

# From supervised to unsupervised deep learning for automatic detection of marine megafauna



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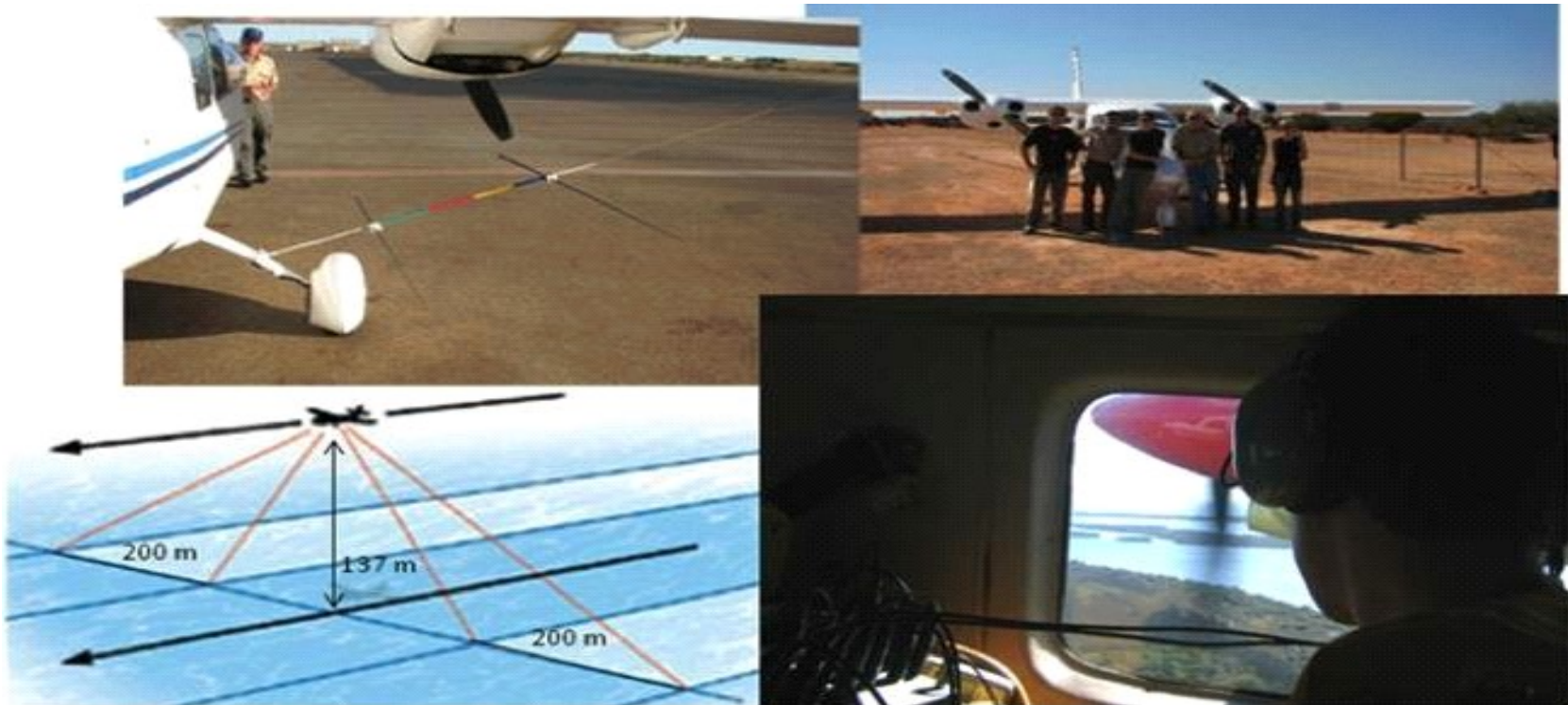
# Semmacape project

