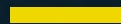# Accurate surface-wave measurements from below – principles and guidelines
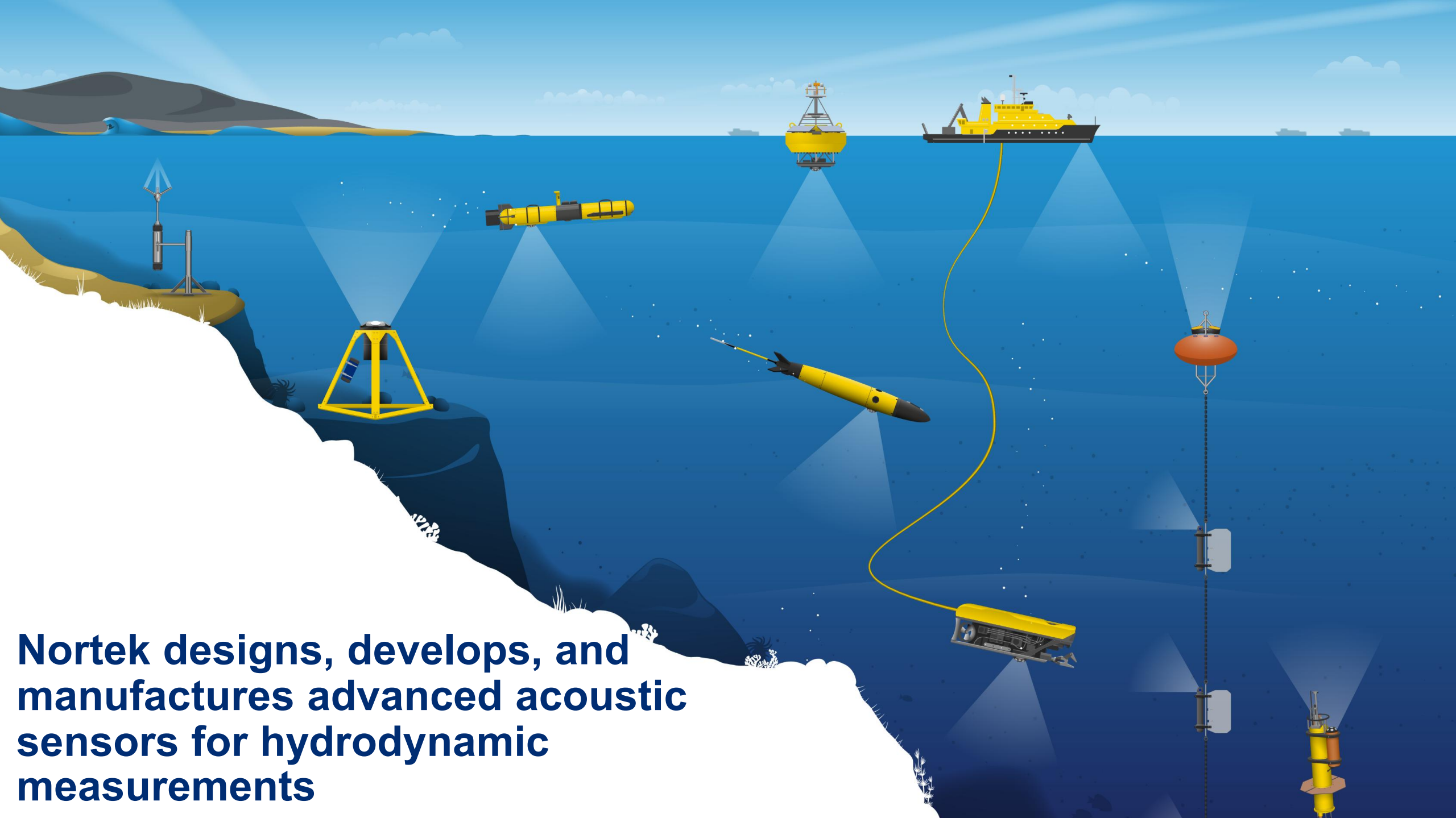
NORTEK

