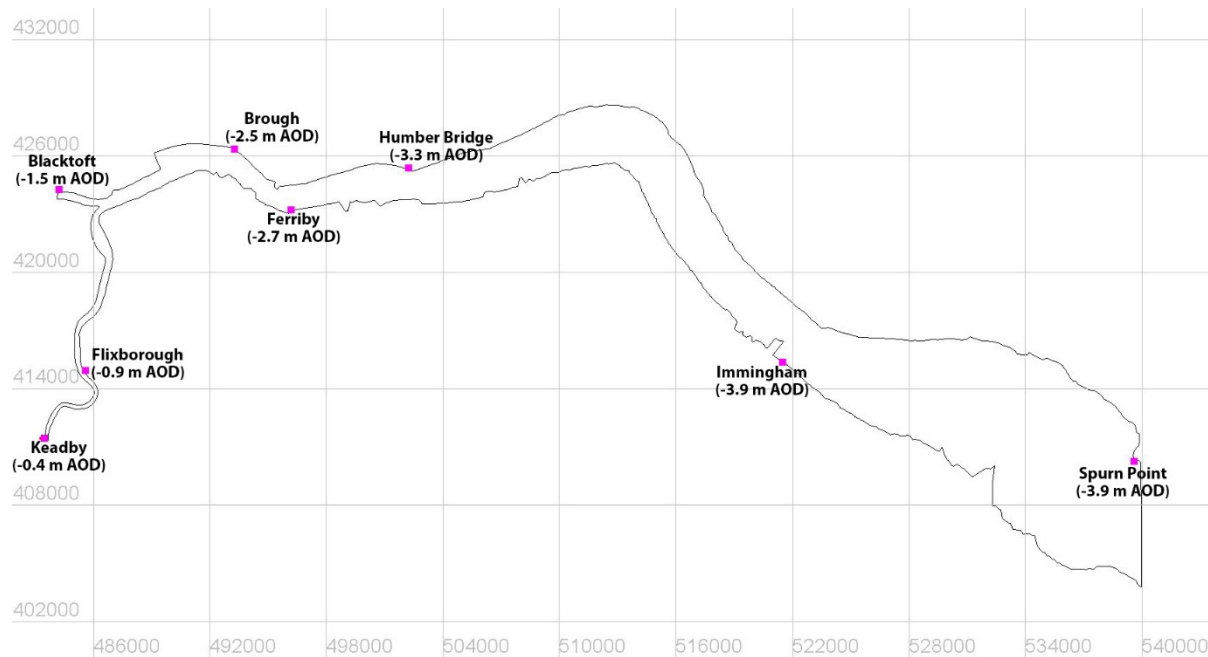


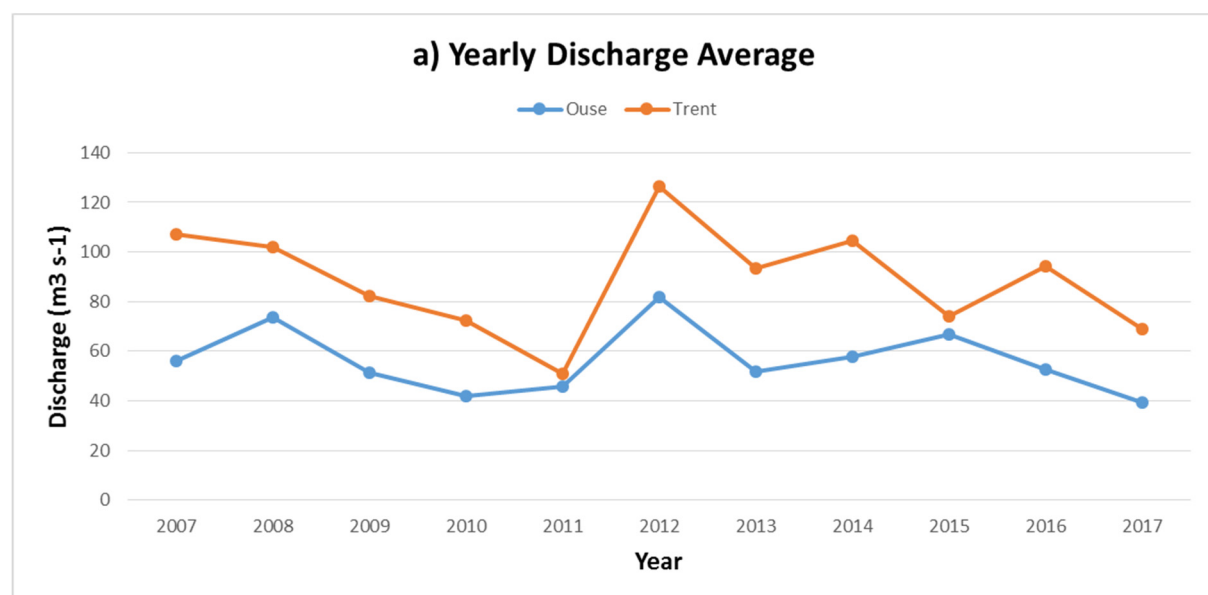
## Supplementary material

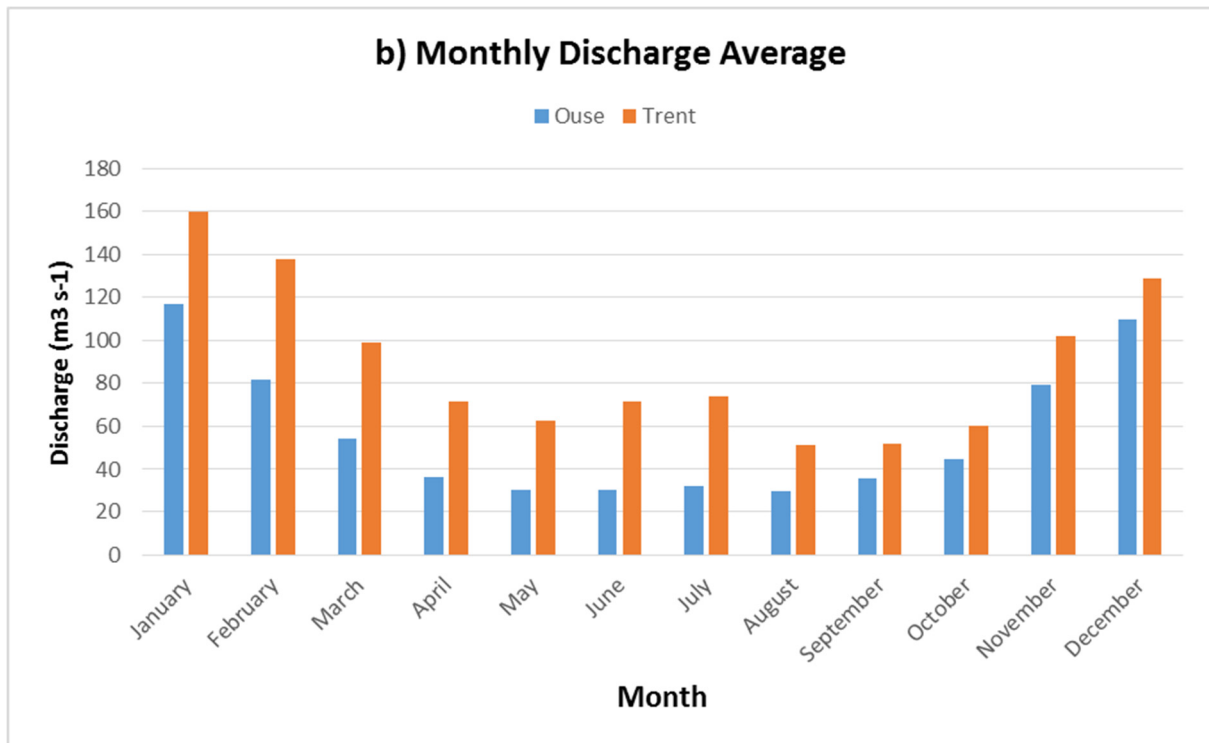


**Figure S1: Outline of the Humber Estuary showing metres Above Ordnance Datum (m AOD) at various locations.