- Use high resolution images and deep learning methods to map marine megafauna



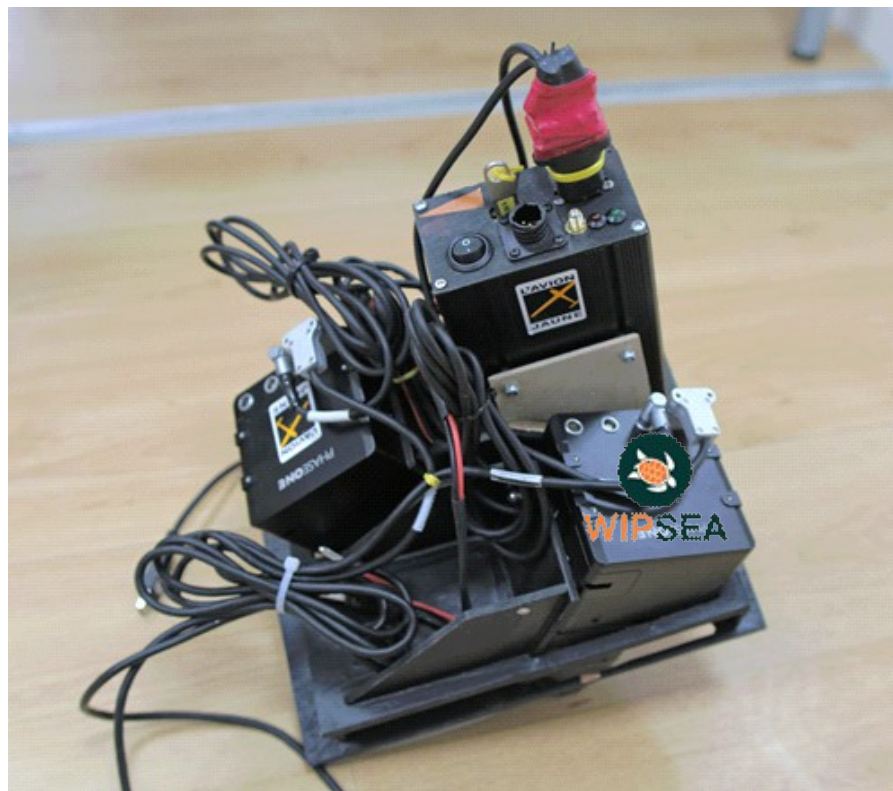
# Issue

- More and more organizations need to census megafauna
  - Offshore wind farms
  - Marine protected areas
- Problem: heavy to deploy, expensive, lacks accuracy



