JOINT ACTIVITIES OF THE JCOMM EXPERT TEAM ON MARINE CLIMATOLOGY (ETMC) 
AND THE EXPERT TEAM ON WIND WAVES AND STORM SURGES (ETWS) 
(Submitted by Val Swail, Chair ETWS, Scott Woodruff, Chair ETMC, and Charles Sun, USA)

Summary and Purpose of Document

This document provides information on existing and potential linkages with the JCOMM Expert Team on Wind Waves and Storm Surges. Activities underway or planned include the development of the JCOMM Extreme Waves Data Base, the potential inclusion of wave summaries in ICOADS, the Pilot Project on Wave measurement Evaluation and Test (WET), and development of storm surge climatologies.

ACTION PROPOSED

The Meeting will review the information contained in this report and comment and make decisions or recommendations as appropriate.

Appendices:  
A Extreme Waves Data Base Plan  
B Prospects for ICOADS Wind Wave Summaries
DISCUSSION

1. Existing linkage with the JCOMM Expert Team on Wind Waves and Storm Surges (ETWS)

1.1 The JCOMM Expert Team on Wind Waves and Storm Surges (ETWS) is part of the Services and Forecast Systems Programme Area (SFSPA) of JCOMM, with interests and responsibilities which cross-cut the three JCOMM Programme Areas of Observations, Data Management and Services for issues dealing with wind waves and storm surges.

1.2 ETWS and ETMC share common interests with respect to historical data on marine winds, waves and storm surges, indices derived from these variables alone or in combination, and the description of past and present states and variability of their climate including extremes. This has lead to active ETWS involvement in the Workshops on Advances in Marine Climatology (CLIMAR) and the Workshops on Advances in the Use of Historical Marine Climate Data (MARCDAT). The third session of ETMC noted several key areas of cooperation between ETMC and ETWS, including (a) CLIMAR; (b) Extreme Waves Database; (c) wave climate summaries in ICOADS; (d) ETCCDI; (e) storm surge statistics; and (f) climate change and design.

JCOMM Extreme Wave Data Base

1.3 DMCG-II requested the ETMC to consider the possibility of developing, with the ETWS and other appropriate groups, a JCOMM Extreme Waves Database. A proposal was subsequently developed (Appendix A) between the ETWS and ETMC for the establishment of such a Data Base for use in model validation and validation of remotely sensed waves, where such models and algorithms suffer from lack of sufficient data. This data base would be populated with measured wave data where the significant wave height exceeds 14 metres, with appropriate accompanying metadata. The rationale for the data base is to have a relatively small and manageable set of extreme storm sea states for comparison with wave forecast and hindcast products, model development and evaluation and satellite sensor calibration and validation. ETWS has recently expressed a strong interest in expanding the scope of the extreme wave data archive to include satellite estimates in the first stages of implementation; eventually data from wave radars such as WaMoS or MIROS might also be included. It has been suggested that an archive of storm surge events for similar purposes should also be considered; this is discussed further in paragraph 2.

1.4 Mr Robert Keeley and Mr Woodruff have run initial searches on selected archived wave databases and were able to identify a number of data meeting these requirements. Mr Swail has also processed and scanned a large archive of satellite altimeter data to provide a large number of distinct events exceeding the threshold; the maximum value obtained was 20.7 m. The searches of three NOAA archives in the US—the National Oceanographic Data Center (NODC), National Data Buoy Center (NDBC), and National Climatic Data Center (NCDC)—identified some significant problems in comparability of the same observations; this is a specific US issue, but points to the possibility, or likelihood, of similar issues arising due to differences in processing, quality control and archiving which must be addressed. These issues actually extend beyond the scope of the Extremes Wave Data Base.

1.5 At its Second Session, Geneva, 20-24 March 2007, the ETWS raised concerns about the need to associate adequate disclaimers with the planned database, since the extracted in situ data will necessarily be very sparse and incomplete. It was also considered likely that some complications would also need to be sorted out on open redistribution and other national or organizational data policies;