Nery Contti Neto
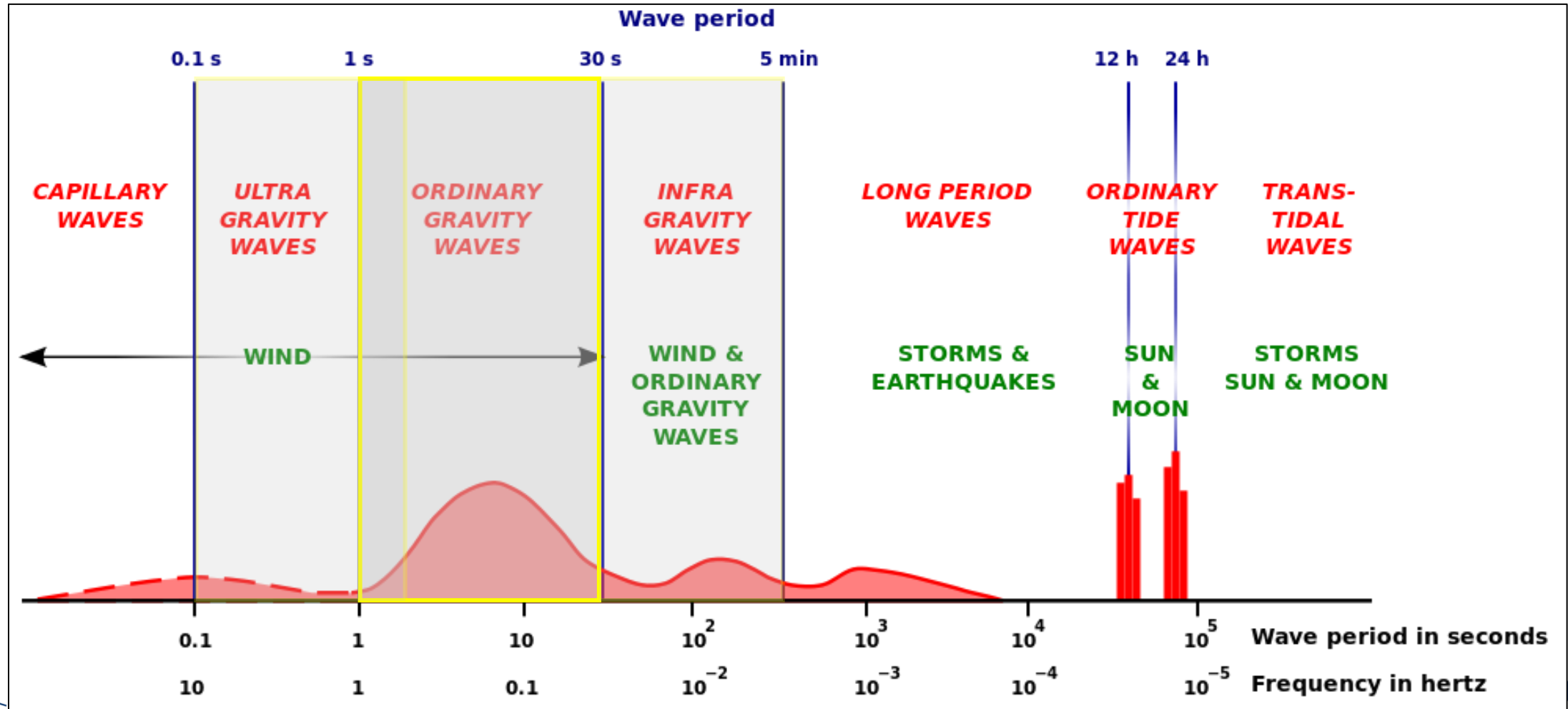**Senior Oceanography Advisor**
nery.neto@nortekgroup.com
support@nortekgroup.com

Nortek designs, develops, and manufactures advanced acoustic sensors for hydrodynamic measurements
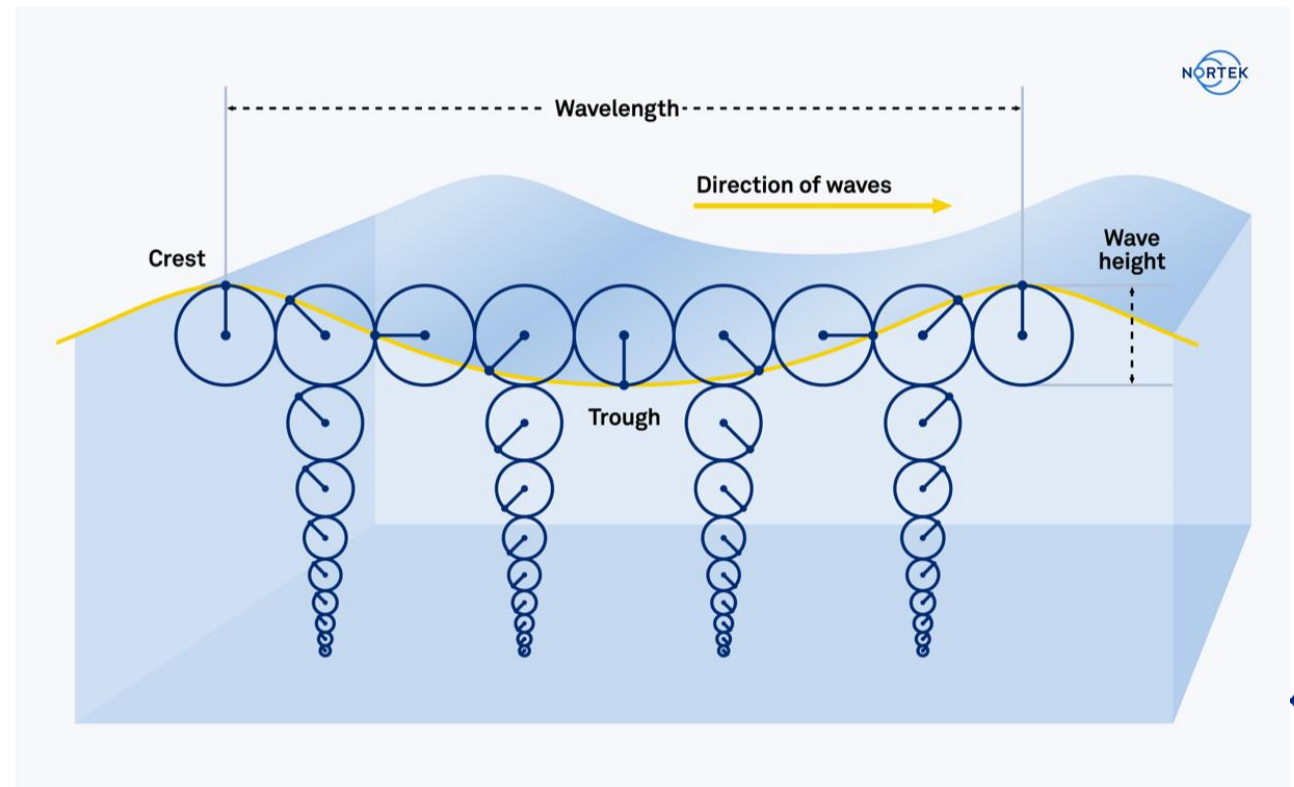
Types of surface waves

