



Joint WMO-IOC Technical Commission
for Oceanography and Marine Meteorology

DBCP-ETWCH Joint Pilot Project on Wave Measurement Evaluation and Testing

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WMO



IOC/UNESCO

OBSERVATION REQUIREMENTS FOR WIND WAVES

(developed by the JCOMM Expert Team on Waves and Coastal Hazards Forecasting Systems)

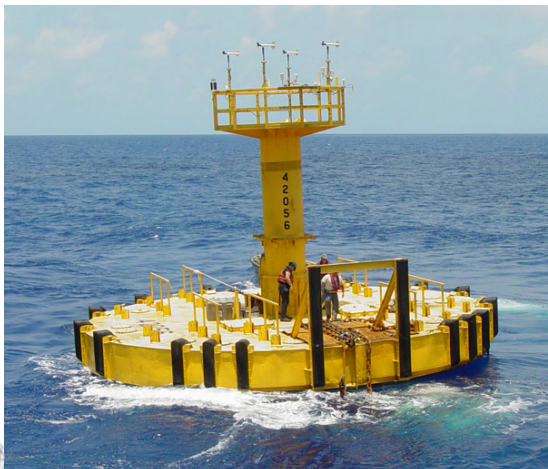
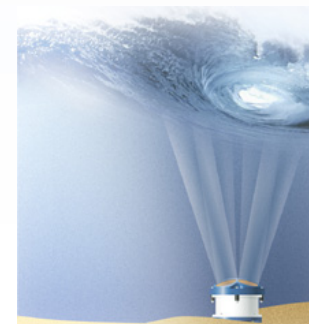
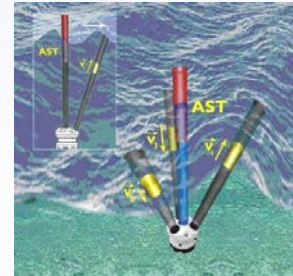
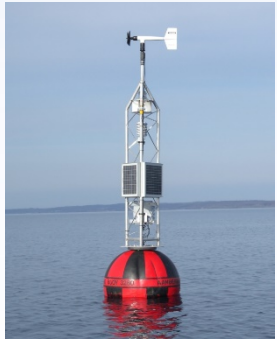
Applications:

- Assimilation into offshore wave forecast models
- Validation of wave forecast models (and hindcast and reanalysis)
- Calibration / validation of satellite wave sensors
- Ocean wave climate and variability
- Role of waves in coupling
- Coastal zone modelling – erosion, sediment transport, inundation etc.
- Wave power resource assessment

