Joint WMO-IOC Technical Commission
for Oceanography and Marine Meteorology

JCOMM Pilot Project on Wave measurement Evaluation and Test from moored buoys

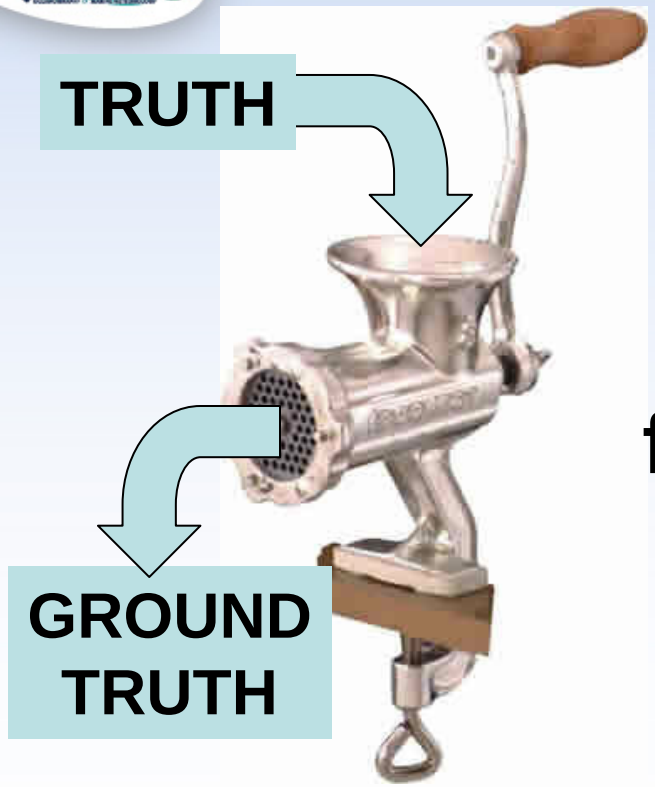
Val Swail and Boram Lee

WMO

IOC/UNESCO

How is your wave measurement?

Courtesy C-C Teng



New System for obtaining "ground truth" for wave measurements

Or

What about an independent group of assessors??

Courtesy Don Resio

PP-WET: Objectives

- Develop the basis for an international framework for the continuous testing and evaluation of existing and planned wave buoy measurements
- Coordinate buoy inter-comparison activities.
- Develop technical documentation of differences due to hull, payload, mooring, sampling frequency and period, processing (e.g. frequency bands & cutoff), precision, transmission
- Develop training material to educate users about how to deploy and operate wave sensors appropriately.
- Contribute appropriate material to the JCOMM Standards and Best Practice Guide
- Establish confidence in the user community of the validity of wave measurements from the various moored buoy systems

PP-WET Steering Team membership

- Val Swail, Co-Chair (ETWS, EC)
- Bob Jensen, Co-Chair (USACE)
- David Meldrum (DBCP, SAMS)
- Jean Bidlot (ECMWF)
- Hester Viola (DBCP)
- Chung-Chu Teng (NOAA/NDBC)
- Bill Burnett (NOAA/NDBC)
- Julie Thomas (UCSD)
- Hans Graber (U. Miami)
- Diana Greenslade (Australian Bureau of Meteorology
- Ian Young (Swinburne University of Technology)
- Bill O'Reilly (UCSD)
- Jon Turton (Met Office)
- Christian Meinig (NOAA/PMEL)
- Anne Karin Magnusson (KNMI)
- Kevin Ewans (Shell)
- George Forristall (ForOcean)
- Dong-Young Lee (KORDI)
- Kwang-Chang Lim (KHOA)

- Secretariat support will be provided by WMO and IOC.

- Boram Lee (IOC)
- Etienne Charpentier (WMO)

PP-WET Results - Year 2

- Contract let to CDIP/SIO to develop
  - Intercomparison web site
  - Quality Assurance standards proposal
  - Special metadata requirements for intercomparisons
  - Provide intercomparison software to partners
  - Advice on use of intercomparison methodology and web site (CB)
  - Advice on intercomparison technical issues
  - Conduct individual intercomparison analyses

- Intercomparison activities –
  - Canada – two co-location deployments – see following slides
  - UK – Comparison of heave sensor and Triaxys on K5 – report on WET web page
  - Norway – plan to submit Ekofsik platform wave data to CDIP for analysis – laser, waverider, MIROS
  - Korea – plans for multiple co-locations and analysis
  - OGP – interest in providing co-located measurements to CDIP for analysis

