CRRC Dispersant Research Forum, Red Bank, 1-2. February, 2006

"Fate of dispersed oil: Field trials with dispersant application - Importance for development and calibration of operational model tools"

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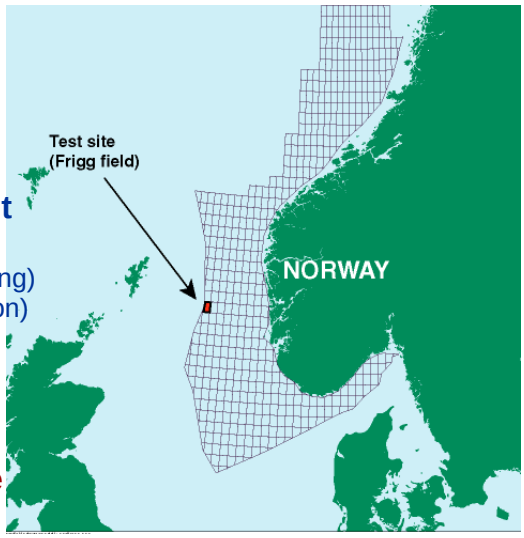
Use of dispersants in Norway

- **Mechanical recovery has traditionally been the primary oil spill response strategy in Norway**
- **Recent years signals from the Authorities:**
  "Dispersants should be a more operational alternative / supplement in certain oil spill situations" i.e:
  where dispersants are considered to give the overall most environmentally benefit (NEBA-philosophy)
- **New regulations for use of dispersants (2002)**
  - ⇨ Oil industry: preparing contingency plans including pre-approval use of dispersants in specific regions / locations: refineries, oil terminals and off-shore fields
  - ⇨ The Government (NCA) is planning to build up a dispersant contingency along the coast over the coming 3-4 years

Test site for dispersant field trials in Norwegian water

Organized by:

- Norwegian Clean Seas for Operating Companies (NOFO)
- SINTEF: scientific responsible



Series of field trials with different dispersant application methods:

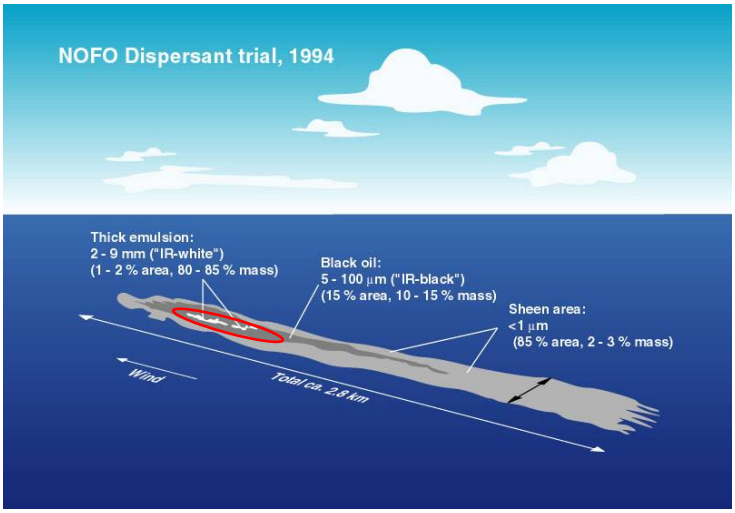
- 1982, 1983, 1984, 1989 (boat/ fixed wing)
- 1994, 1995, 1996 (helicopter application)
- 2006 (new boat application system)

Gained much scientific documentations and operational experiences in use / application of dispersants !

grafisk/admtegner/div-PSD/bonnex-filmthickness examples-nov-01.ppt

Distribution of oil slick thickness

20 m² Sture crude, weathered 3 hours at sea, NOFO field trial 1994,



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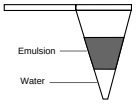
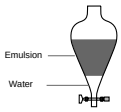
Handling of sampling of surface w/o-emulsion

1. Collection of surface oil / emulsion with a net (bucket) separating off free water from bottom.



2. Transfer to a 2 litres separation funnel, approximately 10 min. settling for draining off surplus (non-emulsified) water plus ≈ 0.5 litre of bottom emulsion.



3. Gentle homogenisation (10 times 180° tilting) of the remaining bulk sample (1.5 to 2 litres).

4. ***Sub-sampling of bulk sample:***

- 1 × 100 mL Pyrex bottles (miscellaneous).
- 4 × 250 mL High Density Poly Ethylene (HDPE) bottles (w/o emulsion viscosity and miscellaneous).
- 1 × 1000 mL HDPE bottle (to make water-free residues).

5. ***Labelling of sub-samples***:
- Sample ID
- Local time
- GPS-ID#

6. ***Logging in journal book***:
- Sample ID (e.g. L2a – St. 4 – 1405, Day 1)
- Local time,
- Weathering time,
- GPS Position / ID#
- Co-ordination (synchronisation) with aircraft : yes / no
- Location in the slick, oilfilm characteristics and eventual other relevant comments.

Sampling in oil spills during response operations

Analysis carried out

In the field (immediately):	In the laboratory (later):
- Water uptake/content - Evaporative loss (preliminary) - Viscosity of w/o-emulsion - Stability of w/o-emulsion - Effectiveness of emulsion breaker - Chemical dispersibility (SINTEF FET test) - Oil film thickness (thick cylinder) - Sub-surface monitoring (*in-situ* UV-fluorescence) - Oil droplet size distribution	- Evaporative loss (GC) - Oil film thickness (pad / teflon) - Pour point - Flash point - Interfacial tension - Density - Sub-surface water samples (detailed chemical analyses by GC and GC-MS).

