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Person Responsible:	Carlota Escutia

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Past Antarctic Ice Sheet Dynamics (PAIS)

Executive Summary

Title: Past Antarctic Ice Sheet Dynamics (PAIS)

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Introduction/ Background:
The overarching goal of PAIS is to improve confidence in predictions of ice sheet and sea level response to future climate change and ocean warming. For this, PAIS aims to improve understanding of the sensitivity of East, West, and Antarctic Peninsula Ice Sheets to a broad range of climatic and oceanic conditions. PAIS builds on the success of SCAR-ACE (Antarctic Climate Evolution), but with a new focus on the ice sheet rather than palaeoclimate reconstructions. Study intervals span a range of timescales, including past "greenhouse" climates warmer than today, and times of more recent warming and ice sheet retreat during glacial terminations. The PAIS research philosophy is based on data-data and data-model integration and intercomparison, and the development of "ice-to-abyss" data transects, extending from the ice sheet interior to the deep sea. The data-transect concept will link ice core, ice sheet-proximal, offshore, and far-field records of past ice sheet behaviour and sea level, yielding an unprecedented view of past changes in ice sheet geometry, volume, and ice sheet-ocean interactions. These integrated data sets will enable robust testing of a new generation of coupled Glacial Isostatic Adjustment-Ice Sheet-Atmosphere-Ocean models that include new reconstructions of past and present ice bed topography and bathymetry. PAIS will accomplish its objectives by: 1) facilitating the planning of new data-acquisition missions using emerging technologies; 2) encouraging data sharing and integration of spatially targeted transect data with modelling studies; and 3) initiating/expanding cross linkages among Antarctic research communities.

Important Issues or Factors: PAIS continent-to-abyss transects build on ongoing and planned projects and therefore guaratee continuous deliverables.

Recommendations/Actions and Justification: Support and input from EXCOM on PAIS plans for the next two-three years of the Programme.

Expected Benefits/Outcomes: Significant publication output (both in content and numbers). Publications and science relevant to "Big- science" programmes and policy makers, enhancement of SCAR profile.

Partners: ANDRILL, AntECO, APECS, IGBP-PAGES, IODP, IPICS, ISMASS, SCADM, SCERCE, SHALDRIL and other SCAR Expert and Action Groups.

Budget Implications: Request for confirmation of SCAR science programme funding at current level until the internal progress review in two years.

Past Antarctic Ice Sheet Dynamics (PAIS)

1. Rationale for the Programme

The Antarctic ice sheets, ice shelves, sea-ice, and surrounding marginal seas play a fundamental role in the global ocean/climate system, affecting global sea level, ocean circulation and heat transport, planetary albedo, air-sea gas exchange, and marine productivity. Obtaining a history of Antarctica's role in these global processes is therefore crucial for understanding past and future ice-ocean-atmospheric and tectonic feedbacks within Earth's climate system.

Despite the critical role of Antarctica and the Southern Ocean in the global system, key geological and geophysical data from this region are lacking. In part, this is because Antarctica's massive ice sheets hide most of the Cenozoic geological record. Terrestrial records from rock exposures around the Antarctic margin provide snapshots of regional climate, but these records are geographically sparse and difficult to date. Coastal and open marine records provide a better-dated and more complete window into Antarctic ice sheet behaviour. However, these records are also sparse in their local coverage (i.e., representing coastal or offshore conditions, but not both) and there are many areas of the Antarctic margin without any records recovered.

Antarctic palaeoenvironmental records are the primary missing link for reconstructing equator-to-pole temperature gradients through time, the key factor to determine the strength of "polar amplification" and climate sensitivity in general. These records are also directly relevant to ice sheet and sea level change, because the magnitude of accelerating ice sheet loss, both in Greenland and Antarctica, suggests that ice sheets will be the dominant contributors to sea level rise in coming decades, and their contribution will "likely" exceed current IPCC projections for the 21st century (Rignot et al., 2011b).

