**US Army Corps
of Engineers**
Waterways Experiment
Station

Wind Products for Use in Coastal Wave and Surge Models

by   Zeki Demirbilek, Steven M. Bratos, Edward F. Thompson
Coastal Engineering Research Center

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U.S. Army Corps of Engineers
Waterways Experiment Station
3909 Halls Ferry Road
Vicksburg, MS   39180-6199

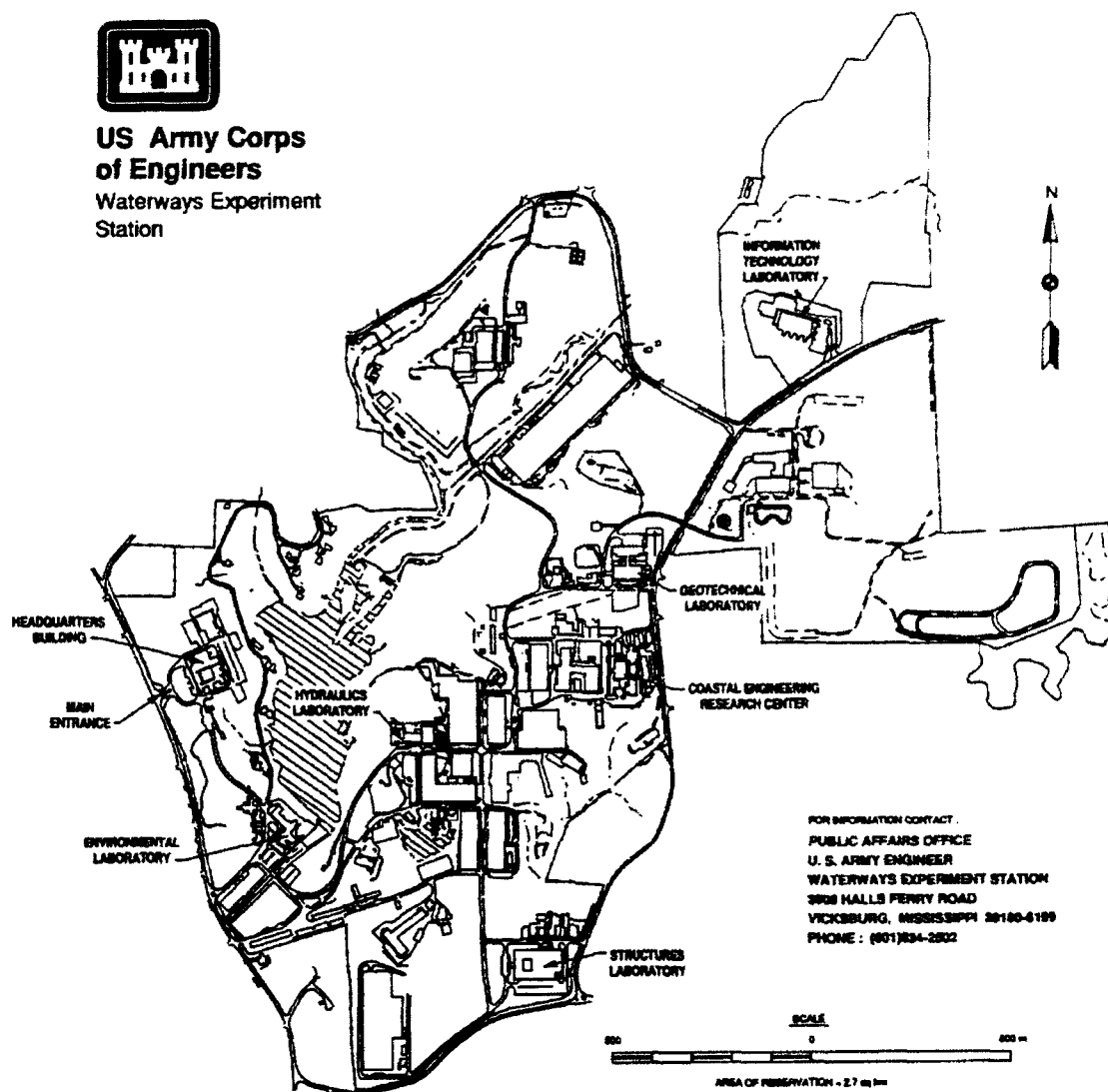| Accesion For		
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Preface

1 Introduction

Background and Purpose

Winds over the ocean surface are the essential driving force in creating waves. They also have important effects on currents and nearshore water levels. Wind information is often used within the Corps of Engineers (CE) as input to numerical models of waves, storm surges, and circulation.

The National Oceanic and Atmospheric Administration (NOAA) and US Navy routinely produce global wind information. Significant recent advances in atmospheric modeling capabilities and operational numerical models within NOAA and the Navy have made available new and improved products applicable to CE hydrodynamic modeling. These products are potentially extremely useful in coastal hydrodynamic modeling. A few NOAA and Navy products have been used in past CE modeling efforts, but new products are now available in new formats. In particular, it is now feasible to obtain wind products in near real time.

The objective of this study is to facilitate the use of NOAA and Navy products in CE hydrodynamic models. Wind products for use with climatological and extreme event applications, using long term records of historic information, and real time applications are considered.

The CE standard spectral wind wave growth model WISWAVE 2.0 is used as a tool for evaluating wind products. The wave model is used in preference to surge or circulation models because wave growth occurs over open water and is characterized by time and space scales compatible with NOAA and Navy products.

This report includes a number of acronyms which are not often used in the CE. To assist readers in this regard, a comprehensive list of acronyms is provided in Table 1.

Table 1	
Acronyms Used in This Report	
Acronym	**Explanation**
CE	Corps of Engineers
CEDRS	Coastal Engineering Data Retrieval System
CERC	Coastal Engineering Research Center
ECMWF	European Center for Medium-Range Weather Forecasts
FNOC	Fleet Numerical Oceanography Center
GMT	Greenwich Mean Time
IEEE	Institute of Electrical and Electronic Engineers
IPOPS	Interim POPS database
LSC	Large Scale Computer
NAVOCEANO	Naval Oceanographic Office
NDBC	National Data Buoy Center
NOAA	National Oceanic and Atmospheric Administration
NODDS	Navy Oceanographic Data Distribution System
NOGAPS	Navy Operational Global Atmospheric Prediction System
PFCS	Permanent File Computer System
POPS	Primary Oceanographic Prediction System
SPOP	Sun front end to POPS system
SSC	Stennis Space Center
SWADE	Surface Wave Dynamics Experiment
UTC	Universal Time Coordinate
WIS	Wave Information Studies
WISWAVE	Wave Information Studies Wave Model
3GWAM	Third Generation Wave Forecast Model

Previous Studies

Surface winds are typically the primary forcing mechanism for waves and surge during severe storms along the coast. Nearshore circulations are also strongly influenced by wind as well as tide. Because of its importance, the wind and its effect on nearshore hydrodynamics has received attention in many previous studies.

The problem of properly representing the effect of wind in nearshore hydrodynamic models may be separated into two parts. First, wind characteristics near the water surface must be estimated. Second, the coupling

between surface wind and water must be determined. Both of these problems are difficult to solve accurately. They have been the subject of many research studies.

Historically, the CE has most successfully solved the problem of estimating surface winds over the ocean by using atmospheric pressure fields and a parameterized surface boundary layer wind model (Resio et al. 1982). Pressure fields were obtained from NOAA and Navy sources and surface winds were estimated at the standard 10-m elevation.

As NOAA and Navy wind models have become more powerful and refined, the CE has begun to explore and use these information sources. The NOAA and Navy products offer promise to CE studies for major time and cost savings and improved accuracy. Navy surface wind estimates have recently been used for a wave hindcast along the Somalian coast (Bratos 1992), a wave hindcast for the Coast of Delaware (Cialone and Hubertz, 1992), and a comparison of the measured and hindcast wave conditions at Lake Worth and Hollandale, Florida (Hubertz and Brandon, 1992).

The Navy products pertinent to CE hydrodynamic models include two types of wind information: a surface stress parameter, and a surface wind. Thus there are two direct alternatives for driving hydrodynamic models. While most applications to date have relied on surface wind, some research studies have used stresses. In particular, Surface WAve Dynamics Experiment (SWADE) studies include extensive use of stresses, as discussed in Chapter 5. Vincent et al. (1992) investigated the performance of a third generation wave forecast model 3GWAM using Navy wind stresses.

The viability of surface stresses from an atmospheric model for use in wave modeling is also a concern in the European research community. Janssen et al. (1992) recently reviewed literature documenting inconsistencies between surface wind and stress produced by atmospheric models, especially for high wind speeds. Stresses have a tendency to underpredict wave height. Janssen, et al., also evaluated surface stresses and surface winds from the European Centre for Medium-Range Weather Forecasts (ECMWF) atmospheric model. Both wind products were used to drive the 3GWAM wave model. They concluded that the ECMWF stresses also underpredict wave height and attributed the problem to a flawed numerical integration scheme in the near-surface boundary layer of the ECMWF atmospheric model.

Drag laws

The effect of wind on the water surface is complex, requiring empiricism and simplifications in both wind and hydrodynamic numerical models. Momentum imparted by the wind to the water surface gives rise to waves and currents. In deep water, the effect of wind on a column of water can reach hundreds of meters below the surface. In shallow water, the whole water column may be affected. Concepts for linking near-surface wind action and water surface response are generally based on a drag law. A variety of drag

law formulations have been used. These concepts are reviewed in tine following paragraphs. A more detailed discussion is given by Long and Hubertz (1988).

To consider the effect of winds on the sea surface, it is intuit⁻e that the force imparted to the water increases with the mean wind speed. Hence, an estimation of wind effect based on an average wind speed just above or near the sea surface would be a first-order approximation. For typical low- to mid-altitude conditions, an idealized atmospheric boundary layer over the water surface provides estimates of the first-level planetary boundary layer winds above the air-sea interface. Inside this layer, wind frictional stresses are fairly constant, but wind speed within the boundary layer immediately above the sea surface can vary substantially due to elevation above the surface and difference between air and water temperatures. Surface winds are usually taken as a characteristic wind at the 10-m to 20-m elevation. The shear stress within the boundary layer is then empirically related to the characteristic wind speed. The usual relationship, known as the "quadratic drag law" or "bulk parameterization," is given by

$$T = \rho \, C_D \, U^2 \tag{1}$$

where
    T = surface stress
    ρ = air density
    C_D = drag coefficient
    U = characteristic wind speed

Development of this drag law is discussed in the pioneering works of van Dorn (1953), Garratt (1977), and Reid et al. (1977).

Observed or predicted winds are usually adjusted as needed to match conditions required by hydrodynamic model formulations. The adjustments are also necessary so that the horizontal frictional stress remains nearly independent of elevation. A critical parameter affecting wave growth is the air-sea temperature gradient. Since this gradient information is often unavailable, the wind speed at a 10-m elevation under the condition of neutral stability ($\Delta T=0$) is often used to characterize the wind-stress causing waves. At sufficiently greater elevation above the sea surface, winds remain fairly uniform and are geostrophic. The adjustment height of 10-m is adequate for wave heights less than 3-m, and a 20-m height is more appropriate for wave heights between 3-m and 10-m.

Wind stress is the forcing mechanism for wave growth at the sea-air interface. According to Equation 1, the force acting on a fluid particle is proportional to the product of the particle's surface area, a drag coefficient, and the dynamic head (ρU^2). Thus wind stress is proportional to the square of wind speed. The kinematic form of wind stress components may be expressed in terms of the adjusted wind speed as

$$T_x = K \, U_{10}^2 \cos \theta$$

$$T_y = K \, U_{10}^2 \sin \theta \qquad\qquad (2)$$

where

T_x, T_y = components of surface wind stress
K = dimensionless coefficient
U_{10} = wind speed at a 10-m elevation over the water
θ = angle between the wind velocity vector and x-axis

The coefficient K, which can be considered as equivalent to ρC_D in equation 1, is generally a function of wind speed (van Dorn 1953 and Reid et al. 1977). For low to moderate wind speeds, K is given by (Reid et al. 1977)

$$K = K_1 \qquad\qquad \text{for } U_{10} < U_c$$

$$K = K_1 + K_2 \, (1 - R)^2 \qquad \text{for } U_{10} > U_c \qquad\qquad (3)$$

where

$$R = \frac{U_c}{U_{10}}$$

$$K_1 = 1.2 \times 10^{-6} \qquad\qquad (4)$$

$$K_2 = 1.8 \times 10^{-6}$$

$$U_c = 14 \text{ knots} \quad (7 \text{ m/sec})$$

For large wind speeds if the ratio of air density to water density is 1.2×10^{-3} or less (which is often a reasonable approximation), K approaches the limiting value of 3.6×10^{-6}. This value corresponds to a drag coefficient of about 3.3×10^{-3}.

Friction velocity within the immediate vicinity of the boundary layer overlaying the sea surface is related to wind speed at elevation z by the following form (Schlichting 1979)

$$U_*^2 = \frac{T}{\rho}$$

$$T = \mu \frac{\partial U_{10}}{\partial z} \qquad (5)$$

$$\frac{U_{10}}{U_*^2} = \frac{z}{\nu}$$

where
  μ = dynamic viscosity of air
  ν = kinematic viscosity of air
  z = elevation above the water surface

With Equations 1-5, the drag coefficient may be defined in terms of U_{10} and U_* as

$$C_D = \frac{U_*^2}{U_{10}^2} \qquad (6)$$

Thus the drag coefficient depends on wind speed and friction velocity. A number of empirical forms have been devised for this relationship (van Dorn 1953, Reid et al. 1977, Large and Pond 1981) for use in wind wave modelling.

The drag coefficient relationship adopted in WISWAVE 2.0 is of the following form:

$$C_D = 0.001 \; (1.1 + 0.035 U_{10}) \; U_{10} \qquad (7)$$

This form, although parabolic, nearly represents a straight line approximation of the drag coefficient versus wind speed for low values of wind speed. The relationship is different from several historical measurements for open ocean momentum flux by the eddy correlation (known also as the Reynolds flux) and dissipation methods (van Dorn 1953, Smith and Banke 1975, Garratt 1977, Yaglom 1977, Pond and Large 1978, Large 1979, Smith 1980, and Large and Pond 1981). The historical measurements have clearly demonstrated that drag coefficient reduced to 10-m height and neutral conditions is independent of stability and fetch but increases with wind speed above 10 m/sec. Below U_{10} = 10 m/s, C_D does not vary appreciably with wind speed and should remain essentially constant (Garratt 1977 and Smith 1980). The best constant should

6

be in the range 1.1 x 10^{-3} to 1.3 x 10^{-3} (Large and Pond 1981). Equation 7 simply fits a smooth line to C_D for all wind speeds.

For coastal and shallow water locations, Garratt (1977) established the following relationship for drag coefficient based on extensive field measurements

$$C_D = 0.001\ (1.1) \qquad\qquad 1 < U_{10} \leq 10\ m/sec$$
$$= 0.001\ (0.44 + 0.065\ U_{10}) \qquad 10 < U_{10} \leq 26\ m/sec \tag{8}$$

For open ocean situations, the following expressions, also obtained directly from field measurements, have been suggested and used extensively in offshore engineering (Smith 1980, Smith and Banke 1975, Large and Pond 1981)

$$C_D = 0.001\ (1.11) \qquad\qquad U_{10} \leq 10\ m/sec$$
$$= 0.001\ (0.44 + 0.063\ U_{10}) \qquad 6 < U_{10} < 25\ m/sec \tag{9}$$

$$C_D = 0.001\ (1.18) \qquad\qquad U_{10} \leq 10\ m/sec$$
$$= 0.001\ (0.61 + 0.075\ U_{10}) \qquad 6 < U_{10} < 22\ m/sec \tag{10}$$

$$C_D = 0.001\ (1.14) \qquad\qquad 4 < U_{10} \leq 10\ m/sec$$
$$= 0.001\ (0.49 + 0.065\ U_{10}) \qquad 10 < U_{10} < 26\ m/sec \tag{11}$$

In essence, Equations 9-11 state that over the deep ocean, a constant neutral 10-m drag coefficient is an adequate description of most results throughout the wind speed range 2-12 m/sec, and a reasonable compromise would be to use $C_D = 1.1$ x 10^{-3} in the bulk formula for winds below 10 m/sec. For higher wind speed in open seas, Equation 11 by Large and Pond (1981) is probably best accepted, though it is similar to Equations 9 and 10 at higher wind speeds.

Procedure

The study objective is met by, first, providing descriptions of the available products and procedures for accessing them. The NOAA products are discussed in Chapter 2 and Navy products in Chapter 3. Recently, upgraded weather information has become available from the Navy's Fleet Numerical Oceanography Center (FNOC) daily weather forecast stream, disseminated to

the US Navy through a networking system. The FNOC database includes a variety of meteorological parameters at varying spatial and temporal resolution. Chapter 3 of this report provides detailed information about this product.

A smooth interface between meteorological data sources and wave and water level numerical models is a prerequisite for efficiency and user-friendliness in engineering studies. An interface between the Wave Information Study (WIS) wave model WISWAVE 2.0 and the FNOC meteorological database was developed in this study to facilitate routine CE applications. Computer routines were developed to take the raw Navy products and convert them to a form for direct input to the CE wave model WISWAVE. The interfaces are presented in Chapter 4.

Various Navy products were used to drive WISWAVE. The results were inter-compared with wave buoy measurements in Chapter 5 to evaluate the usefulness of the products for hydrodynamic modeling. Recommendations for products and procedures to be used in future CE hydrodynamic studies are given in Chapter 6.

2 NOAA Wind Products

The NOAA National Meteorological Center (NMC) routinely produces global wind estimates. The global grid can provide a resolution of about 1 deg in latitude and longitude. The NMC is developing methods for much finer resolution in selected regions. A characteristic fine-mesh resolution is 0.5 deg in longitude and 0.33 deg in latitude (Gemmill 1991).

The NMC produces two types of global forecast. The aviation (AVN) forecasts are run daily at 0000 UTC and 1200 UTC. Forecasts extend out to 3 days. Forecasts are issued after a 2.75-hr wait for arrival of data for assimilation into the 0-hr forecast. The AVN forecasts, used mainly for aviation purposes, are transmitted world-wide on the Global Telecommunications System. The medium-range forecasts (MRF) are run once per day from 0000 UTC. The forecasts, extending out to 10 days, are issued after a 6-hr data hold. A more detailed review of NMC global weather prediction systems was given by Kalnay et al. (1990).

The NMC wind products are discussed further as part of the SWADE experiment (Chapter 5). The NMC model provides wind estimates of sufficient quality to be useful in CE hydrodynamic modelling. However there is no convenient way at present for CE users to access that information in digital form. Therefore, the NMC products are not described in detail in this report.

3 Navy Wind Products

Description

Products related to surface winds which are available from the US Navy FNOC are described in this section. FNOC products related to surface winds are available from several Navy database sources. The sources are grouped in the following discussion into archived information covering a time period of multiple years (needed for climatological and extreme conditions) and recent information ranging from the most recent several months to present and forecast conditions. The following paragraphs provide a description of the information available and some relevant background on how the information is calculated by the Navy model.

The Navy's global numerical weather prediction is based on the Navy Operational Global Atmospheric Prediction System (NOGAPS). The first version of NOGAPS was a nine layer, finite difference model with horizontal resolution of 2.4° x 3.0° (Hogan and Rosmond 1991). After several improvements in physical parameterization and resolution, NOGAPS Version 3.2 was introduced in 1989. NOGAPS 3.2 is a global spectral model with 18 vertical levels. It produces output fields on grids with 2.5-deg and 1.25-deg horizontal resolution. The NOGAPS consists of components for data quality control, data assimilation, and initialization and forecasting. NOGAPS 3.2 is described by Hogan and Rosmond (1991). The planetary boundary layer model used in NOGAPS is similar to that of the ECMWF (Louis et al. 1982). The FNOC also operates a Navy Operational Regional Atmospheric Prediction System (NORAPS) for several regions of the world, including the Western Atlantic Ocean encompassing the U.S. coast. Additional information on NORAPS and NOGAPS is available from Bayler et al. (1991).

NOGAPS is an operational model used to drive a variety of the Navy's ocean, wave and ship and aircraft routing models. The model is run at 0000Z and 1200Z each day, forecasting a period of up to 72 hr. The "Z" indicates times are referred to Greenwich Mean Time (GMT), also known as the Universal Time Coordinate (UTC). Available data, measured and observed, are assimilated into the model at startup time. The startup time is labeled with

a forecast time of $\tau=0$. Fields at any times other than $\tau=0$ are forecast fields and have a forecast time of $\tau=3$, 6, ..., 72 hr.

All of the wind products discussed in this chapter are produced on the NOGAPS "global_73x144" and "global_288x144" grids. Both grids are based on spherical projections. The global_73x144, referred to in this report as the "coarse" grid, has a spatial resolution of 2.5° latitude and longitude increments. The global_288x145, or "fine" grid, has a spatial resolution of 1.25 deg. In Navy references, the coarse and fine grids are often referred to as the "regular" and "super" grids. In some Navy products, the regular grid is called the "spherical" grid, though both the regular and super grid are based on a spherical projection of the earth. Additional details of the grids are given in Table 2 and illustrated in Figure 1.

Table 2 **FNOC Global Grids**						
Formal Grid Name	**Abbrev. Grid Name**	**Spatial Reso- lution (deg)**	**Grid Size**		**Grid Origin[1]**	
			Lat	**Long**	**Location Relative To Grid**	**Latitude, Longitude**
global_73x144	Coarse (regular)	2.5	73	144	Upper left corner	90°N, 60°E
global_288x145	Fine (supergrid)	1.25	145	288	Lower left corner	90°S, 60°E
[1] Grid point at which (x,y) coordinate is (1,1).						

Archived data

Archived surface wind information is available through FNOC for a period ranging from 1976 to the present. CERC's WIS group has archived information from the period from 1976 to 1990 for CE use. Surface winds are at 19.5-m elevation and are presented in terms of U-V windspeed components in meters/sec. The winds are available on a global basis at a spatial resolution of 2.5 deg (corresponding to the coarse grid) every 6 hr. This wind product, labelled A29/A30 (U/V component) in the FNOC database, is obtained from atmospheric numerical models, including NOGAPS after 1981, which assimi- late observed data from ships, buoys, and satellites.

Recent data

POPS. Surface fields are available on a component of the Primary Oceanographic Prediction System (POPS), an automated information system under the Commander, Naval Oceanography Command. POPS consists of two supercomputers and associated subsystems. One supercomputer is located at
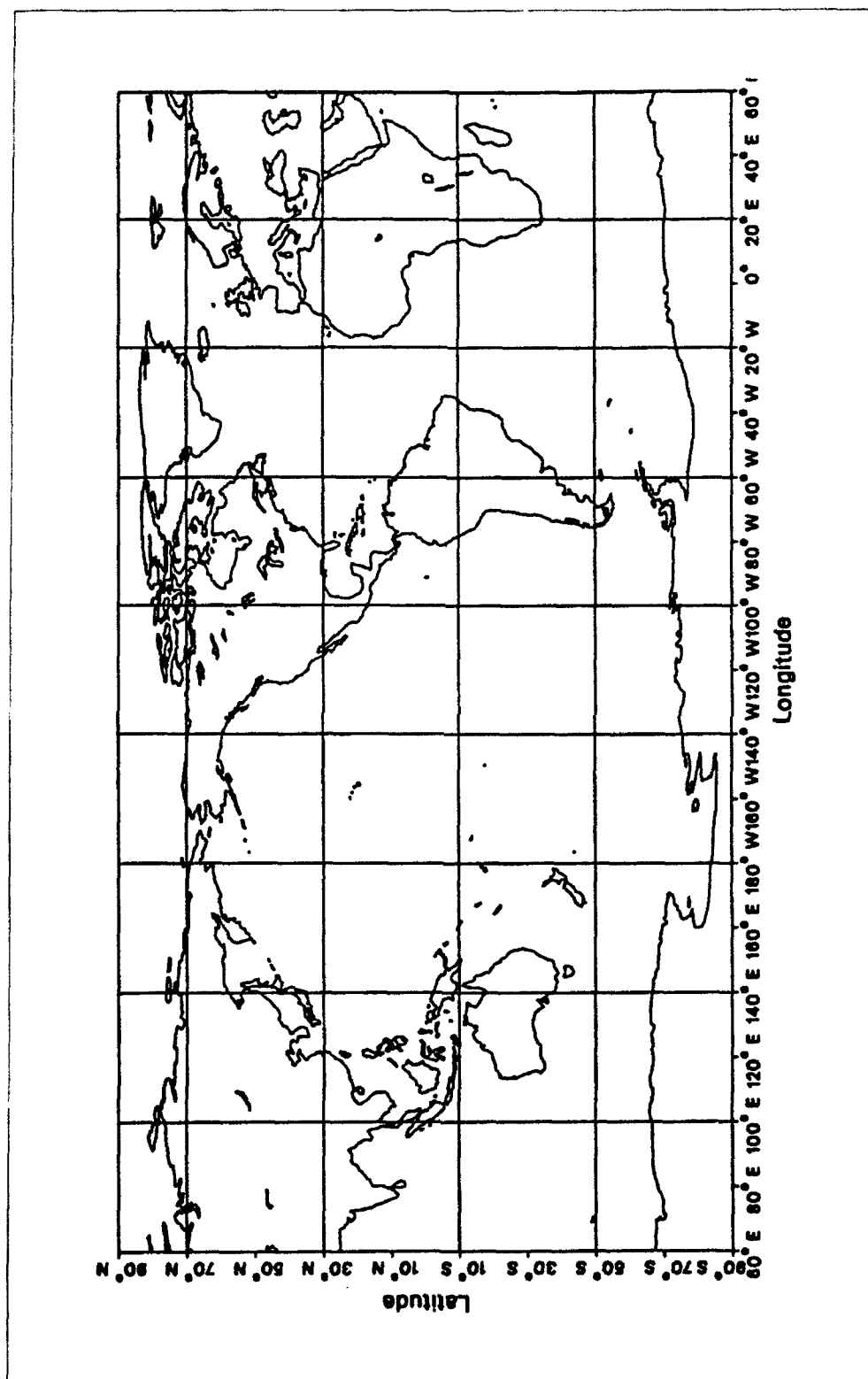
Figure 1.. Navy global grid boundaries

the Naval Oceanographic Office (NAVOCEANO) at Stennis Space Center (SSC), MS. The other supercomputer is located at FNOC in Monterey, CA. The two supercomputers are linked by a high speed data connection for efficient data transfer. A subset of the data available on the FNOC database is transferred to the Permanent File Computer System (PFCS) located at NAVOCEANO. A complete listing of the grids and fields available on the PFCS appears in Appendix A. The data may be accessed through any of the components of POPS at SSC including a Cray system known as the Large Scale Computer (LSC) and two Sun systems which serve as front ends to POPS on the LSC. The Sun systems are known as SPOP and POPS.

Two surface wind products are available from the PFCS. One is an unadjusted surface wind at an elevation 10 m in terms of U-V components (A58/A59). This wind product is not adjusted for any air/sea temperature differences. The units are generally in m/s but this is not always consistent as will be explained in the Access portion of this chapter. The other surface wind product is the surface wind stress in terms of U-V components (A60/A-61) with units of N/m^2.

Both the surface wind and wind stress are available on the coarse and fine grids. However the available resolution in time varies with the type of product and grid (Table 3). A surface pressure field (A01) at mean sea level in units of millibars is also available from the PFCS as indicated in Table 3.

Table 3
Summary of FNOC Products Related to Surface Winds

Grid	Surface Wind		Surface Stress		Surface Pressure	
	Time Increment[1] hrs	Longest Forecast hrs	Time Increment[1] hrs	Longest Forecast hrs	Time Increment[1] hrs	Longest Forecast hrs
Coarse	6	72	12	0	12	0
Fine	12	24	3	48	6	48

[1] Time interval at which 0-hr forecasts are available; also the time increment for forecasting between 0 hrs and the longest forecast time.

NODDS. FNOC surface winds at 10-m elevation in units of knots, labelled A58/A59 (U/V comp) on the FNOC database, are available through the Navy Oceanographic Data Distribution System (NODDS). NODDS is a PC-based software interface to the mainframe FNOC database. The spatial resolution for this windfield is 2.5 deg. It is available every 12 hr. Only forecasts and the most recent analysis are available through NODDS. A pressure field, in millibars (labelled A01 on the FNOC database), is also available at 12-hr intervals.

The NODDS system is intended primarily to provide guidance to U.S. Department of Defense meteorologists and oceanographers. It provides access to a portion of the data available from the FNOC database in a user-friendly,

menu-driven format where details of the database and transfer of the fields is transparent to the user.

Access

Archived

The FNOC is an operational center, but it also maintains an archive of selected operational products. The archived products are accessible to the general public through NOAA's National Oceanographic Data Center in Asheville, NC. Within CERC the information is available on tape from the WIS group. WIS presently has data from the years 1976 to 1990.

NODDS

To access data through NODDS, the NODDS software and documentation must be acquired from FNOC. CE users may also obtain the information from CERC. For users within the U.S. Department of Defense, inquiries may be directed to:

> Commanding Officer
> Fleet Numerical Oceanography Center
> Monterey, CA 93943-5005
>   Attn: Code 344

The CERC has a licensed copy of NODDS which may be shared on site, but the license forbids simultaneous access to the FNOC database by more than one user. In order to run the NODDS software the user must have a licensed copy of the communications software PROCOMM PLUS. Information is accessed interactively in the NODDS package by linking the user's PC to the FNOC database via modem. Desired information is transferred to the user's PC automatically. The information can be written in the form of a standard ASCII file if the user modifies the PLOTMAP.BAT program in NODDS. Step-by-step instructions for using NODDS are given in the documentation (U.S. Navy 1991, 1992).

POPS

Access to FNOC data on the PFCS is designed mainly for Navy users. Users must have an account on POPS and clearance to access the data. Sponsorship from a Navy office is a prerequisite for user accounts on POPS. With sufficient need and Navy support, a limited number of CE users have received permission to access POPS. Inquiries by qualified users about an account on POPS computers may be directed to the following Navy office:

POPS Supercomputer Center
1002 Balach Blvd
Stennis Space Center, MS 39522-5001

Data transferred from FNOC to the PFCS at SSC is accessed through the
Interim POPS database (IPOPS). Inquiries by qualified users about gaining
access to IPOPS may be directed to:

Naval Oceanographic Office
Code AM, Supercomputer Center
Stennis Space Center, MS 39522

The interim set of subroutines included in IPOPS is designed to simulate a
subset of POPS Prototype routines. IPOPS routines are intended for temporary
use until a permanent database management system is available and tested with
the IPOPS Data Base (DB) Prototype routines. IPOPS simulates several POPS
DB Grid Data Routines (Table 4). Routines are also available which produce
a listing identifying all grid fields contained within an IPOPS file. IPOPS
provides Cray and Sun users at SSC and FNOC the capability to read gridded
environmental fields which have been transferred from the FNOC-CYBER
mainframes to the PFCS. Users may also write and read grid fields on their
own files. Fields are available on the PFCS in a single random file created for
each FNOC 12-hr watch (0-hr forecast every 12 hr). Additional details on
extracting surface wind products from IPOPS are given in Appendix B.

In order to automate the process of retrieving wind data from IPOPS, a
base program containing IPOPS subroutine calls, provided by IPOPS
personnel, was modified to extract multiple wind fields given a user-defined
time increment. The fortran program, named **extwind.f**, can be applied to
either the coarse or fine grid. By editing the parameter statement and several
other lines of program **extwind.f**, 10-m winds (A58/A59) or wind stresses (A6-
0/A61) from either grid may be extracted for any time period. A complete
listing of **extwind.f** is included in Appendix B. The lines which must be
changed for each run are identified in the listing.

Table 4
POPS DB Grid Data Routines Included in IPOPS

Name	Purpose
GOPN	Open grid data
GRD	Read grid data
GWR	Write grid data
GWRAS[1]	Associative grid write[1]
DBSTART[1]	Start data base[1]
DBSTOP[1]	Stop data base[1]

[1] Inactive; provided only for compatibility with POPS.

4 Interface with CE Hydrodynamic Models

One objective of this study was to make NOAA and Navy products more accessible for use in CE wave, surge, and circulation models. The descriptions and access possibilities discussed in Chapter 3 provide a first step. Additional steps taken to make Navy products easily used in CE hydrodynamic models are described in the following paragraphs. The effort was focussed mainly on WISWAVE because it is the CE model most likely to require winds over large spatial areas. Interface with archived NOAA buoy data, useful for evaluating model predictions, is also discussed.

Model Grid

Considerations in setting up WISWAVE are reviewed in the following paragraphs. A first step in using wind fields in WISWAVE 2.0 is creating a grid for the wind input and wave model. A grid may be generated on the CE Cray computer using software items developed in this study. The software takes advantage of map features available in the DISSPLA graphics package. The program **mapgrid** draws a map and overlays a grid of specified interval in longitude (x) and latitude (y). Files involved in using the program are summarized in Table 5.

Table 5
Files for Creating WISWAVE Grid

File Name	Description
mapgrid.f	Fortran program to generate grid and shoreline display metafile
mapgrid.c	Shell file to run mapgrid and hpgl
hpgl.f	Fortran program to convert a metafile to HPGL format
dispop.inp	Parameter input file for use in DISSPLA

A detailed description of **mapgrid** and other associated programs, including run procedures and postprocessing steps is provided within the files.
Comments in **mapgrid** give necessary information for using the program. The files are listed in Appendix C.

Output files are in HPGL format and may be transported into word processing software as graphics files. The files may be modified if necessary and printed using a standard laser printer. Sample plots are shown in Figures 2 and 3 for 2.5° x 2.5° and 1.25° x 1.25° grids used in this study. The **mapgrid** program includes options for displaying NDBC buoy locations on the gridded maps.
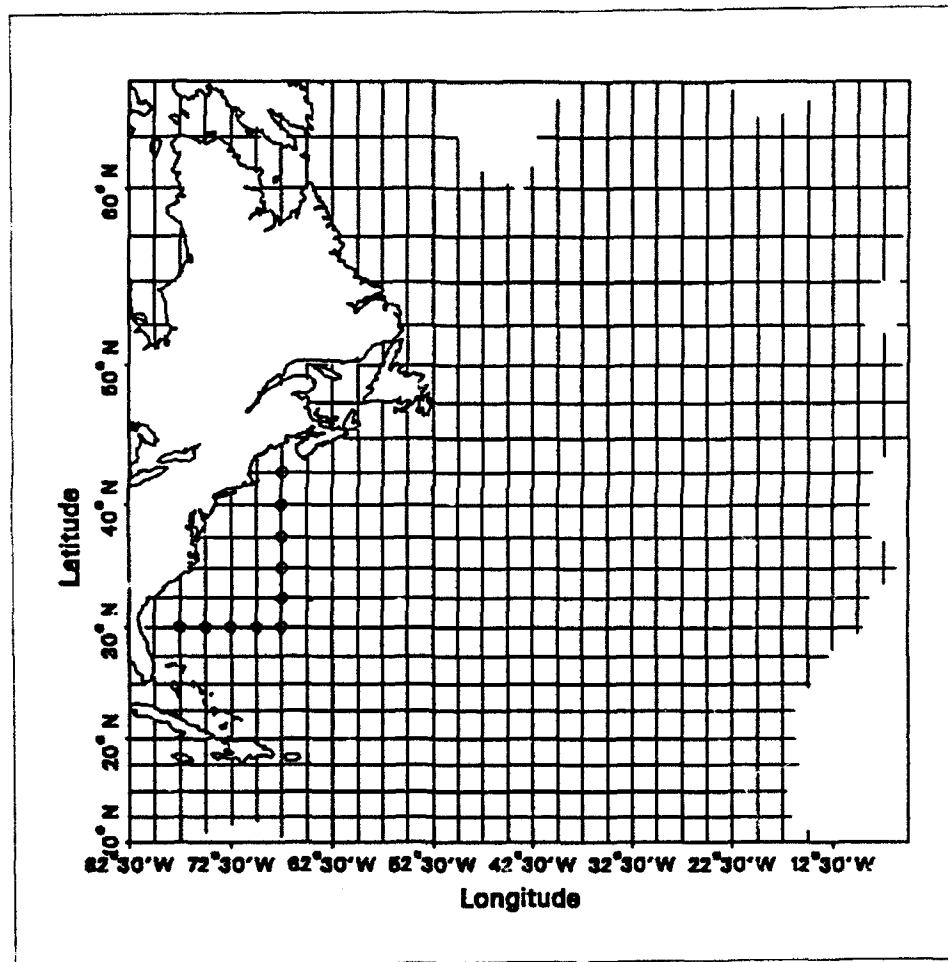
Figure 2.. Coarse grid (2.5-deg resolution) for wave model test in north Atlantic ocean

The WISWAVE grid system is based on latitude and longitude lines with the origin located in the lower-left grid corner. Latitude lines correspond to rows of constant y-value on the grid, denoted by values of J with a maximum of JDMN. Longitude lines describe columns of constant x-value, and are referenced by values of I whose maximum is set to IDMN in the parameter

statements. Array dimensions in the model are specified by parameter files **para1.inc** and **para2.inc**, as discussed later in the chapter.
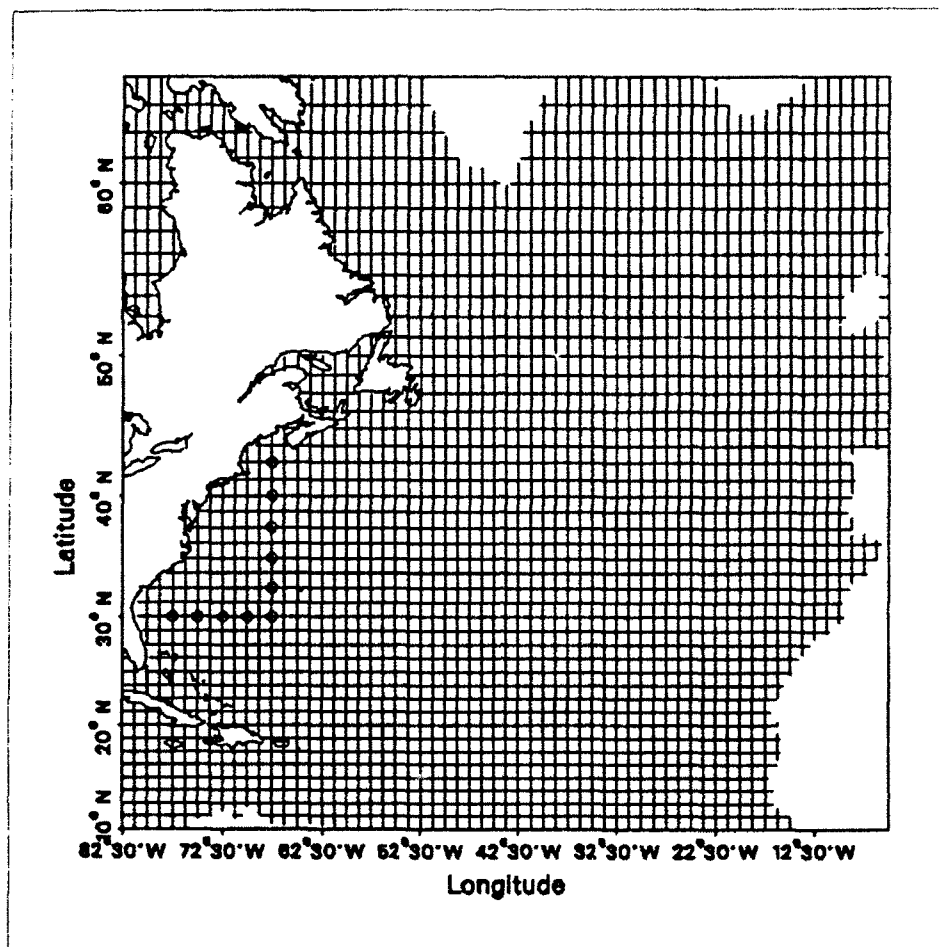
Figure 3.. Fine grid (1.25-deg resolution) for wave model test in north Atlantic ocean

Wind Input File

The use of program **extwind.f** to extract surface wind products from IPOPS was discussed in Chapter 3. Files created by **extwind.f** are based on FNOC's global grids. In order to interface the FNOC wind products to WISWAVE, a program was written which takes a user defined subgrid of the global wind product extracted from IPOPS. The U-V components of winds or stresses are converted to windspeed and direction and written to a file in the format of the WISWAVE wind input file. The program, written in fortran, is named **popuvwinds.f**.