Checking oils' dispersibility in the field:

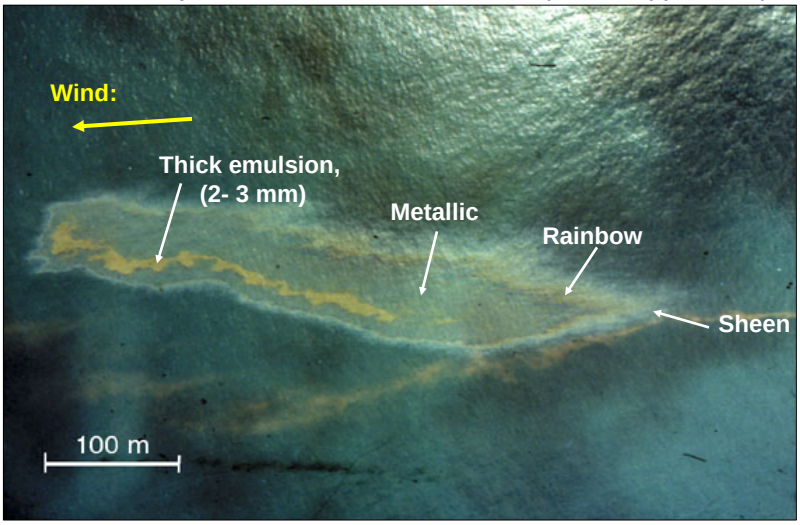
SINTEF Field Effectiveness Test (FET)

Visual criteria:

1. **Good dispersible**
2. **Reduced dispersibility**
3. **Bad dispersible**

Dispersant Field trial (North Sea)

20 tons Statfjord crude, weathered 2 hours (before application)



Dispersant application

Small -aircraft

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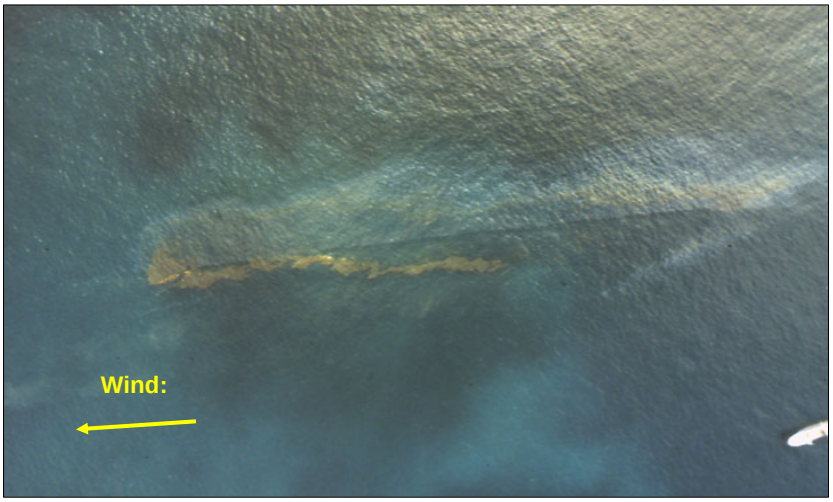
During dispersant application

(picture taken just after the 2nd. pass)



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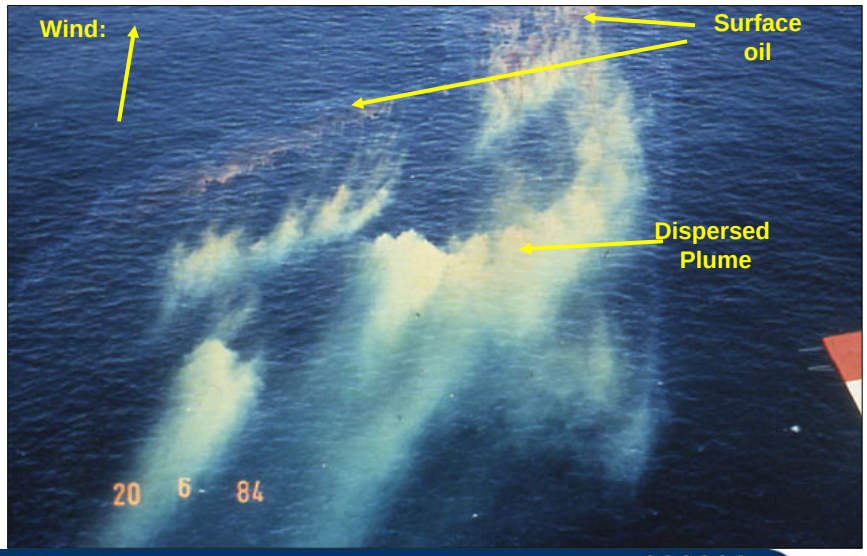
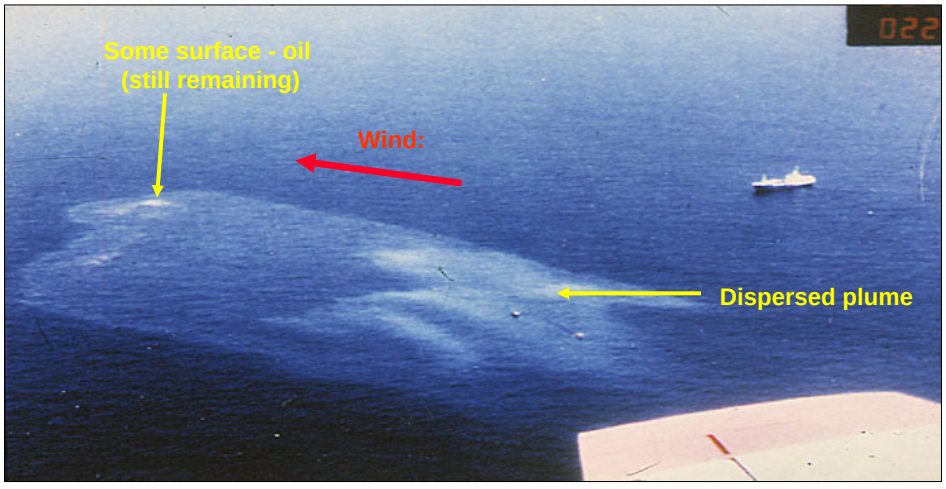
15 min. after dispersant treatment of the slick

- Dispersion of the thick emulsion started'
- Creation of a visual "gray" plume of dispersed oil in the water



2 hours after dispersant treatment

- Dispersed plume 500 m behind the front of slick (remaining surface oil)
- The surface slick degraded / disappeared during the night



