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INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION

WORLD METEOROLOGICAL ORGANIZATION

WORLD CLIMATE RESEARCH PROGRAMME (WCRP)

WCRP International Programme for Antarctic Buoys (IPAB)

Report of the fourth session of the WCRP IPAB Participants

(Bremerhaven, Germany, 5-6 September 2003)

May 2004

WCRP Informal Report No. 7/2004

Table of contents

1. Organisation of the session

Dr Enrico Zambianchi, the Chairman of the Executive Committee for the IPAB, opened the fourth session of the WCRP International Programme for Antarctic Buoys (IPAB) at 10:00 on Friday 5 September 2003 in building F of the Alfred Wegener Institute (AWI) in Bremerhaven, Germany.

The Chairman thanked Dr Eberhard Fahrbach and Dr Christian Haas for their invitation to hold the meeting at AWI and for providing an excellent venue and arrangements for the reunion. He encouraged the participants to take advantage of holding the session as part of the Southern Ocean Science Week (SOSW), which took place in AWI from 5 to 13 September 2003.

Dr Eberhard Fahrbach welcomed all attendees as the host of the meeting and wished it every be success. He informed the participants of the other meetings of the SOSW, which were open for all thus providing opportunities for interchange of knowledge and ideas.

The meeting was then invited to review the provisional agenda and agree on the organisation of its work during the session. A list of the participants in the meeting can be found in Appendix 1. The agreed agenda of the meeting is given in Appendix 2. The introductory part of the meeting was concluded with a round of self-introductions.

2. Report of the IPAB Co-ordinator

Dr P. Wadhams, Co-ordinator of the Programme, presented a report on the IPAB developments in 2000-2003. The report is given in Appendix 3.

In the course of subsequent discussion the participants emphasised the importance of having an active office of IPAB Co-ordinator and a web site of the programme, which would be regularly updated. Due to weak publicity and problems with the web site, IPAB was loosing visibility. Dr P. Wadhams felt that it was indeed important for IPAB to get more widely known. He assured the meeting that the transfer of the office to the Scottish Association for Marine Science's Dunstaffnage Marine Laboratory (DML) in Scotland offered good opportunities for the office operation, particularly because the office would be co-located with that of the National Focal Point of the Data Buoy Co-operation Panel (DBCP). After the installation of the group in a new building the web site should be re-launched.

The group analysed existing opportunities and difficulties in running the programme. The high cost of the buoys (typical one being 7-8 thousand British Pounds) was considered as an important limiting factor. The discussion touched some other types of buoys than ice buoys, e.g. drifters and ocean buoys. A need to establish contacts with groups employing buoys in the IPAB area and to make sure that their data; particularly atmospheric pressure report, is available on the WMO Global Telecommunication System (GTS), was emphasised. Dr. S. Piotrowicz informed the participants that real time data dissemination was considered one of important preconditions for participation of an observing system element in the Integrated Ocean Observing System.

The group also briefly discussed possible approaches to the improvement of IPAB data quality control. A need for both real time and delayed mode quality control was raised. Once a year the IPAB data is sent to the coordinator with corrections, so the archived data should contain fewer and smaller errors. For the real time data going to weather analysis and forecasting centres there is additional quality control at the centres. So, it is the data availability on the GTS, which is of higher importance. However, the real time IPAB reports are usually coming from remote locations where direct comparison with other stations data is less reliable. Therefore the development of quality control was seen to be more essential than for the real time data. Experience of ARGO in this connection was considered useful: they were using fourteen various checks. Dr Piotrowics also underlined a need and value for the real time monitoring of data availability.

3. Reports from Participants

Biennial status reports were given by Dr Christian Haas (for AWI) and by Dr Enrico Zambianchi (for the Italian National Programme for Antarctic Research). In addition, the Chairman presented reports by of Australian (Dr Ian Allison), Finnish (Dr Jouko Launianen), and Japanese (Dr Shuki Ushio) Participants.

Australia

The Australian Antarctic Division (AAD), and the Cooperative Research Centre for Antarctic and Southern Ocean Studies (Antarctic CRC) have a programme of buoy deployments in the sea ice zone of the Southern Ocean south of Australia. Since 2000 the level of activity has been lower. Australian ships have left Antarctic waters early over the last few seasons, not providing an opportunity to deploy buoys in the area of new sea ice. Ice drift data are available from only three platforms for the period June 2000 to June 2003. These are:

AAD76	Beset vessel	deployed	29/11/00	-65.2°,	108.1°
		ceased	19/12/00	-64.3°,	103.4°
AAD77	MetOcean	deployed	08/03/01	-68.0°,	76.7°
		ceased	07/04/01	-67.8°,	75.7°
AAD78	MetOcean	deployed	28/03/01	-65.1°,	109.7°
		ceased	05/01/02	-62.1 °,	115.9°

A more active buoy deployment programme is about to commence in September/October 2003 when a sea ice research experiment will be undertaken in the region around 64°S, 115°E. The objective of this programme is to validate sea-ice geophysical products derived from a number of important new satellite sensors that have recently been launched.

In particular, the work aims to quantify the accuracy of standard (routine) sea-ice geophysical products from the NASA Earth Observing System (EOS) Aqua Advanced Microwave Scanning Radiometer (AMSR-E) and EOS Terra and Aqua Moderate resolution Imaging Spectro-radiometer (MODIS). The work will take place over an experimental area of about 75 km x 100 km, and the drift and deformation of the ice will be monitored with a dense array of 12 or more GPS buoys with air and snow/ice interface temperature sensors.

Australian sea ice researchers also propose to participate in the German ISPOL experiment in the Weddell Sea in 2004/05. Further buoys will be deployed during this programme to determine the impact of dynamics on sea ice melt, and to help refine high resolution models of sea ice fracture.

Work is also proceeding within Australia to bring the IPAB data set deposited with National Snow and Ice Data Center up-to-date to the end of 2000. This includes recovering data from buoys that were missed in the original records. The new data are expected to be lodged with NSIDC before the end of year 2003.

Finland

Since the Third IPAB Meeting, the Finnish Institute for Marine Research (FIMR) has not had Antarctic buoy activities. Arctic buoys were deployed in 2002. Applications for national funding for establishing "semi-regular" buoy deployments to contribute to IPAB needs through the Finnish national Antarctic programme FINNARP were unsuccessful. Possible Finnish buoy contribution to IPAB may come from a joint initiative by FIMR and FMI (Finnish Meteorological Institute). For the ISPOL campaign in 2004-2005, FIMR plans to deploy one or two buoys reporting their location and atmospheric pressure.

Jari Haapala, Timo Vihma and Jouko Launiainen of FIMR lead a project entitled "Inter-annual variability of the Weddell Sea ice motion". It is based on an ice drifter buoy related sea ice study. Buoy drift studies and modelling have indicated the dominant role of the atmospheric forcing in the sea ice kinematics and dynamics in the Weddell Sea. The Antarctic Oscillation (AAO) stands out as the leading mode determining the atmospheric forcing field in the southern hemisphere. IPAB data and sea-ice model were used to relate the sensitivity of the atmospheric forcing including AAO to the motion and thickness of the Weddell Sea pack ice. The results suggest a crucial need of further buoy data for studies of sea-ice movements and ice transport out of the Weddell Sea, especially buoy data in winter conditions during various phases of AAO and data from the continental ice shelf edge and coastal polynyas in the southern and western Weddell Sea. The data is needed for sea ice studies and model validation, as well as sea ice monitoring related to the global change.

Germany (AWI)

Dr Christian Haas presented the report, a summary of which is given in Appendix 4, Annex 1. The AWI is dedicated to serve the IPAB programme but it has no strong direct interest in ice buoys. Therefore it is very important for IPAB to attract interest of operational weather centres. The IPAB data by AWI is available through the institute web site. The discussion of the presentation by Dr. C. Haas revealed that IPAB has to follow several types of environmental protection requirements on materials for the buoys and the batteries. The requirements are coming from both national and international sources.

Italy

The Italian National Programme for Antarctic Research continues of a long-term programme of WOCE-TOGA drifters deployment, which covers the IAPB area of operation. A summary of the deployment locations and drifts is shown in Appendix 4, Annex 2. Totally 26 drifters have been deployed, from one to six buoys per year, and four of them were still active at the time of the meeting. In addition, 5 Alace floats were deployed in 1994, and there were 2 unsuccessful attempts to deploy an ice buoy in 1998. The average life-time of a drifter for all 26 drifters was 565 days, varying from tens of days to more than 2500 days. There are firm plans to continue the deployments.

Japan

In the framework of the activities of the Japanese Antarctic Research Expeditions (JAREs), Hydrographic and Oceanographic department of Japan Coast Guard deployed surface drifters from icebreaker SHIRASE in the Indian Sector of the Antarctic Circumpolar Current. The deployments are summarised in the table below. Two or three surface drifters will be deployed every year.

ARGOS ID	deployment date	Latitude(°S) / Longitude(°E)	end date
21866	09DEC00	59.24 / 110.04	08DEC01
21864	14MAR01	59.67 / 150.05	09MAR02
21486	08DEC01	55.15 / 108.75	28APR02
21487	14MAR02	59.19 / 150.11	18APR03
21488	14MAR02	51.99 / 150.30	still active
21714	09DEC02	44.46 / 110.06	08MAR03
21563	02DEC02	59.99 / 109.89	still active
21769	16MAR03	49.12 / 150.13	still active

In the framework of JARE44 summer cruise, the National Institute of Polar Research (NIPR) deployed several PROVOR subsurface floats with SBE CTD. The deployments were made from R/V TANGAROA off Adélie Land. The following table gives a summary of them. All these floats have parking depth of 1500db and the mission interval is 10-day.

ARGOS ID / WMO ID	deployment date	Lat(°S) / Long (°E)	end date
30474 / 7900010	25FEB03	65.44 / 143.01	still active
30626 / 7900011	25FEB03	65.44 / 143.02	06MAR03
30687 / 7900012	28FEB03	65.38 / 139.82	09APR03

Three floats will be deployed at the eastern area of Kerguelen Plateau in December 2003 from icebreaker SHIRASE.

Other contributions

Deployment of significant number of drifters were made in the area of IPAB operation by the Woodshole Oceanographic Institution. US Army Cold Regions Research and Engineering Laboratory (CRREL) activities represent significant interest for IPAB including deployment of a sea ice mass balance buoy. The British Antarctic Survey also has conducted observations of importance for IPAB.

4. Review of IPAB progress to date

Dr E. Zambianchi, the Chairman of the IPAB Executive Committee, reviewed the progress of the Programme from June 1994 to September 2003. He presented the geographical area of IPAB operation as a Data Buoy Coordination Panel (DBCP) Action Group (see figure 1) and reiterated two kinds of needs for IPAB measurements namely real-time collection of meteorological data and dissemination through the WMO GTS and collection of data to support research in the region related to global climate processes and establishing a basis for on-going monitoring and atmospheric and oceanic climate in the Antarctic sea-ice zone.

Describing new applications and thus substantiating the value of IPAB data, Dr. E. Zambianchi demonstrated to the meeting an estimate of expected RMS error in GRACE recovery of ocean mass from satellite gravity data as a consequence of errors in atmospheric mass computed from sea level pressure observations. This illustration was prepared by Dr. M. Drinkwater of the European Space Agency (see figure 2).

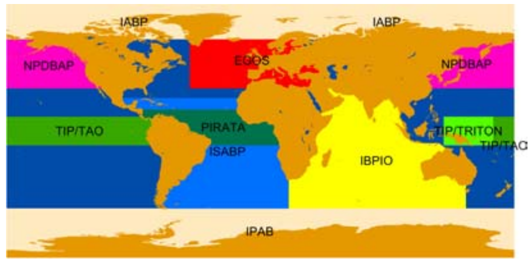

Figure 1. DBCP areas of operation

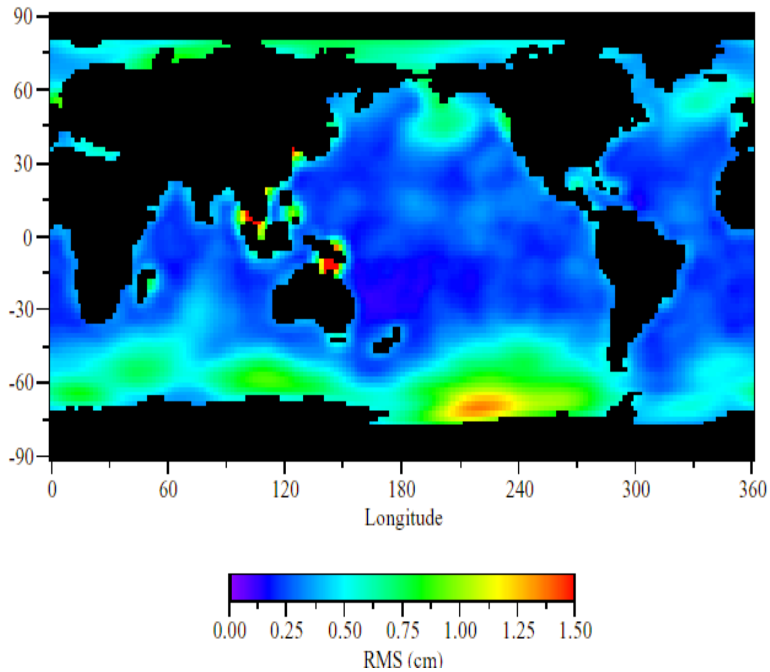

Figure 2. RMS Error in GRACE recovery of ocean mass from satellite gravity data (550 km averaging radius) as a consequence of errors in atmospheric mass computed from ECMWF – NCEP sea level pressure (SLP) differences.

The errors in the mean sea level atmospheric pressure analyses were estimated using a systematic difference between ECMWF and NCEP pressure fields over the ocean using a 550 km averaging radius. The estimates show that significant benefits can be gained, mostly in Southern Ocean, from additional improved sea level pressure observations. The IPAB Argos drifters are big importance. Periodic deployment of a GTS reporting SLP device on Peter I island in Bellingshausen Sea is desirable.

The statistics of IPAB buoys is presented in figures 3-5.

The conclusions of Dr. E. Zambianchi were as follows:

- the numbers are fairly good, even though the optimal coverage has never been reached;
- the programme is not sufficiently known to the science community and potential participants;
- there is little coordination through IPAB of individual research projects;
- IPAB has been acting as an a posteriori coordinating programme, offering archiving facilities and a general framework for activities, but having little propulsive strength - so far as a programme IPAB has just been a data collector and, sometimes, a data analyser.

