Drifting instrumented chains. New technical developments and applications

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Outline

- Existing technology;
- Example of applications –measurements of very large amplitude internal waves;
- Benefits vs drawbacks of existing technology;
- Planned technical developments;
- Conclusions.

Existing technology (1/3)

Internal waves set-up:

I) 200 m long;

II) Internally recording (2Gb storage);

III) Argos up-link (to transmit GPS);

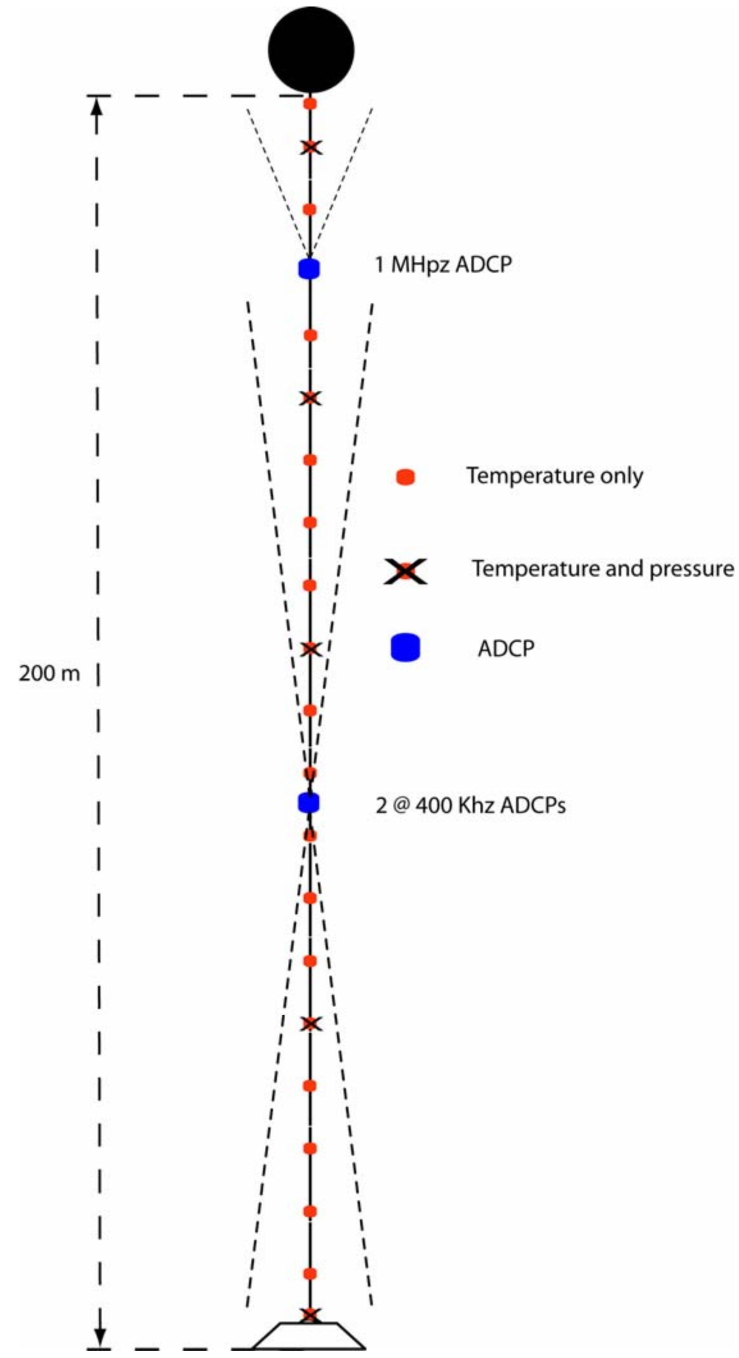
IV) Up to 20 T-P inductive sensor system;

V) 2 or 3 internally recording ADCP's;

VI) 1s internally recorded GPS;

