



Weathering and Fate of a Heavy Fuel Oil: The M/V Cosco Busan Spill

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Understanding the potential impact of an oil spill on the marine environment is critical for determining appropriate response efforts and informing legal decisions. Heavy fuel oils (HFOs) are of particular interest because they are used to power marine vessels increasing the risk of their release into the marine environment. With increasing energy demand and rising prices the use of these cheaper, sulfur-rich, fuels is expected to increase. To date there have been few studies of these fuels in the environment and understanding how they are naturally weathered can assist in directing cleanup and recovery efforts of future spills. To study the fate of HFOs, we analyzed samples from the M/V Cosco Busan HFO spill (November 2007; San Francisco Bay, CA, USA) and characterized changes in the oil composition across sites and time. Samples from three impacted shorelines were analyzed for petroleum hydrocarbons and polycyclic aromatic hydrocarbons (PAHs) via traditional gas chromatography (GC) and comprehensive two-dimensional gas chromatography (GC \times GC). Impacts from evaporation/dissolution, biodegradation and photodegradation were considered. Traditionally the impacts of evaporation and dissolution are difficult to separate and are often lumped together in oil spill studies, however, these processes play a direct role in determining the toxicity of an oil spill. Evaporation moves compounds from the oil into the atmosphere, while water washing transports them directly into surrounding waters where they become available, and potentially toxic, to marine organisms. We used GC \times GC and numerical modeling to differentiate the fate of individual compounds affected by these processes. This research supports previous work showing compounds within a given family do not necessarily have similar partitioning between the atmosphere and surrounding waters and expands our understanding of oil spill weathering. Impacts consistent with evaporation, dissolution biodegradation, and photolysis were all observed. Though variable across sites, compounds with GC retention times less than n-C16 were generally lost by evaporation and dissolution with preferential transfer of more soluble compounds into surrounding waters. Changes in n-C18/phytane and benz[a]anthracene/chrysene ratios indicated some biodegradation and photodegradation, respectively. Asphaltene content of samples increased with time as GC-detectable components were lost.