The Second JCOMM Workshop on Advances in Marine Climatology (CLIMAR-II)*

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Background

Increasing concerns regarding regional and global climate variability and trends underscore the crucial importance of extracting the maximum information from the historical marine record, as well as improving the Global Climate Observing System (GCOS) so that future results will not suffer the uncertainty of historical ones. Accordingly, the Second Joint Commission for Oceanography and Marine Meteorology (JCOMM) Workshop on Advances in Marine Climatology (CLIMAR-II) was held at the Résidence Palace, Brussels, Belgium on 17-22 November 2003, at the kind invitation of the government of Belgium. Poster presentations started on 17 November and oral presentations took place from 19 to 22 November. A wrap-up session took place on 22 November. More than 80 people from 20 Member nations from all the WMO Regional Associations attended the workshop. Overall, 46 oral presentations and 28 poster presentations were given.

As recommended by JCOMM-I (Akureyri, Iceland, June 2001), CLIMAR-II was linked to, and immediately followed, the two-day celebration (17-18 November) of the 150th anniversary of the International Maritime Conference held in Brussels in 1853, which was convened by USA Navy Lt. Matthew Fontaine Maury and chaired by Belgian Observatory Director Dr Adolphe Quételet. The 150th anniversary ceremony was opened by His Majesty King Albert II of Belgium. CLIMAR-II was organized jointly by JCOMM and the Royal Meteorological Institute of Belgium, and sponsored by the Belgian Federal Science Policy Office, Environment Canada, the Japan Meteorological Agency and the US National Oceanic and Atmospheric Administration. The international Organizing Committee was composed of members from Belgium,

* A shortened version of this article is being published in the WMO Bulletin.

Canada, Poland, the United Kingdom, USA and WMO, chaired by Scott Woodruff (USA).

CLIMAR-II was the direct successor to CLIMAR99 (Vancouver, Canada, September 1999; JCOMM, 2003a) and to the Workshop on Advances in the Use of Historical Marine Climate Data held in Boulder, USA, in January - February 2002. The latter Workshop made a range of recommendations for activities in marine climatological data development and research (Diaz *et al*., 2002). CLIMAR-II was organized partly in the light of these recommendations, and this report summarizes our progress in fulfilling them so far.

Proceedings

Like the Boulder workshop, CLIMAR-II was divided into three main sessions. In Session I, on cross-cutting issues, presentations included databases, metadata, quality control (QC), homogeneity, biases, statistical analysis techniques, reanalyses, and user products. Presentations in Session II concentrated on sea level pressure (SLP), wind and waves; and those in Session III dealt with marine temperatures and sea ice. Estimation of uncertainty was a common theme in all the sessions. Many of the presentations in each session were based on the International Comprehensive Ocean-Atmosphere Data Set (ICOADS) named I-COADS at the Boulder workshop but now re-named to ease citation and web paging. ICOADS is an upgrade of COADS, created by blending COADS with the Met Office's Marine Data Bank and millions of newly digitized logbook records, with careful elimination of duplicates (Diaz *et al*., 2002). A final summary session reviewed progress since the 2002 Boulder workshop, and discussed future activities.

Comparison with the Boulder recommendations (Diaz *et al.,* 2002) revealed good progress on :

1) Increased coverage of data, especially for data-sparse times and places.
2) Understanding and reduction of biases, e.g. in *in situ* marine air temperature (MAT) and in satellite-based sea surface temperature (SST) data.
3) Specification of uncertainties and their inclusion in analyses.
4) Comparison of QC techniques.
5) Availability of additional land-station SLP data to support marine analysis.
6) Development of techniques for reanalysis of atmospheric circulation in the pre-radiosonde era.

