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WORLD CLIMATE PROGRAMME

WORLD CLIMATE SERVICES PROGRAMME

DEVELOPERS MEETING ON THE GFCS-RELEVANT CLIMATE DATA, PRODUCTS, AND TOOLS FOR IMPLEMENTATION OF THE CLIMATE SERVICES INFORMATION SYSTEM

6-8 December 2016

Geneva, Switzerland

MEETING REPORT

WORLD METEOROLOGICAL ORGANIZATION

March 2017

The **World Climate Programme (WCP)** implemented by WMO in conjunction with other international organizations consists of the following major components as per decision of the seventeenth World Meteorological Congress (Cg-17) in 2015:

Global Climate Observing System (GCOS)
World Climate Research Programme (WCRP)
World Climate Services Programme (WCSP)
Global Programme of Research on Climate Change Vulnerability, Impacts and Adaptation (PROVIA)

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Participants of the Developers Meeting on the GFCS-Relevant Climate Data, Products, and Tools for Implementation of the Climate Services Information System

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Executive Summary

The WMO Commission for Climatology (CCl) supports the implementation of the Global Framework for Climate Services (GFCS) with a particular focus on the Climate Services Information System (CSIS), which is the core operational component of GFCS at the global, regional and national levels. The CSIS constitutes a key contribution of WMO to the GFCS as articulated in Resolution 17 of the World Meteorological Congress at its sixteenth session (2011), and CCl, at its Sixteenth Session in 2014, established an Implementation Coordination Team on CSIS (ICT-CSIS). CSIS is designed for producing and operationally delivering authoritative climate information services, data and products, its functions include climate analysis and monitoring, assessment and attribution, prediction (monthly, seasonal, decadal) and projection (centennial scale) as well as tailoring the associated products to meet user requirements. Part of the CSIS is in place, but new infrastructure is needed to be further developed.

A Developers Meeting on the GFCS-Relevant Climate Data, Products, and Tools, under the auspices of the CCl ICT-CSIS, was held 6-8 December 2016 at WMO Headquarters in Geneva, Switzerland, and focused on development of the Climate Services Toolkit (CST). The Meeting brought together about 30 international Subject Matter Experts (SMEs) and developers of climate data, products, and tools that will constitute the initial CSIS data and products portal and CST core capabilities to be incorporated into a prototype CST for demonstration and use by selected countries; plus WMO Secretariat participants (ref: Annex I: List of participants).

Participants in the Meeting considered initial guidance provided by the Intergovernmental Board on Climate Services (IBCS) Expert Team on Specific Data Requirements (ET-SDR) on additional potential requirements from country-level GFCS implementation and from a review of data requirements in the GFCS priority areas. The meeting reviewed the GFCS-relevant data and products currently available from WMO global and regional centres, and from the ECV inventory. Drawing on this background, the Meeting focused on the identification, compilation and integration of specific data sets, products, and tools relevant to GFCS development, including through the CST, with the Regional Climate Centers (RCCs), Regional Climate Outlook Forums (RCOFs) and National Meteorological and Hydrological Services (NMHSs) as the target users.

Outputs of the Meeting included a short-term plan to seek contributions and commitments to populate a prototype CSIS data and products portal and CST for demonstration at the forthcoming International Workshop on the CSIS that will be held 21-24 March 2017 in Nanjing, China; a longer-term plan to more fully consolidate the CST architecture and provide full access to its data, tools and products ; and guidance regarding the planning of the upcoming International CSIS Workshop that will be held 21-24 March 2017 in Nanjing, China.

Specific recommendations were formulated by the meeting addressing:

- CST content and specifications;
- Implementation of the CST prototype;
- Registration of CSTs in the WMO Information System catalogues;
- Establishment of a CST developers network and coordination mechanism; and
- Next steps towards CST implementation and, in any event, prior to the upcoming International CSIS Workshop, by which time:
    - a team of developers should prepare a white paper on CST coordination; and
    - with guidance from the CCl ICT-CSIS, the developers should contribute to populating the prototype CST with existing data, tools and products.

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DEVELOPERS MEETING ON THE GFCS-RELEVANT CLIMATE DATA, PRODUCTS, AND TOOLS FOR IMPLEMENTATION OF THE CLIMATE SERVICES INFORMATION SYSTEM

1. Opening

The Secretary-General of the World Meteorological Organization (WMO), Prof. Petteri Taalas, warmly welcomed the participants in the Developers Meeting on the GFCS Relevant Climate Data, Products and Tools. He emphasized the importance of this Meeting and the need to strengthen climate services in Member countries, to ensure knowledge transfer, and to generate impacts forecasts in support of better decision-making. Mr Taalas indicated that the WMO approach focusses on the application of science for services, rather than the application of science for publications.

Ms Elena Manaenkova, Deputy Secretary-General of WMO, noted the urgent requirement to have in place a Climate Services Information System (CSIS) for decision-makers, and urged participants in the Meeting to rapidly converge on means of making the CSIS operational, building on the existing tools and systems.

Mr Roger Pulwarty (National Oceanographic and Atmospheric Administration [NOAA]), Lead of the Implementation Coordination Team on the Climate Services Information System (ICT-CSIS), noted that the Meeting would focus on the development of climate data, products and tools in support of early warning systems and mitigation of the effects of climate variability and climate change. He noted that the Meeting would take a forward looking view of data, bearing in mind how people respond to data; and that it would produce guidance on the standards for the Climate Services Toolkit (CST).

Mr Albert Klein Tank (Royal Netherlands Meteorological Institute [KNMI]), co-lead of ICT-CSIS, emphasized the high expectations on the meeting outcomes to be achieved through active contribution and commitment of all participants.

The Opening session was followed by a tour de table of self-introduction of participants (list of participants is presented in Annex I).

2. Organization of the meeting

The plenary sessions were chaired by the ICT-CSIS Lead Mr Roger Pulwarty and Co-Lead Mr Albert Klein Tank. The provisional agenda was discussed and adopted (ref: Annex II).

All presentations and relevant documentation are accessible through the meeting webpage:

http://www.wmo.int/pages/prog/wcp/ccl/meetings/ICT-CSIS/ICT-CSIS-2016.php

3. Background

Mr Maxx Dilley (WMO) outlined the background for the Meeting including WMO Constituent Body decisions relevant to CSIS implementation; and the CSIS structure, functions and status; he also noted the key challenges in CSIS implementation.

Mr Dilley presented the guidance offered by the World Meteorological Congress (Cg), the Executive Council (EC) and the Intergovernmental Board on Climate Services (IBCS) that call for the delivery of an operational CSIS providing standardized data and products, with contributions from global, regional and national entities (a layered system). Mr

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Dilley summarized the WMO and GFCS Constituent Bodies guidance on the CSIS as follows:

- implementation as an operational system should follow the WMO Technical Regulations;
- the initial focus should be on the Global Climate Observing System (GCOS) Essential Climate Variables (ECVs) (past, present and future);
- WMO centres should make relevant data and products available and accessible in a structured way; and
- benefits should be realized/visible at country level.

Key decisions and resolutions of WMO Constituent Bodies relevant to CSIS implementation include:

- Resolution 17 (Cg-XVI), 2011, Implementation of Climate Services Information System, that decides/requests inter alia, the establishment of a Climate Services Information System with global, regional and national entities providing operational climate information, including data, monitoring and prediction products within the GFCS; the implementation of CSIS should be guided by the Commission for Climatology.
- Extraordinary Congress (2012) decides to adopt the draft Implementation Plan of the Global Framework for Climate Services for the subsequent consideration by the Intergovernmental Board on Climate Services.
- IBCS-1 (2013) approved the Implementation Plan of the Global Framework for Climate Services, which should start without delay;
- Resolution 60 (Cg-17, 2015), WMO Policy for the International Exchange of Climate Data and Products to Support the Implementation of the GFCS, decided that GFCS relevant data and products from the WMO WDCs, GPCLRFs, RCCs, RCOFs and the ICSU WDS, as well as from the framework of the GCOS ECVs (Atmospheric, Oceanic and Terrestrial), will constitute an essential contribution to the Framework and therefore should be made accessible among Members, in particular through the GFCS CSIS, on a free and unrestricted basis.
- A number of EC-68 (2016) decisions[1] that (i) endorse the recommendations of the Executive Council Task Team on Data Policy and Emerging Issues […] with respect to the implementation of Resolution 60 (Cg-17), concerning […] the initial focus on the Global Climate Observing System (GCOS) Essential Climate Variables; (Decision 41); (ii) requests the World Data Centres, Global Producing Centres for Long-range Forecasts, Regional Climate Centres, National Meteorological and Hydrological Services and other associated entities within the CSIS to increase and harmonize the exchange of historical, current and forecast-related climate data and products called for by Resolution 60 (Cg-17), in support of CSIS implementation; (iii) decide that the WMO CCl, in close coordination with the CBS and other relevant technical commissions, the GFCS and the WCRP to lead a review of the GFCS relevant data and products to be provided by the Global and Regional Climate Centres, with a view to making them more widely accessible and available.

Furthermore Mr Dilley described the structure of the CSIS, noting that it harnesses data and products for climate services that seamlessly address a range of temporal dimensions and spatial dimensions and offers reanalysis, forecasts and projections (ref:

[1] https://docs.google.com/document/d/18-8K2DBscl8La8ZHL5-swOt3lRPaUHD4rXWjvhbp4BI/edit

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Annex IV: CSIS Schematic). He summarized the key challenges associated with the development of the Climate Services Toolkit (CST) as follows:

- inventorying the data, products and tools that are already available;
- making what is available accessible;
- making what is accessible useable; and
- making systematic improvements (i.e. by enhancing access to developer's tools).

Mr Dilley noted that the Meeting was expected, inter alia, to recommend actions for sustainable development and maintenance of the CST, and to provide guidance on organizing the International Workshop on CSIS that will be held 21-24 March 2017 in Nanjing, China. The upcoming Workshop will develop an implementation plan for CSIS identifying concrete actions that will enable systematic access to, use of, and continual improvement of, GFCS-relevant data and products (e.g. ECVs) under WMO auspices.

4. Overview of the selected resources relevant to the CSIS implementation

The meeting participants were apprised of some examples of resources relevant to the implementation of CSIS. The list of the potential resources and links to respective websites are provided in Annex III.

