



Delivering green results - A summary of European AIRE project results in 2009

AIRE partners in Europe



AIRE project results - 2009	Content
A greener tomorrow starting today	p.04
AIRE: reducing aviation's environmental footprint	p.04
2009 trial flights: an introduction	p.05
Executive Summary of results in 2009	p.06
AIRE projects: surface	p.07
AIRE projects: terminal	p.09
AIRE projects: oceanic	p.13
Conclusions and the way forward	p.16

A greener tomorrow starting today

When the European Commission and the Federal Aviation Administration (FAA) launched the Atlantic Interoperability Initiative to Reduce Emissions (AIRE) in 2007, few would have expected that results could be delivered so quickly. In 2009, AIRE executed more than 1,000 commercial flight trials in five different locations. The trials aimed at improving the environmental performance of flights capitalising on current technologies, but with improved operational procedures. The results presented in this summary are very encouraging.



The aviation industry assumes its responsibility towards a more environmentally friendly way of flying. The quickest way to cut aircraft emissions is better flight management, an Oxford University study has just recently determined.¹

AIRE clearly shows that through partnership between aviation players on both sides of the Atlantic concrete benefits can be achieved already today. The SJU is committed to continuing this work.

Patrick Ky, SESAR Executive Director

AIRE: reducing aviation's environmental footprint

AIRE is a programme designed to improve energy efficiency and aircraft noise in cooperation with the FAA. The SJU is responsible for its management from a European perspective.



Under this initiative ATM stakeholders work collaboratively to perform integrated flight trials validating solutions for the reduction of CO2 emissions for surface, terminal and oceanic operations to substantially accelerate the pace of change.

The strategy is to validate continuous improvements, to be implemented by each partner in order to contribute to reaching the common objective. In 2009, the SJU supported around 1152 trials in real conditions. The trials have shown positive results and will be further detailed in the following chapters.

¹"Future of Mobility Roadmap, Chapter 3, Air". University of Oxford, Smith School of Enterprise and the Environment, 2010.

2009 trial flights: an introduction

In 2009, about 1152 demonstration trials took place in five locations involving 18 partners: Air France, DSNA, Aéroports de Paris, ADACEL, AVTECH, Egis Avia, Nav Portugal, TAP Portugal, Isavia, Icelandair, TERN Systems, AENA, INECO, Iberia, LFV, Novair, Airbus and Thales. The trials included surface as well as terminal and oceanic green procedures.

Ground movement

On average, aircraft are responsible for only about half of the emissions produced at and around airports. The airport related emission sources are generally categorised under aircraft emissions (aircraft engines and auxiliary power units), aircraft handling emissions (mainly ground support equipment, airside traffic, aircraft de-icing and refuelling), infrastructure or stationary sources (surface de-icing, power/heat generation plant, construction activities, etc.), and all vehicle traffic sources associated with the airport on access roads.

In 2009, green ground movement trials performed at Paris CDG demonstrated the effectiveness of a new collaborative decision support system which minimises taxi time and allows for reduced engine taxi operation.

Terminal

Airports are one of the bottlenecks of the current air traffic management system. Air traffic flows are managed on a first-come, first-served basis leading to unnecessary fuel burn, as air traffic control (ATC) often requires aircraft to level off and hold at intermediate altitudes during descent.

'Green' approach (such as Continuous Descent Approaches - CDA) or green climb trials at Madrid, Paris and Stockholm airports were conducted. The first 'Required Navigation Performance' (RNP) - based CDA approach ever to be performed in Europe was conducted at Stockholm's Arlanda airport.

Oceanic

In the current system, ever increasing traffic flows between Europe and North America are leading to inefficient fuel consumption, fewer accepted airline requests and schedule disruptions.

Trials for "green" oceanic procedures and techniques (speed, horizontal and lateral flight profile optimisation) on selected routes between Europe and North/Central America and the Caribbean's were carried out.

