COADS Project Report:
Early Data Digitization and United States Code History

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Abstract

In an effort to better establish an historical metadata file for the COADS project, a complete set of U.S. instructions to the marine meteorological observer has been collected, for the period 1903 to the present. In addition, some instructions from the late 1800's were also found in the archives. This provides some interesting insights into the practices and procedures of observing, coding, and transmitting weather information during a given segment of time. It occasionally takes a combination of inspecting the original observation forms and published instructions to determine the conventional practices of the time. With regard to winds, a history of the U.S. observing and coding practices is discussed, as well as the digitizing of early marine observations from the Maury Collection, which were basically collected before the common usage of the Beaufort wind scale.

Introduction

The history of the Beaufort wind scale, its evolution, adaptations, and usage are very difficult to establish and verify, as with most historical events. Slightly different facts and slants are noted in the literature and it is certainly evident that every ship's crew using the Beaufort scale to estimate surface wind speeds, did not apply the scale in a consistent manner. Numerous accounts on the subject have been published. Some good references are Ramage (1982), Kinsman (1969), Cook (1989), Smith (1925), and Garbett (1926) which provide important historical, although somewhat differing, facts and insights. It is always difficult to ensure exact factual truths and, in our work to establish the COADS winds metadata file, this has proven to be especially true.

In beginning to digitize the U.S. Merchant Marine observations between 1912 and 1946, it was quickly realized that it was necessary to know what guidance (instructions) was I given to the observer at the time the observations were being recorded. It was critical to know what the coding and observing practices were and how they evolved over time. This information was needed so that proper digitizing procedures could be established and so that accurate documentation would be available for future users and for converting the digitized records correctly to a common format compatible with COADS. First

efforts were to collect only those editions of instruction to the marine meteorological observers of the U.S. Weather Bureau for the period 1912 through 1946 which covered the data periods being digitized at NCDC. An agreement was later reached with the Chinese National Oceanographic Data Center to digitize the Maury Collection, which consists basically of U.S. collected observations between 1820 and 1860, (the original Maury Collection is located at the National Archives, with a microfilm copy maintained at NCDC; it contains some observations from as early as 1792 and as late as 1900). This prompted us to locate as many earlier editions as possible, together with any additional publications or documentation that could provide guidance.

In an Earth System Monitor article (Elms et al., 1993) describing digitizing efforts in support of COADS including the project at NCDC for the 1912-1946 U.S. Merchant Marine observations, a table was developed based on the instructions issued from the late 1800s through 1949. This illustrated examples of changes in the codes and observing practices for the basic elements. The focus of this study is restricted to winds only, but with an expanded time horizon from the earliest available records of wind information to the present.

Important Dates

As mariners began to enter, in their ship's log, the strength and direction of the winds they encountered, they had to devise a somewhat uniform system for recording the information. As early as 1626, Captain John Smith published a list of names given to winds (Smith, 1925) which, somewhat surprisingly, are not very different from those used by Beaufort in 1806 when he first entered his scale into his ship's log. Lamb (1991) republished some wind terms which were first published by Defoe in 1704, and used by English sailors of the period; they too are similar to those later jotted down by Beaufort. In 1771 William Falconer published a glossary of technical sea terms which helped further standardize the reporting of customary terms. The East India Company, which had been sailing between England and India since 1599, appointed Alexander Dalrymple as hydrographer in 1779. Dalrymple had devised a 1-12 wind scale based on engineer John Smeaton's work with windmills. He entered this scale in an unpublished treatise entitled "Practical Navigation" and a synopsis of the wind scale also appears in some letterpress volumes now housed in the Library of Congress. Dalrymple later provided the information to Beaufort in 1805 (Cook, 1989).

In 1806, Beaufort first entered his adaptation of the Dalrymple wind scale (1-13) in his log, plus a notation for weather. As he advanced in the British Navy, he was able to bring the wind scale and weather notation into general use, and in 1838 the British Navy officially adopted the Beaufort wind scale (Garbett, 1926). The Beaufort scale was adopted for general use in the Merchant Marine by the Maritime Congress being held in London in 1874, with some modifications first recommended by the Maritime Congress held in 1872. In 1947, the International Meteorological Organization held a conference in Washington, D.C., and agreed to start reporting wind velocities in knots on January 1, 1949. However, the wind reports were still very closely linked to the Beaufort scale, as is still the case today for most estimated wind speeds. Increase in size and height of vessels over the past century may also have biased the estimated wind speeds.

