

ORCI Project

TADA-ORCI-AWARE Joint Open Day

30th September 2026

ISA, renowned developer of aviation software and modelling solutions, supporting ATM simulation, validation and bespoke concept analysis services around the globe.



INECO is a multidisciplinary engineering and consulting Public Entity focused, in the scope of this proposal, on data science air transport field, including ATM and airport operations and management for more than 30 years.



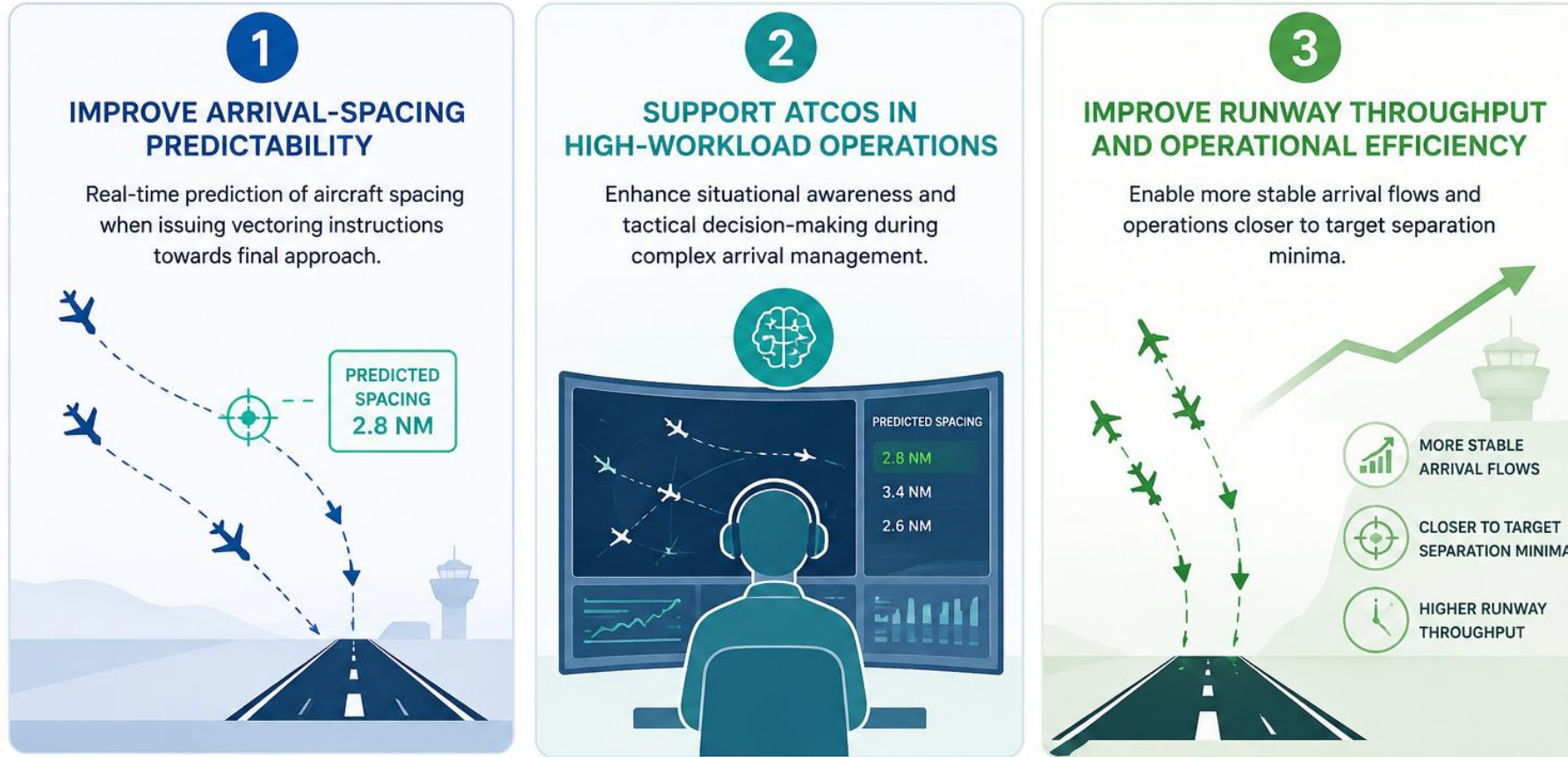
ENAIRe is the main provider of air navigation and aeronautical information services in Spain, the fourth in Europe by traffic volume.



Navegação Aérea de Portugal – NAV Portugal, E.P.E., is responsible for providing Air Navigation Services in Portugal, Azores and Madeira

