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Local Applications of an Environmental Buoy at Cape Kennedy

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ABSTRACT

The National Oceanic and Atmospheric Administration (NOAA) has plans for the deployment of several Environmental Buoys (EBs) to measure significant meteorological and oceanographic parameters. Such data obtained from a buoy placed off the coast of Cape Kennedy would be extremely useful for the scientific and operational meteorological community. This report describes some of the local applications an EB would have. It presents a brief view of some of the present and future programs which would benefit from this ocean surface data.

INTRODUCTION

In 1966, the National Data Buoy Project (NDBP) began as a program within the National Oceanic and Atmospheric Administration (NOAA). Under this program a number of Ocean Platform Systems (OPSs), referred to as Data Buoys, have been developed. These buoys will be moored in the deep ocean in a systematic array. This paper discusses the operationally significant local applications such a Data Buoy would have if it were located off the coast of Cape Kennedy, Florida. Due to the wide variety of local uses, this paper is basically a survey. So that the reader will better understand the local applications, the paper first discusses the Data Buoy itself and the type of instrumentation available on the buoy. Next, it is shown how the buoy could add to the microscale meteorological data network at Cape Kennedy and how this addition would be useful in issuing daily forecasts for test operations at the Air Force Eastern Test Range AFETR). Finally, particular emphasis is placed on the use of the Data Buoy to calibrate sea surface temperatures obtained from infrared satellite data.

I. THE BUOY

The Data Buoys are unmanned automatic stations, which are serviced at regular intervals, with an ultimate design goal of one year of reliable, unattended operation. All the buoys are equipped with sensors to measure meteorological and oceanographic environmental parameters.

There have been several buoys developed under the NDBP. One of these known as the "Monster Buoy" was developed for the program by General Dynamics. The buoy consists of a 40 foot diameter disk-shaped body and weighs 100 tons.

Several smaller buoys have also been developed for the NDBP. Their size and limited instrumentation have obtained for them the name of Limited Capability Buoy (LCB). LCBs have been developed by Lockheed, General Electric and the Magnavox Corporation. A typical LCB would be the Lockheed buoy. The buoy consists of a hull-shaped body, 4 1/2 feet in diameter and 11 feet long, with a 4 foot keel attached at one end. All of these buoys utilize radio data links to transmit the data to shore stations for dissemination to meteorologists, marine scientists and industry.

Instrumentation for the buoys has been developed by the Westinghouse Electric Corporation's Oceanic Division at Annapolis, Maryland. On the "Monster Buoy" one sensor package is attached to the buoy hull at the water line and twelve oceanographic sensor packages are attached to the mooring line at intervals to a depth of 500 meters. Meteorological sensors are installed at the 5-meter and 10-meter levels above the platform surface. Inside the buoy are the power supplies, transmitters, digital data processors and a sensor deck unit used to interrogate and control the sensors, and to digitize the data. The sophistication and ruggedness of these instruments are notable; they have been designed to operate unattended for one year in a marine environment.

The specific parameters, which can be obtained from the "Monster Buoy," are listed below in Tables 1 and 2.

TABLE I - METEOROLOGICAL SENSORS

Parameter	Range and Accuracy
Wind Speed and Direction	0 to 80 m/sec ±0.5 m/sec
Air Temperature	-10°C to +40°C ±0.5°C
Dewpoint Temp	-10°C to +40°C ±.5°C
Air Pressure	900 mb to 1100 mb ±1 mb
Ultraviolet Radiation (Global Rad. Sensor)	0 to 2 Ly/min ±0.05 Ly/min
Infrared Radiation (Global Rad. Sensor)	0 to 1 Ly/min ±0.05 Ly/min

Precipitation/Rate	0 to 20 cm/hr ±0.1 cm/hr
Magnetic Compass	0 to 360° ±3°

TABLE II - OCEANOGRAPHIC SENSORS

Parameter	Range and Accuracy
Water Temperature	0 to +40°C ±0.05°C
Water Pressure	0 to 55 Kg/cm^2 ±.5 Kg/cm^2
Conductivity	16 to 77.4 m mhos ±.01 m mhos
Water Current Velocity	0 to 3 m/sec ±0.02 m/sec

The small LCBs are not capable of carrying instrumentation to measure all the parameters listed in Tables 1 and 2. The LCBs measure only the basic environmental parameters: air pressure, air temperature, wind direction and speed, water pressure and water temperature at several layers.