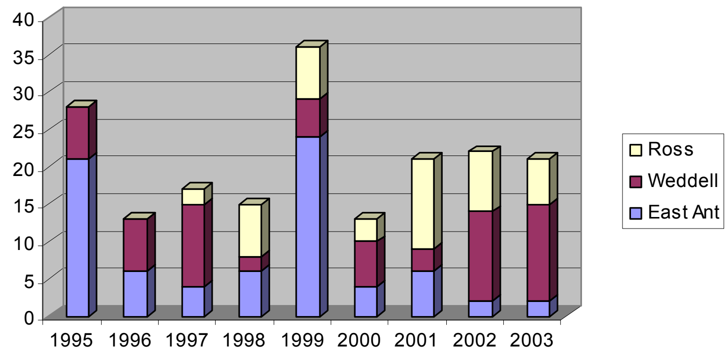

Figure 3. IPAB new buoy deployments per year

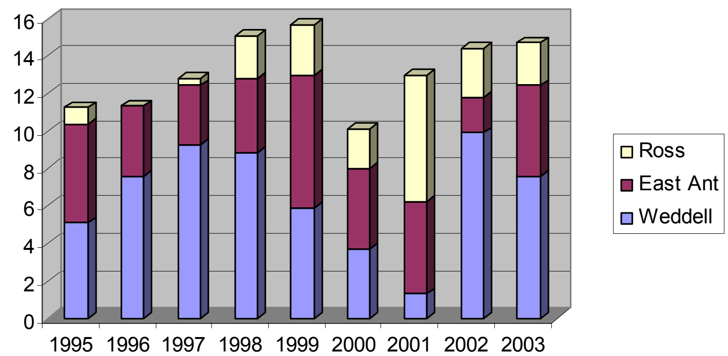

Figure 4. IPAB average number of active buoys

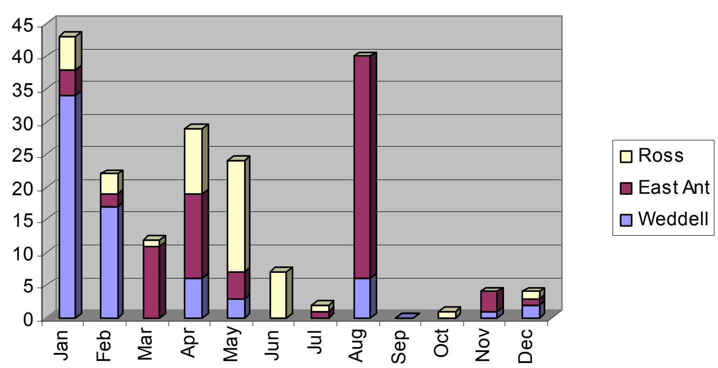

Figure 5. IPAB new buoy deployments per month

In the subsequent discussion the participants expressed their view that IPAB required strengthening. Despite all the efforts, it has not been feasible to achieve the target 500 km buoys spacing. There are some other activities in the region and some investigators report observations not even knowing about IPAB. East Antarctica is particularly poorly covered by data.

IPAB needs to become more widely known. It requires a good web site, a good quality publication describing the programme, and a promotional campaign. It needs more attention from meteorological services. At present, among the participants of IPAB three are national meteorological services namely of UK, South Africa and Australia. It was acknowledged at the meeting with appreciation that UK Meteorological Office, in their letter of intent of September 2000, offered to IPAB to cover the expenses of using the Service ARGOS for up to 2 PTT-years worth of IPAB data.

Opportunities for raising support to IPAB should not be missed. One obvious potential sponsor is the ICSU Scientific Committee for Antarctic Research (SCAR). According to the view of participants in the session, potential interest to the programme existed in Brazil, China, India, and Republic of Korea. The

International Polar Year 2007/08 represents a rare opportunity to strengthen IPAB. In this connection the meeting considered with great interest a proposal to deploy buoys jointly with CliC and ASPECT, which was submitted to the session by Dr. Ian Allison. In this connection Prof. P. Wadhams mentioned a possibility to undertake a pre-deployment analysis that would take into account cruise planning, expected buoys path, survivability, and ensure more or less optimal distribution of buoys. Dr C. Geiger emphasised a need to make it clear to the scientific community and funding organisations that despite the fact that satellite coverage was able to generate good spatial coverage of the area of interest, only buoys were able to produce in situ data with sufficiently high temporal resolution so that the most energetic events such as storms would be resolved.

5. Status of the membership role

A review of participants and their contribution to the programme was given.

CURRENT IPAB PARTICIPANTS:

Alfred Wegener Institut, Germany
Australian Antarctic Division, Australia
Australian Bureau of Meteorology (Tasmania and Antarctica Regional Office)
British Antarctic Survey, UK
Finnish Institute for Marine Research, Finland
Geophysical Institute, University of Alaska, USA
Institut fur Meteorologie und Klimaforschung, Universsitat Karlsruhe, Germany
National Ice Center, USA
National Snow and Ice Data Center, USA
Programma Nazionale di Ricerche in Antartide, Italy
Scott Polar Research Institute, UK
Senahmi, Peru
Service Argos, France
South African Weather Bureau, South Africa
United Kingdom Meteorological Office, UK

Potential participants are:
Indian National Buoy Programme, India
Norwegian Polar Institute, Norway

Contributions to the programme also come from the Arctic and Antarctic Research Institute (Russia) and National Institute of Polar Research and Hydrographic Department of the Maritime Safety Agency (Japan). However, they did not send official letters of participation to IPAB.

It was decided that a letter of invitation should be sent to potential participants. The group discussed a format for the IPAB Letter of Intent. It was decided to make it less formal in specifying the participants' contribution. It was felt that the letter should contain certain expression of interest in IPAB, a point of contact and a description of the proposed commitment. The group also decided to update the IPAB mailing list. The letter inviting participants to IPAB should be sent via the following channels: Arcinfo, Cryolist, DBCP, GOOS, CliC, CLIVAR/CliC Southern Ocean Panel. The group also recommended to the Chairman to send a letter to the International Arctic Buoys Programme and invite them to prepare a coordinated proposal for the Arctic Ocean and Southern Ocean buoy deployment during the International Polar Year. In addition to that, the Chair and Coordinator were requested to send a letter to contributors to the programme who are not formally a part of IPAB and invite them to join the programme.

6. Related research, observational and data programmes

Dr. V. Ryabinin informed the meeting of actions undertaken by the WCRP to solicit support for IPAB. In November 2002 a presentation on IPAB was given to the WMO Executive Council Working Group on Antarctic Meteorology. It was intended to explain the role and value of IPAB observations to WMO activities in Antarctica and Southern Ocean. The presentation was well received by the group and resulted in a recommendation in favour of supporting IPAB. This recommendation was presented to the 56th Session of the WMO Executive Council in May 2003. The Executive Council adopted resolution 15

"Support and Maintenance of the WCRP International Programme for Antarctic Buoys". The text of the resolution is given in Appendix 5.

Reports were delivered by Dr Carolin Schmitt (University of Karlsruhe) on the Atlas of Sea Ice Drift, Dr Cathleen Geiger (CRREL) on GLOBEC data and Dr Steve Piotrowicz on the status of the ARGO programme and on developments of the Iridium telecommunication technology.

Atlas of Sea Ice Drift in the Antarctic

The objectives of the project are to obtain a comprehensive view of sea ice motion around Antarctica, taking data on ice motion from satellite or in-situ measurements, and to generate a combination of georeferenced data, allowing analysis and mapping of sea ice effects over a long period. Consistent datasets should be produced for different regional and temporal scales. First results of the study made it possible to overview the mean structure and variability of ice drift and to indicate locations where satellite derived drift over- or under- estimates the true ice velocity. A gridded drift database was generated that can help to define the temporal variation in the spatial covariance of drift and atmospheric forcing. Drift data from database can be used for initialisation and evaluation of sea-ice models. The data record is long enough to allow for statistical examination of the variance of the drift in different temporal and regional scales. A poster with a presentation of the project is given in Appendix 6, part 1.

Sea-Ice study under the GLOBEC project

Dr C. Geiger presented a study of sea-ice and snow properties based on autonomous sea-ice mass balance buoys. It was conducted in the course of an expedition held under the auspices of the South GLOBEC Programme in 2001 and 2002. An abstract of the presentati0on is given in Appendix 6, part 2.

Data transmission capabilities using low-orbit satellites

Dr S. Piotrowicz gave a review of new technologies available for real-time data transmission from oceanographic observing platforms. A summary is given in Appendix 6, part 3.

U.S.ARGO float deployment activities

Dr S. Piotrowicz presented the status of ARGO Programme in the Southern Ocean and plans to deploy more ARGO floats. This activity will significantly reduce the data-void areas in the Southern Ocean. A summary is available in Appendix 6, part 4.

7. Review of the operating procedures of the programme

The Operating Procedures and the Terms of Reference for the Coordinator of the IPAB were reviewed and amended (see appendix 7 to this report and its Annex).

8. Technical presentations

Presentations on marine and ice buoy design and production were made by the Denkmanufaktur (http://www.denkmanufaktur.de) and the Scottish Association for Marine Sciences buoy development group (http://www.sams.ac.uk).

9. Activities to improve the awareness about the IPAB within the scientific community

The session discussed the importance of making the IPAB more visible for the scientific communities. The importance of setting up a working web page and data base was once again underlined, as well as the crucial role of the coordinator in liaising with current and possible prospective participants in the programme. Action list is given in Appendix 8.

10. Future activities and any other business

Following a suggestion by Dr. I. Allison, the meeting agreed to prepare an intensive deployment campaign to be undertaken in the framework of the International Polar Year as an effort to get support for a one-year "optimum" buoy deployment around Antarctica. It is expected to involve

* an early season deployment of 20-30 well distributed buoys, all within the sea-ice zone,
* a later top-up deployment of an additional 10-15 buoys,
* 6 - 10 participant institutions,
* all buoys measuring at a minimum temperature and pressure, and all reporting via the GTS,
* coordinated and shared logistics for deployments.

In addition the campaign should envisage:

* close collaboration with satellite agencies deriving remote sensing sea-ice drift fields,
* collaboration from at least one of the main meteorological analysis agencies to ensure that data from the buoys are included in the analyses so that the value of the additional observing network could be assessed. This could be done in association with the ARGO programme.

The expected outcome of this initiative will likely be the following:

* a one year snap-shot of the ice drift around the whole of Antarctica,
* a valuable data set for validation of the satellite velocity products,
* the possibility of interpolating between buoy data with the satellite products,
* an enhanced network that should improve the Southern Hemisphere meteorological analyses,
* with improved South Hemisphere analyses, a good data set will be produced for analysing Antarctic-wide sea-ice dynamics
* possibly, data sufficient to model Antarctic-wide sea ice mass budget and thickness distribution,
* if there is a significant improvement in the meteorological products, a demonstration of the value of the buoys that might convince operational agencies to continue deployments.

The group decided that actual programme of actions in this connection would be developed by the IPAB Chair, Co-ordinator, Dr. I. Allison and interested participants. Support and endorsement of scientific research and operational organisations active in the Southern Ocean Sea-Ice Zone should be sought.

11. Administrative aspects of the IPAB

In accordance with the IPAB Operating Principles, the meeting elected the Executive Committee of the Programme and appointed the Co-ordinator. The composition of the Executive Committee for IPAB is as follows:

Chairman	Dr E. Zambianchi
Vice-Chairman	Dr J. Launiainen
Member	Dr S. Ushio
Member	Dr I. Allison
Member	Dr C. Haas

Prof. Peter Wadhams expressed his willingness to continue his duties as IPAB Coordinator and was reappointed as such on an interim basis until January 2004.

12. Venue and date for the next meeting, draft meeting report

Dr. Enrico Zambianchi suggested that the next IPAB meeting be scheduled for October 2005 and was organised in association with the 2005 Conference on the Ross Sea Oceanography. The venue will be Venice, Italy. This suggestion was unanimously approved. A skeleton of the meeting report was presented to the participants and was also approved.

13. Closure of the Meeting

The IPAB-IV closed at 14:00 of Saturday, 6 September 2003.

Appendix 1

List of participants

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Appendix 2

Agenda of the Fourth Session of IPAB

1. **Organisation of the Session**
2. **Report of the IPAB Co-ordinator**
3. **Reports from Participants**
4. **Review of IPAB progress to date**
5. **Status of the Membership Role**
6. **Related Research, Observational and Data Programmes**
7. **Review of the Operating Procedures of the Programme**
8. **Activities to Improve the Visibility of the IPAB within the Scientific Community**
9. **Future Activities and any Other Business**
10. **Administrative Aspects of the IPAB**
11. **Venue and Date for the Next Meeting, meeting report**
12. **Closure of the Meeting**

Report of the IPAB Co-ordinating Office

The co-ordinating office staff (Peter Wadhams and Martin Doble) transferred from the Scott Polar Research Institute at the end of 2002, relocating to the Scottish Association for Marine Science's Dunstaffnage Marine Laboratory (DML) in Scotland. The move represents an excellent opportunity to further the work of IPAB, since the co-ordinating office is now co-located with that of the National Focal Point of the Data Buoy Co-operation Panel (DBCP).

Buoy activity 2001-2003

The number of buoys operating in Antarctic waters has fluctuated considerably over the past three years. From a relatively stable inventory of around ten buoys in 2000 and 2001, numbers dropped off to leave one solitary buoy reporting to the GTS for November and December 2001, close to South Georgia. The first months of 2002 saw this rapidly redressed, however, with multiple deployments in the Weddell Sea and up to 20 buoys reporting. Numbers then fell again, reaching only six in October 2002. A mass deployment in the waters around the South Sandwich Islands, north of the Antarctic Peninsula, boosted numbers to the low twenties in the first half of 2003. Figure 1, below, shows the total GTS buoy population, split into the three IPAB areas; Weddell (60^{o}W – 20^{o}E), East Antarctica (20^{o}E – 170^{o}E) and the Bellingshausen, Amundsen and Ross Seas (170^{o}E – 60^{o}W).

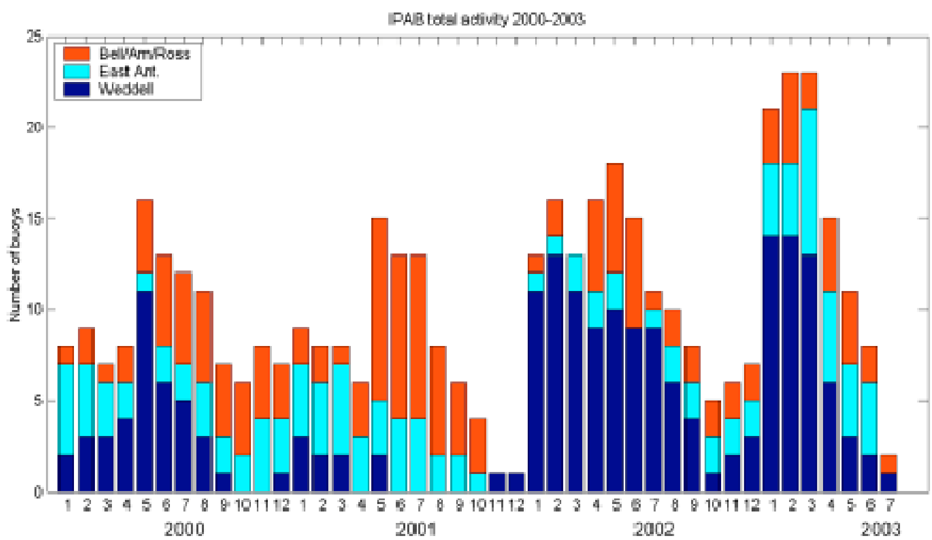

Figure 1: Buoys reporting to the GTS since 2000

While the very cyclic nature of the number of buoys reporting is itself undesirable, even the relatively well-represented months show a worrying lack of spatial coverage. Large numbers of buoys have been deployed in small areas, leaving the remainder of the Antarctic waters almost un-instrumented. The situation is well illustrated by examining drift tracks for the best represented months (May 2001, May 2002 and March 2003), shown in Figure 2 (a)-(c). The poorest coverage, in November 2001 is also illustrated in Figure 2 (d).

The majority of recent deployments have been performed by the WHOI SO-GLOBEC interests in the Peninsula region and have occurred exclusively in open water regions.

