WORLD METEOROLOGICAL ORGANIZATION
==

COMMISSION FOR BASIC SYSTEMS

MEETING OF THE EXPERT TEAM ON INFRASTRUCTURE FOR LONG-RANGE FORECASTING

FINAL REPORT

Geneva, Switzerland, 12-16 November 2001

1. OPENING OF THE MEETING

1.1 The meeting of the Expert Team on Infrastructure for Long-range Forecasting was held at the WMO Secretariat in Geneva, Switzerland, from 12 to 16 November 2001. Dr Alexander Frolov (Russian Federation) opened the meeting at 10.00 a.m on Monday 12 November 2001. He also chaired the meeting.

1.2 On behalf of Prof. G.O.P. Obasi, the Secretary General of WMO, Mr Evans Mukolwe, Director Co-ordinator Scientific and Technical Programmes welcomed the participants. Mr Mukolwe noted that the team was asked to provide input, to the Inter-Commission Task Team on Regional Climate Centres (ICTT), concerning the establishment of appropriate operational infrastructure for the production and exchange of long-range forecasts. He further noted that the team was also asked to develop procedures for exchange and definition of products, terms and conditions for and actual implementation of experimental exchange, report on results and make appropriate recommendations to CAS, CCl and CBS.

1.3 Mr Mukolwe invited the team to take into account relevant directives and conclusions of EC-LIII, specifically those that relate to the CBS-XII report on the efforts which are in progress to further develop the WWW aspect of the infrastructure for long-range forecasting. To this end, Mr Mukolwe paid tribute to Dr Frolov, for his leadership of the team, thanked all members of the team for their contributions to the documentation and work of the team and wished the meeting every success.

2. ORGANIZATION OF THE MEETING

2.1 Approval of the agenda

The meeting adopted the agenda given in Appendix I and the list of participants is given in Appendix II.

2.2 Working arrangements for the meeting

The meeting agreed on its working hours, mechanism and work schedule. There were 12 participants at the meeting as indicated in the list of participants given in Appendix II. Experts attending the meeting included representatives from CBS, CCl, CAgM, CAS and WCP/CLIPS.

3. REVIEW OF REQUREMENTS FOR INFRASTRUCTURE AND INPUT FROM OTHER BODIES

Under this agenda item, the experts considered the recommendations of the EC-LIII and infrastructure needs for LRFs developed by the ICTT and other relevant WMO Expert Teams.

3.1 EC-LIII conclusions and decisions

3.1.1 The meeting took into account relevant conclusions and directives of EC-LIII summarized below:

- That efforts will continue under WWW/GDPS with experimental implementation of updated verification system for long-range forecasts, further develop the WWW aspects of the infrastructure for long-range forecasting and contribute to the work of the Inter-Commission Task Team on Regional Climate Centres.

- That a CLIPS Expert Team will consider all aspects of the verification of forecasts within the CLIPS context, and in particular the need to ensure improved provision of information to end users.

- That progress was being made towards the creation of an ad hoc CLIPS Expert Group on Research Needs for SI Prediction and its Applications over the next Decade.

- That the optimum manner in which forecasts might be produced is through multi-model ensembles, and Council recognized that the models involved do not all belong to NMHSs. Forecasts from some of these models, from WMO Regional Specialized Meteorological Centres, such as ECMWF, and elsewhere, are available to Members.

- That the creation of Regional Climate Centres should follow established procedures for the designation of RSMCs and that this process should involve all relevant Commissions in order to discriminate clearly the additional activities of the Centres from those of existing GDPS RSMCs.

- That commitments to providing operational SI Forecasts would need to be sought from producing centres. In a first developmental stage the Council agreed that a limited number of forecast producers with global capabilities be approached, including both numerical and empirical producers. The Council noted that the ICTT proposed the following centres be approached in the first instance: BoM, Australia; CPTEC, Brazil; MSC, Canada; MF, France; JMA, Japan; SAWB, South Africa; MO, UK; CPC, USA; ECMWF; IRI, USA. The Council was pleased to note that the Max Planck Institute for Meteorology in Germany has agreed to serve as a producing centre. Recognizing that SI Forecast capabilities exist in a substantial and growing number of centres, the Council strongly recommended that neither the initial limited list of producers, nor any subsequent expanded list, be exclusive of any organizations that wished to participate provided that they could fulfil the stated requirements.

3.2 Observational and historical data requirements

3.2.1 The experts welcomed the rolling requirements review for observations established by the ET on Observational data requirements and redesign of GOS, including requests for Seasonal and Inter-annual Forecasting. It was noted that supplementary data from global oceanic and land surface observing systems is critical for assessment of the lower-boundary forcing. The sub-surface ocean measurements in the tropics (e.g. from the TAO, PIRATA and TRITON Arrays) have substantially benefited the SI forecasts. The meeting recommended that the upper oceanic profiles of temperature and salinity from the drifting profilers (ARGO program) should be also available on an operational basis.

3.2.2 The experts considered the observational requirements proposed for verification purposes and agreed with the proposal. The meeting reviewed and proposed a few amendments to the ICTT proposals on observational data and products, required for regional and national verification purposes, as given in the Annex to this paragraph. The suggested amendments are indicated in Italics and two requirements, are proposed to be upgraded to bold status. The observational requirements for verification of global products are covered under the standard verification system, developed by the CBS Expert Team to develop a Verification System for LRF.

3.2.3 The experts agreed that operational SI infrastructure should provide monitoring of availability of data and information from contributing observing systems.

3.3 Requirements for research and model/method developments

3.3.1 The team recognized that requirements for research and model/method developments are specified by WCRP/CLIVAR but additional works are required. The team noted that EC-LIII agreed to the proposed ad hoc CLIPS Expert Group on Research Needs for Seasonal to Interannual Prediction and its Applications over the next Decade. The Team recommends coordination of these activities with WCRP, CAS and CBS to assure that research communities address the requirements of all interested parties and beneficial results are disseminated and implemented in operational centres.

3.3.2 The data assimilation schemes should produce a regular physically consistent. four-dimensional representation of the atmosphere/ocean/land surface system from a heterogeneous array of *in situ* and remote instruments. Models and observations are linked in construction of this representation; that is why the experts recommended to the President of CBS to invite WCRP/CLIVAR and CAS to consider with high priority the research needs for the development of the advanced data assimilation schemes based on the coupled ocean-atmosphere GCMs. In the framework of SI operational prediction.