To date, three Data Buoys have been deployed under the NDBP. They are: EB01 in the Atlantic Ocean, 120 NM E of North Carolina, EB03 in the Gulf of Alaska, 210 NM SE of Kodiac Island, and EB10 located in the Gulf of Mexico, 160 NM S of Mobile. Within the next six months, the NOAA National Data Buoy Center expects to deploy five additional buoys. The remainder of this paper shows how one of these buoys deployed off the coast of Cape Kennedy could benefit present and future operations at Cape Kennedy.

II. WEATHER NETWORK AT CAPE KENNEDY

Meteorological support for launch operations at Cape Kennedy is provided by both NASA and Air Weather Service meteorologists. Air Weather Service Staff Meteorologists from Detachment 11, 6 Weather Wing, at Patrick AFB are also responsible for all meteorological support to the Air Force Eastern Test Range (AFETR). Meteorological support includes forecasting, observing, climatological and consultant services.

To provide the meteorological support needed, a highly sophisticated instrumentation network has been constructed at Cape Kennedy. Equipment at Cape Kennedy Air Force Station includes an AWS FPS-77 storm detection radar and a NASA WSR-72X short range weather radar, microscale wind observation network, atmospheric electrical detection systems, Muirhead 115B/1 satellite photo readout capability, and computerized storm movement prediction capability. Upper air data is obtained on a regular basis from both rawinsonde and rocketsondes operated under contract to the AFETR by Pan American Airways. Some of these systems have been designed and constructed at Cape Kennedy to provide specific support to launch operations. Basically, these systems have been designed to detect and predict local meteorological phenomena near the launch pads.

Figure 1 shows the Weather Information Network Display System (WINDS) found at Cape Kennedy. The system has been developed for predicting and monitoring low level diffusion characteristics. This information is necessary for predicting gas dispersion patterns in case of a toxic fuel spill during a test. Meteorological parameters necessary for making the diffusion forecast are obtained from 16 stationary towers, with sensors, that range in height from 54 feet to 500 feet, located throughout the Cape Kennedy and Merritt Island areas.

Also found at Cape Kennedy is a system of sensors, field mills, used to determine the electrostatic field gradients and changes in the vicinity of the sensor. The field mill antenna network is shown in Figure 2. This system, together with several other systems oriented toward detecting electrical activity, enables the duty forecasters to predict areas of probable lightning occurrence at Cape Kennedy AFS and the Kennedy Space Center.

These several systems make-up one of the most sophisticated mesoscale observational and forecasting networks in the world. This network could be improved by expanding the data base. Note from Figures 1 and 2 that the observational network extends only over the land areas. There is no regularly obtainable data east of the launch complexes. In fact, there is no regularly obtainable operationally significant surface data immediately east of Cape Kennedy or along the entire coast of Florida.

EB(s) placed off Cape Kennedy would expand the present data base and prove to be extremely useful in daily operations. The applications of this expanded data base will now be discussed.

III. LOCAL APPLICATIONS

Meteorological parameters obtained from an EB(s) east of Cape Kennedy could greatly aid operational meteorology. Wind and temperature information would have numerous applications. Some of these applications are listed here:

a. Sea surface winds near the Gulf Stream, combined with higher level wind observation, would enable the forecaster to more accurately predict the formation of or advection of thunderstorms into the Cape Kennedy area. These storms often form over the Gulf Stream and present a potential lightning threat if advected onto the mainland.

b. Wind data to the east of the influence of the daily land/sea breeze circulation would enable the forecaster to better predict diffusion paths of possible toxic gas spills.

