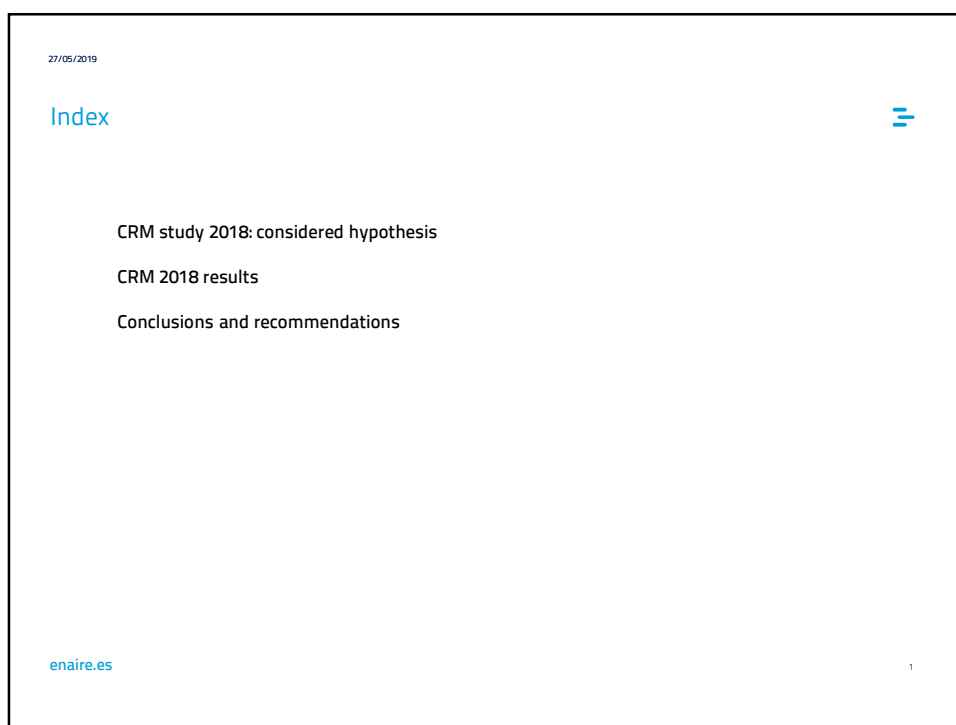
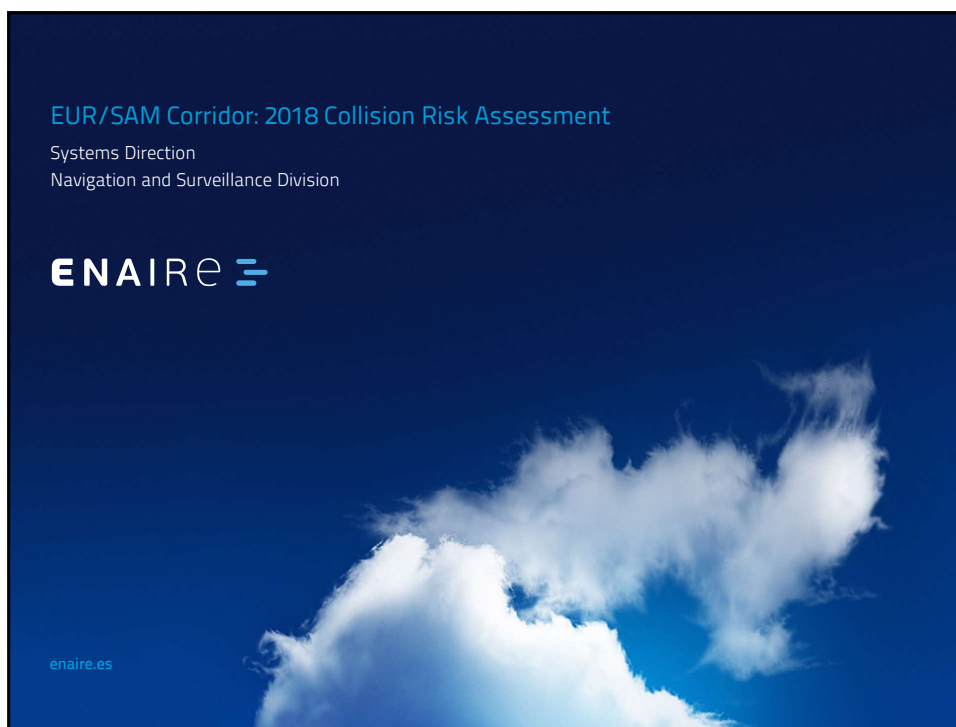