3.4 Requirements for Products and user requirements

3.4.1 The ET considered the recommendations in Annex 1 to ICTT and the recommendations of the CBS ET on EPS in its discussions of product requirements. The forecast product requirement addressed by ETILRF is that of experimental access by all NMHSs to LRF products from global scale producing centres. Wider user requirements are addressed in recommendations of the ICTT. ETILRF recommended a list of global products to be made available by global scale producing centres, as given in the Annex to this paragraph.

3.5 Guiding Principles

3.5.1 The experts agreed that operational LRF infrastructure should:

- Be structured and function to support the NMHSs in playing a central role in the provision of LRF products and services and harness their capabilities in providing the highest quality LRF services in each country.
- Allow for and contribute to active and continuing LRF research activities including co-operation with institutions outside WMO.
- Be oriented as much as possible on the existing WWW Basic Systems infrastructure and include ready access to all LRF providers.

- Ensure that the infrastructure is inclusive of any organizations that wish to participate provided that they contribute routine and reliable products of satisfactory quality.
- Encourage potential producers to participate provided that they contribute routine and reliable products of satisfactory quality.
- Utilize the WCP/CLIPS project in a way that complements and extends the activities of the WWW Basic Systems and builds the application component of the LRF services.
- Ensure access to data and information by all NMHSs and RCCs and global LRF producing centres on a non-discriminatory basis and be constructed within the guidelines laid out in WMO Resolution 40.
- Make provisions to ensure that adequate documentation and guidance information accompanies the LRF products so that users may understand, interpret, and effectively use them within the confidence levels attached to the products.

4. PROCEDURES FOR EXCHANGE OF LRF FORECASTS INCLUDING DEFINING PRODUCTS

4.1 Aspects of the provision of the global scale LRF products for international exchange

4.1.1 The team examined the dynamical global-scale LRF process used at lead centres, which often consists of first predicting the global SSTs using an oceanic GCM and then using the predicted SSTs as lower-boundary conditions to force one or several atmospheric GCMs (two-tiered approach). Post-processing is used to formulate the forecasts in probabilistic form. The ECMWF has fully coupled ocean and atmosphere GCMs for seasonal prediction and other centres expect to implement CGCMs in the near future.

4.1.2 The meeting was presented with the summary of SI products and operational infrastructure of major centres. This information for most of the centres is in the annual GDPS Technical Progress Report available on the WMO web site at: http://www.wmo.ch/web/www/DPS/gdps-tpr-cover.htm. Updates presented at the meeting are given in the annex to this paragraph.

4.1.3 The team included consideration of Annex 1 to the ICTT and the recommendations of the CBS ET on EPS in its discussion of list of recommended LRF products to be made accessible from global producing centres. This list is given in Annex 3.4.1 of the report. The team noted that the rolling requirement review for the global scale LRF products should be established.

4.1.4 The experts considered the list of extended and LRF products developed by the CBS ET on EPS with a view to recommending it for adoption and inclusion in Appendix II.6 of the Manual on the GDPS. The team was of the opinion that it was too early to update in the Manual on the GDPS in view of flexibility required in accommodating the foreseen rapid scientific evolution in LRF.

4.1.5 The LRFs relies significantly on post-processing techniques that are very specific for each producing Centre. The team encouraged the Canadian Meteorological Centre of the Meteorological Service of Canada making available post-processing methods and/or software to the NMHSs. The team recommended extending this practice among other global scale LRF producing centres. Centres are encouraged to make their retrospective data sets available (to assist RCCs and NMHSs in developing user applications and downscaling).

4.2 Aspects related to forecast skill and confidence level, verification and documentation

4.2.1 The team noted that the ICTT had proposed requirements for LRFs confidence level, supplying verification and documentation (Annex 1 to general summary of session of the ICTT). The team modified the proposed requirements with some corrections and additions as given in Annex 3.4.1 (Section 2).

4.2.2 The team agreed that the CBS Standardised Verification System for LRF is appropriate for assessment of the quality of operational global scale LRFs including verification scores (RMSSS, ROC), verification areas and verification strategy. Australia has been designated as a lead centre to create and maintain a Web site for these statistics and make results available to the NMHSs. The (SVS) for (LRF) specifications and example of reporting templates to be implemented by SI providing centres is accessible on the WMO Web site at:

(http://www.wmo.ch/web/www/DPS/verification_systems3.html)

The team invited the CBS Verification Team to develop a verification system for LRF, to review the tropical area definition and harmonize it with current practices of the CBS NWP verification system.

4.3 Delivery technology

4.3.1 The team noted that delivery technology needs to account for the wide range of products and forms and be appropriate to the facilities of the NMHSs and other users. Since most of the products will be EPS based there are three types of products:

(i) Text and graphical products;
(ii) Gridded derived products such as probabilities of exceeding various thresholds, ensemble mean and spread;
(iii) Full or sub set of model fields of individual ensemble members.

4.3.2 The Internet technology is suitable for most WMO member-countries. In the global producer Web site, a catalogue of LRF products, the LRF products themselves in text and graphical forms, verification scores, accompanying documentation, time of availability of products should be provided.

4.3.3 For making available gridded derived products, full set or subset of model fields the team considered and agreed that FM-92 GRIB Edition 2 (GRIB 2) should be used for products posted on FTP- sites or disseminated through the GTS. The team noted that GRIB 2 software is expected to be available for distribution during 2002. The meeting recommended that the OPAG on ISS monitor the use of GRIB 2 for EPS and LRF products and move quickly to remedy any deficiencies or omissions in the formulation of GRIB 2, so that there is no impediment to the exchange of LRF products.

4.3.4 The experts noted that for small data sets (e.g. timelines of indices, regionally-averaged forecasts) simple ASCII files with how-to-read instructions are generally simple to make available using the Internet. For regional LRF purposes it may be convenient to define subsets of global fields for exchange.

4.3.5 The team requested the WMO Secretariat to maintain a WEB page with URLs for sources of global LRF products and related information. WMO Secretariat should be informed by product generating centres of web site URLs and any changes in order to maintain the list.

4.4 Conditions for exchange

4.4.1 The team noted that many products are already in the public domain, but not all centres currently make their products available. There may be many reasons why some centres are reluctant to publish results – such as the low skill of many LRF techniques, liability issues - given the importance of such products including the commercial value of the products. Some institutions and agencies outside the WMO system may be willing to make products available to NMHSs and RCCs, within a well-coordinated "public good" framework, which can ensure the integrity of the use and availability of the products.

