Workshop Summary and Recommendations

With support from the NOAA Office of Global Programs, an International COADS Workshop was held in Boulder, Colorado during 13-15 January 1992, to discuss the Comprehensive Ocean-Atmosphere Data Set (COADS). A total of 66 participants attended the workshop, from Australia, Canada, China, Germany, India, Japan, Russia, Spain, Sweden, the United Kingdom, and the United States, plus a WMO (Geneva) representative.

The overall objectives of the International COADS Workshop were to discuss the quality of the data and the utility of the various COADS products currently available, and to formulate recommendations for updates and improvements to the data set (see Background). A total of 36 papers were presented (one scheduled speaker cancelled because of illness). The presentations were organized according to the following six broad themes, with session chairs as indicated:

- Improvement of the COADS database (R. Jenne)
- Evaluation of COADS wind fields (D. Parker)
- Evaluation of COADS sea surface temperature fields (C. Ropelewski)
- Evaluation of COADS hydrological variables (C. Deser)
- COADS as an analysis tool I (R. Reynolds) and II (K. Wolter)
- Computer applications (S. Woodruff)

In a final session, chaired by H. Diaz, the earlier chairs each reviewed important themes covered in the session presentations and summarized major issues raised in discussion. Following is a summary of these findings and other recommendations from the workshop:

Improvement of the COADS Database

COADS products are currently available encompassing the period 1854-1991. COADS Release 1, issued in the mid-1980s, provided summary statistical products and individual observations up through 1979. Following Release 1, “interim” updates have been completed approximately on an annual basis, now providing a partial set of summary statistics and individual marine reports in abbreviated format, through 1991.

Ship observations since World War II typically have been reported at 00, 06, 12, and 18 UTC, with locations recorded as degrees and tenths of latitude and longitude. Data from buoys and other automated platforms may be reported at higher temporal and spatial resolutions. In contrast, older ship data may have been reported only once or twice a day (e.g., only at Greenwich Mean Noon for some early U.S. ship data), with latitude and longitude in some cases recorded or digitized only to whole degrees. It was noted that spatial coverage has varied markedly through the decades, and in this century, significant gaps are evident around the two world wars.

Statistical summary products, rather than individual observations, have been chosen by the majority of COADS users. Observations falling within 2° latitude x 2° longitude boxes have been summarized by calendar month, with seven statistics plus corresponding sextiles computed for each of eight “observed” and eleven derived variables (the 1980-91 interim products include only

the mean and number of observations for each variable). Update plans include a complete set of statistics for 1980-91 scheduled for release in late 1992, and a major update for the total period 1854 (or earlier) to date, by the mid 1990s. A general update strategy was described, providing for continued annual updates, and also for periodic major updates.

A number of important quality control issues were discussed, including data problems related to WMO code changes. Ship mislocation is a significant problem; it was noted that track checking is not planned at the present time, but that platform IDs and other information will be made easier to use in enhanced report formats. Improvements to the current outlier trimming procedure are also planned, since in current summary products valid SST observations in warm events were trimmed (not used).

For the past 20 or so years, a number of new observing platforms have become available, such as moored and drifting buoys. In current COADS summary products, buoy and ship data are simply combined; significant efforts appear necessary to develop the algorithms to properly incorporate these data with the set of voluntary observing fleet observations (e.g., it was shown that at higher wind speeds ship winds are significantly stronger than buoy winds).

As a first step, it may be desirable to produce separate sets of summaries for selected platform types and variables. For the majority of users, a blended summary product could later be produced from these subsets with attention to the frequency of observations and other differences. We do not anticipate incorporating the decade or so of satellite-derived SSTs directly into COADS, but these data could prove useful in developing analyzed fields.

There is some need in a number of applications for higher spatial (1° latitude x 1° longitude) and temporal (5-10 days) resolution of the summarized products, at least for selected variables in areas of high observational density. It may be practical to do this for variables such as SST and air temperature after about 1957. However, the storage volume for statistics at very fine spatial and temporal resolutions grows rapidly, so it may be more cost effective to supply individual observations and extraction software to users with very specialized requirements.

