18. Offshore Wind Module

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This module is designed as a multi-agency (NOAA, Department of Energy, Department of the Interior) supplemental data collection effort to gather hurricane environmental information in the vicinity of proposed offshore wind farms. Offshore wind energy is seen as an important component in President Obama's goal of the U.S. supplying 80% of energy needs from clean energy by the year 2030. The Bureau of Ocean Energy Management (BOEM) has identified several wind energy and lease areas in federal waters off the Atlantic coast and the Department of Energy has identified additional areas as demonstration projects for offshore wind power development (Fig. 18-1; Table 18-1). For offshore wind energy to develop into a new industry, the turbines must be designed to withstand extreme environmental conditions that occur during hurricanes.

Modern offshore turbines are huge structures with masts near 100 m above the surface and rotor zones extending to near 180 m. Conventional offshore turbines are erected upon foundations constructed in shallow (<40 m) water but new designs for deep water turbines are in operation off Norway and Portugal and expected off the coast of Maine as part of a DOE funded program to get demonstration projects in the water. Current standards for the design of tall offshore structures are governed by power law wind profiles specified with constant roughness or wind profiles based on Norwegian Sea that are unrepresentative when compared to GPS sonde based hurricane wind profiles. Turbulence intensity specifications used for the design of offshore wind turbines specified according to a marine roughness that increases with wind speed. To better document design wind profiles in hurricane conditions, additional GPS sonde and airborne Doppler wind profiles are needed in relatively shallow water areas in the vicinity of the proposed wind farm locations. In addition, wave height and directional wave spectrum measurements from NOAA's wide-swath radar altimeter are needed to determine wave loading.

Samples of the mean wind profile, wave heights and spectrum, and profiles of air density, temperature, humidity, and rainfall will assist design engineers in specifying materials and construction that will allow wind farms to survive hurricane conditions. Since this module is generally a "piggyback" mission, we request additional GPS sonde launches in the vicinity of the wind farm location. The PI will provide data collection coordinates to the Lead Project Scientist of the primary mission. This module is requested whenever a NOAA aircraft is flying and the hurricane is projected to be within 150 nm of an identified offshore wind development site (Table 18-2).

As an example, we show a "fly-by" pattern in Fig. 18-2 in which the wind farm location is near the route to or from the storm or near an existing leg of the primary experiment flown that day. In this case 4 GPS sondes are dropped in succession. It would be preferable to repeat the pattern and collect these measurements on the inbound or outbound routes to the storm, or as part of the pattern in the storm.

Since the Hurricane Field Program will already be in operation and experiments flown, the offshore wind module is a cost effective solution for participating federal agencies and industry partners to collect critical data relevant to the design risk. Since flight hours have already been dedicated to existing HFP experiments, those experiments have priority. The opportunity to fly the offshore mission as a piggy-back module is at the discretion of the Field Program Director. In order to fly the module, support for expendables is required. In addition, collection of data from many of the specialized data and analysis systems (e.g. Doppler radar, Scanning radar altimeter) depends on availability and may require additional support.

Figure 18-1: Potential offshore wind farm and Atlantic Wind Connection subsurface transmission line locations in federal waters off the U. S. Atlantic coast. Additional areas include state waters off Nantucket Sound MA, Block Island RI, Atlantic City NJ, Virginia Beach VA and Georgia. (Table 1).

Offshore Wind Farm	Location	State or Federal
Fisherman's Energy	Atlantic City, NJ (3 miles offshore)	State
Dominion Virginia Power	Virginia Beach	Federal
Statoil North America (Hywind Maine)	Boothbay Harbor	State
University of Maine (DeepCwind)	Monhegan Island	State
Deepwater Wind	Block Island (5 mi SE)	State
Cape Wind	Nantucket Sound (Horseshoe shoal)	State
Maryland Wind Energy Area	See Fig. 18-1	Federal
Rhode Island Wind Energy Area	See Fig. 18-1	Federal
New Jersey Wind Energy area	See Fig. 18-1	Federal
Maryland Wind Energy Area	See Fig. 18-1	Federal
Virginia Wind Energy Area	See Fig. 18-1	Federal
Delaware	See Fig. 18-1	Federal
North Carolina	See Fig. 18-1	Federal
South Carolina	See Fig. 18-1	Federal
Georgia	Lease request for a MET mast off Tybee Island	Federal

Table 18-1: Listing of DOE funded demonstration projects and other offshore wind developments planned or projected in state and federal waters.

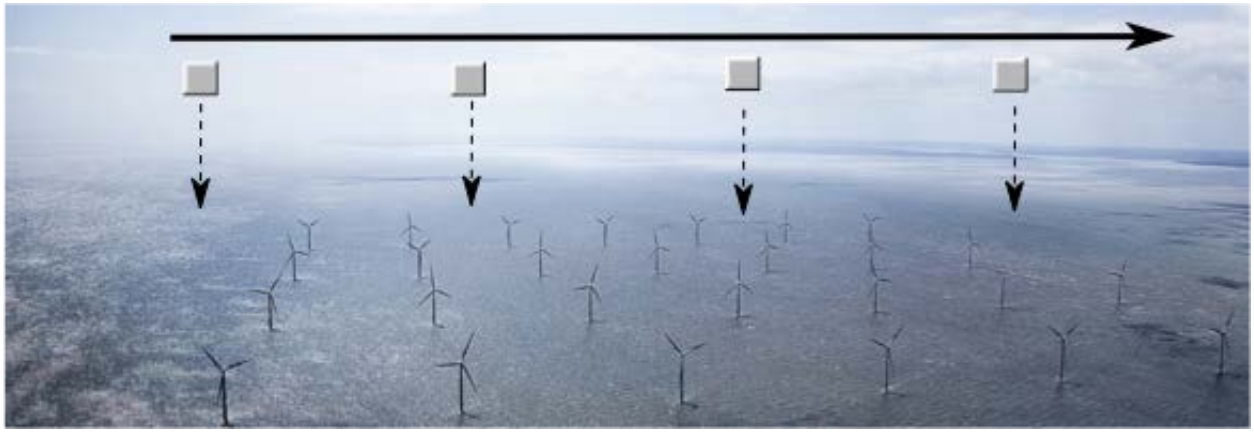

Figure 18-2: Schematic of piggyback pattern showing hypothetical wind farm fly-by with expendable launches at a 2-4 km interval. No U.S. wind farms are yet in operation. (Dong Energy Gunfleet Sands 1farm off SE England)

Table 18-2: Expendables (Ex) and aircraft (A/C) measurement systems required for conducting offshore wind experiment

Observing system	Measurement	Number	Type
GPS sonde	Pressure, Temperature, Humidity, Velocity	4-10	Ex
Stepped Frequency Microwave Radiometer (SFMR)	Surface wind speed rain rate		A/C
NOAA wide-swath radar altimeter	wave height and directional wave spectrum		A/C
Airborne Doppler radar	3D wind velocity, rain rate		A/C
Lower fuselage radar	reflectivity		A/C