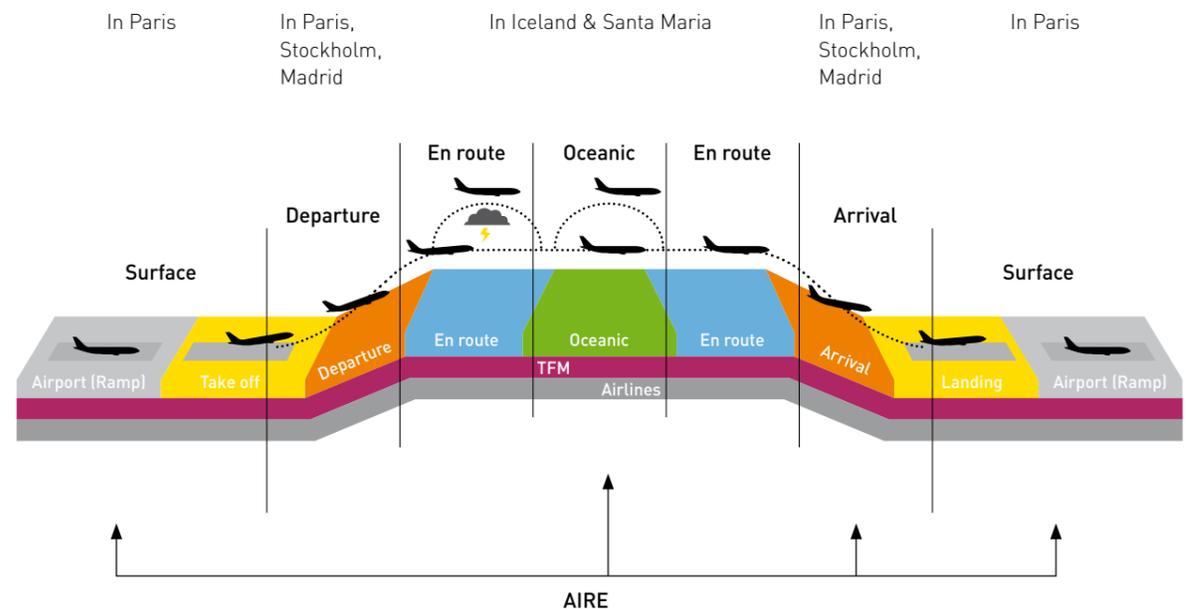


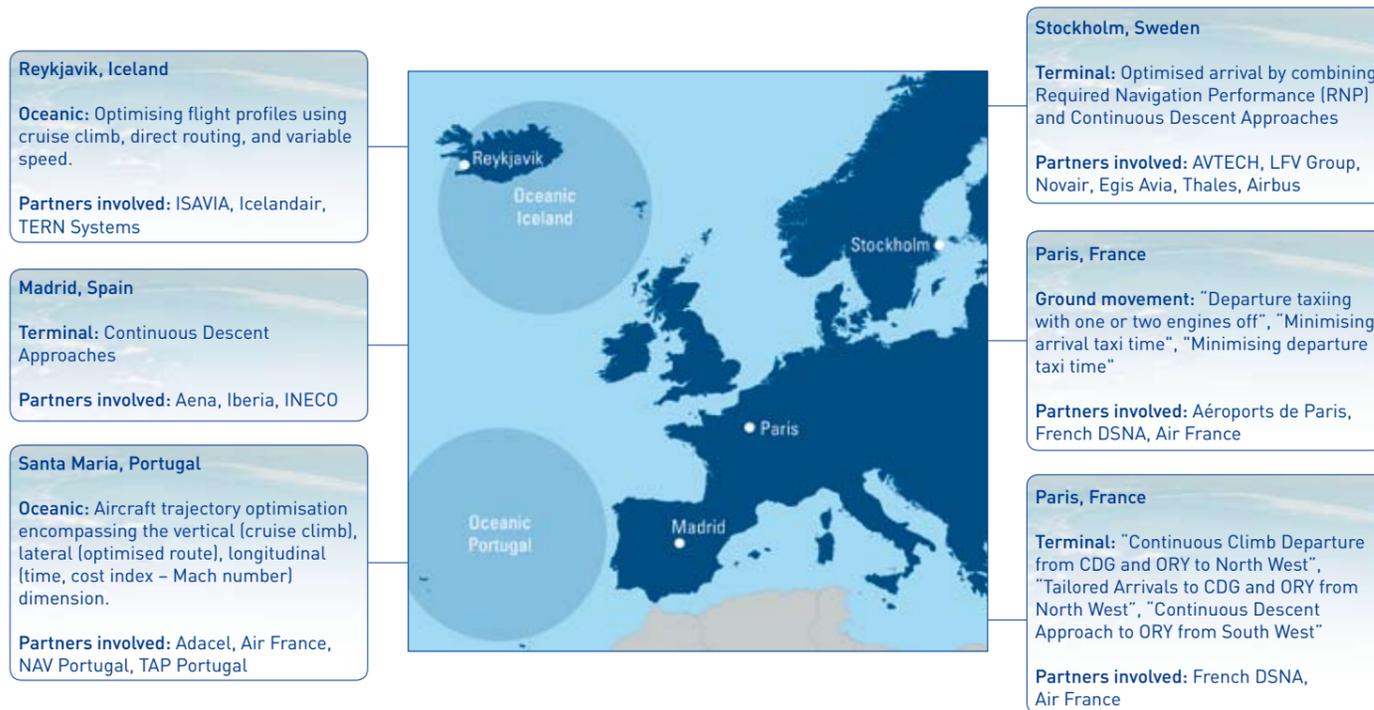
Illustration of AIRE domains during 2009

