WORLD METEOROLOGICAL ORGANIZATION

COMMISSION FOR BASIC SYSTEMS

EXPERT TEAM ON EXTENDED AND LONG-RANGE FORECASTING

Exeter, United Kingdom, 28 June – 2 July 2010

FINAL REPORT

Photographer: Steve Fallon

Back row:
Peer Hechler, Jacobus Olivier, Peter Chen, David Jones, Richard Graham, Takayuki Tokuhiro, and Benoit Archambault

Front row:
Rupa Kumar Kolli, Vincent Sakwa, Caio Coelho, Arun Kumar, Laura Ferranti, Alice Soares, Jean-Pierre Ceron, and Hyun-Soo Lee

EXECUTIVE SUMMARY

The meeting of the CBS Expert Team on Extended- and Long-Range Forecasting (ET-ELRF) was held in Exeter, UK, from 28 June to 2 July 2010.

The Team reviewed the status/progress reports by Global Producing Centres (GPCs): Beijing, CPTEC (Brazil), Exeter, Melbourne, Montreal, Moscow, Pretoria, Seoul, Tokyo, Toulouse, Washington and the ECMWF. It noted that significant progress had been made in developing the GPC network and services since the previous ET-ELRF meeting (Beijing, 2008), including: (a) designation of 2 additional GPCs bringing the total to 12; (b) designation of the LC-LRFMME; (c) development of new LC products, including user selectable multi-model forecast combinations; and (d) active engagement of some GPCs with RCCs and RCOFs, in promoting and assisting use of GPC products. The Team also reviewed GPC compliance with designation criteria. It concluded that all GPCs were providing real-time seasonal forecast anomalies for at least 2-metre temperature and precipitation, with accompanying verification information. Some GPCs were not fully compliant with the designation criteria, partly due to difficulties in maintaining compliance during enhancements to their prediction systems Recognizing that temporary periods of non-compliance are acceptable in light of the competing need for forecast system development, the Team encouraged all GPCs to reach or regain full compliance. In addition, the Team concluded that a number of GPCs were making significant developments to their extended-range prediction systems. It recommended that advances in evaluation and use of these forecasts would be best addressed, at this time, through GPCs conducting pilot studies with users, and encouraged GPCs to do so.

The Team noted and welcomed the decision at the World Climate Conference-3 (WCC-3) to develop a Global Framework for Climate Services (GFCS), and concluded that the above progress, together with developments in establishing RCCs, represents significant contributions to secure the foundation of the GFCS. The Team welcomed the initiative to develop a Global Seasonal Climate Update (GSCU) within the context of the GFCS, and concluded that a number of developments to GPC and LC products would help to assist the preparation of GSCU, including: development of new LC-LRFMME probability products, verification of LC-LRFMME multi-model products and, possibly, centralized calculation of verification for individual GPC products. It therefore urged the GPCs and LCs to review the feasibility and make progress on these issues and to participate in the scoping workshop for GSCU, planned to be held in Geneva, from 12 to 14 October 2010.

The Team acknowledged that, particularly in the context of the GFCS, the WMO Executive Council, at its sixty-second session (EC-LXII, June 2010), had urged GPCs to make their hindcasts available to users. It noted that 9 GPCs were providing their hindcasts to the LC-LRFMME and that others were making hindcasts available on a case-by-case basis through active engagement at RCOFs. It was noted that since its previous meeting (Beijing, 2008), one additional GPC had decided to make its hindcasts available to the LC-LRFMME.

In addition, the Team concluded that it should respond to the GFCS requirement for development of predictions on longer than seasonal timescales. It welcomed the offer from GPC Exeter to contribute in coordinating international collaboration in research on decadal prediction and, through the ET-ELRF to report back to CBS on the potential for multi-annual prediction and to CCl OPACE-3 on potential for predictions of greater-than-two-year range.

The Team noted that RCCs were being encouraged to make use of the set of verification scores embodied and documented in the *Standardized Verification System for Long-Range Forecasting* (SVSLRF). In this context, the Team agreed that the *Manual on the Global Data-Processing and Forecasting System (GDPFS)* (WMO-No. 485), Attachment II.8 required some revision since it currently addressed only requirements on GPCs; and therefore tasked the LC-SVSLRF with leading preparation of the necessary amendments. In addition, the Team concluded that Level 3 verification scores should no longer be mandatory for GPCs as such scores are more meaningful when generated at regional level.

The Team took note of the recent survey on use of GPC products and recommended that a number of activities be undertaken to improve accessibility and use of the products, including; (a) development of a ‘flyer’ describing GPC services; (b) development of clearer navigation to and identification of GPC websites; (c) development of training material; (d) a review of the completeness of GPC products for RCC use; and (e) active engagement of GPCs in the process of developing regional forecasts at RCCs and RCOFs. The Team also recommended that wiki pages be created to facilitate discussion between GPCs, RCCs and LCs on the development of LC services, and also to facilitate discussion between GPCs, RCCs and NMHSs during the process of preparing and assessing regional forecasts

GENERAL SUMMARY OF THE WORK OF THE SESSION

1. OPENING

1.1 The Meeting of the CBS Expert Team on Extended- and Long-Range Forecasting (ET-ELRF) was opened by its chairperson, Dr Richard Graham (UK), at 09.00 hours on Monday, 28 June 2010, at the Met Office (UK), in Exeter. On behalf of Dr Chris Gordon, the Deputy Director of Climate Science, and on his own behalf, Dr Graham welcomed participants to the Met Office (UK).

1.2 Dr Graham noted that in recent years there had been a substantial increase in interest in long-range forecasting. In particular, the climate change agenda had highlighted the need for better long-range forecasts as a central tool in climate risk management and early warning systems. In the context of improving its long-range forecasting system, Dr Graham noted that a few years ago, the Met Office Hadley Centre (UK) consolidated its work in these areas by integrating its seasonal and decadal research and forecasting programmes. He assured the Team that seasonal forecasting is of a high priority for the Met Office (UK).

1.3 Dr Graham recalled that the proposed Global Framework for Climate Services (GFCS), coming out of the World Climate Conference-3, had brought the wider requirements of long-range forecasts to the fore and also highlighted a growing interest in decadal prediction systems to assist in climate change adaptation. He noted that some of the GPCs represented on the ET-ELRF, along with other global centres, were developing multi-annual to decadal prediction systems, and that the ET should therefore consider making recommendations on the research and international collaborations needed to advance multi-annual to decadal prediction science towards application within the GFCS. He stressed that this issue clearly needed to be discussed and agreed. He concluded by welcoming again participants to the Met Office (UK) and by wishing a very productive meeting.

1.4 On behalf of the Secretary-General of the WMO, Mr Peter Chen welcomed participants to the meeting and expressed appreciation to Mr John Hirst, Permanent Representative of United Kingdom of Great Britain and Northern Ireland, and Dr Chris Gordon, Deputy Director of Climate Science, for hosting this meeting in Exeter and for providing these excellent facilities. Mr Chen also thanked Mr Simon Gilbert of the Met Office (UK) for his work in organizing the local arrangements, and Dr Richard Graham, the Chairperson of the CBS Expert Team on Extended- and Long-Range Forecasting, for guiding the work of this meeting.

1.5 As the CBS-Ext(10) and the Sixteenth World Meteorological Congress were approaching, Mr Chen was pleased to note the significant progress made towards accomplishing all requests by the Fifteenth World Meteorological Congress (May 2007), in particular in establishing procedures for designating WMO RCCs as an integral component of the WMO's Global Data-Processing and Forecasting System (GDPFS). In addition, Mr Chen informed that there were currently twelve GPCs designated, with the most recent addition of GPC CPTEC (Brazil), approved by the WMO Executive Council, at its sixty-second session (June 2010). Mr Chen pointed out that, however, CBS, at its fourteenth session (March/April 2009), noted that related to Long-Range Forecasting, a number of issues need to be studied and discussed, including within the context of the proposed GFCS.

1.6 In this context, Mr Chen recalled the outcomes of the World Climate Conference-3 (WCC-3, 31 August- 4 September 2009, Geneva, Switzerland), which decided to establish a GFCS to strengthen the production, availability, delivery and application of science-based climate prediction and services. In relation to the proposed GFCS, he encouraged the Expert Team to develop future directions and planning strategies for strengthening the role of GPCs in providing long-range forecasts and in guiding the development of services both for the extended (monthly) range and the longer-than-seasonal ranges. He noted that the ET should also develop strategies for guiding

the introduction of GPC products within the RCC and NMHS activities for operational climate prediction.

1.7 In concluding, Mr Chen expressed gratitude to participants in the meeting for their contributions to the work of the CBS Expert Team on Extended- and Long-Range Forecasting, which would continue to assist WMO to provide even better assistance to its Members in facing challenges of improving their forecasting systems for supporting climate services. Finally, he concluded by wishing everyone a successful meeting.

2. ORGANIZATION OF THE MEETING

2.1 Adoption of the agenda

2.1.1 The Team adopted the provisional agenda without change, as provided in Annex I to this report.

2.2 Working arrangements

2.2.1 All documents submitted for the meeting are referenced and hyperlinked in the Documentation Plan (INF. 1), which had been posted on the WMO web site at:

http://www.wmo.int/pages/prog/www/DPFS/Meetings/ET-ELRF_Exeter2010/ET-ELRF_Docplan.html

2.3 The Team agreed its hours of work and other practical arrangements for the meeting. Noting that a number of participants were new to the Expert Team, they briefly introduced themselves, to facilitate interactions throughout the meeting. The list of participants in the meeting is provided in Annex II to this report.

3. INTRODUCTION / REVIEW OF DECISIONS OF THE WMO GOVERNING BODIES AND STATEMENTS ADOPTED BY CBS RELATED TO THE ET-ELRF

3.1 The Team was presented with background information related to the ET-ELRF, including recalling the relevant decisions of the sixty-first and sixty-second sessions of the WMO Executive Council (EC-LXI, June 2009; and EC-LXII, June 2010), and statements adopted by the fourteenth session of the Commission for Basic Systems (CBS-XIV, March-April 2009).

3.2 The Team recalled that CBS-XIV noted that Roshhydromet Centre (Moscow) and RSMC Pretoria (South Africa) were fully compliant with the required criteria for GPC designation and recommended them for GPC designation, and that they be included in the list of designated GPCs in the Manual on the GDPFS. This recommendation was endorsed by EC-LXI. The Team also noted that the designation of GPC CPTEC (Brazil) had been completed, following the encouragement given by CBS-XIV. The president of CBS received an application from Brazil and, with supporting technical information provided by the ET-ELRF, recommended designation to EC-LXII. EC-LXII approved designation and an associated amendment to the *Manual on the GDPFS.*

3.3 The Team noted that CBS-XIV made a number of recommendations, which were endorsed by EC-LXI, including amendments to the *Manual on the GDPFS*, in relation to (1) a list of additional products and services that GPCs may supply on request by RCCs or NMHSs (in addition to the minimum requirement); (2) guidelines to assist and encourage RCCs and NMHSs to provide feedback to GPCs on their products and services; (3) the designation of GPC Seoul and GPC Washington as Lead Centre for Long-Range Forecast Multi-Model Ensembles (LC-LRFMME) and its list of functions; and (4) the designation criteria for RCCs, resulting from close collaboration between CBS and CCl.

3.4 In relation to the RCC designation, the Team noted that EC-LXI approved *Resolution 4 (EC-LXI) – Establishment of Regional Climate Centres*, and that Beijing Climate Centre (BCC) and Tokyo Climate Centre (TCC) had been designated WMO RCCs in RA II. It was noted that while only two RCCs are currently designated, good progress had now been made towards establishing RCCs or RCC-Networks in other WMO regions. The Team was also informed that a document on "Procedures for Establishment and Designation of WMO Regional Climate Centres and RCC-Networks", laying down the process for the establishment and implementation of RCCs and RCC-Networks, had been prepared to facilitate the expansion of the RCC implementation to cover all WMO Regions.

3.5 In this context, the Team noted that EC-LXII appreciated the formation of a focused CCl Expert Team on RCCs to help expand and enhance the RCC coverage around the world. Considering the significant role of CBS in the RCC designation process, EC-LXII endorsed the proposal to convert this Expert Team to be a Joint CCl-CBS Expert Team, and requested CCl and CBS to closely collaborate in facilitating the team's work. The Team (ET-ELRF) noted that CBS had been asked to nominate two experts to serve as members of this Joint CCl-CBS Expert Team. The Team (ET-ELRF) agreed with the proposed approach to create a better interface between CBS and CCl, and therefore decided to address this issue, including the review of the Terms of Reference for this joint team, under agenda item 4.3.

3.6 The Team noted that the EC-LXII appreciated that Regional Climate Outlook Forums (RCOFs) had been established around the world in Africa, Asia, South Eastern Europe, South America, and South Pacific Islands and were being regularly held. EC-LXII welcomed the WMO initiatives to establish and sustain new RCOFs in South Asia, Southeast Asia and Polar Regions; and noted the additional plans for RCOF development, such as that for the Indian Ocean Islands and the re-establishment of the RCOF in the English-speaking Caribbean countries. The Team noted that these are important initiatives that contribute to capacity building in the various regions, and agreed that the GPCs should be encouraged to promote their products within these forums and participate in training in their use. This also supports the requirement for GPCs to expand their data exchange. The Team also agreed that special attention should be given to regions that cross two or more Regional Associations (e.g. the Mediterranean and Polar Regions).

3.7 The Team noted that EC-LXII encouraged CCl in collaboration with CBS, to explore the possibility of expanding the consensus-based WMO El Niño/La Niña Updates to become the WMO Global Seasonal Climate Update. Such an Update should be started on a trial basis, allowing a sufficient period of few years to gain experience and making it reliable and effective. The Team recognized the importance of these efforts and agreed to address this issue under agenda item 4.2.

3.8 The Team noted that EC-LXII approved the WMO Position Paper on the Global Framework for Climate Services (GFCS), which highlights the role of GPCs in the GFCS, as a key building block of the Climate Services Information System (CSIS) component. The Team agreed to consider the content of the approved Executive Summary of the Position Paper under the agenda item 4.1. In addition, the Team noted that, within the GFCS, as it develops, some of the GPCs, along with other global centres, may provide climate predictions on seasonal and longer (multi-annual, decadal) time-scales. The Team agreed that this issue should be carefully discussed under agenda item 9 and the Terms of Reference for the ET-ELRF should be expanded as appropriate (under agenda item 10).

4. GLOBAL FRAMEWORK FOR CLIMATE SERVICES (GFCS)

4.1 Review of recent activities on the GFCS development, including discussions on potential implications for the Global Data-Processing and Forecasting System (GDPFS)

4.1.1 The Team was informed of recent activities, following World Climate Conference-3, in the development of the GFCS, including the establishment of the High-Level Taskforce (HLT) on the GFCS and its ongoing work. The Team noted that, as an overarching outcome of WCC-3, Heads of State and Government and other invited dignitaries, along with ministers and other national representatives, adopted a Conference Declaration (http://www.wmo.int/wcc3/declaration_en.php), which decided to establish the GFCS to strengthen the production, availability, delivery and application of science-based climate predictions and services; requested the Secretary-General of WMO to convene an intergovernmental meeting of Member States of the WMO to approve the terms of reference and to endorse the composition of a task force of high-level, independent advisors for implementing the GFCS; decided further that the report of the task force shall be circulated by the Secretary-General of WMO to Member States of the WMO for consideration at the next WMO Congress in 2011, with a view to the adoption of the GFCS and a plan for its implementation; and invited the Secretary-General of WMO to provide the report to relevant organizations and to the UN Secretary-General. The team was apprised of the salient aspects of the work of the HLT and its further plans in preparing the report – which is likely to be finalized by January 2011.

