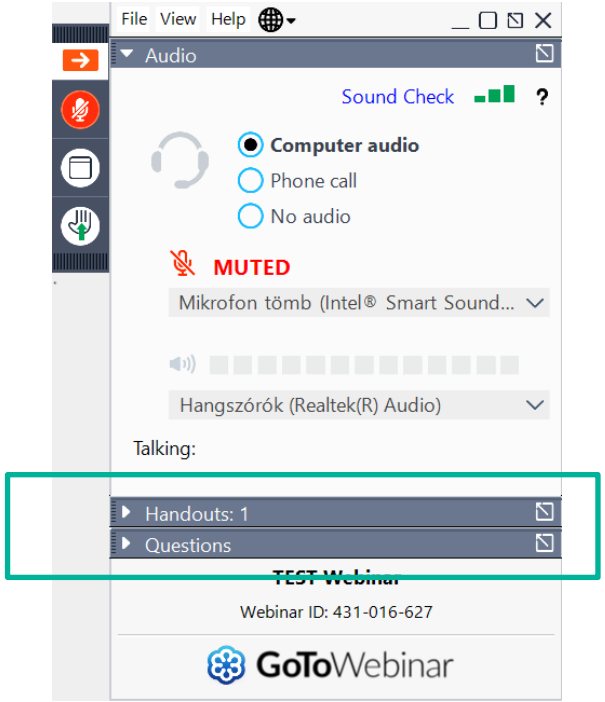
ETP 4 HPC

ETP4HPC webinar #19
Two FF4EuroHPC success stories focused on environmental impact

8 July 2022

Before we start

- This webinar is recorded, you will receive the link tomorrow
- This webinar is in listen-only mode
- Use the GoToWebinar control panel displayed on the right of your screen
  - to ask questions
  - to download handouts



Agenda

11:00	Introduction and house-keeping information	Pascale Bernier-Bruna
11:05	Introducing FF4EuroHPC and the speakers	Tina Crnigoj Marc (FF4EuroHPC Communication Lead)
11:10	Marine Litter Hunter	Emanuele Della Volpe, CEO and Aerospace Engineer at Green Tech Solution
11:25	HERCULES	Jose L. Munoz Gamarra, Technical Director at Aslogic
11:40	Q&A session	moderated by Tina Crnigoj Marc
12:00	End	

Speakers

Emanuele Della Volpe
CEO and Aerospace Engineer at Green Tech Solution

- Aerospace engineer at the Federico II University of Naples and aerospace designer at the Aerospace District of Campano (DAC).
- Since 2015 he has started an independent research and development course aimed at demonstrating the feasibility of an automatic system for the protection of the sea from floating solid waste, called Litter Hunter, creating scale prototypes and automatic mission management software.
- He was a researcher at the Department of Science and Technology of the University of Naples Parthenope. From 2016, the research path becomes broader on process automation technologies in view of Industry 4.0 and unmanned navigation systems in the air (UAV), land and marine (USV) environments.

Jose L. Munoz Gamarra
Technical director at Aslogic

- After completing his PhD in microelectronics at the University of Barcelona and CEA LETI Jose Luis joined Aslogic developing Decision Support Systems based on Machine Learning techniques. During the last years, they have focused their efforts on Air Traffic Management and the integration of Unmanned Aerial Vehicles.

Connecting business with **cutting-edge** technologies

Tina Crnigoj Marc, FF4EuroHPC Communication Lead

The FF4EuroHPC Project

- FF4HPC: HPC Innovation for European SMEs
- Funded under the H2020-JTI-EuroHPC-2019-2 Call
- Commenced 1.9.2020; 36 months duration
- Coordinator: HLRS High-Performance Computing Center | Stuttgart
- Other Partners:

ARCTUR CESGA Centro de Supercomputación de Galicia CINECA scapos Teratec

Stimulating the Innovation Potential of SMEs

FF4EuroHPC contributes to this EuroHPC objectives

- Increase the innovation potential of industry, and in particular of SMEs, through the use of advanced HPC infrastructures, applications and services.

Stimulating the Innovation Potential of SMEs

FF4EuroHPC contributes to this EuroHPC objectives

- Facilitate access to HPC-based infrastructures and services for a wide range of users of new and emerging data and compute-intensive applications and services.

Source: EuroHPC JU

Stimulating the Innovation Potential of SMEs

FF4EuroHPC contributes to this EuroHPC objectives

- Foster wider innovation, for example by exchanging and promoting best practice use cases or application experiences.

FF4EuroHPC contributes to this EuroHPC objectives

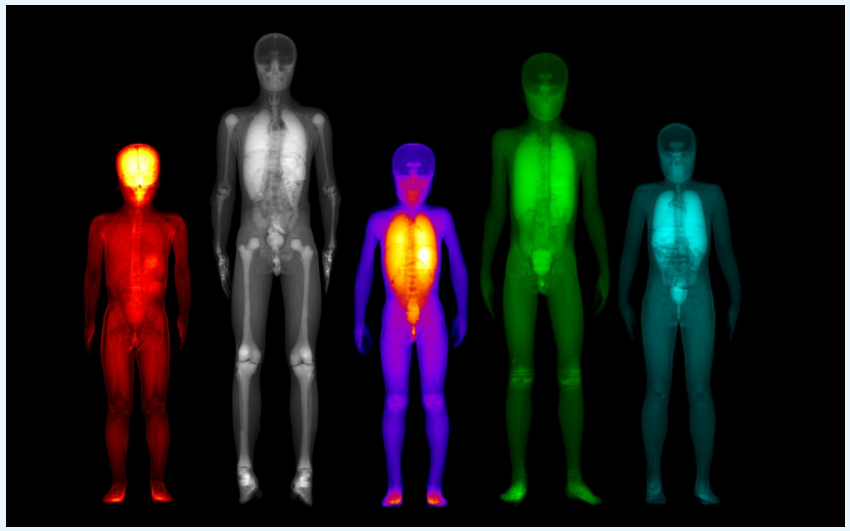
- Provide an effective mechanism for inclusion of innovative, agile SMEs lowering the barriers for small actors to enter the market and exploit new business opportunities.

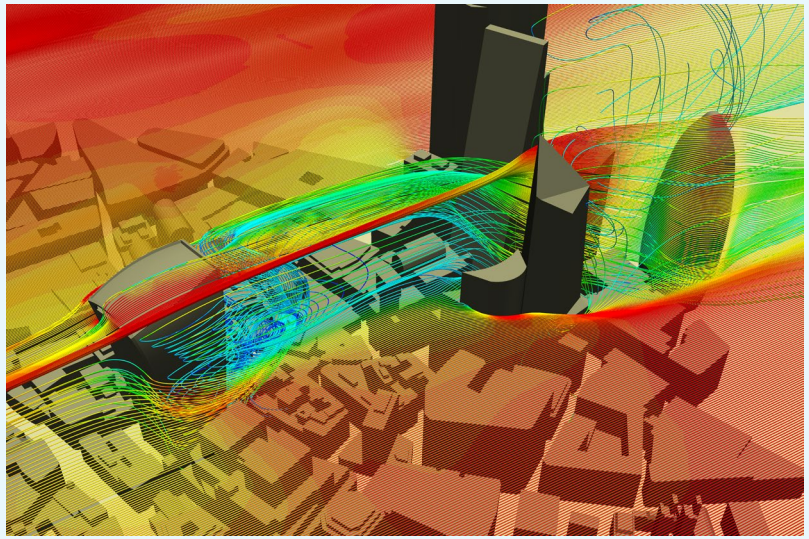
FF4EuroHPC Experiments in a nutshell

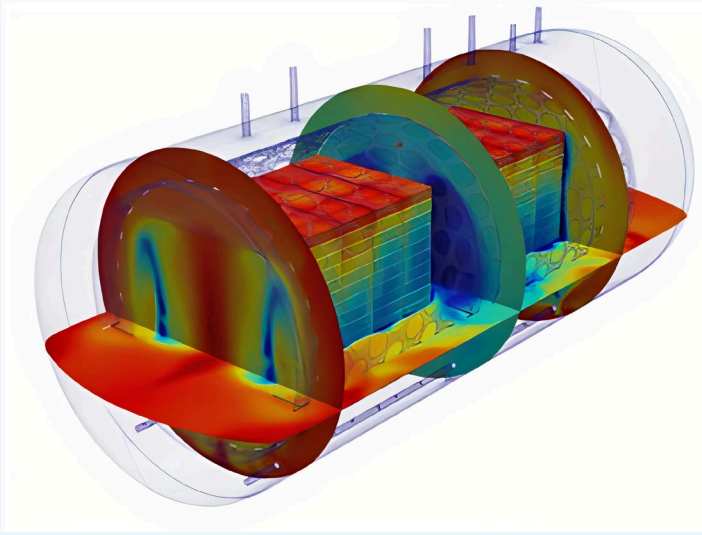
- Two Open Calls were offered, targeting the highest quality experiments involving innovative, agile SMEs
- In total, 42 experiments were selected for funding, INCLUDING 132 partners from 22 EuroHPC JU Member States
- 62% are Small and Medium-Sized Enterprises
- Experiments address business challenges from European SMEs from varied application domains, focus on *Manufacturing 57%*

Success Stories

- When the experiment is successfully concluded, it is resulting in a **Success Story**, highlighting the benefits and inspiring the Industry community.

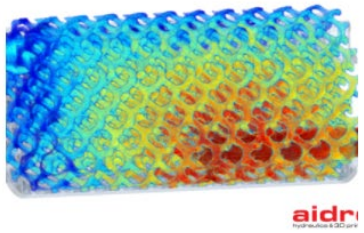






FF4EuroHPC Experiments

www.ff4eurohpc.eu/en/experiments/

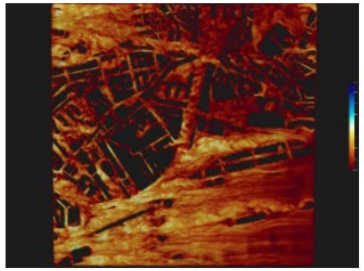


TOpoLogy Optimization of Micro-channel Heat-Exchangers
Read more

Power Systems Maintenance Planning for Energy Transition
Read more

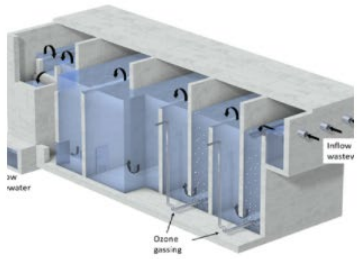
Multi-head Additive Manufacturing with Optimal HPC Thermal Stabilization
Read more

Market-Innovation-Sourcing
Read more

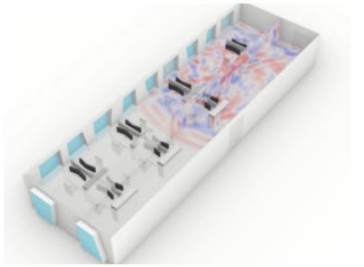


Improving BettAir Maps
Read more

HPC-based vessel predictive maintenance optimization through Natural Language Assistance
Read more

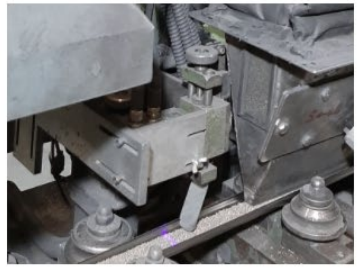


Ozone and Dissolved Air Flotation Systems
Read more

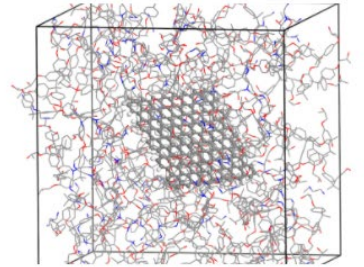


CBAAS: Cloud-Based Architectural Acoustics Simulations
Read more

HPC-based platform for low-emissions hydrogen combustors
Read more



SIMPSEG: SIMulation of Powder SEGregation in Cored-Wire Manufacturing
Read more



Improving Graphene-Epoxy Mixing Recipes with HPC Simulations
Read more

GEMINI: hiGh fidElity Modeling for small wINd turbIne
Read more

Get inspired!

- Success Stories
- HPC related events
- HPC related content

Let's get **in touch**

www.ff4eurohpc.eu

#FF4EuroHPC

Subscribe to the newsletter
and **get inspired!**

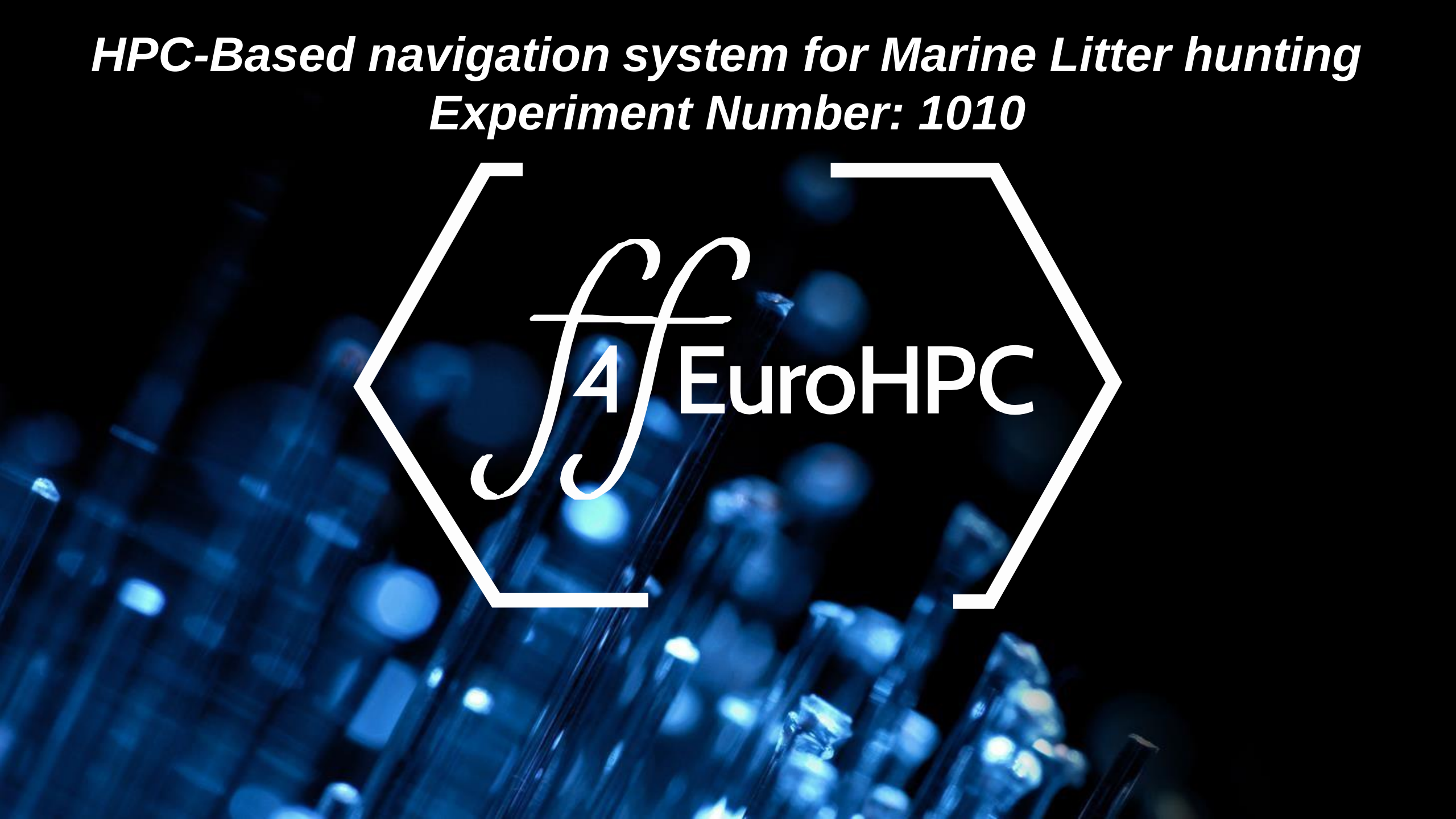
Thank you!

Tina Crnigoj Marc, FF4EuroHPC Communication Lead ff4eurohpc@hlrs.de

This project has received funding from the European High-Performance Computing Joint Undertaking Joint Undertaking (JU) under grant agreement No 951745. The JU receives support from the European Union's Horizon 2020 research and innovation programme and Germany, Italy, Slovenia, France, Spain.

