GCOS SST&Sea Ice Working group: Inaugural meeting of the Sea Ice Subgroup

Summary

Sunday 26 March 13:00
Bechtel Collaboratory, Discovery Learning Center, University of Colorado

Attendance:
From initial core group:
Florence Fetterer (NSIDC), Steve Ackley (ASPeCt), Per Gloersen (NASA GSFC), Søren Andersen (DMI/Eumetsat OSISAF)
Initial core group not present:
Mark Drinkwater (ESA), Pablo Clemente-Colon (NIC, IICWG), Vasily Smolyanitsky (JCOMM-ETSI, GDSIDB)
Additional participants:
Craig Donlon, John Stark (UK Met Office), Chelle Gentemann (Remote Sensing Systems), Peter Minnett, Bob Evans (University of Miami), Ken Casey (NOAA NODC), Gary Wick (NOAA ESRL), Walt Meier (NSIDC), Helen Beggs (BOM Australia)

Background
The GCOS SST&SI working group was recently reformed with the decision to form a specific subgroup on sea ice (SI). It was emphasised that an initial core group should be contacted and brought together as soon as possible. For additional background see [ANNEX 2]. In order to facilitate the development of a good understanding of the connection and possible shared activities between the SI subgroup and the main group, the decision was made to arrange the meeting in connection to the GHRSST 7th science team meeting in Boulder, Colorado. In specific, it was desired to explore the relationship between the newly formed GHRSST SI working group as well as the intercomparison infrastructure that is being developed at NODC as a contribution to both GHRSST Reanalysis and GCOS SST&SI WG.

A number of relevant groups had been identified as participants to the initial core group: ESA, ASPeCt, IICWG, JCOMM ETSI, NSIDC and NASA. All responded positively, however ETSI and IICWG were unable to attend, whereas ESA provided a presentation in absentia.

Summary
The meeting was opened with an introduction to the purpose and motivation of the working group. It was suggested to adopt a role as advisors to the specific climate SST&SI analysis community, thus emphasising the focus on the problems identified and described in [ANNEX 2]. The desire to engage a wide community of analysis producers in the intercomparison activities was underlined, since that is felt to be the major source of confidence and fundamental to the creation of consensus in methods and metrics. Similarly, the reconciliation of ice chart and passive microwave analyses requires the close cooperation of experts from several environments. The relationship with GHRSST was clarified as above.

Peter Minnett presented an introduction to the GHRSST Sea Ice working group. The group will focus narrowly to determine the best ice mask for SST and examine effects on SST due to the special physical conditions, such as dry atmospheres, high air-sea temperature differences and cold water IR emissivity near the ice edge. Stringent requirements to spatial and temporal resolution rather than accurate concentration and even distinction between ice and cloud are characteristic in operational SST applications. Consequently, the use of single platform techniques (e.g. use of the IR and VIS signal) is envisaged, possibly in combination with external background data. Use of the presence of sea ice as a prescription of the SST (e.g. -1.8) should be treated with care. For ice that is forming this may be acceptable, however for melting ice, a low salinity layer may form on the surface with a higher freezing point. Possible complementarities were identified in the GHRSST need for validation ice edge data, where ice chart data may be considered an efficient and high quality validation source as well as in the assembly of inventories of existing methods and analyses. Several members of the GCOS core group were attending the session of the GHRSST-SI working group during the GHRSST meeting.

The GCOS SST&SI group's intercomparison activities on SST are closely linked with the GHRSST Reanalysis group. Ken Casey gave a presentation on the status and plans for the latter group. The group is building up activities and there is a GHRSST Reanalysis website at http://ghrsst.nodc.noaa.gov with a link to the GCOS SST&SI intercomparison server. Examples of the usefulness of intercomparison based on HadISST, Pathfinder and operational SST fields were given. Coordination, such as the definition of common color scales and grids were highlighted as crucial factors affecting the efficiency of intercomparison activities. At present the system features four SST analyses on a common 1-degree resolution grid and in the same Matlab format. It is envisaged to move to an open standard format such netCDF or HDF. It was emphasised that the server will not in its own be a solution to all the requirements of the group, however it will enforce the process of establishing standards for intercomparison and data access. Its basic function as a data repository should not be underestimated. The subsequent discussion touched the following points:

Projections and grids: The current system uses regular geographical coordinates, however sea ice products are most meaningfully stored and displayed in a polar aspect projection. The two most widely used are the polar stereographic and the equal area scalable earth [EASE] grid. NSIDC recommended the EASE grid which allows simple calculations of area. A pragmatic approach is called for and the group converged on creating an inventory of available data sets to provide a basis for later decisions.

