude band (feet) | % of time in the band | Average time flown level (min) | Altitude band (feet) | % of time in the band |
| Airport 1 | 2.8 | [2000,3000) | 30.3% | 0.4 | [35000,36000) | 15.8% |
| | | [3000,4000) | 15.6% | | [33000,34000) | 12.4% |
| Airport 2 | 5.6 | [4000,5000) | 21.4% | 0.5 | [10000,11000) | 11.4% |
| | | [15000,16000) | 15.6% | | [26000,27000) | 10.7% |
| Airport 3 | 6.4 | [8000,9000) | 20.5% | 1.1 | [6000,7000) | 49.2% |
| | | [9000,10000) | 15.5% | | [7000,8000) | 5.2% |
| Airport 4 | 5.3 | [4000,5000) | 23.6% | 0.4 | [33000,34000) | 11.0% |
| | | [11000,12000) | 21.0% | | [31000,32000) | 10.8% |
| Airport 5 | 3.9 | [4000,5000) | 17.6% | 0.6 | [34000,35000) | 17.3% |
| | | [5000,6000) | 13.4% | | [35000,36000) | 12.0% |
| Airport 6 | 2.7 | [5000,6000) | 15.8% | 0.5 | [34000,35000) | 32.3% |
| | | [33000,34000) | 10.5% | | [31000,32000) | 12.1% |
| Airport 7 | 1.4 | [3000,4000) | 14.1% | 0.3 | [34000,35000) | 17.8% |
| | | [2000,3000) | 11.7% | | [36000,37000) | 13.8% |
| Airport 8 | 1.7 | [2000,3000) | 22.7% | 1.0 | [30000,31000) | 39.3% |
| | | [3000,4000) | 14.8% | | [32000,33000) | 22.9% |
| Airport 9 | 5.1 | [15000,16000) | 15.3% | 0.8 | [6000,7000) | 9.9% |
| | | [14000,15000) | 10.0% | | [4000,5000) | 9.5% |
| Airport 10 | 1.3 | [3000,4000) | 30.0% | 0.2 | [35000,36000) | 17.1% |
| | | [4000,5000) | 25.8% | | [36000,37000) | 15.6% |
| Airport 11 | 3.1 | [32000,33000) | 11.3% | 0.7 | [35000,36000) | 12.9% |
| | | [30000,31000) | 9.1% | | [33000,34000) | 11.0% |
| Airport 12 | 1.0 | [9000,10000) | 20.7% | 0.2 | [36000,37000) | 8.7% |
| | | [4000,5000) | 19.5% | | [35000,36000) | 8.6% |
| Airport 13 | 2.2 | [3000,4000) | 21.6% | 0.4 | [34000,35000) | 19.7% |
| | | [4000,5000) | 7.3% | | [36000,37000) | 12.6% |
| Airport 14 | 6.4 | [11000,12000) | 41.1% | 0.7 | [12000,13000) | 15.7% |
| | | [4000,5000) | 15.1% | | [9000,10000) | 10.6% |
| Airport 15 | 1.0 | [3000,4000) | 21.4% | 0.2 | [36000,37000) | 9.3% |
| | | [4000,5000) | 16.7% | | [34000,35000) | 8.9% |

# 6 Case studies

### 6.1.1 Airport 2

The average time flown level for flights to and from Airport 2 in 2016 has increased with respect to 2015. Especially the average time flown level per flight during descent has increased significantly by 1.4 minutes (Figure 3). Figure 5 contains the monthly results for Airport 2 and shows that the descent value improved from January 2015 to June 2015. It stayed quite stable until August but in September 2015 there was a sudden increase in the descent value. Since then the value remained relatively stable. The climb values are staying rather constant.

