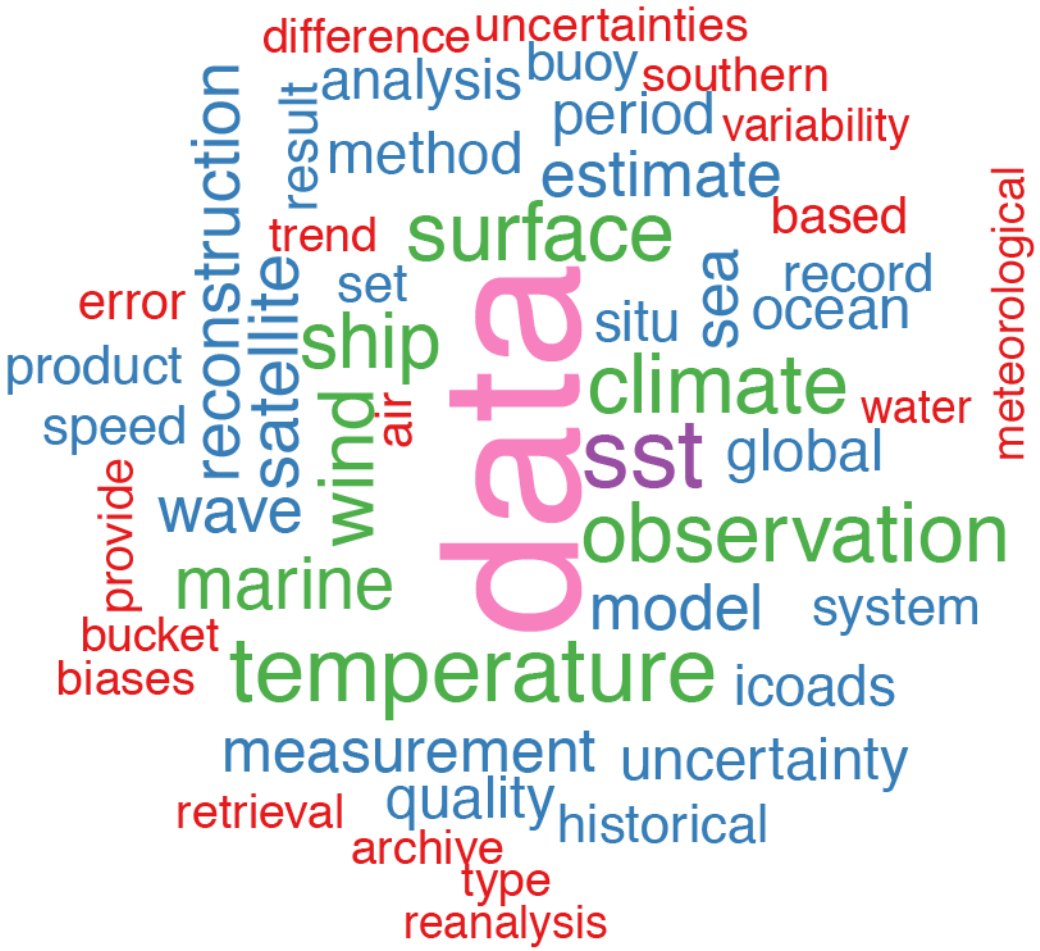
Fourth International Workshop on the Advances in the Use of Historical Marine Climate Data (MARCDAT-IV)

18 – 22 July 2016, National Oceanography Centre, Southampton, UK



National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

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Acknowledgements

The venue, local support and the provision of refreshments have been provided by the UK National Oceanography Centre. The organising committee have been funded by their home institutions.

Past Meetings

Proceedings and outcomes from past (and related) meetings can be found via the following webpages:

International Workshop on the Advances in the Use of Historical Marine Climate Data (Community led)

MARCDAT-3 (2011): http://icoads.noaa.gov/marcdat3/
MARCDAT-2 (2005): http://icoads.noaa.gov/marcdat2/
MARCDAT-1 (2002): http://icoads.noaa.gov/advances/workshop_plan.htm

JCOMM Workshop on Advances in Marine Climatology (JCOMM led)

CLIMAR-4 (2014): http://icoads.noaa.gov/climar4/
CLIMAR-3 (2008): http://icoads.noaa.gov/climar3/
CLIMAR-2 (2003): http://icoads.noaa.gov/climar2/
CLIMAR-1 (1999): ftp://ftp.wmo.int/Documents/PublicWeb/amp/mmop/documents/JCOMM-TR/J-TR-10-CLIMAR-99/START.htm

Cover image: word cloud based on abstracts within this programme.

Time Table

Time	Slot	Title	Author (presenter if different)
Monday 18th July			
0900 - 1000	Registration		
1000 - 1020	Welcome and administration		
Data homogenization (bench marking, bias adjustments, step change analysis, metadata)			
1020 - 1050	S1E1	Field Laboratory for Ocean Sea State Investigation and Experimentation: FLOSSIE Intra-Measurement Evaluation	Jensen
1050 - 1110	S1T1	The SAMOS Initiative – A Decade of Successful Data Stewardship	Smith
1110 - 1130	Coffee		
1130 - 1150	S1T2	Improving the global SST record: estimates of SST biases in the modern era using high quality satellite data	Carella
1150 - 1210	S1T3	Intercalibration of Visual Winds from VOS and Scatterometer Winds	Li (S. Smith)
1210 - 1400	Lunch		
1400 - 1420	S1T4	Dreaming of relative statistical homogenization of SST	Venema
1420 - 1440	S1T5	Impact of data assimilation into atmospheric reanalysis on marine wind and wave climate	Sasaki
Quantification and estimation of uncertainty			
1440 - 1510	S2E1	Uncertainty modelling for satellite-based sea surface temperatures	Merchant
1510 - 1530	S2T1	Exploring and Quantifying Uncertainties for Extended Reconstructed Sea Surface Temperature (ERSST) Version 4	Huang
1530 - 1550	S2T2	Error Characterization in iQuam SSTs Using Triple Collocations with Satellites Measurements	Xu (Ignatov)
1550 - 1610	Coffee		
1610 - 1620	Introduction to breakout 1		
1620 - 1800	Breakout 1		
Tuesday 19th July			
0930 - 1000	Report on breakout 1		
Integrating In-situ / satellite data sources			
1000 - 1030	S3E1	Integrating in situ data and satellite ocean-colour towards improved estimation of marine autotrophic-carbon stock	Roy
1030 - 1100	Coffee		
1100 - 1130	S3E2	EUSTACE: combining different components of the observing system to deliver global, daily information on surface air temperature	Rayner
1130 - 1150	S3T1	Stability Assessment of Satellite Sea Surface Temperature Estimates Using the Penalized Maximal T-Test	Berry
1150 - 1210	S3T2	Satellite and in situ SST reprocessing and harmonization at NOAA	Ignatov
1210 - 1230	S3T4	The Distributed Oceanographic Match-Up Service	S. Smith
1230 - 1400	Lunch		
Reconstructing past climates (methods)			
1400 - 1430	S4E1	Climate Reconstruction Improvements from Iteratively Adjusted Statistics, Demonstrated Using Model SST	T. Smith
1430 - 1450	S4T1	Advanced approaches to space-time integration of surface turbulent heat fluxes	Gulev
1450 - 1520	Poster session 1: poster introductions (3 minutes each)		

Time	Slot	Title	Author (presenter if different)
1530 - 1550	Coffee		
1550 - 1700	Posters		
Wednesday 20th July			
0930 - 0950	S4T2	The influence of atmospheric circulation on marine air temperature	Harrison
0950 - 1010	S4T3	Improvements to the low-resolution Met Office Hadley Centre Sea Surface Temperature data set, HadSST	Kennedy
1010 - 1030	S4T4	Historical land surface temperature reconstruction with observations over land and oceans	Yasui
1030 - 1100	Coffee		
Reconstructing past climates (products)			
1100 - 1130	S5E1	The Met Office Hadley Centre Sea Ice and Sea-surface Temperature Dataset, HadISST.2.2.0.0	Kennedy
1130 - 1200	S5E2	CERA-20C: a 20th century record of consistent ocean-atmosphere states	de Boisseson
1200 - 1400	Lunch		
1400 - 1420	S5T1	Global ocean wind waves 1878-2016: new update of the IORAS VOS-based wave products	Grigorieva
1420 - 1440	S5T2	HadISDH.ocean: A new multi variable marine humidity product for climate monitoring	Willett
Reconstructing past climates (applications)			
1440 - 1510	S6E1	Blended sea ice climatologies based on national ice charting products for the Arctic and Antarctic - content and possible applications	Smolyanitsky
1510 - 1530	S6T1	Early-nineteenth century southern African precipitation reconstructions from ships' logbooks	Hannaford
1530 - 1550	Coffee		
1550 - 1600	Breakout 2 introduction		
1600 - 1730	Breakout 2		
Thursday 21st July			
0930 - 1000	Breakout 2 reports		
1000 - 1030	Poster session 2: poster introductions (3 minutes each)		
1030 - 1130	Coffee and posters		
Data management, recovery and reprocessing			
1130 - 1200	S7E1	Implementing the New JCOMM Marine Climate Data System	Gates
1200 - 1400	Lunch		
1400 - 1420	S7T1	Aligning the German Marine Data Base with the Modernized MCDS Data Streams	Andersson
1420 - 1440	S7T2	Heroic observations of old weather	Brohan
1440 - 1500	S7T3	ICOADS Release 3.0: Data Characteristics and Future Priorities	Freeman
1500 - 1520	S7T4	The potential for improvements to ICOADS: lessons from ship tracking	Kent
1520 - 1540	S7T5	Data rescue, reanalysis, and a station dataset: report from the 2016 ACRE meeting	Brohan
1540 - 1600	Coffee		
1600 - 1730	Breakout 3 / plenary discussion		
Friday 22nd July			
0930 - 1030	Structured discussion and planning for ICOADS 10 year plan (led by ICOADS Steering Committee)		
1030 - 1100	Coffee		
1100 - 1230	Structured discussion and planning for ICOADS 10 year plan		
Close			

Session 1: Data homogenization (bench marking, bias adjustments, step change analysis, metadata)

S1E1

Field Laboratory for Ocean Sea State Investigation and Experimentation: FLOSSIE Intra-Measurement Evaluation

R.E. Jensen[1], T.J. Hesser[1], V.R. Swail[2] and R. H. Bouchard[3]

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2 Environment and Climate Change, Canada

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The NOAA-National Data Buoy Center (NOAA-NDBC) and Environment Canada (EC) have been operating a network of meteorological and wave measurement sites in the Atlantic, Pacific, Gulf of Mexico and Great Lakes for the past four decades. The platforms used by these two agencies vary from discus buoys of varying sizes to a standard 6-m (6N) Navy Oceanographic and Meteorological Automatic Device, or NOMAD buoy. These data sets have been instrumental in the evaluation of wave model results in a hindcast or forecasting mode, calibration/validation of satellite-based remote sensing algorithms estimating the significant wave height from altimeters, and wave properties from SAR images, research efforts studying the role of surface-gravity wind waves on atmosphere-ocean coupling, coastal inundation and erosion studies, and wave energy resource assessment.