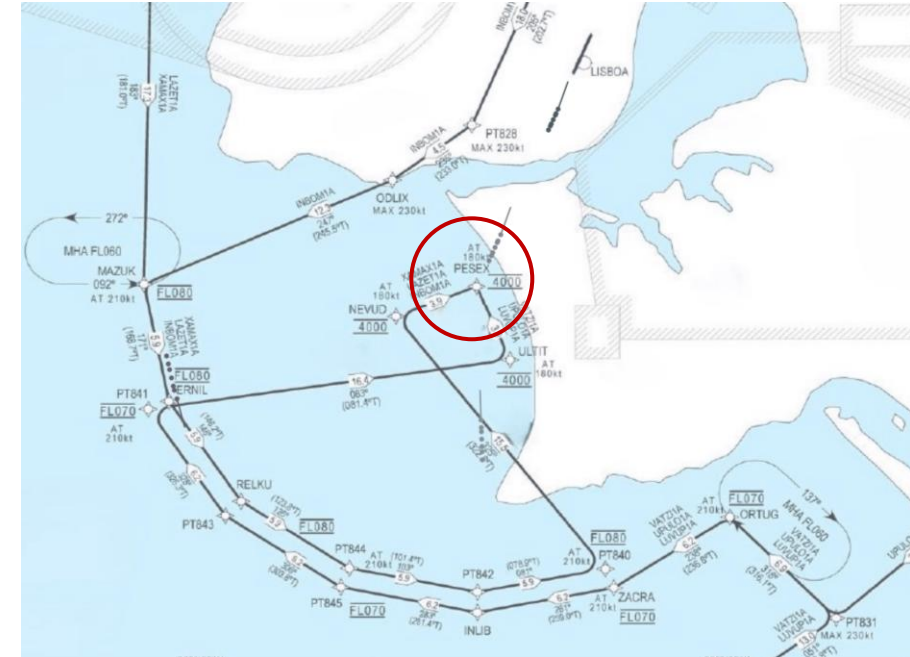


ORCI – Main Objectives



HUMAN-CENTRIC • AI-POWERED • SAFE • EFFICIENT



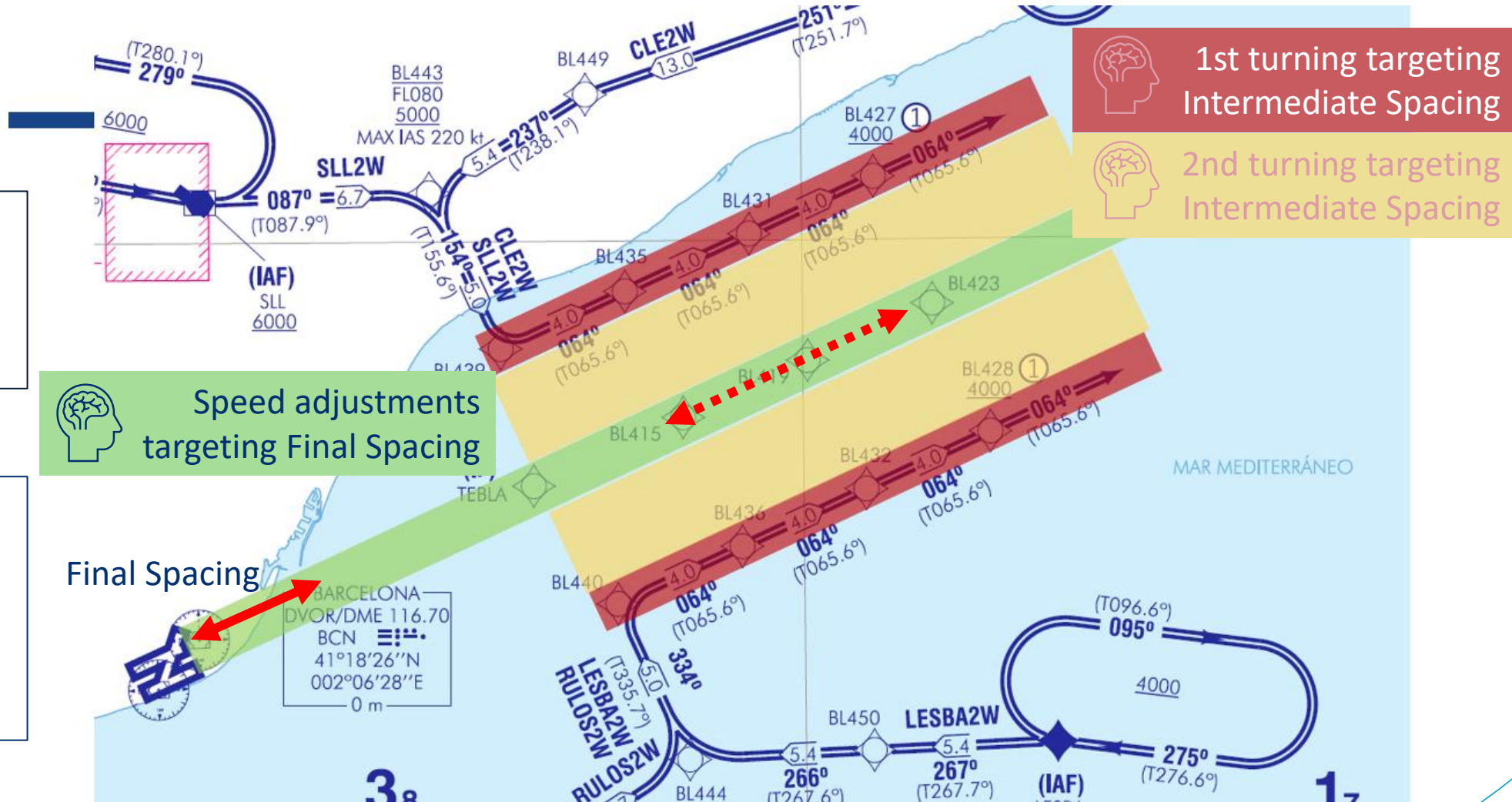


- Trombone and Point Merge System are Transition RNAV procedures.
- **They allow demand elasticity acting as linear holding paths:** the greater the demand are, longer segments have to be flown.
- **In high demanding periods:** ORCI helps the ATCO in determining the optimal instant to instruct the turn order to LOC or Merge Point (PESEX) enabling a better inter-spacing between arrivals.

