ADS-B Implementation Workshop

SESAR DEPLOYMENT MANAGER

18th October 2022

sesar DEPLOYMENT MANAGER

Practicals & Agenda

Jan Stibor & Predrag Vranjkovic
SDM

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DEPLOYMENT MANAGER

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Practicals online participants

- For the most optimal user experience during this streamlined event, please use **Google Chrome, Firefox or Safari** to connect (Edge is not supported). Otherwise, you may not be able to hear the sound of the event.
- The **chat and Q&A are moderated to ensure relevance for all participants** during the event.
- **Please use the chat to send in your questions** for the dedicated Q&A sessions. Questions that aren't answered during this event will be handled afterwards.
- For **technical issues**, use the chat or email us at communication@sesardeploymentmanager.eu

Practicals live participants

- If you have any questions, you can raise them during the **dedicated Q&A slots** using your microphone.
- The Event is **recorded and will be shared** with all participants in the coming days.

Agenda

• **14:00 – 14:10**	**Opening Remarks**	Erich Klock - SDM
• **14:10 – 14:25**	**SPI IR: ADS-B in the regulatory perspective**	Bryan Jolly - EASA
• **14:25 – 14:40**	**Implementation Status**	Johan Martensson/Jan Stibor - SDM
• **14:40 – 14:50**	**Airspace Users perspective**	Laurent Puzenat - Air France, Thomas Körber - Lufthansa
• 14:50 – 15:05	**Military perspective in ADS-B implementation**	Vicente Cristóbal de Frutos - EDA
• ***15:05 – 15:15***	***Q&A***	
• **15:15 – *15:25***	Break	
• **15:25 – 15:40**	**ADS-B in Sweden**	Anders Andersson - LFV
• **15:40 – 15:55**	**NAV Portugal Experience in ADS-B Implementation**	Andre Maia/ Paulo Raposo - NAV Portugal
• ***15:55 – 16:10***	***Q&A***	
• **16:10 – 16:25**	**FAA ADS-B Overview: Current and Future Status**	Alex Rodriguez - FAA
• **16:25 – 16:40**	**ADS-B Integration in Austro Control**	Robert Guttman - AustroControl
• **16:40 – 16:55**	**DFS ADS-B Implementation Program**	Stefan Stanzel - DFS
• ***16:55 – 17:10***	***Q&A***	
• **17:10 – 17:15**	**Closing Remarks**	Cristian Pradera - SDM

Opening Remarks

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Erich Klock

Head of Strategy and Technical Execution

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SESAR Deployment Manager – the new set up

SESAR DEPLOYMENT MANAGER

A NEW CONSORTIUM THAT BRINGS TOGETHER THE MAJOR ATM ACTORS

Airlines

AIRFRANCE
business by easyJet
LUFTHANSA GROUP
RYANAIR

Air Navigation Service Providers

austro CONTROL
CROATIA CONTROL
dgac DSNA
DFS Deutsche Flugsicherung
ENAIRE
enav
HungaroControl Hungarian Air Navigation Services
IAA
LFV AIR NAVIGATION SERVICES OF SWEDEN
NAVIAIR
NAV PORTUGAL
PANSA Polish Air Navigation Services Agency
romatsa
skyguide

Airports

ACI EUROPE AIRPORTS COUNCIL INTERNATIONAL
ACI EUROPE AIRPORT GROUPING

ECTL NM

EUROCONTROL

"MODERNISING AIR TRAFFIC MANAGEMENT AS ONE"

SESAR Deployment Manager membership – an unparalleled reach

4 Airline groups

covering 3 million flights with
around 500 million passengers per year
(one third of the overall European passengers)

Airports through ACI Europe

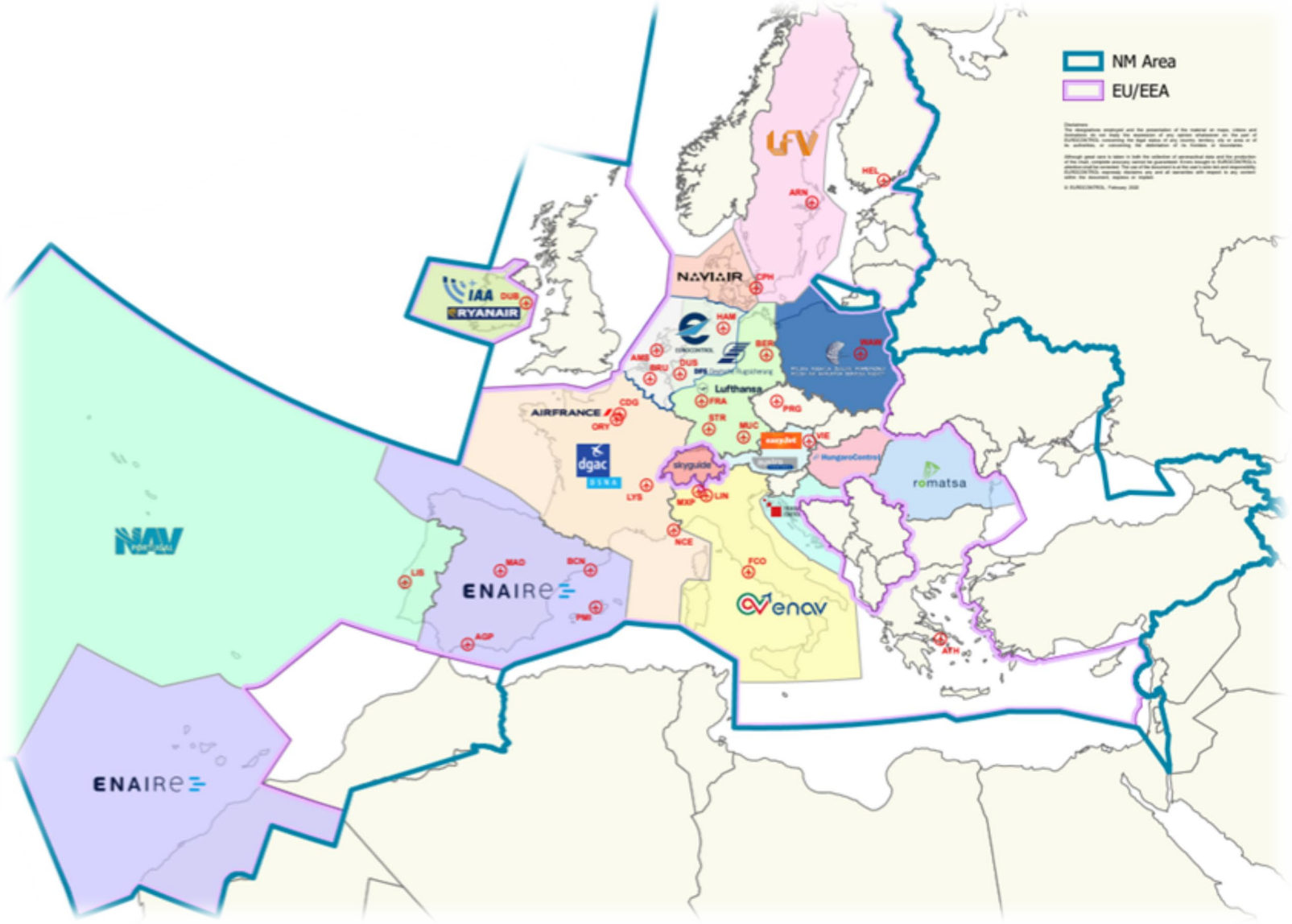
over 530 airports in 55 countries
all 28 airports included in CP1
all type of operational environments
unique standpoint on passengers' experience

14 ANSPs

controlling around 80% of traffic in the EU
around 8 million flights per year
managing all major traffic flows
operated in Europe

ECTL NM (Consortium Coordinator)

best placed to provide the Network view
unique technical and operational expertise
a strong institutional partner



ADS-B programme – the overall view

Previous SDM mandate holder run a successful ADS-B programme

Workshop goal: to disseminate these results to stakeholder community

- *The ADS-B equipage for the mandated fleet is progressing in line with the requirements and airline plans - currently reaching over 90%.*
- *The ANSPs are improving the ADS-B surveillance coverage (WAM/ADS-B and SBA) but there is a room for acceleration given the increase in the aircraft equipage rates.*
- *In many areas, there are still challenges in terms of aircraft equipage (especially at lower altitudes) for non-mandated aircraft, airspace equipage requirements and in some areas interference, which constrains the surveillance infrastructure optimisation (and in few cases the integration).*

*The **CEF call** is an opportunity*

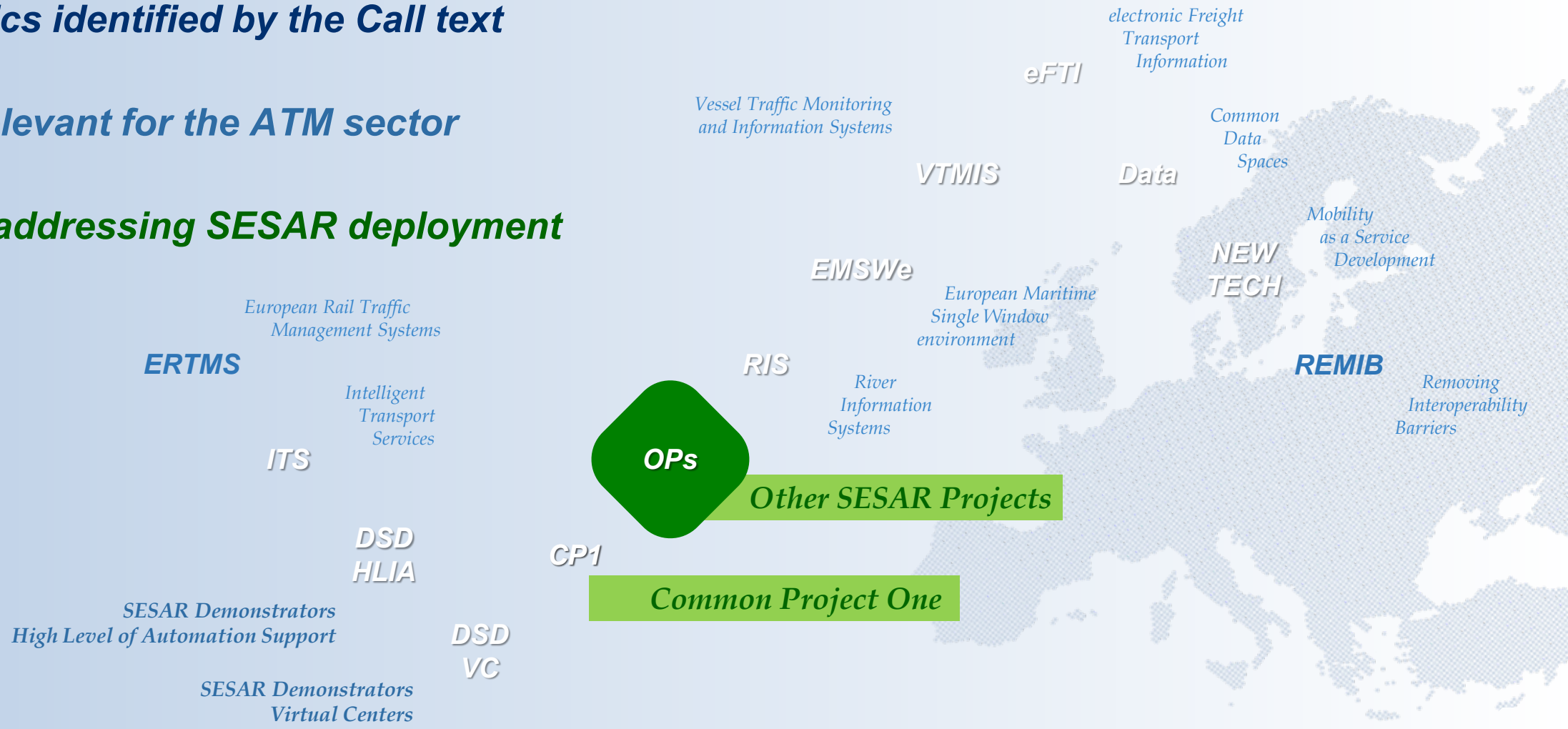
Overview of the CEF 2 Transport 2022 Call

The main topics addressed by the Call

13 topics identified by the Call text

4 relevant for the ATM sector

2 addressing SESAR deployment



Other Projects topic – among them ADS-B

The main deployment priorities for other SESAR projects, as identified in the Call text

*"projects that implement **Communications, Navigation and Surveillance (CNS) ground and airborne infrastructure**, route and procedures that are not addressed by the CP1"*

Performance Based Navigation

Adoption** of **SIDs and STARs** using PBN specifications and **optimization** of **TMAs airspace

*Equipping **aircraft** with **SBAS-capable avionics***

*Rationalizing the **ground navigation infrastructure***

Surveillance

*Synchronised **evolution of airborne and ground surveillance infrastructure***

*Adopt **new types of ground surveillance** to enable **decommissioning of the existing radar infrastructure***

*Equipping **avionics with ADS-B** or equivalent performance for **military and General Aviation***

Datalink Services

***Avionics updates** to resolve interoperability issues*

*Enable Airspace Users to take **full advantage of operational datalink services** without any restriction*

*Setup of a **single proposal** that covers several aircraft operators*

SPI IR: ADS-B in the regulatory perspective

Bryan Jolly - *EASA*

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European ADS-B Implementation status

Johan Martensson/Jan Stibor - SDM

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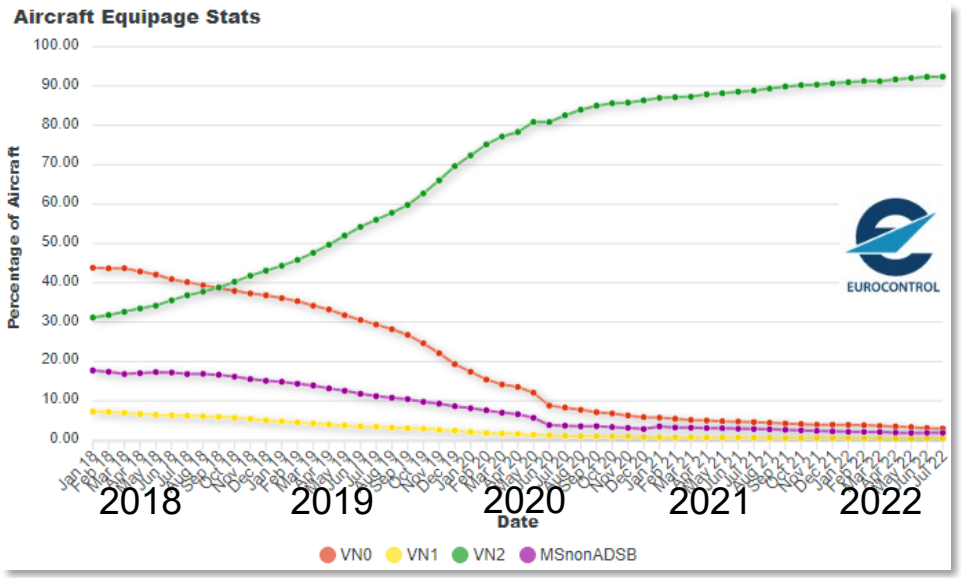
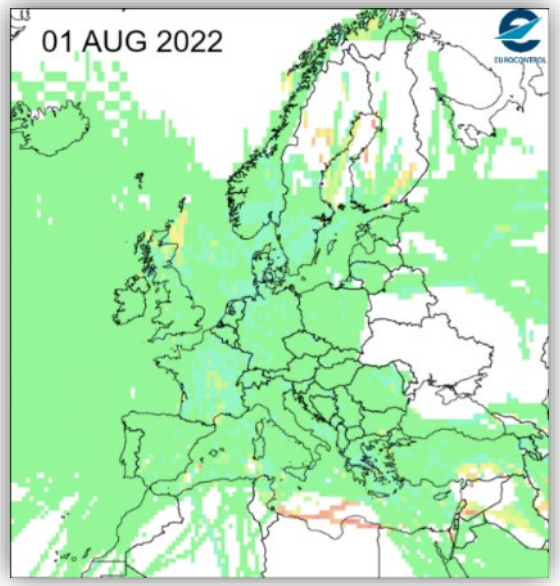
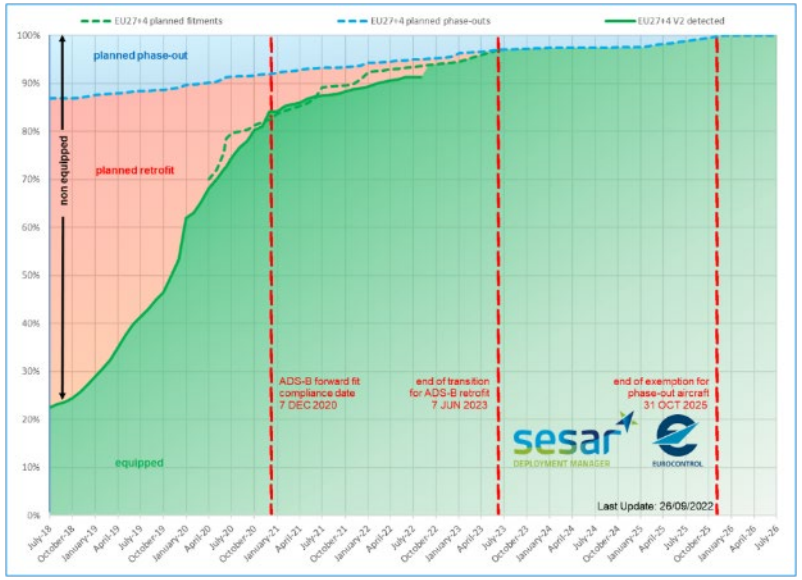
Implementation progress

AIR

Airborne ADS-B v2 equipage increase in line with expectations and requirements

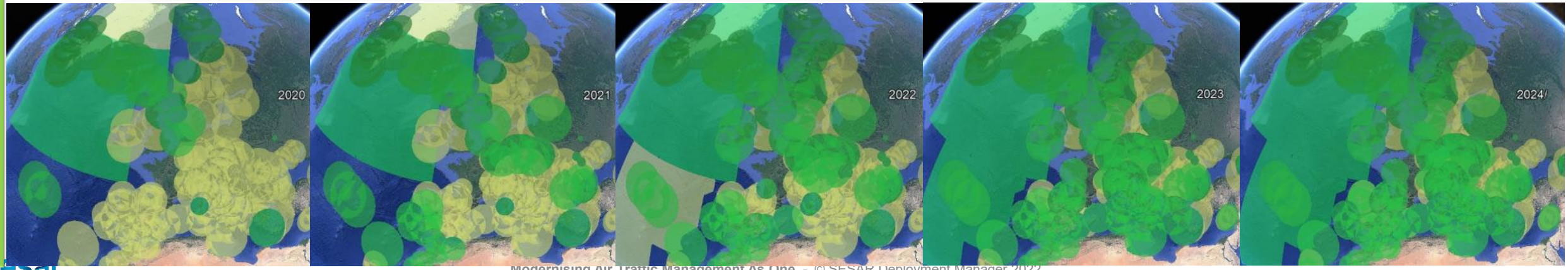






GROUND

Ground deployment and integration is progressing well based on increasing airborne equipage levels



Implementation progress

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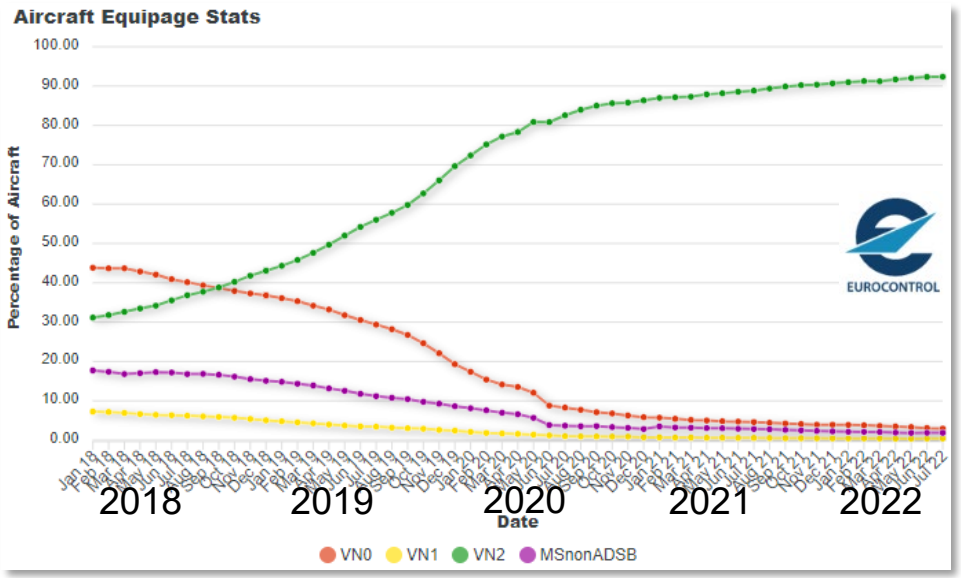
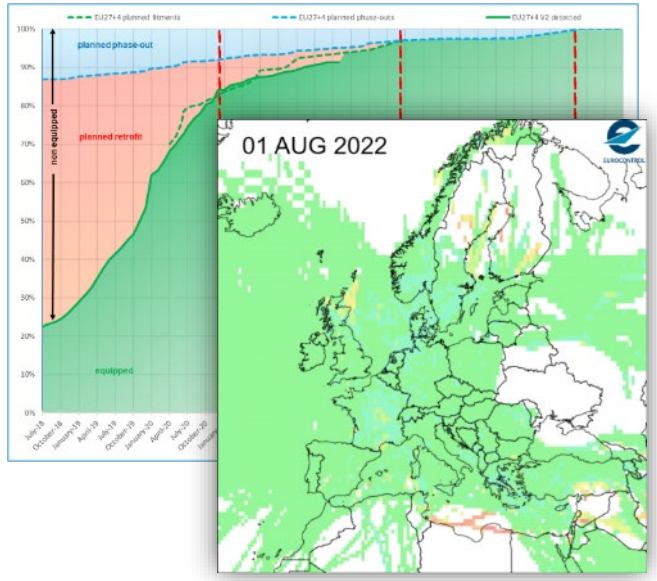
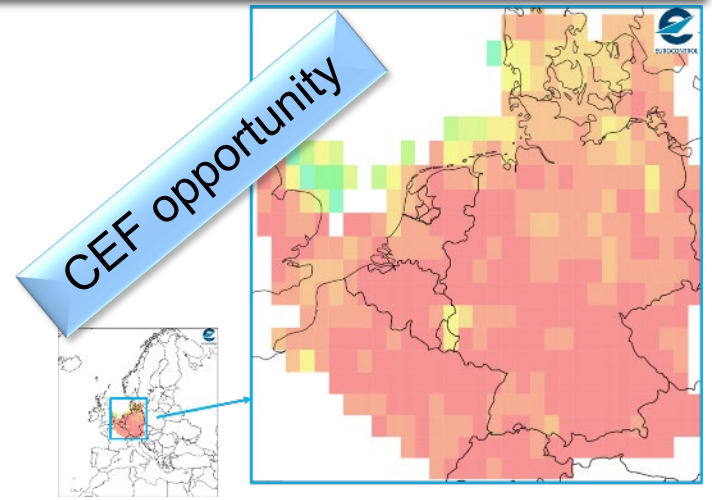




Small aircraft / airspace equipage

Challenge to be addressed in order to:

- Enable full operations & optimisation
- Air-Air conflict avoidance solution



GROUND

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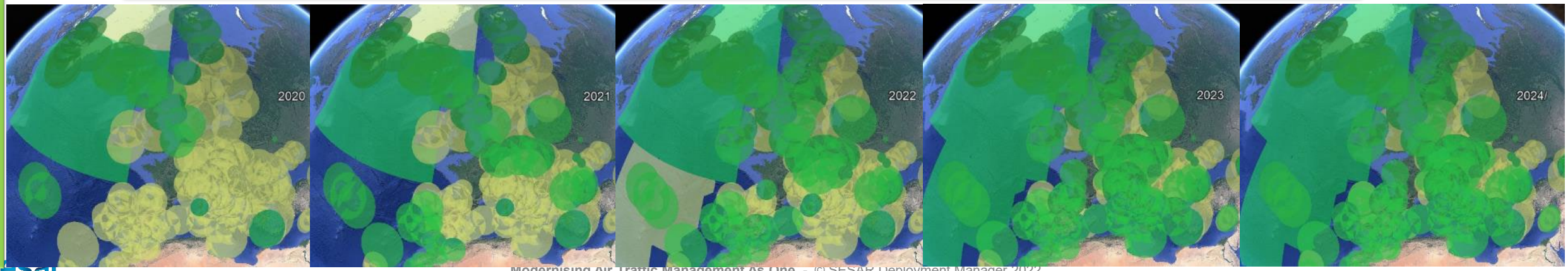

