Bonn Agreement
Accord de Bonn

Bonn Agreement Oil Appearance Code

Photo Atlas

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PART 1: GENERALITIES

1-Introduction

1.1 Generalities

Visual observation of pollution and polluter provides essential information about appearance, size and coverage of the spill that are used to identify the substance and to calculate the initial estimate of the volume.

The visual form of an oil slick may also suggest the probable cause of pollution:

- A long and small thin slick of oil sheen suggests a possible illegal discharge of oil from a ship. The cause is obvious if the ship is still discharging, as the slick will be connected to the ship, but the slick may persist for some time after the discharge has stopped; it will subsequently be broken up and dispersed by wind and waves.

- A triangular slick with one side aligned with the wind and another aligned with the prevailing current suggests a subsurface-release, such as that from a sub-sea pipeline or oil slowly escaping from a sunken wreck.

- Slicks seen some distance ‘down current’ of oil installations, particularly in calm weather, may be caused by re-surfacing of dispersed oil from permitted discharged of produced water.

The observation can be influenced by several factors, cloud, sunlight, weather, sea and angle of view, height, speed and local features as well as the type of oil or substances. The observer should be aware of these factors and try to make the adjustments for as many as possible.
It is recommended that the slick should be viewed from all sides by flying a racetrack pattern around the oil. The best position to view the oil is considered to be with the sun behind the observer and the observer looking at the object / subject from an angle of an angle of 40° to 45° to the perpendicular.

It is suggested that the ideal height to view the oil will vary from aircraft to aircraft, but for an aircraft with a speed of around 150 knots a height of 700 to 1000 feet is suggested.

For evaluation of the data collected, including the imagery, it is strongly recommended to take still photo’s or record a video with a down-ward looking camera and not only oblique as the angle of view will be effected by incoming light.

The oil appearances will generally follow a pattern. The thinner oils, sheen, rainbow and metallic, will normally be at the edges of the thicker oils, discontinuous true color and true colour, all the codes will be defined in the following paragraph. It would be unusual to observe thick oil without the associated thinner oils; however, this can occur if the oil has aged and/or weathered or if the oil is very heavy and viscous. Heavy oil will tend to be mainly true colour and have very sharp defined edges, due to the high viscosity of HFO, and its tendency/potential to form stable without emulsions, although there might be some sheen at the edges.

Extra caution should be used when emulsion is present. Aircrew should use all the available information or intelligence to estimate the volume.

1.2 Aim of the atlas

This document has been written to help in training the crews who are involved in the aerial observation of pollution during their flights.
In the following pages you will find many pictures on the aerial observation of oil in accidents but also during discharges by ships or rigs with different conditions of observation.
In order to have the best assessment you will find as well e.g. photos of noxious liquid substances (NLS) and natural phenomena that may be observed in European waters.

This photo atlas is an additional document for the aerial surveillance and to be considered as a part of the BA-AOH.

2-BA-OAC

Since the colour of the oil itself as well as the optic effects is influenced by meteorological conditions, altitude, angle of observation and colour of the sea water, an appearance cannot be characterised purely in terms of apparent color and therefore an « appearance » code, using terms independent of specific color names, has been developed.

The Bonn Agreement Oil Appearance Code has been developed as follows:
-In accordance with scientific literature and previously published scientific papers,
-Its theoretical basis is supported by small scale laboratory experiments,
-It is supported by mesoscale outdoor experiments,
-It is supported by controlled sea trials.

Due to slow changes in the continuum of light, overlaps in the different categories were found. However, for operational reason, the code has been designed without these overlaps.

Using thickness intervals provides an estimation of volumes that can be used both for legal procedures and for response.
The BONN Contracting Parties have agreed that the lower figure is used in official statements whereas the upper figure is used to indicate the required response measures.

Again for operational reasons, grey and silver have been combined into the generic term “sheen”, as the old terminology suggested an appearance that could not be justified by measurements of layer thickness.

Five levels of oil appearances are distinguished in code detailed in the following table:

Code	Description - appearance	Layer thickness interval (µm)	Litres per Km²
1	Sheen	0.04 to 0.30	40 – 300
2	Rainbow	0.3 to 5.0	300 – 5000
3	Metallic	5.0 to 50	5000 – 50 000
4	Discontinuous True Oil Colour	50 to 200	50 000 – 200 000
5	Continuous True Oil Colour	More than 200	More than 200 000

The appearances described cannot be related to one thickness; they are optic effects (codes 1-2-3) or true colours (codes 4-5) that appear over a range of layer thickness. There is no sharp delineation between the different codes; one effect becomes more diffuse as the other strengthens.

Besides describing in the reporting format, what appearance was observed in a slick it is of utmost importance to also describe other relevant findings e.g. breaking waves over the oil slick; the forming of emulsion (reddish color), so more physical characteristics.

Definition of oil from MARPOL convention Annex 1
Oil means petroleum in any form including crude oil, fuel oil, sludge, oil refused and refined products (other than those petrochemicals which are subject to the provisions of Annex II of the Marpol Convention) and, without limiting the generality of the foregoing, includes the substances listed in appendix I to this Annex 1.

For more explanations about the BA-OAC see the BA-AOH part III.

Acknowledgements to the contracting parties for their contribution to this photo Atlas (photo credits).

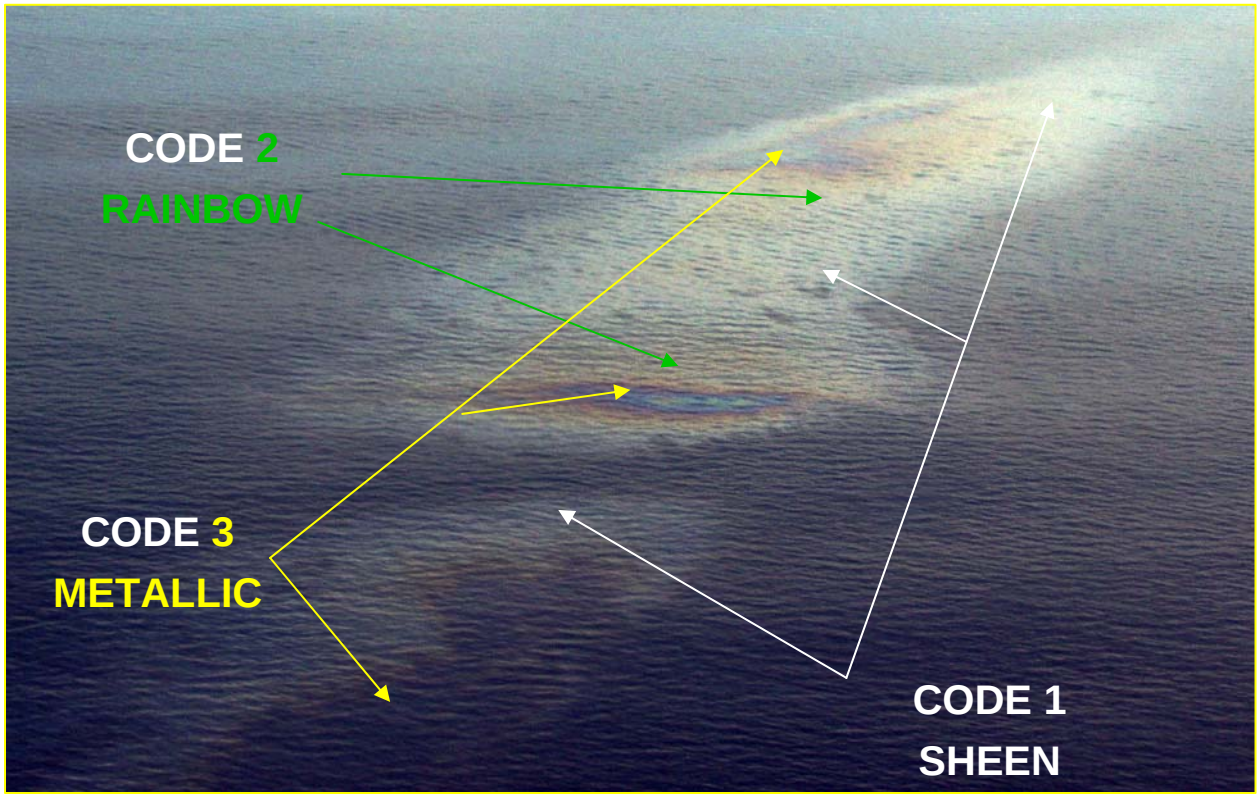
PART II: PHOTOGRAPHS

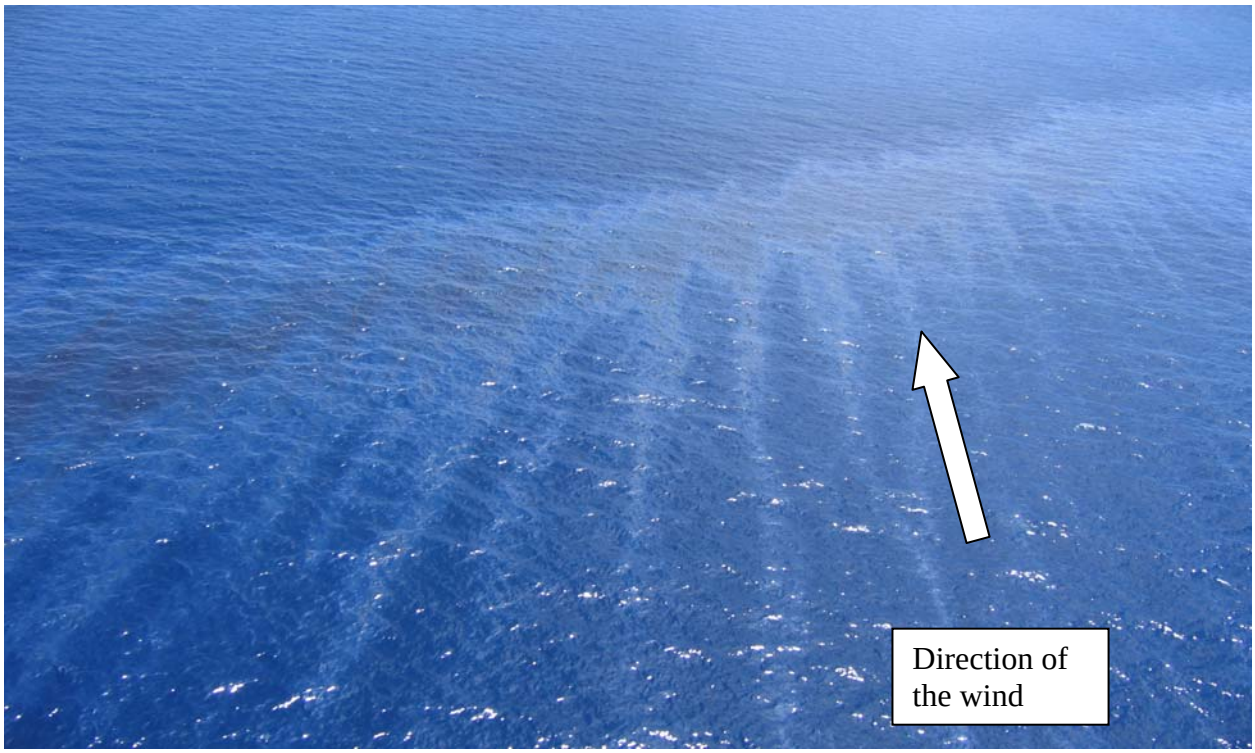
3- Mineral oil

3.1 BA-OAC description

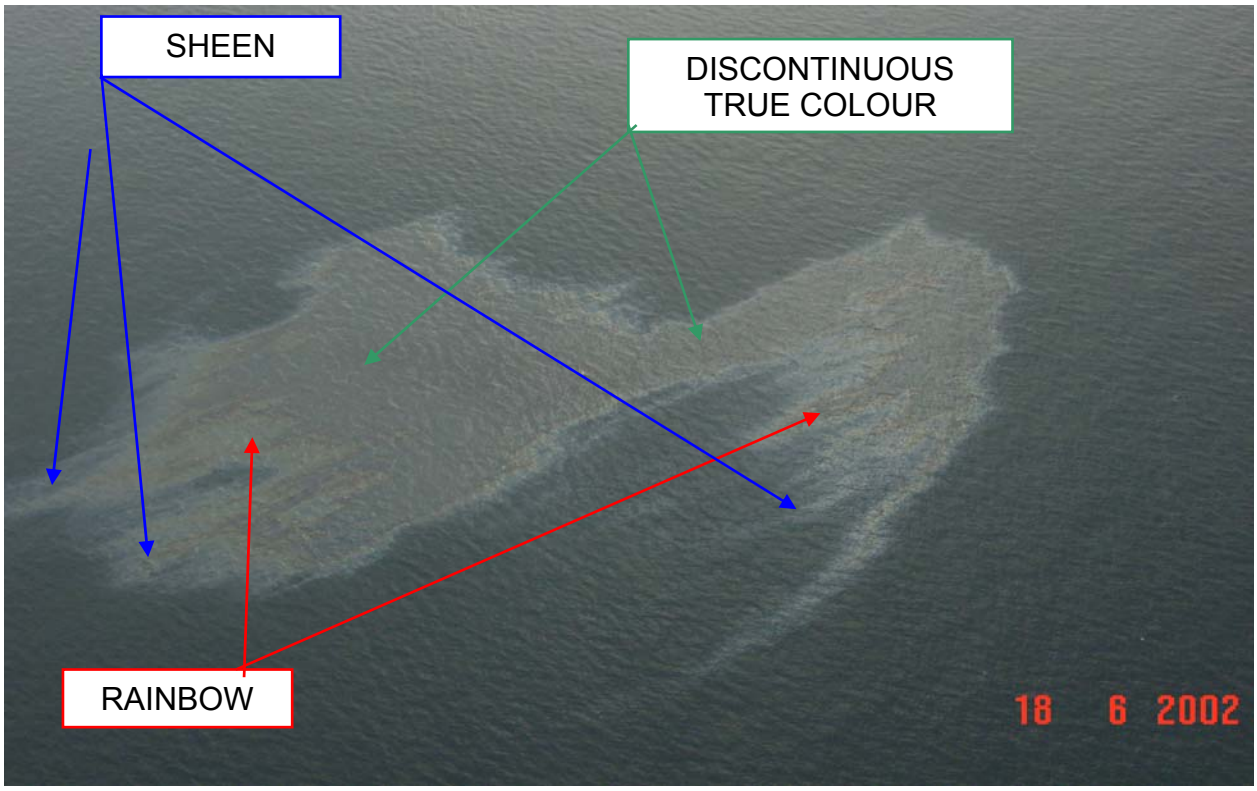
Sheen, rainbow and Metallic

Sheen, rainbow and Metallic

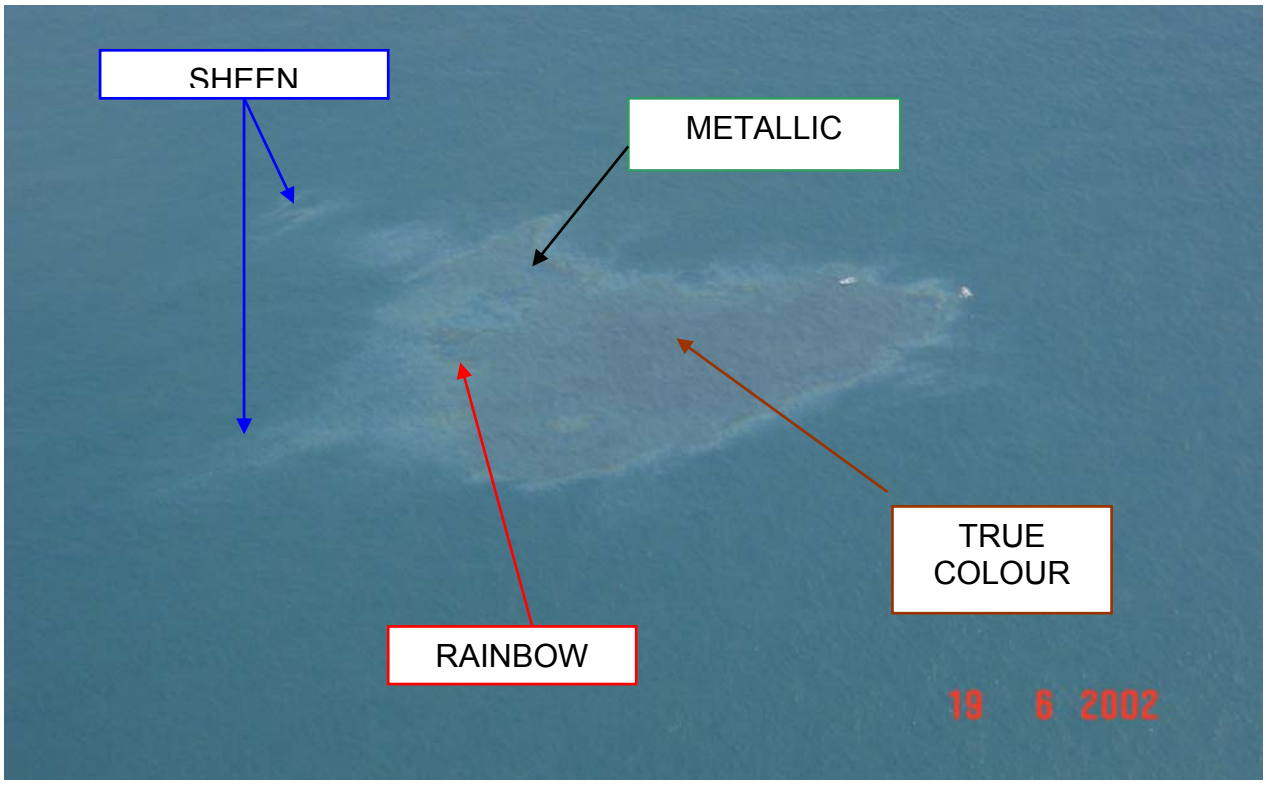




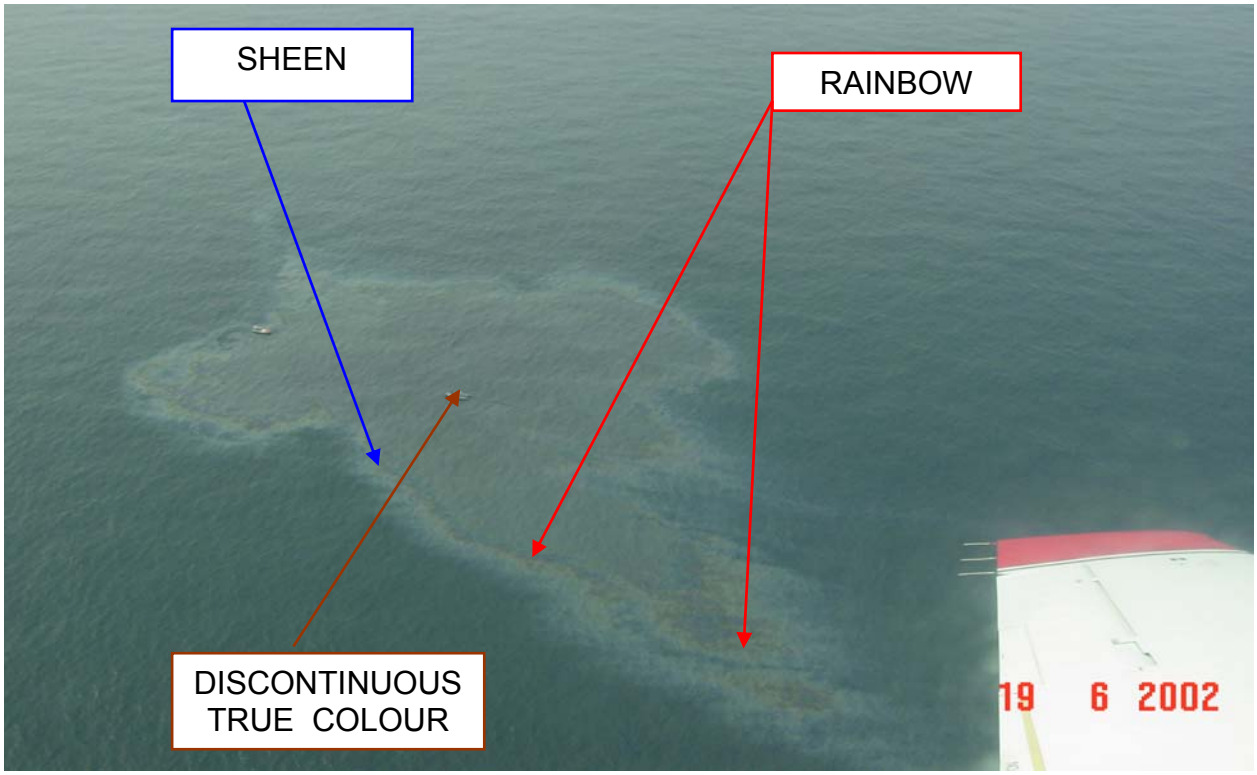
As the slick weathers thicker zones appear, the thicker area (on the top of the photo), mainly classified as METALLIC is pushed by the wind more quickly than thinner area classified as SHEEN.



Notice the difference between “RAINBOW” and “DISCONTINUOUS TRUE COLOUR”. Difficult to see from the air.

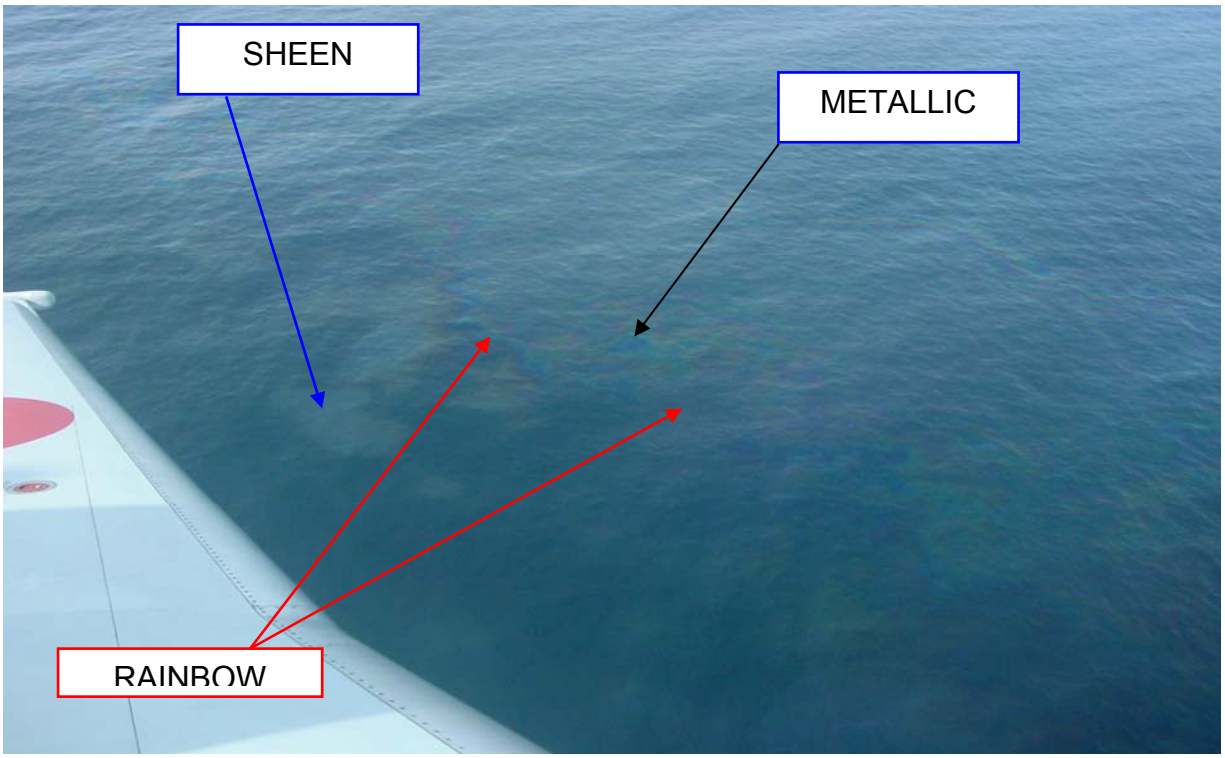


Notice”SHEEN” at the edge. ”RAINBOW” close to the edge and in a circular area. The thicker oil is in the middle of the pollution.



