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1. Opening

The 21st Session of the CLIVAR Scientific Steering Group meeting was held November 10-12, 2015. It took place in Moscow, Russian Federation, on the premises of the Russian Academy of Science as well as at the Institute of Oceanography of the Russian Academy of Science. The agenda for the meeting can be found in Appendix A.

1.1 Opening Remarks

Prof Nigmatulin, Director General of the Institute of Oceanography of the Russian Academy of Science, welcomed the SSG to Moscow and remarked how pleased he was that the SSG would visit his institute on Tuesday afternoon for presentations by staff and students.

Dr Stammer, SSG Co-chair, thanked the local hosts, and in particular Sergey Gulev and his team, for the excellent organization of the meeting. He also thanked the outgoing SSG members, Drs Drinkwater, Gulev, Schubert (in absentia) and Visbeck and welcomed new members Drs AchutaRao, Bindoff, Dewitte (in absentia), and Guemas (see Appendix B for the list of participants).

The main topics and objectives of the meeting would be (a) review of progress and provide feedback to the Research Foci and CLIVAR-led Grand Challenge teams, (b) how to connect to the other WCRP Grand Challenges, (c) formation of the new Knowledge Exchange and Climate Dynamics Panels, (d) preparation of the Open Science Conference, (e) the Science Plan and Achievements Report, (f) CLIVAR finances and outreach and (g) Panel membership and business. Dr Stammer highlighted the importance of outreach and advertising what CLIVAR does and how it contributes to advancing climate science. He noted that Open Science Conference would present an important opportunity, but also urged SSG members to organize sessions at annual meetings like AGU and EGU.

1.2 WCRP Update (Guy Brasseur)

In his presentation, Dr Brasseur, incoming Chair of the WCRP Joint Scientific Committee (JSC), highlighted four current priority areas for WCRP:

- Grand Challenge implementation;
- Regional dimension of WCRP, enhancing participation of scientists from all parts of the world;
- Capacity building, outreach, increasing involvement of young generation;
- Relations with Future Earth.

Much of the subsequent discussion focused on the relations between WCRP and Future Earth. Dr Brasseur noted that WCRP is to be seen as an equal partner with Future Earth. Despite the fact that WCRP activities are essential for the success of Future Earth, the programme has not been integrated under the Future Earth banner primarily because of its key contributions in support of sponsor missions, namely the Global Framework for Climate Services and support to IPCC.

The SSG agreed that CLIVAR, but more broadly also WCRP as a whole, must clearly identify its unique contributions, building on collaboration with IMBER, SOLAS, PAGES, etc., and

emphasizing that progress in fundamental climate science is key to success in addressing societal needs, climate services and sustainability.

Dr Brasseur also summarized the outcomes of the joint WCRP / IPCC meeting that took place in Bern, Switzerland on 8-10 September 2014, with the objective of identifying gaps and recommendations from the lessons learned in the Fifth IPCC Assessment Report. A proposal has been made to initiate a feasibility study for a WCRP Earth System Reanalysis Project. Modeling and observing system development priorities were highlighted, as were key outstanding scientific challenges that should be addressed through the Grand Challenges or perhaps requiring new WCRP-wide initiatives, for example on decadal climate variability and predictability. Discussions on how to improve and facilitate the IPCC process included the possibility of WCRP producing synthesis documents between IPCC assessments.

2. CLIVAR Research Foci

CLIVAR's Research Foci (RF) teams had met during the pan-CLIVAR meeting in The Hague in July, 2015. All RF were asked to subsequently revise their science plans and implementation strategies and to submit revised plans. During this session the SSG discussed those revised plans with respect to scientific objectives and how relevant, unique and realistic the approach was. The goal of the session was to identify those RF that were ready and to provide them the sanctioning to go forward and intended to provide recommendations to those that were still in the design phase. One SSG member had been assigned to liaise with each Research Focus team to prepare a presentation for the SSG and also to lead the discussion at the meeting.

2.1 Research Focus on Monsoons (Krishna AchutaRao discussion leader)

The SSG was appreciative of the development and evolution of the RF prospectus, restricting its focus to the sub-seasonal timescale, addressing science questions that will benefit from international and cross-program engagement. The refined focus at the sub-seasonal timescale is motivated by the considerable impact that skillful predictions with a 20-day lead time would have on societal adaptation efforts. The RF will build on new efforts on sub-seasonal monsoon research, including regional monsoon system aspects, exploiting new understanding of the role of land surface processes and their impact on forecast skill, and strengthening linkages across research and user communities. The RF addresses the topics predominantly from a modeling perspective, though also highlighting current observational limitations, e.g. diminishing numbers of rain gauges in the Tropics, and monsoon regions being devoid of surface flux measurements needed to constrain models.

It was noted that the RF's prospectus does not highlight key questions about the role of sub-seasonal variability, e.g. MJO, the diurnal cycle, the ocean mesoscale.

It was suggested that the regionally-orientated user engagement plans could be expanded with a few example projects, maybe one implementation activity for each region. Close collaboration with the WCRP Working Group on Regional Climate (WGRC) could be advantageous.

It was also noted that the proposed RF membership is currently closely related to the composition of the Monsoons Panel. More specificity in the RF implementation plans would clarify the distinct nature of the RF in relation to the Monsoon Panel, how the RF will foster cross-panel interactions, and the relation of the RF to the WWRP-WCRP S2S Project.

