Report from EarthTemp Network SST-ICOADS Exchange of Visiting Scientists at NOC (Southampton) and Met Office (Exeter), UK 4-10 April 2013

This report documents the results of meetings held in Southampton, UK 4-5 April 2013 at the National Oceanography Centre (NOC), and then in Exeter, UK 8-10 April 2013 at the Met Office. The purpose of these meetings was two-fold: (i) to discuss advances in the analyses of sea surface temperature (SST); and (ii) to discuss proposed new international collaborative arrangements to facilitate future development of the International Comprehensive Ocean-Atmosphere Data Set (ICOADS). Regarding SST, NOAA/NCDC, NOC and the UK Met Office endeavor to produce improved bias adjusted marine temperature datasets by exploiting extensive historical marine archives--principally ICOADS--and utilizing innovative methods of homogeneity adjustment. As both NOC and NOAA/NCDC embark on the exercise of developing new independent marine temperature datasets based on ICOADS, this face-to-face collaboration enhanced mutual understanding of dataset development, global ship and buoy data quality control, bias adjustments and usable uncertainty estimates. The main benefits of the visiting scientist exchange were:

I. Ensuring understanding of the treatment and quantification of uncertainties present in existing marine temperature datasets by:
    a. discussing and assessing bias adjustment methodologies for in situ marine temperature observations
    b. sharing algorithms and code for data quality control, and bias adjustments
    c. examining foundational assumptions and resulting treatment of data in four especially problematic areas:
        i. ice-covered regions,
        ii. marginal ice zones,
        iii. coastal areas,
        iv. data sparse regions – especially the Southern Ocean
    d. exploring the potential for using satellite-based observations of marine temperature to improve the entire in situ marine temperature record.

II. Leveraging existing expertise on time and labour-intensive data transformations, quality control, validations, and assimilations developing the new Release 2.6 of ICOADS by agreeing on partnership roles within the ICOADS project, including with the UK Met Office and the National Oceanography Centre (NOC), to support the production of a new release of ICOADS (Release 2.6) by approximately the end of 2014 (see Appendix B for further information on R2.6).

The meetings were held in round table discussion forums with talking points introduced by presentation or through brief subject introductions. Topics were then openly discussed and notes and actions from each meeting were captured and are available below in Part 1 for the NOC portion of the meeting and Part 2 for the Exeter portion of the meeting.

The meetings were very successful with the following major outcomes proposed:

- A journal article to be submitted to a high-profile journal (e.g. the *Bulletin of the American Meteorological Society* (BAMS) or *Nature*) describing the importance of ICOADS;
- Letter of Intent proposed to be signed among ICOADS, DWD, UK Met Office, NOC, and possibly other organizations, outlining intentions for enhanced international partnerships. The letter will describe specific duties for the contributing organisations and will be a step toward a formal partnership (possibly a WMO-IOC Marine Climate Data System (MCDS) Centre for Marine Meteorological and Oceanographic Climate Data (CMOC), see the Annex to Appendix B for further information);
- Using a marketing-style strategy to promote ICOADS by producing a glossy brochure for senior managers and stakeholders describing the dataset's significance to the ocean and climate communities;
- Agreement to hold bi-monthly/quarterly meetings between the centers to discuss marine climatological issues, dataset development, SST bias corrections and uncertainties and general topics needing immediate attention;
- A report or journal article describing and comparing uncertainties in a range of marine surface temperature datasets (i.e. HadSST3, ERSST, HadNMAT2);
- And to consider the future of bias adjustments and the potential to develop new methods of exploiting ICOADS, possibly including Reanalysis products and/or Coupled Ocean-Atmosphere Reanalyses

The group would like to acknowledge EarthTemp for providing support for this meeting. Thanks are also extended to the National Oceanography Centre – Southampton and the UK Met Office for hosting the meetings.

Contents

Part 1. EarthTemp Meeting Notes and Actions: SST Biases and ICOADS

National Oceanography Centre Southampton (NOC)
4-5 April 2013

Participants:

NOAA/NCDC:	**UK NOC-Southampton:**
Boyin Huang (remote only)	Elizabeth Kent
Eric Freeman (ERT/STG)	David Berry
Scott Woodruff (CIRES)	Giulia Carella
Wei Liu (CICS) (remote only)	
Jay Lawrimore (remote only)	**FSU:**
	Shawn Smith (remote only)
	Mark Bourassa (remote only)
	Rachel Weihs (remote only)

1) ICOADS

a) Scott Woodruff gave an overview of ICOADS detailing:
   i) resources and expanding partnerships
   ii) near-real-time preliminary extensions
   iii) historical reprocessing
   iv) format (IMMA) and QC/Trimming improvements
   v) ICOADS – Value Added Database (IVAD)

b) **Action (ICOADS):** Transition website, codes, knowledge from ESRL to NCDC as soon as possible. Agreed that this should be top priority given recent budget cuts and a dismal outlook on future funding.

c) **Action (D. Berry):** Investigate to see if data translations from raw formats to IMMA1 are possible. This will help with data preparations for the next delayed mode release. Potential sources include ACRE data spreadsheets and remaining US Lightship data from CDMP.

d) **Action (S. Woodruff):** Provide information from Gil Compo on prioritization of untranslated ACRE spreadsheet data sources [post-meeting note: completed 7 May 2013].

e) **Action (E. Freeman):** Locate metadata publications stored in the EV2 database and extract for placement, as appropriate, on the Marine Climatology website (http://www.marineclimatology.net/web/).

f) Provide inventory and investigate any restrictions on pubs being provided externally. [post-meeting note: completed 20 May 2013]

g) **Action (E. Kent):** produce outline webpage(s) for making observational metadata information available

h) **Action (S. Woodruff):** provide E. Kent with links for all currently available observational observing instructions metadata (e.g. from RECLAIM, ICOADS website) [post meeting note: largely accomplished via 14 May 2013 e-mail]

i) **Action (ICOADS):** Add UIDs to NRT data in IMMA1 format

j) **Action (ICOADS):** Engage Reanalysis community more broadly to inform them of UIDs being used in the new IMMA1. This will allow feedback to ICOADS from multiple Reanalysis products.

k) **(M. Bourassa)** Reported that AOPC and OOPC are supportive of ICOADS and will do what they can to make ensure its continued success.

l) **Action (ICOADS):** Consider record compositing of near duplicate data from different sources containing different populated data fields (e.g. delayed mode observations blended with model feedback information from UK BUFR data [VOSClim/VOS/Buoy]

2) IMMA Format

a) UID

i) **Action (ICOADS):** Rename *Uid* attm to *Uida* attm to avoid confusion with the UID field in that attachment.

ii) **Action (ICOADS):** Investigate ways to link duplicates by UID so that they can be identified for further investigation

iii) **Action (ICOADS):** Investigate the potential to composite records and assign a new UID to the composited record.

b) IVAD Attm

The group discussed the IVAD attm and proposed the following changes:

i) **Action (S. Woodruff, E. Freeman)**: Expand IVAD attm to add additional character for higher precision output fields and add a precision indicator for VAD, VAU1, VAU2, and VAU3 fields.

ii) **Action (S. Woodruff, E. Freeman):** Change uncertainty field abbreviations (e.g. VAUR, VAUB, VAUA) to VAU1, VAU2, and VAU3 and add a table for VAU Indicator fields to allow more flexibility by data providers.