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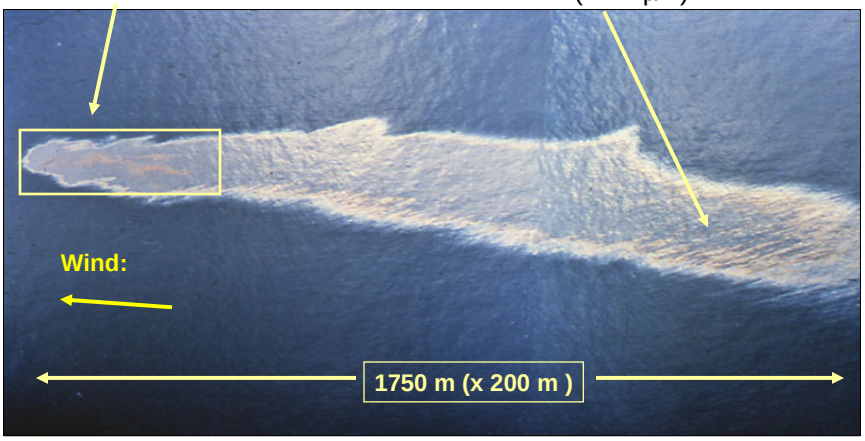
Control (non-treated slick - next day)

20 ton Statfjord crude

Thick emulsion (2 - 5 mm)
in the front of slick

Long tail of sheen
(< 1 µm)



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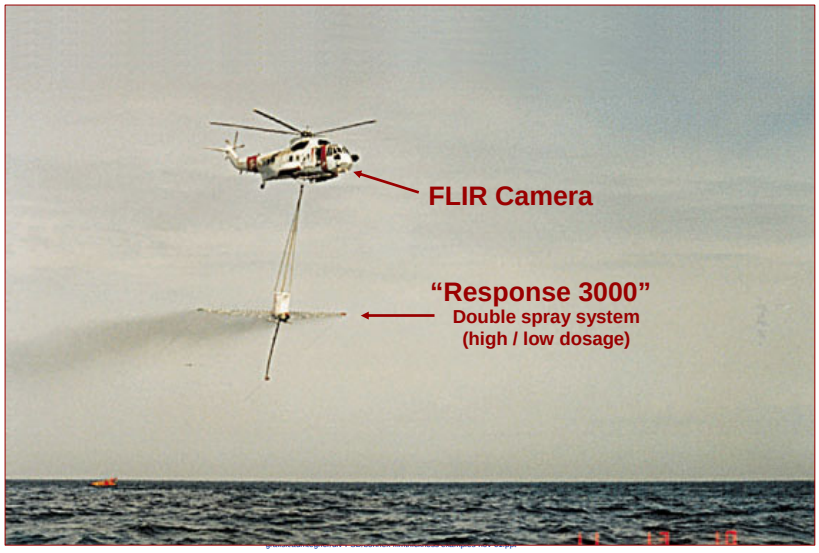
Dispersant Experiment North Sea
Testing of a new heli-bucket "Response 3000"



Operational use of FLIR camera/down link

(Norwegian, NOFO field trial 1996)

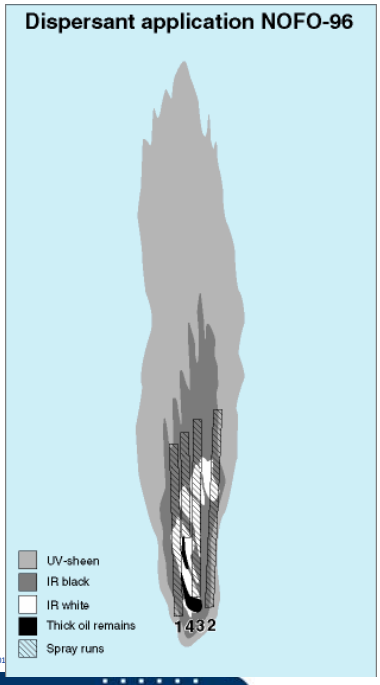
Ordinary visual video camera mode

same as above (a few seconds later), but seen trough the FLIR camera

grafisk/admtegner/div-PSD/bonnex-filmthickness examples-nov-01.ppt

Operational strategy for application from helicopter:

- FLIR - camera: important operational tool for precise application
- Treat the thick part of the slick (re-treatment - may be necessary for optimal dosage)



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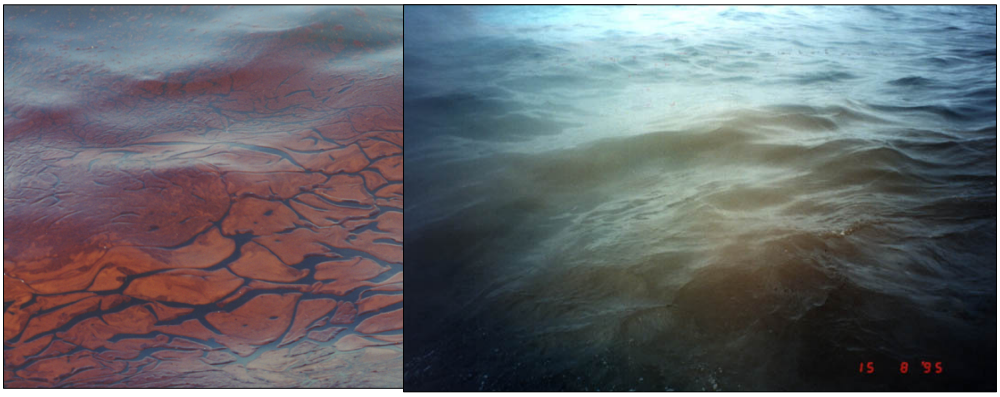
Optimal dosage - give rapid dispersion

Before treatment:
- thick emulsion
(3 hours at sea)

10 min. after application (2 x):
- All surface-emulsion broken up and dispersed into water column!



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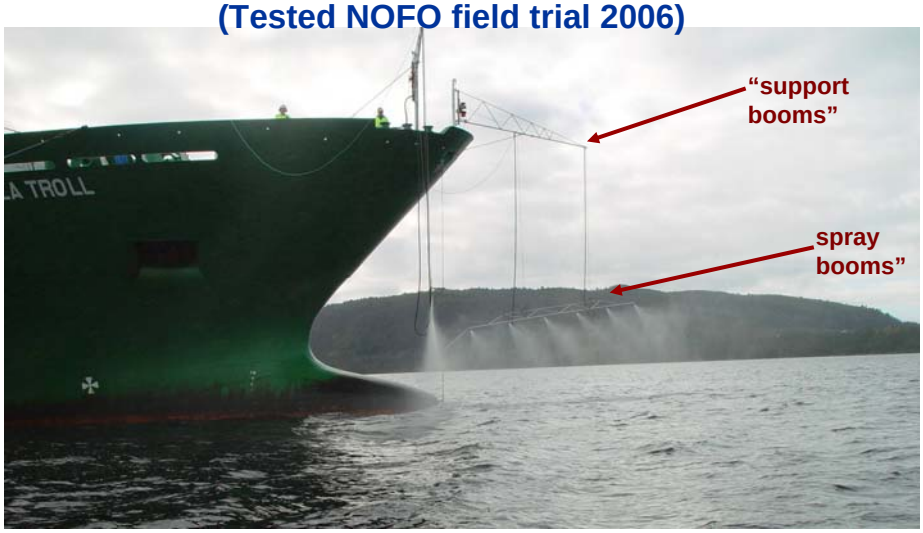
New boat application systems