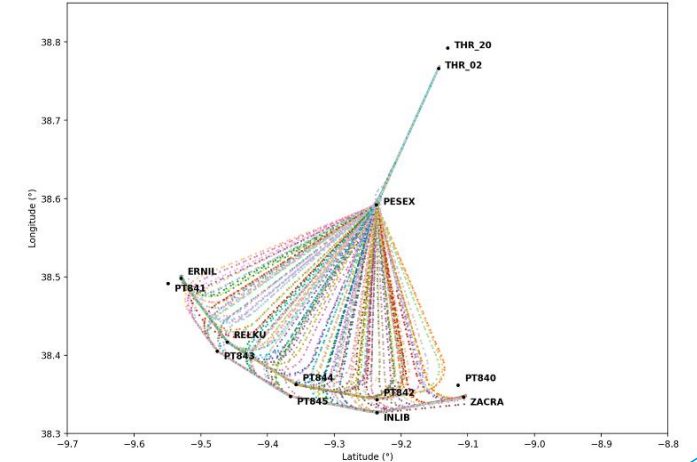
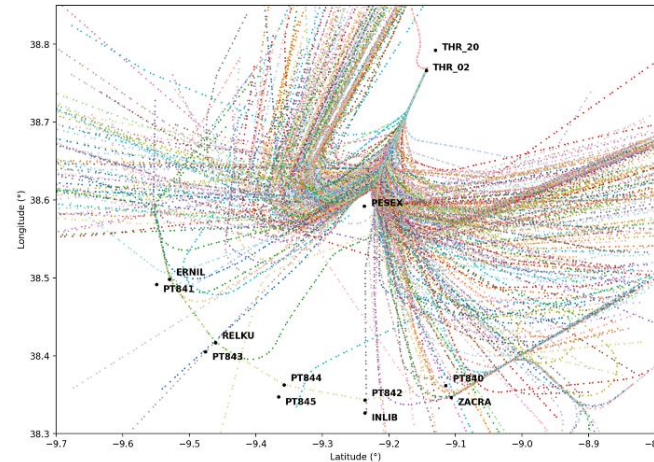
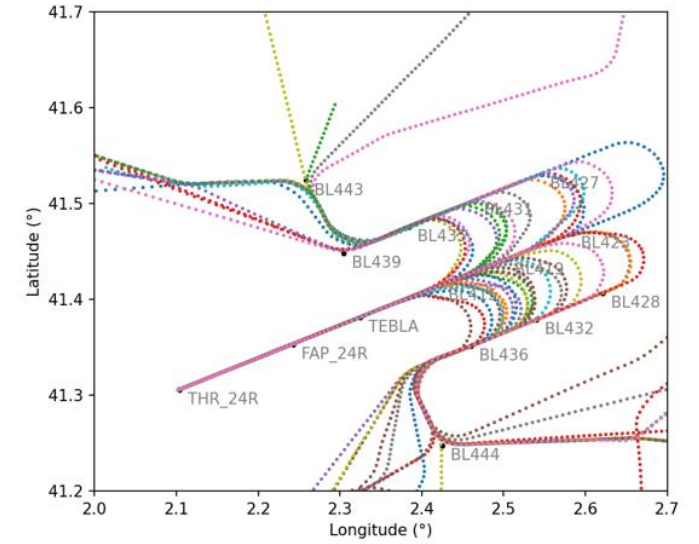
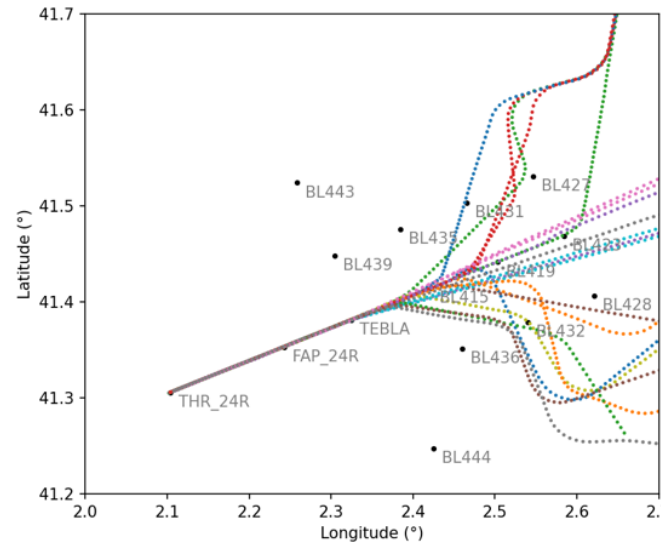
Two Cognitive tasks:

1. Direct to/Turn
2. Speed Adjust

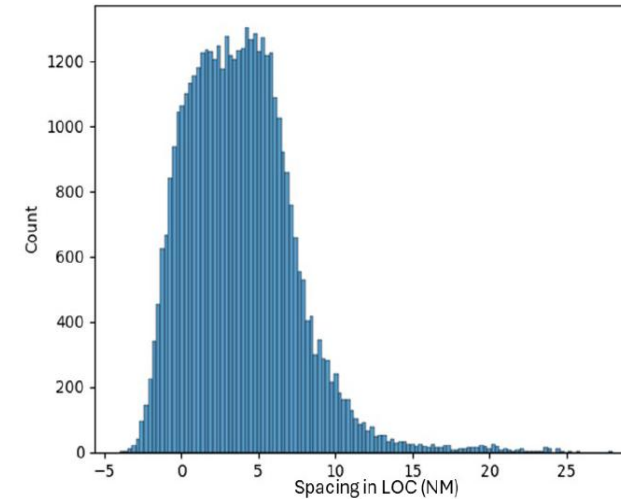
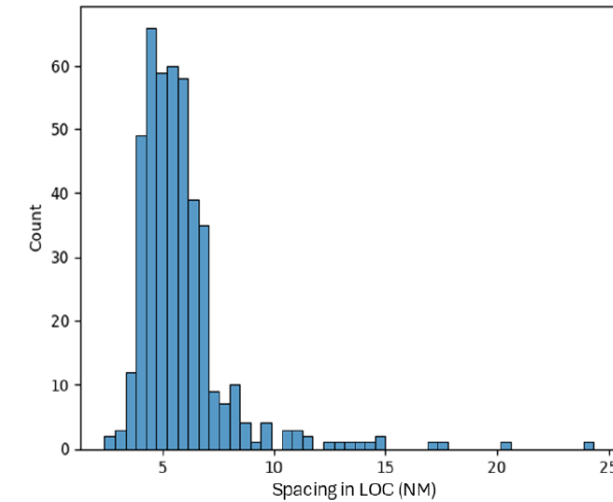
Final spacing
achieved via larger
intermediate spacing at
LOC (**compression**
effect)



- Summer months (typically associated with higher traffic demand) real traffic surveillance data
- **Identify valid operations:**
 - Flights following the transition procedure correctly
 - Non-compliant trajectories discarded
- **Validate aircraft roles:**
 - Valid preceding aircraft + Valid follower aircraft
- Under low-traffic-demand conditions, the transition approach phase may be omitted, and aircraft may be instructed to proceed directly to TEBLA or PESEX.
- In the training set, only valid flights that consistently follow the defined approach procedure are selected to ensure that contains trajectories that are representative of the actual approach procedure.



- To generate a more complete dataset, we manipulate the times of the **preceding** aircraft in each valid pair of flights by advancing or delaying it in 10s intervals, leaving the follower “frozen” **without altering the real 3D trajectories**.
- That technique enables a single pair of real flights to generate multiple scenarios with different final inter-spacing, creating a full spectrum of possible scenarios:
 - Real operative situations.
 - Excessive separation situations.
 - Situations where follower aircraft “overtakes” or even “collide” with the preceding (which do not happen in real life).