iii) **Action (IVAD):** Find an alternative QC flag scheme for what is currently proposed in table C96a representing VQC in the IVAD attm.

iv) **Action (S. Woodruff, E. Freeman**): Expand VQC field to base36 to allow more flexibility

3) Data Quality Control

a) ICOADS QC

i) **Action (NOC, ICOADS):** Investigate updating trimming procedures for R2.6.0. This will be a major improvement to ICOADS QC. As is the case for the original COADS Release 1-based limits (http://icoads.noaa.gov/dsul.html), which are available in digital form for the three separate climatological trimming periods (1854-1909, 1910-49, and 1950-79) currently in use, an associated dataset should be planned containing the actual medians and limits used for each climatological time period.

ii) **Action (ICOADS):** Consider deprecating NCDC QC flags in the IMMA format since they are legacy and rarely used, except importantly as factor in selecting the "best" report among a group of duplicates. More generally, it was suggested to consider the possibility of renaming and reusing some of the other existing QC flag field in the IMMA format? Might allow information on specific additional variables (e.g. a flag to say that a weather/cloud codes are inconsistent). NCDC-QC and MQCS (IMMT flags) possibly have some cross-checks among variables that could allow for inconsistency checks for specific variables.

b) HQCS

i) There is a need to incorporate information from QC developed in the scientific community alongside HQCS. Continue this discussion at Met Office.

4) IVAD (see also Appendix A)

a) Extended Cloud Reconstructions (ECR)

i) **Action (NOC, S. Smith)**: Contact Ryan Eastman to see if he can help with ECR QC

ii) **Action (NOC):** Clean up translation errors in ECR attm (i.e. problems with *N*=9). Agree with ICOADS whether this can be done for the main record or in the ECR attm only [post-meeting note: resolved in R2.5.1 (and its intermediate version R2.5.1$_i$) 18 May 2013; ref. http://icoads.noaa.gov/e-doc/R2.5-N=9Fix.pdf].

iii) **Action (NOC):** Discuss with Steve Worley if ECR attm can be added as an Auxiliary dataset at NCAR with UIDs added.

iv) **Deliverable (NOC, ICOADS):** Produce ECR Auxiliary dataset with UIDs in consultation with ICOADS for UID assignments and port to NCAR to be held as subsidiary dataset until Release 2.6.0 is produced.

b) Pub 47 Metadata

i) **Action (NOC)**: NOC will continue populating Pub 47 metadata attm in ICOADS (Attm C7) in the current format

ii) **Action (D. Berry, ICOADS)**: Produce draft of enhanced and expanded Pub 47 metadata attm to incorporate new fields contained in the publication (longer term goal) and make those available in an Aux or supplemental dataset. Investigate the potential for including more uncertain metadata information e.g. probabilistic or country-based.

c) Buoy Metadata

David Berry presented on moored buoy bias adjustments, the accuracy of their measurements, and the need to collect buoy (and C-MAN and other automated platform) metadata and make it available and easily accessible. Need to consider using the NDBC 'active stations' list in the future to supplement buoy metadata.

i) **Action (NOC):** Contact NDBC about buoy metadata availability after 2003. Talk to John Turton (Met Office) about metadata for UK/E-SURFMAR buoys.

ii) **Action (D. Berry):** Create an Auxiliary dataset of buoy metadata from his metadata spreadsheet collected from NDBC website. Provide to NCAR for storage.

iii) **Action (S. Woodruff):** Send TAO information to D. Berry for investigation of potential inclusion in Auxiliary dataset of buoy metadata.

iv) **Action (S. Woodruff):** Send D. Berry minutes of last meeting with NDBC [post-meeting note: completed 21 May 2013].

v) **Action (S. Woodruff):** Send D. Berry information on buoy metadata available from JCOMMOPS

vi) **Action (E. Kent):** contact groups who may have collected buoy metadata information for e.g. satellite validation

d) Tracking Attm

i) **Action (IVAD, NOC):** IVAD to make *Track* attm publicly available on the IVAD website for all to use once it is produced, probably in 2014.

e) IVAD Database Management

i) **Action (S. Worley, D. Berry, S. Smith):** Investigate using PostgreSQL rather than MySQL for IVAD database since it is more flexible with geospatial processing.

f) Relative Humidity

i) **Action (D. Berry):** Investigate producing RH values as an IVAD attm with UIDs

ii) **Action (E. Kent, S. Smith):** Share code for humidity calculations

g) Nocn Attm

i) **Action (IVAD):** Expand calibration indicator to include:

(1) Calibrated

(2) Not calibrated

(3) Bottle calibrated

(4) Others?

h) Alt-QC Attm

i) **Action (IVAD):** Investigate incorporating external providers QC flags from their processing into the proposed Alt-QC attm.

i) ARC and proper citations of original work by IVAD attm providers

i) **Action (IVAD):** Discuss options for user downloads of data from NCAR to ensure that documentation produced on the fly contains how to cite the original ARC so that the scientists that provided the corrections get full credit for their work in addition to ICOADS/IVAD as the data/information provider. Need to add contact details in ARC in case users have questions about VAD values.

j) IVAD Discussion Forums

i) **Action (E. Kent, S. Worley)**: Investigate using NCAR Climate Data Guide as a potential forum for ICOADS/IVAD discussion topics and FAQs

ii) **Action (IVAD)**: Investigate social media options (Facebook, LinkedIn, Twitter, etc) for potential ways to share information on ICOADS/IVAD and provide user forums for discussions.

k) IVAD Exercising by FSU

i) **Action (NOC):** Provide all available IVAD attms to NCAR by ~August 2013

ii) **Action (NCAR):** Use IVAD attms provided by NOC to develop interface to serve these attms

iii) **Action (FSU):** FSU to pull the data from the NCAR interface and use them to exercise the IVAD attms for Proof of Concept.

5) SST

a) Elizabeth Kent presented information on behalf of the recently funded HOSTACE project that is getting underway with an aim to produce a new global gridded SST dataset spanning at least 1850 to present with accurate uncertainty estimates. The presentation described:
   (1) the evolution of the observing system
   (2) bias adjustments of *in situ* SST from HadSST3 and ERSST
   (3) and the proposed work plan for HOSTACE and associated partners

b) Boyin Huang presented the ERSSTv3.5 dataset and the upgrades that have been made since ERSSTv3b was released. Upgrades include using ICOADS R2.5 and updating bias adjustments.

i. **Action (NOC):** Provide HadNMAT2 dataset with missing months. Follow up with Met Office on official version to be released and provide to ERSST for testing.

ii. **Action (B. Huang):** Investigate removal of warm decks (e.g. DCK 193) from HadNMAT2 in comparison with ERSSTv3.5 (prototype version).

iii. **Action (B. Huang):** Once HadNMAT2 data is received, investigate bias adjustments as compared to previous NMAT dataset. There is a potential for overcorrection that needs to be assessed.

iv. **Action (B**. **Huang**): Compare previous work done by Boyin (MOHMAT and HadSST3 vs. ICOADS and ERSST) using new HadNMAT2 data.

v. **Action (B. Huang)**: Investigate use of ARC satellite data in ERSST comparisons.

vi. **(M. Bourassa)**: Groups should consider using Gulf of Mexico to test ship/buoy/satellite comparisons since this area is rich in all three data sources.

vii. **Action (NOC, ERSST)**: Coordinate another video conference in the next 2-3 months to discuss progress of SST bias adjustments in ERSST using new HadNMAT2 dataset. This meeting should include Tom Smith. NOC may be able to host regular Video Conferences (VCs) perhaps starting at 3pm UK time. Slides can be jointly viewed as well.

viii. **Action (ERSST, NOC)**: Coordinate in-person meeting in Asheville, NC prior to or after the CLIMAR-4 meeting being held in Apr-May 2014.

a) SST-ICE

i) **Action (NOC):** Investigate ice mask that NOC uses from OISSTv2 to determine how well ice is represented in that dataset.

ii) **Action (B. Huang):** Produce ice plots for discussion with J. Kennedy and others during EarthTemp meeting with the Met Office and NOC.