**

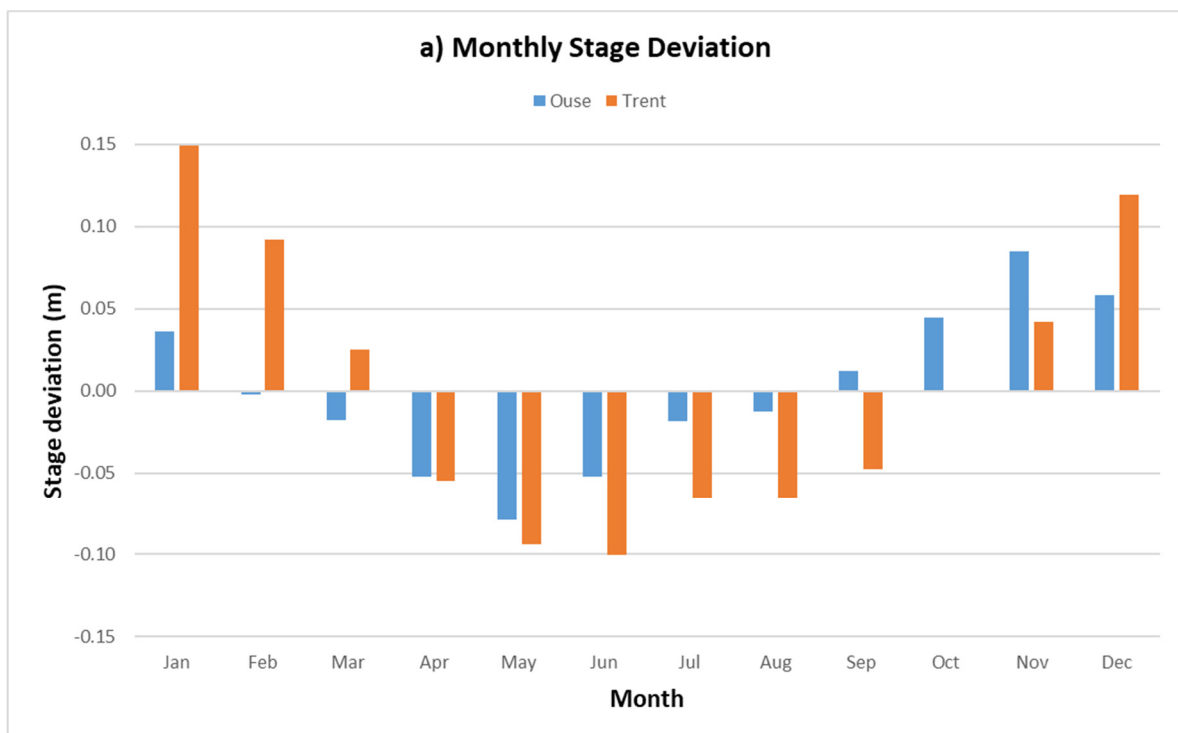
**Table S1: Seasonal mean discharges of freshwater ( $\text{m}^3 \text{s}^{-1}$ ) into the Humber Estuary in the period 2007 – 2017 (UK Environment Agency data)**