Recommendation: *The Monsoons RF should refine its science and implementation plan, in consultation with the Monsoons Panel, seeking (intersession) endorsement from SSG as soon as possible in the coming year. For both the Monsoons Panel and the RF, more clarity in their unique responsibilities and activities is needed. RF should identify the cross-panel linkages necessary for the RF, and adjust/increase membership accordingly.*

2.2 Research Focus on Marine Bio-physical Interactions and Dynamics of Upwelling Systems (Pedro Monteiro, discussion leader)

The SSG was pleased to see that the RF is developing well, though the process of establishing a focus to the activity is still ongoing. There are still questions as to whether the activity will address coastal upwelling regions, open ocean upwelling, the sensitivity of upwelling systems to large-scale climate drivers, and the impact of upwelling systems on global climate. The topic provides a connection from CLIVAR to IMBER, SOLAS and the carbon cycle activities within WCRP and Future Earth. Currently several workshops focused on specific aspects of the RF are being planned; the team was urged to entrain scientists from all regions around the globe. The CLIVAR Open Science Conference would be an opportunity to discuss plans for this RF and to strengthen linkages in particular with IMBER and SOLAS. It was also noted that links with the ocean region and modelling panels should be established, for instance concerning the upwelling studies being developed in the Eastern Indian Ocean and current initiatives for the study of the Humboldt system

Recommendation: *The SSG encouraged the RF team to continue to consult with the community to develop a science and implementation plan.*

2.3 Research Focus on Decadal Climate Variability and Predictability (Annalisa Bracco, Ed Hawkins, discussion leaders)

The RF as currently defined covers the broader decadal climate variability and predictability (DCVP) theme that is relevant across WCRP and is also related to the Grand Challenge on Regional Climate Information. The SSG recognized that it is broader than the predictability/prediction focus of the Decadal Climate Prediction Panel/Project (DCPP).

The CLIVAR SSG applauded the focus that has been given to the initiative, building on the outcomes of the break out session at the Pan-CLIVAR meeting. It is particularly supportive of an initiative that will address climate modulations more broadly, rather than being limited to the 'hiatus'. As such, the SSG is supportive of the RF contribution to the design of the DCPP 'Component C' coordinated experiments on furthering the understanding of mechanisms and case studies as part of its contribution to CMIP6.

Recommendation: *The RF should move forward with its contribution to design of the CMIP6 experiments.*

Recommendation: *The Implementation Plan should be refined over the next 6 months with more emphasis on the research that will be undertaken. Currently the activity as described is more like an oversight 'panel' with proposed activities such as monitoring, advocating, etc. The SSG will review progress as soon the revised Plan is made available.*

2.4 Research Focus on ENSO in a Changing Climate (Carlos Moffat, discussion leader)

The Research Focus is proposing three main goals: 1) in the context of a changing climate, better understand processes that control ENSO characteristics in nature and in the models, namely diversity of El Niño events and decadal variations, 2) propose a standard ENSO evaluation protocol for CGCMs as a resource for model developers and impacts studies and 3) understand how ENSO characteristics might be modified in the next decades, namely under the influence of anthropogenic climate change and summarize the state of the art in a review publication.

The SSG was glad to see that the RF had become more focused, and that the broader community had been entrained since the break out discussion at the Pan-CLIVAR meeting (although more representation from S. America should be sought). There was, however, considerable discussion about how appropriate the three goals outlined above were for the RF. Although there was not universal agreement amongst members, in general it was agreed that the first goal was predominantly an area of focus of the Pacific (and Indian Ocean) Region Panel and the second the development of a tool that could be driven by a particular lab. It was noted that the USCLIVAR Working group on ENSO diversity is pursuing activities towards defining/proposing process-based metrics to assess ENSO in CGCMs. The third topic seemed to be the most suited a RF theme, going beyond what is traditionally covered by the Pacific Region Panel.

The SSG observed that an ENSO workshop was planned for February 2015 in Australia and asked the RF team to consider how they might make use of this opportunity to meet.

***Recommendation:** the RF should be short lived (order 2-3 years) and focus on understanding how ENSO characteristics might be modified in the next decades. Complementary to that, the RF should consider how the climate change expectation aspects of ENSO might be qualified by documenting the limitations of the models and how that translates into ENSO simulation/prediction/projection skill*

***Recommendation:** Plans for the RF should expand on how this activity will go beyond activities of the Pacific Panel.*

2.5 Research Focus on the Consistency Between Planetary Energy Balance and Ocean Heat Storage (Sergey Gulev, discussion leader)

Five major questions are addressed:

- What is the magnitude and the uncertainties of our estimates of Earth's energy imbalance (EEI), and how does it vary over time?
- Can consistency between planetary heat balance and ocean heat storage be achieved and what are the major limitations?
- How are TOA net radiation and ocean heating rate distributed in space and time?

How can we improve validation requirements for and from coupled climate models to improve estimates of EEI?

- How can we better constrain the surface energy fluxes and their spatio-temporal variations at regional scale?

The SSG felt that the RF posed a balanced set of questions, bringing together a comprehensive range of communities to address a topic of high international relevance, including aspects related to surface fluxes, and focusing on the role of ocean heat content in climate change. The SSG urged the RF to consider having as an objective understanding of the human influence (detection and attribution) on the planetary energy balance, with the aim of issuing a statement at the end of the RF duration on what is the component of change in energy balance that can be attributed to human influence.

***Recommendation:** In addition to the planned analysis of the Ocean Reanalysis Intercomparison Project (ORA-IP) dataset, the analysis should be extended to include the Coordinated Ocean-ice Reference Experiments, Phase 2 (CORE-II) hindcast simulations.*

***Recommendation:** The Plan be refined to include more specific about implementation, including a proposal for a steering group (6-8 people) with Terms of Reference, and to further develop the proposed plan to hold a workshop to align the implementation activities across the range of disciplines participating in the RF.*

2.6 General Discussion on CLIVAR Research Foci

The Research Focus framework within CLIVAR was initiated three years ago. The differing degrees of maturation of the current proposed themes is expected and reflects the different engagement and scientific challenges that are being addressed. Some initiatives will be at an implementation stage sooner than others, and there could be a variety of temporal expectations for the duration of each proposed activity, ranging from 2-5 years, or in some cases longer. The SSG endorsed a staged approach to implementation of the RFs. Based on the reports and discussion, the SSG considered that three of the RF, namely Decadal Climate Variability and Predictability, Consistency Between Planetary Energy Balance and Ocean Heat Storage and ENSO in a Changing Climate (and the Sea Level Rise GC), were ready to move forward on implementation. The RF on Monsoons and Marine Biophysical Interactions and Dynamics of Upwelling Systems needed more time to develop their plans.