6) Fourth JCOMM Workshop on Advances in Marine Climatology (CLIMAR-IV)

Eric Freeman introduced the CLIMAR-IV meeting that will be held in Asheville, NC in Spring 2014.

i) **Action (ETMC, CLIMAR-4 Organizing Committee)**: Recruit additional members for the scientific Organizing Committee for CLIMAR-4

ii) **Action (D. Berry):** Consider being Organizing Committee Chair.

iii) **Action (E. Freeman)**: Continue work with local organization and information gathering.

iv) **Action (E. Freeman, CLIMAR-4 Organizing Committee):** Report on meeting with UNC-Asheville and make determination, in coordination with the Organizing Committee, on where to officially hold the meeting

v) **Action (CLIMAR-4 Organizing Committee):** Consider themed sessions and persons to chair those sessions. Initial thoughts on sessions include:
   (1) Waves and storm surges (V. Swail)
   (2) Marine temperatures
   (3) Cross-cutting session on uncertainties
   (4) Air-Sea interactions
   (5) HQCS and general data QC
   (6) IVAD Progress

vi) **Action (S. Smith):** Contact Sid Thurston and/or Bill Murray for potential support from NOAA/CPO

vii) **Action (J. Lawrimore):** Investigate NOAA rules for spending on workshop, including Ice-Breakers and workshop dinners, gift bags, etc

7) Miscellaneous actions (may be related to or duplicates of items above)

i) **Action (E. Kent)**: Send draft satellite humidity paper to S. Smith and M. Bourassa once current round of editing complete

ii) **Action (D. Berry)**: Circulate CCHDO (CLIVAR and Carbon Hydrographic Data Office) standards document [post meeting note: completed via 5 April 2013 e-mail]

iii) **Action (E. Kent)**: Investigate the possibility of inclusion of UK Research Vessel data in ICOADS following COAPS/SAMOS methods

iv) **Action (S. Woodruff)**: Investigate whether original information on Beaufort codes can be extracted from supplemental data and included in historical attm

v) **Action (S. Woodruff)**: Revisit the configuration of the value-added QC flag (VQC) in Table C96a of the Proposed IMMA Revisions document.

vi) **Action (D. Berry)**: Provide Shawn Smith with information on tests for improved field quality used to assess NOC data in PhD thesis. Related discussion on use of div and curl for wind

vii) **Action (D. Berry)**: Circulate information on code version control and sharing with GIT (via github) to start discussion on how to share code. DB to also populate prototype site with IVAD reader to associate auxiliary information with ICOADS via the UID. DB to talk to P. Brohan with a view to making the perl translation scripts used for OldWeather IMMA translation available. DB to think more generally about how a wider code versioning/sharing site should be structured.

Part 2. EarthTemp Meeting Notes and Actions:
SST Biases and ICOADS

UK Met Office, Exeter, UK
8-10 April 2013

Participant List

NOAA/NCDC:	**UK NOC-Southampton:**	**UK Met Office – Hadley Centre:**
Boyin Huang (remote only)	Elizabeth Kent	John Kennedy
Eric Freeman (ERT/STG)	David Berry	Philip Brohan
Scott Woodruff (CIRES)	Giulia Carella	Rob Allan
Wei Liu (CICS) (remote only)		Chris Atkinson
Jay Lawrimore (remote only)	**Florida State University (FSU):**	Matt Palmer
	Shawn Smith (remote only)	
UK Met Office, Edinburgh:		**Deutscher Wetterdienst (DWD):**
Nicola Scott	**University of Edinburgh:**	Gudrun Rosenhagen
Fraser Cunningham	Chris Merchant (remote only)	

1) ICOADS:
   a) Eric Freeman gave an overview of ICOADS detailing:
      i) resources and expanding partnerships
      ii) near-real-time preliminary extensions
      iii) historical reprocessing
      iv) format (IMMA) and QC/Trimming improvements
      v) ICOADS – Value Added Database (IVAD)
   b) What needs to be done to simplify ICOADS processing to produce future delayed mode releases and satisfy different user groups?
      i) new tools
      ii) open source software
      iii) ability to output multiple formats (e.g. netCDF, csv, etc)
   c) Identifying historical ship names in ICOADS is difficult [noting that for many older historical decks, ship names weren't digitized; in some cases ship numbers were keyed, in other cases no information]. When stored in the (9-character) IMMA ID field they can be truncated or assigned a generic ID.
      i) Need to consider a central historical ship name repository from combined sources including WMO Publication No. 47, Lloyds Register (publicly available late 1800s to present, poor scans [note: published holdings should extend back to ~1764]), and similar published historical sources [see e.g.: http://www.mariners-l.co.uk/ResLloydsRegister.htm], IMMA Supplemental attachment (where the full name was digitized in the original record), and

making use of the proposed Historical Attm that is proposed to have a specific field for the full ship name.

ii) The Met Office maintains the FLEET database that holds Pub 47 metadata plus additional metadata produced by the Met Office:
   (1) History of all instruments used on their vessels, calibration information, other
   (2) FLEET was initially developed for active ships and needs a historical component. It could be very useful in the international community if expanded and possibly coordinated through JCOMM/ETMC.

2) International Maritime Meteorological Archive (IMMA) format proposed changes
   a) Scott Woodruff provided and overview of changes to the IMMA format based on work by the ICOADS/IVAD group as well as reflections of discussions at NOC, 4-5 April 2013.
   b) John Kennedy noted the difficulties associated with downscaling HadSST3 gridded data to a single point observation for inclusion in the IVAD attachment. There is also additional complexity due to the multiple realizations including how to provide correlation structure information with uncertainty values.
   c) *Alt-QC* (attachment) attm
      i) The group proposed including a field for probabilistic confidence in the IVAD attm. **(Action: ICOADS/IVAD)**
   d) Platform tracking (proposed *Track* attm)
      i) The group recommended that IVAD consider a field for pseudo-IDs including uncertainty or confidence feedback from the tracking assignments, also potentially space for a revised platform type (*PT*) setting. **(Action: ICOADS/IVAD)**
   e) Historical (*Hist*) attm
      i) The proposed historical attm was discussed including the benefits. It is proposed to include many fields of historical information that do not fit into the *Core* or other ICOADS attm including: ship names, wind vectors, Beaufort wind forces, sympiesometer pressures, etc. ICOADS was urged to consider making this attm available in the future **(Action: ICOADS)**
   f) More information is available from [post meeting note: planned changes agreed at the EarthTemp meetings have now been incorporated into IMMA-Rev-v14.pdf here]: http://icoads.noaa.gov/ivad/documents.html