4.4.2 Some WWW GDPS global scale LRF producing centres may want to impose restrictions according to **Resolution 40** for regional scale user-oriented products. The team noted that for FTP/Web technologies, registered user or password-restricted access for users can be used.

5. EXPERIMENTAL EXCHANGE OF LONG-RANGE FORECASTS

5.1 Currently available LRF products

5.1.1 LRF products are currently available on Web sites from many institutions These products are key inputs used routinely by agencies including NMHSs in preparing long-range forecast products. So the distribution of LRF products has already begun using the widely available systems and formats of the World Wide Web.

5.1.2 This current sharing of products is based on web sites where many products are pooled and available to users, rather than through a formal "exchange" of products. Web products have the advantage of being accessible by standard widely available technology. Evolving technology is likely to facilitate distributed information databases and make the products even more accessible.

5.1.3 However, the current arrangements are ad hoc and uncoordinated; the availability of products varies considerably among producing centres, and a variety of formats and standards are used.

5.2 Multi-model ensemble activities

5.2.1 DEMETER is a 3-year collaborative research project on the development and application of a European multi-model ensemble system for seasonal climate prediction. A major part of the project is the assembling of retrospective forecast datasets extending over 20-30 years, based on 9-member ensembles started at 3-month intervals and running to a range of 6 months. The contributing prediction systems include 6 coupled GCMs from various European centres.

The predictive skill of multi-model combinations will be investigated, in addition to the skill of the separate systems. Other aspects of the project include post-processing, downscaling, and agricultural and health sector applications.
See http://www.ecmwf.int/research/demeter for further details

5.2.2 The team noted that KMA has been carrying out the APEC Climate Network (APCN) project for the real-time exchange of LRF products among the APEC member economies. As the first step in establishing a network under the APCN for the exchange of real-time climate information, the dynamic multi-model ensemble forecast has been attempted to form the basis of optimum global seasonal prediction. The dynamic ensemble seasonal prediction data for the summer precipitation, which is one of the most difficult and challenging parameters to predict, have been collected from NMHSs and research institutes equipped with infrastructure to produce the dynamic seasonal prediction information.

5.2.3 The participating organizations and institutes involved in the real-time multi-model ensemble experiments to build-up the infrastructure for joint operational seasonal forecast are: the Meteorological Service of Canada, China Meteorological Administration, Institute of Atmospheric Physics of China, Central Weather Bureau of Chinese Taipei, Japan Meteorological Agency, Korea Meteorological Administration, Meteorological Research Institute of Korea, Russian Federal Service for Hydrometeorology and Environmental Monitoring, Main Geophysical Observatory of Russia, National Aeronautics and Space Administration, National Centres for Environmental Prediction (NCEP) of the USA, and the International Research Institute for Climate Prediction of the USA. KMA is responsible for the processing of dynamic ensemble prediction data and making it available to the participating members. The multi-model ensemble products can be distributed through the provision of access to the APCN web site, upon agreement under the auspices of WMO.

5.2.4 The APCN project will be carried out in two phases: the experimental phase and the implementation phase. Included in the experimental phase are activities for establishing the scientific basis for multi-model ensemble forecasts and the enhancement of necessary infrastructure, followed by the generation of multi-model ensemble based on the prediction information provided by participating members and dissemination of climate monitoring and forecast information to participating members in the implementation phase. An organized research team can carry out the research project to develop science and technologies involved in optimal method of blending various model outputs.

5.2.5 The team encouraged global producing centres to participate in multi-model ensemble prediction system developments.

6. INPUT TO INTER-COMMISSION TASK TEAM ON REGIONAL CLIMATE CENTRES CONCERNING THE ESTABLISHMENT OF APPROPRIATE OPERATIONAL INFRASTRUCTURE FOR THE PRODUCTION AND EXCHANGE OF LRF

6.1 The meeting noted that the main aim of the LRF infrastructure is to facilitate availability of products to NMHSs. The meeting concentrated on preparing details of operational provision of LRF products to be made available from global-scale producing centres. The proposed list of products and information to be shared was based on the list of requirements developed by ICTT and is presented in the Annex to paragraph 3.4.1. Other proposals of the Team are given in Items 3 and 4 of the report.

6.2 The proposal lists a set of products and information to be provided by global centres for use by NMHSs, noting that RCCs may be established in some regions to assist NMHSs.

The proposal concentrates on details of the global scale centres, noting that the details of RCCs are now being dealt with by Regional Associations with guidance from CBS and CCl.

6.3 The meeting also noted that an invitation was being sent from WMO to potential global-scale producing centres as listed by EC-LIII. This meeting agrees that time is right to involve centres in commencement of a coordinated experimental sharing of products. However, the meeting recommends that these potential centres be advised of the set of products prepared by this ET and that these be recommended as a basic set for initial availability.

6.4 It is also recommended that the Expert Team be advised of the responses to the invitations with a view to revising the list of products and developing other requirements if required. The meeting also supports the concept of a workshop of potential global producing centres to facilitate the early commencement of the experimental sharing of products. The workshop could consider aspects such as:

- Interpretation of products;
- Coordination of production schedules and formats;
- Research requirements;
- issues left unresolved by the ET (Annex to paragraph. 3.4.1).

7. RECOMMENDATIONS FOR FUTURE CONSIDERATION

7.1 The Expert Team recognised that the future activities of the group will strongly depend on the feedback to proposed arrangements for operational infrastructure for LRFs including the list of recommended LRF products to be made accessible from the global producing centres.

7.2 Taking into account the terms of reference the Team should monitor the progress of implementation of experimental access of LRF products and prepare the report to the CBS, CCl and CAS.

7.3 The Team recommended that CBS establishes a review process of the LRF products using inputs from interested parties.

8. CLOSURE OF MEETING

8.1 The meeting was closed on Friday 16 November 2001.

Annex to paragraph 3.2.2

List of Observational data and Products required for regional and national verification activities

Requirements that have attracted a significant consensus are shown **in bold**). Some of the requirements are new or newly stated relative to previous recommendations noted above.

As stated earlier, the observational requirements proposed here are related to regional and national forecasting and verification activities.