Of particular interest to this meeting is the use of these in situ measurements in the investigation of wave climate trend and variability. These data have been widely used to assess the trends in the wave climate (e.g. Komar and Allan, 2008; Ruggiero et al., 2010; and Menéndez et al., 2008). However, over the period of record there have been numerous modifications to the hull, sensor, and payload (on-board analysis package) that can affect long-term records (Gemmrich et al., 2011; Livermont et. al, 2015). .

In 2012, a plan for an experiment (FLOSSIE) was developed where a 6N hull would be configured with all historical sensor, and payload packages used by NOAA-NDBC during the past four decades. The data will provide a means to account for temporal changes in payloads and sensor systems by NOAA-NDBC while evaluating the accuracy of the archive data sets. In addition to the NOAA-NDBC sensor (and payload systems), Environment Canada also provided their sensor and payload, and AXYS™ has provided their new sensor system (TRIAXYS) and payload, that will be used to directly assess differences between historical EC and NOAA-NDBC 6N buoy records.

FLOSSIE was deployed in August 2015 in Monterey Canyon with the multiple sensor/payload systems as part of an existing Buoy Farm (multiple wave measurement platforms). The domain is populated with a Datawell™ directional waverider buoy, a NOAA-NDBC standard 3-m discuss buoy containing a HIPPY and 3DGM sensor and payload systems, and AXYS™ will also deploy a TRIAXYS buoy system. These entire buoy systems will be evaluated using WaveEval Tools (Jensen et al. 2011) and the results presented that will have an impact on present and historical wave data records for climate trend and variability analyses.

Oral

- **Data homogenization (benchmarking, bias adjustments, step change analysis, metadata)**

S1T1

The SAMOS Initiative – A Decade of Successful Data Stewardship

Shawn R. Smith[1], Jeremy J. Rolph[1], Kristen Briggs[1], Jocelyn Elya[1], and Mark A. Bourassa[1,2]

1 Center for Ocean-Atmospheric Prediction Studies, The Florida State University, Tallahassee, FL, USA

2 Earth, Ocean, and Atmospheric Science Department, Florida State University, Tallahassee, FL, USA

The authors will describe the successes and lessons learned from the Shipboard Automated Meteorological and Oceanographic Systems (SAMOS) initiative. Over the past decade, SAMOS has acquired, quality controlled, and distributed underway surface meteorological and oceanographic observations from nearly 40 oceanographic research vessels. Research vessels provide underway observations at high-temporal frequency (1 min. sampling interval) that include navigational (position, course, heading, and speed), meteorological (air temperature, humidity, wind, surface pressure, radiation, rainfall), and oceanographic (surface sea temperature and salinity) samples. Vessels recruited to the SAMOS initiative collect a high concentration of data within the U.S. continental shelf, around Hawaii and the islands of the tropical Pacific, and frequently operate well outside routine shipping lanes, capturing observations in extreme ocean environments (Southern, Arctic, South Atlantic, and South Pacific oceans) desired by the air-sea exchange, modeling, and satellite remote sensing communities.

This presentation will highlight the data stewardship practices of the SAMOS initiative, focusing on efforts to homogenize underway meteorological and thermosalinograph data collected using varying instrumentation and data acquisition hardware on research vessels. The authors will focus on metadata collection, standard data formats, uniform quality evaluation procedures, use of interoperable vocabularies, and finally routine distribution and archival practices. We will describe lessons learned over the past decade regarding metadata requirements and will outline plans to upgrade the SAMOS netCDF format to meet modern climate and forecast standards. Our interactions with vessel operators will be described and we will provide examples of best practices for instrument siting/exposure on research vessels and professional development activities for research vessel technicians. Finally, we will report on recent efforts to subset the SAMOS data archive for inclusion into the International Comprehensive Ocean Atmosphere Data Set (ICOADS). For ICOADS, the SAMOS team has applied the SAMOS quality control flags and used the metadata collected to ensure the highest quality SAMOS records are submitted to ICOADS.

Oral

- **Data homogenization (benchmarking, bias adjustments, step change analysis, metadata)**

S1T2

Improving the global SST record: estimates of SST biases in the modern era using high quality satellite data

Giulia Carella[1], Elizabeth C. Kent[1], David I. Berry[1], Simone Morak-Bozzo[2], Christopher J. Merchant[2,3]

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3 National Centre for Earth Observation, University of Reading, Reading, UK

Sea surface temperature (SST) is typically used as the marine component of the global surface temperature record, a primary metric of climate change. SST observations from ships form one of the longest instrumental records of surface marine climate. However, over the years different methods of measuring SST have been used, each with different bias characteristics. The estimation of systematic biases in the SST record is critical for climatic decadal predictions, and uncertainties in long-term trends are expected to be dominated by uncertainties in biases introduced by changes of instrumentation and measurement practices. Although the largest systematic errors in SST observations are typically assumed to relate to the period before about 1940, where SST measurements were mostly made using uninsulated buckets, there are also issues with modern data, in particular when the SST reported is the temperature of the engine-room cooling water intake (ERI). On the other hand, biases associated with modern buckets observations are assumed to be typically smaller but yet not negligible. Even in the well sampled modern era, existing studies on SST biases only provide broad estimates based on subsamples of the data and ignoring ship-by-ship differences. Moreover, although most of the observations in this period have known measurement type, this information can still be missing or wrongly reported. Here we take advantage of a new, high spatial resolution, gap-filled, daily SST for the period 1992-2010 from the European Space Agency Climate Change Initiative (ESA CCI) for SST dataset version 1.1. In this study, we use a Bayesian statistical model to characterise the uncertainty in the SST reports for individual ships using the ESA CCI SST as a reference. A Bayesian spatial analysis is used to model the differences of the observed SST from the ESA CCI SST for each ship. Known metadata and differences in the diurnal cycle are used to classify ships according to their measurement method and different models are then applied to characterise buckets and ERI biases. For bucket observations the difference between the observed SST and the ESA CCI SST is modelled as a function of the climatological air-sea temperature difference, while for ERI reports a constant offset plus a function of the climatological SST is used. By explicitly modelling the spatial correlation present in the data, this method allows us to better estimate the seasonal mean bias and the related uncertainty for each ship, down weighting observations taken at the same site as well as whole regions which where found artificially warm or cold relative to other areas sampled by the ship. Future work will use the results from this well-characterised period to understand how to extend the analysis back in time to periods where such high quality reference SST is not available, leading to a full characterisation of the SST ship biases and their uncertainty and a better estimate of the SST trend.

Oral

- **Data homogenization (benchmarking, bias adjustments, step change analysis, metadata)**

S1T3

Intercalibration of Visual Winds from VOS and Scatterometer Winds

Keqiao Li[1,2], Mark A. Bourassa[1,2], and Shawn R. Smith[2]

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2 Center for Ocean-Atmospheric Prediction Studies, Florida State University, Tallahassee, FL 32306 USA

The calibration of visually estimated winds (Beaufort winds) from Volunteer Observing Ships (VOS) is assessed in comparison to QuikSCAT equivalent neutral wind speeds. Visual winds are expected to be more stress-like than wind-like, in that the characteristics observed are more stress-like than wind-like: white capping and other wave characteristics are more directly a function of stress than wind, and like equivalent neutral winds they are relative to the moving surface. We hypothesize that visual wind estimates will have a similar calibration to scatterometer winds, and use statistical analyses to show that this is the case. The calibration is examined as a function of wind speed, and for most wind speeds is statistically indistinguishable for scatterometer winds. At low wind speeds, there is the appearance of considerable bias, but this is demonstrated as being due to a statistical artifact associate with the noise in the VOS observations. While the calibrations are remarkably similar, there is much greater random error in the VOS winds (~3ms^{-1}) than in the scatterometer winds (~1ms^{-1}). The calibrations are also compared to prior calibrations such as Lindau (1995).

Oral

- **Data homogenization (benchmarking, bias adjustments, step change analysis, metadata)**

S1T4

Dreaming of relative statistical homogenization of SST

Victor Venema and Ralf Lindau

University of Bonn, Germany

Over the last few years relative statistical homogenization methods have become much more powerful. Relative methods compare a candidate station with nearby reference stations. We have moved from single-breakpoint methods to multiple breakpoint methods. First attempts to detect breaks in all series simultaneously (joint detection) are made and joint correction methods are used more and more.

An important advantage of relative homogenization is that inhomogeneities are corrected whether their cause is known or not. It may thus be interesting to study whether statistical homogenization can be used to detect currently unknown inhomogeneities in sea surface temperature.

In current state-of-the-art datasets the secular sea surface temperature trend is small compared to the land surface temperature trend. The difference may be even larger, because recent results suggest that the global land temperature trend in the main collections show too little warming due to remaining inhomogeneities. The main indication is that well-homogenized national datasets on average show clearly more warming than global collections when averaged over the region of common coverage.

Relative homogenization efforts for marine data may be impossible because of the small amount of data. However, if we limit our aim to estimating the long-term trend, we only need to do it for a few dozen locations spread over the world. It is thus possible to focus on data dense regions, such as much used shipping routes. Even if we could only perform relative homogenization at a few locations, this would still be an important independent estimate to compare our current SST datasets to.

Detecting breaks with relative statistical homogenization requires difference time series with a low noise level. In addition, the platforms would need to have a stable ID over their observing time, so that multiple encounters can be used to compute a difference time series. For marine data the difference series will be sparse, but there are many difference series to perform joint detection, which would optimally halve the noise. It would be a strong simplification if break detection were not necessary and the problem could be reduced to computing one adjustment for every unique platform.

Next to ocean weather ships, ferries and liners using locations close to islands, light houses, moored buoys and coastal land stations could help in making more comparisons. For some inhomogeneities, climate may be less important (engine intake bias), which would allow the use of any encounter for a comparison between ships regardless of location. If the difference in biases within a group is not too large (buoys?), they may also be treated as a group making the number of comparisons larger. Detection of breaks may also be helped by comparing sea surface temperature to observed (night) marine air temperature.

