

WCRP REPORT

World Climate Research Programme



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WORLD CLIMATE RESEARCH PROGRAMME (WCRP) SCIENTIFIC COMMITTEE ON ANTARCTIC RESEARCH (SCAR)

Climate and Cryosphere (CliC) Project

Report of the 3rd session of the
CliC Scientific Steering Group (SSG-III)

(Boulder, Colorado, USA, 4-8 December 2006)

November 2007

WCRP Informal Report Nr. 19/2007

The World Climate Research Programme is sponsored by the World Meteorological Organization, International Council for Science, and the Intergovernmental Oceanographic Commission of UNESCO.

Climate and Cryosphere (CliC) is a core project of the World Climate Research Programme, cosponsored by the Scientific Committee for Antarctic Research.

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NOTE

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**WORLD CLIMATE RESEARCH PROGRAMME (WCRP)
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1. Meeting Summary

The third meeting of the CliC Scientific Steering Group (SSG), was held at the *Cooperative Institute for Research in Environmental Sciences (CIRES)* on the University of Colorado campus in Boulder from Monday 4- through Friday 9 December. Wednesday was a science day when various members of the SSG and CIRES gave presentations on current research interests in the cryospheric sciences. The rest of the week was taken up with the CliC SSG business.

Dr Ann Henderson-Sellers, Director of WCRP, presented current WCRP activities, such as COPES, the new major initiative of WCRP for the next few years, and the cross-cuts which WCRP is pursuing.

For several years, CliC was grouped into the following four CliC Project Areas (CPAs):

- CPA1: The terrestrial cryosphere and hydrometeorology of cold regions (led by T. Khromova)
- CPA2: Glaciers, ice caps and ice sheets and their relation to sea level (K. Steffen)
- CPA3: The marine cryosphere and its interactions with high latitude oceans and atmosphere (T. Worby)
- CPA4: Links between the cryosphere and global climate (J. Turner).

In August 2006, CliC gave presentations on its four CPAs at the IGS conference in Cambridge, UK. However, it was reluctantly agreed that the cryospheric community had not really embraced the CPAs, and that many scientists were still unaware of them. It was therefore agreed that CliC's work in these four important areas of research should be re-branded and given a clearer focus. This will be carried out over the next year. These four areas of work will be known as CliC *themes* and will deal with:

1. The Terrestrial Cryosphere and Hydrometeorology of Cold Regions (TCHM)
2. Ice Masses and Sea Level (IMSL)
3. The Marine Cryosphere and Climate (MarC)
4. Global Prediction of the Cryosphere (GPC)

The old CPA 4 is therefore renamed the CliC *Global Prediction of the Cryosphere* theme. This will hopefully have a much clearer role of developing a view on how the cryosphere will evolve over the next century. The theme leaders will establish small steering committees to guide the work of the group. There was still a great deal of concern about the lack of funds available to CliC to hold workshops, and support travel and data-recovery initiatives. However, this problem affects the whole of WCRP, and the situation is unlikely to improve over the next few years. The CliC themes therefore do not have budgets and have to apply to WCRP for funding on a case-by-case basis.

Virtually a whole day was devoted to the IGOS-P Cryospheric theme with SSG members and invited experts reviewing individual chapters. After three workshops in as many countries, the theme report has been drafted. The reviewers provided very useful comments that helped improve the structure and content of the report. Theme implementation mechanisms and governance were also discussed. See <http://stratus.ssec.wisc.edu/igos-cryo/> for update.

2. CliC Theme Progress Reports (former CPAs)

Presentations were given showing the progress with the four CliC themes since the last SSG meeting.

2.1 *The Terrestrial Cryosphere and Hydrometeorology of Cold Regions - TCHM (former CPA1)*

Tatiana Khromova outlined the major central science questions surrounding TCHM that included the need to assess changes in the terrestrial cryosphere, water and carbon cycles, and a variety of climatic and terrestrial feedbacks. Achieving high quality and robust historical records of cryospheric components, either via in-situ observations or remote sensing, was identified as the key to evaluating such changes. To this end, the establishment of transects and supersites was identified as a key step. The concept of supersites was detailed in the recent ICARP-II research plan for the terrestrial cryosphere and hydrology, a plan that was adopted as part of the TCHM (see below). It was further noted that these supersites would permit up/down-scaling, process parameterization, modelling validation (e.g., as employed in Land Surface Models or weather prediction) and remote-sensing verification.

The key to achieving the above goals was to obtain scientific contributions from a number of international and multinational programmes. Several examples cited included: the Northern Eurasia Earth Science Partnership Initiative (NEESPI); Global Land Ice Measurement from Space project (GLIMS); Global Carbon Project (GCP); GCOS/GTOS Global Terrestrial Network on Permafrost (GTN-P); Thermal state of permafrost (TSP); and Active layer (CALM). It was considered particularly important to establish links with efforts initiated via the ICARP-II Terrestrial Cryosphere and Hydrology project and Arctic-HYDRA. Representatives from these two groups met in St. Petersburg, Russia in early November 2006 to begin formulating circumpolar plans on observation that will include supersites (depending on IPY funding from the various circumpolar countries). Recognizing the potential of the ICARP-II plan, CliC officially declared its support for the project in the ICARP-II Implementation Workshop in Potsdam, Germany, November 2006. The efforts of the group have been incorporated into CliC-TCHM. Furthering of the goals identified in this cryosphere-hydrology plan will hopefully occur at an upcoming science planning meeting for Asia-CliC in Yokohama, Japan, May 2007.