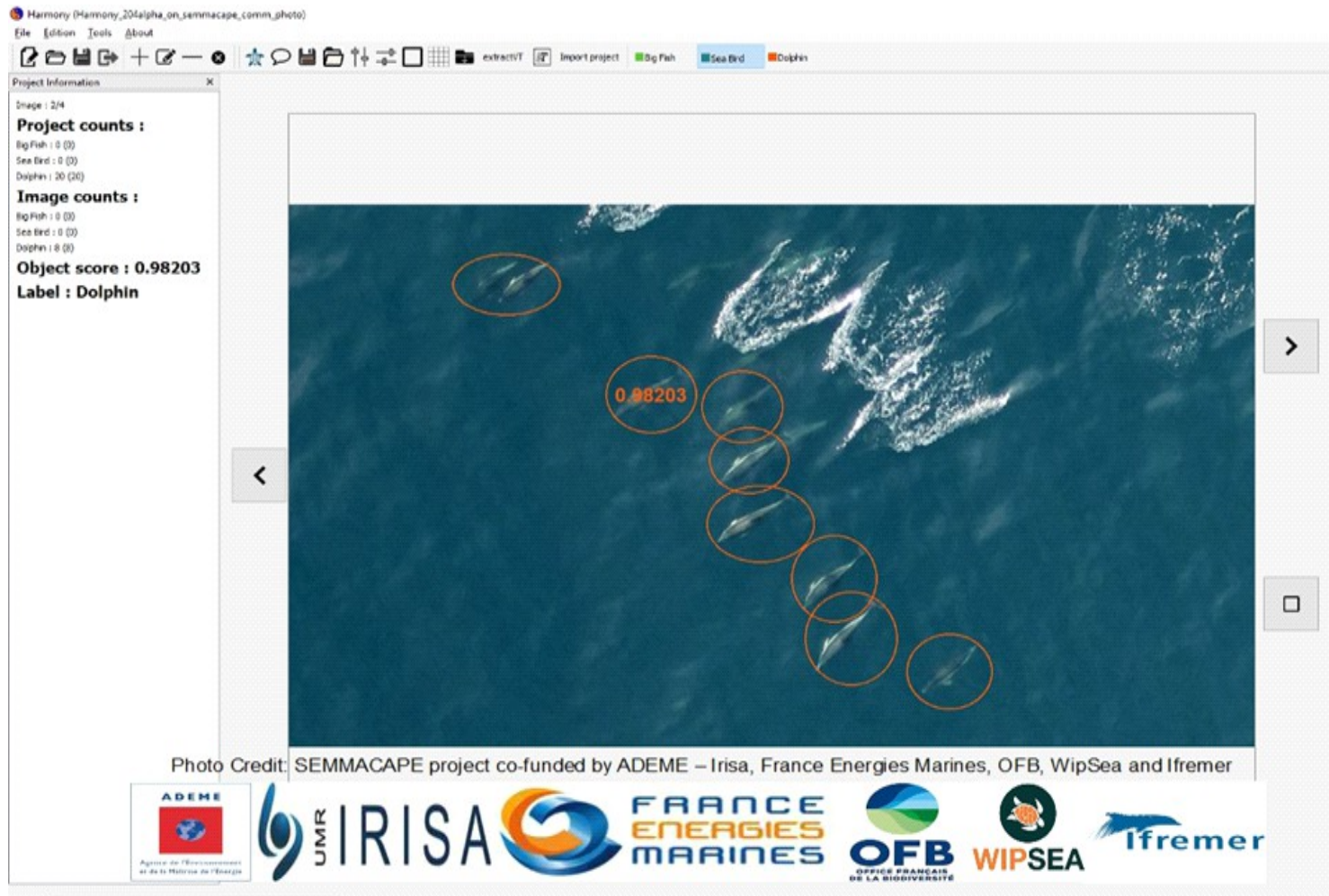
# Solution

- High resolution aerial imagery
  - Shot with WIPSEA and/or partners cameras
  - Verifiable by « picture proof »



# Solution

- Megafauna automatic detection and classification software solution (Deep Learning) to manage Big Data



The screenshot displays the Harmony software interface. The main window shows an aerial photograph of the ocean with several dolphins circled in orange. A central circle contains the object score "0.98203". On the left, a "Project Information" panel provides the following data:

- Image : 2/4
- Project counts :**
  - Big Fish : 0 (0)
  - Sea Bird : 0 (0)
  - Dolphin : 20 (20)
- Image counts :**
  - Big Fish : 0 (0)
  - Sea Bird : 0 (0)
  - Dolphin : 0 (0)
- Object score : 0.98203**
- Label : Dolphin**

At the bottom, a photo credit reads: "Photo Credit: SEMMACAPE project co-funded by ADEME – Irisa, France Energies Marines, OFB, WipSea and Ifremer". Below the credit are the logos for ADEME, UMR IRISA, FRANCE ENERGIES MARINES, OFB, WIPSEA, and Ifremer.

# Solution

- > 100 000 high resolution photos at 180m altitude already shot (~3000 km<sup>2</sup>)
  - Goal : develop robust solutions for marine megafauna aerial surveys and compare detections with onboard visual observations
- R&D collaborative project funded by *Agence De l'Environnement et de la Maîtrise de l'Energie*
- Partners :
  - *IRISA, Office Français de la Biodiversité*
  - *France Energies Marines, IFREMER*



# Dataset and detection models in a supervised context

- Iterative dataset/model building
  - Megafauna in the mass of photos are, at first, like « a needle in a haystack »