1.6 Management and hosting of the database—the global extreme wave event archive (GEWEA)—has been offered by the US NODC, in collaboration with the Integrated Science Data Management (ISDM) of Canada. On 13 August 2009, Dr. Charles Sun of NODC visited ISDM and led the discussion of the strategy of the development and implementation of the GEWEA. NODC has developed and tested an ocean wave data and information portal (OWDIP) for hosting
GEWEA. The OWDIP is scheduled to be fully operational by fall 2010. ISDM will start to prepare and transfer extreme wave data to NODC, beginning spring 2010. ISDM will assist NODC in data processing as needed. The cooperation between NODC and ISDM is the pilot phase of the project to develop procedures and protocols for in-situ wave measurements. After this, other nations will be approached for their contribution and the project will expand to include remotely sensed wave measurements such as from coastal radars and satellites. NODC’s initial commitment for the extreme wave data archive will be very simple at first, treating this incoming data as the same long-term preservation activities as we apply to other data sets. NODC will host a website to point to these data, more sophisticated data access tools (e.g. SQL database queries, OPeNDAP access, etc) are not being promised at this point, but could be considered for the future.

1.7 While the initial concept for the extreme wave archive has been successfully established, together with its hosting at US NODC, much more work is needed to help populate the archive and eventually make products available.

**Wave Climate Summaries in ICOADS**

1.8 A considerable amount of wave data from ships and buoys is already available in ICOADS. The potential for calculating wave summaries for ICOADS has been under consideration for several years - recommendations from the CLIMAR and MARCDAT meetings have supported the development of wave climate statistics and summaries using these data (e.g. see [http://www.marineclimatology.net](http://www.marineclimatology.net)) - but resource limitations and questions about the impacts of code changes within the historical VOS and other wave records have thus far slowed progress. Appendix B describes a number of technical issues which need to be addressed if wave climate summaries are to be produced.

1.9 The resource issues are more problematical. Proposed actions have included developing new ICOADS staff at different international institutions; this is also accompanied by concerns about the logistics of internationalization, especially given resource limitations within Members/Member States.

1.10 A proposal for a wave climate summaries scheme could be developed, to address both the technical and resource issues and presented as a discussion paper at the next MARCDAT meeting.

2. Discussion of potential additional linkages

2.1 The 3rd Session of JCOMM (JCOMM-III, Marrakech, Morocco 4-11 November 2009), identified some new areas for possible cooperation between ETWS and ETMC.

**Storm Surge Data Base and Climatology**

2.2 JCOMM-III agreed that there is a need for enhanced global and regional storm surge statistics. This would involve guidelines for storm surge historical databases and statistical techniques to enable members to carry out statistical analysis in their countries. It was also recommended to explore how risk areas of storm surge inundation zones and MEOW (Maximum Envelope of Water) can be identified and mapped. JCOMM-III recommended development of a joint work plan between ETWS and ETMC using the results of the JCOMM Scientific and Technical Symposium on Storm Surge Seoul, Korea, 2-6 October 2007. This topic will also be addressed at the upcoming 3rd session of the ETWS in May 2010.

**DBCP Pilot Project on Wave measurement Evaluation and Test (WET)**

2.3 ETWS is presently carrying out a Pilot Project ([www.jcomm.info/WET](http://www.jcomm.info/WET)) for the Data Buoy Cooperation Panel to address potential biases in in-situ wave measurements from buoys. Comparisons with satellite altimeter data suggest that there are significant biases between operational buoy networks operated by different national agencies, even with the same platforms.
Biases are a serious concern in climatology, especially in computation of trends, but are also relevant for example in comparisons of wave model performance and regional statistics. Such biases would be important to consider in ICOADS wave summaries.

2.4 The ETMC is invited to consider how it might contribute to the work of the Pilot Project. A Steering Committee meeting is scheduled to be held in Portland Oregon on February 27, 2010, in conjunction with the AGU Ocean Sciences meeting.
APPENDIX A

JCOMM EXTREME WAVES DATA BASE

**Purpose:**

Phase 1: To provide a source of instrumented wave observations of extreme wave events for model development, forecast verification and satellite validation.

Phase 2: To provide a comprehensive source of all instrumented wave measurements (*in-situ*, remote-sensing) for known extreme wave events, both recent historical events and ongoing.

**Data qualification:**

- Data will be captured for those storms in which a SWH $\geq 14m$;
- Storms will be defined as commencing when the SWH first exceeds 5 m and ending when the SWH first falls below 5m;
- Area of interest will include all wave observations within a 500 km radius of the buoy (or other platforms) registering the extreme event;
- Appropriate information about the type of instrument, sampling characteristics, data processing carried out, etc., will be held with the data;
- Appropriate attribution of contributors will be maintained.