Full details of each GTS buoy are given in the Annex. Non-GTS buoy activity known to the co-ordinating office is included, though IPAB members outside the UK have not provided any details of these activities to the co-ordinating office. It is suggested that members report these non-visible deployments as a matter of course to the co-ordinator, as this would greatly increase the value of the IPAB function above that currently provided by MEDS.

Website

The move to Scotland has caused some disruption to the provision of an up-to-date and useful website, since the new organisation is itself upgrading all major computer and server facilities. The laboratory has a large dedicated IT department, however, who will provide the database preparation and maintenance services for the website. In the meantime, IPAB data provided by the Australian office has been integrated with the searchable Oracle database maintained at the British Antarctic Survey (BAS), which can be found at http://www.antarctica.ac.uk/met/metlog/cui.html. Perl scripts allow the user to select data on the basis of several fields, whether WMO ID, date, position or sensor information. Data are then output directly to screen in either text or graphical format, which can then be directly downloaded. This is seen as a significant extension to the NSIDC interface and will be incorporated in the new co-ordinator's website as time allows. The figure below shows a screen-grab of the BAS interface.

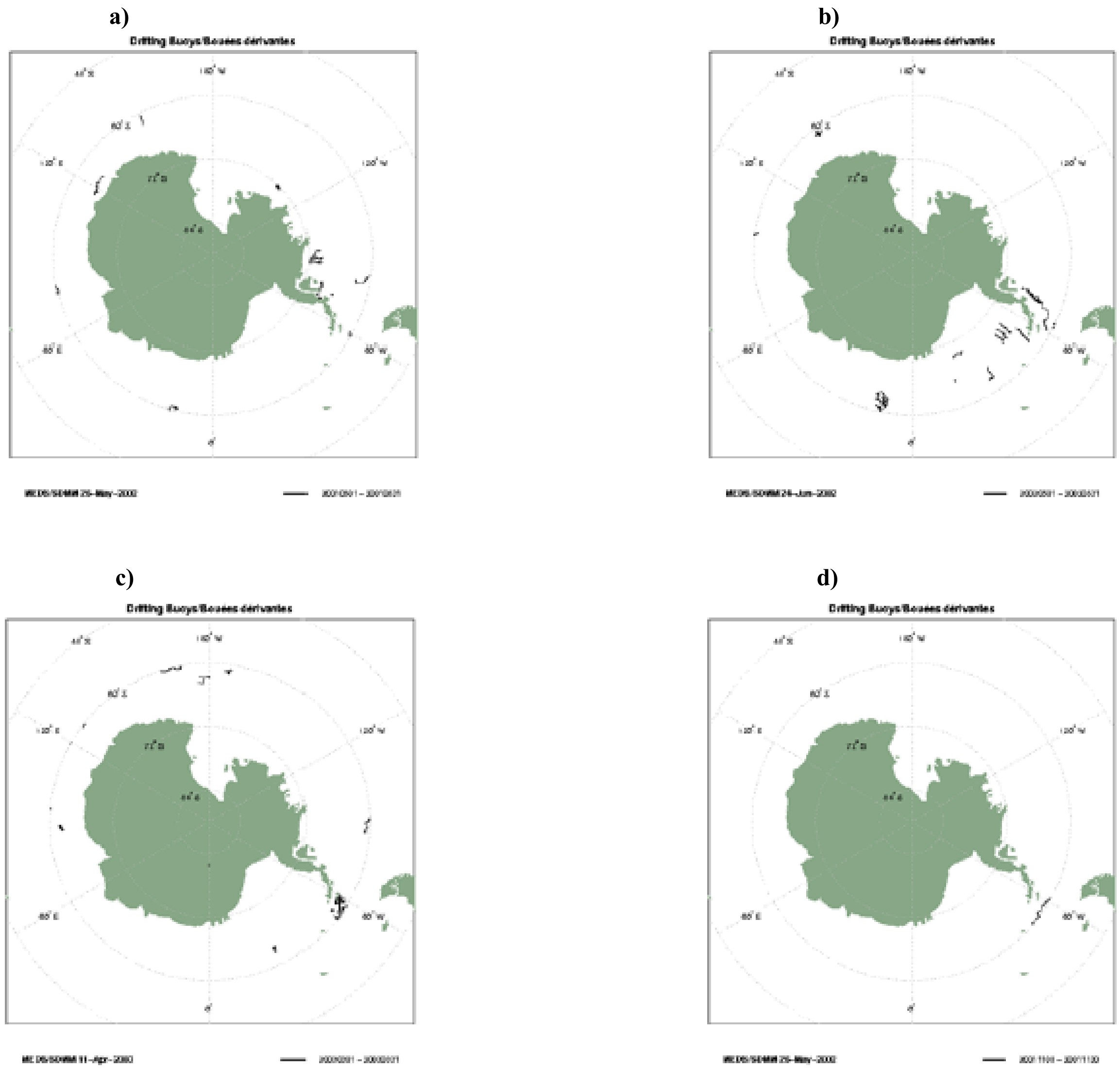

Figure 2 (a)-(d): Tracks of buoys reporting to the GTS during the 'glut months' over the past three years (a)-(c); and (d) the sole reporting buoy in November 2001. The far from ideal nature of the buoy distribution is clearly shown, with the majority of the buoys in the region of the Antarctic Peninsula and very little activity elsewhere.

The coming year will see automated scripts running to strip IPAB-relevant data from the available data sources and thus maintain an up-to-date listing of IPAB activities at all times. It is further suggested that members will enter their relevant details onto a web-based form. These will then also be automatically incorporated into the IPAB statistics.

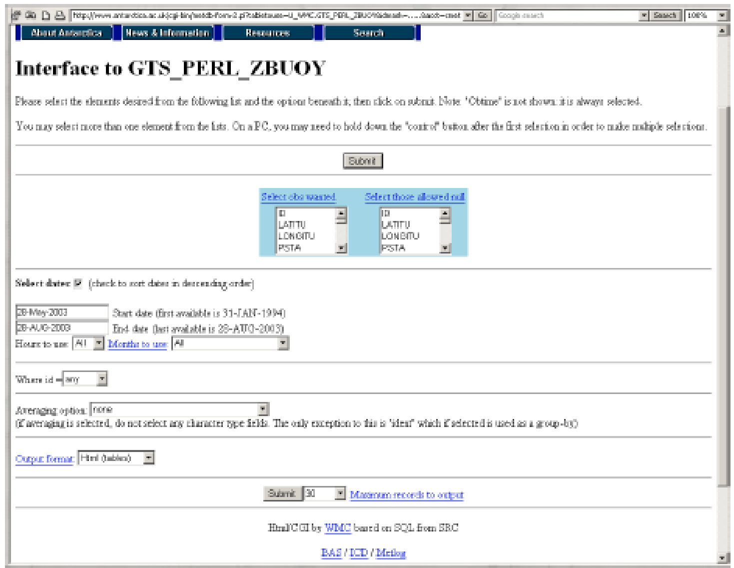

Figure 3: Searchable Oracle database for IPAB data 1995-1998.

Annex: Summary of IPAB buoy activities in 2001-2003

Abbreviations and notes:

Institutions

SAWB: South African Weather Bureau
WHOI: Woods Hole Oceanographic Institution
SIO : Scripps Oceanographic Institution
AAD: Australian Antarctic Division
ABOM: Australian Bureau of Meteorology
BAS: British Antarctic Survey
SPRI: Scott Polar Research Institute
DML: Dunstaffnage Marine Laboratory

Areas

W: Weddell Sea 60°W – 20°E
E: East Antarctica 20°E – 170°E
B: Bellingshausen, Amundsen and Ross Seas 170°E – 60°W

Sensors

P: Atmospheric pressure
Ta: Air temperature
SST: Sea surface temperature (usually hull temperature)
W: Wind speed and direction
Ti: Ice temperature
Tw: Thermistor chain temperatures
Hd: Buoy heading
SP: Wave spectrum
Drg: Drogue fitted, with centre depth if known
Doubtful records (launch date apparently too old) are shown in *italics*

2001: Buoy details

IPAB No.	**WMO**	**Argos**	**Argos**	**First deployment**			**Area**	**Buoy**	**Drg**	**Deployed**	**GPS**			**Sensors**	
	ID	**PTT**	**Prg**	Date (m)	Lat	Lon		**type**				P	Ta	SST	Other
SAWB 01	17644	25475	243	2000			W		Y			X		X	
SAWB 02	17645	25480	243	2000			W		Y			X		X	
SAWB 03	17647	8528	243	5			W					X	X		
SIO 01	33949	14826	9325	5			W		Y					X	
SPRI 08	71513	19079	9484	4	69°21'S	88°20'W	B	SVPB	Y	Pancake ice		X			
AWI 104	71554	09364	10919	2000			B					X	X		
WHOI A11	71571	22957	9325	5			B	SVP	15m	Open water				X	
WHOI A9	71572	22956	9325				B	SVP	15m	Open water					
WHOI A2	71572	26373	9325	5			B	SVP	15m	Open water				X	
WHOI A3	71573	22406	9325				B	SVP	15m	Open water					
WHOI A4	71573	30461	9325	5			B	SVP	15m	Open water				X	
WHOI A7	71574	22405	9325	5			B	SVP	15m	Open water				X	
WHOI A5	71580	30458	9325	5			B	SVP	15m	Open water				X	
SPRI 09	71582	19081	9484	4	69°30'S	85°41'W	B	SVPB	Y	Pancake ice		X			
SPRI 10	71583	16187	9484	4	70°00'S	87°00'W	B	SVPB	Y	Pancake ice		X			
AAD 74	73501	18657	1155	4/99			B					X	X	X	
AAD 75	73502	18658	1155	3/00			E					X	X	X	
AAD 53	73509	18659	1155	3/99			E		Y			X	X	X	
AAD 79	73509		1155	10											
SIO 02	73650	27540	7325	2000			E		Y					X	
SIO 03	73651	27539	7325	2000			E		Y					X	
SIO 04	73651		7325	7					Y					X	
AAD 78	74531	18651	1155	3								X	X	X	
AAD 80	74531		1155	6					Y					X	
ABOM 01	74534	04871	85	2000			E		Y			X	X	X	
BAS BB1		21384		2	70°59'S	87°04'W	B	CALIB		Pack ice		X			
BAS BB2		21388		2	70°54'S	87°28'W	B	CALIB		Pack ice		X			
BAS BB3		21376		2	71°47'S	80°18'W	B	CALIB		Pack ice		X			
BAS BB4		21392		4	71°05'S	85°21'W	B	CALIB		Pack ice		X			
AAD 76		20138		3/00								X	X		
AAD 77		20140		3/00								X	X		
WHOI A8		26367		5			B	SVP	15m	Open water				X	
WHOI A14		26368		6			B	SVP	15m	Open water				X	
WHOI A10		26369		5			B	SVP	15m	Open water				X	
WHOI A12		26372		5			B	SVP	15m	Open water				X	
WHOI A6		30459		5			B	SVP	15m	Open water				X	
WHOI A1		30460		5			B	SVP	15m	Open water				X	

2001: Buoy lifetimes

Numbers of messages are shown for those buoys reporting to the GTS. Functioning non-GTS buoys are indicated by an 'X'. These are not assigned a WMO ID.

IPAB No.	**WMO ID**	**Argos PTT**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
SAWB 01	17644	25475	691	643	390									
SAWB 02	17645	25480	664	638	53									
SAWB 03	17647	08528	2				486	478	736	623	55			
SIO 01	33949	14826					277							
SPRI 08	71513	19079			X	X	683	705	744	741	698	4		
AWI 104	71554	09364	175	185	221	222	221	181	206	206	180	124		
WHOI A11	71571	22957					244	425	514					
WHOI A9	71572	22956					239	119	13					
WHOI A2	71572	26373								149				
WHOI A3	71573	22406					236	110	16					
WHOI A4	71573	30461								160				
WHOI A7	71574	22405					239	481	333	453	11			
WHOI A5	71580	30458					19	487	130					
SPRI 09	71582	19081			X	94	338							
SPRI 10	71583	16187			X	93	735	705	743	740	340			
AAD 74	73501	18657	704	567			530	718	372					
AAD 75	73502	18658	727	659	742	713	737	711	742	742	720	52		
AAD 53	73509	18659										411	545	671
AAD 79	73509													
SIO 02	73650	27540	325	418	496	465	496	466	361					
SIO 03	73651	27539	320	408	3									
SIO 04	73651								74					
AAD 78	74531	18651			132									
AAD 80	74351							349						
ABOM 01	74534	04871	613	523	490	452	193							
BAS BB1		21384		X										
BAS BB2		21388		X	X									
BAS BB3		21376		X	X	X	X							
BAS BB4		21392				X	X							
AAD 76		20138	X	X	X	X								
AAD 77		20140	X	X	X	X	X	X	X	X	X			
WHOI A8		26367					X	X	X	X	X			
WHOI A14		26368						X	X	X	X			
WHOI A10		26369					X	X	X	X	X			
WHOI A12		26371					X	X	X	X	X			
WHOI A13		26372					X	X	X	X	X			
WHOI A6		30459			X	X	X	X	X	X	X			
WHOI A1		30460			X	X	X	X	X	X	X			
No. buoys reporting on GTS			**9**	**8**	**8**	**6**	**15**	**13**	**13**	**8**	**6**	**4**	**1**	**1**

2002 Buoy details

IPAB No.	**WMO**	**Argos**	**Argos**		**First deployment**		**Area**	**Buoy**	**Drg**	**Deployed**	**GPS**			**Sensors**	
	ID	**PTT**	**Prg**	Date	Lat	Lon		**type**				P	Ta	SST	Other
WHOI	15907	33840	7325	12-1-02	61°59'S	23°59'W	W	SVPB	Y			X		X	
WHOI	15910	33845	7325	20-1-02	60°00'S	40°00'W	W	SVPB	Y			X		X	
WHOI	34515	13565	7325	26-2-02	60°02'S	101°35'W	B	SVP	Y					X	
WHOI	34517	13556	7325	27-2-02	57°59'S	97°08'W	E		Y					X	
	54914			12			B		Y			X	X	X	
	56514	*02935*	*9085*	*1-5-95*	*53°54'S*	*130°51'E*	*B*	*SVPB*	*Y*			*X*	*X*	*X*	
	56517	*04879*	*9085*	*1-1-98*	*11°45'S*	*120°16'E*	*E*	*SVPB*	*Y*			*X*	*X*		
	63661			12			W						X		
	71541	08060		1			W					X	X		
	71542	09728		1, 5			W					X	X		
	71543	09781		1, 5			W					X	X		
	71544	08066		1			W					X			
	71545	08067		1			W					X			
	71546	08068		1			W					X			
AWI 104	71554	09364	10919	2000			B					X	X		
WHOI	71566	33847	7325	7-2-02	62°30'S	00°45'W	W	SVBP	Y			X		X	
AAD 53	73509	18659	1155	10/01			W					X	X	X	
	74519	24086		1			W		Y			X		X	
	74520	24811	243	21-1-02	64°54'S	35°02'W	W	SVPB	Y			X		X	
	74535	02695		2			E		Y			X	X	X	
WHOI	74903	33846	7325	6-2-02	64°59'S	0°08'W	W	SVP	Y			X		X	
	74904	*24476*	*1325*	*18-4-96*	*47°34'S*	*125°11'W*	*B*	*SVP*	*Y*					*X*	
WHOI	74905	24477	7325	13-2-02	66°40'S	69°28'W	B	SVP	Y					X	
WHOI	74906	25119	7325	20-2-02	68°15'S	69°59'W	B	SVP	Y					X	
WHOI	74907	25181	7325	22-2-02	68°06'S	70°31'W	B	SVP	Y					X	
WHOI	74908	34225	7325	17-5-02	61°00'S	63°01'W	B	SVP	Y					X	
WHOI	74909	34226	7325	17-5-02	60°01'S	63°19'W	B	SVP	Y					X	