- **Real time synoptic data from the Regional Basic Synoptic Network.**
- **Sufficient national synoptic and climatological data to permit the development and updating of methods of downscaling.**
- **Monthly data and other statistics based on daily rainfall and temperature data (such as decile rankings) to be supplied from a subset of national stations to approved regional verification and monitoring centres. At least monthly data required within one week of end of month. Subset to give adequate representation of geographical regions (plateaux, flood plains etc)**
- **Grid box (*2.5*-degree square) averages of observational station *data* for monthly rainfall and mean temperature within region, available within a month.**
- Regional soil moisture deficits *(is difficult to provide)* and flood cover on a weekly basis, to be available within a week.
- Regional drought, fire and pollution indices on a weekly basis, to be available within a week.
- Global mappings of monthly pressure, rainfall and cloud cover anomalies, and anomaly maps of Northern Hemisphere snow cover, on a monthly basis.
- **Sea surface temperature** *and sea ice* measurements, **but preferably weekly and monthly anomaly maps for the global oceans averaged over 2 1/2 degree squares.**
- **Analyses of sea level, surface wind stress** and global *ocean* sections of temperature and salinity to 400m depth on a monthly basis.
- **SO and NAO indices,** *monthly* **means and available within a few days.**
- **Archival data, including metadata, sufficient to determine the monthly climatology of the nation and region.**
- **Climate Atlases, station climate normals and other statistics relating to historical percentiles, extremes, return periods etc.**
- **Historical data series for the SOI and Niño area SSTs.**

Annex to paragraph 3.4.1

List of recommended LRF products to be made available by global scale producing centres

The ET considered the recommendations in Annex 1 to ICTT and the recommendations of the CBS ET on EPS in its discussions of product requirements. The forecast product requirement addressed by ETILRF is that of experimental access by all NMHSs to LRF products from global scale producing centres. Wider user requirements are addressed in recommendations of the ICTT.

Requirements that have attracted a significant consensus are shown **in bold**). Some of the requirements are new or newly stated relative to previous recommendations noted above.

1. Forecast Products

Note: it is recognised that some centres may provide sub-sets of the product list, according to their LRF capacity.

Basic properties
Temporal resolution.
Monthly and seasonal (3-month) averages/accumulations/incidences

Spatial resolution.
2.5° x 2.5° (note: selected to match resolution of current verification data)

Spatial coverage. **Global**
(separate areas of interest to users, down to sub-regions of a continent or ocean basin, may be provided on special request from Members)

Lead time. **0 – 6 months for monthly forecasts and 0-4 months for seasonal forecasts. This reflects the 6 month requirement regarding products to be issued to end user.** Some end user requirements extend to 15 months. Note end-user requirement of **3 months minimum** for warnings of high amplitude and abnormal events, such as increase in tropical storm frequency or change in phase of ENSO. (Forecast range determines how far into the future LRF are provided. Forecast range is thus the summation of lead time and forecast period) Note on definition of lead time: for example, a monthly forecast issued on 31 December has a lead time of 0 months for a January forecast, and a lead time of 1 month for February forecast, etc.; a three-monthly forecast issued on 31 December has a lead time of 0 months for a January-to-March forecast, and a lead time of 1 month for February-to-April forecast, etc.

Issue frequency. **Monthly**

Output types. Gridded numerical values, area-averaged values and indices, and/or images.

Indications of skill **must be provided** (see "skill and confidence levels" in Section 2), in accordance with recommendations from CBS on the Standardised Verification System.

Content of basic forecast output: (some products are intended as directly meeting NMS requirements with regard to information needed for end-user applications [direct or further processed]; others are to assist the contributing global centres in product comparison and in the development of multimodel ensembles. These products are regarded as feasible from current systems).

A. Calibrated outputs from ensemble prediction system showing the mean and spread of the distribution for:

- **2 metre temperature over land**
- **sea surface temperature**
- **precipitation**
- **Z500, MSLP, T850**
- **Sea surface temperature area averages for the principal Niño areas (Nino3, Nino3.4, Nino4), including ensemble plumes of monthly values.**
- **Surface pressure field indices including the SOI (eg inferred Tahiti-Darwin pressure difference) and the NAO (Iceland -Azores difference), including ensemble plumes of monthly values.**

Notes:
1. These fields are to be expressed as departures from normal model climate.
2. SST used as boundary conditions for (two-tiered) AGCM predictions should be made available.

B. **Calibrated probability information for forecast categories. Tercile categories should be provided**, consistent with present capabilities. Information for larger numbers of categories (eg deciles) is foreseen, however, as capabilities increase and to match better the anticipated end-user requirements. These targets are implied also for forecasts from statistical/empirical models.
Note: information on category boundaries should be included.

- **2 metre temperature over land**
- **SST**
- **precipitation**
- **Z500, MSLP, T850**

(Note: "Calibrated" implies correction based on past performance for systematic errors in anomaly predictions, using at least 15 years of retrospective forecasts.)

The ET noted the following issues regarding uniformity of products to be addressed in implementation of the experimental accessibility:
- use of a common grid
- reference climatology
- resolution of the probability distribution
- definition of period for terciles
- category boundaries for terciles
- indication of uncertainty (is spread sufficient ?)
- timing of issue of forecasts

Other requirements, as adapted from ICTT (Annex 1)
Some requirements are not as well established or may not be achievable at present. The predictability associated with some products is not yet established.

- As in A and B for sunshine, solar radiation and cloudiness
- **As in A and B for 850hPa wind, Z200**
- **SST area averages for tropical Atlantic and specified sectors of North Atlantic and Indian Oceans**

- Ensemble related predictions of the equatorial zonal wind average at heights of 30 and 50 hPa, as an indicator of the QBO.
- **Likely seasonal tropical cyclone activity (may be inferred from proxy mean fields)**
- likelihood of within-season activity of wet (including heavy rain) and dry spells, hot and cold (including frost) spells, to provide indications of whether the frequencies and severity will be above normal. (Note: these may be inferred from mean fields)
- Ensemble output related to heating/cooling and growing degree-days using regionally supplied thresholds (Note: these may be inferred from proxy mean fields) (details will depend on regionally-supplied requirements, such as thresholds and averaging periods)
- **Ensemble output to indicate onset and duration of rainy and monsoon seasons.**
- Non-ensemble outputs of all the above variables/events where models are not operated in ensemble mode (e.g. statistical models)
- **Threshold value for the category boundary**, e.g."above/near/below normal"
- Related input from centres without global LRF capability.

Note: for some of these quantities (e.g. monsoon onset) provision of daily model fields for all ensemble members for selected areas may be necessary.

2. Skill and <u>Confidence levels</u>

- **skill information must accompany each product, with corresponding spatial and temporal detail**, to indicate predictability levels. (e.g. a gridded map product should have skill information for the same grid, averaging period and lead time) The skill measures should follow the recommendations of CBS on the Standard Verification System (e.g. ROC values), should be based on at least 15 years of retrospective forecasts, and should also include a widely-understandable form (such as % correct) suitable for direct communication to end-users if required.

