Marine snow hampers oil biodegradation in an ocean sediment layer

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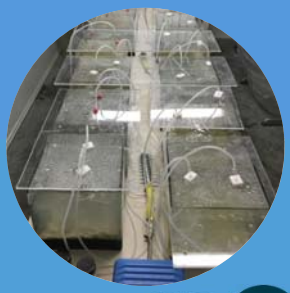

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C-IMAGE - II Center for the Integrated Modeling and Analysis of Gulf Ecosystems

TripleP@Sea

GoMRI C-IMAGE - WUR – IPOP TripleP@Sea

Background

- Deepwater Horizon explosion
- Marine snow; MOSSFA

  (Marine Oil Snow Sedimentation and Flocculent Accumulation)
- Estimates vary, as much as 14% of total oil on sediment (Daly et al., 2016)
- What are the consequences for oil biodegradation?

MOSSFA
MARINE OIL SNOW SEDIMENTATION & FLOCCULENT ACCUMULATION

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Daly et al. 2016 Assessing the impacts of oil-associated marine snow formation and sedimentation during and after the Deepwater Horizon oil spill, *Anthropocene* 13: 18–33

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Objective

- Question

  What is the effect of marine snow on oil biodegradation in the sediment layer?

- Hypotheses

  Marine snow negatively affects oil biodegradation in the sediment layer

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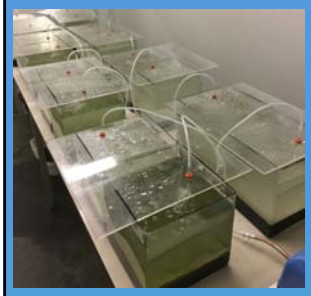
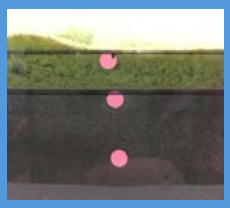
Setup of Aquarium Experiment

- Natural sediment and organisms from intertidal area in Waddensea, NL
- Temperature and light controlled room
- 5 treatments in triplicate:
  - Control — sediment, no addition
  - Clay — sediment, kaolin clay
  - Snow — sediment, marine snow
  - Clay + Oil — sediment, clay with oil
  - Snow + Oil — sediment, marine snow with oil
- Oil: 10 g/m^2 in each aquarium
- Oil-degrading bacteria added
  - *Rhodococcus qingshengii* TUHH-12
  - *Pseudomonas putida* F1

Setup of Aquarium Experiment

- Aquaria





Snow on top of the sediment

Clay + Oil

Snow + Oil

- Samples

  t=1, 16, 30 and 42 days for oil biodegradation

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Marine snow

Marine snow in the lab: EPS, alginate-like polysaccharides excreted after exposure to oil spill dispersants[1]

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[1] van Eenennaam et al. 2016, Oil spill dispersants induce formation of marine snow by phytoplankton-associated bacteria, *Marine Pollution Bulletin* 104(1-2): 294–302

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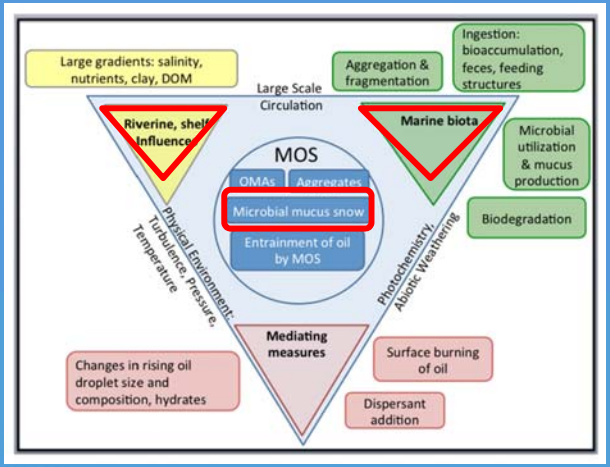
Marine snow

Ingredients of marine snow



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Daly et al. 2016 Assessing the impacts of oil-associated marine snow formation and sedimentation during and after the Deepwater Horizon oil spill, *Anthropocene* 13: 18–33

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Artificial marine snow

Created with alginate, algae biomass, kaolin clay with or without oil (slightly weathered BP surrogate oil)

