WORLD METEOROLOGICAL ORGANIZATION

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COMMISSION FOR BASIC SYSTEMS
OPEN PROGRAMMME AREA GROUP ON
INTEGRATED OBSERVING SYSTEMS

IMPLEMENTATION-COORDINATION TEAM ON INTEGRATED OBSERVING SYSTEM (ICT-IOS)
Eighth Session

GENEVA, SWITZERLAND, 7 – 10 APRIL 2014

CBS/OPAG-IOS/ICT-IOS8 / Doc. 4(4)
(31.03.2014)

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ITEM: 4

Original: ENGLISH

REVIEW OF THE STATUS OF THE SURFACE-BASED COMPONENTS OF THE GOS

STATUS OF THE SURFACE-BASED SUB-SYSTEM OF THE GOS IN REGION IV

(Submitted by Jay Lawrimore, Matt Menne, Bryant Korzeniewski, and Eric Freeman (USA))

SUMMARY AND PURPOSE OF DOCUMENT

The document provides information on the Status of the surface-based sub-system of the GOS in Region IV.

ACTION PROPOSED

The Meeting is invited to note the information contained in this document when discussing how it organises its work and formulates its recommendations.

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Appendices: A. Table A-1 – Major format, processing, and metadata improvements planned for ICOADS Release3.0

DISCUSSION

Background

The National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center (NCDC) serves as the GCOS Lead Center for Region IV and as the GSN and GUAN Archive and Analysis Center. Region IV stretches from the Canadian Arctic to the equator. It includes three large countries; USA, Canada and Mexico which contain more than 75% of the surface-based observing stations as well as many smaller countries and island nations that provide critical coverage for weather and climate observations throughout the region. The large number of small nations makes coordination and support an essential part of ensuring the health of the region's observing network.

This report contains a summary of the state of the surface-based global observing system for the RBCN and RBSN including the GSN and GUAN networks with a specific focus on those provided by Region IV members. Also included is a summary of global land and marine observations collected and maintained through the Global Historical Climatology Network (GHCN) and the International Comprehensive Ocean-Atmosphere Dataset (ICOADS) as part of NOAA/NCDC's Archive and Analysis Center responsibilities.

NCDC provides monthly updates of web accessible GSN and GUAN reports which provide information on the number of hourly, synoptic, and CLIMAT reports received at the Center for all WMO regions. The reports are available at ftp://ftp0.ncdc.noaa.gov/pub/data/gcos/. Representatives from other organizations are invited to review these reports and provide feedback on their usefulness and any recommendations for future changes. There are two basic types of reports; the first providing an annual total of the number of reports received by type and hour of the day and secondly files that provide month-year totals of the number of hourly and synoptic reports received and information on CLIMAT receipt.

Performance of the RBSN Surface station network in Region IV

There are 635 Region IV surface stations in the RBSN inventory for 2014. Canada and the U.S. comprise almost 75% of the network each having 272 and 199 stations, respectively. Although data collection efforts strive for a data receipt rate of 100%, operational and equipment issues often result in collections below that target. In this report a threshold of 500 hourly observations in nine of 12 months is used to assess the performance of each surface station. Over the past decade there has been great improvement in the amount of data transmitted and received. As shown in Figure 1 the percent of Region IV stations meeting this threshold increased from less than 40% to approximately 70% in recent years. Areas of Region IV with the best performance include the U.S. and large parts of Canada.

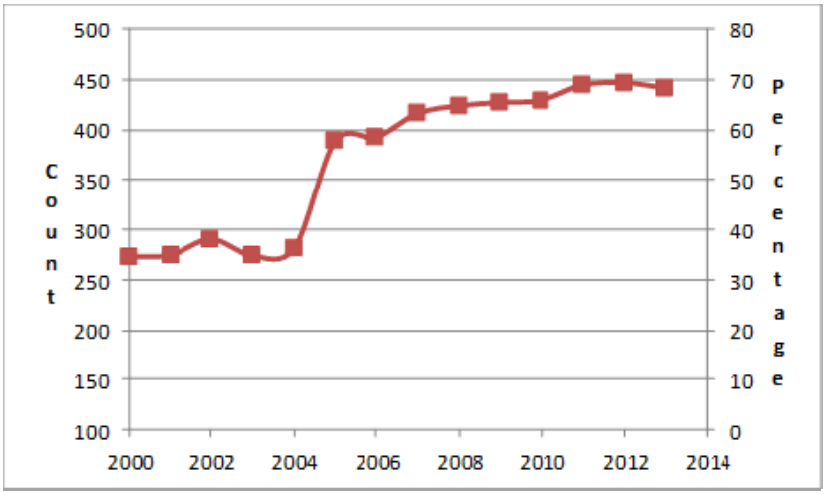

Figure 1. Region IV RBSN Stations reporting hourly observations (at least 500 hourly observations in nine of 12 months each year) from 2000 through 2013. The left axis shows the number of stations. The right axis shows the stations as a percentage of the network inventory (based on the number of stations in the January 2014 inventory).