2002: Buoy lifetimes

Numbers of messages are shown for those buoys reporting to the GTS (derived from MEDS). Functioning non-GTS buoys are indicated by an 'X'

IPAB No.	WMO ID	Argos ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
WHOI	15907	33840	393	151										
WHOI	15910	33845	41	60										
WHOI	34515	13565				288				37	12	116		
WHOI	34517	13556											132	484
	54914													39
	56514	02935						124	393	492	467	502	500	489
	56517	04879	75	372	490	456	439	475	483	453	453	363	224	326
	63661													48
	71541	08060	5	219	248	225	211	185	104				1	
	71542	09728	4	222	235		199	211	214	216	12			
	71543	09781	4	221	247		207	210	212	199	56			
	71544	08066	5	217	242	220	211	221	230	212	97			
	71545	08067	5	223	245	224	221	239	245	244	235	242	237	244
	71546	08068	5	220	239	228	217	226	225	103				
AWI 104	71554	09364	17	9										
WHOI	71566	33847		387	695	665	680	746	288					
AAD 53	73509	18659	744	670	744	40								
	74519	24086	418	670	738	709	17			94				
	74520	24811	243	409	382	707	685	467	128					
	74535	02695		10	490	467	67				73	191	370	114
WHOI	74903	33846		391	604	19	636	662	280	293				
	74904	24476				442	487	68						
WHOI	74905	24477				421	467	305						
WHOI	74906	25119				446	462	47						
WHOI	74907	25181				439	447	123						
WHOI	74908	34225					37							
WHOI	74909	34226					3							
No. buoys reporting to GTS			**13**	**16**	**13**	**16**	**18**	**15**	**11**	**10**	**8**	**5**	**6**	**7**

2003 Buoy details

IPAB No.	WMO ID	Argos PTT	Argos Prg	First deployment Date	Lat	Lon	Area	Buoy type	Drg	Deployed	GPS	Sensors P	Ta	SST	Other
WHOI	33589	34230	7325	21-12-02	59°59’S	64°47’W	W	SVP	Y	Open water				X	
WHOI	33591	39140	6325	13-2-03	61°14’S	60°00’W	W	SVP	Y	Open water				X	
WHOI	33592	39145	6325	13-2-03	60°57’S	60°32’W	W	SVP	Y	Open water				X	
WHOI	33594	39139	6325	19-2-03	60°28’S	55°38’W	W	SVP	Y	Open water				X	
WHOI	33595	39141	6325	14-2-03	60°01’S	58°34’W	W	SVP	Y	Open water				X	
WHOI	34517	13556	7325	6-11-02	60°00’S	62°13’W	W	SVP	Y	Open water				X	
WHOI	55614	34174	6325	9-3-03	60°00’S	160°00’E	B	SVPB	Y	Open water		X		X	
WHOI	55615	34190	7325	9-3-03	58°00’S	157°25’E	E	SVPB	Y	Open water		X		X	
ABOM	*56514*	*02935*	*9085*	*1-5-95*	*53°54’S*	*130°51’E*	*B*	*SVPB*	*Y*	*Open water*		*X*	*X*	*X*	
ABOM	*56517*	*04879*	*9085*	*1-1-98*	*11°45’S*	*120°15’E*	*E*	*SVPB*	*Y*	*Open water*		*X*	*X*		
MSA	56612	21563	221	2			E		Y					X	
AWI	63661	08056	919	12/02			W						X		
AWI	71545	08067	919	1/02			W					X			
WHOI	71569	34228	7325	27-11-02	59°00’S	63°24’W	W	SVP	Y	Open water				X	
WHOI	71570	39096	6325	23-1-03	61°32’S	56°36’W	W	SVP	Y	Open water				X	
WHOI	71574	39133	6325	23-1-03	61°14’S	56°31’W	W	SVP	Y	Open water				X	
WHOI	71575	39110	6325	22-1-03	61°47’S	57°02’W	W	SVP	Y	Open water				X	
WHOI	71577	39119	6325	22-1-03	61°31’S	57°32’W	W	SVP	Y	Open water				X	
WHOI	71578	39111	6325	21-1-03	60°02’S	58°29’W	W	SVP	Y	Open water				X	
WHOI	71579	39112	6325	20-1-03	61°46’S	58°59’W	W	SVP	Y	Open water				X	
WHOI	71580	39132	6325	22-1-03	61°14’S	57°14’W	W	SVP	Y	Open water				X	
WHOI	71603	39130	6325	20-1-03	60°32’S	58°22’W	W	SVP	Y	Open water				X	
WHOI	71604	39131	6325	20-1-03	61°34’S	58°34’W	W	SVP	Y	Open water				X	
WHOI	71605	39097	6325	19-1-03	62°07’S	60°05’W	B	SVP	Y	Open water				X	
WHOI	71606	39113	6325	19-1-03	61°55’S	59°36’W	B	SVP	Y	Open water				X	
WHOI	71607	71607	7325	18-1-03	59°59’S	65°55’W	B	SVPB	Y	Open water		X		X	
WHOI	73651	34179	7325	8-1-03	59°03’S	63°39’W	E	SVPB	Y	Open water		X		X	
WHOI	73652	34191	7325	16-12-02	57°59’S	156°28’E	E	SVPB	Y	Open water		X		X	
ABOM	74535	02695	-	3			E		Y			X	X	X	
ABOM	74536	08035	-	1			E		Y			X	X	X	
ABOM	*74537*	*08038*	*9035*	*30-5-94*	*18°19’S*	*118°30’E*	*E*	*SVPB*	*Y*	*Open water*		*X*	*X*	*X*	

2003: Buoy lifetimes
Numbers of messages are shown for those buoys reporting to the GTS. Functioning non-GTS buoys are indicated by an 'X'

IPAB No.	WMO ID	Argos ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
WHOI	33589	34230	266	155										
WHOI	33591	39140		15	300	293		151	471					
WHOI	33592	39145		16	388	275								
WHOI	33594	39139				4								
WHOI	33595	39141			18									
WHOI	34517	13556	292											
WHOI	55614	34174			279	683	721	651	174					
WHOI	55615	34190			125	517								
BOM	56514	02935	476	374	469	454	575	92						
BOM	56517	04879	423	432	485	173								
MSA	56612	21563		67	101									
AWI	63661	08056	237	127										
AWI	71545	08067	246	220	241		181							
WHOI	71569	34228	178	90										
WHOI	71570	39096	36	414	36									
WHOI	71574	39133	35	419	392	449	239							
WHOI	71575	39110	34	417	381	191								
WHOI	71577	39119	35	411	34									
WHOI	71578	39111	36	390	271									
WHOI	71579	39112	32	417	388	446	503	174						
WHOI	71580	39132	11	129	3									
WHOI	71603	39130	24		13									
WHOI	71604	39131	31	423	373									
WHOI	71605	39097	35	324										
WHOI	71606	39113	36	182										
WHOI	71607	71607					55							
WHOI	73651	34179	34	634	522	674	638	386						
WHOI	73652	34191	35	634	267	684	378							
BOM	74535	02695			30	453	562	212						
BOM	74536	08035	18	103	65	457	561	265						
BOM	74537	08038		233	487	453	543	271						
No. buoys reporting to GTS			**21**	**23**	**23**	**15**	**11**	**8**	**2**					

AWI buoys operated or deployed during 2000-2003 period and future plans

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In the framework of IPAB, AWI has deployed 9 (3 each in 2000, 2002, and 2003) sea ice buoys (Fig. 1a) and 40 (10 +/- 1 each year) iceberg drifters (Fig. 1b) in the reporting period 2000-2003. Sea ice buoys were equipped with pressure and T sensors according to WMO standards, and with GPS. The buoys were reporting their measurements and GPS position every 3 hours. Through Service ARGOS the data went onto the GTS. Currently (June 2003) two buoys are still operating. Iceberg drifters were deployed to study the contribution of icebergs to the Weddell Sea fresh water budget. Therefore, we were mainly interested in their drift tracks and they were only recording their GPS positions. Only 9 (3 each year between 2001 and 2003) had air pressure sensors.

In April 2004, we plan the deployment of 3 buoys with RV Polarstern in the Antarctic Coastal Current close to the Greenwich meridian (Ant 21/4). The buoys shall serve as tracers for the preparation and conduction of Polarstern Expedition Ant 22/2 in November 2004 - January 2005 with the ISPOL ice station. During Ant 21/2 10 iceberg drifters will also be deployed in the Southern Weddell Sea and close to the Antarctic Peninsula.

All sensors are manufactured by the German company Sellmann&Kruse, which was renamed into Denkmanufaktur in 2002 (http://www.denkmanufaktur.de).

Tables 1-3 summarise the start and end dates and positions of the sea ice buoys and iceberg drifters. Figures 2 to 8 show drift tracks for buoys and drifters deployed between 1999 and 2003.

a)

b)

Figure 1: Sea ice buoy with 2 m temperature and pressure sensor (a) and iceberg drifter (b).

Table 1: Summary of all sea ice buoys deployed by AWI between 2000 and 2003. Drift tracks are shown in Figures 1-3.

Argos ID	Start date	Start position		End date	End position	
		Lat	Lon		Lat	Lon
9358	Feb. 00	-71.095	-106.894	30.11.00	-71.673	-119.630
9361	Feb. 00	-72.134	-105.558	20.11.00	-73.385	-136.274
9364	Feb. 00	-71.071	-103.734	23.10.01	-71.870	-143.497
9781	04.01.02	-71.9083	316.898	24.10.02	-55.4626	333.6764
9728	04.01.02	-71.7611	314.8109	02.12.02	-56.3683	333.1484
8060	04.01.02	-71.4646	317.1497	01.03.03	-55.075	346.9153
8064	09.03.03	-70.986	258.755	08.05.03	-72.9342	255.0986
8059	09.03.03	-70.7076	257.8971			
8058	09.03.03	-70.7076	257.8974			

Table 2: Overview of AWI iceberg drifter deployments 1999-2003

Polarstern cruise	Deployment period	Number of drifters	with P_{Air} sensors	Drift track shown in Figure No.
ANT XVI/2	Jan/Mar 1999	12		5a
ANT XVII/2	Jan/Feb 2000	9		5b
ANT XVIII/3	Dez 2000/Jan 2001	11	3	6
ANT XIX/2	Jan/Feb 2002	10	3	7
ANT XX/2	Dez 2002/Jan 2003	10	3	8

Table 3: Summary of iceberg deployments in 2003 (c.f. Figure 8)

Argos ID	Deployment date	Latitude	Longitude	Length x Width x Freeboard (m)	P-Sensor
9360	11.12.2002	65° 57.15' S	2° 28.89' W	200 x 200 x 26	Yes
14959	13.12.2002	70° 20.88' S	8° 20.44' W	1600 x 750 x 40	
14958	13.12.2002	70° 13.61' S	7° 57.00' W	380 x 380 x 25	
14960	14.12.2002	70° 16.63' S	9° 39.85' W	380 x 380 x 40	
14956	16.12.2002	69° 06.05' S	0° 29.81' E	380 x 380 x 20	
8056	18.12.2002	66° 07.24' S	0° 24.79' E	180 x 180 x 10	Yes
14955	19.12.2002	64° 52.09' S	0° 16.97' E	180 x 150 x 50	
9835	23.12.2002	64° 01.33' S	8° 17.02' E	200 x 100 x 15	Yes
14954	29.12.2002	69° 10.98' S	22° 32.06' E	1000 x 300 x 30	
14961	29.12.2002	69° 24.07' S	21° 34.69' E	300 x 300 x 35	

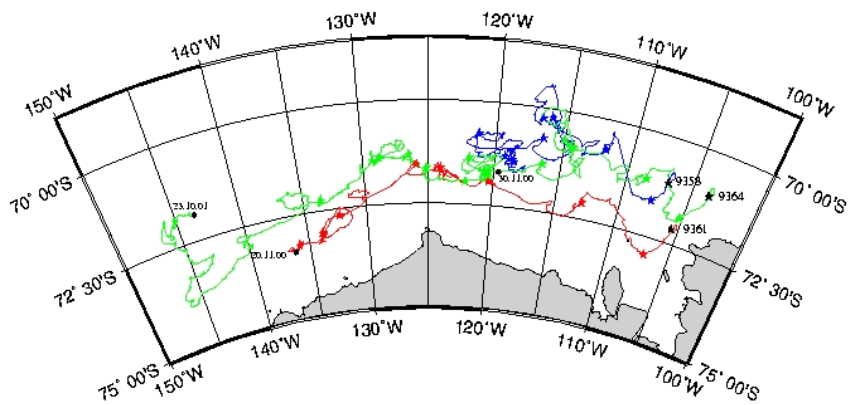

Figure 2: Sea ice buoys deployed by AWI in cooperation with RV N.B. Palmer in early 2000

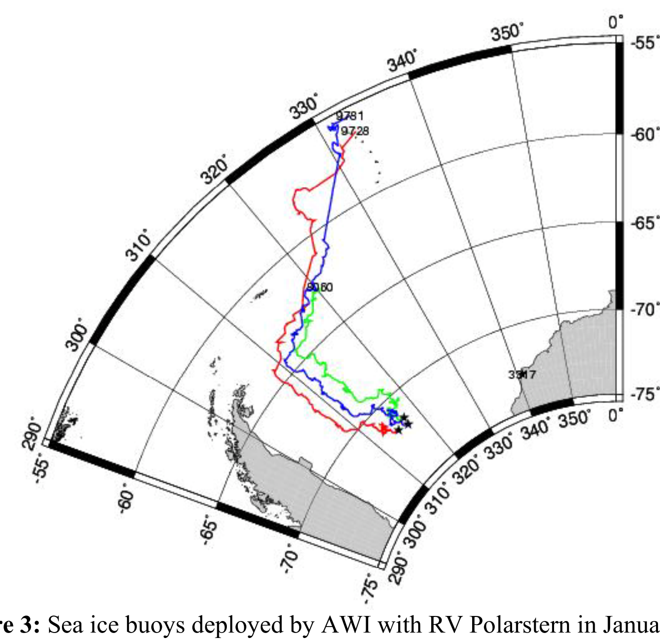

Figure 3: Sea ice buoys deployed by AWI with RV Polarstern in January 2002

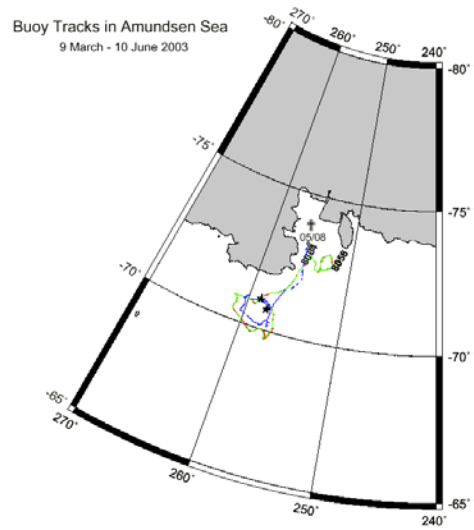

Figure 4: Sea ice buoys deployed by AWI with RV James Clark Ross in March 2003

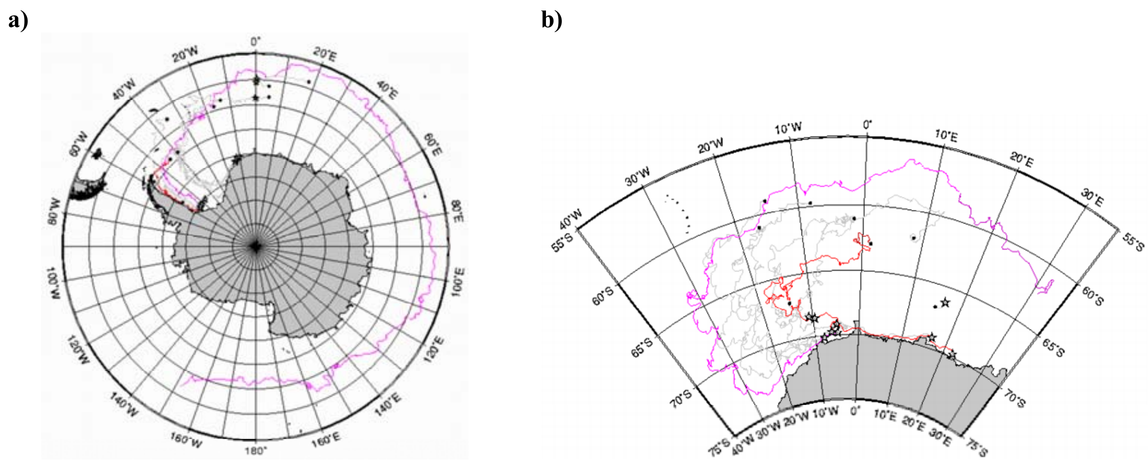

Figure 5: Tracks of iceberg drifters deployed in 1999 (a) and Jan/Feb 2000 (b); c.f. Table 2.

