Workshop on Advances in the Use of Historical Marine Climate Data

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A Workshop on Advances in the Use of Historical Marine Climate Data was held at the NOAA Climate Diagnostics Center, Boulder, Colorado, USA on 29th January - 1st February 2002. The workshop was organized by NOAA, the Met Office, and Japan Meteorological Agency (JMA), and was sponsored by the Global Climate Observing System (GCOS) and the World Meteorological Organization (WMO). The 39 participants were from Canada, Germany, Japan, Poland, Russia, UK, USA and WMO. The new Joint WMO/Intergovernmental Oceanographic Commission (IOC) Technical Commission for Oceanography and Marine Meteorology (JCOMM) was represented through its Expert Team Chairpersons on Marine Climatology, Sea Ice, and Wind Waves and Storm Surges.

Scope

The overall scope of the workshop was to build on the recent blend of the US Comprehensive Ocean-Atmosphere Data Set (COADS) with the Met Office Marine Data Bank (MDB) and several million newly digitized data from the Japanese Kobe Collection, the US Maury Collection and from other international partners. This blend, encompassing 1784-1997, provides the climate research community with an unprecedented assembly of *in situ* marine data. There have been dramatic improvements in data availability for the mid 19th Century, and substantial improvements thereafter up to the mid 20th Century (e.g. Figure 1). The new observational archive has been named the International Comprehensive Ocean-Atmosphere Data Set (I-COADS). A key focus was on the work of the Sea Surface Temperature and Sea-Ice Working Group (SST/SI WG) of the GCOS/World Climate Research Program (WCRP) Atmospheric Observation and Ocean Observations Panels for Climate (AOPC/OOPC). Other crucial climate variables considered were marine air temperature (MAT), mean sea level pressure (MSLP) and surface wind.

Proceedings

The Workshop began with over 2 days' presentations to plenary sessions on historical marine data sets, SST and sea ice, marine air temperature, MSLP and wind, and recommendations from the second CLIVAR Climate of the Twentieth Century (C20C) workshop (see below). Full details, including abstracts of presentations, are at http://www.cdc.noaa.gov/coads. The Workshop then split into three breakout groups covering 1) SST, air temperature and sea-ice; 2) MSLP and wind; and 3) technical requirements, respectively. These groups made recommendations which are summarised below. General background to the recommendations includes the need to reduce the remaining biases in the data; to increase, where possible, coverage and temporal resolution; to specify uncertainty in analyses; to clearly distinguish versions of datasets; and to promote easy access to all data. The Workshop agreed on a staged timetable for implementation. Firstly, a 2-year period would lead to the third C20C Workshop around April 2004; and secondly, a period of about 5 years will lead to the

Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC).

Recommendations

1. SST, air temperature and sea-ice (Chair: C K Folland; Rapporteur: R W Reynolds)

Within 2 years:

1.1. We need to re-examine the historic bias corrections to SST, especially for the late 1930s through the end of the 1940s. This is necessary because of the new mix of data that results from the blend. The present step change in the bias corrections at the end of 1941 may over-emphasize the 1941 El Niño; there is evidence that a less sudden change may be needed in the Southern Hemisphere for instance. We need more information on the history of the decrease in the use of buckets and on the countries of origin of the data. Further analysis of apparent changes in the annual cycles of SST will also help to specify the types of *in situ* measurement (uninsulated bucket, engine intake, etc.) and their biases.

1.2. All the ship metadata in the issues of WMO No. 47 (International List of Selected, Supplementary and Auxiliary Ships) should be digitized and made available, biases in recent night marine air temperature (NMAT) data should be evaluated, and the NMAT interpolation techniques used by the Met Office should be re-assessed. The Met Office definition of "night" (sunset + 1 hour to sunrise + 1 hour) is likely to be adopted because it minimizes the impacts of solar heating of ships' decks.

1.3. Geostationary satellite and moored buoy data should be used to analyse the diurnal cycle of SST, particularly in the tropical west Pacific warm pool, as this may systematically affect convection in climate models forced with observed SST. It is recommended that the Voluntary Observing Ship Climate (VOSClim) Project be extended, or a parallel project be initiated, to include buoys. In climate change studies it should be recognised that the “ideal” SST measurement is a daily average over the top metre of the ocean measured by a calibrated hull contact sensor. Owing to abundance of data, a good climate reference period is 1971-2000.