Oral

- **Data homogenization (benchmarking, bias adjustments, step change analysis, metadata)**

S1T5

Impact of satellite data assimilation in atmospheric reanalysis on marine wind and wave climate

Wataru Sasaki

Japan Agency for Marine-Earth Science and Technology

This study investigated the impact of assimilating satellite data into atmospheric reanalyses on trends in ocean surface winds and waves. Two experiments were performed using a numerical wave model forced by near-surface winds: one derived from the Japanese Reanalysis for 55 years (JRA-55) (Exp.A) and the other derived from the JRA-55C that assimilated conventional observations only (Exp.B). The results showed that the satellite data assimilation reduced upward trends of the annual mean of wave energy flux (WEF) in the midlatitude North Pacific and Southern Ocean south of Australia from 1959 to 2012. We also found that assimilation of scatterometer winds reduced the near-surface wind speed in the midlatitude North Pacific after the mid-1990s, which resulted in the reduced trend of WEF from 1959 to 2012. In contrast, assimilation of the satellite radiance for 1973–1994 increased near-surface wind speed in the Southern ocean south of Australia, while the assimilation of the scatterometer winds after the mid-1990s reduced wind speed. The latter led to the reduced trend of WEF south of Australia from 1959 to 2012.

Oral

- **Data homogenization (benchmarking, bias adjustments, step change analysis, metadata)**

S1P1

Examination of SAMOS Sea Temperature Biases

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1 Earth, Ocean, and Atmospheric Science Department, Florida State University, Tallahassee, FL, USA

2 Center for Ocean-Atmospheric Prediction Studies, The Florida State University, Tallahassee, FL, USA

Since 2005, the Shipboard Automated Meteorological and Oceanographic System (SAMOS) Initiative has been aiming to collect, quality evaluate, and preserve navigational, meteorological, and oceanographic observations from research vessels (RVs). Among these observations is sea temperature, which eight of the aforementioned vessels have two independent methods of measuring (TS and TS2). Each RV has a different system of sensors that it utilizes for its respective TS and TS2 values, with common sensors being located at the sea-water intake for the engine or within the scientific flow water system, and no standard in place to determine which temperature variable belongs to which specific sensor. Thus, biases exist in regards to both of the following questions: which temperature tends to be higher? By how much do the two temperatures typically differ? Biases are examined using basic statistical analysis of RV data dating back from 2008 until the more densely sampled 2015, by month, for each individual vessel. With the primary statistical focus being mean temperatures, biases are wide-ranging and often skewed by irregular data clusters associated with an RV's presence in port. Other, more qualitative characteristics are also examined, such as daily bias variability based on a vessel's geographic location and time of day, as well as the impact of visual quality control for lowering biases. The ultimate goals of this analysis are to examine the overall quality of the measurements, provide grounds for adding new quality control procedures to future data sets, acquire better knowledge of the requirements for sea temperature instrumental metadata, and finally connect anomalous observations with probable causes in a more efficient manner.

Poster

- **Data homogenization (benchmarking, bias adjustments, step change analysis, metadata)**

S1P2

Observation-based estimates of air flow distortion by Research Vessels

Elizabeth C. Kent, Brian A. King, Margaret J. Yelland and David I. Berry

National Oceanography Centre, UK

Wind measurements from ships at sea contain uncertainties due to the distortion of the air flow around the ship. For air-sea interaction studies these uncertainties are often estimated by numerical modelling of the airflow, but this approach is limited by the need to generate detailed models of the ship and the instrument environment.

Biases in wind speed and direction due to the effects of flow distortion can often be seen clearly in time-series of measurements from Research Vessels. The ships' frequent and sudden changes in speed and course as they follow their measurement program, typically occupying hydrographic stations either head-to-wind or head-to-current then steaming to the next station, means that a wide range of different relative wind directions are sampled.

We present the results of an in situ experiment, designed to measure the air-flow distortion over the RRS Discovery, which was carried out during a hydrographic cruise across the North Atlantic from Florida Strait to the coast of Morocco in January 2016. We also present the results of an attempt to calculate the effects of flow distortion directly from routine measurements of wind speed and direction and the ship's navigation parameters. An assessment of this method is made using data from the RRS James Clark Ross, a ship which has been the subject of detailed numerical modelling studies.

Poster

- **Data homogenization (benchmarking, bias adjustments, step change analysis, metadata)**

S1P3

Characteristics of drifting buoy observations of SST in the International Comprehensive Ocean Atmosphere Data Set (ICOADS)

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Over the last two decades, records of sea surface temperatures (SSTs) by drifting buoys have become the most prevalent in situ measurement method. Drifting buoy data are widely used because of their relatively high spatial density and temporal coverage. Their freedom of movement allows them to provide data outside shipping routes and distant from moorings. The high temporal resolution gives insight not only into daily to multi-annual variability, but also diurnal (sub-daily) variations of SSTs.

This study focuses on the characteristics of and artefacts in the drifting buoy sea surface temperature (SST) data from the International Comprehensive Ocean Atmosphere Data Set (ICOADS) version 2.5. It investigates the drifters' lifetime story from deployment to death, the development of the network over time and determines the quality of the data.

Based on this, a set of additional quality-control measures for drifting buoy data are being developed, which can be used in addition or instead of the limited QC product provided by ICOADS. The set includes detection of stranded buoys, misplaced buoys, outlier reports.

The quality-controlled data will ultimately be used to estimate the uncertainty in the measured SST on a buoy-by-buoy basis using the European Space Agency Climate Change Initiative (ESA CCI) ESA SST product as proxy. The resulting data and associated uncertainty will be contributing to a new SST reconstruction dating back to 1850, under the project HOSTACE (Historical Ocean Surface Temperatures: Accuracy, Characterisation and Evaluation).

Poster

- **Data homogenization (benchmarking, bias adjustments, step change analysis, metadata)**

S1P4

Comparing laboratory measurements from different SST bucket types and assessing the validity of existing heat exchange bucket models

Giulia Carella[1], A. K. R. Morris[1], R. W. Pascal [1], M. J. Yelland[1], David I. Berry[1], Simone Morak-Bozzo[2], Christopher J. Merchant[2,3] and Elizabeth C. Kent[1]

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Accurate knowledge of the earth's surface temperature is needed to provide confidence in model predictions, particularly over the recent ca. 150 years. Recent studies have highlighted the importance of quantifying uncertainty in adjustments applied to sea surface temperature (SST) observations. Indeed, one of the main key deficiencies in historical SST observations is their time-varying biases, because of evolving measurement practices. Existing studies have shown that these biases are significantly large before about 1940s, when SST measurements required water samples to be collected in buckets. The factors affecting bucket measurements of SST are reasonably well-known and can be estimated using fairly simple physical models developed by Folland and Parker (1995, hereafter FP95). This study simulates the heat exchange experienced by a sample of water in wooden (partly insulated) and canvas (uninsulated) buckets under different external forcings. FP95 models have been used in existing SST datasets, but their results have not been fully tested. To address this lack of validation, we designed laboratory experiments to test FP95 wooden and canvas models under controlled conditions. Repeated experiments for each bucket type were performed with different air-water temperature regimes, wind speeds and mixing, at ambient relative humidity. For well-mixed samples of water, the experimental results are in good agreement with FP95 model simulations for both wooden and canvas buckets. FP95 models were found to reproduce well not only the evolution of the water sample over time but also the air-water temperature and wind speed dependences. However, impact of water mixing, which is not included in FP95 model, was found to be critical for canvas buckets, giving rise to approximately 0.2 C differences in the first minute. However, the difficulty remains of applying FP95 models to historical measurements made using buckets of unknown dimensions and thermal properties in environmental conditions that are also uncertain. In order to study the thermal response of a generic bucket, we derived a simplified heat transfer model in which the unknown parameters depend both on the bucket structure and its thermal properties and can be determined by model fitting. Using this simplified model, we fitted the experimental results for both bucket types; while for canvas buckets both direct heat and evaporation are important, the evaporation term is significantly smaller for wooden buckets due to the partial insulation of the bucket walls. Future work will focus on comparing the results from this analysis to the signals detected in the historical data, in order to characterise the bucket characteristics on a ship-by-ship basis.

Poster

- **Data homogenization (benchmarking, bias adjustments, step change analysis, metadata)**

S1P5

Reconstructing ship voyages in ICOADS: the importance of ship type for SST bias adjustments

Giulia Carella[1], Elizabeth C. Kent[1], David I. Berry[1], Simone Morak-Bozzo[2], Christopher J. Merchant[2,3]

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It is increasingly recognised that metadata can significantly improve the quality of scientific analysis. The International Comprehensive Ocean-Atmosphere Data Set (ICOADS) provides the main archive for surface marine observations for the past ca. 150 years. ICOADS observations are frequently used in climate studies and the associated metadata are key to understanding many possible data biases and estimating random errors. However, metadata information can often be missing or wrongly reported, constituting the limiting factor for many climate analyses. Following previous work (Carella et al. 2015) here the authors give updates on the implementation of the tracking attachment to ICOADS. The tracking attachment contains the ship identifier, or ID, by which groups of reports can be associated with an individual ship or ship track. As a new output, the tracking attachment includes for each ID a guessed ship type. Steam ships began operating long-distance routes from about 1870, and it is well known that sail and hybrid sail/steam ships were in use until the early 20th century. However, a detailed proportion of the mix of vessel types is still unknown and information on ship type can be extremely valuable for sea surface temperature (SST) bias adjustments. Estimation of ship-by-ship biases requires knowing the measurement method: while on steamships the SST reported can be either the temperature of the engine-room cooling water intake or that collected in a bucket, on sailing vessels only buckets measurements are possible. Ship tracking permits a better estimation of ship speed which, when regressed against wind speed, can give insights on the ship type: ship speeds are well correlated with wind speeds for sailing vessels, but poorly correlated for steamships. In this study we analysed the correlation between ship speed and observed wind speed for each ID in ICOADS sampling at least 3 observations in 4 different Beaufort categories and with more than 20 observations per year. Comparing the data to three different models (sail, steam and hybrid) we then assigned to each ID a ship type, complete with uncertainty estimates. Overall statistics show, as expected, that the proportion of sailing vessels is higher in the early part of the record and with sailing ships basically disappearing from 1920s. However, a part from the 1880s when more than half of the observations were assigned a ship type, in the period when all sailing, hybrid and steam ships are present, the ship type was derived on average only for less than 30 per cent of the observations. The method presented here can be used to derive the ship type for IDs in ICOADS that sample a wide-enough range of wind speed conditions, but cannot be applied to all IDs. Future work will focus on developing new techniques that, on a ship-by-ship basis, can give useful information on the method adopted to measure SST.