Background: measuring waves from below

- Signals below the surface: orbital velocities, pressure and η
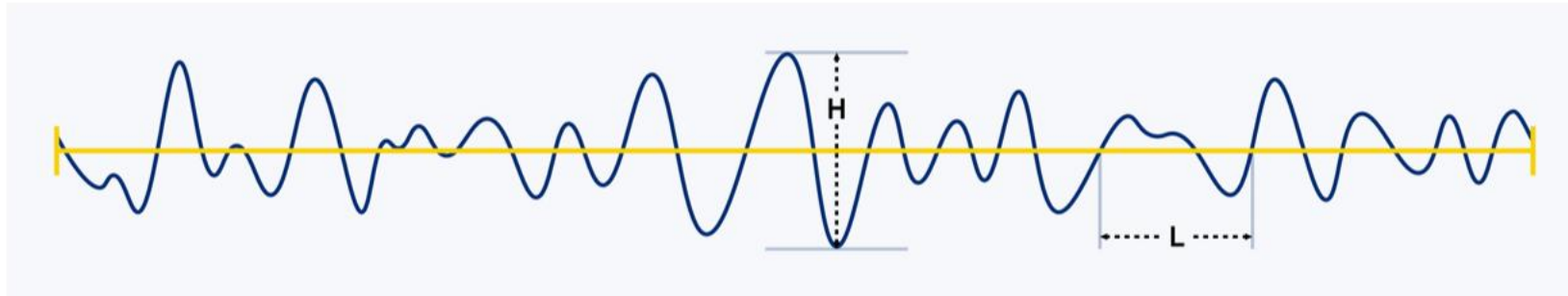- The behavior is well described with linear wave theory

- Why would you want to measure waves from below?
  - Precision
  - Fishing activities
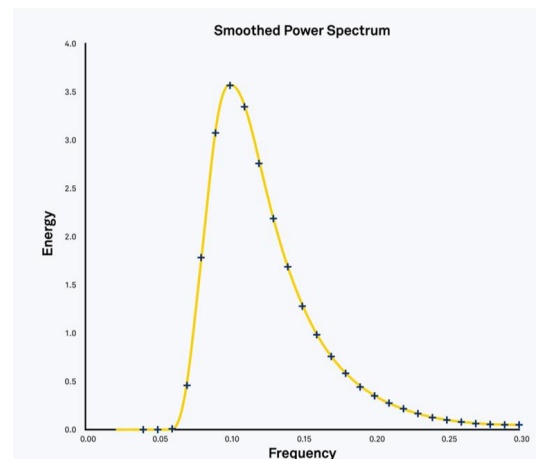 - Vessel traffic
  - Vandalism / theft

