



Supplement of

Building a dataset of offshore oil and gas extraction platforms from satellite data (2017–2023)

Lulu Si et al.

Correspondence to: Lulu Si (lsi@doctor.upv.es)

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Supplement

1 Information of other data sources of offshore oil and gas platforms

Table S1. Statistical and description of every platform database used for validation in 2023 in this study.

Data source	Identify	Total records	Actual counts	Area
BSEE	Complex Id	1419	1154	NGoM
NOAA	platformid	2147	1539	NGoM
OESNS	NAME	600	362	NS
OGIM	OGIM_ID	2964	2964	six gulfs

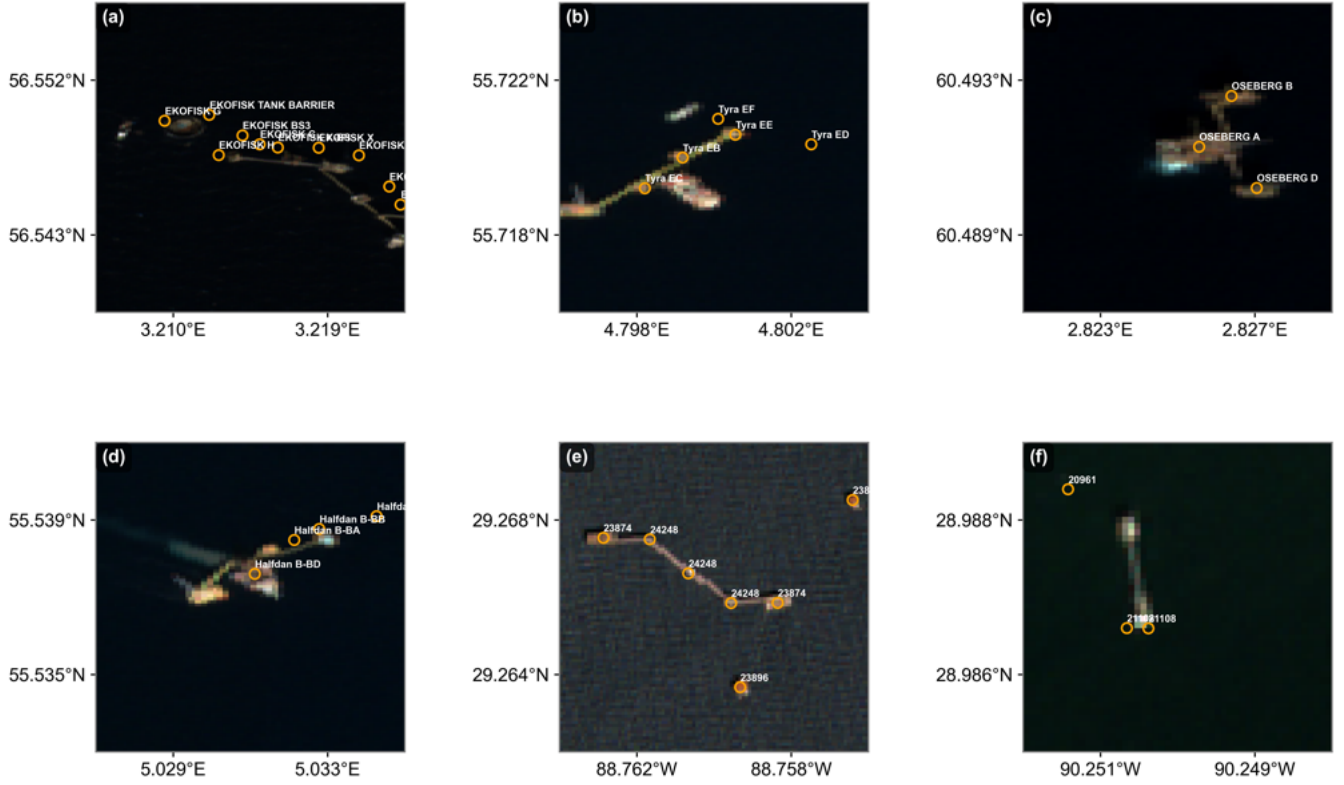


Figure S1. Examples of offshore platform configurations shown in six samples. (a–d) The text annotations come from the NAME field of the offshore energy structure dataset in North Sea (Martins et al., 2023), which includes both the platform name (e.g., Tyra in panel (b)) and the structure name (e.g., EF in panel (b)). (e) The numbers correspond to the platformid field from the NOAA dataset, where identical values indicate structures belonging to the same platform. (f) The numbers come from the Complex Id field of the BSEE dataset, similarly showing different structures associated with the same platform.