Other meetings with special importance to CliC-TCHM goals include an international conference entitled “The terrestrial cryosphere: its present, latest past and nearest future” planned for 2007 in Russia; the International conference on Permafrost, scheduled for 29 June-3 July 2008 in Fairbanks, Alaska, and an Arctic Hydrology workshop planned for Iceland in 2009. CliC-TCHM could play major roles in these meetings as it did in the joint meeting with the International Glaciological Society in Cambridge, August, 2006.

2.2 *Ice Masses and Sea Level – IMSL (former CPA 2)*

Koni Steffen reported on the great deal of work done on the Greenland ice sheet, which continues to show marked melting in the coastal regions, although increasing precipitation over the interior. Remarkable video footage was shown from (waterproof) cameras lowered down into streams of melt water descending into the ice sheet. This water is thought to be providing greater lubrication to the base of the ice sheet. IMSL also held a very successful workshop on sea-level rise during the summer.

He also presented the following cryosphere recommendations:

- Reconcile estimates of ice sheet mass balance derived using different techniques, and determine whether recent increases in mass loss are anomalous or simply reflect improvements in observational techniques.
- Identify causes for the apparent recent increases in mass loss to enable development of improved glacier models.

- Extend ongoing measurements of ice-thickness transects to cross each major outlet glacier in Greenland and Antarctica.
- Complete the World Glacier Inventory through sustained support for the Global Land Ice Measurements from Space (GLIMS) program.
- Extend observational coverage of terrestrial glaciers beyond traditional areas (e.g., the Alps and Alaska) to include all representative regions, thereby enabling improvements in monitoring and modelling.
- Utilize the ICESat laser and CryoSat-2 radar altimeter satellites – complemented by aircraft altimetry – to survey changes in the surface topography of the ice sheets; and based on experience gained, develop a suitable follow-on satellite.
- Utilize GRACE and appropriate follow-on missions to infer changes in the mass of the glaciers and ice sheets.
- Seek continued access to satellite Interferometric Synthetic Aperture Radar (InSAR) data in order to measure flow rates in glaciers and ice sheets; this will require suitable satellite missions – both existing and new – and ready access to resulting data, particularly over near-coastal regions of Greenland and Antarctica.
- Improve models to identify causes for the apparent increased mass losses from the polar ice sheets and use that as the basis for better simulations of future scenarios; particular effort is needed with respect to ocean/ice shelf interactions, surface mass balance from climate models, and the inclusion of higher-order stress components in high-resolution ice-dynamic models.

2.3 *The Marine Cryosphere and Climate – MarC (former CPA3)*

Tony Worby gave a report on a number of recent activities and research results that directly address the goals of the Marine Cryosphere program. These included:

- A report on the Antarctic sea-ice thickness workshop held prior to the SCAR Open Science Conference in Hobart. The workshop was a great success, attracting more than 50 participants from 14 countries, and Tony was thanked for his hard work in convening the meeting. A number of initiatives came out of the meeting, including the need for a coordinated modelling effort with regard to Southern Hemisphere sea ice, the desire for a sea ice thickness data portal at one of the major data centres and more coordinated field programs for calibration and validation of satellite altimetry data. A report on the workshop is being prepared.
- Coordination of sea ice and ice shelf activities during IPY, in particular the two major sea ice research voyages that form part of IPY Proposal 141 “Antarctic Sea Ice in IPY”.
- Ongoing discussions related to the development of a Southern Ocean Observing System (SOOS) and the role that CliC has to play in helping develop observing networks for the marine cryosphere in the Southern Hemisphere. This particularly relates to ensuring future observations of ice shelf and sea ice properties and processes are consistent with the needs of the climate community. Historical data rescue is also an important part of this activity.
- The role of CliC in providing relevant data sets to programs such as TFSP
- Report on the Cambridge IGS Symposium on the role of the cryosphere in climate change, which was co-sponsored by CliC. Presentations at this symposium were used to publicise the activities of CliC and the four theme areas of our program.
- New links with the GCOS SST and Sea Ice Working Group which is working towards generating standardised sea ice concentration products for the climate community.
- Presentation of recent scientific results

Tony also outlined the need for each theme within CliC to establish a working group that would develop a core set of objectives for the programs. This would clearly require resources for

meetings, but would enable each them to develop plans for workshops, data rescue initiatives and requirements for field research and observational programs.

2.4 *Global Prediction of the Cryosphere – GPC (former CPA4)*

John Turner gave a series of presentations related to progress in predicting the state of the global cryosphere. A valuable outcome of the fourth IPCC Assessment Report was the 23 models used to compile the report (see http://www.pcmdi.llnl.gov/ipcc/about_ipcc.php). These models observed greenhouse gas measurement (from 1850 to present), then through 2100 using a range of greenhouse gas emission scenarios. John highlighted the difficulty these models had in reproducing the observed variability of the cryosphere over the last two decades.