Mr Cédric Bergeron (European Centre for Medium-Range Weather Forecasts [ECMWF]) presented Copernicus Climate Change Service (C3S), an European Programme for the establishment of a European capacity for Earth observation, which will be an authoritative source of information for Europe. The European Commission has entrusted ECMWF with the implementation of the C3S. The Climate Data Store (CDS) will be at the heart of the C3S infrastructure and will provide information about past, present and future climate in terms of ECVs and derived climate indicators. It will be designated as a distributed system, providing improved access to existing datasets through a unified web interface. It will contain observations, global and regional climate reanalyses, global and regional climate projections and seasonal forecasts. The CDS will also provide an authoritative set of software (toolbox), including tools that perform basic operations on data.

Mr Joachim Saalmüller (European Organization for the Exploitation of Meteorological Satellites [EUMETSAT]) presented the EUMETSAT Satellite Application Facility on Climate Monitoring (CM SAF) products and opportunities of use of satellite data and tools in support of climate services. The CM SAF aims at the provision of satellite-derived climate data of geophysical variables suitable for climate monitoring. It contributes to the sustainable observing of the climate system by providing ECVs related to the energy and water cycle of the atmosphere. Products are available through a web-user interface from January 1982 to September 2014 with a spatial resolution from 0.03° to 1° at regional and global scale. The CM SAF provides also access to different tools to work with CM SAF data products (R package). The tools are aimed at users with little or no scripting experience and allow them to manipulate and visualize the data and generate basic statistics (offered the example of users measuring solar radiation using a cellular phone app). Mr Saalmüller informed about plans to expand training activities and recommended to empower regional centres of Excellence to help countries to use SAF products.

Mr Tufa Dinku (International Research Institute for Climate and Society [IRI]) presented the IRI Data Library that is a freely accessible data repository, analysis, and visualization tool with more than 400 datasets. It allows a user to view, analyze, display and download hundreds of terabytes of climate-related data through a standard web browser and enables users to analyse data, plot maps, generate animations for specific applications and download data in a variety of commonly-used formats. The maproom feature of the data library is a collection of maps and other figures that monitor climate

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and societal conditions at present and in the recent past. Mr Dinku also introduced the Enhancing National Climate Services (ENACTS) initiative, that strives to improve availability, access and use of climate information. It works with National Meteorological and Hydrological Services (NMHSs) to quality-control all available station data. The available data is also merged with satellite estimates for rainfall and with reanalysis products for minimum and maximum temperatures. These proxies enable to fill the spatial and temporal gaps in station observations. ENACTS also provides online mapping services that provides user-friendly tools for the analysis, visualization, and download of climate information products. The initiative is currently implemented in Ethiopia, The Gambia, Ghana, Madagascar, Mali, Rwanda, Tanzania, Zambia, Kenya, Uganda and Malawi.

Mr Rupa Kumar Kolli (WMO) and Ms Sarah Diouf (WMO) made a presentation based on an inventory of data and products deemed relevant for the implementation of the GFCS and currently available among the CSIS entities. Major gaps along with recommendation have been laid down to improve the availability and access to data and products to support the implementation of the Framework. The inventory unveiled a wealth of data and products available in the public domain and spanning all time scales. However, the lack of organization of this information leads to under-utilized data and products. They mentioned the need for democratizing the access to data and products, also an increase of a number of hydrometeorological variables (e.g. streamflow, soil moisture, evapotranspiration, *etc*.) and increase of access to long-term records, daily data and even higher resolution data. CSIS should also adopt a notion of seamlessness concerning the delivery of data at all time and spatial scales. The metadata is not systematically available and does not follow formatting standards. Quality control and homogenization of data are not uniformly available. It was recommended to standardize the metadata to maintain a comprehensive and always up-to-date documentation. The need of prioritization among the GCOS ECVs in terms of relevance regarding climate service was also raised. Finally, they stressed the role of guiding mechanism that CSIS should play to help users to interpret and use data and products.

Ms Caroline Richter (WMO) provided an overview of the GCOS implementation, including ongoing activities, challenges and plans. Several steps needs to be done, such as:

- securing and improving observation systems;
- supporting countries and implementing the appropriate observations that meet their needs and priorities;
- providing open access to observations and data access;
- ensuring the delivery of high resolution global products.

These measures will contribute to successful adaptation and mitigation, managing and reducing climate risks, enhanced livelihoods, foods and water security.

Mr Abdoulaye Harou (WMO) presented the Global Data Processing and Forecasting Systems (GDPFS). The GDPFS is organized as a three-level system (global, regional and national levels) to carry out functions, particularly the World Meteorological Centres (WMCs) at global level, the Regional Specialized Meteorological Centres (RSMCs) (including the Regional Climate Centres (RCCs)) at regional level, and the National Meteorological Centres (NMCs) at national level. Currently, the GDPFS is comprising of 3 WMCs, 25 RSMCs with geographical specialization and 16 RSMCs with activity specialization, 12 Global Producing Centres for Long-Range Forecasts (GPCLRFs), 8 RCCs and 3 RCC-Networks. It provides the core operational prediction capabilities and systems of WMO.

The GDPFS contributes to many of the WMO's high priorities, notably through the Severe Weather Forecasting Demonstration Project (SWFDP). The project is in development or operational in most regions of the world (Southern Africa, South Pacific Islands, Eastern

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Africa, South-East Asia, West and Central Africa, Central Asia) and in discussion in South-East Europe and in the Caribbean.

The GDPFS must evolve to provide seamless across timescales and disciplines, impact based forecasts and risk based warnings, serving more users through an integrated system. (it was noted in the discussions that impact based forecasting requires non-climate datasets, for example, social and economic datasets and that it is important to work with partners to integrate datasets).

Mr David Thomas (WMO) presented the WMO Information System (WIS) as an overarching approach to meet information discovery and exchange requirements of all WMO Programmes. It helps WMO to avoid data incompatibilities, and problems in the sharing of valuable data between various programmes. It ensures interoperability of Information Systems between WMO Programmes and outside of the WMO community. Anyone can discover information and services in WIS, and in interoperable systems such as GEOSS, and can access information according to the data policies and service provided by the data custodian. Authorised centres can register their information and services in the WIS discovery catalogue and use the WIS to exchange data. Being a registered as a data provider in WIS requires centres to be supported by a WMO programme or constituent body and to be certified by the Commission for Basic Systems as complaint with the required WIS functions and technical specifications. Candidate data centres was approved by WMO Executive Council are designated as a Data Collection or Production Centre (DCPC)or as National Centres (NC). To make CSTs discoverable in the WMO and connected communities' information systems, CSTs existence must be registered in WIS.

Mr Lars Peter Riishojgaard (WMO) provided an overview of the WMO Integrated Global Observing System (WIGOS), a fundamental activity addressing the observing needs of the weather, climate, water and environmental services of its Members. WIGOS constitutes a framework for integrating all WMO observing system and WMO contributions to co-sponsored observing system under a common regulatory and management framework. Together with the WIS, WIGOS is a WMO contribution to Global Earth Observation System of Systems (GEOSS). It is important to recognize that WIGOS is not replacing the existing observing systems, but is rather an over-arching framework for the evolution of these systems which will continue to be owned and operated by a diverse array of organizations and programmes.

WIGOS Information Resource, including the Observing Systems Capabilities analysis and Review tool (OSCAR) is among five priority areas of WIGOS implementation. The WMO Rolling Review of Requirements (RRR) is supported by three key databases of OSCAR, i.e. OSCAR/Requirements, OSCAR/Space and OSCAR/Surface

5. Climate Services Toolkit: Concept and potential resources

This section reviews the draft concept of the CST, existing tools potentially significant for the CST in term of GFCS relevance, potential for producing user-targeted products based on scientifically-sound methodology, readiness for contributions to/integration in CST and availability of expert support.

5.1 Overview

Mr Roger Pulwarty (NOAA) recalled the definition of the CSIS, the operational core of the GFCS designed for producing and delivering authoritative climate information products through appropriate operational mechanisms, technical standards, communication and authentication. The functions of the CSIS include climate analysis and monitoring, assessment and attribution, prediction (monthly, seasonal and decadal) and projection (centennial scale). A number of CSIS priority activities are establishment of National

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Frameworks for Climate Services in developing countries, building up a Climate Services Toolkit and making available to all countries, standardization of the operational CSIS products, implementation of the Climate Watch System, facilitating the effective use of GPC and other global climate products by regional and national providers (e.g. RCCs and NMHSs), strengthening regional and national systems for providing climate services (RCCs, RCOFs, NCOF/NCF).

The flagship activities of the CSIS for the next year are producing a CST prototype, a Technical Guidance for developing climate services at national level, and initiating a prototype CSIS, including capacity development in GFCS priority countries drawing on successful approaches and existing networks.

Ms Marina Livezey (NOAA) continued with the presentation of the CST. WMO, through the Commission for Climatology (CCl) will coordinate the compilation, production and distribution of a CST, as an emerging mechanism to accelerate GFCS implementation at regional and national levels. The CST will ensure that the information and products developed for and provided to end-users are reliable, consistent (through time and across regions), adhere to standards and of high quality. The CST would share new tools, information and methods, and thereby enables all CSIS providers to take advantage of research advances. It would enable more countries to develop their national products, and so encourage improved data sharing, and foster the interaction and shared learning between information providers through the development of a common set of skills. It aims to reduce the need for expensive capacity building through availability of training resources, making training workshops more focused, tangible and efficient. The main users of the CST are, but are not limited to NMHSs, it is expected to serve users from all GFCS sectors. The current version of the CST website is a wire frame (CST mock-up) that will be populated by tools with the help of developers.

5.2 Climate Data

Mr Alexander Sterin (Russian Research Institute for Hydrometeorological Information – World Data Center [RIHMI-WDC]) made a presentation on the RIHMI - WDC that collects data from diverse sources. It is used in research and developments for the benefit of climate-sensitive sectors and activities (energy, water, agriculture, forestry, *etc.*). In the meantime Mr Sterin mentioned the climate data requirements, which must be complete, with minimum of gaps, quality controlled, homogenized, following standards and unifications. The CST is expected to integrate functionality in data access, data analysis and data visualization.

Mr Atsushi Goto (Tokyo Climate Center [TCC]) presented ClimatView, a tool that enables the visualization and download monthly temperature and precipitation data climatological normal, as well as anomalies for the available stations. Data are available from June 1982 to the last month. It is based on CLIMAT reports sent from about 2 700 observation stations worldwide. ClimatView is freely available to public.

Mr Denis Stuber (Météo-France) presented on Climate Data Management Systems (CDMS) an integrated computer-based system that facilitates the effective archival, management, analysis, delivery and utilization of a wide range of integrated climate data. The publication *Climate Data Management Systems Specifications* (WMO, 2014) established a framework defining the functionality required within a CDMS. A questionnaire on the current status of CDMS in NMHSs conducted in 2010 unveiled that 25% of the respondents do not use a DataBase, and for 38% of the respondents their CDMS is not fully operational. Denis Stuber noted, that no CDMS is currently compliant with the CDMS Specification publication (WMO-No. 1131), and significant investments are required to conform to the requirements of WMO-No.1131. Open source CDMSs could be the solution and should converge on one reference open source CDMS.