Performance of the RBCN CLIMAT and GSN networks in Region IV

There are 337 CLIMAT stations in the 2014 RBCN inventory for Region IV. As with the RBSN surface network, Canada and the U.S. have the greatest number of stations; 134 and 105 stations, respectively. The subset of GSN stations consists of 177 stations in the region. A large improvement in the percentage of RBCN and GSN stations providing CLIMAT observations in at least nine months each year is shown in Figure 2. The GSN network increased to more than 95% while the larger set of RBCN stations increased to approximately 80% in recent years. Figure 3 shows RBCN stations providing at least nine CLIMAT reports in 2013 and those that did not meet that threshold. The same is shown for GSN stations in Figure 4. No GSN stations were silent in 2013, but system outages resulted in some stations providing less than complete annual coverage, most notably in remote areas for which unscheduled maintenance cannot be readily performed. The greater than 95% coverage of stations with good reporting practices in the GSN network indicates the benefit that careful monitoring and attention to the performance of a subset of stations can provide to improving data collection.

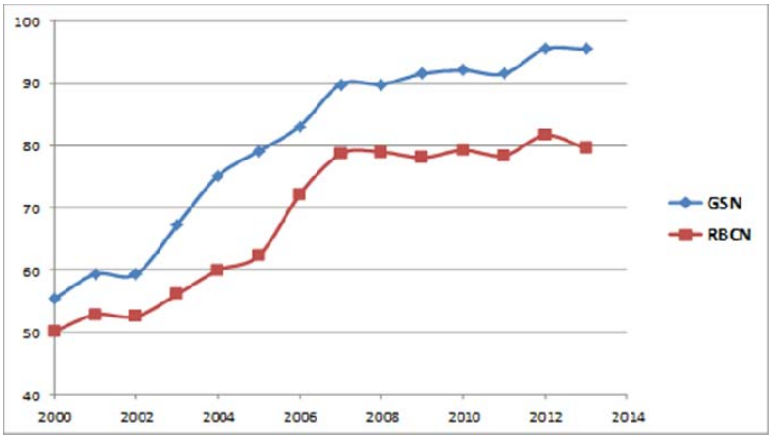

Figure 2. Percentage of Region IV RBCN stations providing CLIMAT reports (red line) and the subset of GSN stations (blue line) providing CLIMAT reports in at least nine months each year from 2000 through 2013.

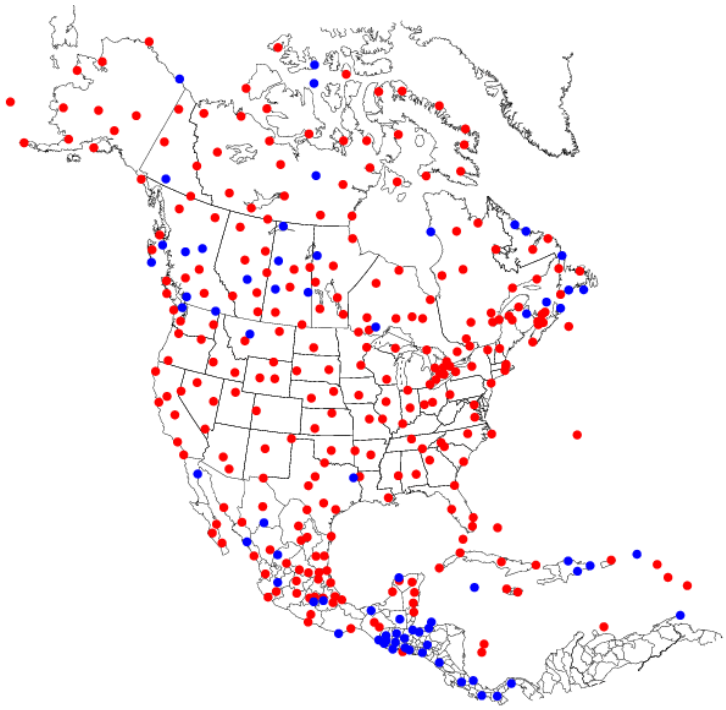

Figure 3. The 337 Region IV stations in the RBCN network with nine or more (red) and fewer than nine (blue) CLIMAT reports in 2013.