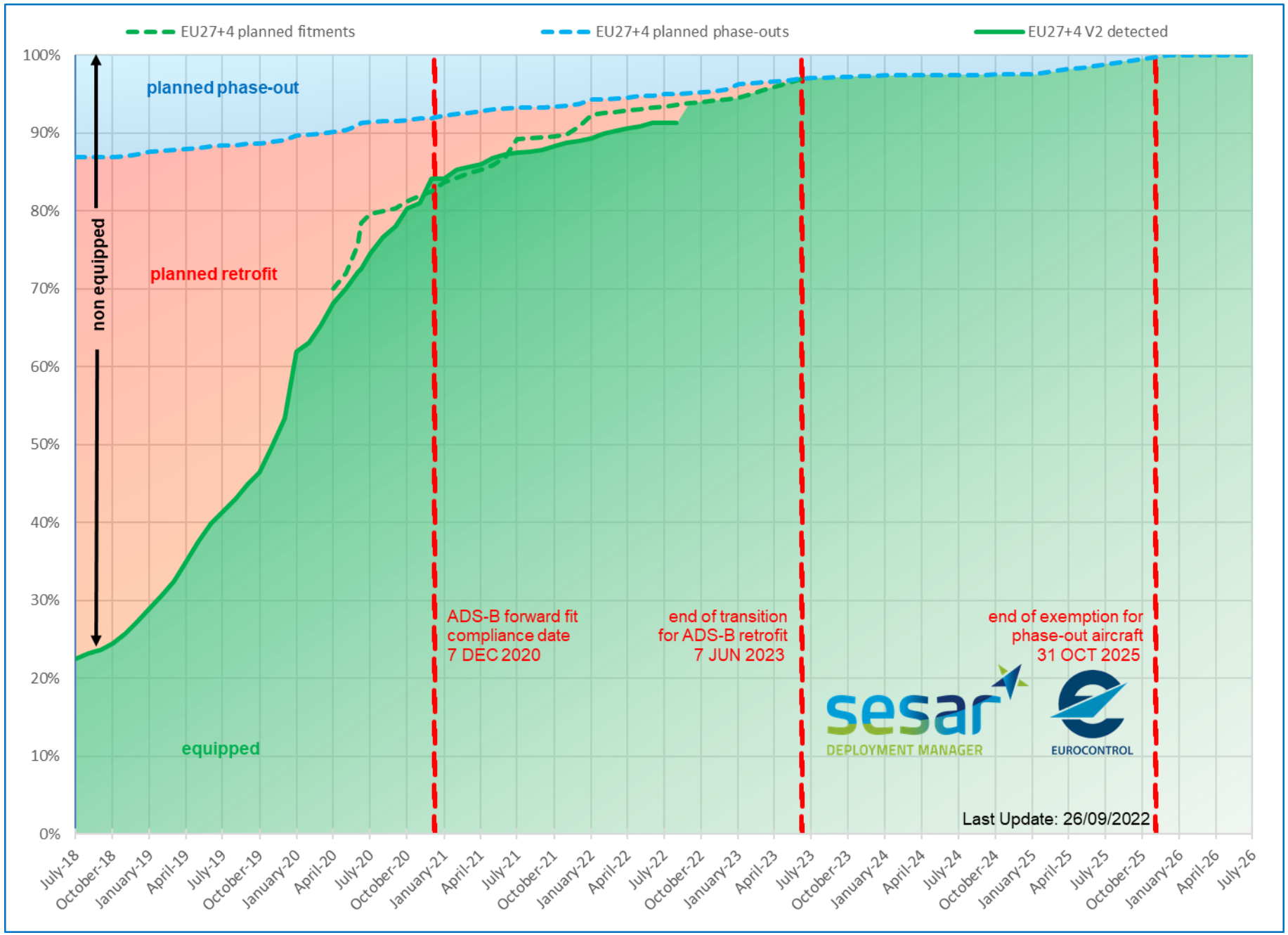
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EU27+4 planned phase-outs
EU27+4 V2 detected
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compliance date
7 DEC 2020
end of transition
for ADS-B retrofit
7 JUN 2023
end of exemption for
phase-out aircraft
31 OCT 2025
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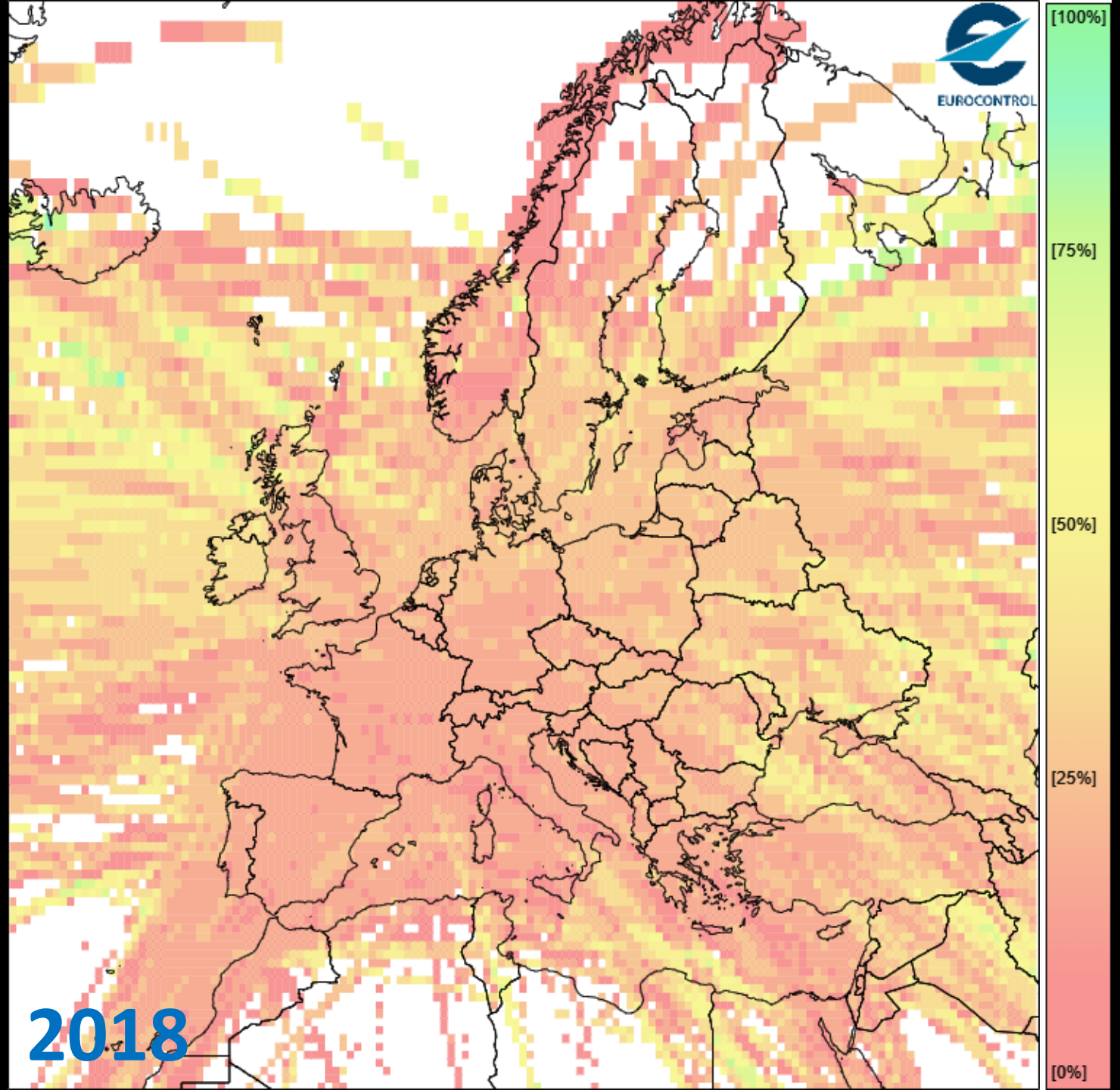
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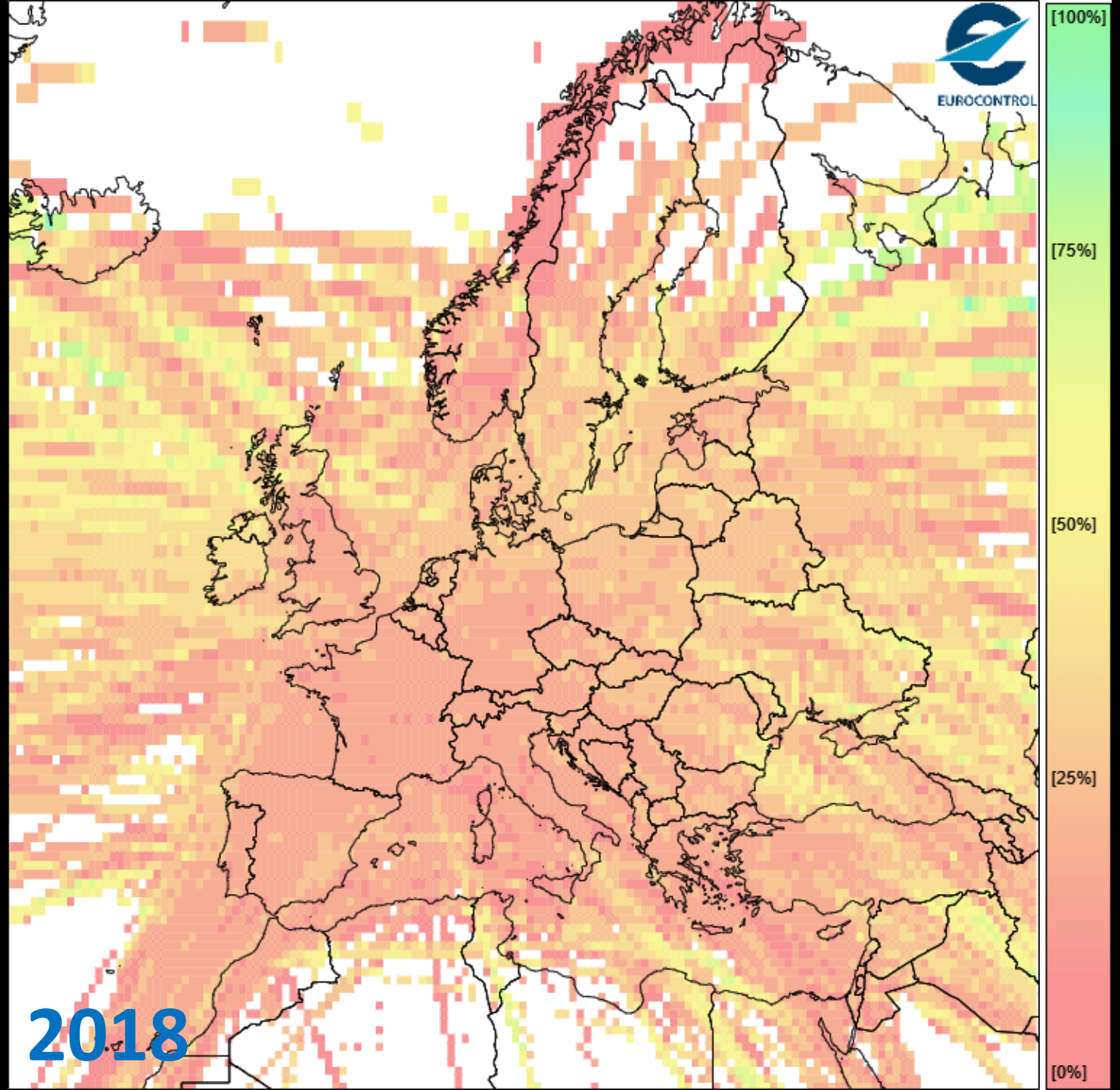
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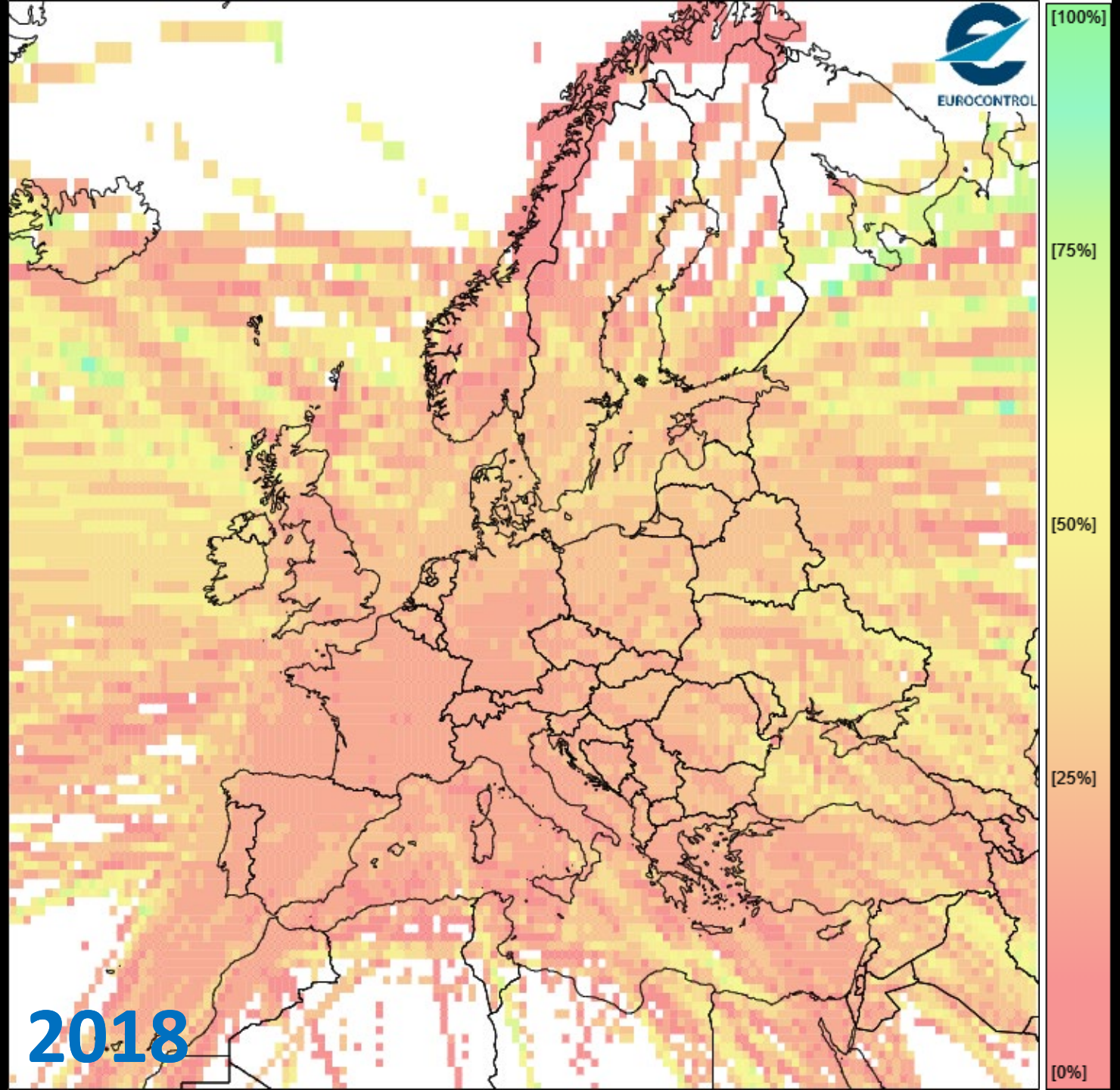
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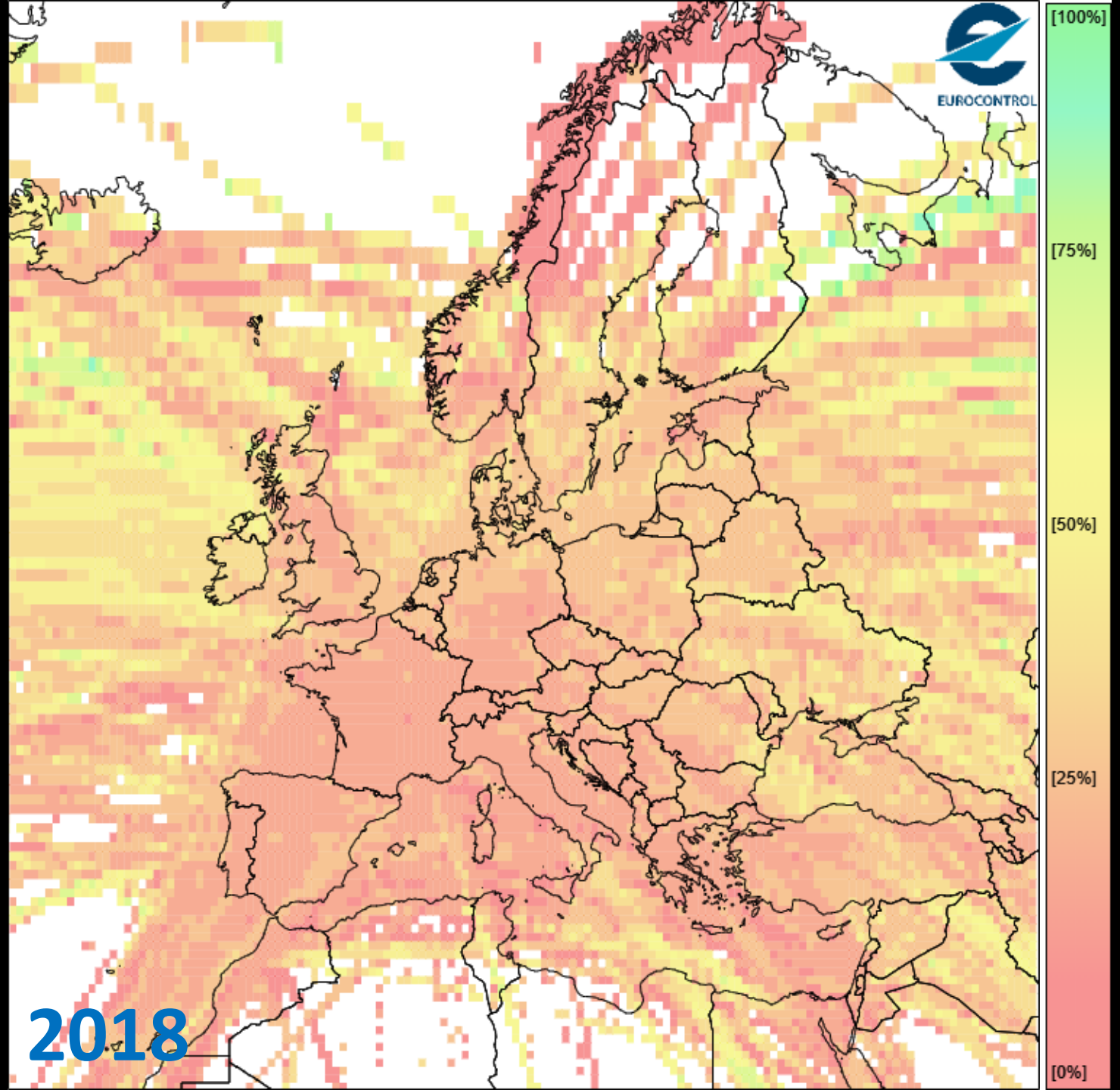
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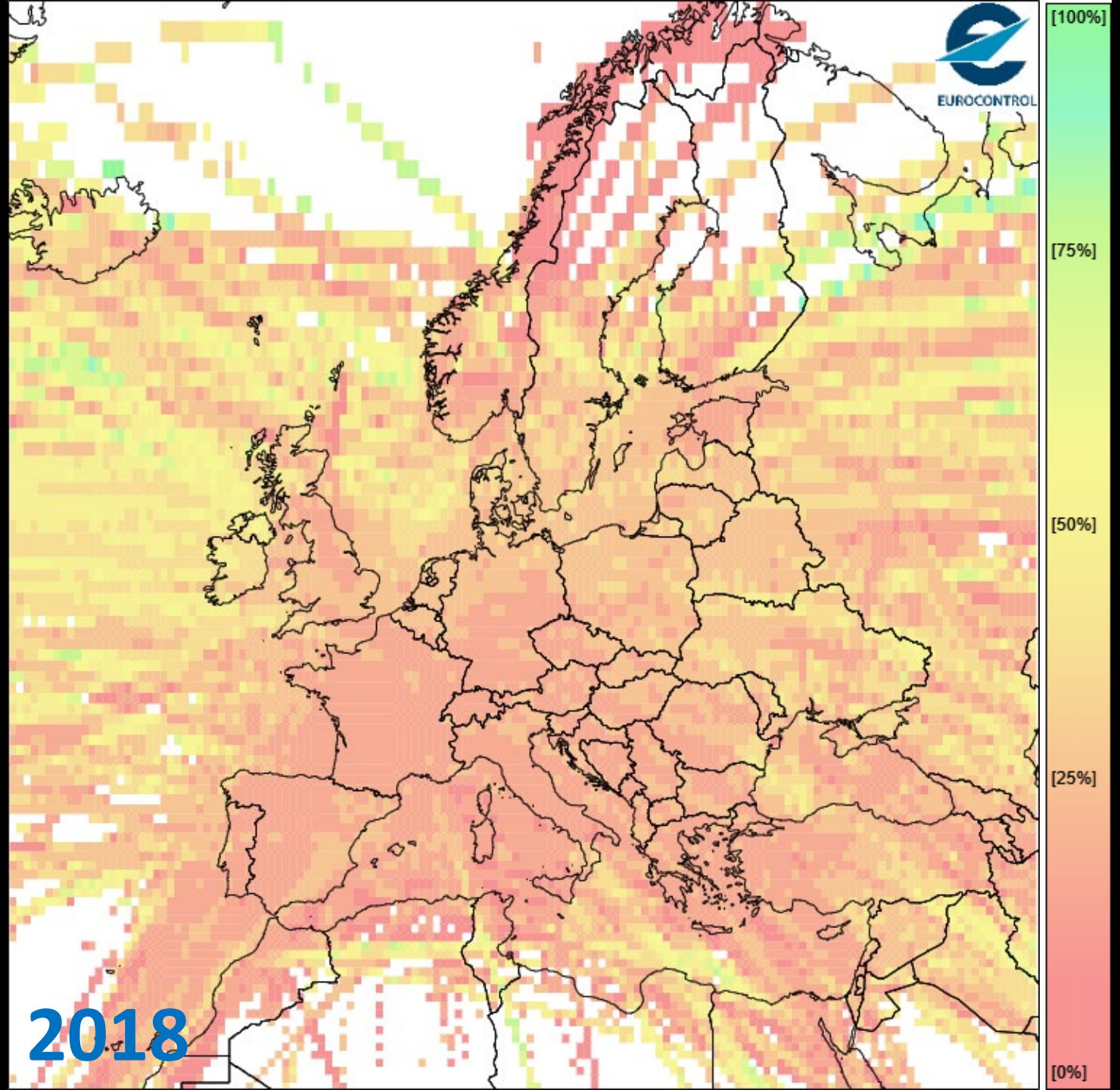
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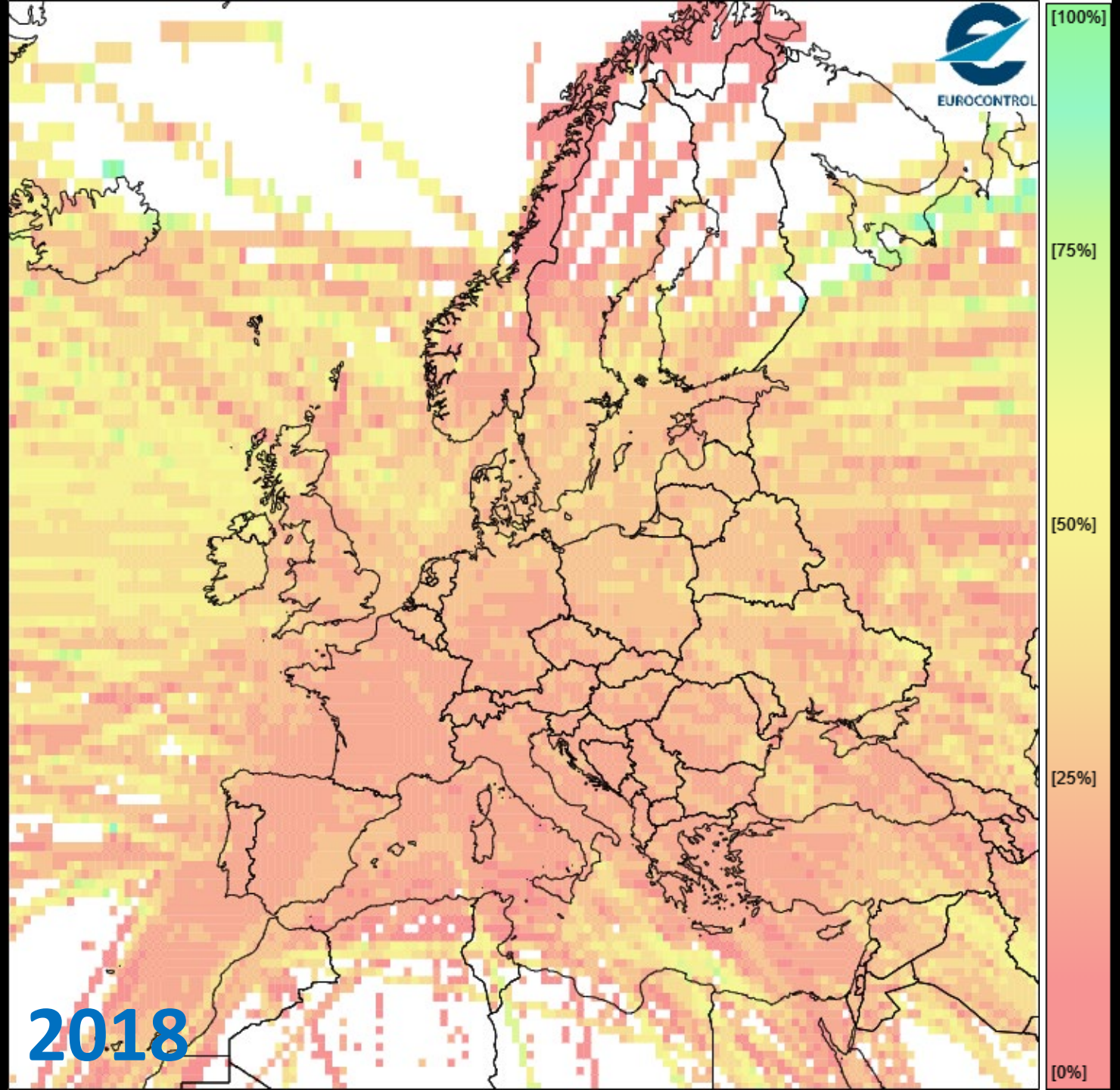
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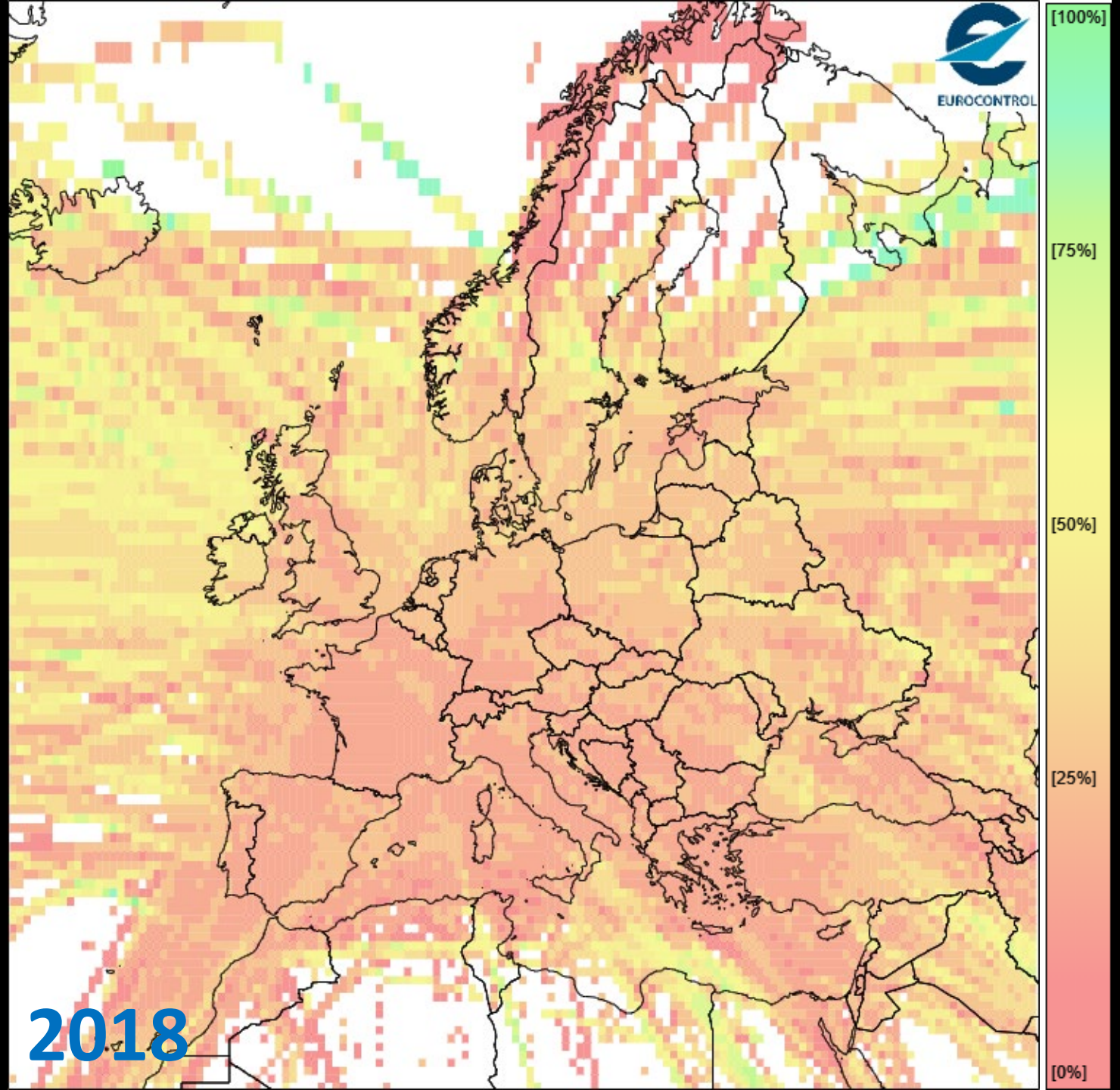
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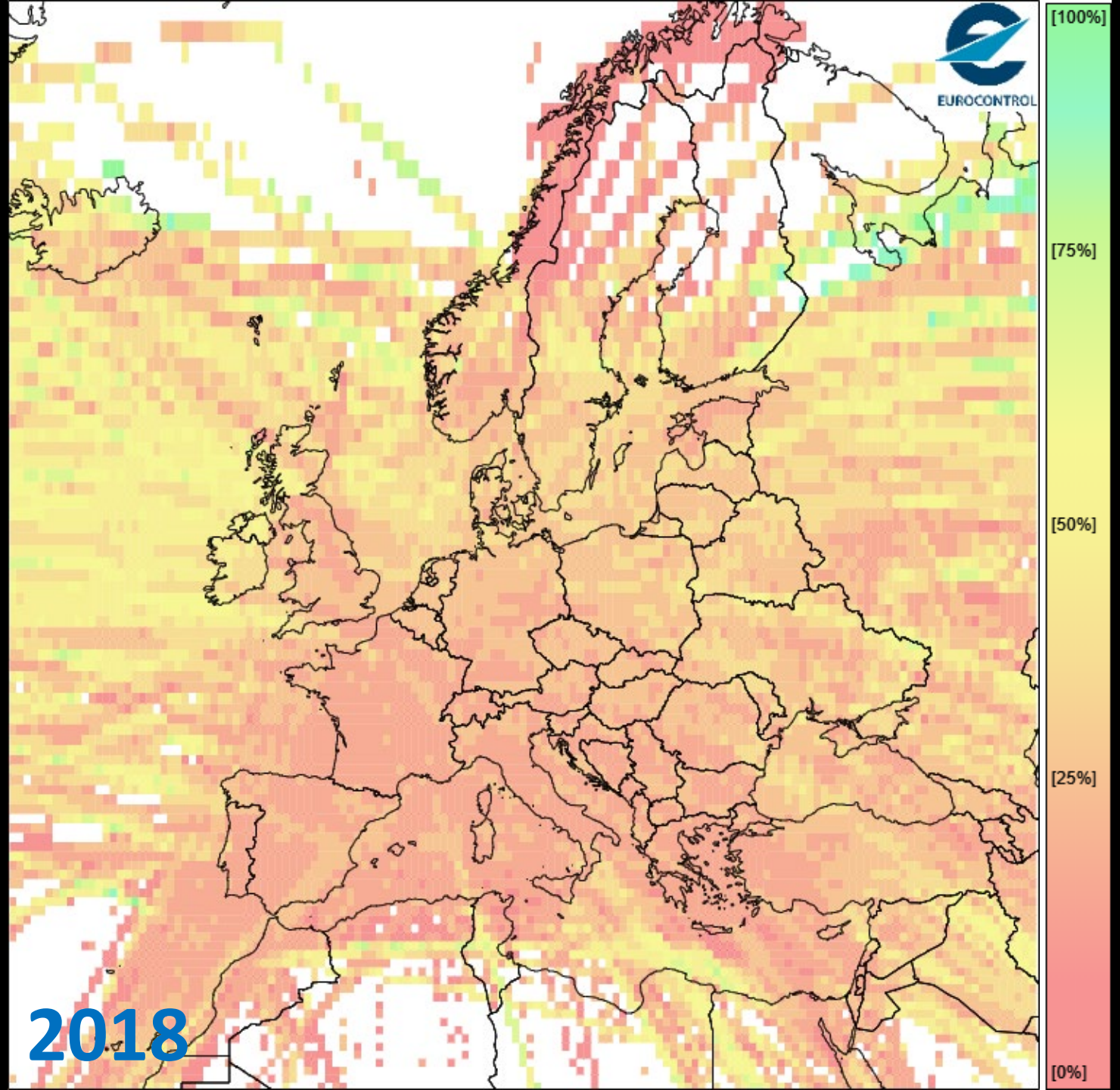
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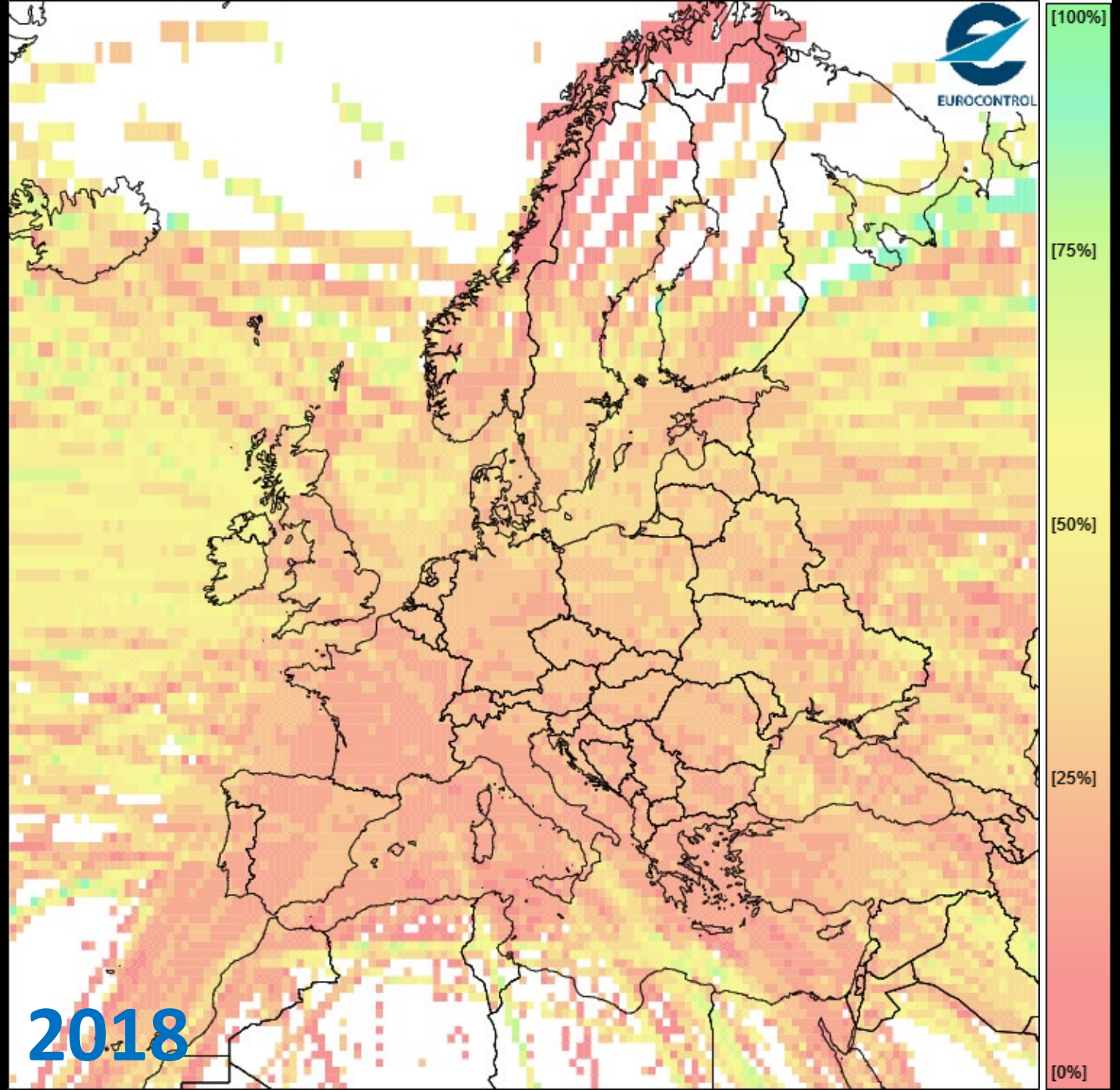
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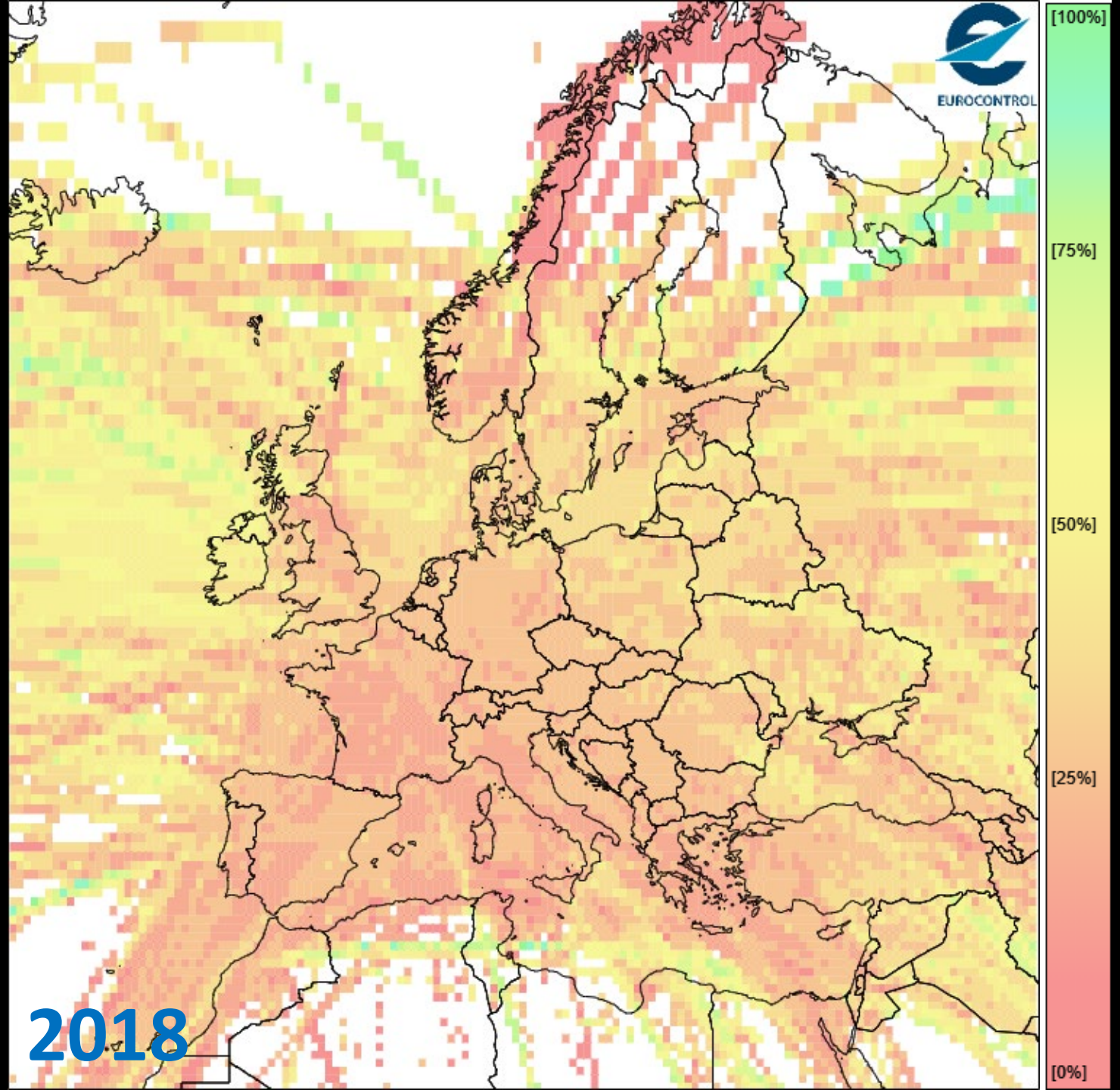
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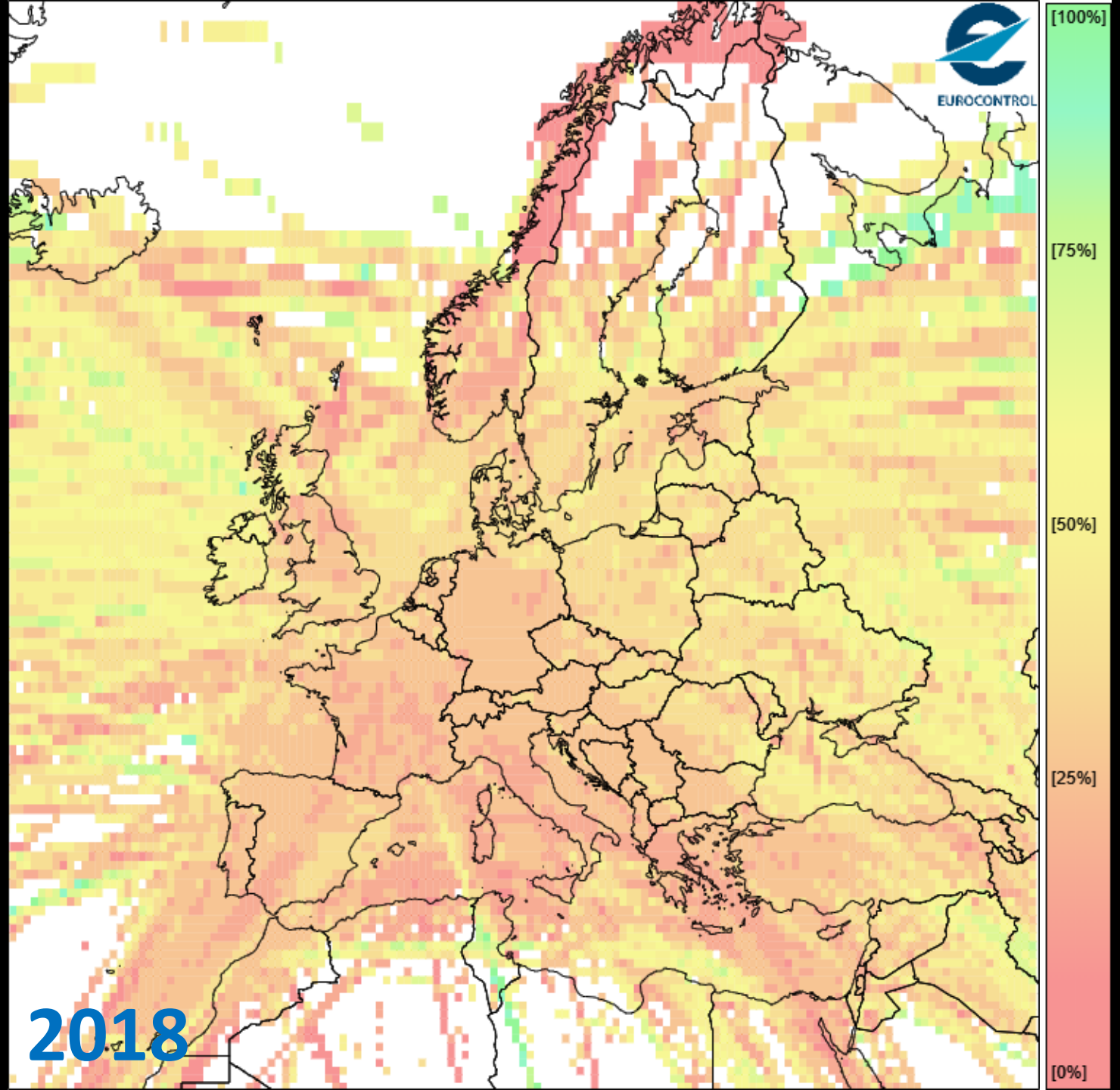
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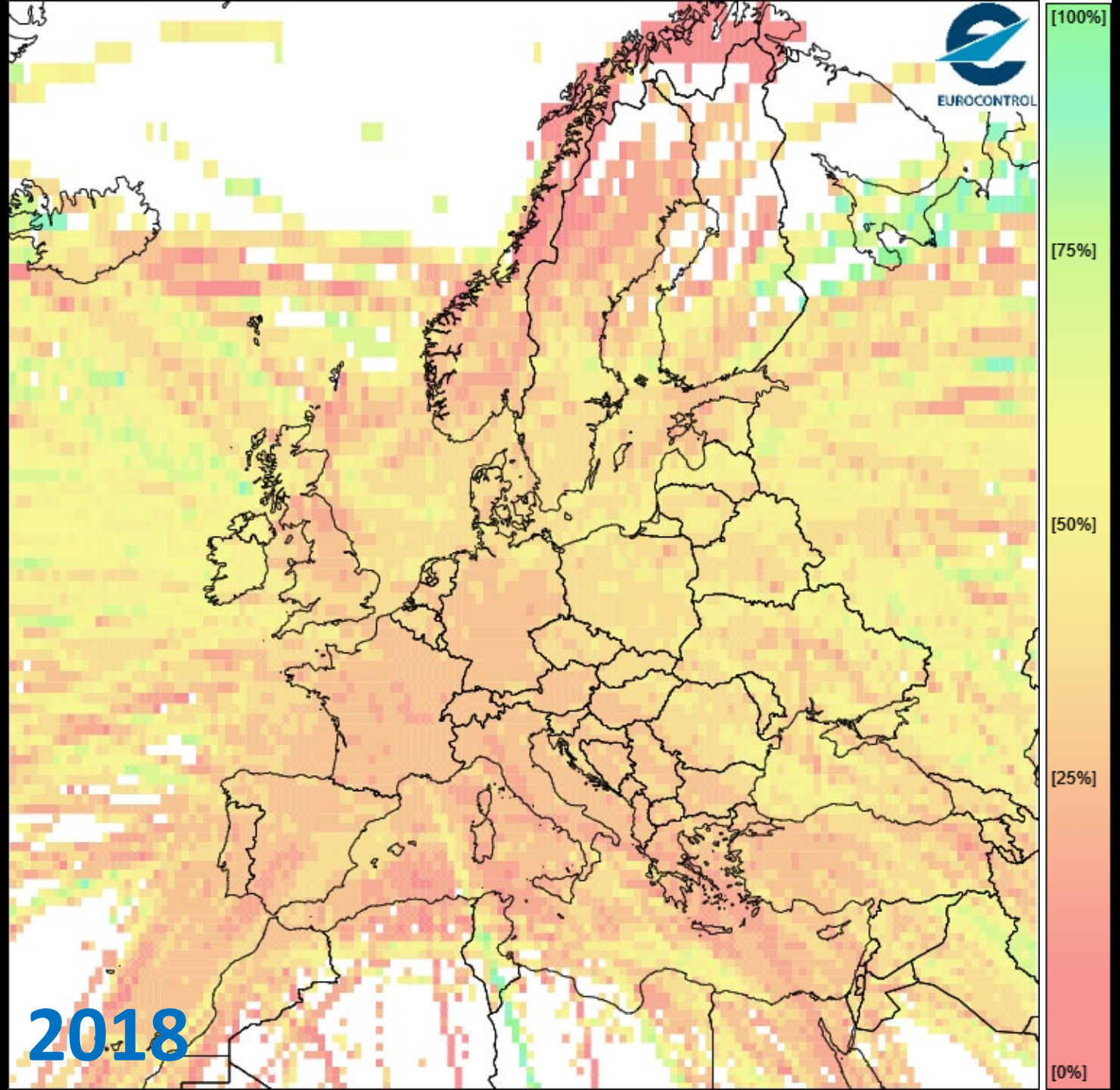
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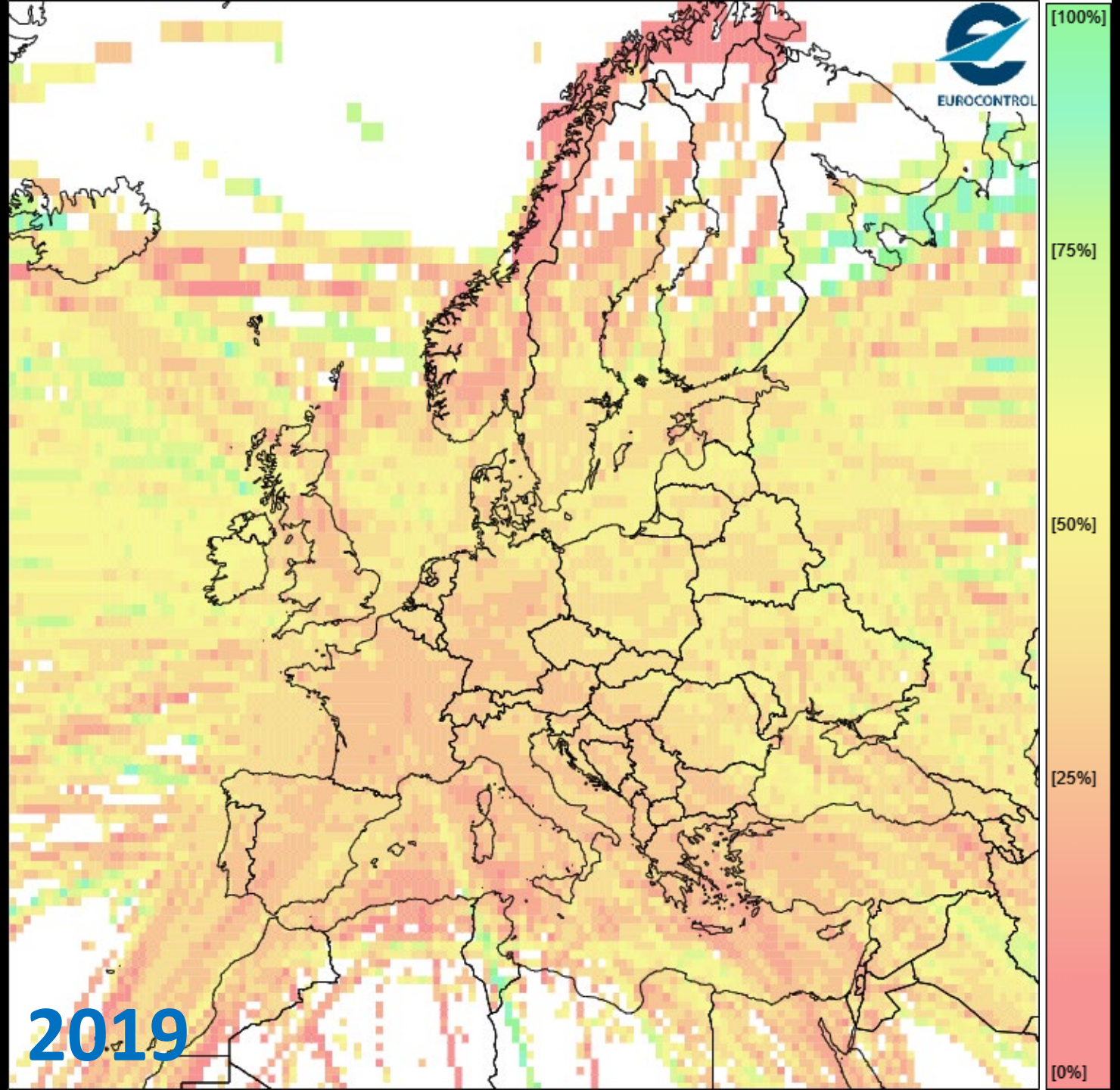
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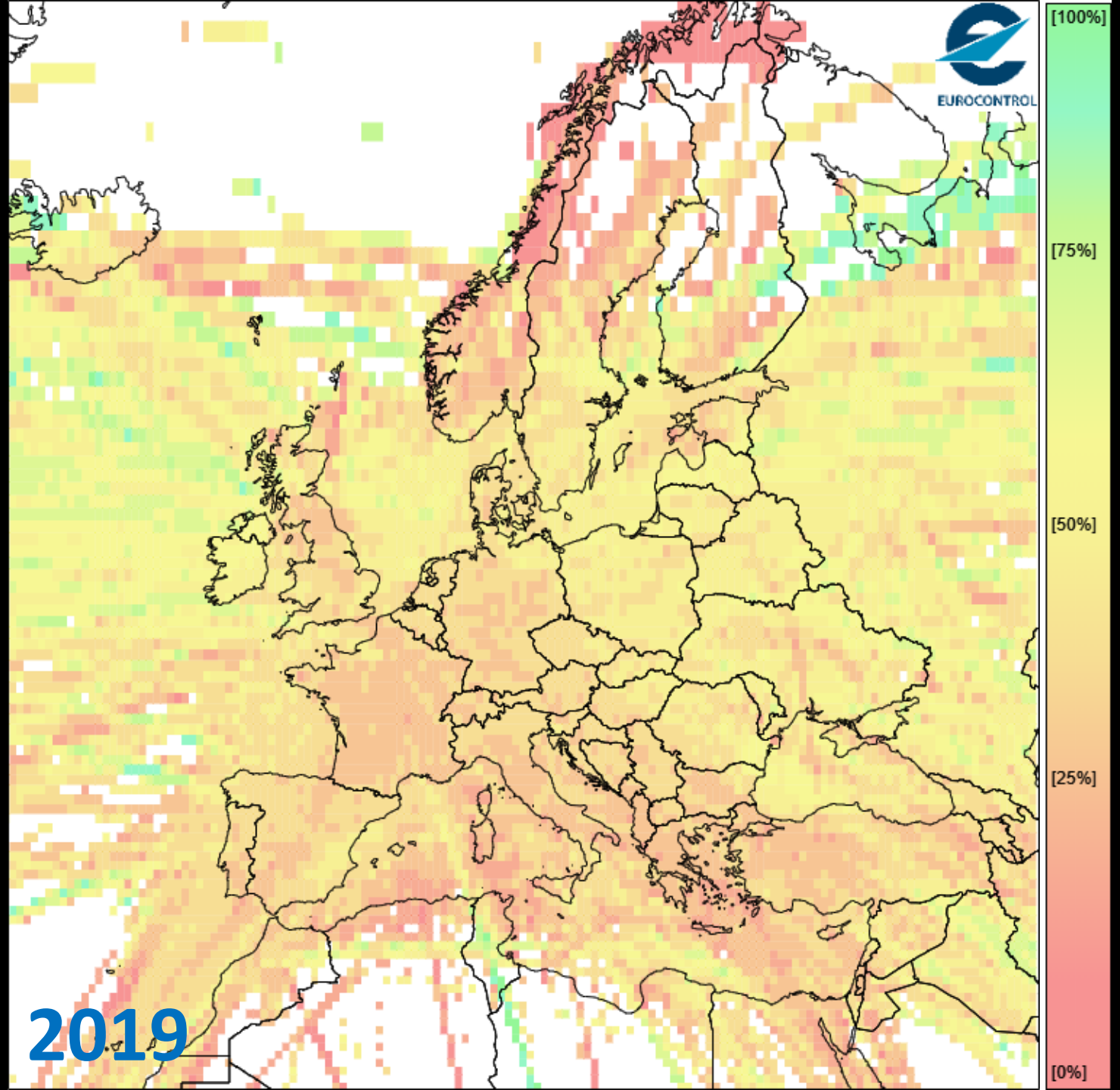
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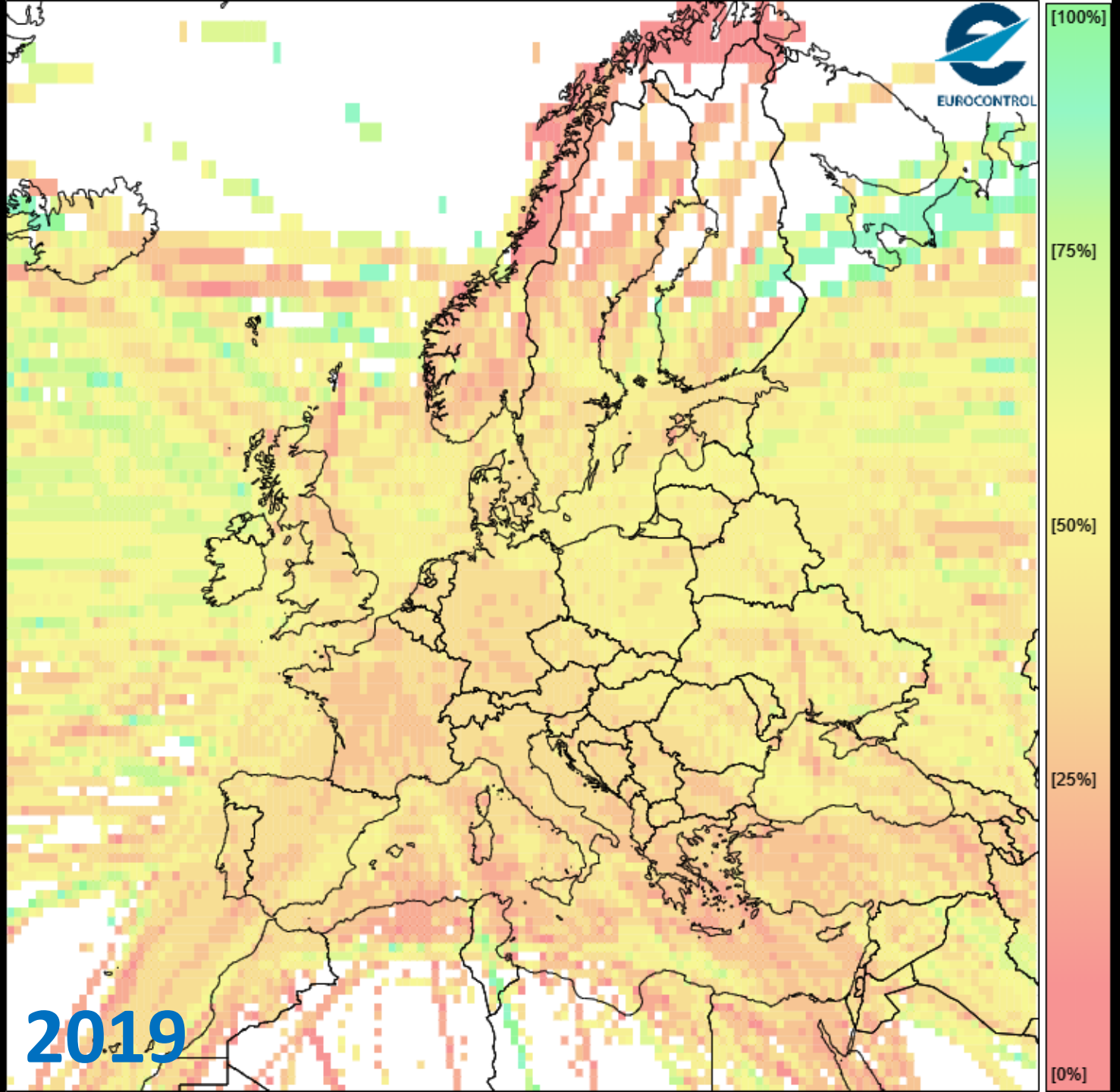
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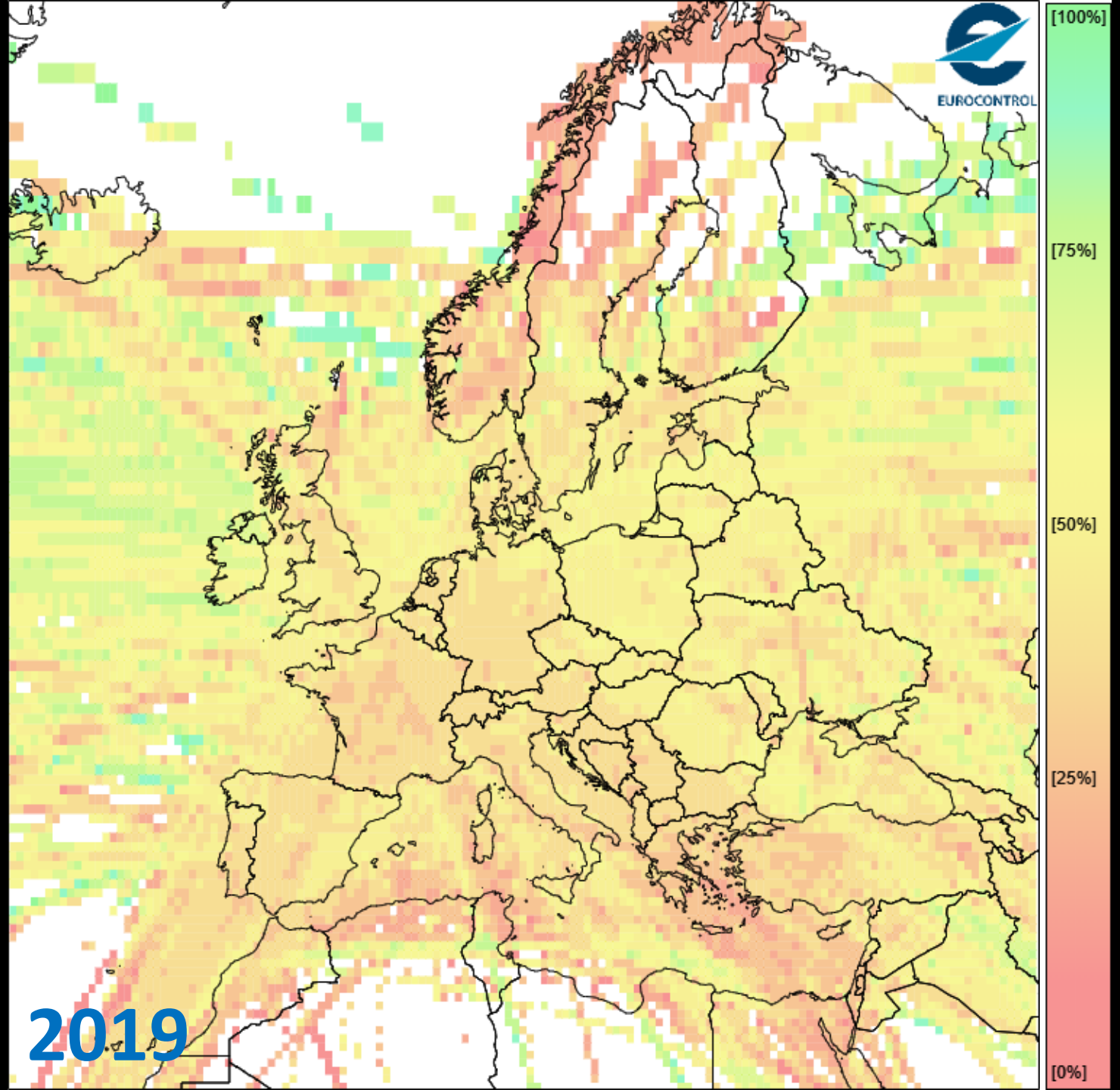
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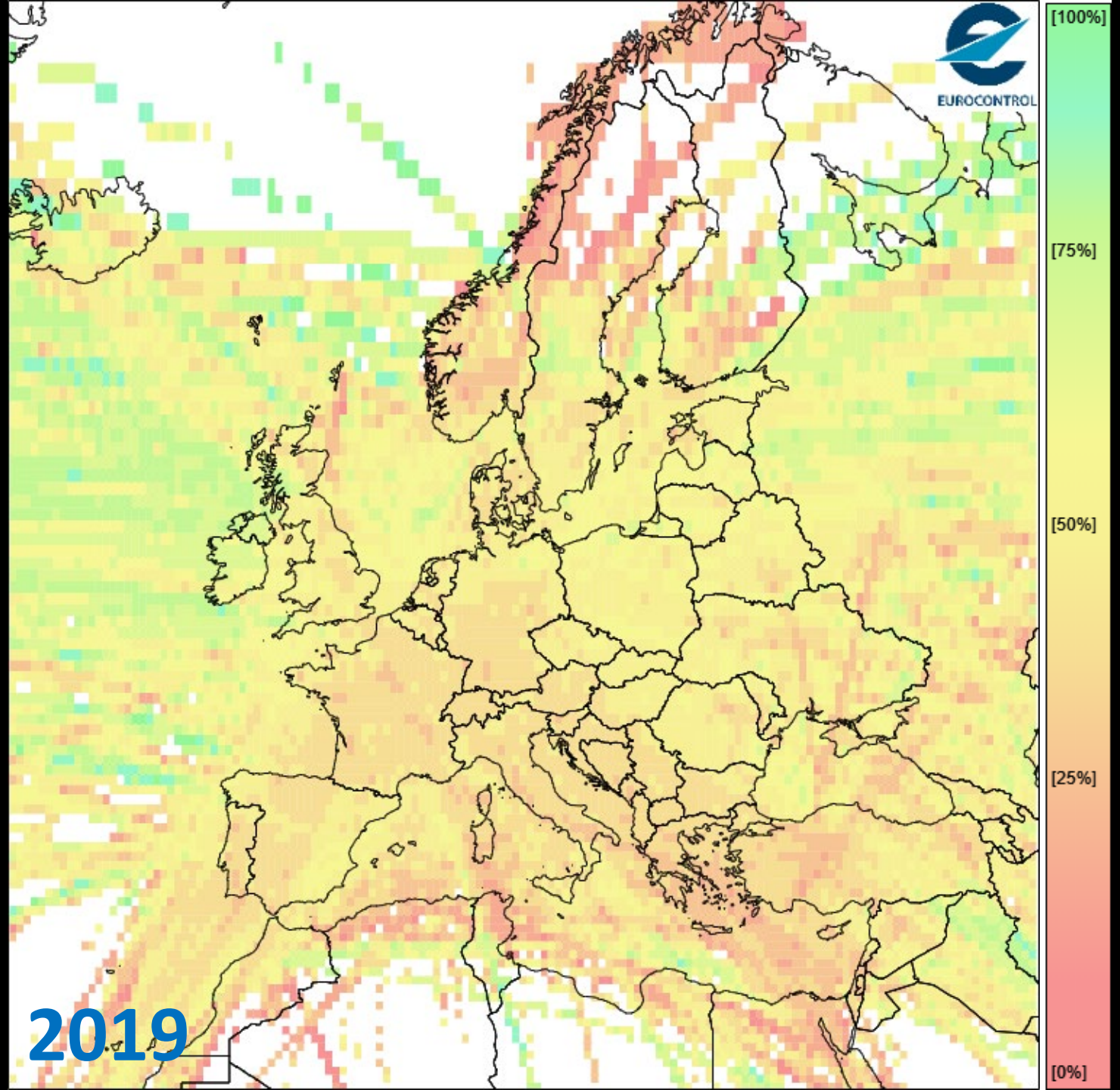