3) Data Sparseness/Data Rescue:
   a) Rob Alan presented information on behalf of ACRE detailing different international projects and potential new sources of data for ICOADS, some of which images/data are available via Dropbox:
      i) ACRE Pacific:
         (1) Wragge Records 1889-1903 – Queensland area
         (2) Australian National Tidal Centre Hourly Tide Gauge meteorological observations
      ii) ACRE Chile:
         (1) 6k logbooks from the Antarctic and Pacific regions, 1860s onward
      iii) ACRE China:

(1) mostly terrestrial data, but some published marine reports including some from WW2 era

iv) Indian Ocean basin:
   (1) Published met data from India 1820s-1840s, marine and terrestrial
   (2) Mauritius logbooks, 1850-WW1 era

v) Europe:
   (1) UK Met Office has more WW1 and WW2 logbooks
   (2) French archives are being abated for asbestos contamination, but may be able to salvage logbooks
   (3) German colonial data and archives
   (4) Investigating Portuguese colonies
      (a) Portugal had colonies around the world that were serviced by ships, especially in Africa. Need to see if logbooks exist in those present-day locations or Portuguese archives
   (5) Russian logbooks from Pacific Ocean in St. Petersburg, 1850s-1860s

b) NOC mentioned that Clive Wilkinson had contacted them about their holdings of historical logbooks from some UK research or other vessels that may contain meteorological observations. For ETMC, Shawn has been working on Annex H: Automated Research Vessel (R/V) Observations Catalog in: http://icoads.noaa.gov/reclaim/pdf/marine-data-rescue.pdf

c) Philip Brohan will provide documentation for crowdsourcing data formats for data that will eventually flow to ICOADS. **(Action: Philip Brohan)**

d) Time periods where data is sparse and badly needed:
   i) 1850s-1890s
   ii) WW1 and WW2 periods

e) Buoy Metadata Sparseness
   i) Dave Berry is working to collect buoy metadata. The following are potential sources:
      (1) NDBC up to 2003.
      (2) FLEET database from the UK Met Office
      (3) activestations.xml from NDBC (http://www.ndbc.noaa.gov/activestations.shtml)
      (4) DBCP
   ii) Dave Berry will check to see if BUFR buoy templates have metadata included. **(Action: D. Berry)**

f) Meetings related to Data Rescue:
   i) Session ECC1 "Recovery, imaging, and digitisation of historical observations and metadata" Convener: S. Bronnimann Co-Conveners: R. Allan, P. Jones at the 13th Annual Meeting of the European Meteorological Society (EMS) and the 11th European Conference on Applications of Meteorology (ECAM). These meetings will take place 9 – 13 September 2013 in Reading, UK (http://www.ems2013.net/)
   ii) International Workshop on Rescuing Climate Heritage of Indian Ocean Countries: A necessary step for Improved Data foundations for Climate Services; Maputo, Mozambique, 17-19 September, 2013.

iii) Matt Palmer is attending a CLIVAR meeting in Hobart, Australia, "CLIVAR-GSOP Coordinated Quality-Control of Global Subsurface Ocean Climate Observations," 12-14 June 2013; http://www.clivar.org/organization/gsop/activities/clivar-gsop-coordinated-quality-control-global-subsurface-ocean-climate) and will relay information back to the group in regards to metadata access and data rescue activities coordinated through GODAR. **(Action: Matt Palmer)** [Post meeting note: Matt has also agreed to make a short presentation at that workshop on behalf of ICOADS, including some "lessons learned."]

4) ICOADS Promotion and Stewardship:
   a) There is a need to develop a marketing-style strategy to promote ICOADS and be able to explain to Senior Managers and Stakeholders why the dataset is so important. Many examples can show how important ICOADS is and the projects that depend on it:
      i) Doing a reanalysis without ICOADS data
      ii) Doing SST reconstructions without ICOADS data
      iii) Extensive direct and indirect citations for the dataset
   b) Philip Brohan will provide a list of risks associated with the loss of ICOADS and how he relies on ICOADS data. **(Action: P. Brohan)**
   c) Need to develop figures to illustrate the importance of ICOADS **(Action: All)**
      i) Citation trees to show how ICOADS is referenced, directly and indirectly
      ii) Products and communities dependent on ICOADS
      iii) Illustration showing the continuing importance of ship data
   d) Figures produced in c) above should be shared with high level persons for input on what will help influence persons willing to invest or provide resources for ICOADS or that can get the message out to various groups on the importance of ICOADS. Suggestions include:
      i) Mark Bourassa, OOPC
      ii) Adrian Simmons, AOPC
      iii) Global Framework for Climate Services (GFCS). Rob will connect Scott Woodruff and Etienne Charpentier with colleagues in the GFCS that may be able to help. **(Action: Rob Allan)**
      iv) Kevin Trenberth, NCAR
   e) Three major items will be produced as a result of the meeting to promote ICOADS and make it more visible to the public while stressing the importance of the dataset by showing how it underpins many projects:
      i) A journal article to be submitted to a high-profile journal (e.g. the *Bulletin of the American Meteorological Society* (BAMS) or *Nature*) describing the importance of ICOADS **(Action: E. Kent and P. Brohan to start the process)**
      ii) A glossy brochure with figures (ref. 3c) to be made available to senior managers, stakeholders, distributed at workshops and meetings. **(Action: All)**
      iii) Letter of Intent proposed to be signed among ICOADS, DWD, UK Met Office, NOC, and possibly other organizations, outlining intentions for enhanced international partnerships. The letter will describe specific duties for the contributing organisations and will be a step toward a formal partnership (possibly a WMO-IOC Marine Climate Data System (MCDS)

Centre for Marine Meteorological and Oceanographic Climate Data (CMOC), see the Annex to Appendix B for further information) **(Action: ICOADS, DWD,UK Met, NOC)**

5) JCOMM (presented by Scott Woodruff)
   a) CLIMAR-IV
      i) NCDC has offered to host the meeting and it is going to be held in Asheville, NC, USA around March-April 2014.
      ii) The team recommended including representatives from the GFCS, WMO Commission for Climatology (CCl), and IOC International Oceanographic Information and Data Exchange (IODE).
      iii) Need to complete the Organizing Committee. Dave Berry is the proposed Organizing Committee Chair and Eric Freeman will help with local arrangements.
      iv) Need to consider possible 'theme sessions' and chairs for each:
         (1) Waves and storm surges – Val Swail
         (2) SST and marine temperatures – Elizabeth Kent
         (3) IVAD – Shawn Smith
         (4) Etc…
   b) WMO-IOC Marine Climate Data System (MCDS)
      i) MCDS is proposed to reduce complexity, increase harmonization and strengthen IODE-JCOMM linkages related to climate data and related products within marine meteorology and oceanography.
      ii) It will build on existing systems to enable:
         (1) Free and open data, metadata, and product access
         (2) Making data more discoverable & accessible via ODP and WIS
         (3) Standardized quality management
         (4) International mirroring for improved access and security
         (5) Permanent archival (with ICSU/WDS)
   c) Centres for Marine Meteorological and Oceanographic Climate Data (CMOCs)
      i) Proposal for ICOADS to become a CMOC has been delayed due to budgetary reasons.
      ii) Future goal is to partner with Germany and UK for a potential 3-way partnership formalized under the MCDS to:
         (1) share work
         (2) provide database enhancements
         (3) and provide more rapid development of ICOADS

         [Note: DWD/Germany and China/NMDIS already applied to become CMOCs, which were provisionally endorsed by JCOMM-IV and IODE-XXII.]