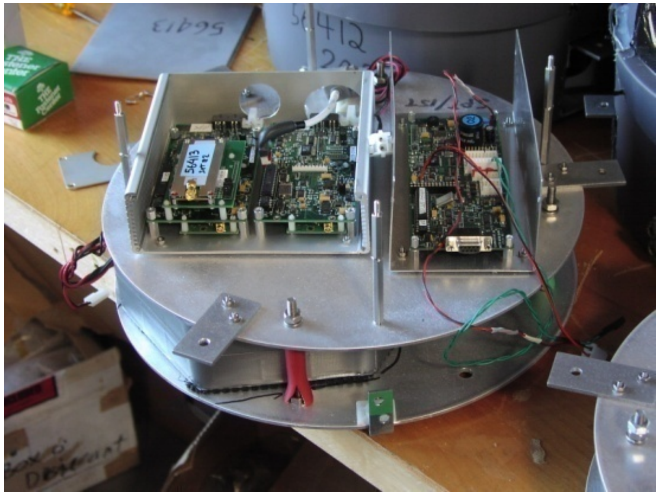
VII) Turbulence probes (J. Moum).

Note: other sensors have been used for different applications and they include: barometers, hydrophones, vanes & compasses and optic sensors.



Existing technology (2/3)

- Buoy contains GPS and ARGOS communications, data loggers and batteries;



- The chain (200m long) has 20 thermistors and pressure sensors (by Clearwater), can also carry 3 ADCP (by Nortek) for measuring subsurface currents.

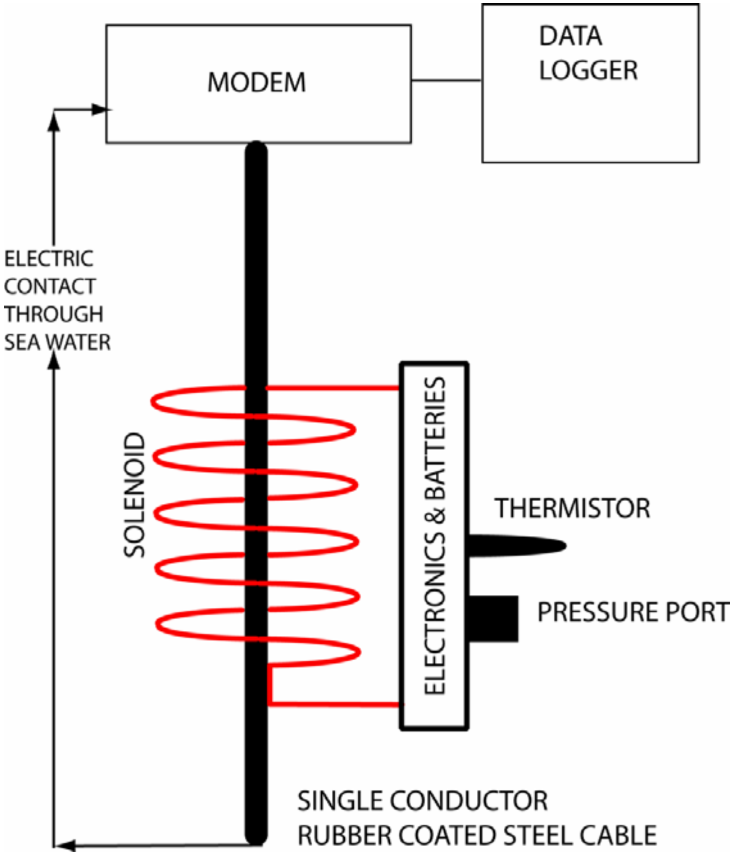
Existing technology (3/3)

Unlike many analog thermistor chains available on the market, we employ digital data transmission from the nodes to the buoy using the electromagnetic inductance principle. This eliminates node failures and data accuracy degradation due to small damages to the cable.