PP-WET Results - Year 2

- Special Session, discussion session, side meeting at 11th International Workshop on Wave Hindcasting and Forecasting – October 2009 – Halifax (www.waveworkshop.org)

- Presentations to ETMC-III, ETWS-III, OGP – 2010

- *Status report to DBCP XXVI – September 2010 – Oban*

Wave intercomparison Web site

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Documentation

- **FAQs & Summaries**
- **Glossary**
- **Publications**
- **Introduction**
  - History and Funding
  - Program Goals
- **Wave Measurement**
  - Wave Generation
  - Wave Dynamics
  - Irregular Waves
  - Spectral Analysis
  - Gauging Waves
  - Hurricane Events
  - Tsunami Events
- **Instrumentation**
  - Instrument Types
  - Deployment & Use
- **Data Acquisition**
  - System Organization
  - Hardware
  - Software
- **Data Processing**
  - System Organization
  - Software
  - Quality Control
- **Data Management**
  - Stations and Sets
  - Files and Storage
- **CDIP Products**
  - Data Formats
  - Web Products
  - COOS Integration
  - QARTOD

Wave Sensor Comparisons

CDIP071012007_v_NDBC46023012007

Time Series Plots | Wave Component Plots | Scatter Plots (future) | Documentation

All Waves 0.03-0.50Hz | Forerunners 0.03-0.05Hz | Long Swell 0.05-0.08Hz | Short Swell 0.08-0.12Hz | Long Seas 0.12-0.25Hz | Short Seas 0.25-0.40Hz | Wind Chop 0.40-0.50Hz