How do we analyse wave data?
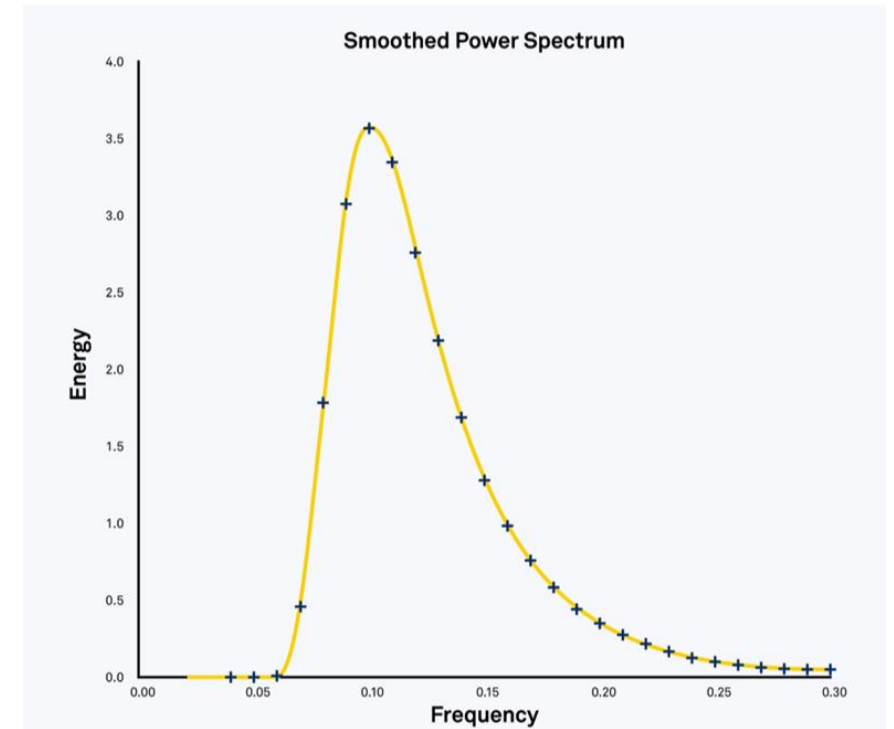
- Time domain (Zero crossing method)
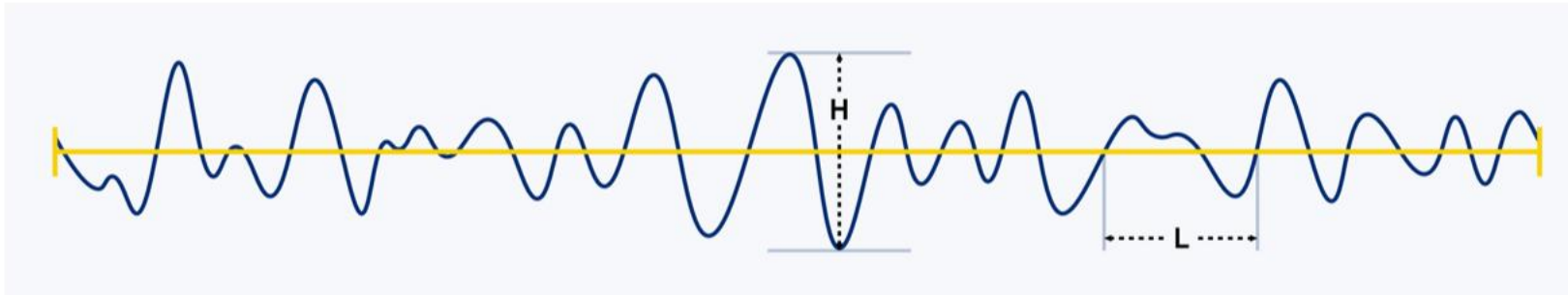

- Frequency domain

Frequency domain

- Indirect measurements
  - Pression
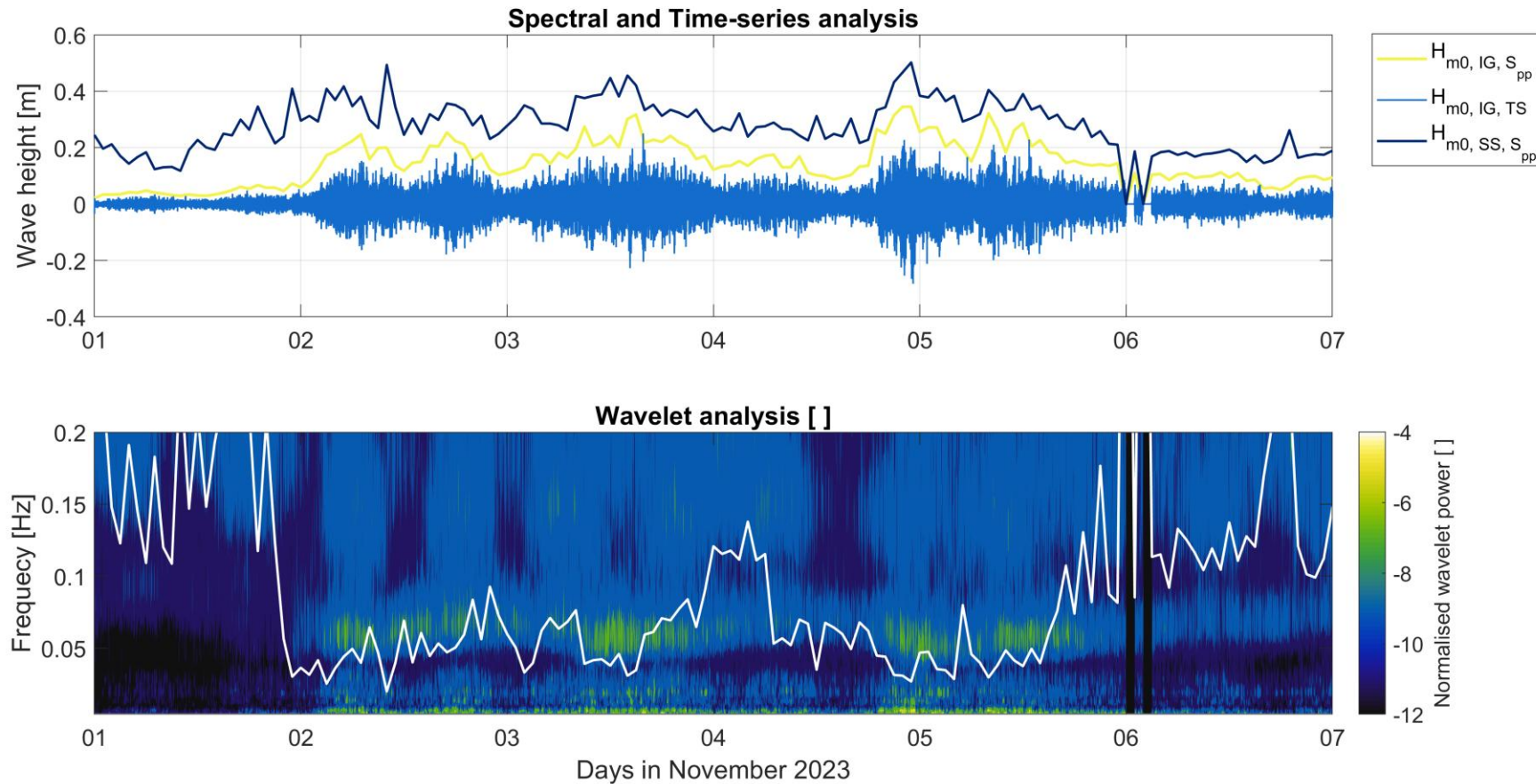 - Orbitals
- FFT
- **Tpeak, Tm02 y Hm0**
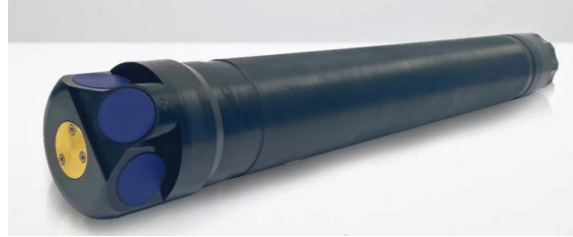
Time domain analysis