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Considered hypothesis



- For time flight during 2018, Canaries has been used as a reference.
- Only deviations in nominal routes or incorporating to nominal routes have been considered.
- Only crossing routes with four or more flights per month have been considered.
- Whenever time information in deviations is not known, **five minutes** has been considered.
- P_z obtained from Eurocontrol information: $P_z(1000)=9.647 \cdot 10^{-13}$
- Traffic growth hypothesis from STATFOR information (February 2019): 3,3%

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Considered hypothesis. Not published crossing routes. Canaries and SAL. Direct routes

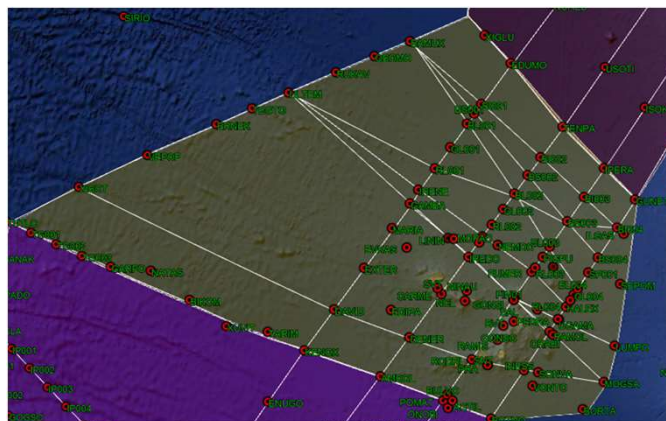


Canaries

- NORED-ETIBA

SAL

- BAMUX-LUMPO
- BAMUX-ILGAS
- ULTEM-ILGAS
- ULTEM-LUMPO
- BAMUX-SEPOM
- XIBOT-MOGSA



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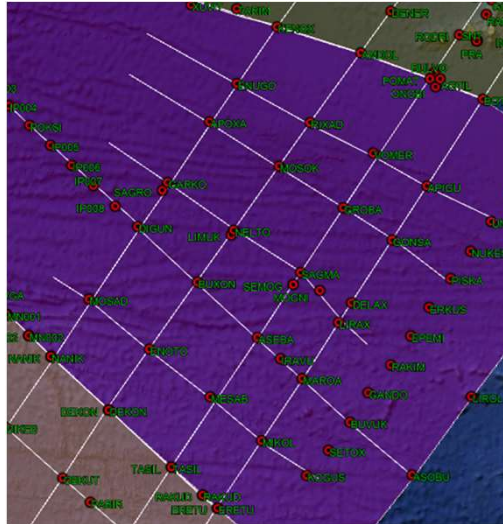
Considered hypothesis. Not published crossing routes. Dakar. Direct routes



Dakar

- ENUGO-APIGU
- APOXA-GONSA
- GARKO-LIRAX
- MOSAD-MIKOL

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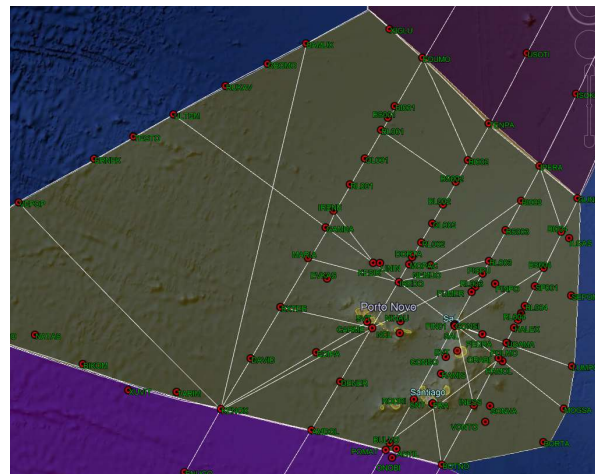
Considered hypothesis. Not published crossing routes. SAL.