4.1.2 The Team noted that, in accordance with the request made by EC-LXI (June 2009), WMO Secretary-General initiated steps to prepare a draft Position Paper articulating how WMO Programmes should become core elements of the GFCS, especially through the unique capabilities and capacities of the NMHSs, and to actively promote these contributions as elements of the proposed GFCS. On the basis of advice from the Executive Council Working Group on Climate and Related Weather, Water and Environmental Matters (ECWG-CWE) the Position Paper was revised, structured along the five components of the GFCS: (i) Observations; (ii) Climate research, modelling and prediction; (iii) a Climate services information system (CSIS); (iv) a Climate user interface programme (CUIP); and (v) Capacity building. EC-LXII (June 2010) agreed that the contribution of relevant programmes and activities of WMO have been adequately reflected in the Position Paper, ensuring a strong role for them in supporting the various components of GFCS and endorsed the finalization of the Position Paper, which can be found at: http://www.wmo.int/pages/gfcs/documents/GFCS_Position_Paper_DRAFT_REV_1_en_1.pdf.

4.1.3 The Team agreed on the need to ensure that the role of GPCs is adequately highlighted in GFCS, as a key building block of the CSIS component. To this end, the Team decided to review the description of GPCs and their roles within the Position Paper, and requested the chairperson with the assistance of Dr Arun Kumar, to collect and summarize the views expressed by GPC representatives by the end of August 2010. The Team agreed that the chairperson should then bring this to the attention of the CBS, through its ICT-DPFS, to take further necessary action.

4.2 The Global Seasonal Climate Updates (GSCU) within the context of the GFCS

4.2.1 The Team was briefed on the proposal for Global Seasonal Climate Updates, endorsed by CCl-XV and encouraged by EC-LXII, and its proposed scoping meeting (see the GSCU concept note at Annex III). The Team shared views on GPC potential roles in facilitating the process. The Team expressed support to the idea, but noted certain concerns, e.g., on the timing of the release with respect to the target season. It proposed to consider making more effective use of the LC-LRFMME products in this context. The Team agreed that more in-depth discussion of the various aspects of GSCU (e.g. format, approaches for achieving consensus, verification methods, use of descriptive indices of large-scale features), could be taken up at the scoping meeting planned to be held from 12 to 14 October 2010.

4.3 Review of the work and functions of the GPCs for meeting the needs of the WMO Regional Climate Centres (RCCs) and Regional Climate Outlook Forums (RCOFs), including discussion on related activities for climate-sensitive areas, including Polar Regions

4.3.1 The Team was provided with updated information on the status of the RCC and RCOF implementation and operation worldwide, and discussed ways to strengthen their interfaces with the GPCs. The Team encouraged active participation of GPCs in RCOFs recognizing that this is the case in many regions already. The Team also encouraged RCOFs to make optimal utilization of the LC-LRFMME products and services in this regard.

4.3.2 The Team reviewed the Terms of Reference of the CCl/CBS ET on RCCs as approved by the CCl-XV Management Group, and suggested that these may be slightly adjusted to reflect the CBS aspects more clearly. The Team proposed that CBS may be represented by Dr David Jones (Australia) and Dr Caio Coelho (Brazil) on this joint ET, and requested the President of CBS to consider communicating these names to the President of CCl at an appropriate time.

4.3.3 The Team acknowledged the discussions in progress on implementing RCOFs and RCCs for certain climate-sensitive areas spanning across more than one WMO Region, such as the Greater Mediterranean Basin (RAs I and VI), the Polar Regions (all RAs), Southeast Asia (RAs II and V), etc. The Team pointed out that the required GPC information on the currently available LRF skills for such areas can be obtained from the LC-SVSLRF. The Team noted that the GPCs and LCs have additional, more specific, information that may be provided on request.

5. PROVISION OF LONG-RANGE FORECASTS (LRF)

5.1 Review of the work, functions and specific needs of the Global Producing Centres (GPCs), including status/progress reports

5.1.1 The Team was presented with and reviewed the status/progress reports by representatives from the following Global Producing Centres (GPCs): CPTEC (Brazil), Exeter, Melbourne, Montreal, Pretoria, Seoul, Tokyo, Toulouse, Washington and the ECMWF, against the minimum criteria for GPC designation. The Team also reviewed the status/progress reports from GPC Beijing and GPC Moscow (representatives from these two GPCs were unable to attend the meeting). All GPC status/progress reports are available on the WMO Web site at: http://www.wmo.int/pages/prog/www/DPFS/Meetings/ET-ELRF_Exeter2010/ET-LRF_Docplan.html

5.1.2 The Team noted that all GPCs were providing probabilistic forecasts of the key variables, such as temperature and precipitation, together with appropriate hindcast validation to allow prudent use of the forecasts. However it was noted that some GPCs were in a temporary period of non-compliance with the full designation criteria. This was a result of substantial development of the prediction systems at many of GPCs, which puts pressure on the considerable resources needed to maintain compliance. The Team congratulated GPC CPTEC (Brazil), GPC Montreal, GPC Pretoria and GPC Toulouse who were fully compliant, and encouraged the other GPCs to reach or regain full compliance as soon as possible.

5.1.3 The Team noted the specific needs expressed by the GPCs. In general, these include: (1) feedback from users on the usefulness of GPC products; (2) the exchange of hindcast data; and (3) the access to existing observational data, including metadata, for verification and calibration purposes. Noting the data exchange policies and the WMO Resolution 40, the Team was informed of an alternative method that had been developed by the Joint CCl/WCRP-CLIVAR/JCOMM Expert Team on Climate Change Detection and Indices, which developed software that produces standard products/indices. This software had been distributed to Members and they share the output products instead of the raw data.

5.1.4 The Team noted that CPTEC (Brazil) had expressed an additional need for guidance on how to evaluate and verify subjective consensus forecasts, produced by compiling diagnostic analysis, forecast products from climate models and expert knowledge. Such evaluation is valuable to users and is also needed for administrative purposes (e.g. to demonstrate the time evolution of consensus forecast skill). In this context, the Team was informed that a CCl guidance document on verification of operational seasonal forecasting had been prepared and would be published soon. The Team requested the Secretariat to provide the GPCs with the draft document.

5.1.5 The Team noted that all GPCs had been involved in capacity building and training activities, including at RCOFs, and would be able to continue to do so. The Team recommended that a seasonal forecasting training programme or syllabus should be prepared as part of the training and capacity building strategy, and agreed to consider this issue under agenda item 5.5.

5.1.6 In relation to the need within the developing GFCS, for predictions on monthly, seasonal and longer time-scales, the Team noted that a number of GPCs had been providing a broad range of monthly to multi-seasonal forecasts and a few are developing decadal forecasts or plan to do so as part of future developments in the next 1 to 5 years. The Team agreed to consider this information when discussing agenda item 9.

5.2 Review of the outcomes of the GPC survey, including discussion on potential standardization of products

5.2.1 The Team was apprised of the analysis of a survey on the use of GPC products and services (see Annex IV). The Team appreciated the survey and its analysis, which brought out the following issues to be addressed in order to improve the uptake of GPC products:

- Training and capacity building including provision of guidance material;
- Enhanced exchange of digital forecast and hindcast data;
- Promotion of verification activities; and
- Promotion of GPC activities.

5.2.2 The team noted these aspects shall be addressed in the respective agenda items of the current meeting (5.5, 6.1, 7.1 and 8.2).

5.3 Review of the work and specific needs of the Lead Centres for Long-Range Forecast Multi-Model Ensembles (LC-LRFMME) and for Standardized Verification System for Long-Range Forecasts (LC-SVSLRF)

Lead Centre for Long-Range Forecast Multi-Model Ensembles (LC-LRFMME)

5.3.1 The Team recalled that the goal of the Lead Centre for *Long-Range Forecast Multi-Model Ensemble (LC-LRFMME)* is to provide a conduit for sharing the GPC predictions and to develop a well-calibrated Multi-Model Ensemble (MME) system. In this context, the Team noted that currently the forecast anomalies from various GPCs (for sea surface temperature, 2-metre temperature, precipitation, mean sea level pressure, 850hPa temperature, and 500hpa height) were being collected at the LC-LRFMME, and the forecast data had been used for displaying various seasonal forecast products. The product display includes seasonal mean anomalies from individual GPCs, and also a synthesis of information in terms of consistency in the sign of anomalies from all GPCs. The region for forecast display can be chosen by a user driven interface. The access to the LC-LRFMME website is password protected, and information about how to gain access to forecast products is provided (www.wmolc.org). Some examples of the forecast products provided at the LC-LRFMME Web site are provided in Annex V. The Team also noted that GPCs are asked to supply derived model climatologies in addition to their hindcasts, and that not all centres were currently supplying this quantity. The Team therefore encouraged GPCs to provide the model climatologies to the LC-LRFMME, this will facilitate generation of MME products by the LC.

5.3.2 The Team noted that forecast information from all individual GPCs is currently synthesized into a simple multi-model average with equal weights. MME based on skill dependent weights can also be constructed using the subset of models for which hindcasts covering a sufficient length have been provided. In this context, the Team urged GPCs to supply hindcast data to the LC-LRFMME. The Team agreed to further address the issue of exchanging hindcast data under agenda item 6.

5.3.3 The Team noted that LC-LRFMME products had been shared and used by RCOFs (e.g., PRESAO, GHACOF, FOCRAII for Asia, SASCOF for summer forecast of South Asia,) and RCCs; and encouraged GPCs to continue to promote the use of LC-LRFMME products at RCOFs.

Lead Centre for Standardized Verification System for Long-Range Forecasting (LC-SVSLRF)

5.3.4 The Team recalled that the Standardized Verification System for Long-Range Forecasts (SVSLRF), as defined in the *Manual on the GDPFS*, sets out a detailed methodology for assessing Long Range forecasts. The Team further recalled that a Lead Centre for SVSLRF was established to facilitate the exchange of seasonal and longer range forecast verification results. The Team acknowledged the good progress in developing verification information for display on the LC-SVSLRF Web site (http://www.bom.gov.au/wmo/lrfvs). Some examples of the verification information provided at the LC-SVSLRF Web site are provided in Annex VI. However, the Team noted that a number of GPCs are lagging somewhat in the provision of all scores to the LC-SVSLRF, and invited those GPCs that had not submitted all the required levels 1 and 2 data, to do so as soon as possible. The Team further noted that no progress had been made to date on the display of Level 3 verification (Contingency Tables for individual grid-points). In addition, the Team identified a number of aspects of the SVSLRF that required review (including potential standardization of datasets and hindcast periods, the set of skill scores defined as the 'core' SVS and the recommendation for stratification of skills scores for El Niño and La Niña events) and agreed to address these issues under agenda item 7.

5.3.5 The Team reviewed the statistics that had been compiled on the use of the LC-SVSLRF Web site over recent months as a guide to its value to GPCs, RCCs and others; and noted that these suggest a rather low level of use with the main page and user guides alone accounting for about half of the total site visits. The Team also noted that the number of hits on individual verification scores appears very low, and that this likely reflected a need for training in their use and recommended that a 2-3 day training session on these aspects (including use of probability forecasts) could be included as an integral part of the CLIPS training events. The Team agreed that feedback and comments from users would help to guide further development and change of the Web site; and therefore urged GPCs and RCCs to provide feedback and comments to the LC-SVSLRF on the usefulness of the verification information.

5.4 Review of observational requirements for LRF, including the Statement of Guidance (SoG) for Seasonal to Inter-Annual (SIA) Forecasts

5.4.1 The Team thanked the ECMWF for the review of observational data requirements for Long-Range Forecasting as updated from Beijing 2008; and agreed that there was no need to change it. The Team endorsed a revised version of the Statement of the Guidance (SoG) for Seasonal to Inter-Annual (SIA) Forecasts (see Annex VII), which represents a gap analysis, and agreed that this should be passed to the CBS Expert Team on Evolution of the Global Observing System (ET-EGOS) for consideration. In addition, the Team expressed the importance of global station data for validation of LRF. This is particularly important for rainfall, where high-quality, high-density and readily available data would be of great value both for assessing model quality and for empirical downscaling of global model output for local use. The Team recommended that the ET-EGOS consider these aspects when developing the *Vision of the Global Observing System (GOS) for 2025.*

5.4.2 The Team pointed out that long records of station data would be very useful for calibration and downscaling purposes, and would greatly help the application and usefulness of the seasonal

forecasts products. In this context, the Team recommended that this requirement be passed to the relevant CCl OPACE-1 dealing with climate data, including data rescue aspects. In the same context, the Team was informed that the accessibility to and exchange of existing climate data was under consideration by WMO, which was planning to hold an International Conference on Climate Data (tentatively in 2013) to address this issue.

5.5 Identify needs for training and guidance material

5.5.1 The Team discussed the specific training needs including the development of guidance material and capacity building aspects to help NMHSs, RCCs and other potential GPC users as well as RCOFs to fully exploit the benefits of GPC products and to apply them more efficiently to address the relevant global, regional and national needs for climate prediction. The Team formed a sub-group headed by Mr J.-P. Ceron to prepare an outline for the training curriculum as well as to address training coordination aspects and identify the minimum set of infrastructure requirements to access and use the GPC products. The outline for the training curriculum is provided in Annex VIII. The Team proposed that the CBS/CCl Expert Team on RCCs comment on the outline and that WMO secretariat advise on collating material and coordinating the training.

5.5.2 The Team encouraged GPCs to provide guidance material, such as manuals, guides on the use of GPC products including scientific and technical aspects, etc., through their web pages.

5.5.3 The Team recognized the need for information on technical requirements (e.g. hardware specification, communications bandwidth) for efficient access to and application of GPC products for regional and national applications and services. It therefore encouraged projects delivering institutional strengthening (e.g. the KOICA project for Greater Horn of Africa) to consult with the GPCs already engaged with the institutions concerned to help establish the technical requirements.

6. FUTURE DEVELOPMENT OF THE DATA EXCHANGE AND LC-LRFMME PRODUCTS

6.1 Review of the current status of hindcast exchange and recommendations for future exchange

6.1.1 The Team noted that the hindcast exchange is not mandatory, but acknowledged the importance of hindcast data in the context of the GFCS. The Team further noted that all GPCs had been supplying real-time forecasts to the LC-LRFMME, and encouraged them to continue to provide such forecasts in the future as part of the defined ‘core’ exchange. The Team also noted that many GPCs had already been providing hindcasts to the LC-LRFMME as part of an additional exchange and also as part of specific engagement with RCOFs on a case-by-case basis.

6.1.2 The Team noted that since the ET meeting in Beijing (2008), one additional GPC had, after reviewing data policy, decided to make their hindcasts available to the LC-LRFMME.

6.1.3 The Team recognized that the provision of daily forecast data and sub-monthly information could be useful to assess the frequency of events, but that the skill of such forecasts are still largely untested, and due to data policy restriction and bandwidth issues, the Team recognized that the exchange of such data was not feasible in the near future. It therefore agreed that this issue should be discussed in future meetings of the Expert Team.