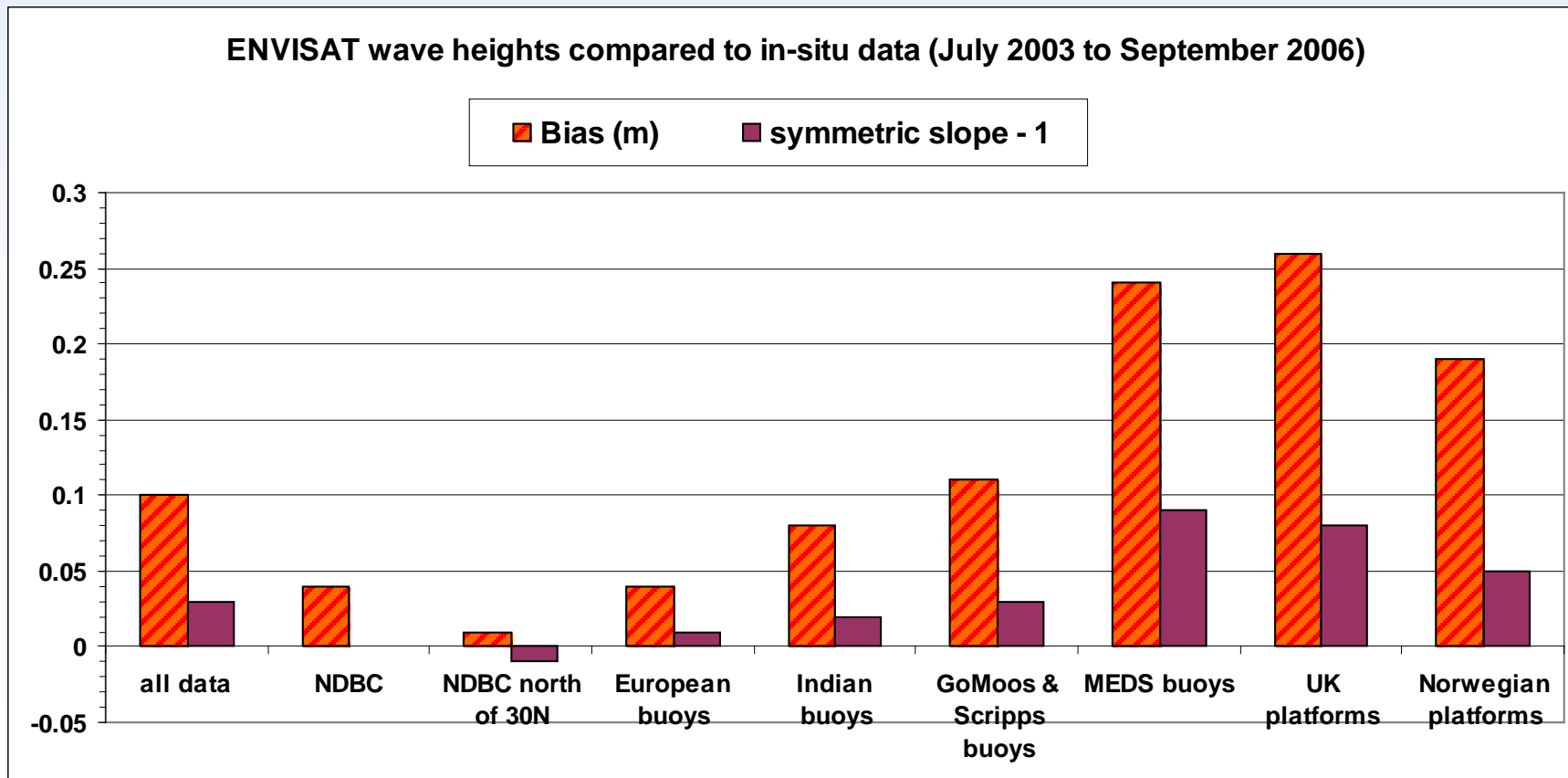
- Reference:

- *OceanObs09 paper Swail et al.*
- *OceanObs99 paper Swail et al.*
- *DBCP-22 Meeting Report October 2006*
- *ETWS-II Meeting Report March 2007*
- *CBS/OPAG-IOS/ET-EGOC-3 Doc. 7.2.6*

How to “ground truth” the “ground truth” ?



Why Do We Need to Test and Evaluate



Bias: altimeter Hs – in-situ Hs

Symmetric slope: ratio of variance altimeter to variance in-situ



How is your wave measurement?



“My waves are 10% higher than your waves.”



“10%? That’s a lot!”

“Continuous testing and evaluation of operational and pre-operational measurement systems is an essential component of a global wave observing system, equal in importance to the deployment of new assets”

Swail et al., *Wave Measurements, Needs And Developments For The Next Decade*. OceanObs09 publication.

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

Status of Intercomparison Activities during the Year

- **Canada** – No progress due to lack of ship time and a lost 6N mooring. East Dellwood buoy should continue to log onboard, including SIO GPS sensor.
- **Norway** – No progress. Ekofsik LASAR Intercomparison shelved due to seemingly insurmountable logistics issues.
- **Korea** – No progress due to lack of available funding.
- **United States** – No progress, at least in terms of deployments or new analyses, due to funding issues including US government shutdown. However, significant planning and development (described later)
- **United Kingdom** - Datawell DWR deployed at Aberporth September 3, 2014 near existing operational K-type buoy. Data presently being archived for later analysis