Action-1: Andersen to assemble first draft inventory of passive microwave sea ice analyses, including information on formats, projections, algorithms, methods and base data.

Data formats: Members of the group aired the preference for flat binary data due to their ease of use. It was argued that this approach is not scalable and can become very complex when the number of analyses increases. In addition, a minimal set of metadata is part of the required practice in the archiving and data stewardship community. Ice chart data was recognised as an exception and should initially not reside on the NODC server. The Global Digital Sea Ice Data Bank (GDSIDB) was emphasised as an existing resource. Ice charts are already widely standardized in the SIGRID convention vector formats. The latest version (SIGRID-3) allows and has encouraged the inclusion of more detailed meta-data (e.g. per-polygon data sources) than former versions. The conversion into gridded raster formats was identified as a non-trivial operation. In addition, from ASPeCt

experience, it was remarked that a number of operations were most efficiently done in a GIS framework. Others maintained that GIS presently lacks a workable spatio-temporal model. It was noted that the passive microwave analyses are inherently raster based and the group is highly experienced in grid based analyses but not in GIS applications. In view of the uncertainties, no final decision could be made, however GIS expertise may likely get engaged through the ice charting community (see Action-9).

Decision-1: The group will work to initially create an overview of data availability and characteristics with a view to inclusion of sea ice analyses in the NODC intercomparison server.
Decision-2: Ice chart data to reside off the NODC server, possibly using another existing infrastructure such as GDSIDB or a simple webpage.

Florence Fetterer gave a related presentation on activities for NIC to create an ice chart climatology. The activity is relevant in several respects: 1) An increase in both detail and average ice concentration took place in 1997 with the introduction of Radarsat data, 2) the project developed a methodology for conversion from vector to raster format.

Action-2: Fetterer to assemble inventory of available chart analyses and provide more details on the NSIDC SIGRID to raster grid conversion methodology.

Steve Ackley introduced the development of a four year dataset of Antarctic ice thickness merging observations from ships with ice charts. ASPeCt (http://www.aspect.aq) has conducted activities to compile a large data base of ship observations in the Antarctic, including the development of an ice observation protocol. The archive now contains 20000 observation records made over 80 voyages since 1980. Ice charts do not generally contain information on ice thickness but rather indicate a "stage of development", which can be used as a proxy. By co-registering the ship-based ice thickness point observations, the ice charts can in effect be calibrated to provide fields of ice thickness. The study used weekly ice charts from National Ice Center (NIC), however it was noted that NIC no longer include an assessment of the stage of development in their ice charts. In terms of both present and future requirements for ice thickness time series this is unfortunate and the working group agreed to recommend to NIC to reintroduce the stage of development analysis in ice charts.

Action-3: Andersen to draft recommendation to NIC to reintroduce the stage of development analysis in Antarctic ice charts.

Of interest to the GCOS SST&SI group is that the procedure involves the estimation of error not only in the ship observations but also in the ice chart.

Action-4: Ackley to provide information on the estimation of ice charting errors.

In addition to ice thickness, the ASPeCt observation archive and observation forms include information on ice edge observations. This was identified as a very useful resource for the GCOS SST&SI working group activities and it was confirmed that the dataset is available to the group and could be obtained by contacting Tony Worby or Steve Ackley. It was felt that the observation data rescue methodology and standards would be applicable and desirable in the Arctic.

Decision-3: Endorse the use of the ASPeCt ship observation data base within the group. Encourage extension of framework to Arctic.

Action-5: Andersen to setup website containing observations (or links to it) including available (rasterised) ice charts, lake ice and possibly the ASPeCt observation archive.