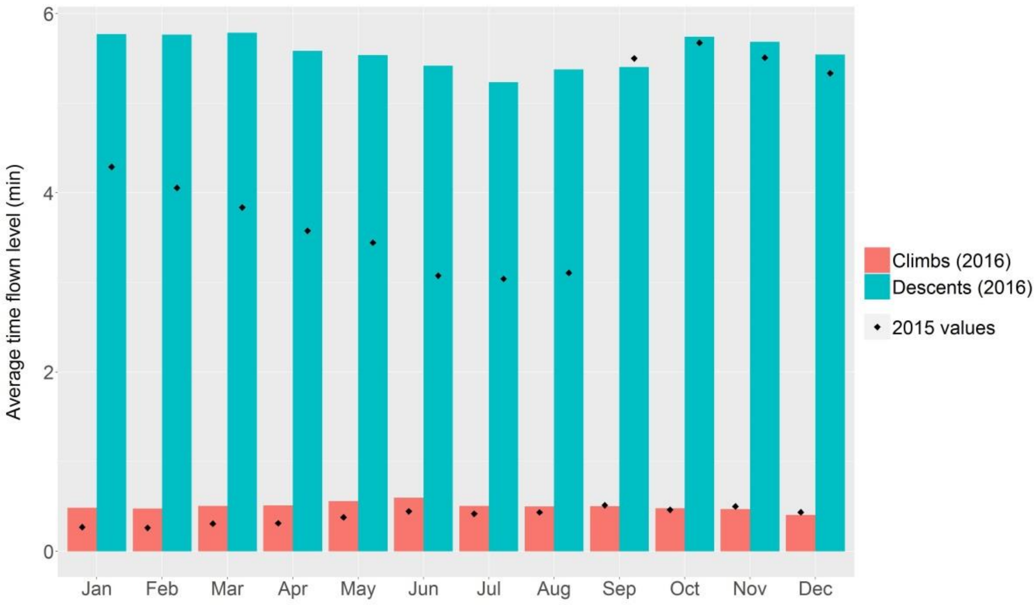


**Figure 5: Monthly average time flown level per flight to/from Airport 2**

Figure 6 presents the monthly median CDO/CCO altitudes. The median CCO altitudes stay fairly constant while the median CDO altitudes improved from January 2015 to June 2015. From June to August there was no important change but since September 2015 the median CDO altitude decreased significantly by more or less 19,000 feet to values between 4,000 and 5,000 feet.

Overall, since September 2015 the arriving flights are experiencing more level flight during the descent and the level flight occurs at much lower altitudes, which is a double increase of the environmental impact of these level segments.

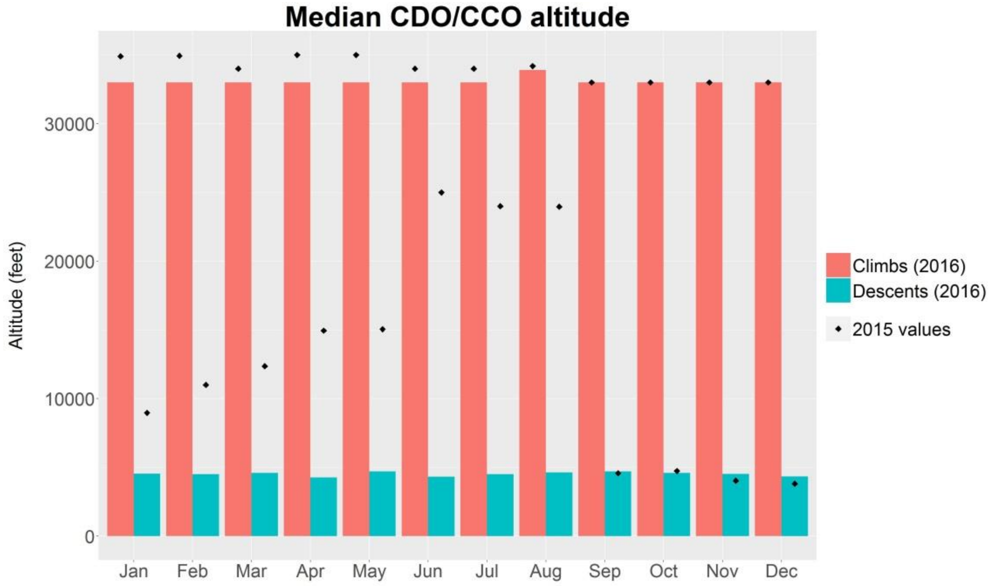


**Figure 6: Monthly median CDO/CCO altitude to/from Airport 2**

In an attempt to find out the reason for the sudden change in vertical flight efficiency in September, the daily values are examined as well. Figure 7 shows the daily average time flown level per flight from 01/08/2015 to 30/09/2015. The climb values are rather constant while there is an abrupt and significant increase of the descent value as from 02 September 2015. The median CDO altitude falls substantially on the same date (Figure 8). The reason for this sudden change is still under investigation.