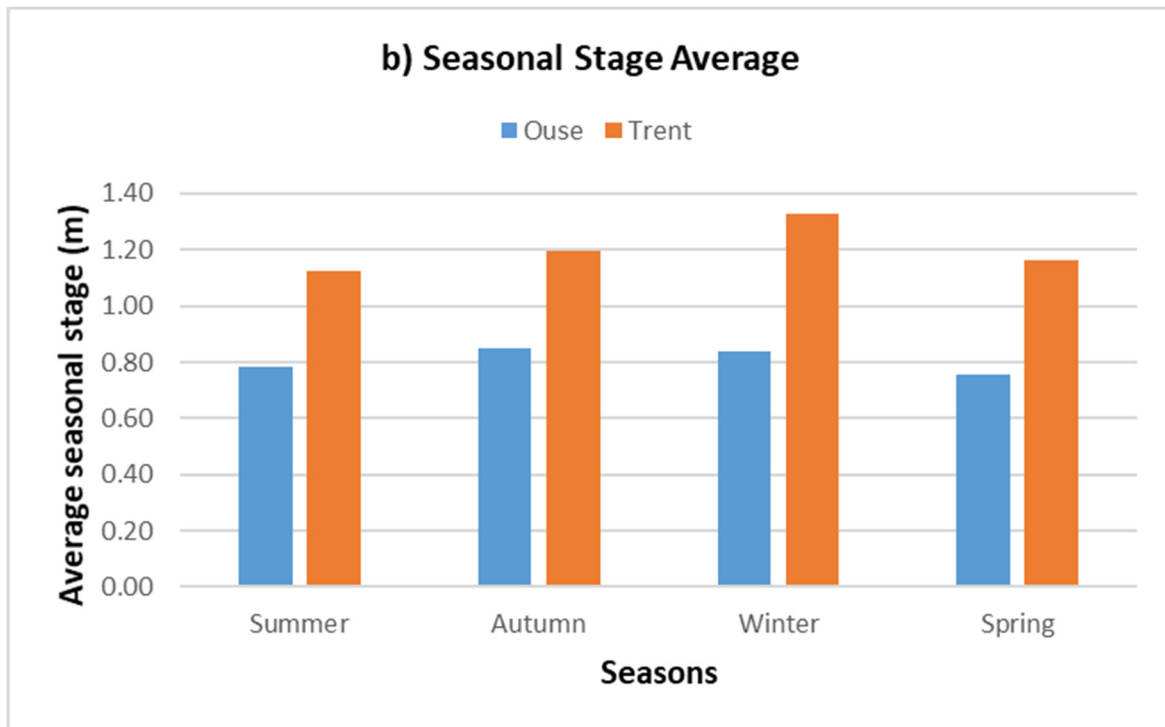
Season	River Ouse	River Trent
Summer (JJA)	30.95	65.53
Autumn (SON)	53.13	71.43
Winter (DJF)	102.60	141.98
Spring (MAM)	40.45	77.85





**Figure S2: a) Yearly discharge averages for Rivers Ouse and Trent; b) Monthly discharge averages for Rivers Ouse and Trent (2007 – 2017).**





**Figure S3: a) Average monthly deviations from annual stage averages (m) at Blacktoft (River Ouse) and Keady (River Trent) from 2007 to 2017; b) Seasonal stage averages (m) at Blacktoft and Keadby (2007 – 2017). Seasonal definitions: summer = JJA; winter = DJF.**

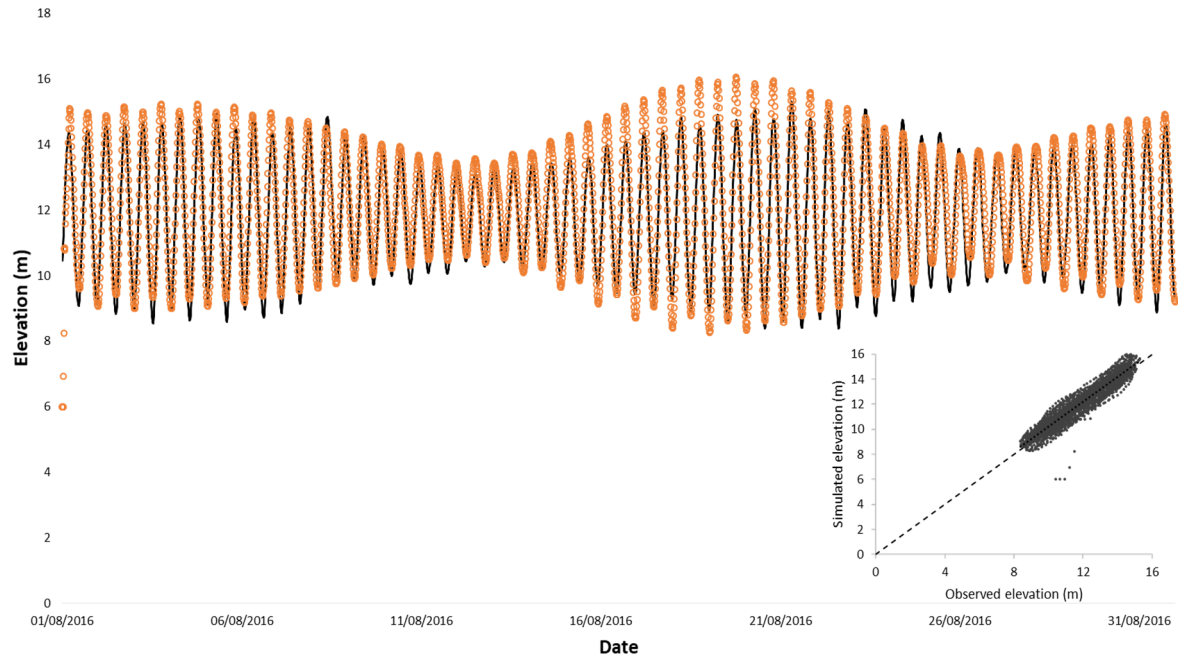
**Table S2: Summary of the oil slick release scenarios (tidal stage is with reference to Immingham station). Scenarios are repeated for both L1 and L2.**