The group discussed the availability of ship-based ice observations. It was found that there is no systematic framework for reporting observations of sea ice from ship. The group encourages activities within JCOMM to facilitate the inclusion of sea ice observations in VOS (Voluntary Observing Ships) reports on GTS.

Action-6: Donlon to encourage JCOMM to further the inclusion of sea ice observations in VOS reports on GTS, possibly taking ASPeCt experiences and framework into account.

Per Gloersen showed a study on the relationship between Arctic minimum sea ice extent, local temporal minimum and extent of multi-year ice the following winter. Using 24 years of satellite data, it was demonstrated that the assumption that all the ice at the minimum sea ice extent (typically in September) becomes multi-year ice the following winter leads to exaggerated estimates of multi-year ice area. In stead one should use the local temporal minimum, which is defined as the per-pixel minimum ice concentration. It was shown that there has been a 20 % decrease in the sea ice minima over the 24 year period. The study illustrated the usefulness of the long time series of passive microwave observations in monitoring and developing an understanding of the Arctic climate system. Chelle Gentemann presented similar findings from trends in ice-days (the number of days in which a given pixel has ice in it).

Søren Andersen presented work on comparison of ice concentration algorithms with classified SAR data. The study illustrated considerable differences between the algorithms. It was shown that these differences translate into differences in trends of both ice area and ice extents. Differences in ice extent estimates combined with known atmospheric sensitivities of algorithms could indicate that trends in atmospheric fields produced a cross-talk signal in trends of ice extent. A framework for estimating retrieval errors was introduced. As a first response to the requirement staged in ANNEX 2, it is envisaged to implement this scheme in the frame of the EUMETSAT OSISAF reanalysis activities taking place during 2006.

Mark Drinkwater was unable to attend the meeting but had prepared a set of slides representing ESA's views on the working group. ESA welcomes activities to reconcile differences in sea ice concentration analyses, noting that the combination with ice thickness and drift is crucial for the estimation of actual mass fluxes. As a space agency ESA is mainly experienced in satellite Earth Observation, however the importance of extending the data records beyond the satellite era was recognised. Mark Drinkwater underlined that related activities are and have been taking place in the frame of WCRP-CliC and that the GCOS SST&SI working group should make sure to coordinate activities and identify complementarity. Four concrete recommendations were made concerning the group's activities:

1) Work to define accuracy and resolution requirements for climate observations with account of the relations between sea ice and ocean-atmosphere fluxes. The group recognised this, noting that the present group had mainly and observational background. It was considered necessary to have a stronger representation of e.g. climate modellers. In terms of the SI subgroup focus it was felt that these requirements should originate from the climate analysts

of the larger SST&SI working group and that the SI group should remain focussed on determining the extent to which these requirements were filled. It was further noted that an activity focussed exactly on accuracy requirements for sea ice is being developed in the frame of IGOS Cryosphere Theme (http://stratus.ssec.wisc.edu/igos-cryo/index.html). Walt Meier participated and it was decided to monitor and report these activities rather than defining own action.

Action-7: Meier to inform group of progress in IGOS activities and take into account possible GCOS SST&SI working group views.

2) define stringent quantitative metrics for intercomparison and uncertainty estimates. The group applauded this, however a phased approach is adopted such that initially the assembly of an overview of available analyses is prioritised.
3) Work to define an integrated SST, sea ice concentration and temperature product. The group agreed that such a product is desirable, however in particular for ice/snow surface temperature substantial research was required before it could become suitable for climate research.
4) Consider new possibilities for validation through enhanced satellite Earth Observation capabilities. The group agreed.

Finally some considerations concerning the demarcation between CliC and GCOS activities were made. A main concern is to ensure an unbiased approach to the activities, e.g. when algorithm developers participate. The group agreed that care must be taken to ensure this. It was felt that as long as the climate data product end users in the larger SST&SI working group maintained the role of critically directing and monitoring the work of the SI subgroup this concern would largely be taken into account. This essentially echoed Mark Drinkwater's recommendation.