"RAINBOW" will always appear between "SHEEN" , "METALLIC" and "DISCONTINUOUS TRUE COLOUR".

Most of oil observed is a thin film (SHEEN) on the sea surface.



Expect more oil than anticipated when you observe “RAINBOW” and “METALLIC”.

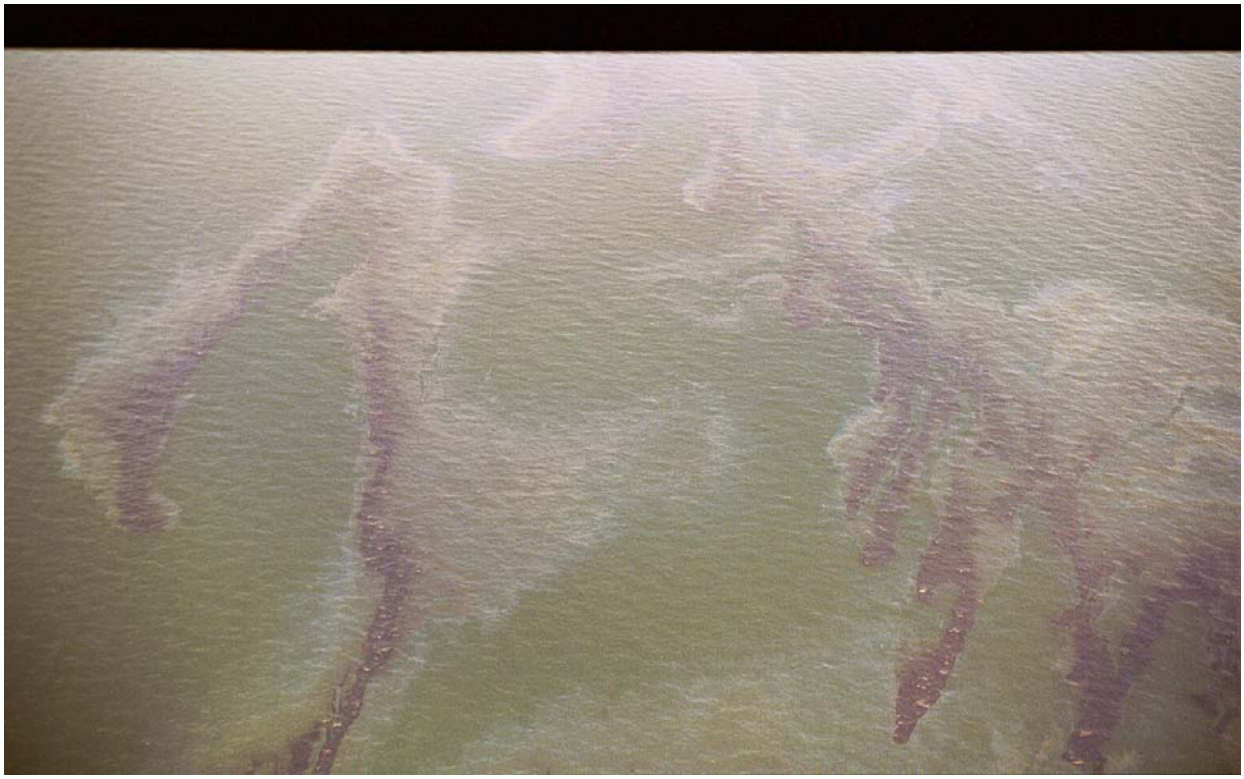
Following 2 pictures from an exercise: 5 tons of crane crude oil had been released and the visual observation from the aircraft has been carried out 3 hours after. The slick was 1.8 X 1.8 km^2

Observation of crane crude oil: code 1, 2, 3 and 4

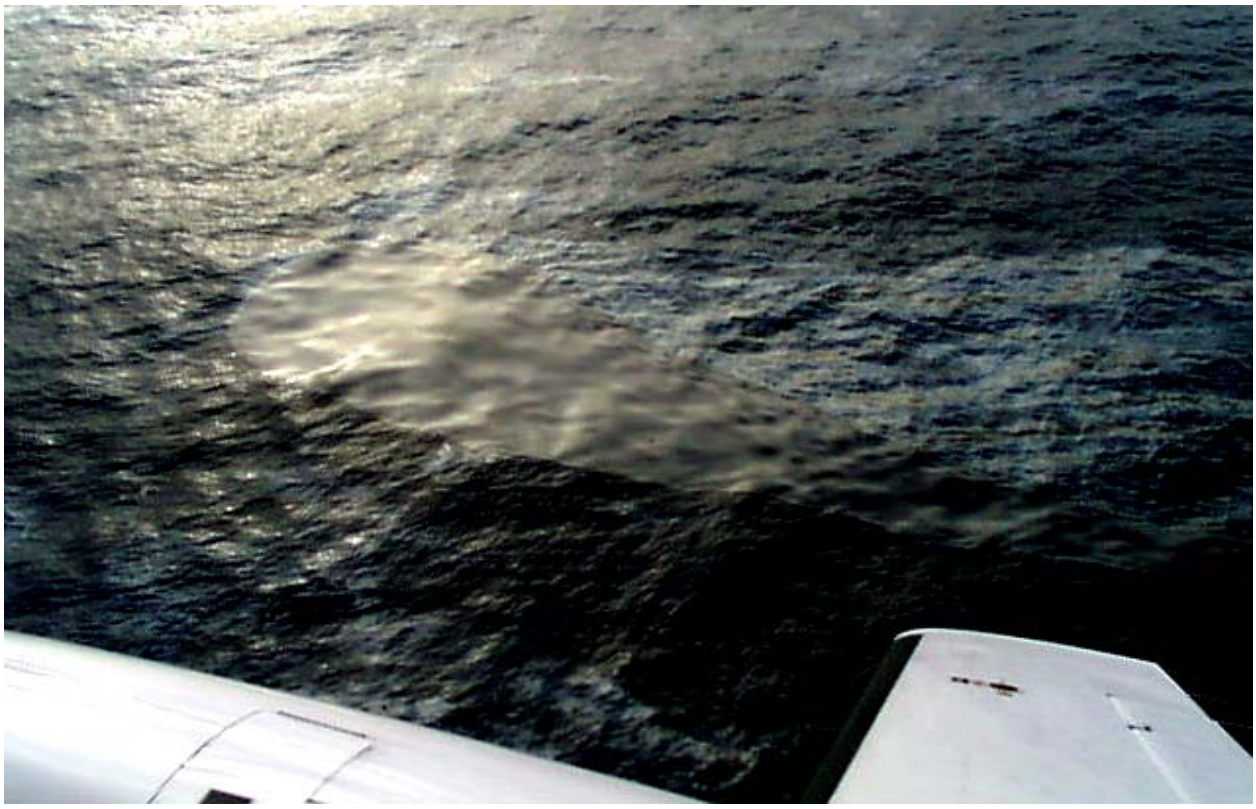
Conditions of observation: Wind 320/15 – clouds overcast at 800 Ft – visibility 5 Km – Sea state 2

3.2 Accidents

Heavy fuel oil (black)



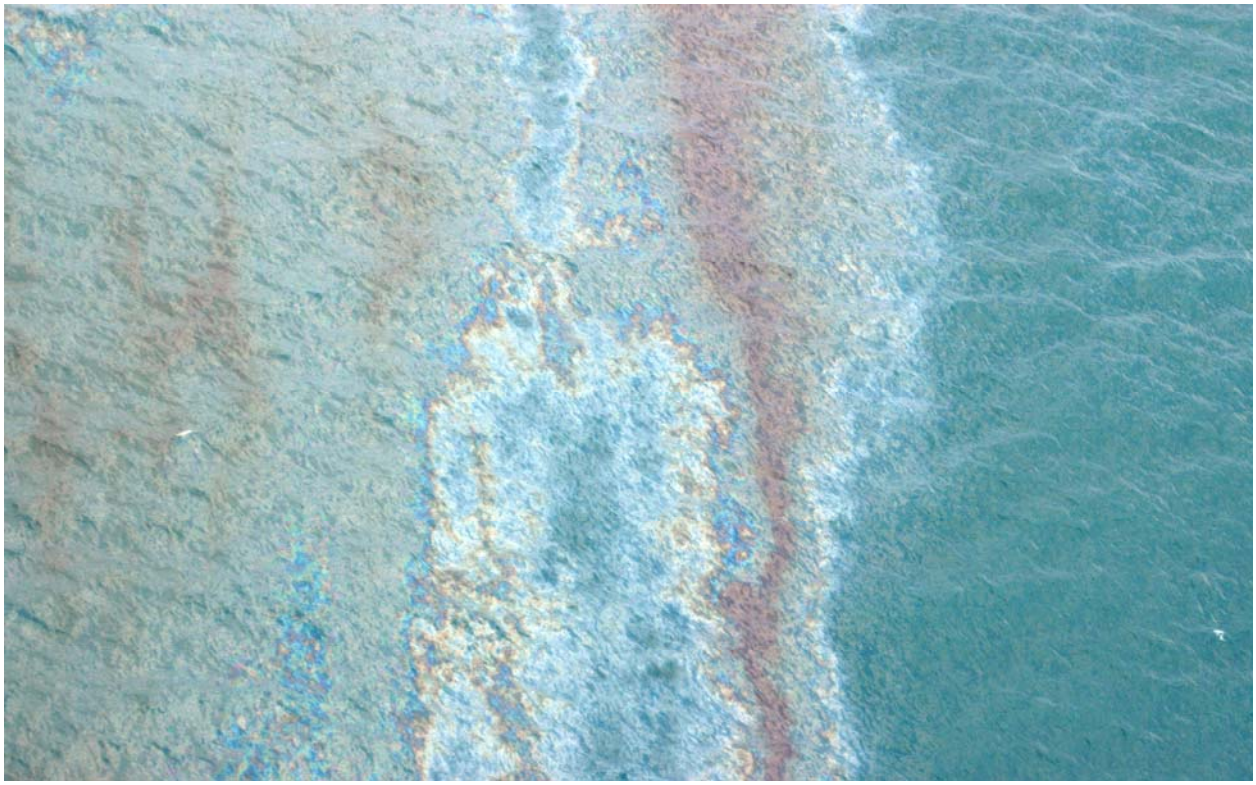
Difference between sensors and eyes. This was seen/reported from the aircraft as “SHEEN” and”RAINBOW”. Remember the importance of low speed and thorough observation under the passage. In this picture we have code 1 to code 4 (SHEEN TO DTC).



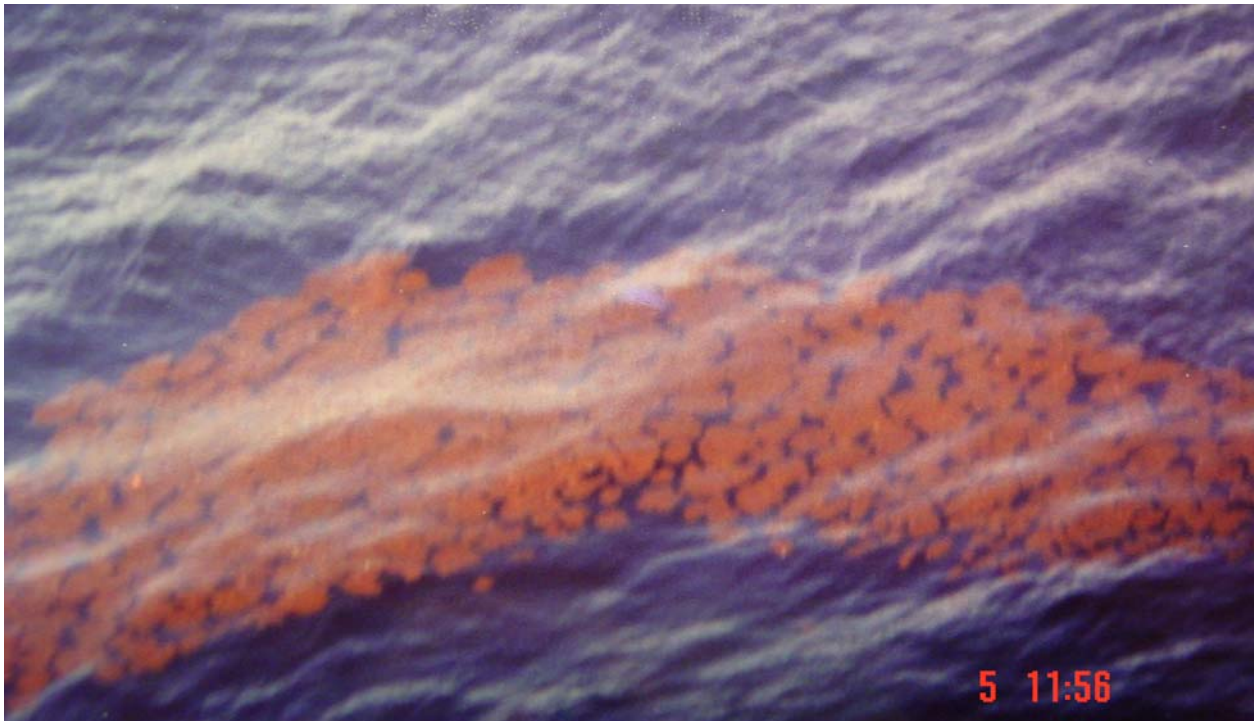
Heavy fuel oil with sharp defined edges, notice the thin part of the slick on the right side of the picture and the appearance.

Code 1, 2 and 3, Code 3 “METALLIC “in the middle of the oil slick

Different views of oil at sea: remember that it may be oil as the definition of Marpol (see page 5)

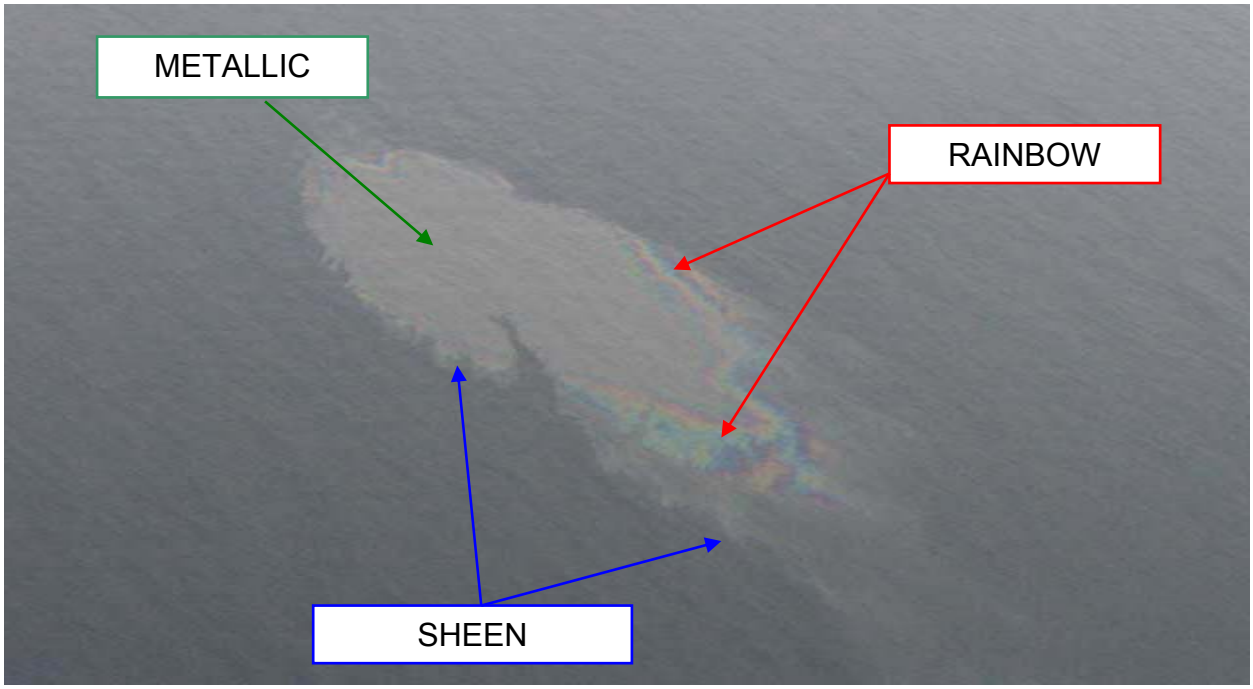


Ageing and behaviour of heavy fuel oil at sea (Prestige)

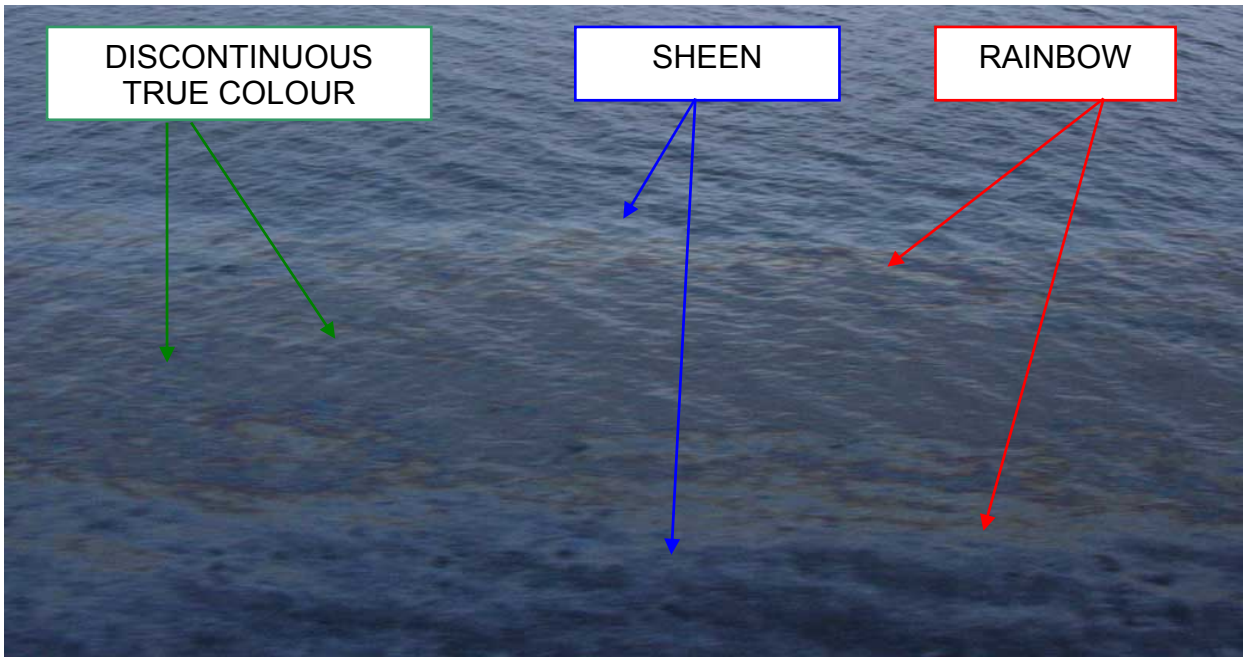


”Emulsion”. If a brown substance is observed it might be emulsified oil (oil that have absorbed water), looks like chocolate mousse.

Lessons learnt from Prestige case: SLAR and also visual search, certainly it is an evidence that many slicks could have sunk, so it was very difficult to detect these oil slicks with due to the difference of temperature at day or night, oil slicks have been found again later according to drift prediction



It is important that the percentage calculation of different colour codes is done in corporation among the crew. The calculation of an oil spill has to be as close to reality as possible.
5%"SHEEN" (thinnest) at the edge. 15%"RAINBOW" and 80%"METALLIC" (thickest).



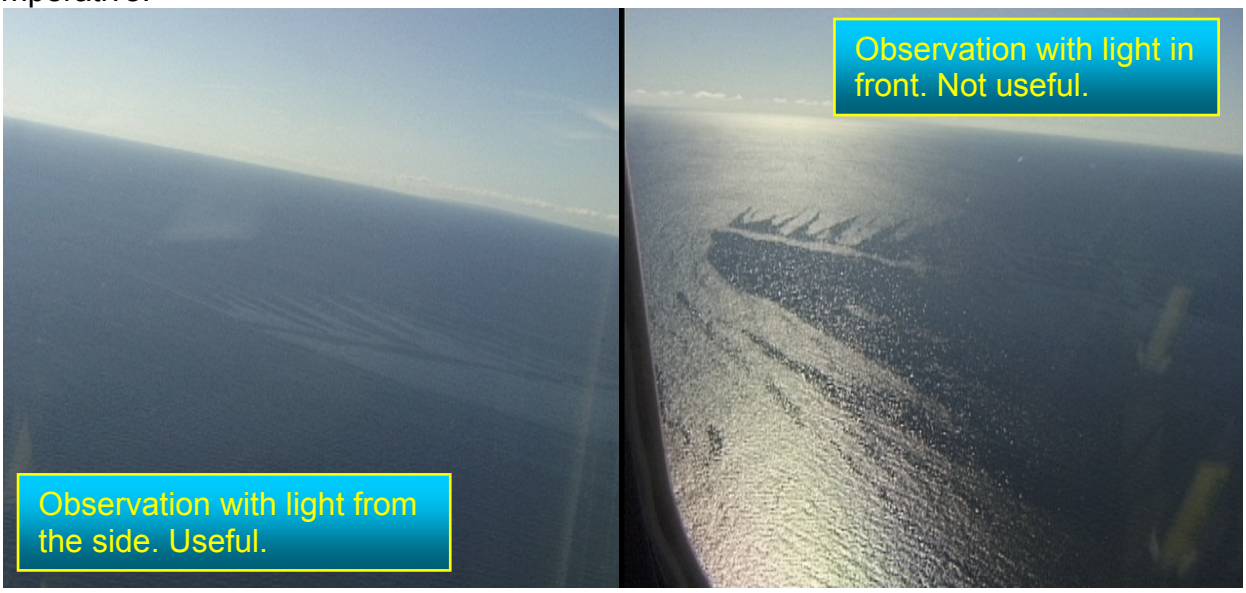
30% ”SHEEN” (thinnest) at the edge, 15% ”RAINBOW” and 55% ”DISCONTINUOUS TRUE COLOUR” (thickest).

REMEMBER!
IT IS IMPORTANT THAT THE OBSERVATION IS THOROUGH. THE OBSERVATION IS THE BASIS FOR JUDGMENT AND PENALTIES.

