ECATS

2005 to 2012

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"In terms of improving the understanding of the environmental impacts of aviation, the ECATS programme has achieved major goals."

Sigrun Matthes
chair, ECATS

ECATS

ECATS is an EU funded project

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Rising to the challenge

Dietrich Knörzer
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The growth of the aviation industry over the past 50 years has been spectacular and has of course brought significant economic and social benefits, while here in Europe the aeronautics and air transport sectors remain key drivers of our national economies.

But it is vital that the aviation industry is prepared to meet the challenges of the changing world, and those challenges are no more serious than the impact of climate change on our planet and the importance that must be given to creating a sustainable future for the industry. Indeed, given the continued strong growth of air travel in developing nations, especially in the Far East, the challenge for the industry of meeting its environmental obligations is all the more stark.

However these are challenges which the ECATS network, along with several other organisations, has now been tackling for several years, and also tackling on many different yet inter-related fronts as this overview of activities within ECATS since 2005 shows. Whether it be helping to address capacity or air quality issues at our major airports; researching the use of alternative fuels in air travel; or even responding to the ash cloud crisis that swept Europe in 2010, ECATS has been at the forefront of the research debate.

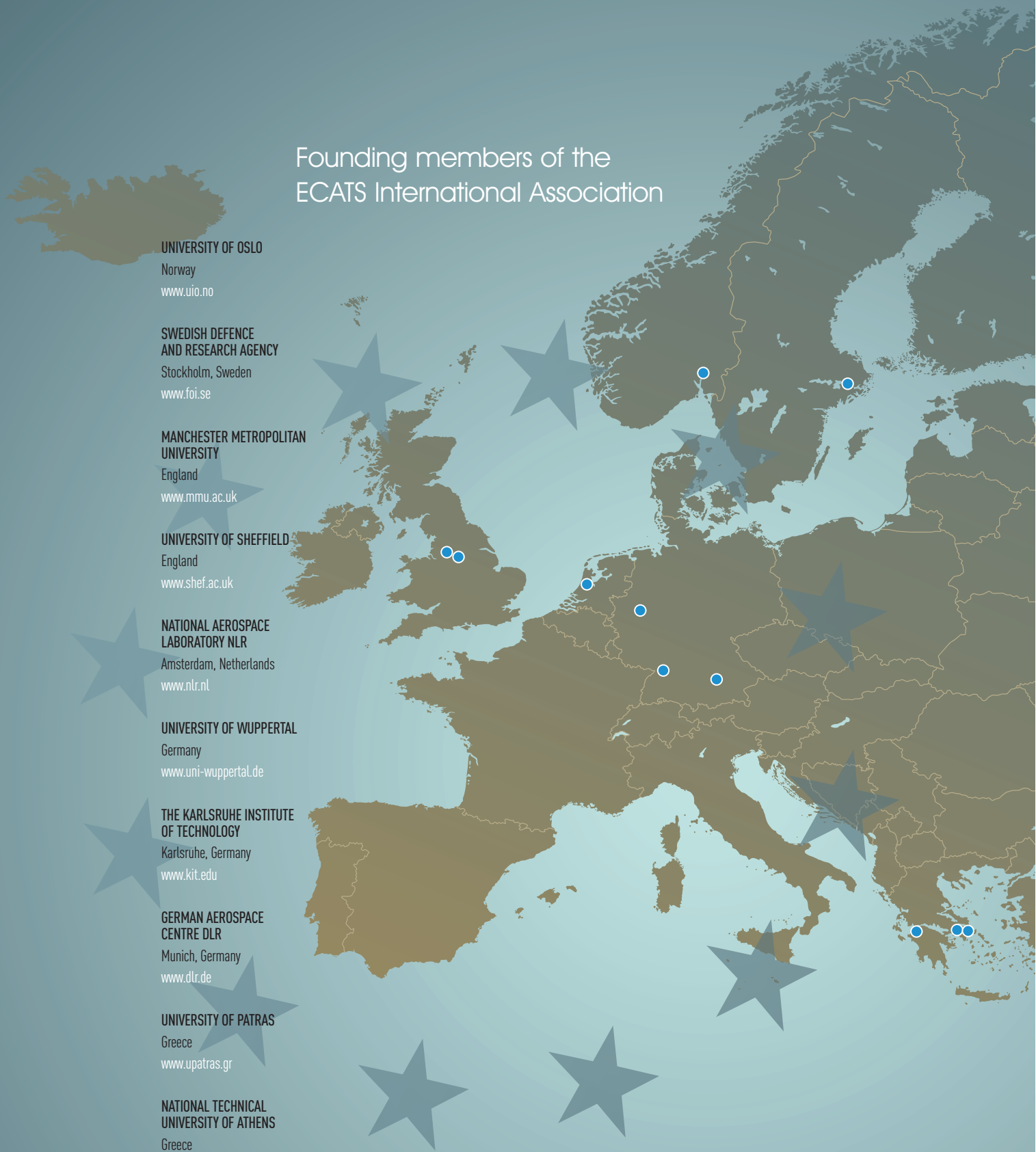
"ECATS is today a highly competitive research structure with impressive resources and infrastructure at its disposal."

From the very beginning ECATS' purpose was to harmonise and integrate European aviation research with a close focus on the environmental sustainability and competitiveness of air transport systems. Realizing these goals has required a collaborative effort, guided by a single shared vision, and achieved by creating a common framework for European research and development. Within this framework a diverse range of expertise now co-exists and multi-disciplinary collaborations between partners from across Europe are common-place. Successfully breaking down the barriers that can inevitably arise in the world of academia has been one of the hallmarks of the ECATS project.

ECATS is today a highly competitive research structure with impressive resources and infrastructure at its disposal. The organisation performs strategic and scientific assessments; commissions educational and professional workshops; provides a basis for efficient networking of personnel; and is supported by a robust dissemination strategy. It is a professional liaison and vital link between the aviation industry and the expert members of the association.

In short, ECATS is here to stay and will go from strength to strength. We hope you enjoy reading about its work so far.

Founding members of the ECATS International Association



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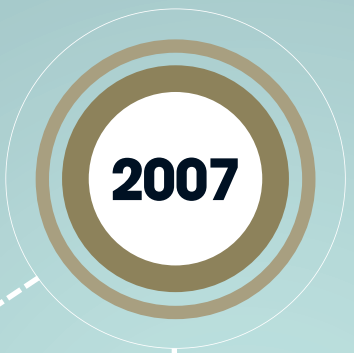
TIMELINE
2005 TO 2012

2005

The Stern review on the economic impact of climate change reinforces the need to address global warming and need for effective measures and international collaboration. The report identified Emissions Trading Schemes (ETS) as an effective mechanism for achieving sustained reductions in global CO_2 emissions. A European ETS is regarded as an important step towards a broader international agreement to address aviation emissions.

First test flights of the A380, Airbus' double-deck, wide-body, four-engine jet airliner. It is the largest passenger airliner in the world and due to its size many airports begin improving their facilities to accommodate the plane. The plane enters commercial service on schedule two years later.

LAUNCH OF SUSTAINABLE AVIATION



2006

The EU announces that aviation will come under the EU emissions trading scheme (ETS) from 2012. Giovanni Bisignani, IATA's Director General, says the industry supports emissions trading as one of a package of measures to reduce CO_2 emissions. "If properly designed, it can play an important role in tackling aviation's contribution to global warming along with investment in technology and more efficient infrastructure," he says. Meanwhile the inefficiences in Europe's air traffic management systems continues to be laid bare. Adds Bisignani: "We have 34 air traffic control centres in Europe but only one in the USA for a similar traffic and land size. This leads to inefficiencies, delays, and too much time in the air." But he says aviation is working hard to reduce emissions.
"In 2005 we shortened 300 routes saving 6 million tonnes of CO_2."

2007

The SESAR programme (Single European Sky Atm Research) is launched by the European Commission as the pillar of the Single European Sky initiative to improve the European air traffic management system. The European Commission funds the SESAR programme with a total of €700m. The Eurocontrol agency is involved in SESAR on behalf of member states.

Christopher Parypa / Shutterstock.com

45-MINUTE FLIGHT ON AN ALTERNATIVE BIOMASS DERIVED JET FUEL

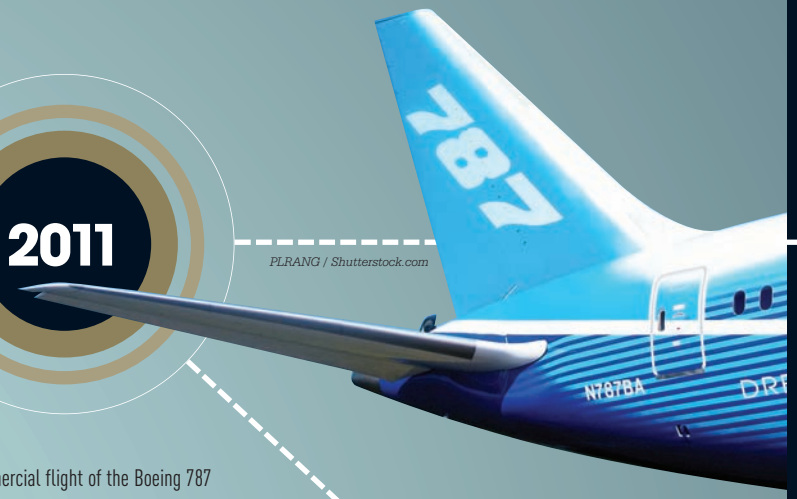
2008

Virgin Atlantic is the first commercial carrier to demonstrate that flight on an alternative biomass derived jet fuel was possible. The 45-minute flight between London and Amsterdam was operated with one of the four Boeing 747–400 engines fuelled with a blend of Jet A-1 and 20% coconut and babassu palm oil.

The 2008 ambient air quality directive sets legally binding limits for concentrations in outdoor air of major air pollutants that impact public health such as particulate matter and nitrogen dioxide. As well as having effects, these pollutants can combine in the atmosphere to form ozone, a potent greenhouse gas which can be transported great distances by weather systems.

Launch of The Clean Sky Joint Technology Initiative (JTI), a major EU-wide research programme designed to integrate results of earlier research programmes into large-scale demonstrations. The €1.6bn, seven year project will develop and validate technologies and operating practices.

THE FUTURE
...AND BEYOND



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2011

2012

2010

2009

2011

- First commercial flight of the Boeing 787 Dreamliner which the manufacturer claims is its most fuel-efficient aircraft to date and the world's first to use ligher composite materials for the majority of its construction.
- Iberia and Repsol stage Spain's first commercial flight powered by biofuel as an Iberia Airbus A320 flies from Madrid to Barcelona using a mixture of 75 per cent conventional A-1 jet fuel and 25 per cent biofuel. Other airlines across Europe test the use of biofuels in commercial flights.
- European Commission launches European Vision for Aviation document.
- Another Icelandic volcano Grímsvötn starts erupting, again causing air travel disruption across Europe. Chilean volcano Puyehue-Cordon Caulle also erupts.

2010

- Eruption of the Eyjafjallajökull volcano in Iceland causes widespread chaos and is estimated to cost the European economy $5bn as thousands of flights are cancelled as an ash clould hangs over Europe for several weeks. The International Air Transport Association calculates that airlines lose $1.7bn in missed revenues and airports lose up to €250m.

ESTIMATED COST TO EUROPEAN ECONOMY
$5 BILLION

2009

- Qatar Airways operates a commercial flight using gas to liquid (GtL) kerosene producton. The airline uses a 50:50 blend of GTL (gas to liquid) and conventional Jet A1 kerosene to power a commercial flight of an Airbus A340-600 from London to Doha.
- First fully synthetic fuel approved by authorities.
- UN climate summit in Copenhagen widely seen as failing to achieve a new global deal for tackling climate change.

2012

- A new version of the SESAR (Single European Sky Atm Research) masterplan will be published by the European Commission, outlining a revised air traffic management masterplan for Europe to help alleviate congestion issues across the continent, improve effiiciency at airports, and reduce carbon emissions.
- The European Commission will begin work reviewing its 2008 air quality directive.
- Airline operators are brought under the wing of the European Trading Scheme whereby airlines will have to surrender one allowance per tonne of CO_2 emitted on a flight to and from (and within) the EU. This covers passenger, cargo and non-commercial flights and applies no matter where an operator is based. Non-EU carriers will also need to comply with the scheme and non-complying operators face a penalty of €100 per missing allowance on top of the obligation to procure and surrender missing allowances. They may even be banned from operating in the EU.