SAL

- | | |
|---------------|---------------|
| • EDUMO-BI002 | • MARIA-IREDO |
| • BL002-CVS | • BOTNO-SNT |
| • NEMDO-BI003 | • EXTER-CARME |
| • BL003-IREDO | • BAMUX-KENOX |
| • IPERA-BI004 | • VEPOP-KENOX |
| • PISPU-CARME | • CARME-KENOX |
| • CVS-BS004 | • SVT-KENOX |
| • IRENE-KESIK | • ORABI-BULVO |
| • CVS-UGAMA | • CVS-INESS |
| • BL001-BS002 | |

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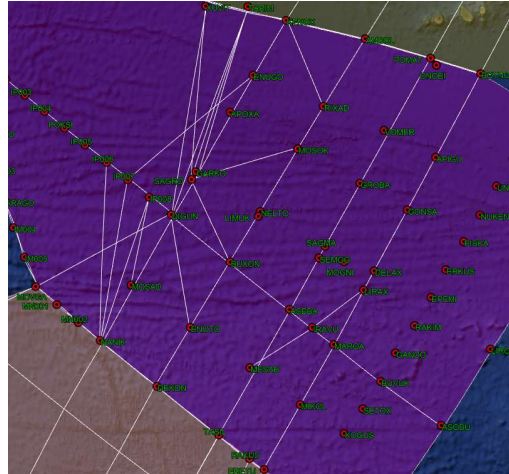
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Considered hypothesis. Not published crossing routes. Dakar.



Dakar

- XUVIT-DIGUN
- TARIM-DIGUN
- TARIM-GARKO
- TARIM-SAGRO
- KENOX-RIXAD
- SAGRO-MOSOK
- LIRAX-IRAVU
- SAGRO-BUXON
- XUVIT-SAGRO
- IP006-NANIK
- IP007-NANIK
- IP008-NANIK
- IP008-MOSAD
- ENUGO-IP007
- DIGUN-MOVGA
- ENOTO-DIGUN
- IRAVU-MESAB



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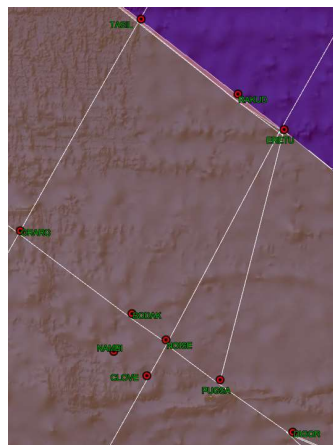
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Considered hypothesis. Not published crossing routes. Recife.



Recife

- ERETU-PUGSA



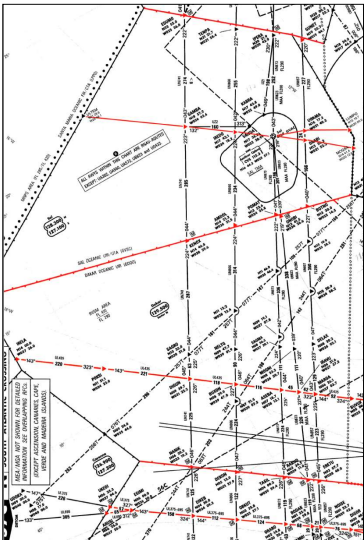
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2018 CRM results. Evaluation points

- Canaries: FIR/UIR limit
- SAL1: UR-976/UA-602
- SAL2: UIR SAL Oceanic/UIR Dakar Oceanic
- Dakar1: UL-435
- Dakar2: UIR Dakar Oceanic/Atlantic FIR
- Recife: UL-375/UL-695

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CANARIES

SAL1

SAL2

DAKAR1

DAKAR2

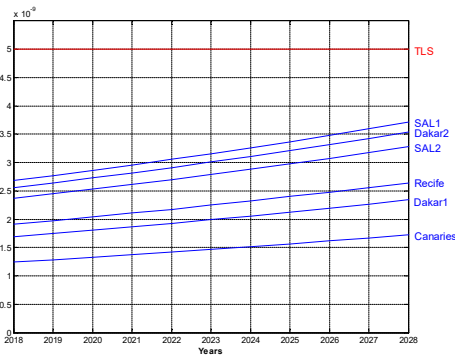
RECIFE

2018 CRM results. Lateral risk

- It models the lateral collision risk due to the separation loss between parallel routes at the same flight level.
- $TLS=5 \times 10^{-9}$



FIR	Lateral Collision Risk 2018	Lateral Collision Risk 2028
Canaries	1.2461×10^{-9}	1.7240×10^{-9}
SAL1	2.6845×10^{-9}	3.7142×10^{-9}
SAL2	2.3702×10^{-9}	3.2794×10^{-9}
Dakar1	1.6920×10^{-9}	2.3410×10^{-9}
Dakar2	2.5580×10^{-9}	3.5392×10^{-9}
Recife	1.9113×10^{-9}	2.6444×10^{-9}



