The Engage KTN – achievements, lessons and legacy

Andrew Cook (University of Westminster, London) & **Paula López-Catalá** (Innaxis, Madrid)

SESAR digital academy

SESAR JOINT UNDERTAKING

Engage

founding members

EUROPEAN UNION

EUROCONTROL

Overview

- **Very brief review of the KTN**
  - **consortium, industry partners, core activities, thematic challenges**
- **Catalyst fund projects: a focus for today**
  - **18 projects; 31 unique partners; 88 assessments from mentors** (+ coordinator)
- **The EngageWiki**
  - **live demonstration**

- **PhDs and summer school**
  - **final summer school AUG–SEP 2021 (further reporting in 2022)**
- **Lessons, legacy and looking ahead**

Engage – the SESAR Knowledge Transfer Network

UNIVERSITY OF WESTMINSTER

EUROCONTROL

EASA European Aviation Safety Agency

FREQUENTIS

innaxis

TU Delft Delft University of Technology

UNIVERSITY OF BELGRADE

UNIVERSITY OF TRIESTE

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wikiengagektn.com

twitter.com/EngageKTN

Advanced Logistics Group (ALG)
AGIFORS - Airline Group of the International Federation of Operational Research Societies
Air Traffic Controllers European Unions Coordination (ATCEUC)
airBaltic
Airport Gurus
Airport Regions Conference (ARC)
American Airlines
ANS CR
Aslogic
Association for the Scientific Development of ATM in Europe (ASDA)
Autoridade Nacional da Aviação Civil (ANAC)
Barcelona Supercomputing Center (BSC)
Boeing Research and Technology Europe (BR&T-Europe)
Bundesaufsichtsamt für Flugsicherung (BAF)
Cirium
Civil Aviation Authority (CAA)
COOPANS Consortium
Department for Transport (UK)
Direction des Services de la Navigation Aérienne (DSNA)
Direktorat civilnog vazduhoplovstva Republike Srbije (DCV)
Egis
European Meteorological Services Network (EUMETNET)
European Passengers' Federation (EPF)
Executive Airlines
Ferrovial Agroman
Finnair
Flughafen München / Munich Airport
Gestair SL
Heathrow Airport Limited
HEMAV - High Endurance Multipurpose Aerial Vehicles
Honeywell Aerospace
HungaroControl
Icelandair
IFSTTAR - Institut Français des Sciences et Technologies des Transports, de l'Aménagement et des Réseaux
INFORM - Institut für Operations Research und Management GmbH
International Air Transport Passenger Association (IATPA)
International Federation of Air Traffic Controllers' Associations (IFATCA)
International Federation of Air Traffic Safety Electronics Associations (IFATSEA)
Irish Aviation Authority (IAA)
LFV - Luftfartsverket
London Luton Airport
Lufthansa Systems
Manchester Airport
NATS
Naviair
Network Manager - nominated by the European Commission
NEXTOR II Consortium - University of California, Berkeley and University of Maryland
PACE Aerospace Engineering & Information Technology
Pegasus Airlines
QinetiQ Ltd
Raytheon UK
Sabre Airline Solutions
skeyes
SWISS - Swiss International Air Lines
TÜBİTAK - The Scientific and Technological Research Council of Turkey
Turkish Airlines

Core activities: 2018 – 2021

‘One-stop’ European knowledge hub, concepts roadmap, research repository

Thematic challenges

4 series of SESAR Innovation Days (non-disruptive; industry)

4 series of thematic challenge workshops (plus *ad hoc*)

35% of €4m as consortium effort

3 European summer schools (Belgrade ‘19, virtual event ’20, virtual event ’21)

10 PhDs; 18 catalyst fund projects; 65 deliverables

‘legacy’

Future ATM skilled work-force; student mobility

SESAR Digital Academy

under-/post-graduate teaching & training initiatives

internships & employer links

journal publication grants; travel grants

Integrate IR and ER

Thematic challenges – proposed by community

- 4 thematic challenges in parallel
- dedicated workshops
- alignment with most PhDs

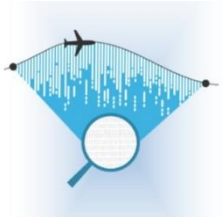
dedicated sessions
SIDs & summer school

18 ↓ max

- ~~16~~ catalyst funds up to €60k
- (mostly) migration to higher TRL
- 'light touch' – 12 months max
- 2 CF Calls: NOV18 and JAN20
- no further PhD Call (AUG-NOV18)

Thematic challenges – final workshops in 2021

#1. CNS vulnerability and security ***Paula López, Innaxis***
15 September 2021



#2. Data-driven trajectory prediction ***Dirk Schaefer, ECTL***
"AI, ML and Automation"
03 September 2021

#3. Efficient use of MET data ***Tatjana Bolić, Uni. Westminster***
09 September 2021

#4. Novel market mechanisms in ATM ***Andrew Cook, Uni. Westminster***
"Economic incentives for future ATM implementation"
21 June 2021

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D3.6

New research ideas

Catalyst fund projects

Catalyst fund projects – overview

20

- **Illustrative examples** (no order or preference implied)
  - **1) a *flavour* of the breadth and depth**
  - **2) some deeper insights into 4 projects**
  - **apologies and thanks to the super CF teams**
  - **fuller slides at the end of this pack (TBC)**
  - **materials and reports on the Engage website**
  - **watch out for associated SIDs papers**
- **Consolidated lessons learned**

Catalyst fund projects – overview

	Open	TC1	TC2	TC3	TC4	Σ
		cyber	TP	MET	market	
PhDs	2	-	5	2	2	10
CF Wave 1	-	2	3	4	1	10
CF Wave 2	1	3	1	2	1	8
Σ	3	5	9	8	4	28

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Wave 2 – closed 2021

Full title	TC	Project coordinator	Partner(s)
Proof-of-concept: practical, flexible, affordable pentesting platform for ATM/avionics cybersecurity	1	University of Jyväskylä, Finland	–
Safe drone flight - assuring telemetry data integrity in U-Space scenarios	1	NATS, UK	Open University, UK
Collaborative cybersecurity management framework	1	Winsland, UK	Movable-type, UK; MSDK, Bulgaria; BULATSA, Bulgaria
Probabilistic information integration in uncertain data processing for TP	2	CIRA[1], Italy	–
Meteo sensors in the sky	3	NLR, The Netherlands	AirHub B.V., NL
Weather impact prediction for ATM	3	FRACS[2], France	MetSafe, France
Role of markets in AAS deployment	4	Think Research, UK	–
Flight centric ATC with airstreams	(2)	NEOMETSYS, France	ENAC, France

[1] Centro Italiano Ricerche Aerospaziali
[2] France Aviation Civile Services

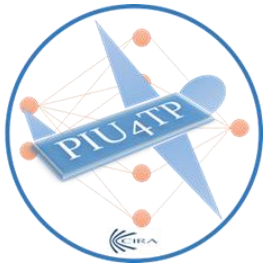
Catalyst fund projects – flavour

- **TC4: Novel market mechanisms in ATM**
  - **from small acorns, great oaks**

- **FC2A** (‘open’, designated to TC2)
  - **flight-centric ATC with airstreams**

FC2A
Flight Centric ATC with Airstreams

- **PIU4TP** (TC2: data-driven trajectory prediction)
  - **mapping likely flight trajectories (synthetic data)**

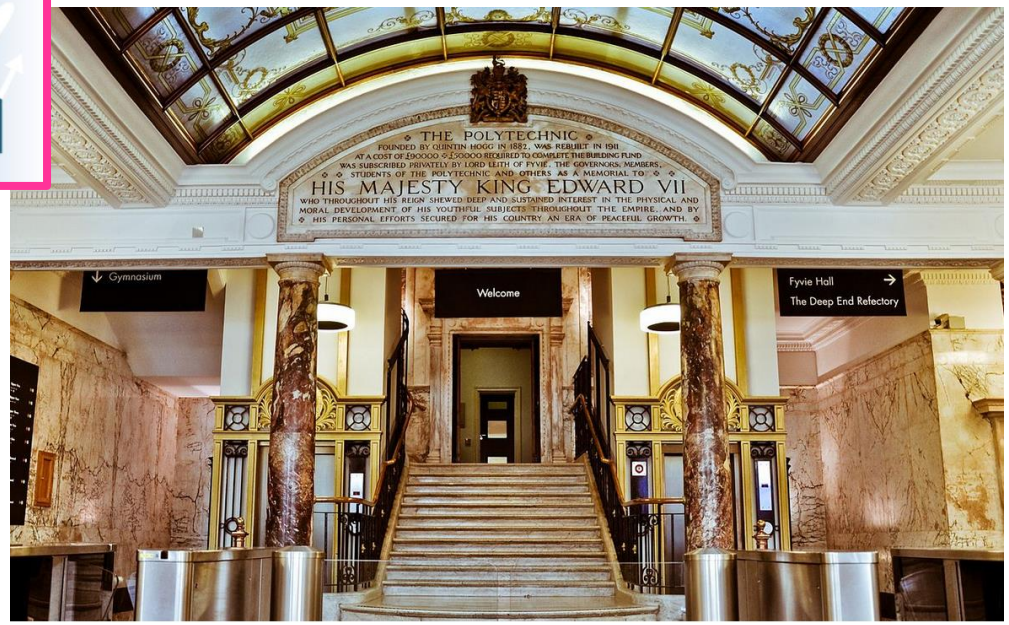


- **OPAS** (TC3: MET)
  - **SO_2 volcanic plume height (TRL)**

OPAS

2 slides each (more at end of pack)

TC4



HIGH- PERFORMING AVIATION FOR EUROPE

SESAR E-News - November 2018

Project of the month - News - Events - Publications

SESAR KTN, Engage, Call for catalyst funding proposals now open

November 2018

The Call for proposals funded by catalyst funding is now open on the Engage website. The call closes on 15 February 2019.

Proposals may be aligned with the Engage thematic challenges

Thematic challenge 4

Novel and more effective allocation markets in ATM

October 2018

Workshop final programme

Exploring UDPP Concepts through Computational Behavioural Economics

NOMMON

November 2019

11th SESAR Innovation Days

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TC4

21 June 2021, Think Research: RoMiAD CF project
Industry panel, ER panel, interactive board session

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SESAR-ER4-08-2019 – Behavioural economics in ATM

Current economic models applied in ATM are often normative … demonstrated not to work in practice

→ BEACON project

SESAR-ER4-16-2019 – Innovation in network management

Responding to emerging business needs [..] by the increased collaboration between stakeholders

→ CADENZA project

SESAR-ER4-27-2019 – Future ATM architecture

Use of digital technologies to enable a more efficient organisation of the entire mobility system

→ SlotMachine project

SESAR-ER4-07-2019 – Accelerating change in ATM

New technology advancements [...] currently slow [...] better understand the economic barriers

→ ITACA project

Think

ATM & Airports Consultancy

HOW TO INCENTIVISE INNOVATION IN ATM?

Engage

At the core of the Engage KTN is the definition of various thematic challenges: new ideas suggested by the research community, not already included within the scope of an existing SESAR project. They are developed along with the ATM concepts roadmap and complementarily with some of the network's PhDs and theses.

Thematic challenge 4

Economic incentives for future ATM implementation

3rd workshop programme

Edition 2.0, 18 June 2021

Workshop date:	21 June 2021, 1100-1545 (CEST)
Host:	Think Research, University of Westminster, EUROCONTROL (virtual)
URL for access:	https://eurocontrol-int.zoom.us/j/68439904897?pwd=Ynh0SFNzTVpiSDdmVmtYQU5iaGFMZz09

FC2A
Flight Centric ATC with Airstreams

‘open’ → TC2

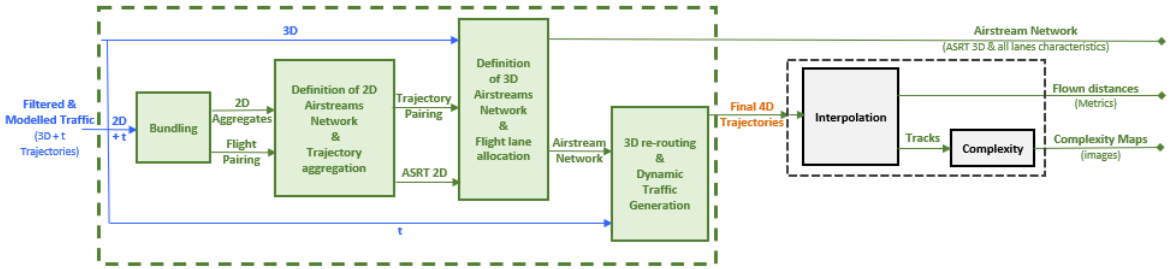
Aim to evaluate whether flight-centric ATC with airstreams is a promising approach for emerging Dynamic Airspace Configuration management

Objectives

- Assess the amount of traffic captured by Airstreams for **complementing and supporting the free route and dynamic airspace configuration approaches**
- Define **initial characteristics** of the **Airstream structure** to cope with the constraints of the European airspace and traffic demand
- Assess whether **traffic structural complexity is reduced** due to the introduction of Airstreams

Methods

- Experimental environment, based on a ‘spin-off’ of the **π-rats tool from ENAC**

