Marine algae and particles can greatly influence the fate and persistence of chemically dispersed oil

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Introduction

Greatly increased production of marine snow enhanced sedimentation of oil, particles and surface plankton during the Deepwater Horizon oil spill. The resulting thick toxic oil layer on the deep sea sediment currently still persists and prevents the benthic ecosystem from recovering.

Within the Dutch C-IMAGE group, we study the hypothesis that oil spill dispersants contributed to the observed enhanced sedimentation of oil through induction of marine snow formation by stressed algae, followed by interaction of the excreted extracellular polymeric substances (EPS) with oil droplets and particles in the water. This mechanism of marine snow formation will be missed in oil fate experiments performed in clear sea water.

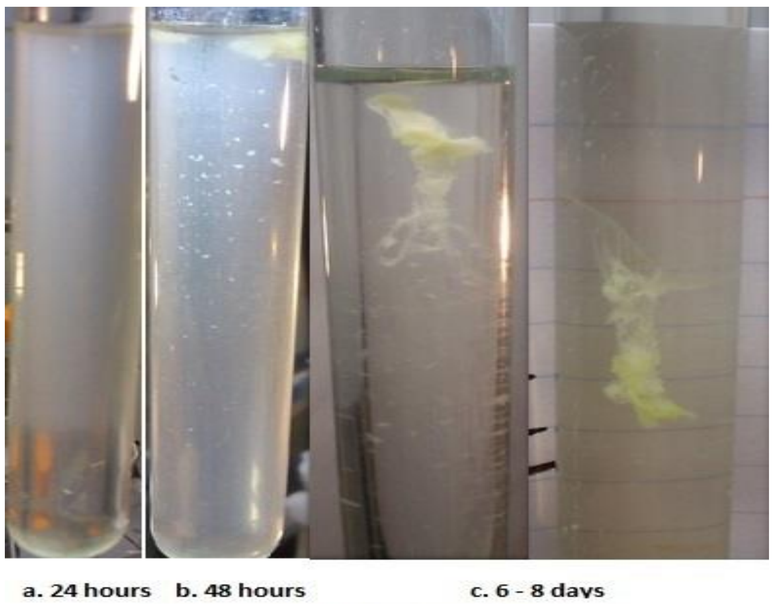

Figure 1: Formation of flock over time, algae exposed to 0.5 ml/l dispersant (Corexit 9500)

Results

The dispersant induced excretion of extracellular polymeric substances (EPS, Figure 1) by all four marine algae species tested. The EPS excretion occurred at lower concentrations than those inducing algal toxicity (determined as reduced cell numbers). The EPS and water contained dispersant-dependent increasing amounts of proteins (Figure 2). Polysaccharide and protein content are currently being characterised and quantified. EPS formed in December 2012 still shows no sign of biodegradation (kept at room temperature, data not shown).

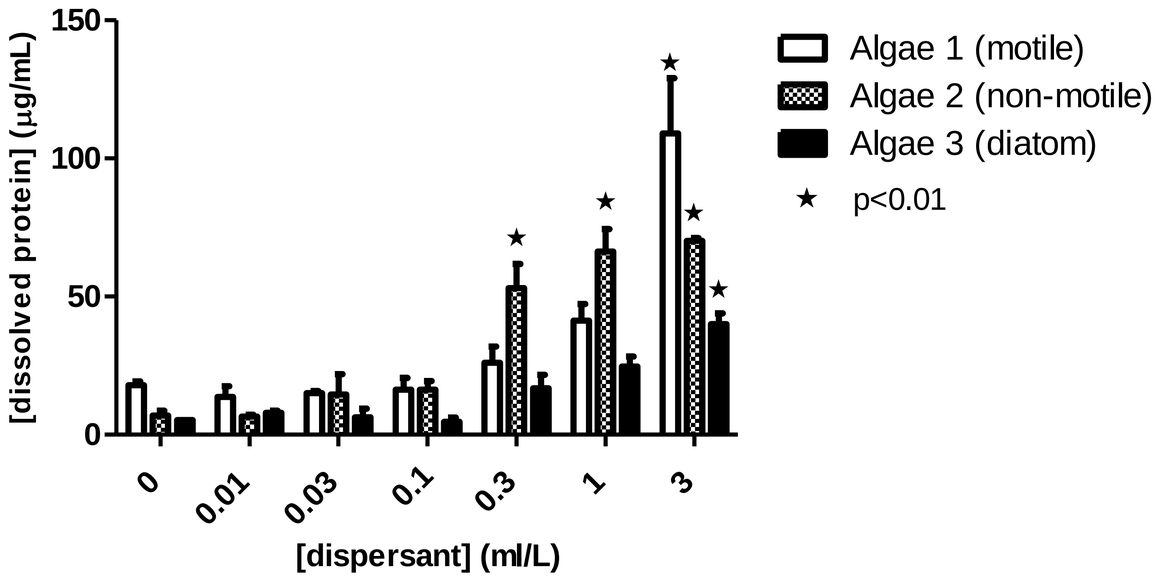

Figure 2: Exposure to increasing dispersant concentration leads to significantly increased dissolved protein concentration in three species of marine algae (measured using Bradford assay).