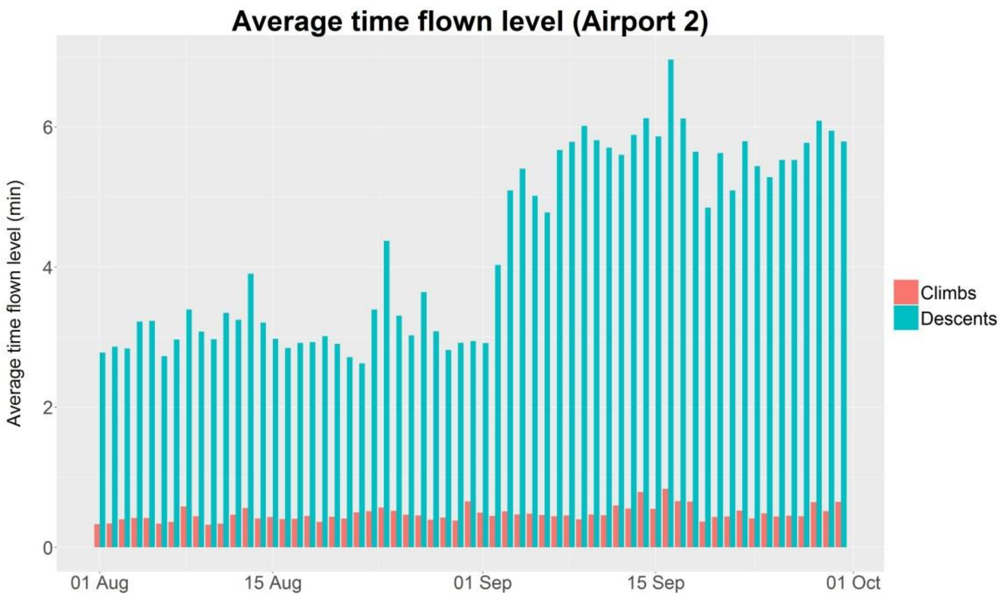


**Figure 7: Daily average time flown level per flight to/from Airport 2**

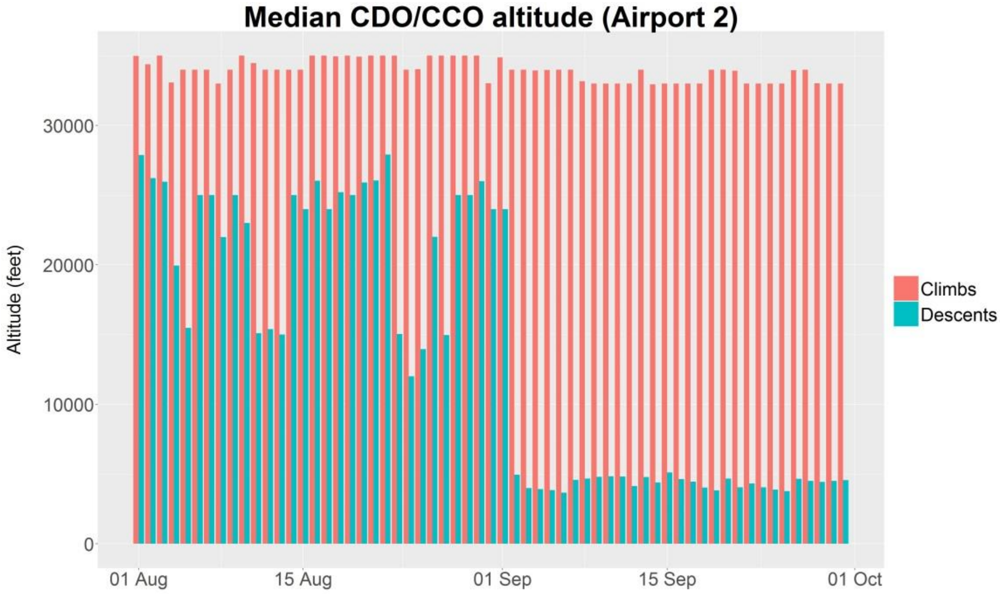


**Figure 8: Daily median CDO/CCO altitude to/from Airport 2**

To get a better view on the altitudes of the level flight segments, the vertical trajectories of arrivals into Airport 2 in July 2016 are plotted in Figure 9. The detected level segments are highlighted in red. As mentioned in Table 4, the altitude bands with the highest share of level flight are [4000,5000) feet (21.4%) and [15000,16000) feet (15.6%).