6) HOSTACE Project
   a) Elizabeth Kent presented information on behalf of the recently funded HOSTACE project that is getting underway with an aim to produce a new global gridded SST dataset spanning at least 1850 to present with accurate uncertainty estimates. The presentation described:
      i) the evolution of the observing system

ii) bias adjustments of *in situ* SST from HadSST3 and ERSST
iii) and the proposed work plan for HOSTACE and associated partners

b) Next steps for the project include:
i) Track ship observations to cluster observations from the same ship (G. Carella)
ii) Implement and test Folland & Parker wooden and canvas bucket models (E. Kent)
iii) Finish moored buoy characterisation for ARC/ATSR period 1991-2012 (D. Berry)
iv) Preliminary SST variability estimates (U. Reading PDRA, D. Berry)
v) Start development of statistical data set reconstruction methods (D. Berry)
vi) Assessment of characteristics of modern ship data (U. Reading PDRA, G. Carella, E. Kent)

7) JCOMM Extreme Wave Data Set (EWDS)
a) Nicky Scott presented the planned UK contribution to the JCOMM Extreme Wave Data Set on behalf of Emma Steventon (UK Met).
b) This UK dataset was produced from a collection of 78 buoys moored around the UK since the 1980s.
c) There have been a total of 96 extreme waves verified, with two of those being 19m! Extreme waves around the UK typically occur during November to March.
d) Dave Berry suggests using the full time series to compare with ship observations to see if ships reported any of these or can help verify their existence.
e) Questions on EWDS and wave data in general **(Action: E. Steventon)**:
i) What frequency are buoys reporting?
ii) Are extreme waves instantaneous or e.g. within the past hour?
iii) Could these data potentially be provided to ICOADS as a delayed mode set?
f) Check to see if waves are reported in the UK BUFR files provided to NCDC for ICOADS and VOSClim data processing. **(Action: E. Freeman)**
i) [Follow up – Waves are not provided in the UK BUFR files sent to NCDC. (Freeman)]
g) Discuss with Val Swail how these data are used and by whom. **(Action: P. Brohan)**
i) Additional information on EWDS:
http://www.jcomm.info/index.php?option=com_oe&task=viewDocumentRecord&docID=4723
http://www.jcomm.info/index.php?option=com_oe&task=viewDocumentRecord&docID=10553
http://www.jcomm.info/index.php?option=com_oe&task=viewDocumentRecord&docID=10711
h) Dave Berry is collecting buoy metadata from multiple sources. Nicky and Emma will work to send the information to Dave as it is compiled into the FLEET database. **(Action: N. Scott, E. Steventon)**

8) Vision for a Met Office – Ocean Atmosphere Data Set (MO-OADS)
a) Nicky Scott presented information on the vision for a new dataset intended to meet the needs of Met Office climatological applications and commercial/consultancy services.
b) The dataset will use ICOADS as a base for historical observations while including additional data not included in the most current release of ICOADS:
i) MIDAS database
ii) real-time GTS data including drifters

iii) UK quality controlled data – Navy and near-real-time (NRT)
iv) GCC quarterly data
v) 3rd party data – offshore platforms, etc
vi) rescued data awaiting blending into a future ICOADS release
vii) Lookup tables including but not limited to: metadata, unmasked call signs, historic format codes, bias adjustments
viii) Other: software, version control, unique IDs

c) There should be a plan for IVAD convergence since much of this information fits into that structure.
d) MO-OADS can potentially supply new data (delayed-mode and near-real-time) to ICOADS on a monthly/quarterly basis as an auxiliary/intermediate dataset, or possibly be incorporated into the newly developed NRT product.

9) Higher Quality Control Standards (HQCS)
a) Gudrun Rosenhagen presented the latest on the DWD HQCS software currently being developed and tested. The software performs the following checks:
i) gross error checks
ii) land mask to 0.01° with a 0.15° radius tolerance
(1) A less stringent land mask check may be needed for historical ship data since many of the latitudes/longitudes were coarse and often only reported to whole or tenths of a degree.
(2) Dave Berry suggests considering using vector analysis in land mask rather than raster.
iii) platform tracking
(1) observations without call signs tracked by positions
(2) uses DM and RT data
(3) Should collaborate with ship tracking work at NOC with the HOSTACE project
iv) ERA-INTERIM climatological checks, base period 1981-2010 on 1° grid
(1) Rob Allan suggests considering using other reanalysis products such as the 20th Century Reanalysis (20CR) for the climatological checks.
v) time consistency checks
vi) internal plausibility
vii) near-neighbor checks
b) The software uses the Numerical Algorithm Groups (NAG) library.
i) Costs ~700€
ii) Access to the NAG library is needed to be able to test software and easily implement.
c) Need to develop a way to incorporate the flags produced from the HQCS into an Alt-QC attachment for ICOADS.
i) These flags can replace MQCS flags in IMMT data and possibly replace the NCDC-QC Flags in the IMMA format used by ICOADS which are not utilized for trimming [note: but are used during duplicate elimination processing for selecting “best” duplicates].
d) There is a need to know what NAG Library functions are being used and those to be shared with NOC to see if there are alternative approaches **(Action: G. Rosenhagen)**

e) There are future plans to do more comparisons within HQCS using model output and satellite data.

10) Integrated Database of Surface and Sub-surface Temperature and Salinity Observations
    a) Chris Atkinson presented his and Nick Rayner's work on integrating surface and sub-surface temperature and salinity observations.
    b) The database uses surface temperatures from ICOADS R2.5.1 and sub-surface temperatures and salinities from the Met Office Hadley Centre EN4 dataset.
        i) May include underway data from GOSUD in the future.
    c) Currently in ODB API format (flat tables), but eventually would like to move to SQL for more flexibility.
    d) The database will incorporate bias corrections and uncertainty estimates based on the model used for HadSST3.
    e) The database will incorporate tracking QC and, where possible, unmasked ship callsigns from December 2007 to present.
    f) These data will make a great contribution to IVAD efforts and should be considered by Chris and Nick to be submitted to IVAD as an auxiliary dataset. **(Action: C. Atkinson, N. Rayner)**

11) HadSST3
    a) John Kennedy presented on the HadSST3 dataset and lessons learned along the way. This information is very valuable for collaborations with NOC and ERSST on developing SST reconstructions by independent methods for verification purposes.
        i) Comparisons with ARC SST, sub-surface data and land temperatures (via AMIP style analysis).
        ii) Larger ensemble generated: allows for refinement of uncertain parameters in bias adjustment scheme by comparison with independent data subsets and to explore greater range of structural uncertainty by including Smith and Reynolds (SR) style bias adjustments (as used in ERSST) in HadSST3 ensemble.
        iii) Exploring importance of vertical temperature gradients in the upper 30m. Significant temperature gradients identified from profiling moorings.
        iv) Intercomparison of different estimates of random and correlated error uncertainty in individual SST measurements, assessing change in measurement uncertainties over time.
    b) SST reconstruction developers were encouraged to make itemized lists of exactly what goes into each dataset and compare. **(Action: B. Huang, J. Kennedy)**
12) ERSSTv3.5
    a) Boyin Huang presented the ERSST dataset and the many upgrades that have been recently made to produce a new version of the dataset.
        i) Upgrade ICOADS from R2.4 to R2.5
        ii) Upgrade EOT using monthly OISST.v2 (1982-2011)
        iii) Upgrade QC using STD of monthly OISST.v2 (1982-2011)
        iv) Calculate SSTA at in situ locations
        v) Update ice concentration

vi) Replace 0-anomaly filling with non-0-anomaly
vii) Plans to upgrade ship SST bias correction using HadNMAT2

b) Boyin will compare the SR run of HadSST3 that John did and collaborate with John on the results. **(Action: B. Huang, J. Kennedy)**

