

## **6.0 RELATIONS WITH INTERGOVERNMENTAL ORGANIZATIONS**

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- 6.2 Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP), p. 6-1** *Urban*
- 6.3 North Pacific Marine Science Organization (PICES), p. 6-15** *Sun Song*

## 6.0 RELATIONS WITH INTERGOVERNMENTAL ORGANIZATIONS

### 6.1 Intergovernmental Oceanographic Commission (IOC)

Sicre

Report will be distributed before the meeting

### 6.2 Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP)

Urban

#### GESAMP Working Group 38 on Atmospheric Input of Chemicals to the Ocean

Report on two workshops on the changes in the acid/base balance of the atmosphere and ocean and their subsequent impacts on air/sea chemical exchange

*University of East Anglia, Norwich, United Kingdom 27 February - 2 March 2017*

From 27 February to March 2 two workshops took place at the University of East Anglia (UEA), Norwich, United Kingdom under the auspices of GESAMP Working Group 38 and sponsored by WMO, NSF, SCOR, SOLAS, and UEA. These workshops focussed on the changes in the acid/base balance of the atmosphere and ocean, and their impacts on air-sea exchange.

Workshop 1 focussed on *Changing Atmospheric Acidity and its Impacts on the Oceanic Solubility of Nutrients* and Workshop 2 focussed on *The Impact of Ocean Acidification on Fluxes of Non-CO<sub>2</sub> Climate-Active Species*. These two themes recognise the importance of both atmospheric nutrient deposition to the biogeochemistry of the oceans and also the importance of the emissions of trace gases from the ocean for atmospheric chemistry and climate regulation. Given that there has been a great deal of focus on the air-sea exchange of CO<sub>2</sub> in many symposia, the focus here in Workshop 2 was on a range of other climatically important gases including halogen, nitrogen and sulphur species. These gases play a key role in controlling radiative forcing, atmospheric oxidising capacity and atmospheric chemistry. The other key context for the meeting was the changing nature of the ocean and atmospheric acid/base balance and associated pH regime.

The atmosphere has already been through a major phase of anthropogenic acidification due to the emissions of extra SO<sub>2</sub> and NO<sub>x</sub> to the atmosphere from combustion sources. This acidification has been offset to some extent by neutralisation associated with ammonia emissions which come mainly from agriculture. Vigorous regulatory efforts over the last few decades have greatly decreased SO<sub>2</sub> emissions, and the impact of NO<sub>x</sub> control measures on vehicles have meant that NO<sub>x</sub> emissions from these have been stabilising. However, continuing intensification of agriculture has increased ammonia emissions. The combined effect of these changes in emissions is a steady reduction in atmospheric acidification. This process has reduced acidity in many areas of the world and may even lead to alkaline rain

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long term. The solubility of several key ocean nutrients (particularly iron and phosphorus), which are mineral aerosol-bound, is very sensitive to pH, and hence changing atmospheric acidity has the potential to change the inputs of bioavailable soluble nutrients in the future. Workshop 1 considered this issue and its effects on ocean biogeochemistry, utilising a wide range of approaches from fundamental chemistry, through modelling, to field work.

The oceans are now demonstrably being acidified by the uptake of CO<sub>2</sub> as this increases in concentration in the atmosphere. This process will continue for decades, before (hopefully) the Paris Climate agreement begins to control the problem. While there have been great advances in our understanding of the direct biogeochemical impacts of ocean acidification, the question considered by Workshop 2 was how this ocean acidification may affect the production and air-sea exchange of these trace gases, and whether this effect will mitigate or enhance global change pressures. Thus, Workshop 2 considered the impacts of ocean acidification on ocean biogeochemistry and ecosystems, and how this in turn can affect air-sea exchange at both the global and regional scale. The workshop considered a wide range of approaches from fundamental cellular processes through ecosystem considerations to global models, and from laboratory to mesocosm and field studies. It also considered the links to other global change stressors, particularly global warming and its ramifications for ocean circulation.

Given the intriguing symmetry of potentially important impacts of changing acidity (albeit in opposite directions) on both sides of the air-sea interface we wanted to host these two meetings in parallel to allow crossovers between the various experts to develop. So 25 scientists from around the world gathered in Norwich, UK along with 8 locally based experts and discussed a wide range of issues around these respective themes, often as two separate groups, but with regular social interactions over shared refreshments, and also some more structured joint sessions.

The meetings took the form of rather informal presentations from experts followed by very lengthy discussion sessions exploring multiple issues and feedbacks evident in these complex air-sea interaction issues. The invited scientists were selected for their expertise and interest in these areas, and also to provide a wide spectrum of expertise from modellers to experimentalists. We drew scientists from 16 different countries and also from a wide range of career stages from senior scientists to graduate students.

The participants all seemed to leave Norwich full of enthusiasm for the process and the new scientific insights the groups had developed. The aim now is to write a series of papers synthesising these conclusions. By an interesting coincidence, two papers from a similarly sponsored and structured GESAMP WG 38 workshop were published at about the time of the workshop: Sharples et al. (2016) “What proportion of riverine nutrients reaches the open ocean?”, *Global Biogeochemical Cycles* 31, doi:10.1002/2106GB005483 and Jickells et al. (2017) “A re-evaluation of the magnitude and impacts of anthropogenic nitrogen inputs on the ocean”, *Global Biogeochemical Cycles* 31, doi:10.1002/2016GB005558. These papers, in turn, are based on an earlier similar workshop reported in Duce et al. (2008) “Impacts of atmospheric nitrogen on the open ocean”, *Science* **320**, 893-897.

The following appendices provide the agendas of the two workshops, a tentative list of the peer-reviewed scientific papers that we expect to result from these workshops, a list of the workshop participants and their addresses, a list of the members of GESAMP Working Group 38, and a photo of the workshop participants.

We thank WMO, NSF, SCOR, SOLAS, and UEA for their strong financial and intellectual support for these workshops. We also thank all the participants for travelling from near and far to participate, for leaving their families, day-to-day cares and duties (well the e-mail still finds you!) and for embracing the excitement of this scientific dialogue, and we look forward to the speedy preparation of all of the promised manuscripts.

