Time and Length Scales in Spill Response

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- *Oil Chemistry - sets the time-scale.*
  - *High-evaporation rates lead to short time-scales.*
- *Environmental Situation - sets the length scale.*
  - *Wind and currents move the spill.*

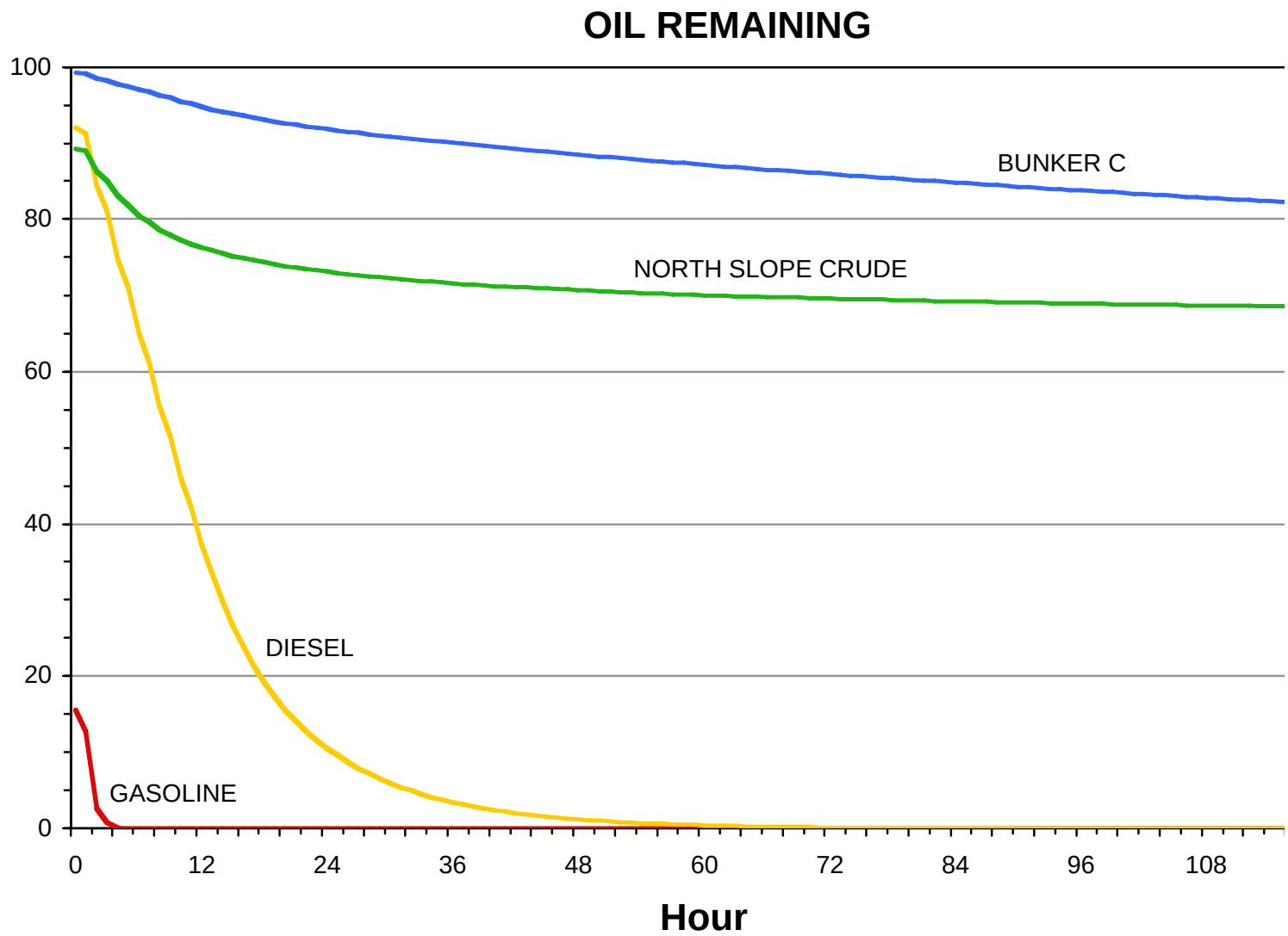
Oil Weathering

- *Evaporation (less than 5 days)*
- *Dispersion (less than 5 days)*
- *Dissolution (less than 5 days)*
- *Emulsification (Onset can be delayed for days but the emulsification process happens rapidly)*
- *Sedimentation (5 days or more)*
- *Photo-oxidation (weeks)*
- *Biodegradation (weeks to months)*