c. The advection of sea fog or low ceilings hazardous to flying conditions could be better predicted with knowledge of sea surface or low level winds.

d. Sea surface winds and pressure would be a forecasting aid for predicting the onset of easterly waves which frequent the Florida area during the summer months.

e. Precipitation and precipitation rate would be an indication to the forecaster of storm intensity.

f. Sea states could be obtained indirectly from the prevailing sea surface winds. Sea states are of operational significance to various programs on the Eastern Test Range.

g. Sea surface data from an EB would improve rescue services of the Air Force, U.S. Coast Guard and civilian community by providing current off-shore observations and furnishing data for more reliable forecasts.

h. Several times per year, AFETR is required to provide launch support to submarine missile launches. A more accurate sea surface forecast would be extremely useful in providing forecasts for the support ships.

i. Sea surface data made available to the National Weather Service would be a valuable aid in issuing small craft warnings. This data would also be useful to the National Weather Service for monitoring storm systems such as tropical storms or hurricanes.

j. A theoretical use of the buoy data would be to estimate evaporation rate occurring over the sea surface by using the temperature, dew-point and wind speed.

k. Cape Kennedy is one of the few locations in the Continental United States having regular upper air soundings using rocketsondes. These soundings could enable studies to be made between the high altitude ozone content and surface incidence of ultraviolet radiation. This incident ultraviolet radiation is measured by the global radiation sensor provided on the EB.

These are some of the applications an EB located at Cape Kennedy would have. The most interesting and, perhaps, most valuable application would be calibration of sea surface temperature data obtained from infrared satellite imagery.

IV. CALIBRATION OF SEA SURFACE TEMPERATURES

The newest generation of satellites such as the ITOS-D(NOAA-2) are equipped with simultaneous scanning radiometer imagery of the video and infrared. This system is designed to provide imagery below the satellite night and day. The radiometer scans (horizon to horizon) beneath the satellite's path yielding picture resolution of 2 NM in the visible and 4 NM in the infrared at the satellite subpoint. Figure 3 is an example of an infrared photograph taken on 5 Dec 72 at 0700Z showing a portion of the ocean off the coast of Cape Hatteras. As can be seen, it is possible to determine the location of the Gulf Stream due to the presence of the associated thermal gradient. Due to the limitations on the resolution of this type of IR imagery, it is not possible to accurately determine the fine temperature gradients on the ocean surface. This picture was obtained, as stated, from NOAA-2 launched on 15 Oct 72. Until recently, this was the highest resolution data made available for public use.

However, imagery from a military system has recently been made available to the scientific community. Due to the advanced sensors on the system, it is possible to obtain much higher resolution. The onboard radiometers scan a 1,800 NM wide path producing picture resolution of 1/3 NM in the visible and near infrared (.4 - 1.1 μ), and 1/3 NM in the infrared (8 - 13 μ). Figure 4a is an example of the visible and near infrared data (1/3 NM). Figure 4b is an example of the infrared data (2 NM resolution) also obtained from this system. This picture shows the thermal gradients associated with the Gulf Stream.

The different shades of grey in the picture can be related to a specific surface temperatures. When comparing actual sea surface temperatures obtained from surface observations with the theoretical calculations obtained from the infrared data, a difference of several degrees has been found to occur, i.e., colder temperatures than actual have been measured. This difference is due to emission of intervening water vapor, ozone aerosols and carbon dioxide between the satellite and surface. A correction factor can be calculated by calibrating the infrared data with actual sea surface temperatures obtained from an EB.

The meteorological community is vitally interested in these sea surface temperature patterns to investigate the movement and intensification of hurricanes or typhoons. Knowledge of sea surface temperature patterns and related parameters such as heat flux and sea state on a global synoptic basis is required for the advancement of meteorology, oceanography, fisheries management, pollution control and underwater acoustic communication. In addition, other sea surface properties can be correlated with spectral regions aboard existing satellites, such as microwave radiometry aboard NIMBUS.