Annotations  
→ Dataset improvement

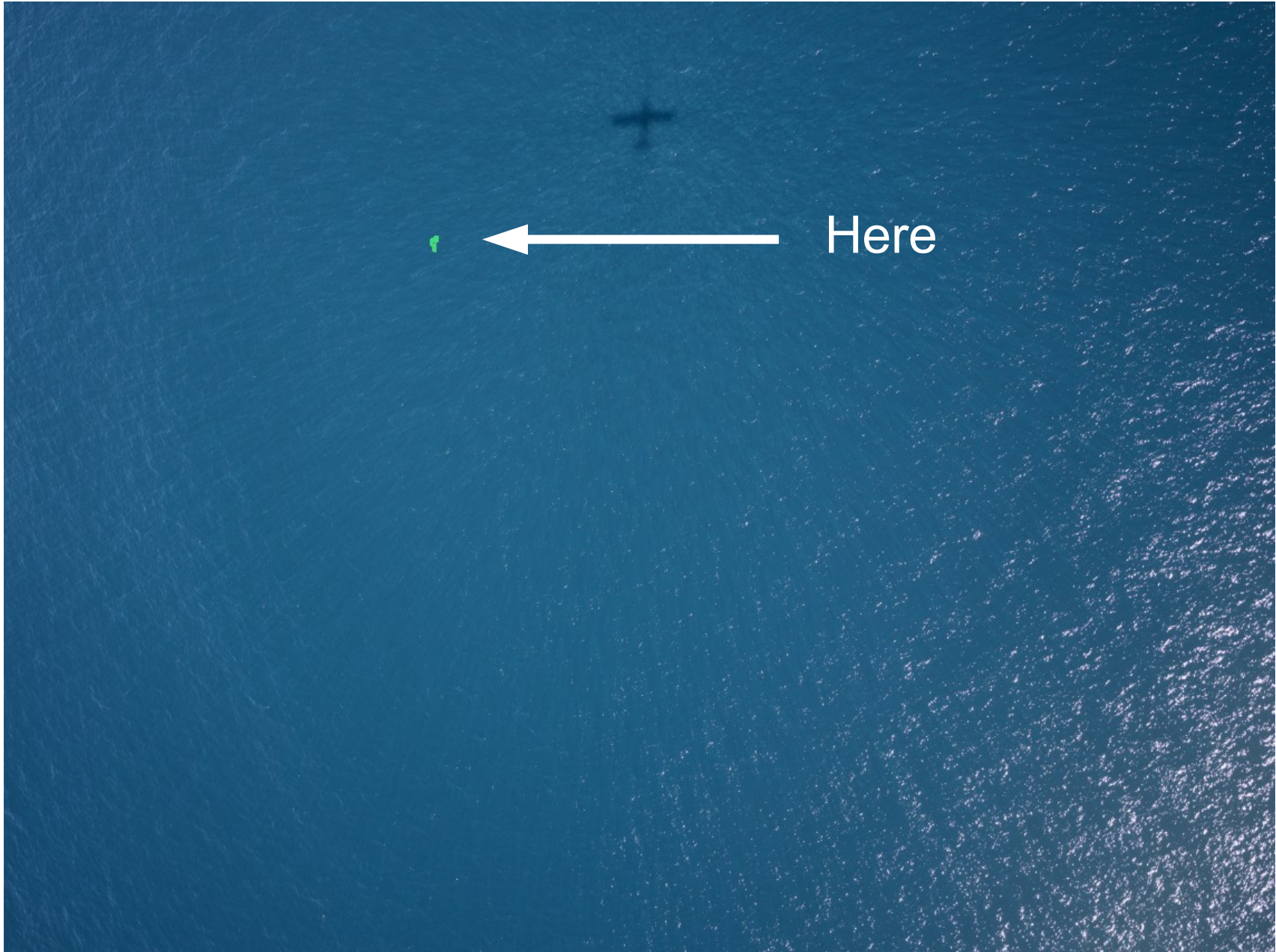


New models  
→ Detection improvement

