J1.5 RIP CURRENT TRAINING FOR COASTAL FORECASTERS

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1. INTRODUCTION

Since 1990, the Cooperative Program for Operational Meteorology, Education and Training (COMET®) has been conducting residence courses and delivering distance learning materials to support the integration of science into the operational forecast process. With NOAA's National Weather Service (NWS) as its core sponsor, the COMET Program has produced web-based training on many aspects of weather forecasting including, hydrology, aviation, fire weather, various mesoscale phenomena, numerical model prediction, and satellite meteorology. In the mid-1990's the COMET Program produced its first marine meteorology training delivered via laser disc and later converted it to CD-ROM. The focus of this material was primarily on offshore (deep water) forecast issues that would affect the commercial and recreational mariner. In 2003 the COMET Program began working to update this material with new advances in modeling and remote sensing in addition to making the content web-based (http://www.meted.ucar.edu/topics_marine).

While the COMET Program was updating these offshore training materials to support the NWS Marine Professional Development Series, the NWS Marine and Coastal Weather Services Branch (MCS) was beginning to develop a national rip current program. In late 2003, Tim Schott of MCS approached COMET about creating interactive training for operational weather forecasters regarding rip currents in the nearshore marine environment to support its new Surf Zone Forecast (SRF) product.

During May 2004, the NWS in partnership with the United States Lifesaving Association (USLA) and NOAA's National Sea Grant College Program started a national public safety campaign about rip currents – *Break the Grip of the Rip!* Simultaneously, the NWS and the COMET Program began development of distance learning modules to increase the rip current forecast skills of the coastal operational meteorologist. For this effort COMET will work with NWS rip current experts from forecast offices as well as the Office of Science and Technology (OST) to produce four training modules related to rip currents (Figure 1). Additional technical oversight has been provided by the coastal scientists from NOAA Sea Grant universities.

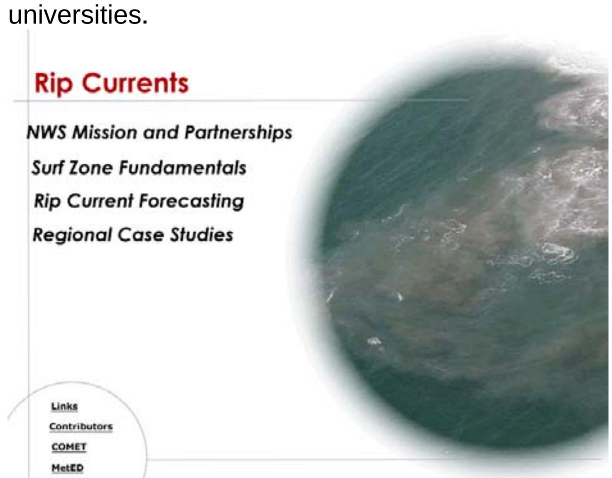

Figure 1. Interface for COMET Rip Current Training

2. NEED FOR RIP CURRENT TRAINING

The first NWS efforts at providing the public with rip current information began in the early 1990's. While advances in wave modeling, buoy technology, and numerical guidance products have lead to more accurate and specialized marine forecasts, they have also necessitated the creation of formal rip current forecast training. The following statistics from the USLA support the need for operational rip current forecast training:

- At least 100 people die annually from rip currents.
- It is estimated that 80 percent of all lifeguard rescues are the result of swimmers unable to escape a rip current.

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- From 1994-2003 rip currents are estimated to be the second largest annual average cause of weather related deaths in the U.S. At this time the Centers for Disease Control (CDC) does not maintain a nationwide database on fatalities occurring in the surf zone.

The SRF product has increased in importance among NWS products because of the large numbers of people living near the nation's coastlines. Currently more than half of the U.S. population—141 million people—reside within 50 miles of the coast, which occupies only 11 percent of the land area of the lower 48 states. (Economic Statistics, NOAA, March 2003). In addition, 30% of NWS WFOs include coastal and Great Lakes beaches. At the Wilmington, North Carolina WFO alone, nearly a million people seasonally visit the beaches in their area of responsibility on any given weekend. These demographic statistics suggest an expanding customer base and demand for the parameters and information provided in the Surf Zone Forecast (SRF).

Many of the weather forecasters are familiar with the atmosphere above the water surface, but they have a limited understanding of the forces that direct the circulations in and below the water itself. This may be due to the fact that most atmospheric science degrees do not require or encourage individuals to complete courses beyond an introductory course in oceanography. Forecasters, like the public, are not as familiar with the various terminology used in association with the nearshore environment. Widespread misconceptions exist about what a rip current is and is not. For example, an "undertow" and a "rip tide" are not the same as a rip current. The MCS, in concert with regional NWS Marine Program Managers, determined it was essential to provide NWS forecasters with an instructional series defining the nearshore environment, the nearshore circulation system, and how rip currents are simply one subset of the nearshore environment. An understanding of nearshore dynamics and use of correct terminology would allow forecasters to work more effectively with all NWS coastal partners, to include the USLA and NOAA Sea Grant researchers.