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Mr Albert Klein Tank (KNMI) presented the International Data Rescue (I-DARE) portal. I-DARE aims to provide a single point of entry for information on the status of past and present global data rescue needs and data rescue projects, guidance on best methods and technologies involved in data rescue, and on metadata for data that need to be rescued. The portal is being populated through country focal points nominated by the Permanent Representatives of WMO Members, the efforts are underway to liaise with the DARE community and to further improve the I-DARE portal based on user feedbacks .

Mr Albert Klein Tank (KNMI) also introduced the KMNI Climate Explorer, which hosts data and products (station data at daily and monthly time scales, climate indices, reanalysis, climate model outputs, seasonal forecasts, decadal forecasts, *etc.*) and allows users to retrieve datasets, also create and download figures. Some restrictions are in force, notably the possibility to define individual indices, to upload data into the KNMI Climate Explorer and to handle large datasets. To benefit these features, a registration, which is free, is required by only providing a name, an e-mail address and the institute.

Ms Ana Pinheiro Privette (US Global Change Research Program [USGCRP]) introduced the Partnership for Resilience and Preparedness (PREP). PREP is a public-private collaboration to empower a data-driven approach to building climate resilience. It aims to help planners, investors and resource managers more easily incorporate climate risks into their decisions by enhancing access to relevant data and facilitating collective learning. The PREP comprises three workgroups Data, Engagement and Platforms. Since September 2016, PREP released a beta platform as a first step.

5.3 Climate Monitoring, Analysis, Predictions, Projections

Mr Albert Klein Tank (KNMI) presented the International Climate Assessment & Dataset (ICA&D) climate services concept, which is built on the European Climate Assessment & Dataset (ECA&D) concept transferred to other regions of the world, in particular Southeast Asia, Latin America and West Africa.

The ECA&D gathers, archives daily station records in a central repository for 62 countries throughout Europe and the Mediterranean, based on which generates and disseminates extreme climate indices, defined by the Expert Team on Climate Change Detection and Indices (ETCCDI). A user-friendly R-based software (RClimDex), developed by Environment Canada, is available for the calculation of these indices [2]. It proposes harmonized data quality control and homogeneity testing procedures. Several regional workshops have been conducted in different regions around the world to promote the use of the software and analyse extremes.

Mr Wassila Thiaw (NOAA) presented the NOAA Climate Prediction Center (CPC) Climate Monitoring Tool. The Climate Monitoring Tool is a web-based tool used to monitor seasonal climate trends. It provides spatial precipitation maps, cumulative precipitation time series, seasonal rainfall performance probability, standardized precipitation index and soil moisture and runoff percentile. An initial beta version has been developed and implemented, primarily focusing on West Africa, East Africa and Southern Africa. It is planned to include more countries and also to include sub-seasonal to seasonal forecasts.

Mr Peer Hechler (WMO) introduced the National Climate Monitoring Products (NCMP). The NCMP are products which summarize the weather and climate across a country and which ideally provides some contexts for the current conditions. The Expert Team on National Climate Monitoring Products (ET-NCMP) defined a shortlist of standardized NCMPs, with respect to a baseline of 1981-2010. The Environment Canada has produced an R based open-source prototype software (based on the ETCCDI software) to realize data quality control and compute these NCMPs. It is expected to be released in February

[2] http://etccdi.pacificclimate.org/software.shtml

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2017. Guidance have also been developed on interpretation and reasoning behind NCMPs.

Atsushi Goto (TCC) presented Interactive Tool for Analysis of the Climate System (iTacs) developed by the Japan Meteorological Agency (JMA), and available on the TCC website. The iTacs is a web-based application to assist NMHSs in the production of analysis information on extreme climate events and the climate status monitoring. The tool allows users to create two-dimensional maps, cross sections, time-series representations and other types of chart interactively, and enables various types of statistical evaluation, allowing users to upload their own data or indices for statistical analysis.

Mr Simon Mason (IRI) presented the Climate Predictability Tool (CPT), an easy-to-use software package, developed by IRI, for constructing a seasonal climate forecast model, performing model validation, and producing forecasts given updated data. Its design has been tailored for producing seasonal climate forecasts using Model Output Statistics (MOS) corrections to climate predictions from General Circulation Model (GCM), or for producing forecasts using fields of sea surface temperatures or similar predictors. The CPT is freely available on the IRI website, online tutorials and frequent training programmes, a Help Desk, being widely used, notably through RCOFs and in universities.

Ms Yun-Young Lee and Mr Hyunrok Lee (Asia-Pacific Economic Cooperation Climate Center [APCC]) presented the CLimate Information toolKit (CLIK), a web-based climate information tool to empower users to take advantage of climate information and forecasts in user friendly interface. CLIK enables users to retrieve and utilize climate prediction data and information and it also provides customized 3-month Multi-Model Ensemble (MME) probabilistic and deterministic prediction with verification. In addition, it has a region-specific statistical downscaling prediction tool. Diverse dynamical seasonal prediction modeling data provided by 16 institutions from 10 countries are available for MME prediction and statistical downscaling prediction in CLIK. Target users are NMHS staffs having basic understanding of climate and meteorology, but are not strictly limited. The tool has potential to contribute to early warning and management of climate-related disaster and resource management, particularly in developing countries. Training programs on CLIK have been conducted by APCC in several regions of the world. In the future, CLIK aims to enhance computing mechanism through in-house HPC, develop and generate tailored information, and improve training workshop and tutorial program continuously.

Mr Caio Coelho (Center for Weather Forecasts and Climate Studies [CPTEC] / National Institute for Space Research [INPE]) made a presentation on the GPCLRFs. In 2006, the WMO began a process to designate centres responsible for generating and delivering global seasonal forecasts as WMO GPCLRFs. This forms an integral part of the WMO GDPFS. Through this designation process, the GPCLRFs adhere to certain well-defined standards. A comprehensive set of standard verification measures has also been defined, and is known as the WMO Standard Verification System for Long-Range Forecasts (SVSLRF). There are certain criteria and requirements set up for GPCLRFs in terms of products, lead time, frequency of issue, delivered type of products, variables, as well as LRF skill assessments according to SVS LRF.

Mr Coelho also briefed about two designated WMO Lead Centers, the Lead Center for Long-Range Forecast Multi-Model Ensembles (LC-LRFMME), responsible for collecting GPCLRFs forecasts, displaying the forecast information, generating multi-model products, and the Lead Centre for Standard Verification System of Long-Range Forecasts (LC-SVSLRF), responsible for providing documentation on verification scores, software and datasets for long-range forecast verification.

Mr Caio Coelho concluded his presentation by mentioning that available data and products disseminated the WMO LC-LRFMME are well structured can be integrated in the CST, while under development sub-seasonal forecast products could be integrated in the CST at a later stage. Various challenges still need to be addressed, such as data format,

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tailoring/downscaling, interpretation/communication, delivery timeliness of products and services, managing model changes and impacts on user procedures.

Mr Caio Coelho continued with a presentation on the EURO-Brazilian Initiative for Improving South American Seasonal Forecasts (EUROBRISA). The key idea of EUROBRISA is to improve seasonal forecasts in South America, a region with seasonal forecast skill and useful value, and to strengthen collaboration and promote exchange of expertise and information between Europe and South American seasonal forecasters. This research initiative brings together expertise on coupled ocean-atmosphere seasonal forecasting and statistical calibration and combination of multi-model ensemble forecasts, to produce improved well-calibrated real-time probabilistic seasonal forecasts for South America for non-profitable governmental use in relevant GFCS priority areas. The forecast products are disseminated to the Regional Climate Outlook Forums (RCOFs) and the National Climate Outlook Forums (NCOFs) and are readily available via EUROBRISA website.

Mr David Hein-Griggs (UK Met Office) presented the Providing Regional Climates for Impacts Studies (PRECIS), a regional climate modeling system developed at the Met Office Hadley Centre with the intention of allowing users in developing countries to easily produce detailed climate projections with higher resolution of 25 or 50 km for any chosen region of the world. This allows for a more realistic representation of the climate over the region of interest. Between 2003 and 2016, around 50 training workshops have been conducted worldwide. PRECIS will evolve to become freely available as a LINUX Virtual Machine as a capacity building tool and will also be deployed on cloud computing systems for downscaling long reanalyses to create proxies of past observations. Efforts will be made to improve training methodologies to reflect educational research.

Ms Clare Goodess (Climatic Research Unit [CRU]) presented climate change data and products from the WCRP Coupled Model Intercomparison Project (CMIP) and the WCRP Coordinated Regional Downscaling Experiment (CORDEX). CMIP coordinates climate model experiments involving multiple international modeling teams worldwide. It has led to a better understanding of past, present and future climate change and variability in a multi-model framework. CMIP has developed in phases, with the simulations of the fifth phase, CMIP5, now completed, and the planning of the sixth phase CMIP6, is underway. The output files in NetCDF are available through the Earth System Grid (ESG) portal and also from the Intergovernmental Panel on Climate Change (IPCC) Data Distribution Centre.

The CORDEX vision is to advance and coordinate the science and application of regional climate downscaling through global partnerships. There are 14 domains for which the regional downscaling is taking place. The resolution is around 0.44° (0.11° for the European domain). The core set of variables is archived in NetCDF standards. There is no central CORDEX archive but CORDEX output can be accessed through different webpages.

5.4 Tools for Tailoring Climate Information

Mr Nicholas Herold (Climate Change Research Centre and ARC Centre of Excellence for Climate System Science) introduced ClimPACT2, a software for calculating indices of climate extremes. The software has been developed by the Expert Team on Sector-specific Climate Indices (ET-SCI). It directly incorporates the R packages developed by the Pacific Climate Impacts Consortium (PCIC). The software allows users to calculate more than 60 indices via a Graphical User Interface. It is open source and runs on LINUX, Windows and Mac OS. The next version will run through the user's web browser and possibly from a web server, so no installation process will be required.