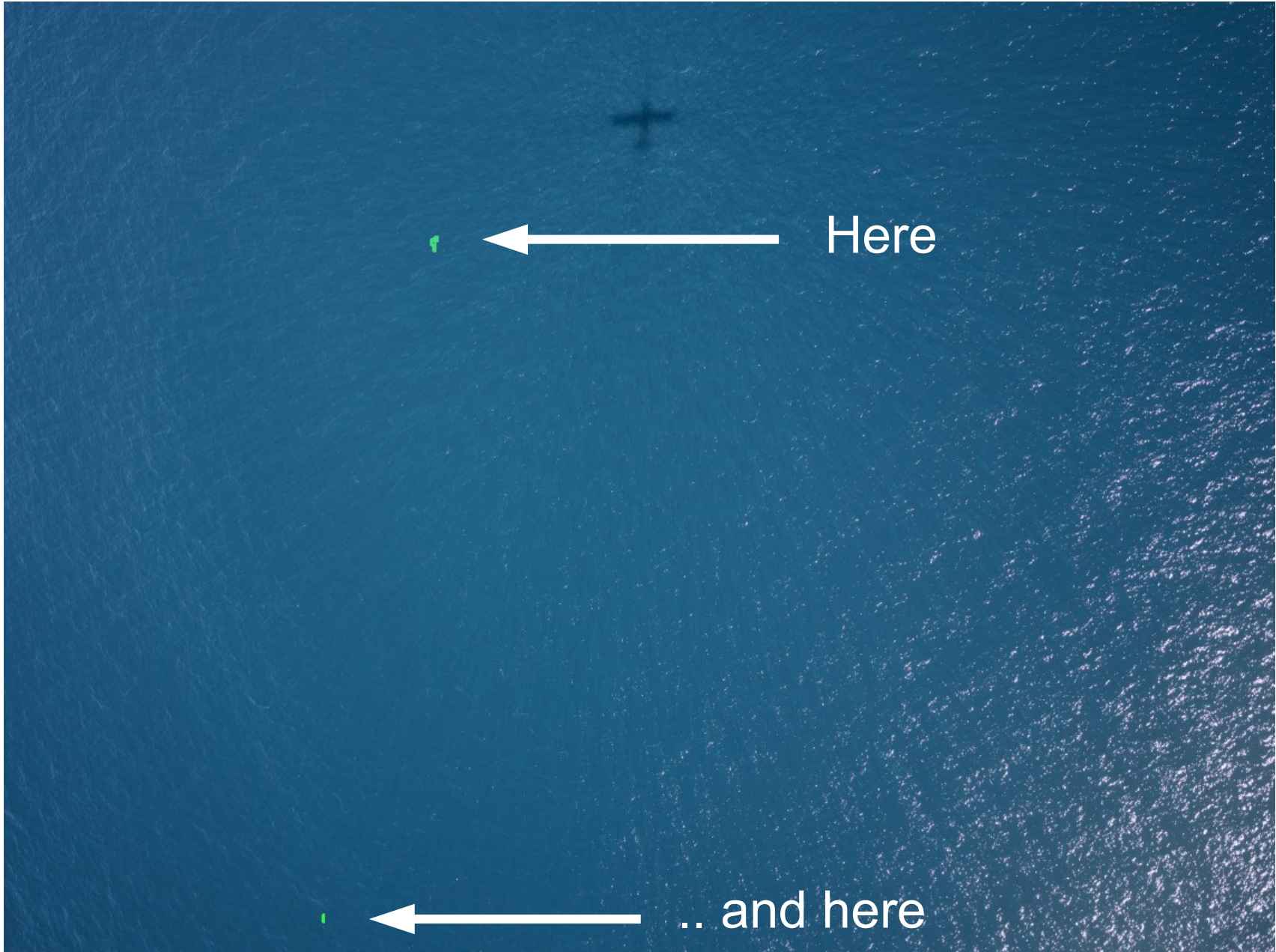


A needle in a haystack :  
where are the dolphins ?