...AND BEYOND

- The development of more fuel-efficient aircraft continues with work on creating more efficient turbofan engines, lighter structures, aerodynamic improvements and developing sophisticated flight management systems. Meanwhile work also continues on analysing the prospects of changing the plane's traditional shape completely in order to create an even more fuel-efficient aircraft. ECATS among those organisations playing a key role in helping to mitigate the effects of aviation emissions.

Searching for a sustainable future

THE GLOBAL ECONOMIC DOWNTURN MAY HAVE PUSHED THE GREEN AGENDA OFF THE FRONT PAGES, BUT THAT DOESN'T MEAN THAT THE DEBATE AROUND ENSURING THE AVIATION INDUSTRY GROWS IN A SUSTAINABLE WAY HAS GONE AWAY. IF ANYTHING EFFORTS HAVE STEPPED UP TO TACKLE THE PROBLEM

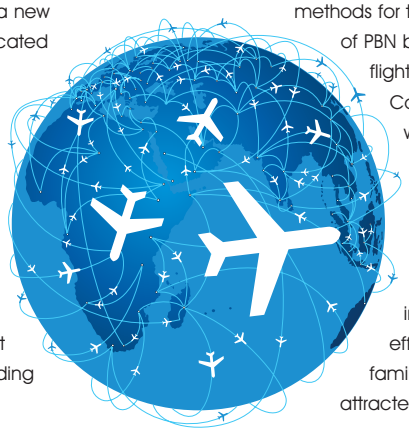
Creating a truly sustainable future for aviation is being tackled on many fronts, whether through the latest fuel and air traffic management technologies or wider 'green navigation' policies.

Indeed the drive was recently epitomised when Air France and Airbus completed what they claimed was the world's 'greenest commercial flight' thanks to technological improvements. The Airbus A321 flight from Toulouse to Paris showed it was possible to cut in half CO_2 emissions compared to a regular flight by combining the use of bio-fuels (50 per cent in each engine), optimised air traffic management (ATM) and efficient Continuous Descent Approach (CDA) systems.

Air France described the flight as the "synthesis" of many initiatives in the area of sustainable development, while Andrea Debbane, Airbus Head of Environmental Affairs, summed up the wider programme: "This is not just a bio-fuel flight but the first flight that really puts into practice elements in the Airbus roadmap, namely bio-fuels, optimised ATM, green navigation." And it's precisely this roadmap that ECATS has been pursuing since its formation too, bringing together research excellence in the above areas from across the European continent.

Events have moved fast in the sustainable aviation debate. For instance thanks to several test flights and collaboration with fuel standards bodies, today the use of 50 per cent bio-fuel blends are authorised in commercial flights. Meanwhile the development of more efficient ATM systems are helping to reduce the amount of fuel burned by aircraft and therefore the CO_2 emitted.

Airbus itself is a big supporter of streamlining ATM and recently launched a new subsidiary Airbus ProSky dedicated to the development and support of modern ATM systems to achieve the highest operational efficiencies with more direct routings. In particular CDA is becoming more widespread as a way to reduce fuel burn as during a CDA procedure the aircraft descends continuously, avoiding level flight prior to the final approach and requiring significantly less engine thrust and therefore less fuel burn.



Airbus has also been selected to provide ATM and Performance Based Navigation (PBN) expertise for the Federal Aviation Administration's (FAA) Greener Skies Initiative. As part of Boeing's FAA System Engineering 2020 team, Airbus will identify procedures which fully utilize aircraft precision navigation capabilities to reduce fuel burn, lower emissions and decrease noise. The industry consortium includes Adacel, Airbus, Boeing, Cessna and Honeywell, and is tasked with establishing methods for the full implementation of PBN by utilizing advanced flight deck and Air Traffic Control (ATC) capabilities while analyzing new policies and procedures.

Airbus and Boeing have naturally been busy looking for increased fuel efficiencies in their new families of planes. Boeing attracted plenty of headlines

Fuel impact on operating costs

The global airline industry's fuel bill is forecast to total $176 billion in 2011 (accounting for 30% of operating expenses at $110.0/barrel Brent of oil). This is an increase of $37 billion over 2010 and is four times 2003's fuel bill of $44 billion.

Year	2003	2005	2007	2009	2011
% of operating costs	14%	22%	28%	26%	30%
Average price per barrel of crude	$28.8	$54.5	$73.0	$62.0	$110.0
Break-even price per barrel	$23.4	$51.8	$82.2	$55.4	$112.5
Total fuel cost	$44bn	$91bn	$135bn	$125bn	$176bn

Source: IATA

the facts

Dreamliner 787

- The 787-8 carries 210-250 passengers on routes of 7,650 to 8,200 miles, while the 787-9 carries 250-290 passengers on routes of 8,000 to 8,500 nautical miles.
- The planes use 20 per cent less fuel than today's similarly sized airplanes.
- Composite materials make up 50 per cent of the primary structure of the 787 including the fuselage and wing. New engines from General Electric and Rolls-Royce are used in the plane with advances in engine technology the biggest contributor to overall fuel efficiency improvements.
- The design and build process of the 787 added further efficiency improvements. For example manufacturing a one-piece fuselage section eliminated 1,500 aluminum sheets and 40,000-50,000 fasteners.

Airbus 380

- The design for the new range started as an improved version of the A330. In time Airbus widened the fuselage, made the wing larger, and gave the plane more powerful engines so it could cruise at a higher speed.
- The Airbus A350 XWB is substantially more fuel-efficient than its predecessor, the A330, and about 60 per cent of the airframe will be built of advanced materials like carbon fibre reinforced plastics (CFRP) and aluminium lithium alloys. In the A330 this is only 15 per cent.
- The XWB range will be the first Airbus product with an all-composite wing. The rear fuselage and the tail cone will be constructed from composites as well. An aluminium lithium alloy is being used in the forward and aft sections of the fuselage.

Main image: Steve Mann / Shutterstock.com Inset: TH Klimmeck / Shutterstock.com

Shanghai airport: Soaring growth in the East

BY 2014 THE NUMBER OF PASSENGER JOURNEYS IS EXPECTED TO REACH 3.3 BILLION

during the summer of 2011 when it launched its much-trumpeted Dreamliner which, thanks to its newly designed engines, aerodynamic improvements, increased use of lightweight composite materials and advanced systems, consumes 20 per cent less fuel than its predecessor. However this drop in fuel consumption means it can also go 20 per cent further (up to 15,200km), and for the likes of customers such as Air Nippon Airways this has huge benefits as it means it can fly non-stop routes from Japan to anywhere in Europe or the US.

In late 2010 Airbus itself brought out a re-engined version of its A320 offering fuel savings of up to 15 per cent. More than 1,000 have since been ordered, many by fast-growing budget airlines in the Far East such as India's IndiGo and Malaysia's AirAsia. Meanwhile the A350 XWB (eXtra Wide Body) is Airbus's answer to the Dreamliner and three versions of the new airliner are planned. The XWB-800 will carry around 250 passengers, the XWB-900 around 300 and the XWB-1000 around 350.

Boeing forecasts demand for 28,980 new aircraft valued at around $3.5bn over the next 20 years

Fuel efficiency is certainly very high up the aviation agenda. With the rising price of oil now accounting for a third of operating costs (see table) a rise of just $1 in a barrel of oil adds some $1.6bn to airlines' costs. The International Air Transport Association (IATA) expects a barrel to cost an average of $30 more in 2011 than 2010, such that the industry's net profits in 2011 will come in at around $4bn, considerably down on 2010.

Both the 787 and A350 XWB represent major shifts in materials, systems and production processes and will form the basis of twin-aisle aircraft designs for the next 50 years. Over the next 20 years alone that market is put at 7,330 aircraft worth $1.77trn.

But given the inexorable rise in air traffic how can you realistically make headway on emissions when the number of passenger journeys continues to soar? Aviation may still only be responsible for around 12 per cent of CO_2 emitted from transport, but its share is growing, not least because the impact of fuel emissions at flying altitudes is far greater than on the ground.

For governments, such a growth in passenger numbers poses tough questions when it comes to trying to persuade their electorates that they really are addressing their CO_2 targets. And when they do take the regulatory route with airlines, typified by the European Union's attempts to extend the Emissions Trading Scheme to cover airlines from January 2012 (see page 10), they face an airline industry in no mood to roll over quietly.

As such governments and industry needs reliable and informative data on what is happening right now in terms of the impact of aviation on the environment, and this is where the likes of the research being brought together under the ECATS banner is of considerable value.

Coming to an airport near you

So, just what will the aircraft of tomorrow look like? Well, as engineers look for ever more fuel-efficient flying machines the days of the traditional plane shape may be numbered, although it could be well into the second half of the 21st century before more revolutionary design ideas become commonplace.

Indeed many aircraft designers believe that just about all the efficiency gains available have been wrung from the plane's traditional shape. More efficient turbofan engines, lighter structures, various aerodynamic tweaks and the development of sophisticated flight-management systems can all play their part, but some say a complete overhaul of a plane's structure is now the only solution to making planes really fuel efficient.

Airbus recently provided a glimpse of what aviation may look like in the year 2050. Their 'engineer's dream' design, which recently went on show at the Singapore Aviation Centennial exhibition, was put together by experts in materials, aerodynamics, cabins and engines, and is characterized by its ultra long and slim wings, semi-embedded engines, a U-shaped tail and lightweight 'intelligent' body.

Additional features of the Airbus Concept Plane include a bionic structure that mimics the efficiency of birds; cabin walls that become transparent at the touch of a button to enable 360-degree views; and a new intelligent environment with entirely recyclable fixtures and fittings.

Airbus stress that it is not a plane intended to fly, rather a representation of the main technological fields that are being explored to face future needs, including a significant cut in fuel burn and emissions, less noise and greater comfort.

Meanwhile in 2010 much fanfare greeted a design led by a team from Massachusetts Institute of Technology (MIT) for a plane that it is

For instance, just what is the environmental impact of flight emissions, not only in airspace but also on the ground at airports? What are the realistic prospects for developing sustainable, alternative jet fuels, and just how long will this process take? And how can you make ATM systems more efficient?

As ECATS chair Sigrun Matthes remarks: "In terms of improving our overall understanding of the environmental impacts of aviation, the ECATS programme has achieved major goals and assessment of mitigation options can be performed. We are providing expertise to the industry which is now far more motivated and keen to work with us than it was when we first started. We have established a joint exchange platform and people now come to us for answers. This is where there has been real improvement."

Another string to ECATS' bow is the interdisciplinary nature of their studies and the ability to weigh up and analyse the inherent trade-offs that exist in the complex study of aviation and environmental impact. For instance, if you start using new alternative fuels in engines then what are the impacts on areas such as noise pollution? Will they make aircraft noisier and so cancel out their benefits?

No let-up in aviation growth

According to Airbus' latest Global Market Forecast (GMF), by 2030 the global passenger fleet will more than double from today's 15,000 aircraft to 31,500. This will include some 27,800 new aircraft deliveries of which 10,500 will be needed for replacing older less fuel efficient aircraft. The trend towards larger aircraft will continue in order for the aviation sector to keep pace with future growth in demand.

Over the next 20 years the aviation sector is expected to remain resilient to cyclical economic conditions. Airbus forecasts that Revenue Passenger Kilometres (RPKs) will grow by an average 4.8 per cent per year, which is equivalent to traffic more than doubling in the next 20 years.

Factors driving demand for new aircraft include population growth with increasing wealth, dynamic growth in emerging economies, strong continued growth in North America and European markets, greater urbanization and a more than doubling in the number of mega cities by 2030. Drivers also include the ongoing expansion of low cost carriers, and the need to replace older less efficient aircraft with new eco-efficient models in established markets.

Over the next 20 years Asia-Pacific will account for approximately 34 per cent of demand, followed by Europe (22 per cent) and North America (22 per cent). By share of passenger traffic, Asia-Pacific will be the biggest market with 33 per cent, followed by Europe (23 per cent) and North America (20 per cent).

In terms of passenger traffic on domestic markets, India (9.8 per cent) and China (7.2 per cent) will have the fastest growth rates over the next 20 years. Long established aviation markets will also continue to grow with the domestic US (11.1 per cent) and Western Europe (7.5 per cent) markets having the first and third largest shares of the total traffic in 2030.

By 2030, 60 per cent of the world's population will be urbanised and the number of mega cities will have more than doubled to 87 from today's 39.

MIT/Aurora Flight Sciences

claimed could use 70 per cent less fuel than current planes while also reducing noise and emission of nitrogen oxides.

