Surface Ocean CO_2 Atlas (SOCAT)

and

Surface Ocean pCO_2 Mapping Intercomparison (SOCOM)

Event

7 September 2015

SOLAS Open Science Conference 2015

University of Kiel, Germany

Convenors for SOCAT:

Dorothee Bakker (UEA, UK), Emilie Brévière (SOLAS, Germany), Kim Currie (NIWA, New Zealand), Shin-ichiro Nakaoka (NIES, Japan), Kevin O'Brien (NOAA-PMEL, USA), Are Olsen (UiB, Norway), Tobias Steinhoff (Geomar, Germany), Maciej Telszewski (IOCCP, Poland)

Convenors for SOCOM:

Christian Rödenbeck (MPI, Germany), Peter Landschützer (ETH Zürich, Switzerland)

Minutes:

Leticia Barbero (NOAA-AOML, USA), Matthew Humphreys (University of Southampton, UK), Steve Jones (University of Exeter, UK)

Report:

Kim Currie (NIWA, NZ), Peter Landschützer (ETH Zürich, Switzerland), Dorothee Bakker (UEA, UK)

Logos:

Pete Brown (National Oceanography Centre, UK) designed the SOCAT and SOCOM logos.

Meeting support:

Stefan Kontradowitz (SOLAS, Germany)

Support for this event was provided by:

Contents

Overview

The **Surface Ocean CO_2 Atlas (SOCAT)** is an activity by the international marine carbon research community. It improves access to surface water CO_2 data by regular releases of quality controlled and documented, synthesis fCO_2 (fugacity of carbon dioxide) data products for the global oceans and coastal seas. SOCAT data products enable detection of changes in the ocean carbon sink, quantificaton of ocean acidification and model validation.

The SOCAT event has these aims:

- Release of SOCAT version 3
- Launch of the SOCAT automation system
- Showcase SOCAT science
- Update the SOCAT community on recent progress
- To welcome new members
- To enable discussion of SOCAT strategy
- To set the SOCAT agenda for the next 24 months.

The **Surface Ocean pCO_2 Mapping Intercomparison (SOCOM)** is a comparison of data-based air-sea CO_2 flux estimates, many of them using SOCAT. Different methods are applied for interpolating sparse pCO_2 (partial pressure of CO_2) data in time and space. Approaches include interpolation, regression and model-based regression and tuning. The methods have different characteristics, making them suitable for mapping different space- and time scales. The SOCOM initiative aims to quantify uncertainties and to identify common features in the mapping methods. The SOCOM event will showcase SOCOM science and enable discussion.

Dorothee Bakker, Chair of the SOCAT global group, was recognised for her outstanding contribution to the SOCAT community with an award presented at the SOLAS (Surface Ocean Lower Atmosphere Study) Open Science Conference on 10 September 2015.

Surface Ocean CO_2 Atlas (SOCAT)

Release of SOCAT Version 3 and Automation System

Introduction and Aims

Dorothee Baker, the Chair of the SOCAT global group, welcomed the participants to the Workshop, and outlined aims (see Overview) and the timetable for the day (Appendix 1). An overview of the SOCAT project and its history provided context for the presentations and discussions to follow. Fifty four participants from 18 countries attended the SOCAT and SOCOM Event, and a show of hands indicated that attendees included those who provide data, those who manage the data, those who carry out SOCAT quality control (QC), those who are using the data, those who contribute to SOCOM and those who are involved in science and programme management. A list of participants is in Appendix 2.

Participants of the SOCAT and SOCOM Event (Photo by Mariana Ribas Ribas).

Release of SOCAT Version 3

Before the release of SOCAT Version 3, Benjamin Pfeil presented a brief history of the SOCAT project, which started with the SOCOVV meeting in Paris in 2007 where the need for a publicly available, quality controlled data synthesis product was recognized (IOCCP, 2007). The first version of SOCAT was released in 2011 (Pfeil et al., 2013; Sabine et al., 2013) and Version 2 was released in 2013 (Bakker et al., 2014).