Scenario	Oil release time	
	Summer (August 2017)	Winter (February 2010)
HW NT	02/08/2017 (02:00)	07/02/2010 (23:15)
LW NT	01/08/2017 (18:45)	06/02/2010 (17:30)
HW ST	08/08/2017 (18:00)	01/02/2010 (19:30)
LW ST	08/08/2017 (00:15)	01/02/2010 (14:00)

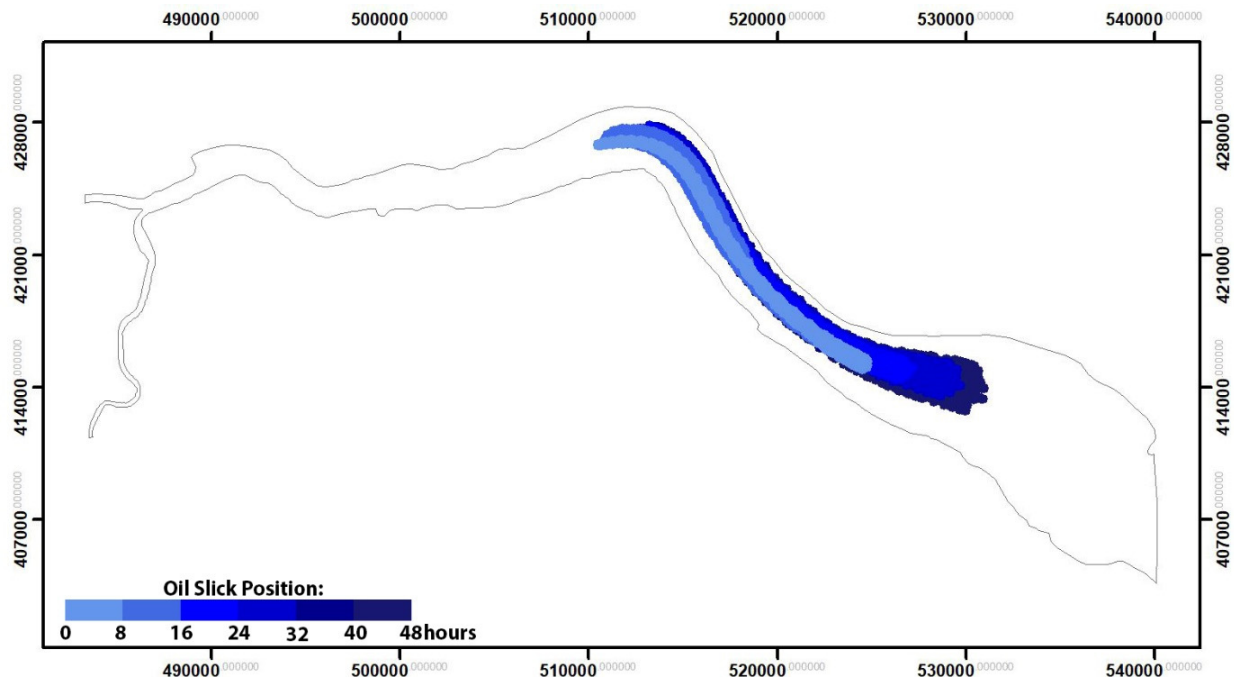
Note: HW = high water; LW = low water; NT = neap tide; ST = spring tide.