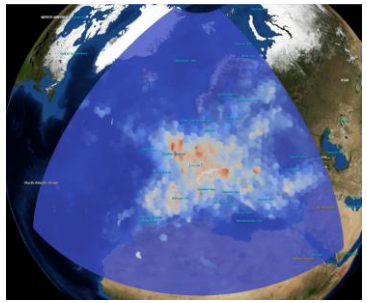


- **Stakeholder survey** structured around two workshops – working sessions with different **operational and industrial actors**

FC2A
Flight Centric ATC with Airstreams

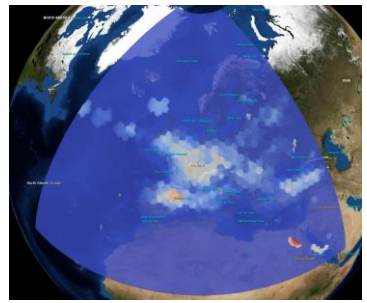
Extended complexity calculation to large area & introduced mean complexity indicator for comparison of different traffic patterns

~42% reduction in structural traffic complexity with the use of Airstreams



High Week Day original

	Low weekend		Low weekday		Mean weekend		Mean weekday		High weekend		High weekday	
	Original	Airstream	Original	Airstream	Original	Airstream	Original	Airstream	Original	Airstream	Original	Airstream
Mean complexity	1,746	1,034	1,19	0,701	2,095	1,162	1,642	0,886	2,191	1,294	2,367	1,401
Complexity decrease	-41%		-41%		-45%		-46%		-41%		-41%	

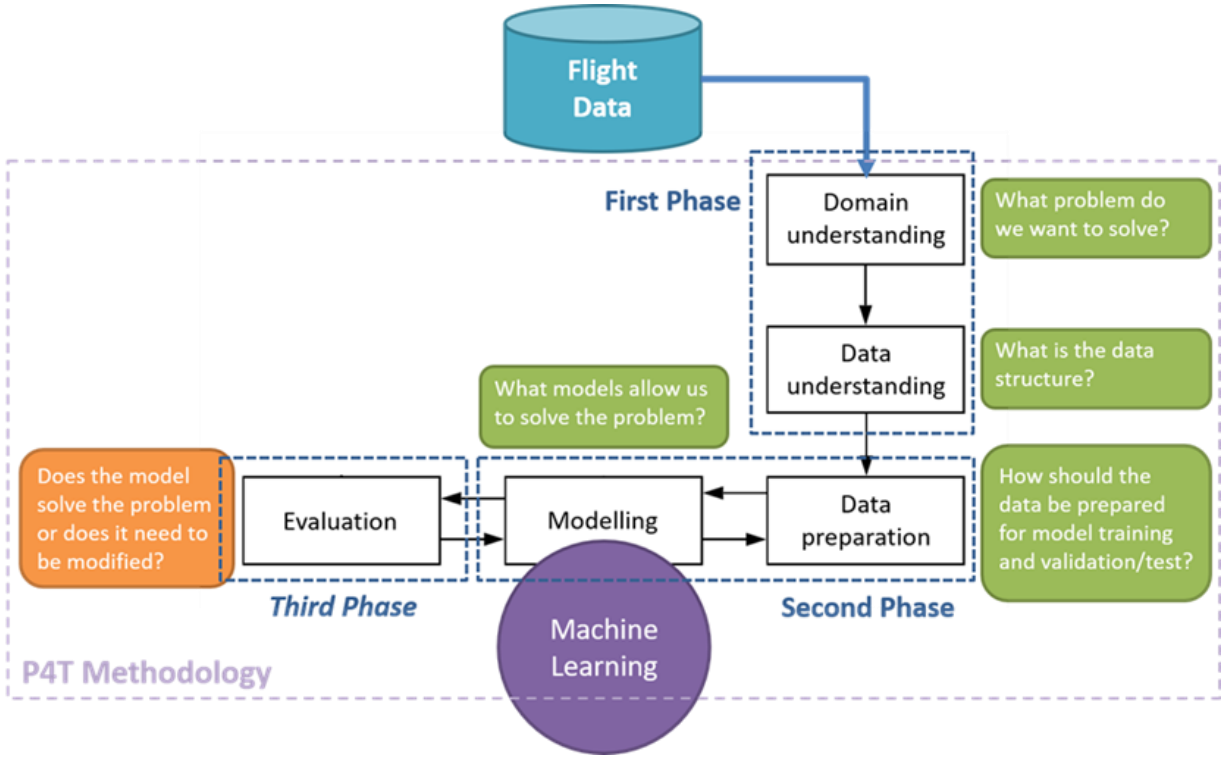


High Week Day Airstream

- Initial algorithms for traffic aggregation & definition of tri-dimensional structure of the Airstream developed
  ~65% of eligible traffic captured by aggregation mechanism: encouraging
- Development of a **first demonstrator: 'AirStream Factory'**
  Supports TRL maturation of a technical solution and basis for the **initialisation of an operational mock-up** and reaching a **higher TRL level in future activities**

PIU4TP objectives and methods

Proof of concept for the **development of a data-driven methodology** (named P4T) for the prediction of the flight trajectory able to provide a *map* of likely flight trajectories with the relative confidence on the basis of five input variables: **take-off weight**, forecast **air temperature** and **wind speed** along the three directions **south-north, west-east, up-down**

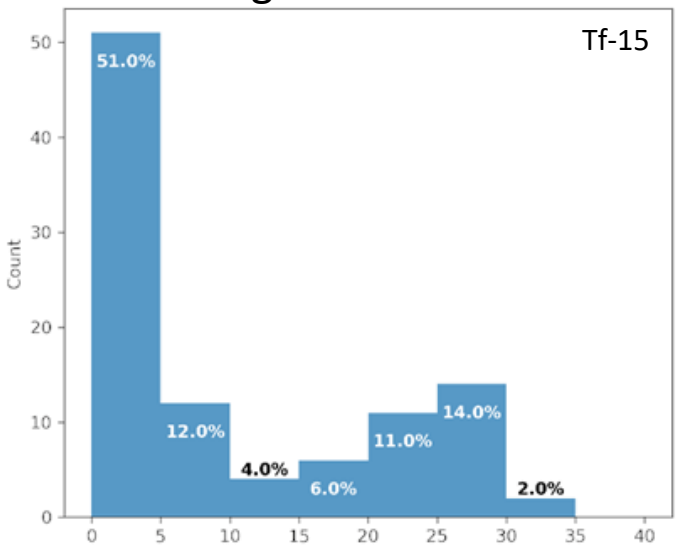


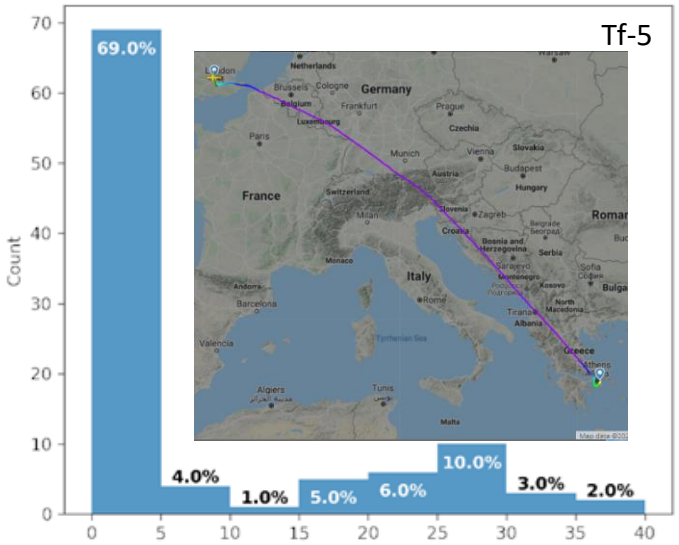
Objectives

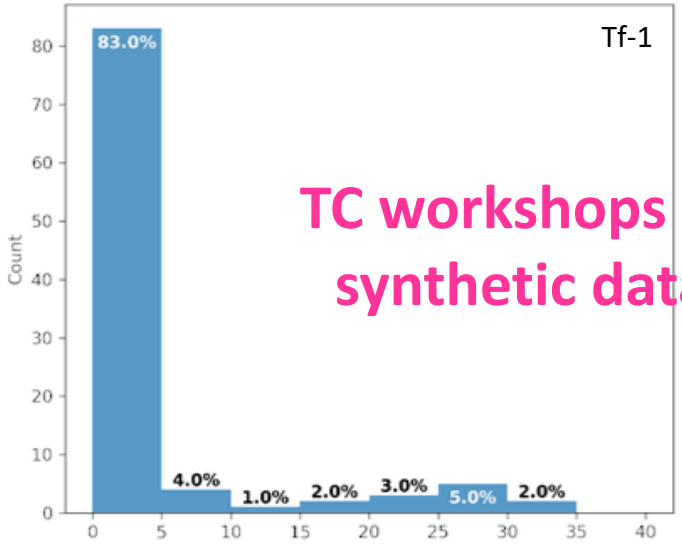
- Use of **state of the art machine learning /data mining algorithms**, able to learn from past experience how to obtain behavioral models based on complex but statistically reliable rules
- Provides results that show the abilities of the developed methodology at the **pre-tactical** stage of operations
- It is intended to **support planning** activities in terms of **demand-capacity balance** and pre-tactical identification of conflicts

PIU4TP key results

Among the algorithms tested during the development of the methodology (including Bayesian nets and neural networks), **decision trees** and random forests perform better for the **classification of the flight plan** (lateral and vertical), **cf.** **random forests** showed the **lowest errors** for the estimation of the **duration** of the flight for both the London-Athens route and the London-Malta route







TC workshops => synthetic data

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***Distribution of absolute error of the flight duration estimation in minutes**, London-Athens route. Similar results are obtained for the London-Malta route.*

(Tf = time of flight)

	Lateral flight plan	Flight level
Tf-15	31 %	48 %
Tf-5	63 %	67 %
Tf-1	78 %	88 %

Accuracy for the prediction of the flight plan for the London-Athens route. Similar results are obtained for the London-Malta route.

Operational alert Products for ATM via SWIM (OPAS)

Royal Belgian Institute for Space Aeronomy (BIRA)

Mentoring and advisories from

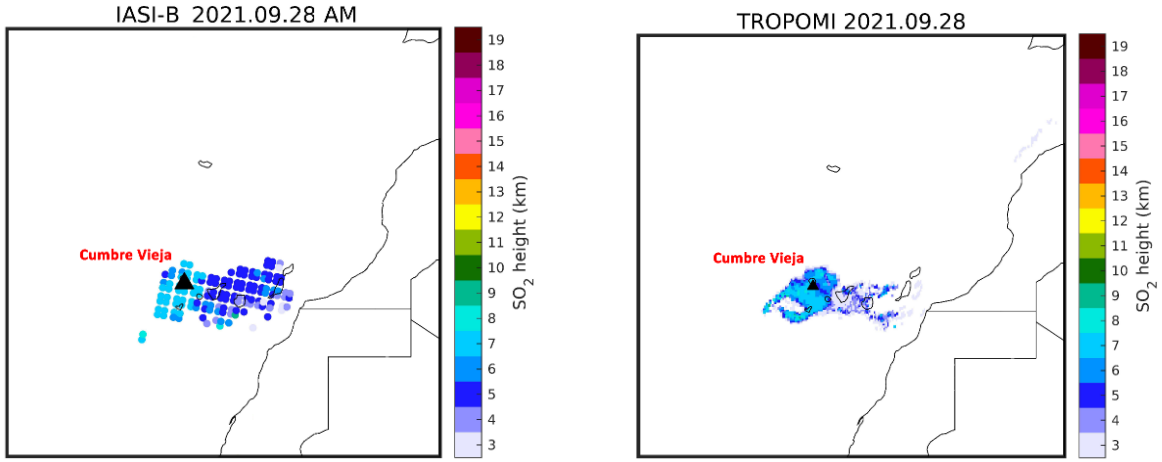
EUROCONTROL and Rolls-Royce

Development of a SWIM Technical Infrastructure Yellow Profile service providing notification & data access to volcanic SO_2 height

Objectives:

1) Algorithmic development of TROPOMI (**satellite sensors**) SO_2 height **[Extended iterative spectral fitting]**
2) Operational implementation of SO_2 height **[Automatisation]**
3) Tailored alert products of SO_2 height **[AI and machine learning]**
4) **Implementation of SO_2 height early warnings** **[Build on existing service]**
5) **SWIM registry of OPAS as a notification service (Yellow Profile)** **[Design, definition, publication]**

Key results



Visualisation

- **Algorithm development and operational run of SO_2 height (from TROPOMI satellite sensors)**
  - → Use of BIRA facilities and expertise in NRT SO_2 retrievals (*Brenot et al. 2014, NHESS; Theys et al. 2017, AMT*)
  - → **Validation using external observations** (*Brenot et al. 2020, SIDs*) ➔ **TRL4**
- **Alert products of SO_2 height from TROPOMI and upgrade for IASI sensors**
  - → **Benefits of early warning system:** SACS (Support to Aviation Control Service)
    & Transfer of EUNADICS-AV (European Natural Airborne Disaster Information and Coordination System for Aviation) development (*Brenot et al. 2021, NHESS**) ➔ **TRL5**
- **SWIM Yellow Profile Notification service: "OpasSo2lhDatasetNotification"**

https://eur-registry.swim.aero/services

* NHESS is an interactive, open-access journal of the European Geosciences Union

Catalyst fund projects – 4 deeper insights

- **SDF** (TC1: CNS vulnerability and security)
  - **Safe drone flight**
- **DIAPasON** (TC2: data-driven trajectory prediction)
  - **A data-driven approach for dynamic and adaptative trajectory prediction**
- **METSIS** (TC3: efficient use of MET data)
  - **Drones as aerial sensor network for low altitude, hyper-local wind now-casting**
- **WIPA** (TC3)
  - **Weather impact prediction tool for ATM**

Safe Drone Flight (“SDF”)

Assuring telemetry data integrity in U-space scenarios

July 2020 – July 2021

NATS

The Open University

Industry

Project lead

+ ATM and U-space **operational knowledge**
+ **Industrial application** know how

Academia

Project partner

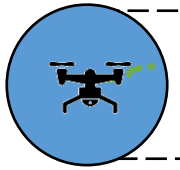
+ Technical **software engineering skills**
+ Cutting edge **blockchain technology research**

Objective

Given the diversification of airspace users (e.g. emergence of drones) and limitations of conventional surveillance assets, the project objective was to develop and assess a **novel drone surveillance concept** which utilises **mobiles phones** as portable drone detectors while leveraging the cybersecurity mechanisms of **blockchain technology** to assure the integrity of the data from a distributed set of devices.