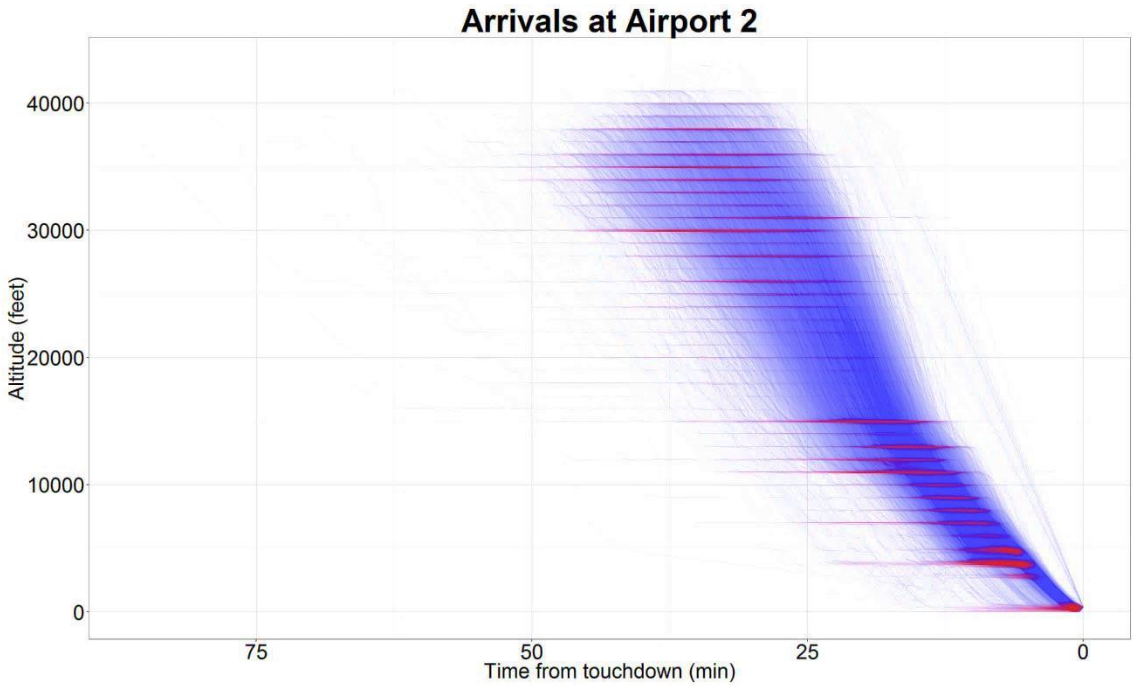


**Figure 9: Vertical trajectories of Airport 2 arrivals**

Figure 10 presents the top down view of the same July 2016 arrival trajectories into Airport 2. At almost every geographical location, there is some level flight. However, it’s worth noting that a lot of level flight is seen when the arriving flights are crossing FIR boundaries. This might be due to arrangements between neighbouring ANSPs or ACCs.

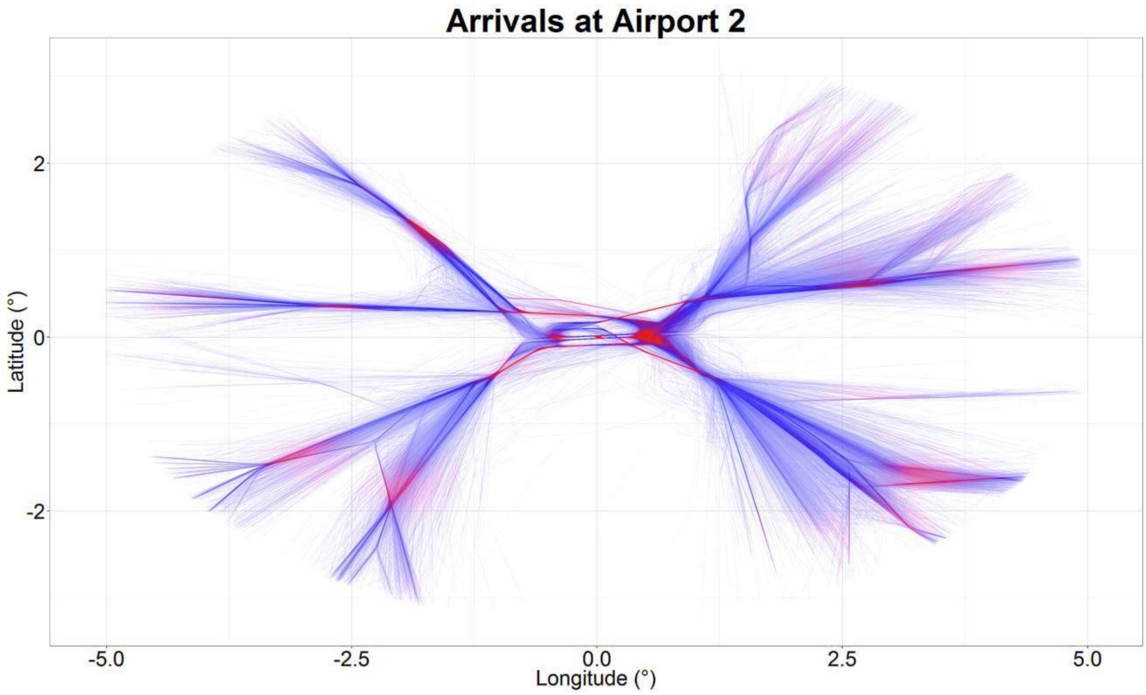


**Figure 10: Horizontal trajectories of Airport 2 arrivals**

To examine the sudden change in vertical flight efficiency for Airport 2 arrivals, the months of June to August in 2015 and 2016 are analysed further. During these months, it appears that the altitude bands with the highest shares of level flight in 2015 are [15000,16000) and [30000,31000). In the same months in 2016 these altitude bands had similar amounts of level flight but the amounts of level flight in the altitude bands [4000,5000) and [11000,12000) increased significantly, making them the altitude bands with the highest share of level flight in 2016. Figure 11 highlights the geographical locations of the level segments around FL150 in 2015, while Figure 12 highlights the geographical locations of the level segments around FL40 in 2016.