John also reported on the High Latitude Re-analysis workshop held in Cambridge, UK in April 2007, and highlighted the request from ECMWF for better lake- ice and snow- cover data for future re-analysis exercises.

2.4.1. *Planned GPC Workshops*

- A second workshop on recent *High Latitude Climate Change* scheduled for 22-24 October 2007 in Seattle. This is sponsored by SCAR, CliC and ICPM.
- A workshop concerned with *Southern Ice Ocean Model Intercomparison (SIOMIP)* will be held in the first part of 2007. It is being organised by Todd Arbetter and Siobhan O'Farrell and is sponsored by CliC and SCAR.

With limited WCRP funding in 2007, it is unclear whether the CliC SSG will meet that year. However, the dates of 12-16 November 2007 have been penciled in for a possible meeting in Geneva.

3.0 **CliC Regional Activities**

Australia, Belgium, Russia, and S.America updated national activities on website. (the rest of them has done nothing for years.)

4.0 **CliC Working Groups and Panels**

DMIP dissolved – J. Moore continues as rapporteur.

WMP

WGCM

ACP

5.0 **International Polar Year**

6.0 **NSF perspective**

Three NSF initiatives

APPENDICES

Appendix 1

Agenda

CliC SSG - Boulder, Colorado, 4-8 December 2006

Monday, Dec 4

1. Organisation of the Session

- 1.1 0800-0830 Registration and light breakfast
- 1.2 0830-0835 Opening. *B. Goodison.*
- 1.3 0835-0845 Welcome and local arrangements. *K. Steffen.*
- 1.4 0845-0900 Self-introductions, changes to agenda, documents for SSG. *V. Lytle, V. Ryabinin.*
- 1.5 0900-0920 WCRP, current status and future. *A. Henderson-Sellers*
- 1.6 0920-0930 Goals of the SSG-III, WCRP JSC and Chairs and Directors mtg. *B. Goodison.*
- 1.7 0930-0940 IPY introduction and CliC's activities. *V. Ryabinin.*
- 1.8 0940-1000 Discussion. *B. Goodison.*

- 1000-1025 **Coffee break**

2. CliC Glaciers, Ice Sheets and Sea Level CPA2 (K. Steffen)

- 2.1 1025-1045 CPA 2: Challenges, open issues, opportunities. *K. Steffen.*
- 2.2 1045-1100 Sea Level Uncertainty Workshop, Paris. *K. Steffen.*
- 2.3 1100-1110 WS Model intercomparison of solid precipitation over ice sheets. *K. Steffen.*
- 2.4 1110-1120 WS Ice sheet mass balance. *K. Steffen*
- 2.5 1120-1135 IPY Activities coordinated through CliC/CPA2. *K. Steffen.*
- 2.6 1135-1150 IGBP-PAGES review of proposal, *V. Lytle & K. Steffen*
- 2.7 1150-1215 Future activities and outreach. *K. Steffen.*
- 2.8 1215-1230 Discussion. *All*

- 1230-1330 **Lunch break – lunch provided**

3. CliC Links with Global Climate CPA4 (J. Turner)

- 3.1 1330-1400 CPA4 Advances in the science. *J. Turner*
- 3.2 1400-1430 CPA4 Future ideas, IPY, proposals. *J. Turner*
- 3.3 1430-1500 CPA4 Discussions. *All led by J. Turner*

1500-1520 **Coffee Break**

4. CliC Marine Cryosphere CPA3 (A. Worby)

- 4.1 1520-1550 CPA 3: Challenges, open issues, opportunities *A. Worby, H. Fricker*
- 4.2 1550-1610 Hobart Workshop and Southern Ocean Initiatives. *A. Worby*
- 4.3 1610-1630 IPY Activities coordinated through CPA3 *TBD*
- 4.4 1630-1640 IPAB and IABP, information. *V. Lytle or V. Ryabinin*
- 4.5 1640-1700 CPA 3 Discussion. *Led by A. Worby*

Appendix 1 (cont'd)

Tuesday, Dec 5

0800-0830 Light Breakfast

5. *CliC Marine Cryosphere CPA 3 cont'd (A. Worby)*

- 5.1 0830-0850** SIOMIP. *T. Arbetter*
- 5.2 0850-0910** SOIP. *D. Thompson*
- 5.3 0910-0920** IICWG results. *A. Worby + V. Ryabinin*
- 5.4 0920-0930** OOPC, their WG on Sea ice, Ocean Reanalysis. *A. Worby*
- 5.5 0930-0940** GlobIce. *M. Drinkwater*
- 5.6 0940-1000** CPA3 Discussions (including ACP). *All, A. Worby*

1000-1030 **Coffee break**

6. *CliC Terrestrial CPA1 (T. Khromova)*

- 6.1 1030-1040** CPA1: Challenges, open issues, opportunities. *T. Prowse, T. Khromova*
- 6.2 1040-1100** ICARPII implementation and the role of CliC. *T. Prowse*
- 6.3 1100-1115** Arctic-HYCOS and IPY- Arctic-HYDRA. *T. Prowse*
- 6.4 1115-1135** Joint activities with IPA , Permafrost and Carbon. *J. Brown*
- 6.5 1135-1155** Alpine cryosphere. *G. Casassa, R. Barry*
- 6.6 1155-1210** Discussions