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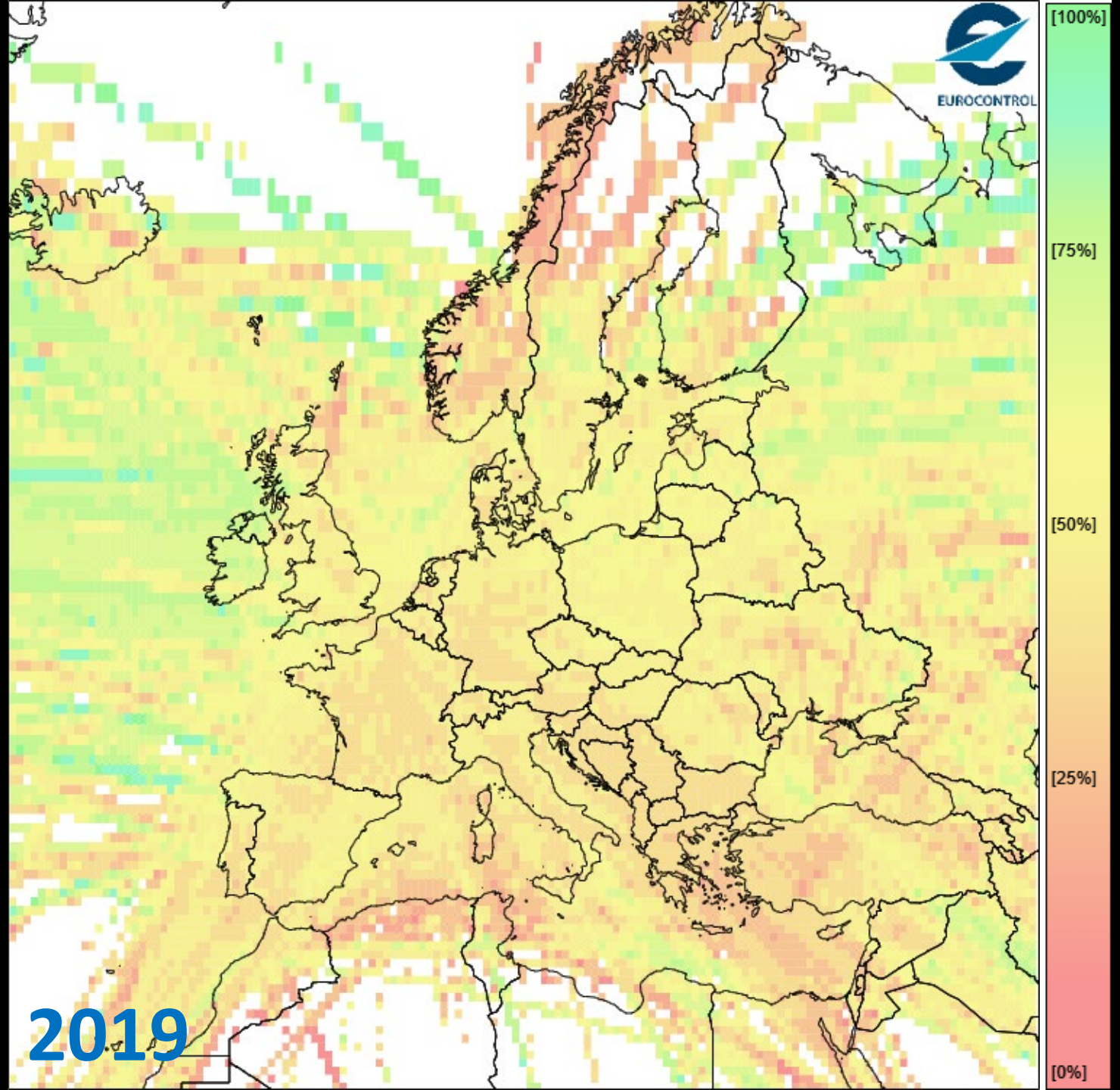
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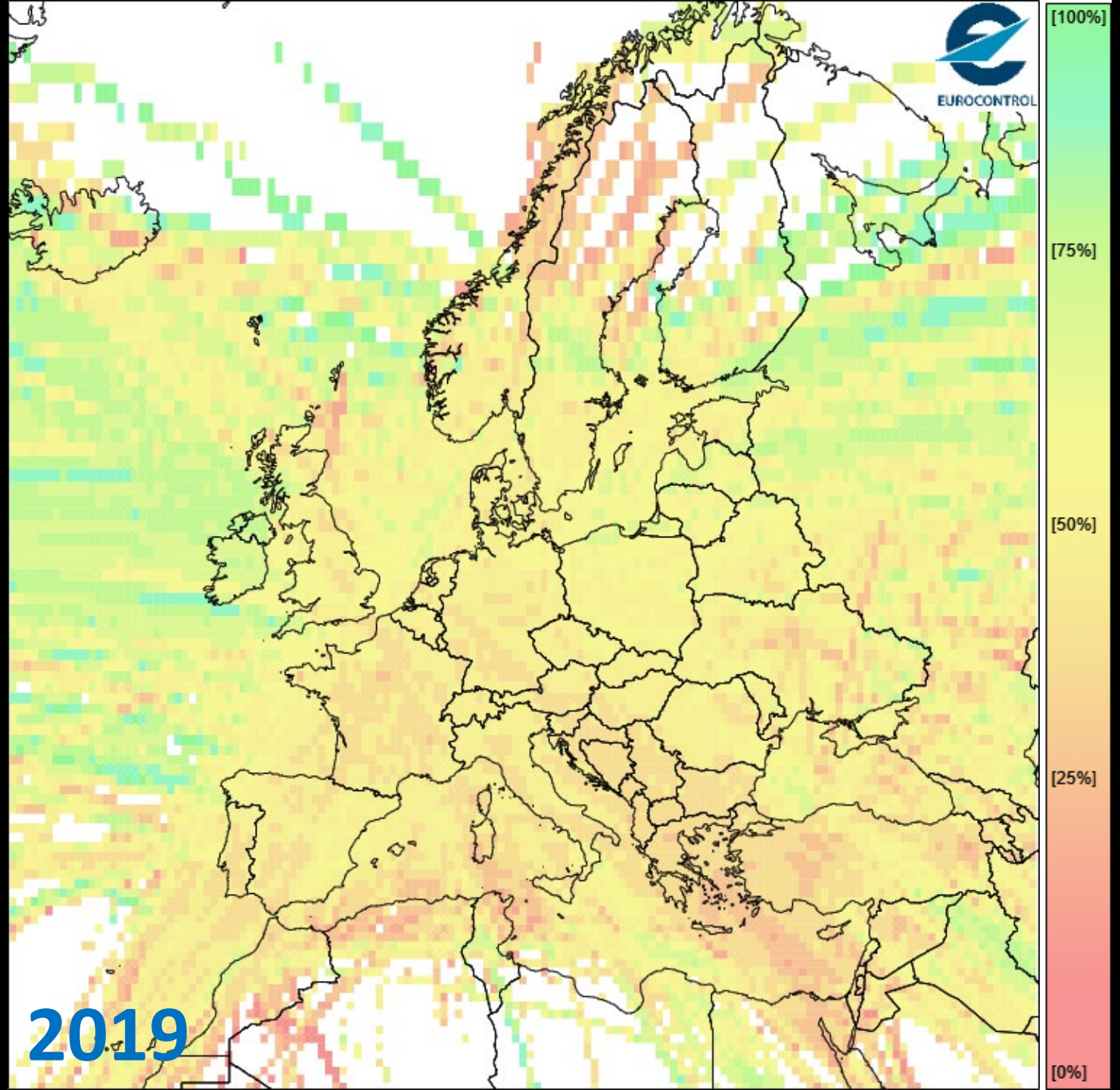
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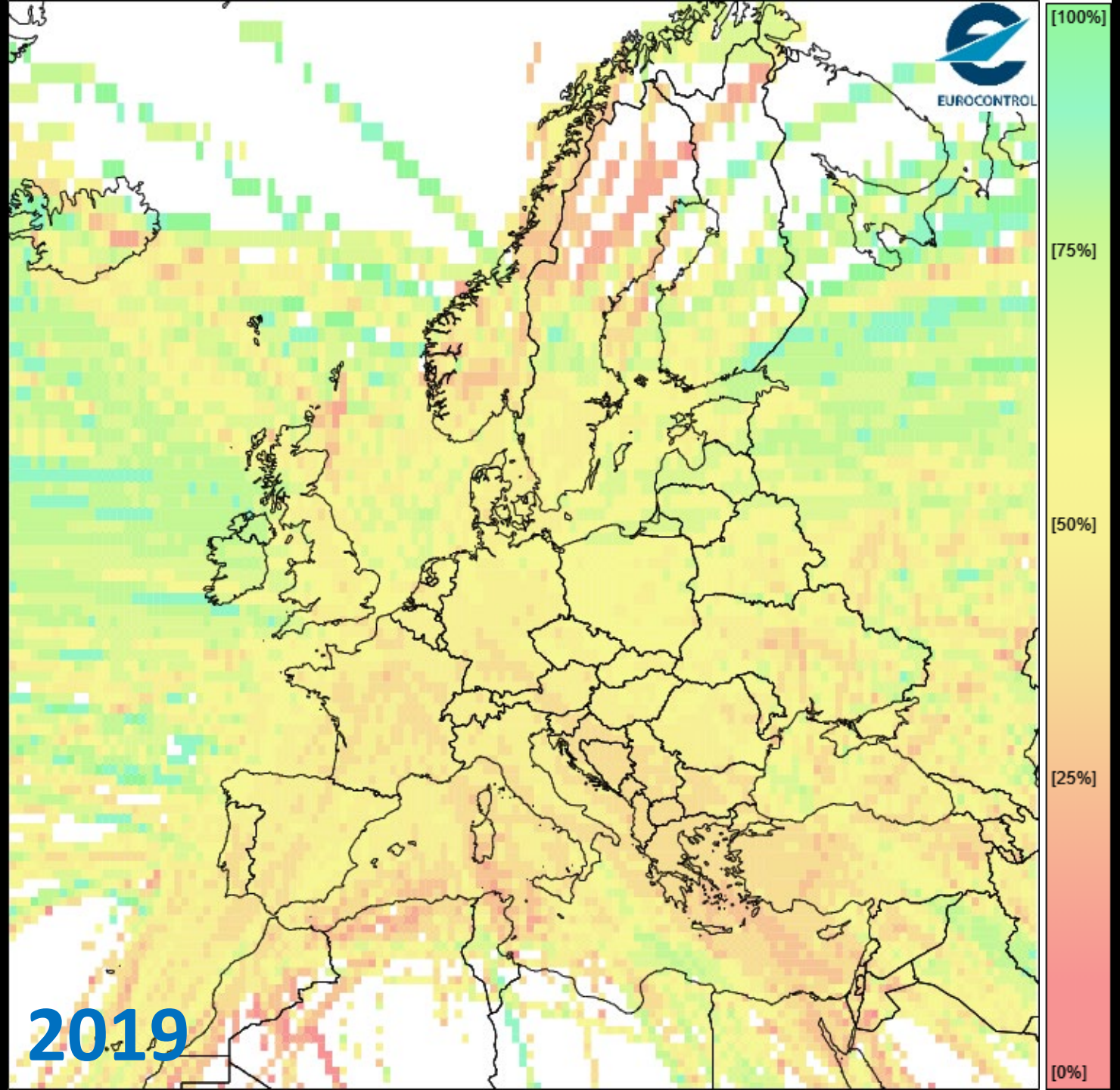
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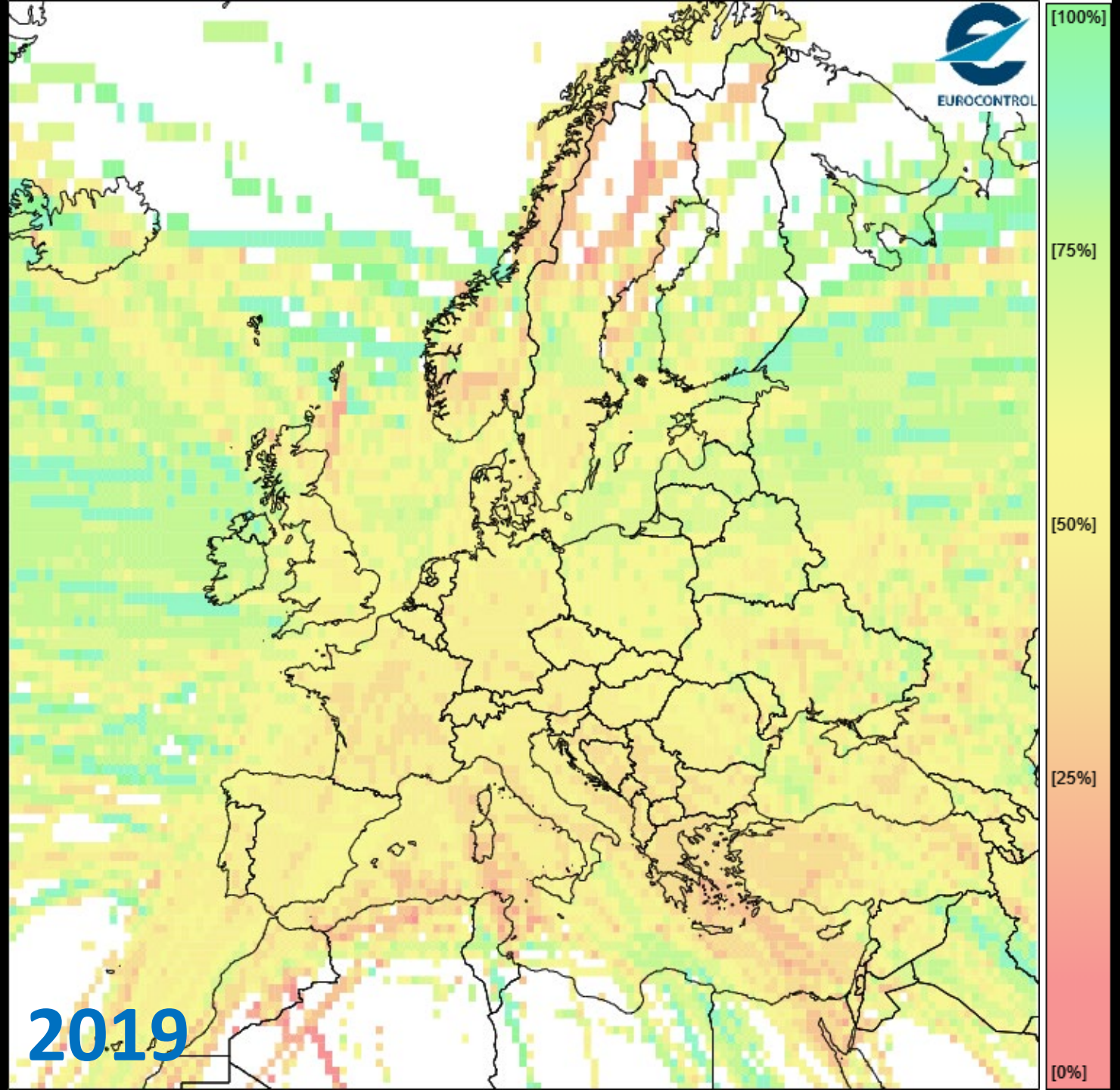
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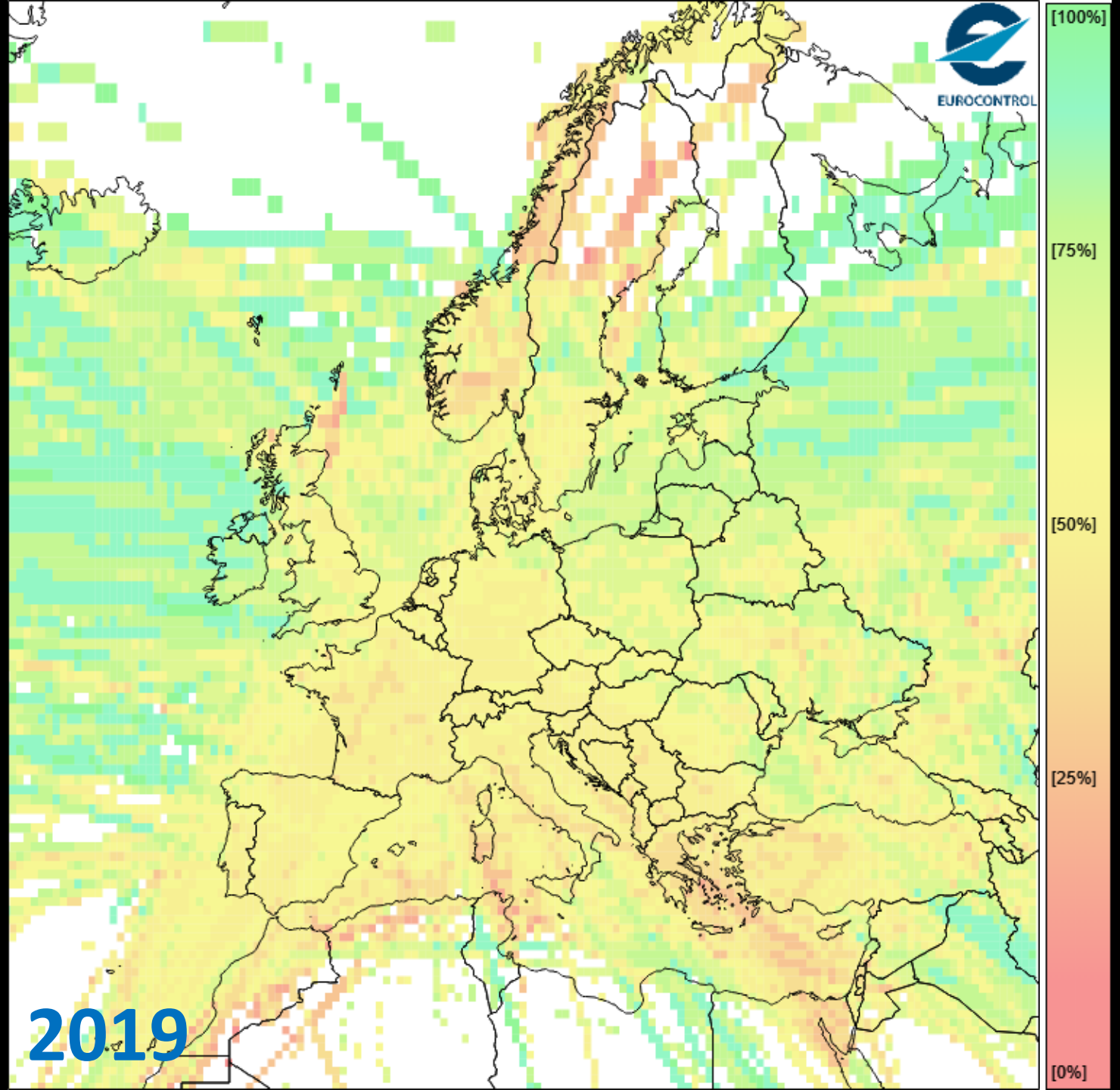
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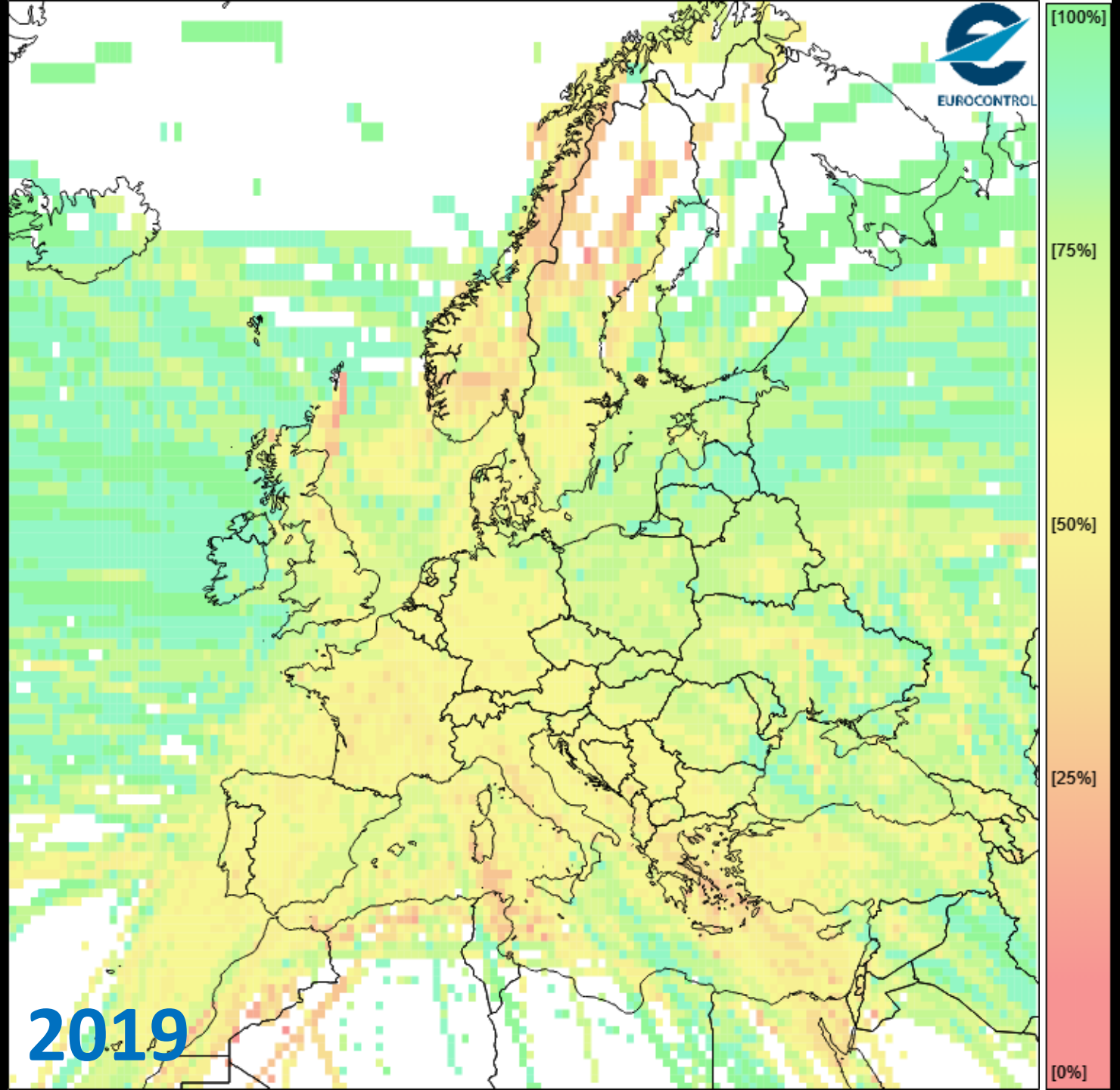
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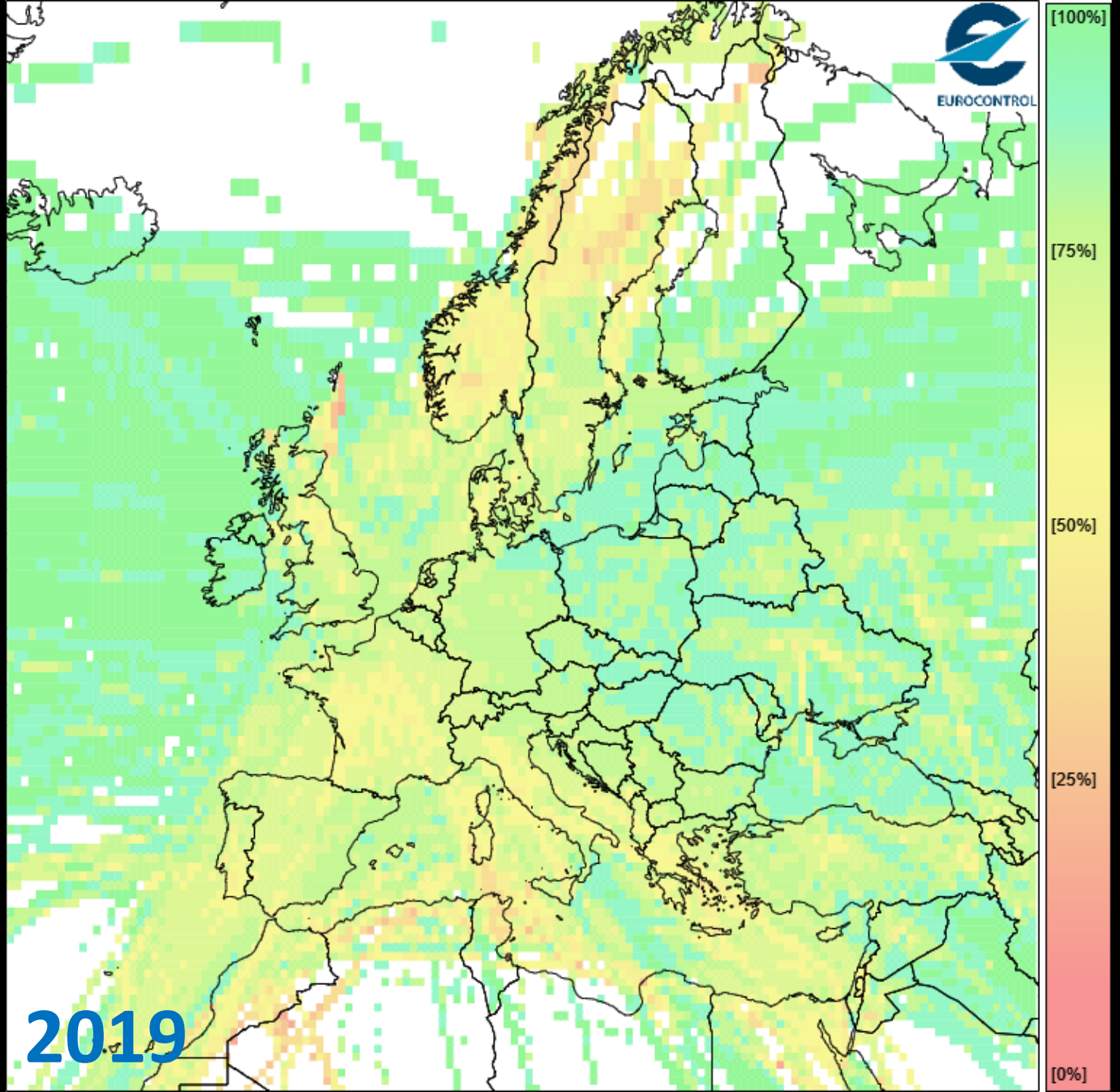
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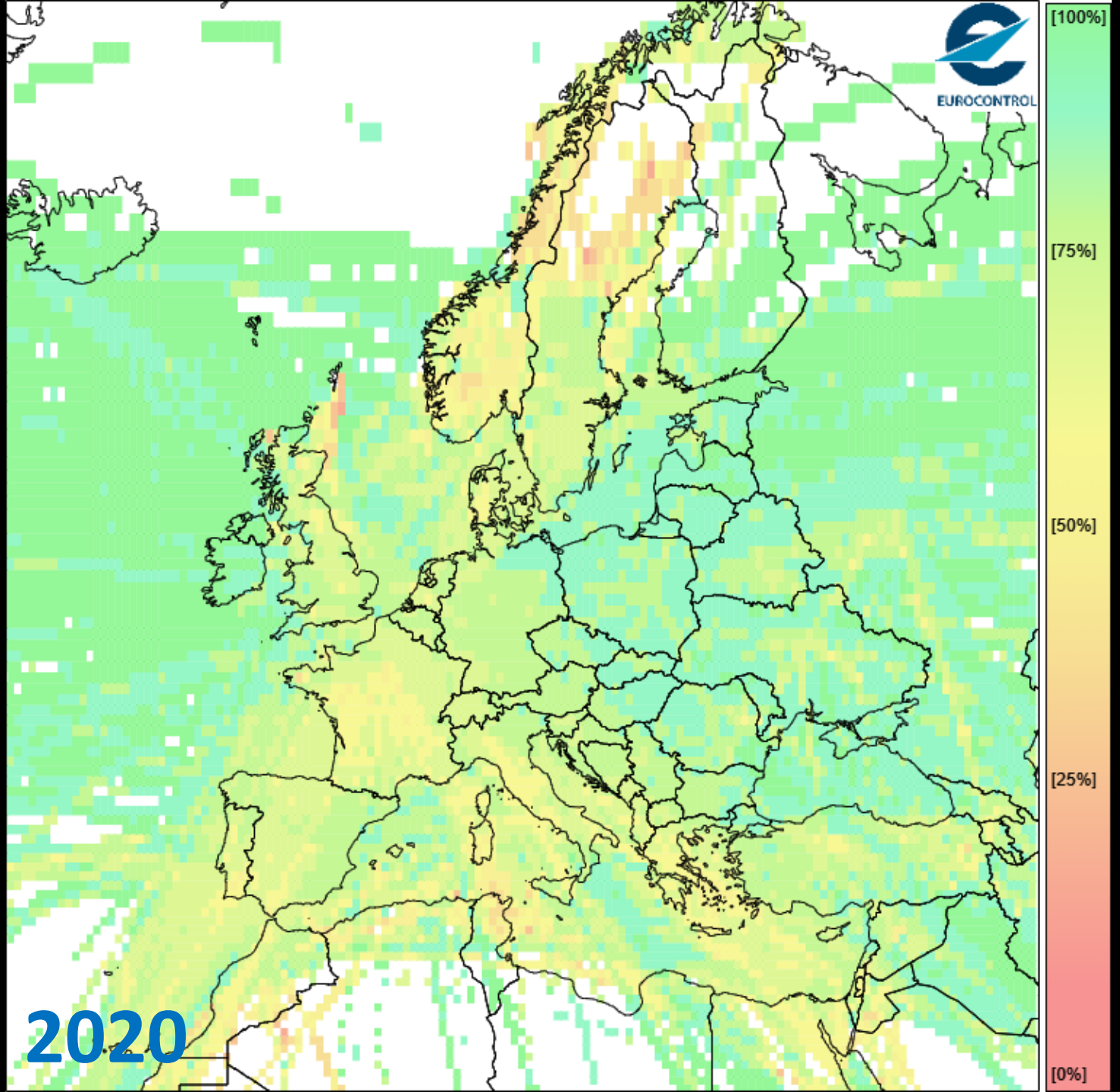
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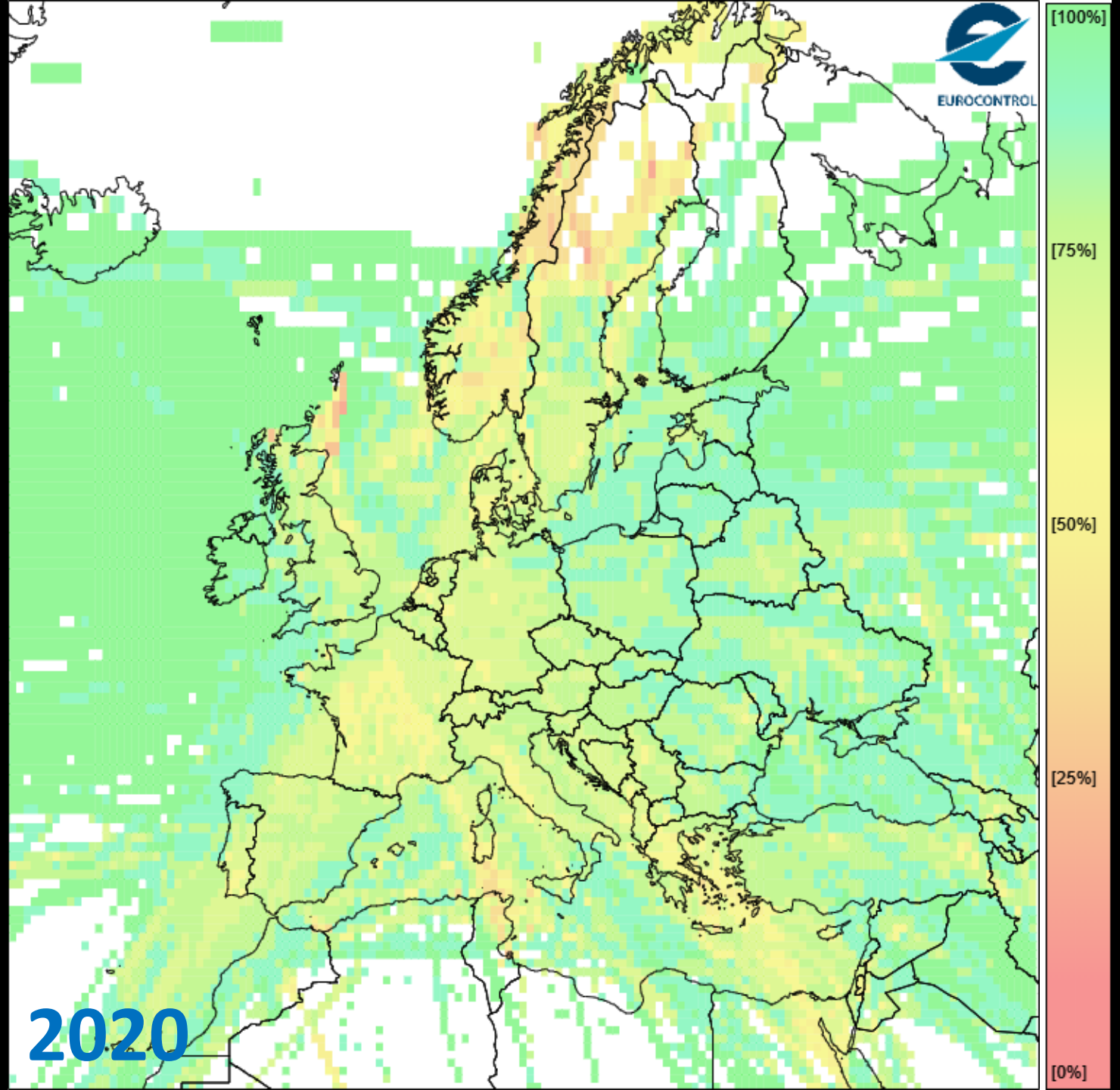
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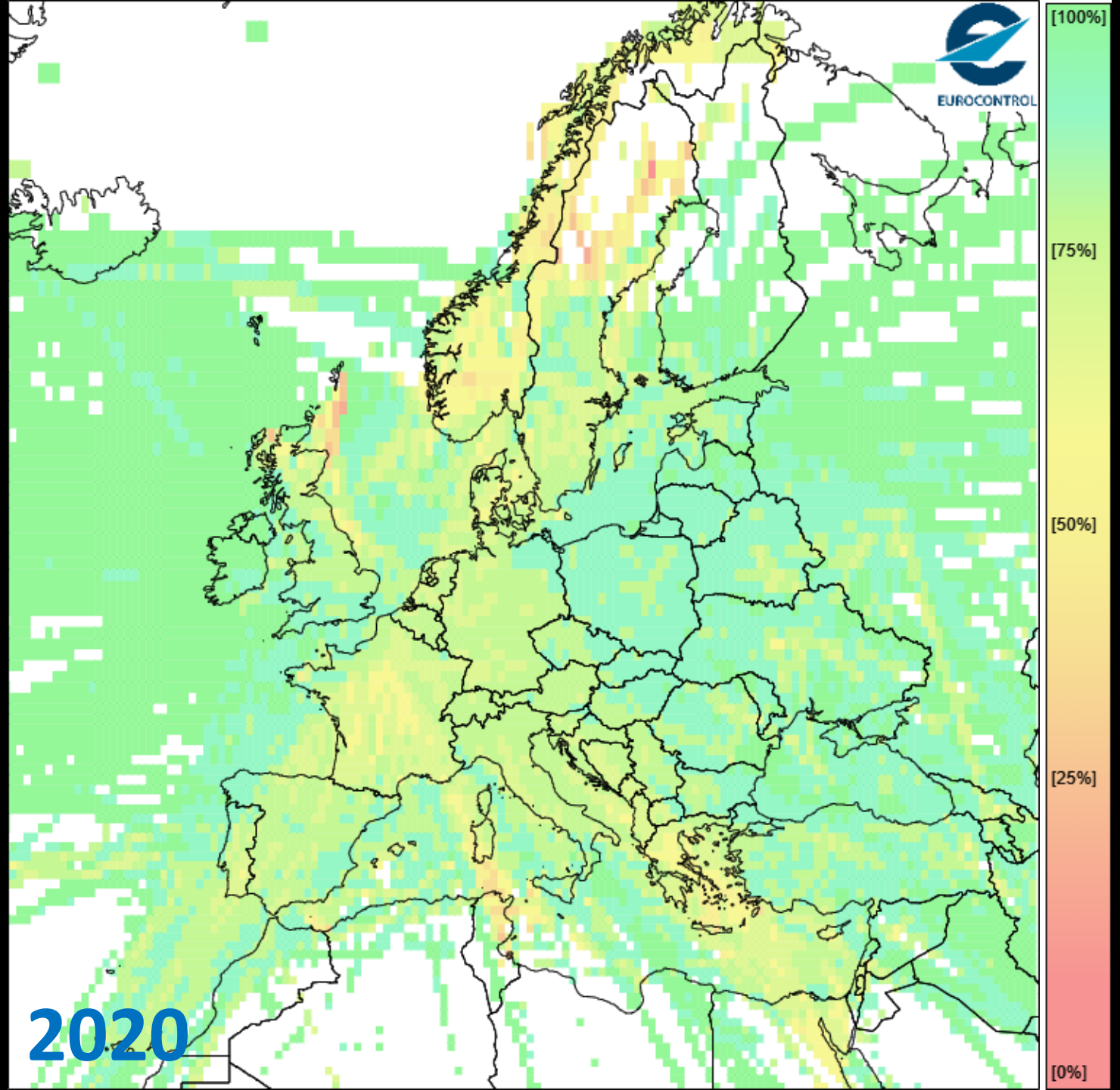
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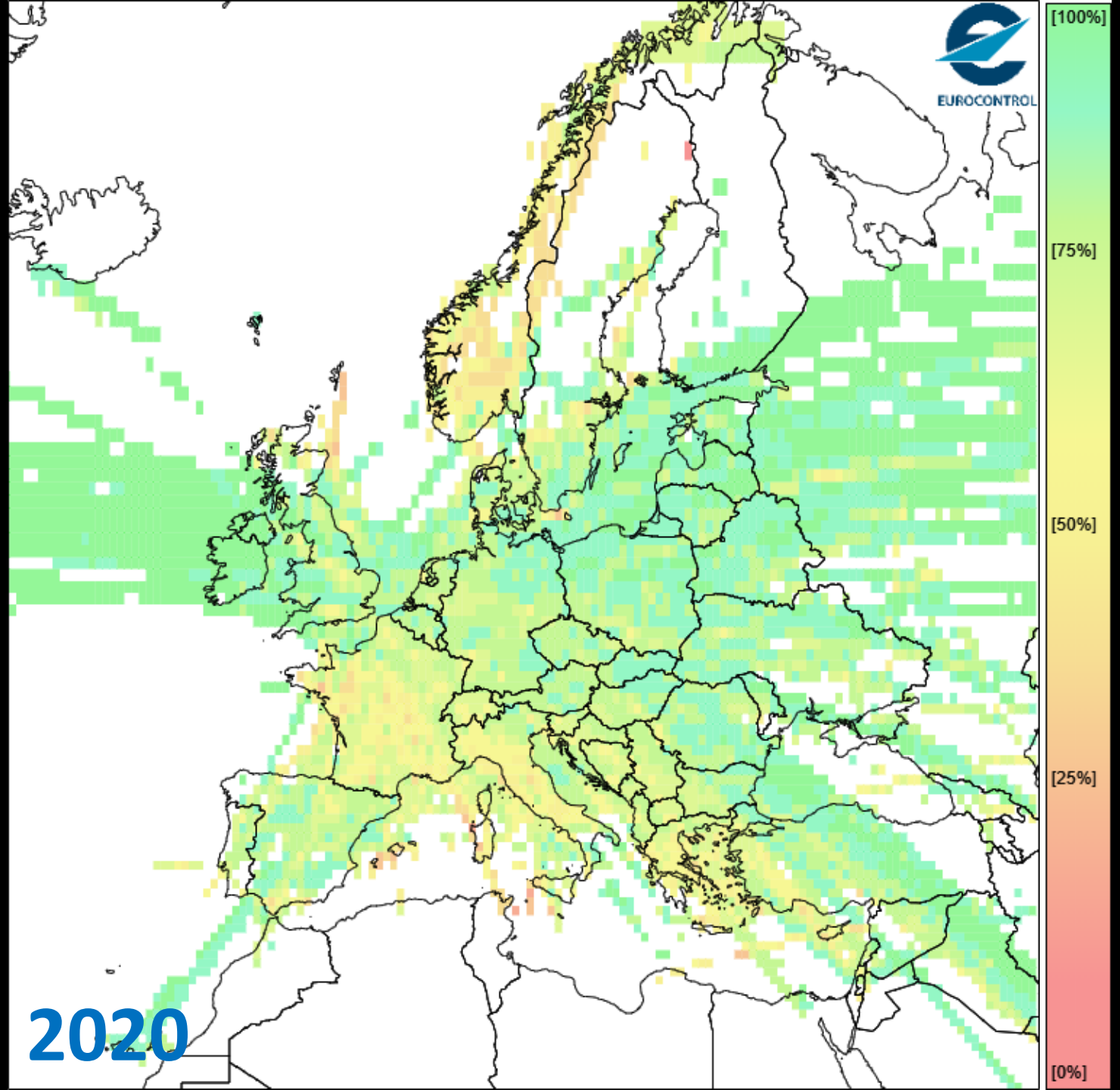
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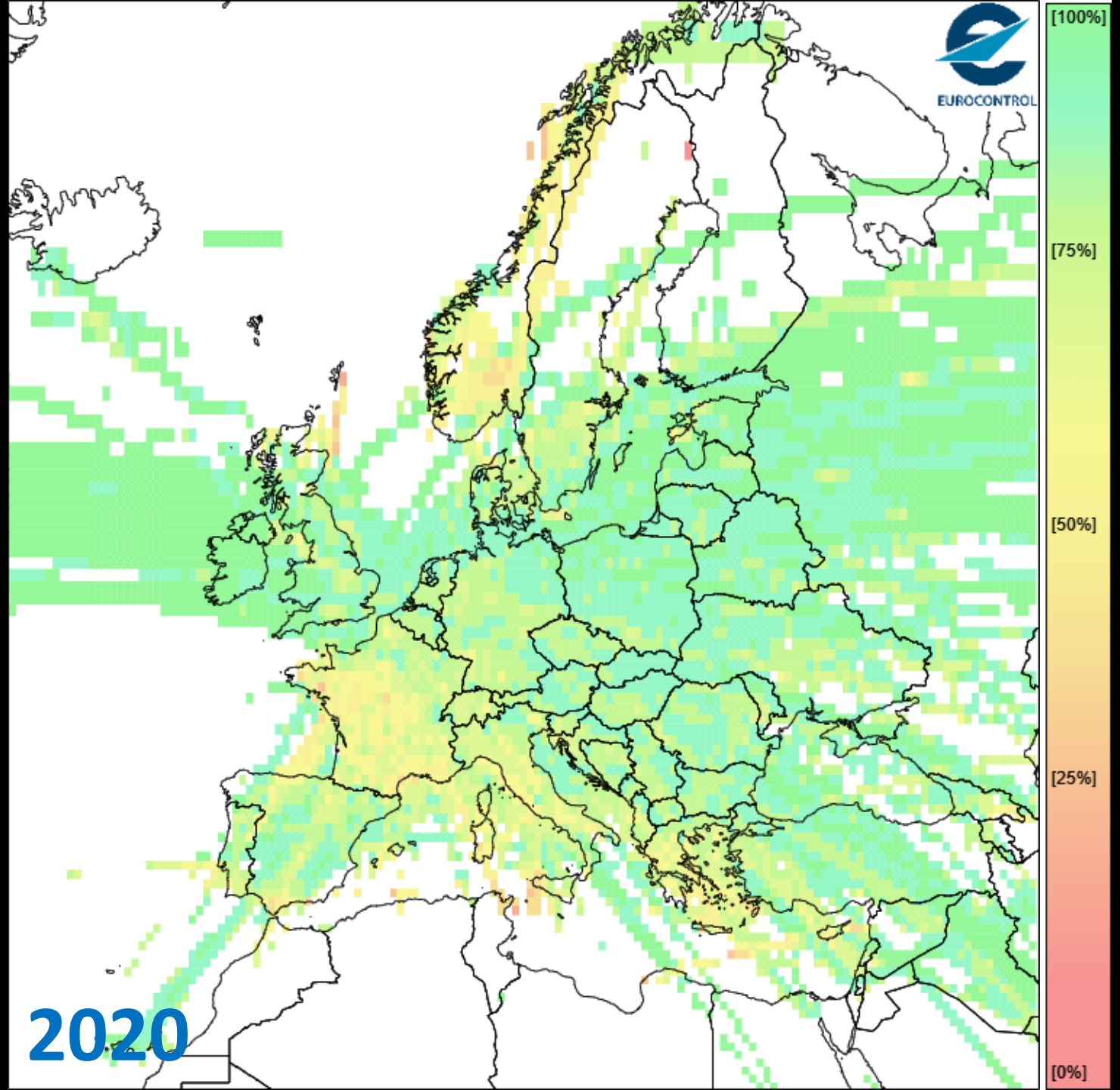
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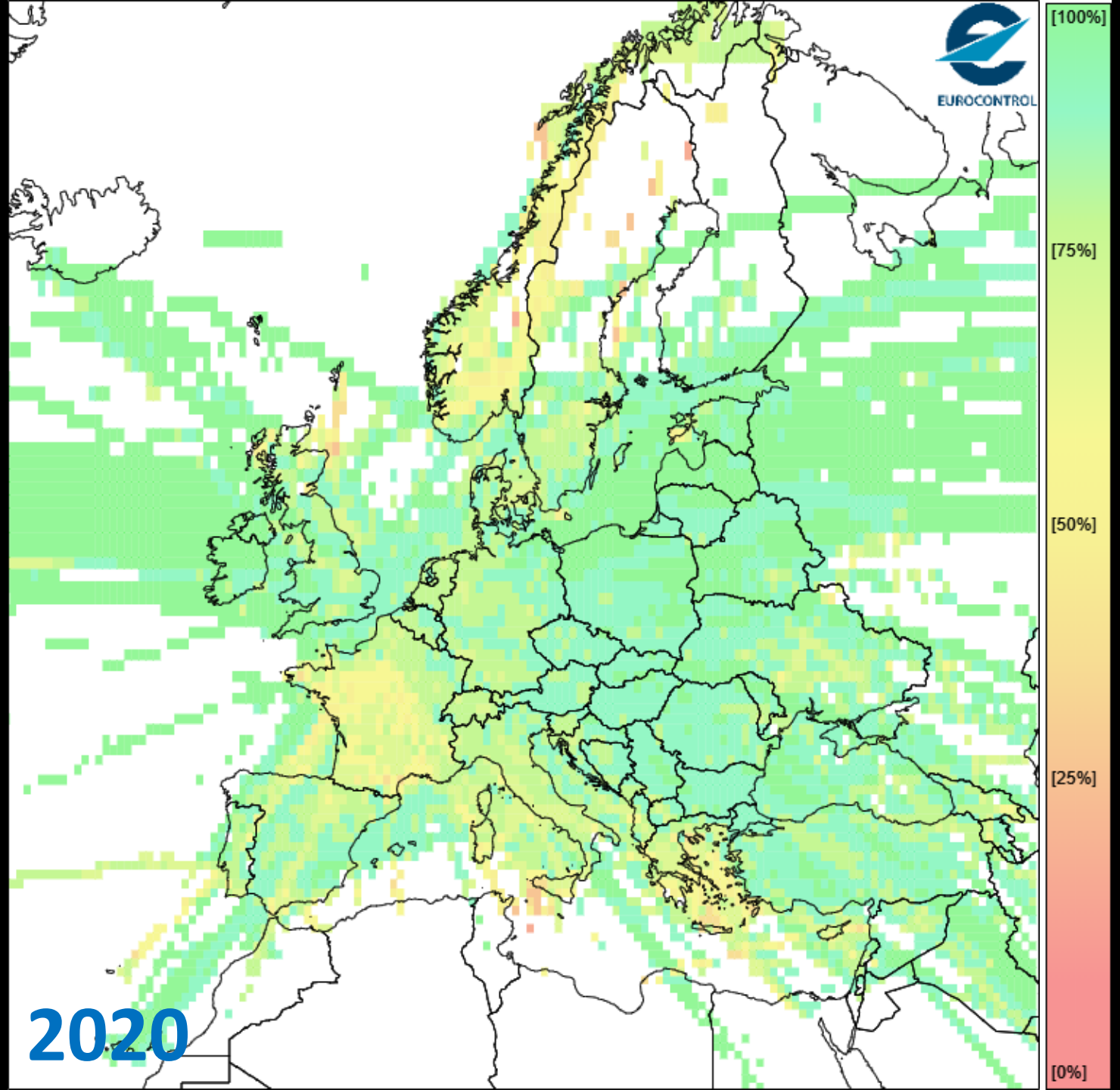
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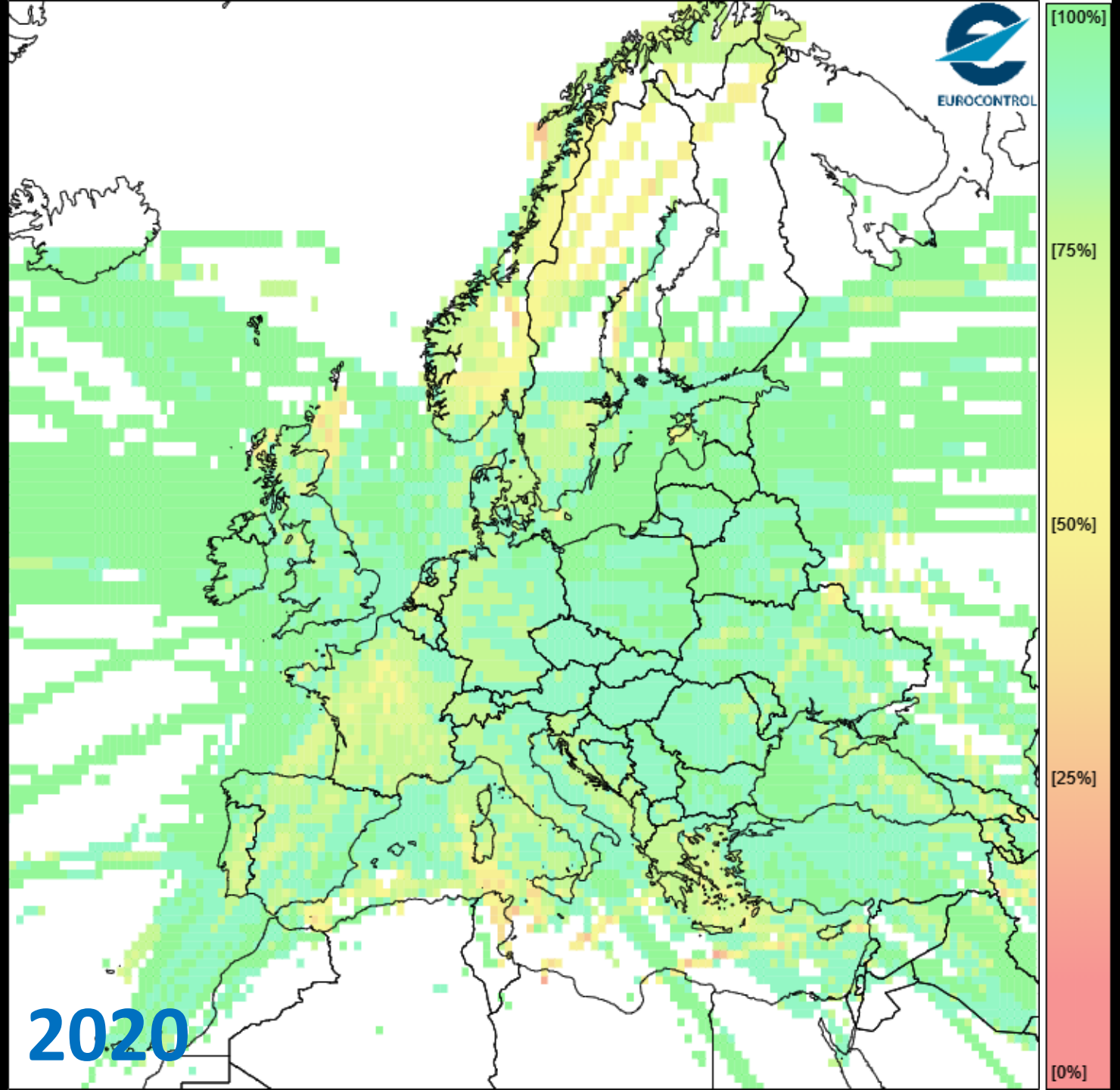
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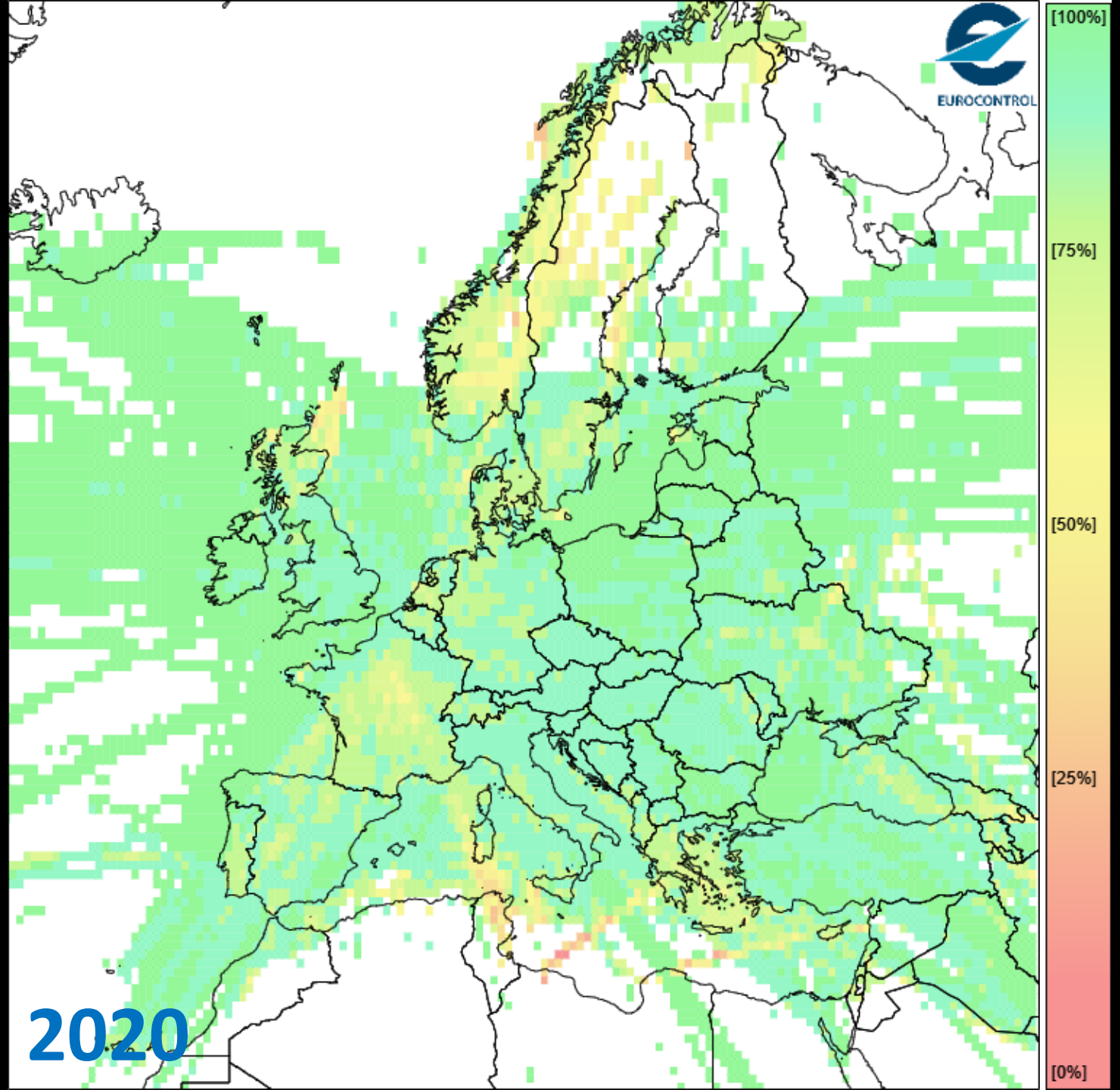
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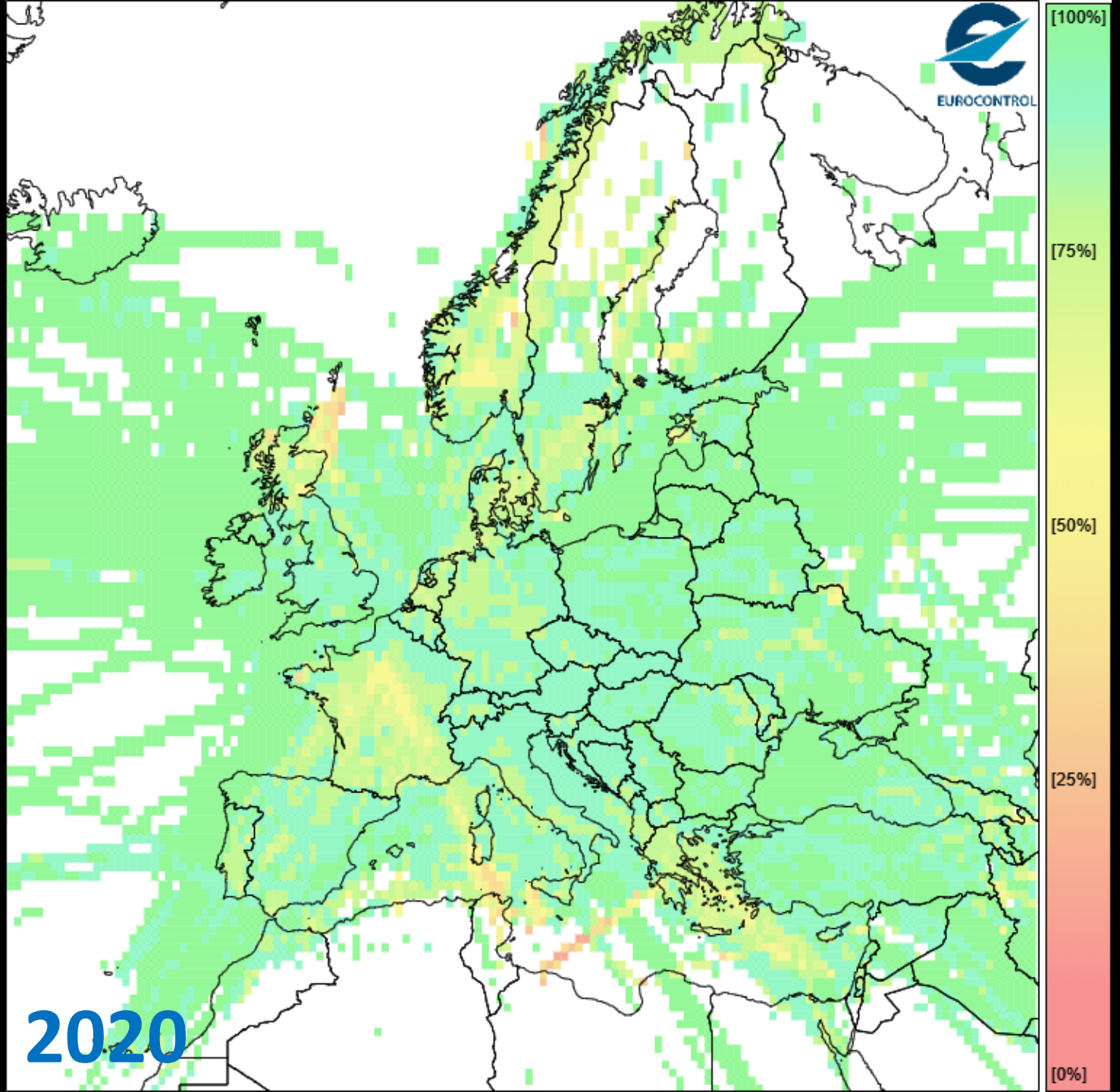
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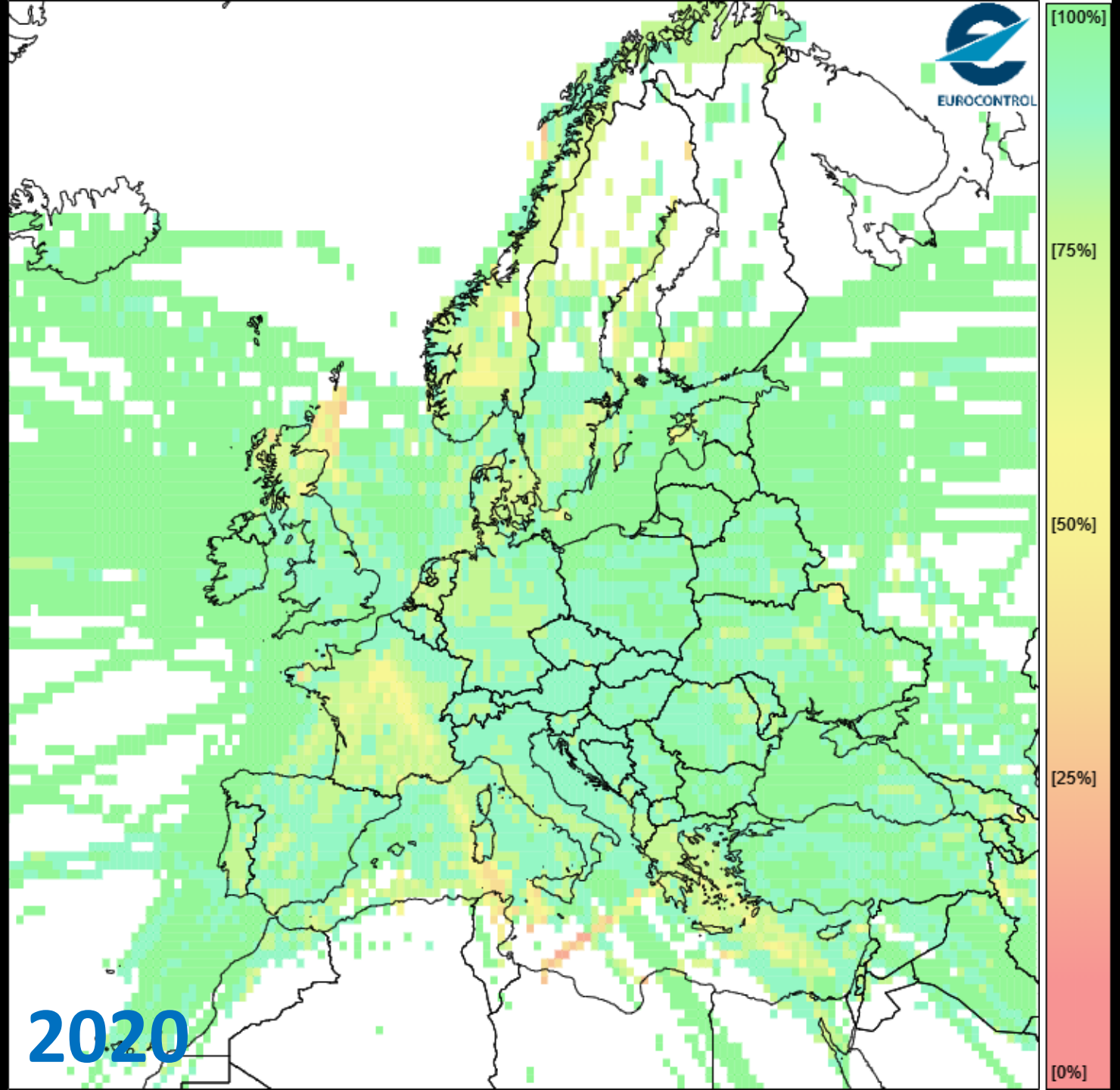
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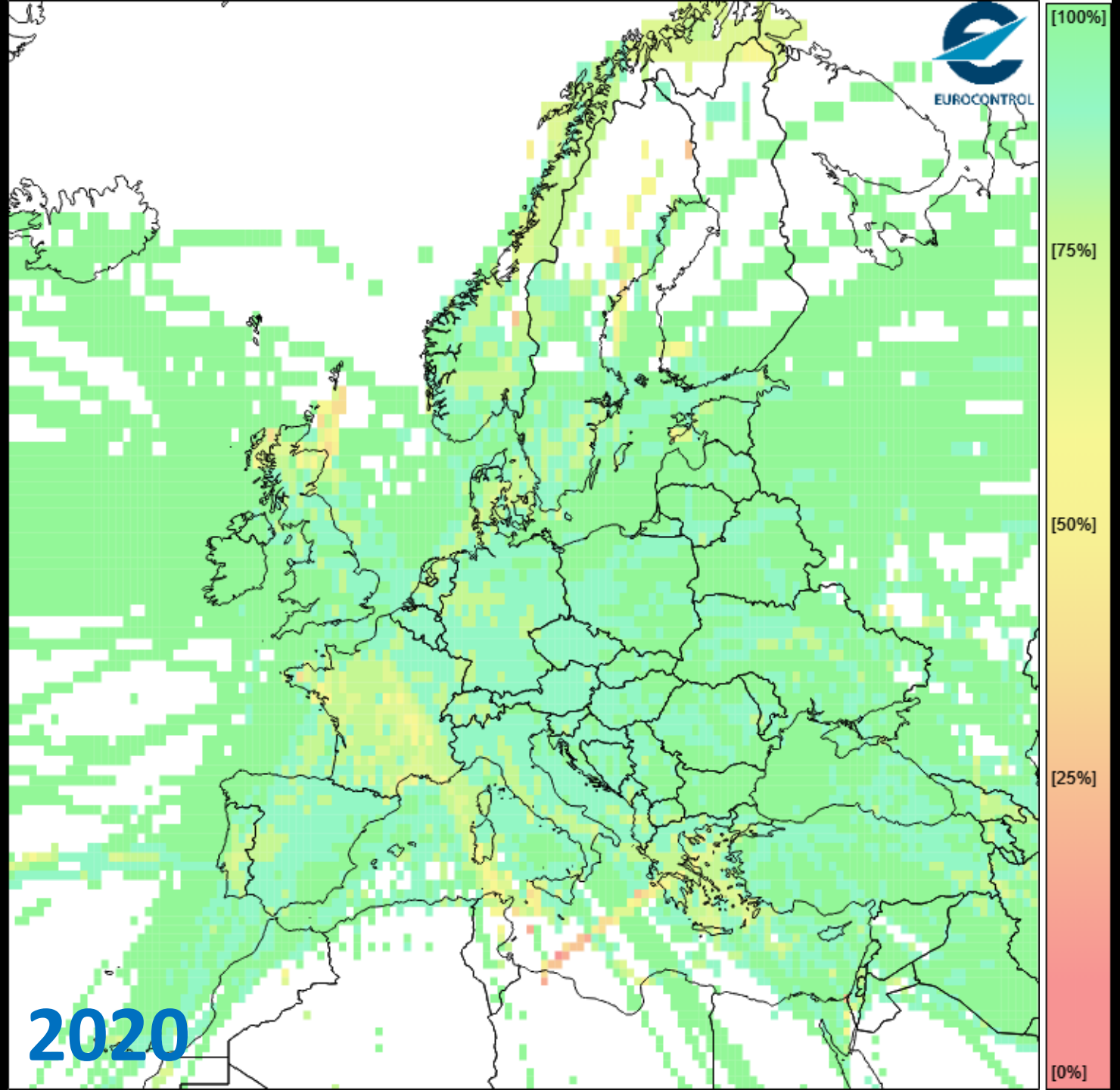
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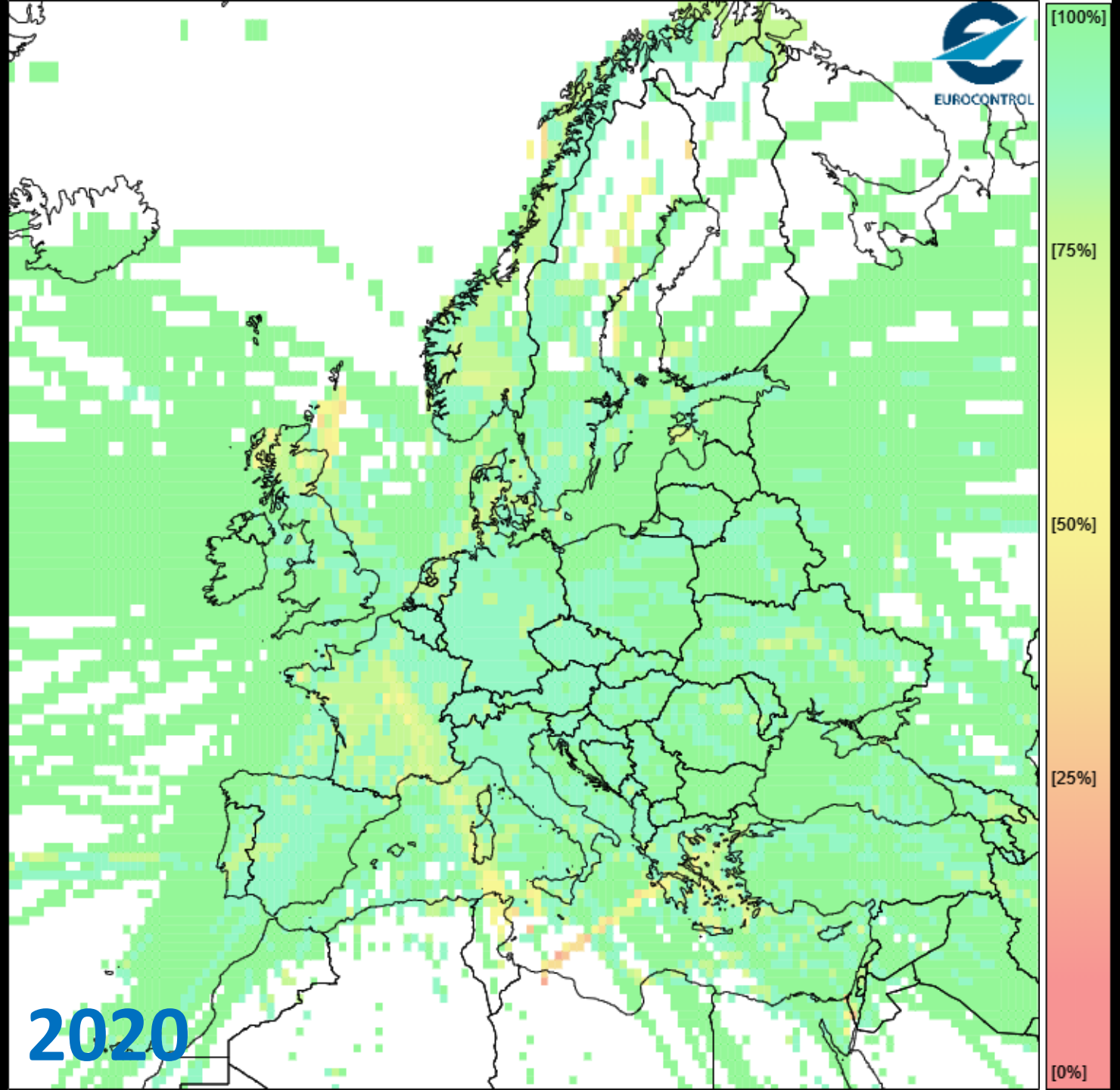
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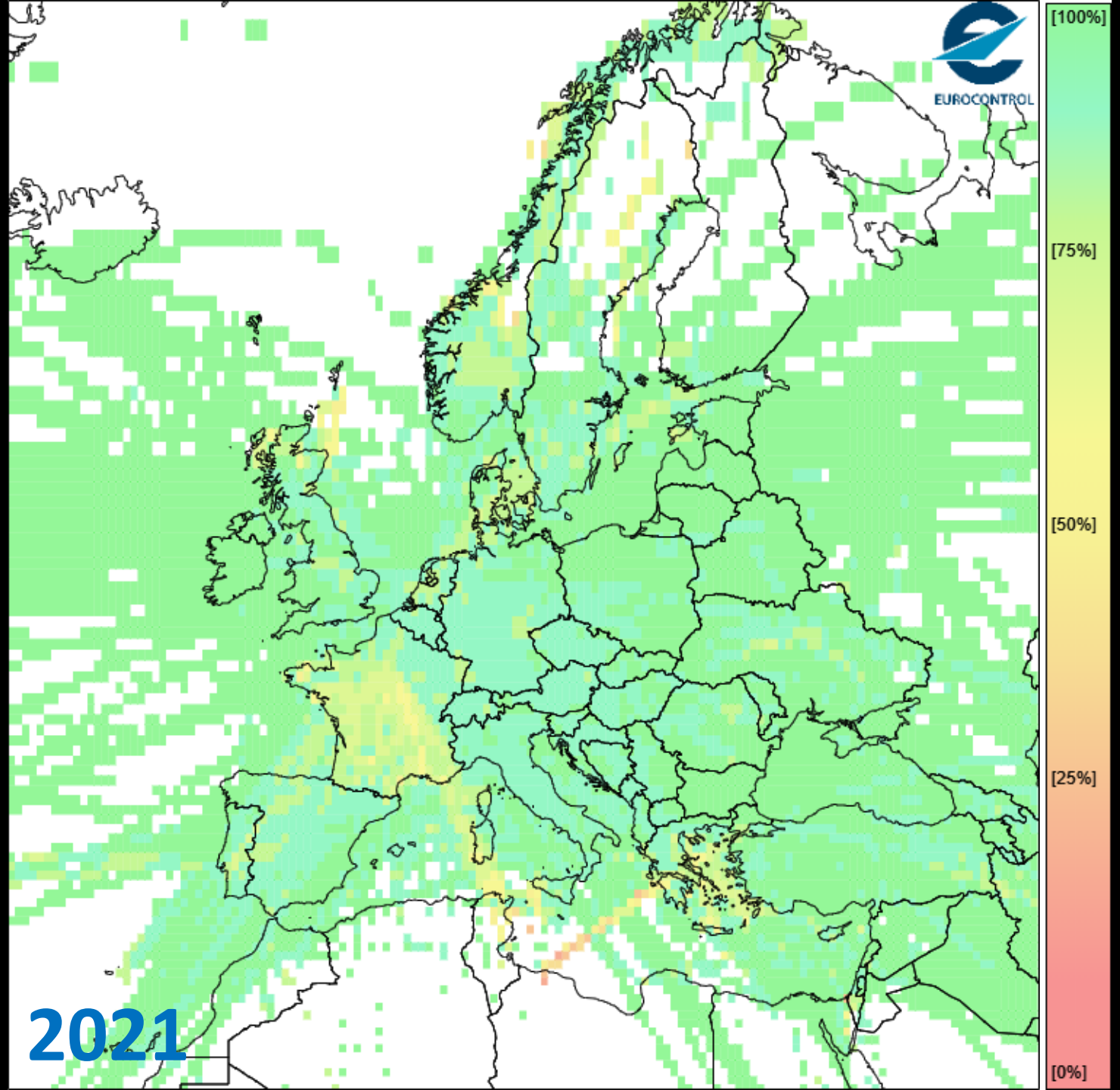
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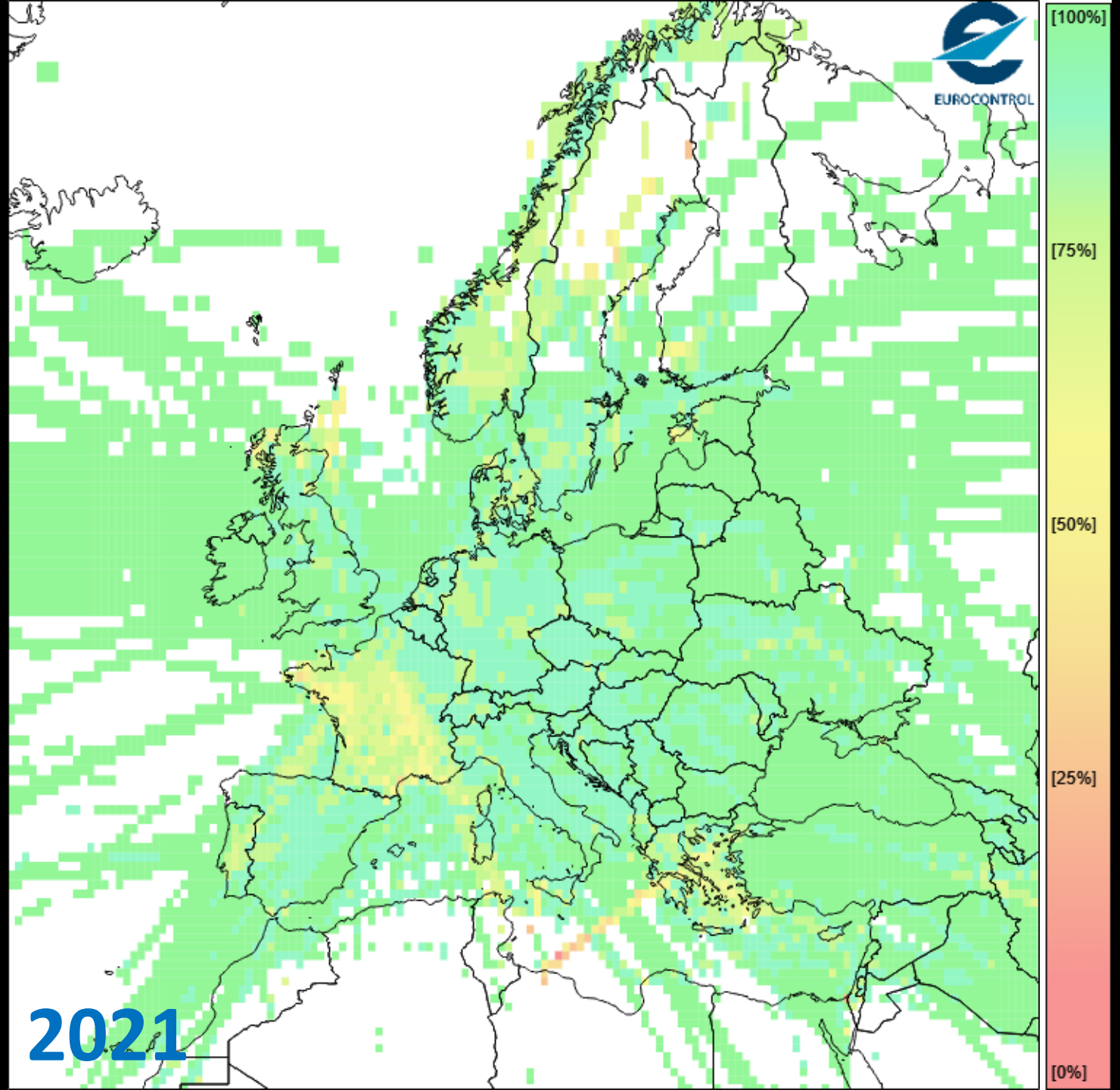