Here, Benjamin Pfeil officially released SOCAT Version 3. Benjamin gave an overview of the new product, including the new features and challenges associated with the production and use of SOCAT Version 3. Version 3 has over 3,600 datasets and 14.5 million fCO_2 values collected between 1957 and 2014. The data is citable using a DOI, and is available via the interactive Cruise and Gridded Data Viewers, is downloadable at CDIAC (Carbon Dioxide Information Analysis Center) and is available as a data package in Ocean Data View (ODV).

New features in SOCAT Version 3 include:

- 4.4 million additional fCO_2 values in 969 data sets, mainly from 2008 to 2013, but also from earlier years,
- Extension of the data set backwards to 1957 (from 1968) and forwards to 2014 (from 2011),
- Accuracy criteria for all fCO_2 values (accuracy ≤ 2 µatm for flags of A and B, ≤ 5 µatm for flags of C and D, ≤ 10 µatm for a flag of E) (Wanninkhof et al., 2013),
- Addition of a new data set QC flag of E with an accuracy of better than 10 µatm,
- Inclusion of fCO_2 data from well calibrated sensors and alternative platforms,
- Automated data checks during data upload,
- Powerful graphical tools in the Cruise Data Viewer.

All data products can be accessed via the SOCAT website (http://www.socat.info). The following data products are available:

- Individual data set files (at Pangaea),
- Synthesis dataset (at CDIAC, via the Cruise Data Viewer and in ODV),
- A gridded dataset (at CDIAC, via the Gridded Data Viewer and in ODV).

For consistency with earlier versions, the synthesis files and gridded products in Version 3 contain data sets with flags of A to D. Data sets with a flag of E are reported in a separate file.

1900 files were submitted for SOCAT Version 3, of which some were new data and some were updated files. Quality control in SOCAT Version 3 was carried out in two stages: Automated QC during data upload where fCO_2 values and supporting parameters (e.g. date, position, temperature) in a data set were checked for unrealistic and out of range values and where such data points were given an automated WOCE flag, and a secondary QC where the overall dataset quality was evaluated, each data set was given a data set QC flag, individual data points were given a WOCE flag and the automated WOCE flags were checked.

Putting together SOCAT Version 1 already highlighted the need for an automated data upload system which would provide several advantages including: better management of data submission, scalability, version control, and standardization of metadata and data formats. Automated data checks during data upload is a new feature in Version 3 and is the first step towards automated data upload, now operational for Version 4.

Benjamin provided insight of visitors to the SOCAT website (www.socat.info) via Google analytics. The site receives more than 8500 hits per year. Most visitors are based in the USA, Norway and the UK followed by France, Japan, Germany, Brazil, Australia, China and Canada. Noteworthy is the large number of site visits from government departments, government agencies and international organisations around the world (e.g. based in Washington D.C., Brussels, London).

Benjamin finished by acknowledging the work of the quality controllers and other SOCAT contributors, while emphasizing the importance of having dedicated colleagues for data management and quality control as well as scientists carrying out surface water fCO_2 measurements.

Launch of the SOCAT automation system

Kevin O'Brien officially launched the new system for uploading and submitting data directly on the SOCAT quality control system. This automation system integrates data upload, data submission and subsequent SOCAT quality control on a single platform. The automation system thus enables parallel data upload and quality control, processes which until now had been carried out in series, in separate time blocks. Kevin illustrated the various steps and options of what is a major step forward in the continuing development of SOCAT.

