Potential oil spill risk from an oil terminal at the Port of Taranto (Southern Italy)

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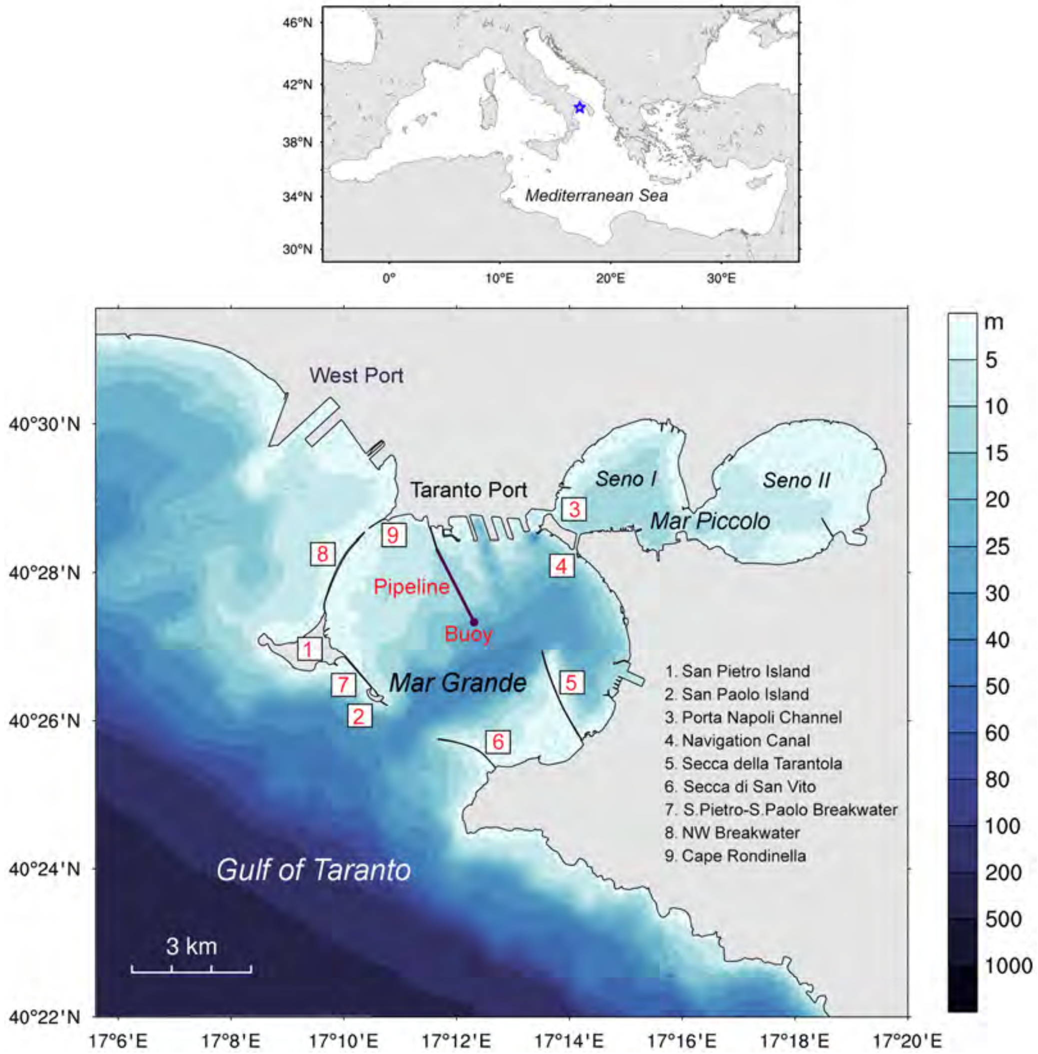
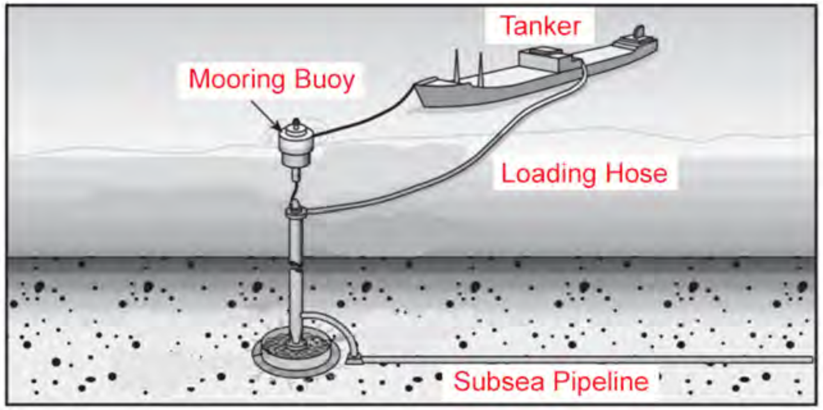
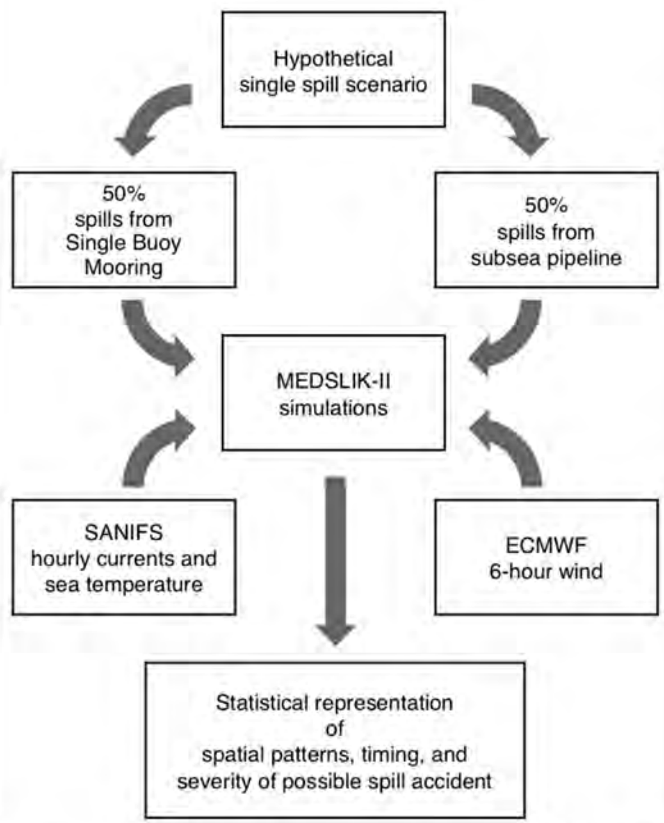
Study Area