2 Exploration of backscattering Coefficients

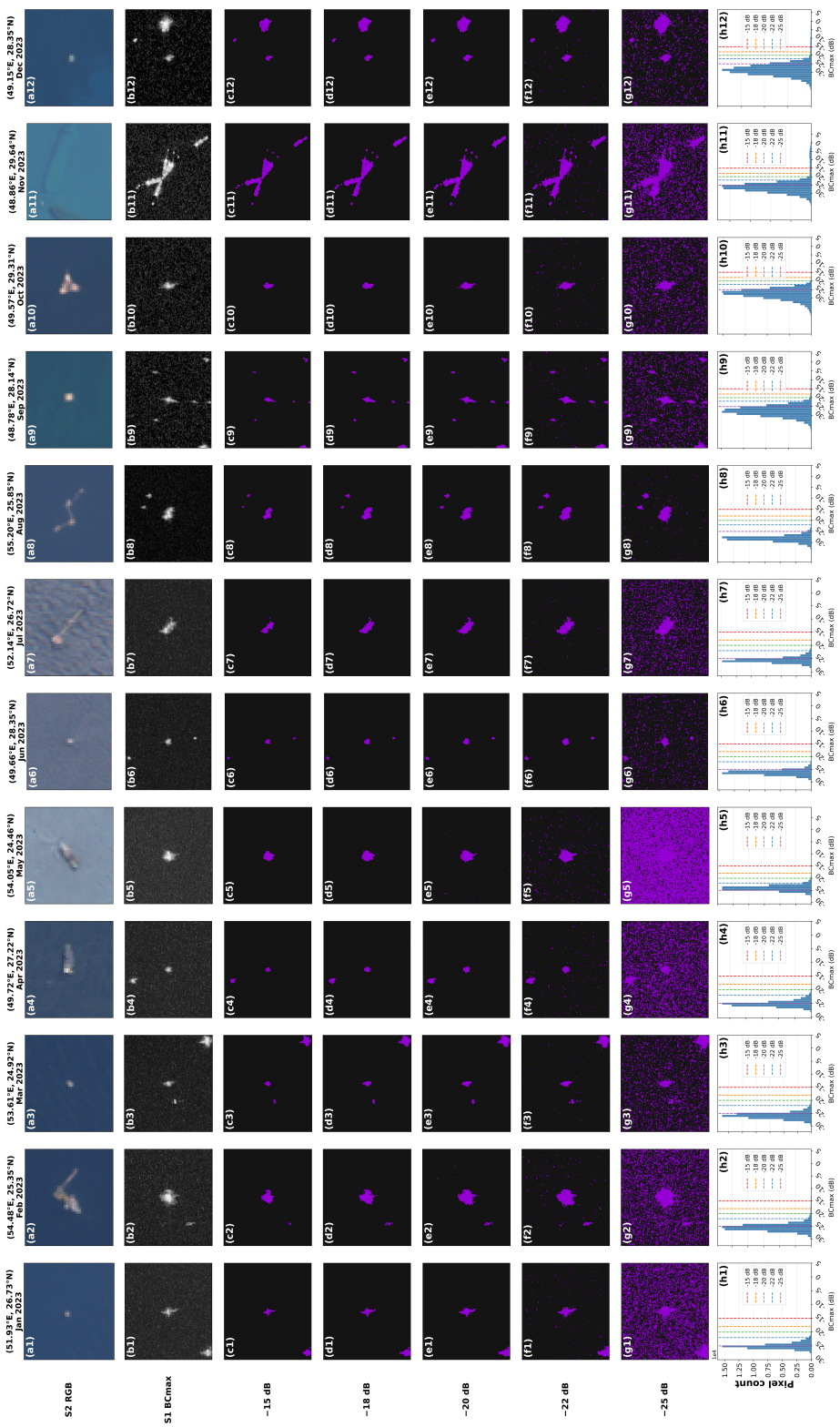


Figure S2. Sensitivity of absolute $BC_{\max}$ thresholds at 12 representative OOGP locations in the GoM (2023). Each column corresponds to one platform location, labelled by coordinates and acquisition month. (a1-a12) Sentinel-2 true-color imagery using a 200 m buffer; (b1-b12) Sentinel-1 monthly $BC_{\max}$ in VH polarization using a 1000 m buffer, shown in grayscale; (c1-c12) to (g1-g12) binary retention masks under absolute thresholds of -15 , -18 , -20 , -22 , and -25 dB, respectively; and (h1-h12) histograms of $BC_{\max}$ pixel values within the 1000 m buffer, with the five candidate thresholds indicated by vertical dashed lines. Purple pixels indicate values exceeding