WORLD METEOROLOGICAL ORGANIZATION

COMMISSION FOR BASIC SYSTEMS

EXPERT TEAM ON EXTENDED AND LONG-RANGE FORECASTING

Geneva, Switzerland, 26 – 30 March 2012

FINAL REPORT

Photo: meeting of the ET-ELRF, WMO Headquarters, Geneva, 29 March 2012

EXECUTIVE SUMMARY

The meeting of the CBS Expert Team on Extended- and Long-Range Forecasting (ET-ELRF) was held in Geneva, Switzerland, from 26 to 30 March 2012.

The meeting reviewed the status/progress reports by representatives from all 12 Global Producing Centres (GPCs): Beijing, CPTEC (Brazil), Exeter, Melbourne, Montreal, Moscow, Pretoria, Seoul, Tokyo, Toulouse, Washington and the ECMWF, against the minimum criteria for GPC designation. While noting that all GPCs were providing probabilistic forecasts of the minimum variablesthe meeting noted that some GPCs were in a temporary period of non-compliance with the full designation criteria. For several GPCs temporary non-compliance was a result of substantial development of their prediction systems, since the last ET-ELRF meeting (Exeter, 2010). Key developments include implementation of a coupled (1-tier) system, and major upgrades to model physics and resolution. The meeting also noted with appreciation that, 5 GPCs now have hindcast periods that include the 1981-2010 period – the period recommended for hindcasts by the Exeter (2010) meeting.

In relation to the need within the developing GFCS, for predictions on monthly, seasonal and longer time-scales, the meeting reviewed activities on monthly and multi-annual/decadal timescales in addition to activities on the seasonal range. The meeting noted that a number of GPCs are running extended range forecasts either in research or operational mode and recognized that there had been substantial development to some of these systems since the Exeter (2010) meeting. The meeting recalled that Cg-XVI requested the LC-LRFMME to explore the possibility of extending its role to include exchange of extended-range predictions, and invited GPCs to also provide data from their monthly forecast systems so that the LC-LRFMME would be able to provide sub-seasonal forecast products through the LC-LRFMME web pages. In response to the above request from Cg-XVI, the meeting recognized the need to coordinate with the proposed WWRP/THORPEX/WCRP research project to improve skill in the extended-range. In this context, the meeting prepared a minimum (preliminary) list of variables based on the minimum products list for seasonal forecast exchange (as stated in the Manual on the GDPFS) and extended to include the MJO diagnostics particularly relevant to the sub-seasonal range. The data required to generate the products, and specifications of issuance frequency and timing were also considered. The meeting strongly encouraged GPCs which have implemented monthly forecast systems to display these products (plots) on their individual websites, and also to seek standardization in the display of plots, including through use of the same geographical regions. In addition, the meeting expressed its appreciation to the LC-LRFMME for agreeing to host a preliminary exchange of extended range forecasts and encouraged GPCs to participate (on a voluntary basis) in this exchange following the guidance provided. The LC-LRFMME agreed to develop displays of individual model forecasts and multi-model forecasts from the participating GPCs. The meeting recognized that in terms of verification the seasonal forecast infrastructure is not readily transferable to sub-seasonal predictions.

The meeting noted WMO Executive Council had requested CBS in collaboration with CCl to consider how multi-annual to decadal prediction systems being developed by some GPCs might be brought into the CSIS of the GFCS. In this context GPC Exeter (at the Exeter 2010 meeting) had agreed to continue with an informal exchange of real-time decadal predictions and to report on results to the current meeting. The meeting noted with appreciation that a number of research centres had responded positively to the informal exchange coordinated by GPC Exeter. The meeting encouraged GPC Exeter to continue with the informal exchange and to prepare a written submission to CBS and CCl on results and recommendations on how such multi-annual/decadal might be incorporated into the GFCS/CSIS.

A list of key requirements from GPCs, from ACMAD's perspective, was discussed. It was agreed that these additional requirements for GPCs should be further discussed at the proposed workshop between GPCs and RCCs.

The meeting congratulated the LC-LRFMME, operated by KMA and NOAA NCEP, for significant achievements since the last ET-ELRF meeting (Exeter, 2010), including: development and display of probabilistic MME forecasts; development of a facility for viewing GPC forecasts side by side; and an upgrade to the LC-LRFMME website. The meeting noted that LC-LRFMME products have been used in various RCOFs and RCCs. Additionally, LC-LRFMME products would be part of the core information for the WMO's Global Seasonal Climate Update (GSCU). The meeting considered priority areas for extending the GPC exchange of seasonal data beyond the minimum requirement in order to make it more useful for users, including: (a) hindcast exchange; (b) exchange of forecasts with longer lead time than 1 month; (c) provision of forecasts for higher order categories (e.g. outer quintiles); (d) additional variables; (e) additional SST Indices; (f) pre-selected geographical domains; (g) generating probabilistic multi-model products on the LC-LRFMME website which would allows the user to selected subsets of the 12 individual GPC models in the multi-model combination; and (f) explore the possibility of making forecast/hindcast data from the GPCs available and readily accessible in CPT format, through the LC-LRFMME. The meeting recognized that these aspects would create an enormous amount of work for the LC-LRFMME, and requested it to explore the feasibility of and prioritize these issues, and provide timelines as appropriate.

The meeting noted with appreciation that the LC-SVSLRF has achieved its primary aim of introducing standards and rigour into the verification of GPC forecasts and the sharing of associated verification information between GPC and the user community (RCC and NMHS). The meeting identified a number of aspects of the SVSLRF that required review, including potential standardization of datasets and hindcast periods, the set of skill scores used in the verification and the stratification of skills scores for El Niño and La Niña events. The meeting noted that one of the limitations of the LC-SVSLRF is its focus on historical hindcast data only. It agreed that there is a significant need for the real-time documentation of forecast performance/skill for GPC models as soon as possible after the end of the forecast period. While noting that the LC-SVSLRF does not currently have resources or a mandate for this role, the meeting suggested that individual GPCs make their real-time forecast verification, including the exchange of forecast skill measures, available on their websites and a link to them should be provided from the LC-SVSLRF website.

The meeting revisited discussions at the Exeter (2010) meeting regarding potential for centralized verification of GPC and multi-model products. It was concluded that although in principle centralization would assist in standardization of scores and verification of the multi-model it was not currently a practical option due mainly to the large resource needed by the centre undertaking the task. It was therefore decided to continue with the distributed approach to verification. Noting that the LC-LRFMME has responsibility for the development of forecasts based on multi-model ensembles, the meeting agreed that the LC-LRFMME multi-model hindcasts be verified in the same way as individual GPC hindcasts, using the SVSLRF. The LC-LRFMME agreed to provide necessary the SVSLRF scores for the multi-model hindcasts and to display the scores on the LC-LRFMME website, and also submit the same scores to the LC-SVSLRF. The LC-LRFMME will also provide the relevant verification maps to coordinators of the GSCU.

The meeting was presented with a brief report on the WWRP/THORPEX/WCRP research initiative on seasonal to sub-seasonal prediction. The meeting agreed that this is an important initiative and agreed to contribute to this project as appropriate. The meeting was also brief on the implementation of the SWFDP in Eastern Africa. It noted that the SWFDP had established a method of 'cascading forecasts' that could also be applied in demonstrating the utility of extended range forecasts. The meeting agreed that such a demonstration project would be appropriate to promote the use of these products, and to seek user feedback.

The meeting discussed several options to further promote the use of GPC products, including progress with a flyer on GPCs and the GPC websites, 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).

The meeting recalled that the ET-ELRF prepared, at its last meeting (Exeter, 2010), an outline for the training curriculum, the main objectives of which include understanding (a) climate and its drivers; (b) climate models; (c) GPC products and services; (d) verification; and (e) communications (to convey the forecast in an efficient way to users). Based on the GPC status/progress reports, the meeting noted that all GPCs have been involved in capacity building and training activities (including at RCOFs), covering all or part of these aspects, and would be able to continue to do so. The meeting discussed the specific training needs including the development of guidance material to help primarily RCCs, but also advanced NMHSs, 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 meeting 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, and provide the web addresses to the WMO Secretariat, in order to develop a "pool" of training materials.

The meeting reviewed its Terms of Reference and proposed amendments. The meeting noted the proposal to convert the CBS ET-ELRF in a joint CBS-CCl ET-ELRF, whose membership would include two CCl representatives. The meeting generally agreed with the proposal in pursuit of stronger collaboration between the two Technical Commissions, but desired that the Terms of Reference retain the existing focus on operational aspects which already reflect a significant thrust on CBS-CCl collaboration. The meeting requested that a formal proposal in this regard be made through the presidents of CBS and CCl for approval by the Executive Council as per the applicable WMO regulations.

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 09.30 hours on Monday, 26 March 2012, at the WMO Headquarters, in Geneva, Switzerland. Dr Graham welcomed participants to the meeting. He noted that significant progress had been made by GPCs and the two Lead Centres (LCs) in developing systems, products and services since the previous ET-ELRF meeting (Exeter, UK, 2010), including: (a) upgrading of the prediction systems of some GPCs; (b) development of new products by GPCs and LCs; and (c) active engagement of some GPCs with RCCs and RCOFs in promoting and assisting use of GPC products. Dr Graham stressed that there were important issues to be discussed and agreed in order to ensure GPCs and LCs respond effectively to the challenges of the developing Global Framework for Climate Services (GFCS). He noted that GPCs and LCs play an important role in the GFCS, as a key building block of its Climate Services Information System (CSIS) component. He noted that the meeting would have a considerable work programme for the week, in formulating recommendations for consideration by the fifteenth session of the Commission for Basic Systems (CBS-XV), which was planned to be held in Indonesia, in September 2012. These recommendations would address: (a) improvement of the data exchange; (b) further development of prediction products in accord with users requirements, especially within the framework of the GFCS; (c) exchange of extended-range forecasts; and (d) capacity building.

1.2 On behalf of the Secretary-General of the WMO, Dr Herbert Puempel, welcomed participants to the meeting, to Geneva in general and to the WMO in particular. Dr Puempel congratulated Dr Richard Graham for having been awarded an OBE in the 2012 UK Honours List for his outstanding contribution to long-range weather forecasting in the developing world. In particular, Dr Graham has been focusing on Africa, where he has been working tirelessly to promote the use of long-range forecasts for poverty alleviation and sustainable development. Dr Graham thanked Dr Peumpel for his welcome to participants and also for his generous congratulations. Dr Graham expressed his gratitude to WMO Secretariat for CBS and CCl and ET-ELRF members for their collaboration in long-range forecasting, adding that achievements of this collaboration had, in his opinion, undoubtedly contributed to his nomination for the award.

1.3 Dr Puempel recalled the outcomes of the World Climate Conference-3 (WCC-3, Geneva, Switzerland, 2009), which decided to establish a GFCS to strengthen the production, availability, delivery and application of science-based climate predictions and services. He noted that within the context of the GFCS, the GPCs for Long-Range Forecasts would play a major role in designing and coordinating the provision of global climate predictions from sub-seasonal to longer time-scales. He highlighted that verification is a critical component that contributes to Quality Management. Dr Puempel 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 services to Members facing the challenges of improving their capabilities to provide climate services. He concluded by wishing everyone a successful meeting.

2. ORGANIZATION OF THE MEETING

2.1 Adoption of the agenda

2.1.1 The meeting 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_Geneva2012/ET-ELRF_Docplan_March2012.html

2.3 The meeting 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

3.1 Review of WMO (CBS/CCl) decisions and other initiatives relating to ET-ELRF Terms of Reference, including new applications for GPC status

3.1.1 The meeting was presented with background information relating to the ET-ELRF, including a summary of the relevant decisions of the sixteenth session of the World Meteorological Congress (Cg-XVI, May 2011), and statements adopted by the 2010 extraordinary session of the Commission for Basic Systems (CBS-Ext.(10), November 2010) and by the fifteenth session of the Commission for Climatology (CCl-XV, February 2010).

3.1.2 The meeting noted that CBS-Ext.(10) endorsed the work programme for the ET-ELRF, as agreed at the last ET-ELRF meeting (Exeter, 2010). It noted that Cg-XVI appreciated that twelve GPCs have been actively contributing seasonal forecast data to the LC-LRFMME, and that the LC-LRFMME products are in use at RCCs, RCOFs and NMHSs and urged continued collaboration between CBS and CCl. The meeting also noted that Cg-XVI requested GPCs and associated LCs to play a key role in development of the Climate Services Information System (CSIS) component of the Global Framework for Climate Services (GFCS), including assisting in the preparation of WMO Global Seasonal Climate Updates (GSCU). The meeting, which included participants representing RCCs/developing RCCs from RAI, RAII and RAVI agreed to scope a possible exchange of extended range forecasts under agenda item 7.

3.1.3 The meeting noted that CBS had received no further applications from prediction centres wishing to be designated GPC status.

3.1.4 The meeting noted that Cg-XVI requested: (a) the LC-LRFMME to explore the possibility of extending its role to include exchange of extended-range predictions, and invited all GPCs to also provide data from their monthly forecast systems so that the LC-LRFMME would be able to provide sub-seasonal forecast products through the LC-LRFMME web pages; (b) CBS, in collaboration with CCl, to develop a set of minimum forecast and verification products, data exchange protocols, and revised roles and functions of the LC-LRFMME, starting with the provision of hindcast and forecast surface data, aiming to extend this to other variables in due course; and (c) CBS, in coordination with CCl and the WCRP, to coordinate international collaboration in, and review research on initialized predictions for time scales longer than seasonal scales and evaluate the potential for operational predictions.