HPC-Based navigation system for Marine Litter hunting

Experiment Number: 1010



HPC Litter Hunter

HPC-Based navigation system for Marine Litter hunting

Experiment Number: 1010

Green Tech Solution SRL (GTS)

University of Naples "Parthenope“

CINECA

Bi-REX

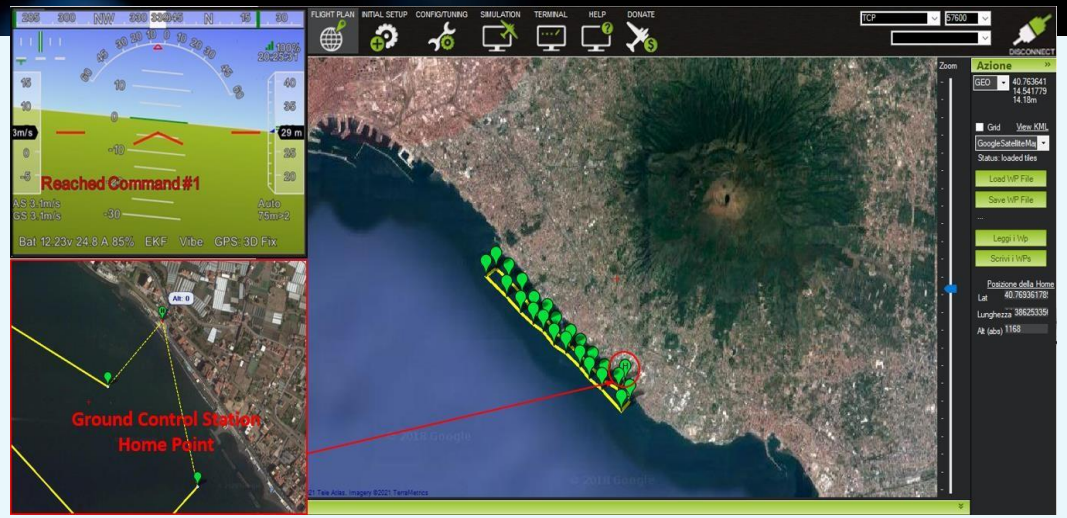
Experiment Consortium & Roles

PARTNER	PARTNER ROLE
greentech solution	Green Tech Solution s.r.l. (GTS) is a Start-up focused on the digital integration of ICT, AI and UV. Environmental service relies on AI controlling marine, terrestrial and flying UVs by intelligent algorithms.
UNIVERSITÀ DEGLI STUDI DI NAPOLI PARTHENOPE	University of Naples Parthenope is a public Italian university with a background in the science of navigation, maritime economy, computer science, computer vision, pattern recognition, flight and naval dynamics.
CINECA	CINECA is the largest Italian supercomputing centre with an HPC environment equipped with cutting-edge technology and highly-qualified personnel
bi-rex Big Data Innovation & Research Excellence	BI-REX is one of the 8 Italian Competence Centers with a specific focus on Big Data, innovation processes, and the adoption of enabling technologies, with a business perspective.

GST Approach

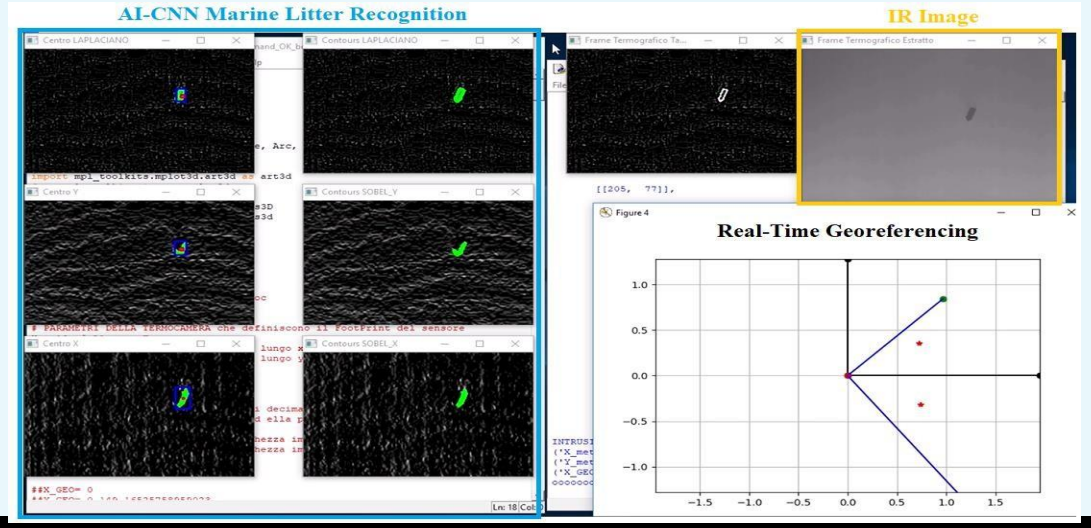
GTS-Approach

GTS has automated the collection of marine litter. The approach consists of real-time identification of floating plastic debris on the sea via unmanned vehicles that send GPS coordinates to an unmanned vessel, through a ground control station, which reaches and collects the plastic waste, without the intervention of the operators.



Operational Problem

The current algorithm provides an estimate of the debris speed and direction with a spatial and temporal accuracy of 20-30 meters and 3-5 minutes. This forces the flying UV to stay close to the debris before collection takes place and to check for any change in position.



HPC – Approach

The limited ability to predict the future position of the debris is limiting the efficiency of the entire system as the time and energy consumption of collection increases significantly.

The HPC experiment is fundamental to drive into the next phase the collaboration of the unmanned systems for:

- Marine Litter Recognition
- Marine Litter Path Prediction
- Marine Litter Recovery Strategy Optimization

It’s required >250.000 hours of deep learning which is impossible under conventional computational systems but possible thanks to CINECA.

Competitor

As per today, GTS has not found direct competitors and is the only UE company that uses collaborative Unmanned Vehicle (Uvs) to drive cleaning operation in sea in a cost effective, sustainable and scalable way. In the Litter Hunter operating on **the Amalfi coast GTS collected 250 kilograms of plastic detritus each day** from July to August 2019. Trough HPC we plan to triple the amount of kg of plastic.

KPI	Sweeping boats	buckets\booms	Air patrol services	GTS: UAV-USV
Recovery area	3 km^2	Passive device	8 km^2	6 km^2
Labours (persons)	Min 4	n.a.	Min 6	1 / 0
Recovery strategy	Random exploration with a 10m observation length	Visit at the location of the placement randomly organized	Recovery on hot spot where density of waste is high to justify costs	Optimized path to collect the selected waste
Litter classes	>2.5 cm	> 10 cm	> 50 cm	> 1 cm
Cost per Km	7.300€	12.000€	18.000€	3.000€
Environmental Impact	Exhaust Emission	Microbiological contamination	Exhaust Emission	Clean and Green

HPC Benefit & Results

Direct Benefit:

- Release of proprietary automation navigation software running in cloud
- Improved accuracy of neural network performance due to the increase in computational power and the consequent reduction in response times
- New IPRs (Patent on navigation, Industrial Design model, Utility Model, proprietary Software)
- A new Digital Platform for Marine Litter monitoring (https://www.marinelitter.it/ + https://digitalplatform.marinelitter.it/)
- Improving the company sustainability.

Expected Results:

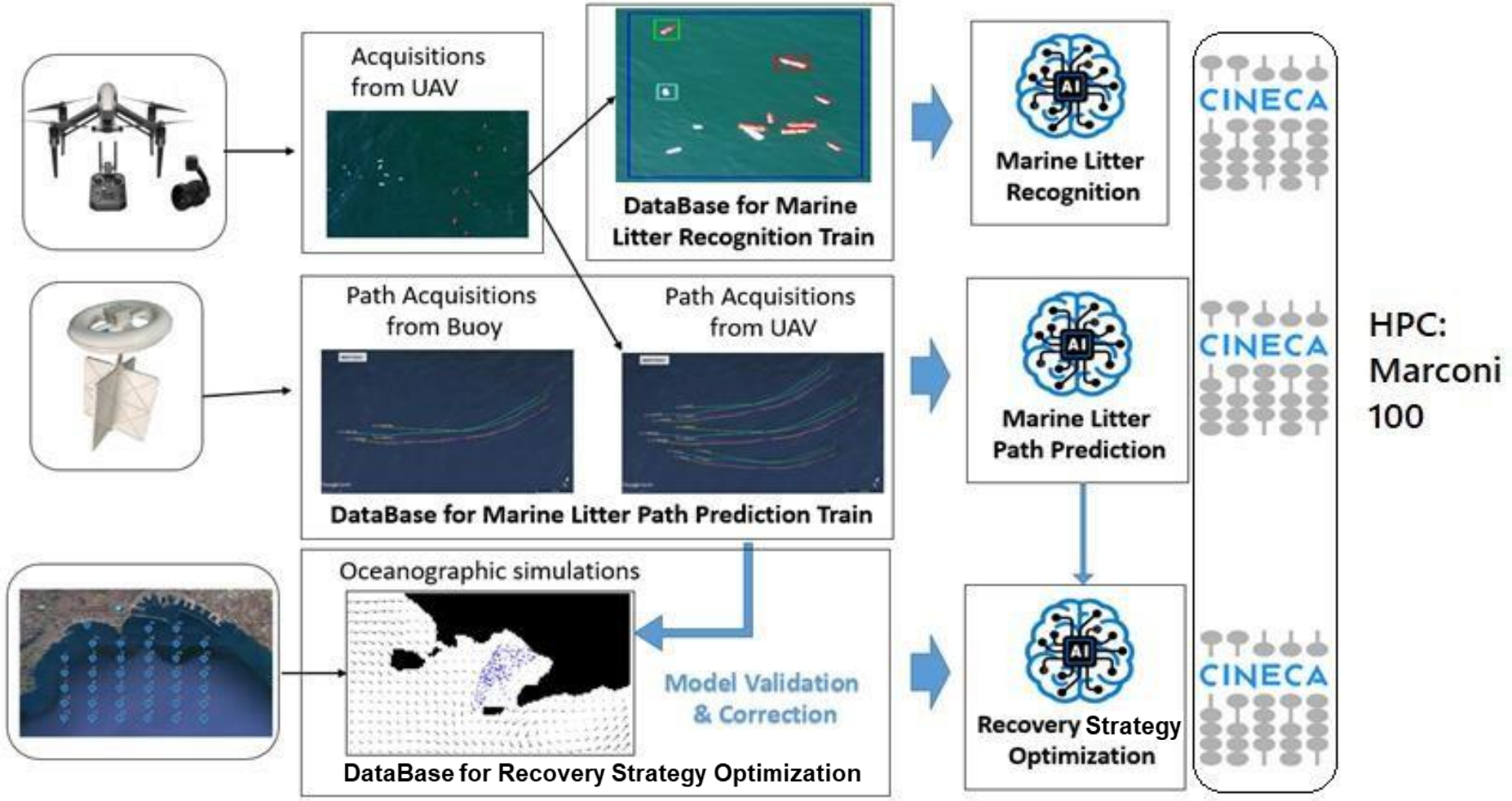
- Improved accuracy to forecast litter evolution in time and space over a wide area [h vs min & 10-km2 vs 0,3km2]
- Identify and classify marine litters in terms of dimensions and materials (PET, PPT, Biological)
- Predict the possible trajectories of classified waste over longer time
- A real-time tool for navigation optimization and mission planning able to reach
  - An estimated energy saving of 60% per km2 of monitoring operation
  - A reduction of 80% in time-to-planning, 50% in time-to-recovery and 40% in maintenance cost
  - A price for services of 2k €3k € per costal Km (Vs 7k € of competitor)
- Reaching 2.000 Km of UE coastline (Greece, Spain and Norway) in next 5-6 years

Sources of data: connecting small with big scale to reach higher accuracy and wider operation

This flow chart summarizes the **data acquisition** (Drone, Buoy and Oceanographic Simulations)

the consequent **processing** of the images and path dataset

the **training of the neural networks** of Recognition, Path Prediction and Recovery Strategy Optimization

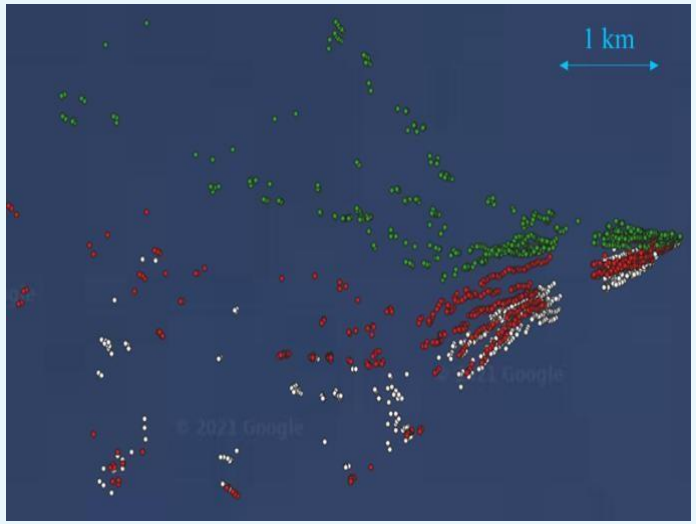


Task 1 [completed 100%]

Marine Litter Images

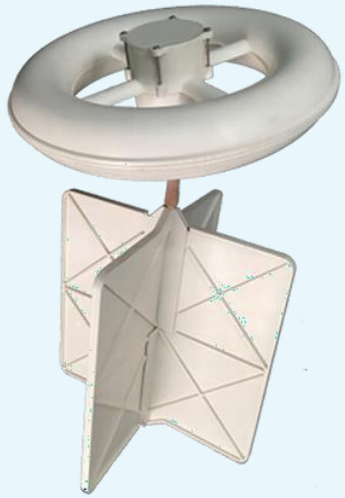
- 10’000 images acquired (4000x3000 px)
- 60 minutes of 4K resolution video acquired
- 70’000 frames of individual extracted objects

Marine Litter Path



- 540’000 frames extracted (1920x1080 px)
- 300 real trajectories sampled with at 1/2 Hz and a duration of 2 hours
- 50’000 coordinates of cluster of objects sampled at 1/10 Hz and with a duration of about 2 hours

Laser Drift Path

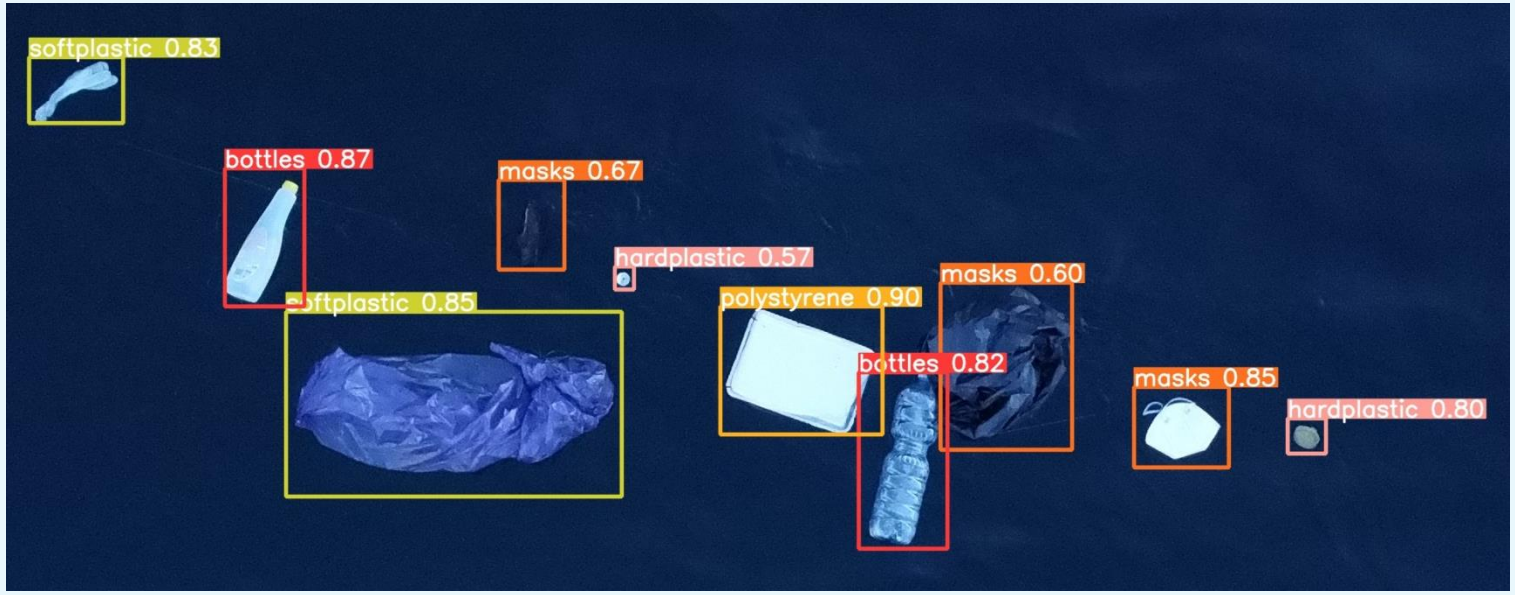


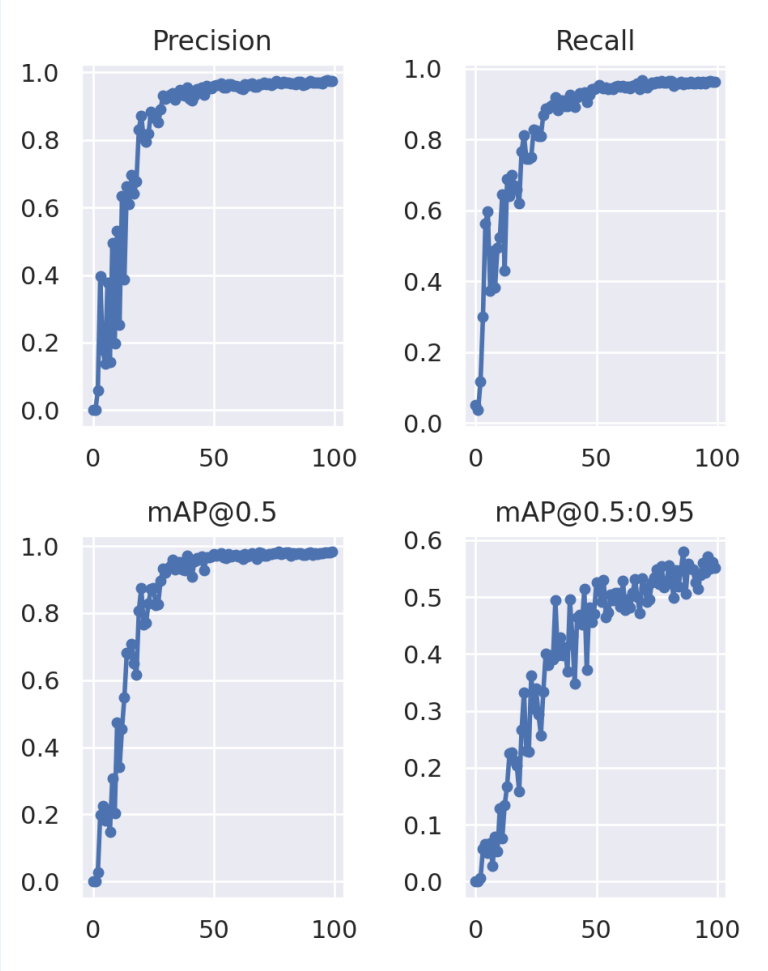
The laser drifts were positioned to form a square where the bottles were released. **Five days of acquisition** were performed. The set of data produced by the drift generates a **dataset with 4 traces of the device for the 5 days** of acquisition, equal to a total of 20 real traces of displacement of the Laser Drift.

