Background

Contrails are condensation trails caused by hot aircraft jets in supersaturated air. There are other causes of contrail formation, but this one is the dominant aspect. The way these contrails evolve depends on the atmospheric conditions [see technical literature on the subject], but essentially they can either disappear in a few minutes or evolve into high-altitude cirrus clouds, with potential long-lasting effects on the local weather. In Figure 1 we show an example of short-lived contrails evolving into rings and eventually disappearing. The bottom photograph instead shows the effects of air traffic congestion with atmospheric conditions tending to medium- to long-term contrail evolution.
Solution

There are at three two ways to avoid conditions for contrail formation, some of which are unreasonable, unsatisfactory or simply not allowed by the international regulations:

- Wait until the weather conditions improve [a ludicrous proposition]
- Re-route the airplane into another corridor [almost as ludicrous, see air traffic in Figure 1]
- Change flight altitude [possible, but not acceptable]

The FLIGHT program, Ref. [1], has the option of solving the problem in the second and third instance, by analysing the optimal flight altitude and determining upward and downward shifts in altitude. Currently the program works with atmospheric conditions that are constant throughout the cruise, but with the use of appropriate databases it is possible, in principle, to use local atmospheric conditions [at least in 100 n-miles sections], to navigate the airplane along the best route, Figure 2. The figure shows a clouded area of ice super saturated region most likely to lead to a contrail. The black line is the conventional altitude profile of the airplane and the blue lines are two alternatives A and B in the latter part of the flight. Obviously, this is a simplification, because other weather factors may intervene – to say nothing of air traffic constraints.

![Contrail Avoidance](image.jpg)

**Figure 2:** Contrail avoidance by altitude shifts, adapted from Ref. [2].

Further References


For enquiries, please write to:

Antonio Filippone  
The University of Manchester  
Manchester M13 9PL  
United Kingdom  
Email: a.filippone_at_manchester.ac.uk