the threshold and are therefore retained, whereas black pixels indicate values below the threshold and are therefore excluded.

3 Sensitivity test of percentile threshold to detect platform initially

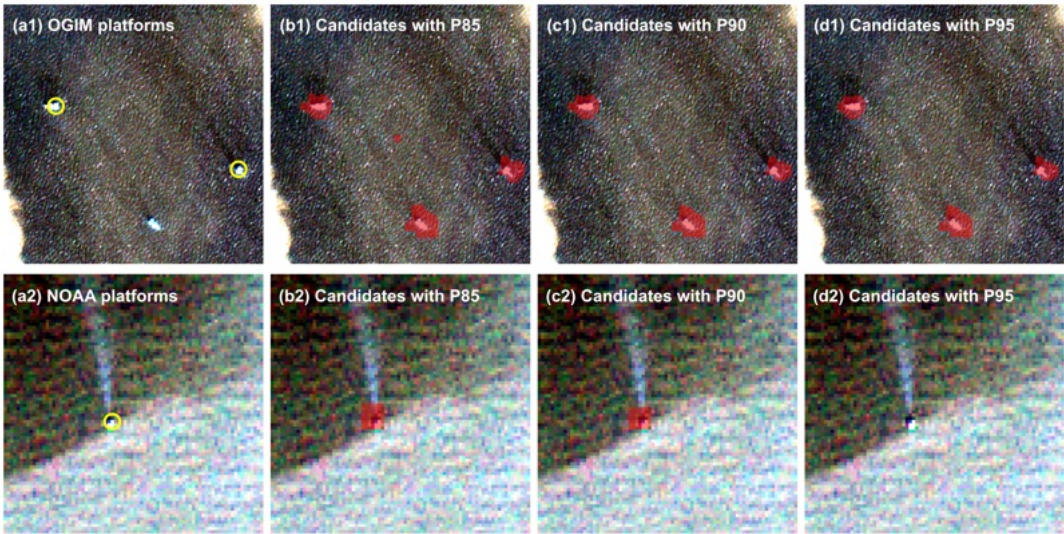


Figure S3. Sensitivity analysis of percentile thresholds for offshore platform detection. Yellow circles: verified platforms (OGIM database). Red areas: detected candidates at different percentile thresholds. Basemap: Sentinel-2 true color iamge (January 2023). (a1-d1): Southern GoM site (29.594°N, 92.231°W) with three candidates. (a2-d2): Northern GoM site (29.052°N, 91.448°W) with one candidate.

Table S2. Accuracy assessment of offshore platform detections based on different percentile threshold methods in NGoM.