To understand Cenozoic Antarctic cryosphere evolution in the context of the Earth's climate system, PAIS will help coordinate palaeoenvironmental and tectonic studies along transects from the interior of the continent to abyssal plains. These studies will preferably extend from specific drainage sectors, because it is expected that different regions of the ice sheet undoubtedly will have different histories. These records, integrated with state-of-the-art coupled GIA-ice sheet-ocean-climate models have the potential to substantially advance our understanding of forcings, magnitudes and rates of response, and feedbacks at the ocean-ice interface, thus improving ice sheet model parameterizations.

PAIS also aims to advance our understanding of processes forming sediment archives that record transitions, thresholds, and rates of change when chronology makes it possible, especially during the past 1 million years. On this time scale, collaboration with the ice core community will provide high-resolution records of continental interior conditions that can be compared with the response of the WAIS and the larger East Antarctic Ice Sheets (EAIS).

PAIS aims to constrain past ice sheet dynamics that are relevant to future scenarios of ice sheet behaviour and sea level change as a response to elevated CO_2 and temperatures during this century (Solomon et al., 2007). To achieve that aim, PAIS will focus on temporal targets that span the last deglaciation to the early Cenozoic greenhouse world, with the main focus on periods of rapid warming and climatic conditions warmer than present. These intervals include: a) the transition from the Last Glacial Maximum (LGM) to early Holocene warmth; b) Pleistocene "super-interglacials" (e.g., MIS5, MIS11, MIS 31), long suspected as being times of significant WAIS retreat; and c) times of elevated global temperatures and CO_2 levels that are close to what is forecasted for our near future (Solomon et al., 2007), such as the Pliocene PRISM interval from~3-3.3Ma and the extended period of maximum warmth during the early Pliocene (4.2 to 3.7 Ma) when significant grounding-line retreat is suspected around sensitive areas of the East Antarctic margin, which addresses the sensitivity of EAIS to relatively small increases in temperature and CO_2. Periods representing prolonged warmth include the Miocene Climate Optimum (17-14 Ma), and the persistent elevated temperatures and pCO_2 levels exceeding 1000 ppmv prior to the formation of continental Antarctic ice sheets 34 million years ago. This greenhouse world includes

temperature spikes (hyperthermals) lasting ~100,000 years, somewhat analogous to the conditions projected for a continued “Business As Usual” carbon emissions scenario.

2. Important Issues or Factors

i) Suggested Steering Committee

We suggest that the PAIS Scientific Research Programme be led by a steering committee (SC) of 14-16 persons that will include the broad range of expertise represented by PAIS science. The SC will include a Data Coordinator and a member from APECS. SC members will have 3-year terms with the possibility of extension depending on contribution and performance. The founding co-chairs C. Escutia and R. DeConto will stand down at the end of 2014, to avoid complete rotations of the SC. The SC will meet at least once a year in coordination, when possible, with major international symposia including AGU and EGU.

Thematic components of the SC:

1. Geophysics (sea-floor morphology, seismic stratigraphy, regional structure and basin analysis)
2. Sedimentology (glacial/interglacial sequences and processes onshore-nearshore-offshore, high resolution stratigraphy, etc.)
3. Palaeoceanography (ocean-basin history, water mass processes, sediment-ocean-air interfaces, sea ice, ice rafting, etc)
4. Geochemistry (tracer geochemistry, biogeochemistry, carbon cycle, ice-sheet and ice-rafted sediment provenance, etc.)
5. Geochronology and palaeomagnetism (age-dating techniques, rock-magnetic properties, chronostratigraphy)
6. Palaeontology (biostratigraphy, palaeoecology, evolution of polar biota, palaeoenvironmental proxies)
7. Ice sheet modelling (used to ‘test’ hypotheses derived from interpretation of the geological record and establish past accumulation patterns by integrating models results with internal ice-sheet layers identified by ice-penetrating radar)
8. Glacial Isostatic Adjustment (GIA) modelling
9. Palaeoclimate modelling (ice-sheet models coupled with atmosphere-ocean General Circulation Models (GCM’s) to examine glaciation feedback mechanisms and to examine physical processes responsible for ice sheet configurations outlined in component 8)
10. Ice cores for marine-ice core comparisons over the past ~1 million years (air temperaturs vs surface water temperatures, CO_2, and ground-truthing palaeoclimate models)
11. Tectonics and climate change (interactions among climate change, ocean circulation, the ice sheet dynamics, and Antarctic tectonism).
12. Data management representative (geologic, geophysical, and glaciological data)
13. Technological development (drilling/coring/sampling systems, geophysical data acquisition).
14. APECS representative