Progress has been made on all RF topics since the Pan-CLIVAR meeting. The assignment of SSG members to liaise and enhance communication with the SSG and the RF leadership has been successful and should be maintained. The RF have been demonstrated to be an effective means for CLIVAR to initiate activities and invigorate progress in areas that go beyond the traditional areas addressed by the Panels, fostering cross panel, cross community collaboration, and an opportunity to bring young scientists into CLIVAR. Once RF are endorsed and implemented, communication with funding agencies is recommended to raise the profile of the initiatives to stimulate funding opportunities.

The formulation and subsequent implementation of the RF plans depends on the resources that can be garnered to support activities, including ICPO support. More information regarding both funding for network activities and project management support will help constrain the proposed activities. Progress should be tracked by the SSG and ICPO according to how the RF questions and deliverables are met and the RF should ensure there is a legacy once the activities come to a close. The challenges, or difficulties, encountered in implementing the initiatives should also be

reported. Soliciting national reports on the funding awarded to RF activities could be a means to quantify success.

***ACTION:** Each RF to develop timeline and deliverables; assign SSG members to follow RF intersession and report on progress.*

3. WCRP Grand Challenges

CLIVAR is involved in most of the WCRP Grand Challenges (GC). This session reviewed the status of CLIVAR involvement in four GC efforts and also analyzed to what extent interactions can be enhanced. Dr Brasseur reported that the JSC is currently discussing the scope of the GCs with a view to focusing them on producing some specific deliverables in 3-5 years and not duplicating what is being done elsewhere.

3.1 Grand Challenge on Understanding and Predicting Weather and Climate Extremes (Pascale Braconnot, discussion leader)

An extensive Implementation Plan has been developed for the Grand Challenge on Understanding and Predicting Weather and Climate Extremes. CLIVAR contributes to the overarching WCRP Grand Challenge, without a separate CLIVAR RF effort.

The GC focuses on four themes:

(1) Integrated observations, (2) Improved models, (3) New process understanding of the physical drivers of extremes, (4) Fast-track attribution.

The SSG made the following observations concerning the GC as currently proposed: CLIVAR in particular contributes to Themes 1, 2 and 4. Themes 1 and 2 are long standing challenges and the GC should advocate for improvements in existing observations and tools to make progress. How these can be concretely addressed through a GC needs to be established. Theme 2 requires strong involvement of the WCRP model development groups. Theme 3 requires a strong link to the Climate Dynamics Panel and Monsoons Panel. Theme 4, dependent on progress in Theme 3, is very relevant internationally and would be a high visibility topic for WCRP to pursue through the GC, with a considerable expertise contributed by CLIVAR.

***Recommendation:** The GC should proceed with implementation, but taking care to define what are the deliverables and what will be the impact of this effort in a 5-year timeframe.*

***Recommendation:** The GC should involve representatives of the Climate Dynamics and Monsoons Panel, so as to properly reflect the activities of these panels that might contribute to the GC, and to ensure that the panel highlights the GC objectives in their own implementation plans. Since CLIVAR will contribute directly to the GC without a dedicated RF of its own, the work plan of the GC should be fully grounded in the relevant CLIVAR panel activities.*

***Recommendation:** The role of the ocean in weather and climate extremes should be reinforced, as well as ocean climate extremes as a phenomenon and their impact on the marine ecosystem. A strong connection is thus needed with GSOP regarding indicators and other related efforts.*

3.2 Grand Challenge on Sea Level Rise and Regional Impacts (Detlef Stammer discussion leader)

This WCRP Grand Challenge is one and the same as the CLIVAR Research Focus and encompasses five major themes:

- An integrated approach to constraining historic sea level estimates (paleo time scale)
- Quantifying the contribution of land ice to near-future sea level rise
- Contemporary regional sea level variability and change
- Predictability of regional sea level
- Sea level science for coastal zone management

The last element drives the overall effort and the other elements all contribute to this overarching aspect of science for management.

The SSG applauded the GC/RF Implementation Plan, recognizing that it encompasses a well-integrated program that addresses issues of critical international importance. The approach brings together the full breadth of diverse communities involved in sea level research, with five well-developed Work Packages, and also includes current funding opportunities. The team proposes to make a biennial assessment of progress in the field and adjust research goals within the GC as appropriate. Annual meetings of the executive team are suggested, though meeting less frequently could be sufficient, given that the WP subgroups would also meet regularly.

***Recommendation:** The SSG endorses the Implementation Plan of the Grand Challenge on Sea Level Rise and Regional Impacts and recommends that the GC moves into an implementation phase.*

***Recommendation:** Review the team makeup and leadership in the near future to address gender and geographic balance.*

***Recommendation:** Consideration should be given to holding the proposed sea level conference in 2016 in association with the CLIVAR Open Science Conference.*

3.3 Grand Challenge on Regional Climate Information (Lisa Goddard, discussion leader)

The new GC leadership team has revisited the original GC proposal that had identified regional climate information challenges according to timescales (seasonal, decadal, centennial). The revised proposal plans to address these challenges as seen from the perspective, or through the lens, of informing risk management and decision making, going across timescales, and identifying what are the gaps and limitations in enabling the provision of the required climate information. The SSG supported this new formulation, though recommended that the effort become more focused, perhaps through regional consultation.

The concept of 'regional laboratories' was presented. The Regional Laboratories allow for impacts of specific phenomena to be studied at a region scale and incorporate all aspects (quality of observations and model simulations to represent impacts, study of processes with available data, assessment of what can and cannot be said of climate variability and change for the region). Such activities would foster a collaborative effort that would draw upon the science advances from all the Grand Challenges. The GC also raises the challenges related to sparse observations being available in many parts of the world.

The GC, mainly led through the WCRP Working Group on Regional Climate, is a mechanism for WCRP to directly link to its stakeholders such as GFCS and IPCC. The GC plans are still in a preliminary phase and there is ample opportunity for CLIVAR to provide input and ideas.