Thermistor chain data scan rate can be as high as 1 per minute;

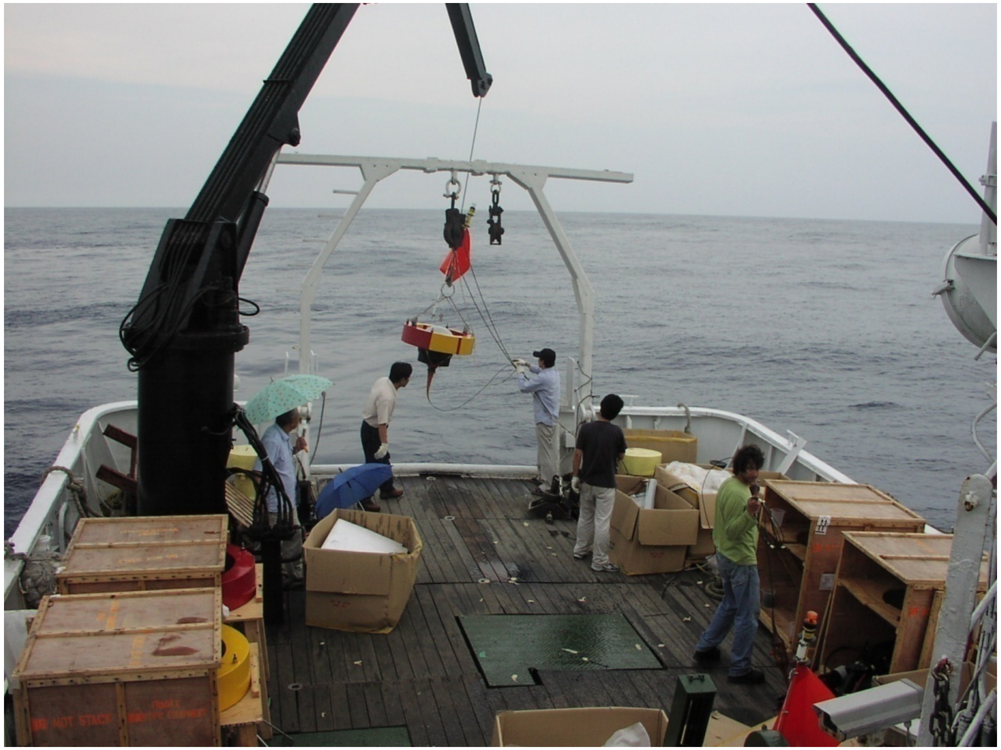
T accuracy is ~0.02 deg C;

Life-time of pods: up to 5 years.

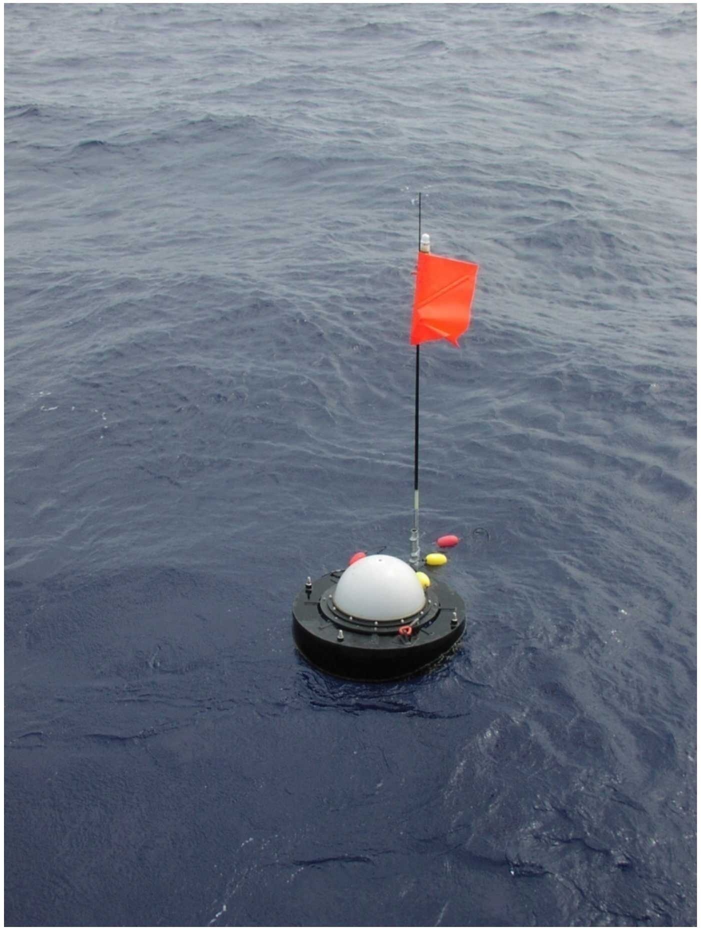


Examples of applications (1/5)