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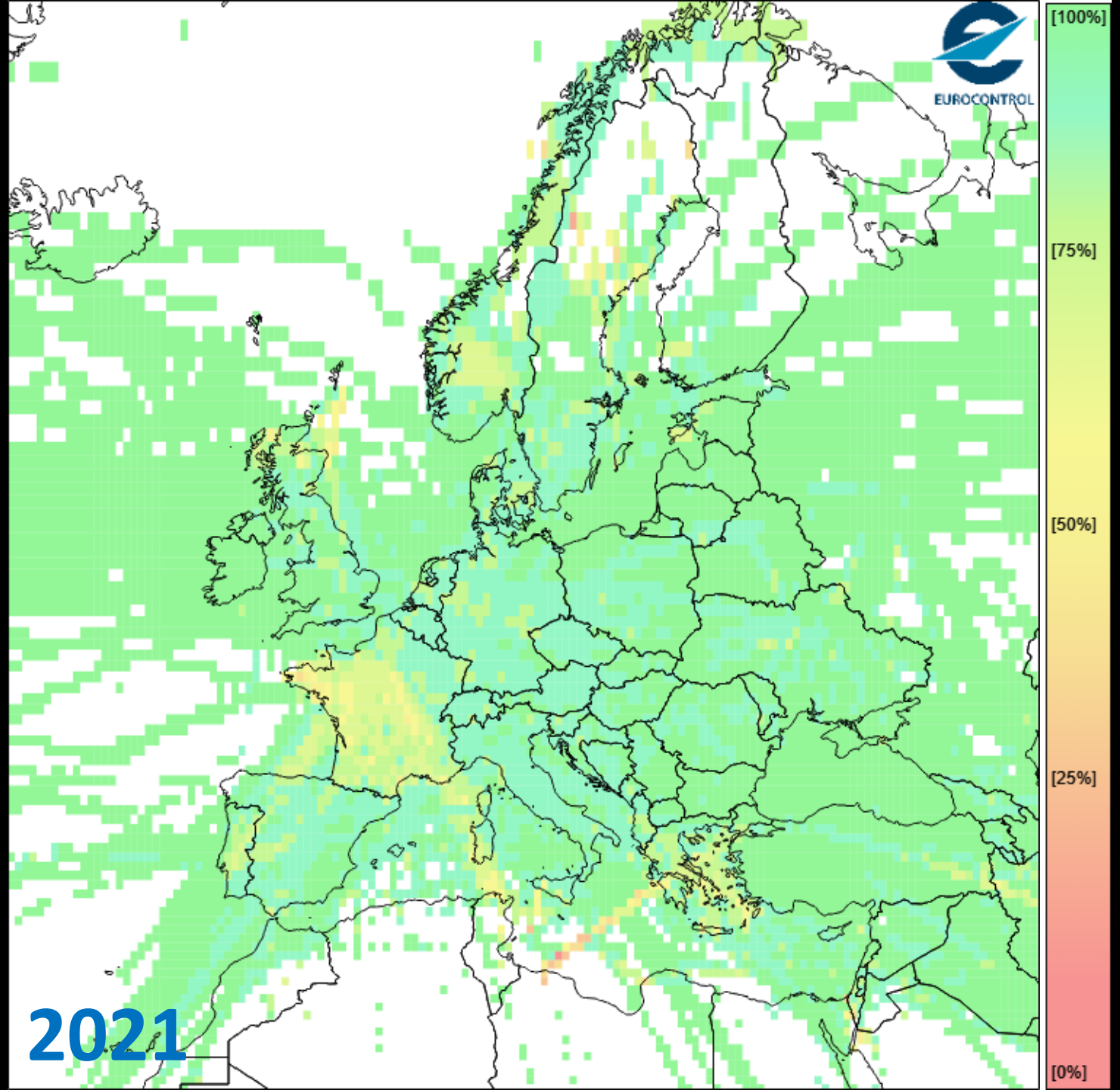
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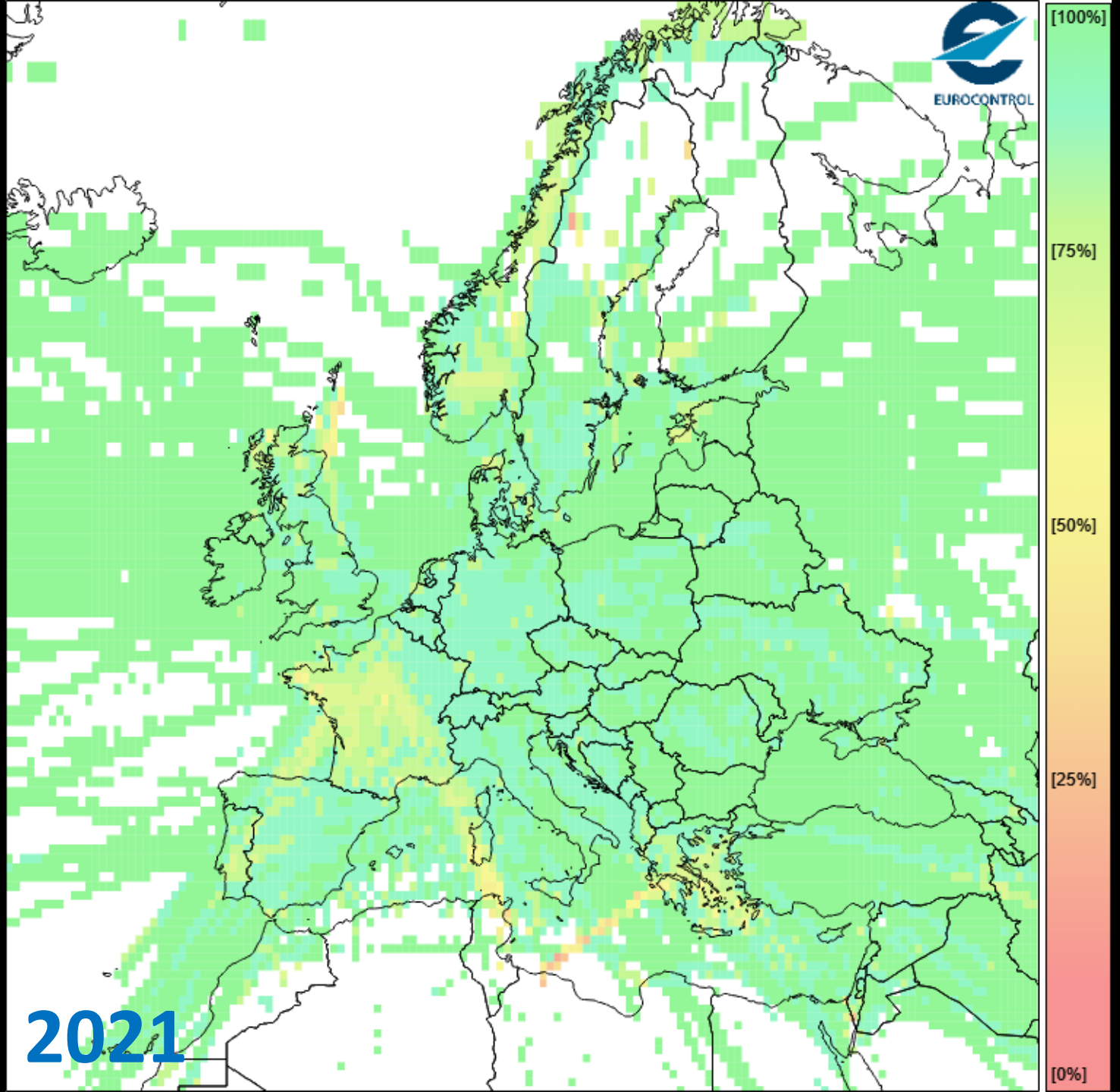
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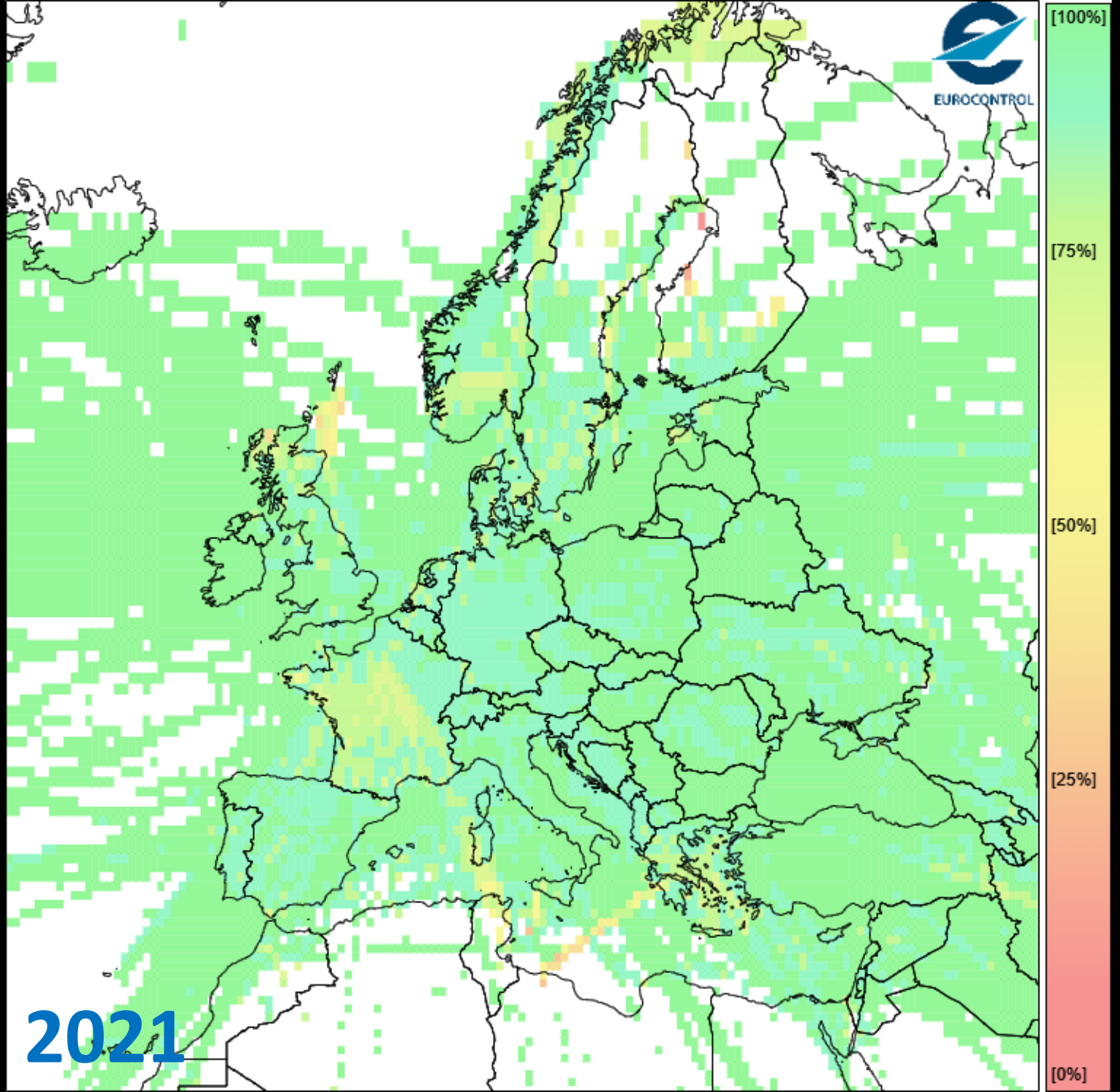
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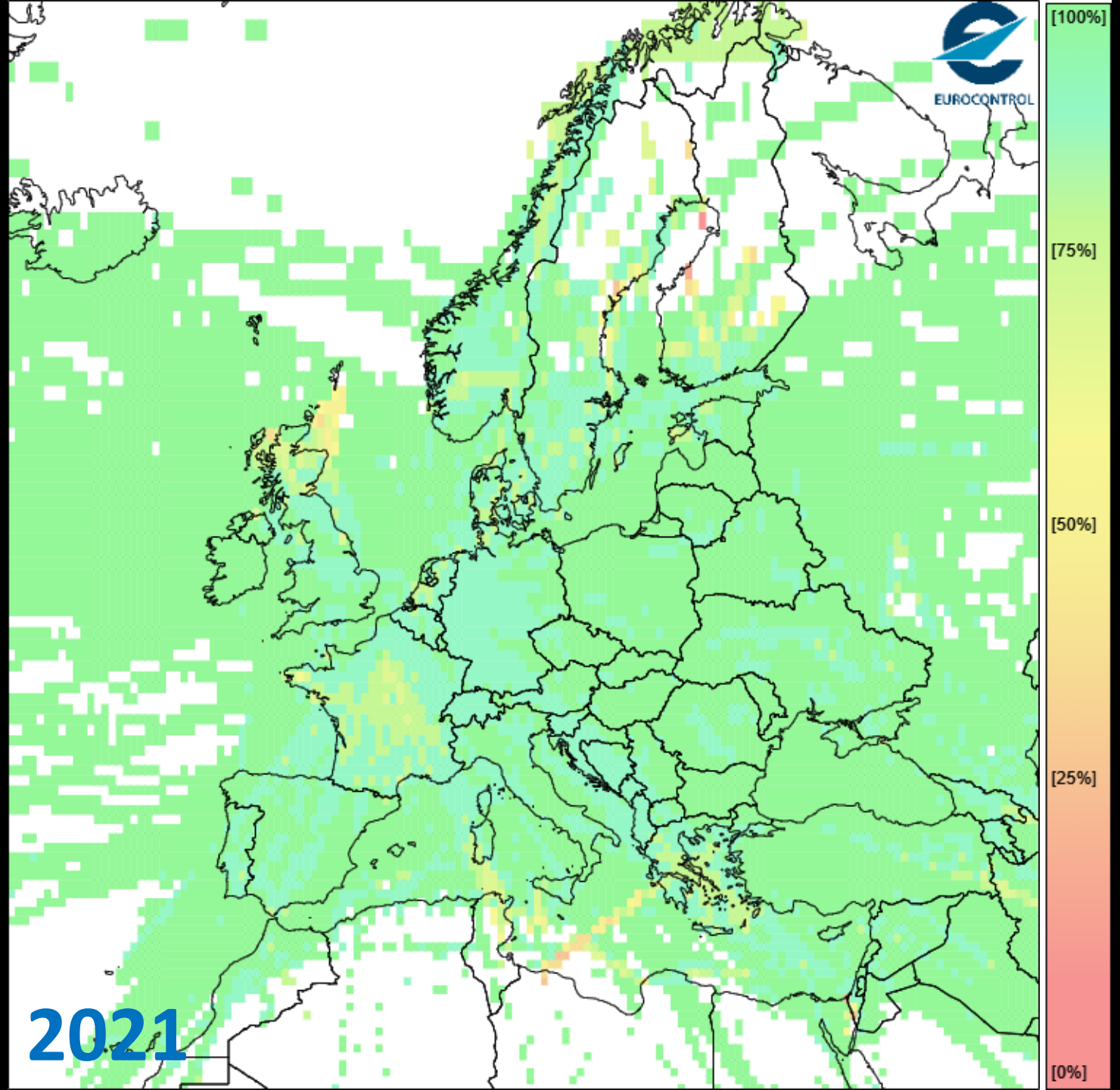
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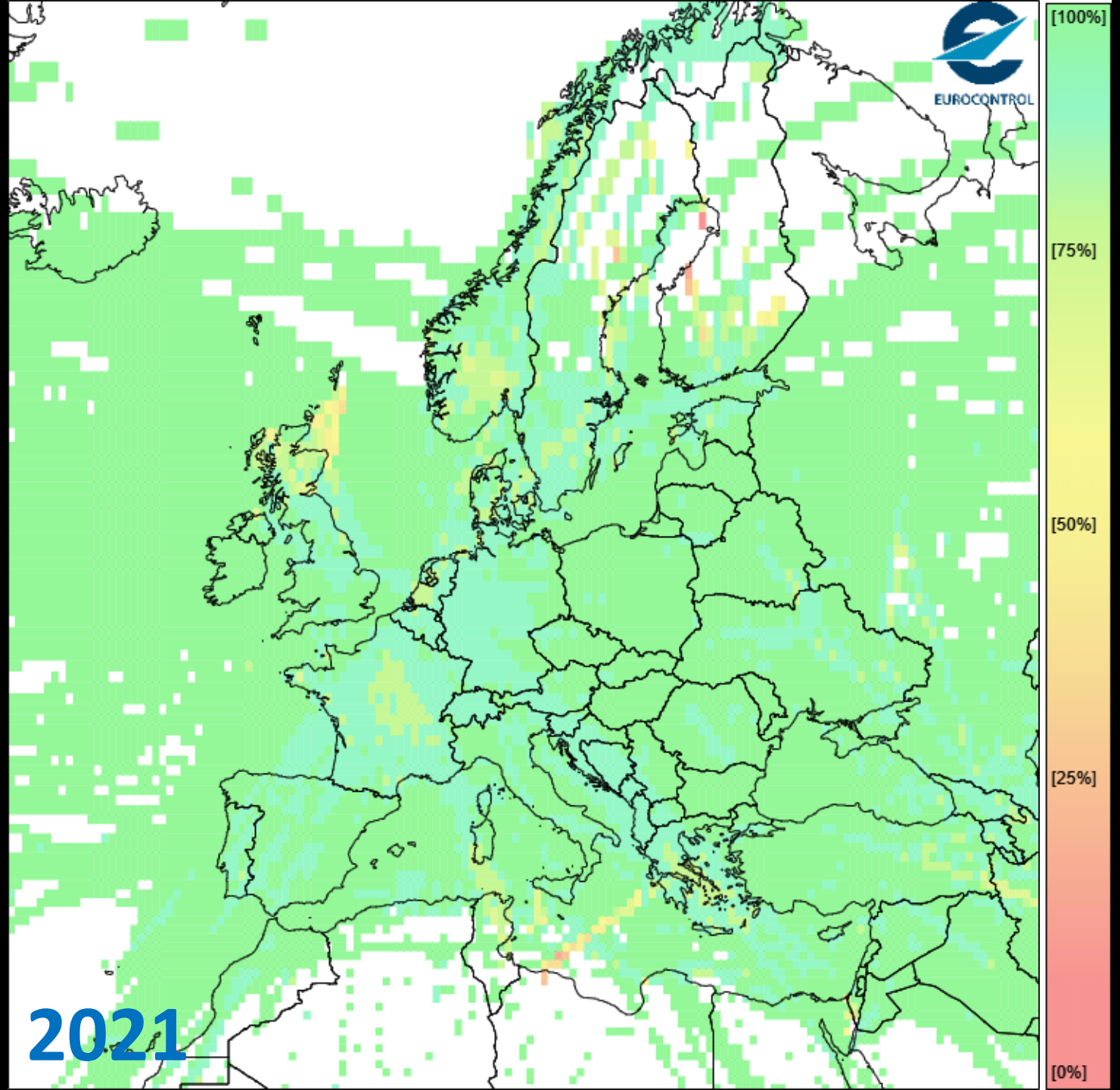
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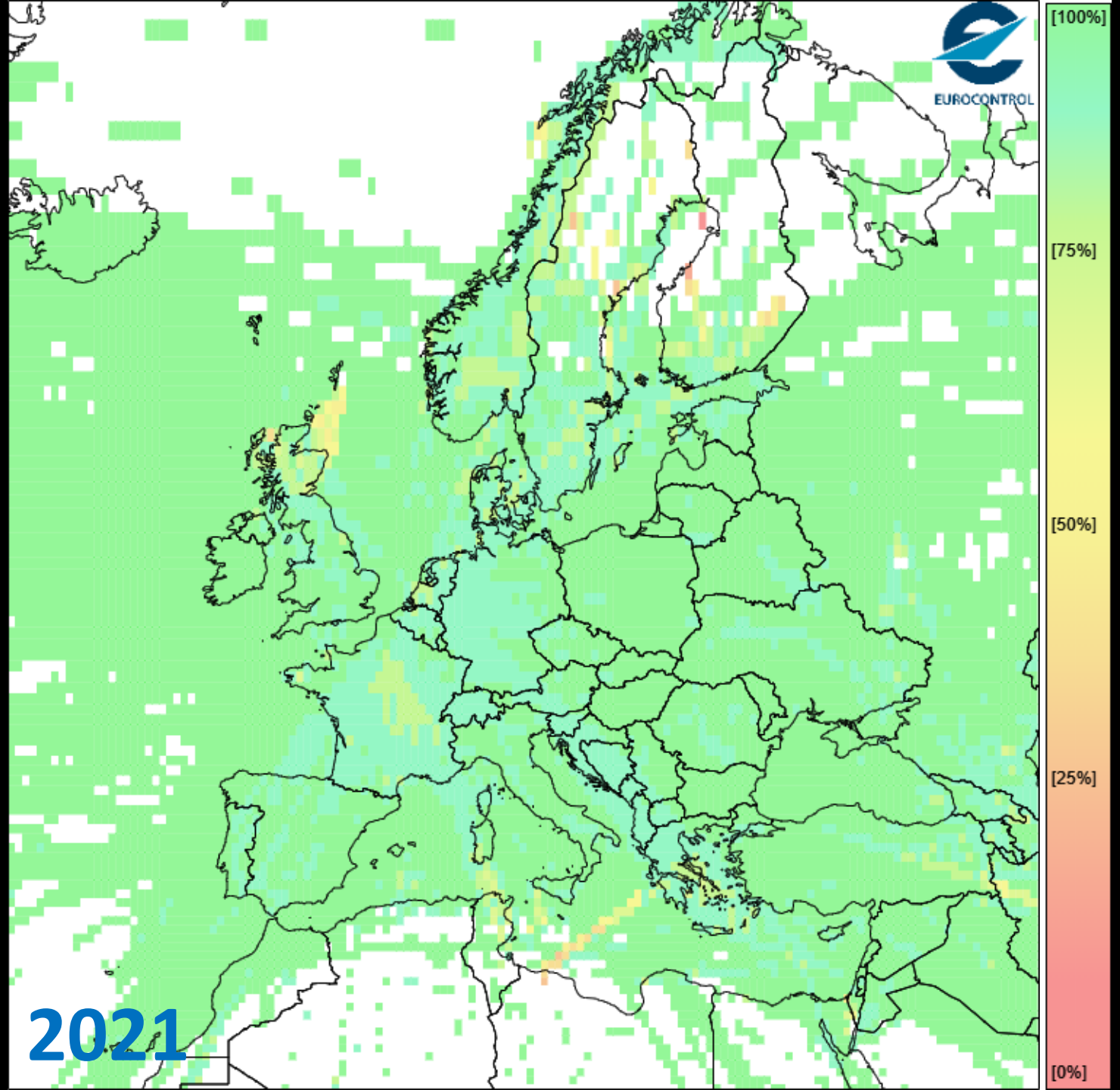
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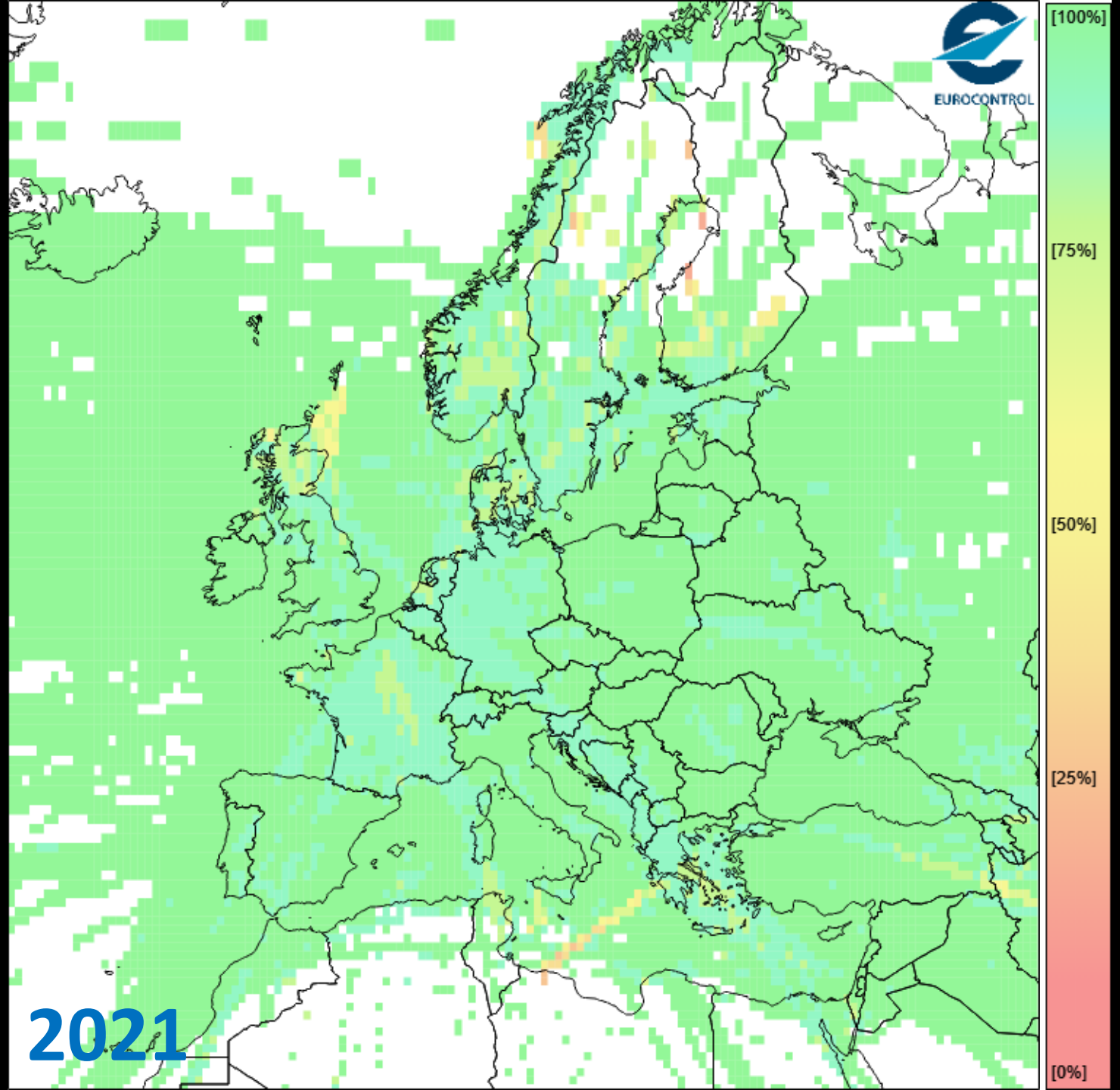
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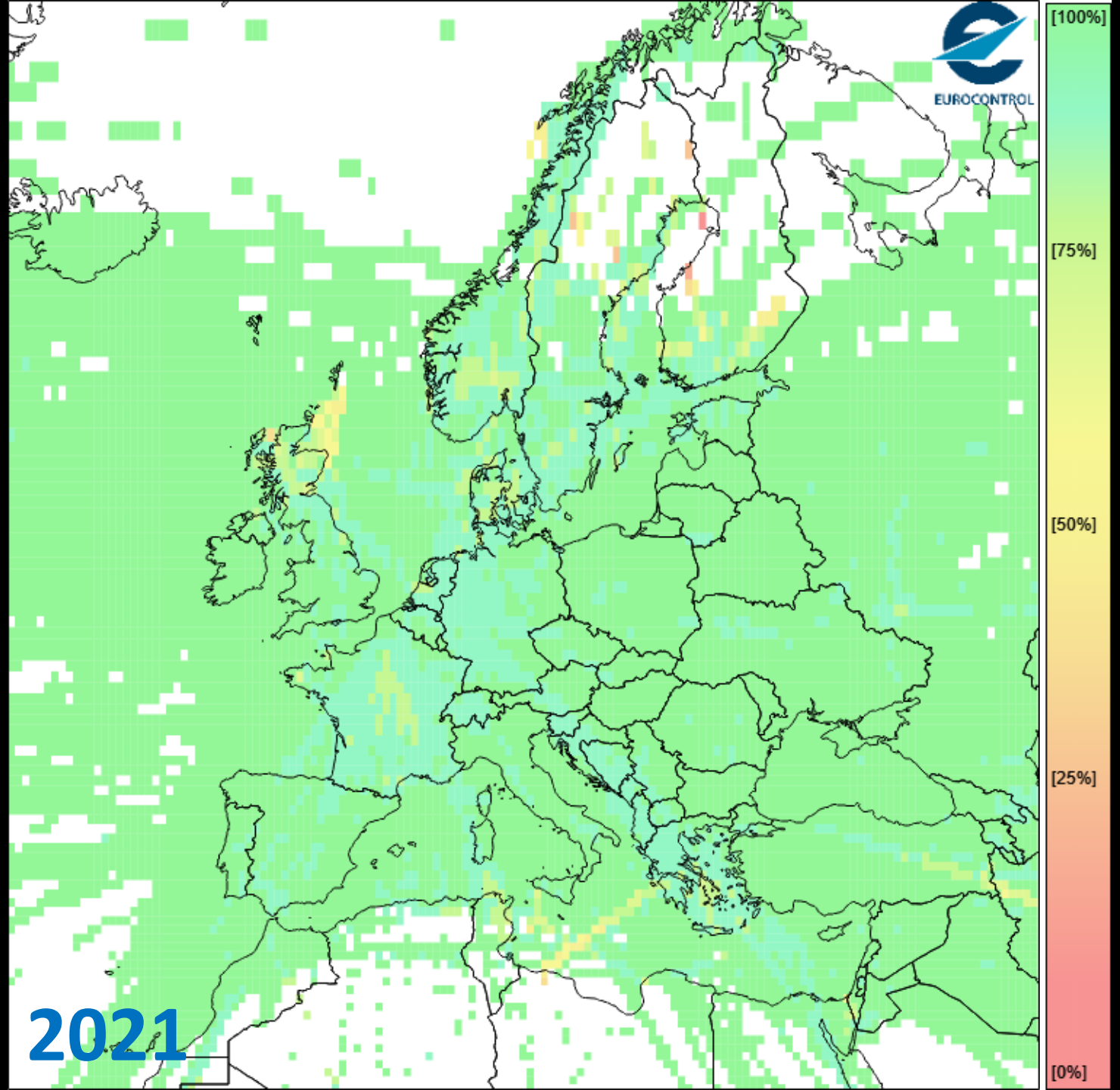
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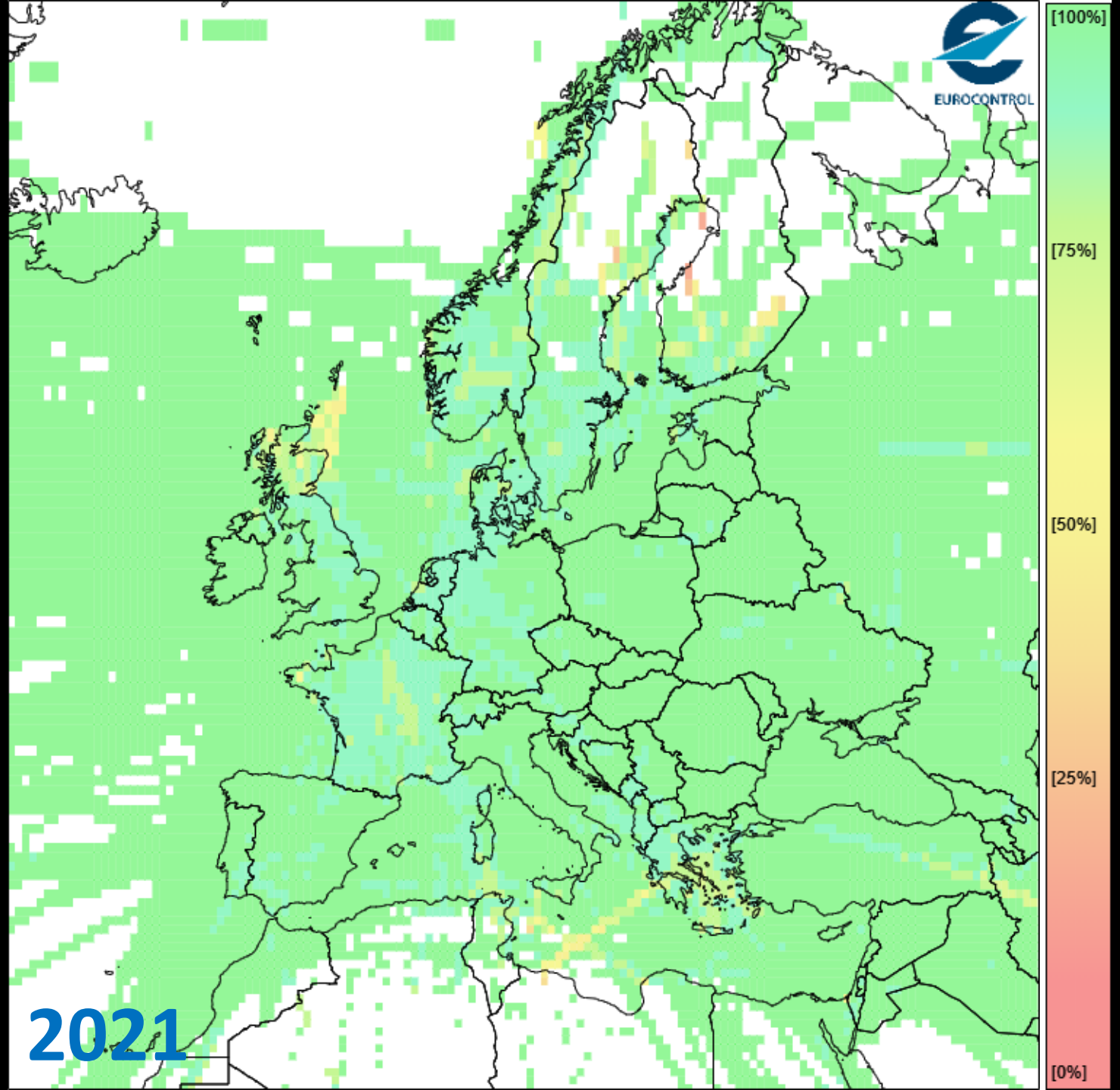
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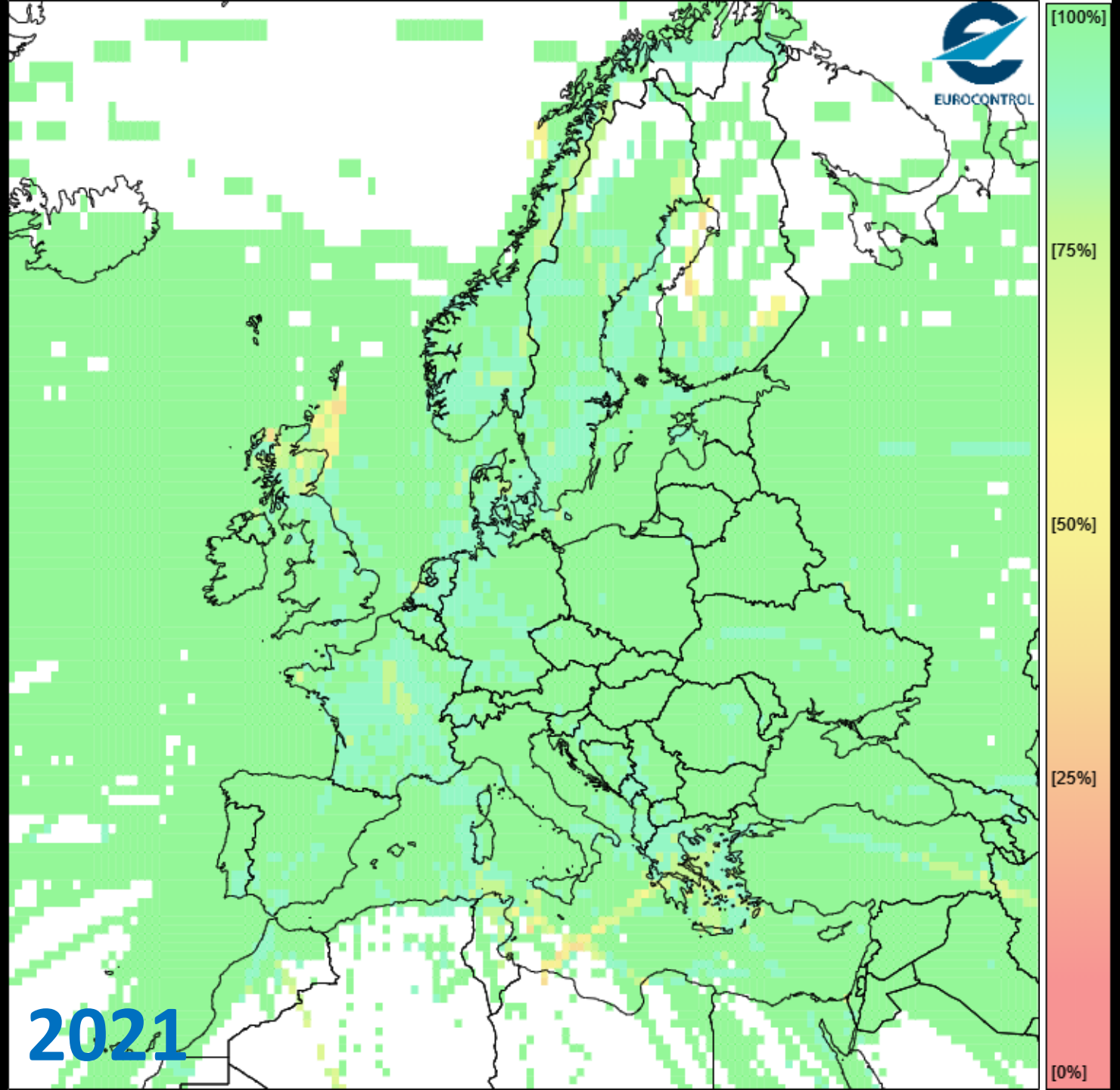
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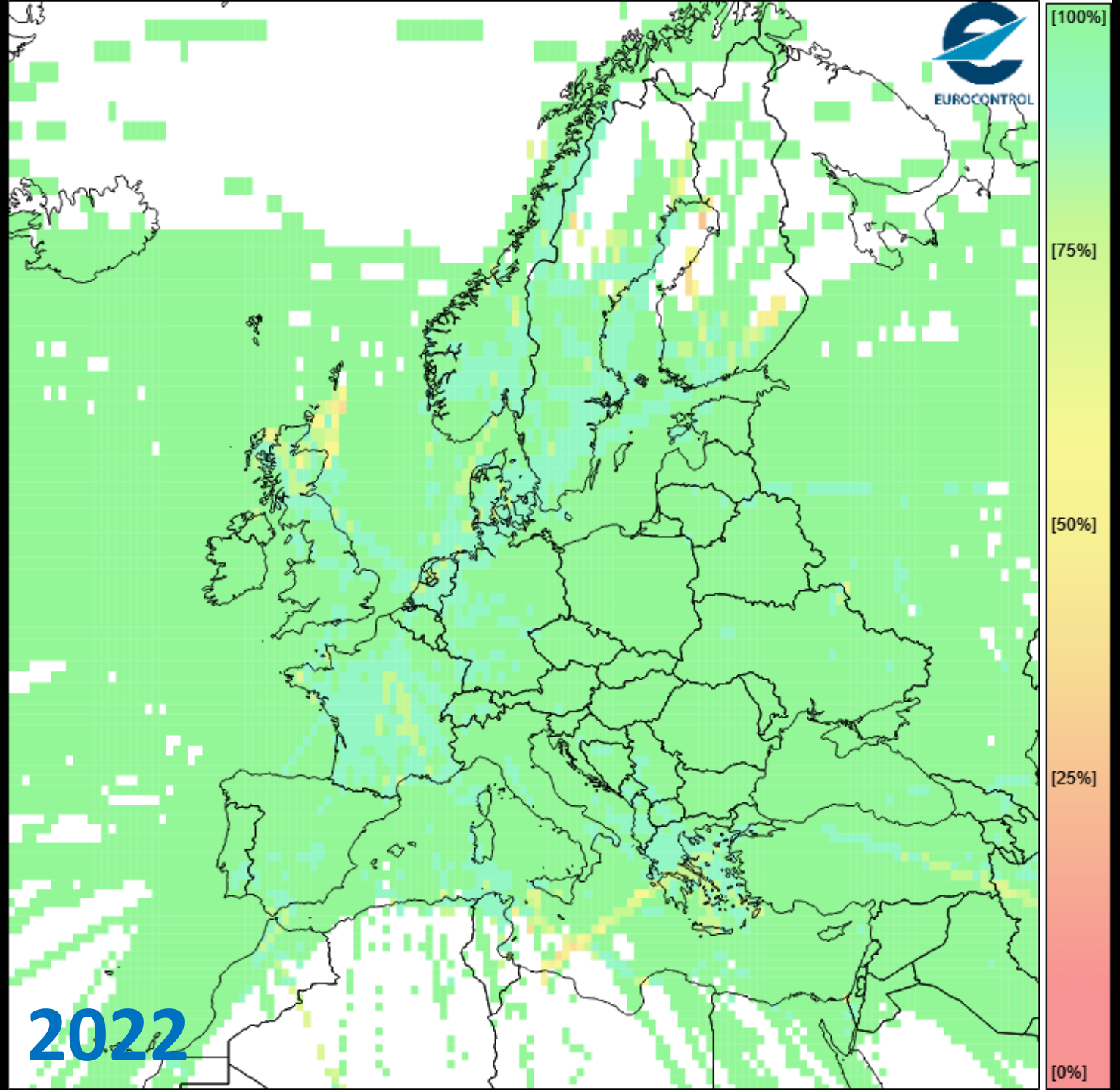
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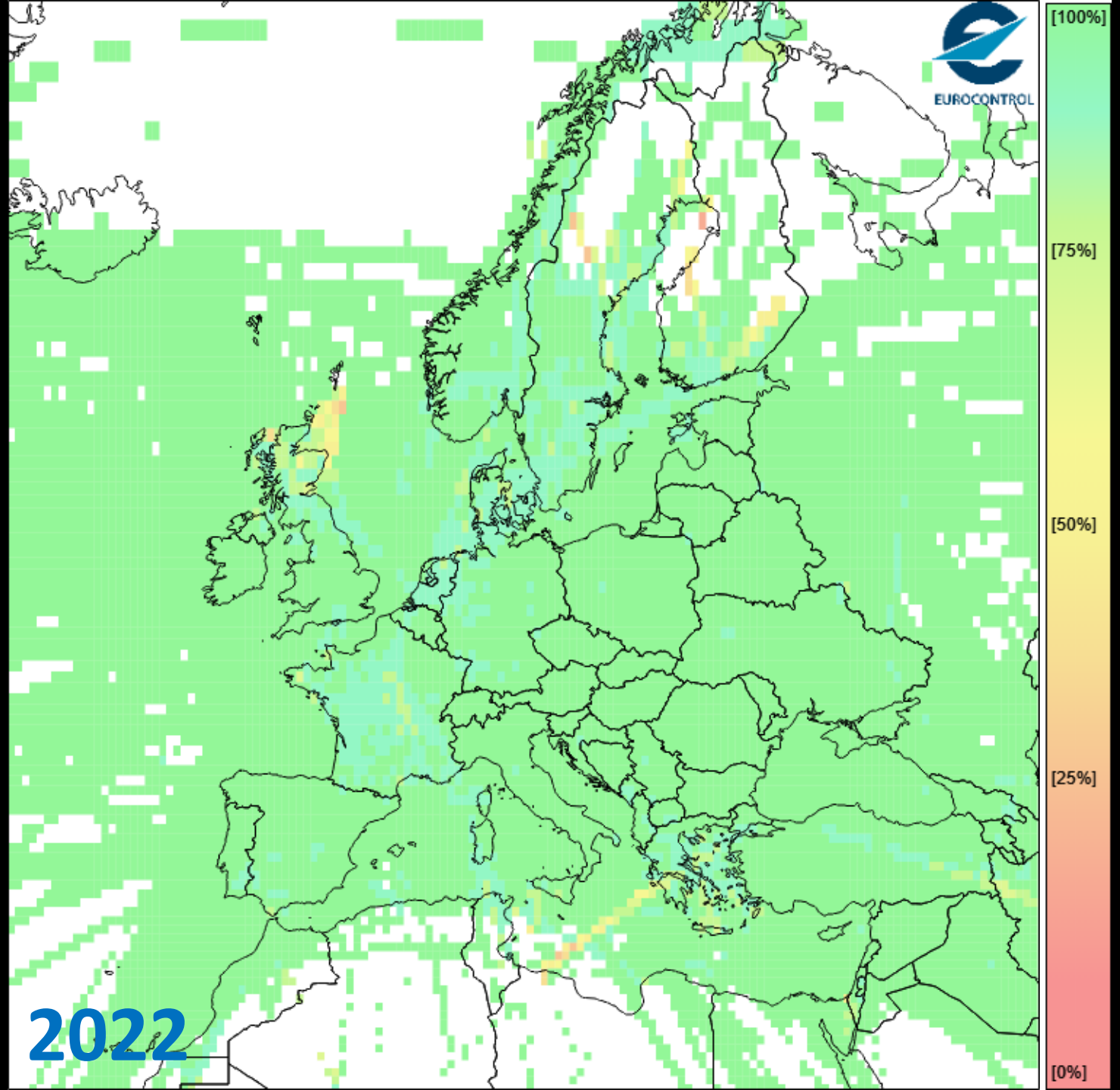
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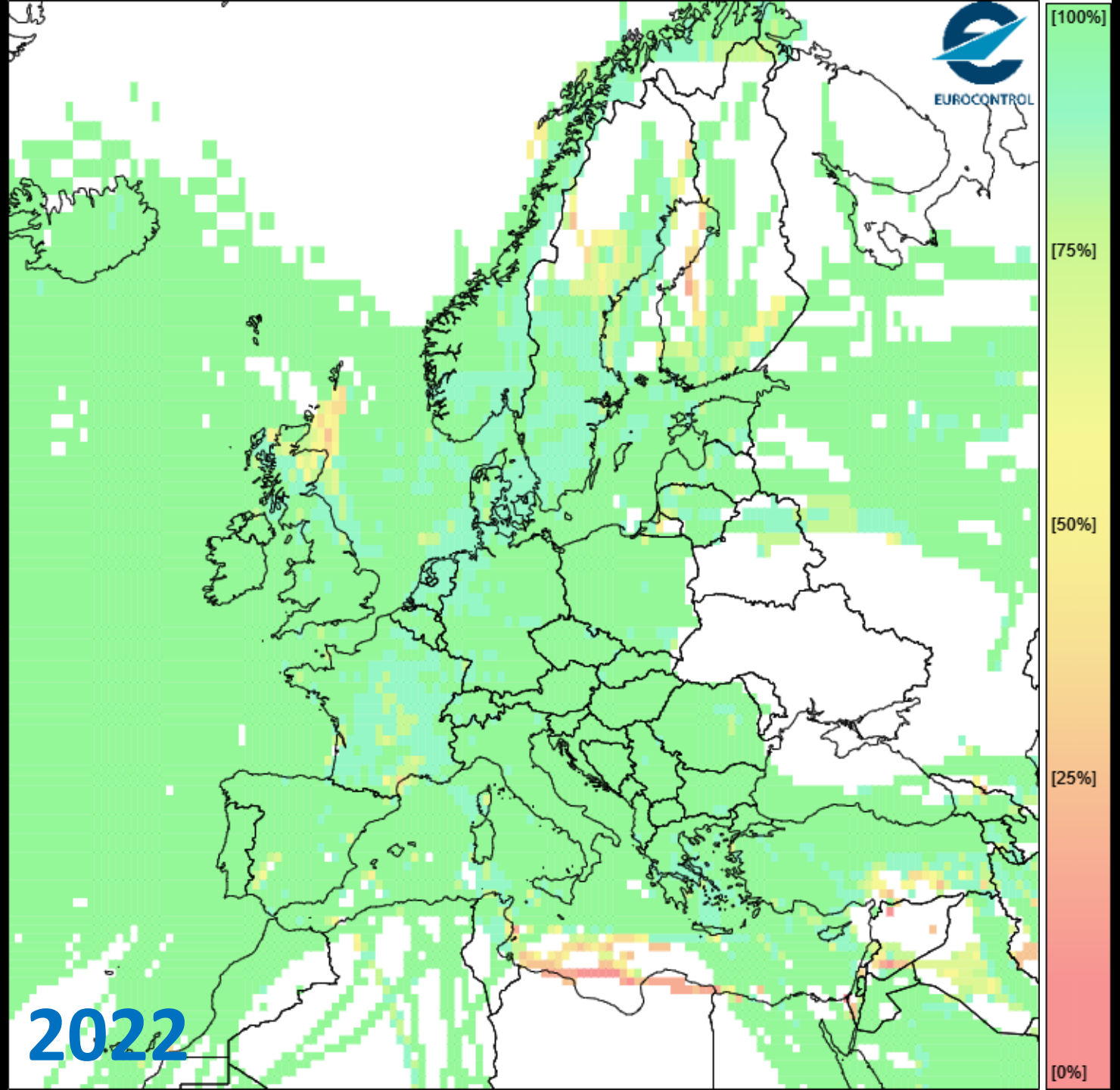
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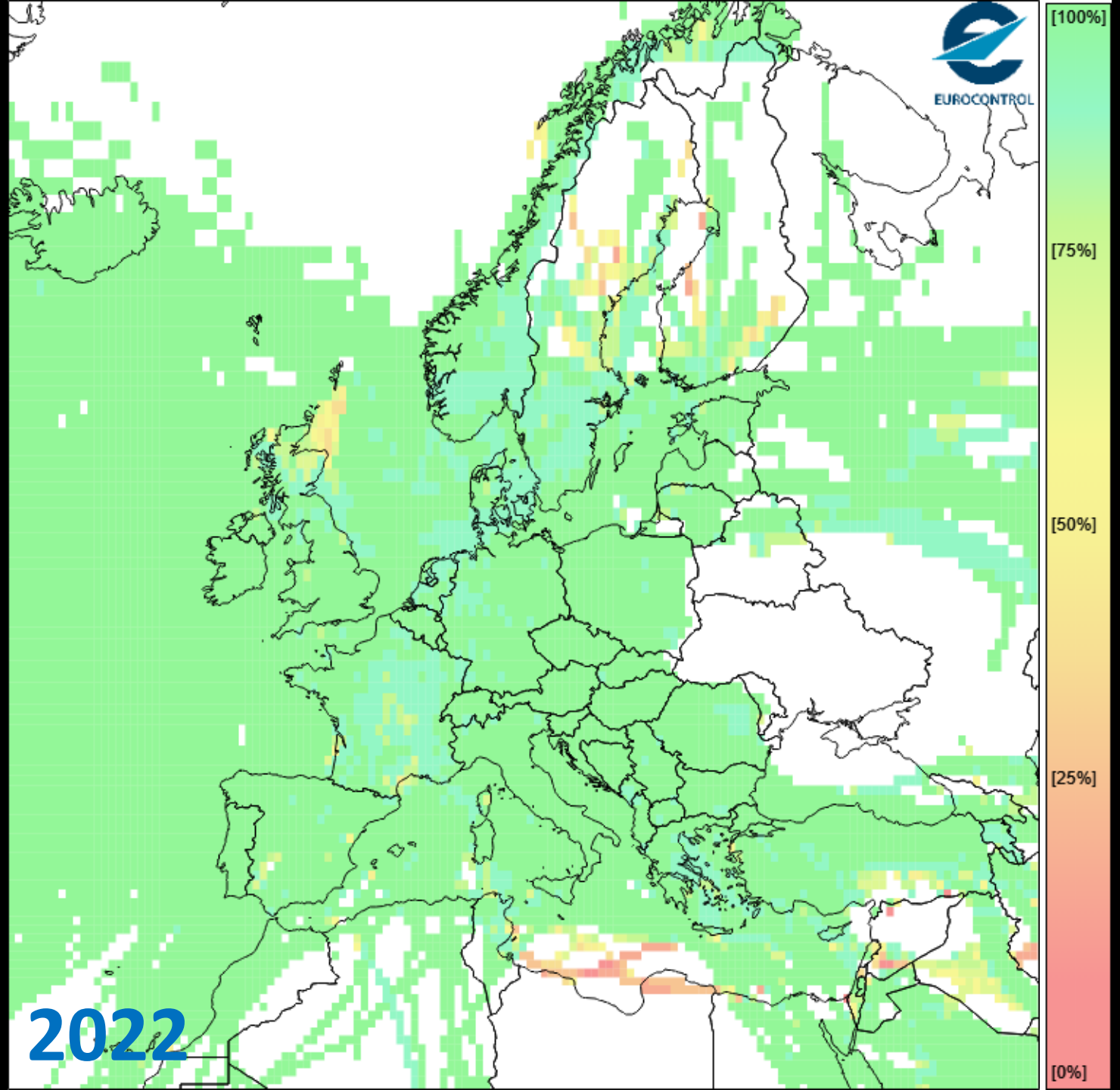
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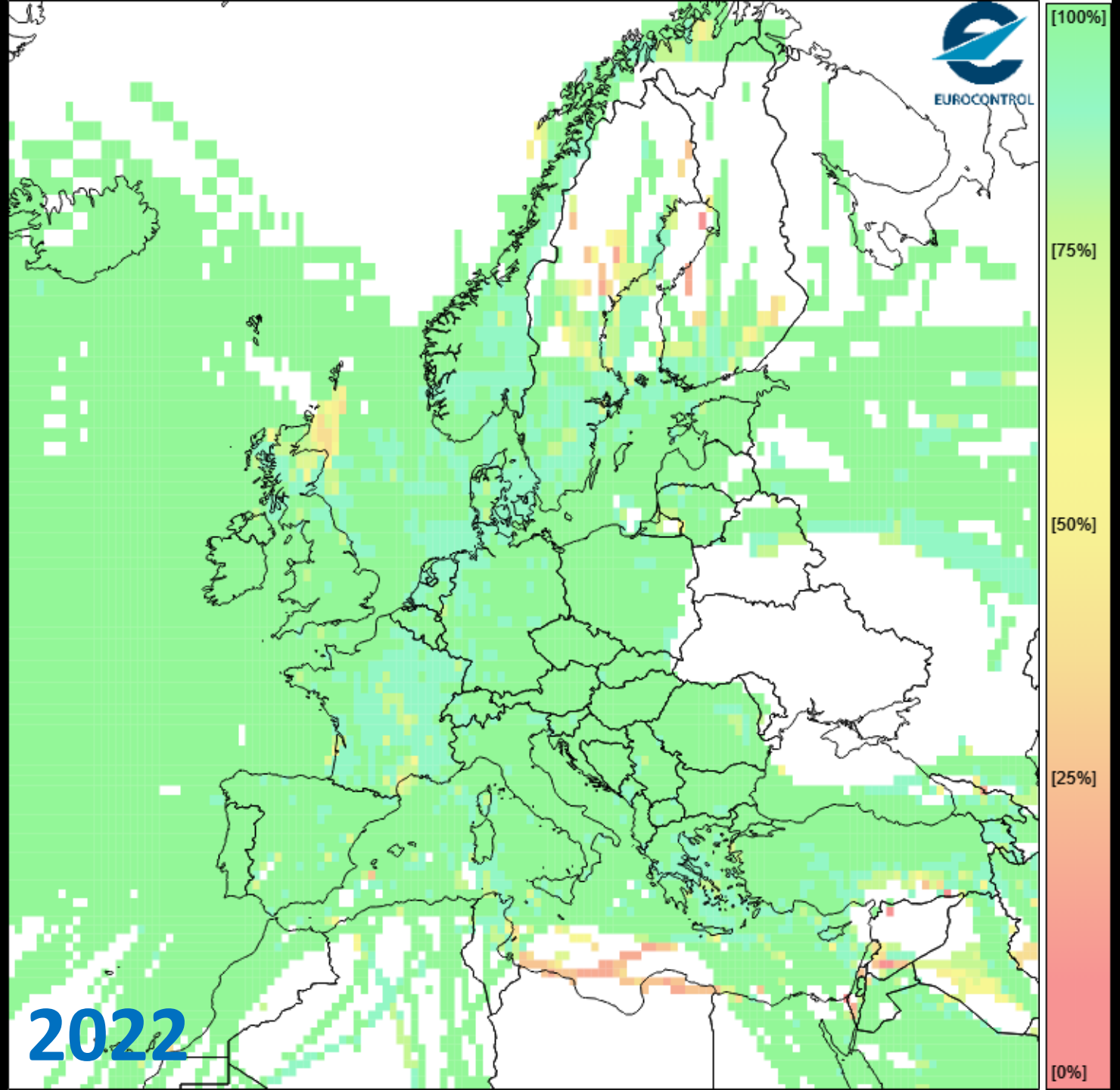
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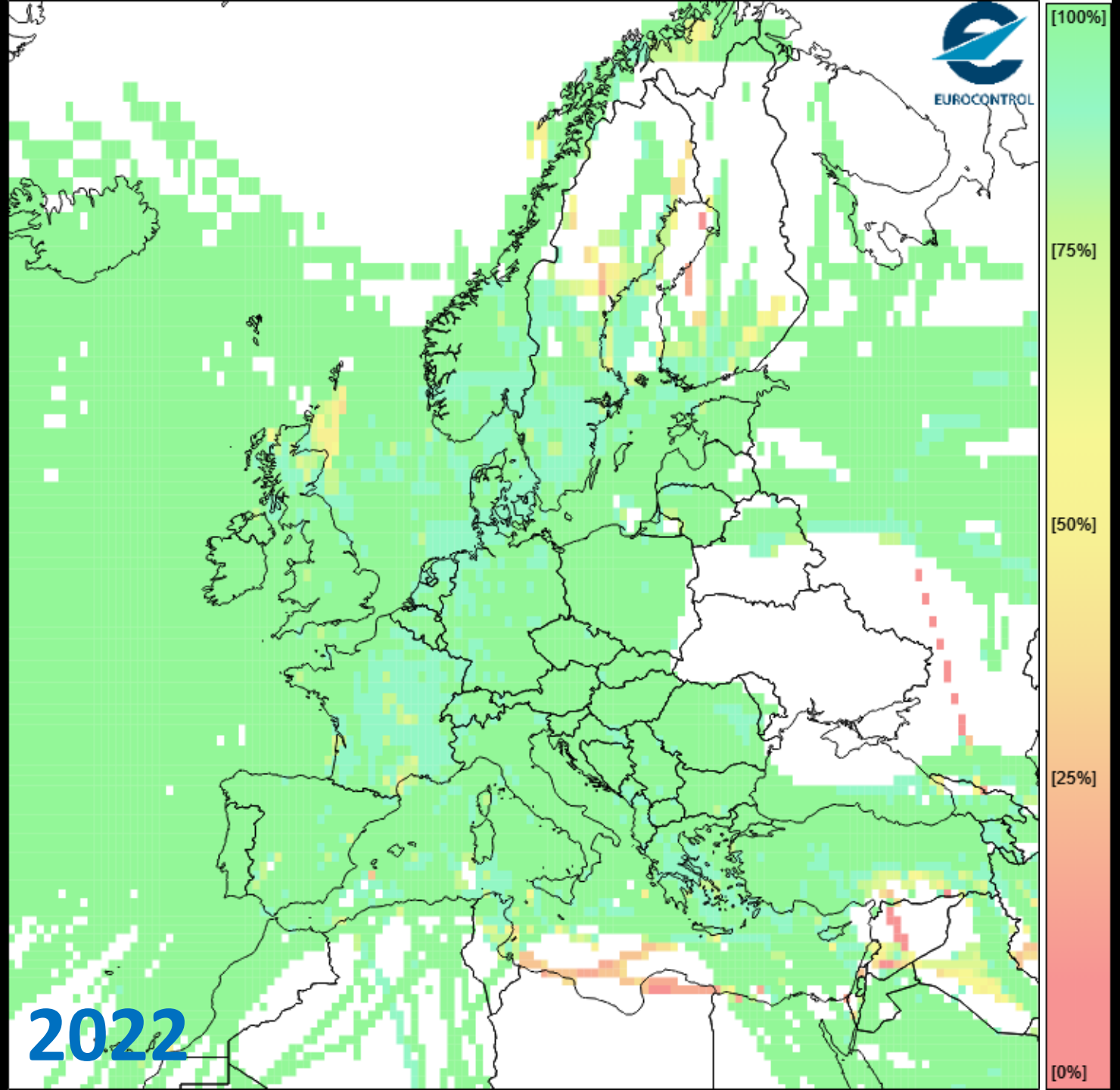
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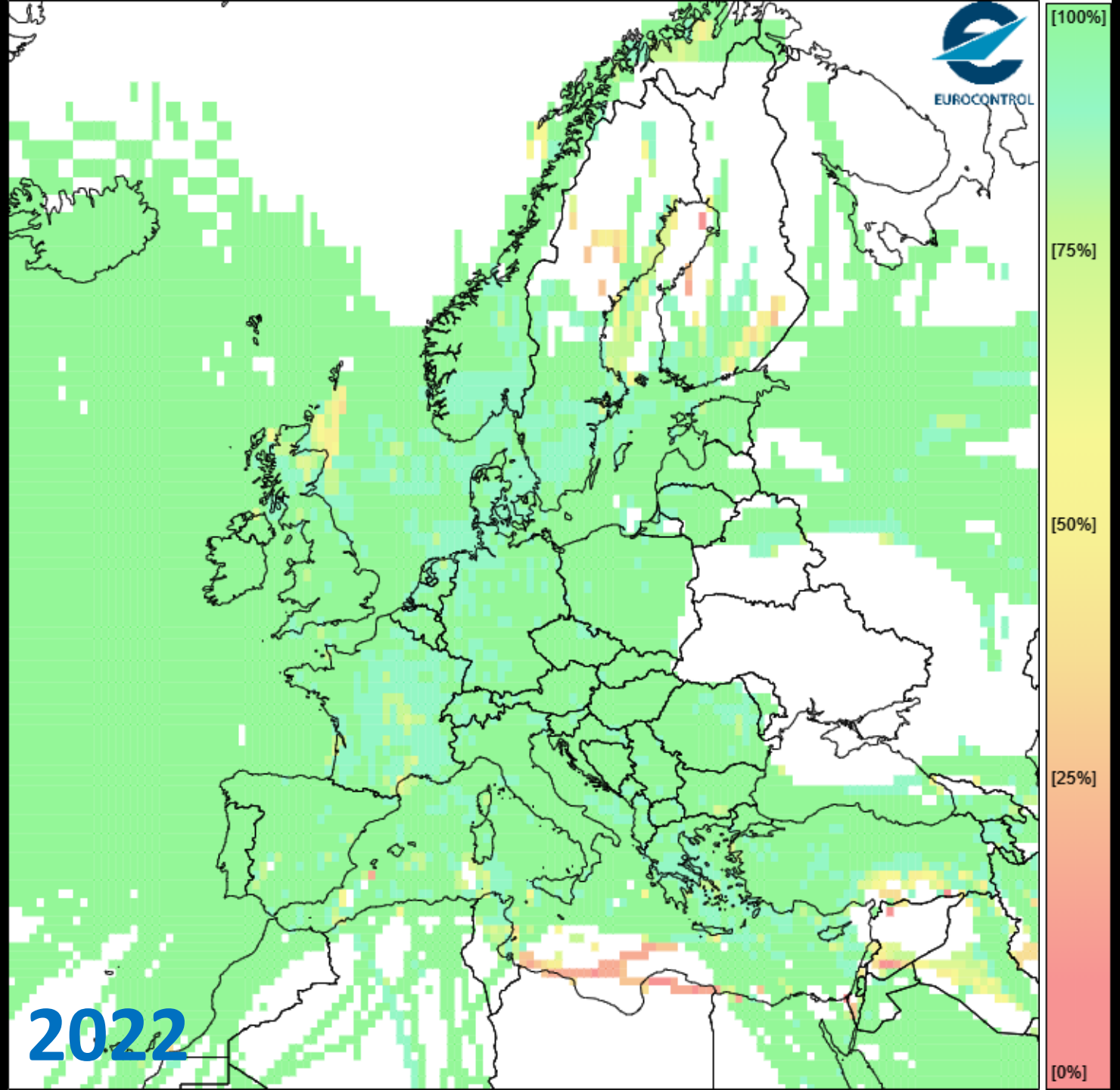
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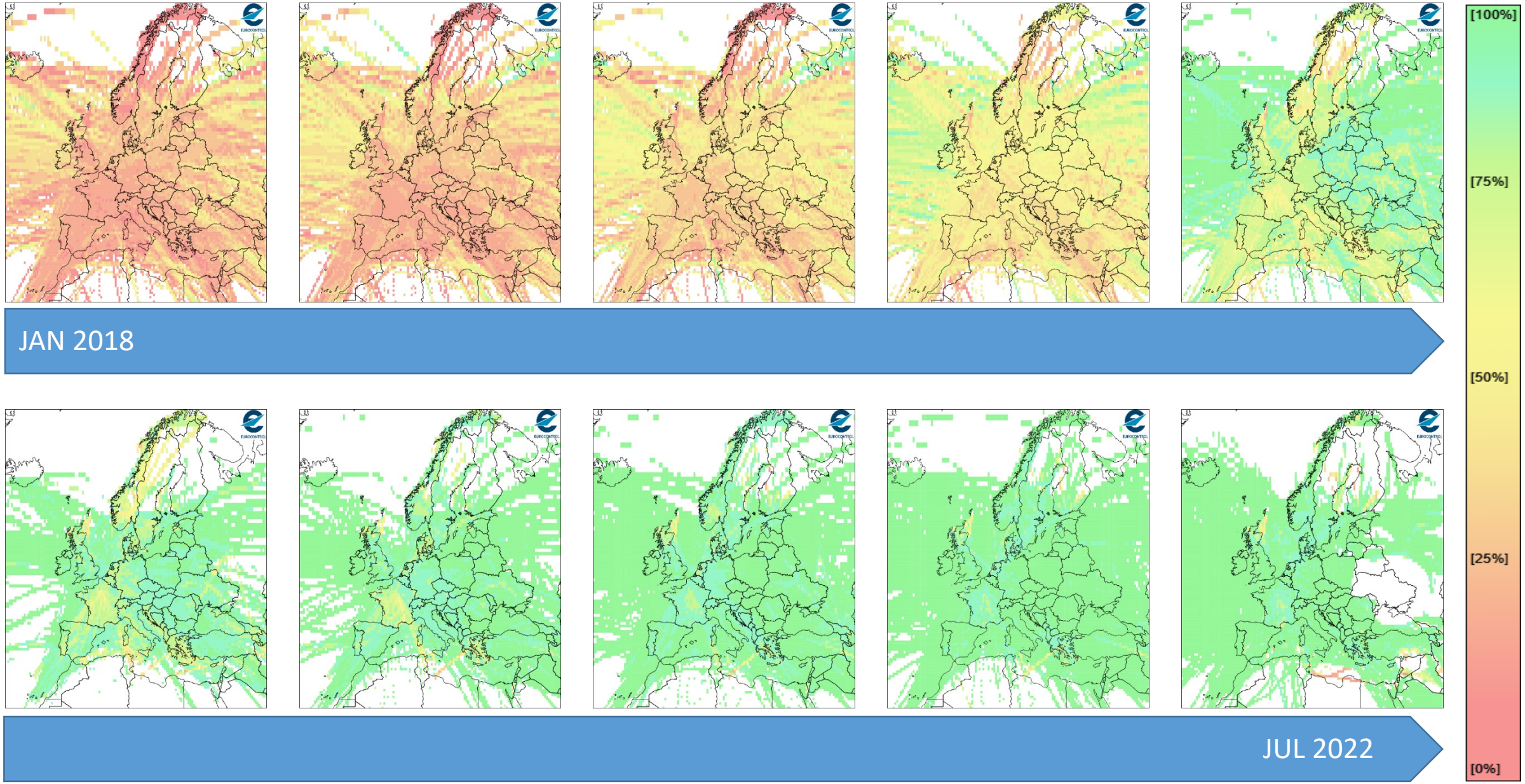
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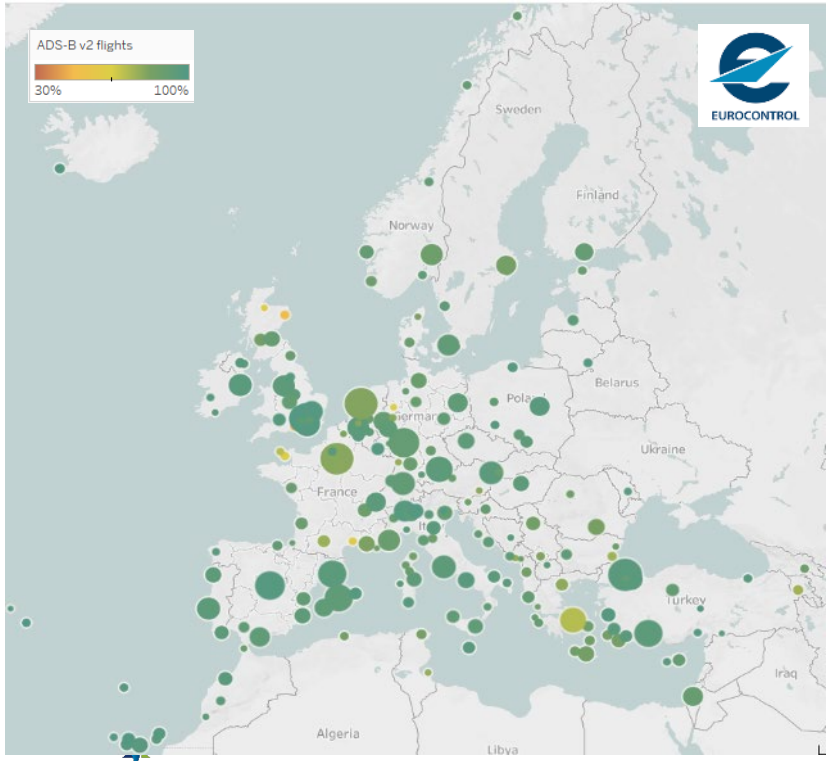
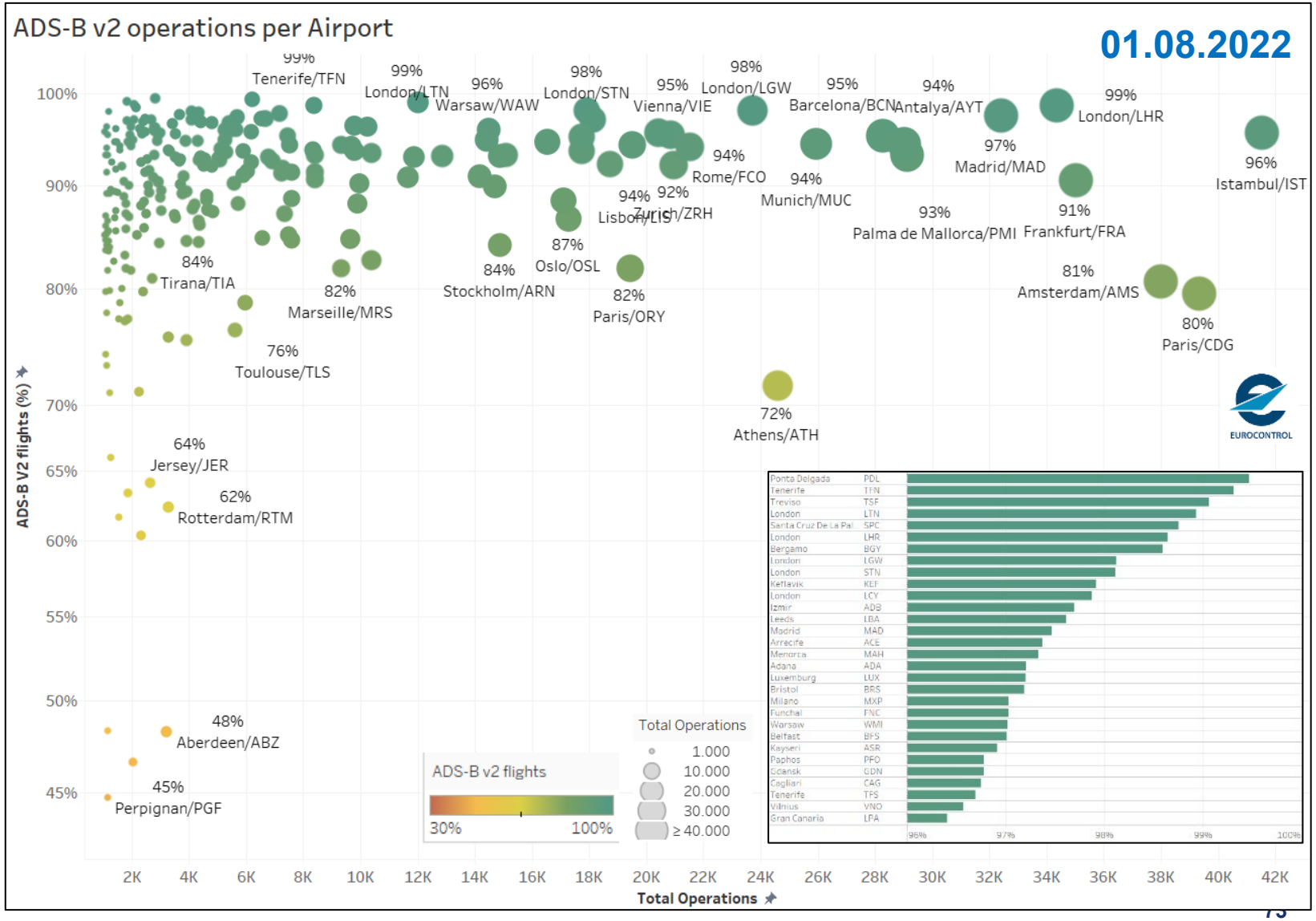
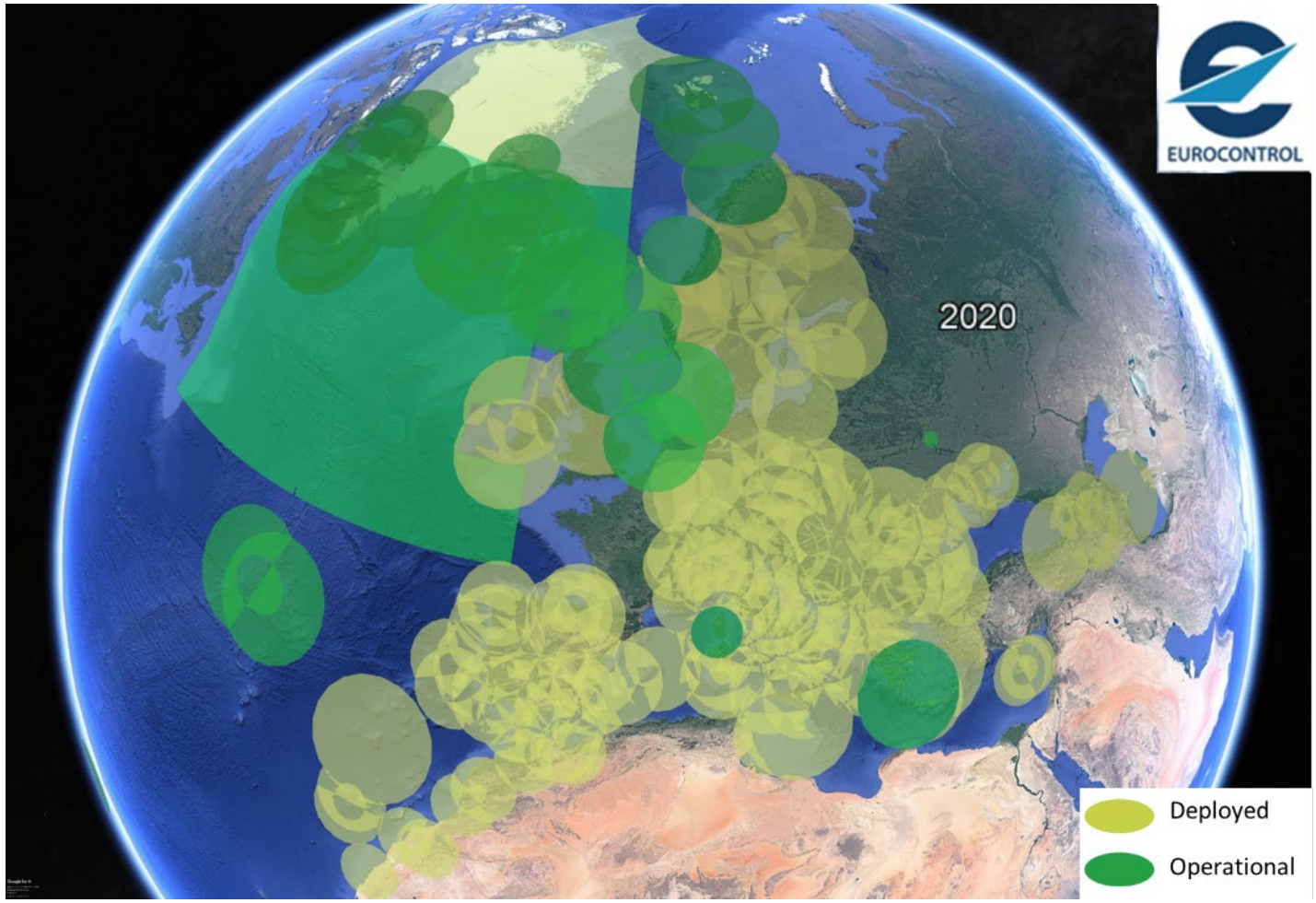
Airport/TMA view