(Tested NOFO field trial 2006)



Under spraying operations: spray arms 3m above sea surface"

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New boat application systems
(Tested NOFO field trial 2006 on oil slicks)

Application speed: tested up to 18 knots (worked well !)

grafisk/admtegner/div-PSD/bonnex-filmthickness examples-nov-01.ppt

NOFO oil –on water exercise 2006

Down-link of FLIR-video from Helicopter to Spraying Vessel

grafisk/admtegner/div-PSD/bonnex-filmthickness examples-nov-01.ppt

NOFO oil –on water exercise 2006

Down-link of FLIR-video from Helicopter to Spraying Vessel

intro Havila

8A 1. run

8A etter 1. run

8A beste (2. run)

8A siste run

8B mislykket run

Monitoring in water after dispersant application

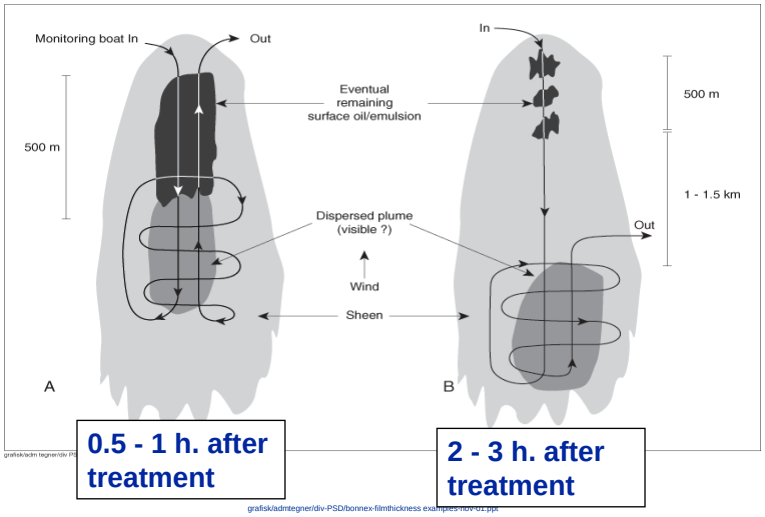
NOFO OOWE – May 2006, exp. 8B (13:15 – 14:00)

Monitoring in water after dispersant application

NOFO OOWE – May 2006, exp. 8A
Turner in-situ UVF (1.5 and 5 m depth)

Guiding of monitorering team in the slick

Example of monitorering of the disperseds oil



0.5 - 1 h. after treatment

2 - 3 h. after treatment

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Monitoring in water after dispersant application

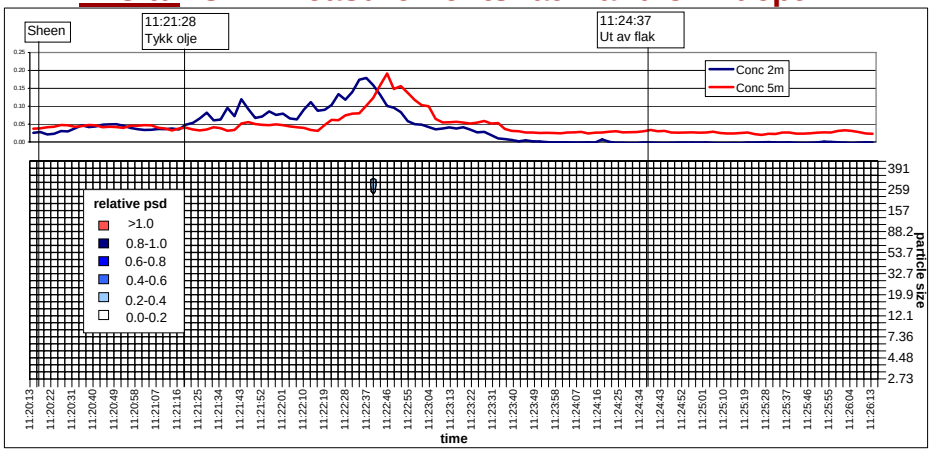
NOFO OOWE – May 2006, exp. 8A and 8B

LISST – droplets size distribution

Monitoring in water before dispersant application

NOFO OOWE – May 2006, experiment: 8A

in-situ- UVF measurements: at 2 and 5 m depth

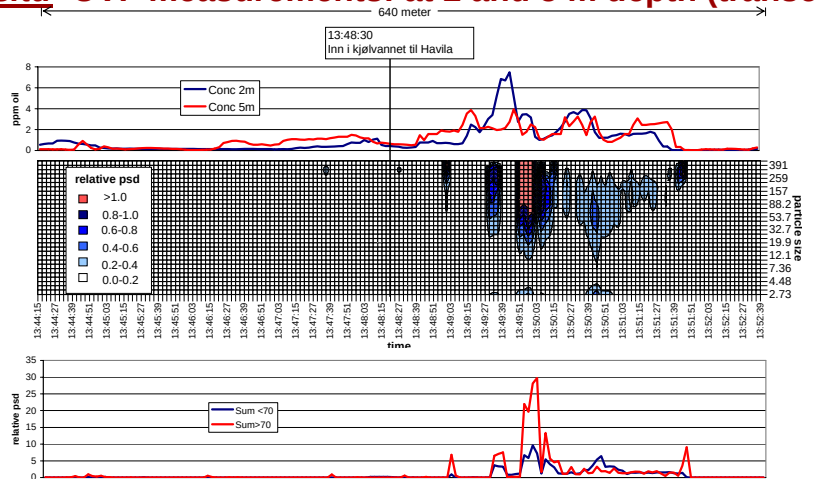


LISST – droplets size distribution

Monitoring in water after dispersant application

NOFO OOWE – May 2006, Experiment: 8A

in-situ- UVF measurements: at 2 and 5 m depth (transect: 3)