3. INSTRUCTIONAL DESIGN ASPECTS

The goal of the COMET Program is to develop scientific training that is designed with specific methods of instruction which most effectively teach a particular subject to a given audience. In other words, the method of instruction for any given module is dependent on the subject being taught and the audience who is learning. These computer-based learning modules contain highly interactive instruction and use a mix of case studies, graphics, animations, audio, and video. Text and spoken dialogue introduce concepts that are reinforced by pioneering graphic materials such as a three dimensional animation of the nearshore circulation or a profile view of wave characteristics in shallow water. Many of the graphics and animations developed for the rip current series are the first of their kind, as there seems to be little of this type of instruction. At various points throughout the modules, learners can practice using the concepts covered by answering questions and working through realistic case examples. Much of this instructional design follows the principles of cognitive apprenticeship and situated cognition described by Collins (1991) and Brown, Collins, & Duguid (1989), respectively.

The first rip current training proposal covered four focus areas in one module. Each area had its own objectives (Table 1). An instructional design of the module content prompted a new conceptual prototype of how the various goals and objectives could be organized in to multiple pieces (Figure 2).

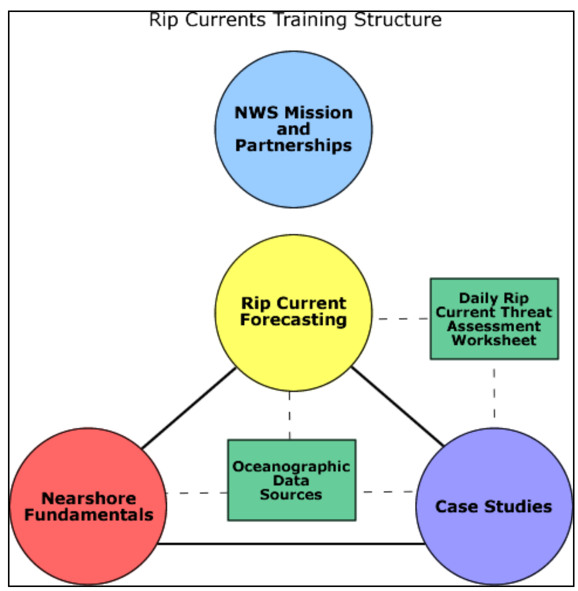

Figure 2. Conceptual organization of the rip current training modules (circles) showing the inter-relationships between them and the learning objects (squares).

Learning Objectives for each Focus Area			
Introductory Information	**Nearshore Fundamentals**	**Rip Current Forecasting**	**Case Study**
Understand the prevalence of rip current rescues.	Understand rip currents are one segment of a larger nearshore circulation, which is one aspect of the larger ocean circulation	Understand how wave models may be used in the Rip Current Outlook product.	Apply the skills and knowledge learned in the first three sections.
Recognize the distinct yet cooperative roles of the NWS, Sea Grant, and lifeguards in addressing rip currents.	Understand basic wave parameters and analysis	Understand the requirements of NWSI 10-310.	Become aware of regional (East, West, and Gulf Coasts) differences in nearshore environments that influence rip current development.
Recognize the value of lifeguards in providing ground-truth to the rip current forecast product.	Understand basic rip current parameters	Understand the relationship between significant rip current events and climatology patterns for the CWA	
Recognize the importance of partnerships with local lifeguard associations.	Understand how a complex combination of mechanisms in the surf zone creates rip currents		
Recognize the importance of partnerships with coastal scientists from NOAA's Sea Grant university.	Recognize visual clues for detecting rip currents		

Table 1. The goals and objects of each of the major focus areas of the rip current training effort.

The decision to create four separate modules and two learning objects was made for several reasons:

- A survey conducted by the Executive Producer of the NWS Marine Professional Development Series that forecasters preferred shorter modules that could be completed during a single shift
- The recognition that separate modules might be more appealing to specific groups (e.g., the *NWS Mission and Partnership* module could be geared toward management and the general public, while the *Rip Current Forecasting* module could aimed at professional forecasters, etc.)
- The ability to use different instructional methods to better suit the content (e.g., webcast, interactive web module, case study approach, learning object)
- The numerous goals and objectives of this effort were too large to fit into a single piece of instruction. Shorter training sessions give more flexibility to the learner.