As part of Nonlinear Internal Wave Study in the South China Sea
2005 (May): NLIWI pilot experiment (4 ADCP – T chain drifters); OR2,3
2007 (April-May): NLIWI main experiment (8 ADCP-T chain drifters) OR2

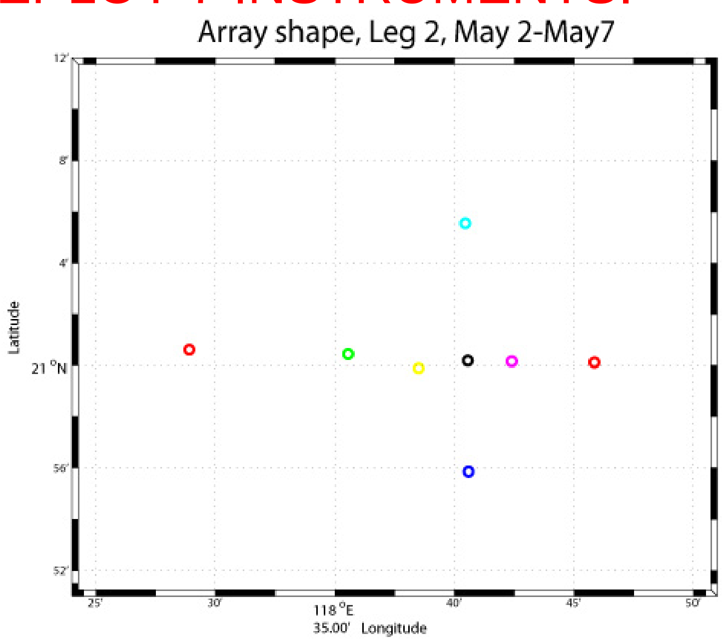


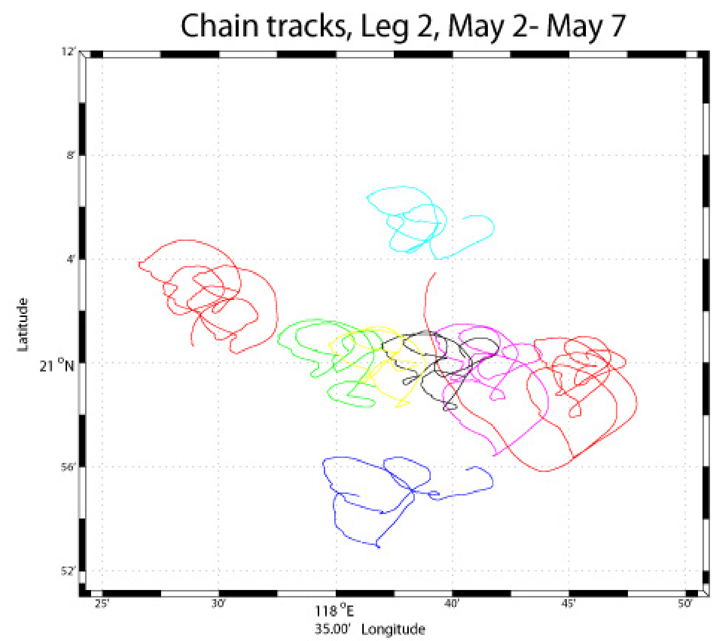
Deployment of a drifting thermistor chain from a small ship R/V “Ocean Researcher 2” in the South China Sea



