



WORLD CLIMATE PROGRAMME

WORLD CLIMATE APPLICATIONS AND SERVICES PROGRAMME

WORKSHOP ON STRATEGY FOR IMPLEMENTATION OF CLIMATE SERVICES INFORMATION SYSTEM (CSIS)

5-7 April 2011, Geneva, Switzerland

FINAL REPORT

WORLD METEOROLOGICAL ORGANIZATION
June 2011

The **World Climate Programme (WCP)** implemented by WMO in conjunction with other international organizations consists of the following major components:

- World Climate Research Programme (WCRP)
- World Climate Data and Monitoring Programme (WCDMP)
- World Climate Applications and Services Programme (WCASP)
- World Climate Impact Assessment and Response Strategies Programme (WCIRP)

World Meteorological Organization
7bis, av. de la Paix
Case postale 2300
CH 1211 Geneva
Switzerland

Telephone : +41 (0) 22 730 81 11
Telefax : +41 (0) 22 730 81 81
Email: wmo@wmo.int

NOTE

The designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the Secretariat of the World Meteorological Organization concerning the legal status of any country, territory, city or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Editorial Note: This report has for the greater part been produced without editorial revision by the WMO Secretariat. It is not an official publication and its distribution in this form does not imply endorsement by the Organization of the ideas expressed.



Participants at the Workshop on Strategy for Implementation of CSIS.

List of Abbreviations

ACMAD	African Centre of Meteorological Application for Development
APCC	APEC (Asia-Pacific Economic Commission) Climate Centre
BCC	Beijing Climate Centre
CIIFEN	Centro Internacional para la Investigación del Fenómeno de El Niño
CCI	WMO's Technical Commission for Climatology
CLIPS	WMO's Climate Information and Prediction Services project
CSIS	Climate Services Information System (GFCS component)
GCOS	Global Climate Observing System
GDPFS	WMO's Global Data Processing and Forecasting System
GFCS	Global Framework for Climate Services
GPC	WMO Global Producing Centres for Long-range Forecasts
GSCU	Global Seasonal Climate Update
ICPAC	IGAD Climate Prediction and Applications Centre
IRI	International Research Institute for Climate and Society
LC-LRFMME	WMO Lead Centre for Long-range Forecast Multi-Model Ensembles
LC-SVSLRF	WMO Lead Centre for Standard Verification System of Long-range Forecasts
LRF	Long-range Forecasting
NCC	National Climate Centre
NCOF	National Climate Outlook Forum
NCS	National Climate Service
NEACC	North Eurasian Climate Centre
NMHS	National Meteorological and Hydrological Service
NOAA	National Oceanic and Atmospheric Administration
RCC	WMO Regional Climate Centre
RCOF	Regional Climate Outlook Forum
TCC	Tokyo Climate Centre
UIP	User Interface Platform (GFCS component)
UKMO	UK Met Office
WCRP	World Climate Research Programme
WIS	WMO Information System
WMO	World Meteorological Organization

TABLE OF CONTENTS

1. Opening.....	1
2. Organisation of the meeting	1
3. GFCS and its CSIS component – background, current status and workshop concept.....	1
4. Towards an efficient uptake of global and regional information at national level	1
5. Prospects of extending WMO RCC and RCOF concepts to national levels	2
6. Towards an overall WMO infrastructure for climate information	3
7. Any other business.....	3
8. Conclusions and recommendations	3
9. Closing	6

Annexes:

I. Workshop Agenda.....	7
II. List of Participants	10
III. Work Plan of the Workshop.....	13
IV. CSIS Workshop Concept Note.....	16
V. Overview of Functions and Products of Potential WMO CSIS Elements	18
VI. Regional Climate Centres – Status By Region.....	21
VII. Towards an Overall WMO Infrastructure for Climate Information	31
VIII. Implementing Climate Monitoring In CSIS	36
IX. LRF Component of the CSIS.....	40

WORKSHOP REPORT

1. Opening

The WMO Workshop on Strategy for Implementation of Climate Services Information System (CSIS) was opened at 0900 Hours on Tuesday, 5 April 2011, at WMO Headquarters in Geneva, Switzerland. Mr Avinash Tyagi, Director Climate and Water Department, welcomed the participants on behalf of the Secretary-General. In his opening statement he addressed the Global Framework for Climate Services (GFCS) and its implementation schedule as being proposed to the 16th World Meteorological Congress (Geneva, May-June 2011). Congress is expected to request a detailed GFCS implementation plan by early 2012 to be elaborated by an intergovernmental mechanism. Mr Tyagi stated that it is now time to start detailed discussions on how various GFCS structures might look like in order to facilitate related Congress discussions as well as to provide input to the work of the expected intergovernmental group. Accordingly, this CSIS workshop is intended to shed light on CSIS operational aspects.

Dr Michael Coughlan and Mr Stefan Rösner, co-chairs of the workshop, welcomed the participants and encouraged a lively discussion during the Workshop.

2. Organisation of the meeting

2.1 *Adoption of the agenda*

The agenda was adopted without any changes, as provided in Annex I to this report.

2.2 *Working arrangements*

The workshop agreed its hours of work and other practical arrangements. The list of participants attending the workshop is provided in Annex II to this report. Mr Coughlan introduced the proposed work plan for the workshop (Annex III). The participants agreed on the proposed structure of, and share of responsibilities within, the different sessions of the workshop.

3. GFCS and its CSIS component – background, current status and workshop concept

Mr Tyagi introduced the key findings of the High-level Task Force on GFCS as laid down in its final report (http://www.wmo.int/hlt-gfcs/downloads/HLT_book_full.pdf). The subsequent discussion highlighted the fact that the ultimate proof of the success of GFCS will be that climate services are delivered at the local level and improve related local community decision making in a sustained manner.

Dr Coughlan presented the *CSIS Workshop Concept Note* (Annex IV) and emphasised the need to consider during the workshop (i) the close linkages amongst GFCS components and (ii) the fact that GFCS, including CSIS, will involve the integration of contributions from entities and mechanisms both within and outside the existing WMO structures.

4. Towards an efficient uptake of global and regional information at national level

The workshop was presented with examples of available global and regional climate data, monitoring, prediction and projection information from global, regional and national entities and mechanisms (introductory overview see Annex V), such as WMO Global Producing Centres for

Long-range Forecasts (GPCs), the WCRP Coupled Model Intercomparison Project (CMIP), WMO Regional Climate Centres (RCCs; status document see Annex VI), the WMO RCC Tokyo (Japan), the WCRP Co-ordinated Regional Climate Downscaling Experiment (CORDEX), Regional Climate Outlook Forums (RCOFs), the WMO Climate Watch concept, the Caribbean Institute for Meteorology and Hydrology (CIMH), the Climate Prediction Centre (CPC) of the USA, the National Climatic Data Centre (NCDC) of the USA, the Global Drought Monitor Portal (hosted by the NCDC), and the Southeast European Virtual Climate Change Centre (SEEVCCC). Also, aspects of global climate data were addressed.

The subsequent discussion highlighted the following issues for further consideration:

- Setting-up a catalogue of mandatory and highly-recommended CSIS products
- Expanding where feasible climate prediction activities to monthly as well as multi-annual to decadal timescales, and thereby contributing to the notion of a seamless set of services provided by CSIS on climate-relevant prediction time-scales
- Improving visibility and accessibility of CSIS-relevant global and regional products
- Assessing the level of user involvement in climate product generation, such as consensus processes during RCOFs: Are users interested in technical and scientific details? Preferable to focus separately on the communication of forecast products jointly with users to better capture their respective needs.
- Developing a thorough understanding of user needs and user decision processes in order to successfully tailor climate products.
- Setting up co-ordination mechanisms in regions where more than one WMO RCC delivers products and services.

Furthermore the workshop was presented with examples of national climate services delivered by the NMHSs of Armenia, Australia, Pakistan and Serbia with a view of examining their respective capabilities to apply global and regional climate information. The experience from various NMHSs highlighted that they usually have capabilities to access global and regional information but many require extensive training on how to use it effectively.

Eventually, the workshop participants organized themselves into two working groups to discuss improvements in the uptake of global and regional climate information at national level from (i) global and regional provider perspectives and (ii) from NMHS perspectives. The outcomes of the working group discussions were further elaborated during the workshop and form the essence of the workshop's '*Conclusions and Recommendations*' as recorded in section 8 of this report.

5. Prospects of extending WMO RCC and RCOF concepts to national levels

Dr Simon Mason and Dr David Walland introduced the work of the CCI Task Team on CLIPS (WMO Climate Information and Prediction Services project), a key task of which is to prepare a conceptual plan for the transition of CLIPS into the GFCS. Amongst the outcomes of the Task Team's considerations so far are (i) a concept note on *National Climate Centres* and *National Climate Services*, (ii) a set of standards and recommended tools for a *CLIPS Tool Box* and (iii) an analysis of the strengths and weaknesses of the current CLIPS Focal Point Network including draft recommendations on more appropriate mechanisms.

In the subsequent discussions, it was highlighted that further clarifications on the nature and operation of the proposed GFCS User Interface Platform (UIP) are needed in order to characterise fully how the very diverse user community will take up CSIS products and services. It was emphasised that provider/user interactions might often be more effective at user-led meetings rather than at climate-centred workshops and meetings. One example cited is the Malaria Outlook Forum, to which climatologists contribute the climate part of the forum.

There are also some examples with National Climate Outlook Forums (NCOFs) which have a certain potential to attract users that are well informed about the potential impacts of climate variability and extremes. In order to reach the main part of the user community, however, information brokers, boundary organisations and communicators are generally needed. NMHSs alone cannot manage this task, and while the UIP is yet to be fully defined, CSIS mechanisms should be flexible to adapt to respective user demands.

6. Towards an overall WMO infrastructure for climate information

Mr Bernard Strauss introduced the WMO Global Data Processing and Forecasting System (GDPFS) and its operating principles, which are of great importance for CSIS. The GDPFS constitutes WMO's worldwide network of operational meteorological centres that also include GPCs and RCCs. GDPFS operating principles are based on clearly stated requirements, and comprise committed products and services available to all WMO Members.

Mr Peiliang Shi presented an overview of the WMO Information System (WIS), which forms *the* single co-ordinated WMO infrastructure for data and product exchange. In order to gain maximum benefit from this unique infrastructure, it will be essential that as many CSIS operations as possible be WIS compliant. Designation of CSIS entities as WIS centres (e.g. Data Collection and Production Centres, DCPCs) should be highly encouraged.

Ms Maryam Golnaraghi provided an overview of WMO's Disaster Risk Reduction Programme, which is an integrated and user-oriented programme requiring state-of-the-art climate services at all scales for the direct benefit of societies.

Mrs Leslie Malone introduced the currently launched activities of CCI in the domain of climate information for adaptation and risk management, where the efficient uptake of climate information by user communities is a key issue.

Mr Peer Hechler presented the discussion paper *Towards an overall WMO Infrastructure for Climate Information* (Annex VII).

The subsequent panel discussion highlighted important aspects relevant to CSIS and its further evolution. Its key outcomes are reflected in section 8 *Conclusions and Recommendations* of this report. More comprehensive draft statements on climate monitoring and climate predictions are available in Annexes VIII and IX.

Finally, the workshop participants reviewed a first draft for an implementation strategy for CSIS and provided comments. The draft will be further consolidated on the basis of the workshop recommendations.

7. Any other business

No further items were raised by the participants.

8. Conclusions and recommendations

The following draft conclusions and recommendations were made in order to facilitate the implementation of CSIS. They address WMO contributions to CSIS, which are expected to form the core part of CSIS. Appropriate linkages to further contributions to CSIS from outside the WMO community need to be identified and defined.