Each module can be taken by the learner separately, but some dependencies on knowledge gained while going through the series do exist. Each module is linked together with a "Supporting Topics" menu that allows the learner to see where these dependencies exist. In this way, the learner who is taking a module can revisit a piece of a previously completed module to refresh their memory or fill their knowledge gap on that particular subject (the connecting lines in Figure 2 represent this feature).

4. SCOPE OF MODULES

The overall scope of the rip current training is to become familiar with the NWS rip current program and be able to recognize and forecast potential situations where rip currents are likely to occur. As mentioned previously, a series of four modules is used to accomplish this goal and each is discussed below.

4.1 *NWS Mission and Partnerships*

This first training module is actually a "webcast", (an online lecture) where Tim

Schott from MCS is the presenter. He dicusses basic knowledge of rip currents, standards for rip current information and terminology, and the NWS national rip current program objectives. Also, an overview of the SRF is presented as well as how it relates to other NWS products.

USLA data and statistics are presented to demonstrate the severity of the hazard that rip currents present and to stress the need to inform the public of the daily risk. A section discusses the USLA, Sea Grant, and the NWS forming the Rip Current Task Force and covers the agreement to create a partnership on public outreach, consistent communications regarding rip currents, and knowledge transfer from the research to the operational community.

This is a relatively short piece (20 minutes) that is intended for all forecasters, but may be especially useful to those in NWS management positions so they can obtain an overall picture of rip currents, the NWS rip current program, and its partners.

4.2 *Nearshore Fundamentals*

The second module in the series discusses the nearshore environment and its circulation. The subject matter expert is Dr. Chung-Sheng Wu from NWS/OST. This self-paced web module shows rip currents as a natural part of the nearshore circulation and it discusses rip current characteristics in detail (Figure 3). This module provides the knowledge needed to understand various aspects of the nearshore circulation and surf zone such as a longshore current, variable and fixed bathymetry, multi-spectrum waves, variations of wave heights within the surf zone, as well as the slope of the beach. The relationship between these aspects of the nearshore environment and rip current characteristics is the main focus. The module discusses the transformation and dissipation of wave energy as it comes into shallow water since this is a significant contributor to the development and strength of rip currents.

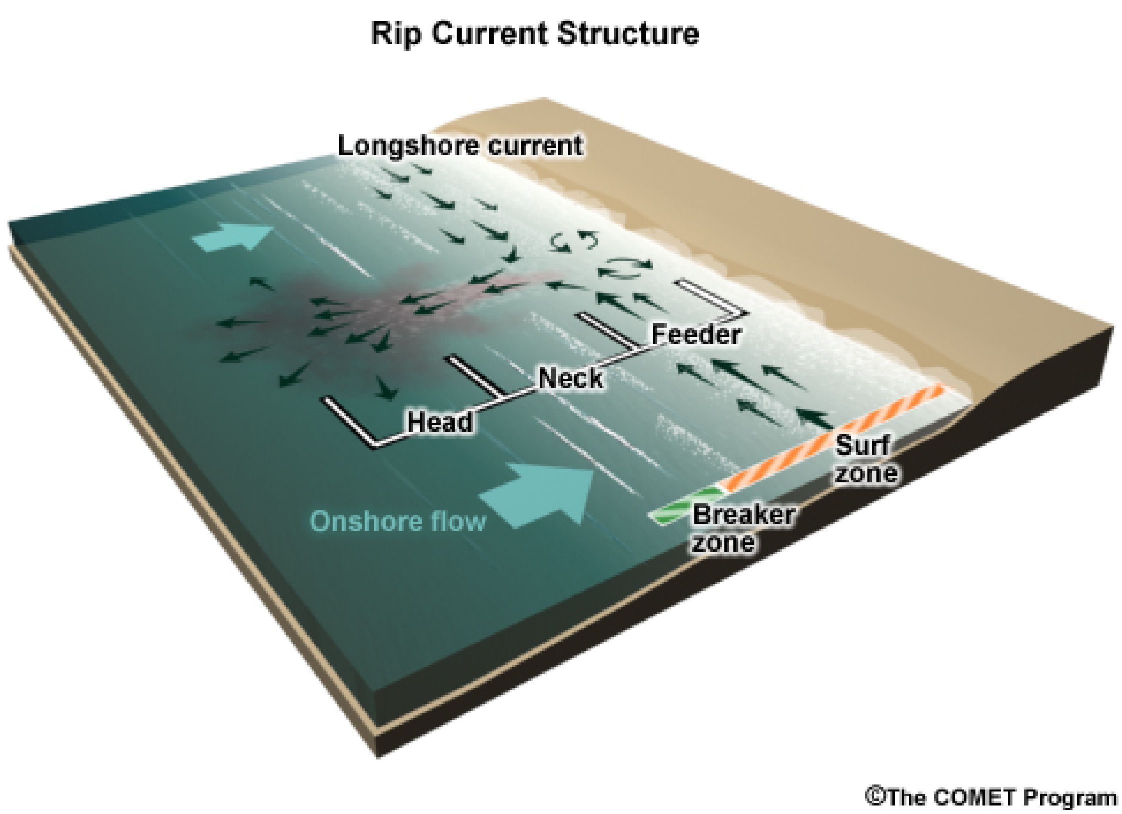

Figure 3. Three-dimension conceptual graphic of the rip current as part of the nearshore environment.