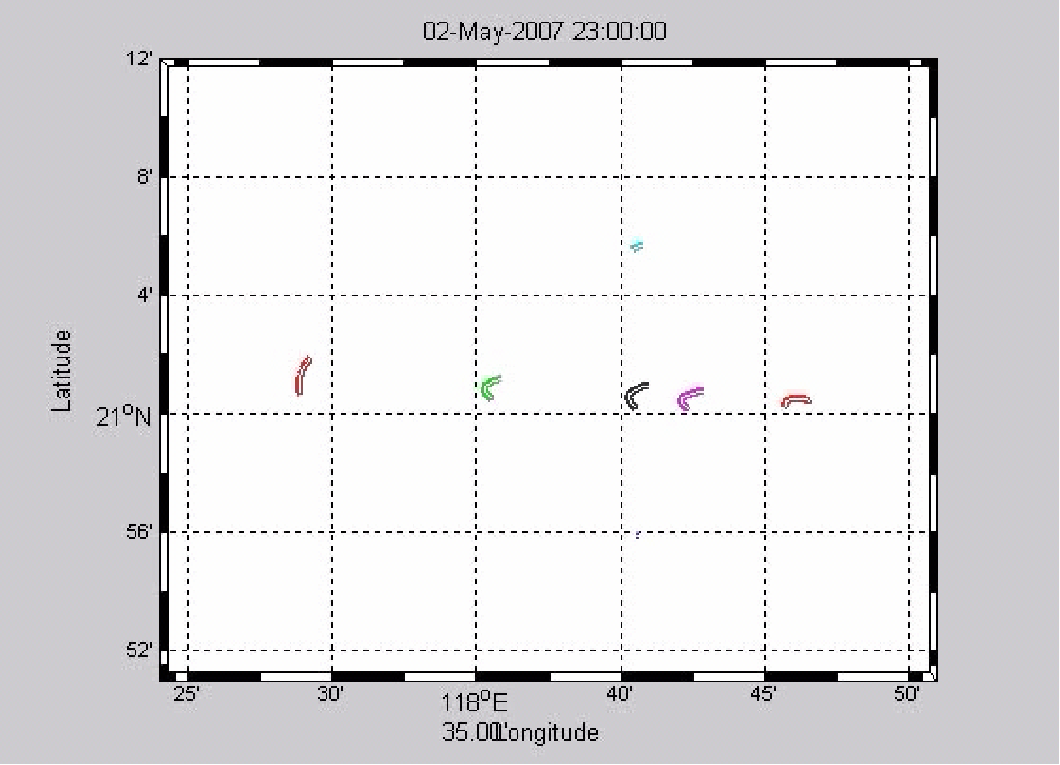
Example of applications (2/5)

- 1st baroclinic mode speed 2.5 m/s derived from the averaged density profiles.
- The semidiurnal internal tide (12h), wavelength L=108 km (58 nm). Array large scale L/4=15nm.
- The pycnocline Vaisala-Brunt frequency (about 12 min) manifested by oscillations in the wake of a passing wave packet. Array small scale *l* = 1.8 km (1 nm) length scales.
- The six drifters along west-east line have separations: 6, 3, 1.5, 1.5, 3 nautical miles – resolve large and small scales
- The three drifters along north-south line have separation 7.5 nautical miles – determine direction of the wave. IT TOOK LESS THAN 12 H TO DEPLOY 7 INSTRUMENTS.