1.4. Regular comparisons of the quality control (QC) procedures for SST at the Met Office, JMA, NOAA and elsewhere should be commenced. For these, common *in situ* input data should be used.

1.5. NOAA Pathfinder satellite SSTs for inland seas and large lakes should be collated.

1.6 Sub-monthly analyses of SST since 1950 should be developed.

1.7 The JCOMM Expert Team on Sea Ice (ETSI) should provide recommendations on the blending of sea-ice data and on the interpretation of microwave observations of sea-ice. Techniques reported by ETSI may be used to assess, retrospectively, the stages of melting of sea ice in relation to visible and microwave observations. This will provide much-needed information on variations in sea ice thickness.

1.8. It is desirable that the ETSI should provide an inventory of historical sea ice data for the Southern Ocean.

1.9. The use of satellite SSTs to develop statistical relationships between SST and sea ice concentration should be re-assessed owing to possible contamination of these SSTs by the sea-ice. The effectiveness of linear versus nonlinear relationships should be compared. The improved sea-ice data and any refined relationships should be incorporated into new and operational SST analyses.

Within 5 years:

1.10. Cloud-clearing techniques for satellite-based infrared SSTs should be compared, under the aegis of GCOS.

1.11. Regular comparisons of the SST analyses of the Met Office, JMA and NOAA should commence.

1.12. All SST analyses need to include gridded fields of analysis error including bias correction error. Error covariances are also needed.

1.13. Monthly and sub-monthly blended SST/sea-ice products should be created using the Russian Global Digital Sea Ice Data Bank (GDSIDB) which holds digital historical ice concentration and age charts for the Arctic back to 1950 and Antarctic back to 1973. Estimates of errors, and indications of sources of data, should be included in the product.

2. Mean sea level pressure and wind (Chair: D E Parker; Rapporteur: V R Swail)

Well within the 2-year timeframe, and ideally by early 2003:

2.1. The Hadley Centre global monthly MSLP data set HadSLP should be completed for 1871 to date, and kept up to date in quasi-real time.

2.2. The Terms of Reference of the AOPC/OOPC MSLP Working Group should be expanded to include the homogenisation and analysis of surface winds, especially over the oceans, and their consistency with surface pressure.

2.3. A catalogue of available wind and pressure products should be developed and maintained.

Within 2 years:

2.4. Florida State University will have a non-global (Pacific & Indian Oceans) data set of surface wind and MSLP, fluxes, and related variables from 1950 onwards.

2.5. Appropriate techniques for the adjustment of both estimated and measured wind speed observations should be investigated and applied, using WMO No. 47 and the planned JCOMM buoy metadata base (Ocean Data Acquisition System (ODAS) metadata) for the measured winds. The improved winds should be made available to future reanalysis projects.

2.6. Monthly wind statistics for 1854 to date should be computed using the adjusted estimated and measured winds, and compared with existing summaries. Comparisons should include wind derivatives (curl and divergence), which are important for forcing ocean models.

2.7. The Meteorological Service of Canada has created a high-resolution analysis of winds over the North Atlantic for 1958-1997 by semi-manual re-assimilation of bias-adjusted observed winds into background fields based on the National Centers for Environmental Prediction (NCEP) / National Center for Atmospheric Research (NCAR) Reanalysis. The use of historical daily MSLP fields to backdate this analysis should be investigated.

2.8. Biases from the US Maury Collection pressure data set should be investigated.

2.9. More observations on pressure are needed to improve historical MSLP analyses. Therefore, a priority is to get new marine data sources digitized and incorporated into analyses; this activity will carry on into the 5-year time frame.

2.10. The new JCOMM ODAS metadata base should be populated with current and historical data. The merged COADS and WMO No. 47 data base for 1980-97, developed by E Kent (Southampton Oceanography Centre), should be made available at least on a limited, experimental basis.

In the 5-year timeframe:

2.11. Improved monthly (and daily if possible) surface pressure for land stations should be made available for blended land-marine analysis.