13) SST Uncertainties and Bias Adjustments
   a) The group proposes to write a report or journal article on what the uncertainties in each dataset mean. John Kennedy has already submitted a journal article on uncertainties to Reviews of Geophysics and the group can supplement the article with a more specific document. **(Action: ERSST, NOC, HadSST3)**
   b) The group was urged to consider the future of bias adjustments and the potential to develop new methods, possibly including Reanalysis products and/or Coupled Ocean-Atmosphere Reanalyses.

14) Satellite SST
   a) Chris Merchant discussed current activities within the Satellite SST community including information about the European Space Agency (ESA) - Climate Change Initiative (CCI). Phase 1 of the CCI is finishing soon but bids for Phase 2 will be prepared in summer 2013.
   b) The ATSR method of radiative transfer modelling has been applied to AVHRR brightness temperatures to produce ATSR-like SSTs, bias adjustment is then applied to improve agreement with ATSR itself. The 2 data sources have been combined within the OSTIA analysis system to give a 20-year blended product on a 1/20˚ daily grid.
   c) It was noted for Phase 2 of the CCI that the current absence of an ATSR sensor is a problem, and it is hoped that it will be possible to extend the record back in time, but this may not be possible within the call. Plans are to reprocess AVHRR data back to 1984 (1991 w/ ATSR), but a new method is needed for data prior to 1991. Time of day adjustments are applied to the SST depth version at the same time as the depth adjustments. The time of day adjustment is typically ~< 0.2K. The skin version is not adjusted for time of day.
   d) A tool will be produced to aggregate the data to coarser grids and to propagate the uncertainties properly through the aggregation.
   e) A factor of 10 uncertainty in the ATSR gridded data is seen, differences depend on day/night, fraction of cell seen, sampling and representativeness and random error in the measurement system.
   f) It is expected that the new AVHRR data will improve on the existing data and give accuracies ~ 0.1K excluding the Pinatubo period, final adjustments will give typical accuracy < 0.1K, accuracy should be better than 0.5K at worst.
   g) It was noted that there had been difficulties incorporating ARC ATSR data into HadISST2 as the ARC errors are much smaller than the other data sources. ATSR1 data remains a problem and isn't being used in HadISST2. It was also noted that the length of the high-resolution (usually satellite) data record used to define modes for reconstructions has a strong impact on the results.

15) Buoy Data

a) There is a need for observations in the Eastern Pacific.
b) There has been a troubling decline in tropical mooring observations since 2011 due to resource issues and servicing problems.
c) With the increasing reliance on drifting buoys there has been a steady decrease of variables observed. Most common now are pressure and sst.
d) The group was urged to consider using Argo floats as a good source of near-SST (and potentially other near-surface ocean) data.
    i) They have good calibration, but spend a lot of time underwater.
    ii) ICOADS will investigate if these are being provided through the World Ocean Database (WOD) that is incorporated into ICOADS delayed mode releases. **(Action: ICOADS)**
        [Follow-up notes: WOD does include Argo data, although not in NRT.]
    iii) ICOADS will consider Argo surface observations for NRT products, which could then have significant benefits to downstream applications (e.g. SST analyses), including possibly for populating the Near-surface oceanographic (*Nocn*) attm. From a single Argo float there is one surface report per ~10 days, but global coverage is great and would likely work well in a monthly product such as the NRT. **(Action: ICOADS)**

Appendix A

Notes from Shawn Smith regarding IVAD related items

Questions to address regarding IVAD attm format

Note: Latest IVAD attm template is on page 14 of IMMA-Rev-v13.pdf

Topic 1

What should be stored in the VAD? **Decision:** The adjusted value. How derived is in the ARC.

If we allow an IVAD attm with uncertainty or VQC values, but no change to the original data value, do we populate VAD? Leave it blank? Fill with unchanged value from ICN and FN value? N/A

Does this break the original IVAD concept? N/A

Topic 2

Should we provide for a precision of the VAUR, VAUB, and VAUA that is different than the value to which the uncertainties apply (from ICN and FN)? Or is the present plan to inherit the precision from the value sound?

If we provide for an alternate precision, do we still require inheritance of other FN characteristics (e.g., units, etc)? (Yes!)

Good practice to include one more decimal place to precision in the IVAD attm.

AI – Scott Woodruff: Add a scaling factor for each VAU and for VAD and expand each field by 1 more space.

Topic 3

Should we retain the VAUA field?

Originally included a third uncertainty field for something like an "interplatform uncertainty" as suggested by Liz, but we thought having some flexibility for the developer would be nice.

Decision: Keep the third field and change all three fields to be user defined. Each would be linked to an indicator with a short list of uncertainty types (e.g., 1 – random, 2 – bias, 3 - …). Details of type of random uncertainty calculation would be in the ARC document.

Topic 4

Should we retain the VQC or move this concept to the Alt-QC attm?

Originally consensus was to remove VQC, however Dave noted we need to discuss the implications for pre-existing QC flags (e.g., trimming).

Thought on Friday was to change the VQC to a "new trimming" flag. Developers would "retest" their VAD for exiting limits and applying new flag.

Decision: Retain the VQC as a base36 field with use "to be determined" in the future. (This supports continued work on prototype IVAD attm, with a locked down format.

Topic 5

Just want to confirm agreement on the following:

1. Submission of IVAD attm from a developer will include the full Uid attm for each record. (Yes)

A registry will need to be set up for the ARC, allowing developers to select/submit an ARC for their specific documentation. (Yes) – Question raised as to whether or not NCAR can store documents/source code linked to ARC? Requested that the registry is hosted on the IVAD web site/at a location where one can retrieve the data. Link via DOI (ARC, DOI or link, document itself) **AI: Shawn Smith** – Contact Steve Worley and discuss w/ IVAD U.S. team how to establish the registry within the context of IVAD server/database at NCAR.

Appendix B
ICOADS Release 2.6 (R2.6) Scientific Justification and FY2014 Resource Requirements

Unmet budget requirement: ~$120K[1] per FY2014
R2.6 reasonable completion date: end of FY2014[2]
DRAFT (16 May 2013; S. Woodruff, S. Worley, et al.)

Executive Summary

Release 2.6, a next-generation of ICOADS, is urgently required to stabilize the future for ICOADS; it will complete the handover of data processing to a new generation of data engineers, bring new international partners into active participation roles (see Annex), cover important high technical level software modification and development, and enable IVAD to achieve, for the first time, an observational database strategy that incorporates community provided bias adjustments and with significant additional potential. This is the most critical turning point ICOADS has faced in decades. Project management, U.S. and international coordination, supervision and analyses to support this request, and worldwide free user data access is secure and in place. What is needed is $120K (for NOAA or CIRES salary support) for senior marine computer programmer Ms. Sandy Lubker. This is essential for the completion of R2.6 within FY2014. Without this funding the technical capability to produce ICOADS will be irrevocably lost.