Task 2 - Training and Validation Marine Litter Identification [completed 100%]

Main Achievement

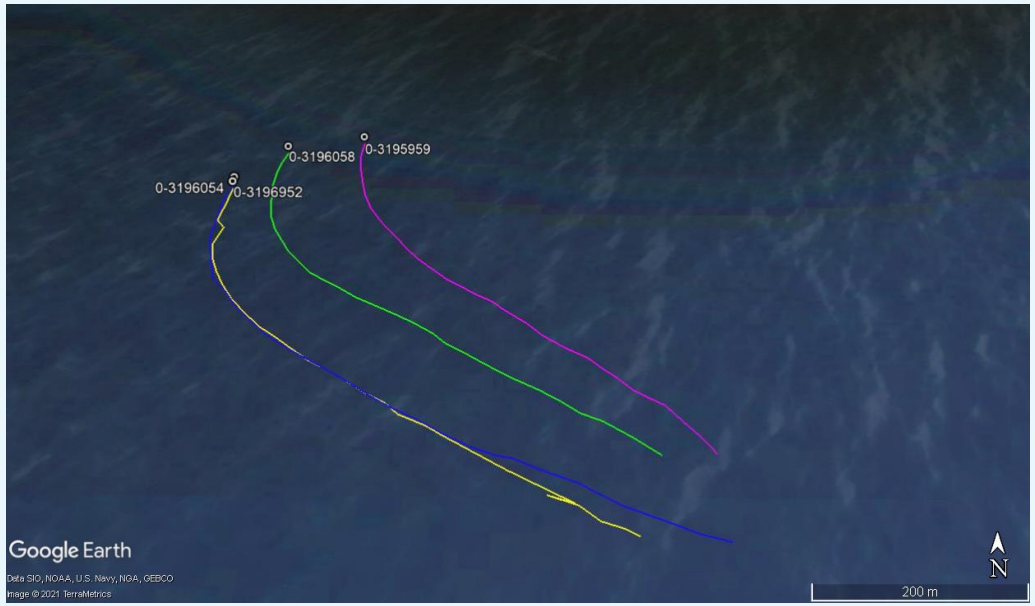
- Training of a neural network based on yolov5 model, for Marine Litter Identification. Training performed on Marconi100 cluster by Cineca
- This neural network can recognize 5 different classes of objects: hard plastics, soft plastics, bottles, masks and polystyrene, with over 90% total accuracy.

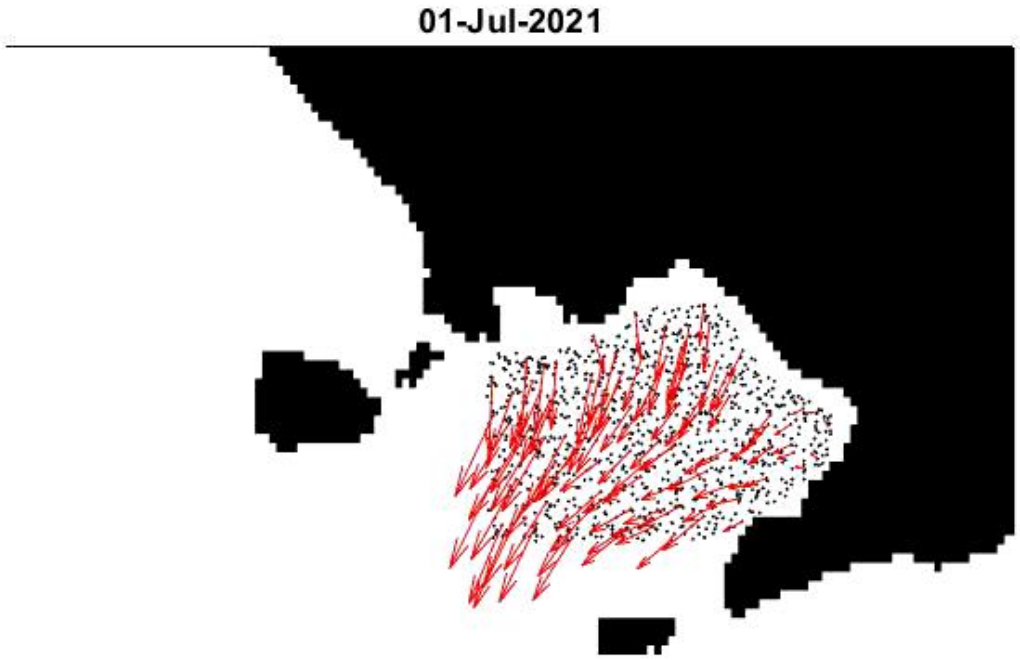




Task 2 - Oceanographic Model Simulation and Validation for Marine Litter transport [completed 100%]

60 simulations were performed from 01/07/2021 to 30/07/2021 and from 1/09/2021 to 29/09/2021. For each of them, virtually **10.000 passive tracers** were released in area that cover the entire Gulf of Naples. The simulation sampling rate is 1'.





Example simulation for 01/07/2021: In black the evolution of the passive tracers advected by the **CROM** simulated surface current field (red arrows).

Task 2 - Training and Validation for Marine Litter Path Prediction [completed 100%]

Main Achievement

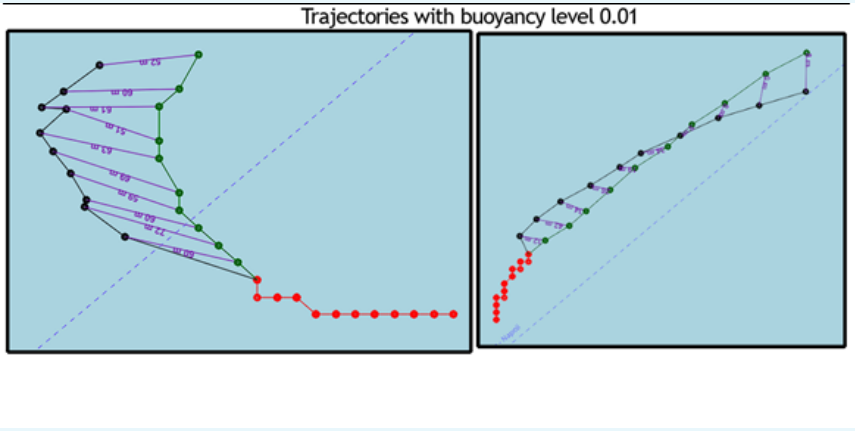
Simulated trajectories have been used in order to train the neural network and to produce floating path of marine litter, using known meteorological and morphological conditions.

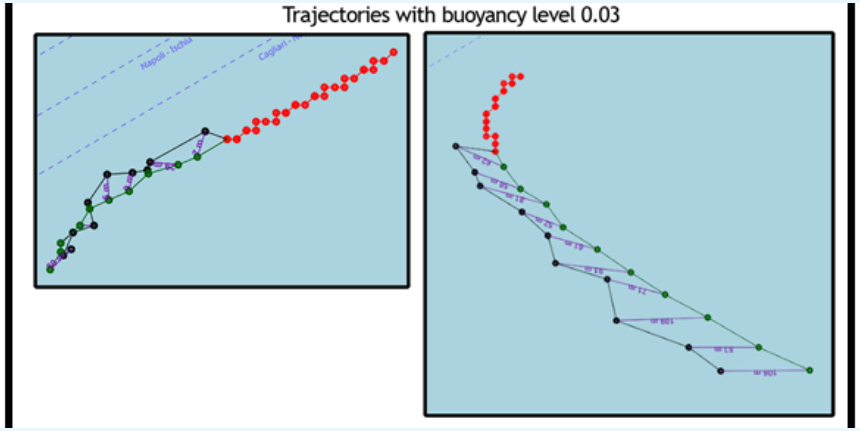
The training consists of:

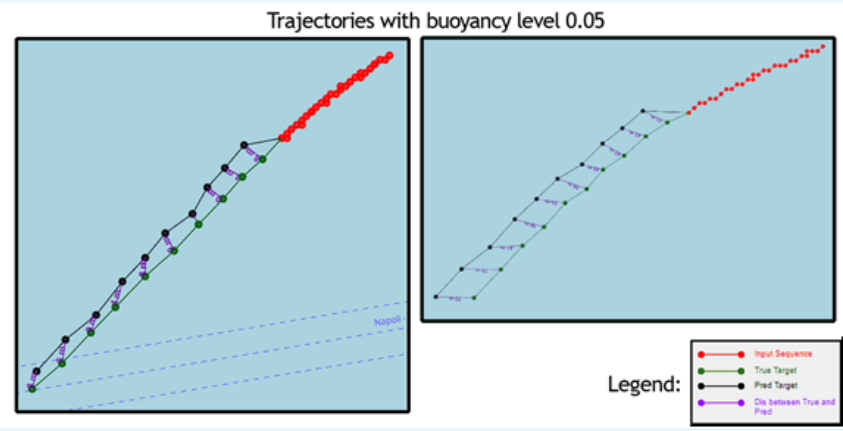
- Pre-processing the data to make it fit the model.
- Training in 10 epochs and 256 batch size
- Loss obtained on the test dataset: 9.0331e-06.

A running example with:

- 30 observed instants (red)
- 10 predicted samples (black)
- The difference with the true positions (green)







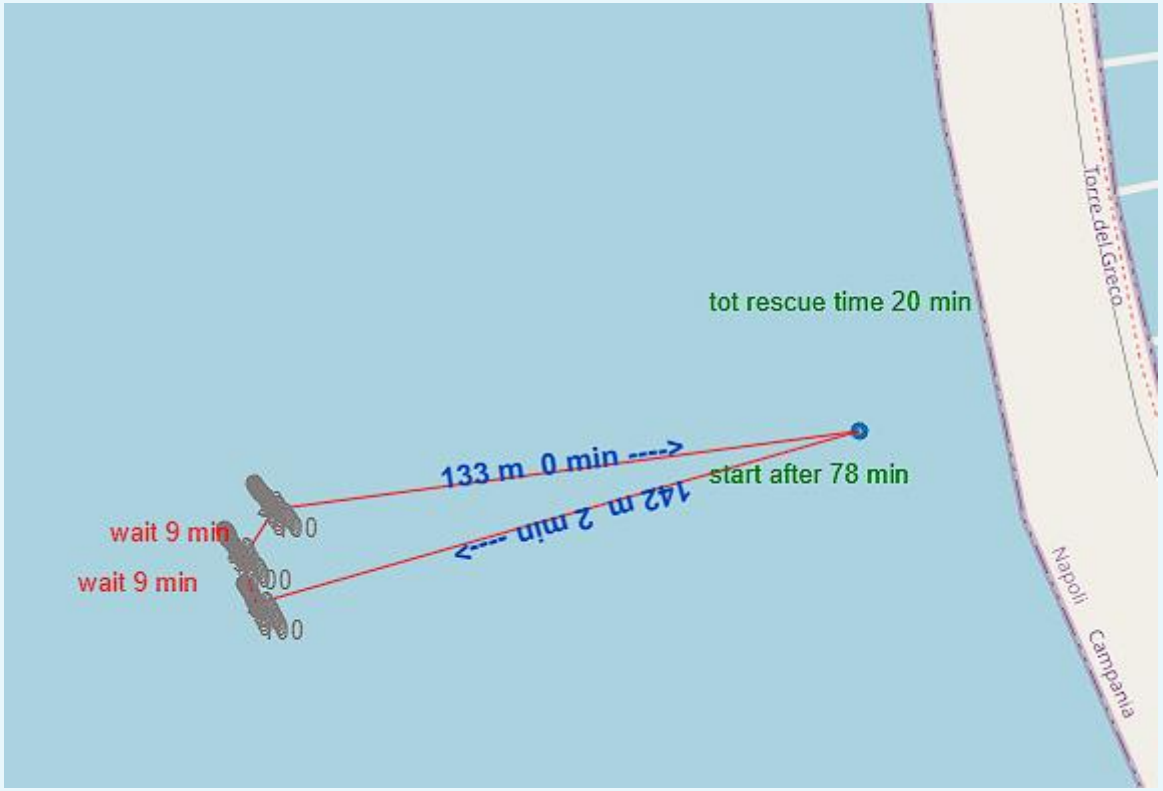
Task 3 - Training and Validation of Optimization strategy for the litter recovery [in progress 60%]

Main Achievement

Multi-objective genetic algorithm capable of minimizing distance covered and time spent by the USV to retrieve marine litter, while respecting the construction and performance limitations of the USV (cruise speed, max speed, battery life…).

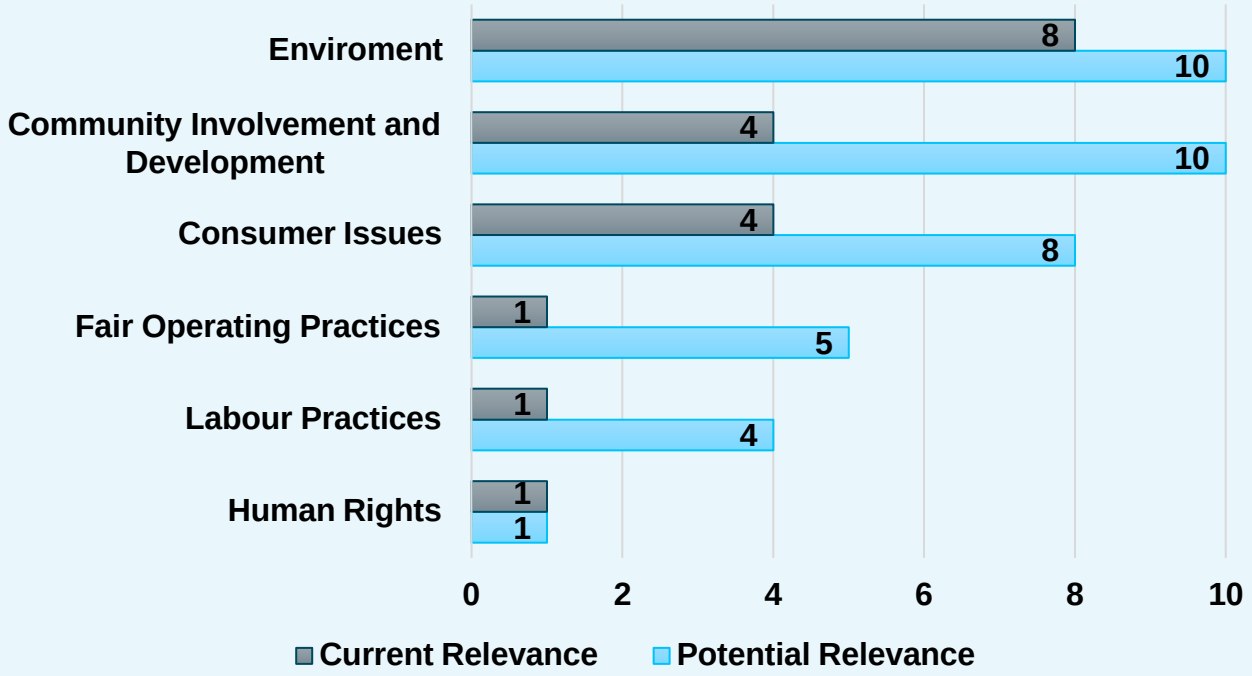
Next Steps

Furthermore, a validation campaign will be carried out on 5 demonstration sites in the "Campania Region" to verify the overall reliability of the software and reach TRL 8.