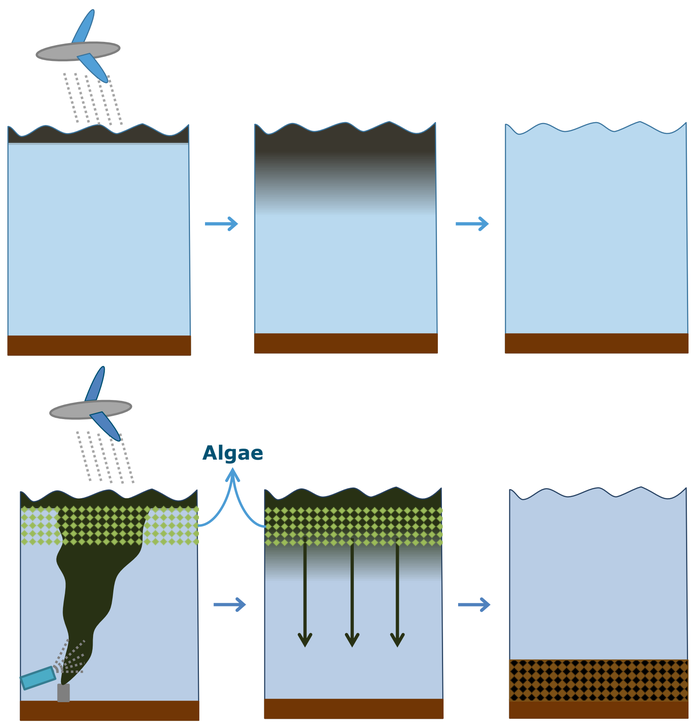

Figure 3: Application of dispersants on a surface oil spill (top). During the Deepwater Horizon spill, dispersants were applied at the surface (with high algal density) and in the deep sea, creating the thick toxic layer on the sediment (bottom).

Discussion

The presence of excreted EPS, also known as marine snow, in water with a high sediment load (e.g. sand or clay) and (dispersed) oil droplets, facilitates formation of negatively buoyant aggregates and subsequent sedimentation (Figure 3). In the aggregates, additional oil droplets and planktonic organisms (phytoplankton, zooplankton, eggs, larvae, etc.) can be caught and brought down to the sediment.
Several historical spills occurred in periods of algal blooms (Figure 4). In most cases the benthic effects were not studied.

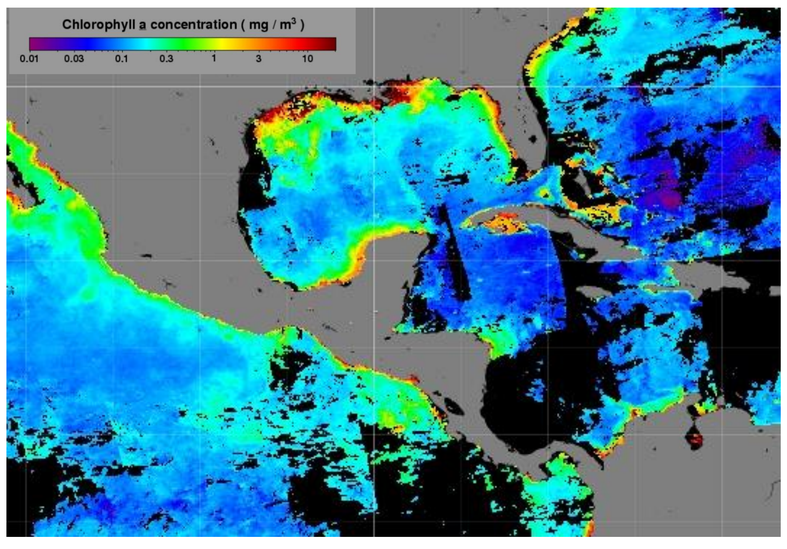

Figure 4: Chlorophyll-a concentration in the Gulf of Mexico during the Ixtoc I oil spill, June 1979 *(Source: Nara Davaasuren, IMARES)*

Conclusion

In situations of algal bloom, the application of dispersants should be reconsidered.

Acknowledgements

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