- **An indication (text statement and/or quantitative indicator) of the confidence in each forecast for example based on model ensemble characteristics, uncertainties in initial conditions, model uncertainties, and degree of consensus and intrinsic lack of predictability.**
- **An alert, to accompany forecasts, of significant changes in models or practices used to generate the forecasts**. Examples are changes to analysis schemes for surface wind stress and sea surface temperature changes in assimilation techniques and model resolution.
- Regions where probabilities are close to climatology level reflect either a lack of predictability demonstrated for the region, or no clear forcing on the climate for the particular forecast period, even though predictability on the average has been demonstrated for the region. It may be useful to distinguish between the two in map format.
- **Verification to discriminate between seasons and lead times.**

<u>Verification of issued forecasts.</u>

- **With each statistical and dynamical model output (single forecast and ensembles), and each consensus forecast, a time series of verification data describing the model and consensus performance. Such data to include outputs from the WMO Standardised Verification Scheme for Long Range Forecasts including ROC catering for flexible event definitions.**
- Verification based skill masks to be applied to forecasts for areas where there is little skill, to be developed using criteria agreed with users.

Documentation

- **Descriptions of statistical and dynamical models including scope and limitations.**
- **Descriptions of forecast and hindcast processes.**
- **Description of consensus procedures.**
- **Description of calibration and validation procedures with provision of forecast systematic error fields.**
- **Notifications of intention to upgrade or change models and procedures.**

Annex to paragraph 4.1.2

Additional information concerning LRF provision

National Centers for Environmental Prediction (NCEP)

The dynamical climate forecast process used at NCEP consists of first predicting the tropical Pacific SSTs using an oceanic GCM and then using the predicted SSTs as surface boundary conditions to force an atmospheric GCM. In addition to the dynamical SST forecasts, NCEP also utilizes statistical techniques to predict SSTs, and the impacts that they might have on temperature and precipitation over the United States.

Probability predictions of surface temperature and total precipitation, for the conterminous U.S.A, Alaska and Hawaii, for the upcoming month and for the 13 overlapping 3-month periods (extending out to approximately 1 year in advance). The forecasts are derived from a combination of several objective forecast tools – both statistical and dynamical. These tools include a Canonical Correlation Analysis (CCA), Optimal Climate Normals (OCN) and the Coupled Model Forecasts (CMF). Any method used in producing the Climate Outlook is required to be accompanied by sufficiently thorough skill records, in order that the forecasts can be objectively combined with other forecasts via a multiple linear regression-like procedure. The forecasts of each of the forecast tools are displayed in the same format on the web.

The observed distributions of seasonal mean temperature and total precipitation during 1971-2000 are divided into three equally likely categories – BELOW, NORMAL, and ABOVE, for temperature, and BELOW, MODERATE, and ABOVE, for precipitation. The tercile limits are based on a Gaussian distribution for temperature, and a gamma distribution for precipitation. 102 approximately equal-area climate divisions are forecasts for the contiguous United States. The average likelihood, or climatological probability, of these categories is 1/3, 1/3, and 1/3, respectively. For simplicity we designate this category as “CL”, which signifies “Climatological probabilities.” For regions where there is expected skill in forecasting a tilt in the odds toward either the BELOW or ABOVE categories, isolines are drawn that depict the anomaly of the probability with respect to the climatological probability (33.3%) of occurrence.

Probability predictions of seasonal mean SST and SST anomalies in the tropical Pacific are produced by objectively combining forecasts made using both statistical and dynamical techniques. The resulting consolidated SST forecast then serves as the basis for making ENSO-based composites, based on historical temperature and precipitation data. These composites are then used subjectively to adjust the final U.S seasonal temperature and precipitation probability outlooks.

On the web, a skill map is provided for each predictive tool for each of the 12 3-month seasons. A graph representing time series of overall skills of the seasonal forecasts over the last few years is also posted.

International Research Institutes (IRI)

1. PRODUCTION OF GLOBAL SCALE LONG RANGE FORECASTS AT IRI, AND RESULTING SUITE OF IRI FORECAST PRODUCTS

URL: http://iri.columbia.edu/climate/forecast

The IRI produces forecasts for temperature and precipitation for four overlapping 3-month periods running out to 6 months in advance. Forecast are expressed as probabilities of the three tercile categories. The climate forecast operation at the IRI is largely based on dynamical models of the ocean and the atmosphere. A 2-tiered system is used. The first tier consists of the production of a forecast of the global sea surface temperature anomaly, and then using the forecast SSTs as surface boundary conditions to force several atmospheric GCMs (AGCMs). The SSTs are forecast using different models for different portions of the global oceans. For the tropical Pacific, the NCEP coupled ocean-atmosphere model is used. For the Indian Ocean and the tropical Atlantic, a statistical method (canonical correlation analysis) is used. In the extratropics, damped persistence of the anomaly of the most recently observed month serves as the forecast. The set of AGCMs is non-static; it changes as new models emerge (or become available) and other ones are discontinued. Potential AGCMs must show an adequate level of overall global skill. The AGCMs used in the second part of the IRI's forecast operation, as of November 2001, are as follows: (1) CCM 3.2 (NCAR, Boulder, CO., U.S.; (2) NCEP MRF9 (NCEP, Washington, DC, U.S.); (3) ECHAM 3.6 (Max Planck Inst., Hamburg, Germany), (4) ECHAM 4.5 (Max Planck Inst., Hamburg, Germany); (5) NSIPP (NASA/GSFC, Greenbelt, MD, U.S.); and (6) COLA model (COLA, Calverton, MD, U.S.). The CCM 3.2, ECHAM 3.6 and ECHAM 4.5 models are run at the IRI by IRI personnel, while the other three models are run at their institutions of origin.

In addition to the approximately 10 ensemble runs produced from each of the six AGCMs using forecast SST as the lower boundary condition, several of them are also run with persisted SST for the first (shortest lead) forecast season. Two multi-model ensembling processes are applied to the results of the participating models, resulting in forecasts for 3-month mean temperature and total precipitation for the upcoming six months, given as four overlapping 3-month periods. The two multi-model ensemble results are combined with equal weights, and the forecasters then modify the final forecast in view of uncertainties in the SST forecasts or other factors that may be ignored in the objective process. Additionally, an analog method is used during ENSO episodes, and the results are allowed to contribute to some extent when the objective results appear to have neglected an important analog-based empirical relationship.