The program **popuvwinds.f** reads output from IPOPS coarse or fine grids and creates a subgrid according to user defined parameters. Either surface winds or wind stresses may be specified. WISWAVE will accept only surface wind as input, but friction velocities are computed in WISWAVE from the

surface winds to estimate wave growth. To make the IPOPS stresses suitable for input to WISWAVE, the program **popuvwinds.f** includes a procedure for converting stresses to surface winds. The procedure is an inverse of that in WISWAVE, so the stresses ultimately computed in WISWAVE are equivalent to the original FNOC stresses. The files required to run **popuvwinds.f** are summarized in Table 6. An example wind field derived from IPOPS is shown in Figure 4. Details of the program are given in Appendix D.
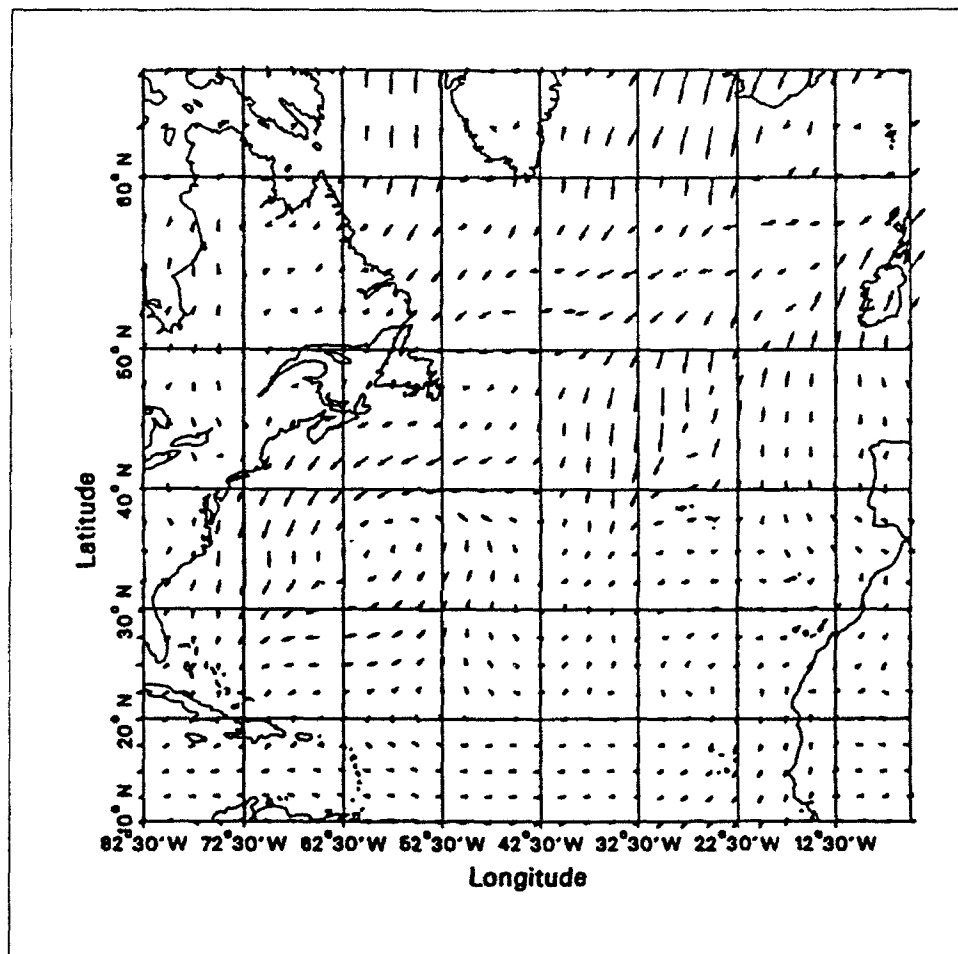
Figure 4.. Example wind field derived from IPOPS, 1200 hr, 14 Dec 92

Wave Model Execution

Execution of WISWAVE 2.0 is described in the user's guide (Hubertz 1992) and is only briefly covered here. Although the general term "WISWAVE" is used to refer to the model in this report, a run with WISWAVE 2.0 requires a number of specific files (Table 7). File names other than those in the table may be used as desired, although the names must be specified consistently in program and shell files.

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Table 6
Files for Creating WISWAVE Wind Input File

File Name	Description
popuvwinds.f	FORTRAN program to create surface wind input file for WISWAVE
popuv.c	Shell file
fort.20	Output file

Table 7
Files for Executing WISWAVE

File Name	Description
wiswave.f	FORTRAN program
wiswave.c	Shell file
wiswave.opt	Option or input file including sea-land matrix data
para1.inc	Parameter file for dimensions
para2.inc	Parameter file for dimensions
wind.dat	Atmospheric forcing file for wind speed and direction
fort.17	Output file
fort.92	Output file for postprocessing
fort.93	Output file

The files **para1.inc** and **para2.inc** contain critical parameters defining array dimensions. These files must reside in the same directory as the program being run. In addition to dimensions of the grid, the files include dimensions for frequency (if) and direction (ia and ig). Other parameter values are dimensions for the number of saved points (nobpts) and saved boundary points (nbn). A complete description of all parameters that specify the details of a particular application are described in the WISWAVE user's guide (Hubertz 1992).

The WISWAVE program was modified in this study to create an additional output file, **fort.92**, which contains condensed output information for postprocessing. It includes station number, date of computation step, significant wave height, peak wave period, mean wave period, peak wave direction, wind speed, and wind direction in columnar format convenient for the postprocessing program **plotzd.f**. Only user-specified stations are included, which, in this study, are those nearest to NDBC buoys.

Buoy Data

Buoy measurements are highly desirable for verification of wave model results. The National Data Buoy Center (NDBC) data can be obtained by CE users from CERC's Coastal Engineering Database Retrieval System (CEDRS) (McAneny and Jones, 1992 and 1993). The format for archiving buoy data is described in Appendix E. For this study, individual buoy data were extracted from CEDRS in NDBC's "Record B" format.

The program **buoy.f** was developed to facilitate application of buoy data in wave modeling studies (Appendix E). Files involved in using the program are summarized in Table 8. The Record B buoy file is directly input to the program. The program separates out parameters in the Record B buoy data records of interest in hydrodynamic modeling and generates an output file containing only these parameters. The output file can be used as an input file to the postprocessing program **plotzd.f**.

Table 8
Files for Extracting NOAA Buoy Data

File Name	Description
buoy.f	Fortran program to extract buoy data
buoy.c	Shell file
fort.1	Input buoy data
fort.2	Output file

Display of Results

In addition to standard WISWAVE postprocessing tools, a program, **plotzd.f**, was written to generate time series plots of model results and/or NDBC buoy measurements (Appendix F). The files needed to use **plotzd.f** are listed in Table 9. The WISWAVE output file **fort.92** includes model results at selected stations nearest to buoys for comparison. To compare model estimates with buoy data or to simply plot the model time series, results from the appropriate station must be written to a new file, which can be generically referred to as **station.92**. The desired station may be separated from the others in **fort.92** by using text editing capabilities or, alternatively, "sort" and "grep" utilities in the UNIX operating system on the Cray.

Buoy data files for postprocessing are created using the program **buoy.f**, as discussed earlier. The file **station.92** and the corresponding output file from **buoy.f** serve as input to the postprocessing program **plotzd.f**. Both buoy and model station predictions should have corresponding start and end times, although **plotzd.f** is sufficiently general that it will process time series data of

any desired length. If no buoy measurements are available, the program will process only the model predictions; there is no need to specify null input.

Table 9 Files for Plotting WISWAVE and NOAA Buoy Wind and Wave Information	
File Name	**Description**
plotzd.f	Fortran program to plot wind and wave information
plotzd.c	Shell file
fort.2	Input buoy data
fort.92	Input WISWAVE information

The program **plotzd.f** displays the parameters wave height, period, and direction and wind speed and direction. Values of these parameters are plotted (y-axis) over a 24-hour time span (x-axis) for five days. An example for wave height is given in Figure 5. Thus **plotzd.f** produces five plots for each parameter per page. To process information for more than five days, only the parameter "ndays" in the parameter statement contained in the program need be changed. Similarly, if the time interval used for WISWAVE output is different than 1 hour, the parameter "ihrs" should be modified.
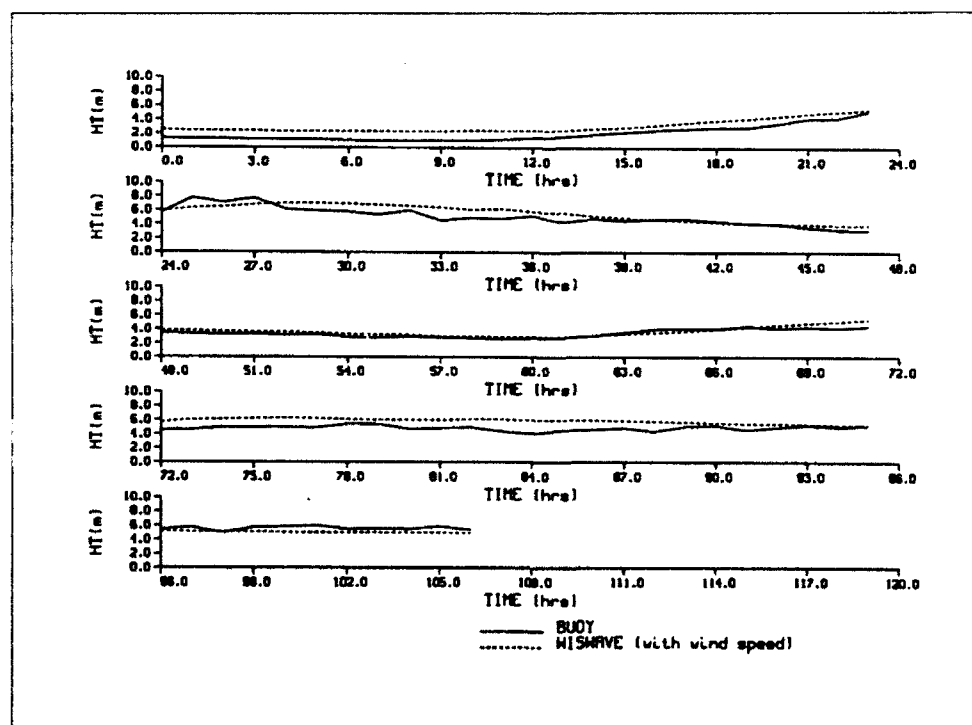
Figure 5.. Example wave and wind plot from **plotzd.f**

5 Evaluation of NOAA and Navy Wind Products

SWADE Experiment

The SWADE experiment was conducted by a multi-agency, international group of scientists during 1 October 1990 to 31 March 1991. The primary objectives were to understand the dynamics of the evolution of the surface wave field and to determine the effect of waves on the air-sea transfers of momemtum, heat, and mass (Weller et al. 1991). Field measurements of a variety of meteorological and sea state parameters were obtained from a dense array of buoys located off the middle Atlantic coast of the U.S. The measurements were augmented with wind information derived from a variety of sources including FNOC, NMC, ECMWF, and a manual kinematic analysis (Cardone et al. 1980).

The post-SWADE analyses include intercomparison of wind fields from different sources and evaluation of wave estimates derived from the various wind fields. Although the FNOC and ECMWF wind fields for SWADE are based on standard products, the NMC wind fields have been modified to increase spatial resolution. The SWADE analyses are still in progress. They indicate that the FNOC and NMC wind fields lead to useful wind and wave estimates, but the shortcomings of the wind forcing field still remain the largest source of error in predicting the sea state (Graber et al. 1991, Caruso et al. 1993). Jensen et al. (1991) reported promising wave estimates derived from the FNOC wind stress information.

Deep Water, Atlantic Coast

A special evaluation of Navy wind products available through the POPS system was conducted. These products were chosen because they are the most accessible and complete products presently available, as discussed earlier. The objectives of the evaluation were to:

(a)   Check and verify the interfacing procedures.
(b)   Evaluate WISWAVE results relative to the Navy wind parameters used (v/ind speed vs. wind stress) to create the input wind fields.

The model WISWAVE 2.0 was set up to run over the north Atlantic Ocean. Buoy measurements of wind and waves along the Atlantic coast were used for evaluation of model results.

Numerical grids used in WISWAVE 2.0 consist of latitude and longitude lines covering a significant area of the northwest Atlantic, including the entire eastern coastline of the United States. Grids developed for this study covered latitudes between 10° and 65°N and longitudes between 5° and 82.5°W. The program requires an input land-sea matrix and a water depth at each grid point designated as sea. Deepwater conditions were assumed in this study and depths for all sea grid points were set to 999 m. Thus only deepwater wave growth and propagation are modelled; wave shoaling and refraction are omitted. This simplification is justified considering the buoy locations. Also it allows the model vs. buoy wave comparisons to be a more direct evaluation of the quality of wind products, unaffected by assumptions about wave-bottom interactions.

Two grids were used in this study (Figures 2 and 3). The grids have different levels of spatial resolution, corresponding to the two levels of resolution in the Navy products (Table 10). Wave information was saved at selected grid points along the east coast of the United States. The output points include those grid points nearest to NOAA buoy sites (Table 11 and Figure 6).

Table 10
North Atlantic Grids Used with WISWAVE

Grid	Spatial Resolution		Grid Size	
	deg	km	Latitude	Longitude
Coarse	2.5	278	23	32
Fine	1.25	139	45	63

Table 11
NOAA Buoy Locations

NOAA Buoy			WISWAVE Grid Point[1]		
Identification Number	Location		Location		Distance from Buoy km
	Latitude	Longitude	Latitude	Longitude	
44004	38.5°N	70.7°W	37.5°N	70.0°W	140
44008	40.5°N	69.5°W	40.0°N	70.0°W	80
44009	38.5°N	74.6°W	37.5°N	75.0°W	120
44014	36.6°N	74.8°W	37.5°N	75.0°W	100
44025	40.3°N	73.2°W	40.0°N	72.5°W	80

[1] These points were used from both coarse and fine WISWAVE grids for comparison with buoys.
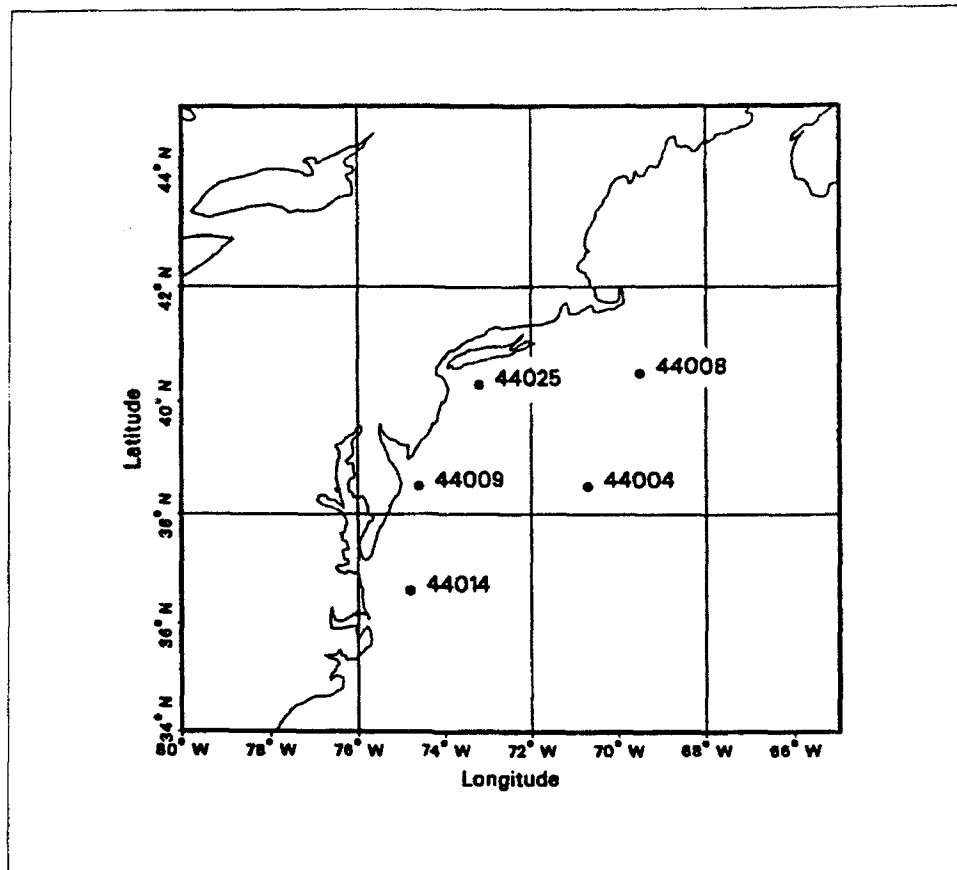
Figure 6.. NOAA buoy locations

Time periods for which both Navy information and buoy data were available were extremely limited at the time of this study. Access to the Navy POPS information had just been established; and, because of the time lag before buoy data are available, the POPS and buoy overlap was short. The approach taken was to process an initial 4-day time period (1-4 September 1992) to check and verify interfacing procedures and to form a first impression of the wind speed vs. wind stress comparison. Then a 5-day time period during a large, severe storm (10-14 December 1992) was processed to give a quantitative comparison between the effect of wind speed vs. wind stress as input to the wave model. This storm comparison was made possible by a special early release of NDBC buoy data.

Initial evaluation

Wind products for August 13 through September 15, 1992, were obtained from the Navy POPS database. Although the period of interest was September 1-4, the August wind information was needed to allow WISWAVE adequate spin-up time. Surface winds are available on a 6-hr time step for the coarse grid and a 12-hr time step for the fine grid (Table 3). The 10-m wind speed and direction were used.

The fine grid was also tested with wind stresses from the Navy database. Computer programs were developed to use stresses to create equivalent 10-m wind speeds and directions for input to WISWAVE, as discussed in Chapter 4. Stresses are available in 3-hour increments, so the stress-based 10-m winds were supplied to the wave model on a 3-hour time step.

The WISWAVE model was configured to use twenty frequency bands with corresponding mid-band periods ranging between 3 to 24 seconds. Sixteen 22.5° directional bands were used. Model results were output every hour to coincide with measured buoy data.

The wave model was run for the time period August 13 through September 15, 1992. Model results were saved for the entire period, but the days in August are considered as necessary spin-up. Model results were plotted and evaluated only for the period September 1-4, the days for which buoy data were available.

In the analysis and presentation of results, all times are referenced to GMT. Comparisons of model hindcast and NDBC buoy measurements include wave height, wave period, wave direction, wind speed, and wind direction. Wave parameters are defined in both model and buoy results as spectral significant wave height, peak period, and peak mean direction. Peak mean direction from WISWAVE is an energy weighted mean of all directions in the peak frequency band. The convention used for both wave and wind directions follows the Mariner's direction convention (used in WISWAVE), namely the direction the waves or wind are "coming from." For example, a 90° direction represents waves coming from the east and going toward the west.

Wave heights from WISWAVE are based on the sum of energy under the discrete spectrum, and thus, are an integrated quantity. Significant wave heights are obtained from NDBC buoys by a similar method. In terms of wave spectra, the significant wave height is proportional to the square root of the area under a spectral curve. For purposes of this study, predicted and measured wave heights can be considered as equivalent parameters.

Peak wave mean directions from WISWAVE are the energy-weighted mean of all wave directions in the peak frequency band, and therefore, are integral quantities. Peak mean direction is associated with the region of the spectrum containing the highest energy density. On the other hand, wave peak period (or dominant period) corresponds to the period associated with the peak spectral energy density, and therefore, is not an integrated or a mean quantity. It is much less stable statistically than the integral parameters. Large differences between measured and hindcast peak periods often occur when spectra have multiple peaks, indicating the simultaneous presence of seas and swells. Despite its limitations, the peak period parameter is widely used and accepted.

The NDBC buoys 44004, 44008, 44009, 44014, and 44025 were used to evaluate the model predictions (Figure 5). All of the buoys are capable of me-

asuring wind and waves. However wave direction measurement requires special sensors which are located only on buoys 44014 and 44025. Model predictions were compared to measurements at all 5 buoys, but results from only the directional buoys are presented in detail here for brevity.

Results from post-processing include individual plots of these parameters: wave height, wave dominant peak period and direction, and wind speed and direction versus time in hours. The plots include superimposed buoy data and model estimates on the same plot. Buoy data may have a time interval different than that used in the model predictions, but in all cases presented here, both had a 1-hour interval.

It is convenient to use an abbreviated designation for results pertaining to the two primary Navy wind products. The convention defined in Table 12 is used in the remainder of this chapter.

Table 12 Convention for Referencing Navy Surface Wind Products		
Name	Explanation	Time Steps and Grids
Method 1	Surface wind	6 hr (coarse) 12 hr (fine)
Method 2	Surface stress	3 hr (fine)

Time series plots of wave height, wave period, wave direction, wind speed, and wind direction from WISWAVE using Method 1 and buoy 44014 on the coarse grid are shown in Appendix G. Overall, the comparison is good, but there are differences. For surface wind on the coarse grid, wave heights from the model are close to buoy measurements; there is a slight but consistent over-prediction by the model. Greater differences are evident for peak period; model predictions are higher than buoy measurements with differences generally less than about 4 sec. Wave direction estimated by the model is roughly 90° while the buoy shows almost a constant wave direction of about 180° for the entire four days span. Highest winds recorded by the buoy are near 8 m/s occurring at the start of the third day. The model indicates maximum wind speeds of 6 m/sec 24 hr later. Wind directions compare best on day 3. Differences in wind directions are not surprising given the low wind speeds.

For surface wind on the fine grid, model wave height estimates are closer to buoy data and are generally lower than with the coarse grid. Wave periods agree better with buoy data in the fine grid except over the first 24 hr. The tendency for model periods to exceed measurements is not evident. Model estimates for wave direction are higher than the coarse grid results, giving a better overall comparison. Wind estimates on the fine grid are very similar to those on the coarse grid. The coarse and fine grid points used here are colocated.

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Similar comparisons between WISWAVE and buoy 44025 are given for winds derived by Method 1 on the coarse grid and fine grid (Appendix H). Wave parameter comparisons between model and buoy show the same general trends as in the earlier comparisons with buoy 44014. Wind parameters vary more between the coarse and fine grids.

Data from both directional buoys were also compared to model predictions based on winds from Method 2, that is, WISWAVE was driven with surface stress on the fine grid (Appendices G and H). Method 2 shows a noticeable tendency to give higher wind speeds than Method 1. As a consequence, Method 2 also gives higher wave heights. Method 2 results for the other parameters differ from those for Method 1 but do not show any strong tendencies relative to the buoy data.

Storm evaluation

The above comparisons were supplemented by special evaluation of a recent storm that damaged a large segment of the US Atlantic coast in December 1992. The WISWAVE model was run with sufficient spin-up time to give valid wave estimates for the time period 10-14 December, which includes the most intense part of the storm. Data from the five buoys were obtained by special request to NDBC. Although comparisons were made for all of the buoys, only the two directional buoys are included in this report.

Data from buoy 44014 are compared to model results from Method 1 on the coarse grid and fine grid (Appendix I). Wave heights are higher on the fine grid and generally compare more favorably with buoy heights. A notable exception is day 4, on which the fine grid lead to overestimates of wave height. The buoy recorded a maximum wave height of about 8 m near the beginning of day 2. The model maxima are 5 m and 8 m for the coarse and fine grids, respectively. Thus the fine grid lead to a significantly better estimate of maximum significant height due to the storm.

Wave period estimates by Method 1 on the fine grid are generally superior to those on the coarse grid in comparison to buoy periods. Wave directions from both grids compare favorably with buoy data, with the coarse grid producing a better overall comparison. Wind speeds on the fine grid show a tendency to be higher than those on the coarse grid. The trend is particularly evident on day 2, where the fine grid gives a close estimate of peak wind speed but overestimates winds for the remainder of the day. Wind direction is estimated slightly better on the fine grid, relative to the buoy.

Measurements from buoy 44025 are compared with model results from Method 1 on the coarse and fine grids (Appendix J). As with buoy 44014, the fine grid produces higher wave heights and a better estimate of the peak storm significant height than the coarse grid. However the fine grid does not consistently give better predictions throughout the storm. Wave periods are generally similar on both grids and compare reasonably well with the buoy periods. Wave directions from both grids are similar and generally within

30 deg of the buoy wave direction. Wind speeds tend to be higher on the fine grid than the coarse grid and they compare favorably with buoy measurements. Wind directions from both grids are similar, but the overall comparison is less favorable.

The above storm comparisons were repeated using Method 2 to generate the winds. The stress-based results are also given in Appendices I and J. The *stress-based wave heights are generally higher than those from Method 1.* They produce large overestimates of the maximum significant height during the storm at both buoys. Period estimates by Method 2 are slightly less satisfactory than those by Method 1. Stress-based wave directions are comparable to those based on Method 1. The stress-based wind speeds are high relative to those from Method 1 and the buoys. Wind directions from Methods 1 and 2 are similar.

Although time series comparisons are helpful in evaluating model *performance, the CE is typically more concerned with climatological and* design parameters. The Navy wind products cannot be fully evaluated in this sense in the present study because of the small data sample. This type of evaluation must be carried out in a future effort to fully validate the use of Navy products in CE applications.

6 Conclusions and Recommendations

The NOAA and Navy operational wind forecasting models are generating information with sufficient detail and accuracy to be useful for at least some aspects of coastal/hydraulic wave and surge modelling. The products from these organizations can greatly reduce the time and cost involved in preparing wind information for driving hydrodynamic models. They also present the possibility of running hydrodynamic models in near real time, which may be desireable during severe storms. The full range of application of NOAA and Navy products should be explored in future hydrodynamic modeling efforts.

The CERC has established on-line access to detailed Navy wind products. Global wind information can be retrieved as desired. Procedures for interfacing Navy products with hydrodynamic models have also been developed, particularly for the wave model WISWAVE. Thus Navy wind products for a selected study area can be promptly and efficiently extracted for input to wave and surge models. Similar access to NOAA products is not feasible at present.

The access and interface capabilities for Navy products have been tested for two weather conditions, a calm sea state during September 1-5, 1992, and a severe storm during December 10-14, 1992. The procedures are working correctly and efficiently. As the structure and file system of the FNOC wind database change in the future, CERC's interface programs will need to be updated.

Preliminary evaluations of the Navy surface wind and surface stress in this and other recent CE studies indicate that both input options give reasonable wave estimates relative to buoy measurements. These products should be used routinely in future CE studies where appropriate. However they need to be evaluated over a much longer time period than that considered in this study to determine which products give the most reliable results.

It is strongly recommended that a systematic and comprehensive comparative study be conducted to investigate performance of the WISWAVE model using the Navy surface wind and surface stress products. It is also

recommended that the model performance be investigated in terms of effects of wind field variability in space and time.

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Appendix A
Navy IPOPS/PFCS Grids, Products, and Parameters

ID Numbers, Geometry Names and Descriptions

Table A1			
Current Grid Registered Geometry Descriptions[1]			
ID Number	**Geometry Name[2]**	**Description**	**Projection**
10[3]	global_73x144[3]	Global	spherical
11	north_hemsph_63x63	Northern Hemisphere	polar_stereo
12	south_hemsph_63x63	Southern Hemisphere	polar_stereo
13	north_hemsph_89x89	Northern Hemisphere	polar_stereo
14	south_hemsph_89x89	Southern Hemisphere	polar_stereo
15	north_hemsph_125x125	Northern Hemisphere	polar_stereo
16	south_hemsph_125x125	Southern Hemisphere	polar_stereo
17	global_49x144	Global	spherical
18	mediterranean_NOGAPS_63x63	Mediterranean	polar_stereo
21	mediterranean_63x63	Mediterranean	polar_stereo
22	indian_ocean_63x63	Indian Ocean	polar_stereo
23	west_atlantic_63x63	West Atlantic	polar_stereo
24	north_pole_63x63	North Pole	polar_stereo
30	gom_86x62	Gulf of Mexico	spherical
31	gulf_stream_150x100	Gulf Stream	spherical
32	arctic_basin_25x47	Arctic Basin	polar_stereo
33	barents_sea_66x74	Barents Sea	polar_stereo
34	gom_xsct_50x40	Gulf of Mexico Cross Section	dpth_xsect
40	tess_atln_32x32	TESS Atlantic	mercator
41	global_144x288	Global	spherical
42	persian_gulf_109x82	Persian Gulf	polar_stereo
43	Med_lambert_109x82	Mediterranean	lambert
52	gins_75x200	GIUK	spherical
57	nkur_100x150	N. Kuroshio	spherical
			(Continued)

[1] From data base tables grid_geom and grid_reg_geom
[2] Text string used an an input to SUBROUTINE GOPN
[3] Coarse grid used in this study

Table A1 (Concluded)

ID Number	Geometry Name	Description	Projection
62	mediterranean_WAM_38x100	Mediterranean	spherical
63	persian_gulf_109x82	Persian Gulf	spherical
64[*]	global_288x145[*]	Global	spherical
65	persian_gulf_lambert_109x72	Persian Gulf	lambert
68	gulf_stream_175x100	Gulf Stream	spherical
69	mediterranean_NORAPS_98x72	Mediterranean	spherical

[*] Fine grid used in this study

FNOC Catalog Number To Grid Parameter

Table A2 Selected Grid Parameters and FNOC Catalog Numbers[1]				
Catalog Number	**POPS Parameter Name[2]**	**Level Description**		
		Type	**Parameter #1[3]**	**Parameter #2[3]**
A01	pres_msl	msl	0.0 (N/A)	0.0 (N/A)
A07	air_temp	ht_sfc	2.0 (meters)	0.0 (N/A)
A10	air_temp	surface	0.0 (N/A)	0.0 (N/A)
A11	sol_rad	surface	0.0 (N/A)	0.0 (N/A)
A13	grnd_sea_temp	surface	0.0 (N/A)	0.0 (N/A)
A15	vpr_pres	surface	0.0 (N/A)	0.0 (N/A)
A16	snsb_heat_flux	surface	0.0 (N/A)	0.0 (N/A)
A18	ttl_heat_flux	surface	0.0 (N/A)	0.0 (N/A)
A27	wnd_spd	marn_lvl	0.0 (N/A)	0.0 (N/A)
A28	wnd_dir	marn_lvl	0.0 (N/A)	0.0 (N/A)
A29	wnd_ucmp	marn_lvl	0.0 (N/A)	0.0 (N/A)
A30	wnd_vcmp	marn_lvl	0.0 (N/A)	0.0 (N/A)
A35	wnd_spd	bdry_lay	0.0 (N/A)	0.0 (N/A)
A36	wnd_dir	bdry_lay	0.0 (N/A)	0.0 (N/A)
A52	ltnt_heat_flux	surface	0.0 (N/A)	0.0 (N/A)
A53	wnd_gust	ht_sfc	19.5 (meters)	0.0 (N/A)
A58	wnd_ucmp	ht_sfc	10.0 (meters)	0.0 (N/A)
A59	wnd_vcmp	ht_sfc	10.0 (meters)	0.0 (N/A)
A60	wnd_strs_ucmp	surface	0.0 (N/A)	0.0 (N/A)
A61	wnd_strs_vcmp	surface	0.0 (N/A)	0.0 (N/A)
A62	prcp	surface	0.0 (N/A)	0.0 (N/A)
AY1	oi_pres	msl	0.0 (N/A)	0.0 (N/A)

Sheet 1 of 3

[1] Selected parameters of possible CE interest are included; information is from data base tables xtn1_grd, grid_parm, and grid_lvl
[2] Used as input to SUBROUTINE GRD to specify desired fields to extract
[3] Used as input to SUBROUTINE GRD to specify level 1 and level 2

Table A2 (Continued)

Catalog Number	POPS Parameter Name[2]	Level Description		
		Type	Parameter #1[3]	Parameter #2[3]
B0F	vis_wav_ht	surface	0.0 (N/A)	0.0 (N/A)
B10	sea_temp	surface	0.0 (N/A)	0.0 (N/A)
B32	curr_ucmp	surface	0.0 (N/A)	0.0 (N/A)
B33	curr_vcmp	surface	0.0 (N/A)	0.0 (N/A)
B45	wnd_wav_ht	surface	0.0 (N/A)	0.0 (N/A)
B46	wnd_wav_per	surface	0.0 (N/A)	0.0 (N/A)
B47	wnd_wav_dir	surface	0.0 (N/A)	0.0 (N/A)
B50	sig_wav_ht	surface	0.0 (N/A)	0.0 (N/A)
B51	pr_wav_per	surface	0.0 (N/A)	0.0 (N/A)
B52	pr_wav_dir	surface	0.0 (N/A)	0.0 (N/A)
B53	sig_wav_ht	surface	0.0 (N/A)	0.0 (N/A)
B54	pr_wav_per	surface	0.0 (N/A)	0.0 (N/A)
B55	pr_wav_dir	surface	0.0 (N/A)	0.0 (N/A)
B56	scdy_wav_per	surface	0.0 (N/A)	0.0 (N/A)
B57	scdy_wav_dir	surface	0.0 (N/A)	0.0 (N/A)
B58	wcap_prbl	surface	0.0 (N/A)	0.0 (N/A)
B65	swl_ht	surface	0.0 (N/A)	0.0 (N/A)
B66	swl_per	surface	0.0 (N/A)	0.0 (N/A)
B67	swl_dir	surface	0.0 (N/A)	0.0 (N/A)
N68	curr_ucmp	surface	0.0 (N/A)	0.0 (N/A)
N69	curr_vcmp	surface	0.0 (N/A)	0.0 (N/A)

Sheet 2 of 3

Table A2 (Concluded)				
Catalog Number	POPS Parameter Name[2]	Level Description		
		Type	Parameter #1[3]	Parameter #2[3]
P00	ice_thkn	surface	0.0 (N/A)	0.0 (N/A)
P01	ice_cvrg	surface	0.0 (N/A)	0.0 (N/A)
P02	ice_vel_ucmp	surface	0.0 (N/A)	0.0 (N/A)
P03	ice_vel_vcmp	surface	0.0 (N/A)	0.0 (N/A)
P04	ice_div	surface	0.0 (N/A)	0.0 (N/A)
P05	ice_pres	surface	0.0 (N/A)	0.0 (N/A)
P06	ice_grth	surface	0.0 (N/A)	0.0 (N/A)
P30	dynamic_ht	surface	10.0 (meters)	0.0 (N/A)
PRS	pres	surface	0.0 (N/A)	0.0 (N/A)
Q10	sea_temp_anom	surface	0.0 (N/A)	0.0 (N/A)
				Sheet 3 of 3

Data Being Transferred

<table>
<tr><td colspan="8">Table A3
Data Fields and Grids Available for Transfer[1]</td></tr>
<tr><td rowspan="3">Field</td><td rowspan="3">Size</td><td rowspan="2">Range of Forecast Times hrs</td><td rowspan="2">Forecast Interval hrs</td><td colspan="2">00Z Forecast</td><td colspan="2">12Z Forecast</td></tr>
<tr><td>No. of Times</td><td>Total Points</td><td>No. of Times</td><td>Total Points</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td colspan="8">supergrid (288x145) geom_name=global_288x145</td></tr>
<tr><td>a01</td><td>41760</td><td>0-48</td><td>6</td><td>9</td><td>375840</td><td>0</td><td>0</td></tr>
<tr><td>a07</td><td>41760</td><td>0-48</td><td>6</td><td>9</td><td>375840</td><td>0</td><td>0</td></tr>
<tr><td>a11</td><td>41760</td><td>0-48</td><td>3</td><td>19</td><td>793440</td><td>0</td><td>0</td></tr>
<tr><td>a15</td><td>41760</td><td>0-48</td><td>6</td><td>9</td><td>375840</td><td>0</td><td>0</td></tr>
<tr><td>a16</td><td>41760</td><td>0-48</td><td>6</td><td>·9</td><td>375840</td><td>0</td><td>0</td></tr>
<tr><td>a18</td><td>41760</td><td>0-48</td><td>3</td><td>19</td><td>793440</td><td>0</td><td>0</td></tr>
<tr><td>a52</td><td>41760</td><td>0-48</td><td>3</td><td>19</td><td>793440</td><td>0</td><td>0</td></tr>
<tr><td>a58/59</td><td>41760</td><td>0-24</td><td>12</td><td>6</td><td>250560</td><td>6</td><td>250560</td></tr>
<tr><td>a60/61</td><td>41760</td><td>0-48</td><td>3</td><td>34</td><td>1419840</td><td>34</td><td>1419840</td></tr>
<tr><td>b32/33</td><td>41760</td><td>0</td><td>0</td><td>2</td><td>83520</td><td>0</td><td>0</td></tr>
<tr><td>p91</td><td>41760</td><td>0</td><td>0</td><td>1</td><td>41760</td><td>0</td><td>0</td></tr>
<tr><td colspan="8">spherical (73x144) geom_name=global_73x144</td></tr>
<tr><td>a01</td><td>10512</td><td>0</td><td>0</td><td>1</td><td>10512</td><td>1</td><td>10512</td></tr>
<tr><td>a07</td><td>10512</td><td>0</td><td>0</td><td>1</td><td>10512</td><td>1</td><td>10512</td></tr>
<tr><td>a11</td><td>10512</td><td>0-72</td><td>6</td><td>13</td><td>136656</td><td>13</td><td>136656</td></tr>
<tr><td>a15</td><td>10512</td><td>0</td><td>0</td><td>1</td><td>10512</td><td>1</td><td>10512</td></tr>
<tr><td>a16</td><td>10512</td><td>0</td><td>0</td><td>1</td><td>10512</td><td>1</td><td>10512</td></tr>
<tr><td>a18</td><td>10512</td><td>0-72</td><td>6</td><td>13</td><td>136656</td><td>13</td><td>136656</td></tr>
<tr><td>a29/30</td><td>10512</td><td>0-72</td><td>6</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>a52</td><td>10512</td><td>0-72</td><td>6</td><td>13</td><td>136656</td><td>13</td><td>136656</td></tr>
<tr><td>a58/59</td><td>10512</td><td>0-72</td><td>6</td><td>26</td><td>273312</td><td>26</td><td>273312</td></tr>
<tr><td>a60/61</td><td>10512</td><td>0</td><td>0</td><td>2</td><td>21024</td><td>2</td><td>21024</td></tr>
<tr><td>b10</td><td>10512</td><td>0</td><td>0</td><td>1</td><td>10512</td><td>1</td><td>10512</td></tr>
<tr><td colspan="8" align="right">Sheet 1 of 4</td></tr>
<tr><td colspan="8">[1] Only grids likely to be of CE interest are listed; total size of one file (all grids) is 14246697 for 00Z forecast and 4008042 for 12Z forecast</td></tr>
</table>