- Easy and direct way to calculate wave height and period

- Output:
  - Significant wave height (**H3** and **H10**),
  - Mean and Maximum wave height (**Hmean** and **Hmax) =➔** Hmax = 1.67Hm0
  - Mean Period (**Tz**)

Time and frequency domain
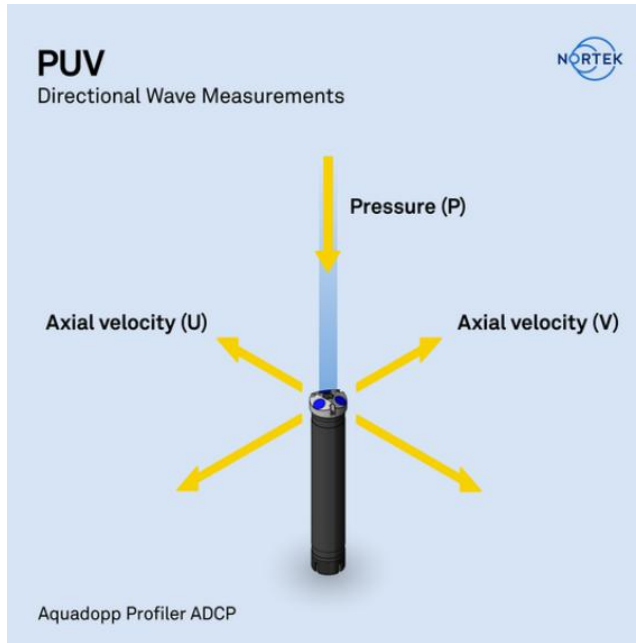
Processing methods

PUV
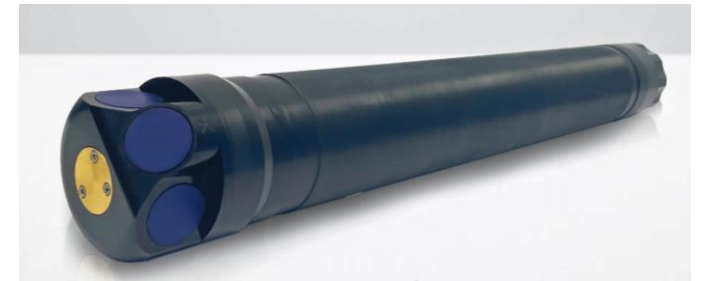
Processing methods - PUV

At instrument level
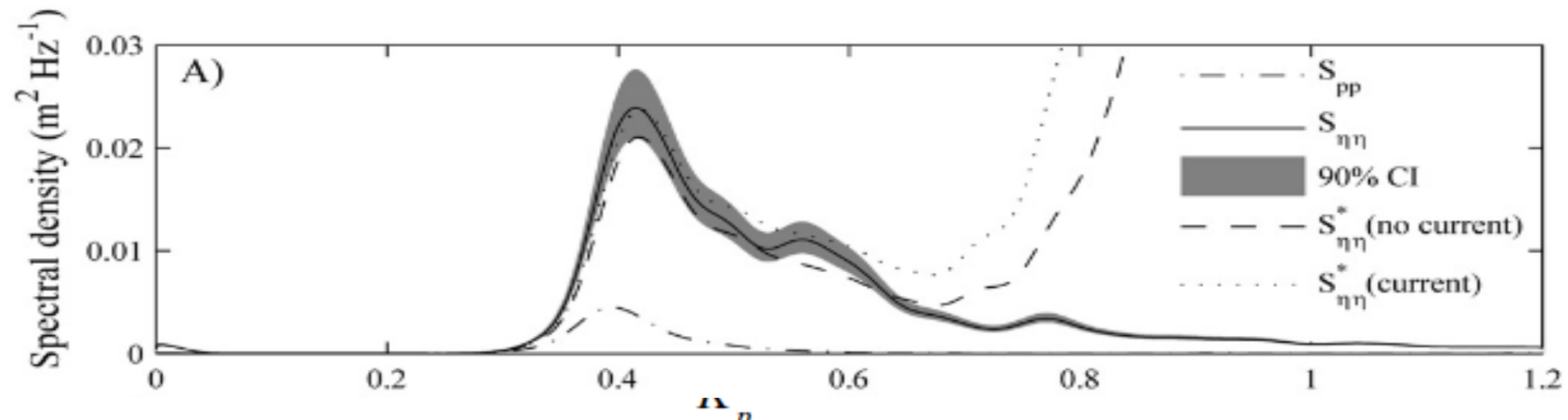
Pressure + UV
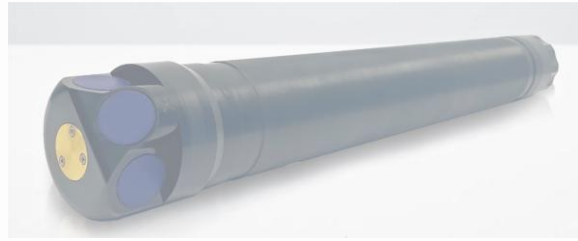
Processing methods – PUV limitations