In addition, six sub-committees are being established to implement the science objectives of PAIS. Membership of these committees allows PAIS to widen involvement in the programme in terms of expertise, gender and nationality.

1. *Palaeoclimate Records from the Antarctic Margin and Southern Ocean* (PRAMSO): aims to provide the Antarctic climate and palaeoclimate communities with the coordination and support for proposed and developing drilling projects. This includes identification of site survey needs.
2. *Palaeotopographic-Palaeobathymetric Reconstructions*, aims to reconstruct circum-Antarctic stratigraphy and palaeobathymetry and the palaeotopography to show change in bedrock elevations, landforms, and geotectonic configurations of Antarctica over the past ~100 million years.
3. *Subglacial Geophysics*, is reconstructing bedrock roughness and drainage networks from land to the coast.

4. *Ice Cores and Marine Core Synthesis*. PAIS will provide the framework within which the sediment and ice core drilling, and ice sheet modelling communities can integrate.
5. *Recent Ice Sheet Reconstruction* group will focused on the last glacial termination, using a range of methods including proximal and offshore geophysical and sedimentological analyses of past groundling-line dynamics, and continental records of ice sheet thickness from exposure-age dating.
6. *Deep-Time Ice Sheet Reconstructions* will rely heavily on the coordination among numerical modelling communities, the *Palaeotopographic-Palaeobathymetric* sub-committee, and the broader palaeoceanographic communities providing indirect estimates of ancient ice volume via geochemical studies and sea-level histories from continental margins.

ii) Outline of Implementation Plan including explicit milestones and expected scientific outcomes, and stating what is going to be achieved by when and if possible by whom

Many PAIS continent-to-abyss transects will encompass more than the eight years of the proposed PAIS Programme, but they build on ongoing, planned, and to be planned projects that should guarantee important outcomes during the life of PAIS and form the seed for such research projects to continue into the future.

Table 1 shows ongoing projects of interest to PAIS objectives (i.e., ANDRILL SMS and MIS, shelf-offshore marine sediment records obtained during the IODP Expedition 318 to Wilkes Land, etc). Outcomes from these data sets will help our understanding of Holocene to Eocene Antarctic cryosphere evolution in the context of the Earth's climate system. Data-data and data-model comparisons and integration between these records and others previously collected by the Ocean Drilling Program (i.e., Legs 178 & 188) and Cape Roberts Project (CRP) will provide information about different histories in different drainage sectors (e.g., Ross Sea vs Wilkes Land Subglacial Basin). In addition, integration of these sedimentary records with state-of-the-art coupled GIA-ice sheet-ocean-climate models have the potential to substantially advance our understanding of forcings, magnitudes and rates of response, and feedbacks at the ocean-ice interface, thus improving ice sheet model parameterizations.

In addition, the next two-four years of work within the PAIS Programme are expected to include results from the ongoing Subglacial Lake Ellsworth and the WISSARD projects and newly approved projects such as the MeBo Amundsen Sea drilling and the Totem Glacier surveys (Table 1). Proposed projects include the IODP Amundsen Sea, ANDRILL Coulman High and Siple Coast; IODP Bellingshausen Sea and Eastern Ross Sea; various subglacial access targets (e.g., see http://icedrill.org/about/sab.shtml); and there are areas of potential great scientific interest where new data collection is essential (i.e., Weddell Sea, Budd Coast, Conrad Rise, Totem Glacier, etc.). New planning will be coordinated through community workshops. Section 3 includes a list of completed and planned workshops and symposiums.