Kevin went through an example to explain how data upload works. All users must be registered in order to use the data upload and quality control system. Several data formats are supported (ascii, csv, tab or comma separated), and additional parameters can be loaded but will not be automatically recognized. It is possible to upload multiple datasets at once, provided that they have a similar format. Eventually, more parameters will be added to the automation process. The uploaded data goes through a range checker that lets the user know if there are any issues. Tools are available to correct some of the more common issues, such as date formatting. Data can then be previewed for an initial check, then metadata is added. The Ocean Metadata Editor (OME) from CDIAC could not be incorporated in time for SOCAT Version 4, so it is not integrated yet. Metadata and additional files (e.g. cruise reports, readme files, etc.) can be added as supplemental material documents. Before data submission a permission statement pops up, as well as tick boxes on how the original data should be made public. This enables data submitters to simultaneously submit their data sets to CDIAC. Upon data submission, the dataset is available for SOCAT quality control.

The quality control process in Version 4 is unchanged from that for SOCAT Version 3. A metadata file must be uploaded when data is submitted, however, there is no automated check for metadata content available yet. Therefore quality controllers will need to check the metadata on a cruise-by-cruise basis. Work on integrating the CDIAC OME in the automated data upload system is essential for automated metadata checks. Ideally the next version of SOCAT will have such automated metadata control checks.

SOCAT 4 and Beyond

The automation system enables annual SOCAT releases from Version 4 onwards. The data upload deadline for SOCAT Version 4 is January 31st 2016 and the QC deadline is March 31st 2016. SOCAT Version 4 will be released on June 30th 2016. Version 5 deadlines are one year after those for Version 4.

Quality Control in SOCAT

Ute Schuster led a discussion on the quality control procedure, noting the large workload of quality controllers and asking for everyone's contribution to the quality control. Quality controllers are needed for Version 4.

Consistency within second level QC is an issue, and it is important that all QC'ers accurately document their allocation of a particular flag to a dataset, including detailed comments. Assessing the quality of the metadata is very time consuming, data submitters are encouraged to submit good metadata. Ute suggested that quality controller should suspend data sets with obscure metadata, putting the onus back on to the data providers.

Most open ocean cruises start and end in coastal ports, therefore are included in the responsibility of the Coastal QC group, adding to its workload. In theory these cruises could be QC'ed only by the regional group for their corresponding basin, however the advantage of the current system is that more people look at the data. Are Olsen proposed to limit the coastal quality control to surveys that mostly take place in coastal regions as opposed to all cruises that cross a coastal region.

Werner Kutsch, director of ICOS (Integrated Carbon Observing System, an European Research Infrastructure), congratulated all SOCAT data providers and contributors on the group effort and the important work, not just on a scientific level but also as a knowledge base for the scientific community. He expressed admiration that SOCAT is run by the community and suggested that the next step is to look for the professionalization of the infrastructure, which would require a constant stream of funding. This would also allow people to spend more time on science and less on data quality control. He explained that, globally, ICOS faces similar discussions and problems. He recommended that, as much as possible, the SOCAT data upload and quality control should be automated.

Alternative Sensors and Platforms

Tobias Steinhoff discussed the increasing use of alternative sensors and platforms for surface water fCO_2 measurements. In the past fCO_2 has usually been measured on shipboard systems using infra-red detection of CO_2 in air equilibrated with surface seawater and calibrated using CO_2-in-air gas standards. Increasingly, fCO_2 is determined using alternative sensors, such as membrane and dye based systems, and alternative platforms, such as wave gliders, gliders, floats and buoys.

This is particularly so in coastal areas, and many of such measurements are associated with ocean acidification studies. The accuracy of these data is often lower than those acquired by traditional systems, and sometimes is not determined. Well documented calibration of these sensors is needed, including pre- and post-deployment calibration and diagnostic variables.

Currently, during the SOCAT QC process these data are assigned the “lower quality” E flag, if data quality is sufficient. The E flag is for a dataset with an accuracy of calculated fCO_{2w} (at sea surface temperature) of better than 10 µatm and which has complete metadata documentation. Datasets who do not meet these criteria are given an S (suspend) flag.

There was discussion around the inclusion of a new flag F for fCO_2 values with an accuracy of better than 25 µatm for inclusion of more, but less accurate, data from alternative sensors and platforms in SOCAT. This would require a recommendation on the use of these data for potential users. It was decided that a 25 µatm accuracy does not fit with the aims of SOCAT.