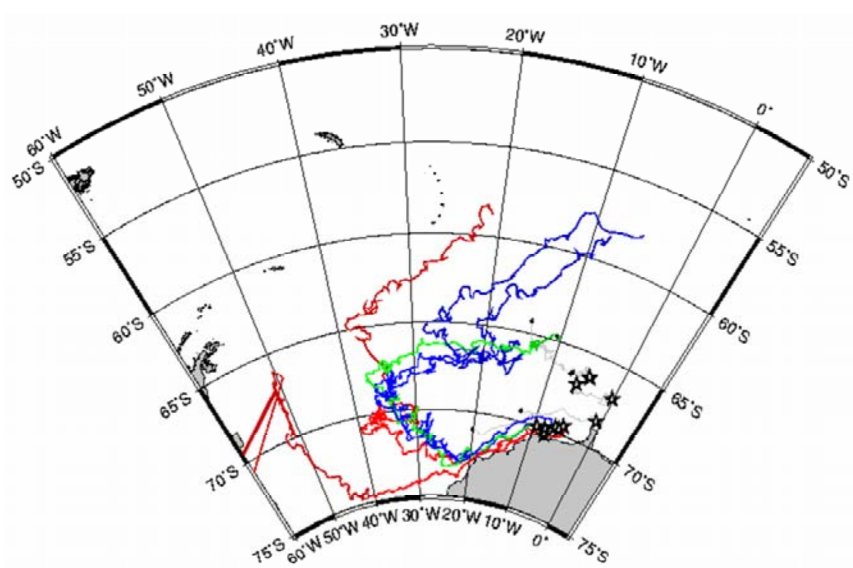

Figure 6: Tracks of iceberg drifters deployed in December 2000/January 2001; c.f. Table 2.

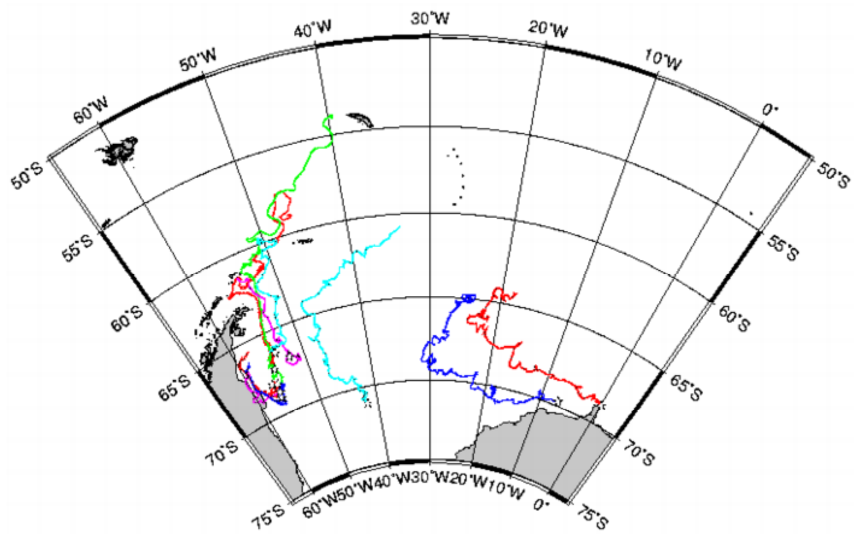

Figure 7: Tracks of iceberg drifters deployed in December 2001/January 2002; c.f. Table 2.

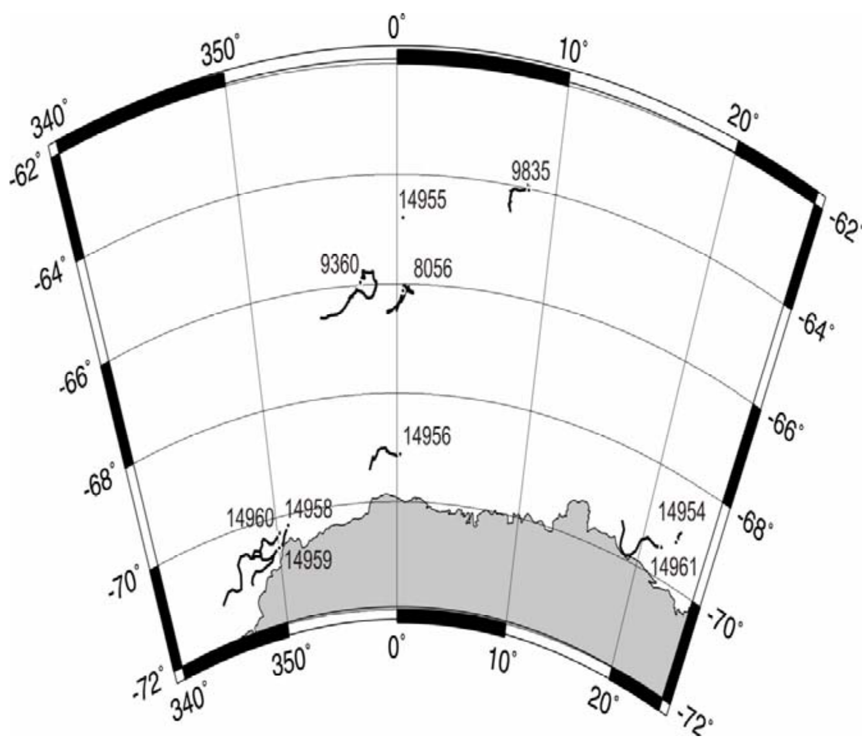

Figure 8: Tracks of iceberg drifters deployed in December 2002/January 2003; c.f. Table 2.

Italian National Programme for Antarctic Research (PNRA)

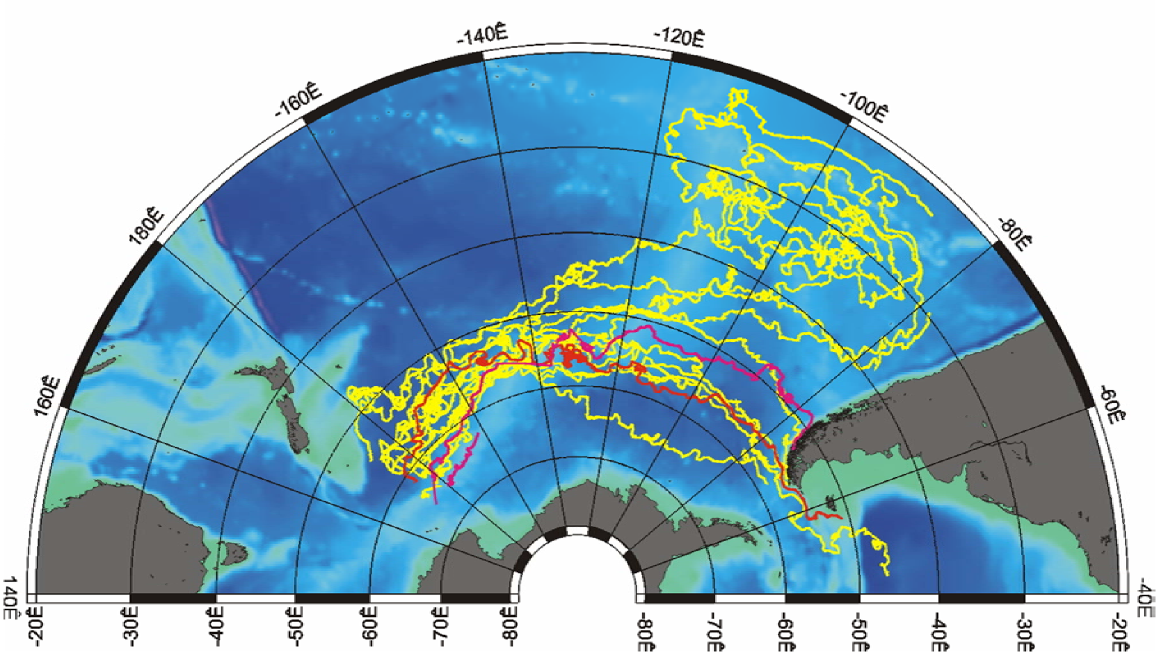

Figure. WOCE-TOGA drifter trajectories 1994-2003

Appendix 5

WMO Executive Council LVI Resolution 15 (EC-LVI)

MAINTENANCE OF AND SUPPORT TO THE WCRP INTERNATIONAL PROGRAMME FOR ANTARCTIC BUOYS (IPAB)

THE EXECUTIVE COUNCIL,

Noting:

(1) Resolution 11(EC-XLVI) – Organization of an International Programme for Antarctic Buoys,
(2) The report of the eight session of the EC Working Group on Antarctic Meteorology (Geneva, Switzerland, 25-27 November 2002),
(3) The report of the third session of the WCRP ACSYS/CliC Scientific Steering Group (Beijing, China, 21-25 October 2002),

Considering the importance of IBAP observations in the Antarctic sea-ice zone for the World Climate Research Programme, the WMO World Weather Watch, the Global Climate Observing System, the Global Ocean Observing System, the programme activities of the Joint WMO and IOC of UNESCO Technical Commission for Oceanography and Marine Meteorology, and as well for the research activities of the Scientific Committee for Antarctic Research,

Recognising

(1) the significant positive impact of existing IPAB observations on operational weather prediction,
(2) that the desired density of the buoy array in the Antarctic sea-ice zone with a spacing of 500 km has never been achieved despite the efforts of the Programme participants,
(3) that the current biggest systematic differences in the mean seal level atmospheric pressure analysis between data of numerical weather forecast centres are located in the Southern Ocean,
(4) that the incorrect compensation for atmospheric column mass fluctuations due to shortage or lack of atmospheric pressure and temperature observations will lead to detrimental consequences of satellite gravity measurements at high latitudes, particularly in locations where atmospheric sea-level pressure variations are poorly characterised, with subsequent implications for many meteorological and oceanographic applications,
(5) that the region of Peter I Island is at present time particularly poorly covered by observations available to Members through the WMO Global Telecommunication System (GTS),
(6) limited life – time of drifting buoys in the Antarctic sea-ice zone,

Urges Members, in particular those, which have active meteorological and oceanographic programmes in the Antarctic and use satellite gravity and altimetry data in their operational and research activities:

(1) to actively participate in the WCRP IPAB programme by provision and/or deployment of sea-ice buoys capable of measuring sea level atmospheric pressure, air temperature and sea ice drift, or to support the Programme through other appropriate means;
(2) to spare no efforts in the maintenance of the drifting buoy network in the Antarctic sea ice zone particularly through using internationally coordinated deployment opportunities with the goal that the buoys are more frequently deployed in areas of minimal current data coverage;
(3) to undertake necessary actions ensuring that the deployed buoys report their observations through the WMO GTS.

Note: this resolution replaces Resolution 11 (EC-XLVI), which is no longer in force.

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Forschungszentrum Karlsruhe
Technik und Umwelt

Carolin Schmitt, Christoph Kottmeier
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Mark R. Drinkwater
Science and Applications Department
European Space Agency / ESTEC

ATLAS OF SEA ICE DRIFT IN THE ANTARCTIC

1. Introduction

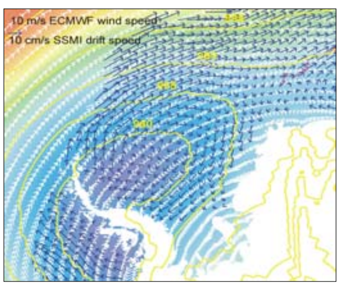
To obtain a comprehensive view of sea ice motion around Antarctica, and to take advantage of the work already done in developing algorithms for ice drift using satellite data as well as the collection of measurement data from drifting buoys, the **Ice Drift Atlas** was planned. The Atlas is designed to achieve a widespread combination of georeferenced data on the Antarctic sea ice drift, allowing analysis and mapping of sea ice effects over long periods. Its objective is to provide consistent datasets for different temporal and regional scales and statistical examinations of 20 years of ice motion data.

3. GIS Ice Motion Database Concept and Additional Data

All ice motion data is uniformly georeferenced in the same polarstereographic projection, so it is suitable for GIS analysis and it is easy to merge and blend vectors from different data types, which allows for example direct, regionwide examinations of the ice drift – wind forcing relation.

Additional used data sets are:

- Sea ice Concentration **Pelicon** *(Project for Estimation of Long-term variability in Ice Concentration)*
- Weather Data from **ECMWF** model (Sea level pressure and 10m wind)
- Seafloor Topography and Land Elevation Data



SSMI_OI Drift
Buoy Drift
ECMWF 10m
Wind

Figure 2: *September 94 Monthly mean ECMWF pressure and wind, buoy drift and SSMI_OI drift*

5. Long Time Series Examinations

20 years of data could be used to create monthly, seasonal and annual means of the ice drift velocity, their single components and their temporal and spatial derivatives like divergence, vorticity and shear. For the investigated domain, 5°x5° mean values for different latitude intervals are plotted to see, if eastward propagating anomaly structures, which have been previously detected in atmospheric and sea ice data (White and Petersen, 1996; Venegas et al., 2001), are evident in the database sea-ice velocities.