3.1.5 The meeting noted that Cg-XVI encouraged NMHSs to consider and promote national mechanisms to coordinate their activities for basic climate data, diagnostics, climate system monitoring, and in many cases long-range forecasts (LRF) to help align the core products and services of GPCs and RCCs/RCC-Networks. At the same time, Cg-XVI recognized the critical role of WMO in putting in place operational mechanisms for providing climate information, products and services and takes the prime responsibility in their implementation. Cg-XVI agreed that the NMHSs, the Regional Climate Centres (RCCs), WMO-designated Global Producing Centres of Long-Range Forecasts (GPCs) and other mechanisms dealing with basic climate data and climate system monitoring at the global level will form the basis for development, production and delivery of climate services, constituting the proposed Climate Services Information System (CSIS) of the GFCS. Cg-XVI emphasized that CSIS would be required to have close interaction with users of

climate services and contribute to communications and feedback processes under the Climate Users Interface Platform (CUIP) component of GFCS.

3.1.6 In addition, the meeting noted that Cg-XVI reiterated the importance of RCCs as a key element of the CSIS/GFCS, and particularly in helping participating Members develop improved climate activities for provision of a wide range of climate information, and emphasized the need that RCCs be developed as centres of excellence, with adherence to standards and criteria that will ensure the highest quality products. The meeting further noted that the CCl Management Group decided to establish an Expert Team on CSIS (ET-CSIS, Terms of Reference given in Annex 3 to the report of the CCl Management Group (Denver, October 2011), available at http://www.wmo.int/pages/prog/wcp/ccl/mg/documents/CCIMGMeetingReportFinal11112.pdf), endorsed the implementation strategy for the Global Seasonal Climate Update (GSCU), and decided to continue its Task Team on GSCU (Terms of Reference available at http://www.wmo.int/pages/prog/wcp/ccl/opace/opace3gscu.php) to guide the implementation of the trial phase of GSCU proposed to be hosted by the WMO LC-LRFMME.

3.1.7 The meeting noted that at least four technical bodies of WMO are addressing different aspects of seasonal prediction: CCl, CBS, CAS and WCRP. The CCl Management Group recognized the need to coordinate these efforts, to ensure consistency and complementarity in the establishment of operational seasonal prediction capabilities at all levels in the CSIS. The CCl Management Group decided that the President would formally write to the CBS, CAS and WCRP proposing a Joint CCl/CBS/CAS/WCRP Working Group on Seasonal Prediction.

3.1.8 The meeting noted that CCl is developing a comprehensive strategy on capacity building for improving delivery of climate services at the national level, and has established an Expert Team on Capacity Building Strategy for Climate Services (Terms of Reference available at http://www.wmo.int/pages/prog/wcp/ccl/opace/et_scbcs.php). This capacity building strategy would underpin the capacity building component of the GFCS. The meeting agreed to discuss development and consolidation of the GPC contribution to capacity building under agenda item 8 – drawing on experience of GPCs already active in this area.

3.1.9 The meeting noted the WMO requirement for systems and services to follow Quality Management Framework (QMF) principles and agreed that a review of current practices would be useful to prioritize possible changes needed – for example in procedures to ensure users are given sufficient warning of upcoming changes to prediction systems. It was agreed that this topic could be explored as part of a workshop between GPCs and RCCs and requested CBS and CCl jointly organize such a workshop. The meeting requested the chairperson to scope out the organization of the workshop in close consultation with the joint CCL-CBS ET on RCCs and the WMO Secretariat.

3.2 Progress with the GFCS and CSIS in particular, and implications for GPCs

3.2.1 The meeting was presented with a brief report on the recent activities for the development of a Global Framework for Climate Services (GFCS), in particular its Climate Services Information System (CSIS). The meeting noted the CSIS structure, and the GFCS principles that are most pertinent to the ET. It also noted the decisions of Cg-XVI regarding GFCS implementation and eventual governance. The meeting was informed that Cg-XVI recognized a central role for CCl, but that CCl would need to work closely with the other Technical Commissions (TCs), including CBS, in the implementation of the GFCS. The meeting noted that all TCs were urged to review their work with regard to the GFCS, and to identify their contributions. GFCS is a key priority in the regular budget, which is another indication of its importance to WMO. WMO President leads a Task Team on GFCS that has a tight timeline for preparations for the upcoming extraordinary session of Cg, which will be held in Geneva, in October 2012.

3.2.2 The meeting noted that there is a zero-order draft of the GFCS implementation plan, and it will soon be made public for wider comments. It was noted that although the GFCS will be built upon existing structures such as the Global Data-Processing and Forecasting System (GDPFS), a

major increase in the exchange of prediction information is envisaged – and this will be very challenging to GPCs and particularly to the LCs. The meeting agreed that it was important that the Implementation Plan acknowledged and addressed these increased challenges (which include issues of data storage and delivery) and GPC representatives agreed to review the Plan and provide comments, particularly on the Annexes on Research, Modelling and Prediction, the CSIS and Capacity Building. GPC representatives agreed to provide comments through the Permanent Representatives of their countries with WMO by 6 April 2012 and WMO secretariat agreed to ensure that comments are made available to the meeting of the Implementation Plan writing team.

3.2.3 The meeting noted that the implementation of the GFCS would be mainly through projects focused on developing countries. However, it agreed that resources should be available for maintaining and improving the existing infrastructures such as the GPCs, LCs, and RCCs – in particular where there are specific challenges as referred to in the previous paragraph. The meeting noted that a Trust Fund was created for the implementation of the GFCS and that the ET-ELRF may consider developing proposals for getting access to part of these funds.

3.2.4 The meeting agreed that within the context of the GFCS, there is a need for standardization of the names of the GPC and RCC products, to facilitate effective search and discovery in the WIS. The meeting recommended that this issue be addressed in the proposed workshop between GPCs and RCCs.

3.3 Progress with the GSCU, implications for GPCs and Lead Centres

3.3.1 The meeting was briefed on the progress with the Global Seasonal Climate Update (GSCU). It noted that the GSCU concept has been developed within the context of the GFCS, to provide the world community with an expert assessment and global consensus on (a) the observed state of the climate over the preceeding season and (b) an outlook for the upcoming season along with information on robustness and uncertainty of the available prediction signals, thereby contributing to an effective application of science-based climate information in climate risk management. The meeting reviewed the development of the GSCU, led by the CCl Task Team on GSCU, through a Mark 0 and Mark 1 version and noted that a pilot phase was now commencing in which the GCSU will be circulated to a review panel for comment and further development.

3.3.2 The meeting noted that the content of the GSCU as developed by the scoping workshop and Task Team was helping to define user requirements on GPCs and LCs some of which are not currently satisfied or are not served by current GPC or LC designated functions. These desired requirements include: (a) exchange of hindcasts by all GPCs – in order that predictions from all GPCs can contribute to MME probability forecasts; (b) exchange of predictions of leads longer than 1 month (possibly only for GPCs with coupled systems); (c) verification of the LC-LRFMME multi-model hindcast. Exchange of additional variables would also be useful, for example upper and lower level wind components. The meeting agreed to address these issues under agenda item 5.2.

3.4 Review of progress with RCC designation

3.4.1 The meeting was presented with a brief report on the progress with RCC designation (see Annex III), by region and expressed satisfaction with the accelerated progress in the implementation of RCCs in all WMO Regions.

3.4.2 The meeting also noted that discussions were underway to explore the establishment of WMO RCCs and RCOFs in areas with common climate characteristics, which straddle the traditional domains of two or more WMO Regional Associations (e.g., Polar Regions, Mediterranean Basin, etc.). The meeting also noted with appreciation that some GPCs had contributed to scoping of an RCOF for the Mediterranean Basin at the recent PRESANORD meeting. The progress in the establishment of the RCCs around the world is summarized in the Report of the First Meeting of CCl/CBS Joint Expert Team on RCCs (ET-RCC, Offenbach, October 2011), which is available on the WMO website at http://www.wmo.int/pages/prog/wcp/ccl/opace/documents/ET-RCC-Final-Report-2011.pdf.

3.4.3 The meeting noted that the ET-RCC reviewed its Terms of Reference and proposed a few minor revisions. The revised ToRs approved by CCl Management Group are given in Annex IV. Noting the ToRs of the ET-RCC and its report to the meeting (further discussed in agenda item 4.4), the meeting noted a need for enhanced interaction between GPCs and RCCs. The Meeting further noted that interactions between GPCs and RCCs should be scoped as part of the proposed workshop between GPCs and RCCs.

3.5 Revised Manual on the GDPFS and implications for the ET and GPCs

3.5.1 The meeting was informed that Cg-XVI, noting the importance of the Manual on the GDPFS (WMO-No. 485) as the single source of technical regulations for all operational data-processing and forecasting systems of Members, including their designated meteorological centres, endorsed the request by CBS-XIV (2009) to undertake a comprehensive review of this Manual. The meeting noted the significant progress made with the revision of the Manual, including the development of a new outline, which was adopted by Cg-XVI through Resolution 6 (Cg-XVI). The meeting was informed of the outcomes of the CBS Expert Meeting on the Revision of the Manual of the GDPFS (Geneva, October 2011), including the template to describe the activities in the new Manual, and the draft new text for the revised Manual on global NWP and coordination of deterministic NWP verification, which would serve as an example for guiding the continuation of the work. Noting that the text for the new Manual would be considered at CBS-XV, the meeting accepted the kind offer of Dr Arun Kumar (GPC Washington) to rearrange the ELRF parts of the Manual in accordance with the new structure.

4. STATUS REPORT FROM GPCs AND RCCs

4.1 GPC compliance

4.1.1 The meeting was presented with and reviewed the status/progress reports by representatives from all 12 Global Producing Centres (GPCs): Beijing, CPTEC (Brazil), Exeter, Melbourne, Montreal, Moscow, Pretoria, Seoul, Tokyo, Toulouse, Washington and the ECMWF, against the minimum criteria for GPC designation. All GPC status/progress reports and presentations are available on the WMO Web site at http://www.wmo.int/pages/prog/www/DPFS/Meetings/ET-ELRF_Geneva2012/ET-ELRF_Docplan_March2012.html.

4.1.2 The meeting noted that all GPCs were providing probabilistic forecasts of the minimum variables; temperature, precipitation and SST (GPCs running coupled models), together with appropriate verification to allow prudent use of the forecasts. Many GPCs were also providing additional forecast variables and SST indices to WMO Members and the meeting urged GPCs to continue and expand on these additional products. However it was noted that some GPCs were in a temporary period of non-compliance with the full designation criteria. For several GPCs temporary non-compliance was a result of substantial development of their prediction systems, which puts pressure on the considerable resources needed to maintain compliance. The meeting congratulated GPC CPTEC (Brazil), GPC Moscow, GPC Pretoria, GPC Tokyo and GPC Toulouse, all of whom were fully compliant, and encouraged the other GPCs to reach or regain full compliance as soon as possible.

4.1.3 The meeting noted that most GPCs had been involved in capacity building and training activities, including at RCOFs, and would be able to continue to do so. The meeting recommended that a seasonal forecasting training programme or syllabus should be further developed as part of the training and capacity building strategy, and agreed to consider this issue under agenda item 8. In order to facilitate capacity building by GPC Pretoria, WMO CCl agreed to request that GPC Pretoria is invited to contribute to SARCOF in its role as GPC, in addition to participating as a country participant.

4.2 New developments in systems and products: including seasonal, extended, multi-annual/decadal; Interactions with RCCs

4.2.1 The meeting was briefed on upgrades and developments in the prediction systems employed by GPCs. It noted with appreciation that there had been substantial developments since the last ET-ELRF meeting (Exeter, 2010). Key developments include implementation of a coupled (1-tier) system at GPC Montreal and major upgrades to model physics and resolution at GPCs Exeter, ECMWF, Melbourne and Washington. These updates have led to improved prediction skill and therefore contribute to improved services to WMO members. The meeting also noted with appreciation that, 5 GPCs (Melbourne, Montreal, ECMWF, Washington and Seoul) now have hindcast periods that include the 1981-2010 period – the period recommended for hindcasts by the Exeter (2010) meeting. A brief of the current specification of GPCs LRF systems is provided at Annex V. The meeting also noted that most of the GPCs are planning further upgrades to their systems in the next few years. The meeting thanked the LC-LRFMME for continuing to highlight such changes in GPC system specification on its website. It was noted that currently the system specification used does not include information on model physics employed and the meeting agreed that the usefulness of providing a more detailed specification could be discussed at the proposed workshop of GPCs and RCCs. With this in mind, Dr Jones and Dr Denis agreed to review the system specifications and also to explore maintaining a single version shared between the LC-SVSLRF and LC-LRFMME.

4.2.2 The meeting noted that new forecast visualization methods had also been developed at some GPCs (notably Montreal and Exeter) to assist communication and usefulness to users. The meeting asked these GPCs to monitor feedback on these new methods and report back to the ET.

4.2.3 In relation to the need within the developing GFCS, for predictions on monthly, seasonal and longer time-scales, the meeting reviewed activities on monthly and multi-annual/decadal timescales in addition to activities on the seasonal range. The meeting noted that 11 of the 12 GPCs are running extended range forecasts either in research or operational mode (see Annex VI) and recognized that there had been substantial development to some of these systems since the last ET-ELRF meeting (Exeter, 2010). The meeting agreed to consider this information when discussing plans for a future operational exchange of ERF under agenda item 7.