Table A3 (Continued)

Field	Size	Range of Forecast Times hrs	Forecast Interval hrs	00Z Forecast		12Z Forecast	
				No. of Times	Total Points	No. of Times	Total Points
spherical (73x144) geom_name=global_73x144 (continued)							
c12	10512	0	0	1	10512	1	10512
d00/20/21	10512	0	0	3	31536	3	31536
d10	10512	0	0	1	10512	1	10512
d12	10512	0	0	1	10512	1	10512
e00/20/21	10512	0	0	3	31536	3	31536
e10	10512	0	0	1	10512	1	10512
e12	10512	0	0	1	10512	1	10512
f00/20/21	10512	0	0	3	31536	3	31536
f10	10512	0	0	1	10512	1	10512
f12	10512	0	0	1	10512	1	10512
g00/20/21	10512	0	0	3	31536	3	31536
g10	10512	0	0	1	10512	1	10512
g12	10512	0	0	1	10512	1	10512
h00/20/21	10512	0	0	3	31536	3	31536
h10	10512	0	0	1	10512	1	10512
h12	10512	0	0	1	10512	1	10512
i00/20/21	10512	0	0	3	31536	3	31536
i10	10512	0	0	1	10512	1	10512
j00/20/21	10512	0	0	3	31536	3	31536
j10	10512	0	0	1	10512	1	10512
k00/20/21	10512	0	0	3	31536	3	31536
k10	10512	0	0	1	10512	1	10512
l00/20/21	10512	0	0	3	31536	3	31536
l10	10512	0	0	1	10512	1	10512

Sheet 2 of 4

Table A3 (Continued)

Field	Size	Range of Forecast Times hrs	Fore-cast Interval hrs	00Z Forecast		12Z Forecast	
				No. of Times	Total Points	No. of Times	Total Points
spherical (73x144) geom_name=global_73x144 (continued)							
l40/41/42	10512	0	0	3	31536	3	31536
l90/91/92	10512	0	0	3	31536	3	31536
m00/m20/ m21	10512	0	0	3	31536	3	31536
m10	10512	0	0	1	10512	1	10512
n00/20/21	10512	0	0	3	31536	3	31536
d10	10512	0	0	1	10512	1	10512
r00/20/21	10512	0	0	3	31536	3	31536
r10	10512	0	0	1	10512	1	10512
r12	10512	0	0	1	10512	1	10512
t00/20/21	10512	0	0	3	31536	3	31536
med wam (100x38) geom_name=mediterranean_WAM_38x100							
b50	3800	0-48	12	5	19000	5	19000
b51	3800	0-48	12	5	19000	5	19000
b52	3800	0-48	12	5	19000	5	19000
pg noraps (109x82) geom_name=persian_gulf_109x82							
a01	8958	0-48	6	9	80622	9	80622
a07	8958	0-48	6	9	80622	9	80622
a15	8958	0-48	6	9	80622	9	80622
a16	8958	6-48	6	8	71664	8	71664
a18	8958	6-48	6	8	71664	8	71664
a52	8958	6-48	6	8	71664	8	71664
a58/59	8958	0-48	6	18	161244	18	161244
a60/61	8958	0-48	6	18	161244	18	161244
a62	8958	6-48	6	8	71664	8	71664

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Table A3 (Concluded)

Field	Size	Range of Forecast Times hrs	Forecast Interval hrs	00Z Forecast		12Z Forecast	
				No. of Times	Total Points	No. of Times	Total Points
med noraps (98x72) geom_name=mediterranean_NORAPS_98x72							
a01	7056	0-48	6	9	63504	9	63504
a07	7056	0-48	6	9	63504	9	63504
a15	7056	0-48	6	9	63504	9	63504
a16	7056	6-48	6	8	56448	8	56448
a18	7056	6-48	6	8	56448	8	56448
a52	7056	6-48	6	8	56448	8	56448
a58/59	7056	0-48	6	18	127008	18	127008
a60/61	7056	0-48	6	18	127008	18	127008
a62	7056	6-48	6	8	56448	8	56448

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Example ipopsident Output

Parameter Name	Geometry ID Number	Level Parameters		Date	Hour	Forecast Time	Length
		LVL1	LVL2				

Table A4
Example of Information in ipopsident File[1]

Parameter Name	Geometry ID Number	LVL1	LVL2	Date	Hour	Forecast Time	Length
air_temp	10	1000	0.0	19920902	12	0	10512
air_temp_ht_sfc	10	2	0.0	19920902	12	0	10512
geop_ht	10	10	0.0	19920902	12	0	10512
geop_ht	10	10	0.0	19920902	12	12	10512
geop_ht	10	20	0.0	19920902	12	0	10512
geop_ht	10	20	0.0	19920902	12	12	10512
geop_ht	10	30	0.0	19920902	12	0	10512
geop_ht	10	30	0.0	19920902	12	12	10512
geop_ht	10	50	0.0	19920902	12	0	10512
geop_ht	10	50	0.0	19920902	12	12	10512
geop_ht	10	70	0.0	19920902	12	0	10512
geop_ht	10	70	0.0	19920902	12	12	10512
geop_ht	10	100	0.0	19920902	12	0	10512
geop_ht	10	100	0.0	19920902	12	12	10512
geop_ht	10	150	0.0	19920902	12	0	10512
geop_ht	10	150	0.0	19920902	12	12	10512
geop_ht	10	200	0.0	19920902	12	0	10512
geop_ht	10	200	0.0	19920902	12	12	10512
geop_ht	10	250	0.0	19920902	12	0	10512
geop_ht	10	250	0.0	19920902	12	12	10512
geop_ht	10	300	0.0	19920902	12	0	10512
geop_ht	10	300	0.0	19920902	12	12	10512
geop_ht	10	400	0.0	19920902	12	0	10512
geop_ht	10	400	0.0	19920902	12	12	10512

Sheet 1 of 8

[1] For brevity, information from only grids #10 and #64 is shown; information was obtained from file /u/a/ipops/fnoc1992090212

| Parameter Name | Geom. ID Number | Level Parameters | | Date | Hour | Fore-cast Time | Length |
		LVL1	LVL2				
geop_ht	10	500	0.0	19920902	12	0	10512
geop_ht	10	500	0.0	19920902	12	12	10512
geop_ht	10	700	0.0	19920902	12	0	10512
geop_ht	10	700	0.0	19920902	12	12	10512
geop_ht	10	850	0.0	19920902	12	0	10512
geop_ht	10	850	0.0	19920902	12	12	10512
geop_ht	10	925	0.0	19920902	12	0	10512
geop_ht	10	925	0.0	19920902	12	12	10512
geop_ht	10	1000	0.0	19920902	12	0	10512
geop_ht	10	1000	0.0	19920902	12	12	10512
ltnt_heat_flux	10	0	0.0	19920902	12	0	10512
ltnt_heat_flux	10	0	0.0	19920902	12	6	10512
ltnt_heat_flux	10	0	0.0	19920902	12	12	10512
ltnt_heat_flux	10	0	0.0	19920902	12	18	10512
ltnt_heat_flux	10	0	0.0	19920902	12	24	10512
ltnt_heat_flux	10	0	0.0	19920902	12	30	10512
ltnt_heat_flux	10	0	0.0	19920902	12	36	10512
ltnt_heat_flux	10	0	0.0	19920902	12	42	10512
ltnt_heat_flux	10	0	0.0	19920902	12	48	10512
ltnt_heat_flux	10	0	0.0	19920902	12	54	10512
ltnt_heat_flux	10	0	0.0	19920902	12	60	10512
ltnt_heat_flux	10	0	0.0	19920902	12	66	10512
ltnt_heat_flux	10	0	0.0	19920902	12	72	10512
pr_wav_dir	10	0	0.0	19920902	12	0	10512
pr_wav_per	10	0	0.0	19920902	12	0	10512
pres_msl	10	0	0.0	19920902	12	0	10512
pres_msl	10	0	0.0	19920902	12	12	10512

Sheet 2 of 8

Table A4 (Continued)							

Parameter Name	Geom. ID Number	Level Parameters		Date	Hour	Fore-cast Time	Length
		LVL1	LVL2				
sig_wav_ht	10	0	0.0	19920902	12	0	10512
snsb_heat_flux	10	0	0.0	19920902	12	0	10512
sol_rad	10	0	0.0	19920902	12	0	10512
sol_rad	10	0	0.0	19920902	12	6	10512
sol_rad	10	0	0.0	19920902	12	12	10512
sol_rad	10	0	0.0	19920902	12	18	10512
sol_rad	10	0	0.0	19920902	12	24	10512
sol_rad	10	0	0.0	19920902	12	30	10512
sol_rad	10	0	0.0	19920902	12	36	10512
sol_rad	10	0	0.0	19920902	12	42	10512
sol_rad	10	0	0.0	19920902	12	48	10512
sol_rad	10	0	0.0	19920902	12	54	10512
sol_rad	10	0	0.0	19920902	12	60	10512
sol_rad	10	0	0.0	19920902	12	66	10512
sol_rad	10	0	0.0	19920902	12	72	10512
ttl_heat_flux	10	0	0.0	19920902	12	0	10512
ttl_heat_flux	10	0	0.0	19920902	12	6	10512
ttl_heat_flux	10	0	0.0	19920902	12	12	10512
ttl_heat_flux	10	0	0.0	19920902	12	18	10512
ttl_heat_flux	10	0	0.0	19920902	12	24	10512
ttl_heat_flux	10	0	0.0	19920902	12	30	10512
ttl_heat_flux	10	0	0.0	19920902	12	36	10512
ttl_heat_flux	10	0	0.0	19920902	12	42	10512
ttl_heat_flux	10	0	0.0	19920902	12	48	10512
ttl_heat_flux	10	0	0.0	19920902	12	54	10512
ttl_heat_flux	10	0	0.0	19920902	12	60	10512
ttl_heat_flux	10	0	0.0	19920902	12	66	10512
ttl_heat_flux	10	0	0.0	19920902	12	72	10512

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Table A4 (Continued)

Parameter Name	Geom. ID Number	Level Parameters		Date	Hr.	Fore-cast Time	Length
		LVL1	LVL2				
vpr_pres	10	0	0.0	19920902	12	0	10512
wind_strs_ucmp	10	0	0.0	19920902	12	0	10512
wnd_strs_ucmp	64	0	0.0	19920902	12	0	41760
wnd_strs_ucmp	64	0	0.0	19920902	12	3	41760
wnd_strs_ucmp	64	0	0.0	19920902	12	6	41760
wnd_strs_ucmp	64	0	0.0	19920902	12	9	41760
wnd_strs_ucmp	64	0	0.0	19920902	12	12	41760
wnd_strs_ucmp	64	0	0.0	19920902	12	15	41760
wnd_strs_ucmp	64	0	0.0	19920902	12	18	41760
wnd_strs_ucmp	64	0	0.0	19920902	12	21	41760
wnd_strs_ucmp	64	0	0.0	19920902	12	24	41760
wnd_strs_ucmp	64	0	0.0	19920902	12	27	41760
wnd_strs_ucmp	64	0	0.0	19920902	12	30	41760
wnd_strs_ucmp	64	0	0.0	19920902	12	33	41760
wnd_strs_ucmp	64	0	0.0	19920902	12	36	41760
wnd_strs_ucmp	64	0	0.0	19920902	12	39	41760
wnd_strs_ucmp	64	0	0.0	19920902	12	42	41760
wnd_strs_ucmp	64	0	0.0	19920902	12	45	41760
wnd_strs_ucmp	64	0	0.0	19920902	12	48	41760
wnd_strs_vcmp	10	0	0.0	19920902	12	0	10512
wnd_strs_vcmp	64	0	0.0	19920902	12	0	41760
wnd_strs_vcmp	64	0	0.0	19920902	12	3	41760
wnd_strs_vcmp	64	0	0.0	19920902	12	6	41760
wnd_strs_vcmp	64	0	0.0	19920902	12	9	41760
wnd_strs_vcmp	64	0	0.0	19920902	12	12	41760
wnd_strs_vcmp	64	0	0.0	19920902	12	15	41760

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Table A4 (Continued)

Parameter Name	Geom. ID Number	Level Parameters		Date	Hr.	Fore-cast Time	Length
		LVL1	LVL2				
wnd_strs_vcmp	64	0	0.0	19920902	12	18	41760
wnd_strs_vcmp	64	0	0.0	19920902	12	21	41760
wnd_strs_vcmp	64	0	0.0	19920902	12	24	41760
wnd_strs_vcmp	64	0	0.0	19920902	12	27	41760
wnd_strs_vcmp	64	0	0.0	19920902	12	30	41760
wnd_strs_vcmp	64	0	0.0	19920902	12	33	41760
wnd_strs_vcmp	64	0	0.0	19920902	12	36	41760
wnd_strs_vcmp	64	0	0.0	19920902	12	39	41760
wnd_strs_vcmp	64	0	0.0	19920902	12	42	41760
wnd_strs_vcmp	64	0	0.0	19920902	12	45	41760
wnd_strs_vcmp	64	0	0.0	19920902	12	48	41760
wnd_ucmp	10	20	0.0	19920902	12	0	10512
wnd_ucmp	10	20	0.0	19920902	12	12	10512
wnd_ucmp	10	30	0.0	19920902	12	0	10512
wnd_ucmp	10	30	0.0	19920902	12	12	10512
wnd_ucmp	10	50	0.0	19920902	12	0	10512
wnd_ucmp	10	50	0 0	19920902	12	12	10512
wnd_ucmp	10	70	0.0	19920902	12	0	10512
wnd_ucmp	10	70	0.0	19920902	12	12	10512
wnd_ucmp	10	100	0.0	19920902	12	0	10512
wnd_ucmp	10	100	0.0	19920902	12	12	10512
wnd_ucmp	10	150	0.0	19920902	12	0	10512
wnd_ucmp	10	150	0.0	19920902	12	12	10512
wnd_ucmp	10	200	0.0	19920902	12	0	10512
wnd_ucmp	10	200	0.0	19920902	12	12	10512
wnd_ucmp	10	250	0.0	19920902	12	0	10512
wnd_ucmp	10	250	0.0	19920902	12	12	10512

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Table A4 (Continued)

| Parameter Name | Geom. ID Num. | Level Parameters | | Date | Hr | Fore- cast Time | Length |
		LVL1	LVL2				
wnd_ucmp	10	300	0.0	19920902	12	0	10512
wnd_ucmp	10	300	0.0	19920902	12	12	10512
wnd_ucmp	10	400	0.0	19920902	12	0	10512
wnd_ucmp	10	400	0.0	19920902	12	12	10512
wnd_ucmp	10	500	0.0	19920902	12	0	10512
wnd_ucmp	10	500	0.0	19920902	12	12	10512
wnd_ucmp	10	700	0.0	19920902	12	0	10512
wnd_ucmp	10	700	0.0	19920902	12	12	10512
wnd_ucmp	10	850	0.0	19920902	12	0	10512
wnd_ucmp	10	850	0.0	19920902	12	12	10512
wnd_ucmp	10	925	0.0	19920902	12	0	10512
wnd_ucmp	10	925	0.0	19920902	12	12	10512
wnd_ucmp	10	1000	0.0	19920902	12	0	10512
wnd_ucmp	10	1000	0.0	19920902	12	12	10512
wnd_ucmp_ht_sfc	10	10	0.0	19920902	12	0	10512
wnd_ucmp_ht_sfc	10	10	0.0	19920902	12	6	10512
wnd_ucmp_ht_sfc	10	10	0.0	19920902	12	12	10512
wnd_ucmp_ht_sfc	10	10	0.0	19920902	12	18	10512
wnd_ucmp_ht_sfc	10	10	0.0	19920902	12	24	10512
wnd_ucmp_ht_sfc	10	10	0.0	19920902	12	30	10512
wnd_ucmp_ht_sfc	10	10	0.0	19920902	12	36	10512
wnd_ucmp_ht_sfc	10	10	0.0	19920902	12	42	10512
wnd_ucmp_ht_sfc	10	10	0.0	19920902	12	48	10512
wnd_ucmp_ht_sfc	10	10	0.0	19920902	12	54	10512
wnd_ucmp_ht_sfc	10	10	0.0	19920902	12	60	10512
wnd_ucmp_ht_sfc	10	10	0.0	19920902	12	66	10512
wnd_ucmp_ht_sfc	10	10	0.0	19920902	12	72	10512

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Table A4 (Continued)

Parameter Name	Geom. ID Num.	Level Parameters		Date	Hr	Fore-cast Time	Length
		LVL1	LVL2				
wnd_ucmp_ht_sfc	64	10	0.0	19920902	12	0	41760
wnd_ucmp_ht_sfc	64	10	0.0	19920902	12	12	41760
wnd_ucmp_ht_sfc	64	10	0.0	19920902	12	24	41760
wnd_ucmp_isbr_lvl	10	10	0.0	19920902	12	0	10512
wnd_ucmp_isbr_lvl	10	10	0.0	19920902	12	12	10512
wnd_vcmp	10	20	0.0	19920902	12	0	10512
wnd_vcmp	10	20	0.0	19920902	12	12	10512
wnd_vcmp	10	30	0.0	19920902	12	0	10512
wnd_vcmp	10	30	0.0	19920902	12	12	10512
wnd_vcmp	10	50	0.0	19920902	12	0	10512
wnd_vcmp	10	50	0.0	19920902	12	12	10512
wnd_vcmp	10	70	0.0	19920902	12	0	10512
wnd_vcmp	10	70	0.0	19920902	12	12	10512
wnd_vcmp	10	100	0.0	19920902	12	0	10512
wnd_vcmp	10	100	0.0	19920902	12	12	10512
wnd_vcmp	10	150	0.0	19920902	12	0	10512
wnd_vcmp	10	150	0.0	19920902	12	12	10512
wnd_vcmp	10	200	0.0	19920902	12	0	10512
wnd_vcmp	10	200	0.0	19920902	12	12	10512
wnd_vcmp	10	250	0.0	19920902	12	0	10512
wnd_vcmp	10	250	0.0	19920902	12	12	10512
wnd_vcmp	10	300	0.0	19920902	12	0	10512
wnd_vcmp	10	300	0.0	19920902	12	12	10512
wnd_vcmp	10	400	0.0	19920902	12	0	10512
wnd_vcmp	10	400	0.0	19920902	12	12	10512
wnd_vcmp	10	500	0.0	19920902	12	0	10512
wnd_vcmp	10	500	0.0	19920902	12	12	10512

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Table A4 (Concluded)

Parameter Name	Geom. ID Num.	Level Parameters		Date	Hr	Fore- cast Time	Length
		LVL1	LVL2				
wnd_vcmp	10	700	0.0	19920902	12	0	10512
wnd_vcmp	10	700	0.0	19920902	12	12	10512
wnd_vcmp	10	850	0.0	19920902	12	0	10512
wnd_vcmp	10	850	0.0	19920902	12	12	10512
wnd_vcmp	10	925	0.0	19920902	12	0	10512
wnd_vcmp	10	925	0.0	19920902	12	12	10512
wnd_vcmp	10	1000	0.0	19920902	12	0	10512
wnd_vcmp	10	1000	0.0	19920902	12	12	10512
wnd_vcmp_ht_sfc	10	10	0.0	19920902	12	0	10512
wnd_vcmp_ht_sfc	10	10	0.0	19920902	12	6	10512
wnd_vcmp_ht_sfc	10	10	0.0	19920902	12	12	10512
wnd_vcmp_ht_sfc	10	10	0.0	19920902	12	18	10512
wnd_vcmp_ht_sfc	10	10	0.0	19920902	12	24	10512
wnd_vcmp_ht_sfc	10	10	0.0	19920902	12	30	10512
wnd_vcmp_ht_sfc	10	10	0.0	19920902	12	36	10512
wnd_vcmp_ht_sfc	10	10	0.0	19920902	12	42	10512
wnd_vcmp_ht_sfc	10	10	0.0	19920902	12	48	10512
wnd_vcmp_ht_sfc	10	10	0.0	19920902	12	54	10512
wnd_vcmp_ht_sfc	10	10	0.0	19920902	12	60	10512
wnd_vcmp_ht_sfc	10	10	0.0	19920902	12	66	10512
wnd_vcmp_ht_sfc	10	10	0.0	19920902	12	72	10512
wnd_vcmp_ht_sfc	64	10	0.0	19920902	12	0	41760
wnd_vcmp_ht_sfc	64	10	0.0	19920902	12	12	41760
wnd_vcmp_ht_sfc	64	10	0.0	19920902	12	24	41760
wnd_vcmp_isbr_lvl	10	10	0.0	19920902	12	0	10512
wnd_vcmp_isbr_lvl	10	10	0.0	19920902	12	12	10512

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Appendix B
Extracting Surface Wind Products from IPOPS

This appendix contains detailed information about the procedures needed to access IPOPS and create a file of global information over a user-selected time period. The discussion of procedures is followed by a listing of the required fortran program **extwind.f.**

As part of this research project, CERC established a link to POPS through the Internet network. A user account on the LSC was accessed using the **telnet** command from a Unix workstation at CERC. There are three POPS subsystems available at SSC for IPOPS access, the SPOP (Sun frontend), the POPS (Sun frontend) and the LSC (Cray). For this project, all access to IPOPS was performed on the LSC.

The IPOPS fields for each FNOC 12-hr watch are available on the PFCS in a single random file. Files may be accessed using a path/file name in the following format:

> /u/a/ipops/fnocyyyymmddhh

where yyyymmddhh represents the year, month, day, and hour (00Z or 12Z) of the watch on which the fields were produced. The IPOPS subroutines reside on the following libraries:

> Sun: /u/a/ipops/sun/libvio.a
> Cray: /u/a/ipops/cray/libvio.a

The compilation/load statement to access this library includes the following parameters on the f77(Sun) or cf77(Cray) statements:

> f77 .... -lvio -L/u/a/ipops/sun ...
> cf77 .... -lvio -L/u/a/ipops/cray ...

This library will access IPOPS data files created between 23 June 1992 and the present. IPOPS data files exist prior to this date but they may contain errors and should not be used.

Grid data arrays must be in single precision floating point format. Data are stored on disk in 32-bit IEEE (SUN) format. The Cray IPOPS routines will automatically convert between this format and the Cray format. Only read access will be available to the general user of FNOC IPOPS files. Both reads and writes may be done to files which the user creates with IPOPS routines. Some parameters in the IPOPS subroutines are modified or ignored. Parameters are described in the discussion of each IPOPS subroutine below.

Subroutine Description

This section describes the IPOPS subroutines, GOPN and GRD, and their parameters. DBSTART should be called once in the program before calling any other IPOPS routines. DBSTOP should be called before exiting the user program. These subroutines are provided for compatibility with the POPS DB Prototype.

GOPN opens the IPOPS Data file to read or write a grid. This subroutine must be called for each IPOPS file to be accessed. Up to 20 IPOPS files can be opened simultaneously. In order to read a different geometry type from a file already open, GOPN must be called again with the new type. GOPN uses Fortran Unit Numbers beginning with 51 and incrementing up to a maximum of 70. The subroutine call to GOPN contains the following parameters:

        CALL GOPN (MDLTYPE, GEOMNM, DSETNM, OPNMODE,
    &   GRDHNDL, GEOM, PCKNULL, STATUS)

The parameters used in the call to GOPN are defined in the following list.
Parameters:

Variable	Description	Type/Size	Reference
MDLTYPE	Unused	CHARACTER*20	
GEOMNM	Grid Geometry Name	CHARACTER*30	Table A1
DSETNM	Data file with path	CHARACTER*50	
OPNMODE	'R' for read only 'R/W' for read/write		
GRDHNDL	Return argument: set to a value, must be passed to GRD &GWR	INTEGER	

GEOM	Unused	INTEGER*4

PCKNULL	Return argument: Database NULL value	REAL

STATUS	Return argument:	INTEGER

STATUS
0 = normal return, successful completion
< 0 = abnormal return, error occurred
> 0 = special return information, no error

If multiple IPOPS files are opened simultaneously, the appropriate GRDHNDL parameter value returned from GOPN for subsequent GWR and GRD calls must be used. The GRDHNDL value tells GWR and GRD which of the files opened is to be accessed on that call. Table A1 in Appendix A shows a list of grids available. The column labled "GEOMETRY NAME" contains the text string used as the input argument GEOMNM in SUBROUTINE GOPN.

GRD reads a grid field. The subroutine call to GRD contains the following parameters:

```
CALL GRD (GRDHNDL, VRSNNM, PARMNM, LVLTYPE, LVL1,
&        LVL2, DATE, HOUR, FCSTPER, FBUFF, UNITS, STATUS)
```

Parameters used in the call to GRD are defined in the following list:

Variable	Description	Type/Size	Reference
GRDHNDL	Value from GOPN	INTEGER	
PARMNM	Name of the field to extract	CHARACTER*30	Table A2
LVLTYPE	Unused	CHARACTER*20	
LVL1	Level 1 Value	REAL	Table A2
LVL2	Level 2 Value	REAL	Table A2
DATE	Year, Month, Day	INTEGER Array DIMENSION (3)	
HOUR	Hour of the day	DOUBLE PRECISION	
FCSTPER	Forecast period	DOUBLE PRECISION	
VRSNNM	Unused	CHARACTER*20	

FBUFF	Return argument:	REAL Array
	Array to receive	DIMENSION (?)
	grid data	

| UNITS | Unused | INTEGER |

| STATUS | Return argument: | INTEGER |

STATUS
0 = successful read
100 = no more fields to read
-1 = failure to read

Table A2 in Appendix A shows a list of grid parameters by FNOC Catalog Number. The column labeled "POPS PARAMETER NAME" contains the text string for PARMNM, the name of the field to extract, which is input into SUBROUTINE GRD. The columns labeled "LEVEL DESCRIPTION - PARAMETER #1" and "LEVEL DESCRIPTION - PARAMETER #2" contain the numbers input into SUBROUTINE GRD as level 1 (LVL1) and level 2 (LVL2) numbers.

IPOPSID

There are two routines to list key identification information on all fields contained within a particular IPOPS file. The script, **ipopsid**, lists fields in the order that they were written into the file. The script, **ipopsident**, lists fields sorted alphabetically with the parameter name as the primary key. Both routines reside in the directory **/u/a/ipops/xxx** where **xxx** equals "sun" or "cray" depending on which system the user is using for execution. The following statements show usage of the routines on the LSC from the **/u/a/ipops/cray** directory:

   <LSC> **ipopsid /u/a/ipops/fnocyyyymmddhh**
   <LSC> **ipopsident /u/a/ipops/fnocyyyymmddhh**

A sample of an **ipopsident** output table is located in Appendix A (Table A4). The table contains parameter name and values for GEOM, the geometry (grid) ID number also listed in Table 1A, LVL1, LVL2, DATE, HOUR, FCST, forecast period, and LENGTH, the number of points in the grid.

Program Usage

In order to automate the process of retrieving wind data from IPOPS, a fortran program containing IPOPS subroutine calls discussed previously, provided by IPOPS personnel, was modified. The new program extracts multiple wind fields, given a user defined time increment, from the supergrid or regular grid. By editing the parameter statement and several other lines of the fortran program **extwind.f**, 10 meter winds (A58/A59) or wind stresses (A60/A61)

from either grid may be extracted for any time period. A complete listing of **extwind.f** is given later.

Parameters used in the IPOPS subroutine calls which require editing are located near the beginning of the program in a designated section. Key parameters are defined in comment statements. The PARAMETER statement, in which a number of key parameter values are specified, has the form

```
      PARAMETER (NC=288,NR=145,DATE1=1992,DATE2=12,
     1      IDAY1,IDAY2,ITAU1=0,ITAU2=9,ITAUINC=3,
     2      igr=2,ifl=1)
```

The parameters are defined in the program listing later in this appendix. The values used in this example are typical for this study. The PARAMETER statement would need to be corrected as needed every time the program **extwind.f** is to be run.

Because the regular grid and the supergrid are stored so that the indexes that represent latitude and longitude are switched, two alternative dimension statements are given in the form:

```
c This statement is used for 1.25 deg. grids
      REAL  UWND(NC,NR),VWND(NC,NR),LVL1,LVL2,PCKNULL
c This statement is used for 2.5 deg. grids
c     REAL  UWND(NR,NC),VWND(NR,NC),LVL1,LVL2,PCKNULL
```

The choice shown is the supergrid. To select the regular grid, the fortran comment character "c" must be added at the beginning of the second line above and deleted at the beginning of the last line.

The following example script file shows how to compile the fortran program, linking the IPOPS libraries, and run the resulting executable file. Note that the U-component is written to fortran unit 71 and the V-component is written to fortran unit 72.

```
# QSUB -eo
# QSUB -x
set -Svx
ja
cd $TMPDIR
cf77 -o extwind $HOME/extwind.f -lvio -L/u/a/ipops/cray
extwind
mv fort.71 /src/pops/a60s1201.g
mv fort.72 /src/pops/a61s1201.g
rm extwind
rm extwind.o
ja -st
```

The script file **extwind.c** and the fortran program **extwind.f** may be copied from the directory **/u3/h2crosb0/ipops** on the Cray at the Waterways Experiment Station. The output data files can be transferred from the LSC to a local computer (Cray or Unix workstation) using the **ftp** command.

Listing of Program extwind.f

```
c  program extwind.f            Steven Bratos, December 1992
c
c
c
c  Program extracts FNOC wind products from the IPOPS database on
c  the Large Scale Computer (PFCS) located at NAVOEANO, Stennis
c  Space Center, MS.  This must run on the LSC in order to access
c  the IPOPS database.
c
c  This code is designed to extract U-V components of 10-meter wind
c  fields (A58/A59) or surface wind stress (A60/A61) from either
c  the global_73x144 (2.5 deg.) grid or the global_288x145 (1.25 deg)
c  grid.
c
c  Parameter Definition
c..........................................
c              NC = grid dimension
c              NR = grid dimension
c            DATE1 = year  (example: 1992)
c            DATE2 = month (1,12)
c            IDAY1 = beginning day (1,31)
c            IDAY2 = ending day (1,31)
c            ITAU1 = beginning forecast hour (0)
c            ITAU2 = ending forecast hour (0,6,9)
c          ITAUINC = increment forecast hour (0,3,6)
c            igr = grid flag
c               = 1 : global_73x144 (2.5 deg)
c               = 2 : global_288x145 (1.25 deg)
c            ifl = field flag
c               = 1 : wind stress
c               = 2 : 10 meter wind
c
c  (See IPOPS documentation for a list of following parameters)
c            GEOMNM = geometry name (example: global_73x144)
c            LVL1 = level 1 value
c               = 10.0  for 10 meter wind
c               =  0.0  for stress
c          PARMNM1 = name of u-component field to extract
c          PARMNM2 = name of v-component field to extract
c              For 10 meter winds
c               PARMNM1='wnd_ucmp_ht_sfc'
c               PARMNM2='wnd_vcmp_ht_sfc'
c              For wind stress
c               PARMNM1='wnd_strs_ucmp'
c               PARMNM2='wnd_strs_vcmp'
c ......................................
c  GRID Parameters
```

```
c  global_73x144  :   NC=144,NR=73 ,igr=1
c  global_288x145 :   NC=288,NR=144,igr=2

c**********ALL REQUIRED EDITING DONE IN THIS ᶜECTION ****

      PARAMETER (NC=288,NR=145,DATE1=1992,DATE2=12,IDAY1,
     1          IDAY2,ITAU1=0,ITAU2=9,ITAUINC=3.igr=2,ifl=1)

      CHARACTER*20  LVLTYPE,MDLTYPE,VRSNNM
      CHARACTER*50  DSETNM
      CHARACTER*30  PARMNM1,PARMNM2,GEOMNM,UNITS
      CHARACTER*4   OPNMODE
      CHARACTER CDATE*10,aday*2,ahr1*1,ahr2*2,am*2
      CHARACTER leadz*1,ada1*1,ada2*2,ah*2,EDATE2*1,FDATE2*2
      INTEGER GRDHNDL,DATE(3),STOPN,STRD,GEOM,DATE1,DATE2
      DOUBLE PRECISION HOUR,TAU

c  This statement is used for 1.25 deg. grids
      REAL   UWND(NC,NR),VWND(NC,NR),LVL1,LVL2,PCKNULL
c  This statement is used for 2.5 deg. grids
c     REAL   UWND(NR,NC),VWND(NC,NR),LVL1,LVL2,PCKNULL
c  Select parameters GEOMNM,LVLTYPE,LVL1,PARMNM1,PARMNM2

      GEOMNM  = 'global_288x145'
      LVL1    = 0.0
      PARMNM1 = 'wnd_strs_ucmp'
      PARMNM2 = 'wnd_strs_vcmp'
c*******************************************************************

      leadz='0'
      LVLTYPE ='ht_sfc'
      MDLTYPE = ' '
      VRSNNM  = ' '
      OPNMODE = 'R'
      LVL2    = 0.0
      DATE(1)= DATE1
      DATE(2)= DATE2

608   format(i2)
508   format(i1)
      encode(4,408,FDATE1) DATE1
      if(DATE2 .lt. 10 ) then
      encode(1,508,EDATE2) DATE2
      am = leadz//EDATE2
      else
      encode(2,608,FDATE2) DATE2
      am = FDATE2
      end if
```

```
          DO 801 iday=IDAY1,IDAY2
          DO 800 ih=1,2
                ihh= 12 * (ih-1)
          DATE(3) = real(iday)
          HOUR    = real(ihh)
            if( iday .lt. 10 ) then
               encode(1,508,ada1) iday
               aday = leadz//ada1
            else
               encode(2,608,ada2) iday
               aday = ada2
            end if
            if( ihh .lt. 10) then
               encode(1,508,ahr1) ihh
               ah = leadz//ahr1
            else
               encode(2,608,ahr2) ihh
               ah = ahr2
            end if


          cdate = FDATE1//am//aday//ah


          DSETNM = '/u/a/ipops/fnoc'//cdate


          CALL DBSTART
c.......Open DB file
          CALL GOPN(MDLTYPE, GEOMNM, DSETNM, OPNMODE,
          &       GRDHNDL, GEOM, PCKNULL, STOPN)
c.......Loop for each forecast time "itau"
          DO 300 itau=ITAU1,ITAU2,ITAUINC
            tau=real(itau)
c.........Write date & itau to output files
            write(71,'(a10,i4)') cdate,itau
            write(72,'(a10,i4)') cdate,itau
c........Read specified field/grid into UWND
          CALL GRD(GRDHNDL, VRSNNM, PARMNM1, LVLTYPE, LVL1,
          &       LVL2, DATE, HOUR, tau, UWND, UNITS, STRD)


c ............. CKECK STATUS ..............................
c
      print *,  'open',stopn, '   read',strd


c-------- WRITE UWND  to  fortran unit 71 -------------------
          IF( igr .eq. 1) then
          IF( ifl .eq. 1) then
          WRITE (71,'(12f7.4)') ((UWND(i,j),j=1,NC),i=1,NR)
          ELSE IF ( ifl .eq. 2) then
          WRITE (71,'(1x,10f9.2)') ((UWND(i,j),j=1,NC),i=1,NR)
          END IF
```

```fortran
        ELSE IF ( igr .eq. 2) then
         IF ( ifl .eq. 1) then
         WRITE (71,'(12f7.4)') ((UWND(i,j),i=1,NC),j=1,NR)
         ELSE IF ( ifl .eq. 2) then
         WRITE (71,'(1X,10f9.2)') ((UWND(i,j),i=1,NC),j=1,NR)
         END IF
        END IF

c........Read specified field/grid into VWND
        CALL GRD(GRDHNDL, VRSNNM, PARMNM2, LVLTYPE, LVL1,
     &          LVL2, DATE, HOUR, tau, VWND, UNITS, STRD)

c-------- WRITE VWND  to  fortran unit 72 -------------------
        IF( igr .eq. 1) then
         IF( ifl .eq. 1) then
         WRITE (72,'(12f7.4)') ((VWND(i,j),j=1,NC),i=1,NR)
         ELSE IF ( ifl .eq. 2) then
         WRITE (72,'(1x,10f9.2)') ((VWND(i,j),j=1,NC),i=1,NR)
         END IF
        ELSE IF ( igr .eq. 2) then
         IF ( ifl .eq. 1) then
         WRITE (72,'(12f7.4)') ((VWND(i,j),i=1,NC),j=1,NR)
         ELSE IF ( ifl .eq. 2) then
         WRITE (72,'(1X,10f9.2)') ((VWND(i,j),i=1,NC),j=1,NR)
         END IF
        END IF

300     CONTINUE
800     CONTINUE
801     CONTINUE
        STOP
        END
```

Appendix C
Files for Generating
a WISWAVE Grid

Shell File mapgrid.c

```
#QSUB -eo
#QSUB -IT  0:10:00
#QSUB -x
ja
set -vx
cd /u3/h2crozd7/winds/maps
cf77 -c mapgrid.f
dis77link -o mapgrid mapgrid.o
mapgrid
mv popfil.dat popfil
cf77 -c hpgl.f
dis77link -o hpgl hpgl.o
hpgl<dispop.inp
#--- ENTER NAME OF OUTPUT FILE
#--- ENTER LENGTH OF OUTPUT FILE NAME
#--- ENTER FILE MODE FROM THE FOLLOWING:
#---    0) APPEND
#---    1) NEW FILE
#---    2) OVERWRITE
#---    3) NO OVERWRITES
#---    4) INCREMENT
#--- ENTER POST-PROCESSOR DIRECTIONS
rm mpgrid mapgrid.o popfil hpgl.o hpgl
ja -st
```

Program mapgrid.f

```
c   program mapgrid.f   zeki demirbilek 12-2-92
c
c  this program plots the grid map of the Atlantic
c  and provides a mesh for generating a grid for WISWAVE
c  The input grid for WISWAVE consists of land & water boundary
c  matrix data.
c
c  to run this program:
c  qsub mapgrid.c <..... shell file to compile & run
c
c  input:
c    modify mapgrid.f as necessary for your input, i.e.,
c    specify level 2 output stations to be used as boundary input.
c                  these are specified as lon and lat and #
c                  desired
c  insert new header info for plots,
c    decide x- and y-direction griding intervals (lon and lat,
c    respectively)
c
c  output:
c  result file will be called "output"; this is an hpgl file
c  rename "output" file to what you want,
c  Down load this file to your PC with ftp bring it down to PC (ftp
c  to your PC)
c  go to WP
c  alt+F9 (1,1,1)
c  c:\wp51\docs\zeki\out2.5
c  6  (choose 3)
c  7  (choose 4)
c  F7
c  shft+F7 (choose V to view first)
c  F7
c  ¹ (print the figure on HP LaserJet III)
c  you should a figure of the map
c
c  To generate the land-water matrix, use the gridded map you have
c  and follow instructions in the WISWAVE usser guide.
c
      common iwork (2000)
      dimension x(33),y(33),x1(10),y1(10),x2(57),y2(57)
     1,x3(26),y3(26)
c  Level 2 uotput station locations (x1,y1)
      data x1/-77.5, -75.0, -72.5, -70.0,
     *       -67.5,-67.5,-67.5,-67.5,-67.5,-67.5/
      data y1/30.0, 30.0, 30.0, 30.0, 30.0,
     *       32.5, 35.0, 37.5, 40.0, 42.5/
```

```
c
      call comprs
      call metnam ('popfil',6)
      call setdev(6,0)
      call page (11.0,8.5)
      call projct ('mercator')
      call area2d (9.0,6.0)
      call swissl
      call shdchr (90.0, 1,0.002,1)
c     call headin ('Atlantic Winds WU - 2.5 Degrees
c             Grid$',100,2.0,1)
      call headin ('Atlantic Winds WU - 1.25 Degrees
          *Grid$',100,2.0,1)
      call xname ('Longitude',9)
      call yname ('Latitude',8)
      call mapgr (-82.5,10.0,-5.0,10.0,10.0,65.0)
      call mapfil ('north america')
c plot positions of level 1 boundary input points with a circle
c Note: these may be substituted for buoys locations or something
c      else if desired.  Make sure you specify coords.
      call marker(16)
      call curve(x1,y1,10,-1)
      call lblank ('land',2000)
c     call grid (4,4) !for 2.5 degr grid:  10 deg inc/4 gives a 2.5
c        *deg grid
      call grid (8,8)  !for 1.25 deg grid:10 deg inc/8 gives a 1.25
        *deg grid
      call endpl (0)
      call donepl
      stop
      end
```

Program hpgl.f

```
C    Program hpgl.f    zeki demirbilek Dec 1992
C
C POST-PROCESSOR ROUTINE FOR DISSPLA
      CHARACTER INFILE*20
      DIMENSION IBUF(16),ITEMP(16)

        IBUF(1)=5
        CALL IOMGR(IBUF,-102)
        DO II=1,16
          IBUF(II)=0
        END DO
```

```
            CALL QQLPRM('i.e. FOR FILE "OUTPUT01.DAT",
      *        ENTER "OUTPUT01"$'.   ,IBUF)

            CALL QQIPRM('i.e. FOR "OUTPUT01", ENTER
      *        "6"$',ITEMP)

        IBUF(16)=ITEMP(1)
        CALL IOMGR(IBUF,-103)
        CALL QQIPRM('ENTER FILE MODE$',IBUF)
        CALL IOMGR(IBUF,-104)
        CALL HP7475 (1)


          CALL METNAM('popfil',6)
          CALL DISPOP (0)

          STOP
          END
```

Example Input File dispop.inp

```
output
6
4
```

Appendix D
Interfacing Surface Wind Products from IPOPS with WISWAVE and Other Hydrodynamic Models

Procedures for extracting surface wind or surface stress information for user-selected areas from files in the Navy IPOPS format are discussed in this appendix. The extracted wind fields can be used as input to CE hydrodynamic models. Specific procedures for interfacing with the CE wave model WISWAVE are included. An annotated listing of the fortran program **popuvwinds.f** follows the discussion of procedures.