2.12. Improved Reanalysis techniques, currently being developed, should be used to produce a combined daily MSLP and surface wind product for as much of the world as possible back to the late 19th Century. This would be very useful for study of extreme winds and waves at sea, including tropical and extratropical cyclones. These extremes are crucial for coasts and oil platforms as well as shipping. However, because of an absence of observations, there are parts of the world where analysis is impossible, and this must be clearly set out.

2.13. For all gridded data sets, error estimates of wind and pressures should include grid box uncertainties and error covariance structures.

3. Technical Requirements (Chair and Rapporteur: S J Worley)

For continual action, without a specific timeframe:

3.1. Data that add the most information to the existing database should be given a priority for digitisation. For example, data are sparse prior to 1960, in high southern latitudes, inland seas and lakes, and from the two world war periods. The data for 1750-1850 (largely pre-instrumental) from the European Climate of the World Ocean (CLIWOC) project would be of value. Rescue of data from all ageing media is vital to prevent permanent loss of important archives. JCOMM Expert Teams / WMO committees should enhance the search effort by promoting worldwide surveys.

3.2. The research community should have access to preliminary or interim data. Version and product identification should clearly distinguish final from interim products such as real-time ship and buoy data from the Global Telecommunication System (GTS), delayed-mode data from the Global Collection Centers, and newly digitised or rescued digital data. Clear documentation must be posted to advise users of potential duplication and lack of QC in the interim products.

3.3. A new, fully documented format should be used for interim and newly-digitised data, to facilitate data exchanges and hasten the update cycle for the final database. Software support in the form of example codes and "frequently asked questions" should be made readily available.

3.4. Global blended land and ocean surface data sets, such as those used by IPCC, should NOT come under the aegis of technical tasks related to marine surface database development. Such analyses should be left to appropriate experts.

3.5. There should be continued development and application of new QC techniques and utilization of metadata. Time-varying statistical QC is required to improve the observational archive. Cross comparison of observations with advanced analyses could further enhance the detection of outlier data. Detailed metadata regarding instrument types and positions on ships and buoys are essential. Further requirements include descriptions of shipping fleets, observational procedures and methods, and coding schemes.

3.6. We recommend continued wide distribution of all data in appropriate formats, and encourage sharing of software to access and analyse the data. We recommend that data should be available freely, e.g. over the Internet, or at a minimum cost for media.

Within 2 years:

3.7. The real-time data collection centres should keep original copies of the GTS data stream. A comparison of GTS receipts at these collection centers should be made to assure archive integrity.

3.8. Modern high quality data, at a higher observational frequency than standard synoptic periods, should be incorporated in the international surface marine database.

3.9. There should be at least one mirror data site for the new I-COADS database, to safeguard against accidental loss. The mirror should be located so as to facilitate easy distribution worldwide.

Conclusion

The Workshop achieved its goals by:

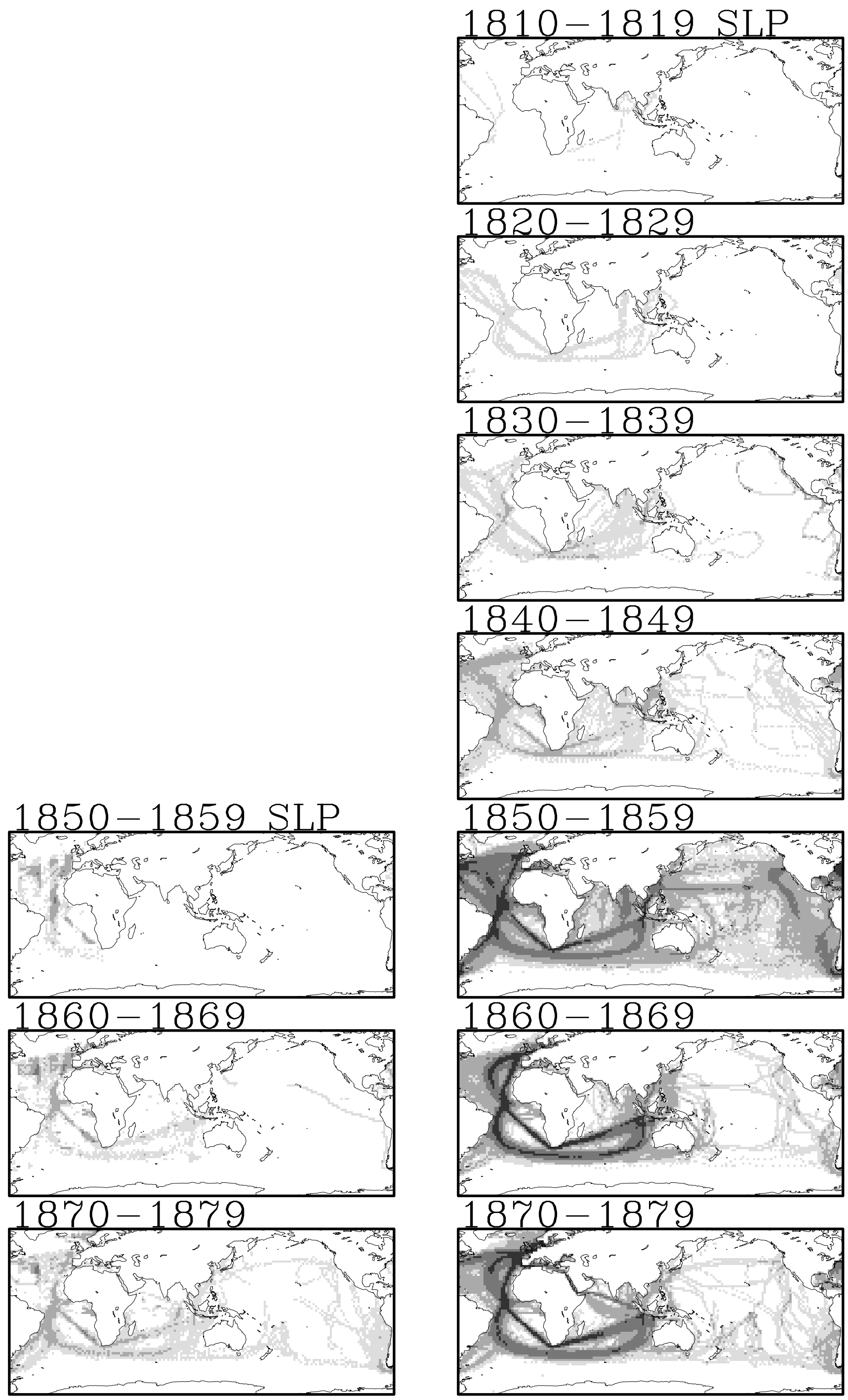
- Creating a timetable for further enhancement of *in situ* marine datasets, taking account of plans for digitization of additional data.
- Developing a strategy for creating and comparing alternative SST, sea-ice concentration and marine air temperature analyses, including satellite data, to provide estimates of uncertainty in analyses and key diagnostics of climate variability and change, and to allow assessment of the effects on Atmospheric General Circulation Models (AGCMs) of legitimate uncertainties in the analyses.
- Taking account of recommendations made by the second Workshop of the CLIVAR C20C Project (held at the Center for Ocean-Land-Atmosphere Studies (COLA), Univ. Maryland, 22nd - 25th January 2002). These included acquiring current and historical SST data for inland seas; archiving quality-controlled SSTs and their uncertainties for assimilation into coupled GCMs; assembly of tropical skin SSTs to test model sensitivity to their use and to the diurnal cycle; provision of analyses with estimates of error associated with each grid-box, including uncertainties in the bias-corrections to SST; testing the sensitivity to alternative SSTs by using different analyses or by perturbing the analyses using their error estimates; creation of sub-monthly historical SST analyses from 1950; acquisition of sea-ice thickness information to improve heat fluxes; incorporation of historical Russian sea-ice data.
- Proposing the further development of analyses of marine surface pressure and winds, with support from the new AOPC/OOPC MSLP Working Group.

In its final plenary session the Workshop voted in support of the name **International Comprehensive Ocean-Atmosphere Data Set (I-COADS)** for the new blended observational database. The name was subsequently agreed with the Director of the NOAA National Climatic Data Center. This name recognises the multinational input to the database while maintaining continuity of identity with COADS, which has been widely used and referenced throughout the meteorological, climatic and oceanographic communities. Finally, the Workshop thanked Dr. Joseph O. Fletcher (Fig 2), who inspired the original COADS project in the 1980s, but who was unable to attend on this occasion. Several speakers acknowledged his major contributions, and participants signed a certificate in his honour.