Threshold	Precision	F1-score
95th	0.948	0.808
90th	0.965	0.806
85th	0.963	0.795

4 Test of transient object removal with different occurrence frequency thresholds in specific regions.

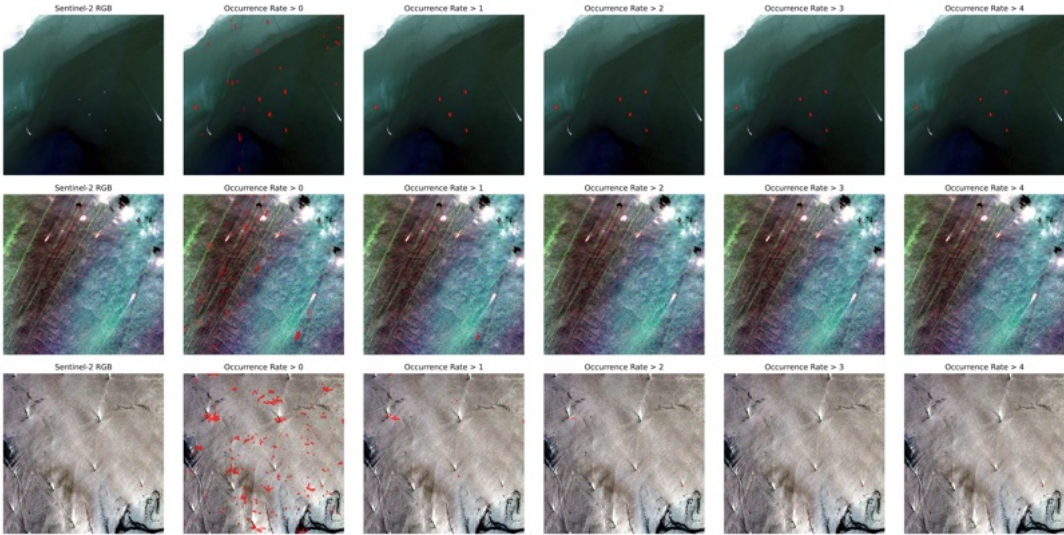


Figure S4. Occurrence Frequency analysis for transient object removal in three typical ship area.

5 To quantify the sensitivity of the detected platform counts to the adopted OF thresholds, we varied each basin’s threshold within 2 steps of the adopted value and computed the relative standard deviation of true positive counts as the sensitivity index σ_{OF} . Results are summarized in Table SS3. Error bars in Fig.10 are calculated as $\delta N_{\text{year}} = N_{\text{year}} \times \sigma_{\text{OF}}$, providing a conservative estimate of algorithmic uncertainty in the temporal trends.

Table S3. OF threshold sensitivity analysis results by basin.

Basin	Adopted OF	Test range	σ_{OF}
GoM	3	2 - 5	3.8%
CS	3	2 - 5	2.2%
GoT	2	2 - 4	2.7%
NS	6	4 - 7	1.6%
GoG	2	2 - 4	4.6%
PG	3	2 - 5	4.7%