4.2.4 The meeting noted WMO Executive Council had requested CBS in collaboration with CCl to consider how multi-annual to decadal prediction systems being developed by some GPCs might be brought into the CSIS of the GFCS. In this context GPC Exeter (at the Exeter 2010 meeting) had agreed to continue with an informal exchange of real-time decadal predictions and to report on results to the current meeting. The meeting noted with appreciation that a number of research centres had responded positively to the informal exchange coordinated by GPC Exeter. Real-time predictions to 10-year range, commencing 2011 and 2012 have so far been received. Analysis of forecasts for regional variations in 2011 annual mean temperature are encouraging (with marked improvement on equivalent prediction from the ensemble of models used in IPCC's 4th Assessment Report (AR4)). Multi-model mean predictions of annual mean temperature to 2019 show some notable differences to those from the AR4 ensemble, indicating that potentially useful information is derived on these timescales from initialization with the current state of the climate. The meeting encouraged GPC Exeter to continue with the informal exchange and to prepare a written submission to CBS and CCl on results and recommendations on how such multi-annual/decadal might be incorporated into the GFCS/CSIS.

4.2.5 The meeting acknowledged with satisfaction the paper published in the journal Climate Research on 31 March 2011 on "Long-range forecasting and the Global Framework for Climate Services", which was prepared by representatives from a number of GPCs, and the WMO Secretariat. This paper documents the evolution, purpose and future plans for the GPC network and its Lead Centres and is available on the website at http://www.int-res.com/articles/cr_oa/c047p047.pdf.

4.3 Use of GPC products by RCCs/RCOFs

4.3.1 Dr Andre Kamga briefed the meeting on progress made in using GPC products as part of ACMAD's RCC demonstration phase. RCC products generated by ACMAD include pan-African forecast maps of 3-month-mean 2m temperature and precipitation anomalies issued the last week before a start of the target season. Verification of GPC forecasts from the LC-SVSLRF website are also used in product generation. ACMAD's forecast and verification products are available on their website at http://www.acmad.org/rcc/index.php, The meeting noted and welcomed this example of ongoing engagement of RCCs with GPCs in these regional activities, and encouraged its continuation. The meeting noted that close links between GPCs and RCCs were not currently established in all regions and encouraged GPCs to establish and maintain such links in their regions in order to build capacity to efficiently apply products and services provided by GPCs and LCs, and requested the WMO Secretariat to assist as appropriate.

4.3.2 A list of key requirements from GPCs, from ACMAD's perspective, was discussed and is given in Annex VII. A number of the requirements, including the need for extended range forecasts, are covered under later agenda items. It was agreed that these additional requirements for GPCs should be further discussed at the proposed workshop between GPCs and RCCs.

4.4 Report from ET on RCCs

4.4.1 The meeting was informed of the outcomes of the meeting of the Joint CCl/CBS Expert Team on Regional Climate Centres (RCCs), which was held in Offenbach, Germany, from 12 to 14 October 2011. The meeting noted that Dr Caio Coelho attended this meeting on behalf of CBS. The ET-RCC reviewed the status of the RCCs in all WMO Regional Associations (RA) in terms of concept and implementation. The meeting noted that a number of recommendations were made by the ET-RCC regarding the RCC establishment and operations. These include:

- Develop, in close liaison with CCl OPACE I experts, a common syntax to uniquely identify RCC products in the GISC catalogue;
- All RCCs need to develop liaison mechanisms with the research community, such as regional CLIVAR panels, universities, research institutions and programmes etc. to operate on the appropriate scientific level. An appropriate action will be included in the RCC Guideline document;
- RCCs need to establish appropriate training programmes and the ET would liaise with the WMO ETR Programme in order to identify and to develop suitable training materials for RCC staff and users;
- Clear labeling of all RCC products is strongly recommended, preferably on dedicated RCC Web pages;
- Designated RCCs and RCC candidates are encouraged to adopt the current WMO practices with respect to the use of normals and reference periods in the development and display of anomaly products;
- The RCC Guidance document being developed by the Expert Team would include liaison principles for RCCs with other relevant CSIS entities and mechanisms. Such principles might include formalized arrangements with individual GPCs to allow for the exchange of data, products and expertise beyond globally agreed minimum requirements;
- RCCs should take the principal responsibility for the generation of technical inputs to RCOFs, and in particular on the current status of the climate system in the region of interest and the seasonal outlooks;
- Keeping in view the GFCS initiatives regarding the implementation of RCCs, RCC candidates are encouraged to identify donors interested in their region and to refer to the 'Compendium of project initiatives to be funded from voluntary contributions' when elaborating specific project proposals.

4.4.2 The meeting noted priority themes for engagement between GPCs and RCCs identified by the ET-RCC including: (a) capacity building and training aspects; (b) establishment of formalized

arrangements for exchange of data and expertise; (c) provision of regional perspectives on the GSCU; and (d) collaboration on the RCC Guidance Document . The meeting recommended that the RCC Guidance Document should include guidance on the use of GPC products by RCCs, and requested the WMO Secretariat to circulate this draft document among the GPC representatives for review as appropriate.

4.5 Observational requirements for GPCs

4.5.1 The meeting thanked the ECMWF for the review of observational data requirements for Long-Range Forecasting. The meeting noted that there had been no need to modify the Statement of the Guidance (SoG) for Seasonal to Inter-Annual (SIA) Forecasts prepared for the Exeter (2010) meeting, with the exception of including clarification on the definition of sub-seasonal predictions and a simplification of the text to avoid repetition with the SoG for Global NWP. The meeting noted that it would be helpful to highlight elements of the observing system that are essential for long-range forecasting such as TOGA/TAO and encouraged its members to review the SoG for SIA Forecasts with this in mind and provide comments to the Point of Contact (Dr Laura Ferranti) as appropriate, prior to the upcoming meeting of the CBS Expert Team on Evolution of the Global Observing System (ET-EGOS), which is planned to be held in May 2012. Dr Ferranti also proposed to incorporate relevant information from the plenary paper for the WCRP Open Science Conference (Denver, October 2011) on "Challenges of a Sustained Climate Observing System" (Trenberth *et al*, 2011), available at http://www.cgd.ucar.edu/cas/Trenberth/trenberth.papers/Trenberth%20paper%20OSC%20October%202011_v13.pdf.

4.5.2 The meeting noted the importance of Observing System Experiments to evaluate the relative impacts of elements of the observing system on the performance of seasonal forecasts, and that experiments of this kind had been conducted to evaluate the impact of the ARGO floats. The Team encouraged WCRP to coordinate more such Observing System Experiments in order to provide firm evidence of the benefits of key observation systems.

5. STATUS REPORT AND FUTURE DIRECTIONS: LC-LRFMME

5.1 LC-LRFMME: status report

5.1.1 The meeting congratulated the LC-LRFMME, operated by KMA and NOAA NCEP, for significant achievements since the last ET-ELRF meeting (Exeter, 2010) including: development and display of probabilistic MME forecasts; development of a facility for viewing GPC forecasts side by side; and an upgrade to the LC-LRFMME website. The meeting gratefully acknowledged the collaboration of APCC in these achievements. Table 1 summarises GPC and LC-LRFMME products currently available to users via the LC-LRFMME website. The full status report from the LC-LRFMME is given in Annex VIII. The Team encouraged GPCs to continue to promote the use of LC-LRFMME products at RCOFs, RCCs and NMHSs.

5.1.2 The meeting noted the methodology used to generate new Probabilistic MME products for tercile categories, available since June 2011. The method used is based on an uncalibrated MME, with model weights being inversely proportional to random errors in forecast probability associated with the standard error of the ensemble mean (i.e. proportional to the square root of model ensemble size) and a Gaussian fitting method for the estimation of tercile-based categorical probabilities (Min et al. 2009).

5.1.3 The meeting noted that LC-LRFMME products have been used in various RCOFs and RCCs. Additionally, LC-LRFMME products would be part of the core information for the WMO's Global Seasonal Climate Update (GSCU).

5.1.4 Statistics from the LC-LRFMME website indicate there are 343 registered users from 78 countries an increase on 123 users from 48 countries registered in spring 2010. The meeting agreed that it would be useful to know the types of user that are accessing the LC-LRFMME

website and requested the LC-LRFMME to monitor this information and feed results back to the ET.

Table 1 – GPC digital data and graphical products provided to the LC-LRFMME

Digital products	Graphical products
- Both forecast and hindcast of monthly mean anomalies of the GPC 's ensemble mean for lead 1~3), following the month of submissions ・ 2m surface temperature ・ Precipitation ・ Mean sea level pressure ・ 850hPa temperature ・ 500hPa geopotential height ・ Sea surface temperature NB: data only available from GPCs who allow redistribution of their data	- Individual forecast ・plots for each GPC forecast anomalies in common graphical format (Rectangular, Time series, Stereographic type, etc.) ・Consistency map ・SST Plume (Nino3.4 SST anomalies) - Deterministic Multi-model Ensemble ・Simple composite mean (SCM) ・Regular Multiple Regression ・Singular Value Decomposition (SVD) - Probabilistic Multi-model Ensemble ・tercile-based categorical probabilities

5.2 LC-LRFMME: future directions and products: including implications for additional data exchange

5.2.1 Based on discussions under the previous agenda items, the meeting considered the following priority areas for extending the GPC exchange of seasonal data beyond the minimum requirement in order to make it more useful for users.

(a) Hindcast exchange: The meeting noted that ten out of twelve GPCs are providing hindcasts to the LC-LRFMME as part of an additional exchange. Lack of a full set of hindcasts means that multi-model probability products cannot be made with the full set of GPCs. The two GPCs not providing hindcasts to the LC-LRFMME do provide their hindcast data as part of specific engagements with RCOFs and other users on a case-by-case basis. The meeting noted that the hindcast exchange is not mandatory. However, acknowledging its importance in the context of enhanced data exchange within the GFCS, the meeting suggested that the WMO Secretariat contact the Permanent Representatives of GPC countries, emphasizing the value of the hindcasts and urging all GPCs to participate in the exchange.

(b) Exchange of forecasts with longer lead time than 1 month: Forecasts displayed on the LC-LRFMME website have so far been limited to a target period of the first 3 months after the month of issue (1-month lead from GPCs). This is the only lead time for which there is a full set of 12 GPC forecasts, since uncoupled systems (of which there are 4 out of the 12) are generally not run to leads greater than 1 month. However there is increasing requirement for longer lead forecasts including from RCOFs in RA II (FOCRAII and SASCOF) which are convened in April for a "target" season of June-August. Lead times longer than 1 month have also been identified as a requirement for the developing GSCU. In this context GPCs (particularly those with coupled systems) are urged to provide their forecast and hindcast data to lead times up to 3 months. Additionally the LC-LRFMME is requested to extend its display of GPC data and its multi-model products to include display of forecasts of greater than 1-month lead time. The meeting pointed out that verification information should also be available for the longer-lead forecasts and agreed to address this issue under agenda item 6.

(c) Provision of forecasts for higher order categories (e.g. outer quintiles): Recognizing the user interest in extreme seasonal anomalies a number of GPCs provide probabilistic

forecasts of outer quintile categories (or similarly defined 'modest' extremes), the meeting discussed whether provision of this information should be added to the list of mandatory GPC products. It was decided that it was premature at this time to make such products mandatory. However the meeting encouraged GPCs to provide forecasts of outer quintile categories, with accompanying skill information, to RCCs on a case-by-case basis, for their use at the regional level and also encouraged RCCs to provide feedback to GPCs on the usefulness of these products. This issue could be a topic for the proposed workshop between GPCs and RCCs.

(d) Additional variables: the meeting considered the possibility of adding variables to the list of products to be made available by GPCs. Noting that the wind components in the lower and upper troposphere (U850, V850, U200, V200) are valuable indicators of large scale features in the Tropics (where geostrophic approximation is not appropriate), the meeting agreed to exchange these additional parameters on, for the time being, a non-mandatory basis. The meeting noted that there were other requirements by RCCs for additional parameters and recommended that this issue be discussed at the proposed workshop between GPCs and RCCs when a revised list of mandatory products could be prepared.

(e) Additional SST Indices: the meeting recognized a requirement for the LC-LRFMME to generate predictions of other SST indices in addition to Nino3.4, particularly for the GSCU but also for use at some RCOFs. The meeting noted that the LC-LRFMME has already generated a range of such indices. To ensure the set of indices matches user requirements the meeting asked Dr Jean-Pierre Céron to prepare a proposal defining a priority set of indices with corresponding definitions and to circulate the proposal among the ET members prior to the proposed workshop between GPCs and RCCs.

(f) Pre-selected geographical domains: the meeting agreed that the LC-LRFMME visualizations should have an option for centering global maps on 180º, to avoid "cutting" of land areas. Additionally, it was agreed the LC-LRFMME would also implement preselected options for all "registered" RCOF regions. Dr Rupa Kumar Kolli agreed to provide a list of the geographical coordinates of the RCOF regions.

(g) The meeting noted that the facility for generating deterministic multi-model products on the LC-LRFMME website allows the user to selected subsets of the 12 individual GPC models in the multi-model combination. It further noted that the LC-LRFMME has a plan to also provide this facility for the probabilistic multi-model products also.

(h) The meeting noted that many RCOFs are making use of the IRI's Climate Predictability Tool (CPT). It requested the WMO Secretariat and the LC-LRFMME work with the IRI in order to explore the possibility of making forecast/hindcast data from the GPCs available and readily accessible in CPT format, through the LC-LRFMME.

5.2.2 The meeting recognized that these above-mentioned aspects would create an enormous amount of work for the LC-LRFMME, and requested it to explore the feasibility of and prioritize these issues, and provide timelines as appropriate.