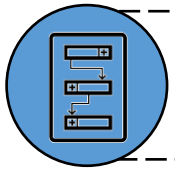
Method

Key results



Use Cases

- 9 U-space operational use cases created with nominal and non-nominal scenarios



Safety assurance hazard assessments

- Deduced integrity requirements (i.e. allowable failure probabilities) on drone telemetry data

Cybersecurity & digital trust

- ID mechanisms for mitigating security threats & requirements on future drone surveillance systems

Workshops

- 2 workshops conducted to disseminate research and validate findings

Prototype development & **concept** maturation

- Improved prototype functionality & assessed suitability of blockchain-based concept for surveillance

Key results

TRL 4 (project self-assessment; software-based prototype, validated aspects through U-space scenario simulations)

Drone surveillance system prototype:

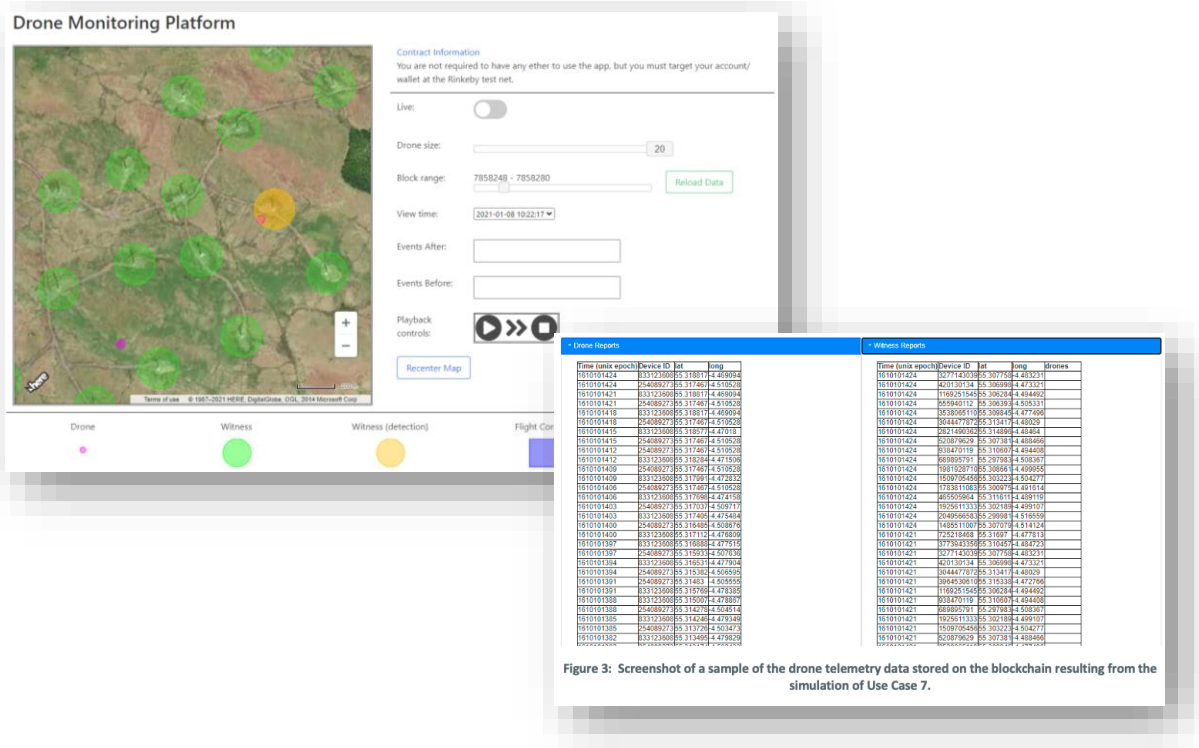
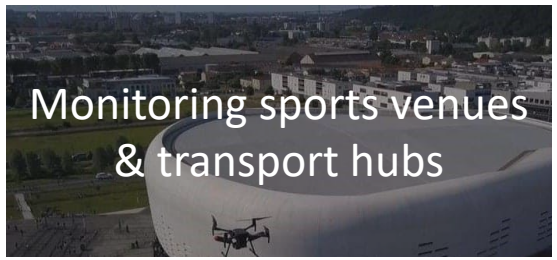


Figure 3: Screenshot of a sample of the drone telemetry data stored on the blockchain resulting from the simulation of Use Case 7.

Successfully simulated detection of drones in several U-space scenarios, recording their location data securely to a blockchain.

Outcome of suitability/applicability assessment:

Potentially suitable for short duration surveillance of operations in lower VLL airspace in urban environments e.g.:



With an additional feature, potentially also suitable for wind farm inspections, grid network monitoring, railway line inspection and **airport security**.

Next steps

1. **Seek grant opportunities to continue the collaboration, develop prototype & increase TRL further**
   - Develop and implement technical features
   - Test industrial application through series of (small scale) validation exercises
   - Refine value proposition
   - Explore commercialisation opportunities
2. **Academic paper being drafted, targeting future publication**
3. Industrial application of some findings within NATS, specifically to inform new airspace user data assurance

DIAPasON Project

DIAPasON

A Data-driven approach for Dynamic and Adaptative trajectory PredictiON

CRIDA I+D+i - ATM

deepblue

Artificial Intelligence & Analytics [ZenaByte] S.r.l.

Spin off Università degli Studi di Genova

Start date: June 2019

End Date: June 2020

Objective & methodology

Objective: **Methodology for TP and traffic forecasting in pre-tactical phase**

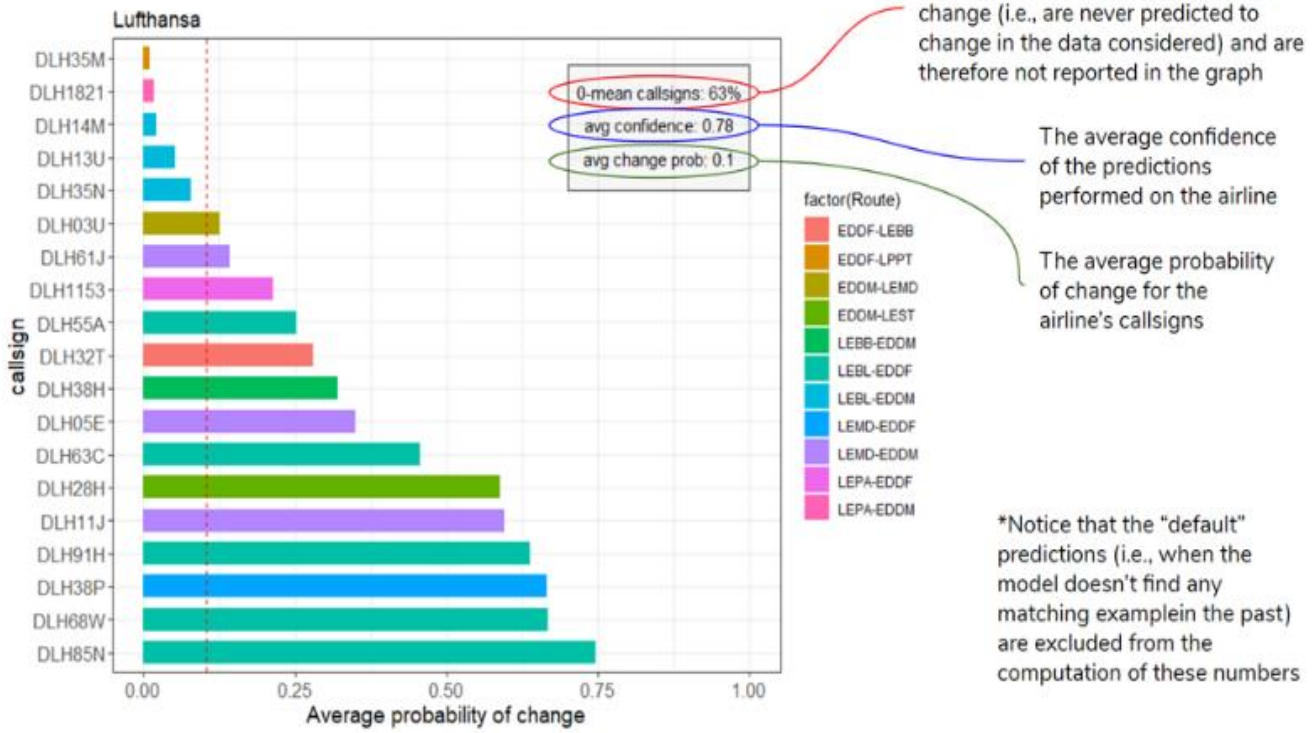
Data-driven: outcomes based on data analysis and interpretation
Dynamic: adjusted to different planning horizons
Adaptative: enhanced iteratively with new tactical data

(2) Validated in a use case (DCB) – *combined* trajectories

Key results 1: dynamic predictive TP framework

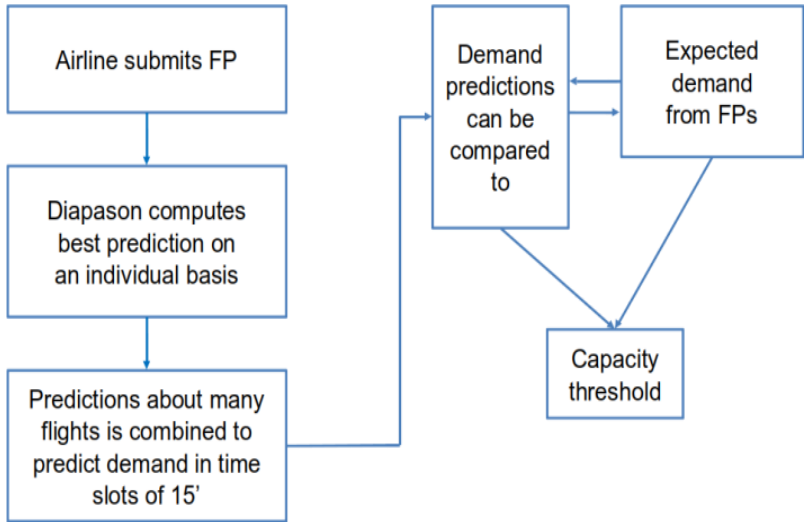
- Prediction at **different time horizons** (re. EOBT): 8h, 4h, 2h, 1h
- Based on data characterisation from **1-year operational dataset**
- Unpredictability of most airlines is **'systematic enough'** to become predictable
- Possible to estimate the probability of change for every flight
  - and apply it in demand forecasting or a value for confidence of the forecast mix

Target **TRL 4** maturity level has been reached (project self-assessment including interviews with operational end users)



Key results 2: application to DCB use case

- Use case: how the predictions could be integrated into the **strategic planning process at NM level**
- Described differences in occupancy counts per sectors between the **real data** in the planning phase, and the **output** of the **predictive framework**
- **Vertical profile estimated** to consider a 4D trajectory (en-route phase)
- **6 days tested**, from summer and winter season 2018 (June & November, respectively)
- 8h and 4h before operation