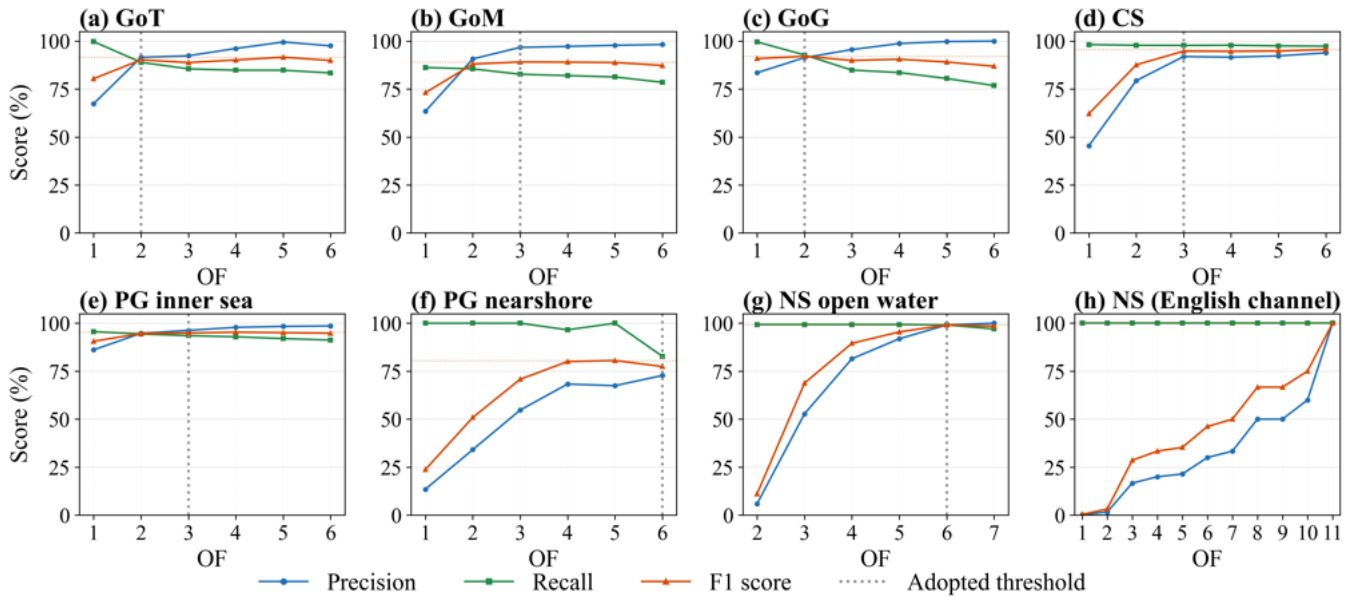


Figure S5. Sensitivity of the OF threshold to platform detection performance across all study regions. Each panel shows precision (blue), recall (green), and F1 score (orange) as a function of OF threshold. The vertical dashed line in each panel indicates the adopted OF threshold for the corresponding regions. In all regions, the dominant effect of increasing OF is the suppression of vessel-induced false positives rather than a reduction in true platform detections, supporting the empirical basis of the region-specific threshold selection.

5 Flowchart of OWTs detection

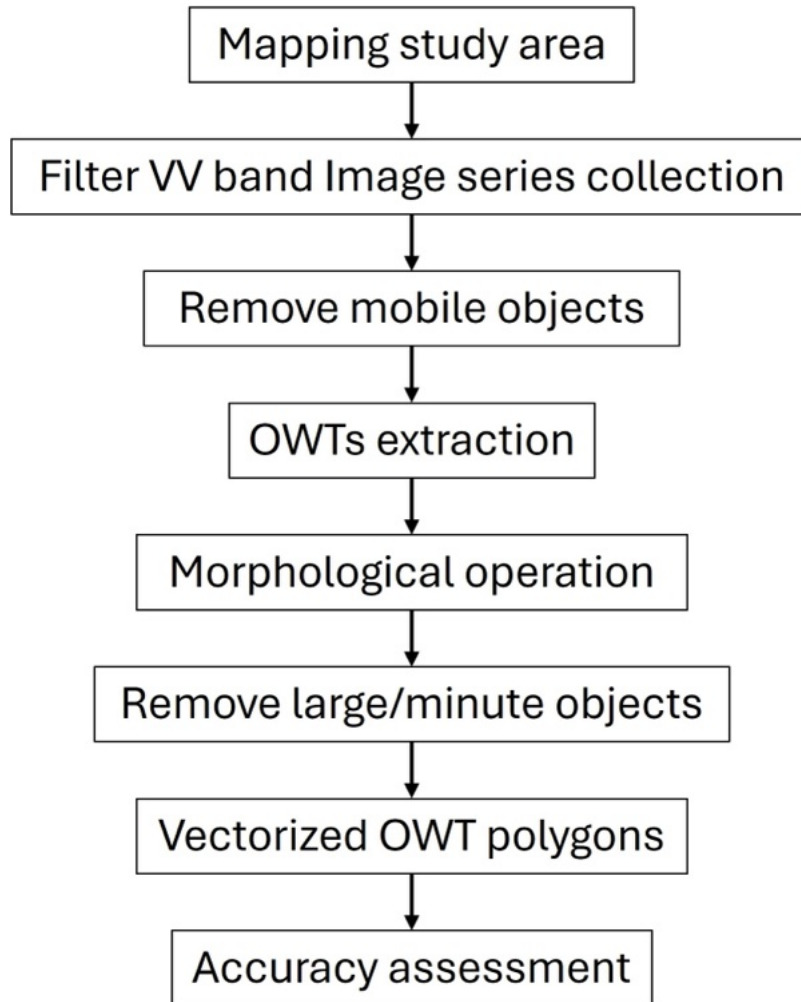


Figure S6. Flow diagram (Zhang et al., 2021) showing the data processing procedures in detecting the offshore wind turbine dataset in North Sea from 2017 to 2023.