3.4 Grand Challenge on Changes in Water Availability (Detlef Stammer, discussion leader)

It was noted that this GC is closely related to current GEWEX priorities, but that CLIVAR can and should contribute to this GC by supporting the objectives of advancing observing system and syntheses efforts, understanding climate variability and extremes, and on model assessment. The overarching questions about water availability in a changing climate still need to be identified. The GC is an opportunity for WCRP to promote access and sharing of national groundwater observational data, key for model development. The SSG suggested that this should gain more visibility in the GC plans.

4. Capabilities

4.1 Ocean observations (Martin Visbeck)

Dr Visbeck reviewed various aspects of international coordination of climate observing systems. He focused on the GCOS Global Ocean Observing System (GOOS), an integrated observing system of operational and research efforts. As an outcome of the OceanObs'09 Conference, the Framework for Ocean Observing was assembled to plan and move forward with an enhanced global sustained ocean observing system over the next decade, integrating new physical, biogeochemical, biological observations while sustaining present observations. In order to provide its full value, the framework needs to set the requirements for observation and processes, as well as defining data and products. The framework is based on a collaborative system of sustained observations, built on requirements for both in situ and satellite data. Currently, the Global Ocean Observing System is estimated to be 60% complete.

CLIVAR and the Global Ocean Observing System (GOOS) have developed a good working relationship throughout the years, particularly via the Ocean Observations Panel for Climate (OOPC). CLIVAR Ocean Region Panels and GSOP are represented at the OOPC meetings, and have provided input to OOPC's Work Plan, the means by which OOPC fosters and facilitates many connections and communication with ocean observing, modelling and user communities as well as sibling panels in GCOS and GOOS. In addition, OOPC's Work Plan includes the assessment of the adequacy of the ocean observing system. The main priorities for the near future are the Tropical Pacific Observing System (TPOS2020), Deep Ocean Observing Strategy, boundary currents and inter-basin flows and air sea flux estimates. An interim support team for TPOS2020 is being setup, and the project is looking for new partners to sustain the Pacific tropical array. Data accessibility is also a big issue. OOPC has developed several recommendations relevant to CLIVAR, including regular updates on the observing system status. Continuous interaction with the CLIVAR Ocean Region Panels is essential and it would be helpful if panel liaisons were identified to work with OOPC. This would ensure a rapid response and feedback from panels for activities like TPOS2020.

Recommendation: OOPC to provide regular updates on status, threats, opportunities, and issues in observing system to the CLIVAR SSG.

***ACTION:** CLIVAR Ocean Region Panels to identify liaisons to work with OOPC.*

4.2 Data, synthesis and information (Nathan Bindoff)

Most of the activities related to this capability are directly linked to GSOP, which, along with OOPC, advocates for a sustained ocean observing system. In January 2014, the GSOP community also provided strong advocacy for the TOGA-TAO system in estimating the state of the tropical Pacific Ocean and ENSO prediction. GSOP has also been working closely with the Ocean Observation Panel for Climate (OOPC) to define observational requirements for Essential Ocean Variables (ECVs) for the Global Climate Observing System (GCOS). GSOP has provided valuable input to the GCOS in terms of spatial and temporal sampling and accuracy requirements for phenomena on different climate timescales for temperature and salinity. These contributions will be used for the 2016 update of observational requirements and observing strategy by GCOS.

GSOP is leading two internationally coordinated efforts: the International Quality-Controlled Ocean Database (IQuOD) (<http://www.iquod.org/>), for coordinated quality-control of Global Subsurface Ocean Climate Observations, and the CLIVAR GSOP/GODAE Ocean View Ocean Reanalysis Inter-comparison (ORA-IP). The overarching goal of the IQuOD initiative is to produce and freely distribute the highest quality, complete and consistent historical subsurface ocean temperature global database together with (intelligent) metadata and assigned uncertainties, and some downstream added-value products.

ORA-IP should be a sustained activity as observational records increase in length, new observations become available, new phenomena/processes need to be examined (e.g., the distribution of deep ocean heat content associated with the “hiatus”), and ocean and coupled ocean-atmosphere synthesis systems are improved and updated products released. Currently, ORA-IP relies on individual ocean synthesis groups to provide diagnostics (e.g., heat content distribution) to individual volunteers who analyse the ensemble results; no dedicated resources are available. Also, a central data repository is required. CLIVAR could help engage various funding agencies (e.g., EU-COST, ESA, NASA, NOAA) to support the continued evaluation of ocean synthesis products in their funding calls, and also with the data providers to release their synthesis data. The recently funded Evaluation of Ocean Synthesis (EOS) under EU-COST is a step forward, but is mostly focused on activities within the European community.

Future plans and priority areas for GSOP, in the framework of the CLIVAR “Data, synthesis and information” capability are the continuous support for IQuOD, ORA-IP and TPOS2020, in addition to new focus on deep ocean observations, ocean climate indicators and coupled synthesis. SSG discussion also highlighted a role for CLIVAR to address more explicitly carbon, both in terms of observations and analysis, given that the carbon community addresses similar questions about heat content, fluxes, etc. It was noted that GoSHIP and the IOCCP under GOOS provide opportunities for both the carbon and physical oceanography communities to interact.

Dr Bindoff pointed out that CLIVAR has a data policy on its website, last updated in 2010, and recommended that the SSG review this periodically. The data policy is generic but compatible with IOC, WMO, GCOS and GEOSS data principles, and it is used as a reference by the CLIVAR endorsed projects during the endorsement process.

***ACTION:** Review CLIVAR data policy and make recommendations if it needs to be revised (Nathan Bindoff)*

4.3 Capacity Development (Pedro Monteiro)

In his introduction, Dr Monteiro observed that it is important that activities in capacity building efforts have continuity; one-off activities in general do not have any lasting impact. One sustained activity that has been developed for the past few years is the creation of the CLIVAR Early Career Scientists (ECS) Network. CLIVAR can stimulate continuity by not only providing support to ECS to attend CLIVAR- related meetings, but also by providing that ECS community the opportunity to engage in the organization of meetings/workshops and play a key role in the outcome of those.