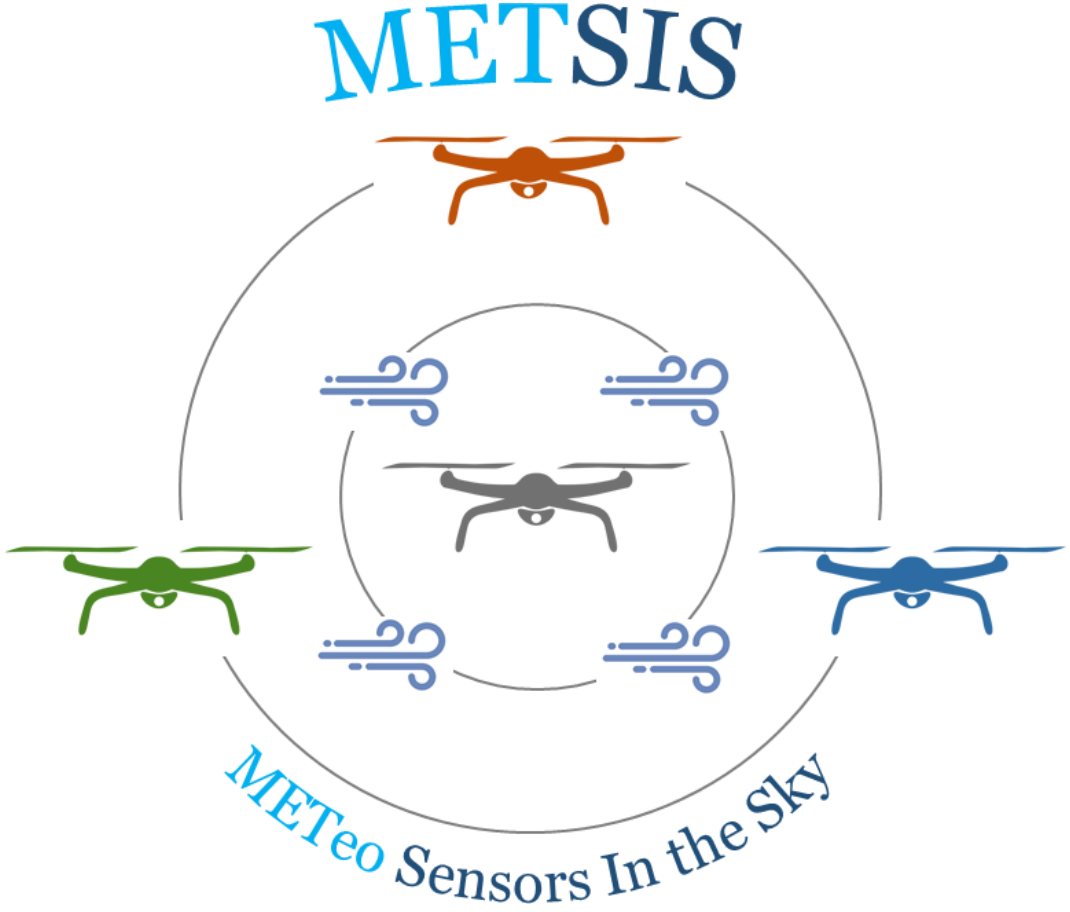
Next steps, conclusions

- Methodology **valid and useful**, although highly **sensitive to input data**
- DDR not fully usable data source for TP: **does not include flight plan updates**
  - for certain TP applications, complementary data sources should be considered

cf. PIU4TP

- Expectations w.r.t. use case were higher than observed, despite considering a large number of factors
  - use case needs to be carefully chosen to extract maximum benefit (there is **no 'one size fits all' TP**, at this stage)
  - in particular, **vertical profile data needed** in the application
- Input from operational staff positive when applying new methodologies to actual operations
  - **operational staff guidance and vision brings a lot of practical value** to projects with a certain maturity level

- Next steps, already in progress:
  - refinement of predictive model itself to obtain better accuracy in **low resolution scenario**
  - refinement of the tool to better **present the results** of the predictive model



Investigating the use of drones as an aerial sensor network for low altitude hyper-local wind now-casting

Consortium

nlr

AirHub

Advisory Board

TU Delft

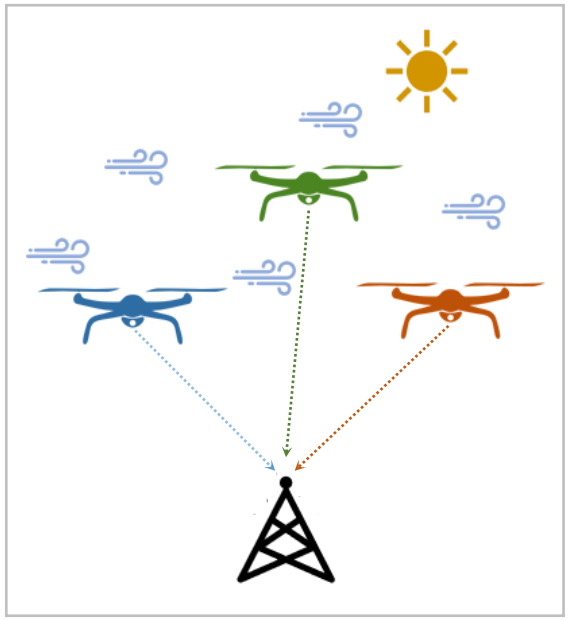
Koninklijk Nederlands Meteorologisch Instituut
Ministerie van Infrastructuur en Waterstaat

Objectives

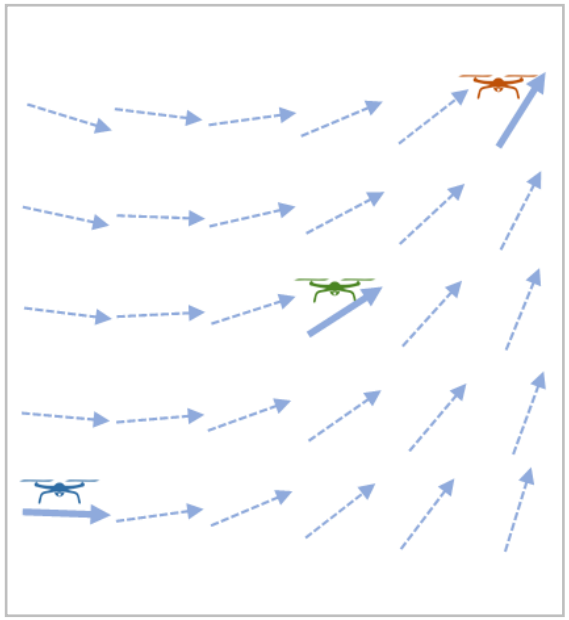
1. Determine accuracy of METSIS concept in presence of static obstacles to estimate low altitude winds below 500 ft
2. Determine how low-altitude wind information should be communicated to drone operators within a U-space system

Concept overview

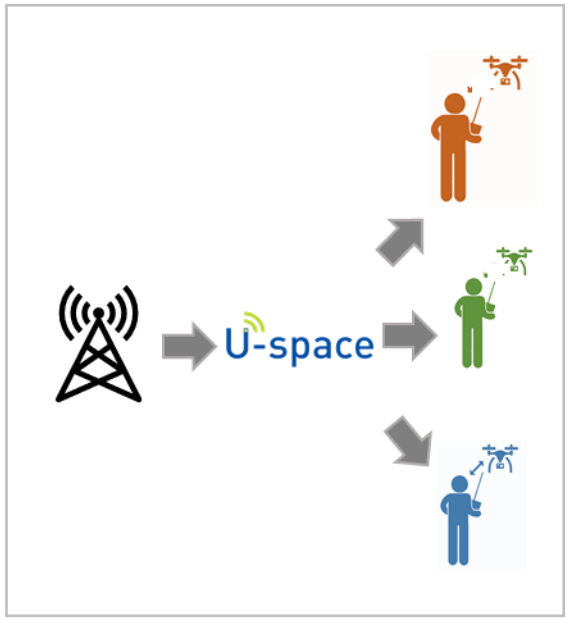
Using drones as an aerial sensor network for low altitude hyper-local wind now-casting



Step 1: Airborne drones measure **instantaneous wind states** and transmit data to a ground station



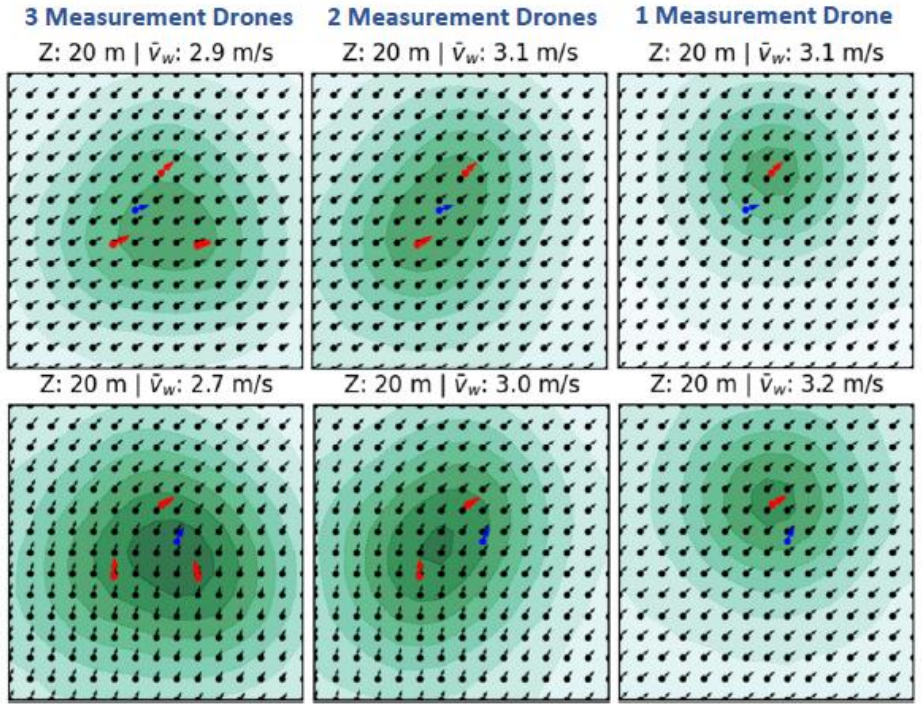
Step 2: Ground station uses the meteo particle model to estimate the **wind field in real time**



Step 3: The ground station communicates wind field data to **drone operators** via the **U-space weather information service**

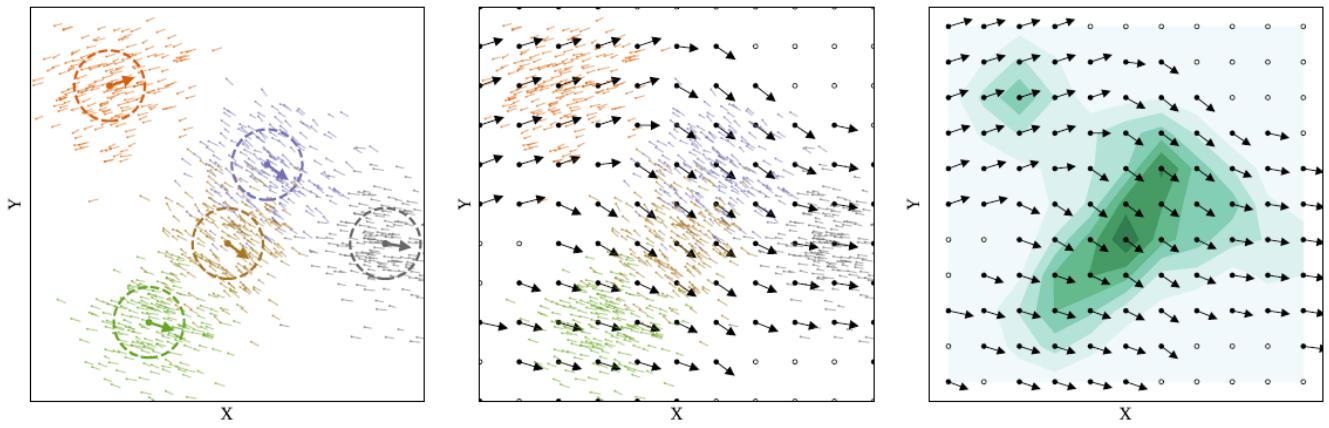
Next steps, and key results

- **Key results**
  - Concept is feasible
    - on average, **speed is reasonably accurate** for both static and dynamic conditions – very promising
  - Accuracy is promising but needs to be further improved
    - direction is less accurate than the WMO standard, particularly in dynamic conditions – caused by **propeller induced flow over the sensors** during dynamic conditions and low wind speeds
- **Future research**
  - Increase scalability and accuracy of concept
  - Looking for partners to cooperate with



SIDs 2021 paper (see next)

SIDs 2021 paper (#88): Sunil *et al.*



(a) Wind observations and particle initialization (b) Wind field constructed from particles (c) Construction of estimation confidence

Figure 2. Illustration of the Meteo-Particle model key processes [5].

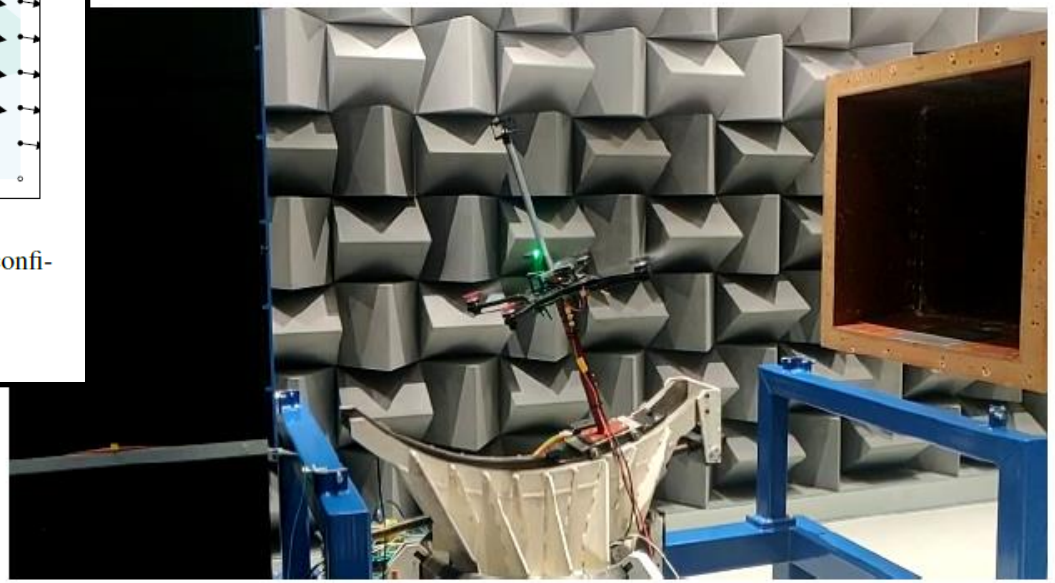


Figure 4. Wind tunnel testing of the Annemoment TriSonica Mini ultrasonic wind sensor mounted on the Foxtech Hover 1 drone.