The objectives of PAIS are particularly timely relevant to the stated objectives of the European Project for Ice Coring in Antarctica (EPICA) (in conjunction with the SCAR supported International Partnerships in Ice Core Sciences (IPICS)), whose long-term mission is to recover an ice core greater than 1 million years in age. EPICA has the potential to reach the MIS-31 event (1.07Ma), when according to sediment drill core records, WAIS appears to have retreated substantially and circum-Antarctic temperatures were particularly warm relative to today (Naish et al., 2009). During the next two years the role of PAIS includes establishing cooperation between the geological and ice core drilling communities clearly has the potential to facilitate high-impact science discoveries, such as confirmation of the MIS-31 WAIS deglaciation.

Table 1. Ongoing and approved projects and scientific objectives relevant to PAIS

Projects	***Location***	***Objectives***	***Year***	***Implementation 2013-2015***
Current				
ANDRILL SMS & MIS	Ross Sea	Pleistocene-Miocene glacial history	2007-2008	Continue review of sedimentary cores from SMS & MIS programmes. Comparison-integration with Exp 318, ODP Legs & CRP, and available onshore data. Provide data to numerical GIA-ice sheet modeling community.
IODP 318	Wilkes Land	Holocene to Eocene Greenhouse palaeoclimate and glacial history	2010	Continue review of sedimentary cores from Exp 318. Comparison-integration with ANDRILL, CRP, ODP Legs, and available onshore data. Work on Holocene ice-core and marine-core integration. Provide data to numerical GIA-ice sheet modeling community. Workshop planned in fall 2013
Subglacial Lake Ellsworth	30 km from the ice divide between Pine Island Glacier and the Institute ice stream	Life forms in the water and clues to past climate in the lake-bed sediments	2009-2014	Continue drilling to sample subglacial/lake sediments. Review of sediment data & provide data to numerical ice sheet modeling community.
Subglacial WISSARD (LISSARD & RAGES) Drilling	Whillans Ice Stream	Marine Ice Sheet Stability and Subglacial Life Habitats in West Antarctica	2009-2015	Analyze water and sediment data and samples collected during the 2012-2013 field season. Planning of the 2013-2014 field season.
WAIS Divide	WAIS ice flow divide	Climate, ice sheet history and cryobiology	2010-2013	2013 field season ended: Ice cores record of past climate and greenhouse gases in the atmosphere that extends back 68,000 years. WAIS divide meeting, 24-25 september, Scripps (USA)
AGAP	Gamburtsev Mountains	Initial ice sheet formation, subglacial hydrological processes	2008-2009	Continue review of data obtained and provide data to numerical ice sheet modeling community.
Approved				
Amundsen Sea shelf - MeBo	Amundsen Sea Embayment shelf	Basic shelf stratigraphy, glacial onset, LGM retreat ages	Approved 2014-15	Planning and implementation of MeBo drilling in the Amundsen Sea
Totem Glacier seismic and coring cruises (US, Australia)	Totem Glacier	Basic shelf stratigraphy, Pleistocene ice sheet dynamics, LGM retreat.	Approved 2014 & 2015	Planning and implementation of NSF eastern Wilkes Land dredging & Totem Glacier surveys Planning and implementation of Australian led international coring cruise to the Totem Glacier
E Ross Sea shelf - SHALDRIL	Southeastern Ross Sea	Cenozoic evolution of West Antarctica and early development of WAIS	Approved currently on hold	