Task 4 - Business impact and risk analysis [completed 100%]

Sustainability assessment



The full potential of the aforementioned CSs can therefore be achieved through specific actions, some examples of which are indicated below:

1. Environment (+2):

Actions → Implement the indicated KPIs relating to the potential of positive impact on the environment of the project.

2. Community involvement and development (+6):

Actions → Development of initiatives that raise awareness in local communities the adoption of the LITTER HUNTER system as sponsorships, social initiatives, investments in R&D with the help of the academic world.

3.Specific aspects relating to consumers / customers(+4):

Actions → Development of initiatives that raise citizens' awareness of solution of the LITTER HUNTER system such as initiatives in schools/volunteer work.

Task 4 – Advanced Business Plan and go-to-market strategy [completed 100%]

It will allow the company to reach foreign clients in a mid term, giving the company an adequate production capacity

25

N° of Boats + Drones In 3Ys

It will allow the company to generate the right awareness about the service provided

200K€

MARKETING EXPENSES In 5Ys

The Business Plan at a glance

	y1 hpc	y2 hpc	y3 hpc	y4 hpc	y5 hpc	
markup	20%	25%	30%	30%	30%	
fleet drone+boat (n)	5	10	25	25	25	
		5	*15*			
pack 1 (D+N+P) month	1	4	8	10	16	
pack 2 (N+D) month	2	5	8	30	56	
pack 3 (N) month	2	6	10	8	5	
pack 4 (D+N) half year	0	1	4	6	8	
potential days for litter gathering	100	420	1000	1680	2500	
eq. Working months	5	21	50	84	125	
pot. Unique clients	5	10	20	31	45	
	y1 hpc	y2 hpc	y3 hpc	y4 hpc	y5 hpc	
TURNOVER	171 000.00 €	702 375.00 €	1 641 900.00 €	2 914 080.00 €	4 580 550.00 €	
TOTAL COSTS FOR THE FLEET	140 300.00 €	140 300.00 €	420 900.00 €			
Marketing and web marketing	60 000.00 €	40 000.00 €	20 000.00 €	30 000.00 €	50 000.00 €	200 000.00 €
TOTAL COSTS FOR mktg+amm+gen exp	96 900.00 €	72 000.00 €	77 000.00 €	148 000.00 €	200 000.00 €	
COSTS FOR EXTERNAL COLLAB		48 000.00 €	72 000.00 €	96 000.00 €	144 000.00 €	
COSTS FOR DIR EMPLOYEES	3 800.00 €	112 500.00 €	225 000.00 €	375 000.00 €	562 500.00 €	
FLEET MANAG OP COST	65 250.00 €	231 050.00 €	532 500.00 €	836 200.00 €	1 256 250.00 €	
TOT COSTS	306 250.00 €	603 850.00 €	1 327 400.00 €	1 455 200.00 €	2 162 750.00 €	
OP MARG	-275 550.00 €	-41 775.00 €	-106 400.00 €	1 458 880.00 €	2 417 800.00 €	53%
CAPITAL EXP	-423 725.00 €					

It will allow to boost up the revenue stream and increase the gross operating margin

Foreign clients

reached in 3Ys

HPC Tech is the key factor to succeed:
+ 50% of potential Turnover
- 40% of maintenance costs

Use of **HPC Technology**

General Challenges and Next Steps

Use of **new oceanographic models'** representative of different scales of phenomenology	→	**Create the right logic for mixing** large-scale models (km) with small-scale ones (m)
Increase the number of floating objects recoverable from the USV	→	**Decrease the sampling of the points of the trajectories predicted** by the neural network to 2-5 mins.
Obtain local meteorological data by analyzing the drone flight data.	→	**Improvement of datasets for path prediction**, in particular of oceanographic simulations
Sizing of objects detected by images	→	▪ **Use of measurement algorithms** based on acquisition inputs (height,footprint,resolution) ▪ **Determination of the buoyancy level** on the basis of the size of the objects and detection of the emerged part
Neural network training for the identification of **a greater number of object classes**	→	**Improvement of datasets for path prediction** in function of object type.
Neural network training for the path prediction of **a greater number of floating object**	→	**Optimization of the control of the catamaran** based on meteorological and oceanographic data

FF4EuroHPC - HPC Litter Hunter

Thank you

This project has received funding from the European High-Performance Computing Joint Undertaking Joint Undertaking (JU) under grant agreement No 951745. The JU receives support from the European Union's Horizon 2020 research and innovation programme and Germany, Italy, Slovenia, France, Spain.

The Problem

Protecting seas and oceans against the litter is becoming a global concern and there is a growing need worldwide for more efficient, clean and **autonomous technologies to identify and collect marine detritus**, especially plastics, in a systematic and repetitive way.

The HPC Litter Hunter project aims to use the computational power of HPC to address a computational problem that GTS encountered during the plastic waste recovery service at sea:

optimize the plastic waste recovery strategy by predicting the position of hundreds of debris floating in the sea with adequate accuracy in space and time and provide optimized sea path to collect litter in a more sustainable and scalable way

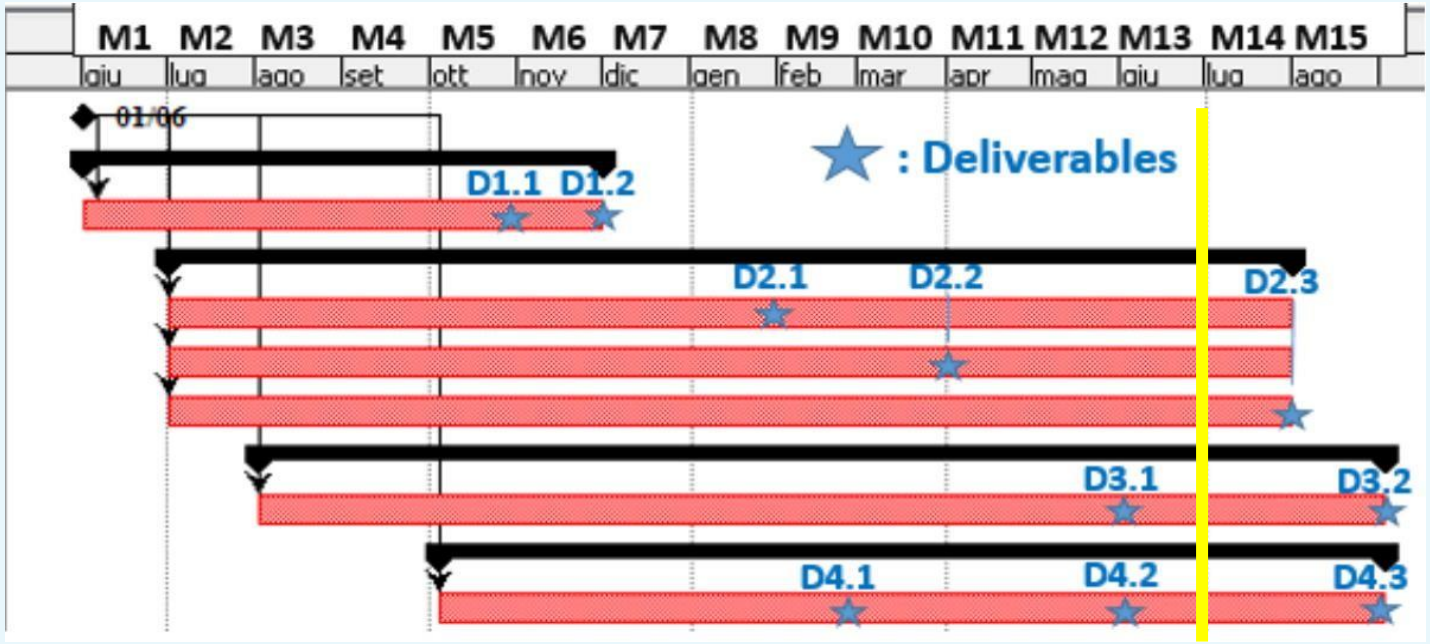
Current Status

Task 1 Drone Data Gathering [completed 100%]:

- ✓ DataBase formation:
  - Drone acquisition (Object detection; Path Prediction)
  - Laser Drifts Buoy (Path Prediction)

Task 2 HPC Training Deep Learning [completed 100%]:

- ✓ Training of a neural network for object detection with a precision of over 90%
- ✓ Oceanographic Simulation dataset
- ✓ Training of a neural network for Path Prediction, providing 100 minutes of prediction, with 60 minutes of observation



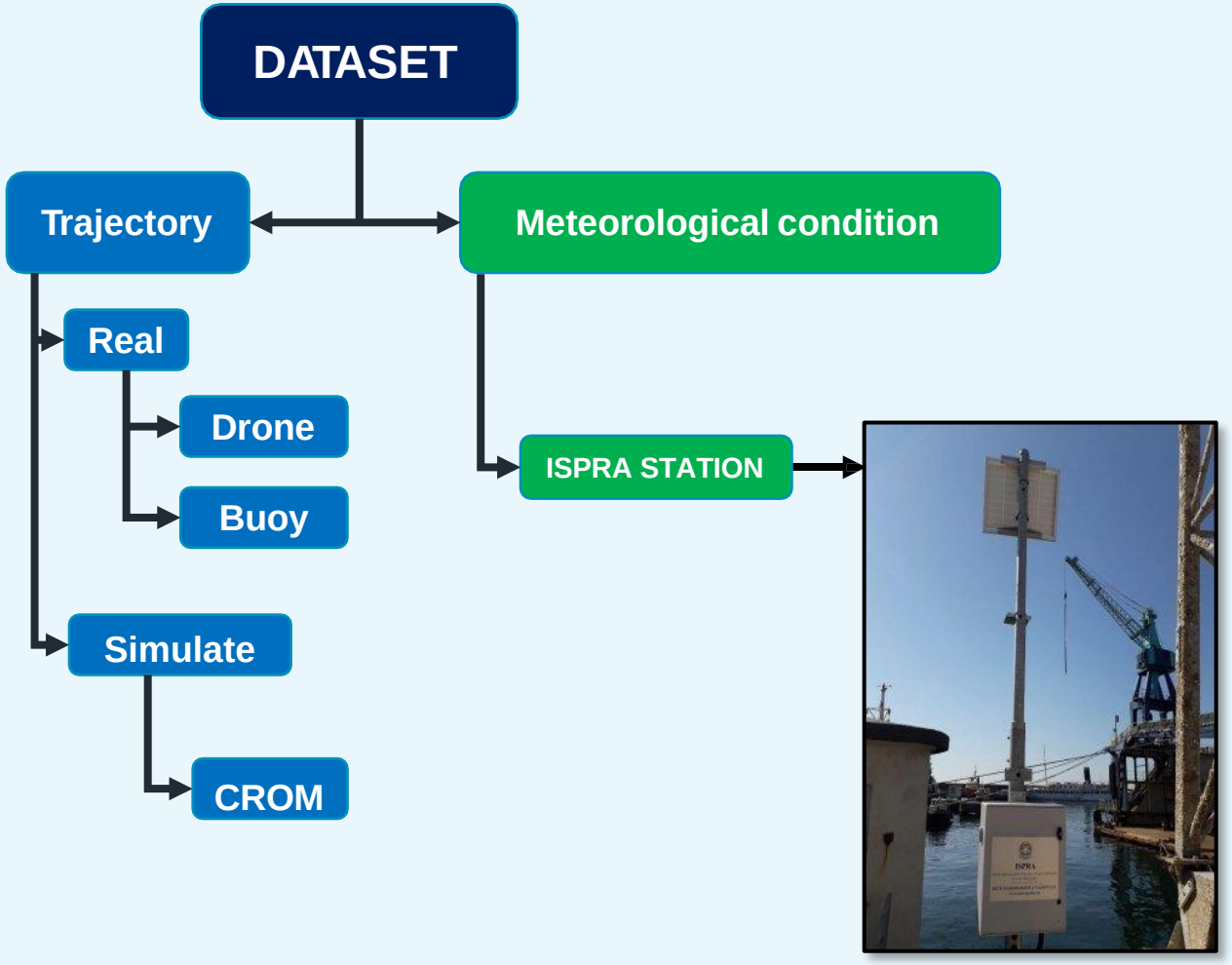
Task 3 - HPC Recovery strategy optimization: [in progress 70%]

- ✓ Dataset for recovery optimization strategy
- ✓ Multi-objective algorithm for recovery optimization strategy
- × Demonstration of recovery optimization strategy in 5 sites

Task 4 - Business impact and risk analysis: [in progress 75%]

- ✓Sustainability assessment
- ✓ Advanced Business Plan and go-to-market
- × Strategy Confidential final Deliverable for public success story:

The ISPRA Station



Meteorological and Marine Parameters

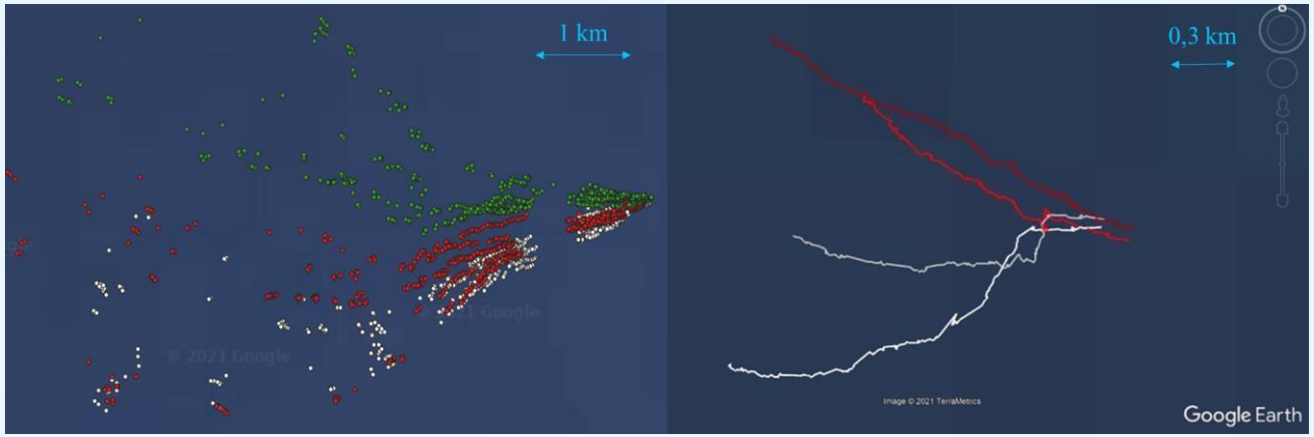
Parameter	Abbreviation	Sampling rate	Instrument	Measurement unit
Hydrometric Level	LI	1/10 min	Piezometric level transducer	m
Water Temperature	TH20	1/10 h	Water temperature transducer	°C
Air Temperature	TA	1/10 h	Air temperature transducer	°C
Relative Humidity	RH	1/10 h	RH%	%
Atmospheric Pressure	PA	1/10 h	Barometric sensor	hPa
Wind Direction	DV	1/10 min	Ultrasonic sensors for wind direction	°N
Wind Speed	VV	1/10 min	Ultrasonic sensors for wind speed	m/s

Task 1 - Drone Data Gathering [completed 100%]

Marine Litter Image

- 10’000 images acquired (4000x3000 px)
- 60 minutes of 4K resolution video acquired
- 70’000 frames of individual extracted objects

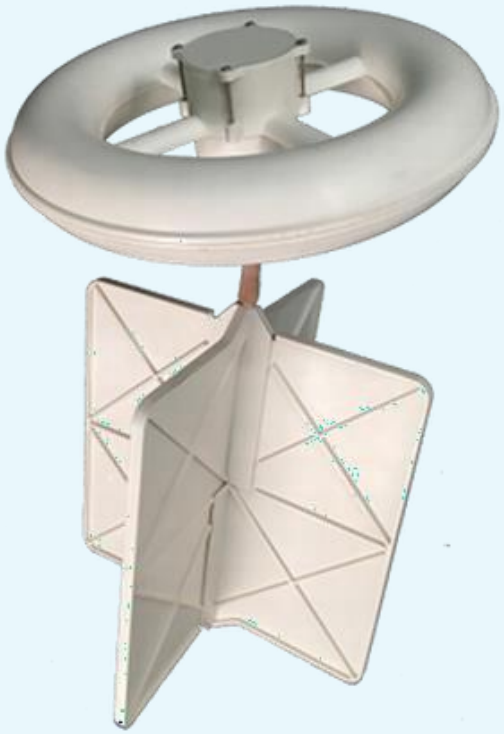
Marine Litter Path



- 540’000 frames extracted (1920x1080 px)
- 300 real trajectories sampled with at 1/2 Hz and a duration of 2 hours
- 50’000 coordinates of cluster of objects sampled at 1/10 Hz and with a duration of about 2 hours