Single Point Buoy Mooring and subsea pipeline
as the possible sources of oil pollution

Spill scenario and stochastic simulations for the Port of Taranto



Schematic diagram of the stochastic oil modeling for the Port of Taranto.

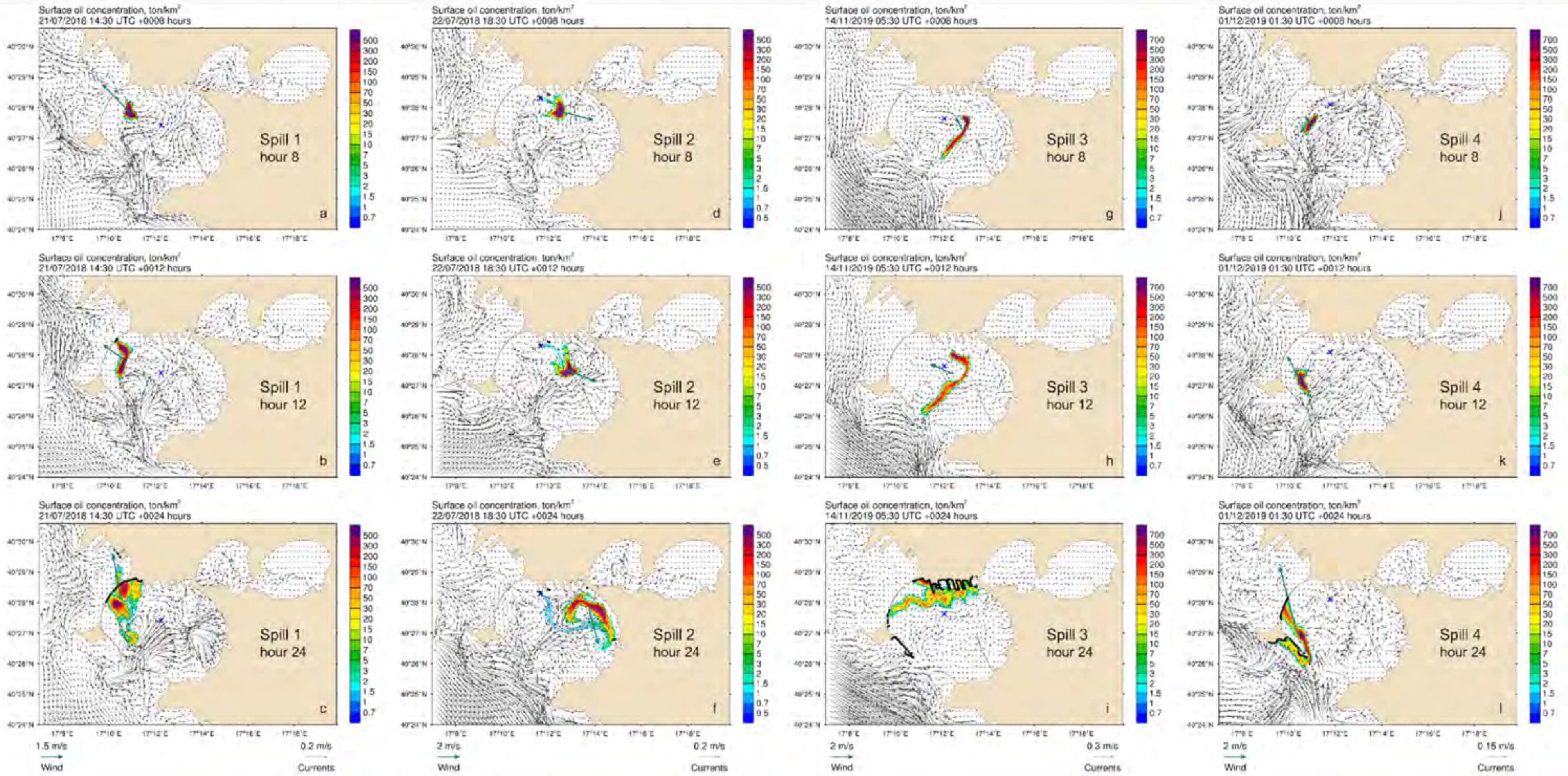
Spill scenario is based on a real accident
caused by a catastrophic pipeline failure near the Genoa Port
in April 2016 (Vairo et al., 2017)

