



**WMO Global Data Processing and Forecasting System**

**“Seasonal Forecasting in the Provision of  
Meteorological Services”**

***Peter Chen***

Chief, Data Processing and Forecasting Systems  
Weather and Disaster Risk Reduction Services Department  
WMO

APEC Climate Symposium  
Lima, Peru  
19 August 2008

# Outline



- ❖ What is WMO's GDPFS?
- ❖ GDPFS' Centres in Long-Range Forecasting
- ❖ Regionalized approach:
  - *Regional Climate Outlook Forum*
  - *"SWFDP" demonstration*
- ❖ Closing thoughts

# The Global Data-Processing and Forecasting System (GDPFS)

*Through its global network of operational meteorological centres ... makes available to Members weather and climate analyses, forecasts and predictions, to enable them to provide ... **high-quality predictions and forecasts, warning and information services** ....*

- Outputs of the NWP Systems, including EPS, and atmospheric transport modelling for environmental emergencies
- GDPFS supports many WMO programmes and relevant programmes of other International Organizations, e.g. ICAO, IAEA, CTBTO.

*(see: “WMO Manual on the GDPFS”)*



# RSMCs of the GDPFS with Activity Specialization

- ◆ **All Regional Specialized Meteorological Centres (RSMC) are operational 24/7**
- ◆ **RSMCs provide guidance to NMHSs**
- ◆ **Activity Specialization:**
  - ✓ Medium-range forecasting
  - ✓ Tropical Cyclone forecasting
  - ✓ Atmospheric Transport Modelling in Emergency Response
  - ✓ UV-forecasting
  - ✓ **Global Producing Centres of Long-Range Forecasts (GPCs)**
  - ✓ **Regional Climate Centres (soon to be recognized by CBS-CCI)**
  - ✓ *(also affiliated: ICAO Volcanic Ash Advisory Centres)*



# WMO DEFINITIONS OF METEOROLOGICAL FORECASTING RANGES

- ◆ **1. NOWCASTING :**
  - 0 -2 HOURS DESCRIPTION OF FORECASTED WEATHER PARAMETERS
- ◆ **2. VERY SHORT-RANGE WEATHER FORECASTING:**
  - UP TO 12 HOURS DESCRIPTION OF WEATHER PARAMETERS
- ◆ **3. SHORT-RANGE WEATHER FORECASTING**
  - BEYOND 12 HOURS AND UP TO 72 HOURS DESCRIPTION OF WEATHER PARAMETERS
- ◆ **4. MEDIUM-RANGE WEATHER FORECASTING**
  - BEYOND 72 HOURS AND UP TO 240 HOURS DESCRIPTION OF WEATHER PARAMETERS
- ◆ **5. EXTENDED-RANGE WEATHER FORECASTING**
  - BEYOND 10 DAYS AND UP TO 30 DAYS DESCRIPTION OF WEATHER PARAMETERS, USUALLY AVERAGED AND EXPRESSED AS A DEPARTURE FROM CLIMATE VALUES FOR THAT PERIOD
- ◆ **6. LONG-RANGE FORECASTING**
  - *FROM 30 DAYS UP TO TWO YEARS:*
    - ☛ *6.1 MONTHLY OUTLOOK*
    - ☛ *6.2 THREE MONTH OR 90 DAY OUTLOOK*
    - ☛ *6.3 SEASONAL OUTLOOK*
- ◆ **7. CLIMATE FORECASTING**
  - *BEYOND TWO YEARS*



# WMO Technical Commissions involved in Long-Range Forecasting

- ❖ CBS : World Weather Watch, including operational forecasting (GDPFS)
- ❖ CCI : climate information and services
- ❖ CAS : Research in weather forecasting and climate