5.3 GSCU pilot phase implementation

5.3 The meeting recalled its discussion under agenda item 3.3. It noted that the GSCU pilot phase started in February 2012. The meeting noted that for the forecast part of the GSCU, multi-model forecast plots have been prepared by the LC-LRFMME using data currently supplied by GPCs. The scoping exercise for the GSCU called for inclusion of forecasts at 1 and 2-month lead times. However, because of the relatively few models providing hindcasts and forecasts at 2-month lead relative to 1-month lead (10 against 4), there tends to be a large, artificial discontinuity between the multi-model forecast signals at the two lead times. The meeting agreed that this situation was unsatisfactory and recommended to the TT-GSCU to withdraw the 2-month lead time forecasts from the GSCU. Reinstating the 2-month lead time forecast could be considered when a

greater number of GPCs are supplying forecasts at both lead-times. In addition, the meeting noted that another barrier to progress with the GSCU pilot phase is that there is currently no verification available for the LC-LRFMME multi-model to aid interpretation of the MME forecasts. It was agreed to discuss verification of the LC-LRFMME multi-model under agenda item 6.

6. STATUS REPORT AND FUTURE DIRECTIONS: LC-SVSLRF

6.1 LC-SVSLRF: status report

6.1.1 The meeting recalled that the Standardized Verification System for Long-Range Forecasts (SVSLRF), as defined in the Manual on the GDPFS (WMO-No. 485), sets out a detailed methodology for assessing Long-range Forecasts (Annex IX). The meeting further recalled that a Lead Centre for SVSLRF was established to facilitate the exchange of seasonal and longer range forecast verification results. The meeting noted with appreciation that the LC-SVSLRF has achieved its primary aim of introducing standards and rigour into the verification of GPC forecasts and the sharing of associated verification information between GPC and the user community (RCC and NMHS). The meeting agreed that feedback and comments from users would help to guide further development and change of the website; and therefore urged GPCs and RCCs to provide feedback and comments to the LC-SVSLRF on the function, value and usefulness of its website.

6.1.2 The meeting noted that a number of GPCs are lagging somewhat in the provision of all scores to the LC-SVSLRF (not mandatory), and invited those GPCs that had not submitted all the required Levels 1 and 2 data, to do so as soon as possible. The meeting noted that following the last ET-ELRF meeting (Exeter, 2010), Level 3 verification information has not been added to the LC-SVSLRF, as it is no longer mandatory for GPCs.

6.1.3 The meeting reviewed the statistics that had been compiled on the use of the LC-SVSLRF website over recent months as a guide to its value to GPCs, RCCs and others; and noted that these suggest a continued low level of use of the main page and other pages (though the numbers on the reliability information pages suggest that these might be being used as an information source by people not connected with GPCs). However, the verification maps get the most hits with a peak around October 2011, perhaps due to the start of the 2011-12 La Niña event around that time. The meeting 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 interpretation of verification maps. It therefore recommended that a training session on these aspects could be included as an integral part of the existing training events, as well as incorporated into the RCC Guidance Document. It also recommended that GPCs develop a brief document summarising the skill of their system over the globe and through the conventional seasons and to link the document from their GPC website and the LC-SVSLRF website.

6.1.4 The meeting identified a number of aspects of the SVSLRF that required review, including potential standardization of datasets and hindcast periods, the set of skill scores used in the verification and the stratification of skills scores for El Niño and La Niña events. The meeting noted that one of the limitations of the LC-SVSLRF is its focus on historical hindcast data only. It agreed that there is a significant need for the real-time documentation of forecast performance/skill for GPC models as soon as possible after the end of the forecast period. While noting that the LC-SVSLRF does not currently have resources or a mandate for this role, the meeting suggested that individual GPCs make their real-time forecast verification, including the exchange of forecast skill measures, available on their websites and a link to them should be provided from the LC-SVSLRF website.

6.2 LC-SVSLRF: Future directions: including verification of multi-model; revisit of potential for centralized verification; new scores.

6.2.1 The meeting revisited discussions at the Exeter (2010) meeting regarding potential for centralized verification of GPC and multi-model products. It was concluded that although in principle centralization would assist in standardization of scores and verification of the multi-model

it was not currently a practical option due mainly to the large resource needed by the centre undertaking the task. It was therefore decided to continue with the distributed approach to verification. However GPCs were urged to redouble their efforts to (a) become fully compliant with the verification requirements by submitting all required scores; (b) to use the single set of verification datasets recommended by the LC-SVSLRF; and (c) to provide confidence intervals on scores using software held by the LC-SVSLRF.

6.2.2 The LC-LRFMME has responsibility for the development of forecasts based on multi-model ensembles. The meeting agreed that the LC-LRFMME multi-model hindcasts be verified in the same way as individual GPC hindcasts, using the SVSLRF. The LC-LRFMME agreed to provide necessary the SVSLRF scores for the multi-model hindcasts and to display the scores on the LC-LRFMME website, and also submit the same scores to the LC-SVSLRF. The LC-LRFMME will also provide the relevant verification maps to coordinators of the GSCU.

7. DEVELOPMENT OF AN EXCHANGE OF EXTENDED-RANGE FORECASTS

7.1 Liaison with the WWRP/THORPEX/WCRP research initiative on seasonal to sub-seasonal prediction

7.1.1 The meeting was presented with a brief report on the WWRP/THORPEX/WCRP research initiative on seasonal to sub-seasonal prediction. It noted that the main goal of this research project is to improve forecast skill and understanding on the sub-seasonal to seasonal timescale, and promote its uptake by operational centres and exploitation by the applications community. Specific attention will be paid to the risk of extreme weather, including tropical cyclones, droughts, floods, heat waves and the waxing and waning of monsoon precipitation. The meeting noted that this 5-year project will focus on some specific case studies, and will contribute to the GFCS.

7.1.2 The meeting was informed that a planning group, which included representatives from WWRP/THORPEX, WCRP, CBS and CCl, drafted the implementation plan, giving high priority to establishing collaboration and coordination between operational centres and the research community involved in sub-seasonal to seasonal prediction, and to sponsorship of key international research activities. This group advocates the establishment of an extensive database of sub-seasonal (up to 60 days) forecasts and hindcasts, modelled in part on the THORPEX Interactive Grand Global Ensemble (TIGGE) database for medium range forecasts (up to 15 days) and the Climate-System Historical Forecast project (CHFP) for seasonal forecasts. The database (3-week delay) will underpin the research that can shape the scope of developing operational products to be provided by the GPCs.

7.1.3 The meeting agreed that this is an important initiative and agreed to contribute to this project as appropriate.

7.2 Scope and plans for an operational exchange of extended-range forecasts

7.2.1 The meeting recalled its earlier discussions that a number of GPCs are running extended range forecasts either in research or operational mode (see Annex VI) and recognized that there had been substantial development to some of these systems since the last ET-ELRF meeting (Exeter, 2010).

7.2.2 The meeting recalled that Cg-XVI requested the LC-LRFMME to explore the possibility of extending its role to include exchange of extended-range predictions, and invited GPCs to also provide data from their monthly forecast systems so that the LC-LRFMME would be able to provide sub-seasonal forecast products through the LC-LRFMME web pages.

7.2.3 In response to the above request from Cg-XVI, the meeting recognized the need to coordinate with the proposed WWRP/THORPEX/WCRP research project to improve skill in the extended-range. In this context, the meeting prepared a minimum (preliminary) list of variables based on the minimum products list for seasonal forecast exchange (as stated in the Manual on

the GDPFS) and extended to include the MJO diagnostics particularly relevant to the sub-seasonal range. The list (provided in Annex X) takes account of requirements from RCC and RCOF representatives at the meeting. The data required to generate the products, and specifications of issuance frequency and timing were also considered and listed in Annex X. The meeting strongly encouraged GPCs which have implemented monthly forecast systems to display these products (plots) on their individual websites. It also encouraged GPCs to seek standardization in the display of plots, including through use of the same geographical regions. The meeting encouraged GPCs to make RCCs aware of these products and to provide feedback on their usefulness.

7.2.4 In addition, the meeting expressed its appreciation to the LC-LRFMME for agreeing to host a preliminary exchange of extended range forecasts and encouraged GPCs to participate (on a voluntary basis) in this exchange following the guidance provided in Annex X. The LC-LRFMME agreed to develop displays of individual model forecasts and multi-model forecasts from the participating GPCs following guidance in Annex X. To inform the technical aspects of this exchange it is recommended that representatives of the ET-ELRF, including from the LC-LRFMME, attend the proposed technical workshop on data exchange issues to be organized by the WWRP/THORPEX/WCRP sub-seasonal to seasonal prediction initiative.

7.3 Verification of ERF

7.3.1 The meeting was presented with the ECMWF experience in assessing the skill of the ERF. It agreed that such information is relevant for the planning of an operational exchange of ERF, and anticipated that the WWRP/THORPEX/WCRP research project on seasonal to sub-seasonal prediction would be able to provide relevant information on this aspect. The meeting recognized that in terms of verification the seasonal forecast infrastructure is not readily transferable to sub-seasonal predictions.

7.4 Links with the East Africa SWFDP

7.4.1 The meeting was presented with an overview of the Severe Weather Forecasting Demonstration Project (SWFDP), and the implementation of the project in Eastern Africa. The meeting noted that SWFDP is a project carried out by WMO/CBS to further explore and enhance the use of outputs of existing NWP/EPS systems. It aims to contribute to capacity building helping developing countries to access and improve their use of existing NWP products for improving warnings of hazardous weather conditions and weather-related hazards. Global-scale products, as well as data and information provided by other regional centres, are integrated and synthesized by a regional centre (typically a designated Regional Specialized Meteorological Centre (RSMC)), which, in turn, provides daily guidance for short-range (days 1 and 2) and medium-range (out to day-5) on specified hazardous phenomena (e.g. heavy rain, strong winds, etc.) to participating NMHSs of the region.

7.4.2 The meeting noted that the SWFDP had established a method of ‘cascading forecasts’ that could also be applied in demonstrating the utility of extended range forecasts. Such an activity would help bridge the gap between weather and climate timescales and could potential bring large socio-economic benefits through improved sub-seasonal predictions of, for example, rainy season onset and cessation and in-season dry spells. The meeting agreed that such a demonstration project would be appropriate to promote the use of these products, and to seek user feedback.

8. PROMOTION AND OUTREACH OF GPCs

8.1 Tailoring GPC output to requirement of RCCs (including plans for new Mediterranean, Polar RCOFs)

8.1.1 The meeting noted that the primary users of RCC products are NMHSs, while noting that there are four categories of users of the GPC products (general public, RCCs, RCOFs and advanced NMHSs). The meeting encouraged GPCs to build or strengthen the links and relationships with RCCs and RCOFs, e.g. through bilateral agreements. The meeting noted that

GPCs provide information to the general public through activities such the WMO press releases and the executive summary of the GSCU which will be shared with public and media.

8.1.2 The meeting noted the progress with the implementation of RCOFs for certain climate-sensitive areas spanning across more than one WMO Region, such as the Greater Mediterranean Basin (RAs I and VI), and the Polar Regions (all RAs), etc. The meeting pointed out that the required GPC information on the currently available LRF skills for such areas can be obtained from the LC-SVSLRF website. It noted that the GPCs and LCs have additional, more specific, information that may be provided on request. In this context, the meeting recommended this issue be discussed at the proposed workshop between GPCs and RCCs.

8.2 Progress with GPC 'flyers' and websites

8.2.1 The meeting discussed several options to further promote the use of GPC products, including progress with a flyer on GPCs to be posted on their respective websites, as well as on WMO website, and to be distributed at appropriate occasions such as RCOFs, RCC-related meetings, GFCS-related meetings, extraordinary session of the World Meteorological Congress (Geneva, October 2012), etc. A first draft was already available at the WMO Secretariat, which would be circulated amongst GPCs and LCs for comments.

8.2.2 The meeting reviewed GPC websites 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). The meeting encouraged GPCs to either consider developing a dedicated GPC entry page or to tag GPC products on their existing web pages. The WMO Secretariat has developed two optional templates for consideration by the GPCs. In addition, the meeting noted the catalogue of products developed at the RCC-Network (node Toulouse), which provides a detailed description of products available. GPCs were encouraged to develop such a catalogue related to their products and make it available on their individual websites. In addition, the meeting suggested that GPCs and LCs prepare brochures to publicize their products. The meeting also recommended that GPCs have a standardized e-mail address. The meeting noted that up-to-date URLs for their GPC websites were contained in the status reports and requested that these be compiled and circulated to participants and used to update the GPC portal page on the WMO website.

8.2.3 Noting that there is relevant information in the GPC status/progress reports and respective PowerPoint presentations, the meeting agreed that part of this information could be made available on the WMO website related to each GPC. It therefore requested the WMO Secretariat to develop a general template for the presentation of the GPC information based on the above-mentioned reports, would be circulated amongst GPCs and LCs for comments.

8.2.4 The meeting noted the strong interest of RCCs, RCOF hosts and NMHSs in digital GPC forecast and hindcast data. The meeting 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 meeting 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 websites and invited GPCs to consider providing such information on a case-by-case basis. In addition, the meeting recommended that WMO Secretariat write to the Permanent Representatives (PRs) of countries hosting a GPC requesting their support to these activities, and afterwards to all WMO Members informing of the guidelines on how to get access and use of GPC products.

8.3 Progress in applying the training outline developed at the last meeting

8.3.1 The meeting recalled that the ET-ELRF prepared, at its last meeting (Exeter, 2010), an outline for the training curriculum, the main objectives of which include understanding (a) climate and its drivers; (b) climate models; (c) GPC products and services; (d) verification; and (e)

communications (to convey the forecast in an efficient way to users). Based on the GPC status/progress reports, the meeting noted that all GPCs have been involved in capacity building and training activities (including at RCOFs), covering all or part of these aspects, and would be able to continue to do so. A summary of the GPC capacity building activities is provided in Annex XI, and constitutes the current GPC contribution to the capacity building efforts, in support of the WMO ETR and within the context of the GFCS.