**Table S3: Wind speed and direction applied to the oil spill simulation.**

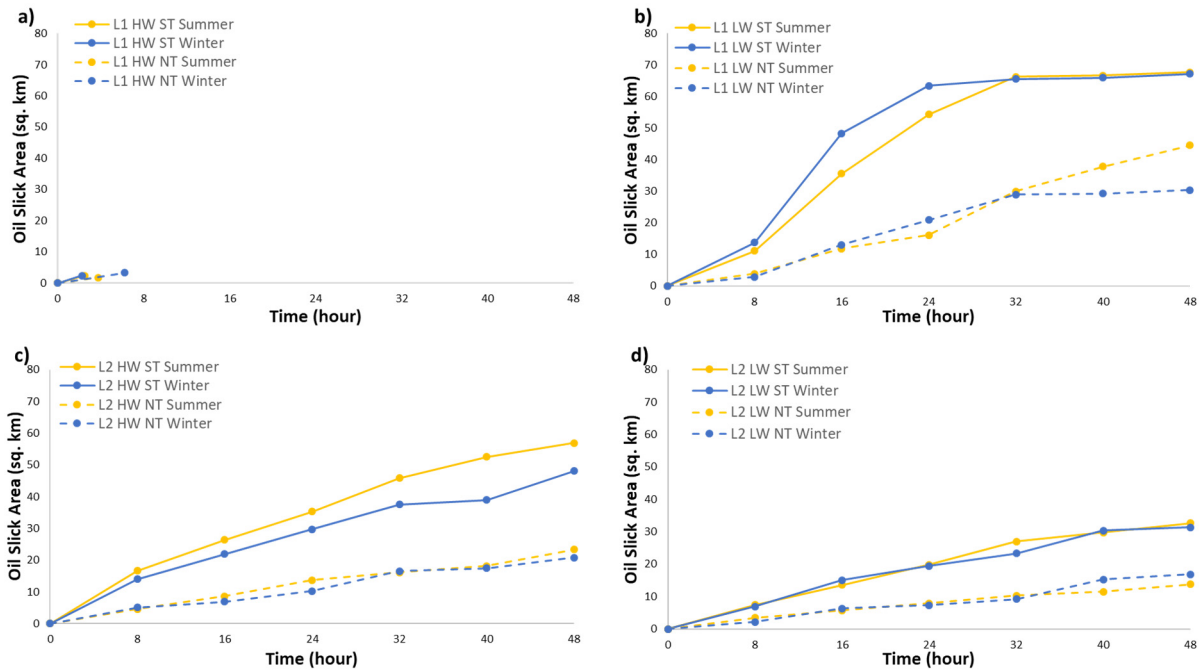
Season	Wind Speed (m s <sup>-1</sup> )	Wind Direction (degree)
Summer (August 2017)	4.75	211
Winter (February 2010)	6.05	167



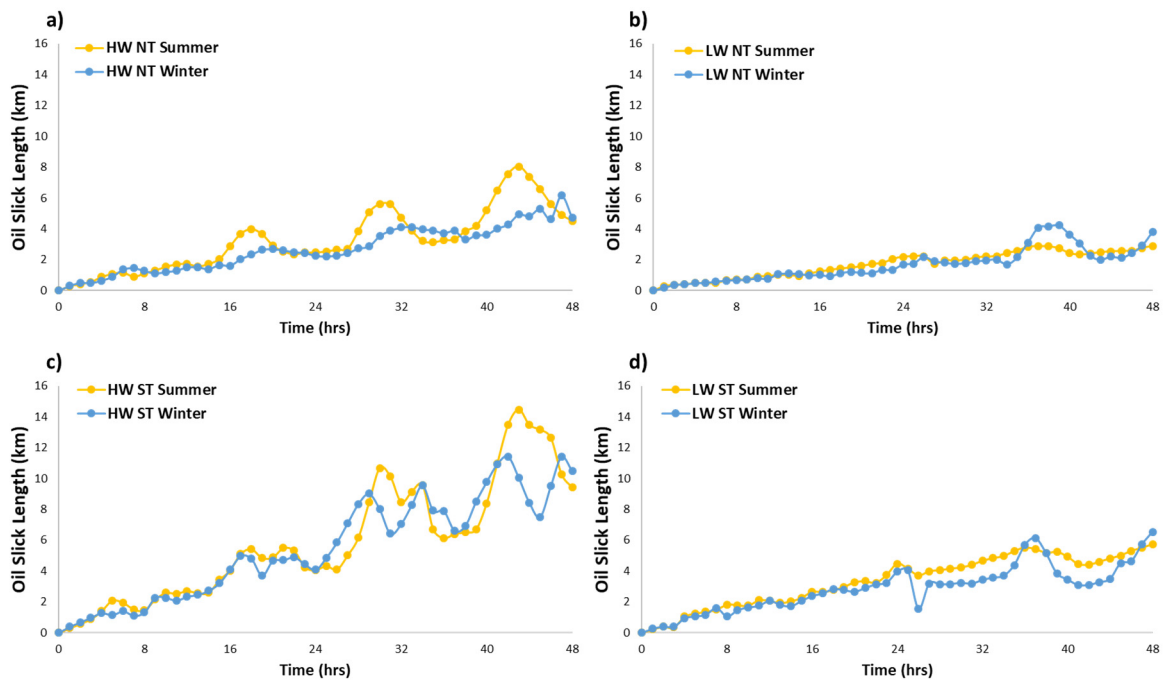
**Figure S4: Observed (line) and simulated (points) free surface elevations at Immingham for the validation summer period (August 2016). Inset: Point correlation between observed and simulated tidal elevations ( $R^2 = 0.912$ ).**