It is well acknowledged that all new activities discussed below may have resource implications that will need to be addressed appropriately.

(A) *CSIS system as a whole:*

- A.1 A set of top-level functions of CSIS can be defined on the lines of the operational functions identified for WMO Global Producing Centres (GPCs) and Regional Climate Centres (RCCs), such as (i) climate data management, (ii) climate monitoring, (iii) climate prediction and (iv) climate projection. These functions include processes of analysis, re-analysis, diagnostics, interpretation, attribution, verification and communication carried out over a global-regional-national system of providers.
- A.2 Formalized structures for CSIS elements and mechanisms are essential for standardization, sustainability, reliability, adherence to policies etc. Existing WMO CSIS elements, particularly on the global level, do not yet fully cover aspects of climate data, climate monitoring or climate predictions other than at seasonal time scales.
- A.3 Knowledge of user requirements and understanding of how users apply climate information are fundamental to the successful generation and delivery of climate services. While the GFCS User Interface Platform (UIP) component is expected to facilitate this process, a basic appreciation of user receptivity is essential for the effective design, dissemination and uptake of CSIS products and services.
- A.4 The achievement of a climate research objective may not of itself result in a usable product or service without further resources to bring it into application or operation. Accordingly, CSIS operational entities, such as WMO RCCs and WMO GPCs, should participate in the formulation of research programmes and projects that are expected to generate outcomes that will improve the effectiveness of CSIS products and services. This collaboration would *inter alia* facilitate the inclusion in research budgets of an estimate of the resources required to transfer the expected research findings into an operational environment.
- A.5 The CSIS must be WIS compliant to ensure interoperability and a wide utilization of its data and services. Global, regional and national climate data sets and climate products generated by CSIS should be identified and catalogued under WIS compliant procedures for exchange.
- A.6 The operational functions of CSIS should follow the procedures developed within the WMO GDPFS framework to ensure that products and services are delivered according to agreed user requirements on quality and reliability. The operational functions of participating centres should be specified, as well as mandatory and proposed additional (highly) recommended products. Information on system and product characteristics and on verification and monitoring results should be made available.
- A.7 Activities to raise awareness on the availability of information on the changing climate and on the use of model-based projections of climate change into the future should be undertaken as part of the CSIS in association with other components of the GFCS.
- A.8 There is a need to enhance training and capacity building initiatives relating to the generation and application of all CSIS products.

(B) *CSIS functions and products:*

- B.1 High-resolution, high-quality and homogeneous climate datasets, including reanalysis, hindcast, proxy and paleoclimatic data, constitute critical inputs for climate services including for developing monitoring and LRF capabilities as well as downscaling tools.
- B.2 To facilitate CSIS product and service generation, WMO Members are strongly encouraged to make key historical data available for inclusion in gridded regional and global climate data sets, which would then allow the free exchange of grid point data in ways that are consistent with national data policies.

- B.3 A large amount of historic climate data and associated metadata stored on perishable media such as paper and microfiche are at imminent risk of permanent loss, and therefore their digitization is an urgent priority.
 - B.4 Standard methods should be developed where possible to reduce the scope of inconsistencies of different climate data sets and climate monitoring products as well as Long-range Forecast products in terms of methodologies used, reference climatologies applied and presentation chosen. Accordingly, relevant standards need to be co-ordinated across different elements of the CSIS. In addition, products should be presented in consistent formats, e.g. for comparison and verification purposes.
 - B.5 The identification and use of a common reference period (climate reference period and hindcast period) for a core set of climate monitoring and prediction products should be encouraged, whilst recognizing that for specific, user-tailored products other reference periods might apply according to respective user needs. In all cases the climate reference period employed must be clearly stated.
 - B.6 The diagnosis and attribution of climate variability and extremes are important CSIS tasks that require close co-operation between national, regional and global entities. Communication of related climate monitoring information is required by users both in quasi-real time mode as well as through thorough scientific analyses in retrospect.
 - B.7 Formal WMO mechanisms for the provision of operational climate prediction services have been developed for seasonal timescales and similar mechanisms, including verification standards, need to be established for forecast activities on monthly as well as multi-annual to decadal timescales. Close links with the research community are needed to ensure that the capabilities and limitations of monthly and multi-annual to decadal predictions are clearly communicated to all users.
 - B.8 Existing gaps in forecast capabilities between weather and climate timescales need to be bridged in order to provide a more 'seamless' set of monitoring and prediction services.
 - B.9 The delivery of climate change information by the research community should be closely co-ordinated with existing and planned climate service delivery systems of CSIS. Related issues should include the provision of advice and guidance on the appropriate use of climate change projections and their limitations.
 - B.10 Delivery of CSIS products across all domains and timescales should be accompanied by appropriate documentation (including metadata) and, where appropriate, scientific publications.
 - B.11 CSIS should clearly communicate the nature and size of any uncertainties associated with its products, including data sets, climate monitoring and prediction products and climate projections.
- (C) *NMHSs within the CSIS:*
- C.1 NMHSs require a suite of tools, including guidelines on their use and respective training programmes, to enable them to efficiently apply global and regional products for generating tailored products for national climate services.
 - C.2 A baseline of current capabilities of NMHSs to implement CSIS and interact with other GFCS components, such as the User Interface Platform, should be established by appropriate means.
 - C.3 NMHSs should be encouraged to document cases of extreme weather/climate events including their meteorological settings and impacts, drawing on regional and global products as appropriate.
 - C.4 NMHSs should explore mechanisms being made available for supporting activities to mitigate and adapt to climate change for gaining resources to carry out data rescue and data homogenisation efforts.

C.5 NMHSs should exploit, through GFCS and its UIP, possibilities for accessing quality-controlled and homogenized socio-economic and impact data in order to develop more efficient and user-oriented products and services.

(D) *WMO RCCs within the CSIS:*

D.1 WMO RCCs, in close liaison with WMO GPCs and upon request from NMHSs, are encouraged to develop capabilities for downscaling predictive information across all climate timescales for use at regional and national levels within their respective regions. In addition, WMO RCCs are encouraged to consider setting up mechanisms which would enable their client NMHSs to perform downscaling/tailoring analyses online.

D.2 WMO RCCs are encouraged, on request from NMHSs, to: (i) generate climate analysis products on a daily basis; (ii) conduct data homogeneity assessments and adjustments; and (iii) co-ordinate agreement on a relevant list of useful climate indices for their region of responsibility.

9. Closing

In closing, the co-chairs Dr Mike Coughlan and Mr Stefan Rösner thanked all the participants for their dedication and valuable inputs to the discussion and the WMO Secretariat staff for their excellent support and advice. It was stressed that the workshop outcome is expected to greatly facilitate Congress discussions on the subject as well as further GFCS implementation activities.

The workshop was closed on Thursday, 7th of April 2011 at 3:26 p.m.

WORKSHOP AGENDA

- 1. OPENING**
- 2. ORGANIZATION OF THE MEETING**
 - 2.1 Adoption of the agenda
 - 2.2 Working arrangements
- 3. GFCS AND ITS CSIS COMPONENT: BACKGROUND, CURRENT STATUS AND WORKSHOP CONCEPT**
- 4. TOWARDS AN EFFICIENT UPTAKE OF GLOBAL AND REGIONAL CLIMATE INFORMATION AT NATIONAL LEVEL**
- 5. PROSPECTS OF EXTENDING RCC AND RCOF CONCEPTS TO NATIONAL LEVELS**
- 6. TOWARDS AN OVERALL WMO INFRASTRUCTURE FOR CLIMATE INFORMATION**
- 7. ANY OTHER BUSINESS (AOB)**
- 8. CONCLUSIONS AND RECOMMENDATIONS**
- 9. CLOSING**

EXPLANATORY MEMORANDUM RELATED TO THE WORKSHOP AGENDA

1. OPENING

The WMO Workshop on Strategy for Implementation of CSIS will be opened at 09:00 hours on Tuesday, 5th of April 2011, at WMO Headquarters in Geneva, Switzerland.

2. ORGANIZATION OF THE MEETING

2.1 Adoption of the agenda

The Chairperson will invite participants to consider the provisional agenda with the view of its adoption.

2.2 Working arrangements

The Meeting will agree on the details concerning the organisation of its work, including the working hours and any other practical session arrangements. The documentation for the meeting and the meeting itself will be in English.

3. GFCS AND ITS CSIS COMPONENT: BACKGROUND, CURRENT STATUS AND WORKSHOP CONCEPT

The Meeting will be briefed on the background and current status of GFCS and its CSIS component with specific focus on WMO's respective strengths and opportunities. Also, the participants will be presented with the workshop concept including expected outcomes.

4. TOWARDS AN EFFICIENT UPTAKE OF GLOBAL AND REGIONAL CLIMATE INFORMATION AT NATIONAL LEVEL

The Meeting will be presented with examples of global and regional climate information provision including GPC products, global climate monitoring products, WMO El Niño/La Niña Updates, GSCU concept, global and regional climate change projections, RCC products, RCOF outcomes, regional climate watch guidance products etc. The Meeting will also be presented with examples of NMHS's national climate services including aspects of using global and regional climate information.

Workshop participants will be invited to specifically review (i) current status of availability of, and access to, global/regional climate information at national level including NMHSs capabilities to convert it into national products and services, (ii) national needs for global/regional climate information, and (iii) respective capabilities of WMO global and regional entities and mechanisms to meet these requirements. The Meeting is expected (i) to discuss options to facilitate an efficient uptake of global and regional climate information by NMHSs and (ii) to recommend on relevant aspects of NMHS capacity building as well as on prospects of extending capabilities of global and regional entities and mechanisms.

5. PROSPECTS OF EXTENDING RCC AND RCOF CONCEPTS TO NATIONAL LEVELS

The Meeting will be briefed on relevant outcome of the meeting of the CCI Task Team on Climate Information and Prediction Services (CLIPS) project. Workshop participants will be invited to discuss prospects of (i) defining a RCC-analogue set of basic and highly-recommended national climate products proposed to be generated by NMHSs and (ii) organising RCOF-analogue National Climate Outlook Forums in close liaison with national user groups.

6. TOWARDS AN OVERALL WMO INFRASTRUCTURE FOR CLIMATE INFORMATION

The Meeting will be briefed on the operating principles of the World Weather Watch's Global Data Processing and Forecasting System (GDPFS), which provides Members with meteorological analyses and forecast products through its three-level system of World Meteorological Centres, Regional Specialised Meteorological Centres and National Meteorological Centres. The Meeting will also be presented with an overview of WIS as well as relevant aspects of WMO's Disaster Risk Reduction Programme. The workshop participants will be invited (i) to discuss aspects of a common approach and mechanism for systematic and standardised provision of climate data, climate monitoring information, climate predictions and projections across global, regional and national levels, and (ii) to identify, and outline the roles of, key elements of a WMO infrastructure for climate information (such as GPCs, RCCs, NMHSs. etc. including identification of missing elements) including its interfaces to enable a consistent flow of information.

Based on the workshop deliberations participants are expected to conclude on aspects of a strategy for, and roadmap to implement, a sustained global-regional-national WMO infrastructure for climate information as a backbone for CSIS.

7. ANY OTHER BUSINESS (AOB)

The Meeting may consider any other issues requiring actions or discussion by the participants.

8. CONCLUSIONS AND RECOMMENDATIONS

The workshop participants will develop their joint conclusions and recommendations as appropriate.

9. CLOSING

The WMO Workshop on Strategy for Implementation of CSIS is estimated to close at 16:00 on Thursday, 7 April 2011.