During discussions, the problem of validation was touched upon. Peter Minnett remarked that there are fundamental differences between SST and Sea Ice, in that for sea ice no authoritative reference measurement exists, whereas for SST the skin temperature can be measured with very large accuracy and precision. The group clearly needs to deal with validation issues, however it is felt that building the intercomparison framework must be the first step. Søren Andersen volunteered to lead the drafting of a plan for implementation of the intercomparison and validation activities. This document should be developed to ultimately contain descriptions of adopted methods and metrics for intercomparison and validation.

Decision-4: Development of intercomparison metrics, uncertainty estimates and later a validation framework will follow the implementation of the intercomparison infrastructure.

Action-8: Andersen to lead the drafting of a plan for implementation of the intercomparison and validation activities.

It was agreed that the group must further engage the ice charting community in the future activities and that the IICWG science working group should be contacted. The next meeting of the working group should take place in connection with the IICWG meeting in Helsinki September 24-29, 2006. Søren Andersen will participate in the ASPeCt ice thickness meeting in Hobart in July 2006 and will present the activities of the working group there.

Decision-5: The group will work through IICWG to engage the ice charting community in the group's objectives.

Action-9: Andersen to contact the IICWG science working group to further the engagement of the ice charting community in the GCOS SST&SI working group activities, e.g. by proposing a session on the relationship between ice charts and the passive microwave record during the science sessions.

The meeting came to a close without time to discuss a list of proposed activities prepared by Søren Andersen. This will be completed offline, however as the list of actions indicate there is a feeling of good commitment across the working group.

Action-10: Andersen to update and distribute a list of proposed activities for the groups consideration, prioritisation and comment.

It is recognised that the groups focus on paleo sea ice observations is so far non-existent. An activity is called for in the terms of action, however it is felt that securing the engagement of the ice charting community must take priority and may in fact help to provide entries into the paleo-observation community.

List of actions

1	**Andersen**	to assemble first draft inventory of passive microwave sea ice analyses, including information on formats, projections, algorithms, methods and base data.
2	**Fetterer**	to assemble inventory of available chart analyses and provide more details on the NSIDC SIGRID to raster grid conversion methodology.
3	**Andersen**	to draft recommendation to NIC to reintroduce the stage of development analysis in Antarctic ice charts.
4	**Ackley**	to provide information on the estimation of ice charting errors.
5	**Andersen**	to setup website containing observations (or links to it) including available (rasterised) ice charts, lake ice and possibly the ASPeCt observation archive.
6	**Donlon**	to encourage JCOMM to further the inclusion of sea ice observations in VOS reports on GTS, possibly taking ASPeCt experiences and framework into account.
7	**Meier**	to inform group of progress in IGOS activities and take into account GCOS SST&SI working group views.
8	**Andersen**	to lead the drafting of a plan for implementation of the intercomparison and validation activities.
9	**Andersen**	to contact the IICWG science working group to further the engagement of the ice charting community in the GCOS SST&SI working group activities, e.g. by proposing a session on the relationship between ice charts and the passive microwave record during the science sessions.
10	**Andersen**	to update and distribute a list of proposed activities for the groups consideration, prioritisation and comment.

Decisions

Decision-1: The group will work to initially create an overview of data availability and characteristics with a view to inclusion of sea ice analyses in the NODC intercomparison server.

Decision-2: Ice chart data to reside outside the NODC server.

Decision-3: Endorse the use of the ASPeCt ship observation data base within the group. Encourage extension of framework to Arctic.

Decision-4: Development of intercomparison metrics, uncertainty estimates and later a validation framework will follow the implementation of the intercomparison infrastructure.

Decision-5: The group will work through IICWG to engage the ice charting community in the group's objectives.

GCOS SST&Sea Ice Working group: First session on Sea Ice

Agenda

Sunday 26 March 13:00
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- Initial summary of the terms of reference
- Introduction to intercomparison activities of the sst group at NODC (Casey)
- Introduction to the GHRSST sea ice group (Minnett)

- Possibility for presentations by ice group members
    - Steve Ackley: intercomparisons of Antarctic sea ice thicknesses derived from ice charts and Aspect ship observations
    - Per Gloersen: Arctic sea ice surviving the summer melt
    - Søren Andersen: Intercomparison of satellite passive microwave sea ice concentration algorithms in Arctic high concentration sea ice.
    - Andersen for Drinkwater: ESA view on activities of OOPC SST/sea ice working group

- Discussion to include:
    - Relations to other groups and activities such as e.g. GHRSST, ETSI, CliC, etc.
    - Methods, techniques and metrics for different types of ice analyses.
    - Requirements to the intercomparison framework. Existing infrastructure, etc.
    - Ice thickness: Include it? What do we want to achieve and how?