WIPA

Weather impact prediction tool for ATM

July 1st, 2020 to July 30th, 2021

Contacts
kamel.rebai@metsafeatm.com
gladys.mercan@fracs.aero

Objectives & approach

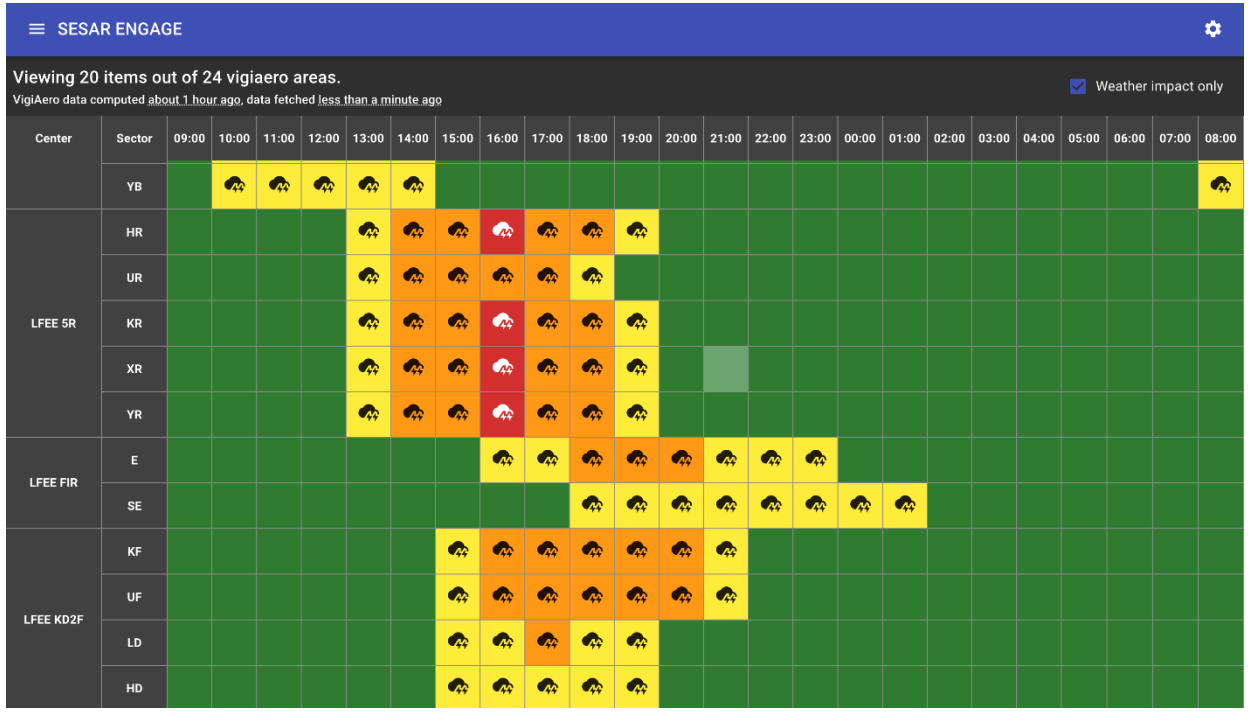
Ambition: to provide weather hazards impact information for ATFCM

3 steps

- **Use cases definition**
- **Delivery of WIPA tool as a SWIM webservice**
  - **built on Engage 'MET Enhanced ATFCM' results: multi-model convection forecast**
- **Technical and operational validation**
  - **DSNA air traffic controllers' involvement**

Expected benefits: (i) anticipation of hazardous weather effect on capacity; (ii) better use of weather regulations; (iii) better use of airspace

Key results



Thunderstorm impact, per hour, per sector for the next 24H+

dgac DSNA

WIPA operational validation

Aix and Reims ATC rooms

May-July 2021

Key results

From technical validation (15 reference days)

- Thunderstorm behaviour different between Mediterranean and continental area: **local tuning is needed on weather impact**
- **ATM complexity needed to be introduced** through consideration of ATM hotspots
- For further experiments: using MET regulations from the NM,
  => **need for an automated post ops** analysis tools

From operational validation (3 months validation)

cf. CDA

- Different operational approach to hazardous weather **between Aix and Reims ATCOs**
- **Strengths** of the tool: temporal progression of weather events, **hourly update of the forecast**, **lightning** impact information on the sectors
- Better anticipation of **ATC workload**

Next steps, conclusions

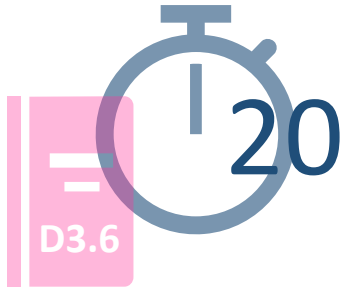
Conclusions

- **After adaptation period**, probabilistic meteorology translated into weather impact **can be used by ATCOs**
- **Collaboration with ATC is crucial** for the development of innovative operational tools
- **Cloud and SWIM-based solutions are suitable** for ATM pre-tactical operations

Next steps

- Pursuance of **validation** with Reims and Marseille UACs (until November 2021)
- Extension to **other meteorological phenomenon** such as icing and clear air turbulence
- **WIPA results industrialised within VigiAero** (an operational ATFCM weather-impact service, by MetSafe)
- Follow-up of other SESAR projects related to weather impact translation

Catalyst fund projects – lessons learned



- **From the projects**
  - **‘light touch’ approach effective – efficient resource allocation (+ KTN support)**
  - **(required) industry context valuable; overall a good instrument as ‘catalyst’**
  - **allowed flexibility in a relatively low risk budgetary environment**
  - **some of the reporting requirements could have been advised earlier**
- **From the coordinator**
  - **complex task setting up the 18 legal contracts and invoicing processes**
  - **batched nature of evaluations sometimes caused a few delays**
  - **very positive experience and dialogues with projects, incl. workshop series**
  - **projects delivered very high value for money (ambitious)**

The EngageWiki

Live demonstration

Engage WIKI

- a number of firsts
- demand-led
- legacy for the research community
- good foundation for future support to development of SDA
- materials on e.g. 426 projects, 1873 deliverables
- link to wiki in the Whova chat (after!)
- future steps at end of this presentation
- now to handover …

Live demonstration

Paula López-Catalá
(Innaxis)

The EngageWiki

Live demonstration

PhDs and summer school

PhDs and summer school

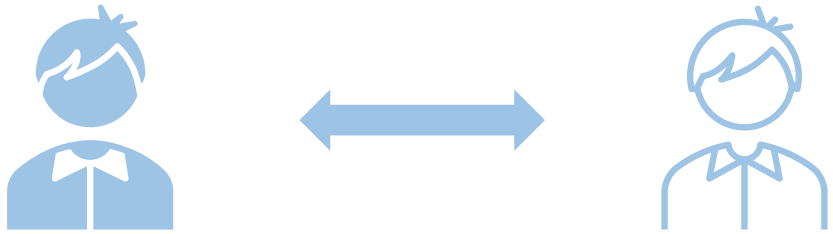
- **recently held final summer school AUG–SEP 2021**
- **10 PhD abstracts on the website**
- **further and fuller reporting in 2022**
- **so just a recap today**

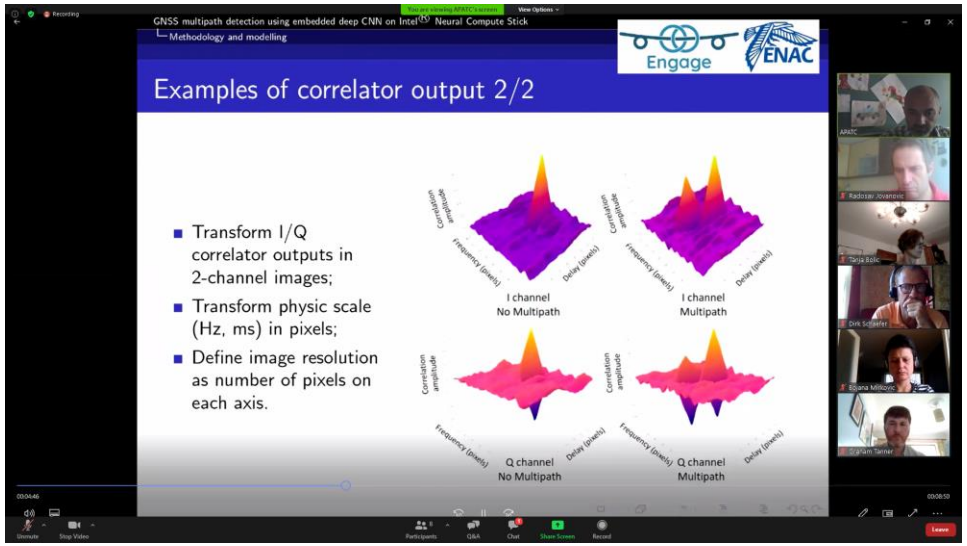
engagektn.com

2019

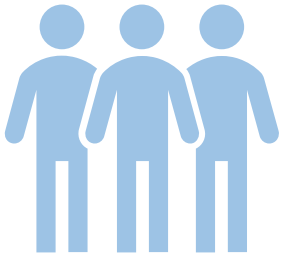

САОБРАЋАЈНИ ФАКУЛТЕТ
FACULTY OF TRANSPORT AND TRAFFIC ENGINEERING

2020




GNSS multipath detection using embedded deep CNN on Intel® Neural Compute Stick
Methodology and modelling
Engage
ENAC
Examples of correlator output 2/2
Transform I/Q correlator outputs in 2-channel images;
Transform physic scale (Hz, ms) in pixels;
Define image resolution as number of pixels on each axis.
I channel No Multipath
I channel Multipath
Q channel No Multipath
Q channel Multipath