Carella, G., E. C. Kent and D. I. Berry, 2015: A probabilistic approach to ship voyage reconstruction in ICOADS, Int. J. Climatol., early view, doi :10.1002/joc.4492.

Poster

- **Data homogenization (benchmarking, bias adjustments, step change analysis, metadata)**

Session 2: Quantification and estimation of uncertainty

S2E1

Uncertainty modelling for satellite-based sea surface temperatures

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This contribution addresses progress in uncertainty modelling for satellite-based sea surface temperatures in two projects. The first project is ESA's Climate Change Initiative for Sea Surface Temperature (SST CCI) in which a model has been developed for context-specific uncertainty estimates to be attached to each measured SST. The model has three components : (independent) random, structured random (locally correlated) and systematic. At the level of full resolution pixels, the random component is associated with noise in the satellite observations, the structured random component arises from SST retrieval errors and the systematic is an overall calibration uncertainty. These uncertainties propagate differently into gridded, averaged data. Moreover, and additional random effect is added to the uncertainty for gridded, averaged data to account for incomplete sampling of the time-space domain of the grid (representativity). A tool has been prototyped to propagate these uncertainties to large-scale average SSTs, account properly for correlation structures, which is somewhat effective, but requires more development.

In a second project, FIDUCEO (Fidelity and Uncertainty in Climate data records from Earth Observation), an even more fundamental approach is being attempted, by building models of uncertainty at the radiance level, i.e, at the level of the records from which SST is retrieved. It turns out that such data also contain structure random errors, as well as noise and systematic effects. These all propagate into errors in the SST retrieval in turn, and the error distributions turn out not to be Gaussian. FIDUCEO will also involve experimentation with ensemble methods for characterising uncertainty at both radiance and SST level, as a means of representing complex correlations when transforming data to different spatio-temporal scales for diverse climate applications.

Oral

- **Quantification and estimation of uncertainty**

S2T1

Exploring and Quantifying Uncertainties for Extended Reconstructed Sea Surface Temperature (ERSST) Version 4

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The uncertainty in Extended Reconstructed SST (ERSST) version 4 (v4) is reassessed based upon i) reconstruction uncertainties and ii) an extended exploration of parametric uncertainties. The reconstruction uncertainty (U_r) results from using a truncated (130) set of Empirical Orthogonal Teleconnection functions (EOTs) which yields an inevitable loss of information content, primarily at a local level. The U_r is assessed based upon 32 ensemble ERSST.v4 analyses with the spatially complete monthly Optimum Interpolation SST product. The parametric uncertainty (U_p) results from using different parameter values in quality control, bias adjustments, and EOT definition etc. The U_p is assessed using a 1000-member ensemble ERSST.v4 analysis with different combinations of plausible settings of 24 identified internal parameter values. At an individual gridbox scale, the SST uncertainty varies between 0.3°C and 0.7°C and arises from both U_r and U_p. On the global scale, the SST uncertainty is substantially smaller (0.03°-0.14°C) and predominantly arises from U_p. The SST uncertainties are greatest in periods and locales of data sparseness in the 19th Century and relatively small after the 1950s. The global uncertainty estimates in ERSST.v4 are broadly consistent with independent estimates arising from Hadley SST version 3 (HadSST3) and Centennial Observation-Based Estimates of SST version 2 (COBE-SST2). The uncertainty in the internal parameter values in quality control and bias adjustments can impact the SST trends in both the long-term (1901-2014) and “Hiatus” (2000-2014) periods.

Oral

- **Quantification and estimation of uncertainty**

S2T2

Error Characterization in iQuam SSTs Using Triple Collocations with Satellites Measurements

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NOAA's in situ SST Quality Monitor (iQuam; www.star.nesdis.noaa.gov/sod/sst/iquam/) [1] was established in 2009 to support calibration and validation of satellite and blended sea surface temperature (SST) products. Recently, iQuam has been upgraded to version 2, which now includes SSTs from Argo floats and several local or experimental programs, in addition to the customary SSTs from drifting and moored buoys and ships, and covers the full satellite era back to 1981 [2]. All in situ SSTs are uniformly quality controlled, using end-to-end robust procedures. This study aims at quantifying the random errors in various in situ data types in iQuam using triple-collocations with SST retrievals from NOAA17 AVHRR and ENVISAT AATSR, derived by the ESA SST Climate Change Initiative (CCI) program [3]. The CCI data were selected because the corresponding retrievals are derived independently of in situ data and AVHRR and AATSR sensors employ very different measurement principles and therefore are expected to be maximally independent. Seven years of AVHRR L2P v1.0 and ATSR L3U v1.1 data from 2003-2009 are used in this study obtained from CEDA website (www.ceda.ac.uk/). The triple-collocation matchups are generated by finding the closest satellite observation for each in situ measurement within (25 km, 3hr) space-time window. By calculating the variance of the difference between each pair of measurements, triple-collocation analysis [4] is employed to estimate the absolute root mean squared errors (RMSE) of three measurements, which are considered independent. Preliminary results show that drifters, tropical moorings and Argo floats have comparable errors of 0.20-0.25K, whereas coastal moorings and ships have larger RMSEs, on the order of 0.45K and 0.75K, respectively. These estimates are largely in line with what is found in the literature. The AVHRR CCI SST shows RMSE~0.45K, whereas the AATSR RMSEs are found to be from 0.20-0.40K. Ongoing analyses include exploration of geospatial and seasonal patterns of the platform-specific errors, as well as trending their performance in time.

Keywords – iQuam, error quantization, sea surface temperature, triple collocation, AVHRR, AATSR.

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Oral

- **Quantification and estimation of uncertainty**

S2P1

Quantification of Uncertainty Estimates of HOAPS-3.3 Evaporation via Multiple Triple Collocation Analyses

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Surface freshwater fluxes (evaporation minus precipitation, E-P) play an essential role in the global hydrological cycle. As they are indispensable in context of calculating energy budget closures, they are important for understanding the climate system and represent a key boundary condition for coupled ocean-atmosphere general circulation models.

Satellite-based remote sensing permits an area-wide determination of E-P, where the evaporative component mainly depends on near-surface specific humidity, wind speed, and sea surface saturation specific humidity. Although of high interest for utilisation in, e.g., water cycle analysis and assimilation studies, systematic and random uncertainty estimates inherent to Special Sensor Microwave/Imager (SSM/I) evaporation estimates are typically not available.

Here, we present results from our comprehensive error analysis for E-related parameters of the Hamburg Ocean Atmosphere Parameters and Fluxes from Satellite Data (HOAPS) set, which is hosted by the Satellite Application Facility on Climate Monitoring (CM SAF). The analyses comprise the time period of 1988-2012 and are based on collocation analyses, whereat a comprehensive in-situ data set provided by the Seewetteramt Hamburg (SWA, German Meteorological Service, DWD) and the International Comprehensive Ocean-Atmosphere Data Set (ICOADS, Woodruff et al., 2011) serves as ground reference. Systematic satellite retrieval errors were quantified by means of double collocation analyses. The random component needed to undergo a correction, i.e. contributions due to the collocation procedure and the in-situ component were removed. The procedure of isolating the random satellite retrieval error was performed using the novel approach of multiple triple (MT) collocation analyses (Kinzel et al., 2016, under review at JAOT).

Next to an overview of the double and MT collocation procedure, the results will show global climatologies of HOAPS total (i.e. systematic + random) uncertainties of evaporation and its related parameters. Particular focus will be put on uncertainty hotspots. A brief outlook will establish a connection to uncertainties in atmospheric water vapour transports. Along with uncertainty estimates of P, which are currently being quantified in the framework of a German research group activity with a strong focus on surface salinity and freshwater flux variability, the presented results proves helpful for assimilation experiments such as GECCO (e.g. Köhl and Stammer, 2008).

Poster

- **Quantification and estimation of uncertainty**

Session 3: Integrating In-situ / satellite data sources

S3E1

Integrating in situ data and satellite ocean-colour towards improved estimation of marine autotrophic-carbon stock

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The autotrophic-carbon stock in the ocean is responsible for almost half of the annual global carbon fixation, and is fundamental to the global carbon cycle. However, an accurate estimation of this carbon stock on a global scale is a non-trivial task. This presentation will deal with some recent developments in this direction. It includes integration of in situ data and satellite-remote sensing through (i) development of novel bio-optical algorithm combining allometric relationships and light-absorption properties of phytoplankton, and (ii) implementation of data assimilation using biogeochemical model, to provide independent estimates of carbon stocks in marine autotrophs (phytoplankton) partitioned into various size classes. The importance of the approaches will be discussed in the context of minimizing uncertainties in phytoplankton-carbon estimates by satellite algorithms and marine ecosystem models.

Oral

- **Integrating In-situ / satellite data sources**

S3E2

EUSTACE: combining different components of the observing system to deliver global, daily information on surface air temperature

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Day-to-day variations in surface air temperature affect society in many ways and are fundamental information for many climate services; however, daily surface air temperature measurements are not available everywhere. A global daily analysis cannot be achieved with measurements made in situ alone, so incorporation of satellite retrievals is needed. To achieve this, we must develop an understanding of the relationships between traditional surface air temperature measurements and retrievals of surface skin temperature from satellite measurements, i.e. Land Surface Temperature, Ice Surface Temperature, Sea Surface Temperature and Lake Surface Water Temperature.

Here we reflect on our experience so far within the Horizon 2020 project EUSTACE (2015-June 2018) of using satellite skin temperature retrievals to help us to produce a fully-global daily analysis (or ensemble of analyses) of surface air temperature on the centennial scale, integrating different ground-based and satellite-borne data types and developing new statistical models of how surface air temperature varies in a connected way from place to place.

We will present an overview of progress, i.e.:

- providing new, consistent, multi-component estimates of uncertainty in surface skin temperature retrievals from satellites for land, ocean and ice;
- estimating surface air temperature over all surfaces of Earth from surface skin temperature retrievals;
- using new statistical techniques to provide information on higher spatial and temporal scales than currently available, making optimum use of information in data-rich eras

and a brief introduction to the other components of the project.