MIT's D-series design was one of two that the team presented to NASA as part of a $2.1m research contract to develop environmental and performance concepts that will help guide the agency's aeronautics research over the next 25 years.

MIT's precise objective was to develop concepts for, and evaluate the potential of, quieter subsonic commercial planes that would burn 70 per cent less fuel and emit 75 per cent less NOx than today's commercial planes. The team met NASA's challenge by developing two designs: the 180-passenger D "double bubble" series to replace the Boeing 737 class aircraft, currently used for domestic flights, and the 350 passenger H "hybrid wing body" series to replace the 777 class aircraft now used for international flights.

The engineers conceived of the D series by reconfiguring the tube-and-wing structure. Instead of using a single fuselage cylinder, they used two partial cylinders placed side by side to create a wider structure whose cross-section resembles two soap bubbles joined together. They also moved the engines from the usual wing-mounted locations to the rear of the fuselage. Unlike the engines on most transport aircraft that take in the high-speed, undisturbed air flow, the D-series engines take in slower moving air that is present in the wake of the fuselage. This technique allows the engines to use less fuel for the same amount of thrust.

Although the H series utilizes much of the same technology as the D series, a larger design is needed for this plane to carry more passengers over longer distances. The MIT team designed a triangular-shaped hybrid wing body aircraft that blended a wider fuselage with the wings for improved aerodyamics. The large centre body creates a forward lift that eliminates the need for a tail to balance the aircraft.

Or take the interdependency modelling field. Although there are a lot of players in the discipline, the ECATS project remains one of the biggest platforms for further development of the subject and for the formation of effective toolkits to analyse the issues.

ECATS has also been able to react to global events too, typified by its work into the study of the impact of volcanic ash on engines prompted by the eruption of the Eyjafjallajökull volcano in Iceland in April 2010 which caused enormous disruption to air travel (see page 12).

As Andreas Petzold, ECATS specialist in the area, explains: "We are one of a number of organisations looking at the whole subject of volcanic ash impacts, but we can contribute to the debate with the advantage that we are speaking to people within both the atmospheric and technical community so are a very useful channel for information.

"On the wider front the aviation industry is now aware that we are here at ECATS, and aware of our network and how we can provide knowledge on the environmental impact of aviation. This is information that the industry is very keen to get hold of and we can build up knowledge in several fields. I see the job of ECATS as digesting all the information that is around. Industry can find it very hard to get a grip on all the research work so it is easier to come to us direct and we can then prepare the information in a suitable way."

HOW WILL ALTERNATIVE FUELS IMPACT ON AREAS SUCH AS NOISE POLLUTION?

The debate over the use of alternative fuels in aircraft engines (see page 16) is another area which attracts many headlines with barely a month going by without some airline heralding a great new experiment in the sky. For instance in October 2011 Spanish airline Iberia flew the country's first commercial flight on an Airbus A320 from Madrid to Barcelona using a blend of fuel made from the camelina plant, while other major European players such as Air France, KLM, Lufthansa and Finnair are all busy working on biofuel projects.

However although some regard using biofuels as a key way to reducing the world's reliance on petroleum, some experts do now question whether biofuels are the great panacea for the aviation industry that they were once thought of as being, citing that extensive further investment in R&D is required across the alternative fuels spectrum before any can begin to replace traditional, kerosene-based jet fuel.

But technological and scientific improvements can only do so much to tackle the chronic congestion that many of the world's biggest airports face. In Europe one of the biggest headaches remains London Heathrow which is operating at virtually full capacity, but without government commitment to expand the airport (or pursue the development of alternative sites for a new airport) the airport faces little choice but to try and improve the efficiency of its air traffic management (ATM) as best it can.

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European Trading Scheme

From January 2012 airline operators will have to surrender one allowance per tonne of CO_2 emitted on a flight to and from (and within) the EU. This covers passenger, cargo and non-commercial flights and applies no matter where an operator is based.

Non-EU carriers will also need to comply with the scheme and non-complying operators face a penalty of €100 per missing allowance on top of the obligation to procure and surrender missing allowances. They may even be banned from operating in the EU.

The International Air Transport Association (IATA), which has estimated that airlines face a bill of at least $26bn to comply with the EU scheme over the next decade, has warned that countries outside the EU may take retaliatory action against the EU's plan unless they are excluded from the EU scheme. In October 2011 countries including the US, Japan, Brazil, Russia, India and China issued a declaration opposing how the EU scheme will apply to flights that start or end in one of the bloc's 27-member states. They say the scheme is inconsistent with international law and should not apply to flights by non-EU carriers, but the EU insists the scheme is consistent with international law

IATA says the EU should abandon its plan to bring airlines within the ETS, saying the issue should be tackled through a global industry framework devised by the International Civil Aviation Organisation. But the EU says ICAO member states have been unable to agree on how to tackle the aviation industry's emissions and it needed to act.

ECATS ATM specialist Tomas Martensson from Stockholm University is conducting extensive research into the subject area and says improving such efficiency has become crucial at some of the world's busiest airports (see page 24). "If you take Heathrow, managing capacity has become a huge issue, not least because of the environmental impact of planes being stacked in the sky waiting to land," says Martensson.

Green campaigners will counter that there are capacity issues for good reason at Heathrow because of the impact any further expansion would have on the environment. Plans for a third runway were recently blocked and ECATS member Dr Peter Wiesen, senior research scientist at the University of Wuppertal in Germany, says the study into the environmental impacts of the extra runway was one of the most detailed works on airport air quality ever carried out (see page 20). Dr Wiesen says one of the key problems with the further expansion of airports is differentiating between how much pollution comes from aircraft and airports themselves, and how much is already in the atmosphere through car pollution for instance.

The aviation industry in Europe has long recognised the challenge of ground emissions and in 2001 the Advisory Council for Aeronautical Research in Europe (ACARE) established a set of targets to reduce emissions by 2020. For instance the ambition is to reduce fuel consumption and CO_2 by 50 per cent per passenger kilometre, cut Nox emissions by 80 per cent, and reduce perceived noise by 50 per cent.

Meanwhile another significant research project in the whole field of sustainable aviation is Clean Sky, whose mission is to develop breakthrough technologies to significantly increase the environmental performance of air travel. The Clean Sky JTI (Joint Technology Initiative) was launched in 2008 and represents a unique public/private partnership between the European Commission and industry. The aim of the project is to speed up technological developments and shorten the time to market for new and cleaner solutions tested on full scale demonstrators.

AIMING TO ELIMINATE 50 MILLION TONNES OF CO_2 EMISSIONS DURING THE 2013-2030 PERIOD

An industry view

In the midst of the recent economic crisis the environmental agenda has taken something of a backseat for governments across the world, not least in Europe. But that doesn't mean the agenda - and that includes the whole discussion over sustainability in aviation - has gone away.

Infact far from it, says Simon McNamara, deputy director general of the European Regions Airline Association, who says he has no doubt that finding ways to make aviation more environmentally-friendly will come back as a priority. "You could actually argue that the issue has never really gone away, typified by the EU's determination to see aviation come under its Environmental Trading Scheme (ETS) from 2012. From the industry's view we should not be complacent at all given the continued growth of the sector and the fact that capacity is now a serious problem with our largest hubs becoming saturated."

McNamara says part of the answer to the latter problem is for governments to "get serious" about building more infrastructure. "With more efficient air traffic management (ATM) and infrastructure improvements there is the potential to make big changes and major achievements, such as what is planned through SESAR (Single European Skies Atm Research)."

McNamara says although the costs of SESAR - approximately 30bn - may seem extremely high in the present climate, he says he would like to see a system where funding is provided upfront to secure investment, and repayments are made as and when benefits come online. "Admittedly funding to achieve that will be difficult in the present climate, but ATM is a pretty sound investment. In terms of risk it is relatively low because of the continued growth in air demand. Air traffic is not going to fall off a cliff, it is stable and growing."

"ATM is a pretty sound investment. In terms of risk it is relatively low because of the continued growth in air demand. Air traffic is not going to fall off a cliff, it is stable and growing."

However one area where McNamara is not in agreement with the EU is over the ETS timetable. He adds: "In theory ETS is a good idea as it allows the industry to grow while ensuring that growth is offset somewhere else. However the problem of the EU going it alone on this, given that aviation is such a global industry, was first flagged up four years ago and that problem has not gone away. You could try and put such a scheme through ICAO (International Civil Aviation Authority) but getting all member states to agree on something is a very difficult and slow process. Europe was not willing to wait but our view is that it is best to try and find some sort of global standard. ICAO has started working hard on this, but people have to accept that this might not happen for four or five years. We would like to see the ETS suspended for aviation until some sort of international solution is reached."

Causing ruptions

THE EVENTS IN ICELAND IN 2010 HAVE DRIVEN SCIENTISTS, ENGINEERS AND POLITICIANS TOWARDS AGREEING NEW GUIDELINES FOR FLYING DURING VOLCANIC ERUPTIONS

If you were looking for a simple way to cut global aircraft emissions then shutting down airspace is certainly one of the most effective.

If you want proof then look no further than the Icelandic volcanic eruption in 2010 which caused chaos in the aviation industry.

During the height of the crisis, demand for airline kerosene fell by 1.2m barrels a day compared with the 4.3m barrels consumed on a normal day. Airlines across Europe avoided using around 350,000 tonnes of CO_2 emissions a day, although admittedly the volcano itself was also emitting about 150,000 tonnes of CO_2 a day.

The eruption of Eyjafjallajökull, which went on for six weeks, caused enormous disruption to air travel across Europe with up to 20 countries closing their airspace amid concerns about the impact of the ash plume on jet engines.

"If you can't see how much ash is coming out of the volcano in the first place then you're going to have problems modelling where it's going."

Because of the prevailing wind direction the ash cloud had a particularly big effect on airspace across northern Europe, airspace which also just happens to be the busiest in the world.

In 2011 another Icelandic volcano Grimsvötn started erupting, again causing air travel disruption although on a far less scale, while the summer of 2011 also saw havoc for aviation in the southern hemisphere caused by ash from a Chilean volcano which carried on erupting for several months. The cloud sent up by Puyehue-Cordon Caulle forced the cancellation of flights across South America, before the plume spread to New Zealand and Australia. Not content with just going around the globe once, the cloud returned a second time to affect the region.

Not surprisingly such a chain of events has left scientists, engineers and politicians across the globe scuttling to provide both answers and a better way forward for the industry in terms of guidelines and safe limits to fly during eruptions.

So what has the role of ECATS been within this whole area? ECATS partner Andreas Petzold is an internationally recognised scientist in the area of measuring nano-sized particles and the effects of particulate emissions from aviation. He was called upon by aviation authorities and the European Commission to help with the response to the ash cloud problem.

Says Dr Petzold: "I have a lot of experience in the area of atmospheric research, and especially within industry too, so the industry came to us to help answer some of the pressing questions that it had. ECATS can really help as we can talk to people within the atmospheric community and the technical community and so act as a good interface and very useful channel for information."

Dr Petzold says because of last year's events a lot of research activity inevitably started but it was quite uncoordinated. "Part of our job was to better bring together the research that had started. ECATS was asked to serve as an exchange platform to establish links and foster communication between the research partners."

As such ECATS has now helped bring together representatives from across the industry including engine manufacturers, airline operators, air frame manufacturers and meteorologists.

Dr Petzold says much of the work has focused on better identifying contaminated

The 2010 Icelandic eruption had a huge impact on the aviation industry

J. Helgason / Shutterstock.com

and non-contaminated airspace, and trying to better predict ash cloud movements. "We are preparing road maps and working out what impact studies we need to perform."

He adds that the highest priority area is improving the detection of ash clouds in the first place. "It is about getting a better method for measuring exactly where the cloud is and how dense it is. There is a lot of pressure from industry for results in this area."

Another area of research is looking at how to improve the management of reacting to events. Adds Dr Petzold: "Last year air traffic control was simply unprepared in terms of how to react to the situation. We need to improve the whole air traffic management process in order to avoid large scale airspace shutdowns and to ensure that airlines react in a way consummate with safety requirements.

Andreas Petzold

Institute of Atmospheric Physics,
DLR, Germany

comments

Many of us will remember where we were in April 2010 when the Icelandic volcano Eyjafjallajökull unleashed its fury not only over Iceland but on an unsuspecting flying public.

I myself was working in Cardiff at the university's Gas Turbine Research Centre where a team of us were investigating particle emissions from aircraft engine combustors as part of an ECATS particulate matter research programme.

