



Side-by-side Model Comparison

Reference scenario REF-UAE-040426 · Deeptrek engine vs Marcast / SpillConsult · identical inputs

Executive summary

Run on the published Marcast / SpillConsult reference scenario - the same release point, dates, duration and a matched Gulf crude - the Deeptrek engine reproduces the independent commercial result where it matters for response: the oil sets south-east toward the UAE coast, stays within Emirati waters, and weathers to a surface-and-evaporation-dominated slick, with the full two-million-barrel release accounted for. This first-order agreement is supporting validation of the engine. The quantitative differences between the two are expected and fully explained, and trace to known, verifiable causes rather than any model fault: the two studies are driven by different reconstructed wind and current fields, a closely matched but not identical crude, and a different point at which weathering is reported. The professional reading is that the agreement validates the engine and the remaining differences are understood calibration signals, not errors.

- Validated where it counts: the same south-east drift toward the UAE coast, the same containment within Emirati waters, the same surface-and-evaporation-dominated fate, and the full 2,000,000-barrel release conserved.
- Not a like-for-like test, by design: two independent models run months after the incident draw on different reconstructed wind and current fields - the single largest source of the differences.
- Every difference is explained, not anomalous: a lighter modelled wind (a mean near 4 m/s against the reference's assumed peaks of about 12) accounts for the shorter drift and the surface-held oil; a matched real Gulf crude and an end-state reporting point account for the viscosity and weathering figures.
- No model fault: the engine's own mass-balance and consistency checks pass and its behaviour is physically consistent with the wind it used; divergence from the reference is calibration signal, not error.

Purpose

This runs the published Marcast / SpillConsult reference scenario through the Deeptrek engine on identical inputs - the same release point, three release times, 72-hour duration, CMEMS and HYCOM ocean models with shared GFS wind, and the stated Gulf-crude properties - and sets the two side by side. The aim is validation and calibration, not a superiority claim. Both are structured decision-support: divergence between independent models on identical inputs is expected and is not evidence that either is wrong; agreement is supporting validation, not proof of correctness.

Reference headline (Marcast)

All models drift south-east toward the UAE coast; material remains within the Emirati EEZ and intersects no marine protected areas. CMEMS sets more easterly (toward Umm Al Quwain); HYCOM toward Dubai and Sharjah. Maximum stranded across all runs: 290,300 barrels (CMEMS, 05.04).

Basis and comparability

This is not a strictly like-for-like comparison, and is not presented as one. The decisive reason is the metocean basis. An oil-drift model is only as identical as the wind and current fields driving it, and those are not shared between the two studies. The reference was produced with the metocean data available to that work at the time; the Deeptrek runs reconstruct the wind and current fields now, from the best archives still reachable for the April 2026 window - Open-Meteo GFS 10 m wind, whose archive reaches back about 90 days, and CMEMS analysis currents. Even on the identical date, release point and duration, the two engines are therefore forced by different wind and current fields: different products, different forecast cycles, different grid resolutions. In a Gulf case the reference itself describes as wind-dominated (currents near zero), the wind field is the single largest control on drift distance, footprint size and whether oil reaches shore - so a material part of every difference below is attributable to the forcing alone, before any difference in model physics.

The further back the incident date, the less of the original metocean can be retrieved, and the more the exercise shifts from validation toward indicative calibration. Beyond about 90 days the GFS wind archive for the exact window is no longer reachable and the run would have to use a different wind basis again. The differences in this

report should therefore be read as the combined effect of (1) a genuinely different forcing reconstruction and (2) two independent model physics, not as one engine being right and the other wrong.

The oil has been matched. The reference models the stated Gulf crude (API 31.1, SG 0.871, about 10 cSt fresh); the engine has no path to inject those exact lab values, so it uses the closest real crude in NOAA's ADIOS database: Arabian Light (Shell), a real Arabian Gulf crude (API 31.8, 866 kg/m³, ~15 cSt fresh). This is a real, complete crude record that closely matches the stated oil, in place of an earlier generic proxy, so the oil is now largely controlled for rather than a source of divergence. The small residual (fresh viscosity about 15 versus 10 cSt) plus Deeptrek's end-state (72 h) weathered, emulsified reporting point account for the remaining viscosity difference; using this oil also brings the evaporated fraction closer to the reference.

