



WP

13

Agenda Item:

2.2.4

Person Responsible:

N.Bertler

EXCOM 2015

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AntarcticClimate²¹
(Antarctic Climate Change in the 21st Century)

Executive Summary

Title: *AntarcticClimate*²¹

Authors: N. Bertler, T. Bracegirdle, A. Khan, P. Mayewski, J. Russell, J. Turner

Introduction/ Background: The overarching question of this research initiative is: How will the Antarctic / Southern Ocean environment change over the 21st Century? To achieve this goal, *AntarcticClimate*²¹ focuses on three themes of research:

- Objective 1. Quantification of Antarctic climate variability.
- Objective 2. Climate model verification for the Antarctic region.
- Objective 3. Antarctic climate projection to 2100 AD

To understand the significance of recent trends in the context of natural variability, we consider changes on a multi-century time scale that are relevant to improve climate projections, the attribution of the causes of environmental change, and the skill of earth system models in the Antarctic / Southern Ocean region.

Important Issues or Factors: *AntarcticClimate*²¹ successfully achieved important milestones for objectives 1 and 2 over the past 12 month. We published the conclusions from our first workshop addressing Objective 1 “Quantification of Antarctic Climate Variability”. Moreover, we held our second workshop focusing on Objective 2 – Climate model verification for the Antarctic region, and published recommendations for a standardized approach for testing and reporting climate model experiments for CMIP6. In addition, we contributed to an AnT-ERA led publication on the first assessment of the cumulative impact of climate change stresses on the Antarctic ecosystem and contribute and co-sponsor to the first AnT-ERA / AntEco / *AntarcticClimate*²¹ workshop to improve our understanding of the vulnerability of the Antarctic / Southern Ocean ecosystem to current and future global change. Finally, the approval of the NSF supported Southern Ocean Carbon and Climate Observations and Modeling (SOCCOM) program (co-led by Prof. J.Russell) catalyzes our efforts especially to improve the modeling skill for oceanographic processes.

Recommendations/Actions and Justification *AntarcticClimate*²¹ represents a large and growing community of active scientists working to improve future projection of Antarctica’s role as driver of and its response to global change. We request the SSGs and SCAR Delegates to approve continued support for *AntarcticClimate*²¹. The outcome of this SCAR initiative will provide important leadership to improve modeling capability for future projections in time for inclusion in the IPCC AR6, it seeks multidisciplinary collaboration between existing SCAR initiatives, encourages new international research efforts, engages proactively in the development of the new generation of CMIP6 experiments, and promotes the integrates early and mid-career scientists.

Expected Benefits/Outcomes: The principle aim of *AntarcticClimate*²¹ is to provide realistic, data-constrained future projections for the next century and beyond, and to support SCAR’s leadership in Antarctic research and policy advice.

Partners: *AntarcticClimate*²¹ seeks to serve and collaborate in particular with PAIS, SERCE, AntEco, AnTERA, APECS, ACCE, ISMASS, ASPeCT, SOOS, PAGES, IPICS, CliC, CMIP, PMIP, WCPR, and PCIP. A new important opportunity is now to also closely work with SOCCOM.

Budget Implications: We kindly request that *AntarcticClimate*²¹ is permitted to use \$3k from our 2016 budget during 2015 to accommodate publication fees not included in the 2015 budget.

AntarcticClimate²¹

1. Rationale for the Programme

Antarctic / Southern Ocean climate model projections of the atmospheric/oceanic changes for the coming decades include accelerating ice sheet mass loss^{1,2}, declining sea ice extent³, weakening AABW formation⁴, and an intensification of the zonal winds⁵, with the potential to lead to accelerated mass transfer of ice into the ocean and thus sea level rise^{6,7}, enhanced CO₂ ventilation and reduced sequestration causing increased atmospheric CO₂ concentrations^{8,9}, and compounding impacts on the ecosystem^{10,11}. Observations confirm ice shelf collapse¹², accelerated ice net loss¹³, strengthening zonal winds⁵, an increase in temperature and acidification of the Southern Ocean^{14,15}, and a decrease of AABW formation^{4,16}. However, observations are spatially limited and short^{14,17}, some being controversial¹⁸, and inter-model variability suggests physical processes are not yet fully captured or understood⁸. An emerging array of high resolution paleoclimate records extending observational data back to analogous periods that are relevant times for future projections support model refinement and process diagnostics⁸, yet large uncertainties remain^{19,20}.