The CLIVAR ECS Network has been in discussion with the Young Earth System Scientists (YESS) community with a view to merge into a WCRP-wide network, and a proposal for endorsement was submitted to the JSC. Dr Brasseur explained that the YESS community was involved in the recent Darmstadt Earth Observations meeting, and played a key role in the ECS activities at that meeting. Regarding the proposal for WCRP endorsement, the JSC requested the YESS community to broaden their international representation and also their scientific scope.

The SSG expressed some concern that a merge between YESS and the CLIVAR ECS might dilute the value of the network by making it too broad. It was noted that the YESS community network website is designed to be able to select particular communities/ topics, so a CLIVAR-focused group would be able to exist within it.

It was recommended that the CLIVAR ECS network play a key role in ECS activities linked to the CLIVAR Open Science Conference and be part of the Scientific Organizing Committee. Another issue raised is that CLIVAR ECS activities should be integrated in panels' activities so as not to develop on a separate track.

***ACTION:** Invite ECS Network to nominate a member to attend the next SSG meeting or a meeting of their choice.*

4.4 Knowledge Exchange & Stakeholder Feedback (Ed Hawkins)

At its 20th session in Kiel, the CLIVAR SSG proposed a new panel to focus on knowledge exchange (KE), engagement and capacity building. Dr Hawkins had put together a proposal for this new panel that combines expertise in climate science, communication and visualization to share knowledge, experience and best practice with a view to enhancing future engagement activities within CLIVAR and the broader climate science community.

The SSG had a long discussion about the new proposed panel and its role and activities. It was decided that the scope could be narrowed to knowledge exchange and the title changed accordingly. If formed, this panel could have an advisory role for all CLIVAR panels and the ICPO on several topics, for instance, briefing notes to media, schematics, guidelines for graph publication (colour scale), and social media activities. Advice from this panel could be initially specific to CLIVAR activities but its role could be expanded.

The SSG Co-chairs reported that there was a clear interest from WCRP in promoting this kind of activity. The SSG Co-chairs will consult with D/WCRP and provide feedback to Dr Hawkins concerning the panel's possible role as a pilot for a WCRP-wide effort.

Recommendation: *The SSG considered that this Panel was not yet ready for implementation.*

Recommendation: *The Co-chairs and ICPO should investigate potential WCRP support for this activity which could be seen as a pilot for a WCRP-wide effort.*

Recommendation: *An interactive session be put together for the OSC that brings some of the communication/knowledge exchange thought-leaders together.*

5. Links with other programmes (Lisa Goddard, Ken Drinkwater)

GEWEX is a major partner given the range of common areas of interest, motivating the joint Pan-CLIVAR, Pan-GEWEX meetings that were held in The Hague this summer. The implementation of joint activities, such as panels (ETCCDI, Monsoons Panel) and RF/GC topics, requires collaboration at a Project Office level in terms of staff support and to manage a joint mobilization of funds in support of meetings.

The Integrated Marine Biogeochemistry and Ecosystem Research (IMBER) Project is one of CLIVAR's main partners. IMBER is approaching a ten-year mark and it is time to reconsider science directions and develop the next phase of research. Several Grand Challenges and Innovation Challenges have been proposed, and CLIVAR has been asked to comment on those.

ACTION: *Ask IMBER office for the procedure in commenting to IMBER Grand Challenges and Innovation Challenges. (Ken Drinkwater)*

Further discussion on collaboration with the Surface Ocean Lower Atmosphere Study (SOLAS) Project was deemed desirable. Martin Visbeck reported that a meeting was being organized by SCOR in early March to bring together representatives from many of the ocean programmes to discuss future directions and collaboration. Invitations had been sent to one of the CLIVAR SSG Co-chairs and the ICPO.

The Past Global Changes (PAGES) Project has signed a Memorandum of Understanding with WCRP. To enhance collaboration with CLIVAR, IMBER, SOLAS and PAGES, all the Project Offices should be informed about CLIVAR open calls for panel membership. The CLIVAR Open Science Conference in 2016 will also present a good opportunity to engage with sister programmes and representatives will be sought for the OSC SOC.

ACTION: *Inform IMBER, SOLAS and PAGES Project Offices of open calls for panel memberships (ICPO).*

ACTION: *Identify IMBER, SOLAS and PAGES representatives for the CLIVAR OSC 2016 SOC (SSG/ICPO)*

6. Modelling activities (Stephen Griffies)

The CLIVAR Working Group on Ocean Model Development has transitioned into the CLIVAR Ocean Model Development Panel (OMDP). Revised Terms of Reference were presented and endorsed by the SSG.

The OMDP coordinates ocean model development internationally, across all ocean climate model development efforts on parameterizations, numerics, nesting, and data assimilation. OMDP continues to establish and encourage collaborations both within the ocean modeling community and more broadly, including other CLIVAR panels, to address model biases, parameterization development, etc. Its role in CLIVAR and WCRP is to support progress of CLIVAR core activities, Research Foci, and WCRP Grand Challenges, and also to collaborate with and to advise other CLIVAR panels and Research Foci Teams on issues related to ocean modelling. One of the OMDP Co-chairs also represents CLIVAR on the WCRP Modelling Advisory Council.

The Coordinated Ocean-ice Reference Experiments (CORE) activities developed by OMDP have been a tremendous success and studies in all ocean basins have been carried out or are underway. As a recognition of CORE as the community standard for ocean-ice simulations, OMDP has been encouraged to submit a proposal to be included as a MIP for CMIP6.

Several joint activities between OMDP and other CLIVAR panels are in development, particularly as a result of interactions at the pan-CLIVAR meeting. A few issues for SSG consideration have been raised. The WCRP Data Advisory Council (WDAC) has an Observations for Model Evaluation Task Team (Obs4MIPS), with no CLIVAR representative. Linkages with other WCRP modelling activities are done via the WCRP Modelling Advisory Council (WMAC). Since this group has only an advisory role, SSG recommended that given the importance of OMDP activities to the overall WCRP goals, OMDP activities should be reported directly to the JSC at their meetings. Dr Brasseur agreed to support this idea. It was also recommended that at CLIVAR SSG meetings, a longer time slot is given to discussion of modelling activities since it is important to strengthen collaborations with WGSIP, DCPD and WGCM.