- Shallow deployments (< 10 m)
- Longer period waves (> 5 s)
- Pressure attenuation
- Doppler shift

Jones and Monismith, 2007

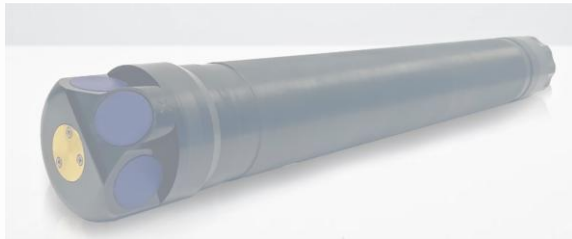# Processing methods - MLM

PUV

MLM

Processing methods – MLM (Maximum Likelihood)

- Generic term for directional measurements with multiple data arrays

- UV measurement in subsurface

- Dedicated orbital velocity cell

Array

Directional velocity

AWAC ADCP

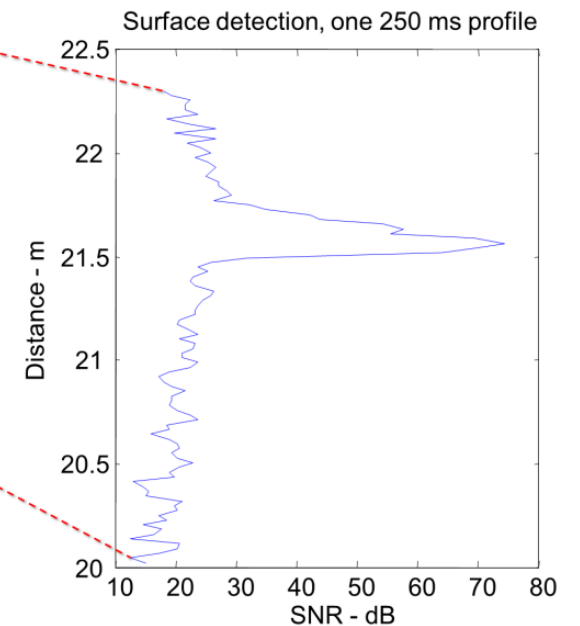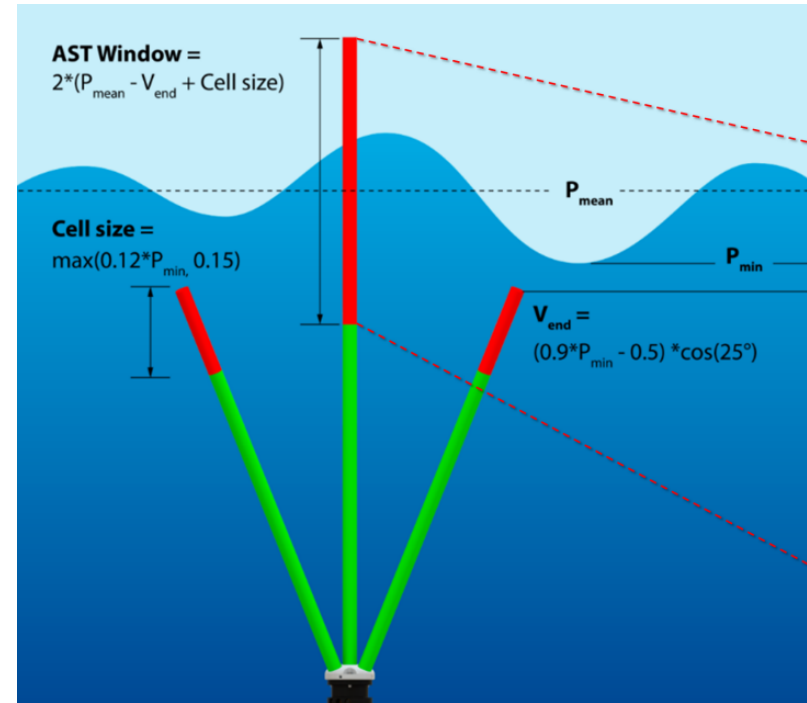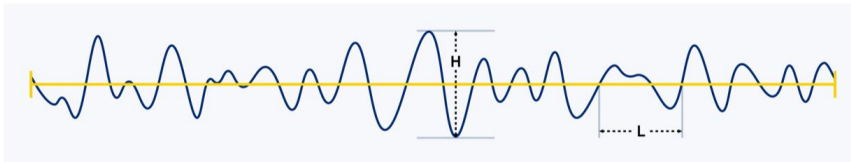# Processing methods

