Discussion of Results and Conclusions

Discussion

For this MSc project, there have been several small studies conducted, on the data received from the stations participating in the National Contrail Network, and three larger studies. The smaller studies are, for example, the analysis of the number of contrails observed on each day at each station and the relation between the number of planes and the number of contrails observed along with the amount of non-contrail related cloud cover. The three main studies that have been conducted, and are the backbone of this research, are:

The analysis of the case study of December 18th 2003.

The analysis of the cluster of the three northeast stations; Bishop Auckland, Consett and Stokesley.

The analysis of the possible seasonal cycling of the occurrence of contrails.

In order to analyse the results from all of the studies carried out the results of each will be noted in turn.

The results of the December 18th case study.

In this case study a large peak in the number of contrails that were observed on this date was present in the data and it was concluded that this peak was likely to have been caused by a certain weather system that was over the UK at that time, as the peak in the number of contrails occurred at nearly all of the stations across the UK, and therefore must have a large, nationwide cause.

To study this idea the five days surrounding the 18th December had their weather systems analysed and classified according to the Lamb classification system. From this it was concluded that anticyclonic conditions favour either the formation of contrails, or the observation of contrails, more so than cyclonic systems.

The results of the analysis of the North East cluster.

Three separate analyses were carried out on the northeast cluster, to test whether or not the formation of contrails is a regional or a wider scale phenomenon. The results from two of these analyses supported the idea of the three northeast stations being a cluster, which suggests that

the formation of contrails occurs on a local scale, while one of the analyses questioned the idea of the cluster, suggesting that the formation of contrails occurs on a wider, national scale. It was concluded overall however that the occurrence of contrails is a wide scale event, so that if one station in the UK sees contrails other stations are also likely to, while the number of contrails that are seen is more of a local/regional scale event, which is probably due to the locality of airports and flight paths.

This large scale formation of contrails therefore also seems to suggest that contrail formation is controlled by a large scale process and is therefore likely to be linked to weather patterns and Lamb weather systems.

The results of the analysis of seasonal cycles of contrail formation.

Ledson (2003) reported the possibility of there being a seasonal cycle of contrail formation. Such cycles have also been reported in other locations (USA, Salt Lake City, the former Soviet Union). To test this therefore the monthly averages of the number of contrails observed at each station were plotted.

The results from this appeared to show that there may not actually be a seasonal cycle, but the monthly fluctuations that have been found at each station shows that there must be a national scale control over the formation of contrails, this is likely to be due to weather systems. Although a seasonal cycle was not found to be present in the data the idea of a seasonal cycle has not been ruled out (there is some evidence of it in the 2002 and 2003 Lancaster data) as there is evidence of it occurring elsewhere. It was therefore concluded that the timeframe of data that has so far been collected is not long enough to draw any firm conclusions and therefore this analysis must be reviewed in the future when there is a longer timescale of data.

The results of the analysis of the correlation between the number of planes and contrails observed and the amount of non-contrail related cloud cover.

From this analysis it was concluded that although large amounts of cloud obscures contrails and so makes the observation of them more difficult it is not solely responsible for the variations we see in the number of contrails, as this is also dependant on the flight paths and the number of flights of aircraft and also atmospheric conditions.

The results of the analysis of the types of contrails observed.

Contrails that are both persistent and dispersed (p+d) are the most important type with respect to climate change, and from this analysis it seems that p+d contrails are one of the most

common types; they form a large proportion of the number of contrails observed and therefore any future growth in the aviation industry can be expected to have an important influence on climate.

From this analysis it was also concluded that the current classifications of the types of contrails used by observers are unclear and will therefore need some revision to make this data more reliable.

The results of the analysis of the ratio of the number of planes to the number of contrails observed.

Here we would expect to see more contrails observed than planes. In the majority of the cases this proves to be so but in some cases (Mugdock, Bangor and Neston) this is not so. Although there are several possible explanations for this it is likely that this pattern has actually been caused by the fact that the average values used are very small, and so are easily skewed.

Conclusions

From the results of the above analyses it can be concluded that:

The formation of contrails occurs on a large national scale.

The number of contrails that form is reliant on local scale factors, such as flight paths.

Contrail formation is related to atmospheric conditions, in particular anticyclonic conditions.

More stations are needed within the National Contrail Network, particularly in Scotland and the south of England , to obtain a more even coverage of the UK . To study just the occurrence of contrails it is not necessary to have a large number of stations located close together, as in the northeast, but if we wish to study patterns in the number of contrails that are formed we need many more stations than there currently are. Therefore the number of stations that are needed in the network is dependant on the type of analysis we want to conduct. It is recommended that the network expands so that more data is available and therefore firmly reliable conclusions can be made and the more data we have, from a greater number of stations, the more analyses which can be conducted.

Home