The program **popuvwinds.f** consists of a main program and two subroutines, FINDU10 and WNDCON. The main program reads output from IPOPS coarse or fine grids and creates a subgrid according to user defined parameters. Either surface winds or wind stresses may be specified. The main program incorporates a DO loop which iterates through the number of forecast wind fields, defined by the parameter **ntau**, for each 12-hour watch. The program continues to read windfields for successive watches until an end of file is detected.

Subroutine WNDCON converts windspeed components to windspeed and direction. Windspeeds are in meters/sec and directions are in the meteorological convention, following the WISWAVE conventions. WNDCON then writes the windfield with a date and forecast time header to a file in WISWAVE format.

Program options are controlled by parameters defined in an include file. This file must be located in the directory from which the program is being run. The following is an example of the include file **para125.inc** for the case of supergrid wind stress fields:

```
PARAMETER(NC=288,NR=145,MC=63,MR=45,ifl=1,igr=2,ntau=4,
&    idc=2,iun=2,rlong1=-82.5,rlong2=-5.0,rlat1=65.0,rlat2=10.0,
&    iovrlap=2)
```

The user desired subgrid is defined by parameters **rlong1, rlong2, rlat1,**
and **rlat2.** The value of these parameters establishes the subgrid in relation to
the global grid. For subgrid purposes the global grid system is based on that
shown in the main report. For the supergrid the longitude varies from -300° to
58.75° and for the regular grid it varies from -300° to 57.5°. The latitude
varies from 90° to -90° for both the regular grid and the supergrid. For the
example parameter statement shown above, **rlong1** equals -82.5° and **rlong2**
equals -5.0°. Since the grid increment is 1.25° the resulting dimension for the
longitude axis is **MC** = 63. From the same example, **rlat1** equals 65.0° and
rlat2 equals 10.0°. This results in a dimension for the latitude axis **MR** = 45.

For this study all **popuvwinds.f** runs were made on the Cray at WES. The
following is an example of the script file **popuv.c** which can be used to run
the program:

```
# QSUB -eo
# QSUB -x
set -Svx
ja
cd /tmp/wiswe
cp $HOME/pops/popuvwinds.f popuvwinds.f
ln /tmp/wispops/a60s1201.g
ln /tmp/wispops/a61s1201.g
cft77 popuvwinds.f
segldr popuvwinds.o -o popuvwinds
popuvwinds
mv fort.20 wis1201.g
```

The file includes links to the global wind stress components extracted from
IPOPS and sent from the LSC to the Cray at WES. The output wind fields
formated for WISWAVE are written to fortran unit 20.

Modification of Wind Stress for Use in WISWAVE

Since the wave model **WISWAVE 2.0** does not have an option for direct
input of wind stress, a procedure for converting stress to 10-m wind speed,
U_{10}, and direction is included in the program in subroutine **findu10.f.** The
drag law assumed is the same as in WISWAVE, but the inverse procedure is
used. The subroutine is rather general, and may be used for other purposes,
such as finding maximum conditions.

Subroutine **findu10.f** computes a matrix that contains the wind speed at 10-m
height (U_{10} values) for various values of the friction velocity, U_*. First, hypo-
thetical values of U_* are created. The values of U_* in the DO 2 loop start with

0.034, corresponding to a value of $U_{10} \approx 1$ m/sec, the lowest wind speed assumed for U_{10}. The largest U_* in the loop is set to 5.033, corresponding to a value of $U_{10} \approx 250$ m/sec or greater, the highest wind speed assumed for U_{10}. The basic rule of thumb for relating U_* to U_{10} is as follows: U_* values from 0.0337 (≈ 0.034 in the subroutine) correspond approximately to U_{10} of 1 m/sec, U_* of roughly 0.8 to U_{10} of about 20 m/sec, and U_* values between 1.0 and 5.0 are associated with high values of U_{10}, say $20 < U_{10} < 250$ m/sec.

To generate a look up table for all feasible values of U_{10} from U_*, the drag coefficient relation used in the WISWAVE model is also employed in the subroutine **findu10.f**. The formula, expressed in terms of U_{10}, is given by:

$$C_D = 0.001 \, (1.1 + 0.035 \, U_{10}) \qquad (1)$$

The equation may be written in more general form as

$$C_D = fact \, (cof1 + cof2 \, U_{10}) \qquad (2)$$

where
$$cof1 = 1.1$$
$$cof2 = 0.035$$
$$fact = 0.001$$

The formula used for relating U_{10} to U_* in the subroutine is

$$C_D = \frac{U_*^2}{U_{10}^2} \qquad (3)$$

An expression for U_* is derived from Equation 3 as

$$U_* = \sqrt{C_D} \, U_{10} \qquad (4)$$

Substituting Equation 3 into Equation 2 yields a cubic equation of the form

$$U_*^2 = fact \, (cof1 + cof2 \, U_{10}) \, U_{10}^2 \qquad (5)$$

The solution of U_{10} directly from Equation 5 requires either trial-and-error or a more formal iterative solution technique such as the Newton-Raphson method. The latter is implemented in subroutine **findu10.f**.

The first part of subroutine **findu10.f** solves Equation 5 for U_{10}. The derived values of U_{10} are called "U10CAL", for the calculated U_{10} values. Thus they can be distinguished from U_{10} values obtained from the FNOC wind stresses.

Calculation of U_{10} values from the FNOC wind stresses proceeds in the following manner. First, stresses are read as component x- and y- after these

have been transferred to CERC's CRAY platform. The U. values are constructed using the following definition of "shear velocity"

$$U_* = \frac{\sqrt{T_x^2 + T_y^2}}{\rho_{air}} \qquad (6)$$

In addition to the stress-based U. values, stress-based direction values are also computed in the subroutine. All calculations with stresses use a Cartesian reference frame. Directions in this frame represent "going toward" or "to".

The procedure in **findu10.f** continues with establishing a match between U. values and U10CAL pre-computed matrix data. That is, any stress-based computed U. value has a counterpart in the look-up tables (here a matrix of values) which contain the U10CAL values. From this matching, the U_{10} values based on stresses are established. The matching is done through an indexing scheme, described within the subroutine. The resulting values will be the true U_{10} data to be used for input to the WISWAVE.

Once the U_{10} values are derived from the FNOC wind stresses, there are two alternative forms for saving them for use as input to WISWAVE. One alternative is to use the combination of U_{10} and the stress based angles (derived and already converted to the WISWAVE angle convention in **findu10.f**). The second alternative is to decompose U_{10} into x- and y-components, again using stress based angles. Either alternative is acceptable. The first alternative is more direct, but the second alternative may be easier for engineers in some applications. Both alternatives were tested and yielded equivalent stress-based wind input for WISWAVE, but only the second alternative is active in the following version of the program.

Listing of Program popuvwinds.f

```
c  program popuvwinds.f        Steven Bratos December 1992
c
c  Program utility to read output from global_288x145 or
c  global_73x144 grids output from IPOPS u-v wind or stress
c  components and write desired subgrid in knots or meters/sec
c  with date and tau id.
c
c  Subroutine FINDU10 converts wind stress components to wind
c  velocity (10m) components
c
c  Subroutine WNDCON converts U-V components to wind speed &
c  direction and writes a file formatted for WISWAVE
c
c  Parameter Definition
c.........................
c       NC      = Global grid dimension (FNOC longitude axis)
```

```
c.............................
c     NC      = Global grid dimension (FNOC longitude axis)
c     NR      = Global grid dimension (FNOC latitude axis)
c     MC      = Subgrid dimension (longitude axis, e.g. WISWAVE)
c     MR      = Subgrid dimension (latitude axis, e.g. WISWAVE)
c     ifl   = Field flag
c              = 1 for wind stress
c              = 2 for 10 meter wind
c     igr   = Grid flag
c
c     Parameter values for each grid are:
c
c         global_73x144(regular) : NC=144,NR=73,igr=1
c         global_288x145(super)  : NC=288,NR=145,igr=2
c
c     ntau      = Number forecast times for a 12-hour watch (1,4)
c     idc   = Direction convention for output
c              = 2 for Meteorological or Compass
c     iun   = Units convention for output
c              = 1 knots
c              = 2 meters/sec
c     rlong1    = Longitude of subgrid western boundary
c              (See Figure in text for grid system)
c                   Regular grid (-300.0 to 57.5)
c                   Supergrid   (-300.0 to 58.75)
c     rlong2    = Longitude of subgrid eastern boundary
c                   Regular grid (-300.0 to 57.5)
c                   Supergrid   (-300.0 to 58.75)
c     rlat1     = Latitude of subgrid northern boundary
c                      (90.0 to -90.0)
c     rlat2     = Latitude of subgrid southern boundary
c                      (90.0 to -90.0)
c     iovrlap   = Control parameter to indicate whether subgrid overlaps
c              the global grid boundary
c              = 1 for no overlap
c              = 2 for overlap

      INCLUDE 'para125.inc'
c     PARAMETER (NC=288,NR=145,MC=63,MR=45,ifl=1,igr=2,
c    1     ntau=4,iun=2,rlong1=-82.5,rlong2=-5.0,
c    1     rlat1=65.0,rlat2=10.0,iovrlap=2,idc=2)



      REAL  UCMP(NR,NC),VCMP(NR,NC),
     1      U(MR,MC),V(MR,MC),u10cal(5000)

      COMMON /WIND/ U,V,idate,itau,u10cal
```

```
              READ (71,107,end=900) iy,im,id,ih,itau
              READ (72,107,end=900) iy,im,id,ih,itau
              itc= itc + 1
107       FORMAT(2x,4i2,i4)
          IF(ifl .eq. 1) then
            READ (71,'(12f7.4)') ((UCMP(i,j),j=1,NC),i=1,NR)
            READ (72,'(12f7.4)') ((VCMP(i,j),j=1,NC),i=1,NR)
          ELSE IF( ifl .eq. 2) then
            READ (71,'(1X,10f9.2)') ((UCMP(i,j),j=1,NC),i=1,NR)
            READ (72,'(1X,10f9.2)') ((VCMP(i,j),j=1,NC),i=1,NR)
          END IF


c ************* regular grid (2.5 deg.)**********************
          IF(igr .eq. 1) then
            IF(iovrlap .eq. 1) then
              jlog1= nint((rlong1 + 302.5)/ 2.5)
              jlog2= nint((rlong2 + 302.5)/ 2.5)
              ilat1= nint((rlat1 - 90.0)/2.5*(-1.) +1.)
              ilat2= nint((rlat2 - 90.0)/2.5*(-1.) +1.)
              DO 300 i=ilat1,ilat2
                DO 302 j=jlog1,jlog2
                    U(i-ilat1+1,j-jlog1+1)=UCMP(i,j)
                    V(i-ilat1+1,j-jlog1+1)=VCMP(i,j)
302             CONTINUE
300           CONTINUE
            ELSE IF(iovrlap .eq. 2) then
              jlog1a= nint((rlong1 + 302.5)/ 2.5)
              jlog2a= 144
              jlog1b= 1
              jlog2b= nint((rlong2 + 302.5)/ 2.5)
              ilat1= nint((rlat1 - 90.0)/2.5*(-1.) +1.)
              ilat2= nint((rlat2 - 90.0)/2.5*(-1.) +1.)
              DO 306 i=ilat1,ilat2
                DO 308 j=jlog1a,jlog2a
                    jl=j-jlog1a+1
                    U(i-ilat1+1,jl)=UCMP(i,j)
                    V(i-ilat1+1,jl)=VCMP(i,j)
308             CONTINUE
                DO 310 j=jlog1b,jlog2b
                    U(i-ilat1+1,j-jlog1b+1+jl)=UCMP(i,j)
                    V(i-ilat1+1,j-jlog1b+1+jl)=VCMP(i,j)
310             CONTINUE
306           CONTINUE
            END IF
c ************* supergrid  (1.25 deg.)**********************
          ELSE IF (igr .eq. 2) then
            IF(iovrlap .eq. 1) then
              jlog1= nint((rlong1 + 300.)/1.25 + 1.)
              jlog2= nint((rlong2 + 300.)/1.25 + 1.)
```

```fortran
          ilat1=  nint((rlat1 + 90.)/1.25 + 1.)
          ilat2=  nint((rlat2 + 90.)/1.25 + 1.)
100           format(4i8)
          DO 301 i=ilat1,ilat2,-1
          DO 303 j=jlog1,jlog2
              U((i-ilat1)*(-1)+1,j-jlog1+1)=UCMP(i,j)
              V((i-ilat1)*(-1)+1,j-jlog1+1)=VCMP(i,j)
303       CONTINUE
301       CONTINUE
          ELSE IF(iovrlap .eq. 2) then
          jlog1a=  nint((rlong1 + 300.)/1.25 + 1.)
          jlog2a=  288
          jlog1b=  1
          jlog2b=  nint((rlong2 + 300.)/1.25 + 1.)
          ilat1=  nint((rlat1 + 90.)/1.25 + 1.)
          ilat2=  nint((rlat2 + 90.)/1.25 + 1.)
          DO 305 i=ilat1,ilat2,-1
          DO 307 j=jlog1a,jlog2a
              jl=j-jlog1a+1
              U((i-ilat1)*(-1)+1,jl)=UCMP(i,j)
              V((i-ilat1)*(-1)+1,jl)=VCMP(i,j)
307       CONTINUE
          DO 309 j=jlog1b,jlog2b
              U((i-ilat1)*(-1)+1,j-jlog1b+1+jl)=UCMP(i,j)
              V((i-ilat1)*(-1)+1,j-jlog1b+1+jl)=VCMP(i,j)
309       CONTINUE
305       CONTINUE
          END IF
          END IF




c*****  DATE  *************************
          ihrtau= ih + itau
          if(ihrtau .ge. 24.) then
          frac= real(ihrtau) - 24.0
          ifrac = int(frac)
          ihr= int((frac - real(ifrac)) * 24.0)
          id= id + ifrac
          else if(ihrtau .lt. 24.) then
              ihr= ihrtau
          end if
          idate= iy*1000000 + im*10000 + id*100 + ihr
       WRITE(30,*) idate , itau
       WRITE(31,*) idate , itau
108    FORMAT(i10.i4)
```

```
c **********convert wind stress to wind speed **********

      IF (ifl .eq. 1) then

       CALL FINDU10

       END IF


c *****units conversion  (iun =1 > knots; iun =2 > m/s)*****
c              V is sometimes in cm/s inwhich case must divide
c              by 100 to convert to m/s

      IF (iun .eq. 1) then
      DO 200 i=1,MR
       DO 201 j=1,MC
         U(i,j)=U(i,j)/0.514444
         V(i,j)=V(i,j)/0.514444
201     CONTINUE
200    CONTINUE
      ELSE IF (iun .eq. 2) then
      DO 400 i=1,MR
       DO 401 j=1,MC
          U(i,j)=U(i,j)
          V(i,j)=V(i,j)/1.
401     CONTINUE
400    CONTINUE
      END IF


c ---------- OUTPUT COMP ----------
      DO 304 i=1,MR
       WRITE(30,*) (U(i,j),j=1,MC)
       WRITE(31,*) (V(i,j),j=1,MC)
c101    FORMAT(12f7.4)                    ! stress
c101     FORMAT(10f9.2)
304    CONTINUE


c ********* CONVERT COMPS TO SPEED & DIRECTION *********

      CALL WNDCON

700  CONTINUE
1000 CONTINUE
      GO TO 1
900   continue
      STOP
      END
```

```
      SUBROUTINE WNDCON
c                        (Steve Bratos    December 1992)
c
c Program converts uv (A58,A59) unadjusted 10 meter wind
c components in knots or m/s accessed from IPOPS via extwind.f
c to windspeed (m/s) and direction (compass) for WISWAVE.

      INCLUDE 'para125.inc'
c        PARAMETER (NC=63,NR=45,idc=2,ifl=2,igr=2)
         DIMENSION U(MR,MC),V(MR,MC),wspd(MR,MC)
     1   ,wdir(MR,MC),u10cal(5000)

         COMMON /WIND/ U,V,idate,itau,u10cal

      PI= 3.14159265
      radc= 180.0/PI

      DO 300 i=1,MR
        DO 400 j=1,MC
         wspd(i,j)= ((U(i,j))**2+(V(i,j))**2)**.5
           IF( U(i,j) .eq. 0.) then
              U(i,j)= 0.1
           END IF
           IF(V(i,j) .eq. 0.) then
              V(i,j)=0.1
           END IF
         wdir(i,j)=radc * atan(V(i,j)/U(i,j))
         IF(U(i,j) .gt. 0. .and. V(i,j) .lt. 0.)then
              wdir(i,j)= 360. + wdir(i,j)
         ELSE IF(U(i,j) .lt. 0.) then
              wdir(i,j)=180. + wdir(i,j)
         END IF
c ----------- Convert to compass (or met) direction convention
         IF( idc .eq. 2) then
              wdir(i,j)= 270. - wdir(i,j)
              if( wdir(i,j) .lt. 0.) then
              wdir(i,j)= wdir(i.j)+360.0
              end if
         END IF
400        CONTINUE
300     CONTINUE
         WRITE(20,202) idate,itau
202        FORMAT(i10,i4)
      DO 500 i=1,MR
         WRITE(20,100) (wspd(i,j),j=1,MC)
100        FORMAT(32f6.1)
101        FORMAT(32f6.0)
500     CONTINUE
```

```
      DO 700 i=1,MR
        WRITE(20,101) (wdir(i,j),j=1,MC)
700     CONTINUE

900     continue
        RETURN
        END
```

SUBROUTINE FINDU10

```
c****************************************************************
c
c       program findu10.f       zeki demirbilek  December 1992
c
c This program first computes a matrix that contains the wind
c speed at 10 m height, U10 values.  This is done by creating
c hypothetical values of ustar.  The values of ustar in do 2 loop
c start with ustar = 0.034 (which corresponds to U10= 1 m/sec,
c the lowest wind speed assumed for U10).  The largest ustar from
c do 2 loop is ustar = 5.033 (which corresponds to the U10 = 425
c m/sec, the highest wind speed assumed for U10).  Note that the
c basic rule of thumb for relating ustar to U10 is:
c               ustar = 0.0337 ~ 0.034 corresponds to U10=1 m/sec
c               ustar = 0.8         corresponds to U10 =20 m/sec
c               1.0 < ustar < 2.0   corresponds to U10 > 20 m/sec
c
c       To generate U10 values from ustar, the drag coefficient
c       used by Resio in the wiswave.f is used here. This formula
c       when expressed in terms of U10 is given by:
c
c               Cd =  (1.1 + 0.035 U10) * 0.001
c               where we define herein:
c               cof1 = 1.1
c               cof2 = 0.035
c               fact = 0.001
c               and therefore, expression for Cd becomes
c
c               Cd = (cof1 + cof2 *U10) *fact
c
c
c       The formula used for relating U10 to ustar is:
c
c               Cd * (U10**2) = ustar**2
c
c       or to get ustar, take the sqrt of
c
c               ustar = sqrt(Cd) *U10
c
c       Substituting this second expression for ustar into the Cd
c       gives a cubic equation given by:
c
c               ustar**2 = fact*(cof1 + cof2 * U10) *U10**2
c
c       To solve for U10 from this last equation, use
c       Newton-Raphson iteration technique.
c
c       zeki demirbilek, December 1992, WINDS WU participation.
```

```
c
c***************************************************************

      include 'para125.inc'

      dimension u10cal(5000),u10(NR,NC)
      dimension U(MR,MC),V(MR,MC),strmg(MR,MC)
      dimension ustr  (MR,MC), ustdr(MR,MC)
c     dimension wsnext(200,200)
c     dimension wisdr(200,200),wdnext(200,200)

      COMMON /WIND/ U,V,idate,itau,u10cal

c set coefficients, limits, and tolerances:
      nustr = 5000
      nustr2 = 2*nustr
      uzero=0.034
      fact = 0.001
      cof1 = 1.1
      cof2 = 0.035
      tol = 1.0e-05
      PI= 3.14159265
      radc=180./PI
c
c generate "nustr" values of ustar ranging from 0.034 to 5.033,
c in increments of 0.001:
      do 2 j = 1,nustr
      ustar = uzero + fact*(j-1)
      ustar2 = ustar**2
C begin to solve for U10 iteratively using the Newton-Raphson
c method:
      ujm1 = ustar2  ! value of u from previous iteration
      uj   = ustar2  ! value of u at current iteration
      it = 0      ! index of iterations for Newton-Rapson method
c define the function and its derivative for Newton-Rapson
c method:
1     func = (cof1*fact + cof2*fact * sqrt(ujm1)) * ujm1 - ustar2
      if (abs(func) .gt. tol)  then
      deriv = (2.0*cof1*fact)*sqrt(ujm1) + (3.0*cof2*fact)* ujm1
      uj = ujm1 - func / deriv
      ujm1 = uj
      if(it .gt. nustr2) go to 3
      it  = it + 1
c     print *,'it =',it,  'uold =',ujm1,  'unew=',uj
      go to 1
      else
      u10cal(j) = sqrt(uj)
c     print *,'it =',it,  'unew=',uj,  'u10cal=',u10cal(j)
```

```fortran
      endif
2     continue
3        write(*,*)'max # of iterations (=10,000)
     *   in the Newton-Raphson procedure for U10 is reached '
c
c  set density of air and tolerance values:
      rhoa = 1.225
      epss = 1.0e-10
c
c  +++++++++    ustar calculations   ++++++++++++
c  determine ustar:  compute ustar values from fnoc stress data
c  as:
      do 5 i= 1,MR
      do 5 j= 1,MC
            IF( U(i,j) .eq. 0.) then
                U(i,j)= 0.001
            END IF
            IF(V(i,j) .eq. 0.) then
                V(i,j)=0.001
            END IF

      strmg(i,j)=sqrt(U(i,j)**2 + V(i,j)**2)   ! (BRATOS 1/93)
      ustr(i,j) = (sqrt(U(i,j)**2 + V(i,j)**2))/rhoa
      ustr(i,j) = sqrt(ustr(i,j))
c      ustdr(i,j) = atan2(V(i,j),U(i,j) + epss)
       ustdr(i,j)= radc *atan((V(i,j)+epss)/(U(i,j)+epss))
         if(U(i,j) .gt. 0. .and. V(i,j) .lt. 0.) then
         ustdr(i,j)= 360. + ustdr(i,j)
         else if( U(i,j) .lt. 0.) then
         ustdr(i,j)= 180. + ustdr(i,j)
         end if
5     continue
c
c  ++++++++++  u10 calculations from ustar values   ++++++++++++
c  match ustar values computed from fnoc stresses to
c  the calculated u10 values, u10cal.  this is done by
c  determining the index (iustr) that takes ustr(i,j) values and
c  relates them to the u10cal(iustr) values:
      umax =0.0
      do 7 i=1,MR
       do 6 j=1,MC
         iustr = 1000*ustr(i,j) - 33
         if (iustr .le. 0)  iustr = 1
         if (iustr .gt. nustr)  iustr = nustr
         u10(i,j) = u10cal(iustr)
c        wsnext(i,j) = u10(i,j)      ! in wiswave notation
c ---------- convert back to u-v velocity componnets(BRATOS 1/93)
         U(i,j)= u10(i,j) * (U(i,j)/strmg(i,j))
         V(i,j)= u10(i,j) * (V(i,j)/strmg(i,j))
```

```
c ------------------------------------------------------------
c  if u10 needs to be converted to knots (1 knot = 0.5196 m/s),
c  activate the next statement.  remember that wiswave wants u10
c  in m/sec.
c          u10(i,j) = u10/0.5196
c  for information purposes, find max speed for each date
             if (u10(i,j) .gt. umax)  then
                umax = u10(i,j)
                iout = i
                jout = j
             endif
6      continue
7    continue
c


c  +++++++++++  formats are:  ++++++++++++
13     format (i10,i4)
c14     format (12f7.4)
14        format(5(12f7.4/),3f7.4)
15     format (32f6.1)  !same format as read(21,213) in wiswave
16     format (32f6.0)  !same format as read(21,214) in wiswave
17     format (2x,'Idate = ',i10,'  Iout = ',i4,'  Jout = ',i4,
      1         '  Umax = ',f6.1,' (kt)',' Dir = ',f6.0,' (WIS)')
18     format (//,2x,'Total Dates Processed = ',i10)
c
       RETURN
       END
```

Appendix E
NDBC Buoy Data

NDBC Record Format Description

RECORD NAME ___Meteorology Oceanography & Wave Spectra (File Type "291")___

14. FIELD NAME	15. POSITION FROM - 1 MEASURED IN (e.g., MM, bytes)	16. LENGTH NUMBER	UNITS	17. ATTRIBUTES	18. USE AND MEANING
ENVIRONMENTAL DATA RECORD (RECORD B)					
BLANKS	117	4			
FILE TYPE	1	3			"291" (constant)
FILE DATE	4	6			YYMMDD of file generation
RECORD TYPE	10	1			Always 'B'
STATION	11	6			Six characters unique name of observation point
OBSERVED DATE	17	6			YYMMDD (UTC)
OBSERVED TIME	23	4			HHMM (UTC) - End of met. data acquisition, rounded to beginning of nearest whole minute
ANEMOMETER HEIGHT	27	3			XXX - Height above water level or ground (meters to Tenths)
AIR TEMPERATURE	30	4			XXXX - Negative temperatures are preceded by a minus sign adjacent to temperature value Deg C to tenths
DEW POINT	34	4			XXXX - Degrees C to tenths
BAROMETER	38	5			XXXXX - Reduced to sea level (MB to tenths)
WIND SPEED (AVG)	43	4			XXXX - m/sec to hundredths
WIND DIRECTION (AVG)	47	4			XXXX - Degrees from true North to tenths
WEATHER	51	1			One-character weather code
VISIBILITY	52	3			XXX - Nautical miles to tenths
PRECIPITATION	55	4			XXXX - Accumulation in millimeters
SOLAR RADIATION (ATMOSPHERIC)	59	3			XXX - Langleys/min to hundredths, wave length less than 3.6 microns
SOLAR RADIATION (ATMOSPHERIC)	62	3			XXX - Langleys/min to hundredths, wave length from 4.0 to 50 microns
SIGNIFICANT WAVE HEIGHT*	65	3			XXX - Corrected for low frequency noise,etc. (meters to tenths)
AVERAGE WAVE PERIOD*	68	3			XXX - Seconds to tenths
MEAN WAVE DIRECTION	71	3			XXX - Mean direction of dominant waves in whole degrees from true North
WATER LEVEL	74	4			XXXX - From MLLW reference level, minus sign indicates below MLLW (meters to tenths)
BLANKS	78	2			

NOAA FORM 24-13

RECORD NAME ___Meteorology Oceanography & Wave Spectra (File Type "291")___

14. FIELD NAME	15. POSITION FROM - 1 MEASURED IN (e.g. bits, bytes)	16. LENGTH NUMBER	UNITS	17. ATTRIBUTES	18. USE AND MEANING
ENVIRONMENTAL DATA RECORD (RECORD B) (Continued)					
TEMPERATURE (SEA SURFACE)	80	4			XXXX – Sea surface negative temperatures are preceded by a minus sign adjacent to temperature value – Deg C to hundredths
PRACTICAL SALINITY (SEA SURFACE)	84	5			XXXXX – To thousandths
CONDUCTIVITY (SEA SURFACE)	89	5			XXXXX – Millisiemens/cm to thousandths
DOMINANT WAVE PERIOD*	94	3			XXX – Seconds to tenths
MAXIMUM WAVE HEIGHT	97	3			XXX – Meters to tenths
MAXIMUM WAVE STEEPNESS	100	3			XXX
WIND GUST	103	4			XXXX – Meters/sec to hundredths
WIND GUST AVERAGING PERIOD	107	2			XX – Seconds
WIND GUST	109	4			XXXX – Meters/sec to hundredths
WIND GUST AVERAGING PERIOD	113	2			XX – Seconds
WIND SPEED (58 MIN AVG)	115	3			XXX – Meters/sec to tenths
WIND DIRECTION (58 MIN AVG)	118	3			XXX – Whole degrees

* Significant wave height, average wave period, and dominant wave period are set to zero when significant wave height is less than 0.15 meters.

14. FIELD NAME	15. POSITION	16. LENGTH NUMBER	UNITS	17. ATTRIBUTES	18. USE AND MEANING
NONDIRECTIONAL WAVE SPECTRA DATA RECORD (RECORD C)					
FILE TYPE	1	3			"291" (constant)
FILE DATE	4	6			YYMMDD of file generation
RECORD TYPE	10	1			Always 'C'
STATION	11	6			Six characters unique name of observation point
OBSERVED DATE	17	6			YYMMDD (UTC)
OBSERVED TIME	23	4			HHMM (UTC) – End of met. data acquisition, rounded to beginning of nearest whole minute
END OF WAVE DATA ACQUISITION	27	4			HHMM (UTC) – Rounded to beginning of nearest whole minute
BLANKS	31	3			
COUNT	34	1			X – Number of frequencies on this record

NOAA FORM 24-13

Shell File buoy.c

```
#QSUB -eo
#QSUB -IT  0:10:00
#QSUB -IM  1mw
#QSUB -x
ja
set -vx
cd /u3/h2crozd7/winds/buoys
ln 44025.b fort.1
make buoy
buoy
rm  buoy.o  fort.1
ja -st
```

Program buoy.f

```
C Program buoy.f     zeki demirbilek  Dec 1992
C PROGRAM TO SEARCH FOR WAVE INFORMATION IN
C B-DATA FORMAT
C CONTAINED IN NOAA BUOY INFORMATION (FORMAT
C ESTAB.1/30/91)
C
C DESCRIPTION OF VARIABLES IN THE NOAA BUOY
C RECORD TYPE "B" FILES
C OBTAINED FROM CEDRS RECORDS IS AS FOLLOWS
C   IDBUOY = ID OF THE NOAA BUOY (skip first 10 characters
C                       in the record)
C   IDATE  = DATE (YYMMDDHHMM)
C   IWS    = wind speed (average; to hundreths)
C   IWD    = wind direction (average; deg from true north to
C                       in tenths)
C   IWVHT  = signficant wave height  (meters to tenths)
C   IWVPR  = average wave period  (seconds to tenths)
C   IWVDIR = mean wave direction  (mean direction of dominant
C      waves in whole degrees from true north)
C   IWVDPR = dominant wave period (peak period to tenths)
C   IGUST  = wind gust speed (m/sec to hundreths)
C   IGSTAV = average wind gust period (seconds)
      do 100 J=1,98
      READ(1,5) IDBUOY,IDATE,IWS,IWD,IWVHT,IWVPR,
     *IWVDIR,IDPR,IGUST,IGSTAV,JUNK
5     FORMAT(10x,I6,I10,16x,I4,I4,14x,I3,I3,I3,20x,I3,
     *6x,I4,I2,I11)
c  extract winds information (ZD 12-05-92):
      WS=IWS
      WS=WS/100.
```

```fortran
            WD=IWD
            WD=WD/10.
            GUST = IGUST
            GUST = GUST/100.
            GUSTDR= IGSTAV
c  extract waves information (ZD 12-05-92):
            HT=IWVHT
            HT=HT/10.
            AVPR=IWVPR
            AVPR=AVPR/10.
           ˙AVDIR = IWVDIR
            DOMPR=IDPR
            DOMPR=DOMPR/10.
c  write information to unit=2 file in the format described below:
            if(j.eq.1) then
              write(2,102)
102           format('******************************')
              write(2,101)idbuoy
              write(2,103)
103           format('******************************'/)
101           format('NOAA BUOY = ',i5)
              write(2,104)
104           format(1x,'DATE',8X,'Hs',5X,'Tp',3X,'Tav',
     *        3x,'AveDir',3x,
     *        'WS',5X,'WD',5x,'GustVel',2x,'GustDir')
              write(2,105)
105           format(13x,'(m)',3x,'(sec)',8x,'(deg)',/)
            endif
            WRITE(2,10) IDATE,HT,DOMPR,AVPR,AVDIR,WS,WD,
     *          GUST,GUSTDR
10       FORMAT(I10,2X,F5.2,2X,F4.1,2X,F4.1,2x,F5.1,2x,F6.2,
     *    2x,F6.2,2x,F6.2,2x,F6.2)
100      continue
         STOP
         END
```

Appendix F
Plotting WISWAVE and Buoy Wave and Wind Information

Shell File plotzd.c

```
#QSUB -q prime
#QSUB -eo
#QSUB -lM 4Mw
#QSUB -lT 1:00:00
#QSUB -x
ja
set -vx
cd /u3/h2crozd7/grd25
ln 44004.dat fort.2
ln sta1-25.92 fort.92
make plotzd
plotzd
rm fort.2 fort.92 plotzd.o plotzd.l plotzd
ja -st
#$ set default [h2crozd7.winds]
#$ assign 44004.dat for002
#$ assign sta1-25.92 for092
#$ fort plotzd.f
#$ disl plotzd
#$ run plotzd
#$ del/noconf *.obj;*
#$ del/noconf *.lis;*
```