- Extension of group: list of contacts to take up within both contemporary and historical/paleo sea ice communities.
- Review terms of reference
- Schedule/next meeting

AOPC/OOPC SST/SI working group discussion meeting
21st October 2005
Nick Rayner

1. Introduction

An email was sent from Dick Reynolds to participants of the 2nd International Workshop on Advances in the Use of Marine Climate Data (MARCDAT-II) meeting on the future of the Global Climate Observing System (GCOS) Atmospheric Observations Panel for Climate (AOPC)/Oceanic Observation Panel for Climate (OOPC) SST/SI working group. In his letter, Dick questioned the present and future utility of the SST/SI working group and suggested that its functions may have been subsumed by other activities. He solicited comments from all interested parties. Following this, a meeting was held on 21st October 2005, chaired by Nick Rayner, to discuss the working group, its terms of reference (ToR), membership and chair.

2. Summary of discussion

There was agreement that there is still a need for the working group (WG) and that its Terms of Reference (ToR) are largely still valid, but require minor revisions (see Section 3 for proposed new ToR). Ed Harrison explained that the group had previously led to significant improvement in SST analyses, particularly through interaction between the NOAA and Hadley Centre groups, and better understanding of the importance of accurate global in situ observations of bulk SST. There was reason to expect further improvement could be achieved by intercomparison of other SST analyses and gaining understanding of the sources of their differences. Given that substantial differences are known to exist in current sea ice concentration analyses, it would also be desirable to carry out similar work with these. Examination of the assumptions used to create historical analyses of SST and sea ice and further comparison of these analyses is also necessary, in order to improve them. The WG might also then act as a source of advice to the general user community on accuracy and sources of differences between analyses. The WG should be separate from, but intimately linked to the GHRSST-PP, allowing two-way support.

It was felt that the best solution was to retain the SST & SI WG as an AOPC and OOPC co-sponsored group and to establish a sea ice (SI) sub-group. This ensures the focus of this sub-group on matters directly relating to the issues faced when creating combined analyses of SST and SI. Other communities are actively engaged on wider sea ice issues. There needs to be representation from the GHRSST-PP SI group and the JCOMM Expert Team on SI, amongst others.

An initial activity for the WG will be to develop an inter-comparison framework, building on experience in previous smaller-scale inter-comparisons. The framework should include initial division of tasks. Previous SST inter-comparison efforts have suffered from ready access to the full range of operational SST and SI products. With product serving technology improvements, there is reason to hope that more groups will provide their state-of-the-art analyses for open inter-comparison. Involvement in such activities offers participants the benefits of greater exposure to users. Once the inter-comparison framework is established and comparisons made, the WG can then start to recommend actions to ensure consistency, quality, bias corrections, etc.

The ToR should be sufficiently open and flexible to allow maximum participation. If necessary, they could be periodically reviewed. Where appropriate, different types of data sets would be compared separately.

It was felt that an inter-comparison system could be set up relatively easily using the infrastructure available within the GHRSST-PP Reanalysis (RAN) project. Ken Casey volunteered to investigate this and take it forward, developing a web site with OpenDAP access to the data sets. Adaptations would need to be made to the existing GHRSST-PP RAN framework to allow for the relatively reduced resolution data sets the WG will be involved in comparing. The NOMADS website (http://nomads.ncdc.noaa.gov/) should be examined as a model.

Additional specific issues relating to SST that the WG should consider include: accuracy of products (as distinct from relative differences); inter-comparison of the uncertainties and climatologies; assumptions of stationarity of means and covariances and other a priori assumptions; representations of secular and interannual variability; applying different QC methodologies to common input data. The driving consideration behind these is the need to accurately define the climate change signal.