6.2 New products and functionalities of the LC-LRFMME, including within the context of the GSCU

6.2.1 The Team reviewed the current functions of the LC-LRFMME and agreed that these should be kept as stated in Attachment II.12 of the *Manual on the GDPFS*. Noting that many GPCs are already supplying hindcast and forecast data to the LC-LRFMME, the Team encouraged the LC-LRFMME to proceed with the preparation of additional products (e.g. predicted indices for

ENSO, North Atlantic Oscillation, Arctic Oscillation, Indian Ocean Dipole) and display them on the Web site. These products contain useful information for the GSCU. The Team also encouraged the LC-LRFMME to move towards the generation of tercile probability products.

6.2.2 The Team recalled the discussion under item 4.2 on the possibility of LC-LRFMME developing a new product in support of the GSCU. The Team noted that this issue would be discussed at the upcoming scoping meeting (October 2010), and recognized that there might be a need to further discuss and review the list of products prepared by the LC-LRFMME.

6.3 Review of current hindcast periods used by GPCs and potential for increased standardization (products and verification)

6.3.1 The Team reviewed the current hindcast periods used by the 12 GPCs. A table summarizing this information is given in Annex IX. The Team noted that the current hindcast periods used by GPCs differ in length and that as a result, full standardization of forecast products and verification is not currently possible. The Team noted that the majority of GPCs use a hindcast period that starts within a few years of 1981, and urged that the period 1981-2010 be adopted as a target for standardization. However the Team recognized that choice of hindcast period was tied to wider research programmes at the GPCs and that consequently convergence on a common period could not be a rapid process.

6.3.2 The Team noted that the climatological reference periods used in observation monitoring and in hindcasts (for use in deriving predicted anomalies) should ideally be equivalent, and that it would be important to work towards such consistency in development of the GSCU so that observed and predicted anomalies are calculated against the same reference. The Team noted that the 1981-2010 period (the next 30 year reference period) may also be appropriate for use in the GSCUs and suggested that this issue be discussed at the upcoming scoping workshop on GSCUs. However, the Team also noted that for climate change studies it is often appropriate to measure anomalies relative to the 1961-1990 period, in order to retain consistency with results from earlier climate change predictions. In this context, the Team also noted that some GPCs had been researching the partitioning of observed (and predicted) anomalies into a component attributable to climate change trend and a component arising from natural variability, it agreed that such attribution of observed anomalies and 'signal' in the seasonal forecasts is an area that the GSCU scoping meeting may wish to discuss.

6.3.3 With regard to the construction of multi-model products the Team noted that standardization of hindcast periods was not likely to be a major problem if the 'equal weights' model combining method is used. However, for verification it would be necessary to select one or two standard retrospective periods for verification of LC-LRFMME MME products (see paragraph 7.1.7).

7. VERIFICATION

7.1 Improvement of the Standardized Verification System for LRF

7.1.1 The Team recalled the discussions under agenda item 5.3 on the status of the LC-SVSLRF, and reviewed the Standardized Verification System for LRF (SVSLRF, Attachment II.8 to the *Manual on the GDPFS*) with a view to its improvement.

Stratification of skill measures by the state of ENSO

7.1.2 The Team reviewed the SVSLRF requirement for GPCs to stratify skill measures according to the phase of ENSO, if the hindcast length provides a sufficient sample of each phase. It was noted that no GPCs are currently performing such stratification of skill. The Team noted that the length of hindcast datasets provided by the GPCs (mainly around 20 years) are currently not sufficiently long to allow statistically robust scores to be calculated for each stratification. In the

light of future potential for longer hindcasts, the Team agreed that the text in the *Manual on the GDPFS* related to this issue was satisfactory and that there was no need for an amendment.

Level 3 verification

7.1.3 The Team recalled that the SVSLRF includes a request for GPCs to provide Level 3 verification (Contingency Tables for individual grid-points) suggesting that these be "provided in the year after Levels 1 and 2 verification has been completed". The Team noted that no progress had been made to date on the display of Level 3 verification and GPCs had not been providing Level 3 verification data to the LC-SVSLRF. The Team noted that RCCs were being encouraged to make use of the set of verification scores embodied and documented in the SVSLRF. In this context Attachment II.8 required some revision since it currently addresses only requirements on GPCs. In addition it was concluded that Level 3 verification scores should no longer be mandatory for GPCs as such scores are more meaningful when generated at regional level. The LC-SVSLRF was tasked with leading preparation of the necessary amendments to the Attachment II.8.

Verification of NINO 3.4

7.1.4 The Team noted that only a few GPCs had been providing verification for Niño3.4. Noting that most GPCs were moving toward implementing coupled systems, the Team decided that the provision of Niño3.4 verification should be retained and encouraged GPCs to become compliant with this request.

Verification of post-processed output

7.1.5 The Team recalled that the SVSLRF provides guidance that verification should preferably be performed on raw forecasts or forecasts that have undergone 'simple' calibration (e.g. removal of mean or variance correction) in order to allow equitable comparison of the performance of GPC prediction systems. It was noted that this strategy does not guarantee equitable comparison, since variance correction improves MSSS values, and that for one GPC variance correction is an integral part of the ensemble generation (GPC Montreal combines ensembles from 4 models, after variance correcting each ensemble). The Team concluded that, on balance, it was preferable that users have access to verification of the forecast products provided. The Team therefore agreed that GPCs should perform SVSLRF verification on their final products (as made available to the LC-LRFMME, RCCs and NMHSs), regardless of the level of post-processing applied. The LC-SVSLRF was tasked with proposing a necessary amendment to Attachment II-8.

Use of different base periods and verification datasets

7.1.6 The Team acknowledged that different dataset and different periods had been used for the hindcast verification and that this makes comparisons of the performance of different GPC systems difficult. Such comparisons are useful for RCCs when deciding on the relative weights to apply to forecasts to different GPCs forecasts for their regions. The Team agreed that moving to a consistent verification period would enable more consistent and robust intercomparison of model skill. However, the Team stressed that a common base period would be constrained by the GPC with the shortest hindcast period and lead to a shorter verification period than currently used by most GPCs and that this would lead to less statistical robustness in the scores. The Team agreed that two standardized periods could be used: (a) a shorter period common to all GPC hindcast datasets; and (b) a longer period, in which GPCs with shorter hindcasts could not participate. It was agreed that use of two periods was recommended for verification of the LC-LRFMME MME products, but that use of two periods would require centralisation of the verification process at a single centre (see paragraph 7.2.1).

7.1.7 With regard to standardization of verification datasets it was noted that not all centres were using the preferred datasets recommended on the LC-SVSLRF website. It was noted that the datasets currently selected as preferred now required some review, since new dataset versions had recently been released. The Team requested the LC-SVSLRF review new dataset availability,

and to revise its recommendations if necessary in consultation with the other Team members. On confirmation of the recommended datasets, all GPCs were urged to use these datasets for calculating verification scores.

Presentation of verification information on the LC-SVSLRF Web site

7.1.8 The Team welcomed plans to update the LC-SVSLRF Web site, which would make use of dynamical mapping, visualization and data extraction using Web Map Services and Web Feature Services adopting open standards. The Team noted that this would follow ISO standards and therefore would be compliant with the WIS.

7.2 Coordination between the LC-SVSLRF and the LC-LRFMME for enhanced linking of GPC forecasts and verification products

7.2.1 Based on discussion under the previous agenda item, the Team agreed that standardization in calculation of SVS scores would be best achieved through centralization of the verification process at one of the LCs or GPCs. It was also noted that such centralisation would greatly facilitate full compliance of GPCs with the minimum designation criteria. However the Team noted that centralized verification could only be achieved for all GPCs if all GPCs made their hindcasts available. It also noted that conducting the centralized verification would require considerable resource from the centre undertaking the task. The Team therefore requested both LCs and all GPCs to assess the resources required to proceed with the centralization and to inform the chair of the ET-ELRF on their willingness to take on the role of centralized verification.

7.2.2 The Team recognized that coordination/discussion is required to achieve the proposed centralization, and therefore recommended that a meeting be held on this issue. This may take the form of a side meeting of GPCs and LCs at the GSCU scoping meeting in October 2010 (see paragraph 7.3.1).

7.3 Recommendation of verification for LC-LRFMME products

7.3.1 The Team noted that it will be important to have robust verification information for all products used in the predictive component of the GSCU, and that LC-LRFMME MME products were likely to play a key role. Noting the plans to have a prototype of the GSCU to demonstrate at the Sixteenth World Meteorological Congress, in May 2011, the Team noted that verification of MME products should be a priority for the LC-LRFMME and urged the LC-LRFMME to start carrying out verification of MME products that were currently displayed on the Web site as soon as possible.

7.4 Introduction of process diagnostics for GPC hindcasts

7.4.1 The Team noted that the LC-LRFMME had implemented a suite of diagnostic programmes to analyze, using hindcasts provided by GPCs, the accuracy with which GPC models reproduce observed circulation characteristics such as the energetics of mean and eddy circulations. Noting that such diagnostics analysis is useful for RCC and RCOF users and complements the assessment of model predictions based solely on different measures of skill, the Team encouraged the LC-LRFMME to expand the current suite of diagnostics in consultation with ET-ELRF.

7.5 Review of new verification techniques

7.5.1 The Team recognized that verification of LRF continues to be a matter of some research and that new verification techniques had been proposed, including those recommended in the *CCl Guide on Verification of Operational Seasonal Climate Forecasts*, prepared by Dr Simon Mason in 2008. The Team decided that promoting awareness and use of the existing SVS products provided by GPCs should remain the highest priority, and that introduction of new scores at this stage would likely detract from that aim.

7.5.2 In this context, the Team noted that Dr Mason had provided to the LC-SVSLRF software to calculate confidence intervals on verification scores using the bootstrapping technique, and that GPC Montreal had recently (March 2010) provided programmes and examples on the SVSLRF Web site to calculate the confidence levels. The Team therefore requested GPCs to make use of this software and asked the LC-SVSLRF to advise on ways to carry out the exchange and display this information. It noted that graphical rendering of confidence intervals on the mapped scores of Level 2 verification would require the most changes to existing practice and therefore recommended that GPCs should first calculate the confidence intervals on the regional Level 1 scores. The Team recalled that in the SVSLRF (Manual on the GDPFS, Attachment II.8) provision of confidence intervals will become mandatory for core SVS scores once guidance for calculation has been provided.

8. PROMOTION AND OUTREACH OF GPCs

8.1 Review of progress in the introduction of GPC products into the Regional Climate Centre (RCC), Regional Climate Outlook Forum (RCOF) and NMHS activities for operational climate prediction

8.1.1 EC-LXI and EC-LXII urged Members to avail themselves of the products of the network of GPCs and LCs and urged CCl and CBS to promote and guide this process. In this context, the Team was briefed on the recent progress made in introducing GPC products into RCC, RCOF and NMHS activities. The Team noted and welcomed the ongoing engagement of many GPCs in these regional and national-scale activities (see also agenda items 5.1 and 5.3).

8.1.2 The outcomes of the GPC survey (see agenda item 5.2) implies, that the use of GPC products can be improved if appropriate knowledge as well as technical capacity is available on the regional and national levels. To this end, the Team encouraged GPCs to further establish and maintain good cooperation with RCCs and RCOFs in their regions in order to build capacity to efficiently apply products and services provided by GPCs and LCs, and requested the Secretariat to provide a full list of RCCs and RCOFs worldwide.

8.1.3 Concerning the issue of Internet connectivity required to efficiently handle GPC products and perform related applications on the regional and national levels, the Team invited GPCs to consider providing an option for a simple and pragmatic Web access to their products and services to support product download from users with limited Internet bandwidth. The Team further recommended to consult, on the Secretariat level, with the WIS Project Office to elaborate respective technical specifications.

8.2 Approaches to ensure improved access to and utilization of GPC products

8.2.1 The Team discussed several options to further promote the use of GPC products and agreed to develop a flyer on GPCs to be posted on respective Web sites and to be distributed at appropriate occasions such as RCOFs, RCC-related WMO meetings, etc. A first draft was already available at the Secretariat which would be circulated amongst GPCs and LCs for comments.

8.2.2 The Team reviewed GPC Web sites and agreed that measures should be taken to help users navigate to and clearly recognize the LRF products generated as part of the WMO GPC mandate (since many centres with GPC status also produce a range of LRF products in addition to the GPC products). Whilst the Team recommended to consider the LC-LRFMME Web site as the entry point to the network of GPCs and LCs, it encouraged GPCs to either consider developing a dedicated GPC entry page or to tag GPC products on their existing Web pages. The Secretariat would assist in developing respective templates and tags.

8.2.3 The Team recommended that the joint CCl/CBS Expert Team on RCCs carry out a review of GPC products in light of their completeness in enabling RCCs to fulfil their mandatory and highly recommended functions and report back to the ET-ELRF with their requirements and suggestions.

8.2.4 The Team noted that making the GPC forecast and verification products available for the specific regions covered by RCOFs greatly encouraged and facilitated use of the products. To this end, the Team requested the Secretariat to attach to its list of worldwide RCOFs (cf. agenda item 8.1) related lat/lon coordinates of the geographical regions covered and encouraged the LCs to provide automatic display facility for these RCOF areas (using either pregenerated maps or predefined selections in dynamic mapping) .

8.2.5 The Team noted that introductory PowerPoint presentations on GPC services had been developed by some GPCs. The Team requested the GPCs and LCs to send related PowerPoint presentations to the Secretariat to be converted into a single presentation draft to be reviewed by the Expert Team. When completed, a consolidated PowerPoint presentation would be used by GPC representatives (and other resource persons, e.g. at RCOFs) for training purposes.

8.2.6 The Team acknowledged that user guidance material and user manuals are currently available from a number of GPCs and encouraged all GPCs to provide such information on their Web sites. This would greatly support WMO's QMF activities.

8.2.7 The Team noted the strong interest of RCCs, RCOF hosts and NMHSs in digital GPC forecast and hindcast data. The Team further noted that GPCs, including those who currently do not provide hindcasts to the LC-LRFMME were assisting in the use of their hindcast data through active engagement in the pre-COF training workshops at which consensus forecasts are prepared. The Team encouraged all RCCs, RCOF hosts and NMHSs to make use of these methods of working and get in direct contact to GPCs to request data additional to those available through the LC Web sites and invited GPCs to consider providing such information on a case-by-case basis.

8.2.8 The Team agreed on the usefulness of an e-Forum (wiki) to discuss issues related to the utilization of GPC products by RCCs, RCOFs and NMHSs experts and suggested to make use of such technologies ahead of RCOF sessions to discuss forecast situations, etc. The Team invited the Secretariat to implement appropriate mechanisms.

8.2.9 The Team noted that training activities required to promote the use of GPC products were captured by the discussions under agenda item 5.2.

8.2.10 The Team noted the widespread use of statistical downscaling tools worldwide and recommended RCCs, RCOFs and NMHSs to make use of existing tools, such as CPT. The Team encouraged GPCs to include the aspects of downscaling and applications into their engagement with RCCs, RCOFs and NMHSs. The Team further noted that some downscaling-related projects were in place already – such as the Pacific Adaptation Strategy Assistance Programme managed by GPC-Melbourne; and the PRESAO-Second Generation project (RCOF for West Africa) involving GPC-Toulouse and GPC-Exeter in collaboration with ACMAD and IRI.

9. OTHER TIME-SCALES

Extended-Range Forecasting

9.1 The Team noted that a number of GPCs had been engaged in operational prediction on timescales that cover all or part of the ERF timescale. It reviewed the status of and plans for ERF (11-30 days range) activities at those GPCs engaged in these activities (see Annex X) and recognized that there had been substantial development to some of these systems since the last ET-ELRF meeting (Beijing, 2008).

