ICAO UNITING AVIATION

Action Plan on Emissions Reduction

Measurement of environmental benefits from the implementation of operational improvements

ICAO International Aviation and Environment Seminar
18 – 19 March 2015, Warsaw, Poland

Sven Halle





Overview

- KPA
- ASSEMBLY RESOLUTIONS
- OPERATIONAL IMPROVEMENTS
- IFSET
- FRAMEWORK






Key Performance Area (KPA)

- ENVIRONMENT

The air navigation system should contribute to the protection of the environment by considering **noise** and **emissions** in the implementation and operation of the global air navigation system.






ICAO Assembly Resolution A37-19

- In October 2010, the 37th Session of the ICAO Assembly adopted Resolution A37-19. The provisions of this Resolutions build on ICAO's past achievements and add new measures relating to **international aviation** including:
- The outcome of the 37th Assembly represents a key milestone in the continuing efforts of ICAO to address GHG emissions from international aviation
- The global annual average fuel efficiency improvement metric of 2 per cent until 2020 and the aspirational goal of 2 per cent annual fuel efficiency improvement from 2021 to 2050
- The medium-term global aspirational goal of carbon neutral growth from international aviation at 2020 levels
- The requests to ICAO to develop the necessary tools in order to assess the benefits associated with ATM improvements






ICAO Assembly Resolutions A38

- In October 2013, the 38th Session of the ICAO Assembly adopted 2 more Resolution A38-17 on the ICAO policies and practices related to environmental protection (general provisions, noise and local air quality) and A38-18 (Consolidated statement of continuing ICAO policies and practices related to environmental protection – Climate change)
- The provisions of these Resolutions address in the introduction …

  Whereas many of the adverse environmental effects of civil aviation activity can be reduced by the application of comprehensive measures embracing **technological improvements, more efficient air traffic management** and **operational procedures** and the **appropriate use of airport planning, land-use planning and management** and **market-based measures**

  Declares that ICAO, as the lead United Nations (UN) Agency in matters involving international civil aviation, is conscious of and will continue to address the adverse environmental impacts that may be related to civil aviation activity and acknowledges its responsibility and that of its Member States to achieve maximum compatibility between the **safe and orderly development of civil aviation and the quality of the environment**






ICAO Assembly Resolutions A38

- The provisions of these Resolutions emphasize also on …

  Recognizing that **air traffic management (ATM) measure**s under the ICAO's **Global Air Navigation Plan** contribute to enhanced operational efficiency and the reduction of aircraft CO2 emissions

  *Resolv*es that States and relevant organizations will work through ICAO to achieve a global **annual average fuel efficiency improvement** of 2 per cent until 2020 and an aspirational **global fuel efficiency improvement rate** of 2 per cent per annum from 2021 to 2050, calculated on the basis of volume of fuel used per RTK performed

  Requests States to:

  …

  e) accelerate the development and implementation of **fuel efficient routings and procedures** to reduce aviation emissions

  f) accelerate efforts to achieve environmental benefits through the application of technologies that **improve the efficiency of air navigation** and work with ICAO to bring these benefits to all Regions and States, taking into account the **Aviation System Block Upgrades (ASBUs)** strategy





Operational ATM improvements

- **Performance Based Navigation - PBN**
- **Continuous Climb Operations - CCO**
  Continuous Descend Operations - CDO
- **Air Traffic Flow Management (ATFM)**
- **Flexible Use of Airspace - FUA**
- **EUROCONTROL Flight Efficiency Initiative (FEI)**
- **….**






ICAO FUEL SAVINGS ESTIMATION TOOL (IFSET)

- Simple to use and scientific defendable
- States are asked to report on fuel savings from operational improvements in 2012
- Not all States have the ability to quantify these savings
- Environmental benefit reports be of interest for various user






What does IFSET

- Allows those States without modelling and/or measurement capabilities to estimate fuel savings from operational improvements
- Consistent with CAEP-approved GHG models
- Consistent with Global Air Navigation Plan
- Easy-to-use / minimal data requirements
- The tool can estimate:
  - Effects of shortening / eliminating level segments on departure and arrival
  - Effects of shorter routes (either in time or distance)
  - Effects of cruising at different altitudes
  - Effects of reduced taxi times





What IFSET does not

The tool does not replace detailed modelling or measurement of fuel consumption already available in a State or from an international organisation (e.g. AEM - EUROCONTROL)






How does IFSET work

- Pre-computed aircraft performance
  - Level, climb and descent fuel consumption
  - By group of aircraft type
  - In 1000 foot intervals
- Detailed scenario input
  - Fleet mix defined for baseline and post-implementation scenario Aircraft type (generic or specific [under discussion])
  - “Remaining flight distance” (as a surrogate for weight)
  - User selects “elements” to define the baseline and “new” procedure
- Evaluation by comparing scenarios
  - Tool estimates the change in total fuel consumption between the 2 scenarios






IFSET quantitative benefits

- IFSET (ICAO Fuel Savings Estimation Tool) should be used to determine actual savings in fuel and resultant reduction in GHG emissions. IFSET should be made available to States for the purposes of estimating changes in fuel consumption from the implementation of operational measures and obtaining State feedback.

- Aircraft engine emissions are directly related to fuel burn. Each kilogram of fuel saved reduces carbon dioxide (CO2) emissions by 3.16 kg

- Quantitative benefits examples per flight (estimates only - using rule of thumb)
  - Shorter routes: flight time saved 4min, fuel 200 kg, 600 kg of C02
  - Improved flight profiles: time saved 0 min but higher/better altitude, fuel 20 kg, 60 kg of C02
  - Better approach procedures: time saved 3 min, fuel 150kg, 450 kg of C02
  - Improved aerodrome operations: time saved while taxiing 2 min, fuel 30 kg, 100 kg of C02