Executive Summary of results in 2009

During 2009, AIRE has demonstrated concrete results based on facts collected from the field. The insights and implications that were developed are encouraging for all projects. Some of the solutions that were validated will bring significant results in the short term.

Domain	Location	Trials performed	CO2 benefit/flight
Surface	Paris, France	353	190-1200 kg
Terminal	Paris, France	82	100-1250 kg
	Stockholm, Sweden	11	450-950 kg
	Madrid, Spain	620	250-800 kg
Oceanic	Santa Maria, Portugal	48	90-650 kg
	Reykjavik, Iceland	48	250-1050 kg
	Total	1152	

Summary of environmental benefits per flight (depending on aircraft type and baseline)



Locations of European AIRE projects directly co-financed by the SJU in 2009

AIRE projects: surface

AIRE Ground Movements project

The AIRE ground movements project was conducted by a consortium involving Aéroports de Paris (coordinator), the French DSNA (Direction des Services de la Navigation Aérienne) and Air France.

Description of the Trials

More than 350 commercial flights participated in the different evaluations, involving over 50 staff members from DSNA, Air France and Aéroports de Paris. They were performed at Roissy Charles de Gaulle (CDG) airport from March to October 2009.

Three types of innovative ground movement measures were evaluated:

- "Departure taxiing with one or two engines off" with the objectives of measuring the fuel savings. This also included assessing the impact on pilot procedures as well as the impact on the surrounding traffic in terms of taxi disturbance and on the surrounding vehicles and staff in terms of jet blast,
- "Minimising arrival taxi time" with the objective of reducing arrival taxi time, when possible. This was possible by assigning the most appropriate arrival runway thanks to anticipated parking information provided to the arrival coordinator, and
- "Minimising departure taxi time" with the objective of optimising the sequence of departures to reduce the waiting time at the departure threshold.

Linked to better take-off time predictability, 16 flights evaluated the "Departure taxiing with one or two engines off" for both B747 and A320 aircraft types departing from CDG. Assumptions were that the average taxiing duration is about 16 minutes at Paris CDG and that for safety reasons all engines have to be started at least three minutes before takeoff.

The evaluation framework for "Minimising arrival taxi time" was restricted to aircraft parking on a specific area (Parking H) and under low to medium traffic conditions. 28 flights were involved in the evaluation.

The evaluation of the initiative for "Minimising departure taxi time" was linked to the introduction of the GLD system (implementing pre-departure sequence concept at CDG airport). This was performed over four days and involving all departing flights from CDG at a given time in the afternoon. 309 flights participated in the evaluation, with the objective of reducing waiting time at the runway threshold and

AIRE Ground Movements project: 353 flight trials involving 50 staff from three partners.





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AIRE projects: terminal

transferring it into holding time at the parking stand with engines off.

Overall the evaluation results obtained for the three initiatives are significant and encouraging for the near future.