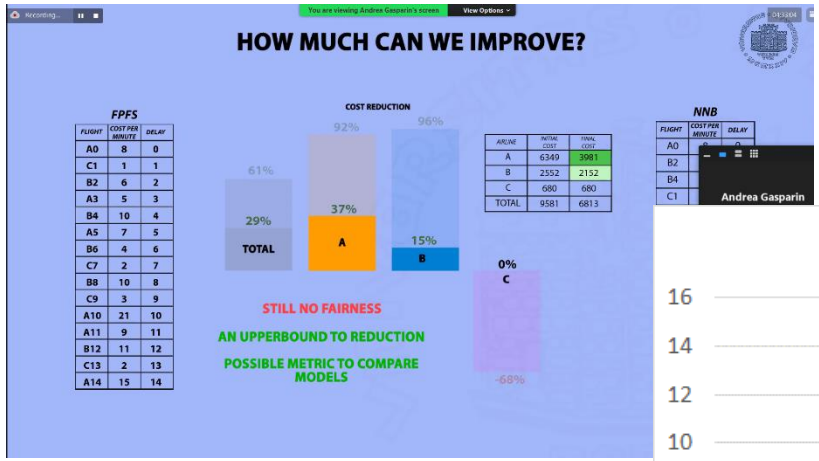
2021

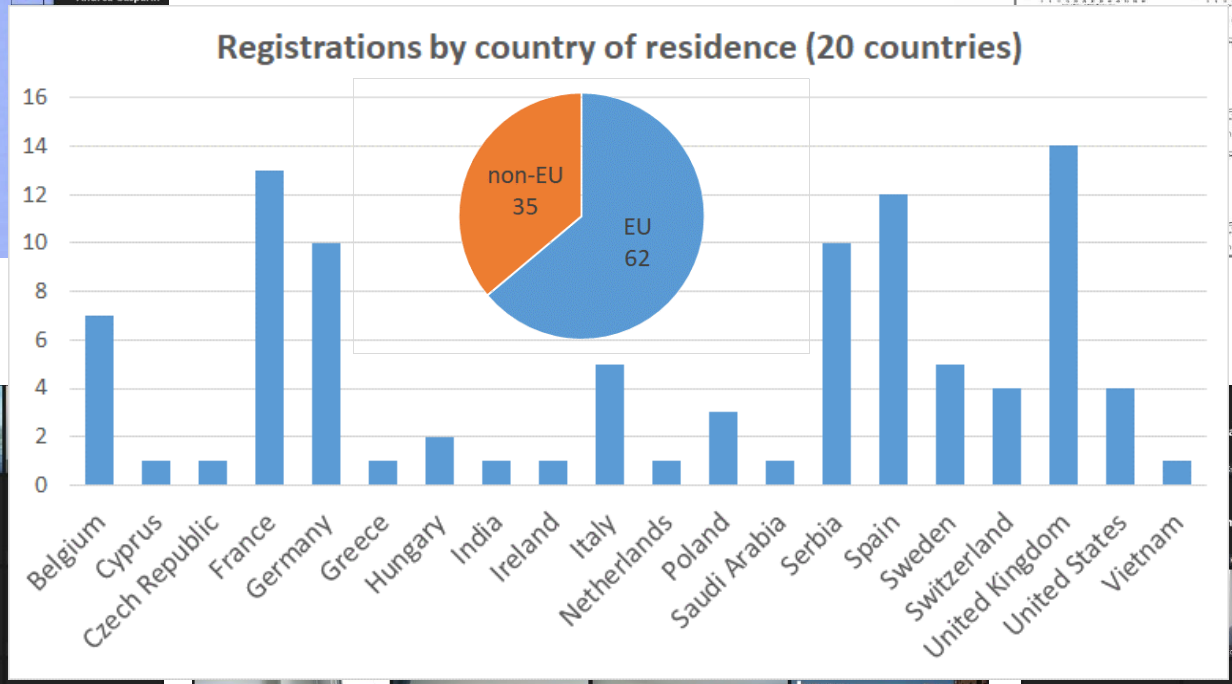


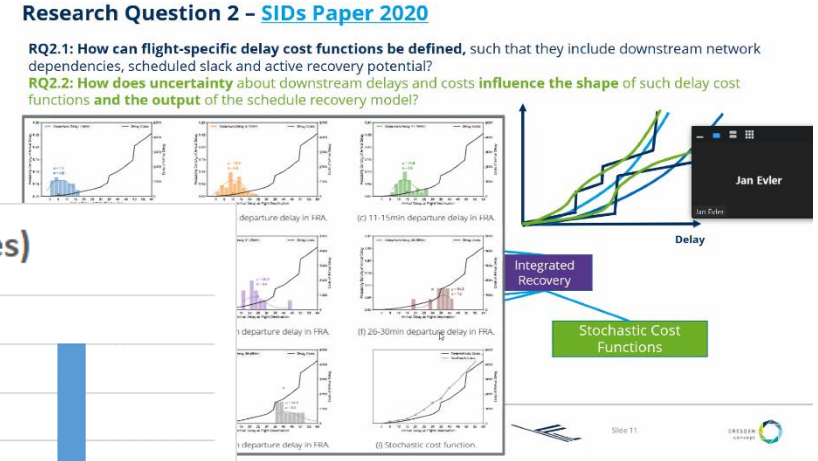
	09.45-10.00	10.00-11.15	11.30-12.30	Lunch break	13.30-14.10	14.10-14.45	15.00-15.30	
MON 30AUG	**Opening** *Andrew Cook (UoW) & Lorenzo Castelli (University of Trieste)*	Airline and airport operations centres *Jonas Langner (TU Braunschweig), Sashiko Shirai Reyna (Amsterdam UAS/ENAC)*	Panel discussion Moderator: *Bojana Mirkovic (University of Belgrade-FTTE)*		Signal processing for trajectory prediction *Homeyra Khaledian (UPC Barcelona)*	Panel discussion Moderator: *Junzi Sun (TU Delft)*	**SESAR Young Scientist Award** *Junzi Sun (TU Delft)*	
		11.15-12.00	12.00-12.30		13.30-14.45	15.00-16.00		
TUE 31AUG		**The Engage wiki** *Pablo Hernandez (Innaxis)*	**Teaching resources in the wiki** *(University of Belgrade-FTTE*)*		DCB hotspot detection and machine learning for traffic demand prediction *Sergi Mas Pujol (UPC Barcelona), Manuel Mateos (Nommon/UPC Barcelona)*	Panel discussion Moderator: *Lorenzo Castelli (Uni. of Trieste)*		
		10.00-11.15	11.30-12.30		13.30-15.30	15.30-16.00		
WED 01SEP		Machine learning and traffic deconfliction *Alevizos Bastas (University of Piraeus), Ralvi Isufaj (UAB Barcelona)*	Panel discussion Moderator: *Fedja Netjasov (Belgrade-FTTE)*		**Shaping a future European ATM Academy** *SESAR Scientific Committee*	Engage PhDs Q&A *UoW*		
		10.00-11.15	11.30-12.30		13.30-14.45	15.00-16.00	16.15-17.00	17.00-17.15
THU 02SEP		Weather prediction / forecasting models *Anastasia Lemetti (Linköping University), Eduardo Andrés (Universidad Carlos III Madrid)*	Panel discussion Moderator: *Tatjana Bolic (University of Westminster)*		Flight prioritisation, UDPP and route charging *Jan Evler (TU Dresden), Andrea Gasparin (University of Trieste), Natalia Solčianska, (University of Trieste)*	Panel discussion Moderator: *Andrew Cook (University of Westminster)*	**Future research horizons** *Dirk Schaefer (EUROCONTROL)*	**Close and what's coming next** *Andrew Cook (UoW)*

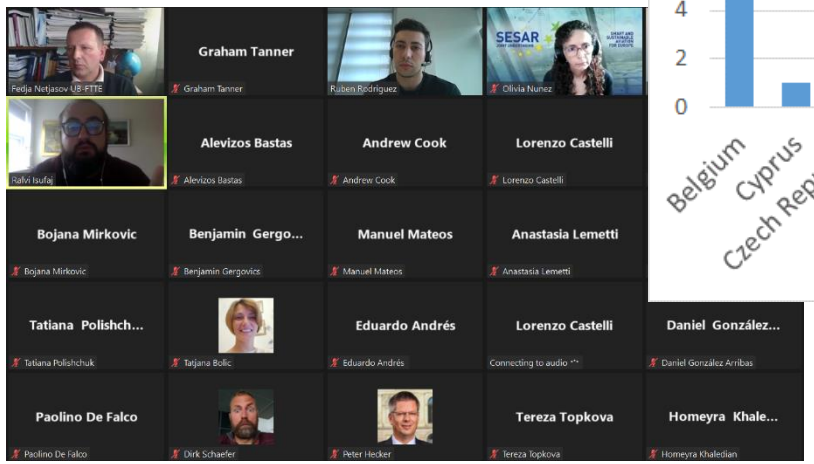
**Bojana Mirkovic, Fedja Netjasov, Danica Babić*

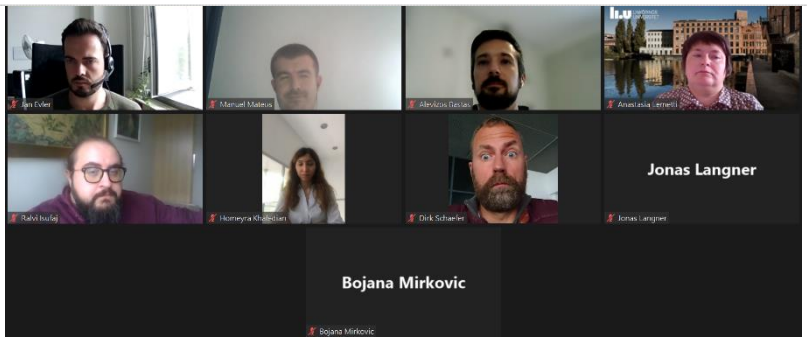
97 registrations

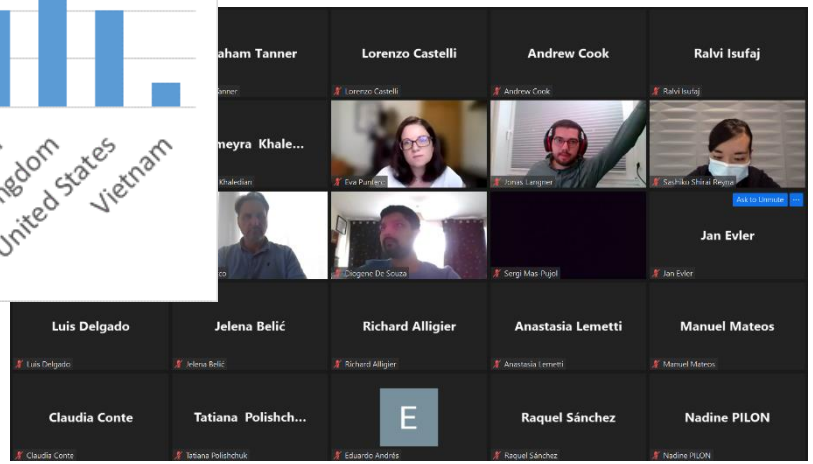












Monday 30 AUG AM

Eva Puntero (SJU)

Luca Crecco (SJU)

Diogene De Souza (Heathrow Airport)

Alan Marsden (EUROCONTROL)

Monday 30 AUG PM

Olivia Nunez (SJU)

Gideon Wormeester (Skyguide)

Emmanuel Isambert (EASA)

Rainer Koelle (EUROCONTROL)

Johan Martensson (EUROCONTROL)

Tuesday 31 AUG PM

Daniel Schuller (NATS)

Lorna Herda (Skyguide)

Ruben Rodriguez (CRIDA)

Wednesday 01 SEP AM

Ruben Rodriguez (CRIDA)

Olivia Nunez (SJU)

Teresa Reis (NATS)

Thursday 02SEP AM

Luca Crecco (SJU)

Kamel Rebai (MetSafe)

Edward Holmes (NATS)

Thursday 02 SEP PM

Riccardo Massacci (SJU)

Anaïs Lacroix (Skyguide)

Jose Manuel Cordero Garcia (CRIDA)

Nadine Pilon (EUROCONTROL)

Giuseppe Murgese (EUROCONTROL)

Thank you panellists!

Lessons, legacy and looking ahead

Lessons, legacy and looking ahead

(public on approval)

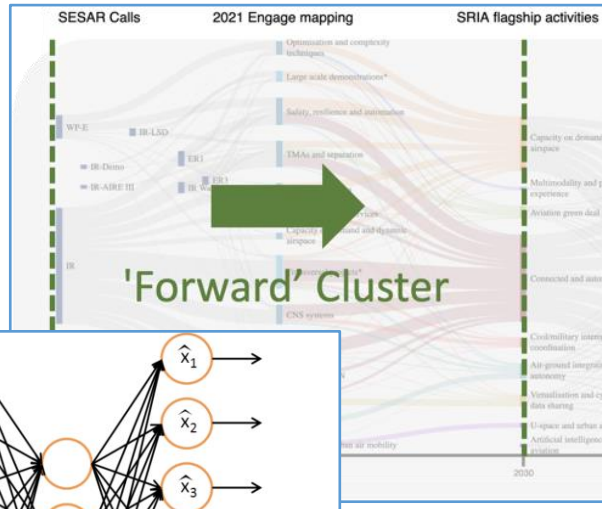
- D3.9: The Engage wiki – functionality and user-manual
- Details on the data sources in the wiki; repository functionality
- How the interactive map was built, deriving the clusters
- Concepts roadmap – relationship with the SRIA
  - Horizon flagships – seeding future-oriented research ideas (e.g. ‘strong AI’)
- University progs, teaching resources, internships, PhD Calls
  - how to engage and edit yourself (instructions also in the wiki itself)
- Full provision to maintain in 2022, videos, handover to SJU
  - *Detailed* lessons (e.g. attacks); next steps (e.g. building discussion fora, SESAR 3)

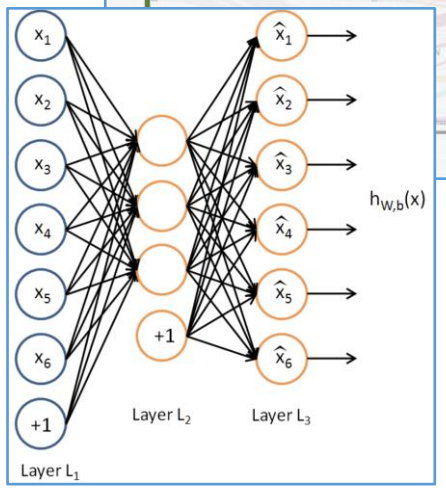
Lessons, legacy and looking ahead

D3.6

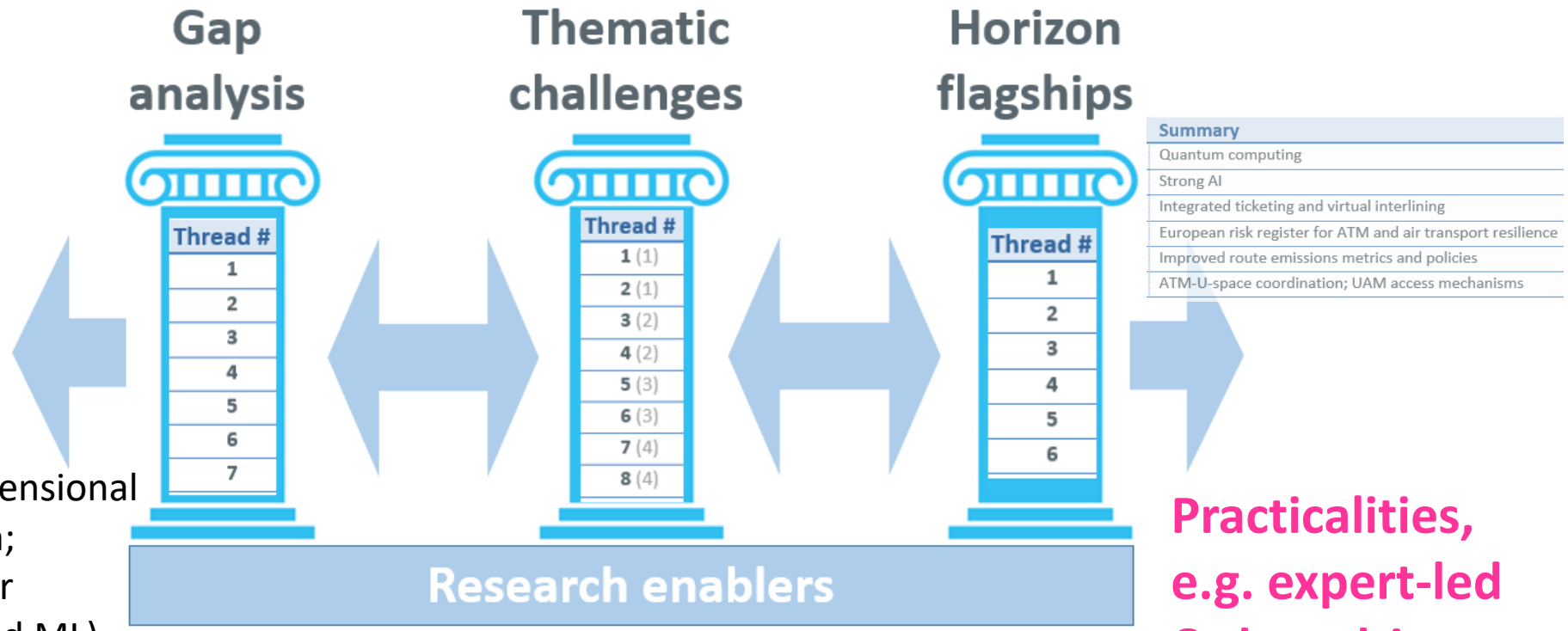
(public on approval)