**Figure S5: Example simulated oil spill trajectory, released from L2 at high water spring in winter.**



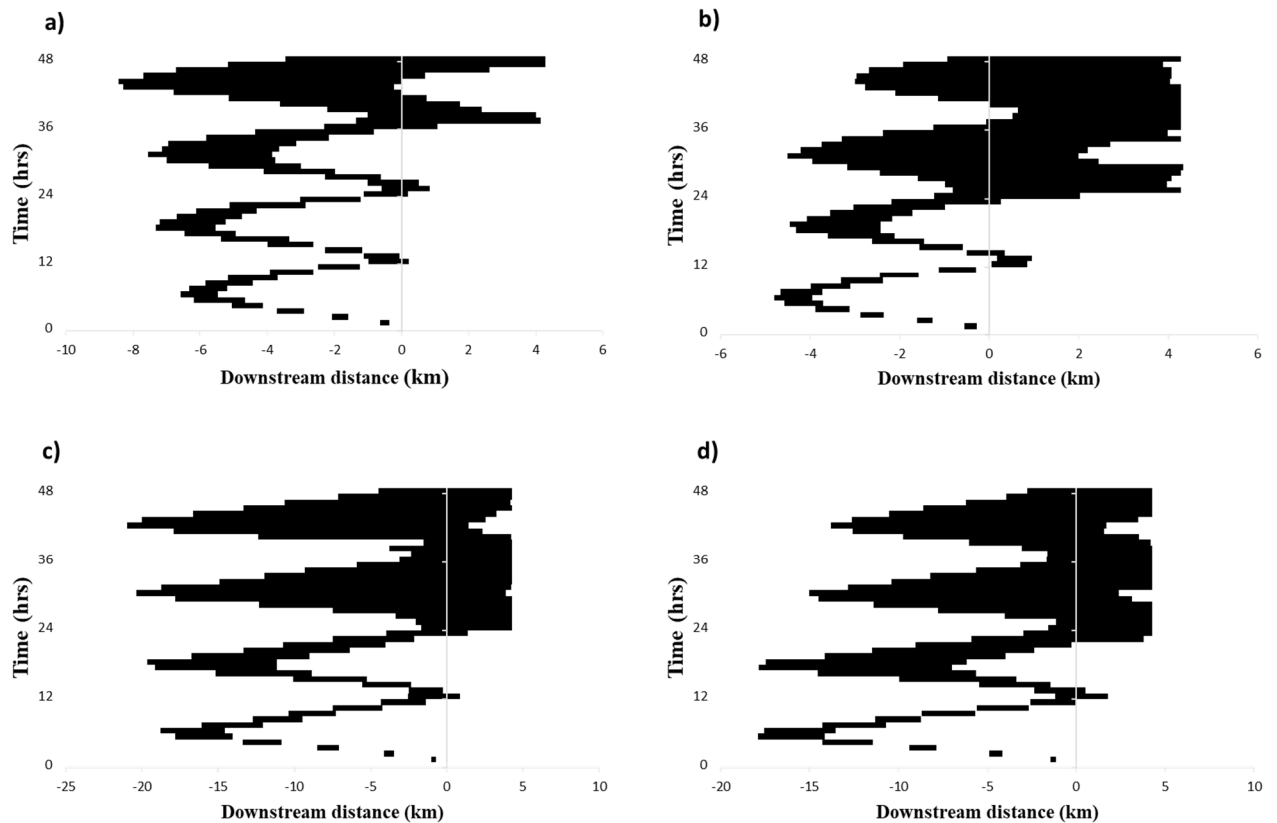
**Figure S6: Area covered by simulated oil slick over time for a spill a) at L1 HW; b) at L1 LW; c) at L2 HW; d) L2 LW at spring tide (solid line) and neap tide (dashed line) in different seasons.**



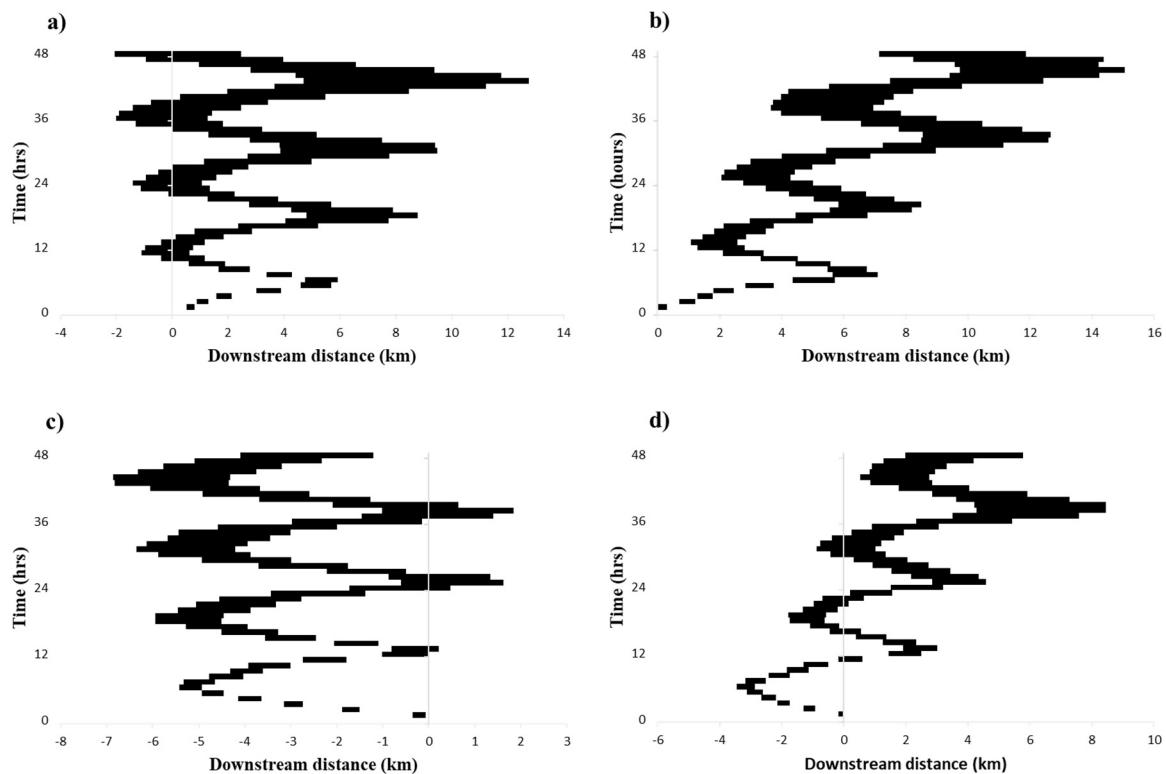
**Figure S7: L2 oil slick length over time for a spill a) at HW NT; b) at LW NT; c) at HW ST; d) LW ST.**