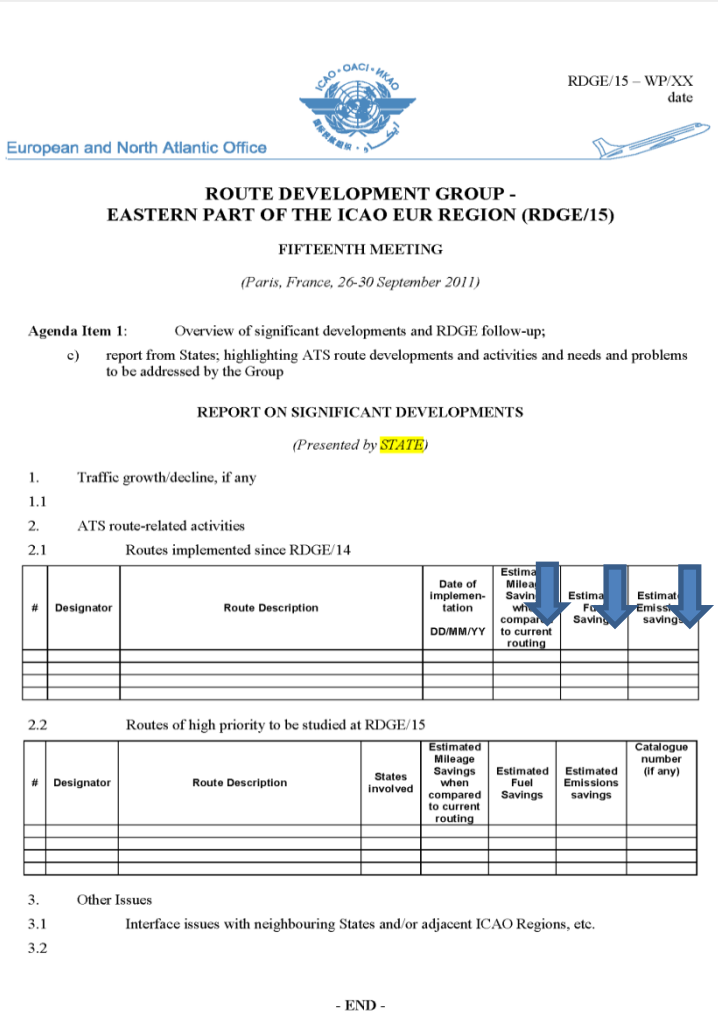





IFSET and ATS Route development

- States are requested to insert at least the indication of the route length difference of the new proposals when compared to the initial route length into the State reports, so that the savings in terms of mileage, flight time, fuel and CO2 emissions could be further analysed by using IFSET

- RDGE confirmed again the importance of such information on the savings which would reflect the efforts made by the whole aviation industry in reducing fuel consumption, flight time, mileage and its impact on the environment (CO2 emissions) and States agreed to submit the information about the implemented ATS Routes to the RDGE meetings



RDGE/15 – WP/XX
date

European and North Atlantic Office

ROUTE DEVELOPMENT GROUP -
EASTERN PART OF THE ICAO EUR REGION (RDGE/15)

FIFTEENTH MEETING

(Paris, France, 26-30 September 2011)

Agenda Item 1: Overview of significant developments and RDGE follow-up;

c) report from States; highlighting ATS route developments and activities and needs and problems to be addressed by the Group

REPORT ON SIGNIFICANT DEVELOPMENTS

(Presented by STATE)

1. Traffic growth/decline, if any

1.1

2. ATS route-related activities

2.1 Routes implemented since RDGE/14

#	Designator	Route Description	Date of implementation DD/MM/YY	Estimated Mileage Savings when compared to current routing	Estimated Fuel Savings	Estimated Emissions savings

2.2 Routes of high priority to be studied at RDGE/15

#	Designator	Route Description	States involved	Estimated Mileage Savings when compared to current routing	Estimated Fuel Savings	Estimated Emissions savings	Catalogue number (if any)

3. Other Issues

3.1 Interface issues with neighbouring States and/or adjacent ICAO Regions, etc.

3.2

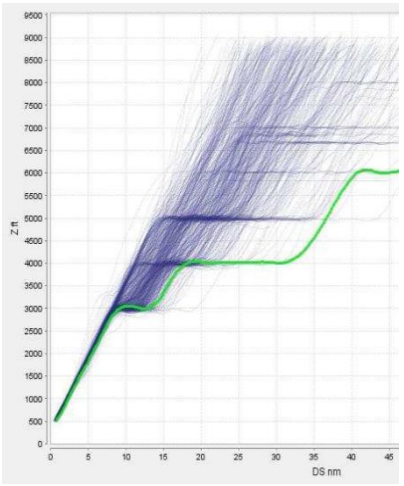
- END -

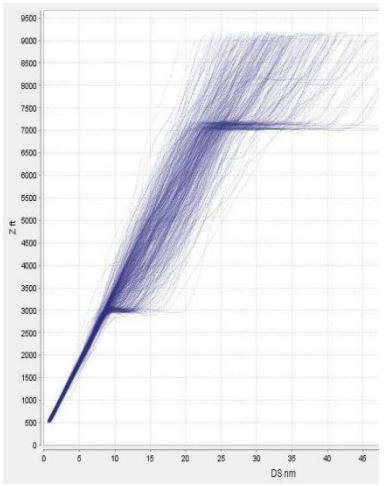


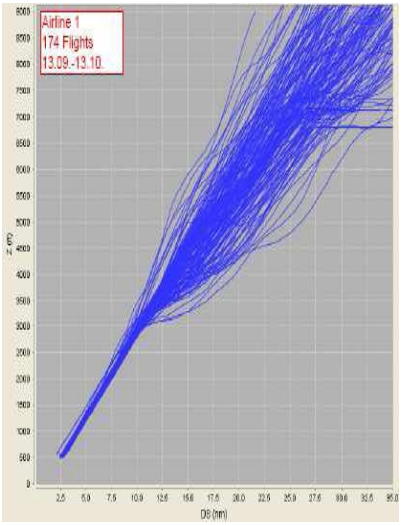


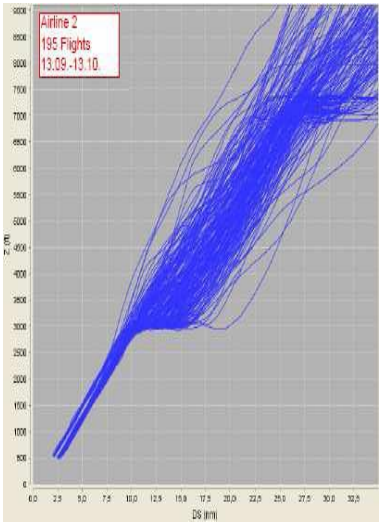

IFSET and Procedure Design

- The availability of the fuel savings and related CO2 reductions could be an additional benefit in the procedure design process when comparing various design options
- The IFSET information could also serve as an extra argumentation element in the actual implementation campaign indicating to all stakeholders the economic and emissions benefits of the new procedures
- After actual implementation the data can also be used to raise the awareness and familarisation aspects of the new procedures to pilots and controllers