Task 1 – Heterogeneous Dataset (Buoy) [completed 100%]

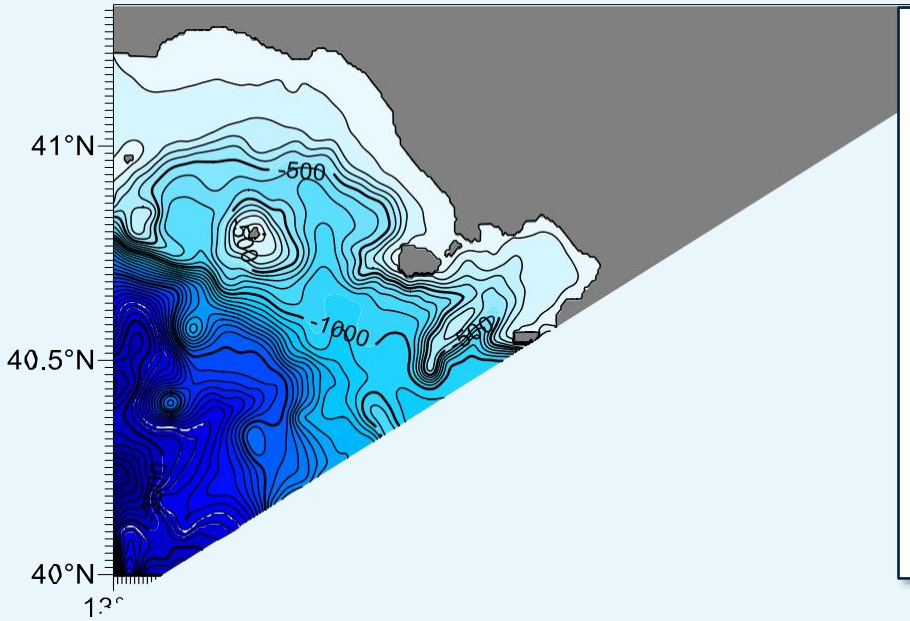
The laser drifts were positioned to form a square where the bottles were released. **Five days of acquisition** were performed. The set of data produced by the drift generates a **dataset with 4 traces of the device for the 5 days** of acquisition, equal to a total of 20 real traces of displacement of the Laser Drift.



Task 1 - Dataset heterogeneous creation (Buoy) [completed 100%]

Task 2 - Oceanographic Model Simulation and Validation for Marine Litter transport

The CROM model



Spatial resolution
1/144° ($\approx 700\ m$)

Surface forcing
Wrf CCMMMA 3 km momentum fluxes through standard bulk formulae

Initial and lateral boundary conditions
One-way nesting with NEMO OPA(1/16°)

De Ruggiero et al. 2016 - Parthenope **DIST**

+

Lagrangian particle-tracking model

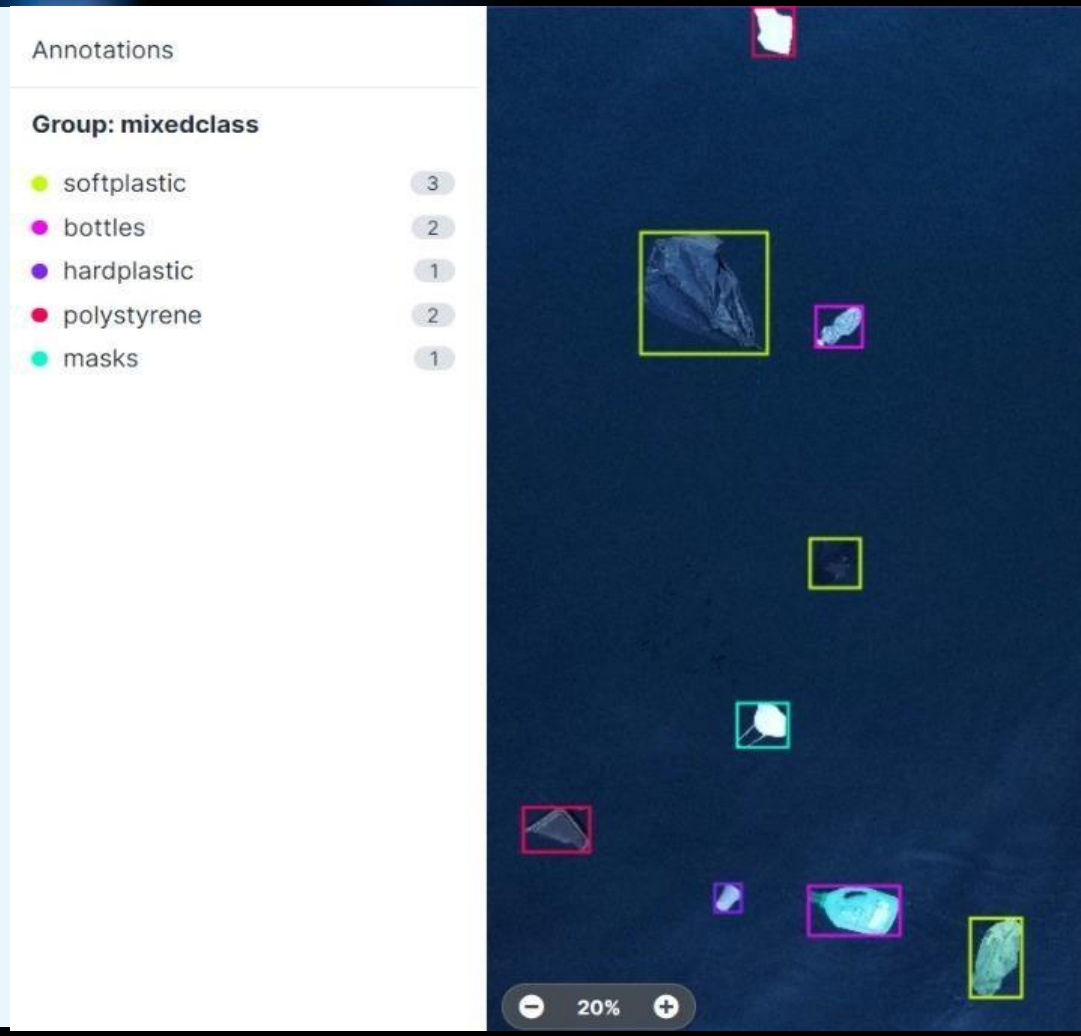
The algorithm adopted is **TRACE** designed by Jarle Berntsen

$$X_p^{n+1} = X_p^n + u_p^n \mathrm{Dt}$$

$$Y_p^{n+1} = Y_p^n + v_p^n \mathrm{Dt}$$

Task 2 - Training and Validation Marine Litter Identification [completed 100%]

- All the objects of each image acquired in Task 1 are labeled using dedicated software, dividing them into different classes: bottles, polystyrene, masks, soft plastics and hard plastics
- The neural network is trained by providing the labeled dataset to the accelerated cluster Marconi100 made available by CINECA.



Task 4 - Litter Hunter Stakeholders

This slide shows 3 Essential and 3 Useful Stakeholders.

Main Objective:

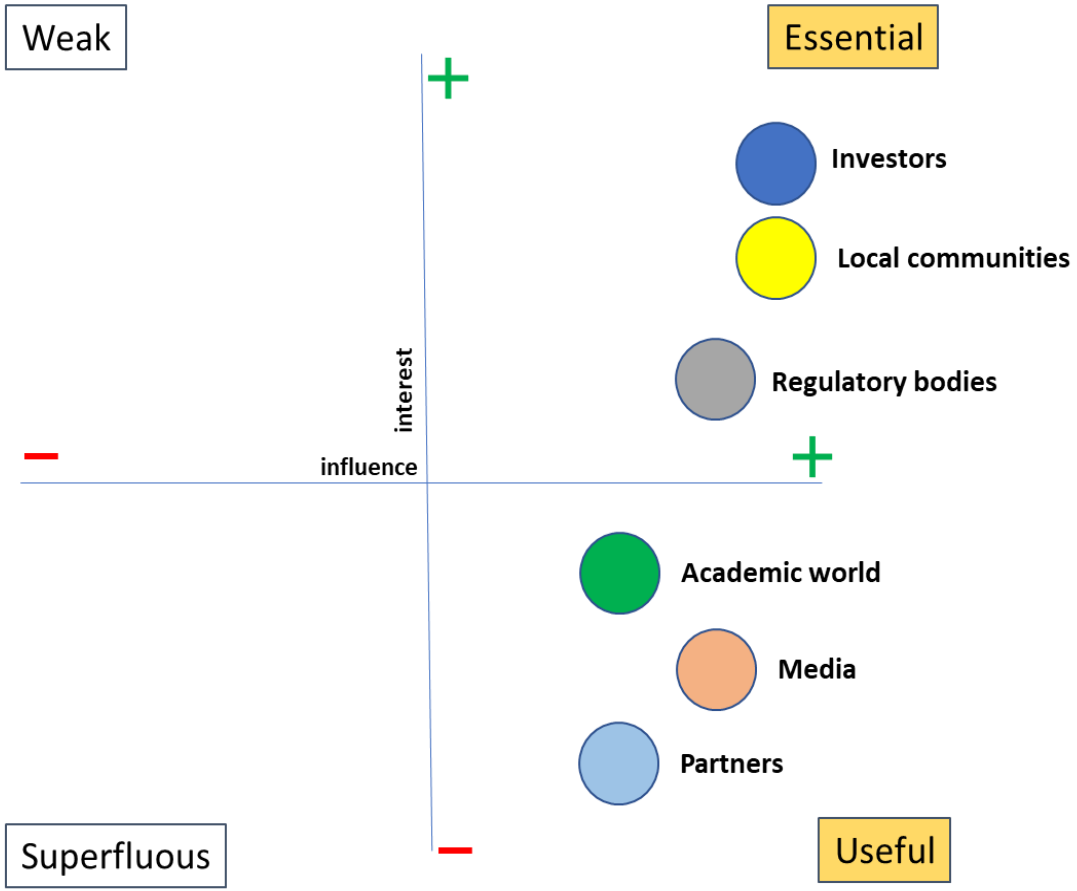
I. Consolidate relations with Investors, Local Communities, and Supervisory Bodies.

II. Activate collaborations both with the academic world and in the private sphere (Partner) and implement a Communication System (especially through Social Media) that allows the project to constantly illustrate the results achieved.

Investors
- Responsibility: +++++
- Influence: +++++
- Representation: +++
- Proximity/proximity: +++++
- Dependence: ++

Local Communities
- Responsibility: +++
- Influence: +++++
- Representation: ++
- Proximity/proximity: +++++
- Dependence: ++

Regulatory bodies
- Responsibility: +++++
- Influence: ++++
- Representation: +
- Proximity/proximity: +
- Dependence: ++

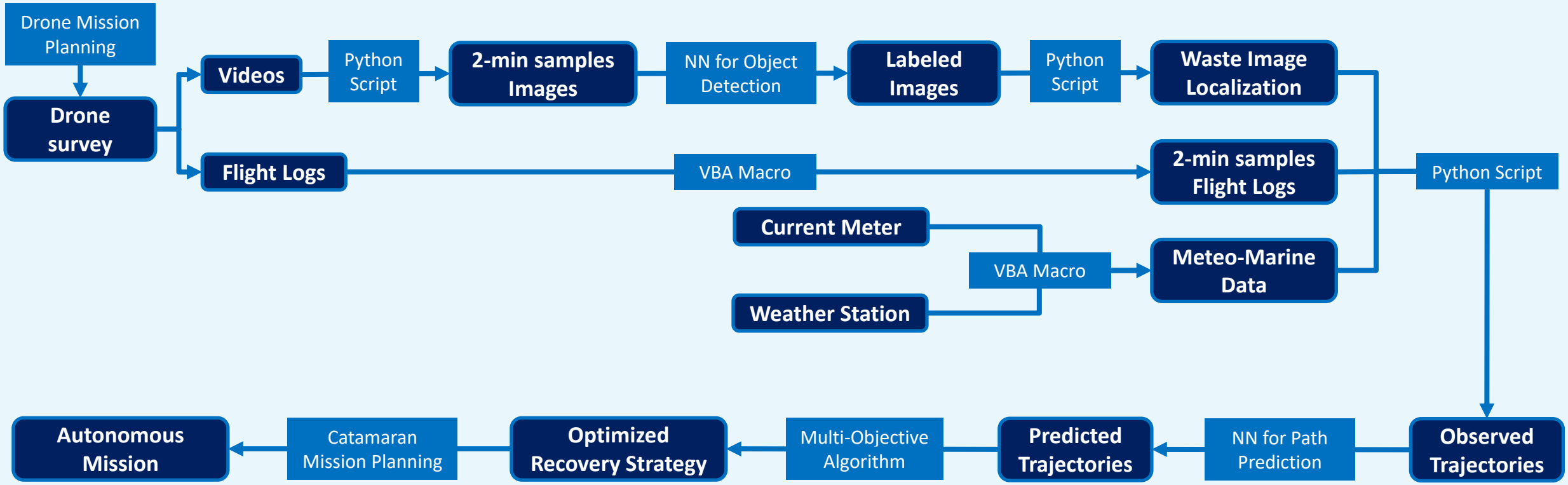


Academic world
- Responsibility: +
- Influence: +++
- Representation: +
- Proximity/proximity: +++
- Dependence: ++

Media
- Responsibility: +
- Influence: ++++
- Representation: +
- Proximity/proximity: +++
- Dependence: ++

Partners
- Responsibility: +++
- Influence: +++
- Representation: +
- Proximity/proximity: +++
- Dependence: +++++

Computational Pipeline



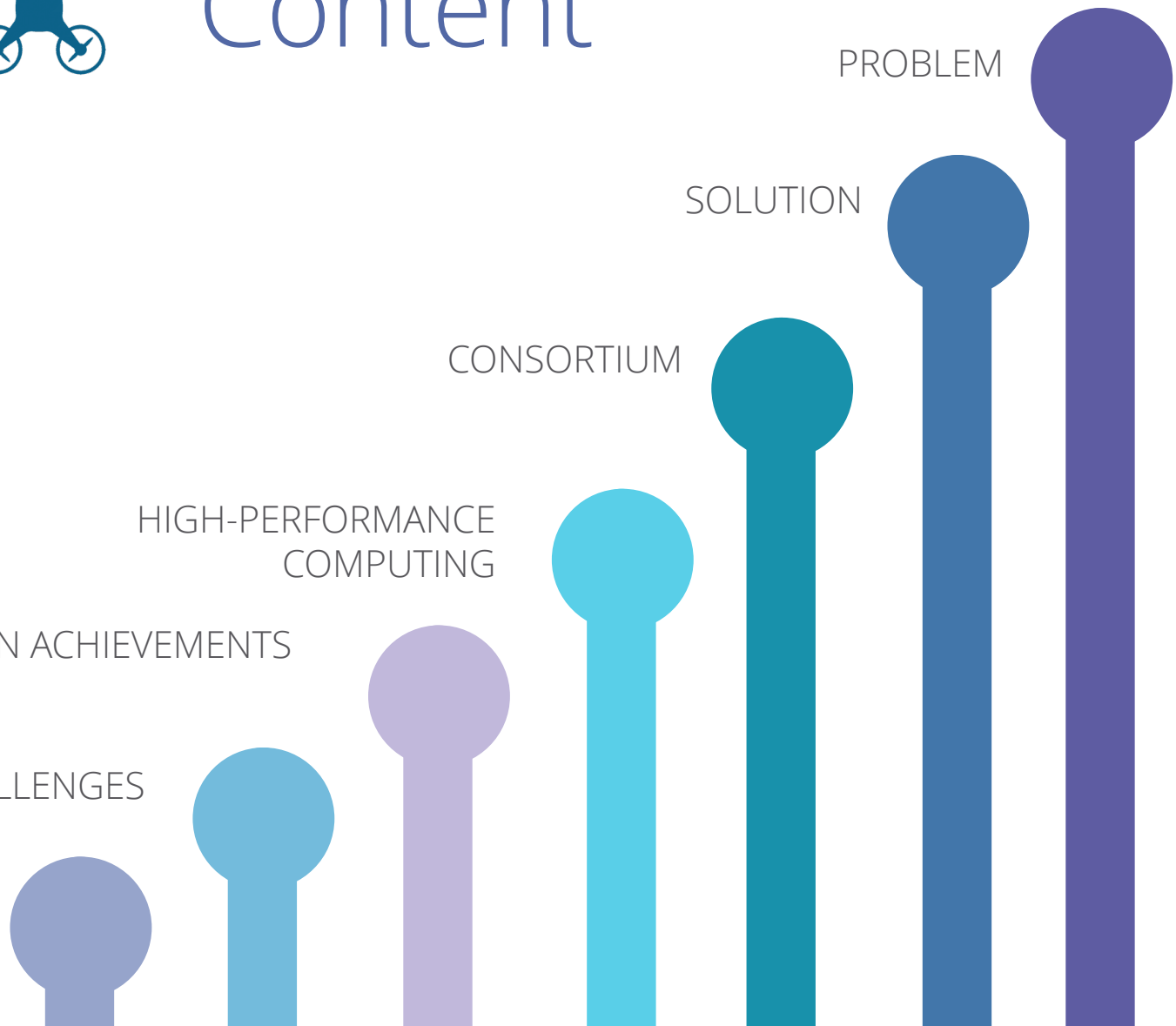
FF4EUROHPC CONNECTS BUSINESS WITH CUTTING-EDGE TECHNOLOGIES

HERCULES

HIGH-PERFORMANCE COMPUTING FOR HIGH-VALUE WEATHER FORECAST

Jose Luis Muñoz Gamarra
jlmunoz@aslogic.es

Content


PROBLEM
SOLUTION
CONSORTIUM
HIGH-PERFORMANCE COMPUTING
MAIN ACHIEVEMENTS
CHALLENGES
NEXT STEPS

PROBLEM

Weather information in ATM

METAR/TAF Reports

Cuatro Vientos Airport

Madrid-Cuatro Vientos, Spain

latitude: 40-23N, longitude: 003-47W, elevation: 690 m

Current weather observation

The report was made **17** minutes ago, at **08:30** UTC

Wind **1** kt from variable directions

Temperature **11**°C

Humidity **76%**

Pressure **1027** hPa

Visibility 10 km or more

no clouds below 1500 m and no cumulonimbus

Change units

Time: 09:47 (08:47 UTC)