$15{,}000^{+}$ spills are simulated

Oil spill scenario and computation parameters for the MEDSLIK-II stochastic simulations.

Start locations	Randomly sampling: 50% from the single-point buoy mooring and 50% along the subsea pipeline
Start time	Uniformly sampling with an interval of 2 hours over 1 July 2018 – 30 June 2020
Oil type	Crude oil with density of 856 kg m^{-3} at 16 °C (API = 33.8)
Spill type	Continuous release
Spill amount	600 tons
Spill duration	2 hours
Number of Lagrangian particles	100,000
Simulation length	48 hours
Bin size	50 m
Integration time step	5 min

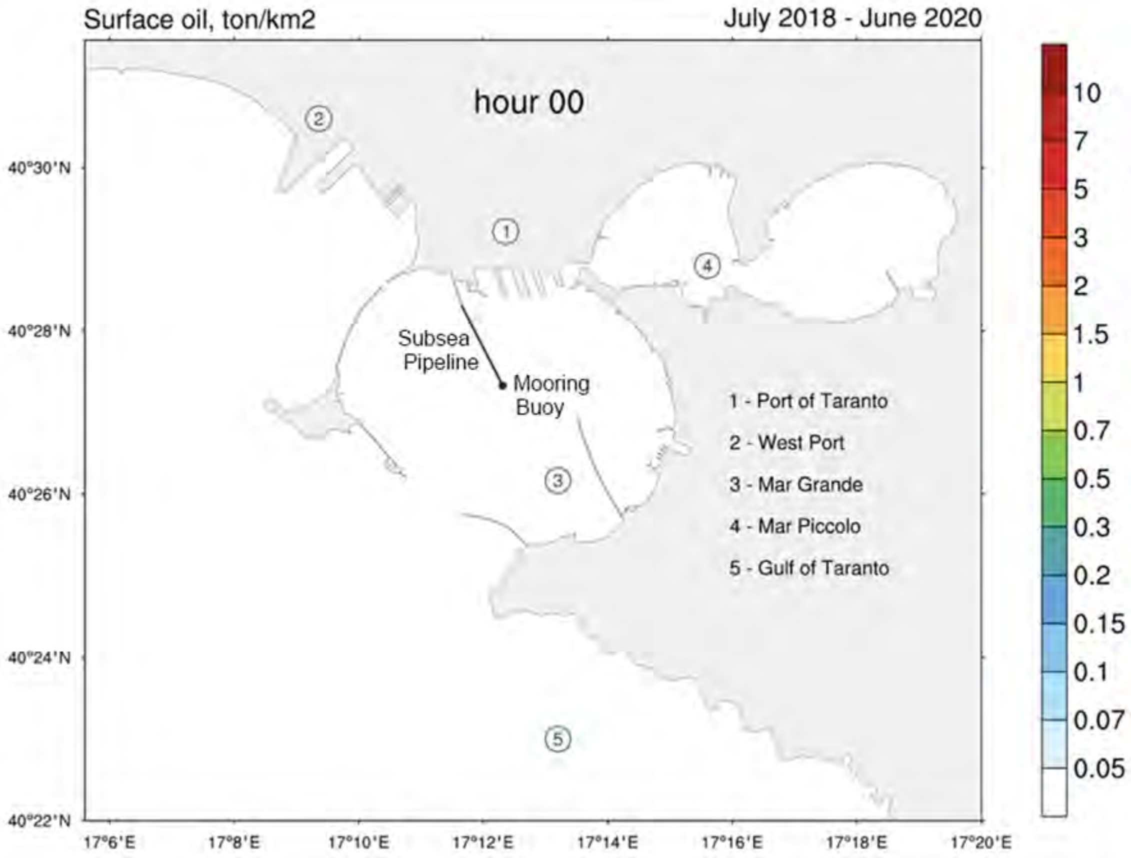
Results: spill snapshots

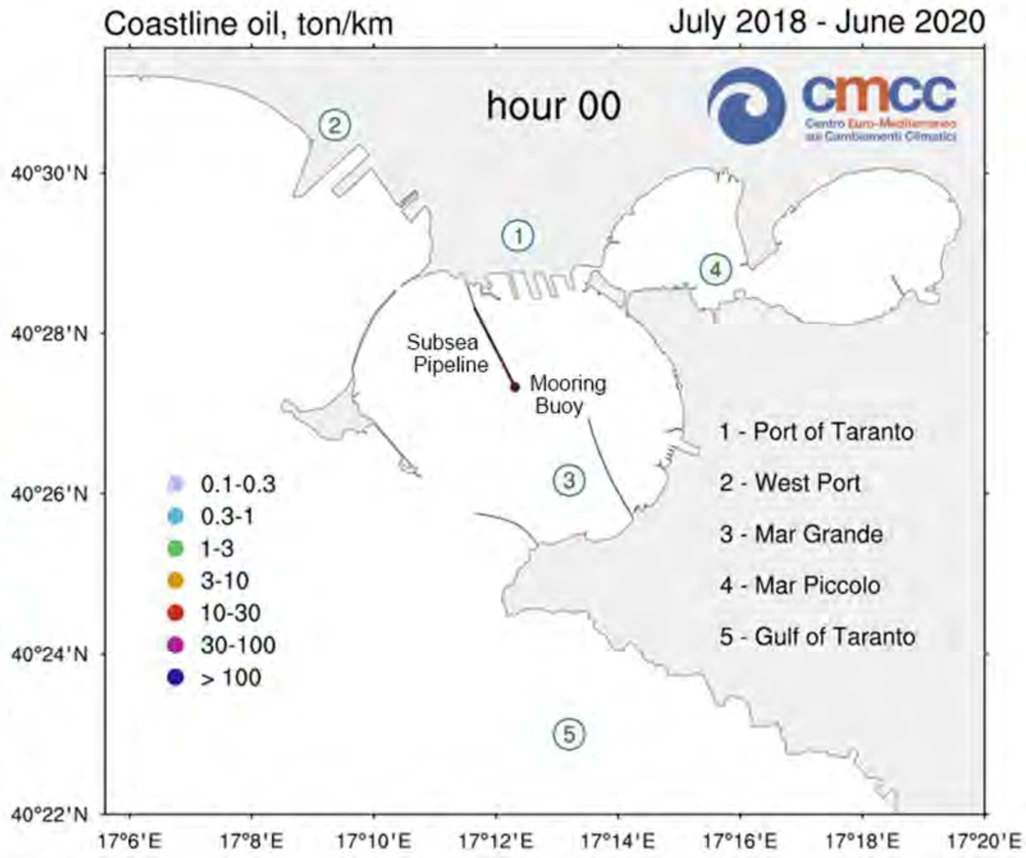


The finer resolution of underlying hydrodynamics, the more stretched and deviated are oil patterns in comparison with the Gaussian or Bessel-type distributions typical of constant currents