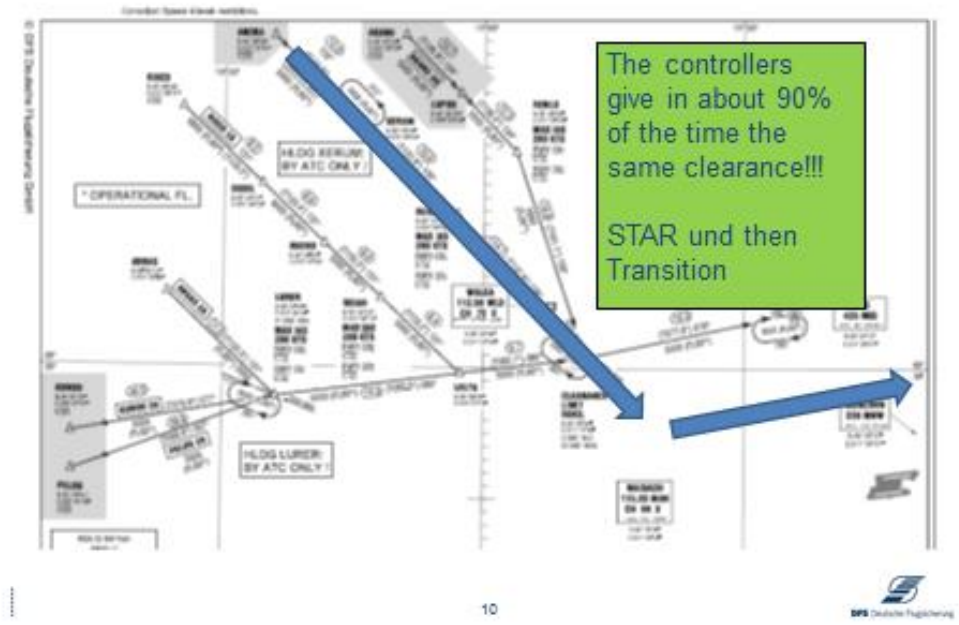


from DFS CDA EDDK presentation at EUROCONTROL

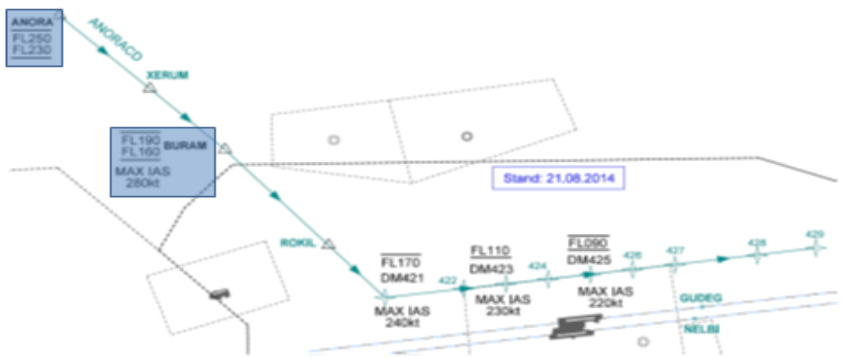
IFSET and CDOs

- Continuous Descend Approaches (CDA) in Munich, Germany

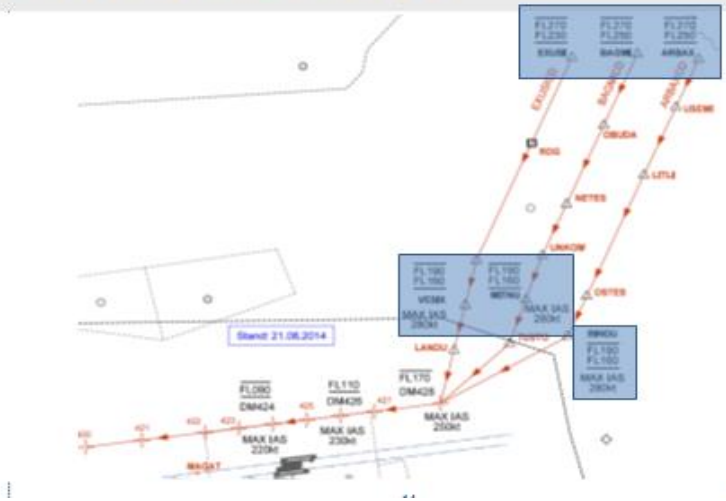
Daily business



ANORA CDO



EXUSI/BAGMI/ARBAX CDO



from DFS CDA EDDM presentation at EUROCONTROL





IFSET and CDOs

CDO – „keep it simple"

- To enable a high amount of CDOs with am fuel-efficient descend out of FL 270 down to FL 090 without reducing the overall capacity
- Basically independent from aircraft type (no Props)
- Runway dependent, only inbounds with a „long downwind"
- Optimized for the overall system – not optimized for every flight
- Avoidance of longer level flights in lower levels
- Benefit: small for each flight, big for the overall system
- Flight level constraints on the STAR:
  - Predictable for the ATC und Cockpit-Crew
  - Flexibility for different aircraft und different weights through „level windows"
  - Directs are always possible, the CDO will be continued at the next waypoint with constraint
  - Usable during „low and medium traffic load" even during the rush hour
- Automating common procedures