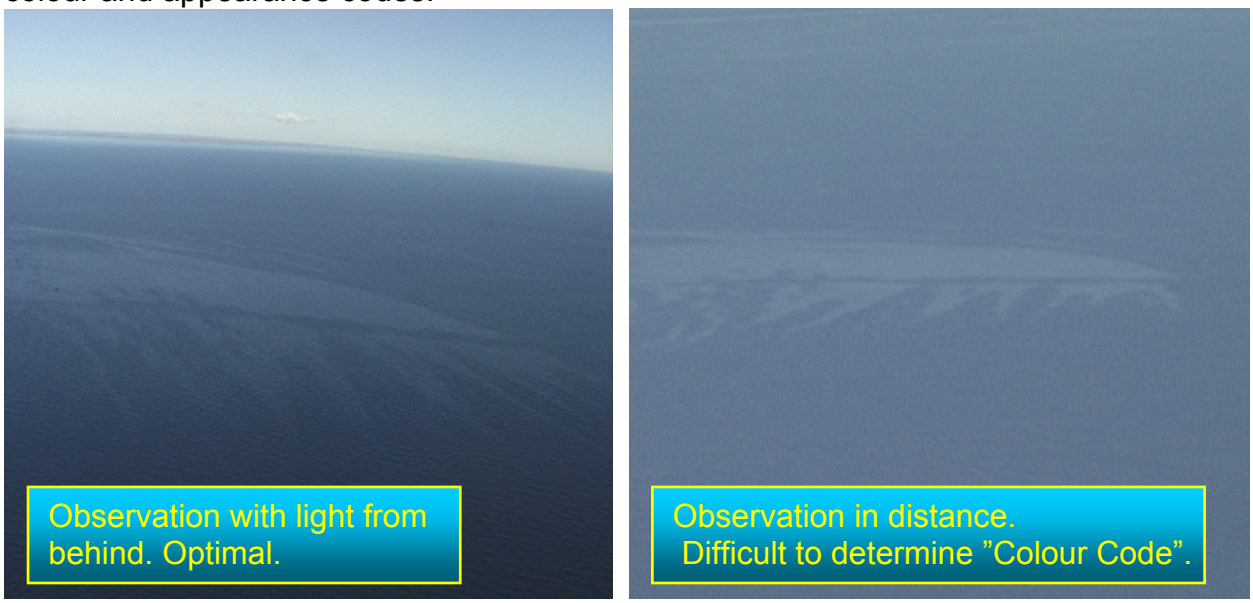
Oil at sea: code 1 to code 5

Code 4 and code 5

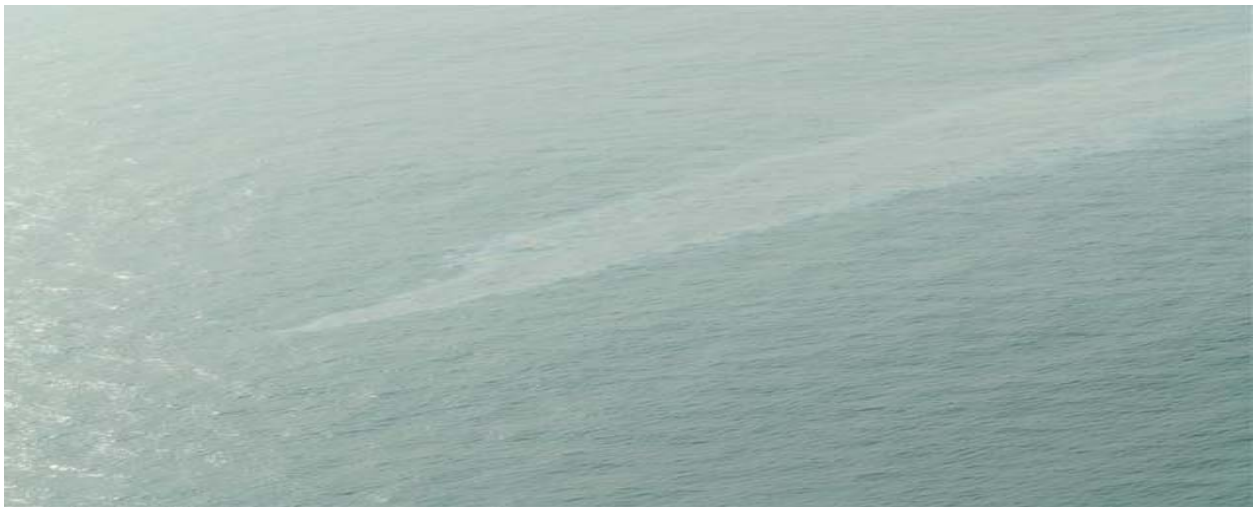
Notice the sunlight's impact on the same oil slick. Observation from the right angle is imperative.



It is necessary to fly overhead an oil slick and look down in it, in order to determine the colour and appearance codes.



A slick from a wreck: 3 pictures in 30 seconds, the difference: angle and position of the sun.

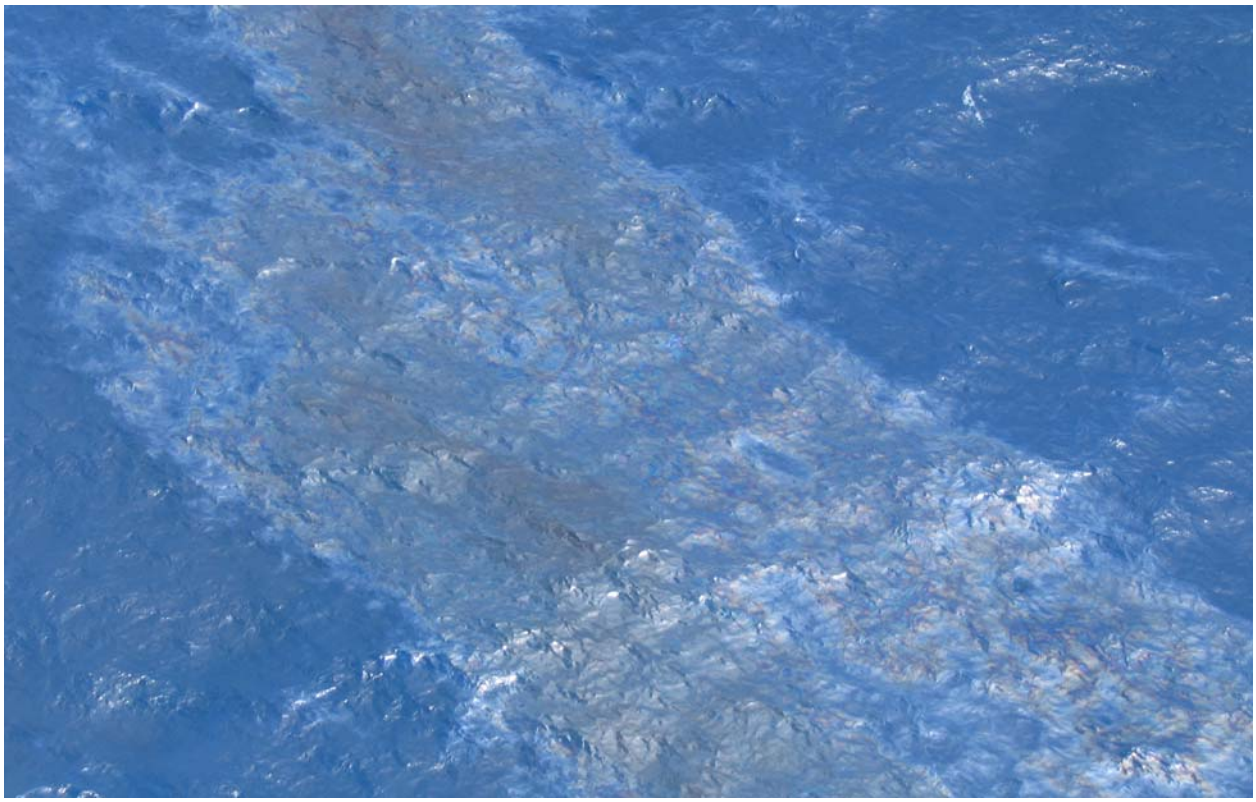


In this case the thickness of the oil slick was measured by the recovery vessel,

Code 5, note the effect of oil on the sea state, with oil the sea is smooth.
This characteristic is used by the SLAR.

Black oil with mirror effect: white dots due to the sun

Depending on the angle of observation it can be difficult to discern sheen from thicker oil



Slick of a light refined product rapidly spreading into a thin film

The colour of thick patches and stripes

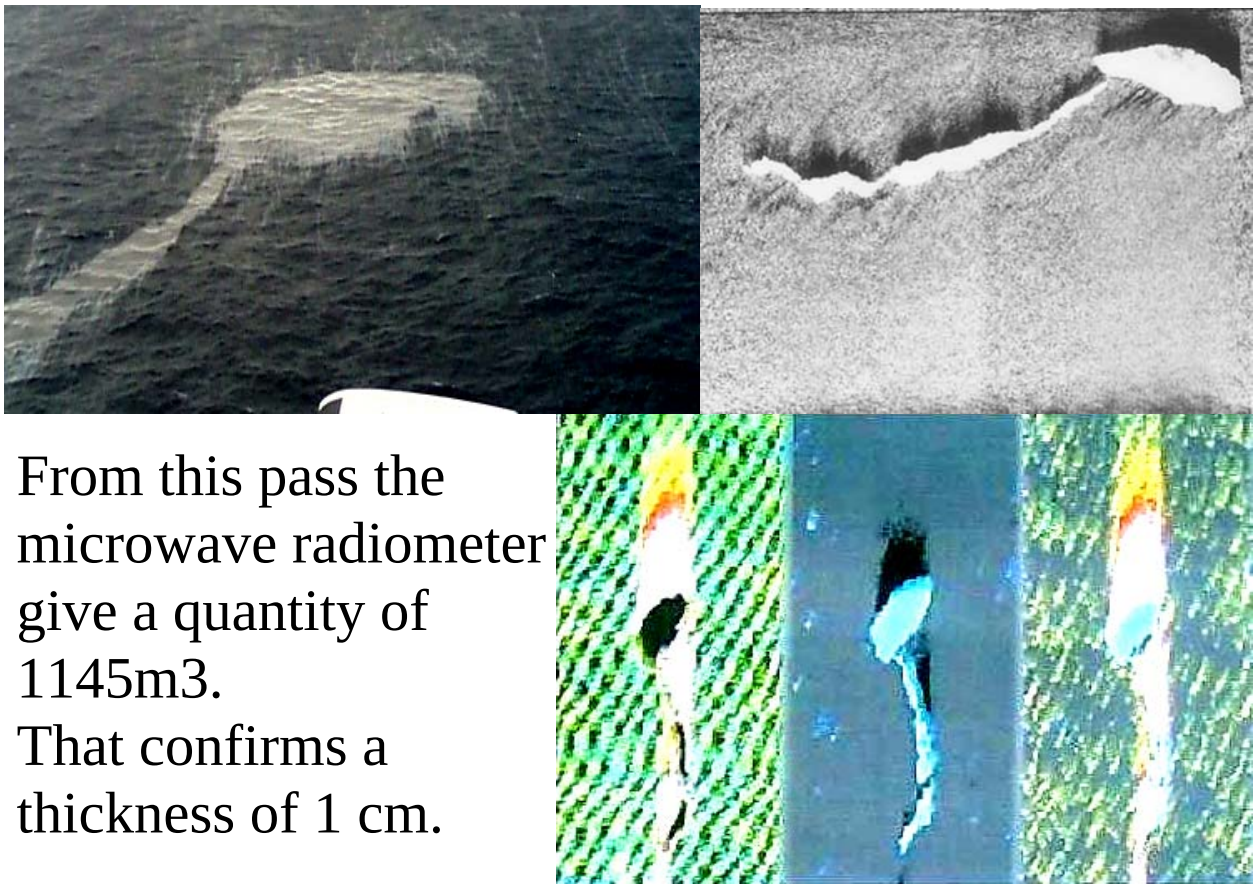
Discontinuous true colour and Sheen, is there Metallic? From this picture, no, but see explanation in the BA-AOH and the difficulty to classify Metallic or DTC.

Oil in ice

Arrival of emulsified heavy fuel oil on the coast of Spain (Prestige)

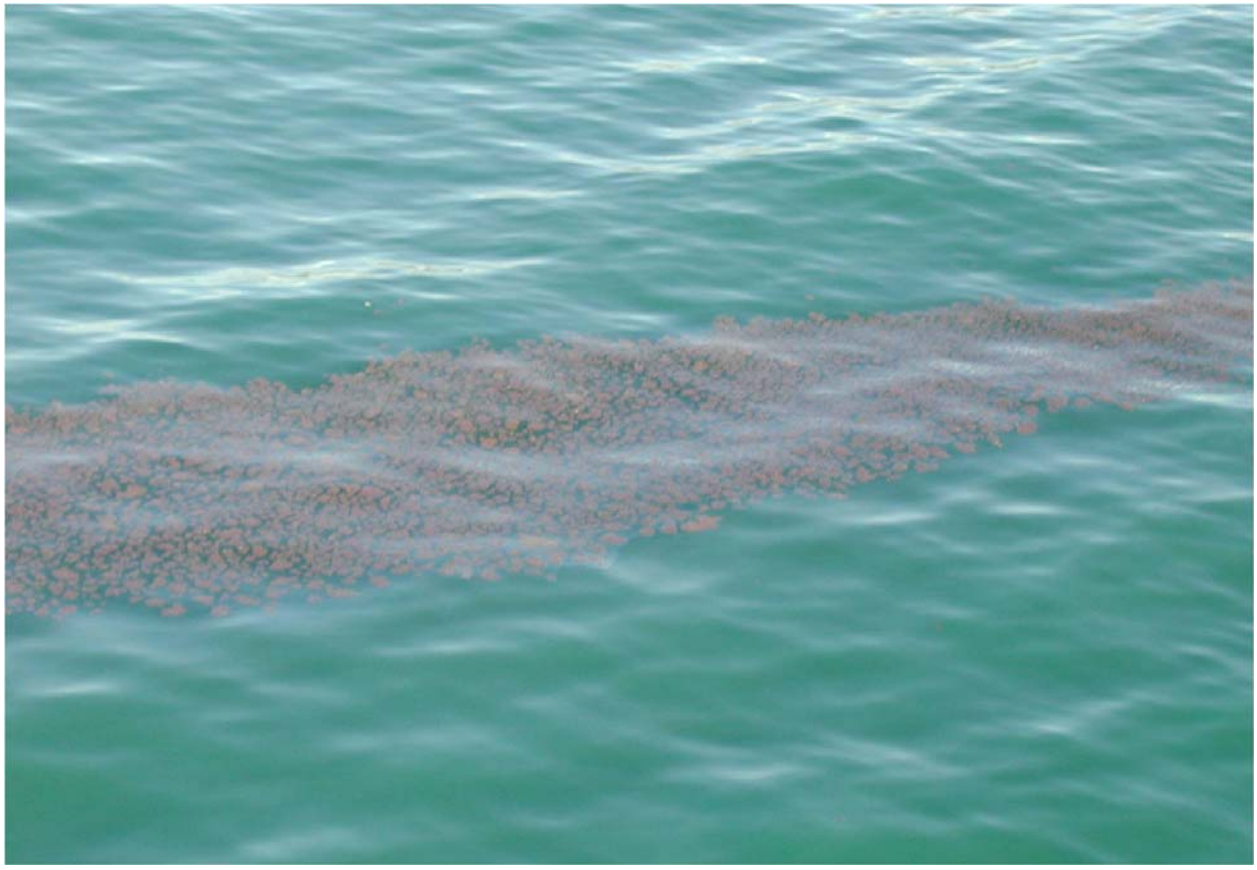
Oil stranding in natural accumulation zones

Oil remobilising from a cobble shore during the ebbing tide weathered or remobilising from a rocky shore



Heavy fuel oil: photo, IR image, microwave image

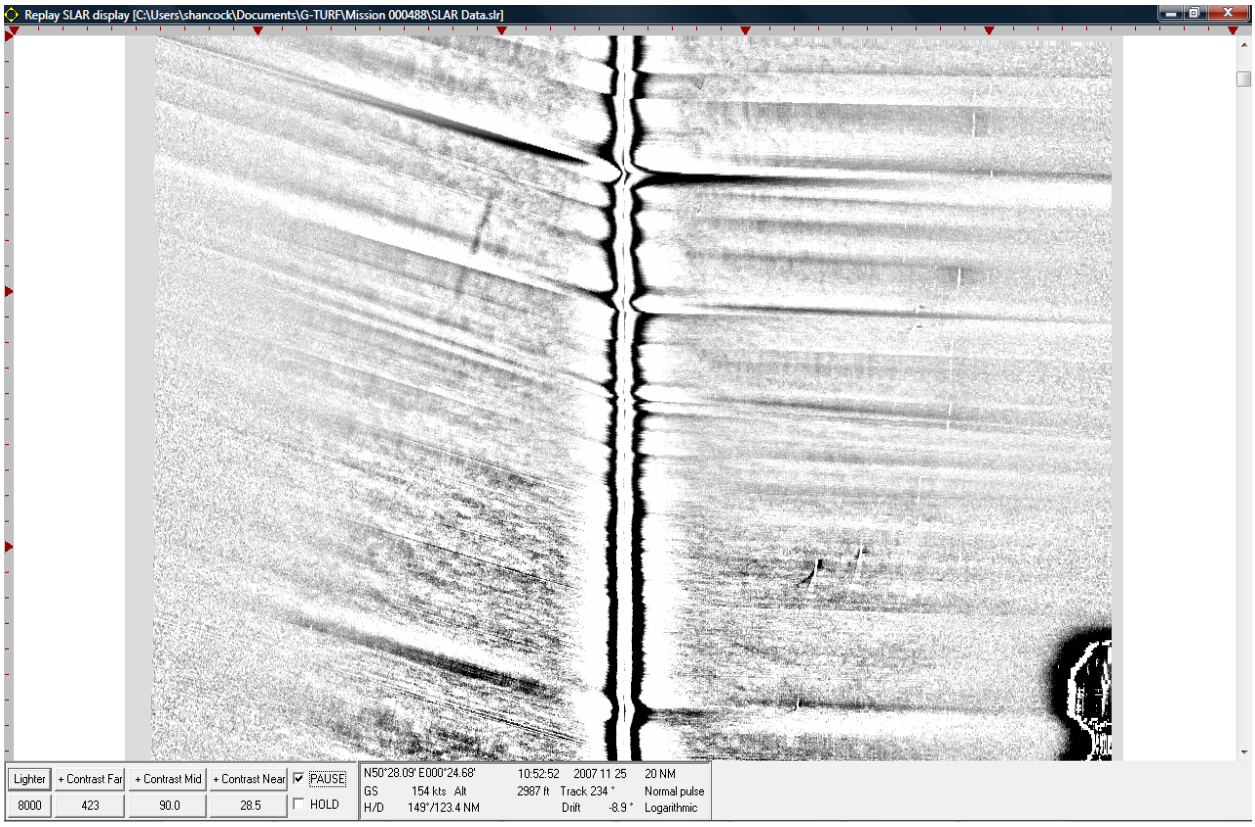
Heavy fuel oil at sea with wind and sea state 5



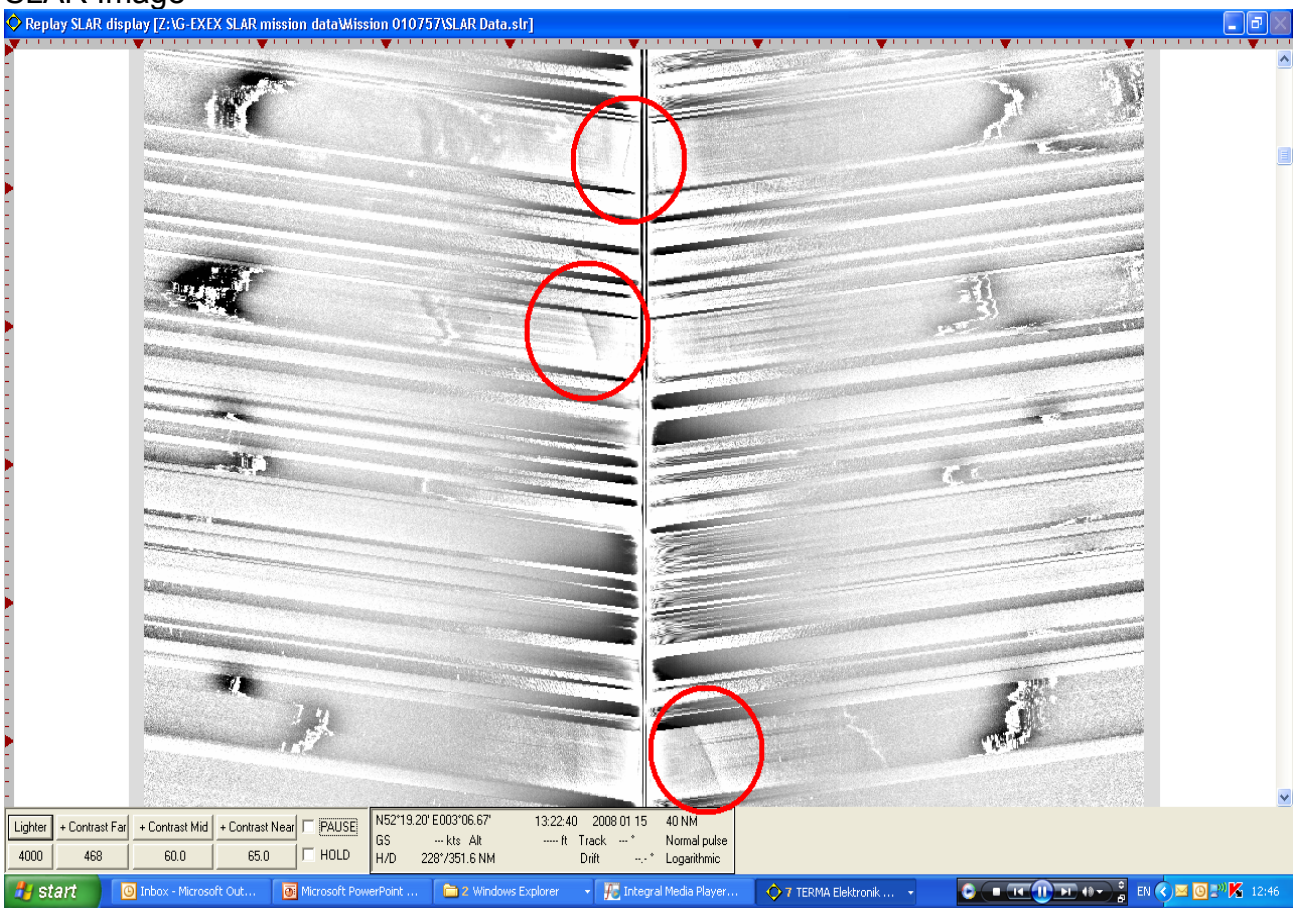
The patches of emulsion fragment and form small tarballs