Program plotzd.f

```
c   Program plotzd.f      zeki demirbilek Dec 1992
c
      parameter (ndays = 5, ihrs = 1)
      dimension nht(9000),ntpeak(9000),imnt(9000),navangt(9000),
     *iwsnow(9000),iwdnow(9000)
      character*80 hdr
c
      COMMON/blk1/time(9000),LOC(10),wh(9000),
     *   wp(9000),wh2(9000),wp2(9000)
      COMMON/blk3/idate(9000),kdate(9000),ICOM, idbuoy
      common/blk4/ht(9000),dompr(9000),avpr(9000),avdir(9000),
     *ws(9000),wd(9000),gust(9000),gustdr(9000)
      common/blk5/ht2(9000),dompr2(9000),avpr2(9000),avdir2(9000),
     *ws2(9000),wd2(9000),gust2(9000),gustdr2(9000)
C
c
c   parameters to be set are: ndays
c                                ihrs
c      ndays = 5
c      ihrs = 3
c
c   where
c   ndays = number of days. this is the same as number of
c          plots per page (i.e., ndays =5 means there will be
c          5 wave height, 5 wave period, 5 wave dir., etc.
c          plots on a given page)
c
c   ihrs = number of hourly intervals wiswave model results are
c          output
c          i.e., ihrs=3 means model results output every 3 hours
c
c+ READ BUOY DATA: ATTENTION READ NEXT FEW LINES
c   read buoy data: get "level 2" buoy data from CEDRS.  Use buoy.f
c   program to extract information necessary for comparison
c   with the wiswave model.  The buoy.f program will produce
c   buoy#.dat file.
c   use the later as buoy.dat (unit=2) to read buoy information:
      jrb=0
90    jrb=jrb+1
      j - jrb
c     if(j.eq.1) then
c        read(2,102) hdr   !read headers
c 102      format(a1)
c        read(2,101)idbuoy
c        read(2,102)hdr   !read headers
c        read(2,102)   !read blank line
c 101      format(12x,i5)
```

```fortran
c       read(2,102)hdr    !read headers
c       read(2,102)hdr    !read headers
c       read(2,102) !read blank line
c     endif
c     read(2,10,end=11) HT(j),DOMPR(j),AVPR(j),AVDIR(j),
c    * WS(j), WD(j),GUST(j),GUSTDR(j)
c10   FORMAT(12X,F5.2,2X,F4.1,2X,F4.1,2x,F5.1,2x,F6.2,
c    * 2x,F6.2,2x,F6.2,2x,F6.2)
c the following format was used only for the Dec 1992 storm buoy
c     records:
      read(2,*,end=11)dum1,dum2,ht(j),dompr(j),ws(j),dum3,
     * wd(j),dum4,dum5,dum6,dum7,avdir(j)
      go to 90
  11  jb =j-1
      print *,'jb = ',jb
c
c
c +++ READ WISWAVE MODEL RESULTS:
c     ATTENTION READ NEXT FEW LINES
c     +++++
c read wiswave model results: use fort.92 file generated by the
c wiswave model.  sort this file and create individual file for
c each station.  feed individual station files to this program
c as fort.92:
      jrm=0
  91  jrm=jrm+1
      j = jrm
      read(92,301,end=111)kdate(j),nht(j),ntpeak(j),imnt(j),
     *navangt(j),iwsnow(j),iwdnow(j)
 301  format(5x,i8,1x,3i3,1x,i3,i3,1x,i3)
      ht2(j)=nht(j)/10.
      dompr2(j)=ntpeak(j)*1.
      avpr2(j)=imnt(j)*1.
      avdir2(j)=navangt(j)*1.
      ws2(j)=iwsnow(j)*1.
      wd2(j)=iwdnow(j)*1.
      go to 91
 111  jm=j-1
      print *, 'jm = ',jm
c
c
C   set plot type parameter, icom:
c                              icom=1 plot wave heights
c                              icom=2 plot wave peak period
c                              icom=3 plot peak wave direction
c                              icom=4 plot wind speed
c                              icom=5 plot wind direction
c
      ICOM=1
```

```
      CALL plot1(jb,jm,ndays,ihrs)
      STOP
      END
c*************************************************************
c
      SUBROUTINE plot1(jb,jm,ndays,ihrs)
      dimension data1(9000),data2(9000),xdata(9000),ydata(9000),
     * ydata2(9000),xdata2(9000),time2(9000)
c
      COMMON/blk1/time(9000),LOC(10),wh(9000),wp(9000),
     *    wh2(9000),wp2(9000)
      COMMON/blk3/idate(9000),kdate(9000),ICOM, idbuoy
      common/blk4/ht(9000),dompr(9000),avpr(9000),avdir(9000),
     *ws(9000),wd(9000),gust(9000),gustdr(9000)
      common/blk5/ht2(9000),dompr2(9000),avpr2(9000),avdir2(9000),
     *ws2(9000),wd2(9000),gust2(9000),gustdr2(9000)
c
c  required DISPOP statements:
      call comprs
      CALL metnam('popfil',6)
      call setdev (6,0)
      call nochek
c  required DISSPLA statements for post processing:
      icom = 1
      if(jb.gt.jm) npts=jb
      if(jm.gt.jb) npts=jm
c  loop to draw five plots per page.  There willbe 5-plots of wave
c  heights on a page, 5 plots of periods, 5 for directions, 5 for
c  wind speed, and 5 for wind direction.  The parameter "icom"
c       controls
c  plot type:
   16 call page (14.0,11.)
      call physor (1.5,9.1)
      call basalf ('STAND')
      CALL HEIGHT (.175)
c
c  start to plot 5 plots on 1 page: j=1 for first plot on the page
c                                   j=2 for 2nd plot on the page
c                                   j=3 for 3rd plot on the page
c                                   j=4 for 4th plot on the page
c                                   j=5 for 5th plot on the page
c
c  The parameter "j" controls the number of plots on a page.  The
c       number of plots on one page or as many pages necessary
c       depends on the number of days buoy and model results are
c       available.  This may be controlled with the parameter "ndays".

      ntot1=0
      ntot2=0
```

```
          do 100 J=1,ndays
c  adjust origin for the next plot:
      if(J.ne.1) call orel (0.,-1.66)
c
c   set axes dimensions to be used in the call graf:
      xmax = 24.0*J
      xmin = xmax - 24.0
      call area2u ,.1.6,1.11)
      call blsym
      call yaxang (0.0)
c label axis & set up the graph:
      call xname (' ',1)
      call xname ('TIME (hrs)$',100)
      call yname (' ',1)
c  define y-axis label:
      if(icom.eq.1) call yname ('HT(m)$',100)
      if(icom.eq.2) call yname ('TP(s)$',100)
      if(icom.eq.3) call yname ('DR(deg)$',100)
      if(icom.eq.4) call yname ('WS(m/sec)$',100)
      if(icom.eq.5) call yname ('WD(deg)$',100)
c
c  define min and max values for x- and y-axis and the increments:
      if(icom.eq.1) then
        CALL GRAF(xmin,3.,xma:,0.,2.,10.)
      endif
c
      if(icom.eq.2) then
        call graf(xmin,3.,xmax,0.,6.,24.)
      endif
c
      if(icom.eq.3) then
        call graf(xmin,3.,xmax,0.,120.,360.)
      endif
c
      if(icom.eq.4) then
        call graf(xmin,3.,xmax,0.,10.,30.)
      endif
c
      if(icom.eq.5) then
        call graf(xmin,3.,xmax,0.,120.,360.)
      endif
c
c   ++++++++++ Buoy data preparation begins here:
c       create x- and y-values to plot the buoy data over a 5 day
c       period.  Plot one day at a time, and therefore, there will
c       be 5 plots per page.  Note that buoy data is output hourly
c       (with a 1 hr interval)
      if(j.eq.ndays) then
        n1b = n2b + 1
```

```
          n2b = jb
        else
          n2b = 24*j
          n1b = n2b - 24 + 1
        endif
c
c
c  prepare buoy data for call curve:  note that buoy data is hourly
c  so it need not be manipulated in some odd fashion.
c  first prepare the values for time-axis in 1-hour intervals over
c  a day (24-hr) period for plotting.  these values will be
c  generated for "ndays" period. note that "ndays" equates to
c    "nplots" per page:
     xtime=0.0
     day = 0.
     nhrs = 24*j
     do 1000 i=1,nhrs
     time(i)=day + XTIME
     xtime=xtime+1.0
     IF(XTIME.GT.23) then
     xtime = 0.0
     day = day + 24.
     endif
 1000 continue
c
c  start assigning x- (xdata)and y-values (ydata) of buoy
c  points to be used in the call curve and determine the number
c  of points (idout) call curve asks for:
c
     idout = 0
     do 50 i=n1b,n2b
     idout = idout + 1
     ntot1 = ntot1 + 1
     xdata(idout)=time(i)
     IF(ICOM.EQ.1) YDATA(idout)=ht(I)  !buoy wave heights
     write(88,241) ntot1,idout,time(i),xdata(idout),ydata(idout)
 241   format ('ntot1 =',i3,2x,'idout =',i5,2x,'time =',f6.2,
     *2x,'xdata = ',f6.2,2x, 'ydata = ',f6.2)
     IF(ICOM.EQ.2) YDATA(idout)=dompr(I) !buoy peak period
     IF(ICOM.EQ.3) YDATA(idout)=avdir(I) !buoy mean direction
     IF(ICOM.EQ.4) YDATA(idout)=ws(I) !buoy wind speed
     IF(ICOM.EQ.5) YDATA(idout)=wd(I) !buoy wind dir.
  50 continue
c
c   .
c  +++++++++ Model data preparation begins here:
c        create x- (xdata2) and y-values (ydata2) to plot the model
c        results over a five day period.  Plot one day at a time,
C        and therefore, there will be 5 plots per page.  Note that model
```

```
c          results will be in "ihrs" interval
c
      if(j.eq.ndays) then
        n1m = n2m + 1
        n2m = jm*ihrs
      else
        n2m = 24*j
        n1m = n2m - 24 + 1
      endif
c
c
c note:  the parameter "ihrs" controls the output time interval for
c        model results, i.e., ihrs = 3 means model results are output
c        every 3 hrs:
c
c  prepare time-axis for plotting:
      xtime=0.0
      day = 0.0
c   compute time in hourly intervals for the entire number of days.
c        note that time will later be made into "ihrs" intervals:
      nhrs =24*j
      do 1020 i=1,nhrs
      time2(i)=day + XTIME
      xtime=xtime+1.0
      IF(XTIME.GT.23) then
      xtime = 0.0
      day = day + 24.0
      endif
 1020 continue
c
c  start assigning x- (xdata2) and y-values (ydata2) to be
c  used in the call curve:
c
      idout2 = 0
      do 150 i=n1m,n2m,ihrs
      idout2 = idout2 + 1
      ntot2 = ntot2 + 1
      xdata2(idout2)=time2(i)
      if(icom.eq.1) ydata2(idout2)=ht2(ntot2)  !model wave heights
      write(88,2411)ntot2,idout2,time2(i),xdata2(idout2),
     *ydata2(idout2)
 2411 format ('ntot2 =',i3,2x,'idout2 =',i5,2x,'time2 =',f6.2,
     *2x,'xdata2 = ',f6.2,2x, 'ydata2 = ',f6.2)
      if(icom.eq.2) ydata2(idout2)=dompr2(ntot2)  !model peak period
      if(icom.eq.3) ydata2(idout2)=avdir2(ntot2) !model ave.dir.
      if(icom.eq.4) ydata2(idout2)=ws2(ntot2)  !model wind speed
      if(icom.eq.5) ydata2(idout2)=wd2(ntot2)  !model wind dir.
 150  continue
      idout2=idout2
```

```
c     print *,'j = ', j, 'n1m =',n1m, 'n2m = ',n2m,
    *      'idout2 =',idout2
c
c   ++++++++++Plot headings and labeling
c   define plot headings:
      if(j.eq.1.and.icom.eq.1) then
      call headin('Wave Height Buoy #44014 vs. Wiswave Model$',
    *100,1.26,2)
      call headin('(Days Processed: Dec 10-15 1992; 1.25 Deg Grid)$',
    *100,1.12,2)
      endif
c
      if(j.eq.1.and.icom.eq.2) then
      call headin('Wave Period Buoy #44014 vs. Wiswave Model$',
    *100,1.26,2)
      call headin('(Days Processed: Dec 10-15 1992; 1.25 Deg Grid)$',
    *100,1.12,2)
      endif
c
      if(j.eq.1.and.icom.eq.3) then
      call headin('Wave Direction Buoy #44014 vs. Wiswave Model$',
    *100,1.26,2)
      call headin('(Days Processed: Dec 10-15 1992; 1.25 Deg Grid)$',
    *100,1.12,2)
      endif
c
      if(j.eq.1.and.icom.eq.4) then
      call headin('Wind Speed Buoy #44014 vs. Wiswave Model$',
    *100,1.26,2)
      call headin('(Days Processed: Dec 10-15 1992; 1.25 Deg Grid)$',
    *100,1.12,2)
      endif
c
      if(j.eq.1.and.icom.eq.5) then
      call headin('Wind Direction Buoy #44014 vs. Wiswave Model$',
    *100,1.26,2)
      call headin('(Days Processed: Dec 10-15 1992; 1.25 Deg Grid)$',
    *100,1.12,2)
      endif
c
c +++++  Call curve to plot the points   +++++++++++
C call curve to plot buoy data:
      call curve(xdata,ydata,idout,0)
c
C call curve to plot model results:
      call dash
      call curve(xdata2,ydata2,idout2,0)
      call reset('dash')
c
```

```
c  place buoy ID below if not wanted in the heading:
c      if(j.eq.5) call messag('BUOY NO. = 44014$',
c      1100,1.0,-1.0)
c
c      if(j.eq.5.and.icom.eq.1) call messag('Wave Height$',
c      1100,1.0,-1.25)
c
c      if(j.eq.5.and.icom.eq.2) call messag('Peak Period$',
c      1100,1.0,-1.25)
c
c      if(j.eq.5.and.icom.eq.3) call messag('Mean Direction$',
c      1100,1.0,-1.25)
c
c      if(j.eq.5.and.icom.eq.4) call messag('Wind Speed$',
c      1100,1.0,-1.25)
c
c      if(j.eq.5.and.icom.eq.5) call messag('Wind Direction$',
c      1100,1.0,-1.25)
c
c      idate(1) = 1992
c      IF(J.EQ.5)call messag('DAYS PROCESSED: SEP 1-4
c           *$',100,1.00,-1.75)
c      IF(J.EQ.5) CALL intno(idate(1),3.917,-1.75)
c  place plot labels after the last plot on a page. define the
c      positions (start and end points) and symbol types for plot
c      labels:
       if (j .eq. 5) then
       call strtpt(5.,-1.)
       call connpt(6.,-1.)
       call messag('BUOY',100,6.2,-1.)
       call dash
       call strtpt(5.,-1.25)
       call connpt(6.,-1.25)
       call messag('WISWAVE (with wind stress)',100,6.2,-1.25)
       call reset('dash')
       endif
       call endgr(0)
       nread =nread + 1
   100 continue
c  stop individual plots on each page and terminate device
       ICOM=icom+1
       call endpl(0)
       IF(ICOM.le.5) GO TO 16
       CALL DONEPL
       RETURN
       end
```

Appendix G
WISWAVE and NDBC Buoy Conparisons, Buoy 44014, 1-4 Sep 92
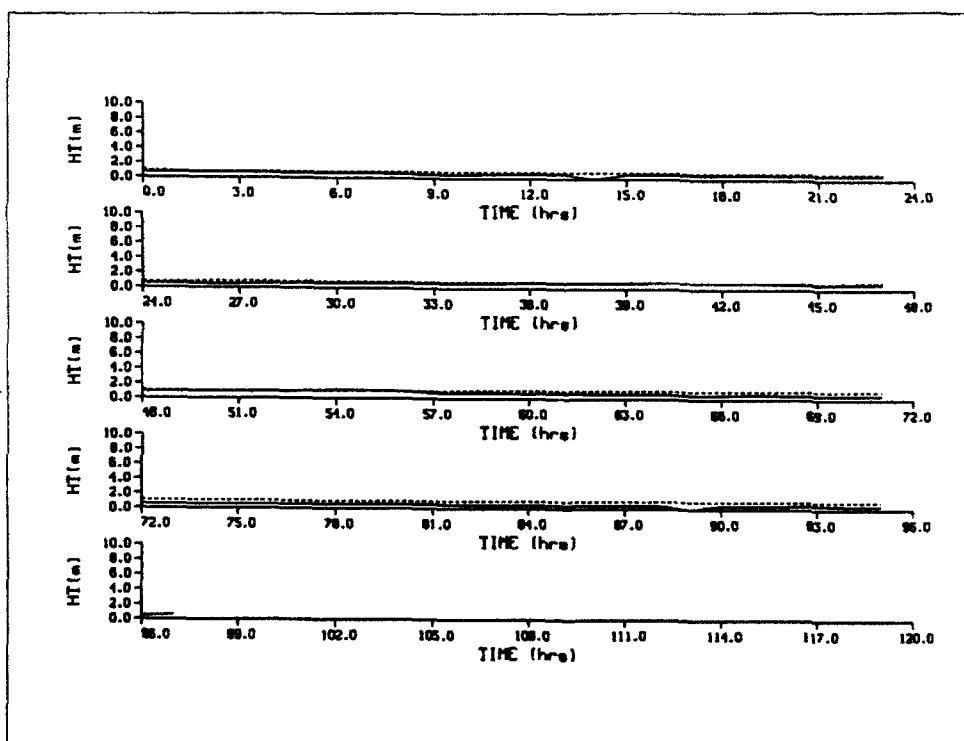
Figure G1. Significant wave height, 2.5-deg grid; buoy (solid line), WISWAVE with Navy surface wind (dashed line)
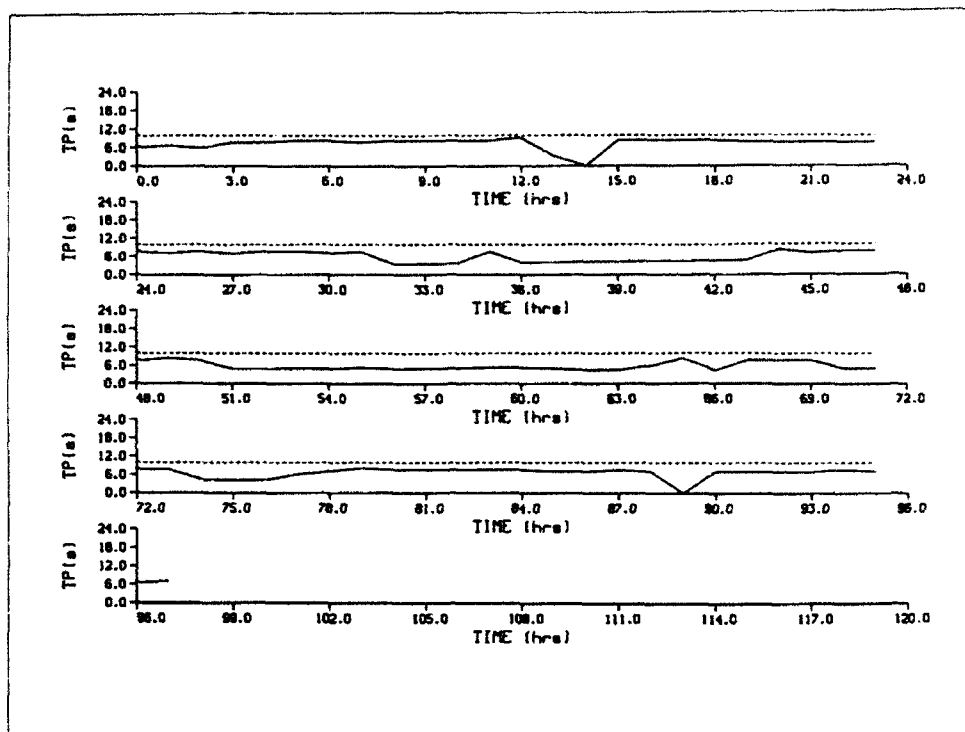
Figure G2. Peak wave period, 2.5-deg grid; buoy (solid line), WISWAVE with Navy surface wind (dashed line)
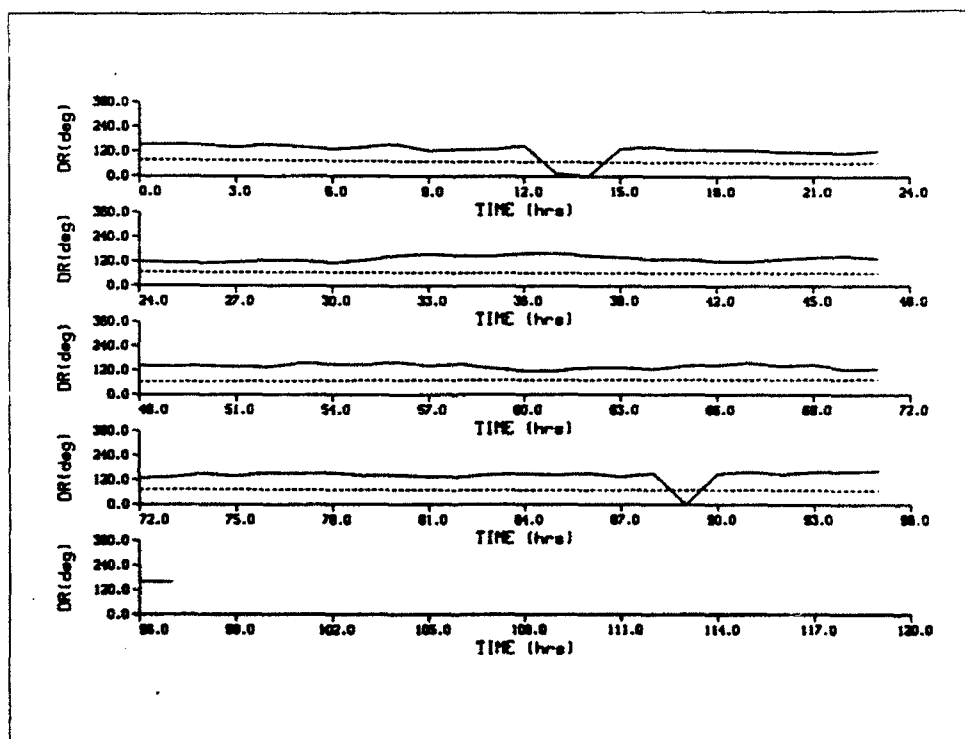
Figure G3. Peak wave direction, 2.5-deg grid; buoy (solid line), WISWAVE with Navy surface wind (dashed line)
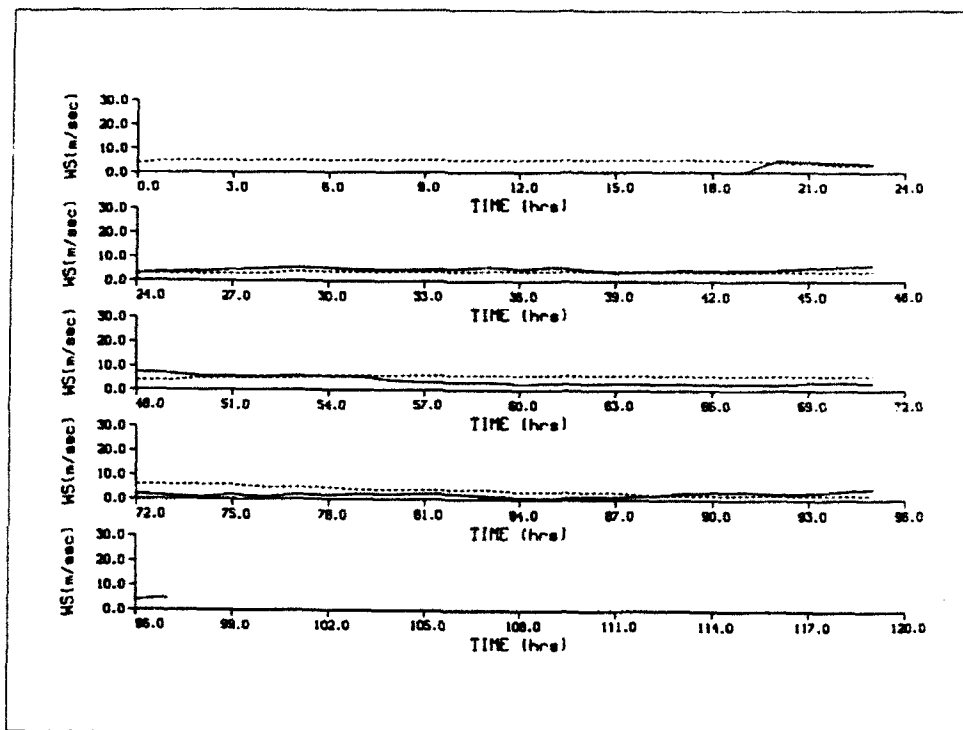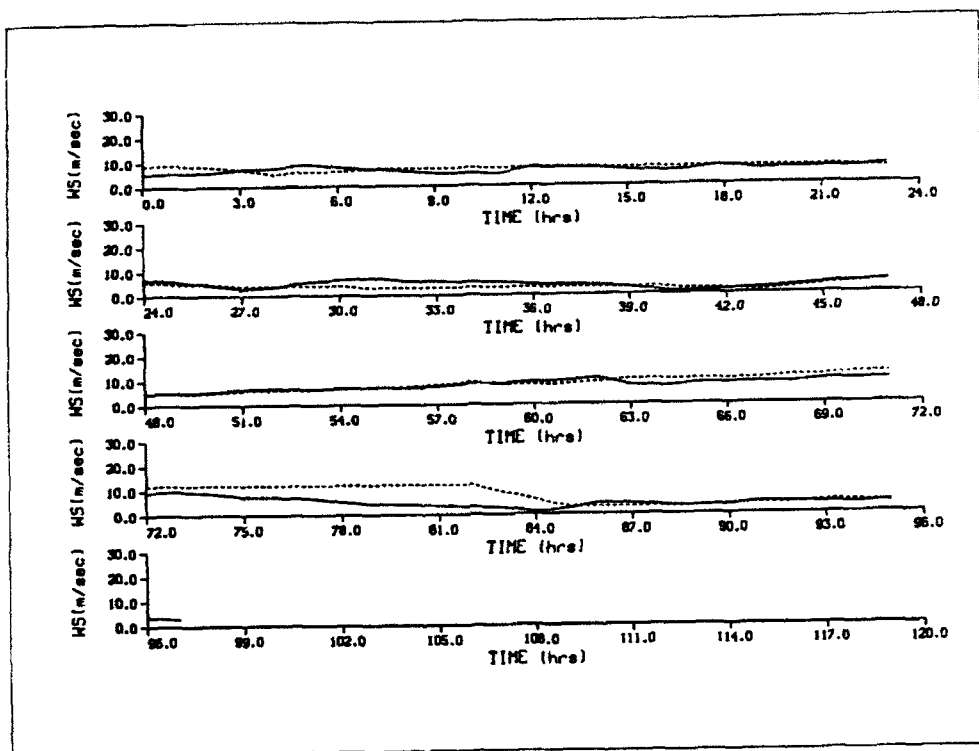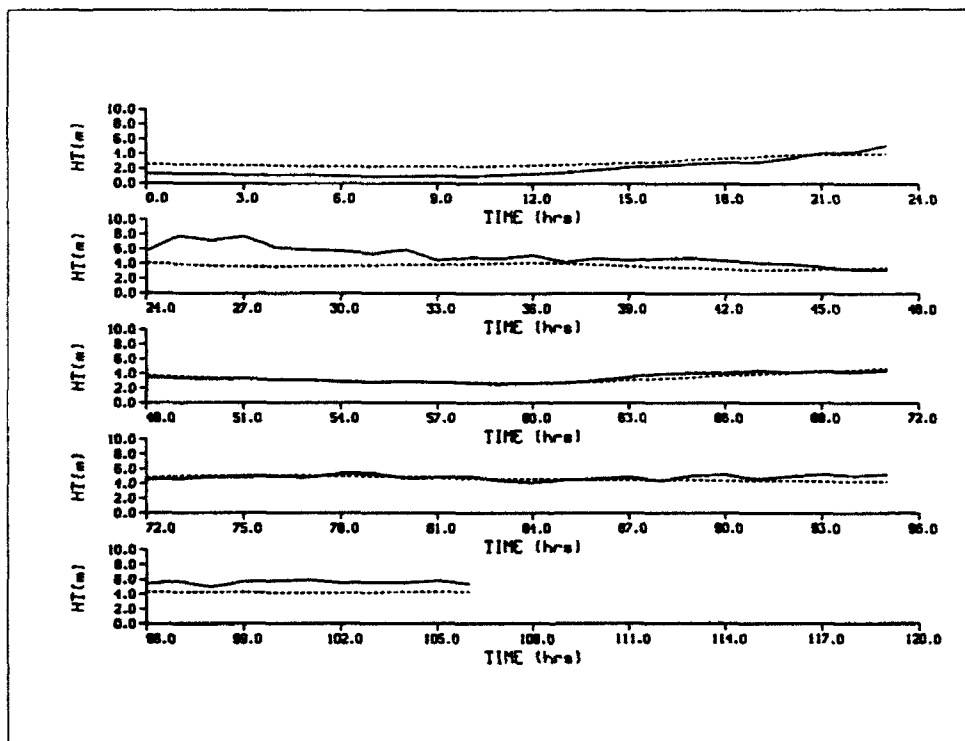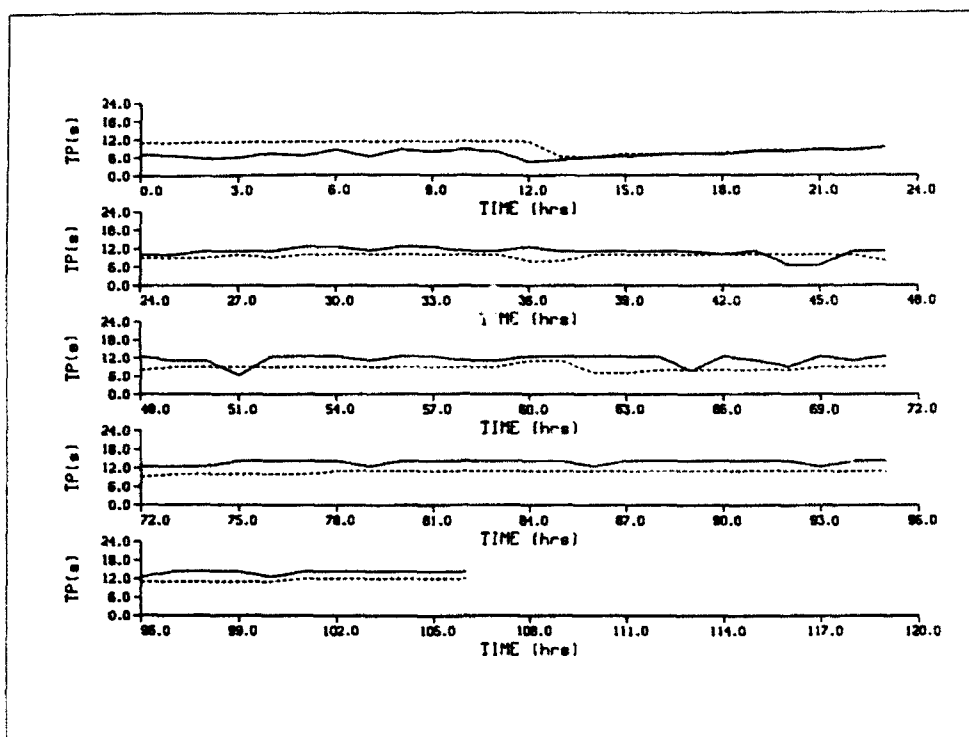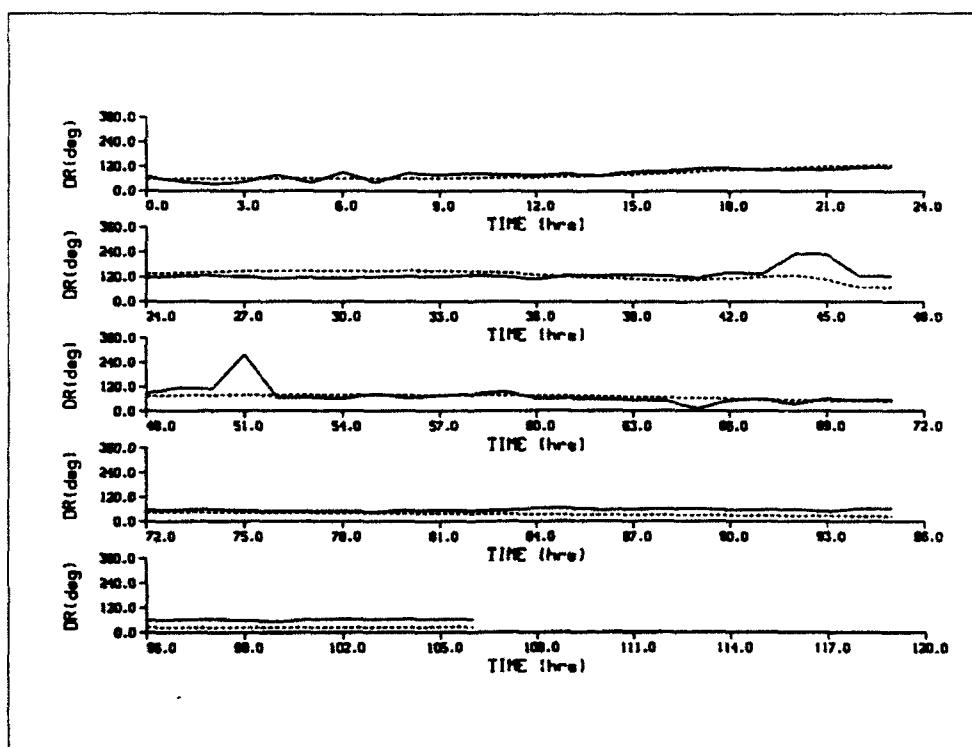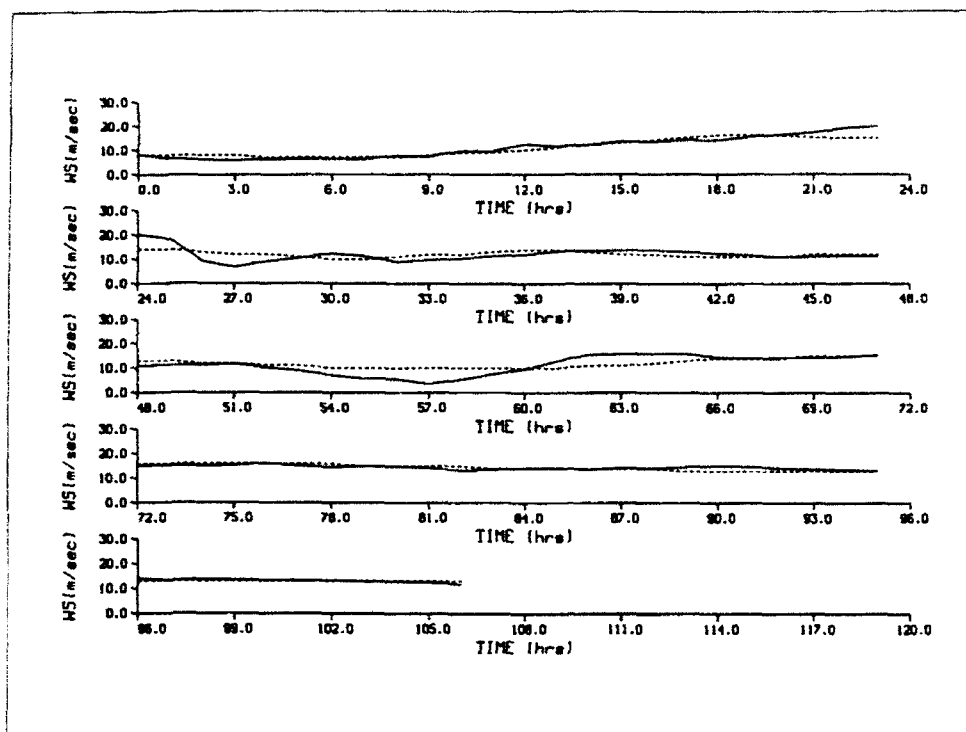
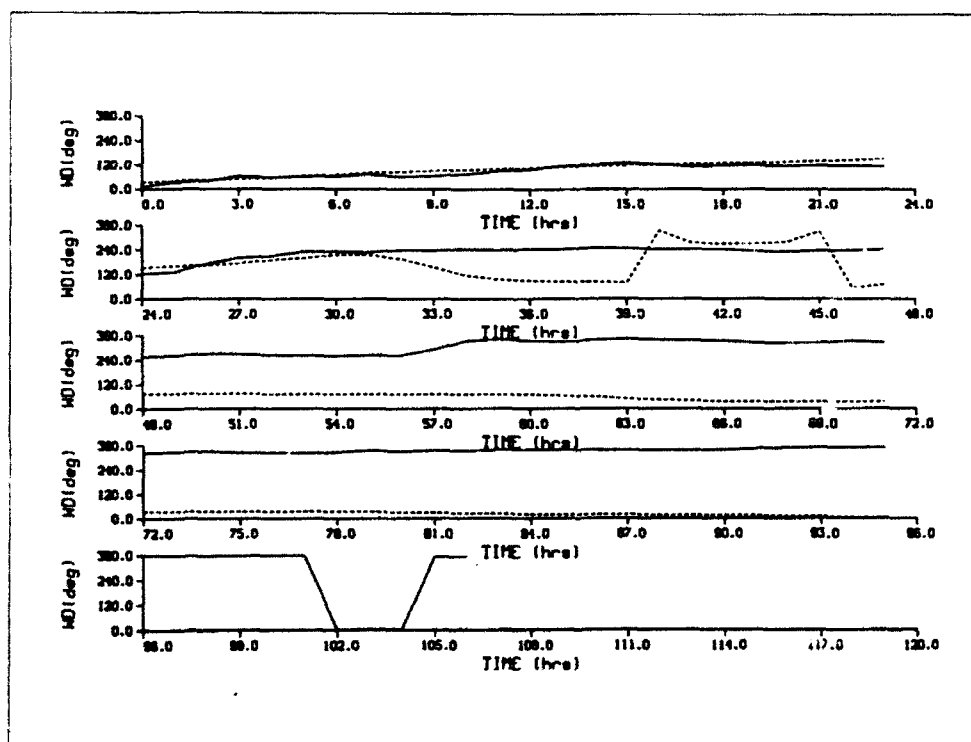Figure G4.   Wind speed, 2.5-deg grid;   buoy (solid line), Navy surface wind (dashed line)
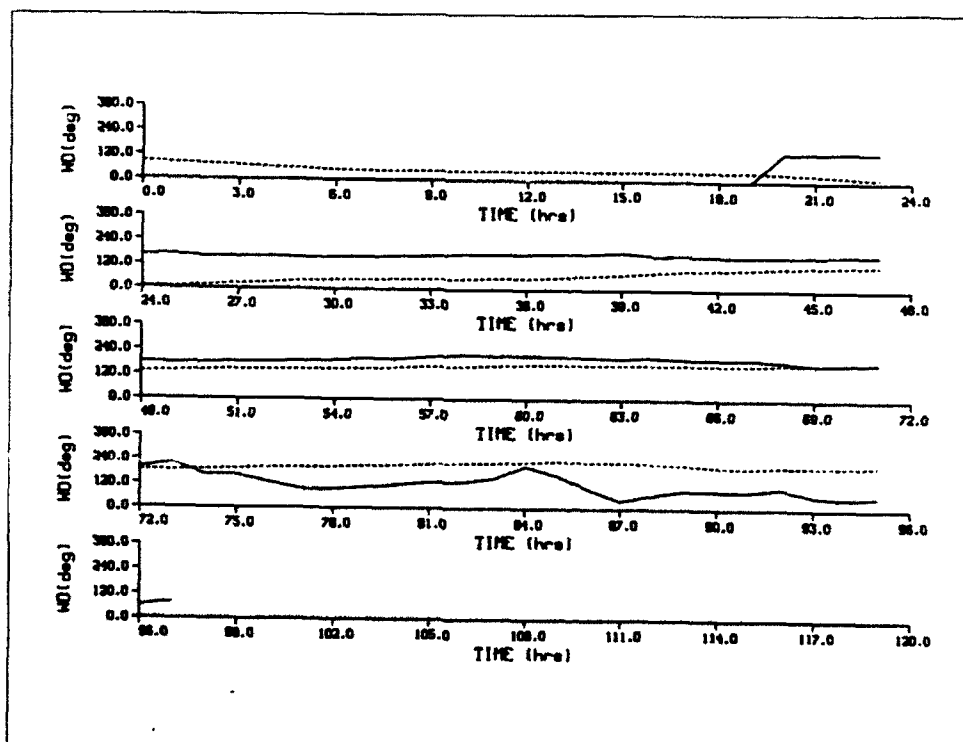
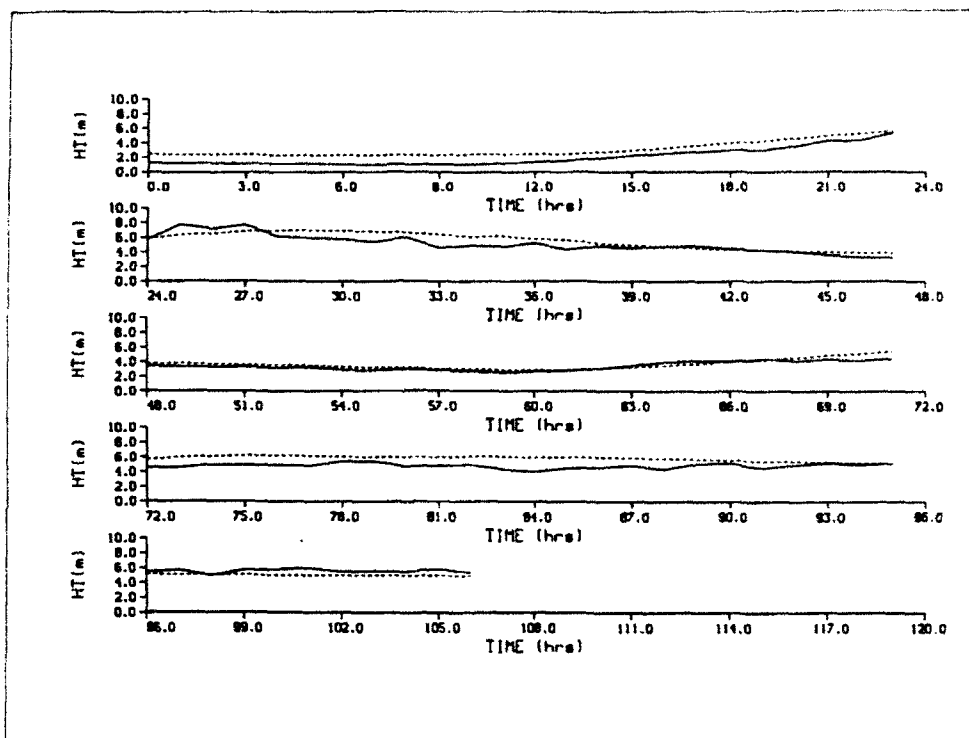Figure G5.   Wind direction, 2.5-deg grid;   buoy (solid line), Navy surface wind (dashed line)
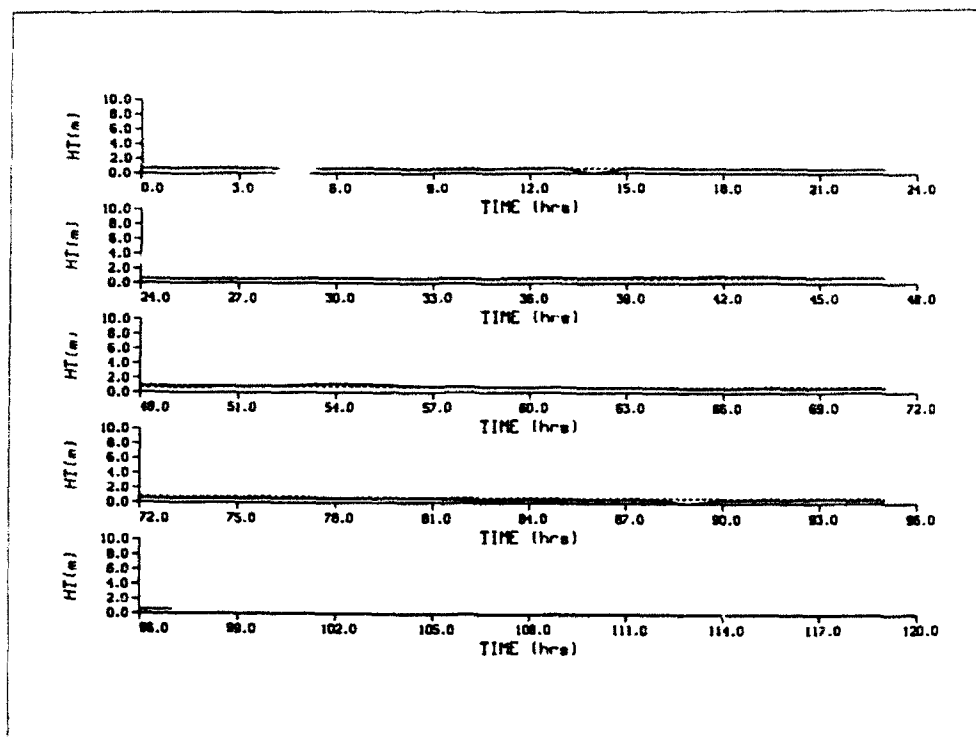
Figure G6. Significant wave height, 1.25-deg grid; buoy (solid line), WISWAVE with Navy surface wind (dashed line)
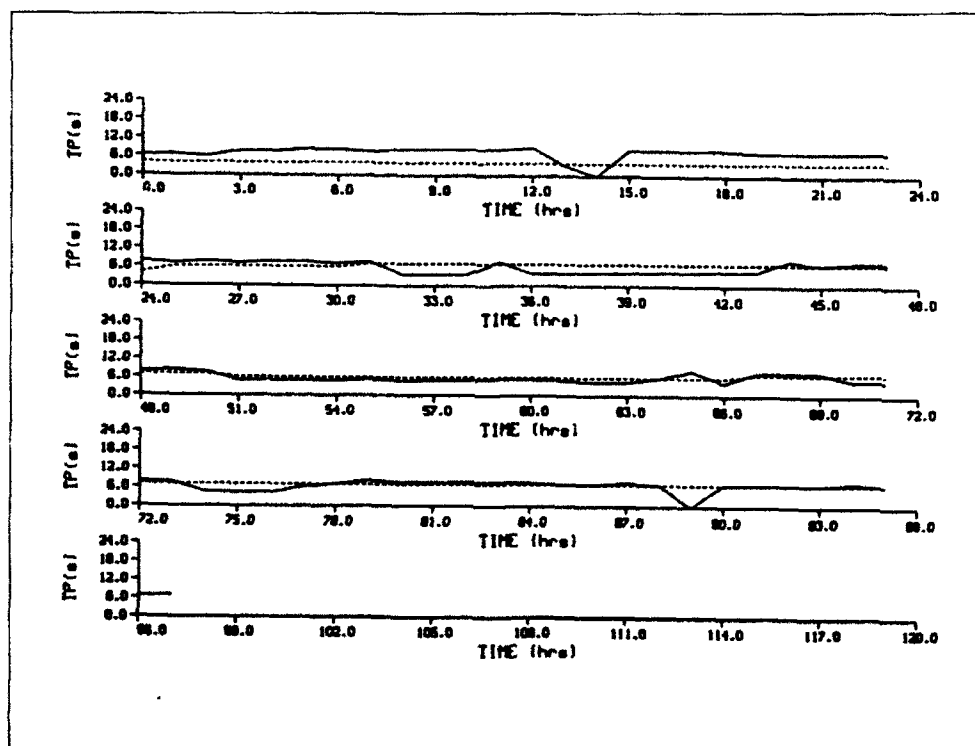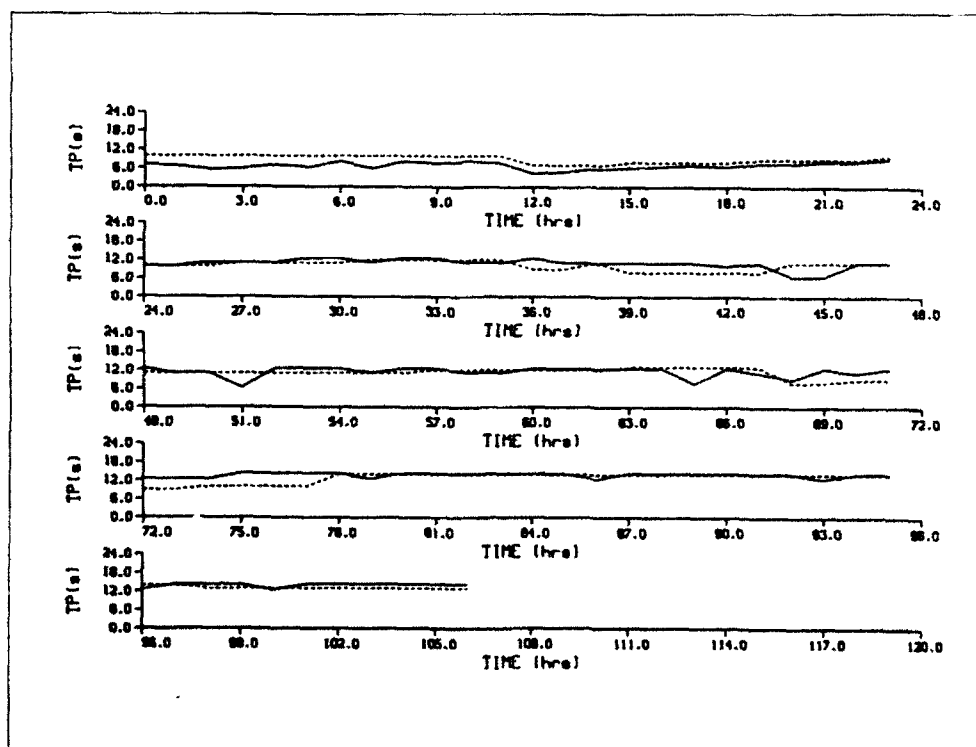

