



Subject: RDI's ADCP Waves Array

RDI's patented ADCP Waves Array applies acoustic profiling technology to measuring directional wave data and current profiles at the same time and from a single device. This innovation not only provides much more capability than just duplicating traditional wave gauges but avoids some of their limitations. Each of the near-surface depth cells along the ADCP's four orthogonal, slanted beams can act as a wave field sensor by measuring wave orbital variability. Further each of the four acoustic beams can directly track variations of the water surface (via ranging) even though the ADCP is deployed safely on the seabed.

The ADCP can therefore supply a data set for the wave analysis that matches an array of surface and near-surface sensors dispersed in space. This spatial network of measurements permits **more complete results** compared with single-point subsurface devices, surface-following devices, and small arrays of bottom-mounted sensors. In this note, we consider the scope of capabilities available from RDI's ADCP Waves Array.

Features of ADCP Waves Array

RDI's ADCP Waves Array provides tremendous versatility:

- ✓ Accurate and well-resolved wave directional analysis like a spatial array of sensors
- ✓ Direct measurement of surface variation like a surface-following device
- ✓ Easier deployment of a single location, bottom-mounted instrument
- ✓ Measurements of surface-layer currents that can distort the wave field
- ✓ Current velocity profiles through the water column
- ✓ Water depth time series

Avoids Several Traditional Limitations

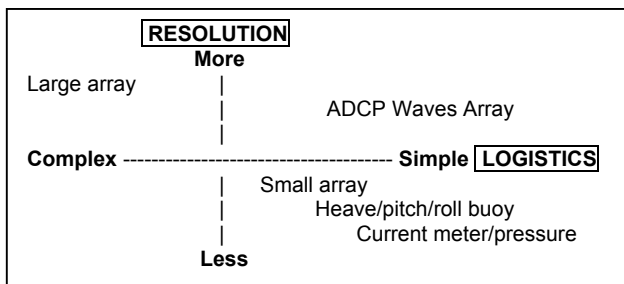
Direct surface tracking detects

- ✓ Higher frequency local seas, which are sometimes missed by pressure-based sensors
- ✓ Longer period swells, which can be missed by surface-following accelerometers

Measuring current profiles and waves at the same time avoids biased wave statistics in the presence of strong surface currents (e.g. tidal regimes). The currents distort the wave field thereby creating ambiguous interpretation of pressure sensor records.

Having a spatial array of data records avoids blurring waves that arrive from multiple directions. (Array enables high-definition, unambiguous polar plots of wave direction)

WAVE DIRECTIONAL RESOLUTION vs. FIELD LOGISTICS



Goals of Directional Wave Analysis

Two important goals for wave analysis are to measure accurately

- ✓ Propagation direction(s)
- ✓ Directional spread of the wave field

The directional wave analysis requires information about how the water surface changes in space (to reveal wave-number information). In the past, this information was obtained

- ✓ Directly, measuring surface height across an array of sensors---using phase information
- ✓ Indirectly, measuring variables related to surface slope at one location---using amplitude information.

This indirect approach has limited ability to measure directional spread accurately. Sometimes, statistical methods are used to combat directional smearing.

Well-Resolved Frequency-Direction Spectra

By measuring near-surface wave orbital variability across a spatial array, the ADCP Waves Array blends both phase and amplitude information to produce a time history of well-resolved frequency-direction spectra. Collecting these time series formerly required a massive and expensive field program. By deploying a single ADCP, they can now be a routine measurement.

These time series are ideal for rapid identification of high-energy events and are output together with directional waves statistics and current profiles. This combination of results tells a more complete story than older wave measuring methods.

Directional Resolution

Considering wave directional resolution, there is a continuum from large, wide arrays to single-point gauges. The ADCP Waves Array is situated in mid-continuum though its physical aperture size changes with water depth and its directional beam width varies with wave frequency. The ADCP is

- ✓ More like a large array for higher frequencies or deeper water
- ✓ More like a small array for lower frequencies or shallower water

Key Advantages of ADCP Waves Array

✓ Discerns Waves Arriving From Multiple Directions

Multi-directional wave conditions—which often exist near channels, shoals, jetties, breakwaters, canyons, or islands—can become mutually smeared in results from PUV** wave gauges. RDI's array data set eliminates this potential bias by analyzing the wave data in 4-degree directional segments.

✓ Avoids Biases Inherent In Other Wave Gauges

By measuring near-surface currents, the ADCP can compute and correct the distortion of the wave field by strong surface currents. As a result, ADCP-based wave statistics avoid potential biases in wave height and direction inherent in results from older methods.

Further, the ADCP measures the water surface directly, which reveals higher-frequency waves that bottom-mounted PUVs cannot see. Thus the ADCP avoids their potential to underestimate significant wave height.

✓ Internal Check on Non Directional Wave Statistics

Another notable advance is that RDI's Waves Array makes three independent measurements (surface track, wave orbital fluctuations, and pressure sensor) for the non-directional wave statistics.

The primary measurement is derived from direct surface tracking that provides the highest frequency response. This leads to more accurate results for significant wave height and wave period. The two other independent measures permit an internal check on data quality --a bonus for QA/QC needs.

✓ More Secure Bottom Mounting

Because RDI's Waves Array uses remote sensing, it can be mounted on the bottom or at deeper depths than other devices, which makes it safer from damage caused by storms, vessel traffic, and vandals. Even from depth, however, the ADCP can still observe surface and near-surface variability that reveals a broader frequency band of the wave field. This can result in more accurate measurements of significant wave height.

✓ Simplicity of a Single-point Installation

RDI's innovative method allows the ADCP to create an array of 12 sensors without the complexity and cost of an array installation. After installing one instrument, you can make multiple, simultaneous ocean measurements: directional wave spectra, current profiles, and water level. In deeper waters, the ADCP can be mounted in a mooring line although directional wave capability reverts to PUV performance. The ADCP Wave Array is operable with acoustic telemetry systems.

***Single-point wave gauge using pressure sensor & 2-d current meter*