Evaporation

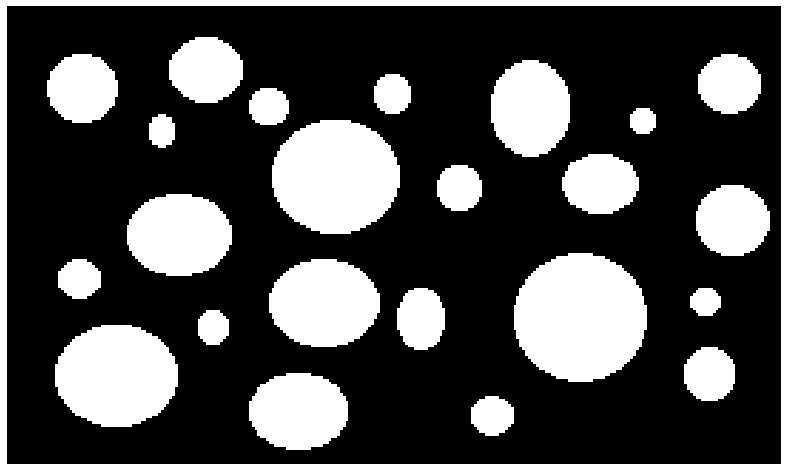
- *Major mechanism for removing oil.*
- *Changes the physical properties of the remaining oil.*
- *Rate of evaporation depends on oil's chemical properties, water temperature and wind speed.*

Evaporation Comparison - 10,000 gallons (38 m^3)



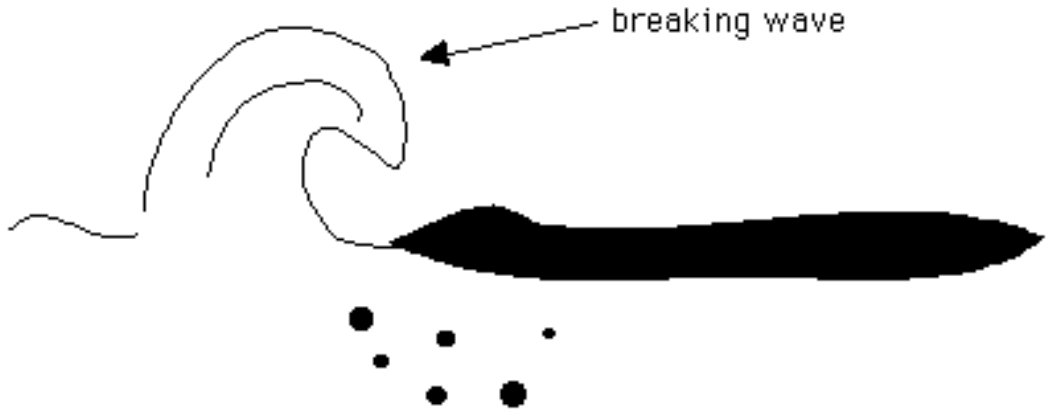
Emulsification

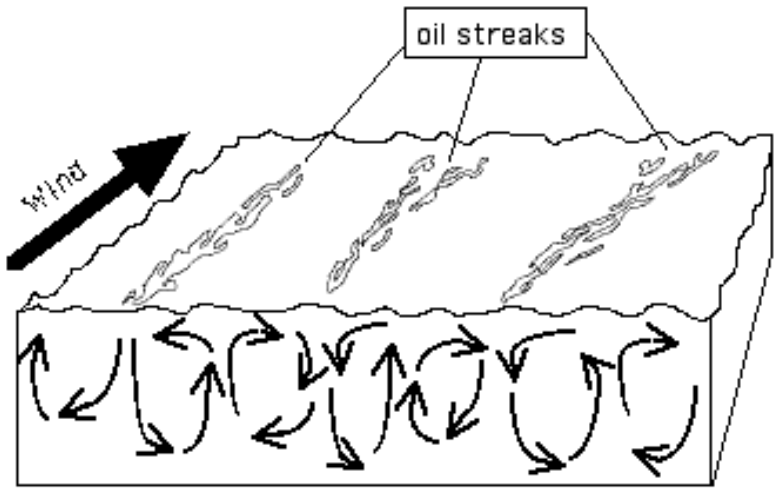
- *Depends on the chemical properties of the oil.*
- *Oil must "weather" a certain amount before forming a stable emulsion.*
- *Oils with high wax and asphaltine content are more likely to emulsify (asphaltine + wax)>5%.*
- *Emulsion can be 70% to 90% water.*