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## APPENDIX I

GESAMP Working Group 38

AGENDAS for two workshops on the changes in the acid/base balance of the atmosphere and ocean and their subsequent impacts on air/sea chemical exchange

*University of East Anglia, Norwich, United Kingdom February 27 - March 2, 2017*

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### **AGENDA - Plenary Session for Both Workshops**

**Monday, February 27, Environmental Sciences Seminar Room**

**09:00 - 09:30** Introduction and local logistics - **Tim Jickells, Co-Chair, WG 38**

**09:30 - 10:00** What is GESAMP? - **Peter Kershaw, Chair GESAMP**

*10:00 - 10:30*

- Working Group 38 and its activities - **Robert Duce, Co-Chair, WG 38**
- Introduction to Workshop 1 **Alex Baker, Co-Chair, Workshop 1**
- Introduction to Workshop 2 **Parv Suntharalingam, Tri-Chair Workshop 2**

**10:30** - Coffee and move to the Blackdale Building

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### **AGENDA - Workshop #1**

Changing Atmospheric Acidity and the Oceanic Solubility of Nutrients

Co-Chairs: Alex Baker and Manmohan Sarin

#### **Terms of Reference:**

- Review and synthesize the current scientific information on the solubility of aerosol associated key biogeochemical elements, the biogeochemical controls on aerosol solubility, and the pH sensitivity of those controls.
- Consider the likely changes in solubility of key species into the future and the potential biogeochemical consequences of such changes.
- Identify the key future research needs to reduce uncertainties in predictive capability in this area.
- Publish the results of this activity in the open peer-reviewed scientific literature.
- Interact with, and provide information to, leading relevant international groups including the Future Earth core projects SOLAS, IGAC and IMBER; SCOR, particularly its GEOTRACES program; and WMO programs such as GAW.

**Monday, February 27 Blackdale Building**

**11:00 - 12:30** Introduction            **Alex Baker and Manmohan Sarin**

**12:30 - 13:15** Lunch

**13:15 - 17:30** Initial discussion presentations

- *Underlying chemical controls on nutrient/trace element solubility* **David Turner**
- *Potential changes in relevant emissions and their likely impact on atmospheric acidity*  
**Maria Kanakidou**
- *Model schemes for simulating the influence of acidity of nutrient / trace element solubility* **Thanos Nenes and Akinori Ito**
- *Modelled nutrient / trace element deposition fields* **Natalie Mahowald and Stelios Myriokefalitakis**
- *Ocean regions likely to be impacted by atmospheric nutrient / trace element supply*  
**Peter Croot and Cecile Guieu**

**Tuesday February 28 Blackdale Building**

**09:00 - 10:30** Conclude discussion presentations (if necessary) and begin open discussion  
- Where do we go from here?

**10:30 - 10:45** Coffee break

**10:45 - 12:30** Continuing evaluation of workshop science questions and how to focus publications.

**12:30 - 13:15** Lunch

*13:15 - 15:30 We will continue with a flexible schedule, if appropriate splitting into smaller topic groups. The aim will be to go with the science flow, but with an ultimate goal of developing one or more topical review papers.*

**15:30 - 15:45** Tea break

**15:45 - 17:30** Continuing discussions and end of day stock-take.

**Wednesday March 1 Blackdale Building**

**09:00 - 10:30** Continuing discussions.

**10:30 - 10:45** Coffee break

**11:00 - 12:30** Continuing discussions

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**12:30 - 13:15** Lunch

**13:15 - 15:30** Continuing discussions/planning.

**15:30 - 15:45** Tea break

*15:45 - 17:30 Continuing discussions/planning/writing and end of day stock- take.*

## **Thursday March 2 Blackdale Building**

**09:00 - 12:30**

- Discussion, assignment of writing tasks
- Report back to plenary session.

**12:30 - 13:15** Lunch – Close of workshop

AGENDA - Workshop #2*Impact of Ocean Acidification on Fluxes of non-CO<sub>2</sub> Climate-Active Species*

Tri-Chairs: Parv Suntharalingam, Marion Gehlen, and Frances Hopkins

**Terms of Reference**

- Review and synthesize the current science on the direct impacts of ocean acidification on marine production and emissions to the atmosphere of key species important for climate and atmospheric chemistry.
- Identify the primary needs for new research to improve process understanding and to quantify the impact of ocean acidification on these marine fluxes (i.e., provide recommendations on the specific laboratory process studies, field measurements and model analyses needed to support targeted research activities and improved understanding on this topic).
- Publish the results of this activity in the open peer-reviewed scientific literature.
- Provide input to and interact with national and international research programs on ocean acidification (e.g., UKOA, NOAA-OAP) and with relevant WMO programs (e.g., Global Atmosphere Watch (GAW)) to build on their recent relevant activity in achieving the above objectives.

**Monday, February 27 Blackdale Building****12:30 - 13:15** Lunch**13:15 - 17:30** Initial discussion presentations**Introduction to Ocean-Acidification and non-CO<sub>2</sub> Trace-Gas Session****CHAIR: Parv Suntharalingam**

- *Introduction and workshop aims* **Parv Suntharalingam**

**Overview of recent progress in ocean acidification research***Talks of ~ 30 mins, including 5 mins for discussion*

- *Lessons learned from the UK Ocean Acidification research programme* **Phil Williamson**
- *Challenges and tools for ocean acidification research* **Cliff Law**
- *Trace-gases (non-CO<sub>2</sub>) and ocean acidification: Overview of experimental methodologies* **Frankie Hopkins**

**15:30 - 16:00** Tea break



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## Ocean acidification Impacts on Ocean Biogeochemistry and Ecosystems

Talks of ~ 30 mins, including 5 mins for discussion

- *Ocean acidification: Biogeochemical Impacts and Feedbacks to the Earth System*  
**Marion Gehlen**
- *Re-evaluation of enhanced export production by carbon overconsumption under high CO<sub>2</sub>*  
**Kitack Lee**
- *Indirect impact of ocean acidification on trace gases through pteropod mortality / aragonite dissolution*  
**Erik Buitenhuis**

Tuesday February 28 Blackdale Building

**09:00 - 12:30** Initial discussion presentations (continued)

Ocean Acidification Influences on Trace Gases

(CHAIR: **Frankie Hopkins**)