9.2 The Team also reviewed the outcomes of its previous meeting (Beijing, 2008) related to ERF and reemphasized its comments, especially those highlighting the potential usefulness of ERF ensemble products. In particular, the Team noted that the importance of the project on ERF for prediction of the Madden-Julian Oscillation (MJO), and invited CLIVAR to consider developing a similar project to address other parameters relevant to the users (e.g. prediction of the timing of rainy season onset). The Team also encouraged GPCs to work with RCCs and RCOFs in evaluating the potential of monthly forecasts, promoting their use where appropriate and to better understand the forecast requirements for the monthly timescale. The Team agreed that a demonstration project would be appropriate to promote the use of these products. It also recommended that the CLIVAR Asian-Australian Monsoon Panel and Variability of African Climate System Panel consider initiating projects on assessing predictions of intra-seasonal variability.

Interannual-to-decadal range prediction

9.3 The Team noted that many civil and other sectors had planning timescales of order 5-10 years and agreed that the Global Framework for Climate Services would benefit from development of prediction capabilities and services for multi-annual and decadal timescales, though recognizing that capability at this range is currently less developed than for seasonal forecasting. The Team also noted that a number of centres had been developing initialized seasonal-to-decadal prediction systems. Noting the WMO Executive Council requests to CBS in collaboration with CCl to consider extending the remit for GPCs developing decadal capabilities, the Team encouraged:

- continued international collaboration in research on decadal prediction, including use of multi-models. At this early stage in scientific development, exchange of hindcasts/forecasts should be informal (such an exchange has been initiated by the Met Office Hadley Centre and a similar activity is being conducted by WCRP/CMIP5);

- compilation of an inventory of centres developing decadal prediction systems with a view to future operational provision;

- In 2012, the Met Office Hadley Centre and collaborators to inform ET-ELRF of progress and results of the informal exchange that has been initiated. The ET-ELRF would then advise CBS on potential for some GPCs (and other centres performing decadal prediction) to extend the range of predictions provided to the multi-annual timescale. Noting that the CBS mandate does not go beyond the 2-years forecast range, the ET-ELRF would also advise CCl OPACE-3 on potential for improved regional predictions, on ranges of 2 years to a decade, from use of dedicated decadal prediction systems, relative to use of uninitialized systems (such as available from IPCC-type projections), and how such systems might be brought into the over arching plan for the GFCS.

10. REVIEW OF THE TERMS OF REFERENCE FOR THE ET-ELRF

10.1 The Team reviewed its Terms of Reference and proposed amendments as given in Annex XI.

11. ANY OTHER BUSINESS (AOB)

11.1 The Team discussed options to further communicate during the intersessional period and agreed that a wiki (e-Forum) could be used in this regard. The Team also agreed that this approach should be reviewed and reported to the next meeting of the ET-ELRF.

12. CONCLUSIONS AND RECOMMENDATIONS

12.1 Based on proposals and discussions under the previous agenda items, the meeting concluded and recommended the following:

- Significant progress had been made in developing the GPC network and services since the previous ET-ELRF meeting (Beijing 2008), including: designation of 2 additional GPCs bringing the total to 12; designation of the LC-LRFMME (at CBS 2009); development of new LC products, including user selectable multi-model forecast combinations; active engagement of some GPCs with RCCs and RCOFs in promoting and assisting use of GPC products (examples include activities at the Beijing and Tokyo Climate Centre, and at the GHACOF and PRESAO RCOFs). The Team also concluded that a number of GPCs had made and were making significant enhancements to their prediction systems.

- The Team welcomed GPC cooperation in the review of GPC compliance with designation criteria. It concluded that all GPCs were providing forecast products such as temperature and precipitation and appropriate verification to make prudent use of these forecasts. However it acknowledged that some GPCs were not fully compliant with the designation criteria. Recognising that temporary periods of non-compliance are acceptable in light of the competing need for forecast system development, the Team nevertheless encouraged all GPCs to reach or regain full compliance.

- The Team noted and welcomed the decision at WCC-3 to develop a Global Framework for Climate Services (GFCS), and concluded that the above progress, together with developments in establishing RCCs, represents significant contributions to secure the foundation of the GFCS.

- The Team acknowledged that, particularly in the context of the GFCS, EC-LXII had urged GPCs to make their hindcasts available to users. It noted that 9 GPCs were providing their hindcasts to the LC-LRFMME and that others were making hindcasts available on a case-by-case basis through active engagement at RCOFs. It was noted that since its previous meeting (Beijing, 2008) one additional GPC had decided to make its hindcasts available to the LC-LRFMME.

- The Team welcomed the initiative to develop a Global Seasonal Climate update (GSCU) and concluded that a number of developments to GPC and LC products would help to assist the preparation of GSCUs including: development of new LC-LRFMME probability products, verification of LC-LRFMME multi-model products and possible centralized calculation of verification scores for individual GPC products. It therefore urged the GPCs and LCs to review the feasibility and make progress on these issues and to participate in the scoping workshop for GSCUs.

- The Team noted that RCCs were being encouraged to make use of the set of verification scores embodied and documented in the SVSLRF. In this context Attachment II.8 required some revision since it currently addresses only requirements on GPCs. In addition it was concluded that Level 3 verification scores should no longer be mandatory for GPCs as such scores are more meaningful when generated at regional level. The LC-SVSLRF was tasked with leading preparation of the necessary amendments to the Attachment II.8.

- The Team took note of the recent survey on use of GPC products and recommended that a number of activities be undertaken to improve accessibility and use of the products, including; development of a ‘flyer’ describing GPC services, development of clearer navigation to and identification of GPC websites, development of training material, a review of the completeness of GPC products for RCC use, and active engagement of GPCs in the process of developing regional forecasts at RCCs and RCOFs.

- The Team also recommended that wiki pages be created to facilitate discussion between GPCs, RCCs and LCs on the development of LC services, and also to facilitate discussion between GPCs, RCCs and NMHSs during the process of preparing and assessing regional forecasts

- The Team concluded that a number of GPCs were making significant developments to their extended-range prediction systems, and noted the potential high value of predictions at this range. It recommended that advances in evaluation and use of these forecasts would be best addressed, at this time, through GPCs conducting pilot studies with users, and encouraged GPCs to do so.

- The Team concluded that it should respond to the GFCS requirement for development of predictions on longer than seasonal timescales. It welcomed the offer from GPC Exeter to contribute in coordinating international collaboration in research on decadal prediction and, through the ET-ELRF, to report back to CBS on the potential for multi-annual prediction and to CCl OPACE-3 on potential for predictions of greater-than-two-year range.

13. CLOSING

13.1 The Meeting of the CBS Expert Team on Extended- and Long-Range Forecasting (ET-ELRF) closed at 16:40 on Friday, 2 July 2010.

Annex I

AGENDA

1. OPENING

2. ORGANIZATION OF THE MEETING

2.1 Adoption of the agenda
2.2 Working arrangements

3. INTRODUCTION / REVIEW OF DECISIONS OF THE WMO GOVERNING BODIES AND STATEMENTS ADOPTED BY CBS RELATED TO THE ET-ELRF

4. GLOBAL FRAMEWORK FOR CLIMATE SERVICES (GFCS)

4.1 Review of recent activities on the GFCS development, including discussions on potential implications for the Global Data-Processing and Forecasting System (GDPFS)
4.2 The Global Seasonal Climate Updates (GSCU) within the context of the GFCS
4.3 Review of the work and functions of the GPCs for meeting the needs of the WMO Regional Climate Centres (RCCs) and Regional Climate Outlook Forums (RCOFs), including discussion on related activities for climate-sensitive areas, including Polar Regions

5. PROVISION OF LONG-RANGE FORECASTS (LRF)

5.1 Review of the work, functions and specific needs of the Global Producing Centres (GPCs), including status/progress reports
5.2 Review of the outcomes of the GPC survey, including discussion on potential standardization of products
5.3 Review of the work and specific needs of the Lead Centres for Long-Range Forecasting Multi-Model Ensemble (LC-LRFMME) and for Standard Verification System for Long-Range Forecasting (LC-SVSLRF)
5.4 Review of observational requirements for LRF, including the Statement of Guidance (SoG) for Seasonal to Inter-Annual (SIA) Forecasts
5.5 Identify needs for training and guidance material

6. FUTURE DEVELOPMENT OF THE DATA EXCHANGE AND LC-LRFMME PRODUCTS

6.1 Review of the current status of hindcast exchange and recommendations for future exchange
6.2 New products and functionalities of the LC-LRFMME, including within the context of the GSCU
6.3 Review of current hindcast periods used by GPCs and potential for increased standardisation (products and verification)

7. VERIFICATION

7.1 Improvement of the Standard Verification System for LRF
7.2 Coordination between the LC-SVSLRF and the LC-LRFMME for enhanced linking of GPC forecasts and verification products
7.3 Recommendation of verification for LC-LRFMME products
7.4 Introduction of process diagnostics for GPC hindcasts
7.5 Review of new verification techniques

8. PROMOTION AND OUTREACH OF GPCs

8.1 Review of progress in the introduction of GPC products into the Regional Climate Centre (RCC), Regional Climate Outlook Forum (RCOF) and NMHS activities for operational climate prediction

8.2 Approaches to ensure improved access to and utilization of GPC products

9. OTHER TIME-SCALES

9.1 Status and specific needs related to exchange of extended- and decadal-range forecasting products and services

10. REVIEW OF THE TERMS OF REFERENCE FOR THE ET-ELRF

11. ANY OTHER BUSINESS (AOB)

12. CONCLUSIONS AND RECOMMENDATIONS

13. CLOSING

Annex II

FINAL LIST OF PARTICIPANTS

Mr Richard **GRAHAM** (Chair) Met Office Fitzroy Road Devon EX13PB **EXETER** United Kingdom	Tel: Fax: Email:	+44 1392 886 361 +44 1392 885 681 richard.graham@metoffice.gov.uk
Mr David **JONES** Australian Bureau of Meteorology GPO Box 1289 **MELBOURNE**, Victoria 3001 Australia	Tel: Fax: Email:	+613 9669 4085 +613 9669 4678 d.jones@bom.gov.au
Dr Caio Augusto **SANTOS COELHO** Instituto Nacional de pesquisas Espaciais (INPE) Centro de Previsão de Tempo e Estudes Cliáticos (CPTEC) Rodovia Presidente Dutra, Km 40, SP-RJ **CACHOEIRA PAULISTA**, SP 12630-00 Brazil	Tel: Fax: Email:	+5512 3186 8670 Caio.coelho@cptec.inpe.br
Mr Benoit **ARCHAMBAULT** Canadian Meteorological Centre (CMC) Meteorological Service of Canada Environment Canada 2121 Trans-Canada Highway **DORVAL**, Quebec H9P 1J3 Canada	Tel: Fax: Email:	+1 514 421 5023 +1 514 421 4657 benoit.archambault@ec.gc.ca
Mr Jean-Pierre **CERON** Météo-France 42, avenue Gaspard Coriolis 31057 **TOULOUSE**, Cédex 1 France	Tel: Fax: Email:	+33 5 6107 8310 +33 5 6107 8309 Jean-pierre.ceron@meteo.fr
Mr Takayuki **TOKUHIRO** Japan Meteorological Agency Climate Prediction Division 1-3-4 Otemachi, Chiyoda-ku **TOKYO** 100-8122 Japan	Tel: Fax: Email:	+81 3 3212 8341 Ext. 3164 +81 3 3211 8406 tokuhiro@met.kishou.go.jp
Mr Vincent Newton **SAKWA** Kenya Meteorological Departement Ministry of Environment and Mineral Resources P.O. Box 30259 00100 **NAIROBI** Kenya	Tel: Fax: Email:	+254 20 3867 880-7 +254 20 3876 955 / 3877 373 sakwa@meteo.go.ke sakwa_v@yahoo.co.uk

Dr Hyun-Soo **LEE** Climate Prediction Division Korea Meteorological Administration 45 Gisangcheong-gil Dongjak-gu, **SEOUL** 156-720 Republic of Korea	Tel: Fax: Email:	+82 2 2181 0476 +82 2 2181 0489 hslkma@korea.kr
Mr Jacobus Willem **OLIVIER** South African Weather Service 442 Rigel Avenue South Erasmusrand **PRETORIA, 0181** South Africa	Tel: Fax: Email:	+2712 367 6008 +2712 Cobus.olivier@weathersa.co.za
Dr Laura **FERRANTI** ECMWF Shinfield Park **READING** RG2 9AX United Kingdom of Great Britain and Northern Ireland	Tel: Fax: Email:	+44 118 949 9601 +44 118 986 9450 Laura.ferranti@ecmwf.int
Dr Arun **KUMAR** Climate Prediction Center National Centers for Environmental Prediction World Weather Building Room 605 5200 Auth Road **CAMP SPRINGS**, Maryland (MD) 20746-4304 United States of America	Tel: Fax: Email:	+1 301 763 8000 Ext 7579 +1 301 763 8125 arun.kumar@noaa.gov
WMO Secretariat 7 bis avenue de la Paix Case postale 2300 1211 **GENEVE** 2 Switzerland	**WWW website** www.wmo.int/web/www/www.html	
Mrs Alice **SOARES**	Tel: Fax: Email:	+41 22 730 8449 +41 22 730 8128 asoares@wmo.int
Mr Peter **CHEN**	Tel: Fax: Email:	+(41 22) 730 8231 +(41 22) 730 8128 pchen@wmo.int
Mr Rupa Kumar **KOLLI**	Tel: Fax: Email:	+(41 22) 730 8377 +(41 22) 730 8042 rkolli@wmo.int
Mr Peer **HECHLER**	Tel: Fax: Email:	+(41 22) 730 8302 +(41 22) 730 8042 phechler@wmo.int

Annex III

DEVELOPMENT OF CONSENSUS STATEMENTS ON GLOBAL SEASONAL CLIMATE UPDATES (GSCU)

Concept Note

Preamble

The Executive Council, at its Sixty first session (June 2009, Geneva), urged Members to avail themselves of the products of the network of Global Producing Centres of Long-Range Forecasts (GPCs) and Lead Centres, and urged the CCl and CBS to promote and guide the uptake of GPC products within Regional Climate Centres (RCCs), Regional Climate Outlook Forums (RCOFs) and National Meteorological and Hydrological Services (NMHSs) for operational climate prediction (EC-LXI Report, Paragraph 3.2.3.7).

The Fifteenth Session of the Congress (May 2007, Geneva), while appreciating the WMO publication of global consensus-driven El Niño and La Niña Updates, recommended that other large-scale indices having regional impacts be considered for future Updates (Cg-XV Report, Paragraph 3.2.5.12). CCl and CBS are actively cooperating in the development and communication of climate monitoring and prediction products. The need to strengthen the production, availability, delivery and application of science-based climate prediction and services was emphasized by the World Climate Conference-3. In this context, GPCs, RCCs, RCOFs and NMHSs have been recognized to be an effective conduit to facilitate the essential flow of climate information from global to local scales.

1. Vision

A Global Seasonal Climate Update is issued jointly by experts of the GPCs, related Lead Centres and monitoring centres acting on the global scale, with input from the Regions (RCCs, NMHSs etc.), a few days ahead of each of the standard seasons (DJF/MAM/JJA/SON).

The Update summarises the current status (monitoring) and the expected future behaviour (prediction) of major general circulation features and large-scale oceanic anomalies around the globe (e.g., ENSO, North Atlantic Oscillation, Indian Ocean Dipole, etc.) and discusses briefly its likely impacts on continental-scale temperature and precipitation patterns. The Update is designed, and thereby standardized, in a way that allows for comparing qualitatively the climate monitoring results of the current Update with the respective climate outlook issued in the previous Update.