Dispersion

- *Other major removal mechanism.*
- *Higher viscosity oils do not disperse as much as lower viscosity oils.*
- *Droplets 50 to 70um in diameter are not likely to resurface due to turbulence.*





Dissolution

- *Closely related to dispersion, as dissolution occurs from the dispersed oil droplets.*
- *Similar time scales as dispersion.*
- *Less than 0.1 (very heavy oil) to 2% (gasoline) of the spilled oil volume actually dissolves into the water column.*

Staten Island Facility Fire, New York

- *21 February 2003*
- *Barge was carrying 4 million gallons (7570 m3) unleaded gasoline.*
- *1/2 cargo unloaded when accident occurred.*
- *2 fatalities.*

Staten Island Facility Fire

QuickTime™ and a
Video decompressor
are needed to see this picture.

Overflight map later that day.

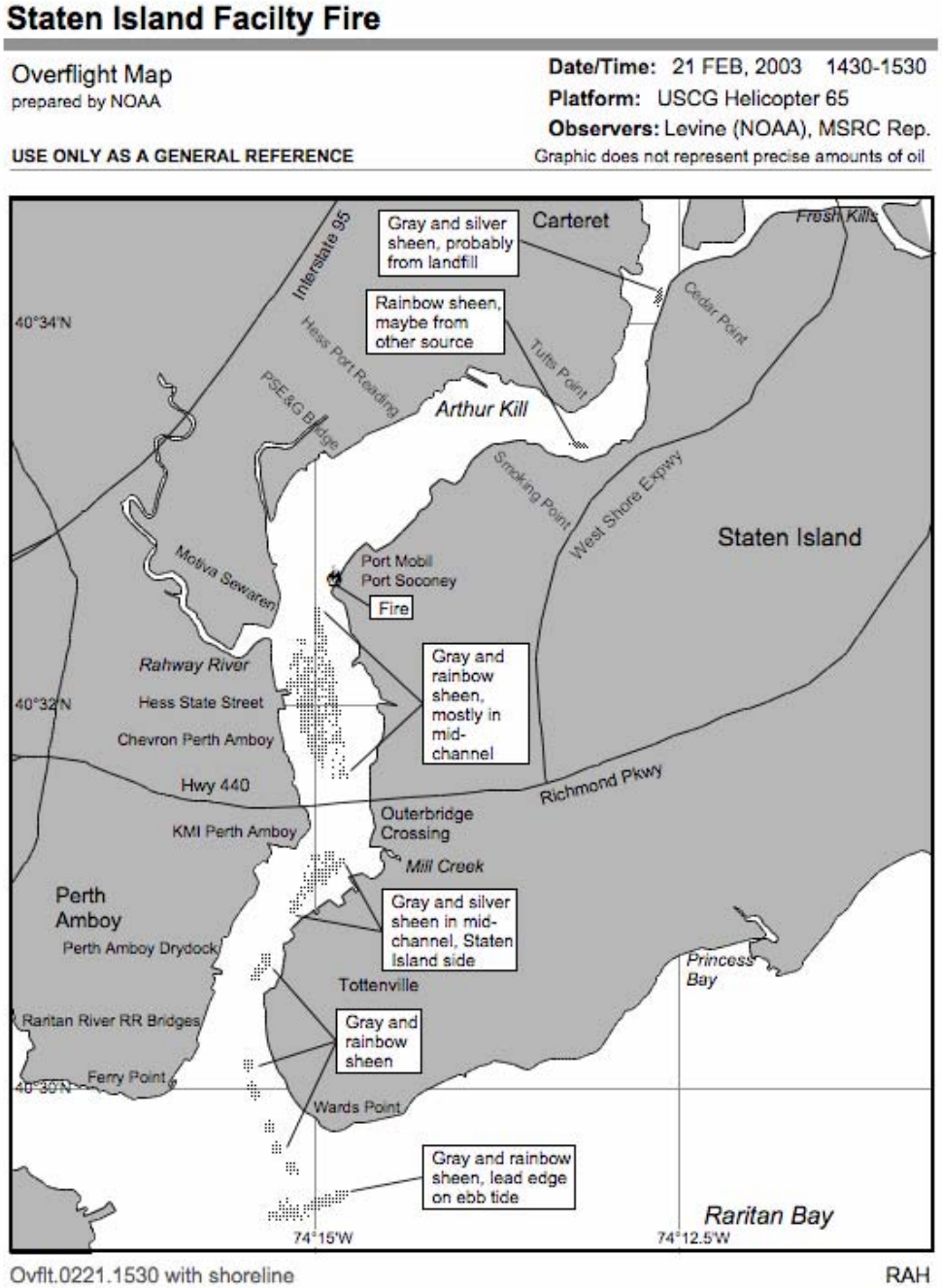


Photo when fire nearly out.