1210-1310 **Lunch break – lunch provided**

- 6.7 1310-1335** Glaciers (GLIMS, WGMS GlobGlacier etc). *R. Barry, R. Armstrong, G. Casassa, T. Prowse*
- 6.8 1335-1350** GEWEX, CEOP, GAME. *T. Ohata, S. Williams*
- 6.9 1350-1400** Solid precipitation. (*V. Kotlyakov, T. Khromova, B. Goodison*)
- 6.10 1400-1450** CPA1 discussion *All, T. Khromova, T. Prowse*

1450-1510 **Coffee break**

7. *CliC Regional Activities*

- 7.1 1510-1540** Asia CliC. *T. Ohata, Qin Dahe*
- 7.2 1540-1600** South America and CliC. *G. Casassa*
- 7.3 1600-1620** Union Commission of Cryospheric Sciences. *K. Steffen*
- 7.4 1620-1640** SCAR. *J. Turner*
- 7.5 1640-1700** Russian CliC. *V. Kotlyakov*

Appendix 1 (cont'd)

Wednesday, Dec 6

8. *Science Day*

- 8.1 0900-0910** Opening remarks. *Barry Goodison, Environment Canada*
- 8.2 0910-0930** IPCC. *Qin Dahe, Chinese Academy of Sciences*
- 8.3 0930-0950** Dome A drilling. *Xiao Cunde, Chinese Academy of Meteorological Sciences*
- 8.4 0950-1010** GIIPSY. *Mark Drinkwater, ESTEC*
- 8.5 1010-1030** Arctic sea ice variability and trends: A consistent decline throughout the years. *Walt Meier, CIRES/NSIDC*
- 1030-1100** **Coffee break**
- 8.6 1100-1120** Melt pond parameterization. *Todd Arbetter, BAS*
- 8.7 1120-1140** Snow-cover parameterization in Canadian atmospheric and hydrological models. *Diana Versegny, Environment Canada*
- 8.8 1140-1200** Northern hydrology. *Terry Prowse, Univ. Victoria*
- 8.9 1200-1220** Multi-Sensor Satellite Snow Cover Mapping and Global Trends. *Richard Armstrong, CIRES/NSIDC*
- 1220-1320** **Lunch break**

9. *Science Day Cont'd*

- 9.1 1320-1340** Continuing glacier and sea ice responses to climate change in the northern Antarctic Peninsula. *Ted Scambos, CIRES/NSIDC*
- 9.2 1340-1400** Antarctic Climate Change and the Environment. *John Turner, BAS*
- 9.3 1400-1420** Greenland Ice sheet melt variability and trend. *Russell Huff, CIRES*
- 9.4 1420-1440** Sea level variability and trend. *Steve Nerem, Aerospace Engineering and CIRES*
- 1440-1500** **Coffee break**
- 9.5 1500-1600** Round table discussion. *Moderator: K. Steffen*
- 1600-17:30** **Poster Session and Reception**

Appendix 1 (cont'd)

Thursday Dec 7

0800-0830 Light breakfast

10. IGOS-CRYO (Jeff Key)

10.1 0830-0850 IGOS-P way forward and recommendations. *J. Key*

10.2 0850-0910 GCOS/CEOS developments and proposals for UNFCCC.
M. Drinkwater, V. Ryabinin, B. Goodison

10.3 0910-1000 **Individual chapter reviews (10 minutes each)**

Snow chapter, review by *V. Kotlyakov*

Solid Precipitation chapter, review by *T. Ohata*

Sea ice chapter, review by *A. Worby*

Lake and River Ice, review by *T. Prowse*

Permafrost and seasonally frozen ground by *O. Fraeunfeld*

1000-1030 **Coffee break**

10.4 1030-1230 **Individual IGOS Chapter review cont'd (10 minutes each)**

Glaciers chapter, review by *G. Casassa*

Ice Sheets chapter, review by *K. Steffen*

Data Management, review by *J. Moore*

Remarks on Implementation. *CPA leaders*

Discussion of IGOS-cryo review of implementation. *J. Key*

1230-1400 **Lunch Break and Executive Meeting**

11. Clic Data Management and Products

11.1 1400-1420 Data Management for CliC/WCRP *J. Moore*

11.2 1420-1440 IPY data management *M. Parsons*

11.3 1440-1530 Discussions. All led by *J. Moore, J. Key*

1530-1600 **Coffee break**

12. Action Items (V. Lytle)

12.1 1600-1700 Review of action items. *V. Lytle*

Appendix 1 (cont'd)

Friday, Dec 8

0800-0830 Light breakfast

13. CliC Modelling Activities (T. Arbetter, D. Verseghy)

13.1 0830-0850 WMP. *T. Arbetter*

13.2 0850-0910 WGCM. *D. Verseghy*

13.3 0910-0930 Results of discussion on modelling at ICARP. *V. Ryabinin*

13.4 0930-0950 Reanalysis activities associated with CliC. *John Turner*

13.5 0950-1010 Discussion of CliC modelling activities. *D. Verseghy, T. Arbetter,*