Other PP-WET Activities during the Year

- Special Session on wave measurement and evaluation at 13th Waves Workshop Banff, Alberta (www.waveworkshop.org)
- 6 papers from WW13 session published in special issue of *Ocean Dynamics*
- PP-WET SC meeting during 13th Waves Workshop to discuss progress, issues and future plans
- PP-WET Co-chairs meeting with CDIP February 2014 to discuss future plans, new analysis functionality, wave drifters
- OGP Metocean Committee Paris (March), Houston (September) to discuss industry participation

Plans for Intercomparison Activities during the Next Year

- **United Kingdom** – In January, plan to exchange the K-buoy for a hydrosphere buoy with a Triaxys installed. Add SIO GPS sensor. Submit data to CDIP
- **Canada** – contingent on ship time, deploy DWRs on east coast at SW Grand Banks or Tail of the Bank with operational 6N, on west coast at Dixon Entrance with operational 3D. Retrieve logged data from East Dellwood 3D (strapdown, TriAxys, Scripps GPS)
- **OGP** – contribute data from two co-located DWR buoys plus downward looking SAAB wave radar off Australia
- **United States** – assemble multiple sets of existing dual sensor platform data for analysis at CDIP; implement Intercomparison program “FLOSSIE” (details in following slides)
- **SIO** – waves from GDP drifters – co-deployment off Scripps (and Monterey) with GPS, Axys, IMU in GDP hull moored, bottom mounted ADCP. Evaluation following WET protocol (First-5)

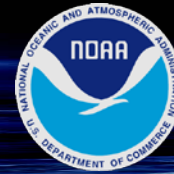
Wave height: White, green or blue water?



Courtesy A.K. Magnusson



FLOSSIE - CHL 6-m Waves Test Buoy Project



Project Description

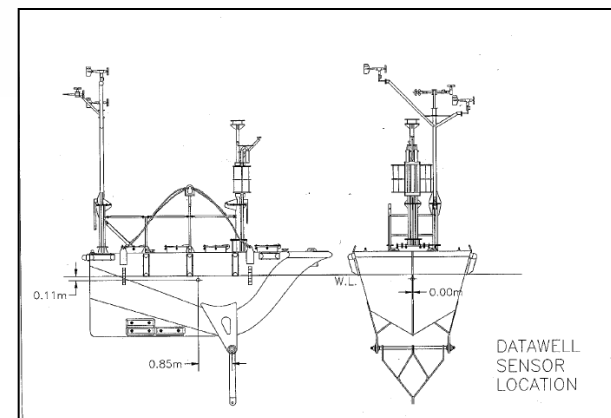
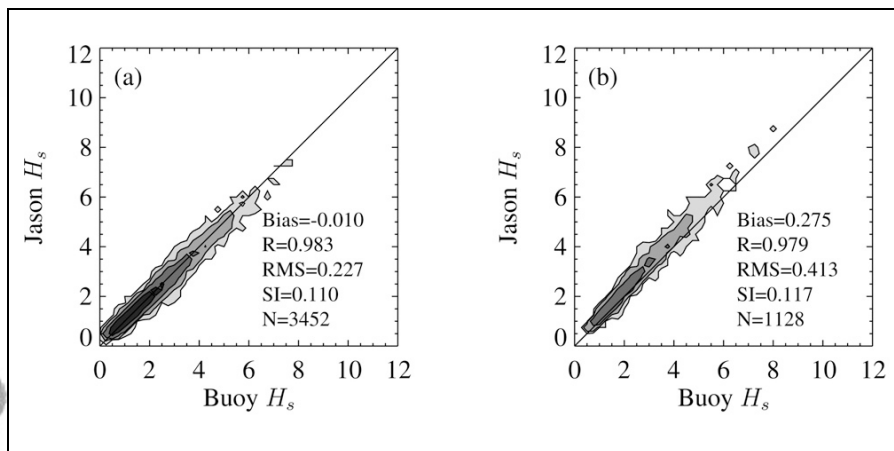
- What:**
- Conduct a 1 to 2 year test of a 6-m NOMAD buoy to address potential differences between wave observation systems
 - Intercompare new and legacy wave measurements on a 6-m NOMAD and compare to a nearby Datawell Waverider buoy (test reference)
 - Wave systems include DACT-WA, DWPM-Hippy, and DDWM systems. Findings will be documented in a report delivered to CHL

