Assessment of the Surface Marine Meteorological Observing System

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The International Comprehensive Ocean-Atmosphere Dataset (ICOADS) contains observations from Voluntary Observing Ships, moored and drifting buoys and other sources of marine data. Whilst ICOADS is essential for climate research the observations archived in the dataset are collected operationally with the primary objective of improving weather forecasts. The link between operators charged with collecting these observations and those involved in their later use in climate analysis and products has not historically been strong. Climate users have not had a voice in the process of observing system design. Whilst assessments of observing system adequacy have been made for forecasting applications there has been little work to assess the observing system adequacy for climate applications, except where the user requirements overlap, for example for sea surface temperature.

A preliminary assessment of the surface marine meteorological observing system is presented. Each stage of the process is challenging, from the collation of user requirements to the development of simple metrics to summarise the health of the observing system. It is shown that there are many different contributions to the estimates of uncertainty in fields derived from the surface marine meteorological observations, from which the observing system metrics are derived. The actual number of observations is not a good indicator of adequacy, rather it is shown that the number of days sampled in a month and the number of different platforms making the observations are better related to uncertainty in the data fields. The importance of platform identification and the availability of measurement method information are also demonstrated.

Session 1: Characteristics of Observational Data (Invited presentation)(S1O1)

A bias corrected SST analysis from 1900 to the present

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More than 15 years of data are now available from the Along-Track Scanning Radiometer (ATSR) series of instruments. Comparison with in situ data sets shows that estimates of global-average marine-temperature change show remarkable consistency over the past 15 years. During this period the composition of the in situ network has changed significantly suggesting that this agreement is, to some extent, fortuitous. A simplified history of SST measurement methods and their typical biases is used to estimate the bias in global average SST from 1900 to the present and it shows that the increase in the number of cold-biased drifting buoy measurements might be compensated by increases in the number of warm-biased engine room measurements. It also shows that large corrections are needed to adjust for the widespread use of uninsulated buckets in the mid twentieth century.

Session 1: Characteristics of Observational Data (Oral presentation)(S1O2)

A Study of Bias and Inhomogeneity in Wind Speeds from Moored Buoys

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Environment Canada

This study investigates two changes in buoy wind measurement methods that have the potential to introduce small but significant inhomogeneities in the long term record. The first was a change during the 1980s and 1990s from a vector to a scalar mean averaging procedure. More recently there has been an increased use of sonic anemometers, usually in the second (back-up) position, as a replacement for the standard propeller and vane anemometers.

The vector-scalar mean comparison uses a large dataset of about 5 years of hourly data when the Canadian buoys reported both the vector and scalar mean wind speed for each RM Young propeller-vane anemometer. This includes a wide range of conditions including intense winter storms and tropical cyclones. Preliminary results suggest that the median value of the scalar-mean wind speed is 1 to 3% higher than the vector-mean from fully functioning anemometers on 6-m NOMAD buoys (excluding lower wind speeds). Preliminary results show that the median difference increases slightly with increasing wave height to about 4%. Differences are larger for wind speeds from damaged anemometers or faulty compasses. The study also examines differences in vector and scalar means in 3-m Discus buoys.

Differences in winds from RM Young propeller-vane anemometers and sonic anemometers installed on the same buoy are also investigated, using several months of recent hourly data from several buoys. All winds in this comparison are scalar means. We adjust for the small difference in measurement height of each sensor. Preliminary results show that the sonic wind speeds are slightly stronger than propeller-vane wind speeds. Median differences (excluding lower wind speeds) are 2 to 4%.

We explore methods to diagnose wind quality problems and to adjust the vector-means in wind time series for use in climate studies. We make a preliminary examination of the impact on buoy wind time series resulting from these changes and adjustments. We also consider the potential effect of the introduction of sonic anemometers.

Session 1: Characteristics of Observational Data (Oral presentation)(S1O3)

Using ship tracking methods to assist in bias adjusting marine observations

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Understanding how global temperature has changed in the past is essential to both our understanding of the current climate and our ability to predict future change. The marine record that is derived from ICOADS provides a wealth of data which extends back to the mid 19th Century. However, this record faces two substantial issues; firstly the availability of metadata, secondly a large number of the observations in the ICOADS (~90% in 1970) have no ship identity. In order to understand the uncertainties and compensate for biases in the marine observations, it is necessary to be able to differentiate between different ship voyages (if not between the ships themselves). Since this is not currently considered possible many of the datasets (i.e. MOHMAT43N) use broad regional averages and hence loose spatial and temporal resolution. To create bias adjustments, the individual voyages must first be identified using their kinematic properties. To do this we have employed a state-of-the-art tracking methodology to break up the mass of unidentified marine observations into ship tracks. This method also has the benefit of being able to differentiate between observing platforms based on the pattern of movement. Here we will present a test case demonstrating the some of the potential available improvements to the marine record and hence to our understanding of changes in global climate.

Session 1: Characteristics of Observational Data (Oral presentation)(S1O4)

Impact of systematic errors in hydrographic data on estimates of ocean warming

Viktor Gouretski

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A review of studies of systematic errors in oceanographic data is presented. Temperature profiles from the World Ocean Atlas 2005 are used to estimate systematic errors in mechanical bathythermograph, expendable bathythermograph and profiling float data, with CTD and bottle data used as a reference. Pure temperature offsets and temperature biases due to systematic depth errors are quantified and a correction procedure is suggested. It is shown, that systematic errors in the most abundant bathythermograph data have a significant impact on heat content anomaly estimates, with the heat content increase between 1950s and 1990s being significantly reduced if biases are taken into account.

Session 1: Characteristics of Observational Data (Oral presentation)(S1O6) (note: S1O5 was withdrawn)

Uncertainties in SST measurements: are we overestimating the reliability of SST data?

John J Kennedy

Met Office Hadley Centre, UK

Measurements of SST, and other marine variables, are prone to measurement errors. These measurement errors can be thought of as a constant offset (the bias of the measurement) and a random component that varies from one measurement to the next. Using this model, error estimates for in situ SST measurements have been calculated from comparisons with Along-Track Scanning Radiometer (ATSR) data. Distributions of biases and measurement error were created and used to estimate uncertainties on grid-box and area-averages. Spatio-temporally correlated biases from a given platform can lead to uncertainties that are a factor of 2 to 3 larger than previously calculated, particularly in sparsely sampled regions such as the southern oceans and at times when there are generally few observations.

Session 1: Characteristics of Observational Data (Poster presentation)(S1P1)

Humidity Biases in VOS Observations

David I. Berry **and Elizabeth C. Kent**

National Oceanography Centre, Southampton, UK

Observations of the surface humidity made by Voluntary Observing Ships (VOS) are often the only reliable source of humidity observations over the oceans. Buoy observations may be of good quality but are only made at a few locations. Although, satellite estimates cover the oceans globally they can suffer from severe biases when the atmospheric conditions are significantly different to those used in the calibration of the satellite data.

However, whilst the VOS observations are often the best source of humidity estimates over the oceans they also contain systematic and random errors that need to be accounted for in any analyses requiring climate quality data. VOS observations from the International Ocean and Atmosphere Data Set (ICOADS) are therefore used, together with information on the observing practices from WMO Publication 47, to examine biases in the humidity observations. Previous studies have shown that observations of humidity using meteorological screens are biased due to the inadequate ventilation of the wet bulb thermometer. Through comparison with observations made by whirling or sling psychrometers it will be shown that observations made using wet and dry bulb thermometers exposed in marine screens overestimate the humidity. A new correction factor is proposed and it is demonstrated that applying this correction reduces the biases in screen humidity measurements.

Session 1: Characteristics of Observational Data (Poster presentation)(S1P2)

Estimating the Random Errors in Marine Air Temperatures

David I. Berry **and Elizabeth C. Kent**

National Oceanography Centre, Southampton, UK

Observations of the Marine Air Temperature (MAT) made by Voluntary Observing Ships (VOS) are collated in the International Comprehensive Ocean-Atmosphere Data Set (ICOADS). These observations have been used in many studies including analysis of climate change, validation and bias adjustment of the SST record, development of surface flux datasets and validation of model and satellite data. However, the observations contain both systematic and random errors that need to be taken into account for accurate estimates of the MAT to be made.

New estimates of the random errors in MAT observations from VOS are presented and the impact of bias corrections on the random error estimates demonstrated. Like previous authors we use the variogram method, estimating the errors as a function of separation distance and the squared difference between the observations, together with a simple linear variogram model. The previous work is also extended, examining the impact of the choice of variogram model and the effects of anisotropy on the error estimates. The new random error estimates are compared to existing estimates and the impact of bias corrections on the random error estimates shown.

Session 1: Characteristics of Observational Data (Poster presentation)(S1P3)

Improved Characterisation and Bias Adjustment of Ship Winds in ICOADS

David I. Berry **and Elizabeth C. Kent**

National Oceanography Centre, Southampton, UK

Observations of wind speed made by ships are a vital part of the climate record. Wind speed has been recorded for more than two centuries and these observations are archived in the International Comprehensive Ocean-Atmosphere Dataset (ICOADS). The consistency of the marine wind record has often been questioned due to the changing mix of visual observations and measured winds combined with increasing measurement heights and changing observing practices. The need for accurate and comprehensive information on observation method and instrument heights has long been recognised.

Recent progress toward understanding and improving the recent marine record will be presented, covering the period 1970 to 2006. Different approaches to improving the quality of the ship wind speeds are described. Firstly an attempt is made to verify and correct the wind measurement method flags based on the characteristics of the data. Visual wind observations are expected to show characteristic large peaks at wind speeds equivalent to the Beaufort mid-points and smaller peaks at the wind speeds equivalent to the range limits for each Beaufort interval. The anemometer wind speed distribution is harder to characterise as observers tend to round observations which may occur when the relative wind speed is recorded, when the true wind is calculated, or at both stages. Characterisation of the wind observations is shown to improve agreement between adjusted visual and measured wind speeds, and to reduce the trend in marine wind speeds from ICOADS.

Several authors have attempted to validate or calibrate trends in marine wind speeds using consistency with observed pressure gradients as a constraint. Past research has either used individual ICOADS pressure observations, which are noisy, or monthly mean gridded pressure fields which may not satisfy the requirements for wind steadiness necessary for the method to be applied. Here the pressure constraint is applied using daily mean pressure fields with known uncertainty estimates. The effects of changing uncertainties in the pressure field, and any changes to wind steadiness are quantified.

Session 1: Characteristics of Observational Data (Poster presentation)(S1P4)

Characteristics of the hydro-meteorological observation data in the North-Western Black Sea

Dumitru Sarafu **and Mirela-milena Nita**

The National Meteorological Administration, Romania

The presentation presents the actual status of the hydro-meteorological observation data in the North-western Black Sea and its perspectives. It also contains a winter storm description analysed with both Doppler Radar and surface data.

Session 1: Characteristics of Observational Data (Poster presentation)(S1P6) (note: S1P5 was withdrawn)

Wave Spectra Construction in the Caribbean Sea Using Satellite Measurements after Buoy Data Analysis

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Construction of wave spectra, making use of significant wave height from Jason-1 satellite is explored employing the JONSWAP preconceived spectra, so this can be used on data assimilation on a third generation wave model operated in the Oceanographic and Hydrographic Research Center - CIOH in the Caribbean Sea. Information from an operational data product, the Operational Sensor Data Record (OSDR) available within 3-5 hours of delay was employed, on which a correction to eliminate systematic bias and necessary quality control were applied to achieve a higher accuracy offered on the Interim Geophysical Data Record (IGDR), a more detailed data product available within 2-3 days of delay. Two directional wave buoys installed by the Colombia's Maritime Authority were used to verify the wave spectra construction results, finding great coincidence between the buoy and constructed spectra.

Session 1: Characteristics of Observational Data (Poster presentation)(S1P7)

Overview of JCOMM Data Management and Advances in Best Practices

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JCOMM was formed in 2001 and is now in the second 4 year intersessional period. At the outset, data management was recognized as an important activity and so was designated as one of the major programme areas in JCOMM's organization. There is currently a number of activities lead by the Data Management Programme Area (DMPA). These include the development of a prototype web based portal for discovery and access to marine data, an examination and development of how to report marine data in real-time using the BUFR format, the development of both a data management plan and implementation plan to identify all of the areas touched by data management and to guide work, and coordination of activities with the many other partners who collect and manage data in the marine environment. In cooperation with these partners, the DMPA is pursuing the acceptance of community standards for managing marine data. This presentation will provide an overview of all of these activities to show the breadth of what is being addressed, and the depth of selected work.

