FAKULTÄT TECHNIK UND INFORMATIK
Department Fahrzeugtechnik und Flugzeugbau

HAW HAMBURG

Aircraft Contrails – Observation and Prediction

How to overcome industry's skeptical and slow attitude towards contrail management?

Everyone can predict contrail lifespan with sufficient accuracy of aircraft flying overhead. Needed is only a smartphone with Internet access and two charts. If it is so easy, pilots, airlines, and air traffic control can also do it. Every pilot can request Flight Level xyz to avoid warming contrails. Time for contrail management is now. The time for excuse is over.

PURPOSE

In this project contrails in the sky are observed. Their existence and persistence is compared with calculations.

METHODOLOGY

Photos are taken of aircraft and of their contrails passing by in cruise. The contrails are categorized according to their lifespan. The website flightradar24.com is used to obtain flight data (altitude and temperature). Also, satellite images and contrail recordings were collected from other publicly available websites. The Schmidt-Appleman diagram (Figure1) and the Schmidt-Appleman criterion were used for predicting contrail existence and persistence. Input data is altitude, temperature (Figure 2), and relative humidity. Relative humidity (Figure 3) was obtained via the website windy.com from the European Centre for Medium-Range Weather Forecasts (ECMWF).

FINDINGS

Contrails can be predicted with the method. For contrail lifespan three categories were defined: no contrails, transient contrails (lifespan of a few seconds up to five minutes), and persistent contrails. The lifespan of contrails was correctly categorized.

RESEARCH LIMITATIONS

The observation took place with the naked eye and a smartphone camera. Accordingly, no observations could be made during the night. In addition, only a limited number of aircraft were observed. The resolution of the relative humidity is limited with respect to altitude and time.

PRACTICAL IMPLICATIONS

A hands-on approach is presented, ready for everyone to apply.

SOCIAL IMPLICATIONS

Contrails can be seen by everyone. Systematic contrail observations readily expose the aviation industry as fostering or boycotting avoidance of warming contrails.

ORIGINALITY

The well-known idea of contrail observation and prediction from the ground may have been deemed too simple and unworthy of science so far to be applied in a project.