ADS-B v2 Equipage





ADS-B Operations until 2020

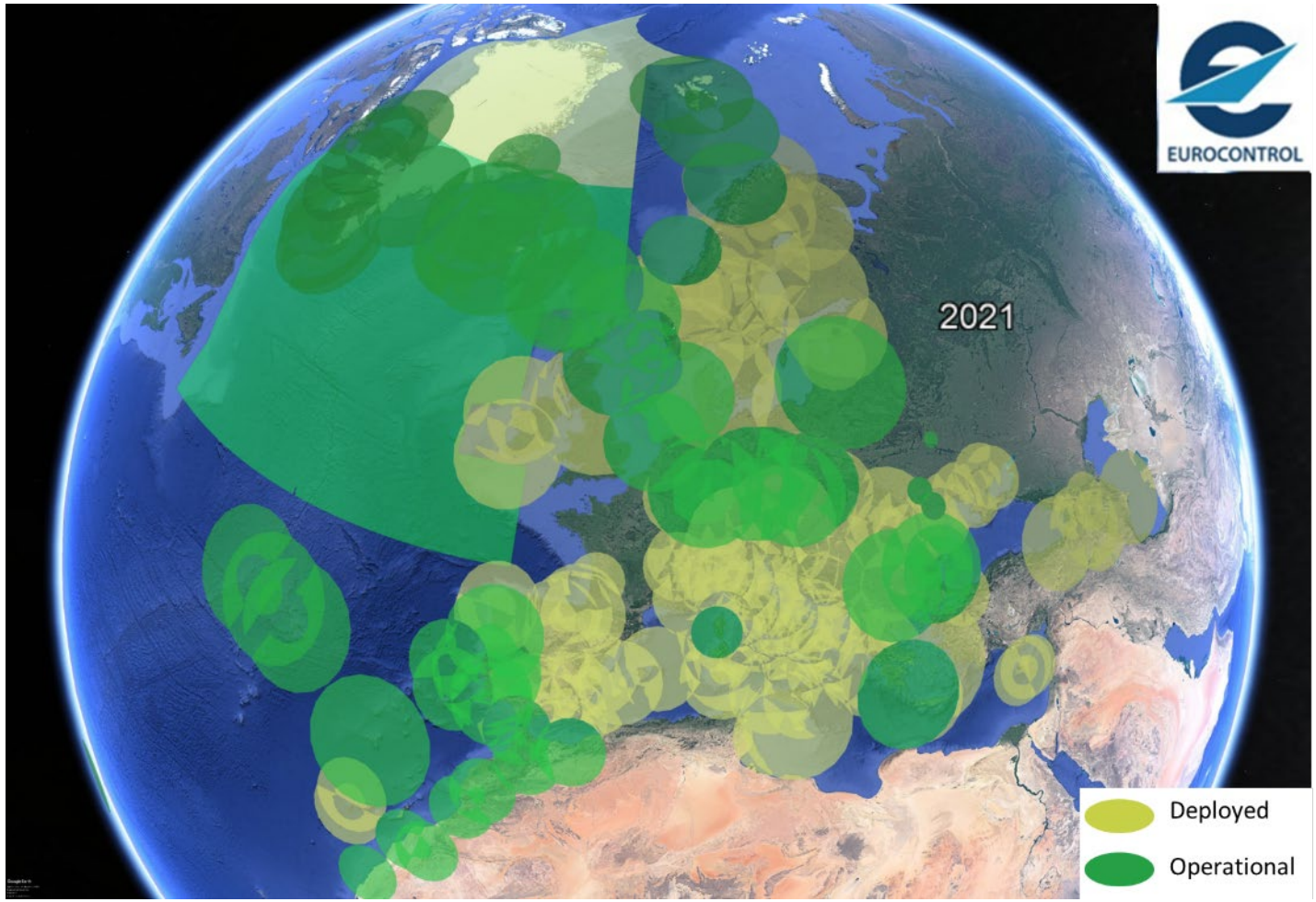


~24% of total area operated by European ANSPs

Operational Systems ≤ 2020
Denmark/Iceland: Reykjavik OCA Space-based ADS-B in west, south and east sectors
North Atlantic SUR corridor: Denmark: - Faroe Islands (Isavia) - Greenland (Isavia and Nav Canada) Iceland Mainland
France: Ajaccio and outside Europe
Hungary (Budapest Airport)
Malta: Kithira
Netherland: North Sea
Norway: - North Sea - Svalbard Corridor
Portugal: Azores, part of Santa Maria FIR
UK: - Shanwick FIR Space-based ADS-B (connecting to Canada/Gander FIR) - North Sea
Ukraine: Kiev Airport

sesar DEPLOYMENT MANAGER

ADS-B Operations 2021



New operations in 2021
Bulgaria (Sofia FIR, Varna Burgas TMA)
Czech Republic: ENR/TMA integration
Germany: Karlsruhe UAC (Phase 1A)
Iceland: Reykjavik TMA
Lithuania: Vilnius FIR
Morocco: Sensors operational
Portugal: Data integration (Country wide)
Switzerland: Locarno (deployed)

~29% of total area operated by European ANSPs

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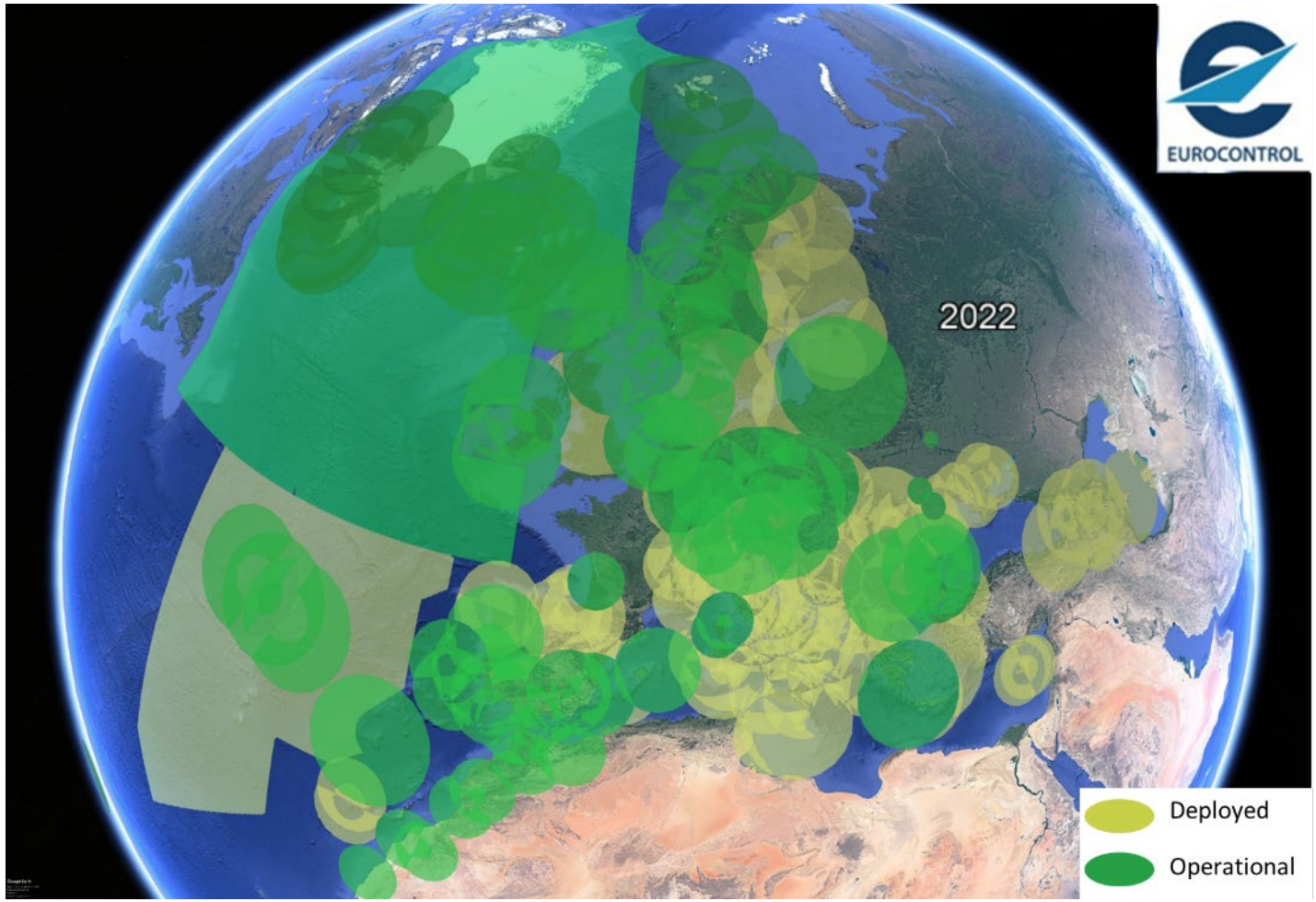
ADS-B Operations 2022



New operations in 2022
Austria: Data Integration (outside FIR and SW of FIR)
France: Bordeaux, Bastia
Hungary: ENR/TMA integration
Iceland: North part of FIR
Ireland: Data integration
Moldova: ENR/TMA integration
Norway: ENR/TMA integration
Spain: ATM Integration

~46% of total area operated by European ANSPs

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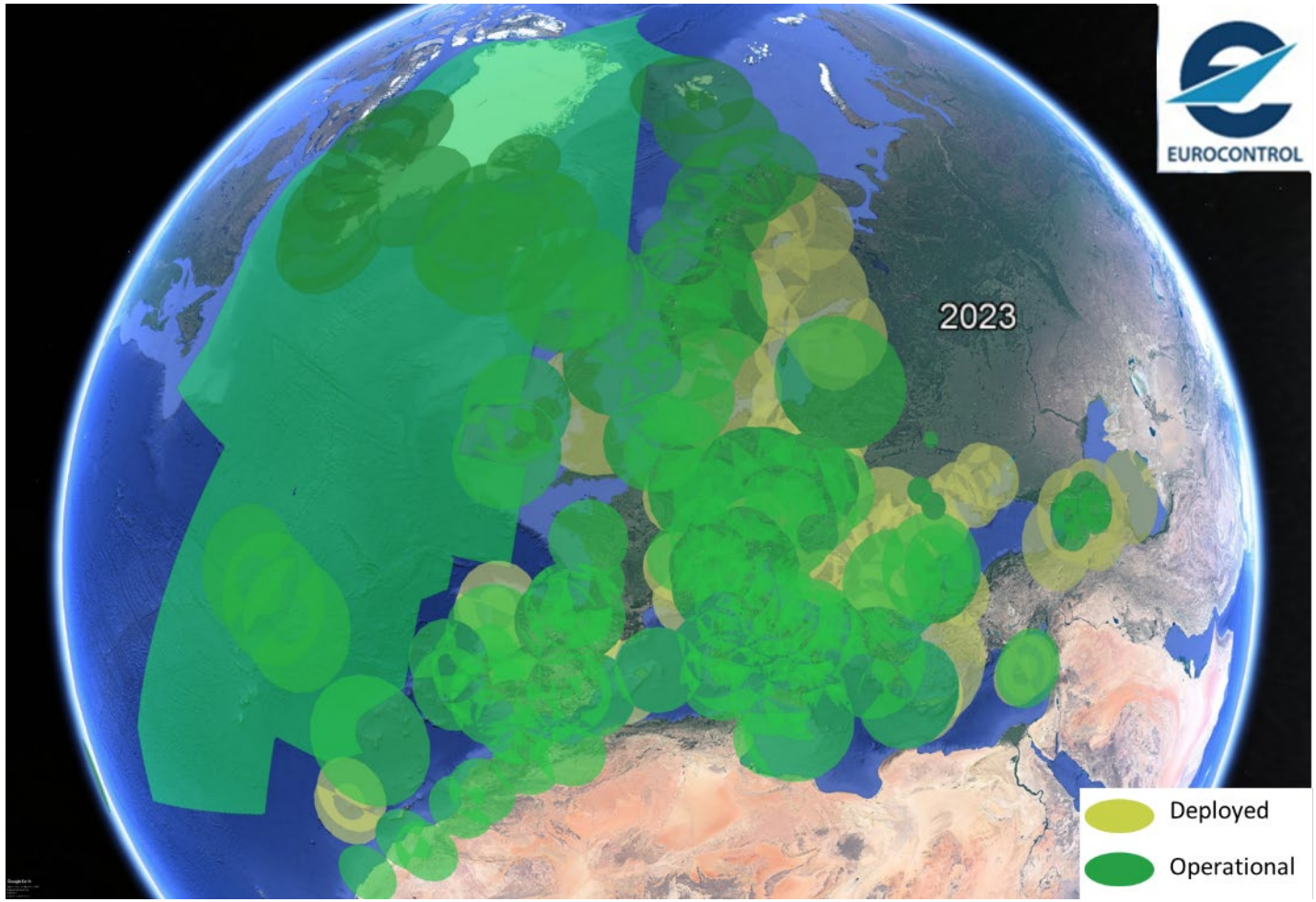
ADS-B Operations 2023



New operations in 2023
Albania: ATM Integration
Austria: ENR/TMA integration
Cyprus: Nicosia FIR
Georgia: ATM Integration
Italy: Data integration (Country wide)
Poland: ATC integration TWR CTR/TMA
Portugal: Space-based ADS-B in Santa Maria FIR
Slovakia: ENR/TMA integration
Switzerland: ENR/TMA integration
Ukraine: ATC integration ENR

~63% of total area operated by European ANSPs

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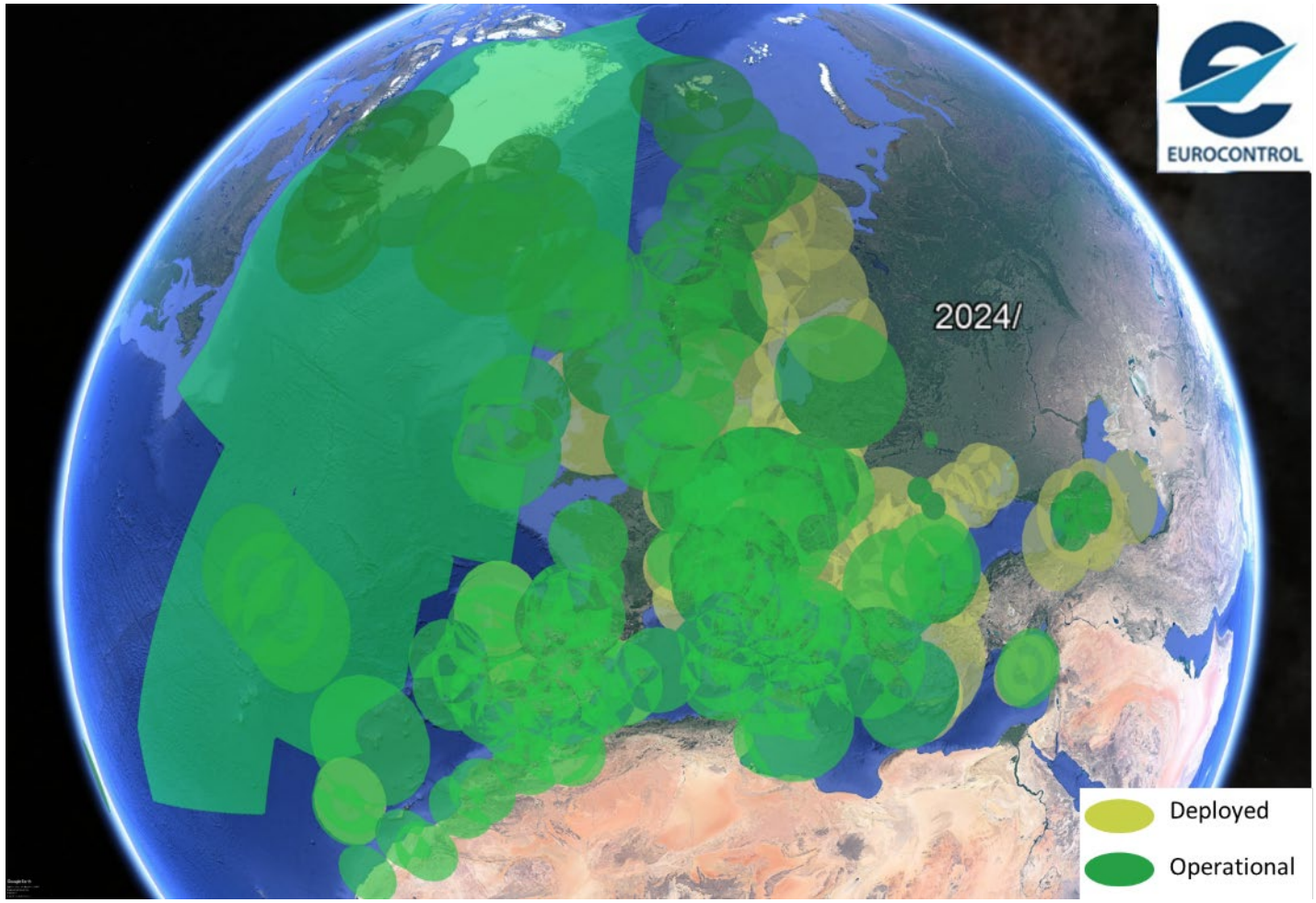
ADS-B Operations 2024 and beyond



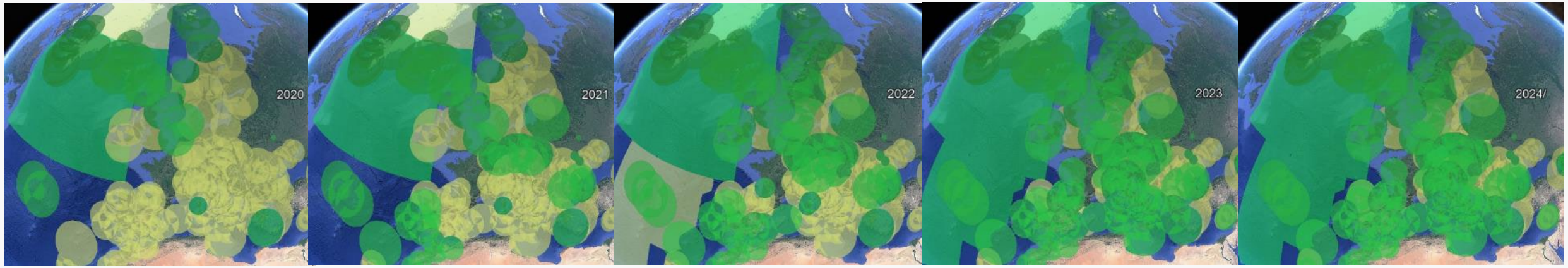
New operations 2024+
Germany: Phase 1B Karlsruhe UAC Phase 2 Southern Lower Airspace and phase 3 (2027)
Israel: LLBG TMA/APP
Latvia: ENR TMA Integration
Netherlands: ENR Integration
Spain: Coverage expansion
Slovenia: Data integration (Country wide)

~64% of total area operated by European ANSPs

sesar DEPLOYMENT MANAGER

ADS-B Operations Summary

Deployed
Operational



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New operations in 2021
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Czech Republic: ENR/TMA integration
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Iceland: Reykjavik TMA
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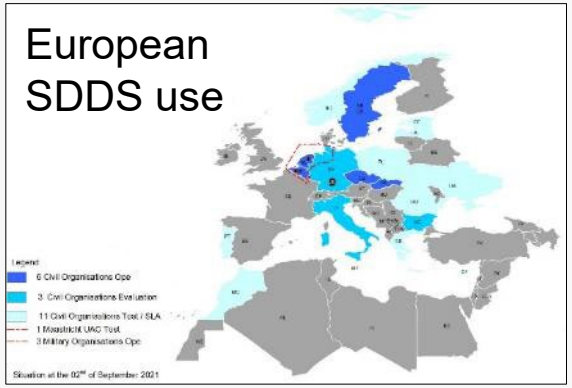
Norway: ENR/TMA integration
Spain: ATM Integration

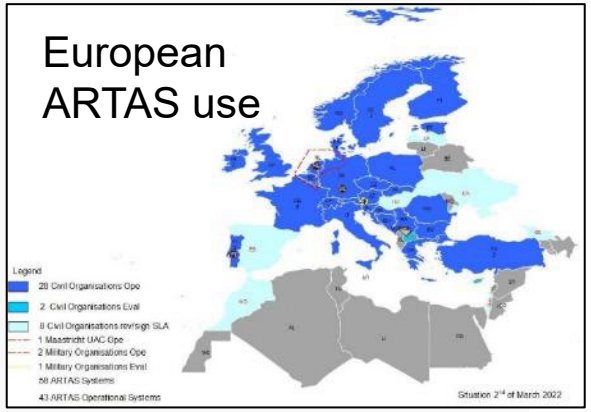
New operations in 2023
Albania: ATM Integration
Austria: ENR/TMA integration
Cyprus: Nicosia FIR
Georgia: ATM Integration
Italy: Data integration (Country wide)
Poland: ATC integration TWR CTR/TMA
Portugal: Space-based ADS-B in Santa Maria FIR
Slovakia: ENR/TMA integration
Switzerland: ENR/TMA integration
Ukraine: ATC integration ENR

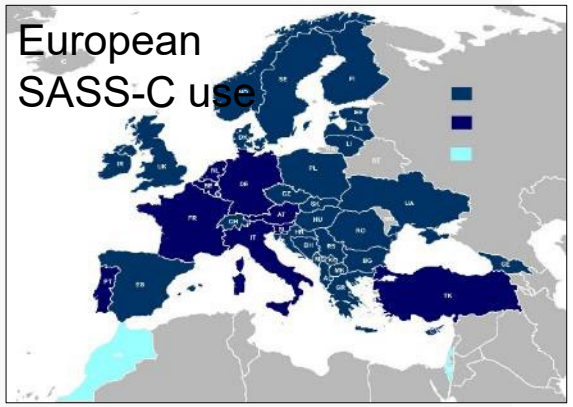
New operations 2024+
Germany: Phase 1B Karlsruhe UAC Phase 2 Southern Lower Airspace and phase 3 (2027)
Israel: LLBG TMA/APP
Latvia: ENR TMA Integration
Netherlands: ENR Integration
Spain: Coverage expansion
Slovenia: Data integration (Country wide)

Surveillance chain readiness

- **Regulations & Specifications**
  - SPI IR, EASA AMC/GM, ESASSP, EMS(), ED-129(), ED-142()
- **Surveillance Data Processing (SDP)**
  - ARTAS - used by most European states and some non-European
  - ADS-B processing in operation by many ANSPs
  - Various other SDPs are used as fallback or main
- **Surveillance Data Distribution (SDD)**
  - SDDS used by several ANSPs in Europe
  - ADS-B Server functionality
- **Surveillance Analysis Support System for ATC Centres (SASS-C)**
  - SASS-C - used by most European states
- **ASTERIX** incl.:
  - ADS-B: CAT021
  - WAM: CAT020
  - SSR Mode S: CAT048







Implementation support

Aircraft

- Installation: CS-ACNS, STC/AML or CS-STAN (SC005 conf. 1)
- Privacy improvements

ATS

- ADS-B Quality Indicators for ATC
- Specimen AIP – No-misleading data & equipage guidance
- Flight plan indications –> *Item 18: SUR/A2*
- Inconsistency mitigation

Support to Stakeholders – ANSP & AU

ADS-B inconsistency mitigations

Non-Performant ADS-B aircraft List (NPAL)

- In operation: 28 aircraft, 6 ADS-B v2
- Coordinated with other regions incl. FAA and NAT

Sensors

- Checks and Guidance material

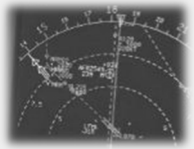
Surveillance Data Processing (SDP) – ARTAS fusion tracker

- Jump/blunder mitigation, Filtering of sensor indicated inconsistencies
- ARTAS v9.1.0 March 2023 (ACP616, 510) – per user plan:
  - Single system solution for detecting and reacting to ADS-B inconsistencies
  - Support ASTERIX CAT025

ADS-B developments

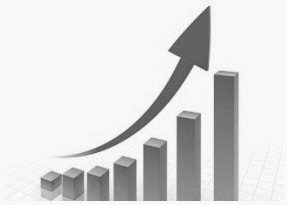
ADS-B improve system operations

- Processing in all sensors
  - Mode S, WAM/MLAT, ADS-B OUT/IN, TCAS/ACAS
- ADS-B alleviating spectrum load
  - TCAS/ACAS hybrid/passive tracking, ADD/DAP data



ADS-B IN

- Traffic Awareness, Surface Alerting, Interval Management



ADS-B v3 – More data, phase overlay (optional)

- Avionics developments, CS-ACNS update
- Ground systems

Airspace Users perspective

Laurent Puzenat – Air France
Thomas Körber – Lufthansa

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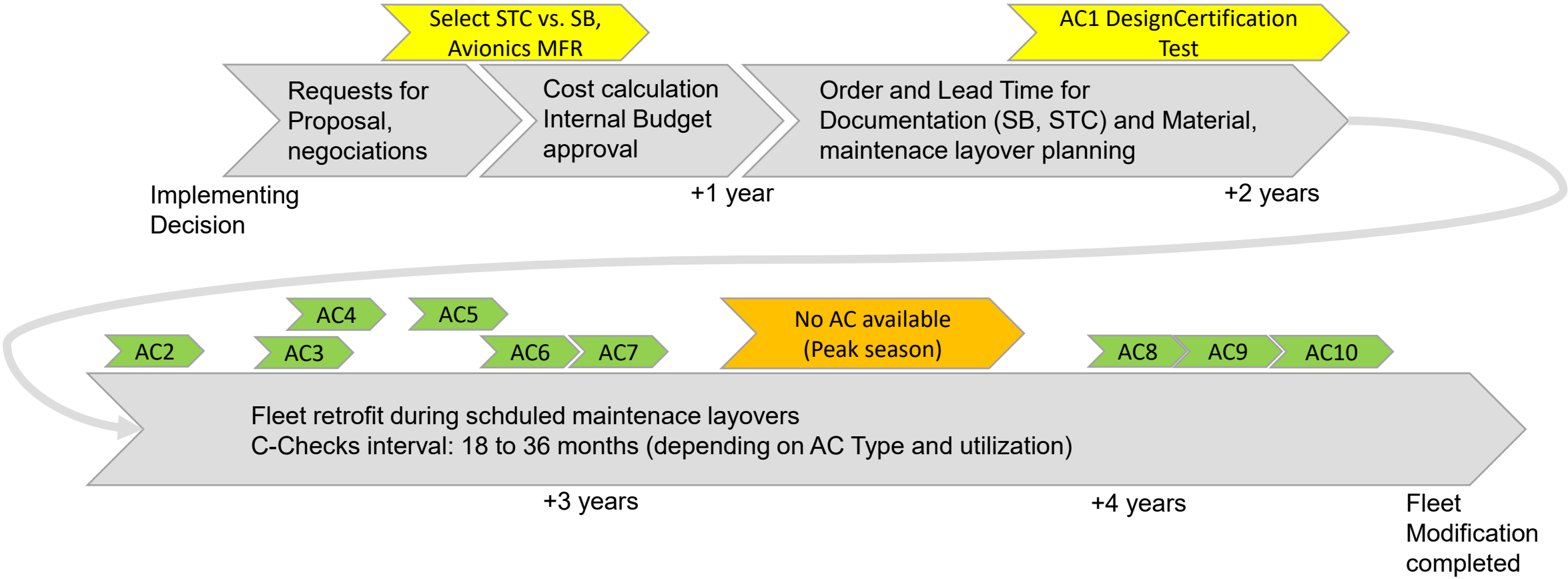
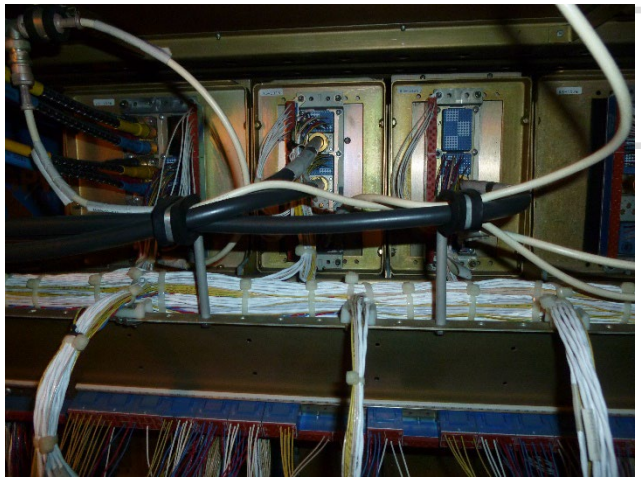
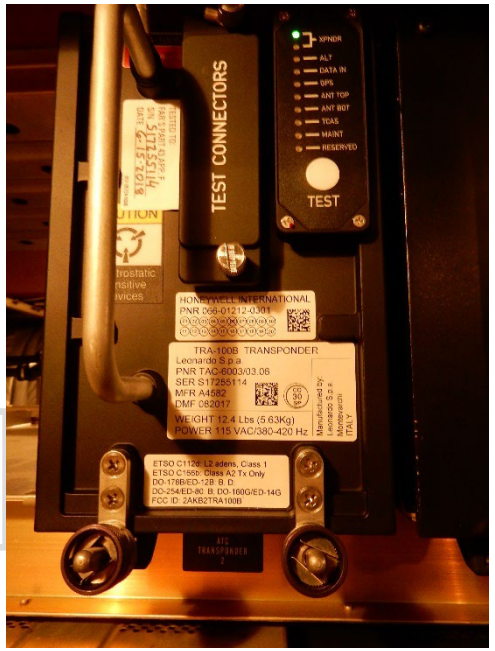
Airspace User view
Implementation timeline for Airline and Business Aviation



Airspace User view
Implementation overview Installation

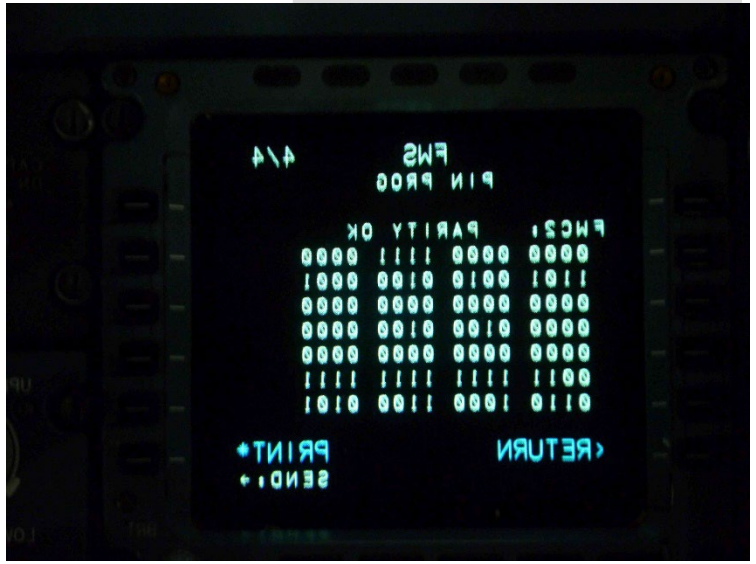


Modify
Wiring



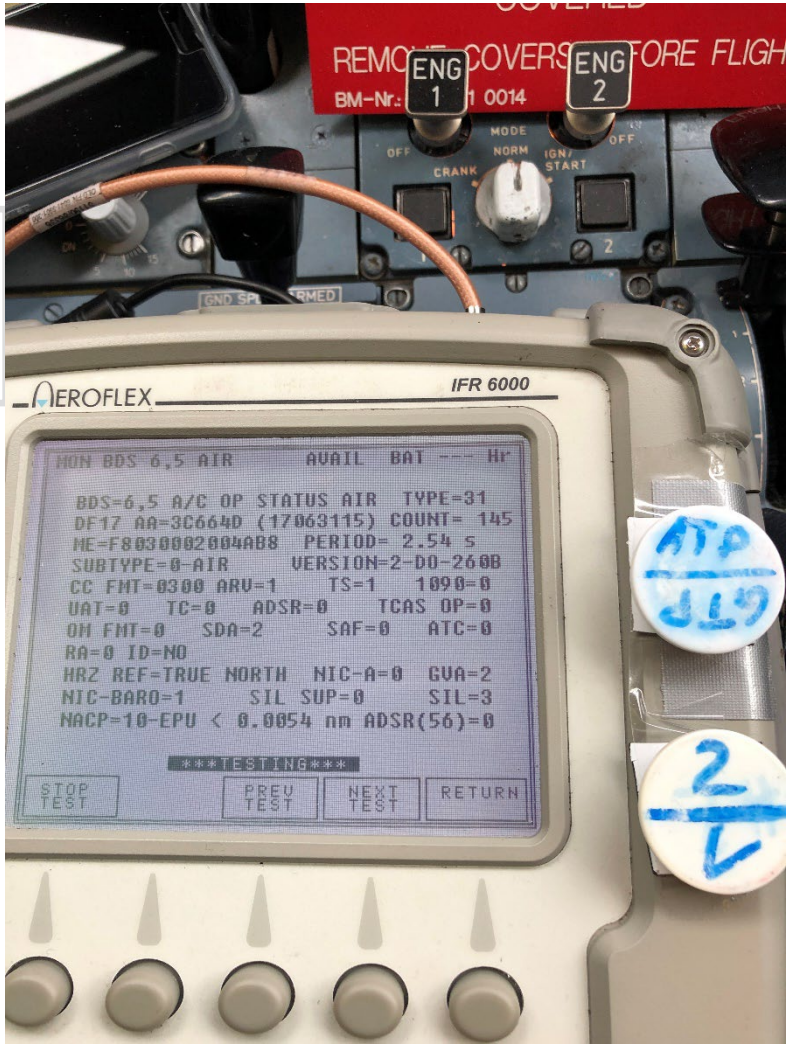
Replace
2ea ATC Transponder Units

Configure
Periphical systems



Airspace User view
Implementation overview Testing

Test
Reporting and
Function

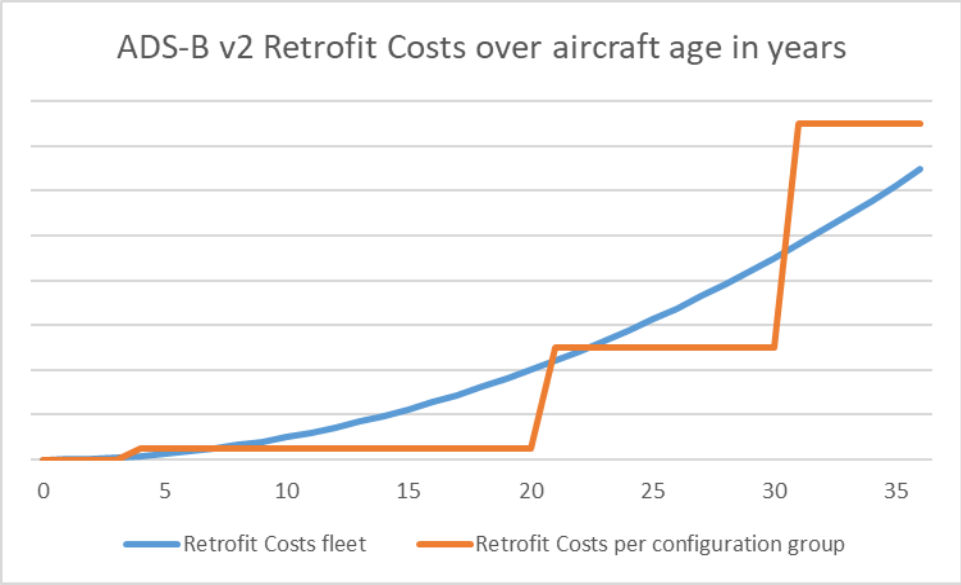


Test
Baro Altitude Reporting

Airspace User view
GA - light weight segment

- Not mandated per SPI IR – implementation entirely voluntary.
- Implementation primarily by CS-STAN, SC005b
  - 3 recognized configurations, not all are V2 level of performance
  - Not applicable to complex aircraft.
- Less costly (components, certification if CS-STAN applies)
- Majority of airplanes is not used commercially
- Subject to CEF Funding priority in 2022
- Linked to congestion of the 1090MHz channel.