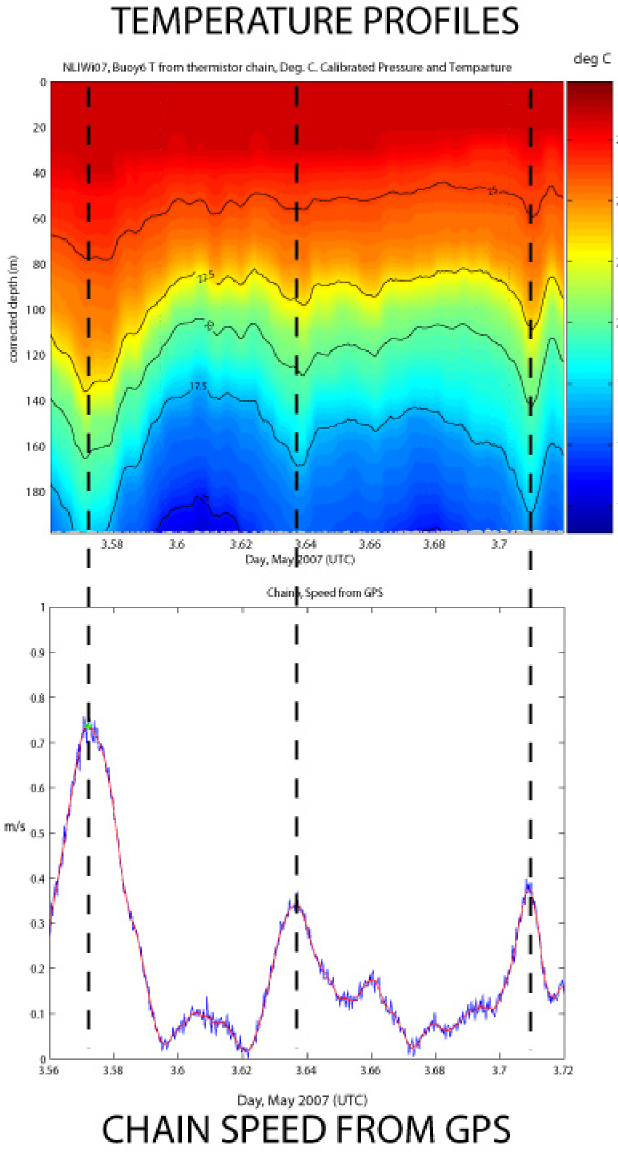


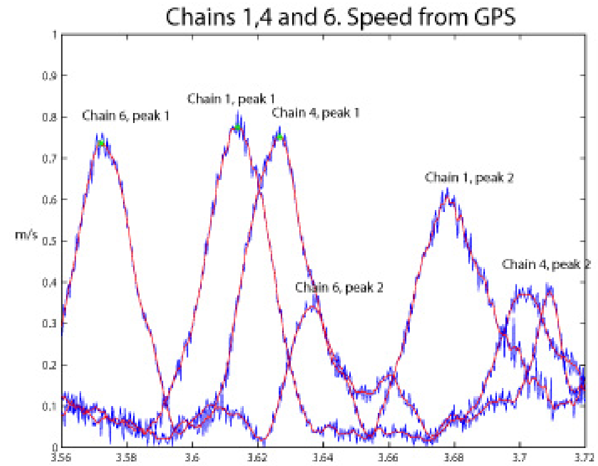


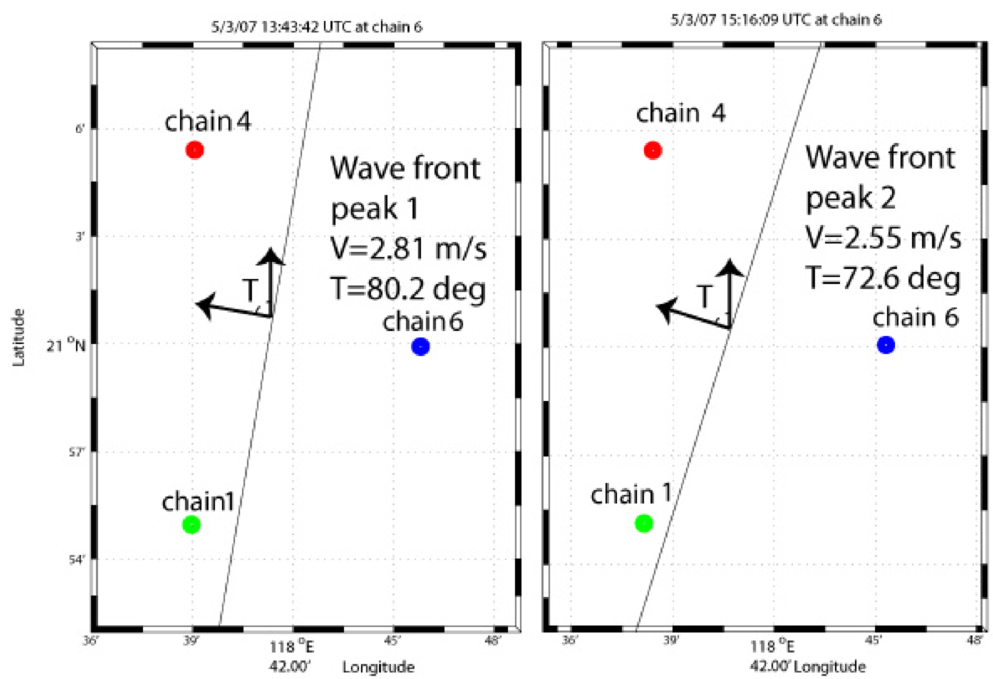
Example of applications (3/5)
Chain tracks: May 2-May 7, 2007 (Movie)