WGCM will start the process of reviewing MIPs for CMIP6 by the end of November. The SSG agreed that CLIVAR should provide a coordinated response. The proposals should be circulated to the Panels and SSG members for comment. Several SSG members volunteered to take part in the review process.

***ACTION:** Recommend a CLIVAR representative to WDAC task team for Obs4MIPS. (GSOP)*

***ACTION:** Next SSG - schedule modeling slot (e.g., 1 hour), including contributions from WGSIP, DCPD, WGCM. (ICPO)*

***ACTION:** SSG and ICPO to coordinate MIPs review (D. Stammer, L. Goddard, K. AchutaRao, V. Guemas, A. Bracco + panel co-chairs, A. Pirani)*

7. CLIVAR Open Science Conference 2016 (Detlef Stammer, Valery Detemmerman)

Dr Stammer noted in his introductory remarks that in 2016 it would be 12 years since the first and most recent CLIVAR Conference that was held in Baltimore USA in 2004. This OSC would

have an even broader scope, and provide a forum for CLIVAR community members to come together with other WCRP and GEC communities to appraise progress, identify new opportunities to engage with CLIVAR, and evolve capabilities and outreach.

There was considerable discussion concerning the role of stakeholders in the Conference. It was noted that the field is evolving quickly for applications and climate services and that CLIVAR should take the opportunity of the OSC to invite organizations involved in these aspects to learn what science can do for them. It was suggested that the SOC could approach GFCS or the Global Partnership and ask how best to make the connection.

It was also noted that the Conference would be an opportunity to highlight climate issues and research in the Asia Pacific region. There was a proposal to organize a think tank before or after the Conference, focused on translation of science, that would provide an opportunity for climate scientists and stakeholders in the region to have a dialogue.

The SSG agreed that the objectives of the Conference should follow closely the CLIVAR mission and goals statements. The Conference should be seen as an opportunity to promote the new CLIVAR science plan and to present and discuss new research foci. An open call for parallel sessions should be organized in the first quarter of 2015.

A special 3-day event by and for ECS should be organized the week before, and ECS should be involved in all aspects of the OSC planning.

Terms of reference for the Scientific Organising Committee (SOC) were presented and agreed as follows:

- Overall responsibility for the Conference
- Determine the vision and the goals of the Conference
- Develop scientific program(s) for plenary, parallel, and poster sessions
- Review contributions (e.g. abstracts, whitepapers) to the Conference
- Develop media outreach (with LOC)
- Establish sub-committees (as needed) to help develop program/symposia details.

First tasks for the SOC would include:

- Decide on conference title and tag line
- Develop some scientific description suitable for advertising of the Conference (words to help potential attendees identify the Conference as relevant to them)
- Identify scope and overall organizational scheme of the Conference (e.g. how many symposia, sessions, etc.) for budgeting purposes.

A proposed list of SOC members was presented that included current and new SSG members and representatives from the other WCRP projects and modelling groups. Drs Lixin Wu and Fangli Qiao, Deputy Director General of FIO, will join Detlef Stammer and Lisa Goddard as Chairs of the SOC. The SSG suggested to add a few more members from Asian countries, as well as 2 representatives from the ECS community. It was suggested that CLIVAR SSG members with links to SOLAS, IMBER and PAGES should approach their project leadership in order to confirm that they could represent their respective projects on the SOC. A local organizing committee (LOC) would be responsible for developing the OSC budget, soliciting sponsorship, making financial arrangements for collecting sponsorship funds and making payments for Conference expenses, overseeing logistics (venue, lodging, catering, AV, special events, etc.) and outreach. The LOC reports to the SOC.

The ICPO has started visiting potential venues, with further details regarding costs still being discussed. Valery Detemmerman presented a timeline for the organization of the event, as well as proposed schedule for the week long programme that followed closely the very successful WCRP OSC 2011 programme with plenary and poster sessions in the mornings and parallel sessions in the afternoon. The SSG agreed that this was a good approach.

In order to support the organization of the event, it was suggested to form a fundraising committee (FRC). The SOC Chairs would also chair the FRC. SSG members were urged to identify key programme managers to be contacted for potential sponsorship. Terms of Reference for the FRC were proposed as follows:

- with LOC, determine funding requirements
- identify potential funding sources;
- develop sponsorship guidelines,
- make contacts;
- assist ICPO in preparation of proposals;
- report to SOC and LOC.

***ACTION:** Prepare an open call for OSC 2016 parallel sessions (SOC and LOC)*

***ACTION:** Invite additional members from Asia and ECS to join SOC.*

***ACTION:** Confirm SOLAS, IMBER and PAGES representation on SOC (S. Gulev, K. Drinkwater and P. Braconnot)*

***ACTION:** Form LOC (ICPO with SOC chairs)*

***ACTION:** Form Fund Raising Committee (SOC, ICPO)*

***ACTION:** SSG members to send to ED/ICPO names of contacts in national funding agencies.*

8. Budget

Valery Detemmerman introduced the proposed WCRP budget allocations for 2015. The plan is to cut back on overall spending due to shortfalls in national contributions, and to allot only 10% of the overall budget to each of the four core Projects. This would mean more than a 50% reduction in CLIVAR spending from the previous year. The SSG discussed various options for distributing the proposed allocation from WCRP but decided that they would need more time to fully analyse the consequences of the reduced budget and to investigate other options for funding the list of proposed CLIVAR activities for 2015.

***ACTION:** SSG members to review meeting requests and send suggested budget distribution to ED/ICPO.*

9. Panel Business

The SSG noted with satisfaction the very complete and informative reports received from the Panels, most of which included detailed sections on accomplishments and future plans and priorities. These would form the basis for both the accomplishments report and the science and implementation plan that would be prepared later this year and early next. In the interim, they agreed that the full reports should be posted on each of the Panel webpages.