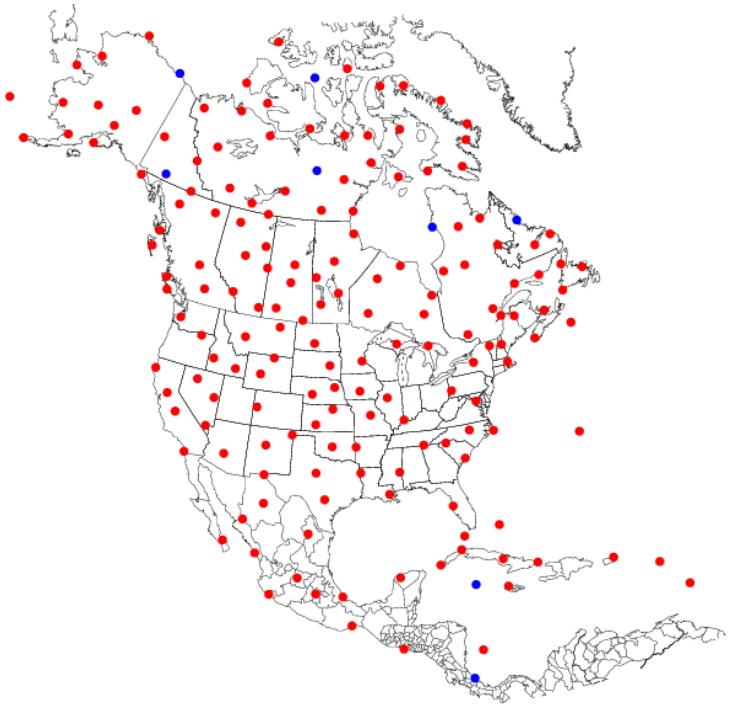

Figure 4. The 177 Region IV stations in the GSN network with nine or more (red) and fewer than nine (blue) CLIMAT reports in 2013.

Global Collections of Summary of the Month data

NCDC collects CLIMAT observations from all WMO regions and uses these as the foundation for US and global climate monitoring activities. They are integrated into the Global Historical Climatology Network-Monthly (GHCN-M) dataset which supports ongoing reports on the state of the Earth's climate. CLIMAT data also are included in the publication Monthly Climatic Data for the World (MCDW).

Typically more than 2300 CLIMAT messages are received at NCDC via GTS transmission within the first two to three weeks of each month. Approximately 400 of these stations are not classified as CLIMAT stations in WMO Publication 9, Volume A (Figure 5, blue dots). NCDC also receives from 100 to 200 E-mail or parcel post reports of CLIMAT summaries and corrections each month. These supplement or correct those reports received via the GTS. It takes several months before NCDC's monitoring reports reflect the mailed messages. Many of these are provided by sources in the Eastern Europe, the Caribbean, Chile, and other scattered areas around the world.

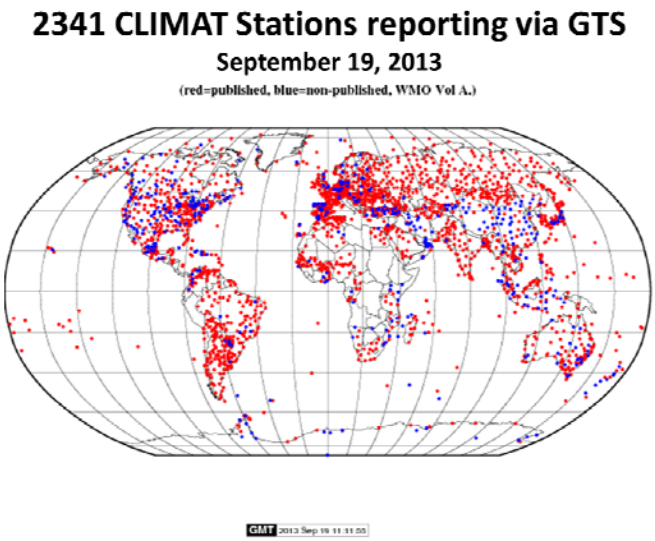

Figure 5. CLIMAT messages received via GTS in September 2013 at the GCOS Archive Centre. Those published in the Monthly Climatic Data for the World are shown in red. Unpublished are shown in blue.

Global collection of Summary of the Day Observations (GHCN-Daily)

NOAA/NCDC's Global Historical Climatology Network (GHCN)-Daily dataset serves as the GSN archive. Approximately 850 out of the 1019 GSN stations have daily data of some kind in the GHCN-Daily data set. Daily data have officially been provided for 556 of these sites as part of GCOS or other bilateral data exchange agreements. However, only a small number of the GSN sites are updated regularly through arrangements made by the GCOS Lead Centers (Iran, Estonia, Uzbekistan, Estonia, Cyprus) while other NMHSs provide occasional updates via email. Notably, a growing number of stations are updated through bilateral arrangements between the Lead Center at NCDC (e.g., USA, Australia, Canada, Russia) and regional data collection and integration efforts like the European Climate Assessment and Dataset (ECA&D). Figure 6 provides a map view of the areas covered by these arrangements

It is hoped that further development and exploitation of web services for climate data, bilateral agreements for data sharing as well as surface data collection efforts under the auspices of the International Surface Temperature Initiative (as discussed below) will increase the daily periods of record for surface stations and the number of station records that can be routinely updated. GHCN-Daily will continue to incorporate new sources of daily data as opportunities arise. For many stations outside of the USA, Canada and Australia, updates from the previous month are provided by daily summaries from synoptic reports, which are then overwritten with time-delayed sources where possible.