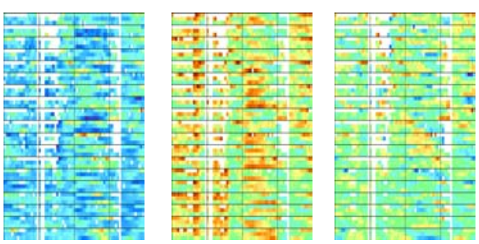
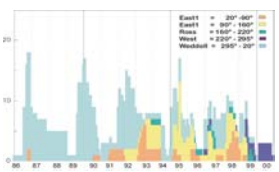


Figure 6: *Seasonal anomaly (lat70 – lat 65) of drift velocity (left) , seasonal meridional velocity (middle) and seasonal meridional velocity anomaly (right). Black lines show the direction of eastward propagating anomalies in sea ice extent and sea level pressure as in White and Peterson (1996).*

The minima and maxima of the absolute drift values in Fig.6a show a similar propagation as indicated by the black lines, which could suggest a relation to anomalies shown in atmospheric data. In the meridional velocity component (Fig.6b), the pattern is not so clear, but more dominated by regional dependance. The propagation of anomalies of the meridional velocity component in Fig. 6c agree well with directions of propagating anomalies in sea ice extend .
Because SSMI_OI drift data is only available for month 3-11, only three season blocks are built per year. Austral summer satellite ice drift products are not generated – as the ice surface decorrelates and prevents tracking during the melt season.

2. Ice Motion Datasets:

Drift data from two complementary measurement principles are used in combination:



In-situ measurement data from drifting buoys from the **IPAB** Archive (International Programme for Antarctic Buoys) and additional buoy data from other times, collected at the **AWI** (Alfred Wegener Institut für Polar und Meeresforschung) have a high spatial and temporal resolution, while ice drift from satellite date are more continuous and cover large portions of the Southern Ocean.
Satellite **optimal interpolated ice drift** data from the SSMI Sensor on board the DMSP satellite series is used, including data from 37GHz and 85GHz Channel (Kwok et al.,1998) and buoy data when and where available (courtesy JPL, Polar Remote Sensing Group).

4. Ice Motion and Variation Fields

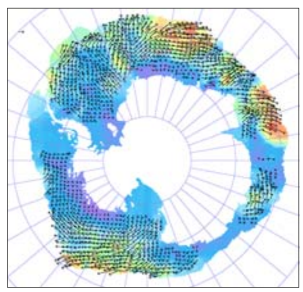


Figure 3: *Monthly mean drift velocity field for October 86. SSMI_OI data (black arrows),Buoy data (red arrows)*

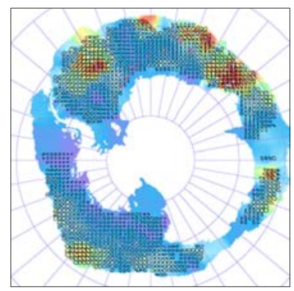


Figure 4: *Monthly mean drift variance for October 86 SSMI_OI data (black) Buoy data (red)*

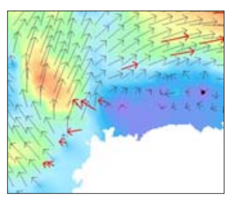


Figure 5: *Zoom Section from above with WMO-ID of the buoys*

Ice drift velocity and variance fields are calculated on different temporal and regional scales. To illustrate the variance fields, more detailed covariance ellipses are calculated and plotted, wherever satellite or buoy data is available. The satellite data is additionally interpolated in gridded velocity fields, within the boundary of the ice concentration fields.
For each buoy position, auxiliary data such as drift and variance parameters, WMO_ID and group name of the buoy field is included as vector attribute information and can be used for identification and direct comparison of selected parameters with the same parameters in gridded SSMI-OI Motion Fields.

6. Conclusions

- The Ice Drift Atlas collects data from different sources, uniformly reprojected by the same methods.
- It gives an overview about the mean structure as well as variability of ice drift.
- It gives an indication of locations where satellite derived drift over/underestimates the true ice velocity.
- A gridded drift database can help to define the temporal variation in the spatial covariance of drift and atmospheric forcing
- Drift data can be used for initialization and evaluation of sea-ice models.
- The long record of data allows statistical examination of the variance of the drift in different temporal and regional scales.
- Presenting and processing the drift data together with atmospheric and topographic data in a GIS makes an areawide, combined analysis and classification of the different data directly possible.

7. References

Kottmeier, Ch., and L. Sellmann, 1996. Atmospheric and oceanic forcing of Weddell Sea ice motion, *J. Geophys. Res., 101(C9), 20809-20824.*
Kwok, R., A. Schweiger, D. Rothrock, S. Pang, and C. Kottmeier, 1998. Sea ice motion from satellite passive microwave imagery assessed with ERS SAR and buoy motions, *J. Geophys. Res., 103(C4), 8191-8214.*
Venegas, S., M.R. Drinkwater, and G. Schaffer, 2001. Coupled Oscillations in the Antarctic Sea-Ice and Atmosphere in the South Pacific Sector, *Geophys. Res. Lett., 28, 17, 3301-3304.*
White and Peterson, 1996. An Antarctic circumpolar wave in surface pressure, wind temperature and sea ice extent, *Nature, 380.*

Appendix 6, Part 2

Summary of Talk by Dr. K. Geiger on results from Southern Ocean GLOBEC expedition

Reference: Perovich, D.K, B.C. Elder, K.J. Claffey, S. Stammerjohn, R. Smith, H.R. Krouse, and A.J. Gow, Sea-ice properties in the marguetie Bay region during winter, submitted to Journal of Geophysical Research Oceans.

Abstract of Submitted Paper: During the winter 2001 and 2002 cruises of the South GLOBEC experiment, we sampled ice physical and optical properties in the Marguerite Bay area of the Western Antarctic Peninsula. At 18 floes, ice thickness was measured every meter along 10- to 120-m-long survey lines. The combined mean ice thickness for these surveys was 62 cm in 2001 and 102 cm in 2002, with medians of 43 cm and 68 cm, respectively. Snow depths averaged 16 cm in 2001 and 21 cm in 2002. At 40% of the thickness holes in 2001 and 17% in 2002, a combination of deep snow and thin ice resulted in negative freeboard and the potential for surface flooding. A stratigraphic analysis of ice thin sections showed that more than half of the ice sampled was granular and that virtually all of the upper 20 cm of the ice cover was granular. There were indications that snow–ice formation at the surface contributed significantly to the overall ice production. A δ18O analysis of ice cores taken in 2001 indicated that 15% of the samples had negative values, implying the presence of snow–ice. At most sites the base of the snow cover was wet and saline. The average ice salinity was 7 psu, with the largest salinities, of approximately 10 psu, found near the surface. The combination of warm ice temperatures and large salinities resulted in brine volumes that were typically greater than 5% and ice that was highly permeable. Autonomous buoys provided a temporal perspective on the sea ice mass balance and temperature.

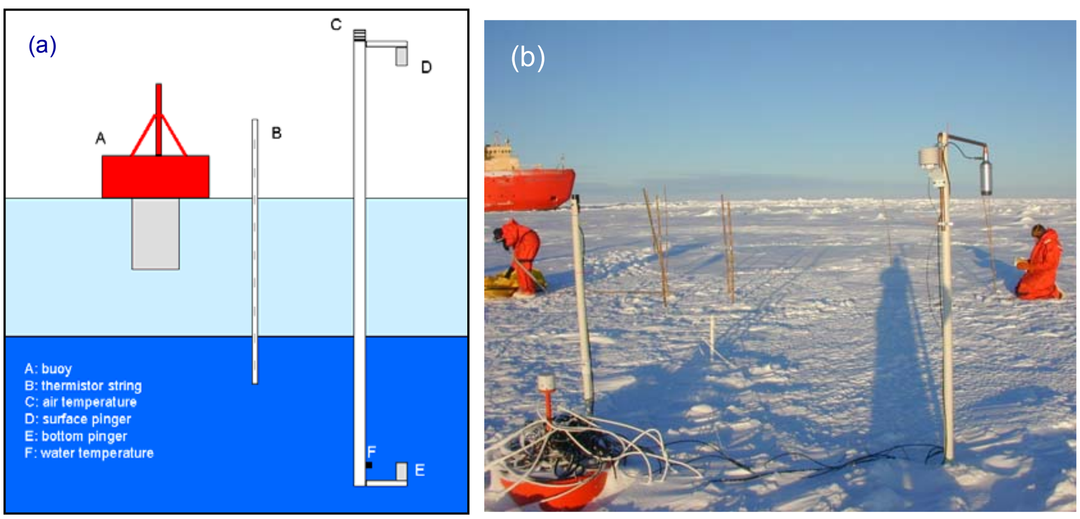


Figure 1. The autonomous mass balance buoy: a) buoy schematic and b) photograph of an installed buoy.

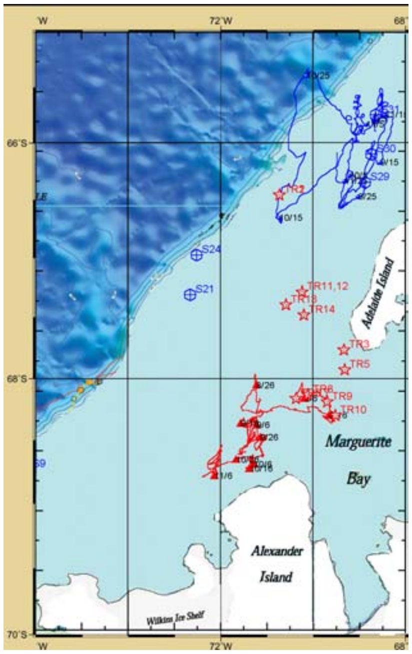


Figure 2. Map showing snow and ice sites of 2001 (red) and 2002 (blue) Gould cruises. Also plotted are the drift tracks for two autonomous mass balance buoys.

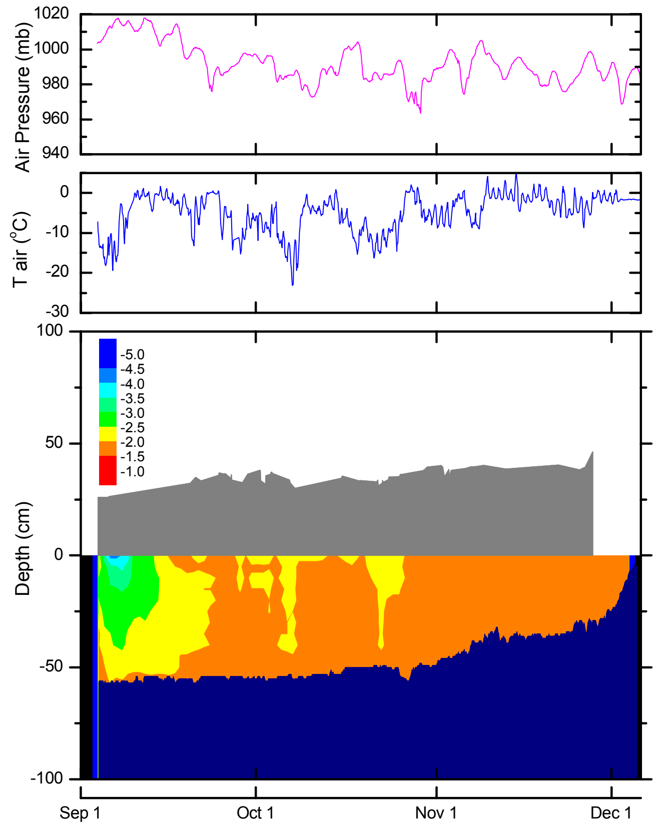


Figure 3: Example Results

Cruise Participation List:

PI: Don Perovich, CRREL
Funding: NSF Office of Polar Programmes
Time period of cruise: Winter 2001/2002
Participants: Perovich, D.K, B.C. Elder, K.J. Claffey, S. Stammerjohn, R. Smith, H.R. Krouse, and A.J. Gow

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University of Calgary
Calgary, Alberta T2N 1N4, Canada

Appendix 6, Part 3

Developing the Iridium Low Earth Orbit Satellite System in Support of Oceanographic Research and Operations

Development of the global ocean observing system (GOOS) in support of oceanographic research and operational oceanography has placed entirely new requirements on systems for acquiring and disseminating oceanographic data. These include (1) global coverage: (2) on demand, interactive communications; (3) low power requirements; and (4) high data transfer rates. In 1998 NAL Research Inc. of Manassas, Virginia received a National Science Foundation (NSF) grant to develop a satellite modem utilizing the Iridium network. One-half way through the project (August, 1999) Iridium LLC filed for bankruptcy and halted services, however, NSF gave NAL Research permission to complete the project with laboratory simulations. NAL Research also received a grant from NOAA in 1998 to develop a data relay system to transmit data from drifting buoys via the Iridium network. While a demonstration of the data link using ORBCOMM was successful, the second phase of this work was not funded due to the uncertainty of the commercial viability of the Iridium network at that time. After Iridium Satellite LLC purchased Iridium LLC (December, 2000), NAL Research received permission from NSF to resume work on the modem as described in the original statement-of-work and the U.S. Department of Defense entered into a contract with Iridium Satellite LLC for $72M over two years with options through 2005.

Commercial voice service was launched in March of 2001 with data services becoming available in June of 2001. There are two active gateways in the system, the commercial gateway in Tempe, Arizona and the Department of Defense gateway in Hawaii. There is a commercial, backup gateway in Fucino, Italy. The Iridium Constellation consists of 66 operational satellites in 6 orbital planes and 13 in-orbit spares. The constellation is expected to operate at full service at least through 2010 with recent technology upgrades estimated to having extended the lifetime through 2014. Iridium offers two-way, on-demand communication with unlimited message size at 2400 bps. Short Burst Messaging (SBM) for messages up to 1.96 kilobytes is now available.

Operational Considerations

A number of factors go into the determination of whether an operator of an observing system or platform will use an LEO system or a Geostationary Orbit (GEO) for telemetry. Figure 1 presents some of the operating considerations for the two types of systems. Major autonomous oceanographic observing systems utilize LEO systems, primarily due to power considerations and platform size. Figure 1 summarizes the cost and data capabilities of three of the four major LEO systems employed by the oceanographic community today.

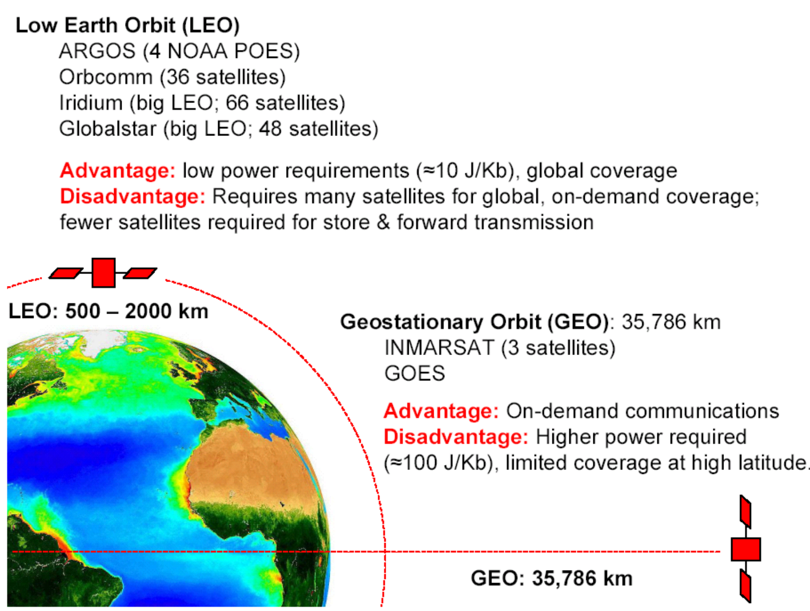

Figure 1: Major Telecommunications Satellite Systems Supporting Oceanographic Observations
(Courtesy of Steven G. Ackleson, ONR)

Table 1 presents the data throughput and general cost structure for three of the four LEO systems in common use. Three rates are provided for Iridium services: (1) a commercial rate and (2) two rates through the Department of Defense (DOD) gateway, DOD usage and non-DOD/U.S. Government. Figure 2 provides further information on the costs of transmission through these three systems.