*CBS: Basic Systems*

*CCI: Climatology*

*CAS: Atmospheric Sciences*

## **GDPFS - LONG-RANGE FORECASTING (LRF)**

### **An established network of Centres**

- ◆ **Global Producing Centres of Long-Range Forecasts (GPC):** Beijing, Exeter, Melbourne, Montreal, Seoul, Tokyo, Toulouse, Washington, ECMWF (*and Moscow, to be proposed at next CBS, March 2009*)
- ◆ **Lead Centre for Standard Verification System of LRF (Melbourne-Montreal) : LC- SVSLRF**
- ◆ **Lead Centre for LRF Multi-Model Ensemble (Seoul-Washington): LC-LRFMME** (*to be proposed at next CBS*)
- ◆ **Regional Climate Centres (RCCs)** (*to be proposed at next CBS*)
- ◆ **National Meteorological Centres (NMCs)**



**STATUS OF RSMCs AND NMCs RELATIVE TO OPERATIONAL NWP LRF (2005, 2006 or 2007 information)** (last update 07/08)

GM = Global Model

Perturbation technique for ensemble: SV = Singular Vectors, LAF = Lagged Average Forecasts, StoP = Stochastic Physics, OP = Observation Perturbations

<i><b>CENTRE</b></i>	<i><b>STATUS</b></i>	<i><b>MODELS</b></i>	<i><b>RESOL.</b></i>	<i><b>LEVELS</b></i>	<i><b>RANGE</b></i>
<b>PRETORIA</b>	RSMC	ECHAM Ens. 12 members LAF	T42	L19	6 month
<b>SEOUL</b>	NMC	GDAPS Ens. 20 members, LAF, 2 tier system	T106	L21	3 months 6 months
<b>BEIJING</b>	RSMC	GM Ens. 48 members LAF coupled 8 atmo x 6 oceano cond.(perturb ocean) Ocean:	T63 GT63	L16 L30	Season
<b>TOKYO</b>	RSMC	GM Ens. 51 members, SV, 2 tiers for SST	T95	60	8 months
		GM Coupled (AGCM/OGCM) Ens. 31 members, SV	T42	40	14 months
<b>LIMA</b>	NMC	CCM3 En. 12 members, SST (forecast by NCEP and perturbed)	T42	L32	9 months
<b>INPE/CPTEC -SAO PAULO</b>	Special Centre	GM Coupled, Ens. 30 members (Random OP) Fixed and predicted SST	T62	28	6 months
<b>IRI (USA)</b>	Special Centre	Ens. multi-models, over 30 members, LAF			6 months
<b>MONTREAL</b>	RSMC	GM Ens. 40 members (24 h LAF, four models) 2 tiers Ocean:	1.875° T32	50 10	9 months
<b>WASHINGTON</b>	WMC / RSMC	Ens. 40 members, (GFS) coupled, Modular Ocean Model ,MOM 3, LAF	T62 1/3-1deg.	64 40	7 months
<b>MELBOURNE</b>	WMC / RSMC	Ens. 30 members, LAF, GM (POAMA) coupled with Ocean model ACOM2:	T47 0.5°-1.5°	17 25	10 months
<b>ECMWF</b>	RSMC	IFS Ens. 41 members OP+StoP, coupled with HOPE , 5 OI ocean analyses with SST perturbation, Ocean:	T159 Zonal resol. 1.4 deg	62 29	7months 4 times a year 13 months
<b>TOULOUSE</b>	T.M. RSMC	ARPEGE-Climat Ens. 10 members – LAF Coupled OPA8.2	T63	31	129 days
		ARPEGE-Climat Ens. 41 members – LAF Coupled 8 atmos. x 5 ocean initial states Ocean:	T63 0.5 – 2 deg.	31 31	16 months
<b>EXETER</b>	Geo. and T.M. RSMC	GM Had CM3 Glosea Ens. 41 members, coupled, OI Ocean, 40 random OP of SST	2.5° 1.25°- 0.28°	19 40	6 months
<b>MOSCOW</b>	WMC, Geo. RSMC	GM Ens. 10 members, two-tier, OI ocean, Semi-Lagrangian AGCM..	1.125°/ 1.40625°	28	4 months