Results

For "Departure taxiing with one or two engines off" on the four engine aircraft (B747) the observed fuel consumption reduction was about 20kg/minute with two engines off and 10kg/minute with one engine off. Therefore the order of magnitude of fuel savings per flight at CDG airport ranged between 200kg and 300kg with two engines off and between 100kg and 150kg with one engine off. For the twin engine aircraft (A320) the corresponding fuel savings were estimated between 60kg and 90kg.

The extrapolation of annual potential savings of this initiative considering the Air France A320 and B747 flights only, leads to 3,900 tons of fuel and 12,300 tons of CO2. This is based on a procedure applicability percentage of 75% taking into account suitable operational conditions.

For the "Minimising arrival taxi time" initiative, benefits came from a mean reduction of taxi-in time of about 1min 45s per aircraft parking on area H2 and also on a positive in-flight impact of 30 seconds (two miles) on the assigned aircraft approach trajectory.

For the A320 family, benefits were estimated at about 50kg fuel savings per arrival flight taxiing to parking area,

equivalent to 160kg CO2 savings. The yearly potential of such a measure for this parking area would save up to 60 tons of fuel and 190 tons of CO2.

As a first step, the feasibility for updating parking information exchange systems, coordinated by DSNA and Aéroports de Paris, will be investigated during the first half of 2010. In parallel, the possibility to extend the initiative to other parking areas under operational conditions will be studied.

For the "Minimising departure taxi time" initiative, the departure taxi time was reduced by an average of 45 seconds per flight in nominal conditions, and of about one minute per flight in non-nominal conditions. This meant that the flight left the gate later than scheduled, but overall the departure throughput was not impacted due to unchanged take-off time.

The estimated total fuel savings for these limited trials were about six tons, equivalent to 19 tons of CO2 savings. According to ATC, such benefits could be reproduced for the four most important departure peaks.

The annual potential savings of this measure has been evaluated to 2,370 tons of fuel and 7,500 tons of CO2. If applied to degraded situations, more potential savings could be envisaged.

The deployment of the pre-departure sequence concept (GLD system) is part of the CDM@CDG2010 project. The full deployment of this initiative at Roissy Charles de Gaulle airport is planned in 2010.

Project in Stockholm, Sweden

The project was carried by a consortium including AVTECH, LFV Group, Novair, Egis Avia, Thales and Airbus with the contribution of an Expert Advisory Group (EAG) including GE Aviation, Thales Avionics, Thales Air Systems and Scandinavian Airlines Systems (SAS).

The MINT (Minimum CO2 in the TMA) partners demonstrated optimised aircraft operation during descent with eleven Novair A321 flights into Stockholm Arlanda airport. The optimised arrival was achieved by combining benefits from using the aircraft Required Navigation Performance (RNP) capability with benefits from flying efficient CDAs. It was also demonstrated the possibility to use these techniques to address noise issues as well as showing that it is possible to combine them with the SESAR defined Controlled Time of Arrival (CTA) concept.

Objectives

The objectives of the project were to achieve optimisation by addressing both lateral as well as vertical parts of the approach. For the lateral part a RNP-Authorisation Required (AR) procedure was developed for Arlanda Runway 01R which minimises track miles while considering noise sensitive areas. The vertical profile was optimised by the uplink of individual flight selected descent wind information. This was to enable the aircraft Flight Management System (FMS) to select the best possible Top of Descent (ToD) point in order to achieve an idle CDA. Last but not least, the objective was also to demonstrate that this efficient procedure could be flown in combination with a time constraint to an entry point inside the Terminal Manoeuvring Area (near 10,000ft). This was to demonstrate the aircraft capabilities to fly an efficient descent while also supporting a time request from ATC for sequencing as foreseen in the SESAR operational concept.

Description of trials

In July and August 2009, ten revenue RNP-AR flights were carried out and the data was logged to be used in the analysis. Four of the ten flights were flown with the CTA constraint. All flights were arriving from the south via the Trosa VOR TMA entry point. An 11th flight – for communication purposes –, was successfully carried out in November 2009. This flight was also flown with a CTA constraint but via the northern Hammar VOR TMA entry point.