Talks of 20 - 30 mins, including 5 mins for discussion

### Metabolism of trace-gases: The importance of metals **Colin Murrell**

*Reactive trace-gases: DMS and Halocarbons*

- *Effects of ocean acidification on marine DMS emissions: results from experimental studies*  
**Steve Archer**
- *Ocean acidification and DMS: what can we learn from cultures?*  
**Gill Malin**
- *Influence of ocean acidification on biogenic short-lived halocarbons by marine algae*  
**Fiona Keng**

**10:30 - 11:00** Coffee break

### Methane, N<sub>2</sub>O and the nitrogen cycle

- *Impact of ocean acidification on N<sub>2</sub>O and CH<sub>4</sub>*  
**Andy Rees**
- *Ocean acidification impacts on the nitrogen cycle*  
**Cliff Law**
- *Modelling impacts of ocean acidification on organic matter stoichiometry: Implications for marine nitrous oxide production*  
**Oliver Andrews**
- *Ammonia, pH and interactions with the sulfur cycle*  
**Martin Johnson**
- *Impact of deoxygenation and ocean acidification on N<sub>2</sub>O and CH<sub>4</sub>*  
**Hema Naik**

(Continue this session after lunch if needed)

**12:30 - 13:30** Lunch

13:30 - 17:30

Trace-gas Synthesis for Workshop Paper: Break-out groups to work on individual trace-gas sections of summary paper. Suggested breakout groups: (a) Short-lived species (DMS, Halocarbons); and (b) CH<sub>4</sub>, N<sub>2</sub>O

Aims: Produce summary from observational perspective for the different species, drawing on available observations, lab and in-situ studies. Identify information on process controls. Identify data gaps.

### **Wednesday March 1 Blackdale Building**

**09:00 - 10:30** Discussion presentations (continued)

Trace gases and multiple stressors (CHAIR:

**Marion Gehlen)**

*Talks of 20 - 30 mins, including 5 mins for discussion*

- *Expected response of greenhouse gases to multiple stressors: thoughts on an experimental approach* **Andy Rees**
- *Expected response of trace gas emissions to multiple stressors: insights from ocean biogeochemical models* **Laurent Bopp**
- *Amplification of global warming through pH-dependence of DMS-production* **Nadine Goris**

**10:30 - 11:00** Coffee

*11:00 - 12:30*

Regions vulnerable to the impacts of ocean acidification: high latitudes, coastal, and upwelling zones (CHAIR : **Frankie Hopkins**)

*Talks of 20 - 30 mins, including 5 mins for discussion*

- *Ocean acidification in the Arctic Ocean and its impacts on DMS cycling* **Martine Lizotte**
- *DMS concentrations in the polar oceans are resilient to short term ocean acidification* **Frankie Hopkins**
- *Nitrogen cycle dynamics in upwelling zones* **Isabelle Dadou**

**12:30 - 13:15** Lunch

*13:15 - 17:30*

Knowledge gaps and uncertainties, and future research needs

- Reports from Rapporteurs: Synthesis of key points from previous sessions
- Break-out sessions to work on the following for summary paper:
  - Main knowledge gaps, uncertainties and challenges
  - Future research needs: Observational programs, experimental methods, and

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requirements for improved model predictions

*Contributors: All participants*

Thursday March 2 Blackdale Building

**09:00 - 12:30**

- *Workshop paper synthesis activities*
- *Report back to plenary session*

**12:30 - 13:15** Lunch – Close of workshop

## APPENDIX II

Draft Paper Titles and Lead Authors – Working Group 1

- *Changing atmospheric acidity as a modulator of ocean biogeochemistry (Alex Baker - Review)*
- **The evolution of iron deposition over the ocean: A composite modeling view** (Stelios Myriokefalitakis)
- *Evaluation of labile iron processing in atmospheric models (Akinori Ito)*
- **Evolution of atmospheric acidity impacts on nutrient deposition** (Maria Kanakidou/Thanos Nenes)
- *Controls and impacts of atmospheric nutrient solubility in the ocean (Peter Croot)*
- **Impacts of the episodic atmospheric deposition on ocean biogeochemistry** (Peter Croot)
- **Links between nutrient stoichiometry of atmospheric deposition and surface seawater** (Natalie Mahowald/Maria Kanakidou)

Draft paper titles and lead authors – Working Group 2

- **Changing ocean acidity as a modulator of atmospheric biogeochemistry and climate** (Frances Hopkins - Review)
- *A synthesis of the DMS response to ocean acidification observed in mesocosm experiments (Steve Archer)*
- **Ocean N<sub>2</sub>O emissions: current estimates and anthropogenically influenced changes** (Parvadhe Suntharalingam)
- **Ocean model internal variability assessment** (Laurent Bopp)
- **Ammonia emissions and atmospheric acidity** (Martin Johnson)

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## APPENDIX III

Participants at the GESAMP 38 Workshops

**University of East Anglia, Norwich, United Kingdom February 27-March 2, 2017**

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## APPENDIX IV

Membership - GESAMP Working Group 38

The Atmospheric Input of Chemicals to the Ocean

**Co-Chairs:**

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APPENDIX V

Photo of Participants at the Two GESAMP WG 38 Workshops

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**SCOR and PICES Collaborative Activities****Report from PICES for the 2017 SCOR Annual Meeting  
September 4-6, 2017, Cape Town, South Africa**

The North Pacific Marine Science Organization (PICES) is an intergovernmental scientific organization established by an international convention in 1992, in order to promote and coordinate marine scientific research in the North Pacific and adjacent seas. Our current member countries are Canada, Japan, People's Republic of China, Republic of Korea, Russian Federation and the United States of America. Our goals are to (1) advance scientific knowledge and capacity available for the member countries, including information on human activities affecting, and affected by marine ecosystems, and (2) provide a mechanism for collaboration among scientists in addressing timely and critical scientific questions about the North Pacific. In the 25 years since its establishment, PICES has become a major forum for the discussion and sharing of marine science in the North Pacific. Information on the Organization and its activities is available on the PICES website at <http://www.pices.int>.

Continuing and expanding collaboration between PICES and SCOR is based on the recognition that PICES can play an important role in bringing a North Pacific perspective to the global activities of SCOR, and that by participating in and implementing these activities in the region, PICES can advance its own scientific agenda.