Proposed				
IODP 732	West of Antarctic Peninsula and Bellingshausen Sea	Late Miocene to Quaternary, Palaeoceanography, Ice Sheet History	Likely scheduled in 2016	Continue fostering IODP proposal for the Antarctic Peninsula.
IODP 751	Eastern Ross Sea	Late Neogene grounding events at the Eastern Basin	Under revision - to be submitted Oct. 2013	Continue fostering IODP proposal for Eastern Ross Sea IODP drilling. PAIS co-funding for writing workshop (June 2013, USA) for the submission of a revised proposal to the IODP in October 2013.
IODP 784	Amundsen Sea Embayment	Stratigraphy, glacial cycles, ice sheet collapse, circum-polar deep water,	Under revision	Continue fostering IODP proposals for Amundsen Sea Embayment.
ANDRILL Coulman High	Ross Sea	Palaeogene to lower Miocene ice sheet behaviour & environments during greenhouse gas levels	Under revision	Continue fostering IODP proposal for Coulman HIgh
Wilkes Land shallow drilling (MeBo)	Eastern Wilkes Land	Ice sheet behaviour & environments: Cretaceous, Eocene and icehouse	Under review	Continue fostering IODP proposal for Wilkes Land shelf drilling.
Planned				
WAIS-Drill	West Antarctica	Ice sheet history from subglacial sediments	2015-	
EPICA	Dome C, Dronning Maud Land	Deep ice core drilling	1996-ongoing	
IODP Weddell Sea	Weddell Sea continental slope and rise	High-resolution Pliocene climate and ice sheet variability		Continue fostering IODP proposal for Weddell Sea
IODP SE Pacific Ocean	SE Pacific deep-sea	Cenozoic suborbital climate variability, biogeochemical cycles, Antarctic ice sheets, tectonic evolution		Continue fostering IODP proposal for SE Pac Ocean
IODP SW Pacific Ocean	SW Pacific deep-sea	Cenozoic suborbital climate variability, biogeochemical cycles, Antarctic ice sheets, tectonic evolution		Continue fostering IODP proposal for SW Pac Ocean
ICECAP/ICEBRIDGE	Wilkes Land (Wilkes and Aurora subglacial basins, Victoria Land	Lithosphere and sub glacial conditions in East Antarctic basins	2008-ongoing	

Other ongoing projects of relevance for modelling ice sheet dynamics in Antarctica are

Paleotopographic & paleobathymetric reconstructions	Antarctica	Topography of Antarctica at 70 Ma and paleobathymetric reconstructions across major events if Antarctic glacial history (i.e., Eocene-Oligocene transition and Miocene ice expansion)	ongoing	Foster paleotopographic and paleobathymetric reconstructions that are critical to ice sheet & GIA modeling
Holcene Ice & marine core integration (HOLOCLIP project)	Ross Sea, Wilkes Land, Weddell Sea	Calibration of proxies & data integration and comparison between ice core & high-resolution marine core records	ongoing	Foster continuing efforts for integration that can provide relevant information about gradients between continent and offshore areas.

3. Outputs/Deliverables

Publications:

Work within PAIS is expected to result on high-impact publications on data and modelling of ice sheet dynamics during past elevated CO2 and temperatures.

In 2013 ongoing work within PAIS has already produced high-impact publications resulting from the study of the sedimentary sections recovered during the IODP Wilkes Land Expedition (Table 1). These include:

Stocchi, P., Escutia, C., Houben, A.J.P., Bijl, P.K., Brinkhuis, H., DeConto, R., Galeotti, S, Vermeersen, B.L.A., and Expedition 318 Scientists. Relative sea levelrise around East Antarctica during Oligocene glaciation. ***Nature Geosciences, Vol 6: 380-384.***

Houben, A.J.P., Bjil, P.K., Pross, J., Bohaty, S.M., Stckley, C.E., Passchier, S., Roel, U., Sugisaki, S., Tauxe, L.,van de Flierdt, T., Olney, M., Sangiorgi, F., Sluijs, A., Escutia, C., Brinkhuis, H., and the Expedition 318 Scientists. Modern Southern Ocean plankton ecosystems arose at the onset of Antarctic glaciation. ***Science, Vol 340 no 6130 pp. 341-344***