Such an Update is used primarily by RCCs, RCOFs and NMHSs in order to elaborate regional and national climate Updates, and also by global user communities such as the Inter Agency Standing Committee (IASC), etc. as well as the general public.

The Global Seasonal Climate Updates, to be delivered routinely through WIS mechanisms (once available), provide the world community with an expert assessment and global consensus on the status of the climate for the current and the upcoming season along with information on robustness and uncertainty of the available signals, thereby contributing to an effective application of science-based climate information in climate risk management. The Global Seasonal Climate Updates feed into the *Annual Statements on the Status of the Global Climate* already being issued by WMO, incorporating both climate monitoring aspects and an assessment of the climate outlooks.

2. Motivation and justification

- Global organizations operating in climate sensitive sectors have expressed the need for a global statement on the coming season's climate;

- The envisaged service builds on existing WMO mechanisms and capabilities, demonstrates and strengthens WMO's service delivery component and, thereby, has the potential to contribute to the goals of the GFCS concept;

- WMO regularly provides global scale climate monitoring information in close co-operation with climate monitoring centres operating on global scales such as the Met Office Hadley Centre, the University of East Anglia/UK, the NCDC/NOAA, JMA, CMA, IMD, BOM and others;

- WMO is actively establishing regional components of a global infrastructure serving climate information and services improvements: RCCs and RCOFs. These regional mechanisms depend on global-scale products and assessments as indispensable input;

- WMO has established a global system for Long-range Forecasting as an integral part of its Global Data Processing and Forecasting System (GDPFS) and put in place a formal designation process. As of June 2010, it consists of 12 GPCs and two Lead Centres for Long-range Forecasting Multi Model Ensembles (LRFMME) and Standard Verification System of Long-range Forecasts (SVSLRF);

- WMO successfully established a consensus mechanism for the well-known El Niño/La Niña Update, which has been well-received worldwide and which has been instrumental in improving consistency, terminology and uptake;

- The success of the El Niño/La Niña Updates can be extended to other aspects of Long-Range Forecasts to enhance the visibility of the GPCs and the associated Lead Centres, the 'climate component' of the GDPFS as well as of WMO as a whole. Other centres operating on global scales for Long-Range Forecasting as well as climate monitoring can be involved in the consensus development process.

3. Endorsement of GSCU Concept

The GSCU concept was presented at the WMO Technical Conference on Changing Climate and Demands for Climate Services for Sustainable Development, which took place from 16 to 18 February 2010, immediately preceding CCl-XV at Antalya, Turkey. The concept was widely supported by the conference participants, and was included as part of the conference recommendations to CCl-XV for strengthening the development and use of climate-related WMO infrastructure and mechanisms. CCl-XV appreciated the initiatives for the development of GSCU, providing regular global consensus statements on the seasonal climate, through expert assessments of global climate monitoring and outlook products. CCl agreed that the focus of such Updates would be to assist the NMHSs in the interpretation, tailoring and assessments of the reliability of seasonal predictions. CCl urged all GPCs, RCCs/RCC-Networks, RCOFs, NMHSs and

other relevant institutions to provide the required inputs and actively support the development of this important product. In pursuance of this decision, GSCU has been included as part of the work plan for the fifteenth intersessional period of CCl (2010-2014). CCl-XV Management Group established a Task Team on GSCU with specific Terms of Reference including:

1. Develop, including through a scoping workshop, a mechanism to generate regular global consensus statements on the seasonal climate, termed Global Seasonal Climate Update (GSCU), through expert assessments of global climate monitoring products of the current season and the outlooks for the ensuing season in terms of the broad patterns of precipitation and temperature, along with the indication of the situation and expected evolution of the major general circulation features of both atmosphere and ocean;

2. Develop practical approaches to facilitate enhanced use of GPC and related Lead Centres' long-range forecast products by RCCs and other regional entities, RCOFs, and NMHSs, including through the GSCU concept;

3. Develop an outline for a consensus statement with a comprehensive assessment of current and coming seasonal global climate anomalies, including the uncertainty aspects, to assist in risk management, adaptation policies and decision making by global partners;

4. Develop an implementation plan to engage potential contributors to develop the GSCU on a trial basis in near-real-time and for limited circulation and peer review;

5. Liaise with the CCl-XV OPACE-2 expert/task teams on aspects of climate monitoring and assessment;

6. Identify lead coordinators for operational production of the GSCU.

CCl-XV Task Team on GSCU has Dr Won-Tae Yun (Korea) as the Lead and Dr Richard Graham (UK) as the Co-Lead.

WMO Executive Council, at its Sixty-second Session (EC-LXII, June, 2010), recognized the widely felt need for consensus-based products like WMO El Niño/La Niña Updates more generally on the seasonal climate prediction, and welcomed the concept of expanding these Updates to other planetary-scale oscillations and their interactions including large-scale climatic impacts. It noted that while challenges to WMO El Niño/La Niña Updates still remain, it encouraged, and urged CCl to work, in collaboration with CBS, to explore the possibility of expanding the Update to become the GSCU. EC-LXII agreed that GSCU should be started on a trial basis, allowing a sufficient period to gain experience and making it reliable and effective. In this context, the Council noted that a number of Members are engaged in sector oriented seasonal predictions (e.g. hydrological and agricultural applications) based on the seasonal climate outlooks and that there is need for bringing consistency in approach to the provision of such climate outlook products.

4. Proposal to convene an international expert meeting on scoping Global Seasonal Climate Updates

In order to facilitate the development of Global Seasonal Climate Updates, it is proposed to organise an international expert meeting, under the auspices of both CCl and CBS, on scoping Global Seasonal Climate Updates, tentatively planned for 12-15 October 2010 at WMO Headquarters, Geneva, Switzerland.

4.1 Objectives

The scoping meeting will consider the development, and outline the mechanism, of regular global consensus statements on the seasonal climate, through expert assessments of global climate monitoring products of the current season and the outlooks for the ensuing season in terms of the broad patterns of precipitation and temperature, along with the indication of the situation and expected evolution of the major general circulation features of both atmosphere and ocean.

4.2 Expected outcome

The scoping meeting will develop:

- a practical approach to facilitate the use of GPC and related Lead Centres' products by RCCs and other regional entities, RCOFs, and NMHSs, including a Global Seasonal Climate Update;

- an outline for a consensus statement with a comprehensive assessment of current and coming seasonal global climate anomalies to assist in risk management, adaptation policies and decision making by global partners;

- an implementation plan to engage potential contributors to develop the Global Seasonal Climate Update on a trial basis in near-real-time and for limited circulation and peer review; and

- identify lead coordinators for operational production of the Global Seasonal Climate Update.

4.3 Proposed agenda outline

Day 1: Setting the frame

- Status of operations of current GPCs and related Lead Centres and other centres providing global-scale Long-Range Forecasts (presentations by experts from GPCs, Lead Centres and other global centres as well as WDS/DPFS)
- Status of global-scale monitoring activities (presentations by climate monitoring centres' experts)
- Skills of monitoring and prediction methods/models (presentation on research perspectives)
    - Discussion based on experts' experiences and Lead Centres' verification activities results
- Formatting/communication of monitoring and prediction "outlook" products, incl. aspects of uncertainty, probability and confidence
    - Discussion based on experts' experiences; presentation of an RCOF expert
- The WMO El Niño/La Niña Update : current status and prospects

Day 2: Discussion of the concept elements

- User requirements for global-scale monitoring and prediction products (presentations by globally active users like the IFRC, IASC, WHO)
- The role of regional and national institutions and mechanisms: user requirements for global-scale monitoring and prediction products and potential contributions to the Update generation (presentations by RCOF-, RCC- and/or NMHS experts)
- Content and structure of the Global Seasonal Climate Update (brainstorming discussion)
- Linking climate monitoring and climate prediction services: The Climate Watch Concept (expert presentation)

- Consensus development process (expert presentation)
- Working arrangements and responsibilities for the Global Seasonal Climate Update, flow of information (brainstorming discussion)

Day 3: Concept development

- Review of the discussion outcomes of days 1 and 2
- Elaboration and presentation of the concept for the Global Seasonal Climate Update
- Implementation plan for a pilot phase of the production of Global Seasonal Climate Updates including the identification of lead coordinators

Note:

1. **In order to optimally utilize the available time and to ensure a certain degree of comparability of the information presented, it is proposed to provide a presentation template/format for describing activities of prediction/monitoring centres.**
2. **Discussion format to be developed in order to derive the information needed for the following days.**

4.4 Potential participants

It is expected that experts from the following institutions or organisations will participate in the scoping workshop:

a) Global users

- Experts from e.g. IASC, IFRC, WHO etc. (preferably Geneva based)

b) Regional providers and users

- Selected experts from RCCs and/or similar institutions, preferably with RCOF experiences (e.g. ACMAD, BCC, CIIFEN, TCC etc.)

c) Global providers

- Selected experts from GPCs and Lead Centres
- Selected experts from international centres active in climate prediction (e.g. IRI, APCC)
- Selected climate monitoring experts (e.g. NCDC, UK MetOffice Hadley Centre, JMA, CMA, IMD, BoMA)

d) Selected experts from CCl and CBS (climate predictions, climate monitoring, Climate Watches, consensus development, user liaison, communication)

e) WCRP scientific expert on seasonal prediction

f) WMO Secretariat: CLW (HWR, WCAS, AgM); OBS (WIS, DMA); WDS (DPFS, DRR, PWS); WCRP

5. Further evolution

It is envisaged to operate the seasonal climate Update mechanism **for one year or more on a pilot basis in *near-real-time*, pre-operational mode with a limited, informal circulation**. During the pilot phase, the consensus statement will be subject to peer review among climate experts, communicators as well as user representatives, and appropriate corrections will be made to the process. Once skills, usefulness and operational capabilities are stabilized at acceptable levels, the Update will be provided to the public (press release(s) / Websites) and released officially to RCOFs/RCCs/NMHSs and global users.

Annex IV

ANALYSIS OF A SHORT SURVEY ON GPC PRODUCTS AND SERVICES

Introduction

In response to EC's request to further promote the uptake of GPC products (cf. EC-LXI final report, paragraph 3.2.3.7), a questionnaire had been issued by the Secretariat to analyse the current situation.

14 out of 25 institutions/persons addressed responded: ACMAD (Niger), Armstatehydromet (Armenia), BCC (China), BoM (Australia), CIIFEN (Ecuador), ICPAC (Kenya), KMA (Korea), Météo-France (France), MeteoSwiss (Switzerland), Met.no (Norway), NOAA National Weather Service (USA), ROSHYDROMET (Russian Federation), TCC (Japan), TSMS (Turkey).
7 out of 14 responding institutions have GPC status: BCC, BoM, KMA, Météo-France, NOAA National Weather Service, ROSHYDROMET and TCC.

The analysis (see tables below) distinguishes between the responses of GPCs and 'Non-GPCs'.

Notes:
(1)The results of the questionnaire should not be considered 'representative', as the choice of addressees was done subjectively on a 'best knowledge' basis. This needs to be taken into account when interpreting specific answers as listed in the tables of Attachment II [e.g. the number of institutions using given GPCs (first table) might be biased by the geographical distribution of the responders]. The fact that a RCC-related structure is not yet established in some of the Regional Associations biases the result additionally.
(2) Some of the responses could not be interpreted clearly by the author and hence assumptions had been made when filling in the tables in Attachment II.

Key findings of the analysis

The analysis suggests consideration of measures to **improve accessibility and operational exchange of LRF digital data incl. hindcast data**. This is needed particularly to develop and apply/run downscaling tools as well as RCMs. Furthermore, **dedicated training and capacity building** activities are required to facilitate the efficient uptake of the GPC products. Training topics should comprise downscaling methods, MME approaches, post-processing methodologies as well as the optimal use of (existing) GPC products. Thirdly, **operational verification activities need to be promoted** within the GPC user community (RCCs, NMHSs) including the development of end user-oriented verification tools for building trust.

Given the quite huge range of different approaches in the use and interpretation of GPC products, **it seems to be desirable to develop guidance material on how to interpret (a given core set of) GPC standard products including methodologies and tools.** This might best be done in conjunction with the definition of RCC- and NCC products and services to allow for a smooth flow of information across the global, regional and national levels.

Note: The columns of the following tables refer to one of the survey questions each. The numbers in brackets explain how many responders provided a certain information (first number), out of how many institutions in this category (7 'Non-GPCs', 7 GPCs,). The row 'All' summarises the responses from both 'Non-GPCs' and GPCs (all in all 14 responding institutions).

	Products (parameter) used from the GPC minimum list	Additional GPC products used	Products used from GPC ...	Mode of use: permanently or occasionally	Use of digital or graphical GPC products
Institutions without GPC status	T2m (7/7) Precip (6/7) SST (2/7) MSLP (3/7) Z500 (2/7) T850 (2/7)	Boundary conditions for downscaling; Z200; weekly 32days forecast; wind vector, relative humidity, surface temperature	ECMWF (7/7) Exeter (2/7) Melbourne (1/7) Moscow (1/7) Seoul (1/7) Toulouse (3/7) Washington (4/7)	Permanently (7/7)	Digital: 3/7 Digital and graphical: 3/7 Graphical: 1/7
Institutions with GPC status	T2m (6/7) Precip (6/7) SST (5/7) MSLP (3/7) Z500 (3/7) T850 (4/7) Nino-plumes (1/7)	Multi-model consistency maps, model hindcasts, climatological data, ENSO products, interpretation and verification techniques, wind vectors and velocity potential (850hPa and 200hPa), stream function (200 hPa), forecasts with leadtime between 5-6 months, circulation regimes	Beijing (4/7) ECMWF (4/7) Exeter (5/7) Melbourne (3/7) Seoul (3/7) Tokyo (6/7) Toulouse (3/7) Washington (5/7) ALL (2/7) VARIOUS (1/7)	Permanently (6/7) Occasionally (1/7)	Digital: 1/6 Digital and graphical: 5/7 ?:1/6
All	*T2m (13/14)* *Precip (12/14)* *SST (7/14)* *MSLP (6/14)* *Z500 (5/14)* *T850 (6/14)* *Nino-plumes (1/14)*	*(cf. rows above)*	*Beijing (4/14)* *ECMWF (11/14)* *Exeter (7/14)* *Melbourne (4/14)* *Moscow (1/14)* *Seoul (4/14)* *Tokyo (6/14)* *Toulouse (6/14)* *Washington (9/14)* *ALL (2/14)* *VARIOUS (1/14)*	*Permanently (13/14)* *Occasionally (1/14)*	*Digital: 4/14* *Digital and graphical: 8/14* *Graphical: 1/14* *?: 1/14*