To discuss on-going and future collaborations, SCOR and PICES continue to regularly exchange observers to the others annual/executive meetings. In recent years, SCOR was represented by Dr. Sinjae Yoo (Korea) at the PICES-2014 annual meeting in Yeosu, Korea and Dr. Sun Song, Vice-president of SCOR at the PICES-2015 annual meeting in Qingdao. Dr. Harold Batchelder (PICES, SCOR Capacity Building Committee) attended the 2013 SCOR Executive Committee Meeting (Wellington, New Zealand), the 2014 SCOR meeting (Bremen, Germany), the 2015 meeting in Goa, India, and the 2016 meeting in Sopot, Poland.

This report provides an update on PICES-SCOR collaborations since the 2016 SCOR Meeting in Sopot, Poland (September 2016). This period includes the PICES 25<sup>th</sup> Annual Meeting, which was in San Diego, USA during November 2016. Dr. Urban (Executive Director, SCOR) attended PICES-2016 Annual Meeting in San Diego (7-13 November 2016) and presented an Observer Organization poster during the poster viewing period, and made a presentation about SCOR activities to the Science Board of PICES on Friday, November 11. During his presentation to the Science Board, Dr. Urban reviewed the common interests shared by PICES and SCOR, particularly highlighting that both organizations are strong proponents of capacity building. One suggestion was for PICES to be more involved in POGO-related projects such as ocean observing training cruises. Or that PICES might consider developing working group proposals for submission to SCOR. He also noted that SCOR and PICES co-funded an Open Access Article by SCOR Working Group 146 ([Radioactivity in the Ocean, 5 decades later](#)



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([RiO5](#)) and PICES Working Group 30 (*Assessment of Marine Environmental Quality of Radiation around the North Pacific*) in the *Annual Review of Marine Science*. SCOR's policy is to typically fund one Open Access article (usually a synthesis paper) per SCOR working group. SCOR used to purchase special issues and distribute them to developing countries, but that practice became too expensive to continue. Ed thanked PICES for its willingness to co-fund the Open Access of the SCOR 146/ PICES WG30 synthesis.

During this reporting interval, SCOR generously provided financial support for travel/local costs of early career scientists of “countries with economies in transition” for three PICES activities (SPF—Mar. 2017; ECS3—May 2017; PICES-2017—September 2017). PICES is greatly appreciative of SCOR's support, since it is difficult for PICES to fund participants from non-PICES countries.

- (1) In the previous year, SCOR provided \$5,000 USD for travel support of country in transition participants to the PICES-ICES 6<sup>th</sup> Zooplankton Production Symposium “New Challenges in a Changing Ocean” that was held in May 2016 in Bergen, Norway. Four scientists were recommended and approved for funding using SCOR funds (**Appendix 1, Table 1**). Three of these young scientists attended. Unfortunately, one from Peru was unable to attend. The unused funds (\$1,490 USD) from the cancelled traveler were reallocated (with the approval of Dr. Urban) to travel support for the May 2017 3<sup>rd</sup> Early Career Scientist (ECS3) Conference “*Climate, Oceans and Society: Challenges and Opportunities*”, in Busan, Korea. SCOR also provided \$2500 USD to PICES to support travel of SCOR eligible developing nation early career scientists to attend the 3<sup>rd</sup> Early Career Scientist Conference. See **Appendix 1 Table 2** for the list of SCOR-supported scientists to ECS3. Overall, 104 of the 124 invited early career scientists attended the ECS3 for four days of scientific sessions, networking and an afternoon excursion to several local cultural sites in Busan. The cancellations were due primarily to personal circumstances or inability to obtain a visa for entry to Korea.
- (2) SCOR provided \$5,000 USD for the PICES-2016 Annual Meeting “25 Years of PICES: Celebrating the Past, Imagining the Future”, which occurred from 2-13 November 2016 in San Diego, CA, USA. The scientists supported by SCOR travel support are shown also in **Appendix 1 Table 1**.
- (3) SCOR provided \$5,000 USD for an international symposium “Drivers of Dynamics of Small Pelagic Fish Resources (SPF)” that was held March 6-11, 2017 in Victoria, British Columbia, Canada. Summary of SCOR support shown in **Appendix 1 Table 2**.
- (4) SCOR provided \$2,500 USD for the PICES-2017 Annual Meeting that will be held from 22 September – 1 October 2017 in Vladivostok, Russia. Plus, Ed Urban approved transfer of \$283 USD residual from ECS3 to the PICES-2017. Projected support from SCOR shown in **Appendix 1 Table 2**.

## LARGE-SCALE OCEAN RESEARCH PROJECTS CO-SPONSORED BY SCOR

PICES contributes to SCOR-sponsored international large-scale ocean research projects, particularly IMBeR (and in the past SOLAS), by: (1) convening joint sessions/workshops with the projects at PICES Annual Meetings, (2) co-sponsoring symposia/workshops, (3) assisting projects having North Pacific activities with meeting logistics, and (4) contributing to participation of early-career scientists from the North Pacific region in project activities.

### ***Integrated Marine Biosphere Research (IMBeR)***

#### ▪ Joint sessions/workshops at PICES Annual Meetings

Until 2015, PICES and IMBeR often convened joint topic sessions at PICES Annual Meetings. IMBeR at PICES-2014 cosponsored a topic session on *Tipping points: defining reference points for ecological indicators of multiple stressors in coastal and marine ecosystems*". Co-sponsorship by IMBeR has been reduced during the past few years, as IMBeR focused on redefining their strategic and implementation plan for the transition from IGBP to Future Earth (FE). In May 2016, PICES Science Board Chairman Thomas Therriault and Hal Batchelder of the PICES Secretariat met with Eileen Hofmann (former chair of IMBER SSC), Einar Svendsen (Executive Officer, IMBeR), and Lisa Maddison (Deputy Executive Officer, IMBeR) in Bergen, Norway to discuss how to enhance collaborations between PICES and IMBeR.