Session 2: Data Management (Invited presentation)(S2O1)

ICOADS: Update Status and Data Distribution

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The International Comprehensive Ocean-Atmosphere Data Set (ICOADS) is the world's largest archive of marine data, currently spanning the period 1784−May 2007 in Release 2.4. The basic observational archive, which comprises 238 million individual marine reports from ships, buoys, near-surface oceanographic observations, and other Ocean Data Acquisition Systems (ODAS), is augmented with derived monthly data products, metadata, and documentation—all accessible via the project's unified web portal (icoads.noaa.gov).

This presentation will describe the data and metadata access options available and planned from the three cooperating US organizations, as well as survey recent observational and product usage statistics. Release 2.5 (1662 to approximately 2000) is a major long-term update, and progress to date will be presented. Impacts of new data sources and enhancements resulting from improved data processing will be briefly introduced. More details about data characteristics and future plans will follow in an associated presentation by Woodruff et al.

Session 2: Data Management (Oral presentation)(S2O2)

ICOADS: Data Characteristics and Future Directions

Scott D. Woodruff [1], **Elizabeth C. Kent** [2], **Philip Brohan** [3], **Richard W. Reynolds** [4], **Sandra J. Lubker** [1], **Shawn R. Smith** [5] **and Zaihua Ji** [6]

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This presentation will describe data and metadata characteristics of Release 2.5 of the International Comprehensive Ocean-Atmosphere Data Set (ICOADS). This major new historical update (introduced in the associated presentation by Worley et al.) is planned for availability around September 2008, and will incorporate data from a wide variety of new or updated sources (covering 1662 through approximately 2000). These will include the Climatological Database for the World's Oceans (1662-1855), near-surface data from the World Ocean Database 2005 (1772-2005), Deutscher Wetterdienst ships (1876-1914), US Marine Met. Journals (1878-94), Japanese Kobe Collection (2003 Ed., 1889-1940) and Whaling Data (1946-84), Russian Research Vessels (R/V; 1936-2000), UK Royal Navy Ship's Logs (~1938-47), a portion of the UK Marine Data Bank (1950-79), 19th-20th Century Antarctic Expedition Logbooks, and Center for Ocean-Atmospheric Prediction Studies (COAPS) R/V Data (1990-98).

In the concluding part of this presentation, anticipated future directions for ICOADS will be discussed, with the aim to continue to steadily add scientific value to the observations, products, and metadata, as well as strengthen the cooperative enterprise through expanded linkages with JCOMM and other international organizations. For example, one key area planned for improvements is our continuing work towards regular ICOADS update extensions (potentially monthly). These improvements include the resolution of complex international issues such as call sign masking for security and commercial concerns, and the transition to table driven code forms (e.g., BUFR) under the WMO Information System (WIS).

Session 2: Data Management (Oral presentation)(S2O3)

The present and future satellite era sea surface temperature climate data record

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Sea surface temperature (SST) is one of the oldest and most fundamental climate data records. For many centuries, mariners have used SST observations to guide their passages that have left a globally sparse but nevertheless interesting record back to the 1800's. Today, operational deployments of many and varied in situ observations provide a better global SST sample than ever before although many regions of the global ocean remain un-sampled on a regular basis. Only using complementary satellite data records together with in situ observations can a robust and meaningful high resolution (daily global coverage, 10km spatial resolution) SST climate data record (CDR) be established. Such a record, which will start at the beginning of the satellite record in 1981 when global coverage, daily, quasi-synoptic observations became a reality, will provide a basis to develop a full characterisation of SST CDR sampling errors using in situ observations alone. The GHRSST-PP re-analysis project has been established to develop and maintain a new generation of modern satellite era SST CDR based on the synergy of complementary in situ and satellite SST observations, supporting data (wind speed, surface solar irradiance, sea ice) and analysis procedures. Today, a number of centres are working together, in a near real time and delayed mode, to deliver the GHRSST-PP SST CDR from climate monitoring purposes and model initialisation. This presentation will first review the characteristics of complementary satellite SST data within the modern satellite-era CDR, provide a summary of GHRSST-PP activities for reanalysis (including data management, SST analysis methods, observations of climate variability/change and future expectations), example applications and concluding with a set of recommendations for future developments within the Joint Commission for Oceanography and Marine Meteorology (JCOMM) and the Global Monitoring for Environment and Security (GMES) SST Thematic Assembly Centre (SST-TAC), which will be the European contribution to Global Earth Observation System of Systems (GEOSS).

Session 2: Data Management (Oral presentation)(S2O4)

Interface between marine historical ecology and climate research

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For the past four years, NOAA's National Marine Sanctuary Program has partnered with the University of New Hampshire to research and analyze historical records that document changes in the condition of fish populations and ecosystems within national marine sanctuaries. This research requires extracting and tabulating relevant information from historical maps, fishing logbooks, fish catch and market records, as well as narratives of fishermen that describe the past conditions of fisheries and the marine environment. In particular, the largely forgotten survey records of the US Fish Commission, the legacy agency of NOAA and the National Marine Fisheries Service, provide detailed records of atmospheric and oceanographic conditions, classify seafloor sediments, and inventory what scientists caught in their sampling nets and dredges in the late-19th and early-20th centuries. For example, the research vessel Fish Hawk, which recorded nearly 40 years of marine environmental conditions along the eastern United States seaboard from the 1880s to the 1920s, include water depth, air and ocean temperatures, salinity, wind speeds and directions, and water currents at specific dates, times and locations. Collectively, these historical records contribute to our understanding of past sanctuary conditions and the relative quantities of marine life they used to hold, as well as how society adapted to changes in the marine environment. We present these records not only to improve understanding of past marine environmental conditions and human adaptations, but also as a significant contribution of geo-referenced data to ICOADS, which may be used to temporally and spatially refine climate trends and models.

Session 2: Data Management (Oral presentation)(S2O5)

SEPRISE - First step towards a pan-European oceanographic real time data exchange

Patrick G. Gorringe

EuroGOOS

SEPRISE (Sustained, Efficient Production of Required information Services) has been a Specific Support Action funded by the EC within the 6th Framework Programme to further operational oceanographic services, in line with the priorities of the members of EuroGOOS. These priorities also coincide with those of the European Commission and of the GMES/GEO initiatives. The project was finalized in May 2007.

One of the deliverables from the project was to deliver an operational demonstration with the main objectives to demonstrate the feasibility of joint pan-European data exchange, regular analysis and forecasting in an operational mode and to demonstrate the European capacity in operational oceanography.

The demonstration includes all operational steps; observation, data management, real time information, forecast and dissemination to users.

Currently 42 European oceanographic and meteorological institutes provide data to SEPRISE. Data is available in real-time from fixed stations and buoys for waves, wind, sea level, salinity, temperature and currents. In addition, model results have been obtained to provide forecasts for the same locations. The SEPRISE demonstration currently includes 378 stations producing 640 time series. Approximately 80% of these time series have corresponding model results with which they can be compared directly. Data is collected and presented once every hour. The demonstration has proven the possibility of sustained coordinated production and acts as a model for continued efforts.

Session 2: Data Management (Oral presentation)(S2O6)

The use of Data Buoy, Ship and Argo Float Observations - data flows and processing

Hester Viola

JCOMMOPS

Marine observations from in-situ observing systems are paramount to generating good quality meteorological and oceanographic products. The in-situ observing networks which underpin JCOMM generate large amounts of data used by many different communities. The JCOMM in-situ Observing Platform Support Centre (JCOMMOPS) provides integrated support with programme planning, implementation and operations. Observing systems need to meet the requirements of all ocean information products, which can vary greatly depending on the application, therefore international coordination is necessary to balance the needs of all actors involved. JCOMMOPS provides international coordination through the Data Buoy Cooperation Panel (including drifting and moored buoys), Argo Profiling Float programme and the Ship Observations Team (including SOOP - XBT, TSG, ASAP and VOS). The real-time data flow via the Global Telecommunications System of WMO will be discussed as well as the role of the various data centres which process and share delayed mode data for buoy and ship observations. A description will be given of the JCOMMOPS metadata database of observing platforms and also the mechanisms in place for relaying quality control information about observational platforms.

Session 2: Data Management (Oral presentation)(S2O7)

The JCOMM (Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology) water temperature metadata pilot project (META-T PP)

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The water temperature metadata pilot project started from a request from the seventh session of the Global Ocean Observing System Scientific Steering Committee (GSSC-VII, Brest, France, 26-29 April 2004) for JCOMM to explore the feasibility of greatly facilitating use of the ocean temperature information by increasing the quantity and quality of relevant metadata in real-time, as well as for delayed-mode activities.

The aim of META-T is to provide an international standardisation framework for collecting sea surface temperature and water temperature profile instrumental metadata from a number of marine observational systems, including drifting and moored buoys, observing ships, sea level stations, sub surface profiling floats, ocean reference stations and ODAS (Ocean Data Acquisition Systems)

The META-T project aims to input to and recommend suitable formats for improved transmission of water instrument metadata in real-time, near real-time and delayed-mode, in line with user requirements.

Current discussions are on the issues of exchange formats

- for real-time data & metadata (e.g. BUFR, SensorML)
- for static / platform metadata (e.g. in the ODAS metadata database, hosted by NMDIS, China or WMO Pub. 47) to be submitted and exchanged
- for delayed-mode data to exchanged (containing all requested data and metadata fields)

One or more data streams will conduct a trial, to determine the pros and cons of a certain approach. For example table-driven code formats, pulling metadata from databases, pushing data from separate sources through to the user together, etc.

Here the Pilot Project will end, and the information gathered will be collated to form proposals to take forward - not only for water temperature data, but to extend to other elements also.

Session 2: Data Management (Oral presentation)(S2O8)

Modernisation of the Marine Climatological Summaries Scheme

Nicky Scott

Met Office, UK

The Marine Climatological Summaries Scheme (MCSS) was first proposed at the third session of WMO Commission on Marine Meteorology (the forerunner to JCOMM, the Joint IOC/WMO Commission for Oceanography and Marine Meteorology) in 1960, and eventually adopted at the fourth congress in 1963. The objective was to establish a joint effort of all maritime nations in the preparation and publication of climatological statistics and charts for the oceans. Eight countries (responsible members), each with a specific ocean area of responsibility, were designated to process the data in prescribed forms and regularly publish climatological summaries. In 1993, to help improve flow and quality control of global data, two Global Collecting Centres (GCCs) were established - one in the UK and one in Germany.

Contributing members (CMs) receive data from their voluntary observing ships (VOS) and once a quarter send these to both GCCs. At the end of each quarter the combined dataset is split into specific areas of responsibility and distributed (in the IMMT-3, International Marine Meteorological Tape format and to a minimum level of quality, MQCS-V) among the eight Responsible Members (RMs) respectively.For each area of responsibility, monthly, annual and decadal summaries may be produced in either chart or tabular form. The summary will provide up to three pieces of information for a given element i.e. for air temperature, mean, standard deviation and number of obs may be displayed.

At the JCOMM ETMC (Expert Team on Marine Climatology) meeting in Gdynia, July 2004, it was decided that a questionnaire should be produced and circulated among WMO members involved in marine climatology to determine members opinions on MCSS. The results showed the need to change the process so a proposal was made to the ETMC in Geneva March 2007.

The proposal highlighted that the end-to-end data management should be more streamlined with less duplication of data and effort to create a better overall service. At ETMC-II (March 2007) a task team for Delayed Mode VOS data (TT-DMVOS) was appointed to plan and address the work involved. A 3-year work plan has now been developed and agreed to consider the following:

- CMs should continue to submit their data to the GCCs on a regular basis but at the end of each quarter, instead of distributing data to each RM, the GCCs will make the full global dataset freely available via FTP to all CMs.
- There be a suitable storage point for all marine VOF data that can be accessed (perhaps by web) by any data user.
- GCCs permitted to become more pro-active in collecting data and provide assistance to CMs having difficulty submitting their data.
- GCCs to work together to develop and implement an agreed Higher Level Quality Control Standards (HQCS)
- End products be developed suited to user requirements.

This presentation will describe in detail the way in which the MCSS is to be modernised and the progress made to date.

Session 2: Data Management (Oral presentation)(S2O9)

NOAA's Climate Database Modernization Program: Preserving Marine History

J. Eric Freeman

Sourcecorp/CDMP/NCDC, USA

The Climate Database Modernization Program (CDMP) is a NOAA program at the National Climatic Data Center (NCDC) dedicated to preserving global climate and environmental data. With a commitment to making data available online for research, CDMP supports one of NOAA's core missions to archive, store and provide public access to valuable historical data, which without preservation, could be lost forever. By working with various national and international agencies, a wide variety of rescue projects has been ongoing since CDMP's inauguration in 2000. Although CDMP preserves many kinds of environmental data, the program continues to faithfully support the global marine community by locating, imaging and keying historical and current marine records and merging the data into national and international databases.