Figures 7 depicts the length of daily data records in the GHCN-Daily database as of March 2014 for maximum/minimum temperature. Note that some stations represent newly established locations whereas the number of stations with reasonably long periods of records available in GHCN-Daily is much larger than the GSN subset. The earliest observation in GHCN-Daily is currently from January 1, 1763 (Milan, Italy).

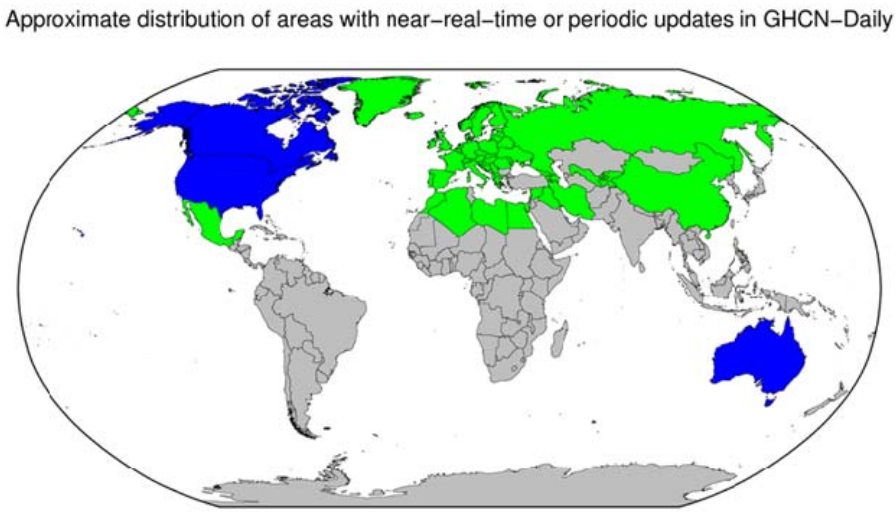

Figure 6. Regions (approximate) that have an arrangement with the Archive Centre at NOAA/NCDC to provide near real-time or routine updates to the GSN database or that can be updated through web services. Canada, USA, and Australia (blue) have provided complete copies of their daily climate databases for inclusion in GHCN Daily and updates for last month are generally available by the 15th of the current month.

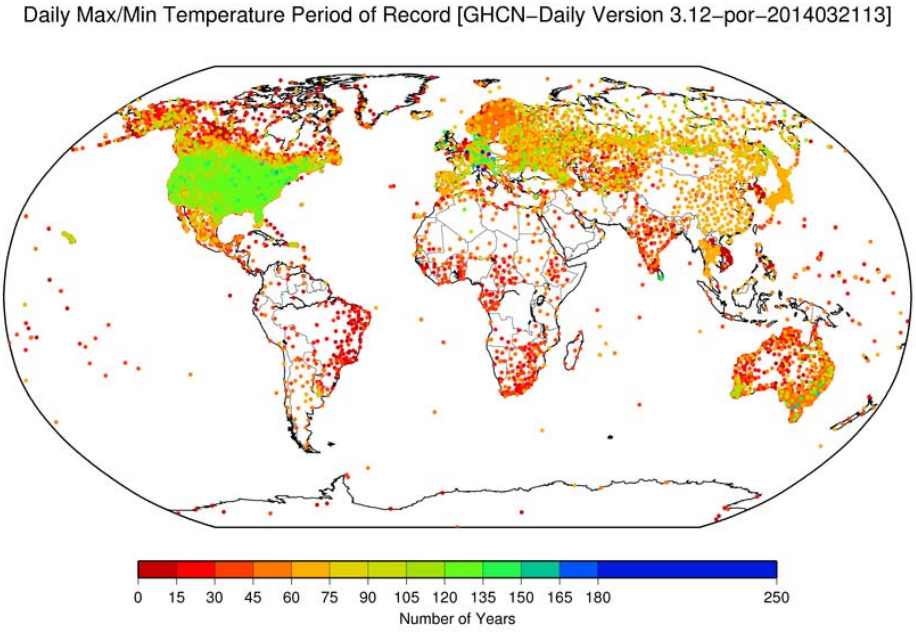

Figure 7. Period of record for daily maximum and minimum temperature data in the GHCN-Daily database as of March 2014.

International Surface Temperature Initiative's Global Databank

To further improve global surface temperature collections while enhancing data management, access, and public transparency with which data are collected, processed, and converted into climate information, the International Surface Temperature Initiative (ISTI; http://www.surfacetemperatures.org/) was initiated in 2010 as a collaborative effort involving countries from each WMO region [Thorne et al., 2011]. One of the major goals of this effort is the development of a global databank of surface temperature data. An improvement over previous data holdings is greater spatial coverage of temperature observations from the 1800's to the present. Together with other initiatives the databank has benefited from a renewed focus on rescuing, collecting, and integrating data from original forms to create the most complete data collection possible. Data provenance also has been improved, which is necessary for more fully characterizing uncertainties inherent in the climate record.