- The PICES-2016 Annual Meeting held November 2-13, 2016, in San Diego, CA, USA had a theme of “25 Years of PICES: Celebrating the Past, Imagining the Future”. IMBeR was invited to submit a theme and cosponsor a topic session or workshop, but chose not to. The 2016 meeting was the 25<sup>th</sup> anniversary meeting of PICES, and had a different structure with more workshops (10), fewer concurrent sessions and more plenary sessions than are typical of the PICES annual meeting. Because there were many more posters than usual, posters were displayed for four days rather than the usual three days, and there will be two evening poster receptions rather than one. Gro van der Meeren (IMBeR Executive Officer) and Cisco Werner (IMBER SSC Vice-Chair) represented the IMBeR International Project Office at PICES-2016, and both made presentations to PICES Science Board. They highlighted some of the areas of overlap and common interest including the ESSAS Regional Program, the Carbon Working Group, and the connections between the IMBeR Human Dimensions Working Group and the PICES FUTURE integrative science program. At PICES-2017, PICES transitioned the Section-Human Dimensions expert group to full committee status (Human Dimensions Committee), which provides greater responsibility and visibility to socioeconomic issues and HD a voice on the PICES Science Board.

#### Co-sponsored symposia/conferences/workshops

- IMBeR co-sponsored (providing \$3,000 USD) the Small Pelagics Symposium that was held in March 2017 in Victoria, Canada. The funds were used to support travel expenses of three scientists as shown in **Appendix 2, Table 1**.

#### Capacity building activities

PICES approved financial support of \$7,000 CAD to IMBeR for cosponsorship of the IMBeR IMBIZO V that will be held in Woods Hole, MA, USA from 2-6 October 2017. **See Appendix 2, Table 2**

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## Regional Program level

- IMBER Regional Program on Ecosystem Studies of Sub-Arctic Seas (ESSAS)
  - PICES and ESSAS share the goal of using a comparative approach in developing predictions of how climate variability and change affect, and will affect, the sustainability of goods and services obtained from Sub-Arctic seas.
  - A topic session on “*Resilience, transitions and adaptation in marine ecosystems under a changing climate*” proposed by ESSAS was held at PICES-2016 and was convened by ESSAS Co-Chairmen Franz Mueter, Ken Drinkwater, and Sei-ichi Saitoh.
  - A PICES/ESSAS special issue of *Progress in Oceanography* on “*Modeling and observational approaches to understanding marine ecosystem dynamics*” (Guest Editors: E. Curchitser, S.I. Ito, M. Kishi, M. Peck and K. Rose) was published electronically in late 2015 and in hard copy in early 2016.
  - ESSAS requested financial support from PICES to cosponsor the ESSAS Open Science Meeting (OSM) in Tromso, Norway in June 2017. The PICES Science Board agreed to provide \$14,000 CAD for early career scientist travel to the OSM. See **Appendix 2, Table 1** for details on financial support. Since these funds came from the PICES trust fund, they can only be spent on early career scientists from within the six PICES countries.
- IMBeR Regional Program on CLimate Impacts on Oceanic TOP Predators (CLIOTOP)
  - PICES was a contributing sponsor of the 3<sup>rd</sup> CLIOTOP symposium, titled “*Future of oceanic animals in a changing ocean*”, held September 14-18, 2015 in San Sebastian, Spain. PICES co-sponsorship was by providing travel support for Keynote speaker, Dr. Emanuele Di Lorenzo, for the theme session on “*Integrated modelling to project and explore future patterns*”
  - No specific financial requests from CLIOTOP were received during the reporting interval.

## Representation

To maintain close relations, IMBeR/ESSAS and PICES regularly exchange observers at each other’s annual/executive meetings.

- IMBER is normally present as an observer at PICES Annual Meetings. Dr. Yi Xu (Shanghai Regional Project Office) represented IMBER at PICES-2015 and provided a presentation about IMBER activities to Science Board; Gro van der Meeren (IMBeR Executive Officer) and Cisco Werner (IMBeR SSC Vice-Chair) represented the IMBeR International Project Office at PICES-2016. We anticipate that Cisco will represent IMBeR at PICES-2017 in Vladivostok, since he is also a member of the Governing Council of PICES.
- Drs. Franz Mueter and Sei-ichi Saitoh represented ESSAS at PICES-2015. Both, along with the third co-chair of ESSAS, Ken Drinkwater were at PICES-2016. Saitoh and Mueter are expected to attend PICES-2017.
- Dr. Sinjae Yoo (Korea) represented SCOR at the PICES-2014 annual meeting in Yeosu, Korea; Dr. Sun Song, Vice-president of SCOR, represented SCOR at the PICES-2015 annual meeting in Qingdao. We are unsure who, if anyone, will represent SCOR at PICES-2017 in Vladivostok—possibly Sun Song of China?

## *Surface Ocean-Lower Atmosphere Study (SOLAS)*

### Joint sessions/workshops at PICES Annual Meetings

- We have no report of significant joint PICES-SOLAS activities in 2016 or 2017. This may be because of similar reasons as the IMBeR hiatus, as SOLAS was also proposing new initiatives to be associated with Future Earth (FE).

### Capacity building activities

- None this year.

## **HARMFUL ALGAL BLOOM ACTIVITIES SUPPORTED BY SCOR**

### Co-sponsored symposia/conferences/workshops

PICES partnered with GEOHAB (with ICES and NOAA as other sponsors) in organizing and funding the workshop on “*Harmful algal blooms in a changing world*” (March 18–22, 2013, Friday Harbor, WA, U.S.A.) to assess the state of knowledge on HABs and climate change, and to identify the most critical research needs that can realistically be addressed over the next 5–10 years. The findings were published in the peer-reviewed journal *Harmful Algae*. Wells, M.L., V. L. Trainer, T. J. Smayda, B.S.O. Karlson, C.G. Trick, R.M. Kudela, A. Ishikawa, S. Bernard, A. Wulff, D. M. Anderson, W.P. Cochlan. 2015, Harmful algal blooms and climate change: Learning from the past and present to forecast the future. *Harmful Algae*, 49 (2015), 68–9.

- The topic areas identified by the workshop participants served as the foundation for an Open Science Meeting on “*Harmful algal blooms and climate change*” that was convened May 19–22, 2015, in Göteborg, Sweden, with supporting sponsors PICES, FORMAS (Swedish Research Council), and GEOHAB. Local sponsors and host in Sweden were the Swedish Meteorological and Hydrological Institute (SMHI) and the University of Göteborg. The symposium was endorsed by SCOR, IOC and ICES.