There has also been some progress in:

1) Approval by the WMO Executive Council of a format for metadata from Ocean Data Acquisition Systems (ODAS) including buoys.
2) Analysis of diurnal cycles in SST using geostationary satellite data.
3) Availability of satellite-based temperatures for inland seas and large lakes.
4) Research to improve the specification of SST in marginal ice zones.
5) Assembly of the first version of a blended sea-ice dataset for the Arctic for 1950-98 by the JCOMM Expert Team on Sea Ice.
6) Improvement of cloud-clearing techniques for satellite-based SST. For example, the SSTs from the Tropical Rainfall Measuring Mission (TRMM) have yielded substantial improvements in cloudy and poorly sampled tropical regions.
7) Assessment of biases in the Maury SLP data.

Furthermore, we note the substantial international effort to prepare recommendations for enhancements to GCOS (GCOS, 2003).

However, none of these advances is complete! For example:

* Millions of marine observations remain to be located and digitized from logbooks (e.g., Fig. 1), and millions that are already digitized remain to be blended into ICOADS.


ABSTRACT LOG

RECOMMENDED BY THE

MARITIME CONFERENCE OF BRUSSELS,

Kept on board the U.S.

Commander, during the years 185

Indexed,

GENERAL ORDER.

Figure 1. Abstract log of the US Frigate Constitution, 1854-1855: Naval Observatory volume #345; Deutscher Wetterdienst Registration #8148 (reprinted from Braun, 2000).

* The biases in marine temperatures around 1939-45 are still poorly understood. Daytime MAT data need to be made useable. Our knowledge of biases for as much of the past as possible needs to be complemented by inclusion of appropriate metadata in data sets, so that proxy and historical data can be made compatible with modern data; also enabling future data to be made compatible with current data. This is an application of the GCOS Climate Monitoring Principles (Appendix 2 of GCOS, 2003). However, it is recognised that finding some of the required metadata will be difficult and may need augmenting by special studies of the character of the data to make deductions about some of the observational practices.
* We are still improving our assessments of uncertainties and need to compare techniques for making these assessments; we also need to specify our target accuracies.
* The global observing system still leaves large areas unobserved at the ocean surface and – especially – below.

Other Boulder recommendations, such as creation of sub-monthly analyses of SST and sea-ice, and adjustment of historical wind-speed data, are still at an early stage. CLIMAR-II supported the need for sub-monthly (pentad) analyses because they provide useful ground-truth even though they may be noisy or even impossible over most of the globe and most of the instrumental record because of the sparsity of observations. Pentad SST analyses based on satellite data (e.g. Reynolds et al., 2002) are very valuable but require in situ data for validation and often for calibration also. Adjustment of historical wind speeds is particularly difficult without metadata. Some useful work has been done for the post Second World War period (e.g. Ward and Hoskins, 1996), which showed that the problems in the raw data are indeed serious, but this needs extending throughout the ICOADS period. QC techniques for all parameters need to be fully and consistently documented; if possible, QC methods used throughout ICOADS should be homogeneous.

There were seen to be shortcomings in the access to ICOADS data. Do we have optimal methods for collecting, preparing and providing information? There are many,

overlapping sources of data and products, and the problem of optimising data provision is complex. Many users are working with outdated versions of COADS. Often data are available, but it is difficult for the uninitiated to discover what is there. There should be a web-based "route map" to the best available data which should be widely advertised to all the various user communities.

The Boulder workshop recommended that the Voluntary Observing Ships Climate (VOSClim) Project be extended, or a parallel project be initiated, to include buoys. CLIMAR-II discarded this recommendation. With the planned availability of buoy metadata, buoy versus model comparison will be possible from existing datasets. Operationally the monitoring of buoy data already takes place.

Recommendations by CLIMAR-II

CLIMAR-II made the following recommendations which, except for the first under "Metadata", are not explicitly in the Boulder list. Within each subsection, recommendations are in order of priority. Ideally, all (except CLIMAR-III) should be implemented within 2 years. The consolidated Boulder and CLIMAR-II recommendations are available at http://www.cdc.noaa.gov/coads/climar2/recs.html. Throughout, the need to improve GCOS, and to adhere to the GCOS Climate Monitoring Principles, is implicit.

Climate Monitoring

1) All observations should be taken following the GCOS Climate Monitoring Principles, remembering that any distinction between "operational" and "climate" observations is artificial.