Input features

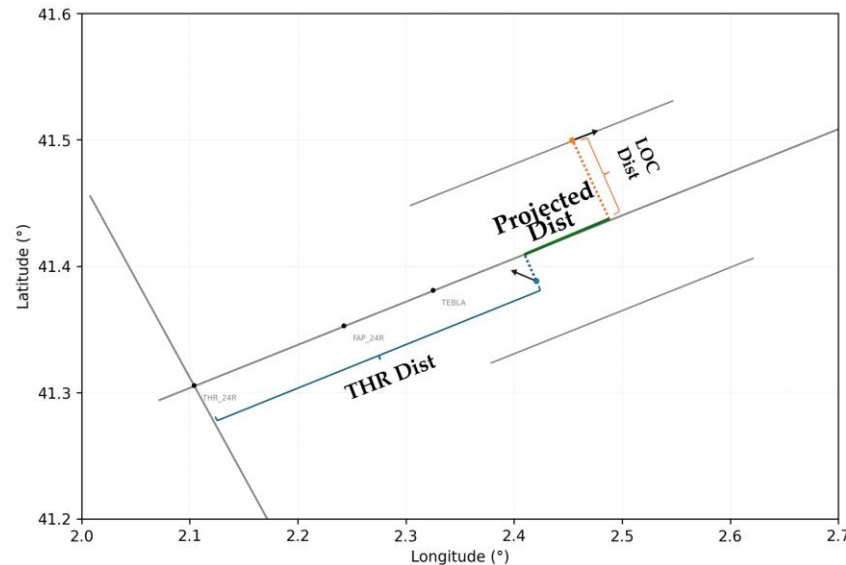
EstelaRECAT	EstelaRECAT_precedente	FL_precedente	GS_precedente	d_LOC_precedente	d_THR_precedente	FL_follower	GS_follower	d_LOC_follower	d_THR_follower	desviacion_rumbo_follower	desviacion_rumbo_precedente_LOC	Separacion_viraje_proyectada_LOC	Separacion_LOC
H+	M+	61,2	270	9,236	13,495	49,2	194	-4,105	15,454	2	15	-1,959	-1,37
H+	M+	59,2	255	8,374	12,291	49,2	194	-4,105	15,454	2	54	-3,163	-1,33
H+	M+	56,8	244	7,057	11,916	49,2	194	-4,105	15,454	2	87	-3,538	-0,69
H+	M+	53,2	239	5,715	11,926	49,2	194	-4,105	15,454	2	90	-3,528	0,39
H+	M+	51	228	4,528	12,349	49,2	194	-4,105	15,454	2	130	-3,105	1,62
H+	M+	48,8	221	4,050	13,479	49,2	194	-4,105	15,454	2	175	-1,975	2,92
H+	M+	47,8	216	4,046	14,071	49,2	194	-4,105	15,454	2	173	-1,383	3,56

Target column

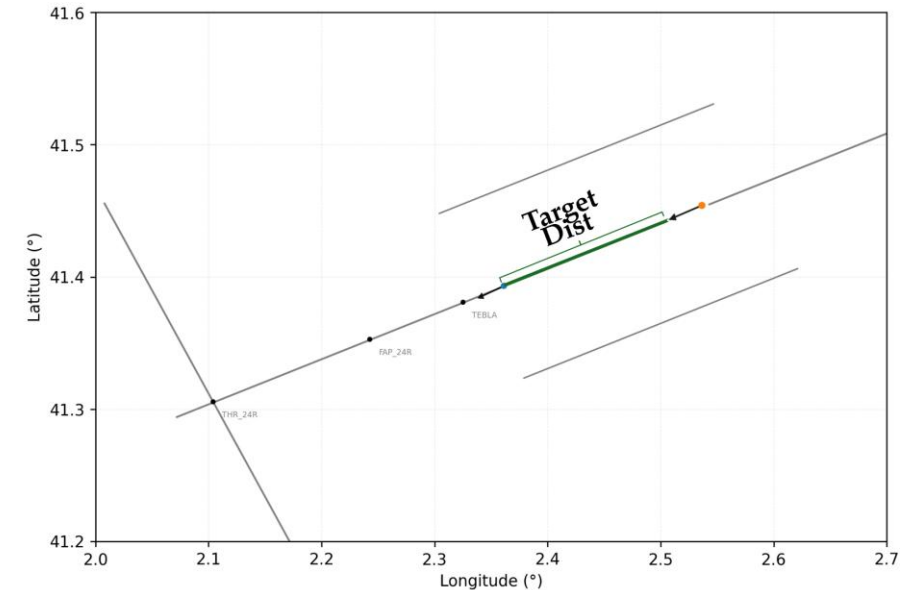
- **Raw radar traces $\neq$ Training Dataset:** integration of follower and preceding aircraft info into a single row $\rightarrow$ **Creation of training lessons.**
- Each lesson helps the ML model refine its weights, improving its ability to learn the relationship between the input features and the target variable: **“Spacing in LOC/PESEX”**

Two ML models depending on the initial conditions.

- **Model 1: Initiating Turn**
Preceding aircraft is in Outbound or maneuvering → Predict trajectory in dynamic conditions.
- **Model 2: Finalizing Turn or established in LOC**
Preceding aircraft is stabilizing → Predict behavior in steady conditions.