Oral

- **Integrating In-situ / satellite data sources**

S3T1

Stability Assessment of Satellite Sea Surface Temperature Estimates Using the Penalized Maximal T-Test

David I. Berry

National Oceanography Centre

The sea surface temperature (SST) is an important indicator of climate change and changes to the SST have been used as a metric of climate change over the oceans in numerous studies and assessments. The SST datasets used have typically been based on homogenized and bias adjusted in situ observations made over the last 150 years. Satellite based records have typically been too short and tied to the in situ record through comparison and calibration with drifting buoy measurements. Recent efforts, through the European Space Agency's (ESA) Climate Change Initiative (CCI), have sought to address this through the creation of an independent satellite based SST dataset calibrated through radiative transfer modeling and homogenized across satellites and to a common reference time (1030 am/pm local) to avoid aliasing of the diurnal cycle. In this poster we present an assessment of the stability of the ESA CCI SST dataset through comparison with in situ dataset using the Penalized Maximal T-test, highlighting obstacles with the in situ data and how these have been overcome.

Oral

- **Integrating In-situ / satellite data sources**

S3T2

Satellite and in situ SST reprocessing and harmonization at NOAA

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NOAA is responsible for satellite sea surface temperature (SST) products from several platforms and sensors, including AVHRR onboard NOAA and Metop satellites (1981-pr) and VIIRS onboard S-NPP (2011-pr) and four future JPSS satellites, J1-4 (scheduled for launch from 2017-2026). The NOAA enterprise SST system, Advanced Clear-Sky Processor for Ocean (ACSPO), is consistently used to process data from various platforms and sensors. All ACSPO SST products are routinely validated against uniformly quality controlled in situ SSTs, provided by another NOAA system, in situ SST Quality Monitor (iQuam; www.star.nesdis.noaa.gov/sod/sst/iquam/).

In addition to operational products, two satellite reprocessing (or "Reanalysis", RAN) efforts are currently underway. The AVHRR RAN version 1 (RAN1) reprocessed data from seven AVHRRs (onboard NOAA-15 to -19, and Metop-A and -B) from 2002-pr. The VIIRS RAN1 reprocessed data of S-NPP from 2012-pr.

In situ data in iQuam have been also reprocessed, and the new version 2 (iQuam2) generated. The iQuam time series have been extended to cover the full satellite SST era from 1981-pr (from 1991-pr in iQuam1) using ICOADS v2.50. Several new data types have been added, including ARGO floats, IMOS ships, GHRSST high-resolution drifters, and Coral Reef Watch buoys.

In RAN1, the AVHRR and in situ SSTs have been harmonized using rolling recalculation of the regression coefficients in the SST algorithm. Work is underway to improve the AVHRR calibration, which is expected to minimize the need for rolling anchoring of its SSTs to in situ data. The VIIRS radiances were found quite stable and therefore static VIIRS SST coefficients have been used in the operations and in RAN1. Work is underway to explore improvements to the time series using dynamic coefficients. The satellite and in situ SSTs are routinely inter-compared in the NOAA SST Quality Monitor (SQUAM; www.star.nesdis.noaa.gov/sod/sst/squam/) system.

This presentation discusses these reprocessing and harmonization efforts, and future work towards periodic reprocessing of the geostationary ACSPO SST from the two close AHI and ABI sensors (onboard the Japan Himawari-8 satellite launched in Oct 2014, and next-generation US geostationary satellite GOES-R to be launched in Oct 2016) and harmonization with in situ iQuam SST.

Oral

- **Integrating In-situ / satellite data sources**

S3T4

The Distributed Oceanographic Match-Up Service

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The Distributed Oceanographic Match-Up Service (DOMS) is a collaborative effort between COAPS, NCAR, and NASA JPL. DOMS is being designed to provide web-based capabilities for users to input a series of geospatial references for satellite observations and receive the in situ observations that are matched to the satellite data within a selectable temporal and spatial domain. Inverse matching, input in situ geospatial references and return matched satellite data, will also be supported. The DOMS prototype includes several characteristic in situ (e.g., International Comprehensive Ocean-Atmosphere Data Set) and satellite observation datasets, with a focus on sea surface temperature, sea surface salinity, and marine winds. DOMS has been designed to support numerous use cases within the marine and satellite research communities, with an initial focus on satellite calibration/validation and algorithm development. The service is designed to provide a community-accessible tool, both via a user web portal and RESTful web services, that will dynamically deliver matched data and allows the scientist to only work with the subset of data where the matches exist. The service is currently in the prototype phase and scheduled to go online in late 2016 – a status of the project development, an outline of use cases, and example data queries will be provided.

Oral

- **Integrating In-situ / satellite data sources**

S3P1

Testing historical reconstructions of sea surface temperature using early satellite data

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The global record of sea surface temperatures (SSTs) is primarily in the form of reconstructions based on in situ measurements. A multitude of uncertainties and biases are introduced into these reconstructions in association with the measurements themselves, and the methods by which they are processed to form the reconstructions. This research aims to use satellite measurements from 1970-71 as an independent means of testing whether the historically reconstructed SSTs are correct to within their stated uncertainties. These measurements were collected by the Infra-Red Interferometer Spectrometer (IRIS) on board the Nimbus 4 satellite. It has been demonstrated that SST can be retrieved from IRIS observations, and this research aims to build upon previous efforts and provide much improved SST estimates. This is facilitated by the availability of recent satellite measurements and continual improvements in radiative transfer models (RTMs).

To date, this research has involved an analysis and comparison of the main SST reconstructions during the IRIS period (April 1970 to January 1971). Currently, an exploratory analysis of the IRIS dataset is being performed, which aims to characterize the data using methods such as Principal Component Analysis (PCA) as well as to quality control the data. This will form the initial step leading to simulation of the IRIS measurements using a Principal Component-based Radiative Transfer Model (PCRTM). Use of data from recent and ongoing satellite missions will enable the eventual retrieval of high-quality SSTs from IRIS.

Poster

- **Integrating In-situ / satellite data sources**

S3P2

The HOAPS Climatology Version 3.2 release compared to an extended version based on a 1D-Var retrieval

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The global water cycle is a key component of the global climate system as it describes and links many important processes such as evaporation, convection, cloud formation and precipitation. Through latent heat release, it is also closely connected to the global energy cycle and its changes. The difference between precipitation and evaporation yields the freshwater flux, which indicates if a particular region of the earth receives more water through precipitation than it loses through evaporation or vice versa. On global scale and long time periods, however, the amounts of evaporation and precipitation are balanced. A profound understanding of the water cycle is therefore a key prerequisite for successful climate modelling. The Hamburg Ocean Atmosphere Parameters and Fluxes from Satellite Data (HOAPS) set is a fully satellite based climatology of precipitation, evaporation and freshwater budget as well as related turbulent heat fluxes and atmospheric state variables over the global ice free oceans. All geophysical parameters are derived from passive microwave radiometers, except for the SST, which is taken from AVHRR measurements based on thermal emission of the Earth. Starting with the release 3.2, the HOAPS climate data record is hosted by the EUMETSAT Satellite Application Facility on Climate Monitoring (CM SAF) and the further development is shared with the University of Hamburg and the MPI. The data can be obtained following the instructions given at the website http://www.hoaps.org through the CM SAF web user interface http://wui.cmsaf.eu. The extended version of the HOAPS data set covers not only the entire record of the passive microwave radiometer SSM/I, as it was the case for the HOAPS release 3.2 in 2012, but also the SSMIS record up to December 2014. The HOAPS data products will be available as monthly averages and 6-hourly composites on a regular latitude/longitude grid with a spatial resolution of 0.5° x 0.5° from July 1987 to December 2014 (December 2008 for HOAPS3.2). Covering nearly 28 years the new HOAPS data set is especially usable for climate applications. The presentation will cover details of the HOAPS-3.2 release, recent enhancements as well as future plans for the further development of the HOAPS data set. E.g., for the precipitation, the liquid water path and the integrated water vapour product a new 1D-Var based retrieval is being developed. Preliminary results present the differences between the regression based retrieval used in HOAPS-3.2 compared to the new 1D-Var based retrieval. Main advantage of the implementation of a 1D-Var retrieval over regression type algorithms is in particular, that retrieval uncertainties of the retrieved geophysical parameters are provided.

Poster

- **Integrating In-situ / satellite data sources**

Session 4*:* Reconstructing past climates (methods)

S4E1

Climate Reconstruction Improvements from Iteratively Adjusted Statistics, Demonstrated Using Model SST

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Historical reconstructions of climate fields such as sea-surface temperature (SST) are important for climate studies and monitoring. Reconstructions typically use statistics from a well-sampled base period to analyze sparsely-sampled historical variations in earlier periods. Here a method is shown for adjusting the base-period statistics using the available historical data so that statistics better represent historical variations. The method is demonstrated using SST from a coupled GCM historical run forced by greenhouse gases and aerosols. Simulated data are constructed from the model SST using observed historical SST sampling and adding historical error estimates. The simulated data are reconstructed and results are compared to the error-free and fully-sampled coupled GCM SST to evaluate the reconstruction, and compare results to other methods. Here annual averages are reconstructed. Testing indicates that reconstruction of shorter periods is not improved using the new methods because historical data are only dense enough to improve the leading large-scale modes of variation. Those leading modes explain most of the annual variance, but monthly variations require higher modes that often describe spatial variations too small to be reliably improved by the methods discussed here. The improvements can be important for giving an improved first guess for monthly variations, and for giving more reliable monitoring of multi-decadal changes. In particular, compared to the low-frequency estimate using ERSST methods, the improved analysis better represents variations from the 19th and early 20th centuries when sparse sampling limits where the ERSST method can form reliable low-frequency estimates.

Oral

- **Reconstructing past climates (methods)**

S4T1

Advanced approaches to space-time integration of surface turbulent heat fluxes

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Space-time integration of surface turbulent heat fluxes is important for obtaining area-averaged budget estimates and for producing climatologies of surface fluxes. Uncertainty of the integration or averaging of fluxes in space and in time are especially high when the data are sparse as in the case of the use of information from Voluntary Observing Ships (VOS) which are characterized by inhomogeneous sampling density in contrast to NWP products and satellite data sets. In order to minimize sampling impact onto local and larger scale surface flux averages we suggest an approach based upon analysis of surface fluxes in the coordinates of steering parameters (vertical surface temperature and humidity gradients on one hand and wind speed on the other). These variables are distributed according to the Modified Fisher-Tippett (MFT) distribution (temperature and humidity gradients) and Weibull distribution (wind speed) which imply a 2-dimentional distribution for the fluxes. Since the fluxes in these coordinates are determined in a unique manner (within a chosen bulk transfer algorithm), they can be easily integrated in the space of 2-dimentional distribution in order to get the averaged values dependent on the parameters of the MFT and Weibull distributions. Conceptually, the approach is similar to that oceanographers apply for analyzing volumetric T,S-diagrams of water mass properties. We developed an algorithm for applying this approach and also provided the analysis of integrated surface fluxes for different regions of the North Atlantic for which heat flux estimates can be obtained from oceanographic cross-sections. Analysis was performed for the last 5 decades. 2-dimensitonal diagrams also make it possible to analyse temporal variability of integrated surface fluxes in the dimension of steering parameters and to further compare estimates with changes in the ocean heat content.