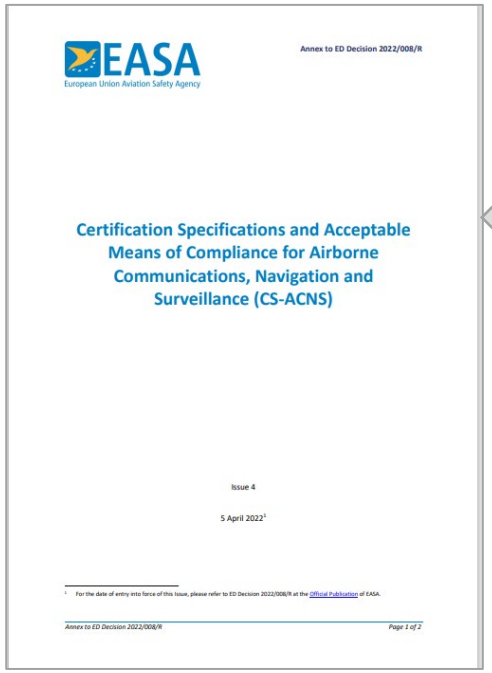
Airspace User view
Costs

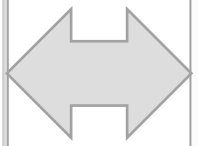


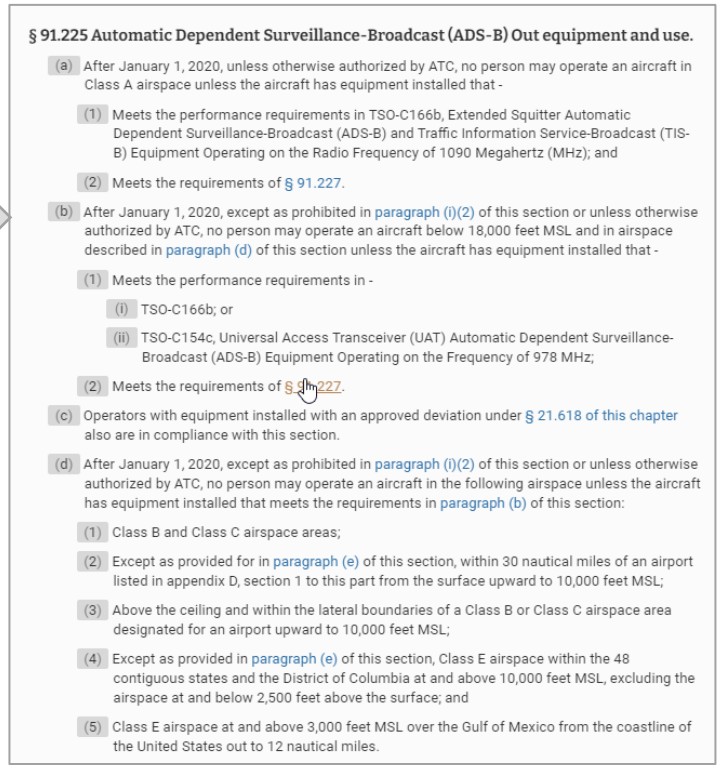
- Amber Curve: retrofit costs per aircraft over age, subfleets per age have different preconditions even if same AC Type
- Blue Curve: Total commulated campaign costs
- Old aircraft more expansive to retrofit
  Drivers:
  - lacking GNSS integration or installation
  - Design/certification costs for small sub fleets
- EU fleet calculated average: 75kEUR per aircraft
  Max reported: 1.5 Mio EUR per aircraft
- Huge amount of money spent globally to comply with EUR SPI IR

Most expansive retrofits have the shortes remaining operation to gather benefits
-> Early benefits have be ensured

Airspace User view
Differences between different areas







§ 91.225 Automatic Dependent Surveillance-Broadcast (ADS-B) Out equipment and use.

(a) After January 1, 2020, unless otherwise authorized by ATC, no person may operate an aircraft in Class A airspace unless the aircraft has equipment installed that -

(1) Meets the performance requirements in TSO-C166b, Extended Squitter Automatic Dependent Surveillance-Broadcast (ADS-B) and Traffic Information Service-Broadcast (TIS-B) Equipment Operating on the Radio Frequency of 1090 Megahertz (MHz); and

(2) Meets the requirements of § 91.227.

(b) After January 1, 2020, except as prohibited in paragraph (i)(2) of this section or unless otherwise authorized by ATC, no person may operate an aircraft below 18,000 feet MSL and in airspace described in paragraph (d) of this section unless the aircraft has equipment installed that -

(1) Meets the performance requirements in -

(i) TSO-C166b; or

(ii) TSO-C154c, Universal Access Transceiver (UAT) Automatic Dependent Surveillance-Broadcast (ADS-B) Equipment Operating on the Frequency of 978 MHz;

(2) Meets the requirements of § 91.227.

(c) Operators with equipment installed with an approved deviation under § 21.618 of this chapter also are in compliance with this section.

(d) After January 1, 2020, except as prohibited in paragraph (i)(2) of this section or unless otherwise authorized by ATC, no person may operate an aircraft in the following airspace unless the aircraft has equipment installed that meets the requirements in paragraph (b) of this section:

(1) Class B and Class C airspace areas;

(2) Except as provided for in paragraph (e) of this section, within 30 nautical miles of an airport listed in appendix D, section 1 to this part from the surface upward to 10,000 feet MSL;

(3) Above the ceiling and within the lateral boundaries of a Class B or Class C airspace area designated for an airport upward to 10,000 feet MSL;

(4) Except as provided in paragraph (e) of this section, Class E airspace within the 48 contiguous states and the District of Columbia at and above 10,000 feet MSL, excluding the airspace at and below 2,500 feet above the surface; and

(5) Class E airspace at and above 3,000 feet MSL over the Gulf of Mexico from the coastline of the United States out to 12 nautical miles.

- Global interoperability need to be ensured
- Requirements for installation and procedures e.g. testing differ and are hard to interpret because they are often referring to third documents or sub-documents
- Differences between EU and US:
  - US initially required Satellite Based Augmentation System
  - Different test requirements
- AUs invest:
  - Improve SUR for ANSPs
  - increase Airspace capacity

  Consequence: AUs are charged additionally for Space Based ADS-B services

  Seems unfair for AUs, as long as there are no monetizable benefits

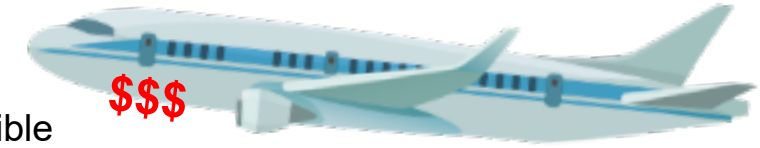
- Future mandates should aim for globally harmonized and clearly described Requirements
- Do not charge AUs additionally for equipping and supporting SUR modernization

Airspace User view
Visibility of progress and operational benefits for AUs

- ADS-B use and integration projects are presented to AUs very well in for very view regions, for others progress is more or less invisible for AUs

- Airspace users recognize ADS-B as an extra surveillance layer and the need to address Strong concern on 1090MHz over-interrogation

- Operational and monetary benefits should be more advertised
  make them visible to Airspace Users and implemented as early as possible



- AUs expect to see operational and financial benefits in Europe
  - Progress in ground deployment in some regions noted, but need to assess induced benefit
  - Slow progress on other regions
  - What are next steps ?
  - Radar rationalization ?
  - ADS-B IN ?
  - Others ?
  - Safety issue ? - What are mitigations and solutions ?

Military perspective in ADS-B Implementation

Vicente de Frutos – EDA

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EUROPEAN DEFENCE AGENCY

Military perspective on ADS-B implementation.

18th October 2022

Vicente de Frutos (EDA)

MILITARY IN SES

EUROPEAN DEFENCE AGENCY

EDA documentation for Government use only

EUROPEAN COMMISSION

Brussels, 7.12.2015
COM(2015) 598 final

MILITARY AVIATION STRATEGY IN THE CONTEXT OF SINGLE EUROPEAN SKY

FINAL - 20 JANUARY 2017

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

An Aviation Strategy for Europe

A DIGITAL EUROPEAN SKY FOR ALL

Strong Interactions

Defence: Member States competences

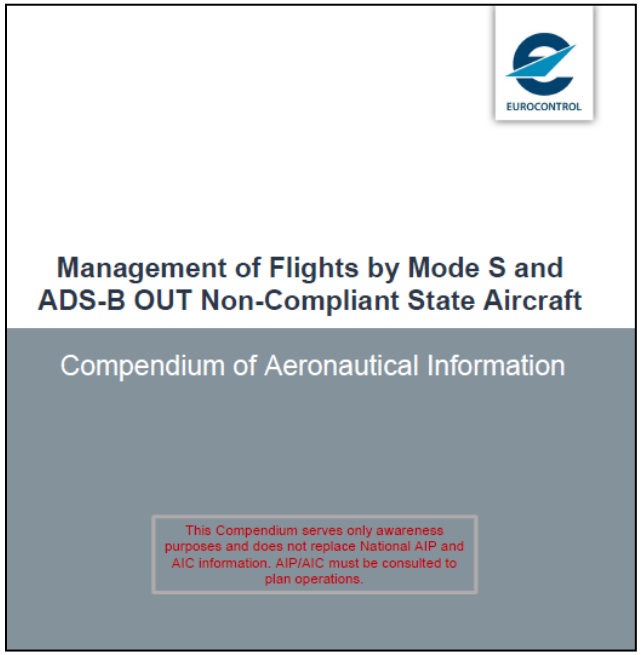
Transport: shared competences (EU/MS)

REGULATORY PROVISIONS (SPI)

Legal basis: Implementing Regulation (EU) No 1207/2011 amended by Regulation (EU) 2020/587 of 29 April 20204. Upcoming EASA NPA

Article 8 of the SPI IR mandates, when operating as GAT/IFR, from 07 December 2020, the carriage of:

- Mode S ELS for **all State aircraft**
- Mode S EHS and **ADS-B OUT** for **Transport type State aircraft** (maximum certified take-off mass exceeding 5 700 kg or having a maximum cruising true airspeed capability greater than 250 knots).



Applicability: EU States. For non-equipped aircraft (under certain conditions), ATS obliged to accommodate.
Non EU States. Non obliged to equip but EU national ATS systems non obliged to accommodate them. National decision. Therefore:

"State aircraft operators that plan to conduct flights with non-Mode S or non-ADS-B OUT transport type State aircraft in European airspace shall consult the National AIPs of the States to be overflown, and submit case by case requests for dispensation/waivers for such particular flights in line with arrangements and procedures published therein" (extracted from the compendium)

ADS-B IMPLEMENTATION BY THE MILITARY. LEVEL OF IMPLEMENTATION

- High rate of foreseen compliance for the assets identified in related regulation (transport aircrafts) with rate of equipage plans to reach 75% by end of 2025 and expectations to achieve more than 90% by 2035.

- However, decreasing operation observed due to increasing security concerns

- Fighter aircrafts, not impacted by regulation, present very low levels of compliance.
  - “legacy” fighters not equipped.

- Upcoming ones such as F35 (350 +/- are expected to be operational in Europe around 2030) will not be equipped with ADS-B.

ADS-B IMPLEMENTATION BY THE MILITARY. ISSUES

Military ADS-B equipage:

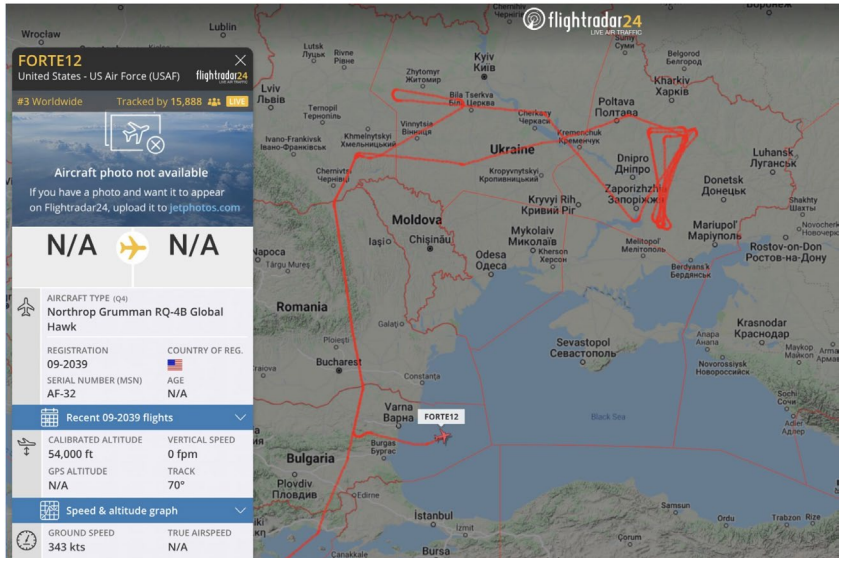
- Public visibility of military traffic. Security and confidentiality are key military concerns in the surveillance domain. Need to conceal the aircraft identification and the aircraft's current and future position to the public.

ADS-B as part of the SUR civil infrastructure

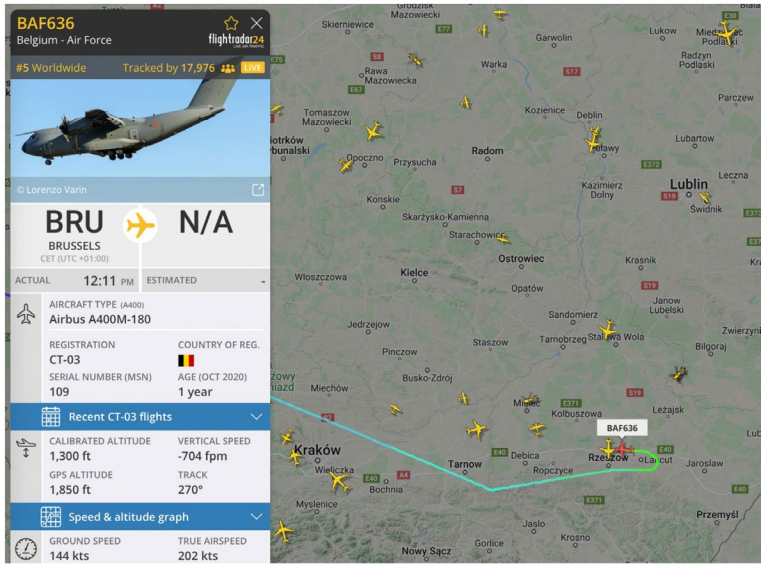
- Surveillance chain (including civil) crucial for military operations.
  - It supports Airspace surveillance (Recognised Air Picture - RAP) and Air Policing missions.
- Military RAPs rely, amongst other means, on primary and secondary radars including civil ones. Trend towards rationalization and replacement by ADS-B .
- Particular attention shall be given to resilience of surveillance systems as they are an essential part of the military C2 structure.
  - Spoofing and vulnerabilities in combination with use of satellite navigation.

CNS MIL strategy

UAVs in the area



The Airbus A400M



WAY FORWARD

From compliance to accommodation:

- Short - and mid-term use of ADS-B OUT following regulations to a maximum extend.
- For the long term an alternative and secure secondary surveillance service needs to be developed. This could include:
  - ADS-B with increased capabilities for integrity (or other electronic conspicuity solutions)
  - Fighter aircrafts. R&D to solve lack of confidentiality requirements
  - Future civil cooperative solutions shall preserve military confidentially requirements for all military flights.

ADS-B conformity should also be considered, especially regarding possible alternative handling solutions.

- Need for harmonization of national accommodation strategies at EU level.

Q&A

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ADS-B Implementation Program in LFV Sweden

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Anders Andersson– LFV
SUR Manager

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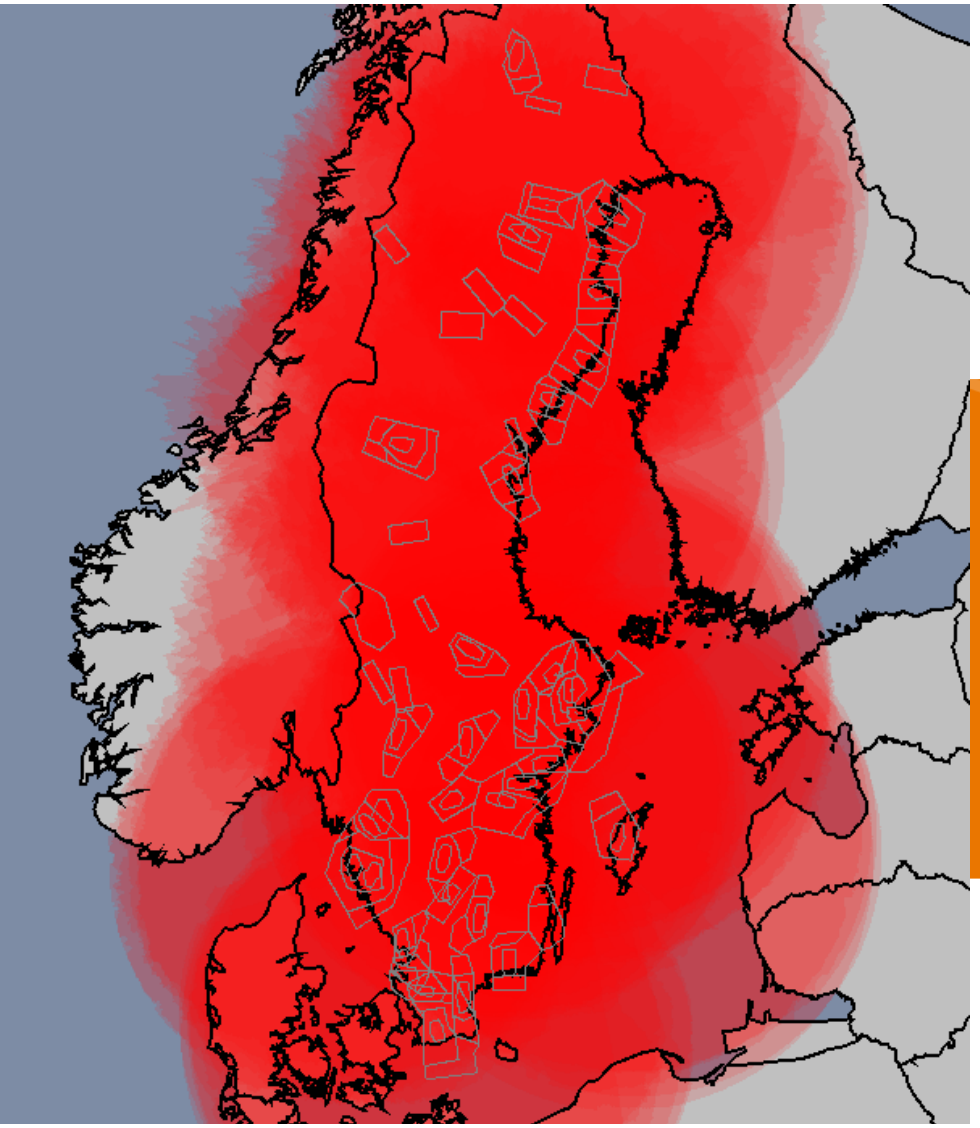


ANDERS ANDERSSON, SUR MANAGER LFV SWEDEN

ADS-B IN SWEDEN

18 October 2022

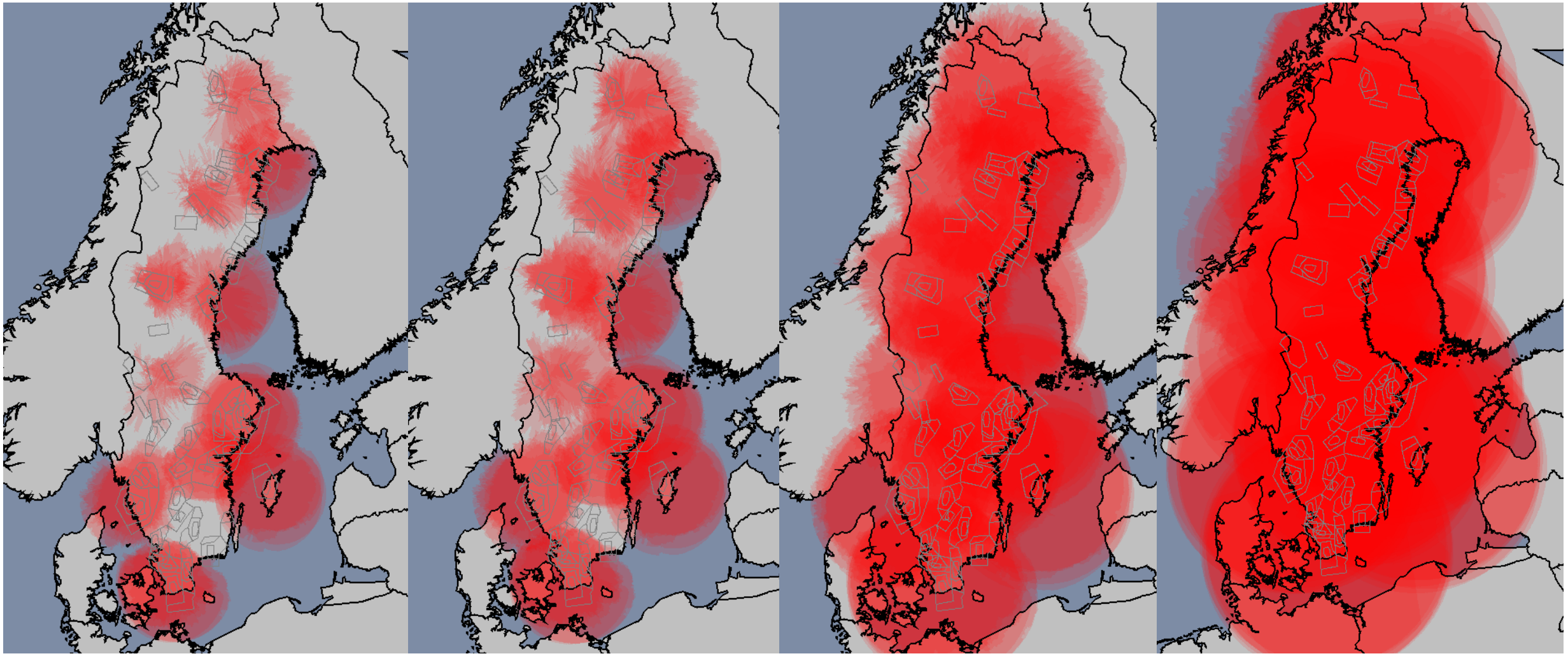
Content

- ✓ Technical status
- ✓ Current use of ADS-B
- ✓ Future use of ADS-B
  - Short term
  - Long term
- ✓ Potential obstacles around ADS-B
  - In general
  - In Sweden in particular

Technical status

- ✓ In Sweden there is a nationwide WAM system where all receivers are ADS-B and at least DO-260B compatible.
- ✓ We have ADS-B data outputs in various configurations
- ✓ We can configure outputs as we like
- ✓ Coverage is very good
- ✓ We can easily extend low altitude coverage as needed/requested to a fairly low cost.

Technical status



FL 20 FL 30 FL 90 FL 285

Current use of ADS-B

- ✓ For ATS services we dont use ADS-B at all besides for Alerting and SAR services
  - For the purpose we have a ADS-B from WAM direct to SAR
  - We have several incidents/accidents where this have made a very positiv difference compared to traditional surveillance
- ✓ Swedish current implementation of FIS prohibits use of as information in a wider scale
  - Need for FIS to be separated from ATS in technical systems or possible filtering of what is presented. This is not available today
  - Technichal limitations in ATS systems regarding how much different datastreams it can receive and let the user control of what is presented
  - Also safety issue to have data in ATS systems that ATCO aren't allowed to use

Future use of ADS-B

- ✓ In short perspective
  - Low altitude coverage at ATS units
    - Require other airspace classes due to 1207/2011 or local requirement regarding equipage
  - FL 195+ for improved tracking and as additional layer assuming all IFR is equipped at that level and no VFR exist (not replacing until ALL is equipped beyond 97+% according to Req in ESASSP)
  - Ground surveillance at airports for at least vehicles and possibly aircraft if local requirement on ADS-B in VFR is put in place.

Future use of ADS-B

- ✓ In longer perspective
  - Add as a third layer in EnRoute
    - Not replacing existing until
      - Enough equipage (more than ESASSP require 97%)
      - GNSS and satelite availability and disturbance is safe enough
        - » We can see how easily it is affected both intentionally and unintentionally
    - Can also depend on and be disconnected when it causes false targets due to jaming or spoofing.

Obstacles for using ADS-B - General

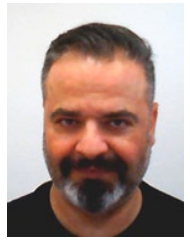
- ✓ Non equipage requirements for VFR
  - Not good in SPI IR from beginning when referring to flight rules instead of airspace classes or other.
- ✓ Consequenses when spoofing and jaming is happening
  - to easy to disturb both intentionally and unintentionally, much more common than on traditional NAV/SUR frequencis
  - Although WAM and ”flying sensors” is most likely the best ”disturbance detector” available for GNSS.
- ✓ Safety perspective
  - NAV/SUR in same ”HW” with potential to lose both must be reflected seriously before removing layers of fallback Nav and Sur infrastructure

Obstacles for using ADS-B - Sweden

- ✓ Locked in airspace classes C and G only in CTR and TMA
  - Will slowly change but that takes long time
- ✓ Special Civil/Military integration requires duplicated coverage where all MIL also are available and they have no intention what so ever to have ADS-B in a wider perspective in Mil aircraft
  - Advantage of this Civ/Mil integration is much wider than the small amount that can be saved on replacing one layer traditional surveillance with ADS-B
- ✓ Just performed large infrastructure upgrade so there is no need the coming years. Add as additional layer brings only costs.

NAV Portugal Experience in ADS-B Implementation

Andre Maia/Paulo Raposo
NAV Portugal



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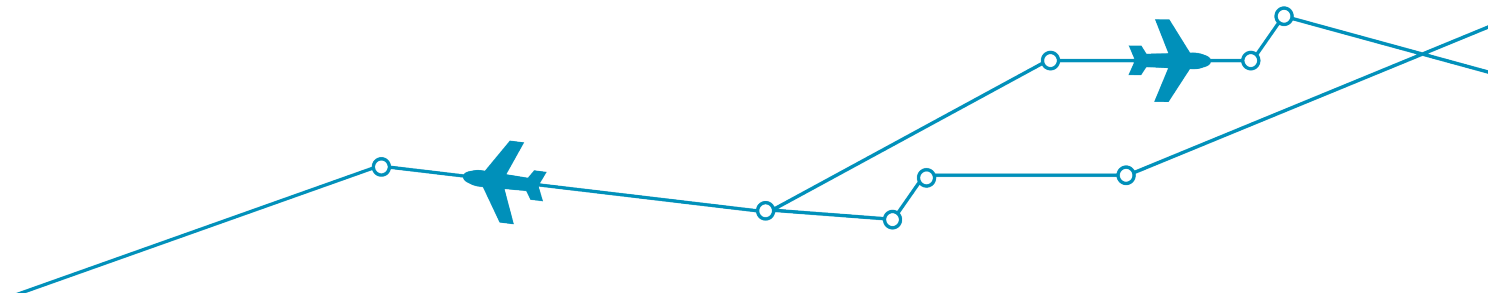
ADS-B in Portugal

Paulo Raposo
André Maia

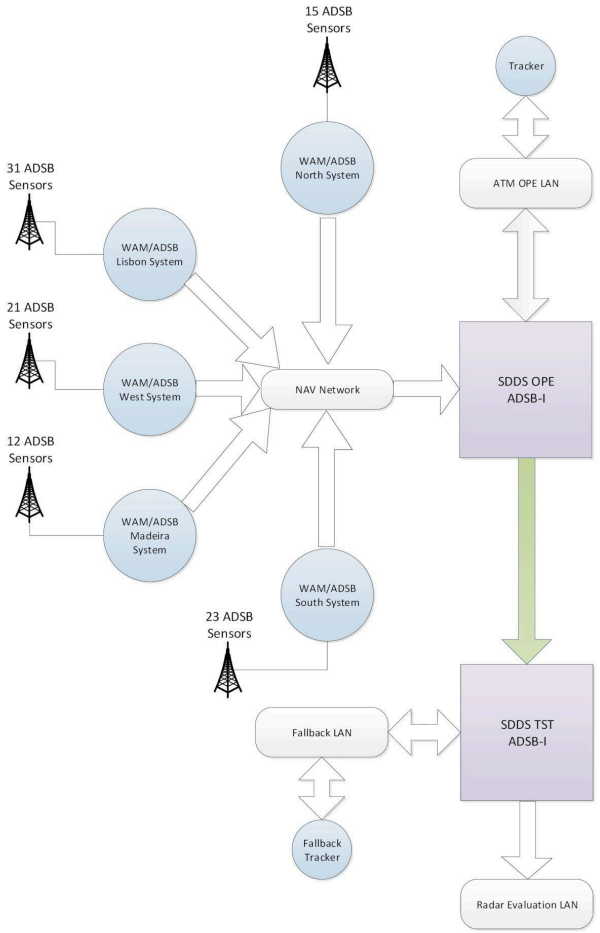


Nav Portugal FIRs

Implementation of ADS-B in Lisboa FIR

ADS-B in Lisbon FIR

Lisbon FIR - Current situation

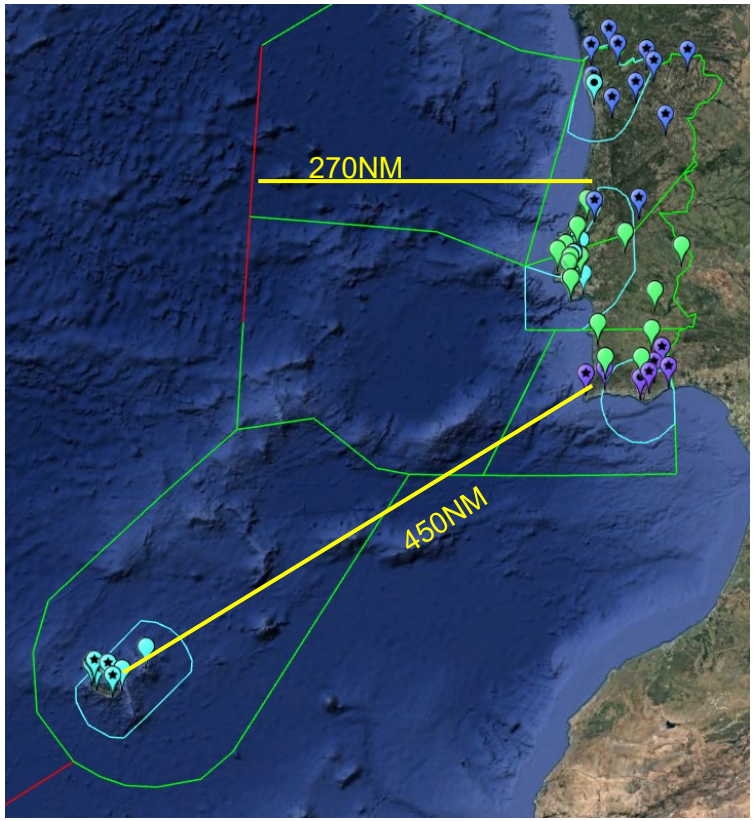


- ADS-B data via WAM-Systems
  - No dedicated ADS-B antenna
- 5 WAM Central Processing systems =>
  - 5 ADS-B local integrators => data driven
- 1 Central ADS-B integrator (at Lisbon SDDS)
  - 3 seconds update
- Using ARTAS V9.0.1

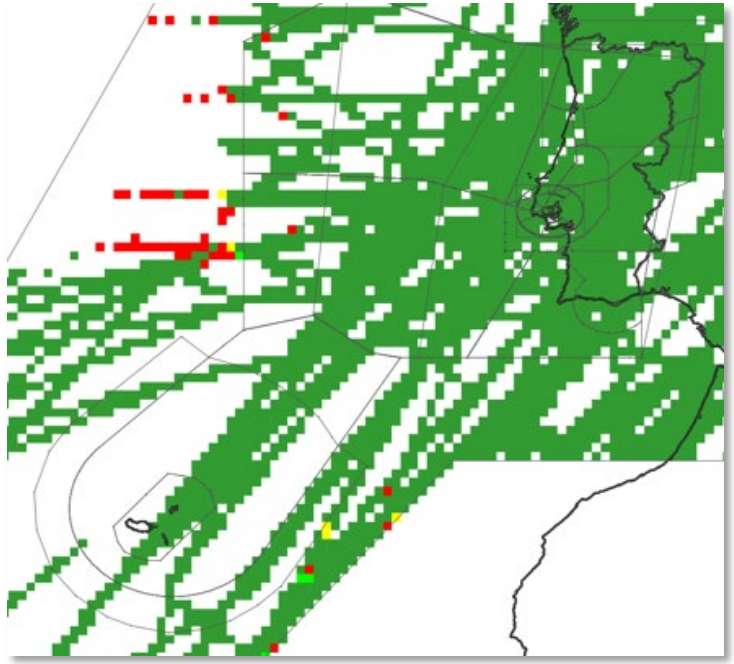
ADS-B in Lisbon FIR

Lisbon FIR - Current situation – Antenae

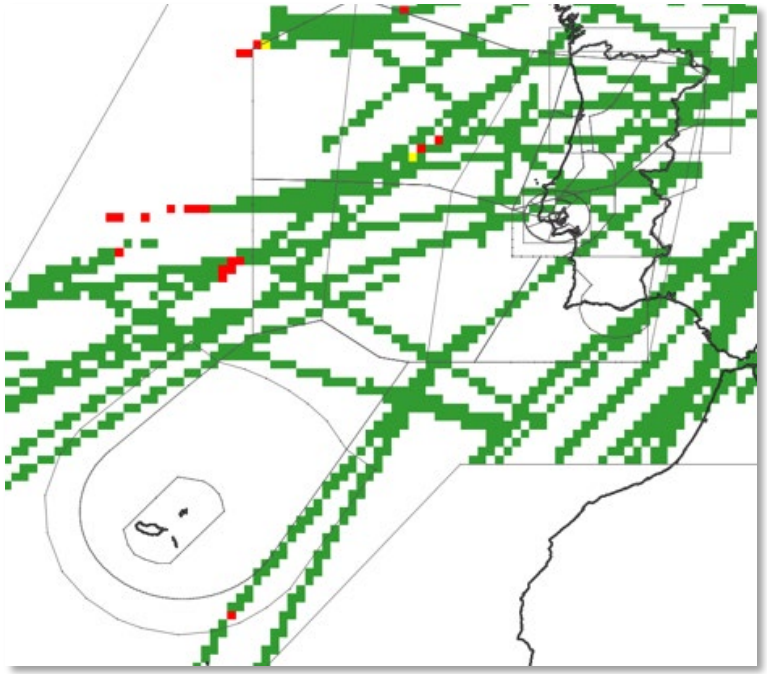
- 102 receiver antenae installed
- 2 High gain directional towards west
- Receive ADS-B Data from ADS-B Espinheiras (Spain)
- Send ADS-B from Madeira to Morocco



FL300-400



FL400-500



ADS-B in Lisbon FIR

Lisbon FIR - ADS-B use

- Since 12 november 2021 – ADS-B use for Tracking Improvement (all Lisbon FIR)
  - ADS-B only tracks max 30 seconds
  - Position Quality Information Filtering : Only v2 XPND with NIC/NAC above 6
  - Increased performance : accuracy, heading stability, mode-c “age”
  - Use of Exclusion List -> Identified via operacional and technical evaluations.
    - Uses Eurocontrol NPAL (and also NAT Exclusion list)
- FPL Tracking in use
  - Track symbol/layer indicates absence of ADS-B contribution for west bound flights
  - Diferent symbol for ADS-B only tracks
- Full “ADS-B only” track display scheduled for 18 October 2022 (today)
  - Separation redution from NRA to 8NM under operational assesment

Transition from procedural control to surveillance control in Santa Maria Oceanic FIR

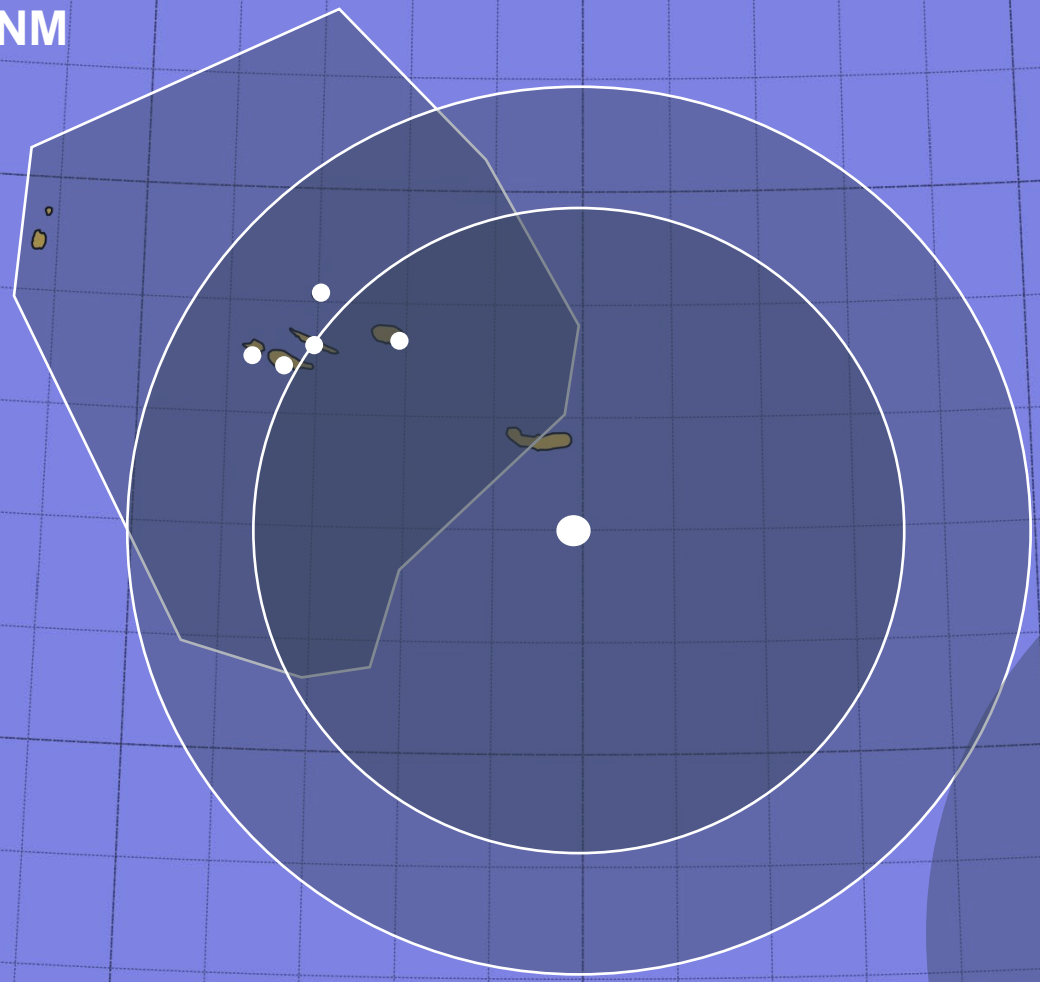
Transition from procedural to surveillance

2006
SSR antenna in Santa Maria
Sector with radius of 170 NM
2 separate ATM systems
(Oceanic / Surveillance)

2012
Radius of 240 NM
Single ATM system

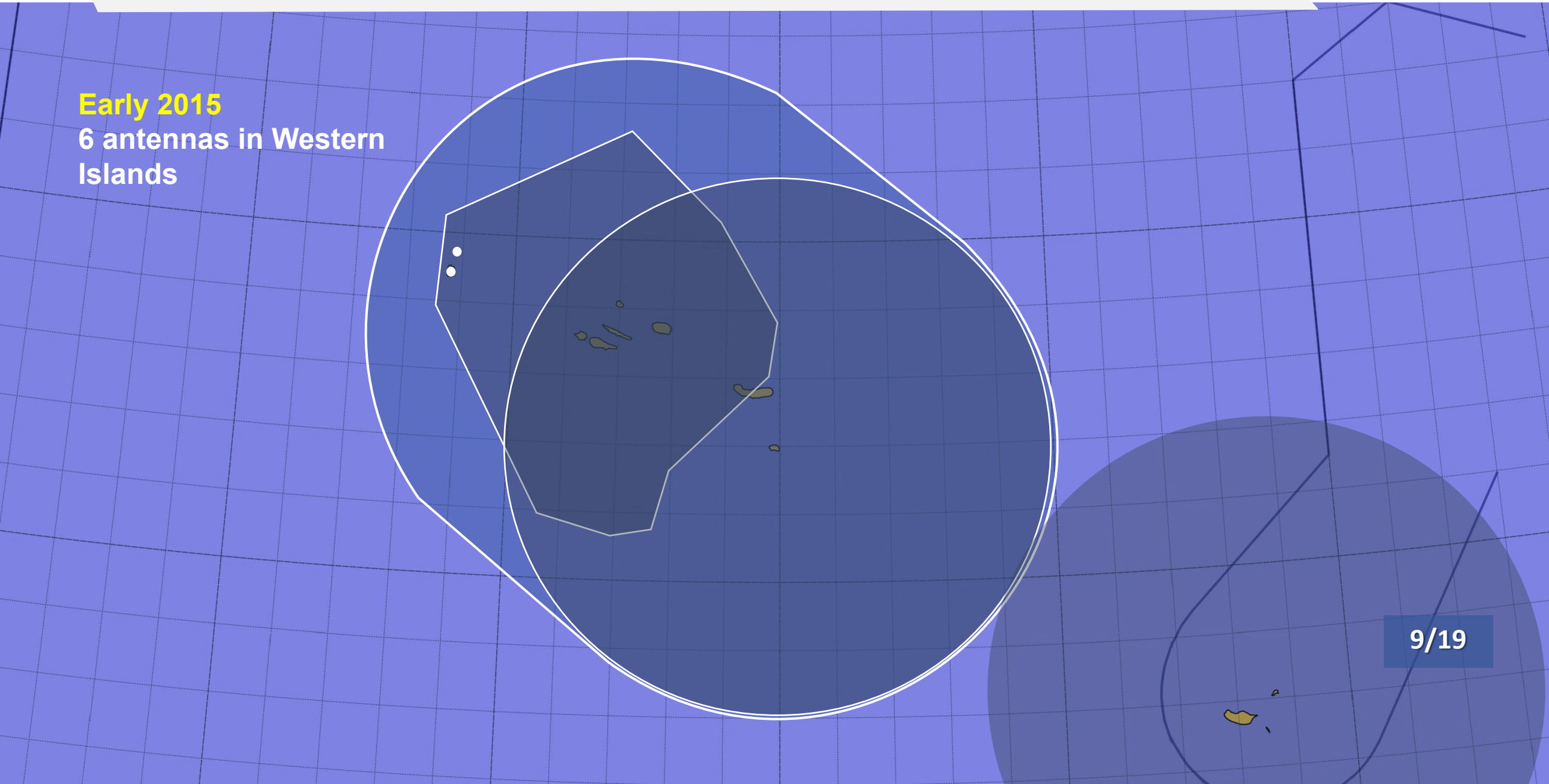
Surveillance data from
PST SSR antenna

11 ground based
antennas in 5 islands

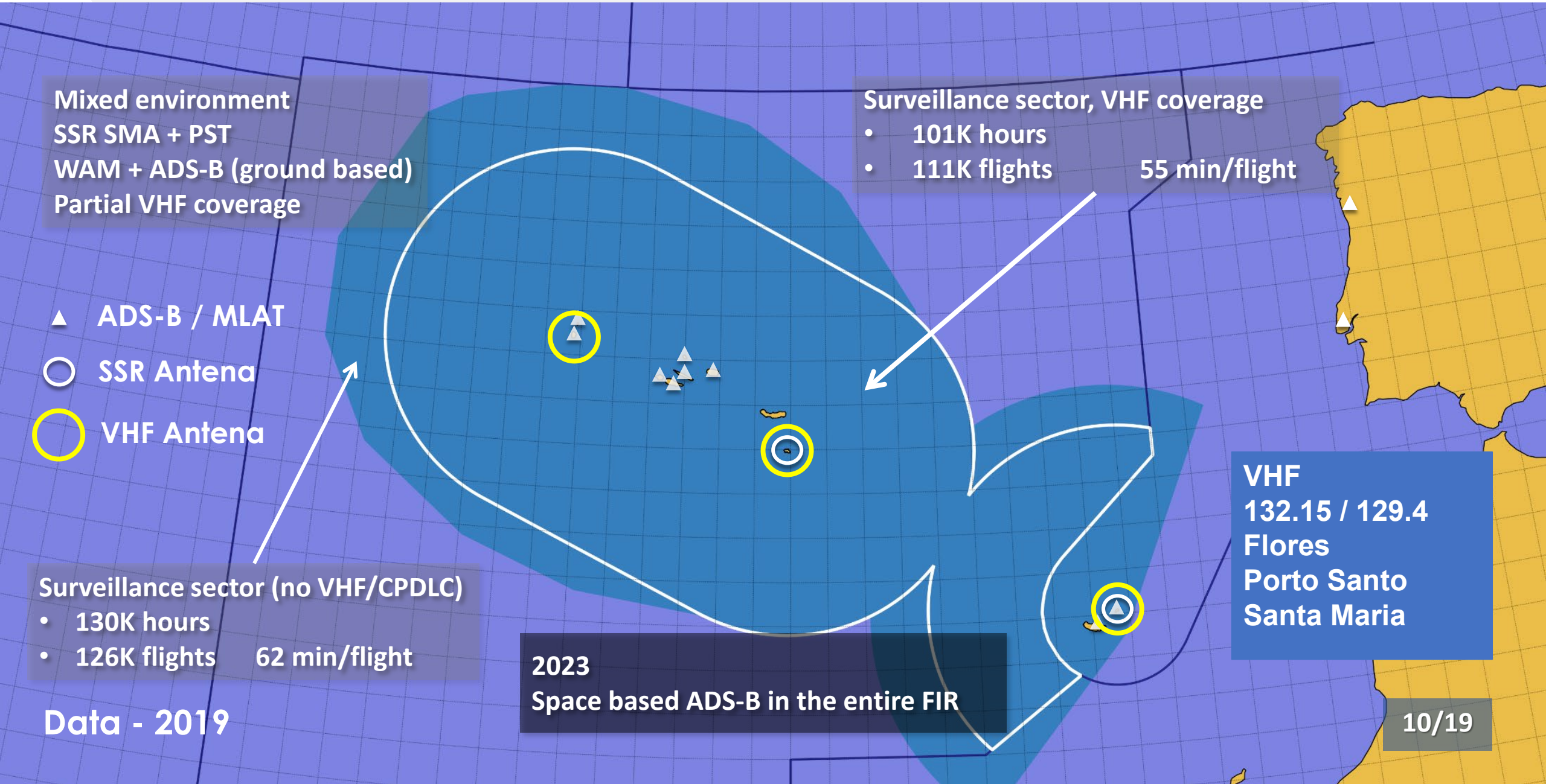


Transition from procedural to surveillance

Early 2015
6 antennas in Western Islands



Current Surveillance Airspace



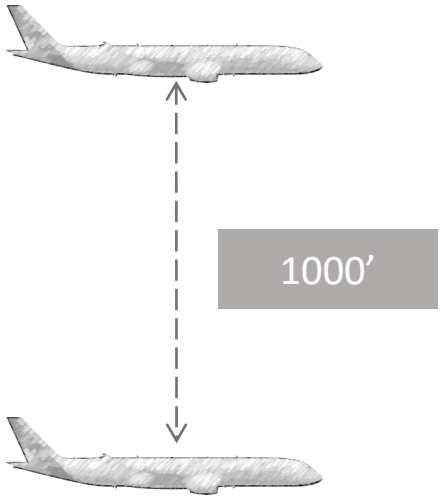
ATM system overview

Main system capabilities

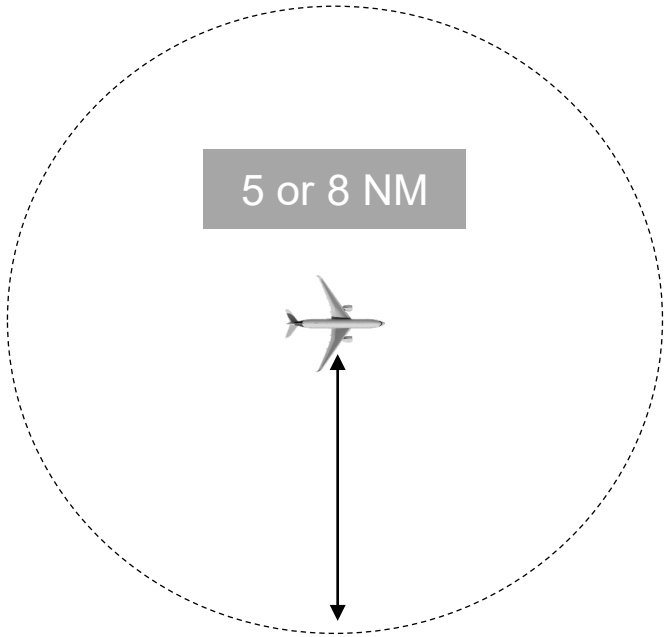
- Surveillance (SSR, MLAT and ADS-B) data processing.
- Flight position interpolation based on procedural reports if lost/no surveillance data.
- Flight equipment and conformance monitoring.
- Select flight level conformance monitoring (ADS-B)
- Data Link capabilities (ADS-C, CPDLC and OCD via ACARS), PBN / PBCS compliant.
- Dynamic conflict prediction based on
  - Flight equipment
  - Flight location
- Long term (CPAR), medium term (MTCD) and short term (STCA) conflict alerts.

Frequently used separation minima

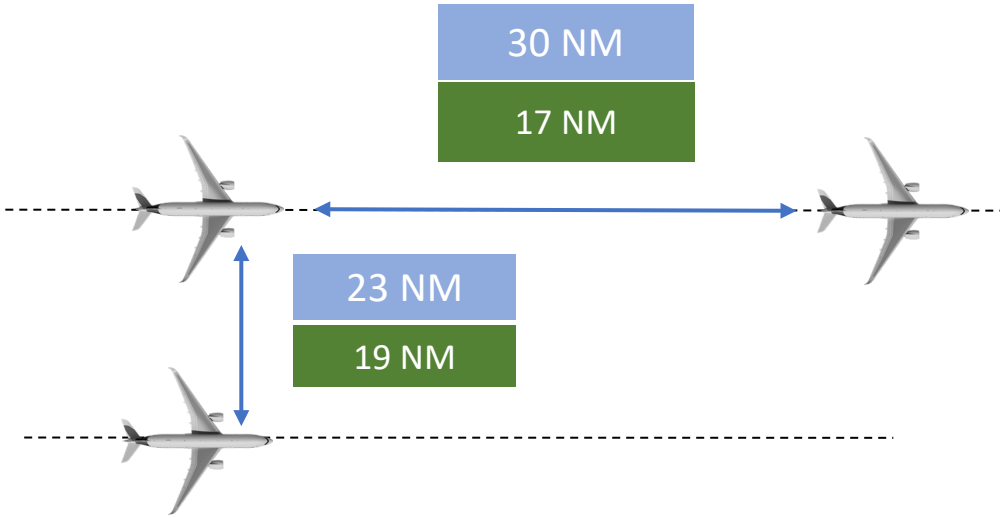
Vertical



Surveillance + VHF



CPDLC + ADS-C



Surveillance + CPDLC

Advantages

Same system for OCS and RDS, with dynamic conflict prediction.