8.4 Development of a 'pool' of training materials

8.4.1 The meeting discussed the specific training needs including the development of guidance material to help primarily RCCs, but also advanced NMHSs, 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. In this context, the meeting was presented with the CLIPS curriculum and example seasonal training materials from the ICPAC-Met Office Hadley Centre Training Workshop (June 2011). The meeting was encouraged to provide feedback on the training tools presented and to consider use and further development/support of the materials.

8.4.2 The meeting 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, and provide the web addresses to the WMO Secretariat, in order to develop a “pool” of training materials. The meeting recognized the need for information on the required expertise for efficient access to and application of GPC products for regional and national applications and services. It therefore requested GPCs to provide such information in conjunction with their training materials.

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

9.1 The meeting reviewed its Terms of Reference and proposed amendments as given in Annex XII.

9.2 The meeting noted the proposal to convert the CBS ET-ELRF in a joint CBS-CCl ET-ELRF, whose membership would include two CCl representatives. The meeting generally agreed with the proposal in pursuit of stronger collaboration between the two Technical Commissions, but desired that the Terms of Reference retain the existing focus on operational aspects which already reflect a significant thrust on CBS-CCl collaboration. The meeting requested that a formal proposal in this regard be made through the presidents of CBS and CCl for approval by the Executive Council as per the applicable WMO regulations.

10. ANY OTHER BUSINESS (AOB)

10.1 The meeting noted that the overall list of output products required for international exchange from GDPFS centres, given in Appendix II-6 of the Manual on the GDPFS (WMO-No. 485), includes products for extended-range under item 4.1 on Ensemble Prediction System products. This entry in the Manual was made prior to the time at which the ET-ELRF included extended-range within its ToR. The chairperson of the ET-ELRF will seek advice on how to proceed from the ICT-DPFS.

10.2 The meeting requested the ET-ELRF chairperson to raise the issue of the ET-ELRF large workload at the upcoming meeting of the Implementation Coordination Team on Data-processing and Forecasting System (ICT-DPFS) which will be held in Paris, from 21 to 25 May 2012. The ToRs now include a remit for extended-range, seasonal and longer than seasonal (multi-annual/decadal) timescales and include both prediction and verification activities. Finding sufficient resource to substantially advance international collaboration in all these areas is a significant challenge.

11. CLOSING

11.1 The meeting of the CBS Expert Team on Extended- and Long-Range Forecasting (ET-ELRF) closed at 14:27 on Friday, 30 March 2012.

Annex I

AGENDA

1. OPENING

2. ORGANIZATION OF THE MEETING
- 2.1 Adoption of the agenda
- 2.2 Working arrangements

3. INTRODUCTION
- 3.1 Review of WMO (CBS/CCl) decisions and other initiatives relating to ET-ELRF Terms of Reference, including new applications for GPC status
- 3.2 Progress with the GFCS and CSIS in particular, and implications for GPCs
- 3.3 Progress with the GSCU, implications for GPCs and Lead Centres
- 3.4 Review of progress with RCC designation
- 3.5 Revised Manual on the GDPFS and implications for the ET and GPCs

4. STATUS REPORT FROM GPCs AND RCCs
- 4.1 GPC compliance
- 4.2 New developments in systems and products: including seasonal, extended, multi-annual/decadal; Interactions with RCCs
- 4.3 Use of GPC products by RCCs/RCOFs
- 4.4 Report from ET on RCCs
- 4.5 Observational requirements for GPCs

5. STATUS REPORT AND FUTURE DIRECTIONS: LC-LRFMME
- 5.1 LC-LRFMME: status report
- 5.2 LC-LRFMME: future directions and products: including implications for additional data exchange
- 5.3 GSCU pilot phase implementation

6. STATUS REPORT AND FUTURE DIRECTIONS: LC-SVSLRF
- 6.1 LC-SVSLRF: status report
- 6.2 LC-SVSLRF: Future directions: including verification of multi-model; revisit of potential for centralized verification; new scores.

7. DEVELOPMENT OF AN EXCHANGE OF EXTENDED-RANGE FORECASTS
- 7.1 Liaison with the WWRP/THORPEX/WCRP research initiative on seasonal to sub-seasonal prediction
- 7.2 Scope and plans for an operational exchange of extended-range forecasts
- 7.3 Verification of ERF
- 7.4 Links with the East Africa SWFDP

8. PROMOTION AND OUTREACH OF GPCs
- 8.1 Tailoring GPC output to requirement of RCCs (including plans for new Mediterranean, Polar RCOFs)
- 8.2 Progress with GPC 'flyers' and websites
- 8.3 Progress in applying the training outline developed at the last meeting
- 8.4 Development of a 'pool' of training materials

9. REVIEW OF THE ET-ELRF TERMS OF REFERENCE

10. ANY OTHER BUSINESS (AOB)

11. CLOSING

Annex II

LIST OF PARTICIPANTS

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Annex III

STATUS OF THE IMPLEMENTATION OF RCCs IN ALL WMO REGIONS

RA I (Africa)

- RCC implementation initiated by identifying six RCCs, viz., African RCC at ACMAD, IGAD-RCC at ICPAC, SADC-RCC at SADC CSC, ECOWAS-RCC-Network by ACMAD and AGRHYMET, North African RCC-Network to be implemented by five North African countries and CEMAC-RCC for Central Africa;
- Demonstration phases have been formally initiated for African-RCC by ACMAD and IGAD-RCC by ICPAC.

RA II (Asia)

- Beijing and Tokyo designated as WMO RCCs in June 2009;
- North Eurasian Climate Centre (Russia) commenced RCC demonstration phase in December 2010 and formal designation may be sought at the forthcoming CBS session;
- India formally expressed, through RA II president, its intent to start a demonstration phase;
- Saudi Arabia expressed interest to host an RCC

RA III (South America)

- RCC implementation initiated by identifying three RCCs, viz., CIIFEN for western coast of South America, Northern South America RCC-Network by Brazil and French Guyana and Southern South America RCC-Network by Argentina and Brazil;
- All three RCC proponents formally expressed, through RA III president, intent to start a demonstration phase

RA IV (North America, Central America and the Caribbean)

- CIMH formally expressed, through RA IV president, interest to start a demonstration phase;
- Proposals for two more RCC-Networks, for Northern America and Central America, under discussion

RA V (South-west Pacific)

- RA V Working Group on Climate Services is in the process of assessing the current RCC-related functions being performed in the Region vis-à-vis the mandatory and highly recommended functions for WMO RCCs

RA VI (Europe)

- Demonstration phase of RCC-Network successfully completed over more than 2 years, with nodes in Germany, Netherlands, France and Russian Federation, and has been recommended by RA VI president for formal designation, which will be sought at the forthcoming CBS session.

Annex IV

REVISED TERMS OF REFERENCE OF THE ET-RCC

Develop and provide to the CCl and CBS Management Groups for further consideration, technical guidance as well as the oversight approaches for the establishment and operation of Regional Climate Centres (RCCs) and RCC-Networks, and to closely liaise with the concerned experts of CBS, Regional Associations and RCCs/RCC-Networks on this matter, with the following specific activities:

1. Guide the implementation, designation and effective operation of RCCs;

2. Identify, and support the adoption of, common standards for mandatory RCC products and services and their delivery as well as verification of forecasts and reporting of results;

3. Promote the use of GPC and RCC products at regional and national levels and development of consensus-based forecasts, especially through mechanisms such as RCOFs;

4. Liaise with other relevant CCl OPACEs, regional associations, WCRP/CLIVAR regional panels, CBS/DPFS, and CAS and other relevant entities;

5. Provide guidance on the development of project concepts for resource mobilization and advise on RCC implementation;

6. Submit reports in accordance with timetables established by the OPACE 3 co-chairs.

Annex V

TABLE SUMMARIZING THE FORECASTS SYSTEM CONFIGURATION

GPC name	Centre	System Configuration (ensemble size of forecast)	Resolution (atmosphere)	Hindcast period used
Beijing (2005)	Beijing Climate Centre	Coupled (48)	T63/L16	1983-2004
CPTEC (2009)	Centre for Weather Forecasts and Climate Studies	2-tier (15)	T62/L28	1979-2001
ECMWF (2011)	European Centre for Medium-range Weather Forecasts	Coupled (41) Coupled (51)	T159/L62 T255/L91	1981-2005 1981-2010
Exeter (2010)	Met Office Hadley Centre	Coupled (42)	1.25°x1.85°/L38/L85	1989-2002 1996-2009
Melbourne (2011)	Australian Bureau of Meteorology	Coupled (30)	T47/L17	1980-2006 1960-2010
Montreal (2011)	Meteorological Service of Canada	2-tier (40) Coupled (20)	T32/T63/T95/2.0°x2.0° (4- model combination) CanCM3+CanCM4 T63/L31 and T63/L35	1969-2004 1981-2010
Moscow (2007)	Hydromet Centre of Russia	2-tier (10)	1.1°x1.4°/L28	1979-2003
Pretoria (2007)	South African Weather Service	2-tier (6)	T42/L19	1983-2001
Seoul (1999)	Korean Meteorological Agency	2-tier (20)	T106/L21	1979-2007 1979-2010
Tokyo (2010)	Japan Meteorological Agency	Coupled (51)	T95/L40	1979-2008
Toulouse (2008)	Météo-France	Coupled (41)	T63/L91	1979-2007
Washington (2004)	National Centres for Environmental Prediction	Coupled (40)	T62/L64 T126/L64	1981-2004 1981-2010

Note: Red text indicates system's changes since the previous ET-ELRF meeting (Exeter, 2010)

Annex VI

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

GPC Beijing

The operational extended range forecast of GPC Beijing is produced by its atmospheric general circulation model (AGCM T63L16) driven by a persisted SSTA. The ERF is issued 6 times every month (i.e., 1st, 6th, 11th, 16th, 21st and 26th of each month) with 40 members at most(among them 20 produced by LAF method from 6 hourly initial conditions per day of previous 5 days and 20 by SVD method). The products provide the ensemble mean and the most likely based on terciles forecast for the each 10-day and whole 30 days for the following 11-40day for precipitation and T2m of global and Asia. The hindcast run is as same as the operational forecast run from 1982 to 2004.

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. Experimental extended range forecasts using CPTEC coupled ocean-atmosphere model (T126L28) based on a single forecast member twice a day (at 0 UTC and 12 UTC) for the following 30 days are also currently produced.

GPC Exeter

A monthly forecasting capability now forms part of the Met Office GloSea4 system. The prediction skill of GloSea4 monthly forecasts is currently being evaluated, including as part of a multi-model system with the ECMWF MFS. The monthly forecasting capability was achieved by moving to daily initialisation of seasonal forecast ensembles, for which 2 members are now run each day to 7 months ahead, and adding a further 2 members run each day to 60 days. Thus 4 members are run each day to at least 60 days, allowing a 28 member monthly ensemble to be aggregated over a 7-day period. Results suggest that the 7-day lag period does not impact on skill levels in weeks 3-4 of the forecast period. GloSea4 is a coupled system (for both monthly and seasonal forecasts). The atmosphere component is HadGEM3 with resolution N96 (~120km) and 85 vertical levels. The atmospheric component is NEMO (Nucleus for European Modelling of the Ocean) with 1°x1° (0.2°x1° over 20°N-20°S) and 75 vertical levels. The 4 members run each day are perturbed using a Stochastic Kinetic Energy Backscatter Scheme (SKEB2). The monthly forecasts are calibrated selecting from hindcasts initialised on 1st, 9th, 17th and 25th of each month, with 3 members run from each start date. The hindcast period is 1996-2009 (14 years). An upgrade in horizontal resolution from N96 to N216 (~50km) is planned for summer 2012. Predictions to 15 days are made using the Met Office Global and Regional Ensemble Prediction System (MOGREPS-15). The GloSea4 monthly system is still under development and currently 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 GPC Melbourne (the Bureau of Meteorology) runs a long-range forecast on the 1st and 15th days of every month from the Predictive Ocean Atmosphere Model for Australia version 2.4 (POAMA2.4) dynamical coupled model. The forecast consists of a 30-member ensemble out to a lead time of 9-months, with 10-members each from three slightly different versions of the POAMA model forming a pseudo multi-model ensemble. Hindcasts are available back to 1960, while the forecasts outcomes are expressed against a 30-year (1981-2010) base period which is also the main base period for hindcast validation. A 'multi-week' (extended range) version of the model is also run every Thursday, with a 30-member ensemble out to a lead time of 4-months. POAMA2 has made advances over POAMA 1.5 through a better ocean assimilation (particularly with regards to salinity) and an improved ensemble generation process. The result of the changes is slightly

improved reliability and higher skill for the prediction of tropical Pacific Ocean conditions. An additional minor upgrade to the modelling system is likely in the second half of 2012.

GPC Montreal

The Canadian monthly forecasts will be produced by the Canadian Global Ensemble Production System (GEPS). The GEPS is now producing medium-range forecasts (16 day) every day at 00 and 12 UTC and has a resolution of 66 km. It is based on 21 members of the GEM model initialized by an Ensemble Kalman Filter (EKF) analysis. The members are perturbed using stochastic physics. To produce the extended range forecast, the GEPS forecasts will be extended to 32 days every Thursday using the 00 UTC initial conditions. The new system will be using persisted SST anomaly with time evolving boundary conditions. The hindcast for each forecast issuance date will be done in real time one to three weeks in advance. It will cover 15 years, 4 members per year for a total of 60 members. The main products from this new system will be categorical probability forecasts of weekly averages as well as for a monthly average. The Implementation of this new monthly system is planed for fall of 2012.