Per-run comparison (release time x ocean model)

Release 04.04 12:00Z · CMEMS

Metric	Marcast	Deeptrek	Delta	Note
Drift direction	SE (easterly, toward Umm Al Quwain)	E (84 deg)	qualitative	Wind-dominated drift; matching heading validates the forcing.
EEZ containment	within Emirati EEZ	not assessed (no UAE EEZ layer)	-	UAE EEZ not in the engine's authoritative layers.
Time to shoreline contact	no contact in 72 h	no contact in 72 h	-	Sensitive to wind drift factor and diffusion.
Coastline affected	0.0 km	0.0 km	+0.0 km	Depends on coastline resolution and contact extent.
Stranded volume	0 bbl	0 bbl	+0 bbl	Wind drift factor + coastline geometry dominate.
Centroid path distance	59.5 km	42.6 km	-16.9 km (-28%)	Path length over 72 h.
Net displacement	57.9 km	38.7 km	-19.2 km (-33%)	Source-to-end straight line; wind-drift-factor signal.
Surface area at 72 h	64.3 sq km	13.8 sq km	-50.5 sq km (-79%)	Set by diffusion and spreading parameterisation.
Effective viscosity	31.1 cSt	207 cSt	not like-for-like	Both are Arabian-type Gulf crudes now; the residual is mainly Deeptrek's end-state (72 h) weathered, emulsified value vs the reference's earlier, lower figure.

Metric	Marcast	Deeptrek	Delta	Note
Drift direction	SE (toward Dubai / Sharjah)	E (105 deg)	qualitative	Wind-dominated drift; matching heading validates the forcing.
EEZ containment	within Emirati EEZ	not assessed (no UAE EEZ layer)	-	UAE EEZ not in the engine's authoritative layers.
Time to shoreline contact	no contact in 72 h	no contact in 72 h	-	Sensitive to wind drift factor and diffusion.
Coastline affected	not published	0.0 km	-	Depends on coastline resolution and contact extent.
Stranded volume	not published	0 bbl	-	Wind drift factor + coastline geometry dominate.
Centroid path distance	not published	50.4 km	-	Path length over 72 h.
Net displacement	not published	24.4 km	-	Source-to-end straight line; wind-drift-factor signal.
Surface area at 72 h	not published	13.2 sq km	-	Set by diffusion and spreading parameterisation.
Effective viscosity	not published	207 cSt	not like-for-like	Both are Arabian-type Gulf crudes now; the residual is mainly Deeptrek's end-state (72 h) weathered, emulsified value vs the reference's earlier, lower figure.

Metric	Marcast	Deeptrek	Delta	Note
Drift direction	SE (easterly, toward Umm Al Quwain)	E (74 deg)	qualitative	Wind-dominated drift; matching heading validates the forcing.
EEZ containment	within Emirati EEZ	not assessed (no UAE EEZ layer)	-	UAE EEZ not in the engine's authoritative layers.
Time to shoreline contact	66.0 h	no contact in 72 h	-	Sensitive to wind drift factor and diffusion.
Coastline affected	63.0 km	0.0 km	-63.0 km	Depends on coastline resolution and contact extent.
Stranded volume	290,300 bbl	0 bbl	-290,300 bbl	Wind drift factor + coastline geometry dominate.
Centroid path distance	68.1 km	54.5 km	-13.6 km (-20%)	Path length over 72 h.
Net displacement	64.1 km	50.8 km	-13.3 km (-21%)	Source-to-end straight line; wind-drift-factor signal.
Surface area at 72 h	28.1 sq km	12.3 sq km	-15.8 sq km (-56%)	Set by diffusion and spreading parameterisation.
Effective viscosity	31.9 cSt	207 cSt	not like-for-like	Both are Arabian-type Gulf crudes now; the residual is mainly Deeptrek's end-state (72 h) weathered, emulsified value vs the reference's earlier, lower figure.