CDMP has been successful in historical data rescue as well as keying of current incoming marine records. Incoming observations from US Voluntary Observing Ships (VOS) and US Navy Ships are keyed on a monthly basis as they are received from participating ships. Logbooks from the Meteorological Service of Canada's VOS program spanning the years 1992-2005 have also been keyed under CDMP.

Historical rescue projects include imaging and keying of: 1910-1912 merchant marine logbooks held in the NCDC's archives, previously undigitized World War I and II era logbooks, and German Maury journals from the mid-19th century. Additional rescue efforts have imaged lightship records off the US coast and Great Lakes shores, and imaged Simultaneous Ship Observations from 1874-1902.

In a joint effort with the United Kingdom, a significant digitization project was completed in 2007. Meteorological logbooks from the UK Royal Navy were imaged and digitized from a sparse World War II (WWII) period spanning 1938-1947. The Royal Navy WWII project preserved nearly 268,000 logbook images and produced approximately 1.5 million observations. The data have been incorporated into the International Comprehensive Ocean-Atmosphere Data Set (ICOADS) as an auxiliary dataset. Future international projects are planned, including digitization of 19th Century Dutch logbooks, East India Company logbooks, and additional World War I era logbooks.

In conjunction with rescuing marine data, CDMP also serves the marine community by preserving early ship card deck reference manuals and important marine reference documents, such as the Matthew F. Maury publications, that hold valuable information regarding observing practices during historical times.

CDMP is vital to NOAA's effort to expand and provide access to its large archive of climate and global environmental data. By recovering historical marine records and making data available online to the public, CDMP is critical to the continued preservation of these historical records and provides valuable data for local and global climate research.

Session 2: Data Management (Poster presentation)(S2P1)

RECovery of Logbooks and International Marine data: (RECLAIM) Project

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7) KNMI, PO Box 201, 3730 AE De Bilt, Netherlands

This presentation will describe the new RECLAIM project, whose overall aim is: "A cooperative international project to image historical ship logbooks and related marine data and metadata, and digitize the meteorological and oceanographic observations for merger into the International Comprehensive Ocean-Atmosphere Data Set (ICOADS) and for utilization for climate research." RECLAIM builds on the results and knowledge gained during the European Union-funded Climatological Database for the World's Oceans (CLIWOC) 1750-1854 project (completed in 2003), which focused on ship logbooks containing "semi-instrumental" (e.g., wind force and wind direction) observations from Dutch, Spanish, French and UK archives. Vast numbers of undigitized historical ship logbooks exist in UK archives, and smaller, but still significant, amounts exist in Dutch, French, German, and other European, US, and international archives.

One significant accomplishment emerging from the RECLAIM project in 2006 was the imaging by KNMI of Dutch logbooks from the 19th century, which are planned for future digitization by NOAA's Climate Database Modernization Program (CDMP). Another major accomplishment was a jointly funded UK and CDMP effort to image and digitize selected UK Royal Navy (RN) Ship's Logs around the data sparse World War II period (1938-47). The completed WWII project preserved 268K images from 302 logbooks and produced 1.5M digitized observations. The data are now available as an Auxiliary data set of ICOADS in IMMA format. Further planned RECLAIM tasks include the imaging and digitization of approximately 1K English East India Company (EIC) logbooks recording instrumental data in the period 1790-1834, and of RN logbooks being selected around the WWI period (1914-23).

The RECLAIM website (http://icoads.noaa.gov/reclaim/) presently provides researchers with data on RN shipping movements between 1800 and 1947, the movements of EIC vessels from 1790 to 1834, and the activities of Arctic exploration vessels and whalers through a set of logbook and movement directories. The associated archive references are also provided. There is also information on UK archives, the format and content of logbooks, and information on digitized logbooks. Several original UK and US documents are reproduced. They include UK Marine Data Bank series manuals and a list of RN WWII Meteorological Logs held by the UK Met Office. US documents include marine card deck reference manuals and instructions for US Marine Meteorological Journals (1878-94). The data and information available is regularly updated and amended. Future developments will include: metadata on vessels and meteorological instruments, additional sets of manuals and instructions, and relevant literature from 19th century scientific journals.

Session 2: Data Management (Poster presentation)(S2P2)

HISTOR: Digitization of German Historical Marine Meteorological Data and Metadata

Reinhard Zöllner

Deutscher Wetterdienst, Hamburg, Germany

There are a number of Institutions all over the world, having at their disposal historical meteorological ship logbooks which contain marine meteorological and oceanographic observations from the world oceans, reaching back into the 20th, the 19th and some of them even into the 18th century. These marine observations are extremely valuable for climate research, because in the existing databases there is only a very limited number of marine datasets covering those times.

Currently several National Meteorological Services and Data Centers are making efforts to extract those data from the logbooks in order to transfer them to computer readable media and make them available for climate research, model validation, verification and other climate applications. In its historical archive the Deutscher Wetterdienst, DWD, keeps more than 37.000 meteorological journals from sailing ships and steamers, the oldest of them date back to the first half of the 19th century. These logbooks form one of the most extensive archives of this kind in the world. The journals contain:

- meteorological measurements and observations, data and meta data
- information on navigation and shipping,
- observations of all kinds of natural Phenomena
- special topics, e.g. biology, historical events, occurrences on board, and other information.

This archive was established in Hamburg in the second half of the 19th century by the Norddeutsche Seewarte, later the Deutsche Seewarte (German Marine Observatory). In the past a big part of the German logbook archive has already been processed and the data transferred to electronic media. But a considerable amount has not yet been worked on. So in 2007 DWD decided to launch a project called HISTOR, which aims at extracting the data and metadata from these books, applying quality control procedures to them, archiving them and making them available in electronic form for the international climate research community and many other users.

WMO strongly recommends the digitization and safeguarding of the historical marine observations (Data Rescue) because deterioration processes associated with the paper or the ink can make the information in the books unreadable on the long (or possibly even on the shorter) run. Therefore in addition to the digitization of the observational data and metadata in the framework of HISTOR the historical meteorological logbooks will be photographed digitally in order to have digital copies of the documents.

DWD is in contact with other international institutions, having historical meteorological ship logbooks in their archives and being engaged in similar projects, in order to exchange experience and to foster cooperation in this field. The poster will show the background of and reasons for the data rescue efforts as well as their benefits. In this context the recently launched DWD project HISTOR is presented in detail.

Session 2: Data Management (Poster presentation)(S2P3)

The CLIWOC Project: overview and reflection on the utility of old ship's logbooks for climatic studies

Dennis Wheeler

University of Sunderland, UK

The CLIWOC (Climatological Database for the World's Oceans: 1750 to 1850) project was funded under the aegis of the EC Framework 5 research programme. It ran from 2001 to 2004 and represented the first comprehensive and international attempt to assess, process and collate the wealth of climatic information contained in the logbooks of ships in the service of the then imperial European states, of which Great Britain, France, Spain and the Netherlands were the leading examples. Over 6000 logbooks of vessels from these nations were examined and the relevant observations, all of which were made daily, were abstracted and prepared for inclusion a database now available from the project website at www.ucm.es/info/cliwoc. This database contains nearly 300,000 such daily records. The observations were, however, non-instrumental in character, estimated by the officer of the day and based on three facets of the weather: wind force, wind direction and a general description of the weather. All three elements required careful treatment before their inclusion in the database. Wind force, in particular, was a problem because the standardized Beaufort Scale had yet to be adopted universally and the vocabulary of wind force terms could be expressed in Beaufort Scale equivalents only after careful calibration and use of 'content analysis' in order to divine their meaning in present day terms of many archaic and now redundant terms. A multi-lingual dictionary of over 600 such terms was prepared by the CLIWOC team and is available from the website (see above). Wind directions presented fewer problems, but their estimation being made with respect to magnetic rather than true north required careful adjustment taking into account the known spatial and temporal variations of magnetic deviation over the past three centuries. The general descriptions of the weather (including note of such phenomena as rain, drizzle, snow, thunder, fog, ice cover and hail) were recorded using the standard language of the day and were the easiest of the logbook entries to manage.

The geographical coverage offered by the CLIWOC logbooks is notable and includes the North and South Atlantic and the Indian Oceans. The Pacific Ocean did not enjoy the same frequency of voyages and remains a significant lacuna on the map of past data gathered from logbooks. It is equally important to note that whilst the CLIWOC team processed some 6000 logbooks, the total collection for this period numbers over 100,000 and this notable resource offers therefore notable scope for an intensification of the coverage of derived data. This is important because logbooks are the only source of such finely detailed and reliable observations of weather and climate over the oceans in those distant, pre-instrumental days.

The CLIWOC project has, however, provided the procedural and methodological basis on which such future projects can develop. This poster reviews these achievements, outlines the methods developed, the problems encountered in 'homogenising' the observations across different languages and time periods and the methods that were used to test the data to verify their reliability and consistency of record.

Session 2: Data Management (Poster presentation)(S2P4)

The Shipboard Automated Meteorological and Oceanographic System (SAMOS) Initiative

Shawn R. Smith, **Mark A. Bourassa and Jeremy Rolph**

Florida State University, Center for Ocean-Atmospheric Prediction Studies, USA

The Florida State University has been operating a data assembly center (DAC) to collect, quality evaluate, and distribute Shipboard Automated Meteorological and Oceanographic System (SAMOS) observations since 2005. SAMOS typically are a computerized data logging system that records underway meteorological and near-surface oceanographic observations collected on research vessels. The authors note that the SAMOS initiative does not provide specific instrumentation for vessels, but instead takes advantage of science quality instrumentation already deployed on most research vessels. The SAMOS initiative provides vessel operators with desired sampling protocols and metadata requirements that will ensure the DAC receives a consistent series of observations from each vessel. The status of the SAMOS initiative will be described.

The DAC and its partners in US National Oceanographic and Atmospheric Administration (NOAA) and the University National Oceanographic Laboratory System have implemented a series of daily data transmission from ship-to-shore using an email protocol. A set of observations recorded at one-minute intervals for the previous day arrive at the DAC soon after 0000 UTC and undergo automated quality evaluation. A trained data analyst reviews data and responds directly to vessels at sea when problems are identified. All quality-evaluated data are freely available to the user community (via http://samos.coaps.fsu.edu) and are distributed to national archive centers. As of November 2007, 12 research vessels operated by NOAA, the U. S. National Science Foundation, the U. S. Coast Guard, and the Wood Hole Oceanographic Institution are providing routine data transfers.

The authors will outline plans to recruit additional vessels, improve metadata retrievals from vessels, expand data distribution, and advance data quality evaluation. The potential expansion of SAMOS activities to Australia and Europe will be discussed. Examples of applications of SAMOS observations will also be provided.

Session 2: Data Management (Poster presentation)(S2P5)

Climate information system and sea state through Capacity Building for Sustainable Development in Guinea-Bissau

Cherno Luis Mendes

Meteorological Service of Guinea-Bissau

Climate studies - resources for climate system modernization have lead to certain expectations - have permitted to establish regional climate change scenarios.

Considering such situations, the National Meteorological Institutes of Lusophone countries, with support from a Portuguese partner, the Evora University, and a meteorological consulting company, 'Audimobil-Télécommunication et Services Lda,' have established a project regarding motorization and modernization of weather/climate and sea state numerical information system. The system was designed by the Climate Information System and Sea State through Capacity Building for Sustainable Development (SICLIMAD) in Guinea-Bissau, São Tomé and Príncipe, and Cape Verde respectively.

NOTE: This is a translation of the summary of a document provided in French.

Session 2: Data Management (Poster presentation)(S2P6)

Microwave sea surface temperatures and climatologies

Chelle L. Gentemann

Remote Sensing Systems, USA

Inclusion of satellite sea surface temperatures (SSTs) in data fusion analyses, numerical models, or climatologies requires accurate estimates of retrieval errors. The main sources of errors for microwave satellite SST retrievals are due to spacecraft navigation, retrieval algorithm, and environmental scene errors. Comparisons to in situ data, other satellite SSTs, and blended SSTs products are all utilized to investigate errors in the microwave (MW) SSTs from AQUA AMSR-E. Individual retrieval errors are calculated, assuming that errors are independent and additive in a root-sum-squared sense. Errors are determined using collocations with buoys from the GTS network to calculate a 'global' daily mean bias and standard deviation. These mean errors are then adjusted using static lookup tables based on a priori knowledge of other error sources. Errors calculated in this manner are distributed in a new dataset that includes time of observation, MW SST, estimated bias, estimated standard deviation, and several other variables. Several climatologies based on infrared SSTs will be compared to the MW SST data.