The objectives of *AntarcticClimate*²¹ are to produce improved projections of the magnitude and patterns of change to Antarctica's physical environment over the next 100+ years as a result of changes in forcings, such as an increase in the concentration of greenhouse gases and the recovery of the ozone hole. The assessment will be based on Intergovernmental Panel on Climate Change (IPCC) Assessment Report Five (AR5) Representative Concentration Pathways (RCP) and updated scenarios as they become available. To achieve this goal, *AntarcticClimate*²¹ focuses on three themes of research:

1. **Quantification of Antarctic climate variability.** This theme concentrates on quantifying and understanding natural and anthropogenically-forced climate change by utilising observational data, proxy records, and climate models. It investigate rates of change, types of trends (linear, thresholds, accelerating), the onset of trends, and identification of contributing or alleviating feedback mechanisms. We focus on key aspects of the Antarctic environment (e.g. temperature, circulation patterns and strength, mass balance, snow accumulation, sea ice extent, ocean circulation, sea surface temperature, ocean salinity).
2. **Climate model verification for the Antarctic region.** This theme uses existing modeling results (i.e. CMIP5) and informs/stimulates new modeling initiatives (i.e. CMIP6) to evaluate and improve the ability of models to reconstruct past Antarctic climate conditions.
3. **Antarctic climate projection to 2100 AD.** The aim of this theme is to provide model output for short term changes (decadal estimates) to longer term projections (50-100+ years). We will focus in particular on the four IPCC AR5 RCPs which bracket low to high emission scenarios using models that are identified in theme 2 to show high skill for the Antarctic region.

The *AntarcticClimate*²¹ SRP proposal was conceived by research needs identified in the SCAR report – *Antarctic Climate Change and Environment (ACCE)* which highlighted the need for improved skill of earth system models in the Antarctic / Southern Ocean region. Considering the important and significant global consequences of change in the Antarctic / Southern Ocean region, this SRP specifically aims to assess the modelling skill in the Antarctic / Southern Ocean region, reduce uncertainties of key parameters and improve future projections in time for inclusion in the IPCC AR6.

2. Important Issues or Factors

*AntarcticClimate*²¹ successfully achieved important milestones for Objectives 1 and 2 over the past 12 months. We successfully published the conclusions and recommendations of our first two workshops and co-sponsored and organized the first AnT-ERA / AntEco / *AntarcticClimate*²¹ combined workshop to be held in Sep 2015. The first workshop, held in 2013 aimed at identifying principle Antarctic / Southern Ocean drivers of change and feedbacks that influence most climate model skill and uncertainty. The resulting Mayewski et al. 2014 publication represents a community perspective of potential surprises which are not

yet adequately considered by the broader science community, require comprehensive assessment in projections, and are not yet included in policy efforts. The second *AntarcticClimate*²¹ workshop, held in Dec 2014, focused on evaluation on the current skill of CMIP5 climate models over the Antarctic / Southern Ocean region and the development of a standardized testing and reporting method in time for uptake for CMIP6 experiments which was published in 2015. Through the initiative of AnT-ERA, led by Dr. Julian Gutt, *AntarcticClimate*²¹ engaged in a dialogue between physical scientists and biologists to improve our understanding of climate change on the Antarctic / Southern Ocean Ecosystem. A first community paper led by Dr. Gutt was published in 2015 and an in-depth workshop to develop this collaboration is organized for September 2015.

i) Five Scientific Highlights

Antarctic sea ice trends linked to atmospheric circulation pattern: While Arctic sea ice has been steadily declining with perhaps a short break in the past two years, Antarctic sea ice extent continues to increase by about 1.5% per decade since 1979. This increase is net effect by a strong decrease in the Amundsen / Bellingshausen Sea over-compensated by a strong decrease in the Ross Sea. Using the available reanalysis data, the variability of the Ross Sea sea ice extent is closely linked with the depth of the Amundsen Sea Low. This semi-permanent low pressure centre located in the Pacific sector of the Southern Ocean has deepened also since 1979 linked to changes in the tropical sea surface temperature. Higher skill IPCC CMIP5 models show agreement that the positive sea ice trend is linked to the internal variability of the ASL. Reference: Turner, J., J. S. Hosking, T. J. Bracegirdle, G. J. Marshall, and T. Phillips (2015a), Recent changes in Antarctic sea ice, *Philosophical Transactions of the Royal Society of London A: Mathematical, Physical and Engineering Sciences*, 373(2045), 20140163.