Cook C.P., van de Flierdt, T., Williams T. J., Hemming S. R., Iwai, M., Kobayashi M., Jimenez-Espejo F.J., Escutia C, González J.J., McKay R., Passchier S., Bohaty S.M., Tauxe L., Sugisaki S., Lopez Galindo A., Patterson M.O., Riesselman C, Sangiorgi F., Pierce E. L., Brinkhuis H., and IODP Expedition 318 Scientists. Dynamic Behaviour of the East Antarctic Ice Sheet during Pliocene Warmth. ***Nature Geosciences, in press***

Bijl, P.K., Bendle, J.A., Bohaty, S.M., Pross, J., Schouten, S., Tauxe, L., Stickley, C.E., Röhl, U., Sluijs, A., Olney, M., Brinkhuis, H., Escutia, C., and Expedition 318 Scientists. Onset of Eocene Antarctic cooling linked to early opening of the Tasmanian Gateway. ***PNAS, in press: Available online at www.pnas.org/cgi/doi/10.1073/pnas.1220872110***

In addition, a special Volume in Global and Planetary Change and focused on the Scotia Sea tectonic evolution and related ice sheet and paeloceanographic changes is planned for publication 2014 (A. Maldonado, I. Dalziel and Philip Leat, Editors). This volume includes results from the Scotia Arc Symposium: Geodynamic Evolution and Global Implications (14-16 May, 2013, Granada, Spain).

Workshops, Symposia and Meetings:

PAIS work on facilitating coordination/collaborations between different multidisciplinary/ interdisciplinary international groups is largely conducted through community workshops and meetings. Some of the already completed and future activities include:

- Antarctic and Southern Ocean Drilling workshop, July 2012 (Portland, USA). Kick-off meeting for community to organize projects in the PAIS latitudinal transect strategy.
- Scotia Arc Symposium: Geodynamic Evolution and Global Implications. May, 2013 (Granada, Spain).
- Eastern Ross Sea IODP Drilling proposal writing workshop, June 2013 (St. Petersburg, USA)
- Wilkes Land workshop, Fall 2013 (NIOZ, NL)
- Joint Model-data workshop for the Late Pleistocene evolution of the Greenland and Antarctic ice sheets. May 22-24, 2014, (just before the IGS International Symposium on Observations, Modelling and Prediction of the Cryospheric Contribution to Sea Level Change, in Chamonix).
- PAIS Symposium 2014 (Korea?)

In addition, PAIS will organize sessions and meetings of the Steering Committee and subcommittees during large international meetings such as AGU and EGU 2013 and 2014, International Conference on Paleoceanography (ICP) 2013 in Barcelona (Spain), SCAR OSC 2014 in Auckland (NZ), and ISAES XII in Goa (India). The first meeting of the PAIS SC is planned during the AGU Fall 2014 meeting in San Francisco.

PAIS Data Bases:

PAIS supports continued development of the Antarctic Data Library System for Cooperative Research (SDLS). The SDLS now contains most processed data from marine multichannel seismic surveys that have been carried out around Antarctica. The SDLS provides open access worldwide to Antarctic multichannel seismic-reflection data collected by many countries to study the structure of Earth's crust of Antarctica. The new website that now provides open access to Antarctic multichannel seismic-reflection data online is http://sdls.ogs.trieste.it/ -- Operated and administered at the Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS) by Nigel Wardell.