As first rumours spread of an upcoming closure of airspace over the UK caused by the volcanic ash plume moving in from Iceland, I remember us rather excitedly switching our particle measurement instrumentation to ambient air sampling to check if there was any elevated particulate matter concentration from the ash plume.

Over the next few days while we continued working at the aircraft engine combustor test rig, UK airspace would be closed for the first time since World War Two. Even a month later, as our work in Cardiff finished, the volcanic ash plume was still causing chaos across Europe. Colleagues returning to Germany were having to take the train, while the Royal Navy was even sent out to bring stranded British tourists back home.

The airspace closure put extreme pressure on the aviation industry, and by the summer of 2010 first discussions had begun on necessary further research into the whole subject. The studies were initiated by the EU commission along with the aviation industry and research networks such as ECATS which was to play a leading role.

Later in 2010, under the lead of Airbus, a consortium would go on to submit a proposal to the EU for developing research road maps targeting particulate matter impacts on aviation, and by July of 2011 we saw the launch of the WEZARD programme on weather hazards for aviation where ECATS provided the communication platform for the project.

"The airspace closure put extreme pressure on the aviation industry."

From its beginning, ECATS has served as an interface between the aviation industry, atmospheric sciences and civil aviation administration, and following the ash cloud crisis the value of the network was there for all to see. Extensive studies on the formation of particulate matter in aircraft engines and their impacts on atmosphere and climate were developed in this interdisciplinary collaboration, and bridges to regulatory bodies were established.

In the aftermath of the volcanic ash crisis I have no doubt the ECATS International Association will continue very successfully in its role of mediating between the aviation industry and atmospheric sciences.

When we had the second eruption in Iceland in 2011 airspace was closed that didn't need to be closed because the processes were not in place. This is a high priority task where we think we can get much quicker positive outcomes."

However Dr Petzold warns that engine impact studies into the effects of ash clouds will take several years to complete. "There are not going to be any quick answers in this area. A lot of work needs to be done analysing precisely what damage is done by ash clouds and what are tolerable thresholds."

"Last year airports were simply unprepared in terms of how to react to the situation. We need to improve the whole process of air traffic management in order to avoid large scale airspace shutdowns."

Ian Lisk is Volcanic Ash Coordination Programme Manager at the UK Met Office and has also been at the heart of the discussions since Eyjafjallajökull erupted. He says that the industry has been aware of the issue since the 1980s when a BA flight hit a cloud of ash over an Indonesian volcano and all four engines stopped, and a KLM 747 survived a similar experience over Alaska. As Lisk recalls: "As a result of the BA and KLM incidents there was a realisation in the community that it needed to set up some sort of watch scheme to have a consistent way of addressing the issue."

The result was the formation of nine Volcanic Ash Advisory Centres (VAACs) around the world, one of which, the London VAAC, has responsibility for providing advisories for volcanic ash plumes originating from volcanoes in the north-eastern Atlantic which includes Iceland.

As Lisk explains: "When a volcano in Iceland erupts, the London VAAC, based at the Met Office, is contacted by the Iceland Met Office as the designated Icelandic state volcano observatory which provides information on the location, start time and estimated plume height of the volcanic eruption. The Met Office atmospheric dispersion and transport computer model, NAME, is then initialised and run using these starting conditions with the VAAC forecaster then using available observational data - usually satellite imagery but more recently research aircraft measurements and ground-based equipment - to add value to the model output to produce six-hourly volcanic ash advisories out to 18 hours ahead."

Lisk says one of the key debates going on in the global research community, and one which was tested to the full by the events of last year, is how VAACs across the world mix this combination of modelling and observational data from satellite images and other observational resources to try and forecast where ash is likely to be dispersed.

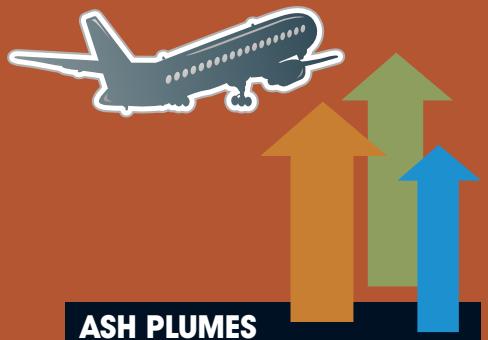
As he adds: "What we are trying to determine is exactly how to produce the best forecast through the blending of data from satellites, other observational resources and the model output. However there are issues with both. For instance if you can't see how much ash is coming out of the volcano in the first place, for example if the weather is bad in Iceland, then you're going to have problems modelling where it's going. It's a similar issue with any observational resource, each has its own strengths, weaknesses and characteristics. For instance satellite imagery cannot detect volcanic ash through cloud cover or when fine volcanic ash descends to lower levels in the atmosphere.

"The trick is to develop an integrated, standardised and resilient volcanic ash observational network that can then play to the strengths of its component parts."

So right now, what are the precise rules over flying? Up until last year the rules said simply that you had to avoid all ash if any was detected, but the 'ash or no ash' rule began to cripple airlines last year because the eruption went on for so many weeks.

In the event the industry agreed upon a new safe to fly limit of under two milligrams per cubic metre of ash. But how did it reach a decision so quickly? Explains Lisk: "The industry had been looking at this issue for a number of years and so some research had already been undertaken in this area. In the end engine manufacturers from around the world were able to say from their own experience and studies that this was a good figure. There has been further research since then which tends to back up the numbers that they came up with although it is recognised that some airlines still view this limit as quite conservative."

FACTS AND FIGURES



ASH PLUMES

25,000ft

The 2010 ash cloud over Europe was the result of a volcanic eruption at the Eyjafjallajöekull glacier which initially erupted on March 20, the first time it had erupted since 1821. Ash plumes reached heights of 25,000ft.

J Helgason / Shutterstock.com

10m passengers

The OECD (Organisation for Economic Co-operation and Development) calculated that the 2010 eruption cost the European economy $5bn. More than 10 million passengers were stranded or unable to board flights while the International Air Transport Association said airlines lost $1.7bn in missed revenues and airports lost €250m.

ACROSS THE GLOBE

At its peak, up to 90 per cent of flights were cancelled in worst-affected countries such as Finland, Ireland and UK. Low-cost carriers cancelled more than 60 per cent of their flights. On one day alone, April 17th, nearly 17,000 flights to and from Europe were cancelled out of about 22,000 on a normal day.

Worldwide, 30pc of total airline capacity was cut. European capacity was cut by 75 per cent, Africa by 30 per cent and the Middle East by 20 per cent.

Demand for airline kerosene fell by 1.2m barrels a day compared with the 4.3m barrels consumed on a normal day. European flights avoided using about 350,000 tonnes of CO_2 emissions per day, although the volcano emitted about 150,000 tonnes of CO_2 per day.

European capacity cut by **75%**

ACCOUNTANCY FIRM PRICEWATERHOUSECOOPERS ESTIMATED THAT **EACH WEEK OF DISRUPTION DESTROYED BETWEEN 0.025 AND 0.05 PER CENT OF ANNUAL BRITISH GDP.**

THE SAME WOULD PROBABLY BE TRUE OF OTHER EUROPEAN COUNTRIES.

Looking back ...

2011

Ash from the Puyehue-Cordon Caulle volcano in Chile forced the cancellation of flights in Argentina, Uruguay and Brazil, before reaching Australia.

1989

A KLM 747 survived a similar experience over Alaska.

1982

A BA flight hit a cloud of ash over an Indonesian volcano and all four engines stopped.

- Because the Eyjafjallajöekull volcano is under a glacier it made last year's eruption highly explosive because when the water leaked into the insides of the volcano, the magma turned the water to steam.

- Iceland is a volcanic hot spot on the Mid-Atlantic Ridge, which is the dividing line between the Eurasian and North American tectonic plates. Indeed there are some 35 active volcanoes in the country, one of which called Katla is very close to Eyjafjallajöekull. Indeed whenever Eyjafjallajöekull has erupted it has been followed by an eruption at Katla.
- Last year Icelandic President Olafur Grimsson said European governments and airline authorities all over the world needed to start planning for the eventual Katla eruption.

$8m BLOOMS DESTROYED

The ash cloud had knock-on effects on global trade transported by air. Although only two per cent of trade by volume goes by air, it accounts for around 35 per cent of value. Exporters of perishables, such as flower and vegetable producers in Kenya, were hard hit by the ash cloud with an estimated $8m worth of blooms destroyed.

Fuelling the future

GREAT STRIDES HAVE BEEN MADE INTO THE RESEARCH AND VIABILITY OF USING ALTERNATIVE FUELS, EPITOMISED BY A STRING OF TEST FLIGHTS IN RECENT YEARS. BUT HOW CLOSE ARE WE TO TRULY FINDING AN ALTERNATIVE SOLUTION?

Ever since the days of the first civil jet airliner, the De Havilland Comet, the airline industry has been trying to reduce fuel consumption through improvements in technology. Indeed today engine fuel burn has been reduced by almost 50 per cent compared with those pioneering days of jet travel, while the aircraft fuel burn per seat has been cut by more than 80 per cent relative to the Comet.

But while the speed at which improvements can be made is in part compromised by the fact that the industry keeps the same planes in use for around 40 years, one technology that could have quicker results on helping to reduce carbon emissions is the development of alternative fuels.

The subject has attracted its fair share of media headlines in recent years, not least as airlines running test flights of new blended fuels scramble over each other to proclaim their environmental credentials. For instance in October 2011 Iberia and Repsol staged Spain's first commercial flight powered by biofuel (see overleaf). An Iberia Airbus A320 flying from Madrid to Barcelona burned some 2,800 kg of a mixture of 75 per cent conventional jet fuel and 25 per cent biofuel derived from the camelina sativa plant. The airline claimed that the use of the mixture brought a reduction of nearly 1,500 kg of CO_2 emissions.

Yet the test flights remain just that. One thing that hasn't changed since the early days of air travel is the fuel used, kerosene. As ECATS partner Professor Chris Wilson from Sheffield University admits, the spec for aviation fuel still comes from lamp oil. "The make-up of the fuel has hardly changed apart from elements being added to it for safety and security of supply."

Wilson is at the forefront of research into viable fuel alternatives and analysing what can be learnt from the various test flights. He says a number of alternative jet fuels, including biofuels, have been identifed that can potentially replace petroleum jet fuel without the need to modify aircraft, engines and fuelling infrastructure.

But measuring the benefits of alternative fuels is no simple process. Wilson says it requires quantifying the full life-cycle emissions from fuel production, distribution and operation. "Analyses have claimed that certain alternative jet fuels could realize CO_2 lifecycle reductions as high as 80 per cent. However, other studies have identified that this may be reduced by the dominant role that may be played by land use changes. Other research has calculated that in order to generate a 60 per cent reduction relative to petroleum, jet fuel requires a careful choice of crop/feedstock and optimisation of the cultivation mechanism."

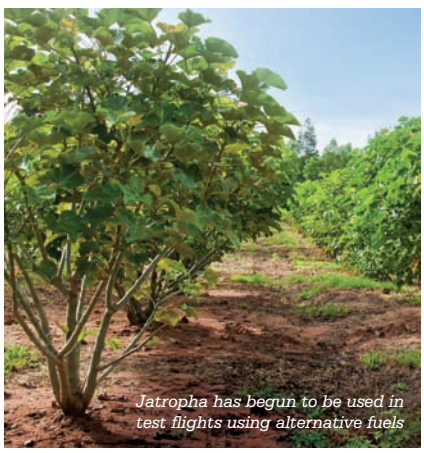
The alternative fuels story began back in 1999 when South African company Sasol approached the authorities for permission to run an aircraft on a synthetic jet fuel. Following an extensive test programme the fuel was approved in blends of up to 50 per cent in 1999 and finally a fully synthetic fuel was approved in 2009. Prof Wilson says the move was significant. "The process of approving both the blend and fully synthetic jet

fuel helped the specification authorities develop a process to accept synthetic kerosenes. This has proved very significant in terms of identifying the process that needs to happen for an alternative fuel to be approved."

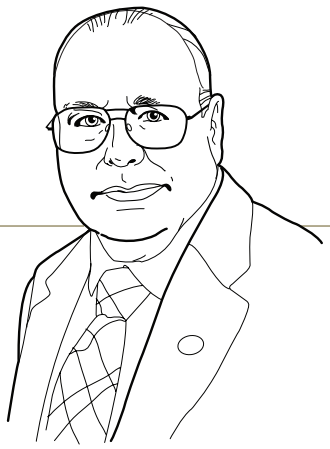
To avoid lengthy approval processes, a powerful international alliance of academia, engine and aircraft manufacturers, airlines, and fuel suppliers have now approved a generic process for production of synthetic fuel that can be blended in amounts up to 50 per cent with conventional petroleum jet fuels. Precisely such a process has allowed test flights such as Iberia's to happen.