Atmospheric carbon dioxide and methane concentration record extended to 1 Million years ago: EPICA Dome provided the longest continuous greenhouse gas record back to ~750,000 years. Since then a coordinated search for the oldest ice is aiming to extend this record at least to 1.5 Million years to capture the transition from 40,000 year climate cycles to 100,000 year cycles. Now, an unconventional method has been tested whereby advecting ice at the margin of the Trans-Antarctic Mountains is reached within a few hundred meters of the surface, potentially reducing the logistical burden of obtaining old ice. The ice recovered from the Allan Hills has been dated using the relative abundance of ⁴⁰Ar to be 1 million years old. The carbon dioxide and methane concentration were shown to vary between 221 to 277 parts per million and 411 to 569 parts per billion, spanning only about 50% of the current range of glacial / interglacial cycles. These results demonstrate that shallow coring of Antarctica's blue ice areas could provide at least a discontinuous record beyond the 800,000 years ago. Reference: Higgins, J. A., A. V. Kurbatov, N. E. Spaulding, E. Brook, D. S. Introne, L. M. Chimiak, Y. Yan, P. A. Mayewski, and M. L. Bender (2015), Atmospheric composition 1 million years ago from blue ice in the Allan Hills, Antarctica, *Proceedings of the National Academy of Sciences*, 201420232.

Assessment of past and future variability of the Amundsen Sea Low – West Antarctic warming and Antarctic sea ice trends: The Amundsen Sea Low (ASL), a semi-permanent low pressure centre in the Pacific Sector of the Southern Ocean, is a strong driver of variability in West Antarctica. Assessment of re-analysis data, ice core geochemistry, and climate model projections suggest that the ASL has deepened since 1979, affecting regional meridional winds, which led to more efficient advection of moisture and heat into West Antarctica. At the same time it encouraged stronger off-shore flow in the Ross Sea leading to stronger sea ice export and production. Projections for the coming century suggest that the ASL will continue to deepen due to greenhouse gas forcing at least during some seasons, which will lead to stronger warming in West Antarctica. Ref: Raphael, M., G. Marshall, J. Turner, R. Fogt, D. Schneider, D. Dixon, J. Hosking, J. Jones, and W. Hobbs (2015), The Amundsen Sea Low: Variability, Change and Impact on Antarctic Climate, *Bulletin of the American Meteorological Society*(2015).

The current and future status of Southern Ocean carbon uptake: The Southern Ocean plays a central role in the global carbon cycle via two opposing mechanisms: carbon dioxide sequestration and ventilation. While occupying only about a third of the global ocean surface area, the Southern Ocean accounts for about half of anthropogenic CO₂ uptake mitigating transient climate change consequences from fossil fuel

emissions. However, the current state and trend of this uptake is uncertain. A new analysis of dissolved inorganic carbon (DIC) from data spanning 1992 to 2011 suggests that Antarctic surface water to about 100 m depth show a storage rate of anthropogenic carbon dioxide of about twice that of the global average. This trend is matched by a decrease in pH which led to a decrease in saturation state of aragonite and a shallowing of the aragonite saturation depth. A decrease of DIC in deeper waters, i.e. Circumpolar Deep Water, is indicative of either reduced ventilation of CO₂ rich deep water or a slowing of the circulation strength. Ref: Williams, N. L., R. A. Feely, C. L. Sabine, A. G. Dickson, J. H. Swift, L. D. Talley, and J. L. Russell (2015), Quantifying anthropogenic carbon inventory changes in the Pacific sector of the Southern Ocean, *Marine Chemistry*, 174, 147-160