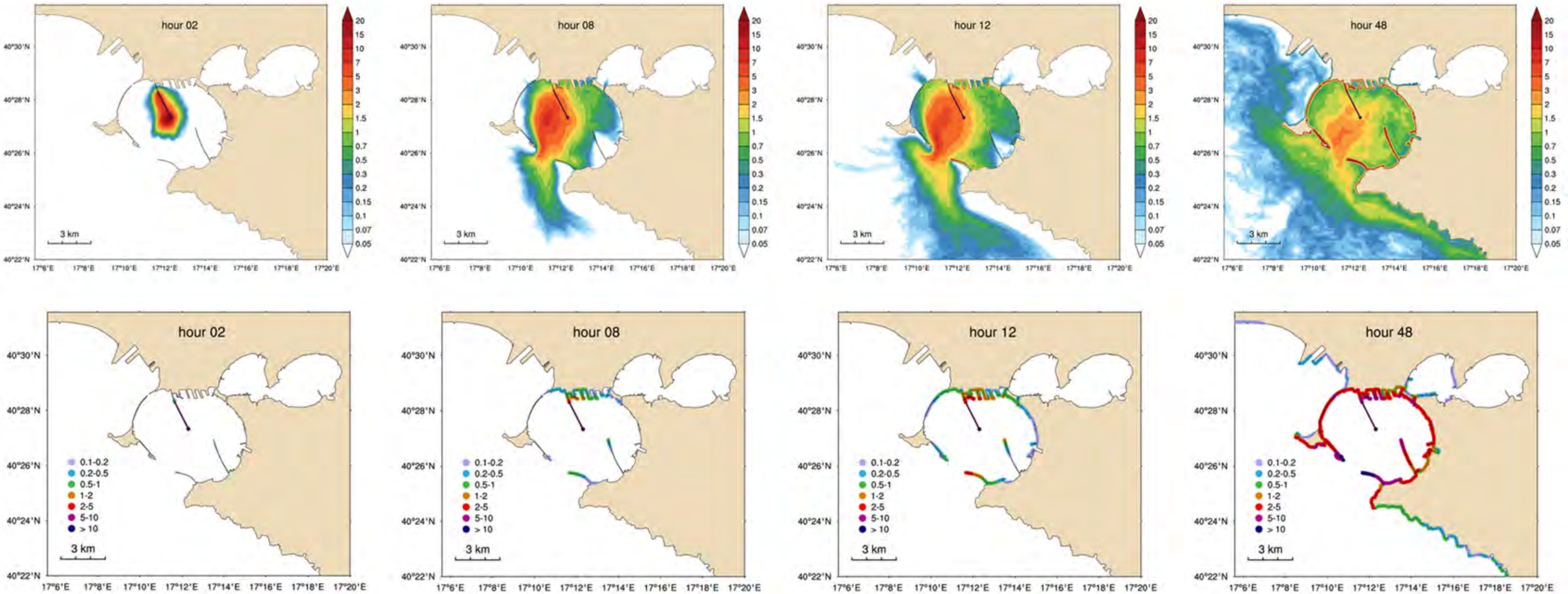
Ensemble mean oil concentration

! *please kick off mp4 below* !