Mr Edward Gardiner (NOAA) presented the US Climate Resilience Toolkit, a website dedicated to enabling decision-makers to better understand the climate-related risks and

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opportunities impacting communities and take action to boost their climate resilience. This toolkit was developed with active input from user communities who it is meant to serve, and that model of development using active input has been central to its ongoing operations. Gardiner emphasized several simple steps that the CSIS/CST team could follow in order to improve its chances of serving the needs of end users. First, characterize and understand the ultimate audience for the CST. Without a firm understanding of who will use this resource, it will be impossible to measure success or progress. Second, prior to building anything, use inexpensive procedures such as card sorting, user experience evaluations, and establish a means of collecting feedback over time in order to ensure that the site's end users have a voice in shaping its contents and structure. Third, deploy updates and innovations through active involvement of and with the professional networks and organizations to which end users belong. Develop case studies that serve the needs of these organizations and their members. By serving the needs of whole communities, there will be a greater likelihood of success in the long term for maintaining the value proposition of the CST.

Mr Chris Hewitt (UK Met Office) presented several case studies on User Interface, such as RCOFs which produce consensus-based, user-relevant climate outlook products for the region in question; Workshops to assess climate risks and impacts on various sectors and gather feedback to improve further climate risk assessments; Monthly face-to-face meetings (e.g. NCOFs) to evaluate forecasts from the user's perspective and discuss requirements for further products; Co-development by users and providers; Website constantly updated and revised based on user feedback. The User Interface is one of the components of the GFCS aiming to provide a means for users, researchers and climate services providers to interact at the global, regional and national levels to ensure that user needs for climate services are met and to promote effective decision-making.

Mr Nabansu Chattopadhyay (India Meteorological Department [IMD]) presented the capabilities of climate services for farmers in India. Several observing systems are implemented in India, e.g. rain gauge stations, upper air and surface observations, automatic weather stations, Doppler radar, weather satellites, *etc.*. CliSys is the existing CDMS that provides a set of tools and procedures that allow all data relevant to climate studies to be properly stored and managed. Farmers contribute to collecting climate data, and help to produce local-specific agrometeorological advisories.

6. Break-out Group Discussions on CST Development

Participants broke into five groups for structured discussions on key aspects of the CST development, addressing a common set of key questions:

a) What is an appropriate set of criteria for data, products and tools integration into CST?
b) How can existing capabilities contribute to supporting the GFCS Priority areas?
c) How to enhance access to GFCS relevant data, products and tools at country level?
d) What WMO guidance, technical documentation, and/or capacity building events are necessary for successful CST implementation?
e) What institutional support should be in place for sustainable CST operations?

Expected Meeting Outputs to keep in mind during discussions:

- A CST prototype with demonstrated core capabilities using web portal for data and tools as well as stand-alone tool-set comprising software and data;
- Recommended actions for sustainable long-term development, maintenance and updating of the CST through institutional collaborations, expert engagement, infrastructural requirements for deployment of GFCS-relevant CST components;
- An active network of climate data and tool experts for CST demonstration for

GFCS partners and priority countries;
- Action Plan for accelerated CST deployment in GFCS priority countries

6.1 Climate Data Management

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Group 1 Members: D. Stuber (Meteo France, Moderator), P. Hechler (WMO, Rapporteur), Leo Rodriguez (SENAMHI, Bolivia), A. Sterin (Roshydromet), T. Dinku (IRI)

Group 1 considered climate data as the essential foundation for a strong CSIS. It identified the following as key CST components in the domain of Climate Data Management:

i. Climate Data Management Systems (CDMS),

ii. Data Rescue including the International Data Rescue Portal (I-DARE),

iii. Climate datasets and metadata including data portals, and

iv. Related capacity development, including training (at the same time, the Group noted the parallel work of Break-out Group 5 on Capacity Development, and hence decided not to go into too much detail here with the understanding that basic capacity development is required for all climate data management components above).

The Group discussed and formulated its responses to the relevant questions raised as follows:

a) What is an appropriate set of criteria for data, products and tools integration into CST?

The Group identified the following criteria/requirements:

i. Institutional commitment from providers to maintain and further develop tools,

ii. Availability of sufficient documentation, capacity development strategy in place,

iii. Compliance with a recommended data exchange protocol (to be determined in due course), as well as CDMS Specifications described in WMO Publication No. 1131,

iv. Quality assessment including provenance information,

v. Consideration of language issue; identify contact point, feedback mechanism, helpdesk, license issues, etc.

vi. Possibility to monitor CST (score, number of view/download).

b) How can existing capabilities contribute to supporting the GFCS Priority areas?

Quality data provides the foundation for all climate services. The following measures were considered to **enhance access to GFCS relevant data, products and tools** at country level:

i. Communication strategy including awareness raising,

ii. Being discoverable as much as possible,

iii. Engagement of users and their feedback mechanisms,

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iv. Capacity building for user community,

v. Open and free access as indicated in Resolution 60 (Cg-17).

d) What WMO guidance, technical documentation, and/or capacity building events are necessary for successful CST implementation?

i. Updated consistent set of WMO guidance around climate data which is easily discoverable and accessible;

ii. Coordination and synchronization of capacity building activities;

iii. Technical documentation to be provided;

iv. Register available CST and technical documentation in WIS;

v. Promote Resolution 60 (Cg-17).

e) What institutional support should be in place for sustainable CST operations?

Institutional Commitment from the provider to maintain and further develop the tool.

6.2 Climate Monitoring and Assessment

Group 2 Members: Ms Manola Brunet India (C3, Moderator), Ms Lisa-Anne Jepsen (WMO, Rapporteur), Mr Atsushi Goto (TCC), Mr Albertus Klein Tank (KNMI), Ms Marina Timofeyeva Livezey (NOAA), Mr Robert Stefanski (WMO)

Ms Manola Brunet, Moderator of the Group 2, noted that the Group focused on products and tools, having determined that data-related matters (for example, time-series quality control and homogenization) fall between OPACE-1 on Climate Data Management, and OPACE-2 on Climate Assessment and Monitoring[3], and have been left aside.

a) What is an appropriate set of criteria for data, products and tools integration into CST ?

- be developed by a NMHS or through a WMO collaboration (WMO Expert Team; WMO Commission);
- ideally be peer reviewed and/or include a description of quality assurance methodologies;
- have a long history of use by a NMHS, RCC, GPC and/or other WMO-recognized institution (e.g. RCC in demonstration phase);
- be operationally maintained by the responsible/contributing institutions (e.g. provision of HelpDesk, training, documentation; availability of sustainable funding and/or support); and
- be recommended or endorsed in a WMO document (e.g Meeting Report; Minutes).

The group noted (i) the IPCC assessment process, which is well documented, and to consider whether the products and tools included in the CST should be harmonized with those used in the IPCC Assessment Reports[4]; and (ii) the need for monitoring and/or assessment products and tools in the CST to address the past, present and future.

b) How can existing monitoring and assessment capabilities contribute to supporting the GFCS Priority areas ?

[3] http://www.wmo.int/pages/prog/wcp/ccl/cclstructure.php
[4] http://www.ipcc-data.org/ddc/site_layout.html

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The Group considered the various products and tools presented at the Meeting, i.e. International Climate Assessment and Dataset (KNMI), Climate change detection indices (ETCCDI), Climate explorer (KNMI), CPC Climate Monitoring Tool (NOAA), National Climate Monitoring Products (ET-NCMP), Interactive Tool for Analysis of the Climate System (JMA).

The Group determined that, vis-à-vis the five GFCS priority areas, the utility of existing tools, such as those listed above, is their ability to provide impact-based climate information, including thresholds and advanced indicators for GFCS priority areas, such as growing degree-days, frost thresholds, sunshine duration, wind and comfort indices, rainfall intensity, etc.

Participants suggested to include Open Source tools in the CST, and to expand the list of tools beyond those presented at the Meeting. Participants were reminded of the need to distinguish between monitoring products and prediction tools, e.g. the KNMI Climate Explorer; and the IRI CPT.

c) How to enhance access to GFCS relevant data, products and tools at country level ?

Group 2 identified the following means of enhancing access at the country level to GFCS-relevant products and tools:

- engaging with NMHSs, initially focusing on the 8 GFCS priority countries;
- providing the Climate Services Toolkit;
- improving/strengthening User Interfaces (e.g. National Stakeholder Consultations, NCOFs, RCOFs);
- sensitizing national policy makers (e.g. involvement in NSCs, NCOFs);
- engaging in relevant outreach activities; provision of communications products;
- capacity development of both providers and users of climate services;
- identifying regional good practices/success stories/lessons learnt including case studies of RCC/NMHS collaboration on effective use of the CST, involving the GPCs as appropriate; (such a case study could examine Bhutan: the sensitivity of climate variables to climate variability and change; the role to be played by each partner in an effective partnership among NMHS Bhutan, the RCC and experts);
- ensuring free and open exchange of climate data.

d) What WMO guidance, technical documentation, and/or capacity building events are necessary for successful CST implementation ?

Group 2 recommended that guidance and technical documentation associated with the products and tools be included in the CST as follows:

- guidance and technical documentation on each product or tool should be provided by the institution that is responsible for/has contributed the product/tool; such documentation should be reviewed by relevant experts; and
- information should be provided on (i) the recommended application of products and tools for each of the five GFCS priority areas (for example, monitoring of exceptional nature of a drought); and (ii) the pros and cons of using a given tool for a specific application.

The Group identified needs for capacity building materials and events, such as (i) Framework for CST Training; (ii) training of trainers at regional level to ensure consistency in CST application; (iii) E-learning materials; webinars; and (iv) Help notes available on line in the CST.

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e) What institutional support should be in place for sustainable CST operations ?

Group 2 identified two levels, at which institutional support for CST operations would be required, particularly the overall governance (to be agreed by CCl), and sustainable support by providers of CST products and tools, as approved in CST configuration by the governance mechanism.

In addition to the institutional support the Group suggested the need to collecting feedback from users of the CST products and tools (NMHSs, research institutes, etc).

6.3 Climate Predictions, Projections, and Delivery Mechanisms

Group 3: Members: J.-P. Céron (Co-chair OPACE 3, Moderator); S. Diouf (WMO, Rapporteur); R. Kolli (WMO), C. Goodess (CRU), S. Mason (IRI), H. Lee (APCC), Y.-Y. Lee (APCC), V. Khan (Hydrometeorological research Centre of the Russian Federation), C. Coelho (CPTEC/INPE)

a) What is an appropriate set of criteria for data, products and tools integration into CST?

During the discussion, it was decided to separate the tools and the Data and Products investigation. Nevertheless, the documentation of Tools, Data and Products and their accessibility are cross-cutting (and very likely beyond this specific group).

- *The tools*

To avoid the possibility of a proliferation of inconsistent, redundant, and possibly sub-standard tools, the latter must meet a set of standards for documentation, design, and support. The report of the Commission for Climatology Task Team on the Climate Information and Prediction Services (CLIPS) Evolution provides some relevant criteria for tools (WMO, 2011).