The Workshop was an appropriate lead-in to the conferences planned by JCOMM for September 2003 in Brussels, to commemorate the 150th anniversary of the conference convened in Brussels in 1853 by U.S. Navy Lt. Matthew Fontaine Maury (Fig. 2) to establish, *inter alia*, the standardization of meteorological and oceanographic observations from ships at sea. Maury's work (see e.g. Lewis, 1996) remains the foundation of much of operational and research maritime meteorology and oceanography.

References

Lewis, J. M., 1996: Winds over the World Sea: Maury and Köppen. *Bull Amer. Meteorol. Soc.*, 77, 935-952.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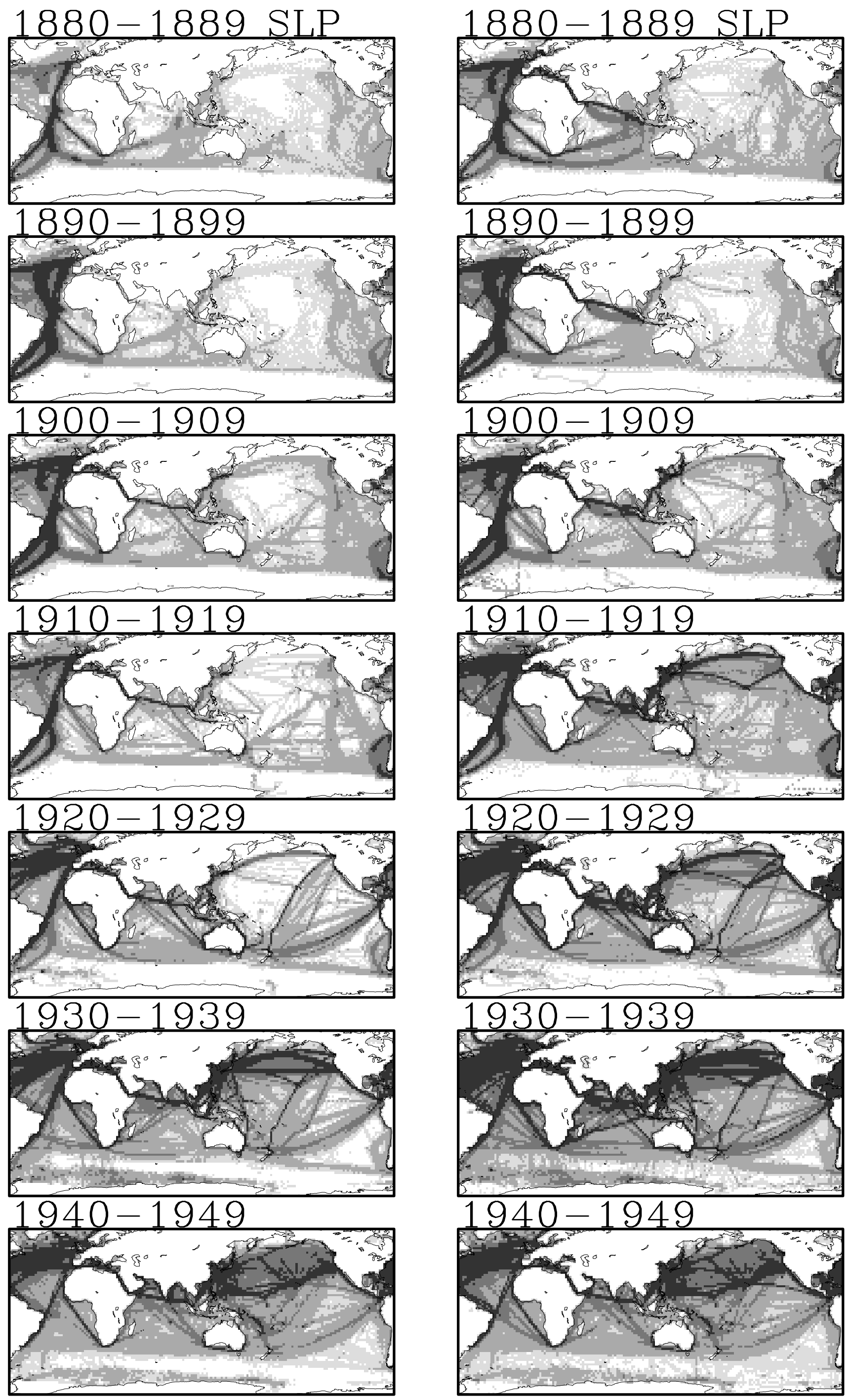
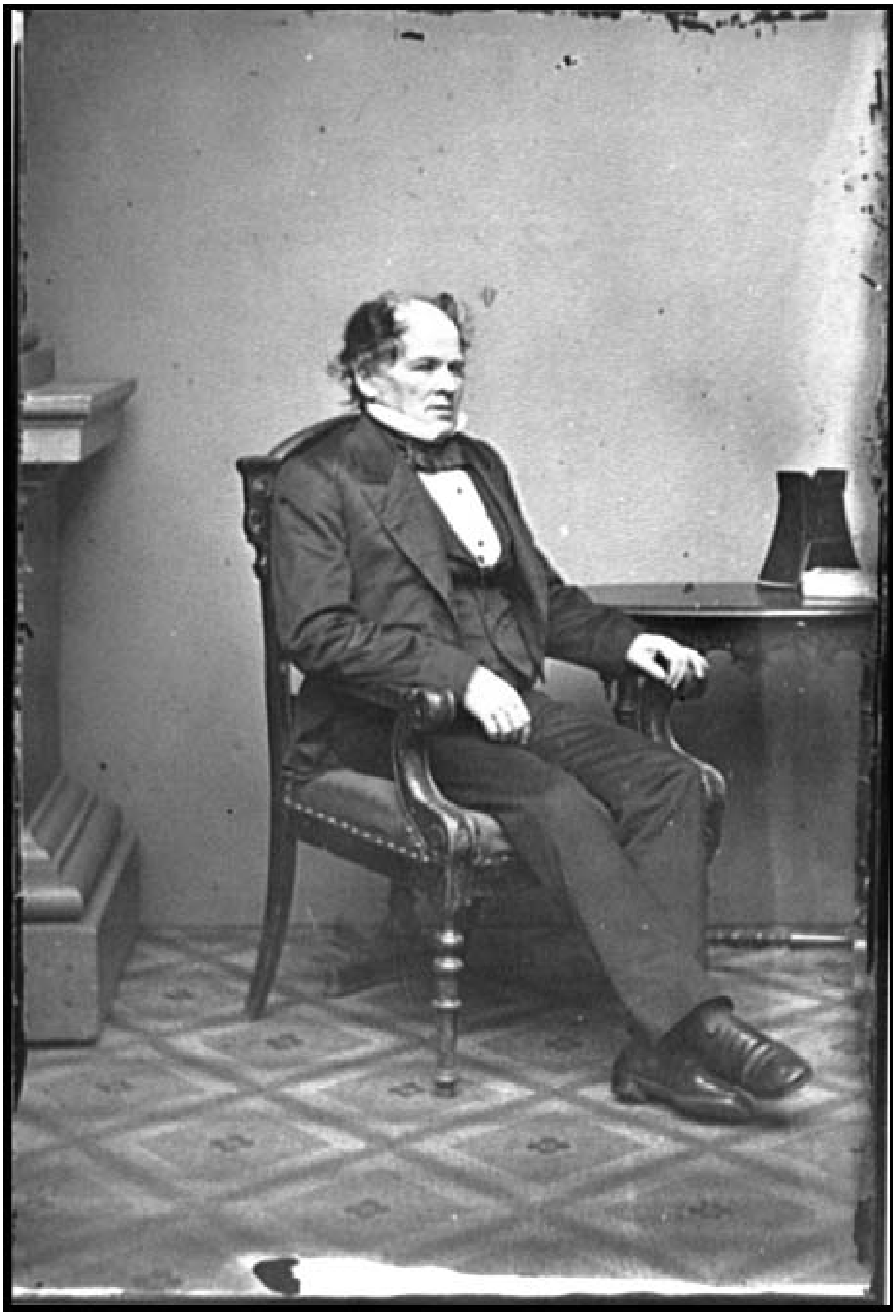


Figure 1. Decadal coverage of mean sea level pressure data over the oceans, COADS (left panels) and I-COADS (right panels), 1810-19 through 1940-49. White in a 2-degree box indicates zero observations in the decade. Four increasingly dark shadings indicate: 1-9, 10-99, 100-399, or 400 or more.



