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"Earth Observation for Disaster Risk Management"
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Committee on Earth Observation Satellites

From Orbit to Action: AquaCubeAI for Onboard Coastal Water-Quality Alerts and Disaster Risk Management

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◆ WHY IT MATTERS

Coastal water quality is critical
for ecosystems, food security and public health.

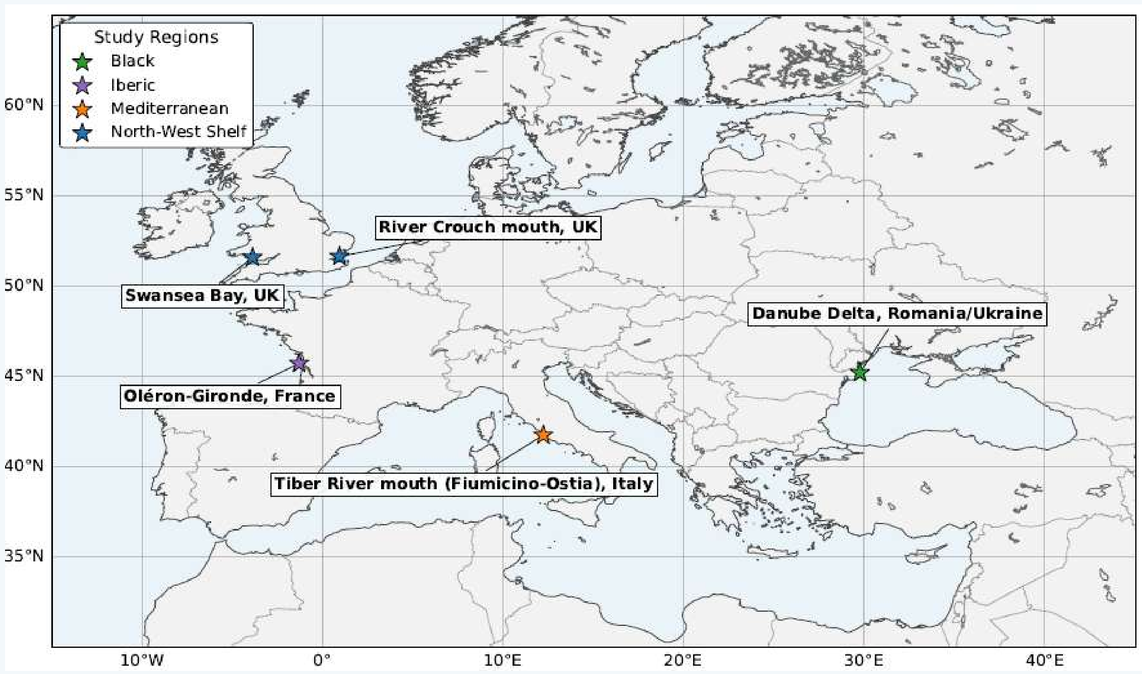
Conventional EO workflows introduce latency
through downlink and ground processing.

On-board AI moves inference to the satellite
reducing data volume and enabling rapid event flagging.

AquaCubeAI targets turbidity
with low-complexity inference and selective downlink.

SDG 6 · CLEAN WATER & SANITATION

◆ STUDY AREAS & DATA



Selected localized coastal sites across four European marine macro-regions

1 — Φsat-2 input
7 multispectral + 1 panchromatic band
Simulated Level-1C, 4.75 m GSD