Prof Wilson says in the US the Commercial Aviation Alternative Fuels Initiative is combining public and private sector efforts in advancing the development of alternative fuels, and has made considerable advances in terms of approval of fuel specifications and research to investigate life-cycle analyses. "Jet fuels from other advanced processes such as pyrolysis, alcohol oligomerization and advanced fermentation are being investigated under the programme," he adds.

Wilson says a major bottleneck in the use of biofuels may come in the availability of large quantities of sustainable biomass to use as



Jatropha has begun to be used in test flights using alternative fuels



Professor Chris Wilson

University of Sheffield

comments

If you'll excuse the pun, research into the use of alternative fuels in aircraft has quite literally taken off in recent years.

Back in 2003 when I first began researching the subject here at Sheffield the whole topic was very much in its infancy, even though people were aware of the potential benefits of finding fuel alternatives in terms of reducing the impact of aviation emissions.

Today the story couldn't be more different. Not only have we witnessed a string of test flights part using alternative fuels, but the infrastructure is slowing emerging too, typified by the giant Pearl Gas-to-Liquids (GTL) project being developed in Qatar. The plant is producing a range of different gas to liquids products and the scope to use a cleaner GTL kerosene as a jet fuel is being widely developed.

"ECATS has really come in its own is the way in which it has been able to marry the scientists with technologists."

But there is still much to do on the infrastructure front. The problem is that the investment we need to get us to where we need to get to simply doesn't exist yet, and the same goes for regulation. The EU may encourage the use of alternative fuels via the Emissisons Trading Scheme, but the practicalities of it going it alone remain extremely challenging in such a global industry.

However where we have seen significant international collaboration is in the approval process for new alternative fuels. A powerful international alliance of academia, engine and aircraft manufacturers, airlines, and fuel suppliers have now approved a generic process for production of synthetic fuel that can be blended in amounts up to 50 per cent with conventional petroleum jet fuels.

So where has ECATS fitted in with the alternative fuels story? Well, it's been at the heart of the debate and research, most notably in terms of setting up a virtual fuel centre which has been able to run tests on a range of alternative fuels. But where ECATS has really come in its own is the way in which it has been able to marry the scientists with technologists in the same area. In industry you would just have the engineers working alone, you would not have the scientists working there as well. ECATS goes across the patch and is multi-disciplinary, and this one-stop-shop capability has tremendous strengths.

On the wider front, ECATS has also shown its ability to put the right people in the right place at the right time if you need to do things in a hurry, as shown by its speedy response to the ash cloud crisis over Europe last year.

feedstock. "Studies in Europe (Novelli, 2011) have shown that an extensive fraction of traditional biomass produced in 2050 would be required to meet industry targets of halving 2005 levels of CO_2 by then. Advances in agriculture would be required in order to cultivate large quantities of land not currently farmed. Another bottleneck comes from the fact that aviation cannot be considered in isolation, since several other sectors, such as energy and other transport modes are also looking to include the use of biofuels to reduce their CO_2 footprint, potentially reducing the biomass available to use."

Which brings us to a wider problem, says Wilson, namely how you get hold of the commercial quantities of alternative fuels required in order to fly from a sustainable source. "There is another EU programme at the moment which shows that you need something like 600 fuel making plants in Europe alone to deal with the European airline industry. There is an awful lot of investment needed, but who is going to pay for it? The authorities are also getting to the stage where they have done a lot of work in terms of approving new fuels, but have seen little action that the fuels are actually being produced. The danger is that the approvals process starts to slow."

Wilson adds that another major stumbling block is that although in theory Europe could go it alone when it comes to starting to use alternative fuels - and indeed is now starting to encourage the use of alternative fuels via the workings of its Emissions Trading Scheme - the fact remains that the global infrastructure required for such a move to happen is simply not in place.

"Aviation is global. You cannot have planes running off alternative fuels in one corner of the world and not in another. Everyone needs to be signing up to this but the practicalities remain difficult."

There are other big questions too, not least given that safety of flight must of course remain paramount. How can you roll-out alternative fuels further if the whole airline fleet is still built around kerosene? If alternative fuels start to be used more widely how do you ensure that the right alternative fuels are going into the right aircraft? And what are the dangers of using alternative fuels in ageing aircraft?

Like Prof Wilson, ECATS partner Peter Habisreuther has been testing alternative fuels in pilot rigs aimed at simulating real-life conditions. He says that although the challenges may appear daunting, the industry knows that it has to rise to the challenge. However he accepts that the days where all airlines routinely use alternative fuels are still some way away. "There is frankly an urgent need to substitute fuels with alternatives because resources are getting short and more expensive. If fuel gets more expensive then that is a real opportunity to switch to other types of fuel and other resources. But there is a lot of work to be done because alternative fuels have other properties that we need to know about."

Dr Habisreuther has personally been looking at the reactivity of alternative fuels and combustion systems. As he explains: "If you are designing an aero engine one of the first things you have to do is look at the stability of the engine. The alternative fuels we have looked at behave relatively the same regards safety with the engines burning as well as they would with traditional fuels. But what we have noticed is that when it comes to emissions there are things that can change significantly as the spectrum of carbon types emitted differs from commercial fuels."

History of test flights

Virgin Atlantic was the first commercial carrier to successfully demonstrate that flight on an alternative biomass derived jet fuel was possible. The 45-minute flight between London and Amsterdam in February 2008 was operated with one of the four Boeing 747–400 engines fuelled with a blend of Jet A-1 and 20% coconut and babassu palm oil.

Japan Airlines ran a test flight, also in January 2009, operating one of four engines on a 50/50 blend of conventional jet fuel and hydro processed biomass feedstock, consisting of Camelina (42%), Jatropha (8%) and Algae (<0.5%).

Qatar Airways operated a commercial flight using gas to liquid (GtL) kerosene producton in October 2009. Qatar used a 50:50 blend of GTL and conventional Jet A1 kerosene to power a commercial flight of an Airbus A340-600 from London to Doha. The Airline is expected to operate regular commercial flights.

Air New Zealand chose Jatropha, a plant which can produce high oil content inedible seeds, for their test flight in December 2008 between Auckland and Wellington. Using hydro processing techniques the seed was converted into a drop-in jet fuel which was then blended with 50% jet A-1.

Continental Airlines operated a twin engine aircraft from Houston in January 2009 where one of the two engines was powered using a 50/50 blend of conventional jet fuel and a mixture of Jatropha (47.5%) and Algae (2.5%). The airline became the first flight to demonstrate operation of an Algae feedstock.

Iberia and Repsol staged Spain's first commercial flight powered by biofuel. An Airbus A320 flew from Madrid to Barcelona in October 2011 burning a mixture of 75% conventional A-1 jet fuel and 25% biofuel derived from the camelina sativa plan. The flight was part of Spain's Green Flight program to advance the use of biofuels in aviation.

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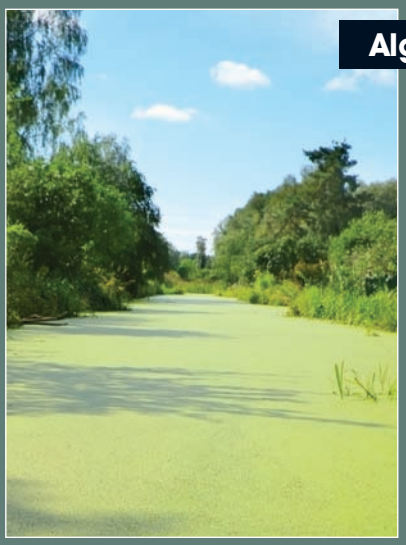
FACTS AND FIGURES

HOT AND COLD

Sustainable alternative jet fuels need to have several properties such as the ability to be mixed with and meet the same specification as conventional jet fuel, and in particular be able to resist cold and hot temperatures.

Hamburg to Frankfurt

Lufthansa has plans to conduct a six-month trial on scheduled commercial flights between Hamburg and Frankfurt to study the long-term effect of biojet on engines.



Algae, jatropha and babassu

Biojet fuels are made from sustainable, non-food biomass sources such as algae, babassu, camelina, halophytes, jatropha and switch grass. Algae are simple, photosynthetic organisms which can be grown with polluted or salt water while babassu is a native-growing Brazilian tree with a high oil-yield nut. Camelina is an energy crop that grows in rotation with wheat and other cereal crops while halophytes grow on salt ground where nothing else grows well. Jatropha reclaims wasteland and is a natural fence for crops and grows in poor soils while switch grass needs little water and produces a high output of biomass.

BETWEEN 2008 AND 2011 SIX TEST FLIGHTS TOOK PLACE USING BLENDS OF HYDROPROCESSED RENEWABLE JET FUEL (HRJ) FROM DIFFERENT FEEDSTOCK.

ENGINES POWERED ON A BIOJET MIX HAVE EVEN SHOWED AN IMPROVEMENT IN FUEL EFFICIENCY IN SOME CASES

USA APPROVED

In 2009 the United States fuel certifying body approved a new specification enabling the use of synthetic fuel blends, such as BTL (Biomass to Liquid), up to 50% in aviation.

LONDON LANDFILL

In 2010 British Airways and US bioenergy group Solena announced that they were evaluating potential sites in east London on which to build a sustainable jet fuel plant aimed at providing at least half of the airline's fuel needs for aircraft based at one of its London airports. The fuel will be derived from waste that would otherwise have gone to landfill. Solena converts the waste material into a gas which is then turned into liquid biofuel through the Fischer Tropsch process.

NEW REFINERIES

In 2011 US President Barack Obama announce he would spend up to $510m to help build new refineries which could produce fuel from wood chips, grasses, or corn cobs. Under the plan, the US government will provide matching funds to private companies building new biofuels refineries, or retrofitting existing plants. "Biofuels are an important part of reducing America's dependence on foreign oil," he said.

Virgin boss Sir Richard Branson recently announced a project to make jet fuel from the waste gases of steel mills. He said that within three years half of his Virgin Atlantic fleet would be powered by the fuel which uses a bacterium found in rabbit guts to ferment waste carbon monoxide.

SUSTAINABLE BIOJET FUELS

The International Air Transport Association (IATA) supports research, development and deployment of sustainable biojet fuels that offer net carbon reductions over their life cycle, do not compete with fresh water requirements and food production, or do not cause deforestation or other negative environmental impacts such as biodiversity loss.

Growth challenges

AIR QUALITY ISSUES REMAIN A HUGE ISSUE FOR AIRPORTS ACROSS EUROPE. ECATS HAS BEEN AT THE FOREFRONT OF RESEARCH INTO THE WAY AHEAD FOR AIRPORTS AS REGULATORS GET TOUGHER WITH THE INDUSTRY

"Everyone knows when they are at an airport because of the smell of kerosene. Using the same logic we are investigating how the human senses could differentiate between different types of pollution."

Precisely how you manage the continued growth of aviation while at the same time containing pollution levels in and around airports is a question that continues to vex governments across the globe.

Indeed the word 'contain' is probably just about all governments can hope to do given the insatiable demand for air travel, not least among the burgeoning middle classes in emerging economies such as China, India and Brazil.

Whatever technical improvements may be made to aircraft or to air traffic management systems to reduce the impact of air pollution, they are being outweighed by the continued growth in passenger numbers. As such local air quality has become a limiting factor in the development of many airports, especially in the developed world and in areas such as northern Europe which are the busiest skies on the globe.

The impact of aircraft is not the only limiting issue for airport development either. Authorities also have to take into account the impact of the ground vehicle traffic of passengers and freight. Indeed the whole process of how you measure aircraft, airport ground traffic and passenger/freight vehicles emissions has become one of major importance across the industry.

Indeed if air traffic is to continue to increase in regions such as Europe, its impact on local air quality will have to be better understood and cleaner modes of operation developed.

It is precisely in this area that ECATS has the expertise and the capability of assessing these wider effects, having as it does the capability to study many of the issues determining local air quality at airports ranging from the dispersion of materials from aero-engines through to the impact of ground service vehicles and tyre smoke when planes land.

One of the particular motivations for airport air quality studies are the new nitrogen dioxide (NO2) concentration threshold limits which came into force in 2010. As such it has become

Stephen Bures / Shutterstock.com

increasingly important for airports to learn exactly what they are contributing to pollution, whatever the source.