The ISTI's Databank Working Group is working toward the release of version 1 of a new monthly dataset that brings together new and existing sources of surface air temperature. The databank consists of monthly mean temperature data for more than 32,000 stations from 49 sources (Figure 8). NCDC's GHCN-Daily dataset provides more than 27,000 of the temperature stations. Data from other sources are used to extend the record further back in time and to fill gaps in spatial coverage that are not possible from sources of summary of the day observations alone.

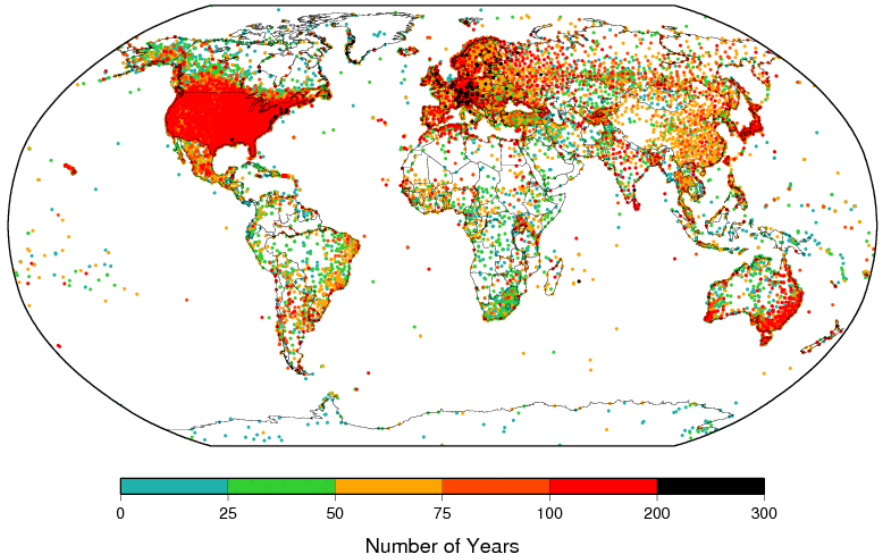

Figure 8. Location of the 32,219 stations in the ISTI Databank Merged (Stage 3) dataset (beta release 4). The colors indicate the length of record.

Figure 9 shows the global percent land coverage based on stations from the GHCN-Daily dataset alone and when combined with all other sources in the Databank. While the GHCN-Daily dataset provides extensive coverage, the additional data from other sources help maximize global land coverage. The percent land coverage peaks at 85% from all sources and 71% from the stations in GHCN-Daily alone.

Three stages of the databank are available online as beta releases at ftp://ftp.ncdc.noaa.gov/pub/data/globaldatabank/monthly/. The keyed observations provided by

the data originator are available in native format as Stage1. Stage 2 contains data converted to a common format with data provenance flags added. These flags provide information on the history of each observation, such as the data source, location of original data archive, method and source of digitization, and mode of transmission. Data from all sources are merged in Stage 3. This process involves identifying and removing duplicate stations, merging some sources to produce a more complete station record, and in some cases, for determining when a new station should be added.

The Stage 3 data are updated each month from sources including CLIMAT reports collected over the GTS, the GHCN-Daily dataset which is itself updated based on a variety of data exchange agreements, and other sources such as the European Climate Assessment and Dataset. The Stage 3 data provides an integrated source of data from which any organization can produce a quality controlled and homogeneity corrected dataset.

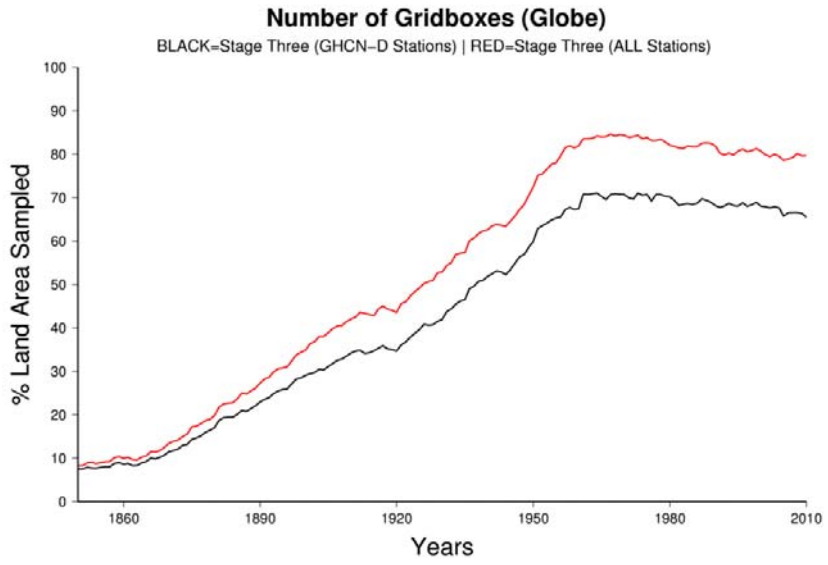

Figure 9. Percent land area covered by the stations in the ISTI Databank merged dataset (based on station averaging within 5° X 5° grids) from the GHCN-Daily source (black) and from all sources (red).