There was some discussion about possible funding mechanisms for this work. It was suggested that, once the WG had established an inter-comparison framework and some preliminary results, groups could bid for funding from the usual sources referring to the need identified by GCOS and the WG.

With Dick Reynolds wishing to step down from the role of chair of the WG, a new chair was discussed. Nick Rayner and Tom Smith accepted the nominations from the group and agreed to act as co-chairs. It was additionally agreed that a small core group of participants should form an Executive Committee and work with the co-chairs to develop the inter-comparison framework. The Executive Committee will comprise: Ken Casey, Liz Kent, Craig Donlon, Alexey Kaplan, Ed Harrison and Dick Reynolds. A wider mailing list will be agreed and contacted via the Executive Committee and co-chairs, once discussions of the framework have stabilised. A shorter form of the WG name will be used from now on: the GCOS SST & SI WG.

The motivation of the SI sub-group was discussed. The main focus of the SI sub-group should be activities related to the creation of homogeneous multi-decadal data sets of sea ice concentration with quantified uncertainties. These activities all have parallels in SST, but are not being actively pursued by the sea ice community at present, so the WG needs to stimulate interest. It is therefore important to engage other groups such as EUMETSAT OSI-SAF, NSIDC, JCOMM ETSI, CLiC, whilst establishing where the demarcation lines are and assessing any political sensitivities. The OSI-SAF are currently engaged in development of sea ice data sets for climate and can offer some funding opportunities through its Fellowships scheme. In addition, EUMETSAT may be a source of funding for a sea ice inter-comparison workshop.

Sea ice thickness and age of ice should also be included in the ToR of the SI sub-group, while it was understood that initial efforts would focus on sea ice concentration. As for SST, the ToR should be reviewed periodically to allow for other activities, as required.

Inter-comparison and reconciliation between data sets derived from sea ice charts and passive microwave retrievals should form a major part of the WG activities. This applies both to comparison between contemporaneous data and between data from different periods to assess and

correct the discontinuities in the data series. HadISST1 was an attempt at this, but that effort only scratched the surface of the problem.

Soren Andersen accepted the nomination to chair the SI sub-group. It was suggested that a core Executive Committee be invited to participate, made up of representatives from other sea ice bodies: Vasily Smolyanitsky (JCOMM ETSI chair), Florence Fetterer (NSIDC), Waleed Abdalati (NASA), Mark Drinkwater (ESA), representative from International Ice Charting Working Group, chair of science working group of ASPeCT. It was agreed to approach these, who may suggest alternatives and others.

It was thought important to convene either an actual or virtual meeting of this core group as soon as possible to get things moving. Perhaps an existing meeting could be used as a convenient occasion.

Bringing the meeting to a close, the consensus was to aim for the next meeting of the GCOS SST & SI WG in Nov/Dec 2006. An annual report on WG activities will be produced each year for its sponsors, regardless of whether the group meets physically.

3. New Terms of reference and group foci

1. To record and evaluate the differences among historical and near real time SST and SST/SI analyses
    a. Identify a standard data set for the intercomparisons of different products, e.g., COADS
    b. Select several standard difference products as a minimum comparison set (i.e., define regions and time periods; compute biases, standard deviations, and RMS differences)
    c. Oversee standards for intercomparisons
2. To identify the sources of differences in the analyses
3. On the basis of comparison of those differences with the expected climate signals in the SST patterns, to recommend actions needed to ensure the quality and consistency of the SST and SST/SI analyses
4. To establish criteria to be satisfied by SST and SST/SI analyses to ensure the quality and consistency required by the Global Climate Observing System (GCOS)
5. Liaise with all appropriate bodies
6. To report annually to AOPC and OOPC on progress and recommendations

Inter-comparisons are motivated in particular by the necessity to evaluate:

- Accuracy of products (as distinct from relative differences)
- Uncertainties, climatologies and the effectiveness of bias corrections
- Impacts of assumptions of stationarity of means and covariances and of other a priori assumptions
- Representations of secular and interannual variability
- Effects of applying different QC methodologies to common input data.

The driving consideration behind these is the need to accurately define the climate change signal.