The IRI's forecasts are issued in terms of the probabilities that the temperature or precipitation will be in each of three climatologically equal categories (terciles): below, near, and above normal. The definitions of the categories are based on the observations for the location and season over the 30-year base period of 1969-1998, using surface data of Mark New from the Climate Research Division of the University of East Anglia, UK. This data is considered to be the best choice for global coverage and quality, and is developed 2 to 3 years behind real-time; hence the "odd" 30-year base period used by the IRI. The forecasts are issued at the spatial resolution used by most of the AGCMs, which is T42, or about 2.8 degrees latitude and longitude. Each T42 "square" is assigned probabilities for being in each of the three categories. These probabilities are rounded to be multiples of 5%, such as 45%, 30%, 25% for being below, near, and above normal, respectively. An exception is the climatology forecast (denoted by "C" on the forecast maps), in which each category is forecast to have a 33.3% probability.

The global SST forecasts that are used as the basis for the AGCM forecasts for the atmosphere are also posted by the IRI. Implicit in these are forecasts for the ENSO, as well as for the other tropical oceans.

Additional material on the IRI web site includes the ensemble mean of the forecasts produced by each additional model (and percentage of normal for precipitation), the skills of each model (as temporal correlations and ROC scores) over a long hindcast period assuming perfectly known SST forcing), and the climatologcial normals and tercile boundaries for each observational grid square. Observational probabilistic composites of temperature and precipitation for El Nino and La Nina conditions, by tercile category, are displayed for each season. For some of the models, the forecasts of individual model ensembles are available.

An archive of all of the IRI's past climate forecasts is accessible, both graphically and digitally, along with the corresponding verification fields, in map form on the web site. The verification data are at 2 degree resolution for temperature, and 2.5 degree resolution for precipitation.

Atmospheric model for long range forecast at Japan Meteorological Agency

Operational one-month dynamical ensemble forecast

The numerical prediction model used for the one-month ensemble prediction is a T106 version of the Global Spectral Model (GSM0103, T213) used for short and medium range forecast. The specifications of the model are shown in Table 1. For the lower boundary condition to the model, SST anomalies are fixed during the 34-day time integration. Soil moisture and snow depth are predicted by the model, although their initial states are taken from climatological values.

Table 1: The specification of GSM for one-month forecast

Horizontal Resolution	*T106 (about 1.125-degree Gaussian grid)*
Vertical levels	*40 levels (0.4 hPa model top)*
Cumulus Parameterization	*Prognostic Arakawa-Schubert scheme*
Land surface process	*Simple Biosphere Model*
Time integration range	*34 days*
Executing frequency	*Twice per week*
Ensemble size	*26 members (13 members x 2 days)*
perturbation method	*Hybrid of Breeding of Growing Mode (BGM) method and Lag Average Forecast (LAF) method*

An ensemble consists of 26 one-month forecast members. The 26 members are prepared with a combination of a breeding of growing mode (BGM) and lagged average forecast (LAF) method. That is, 13 forecasts are computed from 1200 UTC initial fields on Wednesday and the remaining 13 from 1200 UTC on Thursday.

A model systematic bias was estimated as an average forecast error, which was calculated from hindcast experiments for years of 1984 to 1993. The bias is removed from forecast fields, and then grid point values are processed to produce several forecast materials (ensemble mean map, spread map, time sequences figures etc.).

Semi-operational seasonal dynamical ensemble forecast

Now JMA is testing the prototype of seasonal prediction system, which consists of an atmospheric model for ensemble runs and a coupled ocean-atmosphere model which provides the atmospheric ensemble forecast with SST prediction. At present the SST anomalies used as the lower boundary condition of the atmospheric model are provided by the coupled model in the equatorial region and by persistence or climatology in the middle or high latitude regions.

The real time ensemble seasonal prediction (up to 4 - 8 months ahead) is performed every month in semi-operational mode. The model will be run operationally in March 2002 and dynamical seasonal forecast is planned to be used for operation in March 2003. The specifications of the model as shown in table 2.

Table 2: The specification of GSM for seasonal forecast (4 - 8 month forecast) model

Horizontal resolution	*T63 (about 1.875-degree Gaussian grid)*
Vertical levels	*40 levels (0.4 hPa model top)*
Time integration range	*4 months or 8 months*
Executing frequency	*Once a month (4-month prediction)* *Twice a year (8-month prediction)*
Ensemble size	*30 members*
Perturbation method	*Singular Vector method*

- ✔ Physical processes are the same as those of one-month forecast model

European Centre for Medium-range Forecasts (ECMWF)

Seasonal forecasting at ECMWF

ECMWF started an experimental program in seasonal predictions in 1995. Since then a substantial progress has been made by reaching a quasi-operational production of global seasonal predictions for the ocean and atmospheric parameters.

The ECMWF has a state-of-the-art seasonal forecasting system with full coupling between the atmosphere and the ocean. The resolution in the atmosphere of the current system is T63 spectral with 31 levels in the vertical. The ocean model has a lower resolution in the extra-tropics but higher in the equatorial region to resolve the baroclinic waves and processes close to the equator. There are 20 levels in the vertical with a high resolution in the upper 200 m of the ocean. A 200-day integration of the coupled system is made each day. Over a period of a month, an ensemble of approximately 30 members is created from which the products provided on the web are derived.

The seasonal forecast products for the global domain have been available on the ECMWF web pages for WMO members since mid-2000. Over 50% of the WMO members have requested and been given access to the products on the web. The range of ECMWF seasonal forecast products routinely available to the meteorological community (NMHSs) is listed in the Table 1.

Table 1: Products available from the ECMWF forecast suite.

1. Ocean analysis

Parameter:
Temperature anomaly along the equator (ocean cross-section)
Sea level anomaly
Zonal wind stress anomaly

Area: Tropical belt
Period and valid time: 7-day mean, updated weekly

2. Seasonal forecasts:

Nino-3 SST anomaly plumes
Forecast charts:
Parameter:
Precipitation Temperature at 2 metres Mean sea level pressure Sea surface temperature

Area: Global and sub-areas
Type: Ensemble mean value- Probability of below/above average climate value
Lead time: 1, 2, 3 months
Period and valid time: 3-month averages, updated monthly

The ECMWF seasonal forecast range is complemented by a set of documentation describing the forecasting system, some guidance on the quality of the products. In the near future the web site will be enhanced with more information on post-performance evaluation based on hind-casts and preliminary verification

ECMWF Web sites for LRF

1. Public site (no password protection):
   URL: http://www.ecmwf.int/services/seasonal/forecast

2. WMO Members access site (password protected):
   URL: http://www.ecmwf.int/resources

3. Member State Site (password protected):
   URL: http://wms.ecmwf.int

EXISTING CAPABILITIES OF RMSC Montreal (CANADA)

FOR GENERATION OF LONG-RANGE FORECAST (LRF) PRODUCTS

90-day deterministic forecasts are issued 4 times a year (on the 1st day of March, June, September and December). Seasonal products are distributed nationally and internationally through Internet (URL http://www.meteo.ec.gc.ca/saisons/index_e.html) as well as to MSC's Regional offices and to media. The charts are accompanied by skill maps depicting the forecast performance for the same period over the 1969-1994 hindcast dataset. Verification data and charts, showing previous season's prediction and a preliminary analysis of the observed anomaly, are provided.