A new data field for sensor type and platform type, as suggested previously (Wanninkhof et al., 2013), will be added in Version 5.

Decision: SOCAT will not add a data set flag of F for ≤ 25µatm accuracy.

Additional Parameters

Annette Kock gave a brief introduction to MEMENTO (MarinE MethanE and NiTrous Oxide data collection), the database for marine N_2O and CH_4 data, including both surface water data and interior ocean data.

SOCAT is a data base for surface ocean fCO_2 data. SOCAT data products include salinity and sea surface temperature, parameters needed for the recalculation of fCO_2. However, these parameters are not quality controlled to oceanographic standards.

Atmospheric CO_2 measurements are now accepted by SOCAT (Version 4). The intention is to quality control these atmospheric CO_2 values from Version 5 onwards.

Additional surface water parameters accompanying fCO_2 data, such as dissolved inorganic carbon (DIC), total alkalinity, pH, nutrients, methane, nitrous oxide etc., are accepted by SOCAT from Version 4 onwards. These parameters will not be quality controlled as part of the SOCAT process and will be made public in a separate file (SOCAT, 2014). SOCAT would welcome collaboration with other groups for quality control of these additional parameters.

Benjamin Pfeil reminded the meeting participants that the SOCAT system is more than a data product, it is an infrastructure with a set of protocols and tools and therefore could act as a universal database, with individual data products, of which SOCAT is one. Arne Körtzinger emphasized the benefits of MEMENTO and SOCAT teaming up, sharing infrastructure, providing a one stop shop for data providers, while maintaining this as two separate activities with some need for synchronization. Kevin O’Brien commented that while the infrastructure exists for SOCAT, additional resources would be needed for a LAS (Live Access Server) -based QC system for MEMENTO.

Discussion followed on the inclusion of surface water datasets without fCO_2. Rik Wanninkhof argued that SOCAT should not include surface water datasets without fCO_2, as this would be mission creep.

Decision: Convene a working group of MEMENTO scientists, SOCAT data providers and SOCAT data managers to discuss these issues further, starting with N_2O and CH_4 surface water data.

SOCAT Data Policy

Kim Currie and Mario Hoppema introduce and lead the discussion on SOCAT data policy. The current data policy on the SOCAT website asks data users ”To generously acknowledge the contribution of SOCAT data providers, investigators, and quality controllers in the form of invitation to co-authorship, especially to invite data providers as co-authors in regional studies, and/or reference to relevant scientific articles by data providers.” References to the data products are provided on the SOCAT website.

Most data users respect the data policy and most publications correctly acknowledge the data providers. However, there have been several instances when SOCAT data has been used without appropriate acknowledgement to the data providers. In these cases, Dorothee Bakker has contacted the authors and often this has resulted in the omission being corrected (depending on what stage of the publication process the issue has been notified). In other cases the citation was much improved in subsequent publications by the same authors. It is also noted that mis-citation is not malicious.

This issue of data acknowledgement affects many data science communities, and there is no common solution.

During the discussion several alternatives were offered – registration before data access, a tick box affirming acceptance of the data policy, a message regarding the existence of the data policy at point of download, a central DOI for the dataset, or more assertive language in the policy.

Editors can’t be expected to police data use and correct citations. Copernicus journals have public comments, where missing citations can be raised post-publication. Reviewers, who are often part of the SOCAT community, should be vigilant for mis-use of the data policy.

For users of the global dataset it’s sufficient to cite SOCAT. Regional and local studies using a narrow set of cruises should offer co-authorship to the relevant PIs.

Recommendation: Mario Hoppema, Kim Currie and Dorothee Bakker will consider if the wording of the SOCAT data policy can be improved and whether data providers can be made more visible.