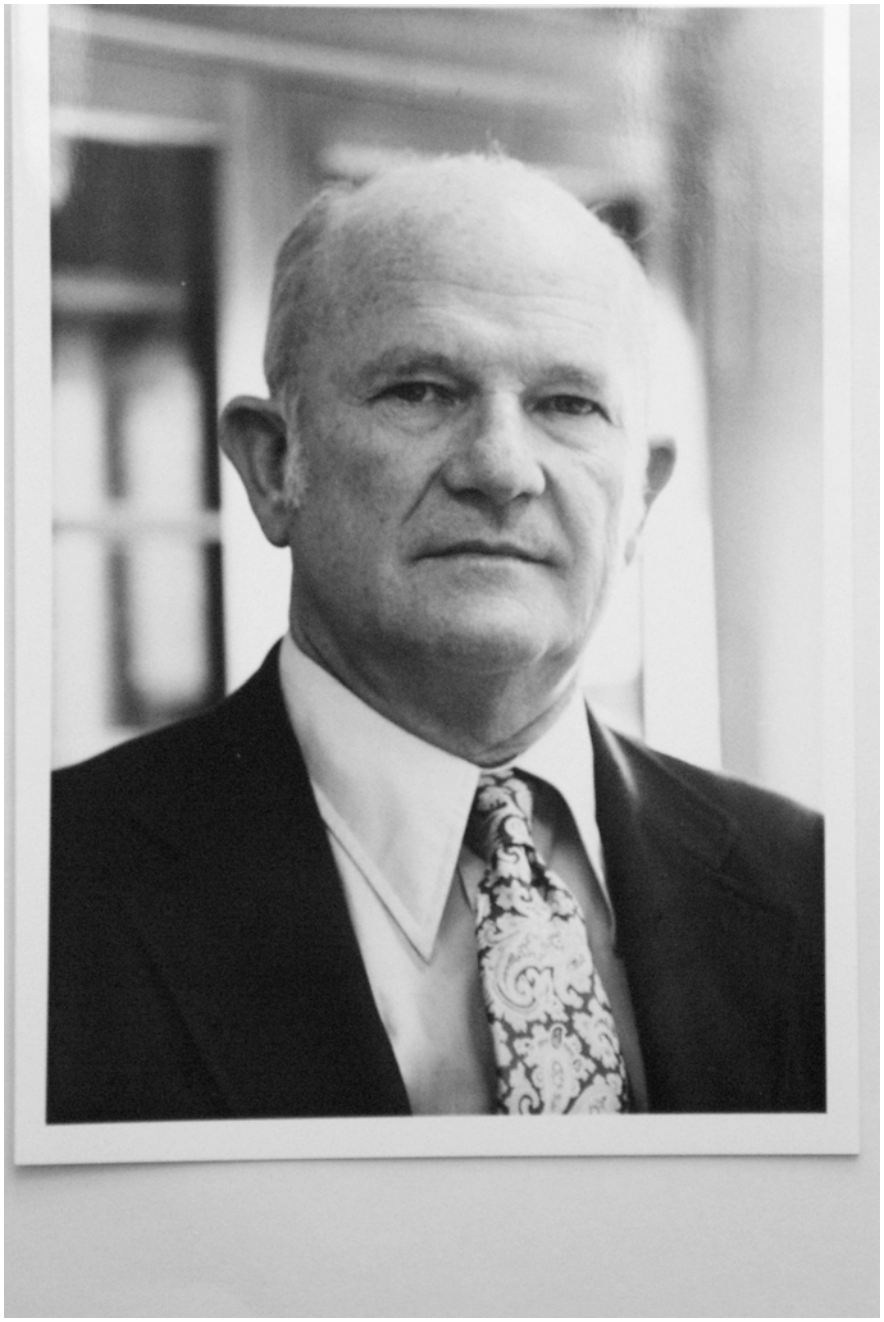


Figure 2. Matthew Maury (top) and Joseph Fletcher (bottom). Photo of Maury courtesy of Library of Congress, Prints & Photographs Division [reproduction number LC-B8172-1335], Brady National Photographic Art Gallery (Washington, D.C.), photographer.