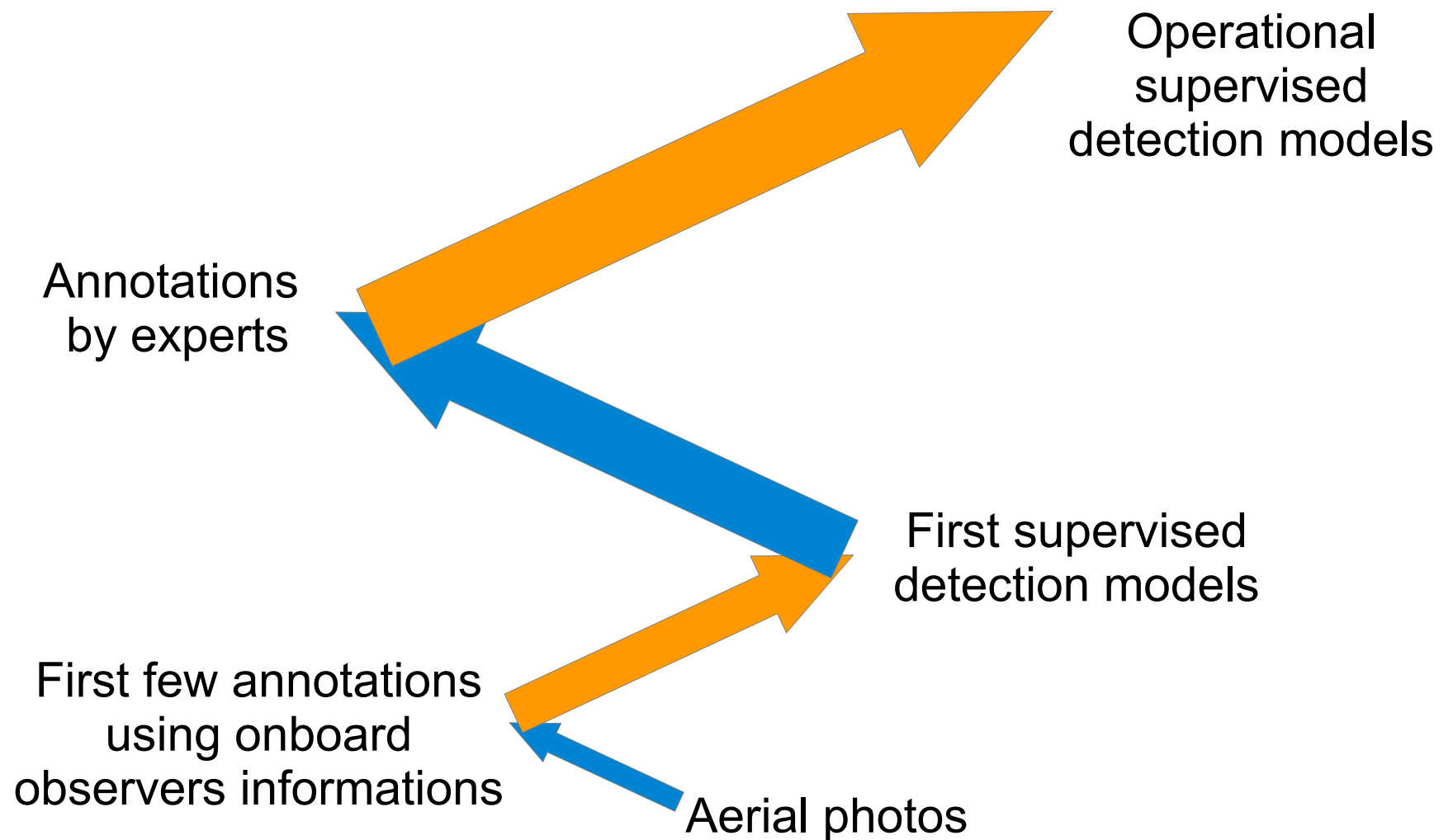
A needle in a haystack :  
where are the dolphins ?



A needle in a haystack :  
where are the dolphins ?

# Dataset and detection models in a supervised context

- Iterative dataset/model building



# Up-to-date dataset

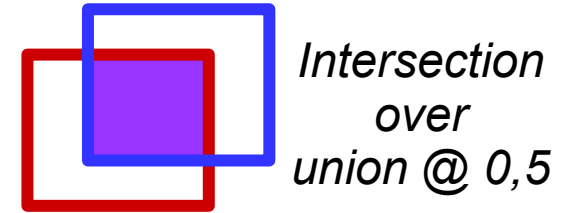
- 6248 photos (~180km<sup>2</sup>) validated by an expert
- Covers spring, summer and autumn
- 910 marine mammals inventoried
- 18443 birds
- 4229 big fishes and sharks

# Supervised detection

- Test procedure
  - **Operational test set  $\neq$  test on objects only**
  - As opposed to many dataset, objects are needles in a haystack
  - Tests apply on hundreds of images, representing tens of square kilometers
  - Aerial images of the sea can show many different shapes likely to trick the detector
- **As 'emptiness' grows in the test set, the detector is more likely to be tricked (false positives issue)**

# Supervised detection

- Current operational performances



	Dolphins, Big fishes, sharks	Birds flying	Birds landed	Jellyfishes
Average precision	0,12* - 0,77	0,49 - 0,56	0,37 - 0,68	0,34 - 0,82
Max F1 score	0,19* - 0,75	0,57 - 0,68	0,46 - 0,70	0,49 - 0,77

Tested on areas from **~20 km<sup>2</sup> to ~50 km<sup>2</sup>**  
**~600 to ~1600 images**  **Close to operational conditions**

\* For now, score varies depending on the test set (season, species population, etc..)

→ Consolidation phase

# Supervised detection

- Current performances
  - Dolphins, big fishes, sharks
    - Fully/partly underwater, hard to detect
  - Birds
    - Different species with very different visual features
      - Size, shapes, contrasts

# Supervised detection

- Conclusion
  - Supervised detection is already effective for the census of megafauna
    - Major help for expert image analysis with dedicated tools
- Work in progress
  - Model improvement using knowledge on data and state of the art methods
  - Detect more specific classes
- What if there are no available annotations ?