Tools need to be based on best practices to ensure that tools are based upon refereed scientific principles and recognized methodologies, and offer the latest scientific and technological advances. They should be provided with support to ensure that users have the expertise to operate the tools properly and interpret the output correctly, with:

- accompanying manuals to gain an understanding of how the tools work;
- accompanying training materials and training programs to gain proficiency and fully understand the functionality of the tools and the correction interpretation;
- mechanisms for providing help desks and feedback;
- certified training programs (workshop and remote-learning)
- benchmark for helping to install and to verify that the tool is running correctly

The sustainability of the tools and their developments should be ensured, especially thought, not only with the guarantee of on-going maintenance to avoid obsolete tools or bugs. The tools need to be user-friendly, with visualization capabilities to present data, analytical results and predictions in publication-quality formats (friendly colour palette, high-quality graphical functionalities, standard formats, *etc.*) and easy-to-access from Internet and/or available on request, especially via WMO entities and including long term permissions.

To enable users to operate the tool in their native or familiar language, the tool should incorporate multilingual user interfaces. The tools should be portable to minimize potential problems arising from operating system, scalable to ensure that the tools can be used on computers with a wide range of power and by personnel with varying levels. Some flexibility to adapt the tools to each users' specificities would be very welcome.

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Free software or freeware is crucial for ensuring that countries are not denied access to technologies on the basis of insufficient resources. A certification procedure can support trainer candidates to gain skills and reach credibility.

Finally, a procedure of certification (or labelization) should be proposed under WMO auspices to guarantee the users that they are using tools that follow WMO recommendations in elaborating climate products and services to the benefit of the stakeholders.

- *Data and Products*

The CST needs to ensure high-quality products and in doing so relevant and best possible datasets for elaborating them. For that purpose, data and products need to be submitted to a quality control and homogeneity procedure (when relevant). They also need to meet standard formats, a fundamental requirement for the exchange of data. Quality control and data formats are criteria that foster data sharing and interaction between information providers.

A key element of the application of climate information is the timeliness of its delivery and in a format that supports decision making. To this end, data and products (e.g. local data, monitoring products, …) must be also provided in time to ensure that the whole process will deliver the final products and services timely. Time and spatial scale are also crucial criteria to take into account in the integration of data and products into the CST. Daily data are particularly relevant to compute climate indices and other climate tailored information.

The hindcasts generated by global centres should be made accessible and the lengths of hindcasts should be sufficient to calibrate the forecast systems and/or provide a measure of the average skill that the forecast system has exhibited in the past as a guide to the skill that might be expected in the future. Further, access to daily forecast values should be of great interest for tailoring climate information for decision making.

The group noted the importance in undertaking a formal process to implement the delivery of projections, which has hitherto not been carried out. The different matrix and tools available in the CMIP and CORDEX framework should be easily accessible for the users.

Diverse sources provide similar information which are not always updated. A guidance on the selection of the most relevant datasets needs to be made widely accessible.

The CST should include all relevant datasets including a description of climate drivers, climate variability and change for the region of interest. All data and products provided by the CST should be evaluated, accessible and useable especially using appropriate delivery mechanisms. One of the goals for the WMO International Workshop on CSIS Operations and Coordination (Nanjing, China, 21-24 March 2017) will be to specify a limited set of data to be included into the CST.

b) How can existing capabilities contribute to supporting the GFCS priority areas?

Existing capabilities can support the GFCS priority areas by providing impact-based forecasts, designated to express the likely impacts as a result of the expected climate. These types of forecasts provide actionable information on the impact of the hazards in way that users may take actions for the protection of life and property.

The National Climate Outlook Forums (NCOFs) are very relevant to link with the priority areas at the country level. They could serve as national platforms for regular dialogue between climate information providers and users, in responding to natural hazards, climate variability, climate extremes and climate change. During a NCOF, large and regional scale forecasts can be adapted to the national context. NCOFs represent the perfect occasion to produce tailored products and translate key messages for users from GFCS priority area sectors.

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A comprehensive toolkit should target different types of users (NMHSs staff, researchers, decision-makers, end-users, sector-specific users, etc.). However, for a same climate-sensitive domain, users may have different expectations and requirements and consequently the decision will be different (e.g. farmers vs governors). CSIS should be aware of the user requirements and their needs of climate information for specific decisions. This question addresses the boundary between the CSIS and the User Interface Platform (UIP) pillar. And we have to acknowledge that this interface is very user dependant and should be as flexible as possible.

c) How to enhance access to GFCS relevant data, products and tools at country level?

First, a communication and outreach strategy on the CST could be undertaken at country level, through flyers or brochures, highlighting the benefits of the Toolkit. Training programs on CST for a specific goal could also contribute to enhance access to GFCS relevant data, products and tools, as well as the networking between universities, Regional Climate Centres (RCCs) and Regional Climate Outlook Forums (RCOFs).

Basic infrastructure (hardware, mandate of the institution) are needed to facilitate the access to GFCS relevant data, products and tools. Access to data and products in decision specific formats is crucial for the CST success.

At country level, the Climate Data Management System (CDMS) is currently mainly focused on observed data. In the future, CDMS should take into account more datasets e.g. prediction and projections.

The in-country training should pay attention to the selection of trainees and to the consolidation of Capacity Building.

d) What WMO guidance, technical documentation, and/or capacity building events are necessary for successful CST implementation?

For the successful implementation of the CST, several guidance documents are needed:

- on operational aspects, including best practice for interpretation of data and products (climate analysis, climate drivers, forecasts, ...);
- for Climate Change issues, guidance should be provided by the research community (WCRP, IPCC, CORDEX, ...) on communicating uncertainties related to the prediction and the projection ; (for projections WCRP can take up the technical level as an expert contribution, Task Group on Data and Scenario Support for Impact and Climate Analysis (TGICA) and IPCC can also play a role); information on the different models used should help in the assessment of the uncertainty inherent to this information.
- on risk assessment and communicating risks associated with the use of the information (appropriateness of the predictions according to the context).

Capacity development can be stratified into core functions of the CSIS (climate data rescue, management and mining, climate analysis and monitoring, climate prediction and climate projection). Training workshops should reflect each of these streams, in order to be more focused, tangible and efficient in imparting operational skills and to better target specific needs of users.

e) What institutional support should be in place for sustainable CST operations?

It is important to establish and maintain a Help Desk to quickly answer questions that a user may encounter. The Help Desk should provide help on the usage of the CST (e.g. data extraction, use of a software, interpretation of products, etc.) and provide a system administration assistance.

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A WMO or GFCS accreditation could be a means of enhancing the visibility of the CST, reaching credibility and getting resource access. The accreditation could be part of the GDPFS.

For sustainable CST operation, it is very important to encourage open source software, which enables a broader user community to take advantage of the CST.

An inventory of publications can be developed and dedicated to different CST aspects.

The presence of CORDEX representatives at the meeting in March 2017 would be highly appreciated. CORDEX representatives could bring their expertise for prediction issues.

- Elements to consider for the CST prototype

At least a minimum set of climate data and products should be integrated into the CST prototype. Lead Centres should provide facilities to countries to predefine geographic domains and enable the subset of forecasts and even hindcasts in areas of interest. It would enable users to extract datasets from a given domain, without having to extract global datasets.

To better meet the immediate needs of countries, the CST should provide proper tools depending on the capacity of the country to assess climate variability and change in regional and national context. The CST could be reduce into a “CST portable” version which can be adapted according to the capacity of the country (especially with respect of Internet requirements) and locally installed. A “short list” of products relevant at the country level could facilitate the selection of appropriate tools relevant to the CST.

6.4 User Interface for Climate Adaptation and Risk Management

Group 4 Members: Rodney Martinez (CIIFEN, Ecuador, Moderator), Anahit Hovsepyan (WMO, Rapporteur), Andre Kamga (ADMAD), Eduard Gardiner (NOAA), Nabatsu Chattopadhyay (IMD), Steve Connor (Colombia University, USA), Nicholas Herold (Climate Change Research Centre, Australia), Chris Hewitt (UK Met Office), Erica Allis (GFCSO)

The improved decision-making for planning, operations, risk management and adaptation to climate change and variability will be achieved through a higher level of climate knowledge along with access to and use of actionable information and products, which requires adequate User Interface (UI) mechanisms. Building these mechanisms are multidisciplinary, and require involvement of core priority sectors, as well as close collaboration within OPACEs of the WMO CCl and other WMO Technical Commissions (Commission for Agricultural Meteorology (CAgM), the Commission for Hydrology (CHy)).

a) Elements to consider for the CST prototype

The Group discussed the Elements needed to establish a user interface for climate risk management and adaptation, which serves as a boundary between climate community and external world.

The UIs require specific information about climate related hazards and information beyond the climate domain, including **exposure, vulnerability and coping capacity / adaptive capacity** (the example of US Resilience Toolkit).

The **guidance documents and tools, produced by the CCl OPACE-4**, particularly Guidance Manuals on Climate Risk Management with a check list of specific climate services for CRM and adaptation, and on User Interface for climate Services, with case studies on user interfaces, as well as ClimPACT tool for generating sector specific information, will be important part in building the UI, and proposed to be included in the UI tools.

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It was proposed to develop and include in the CST a **Template for a Service Delivery Plan**, which comprises definition, development, and validation of services.

Educational and guidance materials related to the conceptual framework of climate risk management and adaptation (including WMO RTCs) will be required to strengthen NMHSs capacities on CRM.

A **catalog of case studies on climate services** for CRM and adaptation classified by categories was proposed to be developed and included in the CST.

The central **role of RCCs** in support of improving climate services of NMHSs until their services are self-sustained, was also considered.

GFCS Exemplar on User Interface Platform was proposed to be included.

b) Recommended actions for sustainable long-term development

The following recommended actions were identified by the Group:

- To build up national user interface mechanisms, such as National Climate Outlook Forums (NCOFs), which will be sustained through establishment of National Framework for Climate Services (NFCS);
- To support the dialogue and interaction between the NMHS and high level national authorities by demonstrating potential benefits of the application of climate services, e.g. through assessment of socio-economic value;
- To support the elaboration of comprehensive services development plans, involving the key partners, authorities and sectoral stakeholders;
- To establish strong partnership with Climate Change institutions to include NMHSs in the National Adaptation Plans and the accomplishment of the Paris agreements regarding climate monitoring and building resilience;
- To identify boundary organizations which could support the dissemination of climate services to the most remote communities (last mile);
- To involve the private sector through strategic partnerships with local and/or national authorities.

c) Action plan

More specific actions have been discussed and proposed by the Group to start the implementation of the UI component of CST:

- Refine the inventory of NMHSs capabilities, building on the results of surveys conducted by WMO;
- National/local Stakeholders mapping, to help identify their climate service requirements;
- Inventory of data and information sources related with vulnerability, impacts or exposure;
- Information design considering the proposed sectors;
- Construction of the prototype based on existing mechanisms and tools;
- Provide adequate training on the use of the CST; and
- Collect and document case studies on best practices.