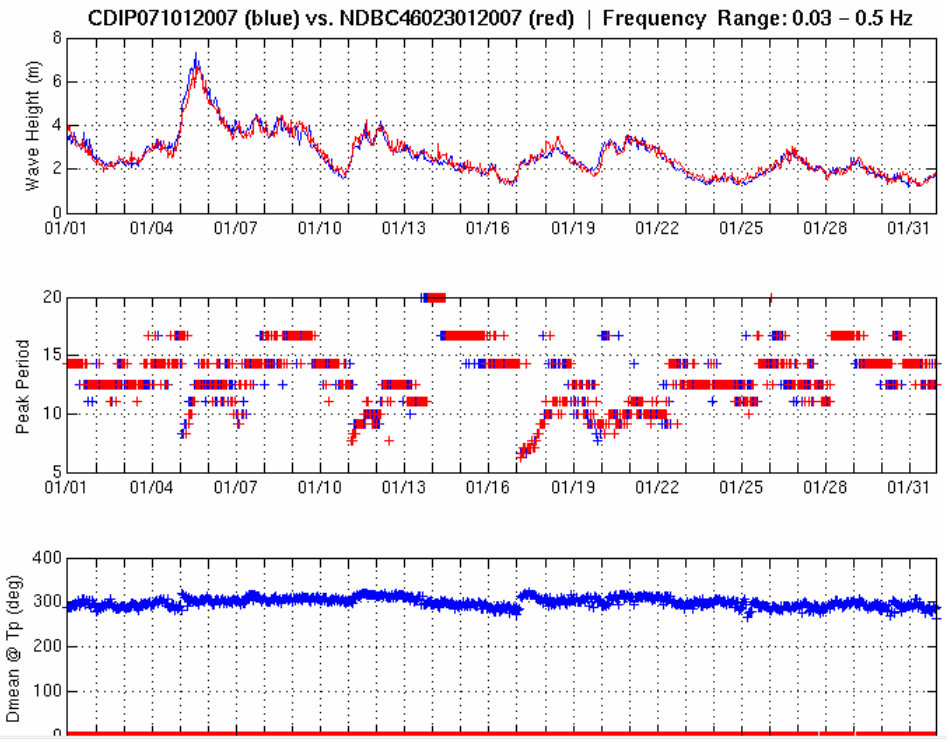
Hs, Tp , Dm @ Tp

Freq Peak & Centroid

a1,b1 Mean Dir & Spread

a2,b2 Mean Dir & Spread

Skewness & Kurtosis



Find: line | Next | Previous | Highlight all | Match case

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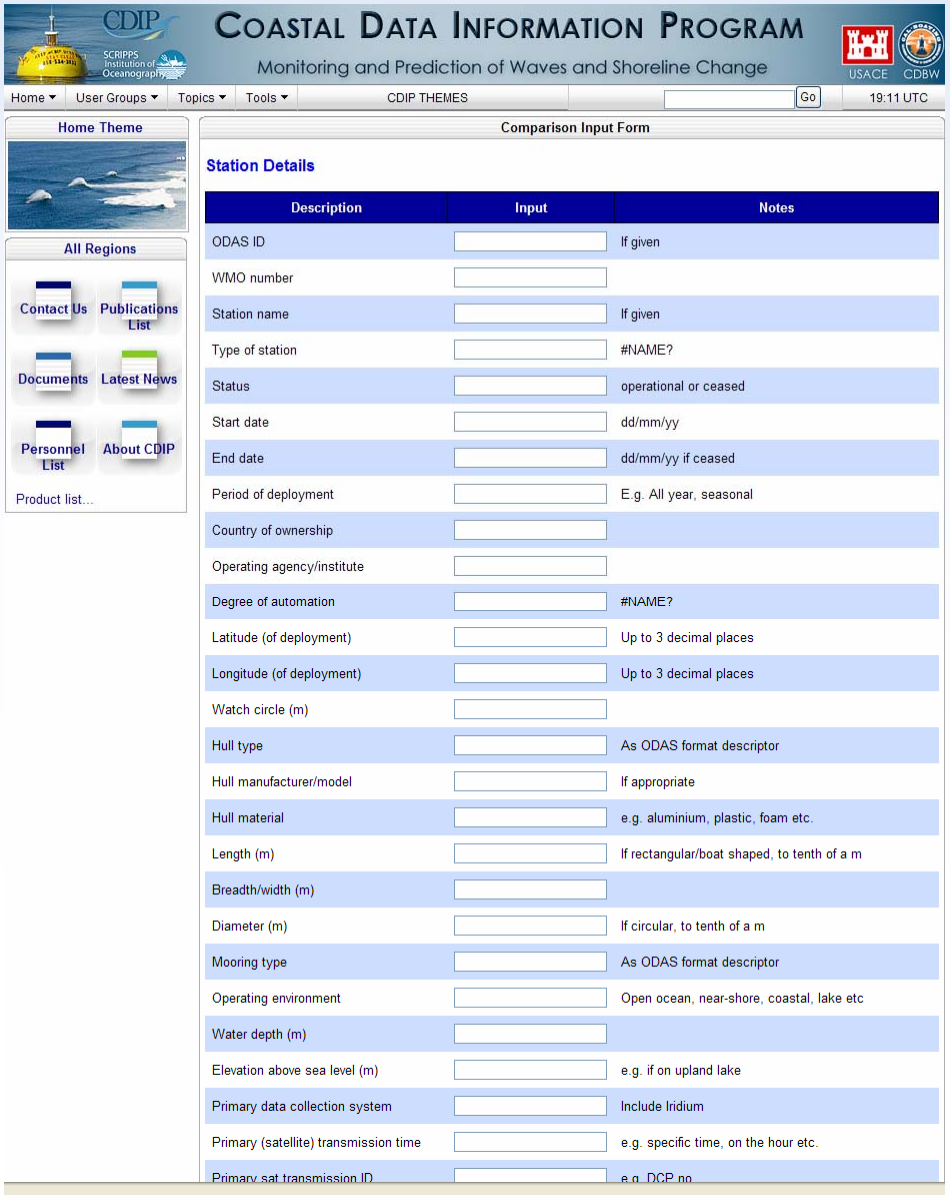
Intercomparison Metadata Form



CDIP
SCRIPPS Institution of Oceanography

COASTAL DATA INFORMATION PROGRAM

Monitoring and Prediction of Waves and Shoreline Change

USACE CDBW

Home | User Groups | Topics | Tools | CDIP THEMES | Go | 19:11 UTC

Home Theme

All Regions

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Product list...