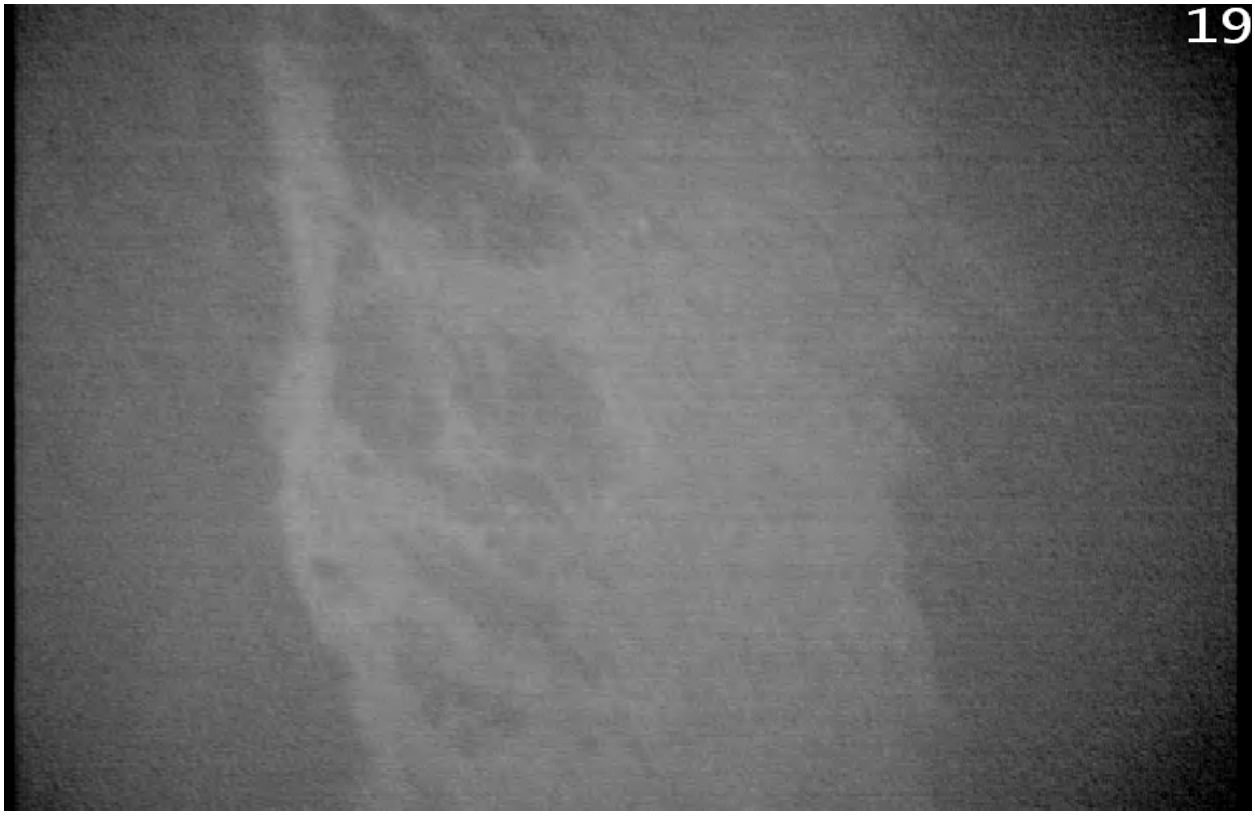
Emulsified oil

MSC NAPOLI CASE: photograph and SLAR image



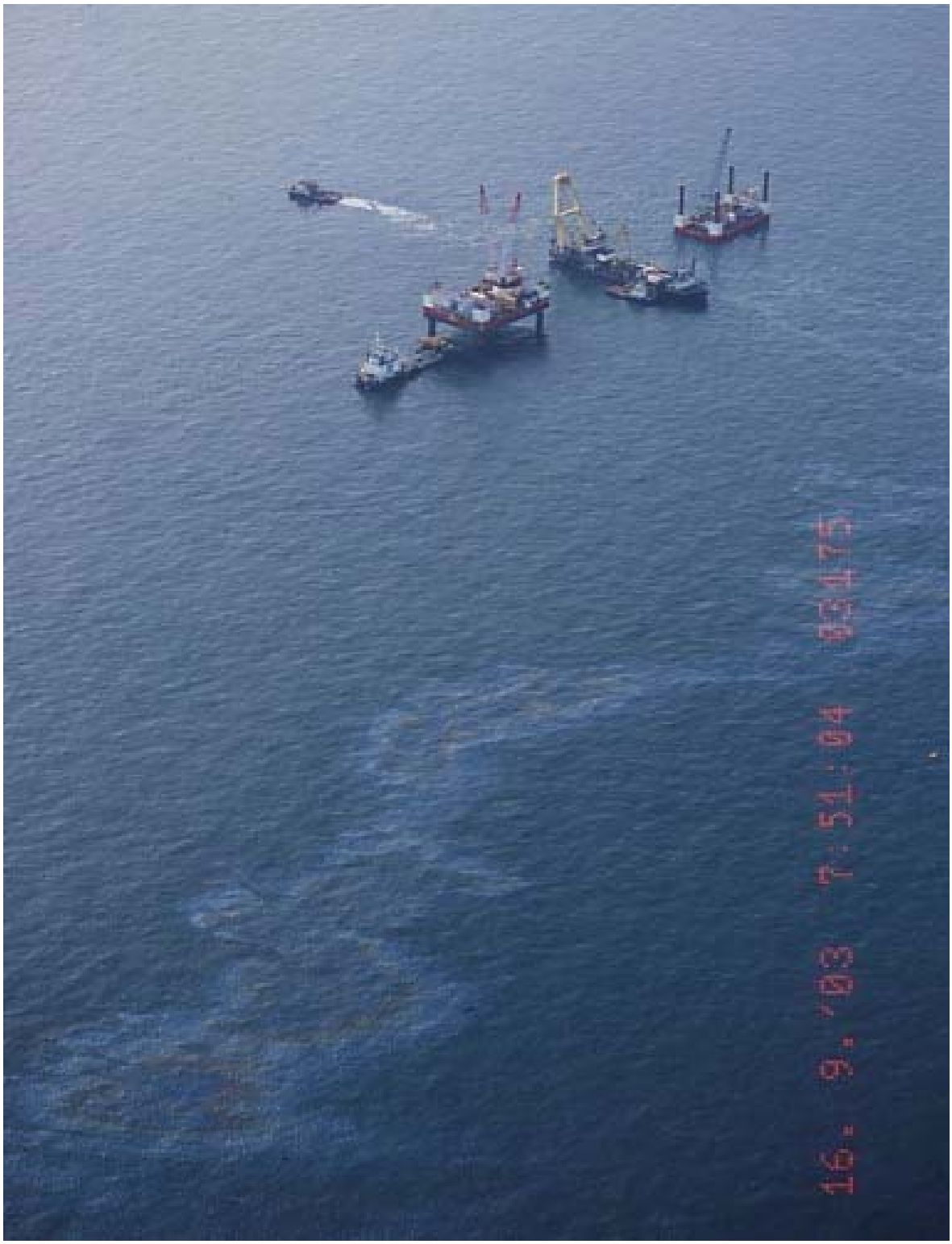
SLAR Image



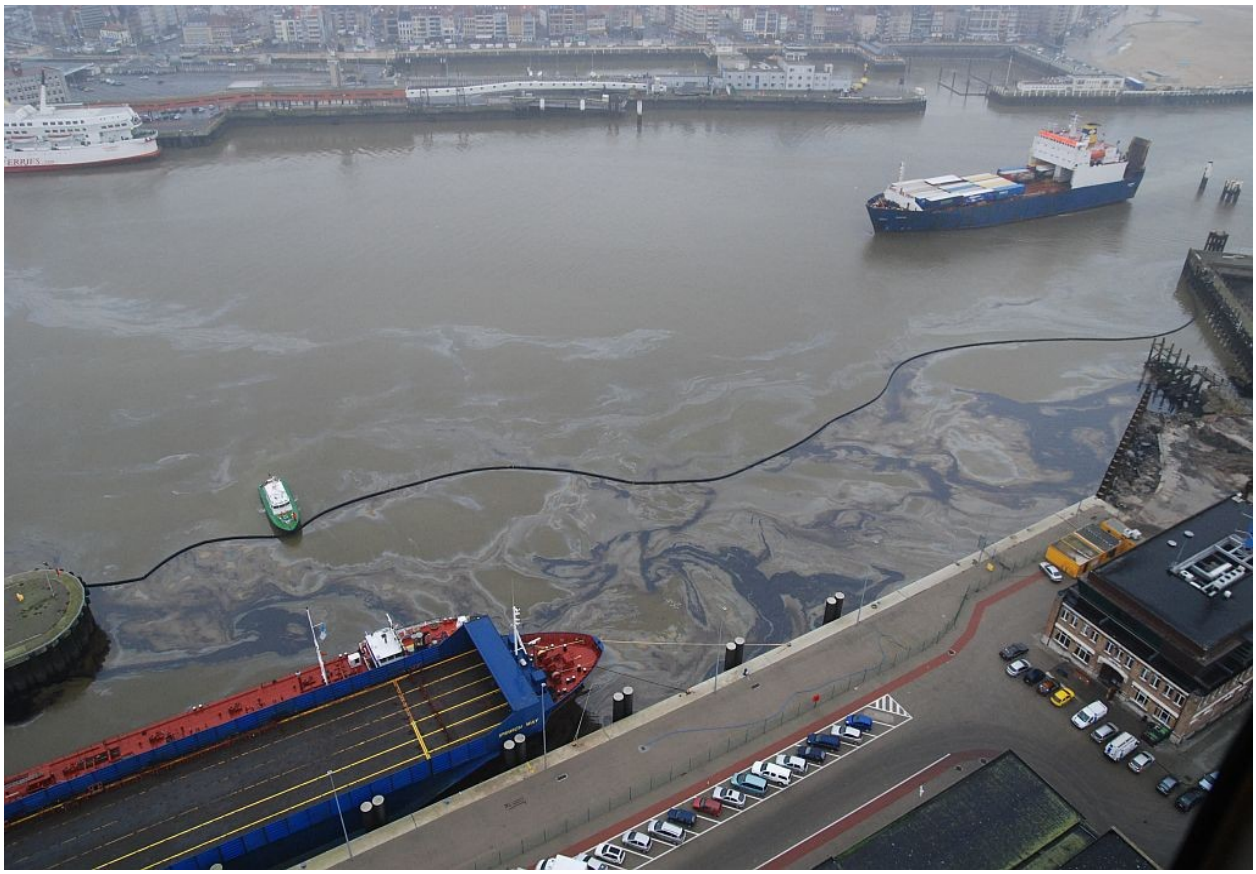


UV IMAGE: a response in the UV band is decisive to qualify mineral oil

MSC NAPOLI Case, to be matched with the SLAR image



“TRICOLOR” salvage site

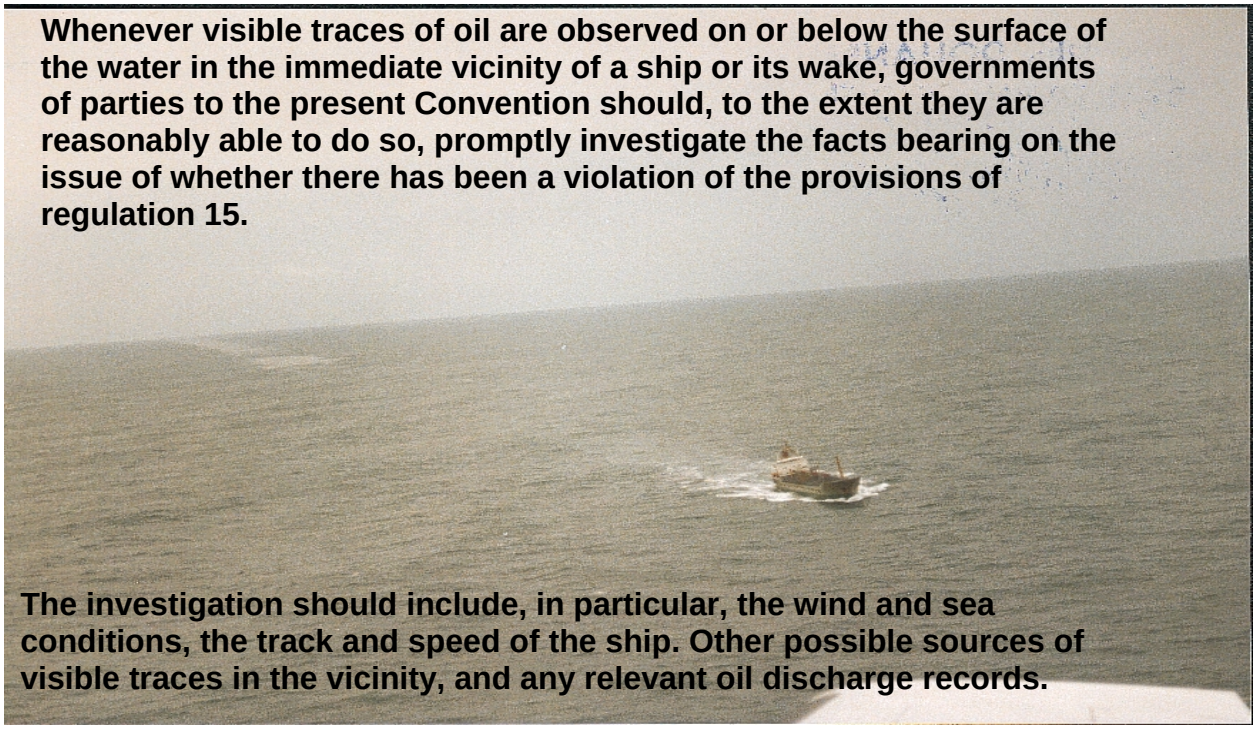


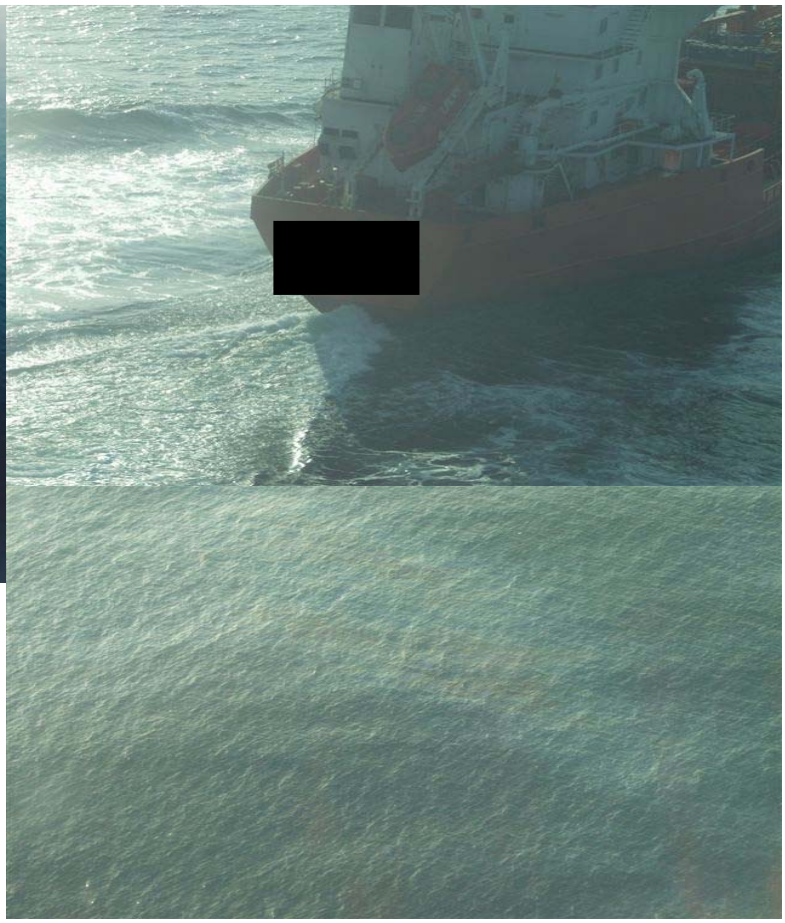
Accident in a port with heavy fuel oil

3.4 Illegal discharges by ships

A visible mark seen with eyes is an evidence of a discharge more than 15 PPM.
It is accepted that a visible discharge of oil is more than 50 PPM in all cases.
MEPC Résolution : 09/07/93

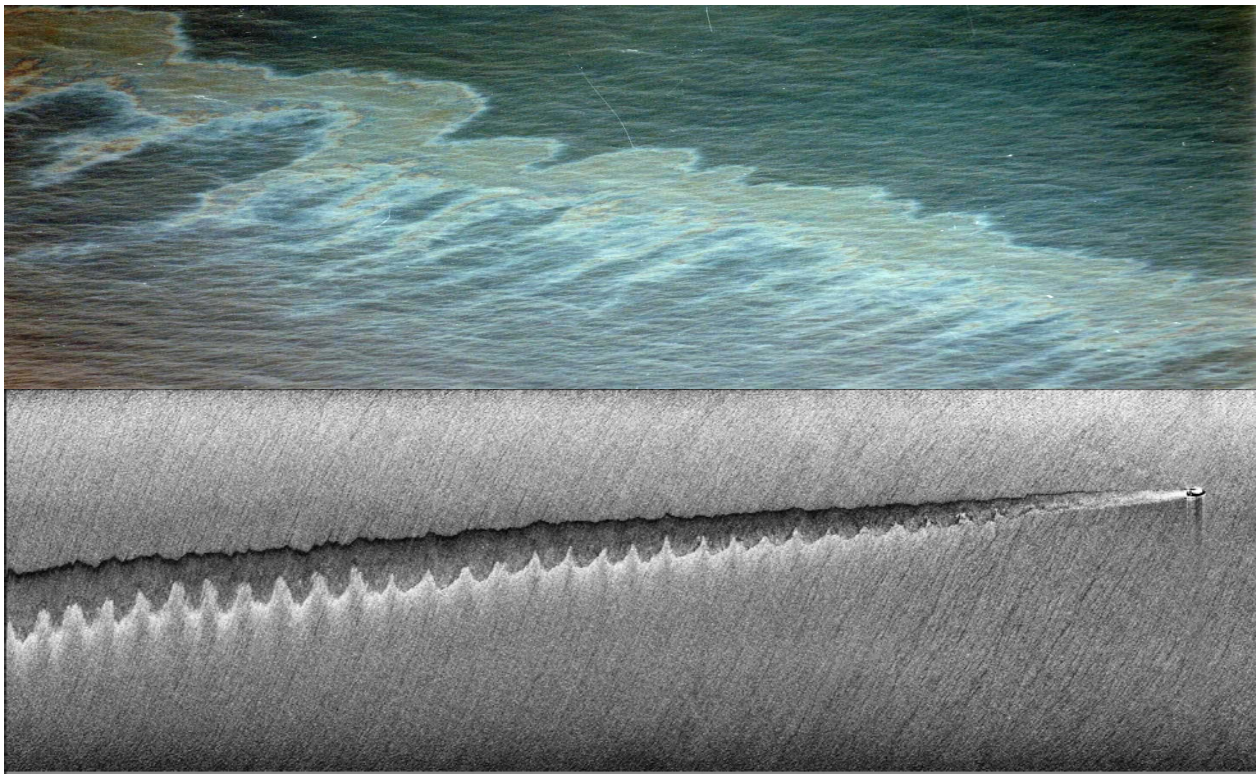
MARPOL 73/78 - Annex I – Rule 15.7





Write up an official report

Record all the evidences



Visual and IR records

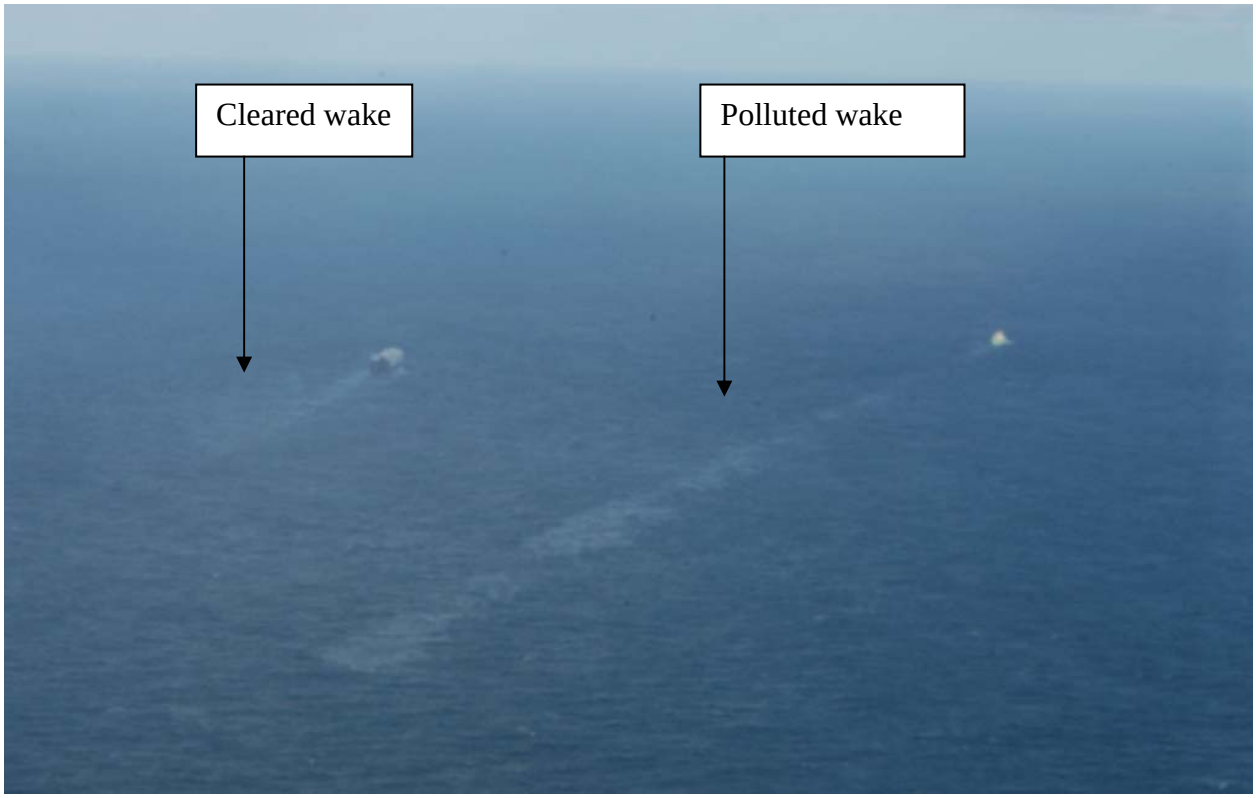
Importance of the altitude and the angle of the picture
Below, it could be difficult to make a link between the ship and the oil spill, but it could be possible with the picture above with high resolution

BA-OAC: code 1 Sheen

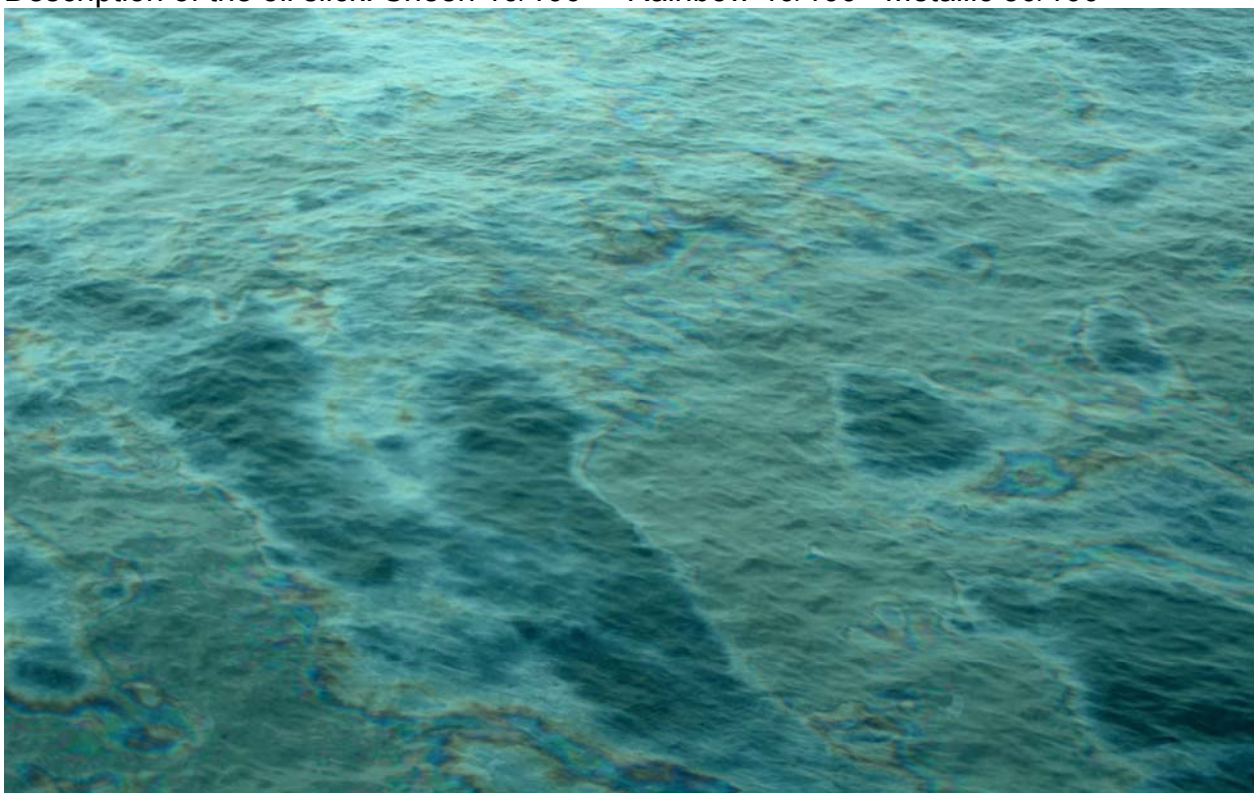
Ship and polluted wake: no oil in front of the ship and on the sides.
Remark: this picture would have been better with more altitude.