Marine Observations

Ongoing collection of marine data is combined with historical observations through the International Comprehensive Ocean-Atmosphere Data Set (ICOADS; http://icoads.noaa.gov). This international resource provides 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.

Data begin as early as 1662 and are updated with data from the GTS. The next full period of record update to ICOADS is planned for completion in 2015 as Release 3.0. This will incorporate a wide range of new or improved data (and metadata) for many historical sources (Figure 10); implement a variety of important format and processing improvements (Table A-1) linked with the ICOADS Value-Added Database (IVAD) project (http://icoads.noaa.gov/ivad/);

and foster closer integration with the oceanographic community, including through extension of ICOADS observations for the first time to include near-surface oceanographic variables (salinity, nutrients, and dissolved carbonate chemistry, etc.).

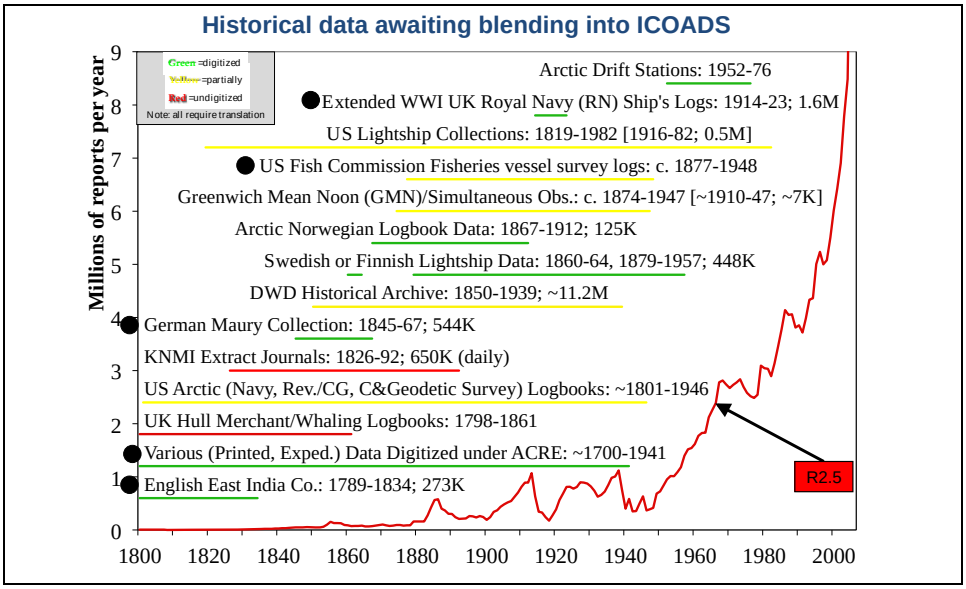

Figure 10. The time periods of selected candidate historical data sources to be blended into ICOADS are spanned by horizontal colored lines: green candidates are fully digitized but require format translation, yellow are partially digitized, and red are in the planning stages for digitization. Each dataset name is appended with the date range and approximate number of reports if known. The solid red curve is the number of reports (millions per year) in the current version of ICOADS (R2.5). Black dots mark sources definitely planned for inclusion (fully or partially) in the next release.

Major sources of surface marine data include ships, moored and drifting buoys, oceanographic profile instruments, and the Coastal-Marine Automated Network (C-MAN[1])—together with other less prominent sources such as oil rigs and platforms. Observations from manned ocean station vessels (OSV) ended almost entirely in the 1990s. As shown in Figure 11, the number of reports from ships has held fairly steady over the past several decades, but in recent years traditional manual observations from ships have increasingly been replaced by automated weather systems (AWS) reporting much more limited numbers of weather elements. Observations from buoys and C-MAN have increased, with the greatest increases in drifting buoys and C-MAN. The sharp increase in C-MAN observations in the mid-2000's is believed due to an increase in reporting frequency rather than a sharp increase in the number of stations.

A measure of the spatial coverage of major marine observing elements (Figure 12), shows a decrease in most elements since the 1980s. The reductions resulted largely from phasing out of manual ship reports that included elements such as winds, waves, and cloud cover, whereas both sea level pressure (SLP) and sea surface temperature (SST) are still reported in ship AWS reports, as well as from drifting buoys. Worrisome recent declines in both SLP and SST

[1] The NOAA National Data Buoy Center's C-MAN program consists of automated weather stations at a variety of coastal locations, e.g.: "on lighthouses, at capes and beaches, on near shore islands, and on offshore platforms" (ref. http://www.ndbc.noaa.gov/cman.php).

coverage arise partly from some deterioration in the global international drifting buoy network owing to budgetary issues.