Session 3: Product Development (Oral presentation)(S3O1)

Diurnal variability in the upper ocean

Chelle L. Gentemann **and Peter J. Minnett**

Remote Sensing Systems, USA

Several recent studies have concluded that coupled climate models should utilize a diurnally varying SST to examine the details of the boundary layer response and ensuing air-sea interactions. This requires a model of diurnal warming and estimates of model error. A new diurnal model has been developed, specifically developed to determine the diurnal warming at the ocean surface and its vertical structure. The global distribution of diurnal warming is clearly linked to wind speed and will therefore respond to the climatic distributions and seasonal or anomalous changes in wind speed, as shown by the response to ENSO wind speed anomalies. The Subtropical High regions in each ocean basin, and the Tropical Indian and Western Pacific Oceans have the largest averages of diurnal warming. The intra-day variability of surface warming has been related to the stability of the boundary layer and atmospheric convection. Since the tropical convection is an important driver of global atmospheric circulation, this example of ocean-atmospheric feedback underscores how diurnal warming of the ocean surface may influence larger scale weather patterns and climate.

Session 3: Product Development (Oral presentation)(S3O2)

Use of satellite records and power spectra to model an observational error of bin-averaged in situ climate data

Alexey Kaplan

Lamont-Doherty Earth Observatory of Columbia University, USA

Objective analyses of historical marine climate data sets require specifications of error for the input climate data. In situ ocean observations usually enter analysis procedures as averages over space-time bins. Their error is due to both an incomplete sampling of the bin volume and a measurement error of individual data reports. The former depends on the full space-time variability of the climate field within the bin and on applicability of the assumption of randomness for the observational sampling of the bin. Twenty years of the satellite-based Pathfinder SST data set were used to produce maps of spatial and temporal variability of SST within monthly bins on a one degree and a five degree spatial grids. Comparisons of the modeled error with the actual differences between one degree bin averages of ICOADS data and satellite SST supported the assumption of random distribution of ICOADS reports within individual one degree bins, but required taking into account their measurement error (Kent and Challenor, 2006). For a five degree grid, variability estimates obtained here were generally consistent with those of Rayner et al. (2006) and the measurement error term was found to be negligible compared to the spatial variability. The assumption of random distribution of observational data points seemed in general less applicable for five degree bins than for one degree bins. When a wavenumber power spectrum description of the climate field is available, observational error models for different grids can be easily converted to each other without recalculating intrabin space-time variability for a new grid from satellite data. This approach can also be applied to error modeling for surface winds.

Session 3: Product Development (Oral presentation)(S3O3)

Estimating Uncertainty of Historical SST Analyses by a Cross Validation Technique

Yoshikazu Fukuda [1], **Masayoshi Ishii** [2] **and Shoji Hirahara** [1]

1) Climate Prediction Division, Japan Meteorological Agency
2) Frontier Research Center for Global Change, Japan Agency for Marine-Earth Science and Technology

In 2003, we produced a set of gridded data of sea surface temperature and marine-meteorological elements (COBE). Later on, these data have satisfied wide range of demands in operational and research activities in Japan. Among those, one application of COBE was done in “Japan Reanalysis” which was completed in 2006.

In addition to investigating an accurate analysis with marine observations, it is necessary to consider uncertainty in gridded data. The present COBE product contains the analysis errors estimated on the basis of the optimum interpolation theory. They are useful in some cases but they are simply given by a function of the number of observed data. Further investigation is needed to understand causes of the errors in the analysis and to apply the analysis to various climate studies. For instance, the uncertainty is taken into account sometimes when initializing dynamical models with the SST analysis by an ensemble technique widely taken in operational centers.

As stated in our previous report at MARCDAT-II, a cross validation technique detected the reproducibility of the historical SST variations among different analysis methods with given observed data for each decade. The technique also presented a kind of measure of the accuracy or uncertainty of the SST analysis. However, the source of uncertainty in the SST analysis are not only the sparseness of observed data but also the analysis parameters and the quality control procedures that we happen to choose. We will discuss uncertainty in the SST analysis from various points of view together with some methodologies for evaluation of the uncertainty. The improvement of COBE will also be presented.

Session 3: Product Development (Oral presentation)(S3O4)

Fast data fusion and its role in developing climate quality sea surface temperature data sets from multiple data sources

Julian G T Hill [1], **Martin N Juckes** [1] **and P W Fieguth** [2]

1) Science and Technology Facilities Council, UK
2) University of Waterloo, UK

Using a fast hierarchical method to estimator of the Kalman Filter to blend together sea surface temperature (SST) records from multiple instruments to produce a high resolution SST analysis. The data that is used is the (A)ATSR multimission archive (Level 2 Meteo Product) and the AVHRR Pathfinder data from 1991 to 2005 inclusive. The method is used to reconstruct the North Atlantic region in three stages and these stages are compared for two different scenarios; one which only uses Pathfinder data and one which combines Pathfinder and (A)ATSR. The results of these analyses are presented and intercompared. The method is computationally suitable for inclusion in ensembling techniques.

Session 3: Product Development (Oral presentation)(S3O5)

The Influences of Differing Temperature and Moisture Roughness Length Parameterizations on Height Adjustment and Turbulent Surface Fluxes

Mark Bourassa [1, 2], **Lisa Bucci** [2], **Carol Anne Clayson** [2], **Charlene Forgue** [2], **Matt Onderlinde** [2] **and Brent Roberts** [2]

1) Center for Ocean-Atmospheric Prediction Studies, USA
2) Department of Meteorology, Florida State University, USA

Height adjustment of winds has been considered reasonably insensitive to the choice of roughness length parameterization. However, there are much greater differences in roughness length parameterizations for temperature and moisture. We examine roughness lengths based on a smooth surface, and more elaborate models (Liu et al. 1979; Clayson et al. 1996; Zilitinkevich et al. 2001). The functional forms of these parameterizations are quite different, resulting in different roughness lengths. Consequently, there are systematic (not random) changes in height adjusted values, turbulent fluxes, and atmospheric stability, which can also cause changes in the stress. We demonstrate that height adjustment of potential temperature and humidity are substantially dependent on the parameterization of their respective roughness lengths. Furthermore, these parameterizations influence the magnitude of surface turbulent fluxes. Differences in height adjusted air temperature can exceed 1.5°C and humidity differences can exceed 2 g/kg. The resulting relative biases are quite substantial. They will change spatial/temporally due to regional differences in roughness lengths, and change temporally due to changes in observation height. Plans to adjust observations to a uniform height should consider this issue prior to provided adjusted data to the community.

Session 3: Product Development (Oral presentation)(S3O6)

Testing the robustness of the proposed HadISST2 analysis using pseudo-world methods

Nick A Rayner [1], **Jen Hardwick** [1], **John J Kennedy** [1] **and Simon F B Tett** [2]

1) Met Office Hadley Centre, UK
2) School of Geosciences, University of Edinburgh, UK

We are currently developing our next generation SST and sea ice analysis, HadISST2, for the period 1850 onwards. Our aim is to produce a flexible system to create analyses on user-specified resolutions, with fully quantified uncertainty estimates. Our analysis system employs EOFs estimated using an Expectation-Maximization technique to capture covariance between observations, enabling reconstruction of complete fields using a reduced space optimal approach. We test this system in an 'ideal world' setting using degraded fields from the HadGEM1 model and discuss our findings and their implications for the uncertainty in HadISST2 related to analysis methodology. We aim to explore, for the first time, the sensitivity of the reconstruction techniques to realistic inputs in a situation where the 'truth' is known. Real data are known to have non-gaussian correlated errors, slowly varying biases and systematic sampling problems. We illustrate the effect that these can have on the veracity of the reconstruction and the estimated analysis uncertainties.

Session 3: Product Development (Poster presentation)(S3P1)

The extreme storm in the south-western Baltic Sea in November 1872 – a reanalysis of the wind fields for coastal protection purposes

Gudrun Rosenhagen

Deutscher Wetterdienst, Hamburg, Germany

In November 1872, a devastating storm occurred in the south-western Baltic Sea. The most outstanding water levels by far since the beginning of instrumental registrations were recorded along the Danish and German coasts and since then, there has not been any situation like that.

The sheer enormity gives reasons for special research. Of course, there is particular interest among coastal engineers to reconstruct the weather situation as exactly as possible using present-day methods. In order to demonstrate the dimension of this storm surge event and for better understanding the complex causes of this extreme event a comprehensive study was carried out aiming at reconstructing the wind fields in November 1872.

The Baltic Sea is a brackish inland sea. The only flow in and out occurs through the relatively narrow Danish straits. The mechanisms inducing high water levels differ from those at open sea. Beside wind stress and air pressure influence, the filling level of the Baltic Sea and the seiche are relevant, whereas the tidal influence is relatively small. The filling level of the Baltic Sea is determined by the inflow from the North Sea during the preceding 2 to 3 weeks. Thus it was necessary to investigate the weather development in all northern Europe for a longer period before the storm surge event happened.

As there are insufficient wind data from those early days, the wind field was estimated indirectly by calculating the geostrophic wind from pressure readings. We succeeded to get pressure readings from 175 stations from northern and central Europe more than 50 of which had at least two readings per day. After a comprehensive data check as to status of reduction, unit, time, geographic position, height etc. the pressure fields of the period November 1 to 13 were analysed manually. The pressure fields were digitized and raster data for a 0.5 degree x 0.5 degree grid evaluated. These gridded pressure fields were used to calculate the geostrophic wind. Those data, in turn, were reduced to 10 m height above sea level.

The data set is an extremely valuable information for coastal engineers enabling them to model the hydrographic conditions, as the water level, waves and currents to estimate the impact, a similar severe storm would cause nowadays.

Session 3: Product Development (Poster presentation)(S3P2)

Estimates of ocean heat uptake and their uncertainty

Matthew D. Palmer [1] **and Keith Haines** [2]

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2) NERC Environmental Systems Science Centre, University of Reading, UK

Estimates of oceanic heat uptake provide one of the strongest observational constraints for assessment of coupled climate models. However, the poor temporal and spatial coverage of historical subsurface temperature measurements means that heat uptake estimates are sensitive to the assumptions made in data sparse regions. A typical approach to filling data gaps is to use "spatial infilling," i.e. contemporaneous data points are used to inform missing data areas. This spatial infilling can be done directly using de-correlation length scales, or through use of error covariances by projecting the observations onto known modes of variability. An alternative approach is to use "temporal infilling," where co-located observations recorded at different times are used to fill the data gaps. We explore the use of simple temporal and spatial infilling for estimating long term oceanic heat uptake and present progress in quantifying uncertainties.

Session 3: Product Development (Poster presentation)(S3P3)

Optimal Estimation for Retrieving Sea Surface Temperature

Christopher J Merchant

The University of Edinburgh, UK

(No abstract text available.)

Session 3: Product Development (Poster presentation)(S3P4)

Uncertainties in SST and Sea Ice Analyses

Nick A Rayner

Met Office Hadley Centre, UK

The Global Climate Observing System (GCOS) SST & SI Working Group (WG) exists to record and evaluate the differences among historical and near real time SST and SST/SI analyses and identify the sources of differences in the analyses. On the basis of comparison of those differences with the expected climate signals in the SST patterns, the WG should recommend actions needed to ensure the quality and consistency of the SST and SST/SI analyses and establish criteria to be satisfied by those analyses to ensure the quality and consistency required by GCOS. Inter-comparisons are motivated in particular by the necessity to evaluate: accuracy of products (as distinct from relative differences); uncertainties, climatologies and the effectiveness of bias corrections; impacts of assumptions of stationarity of means and covariances and of other a priori assumptions; representations of secular and interannual variability and the effects of applying different QC methodologies to common input data. The driving consideration behind these is the need to accurately define the climate change signal.

We present recent progress towards achieving this aim.