It was further proposed to form a working group, which will develop more detailed implementation plan, that will include, inter alia,

- Formation of the National Framework for Climate Services (NFCS), including Steering committee, technical committee;
- Holding NCOFs to discuss and share climate information with the stakeholders;
- Prioritizing the sectoral needs and requirements for further service delivery;
- Restructuring of the organization (ongoing) for strengthening climate services delivery as a key priority;

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- Adequate database management system for better service delivery; and
- Developing proposals to mobilize resources.

6.5 Capacity Development

Group 5 Members: C. McBride (South African Weather Service, Moderator), A. Delju (Rapporteur), D. Hein-Griggs (UK Met Office), W. Thiaw (NOAA), M. Dilley (WMO), P. Parrish (WMO), and F. Lucio (GFSCO)

Capacity Building is a major cross-cutting pillar with a focus on investment in people, practices and institutions to develop capacities to minimise climate related risk and maximise opportunities from favourable climate conditions by providing decision relevant climate information. The Capacity Development Strategy recognizes that there are four types of capacity: institutional, infrastructural, procedural and human resources and must be considered collectively to achieve sustainable capacity development of the National Meteorological and Hydrological Services (NMHSs).

The Group noted that all 4 dimensions of capacity development, namely; infrastructural, institutional, procedural and human resources should be addressed in harmony to ensure the sustainability of the development. It further noted that the following elements are required for NMHSs:

- Training Institution in country
- Long-term development plan for NMHSs
- Training basic systems/ common problem solutions (stories)
- Management training (Guide, Technical Regulations, standards + Total Quality Management)

The Group raised a number of key questions that address 4 dimensions of the capacity development in terms of CST technical requirements:

a) What is an appropriate set of criteria for data, products and tool integration into CST?

- what is needed? (how to choose tools)
- what is possible? (what kind of capacity development can unleash service delivery)
- Could mark resources with a key to indicate the level of human resources, infrastructure, institutional and procedural capacity needed to implement or adopt tool/use data.
- Can classify tools based on the capacity of 5 categories of NMHSs
- Categorize the tools based on sector-specific applications

b) How can existing capabilities contribute to supporting the GFCS Priority areas?

- CCl Guidelines for NMHSs on Capacity Development for Climate Services a good resource
- Climate Service Personnel Competencies also important
- Function of training institutions in the country is an advantage
- Total quality management approach

c) How to enhance access to GFCS relevant data, products and tools at country level?

- Look to training institution in country
- Take into account the long-term development plans of NMHSs

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- Training basic systems could be possible for OPACE 1 to 3. For OPACE 4 focus on common problem and their solutions (look at stories of implementation in other countries)
- Training of management within organisations regarding what is available (Guides, Technical Regulations, standards + TQM)
- Stimulate partnerships

d) What WMO guidance, technical documentation, and/or capacity building events are necessary for successful CST implementation?

- WMO has lots of materials in terms of guides, technical regulations, …. The challenge is making these known especially to management.

e) What institutional support should be in place for sustainable CST operations?

- Metadata for data, products and tools in the CST
- Support for institutional training
- Global Campus – supports e-courses, learning opportunities and platform for promotion of learning
- Consider the Moodle platform as a starting point

Proposal for CST Training

Goal: To demonstrate the value and methods for using the CST in the process of addressing user needs and solving national and regional scale problems that can be addressed by climate services. Create a body of resources to be used for current and future learning opportunities that can be promoted by WMO for wide dissemination.

Concept: The value and proper application of the CST is best taught via use cases, or scenarios of problem solving that utilise the CST in its procedures, as appropriate for the capabilities of stakeholders. We proposed that a general process of solving climate sensitive issues can be distilled from existing and future use cases, and that this general process can be best taught through scenarios.

Proposal: Develop classroom and self-directed resources that can be applied in a wide variety of contexts in all WMO regions. These resources should show a variety of applications for the wide variety of local situations, but also be easily adaptable to new contexts. They should be easily accessible and discoverable through repository tools of the developing WMO Global Campus.

Implementation: WMO departments and outside partners and WMO trust funds pool resources to develop the resources.

Recommendations

- start with a selected number of countries to provide appropriate assistance to explore solutions to the customer needs and problems.

- develop the process and scenarios for getting stakeholders together to analyse customer needs and problems as well as relevant capacities, and assess the suitability of available tools for effectively addressing those problems. Identify events/venues for teaching the process and developing resources to assist. This problem solving process can be conducted within a country or across countries.

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7. Defining path for CST implementation

The meeting participants discussed CST implementation and addressed further relevant aspects including: CST content and technical specifications; CST promotion and outreach; CST prototype implementation and demonstration at the CSIS Workshop in Nanjing, China, 21-24 March 2017; CST deployment approach and timeframe; and CST developers network and coordination mechanism.

The session addressed specific issues, such as:

1. Redundancy or gaps in the climate service coverage observed, while reviewing the tools
2. Recommendation for choosing among more than one tool providing the same function but yield different guidance
3. Technical specification elements, users need to know for implementation of tools
4. Necessary components that CST tool package should include
5. Requirements on tools to be compliant with GPC/RCC standards, with the WMO Guide for Climatological Practices
6. Elements for CST Roadmap Implementation:
    - User Forum and Help Desk necessary content
    - Developers network and coordination mechanism
    - Prototype demonstration at the 2017 CSIS Workshop
    - Promotion and outreach activities
    - Performance metrics
    - Deployment milestones and timeframe

The participants concluded that resources existing in public domain and identified by previous WMO technical meeting are sufficient for initial CST prototype implementation.

Furthermore, they identified a number of requirements and challenges associated with the development and use of the CST including:

- Climate data:
    - Data mining/discovery capabilities
    - Guidance on data homogeneity
- CDMS:
    - information on benchmarking quality for different systems
    - developing CDMS specifications that comply with WMO Technical Regulations, e.g. WMO-No. 1131 CDMS Specifications[5]
    - Metadata /assessment/criteria for selection from multitude of tools
- Climate monitoring software and tools:
    - Guidance for evaluating tools
        - Different results
        - Different Tools
        - Reconciling different outcomes – e.g., predictions, projections, impacts, etc.
    - Framework for selecting tools:
        - National levels/regional aspects
        - Case by case applications
    - Expect-practitioner judgement

[5] http://library.wmo.int/pmb_ged/wmo_1131_en.pdf

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- Drawing on existing efforts
  - What can be learned
  - Climate services model selection and evaluation
- User perspectives
  - "New" knowledge sharing practices
  - Evolution of user requirements
  - Emerging events
  - Evaluating usefulness of tools

The meeting identified the NMHS's staff and affiliates from all countries as primary CST users. Although immediate CST beneficiaries are NMHSs from GFCS priority countries, all WMO Members should be able to take advantages of CST resources.

The participants agreed on the need to consider the evolution of users' requirements including short term analysis of climate change trends. They also agreed that users should be informed of the way CST output may be used.

The following recommendations were made on:

(1) CST content and specifications

Information on technical specifications for the tools should include the following components:

- Capacity to use and/or implement CST
  - Resources
  - Enabling skills/capabilities (pre-requisites)
  - IT requirement for operating systems
  - Guidance similar to CDMS specifications
  - How to start with new tools [include a chapter from WMO 1131]
- OPACE5 guidance on infrastructural and institutional needs
- Tools' input specification and description of outputs
- What the tool is and is not
- Spatial and temporal domains

(2) Implementation of the CST prototype

The participants converged on a short-term approach, whereby **existing data, tools and products will be integrated into a prototype CST that will be demonstrated at the International CSIS Workshop** in Nanjing, China, 21-24 March 2017.

This prototype may be tested in few pilot countries, e.g. the GFCS Priority countries (Burkina Faso, Bhutan, Colombia, Dominica, Moldova, Papua New Guinea, Peru, Tanzania).

The participants agreed to identify the resources, responsibilities and risks that the developers could assume, and contributions to be made by the CSIS community. Furthermore, the participants noted the **importance of bearing in mind the user requirements identified by Group 4, User Interface** (ref 6.4, above).

CST developers network and coordination mechanism

The participants defined a process for coordination and sustained development. **Obtaining institutional commitment from the developers' home institutions** and e**stablishing developers' network is critical** for sharing resources, distributing responsibilities, and minimizing risks of CST implementation. This stage also needs to

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consider process of accreditation – a defined clear goal, which progress could be evaluated.

CST should serve as a platform for developers to communicate and coordinate theirs resources. CST also should provide mapping features using criteria defined by developers and users.

The CST resources coordination should include process of interaction between individual toolkits and CSIS. The developers of CST resources should be aware of what already exist in the GFCS priority countries both from WMO and non-WMO sources. To usefully demonstrate the CST at country level CST should include recommendation for climate services development priorities for these countries.

(3) Next steps towards CST implementation

Some good tools have not been identified in the identified set of existing tools. It was, therefore, recommended to **send a letter for WMO country Members seeking contribution of their resources to the CST**.

A general recommendation is to **develop a White Paper on Coordination Process for CST Resources, preferably drafted prior to 2017 March Meeting**.