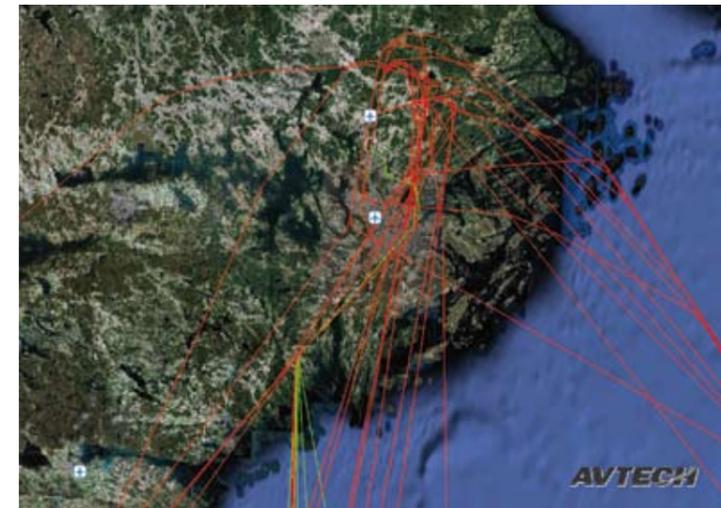


Illustration for 10 MINT flights as well as all 28 baseline flights (lateral flight profiles)

Results

The project identified 165 kg of potential savings of fuel for the 01R runway when arriving from the south and 140 kg potential saving if also including other directions and other runways to the baseline performance. The observed lateral navigation precision of flight of the aircraft was excellent. For the ten flights during the RNP-AR segment the lateral standard deviation is measured to be 21.2 meters.

The RNP procedure showed itself also to be a very strong tool for addressing noise distribution problems by enabling circumnavigation of the areas. For Upplands Väsby (a suburb north of Stockholm) noteworthy for having noise problems due to arriving traffic, the noise could be reduced largely with the defined RNP-AR procedure.

Operationally speaking no problem was identified in implementing the new procedure and it is planned to go to normal operation during low traffic periods as of 2010.

MINT flights demonstrate fuel savings of 165 kg - leading to more than 500 kg reduction in CO2 emissions per landing

Project in Paris, France

The AIRE Terminal Operation Project was conducted by a consortium composed of the French DSNA (Direction des Services de la Navigation Aérienne) coordinating the project and Air France.

Objectives

The aim of the project was to explore improvements which would authorise reductions of fuel consumption and CO2 emissions, taking into account the complexity of the Parisian airports. The joint knowledge of Air France and DSNA on the organization of airspace and procedures in Paris Terminal area allowed for innovative procedures. These flight demonstrations highlighted the achievable potential in terms of operational, economic and environmental efficiency.

Description of trials

Five types of demonstrations took place from April to October 2009: Continuous Climb Departure from CDG and from Orly (ORY) to North West, Tailored Arrivals to CDG and to ORY from North West and Continuous Descent Approach to ORY from South West. In total, 90 flight demonstrations were carried out under the conditions of real traffic, following precise protocols.

The procedures for "Continuous Climb Departure to North West" have been designed to avoid an existing level off during the climb phase and to assess the extent up to which the FMS trajectory predictability information sent to the planner controller could help him/her to accommodate the Continuous Climb Departure. The evaluation was performed thanks to 14 long-haul Air France flights departing in low traffic conditions for the west runway configuration involving A330, B777 and B747 aircraft types.

Tailored Arrivals Orly from North West trials allow assumption that one airline alone could save up to €330,000 per year through this measure.

For "Tailored Arrivals from the North West", the procedures included an enhancement of the vertical profile from cruise to an Initial Approach Fix. In addition for Orly it involved an optimisation of the downwind leg by raising a flight level constraint. The evaluation was performed thanks to 52 long-haul Air France flights arriving from North America or the French West Indies in low traffic conditions involving A340, B777 and B747 aircraft types.

For the "Continuous Descent Approach to Orly from the South West", the procedures included an enhancement

of the existing CDA at Orly by raising the flight level at the Initial Approach Fix (IAF) and to allow a continuous descent from ToD to the IAF to the greatest extent beforehand. The evaluation was performed by 24 Air France short haul flights involving the A320 family arriving from the South West in low traffic conditions.