Comparison Input Form

Station Details

Description	Input	Notes
ODAS ID		If given
WMO number		
Station name		If given
Type of station		#NAME?
Status		operational or ceased
Start date		dd/mm/yy
End date		dd/mm/yy if ceased
Period of deployment		E.g. All year, seasonal
Country of ownership		
Operating agency/institute		
Degree of automation		#NAME?
Latitude (of deployment)		Up to 3 decimal places
Longitude (of deployment)		Up to 3 decimal places
Watch circle (m)		
Hull type		As ODAS format descriptor
Hull manufacturer/model		If appropriate
Hull material		e.g. aluminium, plastic, foam etc.
Length (m)		If rectangular/boat shaped, to tenth of a m
Breadth/width (m)		
Diameter (m)		If circular, to tenth of a m
Mooring type		As ODAS format descriptor
Operating environment		Open ocean, near-shore, coastal, lake etc
Water depth (m)		
Elevation above sea level (m)		e.g. if on upland lake
Primary data collection system		Include Iridium
Primary (satellite) transmission time		e.g. specific time, on the hour etc.
Primary sat transmission ID		e.g. DCP no.

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Quality Assurance Procedures

QARTOD | CDIP | FRF | IOC | NDBC | NOBSKA | NORTEK | RDI | SONTEK

IOC Quality Control Tests : Waves

The tests are from International Ocean Commission (IOC) Manual and Guides 26 prepared by the Commission of the European Community and the Committee for International Oceanographic Data and Information Exchange of the Intergovernmental Oceanographic Commission and published in 1993. The bulk of the wave tests are in SECTION 2.2, APPENDIX A WAVE DATA. Some of the tests have been edited from the Manual for clarity and to accommodate the QARTOD format.
The table below will take you to the relevant tests. To view the Waves section, click here. Also included are the relevant *FORMALISED DESCRIPTION OF QUALITY CONTROL ALGORITHM*.

- DB - Directional Buoy
- NB - Non-directional Buoy

TIME SERIES VALUES (Digital or digitized data)		
TEST: description (click name for more details)	**DB**	**NB**
RAW DATA TIMING: verify number of collected values equals the number of expected values.	✓	✓
GROSS ERROR LIMIT: test for values greater than 6 times standard deviation from the mean.	✓	✓
RATE OF CHANGE CHECK: test that the maximum allowable difference between adjacent samples.	✓	✓
CONSECUTIVE EQUAL VALUES: test for occurrence of 10 or more consecutive points with equal value.		✓
WANDERING MEAN CHECK: test for individual zero up-crossing period of > 25 seconds.		✓
DATA STABILITY CHECK: test if the means or standard deviations of the segments (at least 8) differ from the mean or standard deviation of the entire sample.		✓
CHECK LIMITS TS: test for values greater than 4 times standard deviation from the mean.	✓	✓
BUOY HEADING: Buoy heading directions should be checked to ensure that the values lie between 0 and 360°	✓	
RAW DATA INSPECTION AND EDITING: The routine inspection of the raw data should be one of the first checks carried out on receipt of the data from offshore.		✓
STATIONARITY TS: check all channels for 10 or more consecutive points with equal value.	✓	
SPECTRAL VALUES		
TEST: description (click name for more details)	**DB**	**NB**
ENERGY IN THE SPECTRUM: verify that energy in parts of the spectrum do not exceed expected values.	✓	✓
CHECK RATIO: the check ratio should theoretically be 1 at all frequencies.	✓	
CHECK ON THE CROSS SPECTRA: Each of the cross-spectra has zero expectation at all frequencies. In reality, each should be at least an order of magnitude less than its associated co- or quad-spectrum.	✓	
PARAMETER VALUES (Processed data)		
TEST: description (click name for more details)	**DB**	**NB**
CHECK LIMITS PM: check that parameters do not exceed possible values.		✓
WAVE STEEPNESS: check that wave steepness <= 1 / 7.		✓
GAPS: Checks for gaps in the data should ensure that any defined periods of gaps are consistent with the number of data points nulled or absent.	✓	✓
CHECKS ON INPUT DATA: Are direction data in degrees true or magnetic? Does magnetic correction applied lie between 0 and 16°	✓	
MEAN WAVE DIRECTION: Check that all values of mean wave direction (determined at whatever frequency) lie between 0 and 360°	✓	
DIRECTIONAL SPREAD: Check the rms spread about the mean direction at the spectral peak is 30°	✓	
STATIONARITY PM: check HS or TZ is the same as for the previous two records.		✓

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Wave Sensor Comparisons

CDIP071012007_v_NDBC46023012007

Time Series Plots | Wave Component Plots | Scatter Plots (future) | Documentation