- If a flight's surveillance track is lost, procedural separation minima will be used for that single flight.
- If the surveillance system is not available, procedural separation minima will be used for all flights.

Single rating for ATCO - ACS/OCN/TCL

All workstations can be used for any type of sector

- Surveillance
- Oceanic
- Mixed operations (Surveillance and Oceanic)

Services provided

Services provided

- **FREEROUTE (User preferred routes)**
- **ECON (No speed restrictions)**
- **Cruise climbs / blocks of altitude**
- **Tactical environment, better flight profiles**

Santa Maria ACC

Q&A

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FAA ADS-B Overview:

Current and Future Status

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Alejandro Rodriguez – FAA

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FAA ADS-B Overview: Current and Future Status

Provided by:
Alejandro Rodriguez, Technical Advisor, ATO Program Management Organization

Date: October 18, 2022

Federal Aviation Administration

Outline

- U.S. ADS-B Mandate
- Ground Deployment Status
- Operational use of ADS-B in U.S. airspace
- Future benefits of ADS-B

U.S. ADS-B Out Mandate

- Published May 27, 2010; compliance date January 1, 2020
- Identifies certain **airspace** where ADS-B Out will be required and the **performance** requirements for ADS-B avionics
  - 14 CFR 91.225 specifies Automatic Dependent Surveillance-Broadcast (ADS-B) Out equipment and use including applicable airspace
  - 14 CFR 91.227 specifies Automatic Dependent Surveillance-Broadcast (ADS-B) Out equipment performance requirements
- Applies to **all aircraft** (foreign and domestic)
- Exceptions - The rule does not apply to aircraft
  - Not originally certificated with an electrical system, or
  - Not subsequently certified with such a system installed, including balloons and gliders
- The FAA has initiated a rulemaking effort to update the existing ADS-B regulations (14 CFR 91.225 & 91.227) to include ADS-B Out Version 3 as an acceptable alternate means of compliance.

Understanding U.S. ADS-B Mandate Airspace

Visit: https://www.faa.gov/air_traffic/technology/equipadsb

Ground Deployment Status

Surveillance in The NAS Today

Automatic Dependent Surveillance-Broadcast (ADS-B) service is fully deployed and integrated into all automation platforms.

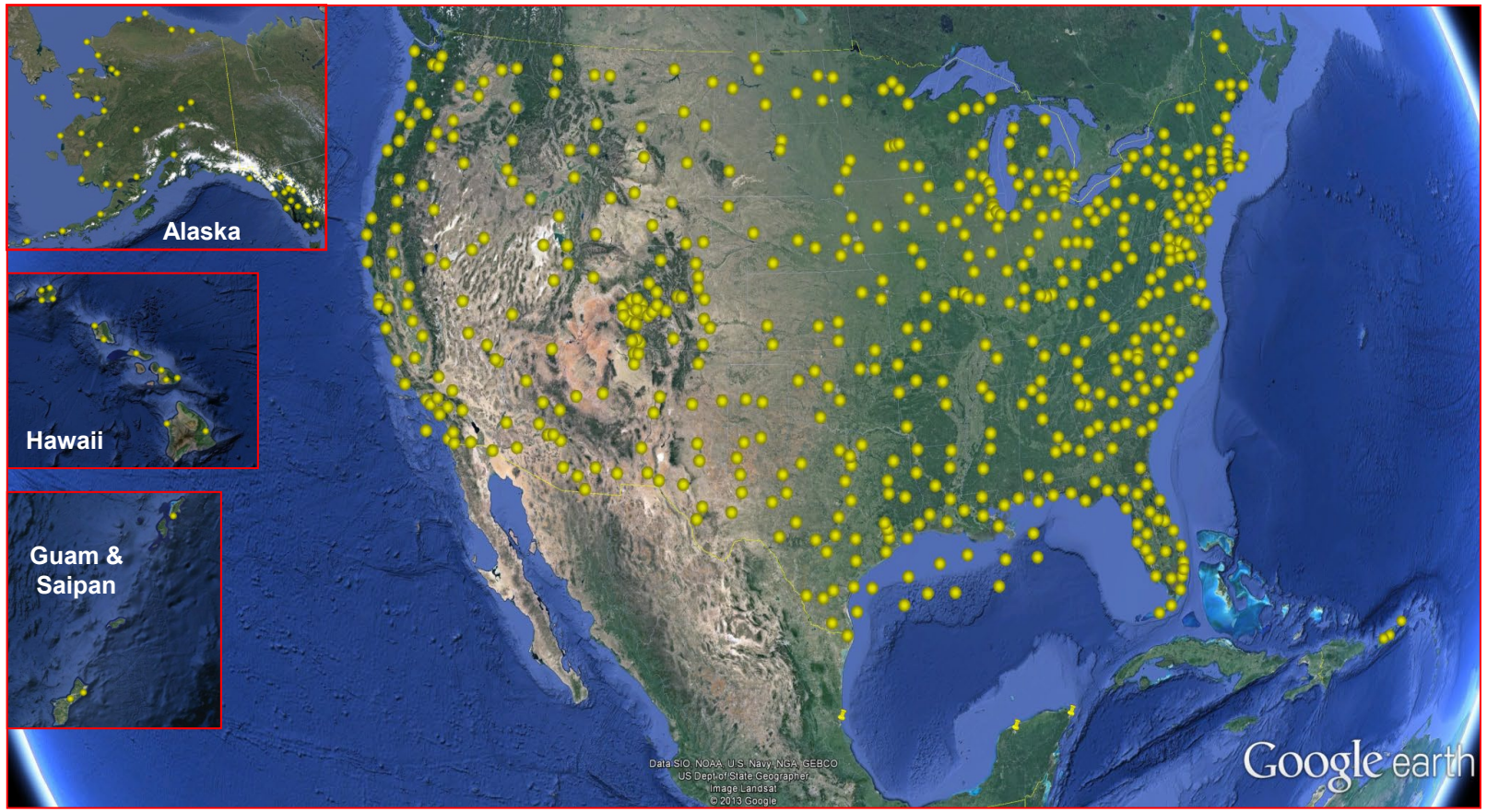
- As of September 2022, **181,314** aircraft were identified as operating with ADS-B Out Version 2 in U.S. airspace
  - 168,153 US registered and 13,161 Foreign registered

Over 750 ground-based radar systems continue to be used for surveillance by FAA, DHS, and DoD.

Wide Area Multilateration (WAM) is a proven surveillance service and considered a backup to ADS-B.

Automation systems fuse together data inputs from ADS-B, WAM and multiple radars to form a single visual for air traffic controllers.

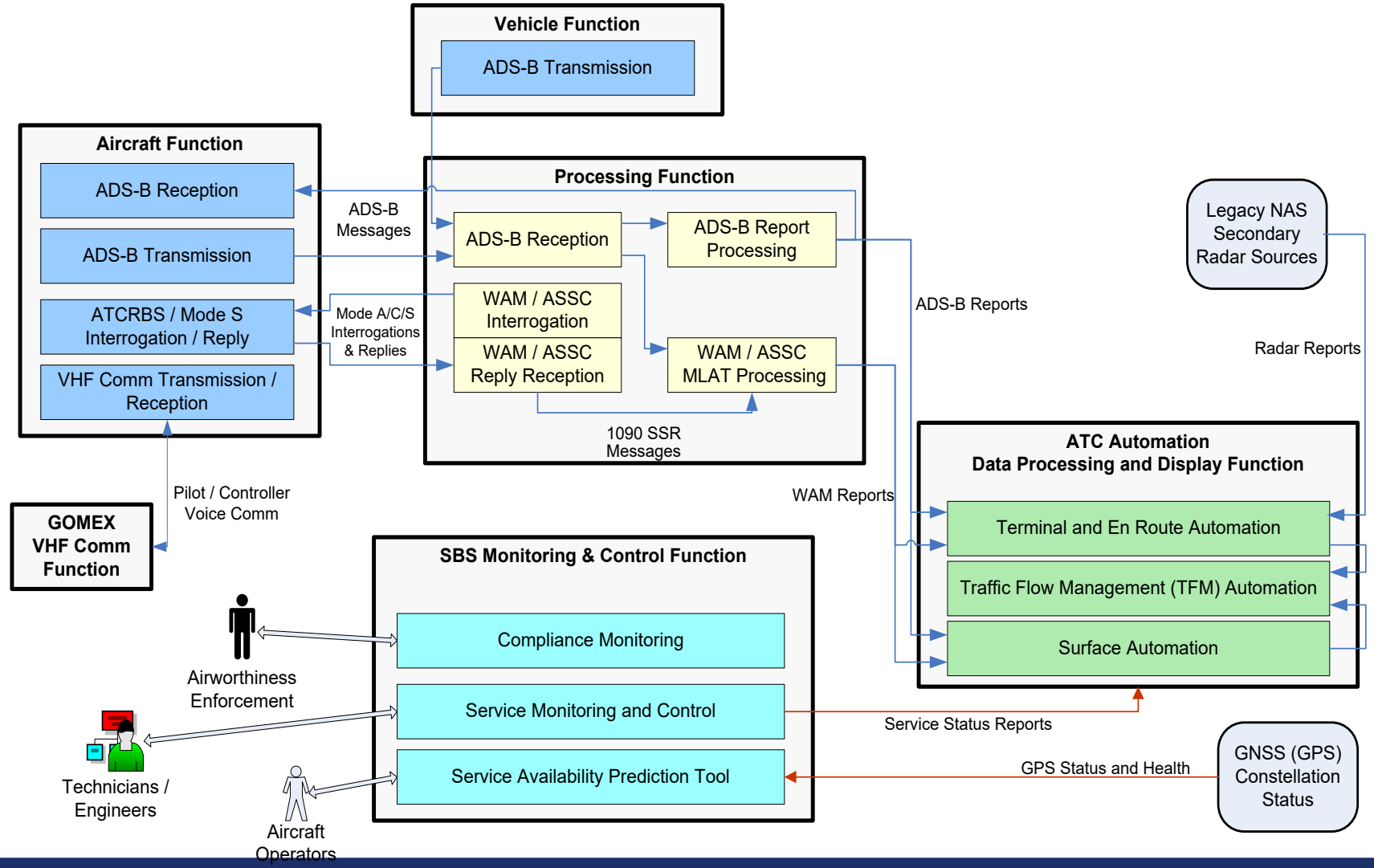
FAA Surveillance and Broadcast Services Implementation Status



https://www.faa.gov/sites/faa.gov/files/air_traffic/technology/equipadsb/research/2020ADS-BAirspaceMap.kmz

Operational Use of ADS-B in U.S. Airspace

FAA Surveillance Functional Architecture



Surveillance in The NAS Today

Automatic Dependent Surveillance-Broadcast (ADS-B) service is fully deployed and integrated into all automation platforms.

- As of November 2020, **148,000+** aircraft in the U.S. are equipped with ADS-B out

Over 750 ground-based radar systems continue to be used for surveillance by FAA, DHS, and DoD.

Wide Area Multilateration (WAM) is a proven surveillance service and considered a backup to ADS-B.

Automation systems fuse together data inputs from ADS-B, WAM and multiple radars to form a single visual for air traffic controllers.

Fusion

- Definition of Fusion for Aircraft Tracking
  - Fusion: A system that is capable of receiving surveillance reports from multiple sensors (Radar, ADS-B, WAM), possibly of different types, and of combining those surveillance reports into a single track for each aircraft that will generally provide more rapid track initiation and higher update rates, and potentially more accurate position and velocity estimates, than could be achieved with any of the individual sensors.

Fusion Considerations in the FAA

- The FAA is utilizing fusion technologies with ADS-B to take advantage of potential benefits related to fusion:
  - Synchronization of track updates on an operational display regardless of surveillance source update rates for improved separation awareness.
  - Improvement to target position and velocity accuracy leading to reduced separation.
  - Provides increased reliability and redundancy for area with multiple sensor coverage.
  - Simpler integration of new surveillance sources, such as multilateration, into automation or other tracking processes.
  - Provides opportunities for computer-human interface improvements and decreased clutter on the display which will also improve situational awareness.
  - Eliminates significant jumps in target position as compared with mosaic displays.
  - Improves Safety Function performance for Minimum Safe Altitude Warning (MSAW), conflict alert, etc.

Fusion Benefits

- Fusion provides better update rates than single sensor and accuracy consistent with the best sensor source
- Fusion provides improvements to Tracker Continuity in a multi-sensor environment
- Fusion provides a smoother track on ATC displays and reduce rerouting or deviations

Future Benefits of ADS-B

Benefits of ADS-B

- The ADS-B program's **strategy** has always been to deploy an infrastructure that can be leveraged for **future operational benefits.** The ADS-B mandate set the FAA on a path to achieve success in:
  - **Reducing Separation: Enable 3nm separation standards in en route airspace where it was not available before.**
  - **Radar Divestiture: Overlapping ADS-B and legacy radar coverage provides the FAA with the opportunity to right-size our surveillance infrastructure across the NAS.**
  - **Surface Surveillance: Continue to leverage ADS-B infrastructure on the airport surface to enhance situational awareness for ATC, pilots, and vehicle operators.**
  - **ADS-B In Applications: ADS-B In brings the opportunity to implement various applications (CAVS, CAS, IM) that transform the ability of controllers and pilots to increase efficiency of spacing operations in the NAS.**
  - **Collision Avoidance: The next generation of collision avoidance capabilities, ACAS-X, is leveraging ADS-B technologies to enhance aviation safety and accommodate new entrants into the NAS.**

Space Based ADS-B Evaluations

Activity	Purpose	Status
1. One-year operational assessment in Caribbean	• Assessed performance and benefits of SBA for 5nm separation	**COMPLETED:** April 2021 **IN PROGRESS:** Final report on assessment and recommendations
2. Evaluation of SBA Data for FAA-wide use	• Looked at use cases and benefits of SBA data across the entire agency, including five lines of business	**COMPLETED:** August 2021; Data purchased through February 28, 2022
3. Data evaluation with all three U.S. Oceanic Air Traffic Control Facilities for use on ATOP	• Explore system performance & identify potential benefits of SBA applications in U.S. Oceanic Airspace • Work with ICAO to identify requirements	**IN PROGRESS:** Final report on assessment with recommendations

Radar Divestiture | Program Overview

Partnership

- Federal Aviation Administration (FAA)
- National Air Traffic Controllers Association (NATCA)
- Professional Aviation Safety Specialists (PASS)
- Departments of Defense (DoD) and Homeland Security (DHS)

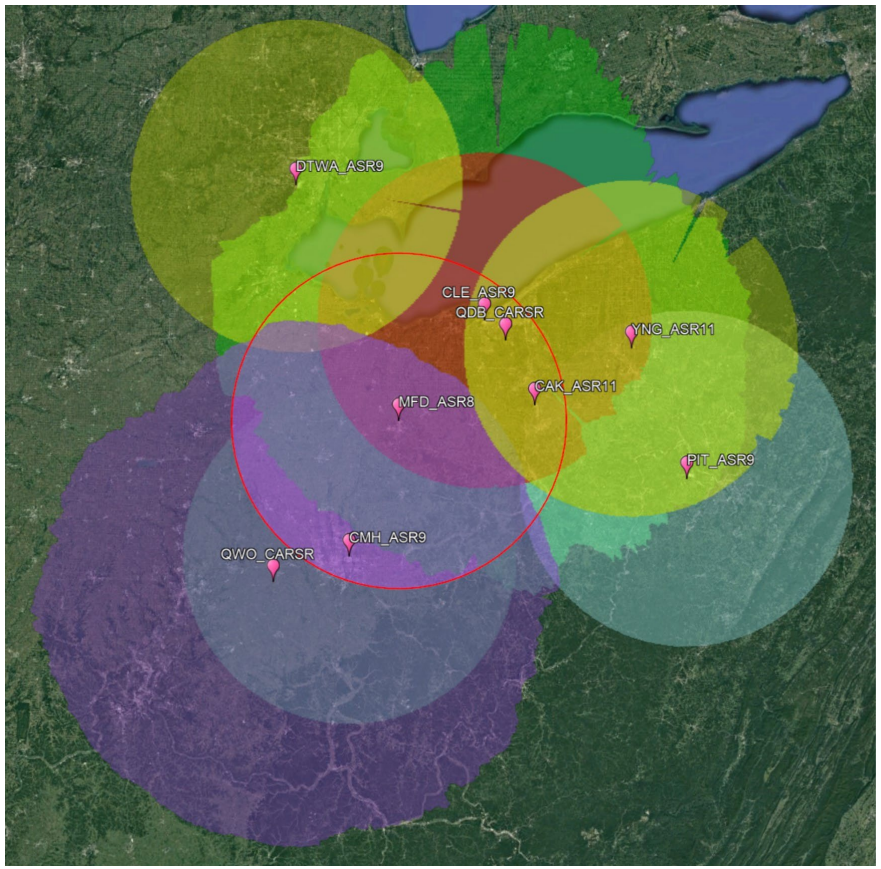
Mission

Capitalize on the benefits of new surveillance technologies by strategically reshaping our radar infrastructure to gain efficiencies and optimize services for ATC operations today and into the future.

Benefits

- Significant cost avoidance through 2035 associated with operating, maintaining, and sustaining radar surveillance systems.
- Operational equipment from divested radars will be used to support the sustainment of the remaining radars in the NAS.

Radar Divestiture | Why divest some radars?



The focus is on divesting radars in areas with multiple layers of overlapping coverage.

Some radars will be strategically divested to:

- Eliminate overlapping surveillance coverage no longer needed.
- Follow through on our commitment to realize the financial benefits of new air traffic surveillance technologies by **safely reducing the radar footprint** in the NAS.
- Avoid significant radar sustainment costs through FY2035.
- Reduce Radio Frequency (RF) congestion in aeronautical spectrum bands.

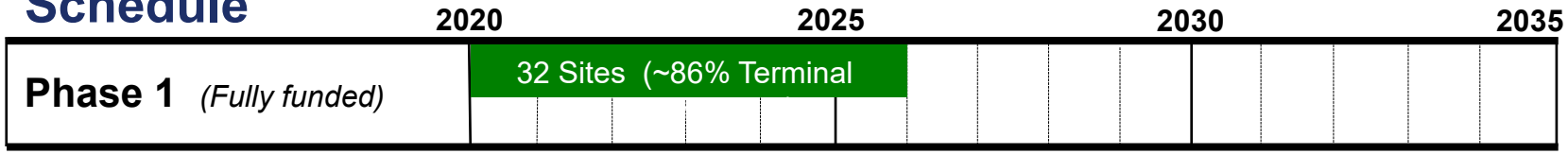
Air traffic safety, services and efficiency will not be jeopardized.

Radar Divestiture | Program Overview

Scope

- Short-range (60 NM) Terminal Radars across continuous U.S. in areas with multiple layers of overlapping coverage.

Schedule



- Beyond 2025, the FAA will continue to pursue radar divestitures that align with the strategic evolution of surveillance services.

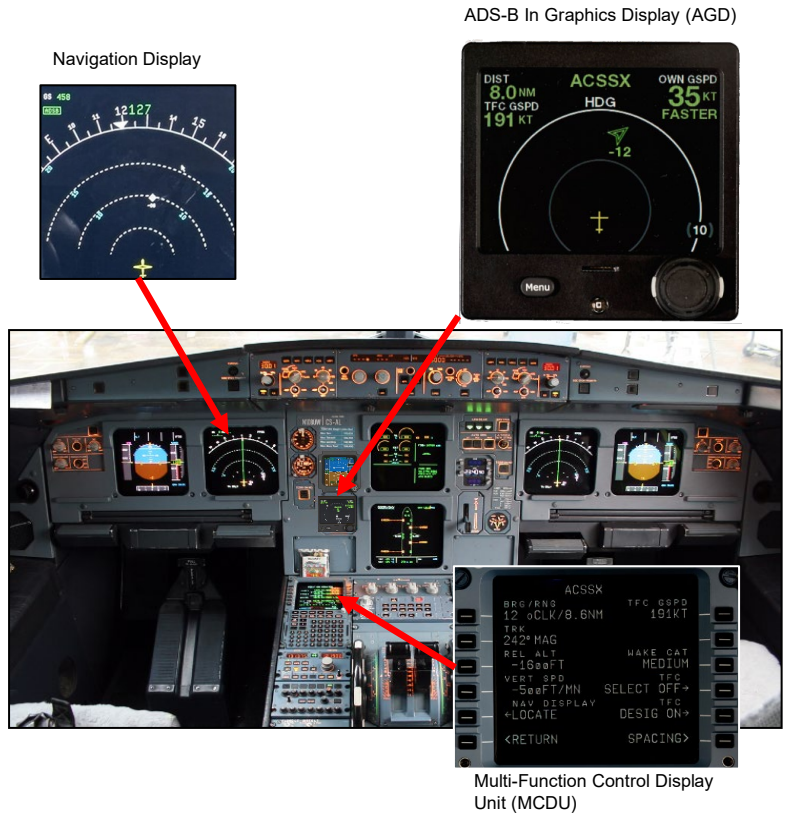
Safety First

- The safety of the aviation system is paramount, and any decision made regarding surveillance capabilities will be **data driven** with a **safety-first** perspective.
- **Local** FAA, DoD, DHS, and other subject matter experts will be involved in surveillance performance analysis (including weather) and safety assessments.

For More Information: www.FAA.gov/Air_Traffic/Technology/RadarDivestiture

ADS-B In Retrofit Spacing (AIRS) Evaluation

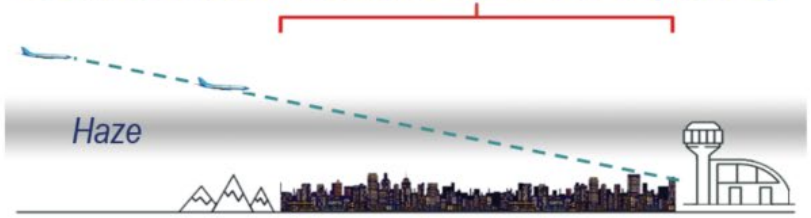
- **AIRS Evaluation will demonstrate the *operational feasibility* and *value* of ADS-B In capabilities using a *retrofit solution***
  - American Airlines is equipping all of their A321 aircraft with certified ACSS equipment (>300 aircraft)
- **Capabilities to be demonstrated:**
  - CDTI-Assisted Visual Separation (CAVS)
  - CDTI-Assisted Separation on Approach (CAS-A)
  - Initial-Interval Management (I-IM)
- **CAVS operations can occur wherever AAL A321s fly**
- **CAS-A operations will occur in Dallas TRACON (D10) airspace for DFW arrivals**
- **I-IM operations will occur in Albuquerque Center (ZAB) airspace for overflights and Phoenix (PHX) arrivals**



AIRS Project Background (CAVS & CAS-A)

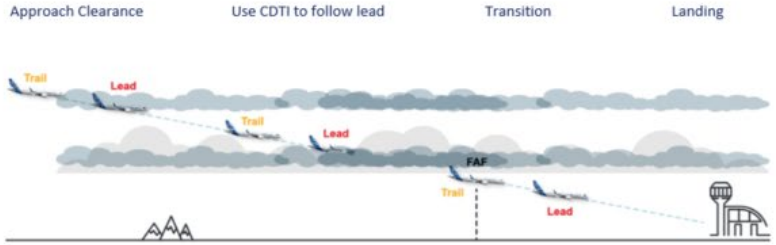
Evaluation of capabilities

CDTI Assisted Visual Separation (CAVS)



- Flight crews can use CDTI to maintain contact with Traffic-to-Follow (TTF) during challenging visibility situations (Haze, Surface Lights, etc.)
- Flight crews must acquire TTF “out the window” (OTW) first, then can rely on CDTI display

CDTI Assisted Separation on Approach (CAS-A)



- Controller clears aircraft for an approach and instructs CAS-A aircraft to use pilot-applied separation behind lead aircraft
- Flight crew acquires TTF on CDTI with no OTW required
- Airport must be VMC but aircraft can transit IMC to the airport (if on instrument approach)

Summary

- The U.S. ADS-B mandate has been in effect since 01/01/2020.
- The ADS-B ground infrastructure deployment is **complete**.
- The FAA continues to leverage ADS-B Out to:
  - Implement Wide Area Multilateration (WAM) rather than Radar
  - Implementation of Fusion
- Find ways to continue to enhance operational efficiency and safety in the airspace:
  - Enable ability to perform 3nm separation standards in en route airspace where it was not available before.
  - Reduce overlapping legacy radar coverage across the NAS.
  - Enhance situational awareness on the airport surface.
  - Reduce 1030/1090 MHz spectrum congestion
  - ADS-B In applications (e.g., CAVS, CAS, etc.)

ADS-B integration in Austro Control

Modernising
Air Traffic Management
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Robert Guttman – Austro Control

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ADS-B integration in Austro Control

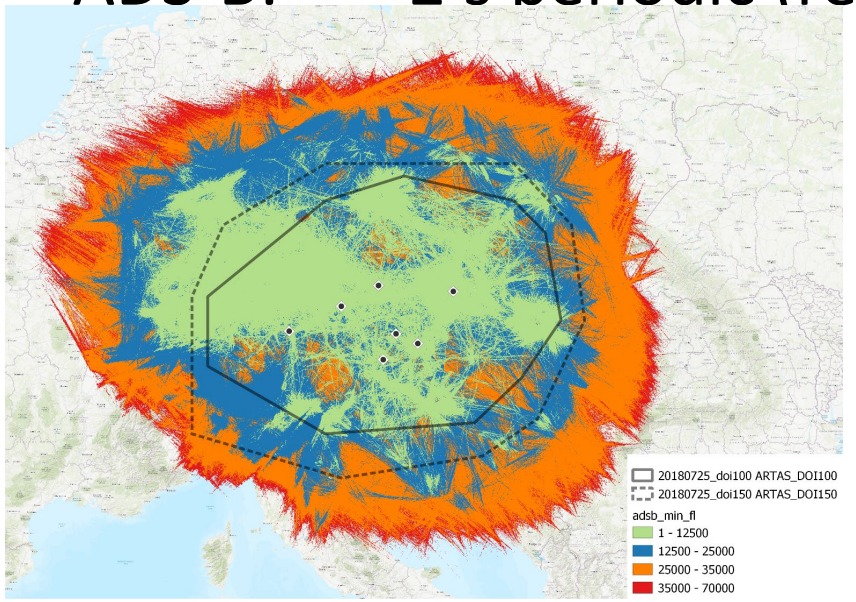
Exploring technology potentials with care

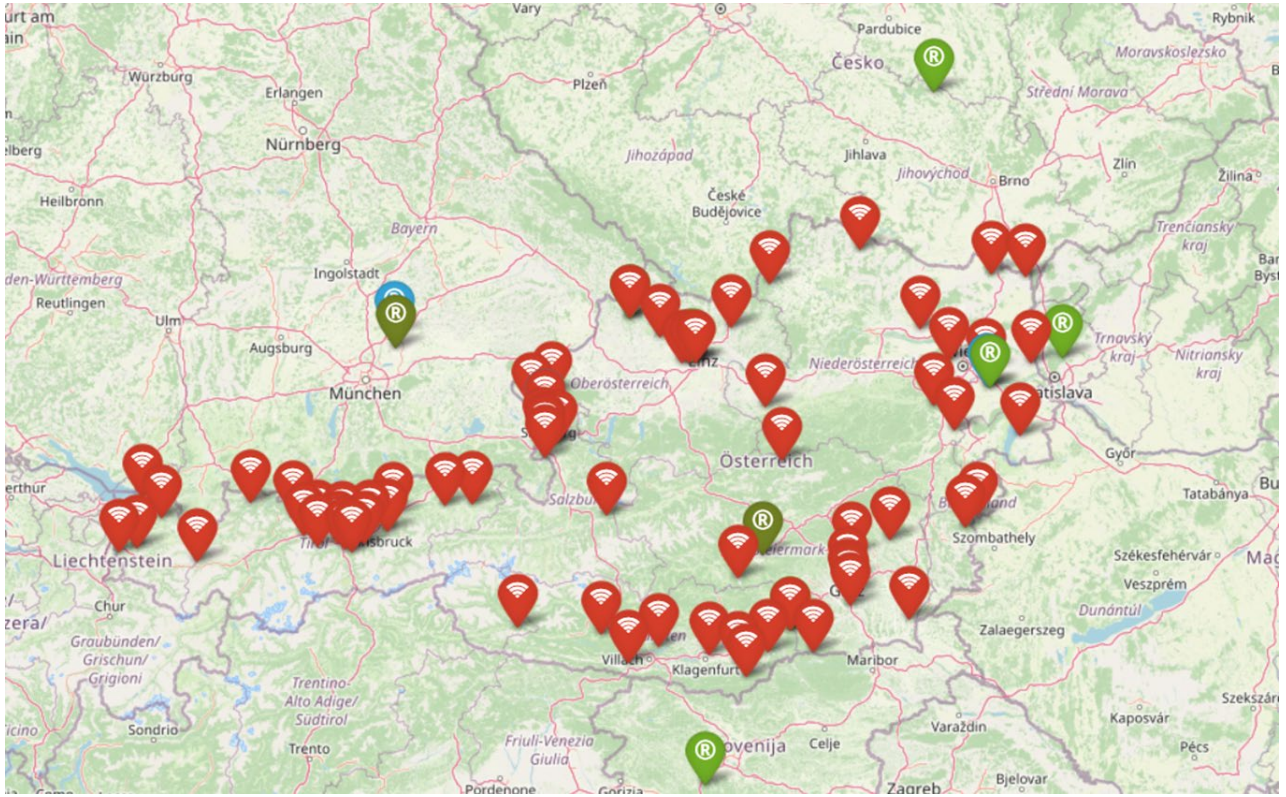
18 October 2022

Robert Guttman, Austro Control, Project Lead ADS-B Tracker-Integration

Surveillance Infrastructure

- Update-rates from Sensors
- Radar: 4 – 5.2 s per Rotation (green/blue)
- WAM: 1 s periodic (red)
- ADS-B: 2 s periodic (red)





ADS-B Integration so far

- Pragmatic approach, following operational needs and

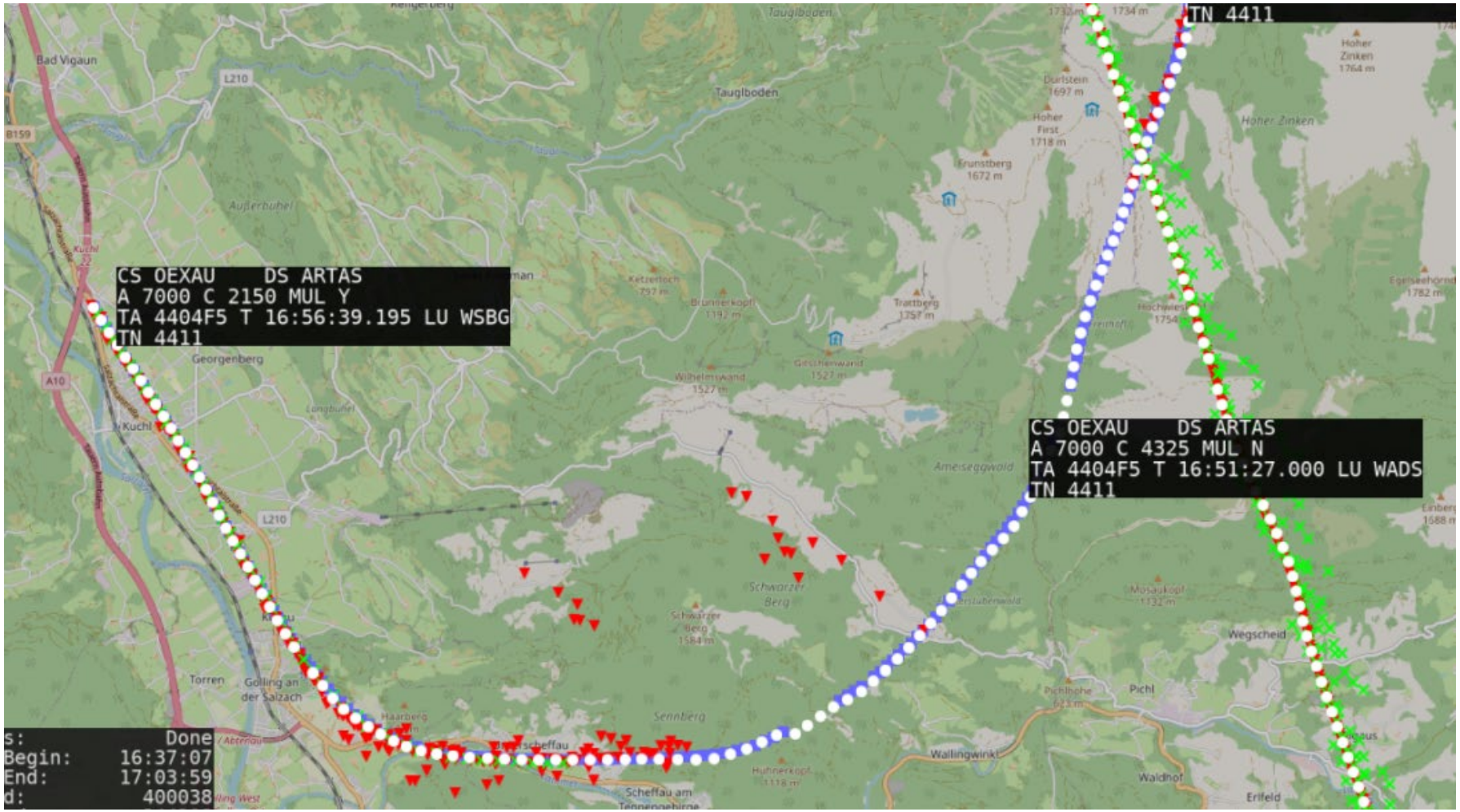
Only implemented for the main operational tracker so far

1. Outside the Area of Responsibility (Italian/Swiss Airspace) –
   - Providing additional coverage in the South West of the Domain of Interest
   - Increased visibility before entering the Area of Responsibility
   - Operational from 30 September 2021 (no complaints since then)
2. Inside the Area of Responsibility (Salzburg Lower Approach Unit)
   - Operational Evaluation from 12 April 2022
   - Additional Coverage in valleys of the Alps

Tracking Problem in valleys of the alps

- **<u>Legend:</u>**
- ARTAS track = white
- ADS-B = blue
- Radar = green
- WAM = red

Improvement for ATCO by using ADS-B



Legend:

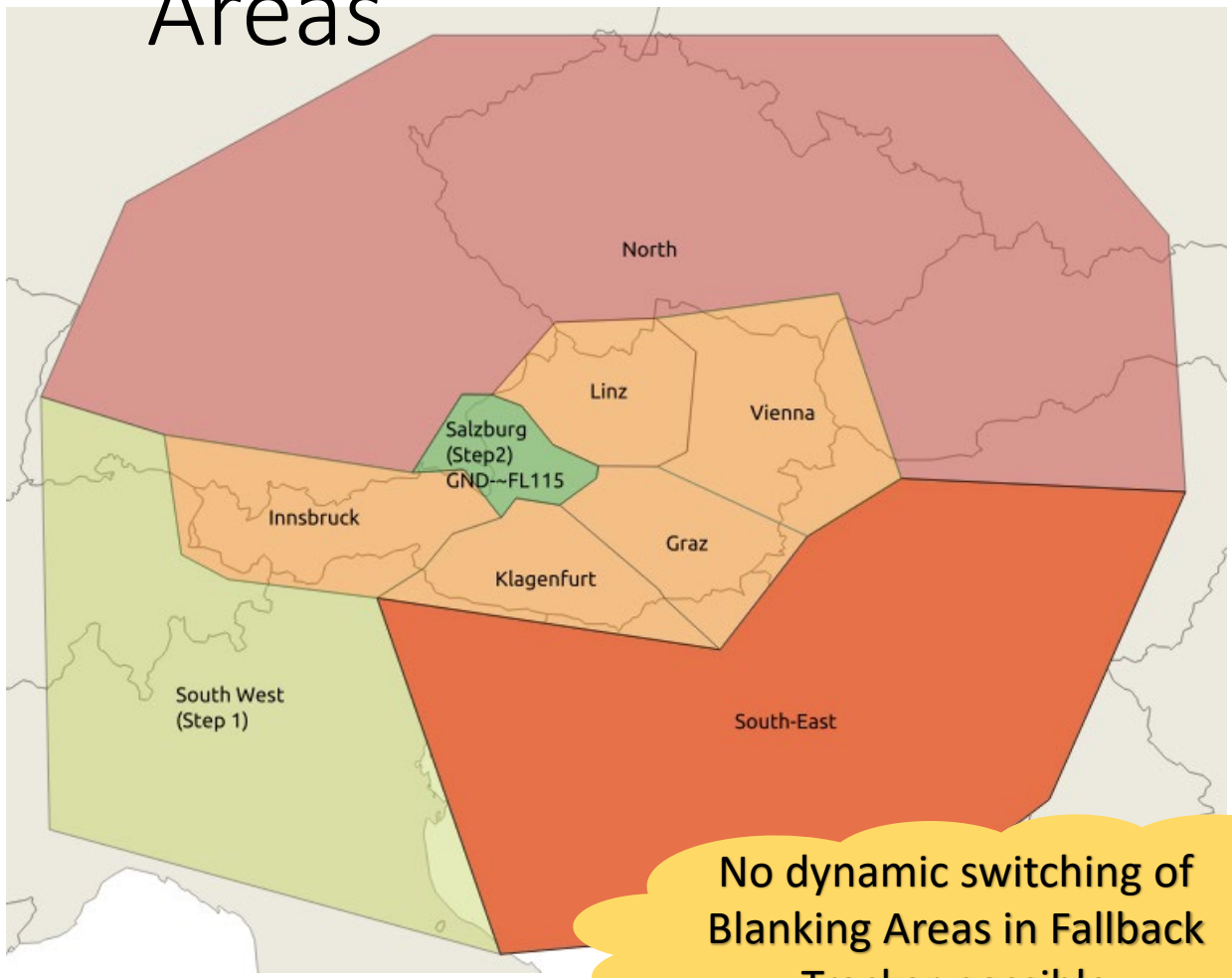
ARTAS track = white

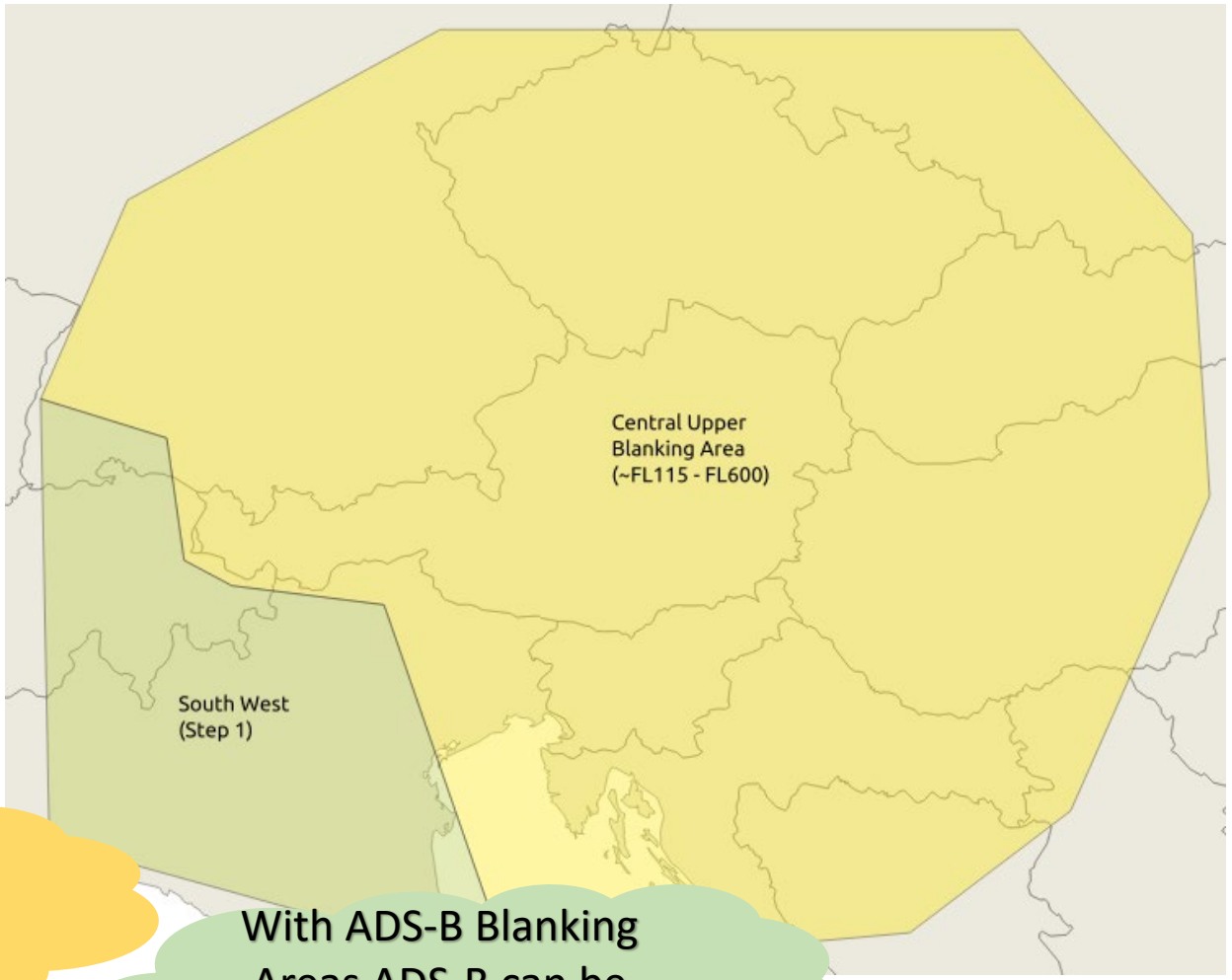
ADS-B = blue

Radar = green

WAM = red

Implementation using ADS-B specific Blanking Areas

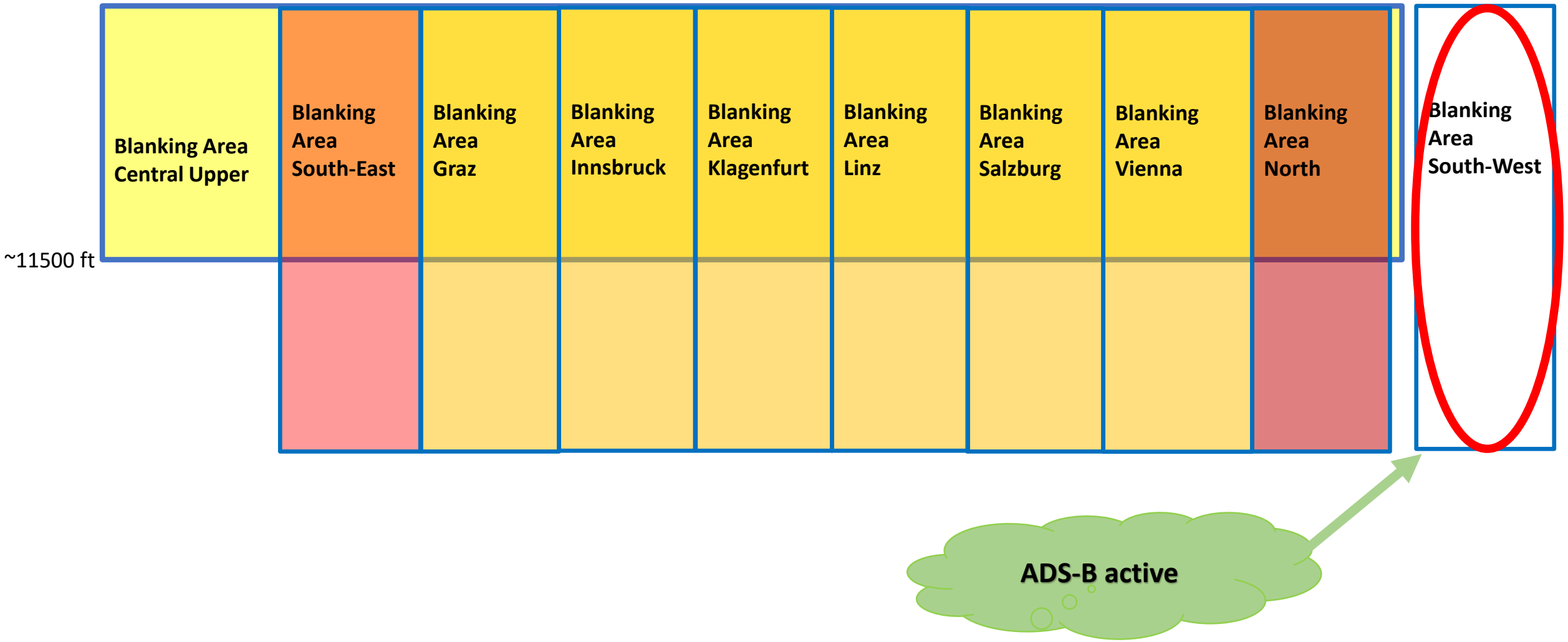




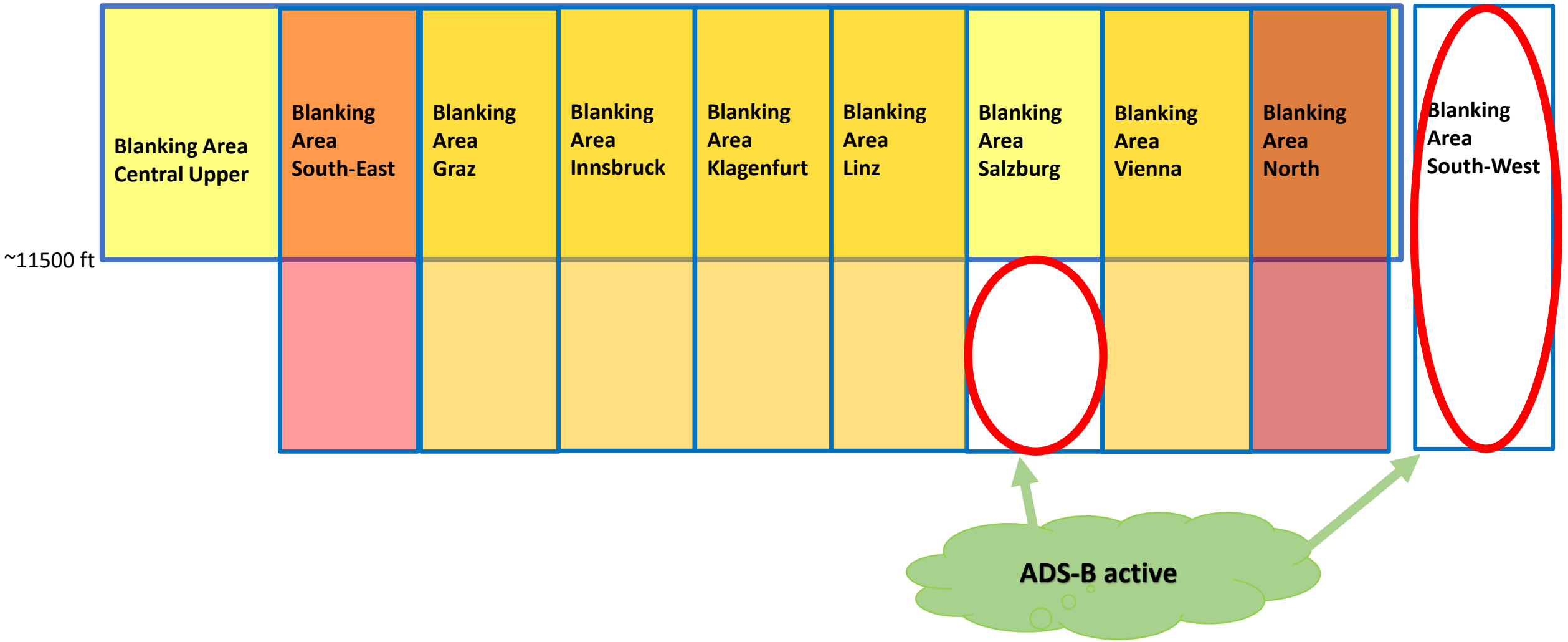
No dynamic switching of Blanking Areas in Fallback Tracker possible

With ADS-B Blanking Areas ADS-B can be deactivated per area by operators any time

Vertical View and Blanking Area Deactivation Step 1 – 30 September 2021



Vertical View and Blanking Area Deactivation Step 2 – 12 April 2022



Use different technologies to increase resilience

- ADS-B is wonderful, when it works well; you cannot find a better position; but it does not work for all aircraft due to equipage; it does not work when GNSS does not work; high vulnerability; the position is not verified on the ground
- WAM is a good technology when it works well; ground based position; scalable
- SSR/Mode S radar: Provides the full set of operationally relevant DAPs, compared to ADS-B; has helped significantly when encountering WAM problems (due to satellite issues)
- Primary radar – is the solution when transponder or 1030/1090 fail

Typical Precision and Robustness of Surveillance Systems

Technology	Primary Radar	SSR/Mode S Radar	WAM	ADS-B	Space Based ADS-B
Frequency used	Different frequencies on L or S Band	1030 MHz Uplink, 1090 Downlink (also shared with ACAS)			
Remarks				**~14-25% of aircraft are not ADS-B V2 equipped or provide insufficient position quality over Austrian Airspace (Sept 2021)**	
Position accuracy (figures to indicate order of magnitude)	100 – 2000m	70 -400m	50-250m	<50m	<50m
Position accuracy is dependent on	Range and Azimuth-accuracy	Range and Azimuth-accuracy	WAM Remote Unit configuration	Onboard equipment, satellite constellation	Onboard equipment, satellite constellation
Significant technical dependencies		• 1030/1090 MHz Frequency • Transponder	• 1030/1090 MHz Frequency • Transponder • GNSS time (for some configs)	• 1090 MHz Frequency • Transponder • GNSS Signal for Position	• 1090 MHz Frequency • Transponder • GNSS Signal for Position • Intercontinental link

Think of your „supply chain“

Satellites failing

Sanctions

Need for optimal mix of SUR Infrastructure Elements

increasing overall (including satellites) complexity and precision

increasing independence and robustness

Frequency and Space related Disturbances

Drone-Gun operator (public security/military)

Disturbance of GNSS Signals

Intentional or Un-intentional collisions

Solar Storms

Disturbance of GNSS Signals

Simulating fake target at 1090 MHz

Transponder

Impacting 1030 MHz and/or 1090 MHz Frequency

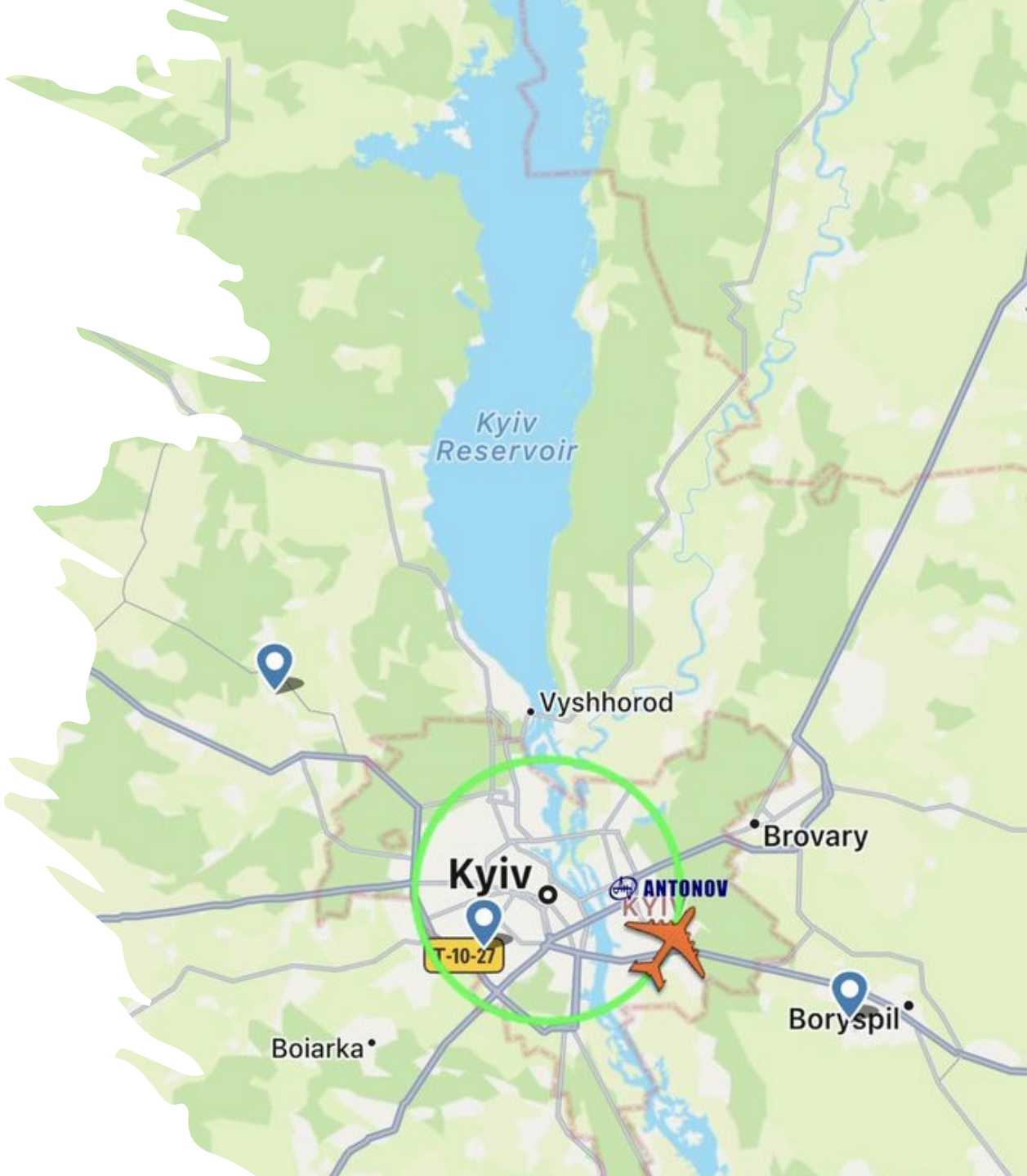
Jamming device

Using Flight Radar 24 has its limitations

- On 11 March 2022 a French IT specialist admitted to have injected a fake target into Flight Radar 24.