2 of the 3 necessary pictures: detail of the slick and the ship with the wake

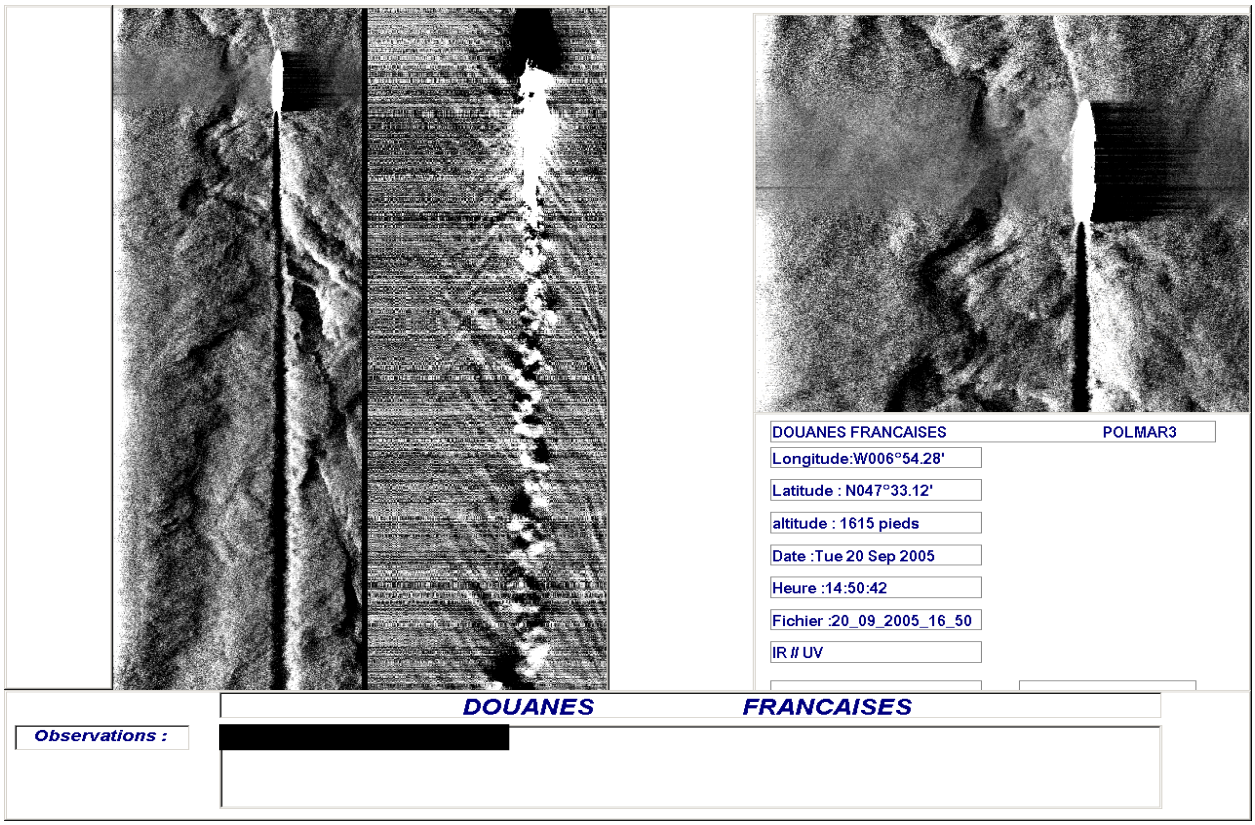
For these 2 photos, it was established that it was a discharge of oily water through the separator 15 PPM, this separator was not working well. It was estimated a discharge of oil between 50 up to 100 PPM
Records of an illegal discharge: visual, SLAR and IR/UV



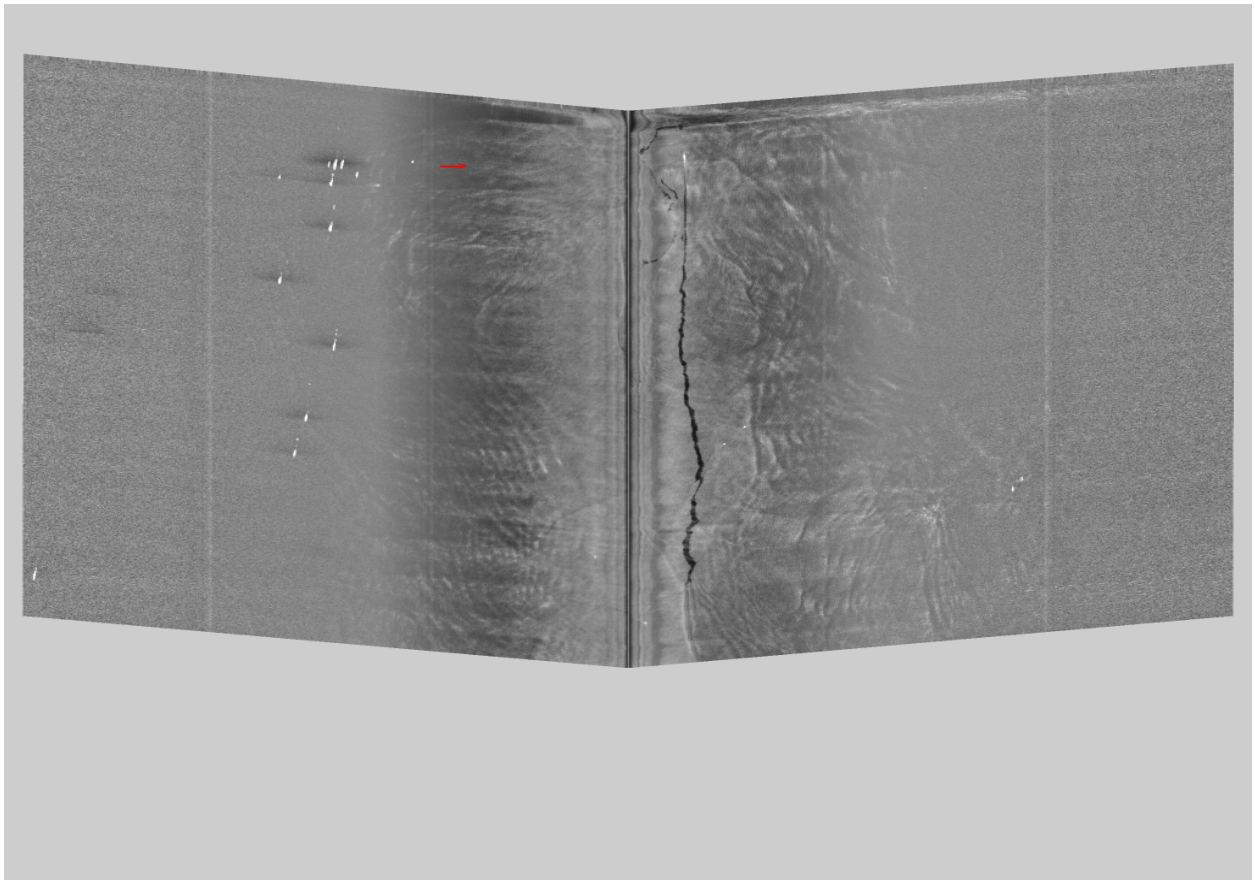
Confirmed illegal discharge:
Meteo from the crew: wind 260/10 visibility 10Km
Description of the oil slick: Sheen 10/100 Rainbow 40/100 Metallic 50/100



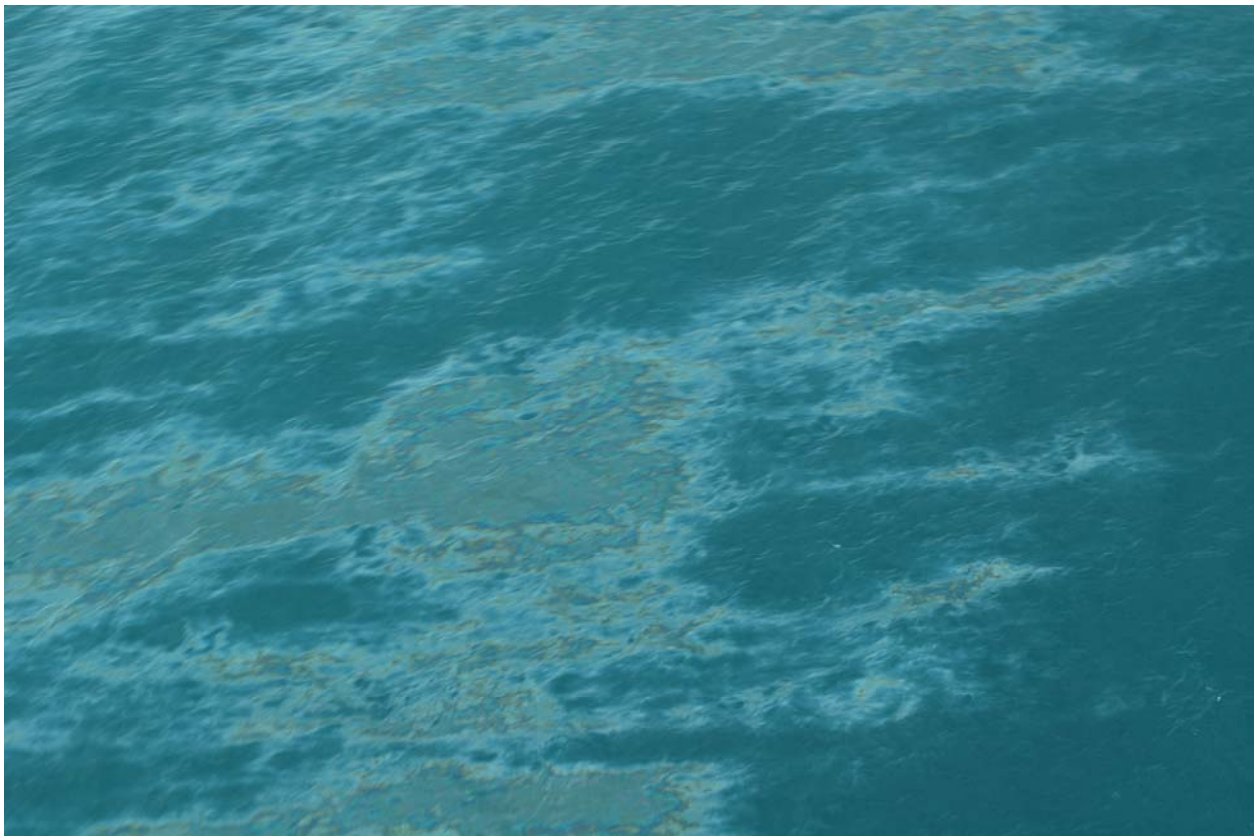
Details of the oil slick



IR/UV and SLAR images

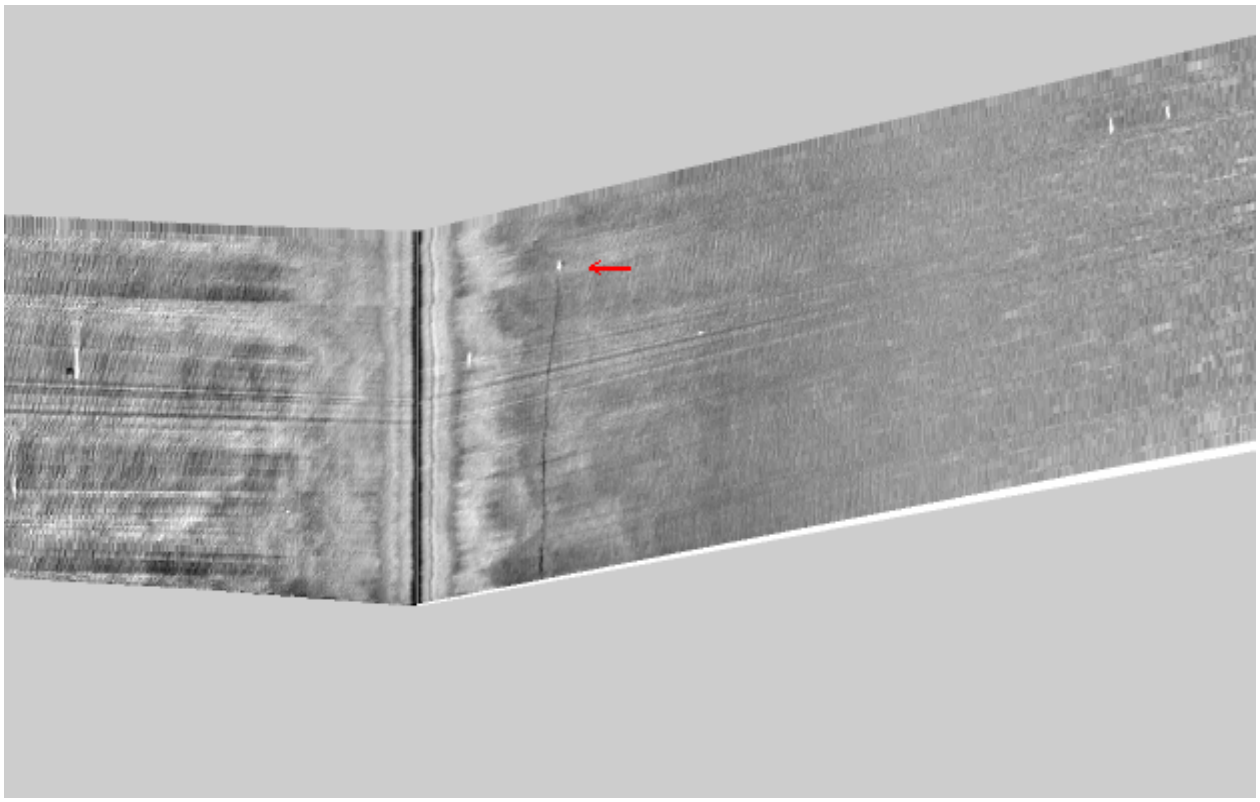


Another example of an illegal discharge: 4 photos
Data from an illegal discharge in 2008
Length: 24 KM / Width: 0.1KM / SURFACE: 2.4 KM2
Proportion of oil 50/100
Wind: 255 / 15 NDS
Meteo: nebulosity overcast, good luminosity, visibility more than 10 Km, sea state 2
Description of the oil slick by the crew:
Sheen 15/100, Rainbow 25/100, Metallic 60/100



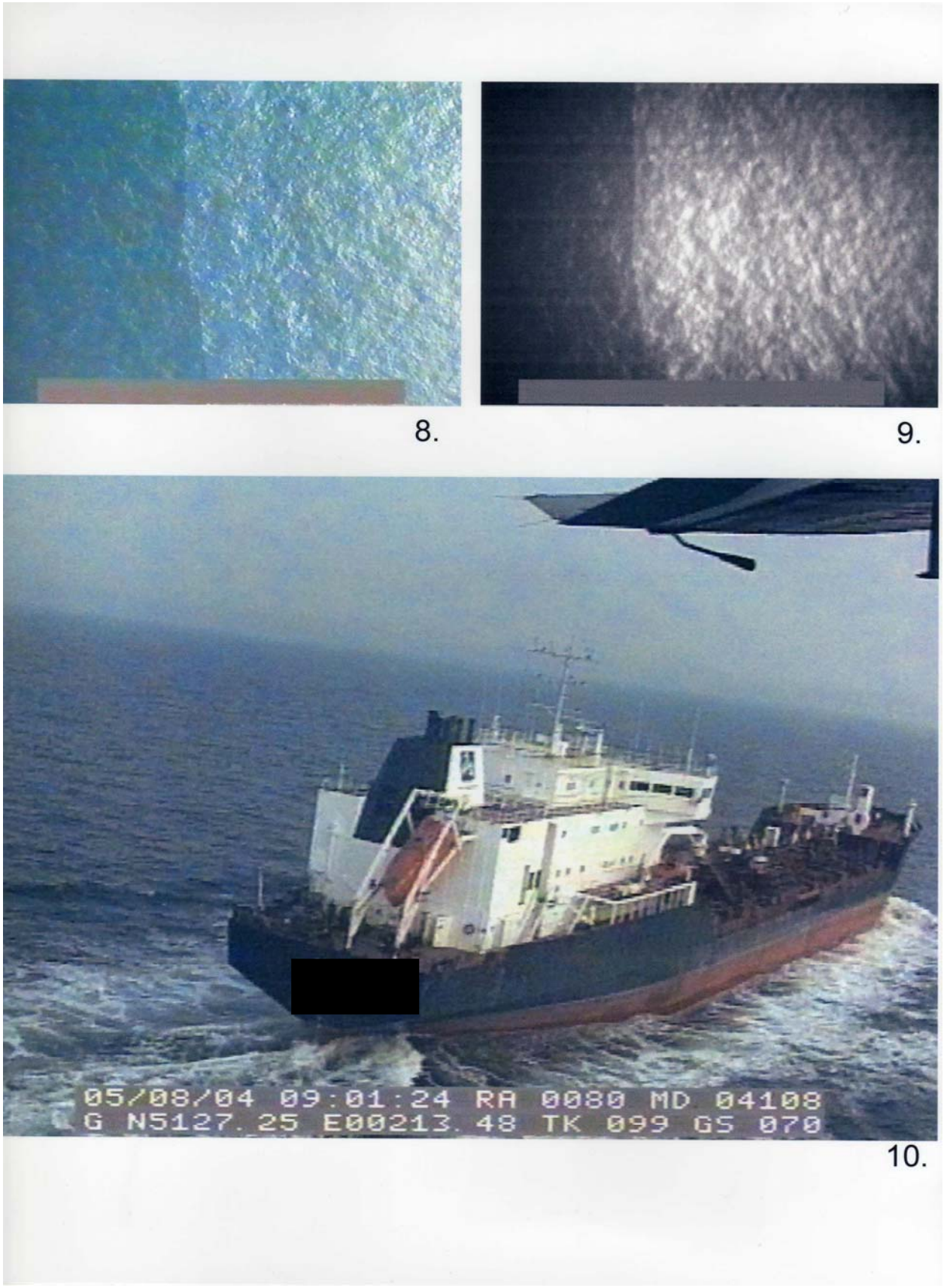
Detail of the oil slick

General view, note the difference with the previous photo page 42, influence of angle and altitude



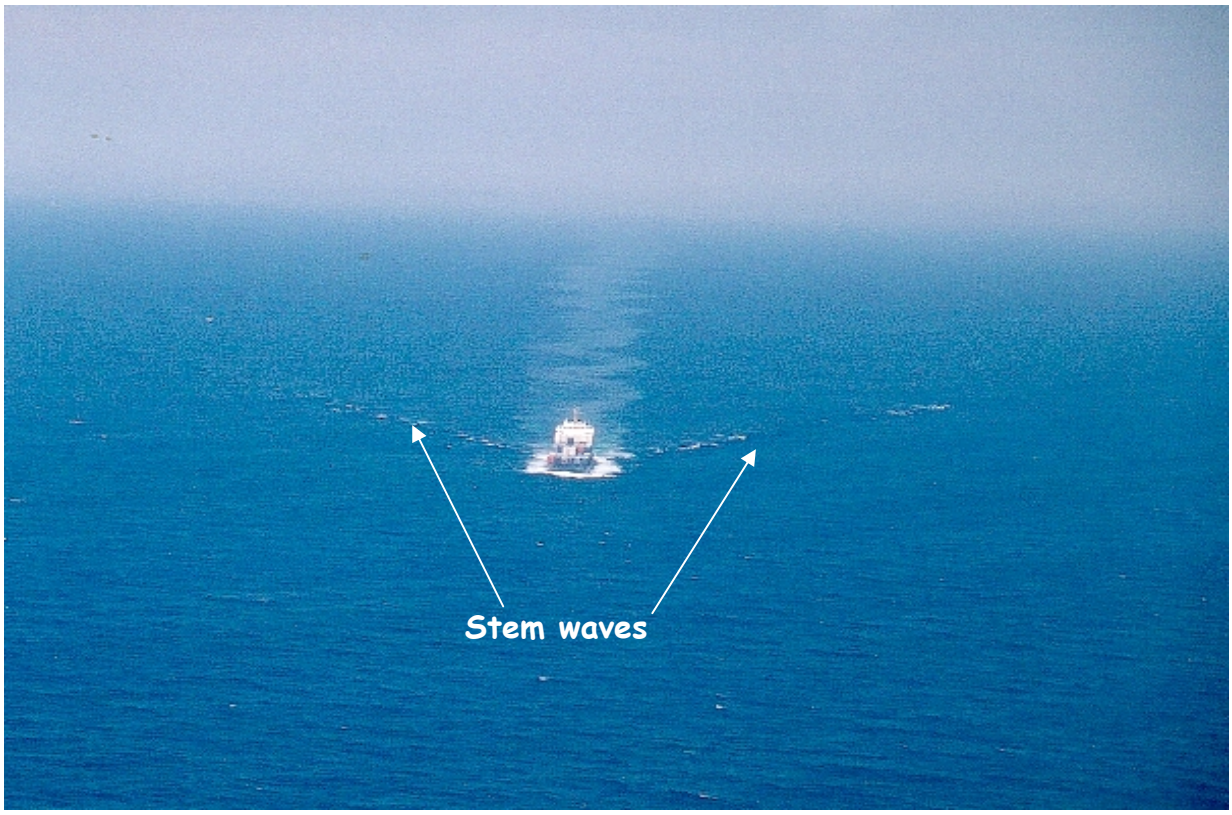
Illegal discharge in 2004

General view of the ship with the oil slick



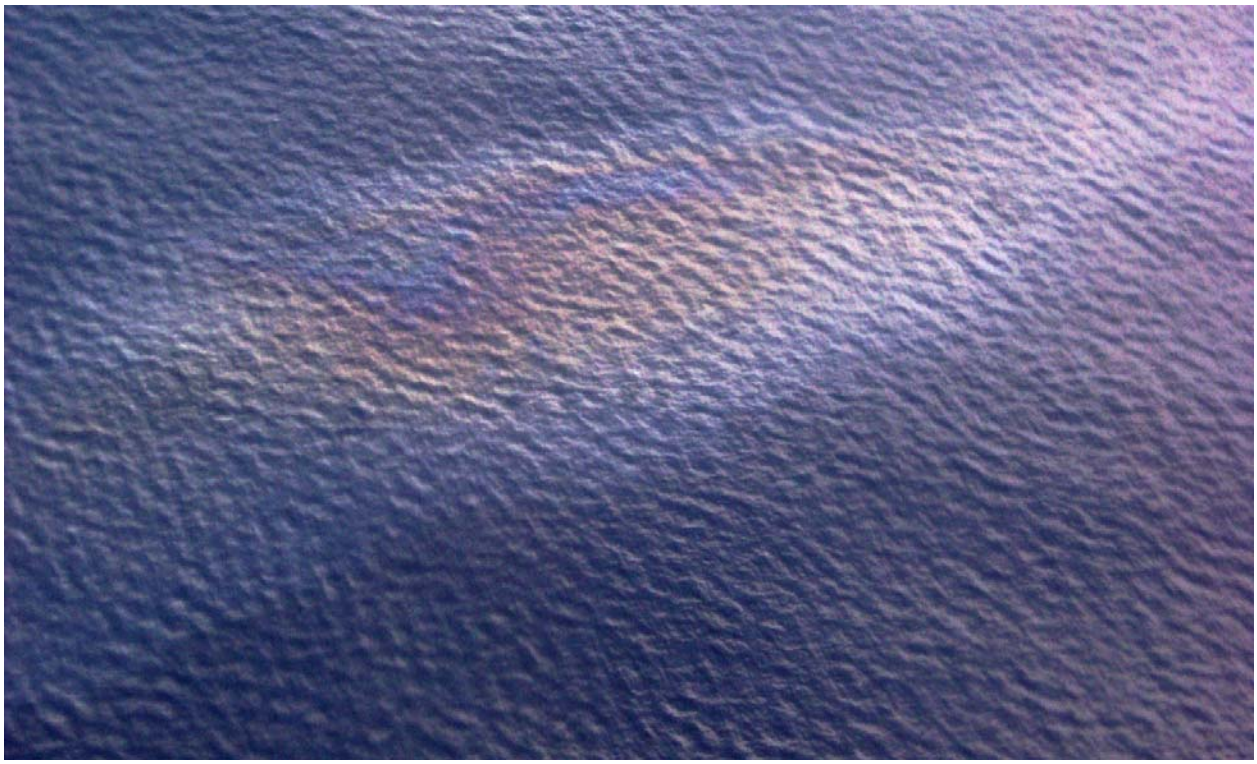
Ref 8: visual, ref 9: UV image (mineral oil classified), ref 10: vessel identification