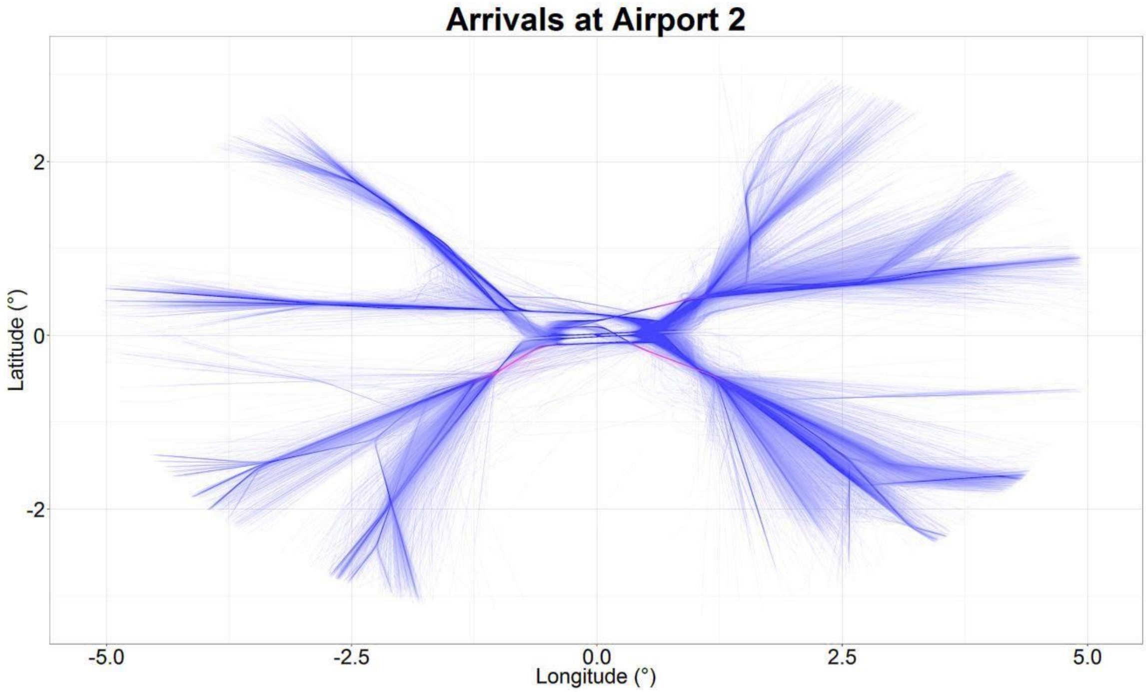


**Figure 11: Horizontal trajectories of Airport 2 arrivals with level segments at FL150 highlighted**

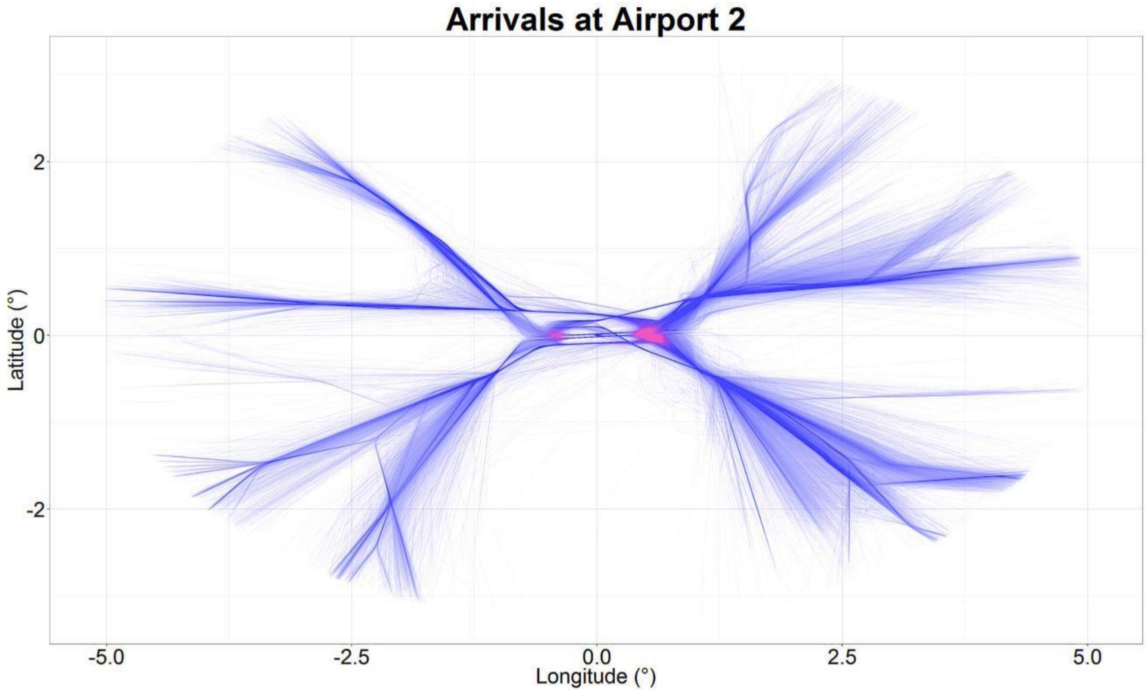


**Figure 12: Horizontal trajectories of Airport 2 arrivals with level segments at FL40 highlighted**

### 6.1.2 Airport 12

In 2016, the average time flown level per flight in the descent slightly decreased for Airport 12 while the median CDO altitude went up, both being an improvement in terms of vertical flight efficiency. The climb values stayed about the same. The monthly values in Figure 13 and Figure 14 confirm these observations.

