Economic Benefits from Ocean Surface Vector Wind Observations and Forecasts

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Summary

Observations, nowcasts, and forecasts of ocean surface wind conditions are of economic value to industries and activities such as maritime transportation, commercial fishing, offshore energy, recreational boating, and search and rescue. In this paper, we estimate the value of ocean surface wind information generated from satellite-based instruments.

Information about ocean surface winds is valuable to organizations and individuals who plan and carry out operations on the ocean. Since operators are interested in wind information for the geographic areas in which they are active, the value of ocean surface wind information is determined in part by the geographic distribution of the user activities. Also, because ocean surface wind information is not an end in itself, but a means to anticipating some other event (for example, the drift of a life raft, or the severity of the sea state), the value of satellite-based ocean surface wind data also depends on what other sources of surface wind information are available for the region (for example, surface- or buoy-based observing stations) and what alternate information is available to predict the event (for example, the deployment of locator beacons with life rafts). The estimate of the value of satellite-based ocean surface wind observations therefore must take into account

- the value of wind nowcasts/forecasts to each user group, as a function of location, taking into account the use of other technologies to address the underlying information requirement;
- the availability of wind observations from other sources, as a function of location; and
- the coverage/quality of wind observations provided by the satellite system.

Commercial ships transiting the North Pacific and North Atlantic oceans are exposed to severe wind and wave conditions associated with extra-tropical storms. These storms impose costs on maritime commerce by delaying and sometimes damaging vessels, or causing loss of cargo. In particular, container ship traffic in these regions is at increased risk of losing containers overboard in severe weather conditions; and dry bulk ships carrying grain (Pacific and Atlantic) and coal (Pacific) face increased risk of structural damage from these conditions. Ocean surface wind information allows ships to limit exposure to these conditions.

Search and rescue (SAR) operations in US waters are carried out primarily by the US Coast Guard. These search activities rely on surface wind and current information to minimize the time until persons in distress are located and rescued. The Coast Guard rescues more than 5,000 persons per year; but another 1,000 or so lose their life at sea, 300 of them after the Coast Guard is notified and mobilizes a search. Better surface wind information improves the efficiency of search efforts and reduces the time to rescue, thereby saving lives and reducing search costs. U.S. commercial vessels (including commercial fishing boats) are required to carry emergency position

indicating radiobeacons (EPIRBs), which can provide direct information about the location of persons in distress. An estimated 20% of U.S. ocean-going recreational craft over 20 ft in length also carry EPIRBs.

Offshore energy operations in the Gulf of Mexico depend on marine conditions information and forecasts for safe and efficient operations. In particular, drilling operations are sensitive to currents and surface wind and waves; and production operations are sensitive to severe weather events that require shutting down and evacuating offshore facilities. Better surface wind information reduces the risk of costly errors in drilling and production operations.

Recreational boats and commercial fishing vessels that venture significantly offshore the US coasts can benefit from better ocean surface wind information to improve passage planning and avoid exposure to hazardous wind conditions.

From a spatial standpoint, these activities fall into two distinct categories. Recreational boating, commercial fishing, and search and rescue operations mainly take place in nearshore waters. For each of these user groups, we estimate that 90% of associated vessel-hours are spent within 20 km of U.S. shores. On the other hand, U.S.-based offshore energy work and trans-oceanic commercial shipping primarily take place in waters beyond 25 km off the coast. This information is captured in Figure 1.

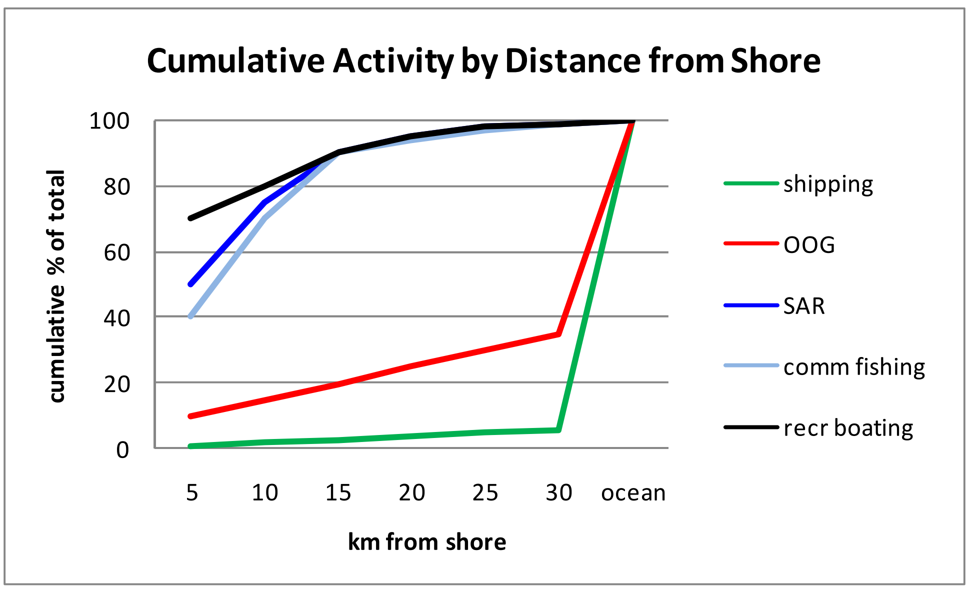

Figure 1: Spatial distribution of ocean surface wind information user activity.