Sensor Intercomparison Tool Instructions

- The CDIP Wave Instrument Intercomparison Tool Manual

Metadata for Moored Buoys

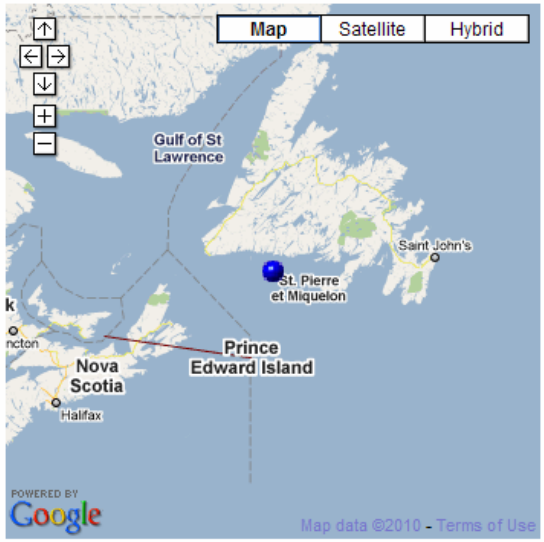
- Header_And_Data_For_Moored_Buoy_Systems.xls
- Sensor Intercomparison Metadata Form

Source Code

- cdiptool.zip (38M)
- cdiptool.tar.Z (44M)
- cdiptool.tar (164M)

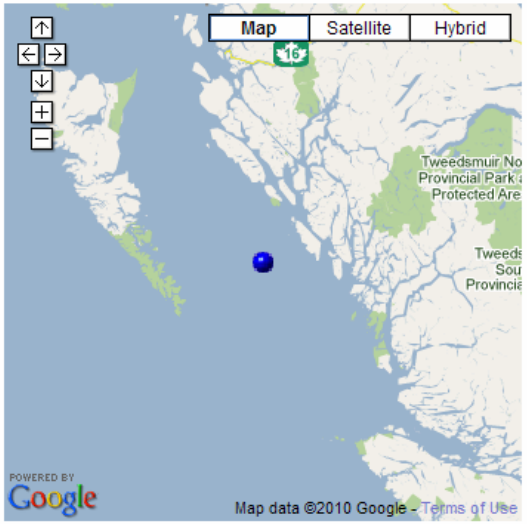
Canadian Co-deployment locations

- Current status: **operational**
- Most recent location: **47 15.91 N 57 20.49 W (47.2652 -57.3415)**
- Instrument description: **Datawell directional buoy**
- Most recent water depth (MLLW): **177 m (581 ft, 97 fm)**
- Measured parameters: **wave energy,wave direction,sea temperature**
- NDBC/WMO identifier: **44235**



170 - Station Map

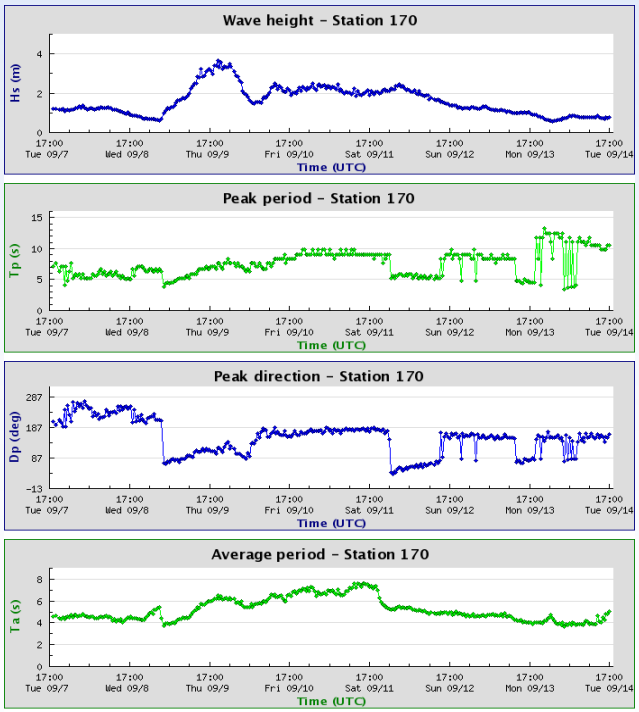
- Current status: **operational**
- Most recent location: **52 26.20 N 129 47.70 W (52.4367 -129.7950)**
- Instrument description: **Datawell directional buoy**
- Most recent water depth (MLLW): **230 m (755 ft, 126 fm)**
- Measured parameters: **wave energy,wave direction,sea temperature**
- NDBC/WMO identifier: **46138**