Example of applications (4/5): phase velocity of waves-the array is used as an antenna



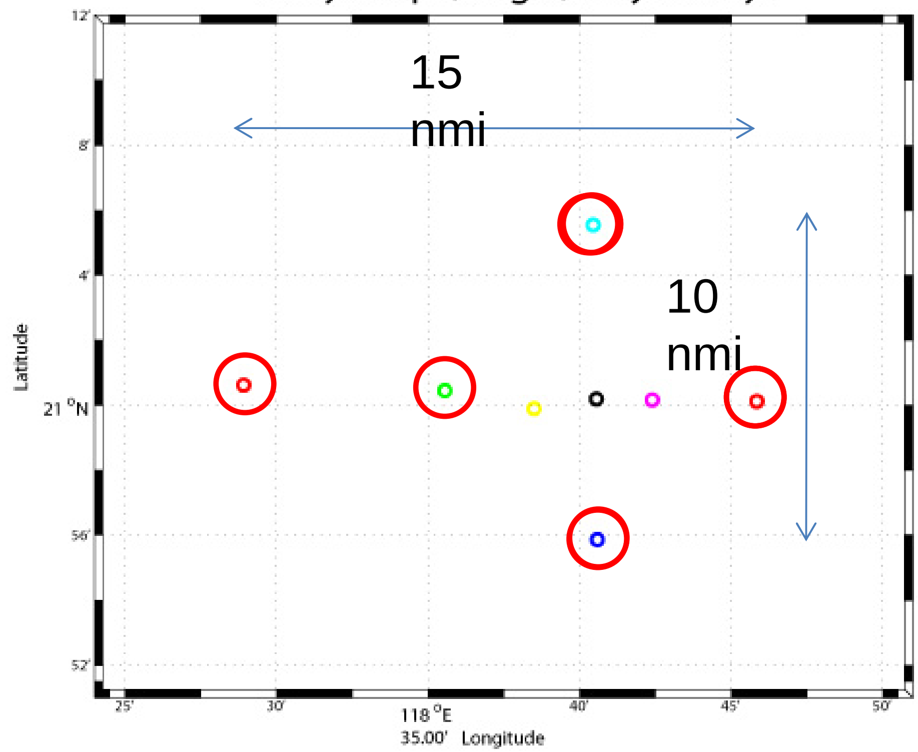




Example of applications (5/5): phase velocity of waves. The array is used as an antenna

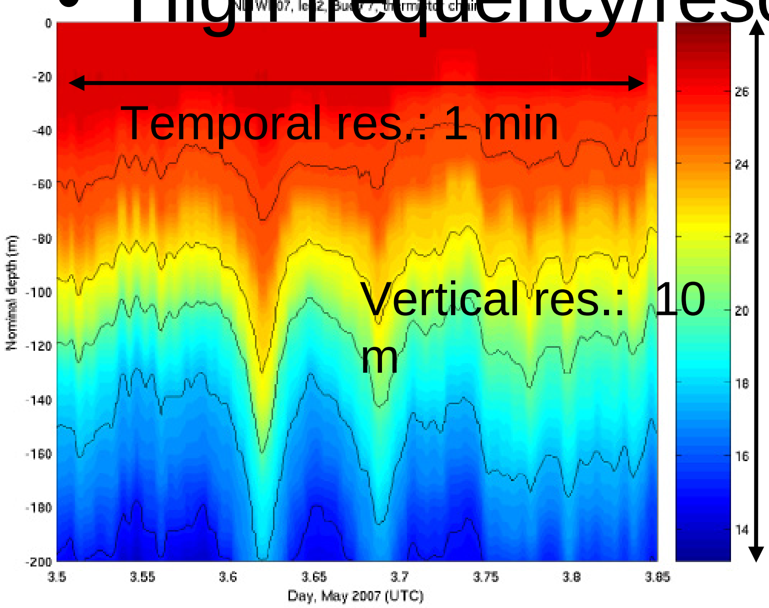
Chains	Peak 1, V and T	Peak 2, V and T
1-3-4	2.75 m/s, 80.4 deg	2.60 m/s, 72.4 deg
2-4-6	2.78 m/s, 81.4 deg	2.56 m/s, 71.5 deg
1-4-6	2.81 m/s, 80.2 deg	2.54 m/s, 72.8 deg