SOCAT Science Highlights and Impacts

Update on SOCAT and the Global Carbon Project

Are Olsen provided an update on the SOCAT and the Global Carbon Project (GCP). The GCP publish an annual Global Carbon Budget (GCB). Prior to 2013 the ocean component of the budget was calculated from models. In 2013 and 2014, data from the SOCAT database was used, however, due to the GCP time table and its emphasis on recent data, also data was included which had not yet been subject to SOCAT quality control (Le Quéré et al., 2015).

Use of SOCAT in the Global Carbon Budget is a high profile and policy relevant output. However, several issues have arisen around the GCB.

In the GCB publications, the terrestrial, atmospheric and marine communities get a single authorship per research group for the contribution of recent data, which may consist of one data set or of many data sets. This is unlike the multi-contributor authorship in the SOCAT publications (e.g. Bakker et al., 2014). In the GCB publications, the single co-authorship policy meant that people and institutions were overlooked, and that the co-authorship did not necessarily reflect the amount of data submitted. It is likely that this arrangement by the GCP will continue with some minor adjustments.

Early data access, prior to SOCAT quality control, potentially favoured the GCB over other synthesis activities. In future, there will be annual, public, versions of SOCAT, so there will be no need for early data access by the GCP or other synthesis activities.

The use of SOCAT recalculated fCO_2 data meant that the PI assigned QC flags were lost. Ideally future GCB will use original data rather than the recalculated data, if the data provider requests this.

Summary of SOCAT Science Highlights and Impacts

Dorothee Bakker presented an overview of the research and publications that have used and cited SOCAT. These are collated on the SOCAT website (http://www.socat.info/publications.html) and include:

- 7 Influential, international reports by e.g. IPCC, CBD, GOA-ON, ICES and OceanObs,
- More than 100 peer-reviewed scientific publications,
- PhD theses and book chapters.

SOCAT applications include:

- Model validation including the Coupled Model Intercomparison Project (CMIP),
- Detection of ocean acidification trends,
- Quantification of CO_2 sinks and sources in coastal and marginal seas,
- Mapping and quantification of the global ocean carbon sink, e.g. by 10 methods in SOCOM,
- Successive Global Carbon Budgets.

Strengthening SOCAT Impact

Maciej Telszewski assessed the impact that SOCAT is having at a policy level, and steps that should be taken to strengthen that impact, and therefore consolidate the future of SOCAT.

SOCAT and SOCAT-based scientific assessments provide stakeholders with information allowing them to meet societal requirements. Verification of the fitness-for-purpose of the ocean carbon observing system for informing policy is the final part of the cycle, something in which SOCAT can play a major role.

SOCAT has not been included in several recent national and international reports and science plans such as the US Sea Change 2015-2025 report and the North Atlantic – Arctic Science Plan. Therefore, SOCAT scientists need to actively ensure that SOCAT is included in all such reports in the future. Stakeholders that need information include national funding agencies, GCOS, GOOS, UNFCCC, and GCP. Maciej Telszewski suggested that although SOCAT is used by many other groups in global assessments, such assessments need to directly link back to SOCAT for use in promotional activities. SOCAT impacts could be highlighted in a short (2 page) synthesis of the many scientific papers that use SOCAT data.

Recommendations:
SOCAT community to provide input on SOCAT in high impact (inter-)national reports.
2-page summary of SOCAT impacts.

Long term Funding and Sustainability for SOCAT

Dorothee Bakker introduced the discussion. SOCAT Version 3 includes contributions from 53 organisations in 18 countries on 5 continents. SOCAT requires sustained funding for staff salaries (data management, QC, co-ordination and automation activities), travel for meetings, and some consumables. Several projects in Europe that provided important financial support for SOCAT have now finished. In Europe funding is currently available via EU Atlantos (SOCAT QC in Bergen), ESA (SOCAT QC in Exeter), ICOS (Norway, Germany, Sweden). Funding is also provided by funding agencies in the USA, Japan, Australia, and New Zealand.