At every issue time, forecasts for the upcoming four 90-day periods are issued, with lead times of 0, 3, 6 and 9 months respectively.

The forecast parameters are the surface temperature and precipitation anomalies in 3 equiprobable categories. The forecast domain is Canada.

Season 1 forecasts (zero lead time)

Season 1 forecasts are produced using a numerical approach. Two ensembles of 6 runs, obtained from 24-hour time lag, are produced: 6 from a T63L23 version of the SEF previous operational prediction model, and 6 from a T32L10 General Circulation Model (GCM2). Both models use the same initial operational analyses. SST anomalies observed over the previous 30 days are added to climatological values over the 3-month period (anomaly persistence); snow is gradually relaxed towards climatology at the end of the first month, except for the GCM, where it is a prognostic variable.

The surface air temperature anomaly forecast is done using 1000-500 hPa thickness (DZ) anomaly extracted from the 12 member ensemble. The 2 ensembles of 6 forecasts are averaged separately for both models. A hybridization of the two DZ forecasts is done using a Best Linear Unbiased Estimator (BLUE) method. The hybridized thickness anomaly is then related to the surface temperature anomalies by a "perfect prog" (PP) technique.

Precipitation forecast is simply the ensemble average of the seasonal precipitation anomaly amount. The anomaly field is normalized to take into account the individual models standard deviations. This ensures that the variance of the forecasts is close to the observed inter-annual variance. The anomaly is calculated using as climate the average of the Historical Forecast Project (HFP) runs.

Temperature and precipitation anomalies are then compared to the model climatology in order to produce the 3-category forecasts. The threshold to be different from normal is ±0.43 times the model inter-annual standard deviation. Maps of the climatology and thresholds are shown on the Web.

In the near future, an additional product depicting the probabilities of ABOVE, NEAR and BELOW NORMAL categories for temperature and precipitation based on ensemble members characteristics will be provided.

Every forecast is verified using a 3X3 contingency table using Canadian surface stations for both temperature and precipitation; several scores are produced, including percentage correct. Contingency tables, various verification scores and maps of forecast vs observed temperature and precipitation anomalies are posted on the Web. Climatology used for the official forecast verification is Environment Canada's 1961-1990 Canadian Climate Normals.

Probabilistic forecasts for both temperature and precipitation anomalies over the global domain are also made by counting the number of members in each category divided by the ensemble size as a probability of occurrence. The predicted fields are direct model surface air temperature and precipitation, both obtained from linearly averaging all ensemble members. These are not disseminated.

Season 2, 3 and 4 forecasts

Seasonal forecasts at lead time of 3, 6 and 9 months are produced, using a Canonical Correlation Analysis technique. The technique uses the SST anomalies observed over the last 12 months to predict temperature and precipitation anomalies at Canadian stations for the following 3 seasons through statistical regression. Maps of ABOVE, NEAR and BELOW NORMAL temperature and precipitation for each 3-month period are produced. Skill maps, as obtained from cross-validation using a 40-year dataset, are also available but only for season 2.

Verification for seasons 2 to 4 has not yet been done.

WMC/RSMC Moscow (Russian Federation)

Extended and long-range forecasts

Both empirical and dynamical-statistical methods have been implemented for operational monthly air temperature anomalies and precipitation prediction over the territory of Russia and the CIS. The basis of dynamical-statistical scheme is the GCM T41L15. The set of initial fields are assembled from 5 time moments with 12 hour consecutive intervals. A procedure for switching among 5 and 10 days of forecasts has been elaborated to start regression assessment of the 20 and 30 day averaged fields. Dynamical extended and seasonal range forecasts are produced on the experimental basis every 10 days over the Northern Hemisphere on 2.5°×2.5° geographical grid. The products include ensemble mean forecasts for 10, 20 and 30 days of averaged geopotential heights, sea level pressure, surface and 850 hPa temperatures and precipitation. Output products also include the standard deviation fields calculated for the first ten days of the whole forecasting period. These fields are interpreted, firstly, as assessments of prognostic fields consistency and, secondly, as a priory predictability evaluation of dynamical forecast for the whole forecasting period.

Seasonal and half-year range forecasts are issued routinely basing on the complexation of individual empirical-statistical forecasts of monthly averaged air temperature and precipitation over the CIS territory. The individual forecasts are obtained from a number of Russian hydrometeorological centers. The complexation is implemented using the Bayes's principle. The skill score of the forecasts derived through the complexation is on the average higher than of any individual forecast. The forecast is issued at the end of March for the period from April through September and at the end of September for the period from October through March.

Many user-oriented long-range marine meteorological products are prepared. Among them the forecasts of the monthly Caspian sea level for the forthcoming year with zero lead-time and forecasts of ice conditions (ice phase break out dates, duration of ice period, ice thickness, ice edge location) in nonarctic seas of Russia for autumn-winter seasons. Long-range hydrological forecasts are also produced. They are forecasts of maximum spring flood levels with 0.5-4.0 month lead-time and water run-off volume in rives of irrigative agriculture a month, a quarter and vegetation period ahead.

Long-range forecasts in gridded, graphical and textual forms are available for users through the FTP and WEB servers. Today the most part of products are password protected.

REPUBLIC OF KOREA

LONG-RANGE FORECASTING PROGRESS REPORT
SEPTEMBER 1999 - DECEMBER 2000

1. Long-range Forecast Activities in KMA

1.1 Dynamic LRF Model

The dynamic ensemble prediction for 1-month seasonal forecasts is performed using KMA Global Spectral Model (GSM) with horizontal resolution of T106 and 21 vertical levels with p-top at 10 hPa. GSM/KMA has 5 dependant variables such as vorticty, divergence, temperature, surface pressure and specific humidity. This model includes the nonlinear normal mode initialization, Kuo cumulus parameterization scheme for the cloud convection, SiB scheme for the land-surface process. The boundary condition over the ocean is fixed throughout the forecast period with the latest weekly SST anomalies added to the monthly climatology obtained from NCEP. Initial soil moisture, initial snow depth, roughness length and albedo are climatological. The ensemble prediction with 20 members is accomplished by simple lagged method using initial conditions analyzed twice a day at 00Z and 12Z.