Summary of Recommendations:

- *Potential CST resources, reviewed during the meeting, are sufficient for initial CST prototype implementation targeting NMHSs as primary users*
- *As a fast-track all existing data, tools and products will be integrated into a prototype CST that will be demonstrated at the International CSIS Workshop in Nanjing, China, 21-24 March 2017*
- *A letter for WMO Secretariat to Member countries to be sent, seeking contribution of their resources to the CST*
- *It is critical to establishing developers' network and obtain institutional commitment from the developers' home institutions*
- *The CST implementation should include demonstration of existing resources through an online portal.*
- *The resources should be accompanied by guidance, technical specifications, training modules, and a reference to technical experts.*
- *CST prototype implementation will use existing WMO guidance on climate services standards and OPACEs recommendations for specific climate services aspects.*
- *The CST performance metrics should include clear goals for near-, medium- and long-term development of climate services at country level.*
- *WMO Secretariat and ICT CSIS should facilitate development of a White paper of Coordination Process for CST Resources preferably prior to March meeting.*

8. Towards global infrastructure for CSIS implementation

The meeting participants discussed opportunities and constraints associated with making GFCS-relevant data, products and tools accessible in a structured way. Mr Maxx Dilley led a talk on CSIS architecture and the role of CSIS within the GFCS vision, where he noted that CSIS is an operational system that develops, generates and distributes a wide range of climate information products and services to inform complex decision-making processes across a wide range of climate-sensitive applications (ref: Annex IV: CSIS

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Schematic). Mr Dilley observed that the CSIS architecture results from the following continuum:

Tools → data → tools → products

Mr Dilley presented the Results Framework for WMO Contributions to the GFCS (Ref: EC-68, Decision 16)[6], country-focused results-based framework and mechanism for WMO contributions to the GFCS that addresses the key requirements. For this purpose, Mr Dilley proposed the following strategy, both in the near- term (2017) and over a longer time frame (2017-2019):

Key Requirements	Short-term Actions (2017)	Longer-term Actions (2017-2019)
System architecture: structured access to data, tools and products (GPCLRFs/WDCs, RCCS, NMHSs)	Compile immediately available resources (CST prototype)	Develop plan to consolidate CSIS system architecture (e.g. through WIS and GDPFS) and put CST on path of long-term continuous enhancement
Physical access: at country level and regional level	Provide immediate access to priority data, tools, and products in selected countries	Identify means for providing full access to priority data, tools, and products on a widespread basis
Capacity development: at country and regional level	Meet immediate needs in selected countries, case by case	Develop plan for how to systematically meet such needs on a widespread basis

Participants agreed to focus initial efforts on the 8 GFCS priority countries (Burkina Faso, Bhutan, Colombia, Dominica, Moldova, Papua New Guinea, Peru, Tanzania); to engage with the relevant RCCs to ensure sustainability; and to collect user feedback on the CST.

9. Planning for International CSIS Workshop in March 2017

The meeting provided recommendations for planned WMO International Workshop on Climate Services Information System Operations and Coordination to be held in Nanjing, China, during March 21 – 24, 2017. The meeting recommended CSIS 3D (Definition, Development, and Demonstration) in near- and longer- term future should be the central pieces of discussions.

The meeting identified the **following groups as potential workshop participants**:

- GFCS priority countries
- RCCs/RCOFs
- SMEs on the CST and Tools
- Experts from all CCl OPACEs
- WMO staff

[6] https://docs.google.com/document/d/18-8K2DBscl8La8ZHL5-swOt3lRPaUHD4rXWjvhbp4BI/edit; https://drive.google.com/file/d/0B8DhC1GSWSmxaldZYVBJZW5UQU0/view

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The meeting discussion included reservations related to CST prototype to be provided to participants well in advance of the Workshop, and ready for demonstration at the March Workshop.

It was proposed to **determine countries capacities/requirements** through:

- Countries to complete a questionnaire on the CST prototype/their requirements from such a system prior to the Workshop;
- An expert mentor assigned for each country, to assist a designated country representative in preparing for the Workshop; and
- GFCSO/WMO Secretariat to make available outcomes of GFCS national consultations and other inventories of countries' capacities.

The meeting recommended **the following agenda items**:

- Presentations from the countries on existing climate services including question on climate services' needs (template to be provided)
- Example of best case studies of climate services at national level
- CST Demonstration (initial prototype should be made available to NMHSs prior to meeting) as the central topic of the discussions
- Demonstration of tool examples for specific climate service
- Discussion on how various tools can interact and work together at a country level
- Approaches for CST operationalization
- Guidance on institutional capabilities
- Development of climate services case studies in GFCS priority countries
- Process for provision of mentor guidance on CSIS implementation to the countries

Workshop outputs should include:

- Development/identification of solutions to immediately address needs specified by Workshop participants; and

- Outline of long-term plans for systematically addressing those needs and similar needs on a widespread basis (i.e. for CSIS implementation).

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Acronyms

APCC	Asia-Pacific Economic Cooperation Climate Center
C3S	Copernicus Climate Change Service
CAgM	Commission for Agricultural Meteorology
CCl	Commission for Climatology
CDMS	Climate Data Management Systems
CDS	Climate Data Store
Cg	World Meteorological Congress
CHy	Commission for Hydrology
CLIK	Climate Information Toolkit
CLIPS	Climate Information and Prediction Services
CMIP	Coupled Model Intercomparison Project
CM SAF	Satellite Application Facility on Climate Monitoring
CORDEX	Coordinated Regional Downscaling Experiment
CPC	Climate Prediction Center
CPT	Climate Predictability Tool
CPTEC	Center for Weather Forecasts and Climate Studies
CRU	Climatic Research Unit
CST	Climate Services Toolkit
CSIS	Climate Services Information System
DCPC	Data Collection or Production Centre
DPFS	Data Processing and Forecasting Systems
ECA&D	European Climate Assessment & Dataset
ECMWF	European Centre for Medium-Range Weather Forecasts
EC	Executive Council
ECV	Essential Climate Variable
ENACTS	Enhancing National Climate Services
EOF	Empirical Orthogonal Function
ESG	Earth System Grid
ETCCDI	Expert Team on Climate Change Detection and Indices
ET-CDMS	Expert Team on Climate Data Management Systems
ET-NCMP	Expert Team on National Climate Monitoring Products
ET-SCI	Expert Team on Sector-specific Climate Indices
EUMETSAT	European Organization for the Exploitation of Meteorological Satellites
GCOS	Global Climate Observing System
GDPFS	Global Data Processing and Forecasting Systems
GEOSS	Global Earth Observation System of Systems
GFCS	Global Framework for Climate Services
GISC	Global Information System Centre
GPCLRF	Global Producing Centre for Long-Range Forecasts
IBCS	Intergovernmental Board on Climate Services
ICA&D	International Climate Assessment & Dataset
ICT-CSIS	Implementation Coordination Team on the Climate Services Information System
IMD	India Meteorological Department
INPE	National Institute for Space Research
IPCC	Intergovernmental Panel on Climate Change
IRI	International Research Institute for Climate and Society
iTacs	Interactive Tool for Analysis of the Climate System
JMA	Japan Meteorological Agency
KNMI	The Royal Netherlands Meteorological Institute
LACA&D	Latin America Climate Assessment & Dataset
LC-LRFMME	Lead Center for Long-Range Forecast Multi-Model Ensemble
LC-SVSLRF	Lead Centre for Standard Verification System of Long-Range Forecasts
MME	Multi-Model Ensemble
MSLP	Mean Sea-Level Pressure
NC	National Centre
NCMP	National Climate Monitoring Products
NMC	National Meteorological Centre
NMHS	National Meteorological and Hydrological Services
NCOF	National Climate Outlook Forum
NFCS	National Framework for Climate Services
NOAA	National Oceanic and Atmospheric Administration

OSCAR	Observation Systems Capabilities and Review
PCIC	Pacific Climate Impacts Consortium
PRECIS	Providing Regional Climates for Impacts Studies
PREP	Partnership for Resilience and Preparedness
RCC	Regional Climate Centre
RCOF	Regional Climate Outlook Forum
RIHMI	Russian Research Institute for Hydrometeorological Information
RRR	Rolling Review of Requirements
RSMC	Regional Specialized Meteorological Centre
SACA&D	Southeast Asian Climate Assessment & Dataset
SST	Sea Surface Temperature
SVSLRF	Standard Verification System for Long-Range Forecasts
SWFDP	Severe Weather Forecasting Demonstration Project
TCC	Tokyo Climate Center
TGICA	Task Group on Data and Scenario Support for Impact and Climate Analysis
UIP	User Interface Platform
USGCRP	US Global Change Research Program
WACA&D	West African Climate Assessment & Dataset
WCAS	World Climate Applications and Services
WDC	World Data Center
WIGOS	WMO Integrated Global Observing System
WIS	WMO Information System
WMC	World Meteorological Centre
WMO	World Meteorological Organization

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Annex II: Annotated Agenda and Work Plan

VENUE: WMO Headquarters, Room C1

Tuesday, 6 December 2016

1. Opening **9:00 – 9:45**

The Developers' Meeting on the GFCS-Relevant Climate Data, Products, and Tools will open at 09:00 on December 6, 2016, in Salle C1, WMO Headquarters with opening remarks from CCl ICT-CSIS and meeting co-chairs R. Pulwarty and A. Klein Tank, and a statement by the WMO Secretary-General or his representative. A *tour de table* of self-introductions of meeting participants will follow.

2. Organization of the meeting **9:45 – 10:00**

The provisional agenda will be discussed and adopted, with the understanding that it can be amended at any time during the course of the meeting. The meeting is suggested to run from 9:00 to 17:30 every day with 30-minute health breaks at 10:30 and 15:30 and lunch breaks starting at 12:30 or 13:00 depending on the schedule. The meeting will adjourn on the Thursday, 8 December 2016, no later than 17:30.

3. Background **10:00 – 10:30**

The meeting will review relevant recent decisions of WMO and GFCS constituent bodies relevant to CSIS implementation.

M. Dilley, WMO Secretariat: *Guidance from the World Meteorological Congress, the Executive Council (EC) and the Intergovernmental Board on Climate Services (IBCS) decisions relevant to CSIS implementation.*

4. Overview of selected resources relevant to CSIS implementation 11:00 – 13:00

The meeting will be apprised of some examples of resources relevant to the implementation of CSIS. All presentations will be 20 min long including discussion (except WMO systems which will be 10 min each), followed by open discussion facilitated by M. Dilley (Director, CLPA Branch, WMO).

C. Bergeron (C3S): *Copernicus Climate Change Service (C3S)*

J. Saalmüller (EUMETSAT): *A case study for the use of toolbox and gridded climate datasets*

T. Dinku (IRI): *IRI data library and maproom*

S. Diouf/R. Kolli (WMO): *Global inventory of GFCS-relevant data and products*

Overview Presentations of relevant WMO Systems (10 min each)

- ***Harou (WMO)****: Global Data Processing and Forecasting System (GDPFS)*
- ***D. Thomas (WMO):*** *WMO Information System (WIS)*
- ***L. Riishojgaard (WMO):*** *WMO Integrated Global Observing System (WIGOS)*

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5. Climate Services Toolkit (CST): Concept and potential resources 14:00 – 17:30

An overview of the draft concept of the CST will be presented and subject matter experts will introduce selected capabilities available in the public domain which can provide potential contributions to the CST. All presentations will be 10 min plus 5 minutes for discussion and will address the following aspects related to presented data sets, products, and tools:

- Brief introduction and/or demonstration of the existing capabilities including plans for their future development and publication references
- Intended target audience including special requirements for technical background
- Utility in climate services development and delivery relevant to GFCS priority areas
- Readiness for sharing the presented data, products and tools as resources for CST integration.