### Other Activities

GlobalHAB, a new initiative of SCOR and IOC UNESCO held a 1<sup>st</sup> meeting of their newly formed Scientific Steering Committee in Oban, Scotland in March 2016. PICES supported the travel and participation of Dr. Vera Trainer (USA, co-chair of PICES Section on Harmful Algal Blooms) to the Oban meeting. The SSC and guests agreed to produce a GlobalHAB Science and Implementation Plan by early summer 2016, which would be presented and discussed at an International Conference on Harmful Algae in Brazil in October 2016. PICES supported Dr. Trainer to attend a GlobalHAB meeting in Naples in March 2017, which produced a paper,

Berdalet, E., Kudela, R., Urban, E., Enevoldsen, H., Banas, N.S., Bresnan, E., Burford, M., Davidson, K., Gobler, C.J., Karson, B., Lim, P. T., Mackenzie, L., Montessoro, M., Trainer, V.L., Usup, G. 2017. GlobalHAB: New Program to Promote International Research, Observations, and Modeling of Harmful Algal Blooms in Aquatic Systems. *Oceanography* 30(1):70–81, <https://doi.org/10.5670/oceanog.2017.111>.

PICES funded the travel of Mark Wells to attend an IPHAB meeting in Paris, France in summer 2017. Other GlobalHAB members attended and presented at the IPHAB also. Vera Trainer presented about PICES and GlobalHAB activities to an International Whaling Commission meeting in Bled, Slovenia in May 2017.

HABs are important concerns in all six PICES member countries, especially so in the Asian members that border the Western North Pacific Asian seas, where HABs have been increasing in prevalence and frequency of occurrence. For this reason, the activities of the Intergovernmental Panel on Harmful Algal Blooms (IPHAB) to consolidate and expand databases on harmful algal events (HAEDAT) and on occurrence of harmful algal species (data will be stored in OBIS), with the view to publish a Global Harmful Algal Bloom Status Report, are important to PICES. PICES is contributing expertise to this report for the Northeast Pacific and Northwest Pacific regions. Other organizations involved in this activity are IOC UNESCO, IAEA, and ICES.

## OCEAN CARBON ACTIVITIES SUPPORTED BY SCOR

### Communication/coordination

- PICES, through its Working Groups on *CO<sub>2</sub> in the North Pacific* (WG 13; 1998–2001) and *Biogeochemical Data Integration and Synthesis* (WG 17; 2002–2005), and now through the Section on Carbon and Climate (S-CC), has provided coordination for synthesis of ocean carbon research and the development of a network of ocean carbon observations in the North Pacific. The importance of ensuring effective two-way communication with other international scientific groups that have a responsibility for the coordination of ocean carbon research, such as the SCOR/IOC International Ocean Carbon Coordination Project (IOCCP) and the SOLAS/IMBER Carbon (SIC) Research Working Group, has been explicitly included in the terms of reference for S-CC. There are S-CC members on SIC's subgroups: Dr. Masao Ishii (Japan) is on the subgroup on *Interior Ocean Observations*, and Dr. Richard Feely is the lead of the subgroup on *Ocean Acidification-Global Context*.
- Ocean acidification has been proceeding for a century, at an accelerating rate, and its impacts are beginning to be felt in many corners of the North Pacific. A workshop on "Acidification of the North Pacific Ocean: a basin-wide assessment" was held on November 3, 2016 at the PICES Annual Meeting in San Diego, CA. It was well attended, and brought together scientists from all of the PICES countries to synthesize our observations and projections of acidification processes and impacts in our respective countries' waters and adjacent international waters. The workshop is the culmination of a two-year long process of collation of relevant information, and synthesis of data collected in each of the countries of the North Pacific basin. The workshop proceedings will form the basis for subsequent assessments, with improved understanding of which ocean regions are most vulnerable to acidification impacts, and how additional resources might best be deployed to predict or detect changes likely to produce significant impacts. There were several topical presentations, as well as individual national updates and extensive discussion of the contents of the proposed Assessment and strategies for completing it. The discussions covered both the open ocean and coastal waters, and roles of observing systems on both sides of the Pacific. One key point that was noted was that locally secular trends in pH and other carbon system indicator variables often differ from the global mean trend, and it is often difficult to

know whether this is simply a result of inadequate data or whether there are local influences that themselves have long-term secular trends. These deviations can be used to build a case for construction and maintenance of observing systems as necessary and interactive factors in decision-making. The driving factors will vary among regions, and we can use scientific understanding of these to guide design of observing systems, as well as mitigation and adaptation policies. Overall the workshop was highly productive and the assessment activity is on track to be completed in 2017.

#### S-CC activities

- The main S-CC goals for 2014–2016 include
  - To complete publication of scientific analyses arising from PACIFICA data synthesis;
  - To develop data syntheses or products related to ocean acidification and de-oxygenation and their biological and ecosystem impacts in support of FUTURE objectives; and
  - To develop a strategy for assessment of the carbon cycle in coastal oceans and marginal seas of the North Pacific (data syntheses, data products, documentation of methods).

#### **SCOR WORKING GROUPS**

PICES regularly provides comments on SCOR Working Group proposals and often recommends and funds an Associate Member for PICES-relevant groups. The support from PICES extends the expertise available within the group, increases the geographic coverage of the groups, and helps individual scientists from the North Pacific become more involved in SCOR activities, which benefits both organizations.

- PICES currently supports an Associate Member of one SCOR Working Group:
  - WG 149 on *Changing Ocean Biological Systems: how will biota respond to a changing ocean?* (COBS) (Dr. Uta Passow, USA)
- The SCOR Working Group proposals for 2017 were reviewed by PICES’ Standing Committees from the viewpoint of their scientific interests and relevance to the PICES integrative science program, FUTURE. Three of the proposed SCOR Working Groups were ranked as “MUST FUND”: FLOTSAM, EBUS, and P-OBS. If one or more of these three WG is approved by SCOR in Cape Town, PICES Science Board would decide (at their annual Science Board meeting in late Sept. 2017) which one of these we would provide travel support for an Associate Member with a linkage to PICES.

#### **CAPACITY BUILDING**

SCOR and PICES have a history of cooperating in capacity building.