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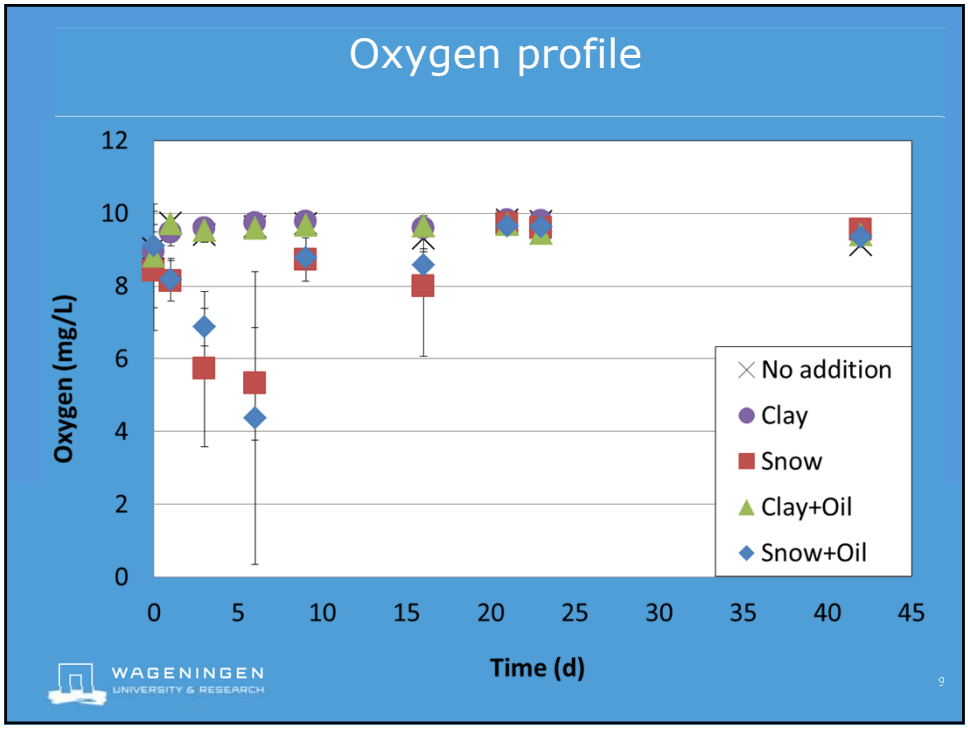
Oxygen profile
Oxygen (mg/L)
Time (d)
No addition
Clay
Snow
Clay+Oil
Snow+Oil
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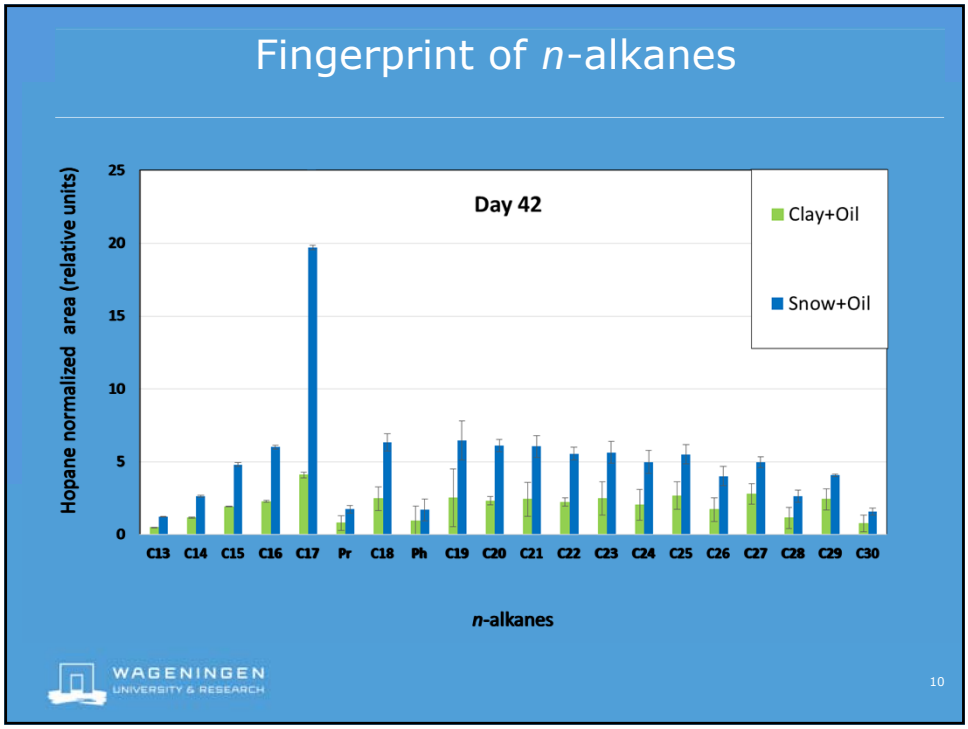
Fingerprint of n-alkanes
Hopane normalized area (relative units)
Day 42
Clay+Oil
Snow+Oil
C13 C14 C15 C16 C17 Pr C18 Ph C19 C20 C21 C22 C23 C24 C25 C26 C27 C28 C29 C30
n-alkanes
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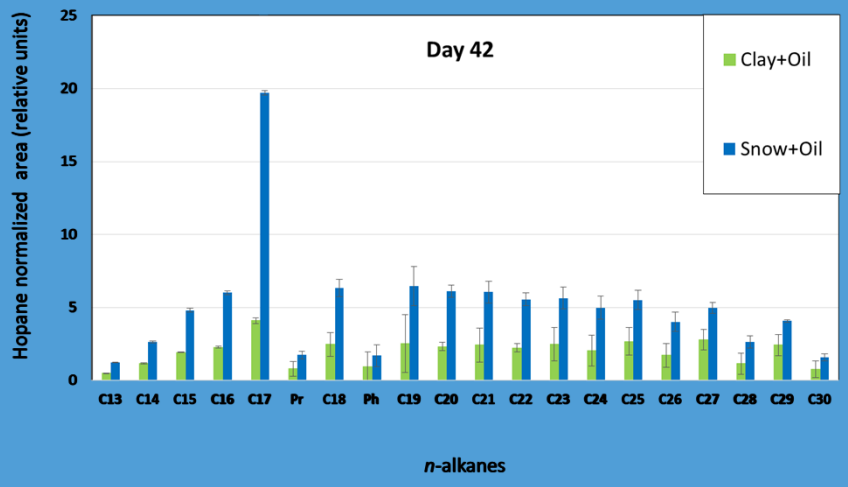
Fingerprint of *n*-alkanes