It was suggested that a budget should be compiled outlining the cost of SOCAT to date, including an estimate of the time commitments, taking care to breakdown each part of the process. This would then be of use to help in sustaining SOCAT in the long term.

Werner Kutsch (Director of ICOS) suggested that in the future ICOS may assist with long-term support, by identifying SOCAT as a science area for national contributions. This would assist the European research infrastructure, thus contributing to the global infrastructure. ICOS could take on tasks that are presently done voluntarily by SOCAT, in particular the quality control. A detailed plan including the budget is required. It would be advantageous to include a higher-level parent organization.

Recommendation: Prepare a budget outlining the annual costs of SOCAT with breakdown of individual components.

SOCAT Science Highlights

All meeting participants were given the opportunity to provide brief science highlights about research that has contributed to, or used SOCAT.

- *Iwona Wróbel and Jacek Piskozub*: Constraining the climatology of CO_2 ocean surface flux for North Atlantic and the Arctic.
- *R. Arruda, P Calil, A. Bianchi, S Doney, N Gruber, I Lima and G Turi*: Air-sea CO_2 fluxes & controls on surface pCO_2 seasonal variability in the coastal and open ocean southwestern Atlantic Ocean: a modelling study.

Surface Ocean pCO_2 Mapping Intercomparison (SOCOM)

The Surface Ocean pCO_2 Mapping Intercomparison project, led by Christian Rödenbeck aims to quantify uncertainties and to identify common patterns in surface ocean pCO_2 based mapping methods. At present the project compares 14 mapping methods of which 10 use data from the SOCAT database (Rödenbeck et al., 2015).

Data-based Estimates of the Ocean Carbon Sink Variability

In his introduction, Christian Rödenbeck emphasized that for many applications in science, like e.g. the quantification of the global air-sea CO_2 flux, SOCAT can be of essential use, however due to the spatial and temporal heterogeneity of the data distribution, it is currently necessary to use a gap filling method. He outlined that using the surface ocean pCO_2-based global flux maps can be a new and independent constraint in closing the Global Carbon Budget. However, additional information can be obtained by the different mapping products. Many of the interpolation methods are complementary and e.g. use pure statistical interpolation techniques, regression to driver data, or model based regression and tuning methods. In a first intercomparison analysis of all 14 methods (Rödenbeck et al., 2015) most of them are capable of reproducing seasonal cycles but there is less agreement regarding inter-annual variabilities (IAV), as illustrated in the equatorial Pacific. This requires the introduction of a mismatch criterion to further sub-select methods according to their capability. One of the most remarkable results shown by Christian Rödenbeck is the strong agreement between methods that from the 1980s through 2000 the ocean carbon sink shows little decadal change, whereas from 2000 onward almost all methods suggest an increase of the global oceanic carbon sink of about 1 PgC yr^{-1} $decade^{-1}$. When only those methods are selected that pass the IAV mismatch criterion, the global IAV amplitude is estimated to be 0.31 PgC yr^{-1}, which is larger than suggested by model based analyses.

This first analysis highlights the encouraging convergence between complementary methods, which illustrates that surface ocean pCO_2 observations can be used for statements regarding the global ocean carbon sink and its variability on interannual to decadal timescales.

The Reinvigoration of the Southern Ocean Carbon Sink

In a second talk, Peter Landschützer highlighted how the arrival of publicly available surface ocean pCO_2 databases, and in particular SOCAT, have led to a large increase in studies regarding the variability of the global ocean carbon sink, and to the inclusion of some of these methods in the Global Carbon Budget.

This talk in particular aimed at showing how this strong increase in the global ocean carbon sink (highlighted by Christian Rödenbeck) can be linked to the to-date most undersampled ocean basin (with respect to its surface area), the Southern Ocean, and how we can use the complementary SOCOM ensemble to gain more confidence in the obtained results. The majority of SOCOM submissions (those that pass the global IAV (interannual variation) mismatch criterion) agree that the Southern Ocean surface pCO_2 has increased more slowly than CO_2 in the atmosphere, causing on average (multi model mean) a ΔpCO_2 increase of 0.4 µatm yr^{-1} leading to an increase of the Southern Ocean carbon sink within the last decade. Even though there is an encouraging agreement regarding the decadal sink trend, there are still differences in the spatial trend pattern between the different submissions.