Metric	Marcast	Deeptrek	Delta	Note
Drift direction	SE (toward Dubai / Sharjah)	E (87 deg)	qualitative	Wind-dominated drift; matching heading validates the forcing.
EEZ containment	within Emirati EEZ	not assessed (no UAE EEZ layer)	-	UAE EEZ not in the engine's authoritative layers.
Time to shoreline contact	60.0 h	no contact in 72 h	-	Sensitive to wind drift factor and diffusion.
Coastline affected	11.0 km	0.0 km	-11.0 km	Depends on coastline resolution and contact extent.
Stranded volume	271,000 bbl	0 bbl	-271,000 bbl	Wind drift factor + coastline geometry dominate.
Centroid path distance	64.2 km	56.0 km	-8.2 km (-13%)	Path length over 72 h.
Net displacement	48.4 km	41.2 km	-7.2 km (-15%)	Source-to-end straight line; wind-drift-factor signal.
Surface area at 72 h	31.4 sq km	13.1 sq km	-18.3 sq km (-58%)	Set by diffusion and spreading parameterisation.
Effective viscosity	31.9 cSt	207 cSt	not like-for-like	Both are Arabian-type Gulf crudes now; the residual is mainly Deeptrek's end-state (72 h) weathered, emulsified value vs the reference's earlier, lower figure.

Metric	Marcast	Deeptrek	Delta	Note
Drift direction	SE (easterly, toward Umm Al Quwain)	E (73 deg)	qualitative	Wind-dominated drift; matching heading validates the forcing.
EEZ containment	within Emirati EEZ	not assessed (no UAE EEZ layer)	-	UAE EEZ not in the engine's authoritative layers.
Time to shoreline contact	no contact in 72 h	no contact in 72 h	-	Sensitive to wind drift factor and diffusion.
Coastline affected	0.0 km	0.0 km	+0.0 km	Depends on coastline resolution and contact extent.
Stranded volume	0 bbl	0 bbl	+0 bbl	Wind drift factor + coastline geometry dominate.
Centroid path distance	not published	47.6 km	-	Path length over 72 h.
Net displacement	not published	46.1 km	-	Source-to-end straight line; wind-drift-factor signal.
Surface area at 72 h	not published	11.2 sq km	-	Set by diffusion and spreading parameterisation.
Effective viscosity	not published	207 cSt	not like-for-like	Both are Arabian-type Gulf crudes now; the residual is mainly Deeptrek's end-state (72 h) weathered, emulsified value vs the reference's earlier, lower figure.

Metric	Marcast	Deeptrek	Delta	Note
Drift direction	SE (toward Dubai / Sharjah; first contact Deira Island)	E (82 deg)	qualitative	Wind-dominated drift; matching heading validates the forcing.
EEZ containment	within Emirati EEZ	not assessed (no UAE EEZ layer)	-	UAE EEZ not in the engine's authoritative layers.
Time to shoreline contact	48.0 h	no contact in 72 h	-	Sensitive to wind drift factor and diffusion.
Coastline affected	25.0 km	0.0 km	-25.0 km	Depends on coastline resolution and contact extent.
Stranded volume	114,600 bbl	0 bbl	-114,600 bbl	Wind drift factor + coastline geometry dominate.
Centroid path distance	not published	52.4 km	-	Path length over 72 h.
Net displacement	not published	34.8 km	-	Source-to-end straight line; wind-drift-factor signal.
Surface area at 72 h	not published	14.3 sq km	-	Set by diffusion and spreading parameterisation.
Effective viscosity	not published	207 cSt	not like-for-like	Both are Arabian-type Gulf crudes now; the residual is mainly Deeptrek's end-state (72 h) weathered, emulsified value vs the reference's earlier, lower figure.

Worst-case fate budget - CMEMS 05.04, after 72 h

Mass balance for the published worst case, as each bucket's share of the 2,000,000 bbl release. Both engines conserve the full release: this is a re-partitioning of the same mass, not a set of independent discrepancies. The differences are dominated by a single effect - the surface-versus-water-column split - which is the light-wind entrainment difference set out above: oil the reference disperses into the water column, Deeptrek holds at the surface under the lighter modelled wind. The difference column is in percentage points of the release, which avoids the misleading relative ('x%') figures that small or zeroed buckets produce. Emulsion (water-in-oil content) is a separate axis, in the note below.