Another area being looked at is whether it is possible to achieve a particular mark for airport pollution, a unit of measurement by which the different types of pollution can be compared.

Studies have taken place in this area previously, such as a study back in 2004 into the impact of emissions on air quality at Zurich airport. Measurements of NO, NO2, CO and CO_2 were taken while air samples were taken to analyse the mixing ratios of volatile organic compounds (VOCs). CO concentrations in the vicinity of the terminals were found to be highly dependent on aircraft movement, whereas NO concentrations were dominated by emissions from ground support vehicles.

Among the VOCs, reactive alkenes were found in significant amounts in the exhaust of an engine compared to ambient levels. Also, isoprene, a VOC commonly associated with biogenic emissions, was found in the exhaust, however it was not detected in refuelling emissions. The benzene to toluene ratio was then used as a marker to differ between vehicle, refuelling and aircraft emissions.

Professor Peter Wiesen

Dean of the Faculty for Mathematics and Natural Sciences, University of Wuppertal, Germany

comments

Airport air quality is one of the key problems with continued air traffic growth since airport-related sources of emissions have the ability to emit pollutants that can contribute to the degradation of air quality of nearby communities. In Europe, in particular, the new nitrogen dioxide limiting values are of paramount importance in this regard.

The two main areas of an airport air quality (AAQ) assessment are the emission inventories and the chemistry/dispersion modelling of pollution concentrations. In this respect, ECATS has developed modelling and measurement capabilities for the assessment of AAQ and for the provision of scientific tools to potential customers and other scientists for the management of AAQ.

Typically, airport environments comprise of a complex mix of emission sources including aircraft, ground service equipment, terminal buildings, and ground vehicular traffic. All of which makes air quality assessment quite difficult. Furthermore, emissions, transport and chemical transformation of air pollutants occur in different scales (via aircraft engines, exhaust plumes, whole aircraft, airport scale, regional scale and global scale), a fact that requires appropriate measurement methodologies as well as modelling tools.

Where does ECATS fit in to this complex jigsaw? Well, one thing ECATS has done is establish a database with measurement data from Athens, London-Heathrow, Manchester, Paris CDG and Budapest Airports, which can be used by potential customers and modellers in the future.

"With the help of the ECATS airport campaigns it should become possible to improve AAQ models."

Looking ahead we anticipate increasing public expectations regarding local air quality levels and increasing public concerns over the effects of aircraft in the near future. But with the help of the ECATS airport campaigns it should become possible to improve AAQ models, and in the long term through further improvements and the coupling of different scales' AAQ models, possible to forecast airport air quality for different scenarios of air traffic development.

Finally, ECATS capability and expertise relating to AAQ monitoring and modelling could be disseminated to the airport operators. Through operational studies it could also illuminate how changes in management practice (e.g. more efficient control of taxiing to avoid aircraft jumps or airport supply of electric energy and air conditioning for aircraft during service) may impact upon local air quality.

Another particular idea being researched by ECATS is to find a chemical substance which is responsible for the typical smell of unburnt kerosene. This may then act as a chemical marker whose dispersion one could use to describe how a cloud of pollution is dispersed. The smell is caused when aero engines are running under idle conditions and when the combustion of kerosene is incomplete leading to the emission of relatively large amounts of hydrocarbons.

One ECATS study took place at Athens International Airport (AIA) where a project measured emissions from aircraft during take-off by putting instruments alongside the runway. The team wrote down the licence numbers of the planes that they saw and from these we were able to identify the engines being used and thus calculate an emissions index and the amount of NOx emitted per kilo of fuel burnt. They were then able to compare this data with International Civil Aviation Organisation (ICAO) databases. The research revealed a large fluctuation in emissions between individual engines of the same type, from which it could be speculated that the difference results from the age of the engines and/or their different maintenance status.

"Little scientific work has been done on airport air quality and one of the particular motivations for airport air quality studies are the new nitrogen dioxide (NO2) threshold limits."

As part of the study ECATS developed a database of air quality and meteorological measurements that will serve as an input and validation data set for future modelling work. Indeed ECATS is now submitting another bid to do a similar trial at a larger European airport such as London Heathrow or Frankfurt.

Athens Airport was the setting for a major ECATS study into air quality

Frankfurt opened a fourth runway in October 2011 thereby increasing capacity 50 per cent from 83 coordinated aircraft movements an hour to 126. Capacity will be gradually ramped up and the plan is to grow flight movements between four and seven per cent a year. The new runway is shorter than the airport's other runways and will be used strictly for landings by aircraft smaller than the 747.

In 2010 53 million passengers passed through Frankfurt's gates, and the airport's goal is to reach 90 million. As such the new runway is part of a major expansion programme which includes a new terminal and a major expansion of its cargo facilities and capacity.

Capacity issues are even more profound at Heathrow. Plans for a controversial third runway – initially given the green light by the previous Labour government on condition that measures were put in place to limit aircraft noise, air pollution and greenhouse gas emissions - were scrapped when the new coalition government came into power in 2010.

British Airways, the biggest operator at the airport, has given up hope of a third runway ever being built and is looking for alternatives to expand elsewhere such as through its Spanish partner Iberia at Madrid Airport which has four runways.

However in late 2011 the government came under increasing pressure over its stance as studies showed the extent to which the UK was missing out on potential global investment as a result of capacity issues at Heathrow. One proposed idea was for a high-speed link betweeen Heathrow in the west of London and Gatwick airport to the south so that the latter could take some of the pressure off Heathrow. Renewed calls for the government to consider building a new airport alongside the Thames estuary were also made.

EU gets tough on air quality

It isn't just pollution at airports which is vexing Europe's political leaders, it's pollution in towns and cities too. Last year the European Union brought in new binding targets over air quality which pose a major challenge for governments to reach.

The EU Air Quality Directive sets concentration limits for particulate matter (PM10) and nitrogen dioxide (NO2) but, significantly, did provide for postponement of the compliance deadlines for PM10 to June 2011 and for NO2 from 2010 to 2015, subject to submission of air quality plans setting out how the limits will be achieved.

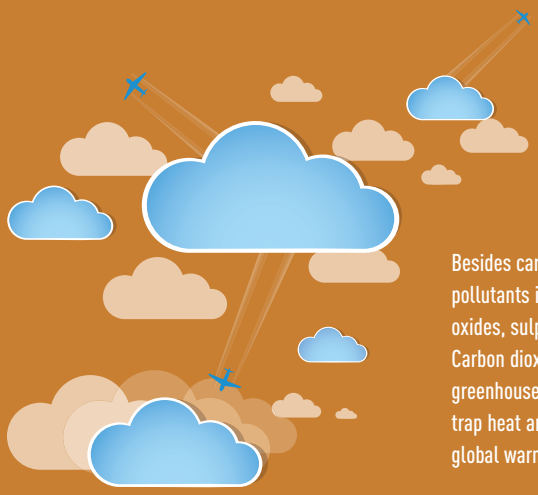
The most important air pollutant in terms of quantified health effects is PM10 – and the World Health Organisation advises there is no safe level of exposure. The health evidence around the long term effects of NO2 is inconclusive as it is difficult to extricate the effects of long term exposure from those of fine particles like PM10. Short term effects of NO2 are however well established. At higher concentrations it can cause irritation to the lining of the lungs and can exacerbate respiratory conditions.

The new EU limit value for NO2 of 40 $\mu g/m^3$ is an annual mean while that for PM10 is 20 $\mu g/m^3$. Ambient concentrations at many European airports are already close to or above these values.

FACTS AND FIGURES

LAND or AIR?

There are many sources of air pollution associated with an airport other than aero-engines: tyre smoke on landing; ground-service vehicles; volatile organics from fuelling operations and road traffic.



Engine pollution

Besides carbon dioxide, jet engines emit many pollutants into the atmosphere including nitrogen oxides, sulphur oxides, soot and even water vapor. Carbon dioxide and water vapor are called greenhouse gases, because they trap heat and contribute to global warming.

GLOBAL WARMING

AERO-ENGINE EXHAUSTS CONTAIN MANY POTENTIALLY HAZARDOUS ORGANIC COMPONENTS, PARTICULARLY WHEN AN ENGINE IS OPERATING AT LOW THRUST

GLOBAL FUEL

FUEL USAGE CUT BY 70%

Air transport has reduced its fuel use and CO_2 emissions per passenger kilometre by 70% compared to the 1970s

Total emissions for 2010 increased by 3.5% to 649 million tonnes CO_2 (compared with 627million tonnes in 2009) as a result of an increase of 5.2% in capacity.

5.2% INCREASE IN CAPACITY

$176bn

The global airline industry's fuel bill is forecast to total $176bn in 2011. This is an increase of $37 billion over 2010 and is four times 2003's fuel bill of $44 bn.

NEW YORK
LONDON
ATHENS
OSLO
BRUSSELS
GREECE
COPENHAGEN
MADRID
ONTARIO
MOSCOW
WASHINGTON
BELGIUM
PARIS
ROME
BARCELONA
VENICE
SYDNEY
SEYCHELLES
TENERIFE
FRANKFURT
BRUGGE
LISBON

The air we breathe

A study by London's Queen Mary University linked particulate matter exposure to pneumonia, particularly among children. It found that Londoners breathe in air that is more harmful than that in Accra, the capital of Ghana. Wood smoke, prevalent in poorer countries, is less toxic to the airway cells than diesel exhausts.

THE INTERNATIONAL AIR TRANSPORT ASSOCIATION'S VISION IS,

FOR CARBON-NEUTRAL GROWTH ON THE PATH TO BUILDING AN EMISSIONS-FREE COMMERCIAL PLANE BY 2057

WHILE THE INDUSTRY ACHIEVES AN AVERAGE IMPROVEMENT IN FUEL EFFICIENCY OF 1.5% PER YEAR TO 2020

THE AIM IS TO REDUCE NET CO_2 EMISSIONS 50% BY 2050

COMPARED TO 2005.

CARBON-NEUTRAL GROWTH MEANS THAT AVIATION'S NET CO_2 EMISSIONS WILL REMAIN FLAT EVEN AS DEMAND GROWS

Assessing new options

THE SKIES ABOVE EUROPE ARE AMONG THE MOST CONGESTED IN THE WORLD. THE INTERDISCIPLINARY EXPERTISE WITHIN ECATS IS HELPING THE INDUSTRY PRODUCE BETTER FORECASTS FOR THE NOISE, EMISSION AND ECONOMIC IMPACTS OF AVIATION

For the world's busiest airports managing capacity issues are paramount and the environmental costs can be great if capacity issues aren't handled efficiently.

For instance to take just one example, most passengers will be able to relive an experience whereby their plane has had to encircle an airport waiting to land and wasted valuable fuel in the process. ECATS partner Tomas Martensson from the Swedish agency FOI, says some airports such as in his home city Stockholm, are already employing continuous descent approach models whereby aircraft effectively glide down, thereby emitting significantly less fuel and creating less noise as they land.

"European air space is becoming more and more squeezed. Soon the centre of Europe will become so saturated that we will have to limit the number of flights."

However he concedes that implementing such measures at larger and busier airports is more problematic. "Medium sized airports are getting better at introducing new ATM processes in general," adds Martensson, "but it is very challenging for the big hubs."

It is precisely these challenges which are being tackled by the European SESAR (Single European Sky ATM Research) project (see overleaf) which is researching effective remedies to air transport capacity bottlenecks and ways of improving air traffic management (ATM) systems.

The project has set itself the ambitious target of helping to eliminate a net amount of 50 million tonnes of CO_2 emissions during the 2013-2030 period by developing a comprehensive new ATM system for the whole of Europe, a move which it hopes will finally bring the dream of a 'Single European Sky' closer. A new version of SESAR's ATM masterplan will be published in 2012 and give more policy detail.

Speaking earlier this year, Siim Kallas, Vice-President of the European Commission responsible for transport, said Europe could not afford to delay the project. "European air space is becoming more and more squeezed. Soon the centre of Europe will become so saturated that we will have to limit the number of flights unless there is serious reform. Our priority is to reform the fragmentation of airspace to create a single european sky not just as a project in itself but as a wider understanding between countries. We need to take serious steps."

Martensson says ECATS can also play its role in making this happen too. "Our main focus has to be to help address this question too. For instance Scandinavia should have just one airspace, while there should be just one for northern Europe. But debate in this area inevitably becomes very political."