LISST – droplets size distribution

grafisk/admtegner/div-PSD/bonnex-filmthickness examples-nov-01.ppt

Oil concentrations measured in the field

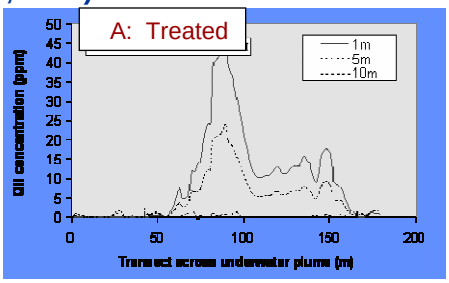
(NOFO trial, 1995)

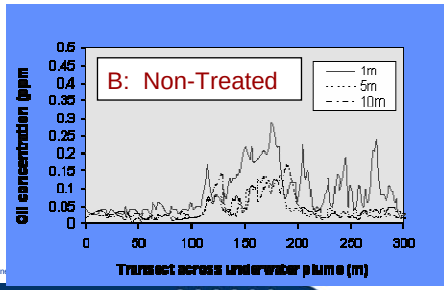
UVF-Profiles (ppm THC) in the water 20 - 30 min. after treatment:

A) Treated from helicopter:
max. 20 - 40 ppm

B) Control slick: < 0.2 ppm

→ Important data–input for calibration and validation of 3-D Plume model tools





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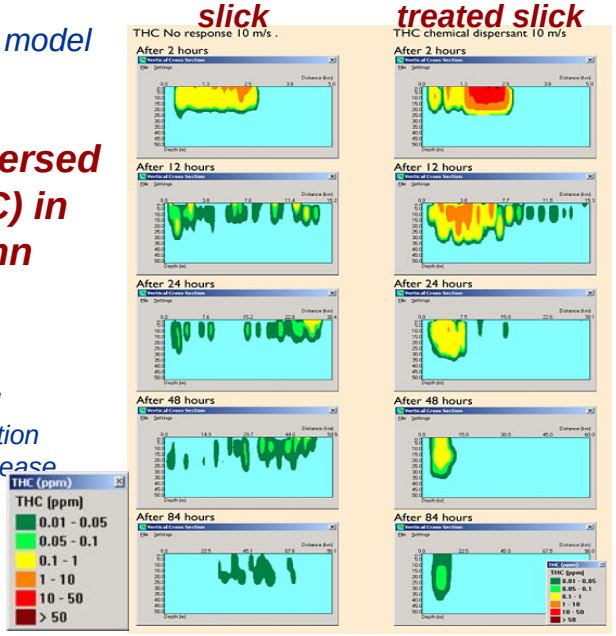
Use of "3-D plume" model tools:

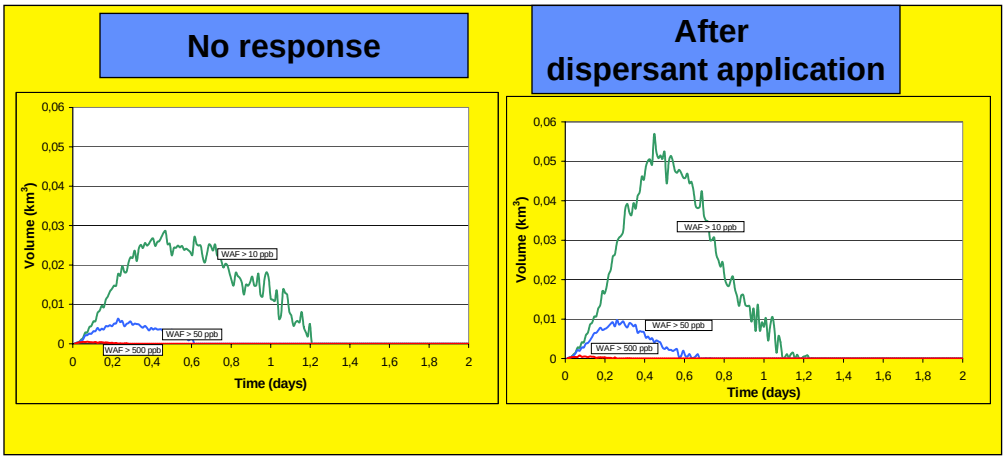
Dilution of dispersed oil (ppm THC) in water column

Spill scenario:
100m³ crude oil
Dispersant application
start 1 hour after release



Volumes, concentrations and dilution of dissolved components (WAF) in water column

(OSCAR calculate concentration of 26 oil component groups)



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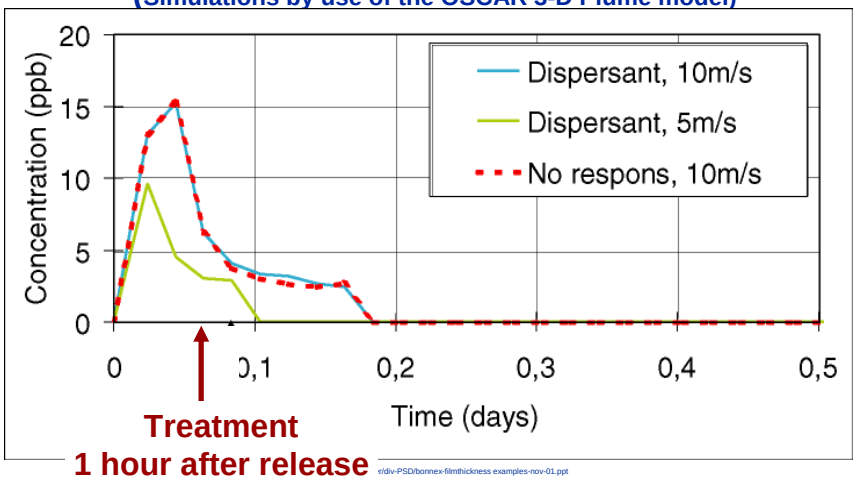
Concentration of volatile / soluble BTX-aromatics in the water column (with and without dispersant treatment)

(Simulations by use of the OSCAR 3-D Plume model)