Oral

- **Reconstructing past climates (methods)**

S4T2

The influence of atmospheric circulation on marine air temperature

Jonathan Harrison, Elizabeth C. Kent and David I. Berry

National Oceanography Centre, UK

Atmospheric circulation is an important influence on local climate, affecting meteorological variables such as temperature, precipitation, cloud cover and humidity. Relationships between surface meteorology and atmospheric circulation have been shown over many land and marine areas. The extent to which these relationships can explain past climate variability however is unclear, especially over the oceans. We investigate the extent to which atmospheric circulation can predict past marine air temperature variations by presenting estimates of marine air temperature from 1880-2010 derived from atmospheric circulation patterns. Atmospheric circulation patterns are defined from calculations of flow direction and flow rotation (indicating the position of the nearest cyclone/anticyclone), which are calculated using only observations or estimates of Sea Level Pressure (SLP). Both observational and reanalysis based datasets of SLP and marine air temperature are analysed. Estimated and observed marine air temperatures are strongly correlated from the mid-20th century onwards, especially in the Northern Hemisphere for both observational and reanalysis based datasets. Differences between the estimated and observed marine air temperatures may highlight other influences on temperature aside from atmospheric circulation. Alternatively such differences may result from uncertainties in SLP, marine air temperature or the circulation based temperature anomalies that require further investigation. The potential for the use of estimates of atmospheric circulation to give insight into past marine climate variability will be discussed.

Oral

- **Reconstructing past climates (methods)**

S4T3

Improvements to the low-resolution Met Office Hadley Centre Sea Surface Temperature data set, HadSST

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A number of improvements to the low-resolution long-term sea-surface temperature data set, HadSST, are described. These include: improvements to the basic Quality Control that slightly increase coverage in the Southern Hemisphere; improvements to the gridding and uncertainty calculations and improvements to the bias adjustments. The bias adjustments now include a broader exploration of parametric uncertainty and are fixed relative to drifting buoys. A simple interpolation technique, combined with the improved error model is used to make estimates of global Engine Room biases and local, ship-by-ship biases in the data at the same time as producing a more globally complete data set of sea-surface temperatures. Validation of the interpolated data (both mean and uncertainty estimates) is performed relative to high quality data (Drifting buoys, Argo, ARC).

Oral

- **Reconstructing past climates (methods)**

S4T4

Historical land surface temperature reconstruction with observations over land and oceans

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We applied the reconstruction method of COBE-SST2 (Hirahara et al. 2014) to the historical land surface air temperature (LST) based on Global Historical Climatology Network (GHCN) and International Surface Temperature Initiative (ISTI) data. The reconstruction method overcame problems of uneven sampling in space and time and large observational noise in LST data. The LST analysis is given monthly on a 1-degree longitude and latitude grid as a sum of secular trend, inter-annual variations on a global grid from 1850 onward. The trend component is the leading empirical orthogonal function (EOF) of annual mean LST observations in 5-degree latitude and longitude boxes. The inter-annual variations are reconstructed using EOFs explaining 95% of the total variance of monthly mean JRA-55 LST. Two types of reconstruction analyses are performed: one with the EOFs of LST (TS_REC) only and the other with extended EOFs of SST and LST (SSTTS_REC). The trend and temporal variations of global mean TS_REC are similar to those produced by previous studies. SSTTS_REC produced more accurate LST analysis than TS_REC with respect to inter-annual variations over data-sparse regions particularly in low latitudes. In COBE-SST2, the uncertainty caused by sampling errors is investigated by a cross validation technique. With the same approach, the uncertainty in the LST analyses will be discussed.

Oral

- **Reconstructing past climates (methods)**

S4P1

Development of an analysis system for estimating globally-complete air temperature estimates for the EUSTACE project

Colin Morice

Met Office Hadley Centre, UK

The EUSTACE project aims to produce daily estimates of near surface air temperatures over the whole Earth, with quantified uncertainties, combining in situ observations with satellite retrievals of air temperature over land, ocean, lakes and ice.

This poster describes progress in the development of a statistical analysis methodology to derive globally-complete air temperature estimates from the observational data developed within and available to the EUSTACE project. The analysis system will merge terrestrial and marine in situ observations with high-resolution satellite-derived air temperatures to permit reconstruction of air temperatures globally from the mid-19th century to present. It will build upon and extend methods previously applied in reconstruction of past climate from observational data, further developing these methods for application to the varied observation sources and large data volumes in EUSTACE using computationally efficient geostatistical methods. Analysis methods will be demonstrated in application to observations over land and sea in a European trial region.

Poster

- **Reconstructing past climates (methods)**

Session 5: Reconstructing past climates (products)

S5E1

The Met Office Hadley Centre Sea Ice and Sea-surface Temperature Dataset, HadISST.2.2.0.0

John Kennedy, Chris Atkinson, Nick Rayner

Met Office Hadley Centre, UK

An update of the Hadley Centre Sea Ice and Sea-Surface Temperature data sets is described. It uses homogenised satellite data from the AVHRR and ATSR instruments together with homogenised in situ data. The AVHRR data are from the ESA SST CCI project, updated using operational SST retrievals from METOP. The ATSR data are from the ARC ATSR Reprocessing for Climate. The in situ data have improved bias estimates, which allow for closer matching with the ATSR data. Quality control of the in situ data was also improved. Together with ship-by-ship bias estimates, this reduces the appearances of "streaks" caused by biased ships and drifters in the reconstructed fields. Reconstruction, as in previous versions of HadISST.2, is via a two-step process with uncertainties represented via an ensemble. Improvements to the local-interpolation allow for a greater number of ensemble members to be generated more efficiently and reduce numerical instabilities in the reconstruction.

Oral

- **Reconstructing past climates (products)**

S5E2

CERA-20C: a 20th century record of consistent ocean-atmosphere states

Eric de Boisseson

ECMWF

Within the ERA-CLIM2 project, ECMWF has developed an ocean-atmosphere coupled data assimilation system (CERA) that aims at producing a self-consistent estimate of the climate system. In CERA, ocean and atmospheric observations are simultaneously ingested, and the coupled model constraints of the variational method imply that the assimilation of an ocean observation can impact the atmospheric state, and vice-versa. An ensemble technique is also used to take into account uncertainties in the observational record. CERA is being used to generate the first climate reanalysis of the 20th century (CERA-20C) at moderate resolution using historical conventional observations from ISPD, ICOADS, HadISST and EN4 datasets. In CERA-20C, 3-hourly estimates of the coupled ocean-atmosphere state are available from 1901 to 2010. CERA-20C can be used for past climate reconstruction, climate monitoring, the detection of signals of decadal variability, as a set of initial conditions (and verification states) for extended-range forecasts. CERA-20C will also provide further insights into the impacts of the various observing systems on the reanalysed climate states. After completion and evaluation, CERA-20C will be made available to the research community to identify its strengths but also its weaknesses and ways forward to address them. In this presentation, the CERA system will be described, and preliminary results from CERA-20C will be presented.

Oral

- **Reconstructing past climates (products)**

S5T1

Global ocean wind waves 1878-2016: new update of the IORAS VOS-based wave products

V. Grigorieva[1] and S. Gulev[1, 2]

1 Sea Atmosphere Interaction and Climate Laboratory P. P. Shirshov Institute of Oceanology, Russia

2 Lomonosov Moscow State University, Russia

The recent massive increase in the global wave information from VOS and from satellite data along with repeatedly updated model wave hindcasts imposes the necessity for developing new updates of the VOS-based wave climatology with advanced pre-processing and data quality control procedures. We present the next generation global wind wave database based on the newly updated IMMA-formatted visual VOS data. The main wave statistics (heights and periods) are now supplemented with the wave geometry characteristics (steepness, wave age and wave length) as well as statistics of extreme waves. All possible sources of uncertainties were estimated and are also included in the climatology. For the pre-processing we used several levels of the quality control technique applied for the correction of raw observations and elimination of erroneous values. Newly developed database is useful for many scientific and practical purposes, such as analyses of global wave climate, estimation of interannual to multidecadal variability and extreme wave statistics. Importantly, the climatology also allows for the global and regional verifications of satellite-based data and model hindcasts as well as testing of wave theories. Some of these applications will be demonstrated.

Oral

- **Reconstructing past climates (products)**

S5T2

HadISDH.ocean: A new multi-variable marine humidity product for climate monitoring

Kate Willett, Robert Dunn, John Kennedy and David Parker

Met Office Hadley Centre, UK

Marine near-surface humidity in the form of specific humidity can be monitored using the in situ based NOCSv2.0 product, reanalyses and also satellite based microwave sensors. There are considerable differences between the different types of product and also within those types. The new HadISDH.ocean in situ based product is designed as a sister monitoring product to HadISDH.land, presenting gridded estimates for several humidity variables from 1973 onwards. It is largely methodologically independent from the NOCSv2.0 product allowing exploration of structural uncertainty in in situ based products. Here we present the main climatological features of the new product, methodological differences from the existing products and steps underway to improve bias correction and uncertainty estimation.

Oral

- **Reconstructing past climates (products)**

S5P1

Updates to gridded estimates of historical night marine air temperature

John J. Kennedy[1], Elizabeth C. Kent[2], David I. Berry[2], Nick A. Rayner[1]

1 Met Office Hadley Centre, UK

2 National Oceanography Centre, UK

Night marine air temperature (NMAT) is an important indicator of marine surface climate change. NMAT has also been used to construct bias adjustments for datasets of sea surface temperature. We present an update to the HadNMAT2 dataset which previously covered the period 1880-2010 on a monthly 5° grid without interpolation. The update covers the period from 2011-2014 and also provides improved estimates for the late 2000s when metadata giving observing height were previously not available. The impact of the new height adjustments on estimates of recent global temperature change will be discussed.