# Required Functions of WMO GPCs

- ◆ **A GPC must as a minimum adhere to the following criteria:**
  - **Fixed production cycles and time of issuance;**
  - **Provide a minimum set of products, as listed in the WMO Manual on the GDFPS;**
  - **Provide verification information, as per the WMO Standard Verification System for LRF;**
  - **Provide up-to-date information on methodology used by the GPC;**
  - **Make products accessible through the GPC Web site and/or disseminated through the GTS and/or Internet.**
  
- ◆ **Additional data or products to the minimum list could also be provided by GPCs (conditions may apply).**



# MANDATORY GPC FORECAST PRODUCTS

- ◆ **(a) Calibrated outputs from ensemble prediction systems showing the mean and spread of the distribution for:**
  - • **2-metre temperature over land;**
  - • **Sea-surface temperature;**
  - • **Precipitation;**
  - • **Z500, MSLP, T850.**
  - *NOTE: These fields are to be expressed as departures from normal model climate.*
- ◆ **(b) Calibrated probability information for forecast categories for:**
  - • **2-metre temperature over land;**
  - • **SST (atmospheric coupled models only);**
  - • **Precipitation.**
  - *NOTES:*
    - - *Tercile categories should be provided, consistent with present capabilities. Information for larger numbers of categories (e.g. 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.*
    - - *Information on how category boundaries are defined, should be made available.*
    - - *“Calibrated” implies correction based on systematic errors in model climatology, using at least 15 years of retrospective forecasts.*



# BASIC PROPERTIES OF MANDATORY GPC FORECAST PRODUCTS

- ◆ Temporal resolution: averages, accumulations or frequencies over 1-month or longer periods (seasons)
- ◆ Spatial resolution:  $2.5^{\circ} \times 2.5^{\circ}$  *Note: Selected to match resolution of current verification data.*
- ◆ Spatial coverage: global (separate areas of interest to users, down to subregions of a continent or ocean basin, may be provided on special request from Members.)
- ◆ Lead-time: any lead times between 0 and 4 months
- ◆ Issue frequency: monthly or at least quarterly
- ◆ Output types: either rendered images (e.g. forecast maps and diagrams) or digital data. GRIB-2 format should be used for products posted on FTP sites or disseminated through the GTS
- ◆ Indications of skill including hindcast should be provided in accordance with recommendations from CBS on the Standardized Verification System. Verification results over the hindcast period are mandatory.



## ADDITIONAL INFORMATION THAT MAY BE PROVIDED BY GPCS to RCCs or NMCs

- ◆ **Other Long-Range Forecast data, products or other information, in addition to the minimum list defined in GPDFS Manual, which could also be provided by GPCs on request by RCCs or NMCs (the RCCs and NMCs would adhere to conditions, if any, attached by the GPCs to these data and products):**
- ◆ **1. Grid point value (GPV) products (these are preferred in GRIB 2 format, especially for downscaling):**
  - hindcast and forecast data for downscaling algorithms;
  - data for RCM boundary and initial conditions;
  - predicted global weekly values of SST.
- ◆ **2. Information to assist in building capacity in areas such as:**
  - interpretation and use of ERF and LRF products;
  - downscaling techniques (both statistical and dynamical);
  - verification techniques (for local verification of RCC generated products and application outputs);
  - development of local user applications from RCC downscaled products;
  - use and implementation of regional climate models.



# **Lead Centre for Standard Verification System for LRF**

**CBS designated WMC Melbourne and the RSMC Montreal as Co-Lead Centre for verification of long-range forecasts (2002);**

**Co-Lead Centre functions include creating, maintaining coordinated Web sites for LRF verification information, so that potential users will benefit from a consistent presentation of the results;**

**Goal is to help the users (RCCs, NMHSs) to improve long-range forecasts and services delivered.**



## **Role of the Lead Centre for Standard Verification System of LRF**

**1 The purpose of the Lead Centre is to create, develop and maintain the website (the “SVSLRF website”) to provide access to the LRF verification information. The address of the website is <http://www.bom.gov.au/wmo/lrfvs/>. The website:**