Assessment of model performance of simulating the Southern Annular Mode – Surface Temperature Relationship: The Southern Annular Mode (SAM) describes the strength and location of the westerly wind belt that circulates Antarctica. Over the recent decades, these winds moved southwards and accelerated predominantly due to greenhouse gas and ozone depletion forcing. Despite the importance of the SAM for Antarctic and Southern Ocean conditions, most models struggle to capture the characteristics of SAM correctly, placing the SAM too far northwards. This new study assessed systematically the skill of five CMIP5 models using six Antarctic meteorological station data with a focus on the relationship between representation of SAM and capturing surface temperatures. The results showed that these models underestimate variability and displayed a seasonal bias with higher skill during winter and lowest skill during autumn and summer. The publication outlines suggestions on performance assessment criteria, such as the correct representation of the climatological mean and variability of the planetary longwaves to improve model skill in the Antarctic / Southern Ocean region. Ref: Marshall, G. J., and T. J. Bracegirdle (2014), An examination of the relationship between the Southern Annular Mode and Antarctic surface air temperatures in the CMIP5 historical runs, *Climate Dynamics*, 1-23

ii) Progress against prior work plan, including metrics of performance.

Since its establishment, the *AntarcticClimate*²¹ Steering Committee met at least yearly in face to face meetings and about three monthly via video conferencing. Overall the group is on target to deliver on scheduled milestones as outlined below with some minor delays. Moreover, we also included additional science targets.

Scheduled Milestones in 2014

- Publication of *Quantification of Antarctic climate variability* Report.
This publication has now been published under the leadership of Prof. Paul Mayewski in *Journal of Quaternary Science* – please see details under 3.Outputs/Deliverables.
- Workshop 2 *Climate model verification for the Antarctic region*
This workshop was held during 11-12 December in San Francisco, USA. Two participants were unable to attend due to severe weather conditions along East Coast of the US which led to cancellations of flights. However, all remaining participants managed to attend this highly successful meeting. Under the leadership of Dr. Thomas Bracegirdle, the group systematically identified those model parameters that are most sensitive to capture and quantify change in the Antarctic / Southern Ocean region and developed guidelines on modeling experiment design and for a standardized reporting of parameters to permit model intercomparison.
- Conduct modeling studies as identified during workshop 2
This milestone has been delayed for two reasons. Firstly, we joined Prof. Julian Gutt, Chair of AnT-ERA to develop a collaboration to assess the impact of current and projected climate change on the Antarctic / Southern Ocean ecosystem. For this we collaborated under the leadership of Prof. Gutt on an initial publication (please see details under 3.Outputs/Deliverables) and then on the organization of a combined workshop to accelerate progress on this important topic. The workshop will be held in September 2015 and we diverted funds to support this workshop. Secondly, the approval of the Southern Ocean Carbon and Climate Observations and Modeling (SOCCOM) programme has been an important development that will permit the inclusion of many more observational data and provides an exciting opportunity to undertake modeling experiments that

are vital and specific to scientific goals of AntarcticClimate21. Prof. Joellen Russell is the leader of SOCCOM theme II – ‘Modeling’ and aims to make available the relevant data and model experiment via the *AntarcticClimate*²¹ webpage.

- SCAR 2014 Open Science Conference – Session on “AntarcticClimate21”

A highly successful AntarcticClimate²¹ session was held during the SCAR 2014 Open Science Conference. We were particularly encouraged by the fact that contributions ranged from atmosphere/ocean/ice observations to reconstructions and modeling studies. A joint session between AnT-ERA and AntarcticClimate21 successfully attracted contributions that investigated ecosystem responses and feedback to environmental change.

3. Outputs/Deliverables

AntarcticClimate²¹ Steering Committee Publications:

- Mayewski, P.A., Bracegirdle, T., Goodwin, I., Schneider, D., Bertler, N.A.N., Birkel, S., Carleton, A., England, M.H., Kang, J.H., Khan, A., Russell, J., Turner, J., Velicogna, I., 2015. Potential for Southern Hemisphere climate surprises. *Journal of Quaternary Science* 30, 391-395

This publication represents the results of the AntClim21 workshop 1, quantifying Antarctic Climate variability with a particular focus on outlining the potential for climate surprises that are not yet well represented in earth system models and / or included in policy discussions.

- Bracegirdle, T.J., Bertler, N., Carleton, A.M., Ding, Q., Fogwill, C.J., Fyfe, J.C., Hellmer, H.H., Karpechko, A.Y., Kushara, K., Larour, E., Mayewski, P.A., Meier, W.N., Polvani, L.M., Russell, J.L., Stevenson, S.L., Turner, J., van Wessel, J.M., van de Berg, W.J., Wainer, I., 2015. A MULTI-DISCIPLINARY PERSPECTIVE ON CLIMATE MODEL EVALUATION FOR ANTARCTICA. *Bulletin of the American Meteorological Society*

This publication represents the results of the AntClim21 workshop 2, Climate model verification for the Antarctic region, providing guidelines for model experiment design and standardized parameter reporting.