Due to the short nature of this SSG session, the SSG was not able to hear reports from individual panels, but the following issues were discussed:

9.1 Climate Dynamics Panel (Annalisa Bracco, discussion leader)

Following discussions at the joint CLIVAR/GEWEX The Hague meetings, the following coupled ocean-atmosphere dynamics topics emerged as areas where international coordination could accelerate progress:

- Storm tracks, jet streams and weather systems.
- Processes for mid-latitude air-sea interactions.
- Climate phenomena and their relevance for regional climate change.

The Panel prospectus was applauded for proposing a convincing program that does not duplicate current efforts within WCRP, but will address the role of the ocean in coupled climate dynamics and modes that span basin regions, establishing strong cross-programmatic links with related activities. In particular, the Panel is seen as an opportunity to foster linkages between CLIVAR and SPARC DynVar activities, as well as efforts in the other core projects. The SSG, however, expressed a downside on the third objective of the Panel plan which is perceived as too broad.

***Recommendation:** Refine the third objective with clearly defined climate modes - a revised formulation of this third objective encompassing targeted processes would be desirable before entering the implementation phase.*

9.2 International Indian Ocean Expedition 2 (IIOE2)

The Indian Ocean Region Panel has been part of the planning discussions for the IIOE2, but the SSG noted that the scope of the science plan (under preparation) is significantly broader than IORP, encompassing, for example, aspects also important to the Monsoons Panel. IOC is calling for countries to nominate members to the Planning Committee that will also have representatives from SCOR, IOC and IOGOOS. WCRP is currently not represented, and the SSG suggested that the Co-chairs approach D/WCRP about the possibility of requesting a seat on the Planning Committee.

***ACTION:** IORP and MP to review the IIOE2 science plan*

***ACTION:** SSG co-chairs to discuss with D/WCRP the possibility of requesting WCRP level representation on the IIOE2 Planning Committee.*

9.3 Indonesian Throughflow Task Team

The SSG recognized that the Task Team had done very good work to build trust, capacity and cooperation in the region. They reviewed the request for an extension and agreed that the work should continue, but should be under the responsibility of the Pacific and/or Indian Ocean Region Panels.

***ACTION:** Indian Ocean and Pacific Region Panels should incorporate the ITFTT activity into their plans.*

9.4 CCI/CLIVAR-GEWEX/JCOMM Expert Team on Climate Change Detection and Indices

It was noted that the ETCCDI had a new work plan that was submitted to CCI, but SSG members were not in agreement as to the relevance of this activity to CLIVAR. The SSG recommended that there be a coordinated discussion amongst the “parents” of this ET to discuss not only membership issues, but also their work plan. As a first step it was suggested that the CLIVAR SSG Co-chairs consult with the GEWEX SSG Co-chairs and that they try to attend the upcoming ET meeting.

***Recommendation:** CLIVAR co-chairs to consult with GEWEX on membership and work plan of ETCCDI and attend ET meeting, remotely if possible.*

9.5 Panel Terms of Reference and Membership

The SSG thanked the panels for their updated terms of reference and recommended that they all be adopted as submitted. Panel memberships were discussed and with a few exceptions were agreed as proposed. New, continuing and outgoing members would be contacted immediately following the meeting. The new rosters would be posted on the CLIVAR website as soon as they were finalized.

10. Science and Implementation Plan

The SSG reviewed the purpose and proposed outline for the new CLIVAR Science and Implementation Plan. It was agreed that the purpose of the document was to describe what CLIVAR is about in a way that would interest and excite young scientists and scientists in tangential fields and motivate them to get involved in CLIVAR. The organization of the document should enhance its readability, hence it was suggested to organize the main chapters around the important science questions being addressed by the research foci and to keep any programmatic descriptions for the end. The core science and international cooperation, e.g., in modelling and observations, facilitated by CLIVAR that allow the GCs (and other climate science efforts) a better chance for success, should also be emphasized.

It was felt that the Plan should reflect the move to greater integration of the science across disciplines, and implementation should include enhanced interactions, for instance with Future Earth and the other WCRP projects. All CLIVAR Panels should be asked to comment on the first draft.

***Recommendation:** Organize Science and Implementation plan around major science questions that are being addressed by the Research Foci.*

11. Achievements Report

Discussion focused on the purpose and organization of this document. The report should give readers a sense of how CLIVAR has transformed post- WOCE and TOGA understanding of the coupled climate system. It was agreed that the outline should follow the original three CLIVAR goals, i.e., improving predictions on seasonal, decadal and anthropogenic climate change time scales, and also have chapters on how CLIVAR has contributed to the five “capabilities”: Improving ocean system models; Improving ocean-observing systems; Ocean data, synthesis and information systems; Knowledge transfer and stakeholder feedback; Education, capacity building and outreach. It should include a bibliography of key papers. White papers prepared for past conferences, IPCC inputs and Exchanges could provide useful input. The SSG viewed the Achievement report as appealing to a wider audience than the Science Plan.

***Recommendation:** Organize Achievements Report around three CLIVAR timescales and capabilities.*

12. ICPO Report (Valery Detemmerman)

Ms Detemmerman reported that the ICPO was now operational in two locations – the First Institute of Oceanography (FIO) in Qingdao, China, and the Indian Institute of Tropical Meteorology (IITM) in Pune, India. The Qingdao office was fully staffed with the Executive Director, two scientific officers and an administrative assistant. The Pune office had a Director and two part-time scientific officers. The Deputy Executive Director, supported by the USA, was located at ICTP in Trieste, Italy. In addition, University of Hamburg was providing in-kind support for the services of a part time webmaster. Ms Detemmerman reviewed the accomplishments for the past year that included preparation of the pan-CLIVAR meeting, publication of two issues of Exchanges, revision of the CLIVAR website, regular e-bulletins and transition of the office to the new locations. Major work items for the coming year would be the Science Plan and Achievements Report, preparation of the Open Science Conference and support to the SSG and Panels. An issue of Exchanges focussed on Monsoons was in preparation and ideas for the subsequent issue were discussed.