Ocean surface wind information is provided, mainly for nearshore waters, by a number of technologies other than satellite systems. Wind sensors on shore-based meteorological stations, coastal buoys and towers, offshore buoys, and vessels of opportunity provide single-point wind observations with considerable density along the immediate shoreline, with some degree of coverage through nearshore waters to 10 km or so from shore, and only very sporadically beyond 10 km. Satellite-based ocean surface wind systems provide more uniform coverage that is limited nearshore by land mask effects. Figure 2 illustrates the spatial coverage of surface wind observations for satellite systems and surface-based technologies.

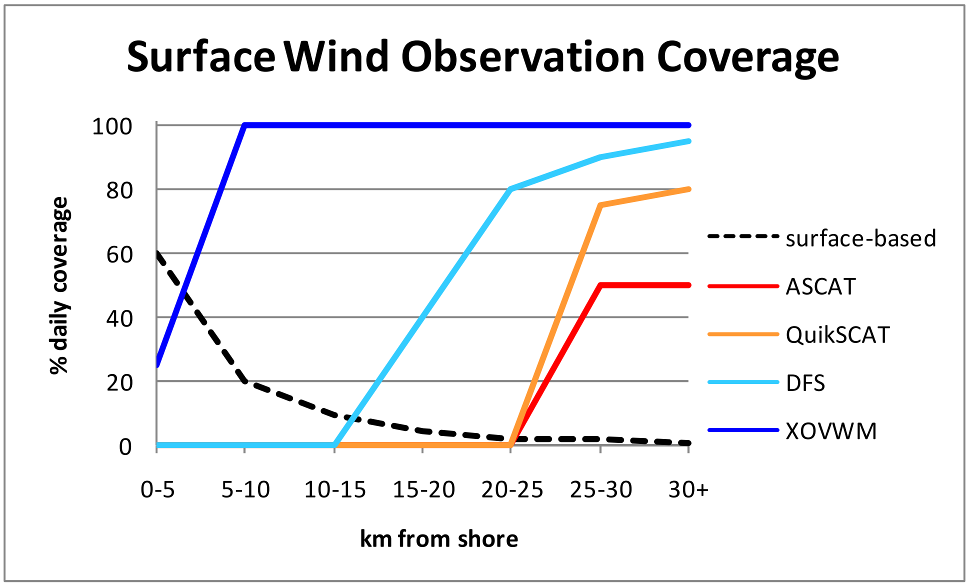

Figure 2: Approximate coverage of surface wind observation from satellite and surface-based sources.

Table 1 summarizes our estimates of annual values that can be generated by the use of ocean surface wind observations, nowcasts, and forecasts. We report a range of annual values loosely associated with a range of wind information from that presently available from QuikSCAT to the more sophisticated data available with a hypothetical instrument such as XOVWM.

Industry/activity	Source of benefit	Annual value, satellite wind obs, $m/year		
		Low range (QuikSCAT)	Mid range (DFS)	High range (XOVWM)
Maritime transportation	Reduced exposure to extratropical storms	156	187	202
USCG Search & Rescue	Improved search efficiency, lives saved	1	4	29
Offshore energy	Reduced downtime, drilling and production	7	9	12
Commercial fishing	Reduced exposure to hazardous conditions	< 1	1	11
Recreational boating	Reduced exposure and improved passage planning	< 1	1	5

Table 1: Summary of benefit estimates by user activity and satellite system**.**

We estimate that average expected annual losses to container shipping (lost containers and associated damage to vessels) in the absence of good information about extratropical storm conditions would be on the order of $250 million/year in the North Pacific and $120 million/year in the North Atlantic; and we estimate average expected annual losses to bulk shipping operations from extratropical storm exposure in these regions to be on the order of $150 million/year.

A significant fraction of this risk can be avoided with ocean surface vector wind observations and forecasts. We model the change in storm conditions exposure that becomes possible with nowcasts and forecasts of ocean surface vector wind fields under information scenarios representing the present QuikSCAT data, the European ASCAT radar, and hypothetical Dual Frequency Scatterometer (DFS) and Extended Ocean Vector Wind Mission (XOVWM) instrument. Model results suggest that the present QuikSCAT information and associated forecasts enable a reduction in annual exposure for shipping traffic in the North Atlantic and North Pacific of about 51%, with total annual net savings of $155 million. This is due mostly to avoided losses in the container ship trades, with $89 million/year in net avoided losses on the Pacific and $66 million/year on the Atlantic. The combined estimate of net annual benefits to shipping operations from ASCAT is $58 million, and hypothetical net benefits from XOVWM are $204 million. A perfect long-term forecast (not feasible with present technology) could deliver expected annual benefits of $520 million from all shipping by allowing for the virtual elimination of storm conditions exposure with no significant increase in operating costs.

In addition to maritime transportation, the offshore energy, commercial fishing, and recreational boating communities are exposed to risk from severe marine conditions:

- Search & rescue operations likely provide the largest potential benefits after maritime shipping; but because SAR events are concentrated in nearshore waters, most of these benefits are realized only if the satellite system can resolve winds near shore.

- Although the risk of potential losses from severe storm events is considerable for offshore energy activities ranging from exploration to development and production, the extent to which this risk can be mitigated with better nowcasts and forecasts is limited. The total value of marine conditions forcasts for the US offshore energy industry in the Gulf of Mexico has been estimated on the order of $20-50 million/year; and the incremental value provided by satellite-based information is likely to be less than 20% of that.
- Commercial fishermen and recreational boaters use marine conditions reports and forecasts to limit exposure to dangerous conditions; the total value to these user sectors of coastal ocean observing information in US waters is estimated to be in the $100s of millions/year. The contribution to this total value of satellite-based data is likely to be on the order of $10-20 million/year. For recreational boater in particular, the value will be greatest for vector wind observing systems that are capable of resolving wind fields well in the immediate vicinity of the coast.