	Assessment of GPC products' ...		
	accessibility and timely availability	completeness and quality	usefulness
Institutions without GPC status	Ok (7/7)	Ok (3/7) High quality but given country often at the edge of the forecast product (1/7) Not complete but good quality (1/7) Ok w.r.t. the technical capabilities at the moment; higher temporal resolution desirable (1/7) skill very low for Northern Europe (1/7)	Useful/very useful (4/7) Not very useful for Northern Europe due to low skill (1/7) Usefulness limited due to low skill over Central Europe (1/7) For a small country, the resolution is too coarse (1/7)
Institutions with GPC status	Ok (4/7) Forecast updates more often than once a month desirable (1/7) Accessibility to be improved; digital data should be available around the 10th of the month (1/7) ? (1/6)	Ok (3/7) Completeness ok; quality to be improved, e.g for monsoon activities (1/7) Quality ok; standard set of GPC products incomplete (-> more hindcast data needed for downscaling; daily data needed for analyses) (1/7) Completeness in terms of variables ok; all digital data incl. hindcast to be exchanged operationally (1/7) ? (1/7)	Useful/very useful (5/7) Fully useful if full digital data exchange incl. hindcasts is realized (1/7) ? (1/7)
All	*Ok (11/14)* *Forecast updates more often than once a month desirable (1/14)* *Accessibility to be improved; digital data should be available around the 10th of the month (1/14)* *? (1/14)*	*Ok (6/14)* *Further improvements desirable – see rows above (7/14)* *? (1/14)*	*Useful/very useful (9/14)* *Not very useful due to limited skill or coarse resolution relative to the size of the country (3/14)* *Fully useful if full digital data exchange incl. hindcasts is realized (1/14)* *?(1/14)*

	Interpretation of GPC products	Use of LC-LRFMME products	Processing of GPC products	Application of verification techniques and use of LC-SVSLRF
Institutions without GPC status	Presentation to users in 3 categories; probabilistic information not fully understood by users (1/7) Used as predictors and in climate diagnostics and analysis tools (1/7) Interpreted, but skill is very low (1/7) Seeking areas of agreements among GPC products (1/7) Presentation of mean and distribution (1/7) By graphical display (1/7) ? (1/7)	No (4/7) Yes; subjective combination (1/7) Yes; use of LC's MME product (1/7) Yes; objective combination (1/7)	No (2/7) Monitoring via GraDs; post-processing in RSM (1/7) Use of own recalibration scheme (1/7) Adjustments to show anomalies w.r.t. 1961-90 (1/7) Downscaling (1/7) Monitoring with ArcGIS and interpolation with national data (1/7)	No (5/7) Yes (2/7)
Institutions with GPC status	Non-availability of hindcasts and digital data is a big constraint (1/7) Use in conjunction with own internal products (1/7) Full interpretation; constraints: timeliness and unavailability of certain parameters (1/7) Generation of probability forecasts with MOS techniques (1/7) Application of downscaling techniques; constraints: limitation of data access for verification (2/7) By graphical display (1/7)	Yes; combination in MMEs (1/7) Yes; subjective comparison (3/7) Occasionally; subjective combination (1/7) No (1/7) Yes; use of LC's MME product (1/7)	No (1/7) ? (1/7) Downscaling (2/7) Downscaling + MMEs (1/7) Downscaling + post-processing (1/7) MOS (1/7)	Yes (7/7)
All	*Products are interpreted quite differently (14/14)*	*6 out of 7 GPCs use LC-LRFMME products, but only 3 out of 7 'Non-GPCs'*	*At least 5 out of 7 GPCs process GPC products in terms of downscaling/MOS techniques, but only 1 (2?) out of 7 'Non-GPCs'*	*All GPCs apply verification, but only 2 out of 7 'Non-GPCs'*

	Forecast applications developed or research studies conducted	Products from other sources than GPCs	GPC Collaboration for the provision of boundary conditions for running RCMs
Institutions without GPC status	No (3/7) Statistical forecasting (1/7) Research on verification, post-processing, MME, soil moisture forecasts, return periods (1/7) Use of GPC products in RCOFs (1/7) Seasonal predictability over the Arctic region (1/7)	Non (2/7) ? (1/7) COLA/IGES, UNISYS (1/7) IRI, COLA (1/7) IRI, CPC/African Desk (1/7) IRI (1/7)	No (3/7) ECMWF and MetOffice for PRECIS (1/7) (IRI) and KMA (1/7) NCEP (1/7) NCEP and ECMWF (1/7)
Institutions with GPC status	No (2/7) MOS (operational) (1/7) Dam management (operational), hydrological forecasts (research), circulation regimes (operational), heating and cooling degrees days (experimental), use for energy domain (beta testing) (1/7) Prediction of Monsoon Index; downscaling (1/7) Statistical downscaling, analyses of sub-seasonal variability, predictability, consensus techniques (1/7) MME techniques (1/7)	? (1/7) None (4/7) IRI (1/7) MGO St. Petersburg, APCC (1/7)	n/a
All	*9 out of 14 GPCs/'Non-GPCs' develop applications and/or carry out research studies*	*Apparently, nearly half of the GPCs/'Non-GPCs' (6/14) use products from other sources than GPCs, especially from IRI (4/14)*	*4 out of 7 'Non-GPCs' receive boundary conditions from GPCs*

	Additional remarks concerning the entire questionnaire
Institutions without GPC status	No (2/7) Training needed on downscaling, MME, data visualisation, use of GPC products (1/7) Training and capacity building needed on downscaling (3/7) Put more emphasis on LRF with statistical models and empirical data (1/7)
Institutions with GPC status	No (1/7) Free exchange of digital data among GPCs highly desirable (1/7) Training in downscaling and tailoring to be applied; data policy for hindcasts to be solved; MME approaches needed; provision of level 3 of SVS could be useful (1/7) Suggestions to prepare detailed documents on numerical model specification and how to use Grid Point Value (GPV) data and products, to provide GPV data with finer spatial resolution (at least 1.25x1.25) especially for Tropics, hold training on the use of GPC products and develop tools for easy handling of GPV data; TCC developed a web-based tool 'Interactive Tool for Analysis of Climate System (ITACS)' (cf http://jra.kishou.go.jp/itacs-info/tcc/conditions.html) (1/7) Suggestions to provide more GPC products on typhoons, monsoon and other oceanic and atmospheric variations such as PNA, South Asia High, AAO and AO (1/7) Basic minimum list of LRF is insufficient for RCCs: minimum list with graphical products is inappropriate for development of new products (that's why regional LRF centres are nowadays mainly attached to particular global LRF Centres (1/7) LC-LRFMME products should be used more widely, related training is needed (1/7)

Annex V

SOME EXAMPLES OF LC-LRFMME PRODUCTS

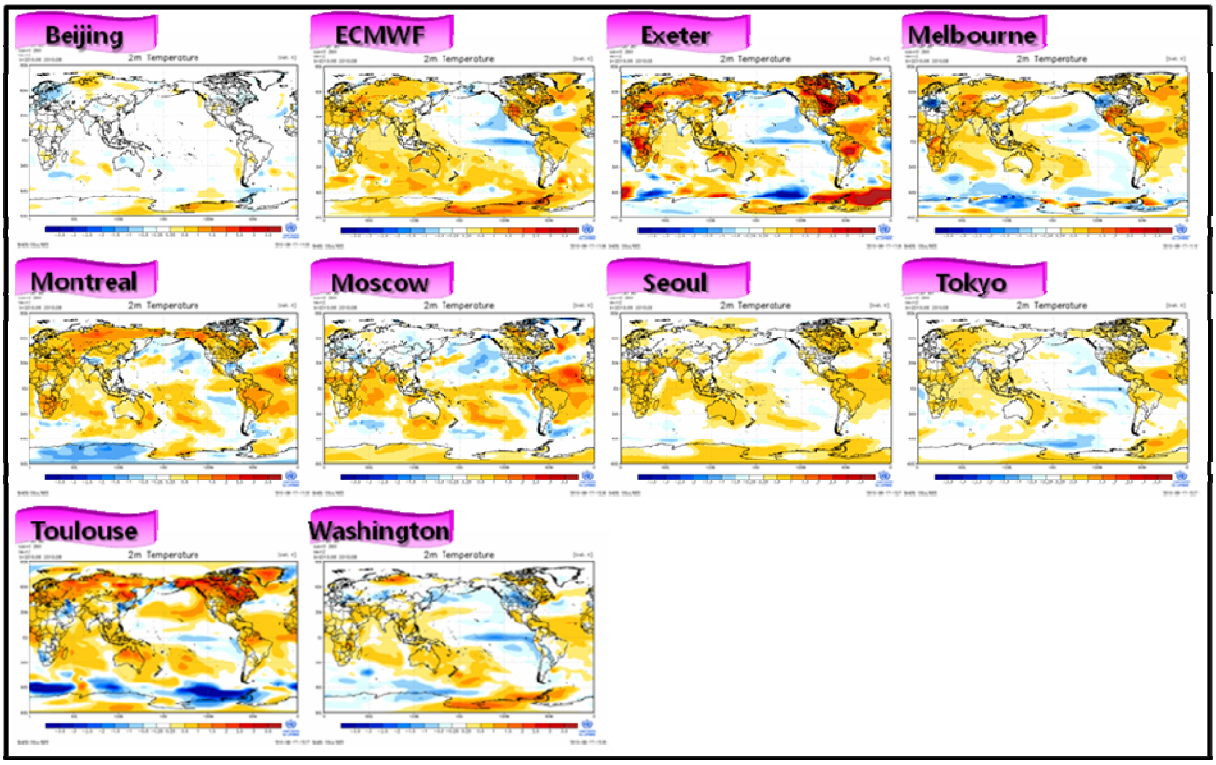

Figure 1 – An example of forecast display map available from the LC-LRFMME website. This particular example is for the 2-meter seasonal mean temperature anomaly from different GPCs. At the LC-LRFMME website the display area (and projection) can be selected by the user.

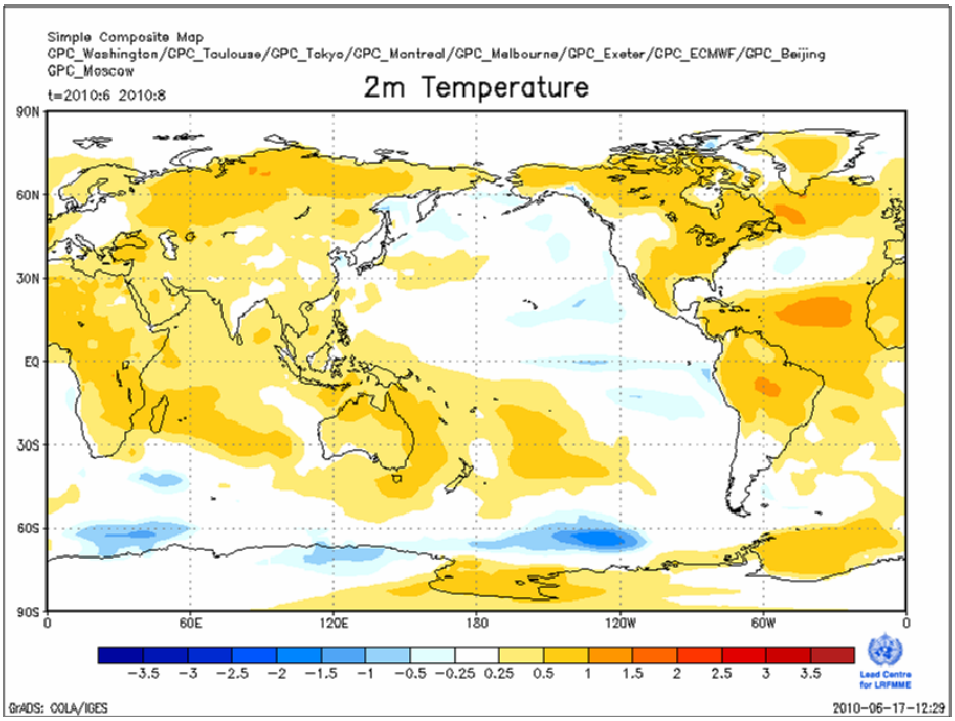

Figure 2 – An example of 2-meter seasonal mean multi-model average anomaly based on equal weights.

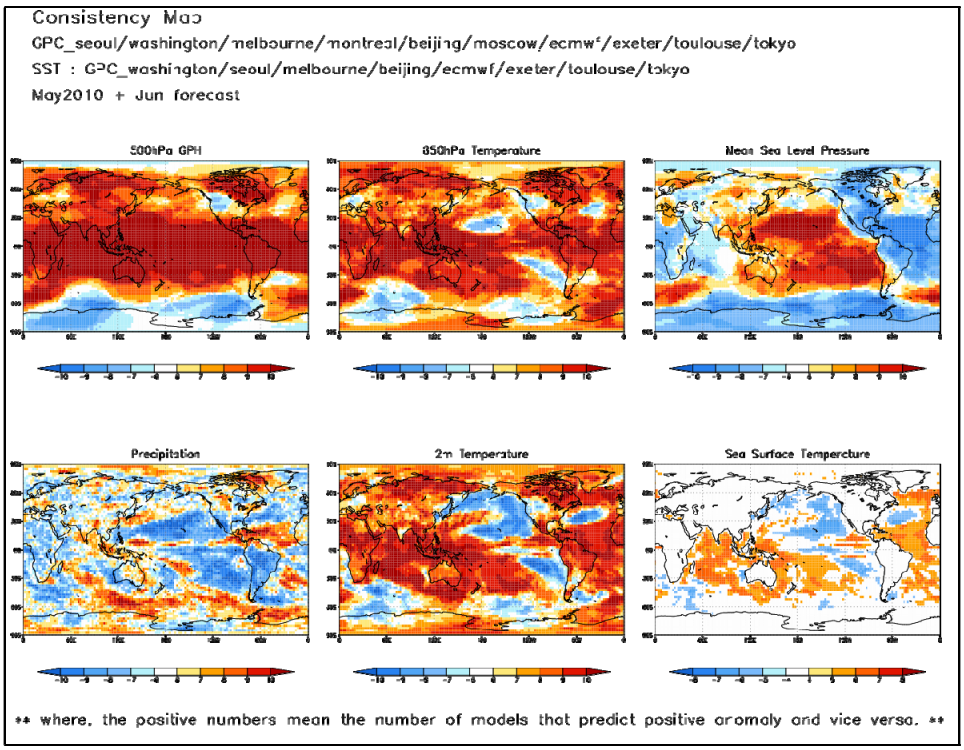

Figure 3 – An example of maps displaying the consistency among the forecasts from different GPCs. Consistency maps are based on number of models that agree with the sign of multi-model average anomaly.

Annex VI

SOME EXAMPLES OF LC-SVSLRF PRODUCTS

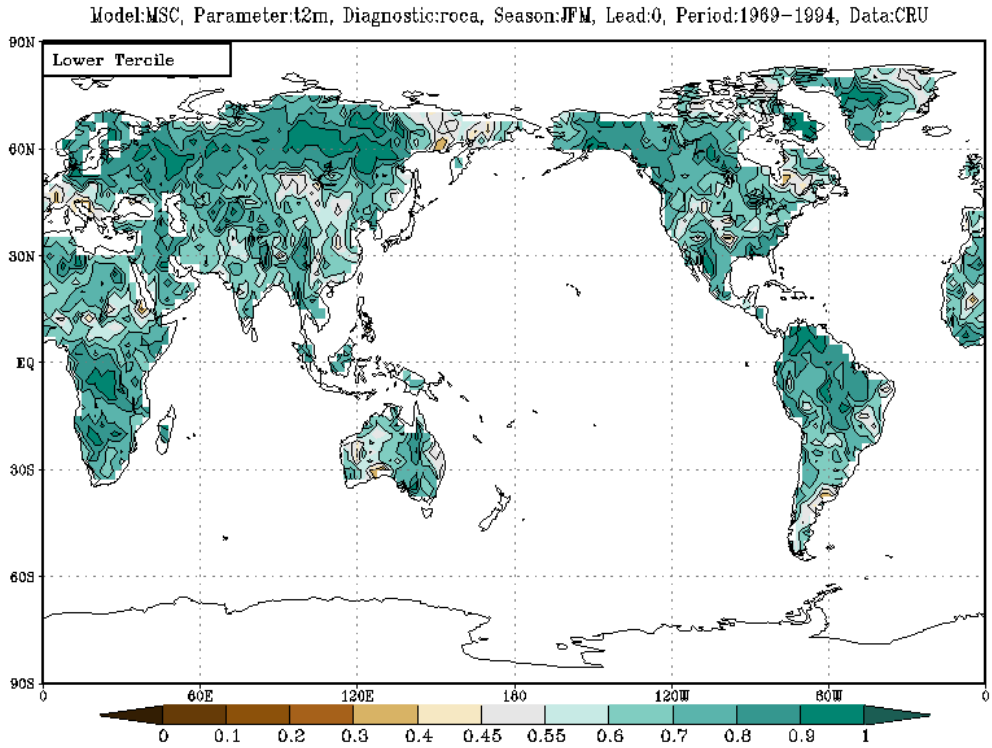

Figure 1 – Output: Global. Model: MSC. Diagnostic: ROC Lower Tercile. Parameter: T2m. Period: 1969-1994.