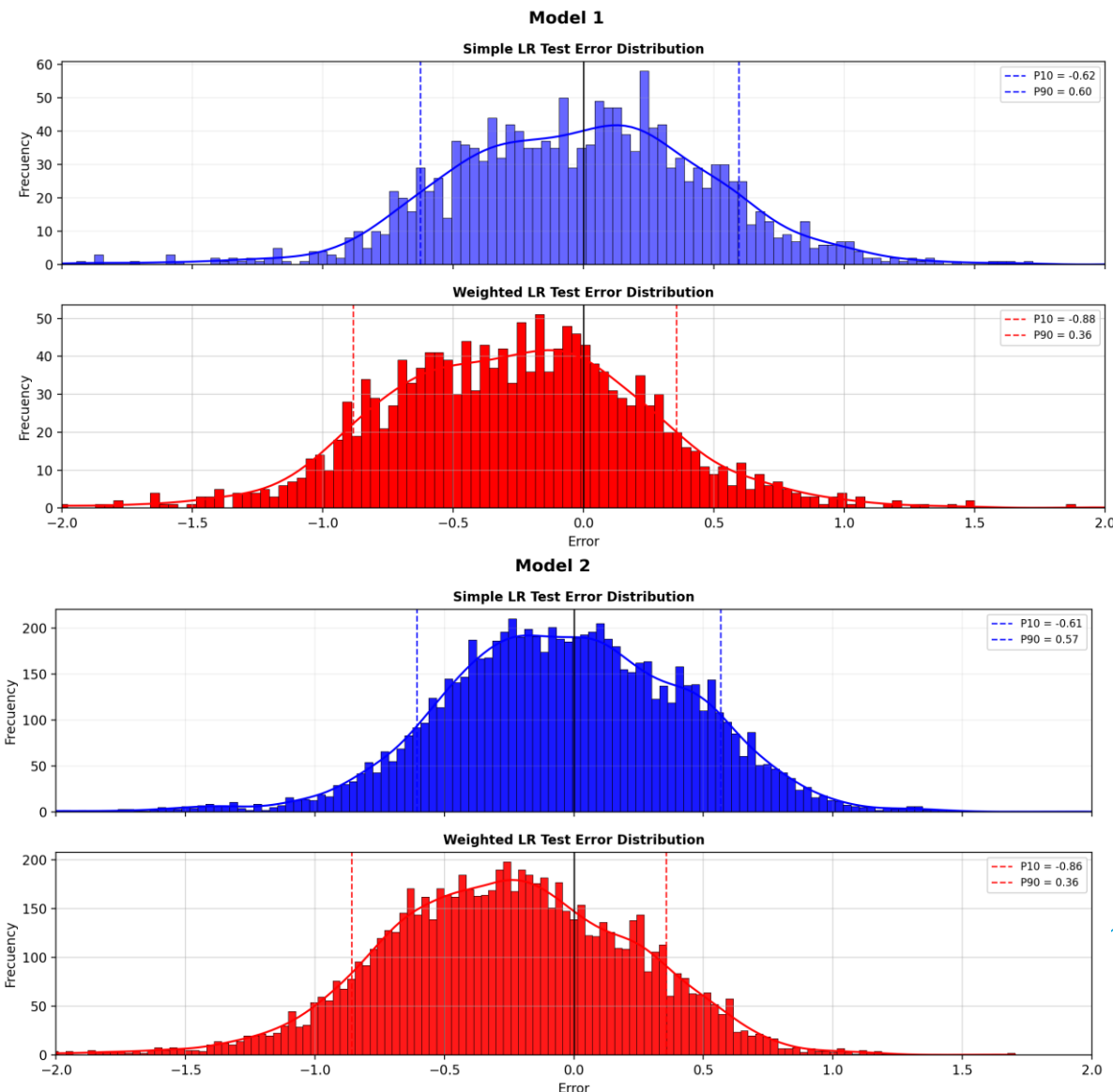
Before (instant when the prediction is made)

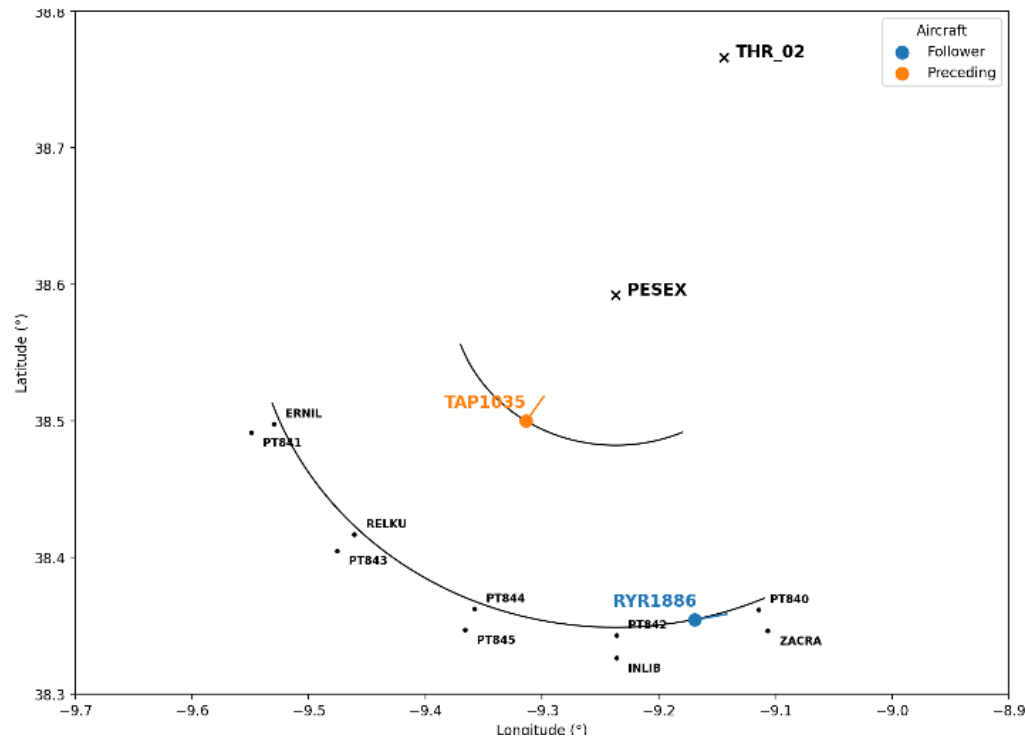


After (follower intercepts LOC)

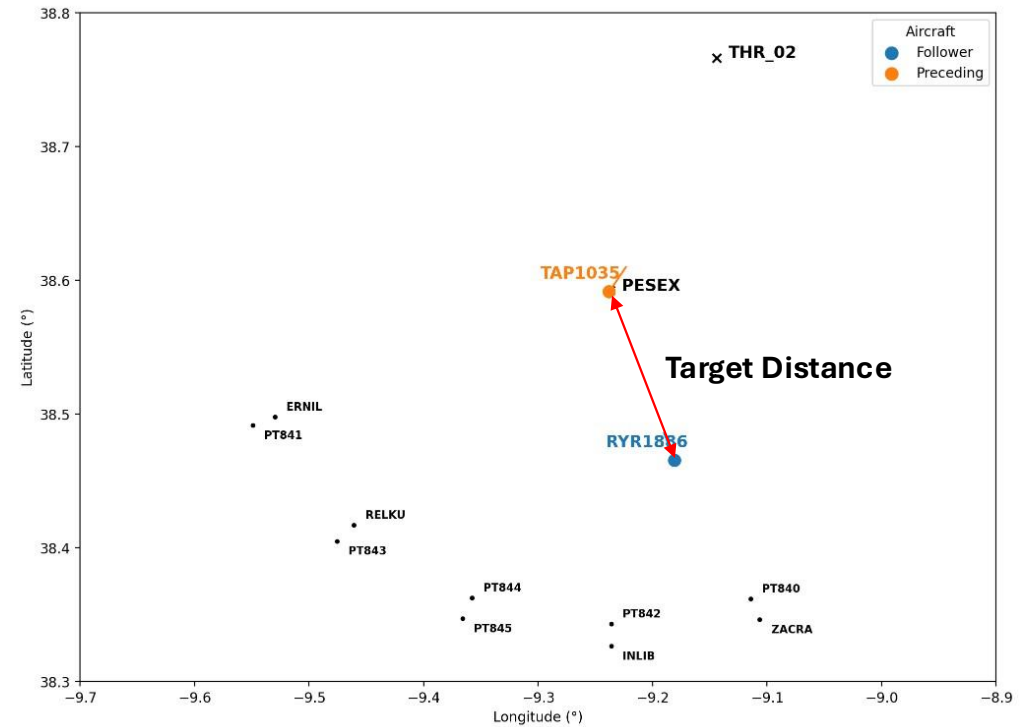
Model /Metric			MAE	MSE	R2	p10	p50	p90
Conventional LR	Model 1	Train	0.380	0.248	0.934	-0.581	0.003	0.603
		Test	0.400	0.276	0.927	-0.625	0.001	0.596
	Model 2	Train	0.367	0.228	0.967	-0.555	-0.001	0.588
		Test	0.382	0.239	0.963	-0.607	-0.035	0.566
Weighted LR	Model 1	Train	0.439	0.319	0.916	-0.856	-0.242	0.369
		Test	0.462	0.356	0.905	-0.88	-0.250	0.356
	Model 2	Train	0.421	0.289	0.959	-0.807	-0.228	0.373
		Test	0.445	0.317	0.951	-0.858	-0.263	0.355