Why: NDBC has compiled a long record of wave measurements from the 6-m buoy platform dating back to the 1980's. Through this time frame, wave measurement systems have changed. Yet, a comparison of the various systems to each other and to an accepted standard has not been conducted. CHL uses NDBC data for correction and validation of its wave models. Small differences or offsets in wave records caused by the wave measurement system could cause significant errors in their models. There has been some evidence to suggest that there are measureable differences between the systems. This project seeks to identify and quantify these potential differences.

Sponsor(s) / Customer (s): **Craig Kohler**
Bob Jensen – CHL

- 6-m NOMAD Development

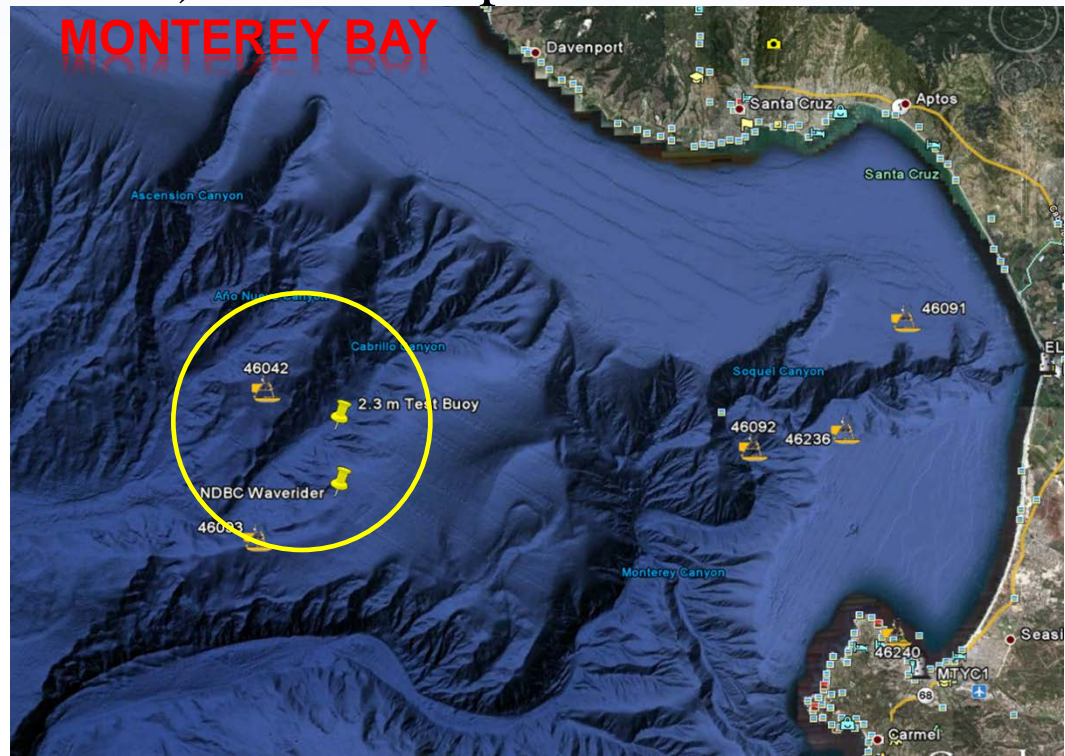
- Assessment of 10% differences NDBC / Environment Canada
- Altimetry algorithms & model improvement dependency
- NDBC:
 - HIPPY/Magnetometer and Inclinator/3DMG
 - Three payloads
- AXYS (no cost)
 - TRIAXYS Sensors with TRIAXYS Payload
- MSC Canada (no cost)
 - Strapped down accelerometer (historical sensor) Watchman Payload