Information from picture and advices

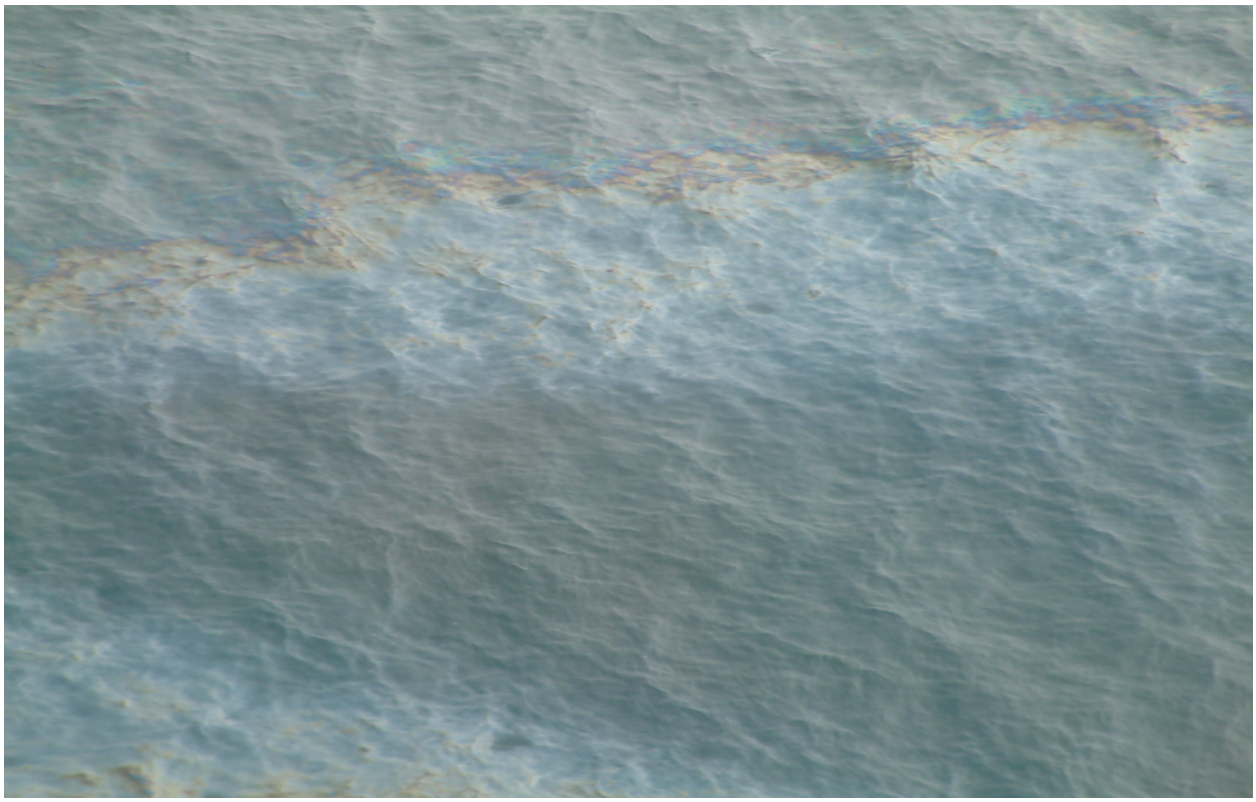


Be careful with sun

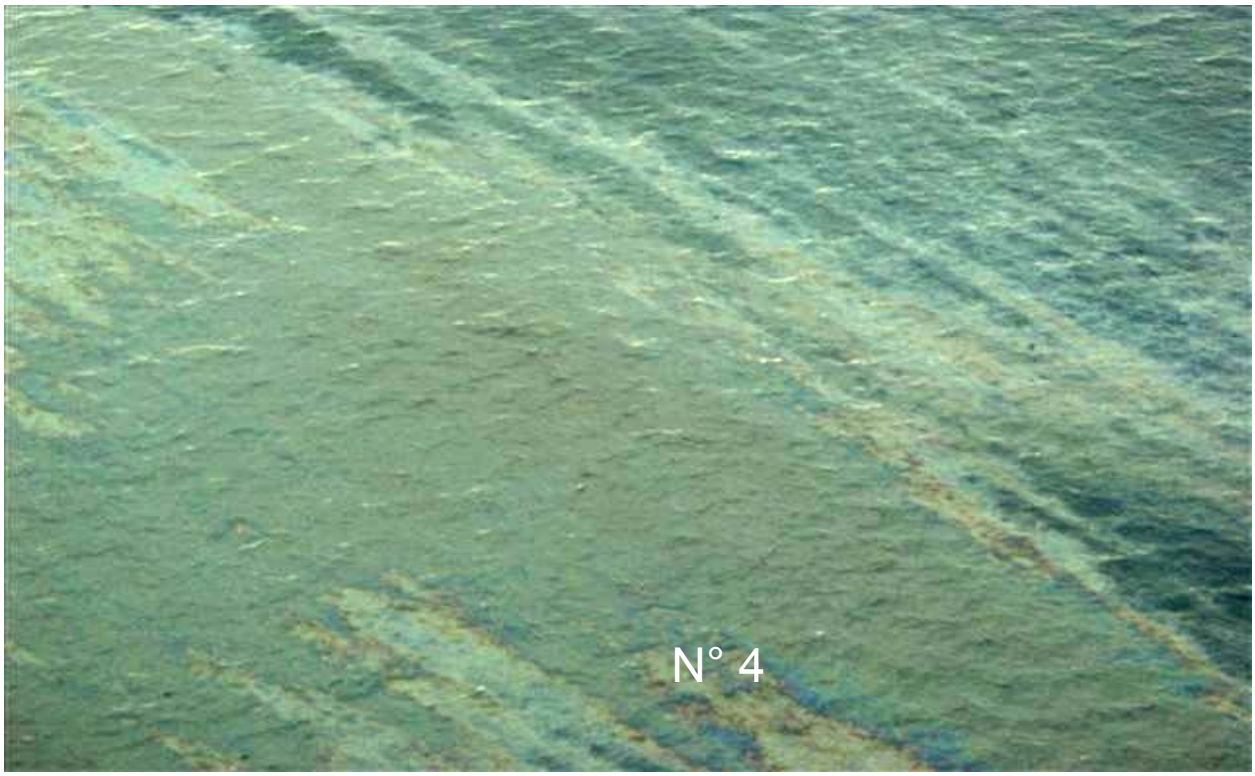
Take care with altitude that involve a different angle, it is necessary to have the right altitude to have the good overview

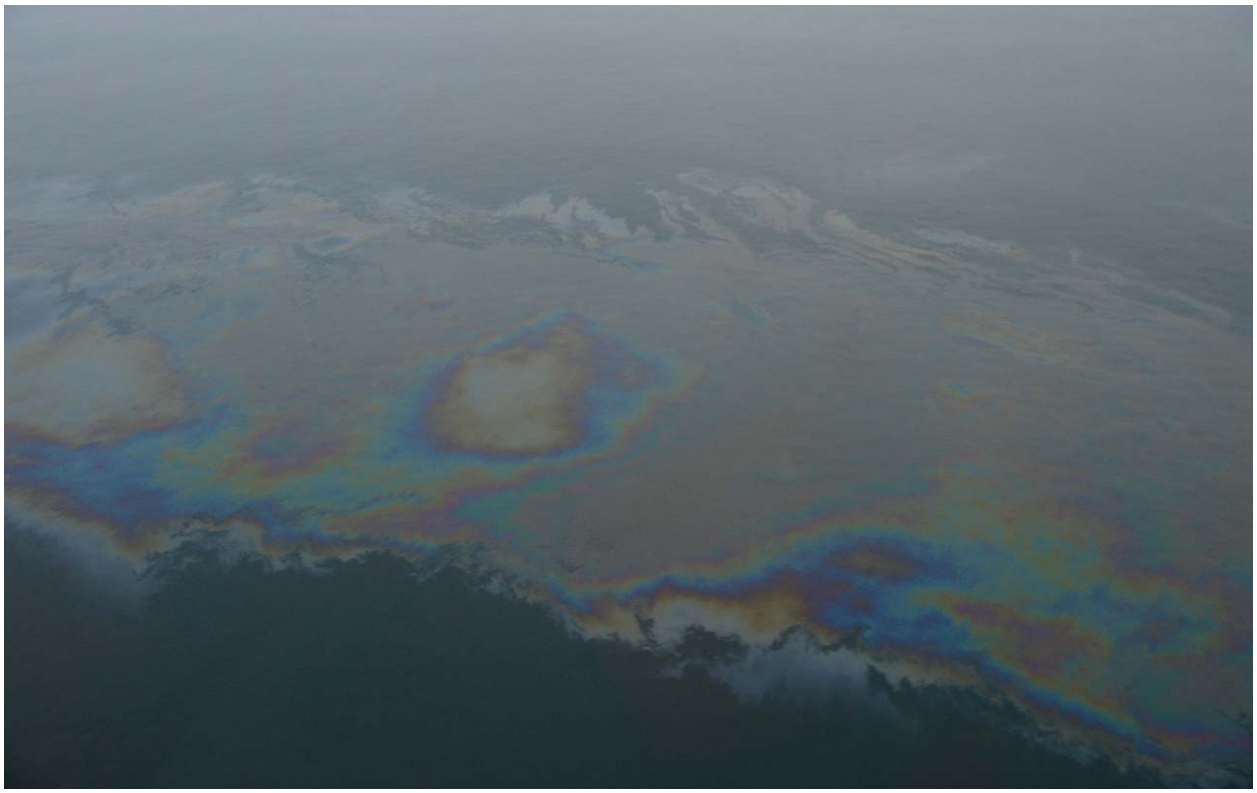


CODE 1, 2, and 3 in the wake of a ship

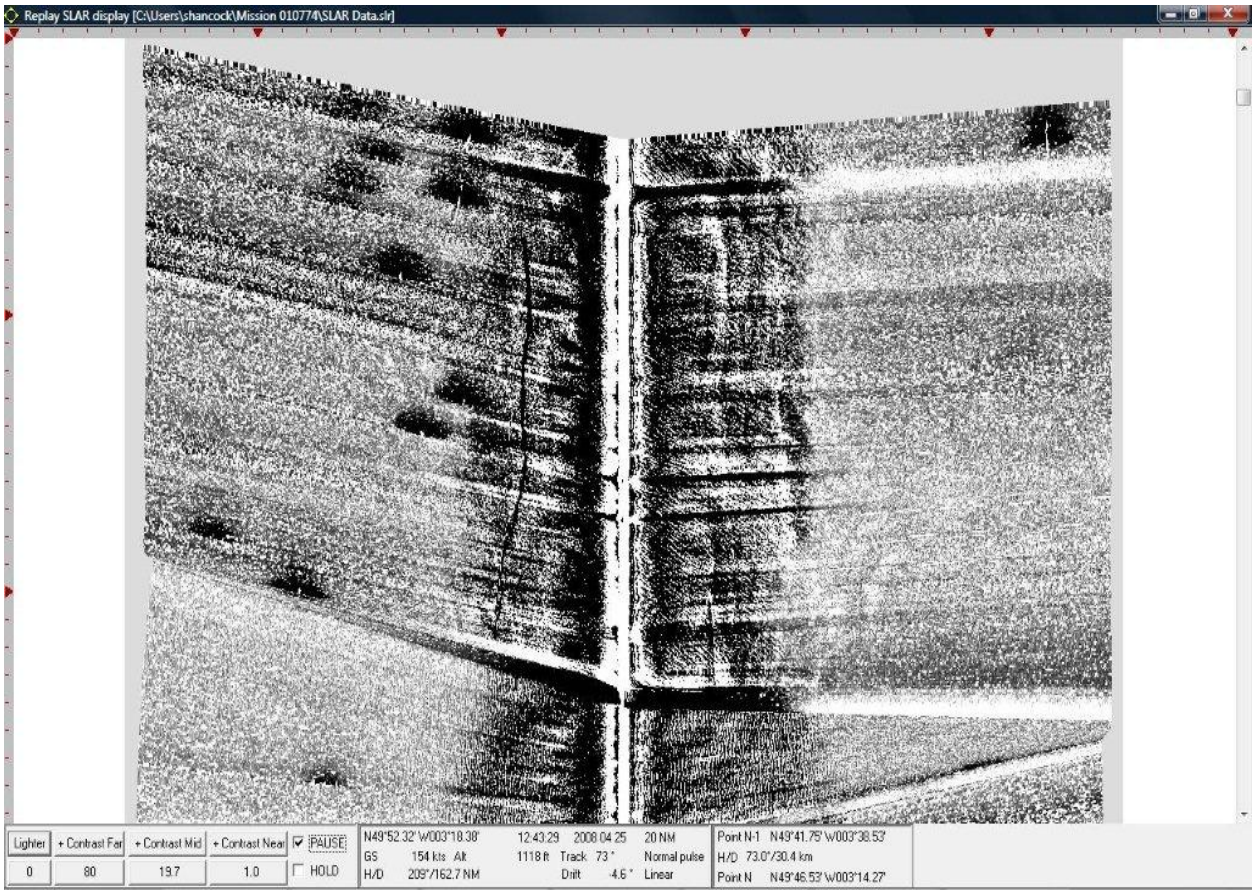


Oil slick from ship

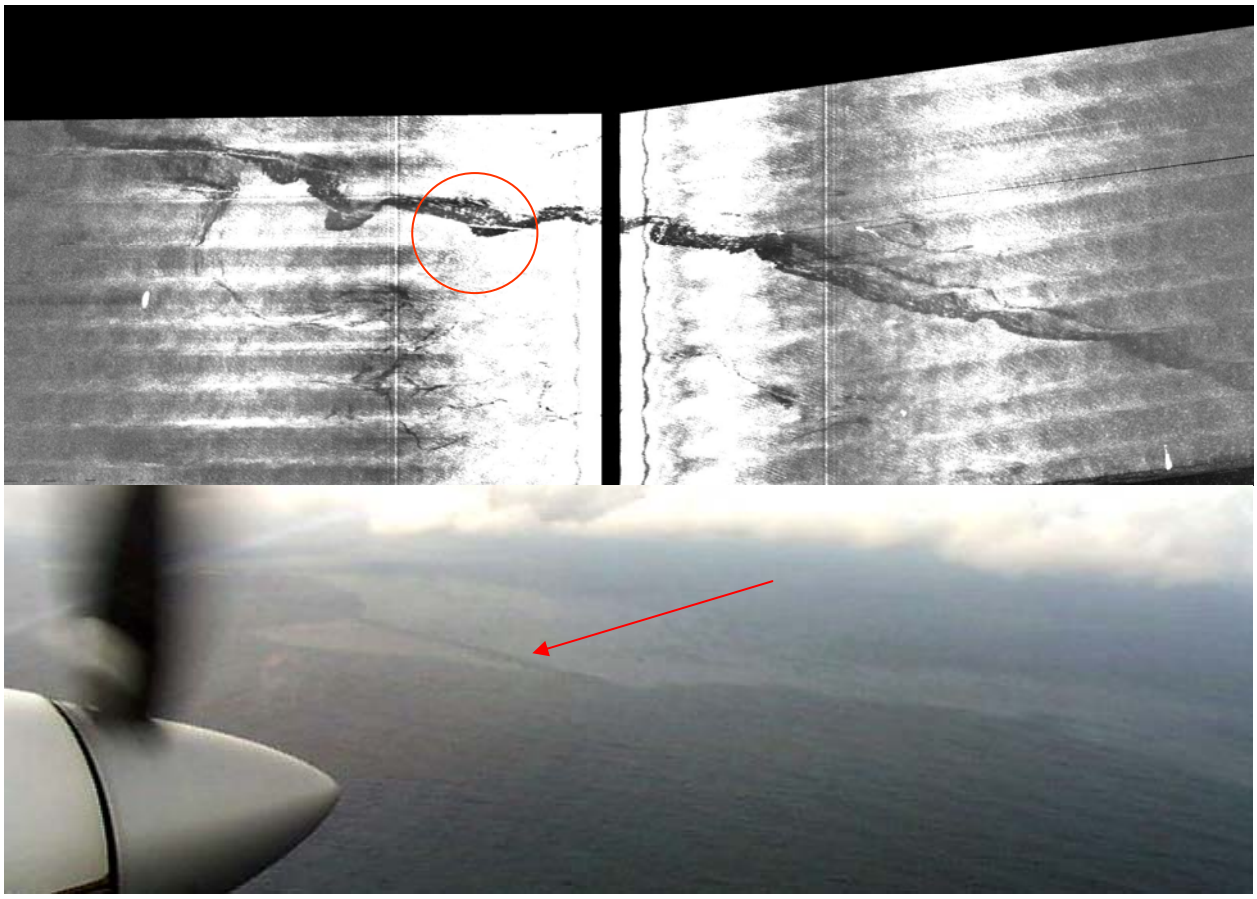




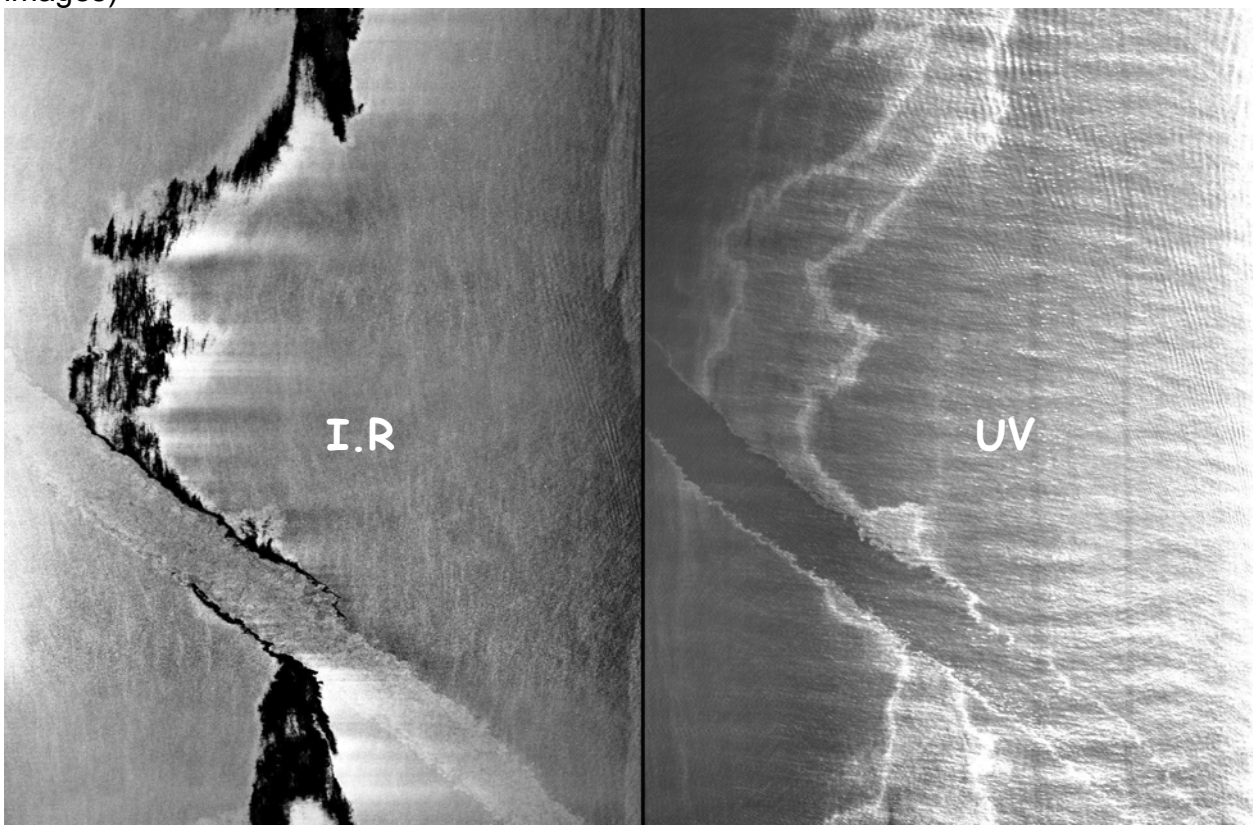
Beautiful colours, aren't' there! Could you evaluate the percentage of the different codes? Try with the other crew members and compare your results (solution page 94)



When a ship goes through an oil slick, there is a clean wake behind, following some examples



Clean wake behind a ship that goes through an oil slick (visual, SLAR and IR/UV images)




That is an exceptional document.
What is this vessel?

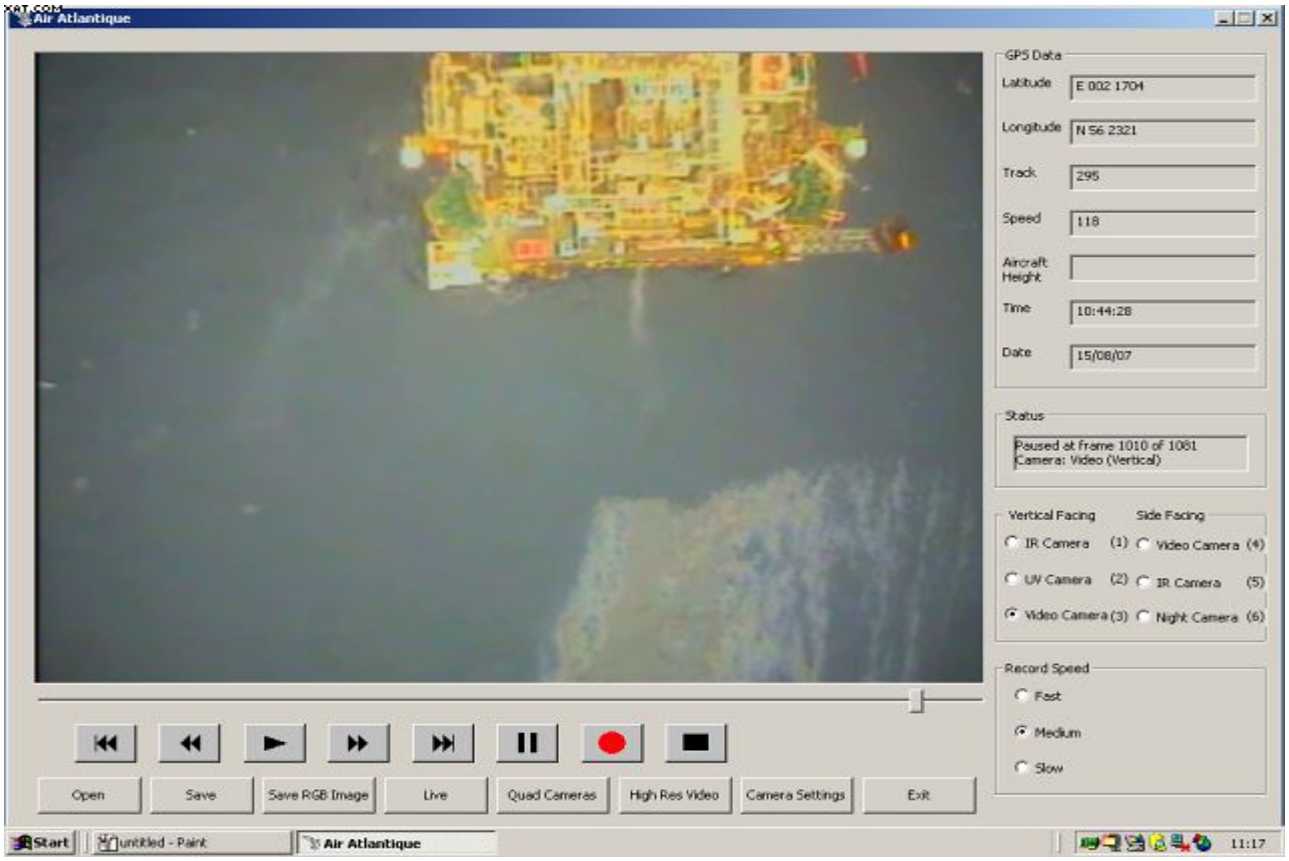
At your opinion, what do you need to be sure it is oil? (See page 94).