**Phase 1:**
- The data base will hold all instrumented observations that are available from the storm period and area including:
  - *In-situ* surface elevation time series;
  - *In-situ* wave spectra from surface-following instruments (e.g., wave buoys, Tucker);
  - Other environmental observations collected *in situ* in the storm period and area will also be included.

**Phase 2:**
- The data base will hold all instrumented observations that are available from the storm period and area including:
  - *In-situ* surface elevation time series;
  - *In-situ* wave spectra from surface-following instruments (e.g., wave buoys, Tucker);
  - *In-situ* wave spectra from surface radars (e.g., MIROS);
  - Satellite derived wind fields;
  - Satellite derived wave estimates.

**Data Assembly and Delivery Services:**

- Contributors will be organized under the auspices of the ETWS
- Administration of the assembly and maintenance of the database (db) will be under the Chairperson of the ETMC

**The archive centre will provide services that include:**

- Receive data from contributors;
- Ensure data pass agreed QC before inclusion;
- Load data into the db;
- Provide the database in a convenient format mutually agreed between the ETWS and the ETMC;
- Provide a convenient download service for the database contents.
Yet to clarify:

• Exactly what data and metadata fields to include (Phase 1 then Phase 2);
• Is the definition of a storm and area adequate?
• How we will solicit an archive?

    NCAR might be interested;
    Proposal will be presented to IODE.

• Who will run the data base?
• What is the "agreed" QC and delivery formats?

    We will need to be flexible in accepting different data formats. On output, we could build something in netCDF or use the IMMA format. We probably should consider a few output formats.

Are the services enough?
This short note is to summarize the current availability of wind wave parameters from the ICOADS collection and to deliver recommendations for potential development of the routine monthly summaries (MSTG) for wind wave characteristics in the same manner as is done for other meteorological quantities.

Currently the ICOADS IMMA format provides the following information about wind waves (as well as preserving in its supplemental data attachment available original input data forms):

- wind sea height, meters
- wind sea period, seconds
- wind sea directions, degrees
- swell height, meters
- swell period, seconds
- swell direction, degrees
- secondary important swell height
- secondary important swell direction

It is important to note that initially all these parameters were reported in codes (e.g. half-meter increments for heights, from 1 sec to 2 sec increments for periods) and then were converted to metric values. Furthermore, there are several important problems in the VOS wave reports which should be first sorted out before any kind of space-time averaging is performed.

I. Temporal inhomogeneity of the type of reported variables. Before roughly 1953-1958 VOS reported wind sea height, period and direction (as stated in the format description). However, in fact (as it is stated in the technical documentation) these were reports of the highest of sea or swell component observed. Thus, all these reports have to be more likely attributed to significant wave height – SWH - (if we assume the highest of sea or swell to be a measure for SWH). Later (after 1953-1958) VOS started to report sea and swell separately. Nevertheless, before 1953 reports of swell exist and it is still unclear how much they are swell and what they are in fact. What can be done certainly is the development of SWH (as \( \text{max}[\text{sea,swell}] \)) products for the period prior to 1950 and the development of products for sea, swell and computed SWH for the period after 1958. It is unclear what to do with the period 1953-1958. New practices were introduced slowly and at the moment there is no way of knowing which practice was applied for the reports within this period. Some semi-manual analysis is presently being done which involves analysis of call signs, SLP and wind speed to sort out the problem. What can be surely done is the development of SWH summaries for the whole 1856+ period, assuming SWH to be defined as \( \text{max}[\text{sea,swell}] \). See details in Gulev and Grigorieva (2004, GRL).

II. Considering the period 1958+, generally all parameters listed above are available, but in fact massively appear starting from 1963. However, their trimming requires much work to handle several biases in VOS wave characteristics. The most critical things are the following.

1. Swell codes for the period prior to 1968 and after 1968. The coding systems were changed in 1968 and this change was not simultaneously accepted by all ship owners. The period of the full acceptance continued until 1974-76 (our estimate). Thus, each swell report for the period from 1968 to 1976 should be checked with respect to the neighboring data and wind/SLP situation to get a hint which period is reported (according to the old or to the new system). Be it sea, things would be easier, but for swell synoptic analysis may not necessarily tell much. This is presently being investigated in Moscow, trying to use ERA-WAM hindcast for these years to sort out the reports. Currently we have sorted out practically all problems for 1970-1976, but the 2-yr period of 68-69 is
still a disaster. Making our products we simply exclude these 2 years from the analysis when analyzing swells.