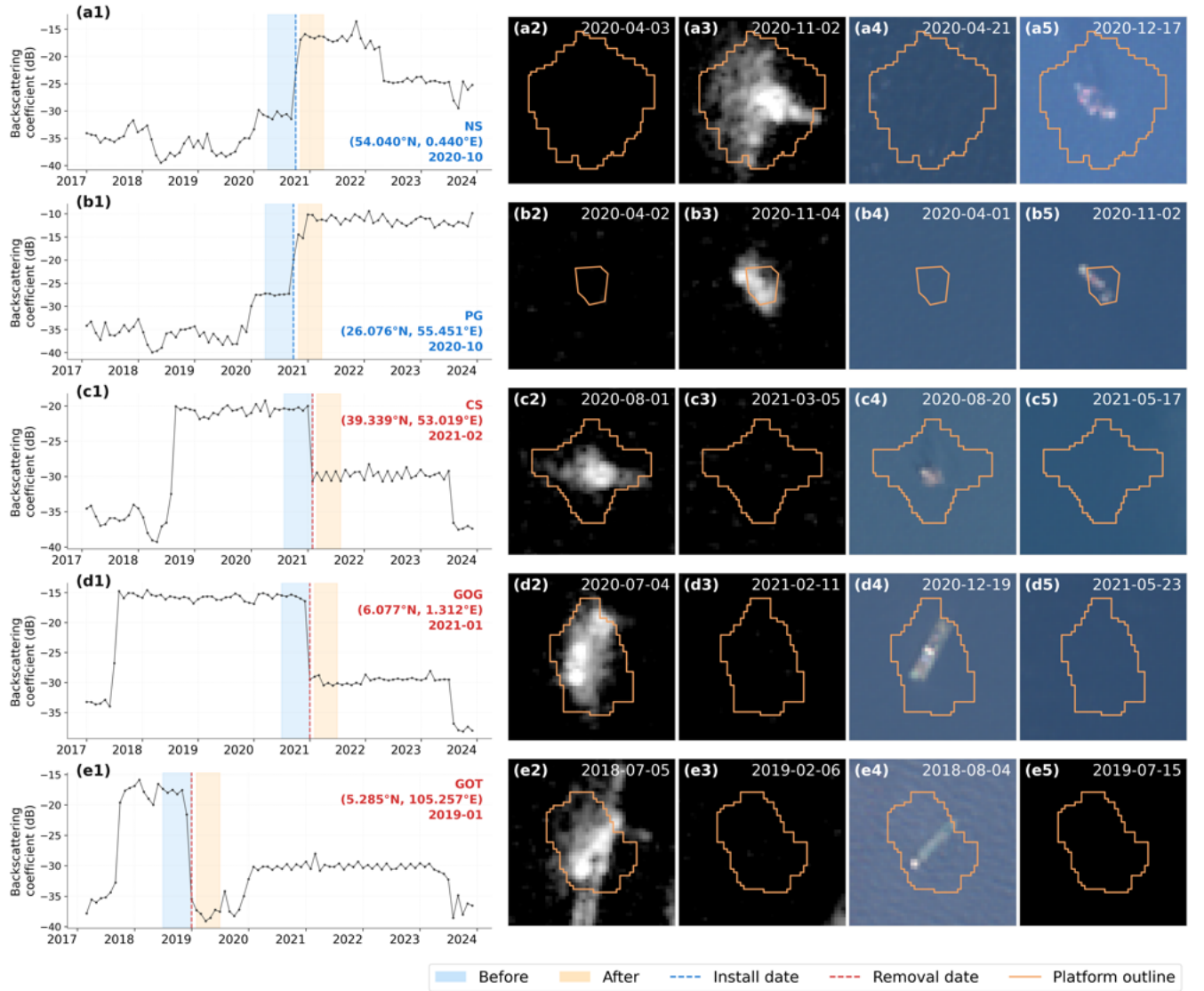


Figure S7. Visual validation of MK-inferred installation and removal dates for representative OOGPs from different study basins. Each row corresponds to one platform: (a1-e1) monthly Sentinel-1 VH backscatter coefficient time series (2017-2023); (a2-e2) Sentinel-1 VH SAR composite before the inferred change point; (a3-e3) Sentinel-1 VH SAR composite after the inferred change point; (a4-e4) Sentinel-2 RGB image before the change point; and (a5-e5) Sentinel-2 RGB image after the change point. Dashed lines indicate the MK-inferred change points. Blue and orange shading indicate the windows before and after the imagery acquisition, respectively. Orange outlines delineate the platform polygon boundary.