1-month forecasts have been issued every 10 days since December 1999 using the results from the ensemble prediction system. The ensemble model results of 1-month and seasonal predictions are available on the KMA Internet home page (http://www.kma.go.kr).

1.2 ENSO Prediction Model

KMA has developed an El-Nino/La Nina prediction model using the intermediate coupled model, originally developed by Cane and Zebiak. The model predictability was improved by changing the ocean initialization method and by modifying the model dynamics, particularly the parameterization of subsurface temperature. We also introduced the statistical atmosphere model in the coupled system, which is related to the eigen modes of predicted SST anomaly. The model results for 6-month predictions of tropical SST anomaly, thermocline depth, and the Nino 3 index are updated every month and are provided on the KMA Internet home page (http://www.kma.go.kr).

Met Office

Descriptions of current LRF products are available in the GDPS Technical Progress Report and at: http://www.metoffice.com/research/seasonal/index.html

The current LRF products are derived from 2-tier AGCM and statistical prediction systems. Products from a coupled ocean-atmosphere GCM will be added in 2002.

Appendix I

AGENDA

1. OPENING OF THE MEETING

2. ORGANIZATION OF THE MEETING

   2.1 Adoption of the agenda

   2.2 Other organizational questions

3. REQUREMENTS FOR INFRASTRUCTURE AND INPUT FROM OTHER BODIES

4. PROCEDURES FOR EXCHANGE OF LRF FORECASTS INCLUDING DEFINING PRODUCTS

5. EXPERIMENTAL EXCHANGE OF LONG-RANGE FORECASTS

6. INPUT TO ICTT ON RCCs CONCERNING THE ESTABLISHMENT OF APPROPRIATE OPERATIONAL INFRASTRUCTURE FOR THE PRODUCTION AND EXCHANGE OF LRF

7. RECOMMENDATIONS FOR FUTURE CONSIDERATION

8. CLOSURE OF THE MEETING

Appendix II

List of participants

RUSSIAN FEDERATION (Chair)	**Dr Alexander FROLOV** Russian Federal Service for Hydrometeorology and Environmental Monitoring (ROSHYDROMET) 12, Novovagankovsky Street 123995 MOSCOW Russian Federation Tel.: (7 095) 252 0313 Fax: (7 095) 255 2269 E-mail: afrolov@mecom.ru
AUSTRALIA	**Mr Terry HART** Bureau of Meteorology P.O. Box 1289K MELBOURNE VIC, 3001 Australia Tel.: (613) 9069 4030 Fax: (613) 9662 1222 E-mail: t.hart@bom.gov.au
CANADA	**Mr Jean-Guy DESMARAIS** Canadian Meteorological Centre 2121 Trans-Canada Highway DORVAL, QUEBEC, H9P, 1J3 Canada Tel.: (1 51 4) 421 4654 Fax: (1 51 4) 421 4657 Email: jean-guy.desmarais@ec.gc.ca
JAPAN	**Mr Nobutaka MANNOJI** Japan Meteorological Agency (JMA) Climate and Marine Department 1-3-4 Otemachi Chiyoda-ku Tokyo 100-8122 Japan Tel.: (813) 3212 8341 ext. 4224 Fax: (813) 3211 8406 Email: nmannoji@npd.kishou.go.jp

KOREA
REPUBLIC OF

Dr Chung-Kyu PARK
Korea Meteorological Administration
460-18, Sindaebang-dong
Dongjak-gu, Seoul, 156-720
Republic of Korea
Tel.: (822) 8366 754
Fax: (822) 8326 108
E-mail: ckpark@kma.go.kr

NEW ZEALAND

Dr Jim SALINGER
National Institute of Water and
Atmospheric Research
269 Khyber Pass Road
P.O. Box 109-695
Newmarket, AUCKLAND
New Zealand
Tel.: (64 9) 375 2090
Fax: (64 9) 375 2051
E-mail: j.salinger@niwa.com

SOUTH AFRICA

Mr Ikalafeng KGAKATSI
Prediction Research Manager
South African Weather Service
Private Bag X097
PRETORIA 0001
South Africa
Tel.: (27 12) 309 3086
Fax: (27 12) 323 4518
Email: kgakatsi@weathersa.co.za

UNITED KINGDOM

Dr Mike DAVEY
Met Office
London Road
Bracknell, BERKSHIRE RG12 2SZ
United Kingdom
Tel.: (44 1344) 854 648
Fax: (44 1344) 854 499
Email: mike.davey@metoffice.com

ECMWF

Ms Laura FERRANTI
European Centre for Medium-Range
Weather Forecasts (ECMWF)
Shinfielf Park
READING, RG2 9AX
United Kingdom
Tel.: (44 118) 949 9000
Fax: (44 118) 986 9450
E-mail: laura.ferranti@ecmwf.int

IRI	**Mr Anthony BARNSTON** Head IRI Forecast Operations International Research Institute for Climate Prediction 61 Rt. 9W, Monell Building Palisades, NY 10964-8000 United States of America Tel.: (845) 680 4468 Fax: (845) 680 4864 E-mail: tonyb@iri.columbia.edu
ICTT on RCCs	**Mr Stefan MILDNER** Deutscher Wetterdienst Postfach 100465 D-63067 OFFENBACH Germany Tel.: (49 69) 8062 2846 Fax: (49 69) 8062 3829 E-mail: stefan.mildner@dwd.de
WMO SECRETARIAT	**Mr Morrison MLAKI** Chief Data-processing System Division World Weather Watch Basic Systems Department 7 bis, avenue de la Paix Case postale No. 2300 CH-1211 Geneva 2 Switzerland Tel.: (41 22) 730 8231 Fax: (41 22) 730 8021 E-mail: mmlaki@www.wmo.ch
	Dr B.S. NYENZI Chief CLIPS Office World Climate Programme Department (WCP) 7 bis, avenue de la Paix Case postale No. 2300 CH-1211 Geneva 2 Switzerland Tel.: (41 22) 730 8273 Fax: (41 22) 730 8042 E-mail: nyenzi_b@gateway.wmo.ch