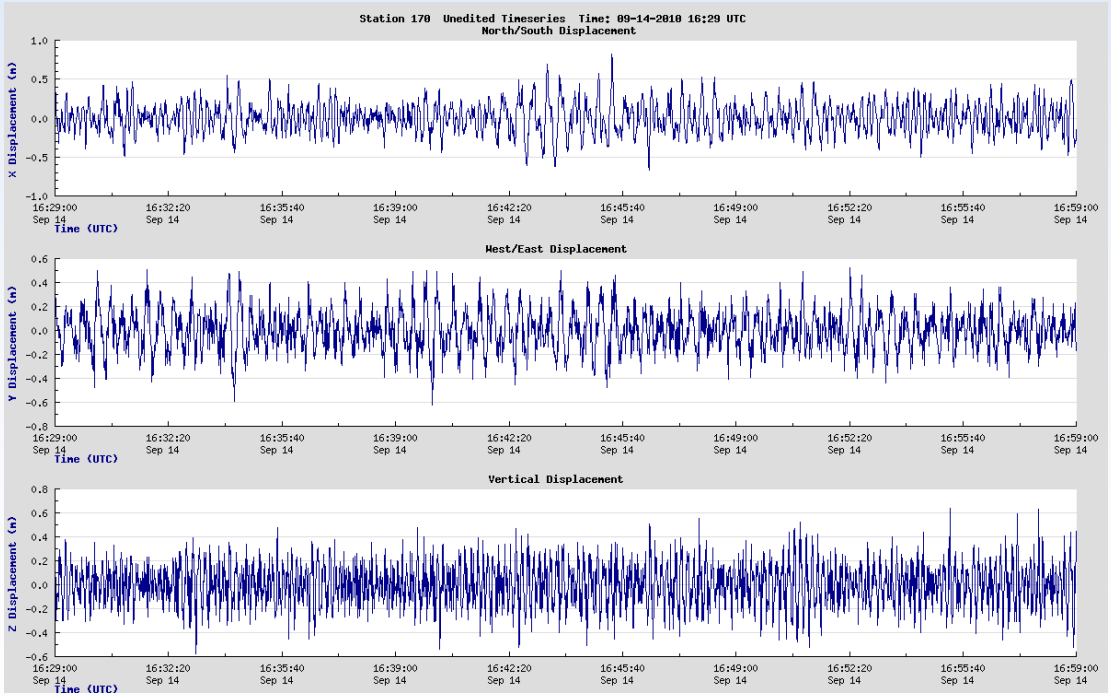
174 - Station Map

170 co-located with operational 6m NOMAD 44255
174 co-located with operational 3m discus 46185 plus TriAxys sensor