While PAIS does not directly support other data archiving infrastructure, it will maximize the effectiveness of it's limited budget by encouraging responsible archiving of data and samples to established data centres and repositories. Among these databases the most relevant to the data to be generated by PAIS will be:

PANGAEA the data Publisher for Earth & Environmental Science- http://www.pangaea.de/
This data repository holds all data from the two past ANDRILL drilling seasons will receive data from the future Coulman High drilling (Table 1), as well as a wealth of data from marine sediment cores from the Southern Ocean. The IODP data bases and core repositories http://www.iodp.org/access-data-and-samples also hold all cores and data obtained during past Antarctic margin and Southern Ocean drilling by the Deep Sea Drilling Project (DSDP), the Ocean Drilling Program (ODP) and the Integrated Ocean Drilling Program (IODP). A data portal that will become relevant for PAIS continental slope-to abyss transects will be the IPEV IMAGES Programme Sub-Antarctic and Antarctic portal - http://gcmd.gsfc.nasa.gov/KeywordSearch/Home.do?Portal=amd_fr, which contains data from both marine and ice core records. Other databases included NOAA NCDC/NSIDC, and national programmes metadata systems.

For data management within PAIS, a Data Coordinator will serve on the PAIS Steering Committee. A PAIS sub-committee on Data Management, guided by the Data Coordinator, will 1) engage in cross-linkage activities and the facilitation of cross-SRP data sharing via web-based utilities, and 2) maintain ongoing communication with national funding programmes, currently expanding their emphasis on responsible and cost-effective data management, protection, archiving, and sharing.

PAIS Education & Outreach:

PAIS education and public outreach to engage the public in scientific efforts to document the behaviour of Antarctica's ice sheets will be linked to the activities conducted by international programmes such as ANDRILL and IODP, and national funded programmes. PAIS will liaise with the SCAR office to ensure effective communication and outreach, as set out in the 'SCAR Communications Plan' and 'A Strategy for Capacity Building and Education'.

PAIS will endeavour to support and encourage the next generation of Antarctic scientists by: 1) including young scientists in the leadership of sub-committees and the SC 2) encouraging young scientists to take part in PAIS meetings and workshops by offering bursaries for travel and subsistence. The level and number of the bursaries will be dictated by funds available; 3) funding of 1-2 graduate students a year to attend the Urbino Palaeoclimate School and the Karthaus Summer School on Ice Sheets and Glaciers in the Climate System. The condition of each bursary will be a report by the holder about their research and workshop experiences, which will be posted on the PAIS website.

4. Budgetary Implications

The funds requested for PAIS are used to promote coordination between the community for planning of programs and/or integrating their results within the PAIS subcommittees. The main expenditure to date are travel claims linked to participation of key scientists in the Wilkes Land IODP proposal, the Scotia Arc Symposium in Granada, and the Easter Ross Sea IODP proposal writing workshop in Florida. Expected expenses before the end of 2013 are linked to the 1st meeting of the PAIS SC, and to funding for the organization of the Joint Model-data workshop for the Late Pleistocene evolution of the Greenland and Antarctic ice sheets. Underspent 2013 budget

will be carry over to fund, with 2014 budget, the organization or the first PAIS symposium in Korea and all parallel activities of the PAIS SC and Subcommittees. For the next 2-years, PAIS is requesting 20,000 $US / year = 40,000 $US

5. Future Plans

2013:

- Scotia Arc Symposium: Geodynamic Evolution and Global Implications. May, 2013 (Granada, Spain);
- Eastern Ross Sea IODP Drilling proposal writing workshop, June 2013 (St. Petersburg, USA);
- Wilkes Land workshop, Fall 2013 (NIOZ, NL);
- 1st meeting of the SC Committee, Fall AGU 2014, San Francisco;
- High impact publications and books;
- Publication of the synthesis paper for IODP Expedition 318, Wilkes Land Glacial History;
- Work on cross-linkages with other programmes (i.e., ice-core & marine core integration, develop links with SERCE and PAIS);
- Continue coordination and integration, through subcommittees, of field work results (ANDRILL SMS and MIS; and Wilkes Land IODP Expedition 318);
- Continue development of process-based multidisciplinary subcommittees to formulate future research directions;
- Continue wok on the effect of the 1st continental ice sheet growth in sea level (data-ice sheet/GIA model comparisons: near- and far-field records);
- Guide submission of the ANDRILL Coulman High Project proposal, and a coordinated set of IODP proposals listed in Table 1;
- Field seasons for major Projects (e.g., WIZZARD, Lake Elsworth, NSF Totem Glacier, etc);
- PAIS sessions in major international meetings (EGU, AGU);
- PAIS reports to SCAR;
- PAIS website;
- Input to databases;
- Participation and support for Urbino graduate summer school in paleoclimatology;
- Outreach via National/International Programmes.