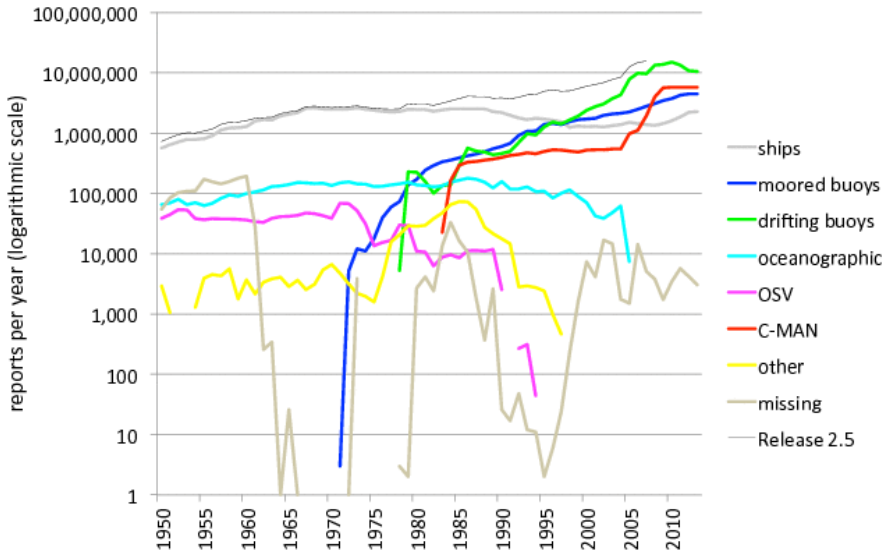

Figure 11. Annual distribution (1950-2013) of major platform types (and total) in Release 2.5, extended with "preliminary" near-real-time data for 2008-13, shown as reports per year (logarithmic scale). Ships (mainly VOS plus some R/Vs), buoys, and oceanographic are self explanatory, Ocean (permanent) Station Vessel = OSV, Coastal-Marine Automated Network = C-MAN, ocean drilling rigs/platforms and other small entities = other, and unidentified platform types = missing (note: most are probably early ship reports).

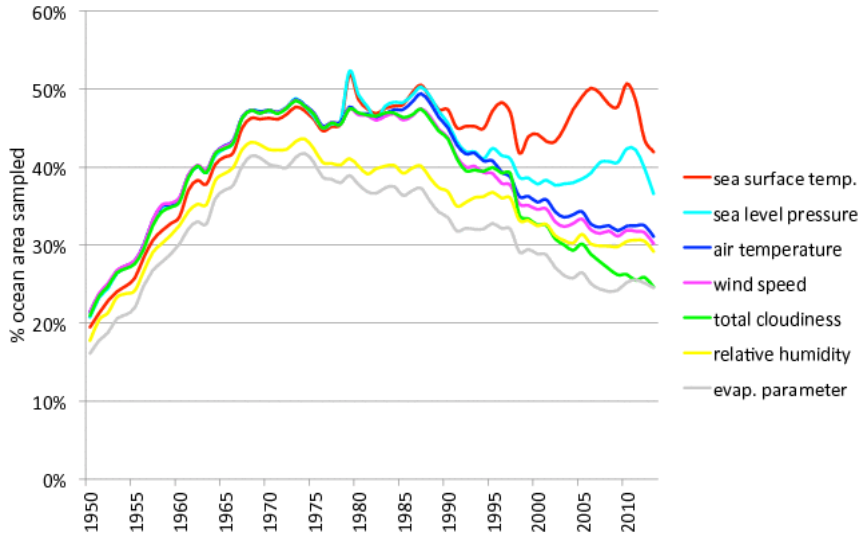

Figure 12. Percentage global ocean and coastal area (1950-2013) sampled in Release 2.5, extended with "preliminary" near-real-time data for 2008-13, based on area-weighted 2° boxes (smoothed) for sea surface temperature (S), requiring at least five observations per month in each box, and determined from the "enhanced" (4.5σ trimming) product that includes ship and buoy records. Other curves compare the S coverage, at five observations per month, with that for sea level pressure (P), air temperature (A), wind speed (W), total cloudiness (C), and relative humidity (R). Also plotted is the evaporation parameter (G), which is computed from S, P, A, W, and R, and thus illustrates the extent to which surface fluxes can be computed from the individual observations.

Upper Air Observations

Ongoing rehabilitation and system improvement efforts have led to increases in the collection and reporting of data from the GUAN network over the past three decades with steady to slightly increasing reporting during the past few years (Figure 13). For the globe as a whole, more than 160 GUAN stations were operating at some point in 2013, and approximately 90 met minimum performance requirements for all variables.

NCDC's Integrated Global Radiosonde Archive (IGRA) serves as the database for the GUAN. IGRA version 2 is in the latter stages of development at NCDC, and a beta release is planned for September 2014, about one year later than originally planned. The construction of IGRA-2 involves reconciling radiosonde records from 33 different sources representing approximately 20,000 "non unique" station records. In many cases, records for one location are available from multiple sources that sometimes contain data for overlapping periods of record and/or for complementary years.