- Error = Prediction – Real Achieved Distance (NM)
- Greather error in Model 1
- Weighted ML models slightly degrade overall prediction performance (↑ MAE)
- However, they significantly reduce errors on the non-conservative side (greather than 0).
- Flexible and easily configurable to accommodate different operational and calibration requirements.





Before (instant when the prediction is made)



After (preceding flies over PESEX)

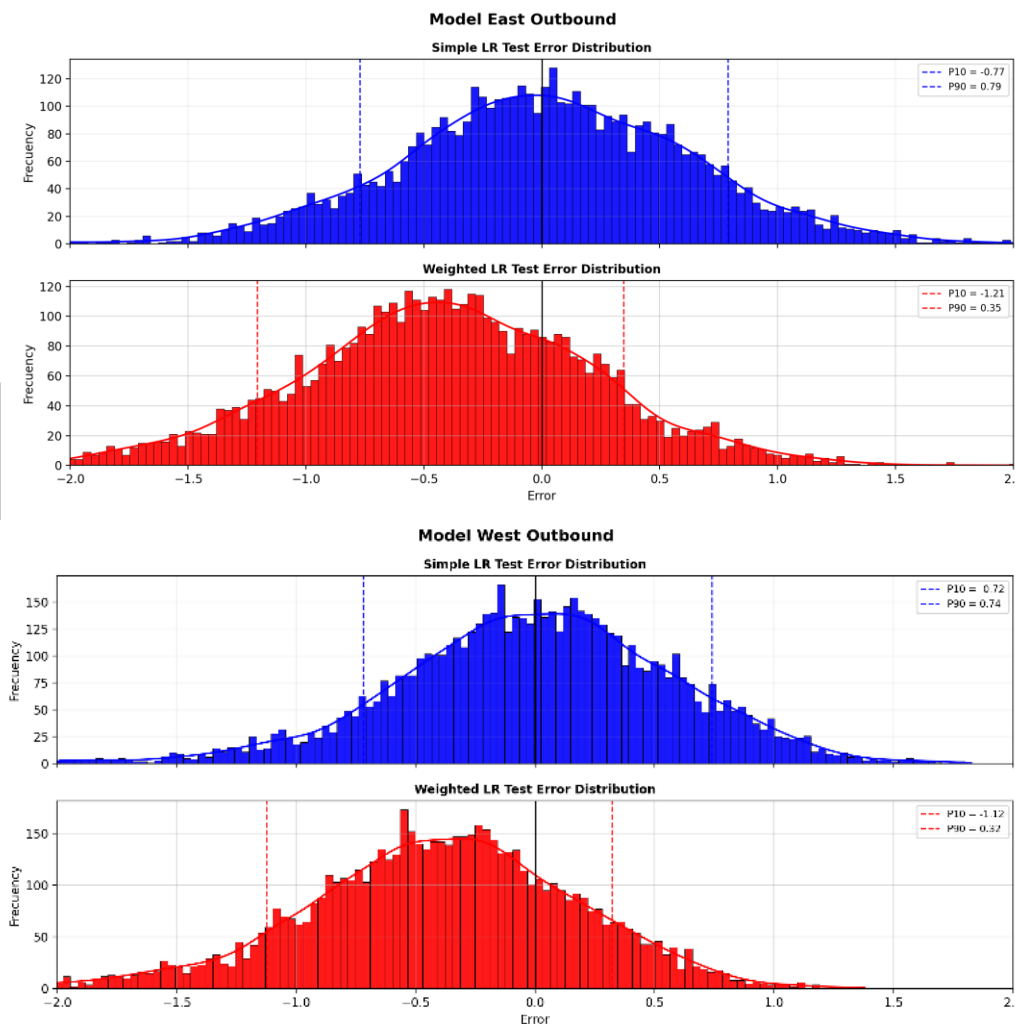
Two ML models depending on the Preceding Outbound.

- **Model 1:** Follower is flying Eastern PMS legs
- **Model 2:** Follower is flying Western PMS legs

Model / Metric			MAE	MSE	R2	p10	p50	p90
Conventional LR	Model East	Train	0,501	0,404	0,962	-0,809	0,013	0,776
		Test	0,498	0,399	0,963	-0,773	0,017	0,794
	Model West	Train	0,514	0,423	0,961	-0,766	0,008	0,756
		Test	0,484	0,376	0,966	-0,715	0,018	0,741
Weighted LR	Model East	Train	0,603	0,583	0,948	-1,250	-0,400	0,350
		Test	0,596	0,559	0,950	-1,210	-0,410	0,350
	Model West	Train	0,576	0,529	0,953	-1,180	-0,390	0,340
		Test	0,561	0,514	0,955	-1,120	-0,380	0,320