LEO Satellite-Based Data Communications

Service	Coverage	Maximum Throughput Kbyte/d	Cost	Current Usage (# Platforms)
Argos	Global	0.8 - 2.1	$10/d/modem	>6,000
Iridium	Global	207,000	$40/mo./SIM [1] $165/mo./SIM [2] $30/mo./SIM + $0.96/min. [3]	>100
Globalstar	Coastal/ Regional	104,000	$500/mo./modem + $1.39/min. over 300 min.	Few

1 U.S. DOD rate through DISA (1 gateway)
2 U.S. Government, non-DOD rate through DISA (1 gateway)
3 Commercial Rate through 2 gateways

Table 1: Operating Characteristics of Three LEO Systems Supporting Oceanographic Observations ***(Courtesy of Steven G. Ackleson, ONR)***

Data Transmission Costs Through Low Earth Orbit Satellites

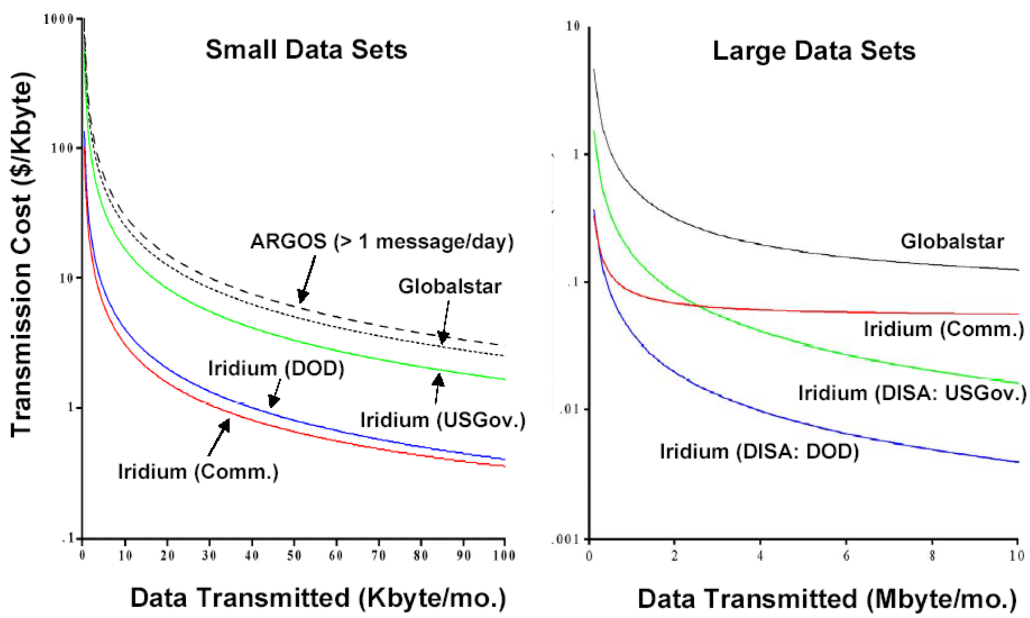

Figure 2: Data Transmission Costs ***(Courtesy of Steven G. Ackleson, ONR)***

New Developments

(a) Short Burst Data (SBD)

The introduction of Short Burst Data (SBD) at the commercial and Department of Defense gateways provide major new options for platform operators. SBD is a packet-based service capable of transmitting 1.96 Kbytes per message. SBD utilizes the same modem as conventional dial-up and is capable of two-way communication. SBD services are still undergoing evaluation, however, it will be priced on a per byte basis making it extremely attractive for small data volumes. Pricing of SBD services is quite variable at this time. A portion of the cost depends on the classification of the location of the platform. Prices that have been encountered are on the order of $20/month for the monthly subscription fee for SBD services only and $1-2/Kbyte depending on location. Figure 3 presents power consumption and commercial cost comparison for SBD services experienced by one user versus conventional Iridium dial-up service.

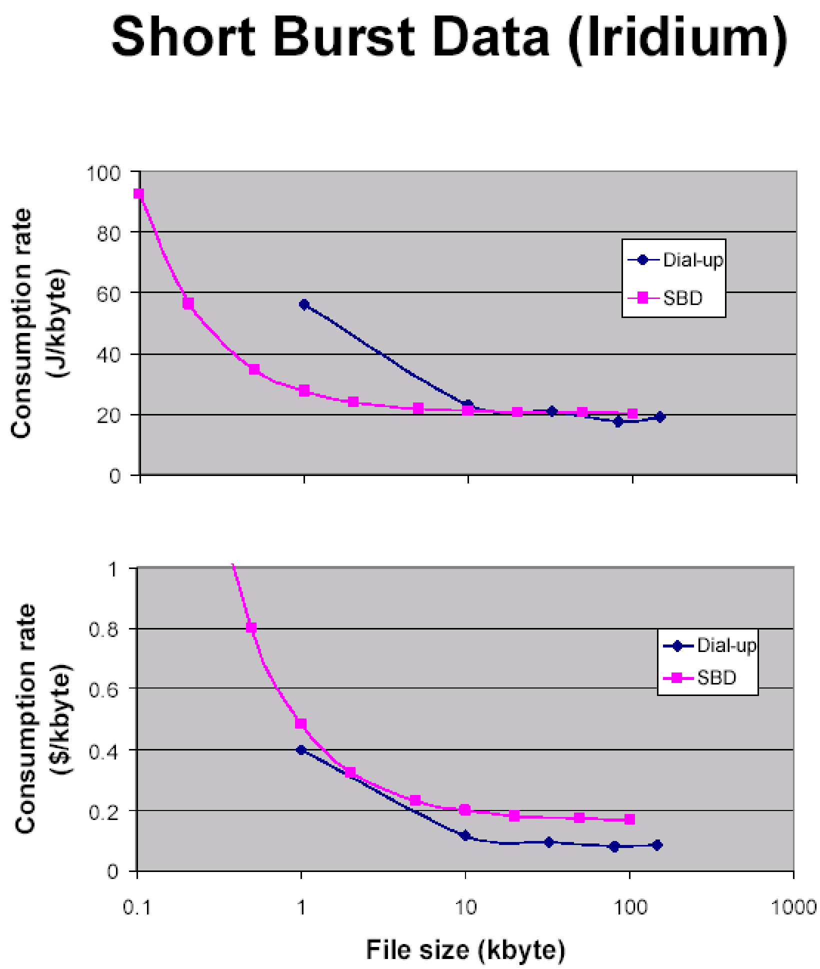

Figure 3: Power and Cost of Short Burst Data Versus Conventional Dial-up Services
(Courtesy of David Meldrum, Scottish Association for Marine Science)

The associated cost curve crosses the Iridium Commercial curve at about 3 Kbyte and the Argos curve at about 12 Kbyte in Figure 2. SBD is very cost effective for small data volumes because you do not pay the minimum connect time cost but this advantage disappears at moderate volumes. There are two advantages to SBD, the first being the power consumption. The second is that SBD is much easier to implement from an autonomous system point of view, as message tracking and re-trying is simpler than with dial -up.

(b) Soft SIM

The Office of Naval Research has under development at NAL Research Corporation of Manassas, Virginia a technology termed "Soft SIM" described in Figure 4. This technology is most appropriate for small data volumes and platforms that do not transmit frequently. Drifting buoys transmitting once a day and profiling floats transmitting once every ten days are ideal applications although short message being transmitted a few times an hour are also potential applications.

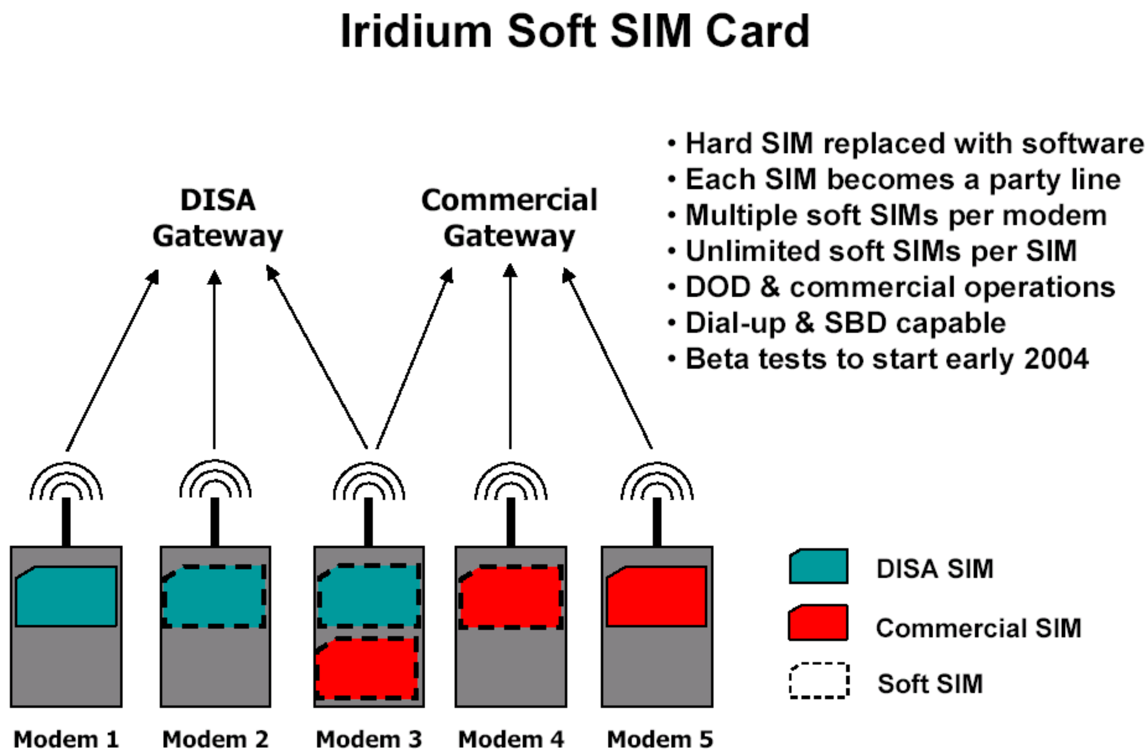

Figure 4: Soft SIM Operations *(Courtesy of Ngoc Hoang, NAL Research)*

Communications using Soft SIM technology are bi-directional, dial-up and SBD capable, however, Soft SIM communications have to be initiated by the mobile platform. Individual platforms are, however, recognized using Soft SIM technology allowing, for example, commands to be stored for transmission to a specific platform whenever it initiates a communications session. A pricing structure for Soft SIM communications has yet to be developed.

U.S. Argo Profiling Float Programme

The U.S. Argo programme was initiated under the National Oceanographic Partnership Programme (NOPP) in 1999 as a three-year effort to use profiling float technology to provide the oceanographic and climate science communities with the capability to obtain systematic real-time information of the physical state of the ocean. An announcement of opportunity was published in the Federal Register in December of 2000 to implement, in fiscal year 2001, an operational float programme in the United States as a contribution to the international programme to implement a global profiling float array. This announcement was for a five-year programme. A single proposal representing a consortium of seven principal investigators was selected for support

I. Programme Implementation

Figure 1 presents the actual U.S. Argo programme funding and number of floats procured through the first five years of the programme (FY 1999-FY2003). The figures for FY 2004 are estimates only. The estimate for the number of floats procured in FY 2004 is based on the U.S. commitment to maintain one-half of the global array (i.e., 1,500 floats with a 4-year average lifetime) plus 10% (assumed failure rate).

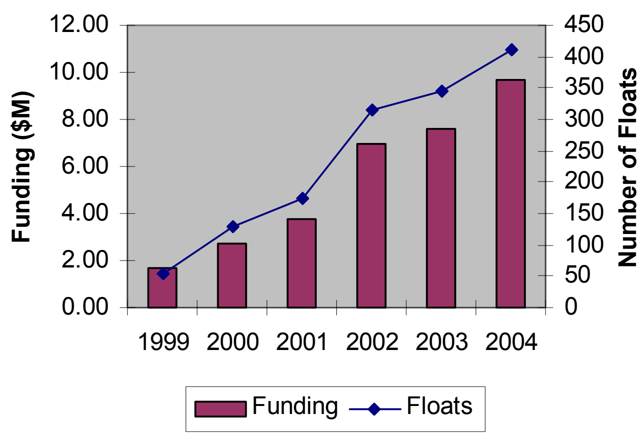

Figure 1: Funding and Float Procurements (Est. for FY 2004)

It takes between one and two years from the time funds are received by a float provider and the time a float is deployed. The time between placing an order for floats with a manufacture and the time a float is received is between nine and fifteen months. There is a similar time lag for those float providers that procure parts and assemble floats. Floats are deployed in accordance with specific, scientifically developed principles. It may take a year, or longer, between the time a float is ready for deployment and the time it is deployed because a deployment platform (research vessel, aircraft, commercial vessel of opportunity) may not be available to deploy floats in a suitable area.

Deployment strategies for the U.S. programme are developed annually by the U.S. Argo Science and Implementation Panel based on a number of criteria including priorities of users of Argo observations; the availability of platform resources and the status of global array. Users of Argo data and their present priorities are:

- U.S. CLIVAR – (1) global, (2) build on presently identified programmes in the Pacific, Atlantic, and Southern Ocean;
- GODAE (Global Ocean Data Assimilation Experiment) – (1) global, (2) build a well-sampled Atlantic quickly;
- NCEP (National Centers for Environmental Prediction) – (1) global, (2) begin in western tropical Pacific/eastern Indian warm pool, (3) tropical Atlantic;
- FNMOC (Fleet Numerical Meteorology and Oceanography Center) – (1) global, (2) western subtropics in North Atlantic and North Pacific; and

- NODC (National Oceanographic Data Center) – (1) global, (2) Southern Ocean, (3) Bay of Bengal.

II. <u>Status of the Array</u>

Figure 2 presents the number of active (i.e., reporting within a 30 day period) of the global Argo array. (Floats are, sometimes, unable to surface in certain areas of the oceans and will not report for several months before reaching areas that they can transmit data.).