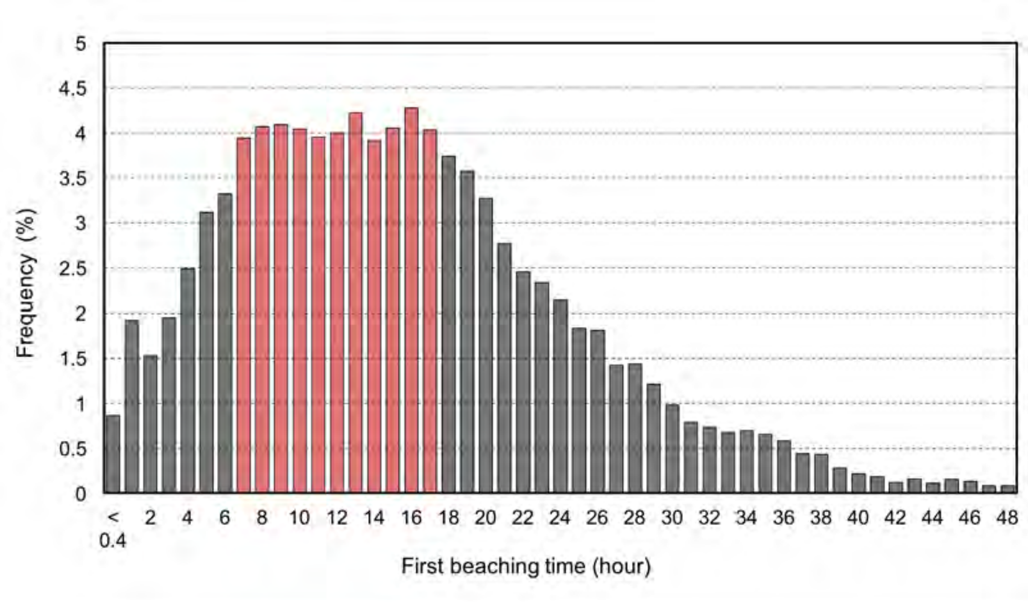


Pollution indices

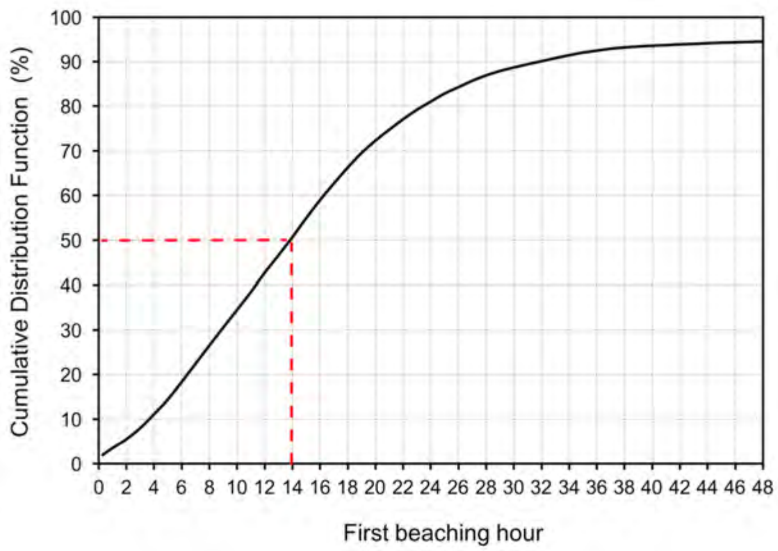


Pollution index maps showing the probability (%) to exceed the pre-defined sea surface threshold concentration of 0.01 g m^{-2} and the coastline threshold concentration of 0.1 g m^{-1} in 2, 8, 12, and 48 hrs after the start of the release