GPC Moscow

GPC-Moscow produces monthly forecast with zero (1-2 days) lead time at the end of each month. Probabilistic forecasts of T2m and Precipitation are posted on the website of the North Eurasia Climate Centre. Forecasts of other variables (Z500, SLP, T850, wind components at H850 and H200 are available by request. It is planned to replace existing AGCM with a new AGSM with upgraded physics in 2012, which is to be followed by a coupled model in some two-three years. Also, starting from mid-2012 it is planned to issue monthly forecasts each week.

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 32 years from 1979 to 2010. 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

The upgrade of the seasonal Climate Forecast System version 2 (CFS.v2) at the National Centres for Environmental Prediction (NCEP) (GPC Washington) was made in April 2012. CFS.v2 is designed to provide both seasonal and monthly forecasts. In real-time, the CFS.v2 forecast configuration includes 16 runs/day to 45 day for monthly predictions, and 4 runs/day to 9-months for seasonal predictions. Real-time forecasts are accompanied by a hindcasts set from 1999-2009 for 45-day predictions run every day, and from 1982-2010 run every 5th day for seasonal predictions. Availability of extensive hindcasts is 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. Because of user demand to provide them sufficient lead-time to recalibrate their application models, the older version of the seasonal prediction system, i.e., CFS.v1, is still running in parallel, and will continue to run at least until October 2012.

GPC ECMWF

At ECMWF an ensemble of ERF is produced twice week (every Monday, 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. 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

Monday and Thursday. Since January 2009 the monthly forecast spatial resolution has increased to TL639L62 for the first 10 days and to TL319L62 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, days 26-32 of the Thursday forecast and 1-7, 8-14, 15-21, 22-28 of the Monday forecast. These periods have been chosen so that they correspond to Sunday to Monday calendar weeks. The range of products from the VarEPS/monthly forecasting system includes probability of occurrence of weather regimes and predictions of the MJO time evolution.

Annex VII

REQUIREMENTS FOR GPC PRODUCTS BY RCCs

To facilitate production of more reliable and skilful forecasts by RCCs, the following suggestions were made:

- ✓ GPCs with Extended range forecasts capabilities consider provision of extended range forecasts in real time as it is the case with Long Range Forecasts to help RCCs derive information on intraseasonal distribution of Temperature and Precipitation

- ✓ GPCs with decadal experimental monitoring/forecasting capabilities consider provision of decadal forecasts of relevant atmospheric and oceanic indices

- ✓ Given the importance of sub-surface sea temperature for SST trends analysis, all GPCs consider increase in the number of latitude/longitude bands on which sub-surface temperature maps are provided. Current sub-surface sea temperature is available from only a few GPCs and along the Equatorial regions of the globe.

- ✓ GPCs provide SST indices (observed and predicted) for other relevant oceanic regions in the Atlantic, Indian and Pacific (e.g. Atlantic, Indian ocean dipole modes, AMO, PDO); similarly for atmospheric indices (e.g. QBO, AAO, Eurasian pattern,…)

- ✓ GPCs consider development of computer based expert systems to supplement human expertise in trends and analog years detection using historical climate analyses databases (with WWRP/WCRP experts communities).

Annex VIII

REPORT BY THE LC-LRFMME

The Korea Meteorological Administration (KMA) and NOAA/NCEP have organized a joint effort to sustain and develop LC-LRFMME activities. This initiative was recognized by the WMO and inclusion of the LC-LRFMME in the Manual on GDPFS was recommended at the 14th Session of the WMO CBS meeting, held in Croatia from 25 March to 2 April 2009. The goal of the Lead Centre is to provide a conduit for sharing of model data for long-term climate predictions and to develop a well-calibrated Multi-Model Ensemble (MME) system for mitigating the adverse impact of unfavourable climate conditions and maximizing benefits under favourable conditions.

At present, the forecast anomalies from 12 GPCs (CPTEC has joined since January 2011) for 2-meter surface temperature, precipitation, mean sea level pressure, 850hPa temperature, 500hPa geopotential height, and sea surface temperature (if available) are collected at the LC-LRFMME between the 1st to 20th of each month, and the forecast data are used in displaying various seasonal forecast products. Table 1 shows the provided GPC digital data and graphical products in standard format available from LC-LRFMME. Members of GPCs, RCC, NMHSs and related institutions that produce LRF forecasts can download forecast and hindcast data products for the GPCs that allow redistribution of their digital data. The product display at the lead center website includes monthly and seasonal mean anomalies from individual GPCs and also a synthesis of information in terms of consistency in the sign of anomalies from all GPCs. In addition to this, 3 types of deterministic MME (Simple Composite Mean, Regular Multiple Regression, and Singular Value Decomposition) and probabilistic MME prediction are shown on the LC-LRFMME website (www.wmolc.org). Access to the website is password protected and information about how to gain access to the forecast products is provided on the webpage.

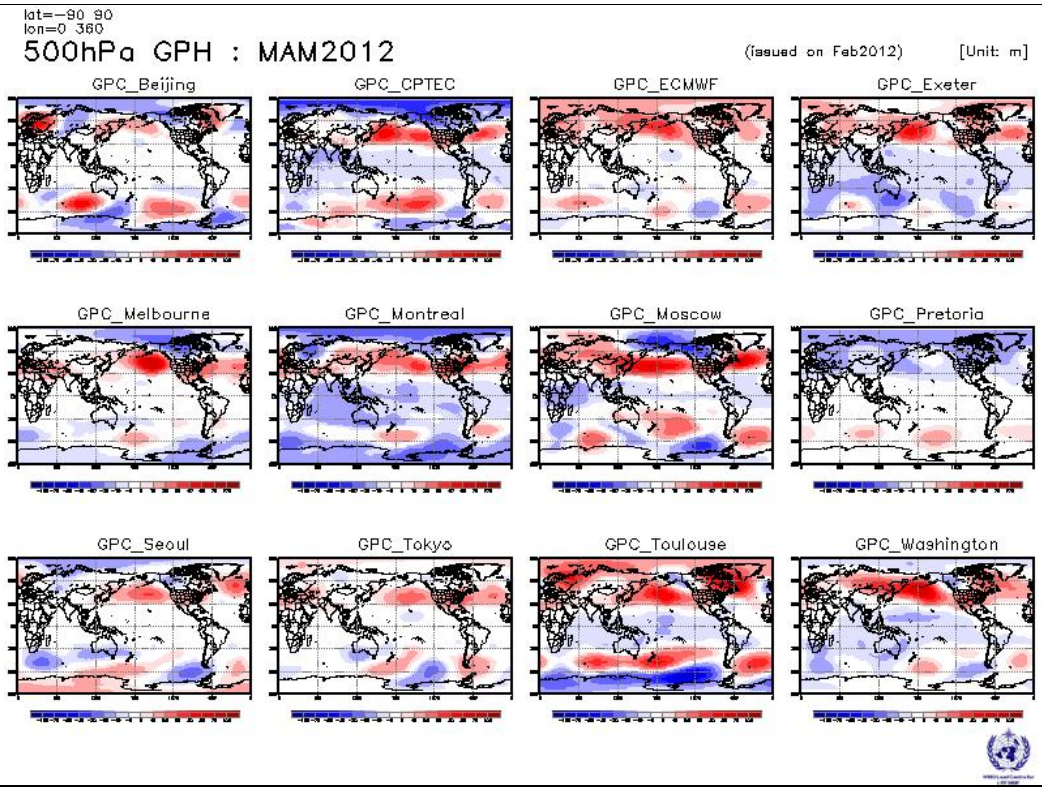
Table 2 – the LC-LRFMME Products: GPC digital data and graphical products.

Digital products	Graphical products
- Both forecast and hindcast of monthly mean anomalies of the GPC 's ensemble mean for lead 1~3), following the month of submissions ・ 2m surface temperature ・ Precipitation ・ Mean sea level pressure ・ 850hPa temperature ・ 500hPa geopotential height ・ Sea surface temperature NB: data only available from GPCs who allow redistribution of their data	- Individual forecast ・plots for each GPC forecast anomalies in common graphical format (Rectangular, Time series, Stereographic type, etc.) ・Consistency map ・SST Plume (Nino3.4 SST anomalies) - Deterministic Multi-model Ensemble ・Simple composite mean(SCM) ・Regular Multiple Regression ・Sigular Value Decomposition(SVD) - Probabilistic Multi-model Ensemble ・tercile-based categorical probabilities

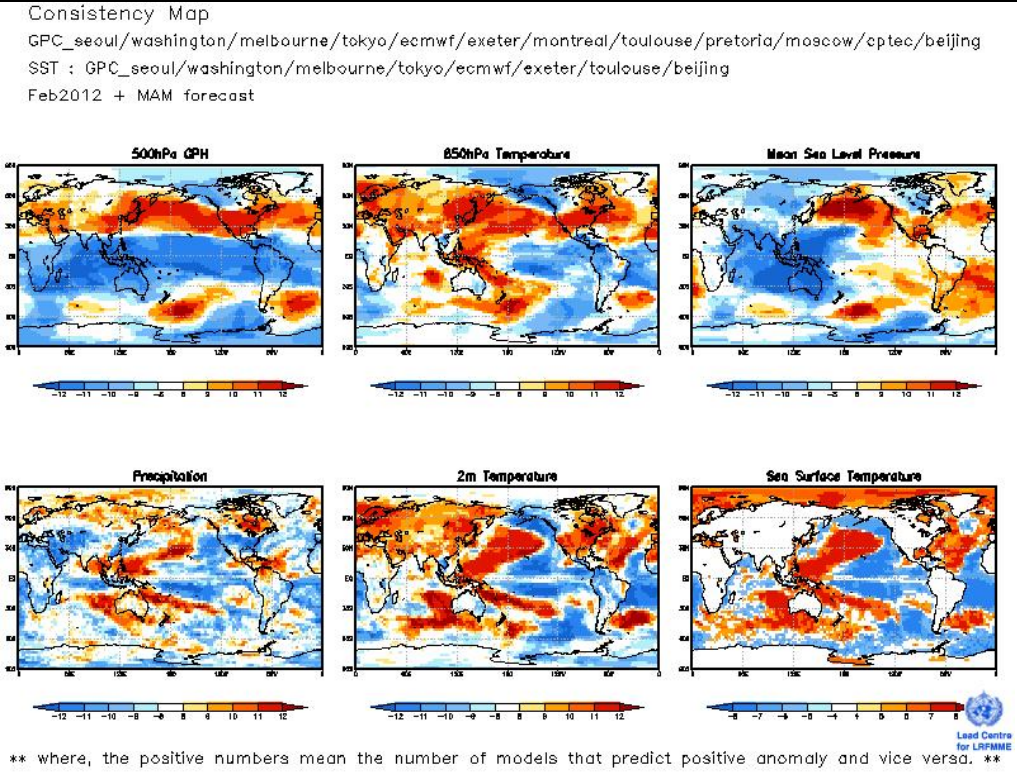
Some examples of forecast maps provided on the LC-LRFMME website are shown in Figs. 1 and 2. Forecast anomalies for a particular variable from individual GPCs can be displayed for an area selected by a user-driven interface (Fig. 1(A)-a). Forecast display also includes consistency maps (Fig. 1(A)-b), where a geographical distribution of the number of models that agree with the sign of the multi-model average anomaly is made. Consistency maps succinctly summarize the agreement in forecast anomalies across different models and are a measure of confidence in the sign of seasonal mean forecast anomalies. For example, if all models agree in the sign of the predicted anomaly, the user can place added confidence in the forecast. Predicted large-scale sea surface temperature indices are also shown on the website (Fig.1(A)-c). Forecast information from individual GPCs can also be synthesized into a simple multi-model average with equal weights (Fig. 1(B)-a). Since hindcasts from all GPCs are not yet available, skill-dependent weighting for constructing multi-model average has some limitations (Fig.1 (B)-b and c).