LIST OF PARTICIPANTS

Armenia

Mrs Anahit HOVSEPYAN
 Armenian State Hydrometeorological
 and Monitoring Service
 (Armstatehydromet)
 54 Leo Street
 YEREVAN
 Tel: +374 10 533616
 Fax: +374 10 532952
 E-mail: anahit_hovs@yahoo.com

Australia

Dr Michael COUGHLAN
 2 Corsewall Close
 HAWTHORN 3122
 Tel: +613 9818 1062
 Mobile: +614 1941 1225
 Fax: +
 E-mail: Coughlan@climate-insight.com

Dr David J. WALLAND
 National Climate Centre
 Bureau of Meteorology
 700 Collins Street, Docklands
 MELBOURNE, VICTORIA 3008
 Tel: +613 9669 4069
 Mobile: +61 405 540 021
 Fax: +613 9669 4678
 E-mail: D.Walland@BoM.gov.au

Barbados

Dr David FARRELL
 Caribbean Institute for Meteorology &
 Hydrology (CIMH)
 Husbands, St. James
 CHRISTCHURCH
 Tel: +1246 425-1362
 Mobile: +1246 731 3456
 Fax: +1246 424 4733
 E-mail: dfarrell@cimh.edu.bb

China

Dr Hui GAO
 National Climate Center
 China Meteorological Administration
 46 Zhongguancun Nandajie, Haidian
 BEIJING
 Tel: +86 10 6840 7486
 Mobile: +13681519751
 Fax: +86 10 6840 6975
 E-mail: gaohui@cma.gov.cn

France

Mr Jean-Pierre CERON
 Météo-France
 42, avenue Gaspard Coriolis
 31057 TOULOUSE, Cédex 1
 Tel: +33 5 6107 8310
 Mobile: +33 687 864 539
 Fax: +33 5 6107 8309
 E-mail: Jean-Pierre.Ceron@meteo.fr

Mr Bernard STRAUSS
 Météo-France
 42, avenue Gaspard Coriolis
 31057 TOULOUSE, Cédex 1
 Tel: +33 567 6987 03
 Fax: +33 567 6987 09
 E-mail: bernard.strauss@meteo.fr

Germany

Dr Stefan RÖSNER
 Deutscher Wetterdienst
 Department of Climate Monitoring (KU23b)
 P.O. Box 10 04 65
 63004 OFFENBACH
 Tel: +49 170 90 54658
 +49 69 8062 4306
 Fax: +49 69 8008 663115
 Email: Stefan.roesner@dwd.de

Japan

Mr Akihiro SHIMPO
Japan Meteorological Agency
1-3-4 Otemachi, Chiyoda-ku
TOKYO 100-8122
Tel: +81 3 3211 4966
Fax: +81 3 3211 2032
Email: iao-jma@met.kishou.go.jp

Pakistan

Mr Sahibzad KHAN
Regional Meteorological Centre
Pakistan Meteorological Department
46 Jail Road
LAHORE
Tel: +92 42 375 62806
Fax: +92 42 375 90499
E-mail: sahibzad@yahoo.com

Serbia

Mr Vladimir DJURDJEVIC
Institute of Meteorology
University of Belgrade
BELGRADE
Tel: +38 1112 625981
Mobile: +38 1641 948240
Fax: +
Email: vdj@ff.bg.ac.rs

Spain

Dr Manuela BRUNET-INDIA
Centre for Climate Change (C3)
University Rovira i Virgili
Dept. of Geography
Av. Catalunya, 35
43071 - TARRAGONA
Tel: +34 977559583
Fax: +34 977559597
Email: Manola.brunet@urv.cat

Sweden

Dr Colin JONES
Swedish Meteorological and Hydrological
Institute (SMHI)
SE-601 76NORRKÖPING
Tel: +46 11 495 8032
Fax: +46 11 49580 01
Email: Colin.Jones@smhi.se

United Kingdom

Dr Richard GRAHAM
Met Office
Hadley Centre
Fitzroy Road
Devon EX13PB
EXETER
Tel: +44 1392 886 361
Fax: +44 1392 885 681
Email: richard.graham@metoffice.gov.uk

United States of America

Dr Arun KUMAR
Climate Prediction Center
National Centers for Environmental Prediction
NOAA-National Weather Service
World Weather Building Room 605
5200 Auth Road
SUITLAND, MARYLAND (MD) 20746-4325
Tel: +1 301 763 8000 Ext 7579
Fax: +1 301 763 8125
E-mail: arun.kumar@noaa.gov

Dr Richard R. HEIM, Jr
Climate Services and Monitoring Division
NOAA's National Climatic Data Center
151 Patton Avenue
ASHEVILLE, NO. CAROLINA (NC) 28801-5001
Tel: +1 828 271 4682
Fax: +1 828 271 4876
E-mail: Richard.Heim@noaa.gov

International Organizations

Dr Jin Ho YOO
APEC Climate Center (APCC)
1463 U-dong, Haeundae-gu
BUSAN 612-020
Republic of Korea
Tel: +82 2 6712 0306
Fax: +82 2 834 5922
Email: jhyoo@apcc21.net,
yoo.jinho38@gmail.com

Dr Simon MASON
International Research Institute
for Climate & Society (IRI)
232 Monell Building
61 Route 9W
PALISADES, NEW YORK 10964-8000
USA
Tel: +1 845 680 4514
Fax: +1 845 680 4865
Email: simon@iri.columbia.edu

Ms Abigail ALVARADO
Centro Internacional para la Investigación del
Fenómeno de El Niño (CIIFEN)
GUAYAQUIL
Ecuador
Tel: +593 4 251 4770
Mobile : +33 62 884 0870
Fax: +593 4 251 4771
Email: a.alvarado@ciifen-int.org

WMO SECRETARIAT

7bis, Avenue de la Paix
CP 2300
CH-1211 GENEVA 2
Switzerland

CLIMATE AND WATER (CLW) Department

Mr Avinash C. TYAGI
Tel: +41 22 730 8355
Email: ATyagi@wmo.int

Dr Mannava V.K. SIVAKUMAR
Tel: +41 22 730 8380
Email: MSivakumar@wmo.int

Dr Rupa Kumar KOLLI
Tel: +41 22 730 8377
Email: RKolli@wmo.int

Ms Leslie MALONE
Tel: +41 22 730 8220
Email: LMalone@wmo.int

Mr Peer HECHLER
Tel: +41 22 730 8302
Email: PHechler@wmo.int

*OBSERVING AND INFORMATION
SYSTEMS (OBS) Department*

Mr Omar BADDOUR
Tel: +41 22 730 8268
Email: OBaddour@wmo.int

Mr Peiliang SHI
Tel: +41 22 730 8219
Email: PShi@wmo.int

*WEATHER AND DISASTER RISK REDUCTION
SERVICES (WDS) Department*

Mr Peter CHEN
Tel: +41 22 730 8231
Email: PChen@wmo.int

Dr Maryam GOLNARAGHI
Tel: +41 22 730 8006
Email: MGolnaraghi@wmo.int

Mrs Alice SOARES
Tel: +41 22 730 8449
Email: ASoares@wmo.int

*GLOBAL CLIMATE OBSERVING SYSTEM
(GCOS) Joint Planning Office*

Ms Carolin RICHTER
Tel: +41 22 730 8275
Email: CRichter@wmo.int

*WORLD CLIMATE RESEARCH PROGRAMME
(WCRP) Joint Planning Office*

Mrs Valerie DETEMMERMAN
Tel: +41 22 730 8242
Email: VDetemmerman@wmo.int

WORK PLAN OF THE WORKSHOP

Workshop Co-Chairs: Mike Coughlan and Stefan Rösner

Note: The following general timing is suggested:

4 sessions per day: 9-10:30; 11:00-13:00; 14:00-15:30; 16:00-18:00

Coffee/Tea breaks will be arranged: 10:30-11:00; 15:30-16:00

Lunch break: 13:00-14:00

Tuesday evening: Cocktail: 18:00-19:00

Thursday afternoon: Session from 14:00-16:00; expected closure of meeting: 16:00

Suggested time slots for presentations/discussions and sessions are preliminary and leave some room for flexibility.

Session 1: Tuesday, 5th of April, 09:00 – 10:30

Agenda item 1: Opening

Agenda item 2: Organisation of the Meeting

- *Documents: Doc. 2.1 Agenda, Doc. 2.1.1 Annotated agenda, Draft work plan outline*

Agenda item 3: GFCS and its CSIS component - Background, current status and workshop concept

Presentations	Presenter
GFCS and its CSIS component : Background and current status (25 min)	Avinash Tyagi
Workshop concept and expected outcome (5 min)	Co-Chairs

- *Document: Doc. 3, WMO Workshop on Strategy for Implementation of the CSIS – Concept note*

Session 2: Tuesday, 5th of April, 11:00 – Wednesday, 6th of April, 13:00

Agenda item 4: Towards an efficient uptake of global and regional climate information at national level

Presentations and Discussions	Presenter/ Moderator
Presentation: Overview of functions and products of potential WMO CSIS elements (30 min)	Peer Hechler
Availability and accessibility of global LRF products (10 min)	Richard Graham
Availability and accessibility of global and regional climate change scenario data sets (20 min)	Colin Jones
NCDC's global climate monitoring products and global real-time re-analysis and analysis products (tbc) (20 min)	Richard Heim
WMO climate data perspective (10 min)	Omar Baddour

WMO Regional Climate Centres: Products and services (10 min)	Mike Coughlan
Regional Climate Outlook Forums: Concept and outcomes (10 min)	Jean-Pierre Céron
Regional Climate Change Scenarios: Products and services of the Southeast European Virtual Climate Change Centre (10 min)	Vladimir Djurdjevic
Presentations: NMHSs' national climate services including aspects of using global and regional climate information at national level (10 min each)	Mrs Hovsepyan (Armenia) Mr Walland (Australia) Mr Shimpo (Japan) Mr Khan (Pakistan) Mr Djurdjevic (Serbia) Mr Kumar (USA)
5 April, ~17:00 -18 :00 and 6 April, 9 :00-10 :00	
Group discussions (~120 min; a second meeting room -6J- is available for the group discussions) Group 1: How to facilitate an efficient uptake of global and regional climate information by NMHSs: (i) analysis of general requirements, (ii) review of capabilities to access, and convert into national climate services, existing global and regional information, (iii) capacity building requirements Group 2: How to efficiently provide global and regional information to NMHSs: Review of existing functions and products including its distribution and prospects of extending functions of global and regional entities and mechanisms	Jean-Pierre Céron (Chair for Group 1) Simon Mason (Chair for Group 2)
6 April, 10:00 -10:30 and 11:00 – 11.30	
Presentation of outcomes of group discussions to plenary (~60 min)	Jean-Pierre Céron Simon Mason
6 April, ~11:30-13.00	
Plenary discussion: Towards an efficient uptake of global and regional climate information at national level (including conclusions and recommendations) (~90 min)	Co-Chairs

- *Documents: Doc.4, Overview of functions and products of potential WMO CSIS elements; Doc.5, Regional Climate Centres – Status by Region*

Session 3: Wednesday, 6th of April, 14:00-15:30

Agenda item 5: Prospects of extending RCC and RCOF concepts to national levels

Presentations and Discussions	Presenter/ Moderator
Overview of CIMH's activities	David Farrel
Report from the meeting of the Task Team on CLIPS (24-26 Nov 2010, Geneva/Switzerland) (30 min)	Simon Mason, David Walland
Plenary discussion: Prospects of extending RCC and RCOF concepts to national levels (including conclusions and recommendations) (60 min)	