15

Simple structure

- **CDO starting points**
  - between FL 230 und 270, free speed
- **before TMA** below FL190, max. speed 280 KIAS
- **Turning to downwind**
  - between FL170 und FL110
  - Speed 230 KIAS
- **Short before abeam EDDM (DM456)**
  - at or above FL 110, Speed 230 KIAS
- **Short after abeam EDDM (DM454)**
  - at FL 90, Speed 220 KIAS (no more vertical guidance)
- **Continue to the last waypoint on the transition (DM450)**

16

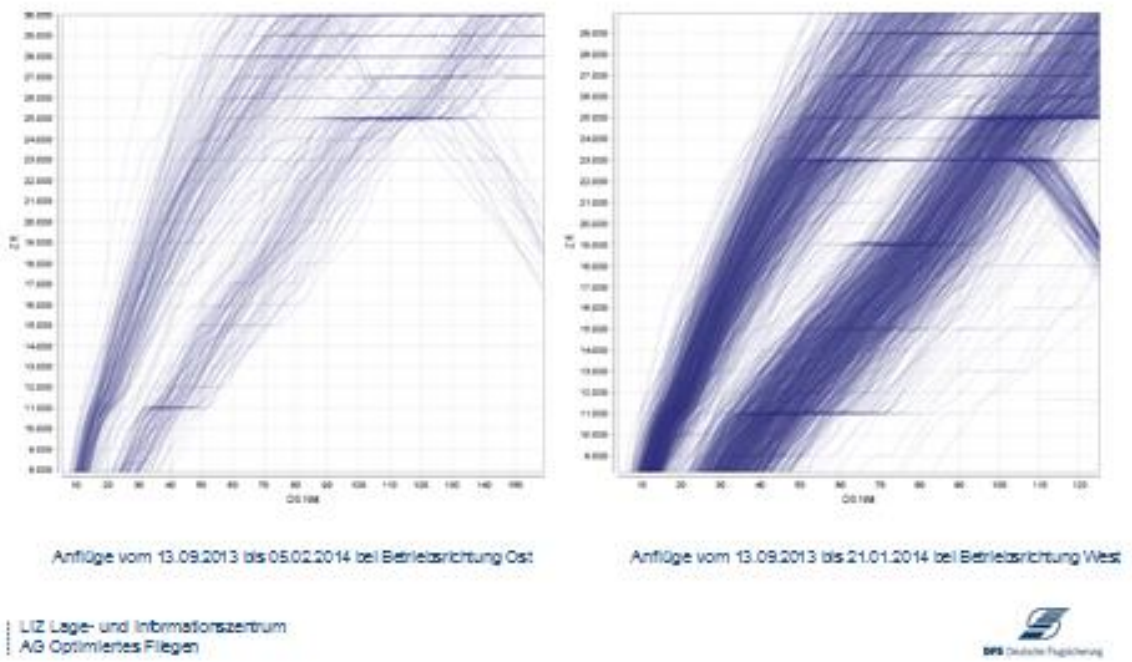
from DFS CDA EDDM presentation at EUROCONTROL





IFSET and CDOs

EDDM - Höhenprofile CDO



Result after 9 months of north CDOs

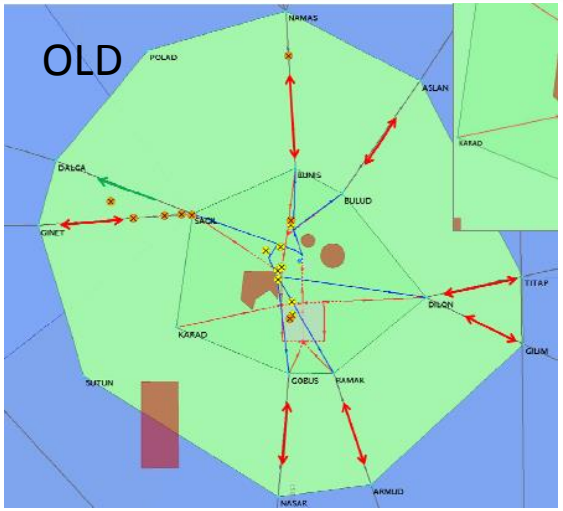
More than 7000 CDOs (> 53 % of possible traffic)

about 280 tons of fuel savings

from DFS CDA EDDM presentation at EUROCONTROL

IFSET and Airspace Design

- Full airspace re-design and implementation of new RNAV SIDs & STARs (as CCOs and CDOs) resulted not only in an increase of safety (less conflicts) but also in fuel savings and related CO2 reductions
- The IFSET simulations included the ATS route length reduction, the possibility to fly on appropriate FLs/Altitudes and the use of optimized flight profiles (more efficient APP/DEP procedures)
- After the actual implementation in Baku FIR in March 2014 the theoretical benefits were compared to the actual operational benefits from the aircraft operators flying in/out of Baku and the initial trends were confirmed after 6 months



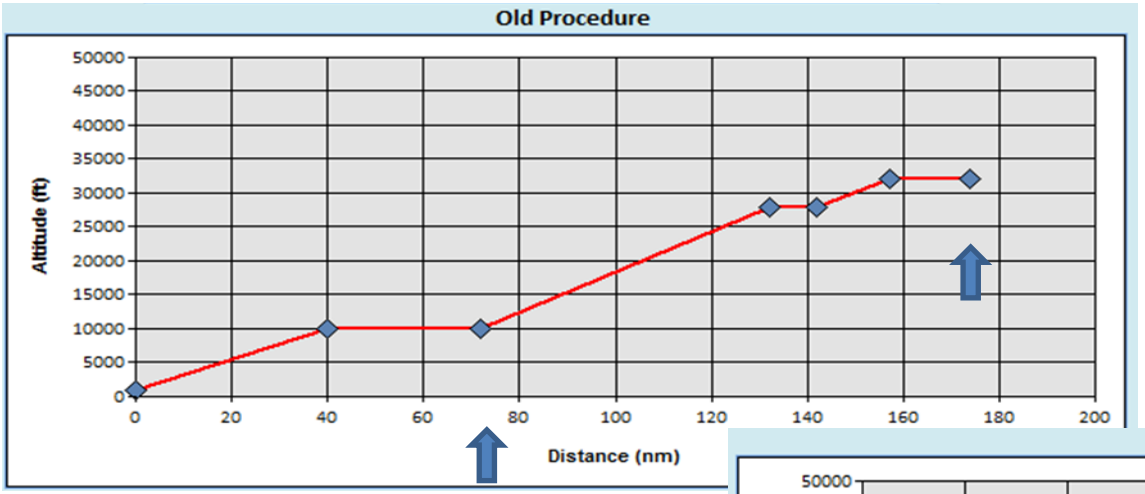
from AZANS presentation at ATMGE19 in 2014