1010-1030 Coffee break

14. Arctic Climate Panel

14.1 1030-1040 ACP review terms of reference status., *all, V.Lytle*

14.2 1040-1100 ACP discussions. *all, B. Goodison*

15. International Polar Year

15.1 1100-1115 IPY future directions. *B.Goodison.*

15.2 1110-1125 NSF perspective. *M. Jeffries*

15.3 1125-1200 Discussion. *All, led by B. Goodison*

1200-1300 Lunch break – lunch provided

16. CliC Infrastructure (V.Lytle)

16.1 1300-1330 CIPO, status, resources, outlook, past and future meetings, *V. Lytle, T. Villinger*

16.2 1330-1415 Discussion. *All, V. Lytle*

16.3 1415-1445 Summaries of actions items. *V. Lytle, T. Villinger, all*

16.4 1445-1500 Date and place of next meeting

1500-1520 Coffee break, invited guests leave

17. SSG Members Only, Closed Session (B.Goodison)

17.1 1520-1540 Discussion of future SSG members

17.2 1540-1620 Actions, Recommendations to the chair, Executive SSG, panels, future outlook

Meeting Closure

Appendix 2

List of Participants

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Appendix 3

Action Items from CliC SSG III, Boulder, 4-8 December 2006

Action Item #	Agenda Item	Action	Responsible	Deadline	Comments
1	1.7, 14.1	GEO task Co-ordination of implementation of IPY data efforts: Talk to GEO Secretariat to refine work plan and discuss funding sources, determine the need to lead the action	VR, JM, RB, TO, QDH, BG, JB, JK	8.12.07	RB: NSIDC has 3 IPY-related data projects
2	2.6	Send a formal response to PAGES	JB, AW, KS, JT, RB, CIPO	01.15.07	Initiated 06.02.07
3	3.1	Link Polar strat. clouds research in SPARC and CliC	VR	28.02.07	
4	3.3	Form alpine group to co-ordinate important issues such as GLIMS, GlobGlacier,	CIPO, exec, MD,TK	01.03.07	T. Khromova lead. Ltr. 27 Apr.
5	4.5	Follow up on write up of IGOS-Cryo ice-shelf section	HAF, JK, AW	15.01.07	Initiated by HAF (AW). Report completed (JK)
6	4.5	Northern hemisphere group for CPA3-identify whom to ask.	AW	28.02.07	Town-hall meeting planned for Dec AGU
7	4.6	Consolidate SIOMIP focus, groups to engage, reply to SSG feedback.	VL, TA, AW, VR, BG, SO	Ongoing	Workshop held, Bremen
8	4.7	Put a group together to tackle ice sheet modelling problem. With goal to include interactive ice sheet predictions in IPCC AR5. VL to initiate for participation.	VL, HAF, AW, KS,	01.06.07	"Vanderveen, Cornelis J" cjvdv@ku.edu is organizing the workshop and has support from NASA; we might organize a second workshop through WCRP/CliC and I will report on that at the SSG meeting (KS).
9	4.10	Contact Laxon (cc Kwok) about update on GlobIce	BG	31.12.06	
10	5.7	Find coordinator to link regular glacier efforts and work with GLIMS and GlobGlacier to develop priorities, appoint alpine rap.	VR, CIPO, CliC Exec. (see 3.3)	01.03.07	T. Khromova, Alpine rapporteur
11	5.8	CEOP-MOLTS sites to Dr S Williams	JM	31.12.06	Done
12	""	CPA leaders to provide list of key CEOP-MOLTS sites to JM	CPA leads	07.12.06	Done

Appendix 3 (cont'd)

Action Item #	Agenda Item	Action	Responsible	Deadline	Comments
13	""	Organize WCRP wide workshop on precipitation	VR, BG	31.12.07	
14	5.9	Start org of solid precipitation WS, write outline of objectives	KS	15.01.07	Not started yet, because of change in priorities. Will report at the SSG meeting.
15	6.2	Contact people re possible Latin America cryo meeting	GC	01.03.07	
16	8.5	Find people to develop plan for future summer schools	SSG, KS, all	ongoing	
17	8.5	Identify data sets for recovery	All	ongoing	
18	10	Define new CliC website audience, goals, timetable	CIPO	01.03.07	Started
19	10	Work with Mike M. at CIRES to develop new website	CIPO, NPI, CIRES	01.06.07	Need a programmer also
20	10.3	Dissolve and thank DMIP, establish new system of one data advisor per CliC theme	CIPO, exec	Ongoing	Thnk U ltrs to DMIP / April
21	10.3	Evaluate progress of IGOS-Cryo implementation actions	SSG, JK	Annually	Transition to GEOS under discussion. Theme approved & published Nov 2007.
22	12.4	Liase with ERA to determine details of what cryosphere data they need (and already have) for future 70 year reanalysis. Develop a plan to provide the data.	JT	01.06.07	
23	12.5	Identify modeling workshops/courses where cryosphere related topics could be included	TA, JT, CCS - KS	ongoing	See other remark by KS
24	12.5	Explore development of cryosphere modeling workshop (possibly with IGS) proposal for IGS conference on cryosphere modeling	TA, DV, PH	01.12.08	
25		Proposal for workshop in Montreal 2009	JT	01.07.07	A. Rinke to lead session
26	12.5	Compilation of how cryosphere is parameterized in IPCC runs	JT, DV	01.07.07	
27	13	Contact J. Walsh re. ACP	BG	01.02.07	Did not accept
28	15	Update theme posters (available on members meetings page http://clic.npolar.no/members/meetings/meetings.php)	TV	15.01.07	TCHM, IMSL, General posters completed, MarC and GPC in