Results

The demonstrations of the "Continuous Climb Departure to North West" initiative showed about 30kg of fuel savings per flight at CDG and about 100kg of fuel savings at Orly (about 100kg and 300kg of CO2 savings respectively). The small number of trials could not be used for annual extrapolations of CO2 savings.

For the "Tailored Arrivals from North West" initiative, the results varied from 100kg to 400kg of fuel savings per aircraft at CDGm, depending on the West or East configuration, and about 200kg of fuel at Orly (in average about one ton and 600kg of CO2 savings respectively). Annual extrapolations of CO2 savings for one airline only are potentially about 1,500 tons (approximately €330,000).

The demonstrations of the "Continuous Descent Approach to Orly from South West" initiative showed about 175kg of fuel savings per flight (i.e. about 530kg of CO2 savings). The annual potential savings of this initiative for Air France has been evaluated to 220 tons of fuel and 700 tons of CO2.



Project in Madrid, Spain

The RETACDA project's consortium is composed of Aena (Air Navigation Service Provider and Airports Operator of Spain), Iberia (airline) and INECO (project coordinator).

Objectives

The RETACDA project's objective was to perform integrated flight trials and demonstrations in the Terminal Area using a CDA, with the aim of reducing CO2 emissions and of optimising the fuel consumption in the Terminal Areas (TMA) around Madrid-Barajas airport.

Description of trials

The data collected for the environmental analysis were obtained from A320 and A340 Iberia commercial fleet during the summer of 2009. The trials were carried out in the Madrid TMA/FIR operational area. CDA procedures were performed during the night at Madrid-Barajas airport in a North configuration. Data from other flights with the same fleet, not performing CDAs, were used as a baseline to compare the CDA benefits.

Specific operational constraints and phraseology were defined for the trial demonstrations. When feasible, ATC coordinated that the CDA was performed from Top of Descent (ToD) to Instrument Landing System (ILS) capture for landing. If there was no ATC coordination, the CDA procedure started at flight level 210. All flights followed one of the North configuration standard terminal arrival routes. More than 1,000 flights were analysed, of which 620 were specific flight demonstrations.

Results

The evaluation method included segregation between "CDA" and "NoCDA" flights to determine the average fuel burn. Computation was performed on a final set of about 900 flights and it started formally from flight level 210 (TMA entry point), although in 96% of the cases due to good coordination between TMA and en-route the flight were optimised from ToD.

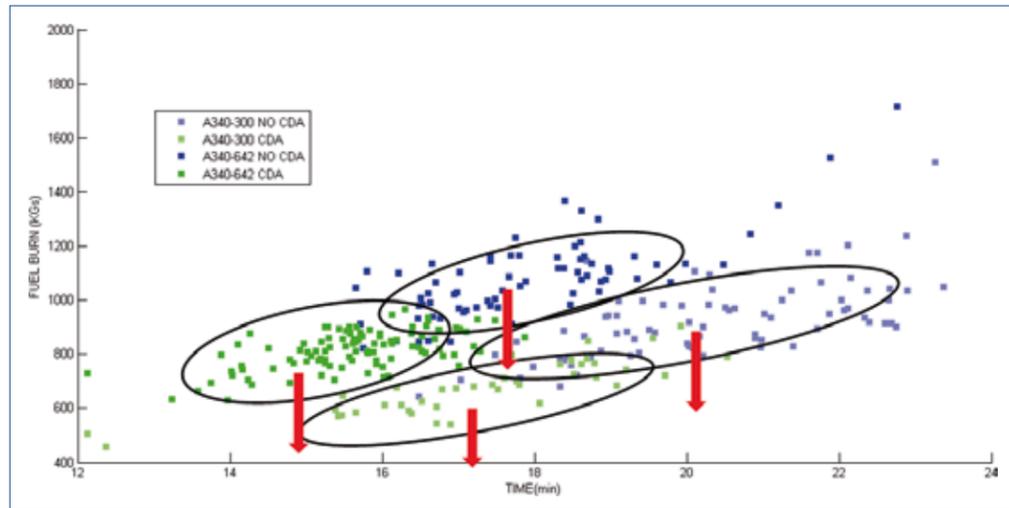
For the twin engine aircraft (A320), fuel savings of about 80kg were estimated. For the four engine aircraft (A340), the fuel consumption reduction was about 260kg. For both types of aircraft, around 25% less fuel during descent was consumed

The RETACDA project executed 620 flight trials.