Poster

- **Reconstructing past climates (products)**

S5P2

Reconstruction of Early 20th Century Climate from Atmospheric Data at Signal Stations along the German Baltic Coastline

Dörte Röhrbein[1], Birger Tinz[1], Hans von Storch[2], Lydia Gates[1]

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2 Institute for Coastal Research of Helmholtz-Zentrum-Geesthacht (HZG), Geesthacht, Germany

At the Hamburg office of Deutscher Wetterdienst (German Meteorological Service, DWD) historic handwritten journals of weather observations are archived. Among others, a considerable number of original observations sheets of signal stations at the western German coast and the southern Baltic Sea coast are now being digitized. The stations are called signal stations as they were positioned close to the shore to warn sailors of severe weather by optical signals such as balloons. A dataset of historic wind and pressure observations from 1877 to 1999 of about 160 signal stations along the western German coast and the southern Baltic Sea coast, from Germany to Lithuania, is potentially available to study long-term trends and extreme events along these coasts. In this study we present a first analysis of wind and surface air pressure data from 1910 to 1939 at 15 selected signal stations between Emden in Germany and Leba in Poland. During this time period, a major storm surge occurred on the coast of the southern Baltic in December 1913. This event is reconstructed and analysed using digitized data of 70 stations along the southern Baltic Sea coast and allows us to analyze this event in more detail than before. It is shown that the spatial homogeneity of the signal station data is sufficient for the description of historic events, but that temporal homogenization will be required for long-term trend analysis.

Poster

- **Reconstructing past climates (products)**

Session 6: Reconstructing past climates (applications)

S6E1

Blended sea ice climatologies based on national ice charting products for the Arctic and Antarctic - content and possible applications

Vasily Smolyanitsky

Arctic and Antarctic Research Institute

TBC

Oral

- **Reconstructing past climates (applications)**

S6T1

Early-nineteenth century southern African precipitation reconstructions from ships' logbooks

Matthew J. Hannaford, Julie M. Jones, Grant R. Bigg

University of Sheffield

Detailed investigations of past rainfall variability are essential for understanding how recent rainfall levels differ from long-term averages. Instrumental rainfall records in southern Africa, however, only become plentiful in the 1880s, and are absent over much of the continent until the early 1900s. This study presents a statistical methodology used to produce seasonal terrestrial rainfall reconstructions in southern Africa from early-nineteenth century marine wind data held within the CLIWOC database and digitised English East India Company logbook data (Hannaford et al. 2015). We obtained these reconstructions by first relating gridded 8° x 8° NCEP-DOE reanalysis seasonal mean wind vectors in the oceans surrounding southern Africa to station-based precipitation over a 30-year calibration period (1979-2008). This revealed significant correlations between southwest Indian Ocean zonal winds and summer precipitation at the stations of Mthatha (Eastern Cape) and Royal National Park (KwaZulu-Natal), and southeast Atlantic Ocean zonal winds and winter precipitation at Cape Town (Western Cape). We then derived the reconstructions using principal component regression with the reanalysis wind vectors as predictors, and applying the regression relationships to the equivalent gridded seasonal mean logbook data over the period 1796-1854. The reconstructions show good correspondence with other regional proxy-documentary reconstructions, while their integration into a southern African multi-proxy rainfall reconstruction suggests that summer precipitation has been declining progressively over the last 200 years (Nash et al. 2015). A westerly index produced from the oceanic areas with significant wind-rainfall correlations also reveals correspondence between documentary-derived reconstructions of El Niño events and increased westerliness, though these events did not always result in drier conditions in the subcontinent.

Hannaford, MJ, Jones, JM, Bigg, GR. 2015. Early-nineteenth century southern African precipitation reconstructions from ships' logbooks. The Holocene, 25, 379-390.

Nash DJ, Pribyl K, Klein J, Neukom R, Endfield GH, Adamson GCD, Kniveton DR. 2015. Seasonal rainfall variability in southeast Africa during the nineteenth century reconstructed from documentary sources. Climatic Change 2015. doi:10.1007/s10584-015-1550-8.

Oral

- **Reconstructing past climates (applications)**

S6P1

Who uses sea surface temperature data? A case study

Viva Banzon and Mara Sprain

NOAA NCEI

In an effort to characterize the evolving user community for sea surface temperature (SST) data, the body of citations for a widely used SST product was examined. As a search tool, the Thomas Reuters Web of Science (formerly ISI Web of Knowledge) was used. Web of Science is a curated database that provides links to journal publications. A total of 752 citations were found for the paper that described the original release of the ¼ degree Daily Optimum Interpolation (DOI) SST in 2008. DOISST was originally developed to support climate modelling, and not surprisingly, about 50% of those citations (~358) were in meteorology and atmospheric science, mostly focused on forecasting or modelling weather and climate phenomena. About 25% of the citations were in oceanography, usually describing air–sea interaction or physical ocean processes. There are smaller but increasing use cases in fisheries, biogeography, ecology, and marine biology. Applications include not only stock assessments, animal distribution models, and physiological studies, but also projections of climate change impacts. While a literature search on a single SST product cannot represent the full range of applications, this work shows that the SST user community is increasing in diversity and may dictate requirements for future products.

Poster

- **Reconstructing past climates (applications)**

S6P2

El Niño Southern Oscillation Reconstructions from Ships' Logbooks, 1815-1854

Hannah G Barrett, Julie M Jones and Grant R Bigg

University of Sheffield, UK

The logbooks from ships which historically travelled the World's oceans contain a vast amount of meteorological information useful for studies of historical climate. They provide daily, marine-based weather observations from the pre-instrumental era. The Climatological Database for the World's Oceans (CLIWOC) and digitised English East India Company (EEIC) logbooks have been used to investigate the climate during the period 1750-1854. A statistical-based reconstruction of El Niño Southern Oscillation (ENSO) has been carried out for boreal winter (DJF) seasons between 1815/16 and 1853/54. Principal Component Regression has been carried out using zonal winds as predictors and Southern Oscillation Index (SOI) as the predictand. Cross validation and Reduction of Error skill scores were used to assess the performance during the modern period, 1979-2013, using ERA-Interim Reanalysis winds as predictors. The statistical relationships were then applied to the historic wind data in order to reconstruct a historical SOI. Additional SOI reconstructions were carried out using a simple Composite-Plus-Scale method in order to assess coherency between reconstruction methods. The presented reconstructions offer an indication of historical ENSO, which along with proxy data sources, provide insights into the behaviour of this important mode of climate variability in the pre-instrumental period. Further digitization of unexploited logbook data would be advantageous, to increase the temporal and spatial scope of the historical reconstructions.

Poster

- **Reconstructing past climates (applications)**

S6P3

Southern Annular Mode Reconstructions from Ships' Logbook Data

Julie M Jones[1], Hannah Barrett[1] and Matthew Hannaford[1], Gareth Marshall[2] and Ryan L. Fogt[3]

1 Department of Geography, University of Sheffield

2 British Antarctic Survey, Cambridge, UK

3 Department of Geography, Ohio University, Athens, Ohio, USA

The Southern Annular Mode (SAM) represents changes in the strength of the Southern Hemisphere westerlies, the strengthening of which in recent decades in austral summer has been linked to stratospheric ozone depletion. Extending the SAM record back further for all seasons is needed to put current changes in perspective and for evaluation of the ability of climate models to simulate the SAM. This study will produce SAM reconstructions during the period 1750-1850 using meteorological observations from ships' logbooks from the Climate of the World's Oceans (CLIWOC) and East India Company (EIC) databases. As data are available all year round, this offers the possibility of SAM reconstructions for the four seasons, which will extend knowledge on seasonal SAM behaviour, and complement existing proxy-based reconstructions which are typically for the summer season or annual.

To determine regions with significant relationships between u-wind and the SAM index, correlation coefficients were calculated between regridded 10m u-wind speed from the ERA-interim reanalysis for the SAM index of Marshall (2003) over the period 1979-2010. These data were first regridded to 8 degree by 8 degree resolution, to provide large enough regions for sufficient seasonal logbook data to be available. Regions of significant correlations overlap with the ship's routes and hence wind data from the EIC and CLIWOC datasets in all four seasons, with data coverage most dense in the Indian Ocean, around southern Africa and across the Atlantic Ocean towards South America. As there is no overlap between the logbook and modern instrumental data, model fitting and calibration is undertaken using 10m u-wind from the ERA-interim reanalysis, and then these relationships applied to logbook data to produce the reconstructions. For each season domains were selected where data coverage and significant correlations overlapped.

Principal component regression (PCR) was used to assess the potential of the dominant patterns of variability in the u-wind in these domains as predictors to reconstruct the SAM index. Fitting and validation statistics give confidence that reconstructions are viable in all four seasons, with reconstruction quality best in autumn and winter, seasons not typically represented in proxy reconstructions. The regression relationships derived in this fitting period will be applied to gridded seasonal mean logbook data to produce SAM reconstructions for periods between 1750 and 1850. This work also highlights the importance of rescuing and digitising existing datasets. Regions of significant mid-latitude correlations also extend south of Australia to New Zealand, where currently digitised logbook data coverage is too sparse to be used for the reconstructions. Similarly, high latitude data from around the Antarctic (Wilkinson pers. comm.) would also provide valuable data for the reconstructions. Results of a sensitivity analysis to determine the potential for improvement in the SAM reconstructions using reanalysis data from these regions will be presented.

Poster

- **Reconstructing past climates (applications)**

Given Name: Dongsheng

S6P4

The Quality Analysis of the ICOADS in Western Pacific Ocean and Its Application in Regional Climate Change Research

Zhang Dongsheng and Liu Yulong

National Marine Data and Information Service, China

Quality control including the duplication check is performed on the ICOADS-IMMA data during the period of 1662-2013. With a duplication rate of 0.26%, the quality of these data varies with time and geographic locations. During the 1970-1979 the good data only covered a ratio of 82.29%, much lower than the average ration at 92.12%. Time series analysis is carried out on the ECVs including sea surface air temperature, sea surface temperature (SST), air pressure and wind speed by 4°× 4° square in the Northwest Pacific (50°N-10°S, 90°E-170°W) during 1950～1992, by using mixed spectrum through which the non-liner effects are taken into consideration. The annual variation rates of these elements in each square are obtained by using the period components plus the linear trend fitting. The analytical results show that sea surface air temperature over Northwest Pacific is rising at the rate 0.0017°C/a, while the water temperature is on a decrease rate of 0.00105°C/a. The variation patterns are uneven over the studied sea area. A high rising-rate zone for both air and water temperature is significant in the equatorial Pacific. In the area of north of East China Sea, Japan Sea, and to the east of Japan there is a low-rising-rate zone for both elements, forming a sharp contrast between the north and the south. The sea surface air pressure over the whole Northwest Pacific presents an increasing trend, with an averaging rate of 0.00840hPa/a. In the area to the east of 140°E and north to 20°N, a decreasing trend presents.

