

## AN INTERACTIVE INFORMATION AND PROCESSING SYSTEM FOR THE REAL-TIME QUALITY CONTROL OF MARINE METEOROLOGICAL AND OCEANOGRAPHIC DATA \*

Marshall P. Waters III<sup>1</sup>, C. M. Caruso<sup>1</sup>, W. H. Gemmill<sup>1</sup>,  
W. S. Richardson<sup>1</sup>, and W. G. Pichel<sup>2</sup>

### 1. INTRODUCTION

The accuracy of numerical prediction models which produce meteorological and oceanographic forecasts are dependent on; (1) the models' ability to adequately describe the physics of the atmosphere/ocean, and (2) the quality and quantity of the data used in their analyses and initializations. Compared to land areas, the ocean observing network for providing operational measurements on a routine basis is spatially and temporally very sparse. Hence, considerable effort is made to quality control (QC) and retain those few available synoptic observations over the oceanic regions. This quality-assured data must also be delivered to the numerical prediction models in a timely manner to be useful.

National weather and oceanographic processing centers are faced with two challenges which greatly affect their marine operations; (1) the time-critical QC of the marine measurements/observations available for ingestion into numerical atmosphere and ocean models, and (2) the timely dissemination of both the QC'ed data and the forecast guidance based on the output from numerical models (Richardson and Feit, 1990). This paper describes the QUALITY Improvement Performance System (QUIPS) being used by the National Oceanic and Atmospheric Administration (NOAA) Ocean Products Center (OPC) for the real-time QC of global marine surface and subsurface observations collected by conventional means (ships, buoys, etc.) and geophysical parameters derived from environmental satellite data. Also described is an expert System for Marine Analysis and Real-Time Quality Control (SMARTQC) which is to be integrated into the existing QUIPS.

---

<sup>1</sup>NOAA Ocean Products Center, Camp Springs, Maryland

<sup>2</sup>NESDIS Office of Research & Applications, Camp Springs, Maryland

\*OPC Contribution No. 61

### 2. BACKGROUND

The NOAA OPC was formed in 1985 through the cooperative efforts of the National Ocean Service (NOS), the National Weather Service (NWS), and the National Environmental Satellite, Data, and Information Service (NESDIS) to develop new and improved marine meteorological and oceanographic guidance products, to provide real-time QC of marine measurements/observations, and to ensure the timely dissemination of these data/products to users. The operational part of the Center, which operates 24 hours/day, 7 days/week, is responsible for the collection and QC of marine data sets in real-time and the generation, preparation, and dissemination of operational marine analysis and forecast guidance products.

The OPC is collocated with the NWS National Meteorological Center (NMC) at the NOAA Science and Operations Center in Camp Springs, Maryland. This collocation allows OPC personnel to utilize NMC's data bases, output fields from large scale meteorological models, and use existing communications networks and computer interconnectability for providing products to operational and research users. In addition, the OPC cooperates with other NOAA and U.S. Navy operational centers as well as with the research and academic communities.

### 3. DATA COLLECTION

Our present sources of information for understanding and forecasting the ocean's structure, variability, and dynamic interaction with the atmosphere are derived geophysical parameters from satellite remote sensors and in situ observations provided from an organized global communications network. This network is a diverse composite of operational measurement systems and platforms operated by an equally varied group of agencies, including NOAA, each with different missions and objectives. Figure 1 depicts the flow of data from these systems and platforms into NMC/OPC.

Conventional surface observational data (sea-level pressure, air and sea surface temperature, winds, waves, etc.) and subsurface data

(temperature and salinity) are measured by ships, moored/drifted buoys, and coastal marine stations. Data from these platforms are transmitted to NMC/OPC by radio and satellite. Marine surface data derived from satellite-borne sensors such as passive microwave (wind speed), scatterometer (wind speed and direction), and altimeter (wind speed and significant wave height) are also becoming more readily available for operational use.

In addition, NMC/OPC receives marine data via the Global Telecommunications System (GTS) and from the Navy via the Automated Weather Network (AWN). These data are used by NOAA to produce analyses and forecast guidance, to improve existing marine warning and forecast systems, to study and quantify the long-term implications of climate and global change programs, and to calibrate/validate satellite-derived measurements.

#### 4. SURFACE DATA QC

The spatial and temporal coverage of the existing, conventional ocean network is sparse compared with equivalent measurements over land. Density ratios of marine conventional observations to those over land average 1:10 and 1:10 000 over much of the high seas area. Looking at these ratios another way, if the land areas had the same sampling densities in time and space that the ocean areas have, meteorologists would be faced with the task of initializing a forecast model for the U.S. with only 19 observations - about 1 observation for every 3 states (Richardson and Reilly, 1989)! Thus the need for more accurate marine observations becomes more apparent when these ratios are realized. As such, considerable effort is made to make every measurement count in oceanic regions.

For any measurement/observation to be operationally useful, the time, location, and accuracy of the measurement/observation must be known. In addition, the measurement/observation must be received by the processing center in a timely manner for ingestion into numerical models for the dissemination of warnings and forecast updates.

Analysts at the OPC QC global marine surface and subsurface measurements from ships, buoys, aircraft, and coastal sites continuously. Approximately 1300 reports (650 ships, 550 buoys, 100 coastal marine stations) of sea-level pressure (SLP), wind speed/direction, and air and sea surface temperatures are QC'ed daily by OPC analysts for each of the four synoptic periods (0000, 0600, 1200, 1800 UTC).

An interactive computer system which involves a network of computers and workstations makes up the real-time QC system (Figure 2). The OPC analysts, using workstations, are assisted in their QC effort by computer software known as QUIPS in the QC of surface and subsurface data. Synoptic observations/measurements, model first guess fields from NMC's Global Data Assimilation System and Aviation Model, and seasonal subsurface climatologies (used to QC subsurface measurements) are made available to QUIPS. Surface observations/measurements that differ from first guesses by predetermined threshold values (see Table 1) are flagged and referred to a VAX workstation for operator review.

TABLE 1. Flagging criteria used by QUIPS

Parameter	Threshold
Sea-level pressure	+/- 4 mb
Air temperature	+/- 8 °C
Wind direction	≥ 140 degrees
Wind speed	+/- 15 kts
Sea surface temperature	+/- 6 °C

Menu driven commands, activated by a mouse, assist the QC analyst in checking flagged data with cruise/parameter plots and nearest neighbors' plots. A composite of the QUIPS display is shown in Figure 3. In addition to numerical model first guess fields, the analyst also has available near-global coverage of satellite imagery (visible, thermal, and water vapor) for additional checks and comparisons as might be appropriate.

For a typical synoptic period, approximately 10 percent of all measurements are flagged for SLP alone. Another 10 to 15 percent are flagged for review due to "questionable" wind speed, wind direction, air temperature, or sea surface temperature. QUIPS software also allows flagged measurements to be displayed in a color-coded format with different symbols for the various types of platforms. Five other windows that can be called up by QUIPS show differences between the interpolated first guess values and platform measurements and decision columns for "reject" and "keep" flags, platform history (up to 8 days for each platform), a window which allows a display of first guess contour fields, a cruise plot displaying the platform's cruise track, and a line graph of a platform's reported parameters over the last 8 days along with the associated first guess parameters.