- Gutt, J., N. Bertler, T. J. Bracegirdle, A. Buschmann, J. Comiso, G. Hosie, E. Isla, I. R. Schloss, C. R. Smith, and J. Tournadre (2015), The Southern Ocean ecosystem under multiple climate change stresses-an integrated circumpolar assessment, *Global change biology*, 21(4), 1434-1453.

This publication, led by Prof. J. Gutt, is the first collaboration between AnT-ERA and AntClim21 to develop a comprehensive assessment of vulnerabilities of the Antarctic / Southern Ocean Ecosystem to current and future climate change and provided the foundation for the AnT-ERA/AntClim21/AntEco workshop scheduled for September 2015.

Workshop:

Second AntarcticClimate21 Workshop: “Climate model verification for the Antarctic region”

This workshop was held adjacent to AGU and was attended by 20 invited participants. The aim of this workshop was to identify key parameters that dominate model skill in the Antarctic / Southern Ocean region and to provide guidelines for effective model experiment design and standardized parameter reporting for inter-model comparison and assessment. The broad range of expertise represented at the workshop supported robust discussions and resulted in a comprehensive set of guidelines which were published as described above.

Databases:

AntarcticClimate21 Gateway: We commenced the process of designing a gateway through the SCAR supported AntarcticClimate21 webpage to provide access, information, and guidelines for data and models for non-experts. We anticipate

Education and Outreach

As a group, AntarcticClimate21 gave over 50 outreach talks to national government agencies, non-expert fora, and public audiences. In particular noteworthy is an invited presentation on sea level rise projections to the 31st General Assembly of ICSU (30 August – 3 September 2014, Auckland, New Zealand). Furthermore, a number of *AntarcticClimate*²¹ SC members have been part of the climate change documentary 'Thin Ice' which has now also produced a TV-length version and secured screening contracts.

4. Budgetary Implications

Main Expenditure; any reasons for underspend; requested budget over next two years

2015 Budget	Expenditure	Budget
2015 Budget Request		\$ 20,000.00
Support for APECS Representative to attend SC Meetings and Workshops	\$ 2,500	
AnT-ERA / AntClim21 Workshop	\$ 17,500	
AntClim21 Webpage	\$ 1,000	

2016 Budget	Expenditure	Budget
2016 Budget Request		\$ 20,000.00
Support for APECS Representative to attend SC Meetings and Workshops	\$ 2,500	
AntClim21 Symposium	\$ 7,500	
AntClim21 Webpage	\$ 4,000	
Publication Fees (incl. \$3k for 2015)	\$6,000	

5. Future Plans

Future plans over next two years, in particular any deviations from original work plan, including information pertinent for SRP review process.

Scheduled Milestones in 2015

- Publication of 'Climate model verification for the Antarctic region' publication.
- This publication is now published under the leadership of Dr. Bracegirdle in Bulletin of the American Meteorological Society – please see details under 3.Outputs/Deliverables.
- Workshop 3 Antarctic climate projection to 2100 AD.
This workshop has been delayed to permit the collaboration on the combined AnT-ERA / AntClim21 / AntEco workshop to be held in September 2015
- Workshop 3 Interactions between biological and climate processes in the Antarctic
This workshop is a new initiative led by Prof. Gutt and focuses on the cumulative impact of current and projected climate change on the Antarctic / Southern Ocean ecosystem and feedbacks from the biosphere on the carbon cycle.

Scheduled Milestones in 2016

- Workshop 3 Antarctic climate projection to 2100 AD.
This workshop has now been moved to 2016 to incorporate SOCCOM efforts and to provide support for the combined AnT-ERA / AntClim21 / AntEco workshop.
- Completion of model projections to 2100 AD for models identified in the "Climate Model verification for the Antarctic region' publication.

We anticipate that this milestone will move into 2017 to permit a rigorous assessment of the model experiments which will be discussed during Workshop 3.

