High-Frequency Coastal Radars in Northern Adriatic:

A Brief Description of Future Plans

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In collaboration with the
Institute of Oceanography, University of Hamburg
1) Introduction

An observational program to measure the surface currents in the Northern Adriatic Sea will be carried out between fall 2002 and spring 2003 by means of high-frequency coastal radars installed along the Italian coast between the River Po delta and Monte Conero. Details about the scientific objectives, instrumentation used, planned locations and environmental impact are given hereafter. Important non-scientific applications of the program results and points of contact are also listed.

2) Scientific Objectives

The Italian Ministry of Education, University and Research (MIUR) and the United States Office of Naval Research (ONR) and other funding agencies have funded a large multi-institutional project to study the physical properties of the Northern Adriatic over the next few years (2002-2003). The rationale of this project stems from the complexity of the Adriatic dynamics that are forced by extreme wind and river runoff events, which in turn are crucial (through advection and mixing of nutrients, of pollutants, etc.) for the functioning of the local ecosystem.

The project involves several Italian oceanographic institutions, including CNR laboratories (IRPEM, ISDGM), the University of Ancona, the Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS) and international partners (University of Hawaii, University of Hamburg, NATO SACLANTCEN Undersea Research Centre, Naval Research Laboratories, University of Washington, etc.). Our component of the project consists of mapping the surface circulation in most areas of the Northern Adriatic with high-frequency coastal radars located along the Italian coast with a horizontal resolution of a few kilometers and with a time interval less than one hour.

3) Instrumentation

The instruments to be deployed are short-wave ocean current-mapping radars. Although the term “radar” has been traditionally used to describe these instruments, they have little to do with pulsed microwave ship radars. They function near the frequency 16 MHz and use a similar radio technology. A very low power transmitter sends continuous modulated waves to the ocean through an array of four transmit antennas. Each antenna radiates about 7.5 W, a power similar to amateur and consumer radio transmitters, and they are arranged to ensure a 22 dB power rejection of the back (landward) lobe compared to the front (seaward) lobe, a factor of about 100.

The antennas are grouped in a transmit array and a receive array. The transmit array consists of four antennas in a rectangle about 9.3 m x 2.8 m (Figure 1). The receive array consists either of a similar square array of 4 antennas or of 12 (or 16) aligned antennas at about 9 m spacing (Figure 2). The antennas are connected to a container including the electronics and computers by coaxial cables laid on the ground (type RG-213), grouped in protective ducts.

The signal reflected by the ocean contains information on waves and currents, which can be extracted using sophisticated digital sampling and processing electronics and software. Two systems are required to measure vectorial ocean currents (magnitude and direction). Typically, a map of currents...
with a range exceeding 100 km from shore (Figure 3) can be produced every 10 minutes, with a resolution better than 2 km. Maps of wave heights are also expected up to 60 km from shore.

Each antenna consists of a coiled short wave radio antenna, obtained off-the-shelf from consumer electronics suppliers, protected by a 2.5 m long and 3 cm diameter fiberglass sleeve. The antenna is hose-clamped on a steel bar cemented in a hole drilled in the rock, or driven into soft terrain, extending about 0.5 m above the surface. The entire assembly is about 3 m high. The steel bar base is sufficiently rigid to avoid guy wires. An alternative installation consists of concrete block bases, with guy wires holding the antenna.

All computers and electronics are housed in a mini-container, flexibly located within 50 m of the antennas; the use of a metal container ensures excellent Faraday shielding of electrical noise generated by the electronics (mostly computers).

Electrical power (2 kW) is needed at each site; 1 kW for the computers and electronics, and 1 kW for air-conditioning in the container. We have explored various sources. Wind is costly and irregular, and solar is even costlier. Both are outside the budget. Direct hookup to a nearby power source is thus the only feasible solution. The cables will be reinforced, following all applicable regulations, and installed under the supervision of a licensed electrician.

We have applied to the “Ministero delle Comunicazioni” for a license at 16 MHz with 150 kHz transmit bandwidth. Passive listening conducted last year along the northern Italian Adriatic coast has shown that band around 16 MHz is devoid of traffic. Our operation will therefore not interfere with commercial, private or government communications, none using this band.

4) Planned location of the instruments

Three systems will be deployed along the Italian Adriatic coast between the Po River delta and Monte Conero (Ancona). In order to provide the best geometry for the radar measurements and to be able to generate maps of surface currents in most of the Northern Adriatic, including important features such as the Po River Plume, the Western Adriatic Current and the Northern Adriatic filament extending from the tip of Istria, sites for the radar installation are sought in the following areas: Ravenna/south of Po Delta, Pesaro and Ancona. Proximity of power hookups and some protection against vandalism are important factors that will influence the selection of the locations.

The operational deployment of the radars will take place from fall 2002 to late Spring 2003. Site preparation, installation and testing will begin in summer 2002.

5) Environmental Impact Minimization

Given the extremely low radio power used, similar to that of consumer CB radios, the only impact is visual; there is absolutely no danger of electrical proximity to people or wildlife. As long as a power connection can be obtained, there is no need for generator, and the system is totally silent. The major visible components are (i) the arrays of transmit and receive antennas, and (ii) the container. Steps have been taken to minimize the visual impact of the installations.
(i) We have entirely redesigned the antennas, compared to the pictures shown in the enclosed manufacturer literature. Instead of using quarter-wave (5 m) high aluminum pipes, which require guy wires and have an unfavorable visual impact, we are using ultra-compact CB coil antennas which are only about 2 m tall. The antennas are enclosed in a blue-gray fiberglass sleeves, reducing light reverberation and subsequently, their visibility.

(ii) The containers are steel mini-containers (about 2.16 m wide, 2.03 m high, 1.72 m deep). The containers are new, and have been painted white with high quality epoxy paint, giving them a clean look. They are windowless.

Upon termination of the project, the sites will be returned to their original condition, and all displaced materials returned to their initial positions. A complete digital photo survey of the sites prior to installation of the instrument will be performed to guarantee this restoration. There will be no permanent impact on the resources of the areas.

6) Non-scientific Applications

The potential of the high-frequency coastal radar technology to track oil in the event of a spill has been demonstrated elsewhere. Graphical representations (current maps, etc.) and summaries of the radar data will also be available in real time through a dedicated web page to many end-users including the coast guards and other agencies to assist search and rescue operations, aid oil spill trajectory predictions, and contribute to pollution discharge studies.

These instruments, being over-the-horizon radars, have potentials for tracking ships and low-flying aircrafts up to a distance of 120 km, beyond that of existing microwave radars. The opportunity of our deployment will be used to test the tracking of fast moving targets.

We will maintain public relation panels, explaining the motivations of this project. Should there be interest, we will be happy to provide unrestricted real-time access to the data to interested parties (civil defense, coast guard, fishermen).

7) Points of Contact

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8) Supporting Documents

- Specifications and principle of the instruments, documentation from the manufacturer of the WERA high-frequency radars
• University of Hamburg Description: “How to set up a WERA Site”.

Figure 1. Rectangular array of 4 antennas

Figure 2. Linear array of 16 antennas
Figure 3. Expected coverage of radars working at 16 MHz.