First beaching time

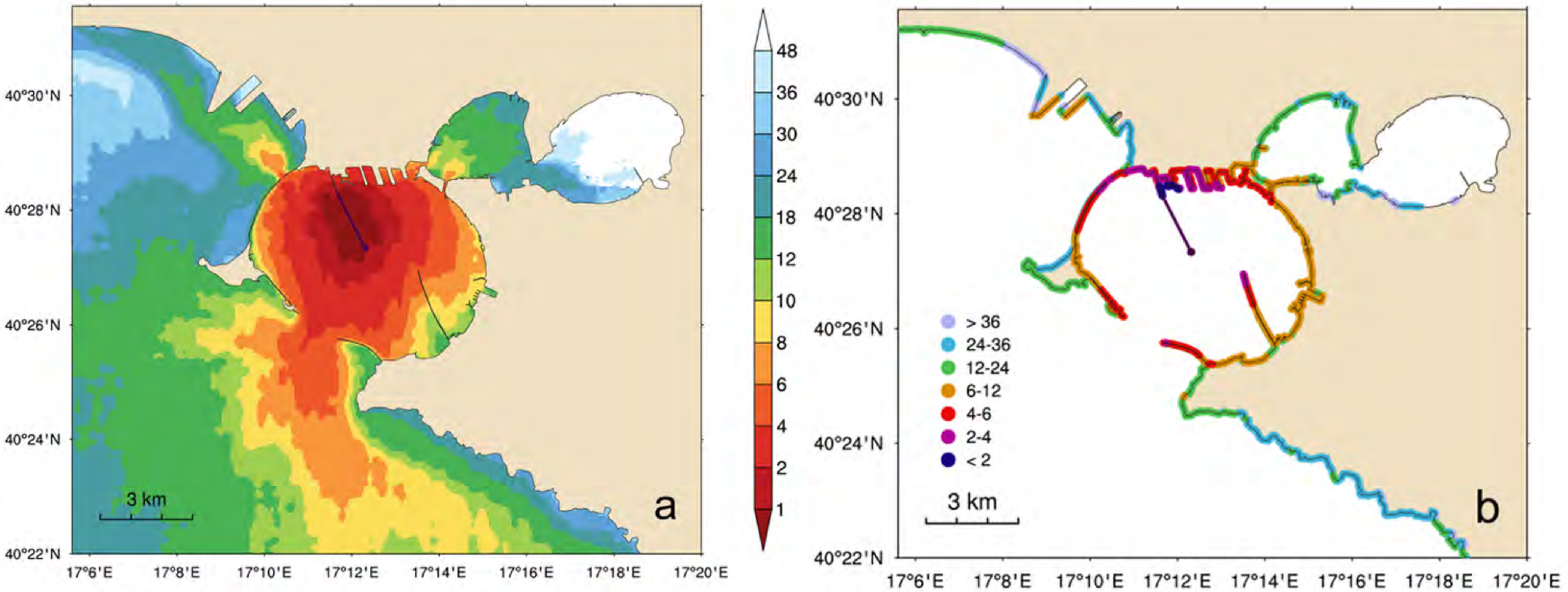


Histogram showing the probability distribution of the first beaching hour. Time interval of 7–17 hours after the start of the release indicates the highest probabilities of 3.9%–4.3% highlighted in red