Changes in U.S. Wind Codes and Observing Practices

In the Maury Collection prior to the mid-1870s, most of the wind reports (generally three per day-first, middle and latter) provide prevailing direction, often with a descriptive term, in the remarks section, similar to the terminology used in the Beaufort scale (e.g. brisk wind, fresh breeze, etc.). There is doubt as to what period of the day is referred to with "first", "middle", and "latter". Oliver and Kington (1970) and the minutes from the 1853 Brussels Conference (Maury, 1854) indicate that these terms represent the 8 hours prior to 4 a.m., noon, and 8 p.m. However, the U.S. "instructions to the observer" from 1876 indicate that they represent the prevailing conditions 8 hours before 8 a.m., 4 p.m. and midnight. Although Oliver et al. and Maury indicated the same eight hour periods of the day, it is not clear from existing documentation the order they were entered on the observing form. Oliver and Kington state that daily entries were made in the logbook for the previous 24 hours meaning the "first part" was the period 1200-2000 hours, the "middle part" 2000-0400 hours, and the "latter part" 0400-1200 hours, meaning all three entries were for periods prior to the time the ship's position was established for the date of the observation. In contrast Maury wrote in the minutes from the Brussels Conference that "The direction and force of the wind should be regularly entered at 4 A.M., noon, and 8 P.M. The force and direction entered should be that which has been most prevalent during the eight preceding hours". This would seem to indicate that the "first part" represented 2000 (previous day) - 0400 hours, the "middle part" 0400-1200 hours, and the "latter part" 1200-2000 hours. To add to the confusion some of the observational logbooks in the Maury Collection contained a note at the bottom that read "Enter the wind for the point of the compass from which it has MOST PREVAILED for the eight hours" and a few even noted "Whether the day commences at noon or midnight, always call from noon to 8 P.M. First Part". This matches the explanation provided by Oliver and Kington (1970). It cannot be established from the observational forms (logbooks) which country originated them and no documentation was located indicating individual country practices or how they evolved over time. It is probable all observers did not follow a common procedure in entering data, thus adding more uncertainty to the data collection.

Although the U.S. merchant marine vessels did not generally begin to report wind force using the Beaufort scale until after the mid- I 870s, it appears that U.S. Navy ships began doing so in the 1850s. If feasible and it can be proven to be scientifically sound, we propose to convert the descriptive terms found in the Maury reports to a Beaufort number, which can then be converted to a wind speed. In a majority of cases, the descriptive terms are exactly the same as, or very close to, the Beaufort descriptive terms. However, there are those terms such as "declining wind", "strong winds", "good wind", etc., which cannot be cross referenced and converted to a Beaufort number. It must be stressed that, before any conversions are performed, a significant amount of research must be conducted to ensure valid procedures are followed. Under all circumstances, we must ensure that the original entries are not lost.

It is uncertain at this point if the wind directions reported in the Maury Collection are magnetic or true. Again, much more work is required in this area to document the common practice during this era. From the minutes of the 1853 Maritime Conference held in Brussels (Maury, 1854), the following statements were included: "The direction of the wind is the magnetic direction, with due allowances for appearances caused by the

motion of the vessel. It is the direction of the wind which has prevailed for the last 8 hours. It should be expressed to the nearest point of the compass". They also agreed that "The force of the wind should be expressed in figures. The nomenclature of Admiral Beaufort was adopted". However, as noted in the above paragraph, the Merchant Marine reports in the Maury Collection did not conform to this recommendation until approximately the mid-1870s; therefore, we cannot assume that the reported wind directions were magnetic, although it is highly likely they were, because of the information needed to correct them to a true direction.