- (a) Provides access to standardized software for calculating scoring information (ROC curves, areas, contingency table scores, hit rates, ...).**
- (b) Provides consistent graphical displays of the verification results from participating centres through processing of digital versions of the results;**
- (c) Contains relevant documentation and links to the websites of global-scale producing centres;**
- (d) Provides some means for the collection of feedback from NMHSs and RCCs on the usefulness of the verification information;**
- (e) Contains information and, preferably, provide access to available verification data sets;**

**2 The Centre also:**

- (a) Produces monthly verification data sets in common format on  $2.5^\circ \times 2.5^\circ$  grids where appropriate;**
- (b) Liaises with other groups involved in verification (e.g. WGSIP and CCI) on the effectiveness of the current standardized verification system (SVS) and identify areas for future development and improvement;**
- (c) Provides periodic reports to CBS and other relevant commissions assessing the effectiveness of the SVS;**
- (d) Facilitates the availability of information to assess the skill of long-range forecasts but not to provide a direct intercomparison between the GPCs’ models.**





# LC-LRFMME

**“Given the anticipated improvements in skill of Long-Range Forecasts (LRF) by using a multi-model ensembles (MME) approach, some GPCs can serve as collectors of global LRF data to build MME and to make MME LRF predictions. Such Centres may become Lead Centres for Long-Range Forecast of Multi-Model Ensembles predictions (LC-LRFMME).”**

# LEAD CENTRES FOR LONG-RANGE FORECAST OF MULTI MODEL ENSEMBLE (MME) PREDICTION *(to be proposed to next CBS)*

- ◆ **1. GPC Seoul and GPC Washington are jointly recognized as a Lead Centre for Long-Range Forecast of Multi Model Ensemble (MME) predictions, including responsibility for a web portal of GPC and MME products with global coverage.**
- ◆ **2. Functions of Lead Centres for Long-Range Forecast of Multi Model Ensemble (MME) prediction include:**
  - **Maintain a repository of documentation for the system configuration of all GPC systems**
  - **Collect an agreed set of forecast data from GPCs**
  - **Display GPCs forecasts in standard format**
  - **Promote research and experience in MME techniques and provide guidance and support on MME techniques to GPCs, RCCs and NMHSs.**
  - **Based on comparison among different models, provide feedback to GPCs about the models performance**
  - **Generate an agreed set of Lead Centre (LC) products**
  - **Provide web pages to satisfy requirements for regional display of Lead Centre products (e.g. for RCOF coordinators)**
  - **Where possible verify the LC products using the SVSLRF.**
  - **Redistribute digital forecast data for those GPC's that allow it.**
  - **Handle requests for the password for the website and data distribution; maintain a database recording the users who have requested access to data/products and the frequency of access**
  - **Maintain an archive of the real-time GPC and MME forecasts.**



## DESIGNATION OF REGIONAL CLIMATE CENTRES (RCCs) AND RCC-NETWORKS *(to be approved by next CBS)*



- ◆ A multifunctional centre that fulfils all the required functions of an RCC for the entire region, or for a sub-region to be defined by the Regional Association may be designated by WMO as a 'WMO Regional Climate Centre' (WMO RCC).
- ◆ A group of centres performing climate-related activities that collectively fulfil all the required functions of an RCC may be designated by WMO as a 'WMO Regional Climate Centre Network' (WMO RCC-Network). Each centre in a designated WMO RCC-Network will be referred to as a 'Node'. A Node will perform, for the region or sub-region defined by the Regional Association, one or several of the mandatory RCC activities (e.g. long-range forecasting (LRF), climate monitoring, climate data services, training).
- ◆ Only centres or groups of centres designated by WMO will carry the title 'WMO RCC' or 'WMO RCC-Network' respectively.
- ◆ Recipients of RCC products and services will be NMHSs, other RCCs and international institutions recognized by the Regional Association and will be referred to as 'RCC Users'.
- ◆ WMO RCCs and RCC-Networks shall follow Guidance published by the Commission for Climatology on technical, climate-related matters.

