InnovAero Competition

Task Description

The InnovAero Competition 2024 is about:

Use of aircraft systems as a contribution to modern weather forecasting and sustainable flight route optimization

You need to solve challenges in the areas:

- Electronics
- Aeronautical Engineering
- Computer Science
- Project Management
- Meteorology
- And further more

Are you interested? Then get in touch with us and your university team with a supervising chair.

Your Chance:

Invitation of teams with the most promising solution to the award ceremony with prize money at Lufthansa Technik in Hamburg.

Events:

30. September 2024:	Team registrations via email
17. November 2024:	Submit a 15 page technical report
December 2024:	Final 3 days event at Lufthansa Technik in Hamburg with the announcement of the winning team. Further information will follow soon

Introduction

Advancing climate change requires a holistic view of the environmental impacts of various industries, especially aviation. Given the increasing global demand for air transport and the associated CO2 emissions, it is crucial to develop innovative approaches that take both environmental protection and economic development into account. In this context, aircraft construction plays a central role, as the development of efficient and low-emission aircraft models can make a significant contribution to climate protection. It is also about modernizing existing aircraft, for example to obtain additional aircraft data and environmental data.
Another important aspect is optimizing flight routes to reduce fuel consumption and emissions and avoid the formation of contrails. By using state-of-the-art technologies such as satellite-based navigation, advanced flight planning systems and aircraft sensors, airlines can choose more efficient routes, especially avoiding warming contrails, thereby reducing their overall environmental footprint.

In summary, the combination of climate protection, development, aircraft construction and flight route optimization requires a holistic approach that takes into account both ecological and socio-economic aspects and relies on innovative solutions. This is exactly where the competition begins.

Description of the Task

The use of aircraft data, in particular through the use of digital data connection systems to exchange information, can be done in different ways. Airplanes continuously provide data about their flight movements, which can be used to change course.
Taking into account the formation of contrails caused by air traffic is becoming increasingly important. When fly at high altitudes, the water vapor in the engine exhaust condenses with the cold ambient air at high altitudes. This creates tiny water droplets or ice crystals that become visible as contrails when reflected in sunlight.
The formation of contrails depends on various factors, including the altitude of the aircraft, the humidity and the temperature in the area. Contrails usually occur on aircraft flying at very high altitudes where the air is very cold and dry. Under these conditions, water vapor can condense on particles from engine exhaust and form contrails, which are often visible as long, narrow stripes of cloud in the sky.
The effects of contrails on the climate are the subject of scientific research. Although contrails vary in duration and often dissipate, they can still enhance the formation of cirrus clouds. These airliner-induced clouds can impact the climate by affecting the amount of sunlight that reaches or is reflected to Earth and increasing the temperature in the atmosphere.

In recent years, various measures have been investigated to reduce the formation of contrails. These efforts aim to reduce the environmental impact of air travel and protect the climate. This is exactly the core of the task.

The task is divided into two focal points

A: Upgrading the airliner with sensors:

1. *What measurements are currently used by a commercial wide body aircraft to contribute to the acquisition of meteorological data?*
2. *What data is needed to determine the formation of contrasts and what does this mean in relation to the current aircraft system data and which conditions or influences must be taken into account? Which components are specifically required for this?*
3. *How can the newly selected components be integrated or installed into the aircraft and which conditions or influences must be taken into account?*
4. *What would you generally recommend to make the recorded meteorological data usable for further investigations or predictions?*

B: Determination of a flight route (flight altitude profile) to avoid condensation trails that have a negative impact on the atmosphere:

5. *Use the newly installed sensors to calculate the potential for contrails all over the flight profile*
6. *Recommend re-planning your flight profile to avoid contrails*

The following flight route is predicted with the corresponding flight profile. The aircraft with a good climb rate flies with optimized fuel consumption at an altitude of 39,000ft.