Forecast

The report was made **3** hours and **47** minutes ago, at **05:00** UTC

Forecast valid from 11 at 06 UTC to 12 at 06 UTC

Wind **4** kt from variable directions

Visibility 10 km or more

no clouds below 1500 m and no cumulonimbus

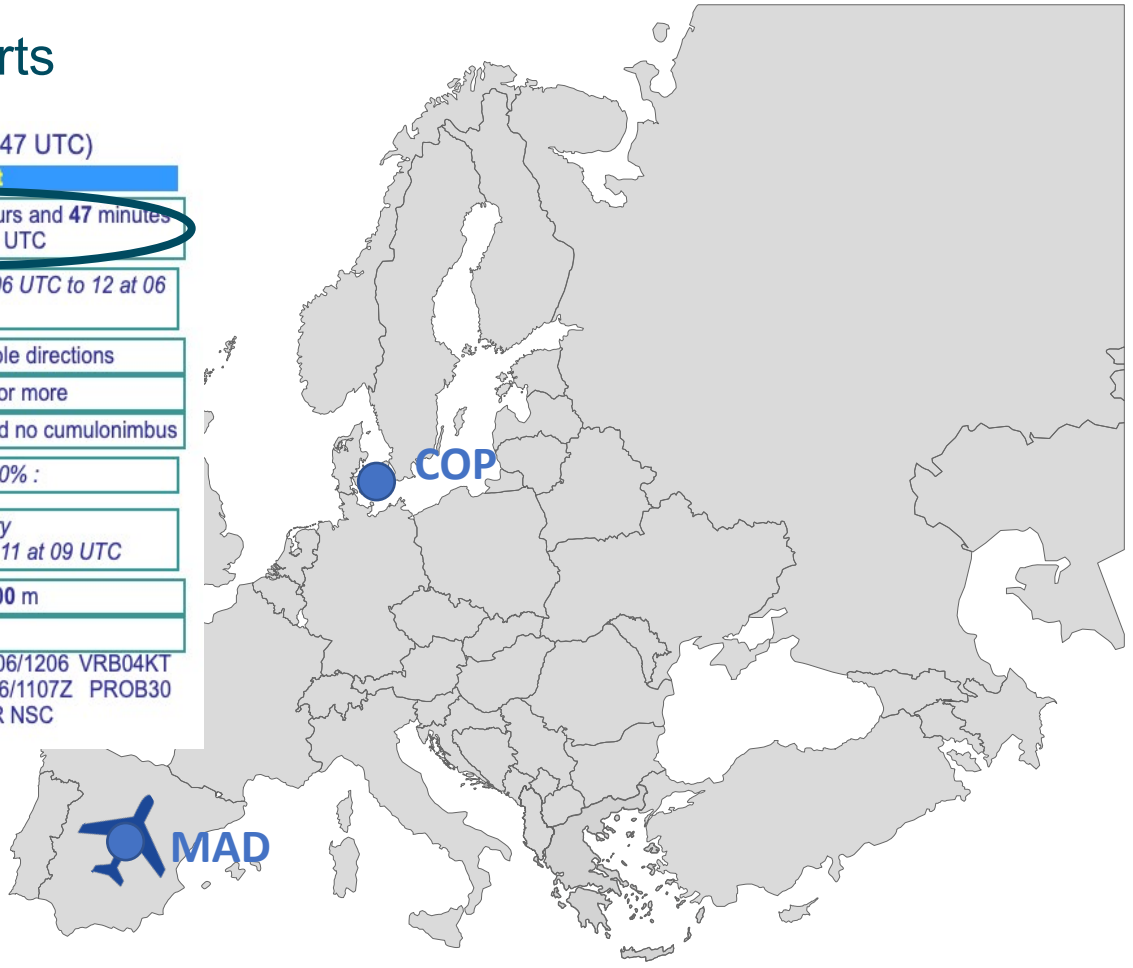
Probability 30% :

Temporary from 11 at 06 UTC to 11 at 09 UTC

Visibility: **3000** m

mist

TAF: LEVS 110500Z 1106/1206 VRB04KT CAVOK TX18/1115Z TN06/1107Z PROB30 TEMPO 1106/1109 3000 BR NSC



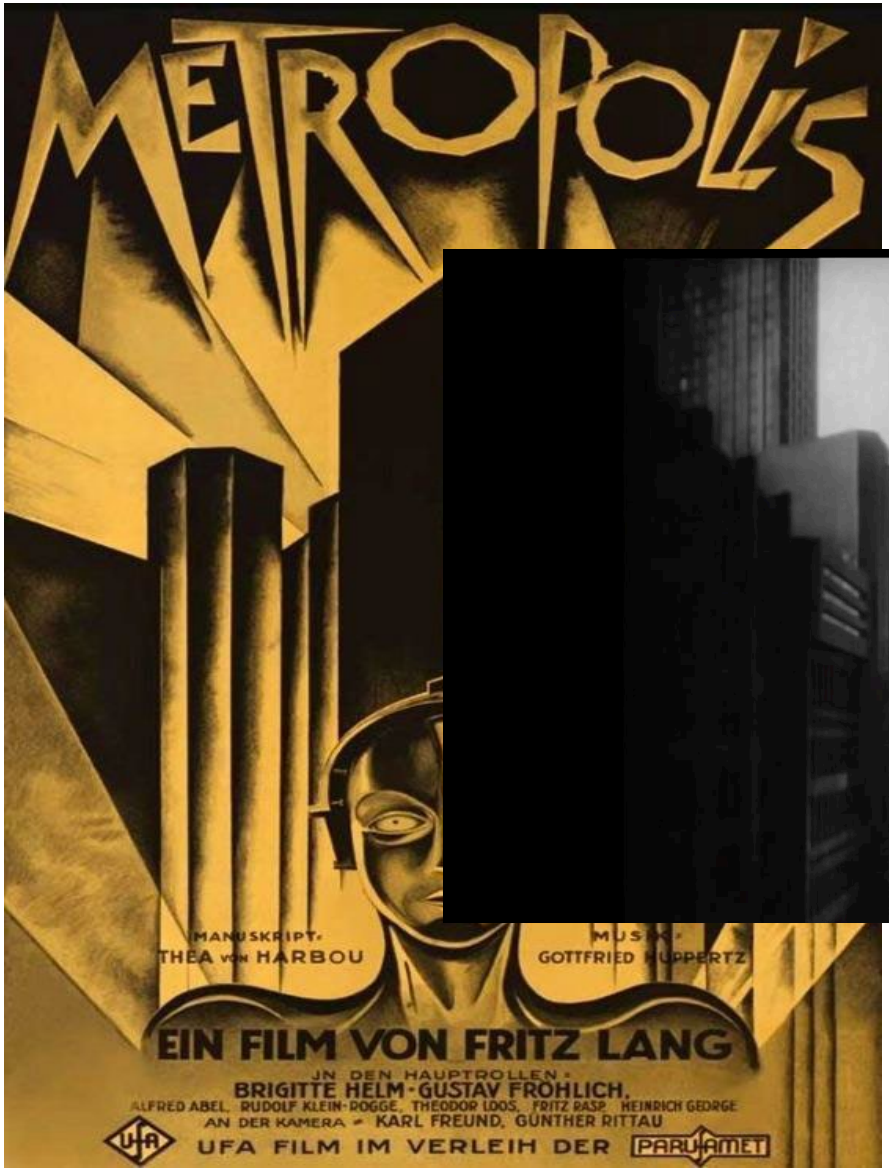

D-MDVC

PROBLEM

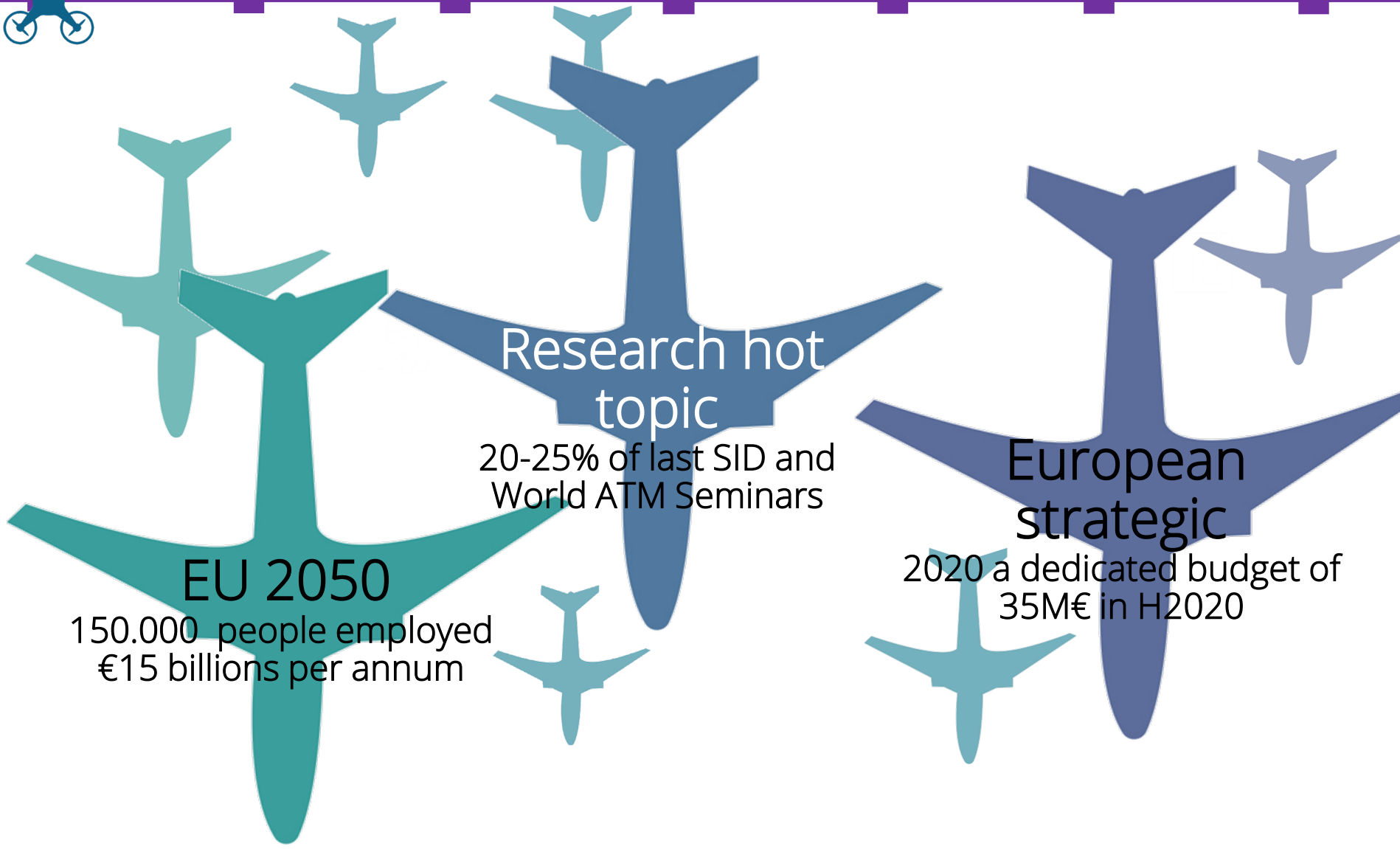
New airspace users New needs

- Origin destination are not fixed so we cannot rely on expensive ground infrastructure.
- No air traffic controllers.
- We need a higher spatial resolution, horizontally and vertically.
- Weather forecast need to be updated more frequently.

PROBLEM


METROPOLIS
MANUSKRIPT·
THEA von HARBOU
MUSIK·
GOTTFRIED HUPPERTZ
EIN FILM VON FRITZ LANG
IN DEN HAUPTROLLEN·
BRIGITTE HELM·GUSTAV FRÖHLICH.
ALFRED ABEL, RUDOLF KLEIN-ROGGE, THEODOR LOOS, FRITZ RASP, HEINRICH GEORGE
AN DER KAMERA · KARL FREUND, GÜNTHER RITTAU
UFA FILM IM VERLEIH DER PARUFAMET

PROBLEM



EU 2050

150.000 people employed
€15 billions per annum

Research hot topic

20-25% of last SID and World ATM Seminars

European strategic

2020 a dedicated budget of 35M€ in H2020

SOLUTION

Development of a sensorized drone for atmospheric characterization

Development of WRF model for low altitude forecast with high spatial resolution

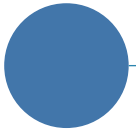
Development of U-space services to provide weather services

CONSORTIUM

Unmanned vehicles service provider

developer of Decision Support systems for aeronautics

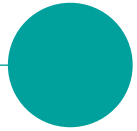
aslogic

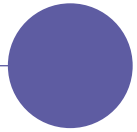


universidad de león

Advanced Meteorological models

Meso-model based on WRF





CESGA
Centro de Supercomputación de Galicia

High-Performance Computing Center

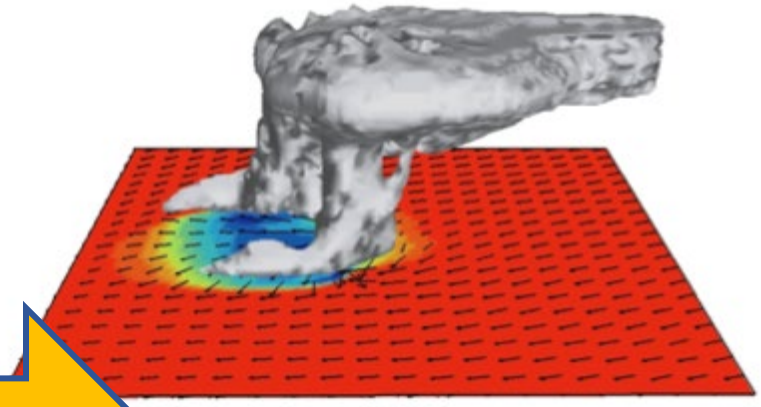
Providing Super Computer capabilities

High-Performance Computing

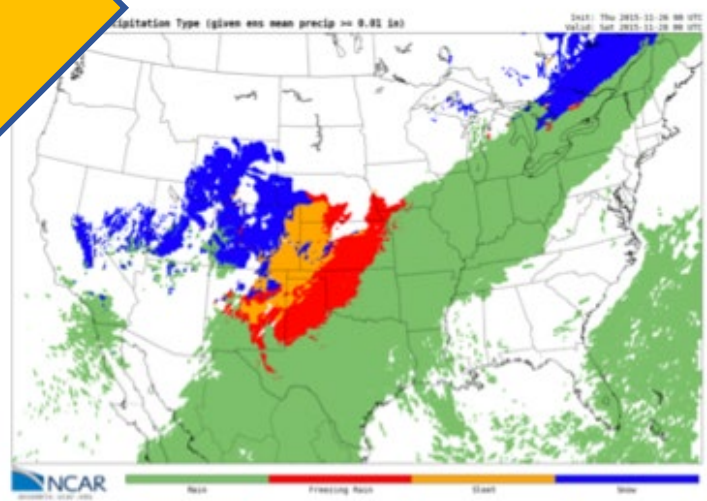
NWP

Numerical Weather Prediction method

Weather Research and Forecasting Model



Idealized Simulations



Experimental real-time forecast

NCAR

High-Performance Computing

$$p = \rho R_d T; \qquad \text{Equation of state}$$

$$\frac{\partial \rho}{\partial t} + \frac{\partial U}{\partial x} + \frac{\partial V}{\partial y} + \frac{\partial W}{\partial z} = 0; \qquad \text{Conservation of mass}$$

$$\frac{\partial U}{\partial t} + c_p \Theta \frac{\partial \pi}{\partial x} = -\frac{\partial Uu}{\partial x} - \frac{\partial Vu}{\partial y} - \frac{\partial Wu}{\partial z} + F_x,$$

$$\frac{\partial V}{\partial t} + c_p \Theta \frac{\partial \pi}{\partial y} = -\frac{\partial Uv}{\partial x} - \frac{\partial Vv}{\partial y} - \frac{\partial Wv}{\partial z} + F_y,$$

$$\frac{\partial W}{\partial t} + c_p \Theta \frac{\partial \pi}{\partial z} + g\rho = -\frac{\partial Uw}{\partial x} - \frac{\partial Vw}{\partial y} - \frac{\partial Ww}{\partial z} + F_z;$$