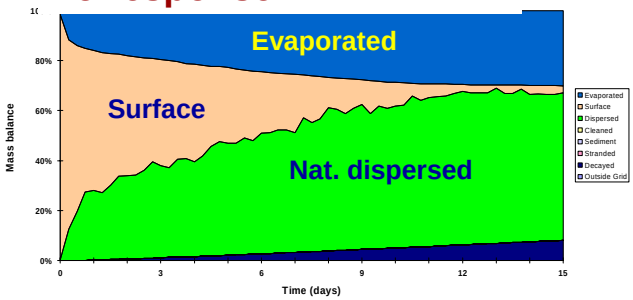


Long term fate of treated and non- treated oil slicks at sea

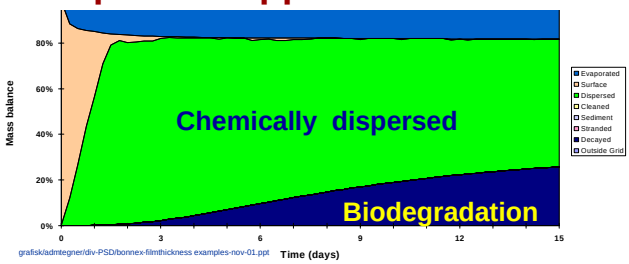
Example:

- OSCAR simulation: 100 m^3 Balder (North Sea crude)
- Chemically dispersed oil biodegrades more rapidly !

No response:



Dispersant application from boat:



Advanced model tools for simulating oil spill scenarios:

OSCAR ("Oil Spill Contingency and Response"):

- A quantitative tool for analyzing environmental consequences for alternative response strategies
- Basis for NEBA - analysis of spill scenarios
- Used for dimensioning functional and cost-effective oil spill contingency solutions

→ Fundamental tool for contingency planning for pre-approval use of dispersants at specific locations in Norway

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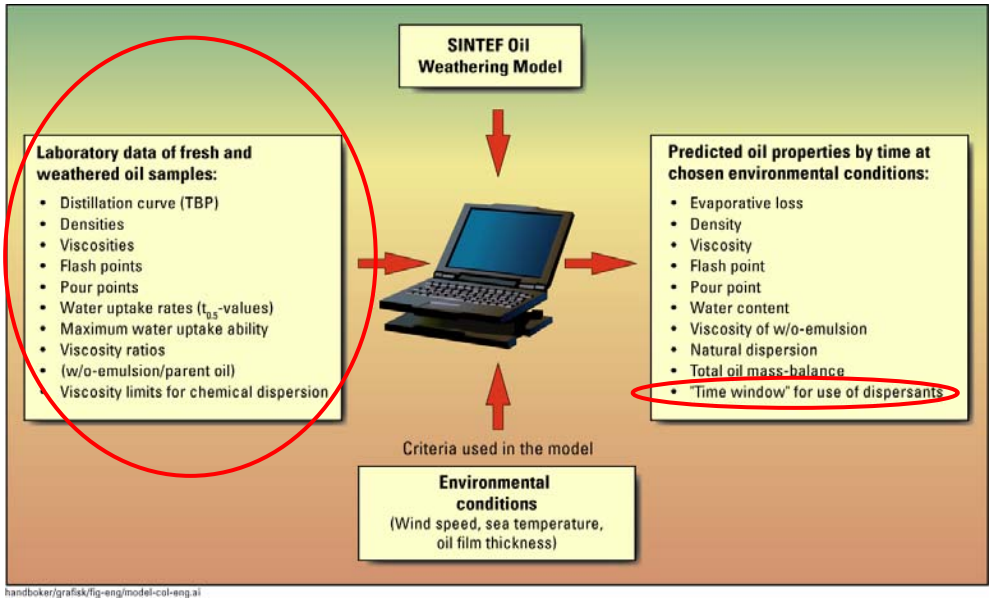
Oil Weathering and Dispersibility Methodologies



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Ground-truth sampling for field verification

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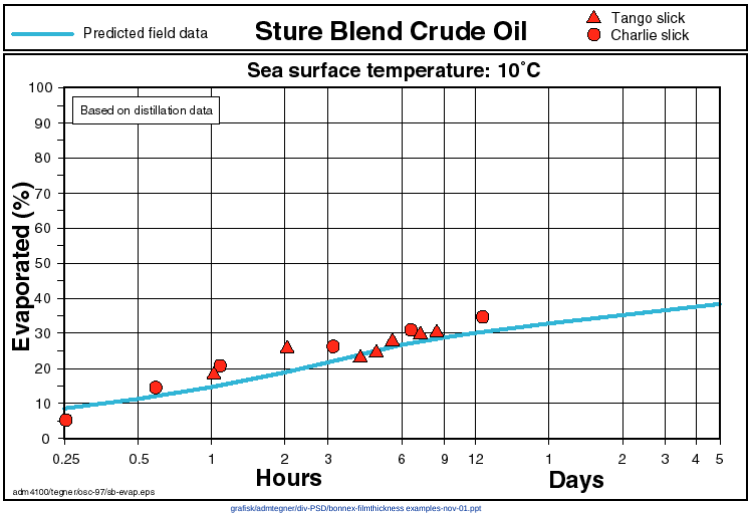
Correlation between SINTEF OWM prediction and field samples (NOFO-trials, 1994) - Evaporation