- Development of the AntarcticClimate21 webpage portal

This is a new initiative and will be based on the current AntarcticClimate21 webpage. The main aim is to provide access to data, model experiments and description for easy access of non-specialist users. This will provide access for example to CMIP4 and CMIP5 model experiments and SOCCOM data and model experiments. In addition, this portal will be populated with guidelines and an assessment for non-expert users on model availability and performance (i.e. which model might be the best choice for a particular purpose) and contact details for experts who can help. Initial work conducted by Dr. Bracegirdle and Prof. Russell has been very successful and outlined a strong need for such a service.

- SCAR Open Science Conference – Session on “Climate / Earth System Model performance in Antarctica”

A coordinated proposal for a session – ‘*The Antarctic ice sheet from Past 2 Future*’ has been suggested by representatives of PAIS, AntClim21, SERCE, ISMASS which we hope will be accepted and would facilitate efficiently collaboration between relevant SRPs.

Milestones for 2017

- Publication of *Antarctic climate projection to 2100 AD* publication.
- Succession planning – what are the next urgent, important science questions?

Milestones for 2018

- Publication of *AntarcticClimate²¹* Report. This report is the principle output from the proposed programme *AntarcticClimate²¹* and will be based on the three publications listed above in addition to two additional chapters – a) Summary for policymakers and b) Important Remaining Questions.
- SCAR Open Science Conference – Session on “*Antarctica Climate Projections – Global Challenges*”

Appendices

Steering Committee

Nancy Bertler (Chair, NZ)
 Thomas Bracegirdle (Leader, Objective 2 – Climate model verification for the Antarctic Region, UK)
 Alia Khan (APECS Representative, USA)
 Paul Mayewski (Co-Leader, Objective 1 – Quantification of Antarctic Climate Variability, USA)
 Joellen Russell (Leader, Objective 3 – Antarctic Climate Projection to 2100 AD, USA)
 John Turner (Co-Leader, Objective 1 – Quantification of Antarctic Climate Variability, UK)

Lead Authors for Publication ‘Quantification of Antarctic Climate Variability’

Paul Mayewski (USA), Nancy Bertler (NZ), Thomas Bracegirdle (UK), Matt England (Australia), Ian Goodwin (Australia), Jung-Ho Kang (Korea), Alia Khan (USA), Paul Kushner (Canada), Joellen Russell (USA), David Schneider (USA), John Turner (UK), Isabella Velicogna (USA)

Lead Authors for Publication “Climate Model Verification for the Antarctic Region”

Thomas Bracegirdle (UK), Nancy Bertler (NZ), Andrew Carleton (USA), Qinghua Ding (USA), Chris Fogwill (Australia), John Fyfe (USA), Hartmut Hellmer (Germany), Alexey Karpechko (Finland), Alia Khan (USA), Kazuya Kusahara (Japan), Eric Larour (France), Walter Meier (USA), Paul Mayewski (USA), Lorenzo Polvani (USA), Joellen Russell (USA), Samantha Stevenson (USA), John Turner (UK), Melchior van Wessern (Netherlands), Willem van de Berg (Netherlands), Ilana Wainer (Brazil)

Confirmed Lead Authors to date for Publication “What are the synergistic effects of multiple stressors and environmental change drivers on Antarctic and Southern Ocean biota”

Julian Gutt (Germany), Nancy Bertler (NZ), Greg Bodekker (NZ), Thomas Bracegirdle (UK), Joey Comiso (USA), Andrew Constable (Australia), Pete Convey (UK), Vonda Cummings (NZ), Bruno David (France), Rob De Conto (USA), Dave DeMaster (USA), Guido di Prisco (Italy), Matt England (Australia), Domack Eugene (USA), Huw Griffiths (UK), Satoshi Imura (Japan), Enrique Isla (Spain), Fred Jopp (Germany), Alia Khan (USA), Paul Mayewski (USA), Alison Murray (USA), Alix Post (Australia), Cavanagh Rachael (UK), Yan Ropert-Coudert (France), Joellen Russell (USA), Reed Scherer (USA), Stefano Schiaparelli (Italy), Irene Schloss (Canada), Oscar Schofield-Quest (USA), Mike Schroeder (Germany), CraigSmith (USA), Jan Stefels (Netherlands), Craig Stevens (NZ), Jan Strugnell (Australia), Scarlett Trimborn (Germany), John Turner (UK), Cinzia Verde (Italy), Elie Verleyen (Belgium), Diana Wall (USA), Nerida Wilson (Australia), Jose Xavier (Portugal)