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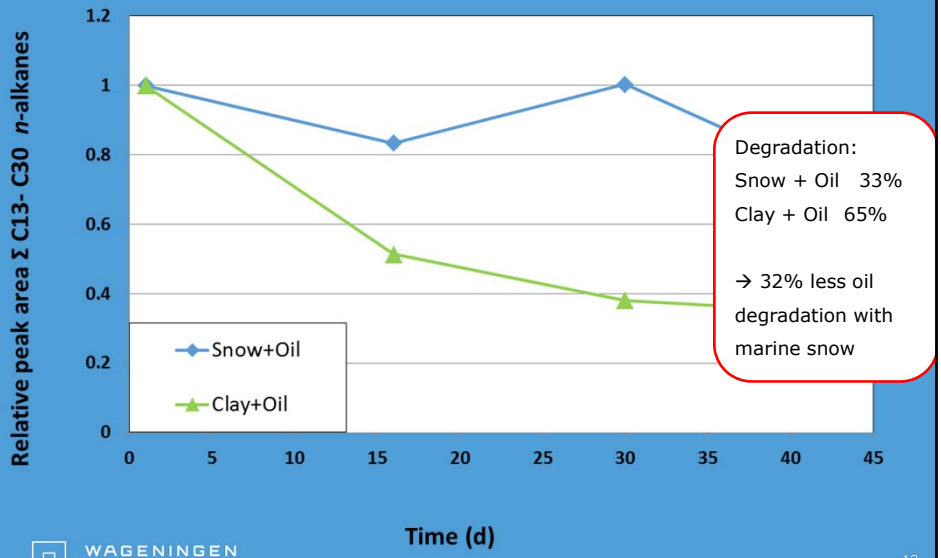
Biodegradation



Degradation:
Snow + Oil 33%
Clay + Oil 65%

→ 32% less oil degradation with marine snow

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Discussion

- Oxygen availability in the sediment layer limited

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  Competition between marine snow and oil for oxygen

- Microorganisms prefer marine snow biodegradation over oil biodegradation

  ↓

  As marine snow has more easy degradable carbon

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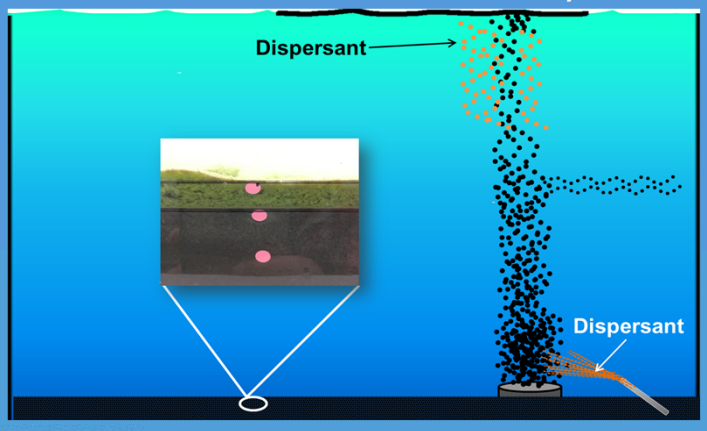
Take home message

Marine snow hampers oil biodegradation in an ocean sediment layer



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Rahsepar et al. 2017, Marine snow hampers oil biodegradation in an ocean sediment layer, *Marine Pollution Bulletin*, in prep

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Edwin Foekema
(Feb 6, MOSSFA Workshop)
Tinka Murk
(Feb 8, 12.15 pm, session 010)
Justine van Eenennaam
(Feb 8, 12.00 pm, session 010)
C-IMAGE NL
Sophie Vonk
Shokouh Rahsepar
Marieke Zeinstra
(Feb 9, 10.00 am, session 018)
Alette Langenhoff
(Feb 8, 12.00 pm, session 012)
Wierd Koops
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populations
biodegradation
model
dispersants
species
oil-contaminated