Overview: The International Comprehensive Ocean-Atmosphere Data Set (ICOADS; http://icoads.noaa.gov) is an invaluable international resource, providing secure and traceable access to a comprehensive archive of surface marine climate data. The observational archive and products underpin a wide range of activities including regional and international climate monitoring and assessments; atmospheric, ocean and coupled reanalyses; and calibration and validation of measurements from satellites.

Release 2.5 (R2.5; 1662-2007), the last major historical update, was completed in 2009. While R2.5 (Woodruff et al. 2011) was accompanied by preliminary updates, based exclusively on Global Telecommunication System (GTS) data, that successfully extend ICOADS monthly in near-real-time—another update for the full historical period is long overdue.

With this new delayed-mode update, Release 2.6 (R2.6), we are poised to incorporate a wide range of new or improved data (and metadata) sources, for both historical (Fig. 1) and contemporary (Fig. 2;

[1] Federal employee NOAA rate (w/ all overheads, probably including IT overhead) approximately $240K/year. If transitioned to CIRES employee (Full time, or less) cost probably significantly less. The funds are requested to cover Ms. Lubker at 50% time for the entire FY2014 (with ESRL suggested to cover her other 50%, as same as current arrangements), or for full time for about half of FY2014 (e.g. Oct.-Mar. or Apr.-Sep.).

[2] Previously, the end of calendar year 2013 was our goal for completion of R2.6. However, in view of the necessity for additional transition activities, we now feel more time will be needed to complete and adequately validate the update.

Table 1) periods; to implement a variety of important format and processing improvements (Table 2) linked with the ICOADS Value-Added Database (IVAD) project (http://icoads.noaa.gov/ivad/); and to foster closer integration with the oceanographic community, including through extension of ICOADS observations for the first time to include near-surface oceanographic variables (e.g. salinity, nutrients, and dissolved carbonate chemistry, etc.). Major innovations in provenance tracking (including unique IDs for all individual marine reports, and dataset DOIs) are also being implemented as part of this update.

Ongoing NOAA budgetary challenges: While ICOADS operated for decades in the US as a partnership between NOAA—its Earth System Research Laboratory (ESRL) and the National Climatic Data Center (NCDC)—and the National Center for Atmospheric Research (NCAR), in late 2011 ESRL, under budgetary pressure, abruptly discontinued involvement. Since then, some short-term restoration of NOAA Climate Program Office (CPO) funding for the core ICOADS work occurred (also for the IVAD project), and substantial progress has been made in transitioning ESRL-based staffing, expertise, and project infrastructure to NCDC. More personnel time and resources however are urgently required, both to complete R2.6 in timely fashion and with appropriate thorough validation, and also to ensure satisfactory final completion of transition of the project's longstanding reservoir of knowledge and expertise to NCDC from ESRL.

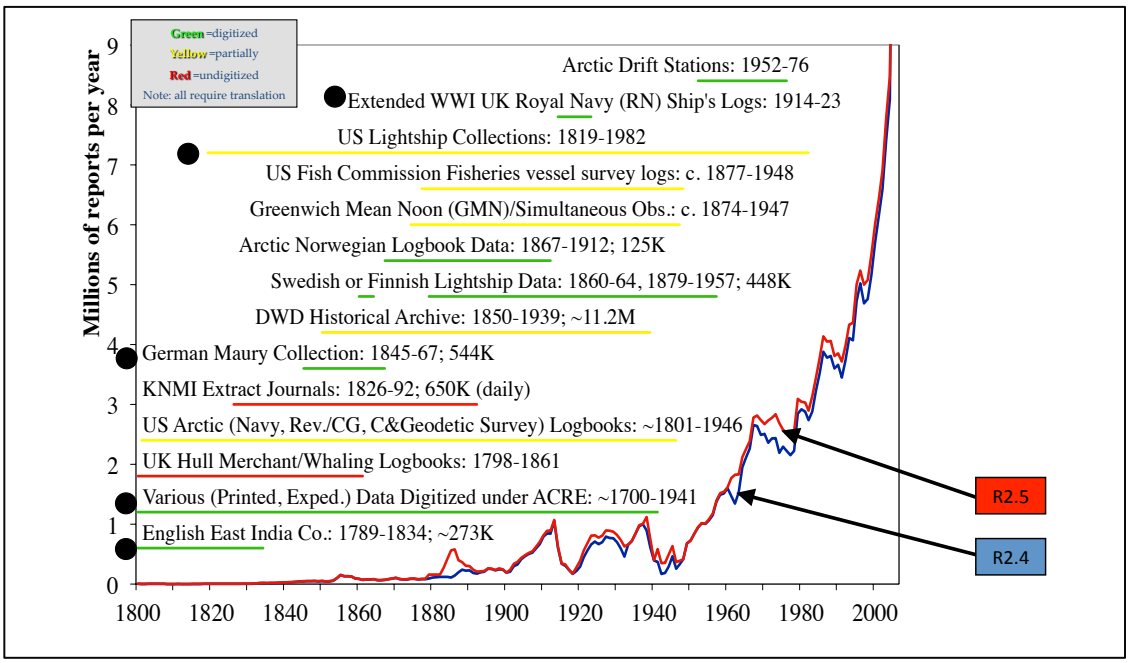

Figure 1. The time periods of selected candidate historical data sources (some discussed in more detail in Wilkinson et al. 2011) to be eventually blended into ICOADS (or offered separately in advance of formal Releases as "Auxiliary" datasets), are spanned by horizontal colored lines: green candidates are fully digitized but require format translation, yellow are partially digitized, and red are in the planning stages for digitization. Each dataset name is appended with the date range and approximate number of

reports (if known). The solid blue curve is the number of reports in ICOADS Release 2.4 (R2.4); the solid red curve is the number in R2.5. Black dots mark sources definitely planned for inclusion (fully or partially) in R2.6, e.g. the "Various (Printed, Exped.)…" source is viewed as key for early historical reanalyses.