- SCOR provides travel support for scientists from countries with “economies in transition” to participate in SCOR-relevant sessions/workshops at PICES Annual Meetings, international symposia and capacity building events led/co-organized by PICES. For this reporting period, funding from the SCOR/NSF fund was provided/committed for the following events (see Appendix 1 for details):

## 6-22

- \$5,000 USD for the PICES-2016 Annual Meeting “*25 Years of PICES: Celebrating the Past, Imagining the Future*”, which occurred from 2 to 13 November 2016 in San Diego, CA, USA.
- \$2,500 USD for travel support for the May 2017 PICES-ICES Early Career Scientist Conference “*Climate, Oceans and Society: Challenges and Opportunities*”, in Busan, Korea. Because \$1,490 USD allocated to a scientist from Peru to attend the 2016 6<sup>th</sup> Zooplankton Production Symposium in Bergen, Norway, cancelled his participation, the unused funds were reallocated (with the approval of Dr. Urban) to travel support for the May 2017 Early Career Scientist Conference “*Climate, Oceans and Society: Challenges and Opportunities*”, in Busan, Korea.
- \$5,000 USD for travel support from SCOR supported travel to an international symposium “*Drivers of Dynamics of Small Pelagic Fish Resources*” that was held March 6-11, 2017 in Victoria, British Columbia, Canada. 237 scientists from 31 countries and 5 international organizations participated in this conference, including seven supported by SCOR (Appendix 1, Table 2).
- \$2,500 USD for travel support from SCOR is being used to support travel of two Russians and 6 Chinese participants to the PICES-2017 Annual Meeting in Vladivostok in the latter half of September. In addition to these specific funds from SCOR, Ed Urban approved the use of ca. \$283 USD (~\$386 CAD) that was not spent on the ECS3 due to a late withdrawal of a Bangladesh early career scientist. (Appendix 1, Table 2).
- PICES continues to provide travel support for students and early career scientists from PICES member countries to summer schools and meetings of SCOR-sponsored large-scale research projects. The following event was co-sponsored by PICES in 2016:
  - IMBeR ClimECO5 Summer School on “*Towards a more resilient oceans: predicting and projecting future changes in the ocean and their impacts on human societies*” (August 10-17, 2016, Natal, Brazil) by providing travel funds for two early career scientists from PICES member countries: 1 from Russia, 1 from China (PICES expenses ~ \$5,374 USD; see earlier description).
- SCOR and PICES share ideas on capacity building, and a PICES representative has participated on the SCOR Committee on Capacity Building. Dr. Harold Batchelder has served in this capacity since September 2012; beginning this year he is one of several newly named liaisons to the SCOR Committee on Capacity Building.

### REQUESTS FOR CONSIDERATION BY SCOR (SINCE THE SOPOT MTG)

- **(PREVIOUSLY APPROVED)**: Travel support at a level of \$2,500 USD is requested for scientists from countries with “economies in transition” to attend sessions/workshops at the [2017 PICES Annual Meeting](#) to be held in October 2017, in Vladivostok, Russia, under the theme “*Environmental changes in the North Pacific and Impacts on Biological Resources and Ecosystem Services*”.
- **(PENDING)**: Travel support is requested for scientists from countries with “economies in transition” to attend an International Symposium on the *Effects of Climate Change on the World’s Oceans* – June 4-8, 2018 in Washington, DC. Anticipated attendance of this meeting is approximately 500. The completed SCOR support form and Organizational cover

letter were submitted to Dr. Urban of SCOR on 6 June 2017. The Symposium web site is at <http://meetings.picesint/meetings/international/2018/climate-change/background>. This is the 4<sup>th</sup> International Symposium in this series.

- **(PENDING):** Travel support in an amount of \$5,000 USD is requested for scientists from countries with “economies in transition” to attend sessions at the International Symposium on *Understanding Changes in Transitional Areas of the Pacific* – April 24-26, 2018 in La Paz, Baja California Sur, Mexico. Anticipated attendance at this meeting is approximately 150-170. The completed SCOR support form and Organizational cover letter were submitted to Dr. Urban of SCOR on 18 July 2017. The Symposium web site is open as of 18 July, and located at <http://www.pices.int/2018-Pacific-TA>.



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## Appendix 1. Financial Summary to SCOR of Capacity Building Related expenditures

### Appendix 1. Table 1. SCOR Funds for 2016 Events/Meetings:

(a) PICES/ICES 6<sup>th</sup> Zooplankton Production Symposium (ZPS6), Bergen Norway, 9-13 May 2016

(b) PICES-2016 Annual Meeting, San Diego, USA, 2-13 November 2016

Event	Participant (Sex)	Country of origin	Grant
<b>6<sup>th</sup> Zooplankton Prod Symp (ZPS6)</b>	<b>Funds provided by SCOR</b>		<b>\$5,000 USD</b>
ZPS6	Tuba Terbiyik Kurt (F)	Turkey	\$720 USD
ZPS6	Mary Mar Noblezada (F)	Philippines	\$1,300 USD
ZPS6	Luz Ximena Orosco Montenegro (M)	Peru	\$1,490 USD
ZPS6	Jorge Luis Barturen Silva (M)	Peru	Orig \$1,490 USD withdrew—funds transferred per Ed Urban to 2017 ECS Conference, Busan, Korea
<b>PICES-2016 Annual Mtg (PICES-2016)</b>	<b>Funds provided by SCOR</b>		<b>\$5,000 USD (= \$6,500 CAD)</b>
PICES-2016	Jianguo Du (M)	China	1,200 CAD
PICES-2016	Jinqiu Du (F)	China	1,000 CAD
PICES-2016	Norma Oliva-Mendez (M)	Mexico	1,000 CAD
PICES-2016	Romeo Saldivar-Lucio (F)	Mexico	1,000 CAD
PICES-2016	Ekaterina Kurilova (F)	Russia	1,300 CAD
PICES-2016	Konstantin Rogachev (M)	Russia	1,000 CAD
		<b>Total USD</b>	<b>\$10,000 USD *</b>
<b>TABLE 1</b>		<b>Total USD Spent</b>	<b>\$8,510 USD</b>

\* SCOR grants total US\$10,000; all spent except \$1,490 USD transferred to 2017 ECS Conference (see Appendix 1; Table 2) per email of Ed Urban.