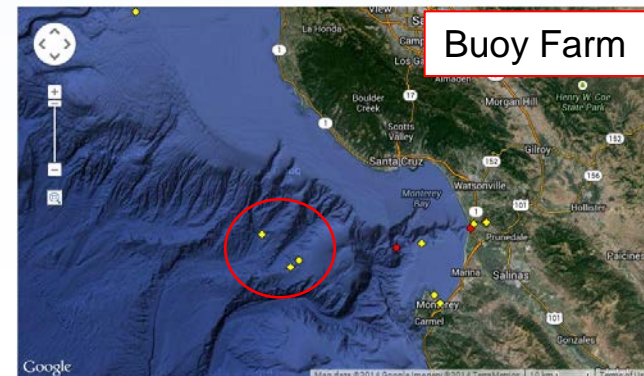
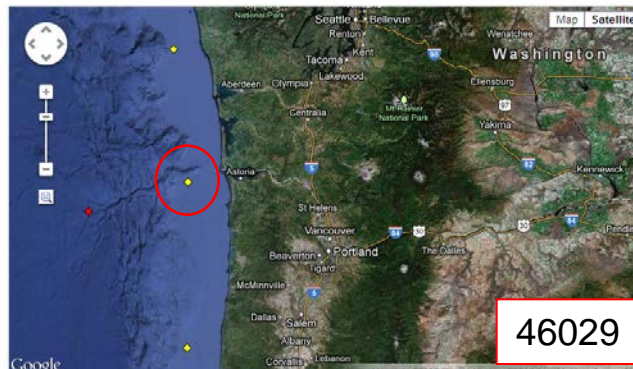
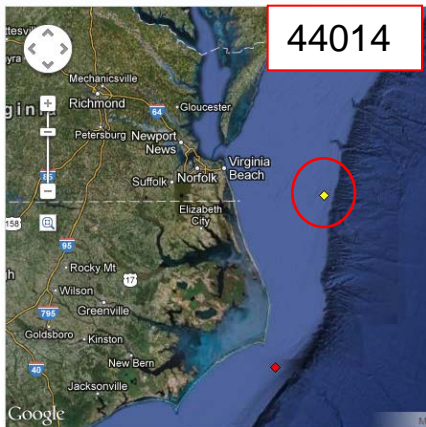


Monterey Buoy Farm Assets

- 3D: 46042 (HIPPIY & 3DMG+ Sensors / Two Payloads)
- DW: 46114 (Datawell / HIPPIY)
- 2.3D: 46044 (Foam Hull 3DMG+ Sensor)
- Additional DWR to the east (46236)
- 6N Deployment ~Jan-Feb 2015 (3 yr deployment)
- One TRIAXYS System (buoy/mooring)
- SIO GDP drifter (moored) with multiple sensors



- Dual Sensor Sites
 - 46029 (Columbia River / Portland District Request)
 - 46042 (Monterey Bay / Buoy Farm)
 - Adding 2 more sites (Scheduling Problems)
- ~3-5 years of data for evaluations
- Ancillary data sets
 - 51001 (NW Hawaii)





Emerging Capabilities

- Scripps Institution of Oceanography funded for past 7 years by U.S. Office of Naval Research to develop, test, and harden a GPS-based wave measuring buoy.
- Designed for free drifting, rapid deployment. Different hull sizes available depending on lifetime required.
- Variable reporting interval capability. Robust bi-directional communications via Iridium to control and reconfigure system.
- Bulk standard wave parameters (H_s , T_p) and first 5 (a's and b's) spectral moments computed onboard using microcontroller and relayed via satellite. Full wave spectrum and bulk parameters.
- Online data management system developed for shore-side operations.
- Buoy powered by alkaline D-cell batteries. No HAZMAT shipping.
- Designed for simple deployment – single switch operation.



The larger form factor buoy on left will last 1 year with 3 hour report intervals (20 minute wave sample bursts. The buoy is drogued at 1m with the yellow parachute shown to allow it to follow surface currents. Hull size similar to surface buoy of SVP drifter.