Session 4: New Climate Products and Intercomparisons (Invited presentation)(S4O2) (note: S4O1 was withdrawn)

Advances in the AVHRR Pathfinder Sea Surface Temperature Climate Data Record and its Connections with GHRSST Reanalysis Activities

Kenneth S. Casey [1], **Craig J. Donlon** [2] **and Nick A Rayner** [2]

1) NOAA National Oceanographic Data Center, USA
2) Met Office Hadley Centre, UK

Significant advances have been made in the production of sea surface temperature (SST) climate data records since the Second JCOMM Workshop on Advances in Marine Climatology (CLIMAR-II) was held in November of 2003. Two related but until now distinct programs have largely enabled this progress: the GODAE High Resolution SST (GHRSST) project and the AVHRR Pathfinder effort. GHRSST is an international collaboration to deliver commonly-formatted SST data with uncertainty estimates from all available satellite platforms, while Pathfinder is a reprocessing of the AVHRR series which extends back to the 1980s. The NOAA National Oceanographic Data Center has been leading the Pathfinder Version 5 effort since 2001 and serves a critical role in GHRSST as its Long Term Stewardship and Reanalysis Facility (LTSRF). Because of the natural synergies of these efforts, NODC is actively merging the Pathfinder data into GHRSST through a comprehensive effort to modernize Pathfinder reprocessing hardware and software, transfer the reprocessing capability from an academic setting at the University of Miami to NOAA, and add the critical uncertainty estimates needed for any robust climate data record. This next generation of AVHRR Pathfinder data will be formatted according to GHRSST standards and will serve as a key baseline for the existing GHRSST climate data record activities, which including several global high resolution SST reanalysis efforts and multi-product ensemble intercomparisons. Also connected to these activities are the efforts of the Global Climate Observing System's SST and Sea Ice Working Group, which is establishing an intercomparison framework at the GHRSST LTSRF to connect the historical reconstruction SST reanalyses to the modern satellite-based climate data records. The current status of these increasingly linked efforts will be presented along with specifics on the latest Pathfinder Version 5 data and the future availability of Pathfinder Version 6.

Session 4: New Climate Products and Intercomparisons (Oral presentation)(S4O3)

Inter-comparison of Historical Sea Surface Temperature Datasets

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2) Tohoku University, Japan

Seven historical sea surface temperature (SST) datasets; the Hadley Center sea ice and SST (HadISST) dataset version 1, the centennial in-situ observation-based estimate of SSTs (COBE), the extended reconstruction of global SST (ERSST) version 2, the optimal smoothing analysis by the Lamont-Doherty Earth Observatory (LDEO), the global monthly summaries of the International Comprehensive Ocean-Atmosphere Data Set (COADS), the Hadley Center SST (HadSST) version 2, the SSTs by the authors at Tohoku University (TOHOKU), are compared with each other. Differences in 30-year climatology and standard deviation of anomaly from the climatology exist especially in the observation sparse areas and periods. Correlation among the datasets mainly depends on the number of observational data. Global means are well consistent with each other, while long-term trends in each grid show differences. Signals of the El Niño/Southern Oscillation (ENSO) highly correlate with each other after 1880, although durations and intensities of each event are different. Temporal variations of the Pacific Decadal Oscillation (PDO) correspond well after 1950, while they are scattered before 1880. These differences would be ascribed to interpolation methods for missing grids, treatments of satellite-derived data, instrumental bias correction methods, and others.

Session 4: New Climate Products and Intercomparisons (Oral presentation)(S4O4)

A project to create bias-corrected marine climate observations from ICOADS

Shawn R. Smith [1], **Mark A. Bourassa** [1], **Scott D. Woodruff** [2], **Steven J. Worley** [3], **Elizabeth C. Kent** [4] **and Nick A Rayner** [5]

1) Florida State University, Center for Ocean-Atmospheric Prediction Studies, USA
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3) National Center for Atmospheric Research, Boulder, CO, USA
4) National Oceanography Centre, Southampton, UK
5) Met Office Hadley Centre, UK

The authors will present a conceptual design for a proposed international project that will result in a bias-corrected version of the International Comprehensive Ocean-Atmosphere Data Set (ICOADS). The primary goal of the project is to develop a set of individual marine reports from ICOADS that are "corrected" in a manner that best represents our current state-of-the-art. The corrections could include (but are not limited to)

- Ship heating,
- Beaufort wind adjustments,
- Height correction,
- Adjustments for known instrument variations, and
- Enhanced QA/QC procedures, including improved platform and measurement method indicators.

All correction factors are anticipated to have associated uncertainty estimates. We expect that the corrections will be applied to the entire ICOADS period (currently 1784-2007, but to be extended back to 1662 in 2008); therefore, the corrections will probably need to vary in time (e.g., ship heating corrections for metal ships would not likely apply to wooden vessels).

Secondary goals of the proposed project would use the corrected ICOADS set to develop new monthly climatologies (i.e., effectively providing an update to the 1994 da Silva et al. climatology), improved ICOADS Monthly Summary Statistics, and marine climate indices. The corrected observations and summaries would be made available via the ICOADS group for the international user community. The outcomes from the proposed activity would form a "master" marine climate data set that includes bias correction and uncertainty measures. The master set would pull together our combined knowledge and efforts of the past several decades to create a global community resource that would not only be available for future generations of scientists, but will also provide a framework to add and improve corrections as the state-of-the-art evolves.

The authors will present an overall structure to the proposed project which will include a flexible central data management that will accommodate data improvements from various groups, a mechanism to define and determine correction factors, and the development of products for the community.

Session 4: New Climate Products and Intercomparisons (Oral presentation)(S4O5)

Reconstruction of interdecadal variability of air-sea interaction in the Atlantic 1880-2004: links to atmospheric circulation patterns

Sergey Gulev

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Using 125 years (1880-2004) of Voluntary Observing Ship (VOS) observations from ICOADS we reconstruct surface ocean-atmosphere heat fluxes over the North Atlantic with monthly resolution in time and variable (2-degree to 5-degree) resolution in space. Methodology of reconstruction is based on the homogenization of sampling density, application of the double-exponential distributions of turbulent fluxes for minimizing sampling errors and the use of specially adopted for incomplete data coverage bulk-algorithms. In particular, a multi-regressive approach is used to reconstruct atmospheric humidity, playing important role in estimation surface fresh water fluxes. The methodology was first validated using the time series from VOS and reanalyses for the well sampled last several decades. Further analysis included computation of monthly anomalies of surface fluxes as well as estimation of the subpolar gyre heat and freshwater budgets. These were computed using two-dimensional distributions of surface fluxes in the coordinates of sea-air temperature difference and wind speed. Reconstructed fluxes reveal long-term trends, implying, for example, about 4 W/m2 per decade growing sensible heat fluxes in the Labrador Sea and about 2 W/m2 per decade secular increase in the Central subpolar gyre. Non-secular signals are represented by the decadal-scale and multidecadal (about 40-50 years variability). Decadal scale signal has a clear association with the NAO-like atmospheric circulation variability during 1880-1915 and after 1955, but has a little association with NAO between 1915 and 1955. The approach formulated allows also for the derivation of the heat energy budgets in different Atlantic regions. These budgets can be alternatively quantified form the oceanographic full-depth sections. Time series of the budget estimates were derived for 2 large regions (subpolar, mid latitudes) and their association with ocean dynamics and atmospheric circulation anomalies was discussed.

Session 4: New Climate Products and Intercomparisons (Oral presentation)(S4O6)

Marine Climatologies from Satellite Remote Sensing, as viewed through a Geographic Information System

Martin J. Rutherford

Defence Oceanographic Data Centre, Australia

The advent of space based sensors able to observe the marine environment provides a potential new stream of data for inclusion in climate products. Whilst the parameters observable from space are limited, and often confined to the open ocean, the data are voluminous, consistent and more widespread than traditional in-situ measurements.

The development and use of satellite derived climatologies by the Australian Defence Oceanographic Data Centre will be discussed and comparisons of satellite derived and in-situ based climatologies for wind, significant wave height, moisture, cloud and precipitation provided.

The presentation makes use of Geographic Information System (GIS) software and demonstrates the powerful visualisation and query tools available using this relatively new technology.

Session 4: New Climate Products and Intercomparisons (Oral presentation)(S4O7)

The WMO Commission for Climatology Expert Team on Climate Monitoring including the use of satellite and marine data and products

Craig Donlon [1] **and co-authors**

1) Met Office, UK

(No abstract text available.)

Session 4: New Climate Products and Intercomparisons (Oral presentation)(S4O8)

A New NOCS Dataset of Sea Surface Heat Fluxes

David I. Berry **and Elizabeth C. Kent**

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Marine meteorological reports from Voluntary Observing Ships (VOS) such as those in the International Comprehensive Ocean-Atmosphere Data Set (ICOADS) are an important source of information on air-sea heat exchange. ICOADS has been used as the source for many air-sea interaction datasets, including the National Oceanography Centre, Southampton (NOCS) Flux Climatology. The NOCS Flux Climatology was released in two versions: NOCS1.1, the unconstrained fields available as both climatological and individual monthly fields, and NOCS1.1a, climatological monthly fields adjusted using estimates of ocean heat transport and global balance and constraints.

An updated version of the NOCS Flux dataset will be presented. The new dataset, NOCS2.0, uses optimal interpolation (OI) to allow estimates of uncertainty to be made. Daily estimates of the basic meteorological variables (wind speed, pressure, air temperature, humidity, sea surface temperature and cloud cover) are made using an optimal interpolation scheme applying bias corrections where possible. These daily fields are then used to calculate daily bulk estimates of sensible, latent, shortwave and longwave heat fluxes. Random measurement uncertainty is accounted for within the OI scheme and the use of daily data enables the sampling uncertainty to be estimated. Bias uncertainty is also estimated.

The heat fluxes are presented on a 1x1˚ monthly grid covering 1970 to 2006 and include estimates of both the random and bias uncertainties for each flux component.

Session 4: New Climate Products and Intercomparisons (Poster presentation)(S4P1)

The GCOS SST/SI Intercomparison Framework for Global SST Analyses

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Global and near-global SST analysis products are created using a wide range of statistical reconstructions and interpolations that are applied to datasets from a variety of input platforms. These datasets are subjected to quality control processes, bias corrections, and input from sea ice data as well as a priori assumptions. The result of these different analysis routines is a collection of products that can say subtly or significantly different things about the changing climate. Indeed, because these analyses contribute to our understanding of the global climate, it is essential that we understand the origin and nature of their differences. Thus, as part of the Global Climate Observing System (GCOS) Sea Surface Temperature (SST) and Sea Ice (SI) Working Group, the National Oceanographic Data Center has undertaken a project to record and evaluate differences among SST/SI analyses, identify the sources of those differences, and, by comparing those differences to expected climate signals in the SST patterns, recommend actions and criteria to ensure the quality and consistency of the SST/SI analyses. In order to quantitatively evaluate the differences between analyses, we first create a framework of standard diagnostics. These include global fields of standard deviation, RMS differences, time-averaged differences, spatial correlations, and global and hemispheric anomalies. Manipulation of these statistical metrics is possible through active online tables that allow application of each test to any combination of SST analyses. This online interface is a central feature of the project, allowing interaction both among members of the working group as well as with the user community. The website, an extension of the NODC GODAE High Resolution Sea Surface Temperature (GHRSST) website (http://ghrsst.nodc.noaa.gov), makes both the analysis products and their various intercomparisons accessible to the general public. The intercomparison diagnostic framework is tested using a set of our own analysis products of varying spatial and temporal resolution and coverage. These include the AVHRR Pathfinder Version 5.0, Daily Optimally Interpolated SST, Operational AVHRR, Hadley Centre SST, Kaplan et al, Extended Reconstructed SST Version 2, and Optimally Interpolated SST Version 2 datasets. To facilitate intercomparison, these products are all formatted to gridded one-degree weekly averages as well as gridded five-degree monthly averages. Each product is available in GHRSST and CF-compliant netCDF as well as Matlab and ASCII data formats for ease of transfer and manipulation. This combination of varied analysis products, subjected to a standardized suite of intercomparison tests, allows for better understanding of the products themselves, the processes used to create them, and ultimately the conclusions they afford about the changing global climate.

Session 4: New Climate Products and Intercomparisons (Poster presentation)(S4P2)

Towards an independent time series of sea surface temperature from satellite observations

Christopher J Merchant [1], **Owen Embury** [1], **David Llewellyn-Jones** [2], **Elizabeth C. Kent** [3], **Nick A Rayner** [4] **and Roger Saunders** [5]

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Recent decades are a period of relatively rapid climate change. This period is also one during which the composition of the in situ observing system for sea surface temperature measurement has rapidly evolved. This raises the unsatisfactory possibility that some apparent change could in truth arise from the evolution of the observing system – or that real trends in SST could be masked.

An independent time series of SST from satellite observations could provide useful constraints on the interpretation of in situ data, if such a time series were of sufficient accuracy and stability. The purpose of this paper is to report on progress towards this goal within the project, (A)ATSR Re-analysis for Climate, (A)RC.

(A)RC will completely re-work the SST records from the series of (Advanced) Along Track Scanning Radiometers, the (A)ATSRs. These are the only SST-capable sensors whose radiometric characterization and calibration approach those required for climate-quality SSTs independent of the in situ record. The 'version 2' (A)ATSR SSTs currently available have known biases and artifacts that will be corrected within (A)RC, the aim being to achieve v3 SSTs that are of climate quality and are fully error quantified for both random and systematic effects.