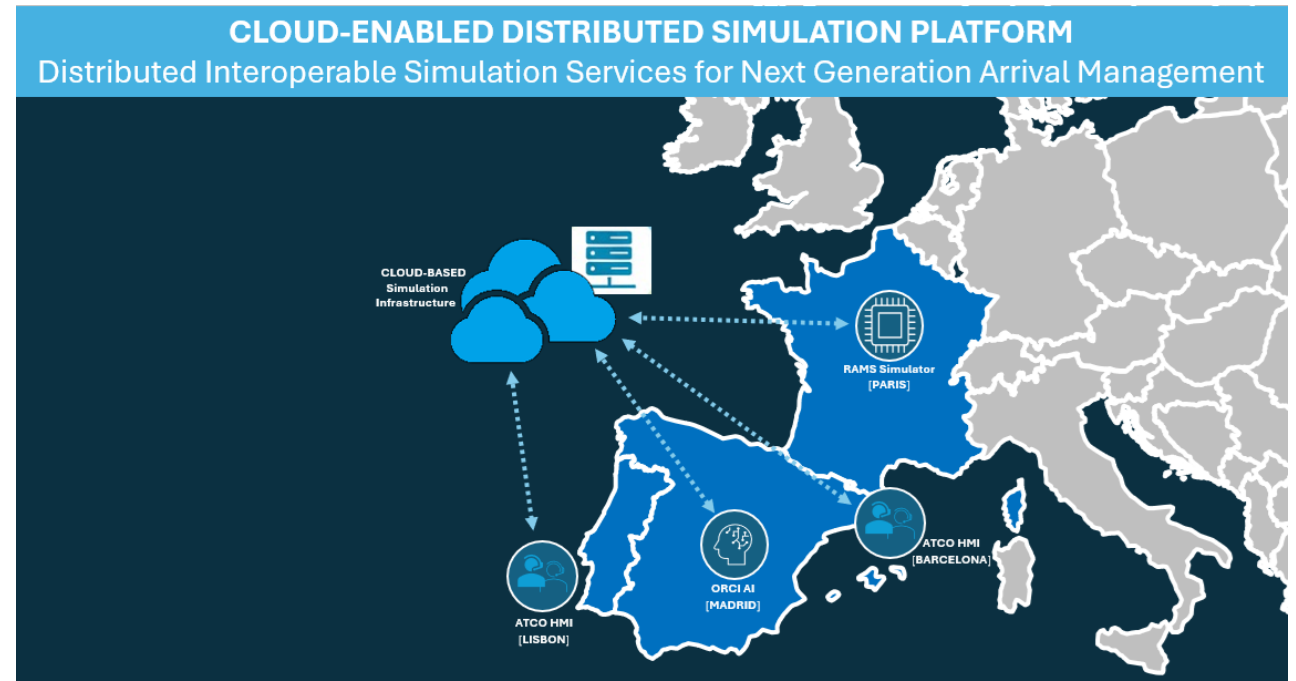
Table 2: Comparison of the different evaluation metrics for each LR and weighted LR model.

* Errors in this layout are slightly larger than in LEBL due to a greater time difference between the prediction and the distance measurement.



Fully Distributed, Hybrid HITL/Model-based Simulation

- Interoperable, **Service-Oriented Architecture**
- **HITL simulation** platform (based on RAMS Plus) in **Paris**
- **ATCO HMI** deployed locally at **Barcelona/Lisbon ACC** (via web)
- ORCI AI-based Decision Support Tool in **Madrid**
 - On-demand service based on publish-subscribe model. ORCI's AI tool is subscribed to two message-queue topics:
 - **Consumer topic** receives flight data from the simulation tool to be processed by the AI engine.
 - **Publisher topic:** returns the predicted spacing distance to be displayed on the HMI.



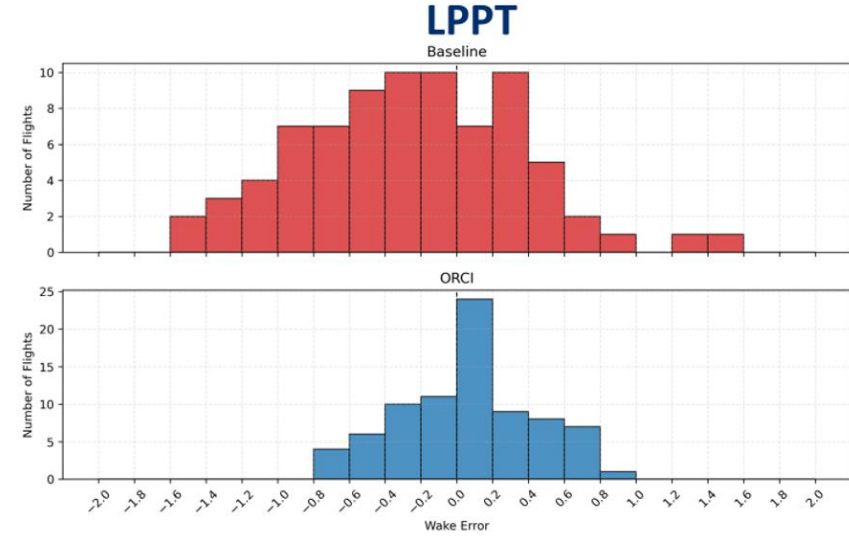
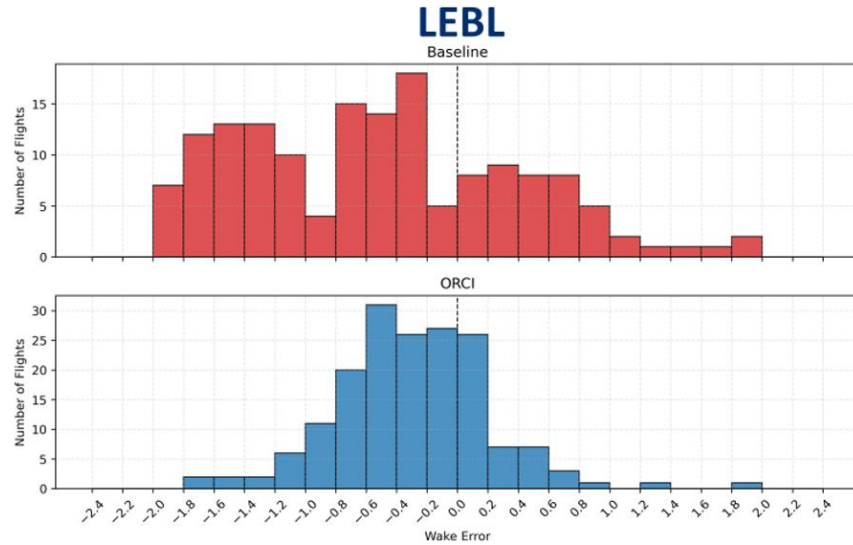
ATC Experts in Lisbon/Barcelona manage arrival flows using “Hybrid” Human-in-the-Loop / Model-based simulations (RAMS / ORCI-AI DST / ORCI-ATCO HMI) in a fully distributed ATM simulation environment via the cloud