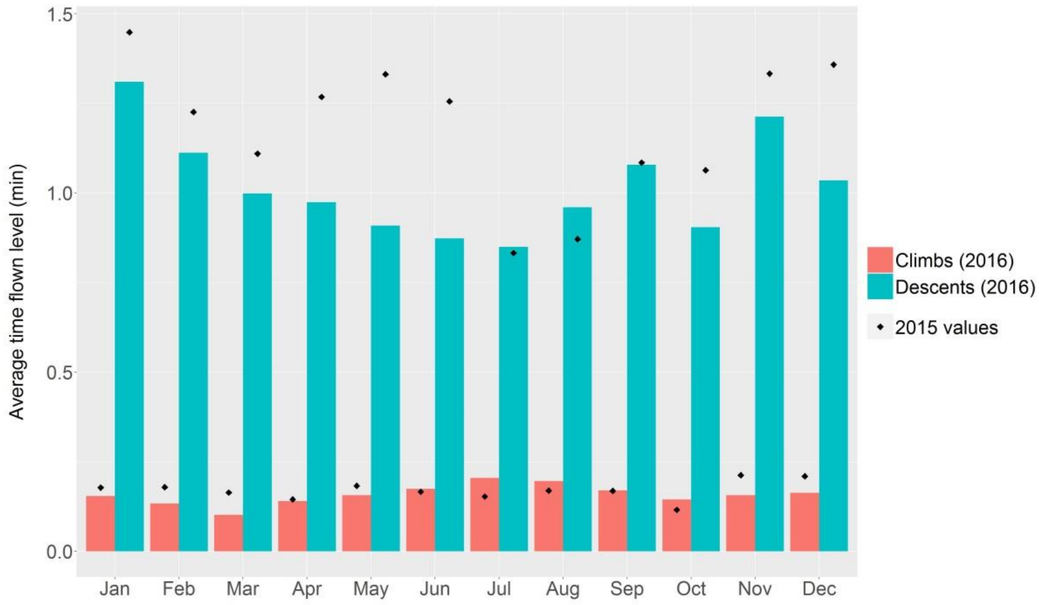


**Figure 13: Monthly average time flown level per flight to/from Airport 12**

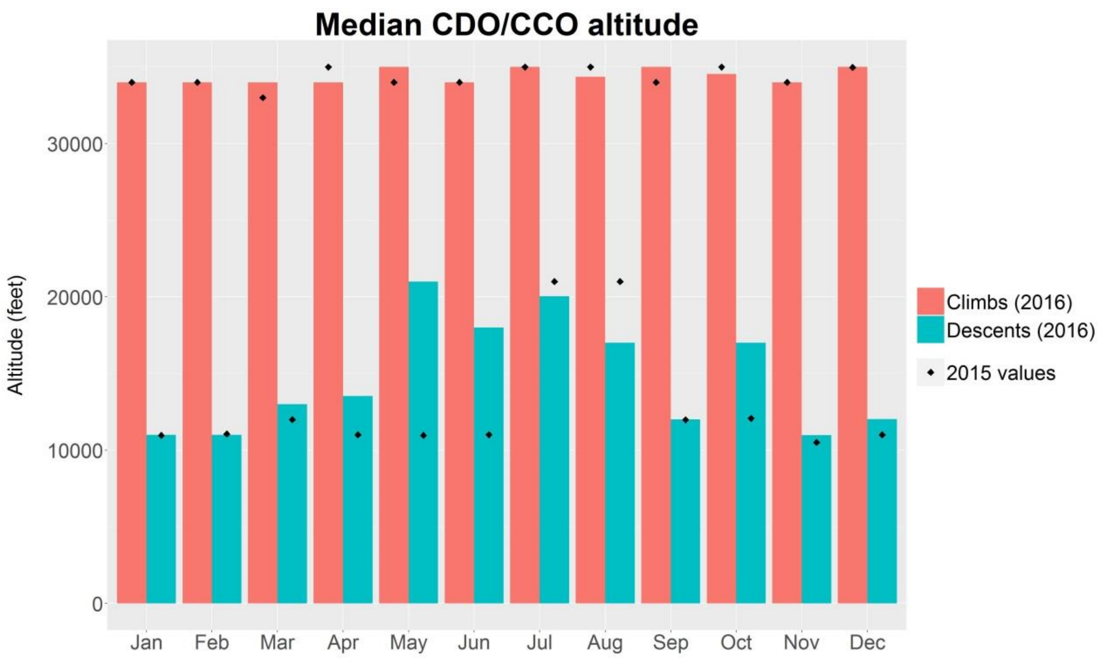


**Figure 14: Monthly median CDO/CCO altitude to/from Airport 12**

The median CDO altitude is the second best in the top 15 but there is still quite some level flight below FL100 and close to the airport as can be seen in Figure 15 and Figure 16. More specifically, 20.7% of the level flight time takes place around FL90 and 19.5% around FL40. Figure 17 highlights the level segments around FL90.