2) Because remotely sensed data are an important part of the climate record, it is recommended that the continuity and overlap of satellite missions should be planned in line with the GCOS Climate Monitoring Principles.

3) It is important that we improve dialogue between Numerical Weather Prediction, climate and data-generation communities, through for example the GCOS Panels. Some CLIMAR-II participants should attend the JCOMM Products Workshop (OCEAN OPS04) (Toulouse, 10-15 May 2004) to broaden its scope.

4) To ensure the extension of adequate climate observations into the future, it is necessary to define target accuracies for fields of each of the basic meteorological variables (SST, MAT, SLP, humidity, wind speed and direction, waves, cloud cover) and for their combination into flux fields (sensible heat, latent heat, longwave radiation, shortwave radiation, precipitation, atmospheric moisture, momentum). The adequacy of the observations collected, as measured against these requirements, should be regularly assessed. The Second Adequacy Report on the GCOS (GCOS, 2003) has already given an overall assessment, but the Statements of Guidance on observing requirements for climate need to be completed and regularly updated through the GCOS Panels.

5) Consider devising recommended standards for the location and design of meteorological masts on new ships. Instruments should be stable in severe conditions. Continuity should be maintained through any improvements and automation of *in situ* observations, following the GCOS Climate Monitoring Principles.

6) Develop, through JCOMM and its Expert Team on Marine Climatology (ETMC), a list of appropriate climate indices for winds, waves and SLP. Indices are a logical

update in technology to marine meteorological summaries under MCSS. Development of climate indices should be done in liaison with the WMO/CLIVAR/CCl Expert Team on Climate Change Detection and Indices, and with the GCOS Panels.

7) The Global Ocean Observing System (GOOS) should support extra spectral ocean wave measurements at existing sites in the Southern Ocean and tropics.

8) Investigate the inclusion of wave information in ICOADS summaries.

Metadata

1) Digital availability of the entire record of the WMO ship catalogue (WMO, 1955-), in a format suitable for use in association with both operational and climate data, should be made a priority. Editions for 1955-72 and 1999 onwards are not yet available in digital form.

2) Observing practice literature, both national and international, is an important aspect of climate metadata. Two of the more important decisions recorded in this literature were the historical WMO/Commission for Marine Meteorology (CMM) decisions which improved VOS data and the Marine Climatological Summaries Scheme (MCSS). To document the evolution of observing practice, a procedure for identifying, archiving and distributing this type of metadata should be developed. The archive should be updated through JCOMM and its ETMC, without destroying the older entries, when observational practice is updated. Eventually, the archive could also link to the results of instrument validations and comparison studies.

3) An archive of metadata for moored and drifting buoys, and other ODAS (e.g. offshore platforms), should be filled by Members, with WMO coordination, as soon as possible with information on both current and historical deployments.

4) If possible, a given buoy should have a unique identifier. The re-use of identifiers (buoy numbers) for different buoys can cause erroneous application of metadata. If buoy numbers must be reused, the metadata should include sufficient features (e.g., timestamps) so that they can be correctly applied.

5) Metadata, including information on homogeneity adjustments applied, should be clearly linked to data.

Homogenisation

1) It remains essential to acquire data from independent platforms (e.g. VOS, buoys, research vessels, satellites), to allow independent validation and homogenisation of records. The important VOSClim data validation and improvement project should be continued.

2) There is a need to investigate the best way of applying wind homogenization techniques in the absence of adequate metadata.

3) Proxy data (e.g. coral-based SST estimates) should be carefully matched with instrumental data, following the GCOS Climate Monitoring Principles. Error-adjusted annual fields may help in this process.

4) Continue efforts to make QC of data more consistent and effective, including documenting and homogenising the methods used as much as possible.

Uncertainties

1) Consider forming a working group on uncertainties in climate data and analyses. This should include all climate data, not just marine, and the group could appropriately work with, and report to, the GCOS Panels and IPCC.