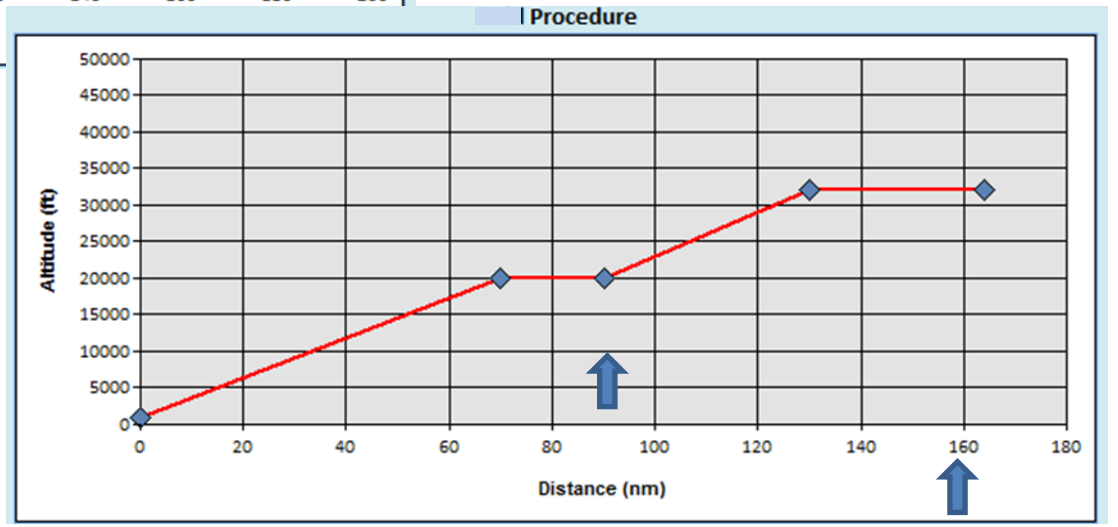





IFSET and Airspace Design

- Example of a CDO





from AZANS presentation at ATMGE19 in 2014

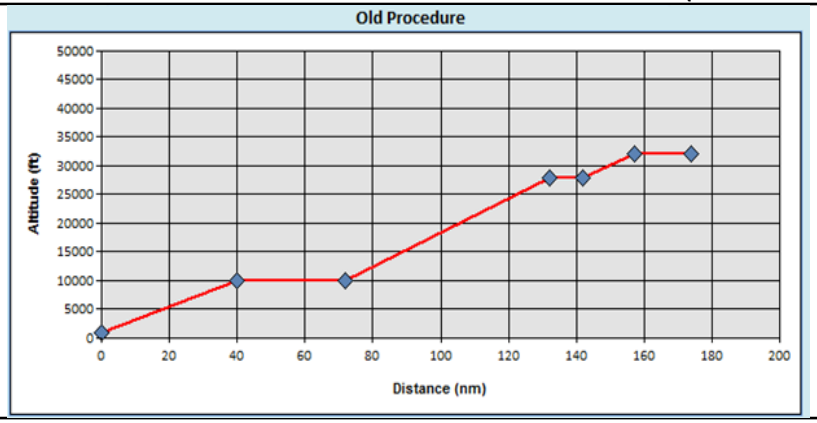


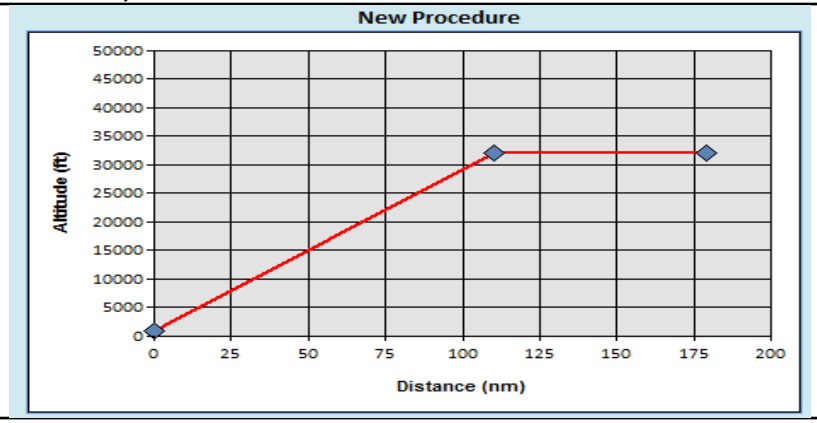



IFSET and Airspace Design

- Example of a CCO

ADEKI DEPARTURE RW 16/18
SCENARIO 1
A/C NUMBER 383
(GYD-SAGIL- ADEKI)