Array shape, Leg 2, May 2-May7



Benefits

- Low cost (US $ 50K for 20 PT nodes and 3 ADCP’s);
- Easy and quick to deploy and recover;
- Can be operated from a small vessel;
- Allows the deployment o
- High frequency/resolutio



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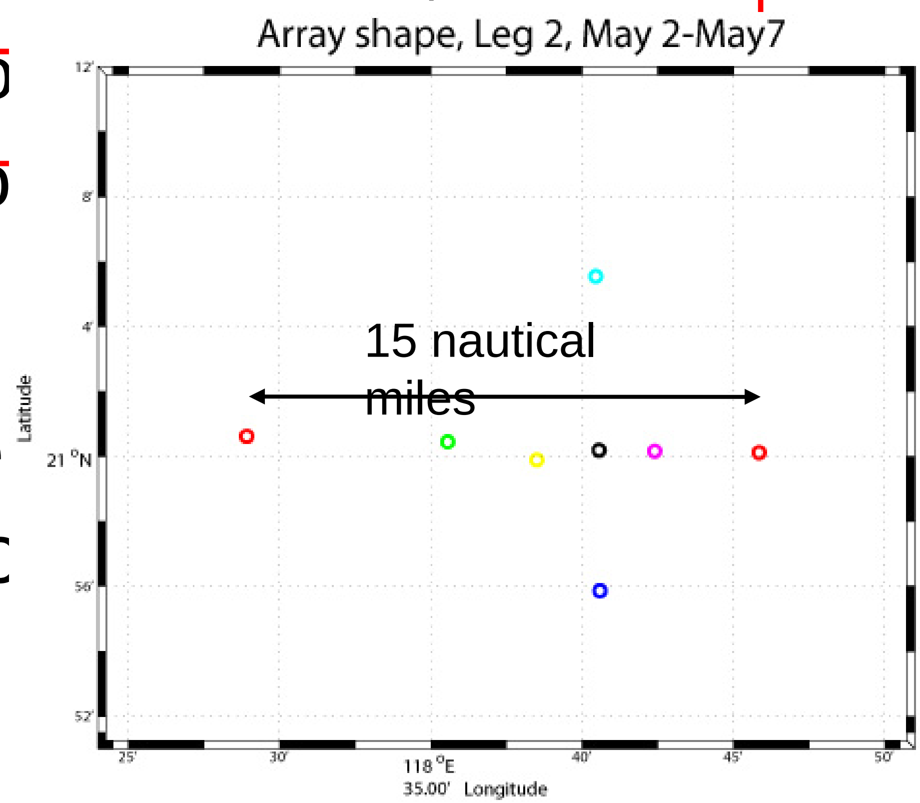

Drawbacks

- Limited depth (200 m) & lifetime (~ 2weeks for ADCP's - depending on settings but 5 years for P & T);
- Mostly internally recording (but T&P data can already be sent through Argos-see hurricane presentation);
- Minimal onboard processing & data reduction;
- Arrays can disperse over time because of ocean currents (a problem only if spatial resolution is of concern).

Technical developments needed for this class of instruments

- Need inductive coupling to transmit ADCP’s data (similar to the P & T system);
- Need to monitor/measure chain 3-D motion and, if necessary, use it to correct ADCP’s measurements (requires on-board processing).
- Need controller capable of reducing corrected ADCP data;
- Need broadband uplink to transmit ADCP data, higher frequency GPS, T and P data;
- Need to miniaturize components;
- Air deployment (see hurricane presentation);

Conclusions

- Light-weight drifting chains are very useful for measuring ocean processes with small spatial scales and fast time scales;
- Light-weight drifting chains are very easy to handle and reduce the cost of sea-going operations (air deployment is goal);
- Efforts are needed to reduce the cost of ADCP heads and for efficient communication of high-quality, accurate data.