7 Site-level assessment of OOGPs detections in North Sea and Persian Gulf

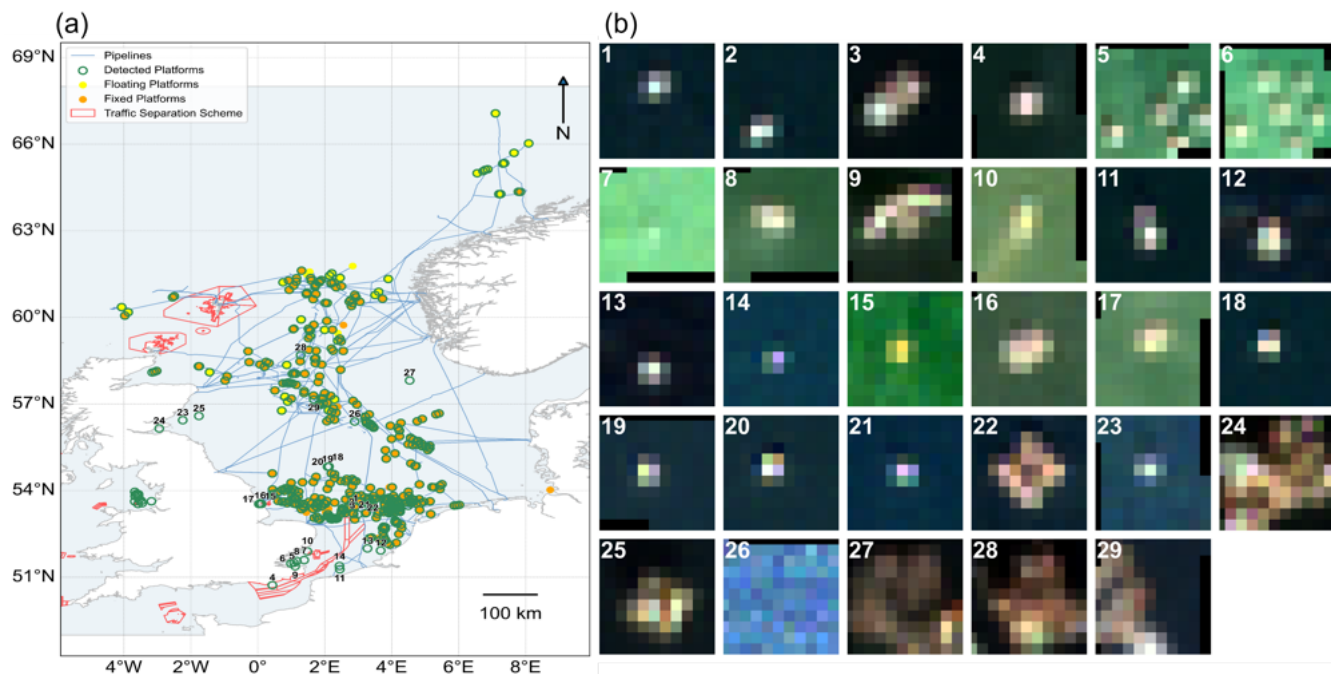


Figure S8. Spatial distribution of offshore oil and gas platforms detected in this study and offshore energy structures in the North Sea (Martins et al., 2023). (a) Green circles represent active platforms detected in 2023, orange and yellow dots represent the locations of active fixed and floating offshore platforms, respectively, in the validation data. The red areas represent the traffic diversion schemes approved by the IMO. The numerically marked circles represent platform records detected in this study but missing from the validation data. (b) Sentinel-2 high-resolution RGB images of these numerically marked platforms.