Session 4: Wednesday, 6th of April, 16:00 – Thursday, 7th of April, 13:00

Agenda item 6: Towards an overall WMO Infrastructure for climate information

Presentations and Discussions	Presenter/ Moderator
Operating principles of WMO's GDPFS (30 min)	Bernard Strauss
Overview of WIS (15 min)	Peiliang Shi
WMO Disaster Risk Reduction Programme and CSIS (working title) (15 min)	Maryam Golnaraghi
Meeting of the CCI Task Team on User Interface: Key messages (10 min)	Leslie Malone
Discussion paper on 'Towards a common approach and mechanism for systematic and standardised provision of climate information' (15 min)	Peer Hechler
<i>Thursday, 9:00-10:30</i>	
Plenary discussion: 'Towards a common approach and mechanism for systematic and standardised provision of climate information' (including conclusions and recommendations) (~90 min)	Panel moderation: Manola Brunet Vladimir Djurdjevic Richard Graham Richard Heim
<i>Thursday, 11:00-13:00</i>	
Review of workshop outcome so far: Wrap up of conclusions and recommendations (~30 min)	Co-Chairs, Secretariat
Plenary discussion: Aspects of a strategy for, and roadmap to implement a sustained global-regional-national WMO infrastructure for climate information as a backbone for CSIS (~90 min)	Co-Chairs

- *Document: Doc. 6, Towards an overall WMO infrastructure for climate information – Discussion paper*

Session 5: Thursday, 7th of April, 14:00-16:00

Agenda item 7: Any other business

Agenda item 8: Conclusions and recommendations

Agenda item 9: Closing

CSIS WORKSHOP CONCEPT NOTE

1. Preamble

The World Climate Conference-3 in 2009 decided to establish a Global Framework for Climate Services (GFCS), an international framework to guide the development of climate services. The High-Level Taskforce (HLT), constituted to provide a report on the implementation of the GFCS, is recommending a three-tiered Framework approach to address global, regional and national dimensions, with an appropriate flow of data and information amongst all three levels.

The establishment of a Climate Services Information System (CSIS) is therefore a key component of the GFCS and is being designed to routinely generate climate information, including data, diagnostics, assessments, monitoring, predictions, projections, etc. that users need for a broad range of climate sensitive decisions at different levels. It is widely recognized that for the generation of reliable operational climate information on the national scale, it is critical that adequate global and regional inputs and products are available. WMO has already put in place or identified several entities to specifically support NMHS climate operations; they include Global Producing Centres for Long Range Forecasts (GPCs), other centres providing climate information on the global scale, as well as several Regional Climate Centres (RCCs), Regional Climate Outlook Forums (RCOFs) and regional Climate Watch systems. WMO is making concerted efforts to promote the products and services delivered by these entities through the Climate Information and Prediction Services (CLIPS) project. All of these efforts are directly relevant to the three-tiered structure recommended by the HLT, particularly in the context of CSIS.

In order to develop a systems approach that will incorporate all the global and regional CSIS entities in the most efficient way to support to NMHSs' climate service provision, it is proposed to organize a workshop to develop a strategy for an effective implementation of the CSIS as an integral component of the GFCS. The outcome of this workshop is expected to bring greater clarity on the roles of each of the components as well as their linkages. The workshop will also facilitate the development of the CSIS presentations to be made at during the 16th World Meteorological Congress (May-June 2011) that will inform Members on the effective roles they can play in the establishment and functioning of the CSIS as well as outline how they will be able to make use of its products to provide better climate services to users at the national level.

2. Vision

To establish a global-regional-national WMO infrastructure with capabilities and linkages for operationally sustainable production and flow of climate information, in analogy to as well as in close liaison with the World Weather Watch and considering the principles of the WMO Information System

3. Objectives

- (i) To review the national needs for global/regional climate information, and assess the current status of the availability of, access to, and effective use of such information within each of the WMO Regions;
- (ii) To review the RCOF process for interaction with users and to explore potential models for its possible extension to the national level;
- (iii) To review the current capabilities of GPCs, RSMCs, RCCs, and other global/regional climate data and monitoring centres and climate change data archives in support of NMHS operations and other national needs, and to make recommendations on the extension of

their capabilities and activities including the communication of products and services through the WMO Information System (WIS);

- (iv) To examine the current and potential capacities of global and regional entities and propose recommendations for systematic and standardized approaches to climate data, climate monitoring, climate prediction and climate change projections;
- (v) To identify and propose ways by which the various global and regional entities might interact through a sustained systems approach in analogy to the World Weather Watch, and underpinned by a state-of-the-art scientific and technological backbone;
- (vi) To propose an operational strategy for developing a CSIS implementation plan that will ensure its access to all WMO Members.

4. Expected outcome

Identification of options for developing all WMO-related nodes of the CSIS and their interactions, and a roadmap towards operational implementation

5. Agenda topics

- Overview/status presentations of a few representative national case studies, that will inform participants on the current status of operational climate information products and services being generated by NMHSs, and their use of global/regional inputs;
- Review of national requirements for global/regional information, vis-à-vis GPCs, RCCs, RCOFs, etc.;
- Overview/status presentations on the existing WMO and related global/regional entities that could underpin the GFCS/CSIS, viz., GPCs, RCCs, RCOFs, etc.;
- Identification of implementation aspects of RCCs and RCOFs worldwide, including future prospects and models for extending the concepts to the national level;
- Proposals for common approaches and mechanisms for providing climate data, climate monitoring, climate prediction and climate projection;
- Conceptual and technical interfaces between GPCs, other centres providing global scale climate information, RCCs, other centres providing regional scale climate information, RCOFs and NMHSs;
- Development of the outline of a WMO strategy for CSIS operational implementation in its entirety.

OVERVIEW OF FUNCTIONS AND PRODUCTS OF POTENTIAL WMO CSIS ELEMENTS

Climate processes are global in character and evolve over a wide range of time and space scales. Decisions, however, are in the context of local climate variations. The flow of information from global to local scales, therefore, is essential and must be facilitated. For an effective delivery of climate information, and its utilisation, it is essential to have appropriate institutional mechanisms that generate, exchange and disseminate information at global, regional and national scales on an operational basis.

This document is intended to provide an overview of examples of functions of WMO designated or co-ordinated entities or mechanisms that are in place to support Members' national climate service generation and provision by appropriate global-scale and regional-scale information (Table 1). Also, the document provides examples of WMO co-ordinated global and regional products relevant to CSIS (Tables 2 and 3).

Notes:

It should be noted that, apart from the examples given in this document, there is a huge variety of global and regional climate information provided either through international cooperation mechanisms or by individual Members. It is understood that such information can be contributed to CSIS at any time, provided the producer agrees to meet CSIS standards, which need to be defined. Relevant aspects are discussed in Doc. 5.

Workshop participants might wish to consult World Meteorological Congress document Cg-XVI/8.3(2) 'Compendium of Project Initiatives Proposed to be Funded from Voluntary Contributions', which on pages 10 to 25 show drafted project outlines to support GFCS implementation (cf. <ftp://ftp.wmo.int/Documents/SESSIONS/Cg-XVI/>).

The following projects are of specific relevance for the deliberations of the Workshop:

- 1.3.1.1 Support for implementation of climate watch systems in Regions*
- 1.3.5.3 Strengthening the capacities of Member countries to provide climate services*
- 1.3.5.4 Training aspects related to GPC and RCC infrastructure*
- 1.3.5.5 Enhanced capacity of NMHSs to more effectively use GPC and RCC products to develop and deliver climate services at national levels*
- 1.3.6.6 Establishment of a worldwide system of regional Climate Centres, with special focus on vulnerable developing regions*
- 1.3.7.7 Development of Climate Outlook Forums worldwide, on regional and national scales*
- 1.3.8.8 Development of user-targeted climate services for agriculture, water, and health sectors for climate Risk management and adaptation.*

Table 1: Examples of functions of WMO-designated or co-ordinated CSIS elements

Entity/Mechanism	Principle Function(s)
<i>Global level</i>	
WMO Global Producing Centres for Long-range Forecasts (GPCs) including Lead Centres for LRF Standard Verification Scheme and for LRF Multi-Model Ensemble	Provision of Long-range Forecast products including respective Multi-model Ensemble products and verification products
WCRP Coupled Model Intercomparison Project data archive (CMIP)	Provision of a protocol for studying the output of coupled ocean-atmosphere general circulation models; Provision of a community-based infrastructure in support of climate model diagnosis, validation, intercomparison, documentation and data access; Provision of a framework for developing climate change projections
<i>Regional level</i>	
WMO Regional Climate Centres (RCCs)	Provision of long-range forecast products including verification; Provision of climate diagnostic bulletins, reference climatologies and climate watch guidance products; Provision of quality-controlled regional climate datasets as well as climate database and archiving services; Provision of information on methodologies, product specifications and guidance on product use, co-ordination of training
Regional Climate Outlook Forums (RCOFs)	Provision of consensus-based climate outlooks, provision of training on LRF, facilitation of user liaison
WCRP Coordinated Regional Climate Downscaling Experiment (CORDEX)	Provision of data access to ensembles of co-ordinated high-resolution Regional Climate Scenarios; Provision of a framework for testing Regional Climate Models and downscaling scenarios

Table 2: Examples of CSIS-relevant WMO co-ordinated global-scale products

Product	Provider
Long-range forecast products over 1-month or longer periods (seasons) including multi-model ensembles and verification	12 WMO GPCs including Lead Centres: Beijing, CPTEC, ECMWF, Exeter, Pretoria, Melbourne, Montreal, Moscow, Seoul, Tokyo, Toulouse, Washington
Annual Statement on the Status of the Global Climate	International collaboration co-ordinated by WMO/WCDMP
El Niño/La Niña Updates	International collaboration co-ordinated by WMO/WCASP
Global Seasonal Climate Updates (in development)	International collaboration (tbd)
Climate projections	International collaboration co-ordinated by WCRP
Climatological Normals, World Weather Records	International collaboration co-ordinated by WMO/WCDMP

Table 3: Examples of CSIS-relevant WMO co-ordinated regional-scale products

Product	Provider
Long-range forecast products including verification	2 WMO RCCs: Beijing and Tokyo (Note: A number of RCC candidates around the globe are expected to be designated in the next couple of years)
Climate diagnostic bulletins	
Reference climatologies	
Climate Watch guidance products	
Regional climate data sets	
Climate projections	WMO RCCs (highly-recommended function), International collaboration co-ordinated by WCRP
Consensus-based climate outlooks	12 RCOFs for Asia, Caribbean, Central Africa, Central America, Central Asia (in preparation), Greater Horn of Africa, Pacific Islands, Southeast Europe, Southern Africa, Southern South America, West Africa, Western South America

REGIONAL CLIMATE CENTRES – STATUS BY REGION

WMO Designated RCCs

Two RCCs and one RCC network have been officially endorsed by WMO under the current GDPFS procedures established jointly by CBS and CCI, viz. the Beijing Climate Center and the Tokyo Climate Center in RA II, and the Pilot Regional Climate Centres Network in RA VI. There are several additional climate centres performing at least some of the functions designated under the GDPFS provisions and hence could conceivably move towards formal ratification within the emerging WMO RCC framework. The WMO website for Regional Climate Centres is: <http://www.wmo.int/pages/prog/wcp/wcasp/RCCs.html#RCCLinks>

Other Centres and Related Activities

A number of the larger WMO Member countries use the term RCC to apply to centres servicing a region wholly within their respective national borders, the USA and Australia for examples, with the latter using the term Regional Climate Service Centre (RCSC). An RCC in the WMO GDPFS context, however, is one that generates products and services for domains extending beyond a single country. It is being further proposed that an RCC may provide products and services for a domain that is outside or extends beyond the boundaries of a single WMO Region.