A lineage of instructions provided to the U.S. Marine observers from the mid-1800s until the present appears in Table 1 with details on when coding and observing practices changed with regards to wind direction and speed. Instructions published between the 1880s and 1910 included the Beaufort scale (0-12) with the description of the wind force as related to the use of sails. However, the wind scale noted in miles per hour was similar to the WMO Beaufort conversion to knots (adopted in 1947) up through force 4; somewhat lower between force 5 and 9; but much higher for force 10 and above (reference Fig. 1). From 1898 through 1924 the published speeds associated with the Beaufort scale were somewhat higher than what would later become known as the WMO convention of mean equivalent wind speeds (WMO,1970) for all Beaufort forces. However, the scale that was published between 1898 and 1924 for forces 10-12 was considerably lower than the instructions published in the 1880s. By 1910, those in the U.S. preparing the instructions for the observer realized they had a problem, as most of the ships were no longer sailing vessels. As a result, they simply dropped any reference to sails and only maintained the word description and equivalent velocities in both statute and nautical miles per hour.

In 1925, the U.S. issued another edition of instructions to the marine observers. In this issue, and the one to follow in 1929, the equivalent wind velocities were presented in meters per second and statute miles per hour. These equivalent wind speeds were those used by the British since 1906 and which were later adopted by the IMO in 1947. To aid the observer in estimating the winds, new descriptive terms were added, one specifically for use on land and a second which was again based on a mode of estimating the wind speed aboard a sailing vessel. By 1938 a different approach was instituted. They again dropped the equivalent wind speed and added descriptive terms based on the state of the sea, but with a few caveats. The descriptions only went through force 5, as they theorized that sea heights generated above force 5 were generally near storm centers where rapid changes of duration and velocity would not permit the sea to reach a state of equilibrium with respect to the wind. The instructions also indicated that, to use this method, the ship had to be in the open sea and the sea surface had to be in a state of equilibrium (no appreciable current, and the wind direction and speed had to remain essentially constant for a sufficient length of time).

Based on the International Meteorological Code adopted by the IMO, Washington, D.C., in 1947, wind directions were to be reported in tens of degrees and speeds in knots. However, the new instructions provided a description of the sea state for each Beaufort number (0-12) and a coded value in knots corresponding to each Beaufort number. This coded value is the one used to convert all Beaufort Force winds in COADS, except for two relatively small data sources which were converted using a slightly different conversion. This conversion only differed by 1 or 2 knots, in 7 Beaufort categories, from the 1947 IMO convention.

With regard to the Beaufort force, the U.S. continued to provide the same instructions from 1949 through 1981, with the exception of 1949 when they published a code value in knots. Pictures of the state of the sea were then published in 1982 for Beaufort forces 3-12 as guidance. Forces 0-2 only carried a description. However, with each photograph a wind speed, rounded to the nearest 5 knots, was inserted into the lower section of the photograph except for force 5 which displayed two photographs, one at 18 knots and a second at 20 knots. In 1992, the Instructions were again revised and color photographs of the state of the sea were published for each Beaufort force (0-12) with only the wind speed range inserted below each photograph.

Summary

Many of the observing practices and changes to those practices have introduced numerous biases to the data. By identifying where these have been introduced, through researching the historical documentation and analyzing the digitized data, it is believed that many of these biases can be identified and adjusted sufficiently to where the wind record contained within COADS will prove most beneficial to ocean research, especially climate and global change studies. We have just begun to identify the U.S. coding and observing practices with this study, yet much more effort is needed to investigate those of all maritime nations.