TRACK MILES	
174,4 NM	162NM
Wastage	Saving
-	12,4 NM
FUEL	
233800 KG	195600 KG
Wastage	Saving
-	38200 KG (16,3 %)

from AZANS presentation at ATMGE19 in 2014






IFSET and Airspace Design

- Departures

Scenario	Old Fuel Consumption in Kg	New Fuel Consumption in Kg	Savings in Kg	Savings(%)	AC
ADEKI DEP 16	233800	195600	-38200	-16,3	96
ADEKI DEP 16 SC-2	808700	782300	-26400	-3,3	383
ADEKI DEP 36	538100	435400	-102700	-19,1	224
ADEKI DEP 36 SC2	1855100	1739500	-115600	-6,2	894
BALUN DEP 16	97800	99000	1200	1,2	54
BALUN DEP 34	211400	215000	3600	1,7	126
BUMAR DEP 16	263900	276100	12200	4,6	143
BUMAR DEP 36	585600	545200	-40400	-6,9	333
DUKAN DEP 16	95000	91600	-3400	-3,6	70
DUKAN DEP 34	231300	238800	7500	3,2	162
GASBI DEP 16	168200	170600	2400	1,4	90
GASBI DEP 34	382500	353700	-28800	-7,5	210
LALDA DEP 16	115800	107000	-8800	-7,6	61
LALDA DEP 34	276000	283000	7000	2,5	141
MEKAN DEP 16	247300	257200	9900	4,0	134
MEKAN DEP 36	577600	514300	-63300	-11,0	313
PEMAN DEP 16 SC1	96400	76400	-20000	-20,7	79
PEMAN DEP 16 SC2	316000	305800	-10200	-3,2	318
PEMAN DEP 36 SC-1	224100	177000	-47100	-21,0	34
PEMAN DEP 36 SC-2	725300	701500	-23800	-3,3	136
RODAR DEP 16	119800	119100	-700	-0,6	91
RODAR DEP 34	308100	293300	-14800	-4,8	214
ULDUS DEP 16	243300	228900	-14400	-5,9	120
ULDUS DEP 34	587900	592100	4200	0,7	281
			-510600		

from AZANS presentation at ATMGE19 in 2014






IFSET and Airspace Design

- Arrivals

Scenario	Old Fuel Consumption in Kg	New Fuel Consumption in Kg	Savings in Kg	Savings(%)	AC
BALUN ARR 16	18800	19800	1000	5,3	56
BALUN ARR 36	43500	59700	16200	37,2	130
BARAD ARR-16	77300	65700	-11600	-15,0	79
BARAD ARR 16 SC2	274000	260300	-13700	-5,0	318
BARAD ARR 34	184700	153400	-31300	-16,9	185
BARAD ARR 34 SC2	688500	614400	-74100	-10,8	741
BUMAR ARR 16	44900	36300	-8600	-19,2	140
BUMAR ARR 36	149500	172800	23300	15,6	328
DUKAN ARR 16	58400	49300	-9100	-15,6	149
DUKAN ARR 36	102900	88700	-14200	-13,8	347
GASBI ARR 16	31300	23800	-7500	-24,0	91
GASBI ARR 36	96900	95900	-1000	-1,0	211
LALDA ARR 16	42400	35600	-6800	-16,0	60
LALDA ARR 34	60100	53200	-6900	-11,5	139
MEKAN ARR 16	39800	34400	-5400	-13,6	130
MEKAN ARR 36	137200	155100	17900	13,0	305
PEMAN ARR 34 SC1	69100	59600	-9500	-13,7	70
PEMAN ARR 34 SC-2	251200	248800	-2400	-1,0	282
PEMAN ARR 16 SC-1	26100	24700	-1400	-5,4	30
PEMAN ARR 16 SC-2	95900	94500	-1400	-1,5	121
RODAR ARR 16	33800	20800	-13000	-38,5	98
RODAR ARR 36	59000	56200	-2800	-4,7	227
ULDUS ARR 16	91500	75100	-16400	-17,9	130
ULDUS ARR 36	143900	132400	-11500	-8,0	302
			-190200		

from AZANS presentation at ATMGE19 in 2014






IFSET and Airspace Design

Final	
Departure	- 510600 kg
Arrival	- 190200 kg
Total	- 700800 kg

from AZANS presentation at ATMGE19 in 2014





IFSET and ATM Performance

- IFSET could also be used to address the deviation from the most efficient flight path (in this example based on the route length for the flight from EDDM to LTAI in the green line)
- The inefficiency of the ATM system operations (actual route lengths for the same city pairs in the red line) could be measured in terms of additional fuel burn and extra CO2 emissions
- Small improvements in the flight efficiency of ATM system operations (various route proposals for the same city pairs in the blue lines) could also be accompanied with estimates in fuel consumption reduction and their related environmental (CO2 emissions) benefits

from EUROCONTROL`s 50 MPCPE evaluation, as presented in RNDSG/74






IFSET Implementation

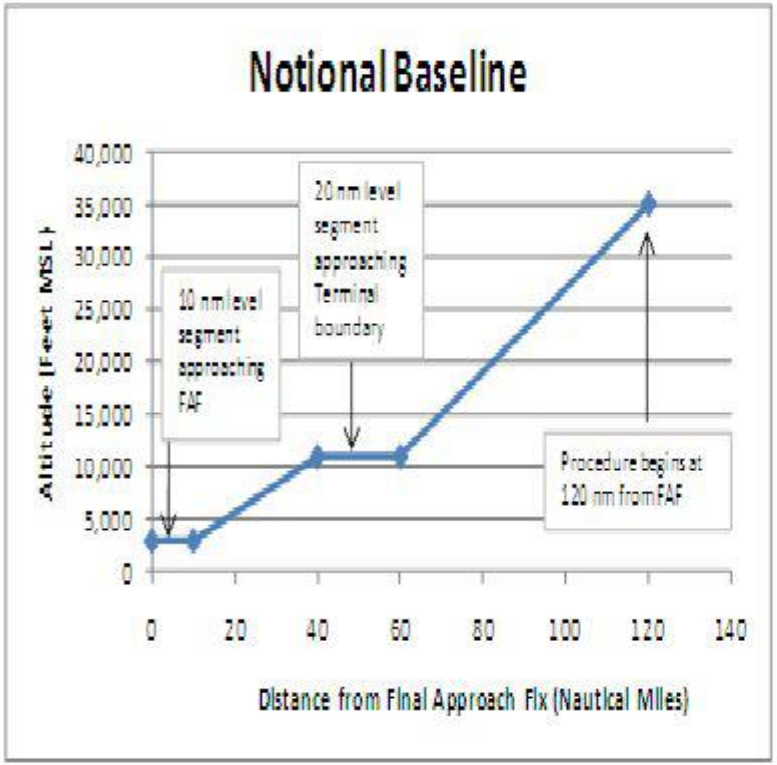
- KPA
- ASSEMBLY RESOLUTIONS
- IFSET (State Letter, AN 13/61-12/4)