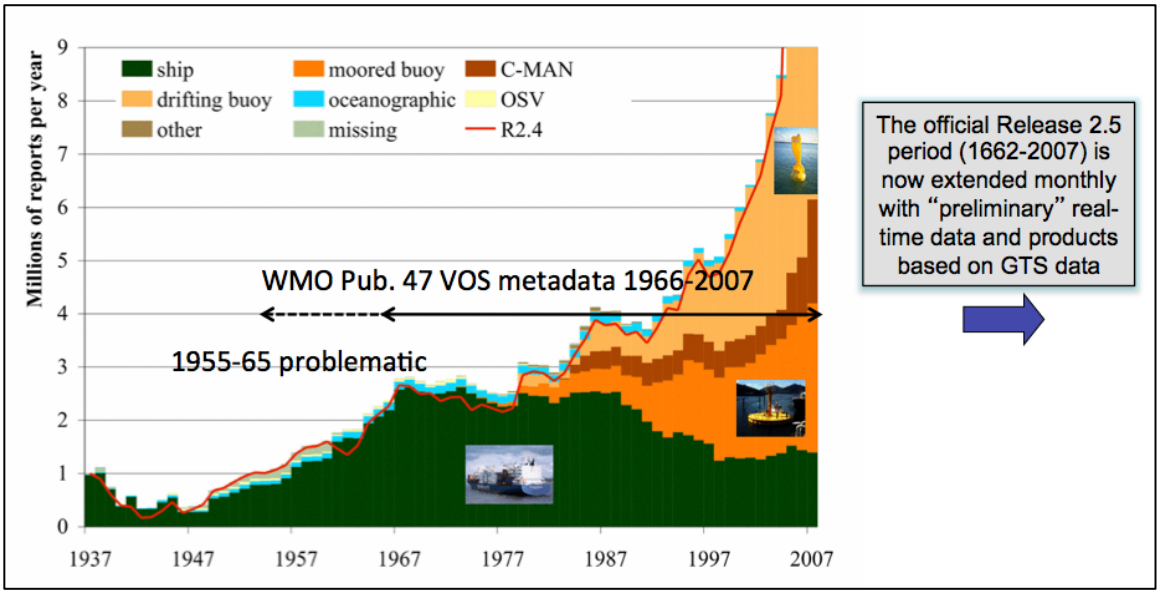

Figure 2. Annual distribution (1937-2007) of major platform types in R2.5 shown as millions of reports per year. For clarity the vertical scale is truncated at 9M; years 2005-07 have 13M, 15M, and 16M total reports (not visible) in Release 2.5, respectively. The red line curve shows the R2.4 annual counts. Ships (mainly VOS plus some R/Vs), buoys, and oceanographic are self explanatory, Ocean (permanent) Station Vessel = OSV, Coastal-Marine Automated Network = C-MAN, ocean drilling rigs/platforms and other small entities = other, and unidentified platform types = missing. (Ship photo courtesy of www.ShipPhotos.co.uk.) Figure adapted from Woodruff et al. (2008).

Table 1. New and improved contemporary data sources planned for R2.6, including status notes.

International Maritime Meteorological Tape (IMMT) data (keyed ship reports)
NCEP-NCDC GTS merge back to at least Dec. 2007 (http://icoads.noaa.gov/merge.html)
Tropical moored buoy arrays: data heavily fragmented (PMEL, NDBC, JAMSTEC, etc.)—introducing large translation costs/complexities
ISDM/Canada drifting (moored) buoy archive (unknown status—ISDM undergoing budgetary contractions)
NOAA/NODC World Ocean Database 2013
Research Vessel (R/V) Data Quality-Evaluated by FSU/COAPS: SAMOS
UK Met Office BUFR GTS data (VOSClim format), other UK sources (?)
{MORE TO BE ADDED}

Table 2. Format, processing, and metadata improvements planned for R2.6.

Error corrections, including elimination of highly erroneous Shipboard Environmental (Data) Acquisition System (SEAS) data (http://icoads.noaa.gov/deck874.html)
Resolution of a major portion of the Voluntary Observing Ship (VOS) callsign masking problem (since Dec. 2007), through inclusion of delayed-mode (logbook) VOS data and newly blended GTS data (http://icoads.noaa.gov/merge.html). This problem compromises our ability to link the VOS reports with published metadata (WMO Pub. 47) and thus our ability to complete many potential modern-day IVAD improvements
Blending (with assistance from UK National Oceanography Centre; NOC) of the VOS WMO Pub. 47 platform/instrumental metadata (see Fig. 2).
Assignment of permanent Unique IDs (UIDs) to each individual marine report in ICOADS, which information will greatly facilitate interaction between users of ICOADS and its primary developers, and affords record traceability through atmospheric and oceanographic reanalysis efforts.
Assignment and management of dataset Digital Object Identifiers (DOIs) to ICOADS that will promote its official and standard citation in publications and enable the capability, over time, to accurately measure the impact of this foundational dataset on scientific progress
Possible QC improvements: This is of crucial importance because the existing climatological based QC limits are missing over important data areas. Revamping these "trimming limits' is planned by NOC but would but probably could fit within the scope of R2.6 only if executed via a new set of flags (i.e. to be carried forward alongside the old)
{MORE TO BE ADDED}

References

Smith, S.R., 2011: Ten-year vision for marine climate research, *Eos Trans. AGU*, **92**, 376 (doi:10.1029/2011EO430005).

Woodruff, S.D., H.F. Diaz, E.C. Kent, R.W. Reynolds, and S.J. Worley, 2008: The evolving SST record from ICOADS. In *Climate Variability and Extremes during the Past 100 Years* (S. Brönnimann, J. Luterbacher, T. Ewen, H.F. Diaz, R.S. Stolarski, and U. Neu, Eds.), Advances in Global Change Research, Vol. 33, Springer, 65-83.

Woodruff, S.D., S.J. Worley, S.J. Lubker, Z. Ji, J.E. Freeman, D.I. Berry, P. Brohan, E.C. Kent, R.W. Reynolds, S.R. Smith, and C. Wilkinson, 2011: ICOADS Release 2.5: Extensions and enhancements to the surface marine meteorological archive. *Int. J. Climatol.*, **31**, 951-967 (doi:10.1002/joc.2103).

Wilkinson, C., S.D. Woodruff, P. Brohan, S. Claesson, E. Freeman, F. Koek, S.J. Lubker, C. Marzin, and D. Wheeler, 2011: RECovery of Logbooks And International Marine Data: The RECLAIM Project. *Int. J. Climatol.*, **31**, 968-979 (doi:10.1002/joc.2102)

Annex: Emerging international ICOADS partnerships

By exploiting existing capabilities amongst principal partner organizations, we anticipate being able to accelerate development of ICOADS, and ensure its long-term sustainability. This partnership agreement will more formally recognize existing and planned international contributions to ICOADS that build on the ongoing investment of NOAA and NCAR as the founding US partners. The agreement is expected to improve the resilience of ICOADS to any short-term fluctuations in national budgets. This partnership

will facilitate possible future formalization of ICOADS as a Centre for Marine-Meteorological and Oceanographic Climate Data (CMOC) under the WMO-IOC Marine Climate Data System (MCDS).

Principal partner organizations are:

US National Oceanic and Atmospheric Administration (NOAA; Lead)
US National Center for Atmospheric Research (NCAR; Co-Lead)
Deutscher Wetterdienst (DWD)
UK Met Office
UK National Oceanography Centre (NOC)

Resources: The program will capitalize on existing and planned activities within the partnering organizations and other contributing organizations including the National Center for Atmospheric Research (NCAR), and Florida State University (FSU). Closer partnership is anticipated to result in more efficient use of existing resources and provide a focus for additional funding in the future.

Collaboration areas:
DWD: Rescue and provision of historical data and metadata, higher-level QC processing, mirroring, satellite data calibration/match-up.
Met Office: Rescue and provision of historical data and metadata, provision of operational data and metadata, data translations, quality control enhancements, permanent archival redundancy.
NOAA: Provision of Assembly of final observational data and gridded products, value-added database (IVAD), general data services, primary permanent archival.
NOC: Provision of observational metadata and translation of research outputs to improve observational data quality

The commitment to ICOADS is expected to be long-term and will be reviewed after five years. By signing, partners agree to work closely with the common goal of enhancing and internationalizing ICOADS, including the near-term goal of completing the next major delayed-mode update, Release 2.6.