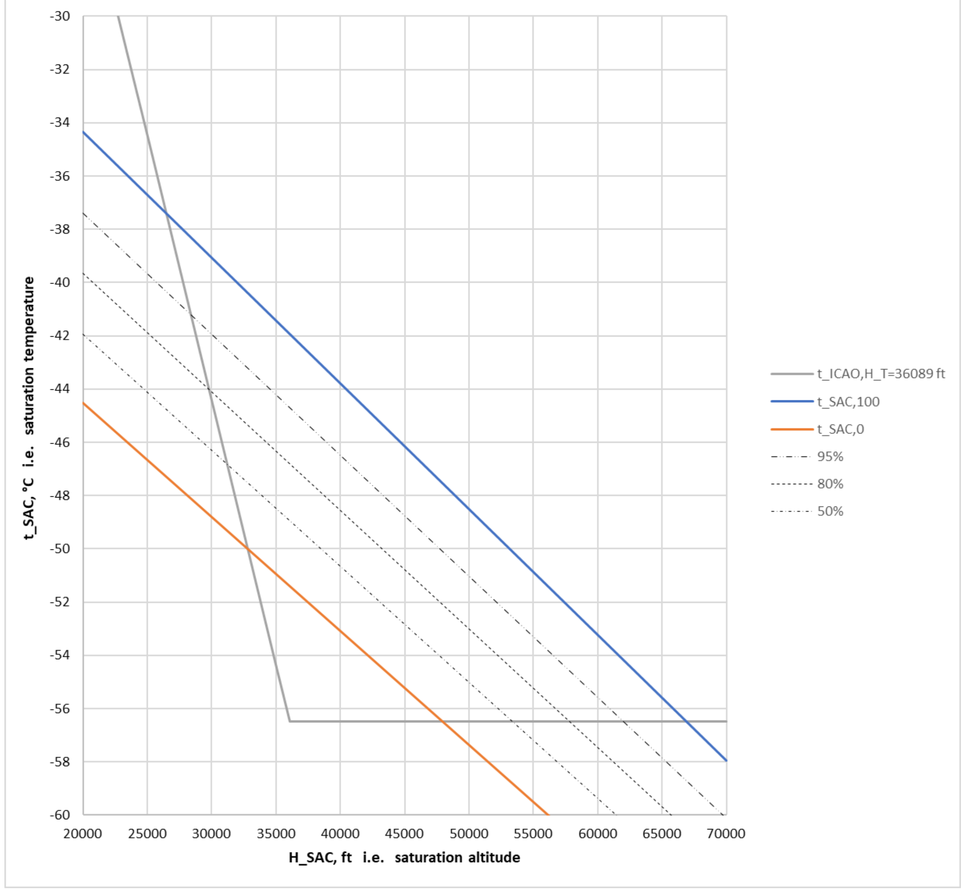
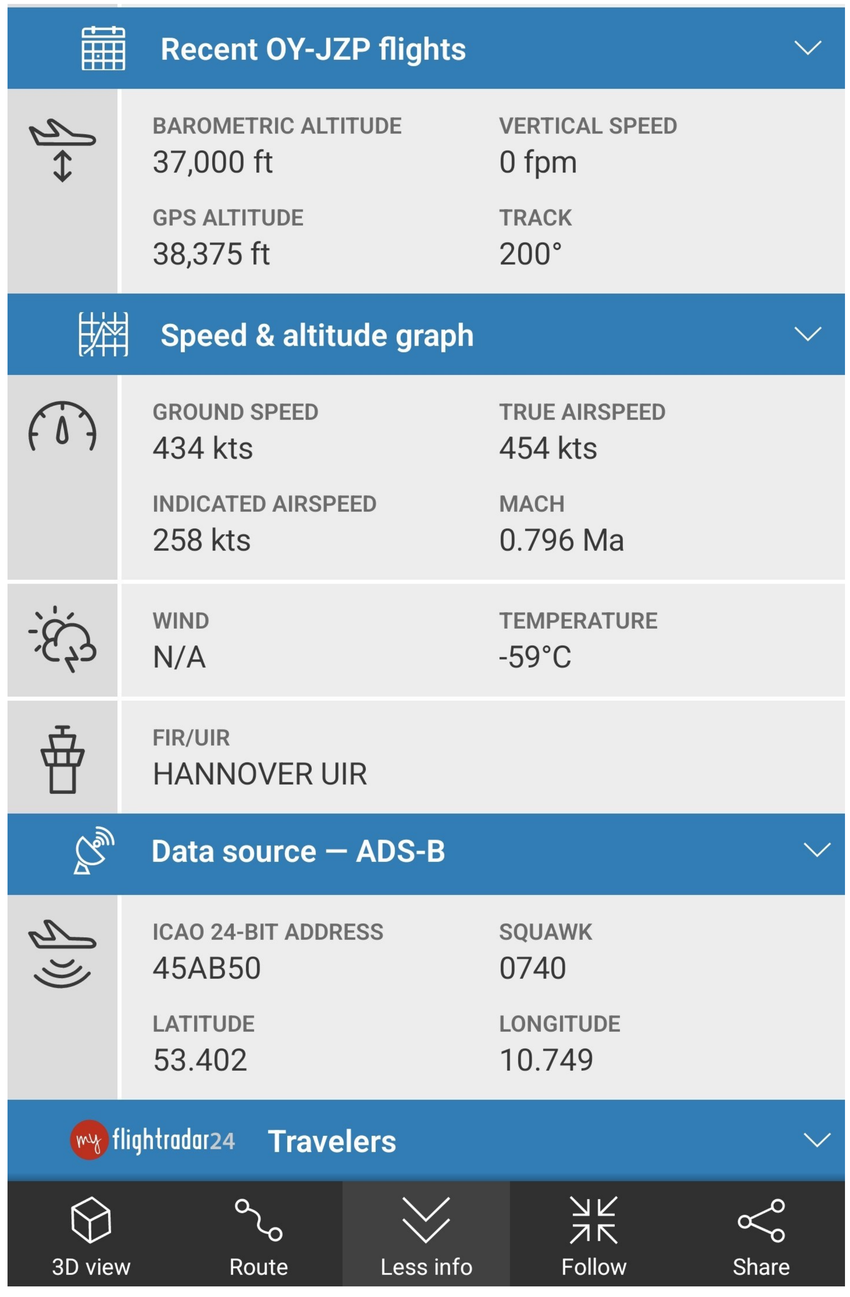