# Minimum set of functions for an RCC

- ◆ **OPERATIONAL ACTIVITIES FOR Long-Range Forecasting:**
  - Interpret and assess relevant LRF products from Global Producing Centres (GPCs), make use of Lead Centre for Standard Verification System on LRF, distribute relevant information to RCC Users; and provide feedback to GPCs
  - Generate regional and sub-regional tailored products, relevant to RCC users needs, including seasonal outlooks, etc.;
  - Perform verification of RCC quantitative LRF products;
  - Generate ‘consensus’ statement on regional or sub-regional forecasts;
  - Provide on-line access to RCC products/services to RCC users;
  - Assess use of RCC products and services through feedback from RCC users.
  
- ◆ **OPERATIONAL ACTIVITIES FOR CLIMATE MONITORING:**
  
- ◆ **OPERATIONAL DATA SERVICES, TO SUPPORT LRF AND CLIMATE MONITORING:**
  
- ◆ **TRAINING IN THE USE OF OPERATIONAL RCC PRODUCTS AND SERVICES**

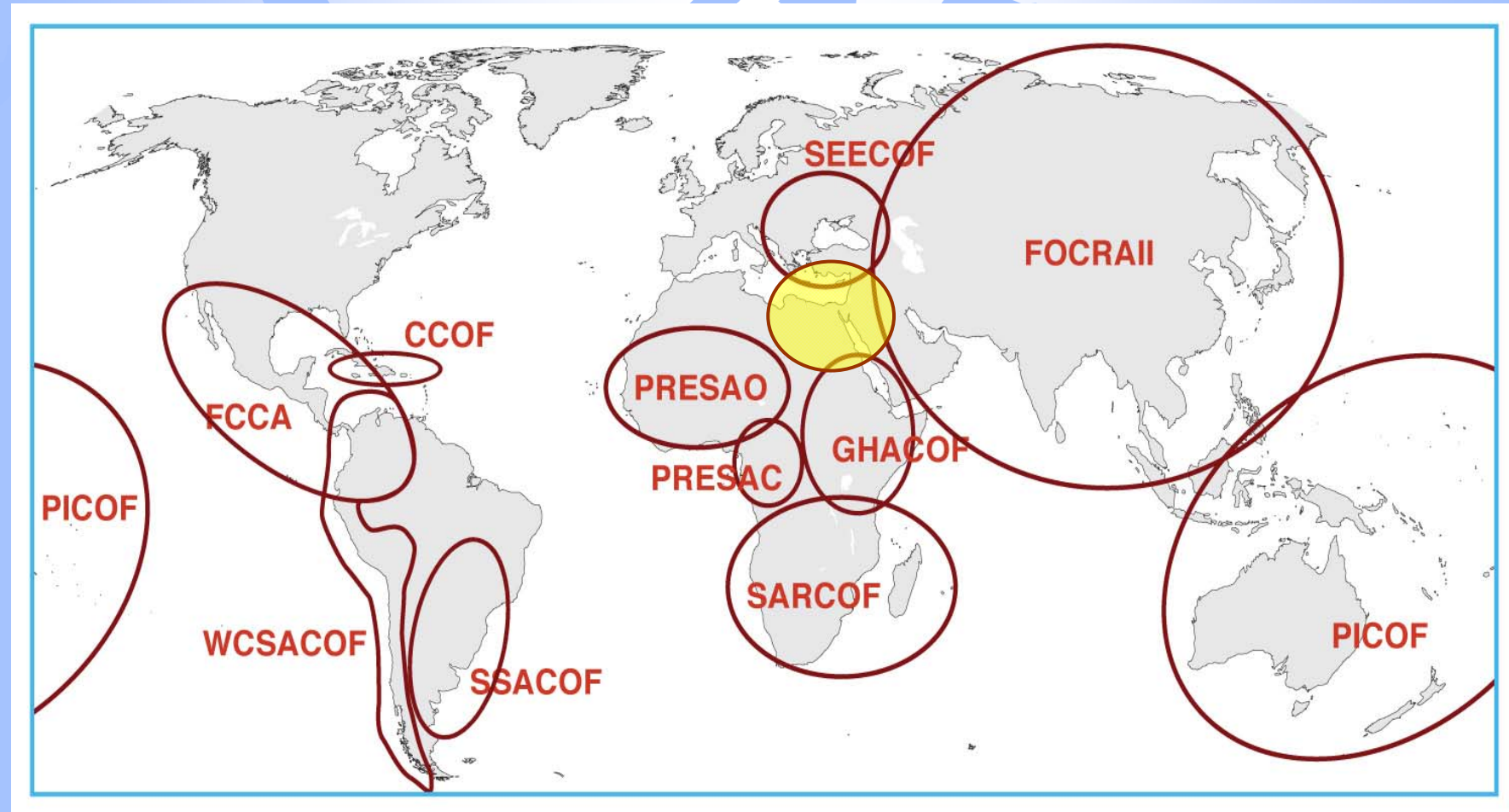


# Regional Climate Outlook Forum (RCOF) Process

- ◆ Meetings of the regional and international climate experts to develop a consensus for the regional climate outlook;
- ◆ Involves scientists and representatives of user sectors, for identification of impacts and implications, and the formulation of response strategies;
- ◆ Training on seasonal climate prediction to strengthen the capacity of the national and regional climate scientists;
- ◆ Special outreach involving sector specialists as well as media experts to develop effective communications strategies.