Based on one SOCOM submission only, Peter Landschützer further showed that there are substantial differences in the driving forces between the Atlantic and the Pacific basin, which is linked to a trend towards a more zonally asymmetric pressure system in the Southern Ocean from 2002 onward.

N.B. A recent publication describes these results (Landschützer et al., 2015).

Discussion

Prior to the meeting the SOCOM community identified 5 key points that were introduced by Christian Rödenbeck, though not all of them were discussed:

1) Are there feedback / requests / questions of the measurement community to the mapping community?
2) Are DIC data (converted to pCO_2) appropriate to be used as additional constraint?
3) Validation of mapping results with observations (SOCAT and independent);
4) How can the SOCAT and SOCOM projects better know each other through coordinated activities (e.g. as being practised in the Global Carbon Budget)?
5) Optimal network design.

There was a particular interest from both the SOCOM and SOCAT communities in keeping up the combined work (e.g. Global Carbon Budget) and in benefitting from each other's work.

P.S. SOCOM now has a logo and a website (http://www.bgc-jena.mpg.de/SOCOM/). Pete Brown (National Oceanography Centre, Southampton, UK) designed the SOCOM and SOCAT logos.

Appendix 1: Agenda of the SOCAT and SOCOM Event

08:30-09:45 Release of SOCAT Version 3 and Automation System

Chairs: Tobias Steinhoff and Shin-ichiro Nakaoka, Rapporteur: Leticia Barbero

08:30 Introduction and Aims (Dorothee Bakker)

08:45 Release of SOCAT Version 3 (Benjamin Pfeil)

09:15 Launch of the SOCAT automation system (Kevin O'Brien)

09:45-10:30 SOCAT Version 4 and beyond

09:45 Quality control in SOCAT (Ute Schuster)

10:30-11:00 Coffee

11:00-12:30 SOCAT Version 4 and beyond (continued)

Chair Kim Currie, Rapporteur: Steve Jones

11:00 Alternative sensors and platforms (Tobias Steinhoff)

11:30 Additional parameters (Are Olsen, Annette Kock)

12:00 SOCAT Data policy (Mario Hoppema, Kim Currie)

12:30-13:30 Lunch

13:30-15:30 SOCAT Science Highlights and Impact

Chair: Kevin O'Brien, Rapporteur: Matthew Humphreys

13:30 Update on SOCAT and the Global Carbon Project (Are Olsen)

14:00 Summary of SOCAT science highlights and impacts (Dorothee Bakker)

14:15 Strengthening SOCAT impact (Maciej Telszewski)

14:45 Long term funding and sustainability for SOCAT (Dorothee Bakker)

15:00 SOCAT Science highlights (open to all, Kim Currie)

15:30-16:00 Tea and Group Photo

16:00-17:00 Surface Ocean pCO_2 Mapping Intercomparison (SOCOM)

Chairs: Christian Rödenbeck, Peter Landschützer

16:00 Data-based estimates of the ocean carbon sink variability (Christian Rödenbeck)

16:20 The reinvigoration of the Southern Ocean carbon sink (Peter Landschützer)

16:40 Discussion (Christian Rödenbeck)

17:00 Adjourn

Appendix 2: Participants

The table below lists meeting participant with their interest in SOCAT and SOCOM, e.g. as data providers ('Data'), as SOCAT data managers or quality controllers ('SOCAT'), as SOCAT users ('Users'), as SOCOM data contributors ('SOCOM') or for some other purpose ('Other'). Specific interests, such as teaching, MEMENTO and ICOS, are also indicated.

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