Allied to the RCC process are a number of Regional Climate Outlook Forums (RCOFs) that seek to reach consensus among participants on current and expected seasonal conditions and deliver a range of regional climate monitoring and outlook products.

The Executive Council Panel of Experts on Polar Observations, Research and Services (EC-PORS, October 2010, Hobart/Australia) is exploring the establishment of RCCs/RCC-Networks for the Polar Regions. EC-PORS agreed to take action on defining the scope of Arctic and Antarctic RCCs in support of GFCS, subject to confirmation by Cg-XVI.

Earthwatch has also adopted the term Regional Climate Centre for a network of centres that deal mostly with climatic impacts on ecosystems; a short summary on each is included.

RCC Implementation Status by WMO Regional Associations

Following is a summary of the most recent relevant Regional Association decisions/resolutions with respect to the establishment of RCCs, together with a status summary of the existing, pilot or proposed RCCs within each Region that are delivering regional climate services on a routine basis or expected do so in the near future. Reference is also made to two climate centres that cooperate with WMO and its members but not formally as RCCs, viz. the International Research Institute for Climate and Society (IRI) and the APEC Climate Centre. Both centres carry out RCC-type functions and deliver a range of climate products and services openly through the Internet.

WMO RA I – Africa

Extract from Resolution 4.2/2 (XV-RA I) – ESTABLISHMENT OF REGIONAL CLIMATE CENTRES November 2010

Decides:

- (1) To keep under review the needs and gap analysis for the establishment of RCCs in RA I, through continued assessment of the Region's requirements and capabilities vis-à-vis the mandatory and highly recommended RCC functions and to mandate the RA I Working Group on Climate Services *[to be established]* under the guidance of the president of RA I to coordinate this process;
- (2) To develop and implement RCCs in RA I, including a pilot phase, with the guidance and support provided from time to time by the presidents of RA I, CCI, CBS and the Secretary-General;
- (3) To keep the RA I RCC operational activities flexible during the pilot phase, allowing them to evolve based on Members' requirements and in compliance with WMO regulations;
- (4) That the implementation of RA I RCCs, as well as the pilot phase prior to formal designation, be coordinated by the RA I Working Group on Climate Services under the overall guidance of the president of RA I;
- (5) To seek formal WMO designation of the RA I RCCs, through the process described in the Manual on the GDPFS and to mandate the president of RA I to initiate this process, following satisfactory evaluation of the Region's requirements as well as capability to fulfil the mandatory functions and demonstration of this capability to CCI and CBS;
- (6) To promote the development of cross-regional RCCs to address the common needs of large areas spread across the domains of two or more regional associations (e.g., Mediterranean Region covered in both RA I and RA VI);
- (7) To regularly review RA I Member's requirements for climate information, products and services, and to ensure a 'state-of-the-art' service provision to Members to meet their priority needs;

Status

There are as yet no RCCs designated under the GDPFS in RA I. At its fifteenth session, RA I expressed the need to establish one RCC in each of the Regional Economic Communities (RECs) and name these centres accordingly: the IGAD-RCC, the ECOWAS-RCC, the SADC-RCC, the North Africa (NA-RCC), and the CEMAC-RCC. Considering the pan-African nature of the ACMAD, the Association assigned it the coordinating role among all RCCs in RA I and called it the African-RCC. Accordingly the Members in each sub-region are requested to establish their RCCs and by the end of 2012, ensure that they demonstrate the mandatory capabilities as laid down in GDPFS manuals. Based on the recommendations of the RA I Task Team on RCCs and that the ACMAD and ICPAC have submitted their expression of interest, the Association approved the establishment of African-RCC and IGAD-RCC at ACMAD and ICPAC respectively. The Association urged AGRHYMET to consider serving as the ECOWAS-RCC with support from ACMAD, and to enhance the RCC operations in terms of hydrological and agricultural applications. The Association agreed that another key regional institution, SADC-CSC, may also be encouraged to be developed as a multi-functional SADC-RCC, as and when it is ready with an appropriate proposal. The Association suggested further consultations among the North African countries to come up with a complementary plan of action for a RCC-network for North Africa. For Central Africa sub-region, the Association invited Members to identify a regional institution to serve as regional centre. Till such time ACMAD as the African-RCC would meet the needs of climate information for the Members in the sub-region. The following centres are directly affiliated with or work closely with WMO:

African Center of Meteorological Applications for Development (ACMAD)

<http://www.acmad.ne/en/homepage.htm>

Location: Niamey, Niger

Domain of interest: All countries of RA I

IGAD Climate Prediction and Applications Centre (ICPAC)

<http://www.icpac.net/>

Location: Nairobi, Kenya

Domain of interest: IGAD Countries (Greater Horn of Africa)

SADC Climate Services Centre

<http://www.sadc.int>

Location: Gaborone, Botswana

Domain of interest: SADC countries

Regional Climate Outlook Forums in RA I

There is a well-established structure of Region Climate Outlook Forums in RA-I supported by the centres above, and sustained since 1997-98: Western Africa (PRESAO: PRÉvisions Saisonnières en Afrique de l'Ouest); Greater Horn of Africa (GHACOF); and Southern Africa (SARCOF).

WMO RA II – Asia

**Extract from Resolution 1 (XIV-RA II) ESTABLISHMENT OF A REGIONAL CLIMATE CENTRE NETWORK IN REGIONAL ASSOCIATION II (ASIA)
December 2008**

Decides:

- (1) To ensure that all RA II Members are aware of the latest guidance on “Establishment and Designation of WMO Regional Climate Centres (RCCs)”;
- (2) To ensure that all RCCs and RCC proponents comply with the definitions of RCCs and RCC Networks and the Commission for Climatology-Commission for Basic Systems recommended mandatory functions and criteria for designation adhere to the relevant WMO Technical Regulations;
- (3) To continue the pilot phase as a means to demonstrate the capabilities of centres in the Region aspiring to be designated as WMO RCCs, under the guidance of the WGCAA-CAS, of which the terms of reference are described under Resolution 9 (XIV-RA II);

Status

RA II is served by a collection of RCCs having pan-Asian as well as sub-regional interests, which have established a joint portal (<http://www.rccra2.org/>) which provides links to Beijing Climate Center (BCC) and Tokyo Climate Center (TCC) products and services, which are the two formally designated RCCs so far. The portal also includes a link to the APEC Climate Center (APCC), another key institution providing regional climate monitoring and prediction products. The following are the basic details for BCC and TCC:

Beijing Climate Center

<http://bcc.cma.gov.cn/en/>

Location: Beijing, China

Domains of interest: East Asian Monsoon and all Asia for monitoring extremes.

Designated as a WMO RCC

Tokyo Climate Center

<http://ds.data.jma.go.jp/tcc/tcc/index.html>

Location: Tokyo, Japan

Domain of interest: All Asia and Western Pacific (40N-20S, 30E-180)

Designated as a WMO RCC

The North Eurasia Climate Centre (NEACC) coordinated by the Russian Federation under the auspices of the Commonwealth of Independent States (CIS), has commenced the pilot phase of its operations to seek formal designation as a WMO RCC, from December 2010:

North EurAsia Climate Centre

www.neacc.meteoinfo.ru (English)

www.seakc.meteoinfo.ru (Russian)

Location: Moscow, Russian Federation

Domain: CIS countries including the Russian Federation, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan.

Three more countries in RA II, namely India, Iran and Saudi Arabia have also expressed their interest in establishing RCCs, and are making concerted efforts to initiate the pilot phase of operations.

Regional Climate Outlook Forums in RA II

Forum on Regional Climate Monitoring, Assessment and Prediction for Regional Association II (FOCRAII) coordinated by China since 2005, and South Asian Climate Outlook Forum (SASCOF) coordinated by India since 2010.

WMO RA III – South America

Extract from Resolution. 4.2/1 (XV-RA III) – ESTABLISHMENT OF REGIONAL CLIMATE CENTRES

September 2010

Decides:

- (1) To conduct a needs and gap analysis for the establishment of RCCs in RA III, through assessment of the region's requirements and capabilities vis-à-vis the mandatory and highly recommended RCC functions and to mandate the RA III Working Group on Climate Services [to be established] under the guidance of the president of RA III to initiate this process;
- (2) To develop and implement RCCs in RA III on a pilot basis with the guidance and support provided from time to time by the presidents of RA III, CCI, CBS and the Secretary-General;
- (3) To keep the RA III RCC operational activities flexible during the pilot phase, allowing them to evolve based on Members' requirements and in compliance with WMO regulations;
- (4) That the implementation of RA III RCCs, as well as the pilot phase prior to formal designation, be coordinated by the RA III Working Group on Climate Services under the overall guidance of the president of RA III;
- (5) To seek formal WMO designation of the RA III RCCs, through the process described in the Manual on the GDPFS and to mandate the president of RA III to initiate this process, following satisfactory evaluation of the Region's requirements as well as capability to fulfil the mandatory functions and demonstration of this capability to CCI and CBS;
- (6) To regularly review RA III Member's requirements for climate information, products and services, and to ensure a 'state-of-the-art' service provision to Members to meet their priority needs;

Status

There are as yet no RCCs designated under the GDPFS in RA III. At the fifteenth session of RA III (September 2010), discussions were held on the establishment of three RCC/RCC-Network structures to cater to the needs of the northern, southern and western sub-regions of South America. The Association welcomed the initiatives undertaken by CIIFEN for its designation as an RCC for the sub-region of Western South America, and encouraged Members to support CIIFEN's efforts. The Association also welcomed the offers of Brazil, in collaboration with French Guyana, and Argentina in collaboration with Brazil, to establish RCCs to serve the sub-regions of Northern and Southern South America, respectively. It approved the candidature of these RCCs in principle and requested the candidate Centres to submit formal proposals of Pilot Projects. The following relevant centres/entities are, affiliated with or work closely with WMO and have been providing regional climate information products:

Centro Internacional para la Investigación del Fenómeno de El Niño (CIIFEN)

<http://www.ciifen-int.org/index.php>

Location: Guayaquil, Ecuador

Domain: Eastern and Southern South America

Centro de Previsão de Tempo e Estudos Climáticos (CPTEC)

<http://www.cptec.inpe.br/>

São Paulo, Brazil

Domain: Central, Eastern and Southern South America

El Observatorio Andino – An Environmental Watch System for the Andean Countries

<http://ole2.org/>

For more details, see the article at:

http://arxiv.org/PS_cache/arxiv/pdf/1006/1006.0926v1.pdf

WMO is organizing a meeting in April 2011 in Brasilia (Brazil) with representatives of RCC-aspirant institutions in South America, to start defining how RCCs in RA III will be established. Additional information including other relevant entities will be available after this meeting in April.

Regional Climate Outlook Forums in RA-III

Western Coast of South America Climate Outlook Forum (WCSACOF) and Southeast of South America Climate Outlook Forum (SSACOF)

WMO RA IV – North America, Central America and the Caribbean

Extract from the General Summary of Fifteenth Session of RA IV
May 2009

4.2.5 Regional Climate Centres (RCCs)

4.2.5.1 The Association noted the significant progress made by WMO, through the joint efforts of the Commission for Climatology (CCI) and the Commission for Basic Systems (CBS) towards development of a formal designation process for Establishment and Implementation of Regional Climate Centres. Recalling the early efforts taken within RA IV (2003) to establish a regional Advisory Group on RCCs (AG-RCCs), and noting with appreciation the launch of the RA IV RCC Pilot Project sponsored by the United States of America and implemented by the Central American Regional Committee of Hydrological Resources (2005) and of a project in 2007 to initiate RCC activities for Central America (supported by the Inter-American Development Bank and the European Union), the Association urged Members to take into account the latest WMO Guidance on Establishment and Implementation of RCCs, and to ensure that all mandatory requirements for formal designation as 'WMO RCCs' are fulfilled by the potential centres in the Region interested in seeking such designation.