**Table S4: Relative properties of comparable oil slicks released in the summer and winter (ratio = summer value / winter value), as measured 48 hours after the spill.**

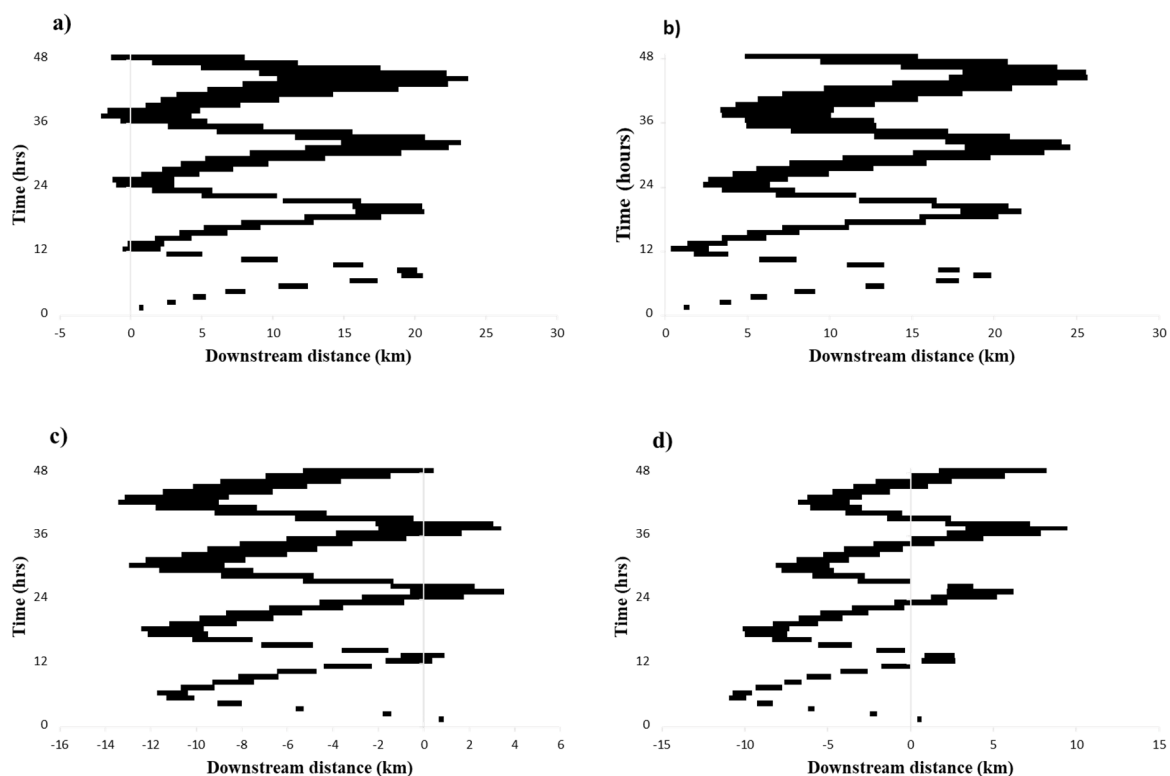
	impacted area ratio						length ratio	distance ratio
	8 h	16 h	24 h	32 h	40 h	48 h	48 h	48 h
L2 HW NT	0.92	1.25	1.34	0.98	1.04	1.12	0.96	0.98
L2 LW NT	1.56	0.91	1.09	1.13	0.75	0.81	0.76	0.73
L2 HW ST	1.19	1.21	1.21	1.22	1.35	1.18	0.90	1.01
L2 LW ST	1.07	0.90	1.02	1.16	0.98	1.04	0.88	0.83
Average	1.19	1.07	1.17	1.12	1.03	1.04	0.88	0.89



**Figure S8: Longitudinal position and extent of L1 oil slicks over time: a) LW NT summer; b) LW NT winter; c) LW ST summer; and d) LW ST winter**



**Figure S9: Longitudinal position and extent of L2 oil slicks over time: a) HW NT summer; b) HW NT winter; c) LW NT summer; and d) LW NT winter**