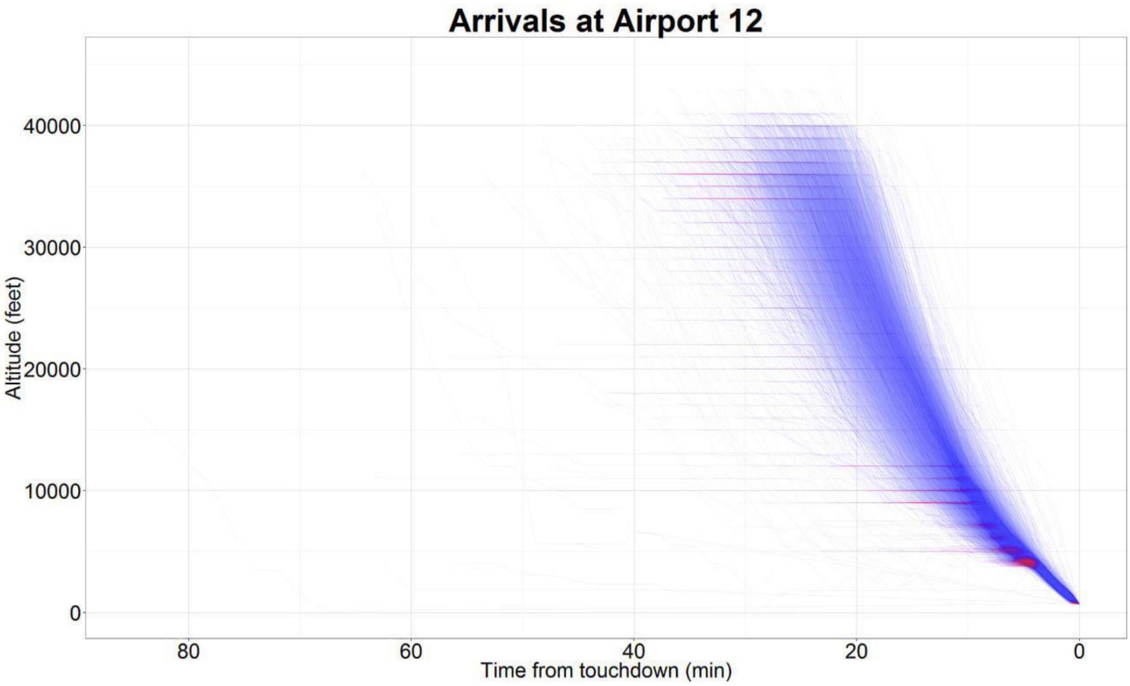


**Figure 15: Vertical trajectories of Airport 12 arrivals**

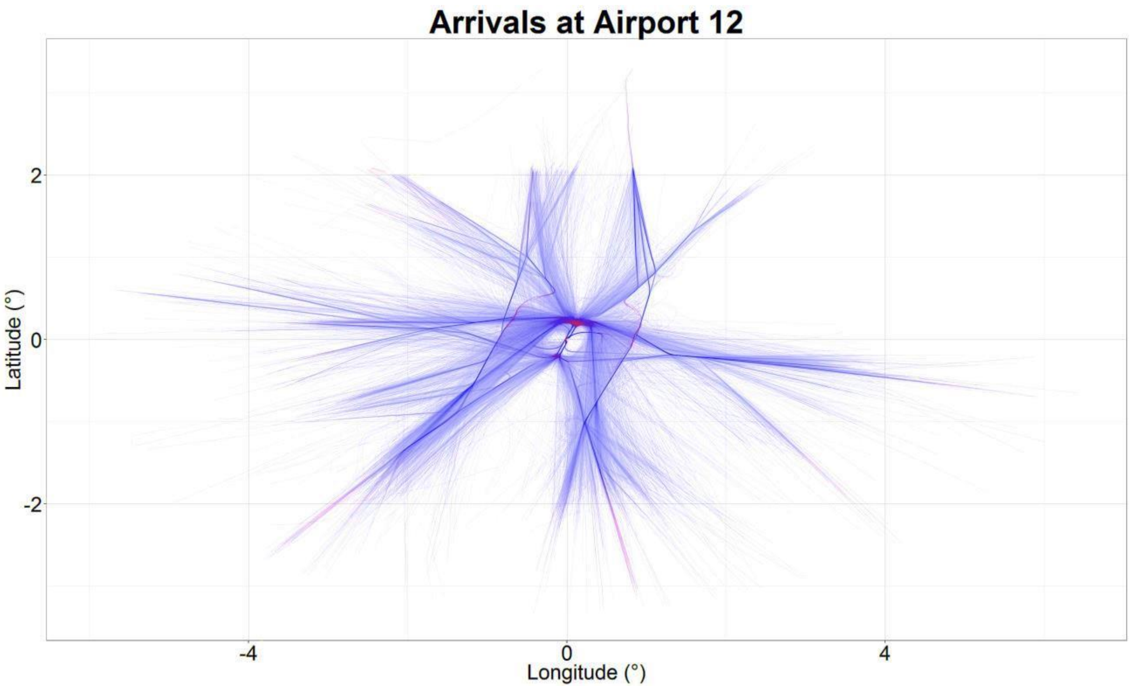


**Figure 16: Horizontal trajectories of Airport 12 arrivals**

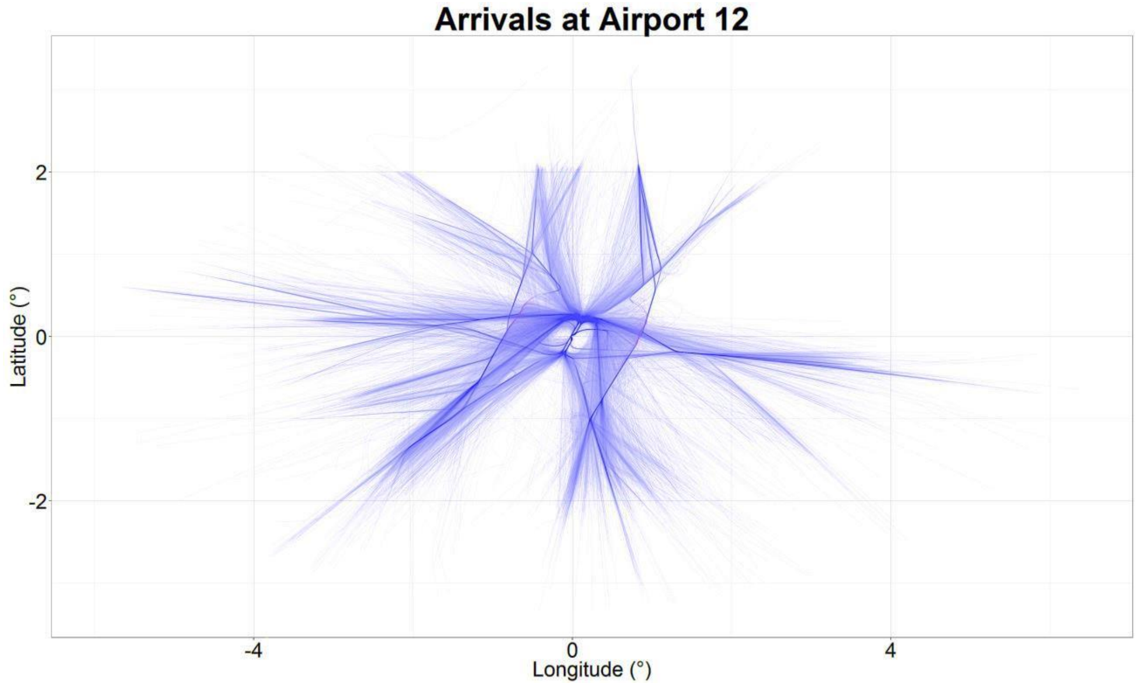


**Figure 17: Horizontal trajectories of Airport 12 arrivals with level segments at FL90 highlighted**

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# 8 Revision History

| Edition | Description | Comment |
|---|---|---|
| 00-01 | New draft – all pages | New document |
| 00-02 | Review | |
| 00-03 | Update to be submitted for consultation | |
| 00-04 | Second review | |