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Fuel burn and time related savings for CDA vs. NoCDA flights (illustrative)

AIRE projects: oceanic

Project in Santa Maria, Portugal

The NATCLM Project was conducted by a consortium composed of Adacel (ATM system supplier), Air France (airline), NAV Portugal (coordinator) and TAP Portugal (airline).

Objectives

The project included a set of activities for aircraft trajectory optimisation, encompassing all three dimensions where optimisation is possible in the oceanic domain: vertical (cruise climb), lateral (optimised route), longitudinal (time, cost index – Mach number).

The timely execution of the optimisation commands required the use of Future Air Navigation System (FANS) equipped aircraft only. ADS-C/CPLDC data link communications have supported the demonstration trials procedures.

The pilot optimised the route according to the latest meteorological information in-flight. The new, optimised routes resulted in CO2 savings of up to 300kg for an A330 flying from Lisbon to Caracas.

Results

The vertical (cruise climb) optimisation demonstration was performed with a manual cruise climb like function with a sequence of 100 ft climbs. The demonstrations were performed on a cruise climb at Mach 0.80, with an average climb rate of 250 ft/min, from flight level 370 to 390, over a distance flown of around 1,600 NM. Overall, an estimation of savings relative to cruise climb showed potential savings of 29kg of fuel (i.e. savings of approx. 90kg of CO2) compared to a 2,000 ft step climb or 12kg (i.e. savings of approx. 40kg of CO2) or two 1,000 ft step climbs (i.e. six kg of fuel per each 1,000 ft climb performed in 100 ft steps).

The enhancements identified in the project are expected to bring a valuable contribution to the removal of constraints that prevent aircraft from flying as close as possible to their business trajectory, consequently maximising fuel efficiency and minimising CO2 emissions.

Description of trials

During 2009, several demonstration flights with Air France B777 and TAP Portugal A330 provided data and derived results for the project. Flights were from Paris to the Caribbean West Indies and also between Portugal and North, Central and South America. The demonstrations were carried out inside the Santa Maria Oceanic Flight Information Region (FIR) (ICAO NAT region) managed by NAV Portugal. The FAA supported some of the flights allowing the extension of the flight profile optimisation from Santa Maria FIR to inside the New York Oceanic FIR.

For lateral optimisation (horizontal), the pilot was allowed to optimise the route with the most up-to-date meteorological information. With the updated met data, a new flight plan could be calculated in-flight. In some cases, the route could be optimised and thus a different route was flown. The

performing "CDA" over "non-CDA". It is noticeable that a gain is also obtained by the shortened time for descent (more than 10% reduction in time).

network. This is where the environment of the airport and the traffic demand will become main factors, to elaborate an Implementation Plan for CDA approaches in Spain.

Translated in emission reduction, the results show that the potential savings per flight are about 250kg and 800kg of CO2 respectively.

The RETACDA trials demonstrated 25% less fuel consumption during descent when performing Continuous Descent Approaches compared with normal approaches.

The results obtained in this study will be used by Aena, after an in-depth analysis of each of the 47 aerodromes of the Spanish



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savings achieved by using this procedure were calculated by comparing the revised flight plan with the new route to a recomputed initial flight plan calculated with the updated meteorological information. The fuel savings with this technique were variable, with values of up to 90kg (i.e. savings of approx. 300kg of CO₂) saved for an Airbus A330 flying from Lisbon to Caracas.

It is expected that longer routes with longer flight times to the entry of the "demonstration optimisation" FIRs should achieve better savings.

For the longitudinal optimisation (time, cost index – Mach number), the study used the comparison of the flight plans computed with derived constant Mach number and the actual cost index (CI). By definition, flying at econ speed (i.e. at the given cost index) minimises total costs and it is thus determines the cost savings obtained by flying at that given cost index when compared to flying at a constant Mach number. Costs difference could then be used to derive the difference in fuel consumption.