*CLIPS : Climate Information and Prediction Services*

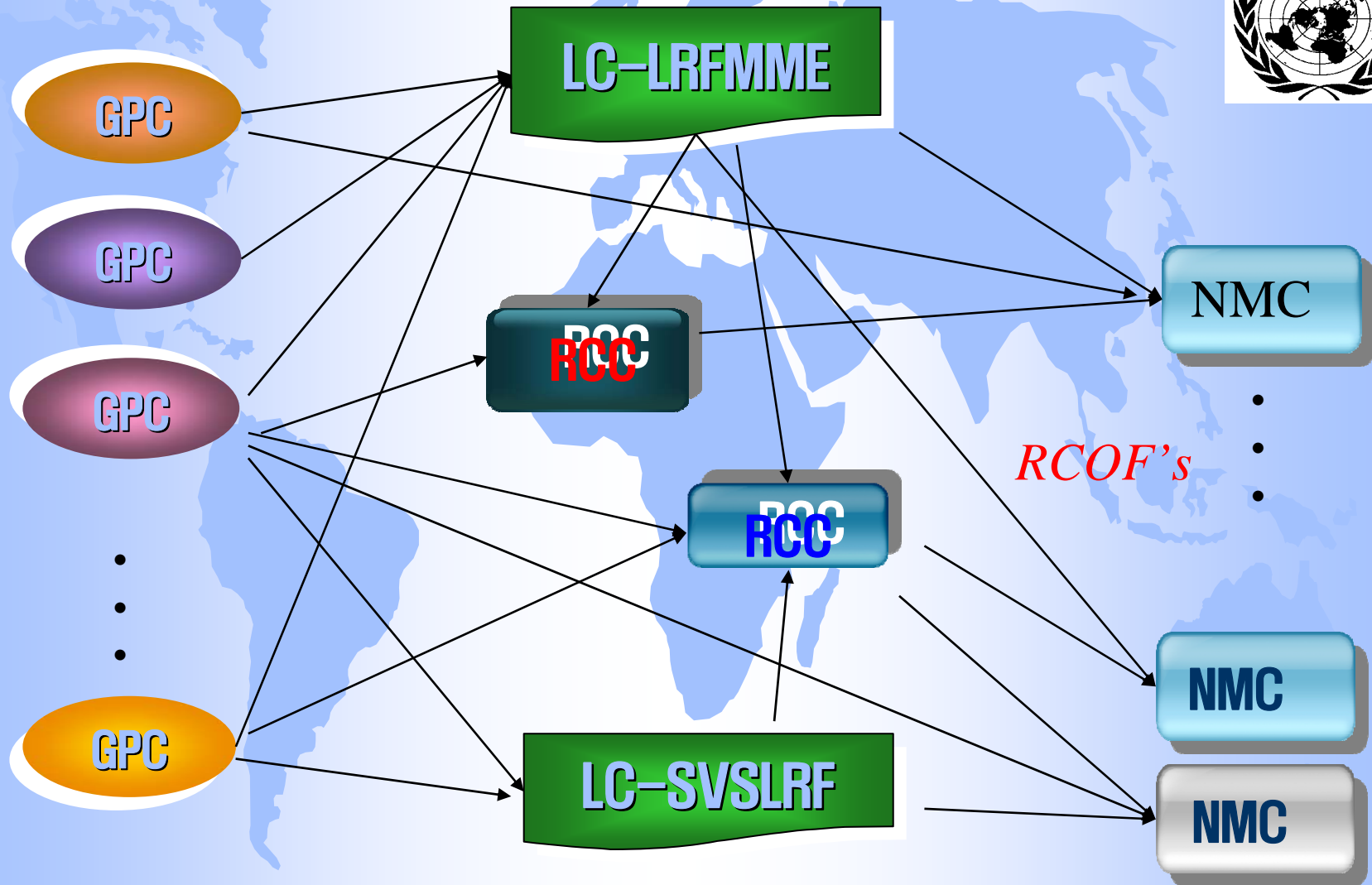
# Existing RCOFs worldwide



[http://www.wmo.int/pages/prog/wcp/wcasp/clips/outlooks/climate\\_forecasts.html](http://www.wmo.int/pages/prog/wcp/wcasp/clips/outlooks/climate_forecasts.html)