Correlation analysis, factor analysis, and empirical orthogonal methods are employed to analyze the variation of SST over Western Pacific. The spatial-temporal relationship between the Western Pacific SST and ENSO and subtropical high are studied. The results show that the Northwest Pacific surface of SST anomaly is suffering from a warming trend with a significant decadal mode and classic El Niño mode. The main mode of SST spatial distribution is the region consistent with strong correlation with Western Pacific Warm Pool decadal oscillation and ENSO mode. The SST's impact on subtropical high indexes varies with seasons and region. It mainly affects the area and intensity index of subtropical high. The influence is also remarkable on the position of west ridge line.

Poster

- **Reconstructing past climates (applications)**

Session 7: Data management, recovery and reprocessing

S7E1

Implementing the New JCOMM Marine Climate Data System

Lydia Gates[1], Eric Freeman[2,3], Etienne Charpentier[4]

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2 National Centers for Environmental Information, Asheville, USA

3 STG. Inc., Asheville, USA

4 World Meteorological Organisation, Geneva, Switzerland

In 1963, by WMO Resolution 35, Congress-IV, the international exchange of delayed-mode marine climatological data was put in place through establishment of the Marine Climatological Summaries Scheme (MCSS). The system was focusing on delayed mode Voluntary Observing Ship (VOS) data. Efforts to modernize the MCSS have been initiated by the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM).

JCOMM tasked its Expert Team on Marine Climatology (ETMC) to develop a new Marine Climate Data System (MCDS) for the exchange and long-term preservation of marine climate data from various sources. The MCDS Strategy and implementation plan were then proposed and endorsed in 2012 by JCOMM. The new system will provide a JCOMM-wide unified approach to data management and higher quality climate observations. This system is now in the implementation phase and encompasses a data flow structure with defined roles and tasks to be applied to all data types across JCOMM. The MCDS will also support the Global Framework for Climate Services (GFCS) and will provide data held to higher quality control standards.

In this presentation we will introduce the new overall structure, the plans for its implementation, and the benefits for stakeholders.

Oral

- **Data management, recovery and reprocessing (digitisation efforts and reprocessing of previously digitised data)**

S7T1

Aligning the German Marine Data Base with the Modernized MCDS Data Streams

Axel Andersson, Lydia Gates, Hildrun Otten-Balaccanu, Martina Schulz

Deutscher Wetterdienst, Hamburg, Germany

The Marine Data Centre of Deutscher Wetterdienst maintains an extensive climatological archive of marine observations. Apart from recent data, the archive consists of a large amount of historic data ranging back to the mid-19th century. Several data streams are combined into a consolidated archive with a constantly increasing data amount. Real-time GTS data from ship, buoys and other marine measurement platforms are automatically archived in an interim database and are consolidated in near real-time for the archive. Additionally, VOS data, which is collected by the Global Collecting Centres (GCC), is injected in delayed mode into the archive. In this context, DWD acts together with UK MetOffice as a contributing as well as a responsible member. In a third stream, newly digitized data from the historic ship journal archive of the DWD are continually added to the archive as well as other available sources. All incoming data sets are routinely checked with a sophisticated high quality control (HQC) procedure that performs several formal and meteorological checks on the data. As part of the contributing member role in the GCC, German ship data undergoes an additional manual quality control.

In the light of the evolution of the Marine Climatological Summaries Scheme (MCSS) into the new Marine Climate Data System (MCDS) new forms of data management are needed, such as flexible data access and product generation. Standardized data formats and metadata handling is essential to allow data exchange with external partners, e.g. ICOADS. The presentation will give an overview of the marine data management at DWD that includes all stages from data collection by the port meteorological officer to data quality assurance and aggregating into marine data products. Current developments such as new routines for automatic and manual HQC, migration of the data archive to a high performance data base system to facilitate user access will be highlighted as well as present and planned data products for a variety of applications.

Oral

- **Data management, recovery and reprocessing (digitisation efforts and reprocessing of previously digitised data)**

S7T2

Heroic observations of old weather

Philip Brohan, Chris Turney, Rob Allan, Gail Kelly, Gil Compo & the oldWeather project.

We know little of the weather in the Southern Ocean in 1916, as ICOADS contains almost no records from there, but some observations were made: In 1914-16 Ernest Shackleton led the 'Imperial Trans-Antarctic Expedition', aiming to make the first crossing of the Antarctic continent (Weddell Sea to Ross Sea). He did not succeed, and the expedition is remembered as a catalogue of disasters and bold escapes. But alongside the chaos and adventure, some science was done - the expedition's two ships made many observations of the weather. These observations were never published, but have been preserved in the archives of the Scott Polar Research Institute. To mark the centenary of the expedition, we have digitised their weather observations, added them to ICOADS, and assimilated them into the 20th Century Reanalysis. We can learn quite a lot just from the records of that expedition, but it is only one of the thousands of voyages of discovery, scientific expeditions, whaling, fishing, trading and military ship logs which need to be rescued and included in ICOADS. Over the last few years we have made substantial inroads into this task, particularly through the contribution provided by the volunteer contributors to oldWeather.org.

Oral

- **Data management recovery and reprocessing (digitisation efforts and reprocessing of previously digitised data)**

S7T3

ICOADS Release 3.0: Data Characteristics and Future Priorities

Eric Freeman, Scott Woodruff, Sandra Lubker, Steve Worley, William Angel, David I. Berry, Philip Brohan, Lydia Gates, Zaihua Ji, Elizabeth C. Kent, Shawn R. Smith

The latest update of the International Comprehensive Ocean-Atmosphere Data Set (ICOADS), Release 3.0 (R3.0), provides major coverage expansions on the previous version (R2.5) for 1662-2014, followed by improved monthly near-real-time (NRT) extensions, e.g. partly addressing the impacts of many masked Global Telecommunication System (GTS) ship callsigns since late 2007. This presentation will describe the data and metadata characteristics of R3.0, and provide details on new data sources and on extensive observational format updates. New or improved data sources cover various time periods, from the late 18th Century all the way into the modern period. These sources include newly digitized historical observations from collections such as the English East India Company and the German Maury collections, and updated external archives such as the Global Tropical Moored Buoy Array (GTMBA) and World Ocean Database (WOD). A major observational format update is an extension to include near-surface oceanographic data elements such as salinity, nutrients and carbon cycle parameters. These parameters, with associated depths, have been populated from the WOD and other near-surface oceanographic sources. The new inclusion of a unique identifier (UID) to each individual marine report will help to improve traceability and facilitate collaboration between ICOADS users. Future plans for ICOADS will be described in the second part of the presentation, introducing the MARCDAT-IV session on ICOADS development. As always, the longstanding MARCDAT/CLIMAR user community will continue to actively help shape the database and improve data management to meet future needs and continue to make ICOADS a valuable resource for global climate research well into the future. Finally, we will report on progress towards establishment of ICOADS as a Centre for Marine-Meteorological and Oceanographic Climate Data (CMOC), within the new WMO-IOC Marine Climate Data System (MCDS), which is anticipated to facilitate further longer-term improvements in the effective management and stewardship of marine and near-surface oceanographic data internationally.

Oral

- **Data management, recovery and reprocessing (digitisation efforts and reprocessing of previously digitised data)**

S7T4

The potential for improvements to ICOADS: lessons from ship tracking

Elizabeth C. Kent, David I. Berry and Giulia Carella

National Oceanography Centre, UK

The International Comprehensive Ocean-Atmosphere Data Set (ICOADS) is the most complete archive of surface marine observations and is widely used in the construction of marine climate records and in reanalysis. ICOADS has set the standard for open, traceable, data access and importantly keeps the multivariate marine record together in a common format.

In recent years the importance of identifying observations made on the same ship or platform has become more apparent as the sophistication of error models for marine data has increased. Unfortunately the marine data in ICOADS contains many observations without identifiers as substantial amounts of historical data were derived from sources that had not retained ship identifier information. As part of the Historical Ocean Surface Temperatures :Accuracy, Characterisation and Evaluation (HOSTACE) project an attempt was made to cluster together observations made by the same ship, but missing ship identifier information, using a probabilistic trajectory estimation method. The ship tracking process proved rather more difficult than anticipated and revealed many interesting features of data characteristics within the ICOADS archive. We will describe features of these data characteristics that are presently problematic for the accurate construction of marine climate records. We will also illustrate how a reprocessing of the historical ICOADS data holdings would improve the quality of the marine climate record.

Oral

- **Data management recovery and reprocessing (digitisation efforts and reprocessing of previously digitised data)**

S7T5

Data rescue, reanalysis, and a station dataset: report from the 2016 ACRE meeting

Philip Brohan

Met Office Hadley Centre, UK

TBC

Oral

- **Data management recovery and reprocessing (digitisation efforts and reprocessing of previously digitised data)**

S7P1

Data Rescue of Historic Observations from the Archives of the German Marine Observatory

Axel Andersson, Birger Tinz, Lydia Gates

Deutscher Wetterdienst, Hamburg, Germany

Deutscher Wetterdienst (DWD, German Meteorological Service) in Hamburg holds an archive of several collections of original historical world-wide weather records from land stations and ships. The archive originates from the Deutsche Seewarte (German Marine Observatory), which was the predecessor organisation of DWD in Hamburg.

The largest archive is the collection of meteorological logbooks from sailing ships and steamers. It contains about 37,000 individual journals with an estimated total amount of 23 Million observations that start in 1829 and end in 1937. The majority of the observations are from the period from 1853 to 1934. The digitization procedure for the journals includes the registration of metadata, archiving of optical scans and manual transcription of the observations. The data are quality checked and transferred into a data base. About 11 Million observations are already stored in the data base. However, a large number of these observations have been digitized during previous decades and still have to be assigned a respective metadata record.

Apart from ship observations, the Deutsche Seewarte also operated a world-wide net of overseas meteorological land stations, many of them situated at the coast or on islands. The archive consists of more than 1500 stations, mostly from the periods from 1884 to 1919 and from 1930 to 1943. Nearly 200 stations have already been digitized with a digitization procedure similar to that of the ship observations. Digitization of the data from China, Korea, the tropical Pacific, Cameroon and Togo has been completed.

The presentation will show the recent progress of the digitization efforts and ongoing analysis of the data. An important activity is the further development of automatic quality control procedures, where the main task is to adapt the modern QC limits to the lower accuracy of the historical observations, different weather classifications, units and conventions.

Poster

- **Data management recovery and reprocessing (digitisation efforts and reprocessing of previously digitised data)**