These pictures were not from the prestige accident, but it was an illegal discharge by this vessel a few months sooner.

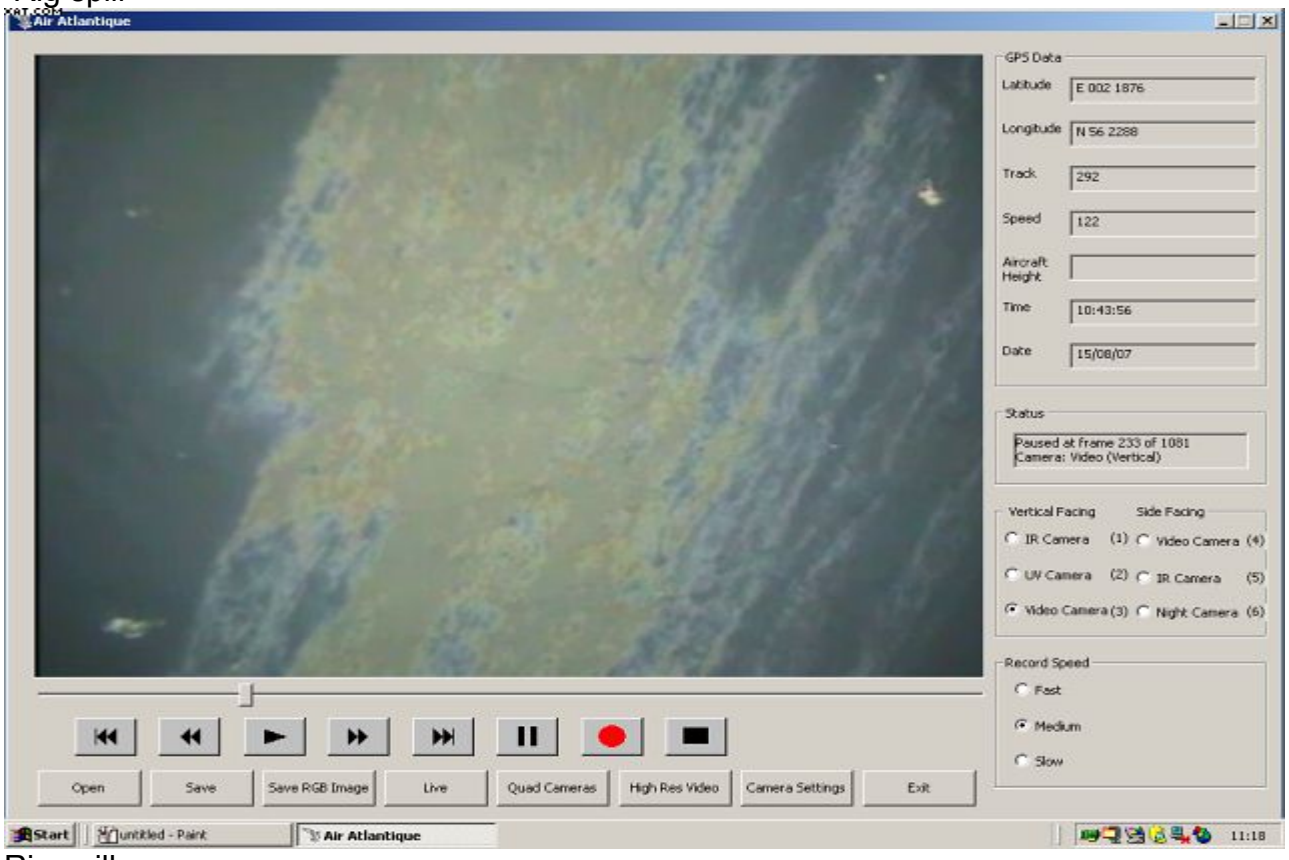
3.4 Discharges by rigs

Rig spill, not a discharge by ship

Rig spill, the tanker is waiting for loading

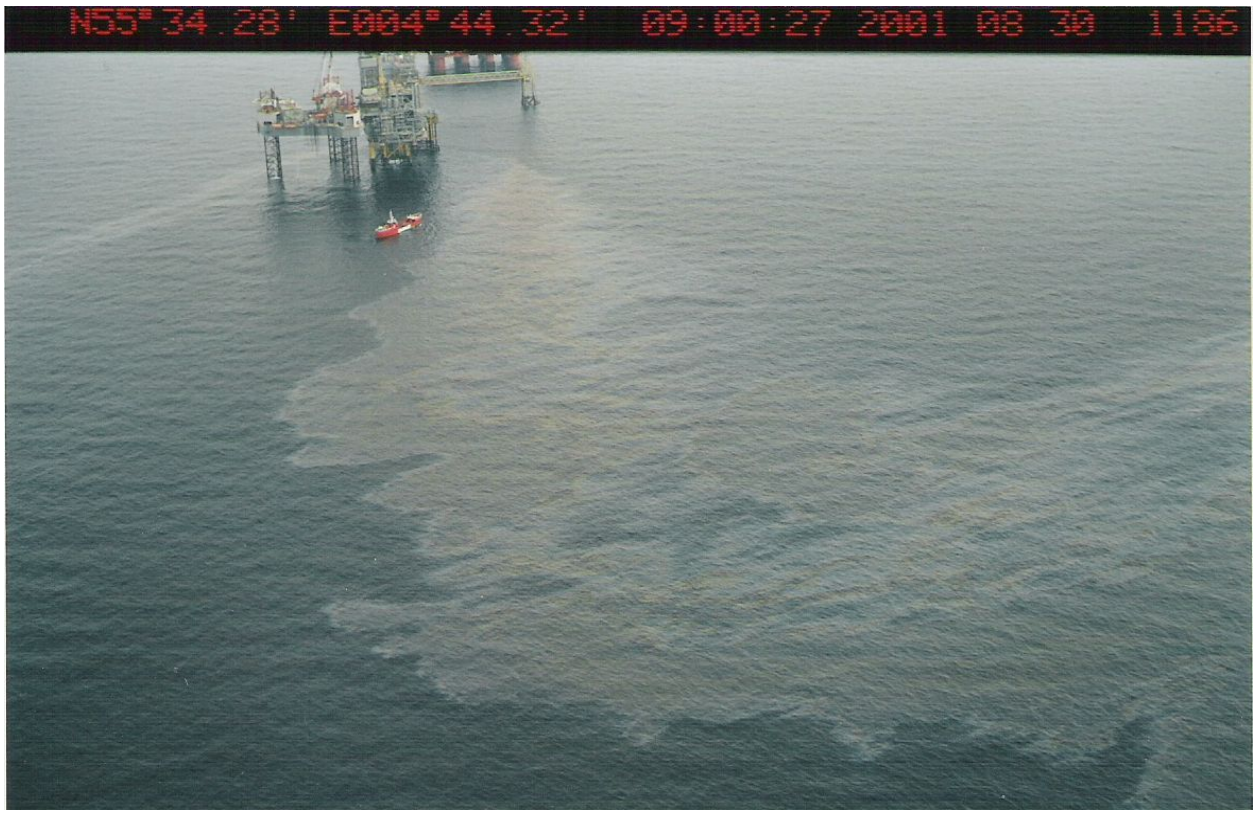


Rig spill



Rig spill

Some examples of rig spills






Some examples of rig spills

Don’t forget that mineral oil has a different behaviour and appearance at sea in comparison with vegetable oil and other products.

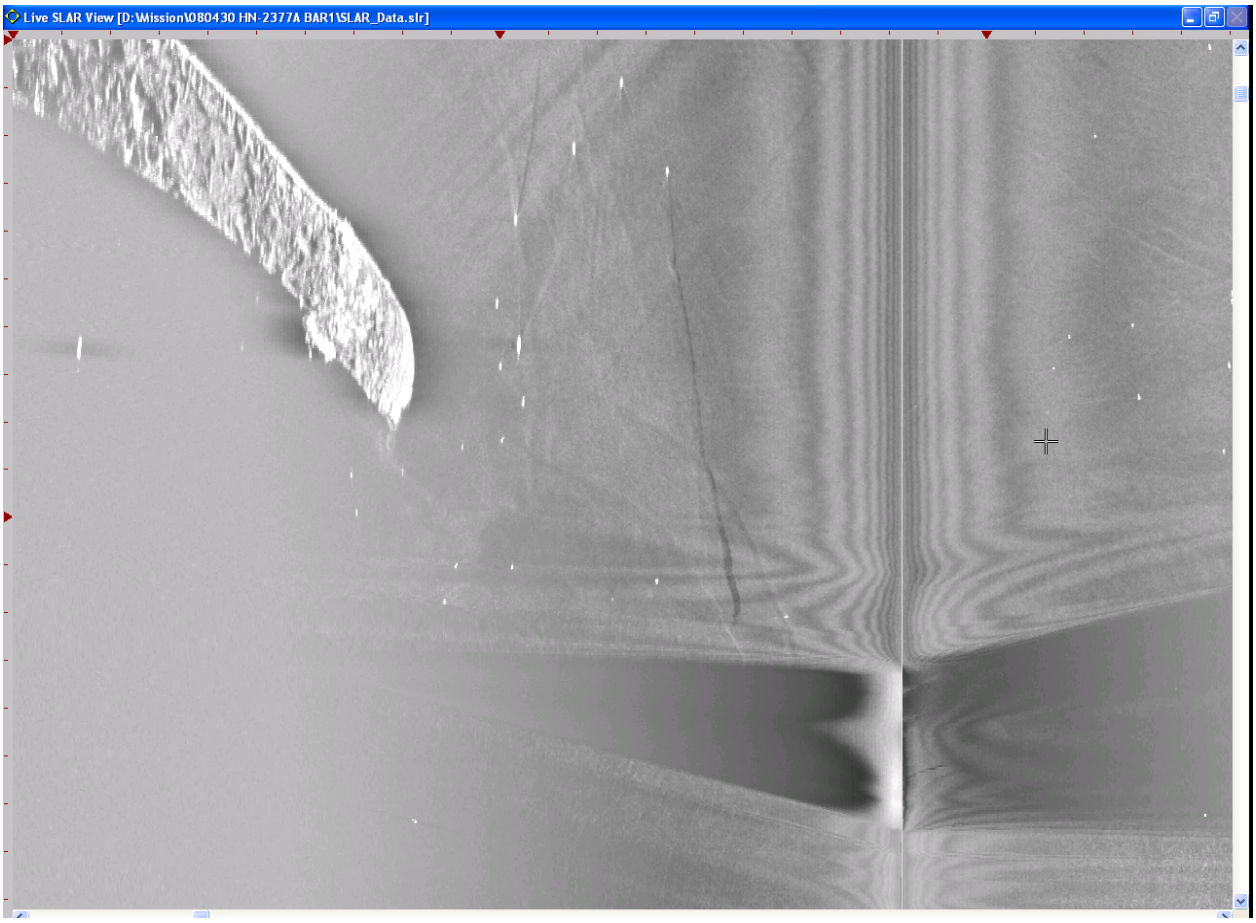
In the following pages, we will see different cases where it may be possible to confuse, but remember BA-OAC, if you don’t see the different codes, it is most likely not mineral oil, of course the context and the behaviour of the product at the sea surface is important.

4 – Vegetable and animal oil

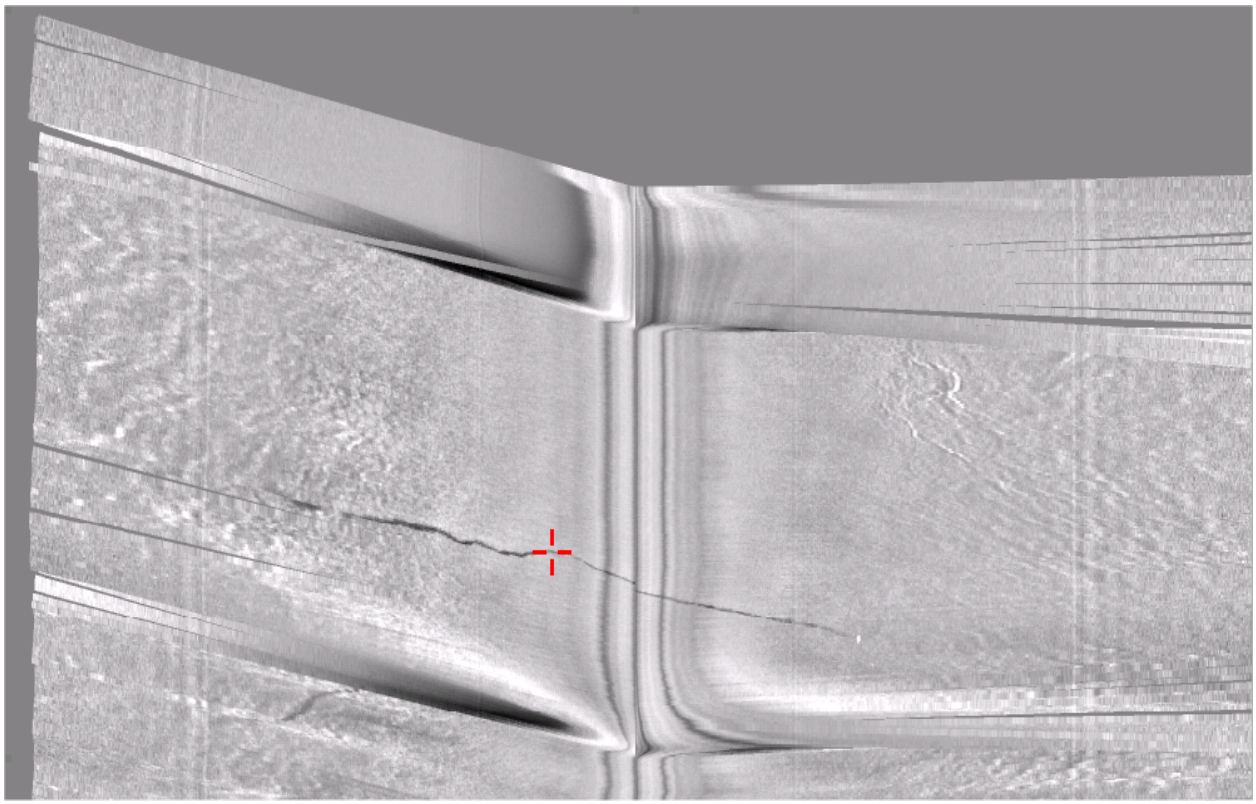
4.1Vegetable oil

A vegetable/animal oil discharge will normally look “SHEEN”.

Vegetable oil discharge from a ship.



Discharge of vegetable oil in 2004

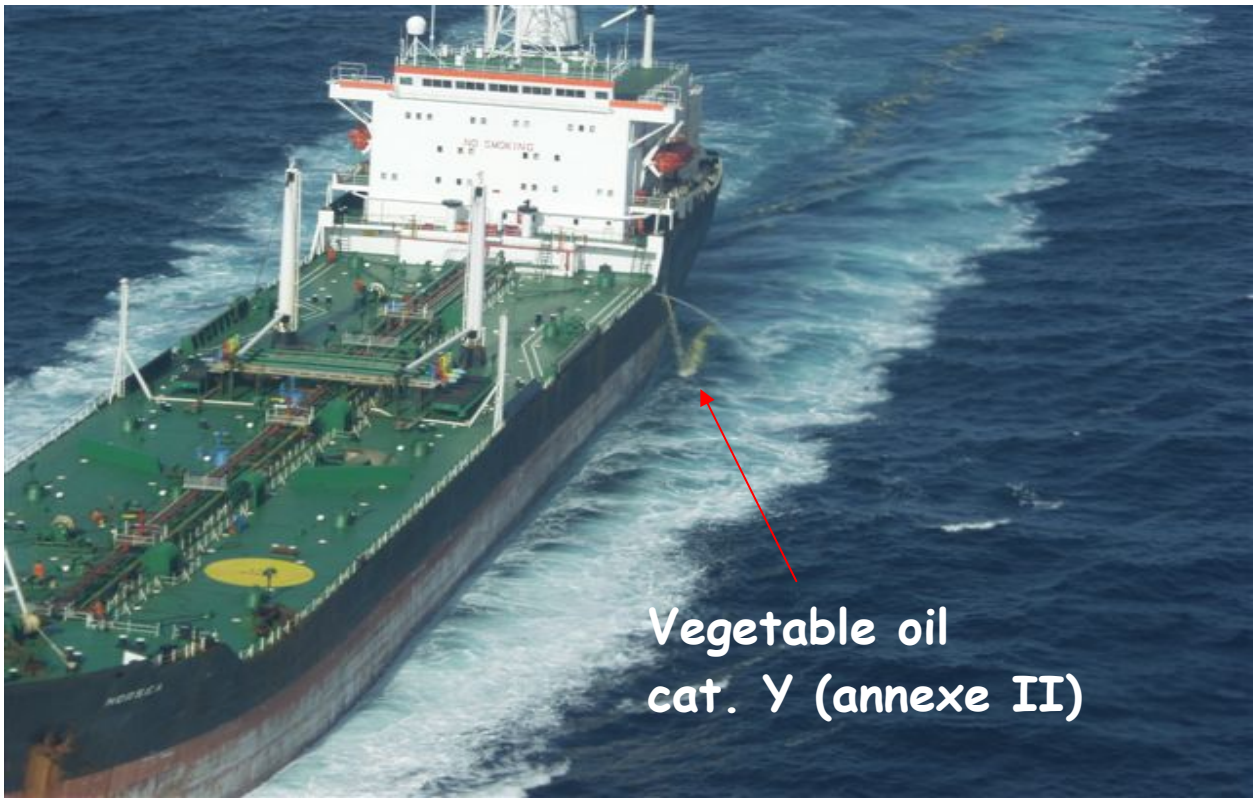


Vegetable oil: SLAR image

Discharge of Soya oil from tank washing

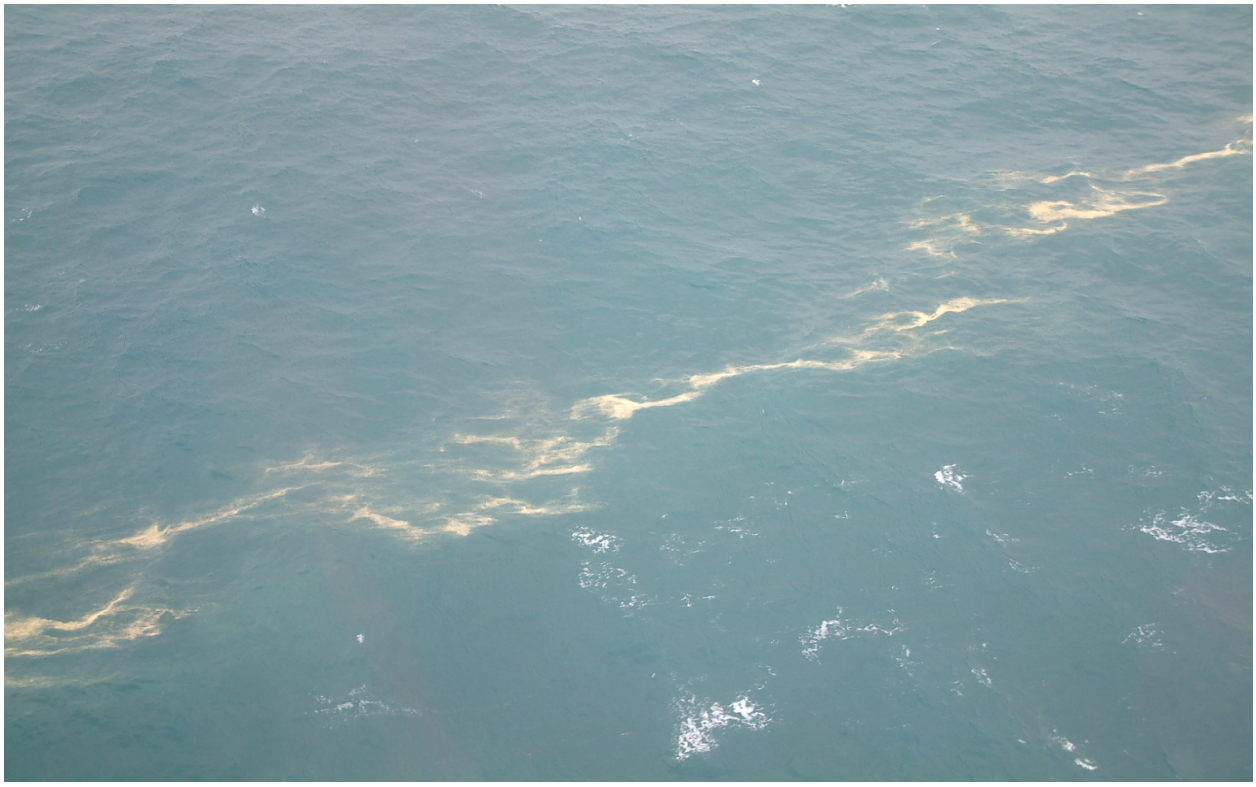
General view: the behaviour of vegetable oil is different of mineral oil at sea surface, vegetable oil is not spreading out as much as mineral oil

Details of vegetable oil: there is no doubt, it is not mineral oil (remember Rainbow, Metallic)