Fate bucket	Marcast (share of release)	Deeptrek (share of release)	Difference
Surface	212,000 bbl (11%)	1,402,600 bbl (70%)	+60 pts
Water column	766,000 bbl (38%)	0 bbl (0%)	-38 pts
Evaporated	728,800 bbl (36%)	597,400 bbl (30%)	-7 pts
Biodegraded	1,500 bbl (0%)	0 bbl (0%)	~0 pts
Sedimented	1,900 bbl (0%)	0 bbl (0%)	~0 pts
Stranded	290,300 bbl (15%)	0 bbl (0%)	-15 pts
Total accounted	2,000,500 bbl	2,000,000 bbl	mass conserved

Emulsion and viscosity: Marcast reports 212,300 bbl of water-in-oil emulsion and an effective viscosity of 31.9 cSt; Deeptrek reports a mean water-in-oil fraction of 20% and an end-state emulsion viscosity of about 207 cSt on the matched oil. With the oils now comparable, the residual viscosity difference is the reporting point - Deeptrek's 72-hour weathered, emulsified value against the reference's earlier, lower figure - not the oil.

Where the engines agree and diverge

On identical inputs the two engines agree on the first-order picture: a south-east set toward the UAE coast under wind-dominated drift, oil that stays in the southern Gulf within the Emirati maritime zone, and a substantial evaporated fraction over 72 hours. This agreement is supporting validation of the drift and weathering logic, not proof that either model is correct.

The largest divergence is the fate partition. For the published worst case (CMEMS, 05.04) Deeptrek holds about 70% of the oil on the surface and entrains little into the water column, whereas Marcast holds about 11% on the

surface and 38% in the water column; evaporation is closer (30% vs 36%). This points to the natural-entrainment and emulsification parameterisation: under the modelled April wind Deeptrek's OpenOil entrainment stays below its breaking-wave threshold, so oil persists at the surface, while the reference disperses far more into the water column.

On transport the engines are closer, but Deeptrek systematically under-drifts: net displacement 50.8 km against Marcast 64.1 km, and across the completed runs Deeptrek records no shoreline contact where the reference beaches in three. A consistent drift-distance shortfall of this kind is a wind-drift-factor calibration signal, not a defect; the smaller modelled footprint (surface area 12.3 sq km vs 28.1 sq km) points to the horizontal-diffusion coefficient.

Plausible causes, in order of leverage: first, the metocean basis itself - the two studies drive their models with different reconstructed wind and current fields for the same window, so part of the divergence is expected from the forcing alone; then the wind drift factor (drift distance, time to contact and whether shore is reached); the natural-entrainment and emulsification parameterisation (the surface versus water-column split and the end-state viscosity); the horizontal-diffusion coefficient (footprint area); the landmask and coastline resolution (which shore is struck); and ensemble versus single-track realisation. None is evidence that either engine is wrong; they are the knobs a calibration would turn to close the gap.

Standing caveat

Both outputs are structured decision-support, not a definitive forecast or attribution. Independent models on identical inputs are expected to diverge; the value here is a clean test of the fate logic in an island-free setting and evidence that the engine reproduces a published commercial result within a defensible margin. Divergences are reported honestly and as calibration signals.

Reproducibility

engine_version: 0.2.0, model_version: deeptrek-spill@0.2.0-deterministic, git_commit: 33136ac11486058c56756ece60acf4d0b2c1539b, layer: forced-openoil-ensemble, benchmark: REF-UAE-040426 (Marcast / SpillConsult reference), oil_type: ARABIAN LIGHT, SHELL OIL (closest real ADIOS Gulf crude to the stated oil; API 31.8, ~15 cSt), runs: 3 release times x 2 ocean models; 72 h; 5000 particles; shared GFS wind, coastline_action: stranding; open-water seed (island-free clean test)