2014:

- Joint Model-data workshop for the Late Pleistocene evolution of the Greenland and Antarctic ice sheets. May 22-24, 2014, (just before the IGS International Symposium on Observations, Modelling and Prediction of the Cryospheric Contribution to Sea Level Change, in Chamonix);
- XXXIII SCAR Meetings and Open Science Conference, 22 august-3 September Auckland, New Zealand: PAIS sessions, workshops and business meetings;
- PAIS Symposium 2014 (Korea?, after SCAR OSC);
- Publication of the special volume in Global and Planetary Change: The Scotia Arc: Geodynamic Evolution and Global Implications;
- Work on cross-linkages with other programmes (i.e., ice-core & marine core integration, develop links with SERCE and PAIS);
- Continue analyses in data from ANDRILL SMS and MIS; and Wilkes Land IODP Expedition 318. Integration with other ODP Legs, CRP and data-model comparisons;
- Guide submission of the ANDRILL Coulman High Project proposal, and a coordinated set of IODP proposals listed in Table 1;
- Field seasons for major Projects (e.g., WIZZARD, Lake Elsworth, Autralian International cruise to Totem glacier, etc);
- PAIS sessions in major international meetings (EGU, SCAR OSC, AGU);
- PAIS reports to SCAR;
- PAIS website;
- Input to databases;
- Participation and support for Urbino graduate summer school in paleoclimatology;
- Outreach via National/International Programmes.

Appendices

The following persons are nominated as the initial Steering Committee of ACE.

Carlota Escutia – Research Council of Spain CSIC-Univ Granada, Spain co-chair
Robert M. DeConto – University of Massachusetts, USA (ice sheet modeling) co-chair
Robert Larter – British Antarctic Survey, UK (Glacial processes)
Karsten Gohl – Alfred Wegener Institut, Germany (Geophysics)
Ross D. Powell – Northern Illinois University, USA (Subglacial sediment records)
Michael Bentley – Durham University, UK (Sedimentology LGM & GIA)
Barbara Stenni – University of Trieste, Italy (Ice Cores)
Rob McKay – Institute of Geological and Nuclear Sciences, New Zealand (Sedimentology: glacial interglacial variability)
Paolo Stocchi – Royal Netherlands Institute for Sea Research NIOZ, Netherlands (GIA Modelling)
Jongkuk Hong – KOPRI (S. Korea)
Yusuke Sugamuna NIRP, Japan (Geochronology)
Alex Pyne, Victoria University of Wellington (Technological development)
Paleontology (TBD)
Paleoceanography (TBD)
Data management (TBN by SCADM)
APECS (TBN by APECS)

The following persons are identified as leaders to conform membership of the six subcommittees. Once developed the subcommittees will elect two chairs.

1. Palaeoclimate Records from the Antarctic Margin and Southern Ocean (PRAMSO)
Chair: L. De Santis (It) and T. Naish (NZ)

2. Palaeotopographic-Palaeobathymetric Reconstructions,
Chair: Doug Wilson (USA) and Karsten Gohl (D)

3. *Subglacial Geophysics*,
Chair: Ross Powell (USA)

4. Ice Cores and Marine Core Synthesis.
Chair: Barbara Stenni (It) and X. Crosta (F)

5. Recent Ice Sheet Reconstruction
Chair: M. Bentley (UK)

5. Deep-Time Ice Sheet Reconstructions
Chair: R. McKay (NZ) and P. Bjil (NL)