MLM **+** **AST** **=** **MLMST**

PUV

Processing methods – AST

- Inverted echosounder

- Pressure determins window
  - 1 mm resolution

AST Window =
$2*(P_{mean} - V_{end} + \text{Cell size})$

Cell size =
$\max(0.12*P_{min}, 0.15)$

P_{mean}

P_{min}

$V_{end} =$
$(0.9*P_{min} - 0.5) *\cos(25°)$

Surface detection, one 250 ms profile

Distance - m

SNR - dB
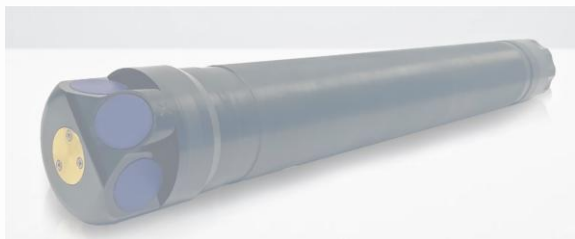
Processing methods – MLMST

- AST+MLM

- Bottom mounted

- Limitation: AST footprint
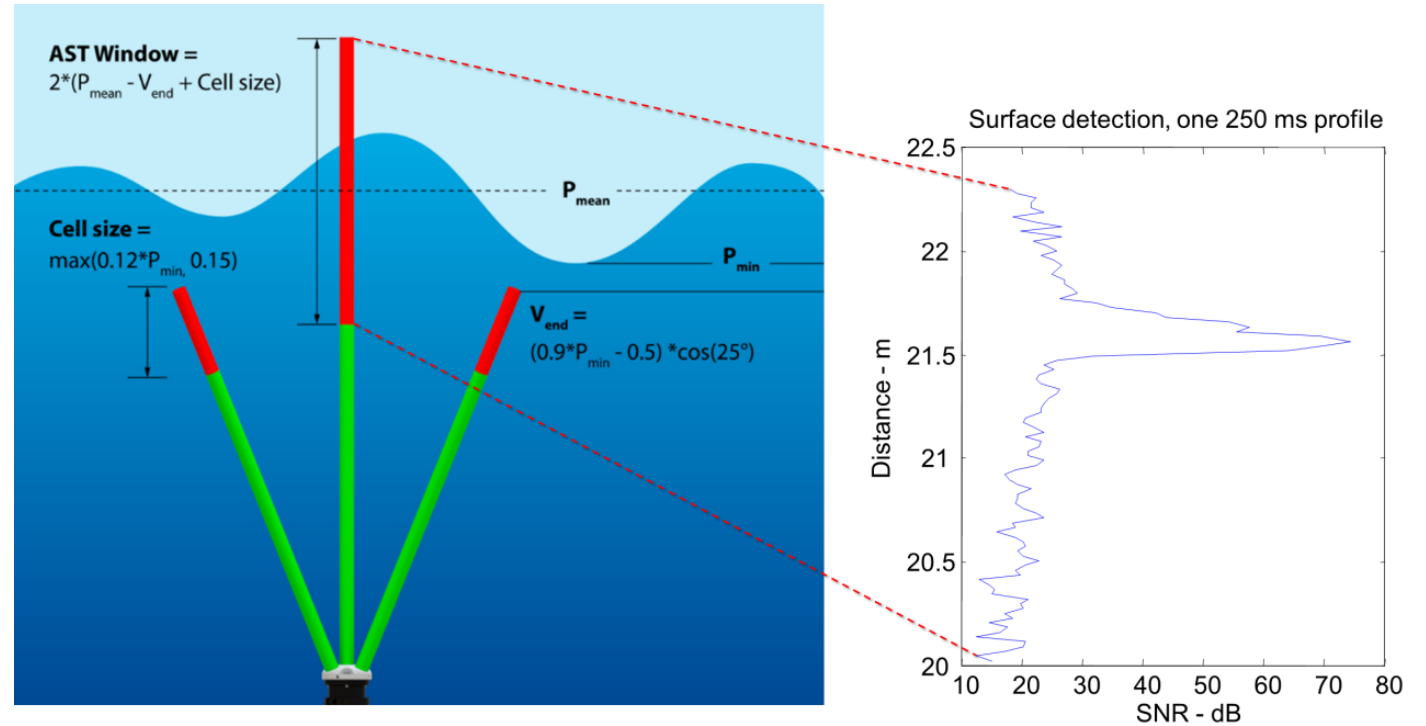
Wave Processing methods