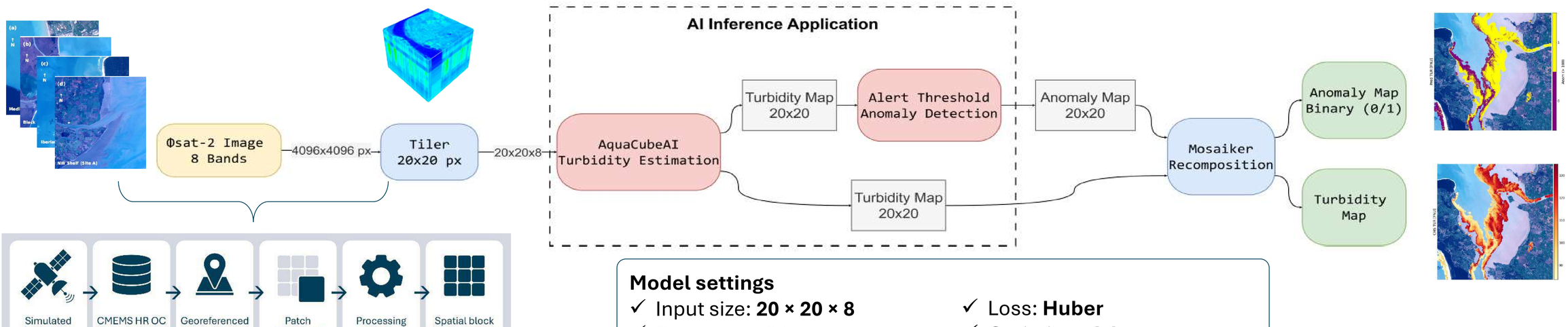
2 — CMEMS labels
HR-OC turbidity products
100 m spatial resolution

3 — Patch support
20 × 20 × 8 pixels ≈ 100 × 100 m
aligned to HR-OC observations

4 — Marine regions
Mediterranean · Black Sea · Iberic
North-West Shelf

Representative Φsat-2 coastal scenes (simulated Level-1C)

◆ Full METHODOLOGY



Model settings

- ✓ Input size: **20 × 20 × 8**
- ✓ Descriptor: **8 features**
- ✓ MLP layers: **512–512–256**
- ✓ Loss: **Huber**
- ✓ Optimizer: **Adam**
- ✓ Spatial split: **15 km blocks**

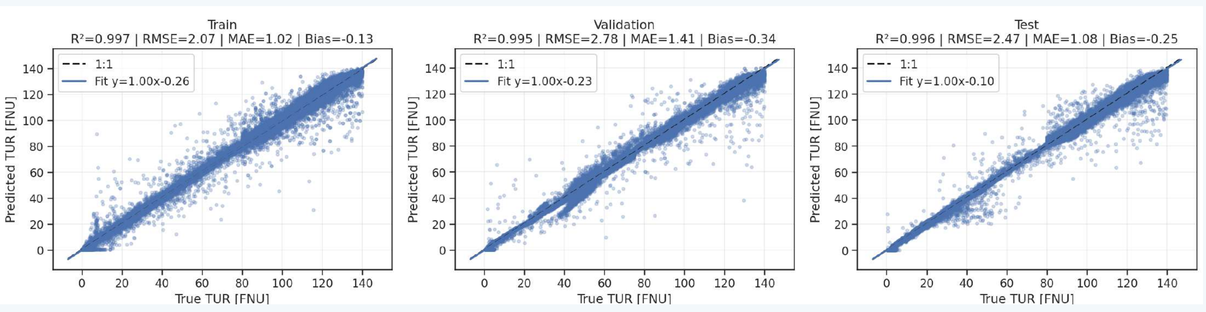
◆ RESULTS

Predictive performance

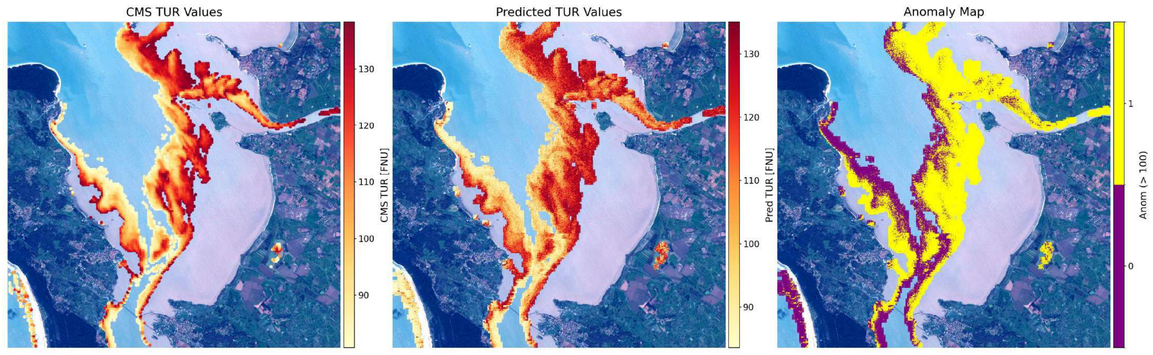
VALIDATION
R^2 = 0.995
RMSE 2.78 · MAE 1.41 FNU

