**Extreme Vessels Meet Extreme Values,
Creating Hazards Near the Coast**

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**Abstract**

In 2018 the economic value of US port operations was estimated at $5.4 trillion, about 26% of US GDP. Every year, many thousands of ships call on maritime ports in the US, linking each port region to the national and international economy. Management of this dense vessel traffic relies on knowledge of the surface winds and ocean conditions in proximate waters, including water depth and density, current speed and direction, and the surface wave environment. Near shore, large-vessel operations are usually constrained by environmental conditions. Planning of vessel maneuvers is often based on historical measures of these quantities which are becoming less applicable due to climate change. Additionally, global economic expansion and competition has been driving an increase in the number and size of commercial vessels for many years, resulting in increased vulnerability to extreme conditions, a lowering of thresholds defining hazardous conditions, and a narrowing of safe operational windows.

We examine environmental hazards encountered by vessels operating in US coastal waters, particularly Florida, and how they relate to vessel operations over the last few years. Some of these hazards are similar to those afflicting land-based structures, but some are specific to vessels as they are “mobile infrastructure” moving through the environment. The most common hazards include high cross currents, extreme low and high water levels, high winds, and low visibility. Vessel susceptibility to these varies with ship length, height above water, depth below water, speed, and proximity to other ships or infrastructure. In many locations the maritime community has developed strategies to reduce the associated risks to vessels. A common tactic is the prohibition of some maneuvers during “extreme” conditions. These prohibitions used to be based on historical records, but in recent decades are increasingly prescribed using monitoring systems of oceanic and atmospheric conditions in and around ports. (The growing records from these systems also informs the adaptation and protection on onshore facilities and infrastructure.) Some large vessels have inverted the typical extreme value-hazardous relation. For example, deeply drafted ships can only traverse a port access channel during very high tide. For these ships, which are increasingly common, nominal conditions are hazardous, and extreme conditions are safe.