CONCLUSION

An Environmental Buoy located off the coast of Cape Kennedy, Florida, would enhance the data base of the micrometeorological observation network constructed at the Cape. This expanded data base would have several operational and theoretical applications; one of the more significant uses would be in the calibration of infrared satellite data.

Based on the applications already discussed, an environmental buoy would be a definite asset to the scientific and operational community at Cape Kennedy.

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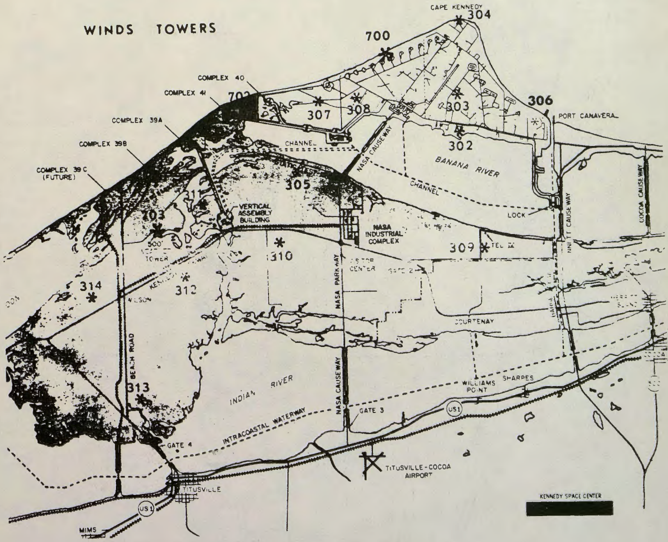

Figure 1. Weather Information Network Display System.

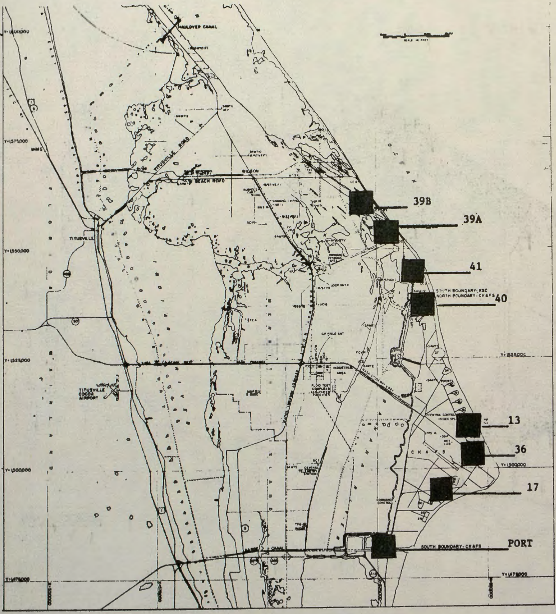

Figure 2. Antenna Network for Measuring Potential Gradients.

Figure 3. NOAA-2 Infrared Satellite Data.

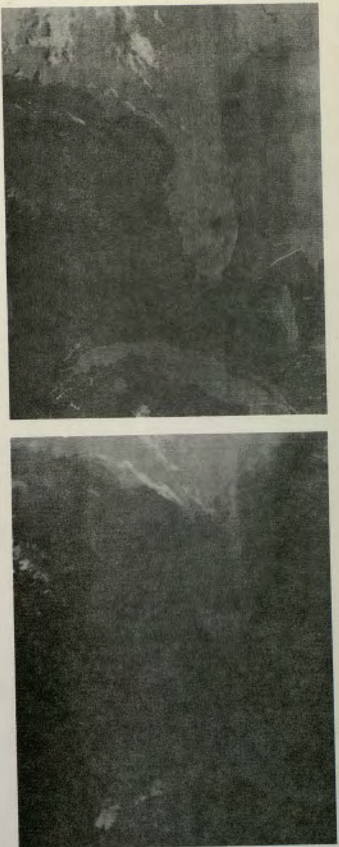

Figure 4. High Resolution Infrared Satellite Data.