Figure G7. Peak wave period, 1.25-deg grid; buoy (solid line), WISWAVE with Navy surface wind (dashed line)
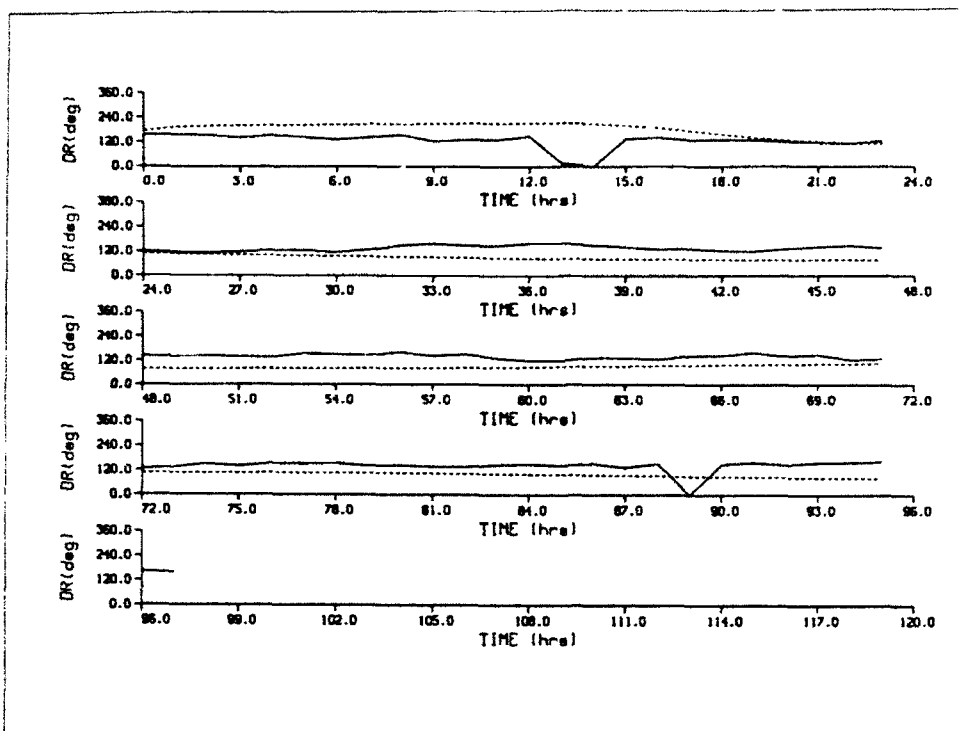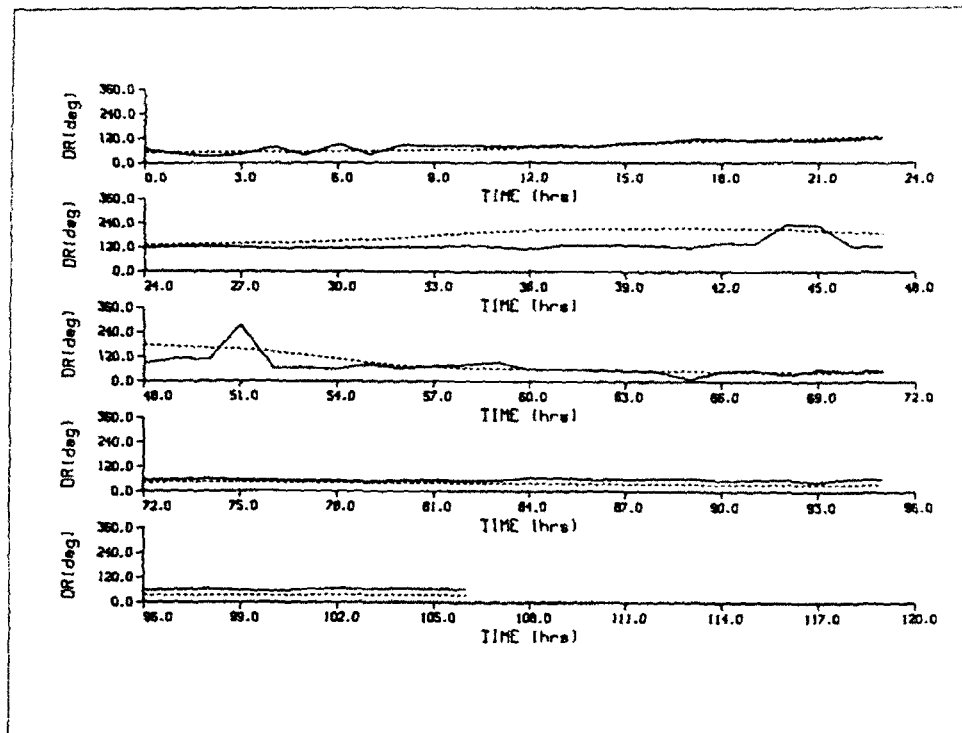
Figure G8. Peak wave direction, 1.25-deg grid; buoy (solid line), WISWAVE with Navy surface wind (dashed line)
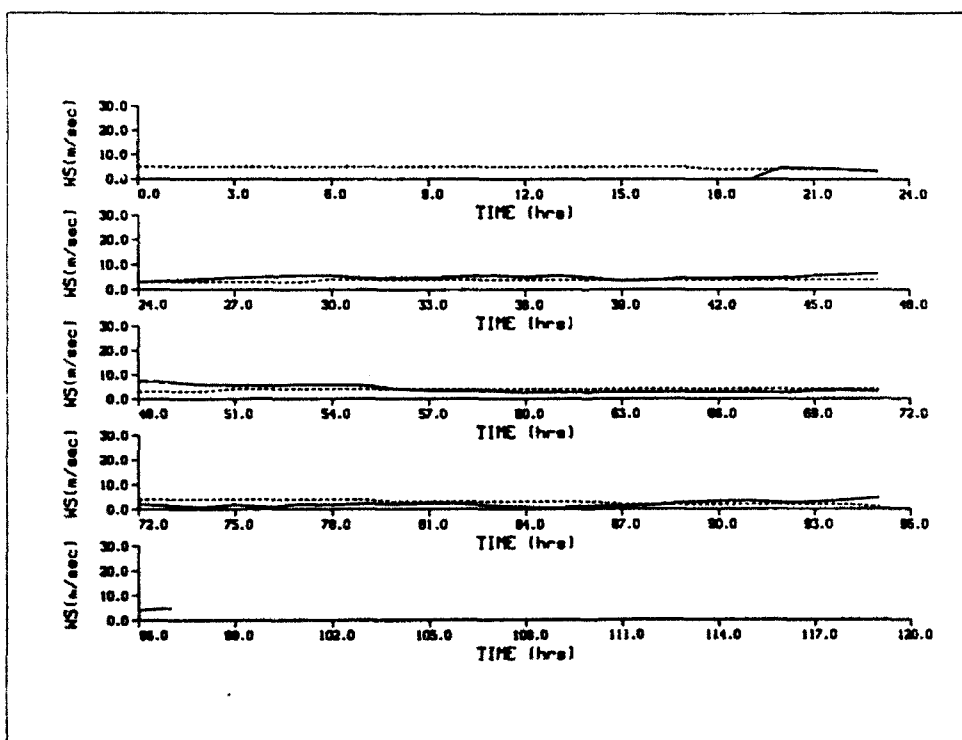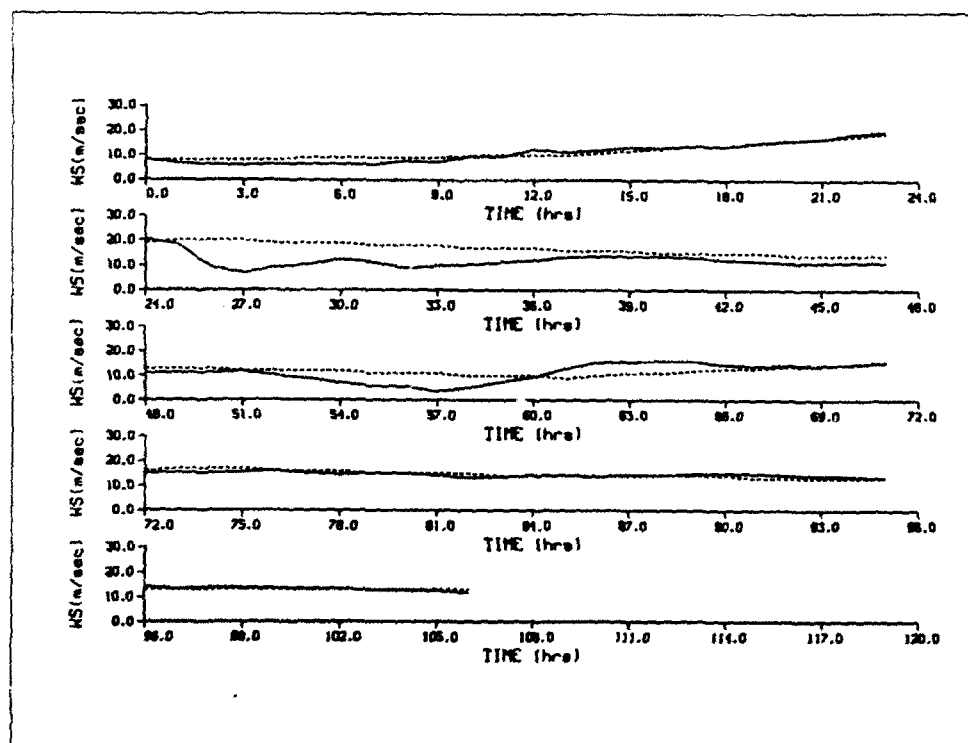

Figure G9. Wind speed, 1.25-deg grid; buoy (solid line), Navy surface wind (dashed line)
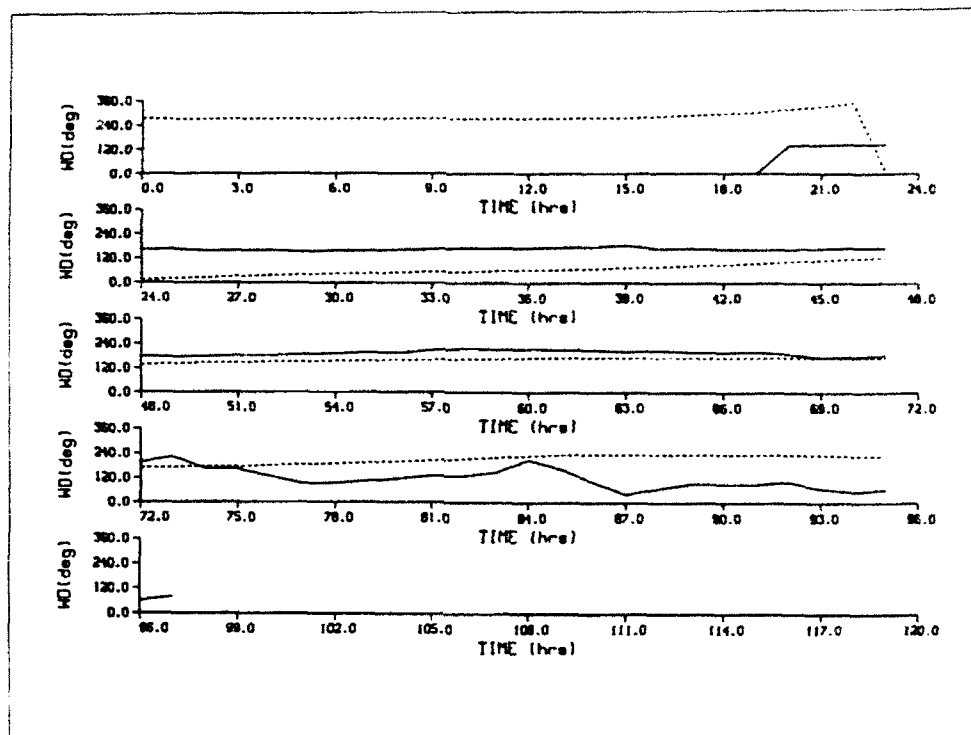
Figure G10. Wind direction, 1.25-deg grid; buoy (solid line), Navy surface wind (dashed line)
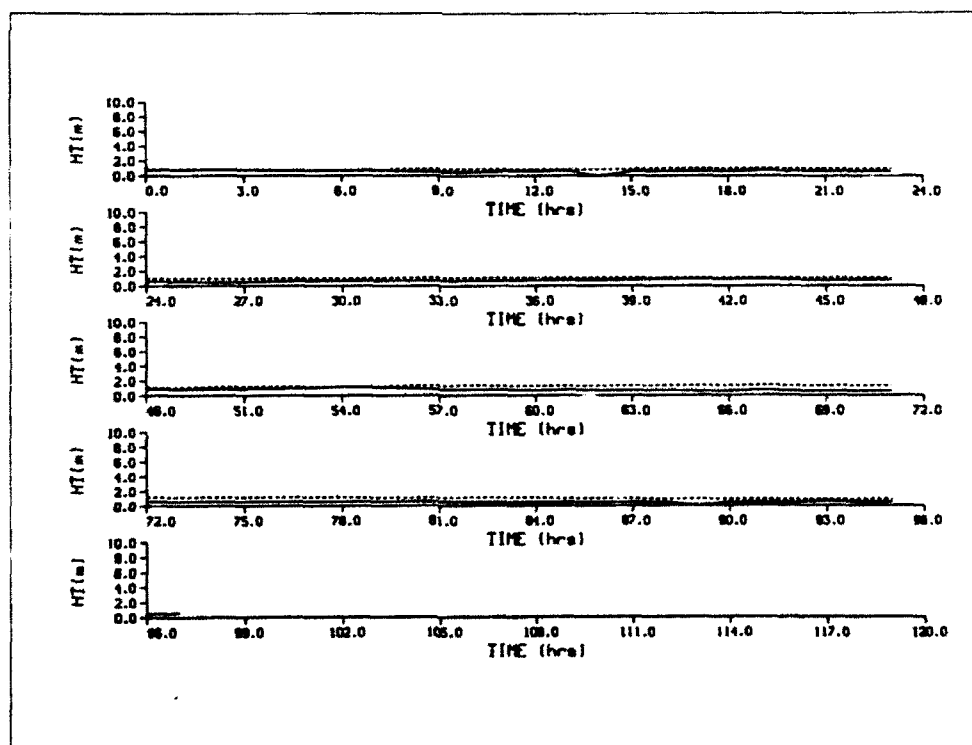
Figure G11. Significant wave height, 1.25-deg grid; buoy (solid line), WISWAVE with Navy wind stress (dashed line)
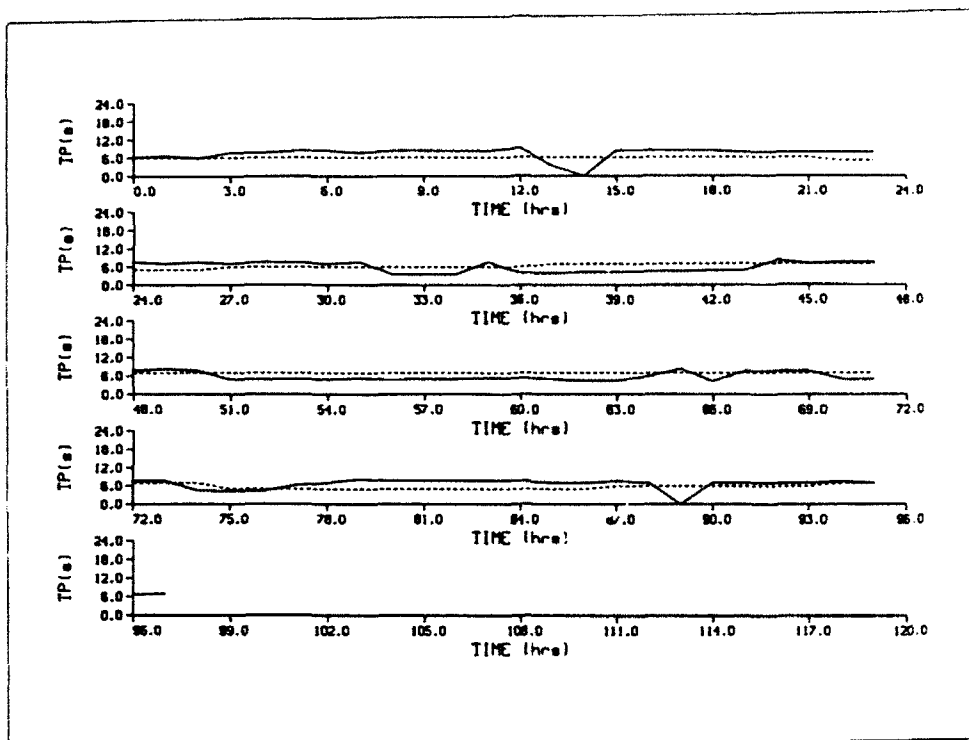
Figure G12. Peak wave period, 1.25-deg grid; buoy (solid line), WISWAVE with Navy wind stress (dashed line)
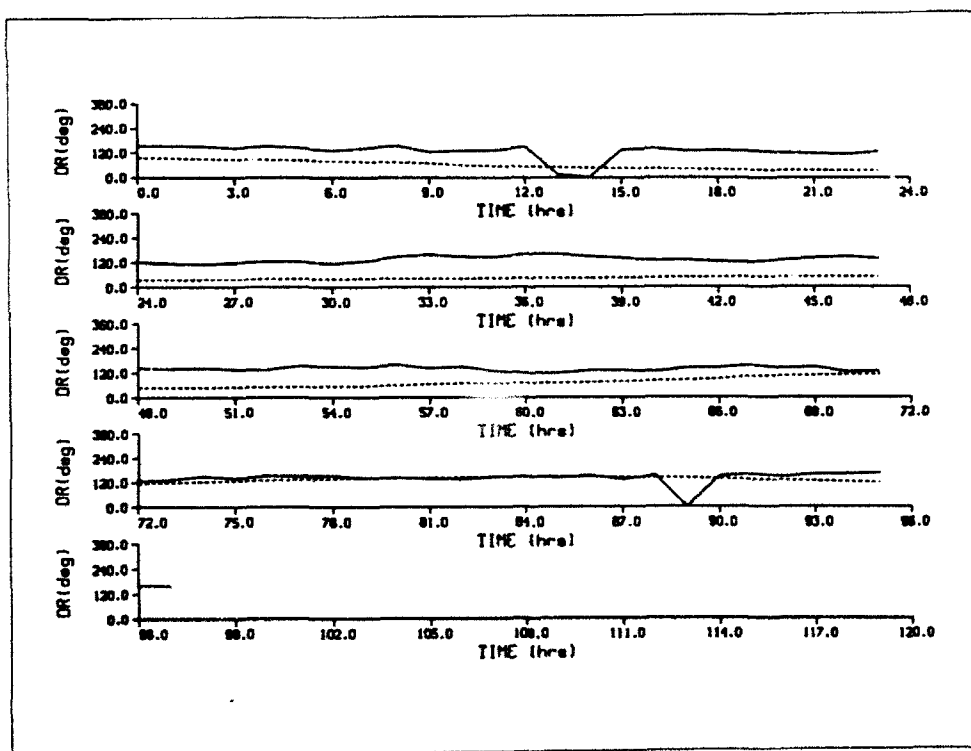
Figure G13. Peak wave direction, 1.25-deg grid; buoy (solid line), WISWAVE with Navy wind stress (dashed line)

G7
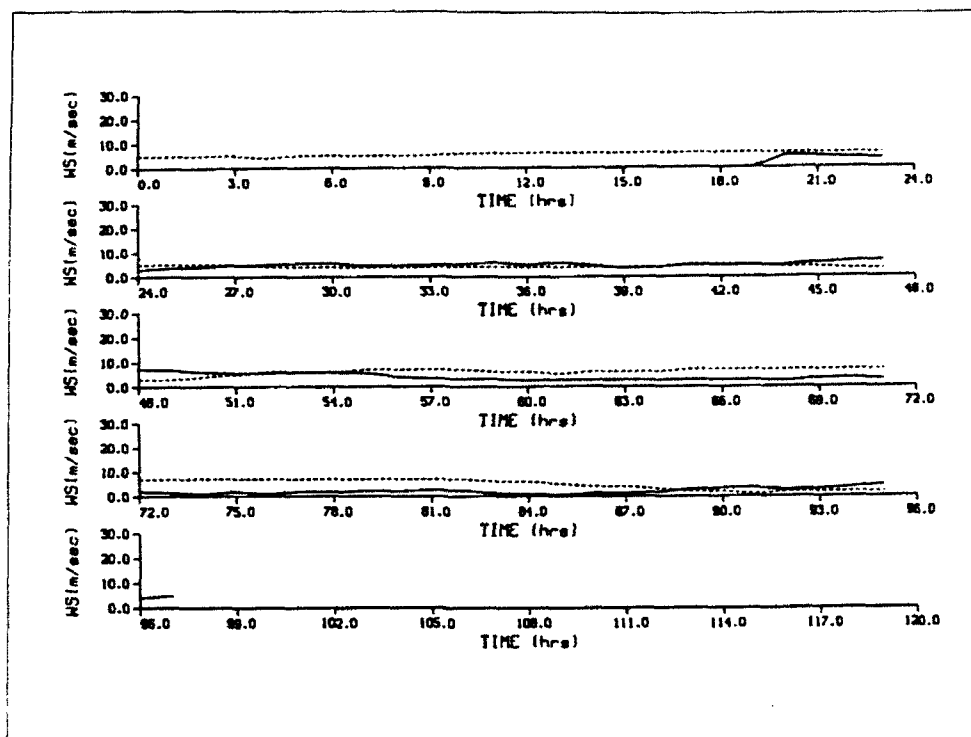
Figure G14. Wind speed, 1.25-deg grid; buoy (solid line), Navy wind stress
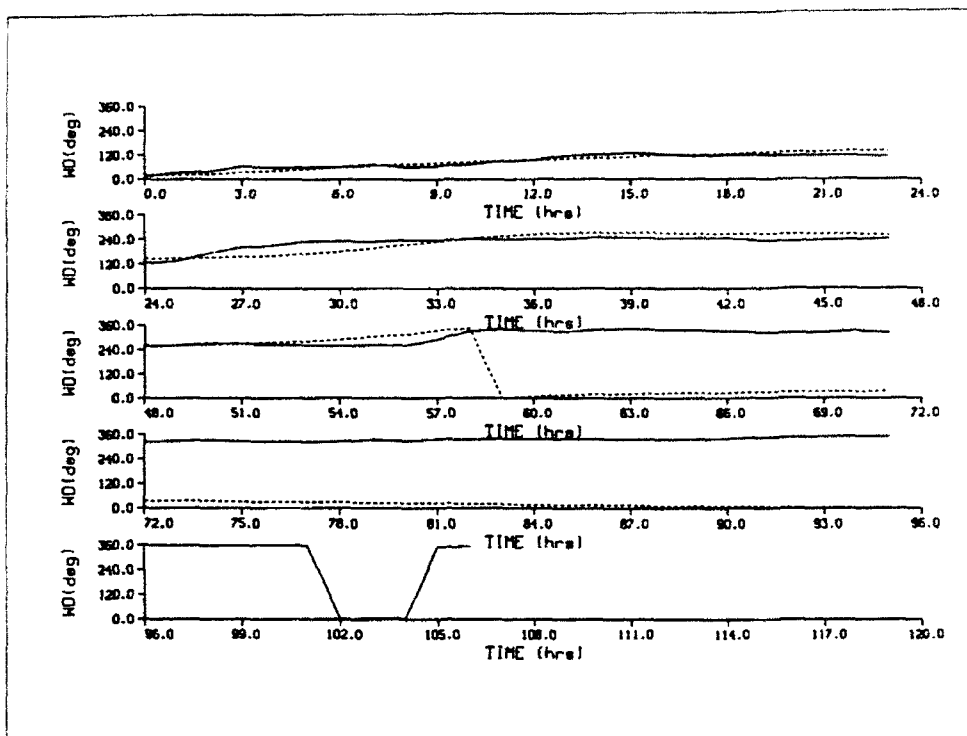(dashed line)
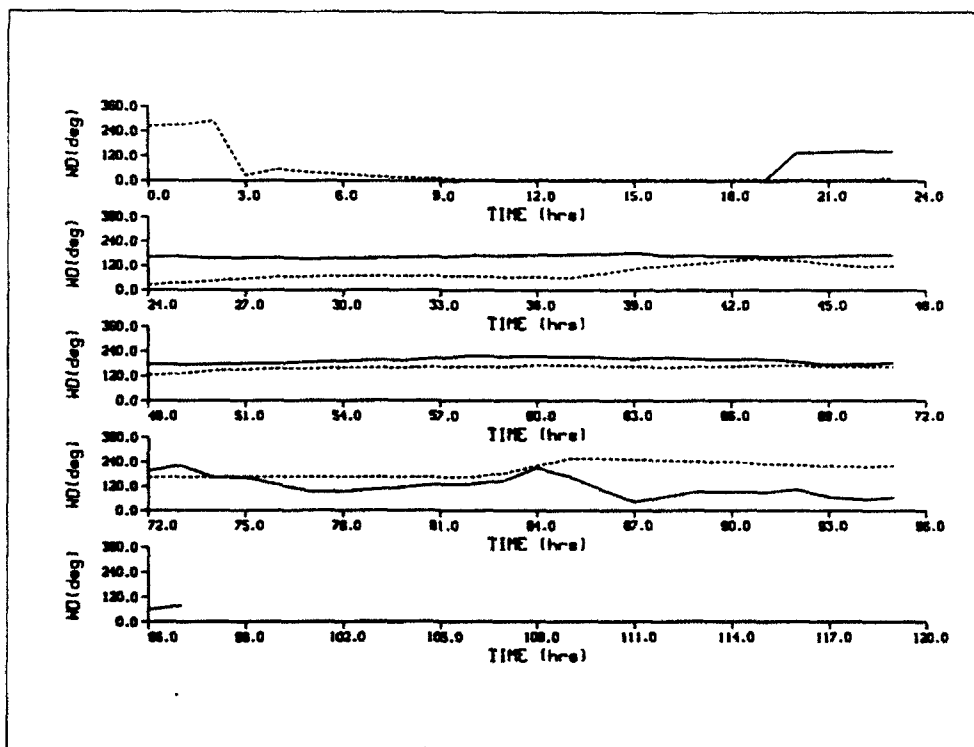
Figure G15. Wind direction, 1.25-deg grid; buoy (solid line), Navy wind stress
(dashed line)