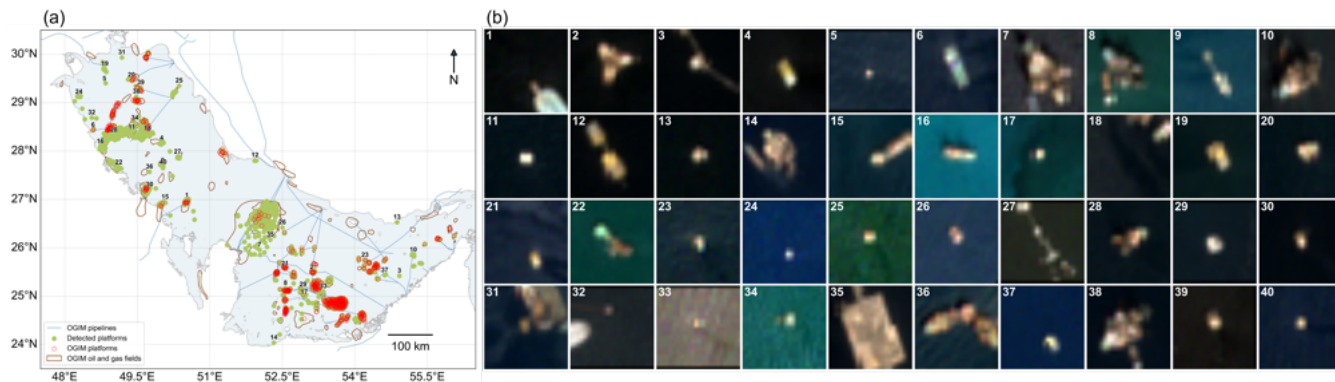


Figure S9. Spatial distribution of offshore oil and gas platforms detected and OGIM structures in the Persian gulf in 2023. (a) Green circles represent platforms detected in 2023, and red circles represent the locations of OGIM offshore platforms. The numerically marked samples represent platforms detected in this study but located outside the 1000m buffer area of oil and gas fields and pipelines. (b) Sentinel-2 high-resolution RGB images of the numerically marked platforms.

8 The temporal trends in PG which reflect infrastructure changes

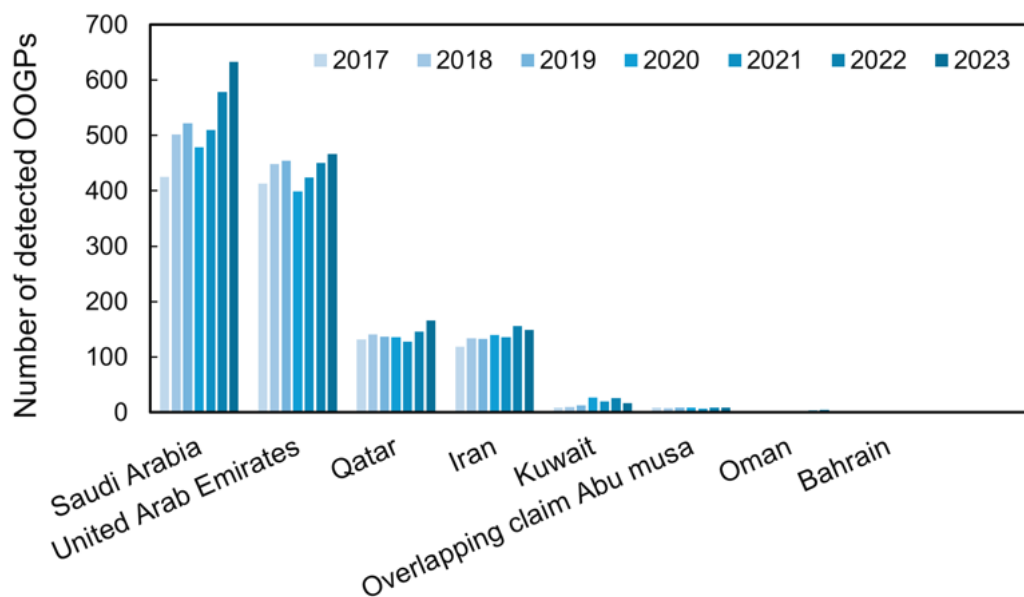


Figure S10. Temporal count changes of detected offshore oil and gas platforms between different countries in the Persian Gulf.

References

- Martins, M. C. I., Carter, M. I., Rouse, S., and Russell, D. J.: Offshore energy structures in the North Sea: Past, present and future, *Marine Policy*, 152, 105 629, <https://doi.org/10.1016/j.marpol.2023.105629>, 2023.
- 15 Zhang, T., Tian, B., Sengupta, D., Zhang, L., and Si, Y.: Global offshore wind turbine dataset, *Scientific Data*, 8, 191, <https://doi.org/10.1038/s41597-021-00982-z>, publisher: Nature Publishing Group, 2021.