Lastly, rip current forcing mechanisms are also presented. These include the following phenomena: longshore variations in incoming waves and wave-boundary interactions like those associated with man-made coastal structures and natural sand bars. Even the tidal cycle is shown to have an influence on rip current development with the time around low tide being more favorable. While an overall picture of the nearshore environment is gained, the main objective is to understand how local aspects of the nearshore affect rip current development and strength and apply this knowledge when considering the information presented to the public in the SRF.

4.3 *Rip Current Forecasting*

With the background knowledge of the nearshore circulation and the associated influence of the surf zone, the focus of the rip current training turns to forecasting these events. In this module subject matter experts from the NWS Wilmington, North Carolina and Miami, Florida weather forecast offices (WFOs) were responsible for developing the training content. Here the forecaster is introduced to wave spectrum analysis of buoy observations and model output (Figure 4) and then taught how to use this to assess the threat of rip currents. The NOAA WaveWatch III is the primary model used in the training.

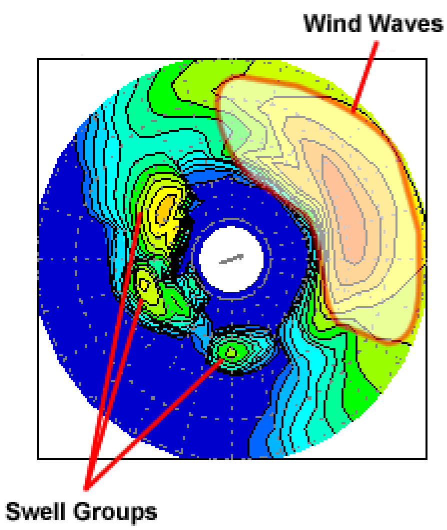

Figure 4. Polar plots of wave energy density from the NOAA WaveWatch III. The concentric circles are plotted at 0.05 Hz intervals, where the innermost circle corresponds to 0.05 Hz and the outermost circle corresponds to 0.25 Hz.

The requirements of the Rip Current Outlook within the new SRF product are also outlined so that the forecaster understands what information needs to be conveyed to the public.

4.4 *Rip Current Regionalized Case Studies*

The fourth part in the rip current series uses case studies from several different regions of the U.S. in order to reinforce what has been learned through the first three parts of the series. The regions examined are in three main categories: Gulf and East Coast, West Coast, and Great Lakes. While the physics of a rip current may be the same, the climatological influences that develop rip currents may be regionally dependent. Likewise the surf zone characteristics are regionally and locally dependent. This module engages the learner to apply the knowledge and skills gained from earlier parts of the series in practical exercises while demonstrating the regional differences in rip current forcing.

5. RELATED LEARNING OBJECTS

There are two topics that support the rip current training series, but these can also stand alone as single training pieces. These are referred to as learning objects. These can be linked to various parts of the rip current modules or other marine modules where relevant. The first has to do with the use of a rip current worksheet developed by a WFO to assess the potential for rip current development. These worksheets incorporate all the effects of the various aspects of the nearshore environment previously discussed in the second module, as well as wave height and period from the spectral analysis discussed in the third module. In some cases the local NOAA Sea Grant university has worked with the WFO to develop this forecasting aid. The learner is presented with how to go about developing one of these worksheets for their local area.

The second learning object is a resource of information on all types of oceanographic data sources. The importance of having general knowledge about the overall local surf zone conditions and bathymetry is emphasized. However, this information covers a large range of marine data from the typical NOAA National

Data Buoy Center (NDBC) buoys and C-MANs to the atypical beach cameras, life guard reports, and National Ocean Service (NOS) acoustic Doppler current profilers (ADCP). Several marine forecasters from the various NWS regions contributed to this resource through their real-world experiences.

6. SUMMARY

The COMET Program is supporting the need of the NWS for rip current forecasting training by creating a series of interactive web-based modules that use innovative graphics and animations and various types of instructional design techniques. These modules provide information on the national rip current program and its partners, the nearshore environment, rip current characteristics, forecasting methods for rip currents, and regional climatological and bathymetric differences in rip current forcing. With a lack of this type of existing instruction in the scientific community, this content and its illustrations are pioneering training for rip currents and the nearshore environment.

7. ACKNOWLEDGEMENTS

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