### Appendix 1. Table 2. SCOR Funds supporting 2017 Events/Meetings:

(a) Int. Symp. on “Drivers of Dynamics of Small Pelagic Fish Resources”, Victoria, Canada, 6-11 March 2017

(b) PICES-ICES 3<sup>rd</sup> Early Career Scientist Conference, Busan, Korea, 30 May-2 June 2017

(c) PICES-2017 Annual Meeting, Vladivostok, Russia, 22 September – 1 October 2016

Event	Participant (Sex)	Country of origin	Grant
<b>Small Pelagic Fish Symp. (SPF Symp)</b>	<b>Funds provided by SCOR</b>		<b>\$5,000 USD (= \$6,760 CAD)</b>
SPF Symp	Daniel Grados (M)	Brazil	\$1,000 CAD
SPF Symp	Karen Walker (F)	Chile	\$800 CAD
SPF Symp	Mutiara R. Putri (F)	Indonesia	\$1,500 CAD
SPF Symp	Alexanra A. Bararinao (F)	Philippines	\$1,000 CAD
SPF Symp	Josephine Dianne L. Deauna (F)	Philippines	\$480 CAD
SPF Symp	Grea Groenewald (F)	South Africa	\$1,500 CAD
SPF Symp	Tamsyn Tyler (F)	South Africa	\$480 CAD
			<b>SUM=\$6,760 CAD</b>
<b>3<sup>rd</sup> ECS Conference (ECS3)</b>	<b>Funds provided by SCOR</b>		<b>\$1,490 USD (residual from ZPS6) + \$2,500 USD; Sum is \$3,990 USD (= \$5,440 CAD)</b>
ECS3	Helena Cachanhuk Soares (F)	Brazil	\$1,500 CAD
ECS3	Edem Mahu (F)	Ghana	\$800 CAD (*)
ECS3	Muthukumar Chandresekaran (M)	India	\$654 CAD (*)
ECS3	Faisal Amri (M)	Indonesia	\$300 CAD (*)
ECS3	Nadeem Nazurally (M)	Mauritius	\$800 CAD (*)
ECS3	Saba Abdulwakil (M)	Nigeria	\$1,000 CAD (*)
ECS3	Islam M. Nazrul (M) (Cancelled late)	Bangladesh	~\$386 CAD (@)
Note: (*) means additional support provided from PICES			<b>SUM=\$5,054 CAD</b>
<b>PICES-2017 Annual Mtg (PICES-2017)</b>	<b><i>Projected SCOR Expenditures (in italics; this meeting has not happened yet)</i></b>		<b>\$2,500 USD + ~\$283 USD (residual from ECS3) SUM=\$2,783 USD (~\$3,543 CAD est.)</b>
PICES-2017	Peng Lian (M)	China	\$150 CAD
PICES-2017	Zhongxin Wu (M)	China	\$500 CAD

PICES-2017	Wu Men (M)	China	\$500 CAD
PICES-2017	Xindong Pan (M)	China	\$500 CAD
PICES-2017	Lisha Guan (F)	China	\$500 CAD
PICES-2017	Benrong Peng (M)	China	\$693 CAD
PICES-2017	Natalia Shlyk (F)	Russia	\$200 CAD
PICES-2017	Kristina Zhukova (F)	Russia	\$500 CAD
			SUM=\$3,543 CAD
<b>TABLE 2</b>		<b>Total 2017 USD SCOR Expenditures</b>	<b>\$11,490 USD #</b>

Notes: # New SCOR Grants to PICES for 2017 total \$10,000 USD; in addition there was a transfer of \$1,490 USD (unused from ZPS6) to the ECS3 (per email permission from Ed Urban); AND, there was a residual of ~\$283 USD (~\$386 CAD) of SCOR funds unused from the ECS3 (last minute cancellation of SCOR and PICES supported ECS), which was approved for use for PICES-2017 (per email of Ed Urban); \* - in addition to SCOR support, there was also support from PICES; @ - Late cancellation from the ECS3 that had partial support from SCOR.

**Appendix 1, Table 3. IMBER funds provided directly by SCOR to PICES for travel support for the Small Pelagic Fish Symposium (March 2017)**

Event	Participant (Sex)	Country of origin	Grant
<b>Small Pelagic Fish Symp. (SPF Symp)</b>	<b>Funds provided by SCOR on behalf of IMBER</b>		<b>\$3,000 USD (= \$3,900 CAD)</b>
SPF	Carola Hernandez Santoro (F)	Chile	\$1,500 CAD
SPF	Vanessa Izquierdo-Pena (F)	Mexico	\$1,200 CAD
SPF	Carmen Grados (F)	Peru	\$1,200 CAD

**Appendix 2, Table 1. PICES funding provided to ESSAS to support travel costs to the ESSAS Open Science Meeting (ESSAS-OSM) in June 2017.**

Event	Participant (Sex)	Country of origin	Grant
<b>ESSAS Open Science Meeting (ESSAS-OSM)</b>	<b>PICES funds to ESSAS for ESSAS OSM travel</b>		<b>\$14,000 CAD</b>
ESSAS-OSM	Hisatomo Waga (M?)	Japan	\$1,480 CAD
ESSAS-OSM	Moojin Kim (F)	Korea	\$1,080 CAD
ESSAS-OSM	Hwa Hyun Lee (F)	Korea	\$1,080 CAD
ESSAS-OSM	Minkyong Bang (F)	Korea	\$1,080 CAD
ESSAS-OSM	Jordan Watson (M)	USA	\$1,800 CAD
ESSAS-OSM	Sofia Ferreira (F)	USA	\$1,750 CAD
ESSAS-OSM	Darren Pilcher (M)	USA	\$1,480 CAD
ESSAS-OSM	Jennifer Marsh (F)	USA	\$950 CAD
ESSAS-OSM	Cathleen Vestfals (F)	USA	\$400 CAD

ESSAS-OSM	Casey Clark (M)	USA	\$2,900 CAD
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**Appendix 2, Table 2. Other PICES financial commitments to SCOR associated organizations for 2017.**

<b>Event</b>	<b>Participant (Sex)</b>	<b>Country of origin</b>	<b>Grant</b>
IMBER IMBIZO V	PICES funds to IMBeR for IMBIZO V travel	TBD—likely from Asia	\$7,000 CAD (to partially support up to 3 ECS)