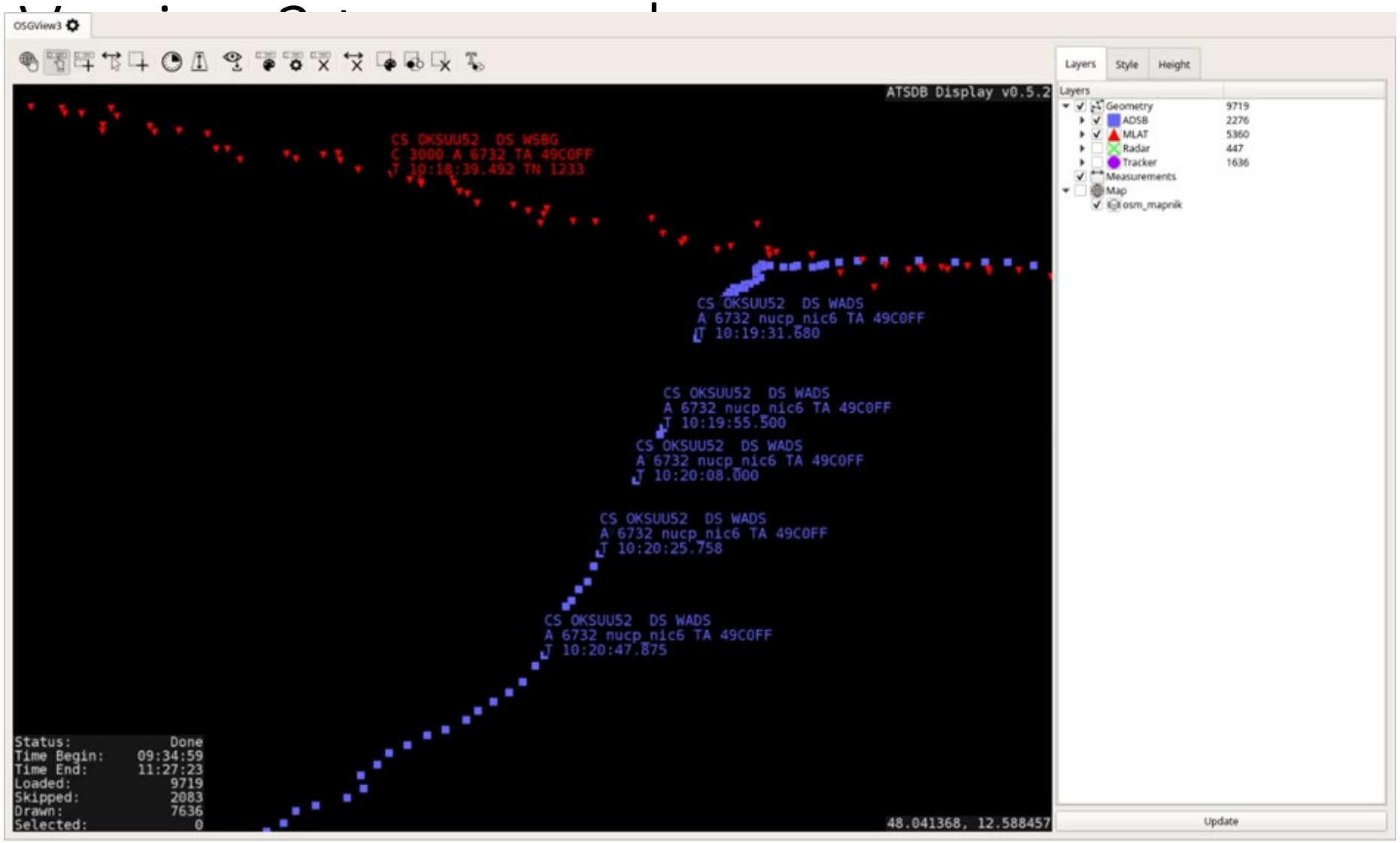
- “I admit, I couldn't resist... “
- “(also shows that tracks on flight radar can easily be spoofed...)”

- The previously destroyed Antonow An-225 was shown as flying in the Kyiv area.

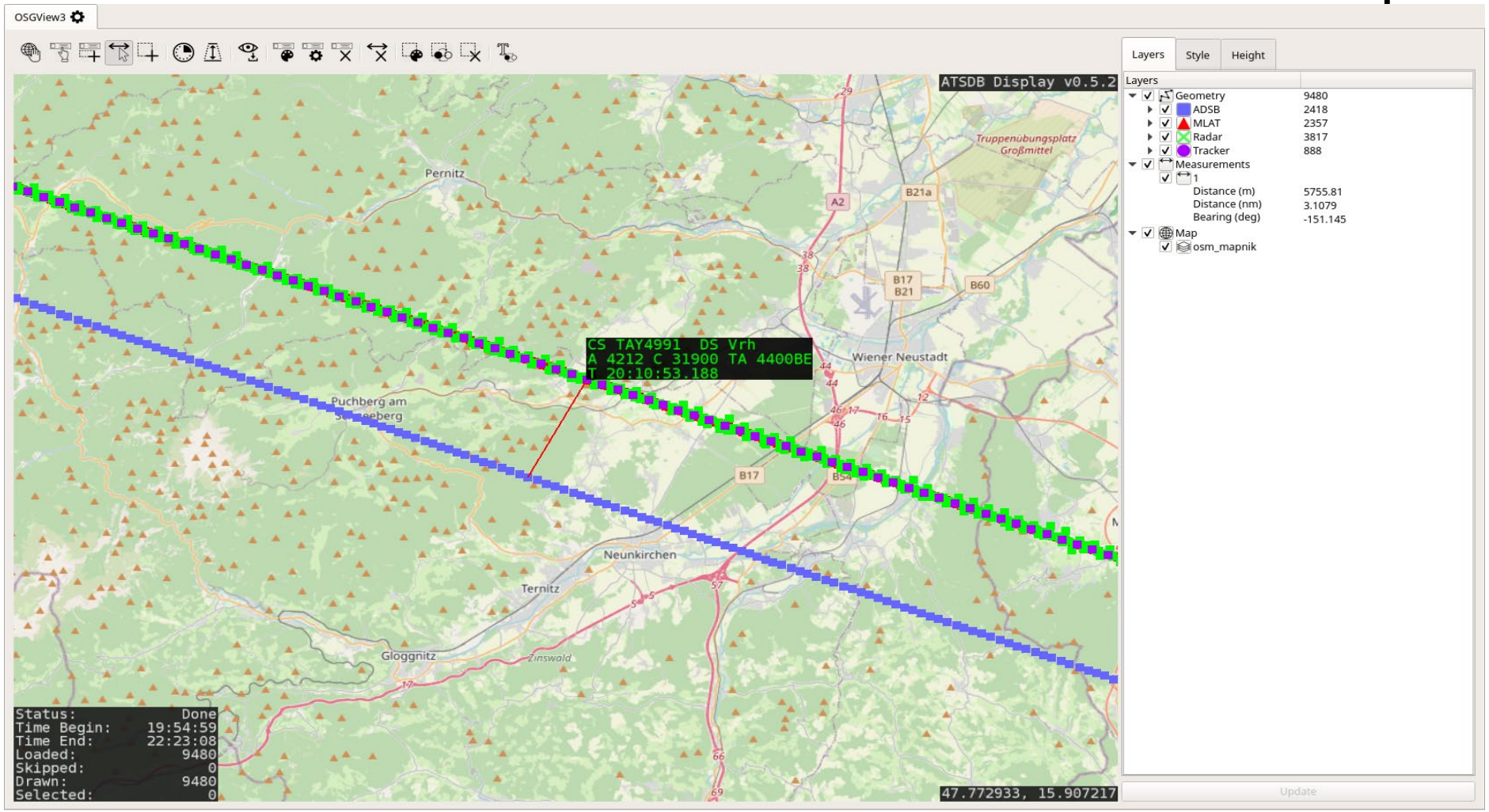


Challenges in ADS-B Data

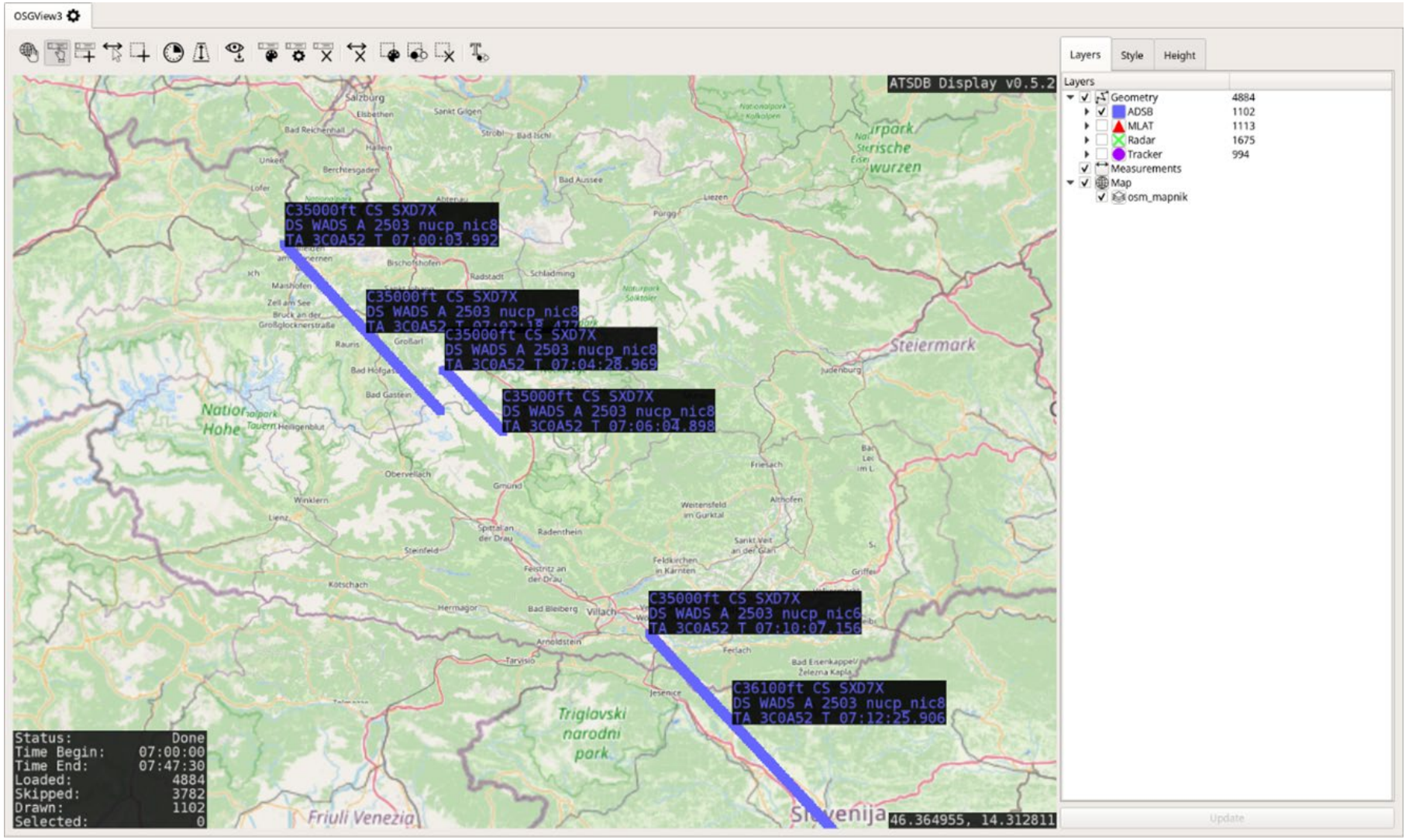
Challenges in ADS-B data:
Freeze of onboard systems – false ADS-B positions



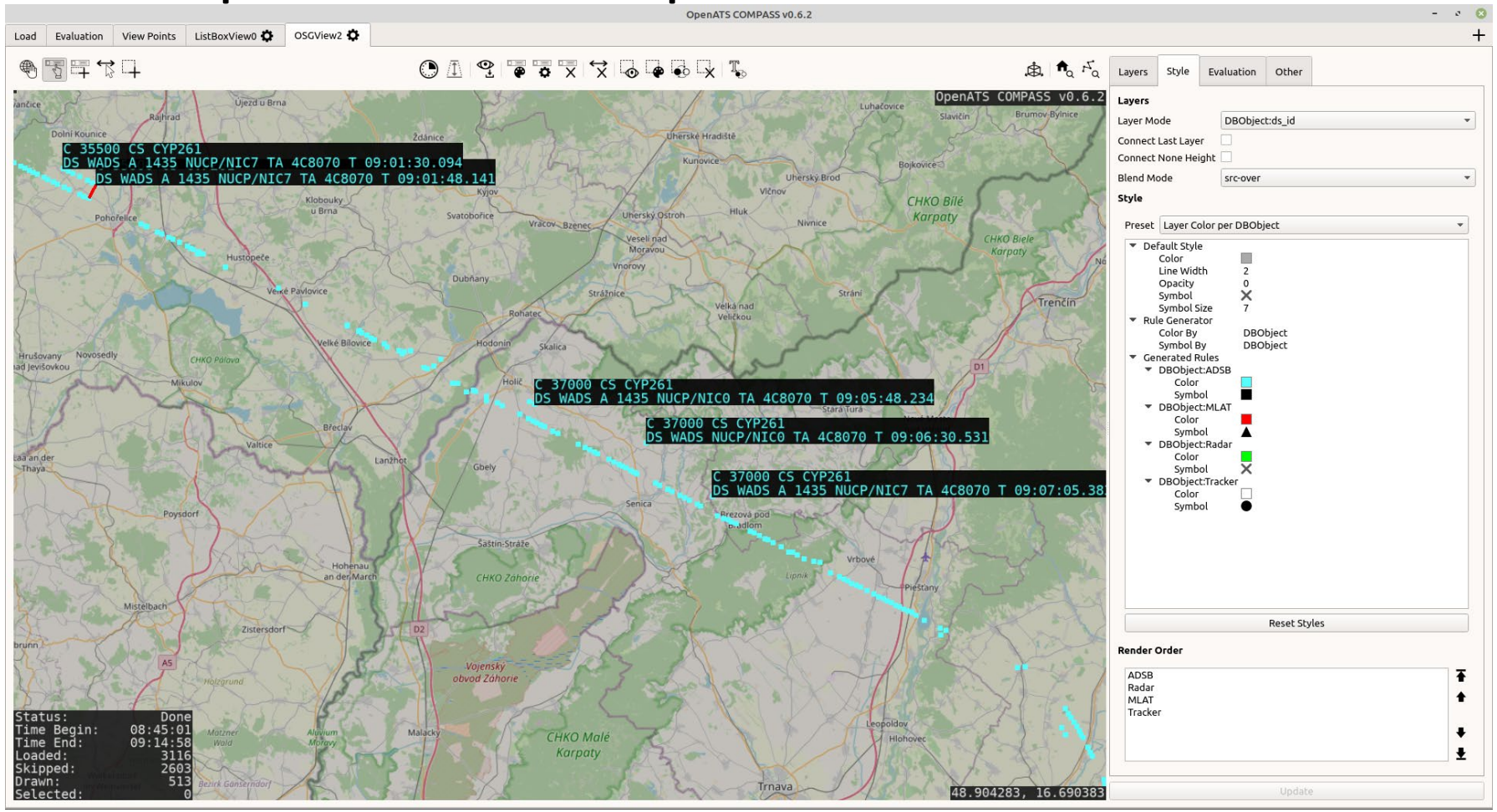
Challenges in ADS-B Data:
ADS-B stable offset – Version 0 Transponder



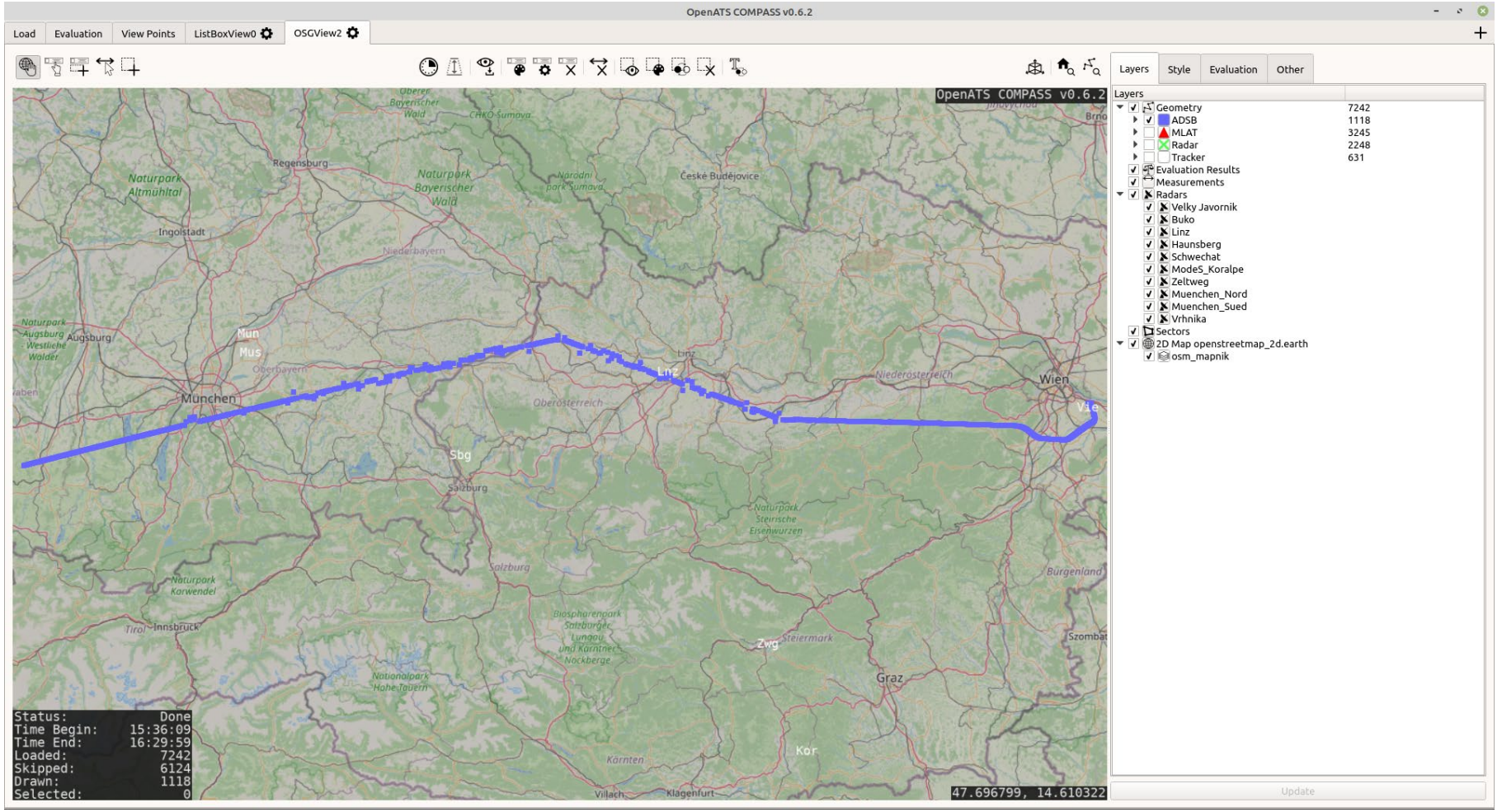
Challenges in ADS-B data:
ADS-B Position Jumps – Version 0



Challenges in ADS-B data: Multiple Data Reports – Version 0



Challenges in ADS-B Data: Multiple Target Reports – Version 2



Response to Challenges in ADS-B Data

Response to ADS-B difficulties

- **No operational procedure requires ADS-B**
- **No separation provision for ADS-B only targets**

1. Use a dedicated position symbol for ADS-B only Tracks – as an indication, that we are trusting the aircraft, and have not verified the position on ground
   "the aircraft is telling me, where it believes that it is"
2. Apply filtering using Quality Criteria
   1. Outside AoR: Position better than 1 NM, SIL >= 2, all ASD-B transponder versions (may change)
   2. Inside AoR: Position better than ~0.5 NM, SIL >=2, only Version 2 Transponders
3. Blacklist – Exclusion List – Non Performant Aircraft List
   - Participation in the NPAL Scrutiny Group Meetings
   - If necessary: adaptation to local needs
   - Report relevant events to the group
4. Disable ADS-B – using an ADS-B Blanking Area or disabling the ADS-B sensor in the tracker

Lessons learnt

- When integrating ADS-B this technology may dominate the track position in a way, that the ATCO may not detect problems of radar and WAM in the same way as before (or not at al)
  - When integrating a new radar, we are considering to switch off ADS-B for some time, in order to be able to capture some, so far undetected shortcomings of the radar
  - Offline post-OPS analysis needs to be increased; possibly running a tracking system without ADS-B and comparing the output with the operational system
- Some effort has been spent to automatically detect ADS-B issues by the tracker
  - With fewer sensors it may be impossible to „know“ which technology is correct
  - Consider an area covered by WAM and ADS-B, where WAM reflections occur from time to time; not possible to find out which position is the correct one
  - Incident investigation is more difficult, with less sensors (e.g. no or less radars)
- The number of entries in the NPAL is moderate
  - currently below 30 for all transponder versions
  - at the NPAL Scrutiny Group meetings usually none to 1-2 airframes are added/removed

ADS-B Implementation Program in DFS

Stefan Stanzel– DFS

sesar DEPLOYMENT MANAGER

Modernising Air Traffic Management As One

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#AsOne

Funded by the European Union

Workshop on ADS-B Implementation,
SESAR Deployment Manager

DFS ADS-B Implementation Program

Brussels, 18. October 2022

DFS Deutsche Flugsicherung

DFS ADS-B Implementation Program

Overview

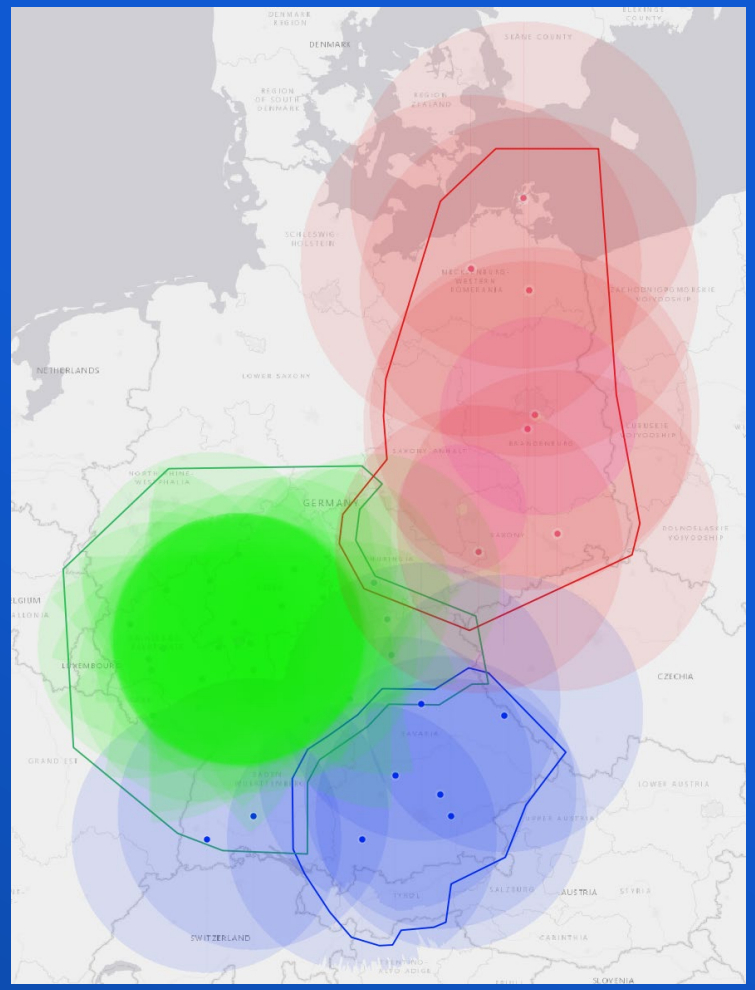
1) ADS-B Program Status

- Implementation Phases
- Phase 1B

2) ADS-B Program Experience

- Spectrum of Tasks
- ADS-B Conformance Monitoring
- ADS-B Validation
- Challenges

3) Conclusion

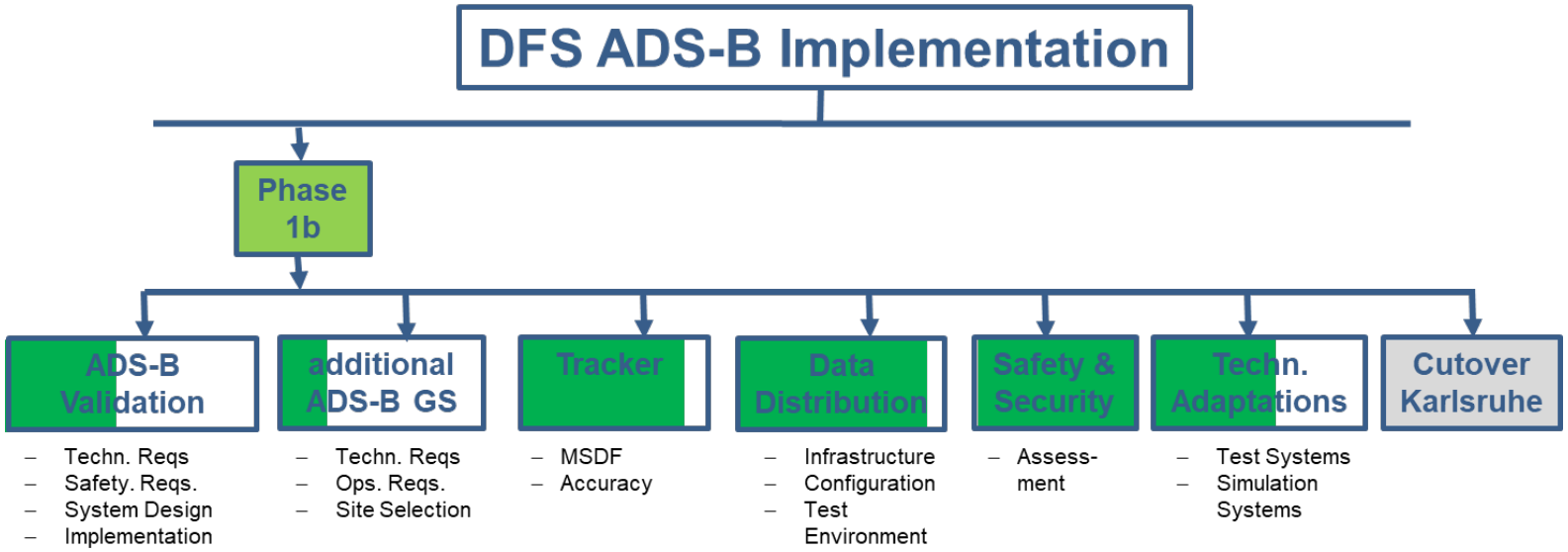


ADS-B Program Status

Implementation Phases

- Implementation Phase 1 (Karlsruhe UAC)
  - Establishment of ADS-B Coverage in accordance with the airspace controlled by UAC Karlsruhe (vertical above FL245).
  - 1a) Use of existing ground infrastructure provided by Wide Area Multilateration System (PAM-FRA). **done (2021)**
    1b) Remaining ADS-B coverage gaps are closed by additional ground stations. **ongoing (2024)**

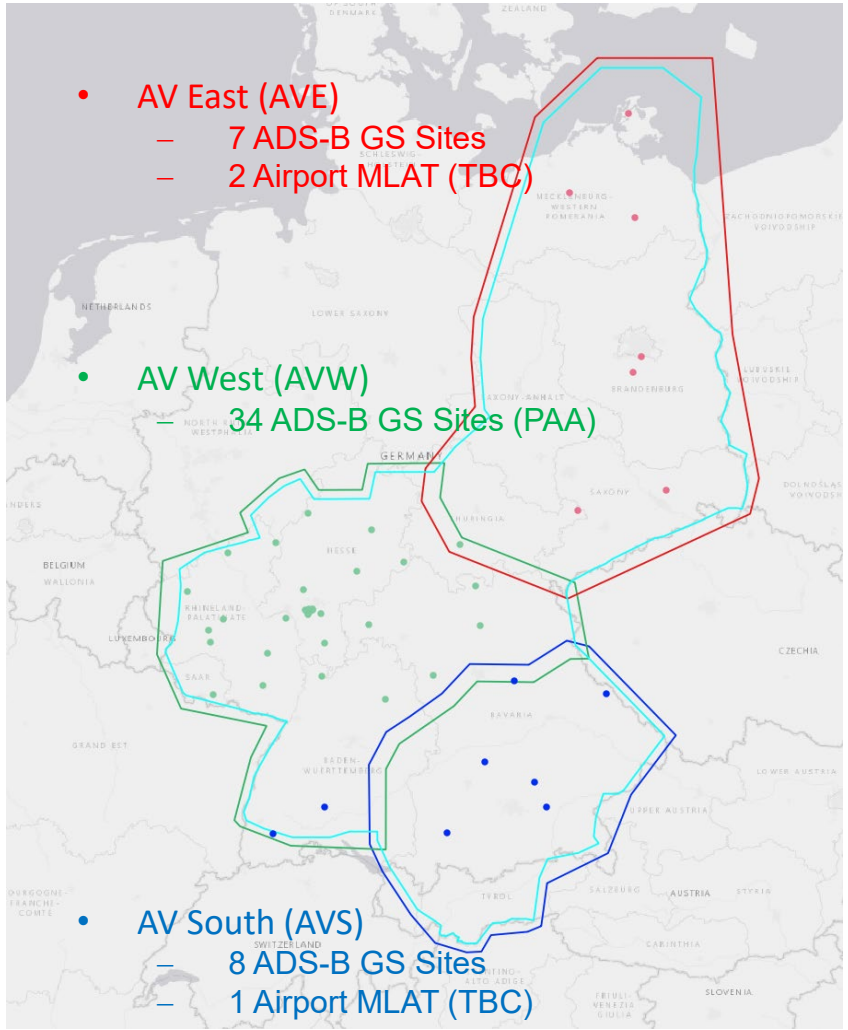
- Implementation Phase 2/3 (Implementation of ADS-B infrastructure for coverage of lower airspace in Germany) **tbd (2027)**
  - Vertical coverage: 3000ft GND or MVA; lateral coverage: Germany
  - In order to fulfill these requirements additional ADS-B infrastructure will be implemented (ground stations and processing).



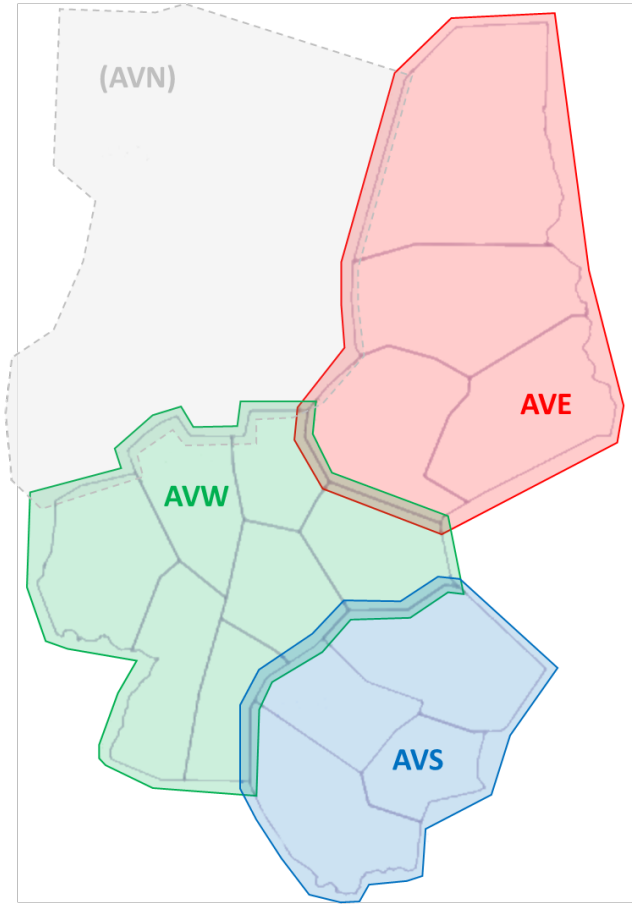
ADS-B Program Status

Phase 1B

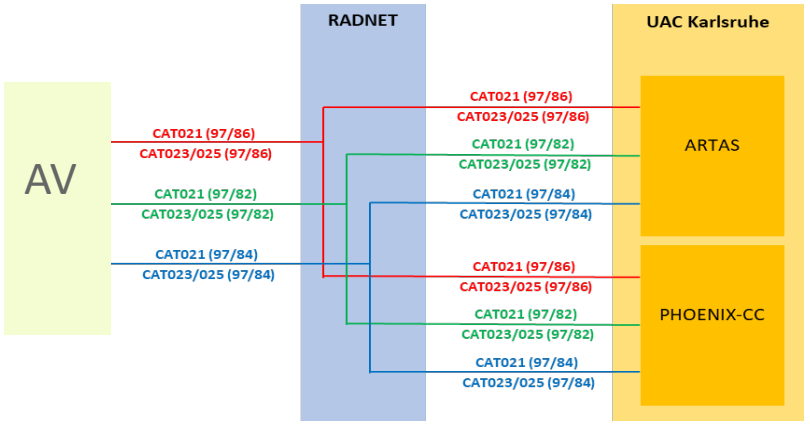
ADS-B Ground Stations/ Systems



ADS-B Services



ADS-B Data Distribution



AV = Validated ADS-B Data

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ADS-B Program Experience

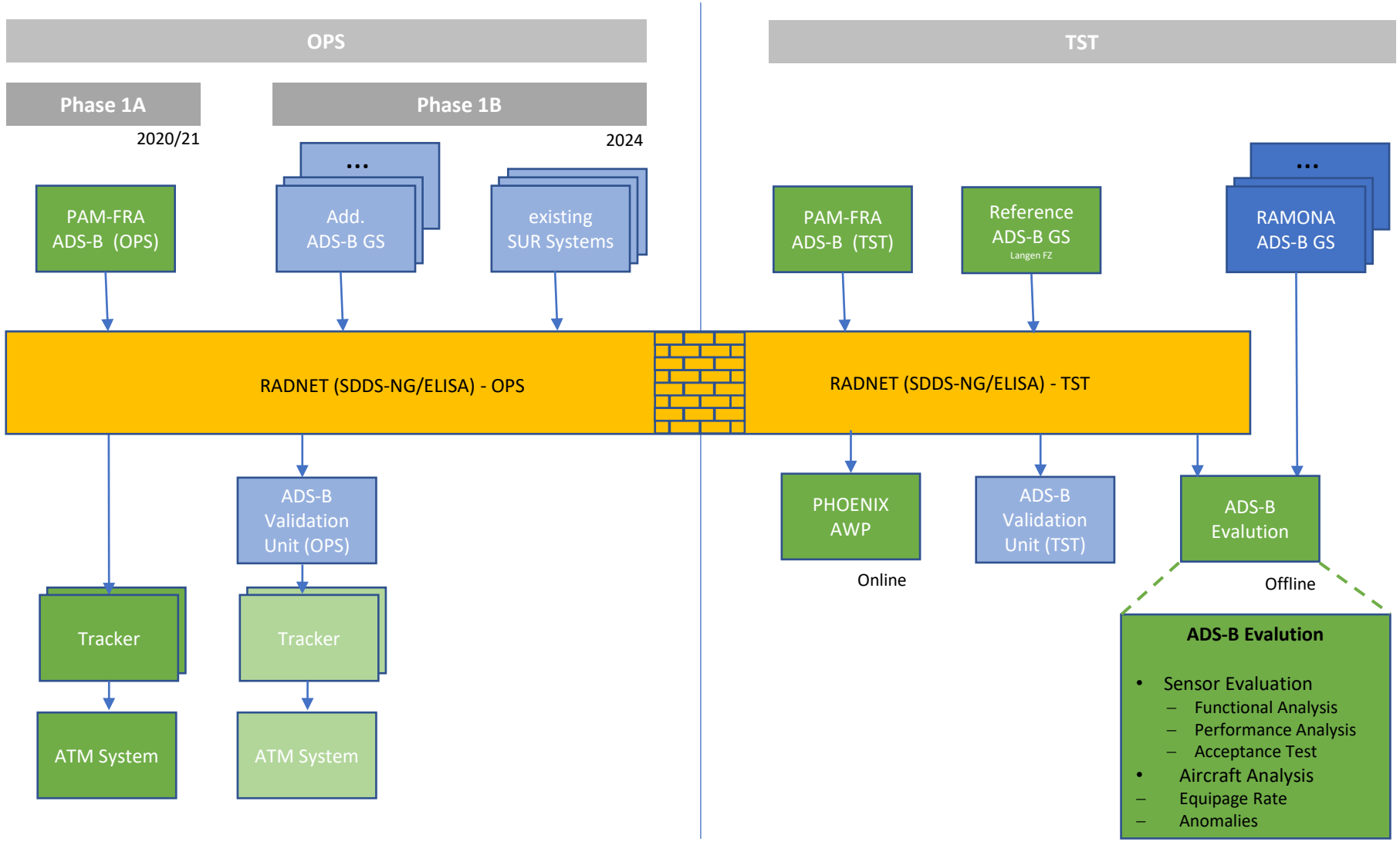
Spectrum of Tasks

ADS-B transition requires the treatment of a wide spectrum of tasks:

- The operational use of ADS-B information with its various data formats is a new task and not commonly specified nor conceptually captured.
- Adaptations of Data Distribution Systems and ATM Systems are likely to happen.
- The incomplete airborne equipage rate and anomalies require appropriate attention and handling.
- Various ADS-B safety and security aspects require appropriate attention and handling.
  - *Data Quality, Data Rate, Aircraft Identification, Security (Jamming, Spoofing, …), Identification for ADS-B unconfirmed Tracks, Operational presentation of ADS-B information*
  - *Threat and Impact Assessment (Failure of ADS-B data, Non-availability of ADS-B data, Plausible/ Implausible falsification of ADS-B data)*
  - *Safety Requirements (Duplicate address processing, Detection of horizontal and vertical position deviations, Impact of ADS-B on SDPS track processing*
- ADS-B only usage for different separation minima has to be clarified.
- In Germany a national Type Certification for ADS-B Ground Systems is required referencing the latest available standards. This requires additional activities and effort for an operational usage of existing ADS-B equipment. ADS-B equipment is likely to become subject to certification requirements by new EASA rules after 2023.
- Fulfilment of safety and integrity requirements for data generated based on own-detection principle will require ADS-B data validation.

ADS-B Program Experience

DFS ADS-B Testbed (conformance monitoring)



- Establishment and further development of systems and methods for ADS-B evaluation (ADS-B Testbed)
- Performing analysis
  - ADS-B Systems (sensors)
  - ADS-B Transponder (flight trials)
  - ADS-B Data
    - Performance analysis
    - Long term statistics (equipment level)
    - Anomaly analysis
- Support of developments
  - ADS-B validation functions
- Integration and acceptance support
  - PAM-FRA ADS-B (Phase 1A)
  - *future:*
    ADS-B Ground Stations (Phase 1B,2,3)
- ADS-B simulations
  - ADS-B load analysis
  - Newsim (tracker evaluation)

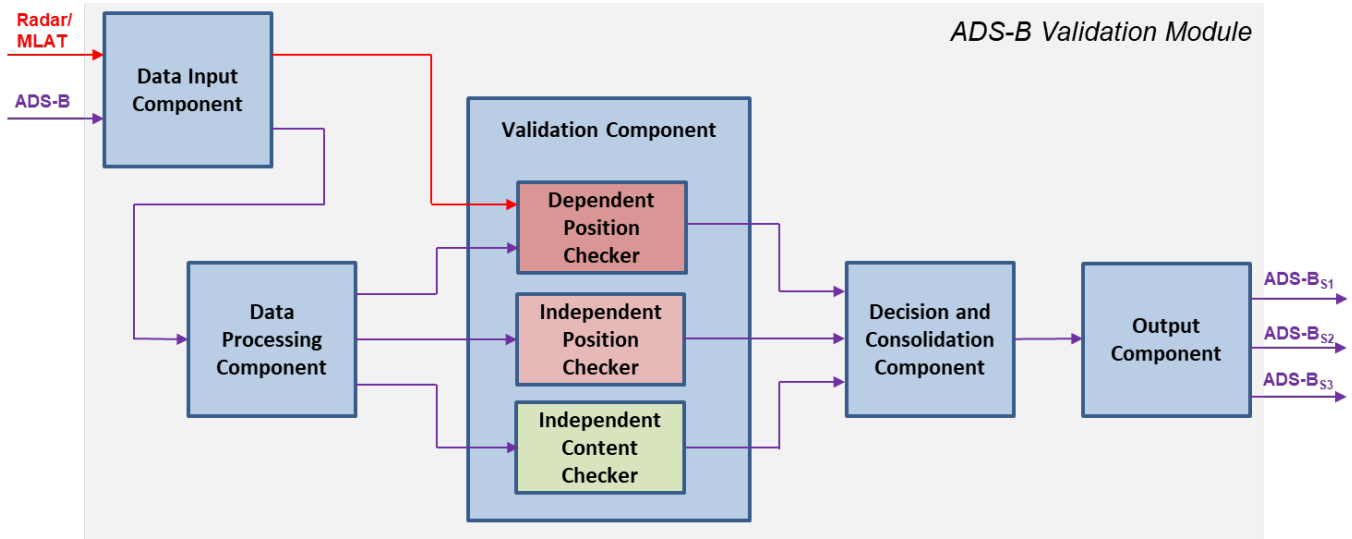
ADS-B Program Experience

ADS-B Validation

- It should be avoided that ADS-B validation has to be done in multiple single entities.
- ADS-B validation should be flexible to be adapted to developing ADS-B technology, different variants of ADS-B sources, detected anomalies, different use cases and safety and security cases.
- ADS-B validation should be based on

  a) dependent validation, based on comparison with data form other surveillance sensors

  b) independent validation, i.e. source location position validation, based on processing of multiple ADS-B data for same target

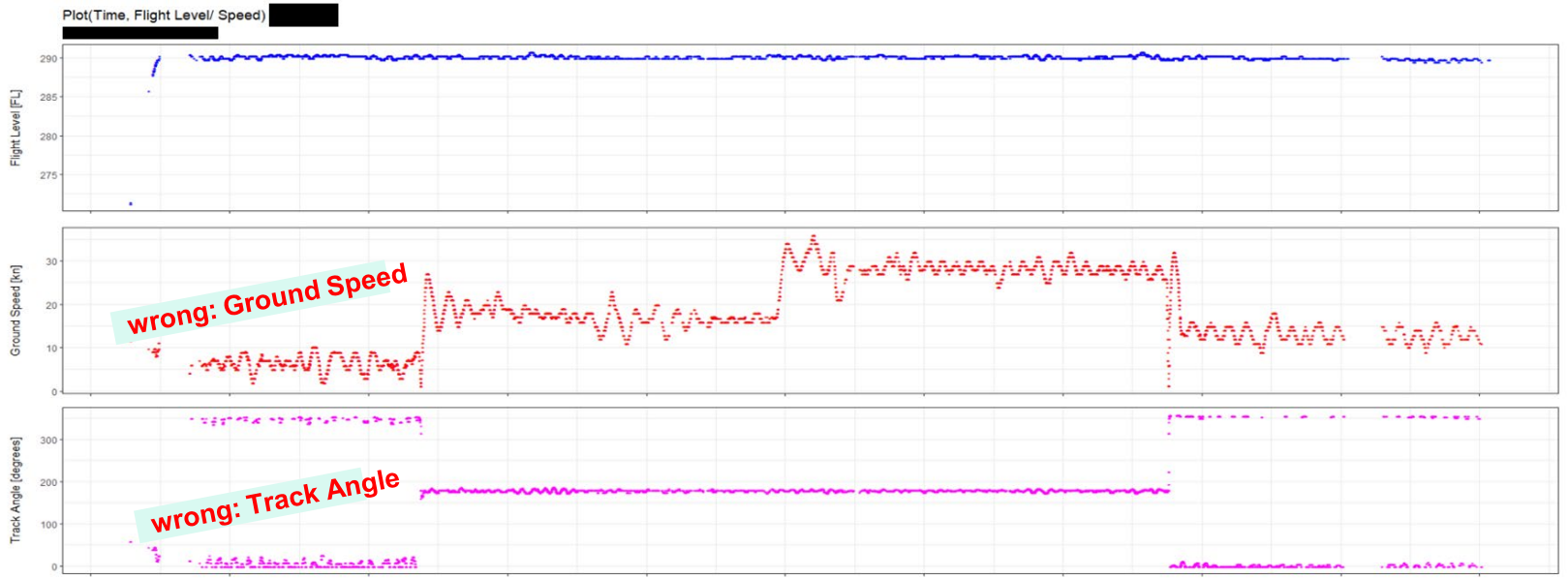


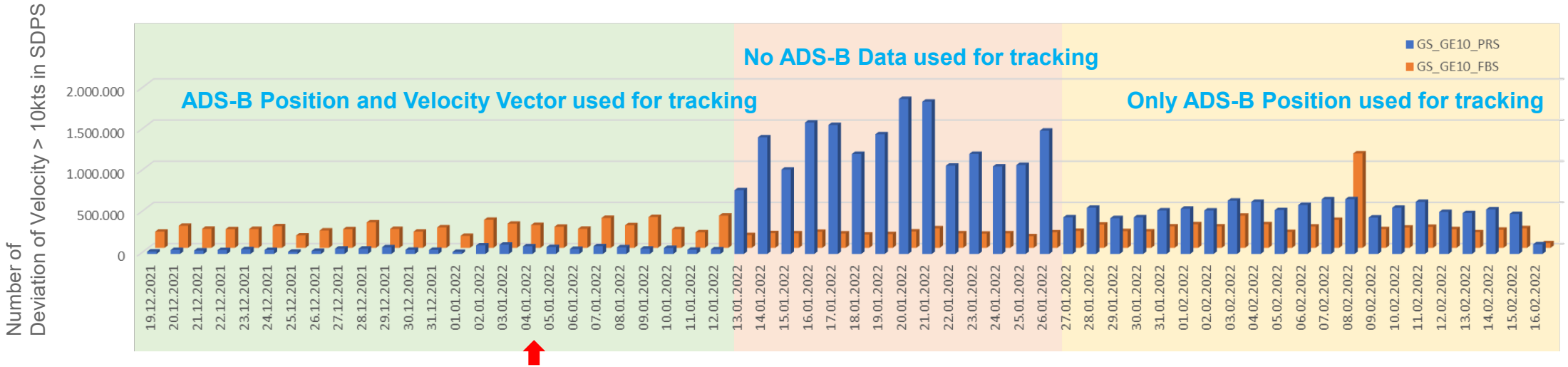
- The ADS-B validation capability increases with the amount of available target data from different sensors.
- The value of the ADS-B surveillance layer increases with its degree of successful independent validation.

ADS-B Program Experience

ADS-B Validation

Example:
A/C providing wrong ADS-B Velocity Vector





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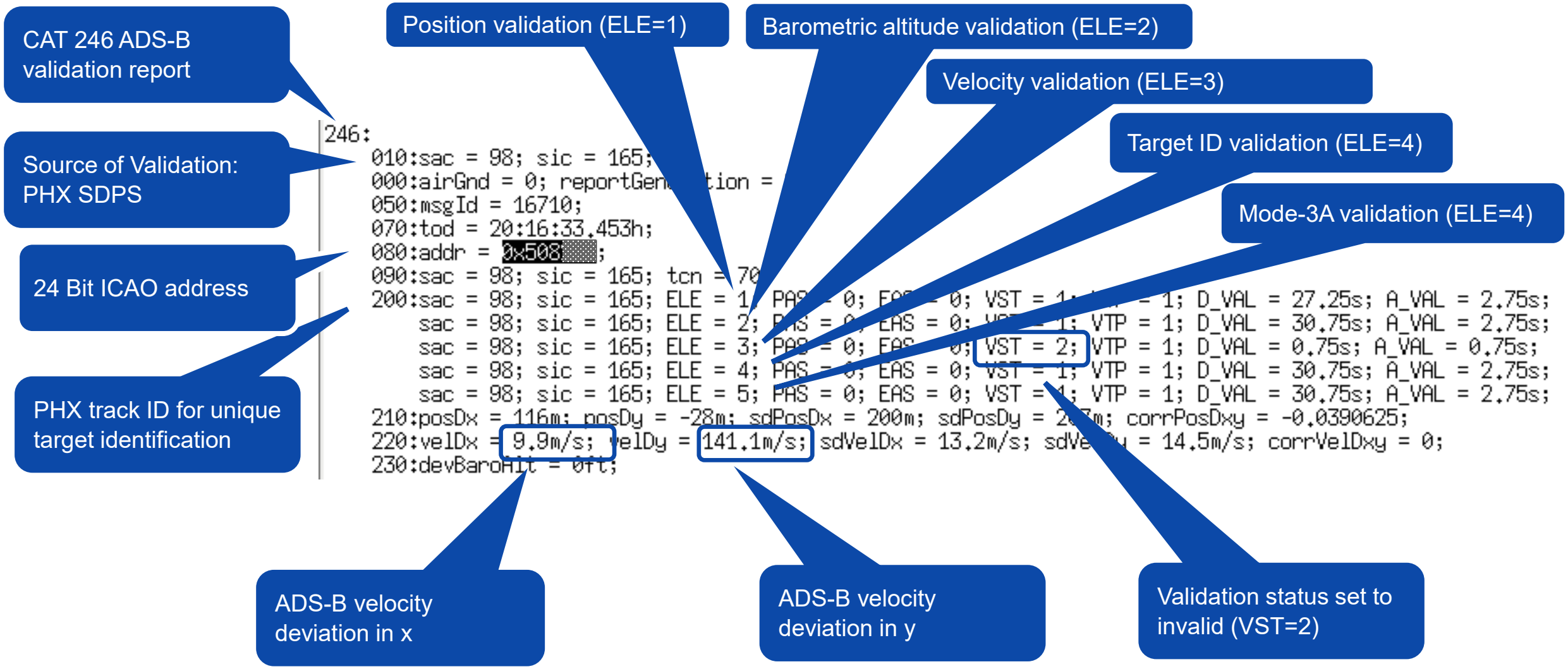
ADS-B Program Experience

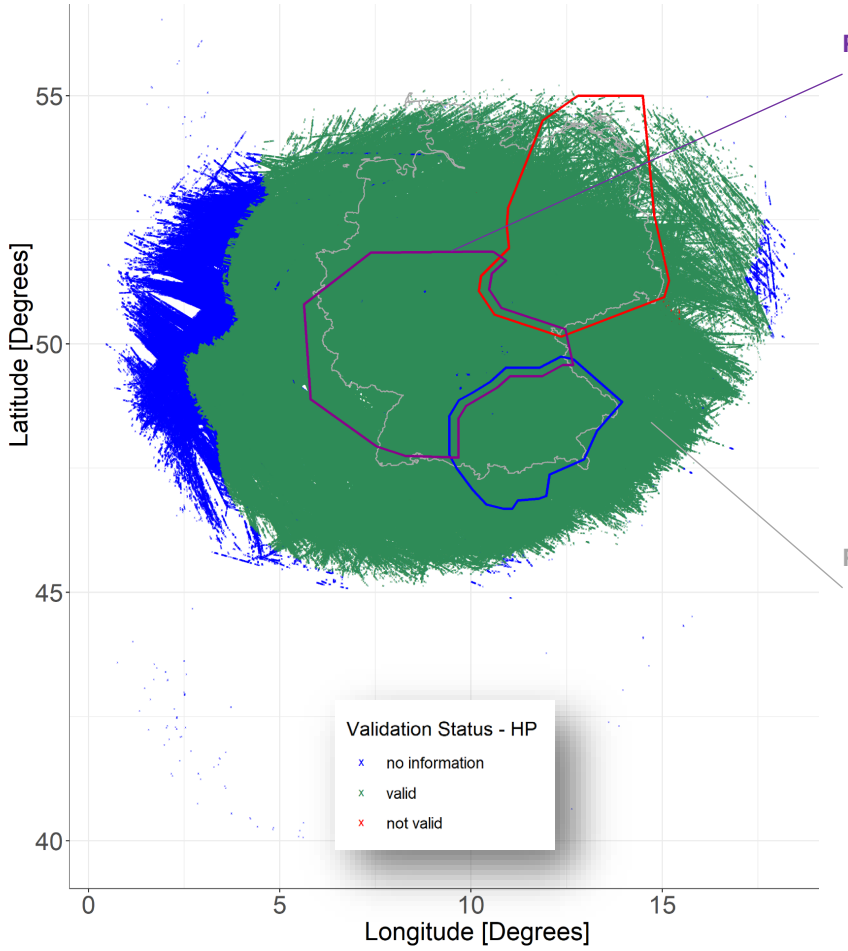
ADS-B Validation



ADS-B Program Experience

ADS-B Validation

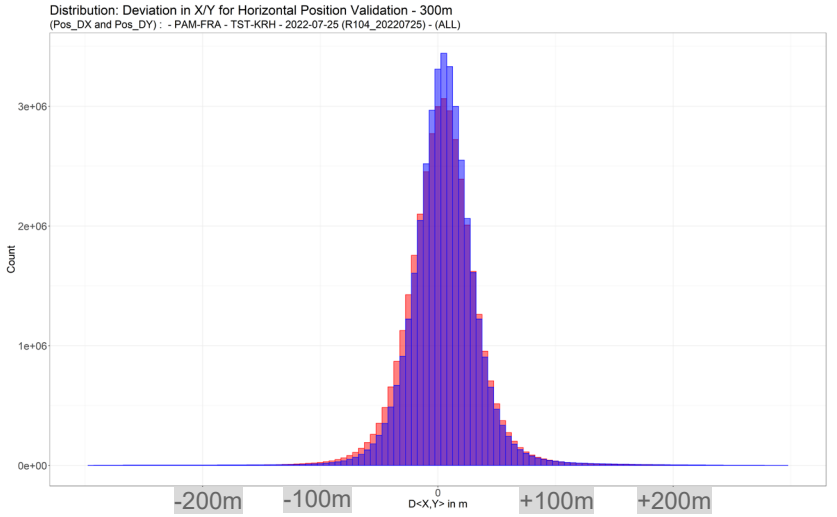
ADS-B dependent validation: horizontal position (geo)



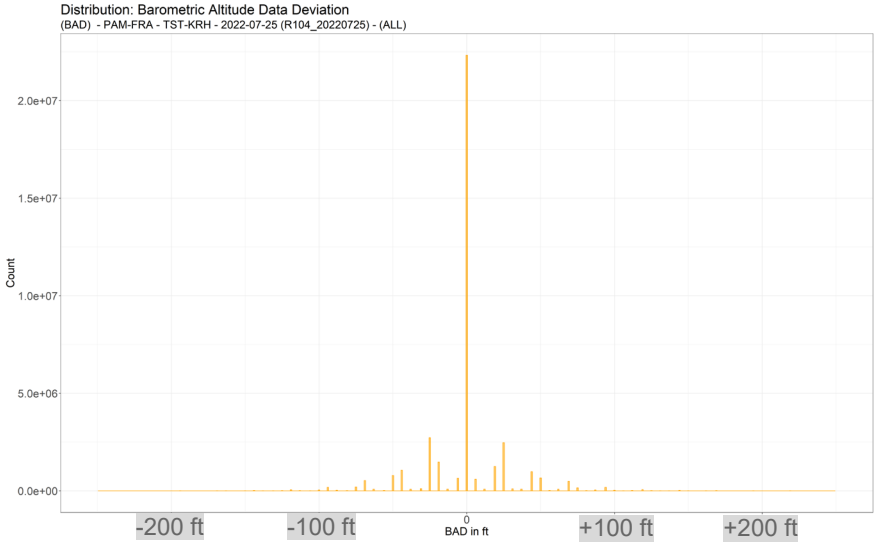
P1A Coverage:
A/C per day: ~2.500
Reports per day: ~13 Mio

PAM-FRA ADS-B Coverage:
A/C per day: ~5.000
Reports per day: ~40 Mio

ADS-B dependent validation: horizontal position (Distr. x/y)



ADS-B dependent validation: barometric Altitude (Distr.)



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ADS-B Program Experience

Challenges

ADS-B only

Should dedicated indications and/or procedures be used?

Which separation could be applied?

Are there any special security considerations necessary?

ADS-B Data Age Processing in SDPS

Does the tracker apply ADS-B data age processing (at least max. data age handling)?

ADS-B ASTERIX Service Categories 023/025

Current implementations of ADS-B sensors and SDPS systems operating with ADS-B ASTERIX Service Category 023, whereas the ASTERIX Category 025 is required by the ADS-B System Specification (ED-129B). What solutions are applied?

ADS-B Version 3 Handling

What ADS-B Transponder Versions (0,1,2,3) are operationally used in the ATC applications?

Especially the changed Priority Status in Version 3 could cause misinterpretation of the ADS-B data.

Conclusion

ADS-B benefits

During the operational use of the ADS-B surveillance chain, a lot of the expected benefits could already be identified (e.g.: better accuracy, improved track model selection and velocity vector calculation, further enhanced surveillance coverage, additional data available, new applications possible).

ADS-B plug/play?

Surveillance System

All components of a surveillance system (sensor, distribution, processing, display) need to be adapted in order to process ADS-B data: e.g. sensor performance optimization in high radio load environments, ADS-B specific tracking (time, error characteristics, data ages), additional network connections and capacity in distribution systems.

Data Integrity

The DFS Safety Assessment identified the need for validation of the ADS-B data integrity. In principle this could be achieved in different ways. An optimized solution to ensure data integrity is to establish a dedicated ADS-B validation, currently not available as product on the surveillance products market.

The validation of the data integrity is a prerequisite to use ADS-B as Mode S equivalent layer in a high-density radar-controlled airspace.

Thank you for your attention

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Q&A

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Closing remarks

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Cristian Pradera - SDM

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