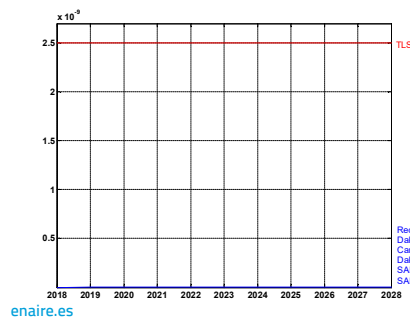
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2018 CRM results. Vertical technical risk

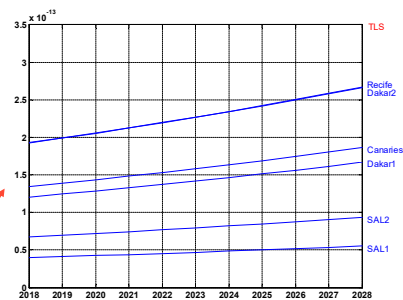
- Vertical risk: technical vertical risk + operational risk
 - Vertical technical risk models the risk due to vertical separation loss between aircraft at adjacent flight levels due to normal deviations
 - Operational risk models risk due to large height deviations (LHDs)

• TLS

- Vertical technical risk: $TLS = 2.5 \cdot 10^{-9}$
- Total vertical risk: $TLS = 5 \cdot 10^{-9}$



FIR	Technical Collision Risk 2018	Technical Collision Risk 2028
Canaries	$1.3458 \cdot 10^{-13}$	$1.8620 \cdot 10^{-13}$
SAL1	$3.9851 \cdot 10^{-14}$	$5.5136 \cdot 10^{-14}$
SAL2	$6.7553 \cdot 10^{-14}$	$9.3464 \cdot 10^{-14}$
Dakar1	$1.2056 \cdot 10^{-13}$	$1.6681 \cdot 10^{-13}$
Dakar2	$1.9260 \cdot 10^{-13}$	$2.6648 \cdot 10^{-13}$
Recife	$1.9301 \cdot 10^{-13}$	$2.6704 \cdot 10^{-13}$



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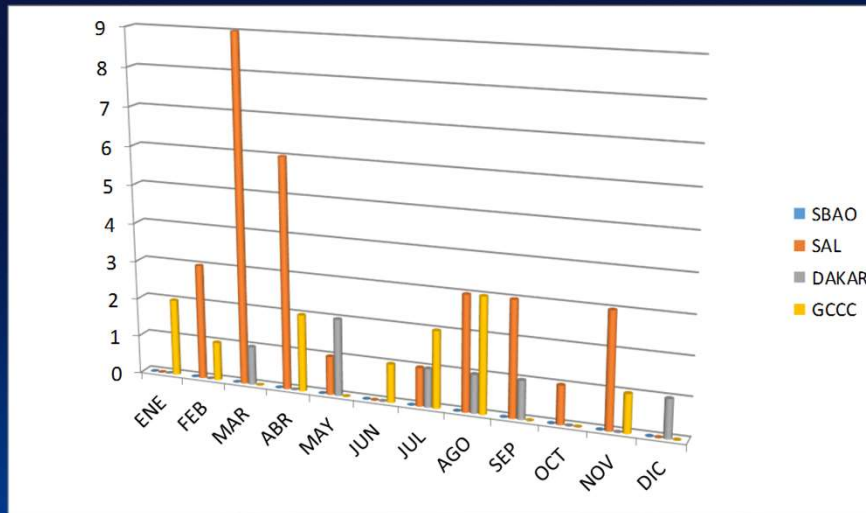
2018 CRM results. Vertical operational risk

- Operational risk includes:
 - Risk due to aircraft climbing or descending a flight level
 - Risk due to an aircraft at a wrong flight level
 - Large height deviations not involving whole numbers of flight levels
- Depends on the reported LHD by the States
- All LHDs are due to coordination errors between ATC units:
 - No transfer notified
 - Transfer at an unexpected flight level
- All reported deviations in Recife were not related to the corridor