5.1 Overview

R. Pulwarty (NOAA): *Importance of Climate Services Toolkit as an enabling factor for CSIS Implementation (15 min)*

M. Livezey (NOAA): *Climate Services Toolkit (CST), concept and structure; target audience; outline of a prototype (30 min)*

5.2. Climate Data (Moderator: E. Allis)

A. Sterin (WDC): *The World Data Centre Obninsk*
A. Goto (JMA): *ClimatView - a tool for viewing monthly climate data*
D. Stuber (Meteo France): *Climate Data Management Systems*
A. Klein Tank (KNMI): *International Data Rescue portal (I-DARE)*
A. Klein Tank (KNMI): *KNMI Climate Explorer*
A. Privette (USGCRP): *Partnership for Resilience and Preparedness (PREP) Data*

5.3 Climate Monitoring, Analysis, Predictions, Projections (Moderator: J.-P. Ceron)

A. Klein Tank (KNMI): *International Climate Assessment & Dataset (ICA&D)*
A. Klein Tank (KNMI): *Climate change detection indices (ETCCDI)*

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5. CST Concept and potential resources (contd.) 09:00 – 13:00

5.3 Climate Monitoring, Analysis, Predictions, Projections (Moderator: J.-P. Ceron)

W. Thiaw (NOAA): *NOAA CPC Climate Monitoring Tool*
P. Hechler (WMO): *National Climate Monitoring Products*
A. Goto (JMA): *Interactive Tool for Analysis of the Climate System (iTacs)*
S. Mason (IRI): *Climate Prediction Tool (CPT)*
Y-Y Lee (APCC): *CLIK 1.0*
H. Lee (APCC): *Climate Informatics and Application*
C. Coelho (CPTEC): *GPCLRFs*
C. Coelho (CPTEC): *EuroBrisa*
D. Hein (Met Office): *PRECIS (Regional Climate Change Projections)*
C. Goodess (CRU): *Climate change data and products (CMIP, CORDEX)*

5.4 Tools for Tailoring Climate Information (Moderator: R. Kolli)

N. Herold (UNSW)*: ClimPACT*
E. Gardiner (NOAA): *Climate Resilience Toolkit*
C. Hewitt (Met Office): *CCI Case Studies on User Interface*

5.5 Open Discussion on CST (Facilitator: M. Livezey)

6. Break-out Group Discussions on CST development 14:00 – 17:30

Participants will break into five groups for structured discussions on key aspects of the CST development, addressing a common set of key questions:

- What is an appropriate set of criteria for data, products and tools integration into CST?
- How can existing capabilities contribute to supporting the GFCS Priority areas ?
- How to enhance access to GFCS relevant data, products and tools at country level?
- What WMO guidance, technical documentation, and/or capacity building events are necessary for successful CST implementation?
- What institutional support should be in place for sustainable CST operations?

The composition of the break-out groups and assignment of the roles of moderators and rapporteurs will be facilitated by the co-chairs R. Pulwarty and A. Klein-Tank, along with a briefing on key issues to be addressed. Secretariat will assist with the locations of break-out group sessions. The moderators will facilitate the breakout discussion and summarise the discussion findings in a standard presentation that will be presented at a plenary session. The breakout groups, with participants self-identified, will be as follows

1. Climate Data Management (Moderator: D. Stuber; Rapporteur: P. Hechler)
2. Climate Monitoring and Assessment (Moderator: M. Brunet; Rapporteur: A. Soares)
3. Climate Predicitions, Projections, and Delivery Mechanisms (Moderator: J.-P. Ceron; Rapporteur: S. Diouf)
4. User Interface for Climate Adaptation and Risk Management (Moderator: R. Martinez; Rapporteur: A. Hovsepyan)
5. Capacity Development (Moderator: C. McBride; Rapporteur: A. Delju)

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6. Break-out Group Discussions on CST development (contd.) 09:00 – 10:30

Moderators: *Reports of the breakout groups (10 min each)*

Analysis of Breakout Session Inputs and open discussion (Facilitator: A.Klein-Tank)

7. Defining path for CST Implementation 11:00 – 13:00

The meeting participants will discuss elements of a road map for CST prototype implementation and address further relevant aspects including (i) CST User Forum and Help Desk, (ii) CST promotion and outreach, (iii) CST performance metrics, (iv) CST prototype demonstration at the CSIS Workshop in 2017, (v) CST deployment timeframe and (vi) CST Developers network and coordination mechanism. The discussions will be facilitated by A. Klein-Tank.

8. Towards global infrastructure for CSIS implementation 14:00 – 15:00

The meeting participants will discuss opportunities and constraints for making available GFCS-relevant data, products and tools in a structured manner.

M. Dilley (WMO): *Lead talk on WMO/GFCS Vision and Emerging Issues (15 min)*

9. Planning for International CSIS Workshop in March 2017 15:00 - 15:30

The meeting participants will discuss the concept of and preparations for the CSIS Workshop planned in March 2017; J.-P. Ceron will serve as facilitator.

10. Meeting summary and recommendations 16:00 - 16:30

The co-chairs will facilitate a brief review of the major outcomes of the meeting and formulate the recommendations.

11. Any other business 16:30 - 16:45

12. Closing 16:45 – 17:00

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Annex III: List of potential resources

CLIK
http://clik.apcc21.org/

ClimPACT2
https://github.com/ARCCSS-extremes/climpact2

ClimatView
http://ds.data.jma.go.jp/tcc/tcc/products/climate/climatview/frame.php

CMIP
http://cmip-pcmdi.llnl.gov/

C3S
https://climate.copernicus.eu/

CORDEX
http://www.cordex.org/

CPT
http://iri.columbia.edu/our-expertise/climate/tools/cpt/

ENACTS
http://iri.columbia.edu/resources/enacts/

ETCCDI
http://etccdi.pacificclimate.org/

EUMETSAT
http://www.eumetsat.int/website/home/index.html

EUMETSAT CM SAF
http://www.cmsaf.eu/EN/Home/home_node.html

EUMETSAT CM SAF Toolbox
http://www.cmsaf.eu/EN/Products/Tools/Tools.html

EUROBRISA
http://eurobrisa.cptec.inpe.br/

ICA&D
http://www.ecad.eu/icad.php

I-DARE
https://www.idare-portal.org/

IRI Climate Data Library and Map Room
https://iridl.ldeo.columbia.edu/index.html?Set-Language=en

iTacs
http://extreme.kishou.go.jp/tool/itacs-tcc2015/

KNMI Climate Explorer
https://climexp.knmi.nl/start.cgi?id=someone@somewhere

NOAA CPC Climate Monitoring Tool
http://www.cpc.ncep.noaa.gov/

PRECIS
http://www.metoffice.gov.uk/research/applied/international-development/precis

PREP
http://www.prepdata.org/

US Climate Resilience Toolkit
https://toolkit.climate.gov/

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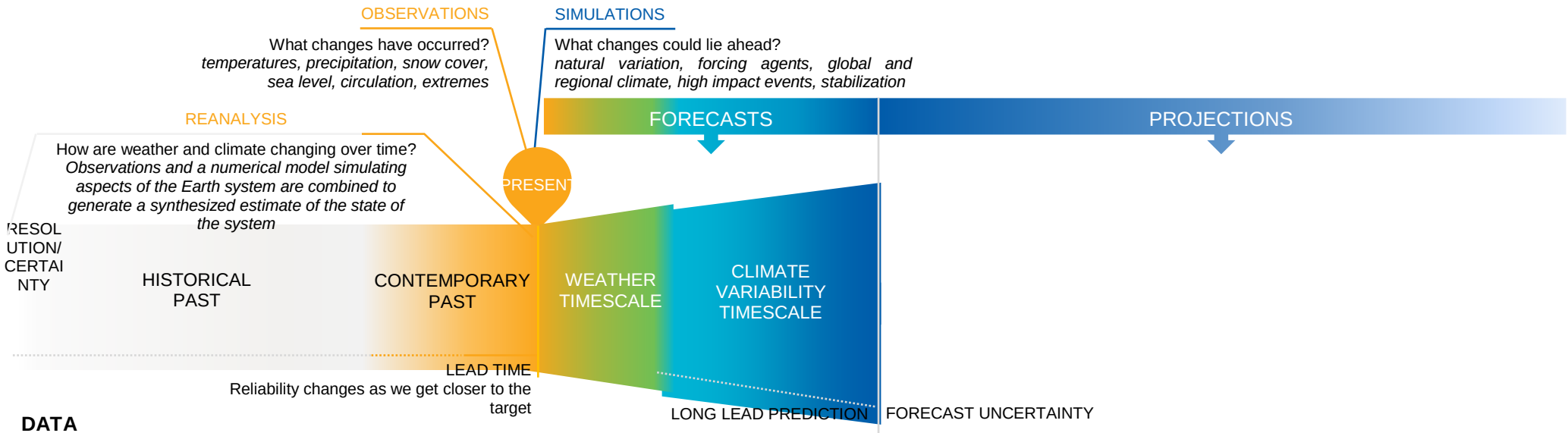
Annex IV: Climate Services Information System: Data and Products for Climate Services



DATA

Historical	Monitoring	Sub-seasonal Seasonal	Interannual to	Multi-decadal
Instrumental data - records of daily data, century-long measurements of surface temperature and precipitation **Paleoclimate and proxy data** - derived from natural sources (tree rings, ice cores, corals, and ocean and lake sediments)	Uses data from recent past and the present		Boundary conditions, Anthropogenic forcing	

PRODUCT

Climate trends, Extreme climate indices, Sector-specific climate indices, Reanalyses, Return periods of extremes, Climate Normals , World Weather Records	Climate monitoring and watch	Flash flood guidance Severe weather forecasting Tropical cyclone forecasting	Climate change indices Information on extremes	Operational projections on climate change timescales

USER INTERFACE - identification and co-production of products; validation of end-use & outcomes

TOOLKIT - facilitates operations and used typically by forecasters

TAILORED PRODUCTS FOR DECISION SUPPORT - products can either be tailored in space and time or according to the decision relevance

DECISION SUPPORT APPLICATIONS – climate services apply past climatological records, contemporary monitoring and expected future conditions to socio-economic sectors

Agriculture (informs crop choice, planting to minimizing crop failure risk), Disaster risk extreme event return periods and trends	optimize yield and identification based on	Emergency response, Disaster Risk Reduction	Contingency plans, humanitarian response, government and private infrastructure investment	Informs mitigation policy and adaptation choices Impacts on water resources, heat stress, crops, infrastructure

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References

WMO, 2011: *Commission for Climatology Task Team on CLIPS Evolution*, Final Report, World Climate Programme, World Climate Services Programme

WMO, 2014: Climate Data Management System Specifications, Version 1.0, WMO-No. 1131