# LONG-RANGE FORECASTING (LRF)

A network of GDPFS Centres



# Severe Weather Forecasting Demonstration Project (SWFDP)

*Regional approach with very positive learning experiences...*

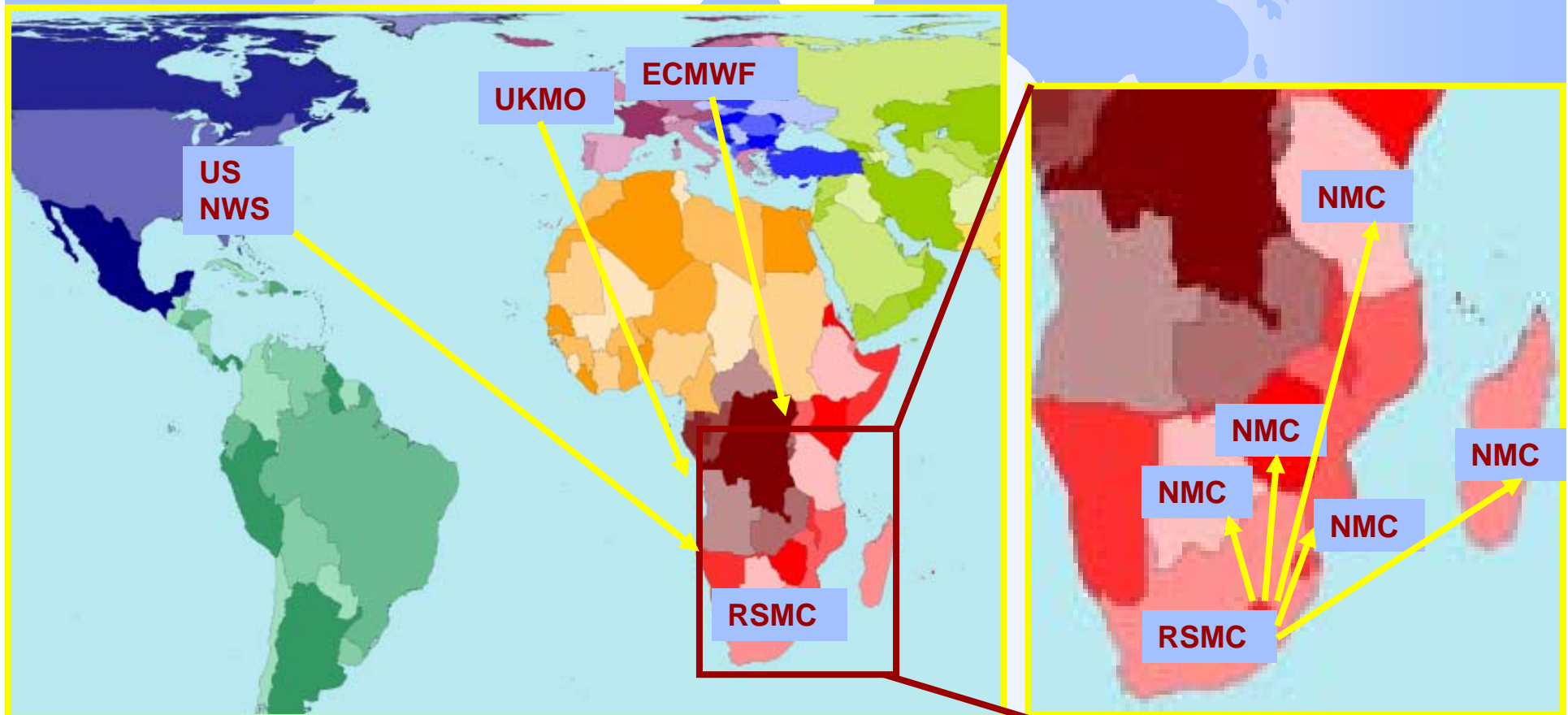
- ❖ Enhancing the use of existing NWP products
- ❖ Regional partnership and operational framework to build forecasting capacity in developing countries

## *Cascading Forecasting Process:*

- ❖ Global NWP/EPS products tailored and provided by major GDPFS Centres
- ❖ Key role of one RSMC in regional guidance (LAM, daily bulletins) through a dedicated Web site/portal
- ❖ Accelerating technology transfer

◆ SWFDP's Cascading principle:

- Special products from Global centres to RSMC-Pretoria
- RSMC prepares guidance forecasts for next 5 days and disseminates daily to 5 NMCs
- NMCs use guidance forecast in preparing warnings when appropriate to civil protection authorities



## Closing thoughts ...

- ❖ S&T for meeting needs of wide range of users, creating advantages in economies, and assuring public safety and security measures for nations
- ❖ Effective partnerships among members and organizations - regionalized approach to focus on well defined regional needs
- ❖ Objective-subjective mix for seasonal forecasting
- ❖ S&T transfers to operations, accelerate implementation of existing and proven technologies in developing countries and economies
- ❖ Leadership of APCC: setting an example of excellence

## Closing thoughts ... (2)

- ❖ GDPFS framework has been built to enhance the provision of forecasting services for WMO Members; e.g. long-range forecasting to contribute to Climate Information and Services
- ❖ GPC-LRF => RCC => (RCOF) => NMS => users and public
- ❖ Forecasters and users of seasonal forecasts have to embrace probabilistic approach to forecasting;
- ❖ Operational seasonal forecasts have a role to influence and indirectly shape policy development for climate change mitigation and adaptation



**WMO Global Data-Processing and Forecasting System  
“Seasonal Forecasting in the Provision of Meteorological Services”**

***Thank You!***

***Mr Peter Chen  
Chief, Data-Processing and Forecasting Systems Division  
Weather and DRR Services Department, WMO***

***+(41 22) 730 82 31***

***+(41 22) 730 80 21 (fax)***

***[pchen@wmo.int](mailto:pchen@wmo.int)***