IGRA version 2 will have between 43 and 44 million soundings. A few hundred thousand soundings from the ERA-CLIM historical upper-air data still need to be incorporated into the IGRA merge algorithm. The number of unique soundings in version 2 will be approximately one third larger than in IGRA version 1. As shown in Figure 14, most of the additional soundings in version 2 are for earlier years in the period of record.

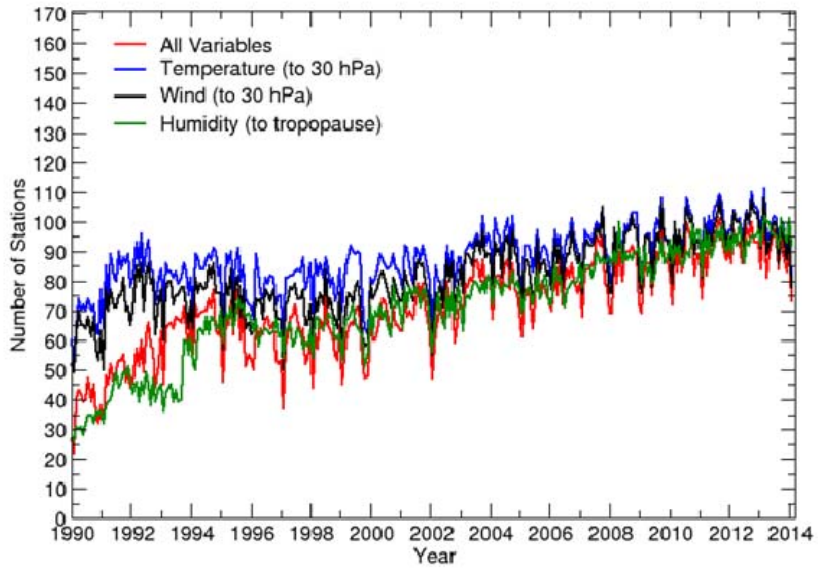

Figure 13. Time series of the number of GUAN stations meeting the minimum performance requirements. Perfect receipt = 171.

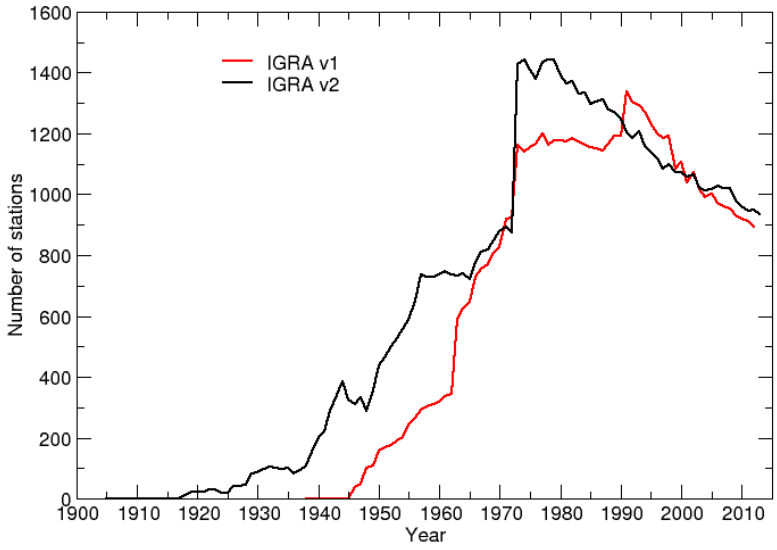

Figure 14. Estimated number of stations by year in IGRA v1 versus IGRA v2.

APPENDIX A

Table A-1. Major format, processing, and metadata improvements planned for ICOADS Release3.0.

Error corrections, including elimination of highly erroneous earlier 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 NCEP-NCDC GTS data (http://icoads.noaa.gov/merge.html). This problem degrades our ability to link the VOS reports with published metadata (WMO Pub. 47) and thus our ability to make adjustments to ship platform data and IVAD improvements
Blending (with assistance from UK National Oceanography Centre; NOC) of the VOS WMO Pub. 47 (Kent et al. 2007) platform/instrumental metadata (see Fig. 2)
Assignment of permanent Unique IDs (UIDs) to each individual marine report in ICOADS, which 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 more accurately measure the impact of this foundational dataset on scientific progress
QC improvements are of crucial importance because the existing climatological based “trimming” (QC) limits are missing over important data areas. Revamping these limits is planned by NOC, but we may carry the new flags alongside the old (or develop other mechanisms to facilitate validation and user assessment of the impacts of these far-reaching changes). Other elements of the ICOADS QC also are overdue for updating including the NCDC-QC flags (which still play an important role in the selection of the “best” duplicate report), and the potential for an expanded role for the IMMT QC flags