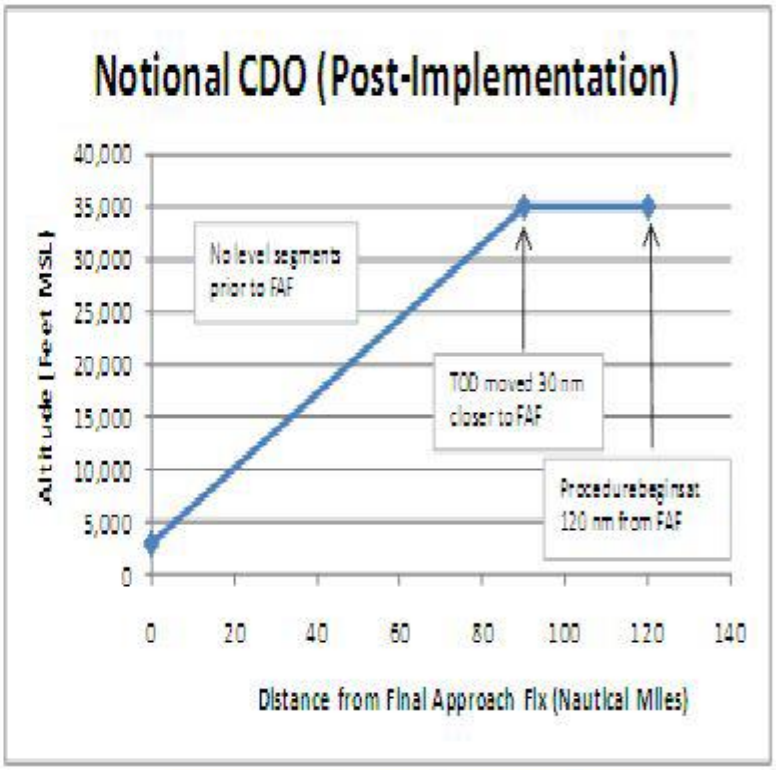
  It is critical that a harmonized implementation of a fuel saving estimation process is used to support a coordinated global effort towards reduction of the aviation impact on climate change; therefore ICAO has developed the ICAO Fuel Savings Estimation Tool (IFSET)
- Regional Performance Framework
- ENV working papers with conclusions endorsed at PIRG level (EANPG, NATSPG, etc.)





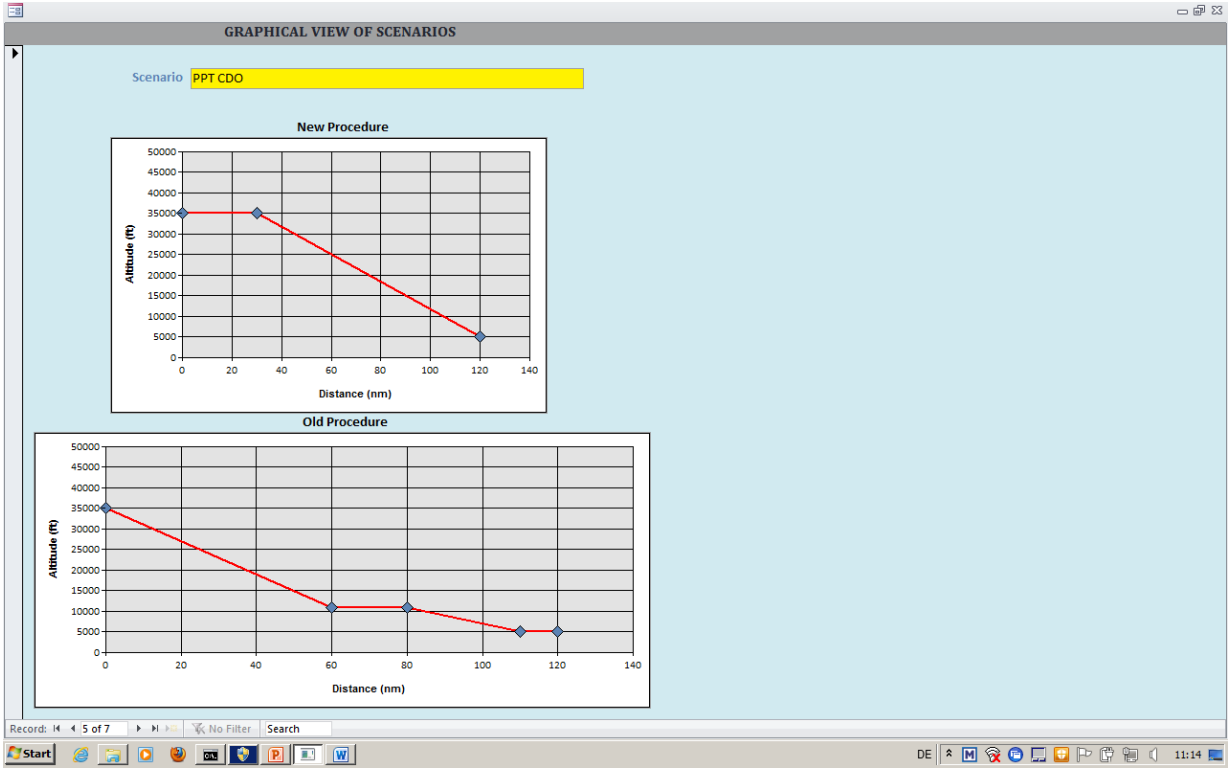

IFSET example





- Fleet Mix
  - Single aisle
  - Twin aisle
  - Commuter
- Procedure mix “distance remaining”

IFSET example



- Fleet mix
  - 100 large single aisle jets
  - 70 single aisle jets
  - 20 turboprop
  - 10 large business jets
- Aircraft mix "distance remaining" between 740 and 2120 NM
- Procedure mix with CDO starting 30 NM later

Estimated Fuel Savings Report

- ✓ Old fuel consumption 87400 kg
- ✓ New fuel consumption 61200 kg
- ✓ Savings 26200 kg fuel and 82792 kg CO2 emissions