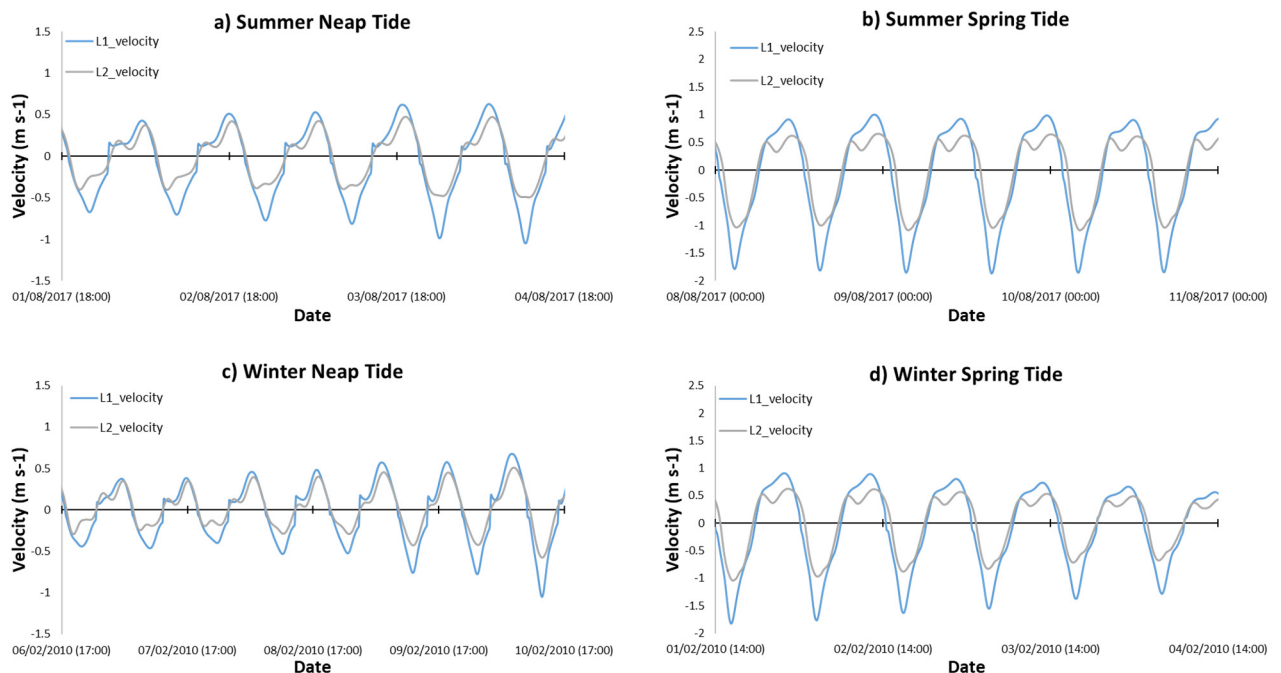
**Figure S10: Longitudinal position and extent of L2 oil slicks over time: a) HW ST summer; b) HW ST winter; c) LW ST summer; and d) LW ST winter**

**Table S5: Summary of maximum oil slick displacement (km) from point of release.**

	upstream displacement (summer)	upstream displacement (winter)	downstream displacement (summer)	downstream displacement (winter)
L2 HW NT	2.07	0	12.75	15.05
L2 LW NT	6.85	3.46	1.84	8.44
L2 HW ST	2.10	0	23.75	25.67
L2 LW ST	13.43	10.96	3.52	9.45

**Table S6: Relative properties of comparable oil slicks released at spring and neap tides (ratio = ST value / NT value), as measured 48 hours after the spill.**

	impacted area ratio						length ratio	distance ratio
	8 h	16 h	24 h	32 h	40 h	48 h	48 h	48 h
L2 HW summer	3.61	3.06	2.57	2.85	2.89	2.44	2.08	1.74
L2 HW winter	2.78	3.16	2.90	2.28	2.23	2.31	2.22	1.71
L2 LW summer	2.17	2.35	2.50	2.62	2.60	2.37	1.99	1.95
L2 LW winter	3.16	2.38	2.67	2.54	1.99	1.86	1.71	1.72
Average	2.93	2.74	2.66	2.57	2.43	2.25	2.00	1.78



**Figure S11: Simulated free surface velocities covering the duration of oil spill during a) SU NT; b) SU ST; c) WI NT; and d) WI ST. Note: negative current velocity indicates upstream movement while positive current velocity indicates downstream movement.**



**Table S7: Relative properties of comparable oil slicks released at high and low water (ratio = HW value / LW value), as measured 48 hours after the spill.**

	impacted area ratio						length ratio	distance ratio
	8 h	16 h	24 h	32 h	40 h	48 h	48 h	48 h
L2 NT summer	1.34	1.49	1.73	1.56	1.59	1.69	1.57	1.71
L2 NT winter	2.29	2.29	1.40	1.80	1.16	1.23	1.24	1.26
L2 ST summer	2.23	1.94	1.81	1.70	1.76	1.74	1.64	1.53
L2 ST winter	2.02	1.45	1.52	1.61	1.28	1.53	1.61	1.26
Average	1.97	1.79	1.62	1.67	1.45	1.55	1.52	1.44

**Table S8: Ratios between impacted areas of oil slick released at L1 and L2.**

	8h	16 h	24 h	32 h	40 h	48 h
LW ST summer	1.15	2.06	2.03	2.90	3.30	3.23
LW ST winter	1.33	2.07	2.87	3.15	1.92	1.80
LW NT summer	1.49	2.62	2.74	2.45	2.24	2.07
LW NT winter	1.99	3.21	3.26	2.81	2.18	2.14