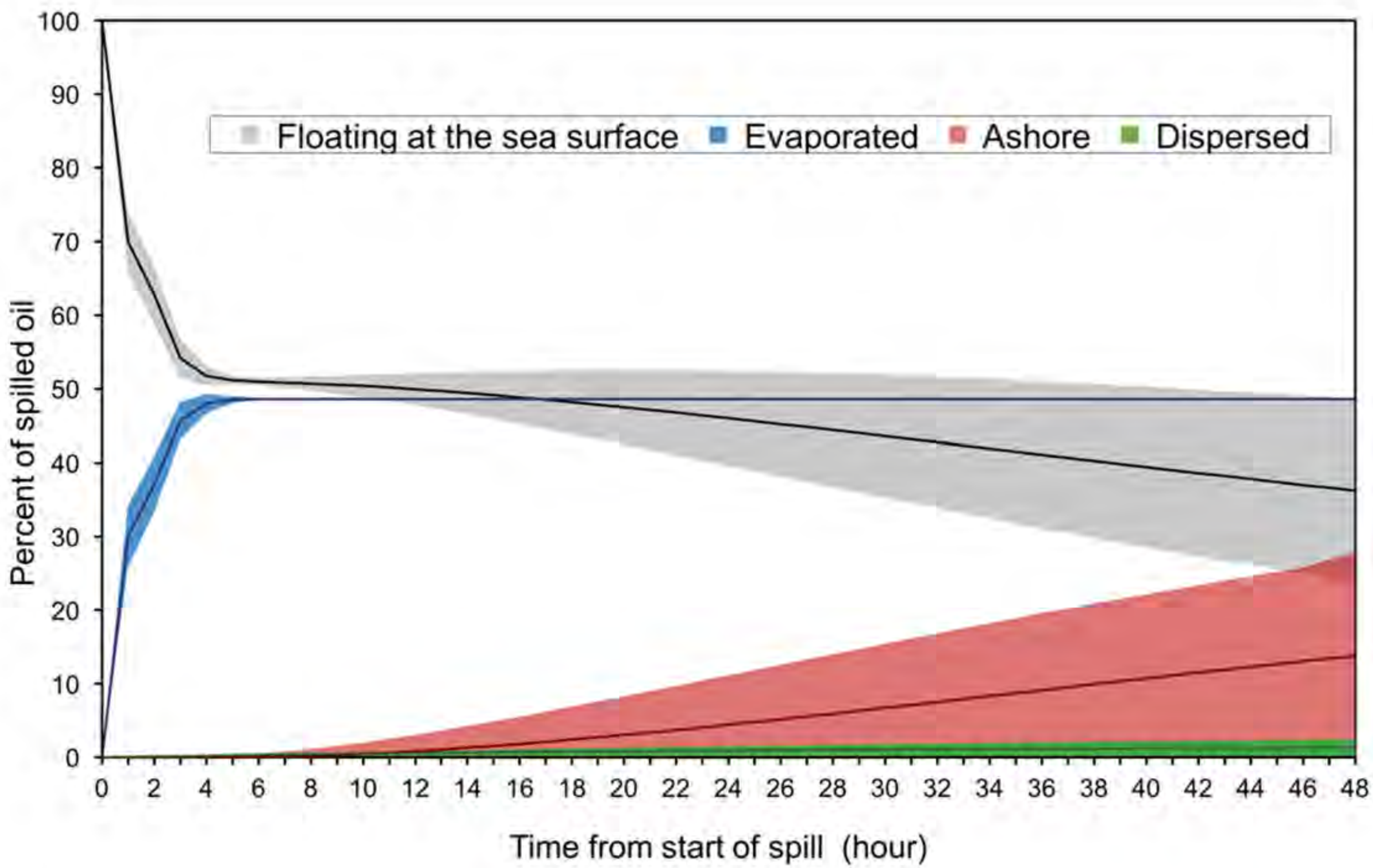
Cumulative Distribution Function (CDF) of the first beaching time. The red lines show that 50% of oil spills reach the coast within 14 hours