Appendix H
WISWAVE and NDBC Buoy Comparisons, Buoy 44025, 1-4 Sep 92
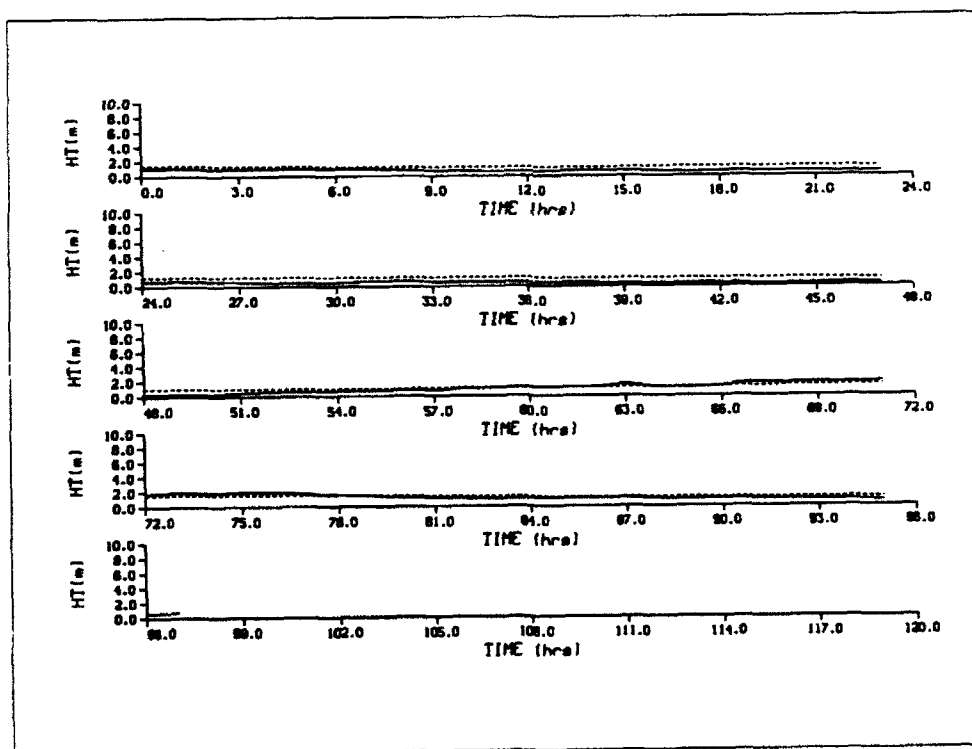
Figure H1. Significant wave height, 2.5-deg grid; buoy (solid line), WISWAVE with Navy surface wind (dashed line)
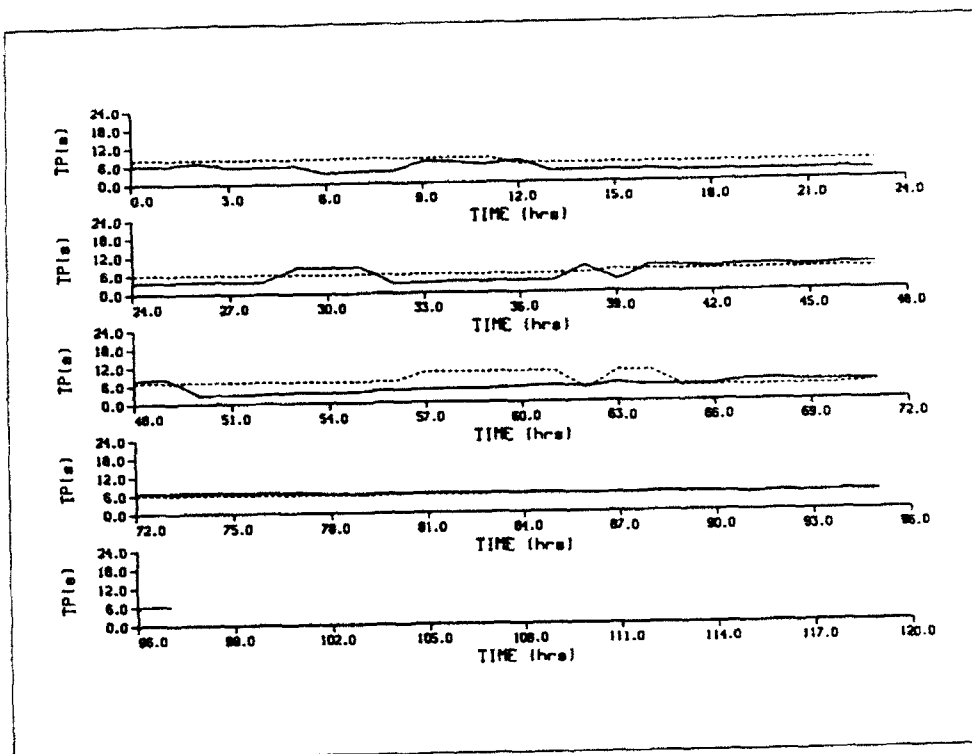
Figure H2. Peak wave period, 2.5-deg grid; buoy (solid line), WISWAVE with Navy surface wind (dashed line)
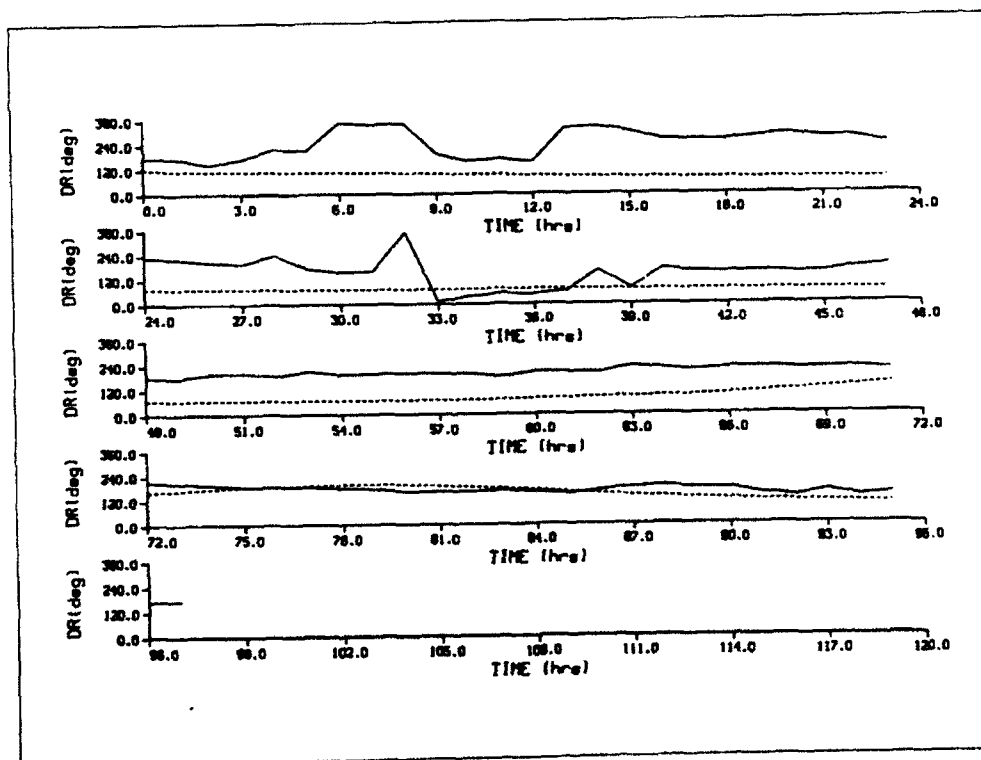
Figure H3. Peak wave direction, 2.5-deg grid; buoy (solid line), WISWAVE with Navy surface wind (dashed line)
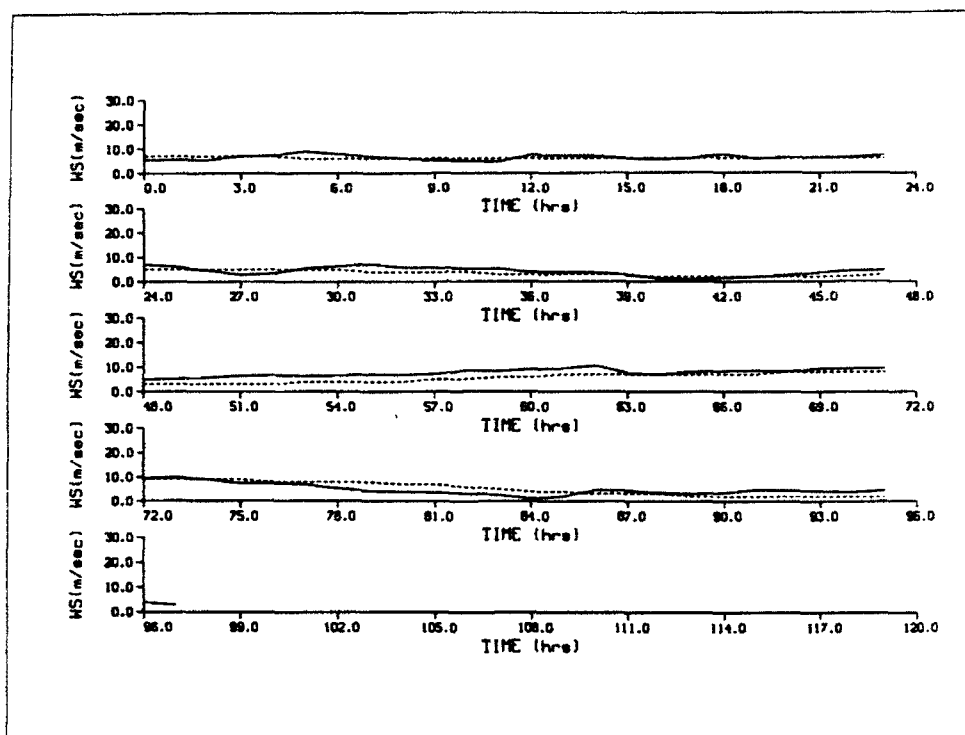
Figure H4. Wind speed, 2.5-deg grid; buoy (solid line), Navy surface wind (dashed line)
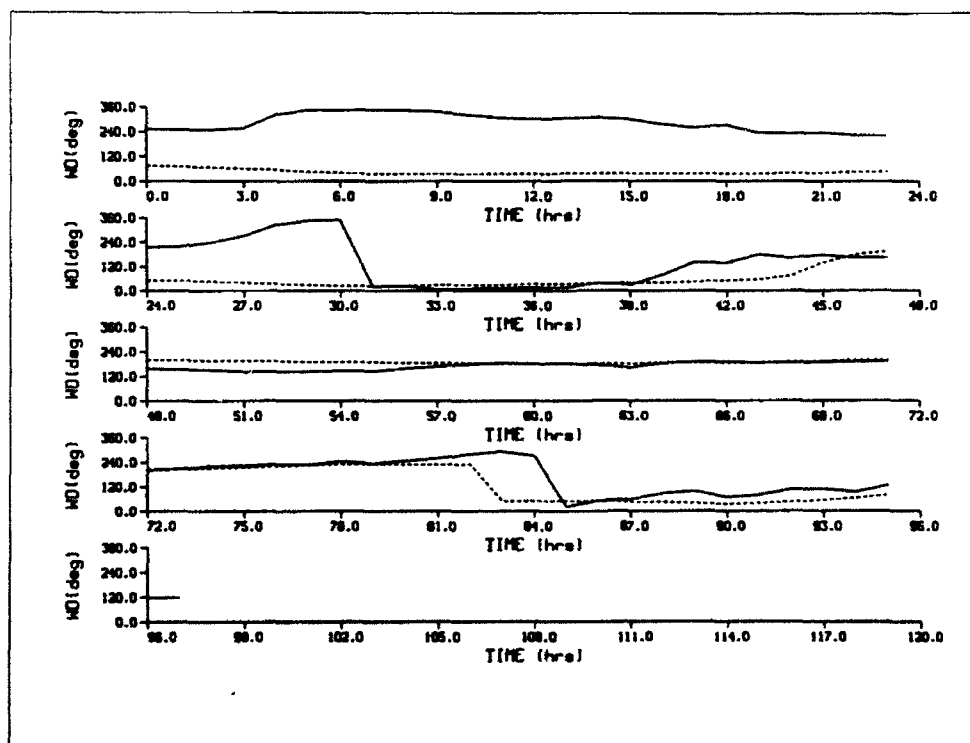
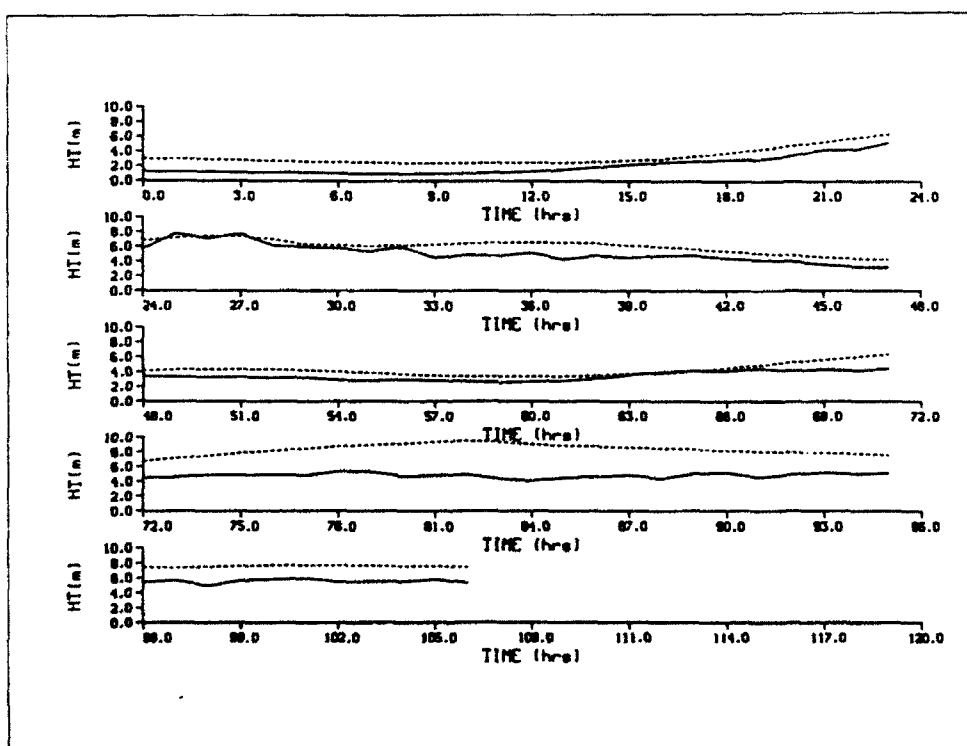Figure H5. Wind direction, 2.5-deg grid; buoy (solid line), Navy surface wind (dashed line)
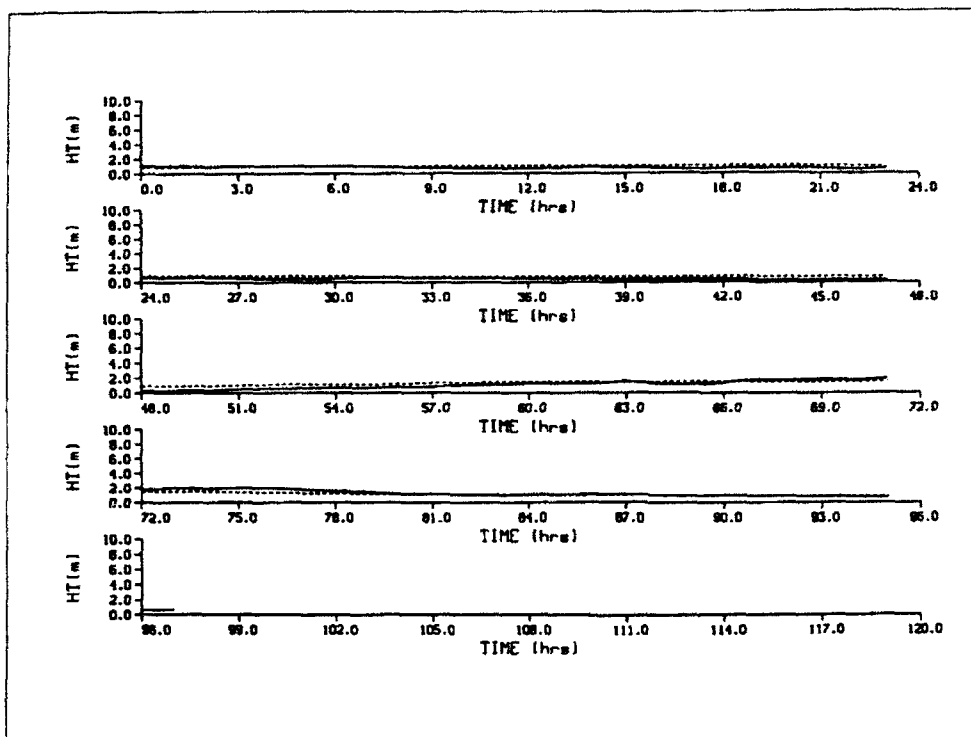
Figure H6. Significant wave height, 1.25-deg grid; buoy (solid line), WISWAVE with Navy surface wind (dashed line)
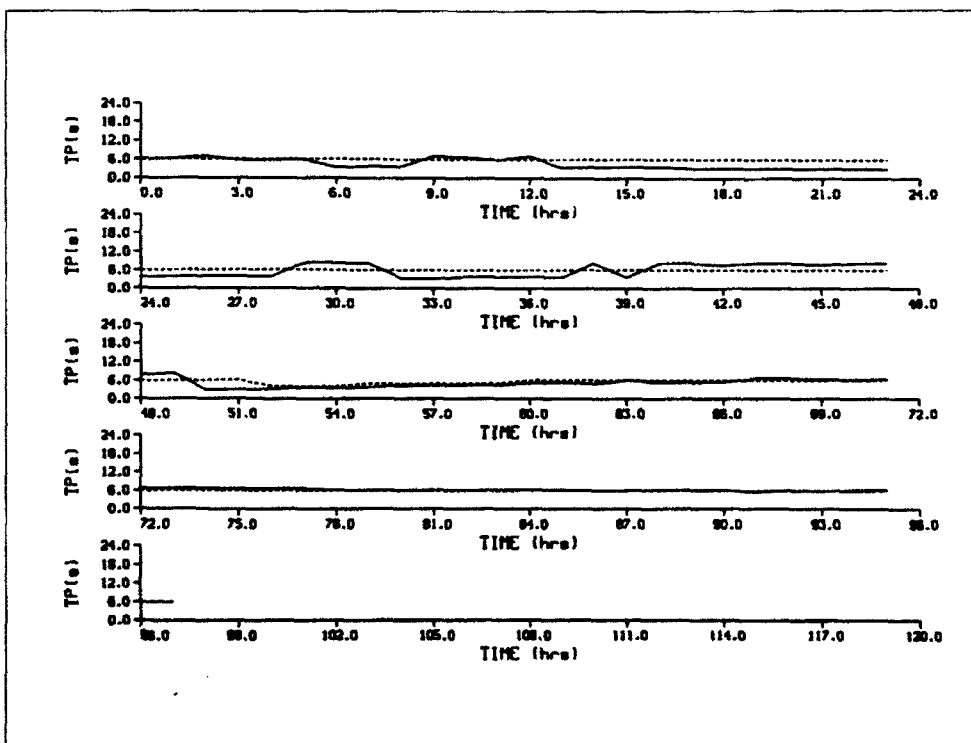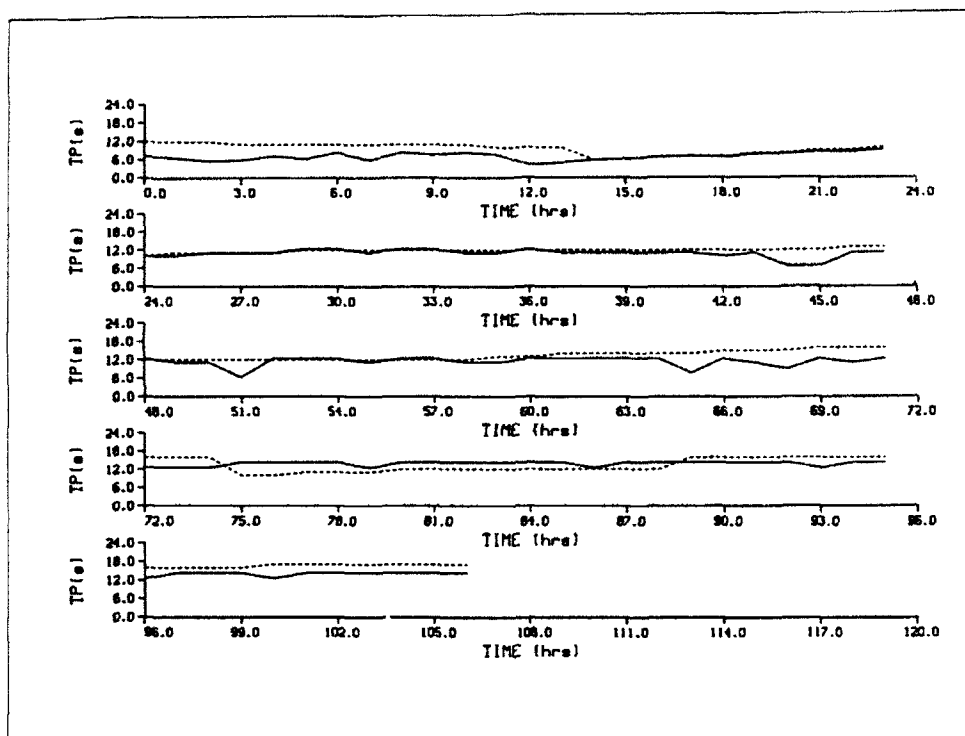

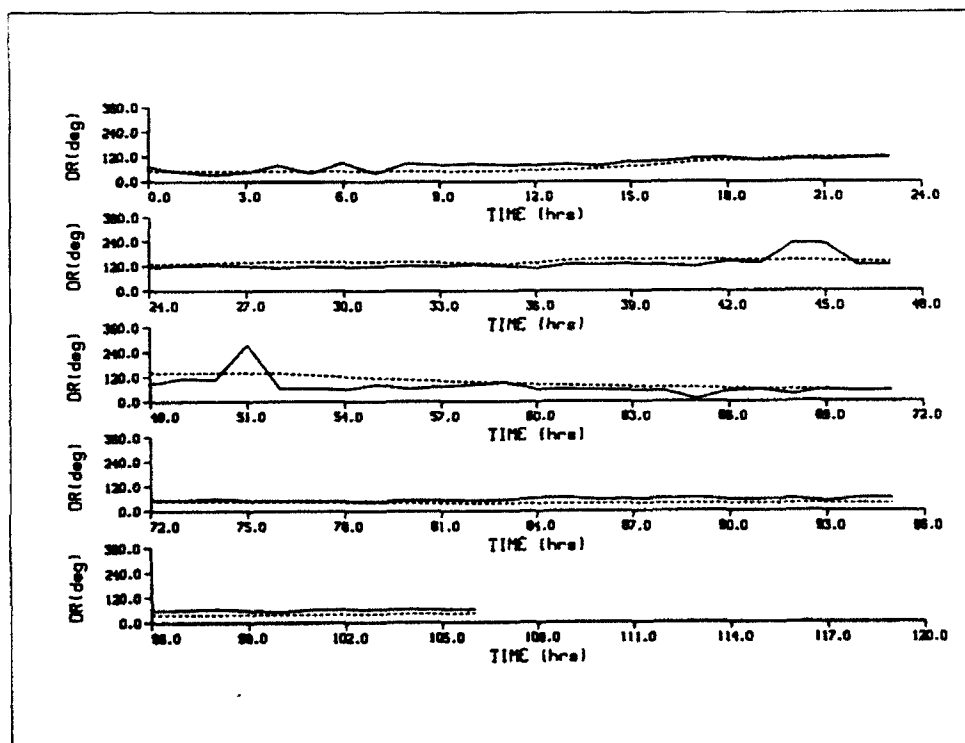Figure H7. Peak wave period, 1.25-deg grid; buoy (solid line), WISWAVE with Navy surface wind (dashed line)
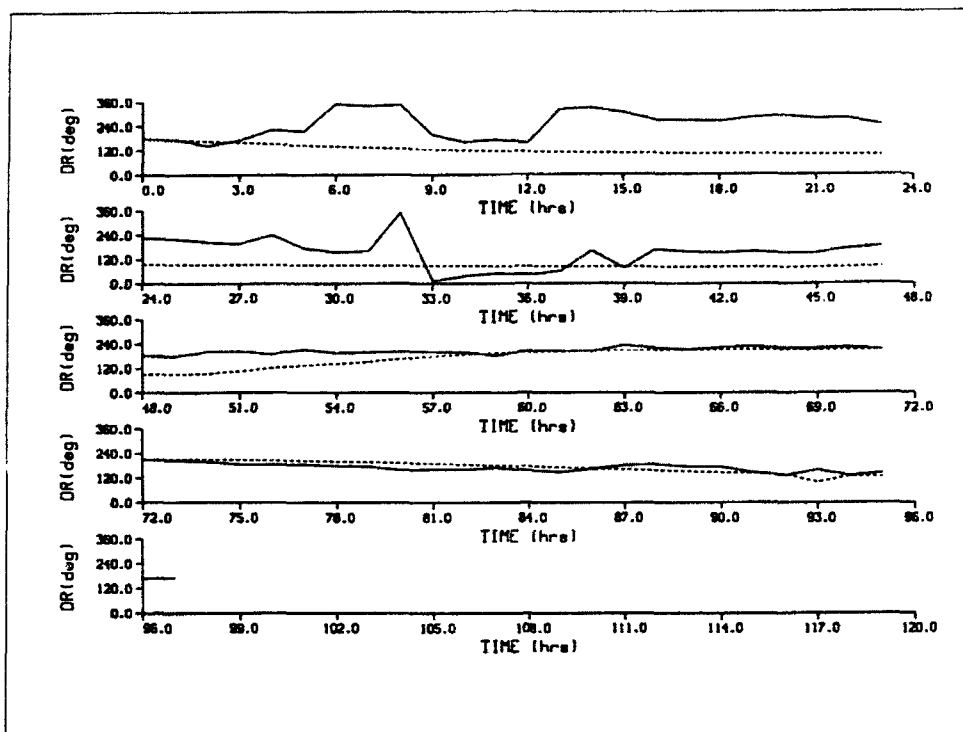
Figure H8. Peak wave direction, 1.25-deg grid; buoy (solid line), WISWAVE with Navy surface wind (dashed line)
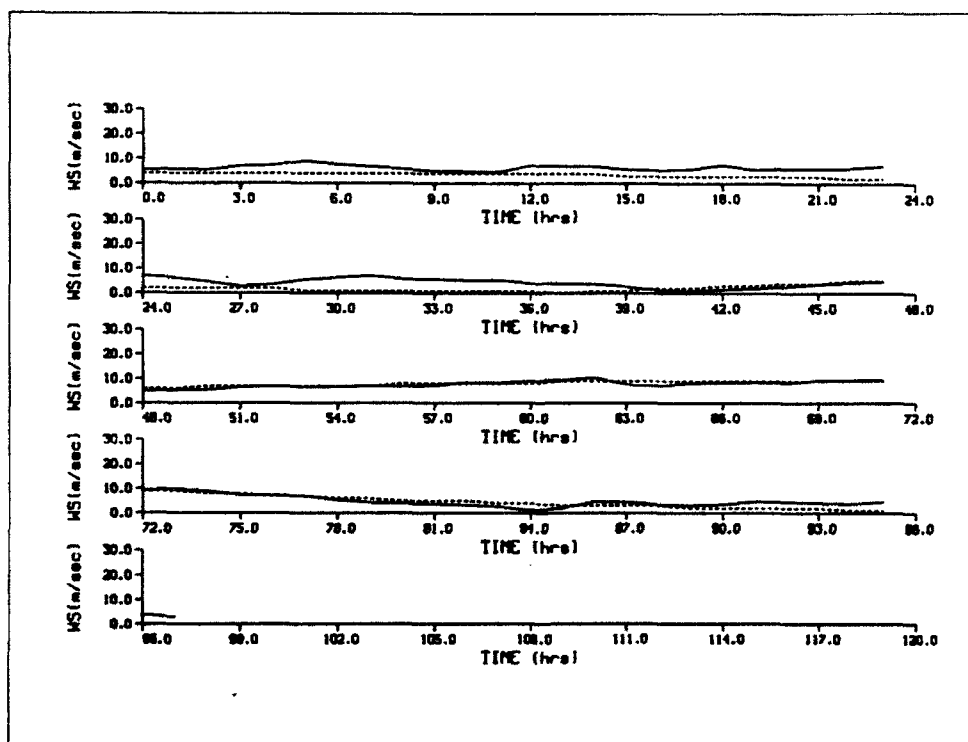
Figure H9. Wind speed, 1.25-deg grid; buoy (solid line), Navy surface wind (dashed line)
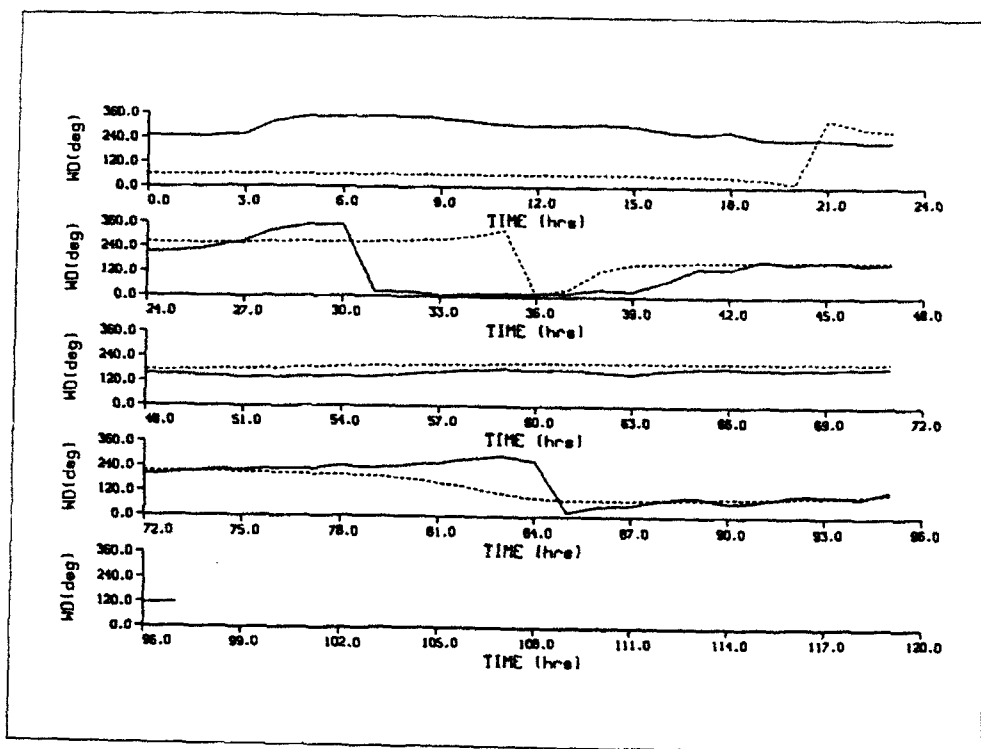
Figure H10. Wind direction, 1.25-deg grid; buoy (solid line), Navy surface wind (dashed line)
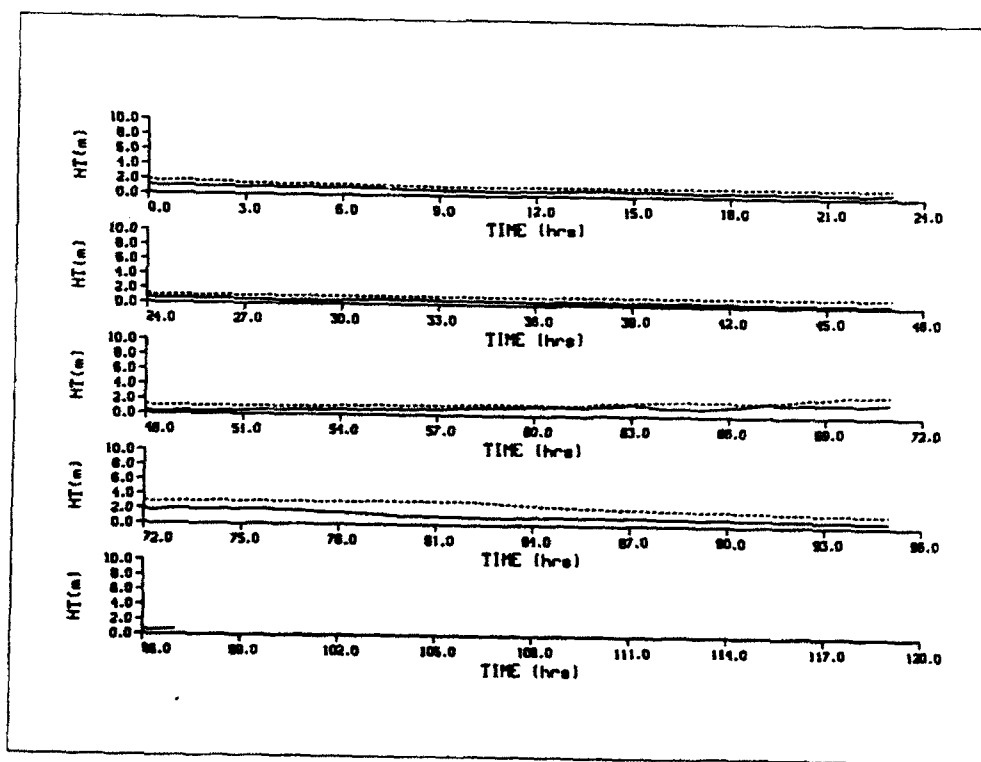
Figure H11. Significant wave height, 1.25-deg grid; buoy (solid line), WISWAVE with Navy wind stress (dashed line)
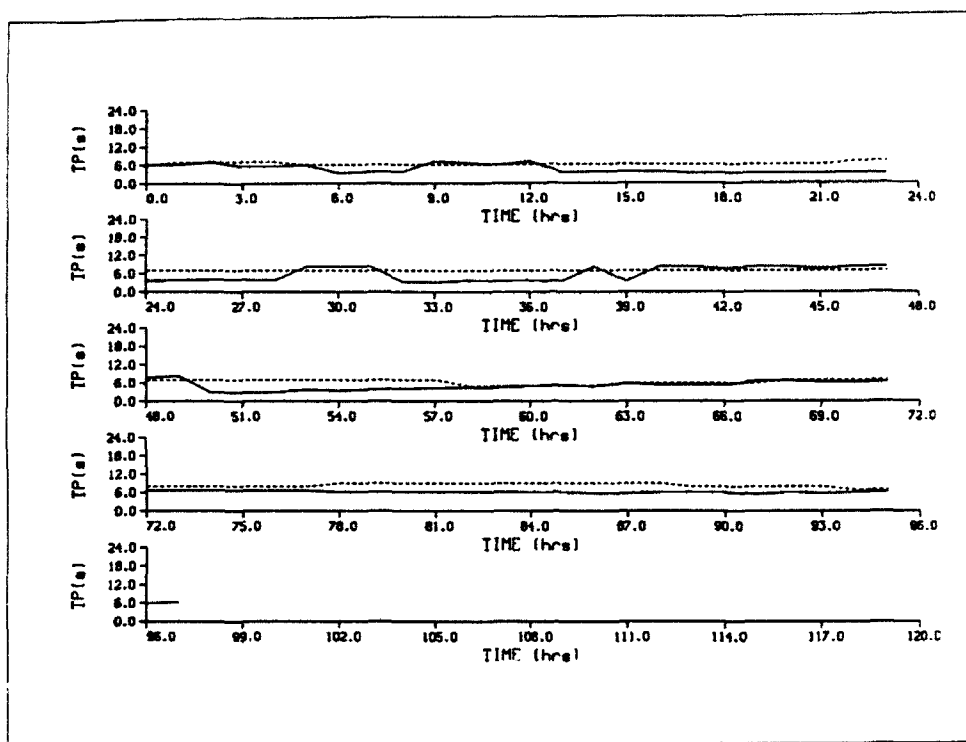
Figure H12. Peak wave period, 1.25-deg grid; buoy (solid line), WISWAVE with Navy wind stress (dashed line)
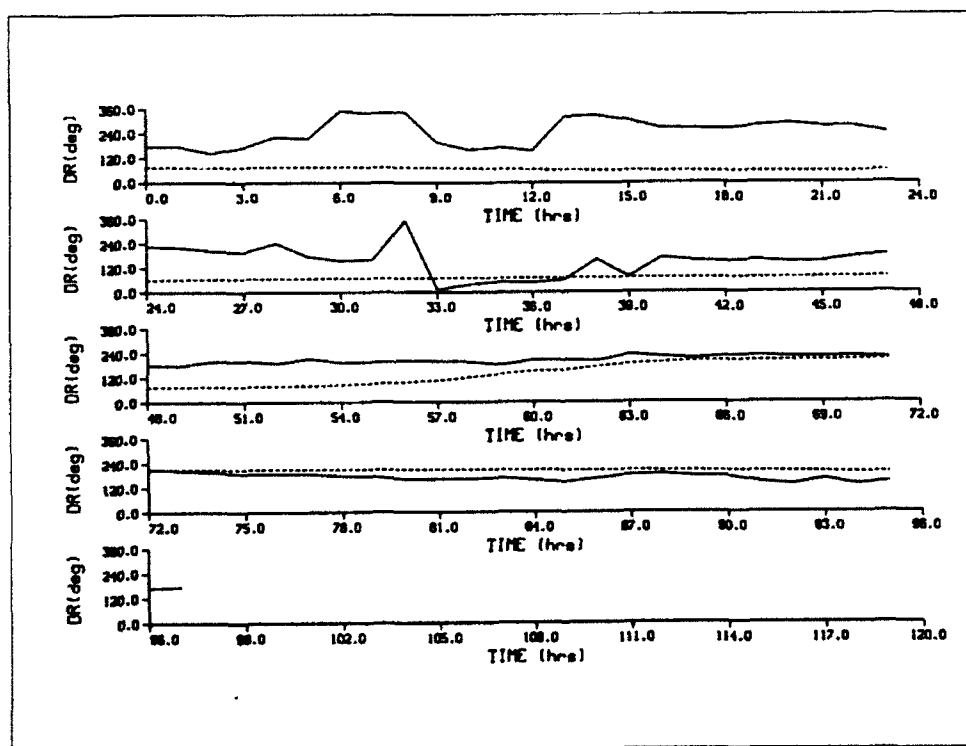
Figure H13. Peak wave direction, 1.25-deg grid; buoy (solid line), WISWAVE with Navy wind stress (dashed line)
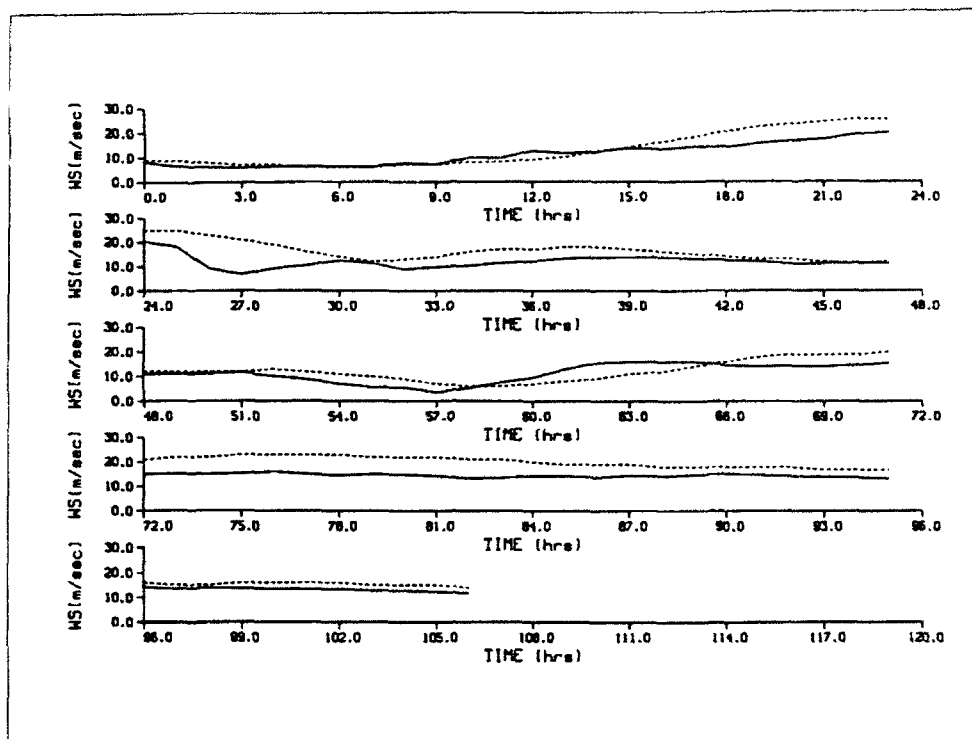
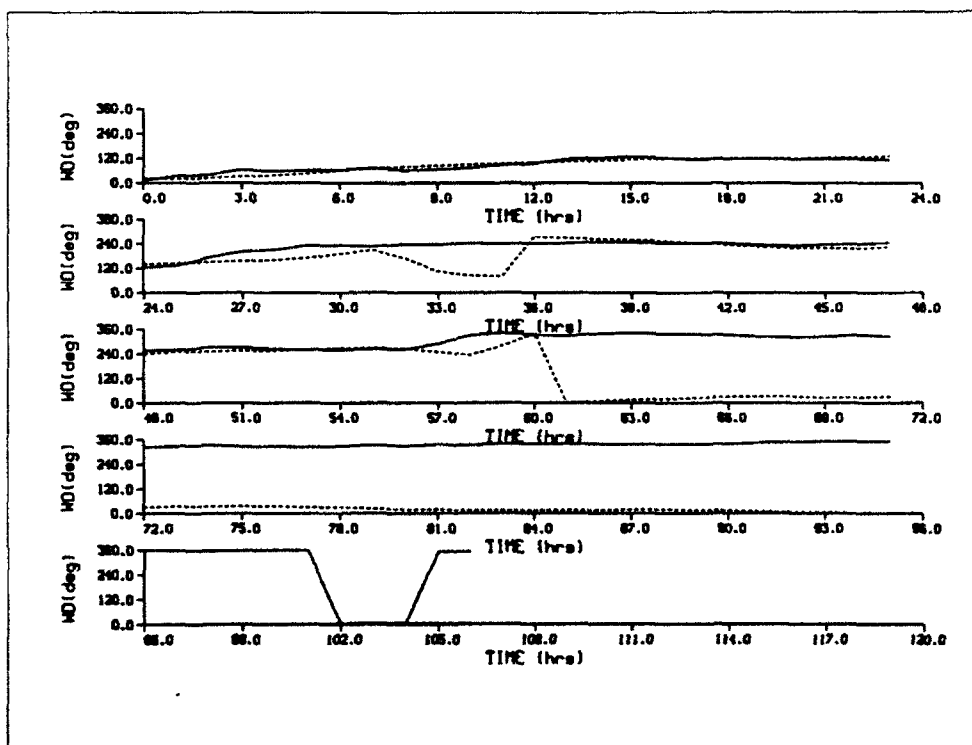Figure H14. Wind speed, 1.25-deg grid; buoy (solid line), Navy wind stress (dashed line)
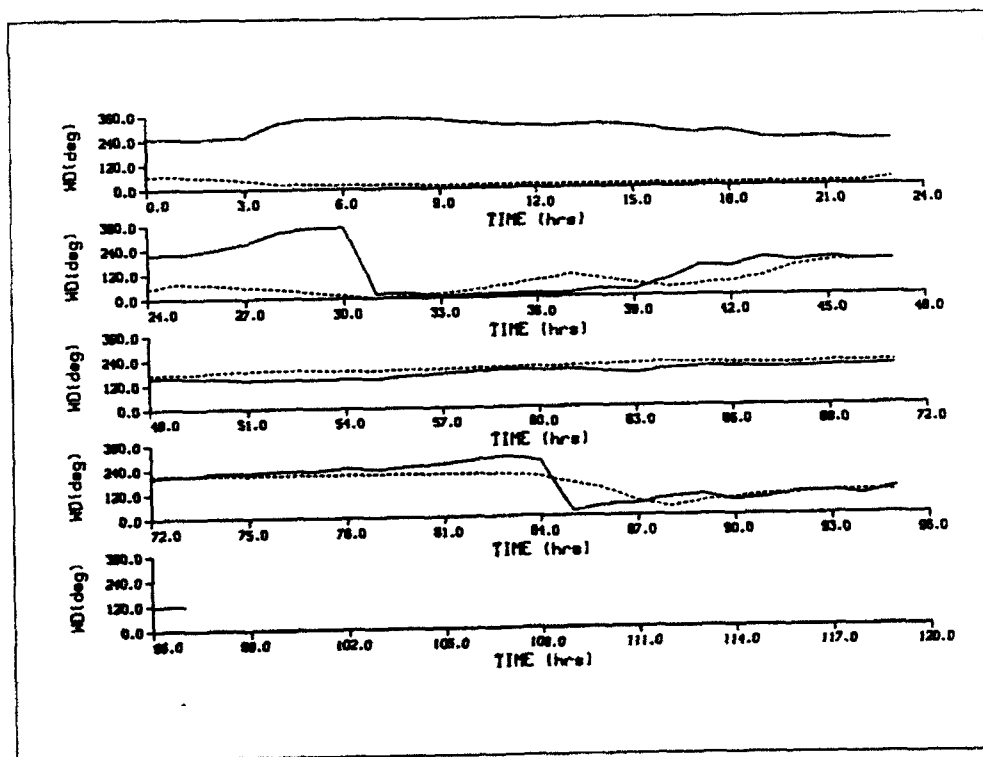
Figure H15. Wind direction, 1.25-deg grid; buoy (solid line), Navy wind stress (dashed line)