Session 4: New Climate Products and Intercomparisons (Poster presentation)(S4P3)

The use of marine data in detection and attribution and other climate modelling activities.

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This paper will discuss some of the recent developments in the use of marine data for attribution of climate change. These include the detection of an anthropogenic influence on sea surface temperatures in the Atlantic and Pacific cyclogenesis regions and the detection of increasing salinity at low latitudes. Such studies are indicating the potential for using observations to constrain important properties of the climate system's response to anthropogenic forcing.

Session 5: Observation-based Analyses of Climate Variability and Change (Invited presentation)(S5O1)

Recalculation of global ocean heat content 1955-2006 in light of recently revealed instrumentation problems

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Recent focus on instrumental biases and data recording problems have prompted the reexamination of ocean heat content calculated from in situ observations. Warm biases have been shown in XBT (and MBT) temperatures in comparison with bottle and CTD observations. But for most of the 1970s through the 1990s, data distribution of temperature observations without inclusion of XBT data is too sparse for global heat content calculations. Time varying XBT and MBT biases are estimated by statistical checks against nearby CTDs and bottle temperature measurements. Cool biases due to pressure offsets during data recording in a significant subset of profiling floats have also recently been discovered. It is anticipated that these pressure offsets can be corrected, but these corrections are not yet available. Here we present yearly heat content calculated using XBT and MBT profiles corrected for the instrumental biases and excluding floats with a cool bias. Comparisons are made with heat content without bias corrections. Other possible methods for dealing with the XBT warm bias are discussed.

Session 5: Observation-based Analyses of Climate Variability and Change (Oral presentation)(S5O2)

Near Surface Ocean Temperature: Trends and Interdecadal Variability

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Long-term temperature trends in the upper few hundred meters of the ocean are calculated from gridded observed data (World Ocean Database 2005) to explore spatial and temporal trend variability. There is much spatial structure in subsurface 50-year trends, with areas of strong warming and strong cooling. This in contrast with the surface ICOADS trends that show strong warming nearly everywhere over the same period. There is strong interdecadal variability at both the surface and subsurface, which is characterized here via overlapping 20-year trends; almost every region studied shows both warming and cooling 20-year trends over a 50-year period. Time series of temperature in many sub-basin-scale regions reveal strong changes in temperature with "regime-shift-like transitions," interpentadal and interdecadal variability present. It is clear that such long-term shifts in temperature can bias 20-year trends, but it is less clear how well longer-term trends represent temperature changes due to heating given that interdecadal variability and regime shifts occur at the surface and in the subsurface records.

Session 5: Observation-based Analyses of Climate Variability and Change (Oral presentation)(S5O3)

Isolating the signal of ocean global warming

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Identifying the signature of global warming in the world's oceans is challenging because low frequency circulation changes can dominate local temperature changes. The IPCC fourth assessment reported an average ocean heating rate of 0.21 ± 0.04 Wm^{-2} over the period 1961-2003, with considerable spatial, interannual and inter-decadal variability. We present a new analysis of millions of ocean temperature profiles designed to filter out local dynamical changes to give a more consistent view of the underlying warming. Time series of temperature anomaly for all waters warmer than 14°C show large reductions in interannual to inter-decadal variability and a more spatially uniform upper ocean warming trend than previous results. The average heating rate for waters warmer than 14°C was 0.12 Wm^{-2} over 1956-2004. This new measure of ocean warming is also more robust to some sources of error in the ocean observing system. Our new analysis provides a useful addition for evaluation of coupled climate models, to the traditional fixed depth analyses.

Session 5: Observation-based Analyses of Climate Variability and Change (Oral presentation)(S5O4)

Monitoring El Niño/Southern Oscillation Behaviour with an Improved Multivariate ENSO Index (MEI)

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This paper addresses the need for an internationally acceptable ENSO index that allows for the global definition of ENSO events under operational, near-realtime conditions. The Multivariate ENSO Index was originally defined as the first Principal Component of six atmosphere-ocean (COADS) variables in the tropical Pacific basin. It provides for a more complete and flexible description of the ENSO phenomenon than single variable ENSO indices such as the SOI or Niño 3.4 SST. Here we describe a new effort to expand the MEI concept to include both satellite (OLR) and subsurface data. Since these data sets are only available for the last two+ decades, this project includes historical analyses to intercompare the new MEI with the original and other hybrid versions that go back further in the record.

Session 5: Observation-based Analyses of Climate Variability and Change (Oral presentation)(S5O5)

Historical chronologies of El Niño Events and Instrumental ENSO indices

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Historical chronologies of El Niño events (by W.Quinn with collaborators and their recent revisions by L.Ortlieb) are trustworthy and very useful for many climate applications. However, the way they were produced sometimes resembles art, rather than hard quantitative science. W.Quinn presented a general scheme of converting the evidence for synchronous sets of El Niño-suggesting factors into a chronology of events occurrence and intensity. He provided references for these factors, but in most cases did not demonstrate how the intensity was derived from the evidence. His evidence set represents mostly coastal ocean and land impacts, plus a few teleconnection factors. These indicators are quite different from typical El Niño indices (e.g. NINO3 or SOI) used today for monitoring or prediction. Nevertheless, consistency between Quinn's rating and instrumental indices like NINO3 or SOI is statistically significant; the outliers are usually excused on the grounds that historical and instrumental indices measure different things. This work attempts to bring Quinn's ratings, Ortlieb's revisions, and the evidence on which they are based, into the context of the newest analyses of instrumental data for the last two centuries. Objective analyses of sea surface temperature, sea level pressure and surface winds from ICOADS based on the marine data are compared with two centuries of historical chronologies. The instrumental data indices show a remarkable cross-variable agreement, particularly good for strong events. Revisions to historical chronologies of El Niño events are proposed.

Session 5: Observation-based Analyses of Climate Variability and Change (Oral presentation)(S5O6)

Changes of the Thermohaline Circulation of the Nordic Seas and Climate

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Dramatic changes in the Arctic climate observed in recent years have generated an urgent need to investigate the Arctic Ocean's heat budget. Transport of the warm and salty Atlantic Water through the Fram Strait is one of the most important components of the Arctic Ocean climate system. Synoptic observations conducted by the Institute of Oceanology Polish Academy of Sciences in the area of the West Spitsbergen Current and Fram Strait, show summer-to summer changes of the Atlantic Water properties and flow structure. Progressive warming of the West Spitsbergen Current was observed since 2004. During summers 2004-2006 isotherm 5ºC at 100m has moved meridionally 4.5º northward. In summer 2006 temperature of Atlantic Water core reached record-high values.

Two branches of the West Spitsbergen Current carry northward Atlantic Water. The core is a prolongation of the mostly barotropic Norwegian Atlantic Slope Current, and flows over the Barents Sea shelf break. The western branch flowing over the underwater ridges is a continuation of the outer branch of the Norwegian-Atlantic current. Intensity of the flow in each branch and mesoscale activity changes over the time. Our observations revealed large positive heat anomalies advected along the western branch in 2005 and 2006. The biggest anomaly carried northward heat surplus enough to melt 130000 square km of 1 m thick sea ice. It coincided with extensive northward shifting of the ice margin.

For a long time the atmosphere and its warming was seen as the main cause of the Arctic Ocean sea-ice shrinking. Only recently influence of the ocean and its heat transport is more and more recognized as very important factor influencing changing of sea ice coverage. The IOPAS data on the West Spitsbergen Current temperature, heat content and transport are confronted with the sea ice extension north of Svalbard. Good agreement between the Atlantic Water layer heat anomaly in July and sea ice extend in next winter is presented.

In summer 2007 the Atlantic Water layer temperature has decreased, probably it could be the beginning of reversing trend in the Atlantic Water temperature.

Session 5: Observation-based Analyses of Climate Variability and Change (Oral presentation)(S5O7)

Using Ships' Logbooks to Understand the Little Ice Age (1685 to 1750): developing a new source of climatic data

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Coordinated efforts have recently been made to publicise the potential of early ships' logbooks as a source of valuable climatic data. Principal amongst these has been the CLIWOC project (Climatic Database for the World's Oceans: 1750 to 1850, see also www.ucm.es/info/cliwoc). This project produced a database of 300,000 observations, and developed methods of processing the non-instrumental observations of wind force and direction that constitute the majority of data from before the mid-nineteenth century. This project is the subject of a separate poster presentation. This oral presentation draws on the CLIWOC experience but extends the record for a further 75 years to 1685. It reinforces the findings of the project that suggest logbooks to be a rich source of marine climatological data, the non-instrumental character of which is no obstacle to its scientific value. Account is taken of the increasingly limited number and geographic range covered by the logbooks as one goes back through the centuries. Fortunately they are sufficiently large in number to provide a daily series for the English seas from 1685 to 1750; this period being the oldest for which such a continuous series can be constructed. The presentation will demonstrate the nature of such archaic climatic information, its vocabulary and how the logbook information can be expressed in modern-day Beaufort terms. Attention will be drawn to the advantages offered by this data source, in particular its abundance, its intrinsically high degree of homogeneity and its reliability even at this distant point in time. The daily database for the period of corrected and homogenized data will be presented and discussed. The presentation reviews the climatic evidence offered for a period that embraces some interesting climatic phases These include the cold decades of the 1680s and 1690s and the warming phase of the 1730s, the Great Storm of 1703 and the intensely cold year of 1740. Data will be presented in terms of derived indices for storminess, westerliness and zonality and precipitation. The dataset will be compared with contemporary data such as the Central England temperature and the Paris air pressure series in order to test its coherence and to demonstrate how it can be used with others to provide a more comprehensive impression of past climates, and one that extends our view to include the marine environment, something not hitherto possible with this degree of temporal resolution and such a high degree of confidence. Finally attention will be drawn to the future possibilities of this vast source and to the very large number of logbooks both in the UK and abroad that have yet to be examined and their contents digitized and exploited in our search for a better knowledge of past climates.

Session 5: Observation-based Analyses of Climate Variability and Change (Oral presentation)(S5O8)

The Characterisation of Marine Climate Using Indices

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Climate change is a complex process whose details need to be distilled to provide simple information for non-specialists, such as politicians. The use of indices is well developed for land based applications. Over land long time series of data are often available and there is a need to provide climatological information on mean temperature changes and high impact events such as droughts, growing season lengths and heatwave durations. The Intergovernmental Panel on Climate Change present many such indices in their Assessment Reports.

Marine indices in current use are either based on large scale temperature averages (e.g. global mean surface temperature, sea surface temperature in El Niño regions) or large scale pressure fields (e.g. North Atlantic Oscillation, Pacific North America Pattern). There is considerable scope for improving the characterisation of the global oceans and regional seas using indices based on marine data. The Expert Team on Climate Change Detection and Indices (ETCCDI) is a joint panel co-sponsored by the World Meteorological Organisation (WMO) Commission for Climatology (CCl), CLIVAR, and more recently, by the Joint WMO/Intergovernmental Oceanographic Commission (IOC) Technical Commission for Oceanography and Marine Meteorology (JCOMM). JCOMM was invited to co-sponsor the ETCCDI in 2005 in recognition of the potential importance of marine indices and to help stimulate their development.

This presentation will provide an introduction to indices and include a short summary of the marine indices in current use. The potential for new marine indices has recently been reviewed by the ETCCDI. Building on this discussion, indices will be developed relating to winds, waves, sea ice, temperatures, sea level and ocean heat content. The presentation is intended to form a background to a plenary discussion on marine indices where input from scientists and marine data experts will be sought on all aspects of the development, maintenance and presentation of marine indices.

Session 5: Observation-based Analyses of Climate Variability and Change (Invited presentation)(S5O9)

Accuracy and Variability of the Turbulent Surface Fluxes over the North Atlantic from VOS Observations

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A new surface flux dataset has been developed at the National Oceanography Centre Southampton using VOS observations, NOCS2.0. This dataset updates previous versions of the NOC Climatology (versions 1.1 and 1.1a), extending the period of the dataset, applying new bias corrections, improving the dataset construction methods and providing uncertainty estimates.

This new dataset is used to examine the variability of the surface fluxes over the North Atlantic. The variability of turbulent air-sea exchange in the North Atlantic will be explained in terms of the variability in the underlying meteorological parameters. The results will be compared to previous estimates, using the uncertainty estimates to understand any differences.

Session 5: Observation-based Analyses of Climate Variability and Change (Poster presentation)(S5P1)

Wind at the Island Hvar on the Middle Adriatic Sea

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One of the most important meteorological factors on the Adriatic is certainly the wind with its speed and force (according to the Beaufort scale) and its directions, which are mostly caused by atmospheric disturbance transfer or its occurrence over the Adriatic, orographic configuration, climate and both geographical and oceanographic characteristics. Knowledge of the wind is very important in maritime meteorological security for the protection, namely in navigation, fishing, nautical and other human maritime activities.