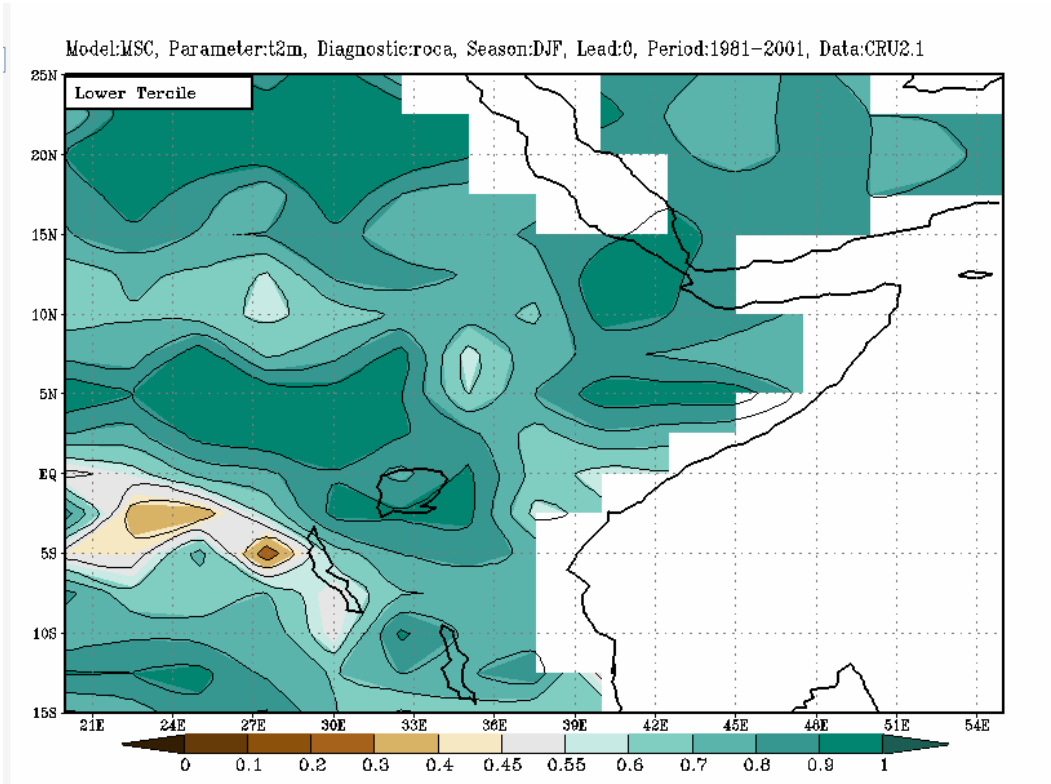

Figure 2 – Output: Regional. Model: MSC. Diagnostic: ROC Lower Tercile. Parameter: T2m. Period: 1969-1994.

Annex VII

REVISED STATEMENT OF GUIDANCE (SoG) ON SEASONAL TO INTER-ANNUAL (SIA) FORECASTS

(Point of contact: Laura Ferranti, ECMWF)

This Statement of Guidance (SOG) was developed through a process of consultation to document the observational data requirements to support seasonal-to-interannual (SIA) climate prediction. This version was prepared originally by the ET-ODRRGOS with experts from the NWP community, and was subsequently updated in consultation with a number of experts from the climate community through the AOPC and by the CBS ET on Infrastructure for Long-Range Forecasting. It is expected that the statement will be reviewed at appropriate intervals by the OPAG on Data Processing Forecasting Systems to ensure that it remains consistent with the current state of the relevant science and technology.

1 Introduction

The physical basis for seasonal and inter-annual climate prediction lies in components of climate that vary slowly compared with individual weather events, i.e. ocean and land surface (including cryospheric components). The ENSO (El Nino Southern Oscillation) cycle is the most relevant phenomenon with predictability on the seasonal time-scale. ENSO consists of a coherent, large-scale fluctuation of ocean temperatures, rainfall, an atmospheric circulation across the tropical Pacific. It is a coupled ocean-atmosphere phenomenon centered over the tropical Pacific but the scale of the fluctuations is quite vast, with changes in sea-surface temperatures (SSTs), tropical rainfall and winds spanning a distance of more than one-half the circumference of the earth. ENSO represents the dominant source of predictive skill for any SIA forecasts. It follows that in order to predict seasonal climate by dynamical means, fully coupled ocean-land-atmosphere models are used. Just as in weather prediction, ensemble forecasts using these coupled models give probabilistic risk forecasts of climate events. ~~Coupled atmosphere-ocean models are used to produce seasonal-to-inter-annual forecasts of climate.~~ While empirical and statistical methods are also used to predict climate conditions a season ahead, the present assessment of how well observational requirements are met relates only to the coupled model inputs. It is noted that historical data sets also play an important role in SIA prediction by supporting calibration and verification activities.

Whilst such forecasting is still subject to much research and development, many seasonal forecast products are now widely available. The complexity of the component models ranges from simple models to full general-circulation-model representations of both the ocean and atmosphere. Coupled model initialization makes use of both atmospheric and oceanic data. There is ~~also~~ large variation in the approach to the assimilation of initial data, with some of the simpler models assimilating only wind information while the more complex models usually assimilate sub-surface temperature information and satellite surface topography and temperature data. Indeed, major challenges remain in the development of assimilation techniques that optimise the use of observations in initialising models.

The time and space scales associated with seasonal-to-interannual variability (large scale, low frequency) suggest the key information for forecasts will derive mostly from the slow parts of the climate system, in particular the ocean, but also the land surface. When considering impacts such as rainfall deficiencies or increased temperatures over land, however, there are very good reasons for considering variables associated with the land surface conditions. In particular, land surface moisture and vegetation should be specified and predicted. The models should also include up-to-date radiative forcing (e.g., greenhouse forcing), which are important for maximising skill in forecasts of land-surface air temperature anomalies relative to recent historical reference-normal periods.

In this list of observation needs, the requirements for SIA forecasts are based on a consensus of the coupled atmosphere-ocean modelling community. It builds on the requirements for Global NWP and represents in addition those variables that are known to be important for initialising models or for testing and validating models. For the most part, aspects that remain purely experimental (i.e., unproven) are not included. There is some attempt to capture the impacts aspects; that is, those variables that are needed for downscaling and/or regional interpretation.

2 Data Requirements

The following terminology has been adhered to as much as possible: marginal (minimum user requirements are being met), acceptable (greater than minimum but less than optimum requirements are being met), and good (near optimum requirements are being met).

2.1 Sea-surface temperature

Accurate SST determinations, especially in the tropics, are important for SIA forecast models. Ships and moored and drifting buoys provide observations of good temporal frequency and acceptable accuracy, but coverage is marginal or worse over large areas of the Earth. Instruments on polar satellites provide information with global coverage in principle, good horizontal and temporal resolution and acceptable accuracies (once they are bias-corrected using *in situ* data), except in areas that are persistently cloud-covered (which includes significant areas of the tropics). Geostationary imagers with split window measurements are helping to expand the temporal coverage by making measurements hourly and thus creating more opportunities for finding cloud-free areas and characterising any diurnal variations (known to be up to 4 degrees C in cloud free regions with relatively calm seas). Microwave measurements provide acceptable resolution and accuracy and have the added value of being able to 'see through' clouds. Blended products from the different satellites and *in-situ* data can be expected to be good for SIA forecasts.

There is a requirement for high quality, fast delivery SST (ideally with accuracy < 0.1 deg C on 100 km spatial scale and < 0.25 deg C on 10 km spatial scale, available within 24h (by SST we mean e.g., bulk temperature at 2m depth).

2.2 Ocean wind stress

Ocean wind stress is a key variable for driving ocean models. It is important to recognise the complementarity between surface-wind and surface-topography measurements. Current models use winds derived from Numerical Weather Prediction (NWP), from specialist wind analyses or, in some cases, winds inferred from atmospheric models constrained by current SST fields. The tropical moored buoy network has been a key contributor for surface-winds over the last decade, particularly for monitoring and verification, providing both good coverage and accuracy in the equatorial Pacific. Fixed and drifting buoys and ships outside the tropical Pacific provide observations of marginal coverage and frequency; accuracy is acceptable.

Satellite surface-wind speed and direction measurements are now the dominant source of this information. Currently their data reach SIA models mostly through the assimilated surface wind products of NWP, where their positive impact is acknowledged. Overall, a two-satellite scatterometer system, or its equivalent, would provide good coverage and acceptable frequency, and it would complement the ocean-based systems. At this time, continuity and long-term commitment are a concern. Improved integration of the data streams and operational wind stress products from NWP and other sources will be needed to achieve acceptable or better coverage, frequency and accuracy.

High-quality scatterometer winds are the best products available at the moment and need to be maintained operationally. Additional data would always be useful. For example, data to allow better estimates of heat-fluxes and P-E (precipitation minus evaporation) could help give a better definition of the mixed layer structure.

2.3 Sub-surface temperature

Many, but not all, SIA forecast models assimilate sub-surface temperature and salinity data, at least in the upper ocean (down to ~500 m depth). The Tropical Atmosphere Ocean (TAO) / TRITON moored buoy network provides data of good frequency and accuracy, and acceptable spatial resolution, of sub-surface temperature for the tropical Pacific, at least for the current modeling capability. The tropical moored network in the Atlantic (PIRATA) is better than marginal but does not yet have the long-term resource commitments and stability to be classified as acceptable. There is no array in the Indian Ocean. The Ships-Of-Opportunity Programme (SOOP) provides data of acceptable spatial resolution over some regions of the globe but the temporal resolution is marginal. It is noted that SOOP is evolving to provide enhanced temporal resolution along some specific lines. The *ARGO* Project is providing global coverage of temperature and salinity profiles to ~2000 m, mostly with acceptable-to-good spatial resolution, but only marginal temporal resolution in the tropics. In all cases the accuracy is acceptable for SIA purposes.

Ocean observation system over Equatorial Atlantic is deficient in moorings. Moorings at and near the equator are important. Equatorial moorings in the Indian Ocean are also useful.

2.4 Salinity

Salinity is becoming an important parameter. Some models are starting to make use of such data in the ocean data assimilation. The *ARGO* is a major source of salinity observations. It provides global coverage of temperature and salinity profiles to ~2000 m, mostly with acceptable-to-good spatial resolution, but only marginal temporal resolution in the tropics. Valuable data also comes from the tropical moorings although data coverage is too limited. Surface salinity will be measured by satellite in the forthcoming research mission. There will be a need for continuity of those measurements.

2.5 Ocean topography

Ocean altimetry provides a measure of the sea surface topography relative to some (largely unknown) geoid (or mean sea-surface position) that in turn is a reflection of thermodynamic changes over the full-depth ocean column. In principle, the combination of altimetry, tropical mooring and *ARGO* will provide a useful system for initialising the thermodynamic state of SIA models. Long-term commitments for satellite altimetry are required. Research satellites are providing a mix of data with acceptable accuracy and resolution and data with good spatial resolution (along the satellite tracks) but marginal accuracy and frequency. The "synoptic" global coverage, particularly beyond the tropical Pacific, is an important requisite. Ocean altimetry data can currently only be used to look at variability in the sea-state. There are plans to make use of geodetic data to obtain information about the geoid and the mean state of the oceans. It is expected that geodetic data will become available from satellites; GRACE and CHAMP are flying missions; GOCE will be an important addition.

2.6 Surface heat and freshwater fluxes

There are a few sites in the tropical ocean where the data on surface heat flux are of value for validation and are required at a number of sites in the tropical oceans. NWP products (derived from analysis from short-range forecast), in principle, have good resolution but the accuracy is at best marginal. Satellite data provide prospects for several of the components of heat flux, particularly shortwave radiation, but at present none is used on a routine basis for SIA assimilation. Precipitation estimates are important for validation because of the fundamental role of the hydrological cycle in SIA impacts. They also have importance in initialisation because of the links to salinity. However, there remain significant uncertainties in estimates of rainfall over the oceans. In addition the fresh water run off information from rivers (large estuaries) will become important in coastal areas and regional parts of the oceans (e.g., the Gulf of Bengal).

2.7 Ocean current data

Models generally do not currently assimilate ocean current data, perhaps in part because data is limited. However, because of the central importance of dynamics and advection, current data are important for testing and validation. For example, experimental fields of surface current for the tropical Pacific and Atlantic are now being produced routinely by blending geostrophic estimates from altimetry with Ekman estimates from remotely-sensed wind observations. Inferred surface currents from drifting buoys are acceptable in terms of accuracy and temporal resolution but marginal in spatial coverage. Satellite altimetry is also being used to infer the distribution of ocean currents. Moored buoys are good in temporal coverage and accuracy, but marginal otherwise.

2.8 *In-situ* sea level

In-situ sea level measurements provide an additional time-series approach (good temporal resolution and accuracy; marginal spatial coverage), particularly for testing models and validating altimetry.

2.9 Atmospheric data

Since several SIA systems are driven by winds and, in several cases, surface heat flux products from operational analyses, the global (atmospheric) observing system is fundamental for SIA forecasts and their verification.

2.10 Land-surface

Snow cover:

Snow cover and depth are important, particularly at short lead times (intraseasonal-to-seasonal). Snow depth observations are marginal.

Soil moisture and terrestrial properties:

Soil moisture use is still very marginal although soil moisture initial conditions are a crucial element in the forecast performance in mid-latitudes Spring / Summer (Beljaars, 1996), and might extend predictability over land in the monthly to seasonal range (Koster, et al., 2004a, b). Soil moisture drifts are ubiquitous in NWP models, due to deficiencies in land surface models and / or the forcing precipitation and radiative fluxes (Viterbo, 1996).

Due to its extended memory, the relevant quantity to initialise is the soil water in the root layer. There is no existing or planned direct observation of such quantity with global or even regional coverage. Soil moisture analysis relies on proxy data. Such data cover three main groups:

- *Observations related to the surface-atmosphere feedback*, or the partitioning of available energy at the surface into sensible and latent heat fluxes (e.g., Screen-level temperature and humidity and early morning evolution of IR radiances in the window channels in geostationary platforms);

- *Observations related to the soil hydrology*, such as microwave remote-sensing; radiances are sensitive to water in the first top few cm of the soil; and,

- *Remote-sensing observations related to plant phenology*, such as leaf area index (LAI), fraction of available photosynthetically active radiation (fAPAR), broadly based in the contrast in reflectances between the visible and NIR. In as much as the phenological evolution of plants depends on available water, there is a soil

water related signal in the LAI and / or fAPAR; conversely, assimilation of such quantities will constrain the model evaporation, impacting on the background soil moisture.