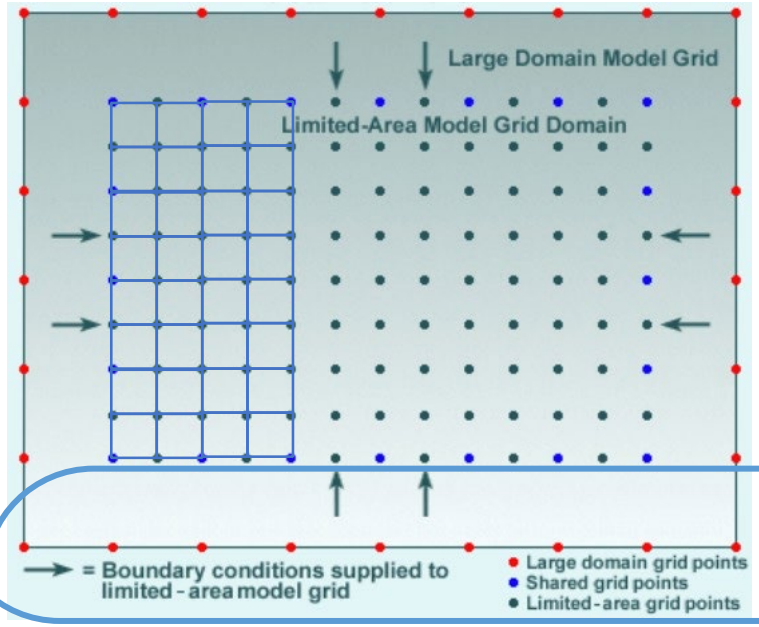
Numerical methods are required!

$$\frac{\partial \Theta}{\partial t} + \frac{\partial U\theta}{\partial x} + \frac{\partial V\theta}{\partial y} + \frac{\partial W\theta}{\partial z} = \rho Q. \qquad \text{Conservation of energy}$$

$$U = \rho u, \quad V = \rho v, \quad W = \rho w, \quad \Theta = \rho \theta,$$

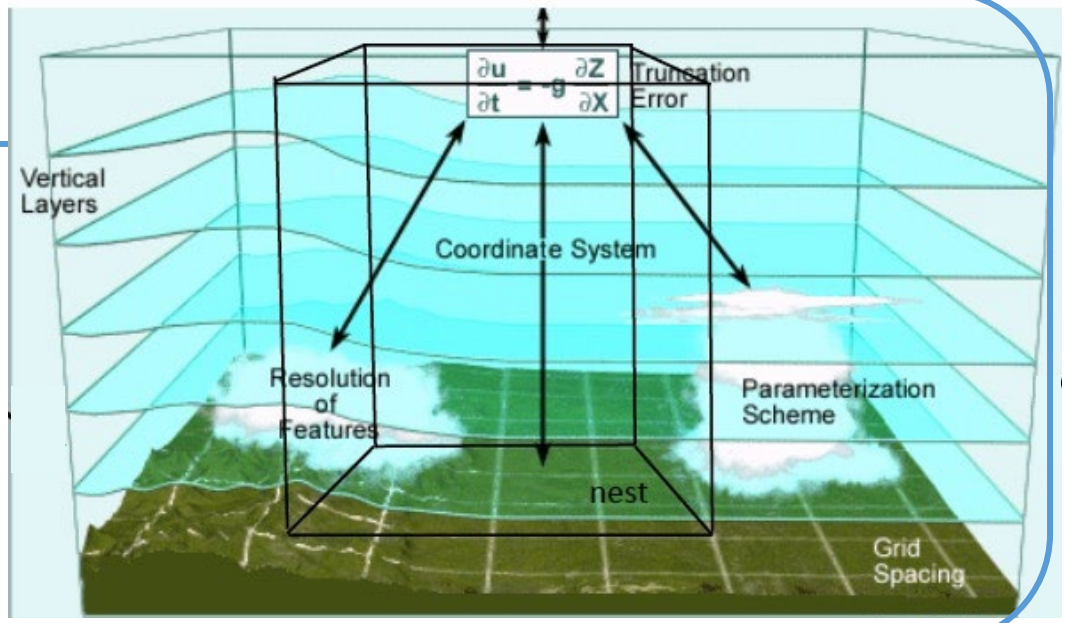
(u,v,w) velocity components in (x,y,z) directions
Θ potential temperatura
ρ air density
T temperature
p pressure
c_p specific heat
R_d gas constant
F_x, F_y, F_z friction term

High-Performance Computing



Horizontal Resolution

Vertical Resolution



High-Performance Computing

Why HPC resources?

Tuning WRF models

- Weather forecast: 4 different WRF parametrisations.
- Each parametrization has 23 variables to be tuned

Running WRF models

Weather forecast model for 30.000 km^2 with a resolution of 3km horizontal at different altitudes (10m,20m,50m,100m and 125m)

ADV.

Shortened development time (from moths to weeks/days)

Reduction of the execution time from tens of hours to minutes

HPC

Is it possible to solve a problem with such resolution in timely manner?

- How quickly do I need a solution?
- What horizontal and vertical resolution for my purpose?
- How many cores? If I use more cores I Will have the results more quickly?
- How large is any data set that you need to load?
- How much memory need to be available for ~~you to complete~~ a run?

High-Performance Computing

HPC resources

Tuning WRF models

- 1491 core-hour
- More than100 jobs were submitted

Running WRF models

- *Every day they are run 2 times per day*
- *Running time= 1hour-1hour30min*
- *HPC resources= 12 core/hour*
- *10 GBs data per execution*

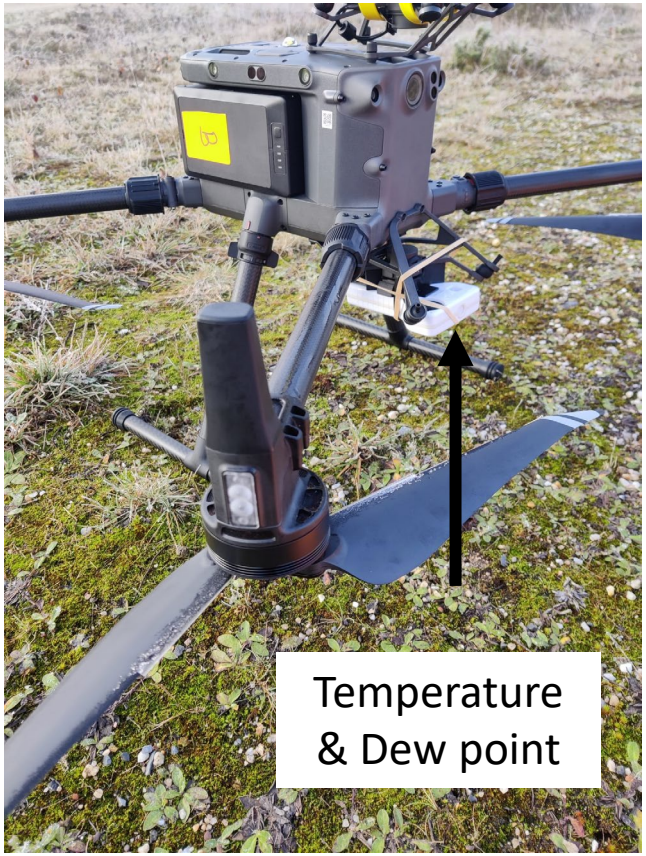
ADV.

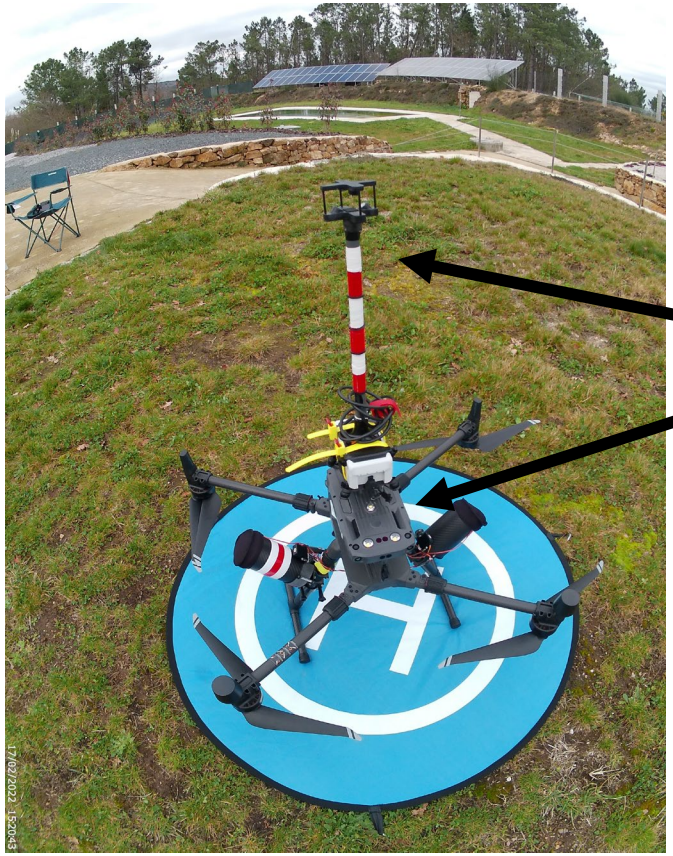
Shortened development time (from moths to weeks/days)

Reduction of the execution time from tens of hours to minutes

Main achievements

Meteodrone designed & validated with ground infrastructure



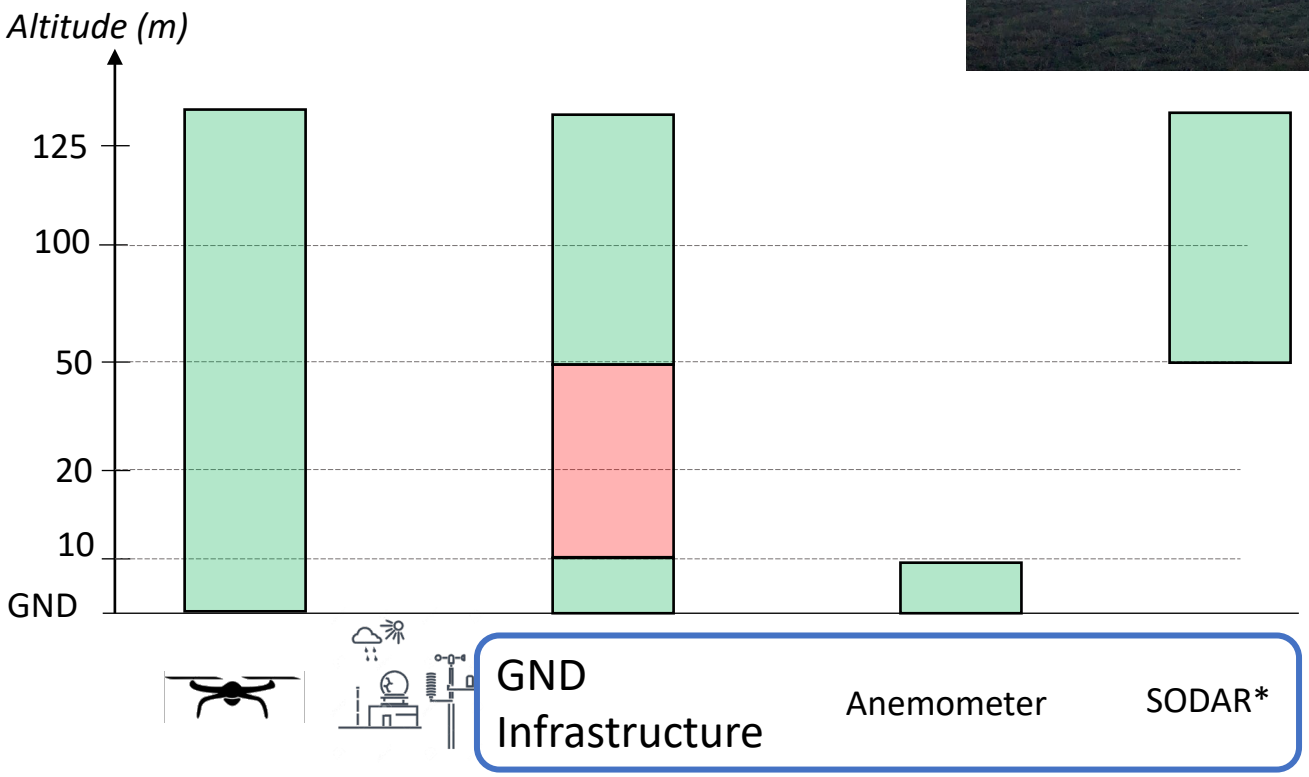


Main achievements

Meteodrone validated with ground infrastructure

Main achievements

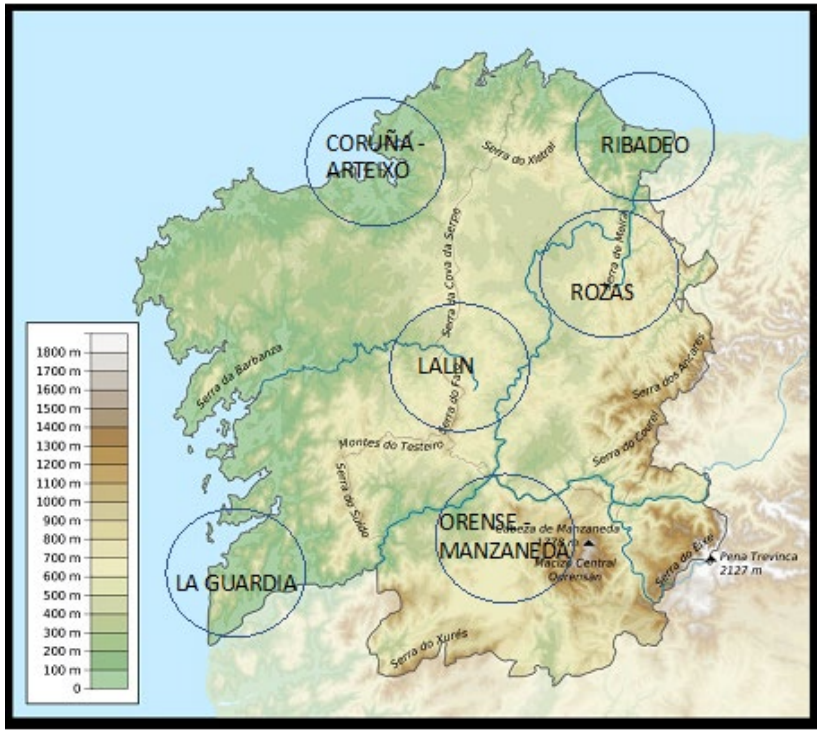
Better wind characterization at low altitudes