Arrival time



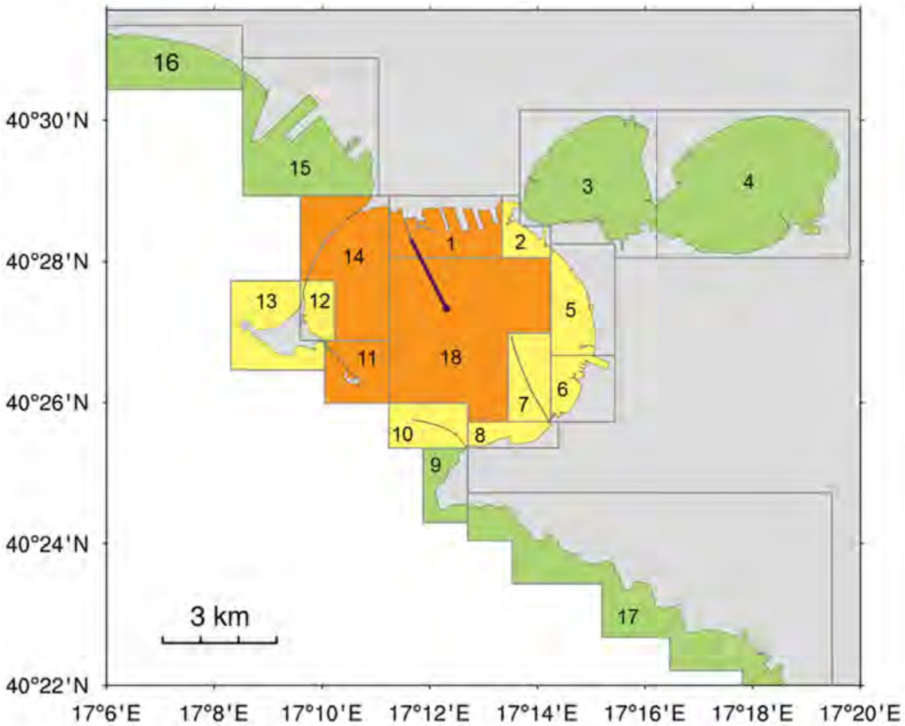
Arrival time plots showing the minimum time (hrs) for the oil to exceed the pre-defined (**a**) sea surface threshold concentration of 0.01 g m^{-2}, and (**b**) coastline threshold concentration of 0.1 g m^{-1}

Oil mass balance



Oil mass balance diagram showing the distribution of oil (%) over the four components: at the sea surface, evaporated, washed ashore, and dispersed in the water column.
Shaded areas depict the spread (mean value ± standard deviation)

Integral pollution of the sub-regions



1. Port Berths
2. Boundary between the Mar Grande and Mar Piccolo
3. Seno I
4. Seno II
5. Urban Area
6. Naval Area
7. Secca Tarantola
8. Praia a Mare
9. San Vito
10. Secca San Vito
11. San Paolo Island
12. San Pietro Island East
13. San Pietro Island West
14. West Breakwater
15. West Port
16. Taranto Gulf NW
17. Taranto Gulf SE
18. Mar Grande Interior

Sub-regions can be conditionally divided into 3 groups with respect to the required response urgency:

(1) Sub-regions that call for imperative countermeasures: the Port Berths, Mar Grande Interior, West Breakwater, and San Paolo Island

(2) Sub-regions where some reasonable response delay is possible: Secca San Vito, Praia a Mare, the Urban Area, Boundary between the Mar Grande and Mar Piccolo, Secca Tarantola, San Pietro Island East and West, and the Naval Area

(3) Sub-regions that are naturally sheltered: San Vito, West Port, the Taranto Gulf NW and SE, Seno I, and Seno II.

Conclusion

- Stochastic model simulations are conducted to predict the statistical footprint of oil pollution associated with the potential spills from the single-point buoy mooring and subsea pipeline at the Port of Taranto
- The MEDSLIK-II oil spill model is coupled to SANIFS run on an unstructured grid at an ultra-fine resolution
- Hypothetical oil spill scenario is based on the real case occurred at the Port of Genoa in 2016
- $15{,}000^{+}$ spill simulations are carried out randomly sampling over the environmental conditions 2018–2020

- The main oil drift is directed southwesterly towards the outlet to the open sea, which is consistent with the mean 2018–2020 surface flow direction
- Under the combined transport by highly variable currents, waves, and turbulent mixing, oil is exposed to multiply strandings and washing offs from concrete constructions at the Port
- Oil tends to be dispersed almost isotropically over the Mar Grande, indicating a rather moderate or small levels of concentration over the pre-defined minimum threshold values
- The first oil beaching is predicted within 7–17 hours after the start of the release
- Arrival time vary 1–16 hours in the interior of the Mar Grande
- The most probable contaminated coastline length is estimated to be 0.6–1 km
- After the rapid evaporation of ~48%, oil tends to be re-distributed between the sea surface and coastline with gradually growing the latter component