CDIP Wave Summaries

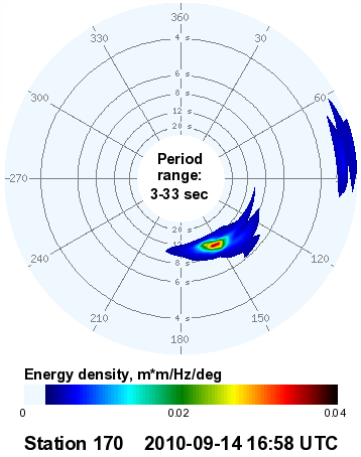


Weekly Summaries

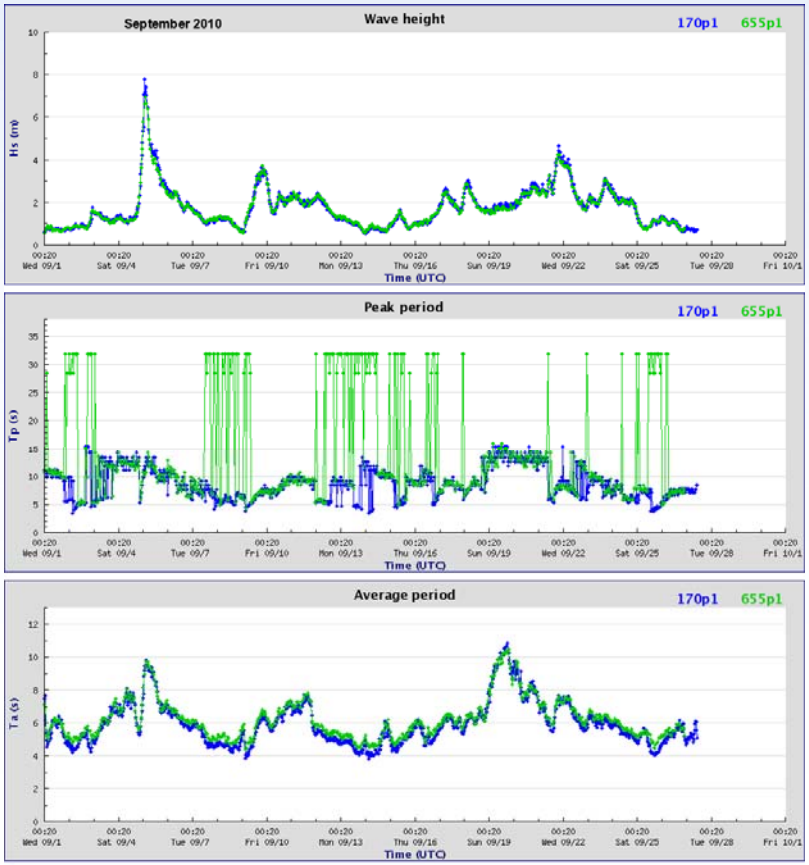


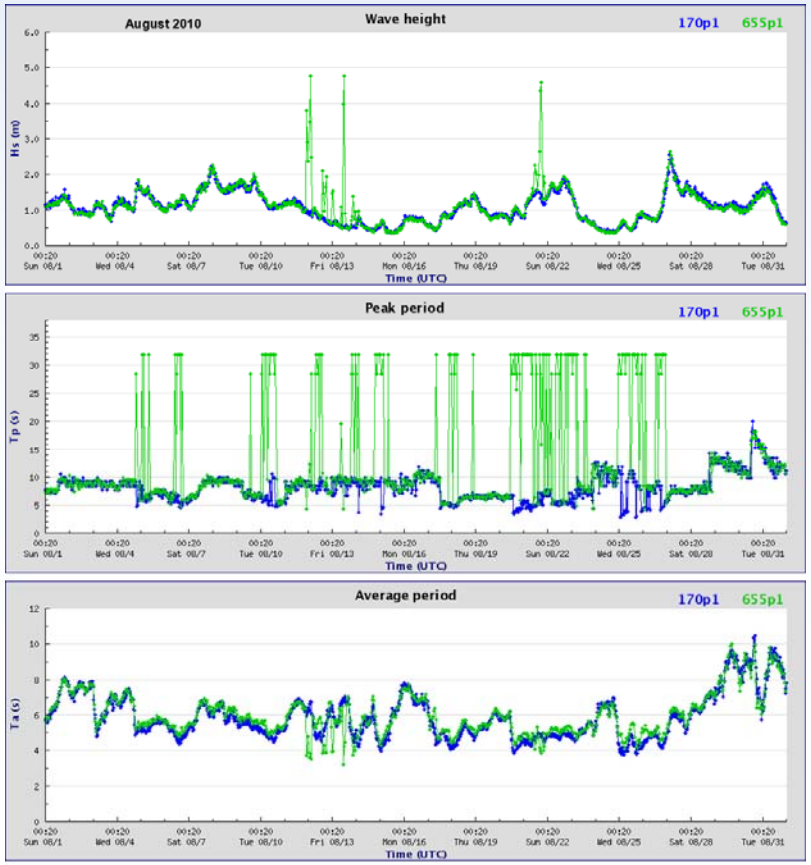
Displacement Time Series

Directional Spectrum



Canadian Wave Intercomparisons – South Ramea Island, all waves

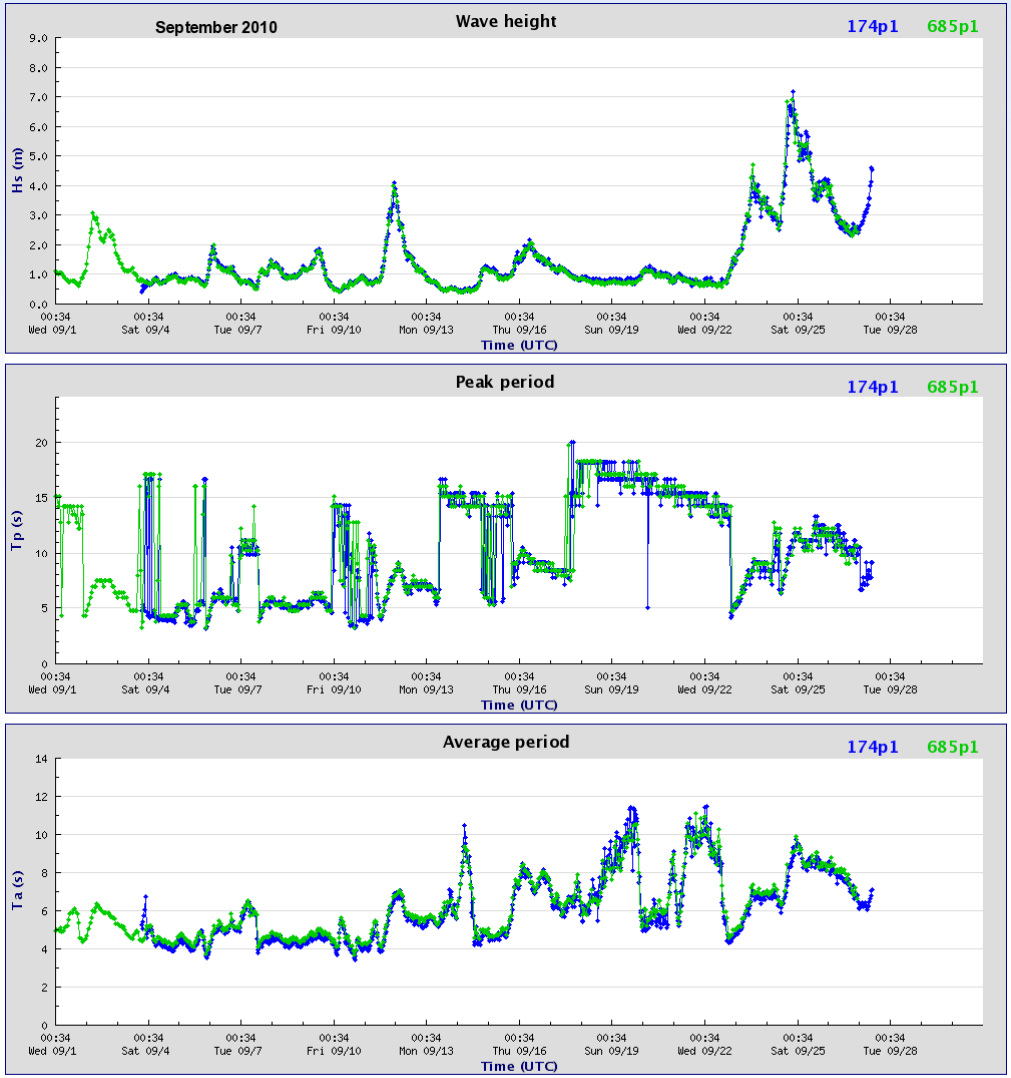




Blue – Datawell directional waverider

Green – EC operational 6m NOMAD

Canadian Wave Intercomparisons – South Hecate, all waves



Blue – Datawell directional waverider

Green – EC operational 3m discus

Plans PP-WET Work Plan - Year 2

- ✓ 2nd Steering Committee Meeting– February 27, 2010 – Portland OR
- ✓ Coordinate intercomparisons of wave measurements from different platforms, on an opportunistic basis
  - Assist participants where appropriate
  - Plans so far: Canada, UK, Norway, Korea
- o Develop a plan for a continuous testing and evaluation program
- o Contribute, as appropriate, to the JCOMM Standards and Best Practice Guides
- ✓ Present results to DBCP-XXVI and other scientific fora
- ✓ Decide if a case can be made to continue the pilot project for a further year and investigate follow-on mechanisms
- ✓ See www.jcomm.info/WET for updated information and link to intercomparisons

Proposed Plans PP-WET Work Plan - Year 3

- 3rd Steering Committee Meeting– Spring 2011
- Coordinate intercomparisons of wave measurements from different platforms, on an opportunistic basis
  - Assist participants where appropriate
- Develop a plan for a continuous testing and evaluation program
- Contribute, as appropriate, to the JCOMM Standards and Best Practice Guides
- Present results to DBCP-XXVII and other scientific fora, e.g. MARCDAT-III, 12th Waves Workshop


Thank you.