Fellow ECATS partner Paul Brok from the National Aerospace Laboratory NLR in the Netherlands is closely involved in the field of policy analysis and more specifically interdependency modelling. This involves complex modelling systems addressing economic and environmental issues including emissions and noise in a harmonised way. As aviation and environmental policymaking

becomes more complex and critical concerning interdependencies, so these tools become more useful for policy analysis and evaluation.

For instance, they can be used to analyse the effects of the extension of the European Trading Scheme (ETS) to cover air travel from 2012 when airline operators will have to surrender one allowance per tonne of CO_2 emitted on a flight to and from (and within) the EU.

Says Brok: "What we have been doing is combining the modelling of aviation emissions, noise and economics and thereby providing both the aviation industry and policymakers with comparative solutions. If you take a policy like the ETS policymakers will not know the precise implications, so in order to analyse and assess such a measure the best thing is to put together a suit of tools to model the system."

Since 2005 Brok has been at the forefront of relevant research projects funded by the European Commission to eventually produce a consistent tool suite to forecast the noise, emissions and economic impacts of policy measures. The aim of TEAM_Play (Tool suite for Environmental and Economic Aviation Modelling for Policy Analysis) is to create a framework which allows existing and new models to be combined or integrated for an assessment of the diverse effects of aviation policies.

For a well balanced sustainable aviation policy - such as what is required for the ETS - it is crucial to be able to assess, in advance, the potential results of any measure or instrument. Brok says one of the drivers of the

Paul Brok

National Aerospace Laboratory,
Netherlands

comments

I'm writing this column on a flight back to the Netherlands from Marseille where I participated in the very informative and social Aircraft Emissions and Noise Reduction Symposium (ANERS). This symposium again provided a bird's-eye view of all relevant aviation and environmental topics such as greenhouse gas and particulate matter emissions, alternative fuels, green flight operations, aircraft noise and - last but by no means least - interdependency modelling.

The symposium showed that the aviation community - whether it be the manufacturers, operators, research and science community or right up to the policymakers - definitely care about the environment. Considerable effort by many stakeholders continues to be put into the research, development and implementation of environment-beneficial technology, operations and policies to jointly accomplish a sustainable growth of aviation via a strategic action plan.

ECATS and its member organisations were well represented and active at ANERS, showing that ECATS is one of the leading players in the field. My fellow ECATS colleagues gave presentations on different research topics with our chairman moderating the Air Traffic Management (ATM) and Environment session, while I moderated the challenging session on International Cooperation on Non-Competitive Research Topics.

From these discussions it became clear that the aviation community is facing up to and taking important steps towards further collaboration on a worldwide scale, beyond the already well-established collaborations of the last decades at national level, regional/European level and between Europe and North America.

"The aviation community is facing up to and taking important steps towards further collaboration."

A worldwide collaboration may take some time, but who would have thought back in the 1980s and 1990s when the European Research Framework Programmes was emerging, that competing organisations like aero-engine manufacturers would now be closely working together in so many European projects, while similar cases exist in North America. For critical and worldwide relevant issues such as community noise and annoyance, airport air quality and climate change, it is manifest to share information and aviation best practices to mitigate any potential negative effects.

A multi-disciplinary and multi-community approach, plus well-considered interdependencies between changes in technology, capacity, economics, noise, emissions and other various impacts – while not compromising safety – are critical to making real progress on the global topic of aviation sustainable growth. ECATS, as an international association with expert members in many research and science disciplines and aware of what is going on in the different communities, will continue to support and help to make aviation sustainable.

project was that until recently Europe had had to rely on tool suites put together in the US, yet European aviation policy demands its own European-based model-based assessment.

Explains Brok: "TEAM_Play involves a large range of activities modelling emissions, noise and economic policy. Policymakers want to harmonise the expertise within Europe which in the past has not always been well organised. Most organisations that were looking at these issues are now involved in the TEAM_Play consortium. We can facilitate the policy ambitions of governments and policy making."

Funding for the project runs initially until 2012 but Brok hopes to be able to extend the project so that tool suites can be continually upgraded and that the framework becomes as open and accessible for governments and industry alike. "If certain European states want to have their own modelling tools included they can then make adjustments to their tools. In this way the whole project creates real added value."

The project also really taps into the unique strength of ECATS, namely its research capability across a range of different disciplines in the sustainable aviation arena.
As Martensson adds: "We are bringing together experts from all domains and all different areas which is a real strength of ours. Within the ECATS network we knew that this was an area which was crying out for better co-ordination of research efforts and we were able to deliver."

Towards a single European sky?

Reforming the world's ATM systems is now high up the political agenda with global aviation authorities looking to modernise the world's air traffic systems by streamlining the routing of flights and providing more real time information to pilots and controllers.

In Autumn 2011 the International Civil Aviation Organisation (ICAO) held a summit at its Montreal headquarters where it presented a proposal to the international aviation community that would assist in the modernization of air traffic management systems.

Raymond Benjamin, Secretary General of ICAO, told delegates that over the next decade some $120bn would be spent worldwide on upgrading the global aviation system to enhance safety, efficiency and overall sustainability. "We have to ensure that it is done in a timely, coordinated and harmonized manner around the world," he said.

However Nancy Graham, director of ICAO's Air Navigation Bureau, added that success ultimately depended on states, operators, air navigation service providers, manufacturers and airports working closely together to synchronize deployment of the future systems.

ICAO's plan is based on an 'aviation system block upgrades' concept which can be implemented by a state or region based on need and level of readiness, although big questions remain over precisely how the whole project will be precisely funded. ICAO will update its plans again in late 2012 when it sets its wider goals for the next decade.

A figure has been put on the costs of Europe's own answer to solving ATM issues, namely the SESAR (Single European Sky Atm Research) programme which is expected to cost in the region of 30bn euros and just like wider global efforts is aimed at developing a new generation of ATM systems capable of ensuring safety and efficiency of air transport over the next generation. The EU-wide implementation of the first new generation SESAR capabilities is planned for 2013.

SESAR's major objectives include moving from airspace to trajectory based operations, so that each aircraft achieves its preferred route and time of arrival; better collaborative planning so that all parties involved in flight management can plan their activities better; and developing new technologies to provide more accurate airborne navigation and optimised spacing between aircraft to maximise airspace and airports capacity.

Another big driver is, of course, reducing CO_2 emissions, and SESAR has set a target for 2020 to achieve 10% fuel savings per flight as a result of ATM improvements alone, thereby enabling a 10% reduction of gas emissions per flight. It also wants to improve the management of noise emissions and their impacts and to ensure that these are minimized for each flight to the greatest extent possible.

A report from consultants McKinsey into the SESAR project found that any initial costs of setting up systems would be dwarfed by the fuel savings that can be achieved and by the wider economic boost to economies of a more efficient aviation system.

McKinsey calculated that SESAR would eliminate a net amount of 50 million tonnes of CO_2 emissions during the 2013-2030 period, equivalent to the annual emissions generated by five million EU citizens. In addition, despite the additional air traffic created. However it warned that a 10 year delay to the project would result in loss of benefits estimated at €268 bn of GDP and the loss of 55 million-tonnes of CO_2 emissions saving.

Many believe the volcanic eruptions in Iceland will also now spur completion of the wider Single European Sky concept, the interlinked attempt to pool sovereignty over airspace. The airlines want Europe to adopt a system for dealing with volcanic-ash eruptions similar to that in America, where the Federal Aviation Authority gives carriers information and data but lets them make their own risk assessments. One issue at the moment is that once the new safe ash cloud limits are breached some countries simply close their airspace altogether while others leave it open and leave it to the discretion of airlines over whether it is safe to fly.

FACTS AND FIGURES

THE AVERAGE FLIGHT IN EUROPEAN AIRSPACE IS

50KM LONGER THAN IT NEEDS TO BE

European air navigation is 60-70% less efficient than in North America. EU airspace is presently managed by 39 national air navigation service providers.

60-70% less

EMISSIONS ELIMINATED

12%

According to the International Air Transport Association (IATA) governments and infrastructure providers could eliminate up to 12% of CO_2 emissions by addressing airport and airspace inefficiencies.

AIRSPACE BLOCKS

In 1999 the European Commission first proposed the creation of a Single European Sky (SES) for air traffic management with the project formally launched in 2004 with the aim of rationalize the fragmentation of European airspace into nine Functional Airspace Blocks.

FLIGHT INEFFICIENCIES CAN IMPACT FUEL BURN BY AS MUCH AS 7%

POTENTIAL PRICE REDUCTION

If civil airspace users pass on the potential savings to customers of SESAR due to increased price competition, this could lead to a reduction in fares of up to €5 per ticket on average.

THE AVIATION INDUSTRY IS SET TO CONTINUE TO GROW BY AROUND 4.7% YEAR ON YEAR. THIS MEANS THAT

TODAY'S FLEET OF AROUND 15,750 AIRCRAFT WILL GROW TO ALMOST 32,000 BY 2028

328,000 jobs created

Flight times shortened by nine minutes

It has been estimated that the SESAR (Single European Sky Atm Research) project could be worth up to €419bn to the European economy between 2013 and 2030, and help create up to 328,000 jobs. It could help shorten flight times by approximately 10 per cent, equating to a reduction of nine minutes per flight on average, as well as 50 per cent fewer cancellations and delays.

FLIGHTS DELAYED

A 10 year delay to the SESAR project would result in loss of benefits estimated at €268 bn of European GDP and the non-creation of 189,000 jobs. It is predicted that 20% of flights in Europe will be delayed by 2020 if the system is not modernized.

Answers in the sky

RESEARCH INTO CLIMATE CHANGE CONTINUES TO POSE SIGNIFICANT CHALLENGES FOR SCIENTISTS. NOT LEAST WHEN IT COMES TO DEVELOPING ROBUST MITIGATION STRATEGIES FOR AVIATION

Few areas of science remain as contentious as the battle to fully understand what is happening to our climate. The challenges and in-depth research that such investigation requires is epitomised by efforts to understand exactly what happens to the atmosphere when a jet airliner is cruising at 35,000ft.

The study into 'green flight', namely looking at the full environmental impact of aviation and how it can be lessened, forms a key part of the ECATS research studies. The subject is also intertwined with other research areas such as efforts to improve the efficiency of the aviation industry through improved air frame technology, alternative fuels and efficient traffic management (ATM) systems.

ECATS chair Sigrun Matthes from the German Aerospace Center DLR-Institute of Atmospheric Physics based in Oberpfaffenhofen, says the study of green flight is best thought of as the study of an air transport system which best benefits the environment. "Given the continued and significant growth of the aviation industry this work is pivotal. It is also not just about analysing the effects of CO_2 emissions but non CO_2 emissions too, such as NOx (via ozone and methane), soot, contrail and contrail-cirrus. These are just as significant because the climate impact of emissions depends heavily on the altitude of the aircraft and where the emissions are released, which adds to the complexity of the research."

"The big question we have to ask is will improving the complexity of modelling help to improve our understanding of what is going on in the atmosphere?"

The ECATS work revolves around better understanding these effects and trying to reduce uncertainties for the industry. However

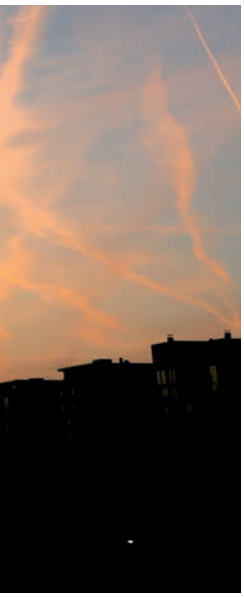
Congested airspace over Frankfurt

Matthes concedes that sadly the ultimate model is not available. "The big question we have to ask is does improving the complexity of modelling help to improve our understanding of what is going on in the atmosphere, or is it more important to identify the driving processes? More complexity does not necessarily mean better results, but we know that modelling is a robust way of getting more reliable answers. The idea is to combine the results and aim for robust solutions. You have to develop ways of how to deal with the uncertainty."

Matthes says ECATS has hence applied several models with differing levels of complexity and analysed the same problems, in so doing also exploiting synergies with other environmental programmes which quantify the impact of transport emissions such as the European QUANTIFY project.

"From these different answers you get a better estimate of what the environmental impact and related uncertainty is," says Matthes. "We have recently developed a modelling chain which links direct to a flight planning tool and from that you can start to search for efficient, robust strategies."

However Matthes says probably the biggest single challenge in this whole area of research is that the atmosphere is by its very nature so changeable, e.g. in terms of temperature. To respond to this atmospheric variability, when searching for mitigation strategies ECATS focuses on specific prevailing weather patterns. For instance this is why ECATS set up the collaborative project REACT4C (see overleaf).