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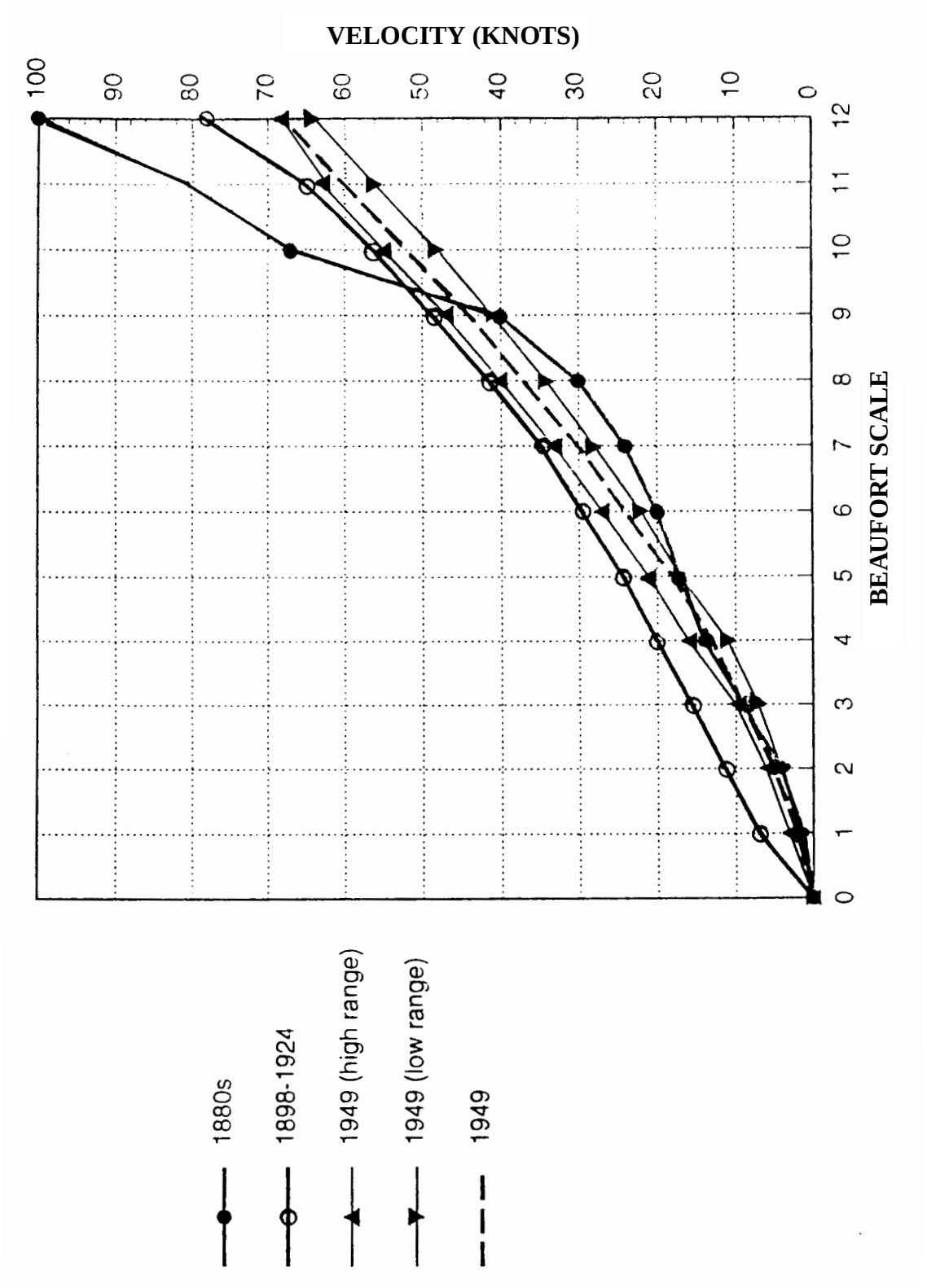
Table 1:

EXAMPLES OF CHANGES IN U.S. CODES AND OBSERVING PRACTICES

Instructions Edition	Edition Year	Wind Speed	Wind Direction
Instruction attached to form	pre-1870's	Descriptive Terms	32 point scale, Magnetic or True?
	1880's	Beaufort Force	32 point scale, mean magnetic direction
	1898		32 point scale, true direction
H.O. Pub 119	1903		
Circular M			
1st Edition	1906		
2nd	1908		
3rd	1910		
4th	1925	Added new descriptions	
5th	1929		
6th	1938	Word descriptions Force 0-5	DD+33=gustiness, DD+67=squalls
7th	1941		
Provisional	1949	Knots	36 Point scale
8th	1950		
9th	1954		
10th	1959		
11th	1963		
12th	1964		
NWS Observing Handbook #1			
1st Edition	1969		
	1971		
	1974, rev		
	Jan, '82	Sea state photos, Force 3-12	
	Jul, '91	Color photos, Force 1-12	
	Nov, '94 (code change)		

Figure 1:


VELOCITY (KNOTS)
100
90
80
70
60
50
40
30
20
10
0
0 1 2 3 4 5 6 7 8 9 10 11 12
BEAUFORT SCALE
1880s
1898-1924
1949 (high range)
1949 (low range)
1949