4.2.5.2 The Association, noting the urgent need for improved climate information reaffirmed its intent to establish an RCC network to assist RA IV Members in meeting these needs. The Association urged the president of RA IV to assess the needs and capabilities in the Region for climate services (by organizing an appropriate survey, if required), and to encourage Members to participate in RCCs and to develop an implementation plan for the establishment of an RCC network in the Region. The Association urged potential RCC hosts to build, under the guidance of the president) CCI, CBS and the WMO Secretariat, demonstrable and sustainable capacity for all the mandatory RCC functions defined in the proposed amendments to GDPFS Manual and, where possible, the highly recommended functions.

4.2.5.3 The Association urged GPCs to continue and to reinforce their inputs to RCCs. The Association urged Members to extend their active support to the implementation of an RCC network in RA IV and requested the potential RCC hosts to adequately address the needs of the Members in the Region while planning their operational activities.

Status

There are as yet no RCCs designated under the GDPFS in RA IV. The United States and Canada have well-established internal regional centres and networks to service their national needs. The Caribbean Institute of Meteorology and Hydrology (CIMH) has expressed its interest in seeking designation as a WMO RCC with the domain of interest being the English-speaking countries of the Caribbean.

Regional Climate Outlook Forums in RA-IV

The Foro Regional del Clima de América Central (FCCA), the Climate Outlook Forum for Central America has been in operation for more than a decade. There is also a recent proposal to establish a Caribbean Climate Outlook Forum (CARICOF), expected to be coordinated by CIMH.

WMO RA V – Southwest Pacific

Resolution 2 (XV-RA V) – ESTABLISHMENT OF REGIONAL CLIMATE CENTRES – May 2010

Decides:

- (1) To work towards the establishment of RCCs in RA V, through assessment of current RCC related functions being performed in the region *vis à vis* the mandatory and highly recommended RCC functions and subsequent gap analysis, with the guidance and support provided from time to time by the presidents of RA V, CCI, CBS and the Secretary-General;
- (2) To implement a RCC Network in RA V on a pilot basis;
- (3) To keep the RA V RCC operational activities flexible during the pilot phase, allowing them to evolve based on Members' requirements and within WMO regulations;
- (4) To seek formal WMO designation of the RA V RCCs, through the CCI-CBS process described in the Manual on the GDPFS (2009 version) and to mandate the president of RA V to initiate this process, following satisfactory evaluation of capability to fulfil the mandatory functions and demonstration of this capability to CCI and CBS;
- (5) That the implementation of RA V RCCs, as well as the pilot phase prior to formal designation, be coordinated by a task team (*or any other structure with this responsibility to be set up by the Association*) as a subsidiary body of RA V under the overall guidance of the president of RA V;
- (6) To regularly review RA V Member's requirements for climate information, products and services, and to ensure a 'state-of-the-art' service provision to Members to meet their priority needs;

Status

There are as yet no RCCs designated under the GDPFS in RA V. There are, however, activities and services being delivered throughout the Pacific areas of RA V that could form a sound basis for developing RCC networks meeting the GDPFS requirements. Notable entities include:

The Pacific ENSO Applications Centre (PEAC)

<http://www.prh.noaa.gov/peac/>

Provides climate services and support to the US-affiliated Pacific Island Countries

The Pacific Island Climate Prediction Project (PI-CPP)

<http://www.bom.gov.au/climate/pi-cpp/>

Working to build basic climate services within several island countries of the SW Pacific including Papua/New Guinea

The Island Climate Update (ICU)

<http://www.niwa.co.nz/our-science/climate/publications/all/icu>

Provides a monthly consensus summary of climate variability and seasonal outlooks for the South Pacific islands.

In addition, the entities and networks listed under RA II in effect also service South East Asian parts of RA V and the North West Pacific. Given the vastness of RA V, and sub-regions with homogeneous climatic regimes spanning across WMO Regional Associations II and V, it may be appropriate for some regional climate services to be delivered from RCC entities or networks in adjacent Regions.

Climate Outlook Forums in RA V

The Internet and teleconferencing between NMHSs and other climate centres are being used very effectively to hold virtual forums regularly to link and coordinate the delivery of NMHS based climate services throughout the region, e.g., Pacific Island Climate Outlook Forum (PICOF).

WMO RA VI – Europe

**Extract from Resolution 1 (XV-RA VI) ESTABLISHMENT OF A REGIONAL CLIMATE CENTRE NETWORK IN REGIONAL ASSOCIATION VI (EUROPE)
September 2009**

Decides:

- (1) To implement the pilot RA VI RCC-Network until the end of 2010 with the following initial structure (noting the consortia of National Meteorological and Hydrological Services in each node, and lead centres):
 - (a) RA VI RCC node on climate data (De Bilt):
 - Royal Netherlands Meteorological Institute (KNMI)/The Netherlands (lead);
 - Météo-France/France;
 - Meteorological Service (OMSZ)/Hungary;
 - Norwegian Meteorological Institute/Norway;
 - Republic Hydrometeorological Service of Serbia (RHMS)/Serbia;
 - Swedish Meteorological and Hydrological Institute (SMHI)/Sweden;
 - Turkish State Meteorological Service (TSMS)/Turkey;
 - (b) RA VI RCC node on climate monitoring (Offenbach):
 - Deutscher Wetterdienst (DWD)/Germany (lead);
 - Armstatehydromet/Armenia;
 - Météo-France/France;
 - KNMI/The Netherlands;
 - RHMS/Serbia;
 - TSMS/Turkey;
 - (c) RA VI RCC node on Long-Range Forecasting (Toulouse/Moscow):
 - Météo-France/France and ROSHYDROMET/Russian Federation (joint lead);
 - Norwegian Meteorological Institute/Norway;
 - RHMS/Serbia;
 - TSMS/Turkey;
- (2) That training in the use of operational RCC products and services, a mandatory function for the designation of Regional Climate Centres, shall be integrated into the activities of all the above three nodes;
- (3) To keep the RA VI RCC-Network structure flexible throughout the pilot phase and beyond, allowing it to evolve based on Members' requirements;
- (4) To ensure that the RA VI RCC-Network meets the criteria for formal designation in all the mandatory functions by the end of the pilot phase, and that the corresponding institutions make available their catalogue of services;
- (5) To appoint an RA VI RCC-Network Focal Point to act as the official and formal contact for the entire RA VI RCC-Network, to coordinate the activities of the network and to implement a Website as a single entry point into the network, noting that the Focal Point would be one of the constituent leads of the RA VI RCC-Network nodes;
- (6) To regularly review Members' requirements for climate information, products and services, and to ensure a state-of-the-art service provision to Members to meet their priority needs;
- (7) To seek formal WMO designation of the RA VI RCC-Network in 2011, through the Commission for Climatology-Commission for Basic Systems process described in the Manual on the Global Data-Processing and Forecasting System (2009 version) and to mandate the president of RA VI to initiate this process, following satisfactory

Status

WMO RA VI has been implementing a pilot phase of RA VI RCC Network since 2009, and is taking steps to seek formal designation as a WMO RCC-Network.

WMO RA VI Pilot Regional Climate Centres Network
(http://www.wmo.int/pages/prog/dra/eur/RAVI_RCC_Network.php)
(<http://www.rccra6.org/>)

Domain: All countries of Europe

Ready for designation as a WMO RCC-Network

Climate Outlook Forums in RA VI

The Southeast Europe Climate Outlook Forum (SEECOF) was established in 2008, and has been continuously in operation. SEECOF is presently being coordinated by Serbia.

Other Climate Centres with Regionally Focused Interests

The following is a non-exhaustive list of entities providing operational climate information on a regular basis, on regional scales. It is important to engage them to optimally exploit the various sources of climate information for decision making at the regional and national levels.

International Research Institute for Climate and Society (IRI)

<http://portal.iri.columbia.edu/portal/server.pt>

The mission of the IRI is to enhance society's capability to understand, anticipate and manage the impacts of climate in order to improve human welfare and the environment, especially in developing countries. The IRI conducts this mission through strategic and applied research, education, capacity building, and by providing forecasts and information products with an emphasis on practical and verifiable utility and partnership.

Location: New York State, USA

Domain of Interest: Global with targeted regional and national activities.

APEC Climate Center (APCC)

<http://www.apcc21.org/en/>

APCC aims to enhance the socio-economic well-being of countries in the Asia-Pacific region by utilizing up-to-date scientific knowledge and applying innovative climate prediction techniques. The Center specializes in multi-model ensemble techniques and developing related climate information products. APCC also provides training and support on seasonal climate prediction and downscaling, particularly targeted to developing countries in the region.

Location: Busan, Korea

Domain of interest: Countries that are members of Asia-Pacific Economic Cooperation

Earthwatch

http://www.earthwatch.org/europe/our_work/corporate/hcp/climate_centres/.

Earthwatch is concerned with monitoring the integrity of life on earth to meet the needs of current and future generations. It works with a wide range of partners, from individuals who work as conservation volunteers on research teams through to corporate partners, governments and institutions. It has established a number of Regional Climate Centres (not to be confused with WMO RCCs) focussing on particular ecosystem types and related problems.

- North America Regional Climate Centre
 - http://www.earthwatch.org/europe/rcc_northamerica
 - In Chesapeake Bay, Maryland, USA, scientists are studying the impact of human activities on forest ecosystems, and how they are likely to be affected by climate change.
- Europe Regional Climate Centre
 - http://www.earthwatch.org/europe/rcc_europe
 - In Wytham Woods, Oxfordshire, UK, research into the effects of climate change on this temperate forest will inform management plans and policy decisions in similar habitats worldwide.
- China Regional Climate Centre
 - http://www.earthwatch.org/europe/rcc_china

- In recent years reforestation efforts have increased dramatically. Scientists working at Gutianshan National Nature Reserve are comparing biodiversity and carbon storage in both new and old forests.
- India Regional Climate Centre
 - http://www.earthwatch.org/europe/rcc_india
 - India's Western Ghats mountain range is a highly biodiverse environment. Scientists here are studying the forest ecosystems that provide food, fuel, shelter and medicines for local communities.
- Latin America Regional Climate Centre
 - http://www.earthwatch.org/europe/rcc_latinamerica
 - The Rio Cachoeira reserve is part of Brazil's threatened Atlantic Forest - one of the most species-rich environments on Earth. Research here is focussed on the responses of trees and animals to climate change in fragmented tropical forests.

TOWARDS AN OVERALL WMO INFRASTRUCTURE FOR CLIMATE INFORMATION

-- DISCUSSION PAPER --

Note:

Whilst this discussion paper addresses WMO contributions to CSIS it is important to keep in mind, that non-WMO CSIS elements will need to be integrated too!

Workshop participants might wish to consult World Meteorological Congress document Cg-XVI/8.3(2) 'Compendium of Project Initiatives Proposed to be Funded from Voluntary Contributions', which on pages 10 to 25 show drafted project outlines to support GFCS implementation (cf. <ftp://ftp.wmo.int/Documents/SESSIONS/Cg-XVI/>).