ORCI

Validation Exercises and Participants

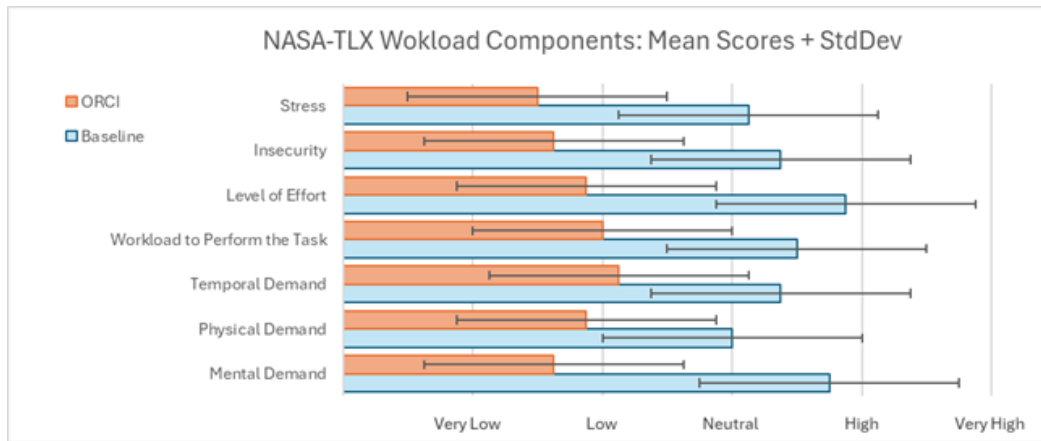
- 8 Individual ATCO from **Barcelona** ACC
 - Experts in Arrival Management for LEBL
 - **Single mode runway operations** (WRL: 24R for ARR)
 - Separation in THR defined by the RECAT Table
 - 2.5 NM between arrivals when no WT effect
 - High initial demand and complexity
 - 48 to 55 arrivals/hour
 - *(declared arrival capacity = 41/h)*
 - ORCI Target spacing (**at LOC**): RECAT Separation + 2 (first rounds) and RECAT + 1.5 (second rounds)
 - 16 Exercises
 - 8 Baseline, 8 with ORCI support
 - ≈40 min traffic / scenario
- 8 Individual ATCO from **Lisbon** ACC
 - Experts in Arrival Management for LPPT
 - **Mixed mode runway operations** (North Config with RWY02 for ARR)
 - Separation in THR depending on the sequence:
 - 3 NM between ARR
 - 6 NM in ARR-DEP-ARR sequence
 - High initial demand and complexity
 - 33 arrivals/hour
 - *(declared arrival capacity = 23/h)*
 - ORCI Target spacing (**at PESEX**): 5 or 8 NM
 - 16 Exercises
 - 8 Baseline, 8 with ORCI support
 - ≈30-35 min traffic / scenario

Validations Results I



	P10	P25	P50 (Median)	P75	P90	P90-P10	MAE
Baseline	-1,64	-1,27	-0,54	0,18	0,74	2,38	0,86
ORCI global	-0,84	-0,59	-0,3	0,01	0,25	1,09	0,45

	P10	P25	P50 (Median)	P75	P90	P90 - P10	MAE
Baseline	-1,02	-0,73	-0,23	0,20	0,48	1,49	0,53
ORCI global	-0,45	-0,2	0,09	0,33	0,57	1,03	0,3

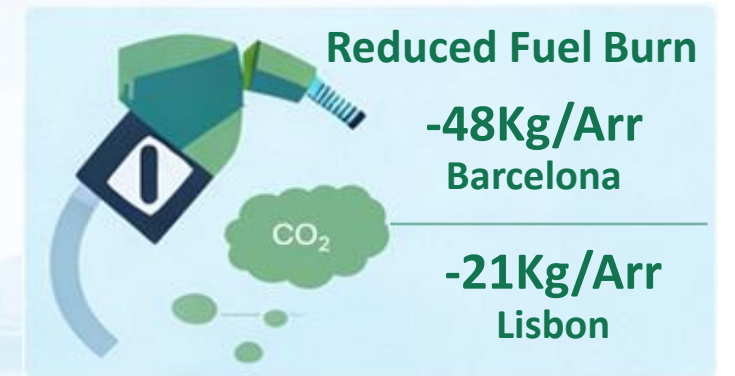
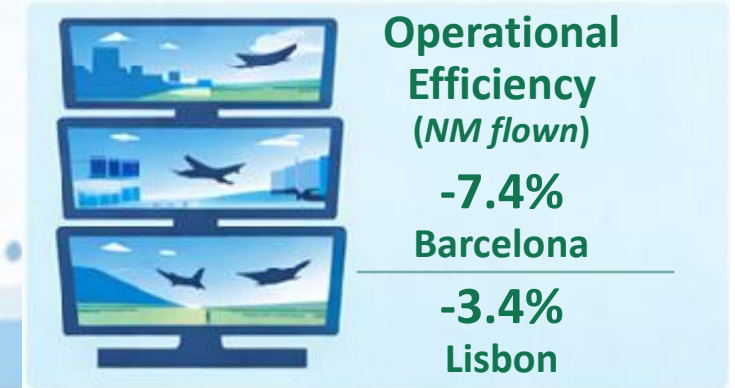


LEBL *Qualitative* reduction in NASA-TLX workload = 47.4%

LPPT *Qualitative* reduction in NASA-TLX workload = 47.8%

- The tool is highly realistic in both its appearance and aircraft behavior, it could even be used for training purposes. Controllers stated that **“they would like to have it available at their CWP tomorrow”**.
- **Support during the Warm-up Period**: ORCI is particularly useful during the first 10-15 minutes of a shift, when controllers typically need time to become familiar with the traffic patterns and operational conditions of the day.
- **Reduced "chain reactions"**: ORCI helps prevent situations where an initial spacing error triggers a cascade of subsequent speed adjustments and vectoring interventions to restore the desired separation.
- **Resource release**: By reducing the mental workload associated with spacing calculations, controllers can focus more effectively on managing complex traffic situations.

KEY RESULTS



Q & A Session

ORCI

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