Appendix 3 (cont'd)

Action Item #	Agenda Item	Action	Responsible	Deadline	Comments
					limbo
29	15	Compile list of cryo-related courses offered at present	CIPO, all	01.06.07	
30	15	Investigate starting YS network similar to permafrost association. KS to check with Todd Albert	KS, CIPO	01.03.07	Done
31	14	Develop questions and list of projects to collect IPY project information for state and fate. Compile response.	CIPO, JK, BG	01.01.07 ongoing	VL Sent request 12/12/06.
32	15	Contact ESA Nordic Country rep about support for UN World Environment Day	VL, CIPO	01.01.07	Contacted via MD.
33	15	Develop guidelines for request and approval of new CliC panels and groups.	CIPO, exec	01.06.07	Use CLIVAR
34	15	Proposals for new SSG members to CIPO to distribute to chair	All, CIPO	01.03.07	initiated
35	15	Review & Develop ToR for CliC panels and theme teams.	CIPO, exec, panel members, theme leads	01.09.07	
36	15	Develop structure, steering committee and Terms of Reference for Asia CliC	TO, QDH, CIPO, exec	SSG 07	Discussed at Asia-CliC symposium, Lanzhou
37	15	Appointment of J. Moore as data rapporteur for CliC	CIPO, JPS	31.01.07	Completed April 2007

Appendix 4

Status of SSG-II Action Items - Copenhagen, 2005

Agenda Item	Action	Responsible	Status
3.1	Include information on errors and co-variances required for data assimilation with data sets in IGOS-P document.	JK/MD	Done
4.2	People to attend individual ICARP breakout sessions on behalf of CliC and report back to CIPO & BG	Send comments to CIPO: WG 1 JC WG 2 RB WG 3 RB WG 4 VL WG 5 JM WG 6 CM WG 7 VK WG8 V.Rom/TP WG 11 KS Permafrost forum JB	1/12/05 VL sent comments to WG4 11/25/05
5.3	Pass IGOS-cryo table of variables around SSG for comments	JK/all	Done 05/06 2006 IGOS draft doc sent to wider community 25/11/06
5.4	Find a lead scientist for Antarctic CEOP site	JT	AW contacted Asutralian BOM who declined.
5.6	Prepare IPY proposal for CEOP approach from CliC to work with Sam Benedict Science & Implementation plan	TO	16/1/06 (IPY deadline, may be moved to 30/1/06)
5.6	Contact Australian Met office about possible CEOP	AW	15/3/06
5.3	Identify people to help Jeff with IGOS-P report esp. leads for each discipline	VL to send out requests	15/12/06
5.3	Workshop for IGOS-cryo in Europe –to look for sponsors	JT	1/02/06
6.3	Discuss MOU between CliC & NEESPI, to include data exchange policy	BG/TK	1/05/06
6.4	Answer request from Prof. Ogallo re: WGMS	RB	Done 05/06
6.5	Possible CLIC- GEWEX radiation workshop. Send names to CIPO.	All BG to contact D.Yang	??
6.5	Ask Richard Essary re: SnowMIP	BG to contact R. Essary	1/04/06
8.6	Compile names for sea ice reanalysis workshop	AW/all	AW sent list 11/05
8.6	Investigate possibility of Cryo reanalysis workshop in Cambridge in conjunction with Atmos. Reanalysis	JT	3/01/06

Appendix 4 (cont'd)