(A) Individual Forecasts

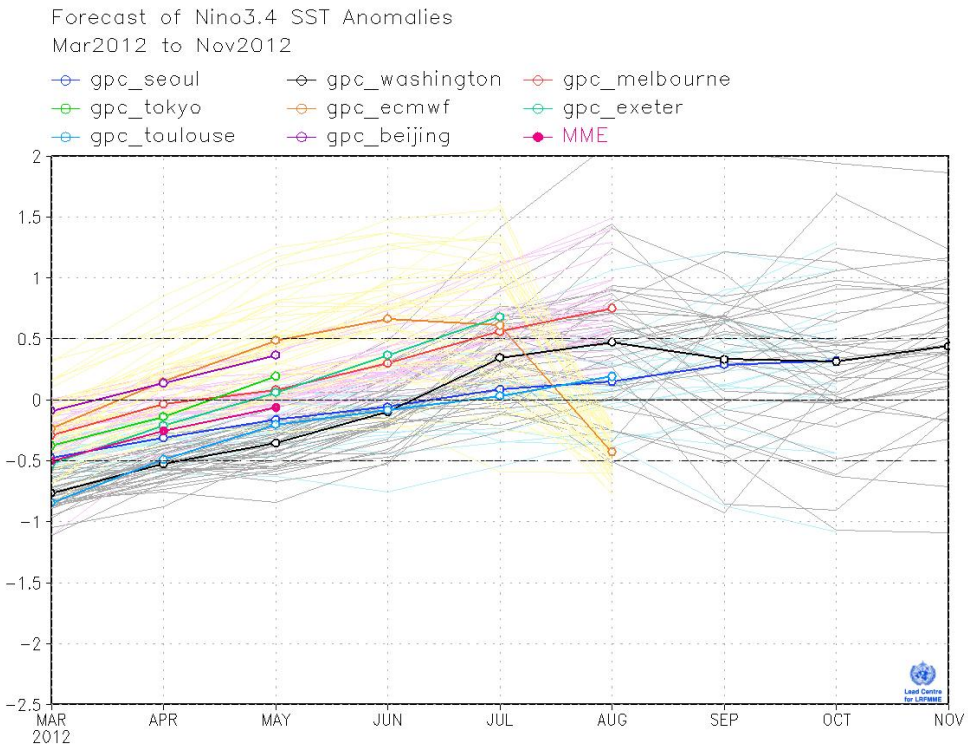
a. All maps



b. Consistency maps

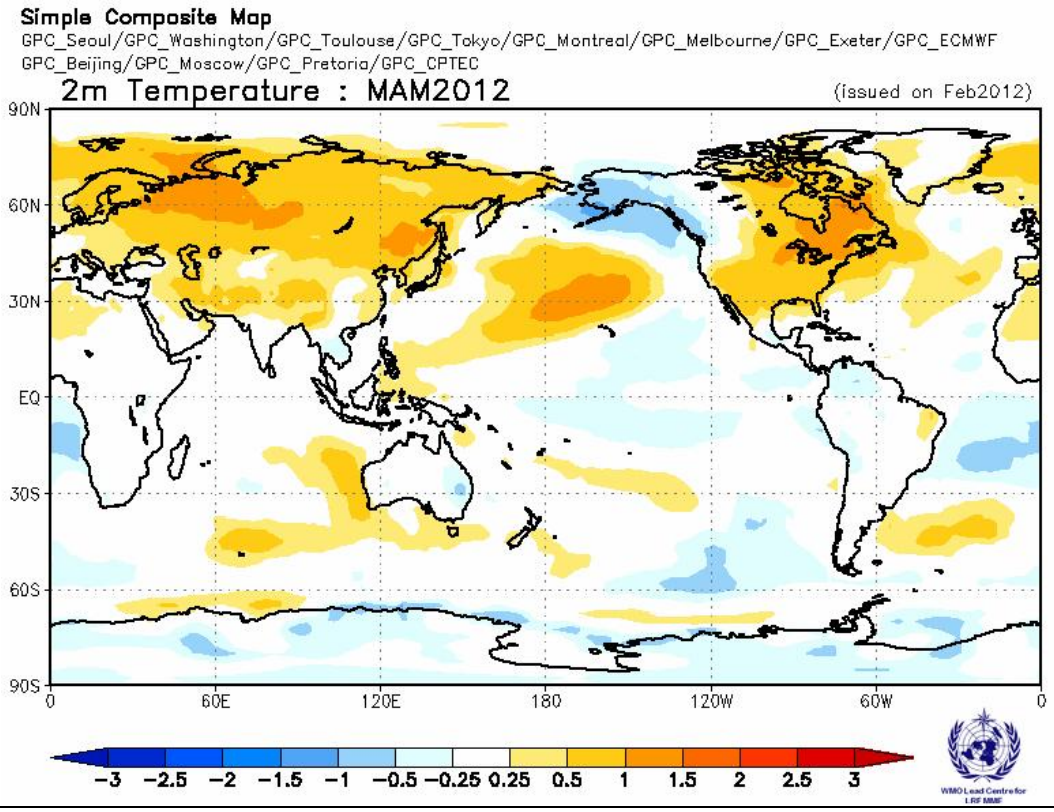


c. SST plume (Nino3.4 SST anomaly)

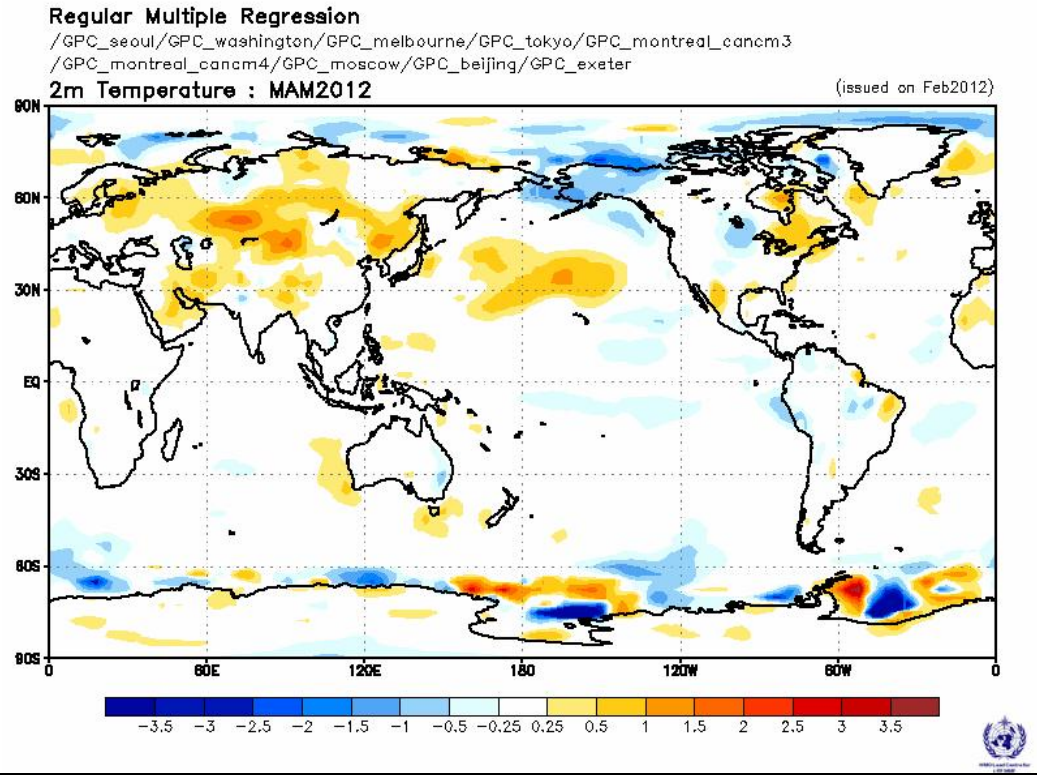


(B) Deterministic MME forecast

a. Simple Composite Map



b. Regular Multiple Regression



c. Singular Value Decomposition

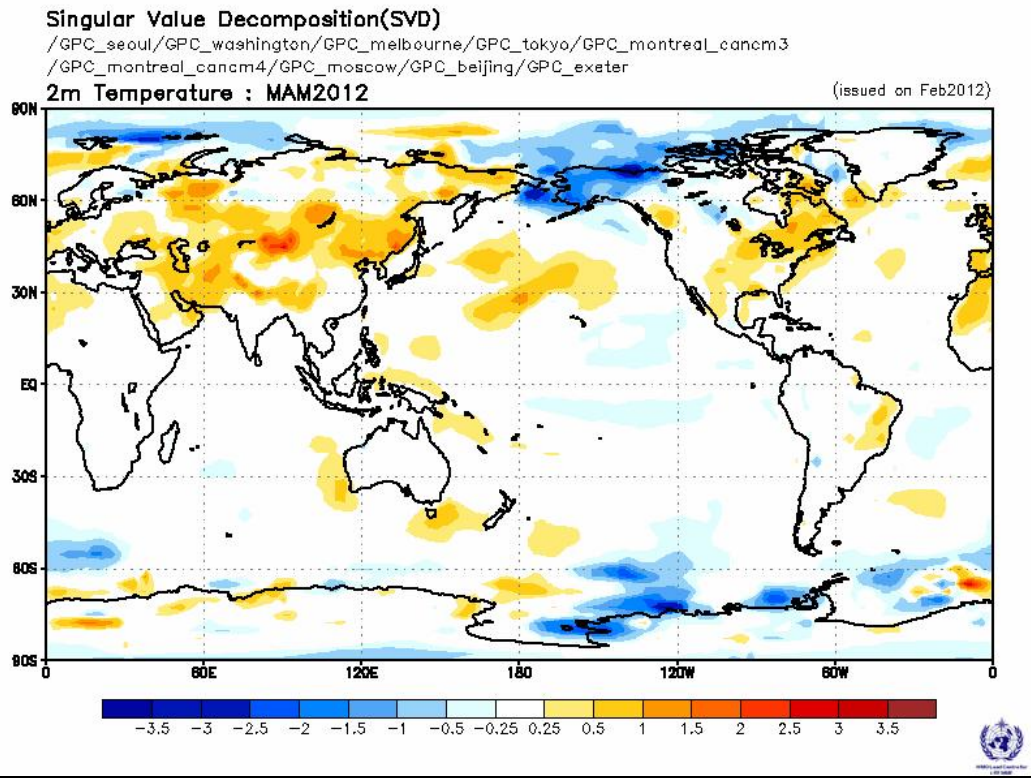


Figure1 – Example of forecast maps available on the LC-LRFMME website. (A) Individual forecast: a- All map type plot, b-Consistency map, c-SST plume, (B) Deterministic MME forecast: a-Simple composite map, b-Regular multiple regression, c-Singular Value Decomposition. This particular example is for the 2 meter MAM2012 mean temperature anomaly. On the LC-LRFMME website the display area (and projection) can be selected by the user.

Since June 2011, categorical probabilities for terciles based on the Probabilistic Multi Model Ensemble (PMME) prediction system have been synthesized by the research team at the APEC Climate Center (APCC). The PMME prediction system used at the WMO LC-LRFMME is based on an uncalibrated MME, with model weights being inversely proportional to random errors in forecast probability associated with the standard error of the ensemble mean (i.e. proportional to the square root of model ensemble size) and a Gaussian fitting method for the estimation of tercile-based categorical probabilities (Min et al. 2009). The PMME forecast maps since the MJJ 2011 prediction are available from www.wmolc.org . Figure 2 shows an example of tercile category probability forecast for 2m temperature for March-May 2012.

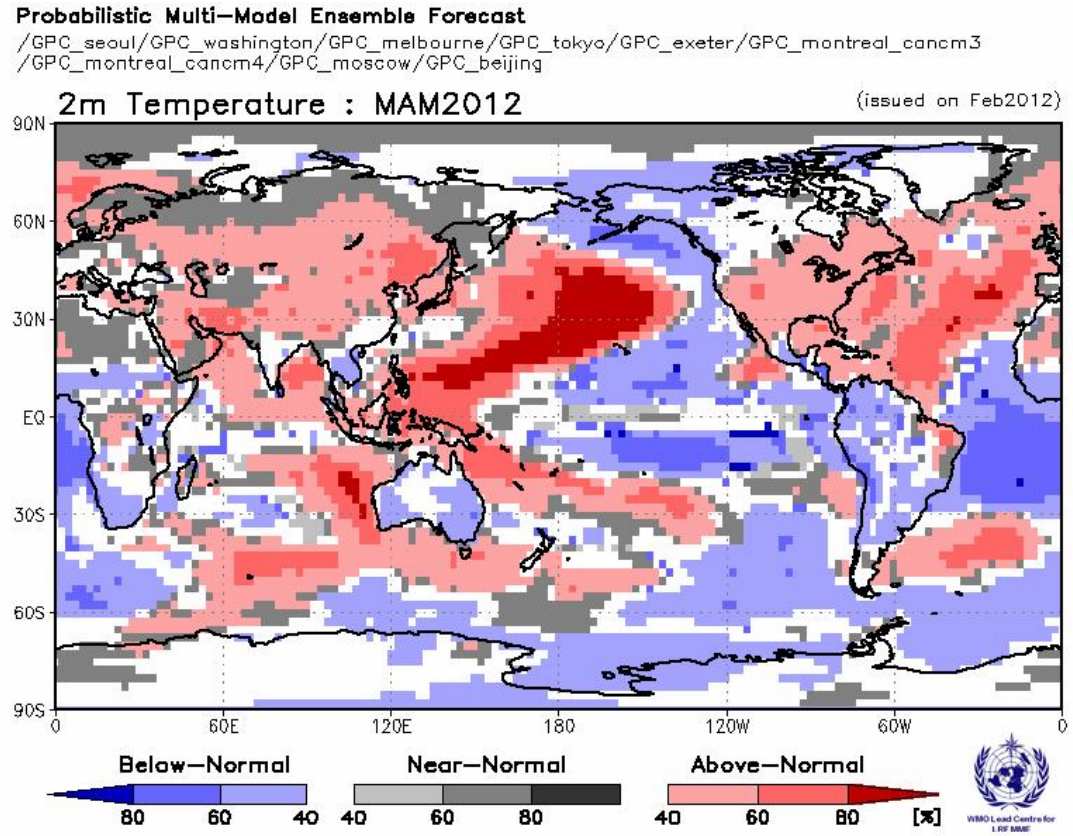


Figure 2 – Tercile category probability forecasts for 2m temperature, March-May 2012. Blue shading: below-normal most likely; red shading: above-normal most likely; grey shading: near normal most likely; white: equal chances

LC-LRFMME products are currently used in various RCOFs (e.g., FOCRAII for Asia, SASCOF for summer forecast of South Asia, GHACOF) and RCCs. Additionally, LC-LRFMME products are also the provide information for the WMO's upcoming Global Seasonal Climate Update (GSCU) effort, and provided the simple composite mean of SST, the 1 and 2 month lead PMME for other variables, and 5 types of oceanic indices (Nino3.1, Nino1+2, IOD, NTA and STA). Moreover, LC-LRFMME makes an important contribution to increasing the resources available for better social-economic planning, and is a valuable asset for the seasonal climate forecast community.

Reference: Min, Y.-M., V.N. Kryjov, C.-K. Park, 2009: Probabilistic Multi Model Ensemble Approach to Seasonal Prediction. Weather and Forecasting, 24, 812

Annex IX
Annex VIII

REPORT BY THE LC-SVSLRF

1. Status Information on the LC-SVSLRF

1.1 The Standardized Verification System (SVS) for Long-Range Forecasts (LRF) defined in the WMO Manual on the Global Data-Processing System (GDPS), Volume I (SVSLRF) outlined requirements for Global Producing Centres (GPCs) to verify their forecasts. The document also outlines how a Lead Centre for the Long Range Forecast Verification System (LC-SVSLRF) may assist GPCs in the verification process.