2. **Separation of sea and swell.** Frequently young swells are reported as seas and vice-versa (mature seas reported as swells). Furthermore, there are simple mistakes when officers are placing information in the wrong fields of the report. This was especially the practice when assistants were changed to mates for doing observations. Two approaches can be used. First, it is possible to use theoretical (or say semi-theoretical, e.g. JONSWAP) functions of wind duration versus wave height and to look at 2D-PDFs. Secondly, one can look at wave age, whose derivation requires wind speed and the component of wind in the wave direction. The second approach involves wave periods which are uncertain for different reasons (see below). See details in Gulev et al. (2003, JGR, 2003, WMO Guide) and in Gulev and Hasse (1998, JPO, 1999, IJC).

3. **Correction of wave periods.** VOS-reported wave periods are known to be biased. Importantly, they can be both underestimated and overestimated. Overestimation results from the cases when the measurements are done properly (i.e. using a watch and counting a parcel of 10 consecutive waves). In this case sailors frequently skip 1-2 small waves in the parcel. The resulting computation of period as \( t_{10}/(n-1) \) or \( t_{10}/(n-2) \) leads to the overestimation compared to the estimate \( t_{10}/n \). Underestimation results from the inappropriate practice of observations, i.e. when the observations are taken arbitrarily or not taken by observing. In this case VOS wave reports are more likely the hindcast of the waves from wind.

4. **Impact of evaluation of true wave period.** This is critical and compared to the wind, it is certain that such evaluation is not practiced. Biases may amount to 30-50%. We corrected most biases by using ship velocity and course data, however the drop in the number of samples is close to critical after the correction is applied.

5. **Small waves - Problem of coding system.** According to WMO (1995) the height of waves from 0.25 m to less than 0.75 m should be coded as “01”. The ICOADS IMMA format (and the previously available LMRF format for ICOADS) return a nominal value of 0.5 m for all code figures “01”. However, observers in general tend to overestimate small wave heights. Moreover, in practice observers frequently apply code 01 to the wave heights less than 0.25 m, which should be coded “00” according to WMO (1995). There is the correction of Gulev et al. (2003) which can be applied to seas; it is unclear what to do with small swell so far. The bias in climatology may be up to 0.2-0.3 meters for the tropical regions, which is quite a large value.

6. **Very high waves** coded as “50” and returned in meters to be equal to 25 meters. There are many of them, too many. For the whole history there are 241 cases of VOS wind waves between 16 and 24.5 meters and about several thousands of waves of 25 meters exactly. If we incorporate all in the averaging, the bias for mid latitudes may amount to 1-2 meters; moreover all extreme wave stats will be strongly biased, distributions will be looking not like a one-peak distributions. A guideline is to simply skip all reports with code “50” or to carefully look at them using wind and SLP information. We are processing these extremes (or potentially extreme artifacts).

III. **Considering development of the products.** one should think about the delivery of SWH which has to be computed from sea and swell, as well as dominant period, which also should be derived from the sea and swell period. Recommendations were derived by Hogben (1984), Barratt (1991) and Gulev et al. (2003). Some uncertainties exist; perhaps new approaches should be developed for different regions. Buoy data and ERA-40-WAM and similar hindcasts can be used further.

IV. **The sampling problem is general, but quite critical for waves.** Our experience shows that for a proper estimation of wave characteristics only reports will all wave parameters, wind, SLP, ship course and velocity should be used. These requirements limit the number of reports available for the analysis to less than those available for flux computations (see Gulev et al. 2007a,b, J. Climate).

**Recommendation:** If the ICOADS community decides to develop wave summaries, a comprehensive compendium guide should be first developed. We can try to lead drafting of this guide
in co-operation with ICOADS and some people still doing VOS waves. The help of captains and officers would be desirable. In a year, such a guide with corresponding codes can be developed. Otherwise, this work can be left out, and will be done anyway. The next release of the VOS wave climatology will be issued (50 years: 1958-2007) by the end of 2008. This will bring probably a new set of guidelines, which can be further used by the community.

**Footnote:** We could retrieve from our archive what comes out from the exercise of taking all reports for e.g. sea height or period, or swell for a calendar month, applying general quality control, then trimming of 4 or 3.5 sigma, and plotting the map – this will be self explanatory even for well sampled months. Anecdotal values will appear in the tropics and in the Southern Ocean, the midlatitudinal patterns will be hardly detectable, there will be no consistency between heights and periods, etc.