This paper is the result of the celebration of the two anniversaries. The first was due to the 190th birth anniversary of the famous Hvar scientist and researcher Grgur Bučić, the founder of the meteorological station in Hvar, the island of Hvar, the 150th anniversary of which is to be celebrated in 2008. This paper is a modest contribution to the memory of these anniversaries. Thanks to the founder of the Hvar meteorological station in 1858 it was possible to research the meteorological characteristics of the winds in Hvar based on 150-year series of climatic data (with negligible discontinuity in series) and hourly periods from 1990 to 2006. We particularly researched frequencies of wind directions, speed and force in accordance with the Beaufort scale and scale of warning for boat and ship safety in the Adriatic and the characteristics of wind force greater than or equal to 6 Bf and greater than or equal to 8 Bf. We also researched various characteristics of the frequency and speed of winds as for example for three 50-year periods (1858-1907, 1908-1957, 1858-2006) in relation to 150-year series (1858-2006). From these observations we noted certain specificities of winds on Hvar which may refer to conditional and important climate changes. Those changes could be connected to general circulation, frequency of baric creations over the Adriatic such as cyclones and anticyclones of temperate latitudes.

Session 5: Observation-based Analyses of Climate Variability and Change (Poster presentation)(S5P2)

Observations of new western Mediterranean deep water formation using Argo floats 2004-2006

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The deep convection that occurs in the western basin of the Mediterranean Sea was investigated using Argo float data over two consecutive winters in 2004-2005 and 2005-2006. The results showed deep mixed layers reaching 2000m in surprising locations, namely the eastern Catalan subbasin (39.785˚N, 4.845˚E) and the western Ligurian subbasin (43.392˚N, 7.765˚E). Subsequently, new deep water was formed in March of 2005 and 2006 with θ = 12.89-12.92˚C, S = 38.48-38.49 and σθ = 29.113 kg m^{-3}. The deep water produced in the Ligurian subbasin during 2006 was more saline, warmer and denser than any historical observations of Western Mediterranean Deep Water. The results show S, θ and σθ in the Western Mediterranean Deep Water are higher than 1990s values, with a salinity increase of 1.5×10-3 yr^{-1}, a temperature increase of 3.6×10-3˚C yr^{-1} and a density increase of $4.0×10^{-4}$ kg m-3 yr^{-1} apparent from a dataset of WMDW properties spanning 1955-2006.

Session 5: Observation-based Analyses of Climate Variability and Change (Poster presentation)(S5P3)

Long-term Trends of SST in the Seas adjacent to Japan

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In order to clarify differences in regional rates of surface ocean warming, the Japan Meteorological Agency (JMA) investigated long-term trends of Sea Surface Temperatures (SSTs) in the seas adjacent to Japan through analysis of in-situ data observed by vessels over the past 100 years.

The seas adjacent to Japan were divided into 13 areas on the basis of different patterns of SST variation by location. The monthly mean SST anomalies were calculated for the respective areas, and then compiled into annual and seasonal mean SST anomalies. Anomalies in the 1940's were unable to be determined owing to insufficient data during World War II.

Long-term time series of annual mean SST anomalies show linear warming trends in most areas at a rate of +0.7 to +1.6°C per 100 years with a statistical significance of 95% confidence level. The warming rates are larger than those of global SST (+0.50°C per 100 years). Specifically, warming trends are at a rate of +1.0 to +1.3°C per 100 years in many areas, and the rate is almost the same as that of annual mean surface air temperature in Japan (+1.1°C per 100 years). As for seasonal mean SST anomalies, warming trends are most prominent in autumn (October-December) and winter (January-March), whereas those of surface temperature in Japan are most prominent in spring (March-May). Seasonal difference in warming trends is greater than that of surface temperatures in Japan.

The larger trend in the seas adjacent to Japan than the global average is probably affected by the fast warming in the mid-latitude of the Eurasian Continent though the larger trend of SSTs is not entirely attributed to global warming due to human activities.

Session 5: Observation-based Analyses of Climate Variability and Change (Poster presentation)(S5P4)

The Antarctic Sea Ice spatial variability for the period 1979-2006 and its relationship with atmospheric circulation

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Principal Components Analysis (PCA) in T-Mode (correlation between spatial fields) Varimax rotated was performed on Antarctic monthly sea ice concentration anomalies (SICA), in order to investigate which are the main spatial patterns, when do they appear and how are they related to several atmospheric variables. This analysis provides 8 principal components (5 for winter-spring and 3 for summer-autumn periods) in positive and negative phase (16 spatial patterns), that represent the most important spatial features that dominated sea ice concentration anomalies (SICA) spatial variability in Antarctic Seas for the period 1979-2006. Monthly Polar Gridded Sea Ice Concentrations database derived from satellite information generated by NASA Team algorithm and acquired from the National Snow and Ice Data Center (NSIDC) were used. The connection between sea ice condition and atmospheric circulation is analyzed by mean of 850 hPa height, surface air temperature and precipitation composites anomalies coupled with each SICA pattern. These data were provided by the National Center for Environmental Prediction reanalysis project. The first spatial winter-spring pattern in positive (negative) phase shows a positive (negative) sea ice concentration anomaly centre over the Drake Passage and north region of Bellingshausen and Northeast Weddell Seas together with another positive centre over the East Indian Ocean basin. Opposite sign centre over the rest of the Atlantic and Indian Oceans basins and the Amundsen Sea are also presented. A strong positive (negative) 850-hPa height anomaly covers most of the Antarctic Continent centred over the Bellingshausen Sea accompanied by three negative (positive) height anomalies in middle-latitudes (Atlantic, Pacific and Indian Oceans), characterize the atmospheric circulation for this first pattern. Temperature anomalies fields show strong negative (positive) anomalies cores over the areas with positive (negative) SICA centres. These temperature anomalies extend their influences over middle-latitudes (up to 30ºS). Therefore, the meridional temperature gradient is enhanced (reduced) over the South Atlantic Ocean and Southwest Pacific Ocean over the areas with the negative (positive) anomalies of height, giving positive (negative) precipitation anomalies over the Southern Oceans. Each sea ice pattern is characterized by a unique spatial behaviour and is accompanied by a different atmospheric structure. The others patterns will be introduced at the presentation.

Session 5: Observation-based Analyses of Climate Variability and Change (Poster presentation)(S5P5)

Ice winter severity in the Western Baltic Sea in the Period 1301-1500

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Bundesamt für Seeschifffahrt und Hydrographie, GermanyVariations in ice winter severity in the Western Baltic in the period 1301-1500 were analysed analogous to an investigation of data series covering the period 1501-1700. The poor reliability of reconstructed ice winter severity, especially in the period from 1301 to 1400, does not allow us a treatment of data in the usual way. A linear relationship between the number of anomalous ice winters per decade and the ice winter severity index, found by Koslowski, was used to calculate the value of the mean ice winter index for the above period.

Session 5: Observation-based Analyses of Climate Variability and Change (Poster presentation)(S5P6)

Mean Sea Level (1817-2007) at the Swinoujscie Tide Gauge

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Swinoujscie tide gauge is located in the westernmost part of the Polish coast in the Pomerania Bay - Southern Baltic Sea (tideless and semi-enclosed sea). Sea level observations have been performed at Swinoujscie since 1811. The time series from Swinoujscie (annual and monthly) is the longest marine time series in Poland. The changes of mean sea level were analyzed on the basis of the observation series and compared with climate indices as NAO from December-January-February-March (correlation = 0,34), NEWO (cor. 0,46), mean sea level of Stockholm (-0,58), and mean sea level of Kronstadt (0,7). Changes of mean sea-level show a steady, gradual increase of this parameter, beginning with the fifties of the XX century. Three intervals of mean sea level were analyzed: 480-489 cm (low); 490-499 cm (normal) and 500-509 (high). Characteristic is a rapid increase of number of annual mean sea level belong to the high level interval beginning from the thirties of the last century as well as practically lack of mean sea level values from low sea level interval during last forty years.

Session 5: Observation-based Analyses of Climate Variability and Change (Poster presentation)(S5P7)

Spectral Slopes and Interannual-to-Subannual Variability Ratios

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The power law is popular in climate dynamics because it provides a succinct summary of spectral characteristics of climate variables. They are also important for historical climate reconstructions because of their connections to temporal persistence. However, in regions where clear spectral peaks are present, such as the tropics, the physical meaning of this measure breaks down. We demonstrated that the ratio of interannual to intermonthly variability is an analogous metric and defined the exact correspondence between the two measures. This ratio is fundamentally a calculation of the spectral power law with the energy binned and averaged in two uneven frequency intervals divided at biannual frequency. This partition is logical in a climatological context and yields intuitively comprehensible results. Moreover, the natural connection of this ratio to interannual climate variability patterns such as El Niño or global trends helps to clarify spectral slopes and their uncertainties. Earlier estimates of spectral slopes were interpreted in this context. We substantiate these associations by evaluating spectral slopes and variability ratios for variables such as air temperature, sea surface temperature, sea level pressure and surface winds from objective historical analyses and atmospheric reanalyses.

Session 5: Observation-based Analyses of Climate Variability and Change (Poster presentation)(S5P8)

The wave climate of the Baltic Sea

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The goal of this paper thesis is to define basic attributes of wave field and estimation of usefulness of the different data sources in the study of wave climate in the Baltic Sea in consideration of lack of regular observations. Furthermore the description of spatial distribution of the basic features of wave fields on the Baltic Sea and connections between respective wave characteristics, and meteorological elements, which may be regarded an attempt to determine the influence of wind time duration on growth of a wave.

The features of wave climate in the Baltic Sea were compiled on the base of two numerical simulations and marine observations carried out on ships.

The first model (HYPAS) had been activated in hindcast mode and the second one in re-analysis mode, i.e. ERA-40. The results of marine observations of wave are regularly collected under the VOS Programme.

The relationships based on models and observations on the Baltic Sea were compared with analogical relationships, referring to the same elements but different bodies of water located outside the Baltic Sea (e.g. Norwegian Sea and the Michigan Lake).

The rate of usefulness of different sources to compilation of wave climate of the Baltic Sea in a situation of lack of regular surveys showed that HYPAS model is an optimal one and can be used in further climate research. Hitherto, results show the necessity of keeping a deep caution in case of work with ERA-40 model.

Session 5: Observation-based Analyses of Climate Variability and Change (Poster presentation)(S5P9)

Far North Atlantic Climate 1760-1799: Evidence from logbooks of the Hudson's Bay Company.

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The high latitudes are amongst the most sensitive of all climatic regions. Yet the remote and inhospitable nature of the environment limits the volume of data and information that we have for the pre-instrumental period (pre-1850). Fortunately there are some sources, of which the logbooks of ships in the service of the Hudson's Bay Company are the most important and span the period 1750 to 1870. This presentation reviews the logbooks for the period 1760 to 1799 and explains their content and application to climatic studies. Some findings are offered to suggest that the record indicates an important solar influence on the region's climate at that time.

Session 5: Observation-based Analyses of Climate Variability and Change (Poster presentation)(S5P10)

Marine climate data and research priorities for the IPCC 5th Assessment

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The IPCC 4th Assessment Report has led to the establishment of international priorities for marine climate data development and climate research before the 5th Assessment. The maintenance of the global network of ARGO subsurface floats for decades to come has very high priority. This will enable us to create a consistent climate data record using ARGO and earlier data, and thus to analyse and interpret trends of regional and global ocean heat content and salinity. ARGO is also crucial for understanding and predicting shorter-term variations such as El Niño and the Interdecadal Pacific Oscillation, which have major impacts in developing countries. The ARGO data will also help close the sea-level budget and may help to reduce uncertainties in trends in the meridional overturning circulation. The ARGO floats should go beneath sea-ice, for polar applications. Climate-quality data from Voluntary Observing Ships and from satellites will help close the oceanic heat and salt transport budgets. Consistent measurements of carbon compounds in the ocean are important for assessing carbon cycle feedbacks.

Session 6: New Initiatives (Invited presentation)(S6O1)

Storm Surge Climatology: the JCOMM Scientific and Technical Symposium on Storm Surges

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One of the most important objectives of the Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM) of the World Meteorological Organization (WMO) and the Intergovernmental Oceanographic Commission (IOC) of UNESCO is to facilitate and support the delivery of the most visible operational outputs of the world's marine meteorological and oceanographic organizations, including warnings of gales, storms, severe tropical weather systems, such as typhoons, hurricanes and tropical cyclones, and ocean associated phenomena and other marine hazards. The continuing provision of safety-related weather and oceanographic products and services is an absolutely fundamental priority of JCOMM.