Much of the work carried out by Matthes and her colleagues has been on understanding the atmospheric processes of the compounds that are emitted by planes. "Industry wants to know which compound to focus on, which compound they need to worry about most," she adds. "Industry would prefer just to have one answer to this, but for the time being the story is not that easy. If anything I would say that the industry is actually increasingly interested in the facts around non CO_2 gases at the moment."

Matthes says the strength of ECATS in this field is in its capacity to bring together different disciplines. "Our USP is our interdisciplinary nature, the fact that we are bringing together lots of different research and ideas. We are bringing together a team of experts under one roof and can act as an efficient interface for industry."

She stresses however that although the industry is very open to research findings, the whole subject is still in the strategic phase. That said, the ECATS research is feeding into the wider IPCC (Intergovernmental Panel on Climate Change) process which is looking for global consensus on tackling climate change. "We are just one piece in a large puzzle," adds MatthesMeanwhile she adds that despite the economic downturn the whole climate change subject still remains very high on the political agenda. "The economic problems have not yet affected our work in this area, and if anything it has made it more important. Trying to reduce fuel consumption is now a big area for industry, not least because of rising fuel prices. If we can continue working on these problems while the global economy is not growing quite so fast then that is actually to our advantage."

Sigrun Matthes

Institute of Atmospheric Physics,
DLR, Germany and Chair, ECATS

comments

Being a co-ordinator of a network of excellence on aviation and the environment brings some major challenges to your daily life. And one of the first questions I had to ask was how exactly I would bring experts from different fields and disciplines together in order to work jointly on important questions of climate science.

For instance bringing atmospheric scientists together with engineers who aim to minimize engine emissions, or with developers who are trying to optimize a corresponding pre-design, or with operational experts who are identifying the best flight paths for aircraft, poses unique challenges. New ground is being explored in terms of combining our understanding of the atmospheric impact of aviation with our knowledge of aeronautics technology.

When talking about atmospheric scientists you might think that they would all speak the same language, but far from it! For instance atmospheric science combines experts on measurement techniques with those in numerical modelling. An experiemental researcher develops an airborne or remote sensing instrument, assuring that it can fly and measure on a research aircraft or a satellite. A global chemistry-climate modeller will design efficient software structures in order to simulate atmospheric processes and to study aviation emissions in the atmosphere.

Here two completely different types of experts are coming together and as a co-ordinator you sometimes end up right in the middle of the two, especially if you started with measurements in your early career and now deal with modelling. But whatever the challenges, all these research efforts need to be joined together in order to identify promising mitigation options in terms of overall efficiency and climate impact.

"Research efforts need to be joined together to identify promising mitigation options."

Another major challenge is how to bring more than 100 researchers together so that they work in an efficient manner. For instance it can sometimes be difficult to motivate experienced professors to use modern systems in order to establish a communication structure. That said, personal meetings are still crucial and we organise regular project meetings and workshops.

Talking of workshops, being a large research network also means that you have young motivated students and scientists in the network, which has led us to develop a dedicated training programme via student schools. I always find it personally very exciting to teach students during school events or listen to their final presentations which make our ECATS student schools such a unique experience. It's all been part of the exciting journey we have been on over the past seven years, a journey I wouldn't have missed for anything.

Looking for the optimal flight route

Several ECATS partners launched a project which takes a closer look at inefficiences in the aviation system with respect to fuel consumption and emissions by investigating the potential of climate optimised flight routing to reduce the overall atmospheric impact of aviation.

The climate impact of non-CO_2 aviation emissions depends on the time and the position of the aircraft, as atmospheric processes leading to climate change vary according to background conditions and transport routes within the atmosphere. Hence a mitigation potential for climate impact exists by identifying climate optimised aircraft trajectories.

The REACT4C (Reducing Emissions from Aviation by Changing Trajectories for the benefit of Climate) research programme was launched in 2010 and is co-ordinated by the DLR Institute of Atmospheric Physics in Oberpfaffenhofen, Germany, along with the Eurocontrol Experimental Centre and the UK Met Office. Its aim is to expand a flight planning tool in order to be able to optimise the total climate impact of flight trajectories by identifying flight altitudes and flight routes that lead to reduced fuel use and reduced overall climate impact.

The work has centred around combining atmospheric models of different complexity for quantifying the climate impact of aviation emissions. For instance one of the partners, the University of Reading in Britain, has worked in collaboration with the UK Met Office to identify typical weather situations. The consortium also includes Manchester Metropolitan University, the University of Aquila in Italy and CICERO (the Centre for International Climate and Environmental Research) in Oslo, Norway.

The end result is that the potential total mitigation gain from environmental flight planning is computed, and the uncertainties in the mitigation gain from environmental flight planning are estimated. Aircraft pre-design concepts are then explored by Airbus France in collaboration with the DLR Institute to identify requirements for an aircraft best suited for climate-optimised trajectories.

As ECATS chair Sigrun Matthes from the DLR Institute explains: "For a set of typical weather situations, 4D (location and time) cost functions were determined that reflect the environmental and climate impact of aviation emissions. From there current operational flight planning tools are extended to account for environmental effects via these cost functions. As a result of the research, concepts of future aircraft are then adapted and optimised for new environmentally-compatible flight routing.

The climate change debate

The whole debate around climate change has now been with us for more than 20 years and the first significant step in the story came in 1988 when the Intergovernmental Panel on Climate Change (IPCC) was founded. Two years later the Norwegian government established in close cooperation with the University of Oslo (an ECATS partner) the Centre for International Climate and Environmental Research (CICERO).

Today the Oslo-based independent research centre is helping drive a string of research projects in the field, including the REACT4C project (see left) where it is working with ECATS partners on developing flight planning tools that can identify flight routes and altitudes that have the least impact on the climate.

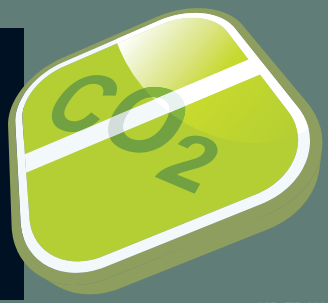
In recent years the IPCC has been criticized by some for being too conservative in its estimates of climate change and by others for exaggerating the anthropogenic impact. Further international, independent initiatives are currently underway which focus on providing a critical review to the approaches adopted in the IPCC.

Meanwhile debate continues to rage about by how much emissions should be reduced. The IPCC says that if we are going to prevent the temperature from rising by more than 2 degrees, global emissions must reach an upper limit by 2015. After that, emissions must be reduced by between 50 and 85 per cent by 2050.

According to the IPCC, the cost of preventing a more than 2 or 3 degree temperature increase by the year 2100 is estimated to be between 0 and 5 per cent of Gross National Product in 2050. If we wait to start reducing emissions, it will be even more difficult to carry out reductions.

The IPCC predicts that sea levels in 2100 will have risen by somewhere between 18 and 59 cm relative to the end of the previous century.

FACTS AND FIGURES



TOTAL CLIMATE CHANGE IMPACT (INCLUDING RADIATIVE FORCING FROM OTHER GREENHOUSE GASES) IS 3%,

AND PROJECTED TO GROW TO 5% BY 2050

AIR TRANSPORT CONTRIBUTES 2% OF GLOBAL MAN-MADE CO_2 EMISSIONS,

PROJECTED TO GROW TO 3% BY 2050

(IPCC 1999)

CO_2 CONSTITUTES ROUGHLY 70% OF AIRCRAFT ENGINE EMISSIONS WHILE FUEL ACCOUNTS FOR

MORE THAN A THIRD OF AN AIRLINE'S OPERATING COSTS

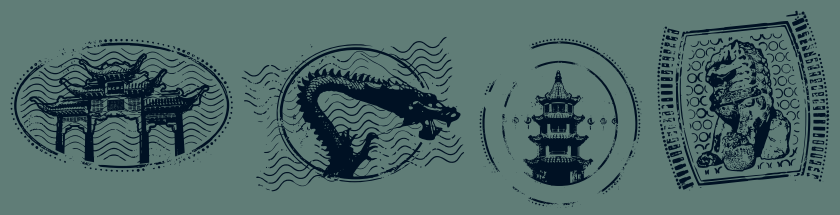
9m passenger flights

3.2 million people

In 2010 close to 9 million commercial passenger flights crossed EU airspace, with over 750 million passengers using EU airports. EU airports and civil airspace users employ directly around 670 000 people, while a further 3.2 million people in Europe depend directly or indirectly on the air transport sector as suppliers, manufacturers or service providers.

ACCORDING TO RECENT RESEARCH...

...if you take the non-CO_2 effects of climate impact into account then this roughly triples the estimate of aviation climate impact as contrail-cirrus and nitrogen oxide impacts are just as significant.



ASIA-PACIFIC DEMAND

Airline traffic is forecast to grow at more than 4 per cent annually over the next 20 years with Asia-Pacific growing fastest. This translates into demand for around 25,000 new jets in the 100-200 seat range, equal to 70 per cent of jet deliveries over the next 20 years. Boeing says China will add 5,000 commercial aircraft worth $600bn by 2030, while Airbus says the country will need more than 4,000. The Commercial Aircraft Corporation of China predicts the total will be just under 4,700, giving the country 15 per cent of the total global aircraft fleet, up from 9 per cent today.

PARIS AIR SHOW

RECORD ORDER!

A record number of orders for planes were taken at the Paris airshow in summer 2011 and it is forecast that international and European air traffic could grow by more than 70 per cent between now and 2030.

2013 AND BEYOND

It has been forecast that the SESAR (Single European Sky Atm Research) project could eliminate a net amount of 50 million tonnes of CO_2 emissions during the 2013-2030 period – equivalent to the annual emissions generated by 5 million EU citizens. If the initiative is delayed 10 years it would result in the loss of 55 million tonnes of potential CO_2 emissions savings.

The A350XWB v Dreamliner 787

The A350XWB is Airbus's rival to Boeing's 787 Dreamliner and is the company's first aircraft to be made mainly from carbon fibre rather than metal. In December 2010 Airbus brought out an upgraded version of its A320 family of aircraft featuring more fuel-efficient engines known as its New Engine Option. The plane promises a 15 per cent cut in fuel burn compared with existing models.

AIRBUS AND BOEING

ARE FORECASTING DELIVERY OF $4000bn WORTH OF LARGE COMMERCIAL JETS BY 2030

Headline to be written

Ian Wilson
ECATS reviewer

ECATS began life in 2005 with a very challenging agenda. As my fellow reviewer Anders Gustafson wrote in his first report a year later, its objective to become a European 'virtual institute' for the research of environmental compatible air transport was very ambitious.

However challenging the task this aim was critical to the rationale for ECATS. Within Europe at the time there were a number of organisations active in aviation environmental research and the overarching objective that partners would form a single association and thereby eliminate overlaps by working in a mutually supportive and co-ordinated way was essential in order to progress efficiently and effectively.

At the same time we were seeing an increasing awareness of environmental issues surrounding aviation growth. Back in 2001 we saw the launch of ACARE (Advisory Council for Aeronautical Research in Europe) which marked something of a turning point for research in Europe. ACARE quickly formulated the SRA (Strategic Research Agenda), setting challenging goals for aviation and the environment by 2020. We are now more than halfway through that timeframe and the pressure to achieve dramatic improvements in environmental impact will only continue to increase.

The timing of the launch of ECATS was also a clear response to the changing technological, environmental and political situation of the time. Since its formation ECATS has not only moved towards its major aim of integrating activity within Europe, but its members have carried out much valuable research on local and global issues. It has also provided high quality educational and professional development opportunities and I fondly recall attending an ECATS summer school in 2007 where it was clear that even in those early years the ECATS was highly regarded by the aviation community. By the time we reviewed progress in early 2011 the ECATS project had been sensibly restructured to cover key areas such as alternative fuels, the climate impact of aviation, interdependency modelling and green flight, and volcanic ash – the latter point being brought into sharp focus by the Icelandic volcano which required a speedy response from the research community.

"ECATS has also provided high quality educational and professional development opportunities."

In our 2011 ECATS review the importance of tangible progress towards integration in the sustainable aviation arena was underscored and it is vital that ECATS secures the means of supporting its activities into the future. The honour and glory of progress toward the long term goals of the SRA will go to the industrial aviation community, but progress cannot be made without underpinning expertise such as that which exists within ECATS.

ECATS is an EU funded project