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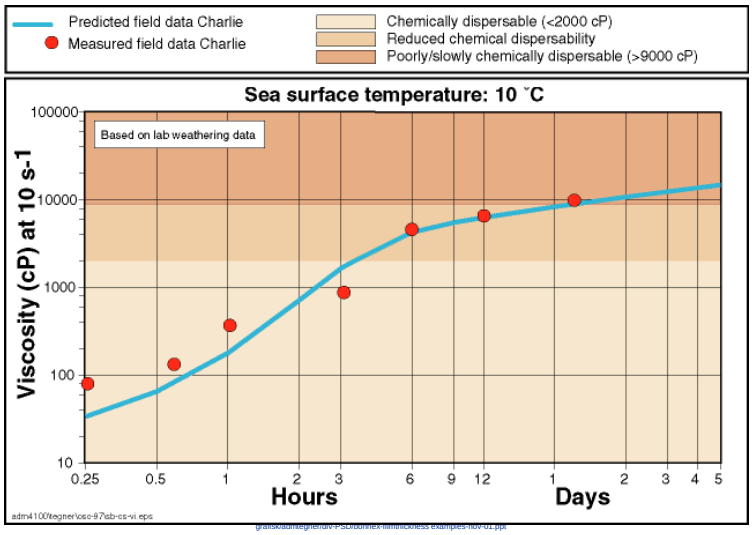
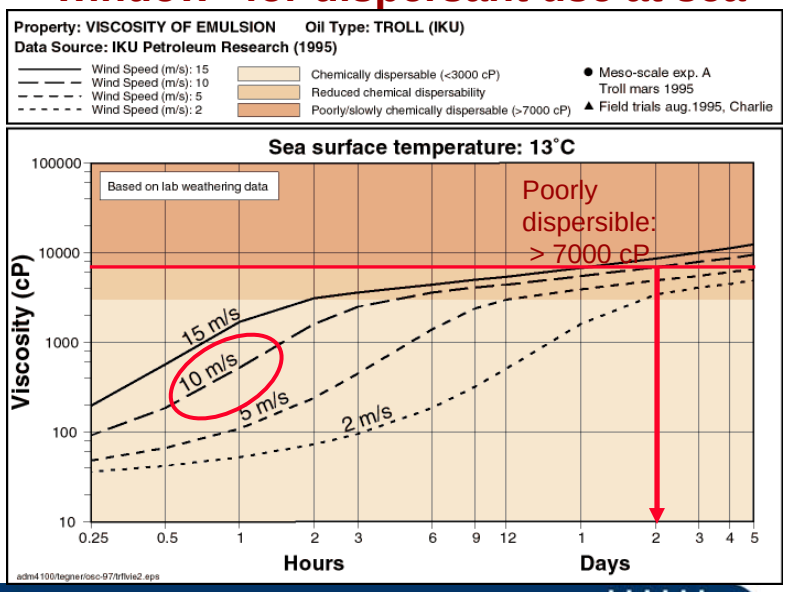
Correlation between SINTEF OWM prediction and field samples (NOFO-trials, 1994)



Predicted Emulsion Viscosity and "time-window" for dispersant use at sea



Support Tool for Dispersant Use

Version 1.0
October 2006

"EMSA Support Tool for Dispersant use"

Purpose

To provide support for decision-making regarding use of dispersants in oil spill response actions in European waters

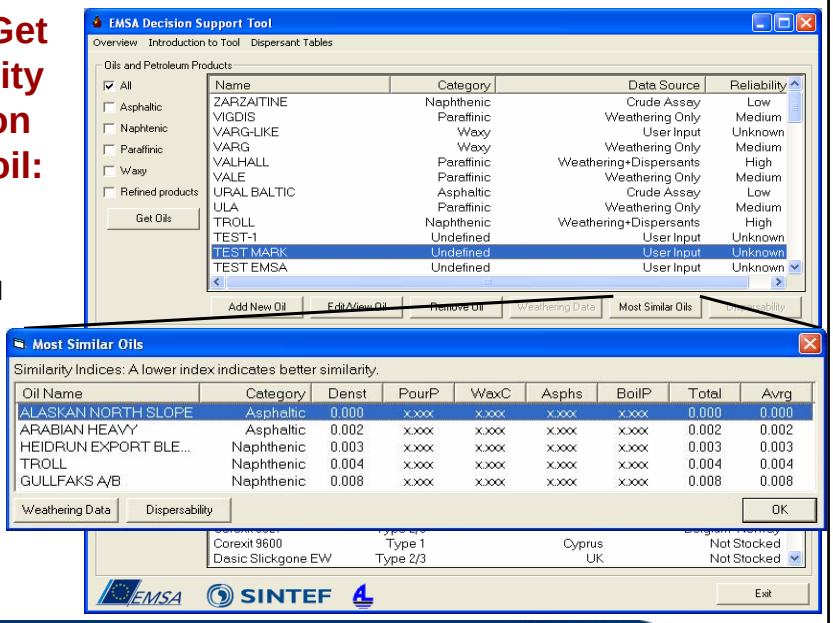
- **Assist in selection of most appropriate dispersant relative to type of oil spilled at sea**
- **Supply information regarding dispersant effectiveness, application and availability**
- **Estimate "time window" for effective use of dispersants for the spilled oil (reliability depend on availability of input data of the specific oil)**

"EMSA Support Tool for Dispersant use"

Example: Get dispersibility information for a new oil:

Search database for most similar oil

More parameters produces a more reliable match to other oils in the database!!!

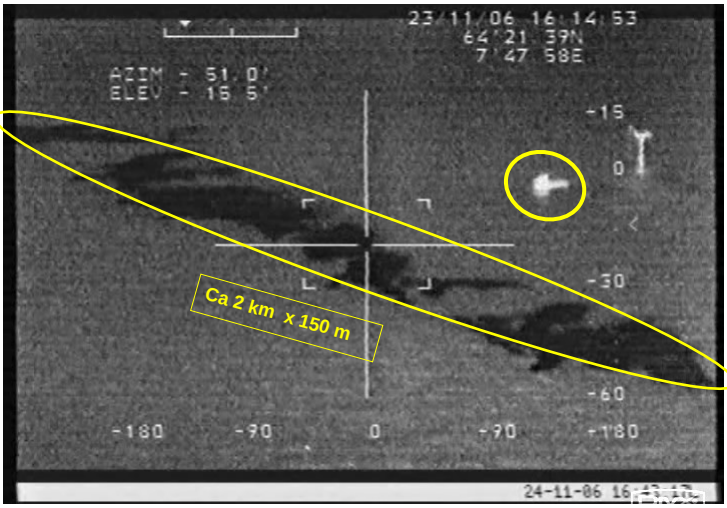


Dispersant application in darkness

Down-link of FLIR-video from fixed wing aircraft / helicopters

Identify area with thick oil in darkness (estimate: ca.100 m³)

Just prior dispersant application



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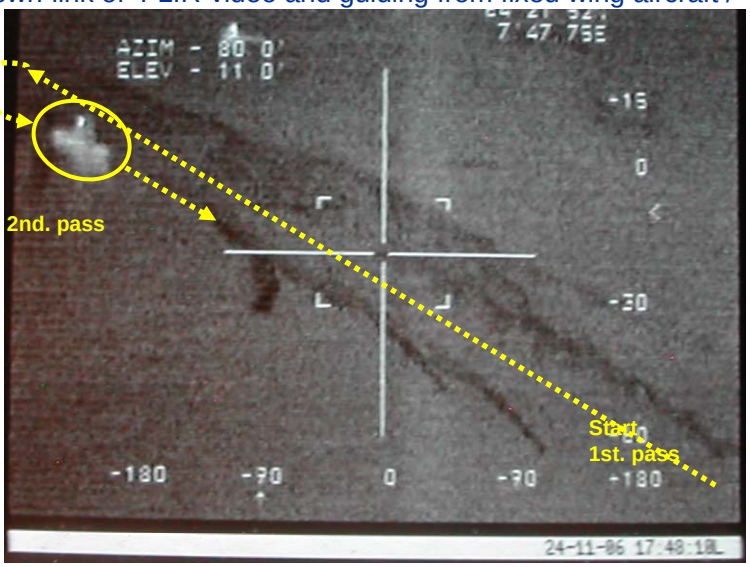
Dispersant application in darkness