1.2 The Lead Centre has been fully functional for near 10 years and is running robustly, though with a fairly minimal level of resourcing and rather low utilisation by WMO members. Both Level 1 and Level 2 products are widely available. We note that no progress has been made on Level 3 products to date as described below. It was agreed at the Exeter Meeting that Level 3 verification is not mandatory for GPCs, noting the difficultly of a global exchange of these data, and the fact that their analysis is better suited to regional study.

1.3 Verification results from the Lead Centre are integrated with forecasts from the Lead Centre for MME.

2. Division of Responsibilities

2.1 The role of the Lead Centre, and the division of responsibilities, are outlined in the table below. The split of responsibilities has worked well with the resource required of the two co-hosts being manageable in the current form.

Table 1 – LC-SVSLRF responsibility across GPC-Melbourne and GPC-Montreal

Role	Responsibility
To develop and maintain the SVSLRF web site.	GPC Melbourne
To host the SVSLRF web site.	GPC Melbourne
To develop the structure of the SVSLRF web site (HTML code, etc.).	GPC Melbourne
To provide access to verification datasets on the SVSLRF web site.	GPC Montreal
To update the verification datasets on the SVSLRF web site on a yearly basis provided that new data is made available.	GPC Montreal
To develop and provide specifications defining the format of the data to be sent to the Lead Centre for graphics preparation. To develop infrastructure to generate all graphics posted on the SVSLRF web site.	GPC Melbourne
To make available on the web site the digital verification information as specified at levels 1 and 2 in Attachment II.8 of the Manual on GDPS. This implies that a structured database will be developed to store digital verification results.	GPC Melbourne
To ensure that clear and concise documentation explaining the verification scores, graphics and data is available and maintained up-to-date on the SVSLRF web site.	GPC Montreal and GPC Melbourne
To consult with the GPCs to make sure that the verification data is correctly displayed before making available their verification results on the SVSLRF web site.	GPC Melbourne

To ensure that the verification results placed on the SVSLRF web site comes from officially recognized global producing centres with operational guidance commitments.	GPC Melbourne
To provide and maintain software to calculate the verification scores (ROC curves, ROC score, MSSS, contingency table scores, hit rates etc).	GPC Montreal
To ensure that appropriate hypertext links to participating GPCs are available on the SVSLRF web site.	GPC Melbourne
To publicise the SVSLRF web site to other organizations involved in verification (such as WGSIP, COLA etc.) and establish contacts in order to receive feedback and facilitate discussion for further development and improvement.	GPC Melbourne and GPC Montreal
Once the SVSLRF web site is operational, to provide progress reports every two years to CBS, prior to its meetings.	GPC Melbourne and GPC Montreal

3. Progress of the Lead Centre

3.1 The LC-SVSLRF has been running without reported problems for some years. As of June 2010, a total of 11 GPCs plus the IRI and CPTEC (Brazil) have submitted some scores (Table 2).

Table 2 – Lead Centre verification by GPC

Model Name	SST	T2m	Precip	N34	MSSS/ROC Bulk Scores			ROC curve	Relibility Curve	ROC Maps	MSSS maps	MSSS1,2,3	Season	Lead Time
					n >20N	t 20S-20N	s >20S							
GPC-Beijing	YES	YES	YES	YES	R	R	R	YES	YES	YES	YES	YES	ALL	1,2,3
GPC-Melbourne	YES	YES	YES		M	M	M			YES	YES	YES	ALL	0,1,2,3,4
GPC-ECMWF		YES			R	R	R						DJF,MAM,JJA,SON	1
GPC-Tokyo	YES	YES	YES		R/M	R/M	R/M	YES	YES	YES	YES	YES	DJF,MAM,JJA,SON-LV1 ALL-LV2	1
GPC-Toulouse	YES	YES	YES	YES	R/M	R/M	R/M	YES	YES	YES	YES	YES	ALL	1,2,3,4
GPC-Washington	YES	YES	YES	YES	R/M	R/M	R/M	YES	YES	YES	YES	YES	ALL	1
GPC-Exeter		YES	YES		R	R	R	YES	YES	YES			ALL	1,2,3
GPC-Montreal		YES	YES		R/M	R/M	R/M	YES	YES	YES	YES	YES	ALL	0,1
GPC-Seoul	YES	YES	YES								YES	YES	ALL	1
GPC-Russia		YES	YES		R	R	R	YES	YES	YES			DJF,MAM,JJA,SON	1
GPC-Pretoria		YES	YES		R/M	R/M	R/M	YES	YES	YES	YES	YES	ALL	1,2,3
IRI		YES	YES		R/M	R/M	R/M	YES	YES				ALL	0,1,2
CPTEC (Brazil)	YES	YES	YES		R	R	R	YES	YES	YES	YES	YES	DJF,MAM,JJA,SON	1

3.2 Some GPCs have not provided all scores to the LC-SVSLRF. The GPCs that have not submitted all the required levels 1 and 2 data are invited to do so as soon as possible. The Lead Centre of SVSLRF will appreciate to receive new relevant data from the official GPCs. The Lead Centre also notes that it is a number of years since some centres have submitted scores, if these centres have changed forecast models in the past few years they are reminded to submit verification scores for the new model. LC-SVSLRF appreciates that to do so can require some considerable effort on the part of GPCs.

3.3 Following the Exeter Meeting of the ET-ELRF, Level 3 verification information has not been added to the LC-SVSLRF. We are unaware of any GPC producing these data for regional studies (as was suggested in the update to Attachment II.8 of the Manual on GDPS). This is perhaps unsurprising given the effort required to produce these data and the difficulty of sensibly communicating this verification data which can be quite overwhelming in volume and information content.

4. Use and feedback on the LC-SVSLRF

4.1 The LC-SVSLRF has achieved its primary aim of introducing standards and rigour into the verification of GPC forecasts and the sharing of associated verification information between GPC and the user community (RCC and NMHS). The LC-SVSLRF requests feedback and comments from users; particularly from GPCs and RCCs to guide further development and change.

4.2 Statistics have been compiled on the use of the LC-SVSLRF website over recent months as a guide to its value to GPCs, RCCs and others. These statistics suggest a continued low level of use of the main page and other pages (though the numbers on the reliability information pages suggest that these might be being used as an information source by people not connected with GPCs). However, the verification maps get the most hits with a peak around October 2011, perhaps due to the start of the 2011-12 La Niña event around that time.

4.3 The two hosts of the LC-SVSLRF would certainly welcome feedback on the function, value and usefulness of the LC-SVSLRF website, either through this ET meeting or by email in subsequent follow-up.

Table 3 – Statistics on the number of web hits on the LC-SVSLRF website by month and page

Number of Web Hits	Jun 2011	Jul 2011	Aug 2011	Sep 2011	Oct 2011	Nov 2011	Dec 2011	Jan 2012	Total for 8 months
Main page	63	83	74	83	133	132	96	77	741
Usersguide	56	21	53	53	82	52	24	39	380
Datasets	24	15	18	40	43	42	20	16	218
Documentation	4	4	10	11	22	30	14	19	114
roc info	27	44	49	38	40	54	44	40	336
reliability info	65	50	72	65	98	85	37	35	507
gpc info	8	8	4	13	10	12	14	9	78
Scores	8	11	13	15	30	35	21	31	164
AttachmentII-8	6	34	33	25	25	33	32	20	208
msss info	13	21	32	23	44	49	31	28	241
maps: /cgi-bin/climate/wmo.cgi	196	234	282	434	724	328	371	648	3217

5. Future of the LC-SVSLRF and Items Recommended for Consideration by the ET-ELRF

5.1 The stratification of skills scores for El Niño and La Niña events has not been completed. An official list of event has still not been provided by the WMO ET on El Niño and La Niña. There are a number of issues with conditional skill estimates; for example the hindcast skill for predefined El Niño and La Niña events will not necessarily be a good guide to the forecast skill owing to issues such as small sample size. Given the continued difficulty in the area of verification and the fact that stratification increase the total effort required by GPCs by four fold, it is our recommendation that this become non-compulsary for GPCs.

5.2 We note the Level 3 verification results have been removed as a requirement of GPCs and as a core component of the LC-SVSLRF. The LC-SVSLRF remains able to provide limited support to GPCs who wish to perform Level 3 verifications.

5.3 A review of the skill scores used in the verification could be considered. For example, presently MSSS maps are less widely used than the ROC maps. There is also a problem with the MSSS maps in that they can give a distorted view of the forecast skill depending on whether bias correction or constraining the variance has been used. For example a centre that bias corrects (so their MSSS3 score is zero) will get a better final MSSS score than a centre that does not. The more comparable score of the three MSSS breakdowns is the MSSS1 which is similar to a correlation - which is much more widely understood by the wider science community. Though it is recognized there is value in identifying any biases or areas of too little/ too much variance in the forecast models.

5.4 Different dataset and different periods are used for the hindcast verification; this makes the comparison of the scores less relevant. A specific example is the verification made over land only versus theses made over the entire globe. The LC-SVSLRF asks the ET-ELRF to consider the use of a specific dataset and/or a specific verification period for the SVSLRF. It is suggested that as we

are now in 2012, that the standard hindcast period be changed to 1981-2010 providing for a full 30 years of hindcasts. Such a move will allow for the first alignment between and standard climate period and extended and long-range forecasts. Such a move will have immediate benefits in lessening confusion between forecast and climatological base periods.

5.5 Finally, we note that one of the limitations of the LC-SVSLRF is its focus on historical hindcast data only. There is a significant need for the real-time documentation of forecast performance/skill for GPC models as soon as possible after the end of the forecast period. The LC-SVSLRF does not currently have resources or a mandate for this role, but it is our suggestion that the ET-ELRF consider the issue of real-time forecast verification including the exchange of forecast skill measures.

Annex X

SCOPING AN OPERATIONAL EXCHANGE OF ERF

The data exchange, and development of products for the extended-range, is envisioned to key on the operational monthly prediction systems at GPCs. Table 1 shows the list of proposed products (plots) to be displayed on the individual GPC websites.

Table 1 – List of proposed products (plots) to be displayed on the individual GPC websites

Products/variables	Covering periods	Charts	Verification scores
• Accumulated precipitation • Average 2m temp	Weeks 1,2,3,4, 3-4,1-4	Probabilistic maps • terciles • outer quintiles (optionally)	Reliability diagrams / ROC
MJO Need: • OLR • U850 • U200	32 days	• Hendon and Wheeler diagram • Hovmoller	Temporal correlation and RMSE -----
Velocity Potential	Weeks 1,2,3,4, 3-4,1-4	Velocity potential anomaly (Ensemble mean for each period)	correlation

Proposed data exchange among GPCs for an extended-range prediction pilot is described below. This lays down some broad guidance and several issues will have to be resolved in near future. It is recommended that some members of the ET-ELRF attend the technical workshop proposed under the WWRP/WCRP initiative on the "Sub-seasonal and Seasonal Prediction" which would be held to resolve data exchange issues. Such a meeting will provide a common ground for research and operational efforts in resolving the data exchange issues.

Variables to exchange: The recommendation for minimum variables is SST, T2m, precipitation, u200, v200, u850, OLR. This list may be augmented following the need to developing specific products.

Frequency of model output to exchange: Exchange of daily model output is recommended. Exchange of daily data will provide the freedom to develop products for different time-averages, for example, weekly means, monthly mean, average over week 3-4. Data should also be exchanged for the individual members in the ensemble so that probability forecasts can be developed.

Exchange frequency: Initially it is recommended that exchange of data will be once a week. Operational schedule of various monthly prediction systems at GPCs need to be considered in deciding on the best day of the week to exchange the data among GPCs.

Forecast length: Forecast length will be determined by the longest common period over which operational monthly prediction systems at different GPCs are run.

Data format: As for the data exchange policy in place for the LC-LRFMME, use of grib format is recommended.

Exchange of full fields: It is recommended that exchange of data should be for full fields. This exchange then needs to be accompanied by the exchange of relevant hindcast data such that forecast anomalies and tercile (or quintile) boundaries for probabilistic forecasts can be computed.

How to exchange the data: Similar to the exchange of seasonal forecast data, i.e., via ftp.

Annex XI

GPCs CAPACITY BUILDING ACTIVITIES

GPC	Climate Knowledge	Climate models	GPC products	Verification	Tailoring	Com.**
Beijing		X	X		X	
CPTEC	X	X	X	X		
Exeter	X	X	X	X	X	
Melbourne	X	X	X	X	X	
Montreal		X	X	X		
Moscow			X	X	X	
Pretoria *			*			
Seoul	X	X	X	X		
Tokyo		X	X	X	X	
Toulouse	X	X	X	X	X	
Washington	X	X	X	X	X	
ECMWF	X	X	X	X	X	

* CB available on request

** this column currently left blank as in cases when GPCs and RCCs/NMHSs are within the same organization it proved complex to define which entity provides training on communication of the forecast. However most of the GPCs are involved to some degree to communication of the forecast.

Annex XII

REVISED TERMS OF REFERENCE OF THE ET-ELRF

The Terms of Reference for the Expert Team on Extended- and Long-Range Forecasting are as follows:

(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), the Lead Centre for the Standardized Verification System for Long-range Forecasts (LC-SVSLRF) and other relevant bodies generating and providing LRF products;

(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, WCRP and other appropriate bodies;

(d) In consultation with relevant experts in CAS and CCl and with the CBS 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 availability and exchange of extended-range forecasts and verification products;

(h) In close collaboration with WCRP, 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.