A related issue concerns improved access to frequently used variables at the individual observation level. Access to the individual marine reports is desirable for the purpose of developing corrections to the time series of such variables as SST and surface wind, for which methodological and instrumental biases are known to exist. While this implies substantial mass storage requirements (on the order of 10 GB), it was felt that routine access by both NOAA and university researchers to these observations was critically needed.

A number of important new data sets are planned for addition to the most recent decades of COADS. These include a combined drifting buoy set for 1980-91 (utilizing NMC data for 1980-85) prepared by Canada’s Marine Environmental Data Service (MEDS), 30 EPOCS moorings or low elevation island stations, tuna boat data for 1972-91, and near surface reports from oceanographic platforms (bathythermographs, etc.) dating back to the turn of the century.

With regard to improving the coverage during the war years, the National Climatic Data Center (NCDC) in Asheville, under separate funding from the NOAA Office of Global Programs has

been digitizing marine observations from U.S. manuscript sources. In the period 1912-1946, approximately 2.5 million observations have been identified, of which, nearly a million have been keyed to date. Assuming continued resources, keying should be completed in late 1993 at a current rate of about 80,000 observations per month (at a cost of about $74,000 per million observations). Deterioration of old ship forms has complicated keying.

In addition, a valuable collection of historical marine data from Japan's Kobe Marine Observatory has been identified (622 rolls of microfilm; copy at NCDC). Merchant ship data from this collection for 1933-June 1961 were digitized in Japan and are already in COADS. However, the microfilm also contains approximately 5-6 million unkeyed observations from merchant (1890-1933) and old Japanese Navy (1903-44) ships. Plans are being discussed to digitize these observations. For hourly data, the question arose whether 4, 6, 8, or more observations should be keyed per day; keying 8 observations at NCDC only costs 25% more than keying 4 observations. Other valuable additions planned for COADS include marine data from the former USSR archives (25 million observations; 1888-1989) and data from the German Seewetteramt archive (1826-1945).

A merge of COADS with the U.K. Meteorological Office's Main Marine Data Bank (1854 to date) also is planned. COADS has more observations than the U.K. set, but each set has unique observations. It was noted that analyses were created for IPCC by blending UK and COADS statistics. Also, available sea-ice data starting in the 1870s is being gathered at the U.K. Meteorological Office. The suggestion was made that perhaps WMO should help ensure that the available data gets incorporated in COADS.

Evaluation of COADS Wind Fields

The COADS wind data were shown to be very valuable for forcing ocean models, and the available wind data may be capable of resolving the-3-day time scale of tropical phenomena. Nevertheless, several speakers documented some biases present in the wind data that are associated with a number of factors, such as observational biases toward the cardinal directions (N, S, E, W), and problems associated with conversion of wind values from one set of rounded measurement units to another.

The WMO wind speed conversion scale from Beaufort force codes to equivalent wind speeds was shown to underestimate wind speeds at force < 6 and to overestimate at higher forces. Problems also may arise with the estimation of wind speed based on sea state during nighttime versus daytime, and depending on whether the ship is moving upwind or downwind. Moreover, corrections for estimated winds may differ according to nationality and with time. Differences in anemometer- measured winds may also occur due to changes in instrument height (known to have occurred) and with changes in stability conditions in the atmospheric boundary layer.

Separate statistics for estimated and measured winds may be helpful in order to assess biases. It is important that users know about data heterogeneities, or use corrected data when available. Cooperative studies are planned or underway with the Institute for Meteorology in Kiel, Germany with the aim of correcting the individual wind speed observations, or, if this approach proves not to be feasible, to correct the area-averaged monthly summaries. New wind-related variables, such

as the cube of the wind speed and geostrophic or gradient wind, were proposed for addition to the summary statistics for COADS Release 2.

Evaluation of COADS SSTfields

It has been shown that corrections to pre-World War II SST data are needed to study century-scale climate variations. Corrections to these data have been applied

previously on 5° latitude x 5° longitude boxes. However, a number of assumptions are necessary to carry out these adjustments, and some may be more applicable at particular places and times than others. An improved procedure may be needed to adjust each observation individually. As noted above, the need to manipulate records at the individual observation level dictates substantial mass- storage resources. Optical disk technology was suggested as a promising medium.