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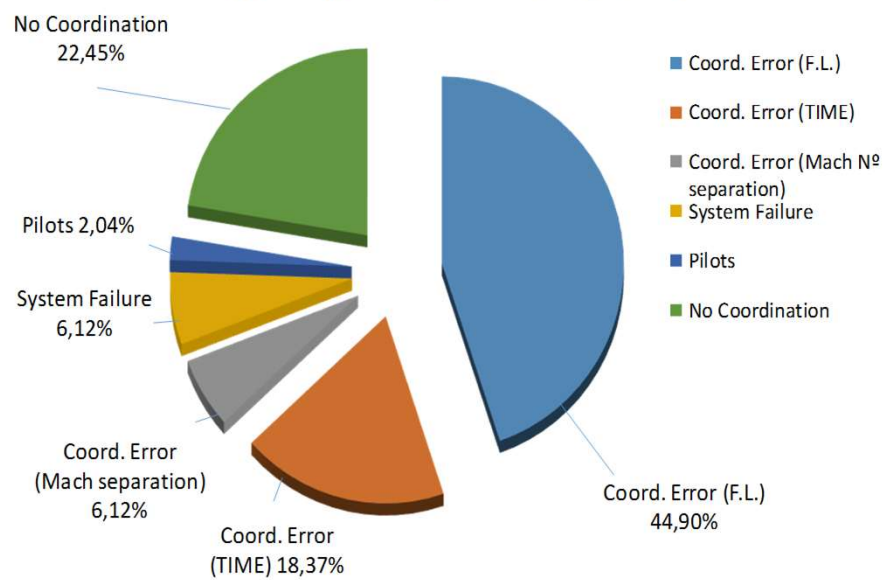
Number of LHD's reported

TOTAL LHD'S : 49

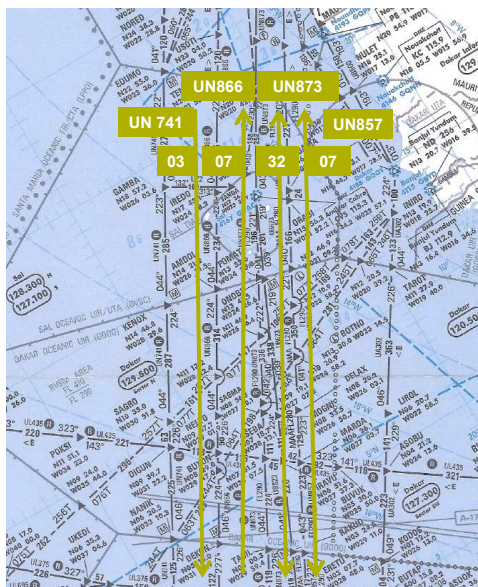


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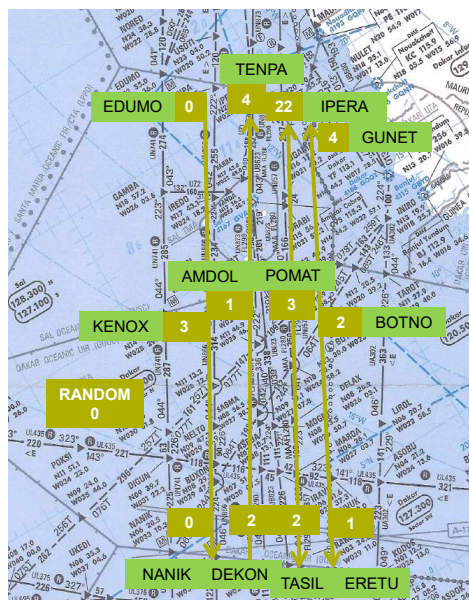
Percentage of LHD'S Contributing Factors



Distribution of LHD's per ATS route



Distribution of LHD per Fix Point

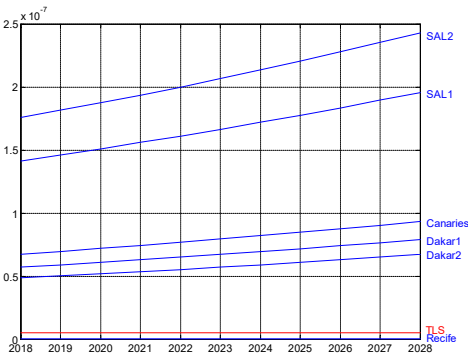


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CRM 2018 results. Total vertical risk



FIR	Overall vertical Collision Risk 2018	Overall vertical Collision Risk 2028
Canaries	6.7431×10^{-8}	9.3296×10^{-8}
SAL1	1.4141×10^{-7}	1.9565×10^{-7}
SAL2	1.7560×10^{-7}	2.4296×10^{-7}
Dakar1	5.7046×10^{-8}	7.8928×10^{-8}
Dakar2	4.8489×10^{-8}	6.7088×10^{-8}
Recife	1.9301×10^{-13}	2.6704×10^{-13}



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Conclusions and recommendations



- Lateral risk and vertical technical risk have values below TLS.
- Vertical operational risk is above TLS (except in Recife), as it includes LHDs contribution.
- Main LHDs source is identified: coordination error between ATC units. Correction measures should be applied.
- Accuracy and reliability if the studies depend on the availability and accuracy of data: more accurate information should be made available, both for traffic measures and LHDs.

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