ICAO COG Performance TF

KPA	OBJECTIVES	FOCUS AREAS	INDICATORS
SAFETY	Ensure safety continuous improvement through reduction of ATM related safety occurrences and implementation of uniform safety standards		Effectiveness of Safety Management (Safety Maturity Survey)
			Level of State Safety/Just culture (Safety Culture Survey)
			Adoption of an harmonized occurrences severity classification system (methodology)
CAPACITY	Capacity meets demand	En-route ATFM Delay	Average en-route ATFM delay generated by airspace volume
		Airport ATFM Delay	Average ATFM delay per flight in the main airports
EFFICIENCY	Ensure users may use most efficient routes	Flight Efficiency	Average horizontal en route flight efficiency (length of the en route part of the actual trajectory/last flight planned route vs great circle
ENVIRONMENT	Contribute to the protection of environment (fuel/CO2 emissions reduction)		CO2 emissions related to inefficiencies in route extension
COST EFFECTIVENESS	Contribute to optimization of costs for ANS	ATCO Productivity	IFR Flights and flight hours per ATCO hour on duty
PARTICIPATION BY ATM COMMUNITY	Ensure States' participation to Regional planning activities		Level of participation of States to Regional planning activities



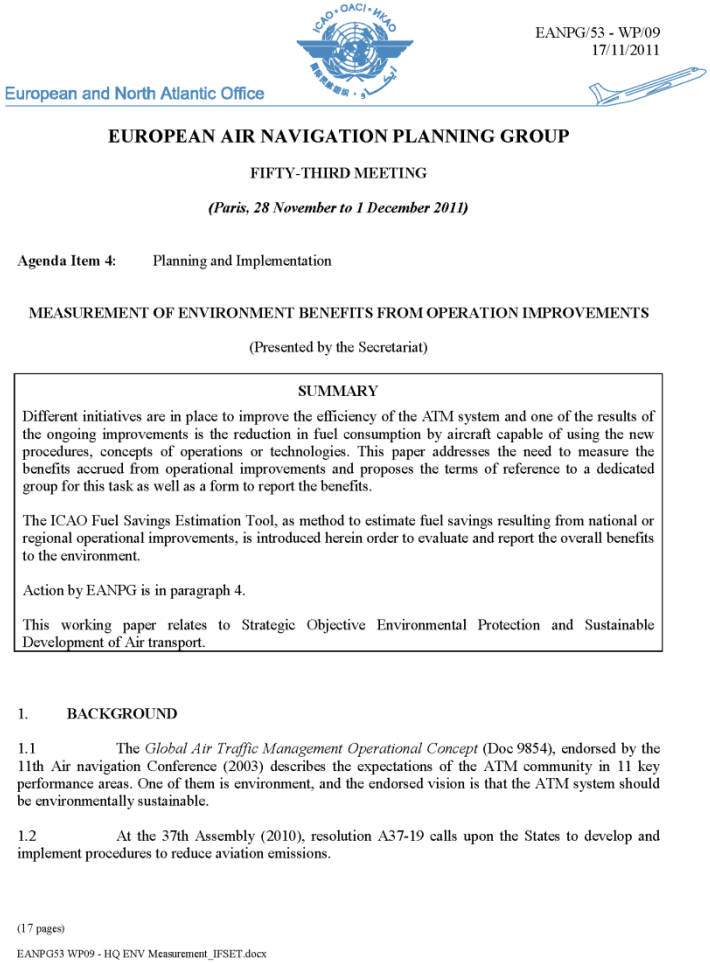



EANPG Conclusion

- EANPG/53 Conclusion 34
  - **Measuring and reporting of environmental benefits from operational improvements**

That ICAO Regional Director, Europe and North Atlantic, invite:

- States to consider that all plans to implement operational improvements to be encompassed by an environment benefits analysis;
- States to use IFSET or a more advanced model/measurement capability available to estimate environment benefits accrued from operational improvements; and
- The COG Performance Task Force to investigate on how the IFSET or a more advanced model/measurement capability available be better used so as to meet the ICAO global reporting requirements on the environmental benefits from operational improvements.



European and North Atlantic Office

EANPG/53 - WP/09
17/11/2011

EUROPEAN AIR NAVIGATION PLANNING GROUP

FIFTY-THIRD MEETING

(Paris, 28 November to 1 December 2011)

Agenda Item 4: Planning and Implementation

MEASUREMENT OF ENVIRONMENT BENEFITS FROM OPERATION IMPROVEMENTS

(Presented by the Secretariat)

SUMMARY

Different initiatives are in place to improve the efficiency of the ATM system and one of the results of the ongoing improvements is the reduction in fuel consumption by aircraft capable of using the new procedures, concepts of operations or technologies. This paper addresses the need to measure the benefits accrued from operational improvements and proposes the terms of reference to a dedicated group for this task as well as a form to report the benefits.

The ICAO Fuel Savings Estimation Tool, as method to estimate fuel savings resulting from national or regional operational improvements, is introduced herein order to evaluate and report the overall benefits to the environment.

Action by EANPG is in paragraph 4.

This working paper relates to Strategic Objective Environmental Protection and Sustainable Development of Air transport.

1. **BACKGROUND**

1.1 The *Global Air Traffic Management Operational Concept* (Doc 9854), endorsed by the 11th Air navigation Conference (2003) describes the expectations of the ATM community in 11 key performance areas. One of them is environment, and the endorsed vision is that the ATM system should be environmentally sustainable.

1.2 At the 37th Assembly (2010), resolution A37-19 calls upon the States to develop and implement procedures to reduce aviation emissions.

(17 pages)

EANPG53 WP09 - HQ ENV Measurement_IFSET.docx






THANK YOU


North American Central American and Caribbean (NACC) Office MexicoCity
South American (SAM) Office Lima
ICAO Headquarters Montreal
Western and Central African (WACAF) Office Dakar
European and North Atlantic (EUR/NAT) Office Paris
Middle East (MID) Office Cairo
Eastern and Southern African (ESAF) Office Nairobi
Asia and Pacific (APAC) Office Bangkok