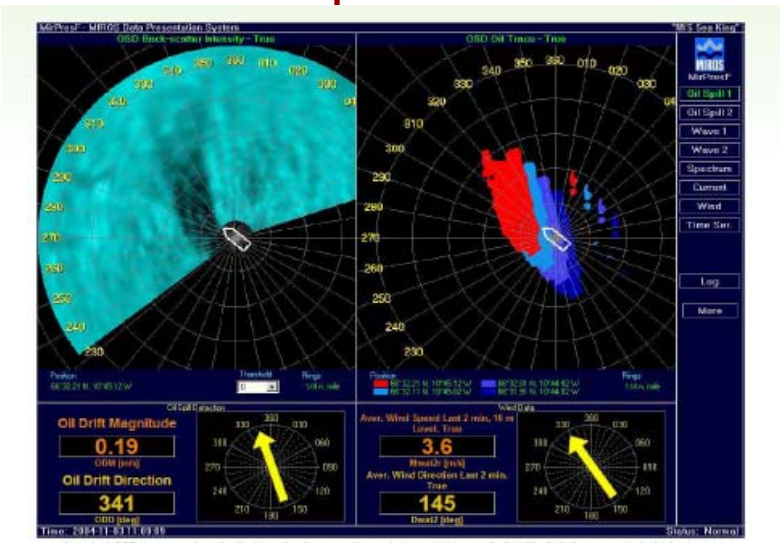
During dispersant application from response vessel in darkness (2nd. Pass)
Down-link of FLIR-video and guiding from fixed wing aircraft / helicopters



After dispersant application in darkness

< 5m³ left on the surface after 3.5 hours spraying operation
Next morning (12 h after treatment): slick total disappeared

Miros oil detecting radar system a good supplement to the FLIR during night operations



A typical OSD presentation displaying a back-scatter intensity image, traces of oil spill, oil drift vector and wind vector.

Conclusions / summary

Recent years:

- **Gained experience from full-scale field studies (offshore):**
  - → improved application strategies
  - → development of numerical model tools (calibrated / validated) for use in contingency planning / NEBA-analysis

- **There is a "time window" for use of dispersants at sea**
  - it varies from oil to oil – due to oils' weathering properties
  - can be calculated by available methodology: (laboratory weathering study and models prediction)

  → Basis for development of support tools for decision-making for dispersant use in various spill situations in Europe (EMSA decision tool)

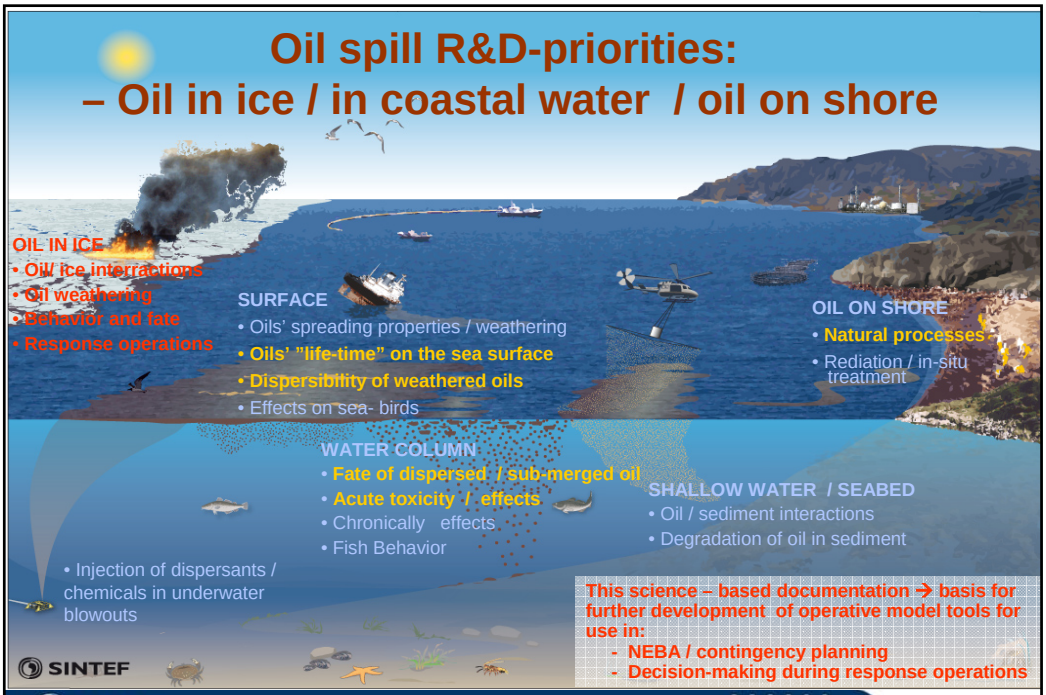
grafisk/admtegner/div-PSD/bonnex-filmthickness examples-nov-01.ppt

In Norway (Scandinavia): Dispersant R&D will focus on:

- **Better documentation for use/non-use of dispersants in:**
  - in coastal areas (sensitive, shallow area)
  - on shore (beach cleaners / dispersants) (JIP)
  - in cold and ice-infested areas (JIP)
- **Better knowledge and documentation of the weathering behaviour / dispersibility on relevant oils (Russian crudes):**
  - transported along the Norwegian coast
  - the Baltic (low-salinity / shallow) (Funded: EU / Scandinavian Government, (SINTEF / CEDRE co-operation)

grafisk/admtegner/div-PSD/bonnex-filmthickness examples-nov-01.ppt

Oil spill R&D-priorities: – Oil in ice / in coastal water / oil on shore



This science – based documentation → basis for further development of operative model tools for use in:
- NEBA / contingency planning
- Decision-making during response operations