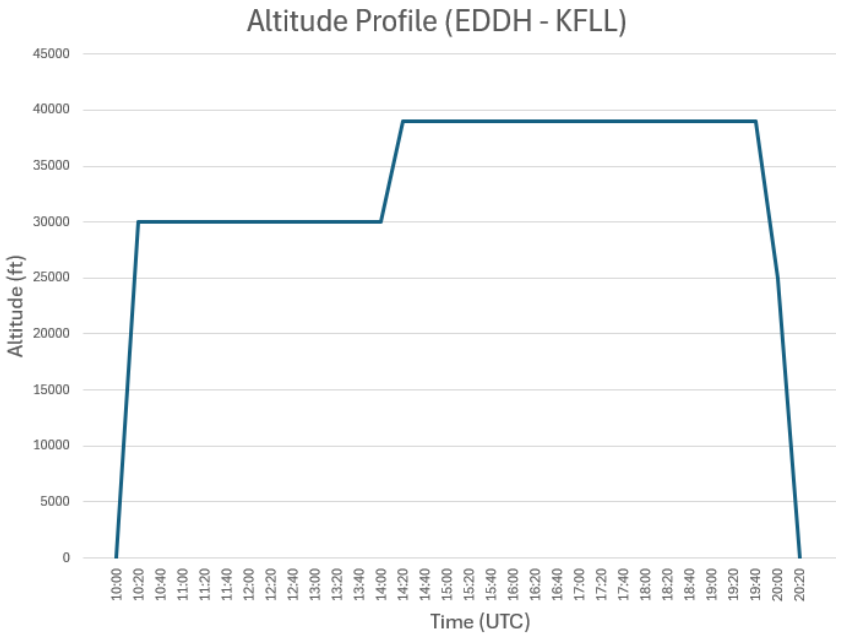

Figure 1: Altitude profile of a wide body commercial aircraft flight

Weather information for the specified flight profile

In the period from start to approx. 2 hours after take-off there is cloud cover at approx. 6,500ft. present throughout. At the specified cruising altitude, an average temperature of -34°C and an air pressure of 300hPa are measured. The relative humidity of the outside air is 70%, which remains valid until the next climb.

What kind of contrails can form up to this point and what negative influences on the atmosphere do you estimate? Name conditions necessary for the formation of contrails?

From 5:40 p.m. to around 6:20 p.m. the aircraft flies into a so-called saturated area. The average values of air pressure is 200hPa and the temperature is -53°C.

What do you do to avoid possible contrails and what potential length of the contrail cirrus do you suspect?

The aircraft then flies into an area where there is a relative humidity of 50% until the descent begins.

What kind of contrails can form up to this point and what negative influences on the atmosphere do you estimate

Notes:

- Explain everything in detail so that your steps and conclusions can be understood
- Explain the calculation methods and sources used
- Consider where the components can be integrated on the aircraft. Use sketches to clarify
- How could the components be designed? Use sketches to clarify
- It is not possible to change the flight course from the planned flight route at any time
- The average vertical spread of the saturated area is 4,000ft.
- Try to display the flight altitude profile in a program to take into account any changes in relative humidity, temperature, pressure and altitude

Required Documents

Technical report:

- Introductory material, this is required but does not fall within the 15 pages limit:
    - Title page: Team name, name of the supporting organization or institution, name of the academic supervisor, head of the student team, date of submission
    - List of members of the student team and number of semesters (Bachelor's or Master's degree program)
    - Abstract (1 page)
- Everything essential must be presented in the 15 pages:
    - Introduction and brief overview of the used literature
    - Listing and representation of aircraft components for the aquisition of wheater data and in the future for the detection of contrails
    - Description and illustration of how the components can be installed in the aircraft
    - Calculation of the possible formation of contrails in the region under consideration
    - Demonstration of flight route re-planning to avoid contrails
    - Required diagrams, tables and figures must be included
    - Conclusion and recommendations for further investigations
- Other required material (does not fall within the 15 page limit):
    - Bibliography

Presentation at the final meeting on site:

The results must be presented at the final event of the challenge. Each team's presentation should not be longer than 10 minutes. Details about the presentation and the event will be communicated after the report has been submitted. It is important to mention that you may receive new weather data on site and need to re-plan your flight route. This serves to validate your approach and opens up the possibility of exchange. Self-created animations or videos are allowed.

The submitted reports will be evaluated by an independent jury based on the following criteria and their weightning are as follows:

- Feasibility (40%)
- Creativity and form (20%)
- Comparison of the submitted solutions (40%)

The report and the presentation are included in the evaluation as follows with appropriate weighting:

- Report 40%
- Presentation 60%

Conditions of participation:

- All participants must be enrolled at an university
- The teams can have a maximum number of five members to show up at the event in Hamburg
- The presentation and the report must be prepared in English language
- The communication for the event will be in English language
- If you have any questions about the task, you can contact the organizer
- The following costs will be covered by Lufthansa Technik for all participants:
    - Flights and associated costs
    - Accomodation for the evening before and on the evening of the event

Submission guidelines:

- The technical report file size should under 10MB and as .pdf
- Email address to which the technical report must be sent: too.haminnovaero.competition@lht.dlh.de
- Subject: LHT_InnovAero2024_teamname

Formal regulation und further information:

- No formulations or ideas from other authors may be adopted without citing the source. If you use the statements or ideas, they must be clearly marked as quotations and given as a footnote. Submitted work containing plagiarism will be disqualified. The paper and presentation must be created independently and exclusively by team members
- The report should meet engineering standards
- The jury consists of aviation experts and the presentation is made to the higher management board

Good luck