Without careful constraints the use of one of the three classes of observations presented above will alias information into the analysed soil moisture. A strong synergy is expected from combining observations from each of the three classes above, because they sample "complementary directions" in the physical space.

2.11 Sea-Ice cover and thickness

Sea-ice cover is important for high latitudes. It is implicitly included in the leading SST products. Sea-ice thickness is important for fluxes and would be useful for initialisation. Too few ice thickness measurements are presently available.

2.12 Other data

There are many other data sets that may play a role in future-generation SIA forecast models. Because these roles are largely unknown, it is premature to discuss the adequacy of observing systems to meet these needs; generally speaking, they are not expected to rank near the above data in terms of priority. These data sets include:

- **Ocean colour:** Ocean transparency is already included in several ocean models and is thought to be a factor in SIA models (helping to determine where radiation is absorbed). Ocean colour measurements provide a means to estimate transparency; and,

- **Clouds:** Poor representation of clouds remains a key weakness of most SIA models. Better data are needed to improve parameterisations but these needs are adequately specified under NWP and elsewhere.

Aerosols data such as volcanic ash is also required. Continuity of satellite observations of volcanic aerosols is important.

Stratospheric ozone concentration data might be of interest in the future for seasonal forecasting.

Annex VIII

TRAINING, GUIDANCE MATERIAL AND BASIC REQUIREMENTS

Group composition:

Dr C.A. SANTOS COELHO
Mr T. TOKUHIRO
Mr V.N. SAKWA
Dr K. KOLLI
Mr J.P. CERON

Main objectives:

Understanding Climate and its drivers
Understanding Climate Models
Understanding GPCs products and services
Understanding Verification
Understanding communication (to convey the forecast in an efficient way to the user)

The objectives to be covered in 5 packages, expanded below:

Climate knowledge: focus on Global and regional aspects, primarily about inter-annual variability (e.g. ENSO, DMI, NAO), General Circulation for both Ocean and Atmosphere, Ocean/Atmosphere and Land Surface interactions, Teleconnection Patterns, regional climate variability and impact of large scale forcings, Climate system

Climate models (CM): basic principle of CM (including parameterizations), operational deployment of CM for SIP, Coupled versus non coupled models, Ensemble forecast/Uncertainty sources, Regional Climate Models, Post-Processing (Diagnostic vs prognostic variables), Validation

GPC products: Calibrations (bias correction, ensemble mean, spread, probabilities, …), practical access (including e.g. format, data analysis codes), visualisation (e.g. Grads), Products sub-setting, Potential additional products, hindcasts vs forecasts, Lead-Time, MME, LC-MME products and access

Verification: reference datasets, terminology, SVS and specific methods (CCl guide), Interpretation and use, LC-SVSLRF products and access, User oriented evaluations

Tailoring for users/communication: downscaling and tailoring (empirical and dynamical), Methods and software, expert assessment, Communication (including multidisciplinary work)

Other

Training at basic and advanced levels to be drawn from the same syllabus (experience suggests e.g. 1 week for basic, 2 weeks for advanced)

A list of experts available for training will need to be maintained

Annex IX

TABLE SUMMARIZING THE FORECASTS SYSTEM CONFIGURATION

GPC	System Configuration.	Atmospheric Model Resolution	Hindcast Period	Forecast Period
Beijing, BCC	Coupled	T63/L16	1983-2004	2008.02~
ECMWF	Coupled	T159/L62	1981-2005	2009.02~
Exeter, Met Office	Coupled	1.875x1.25/L38	1989-2002	2009.09~
Melbourne, BoM	Coupled	T47/L17	1980-2006	2008.07~
Montreal, CMC	2-tier	4 Models	1969-2004	2007.12~
Seoul, KMA	2-tier	T106/L21	1979-2007	2007.12~
Tokyo, JMA	Coupled	T95/L40	1979-2008	2010.02~
Toulouse, Météo-Fr	Coupled	T63/L91	1979-2007	2009.02~
Washington, NCEP	Coupled	T62/L64	1981-2004	2008.02~
Moscow, HMC	2-tier	1.1x1.4/L28	1979-2003	2008.02~
Cachoeira Paulista, CPTEC	2-tier	T62/L28	1979-2001	2009.01~
Pretoria, SAWS	2-tier	T42	1982-2001	2009.09~

Annex X

STATUS OF AND PLANS FOR EXTENDED-RANGE FORECASTING (ERF) AT GPCs

GPC CPTEC (Brazil)

Extended range forecast operational activities at CPTEC are performed using CPTEC atmospheric general circulation model (T126L28) producing an ensemble of 15 members twice a day (at 0 UTC and 12 UTC) for the following 15 day. In other words, each day the model is run twice in ensemble mode to forecast weather conditions in the following two weeks. Research activities in extended range forecasting also include the use of CPTEC coupled ocean-atmosphere model (T126L18) producing a single forecast member twice a day (at 0 UTC and 12 UTC) for the following 30 days.

GPC Exeter

Predictions to 15 days are made using the Met Office Global and Regional Ensemble Prediction System (MOGREPS-15). No model is currently run for the latter half of the extended range period. However, the new Met Office seasonal prediction system provides potential to investigate development of a monthly forecast system. The new system (GloSea4) is initialized at weekly intervals (compared to monthly initialisation used in the former GloSea3 system) – and this potentially allows forecast updates each week for the next 30 days. Initialisation will soon move to daily (rather than weekly) intervals, increasing potential for a monthly forecast system. At present development of monthly forecasting is a research topic rather than an operational capability. Extensive use of the ECMWF varEPS system (which is run to 32 days) is made to generate extended range forecast products for users.

GPC Melbourne

The Bureau of Meteorology forms a lagged extended range forecast every day making use of the last 30 days of 9-month forecasts. The forecasts are aggregated into two and four week forecasts (currently anomalies from average) at zero and one month lag. It is anticipated that the configuration of the extended range forecast system will change with the introduction of the new coupled modelling system (POAMA-2) in late 2010. Likely changes include a larger ensemble set and higher model resolution.

GPC Montreal

The Canadian monthly forecasts will be produces by the Canadian Global Ensemble Production System (GEPS). The GEPS is now producing 16 day forecast every days at 00 and 12 UTC. It is based on 20 members of the GEM model initialized by an Ensemble Kalman Filter (EKF) analysis. The members are perturbed using stochastic physic. To produce the extended range forecast, the GEPS will be extended to a 45 day forecast every 1st, 11th and 21th of the month. The Implementation of this new monthly system is planed for the beginning of 2011.

GPC Pretoria

The Extended Range Forecasting System at SAWS uses the same model as used for the WMO-GPC recognized seasonal forecasts namely the 2-tiered ECHAM4.5 AGCM. The current configuration runs on a weekly basis (every Sunday) and consists of a 24 member ensemble. Initial conditions of members are constructed using a time lagged average approach using Global Forecasting System (GFS NCEP) output for Atmospheric initial conditions and observed Optimum Interpolation version 2 (OIv2) for Sea Surface Temperatures. Forecasts are presented in Probabilities of three equal probable categories for 20 day averages (day 11-30) for Precipitation, Avg. Temperature, Minimum Temperature and Maximum Temperature. Terciles of the categories are calculated using extracted 20 day AMIP2 type ECHAM4.5 hindcasts.

GPC Seoul

The operational KMA extended-range prediction system is called GDAPS (Global Data Assimilation and Prediction System) which is spectral model with a horizontal resolution of T106 and 21 vertical levels with p-top at 10 hPa. As a boundary condition over the ocean, the GDAPS uses predicted SST during the integration provided by SST prediction system of KMA (2-Tier system). This SST prediction system consists of dynamical El-Niño prediction model, lagged linear regression model, coupled pattern projection model, and persistence. Each model of system performs individual SST prediction that is combined for obtaining final SST prediction. The ensemble run for extended-range prediction is made of 20 members by a time-lagged method using 6 hourly initial conditions, four times a day (3^{rd}~7^{th} day of each month). The hindcast run for obtaining model climatology is done for 31 years from 1979 to 2009. The anomaly fields are obtained as the differences of the ensemble mean from the model climatology.

GPC Tokyo

An extended-range forecasting model is an atmospheric general circulation model (TL159L60) with atmospheric initial conditions obtained from the JMA Global Analysis and initial land surface conditions obtained from the JMA Land Surface Analysis System. The sea surface temperature (SST) is used as the lower boundary condition for the AGCM and prescribed using persisted-anomaly. The sea ice is also used as the lower boundary condition and prescribed using the climatological distribution.

The Ensemble Prediction System (EPS) for extended-range forecasting is run once a week with 50 members, and their initial perturbations are obtained using the Breeding of Growing Modes (BGM) method. Among these 50 members, 25 are integrated from initial fields at 1200 UTC every Wednesday, and another 25 from 1200 UTC every Thursday. The overall 50-member ensemble is then used for a one-month forecast issued every Friday. Grid point value (GPV) products for extended-range forecasting are made available on the Tokyo Climate Centre (TCC) website every Friday.

GPC Toulouse

Monthly forecast bulletins (routinely edited) are based on ECMWF monthly forecast products. A statistical post-processing of 2m-temperature is performed with the ECMWF monthly forecast system output up to day 32 on individual members for 1056 sites. Information about daily extremes is also inferred at the same locations.

GPC Washington

In the next upgrade of the seasonal Climate Forecast System (CFS) at the National Centres for Environmental Prediction (NCEP), i.e., the CFSv2, the forecast configuration will provide an opportunity to test the feasibility of developing products on monthly and intra-seasonal time scale. In the real-time, the CFSv2 forecast configuration is expected to include 16 runs/day up to 45 day. The real-time forecasts are expected to be accompanied by a hindcast data set from 1999-2009. Availability of extensive hindcasts will provide an opportunity to estimate skill in the prediction of various phenomena on the intra-seasonal time-scale, e.g., Madden Julian Oscillation (MJO), hurricane activity on a monthly basis, onset and prediction of active and break phases of monsoon etc. It should be emphasized, however, that prediction on monthly and intra-seasonal time-scale is very much a research issue, and availability of hindcasts will clarify some essential issues, e.g., level of skill. It is expected that the CFSv2 would become operational at the end of 2010.

GPC ECMWF

At ECMWF an ensemble of ERF is produced once a week (every Thursday) and most of the products are based on calendar weeks (Monday to Sunday). The VarEPS/monthly forecasting system has been built as a combination of the medium-range ensemble prediction system (EPS)

and the seasonal forecasting system. It contains features of both systems and, in particular, is based on coupled ocean-atmosphere integrations, as is the seasonal forecasting system.

The monthly forecasts are based on an ensemble of 51 coupled ocean-atmosphere integrations (one control and 50 perturbed forecasts). The length of the coupled integration is 32 days, and it is issued every week (on Thursday). The atmospheric component is the same as the integrated forecasting system (IFS) with the same cycle as the operational medium-range deterministic forecast. The frequency of coupling is higher than in seasonal forecasting (every 24 hours), since high-frequency coupling may have some impact on the development of some synoptic-scale systems, such as tropical cyclones.

The first operational real-time monthly forecast was realized on Thursday, 7 October 2004. Before March 2008, the monthly forecasting system was a separate system, after that the real-time VarEPS/monthly forecasting system has replaced the monthly system. This new system consists of 51-member ensemble of 32-day integrations. The first 10 days are performed with a TL399L62 resolution forced by persisted SST anomalies. After day 10, the model is coupled to the ocean model and has a resolution of TL255L62. The extension of VarEPS to 32 days is performed every Thursday. Since January 2009 the monthly forecast spatial resolution has increased to TL639L91 for the first 10 days and to TL319L91 after 10 days.

Similar to the seasonal forecast, in order to construct ERF products a set of re-forecasts (hind-casts) is used. In the present system, the set of re-forecasts consists of five-member ensemble of 32-day coupled integrations, starting on the same day and month as the real-time forecast for each of the past 18 years.

Monthly forecasting products are displayed on the ECMWF web pages. They include anomaly, probability and tercile maps based on comparing the 51-member ensemble distribution of the real-time forecast with the distribution of the model climatology. The forecasts of 2m temperature, precipitation and mean-sea-level pressure are averaged over seven days. The seven-day periods correspond to days 5 -11, days 12-18, days 19-25 and days 26-32. These periods have been chosen so that they correspond to Sunday to Monday calendar weeks. For the purpose of evaluating the skill of extended-range forecasts, this definition has the advantage that the second weekly period is beyond day 10 and corresponds almost to the first week after the 10 days time-range. The length of the monthly forecasting system is 32 days, so that it contains four of these weekly periods. In general the model displays strong potential predictability over a large portion of the extra-tropics for the period 12-18 days. However, there is generally a sharp decrease of potential predictability in the last two weeks of the forecasts. The range of products from the VarEPS/monthly forecasting system includes probability of occurrence of weather regimes and predictions of the MJO time evolution.

On the web site the verification statistics is regularly updated. The analysis used to verify the monthly forecasting system is the ECWMF operational analysis or ERA-40 reanalysis when available. For precipitation, the operational or the ERA-40 forecasts of precipitation between 12 and 36 hours are used as verification data. After 10 days, the spread of the ensemble forecast starts to be large, and the forecasts are essentially probabilistic. The probabilistic scores of the monthly forecasting system are evaluated through the scores obtained with weekly averaged surface temperature, 2m temperature, precipitation and mean-sea-level pressure. Basic methods for verifying probabilistic forecasts, such as Relative Operating Characteristics (ROC), have been in use for several years at ECMWF for medium-range EPS products and the methodology has being naturally extended to monthly forecasts. The statistics collected up to now suggest that for days 12-18 the model has good skill, and up to forecast range days 19-32 the ERF performs better than a forecast based on persistence of the previous weeks.

Annex XI

TERMS OF REFERENCE OF THE ET-ELRF

(a) On the basis of requirements from Regional Climate Centres (RCCs), Regional Climate Outlook Forums (RCOFs) and NMHSs, and in the context of the Global Framework for Climate Services (GFCS), guide future development, outputs and coordination of components in the production of LRF. The components include Global Producing Centres (GPCs), Lead Centres for Long-range Forecast Multi-model Ensembles (LC-LRFMME), and the Lead Centre for the Standardized Verification System for Long-range Forecasts (LC-SVSLRF);

(b) In coordination with CCl, promote the use of GPC and LC forecast and verification products by RCCs, RCOFs and NMHSs, develop interpretation guidance to facilitate their use, and encourage feedback on usefulness and application;

(c) Report on production, access, dissemination and exchange of LRF products and provide recommendations for future consideration and adoption by CAS, CCl, CBS and other appropriate bodies;

(d) In consultation with relevant experts in CAS and CCl and with the Coordination Group on Forecast Verification, review developments in verification scores and practices with a view to updating the Standardized Verification System for Long-range Forecasts (SVSLRF);

(e) Assess applications for GPC status against the designation criteria and make recommendations on designation to CBS;

(f) Review the rules regarding user access to GPC and LC-LRFMME forecasts products;

(g) Review the status of extended-range forecasting activities and promote the exchange of extended-range forecasts and verification products;

(h) Promote international cooperation and research on initialized predictions for timescales longer than seasonal and report on potential for operational predictions to CBS and CCl;

(i) Review the *Manual on the GDPFS* (WMO-No. 485) and propose updates as necessary concerning extended and long-range forecasts.