Figure 1:
Screenshot of the Schmidt-Appleman-Diagram from an own Excel-sheet (https://purl.org/aero/SAC). The orange line represents the line for 0% relative humidity, the blue line for 100%. In between there are lines for 50%, 80% and 95%. The full gray lines represent the ISA-Temperature, decreasing up to 36089 ft constant with -56.5 °C beyond that altitude. If pressure and temperature conditions exist to the left of a humidity line, a contrail will form. If pressure and temperature conditions exist to the right, no contrail is expected to form.



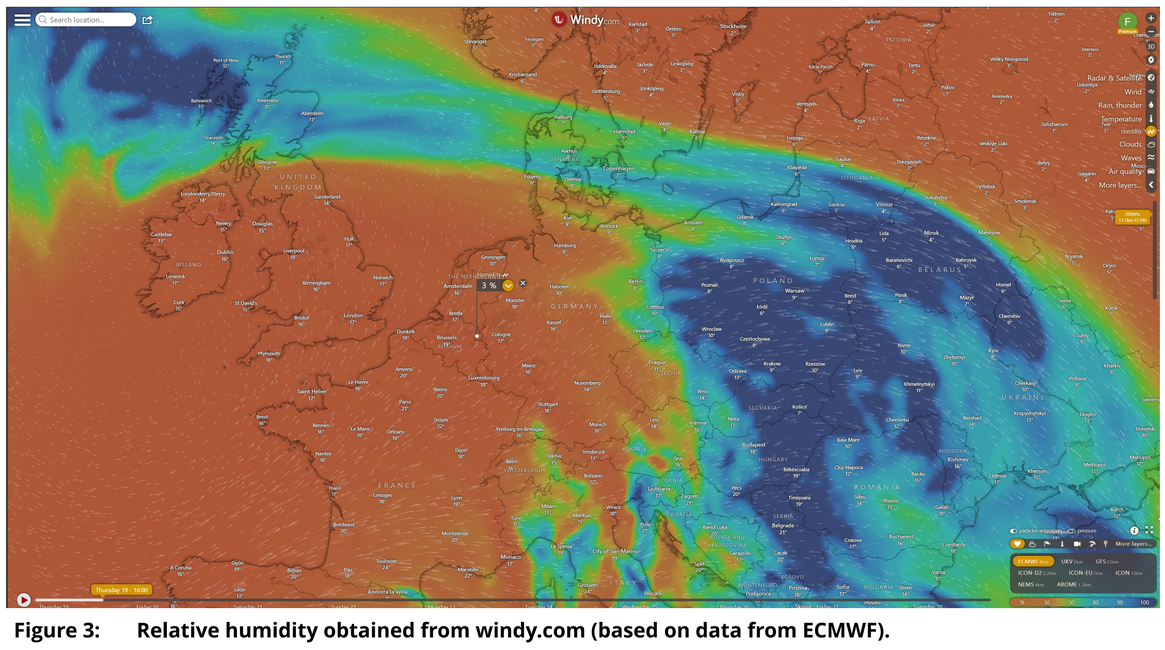


Figure 2:
Aircraft data from flightradar24.com (barometric altitude and temperature).

Figure 3: **Relative humidity obtained from windy.com (based on data from ECMWF).**

All details in the Bachelor Project of Brigert (2024):
https://nbn-resolving.org/urn:nbn:de:gbv:18302-aero2024-03-14.019

Associated research data (Harvard Dataverse):
https://doi.org/10.7910/DVN/9DLURT

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