13. JSC and next SSG meetings

The SSG agreed that the following topics should be highlighted in next year's JSC presentation: budget issues, OSC outline, Science Plan first draft, Future Earth relationship, Knowledge Exchange Panel, Climate Dynamics panel, Research Foci status, highlights from Panels.

The SSG also agreed that despite budget pressures, it was imperative to hold an SSG meeting in 2015, and that this could be combined with a meeting of the OSC Scientific Organizing Committee since SSG members were all members of the latter. The SSG would like to hold the meeting in India in recognition of the contribution of India to the ICPO. The exact location would depend on funding and costs; the ICPO was charged to explore whether co-location with the various IIOE-2 related meetings in Goa the week of 30 November or 7 December could represent cost savings. These dates should be circulated to the Panel chairs and D/WCRP for comment.

ACTION: *Investigate options for holding SSG-22, in conjunction with a meeting of the OSC SOC, in India during the weeks of 30 November or 7 December (ICPO).*

Appendix A

21st Session on the CLIVAR Scientific Steering Group
 Moscow, Russian Federation
 10-12 November 2014
 Agenda

Daily overview:

Day 1 (Monday 10 Nov) – *Russian Academy of Sciences*; Review & assessment of progress on Research Foci; discuss next steps, governance, new foci; status of CLIVAR contributions to WCRP GCs; Climate Dynamics Panel

Day 2 (Tuesday 11 Nov) – *AM: Russian Academy of Sciences; PM: IORAS* - Knowledge Exchange, other capabilities; Open Science Conference – programme, timeline, outreach, local logistics, budget, fund raising; Interaction with other projects; student presentations, reception

Day 3 (Wednesday 12 Nov) – *Russian Academy of Sciences*; Panel business (e.g., IIOE-2, ITFTF, membership, TOR, meeting proposals); Science Plan; Preparation for JSC, ICPO report. Adjourn meeting 15:30.

Monday			Russian Academy of Sciences	Presenter/ Disc lead	time
0900	1		Opening		
		1.1	Welcome		15
		1.2	Local logistics	Gulev	10
		1.3	Meeting objectives	Stammer/Goddard	20
		1.4	WCRP perspective (incl Future Earth)	Brasseur	20
		1.5	Report from IPCC follow-on workshop	Goddard/Stammer	15
1020	2		Research Foci (15 min summary; 15 min discussion)		
		2.1	Monsoons	AchutaRao	30
1050			<i>break</i>		30
1120		2.2	Decadal	Bracco	30
		2.3	Biophysical interactions/ upwelling	Monteiro	30
		2.4	Sea level	Stammer	30
1230			<i>lunch</i>		90
1400		2.5	Extremes	Braconnot	30
		2.6	ENSO	Moffat	30
		2.7	Heat balance/ocean heat	Gulev	30
1530			<i>break</i>		30
1600		2.8	General discussion on way forward	Co-chairs,lead	60
1700	3		Climate Dynamics Panel	Bracco/Pirani	20

1720	4		WCRP Grand Challenges (not covered above)		
		4.1	Regional climate information	Goddard	10
		4.2	Water Availability	Stammer	10
1750			Review of the day	Goddard	10
1800			Adjourn for day		
Tuesday		AM	Russian Academy of Sciences		
0900	5		Capabilities (issues for SSG)		
		5.1	Knowledge Exchange & stakeholder feedback	Hawkins	30
		5.2	Observing systems	Visbeck	15
		5.3	Data, synthesis, information	Bindoff	15
		5.4	Ocean models, modelling (incl OMDP role)	Wu/Bracco (or Griffies via skype)	15
		5.5	Capacity building, outreach, incl ECS/YESS	Monteiro	15
10:30			<i>break</i>		30
1100	6		Open Science Conference		
		6.1	Objectives	Stammer/Brasseur	30
		6.2	Proposed timeline	Valery	15
		6.3	Programme, SOC	Stammer, Goddard, Wu	30
1215			Lunch and move to IORAS		90
Tuesday		PM	IORAS		
1400		6.3	Programme continued		30
		6.4	Budget, venue	Valery/ Wu	15
		6.5	Outreach, ECS	Nico	15
		6.6	Fund raising	Valery	15
1515			<i>break</i>		
1545	7		Interactions with other projects (e.g. GEWEX, PAGES, SOLAS, IMBER...)	Co-Chairs, Drinkwater	30
1630			Review of the day	Stammer	15
1645			IORAS student presentations		105
1830			Reception at IORAS		

Wed			Russian Academy of Sciences		
0900	8		Panel business		
		8.1	Issues arising from panel reports (e.g., IIOE-2, ITF, incl of paleo)	ICPO staff	30
		8.2	TOR	Valery	15
		8.3	Membership	Valery	15
		8.4	Meeting proposals and budget	ICPO staff	30
1030			<i>break</i>		
1100	9		Preparations for JSC	Stammer, lead	30
1130	10		ICPO report	Valery	30
1200			<i>lunch</i>		
1330	11		Science Plan	Stammer	60
1430	12		Actions arising	Valery	30
	14		Place and date of next meeting		15
			Closing		15
1530			Adjourn meeting		

Appendix B

21st Session on the CLIVAR Scientific Steering Group
Moscow, Russian Federation
10-12 November 2014
List of participants

Name	Country	
Detlef Stammer	Germany	Co-Chair
Lisa Goddard	USA	Co-Chair
Martin Visbeck	Germany	Member
Annalisa Bracco	USA	Member
Pascale Braconnot	France	Member
Ed Hawkins	UK	Member
Ken Drinkwater	Norway	Member
Lixin Wu	China	Member
Pedro Monteiro	South Africa	Member
Sergey Gulev	Russia	Member
Carlos Moffat	Chile	Member
Krishna AchutaRao	India	New Member
Virginie Guemas	Spain	New Member
Nathan Bindoff	Australia	New Member
Guy Brasseur	Germany	JSC
Valery Detemmerman	China	ICPO
Anna Pirani	Italy	ICPO
Nico Caltabiano	China	ICPO