Palm oil, general view

Discharge above the sea surface = offence against MARPOL Annex 2



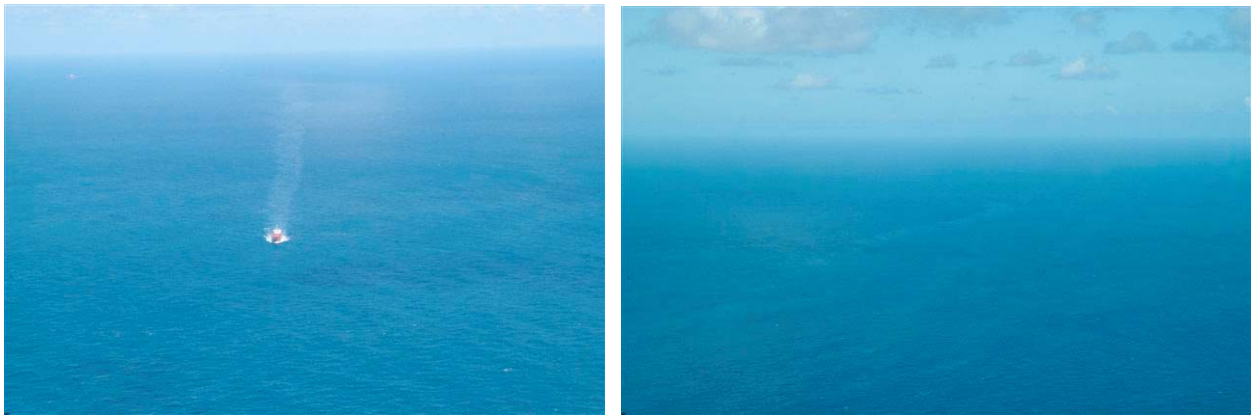
Palm oil, detail

OLIVE OIL

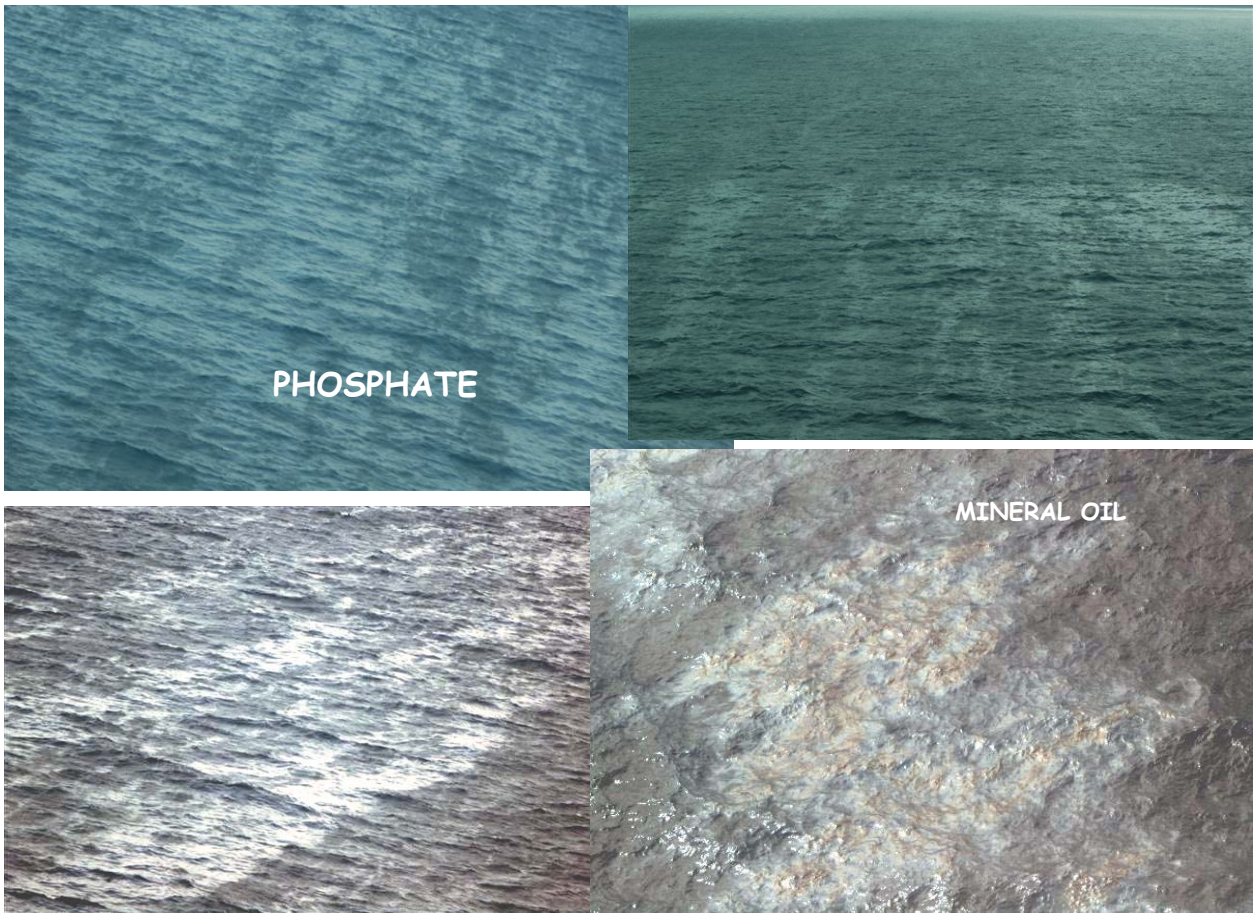
4.2 other oil to be confused with vegetable oil

Vegetable oil

Note the difference of spreading between vegetable and mineral oil



Bio fuel at sea: the same appearance as vegetable oil (spreading and sheen)

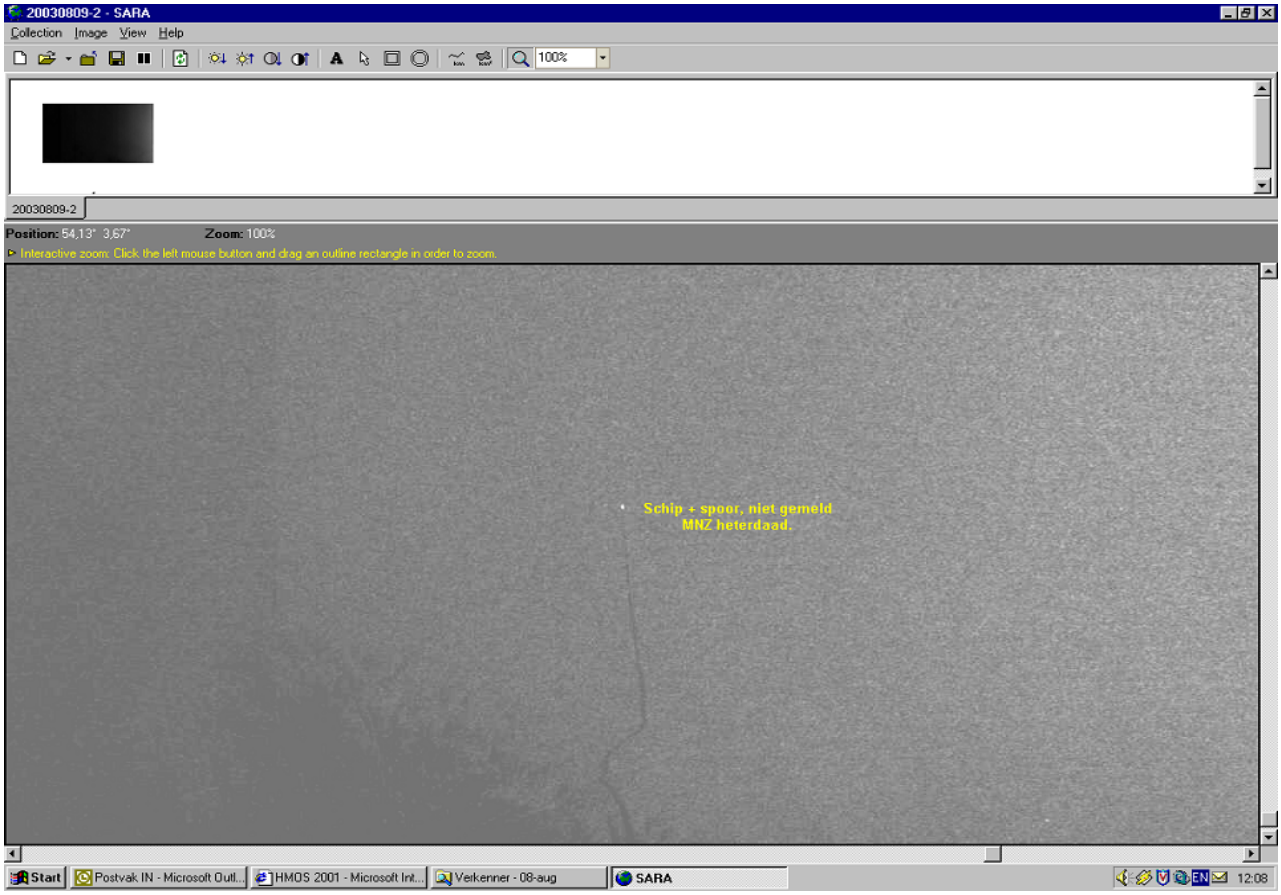


Following 4 photos of discharge of cooling water with cooling liquid due to an accidental leak

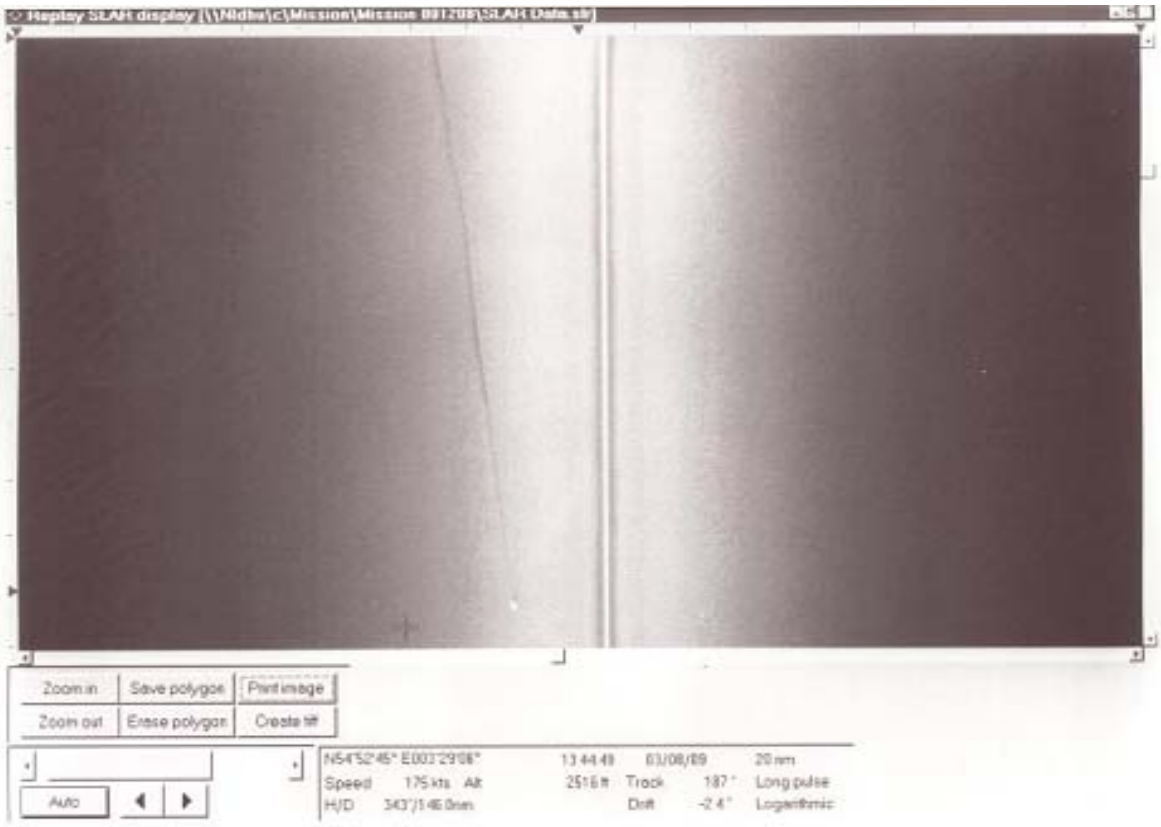
Fishing vessel in action, slick in the wake: length 4.3 km 100% sheen.
Sea state 2 -3, Wind 320 / 10 – 15 Kt, visibility more than 10Km

Following a case of a discharge of vegetable oil: visual, satellite and SLAR images

Visual observation of vegetable oil in june 2009: tank washing annex 2, not allowed due to the fact that the discharge was above the waterline.
We need a picture in detail of the side of the ship with the discharge.

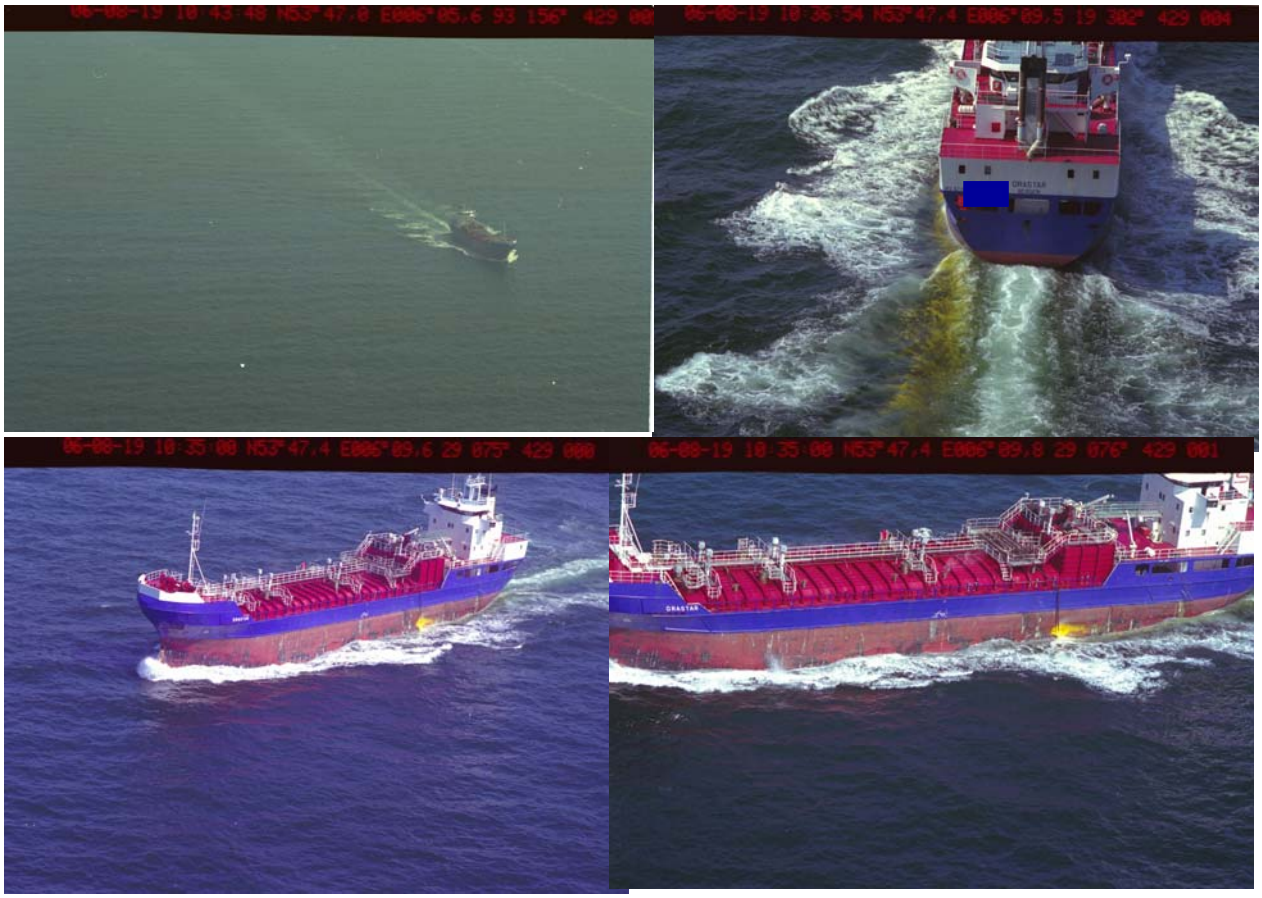


Satellite image of the vegetable oil slick



SLAR image of the vegetable oil slick

4.3 Chemicals



Write an official report for offence to MARPOL convention annex 2, it will be necessary to have an enquiry by the authorities in charge of Marpol regulations

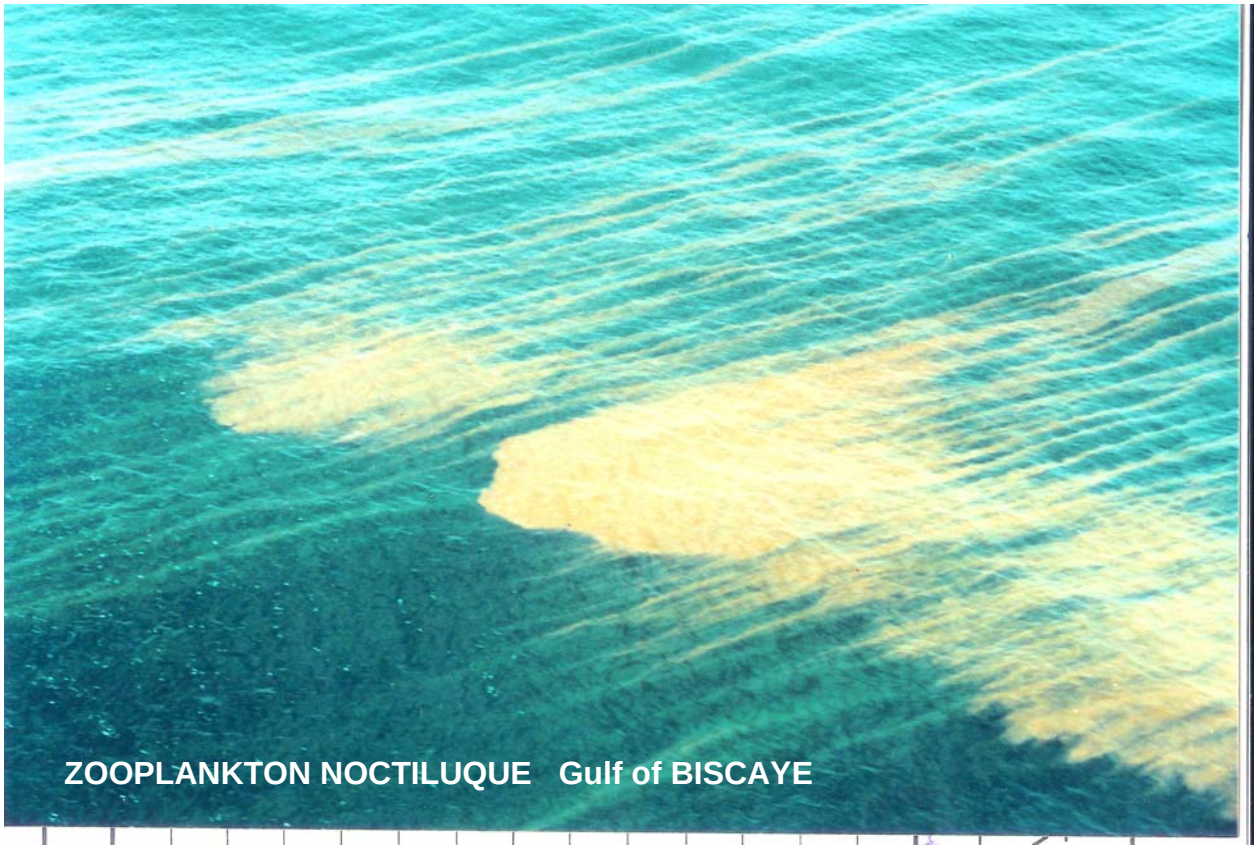
5 - Natural phenomena

5.1 Algae

Bluegreen algae around the Danish island Christiansoe.

Heavy blooming of blue green algae in the Baltic.


N55°10.35' E013°21.50' 13:47:41 2006 07 12 2999 ft


ZOOPLANKTON NOCTILUQUE Gulf of BISCAYE

Algae

Algae

Macro algae

Plankton gulf of Biscay

Algae bloom

Algae bloom

5.2 Phenomena at sea

Current Shear can sometimes be recognised on white foam between the shears.

Current shear in the middle of picture.

With a calm sea, current due to difference of temperature

Separation of waters due to a difference of salinity with white foam

Clouds make shadows on the sea surface.

Clouds make shadows on the sea surface.

Cloud shadows looking like floating oil

Shallow water can under some conditions mistakenly be seen as oil.

Reefs and shallow water areas can mistakenly be seen as oil/algae.

Slick like effects due to the presence of sand banks, sea weed, coral reef, etc.

6 - OTHERS

Engine smoke from ships can under some conditions mistakenly be seen as oil.

Ships can also discharge other substances like mud, limestone etc.

Ships can also discharge other substances like mud, limestone etc.

Ships can also discharge other substances like mud, limestone etc.

Muddy water near the coast

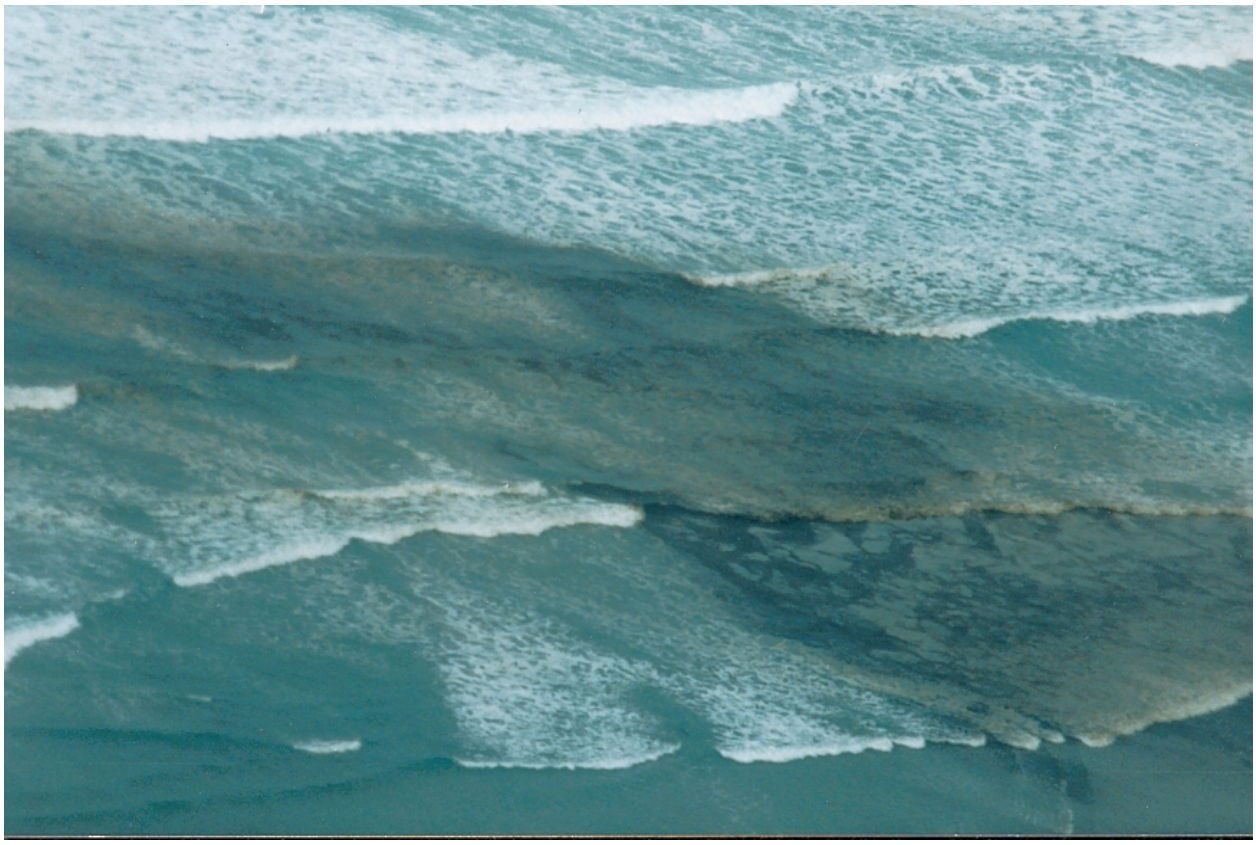
Sludge from dredger

Peat on water surface

Waste with algae

Container carriers: high speed, large wake, white trail, foam

Container carriers: high speed, large wake, white trail, foam



Black effect on the beach

Slick of molasses

Timber pile

Jellyfishes, it may be possible with visual observation from an aircraft to observe “RAINBOW” appearance, but the behaviour and the aspect are very different from oil and not to be confused.

What code? Illegal discharge or not?

Solution: whale, consult ASCOBANS for the type of whale

Solution

Page 49: SHEEN 5% RAINBOW 10% METALLIC 25% DTC 60%

Page 53: In the collection of evidences for a judicial follow-up, we need a detail picture of oil at the sea surface, what appearance from the BA-OAC.