Agenda Item	Action	Responsible	Status
9.1	SCAR co-sponsorship of CliC	VR to discuss w/ Colin Summerhayes	3/01/06
9.3	Add Christian Haas to steering committee of CASO	VR	Declined.
9.3	Report back on IPAB mtg & sea ice mtg in Dunedin	AW	1/2/06
10.2	Summary of workshop on Recent high Latitude Climate Change submitted to CIPO	JT	Sent 11/05
10.2	Contact IGS about CliC visibility and involvement in <i>Cryospheric indicators of climate change</i> conference	JT	1/1/06
10.2	Send out press release when CliC event occurs,	Meeting organizers in conjunction with CIPO	Ongoing
11.3	Contact the glacier and small ice cap community to see if there is some actions that should be considered by CliC or in the SL workshop	RB	1/3/06
11.1	Identify gaps and/or missing ice sheet data that will be needed for <i>IGOS cryo</i>	KS	15/12/06
11	Work with new director of WCRP to suggest that the structure of the IPCC assessment consider Mt. Regions	BG/RB	Next SSG
14	Rotation of members and Appoint new members to DMIP	JM/AW	Waiting on feedback from SSG
14	Check the inter- operability of CEOP metadata with the DISC system	JM	Requested from CEOP, no response
14	Request DMIP representative at Asia CliC meeting	JM/VR/TO	No DMIP rep attended.
14	Liaise with organizers to include data management issues in agenda at IGS meeting in Cambridge	JM/VL/KS	1/6/06
14	Look for people to help with CliC website; feedback & translations	CIPO	Ongoing
17.2.2	Co-ordinate and submit sessions for ESSP Conference	CIPO/all	30/11/05
17.2.3	Suggest names to lead discussions on split sessions at Asia CliC Meeting.	All/TO	1/1/06
17.2.3	Co-ordinate support from WCRP for participants in Asia-CliC meeting	TO/VR	1/2/06
17.2.3	Finalize Asia CliC meeting dates and send to CIPO	TO/VL	Done
Other	Send out organization chart for discussion & comment	VR/ALL	1/1/06
	Compile planned and future workshops with CliC involvement	CIPO/all	ongoing

Appendix 5

Annual Report

CliC International Project Office (2006)

The Norwegian Polar Institute is host for CliC, a global climate project established by the World Climate Research Programme (WCRP) and the Scientific Committee on Antarctic Research (SCAR). Its role is to encourage and promote research into the cryosphere and its interactions with the global climate system.

The current focus on the cryosphere led to the establishment of regional CliC initiatives in 2006. An 'Asia-CliC' Regional Group was formed, and a CliC support office was established in Japan. Latin America is also considering a regional initiative.

For the first time, a chapter dedicated to the cryosphere (*Observations: Changes in Snow, Ice and Frozen Ground*) was included in a report (IPCC4) of the Intergovernmental Panel on Climate Change. Several CliC scientists contributed to the cryosphere chapter as authors and/or reviewers.

CliC sponsored/co-sponsored several meetings during 2006, among others:

- Symposium on Cryospheric Indicators of Global Change
- Workshop on High-Latitude Reanalysis
- Workshop on Sea-Level Rise: the outcomes of this initiative - with all the white papers - will be published in a book in 2007. It will include an executive summary on sea-level rise as recommendations for policy makers
- The Asian Conference on Permafrost
- The International Workshop on Antarctic Sea-Ice Thickness

CliC is involved in several initiatives for the International Polar Year (IPY), and a near term goal is to help ensure that the IPY is not just a "blip", but leaves a legacy of infrastructure, observational and data-management systems that remain after the IPY. An example of this legacy is the document *Integrated Global Observing Strategy Theme on Cryosphere (IGOS-Cryo)*. This CliC-led initiative engaged scientists and agencies in North America, Asia and Europe through CliC sponsored workshops. This is the first document to treat observations of the cryosphere in a comprehensive manner, and it will be used by international programs and space agencies; i.e., the *Global Climate Observing System*, and the *Committee on Earth Observation Satellites*, to define capabilities, needs, and new space missions.

A CliC cryosphere 'specialist' database was established to identify and engage experts for CliC activities in order to enhance its coordination capability. The database contains nearly 300 names and has proved its usefulness on several occasions.

CliC produced and distributed a DVD with the proceedings of the *First CliC Science Conference* held in April 2005 in China. The DVD contains the book of abstracts and the 137 presentations given by 245 participants from 22 countries and can be ordered from the secretariat (clic@npolar.no).

Dr. Prick began to work part-time for the CliC project on 1 July 2006. Her research is primarily focused on periglacial geomorphology and permafrost. She also works for the the International Permafrost Association (IPA) – one of many organizations closely associated with CliC.

Appendix 6
List of Presentation Titles¹

Item #	Author	Title
	Romanovsky, Vladimir	NEESPI: an interdisciplinary program of internationally-supported earth systems and science research addressing large-scale and long-term climate and environmental change
2.	Steffen, Koni	CPA2 Proposed Workshops
3.	Turner, John	CPA4 - Links between the cryosphere and global climate
4.	Worby, Tony	CPA 3: The Marine Cryosphere and its interactions with high latitude oceans and atmosphere
6.	Khromova, Tatiana	CPA1: The Terrestrial Cryosphere and Hydrometeorology of Cold Regions
11	Moore, Jim	DMIP Summary
3.0	Worby, Tony	GCOS SST&SI Working Group
4.0	Fichefet, Thierry et al Turner, John (presenter)	Modelling the Interactions between Greenland Ice Sheets and Climate During the Next Millennia
6.0	XIAO, Cunde	International High Asia Cryospheric Years (IHACYs) - a suggested program during IPY and beyond
2.1	Steffen, Koni	CPA2: Challenges, open issues, opportunities
4.1	Worby, Tony and Fricker, Helen Amanda	CPA3: Challenges, open issues, and opportunities (and some science results)
5.1	Arbetter, Todd	Southern Ice Ocean Model Intercomparison Project (SIOMIP)
7.1	Ohata, Tetsuo Qin, Dahe	Asia-CliC Outline
9.1	Scambos, Ted	Continuing Glacier and Sea Ice Responses to Climate Change in the Northern Antarctic Peninsula
17.1	Lytle, Vicky	SSG Membership Nov 2006
2.2	Steffen, Koni	CPA2: Cryospheric contributions to sea-level rise and variability. WS,

¹ Message to participants: The presentations are posted on <http://cliv.npolar.no/members/meetings/meetings.php>. Please contact the CliC office in Tromsø (cliv.npolar.no) if you need a password.