Appendix I
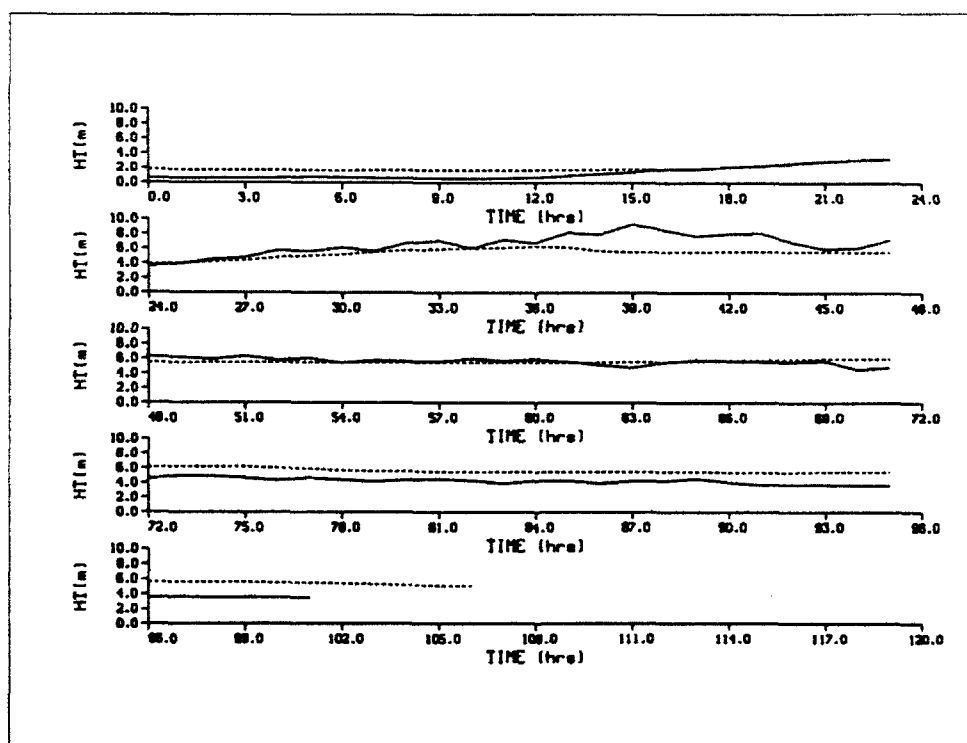# WISWAVE and NDBC Buoy Comparisons, Buoy 44014, 10-14 Dec 92

Figure I1. Significant wave height, 2.5-deg grid; buoy (solid line), WISWAVE with Navy surface wind (dashed line)
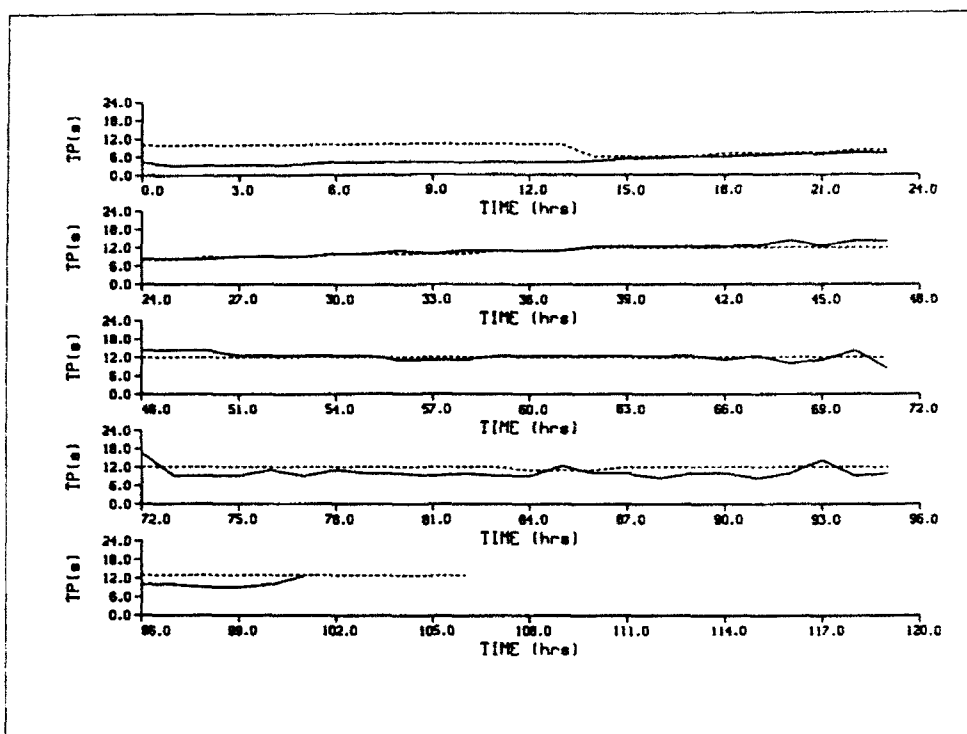
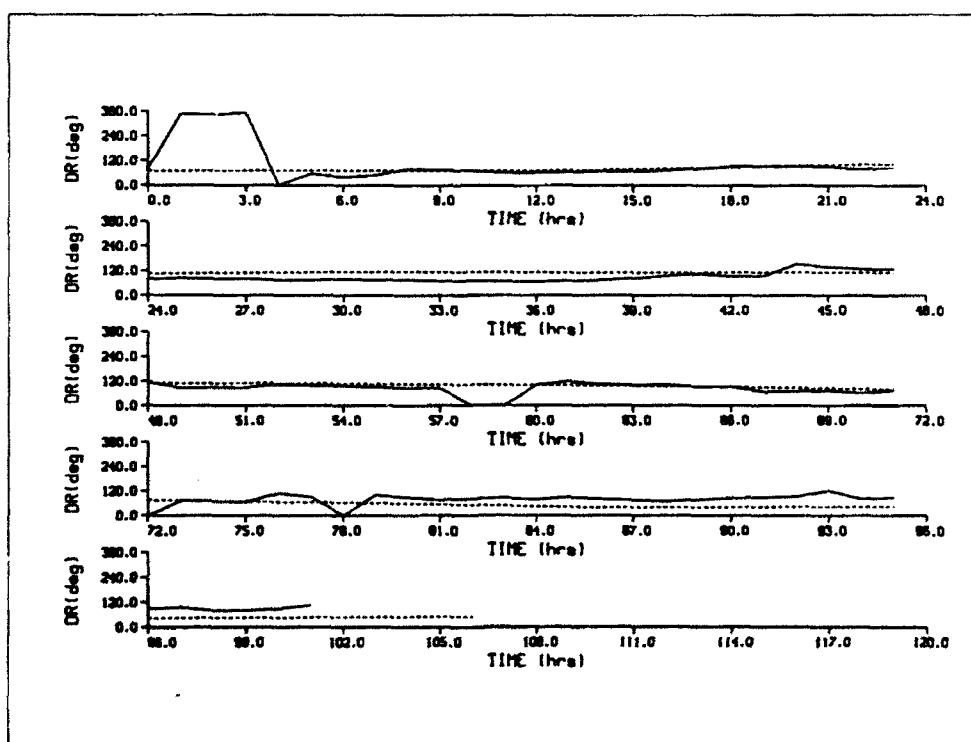Figure I2. Peak wave period, 2.5-deg grid; buoy (solid line), WISWAVE with Navy surface wind (dashed line)

Figure I3. Peak wave direction, 2.5-deg grid; buoy (solid line), WISWAVE with Navy surface wind (dashed line)
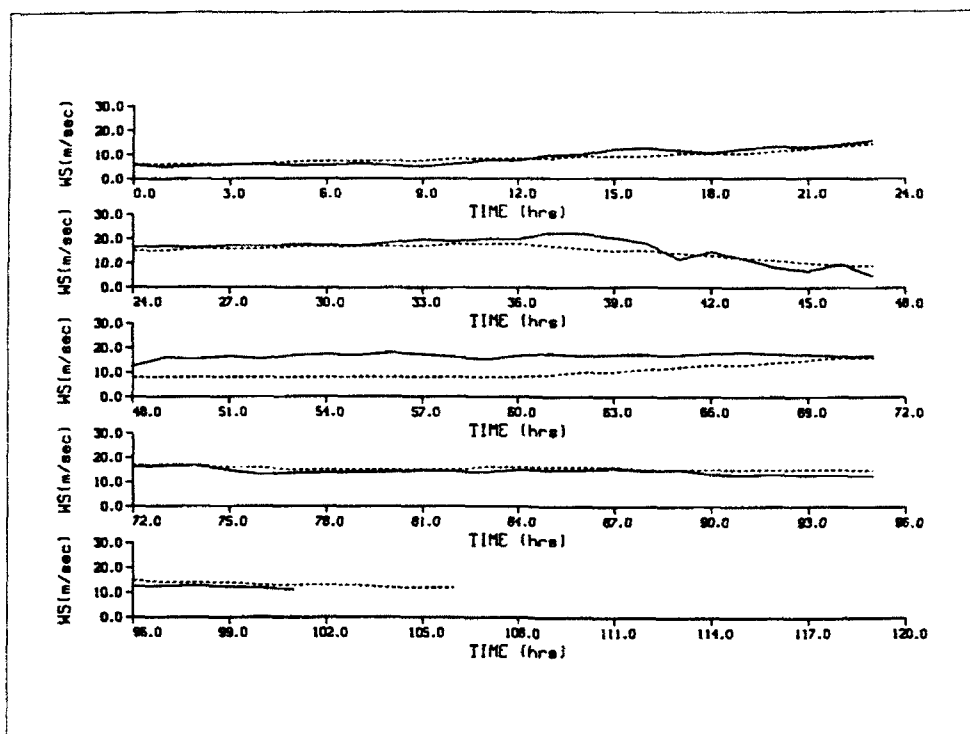
I2

Figure 14. Wind speed, 2.5-deg grid; buoy (solid line), Navy surface wind (dashed line)

Figure 15. Wind direction, 2.5-deg grid; buoy (solid line), Navy surface wind (dashed line)

Figure I6. Significant wave height, 1.25-deg grid; buoy (solid line), WISWAVE with Navy surface wind (dashed line)

Figure I7. Peak wave period, 1.25-deg grid; buoy (solid line), WISWAVE with Navy surface wind (dashed line)

I4

Figure 18. Peak wave direction, 1.25-deg grid; buoy (solid line), WISWAVE with Navy surface wind (dashed line)

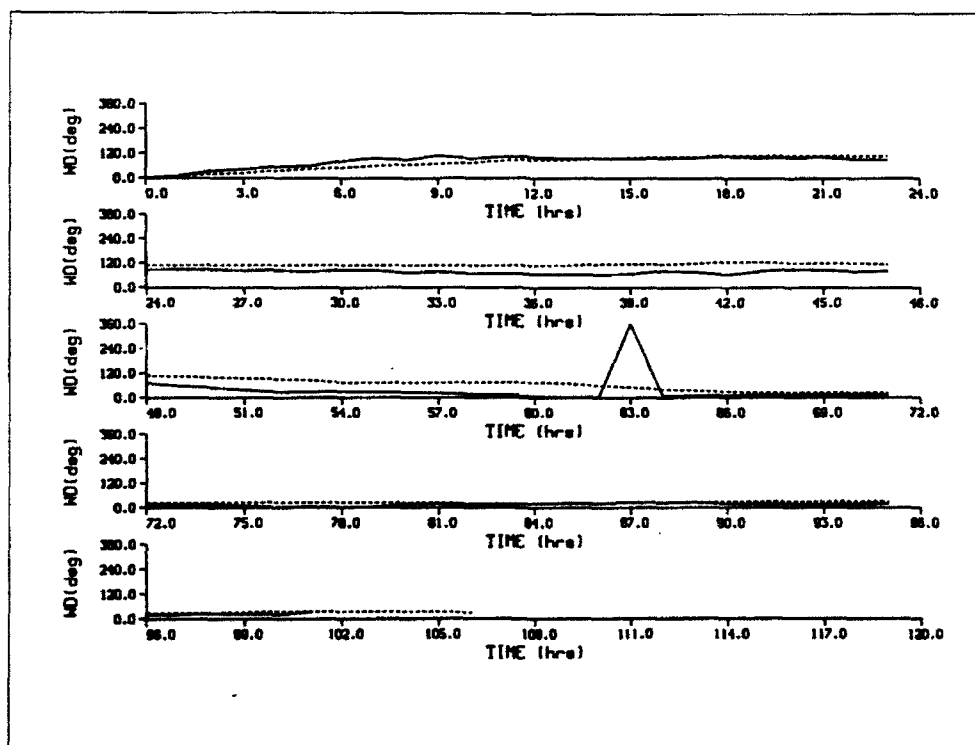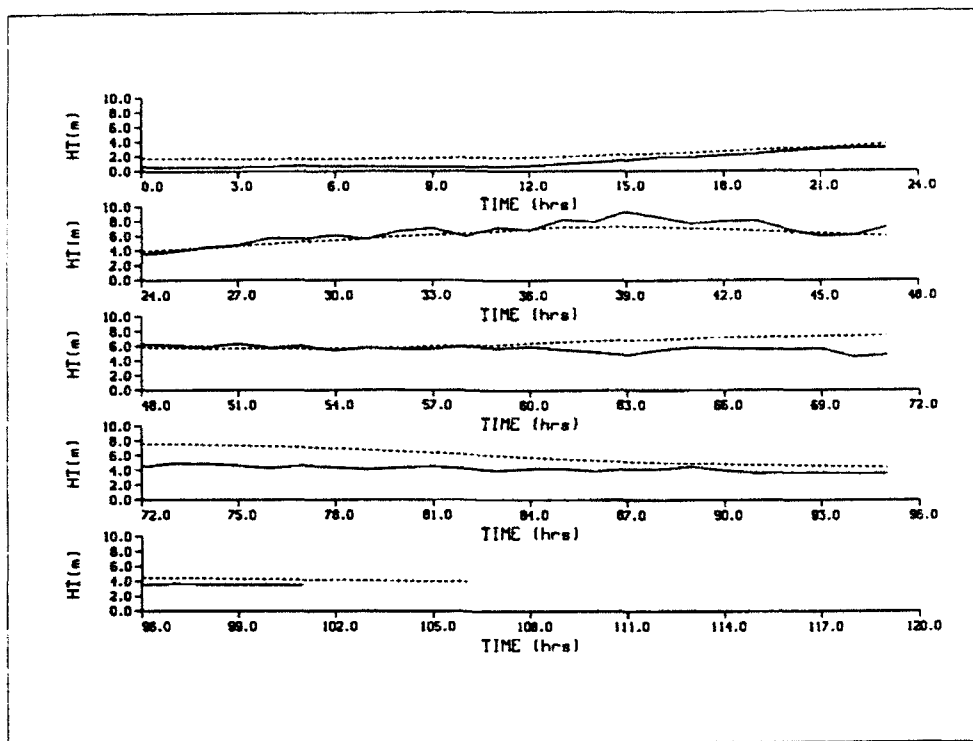Figure 19. Wind speed, 1.25-deg grid; buoy (solid line), Navy surface wind (dashed line)

Figure I10. Wind direction, 1.25-deg grid; buoy (solid line), Navy surface wind (dashed line)

Figure I11. Significant wave height, 1.25-deg grid; buoy (solid line), WISWAVE with Navy wind stress (dashed line)
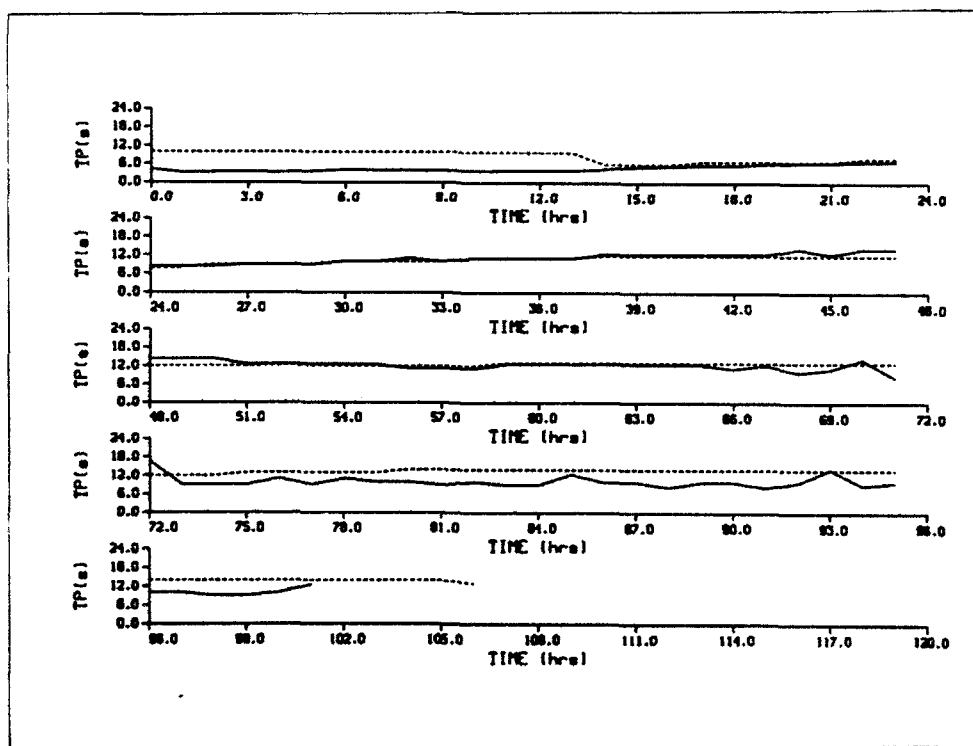
Figure I12. Peak wave period, 1.25-deg grid; buoy (solid line), WISWAVE with Navy wind stress (dashed line)

Figure I13. Peak wave direction, 1.25-deg grid; buoy (solid line), WISWAVE with Navy wind stress (dashed line)

I7

Figure I14. Wind speed, 1.25-deg grid; buoy (solid line), Navy wind stress (dashed line)

Figure I15. Wind direction, 1.25-deg grid; buoy (solid line), Navy wind stress (dashed line)

Appendix J
WISWAVE and NDBC Buoy Comparisons, Buoy 44025, 10-14 Dec 92

Figure J1. Significant wave height, 2.5-deg grid; buoy (solid line), WISWAVE with Navy surface wind (dashed line)

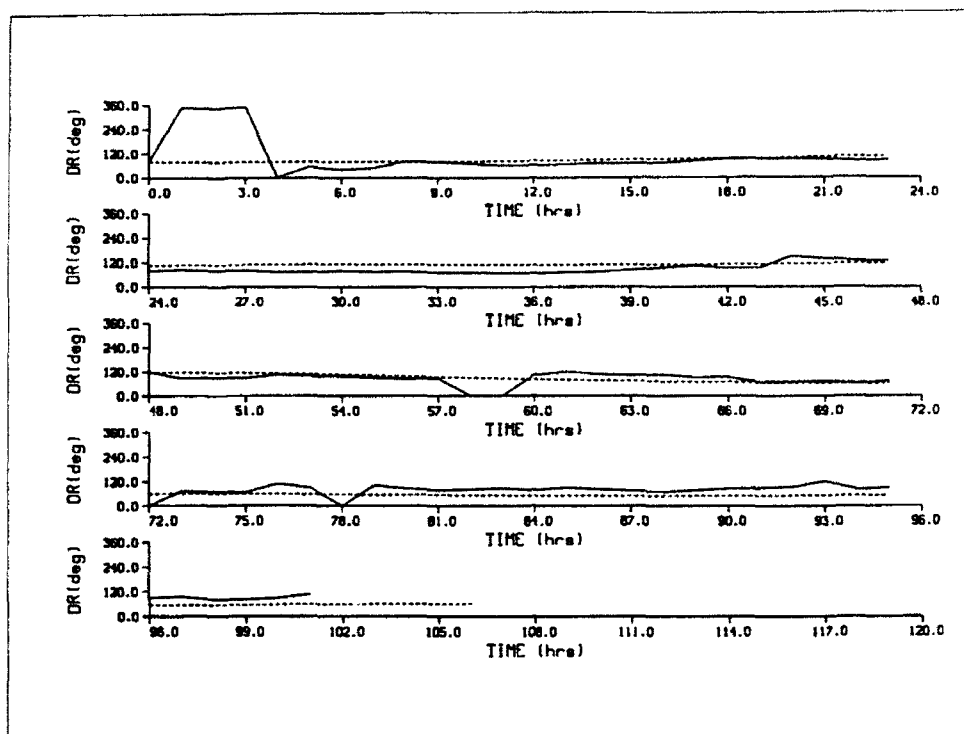Figure J2. Peak wave period, 2.5-deg grid; buoy (solid line), WISWAVE with Navy surface wind (dashed line)

Figure J3. Peak wave direction, 2.5-deg grid; buoy (solid line), WISWAVE with Navy surface wind (dashed line)
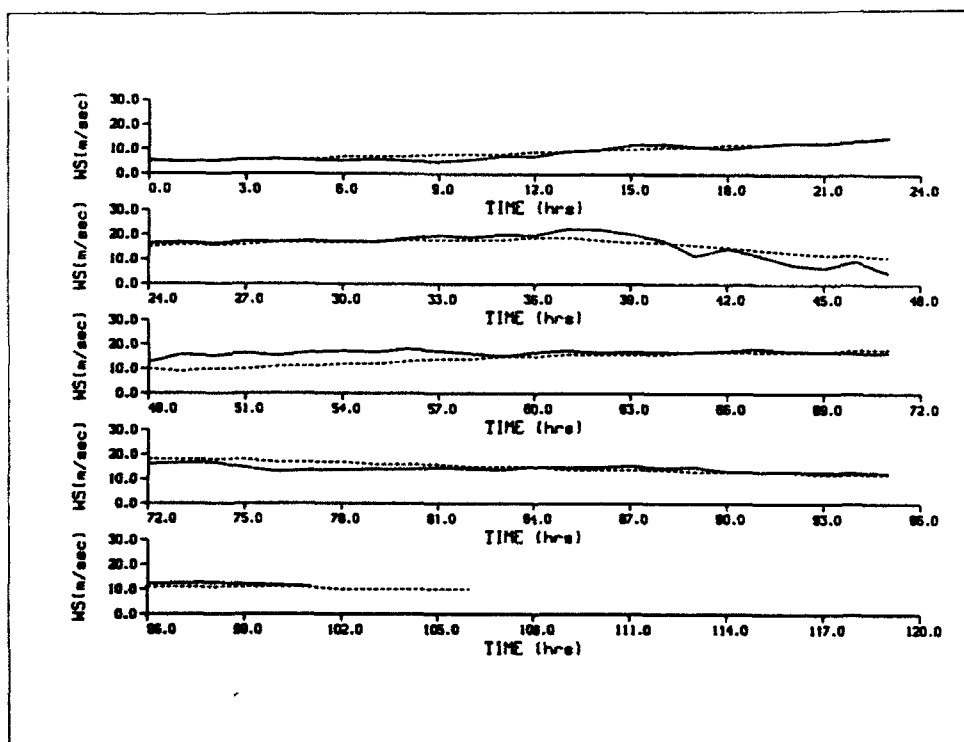
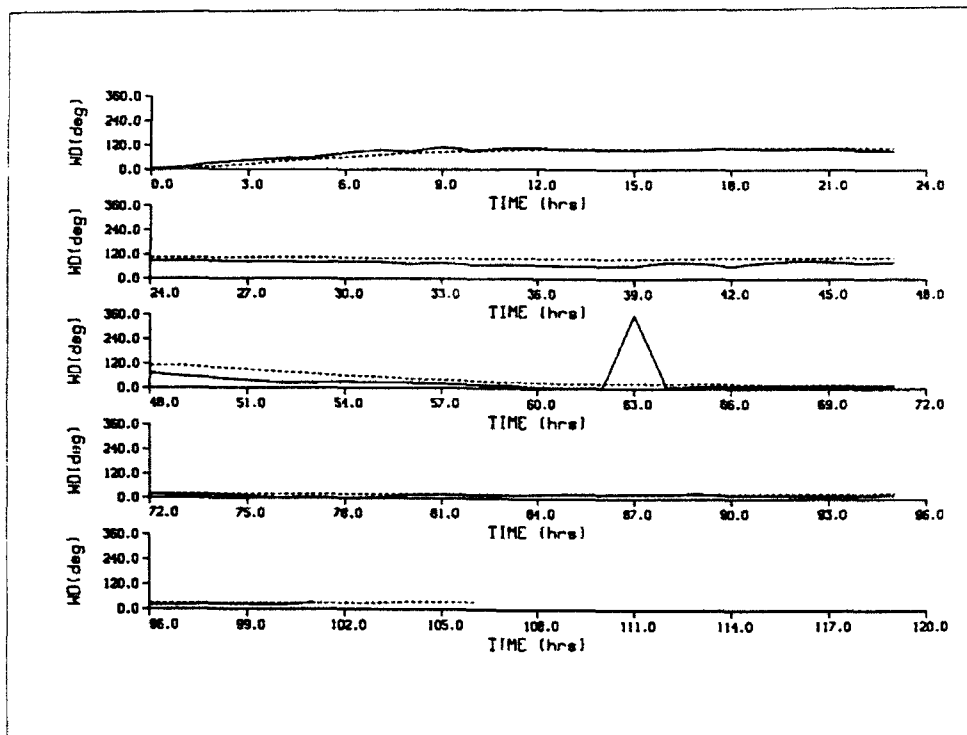Figure J4. Wind speed, 2.5-deg grid; buoy (solid line), Navy surface wind (dashed line)

Figure J5. Wind direction, 2.5-deg grid; buoy (solid line), Navy surface wind (dashed line)

Figure J6. Significant wave height, 1.25-deg grid; buoy (solid line), WISWAVE with Navy surface wind (dashed line)

Figure J7. Peak wave period, 1.25-deg grid; buoy (solid line), WISWAVE with Navy surface wind (dashed line)

Figure J8. Peak wave direction, 1.25-deg grid; buoy (solid line), WISWAVE with Navy surface wind (dashed line)

Figure J9. Wind speed, 1.25-deg grid; buoy (solid line), Navy surface wind (dashed line)

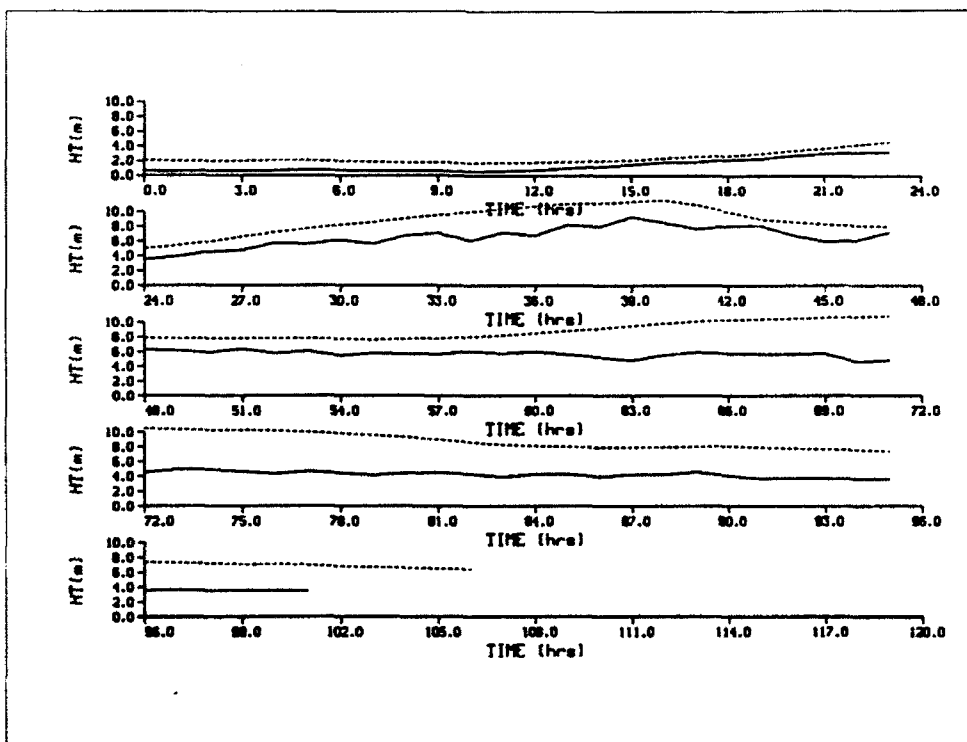Figure J10. Wind direction, 1.25-deg grid; buoy (solid line), Navy surface wind (dashed line)

Figure J11. Significant wave height, 1.25-deg grid; buoy (solid line), WISWAVE with Navy wind stress (dashed line)
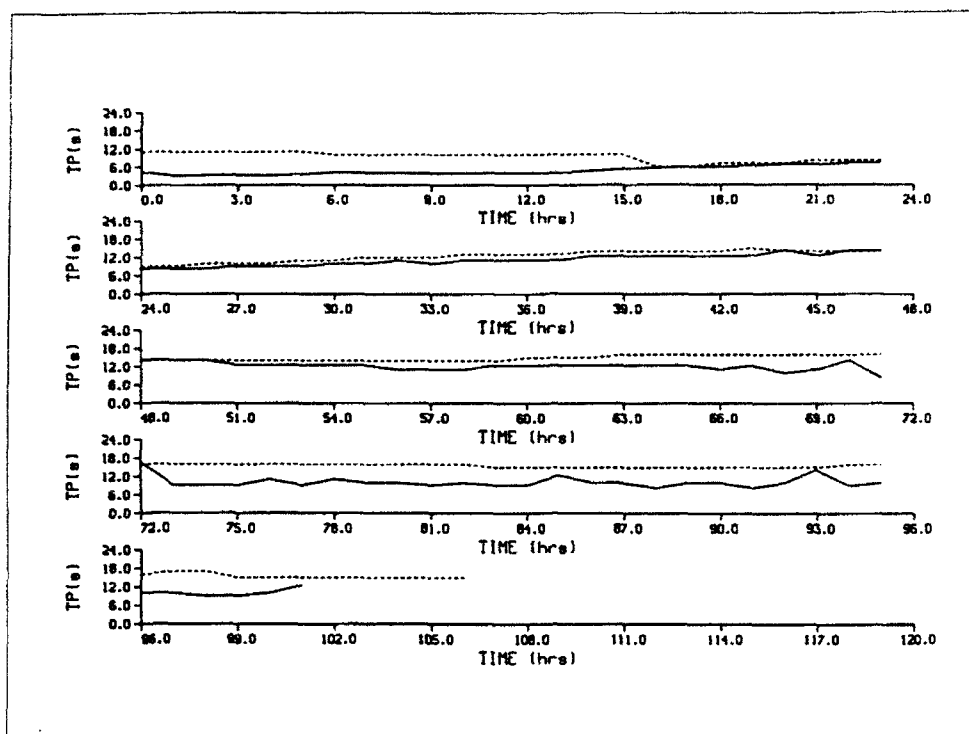
Figure J12. Peak wave period, 1.25-deg grid; buoy (solid line), WISWAVE with Navy wind stress (dashed line)
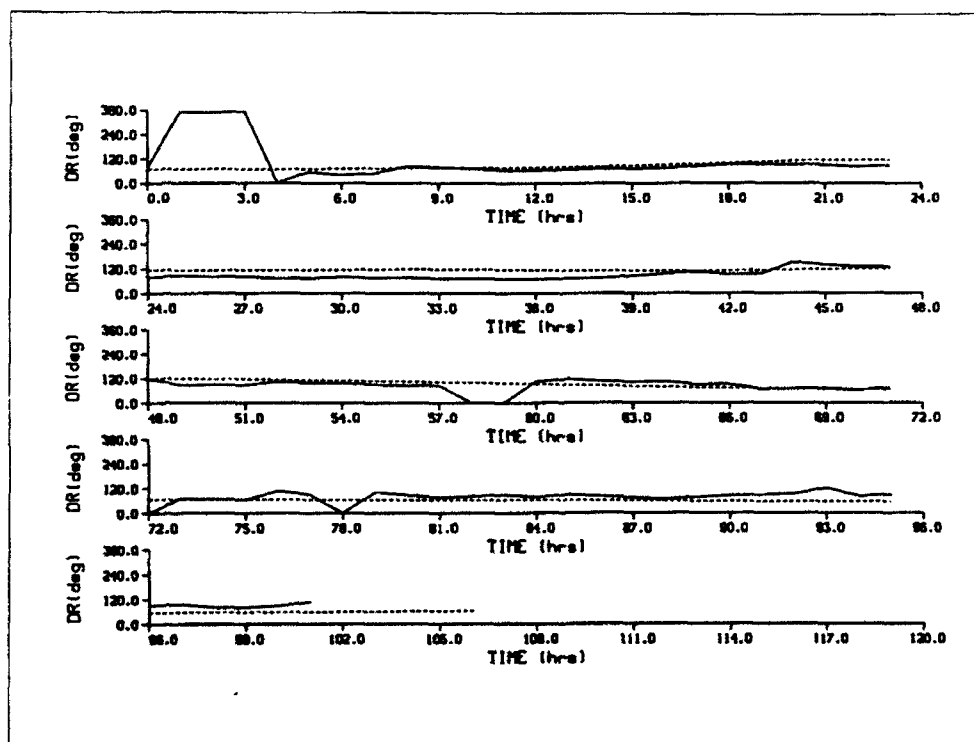

Figure J13. Peak wave direction, 1.25-deg grid; buoy (solid line), WISWAVE with Navy wind stress (dashed line)
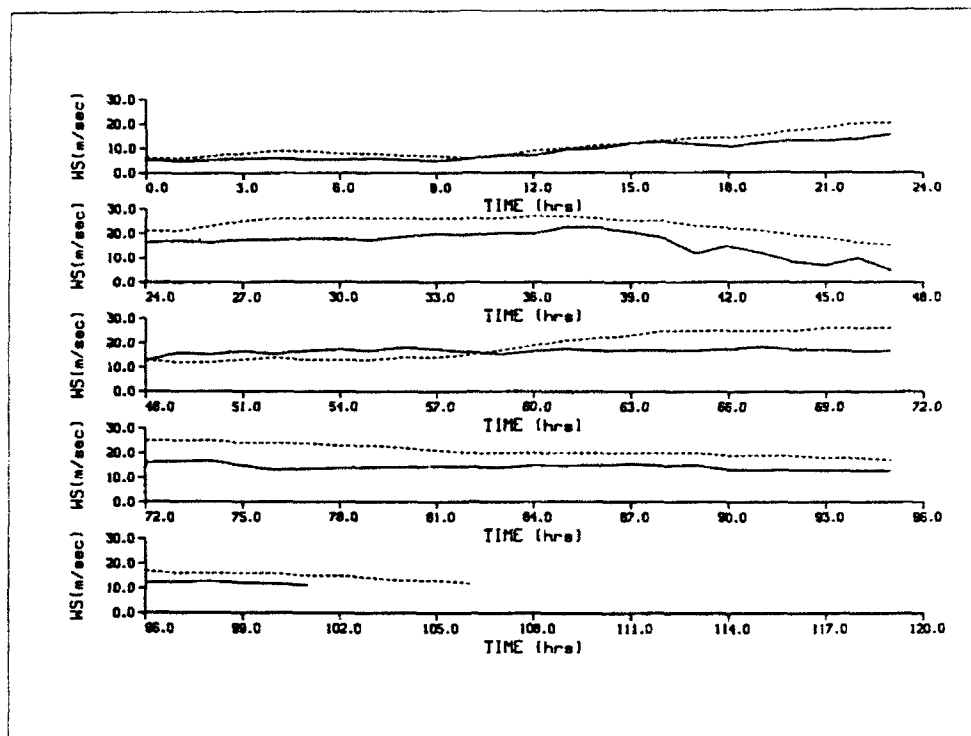
Figure J14. Wind speed, 1.25-deg grid; buoy (solid line), Navy wind stress (dashed line)
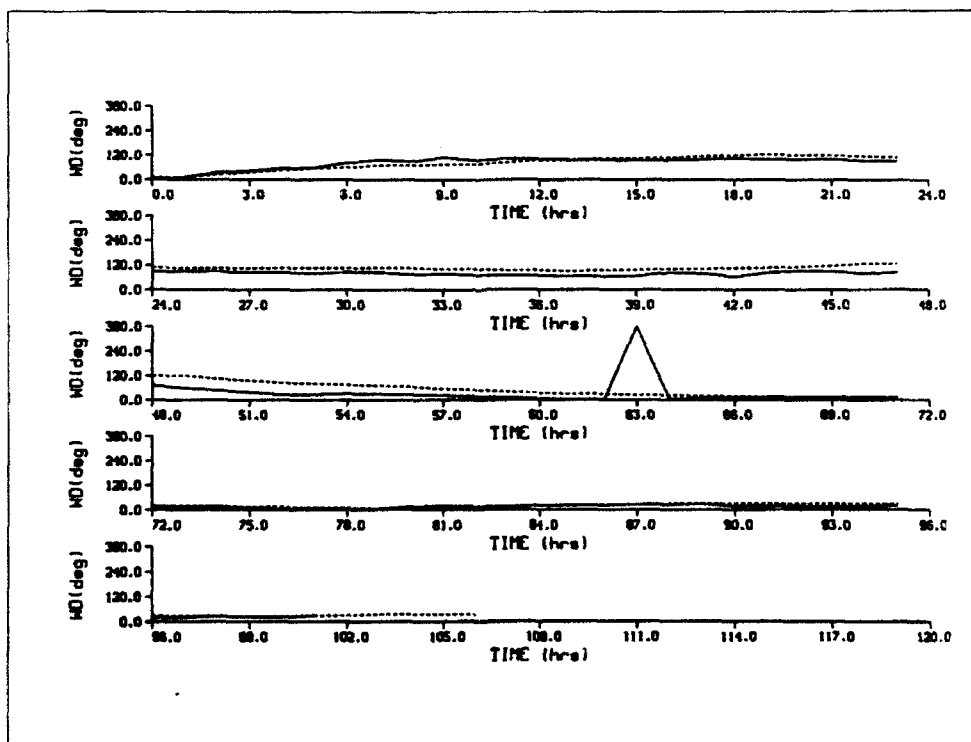

Figure J15. Wind direction, 1.25-deg grid; buoy (solid line), Navy wind stress (dashed line)

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Zeki Demirbilek, Steven M. Bratos, Edward F. Thompson

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13. ABSTRACT *(Maximum 200 words)*

Winds over the ocean surface are the essential driving force in creating waves. Winds also have important effects on currents and nearshore water levels. Wind information is often used within the Corps of Engineers (CE) as input to numerical models of waves, storm surges, and circulation. The National Oceanic and Atmospheric Administration (NOAA) and the U.S. Navy routinely produce global wind information. Recent advances in atmospheric modeling capabilities and operational numerical models, particularly within the Navy, have made available new and improved products applicable to CE hydrodynamic modeling. Available products from NOAA and the Navy are described, including both climatological archives and real time forecasting products. Interfaces to assist CE users in obtaining and using the Navy products are presented. Sources of surface wind (10-m elevation) information of greatest potential value for CE modeling are evaluated using the wave model WISWAVE and NOAA National Data Buoy Center measurements along the U.S. Atlantic coast. Necessary tools are provided and recommendations are given for further evaluation and use of Navy wind information in future modeling efforts.

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