Kuwait Intentional Release, Persian Gulf

- *26 January 1991*
- *World's largest oil spill.*
- *Involved terminals, tankers and sea island installations*
- *Estimated release of 240,000,000 gallons (908500 m^3)*

NOAA Scientific Support Coordinator, Gary Ott (recently retired).

Murphy Oil Spill, Mereaux, Louisiana

- *Caused by Hurricane Katrina, Sept 2005*
- *Potential release of 3 million gallons (11356 m^3) Louisiana Sweet crude oil.*
- *Estimated release of 819,000 gallons (3100 m^3).*

Murphy Oil Spill, 2005

Ixtoc I Exploratory Well Blowout, Bahia del Campeche, Mexico

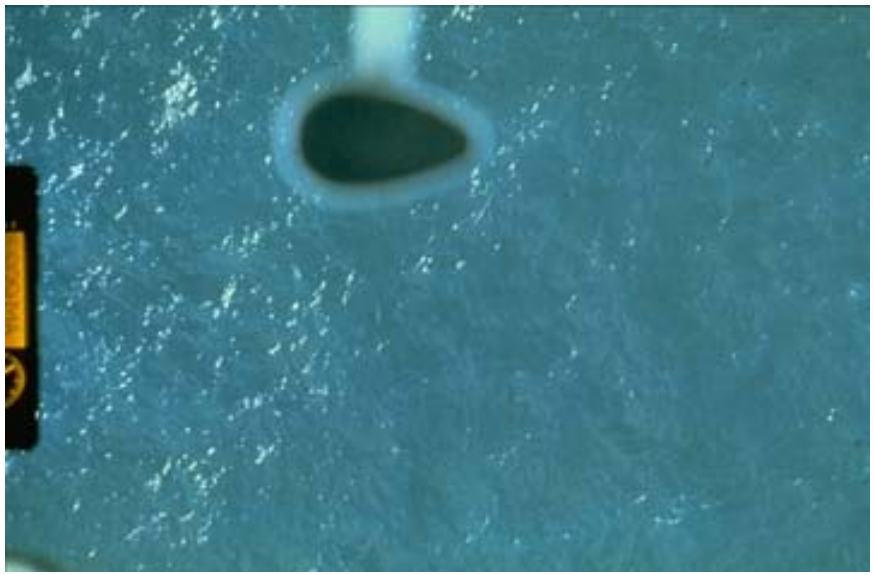
- *3 June 1979 - 23 March 1980*
- *#2 World's largest spill*
- *Initial release 30,000 barrels (4770 m^3) **per day**, eventually slowed to 10,000 barrels (1590 m^3) per day (August).*
- *Total release of 140,000 gallons (530,000 m^3).*
- *Shoreline impacts over 600 miles (965 km) away, oil traveled 2 months to Texas beaches.*
- *Caused by loss of drilling mud circulation.*

Ixtoc I - *(oil surfaced emulsified)*

Tarballs

- *Result from weathering of heavy oils to lighter oils with heavier hydrocarbons.*
- *Small tarballs (coin size) difficult to see and spend a significant amount of time overwashed by waves.*
- *Travel slower that fresher oil because traveling slightly lower in the surface water.*
- *"Fresher" tarballs are sticky on the outside. Over time the surface can form into a crust with fresh oil inside.*

Tarballs

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Conclusions

- *Oil chemistry changes over time.*
- *Oil weathering changes the amount of material.*
  - *Evaporation decreases the amount.*
  - *Emulsification increases the amount.*
- *Fresh oil travels faster on the water's surface than weathered oil (e.g. tarballs).*
- *Wind and currents determine the trajectory and rate of travel.*
- *Tarballs can travel hundreds of miles (kilometers) and are often difficult to see.*

HAZMAT: 27 years of Lessons Learned

- *"I don't know" is not an option.*
- *Answers will be wrong on occasion for various reasons.*
- *Politics and economics are often more important considerations than science.*
- *Keys to success are (1)flexibility, (2)the ability to listen gather facts, and (3)learn from the past.*
- *No two spills are ever the same.*
- *No forecast model will be correct all the time.*
- *No forecast model will be correct everywhere.*
- *The key to predicting how an incident will unfold and providing useful advice is to figure out how and why the current situation changes.*