- **D3.6: Opportunities for innovative ATM research**





(i) Multi-dimensional vectorisation; auto-encoder (unsupervised ML) model; (ii) experts



Practicalities, e.g. expert-led & data-driven

Lessons, legacy and looking ahead

(public on approval)

- **Research enablers**
  - Data and code issues (e.g. access, licencing framework, synthetic data)
  - Community collaboration (people, networks, momentum)
  - Extending the SESAR KPI state of the art
  - Distributed and remote simulations (Covid-19)
- **Research platforms**
  - *Possibilities* for the wiki going forward (= SJU decision)
  - Sources of project data – consolidation and recency
  - Format and implementation of virtual workshops
- ***Active* dissemination (reporting 2022), on which note ...**

Detailed lessons learned across the KTN

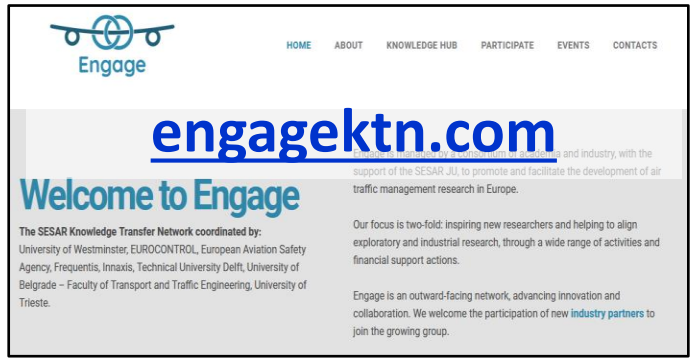
ICRAT 2022

- **Heads-up details**
  - **deadline for papers: (Sunday) 13 February 2022**
  - **physical conference: University of South Florida, Tampa**
  - **19-23 June 2022**
  - **hybrid / virtual (back-up) options**
- **Watch the website for forthcoming details**
  - **www.icrat.org**
  - **(will also be posted on Engage website)**

Thank you

On-line questions most welcome

rest of conference



anytime

FC2A

Additional slide set

FC2A

Flight Centric ATC with Airstreams

Ecole Nationale de l'Aviation Civile
7 Avenue Edouard Belin
Toulouse - France

1 Esplanade Compans Caffarelli
Toulouse - France

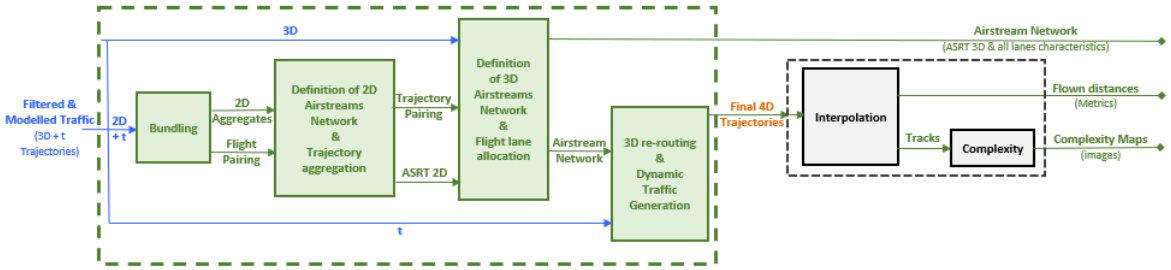
Aim of the project is to evaluate whether Flight Centric ATC with Airstreams is a promising approach to be incorporated into the emerging Dynamic Airspace Configuration management

Objectives

- Assess the amount of traffic captured by Airstreams for **complementing and supporting the free route and dynamic airspace configuration approaches**
- Define initial characteristics of the Airstream structure to cope with the constraints of the European Airspace and traffic demand
- Assess whether **traffic structural complexity is reduced** due to the introduction of Airstreams

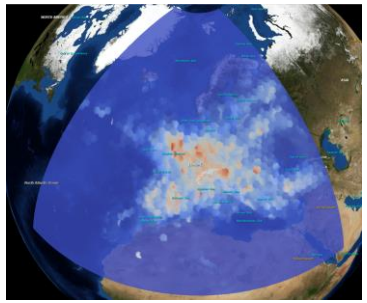
Methods

- experimental environment, based on a "spin-off" of the **π-rats tool from ENAC**



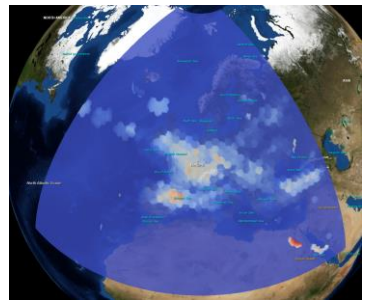
- **stakeholder survey** structured around two workshops

- Extended complexity calculation to large geographical area & introduced notion of mean complexity indicator for comparison of different traffic patterns
  ~42% reduction in structural traffic complexity with the use of Airstreams



High Week Day original

	Low weekend		Low weekday		Mean weekend		Mean weekday		High weekend		High weekday	
	Original	Airstream	Original	Airstream	Original	Airstream	Original	Airstream	Original	Airstream	Original	Airstream
Mean complexity	1,746	1,034	1,19	0,701	2,095	1,162	1,642	0,886	2,191	1,294	2,367	1,401
Complexity decrease	-41%		-41%		-45%		-46%		-41%		-41%	



High Week Day Airstream

- Initial algorithms for traffic aggregation & definition of tri-dimensional structure of the Airstream developed
  ~65% of eligible traffic captured by aggregation mechanism: encouraging
- Simple calculation of the Airstream flight trajectories implemented, but needs to be improved to achieve the expected level of eligible traffic in the Airstream
  ~40% of eligible traffic re-allocated into the Airstream structure

- Two workshops and working sessions with different operational and industrial actors allowed to get their feedback and to refine the hypotheses and parameters in order to set up a structured approach in the implementation of the concept.
- This also allowed the development of a first demonstrator (AirStream Factory). Thus, it helps the TRL maturation of a technical solution and to put in place the basis for the initialization of an operational mock-up and reaching a higher TRL level in future activities
- Potential operational applications
  - Adaptation to corridors for drone traffic management (automation)
  - Identification of similar traffic patterns based on complexity maps to anticipate measures to be put in place

Lessons learned

- A step-by-step building is not the best approach. A recursive mechanism based on limited set of relevant metrics might allow to improve the global efficiency of Airstream generation cycle

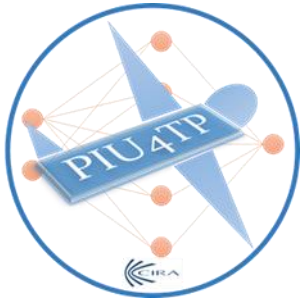
- The methods applied for computing the route segments accessing and exiting the Airstream network must be carefully studied and evaluated as they may jeopardise the benefits on complexity of main flows by inducing an unmanageable complexity of the exit/entry airspace volumes

Next Steps

- Improve clustering mechanisms:
  - Couple clustering mechanism and complexity calculation in order to introduce a quality indicator for the generated medoids allowing a ranking of the various series provided and enhance the complexity metrics
  - Couple the two clustering approaches (medoids & Air-Link) in an integrated process
- Improve Airstream network definition and traffic:
  - Improve tri-dimensional Airstream construction & trajectory recalculation methodologies
  - Reshape the initial medoids closer to an orthodromic route
  - Evaluate environmental benefits of an Airstream network
  - Initiate the definition of the methodology to be applied for Airstream crossing
- Federate tools in a common suite package (in progress)

PIU4TP

Additional slide set



PIU4TP

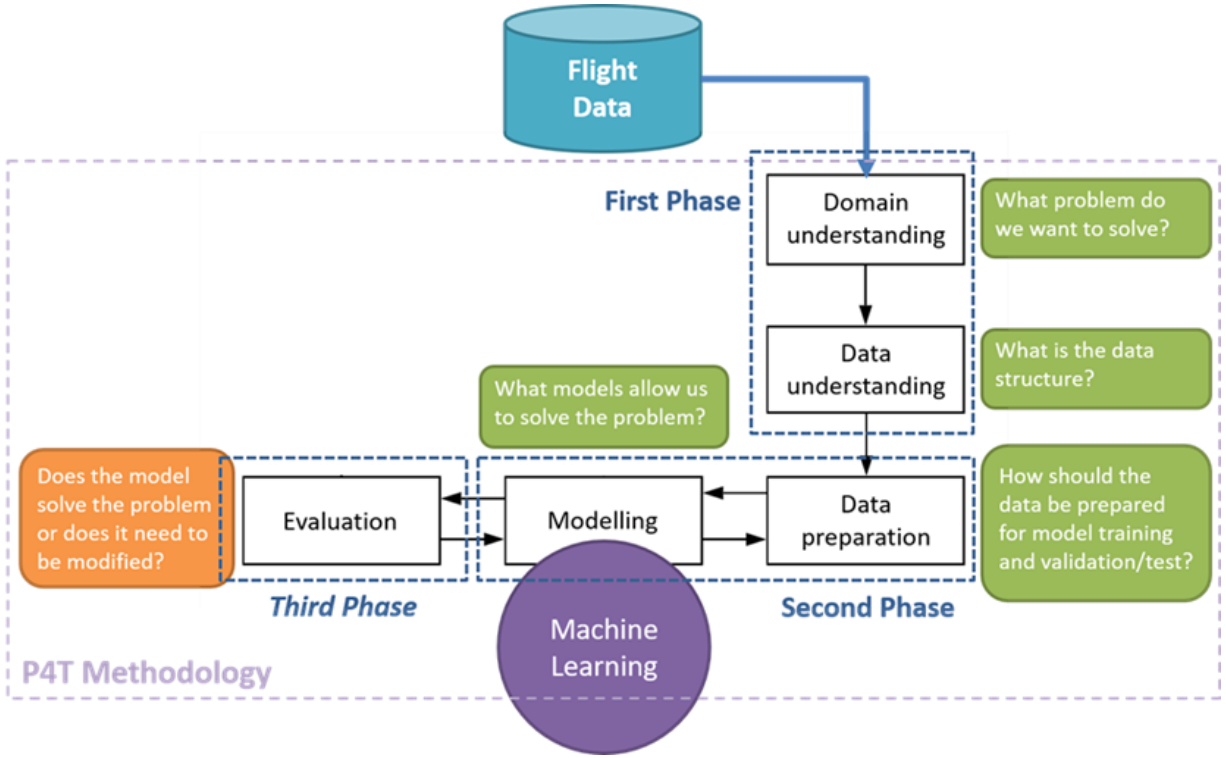
Probabilistic information **I**ntegration in **U**ncertain data processing for **T**rajectory **P**rediction

- Funder: **SESAR Engage KTN – second Call for catalyst funding**
- Thematic challenge 2: **Data-driven trajectory prediction**
- Partner: **CIRA – Italian Aerospace Research Centre**
- Start Date: 01/07/2020
- End Date: 30/06/2021

The PIU4TP project has received funding from the SESAR Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 783287.