Data availability

1) We need to simplify and accelerate data access to users, especially new comers to the field. There should be a "route map" to the best available data. JCOMM should work with the GCOS Panels and appropriate research groups to identify operational, and experimental, integrated climate information products and put them on their web portal.

2) The successful International Marine Meteorological Archive (IMMA) format developed under the ETMC should continue to be used.

3) Support should be given to initiatives to improve the quality of research vessel surface meteorological and oceanographic data and to widen access to these data and associated metadata.

4) Investigate the inclusion of relative humidity (RH) data into ICOADS when RH is the only available moisture parameter.

5) Consider developing links to sources of coastal and island data.

Future workshops

CLIMAR-II saw the need to continue to monitor and assess progress in marine climate data analysis by bringing together the global data-development and research communities approximately every two years. Accordingly:

1) A sequel to the Boulder workshop should be held in 1-2 years' time.

2) CLIMAR-III should be held in 2007.

Conclusions

An important outcome of CLIMAR99 was the Dynamic Part of the *WMO Guide to the Applications of Marine Climatology (WMO-No.781)* (JCOMM, 2003b). Accordingly, presentations made at CLIMAR-II will be incorporated into a further JCOMM Technical Report, and a selection of papers from CLIMAR-II will be published in a special issue of the *International Journal of Climatology*, which will form an update of the Dynamic Part of the *Guide*. Through these publications and the participation of the delegates, CLIMAR-II will provide guidance and technical support to National Meteorological Services in their acquisition, processing, analysis and application of marine meteorological data.

CLIMAR-II was an outstanding success and the progress made since CLIMAR99 was clearly evident. We look forward to reporting further major advances by the time of CLIMAR-III.

Acknowledgements

We are grateful to His Majesty King Albert II, the Belgian Federal Government and to the Royal Meteorological Institute of Belgium for hosting this important event. We thank Chris Folland and Dick Reynolds for useful comments on this paper.

References

Braun, D.S., 2000: Scientific vision, a passion for observation, and the impetus for change: Germany loans Maury logs to the National Climatic Data Center. *Earth System Monitor*, **11**, No. 1, 4-7.

Diaz, H., C. Folland, T. Manabe, D. Parker, R. Reynolds and S. Woodruff, 2002: Workshop on Advances in the Use of Historical Marine Climate Data, *WMO Bulletin* 51 (4), 377-380.

GCOS (WMO/IOC/UNEP/ICSU), 2003: The Second Report on the Adequacy of the Global Observing Systems for Climate in Support of the UNFCCC, GCOS-82, WMO/TD No. 1143. [Available from: http://www.wmo.int/web/gcos/gcoshome.html.]

JCOMM, 2003a: Proceedings of CLIMAR-99. JCOMM Technical Report No. 10. WMO/TD No. 1062, on CD-ROM.

JCOMM, 2003b: Advances in the Applications of Marine Climatology. Dynamic Part of the WMO Guide to the Applications of Marine Climatology, JCOMM Technical Report No. 13, WMO/TD No. 1081, on CD-ROM.

Reynolds, R.W. N.A. Rayner, T.M. Smith, D.C. Stokes, and W. Wang, 2002: An Improved In Situ and Satellite SST Analysis for Climate. *J. Climate*, **15**, 1609-1625.

Ward, M.N. and B.J. Hoskins, 1996: Near-surface wind over the global ocean 1949-1988. *J. Climate*, **9**, 1877-1895.

WMO, 1955-: International List of Selected, Supplementary and Auxiliary Ships, WMO No. 47, Geneva, Switzerland.

Image credits for CLIMAR-II Logo

- US steam frigate Mississippi, in the Gulf of Mexico, March 1847: Library of Congress, Prints & Photographs Division [reproduction number LC-USZC2-3129] (originally published by N. Currier, New York, 1848).
- Florida peninsula, January 1985: NASA Space Shuttle Earth Observations Photography database [photo STS51C-44-0026].
- TAO (Tropical Ocean Atmosphere) buoy and anemometers on NOAA ship Ka'Imimoana. Photo by Jason Poe, courtesy of TAO Project Office.