MLM   +   AST   =   MLMST
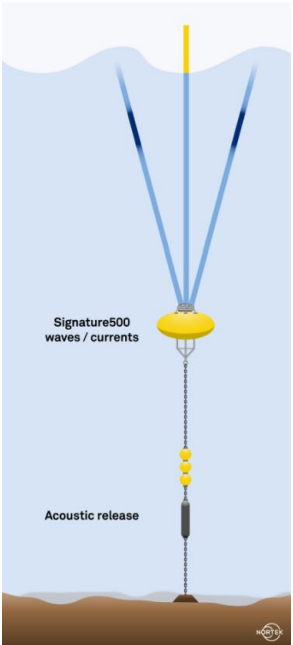
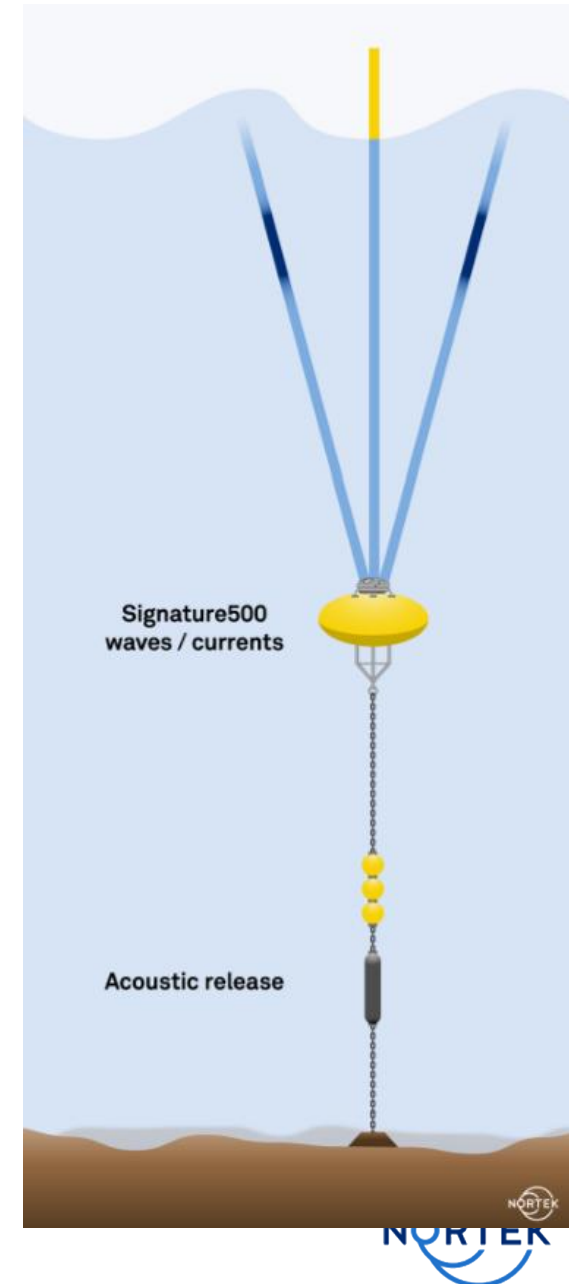

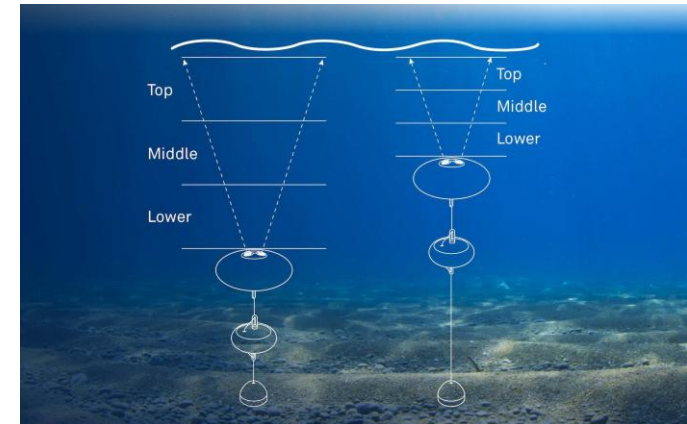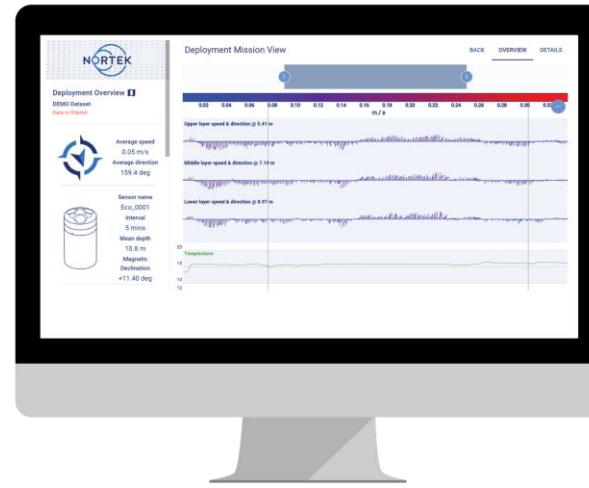PUV   ~~P~~UV   +   AST   =   SUV

NORTEK

Processing methods – SUV

- Nortek patent (2005)
- Orbital velocities measured near the surface with co-located U and V.
- It can be used on a subsurface buoy
- Corrects for the motion of the buoy.
- Recommended for locations with strong currents.

Signature500
waves / currents

Acoustic release

Ocean Contour

Bonus

© Photo by Jason Baer

Thank you!

nery.neto@nortekgroup.com

support@nortekgroup.com