PIU4TP Objectives and Methods

Proof of concept for the **development of a data-driven methodology** (named P4T) for the prediction of the flight trajectory able to provide a *map* of likely flight trajectories with the relative confidence on the basis of five input variables: **take-off weight**, forecast **air temperature** and **wind speed** along the three directions **south-north, west-east, up-down**

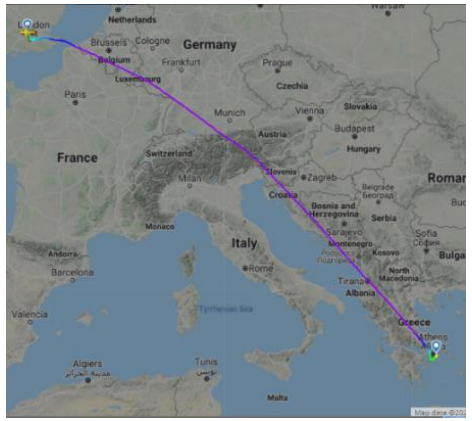


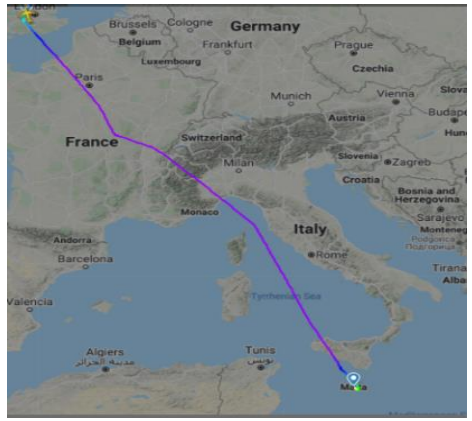
Objectives

- P4T proposes the use of state of the art **Machine Learning/Data Mining** algorithms, which are able to learn from past experience how to obtain **behavioral models** based on complex but statistically reliable rules
- It provides results that show the abilities of the developed methodology at the **pre-tactical stage** of operations.
- It is intended to **support** the planning activities in terms of demand-capacity balance and pre-tactical identification of conflicts

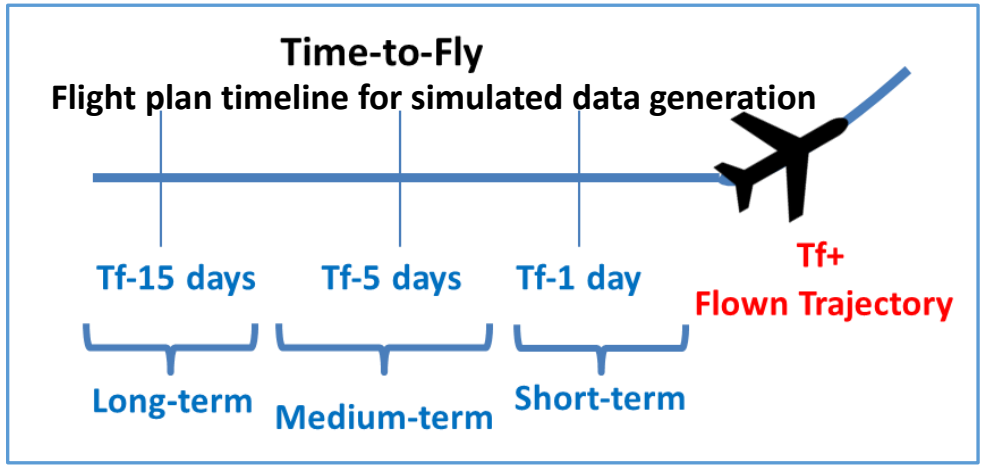
PIU4TP Operational Scenario

- The P4T methodology was developed and validated considering the **European airspace** with reference to two routes:
  - London Heathrow (EGLL) – Athens Eletherios Venizelos (LGAV)
  - London Gatwick (EGKK) – Malta International Airport (LMML)





- The trajectory prediction is performed 15 days, 5 days and 1 day before the day of execution of the flight.
- Input data and related uncertainties required for trajectory prediction are provided on these dates. With the day of flight approaching, the uncertainties get smaller and smaller.
- Simulated actual data experienced during the flight are also available

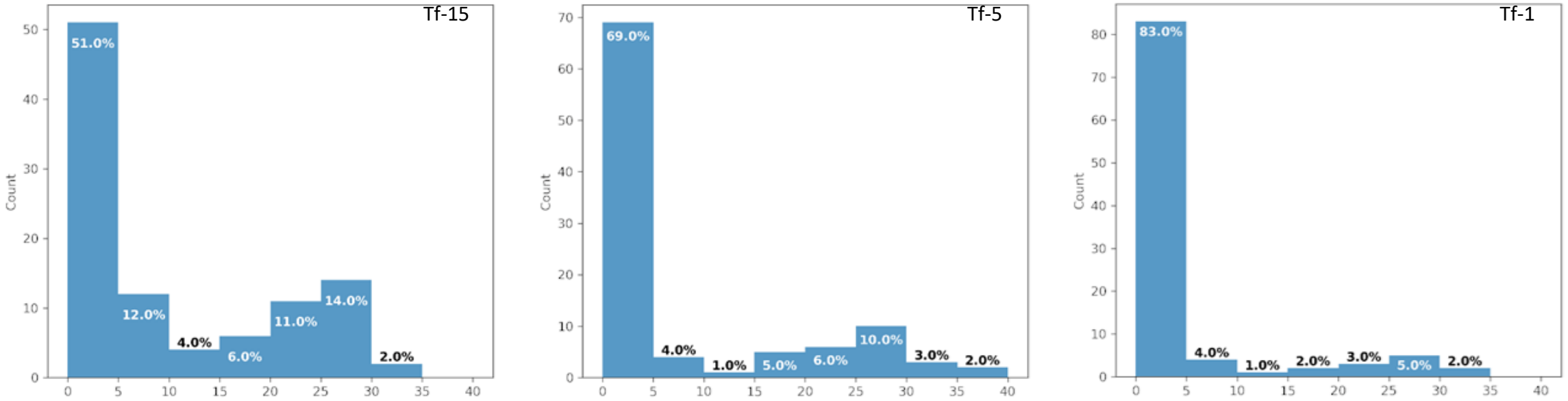


Data Analysis objective:

- prediction of which, among N possible flight plans (lateral and vertical), will be selected for the flight execution (i.e. a **classification problem**);
- estimation of the duration of the cruise phase of the flight (i.e. a **regression problem**).

PIU4TP Key Results

Among the algorithms tested during the development of the methodology (including Bayesian Nets and Neural Networks), Decision Trees and Random Forests perform better for the classification of the flight plan (lateral and vertical), and Random Forests showed the lowest errors for the estimation of the duration of the flight for both the London-Athens route and the London-Malta route



Distribution of absolute error of the flight duration estimation in minutes, London-Athens route. Similar results are obtained for the London-Malta route.

	Lateral flight plan	Flight level
Tf-15	31 %	48 %
Tf-5	63 %	67 %
Tf-1	78 %	88 %

Accuracy for the prediction of the flight plan for the London-Athens route. Similar results are obtained for the London-Malta route.

PIU4TP Lessons Learned and Key Next Steps

- Main pros & cons of joining the Engage KTN catalyst initiative:
  - Low project managerial burden ⟹ Allows to focus on research activities
  - Technical support of mentors ⟹ Added value
  - Short project duration (1 year) ⟹ Suitable for PhD and young researchers
- The establishment and consultation from the beginning of the project of a wide board of external experts helped to address the research activities
- Key next steps if opportunities for future project arise:
  - To perform sensitivity analysis to quantify the effect of the uncertainty in the input data on the uncertainty on the predictions
  - To increase the TRL of the proposed methodology by
    - Removing the simplifying assumption in the scenario used for design and test (increase the number of factors affecting the trajectory selection and consider other sources of uncertainty)
    - Test the methodology on actual flight datasets

OPAS

Additional slide set

Operational alert Products for ATM via SWIM (OPAS)

June 2019 – July 2020 Engage-KTN grant agreement number 783287

Royal Belgian Institute for Space Aeronomy (BIRA)

Mentoring and advisories received from EUROCONTROL and Rolls-Royce

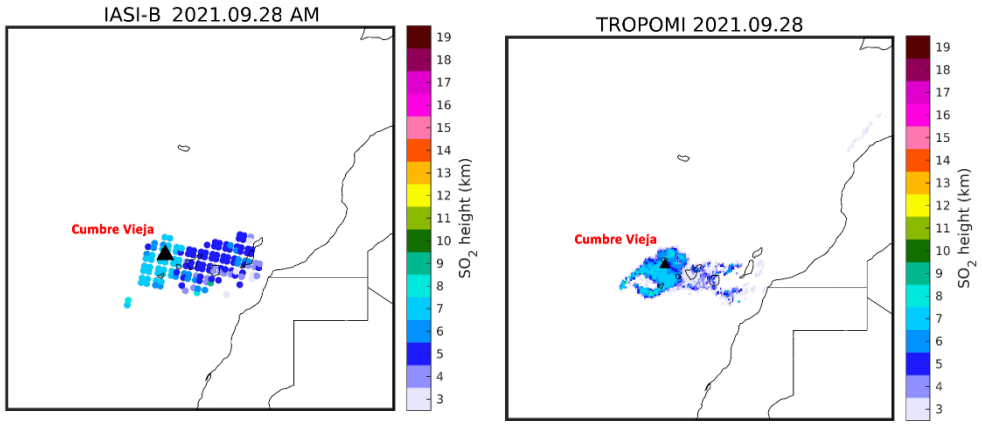
Overview

Development a SWIM Technical Infrastructure Yellow Profile service providing information (notification & data access) to volcanic SO_2 height

Objectives:

1) Algorithmic development of TROPOMI SO_2 height. **[Extended iterative spectral fitting]**
2) Operational implementation of SO_2 height. **[Automatisation]**
3) Tailored alert products of SO_2 height. **[A.I. and machine learning]**
4) Implementation of SO_2 height early warnings. **[Build on existing service]**
5) SWIM registry of OPAS as a notification service (Yellow Profile). **[Design, definition, publication]**

Key results



- **Algorithm development and operational run of SO_2 height (from TROPOMI satellite sensors)**
  - → Use of BIRA facilities and expertise in NRT SO_2 retrievals (*Brenot et al. 2014, NHESS; Theys et al. 2017, AMT*)
  - → Validation using external observations (*Brenot et al. 2020, SIDs*) ➔ **TRL4**
- **Alert products of SO_2 height from TROPOMI and upgrade for IASI sensors**
  - → Benefits of SACS (Support to Aviation Control Service) early warning system (*Brenot et al. 2014, NHESS*)
  - & Transfer of EUNADICS-AV (European Natural Airborne Disaster Information and Coordination System for Aviation) development (*Brenot et al. 2021, NHESS*) ➔ **TRL5**
- **SWIM Yellow Profile Notification service: OpasSo2lhDatasetNotification**
  https://eur-registry.swim.aero/services

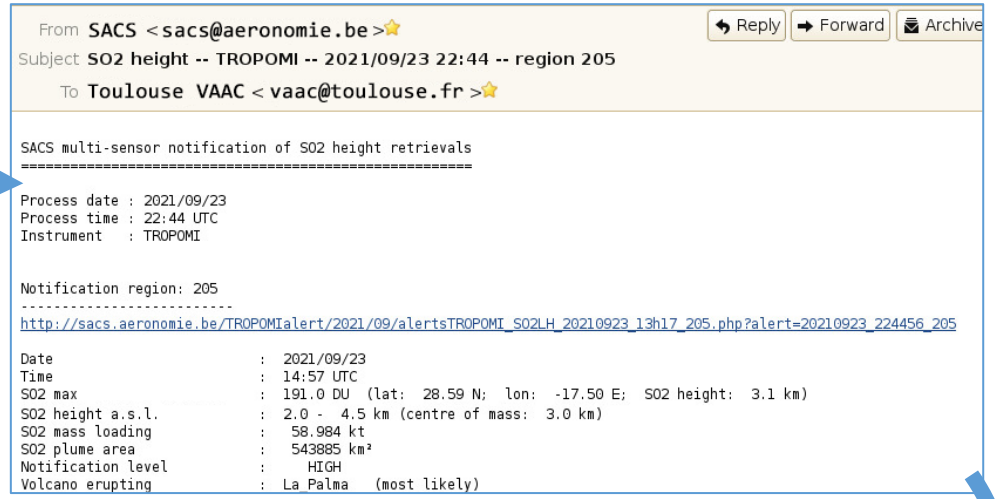
Example of operational applications: on-going eruption La Palma

SWIM YP notification service

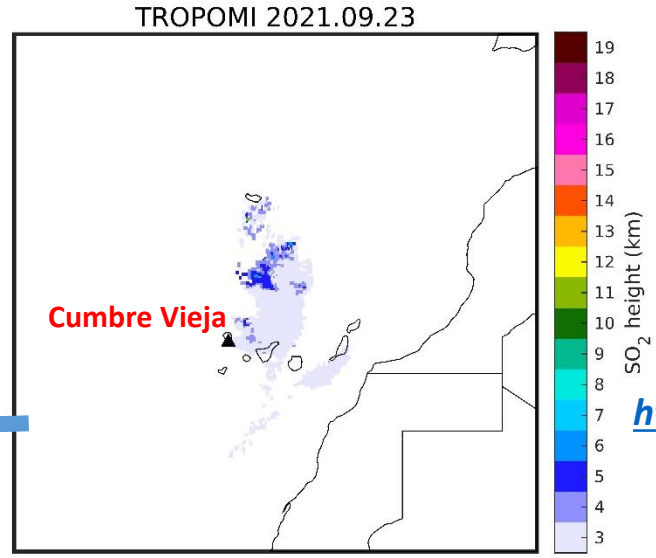
Email notification

Users

e.g. *VAACs, Volcano Observatory La Palma, airlines, pilots*



Visualisation



Data file transfer

https://sacs.aeronomie.be

Lessons learned:

- Very simple to coordinate and management the progress of a small project (only few partners)
- Time duration of 1 year just enough to reach all the goals
- Maintain of service required regular incoming

Notification

Visualisation

Data file transfer

Key next steps:

OPAS Engage-KTN activity will keep developing as a part of the ALARM project:

→ Development of new SO_2/ash/dust alert from GEO satellites

→ Development of alert related to other risks for aviation (Space Weather, Extreme Weather & Environmental Hotspots)

→ Extension of OPAS SWIM service to other natural airborne hazard (i.e. desert dust , smoke from wildfires)

https://alarm-project.eu

Nov. 2020 → May 2023

SESAR H2020 grant n°891467

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