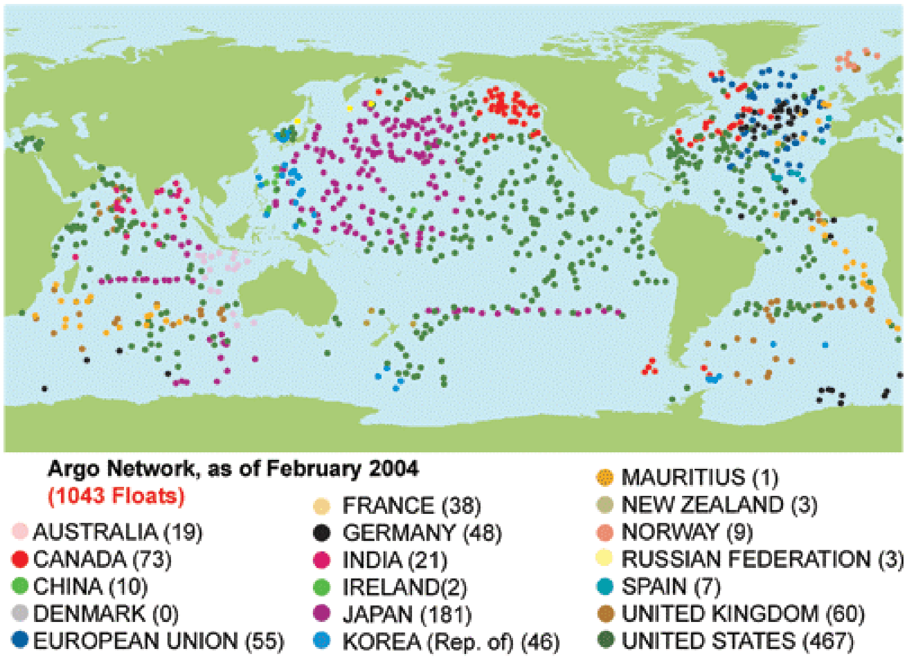

Figure 2: Status of the Global Argo Array

Figure 2 shows several large areas in the South Pacific, South Atlantic, and Indian Oceans that are void of floats. The primary reason for this is the availability of deployment platforms. The National Institute of Water and Atmospheric Research of New Zealand has offered the R/V Kaharoa (Figure 3) for float deployments anywhere in the South Pacific. The U.S. is planning major deployments of floats this year (150 to 200 floats) in areas of the South Pacific that do not have floats at present on board the Kaharoa and other vessels this year (Figure 4). This effort is planned to continue into the Southern Ocean next Austral summer.

Figure 3: R/V Kaharoa

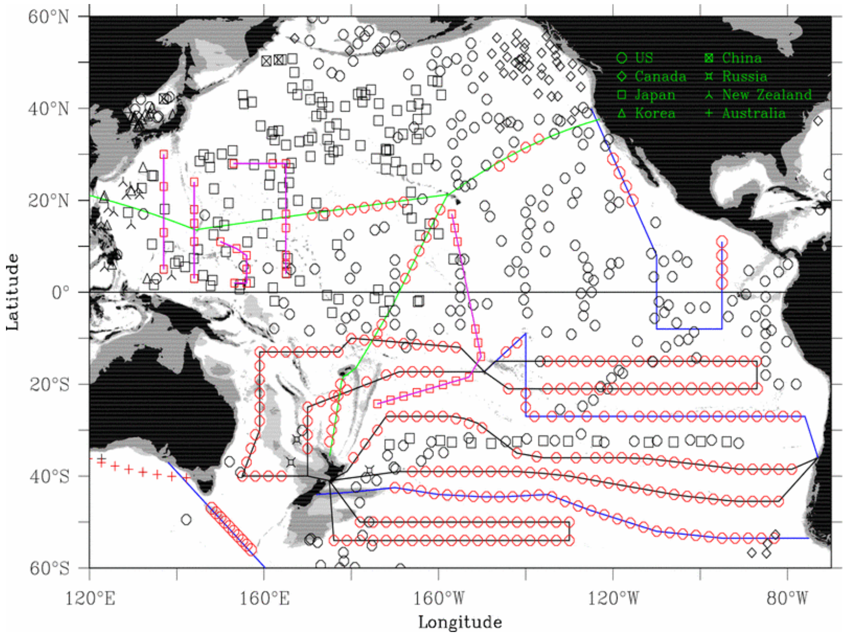

Figure 4: Possible Deployment Plan for 265 U.S. Floats in the Pacific (O).

This plan represents about 50% of the target density in this region

Figure 5 presents the international deployment plans for the Indian Ocean as of October 2003 (courtesy of Helen Phillips/CSIRO).

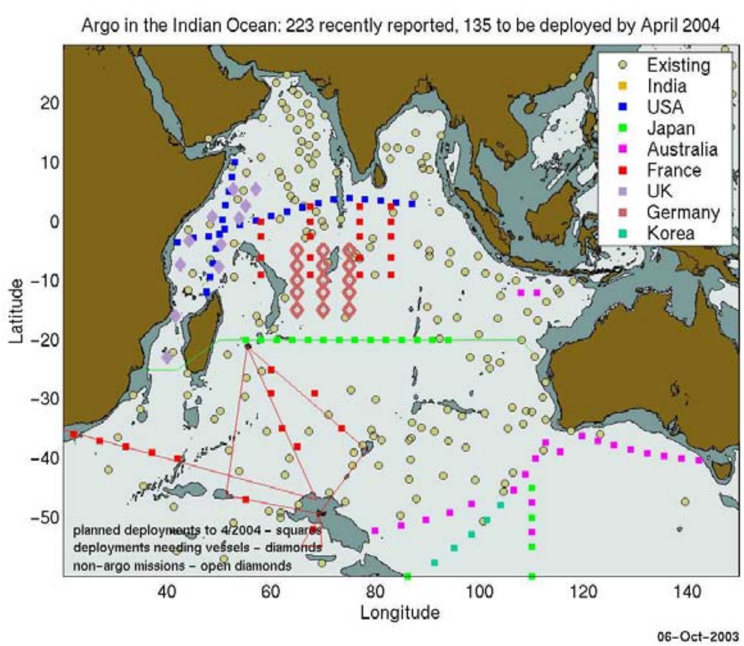

Figure 5: International Argo Float Deployment Plans for Indian Ocean

The U.S. is planning to deploy approximately 180 floats in the Atlantic and Atlantic portion of the Southern Ocean in 2004 (Figure 6).

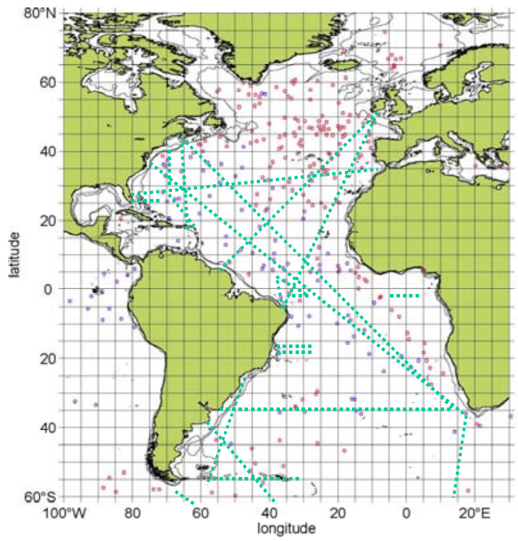

Figure 6: Available Deployment Sites in Atlantic in 2004

Appendix 7

OPERATING PRINCIPLES OF THE WCRP INTERNATIONAL PROGRAMME FOR ANTARCTIC BUOYS

1. This paper sets forth the principles and a set of operating procedures for the WCRP International Programme for Antarctic Buoys (IPAB).

2. Objective

The objective of the WCRP International Programme for Antarctic Buoys is to establish and maintain a data network in the Antarctic sea-ice zone (that portion of the Southern Ocean and Antarctic marginal seas within the sea-ice edge at the time of its maximum seasonal extent), using *in situ* platforms and in particular drifting buoys, in order to:

(i) Support research in the region related to global climate processes and to global change, and in particular, to meet research data requirements specified by the WCRP and other relevant international programmes such as SCAR;

(ii) Contribute real-time operational meteorological data supporting the requirements of the WMO/World Weather Watch (WWW) and WMO/IOC JCOMM;

(iii) Establish a basis for on-going monitoring of atmospheric and oceanic climate in the Antarctic sea-ice zone, in particular contributing to the aims of GCOS and GOOS.

The Programme will build upon co-operation among agencies and institutions with Antarctic and Southern Ocean interests.

3. Programme Principles

The IPAB:

3.1 Promotes the development of an Antarctic buoy network throughout National Antarctic programme agencies, research and operational institutions, SCAR National Committees and other relevant bodies;

3.2 Co-ordinates the development and maintenance of an optimised observational network for near-surface meteorological and oceanographic data within the Antarctic sea-ice zone, using drifter buoys and other appropriate data collection systems;

3.3 Distributes in real-time over the WMO Global Telecommunication System (GTS) the buoy position and air pressure data from the network, plus relevant additional real-time data approved by the principal investigators for public dissemination;

3.4 Ensures that all data from the network are appropriately archived; and

3.5 Liaises and co-operates with other operators of buoys and data collection systems.

4. Observation Programme

4.1 Operational Area:

The operational area of the Programme is south of 55°S and that region of the Southern Ocean and Antarctic marginal seas within the maximum seasonal sea-ice extent.

4.2 Variables:

Buoy position, atmospheric pressure and (for those buoys in water) sea surface temperature will be collected as basic data. Some systems will be equipped to additionally measure other variables, such as air temperature, ice and/or snow temperature, atmospheric pressure tendency, wind speed and direction, snow and sea-ice properties and oceanographic variables.

4.3 Basic Network Density:

IPAB recognises the requirements stated by international environmental programmes (in particular, by WCRP and WWW) for a basic surface observation network with observational points spaced at about 500 km. IPAB buoy deployments will aim to achieve and maintain, as far as possible, this density over the operational area.

4.4 Duration of Programme:

The Programme is proposed as a long-term one, subject to on-going support from Participants.

5. Data Distribution

5.1 Transmitters:

All buoys in the basic network will be equipped with transmitters to enable basic meteorological data to be transmitted in real time (synoptic and asynoptic mode). As a preferred approach, data will be collected and located via a system (for example Service Argos) that inputs synoptic data directly to the GTS.

5.2 Coding:

Data will be coded in a form suitable for extraction of basic meteorological variables. Participants will provide the data relay service and the IPAB Co-ordinator with necessary information to decode these data.

5.3 Global Telecommunication System:

All relevant data collected by Participants should be inserted into the GTS.

6. Data Archiving

6.1 Operational Archiving

All basic data transmitted on the GTS should be archived by the Marine Environmental Data Service (MEDS) in Canada, as the IOC/WMO Responsible National Oceanographic Data Centre for drifting buoy data.

6.2 Research Database:

A uniform, quality-controlled IPAB database for ice motion, surface meteorology and oceanography, as required by the Antarctic research community, is maintained by the IPAB Technical Coordinator. This database will be constantly updated; updates will be annually submitted to appropriate data centres for archiving (in particular, to MEDS and WDC-A for Glaciology).

7. Management Structure

7.1 Participants:

Participants in the WCRP International Programme for Antarctic Buoys will include national Antarctic programme agencies, meteorological and oceanographic institutes, research and operational agencies and non-governmental organisations interested in Antarctic sea-ice zone studies and contributing actively to the Programme. Principal investigators or relevant buoy programmes may also contribute, with agreement from the Executive Committee, as Individual Participants. Intending Participants will indicate their contribution to, and involvement in, the Programme by means of an Expression of Interest or Letter of Intent to be submitted to the IPAB Chairman and copies to the Director WCRP. Expressions of Interest and Letters of Intent will be considered by the Executive Committee in consultation with the Co-ordinator and the accepted Participants will be notified.

The full role of Participants will be reviewed at each biennial meeting.

7.2 Management

The Programme will be co-ordinated by the Participants. The Participants will arrange for the implementation of the Programme within the framework of the stated objectives. On a biennial basis the Participants will elect a Chairman and Vice-Chairman and appoint a **Co-ordinator**. The Chairman and Vice-Chairman plus three other persons representing the Participants shall form the **Executive Committee**.

7.3 Executive Committee

The Executive Committee will be responsible for the management of the Programme within the guidelines set at the meeting of Participants, and will provide guidance and support to the Co-ordinator. The Executive Committee will share responsibility with the Co-ordinator for encouraging participation in the IPAB, and liaising with principal investigators of individual buoy programmes and with international organisations. During inter-sessional periods however, the Co-ordinator will act as the focal point for matters related to the operation of the Programme.

7.4 Co-ordinator

Specific responsibilities and duties of the Co-ordinator are contained in Annex 1, Terms of Reference for the Co-ordinator of the WCRP International Programme for Antarctic Buoys.

7.5 Funding Provisions

The Programme will be self-sustaining, supported by contributions in the form of equipment, services (such as communications, deployment, archiving, co-ordination, scientific or technical advice) or monetary contributions. As necessary, the Participants shall establish a budget and make appropriate provisions for the management of this budget in order to implement the Programme. Other funding arrangements made between Participants will be recognised as contributions to the IPAB if they further the objectives of the Programme.

7.6 Programme Review

The management structure and operation of the Programme shall be reviewed at the Participants' Meetings.

8. Meetings

A biennial meeting of the Participants will be held at a time and location to be determined by them.

Terms of Reference for the Co-ordinator of the WCRP International Programme for Antarctic Buoys

The Co-ordinator shall facilitate the implementation of the WCRP International Programme for Antarctic Buoys. The Co-ordinator will be appointed at the biennial meeting of the Participants and will be directed by the Executive Committee. The Co-ordinator's specific responsibilities are to:

1. monitor and receive appropriate Argos and non-Argos data from the buoy network;

2. co-ordinate with operators of non-Argos buoy programmes and other field operations;

3. liaise with principal investigators and managers of individual buoy programmes in the Antarctic sea-ice zone;

4. arrange for the establishment and maintenance of a research quality data set of ice motion and surface meteorological and atmospheric data from the buoy network, and annually submit it to appropriate data centres for archiving (such as World Data Centres for Glaciology);

5. co-ordinate opportunities for buoy deployment;

6. liaise on technical aspects of buoy development;

7. prepare an annual summary of planned deployments and resources committed to the Programme;

8. liaise with the Technical Co-ordinator of the WMO/IOC Data Buoy Co-operation Panel to ensure that Antarctic data are properly processed and quality controlled for GTS distribution;

9. seek opportunities and arrange for the purchase of buoys and ancillary equipment as well as for Argos data acquisition;

10. maintain up to date information on the Programme and status of deployments on the IPAB web site;

11. respond to requests from WCRP, WMO, and the Scientific Committee on Antarctic Research (SCAR) for technical and scientific information on the Programme;

12. organise the biennial meeting of Participants, present a report of the preceding 2 years' activities, and prepare a plan for the following 2 years;

13. promote the WCRP International Programme for Antarctic Buoys.

Appendix 8

Follow-up actions after IPAB-IV

N	Action	Who	When
1	Draft a short paper presenting IPAB to the IPY	Chair, Coordinator	October 2003
1	2-pager (flyer) on IPAB to accompany the invitation and promote IPAB to a wider audience	Coordinator	October 2003
2	Update IPAB mailing list	Chair, Vladimir Ryabinin	October 2003
3	Draft invitation letter to potential contributors and distribute it	Chair, Coordinator, Vladimir Ryabinin	October 2003
4	Work out details of coordination with IABP and WCRP/CliC on matters related to IPY	Coordinator	October 2003
5	Liaise with buoy operators who operate in IPAB area and invite them to the Programme	Coordinator	October 2003
6	Liaise with ARGO, JCOMMOPS, IABP on approaches to IPAB QC	Coordinator	February 2004
7	Letter of support to Coordinator by WCRP with a reference to the WMO EC-LV resolution	Vladimir Ryabinin with assistance of Coordinator	September 2003
8	Prepare an IPAB poster	Coordinator	February 2004
9	Prepare a CD on Antarctic Ice Drift Atlas	Carolin Schmitt	2004 COMNAP
10	Have web-site up and running	Coordinator	October 2003
11	Consider, if required, further arrangements for the facilitation of the Coordinator’s work	Executive Committee	January 2004