Appendix 6 (cont'd)

Item #	Author	Title
		Paris 2006
3.2	Turner, John and Fichet, Thierry	CPA4: The Way Forward
5.2	Thompson, David	4th International Southern Ocean Region Panel Meeting
7.2	Casassa, Gino	South American Glaciers and CliC
8.2	QIN, Dahe	Climate Change in 2007: the Physical Science Basis (WG1 contribution to IPCC4)
9.2	Turner, John	Antarctic Climate Change and the Environment
10.2	Drinkwater, Mark	CEOS response to UNFCCC and relevance to WCRP CliC and IGOS Cryo
10.2	Drinkwater, Mark	CEOS response to UNFCCC and relevance to WCRP CliC and IGOS Cryo
11.2	Parsons, Mark	Data Management for the IPY: Ensuring the Legacy
8.3	XIAO, Cunde	Dome A: a potential site for obtaining ice-core older than 1.0Ma
9.3	Steffen, Koni and Huff, Russell	Melt Anomalies on the Greenland Ice Sheet and Large Scale Modes of Atmospheric Circulation
10.3	Frauenfeld, Olivier	IGOS Ch 9: Permafrost and Seasonally Frozen Ground
10.3	Kotlyakov, V.	IGOS snow chapter
10.3	Ohata, Tetsuo	IGOS - Solid Precipitation chapter
10.3	Prowse, Terry	River Ice 101 - a Cryospheric Agent
4.4	Ryabinin, V., Lytle, V.	International Arctic Buoy Program; International Program for Antarctic Buoys
6.4	Brown, Jerry	International Permafrost Association Update
7.4	Turner, John	SCAR Activities Relevant to CliC
8.4	Drinkwater, Mark	GIIPSY
9.4	Nerem, R. Steven	Recent Satellite Observations of Sea Level Change

Appendix 6 (cont'd)

Item #	Author	Title
10.4	Casassa, Gino	IGOS - Glaciers and Ice Caps
10.4	Moore, Jim	IGOS Data Management
10.4	Steffen, Koni	IGOS Chapter 6: Ice Sheets
13.4	Turner, John	Reanalysis Activities Associated with CliC
1.5	Henderson-Sellers, Ann	WCRP, Current Status and Future
2.5	Steffen, Koni	IPY Activities Coordinated through CliC - CPA2
3.5	Drinkwater, Mark and Jezek, Ken	Spaceborne Observations of the Polar Regions during IPY
5.5	Drinkwater, Mark	GlobIce Status
7.5	Kotlyakov, Vladimir	Russia-CliC update
8.5	Meier, Walt	Arctic Sea Ice Variability and Trends
2.6	Lytle, Vicky	PAGES-CliC
8.6	Arbetter, Todd	A Rudimentary melt Pond Parameterization for a Basin-Scale Sea-Ice Model
1.7	Ryabinin, Vladimir	IPY 2007-2008
5.7	Khromova, Tatiana	GLIMS
6.7	Armstrong, Richard	The GLIMS Project at NSIDC – University of Colorado
8.7	Versegny, Dianne	Snow Cover Parameterization in Canadian Atmospheric and Hydrological Models
6.8	Williams, Steve	CEOP-CliC Collaboration
8.9	Armstrong, Richard	Multi-Sensor Satellite Snow Cover Mapping and Global Trends

Appendix 7

CliC Science Day Poster Presentations

- MODIS Mosaic for the Antarctic
T Haran and T Scambos
- Monitoring and Understanding Changes in the Dynamics of Greenland and Antarctic Outlet Glaciers.
I M Howat, I Joughin, T Scambos, J Bohlander
- Operational sea ice charts: An integrated data product suitable for observing long-term changes in Arctic sea ice?
W N Meier, F Fetterer, C Fowler, P Clemente-Colon, T Street
- Visualizing Glaciers and Sea Ice via Google Earth
Lisa Ballagh, F Fetterer
- Visualization of Four Dimensional Data on Virtual Globes
R Swick
- Atlas of Cryosphere: A Dynamic Web Mapping Tool for Exploring the Cryosphere
J Maurer, E Sheffield
- Arctic climate change: Are current Climate Models too Conservative
J Stroeve, E Holland, M Serreze
- Response of changes in active layer and permafrost conditions to the hydrological cycle in the Russian Arctic
T Zhang
- Role of Greenland on Heat and Moisture Transports into the Arctic
Kindig, Tsukernik, Serreze
- WCRP/SCAR Climate and Cryosphere Project
V.Lytle, Tordis Villinger
- IGOS-Cryo
J. Key and the IGOS-Cryo team
- Southern Ice Ocean Model Intercomparison Project SIOMIP
V.Lytle, S. O'Farrell, T. Arbetter