Immediate Priorities for PP-WET

- Compare FLOSSIE 6N buoy containing all US and Canadian historical sensor and payload packages, with DWR, TriAxys, 3D
- Evaluate UK buoy (Aberporth) co-located with DWR
- Continue Canadian co-locations including another 6N
- Analyze 2 co-located DWRs and SAAB radar
- Evaluate wave drifters
 - dual-sensor comparison of GPS sensor in 3D hull,
 - multiple sensor comparison in moored GDP hull,
 - field test of ~10 mini-wave drifters (see separate presentation)

Excerpt from CLIMAR-IV Metadata

- Metadata issues: generally the situation is “abysmal” regarding historical buoy/platform instrument metadata
 - ✓ In contrast to WMO Pub. 47 VOS metadata, which have been systematically gathered and published since 1955
- Data Buoy Cooperation Panel (DBCP) working on metadata standard for moored/drifted buoys – forward looking only though, metadata rescue is not part of current plan
- Some metadata are available already:
 - JCOMMOPS
 - NDBC activestations (daily snapshots archived by NCDC since 2013)
 - ISDM/MEDS has historical Canadian buoy metadata by station
 - But no consolidated historical metadatabase to merge or cross-reference
- DBCP has also taken responsibility for RIG/PLATFORM metadata – but no progress known (long problematic)

Recommendations to DBCP-30 for PP-WET

- Reinforce the importance of understanding critical measurement biases to agencies responsible for wave data – action all DBCP members
- Encourage member countries, and RMICs with marine responsibilities, to participate in the Pilot Project Intercomparison activities,
- Encourage co-Chairs and Pilot Project members to contribute the results of the intercomparison exercise to JCOMM and WIGOS in developing standards and best practices, possibly as an outcome of a technical workshop
- Panel members to consider procuring and deploying a small number of the operational SIO mini wave drifters and to inform PP-WET accordingly
- Continue the Pilot Project for another year, with no funding support*
- Panel members to check their records, and make sure that the historical and present wave buoy metadata are made available to the international archives (e.g. ICOADS) in a suitable exchange format such as that recently developed by TT-MB

PP-WET Pilot Project participants

- Val Swail, Co-Chair (ETWCH, EC)
- Bob Jensen, Co-Chair (USACE)
- David Meldrum (DBCP, SAMS)
- Jean Bidlot (ECMWF)
- Julie Thomas (UCSD)
- Hans Graber (U. Miami)
- Diana Greenslade (BoM)
- Luca Centurioni (UCSD)
- Chris Marshall (EC)
- Bruce Bradshaw (DFO)
- Lance Braasch (UCSD)
- Eric Terrill (UCSD)
- Jon Turton (Met Office)
- Anne Karin Magnusson (MET Norway)
- Kevin Ewans (Shell)
- George Forristall (ForOcean)
- Gene Berek (OGP Metocean)
- Tyler Hesser (USACE)
- DBCP Technical Coordinator
- Venkatesan (India)
- Dongkyu Lee (SIO)
- Christian Meinig (NOAA/PMEL)
- Richard Bouchard (NOAA/NDBC)

Secretariat support:

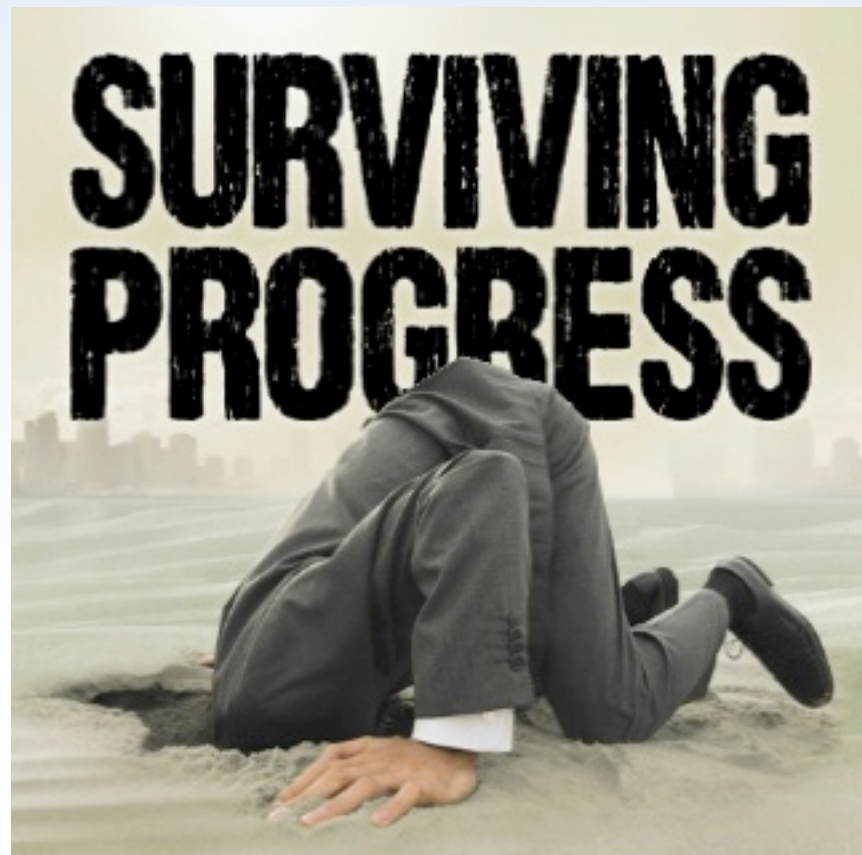
- Boram Lee (WMO - ETWCH)
- Etienne Charpentier (WMO-DBCP)

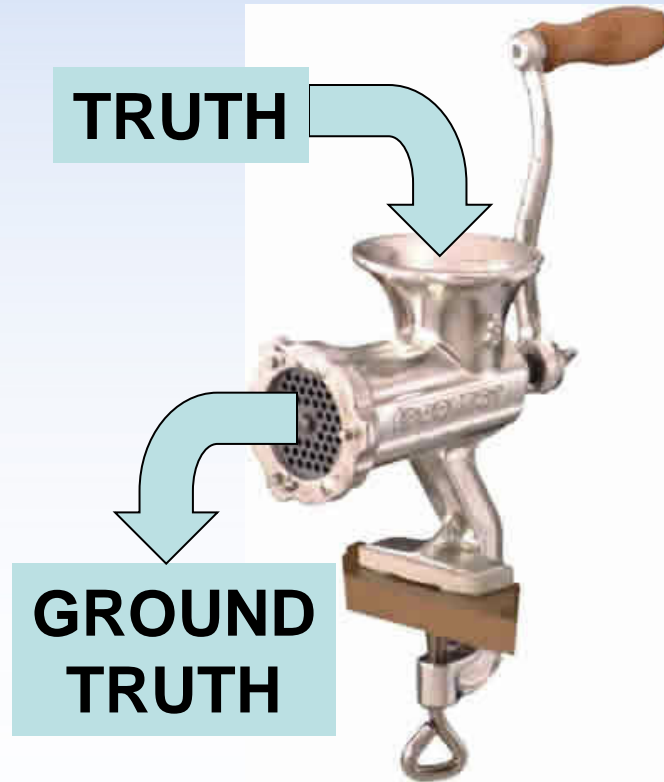
PROPOSED PP-WET WORKPLAN

OCTOBER 2014 TO SEPTEMBER 2015

- Coordinate intercomparisons of wave measurements from different platforms, on an opportunistic basis;
- Publish intercomparison results and updated status reports on Pilot Project web site;
- Develop a plan for a continuous testing and evaluation program;
- Promote widely the pilot project goals and objectives, and results, to encourage enhanced participation and additional partners;
- Contribute, as appropriate, to the JCOMM Standards and Best Practice Guides, including a recommended approach to making reliable, high-quality spectral wave measurements, including directional spectra;
- Decide whether to continue the pilot project for a further year and investigate follow-on mechanisms;
- Present results to DBCP-31 and other scientific fora.

*SOME QUIT DUE TO
SLOW PROGRESS.
NEVER GRASPING
THE FACT THAT...
...SLOW PROGRESS
IS PROGRESS*





Thank you!