The following projects are of specific relevance for the deliberations of the Workshop:

- 1.3.1.1 Support for implementation of climate watch systems in Regions*
- 1.3.5.3 Strengthening the capacities of Member countries to provide climate services*
- 1.3.5.4 Training aspects related to GPC and RCC infrastructure*
- 1.3.5.5 Enhanced capacity of NMHSs to more effectively use GPC and RCC products to develop and deliver climate services at national levels*
- 1.3.6.6 Establishment of a worldwide system of regional Climate Centres, with special focus on vulnerable developing regions*
- 1.3.7.7 Development of Climate Outlook Forums worldwide, on regional and national scales*
- 1.3.8.8 Development of user-targeted climate services for agriculture, water, and health sectors for climate Risk management and adaptation.*

The Climate Services Information System (CSIS) is the component of the GFCS that is designed to provide users with the climate information they need for the decisions they have to make. CSIS involves physical infrastructure such as institutes, centres and computers; professional human resources for product development and consultation; and interactions with the users. Some substantial elements of what should be the fully operational CSIS already exist (such as WMO GPCs), some of which need to be further consolidated, strengthened and implemented globally (such as WMO RCCs and RCOFs). Some other elements are not yet fully in place and need to be developed accordingly. Table 1 provides an overview of WMO-designated global and regional entities providing operational climate information, and visualises missing elements.

The ultimate strength of CSIS is its system's approach where elements are expected to harmonise in terms of availability and accessibility, product consistency, information presentation and delivery, verification etc. CSIS operation, therefore, need to follow Technical Regulations, of which key regulations already exist within the WMO system (such as respective WIS and GDPFS principles) whilst new or additional ones might need to be developed (e.g. in terms of climate product harmonisation). Tables 2.1 and 2.2 provide examples of relevant aspects to be considered.

The most important part of CSIS is the three-tiered global-regional-national level architecture leading to relevant information at the national level where the main user interaction takes place. Capacities of NMSs to provide up-to-date, science-based climate services to users at national level are of ultimate importance. Capabilities to access, process and convert global and regional climate information into national climate services will greatly facilitate the role of NMSs worldwide. Table 3 provides, as an example, aspects of interaction between WMO Regional Climate Centres and NMSs.

Eventually, an overall WMO infrastructure for climate information should:

- (i) be based on a network of WMO-designated entities providing global- and regional-scale climate products and services in the domains of climate data, climate monitoring, long-range forecasting and climate projections,
- (ii) provide standardised minimum products and highly-recommended products, generated and distributed on the basis of agreed-upon operating principles,
- (iii) take advantage of as much authentic information as possible, and
- (iv) ensure capacity on the national level to access, process and convert into national climate services such global and regional climate information.

Table 1: WMO-designated global and regional entities providing operational climate information

	Climate data sets	Climate monitoring	Long-range forecasts	Climate projections
Global level			WMO GPCs and associated Lead Centres	
Regional level	WMO RCCs	WMO RCCs	WMO RCCs	WMO RCCs

Examples of relevant, routinely available products and mechanisms co-ordinated by WMO or WCRP include,

- On global scale:
 - Annual Statement on the Status of the Global Climate
 - El Niño/La Niña Updates
 - Global Seasonal Climate Updates
 - WCRP Coupled Model Intercomparison Project (CMIP) data archive
- On regional scale:
 - Regional Climate Outlook Forums
 - Climate Watch systems
 - Coordinated Regional Climate Downscaling Experiment (CORDEX) data archive

It should be noted that, apart from the examples given above there is a huge variety of further global and regional climate information provided either through international cooperation mechanisms or by individual Members. It is understood that these information can be contributed to CSIS at any time, provided the producer agrees to meet CSIS standards, which need to be defined. Relevant aspects are discussed in tables 2.1 and 2.2 of this document.

Table 2.1. Examples of potential CSIS operating principles

Aspect	Basic principle
Scope of CSIS products and services	Products and services shall serve Members and shall support WMO programmes and programmes of other international organisations in accordance with respective WMO policy decisions.
Access to CSIS products and services	All WMO Members shall have access to, and shall be allowed to use, CSIS products and services
CSIS mandatory products and services	Designated centres, which by definition serve as backbone of the CSIS, are obliged to deliver defined minimum/mandatory functions. These products and services should be standardized in terms of production, presentation, delivery and verification (-> SVS).
Designation procedure	Basic global and regional elements of CSIS shall follow a designation procedure
Provision and exchange of CSIS information	CSIS products and information shall be exchanged and provided through WIS mechanism
CSIS data policy	Exchange of data and products shall adhere to principles of WMO Resolutions 40 and 25
Generation of CSIS products and services	CSIS operations shall adhere to WMO Technical Regulation and shall follow agreed upon WMO practices (e.g. Guide to climatological practices)
CSIS governance	CSIS implementation being guided by WMO's Technical Commission for Climatology (to be confirmed by Cg-XVI)
Quality management	CSIS operations shall apply to the principles of WMO's Quality Management Framework
Building capacities	CSIS operations should be accompanied by capacity building activities according to the CCI strategy for capacity building

Table 2.2. Examples of CSIS product harmonisation aspects

Product	Examples of harmonisation aspects
LRF products	<ul style="list-style-type: none"> Harmonisation of production cycles and forecast periods Harmonisation of model hindcast periods Harmonisation of hindcast periods with climatological reference periods Review of GPC products in light of their completeness in enabling RCCs to fulfil their mandatory and highly recommended functions Make GPC forecast and verification products available for the specific regions covered by RCOFs Harmonisation of output formats and product presentation
Climate monitoring products	<ul style="list-style-type: none"> Harmonisation of climatological reference periods Harmonisation of climatological reference periods with hindcast periods Generation of climate monitoring results in tercile/percentile style to achieve consistency with LRF products Harmonisation of output formats and product presentation
Climate data	<ul style="list-style-type: none"> Harmonisation of quality control procedures Harmonisation of Metadata descriptions (covered by WIS!?)
Climate projections	(WCRP CMIP and CORDEX already provide a frame for harmonisation)

Note: Many of the aspects mentioned in this table were highlighted at various meetings, such as the 15th Session of the Commission for Climatology (19-24 February 2010, Antalya/Turkey), Meeting of the Expert Team on Extended and Long-Range Forecasting (28 June-2 July 2010, Exeter/United Kingdom), Expert Meeting on Scoping Global Seasonal Climate Updates (12-14 October 2010, Geneva/Switzerland) and Meeting of the CCI Task Team on Global Seasonal Climate Updates (15 October 2010, Geneva/Switzerland).

Table 3. Aspects of interactions between WMO Regional Climate Centres and NMSs

RCC functions	RCC-NMS Interaction	Related NMS functions
Interpretation and assessment of relevant LRF products from GPCs	→→ Provision of interpreted LRF products in global perspective	Provision of national long-range forecasts
	←← Provision of feedback	
Regional tailored LRF products incl. seasonal outlooks	→→ Provision of climate outlooks in regional perspective	Provision of national long-range forecasts
	←← Provision of feedback and national expertise/data	
Consensus statements on regional LRF	→→ Provision of climate outlooks in regional perspective	Conduct of National Climate Outlook Forums
	←← Feedback and participation in consensus process	
Verification of RCC quantitative LRF products, incl. exchange of basic forecast and hindcast data	→→ Provision of verification information incl. digital forecast and hindcast data	Verification of national long-range forecasts
	←← Provision of feedback	
On-line access to RCC products and services	→→ Provision of access to RCC products and services	Online access to NMS (climate-relevant) products and services
	←← Access to RCC products and services; feedback on accessibility	
Assessment of the use of RCC products and services through user feedback	→→ Provision of feedback mechanism	Assessment of the use of NMS (climate-relevant) products and services through user feedback
	←← Provision of feedback on RCC products and services	
Climate diagnostics incl. analysis of climate variability and extremes, at regional and sub-regional scales	→→ Provision of climate diagnostics in regional perspective	Perform climate diagnostics incl. analysis of climate variability and extremes, at national scales
	←← Provision of national diagnostics and feedback	
Historical reference climatology for the region	→→ Provision of regional reference climatologies	National historical reference climatology
	←← Provision of data to enable the establishment of a regional reference climatology	
Implementation of Climate Watch systems	→→ Provision of Climate Watch guidance products	Generation and issuance of national Climate Watch advisories
	←← Provision of feedback	
Quality-controlled regional climate data sets	→→ Data sets of regionally exchanged national data	Development of quality-controlled national climate data sets
	←← Exchange of national data	
Climate database and archiving services, at the request of NMSs	→→ Service provision, capacity building	Provision of national climate database and archiving services
	←← Request for database and archiving services (if needed)	
Information on methodologies and product specifications for mandatory RCC products, and provision of guidance on their use	→→ Provision of expertise, capacity building	Provision of national climate services including by understanding, processing and converting RCC products into national products and services; Provision of product information to users; training of users in understanding and applying climate products
	←← Provision of feedback	
Co-ordination of training for RCC users in interpretation and use of mandatory RCC products	→→ Offers of training opportunities, capacity building	Provision of national climate services including by understanding, processing and converting RCC products into national products and services; Provision of product information to users; training of users in understanding and applying climate products
	←← Provision of training requirements; Provision of trainers	

Notes:

- (1) The table deals with RCC mandatory functions as an example only. A similar exercise could be done for RCC highly-recommended functions, which also cover aspects of climate projections.
- (2) It is assumed, that all national climate services are provided in close user liaison (specific user liaison aspects are not captured in this schematic table).
- (3) All NMS functions together, as indicated in the right column, fit –in principle- category 2 (essential climate services) of a 4-level classification scheme of climate services proposed for the GFCS.

IMPLEMENTING CLIMATE MONITORING IN CSIS

Panelist: Richard Heim (NOAA/NCDC),
Summarizing Workshop Contributions by 31 Participants

Climate Monitoring Characteristics

- Strong interconnections with other CSIS components, CSIS Centers, and users
 - Data sets
 - Forecasts
 - GPCs
 - RCCs
 - RCOFs
 - NMHSs
- Cooperation/coordination between the different organizational units within a nation and between the CSIS components is crucial
- Engage the Users
 - Determine user needs to help define monitoring products (feedback, workshops)
 - Roving seminar process to raise awareness of climate change issues, educate users on monitoring products
- Credibility / authenticity is very important

Climate Monitoring Linkages

- Climate monitoring puts current climate ...
 - Need for current data in a timely fashion
 - Adherence to data sharing policies
 - Reliability of access
- ... into historical perspective ...
 - Need for historical instrumental data sets
 - Paleo data / proxy data
- ... and future perspective
 - Link to modeled data (forecasts and climate projections)

Climate Monitoring Data & Metadata

- Data are the basis for climate monitoring products
- High quality data sets be provided by NMHSs
 - Current data provided in a timely fashion
 - Current and historical data – QC'd, homogeneous, complete, high spatial resolution, long record
- Metadata and documentation of methodologies and data sets also very important

Harmonize Monitoring Product Types

- Many different products used by NMHSs
 - Maps, time series graphics, bulletins, reports, etc.
 - Could result in confusion, discordant information
- Recommend that all RCCs (and NMHSs supporting them) provide a standard set of daily climate monitoring products using standard suite of variables (ECVs)*, methodologies, baseline periods, etc.
 - These would be in addition to the products each NMHS prepares
- But the RCCs be versatile by also providing specialized climate monitoring products and variables (ECVs) needed to describe unique climates and events in their RA and their region's Nations (monsoon onset dates, snow season length)
- Perhaps prioritize the products to help the users better utilize the information

* See list below.