Wind characterization

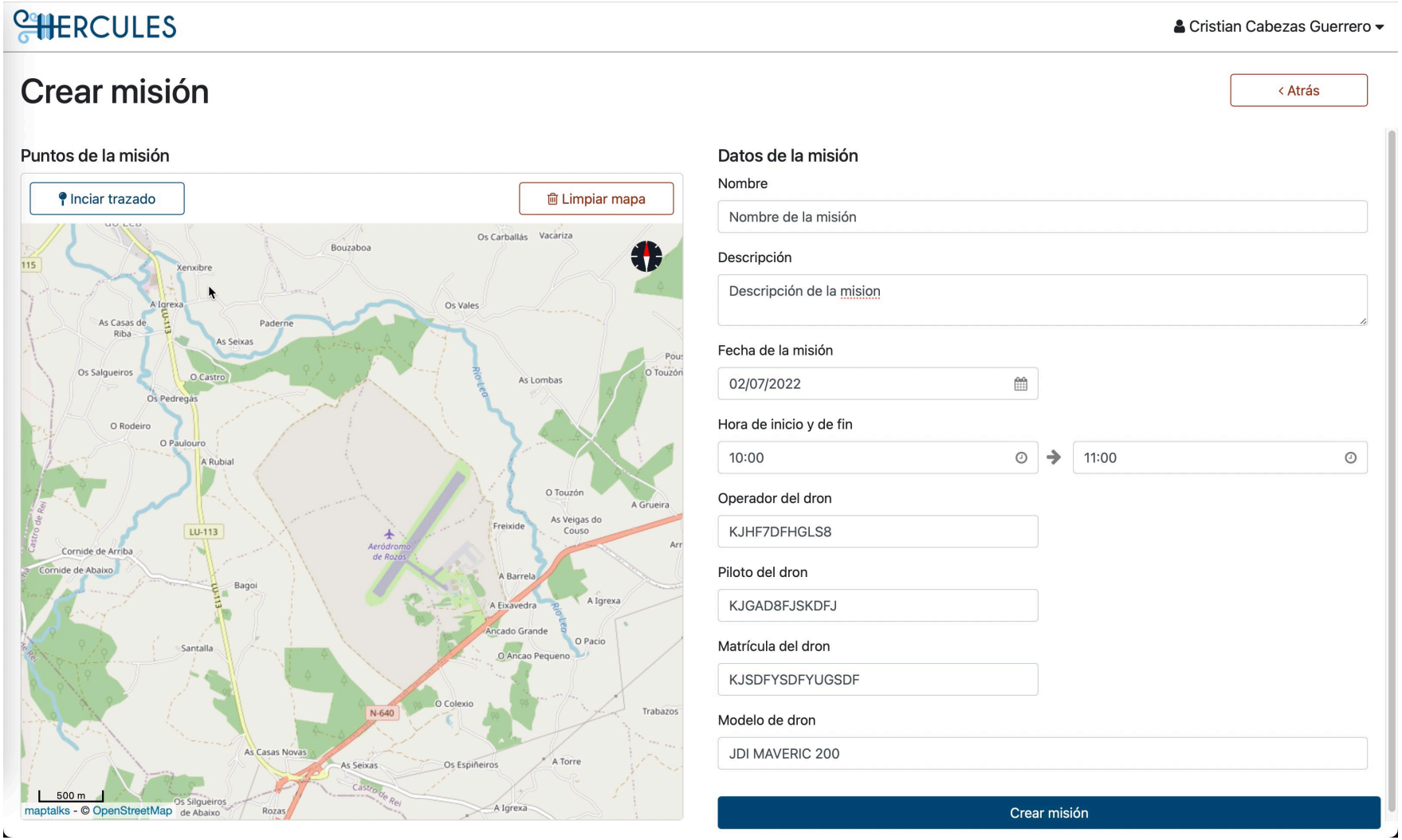
Main achievements

Galicia fully characterized

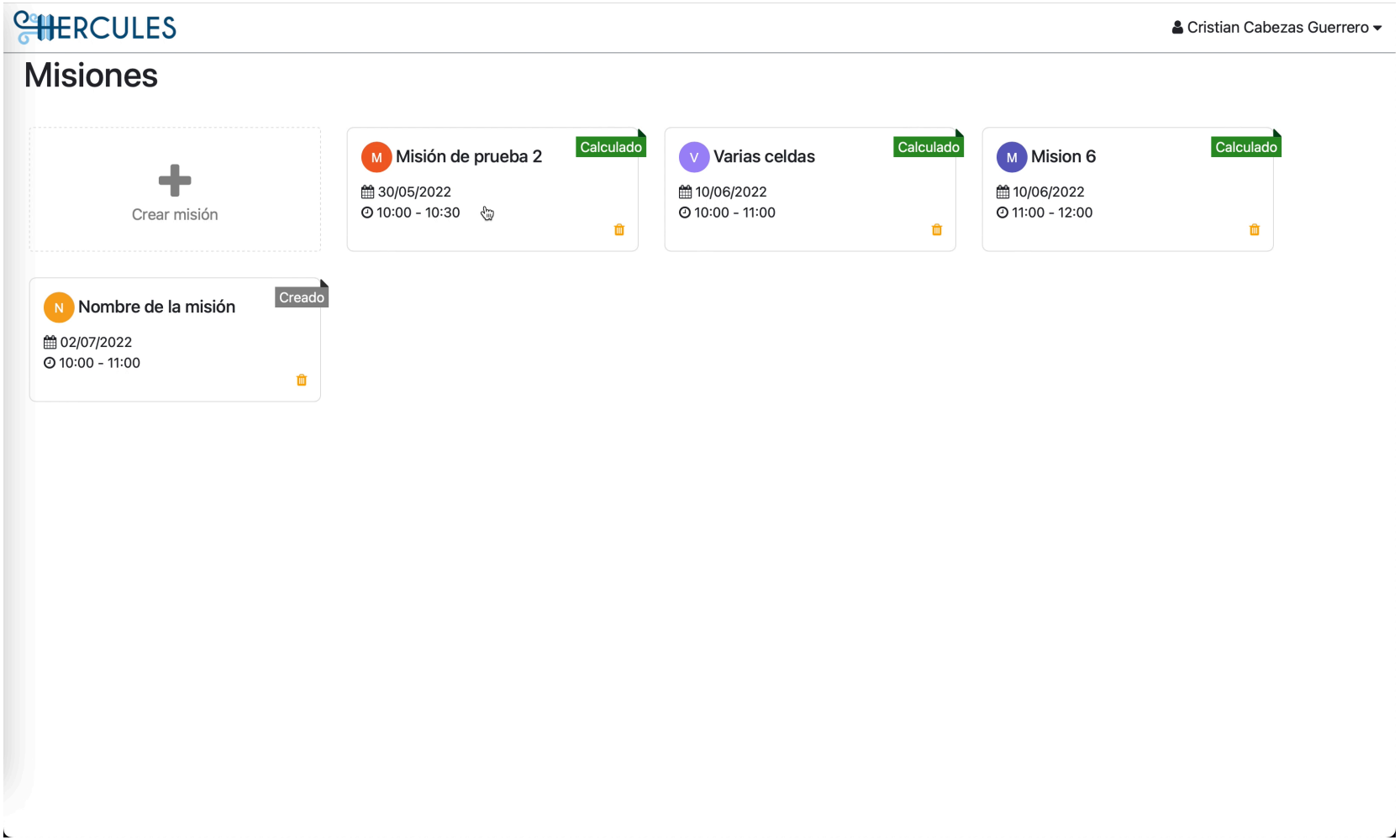


- Data harvesting campaign in 4 different Galicia locations with more than 120 flights.
- Weather forecast model for 30.000 km^2 with a resolution of 3km horizontal at different altitudes (10m,20m,50m,100m and 125m).
- Accuracy of wind prediction in 80% of the territory $\pm 1 m/s$.

Main achievements



Main achievements



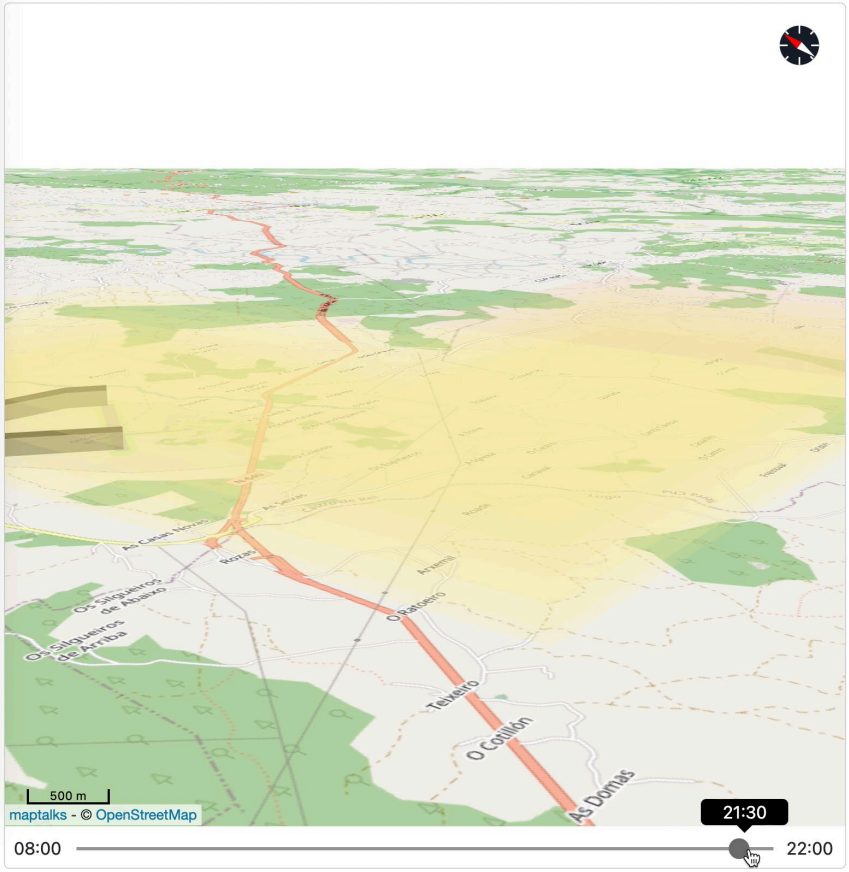
Main achievements

HERCULES

Cristian Cabezas Guerrero

Misión de prueba 2

‹ Atrás



Datos meteorológicos

Valor a mostrar

Temperatura

	Punto 1	Punto 2	Punto 3	Punto 4	Punto 5

	12:30	13:00	13:30	14:00	14:30	15:00	15:30	16:00	16:30
125m	7.1°C	7.3°C	7.61°C	8.05°C	8.38°C	8.54°C	8.46°C	8.6°C	8.45°C
100m	7.36°C	7.56°C	7.86°C	8.3°C	8.64°C	8.81°C	8.71°C	8.86°C	8.71°C
75m	7.61°C	7.82°C	8.12°C	8.57°C	8.9°C	9.08°C	8.98°C	9.12°C	8.96°C
50m	7.89°C	8.09°C	8.39°C	8.84°C	9.18°C	9.37°C	9.24°C	9.4°C	9.23°C
25m	8.2°C	8.4°C	8.71°C	9.17°C	9.52°C	9.71°C	9.56°C	9.72°C	9.53°C
10m	8.44°C	8.63°C	8.94°C	9.42°C	9.78°C	9.98°C	9.8°C	9.95°C	9.75°C

Bueno | Precaución | No volar

Enlaces de interés

ENAIRE

https://drones.enaire.es/

Actividad solar

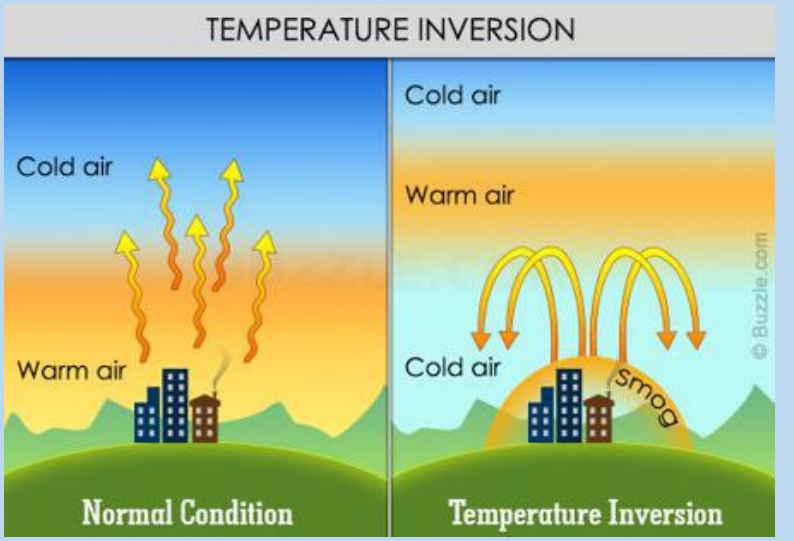
https://sdo.gsfc.nasa.gov/

Ver datos de misión

Main achievements

Validated
with the final user

Challenges



Improvement of accuracy with inversion layers

4G NETWORK

LoRa™

COMMUNICATION ROBUSTNESS

Next steps

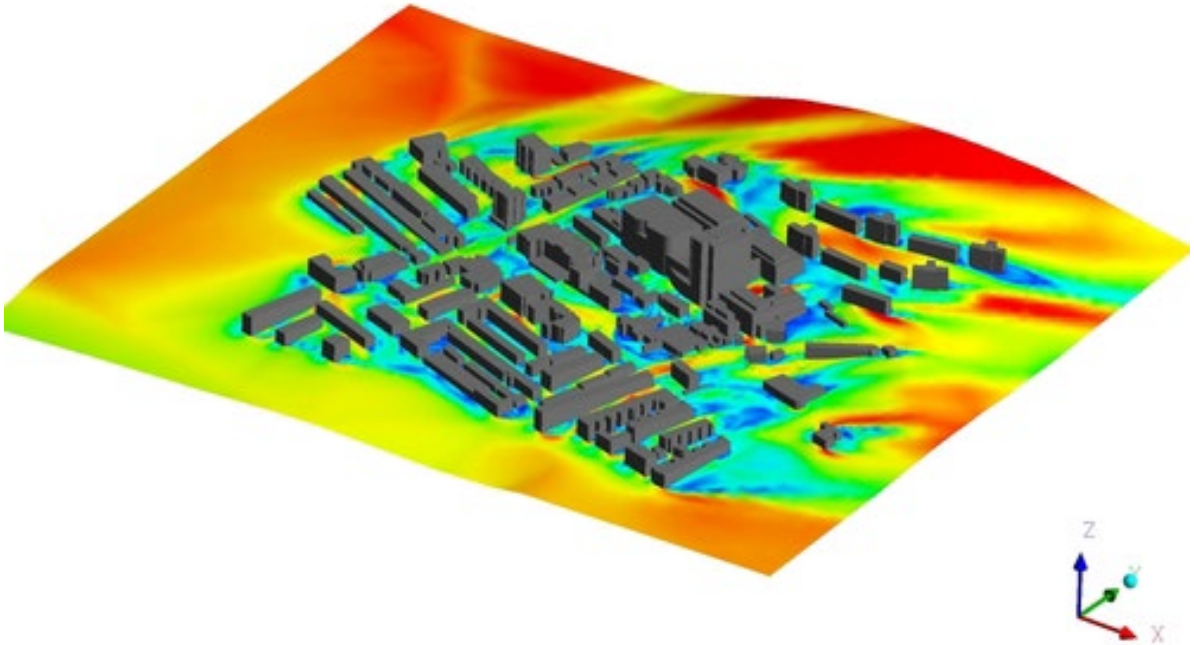
Live information for aircraft support during approach

Certification issues

Next steps

From meso weather models to micro weather

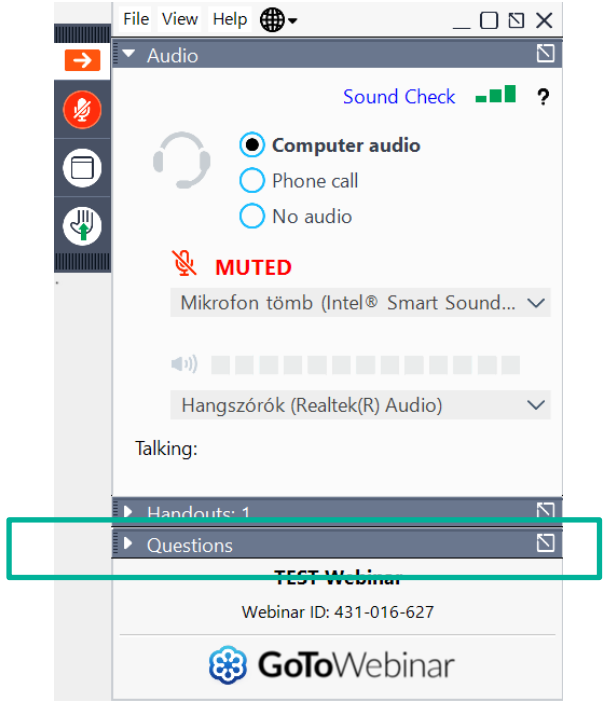
Reduce the lateral resolution of our models from km to tens of meters based on CFD or A.I algorithms



Thank you very much for your attention

Questions?

- You can ask questions in the GoToWebinar Questions panel
- The questions to the speakers will be shared in the Chat



ETP 4 HPC

EUROPEAN TECHNOLOGY PLATFORM FOR HIGH PERFORMANCE COMPUTING

THANKS!

Please fill in the survey to help us improve our webinars!

Next webinar:
16 September: EUMaster4HPC

You can find us at:

@etp4hpc
office@etp4hpc.eu
www.etp4hpc.eu
YouTube