TEST
R^2 = 0.996
RMSE 2.47 · MAE 1.08 FNU

0–40 FNU REGIME
RMSE = 1.39
MAE 0.86 FNU



Spatial products: example over the Iberian Sea (2024-12-23)

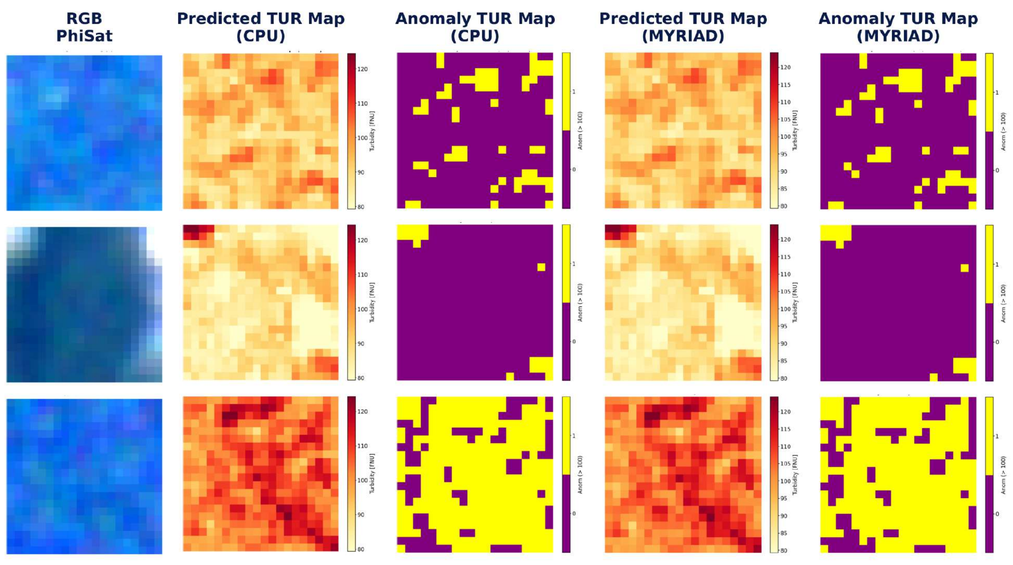


Key findings:

- Best performance in the low-to-moderate turbidity regime (0-40 FNU)
- Strong agreement across the full 0-140 FNU range
- Spatial products enable turbidity mapping and threshold-based anomaly flagging.

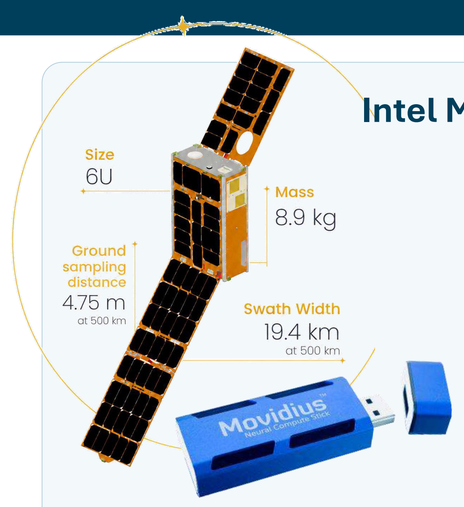
◆ ON-BOARD DEPLOYMENT · INTEL MYRIAD 2

CPU vs Myriad 2 inference (patch examples)



CPU and Myriad outputs are consistent, confirming embedded feasibility.

Intel Myriad 2 VPU



Average latency
8.51 ms per patch

Throughput
117.49 inferences/s

Full 4096x4096 scene
215.6 s
(all retained valid patches)

- ✓ **AquaCubeAI** demonstrates the embedded feasibility of onboard turbidity monitoring under low-compute constraints.
- ✓ A compact **MLP** can achieve strong predictive accuracy under realistic geospatial splitting.
- ✓ **Dense turbidity maps** and threshold-based anomaly masks support selective downlink and rapid decision logic.
- ✓ Future work: **validation on real in-orbit Φsat-2** data and improved robustness for rare high-turbidity events.

◆ REFERENCES

Di Stasio et al. *IEEE JSTARS 2026 - Under review*

Razzano et al. IEEE JSTARS 2024

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