Storm surges, and their associated coastal inundation, are major coastal marine hazards, in both tropical and extra-tropical areas, and are clearly among the critical natural phenomena which should be addressed by GEOSS under its Societal Benefit Area of Disasters, with the aim of reducing loss of life and property in low-lying coastal areas. In this context GEO endorsed the JCOMM Symposium on Storm Surges as such, as a major contribution towards fulfilling the objectives of GEOSS.

To this end, the 1st JCOMM Scientific/Technical Symposium on Storm Surges (SSS) was held in Seoul, Republic of Korea, from 2 to 6 October 2007. The focus of the Symposium was similar to the very successful JCOMM scientific and technical workshops in other related fields, including the International Workshop on Wave Hindcasting and Forecasting and the present CLIMAR Workshops on Advances in Marine Climatology.

The objectives of the Symposium were: (1) To provide a forum for the exchange of ideas and information related to storm surge modeling, forecasting and hindcasting, covering both tropical and extra-tropical storm surges; (2) To provide input to the development of effect-oriented products such as inundation maps and GIS-based tools; (3) To coordinate ongoing R&D initiatives in these fields; (4) To develop appropriate input for the dynamic part of the *Guide to Storm Surge Forecasting*, emphasizing new developments; (5) To provide guidance/technical support for National Meteorological Services and other national agencies; (6) To identify areas for future research and development.

The presentation will provide a summary of the presentations from the SSS, particularly those dealing with storm surge and water level climatology, as well as the rapporteurs reports and the final summary discussion session and recommendations. In a recent survey of national agencies carried out by JCOMM it was apparent that very few climatologies of storm surge existed. The goal of this presentation is to raise awareness of this deficiency within the marine climate community, propose steps to rectify this situation and to promote the storm surge activity within the marine climatology envelope, integrated with work on sea levels and waves to generate climate information on total water level, which is the real source of risk in coastal areas, and to potentially include storm surge in considerations of marine climate indices.

Session 6: New Initiatives (Oral presentation)(S6O2)

Atmospheric Circulation Reconstructions over the Earth, The 20th Century Reanalysis Project, and longer historical reanalyses

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Recent studies have investigated the possibility that the quantity of newly recovered global historical surface pressure observations from both terrestrial and marine sources is sufficient to generate useful reanalyses of at least the lower tropospheric circulation back to 1900. It has been found that using an Ensemble Kalman Filter to blend an ensemble of 6-hour numerical weather prediction model forecasts with the available observations, one can produce high-quality reanalyses of even the upper troposphere using only surface pressure observations.

To enable these high-quality reanalyses, the Atmospheric Circulation Reconstruction over the Earth (ACRE) Initiative has been developed. ACRE will recover, quality control and consolidate global historical instrumental surface data (terrestrial and marine) covering the last 200-250 years. Its overall goal is to recover sufficient data to enable a global surface observations-based reanalysis back to the mid-19th century and a North Atlantic-European region reanalysis back to the mid-18th century. Marine data from ship logbooks are crucial for meeting this goal.

In its initial phase, ACRE is contributing newly digitized land and marine data to the new 20th Century Reanalysis Project. This Project is using the Ensemble Filter, and surface pressure observations from ACRE, ICOADS, NOAA, and other international partners to produce the first-ever reanalysis dataset for the period 1892-2007. This will nearly double the record of 6-hourly tropospheric gridded fields from 60 years to 116, spanning a period for which no gridded upper-air analyses are currently available. These tropospheric circulation fields will also be the first to have objective uncertainty estimates for every variable.

Initial results from the period 1918-1949 will be presented. The potential for even longer-term historical reanalyses under the ACRE initiative will be detailed.

Session 6: New Initiatives (Oral presentation)(S6O3)

ENSO forecasts with an intermediate coupled model initialized and verified by historical climate data sets

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The El Niño - Southern Oscillation (ENSO) is the dominant mode of global interannual climate variability. At present it seems to be the principal mode for which seasonal-to-interannual prediction methods are more skillful than climatology or persistence. Operational ENSO predictions with the Zebiak-Cane interannual climate model started 22 years ago and are used in the current consensus IRI and NCEP forecasts. Historical data sets are necessary for initializing retrospective climate forecasts, for correcting model biases, and for research on ENSO predictability and on the improvement of operational forecasts. A 150-year-long sequence of retrospective forecasts that used our historical SST analyses for model initialization successfully predicted all strong El Niño events in that period with forecast leads of 12 to 24 months. A detailed analysis of ensemble forecasts for the period 1975-2002 identified tropical thermocline depth as the model variable whose accurate initialization is most important for the skill of forecasts. Records of direct observations of thermocline depth are quite short. Extending them back using subsurface temperatures, surface wind, tide gauge data, and model dynamics is important for further work on improving the skill of seasonal-to-interannual climate predictions and for attempting decadal forecasts.

Session 6: New Initiatives (Oral presentation)(S6O4)

Exploration of Antarctic weather: recovering observations from the early 20th century

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Our knowledge of climate changes in the Southern Ocean is limited, because there have, historically, been few observations made there. During the 'Heroic Age' of Antarctic Exploration (1897-1917) more than a dozen expeditions were mounted - some involving several ships over several years, and carrying specialist meteorologists - but the weather records of these expeditions have mostly not made it into ICOADS, or if they have the digitised observations are limited in number or quality. Searches of the archives of the UK Met Office, the Scott Polar Research Institute, the UK National Archives and the Australian National Meteorological Library have revealed meteorological records from some of the expeditions. The data are a mixture of primary sources (log-books) and secondary sources (published reports from the expeditions), and contain a variety of different forms of data (instantaneous measurements, daily averages and ranges). While primary reports of instantaneous measurements are of most value, the secondary data is often all that is available, and deciding how best to use this data is not straightforward.

Observations from nine expeditions have been digitised, converted to IMMA format and submitted for inclusion in ICOADS version 2.5. The resulting 35000 new marine observations will be used in the ACRE reanalysis projects and provide input to future SST and sea-ice studies of the Southern Ocean. The results also highlight the importance of active management of observations archives: Expeditions have collected, analysed and published weather observations, only for them to be lost from use over the last century. Some expedition results remain lost, as the log-books and reports could not be found.

Session 6: New Initiatives (Oral presentation)(S6O5)

BACC: BALTEX Assessment of Climate Change for the Baltic Sea Basin – Summary and Outlook

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The BACC assessment of past, ongoing and future climate change in the Baltic Sea basin offers a review of published knowledge in four chapters, two dealing with the geophysical (atmosphere, ocean, sea ice) side and two with the ecological (terrestrial and marine) dimension.

In the past century here has been a marked increase of temperature of more than 0.7 °C in the region, which is larger than the global mean temperature increase of 0.5 °C. Consistent with this increase in mean and extreme temperatures, other variables show changes, such as increase of winter runoff, shorter ice seasons and reduced ice thickness on rivers and lakes in many areas. These trends are statistically significant but they have not been shown to be larger than what may be expected from natural variability. In addition, no robust link to anthropogenic warming, which on the hemispheric scale has been causally related to increased levels of greenhouse gases in the atmosphere in "detection and attribution"studies, has been established. However, the identified trends in temperature and related variables are consistent with regional climate change scenarios prepared with climate models. Therefore, it is plausible that at least part of the recent warming in the Baltic Sea basin is related to the steadily increasing atmospheric concentrations of greenhouse gases. Efforts are needed which systematically examine the inconsistency of recent trends with natural variability, circulation changes as well as the consistency with elevated greenhouse gas concentrations as a potential cause.

The situation is much less clear regarding precipitation: in the past, a spatially non-uniform pattern of upward and downward trend has been observed, which can hardly be related to anthropogenic climate change. For the future, intensified winter precipitation may emerge later in this century over the entire area, while summers may become drier in the southern part – but this expectation is uncertain for the time being. For the water body of the Baltic Sea, a tendency towards lower salinity is expected. Similarly, no clear signals, whether for the past or for the scenarios, are available with regard to wind conditions.

In view of the large uncertainty in our knowledge about the changing climatic conditions, it is not surprising that knowledge about ecological implications of ongoing and future climate change is far from complete and also very uncertain. The observed changes in temperature in the past have been associated with consistent changes in terrestrial ecosystems, such as earlier spring phenological phases, northward species shifts and increased growth and vigour of vegetation. In lakes, higher summer algal biomasses have been found. These trends are expected to continue into the future; induced species shifts may be slower than the warming which causes it. In the marine ecosystem of the Baltic Sea the assessment is particularly difficult because of the presence of strong non-climatic stressors (eutrophication, fishing, release of pollutants) related to human activities. Changing temperatures have been related to various effects, in particular to the composition of species. A lowering of salinity is thought to have a major influence on the distribution, growth and reproduction of the Baltic Sea fauna. Freshwater species are expected to enlarge their significance, and invaders from warmer seas (such as the zebra mussel Dreissena polymorpha or the North American jelly comb Mnemiopsis leidyi) are expected to enlarge their distribution area. The expected changes in precipitation (and thus river runoff) may have additional detrimental effects on the problem of eutrophication.

Session 6: New Initiatives (Invited presentation)(S6O6)

Regional Comparison of Surface Turbulent Flux Products

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The surface turbulent fluxes (sensible heat, latent heat, and stress) are an important mechanism by which the atmosphere interacts with the ocean. For example, the air-sea exchange of heat plays an important role in driving the large scale atmospheric circulation as well as regulating the sea surface temperature. Wind stress at the surface is an important driving force for ocean currents. Thus, accurate global fields of the turbulent fluxes are crucial to the understanding of ocean/atmosphere variability.

This study compares the surface turbulent fluxes from nine products and investigates the differences on both basin-wide and regional scales over the Atlantic, Pacific, and Indian Oceans. The forcing variables are also examined to identify causes for differences in the derived flux products. Reanalysis products include NCEPR2, ERA40, and JRA25. Products based on in situ observations include NOC (formerly SOC) and FSU3. Satellite derived products include IFREMER and the 2nd version of HOAPS. Hybrid numerical weather prediction model and satellite products include WHOI and GSSTF2.

Zonal averages of the stresses and heat fluxes reveal very large differences amongst the various products. For the Atlantic Ocean, the largest differences in the zonally averaged latent and sensible heat fluxes exceed 60 Wm^{-2} and 15 Wm^{-2} respectively. Comparable differences are also found over the Pacific and Indian Oceans. These differences are large from the point of view of climate modeling. Regional analysis of the distribution of the fluxes shows large variations between products at all quantiles. For example, NCEPR2 has a large inter-quantile range and unrealistic values at the 1st and 99th percentile in the tropics. In some regions, median latent heat flux values differ by 40 Wm^{-2} between products.

Session 6: New Initiatives (Poster presentation)(S6P1)

The CoastDat project at GKSS – assessing ongoing change and projecting possible future changes in marine weather –- winds, surges, waves and currents.

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At the Institute for Coastal Research of the GKSS Research Center, a cascade of downscaling methods are implemented to construct recent and possible future developments of regional and local marine weather in NW Europe. The various spatially and temporally detailed data sets constructed in this way are assembled in the newly established 'CoastDat' data bank. Three steps are taken

1. With a state-of-the-art regional atmospheric model the coarse-grid climate as given by decade-long global re-analyses or scenarios constructed by global climate models a is transformed into a high-resolution (50 or 20 km grid) representation of marine weather (wind and air pressure); the resulting features are similar to the global re-analyses or scenarios on large scales, and an added value is obtained for smaller scales. These regional analyses of marine weather extend over more than 50 years.

2. Hydrodynamic models of the marginal North Sea and semi-enclosed Baltic Sea are simulated using the hourly data of wind and air pressure to simulate the details of (vertically averaged) currents and water levels (down to 100 m grid lengths near coasts). Similarly, ocean wave models are run to derive 2-d wave spectra and derived variables, in particular significant wave height and mean period, on a 5 km grid.

3. Even higher descriptions are obtained by using empirical models, which relate variables derived in step 2 to limited fine-grid simulations or derived form local observations.

The 'CoastDat' cascade, consisting of steps 1-3, has been implemented for both NCEP re-analyses 1948-2005 and for a series of PRUDENCE scenarios (the successful EU project, which has constructed a variety of regional climate scenarios) representative for 2070-2100. The results have been used for a variety of purposes, ranging from assessing ongoing change, including first efforts of detection of anthropogenic climate change and attribution most plausible causes, ecological cause-and-effect studies, assessments of coastal hazards and implied construction requirements and to perspectives for changing risk. The data have also been used in analysis of changing regional transport and deposition of pollutants.

CoastDat is based on a series of significant peer-reviewed journals.

Session 6: New Initiatives (Poster presentation)(S6P2)