- RCCs provide NMHSs with a standard set of analysis & downscaling tools to apply to global/regional products to generate monitoring products at national/sector scales, and homogeneity assessments & adjustments, with remote online access
- This harmonization (standardization) of products and variables (previous slide) provides for the expression of climate anomalies in a global context
- Standard list of ECVs for all regions, but longer list of ECVs for the Global centers
- NMHSs document extreme events & impacts & underlying meteorological factors
- This (previous slide and this slide) provides consistency but versatility in the climate monitoring products
- Even with products harmonized in this way, there still may be spatial inconsistencies & discontinuities along international borders when national products are merged together to form regional products and regional products merged to form global products.
 - Due to diff. station densities, topography, etc.
- This inconsistency must be addressed
 - Could use NADM approach, but that requires resources (to adjust depiction at borders) and international cooperation (agreement among all nations on the adjustments) done in timely fashion
- Consistency in:
 - Variables (ECVs), Product types (previous slides)
 - Climate Monitoring Services
 - Production of the monitoring products
 - Timely production & release of products
 - Availability and accessibility
 - Information presentation and delivery
 - Verification / validation of the information presented in the products
 - Climatological reference periods for monitoring products (previous slide) and also consistent with hindcast periods for forecast-related products
 - Output formats and product presentation
 - Units in monitoring products be consistent with LRF products (e.g., terciles or percentiles in addition to percent of normal and anomalies)
 - Consistent time scales

Attribution, Synoptics

- Relate climate anomalies to causal mechanisms, circulation indices, atmospheric drivers
 - Through attribution studies (climate models)
 - Or simple discussion relating climate anomalies to atmospheric drivers/teleconnection indices
 - Review of forecast accuracy
- Feeds back into the credibility / authenticity issue – building trust with the user, confidence in the science, transparency in the assessment

Standard suite of basic variables for RCC climate monitoring products should include daily and monthly:

- Maximum, minimum, mean temperature
- Precipitation
- SST
- SLP
- Snowfall
- Wind speed and direction
- Large scale circulation patterns (e.g., 500 hPa heights, as well as other levels, and also water vapor and winds as well as heights)

The ECVs are indicated below (drawn from two tables further below):

- The variables listed above, plus
- Water vapor
- Sea level

- Sea ice
- Snow cover
- Ground water
- Glaciers & ice sheets
- permafrost

Other ECVs would be useful to include in the monitoring products, but may not be available on a widespread (many NMHSs) basis.

Useful Links:

<http://www.wmo.int/pages/prog/qcos/index.php?name=EssentialClimateVariables>

<http://gosc.org/ios/MATRICES/ECV/ecv-matrix.htm>

<http://www.fao.org/gtos/doc/ECVs/T13/T13.pdf>

Domain	GCOS Essential Climate Variables
Atmospheric (over land, sea and ice)	Surface ¹ : Air temperature, Wind speed and direction, Water vapour, Pressure, Surface radiation budget. Upper-air ² : Temperature, Wind speed and direction, Water vapour, Cloud properties, Earth radiation budget (including solar irradiance). Composition : Carbon dioxide, Methane, and other long-lived greenhouse gases ³ , Ozone and Aerosol, supported by their precursors ⁴ .
Oceanic	Surface ⁵ : Sea-surface temperature, Sea-surface salinity, Sea level, Sea state, Sea ice, Surface current, Ocean colour, Carbon dioxide partial pressure, Ocean acidity, Phytoplankton. Sub-surface : Temperature, Salinity, Current, Nutrients, Carbon dioxide partial pressure, Ocean acidity, Oxygen, Tracers.
Terrestrial	River discharge, Water use, Groundwater, Lakes, Snow cover, Glaciers and ice caps, Ice sheets, Permafrost, Albedo, Land cover (including vegetation type), Fraction of absorbed photosynthetically active radiation (FAPAR), Leaf area index (LAI), Above-ground biomass, Soil carbon, Fire disturbance, Soil moisture.

GCOS Essential Climate Variables (ECV) Data & Information Access Matrix

The ECV Data Access Matrix provides easy access to data download, metadata and information for each of the ECVs. Data access has been divided into 2 categories: 1) *In-situ* and Non-Satellite and 2) Satellite. The selection of the data sets are based on information from Scientific Steering committees and scientific expert advisory groups and the supporting documentation they provide and publish such as the recent WMO/IOC release: 'Implementation Plan for the Global Observing Systems for Climate in Support of the UNFCCC (August Update; <http://www.wmo.int/pages/prog/qcos/Publications/qcos-138.pdf>).

The ECVs are required to support the work of the United Nations Framework Convention on Climate Change (UNFCCC) and the Intergovernmental Panel on Climate Change (IPCC). All ECVs are technically and economically feasible for systematic observation. It is these variables for which international exchange is required for both current and historical observations. It is emphasized that the ordering within the table is simply for convenience and is not an indicator of relative priority. Currently, there are 50 ECVs. For more information about the ECV Matrix, see <http://gosc.org/ios/MATRICES/ECV/ECV-Introduction.htm>.

¹ Including measurements at standardized, but globally varying heights in close proximity to the surface.

² Up to the stratopause.

³ Including nitrous oxide (N₂O), chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs), sulphur hexafluoride (SF₆), and perfluorocarbons (PFCs).

⁴ In particular nitrogen dioxide (NO₂), sulphur dioxide (SO₂), formaldehyde (HCHO) and carbon monoxide (CO).

⁵ Including measurements within the surface mixed layer, usually within the upper 15m.

ATMOSPHERIC (over Land, Sea & Ice)	OCEANIC	TERRESTRIAL [2]
Surface [4]	Surface [6]	River Discharge (ECV T1)
Pressure	Carbon Dioxide Partial Pressure	Water Use (ECV T2)
Air Temperature***	Current	Ground Water (ECV T3)
Precipitation	Ocean Acidity *	Lakes (ECV T4) *
Surface Radiation Budget	Ocean Color (for Biological Activity)	Snow Cover (ECV T5) ***
Water Vapor	Phytoplankton *	Glacier and Ice Caps (ECV T6) */***
Wind Speed and Direction	Sea Ice	Permafrost (ECV T7)
Upper-Air [5]	Sea Level***	Albedo (ECV T8) *
Cloud Properties	Sea State	Land Cover (including Vegetation Type) (ECV T9)
Earth Radiation Budget (including Solar Irradiance) */***	Sea Surface Salinity (SSS)	Fraction of Absorbed Photosynthetically Active Radiation (FAPAR) (ECV T10)
Temperature	Sea Surface Temperature (SST)	Leaf Area Index (LAI) (ECV T11)
Water Vapor	Sub-Surface	Above Ground Biomass (ECV T12) *
Wind Speed and Direction	Carbon	Fire Disturbance (ECV T13)
Composition	Current	Soil Moisture *
Aerosols Properties	Nutrients	Soil Carbon *
Carbon Dioxide***	Ocean Acidity *	Ice Sheets *
Methane and other Long-Lived Green House Gases [1] ***	Oxygen *	
Ozone	Salinity	
Precursors (supporting the Aerosols and Ozone ECVs) [3] *	Temperature	
	Tracers	
	Global Ocean Heat Content **/***	

* Added or modified per 'Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC - August 2010, GCOS-138 (GOOS-184, GTOS-76, WMO-TD/No. 1523)' (page 19) ([pdf](#))

** Not an official GCOS ECV

*** Holds data sets that are used in the NOAA Climate Services Portal, Global Climate Dashboard, Climate Change tab. Please note that the Dashboard is in development. To access the Climate Portal and the Dashboard go to <http://www.climate.gov>.

[1] The 'Other long-lived greenhouse gases' ECV includes Nitrous Oxide (N₂O), Chlorofluorocarbons (CFCs), Hydrochlorofluorocarbons (HCFCs), Hydrofluorocarbons (HFCs), Sulphur hexafluoride (SF₆), and Perfluorocarbons (PFCs).

[2] Includes Runoff (m³ s⁻¹), Ground Water Extraction Rates (m³ yr⁻¹) and Location, Snow Cover Extent (km²) and Duration, Snow Depth (cm), Glacier/Ice Cap Inventory and Mass Balance (kg m² yr⁻¹), Glacier Length (m), Ice Sheet Mass Balance (kg m² yr⁻¹) and Extent (km²), Permafrost Extent (km²), Temperature Profiles and Active Layer Thickness, above ground Biomass (t/ha), Burnt Area (ha), Date and Location of Active Fire, Burn Efficiency (% Vegetation Burned/Unit Area)

[3] NO₂, SO₂, HCHO, CO

[4] including measurements at standardized but globally varying height in close proximity to the surface

[5] Up to the stratopause

[6] Including measurements with the surface mixed layer, usually with the upper 15 meters.

LRF COMPONENT OF THE CSIS

Panellist: Richard Graham, UKMO

The LRF component of the CSIS could be defined as all climate prediction information that uses the current climate state (i.e. data assimilation).

- There is a need to fill in gaps in current provision to move towards seamlessness across timescales. Currently, the general situation with regard to supply of products is:
 - Monthly (operational in some centres);
 - Seasonal (operational);
 - Multi-annual (limited operational);
 - Decadal (first beginnings of operational).
- The activities with limited current operational application should be included in the 'roadmap' as our plans for the CSIS must anticipate advances in the science and technology. Close links are needed between research and operational activities to help accelerate science development and its transition to operations.
- For the timescales where science is developing there is a need to begin or accelerate the process of:
 - Improving understanding of current capabilities (to avoid raised expectations);
 - Establishing user requirements;
 - Defining minimum products;
 - Defining standard validation criteria;
 - Define criteria for designating centres as GPCs for interannual to decadal prediction (a simple extension of current GPC criteria will not suffice – as many decadal prediction centres are not GPCs for seasonal forecasts).
 - Capacity building to train on new products and build awareness of capabilities and limitations.

The standardisation that has been established for seasonal timescales for current GPCs, though in need of more development, is working well. GPC products are being used and are valued by participants and coordinators of RCOFs and other activities.

- To encourage 'mainstreaming' of climate services there is a need for downscaling, where there is sufficient skill, on all the timescales. Specifically:
 - Downscaling of seasonal-multi-annual-decadal predictions will be needed. In some cases this can be done by RCCs. For some regions there will be a need for global centres to supply regionally downscaled products. Thus responsibility for regional downscaling may need to be built into role of some global centres;
 - The above suggests that a regional clustering of GPCs and RCCs may be appropriate. E.g. Certain GPCs may take on responsibility for providing downscaled products to RCCs for which collaboration already exists.
- Attribution services:
 - A number of global centres are researching climate-model-based attribution systems that can run continuously, with a lag on real time, to monitor the role of anthropogenic effects on contemporary observed climate extremes. These systems will build valuable information to help avoid 'knee jerk' adaptation measures and to

build knowledge on current levels of risk. Although such systems are currently of research status it is again important to build them into the vision of the CSIS. Responsibility for attribution statements could be a specialised activity of some global centres.

- **Standardisation:** There is a need to work towards standardisation of climate reference periods (including for hindcasts), and/or to develop standard methods to adjust climate forecasts to an agreed standard reference climate. This applies across all products and timescales. Note: the issue of how to maintain a standard climate reference in a changing climate needs review. Eg. some users would prefer a synthetic estimate of the 30-year average centred on the present day.
- **Capacity building:** This can be expensive on resources even with the current level of climate service provision. With future provision of e.g. monthly, multi-annual, decadal forecasts there will be a significant increase in resource requirement.
- **Expert Teams:** There is a need to determine the role and responsibilities of WMO Expert Teams in developing new GFCS infrastructure and designation criteria.
- **Resource:** seasonal and decadal research/prediction groups at the main global prediction centres are usually relatively small (e.g. compared to staffing for NWP activities). With substantial work on new infrastructure and new requirements for capacity building, governments will need to be urged to provide resource to their prediction centres.
- **Ownership:** The issue of how and to what extent the GFCS will provide 'customer support' needs to be addressed. For example what will the GFCS provide in terms of a coordinated response to questions from the international community (e.g. the causes of recent extremes)? The Global Seasonal Climate Update (GSCU) may provide information on a subset of such questions – but provision to provide authoritative statements on questions across a wider range of climate issues may be required.