Sea surface temperatures are generally more spatially coherent over longer distances than other fields such as wind speed and cloud cover. Hence, the development of 1° box summaries at least for SST in the more recent record was widely recommended. Submonthly time resolution would also be useful in a wide range of air-sea interaction studies, for example in rapidly changing regions such as the Kuroshio and Gulf Stream, but its utility strongly depends on the available data coverage.

Satellite data will continue to require in situ observations for calibration purposes. Comparisons of satellite multichannel SST (MCSST) and COADS fields in the Atlantic Ocean suggest that, in midlatitudes, both analyses resolve interannual variability and spatial scales > 2000 km. On the other hand, in the tropics, large differences in the spatial and temporal characteristics suggest that problems are present in both data sets.

Evaluation of Hydrological Variables

This session consisted mainly of an assessment of COADS total cloud amount data. A daytime versus nighttime bias has been documented and will require careful editing. Nevertheless, the speakers noted that these data will continue to be very useful for comparison with International Satellite Cloud Climatology Project (ISCCP) data. Although some problems have been documented with the COADS surface wind data, the moisture variables (the observed and saturation humidities) particularly after the mid-1940s have been shown to be useful in mapping the mean fields of oceanic evaporation, as well as in studies of interannual and decadal-scale climatic variability. More effort is needed in assessing potential inhomogeneities in oceanic latent heat flux parameters.

COADS as an Analysis Tool I and II

These sessions were devoted to evaluating the usefulness of COADS data in a broad range of studies. SST data was shown to be critical in the evaluation of the satellite MCSST product. It has been used to provide a measure of the error of estimate present in objectively analyzed surface marine fields and of the uncertainty associated with “global average” surface temperature deviations during the past century.

Because of the long decorrelation scales of SST averages, it was suggested that a set of monthly gridded fields on space scales of the order of 4-5 degrees of latitude and 8-10 degrees of longitude would be a useful product for researchers with modest computational resources. On the other hand, finer spatial and temporal resolution could be helpful in comparative analysis of the statistical structure of observed and analysed fields from forecast center products, including NMC and ECMWF.

Analysis of the number of observations needed at the monthly time scale to measure various COADS variables at a given level of accuracy indicates that substantial differences exist among the various parameters. For example, the greater spatial and temporal variability of marine air temperature compared to SST requires 2 to 3 times the number of observations per unit area to achieve comparable accuracy. Some recent work on modelling the three-dimensional ocean circulation underscores the importance of the COADS data for model initialization and for providing boundary forcing for the oceans. Use of finer spatial resolution (e.g., 1° boxes) would be helpful here.

There is a need to more accurately account for spatial gradients and the annual cycle in the averaging process and for improved estimates of interannual and longer-scale variability. Use of 1° resolution and of submonthly summaries would help to address some of these sampling problems. Because of diurnal sampling biases in the early years of record, a proper accounting of the diurnal cycle in COADS is also important, although the lack of observations in a few ocean basins, such as the South Pacific and the high latitude southern oceans, will continue to impact our ability to provide reliable hemispheric- scale estimates of century-scale climate variations.

Computer Applications

This session dealt primarily with the development of improved data access tools and other software and communications issues as they pertain to the COADS database. It included a discussion of complementary efforts aimed at developing a metadatabase for COADS. Other topics discussed included the structure of the current data formats and relative merits of different storage exchange media (e.g., the availability of monthly summaries in CD-ROM) for future COADS data releases.

Main Conclusions and Recommendations

Restructuring of the database. Plans for COADS updates include merging of many new data sets and attention to problems identified with different observing platform types. In addition, it appears highly desirable to develop summary products with higher spatial and temporal resolution for some variables, most likely for the period since about 1957. For addressing inhomogeneities in the basic variables, it is essential that researchers have access to all the individual observations, which implies mass storage requirements of the order of 10 GB, together with relatively fast access protocols.

Improvements in data quality control. It is clear that improved procedures are needed for trimming of outliers, and for identifying mislocated data. Efforts to develop such improved data quality control techniques have been underway at CRD/CIRES, NCAR, and NCDC for the past

couple of years and are continuing. Efforts at providing homogenized versions of selected COADS variables have also been underway within NOAA and at other organizations both in the U.S. and abroad. These efforts will continue and expand in future years. It is important that the NOAA Office of Global Programs continue to fund ongoing efforts and, in the future, consider additional individual efforts that address specific problems.