Two different city-pairs were considered in the study: Lisbon – Newark and Lisbon – Caracas. Both performed with two different aircraft types, A330-202 and A330-223, in order to consider flights under different weather conditions, flight times under fixed Mach number airspace and aircraft with different maintenance costs.

For the specific cost indexes related to these city pairs, aircraft types, fixed and variable (time) costs for the airline, major savings have been found with a CI corresponding to a different Mach number. Significant savings have been computed in the range of 130kg to 210kg of fuel per flight (resp. 400kg to 650kg of CO₂).

The operational procedures developed by the project have proved to be adequate for the optimization trial flights. These procedures could be used, without major changes, by other airlines and oceanic ACCs.

Since the end of the demonstrations, several airlines are being cleared by Santa Maria FIR on a daily basis to perform profile optimisations.

Project in Reykjavik, Iceland

The Oceanic-NatADSB Project was conducted by a consortium composed by the Service Provider ISAVIA (coordinator), Icelandair (airline) and TERN Systems (the current developer of ATM systems for the Reykjavik OACC).

Objectives

The project aimed at demonstrating, through simulations and flight trials, the environmental benefits that can be achieved by pursuing more optimal flight profiles using cruise climb, direct routing, and variable speed in ISAVIA's proposed ADS-B oceanic corridor within the Reykjavik Control Area (CTA).

Flight simulations were used to extrapolate benefits of radar versus non-radar control in Reykjavik CTA to implementation of ADS-B in the Reykjavik CTA. A special focus was on examining the environmental benefits of pursuing optimised flight profiles using cruise climb, direct routing, and variable speed.

Description of trials

Icelandair ran 48 flight trials on the route Keflavik - Seattle between October 2009 and January 2010. Icelandair's flight control evaluated each flight and executed step climbs, with a reduced rate of climb (approximation of optimized cruise climb, 14 flights), direct routing (22 flights), and/or variable speed when desirable (ten flights). Fuel data was logged and compared to baseline fuel consumption with statistical approach.

Results

For the variable speed, flight trial savings results are inconclusive since the comparison with aircraft supposed to fly at a constant Mach did not actually fly at a fixed Mach number. This led to unreliable data on consumption even though earlier results at Icelandair flying cost/index showed considerable fuel savings. In the current environment and with some adaptation of the Flight Data Processing System, it may be possible to use the procedure limited to the Reykjavik CTA low density part of the airspace and within the surveillance corridor.

The vertical (limited cruise climb) optimisation demonstration was performed with vertical speed of 100 ft per minute and 1000 ft step climbs. Overall, an estimation of savings relative to cruise climb showed potential savings of 330kg of fuel (i.e. saving approx. 1040kg of CO₂). There could be also opportunities to reduce CO₂ emissions by introducing 1.000' feet step climbs instead of today's more common 2.000' feet step climbs. There are confirmed opportunities of cruise

climbs in the Iceland Oceanic airspace, especially in the west and north sector. The opportunities will increase when surveillance is added to the west sector.

For direct routings, flight trial savings are reported at around 80kg fuel reductions or 252kg of CO₂. Medium savings are experienced mainly because the Reykjavik CTA already offers maximum flexibility within the NAT structure. The Flight Data Processing System is capable of maintaining the overview of flights with direct routings and calculating possible conflicts. It is however cumbersome to add the intermediate fixes to the FDPS in a procedural environment as the controller's workload increases.

ISAVIA will cooperate with airlines to help implement the currently validated fuel saving strategies in daily operations as soon as possible.



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Conclusions and the way forward

The AIRE activities performed in 2009 have shown encouraging results. It is now essential that we try to transform them from “flight trials” to “day-to-day operations”, in order to realise the full benefits of AIRE. This is the philosophy of the 2010 activities that the SESAR Joint Undertaking would like to perform with its AIRE partners.

AIRE has also proven that, without major technological investments, the value of working together with common goals can be enormous. This is the partnership spirit in practice.

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N.B.: at the time this report goes to print a number of AIRE final reports are being reviewed. Some findings may change as a result of the acceptance process of the final project deliverables.

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